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SIZE AND SHAPE OF THE HEAD AND NECK FROM BIRTH TO FOUR YEARS

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16. Abstract Three hundred children from two weeks to 48 months of age were measured to determine the size and shape of the head and neck for application to the problem of injuries and death due to head entrapment. Children were selected in ten age categories and on the basis of race and family socioeconomic factors to represent the U.S. population as closely as possible. Manual measurements using standard anthropometric measurement techniques were used to collect data on 34 dimensions of the head and neck and general body size for the full sample of 300 subjects. A ten-camera stereophotogrammetry system was used with 100 of the subjects in four of the age groups to determine the size and shape of critical head contours as well as geometric information describing the locations of anatomical landmarks used in the manual measurements.

For manual measurements, 5th, 50th, and 95th percentile values are presented in tabular form along with sample means, standard deviations, and sample minimum and maximum values in both English and metric units. In addition, scatter plots of measurement values versus subject age are presented for each measurement variable.

Graphic and tabular results of landmark coordinates and contours from stereophotogrammetric data are presented for age group averages as well as for a representative small and large subject from each of the four age groups.

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Finally, we thank all those children and parents who volunteered for this study. We hope that the information obtained through their participation will be instrumental in reducing the numbers of injuries and deaths from head/neck entrapment in the years ahead.

SUMMARY

Three hundred children from two weeks to 48 months of age were recruited and measured to determine the size and shape of the head and neck. Children were selected to obtain thirty subjects in each of ten age categories with equal numbers of males and females in each group. Subjects were also selected with regard to race and family socio-economic factors in order to represent the U.S. population as closely as possible.

Two measurement techniques were used in the data collection. Manual measurements using standard anthropometric measurement techniques were used to collect data on thirty-four dimensions of the head and neck and general body size for the full sample of three hundred subjects. A ten-camera stereophotogrammetry system was used with one hundred of the subjects in four of the age groups to determine the size and shape of critical head contours as well as geometric information describing the relative three-dimensional locations of anatomical landmarks used in the manual measurements.

For the manual measurements, 5th, 50th, and 95th percentile values were calculated for each age group. These results are presented in tabular form along with sample means, standard deviations, and sample minimum and maximum values in both English and metric units. In addition, scatter plots of measurement values versus subject age are presented for each measurement variable.

Projected film images of contrast targets on the head, neck, and torso were digitized to obtain the projected film image coordinates of these targets from which the X, Y, and Z object-space coordinates were constructed. These results were transformed to the head anatomical reference system and data for the twenty five subjects in each of four groups were averaged. Graphic and tabular results of landmark coordinates and contours are presented for these group averages as well as for a representative small and large subject from each of the four age groups.

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INTRODUCTION

In recent years, the Division of Hazard Analysis of the Consumer Product Safety Commission (CPSC) has compiled data on over 472 child accidents involving head entrapment. Of these, 341 resulted in death by strangulation due to entrapment in product structures and openings. These accidents have involved a wide range of products with openings and/or decorative cutouts which allow head entrapment with the potential for subsequent stangulation. At the time of this study, for example, child injuries and deaths due to head/neck entrapment and strangulation in expandable wooden gates and enclosures is a significant issue before the Commission. The background section which follows provides more detailed descriptions of common head entrapment injury scenarios and geometries of product openings that may be involved.

From a purely mechanical point of view, the issue of injury or death due to head/neck entrapment can be reduced to the problem of the interaction of two objects-- namely, the child's head and neck and the physical object or product that the child may encounter. The prevention of injuries and deaths due to head entrapment requires elimination of product designs that allow head entrapment. This in turn requires a knowledge of the size and shapes of childrens heads and necks so that product design criteria required to prevent entrapment can be more clearly established.

In 1975 and 1977 the University of Michigan Transportation Research Institute (UMTRI--formerly HSRI) completed two large-scale anthropometric surveys of U.S. children from birth to 18 years (Snyder et al., 1975, 1977). In these studies, ten measurements of the head and neck were obtained for children two years and older, but only three of these measurements were taken for children under two years. From these limited data, CPSC subsequently attempted to develop a headform test probe for the purpose of conducting performance tests relative to head entrapment in crib headboards. Because of the lack of data available describing the size, shape, and three-dimensional geometry of the head and neck, the CPSC's efforts in this regard only clarified the need for more complete and specialized anthropometric data to address the problems.

The purpose of the present study was to fill this need by providing the CPSC with the required information pertaining to the size, shape, and critical contours of the head and neck for children from birth to 48 months who are at greatest risk of head entrapment. These data will enable the Commission to better evaluate the potential hazards associated with various openings and/or cut-outs in children's play

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The rights, welfare, and informed consent of the volunteer subjects who participated in this study were observed under guidelines established by the U.S. Department of Health and Human Services on Protection of Human Subjects and accomplished under medical research design protocol standards approved by the Committee to Review Grants for Clinical Research and Investigation Involving Human Beings, Medical School, The Univerity of Michigan.

equipment and household products, and will also be used in the development of remedial strategies by way of standards and/or guidelines. Where applicable, improved test devices can be developed for use in compliance activities.

The remainder of this report is divided into two parts. Part I presents further information on head/neck entrapment injury scenarios and typical product geometries involved, and also describes the procedures used for manual and stereophotogrammetry data collection and analysis. Part II presents the study results which describe the size, shape, and three-dimensional geometry of the head and neck for application to evaluating the potential hazards of specific product designs. Section, figure, and table numbers throughout this report are preceded by a I or a II to indicate the part to which they belong.

PART I

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I.A. BACKGROUND

I.A.1. PRODUCT INJURY SCENARIOS

In order to better understand the problem of structural entrapment hazards to infants and children, a review of individual case reports of injuries and deaths recorded in the CPSC files and medical literature was conducted. Much of this information is contained in a report by Miles, Rutherford, and Coonley (1983) which documents over 472 cases of head/neck entrapment related injuries occuring over a period of ten years and resulting in 341 fatalities. The following sections summarize typical product related head/neck entrapment injury situations according to product categories.

Beds and Mattresses

Temporary guardrails are attached to the sides of regular-sized beds so that small children will not accidentally roll out of the bed and fall to the floor. A hazard exists, however, if the child is small enough to slide through the horizontal opening between the guardrails. If the child's body is able to slide through the opening, but the head will not pass between the bars, there is a possibility of hanging. Entrapment can occur with the face downward, pressed into the mattress or bed side, or with the face upwards and the chin trapped on the edge of the guardrail. Most serious injuries have occurred when children slip through the temporary guardrails feet first.

Entrapment may also occur when an infant rolls off the edge of an adult bed that is adjacent to a wall, the head becoming trapped between the mattress or bed frame and the wall. Mattresses are a particular hazard when they do not adequately fit the bed frame and allow space for an infant to become wedged between the mattress and framework of the bed. In such cases, a plastic sheet over the mattress may obstruct the child's nose and mouth causing suffocation, or the position of the neck may be such as to compress the trachea with the same result.

Cribs

Considerable attention and regulatory effort has been devoted to the entrapment hazards associated with cribs, yet cribs continue to be associated with injuries and deaths. Since the enactment of new regulations on crib slat spacing, there have been no reported cases of head entrapment between the slats of a newly-manufactured crib that complies with the regulations. With older cribs, many of which are still in use, an infant can slide feet first through the opening between slats and be "hanged" when the head is unable to clear the opening between slats. In some circumstances, the head can be wedged face down against the mattress producing suffocation or compression of the trachea.

Another concern with cribs is headboard "cut-outs". If the cut-out is open to one edge of the headboard (particularly the top) so as to form a notch, it is possible, depending on the dimensions of the notch, for a child to slide the neck into the opening and, with loss of footing, be unable to extract the head and thereby strangle.

Entrapment has also occurred in cribs with broken, defective, or missing parts. In several cases, the child's neck became entraped in a V-shaped vertical opening created when the upper end of a guide rod became detached from the bed. In other instances, children have stangled when cribs with defective hardware came apart so that the mattress support dropped at one corner and the child was trapped between the mattress support and the crib.

There have been a number of cases in which a child was entrapped between a small mattress and the crib sides. This usually involved flexion of the neck or compression of the trachea and, perhaps, obstruction of the nose and mouth by a plastic sheet. Children have been found with the neck and head caught between the mattress and the side of the bed or wedged between the mattress and the headboard. As with full-sized beds, there have been some cases in which children have become wedged between a bed side and the adjacent wall or piece of furniture. For example, one child died after being caught between the crib rail and an adjacent dresser.

Mesh-sided Cribs and Playpens

There are numerous cases reported of infants becoming entrapped and dying in the loose mesh pocket formed by the side of a playpen that was lowered. In addition, there have been circumstances in which the mattress pad and bottom of the playpen separated, with the victim caught between the mesh and the floor or the displaced bottom of the playpen.

Garage Doors

Garage doors and electrically-operated doors pose entrapment hazards. A child, in trying to slide under a closing garage door, becomes caught between the door and the garage floor. This usually occurs with the child facing downward. Pressure of the door causes injuries to the child's head or asphyxiation because of trachael, neck, or chest compression.

Hinged Lids on Toy Chests and Toilets

Entrapment can occur with toy chests that have hinged lids. As a child leans into a toy chest to get a toy, the upright lid may fall and hit the back of the child's head. This can result in head injury caused by the blow to the head or injury through compression of the neck onto the edge of the toy chest. The lid may come to rest on the back of the child's head and if the child has lost his/her balance, the entire body weight may be supported by the neck with the head trapped inside the toy chest. If there is a lip on the lid of the toy chest, this may increase the potential for head entrapment.

Injury mechanisms associated with toilet seats are similar to those described with toy chests. A child leaning over the front of the commode can be struck on the back of the head by a falling seat lid. Compression of the neck against the commode or seat rim can occur from continued pressure of the lid on the back of the head.

Play Equipment and Furniture

There have been deaths from strangulation when a child's head and neck became entrapped between the steps of a ladder which was part of the play equipment. This has usually occurred when the child placed the head between the stair openings and was unable to extract it or lost footing. Several cases have been reported in which a child had the head entrapped within a dresser drawer. There are also documented cases of children getting the head trapped in the openings of adult-sized recliner chairs, changing tables, and strollers.

Safety Gates and Enclosures

Although frequently used to keep children from falling down flights of stairs or to keep children confined in the yard, these devices can pose a serious hazard for two reasons. First, children, trying to climb over the product, may slip and fall so that the head and neck get caught in one of the "Vee" shaped openings along the top edge. The hazard appears to be related to the angles made by sides of the "Vee". Second, children trying to climb through the diamond-shaped openings may get their head through but then cannot get it back out. The neck may subsequently undergo compression due to the body weight pressing it against the frame of the product.

I.A.2. PRODUCT GEOMETRIES ASSOCIATED WITH HEAD/NECK ENTRAPMENT

As noted in the introduction to this report, the problem of head/neck entrapment reduces to a problem of solid geometry in which one object, the childs head, becomes caught or entrapped in another object, the product. In evaluating a potential hazard, the size and shape of both objects must be considered. The following discussion describes and categorizes product shapes commonly involved in head/neck entrapment. Examples of products with these openings are given and illustrations of the geometric shapes are shown in Figure I.1.

Horizontal Opening

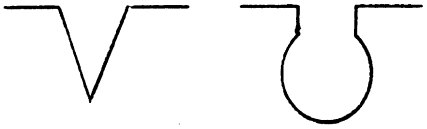
In this geometry, the important feature is a pair of parallel edges which produce an opening that is much wider than it is tall. The important dimension is the narrow spacing between the long horizontal edges while the distance between the vertical edges is so large that it plays no real part in the entrapment. This geometry can be further subdivided according to the rigidity of the edges:

a. two rigid edges
b. one rigid and one compressible edge
c. two compressible edges

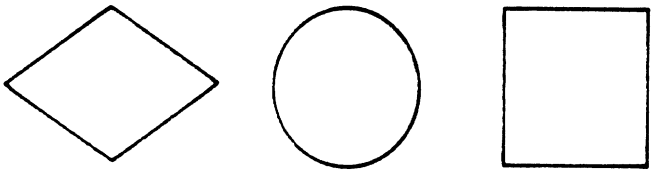
Examples of the first group are the horizontal openings formed between the steel bars in a guardrail on a youth bed, the openings between the horizontal slats on the back of some rocking chairs, and the openings between ladder rungs. Examples of the second group are the openings between bed structures (e.g. headboard, crib frame) and the mattress, and the opening between a wooden chair back and the

Horizontal Parallel Opening

Vertical Parallel Opening



Vee or Cut-Out



Encircling Opening

Figure 1.1 Geometries of product openings involved in head/neck entrapment.

upholstered seat. An example of the third group is the opening between two mattresses when two beds are pushed side by side.

A special case of the horizontal parallel opening is where one or both edges may move. Examples of this include a garage door moving downward with the potential for entraping an individual against the floor, or a dresser drawer being closed by a sibling with a child's head inside.

Vertical Opening

This geometry consists of a vertical slot bounded by long vertical edges that are fairly close together. In this circumstance, the vertical height may play some part in an injury since the child may become entrapped by falling from a higher point in the slot to a lower point, thereby impacting the lower edge with some force. This category can also be subdivided, depending upon whether the edges are rigid or compressible, or a combination of both. Examples of this geometry include the slats in infant cribs, vertical slats in chair backs, the vertical bars in playpens, and banister supports.

Cut-outs and Vee Shapes

Cutouts and Vee shapes are characterized by an incomplete enclosure whereby there is access to the opening at one edge of the structure, usually at the top of the product. Examples are the Vee-shaped openings formed at the top of expandable gates and the decorative cut-outs at the top of the headboards on cribs. Children attempting to climb over or up on these products may get their neck into the opening. Depending on the size and depth of the opening, it may not be possible for the child to remove his/her head from the enclosure except by lifting the neck out in the same way it entered. If the child loses his/her footing, or is unable to figure out how to lift the neck out, the entrapment can lead to subsequent serious injury and death through strangulation. For the Vee-shaped opening, the angle of the Vee may be an important factor in determining entrapment potential.

Encircling Opening

This type of opening is characterized by a completely enclosed opening such that the horizontal and vertical dimensions are similar. Such openings may be square, circular, or diamond-shaped as in the gates and enclosures described above. Obviously, for entrapment to occur in such an opening, the size of the opening must allow the head to pass through. This may be possible as a tight squeeze whereby the head is forced into an opening but then can't be brought out as easily. Also, the head may pass through the opening by a specific orientation of the head relative to the geometry of the opening. If the child cannot reproduce this same orientation to get the head back out, the child may panic with subsequent injury.

In these situations, the head may be injured by the edges of the enclosure, but the more serious hazard is injury and compression to the neck that can result in strangulation and death. The latter hazard is of particular concern if the opening is up high on the product so that the

child has to climb or reach to get the head into it. As with the cut-outs and Vees, loss of footing can lead to head entrapment with the weight of the body producing downward force on the neck.

I.B. METHODS AND PROCEDURES

To accomplish the project goals, two measurement techniques were utilized. The first, which will be referred to as manual measurements, is essentially an expansion of the head/neck anthropometric measurement set of the previous CPSC studies with particular emphasis on measurements that more completely describe the size of the head and neck. The second technique, known as stereophotogrammetry, was used to collect information on spatial relationships of head and neck landmarks used to define the manual measurements and to collect head contour and shape information. The following sections describe the sampling stategies and experimental procedures involved in collecting and processing the data for these two approaches.

I.B.1. SAMPLING STRATEGY AND SUBJECT RECRUITMENT

From the beginning, it was decided to collect data on three hundred infants and children representing the U.S. population ethnic distribution of children from birth to 48 months as well as the U.S. family socio-economic distribution. Subjects would be recruited equally in ten age groups covering the age ranges listed in Table I.1, with each age group containing equal numbers of males and females. As indicated, the first age group spans four months, the next three age groups span three month intervals, while the older groups span six-month intervals. For purposes of age grouping, a month was considered equal to exactly thirty days. As an example of the age interval definition used in this study, a child was placed in the 4-to-6-month age group if, at the date of measurement, he/she had reached the fourth month (i.e., 120 days old) but had not yet reached the 7th month (i.e., less than 210 days old).

Due to the significantly greater time and cost involved with the collection and processing of shape and contour data, the sampling plan established for stereophotogrammetry data collection called for only one hundred subjects (i.e., one-third of the total sample) to be selected equally in four of the ten groups distributed over the age range of the full sample. Also, because the collection of data by stereophotogrammetry required that the subjects be able to sit up in a chair, the 4-to-6-month age group was the youngest group for which these data could be collected. The other age groups selected for stereophotogrammetry measurements included 13-to-18 months, 25-to-30 months, and 43-to-48 months. This sampling strategy is summarized in Table I.2.

Subjects were recruited for measurements using several approaches, including advertisements in local newspapers, postings on shopping mall boards, review of birth announcements in newspaper microfilms, and general word-of-mouth communication of the need for young children. Parents responding to these recruitment methods were informed of the nature and purpose of the study and were questioned with regard to the birth date, sex, and race of their children and with regard to socio-economic factors of family income and parents educational level. The demographic information was entered into a data base file from which subjects would later be chosen for measurement. While many families had more than one child who qualified for the study, only one child per family was subsequently selected for participation and measurement.

Table I.1

Sampling Strategy for Manual Measurements

Group No.	Age Range (months)	Desired Sample Size
1	0 - 3	30
2	4 - 6	30
3	7 - 9	30
4	10 - 12	30
5	13 - 18	30
6	19 - 24	30
7	25 - 30	30
8	31 - 36	30
9	37 - 42	30
10	43 - 48	30
	Total Sample Size =	300

Table I.2

Sampling Strategy for Photogrammetry

Group No.	Age Range (months)	Desired Sample Size
2	4 - 6	25
5	13 - 18	25
7	25 - 30	25
10	43 - 48	25
	Total Sample Size =	100

I.B.2. MANUAL MEASUREMENTS

The measurements listed in Table I.3 were taken for each subject to more completely describe the sizes of children's heads and necks. In addition to new measurements, this list includes fourteen measurements taken previously for children two through eighteen years of age and seven measurements taken previously for children under two years (Snyder et al., 1977). A description, illustration, and photograph showing where and how each measurement was taken is given along with the measurement results by variable in section II.B of this report.

Figures I.2 through I.5 illustrate sample measurements being taken on one subject. Head Circumference was marked by placing a thin band around the head. This was then used to take other measurements involving the location of Head Circumference (e.g., Head Breadth at Circumference, Top-of-Head to Head Circumference Distance). An attempt was made to take measurements in a consistent order that minimized the number of times instruments had to be interchanged or modified (e.g., change the anthropometer blades from points to paddles), but often the measurement order had to be altered to accommodate the moods and activities of smaller children and infants.

It had originally been planned to use the computerized anthropometric measurement system developed in the previous CPSC-sponsored studies to record measurement values automatically. This approach was abandoned after some preliminary measurement sessions, however, in favor of traditional data collection and recording techniques using standard anthropometers, calipers, and measuring tapes. The automated system offers distinct advantages for large sample sizes when the measurements are taken in many different locations where environmental conditions increase the likelihood of human error. In the present study, however, the difficulty of measuring accurately on the heads and necks of squirming infants and toddlers was the primary concern, and the electrical readout instruments, with dangling electrical cables, proved to be a greater source of aggravation than benefit. Also, the measurement assistant was needed primarily to distract and/or hold each subject in position, making interaction with a keyboard and video monitor difficult.

Measurement values were read aloud by the measurer and recorded on a data sheet by the assistant, who repeated the measurement value as it was written down. These values were later keypunched into a computer file on the Michigan Terminal Computer System along with coded demographic results. A package of statistical programs was then used to edit the data. Subject age in months was calculated from the measurement date and the birth date and a categorical variable denoting the subject group number (i.e., from 1 to 10) was created, based on the age-in-months variable and the group age ranges shown in Table I.1. This new variable for "Subject Group Number" was used to sort the data and compile results by age group.

Histograms, scatter plots, sample statistics, and printouts of measurement values by individual subject were generated and examined for "bad" data points. Where "outliers" or questionable data values were found, the original data sheets were consulted in the hope of finding

Table I.3

List of Anthropometric Measurements

+ *	1.	Weight
+ *	2.	Stature
+ *	3.	Sitting Height
+ *	4.	Maximum Head Breadth
+ *	5.	Head Circumference
	6.	Head Breadth at Circumference
+ *	7.	Head Length
*	8.	Head Height
	9.	Tip-of-Chin to Back-of-Head Distance
	10.	Tip-of-Chin to Back-of-Head Circumference
*	11.	Lower Face Height
*	12.	Maximum Face Breadth
	13.	Maximum Jaw Breadth
*	14.	Head Breadth at Ear Openings
	15.	Ear to Head/Neck Junction Distance
	16.	Ear to Tip-of-Chin Distance
*	17.	Ear to Top-of-Head Distance
	18.	Top-of-Head to Back-of-Head Distance
	19.	Top-of-Head to Head Circumference Distance
	20.	Back-of-Head to Head-Breadth Point Distance
	21.	Forehead to Back-of-Head Arc Length
	22.	Forehead to Head/Neck Junction Arc Length
	23.	Ear-to-Ear Over Top-of-Head Arc Length
	24.	Ear-to-Ear Under Chin Arc Length
	25.	Ear-to-Ear Around Back-of-Head Arc Length
*	26.	Neck Circumference
*	27.	Neck Breadth
	28.	Neck Depth
+ *	29.	Shoulder Breadth
	30.	Shoulder Circumference
	31.	Shoulder Depth
	32.	Torso Depth
	33.	Top-of-Shoulder to Top-of-Head Distance
	34.	Shoulder-Circumference-Point to Top-of-Head Distance

* measurements taken in 1977 CPSC study for 2 - 18 year olds
+ measurements taken in 1977 CPSC study for 0 - 2 year olds

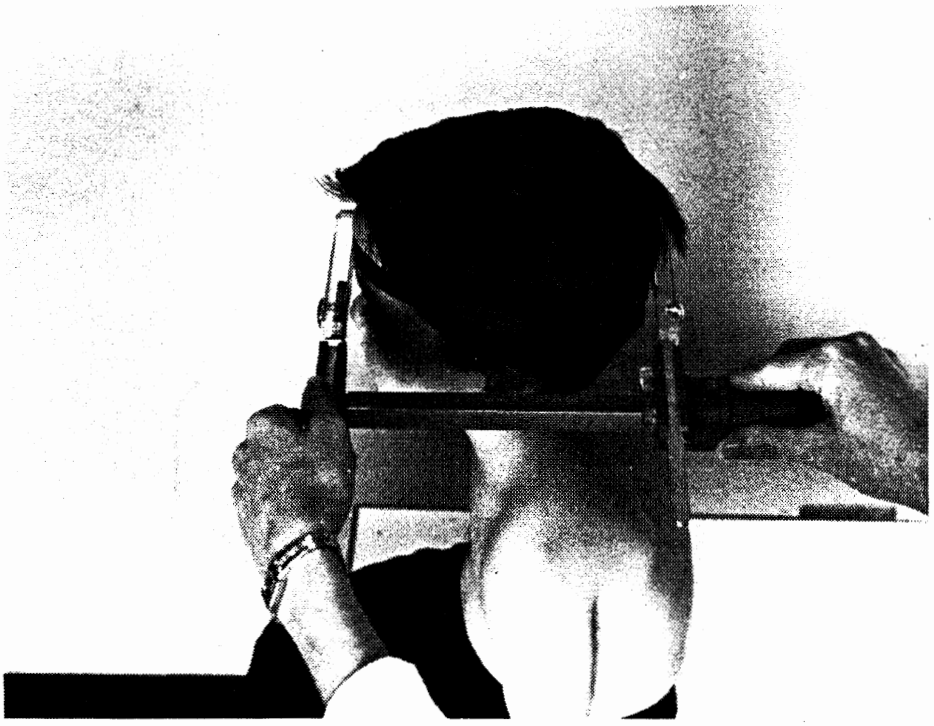


Figure 1.2. Measurement of HEAD LENGTH. Note placement of band at location of HEAD CIRCUMFERENCE.

Figure 1.3. Measurement of FOREHEAD TO BACK-OF-HEAD ARC length.

Figure 1.4. Measurement of LOWER FACE HEIGHT.

Figure 1.5. Measurement of MAXIMUM FACE BREADTH.

the source of the error. Bad data points which could not be traced to a known source of error and thereby corrected were deleted from the sample.

For each measurement variable, the sample statistics were computed for the thirty subjects in each of the ten age groups. Tables of the measurement results are presented in both metric and English units and include the sample mean and standard deviation, the sample minimum and maximum values, and the computed 5th, 50th, and 95th percentile values. Section II.B.1 presents the results by measurement variable and includes scatter plots of the individual measurement values versus subject age. Section II.B.2 presents tabular results for all measurements by age group.

I.B.3. STEREOPHOTOGRAMMETRY DATA COLLECTION PROCEDURES

I.B.3.a. Landmarks and Contours

The technique of stereophotogrammetry was used to collect information describing the shapes of critical head contours and the three-dimensional locations of anatomical landmarks used in the manual measurements (i.e., to describe the spatial relationships of the manual measurements). As described in the next section, the stereophotogrammetry procedures used require that identifiable points are "seen" in two or more camera views. It was therefore necessary to place contrast targets on each subject to identify critical contours and landmarks before taking photographs.

The set of landmarks and contours listed in Table I.4 and illustrated in Figure I.6 was established to accomplish the goals of the study. The head and neck landmarks are points used in the manual measurements and are further defined and illustrated in Table II.3 and Figure II.2 of this report. The shoulder and torso landmarks were included to describe the head and neck geometry relative to the body. The six head contours or arcs, listed at the bottom of Table I.4, were chosen to describe the size, shapes, and relative locations of different regions of the head with respect to the problem of head entrapment. These contours include the following:

1. TOP-OF-HEAD MIDLINE ARC - A midline contour running from just above the nose (sellion), over the top of the head and down the back of the head to the head/neck junction. This contour includes the arc lengths of Forehead to Back-of-Head and Forehead-to-Head/Neck Junction (measurements #21 and #22 in Table I.3) taken manually.

2. HEAD CIRCUMFERENCE ARC - A head circumference contour running around the head above the ears in a plane connecting the furthest forward point on the forehead (glabella) to the furthest rearward point on the back of the head (opisthocranion). This contour corresponds to the manual measurement of Head Circumference (measurement #5 in Table I.3).

Table I.4

Surface Landmarks and Contours
Targeted for Stereophotogrammetry

No.	Name	Explanation and/or Comment
1	Left Tragion	Left Ear Notch
2	Right Tragion	Right Ear Notch
3	Left Infraorbitale	Left lower rim of eye socket
4	Right Infraorbitale	Right lower rim of eye socket
5	Sellion	Indentation above nose
6	Glabella	Front of Forehead
7	Vertex	Top of head
8	Opisthocranion	Back of head
9	Menton	Tip of chin
10	Head/Neck Junction	Bottom of skull at back
11	Left Zygion	Left upper cheek
12	Right Zygion	Right upper cheek
13	Left Gonion	Left lower back of jaw
14	Right Gonion	Right lower back of jaw
15	Left Maximum Head Brdth Point	-----
16	Right Maximum Head Brdth Point	-----
17	Left Head Brdth @ Circum. Point	-----
18	Anterior Neck Depth Point	Front of Neck
19	Suprasternale	Top of sternum (breast bone)
20	Anterior Torso #1	Front of torso point #1
21	Anterior Torso #2	Front of torso point #2
22	Anterior torso Depth Point	Front of torso at depth
23	Left Neck Breadth Point	Left side of neck
24	Right Neck Breadth Point	Right side of neck
25	Left Shoulder #1	-----
26	Left Shoulder #2	-----
27	Left Top of Shoulder	-----
28	Right Top of Shoulder	-----
29	Left Shoulder #3	-----
30	Left Shoulder Circum. Point	-----
31	Right shoulder Circum. Point	-----
32	Posterior Neck Depth	Back of Neck
33	Cervicale (C_7)	Process of 7th cervical vertebra
34	Posterior Torso Point #1	Back of torso #1
35	Posterior Torso Point #2	Back of torso #2
36	Posterior Torso Depth Point	Back of torso at depth
	Contours	
1	Top-of-Head Midline Arc	
2	Head Circumference Arc	
3	Ear-to-Ear over Top-of-Head Arc	see text for description
4	Ear-to-Ear thru Tip-of-Chin Arc	
5	Ear-to-Ear Under Chin Arc	
6	Ear-to-Ear Around Back-of-Head Arc	

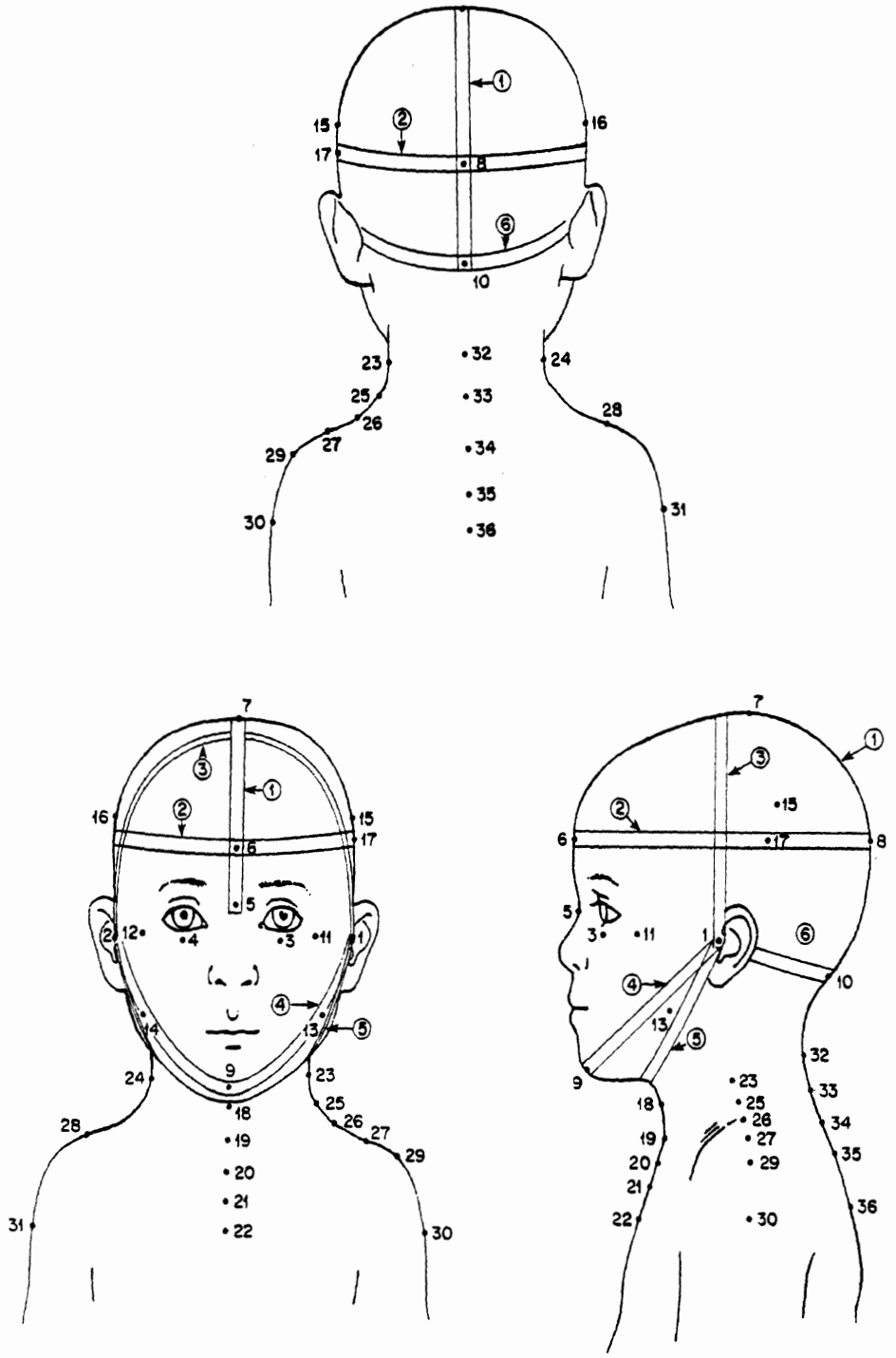


Figure 1.6. Front, top, and side illustrations of targeted landmarks and contours. Numbers correspond to Table 1.4. Circled numbers indicate contours.

3. EAR-TO-EAR OVER TOP OF HEAD ARC - A contour connecting the two ears (tragions) across the top of the head. This contour corresponds to the manual measurement of the same name (measurement #23 in Table 1.3).

4. EAR-TO-EAR UNDER CHIN ARC - A contour connecting the two ears (tragions) under the chin. This contour corresponds to the manual measurement of the same name (measurement #24 in Table 1.3).

5. EAR-TO-EAR THROUGH TIP-OF-CHIN ARC - A contour connecting the two ears (tragions) through the tip of the chin (menton).

6. BACK-OF-HEAD ARC - A contour from the back of one ear to the back of the other ear through the head/neck junction. This contour corresponds approximately to the arc portion of the manual measurement of the same name (measurement #25 in Table 1.3).

It will be noted that the combination of contours #3 and #4 give an approximation to a head circumference measurement taken in a frontal plane just forward of the ears and under the chin. Also, it should be noted that contours #2 through #5 are actually half-head contours for data collection purposes as will be described below. The complete head contours were obtained after data analysis and editing of the half-head contours by assigning both positive and negative Y-coordinate values (i.e., side to side) to contour targets not on the midline.

I.B.3.b. Theory of Stereophotogrammetry

Stereophotogrammetry is a procedure by which the geometric principles of optics are used to obtain precise coordinate information of visible targets that can be photographed in two or more cameras. As shown in Figure 1.7, when an object is photographed, the three dimensions of the object are translated into two dimensions of the image on the film. Thus, any definable point or target on the object can be located with respect to a defined object-space reference system by the three coordinate dimensions X, Y, and Z, but will have only two coordinates in the film plane.

In this study, film image coordinates (actually the projected image coordinates) are referred to as U and V coordinates. The values of U and V for any target or point depend on the location of both the target and the film relative to the camera lens and also on the properties of the lens. As illustrated in Figure 1.8, if identifiable points on an object can be photographed in two or more cameras whose lens properties and geometries are known or calibrated, then the two sets of image or U,V coordinates can be used to geometrically (i.e., mathematically) reconstruct the X, Y, and Z coordinates of these points in the object space.

The particular stereophotogrammetry technique used in this study, known as direct linear transformation or DLT (Abdel et al., 1971; Alem et al., 1978), was used to determine the laboratory X, Y, and Z coordinates of targets placed on the head, neck, and upper torso of infants and children. Collectively, the coordinates of these targets

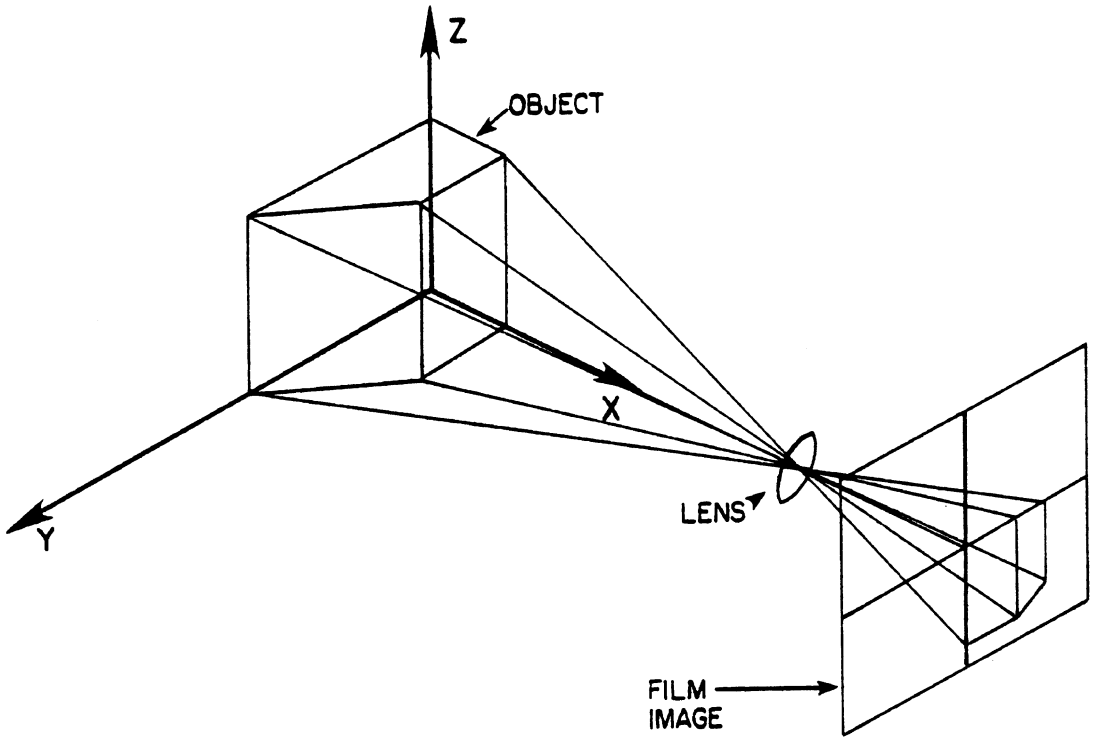


Figure 1.7. Geometric relation between three-dimensional object space and two-dimensional film image space.

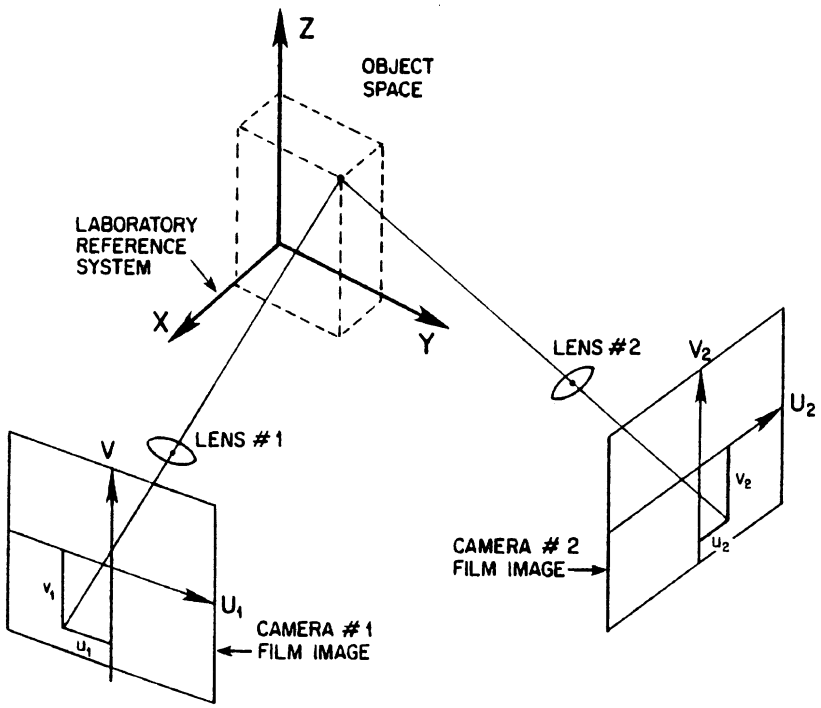


Figure 1.8. Laboratory X, Y, and Z coordinates of targets in calibrated object can be determined from U, V film image coordinates of two or more cameras.

offer a more complete description of the size and shape of the head and neck than is provided by measurement dimensions alone. In the DLT approach, cameras are rigidly positioned and fixed in the laboratory so that they will not move for the duration of project data collection and so that all points of interest can be seen in at least two camera views. With the cameras so established, a three-dimensional array of calibration targets is placed in the desired target space. These targets are positioned precisely with respect to each other so that, with respect to a selected laboratory reference system (a selected laboratory origin and a set of orthogonal axes), their X, Y, and Z coordinates are known.

This array of targets is photographed simultaneously by all cameras and the general geometric equations relating object-space coordinates (X, Y, and Z) to projected film-space or image coordinates (U and V) are solved for the equation coefficients. In effect, for the special case of the calibration grid, the answers are known and the equation coefficients are determined. In this way, the three-dimensional space is calibrated for a specific camera arrangement without having to measure the exact distances, orientations, and lens characteristics of each camera. If the cameras are not moved after this calibration is completed, any object can be placed in the calibrated field, and the laboratory X, Y, and Z coordinates of defineable points "seen" by two or more cameras can be determined with respect to the defined laboratory reference system and origin.

I.B.3.c. Stereophotogrammetry Measurement Facility

Figures I.9 and I.10 show the camera setup and "photo house" used in the current study for stereophotogrammetry data collection. The number of cameras required was minimized by assuming bilateral symmetry of the head with regard to the its basic shape. Targets for defining head contours were therefore only placed on the left side of the head. This also reduced the amount of data reduction and analysis involved, but the setup still required ten cameras to insure that all left-side contour targets and anatomical landmark targets on both sides of the head (e.g., left and right tragion) were photographed by at least two cameras.

Table I.5 describes the ten cameras according to their position and view of the subject and gives their assigned camera number. Two cameras (#'s 1 and 3) were placed down low and angled up to view targets on the midline and left side of the chin and neck. Three cameras (#'s 4,5, and 6) were placed horizontally to view targets on the midline and left side of the back of the head. Camera 7 was also oriented horizontally to obtain a direct right side view of the head and was used to position subjects in the calibrated space as well as to photograph landmark targets on the right side of the head. Cameras 8 and 9 viewed the head from above on the right and left sides, respectively, while cameras 2 and 10 viewed the face from above and front on the left and right sides, respectively.

As shown in Figures I.11 and I.12, each camera was fastened to an aluminum plate machined with a slot to hold and orient the camera body at the appropriate angle. These plates were rigidly attached to the

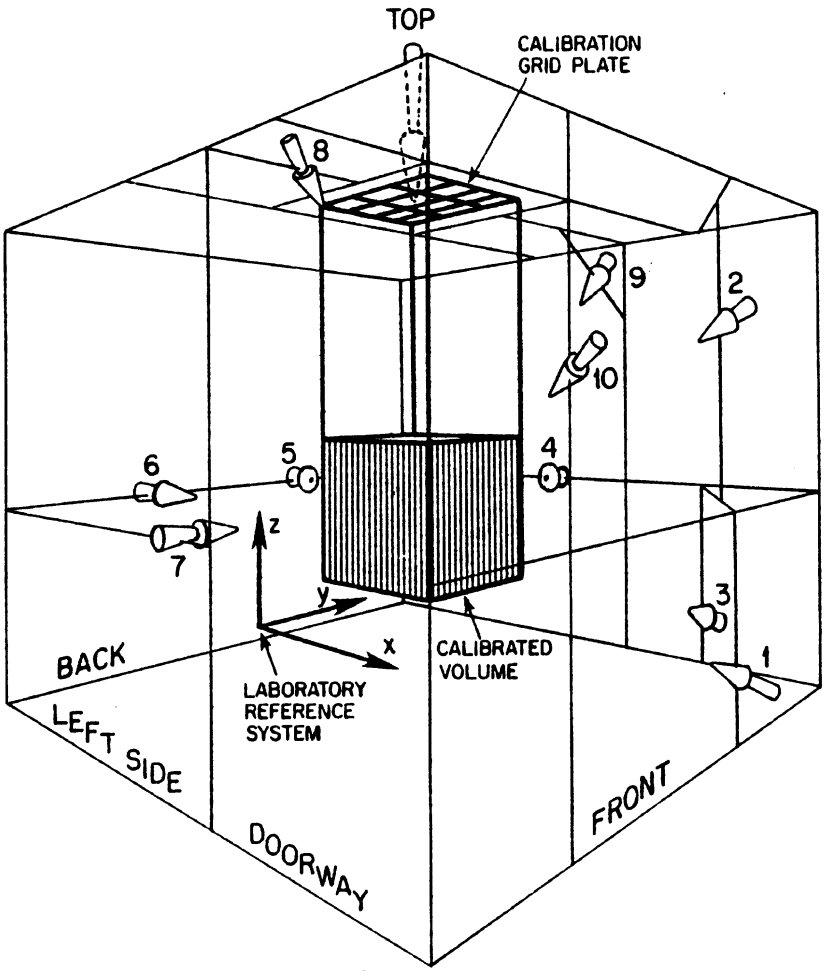


Figure 1.9. Schematic drawing of "photo house" showing locations of ten cameras. View from left front corner.

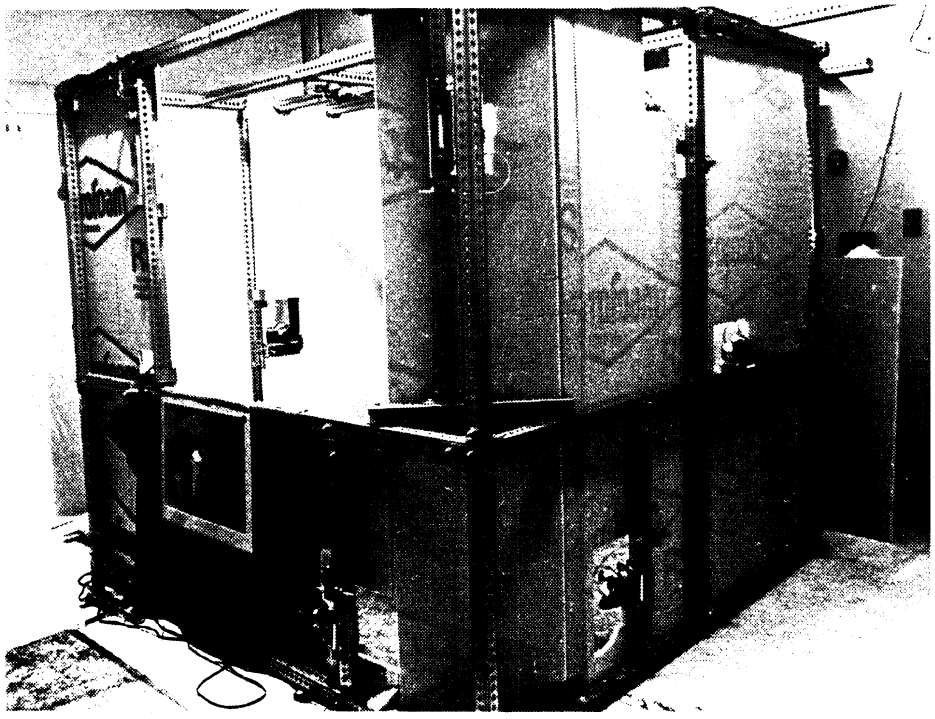


Figure 1.10. View of "photo house" from right front showing locations of several cameras.

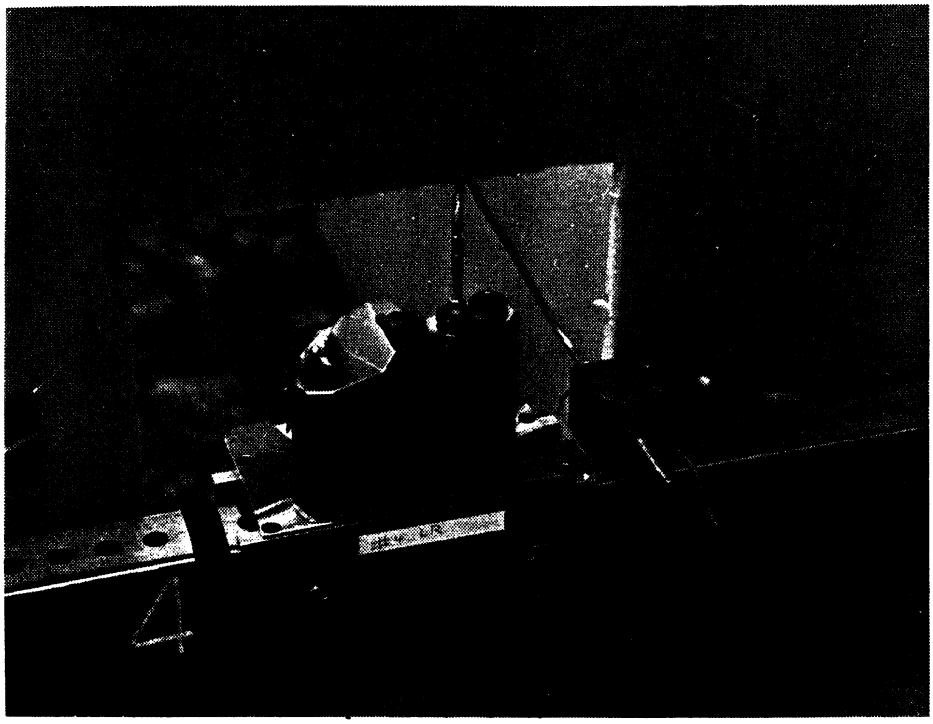


Figure I.11. Camera # 4 mounted horizontally to view subject from the left rear. Solenoid to fire camera shutter through the cable release is on right.

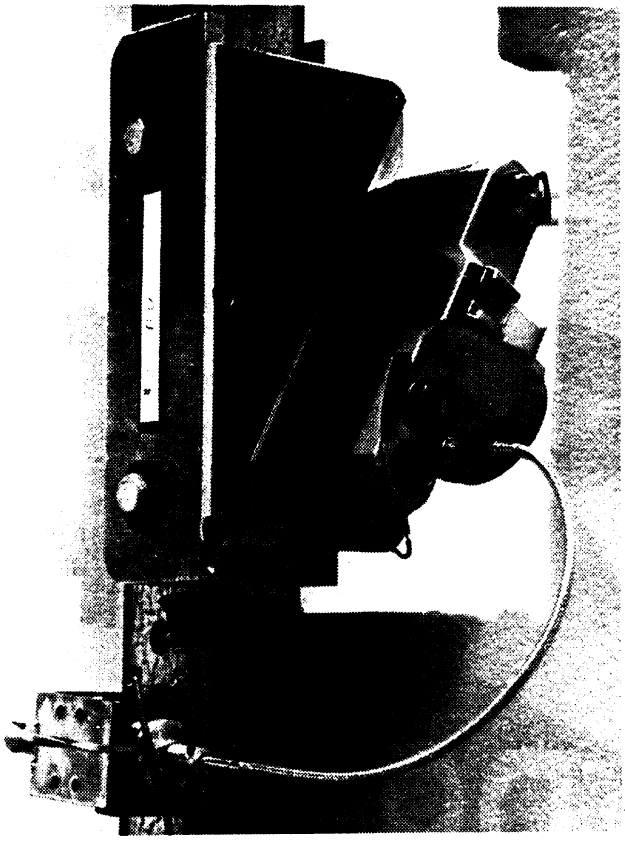


Figure I.12. Camera #2 mounted vertically and angled down to view subject from the upper left.

Table I.5

List of Cameras and Assigned Numbers

Camera #	Camera Name	Camera View
1	Lower Left Front	Under chin
2	Upper Left Front	Face and left side
3	Lower Front Left Side	Under chin
4	Horizontal Left Side Rear	Left side and back of head
5	Horizontal Left Rear	Back of head
6	Horizontal Right Rear	Back and right side of head
7	Horizontal Right Side	Direct right side
8	Upper Right	Right side and top of head
9	Upper Left	Left side and top of head
10	Upper Right Front	Face and right side

steel support frame by two additional aluminum plates that straddled the frame member. Holes were drilled at appropriate locations in each mounting plate to allow unloading of the film without removing the camera from its calibrated position.

The calibration grid shown in Figure I.13 was composed of sixty spherical nylon beads dyed five different colors. The beads were drilled through the center and fixed at 100 mm intervals along twelve wire cables suspended from precisely located holes in an aluminum plate. The cables were tensioned by plumb weights placed in containers of oil to reduce cable motion and vibration. The cameras were loaded with Ektachrome 200, 35 mm color transparency film and were fired simultaneously by means of ten solenoid-powered cable-release systems connected to a common power supply by a single push-button switch. After photographing the calibration grid, the wire cables with nylon beads were wound up and fastened abovethe aluminum plate, out of the way, but available in the event that re-calibration was needed at a later date.

I.B.3.d. Subject Preparation and Data Collection

Figures I.14 through I.17 illustrate the process of targeting and measuring a subject which, for the younger children, often required significant skill and effort in the art of distraction. Prior to subject arrival, colored tapes with contrast colored targets spaced approximately one-half inch apart, were laid out on a glass plate for eventual transfer to the subject. To facilitate attachment of tapes and markers to head regions covered by hair, a nylon cap was placed tightly over the subject's head. This also compressed the hair and significantly reduced head measurement error due to hair depth. It is estimated that even on subjects with substantial hair, the targets were within one to three millimeters of the scalp.

While contrast targets along these contours were placed on only the left side of the head (i.e., bilateral symmetry was assumed), the

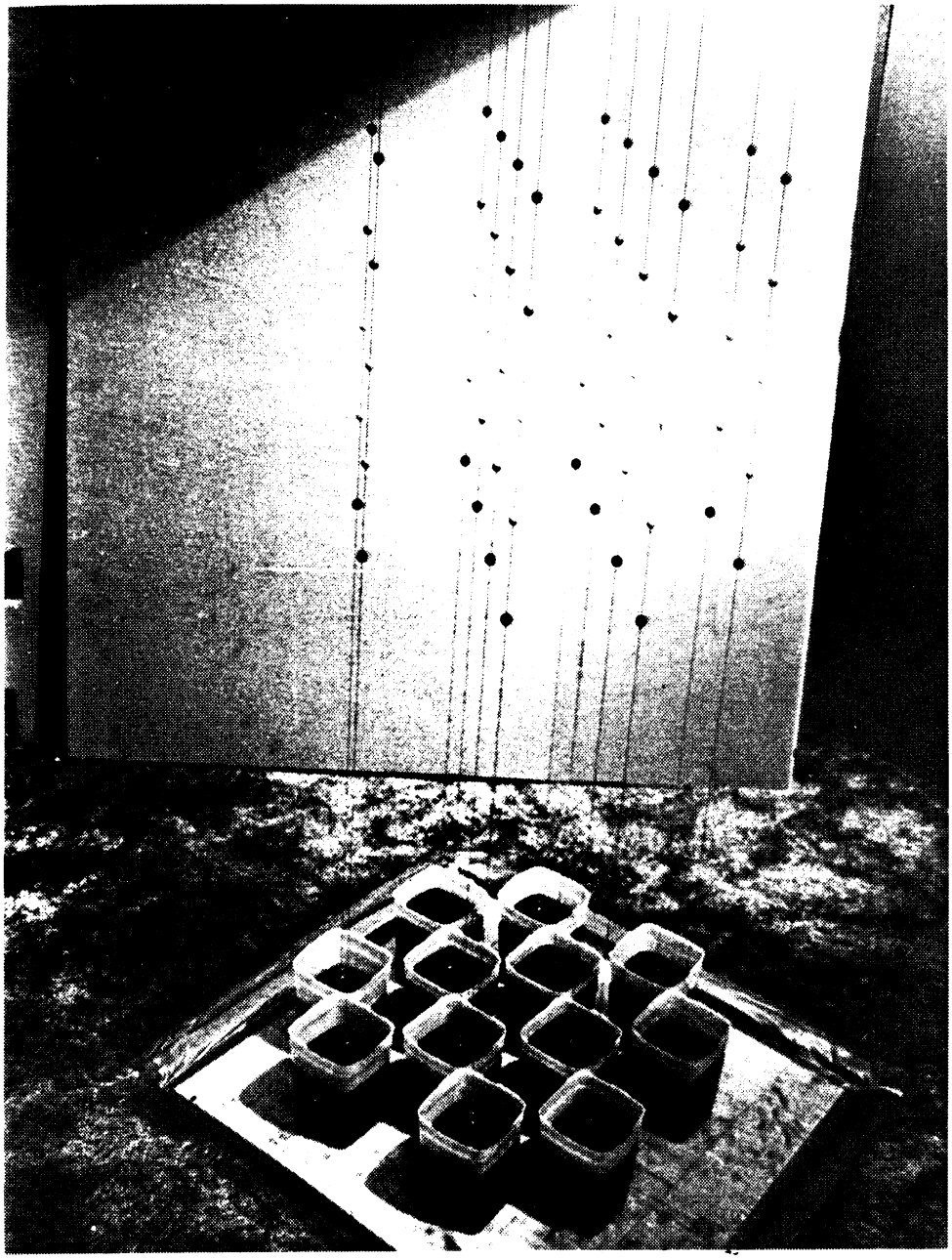


Figure 1.13. Calibration grid composed of colored nylon spheres strung on plumbed wire cables.

Figure 1.14. Measurement of HEAD BREADTH AT EAR OPENINGS after putting on nylon cap.

Figure 1.15. Attaching TOP-OF-HEAD MIDLINE ARC tape with a little help from the subject.

Figure I.16. Placing tape and targets on back of head.

Figure I.17. Placing targets on face.

colored contour tapes were continued completely around the right side of the head to maintain tension and adhesion and to improve the accuracy of tape placement. Since the contrast targets were placed on the tapes prior to attachment to the subjects, the targets usually continued past the midline of the head. A special color-coded "stop" target was therefore placed at the estimated midline of the head (i.e., at the intersection with the "Top-of-Head Midline Arc" tape) after the tapes were in place, so that the person subsequently digitizing the film would know exactly where to terminate digitization of each half-head contour. Manual measurements were taken as landmark targets and tapes were attached. For example, the measurements of Head Length and Head Circumference were generally taken immediately after attachment of the head circumference tape.

Once all tapes and targets were in place, the subject was moved to the "photo room" and seated in the modified high chair as shown in Figures I.18 and I.19. For some subjects, anatomical landmarks on the face were most easily positioned and attached after the subject was seated in the high chair. Using the view finder of the right horizontal side camera (camera #7), the chair height and front/back position were adjusted so that the subject's head, neck, and shoulders were positioned in the calibrated object space. For some smaller infants (4-to-6-month age group) who had difficulty sitting up, it was necessary to stuff pillows between the child and the chair for support. It was also sometimes necessary to hold the arms of younger subjects to insure a clear view of the face, neck, and torso in the lower front cameras.

When everything was ready, and after attaching subject identification numbers, the photo lights were turned on and the subject was distracted or told to look approximately straight ahead. At the proper moment, the ten cameras were fired simultaneously using the push-button switch located near the front of the camera support frame. The cameras were wound immediately to check that all camera shutters had fired and a second set of photos was taken if there was any question or problem suspected with the first set (i.e., child may have moved, camera didn't fire, target came loose, etc.).

I.B.4. STEREOPHOTOGRAMMETRY DATA PROCESSING AND ANALYSIS PROCEDURES

I.B.4.a. Slide Handling and Digitizing

In DLT stereophotogrammetry, the edges of the film frames are used in the calibration and measurement process. These edges are generated by fixed edges inside each camera and they can therefore be used as a reference for the fixed position and orientation of each camera. As shown in Figure I.20, the linear best-fit regression lines determined from nine digitized points along each of the projected film edges were used to establish the optical center or origin of the projected film frame reference system and the directions of the projected U and V coordinate axes. For any camera, the orientation of these U and V axes relative to the X and Y coordinates of the table-mounted digitizer will change from subject to subject due to variation in slide mounting and slide position and orientation in the projector. Once the projected film edges have been digitized and the film image coordinate

Figure I.18. Attaching final targets and subject I.D. numbers in photo room. View through doorway

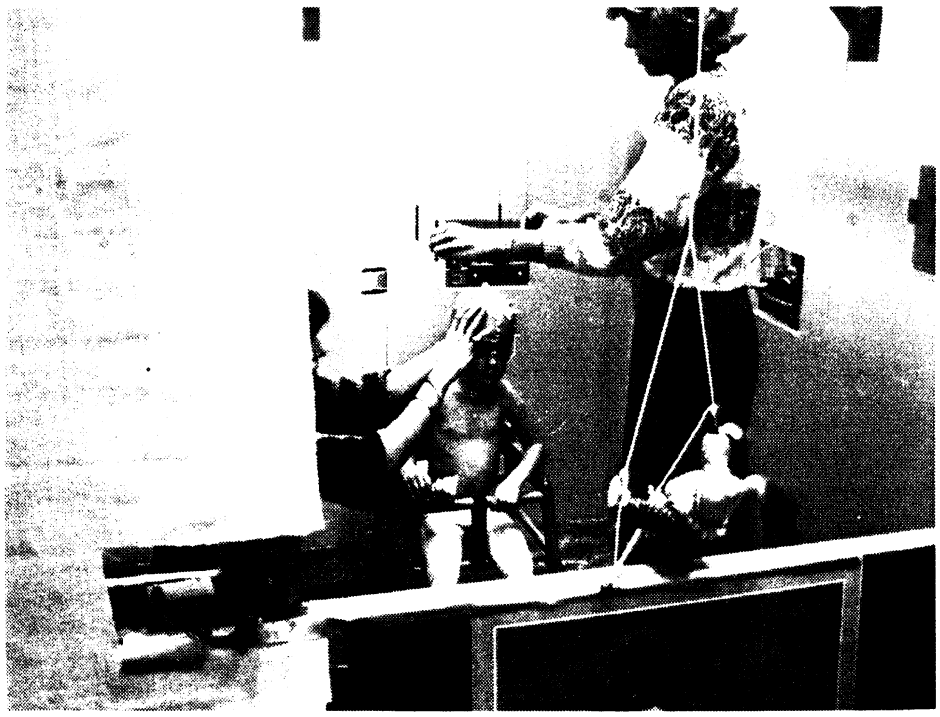


Figure I.19. Final preparation of subject. View through front "window".

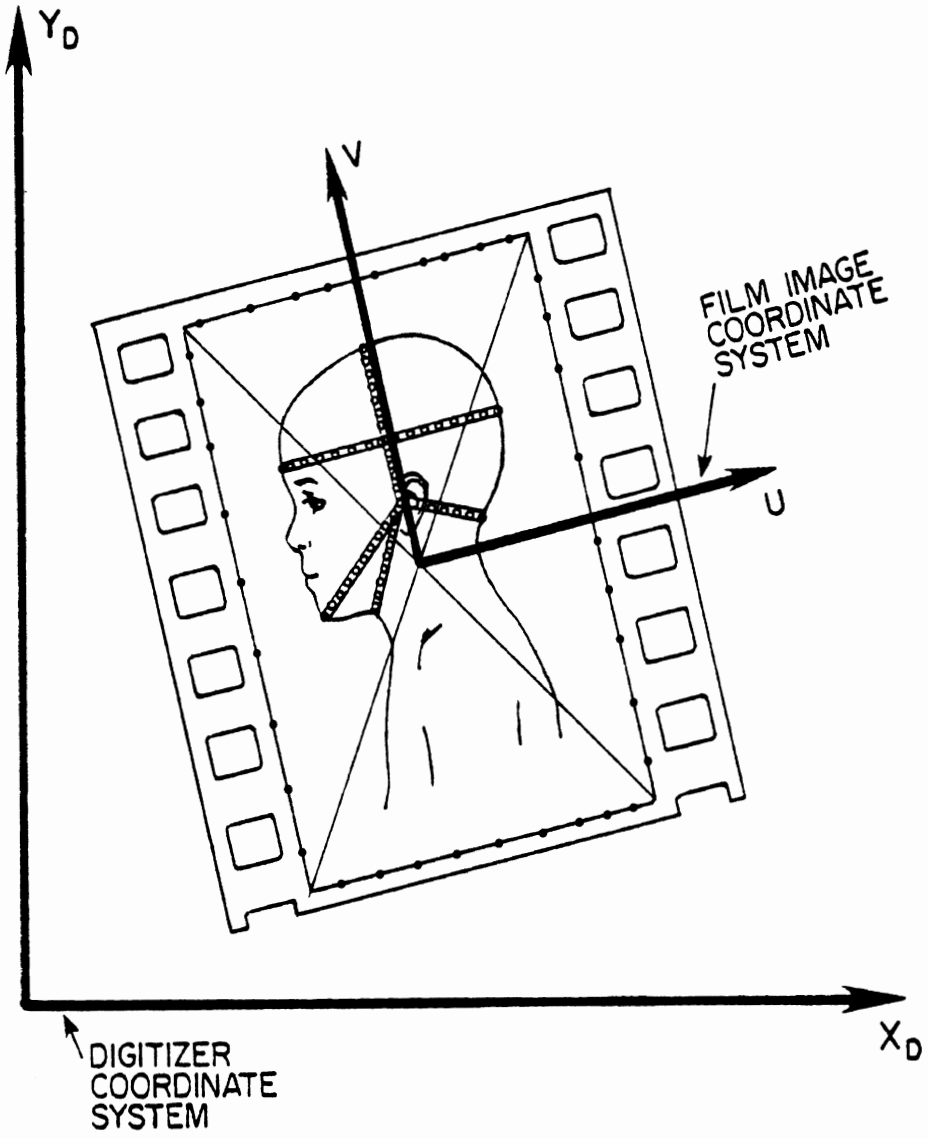


Figure I.20. Relation between digitizer X and Y coordinates and U and V projected image coordinates determined from digitized film edges.

axes established, however, digitizer X and Y coordinate values for targets in that film frame can be transformed into coordinates in the projected U,V reference system which is consistent for all subjects for each camera.

Since only one or two photos were taken of each subject per camera, several subjects were measured and photographed before the cameras, loaded with 20 exposure Ektchrome 200 film, were emptied and the film sent out for processing. To insure that all film edges were intact for digitization and to insure that the correct order of photographs was maintained, the films were processed uncut. Developed film strips were placed on a light table to select the best set of photos for each subject and to carefully cut the films between frames. The cut frames were then mounted between two glass slides to remove curvature and were fitted into aluminum mounts with openings large enough to allow all four projected film borders to be seen. Care was taken in mounting the film frames to make sure that all borders were visible, but otherwise the orientation (i.e., tilt) of the slide in the frame was not critical for the reasons noted above.

The mounted slides were placed in carousel trays in camera number order grouped by subject. Each slide was subsequently projected via a front surface mirror to a smooth horizontal surface where each visible contrast target was digitized by depressing a button when the crosshair of the digitizer sensing unit was over the desired target.

A special computer program was written to sequence the investigator through the targets likely to be visible from each camera view. In addition to sequencing the user through the targets in a predetermined order that was specific to each camera, the program included the option of selecting only specific points for digitization. The latter was useful for redigitizating a film frame to correct targets that had been previously digitized incorrectly. The program also allowed for skipping backward or forward in the target sequence and for coding a particular target as "missing" if it could not be seen.

In order to assist the person doing the digitizing with identification and counting of the targets in the different camera views, special color coding and counting schemes were developed. For example, for each of the six head contours (or half-head contours), "beginning" and "end" targets were defined and the points in the contours were counted sequentially. Also, to help keep track of the contour target numbers in the different camera views, every third dot in the contour was assigned a designated color according to a coded sequence (black dots were the standard contour target color).

I.B.4.b. Reconstruction of Laboratory Coordinates and Data Editing

The digitized U,V film frame coordinates for each target point in each camera view were stored in a UV data file by subject. These U,V coordinate data were subsequently used to reconstruct the laboratory X, Y, and Z coordinates for the targets using the previously determined DLT camera calibration coefficients in the general equations that relate three-dimensional object coordinates to two-dimensional image coordinates. In calibrating the specified object space, the laboratory

origin was selected so that all laboratory coordinate values would be positive (i.e., the origin was located behind, below, and to the right of the array of contrast targets).

The resulting laboratory coordinate values for all contrast targets were stored in an XYZ data file. The data were subsequently examined by producing computer plots of the contour and landmark targets for each subject as illustrated in Figure I.21. Where obvious digitizing errors were found, the appropriate film frames and targets were redigitized and the UV file was thereby corrected. The changed U,V coordinates were again used to reconstruct and change the appropriate laboratory X, Y, and Z coordinate values in the XYZ file. The plots were then regenerated to verify that the bad data points had been satisfactorily corrected. This process of plotting, editing, redigitizing, and reconstructing the data was repeated until all major digitizing errors were resolved.

I.B.4.c. Tranformation to Head Anatomical Reference System

Because the positions and orientations of the subjects' heads in the laboratory varied somewhat between subjects, the laboratory coordinate data could not be used directly to combine and average landmark and contour target results for the twenty five subjects in each group. In order to properly merge the data, the coordinate values needed to be transformed to a reference system common to all subjects.

The obvious choice was the head anatomical reference system illustrated in Figure I.22. The origin of the head anatomical reference system is at the midpoint of a line connecting right and left tragion (i.e., the notch above the cartilaginous flap just forward of the ear opening). The Y-axis lies along this line and is positive toward the left ear. The X-axis is perpendicular to the right/left tragion line, lies in the Frankfort plane (see Table II.4 for definition), and is positive toward the front. The Z-axis is perpendicular to the Frankfort plane and is positive upward.

Using the laboratory X, Y, and Z coordinate values for left and right tragion and the average coordinate values of left and right infraorbitale, the head anatomical reference system for each subject was determined. During digitizing, it was occasionally noted that the left and/or right tragion targets had not been placed in the correct locations (e.g., the contrast target was occasionally forward and/or below the intended ear notch location). In these situations, the visually observed tragion landmarks were also digitized and the coordinates of these adjusted tragion points were used in the construction of the head anatomical reference system.

Once the head anatomical reference system was determined for each subject, it was a simple matter to make the necessary transformation from laboratory coordinates to head anatomical coordinates. For targets on the head, a complete transformation was made. This involved first subtracting the laboratory coordinate values of the head reference origin from the respective X, Y, and Z coordinate values of each head target so that the head anatomical origin was translated and aligned with the laboratory origin. Secondly, a rotation transformation was

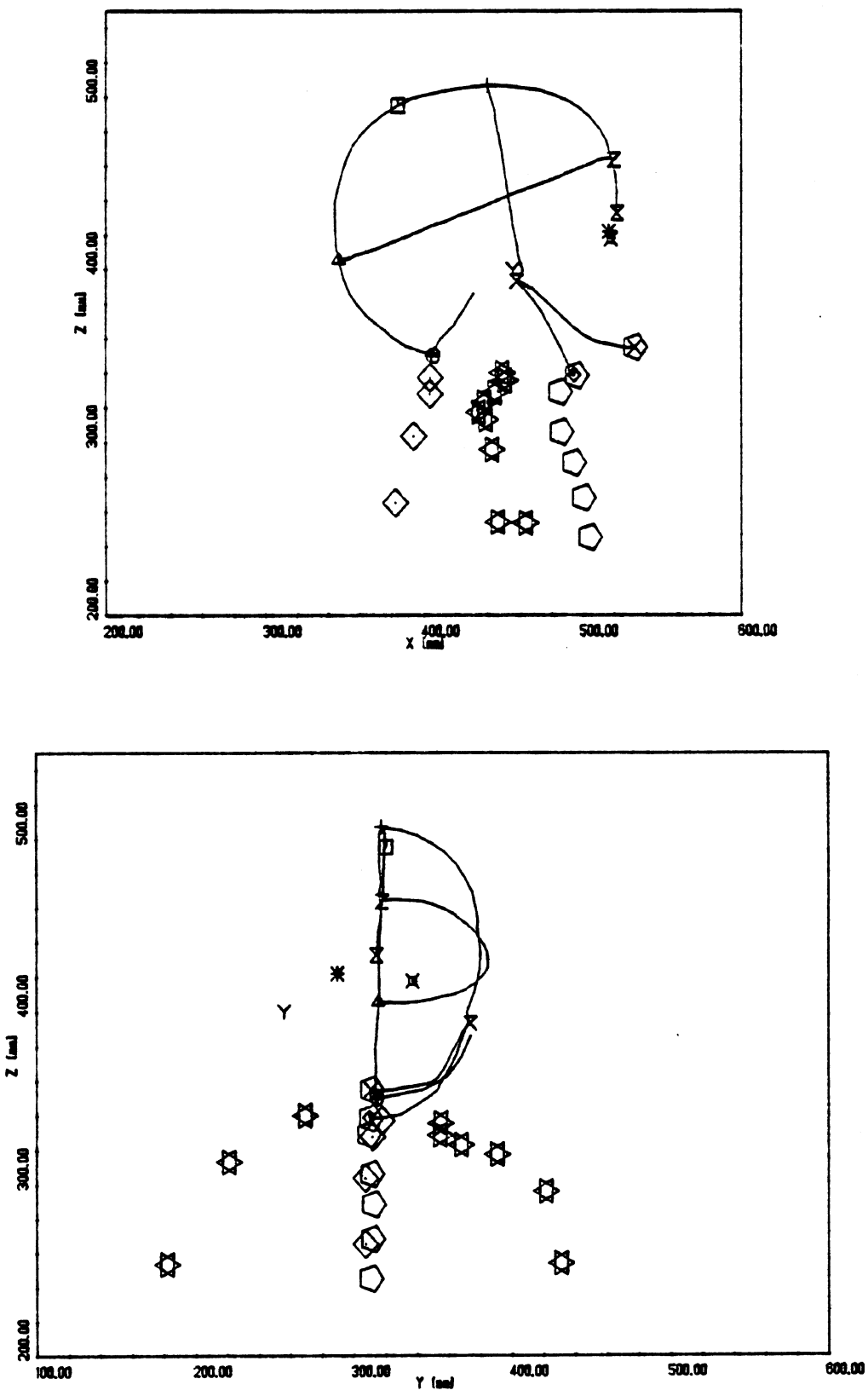


Figure 1.21. Side and front views of reconstructed head target coordinates for one subject. Contour targets are are connected by solid lines. Landmark targets are shown by symbols.

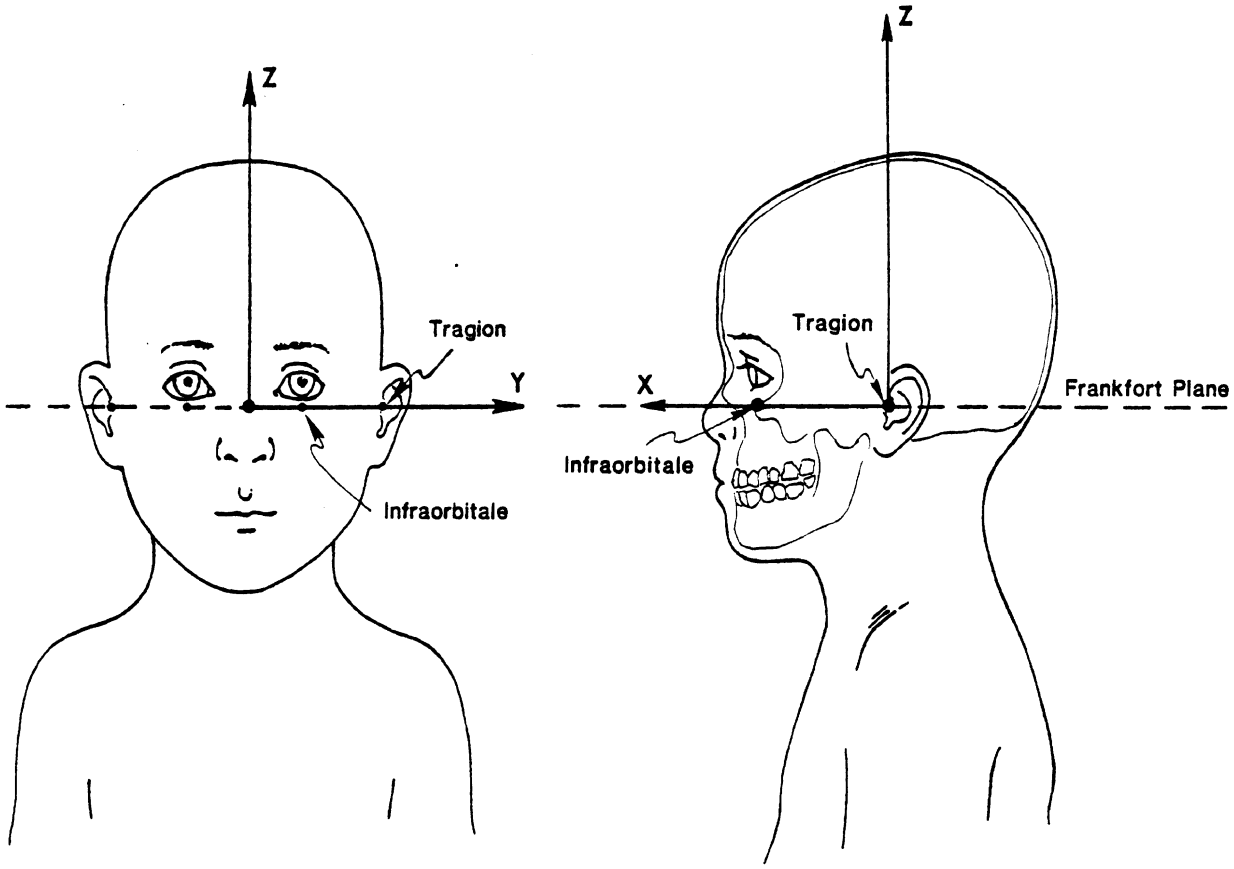


Figure I.22. Head anatomical reference system using Frankfort plane determined by left and right tragions and left infraorbitale.

applied to the head whereby targets on the head were rotated through three angles (yaw, pitch, and roll) about this common origin to align the head anatomical axes with the respective laboratory axes.

Since the rotation transformation angles used for each subject were based on the orientation of the head with respect to the laboratory reference system, application of the rotation transformations to neck and torso targets was not appropriate. Instead, it was assumed that the necks, shoulders, and torsos of all subjects were properly and similarly oriented relative to the laboratory system and to each other (i.e., they were oriented forward and upright in the laboratory) and only the translation part of each subject's transformation was applied to these targets.

I.B.4.d. Further Editing of Head Contour Targets

With the target coordinate data for each subject transformed to that subject's head anatomical reference system, the results were replotted and examined. An example of the head contour and landmark targets in head reference system coordinates for one subject is shown in Figure I.23. Since the X-Z plane of the head reference system defines the midline or midsagittal plane of the head (Y = 0.0), a more detailed review and refinement of the data was possible at this time.

When subjects were measured and targeted, the tape denoting "top-of-head midline arc" was placed at the best estimate of the head midline. This tape was then used to define the end points for the other half-head contours. Construction of the head anatomical reference system, however, provided definition of a more exact midsaggital plane based on tragion (i.e., ear) landmarks. It was therefore possible to make corrections to the digitized contour data by forcing midline points to lie on the true midline of the head as defined by the head anatomical reference system. Thus, the Y-coordinate values of all midline points were set to zero.

Also, at this time, a closer examination of the individual contours was possible and corrections due to tape ripple or less obvious digitization errors than had been found previously were made. To accomplish this editing (and for contour averaging described later), each head contour (i.e., the points in each contour), except "Top-of-Head Midline Arc", was transformed (i.e., rotated) so that the plane of the contour was parallel to one of the orthogonal (i.e., perpendicular) planes of the head anatomical reference system. In actual fact, the target points of each contour did not lie precisely in a plane, but this was the intention when the tapes were placed on the subject. The plane of each contour was therefore defined by the line connecting the first and last points in the half-head contour.

With the half-head contours rotated into the standard reference planes indicated in Table I.6, full scale, in-plane plots of the contours were easily made. Figure I.24 shows the Y-Z or front plane view of the three ear-to-ear arcs after rotation about the common tragion point into the reference planes. The arrows in the insert indicate the original orientations of these arcs prior to rotation. Corrections to coordinate values needed to place midline targets on the

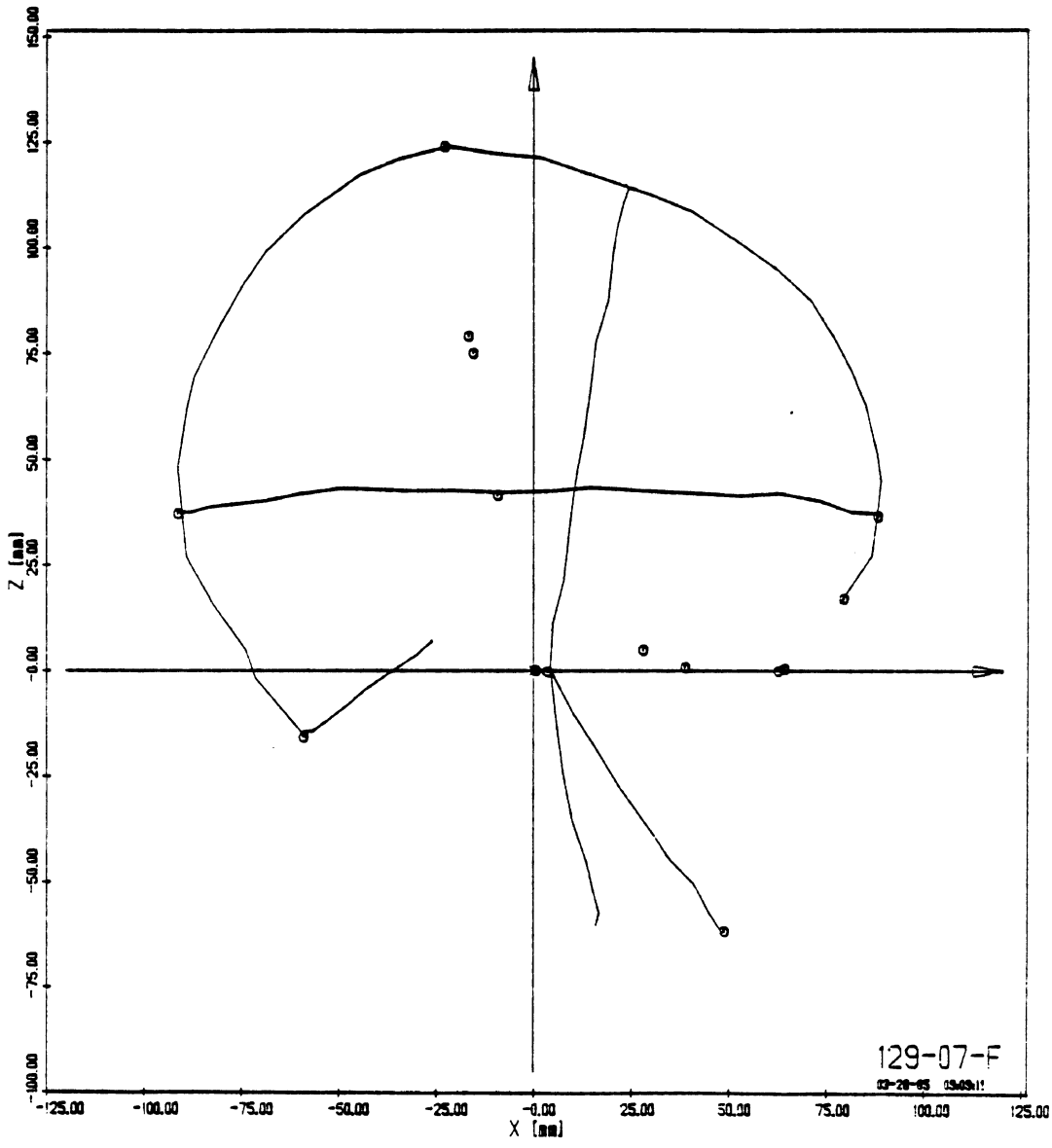


Figure 1.23. X-Z plane view (side view) of head targets for subject #129 transformed to head reference system coordinates.

true midline of the head or to remove errors due to tape ripple were easily made at this time.

After completing this process, the targets of the "planarized" and edited contours were transformed (i.e.,rotated) back through their appropriate angles and replotted as a composite set of head contours for each subject. Figure 1.25 shows a composite side-view plot of edited contours and head landmarks for one subject.

Table 1.6

Head Reference System Planes and Rotation Points Used for Contour Editing and Averaging

Head Contour	Reference Plane Rotated to	Point Rotated About
Top-of-Head Midline Arc	N/A - already in X-Z plane	
Head Circumference Arc	X-Y plane	X=0.0
Ear-to-Ear over Top-of-Head Arc	Y-Z plane	1st point
Ear-to-Ear thru Tip-of-Chin Arc	Y-Z plane	1st point
Ear-to-Ear Under Chin Arc	Y-Z plane	1st point
Ear-to-Ear Around Back-of-Head Arc	X-Y plane	last point

I.B.4.e. Averaging Results Within Age Groups

While computation of group average and percentile values from scalar measurement data involves straight-forward mathematical procedures, it is quite a different matter to average coordinate data of targets which describe three-dimensional geometric relationships and contour shapes. As has already been demonstrated, comparable contours for different subjects in each age group do not all have the same orientation relative to the head anatomical reference system, nor do the contour targets have any correspondence between subjects. It was therefore necessary to develop a suitable technique for combining the data from the twenty-five subjects in each group to obtain a meaningful set of coordinate values describing the group "average" subject.

By transforming the head target points to the head reference system, an important part of the averaging process was completed. This put the head target data for each subject into appropriate alignment with respect to the other subjects in the group, with coordinate values of landmarks and contours expressed relative to a reference system that is anatomically similar for all subjects. Averaging of specific landmark points which had a one-to-one correspondence, such as maximum head breadth point, gonion (jaw), and zygion (upper cheek), was now simply a matter of computing the averages of the X, Y, and Z values respectively. Averaging of contours was more complex and involved two separate parts.

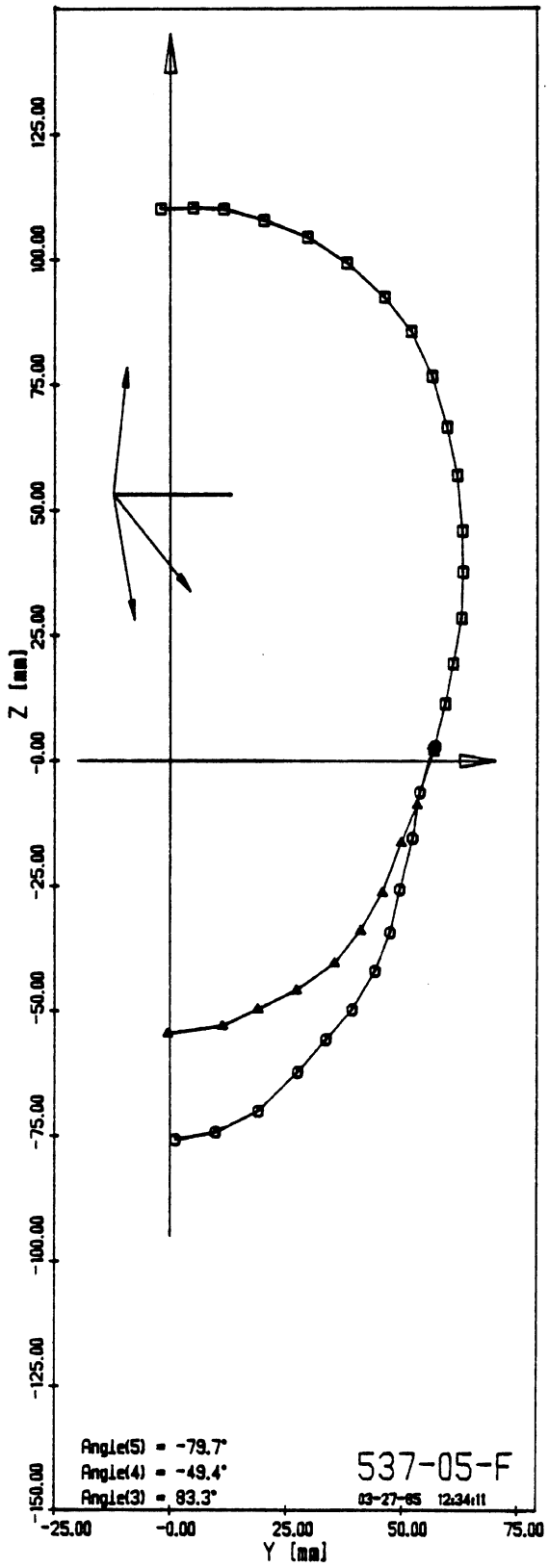


Figure I.24 Y-Z plane views of the three ear-to-ear arcs for subject #537 after rotating each arc into the head reference system Y-Z plane. Arrows of insert indicate angles of arc planes prior to rotation into "working" planes.

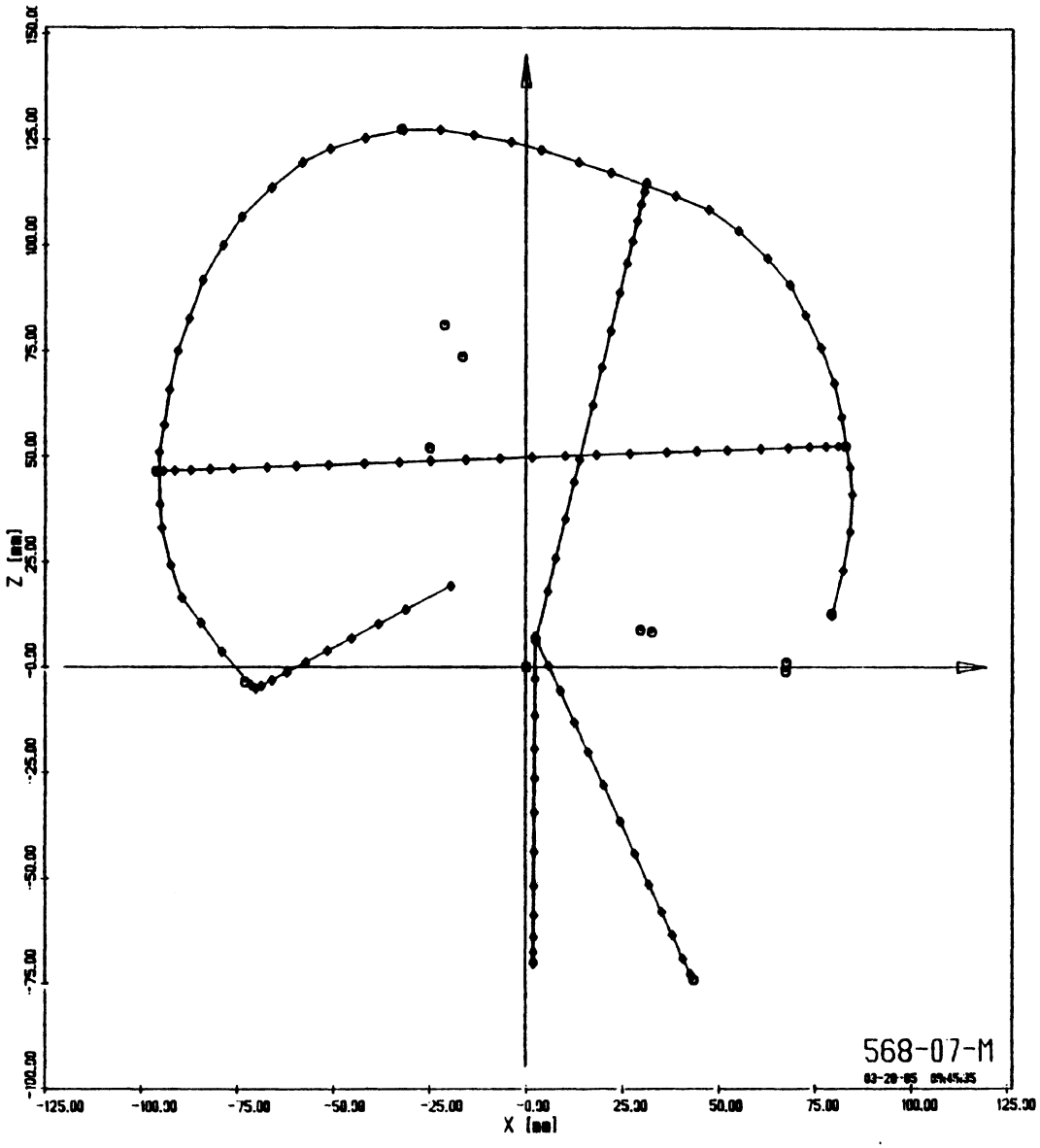


Figure 1.25. X-Z plane view (side view) of head targets for subject #568 after "planarizing" and editing contours.

First, the average size and shape of each contour were determined for each age group. Next, the group average orientations and positions of these shapes relative to the head reference system were determined.

To accomplish the first part of the contour-averaging process, it was necessary to orient contours to be averaged parallel to the same reference or "working" plane. This was achieved as previously described by rotating each "planarized" contour so that its plane was parallel to a head reference system plane. Figure I.26 illustrates the X-Z plane (side) and X-Y plane (top) views of the twenty-five rotated Head Circumfernce Arcs for 13-to-18-month subjects after reflecting the half-head contours to the right side. It is seen that the planes of all contours are parallel to the X-Y reference plane, but that these planes are at different Z values.

With the contours rotated and aligned as described, the size and shape of each group's average head contours were computed from each set of twenty-five separate contours. In doing this, it was important to average along directions which had meaning relative to the shapes of the particular head contours being averaged. Averaging Head Circumference contours along the X or Y axis directions, for example, would not be meaningful and would present problems when the direction of averaging was approaching the direction of the tangent to the contours (e.g., the tangent to the Head Circumference contour is in the X direction near the sides of the head and therefore one cannot meaningfully average along this direction in this region of the contours). Also, since there was not a one-to-one correspondence between targets in the contours from different subjects, it would not make sense to compute the scalar averages of X and Y coordinates of sequential targets in the contours.

The averaging procedure used involved first determining the best estimate for the center of curvature of each set of twenty-five contours (or half-head contours) to be averaged for each subject group. The contours were then averaged along radii from this center. Figures I.27 and I.28 illustrate this process for data points for two hypothetical contours or curves that lie in the X-Y plane.

As shown in Figure I.27, the best estimate for the center of the two curves is determined by computing the simple scalar averages of the X and Y coordinate values for the first and last points in the half contours (points A and B). A straight line is drawn connecting these average points and this line is bisected (point O) with a perpedicular line. The intersections of this perpendicular line with the two curves are determined by a computer program which interpolates between adjacent data points in the curves. The X and Y coordinates of these intersection points are then averaged to determine point C. The point on this perpendicular bisector that is equal distance from points A, B, and C (i.e., equal distance from three points on the average contour) is then determined and used as the center of curvature (point D) for the set of contours.

As shown in Figure I.28, radii from point D are constructed at intervals of a few degrees until all points in all the contours have been included by the set of radii. The points of intersection of each radii with the individual contours are determined by interpolation

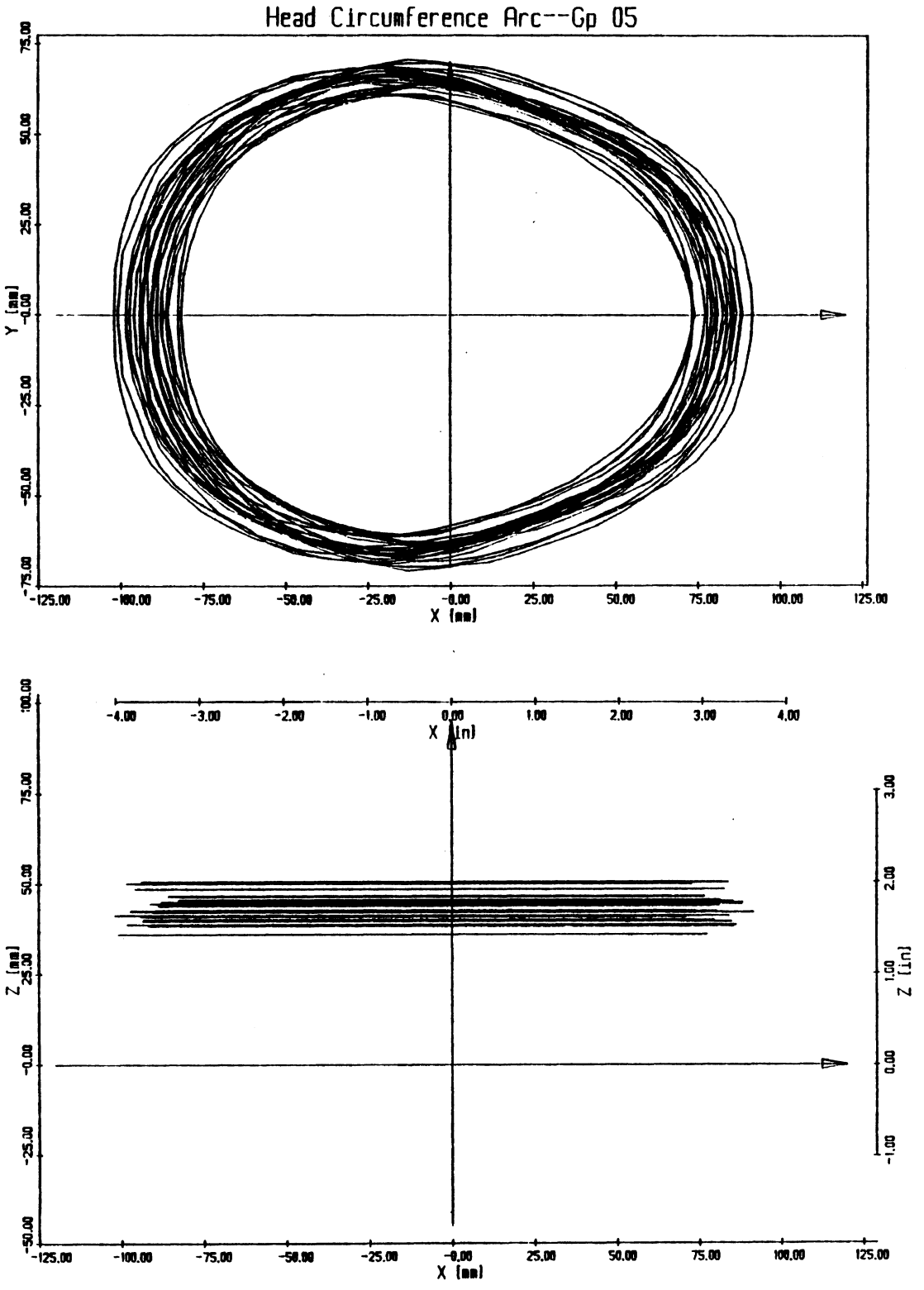


Figure 1.26. X-Y (top) and X-Z (bottom) plane views of twenty-five Head Circumference arcs for 25 to 30 month subjects after rotation into X-Y plane for contour averaging.

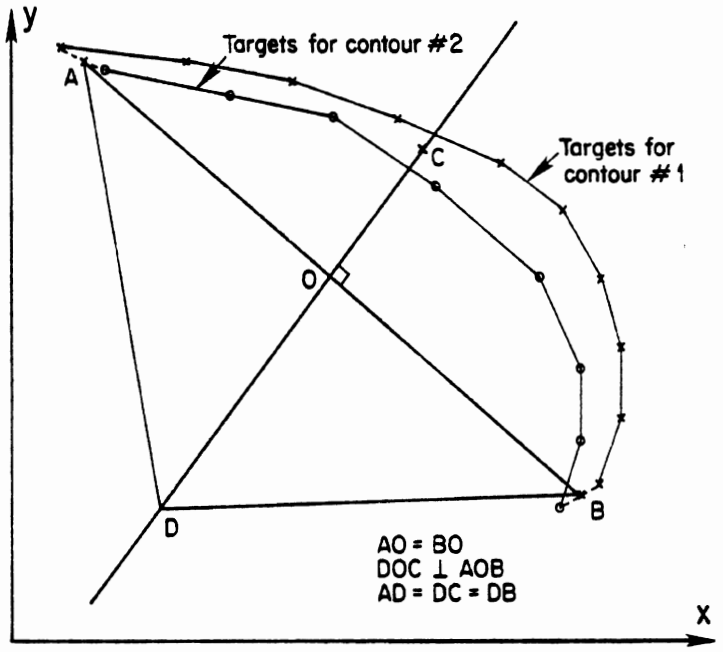


Figure I.27. Determining the "best estimate" for the center of curvature of multiple contours.

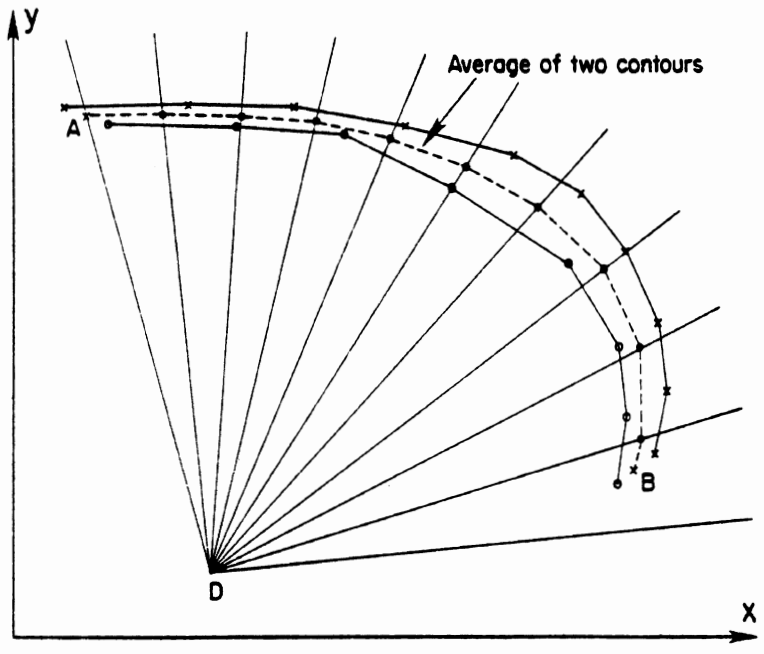


Figure I.28. Averaging multiple contours along radii from the center of curvature.

between target points in each contour and the coordinate values of these points intersection for each radii are averaged to give the data points defining the average contour.

A similar process was used for all targeted head contours, although the head reference plane operated in varied according to the scheme shown in Table I.6. The position of each average contour was determined by averaging the positions of the planes of the respective rotated contours for the twenty-five subjects in each group. The orientation of each average contour was determined by taking the simple average of the angles that the contours had been rotated through to get them parallel to the appropriate head reference system plane. Each group average contour was thus positioned at the group average location for that contour and rotated back through the group average transformation angle. Figure I.29 shows a side view (i.e., X-Z plane) of the average contours for 25-to-30 month subjects after completing this averaging process. For each of the four subject groups, the averages of the different head contours fit together extremely well.

I.B.4.f. Combining Head Target Data with Neck and Torso Points

Most of the analysis described so far has dealt with head landmark and contour targets. The head has been considered a rigid body in which one part does not move relative to another part. It will be recalled that when the transformation from laboratory coordinates to head coordinates was made, both translational and rotational transformations were used for head targets, while only translational transformations were used for neck and torso targets. Rotation of the translated laboratory coordinates of head targets was necessary to adjust for differences between subjects in head orientations with respect to the laboratory reference system so that contour averaging could be accomplished in a meaningful way.

To rotate the neck and torso points through the same rotation transformations used for the head would have resulted, in many cases, in a torso that was inappropriately oriented relative to the laboratory or inertial reference system. However, because the head reference system origin about which the rotational transformations of the head targets were made is not a point of natural articulation for the head relative to the neck and torso, the coordinates of head targets after applying the rotational transformation, are not located appropriately relative to the unrotated neck and torso points.

To present the head, neck, and torso target coordinates together in their proper relationships, the head points needed to be unrotated or put back to their original orientation with respect to the laboratory coordinate system. Before making this correction of head points relative to neck and torso points, it was determined from a review of the subject photos and computer plots of laboratory coordinate data that the yaw (i.e., rotation about the head Z axis) and tilt (i.e., rotation about the head X axis) angles of the head transformation were generally small and that these rotations had relatively little effect on head-to-neck and head-to-torso relationships. Therefore, the primary angle through which the head points needed to be "unrotated" was the pitch or nod angle (i.e., rotation about the head Y axis). For each subject,

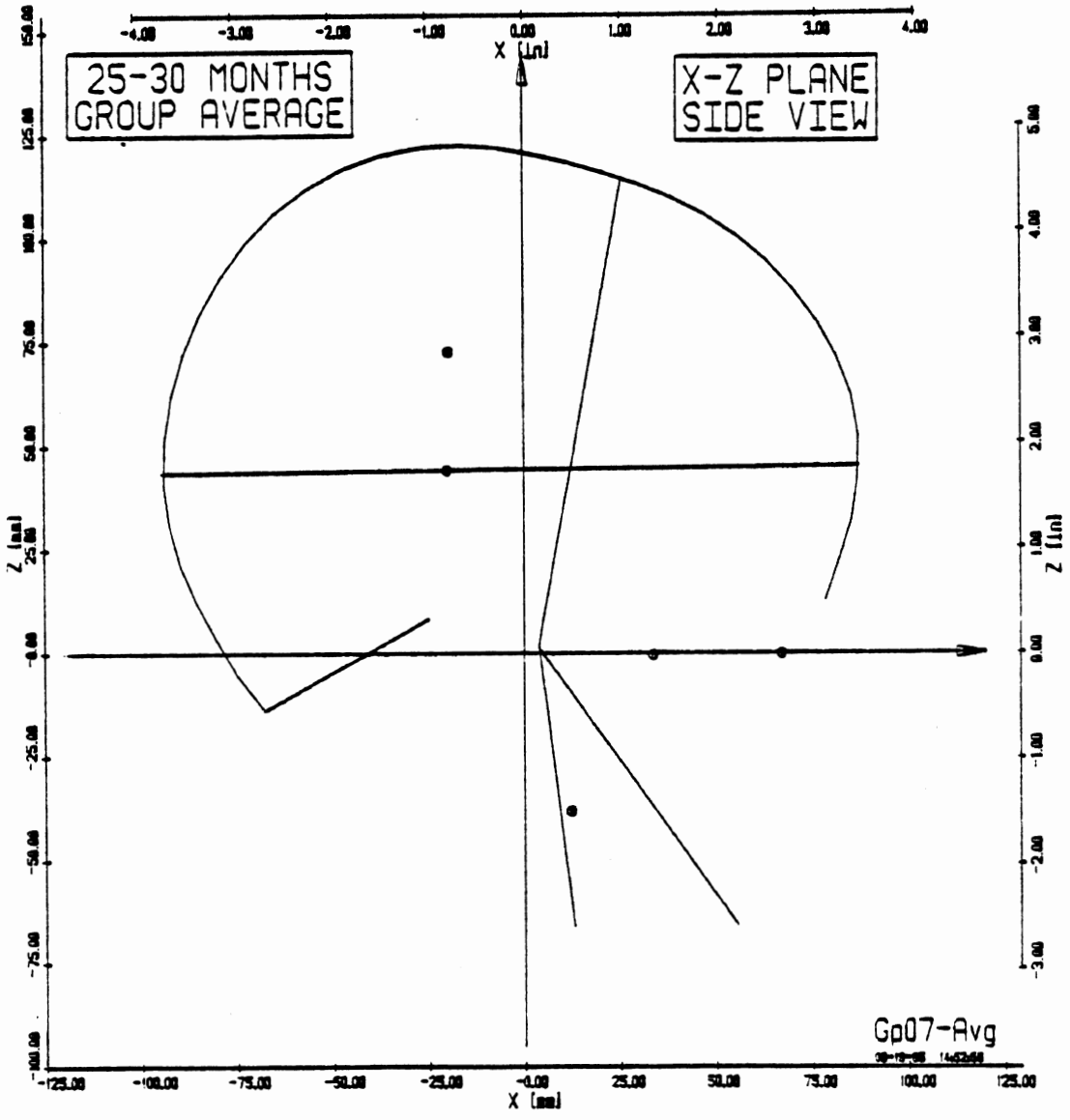


Figure 1.29. X-Z plane view (side view) of averaged head contours and landmarks for 25 to 30 month subjects after rotating back through the averaged contour-plane angles.

then, the head targets were operated on by a rotational transformation which "unrotated" the head about the head reference system Y-axis through the angle that had been used to align the head anatomical X axis with the laboratory X axis. This resulted in correct positioning of the head targets relative to the neck and torso targets.

Figure I.30 illustrates these results for combined head, neck, and torso points for the 25-to-30-month group average. In this case, the average head pitch angle was used to transform the average head target points. As illustrated, the head anatomical X and Z axes are inclined relative to the laboratory axes (i.e., the Frankfort plane is inclined) but the head and laboratory Y axes and origins are still aligned.

I.B.4.g. Construction of Symmetric Head Data Sets

In order to present results for the whole head from the half-head contours, it was a simple matter to assign negative as well as positive Y-coordinate values to contour targets not on the midsaggital plane. Landmark targets off the midsaggital plane, such as Gonion (jaw), Zygion (cheek), and Maximum Head Breadth Point, were targeted on both sides of the head. To maintain head symmetry, the average coordinate values for the pairs of targets were computed and used for the landmarks on each side, with the average Y-coordinate values being assigned both positive and negative for the left and right sides respectively. It was also decided to delete the right shoulder points in favor of reflecting the more complete and accurate data of the left shoulder to the right side by assigning both positive and negative Y-coordinate values to these points.

I.B.4.h. Selection of Group SMALL and LARGE Subjects.

For single-valued measurement data such as the manual measurements of this study, it is common practice to compute the sample 5th and 95th percentile values as an estimate of smallness and largeness in the sampled population. In using such percentile data from anthropometric measurements, it must be remembered that the percentile values for individual measurements do not combine to give representative population percentile values for other measurements. One cannot, for example, add 5th percentile leg length values to 5th percentile sitting height values to get 5th percentile statures. A person who is 5th percentile for one measurement will not be 5th percentile for all other measurements.

The purpose in using stereophotogrammetric techniques to collect landmark and contour target coordinate data was to provide a more complete picture of the size, shape, and geometry of the head and neck than would be provided by manual measurements alone. As such, the primary value of these data is in the combination or composite of the target coordinates which together describe the head in many dimensions and directions. However, just as there is no single definition of smallness and largeness for the full set of manual measurements (i.e., the person who is 5th percentile for one measurement is not 5th percentile for another), so there is no single measure of smallness and largeness for the composite of head target coordinate data. While it would be possible to compute individual measurement values from the

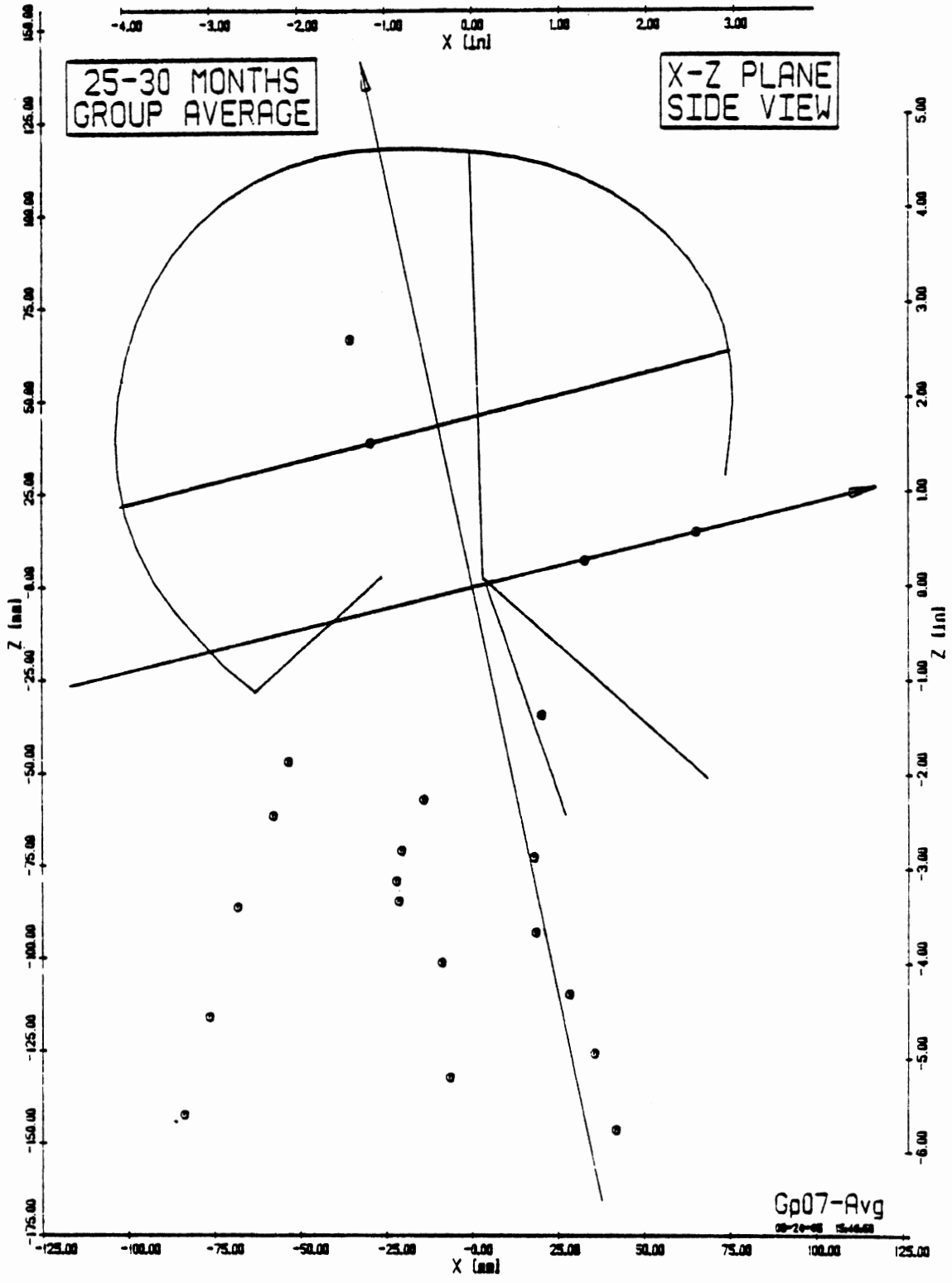


Figure 1.30. X-Z plane view (side view) of average head, neck, and torso landmark coordinates and contours for 25 to 30 month subjects after rotating head pitch angle back to its original orientation. Note angle of head X axis to shifted laboratory X axis.

coordinate data of each subject and thereby compute sample statistics for these measurements[1], such an exercise does not do justice to the main purpose of the target coordinate data.

Therefore, for purposes of presenting the complete set of stereophotogrammetry coordinate data for a representative small and large head in each age group[2], a definition of head size based on an estimate for total head volume was established using the three measures of "Head Length", "Head Breadth", and "Head Height". When multiplied together, these lineal dimensions give an estimate of relative head volume. To determine the largest or smallest head in a given age group, the rankings of this head volume measure within each subject group from largest to smallest were used as the primary indicator of head size, while the rankings of the individual measurement values for Head Length, Head Breadth, and Head Height were used as secondary indicators. For example, the subject with the smallest head volume value in each group was selected as the representative small subject for that group if the three separate measurements were also ranked near or at the smallest for that group. If one or more of the three measurements was not ranked reasonably close to smallest, the subject with the next largest volume (i.e., second smallest) was considered. In a similar manner, the representative large subject was selected for each age group using volume and measurement rankings at or near the largest for each group.

---

1 Some head measurements have been computed from the group average stereophotogrammetry target data and are compared to manual measurement results in section II.D.

2 Smallness and largeness of different regions of the head are also indicated by the composite plots of individual head contours in section II.C.6.

I.C. REFERENCES

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PART II

RESULTS

SECTION	PAGE NO.
A. SUMMARY OF SAMPLE POPULATION DEMOGRAPHICS	53
B. MANUAL MEASUREMENT RESULTS	55
C. STEREOPHOTOGRAMMETRY MEASUREMENT RESULTS	187
D. COMPARISON OF MANUAL AND STEREOPHOTOGRAMMETRY RESULTS	485

II.A. SUMMARY OF SAMPLE POPULATION DEMOGRAPHICS

As previously indicated, it was desired to measure a sample of children whose racial and family socio-economic factors were representative of the U.S. population. Information on each child's race, family income, and mother's and father's education level were therefore requested from parents in addition to the basic information of child's sex and birth date. Table II.1 summarizes the results for the full sample of 301 subjects that were measured and indicates how closely the sample matches the U.S. population in overall percentages and mean values according to the 1980 Census of Population and Housing (see references in section I.C).

By design, the sample was composed of half females and half males except that the 25-to-30 month group contained one extra male subject. The 1980 U.S. census data show 48.9 percent females and 51.1 percent males for children under five years. Racially, the sample is somewhat lower in percentage of minority groups than the national percentages for children under five years, while the mean family income for the sample population is somewhat higher than the mean family income of U.S. families. The latter comparison does not account for economic inflation between 1980 and 1984 which would be expected to raise the U.S. population mean family income value closer to the sample mean family income value. It should also be noted that some of the families with lower level incomes in the study are ones in which both parents were college students at the time their child was measured. These families are therefore not really representative of people whose family incomes are low because of education level and type or lack of employment.

The greatest difference between the sample population and the U.S. population is in parental education levels. As indicated in the table, the proportion of subjects' parents with partial or complete college level educations is large compared to the proportion of adults with college level education in the U.S. population. Also, all of the parents of subjects in the sample population had achieved some high school education, whereas 18.5 percent of adults in the U.S. population were not educated beyond 8th grade. These results clearly reflect the educational environment of Ann Arbor and its surrounding communities which is not representative of the whole United States in this respect.

Table II.1

Summary of Demographic Information

Variable	Study Sample		1980 U.S. Census*
Sex			
Percent Females (# females)	49.8	(150)	48.9
Percent Males (# males)	50.2	(151)	51.1
Race			
Percent White (# white)	86.4	(260)	82.2
Percent Black (# black)	12.0	(36)	15.7
Percent Other (# other)	1.6	(5)	2.1
Percent Non-Caucasian	13.6		17.8
Household Income			
Mean Family Income	$25,746		$23,177
Parents Education Level (% at grade levels)			
K - 8th grade	0.0		18.5
High school	14.2		49.5
College and Grad. school	85.8		31.9

* see references, section I.C.

II.B. MANUAL MEASUREMENT RESULTS

II.B.1. RESULTS BY MEASUREMENT VARIABLE

Table II.2 lists the measurements taken in this study by the procedures described in section I.B.2. Figure II.1 provides a visual index to the results of this section. For each measurement, a written description is given along with a drawing and photograph to help visualize the measurement. In several cases it will be noted that two measurement names have been used. The first name uses common terminology for persons not familiar with anatomy and anthropometry. The second name (in parentheses) uses anatomical and anthropometric terminology to refer to the specific landmarks involved. These anatomical landmark terms are also given parenthetically within the measurement definitions and are defined and illustrated in Table II.3 and Figure II.2. Table II.4 and Figure II.3 describe and illustrate the midsagittal and Frankfort planes used in defining and taking many of the measurements.

For each measurement variable, the definition and illustration page is followed by a page giving tables of measurement statistic stratified by subject group. Two tables are used to present metric and English values for the sample minimimum, maximum, mean, standard deviation, and 5th, 50th, and 95th percentiles of each age group. Each page of tabular results is followed by a scatter plot of the measurement values plotted versus subject age. To assist with locating the results of the individual measurements, the measurement number from Table II.2 and Figure II.1 is given in the upper right or left corner of these pages.

Table II.2

Index to Anthropometric Measurements

No.	Measurement	Page No.
1.	Weight	62
2.	Stature	65
3.	Sitting Height	68
4.	Maximum Head Breadth	71
5.	Head Circumference	74
6.	Head Breadth at Circumference	77
7.	Head Length	80
8.	Head Height	83
9.	Tip-of-Chin to Back-of-Head Distance	86
10.	Tip-of-Chin to Back-of-Head Circumference	89
11.	Lower Face Height	92
12.	Maximum Face Breadth	95
13.	Maximum Jaw Breadth	98
14.	Head Breadth at Ear Openings	101
15.	Ear to Head/Neck Junction Distance	104
16.	Ear to Tip-of-Chin Distance	107
17.	Ear to Top-of-Head Distance	110
18.	Top-of-Head to Back-of-Head Distance	113
19.	Top-of-Head to Head Circumference Distance	116
20.	Back-of-Head to Head-Breadth Point Distance	119
21.	Forehead to Back-of-Head Arc Length	122
22.	Forehead to Head/Neck Junction Arc Length	125
23.	Ear-to-Ear Over Top-of-Head Arc Length	128
24.	Ear-to-Ear Under Chin Arc Length	131
25.	Ear-to-Ear Around Back-of-Head Arc Length	134
26.	Neck Circumference	137
27.	Neck Breadth	140
28.	Neck Depth	143
29.	Shoulder Breadth	146
30.	Shoulder Circumference	149
31.	Shoulder Depth	152
32.	Torso Depth	155
33.	Top-of-Shoulder to Top-of-Head Distance	158
34.	Shoulder-Circumference-Point to Top-of-Head Distance	161

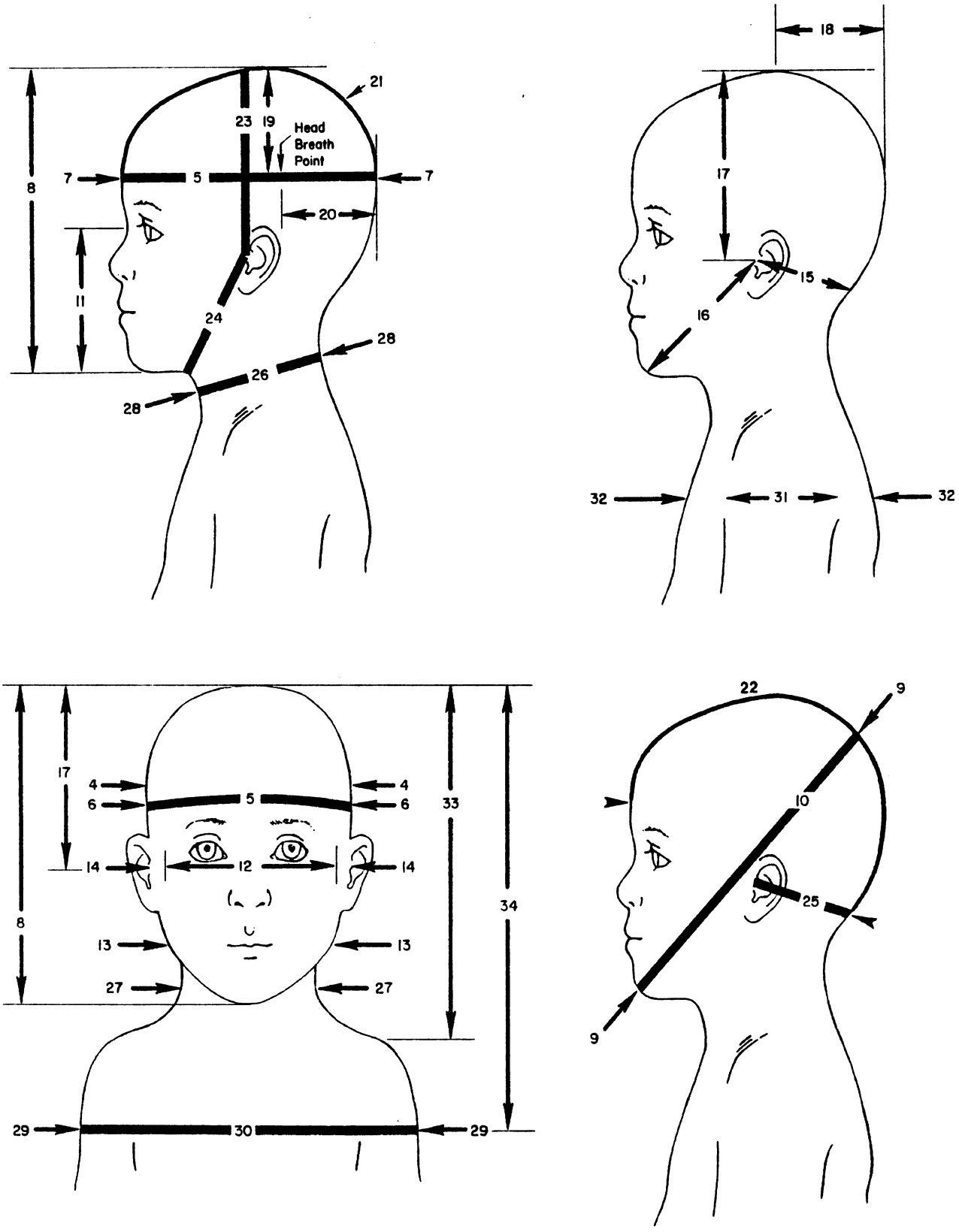


Figure 11.1. Index to manual measurements.

Table II.3

Definitions of Anthropometric Landmarks and Terms

1. Glabella

   The point of greatest protrusion (i.e.,most anterior point on the forehead.

2. Gonion

   The lowest and widest bony point at the back of the jaw bone (i.e., mandible) on each side.

3. Infraorbitale

   The lowest point on the bony socket of the eye that can be palpated under the skin.

4. Head/Neck Junction

   The lowest point of the back of the skull at the junction of the head and neck.

5. Menton

   The most forward and lowest (i.e., anterior-inferior) point on the chin (i.e., the tip of the chin).

6. Opisthocranion

   The point of greatest protrusion (i.e., most posterior point) on the back of the head.

7. Sellion

   The point of deepest indentation above the nose and below the brow ridge.

8. Tragion

   The notch on the ear just forward of (i.e., anterior to) the ear opening and just above (i.e., superior to) a small cartilaginous flap. This point corresponds approximately to the upper margin of the ear drum.

9. Vertex

   The highest point on the top of the head.

10. Zygion

    The points of the upper cheek bones (i.e., zygomatic arches) that define the widest breadth of the face.

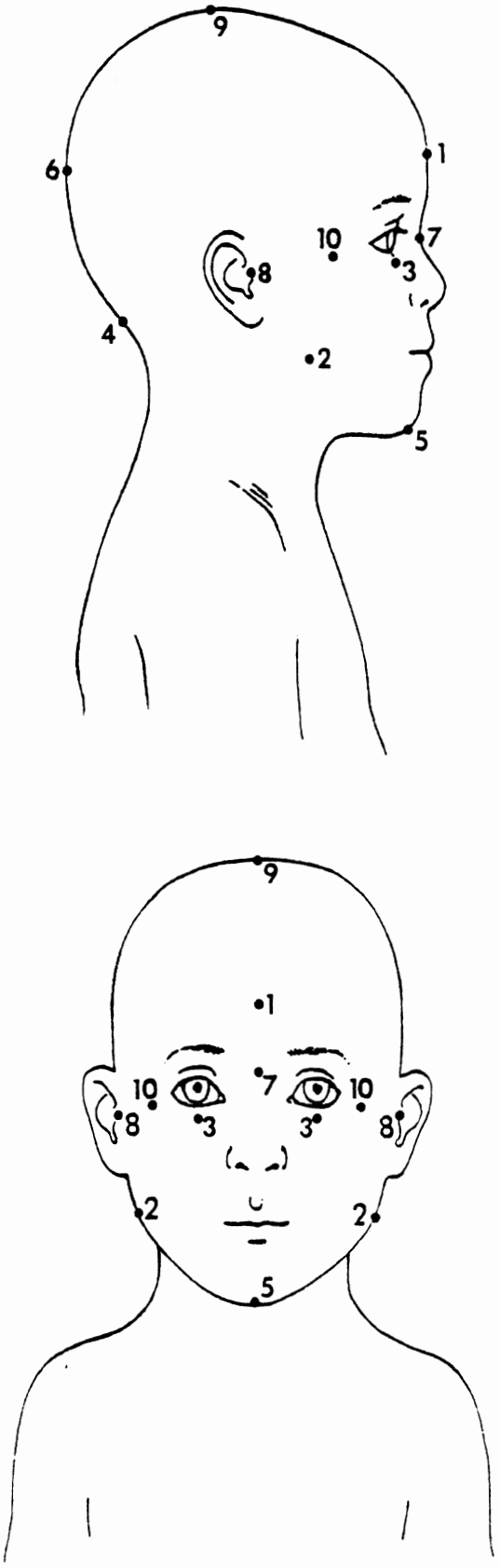


Figure II.2. Anatomical landmarks used in manual measurements. Numbers corrspond with Table II.3.

Table 11.4

Definitions of Anatomical Planes

Frankfort Plane

The standard head refernce plane that is used to describe the orientation of the head and to define the head anatomical coordinate system. Also known as the eye-ear plane, it is traditionally defined by the three anatomical landmarks - right and left tragion and left infraorbitale. It is approximately horizontal when a person stands looking straight ahead and it is approximately vertical when a person is lying on the back looking upward.

Midsagittal Plane

The plane parallel to the long axis of the body extending to the front and back in the midline so that it divides the body into a right and a left half.

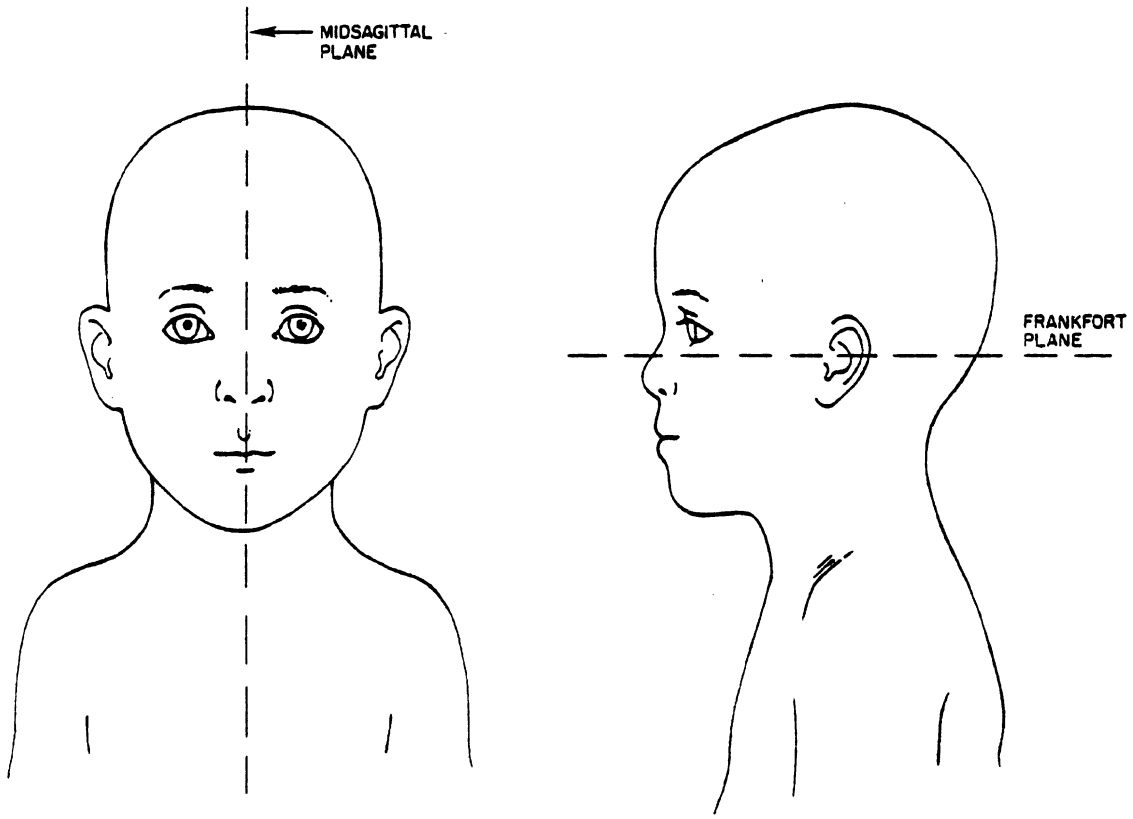


Figure 11.3 Midsagittal and Frankfort Planes

(1)

WEIGHT

The subject is weighed on a clinical scale with clothes and without shoes to the nearest half pound. The weights of infants who cannot stand are obtained by subtracting the weight of the parent from the weight of the parent plus infant.

(1)

Weight (Kg)

(Males and Females)

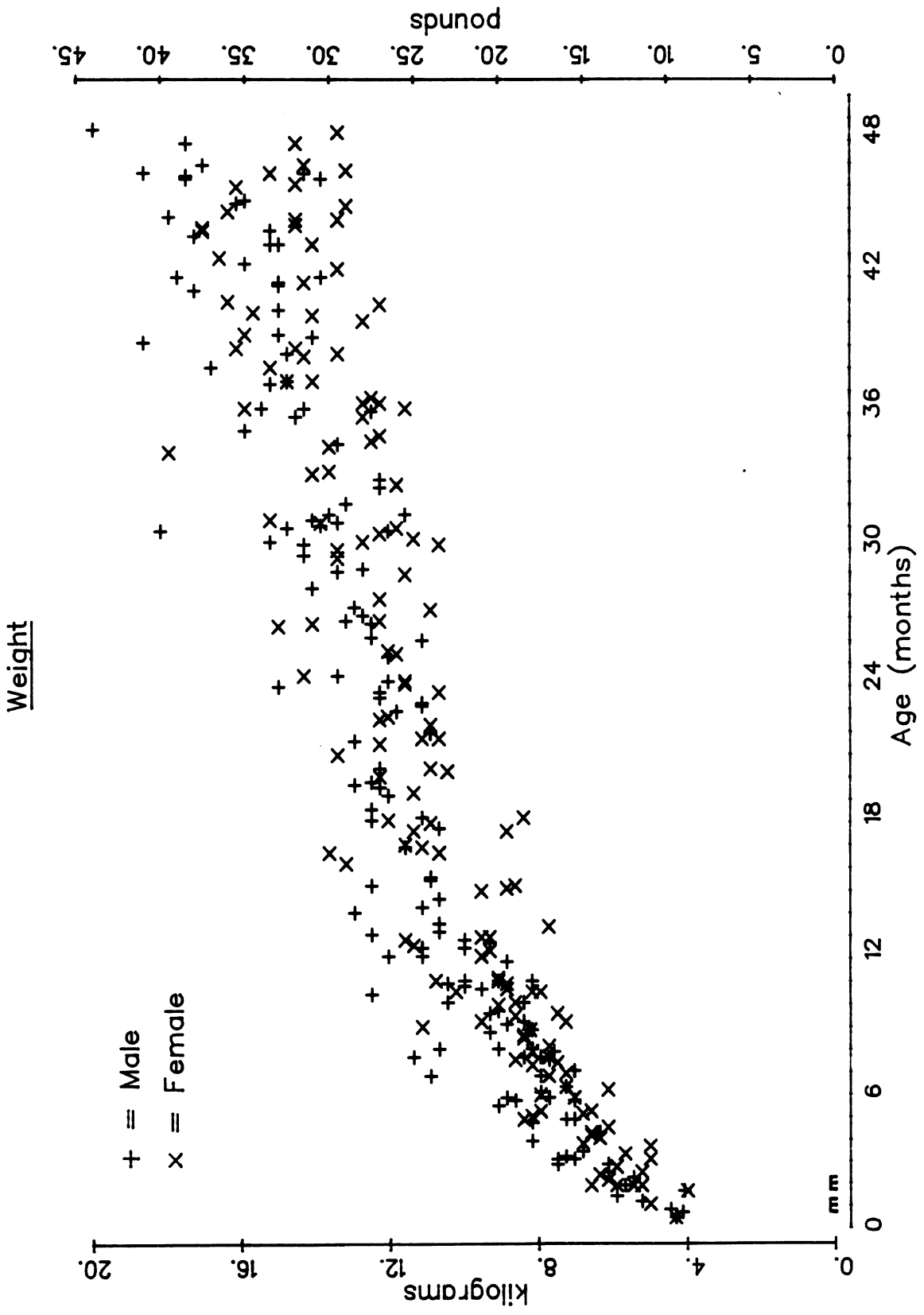
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	5.7	1.0	4.0	4.0	5.7	7.3	7.5
4-6	30	7.5	1.0	6.1	6.1	7.3	8.8	10.9
7-9	30	8.5	1.1	7.0	7.0	8.3	10.7	11.3
10-12	30	9.8	1.2	7.9	7.9	9.5	11.6	12.5
13-18	30	10.9	1.5	7.7	7.7	10.9	12.9	13.6
19-24	30	12.0	1.1	10.4	10.4	12.0	13.4	15.0
25-30	31	12.9	1.5	10.7	10.9	12.7	15.0	18.1
31-36	30	13.5	1.5	11.6	11.6	13.4	15.9	17.9
37-42	30	15.1	1.4	12.2	12.2	15.0	17.2	18.6
43-48	30	15.7	1.8	13.2	13.2	15.2	17.9	20.0

Weight (lb)

(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	12.5	2.3	8.8	8.8	12.5	16.0	16.5
4-6	30	16.6	2.3	13.5	13.5	16.0	19.5	24.0
7-9	30	18.8	2.3	15.5	15.5	18.2	23.5	25.0
10-12	30	21.5	2.6	17.5	17.5	21.0	25.5	27.5
13-18	30	24.0	3.3	17.0	17.0	24.0	28.5	30.0
19-24	30	26.5	2.4	23.0	23.0	26.5	29.5	33.0
25-30	31	28.5	3.4	23.5	24.0	28.0	33.0	40.0
31-36	30	29.9	3.2	25.5	25.5	29.5	35.0	39.5
37-42	30	33.2	3.2	27.0	27.0	33.0	38.0	41.0
43-48	30	34.5	3.9	29.0	29.0	33.5	39.5	44.0

(1)

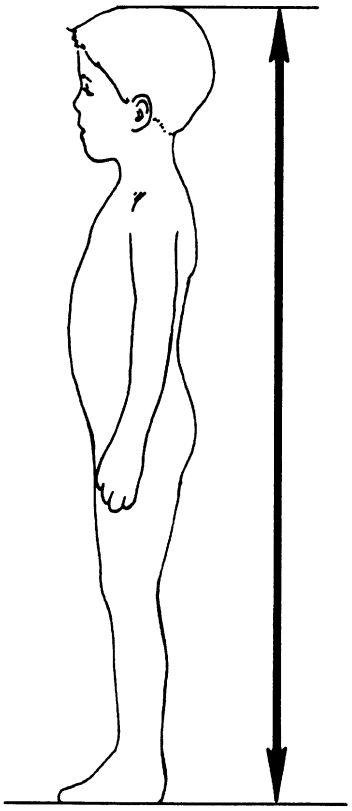

Weight
+ = Male
× = Female
Age (months)
0
6
12
18
24
30
36
42
48
mm
kilograms
0.
4.
8.
12.
16.
20.
pounds
0.
5.
10.
15.
20.
25.
30.
35.
40.
45.

STATURE

The subject stands erect looking straight ahead so that the Frankfort plane is approximately horizontal. With an anthropometer equipped with a paddle blade, measure the vertical distance from the standing surface to the top of the head (vertex).

CROWN-SOLE LENGTH

Crown-sole length is used for infants who are unable to stand. The infant lies on the back looking upward so that the Frankfort plane is approximately vertical. With the legs extended, use an anthropometer equipped with paddle blades to measure from the heel of the right foot to the top of the head (vertex).



(2)

Stature (cm)
(Crown-Sole Length)

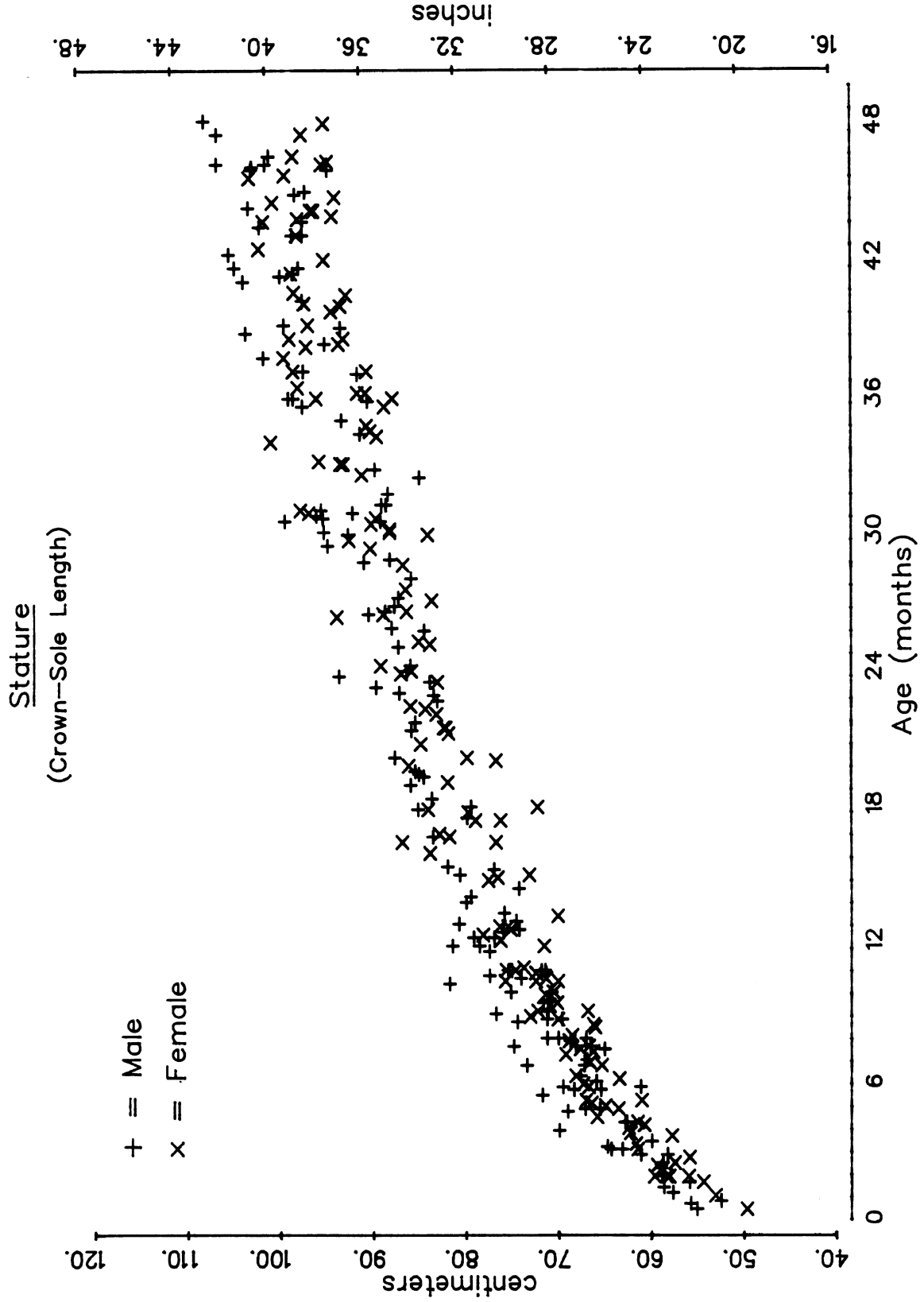
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	58.3	3.4	49.7	49.7	58.4	63.2	64.8
4-6	30	66.0	3.2	60.8	60.8	66.0	70.0	73.5
7-9	30	69.6	2.9	65.1	65.1	69.3	74.5	76.8
10-12	30	74.8	3.2	70.1	70.1	74.7	79.2	81.8
13-18	30	79.0	4.1	70.1	70.1	79.5	84.1	86.9
19-24	30	85.0	3.1	76.8	76.8	85.1	89.2	93.7
25-30	31	89.2	3.8	83.7	83.9	88.2	95.3	99.5
31-36	30	93.0	4.0	85.0	85.0	91.7	98.6	101.0
37-42	30	97.8	3.9	90.7	90.7	97.6	104.0	105.5
43-48	30	99.5	3.8	94.1	94.1	98.4	106.8	108.2

Stature (in)
(Crown-Sole Length)

(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	23.0	1.4	19.6	19.6	23.0	24.9	25.5
4-6	30	26.0	1.2	23.9	23.9	26.0	27.6	28.9
7-9	30	27.4	1.1	25.6	25.6	27.3	29.3	30.2
10-12	30	29.4	1.3	27.6	27.6	29.4	31.2	32.2
13-18	30	31.1	1.6	27.6	27.6	31.3	33.1	34.2
19-24	30	33.5	1.2	30.2	30.2	33.5	35.1	36.9
25-30	31	35.1	1.5	33.0	33.0	34.7	37.5	39.2
31-36	30	36.6	1.6	33.5	33.5	36.1	38.8	39.8
37-42	30	38.5	1.5	35.7	35.7	38.4	40.9	41.5
43-48	30	39.2	1.5	37.0	37.0	38.7	42.0	42.6


Stature
(Crown–Sole Length)
+ = Male
× = Female
centimeters
40. 50. 60. 70. 80. 90. 100. 110. 120.
inches
16. 20. 24. 28. 32. 36. 40. 44. 48.
Age (months)
0 6 12 18 24 30 36 42 48

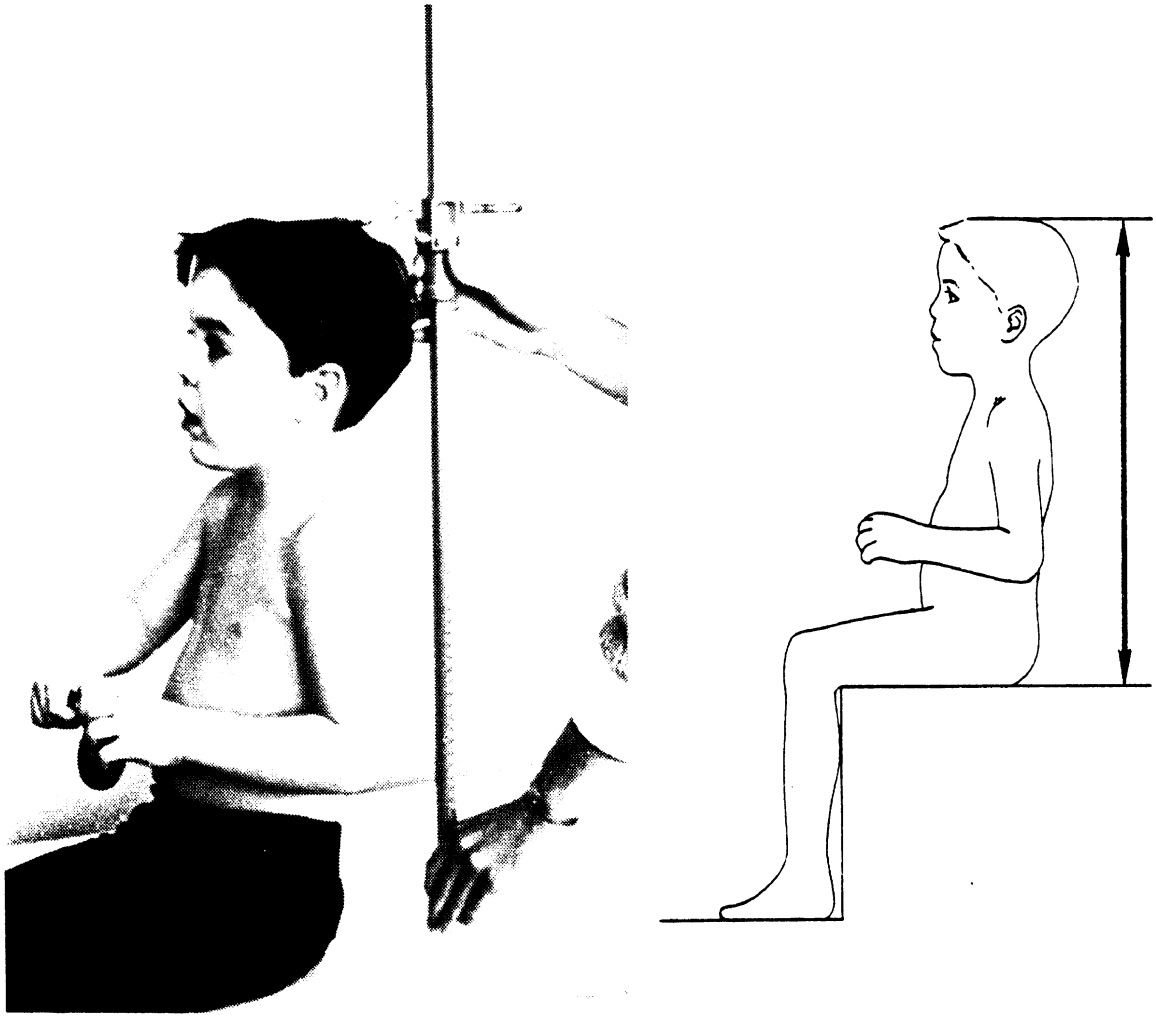
(3)

SITTING HEIGHT

The child sits with an erect posture and the head oriented so that the Frankfort plane is approximately horizontal. With an anthropometer equipped with a paddle blade, measure the vertical distance from the sitting surface to the top of the head (vertex).

CROWN-RUMP LENGTH

This measurement is used to approximate sitting height on infants who cannot sit up. The infant is positioned lying on the back looking up so that the Frankfort plane is approximately vertical. With the right leg flexed approximately ninety degrees, use an anthropometer equipped with paddle blades to measure the distance from the surface of the buttock to the top of the head (vertex). An assistant is required to position and hold the infant.



Sitting Height (cm)
(Crown Rump Length)

(Males and Females)

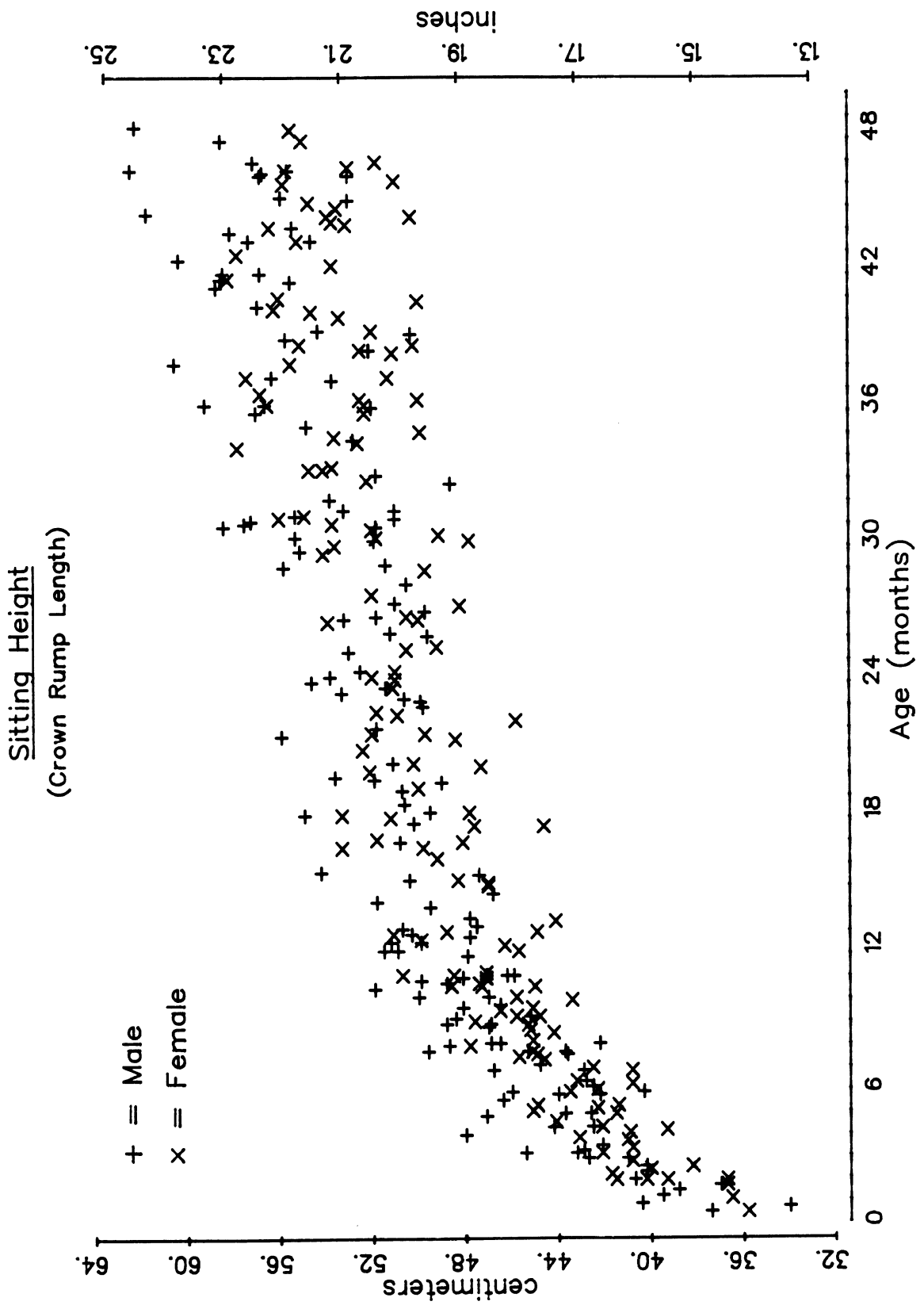
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	40.0	2.6	34.0	34.0	40.2	43.1	45.4
4-6	30	43.2	2.1	39.3	39.3	42.6	46.8	48.0
7-9	30	46.0	1.7	42.2	42.2	45.3	48.7	49.6
10-12	30	48.3	2.2	43.4	43.4	47.9	51.2	51.9
13-18	30	49.3	2.7	44.1	44.1	49.2	53.3	54.9
19-24	30	51.2	2.1	45.8	45.8	51.1	53.8	55.9
25-30	31	52.0	2.6	47.8	48.2	51.8	55.8	58.4
31-36	30	53.8	2.6	48.6	48.6	53.6	57.2	59.2
37-42	30	55.1	3.0	50.0	50.0	55.5	58.7	60.5
43-48	30	55.6	3.0	50.3	50.3	55.4	61.7	62.4

Sitting Height (in)
(Crown Rump Length)

(Males and Females)

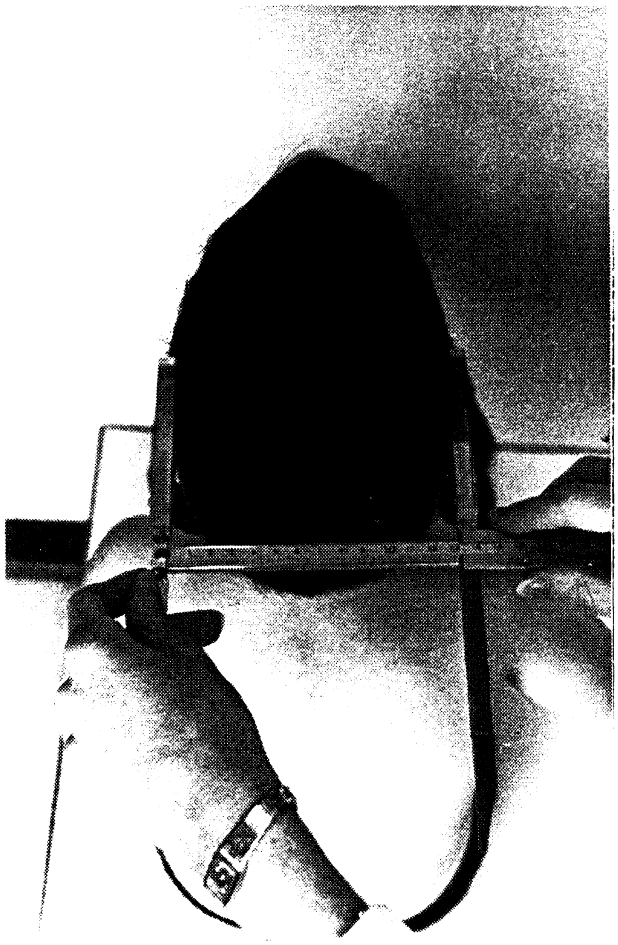
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	15.7	1.0	13.4	13.4	15.8	17.0	17.9
4-6	30	17.0	0.8	15.5	15.5	16.8	18.4	18.9
7-9	30	18.1	0.7	16.6	16.6	17.8	19.2	19.5
10-12	30	19.0	0.9	17.1	17.1	18.9	20.2	20.4
13-18	30	19.4	1.1	17.4	17.4	19.4	21.0	21.6
19-24	30	20.2	0.8	18.0	18.0	20.1	21.2	22.0
25-30	31	20.5	1.0	18.8	19.0	20.4	22.0	23.0
31-36	30	21.2	1.0	19.1	19.1	21.1	22.5	23.3
37-42	30	21.7	1.2	19.7	19.7	21.9	23.1	23.8
43-48	30	21.9	1.2	19.8	19.8	21.8	24.3	24.6

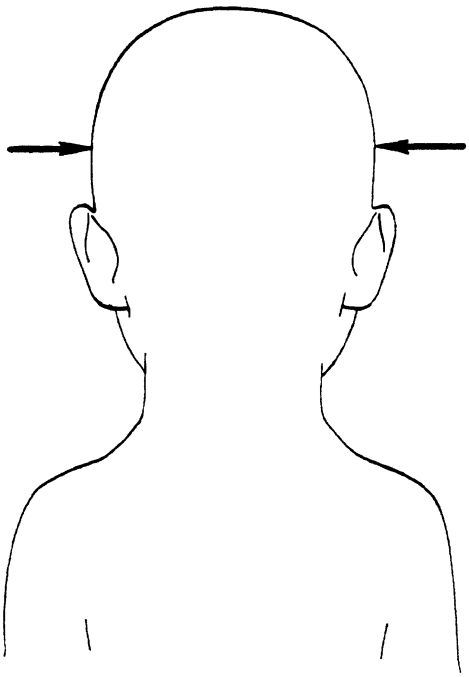
(3)


Sitting Height
(Crown Rump Length)
+ = Male
× = Female
centimeters
32. 36. 40. 44. 48. 52. 56. 60. 64.
inches
13. 15. 17. 19. 21. 23. 25.
Age (months)
0 6 12 18 24 30 36 42 48

MAXIMUM HEAD BREADTH

The subject is placed or held in a seated position. With sliding calipers equipped with paddle blades, measure the maximum breadth of the head above the ears.





(4)

Maximum Head Breadth (cm)

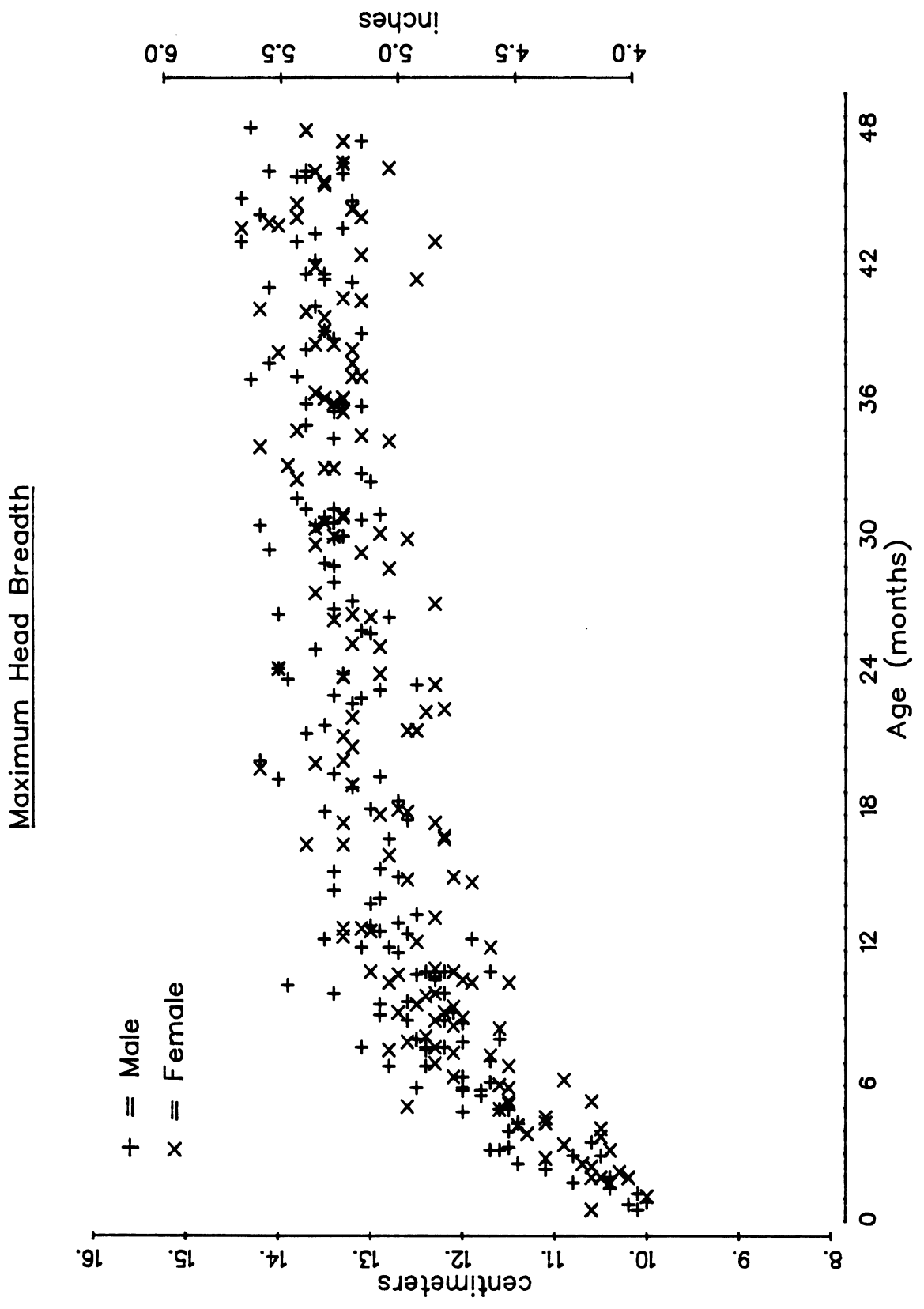
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	10.6	0.5	10.0	10.0	10.5	11.5	11.7
4-6	30	11.7	0.5	10.5	10.5	11.6	12.5	12.8
7-9	30	12.3	0.4	11.6	11.6	12.3	12.9	13.1
10-12	30	12.5	0.6	11.5	11.5	12.4	13.4	13.9
13-18	30	12.8	0.4	11.9	11.9	12.8	13.4	13.7
19-24	30	13.2	0.6	12.2	12.2	13.2	14.0	14.2
25-30	31	13.3	0.4	12.3	12.6	13.4	14.0	14.2
31-36	30	13.4	0.3	12.8	12.8	13.4	13.8	14.2
37-42	30	13.5	0.4	12.5	12.5	13.5	14.1	14.3
43-48	30	13.6	0.5	12.3	12.3	13.6	14.4	14.4

Maximum Head Breadth (in)

(Males and Females)

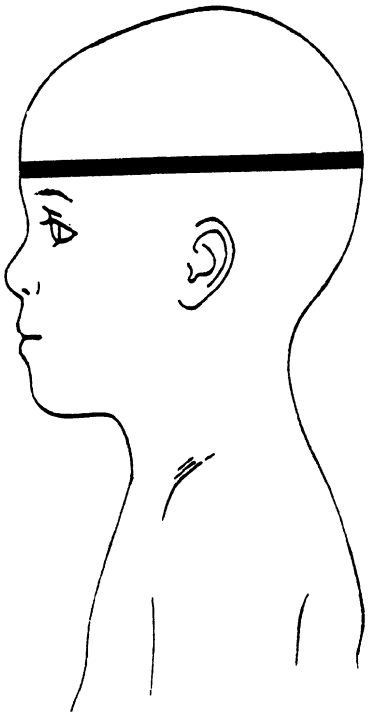
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	4.2	0.2	3.9	3.9	4.1	4.5	4.6
4-6	30	4.6	0.2	4.1	4.1	4.6	4.9	5.0
7-9	30	4.8	0.2	4.6	4.6	4.8	5.1	5.2
10-12	30	4.9	0.2	4.5	4.5	4.9	5.3	5.5
13-18	30	5.0	0.2	4.7	4.7	5.0	5.3	5.4
19-24	30	5.2	0.2	4.8	4.8	5.2	5.5	5.6
25-30	31	5.2	0.2	4.8	5.0	5.3	5.5	5.6
31-36	30	5.3	0.1	5.0	5.0	5.3	5.4	5.6
37-42	30	5.3	0.2	4.9	4.9	5.3	5.6	5.6
43-48	30	5.4	0.2	4.8	4.8	5.4	5.7	5.7


Maximum Head Breadth
+ = Male
× = Female
centimeters
8.
9.
10.
11.
12.
13.
14.
15.
16.
inches
4.0
4.5
5.0
5.5
6.0
Age (months)
0
6
12
18
24
30
36
42
48

(5)

HEAD CIRCUMFERENCE

The subject is placed or held in a seated position. With a cloth measuring tape, measure the circumference of the head in a plane perpendicular to the midsagittal plane passing through the point of greatest protrusion on the forehead (glabella) and the point of greatest protrusion on the back of the head (opisthocranion). A band is placed around the head to mark the location of this circumference.



Head Circumference (cm)

(Males and Females)

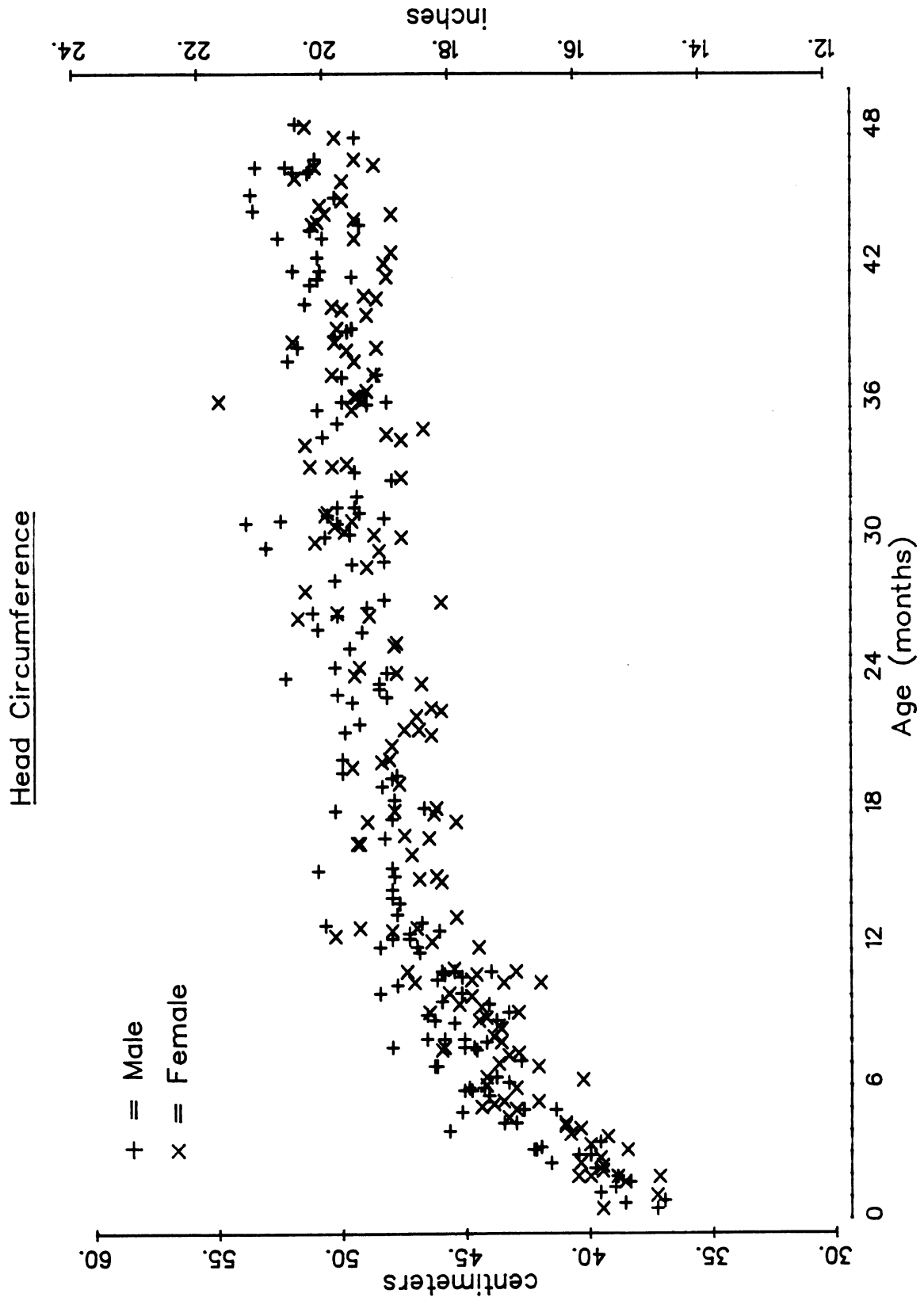
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	39.5	1.4	37.0	37.0	39.5	42.0	42.3
4-6	30	43.5	1.6	40.3	40.3	43.5	45.7	46.3
7-9	30	44.8	1.3	42.8	42.8	44.5	46.6	48.0
10-12	30	46.1	1.8	42.0	42.0	46.0	48.5	50.3
13-18	30	47.8	1.5	45.4	45.4	47.8	50.3	51.0
19-24	30	48.5	1.4	46.0	46.0	48.2	50.2	52.3
25-30	31	49.9	1.7	46.0	47.6	49.7	52.5	53.9
31-36	30	49.7	1.5	46.7	46.7	49.5	51.3	55.0
37-42	30	50.0	1.2	48.0	48.0	50.0	52.0	52.2
43-48	30	50.9	1.4	48.0	48.0	51.0	53.5	53.7

Head Circumference (in)

(Males and Females)

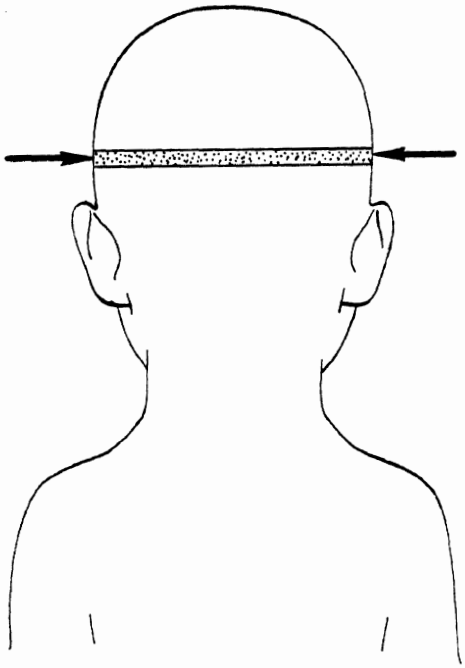
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	15.6	0.6	14.6	14.6	15.6	16.5	16.7
4-6	30	17.1	0.6	15.9	15.9	17.1	18.0	18.2
7-9	30	17.6	0.5	16.9	16.9	17.5	18.3	18.9
10-12	30	18.1	0.7	16.5	16.5	18.1	19.1	19.8
13-18	30	18.8	0.6	17.9	17.9	18.8	19.8	20.1
19-24	30	19.1	0.6	18.1	18.1	19.0	19.8	20.6
25-30	31	19.6	0.7	18.1	18.7	19.6	20.7	21.2
31-36	30	19.6	0.6	18.4	18.4	19.5	20.2	21.7
37-42	30	19.7	0.5	18.9	18.9	19.7	20.5	20.6
43-48	30	20.1	0.6	18.9	18.9	20.1	21.1	21.1

(5)


Head Circumference
+ = Male
× = Female
centimeters
60.
55.
50.
45.
40.
35.
30.
inches
24.
22.
20.
18.
16.
14.
12.
Age (months)
0
6
12
18
24
30
36
42
48

HEAD BREADTH AT CIRCUMFERENCE

The subject is placed or held in a seated position. With sliding calipers equipped with paddle blades, measure the maximum breadth of the head on the head circumference band.



(6)

Head Breadth at Circumference (cm)

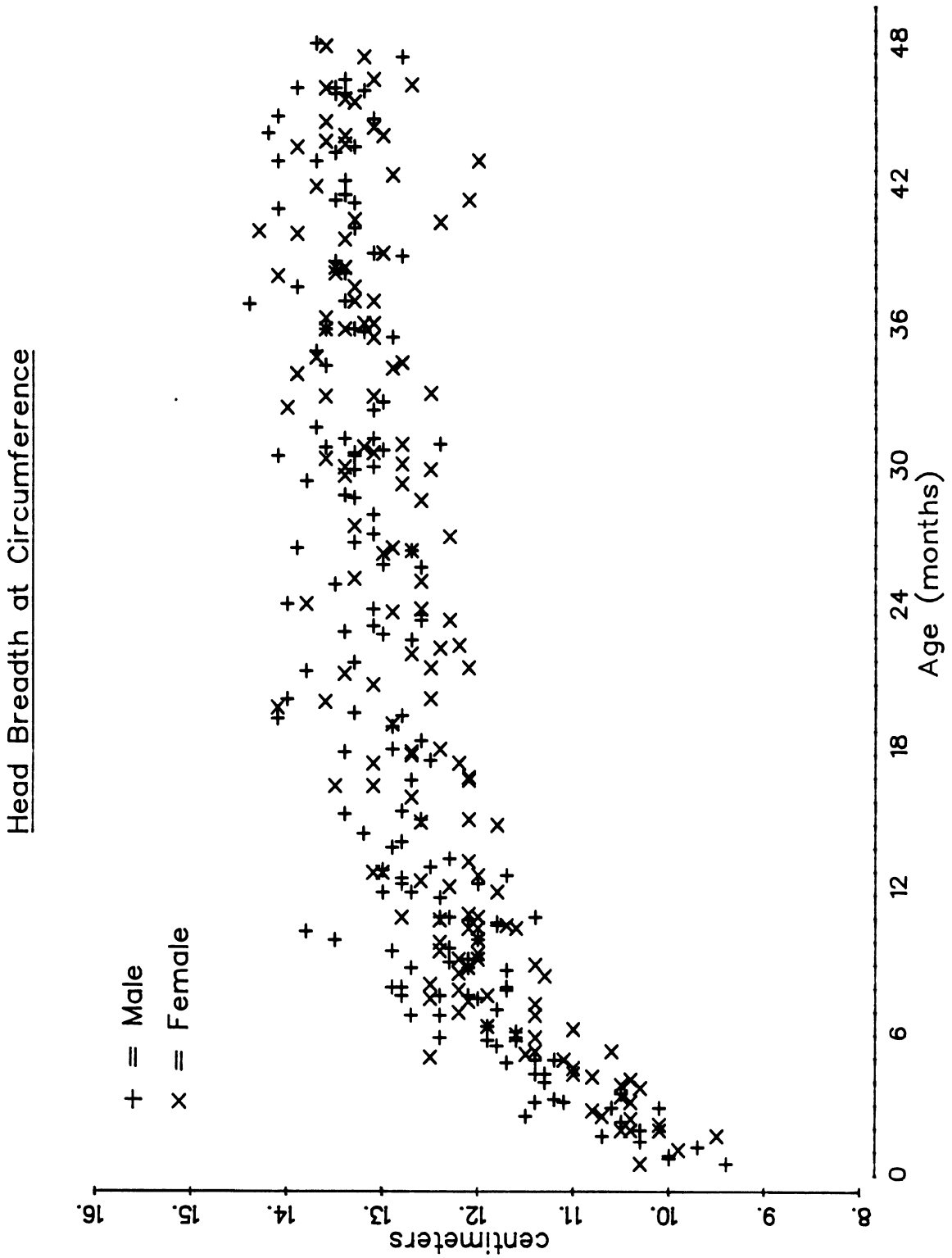
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	10.4	0.5	9.4	9.4	10.4	11.2	11.5
4-6	30	11.5	0.6	10.4	10.4	11.4	12.4	12.7
7-9	30	12.1	0.4	11.3	11.3	12.1	12.8	12.9
10-12	30	12.3	0.5	11.4	11.4	12.1	13.0	13.8
13-18	30	12.7	0.4	11.8	11.8	12.7	13.4	13.5
19-24	30	13.1	0.6	12.1	12.1	12.9	14.0	14.1
25-30	31	13.1	0.4	12.3	12.5	13.1	13.8	14.1
31-36	30	13.3	0.4	12.4	12.4	13.2	13.7	14.0
37-42	30	13.4	0.5	12.1	12.1	13.4	14.1	14.4
43-48	30	13.4	0.4	12.0	12.0	13.4	14.1	14.2

Head Breadth at Circumference (in)

(Males and Females)

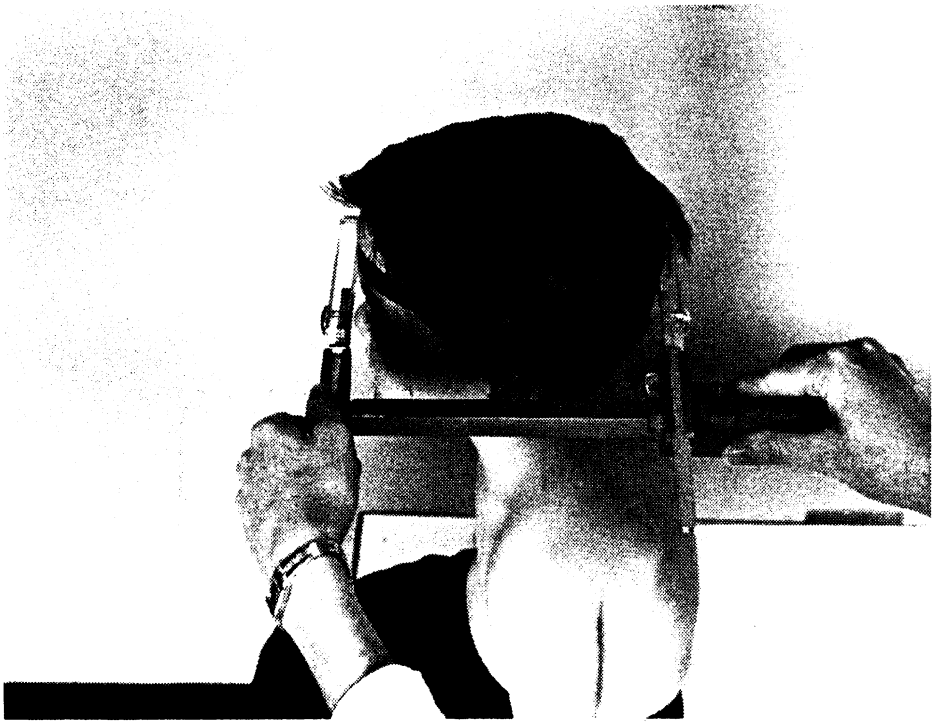
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	4.1	0.2	3.7	3.7	4.1	4.4	4.5
4-6	30	4.5	0.2	4.1	4.1	4.5	4.9	5.0
7-9	30	4.8	0.2	4.4	4.4	4.8	5.0	5.1
10-12	30	4.8	0.2	4.5	4.5	4.8	5.1	5.4
13-18	30	5.0	0.2	4.6	4.6	5.0	5.3	5.3
19-24	30	5.1	0.2	4.8	4.8	5.1	5.5	5.6
25-30	31	5.2	0.2	4.8	4.9	5.2	5.4	5.6
31-36	30	5.2	0.2	4.9	4.9	5.2	5.4	5.5
37-42	30	5.3	0.2	4.8	4.8	5.3	5.6	5.7
43-48	30	5.3	0.2	4.7	4.7	5.3	5.6	5.6

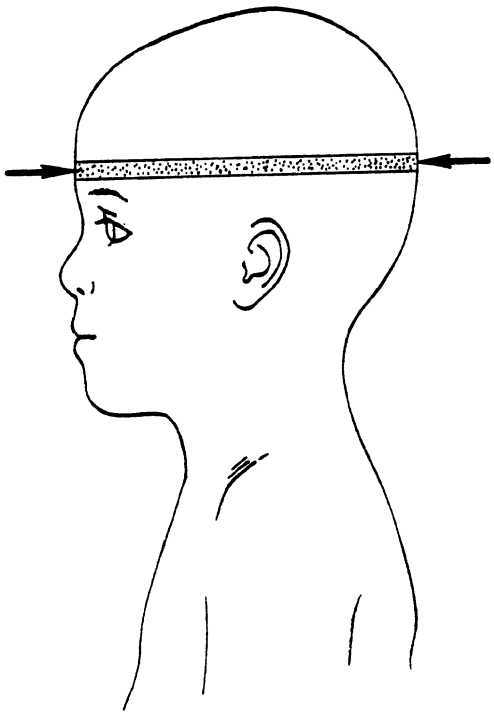

Head Breadth at Circumference
+ = Male
× = Female
centimeters
8. 9. 10. 11. 12. 13. 14. 15. 16.
inches
3.6 4.0 4.4 4.8 5.2 5.6 6.0
Age (months)
0 6 12 18 24 30 36 42 48

(7)

HEAD LENGTH
(Glabella-to-Opisthocranion Distance)

The subject is placed or held in a seated position. With sliding calipers equipped with paddle blades, measure the distance in the midsagittal plane from the point of greatest protrusion on the forehead (glabella) to the point of greatest protrusion on the back of the head (opisthocranion).





Head Length (cm)
(Glabella to Opisthocranion Distance)

(Males and Females)

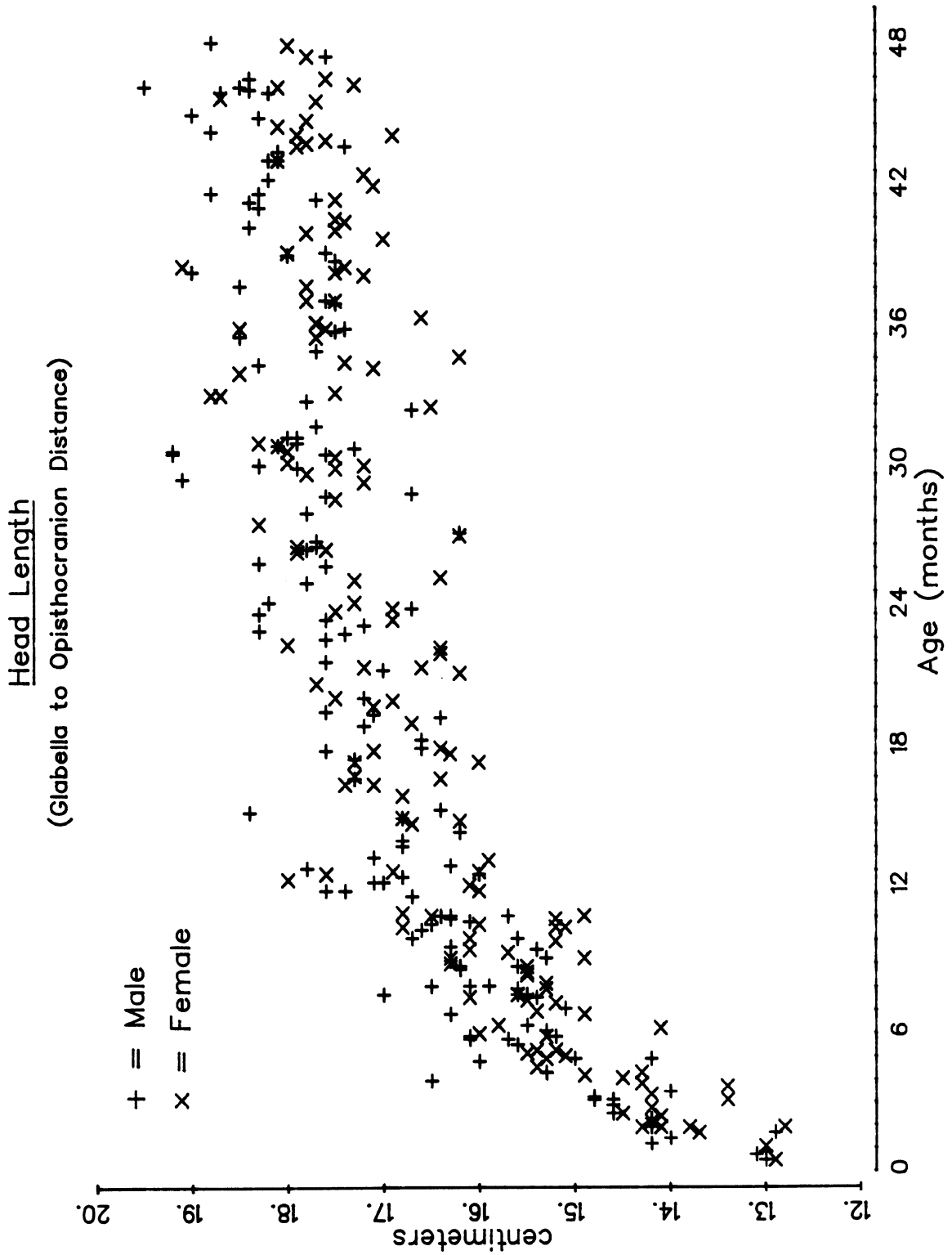
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	13.9	0.6	12.8	12.8	14.1	14.6	14.8
4-6	30	15.4	0.6	14.1	14.1	15.3	16.3	16.5
7-9	30	15.8	0.5	14.9	14.9	15.6	16.3	17.0
10-12	30	16.3	0.8	14.9	14.9	16.3	17.6	18.0
13-18	30	16.8	0.6	15.9	15.9	16.8	17.6	18.4
19-24	30	17.2	0.6	16.2	16.2	17.2	18.2	18.3
25-30	31	17.7	0.7	16.2	16.2	17.7	19.1	19.2
31-36	30	17.7	0.6	16.2	16.2	17.7	18.5	18.8
37-42	30	17.8	0.6	17.0	17.0	17.6	18.8	19.1
43-48	30	18.1	0.5	16.9	16.9	18.1	18.8	19.5

Head Length (in)
(Glabella to Opisthocranion Distance)

(Males and Females)

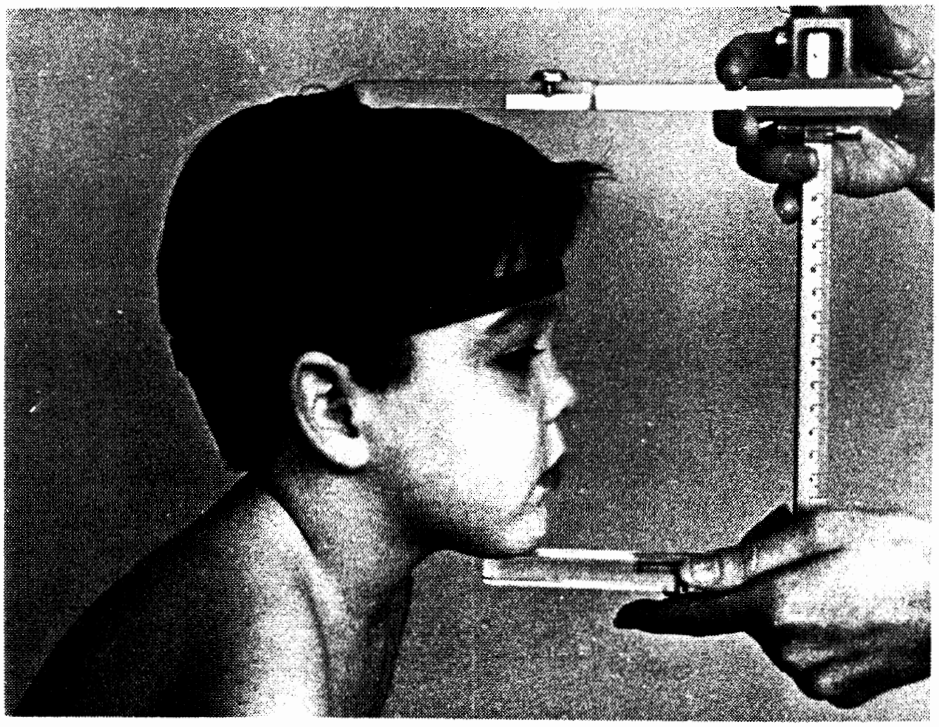
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	5.5	0.3	5.0	5.0	5.6	5.7	5.8
4-6	30	6.1	0.2	5.6	5.6	6.0	6.4	6.5
7-9	30	6.2	0.2	5.9	5.9	6.1	6.4	6.7
10-12	30	6.4	0.3	5.9	5.9	6.4	6.9	7.1
13-18	30	6.6	0.2	6.3	6.3	6.6	6.9	7.2
19-24	30	6.8	0.2	6.4	6.4	6.8	7.2	7.2
25-30	31	7.0	0.3	6.4	6.4	7.0	7.5	7.6
31-36	30	7.0	0.3	6.4	6.4	7.0	7.3	7.4
37-42	30	7.0	0.2	6.7	6.7	6.9	7.4	7.5
43-48	30	7.1	0.2	6.7	6.7	7.1	7.4	7.7

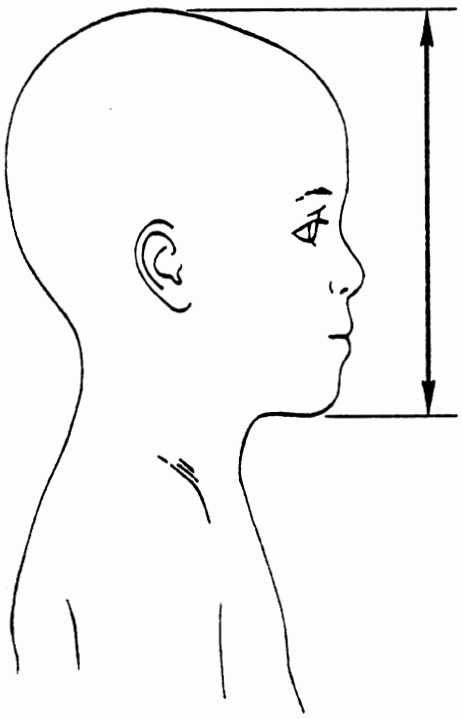
(7)


Head Length
(Glabella to Opisthocranion Distance)
+ = Male
× = Female
centimeters
12.
13.
14.
15.
16.
17.
18.
19.
20.
inches
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Age (months)
0
6
12
18
24
30
36
42
48

HEAD HEIGHT
(Menton-to-Vertex Distance)

The subject is placed or held in a seated position with the mouth closed. With an anthropometer equipped with paddle blades, measure the height of the head from the tip of the chin (menton) to the highest point at the top of the head (vertex). The measurement is taken approximately perpendicular to the Frankfort plane in the midsagittal plane.





(8)

Head Height (cm)
(Menton to Vertex Distance)

(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	13.6	1.0	11.8	11.8	13.5	14.8	15.7
4-6	30	14.5	0.8	12.5	12.5	14.4	15.7	16.4
7-9	30	15.1	0.9	13.2	13.2	14.9	16.3	17.1
10-12	30	15.8	0.9	14.4	14.4	15.8	17.2	17.4
13-18	30	16.3	0.8	15.0	15.0	16.2	17.5	17.8
19-24	30	16.8	0.6	15.6	15.6	16.8	17.7	17.8
25-30	31	17.3	0.9	14.6	16.0	17.3	18.6	19.3
31-36	30	17.5	0.9	15.9	15.9	17.6	18.9	19.6
37-42	30	17.9	1.1	15.4	15.4	17.8	19.7	20.4
43-48	30	17.7	0.9	15.5	15.5	17.6	18.8	20.4

Head Height (in)
(Menton to Vertex Distance)

(Males and Females)

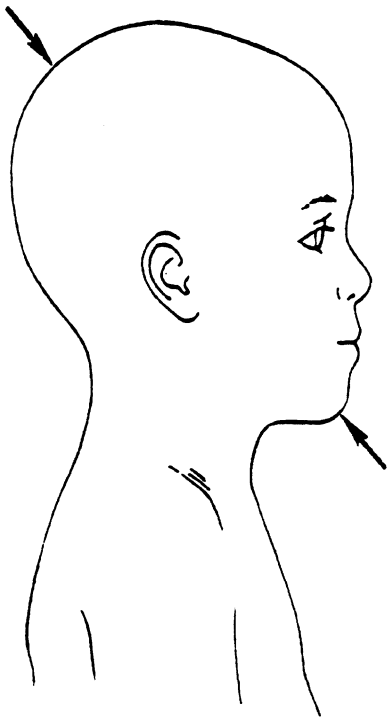
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	5.4	0.4	4.6	4.6	5.3	5.8	6.2
4-6	30	5.7	0.3	4.9	4.9	5.7	6.2	6.5
7-9	30	5.9	0.4	5.2	5.2	5.9	6.4	6.7
10-12	30	6.2	0.3	5.7	5.7	6.2	6.8	6.9
13-18	30	6.4	0.3	5.9	5.9	6.4	6.9	7.0
19-24	30	6.6	0.2	6.1	6.1	6.6	7.0	7.0
25-30	31	6.8	0.4	5.7	6.3	6.8	7.3	7.6
31-36	30	6.9	0.3	6.3	6.3	6.9	7.4	7.7
37-42	30	7.0	0.4	6.1	6.1	7.0	7.8	8.0
43-48	30	7.0	0.4	6.1	6.1	6.9	7.4	8.0

Head Height
(Menton to Vertex Distance)
+ = Male
× = Female
centimeters
10.
12.
14.
16.
18.
20.
22.
inches
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Age (months)
0
6
12
18
24
30
36
42
48

(9)

TIP-OF-CHIN to BACK-OF-HEAD DISTANCE
(Menton to Back-of-Head Distance)

The subject is placed or held in a seated position with the mouth closed. With an anthropometer equipped with paddle blades, measure the maximum distance in the midsagittal plane from the tip of the chin (menton) to the furthest point from the chin on the back of the head



Tip-of-Chin to Back-of-Head Distance (cm)
(Menton to Back-of-Head Distance)

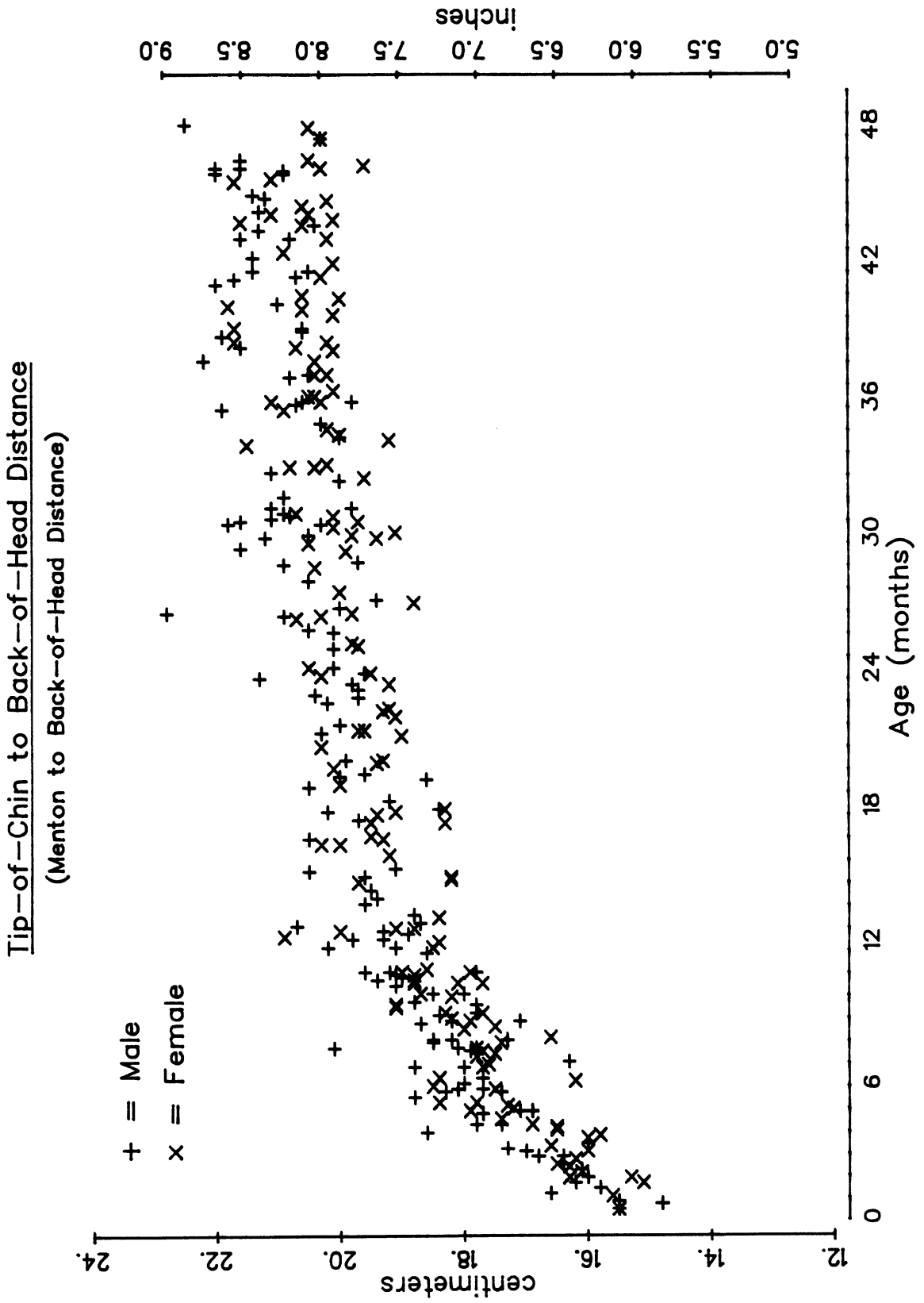
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	16.1	0.6	14.8	14.8	16.1	17.0	17.3
4-6	30	17.7	0.7	16.2	16.2	17.7	18.6	18.8
7-9	30	18.0	0.7	16.3	16.3	17.9	19.1	20.1
10-12	30	18.9	0.7	17.7	17.7	18.8	20.0	20.9
13-18	30	19.3	0.7	18.2	18.2	19.3	20.5	20.7
19-24	30	19.8	0.6	18.6	18.6	19.7	20.5	21.3
25-30	31	20.3	0.8	18.8	19.1	20.1	21.6	22.8
31-36	30	20.5	0.6	19.2	19.2	20.4	21.1	21.9
37-42	30	20.9	0.7	20.0	20.0	20.6	21.9	22.2
43-48	30	21.0	0.7	19.6	19.6	20.9	22.0	22.5

Tip-of-Chin to Back-of-Head Distance (in)
(Menton to Back-of-Head Distance)

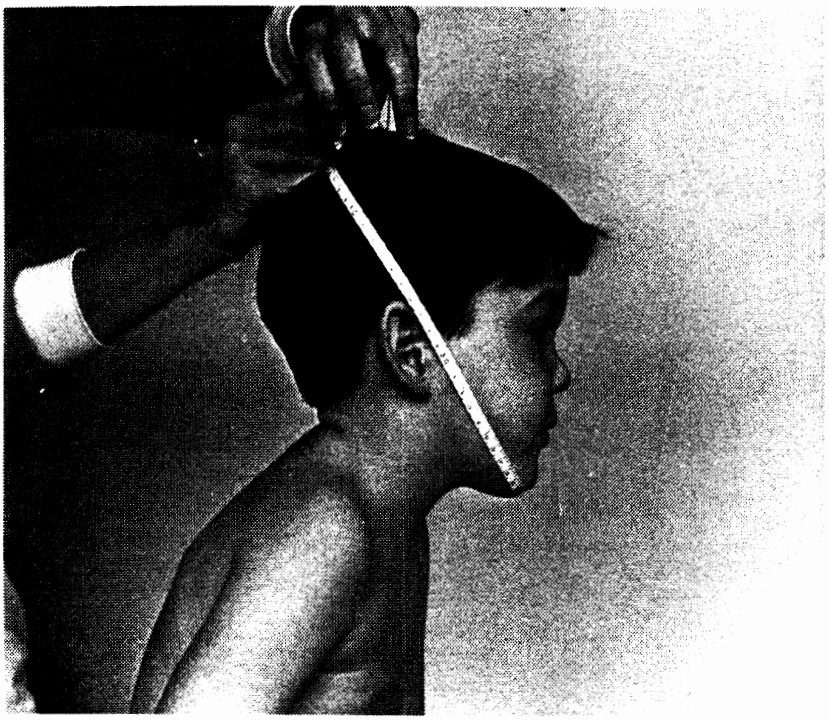
(Males and Females)

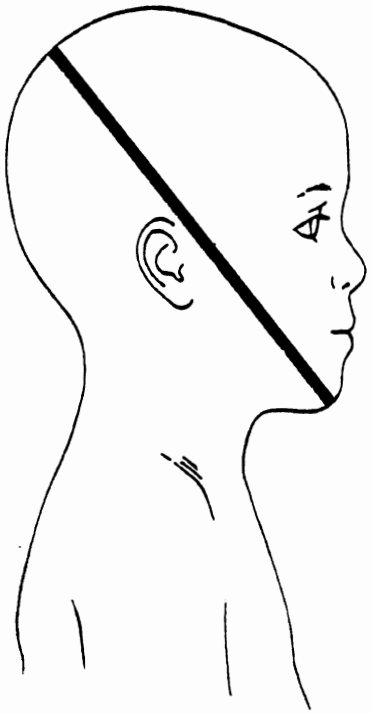
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	6.3	0.2	5.8	5.8	6.3	6.7	6.8
4-6	30	7.0	0.3	6.4	6.4	7.0	7.3	7.4
7-9	30	7.1	0.3	6.4	6.4	7.0	7.5	7.9
10-12	30	7.4	0.3	7.0	7.0	7.4	7.9	8.2
13-18	30	7.6	0.3	7.2	7.2	7.6	8.1	8.1
19-24	30	7.8	0.2	7.3	7.3	7.8	8.1	8.4
25-30	31	8.0	0.3	7.4	7.5	7.9	8.5	9.0
31-36	30	8.1	0.2	7.6	7.6	8.0	8.3	8.6
37-42	30	8.2	0.3	7.9	7.9	8.1	8.6	8.7
43-48	30	8.3	0.3	7.7	7.7	8.2	8.7	8.9


Tip-of-Chin to Back-of-Head Distance
(Menton to Back-of-Head Distance)
+ = Male
× = Female
centimeters
12. 14. 16. 18. 20. 22. 24.
inches
5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0
Age (months)
0 6 12 18 24 30 36 42 48

TIP-OF-CHIN to BACK-OF-HEAD CIRCUMFERENCE
(Menton to Back-of-Head Circumference)

The subject is placed or held in a seated position with the mouth closed. With a cloth measuring tape, measure the circumference of the head in a plane passing through the tip of the chin (menton) and the furthest point from the chin on the back of the head.





(10)

Tip-of-Chin to Back-of-Head Circumference (cm)
(Menton to Back-of-Head Circumference)

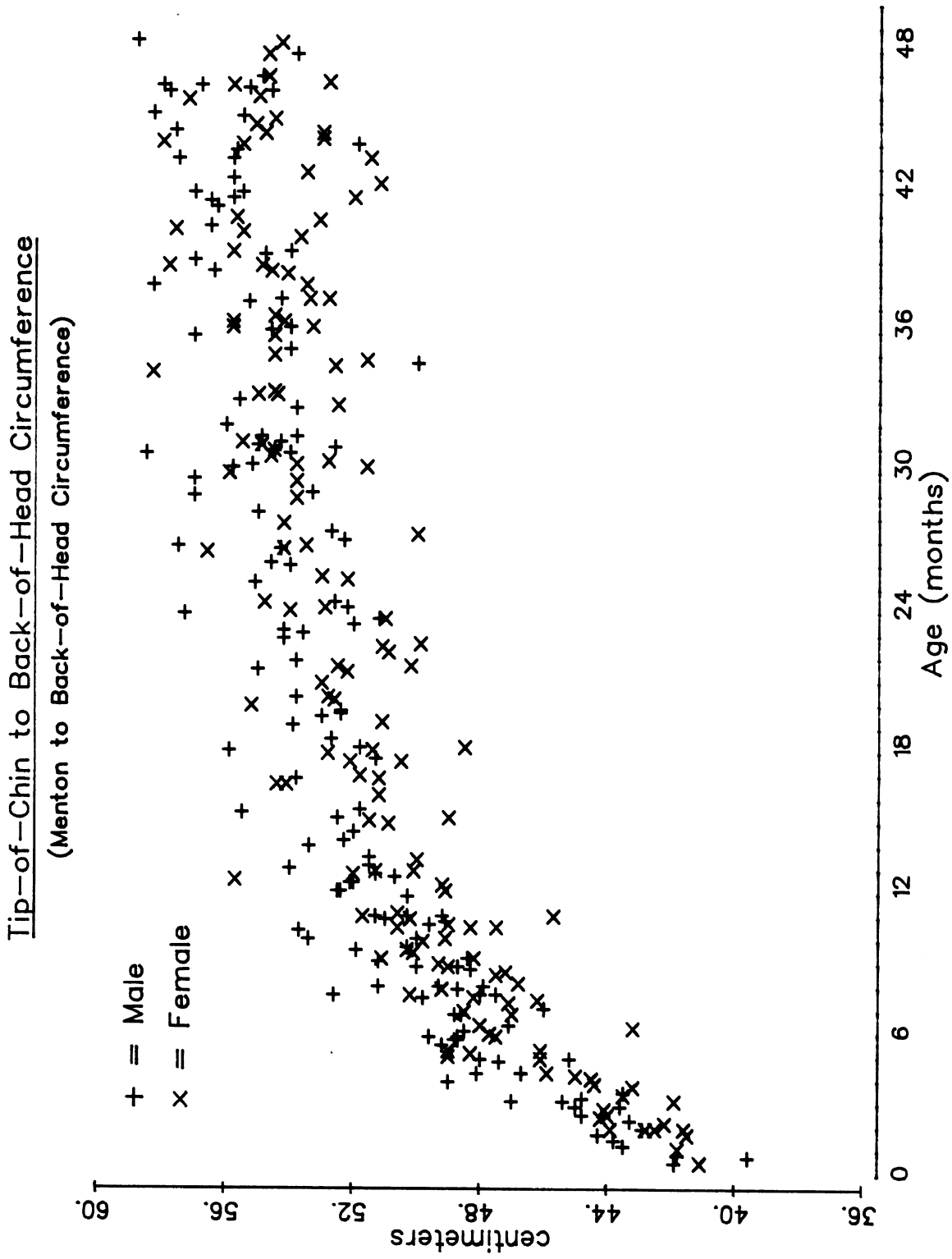
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	43.3	1.5	39.6	39.6	43.5	45.0	47.0
4-6	29	47.5	1.6	43.2	43.2	48.0	49.2	49.6
7-9	30	49.0	1.7	46.0	46.0	48.7	51.2	52.6
10-12	30	50.6	2.0	45.7	45.7	50.3	53.4	55.7
13-18	30	52.0	1.7	48.5	48.5	51.8	54.4	55.9
19-24	30	52.9	1.6	49.9	49.9	52.6	55.0	57.3
25-30	31	54.4	1.8	50.0	51.6	54.2	57.0	58.5
31-36	30	54.4	1.6	50.0	50.0	54.5	56.0	58.3
37-42	30	55.1	1.7	51.2	51.2	55.3	57.6	58.3
43-48	30	55.4	1.9	51.5	51.5	55.1	58.0	58.8

Tip-of-Chin to Back-of-Head Circumference (in)
(Menton to Back-of-Head Circumference)

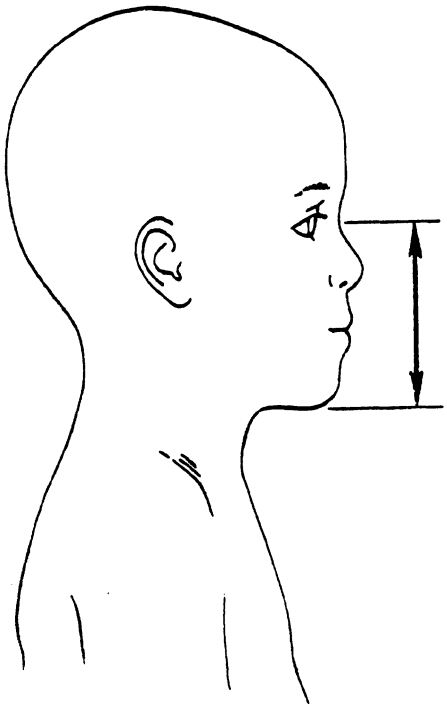
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	17.0	0.6	15.6	15.6	17.1	17.7	18.5
4-6	29	18.7	0.6	17.0	17.0	18.9	19.4	19.5
7-9	30	19.3	0.7	18.1	18.1	19.2	20.2	20.7
10-12	30	19.9	0.8	18.0	18.0	19.8	21.0	21.9
13-18	30	20.5	0.7	19.1	19.1	20.4	21.4	22.0
19-24	30	20.8	0.6	19.6	19.6	20.7	21.7	22.6
25-30	31	21.4	0.7	19.7	20.3	21.3	22.4	23.0
31-36	30	21.4	0.6	19.7	19.7	21.5	22.0	23.0
37-42	30	21.7	0.7	20.2	20.2	21.8	22.7	23.0
43-48	30	21.8	0.8	20.3	20.3	21.7	22.8	23.1


Tip-of-Chin to Back-of-Head Circumference
(Menton to Back-of-Head Circumference)
+ = Male
× = Female
centimeters
36. 40. 44. 48. 52. 56. 60.
inches
15. 16. 17. 18. 19. 20. 21. 22. 23.
Age (months)
0 6 12 18 24 30 36 42 48

LOWER FACE HEIGHT
(Menton-to-Sellion Distance)

The subject is placed or held in a seated position with the mouth closed. With sliding calipers equipped with paddle blades, measure the distance from the point of deepest indentation above the nose (sellion) to the tip of the chin (menton).



Lower Face Height (cm)
(Menton to Sellion Distance)

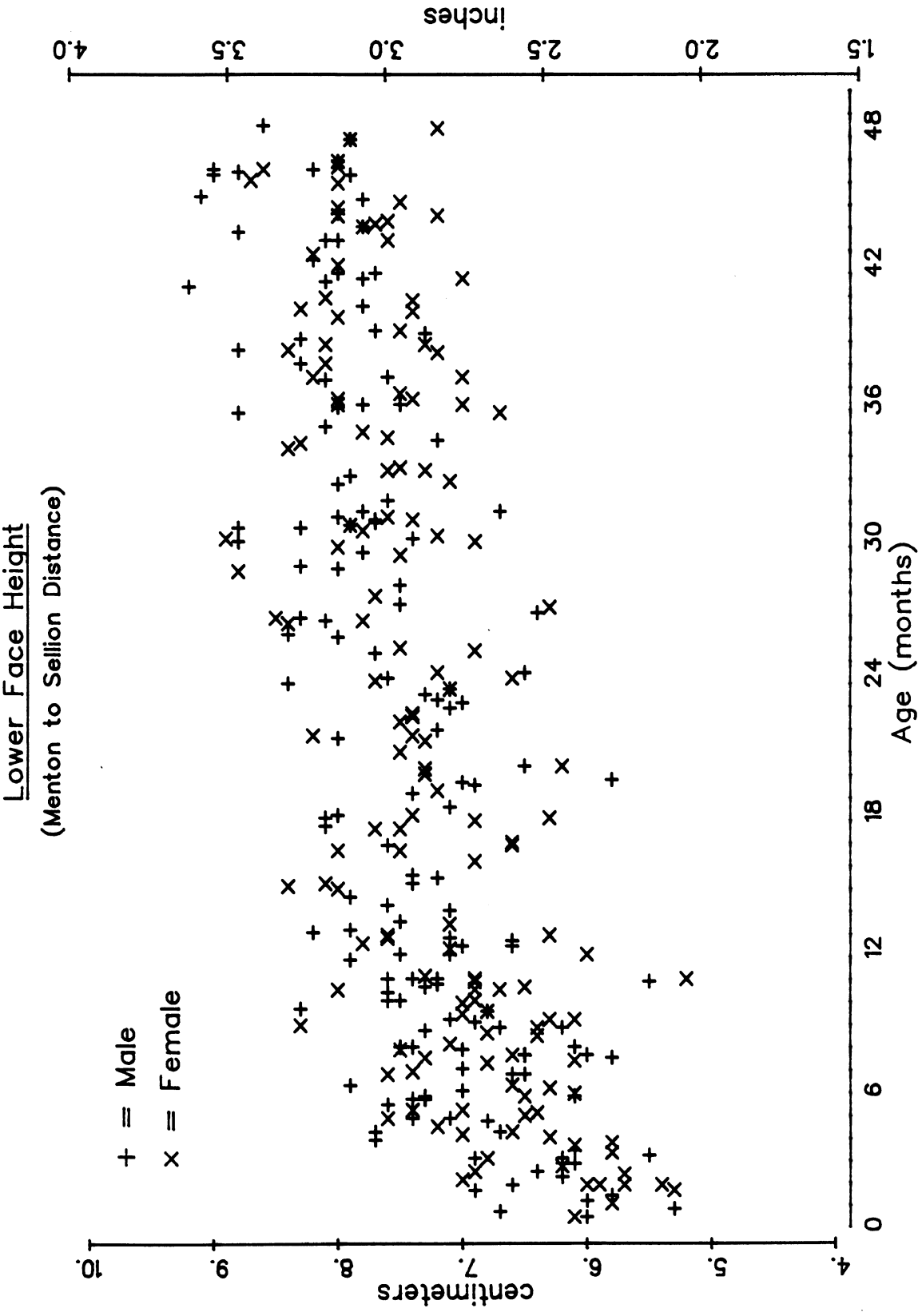
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	6.1	0.5	5.3	5.3	6.1	6.9	7.0
4-6	30	7.0	0.5	6.1	6.1	7.0	7.7	7.9
7-9	30	6.8	0.6	5.8	5.8	6.8	7.5	8.3
10-12	30	7.0	0.6	5.2	5.2	7.1	7.8	8.0
13-18	30	7.5	0.6	6.3	6.3	7.5	8.1	8.4
19-24	30	7.2	0.5	5.8	5.8	7.2	8.0	8.4
25-30	31	7.8	0.7	6.3	6.4	7.9	8.8	8.9
31-36	30	7.7	0.5	6.7	6.7	7.6	8.3	8.8
37-42	30	7.9	0.5	7.0	7.0	8.0	8.4	9.2
43-48	30	8.1	0.5	7.2	7.2	8.0	9.0	9.1

Lower Face Height (in)
(Menton to Sellion Distance)

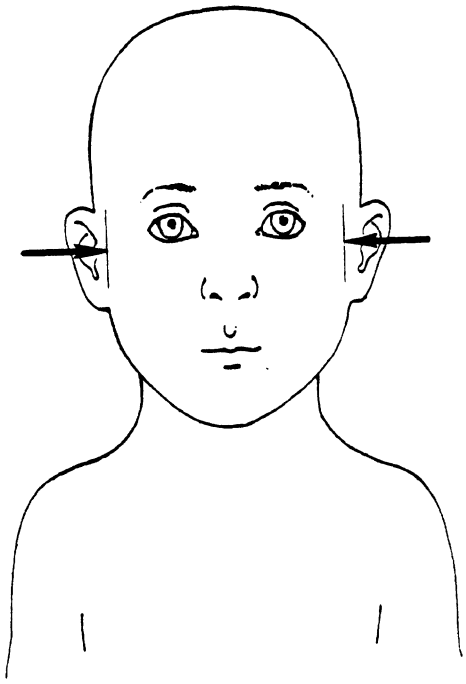
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	2.4	0.2	2.1	2.1	2.4	2.7	2.8
4-6	30	2.8	0.2	2.4	2.4	2.8	3.0	3.1
7-9	30	2.7	0.2	2.3	2.3	2.7	3.0	3.3
10-12	30	2.8	0.3	2.0	2.0	2.8	3.1	3.1
13-18	30	2.9	0.2	2.5	2.5	3.0	3.2	3.3
19-24	30	2.8	0.2	2.3	2.3	2.8	3.1	3.3
25-30	31	3.1	0.3	2.5	2.5	3.1	3.5	3.5
31-36	30	3.0	0.2	2.6	2.6	3.0	3.3	3.5
37-42	30	3.1	0.2	2.8	2.8	3.1	3.3	3.6
43-48	30	3.2	0.2	2.8	2.8	3.1	3.5	3.6


Lower Face Height
(Menton to Sellion Distance)
+ = Male
× = Female
centimeters
4.
5.
6.
7.
8.
9.
10.
inches
1.5
2.0
2.5
3.0
3.5
4.0
Age (months)
0
6
12
18
24
30
36
42
48

MAXIMUM FACE BREADTH
(Bizygomatic Breadth)

The subject is placed or held in a seated position. With sliding calipers equipped with paddle blades, measure the maximum breadth of the face at the most lateral points of the upper cheek bones (i.e., from left to right zygion). Sufficient pressure is applied to cause firm contact with the skin overlying the bony points.



(12)

Maximum Face Breadth (cm)
(Bizygomatic Breadth)

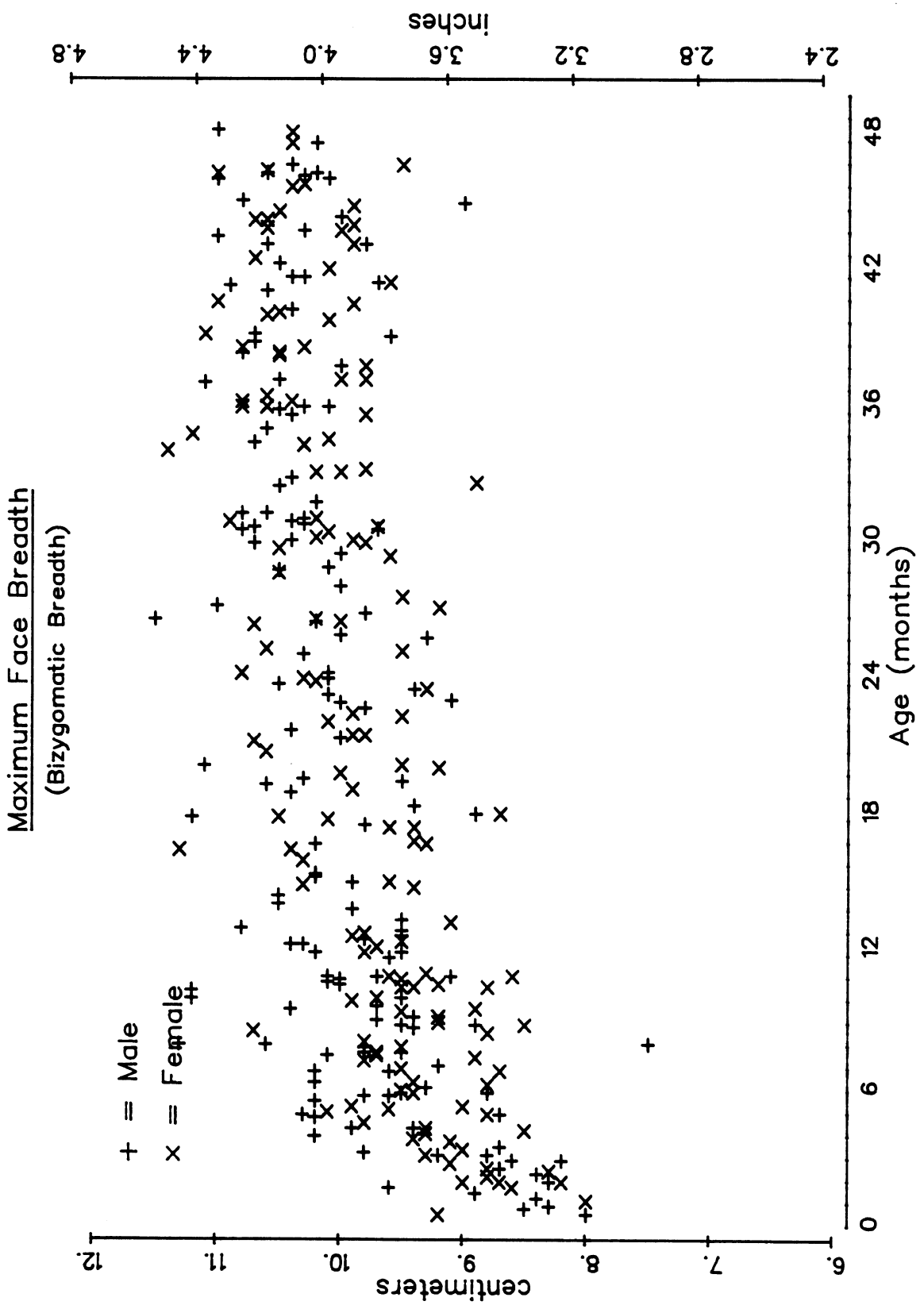
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	8.8	0.5	8.0	8.0	8.7	9.4	9.8
4-6	30	9.5	0.5	8.5	8.5	9.5	10.2	10.3
7-9	30	9.5	0.7	7.5	7.5	9.5	10.6	11.3
10-12	30	9.8	0.6	8.6	8.6	9.7	10.4	11.2
13-18	30	9.9	0.6	8.7	8.7	9.8	10.8	11.3
19-24	30	10.0	0.5	9.1	9.1	10.0	10.7	11.1
25-30	31	10.2	0.5	9.2	9.3	10.1	10.8	11.5
31-36	30	10.4	0.5	8.9	8.9	10.4	10.9	11.4
37-42	30	10.4	0.4	9.6	9.6	10.5	11.0	11.1
43-48	30	10.3	0.5	9.0	9.0	10.4	11.0	11.0

Maximum Face Breadth (in)
(Bizygomatic Breadth)

(Males and Females)

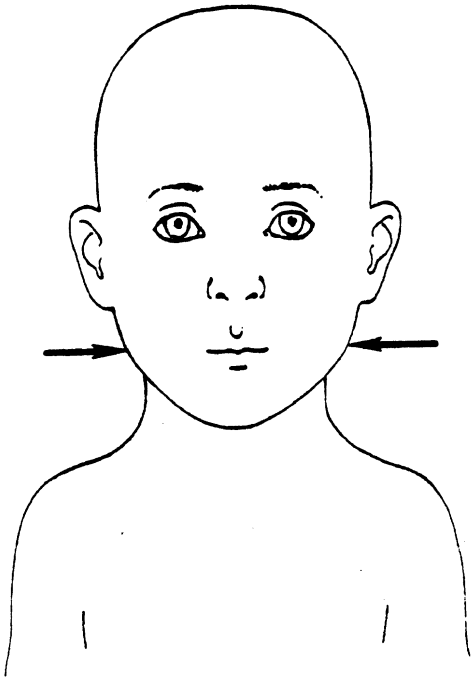
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	3.5	0.2	3.1	3.1	3.4	3.7	3.9
4-6	30	3.7	0.2	3.3	3.3	3.7	4.0	4.1
7-9	30	3.8	0.3	3.0	3.0	3.7	4.2	4.4
10-12	30	3.8	0.2	3.4	3.4	3.8	4.1	4.4
13-18	30	3.9	0.2	3.4	3.4	3.9	4.3	4.4
19-24	30	4.0	0.2	3.6	3.6	3.9	4.2	4.4
25-30	31	4.0	0.2	3.6	3.7	4.0	4.3	4.5
31-36	30	4.1	0.2	3.5	3.5	4.1	4.3	4.5
37-42	30	4.1	0.2	3.8	3.8	4.1	4.3	4.4
43-48	30	4.1	0.2	3.5	3.5	4.1	4.3	4.3


Maximum Face Breadth
(Bizygomatic Breadth)
+ = Male
× = Female
centimeters
6. 7. 8. 9. 10. 11. 12.
inches
2.4 2.8 3.2 3.6 4.0 4.4 4.8
Age (months)
0 6 12 18 24 30 36 42 48

(13)

MAXIMUM JAW BREADTH
(Bigonial Breadth)

The subject is placed or held in a seated position. With sliding calipers equipped with paddle blades, measure the maximum breadth of the jaw at the lowest and widest points on the mandible (i.e., between the right and left gonion). Sufficient pressure is applied to cause firm contact with the skin overlying the bony points.



Maximum Jaw Breadth (cm)
(Bigonial Breadth)

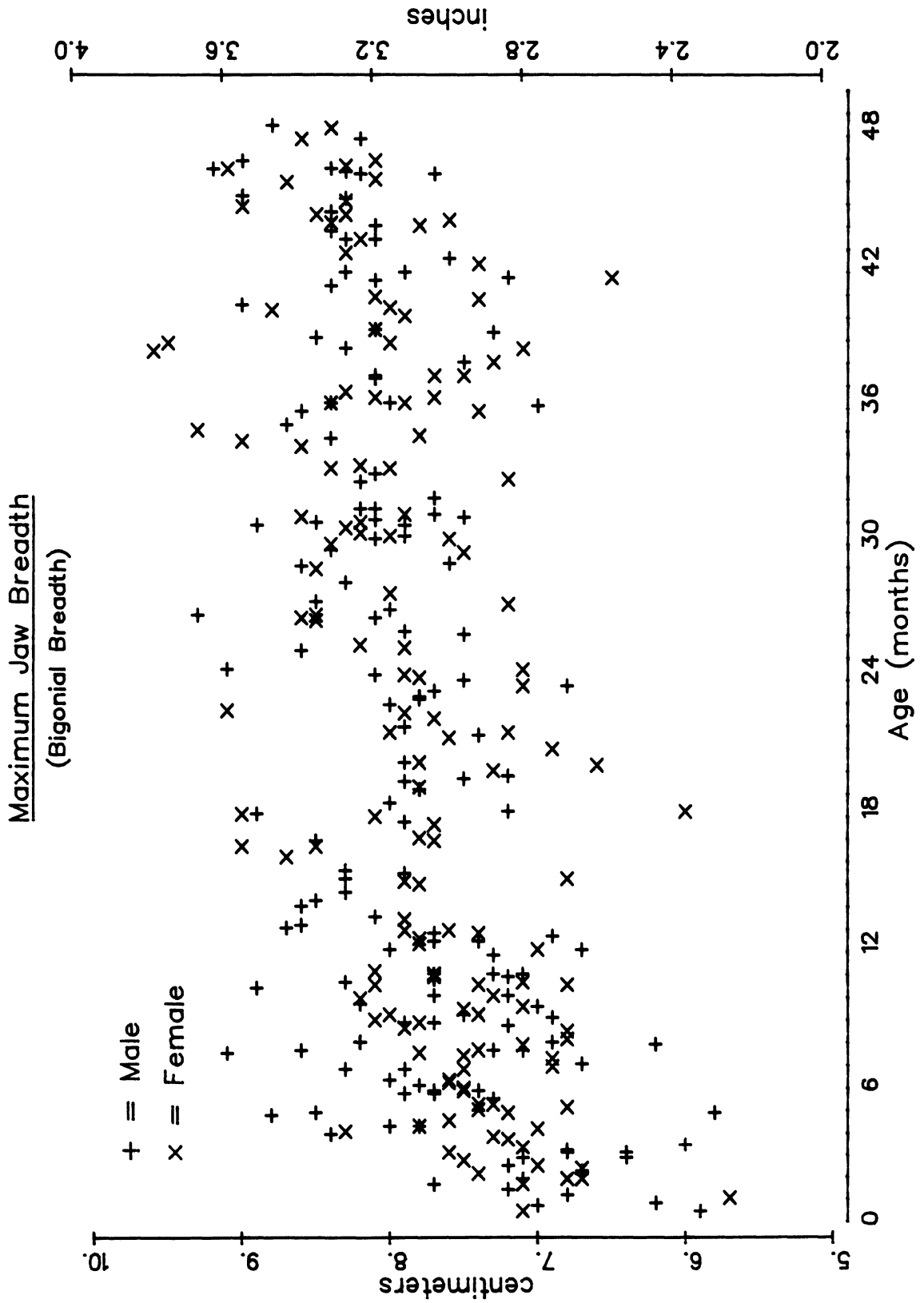
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	6.9	0.5	5.7	5.7	6.8	7.5	7.7
4-6	30	7.6	0.6	5.8	5.8	7.6	8.4	8.8
7-9	30	7.5	0.6	6.2	6.2	7.4	8.2	9.1
10-12	30	7.6	0.5	6.7	6.7	7.7	8.2	8.9
13-18	30	8.1	0.6	6.0	6.0	8.0	8.9	9.0
19-24	30	7.7	0.5	6.6	6.6	7.8	8.1	9.1
25-30	31	8.2	0.4	7.2	7.5	8.2	8.6	9.3
31-36	30	8.1	0.5	7.0	7.0	8.1	8.7	9.3
37-42	30	8.0	0.7	6.5	6.5	8.0	9.0	9.6
43-48	30	8.4	0.4	7.6	7.6	8.3	9.0	9.2

Maximum Jaw Breadth (in)
(Bigonial Breadth)

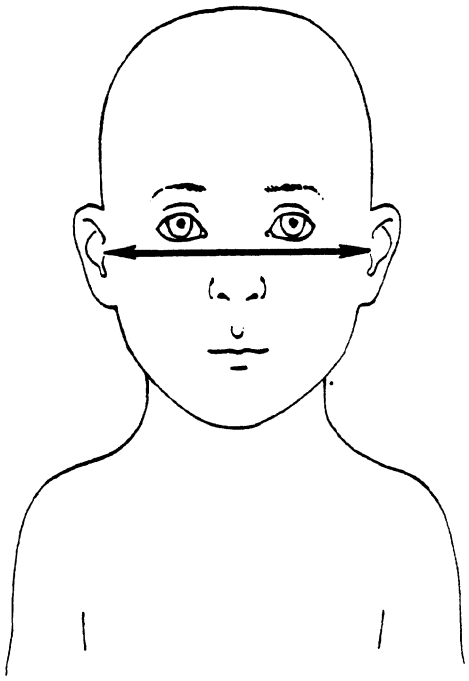
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	2.7	0.2	2.2	2.2	2.7	3.0	3.0
4-6	30	3.0	0.2	2.3	2.3	3.0	3.3	3.5
7-9	30	3.0	0.2	2.4	2.4	2.9	3.2	3.6
10-12	30	3.0	0.2	2.6	2.6	3.0	3.2	3.5
13-18	30	3.2	0.3	2.4	2.4	3.1	3.5	3.5
19-24	30	3.0	0.2	2.6	2.6	3.1	3.2	3.6
25-30	31	3.2	0.2	2.8	3.0	3.2	3.4	3.7
31-36	30	3.2	0.2	2.8	2.8	3.2	3.4	3.7
37-42	30	3.1	0.3	2.6	2.6	3.1	3.5	3.8
43-48	30	3.3	0.2	3.0	3.0	3.3	3.5	3.6


Maximum Jaw Breadth
(Bigonial Breadth)
+ = Male
× = Female
centimeters
5.
6.
7.
8.
9.
10.
inches
2.0
2.4
2.8
3.2
3.6
4.0
Age (months)
0
6
12
18
24
30
36
42
48

HEAD BREADTH AT EAR OPENINGS
(Bitragion Breadth)

The subject is placed in a sitting or supine position. With spreading calipers, measure the distance from the notch on the right ear just forward of the ear opening to a similar point on the left ear (i.e., from right tragion to left tragion).



(14)

Head Breadth at Ear Openings (cm)
(Bitragion Breadth)

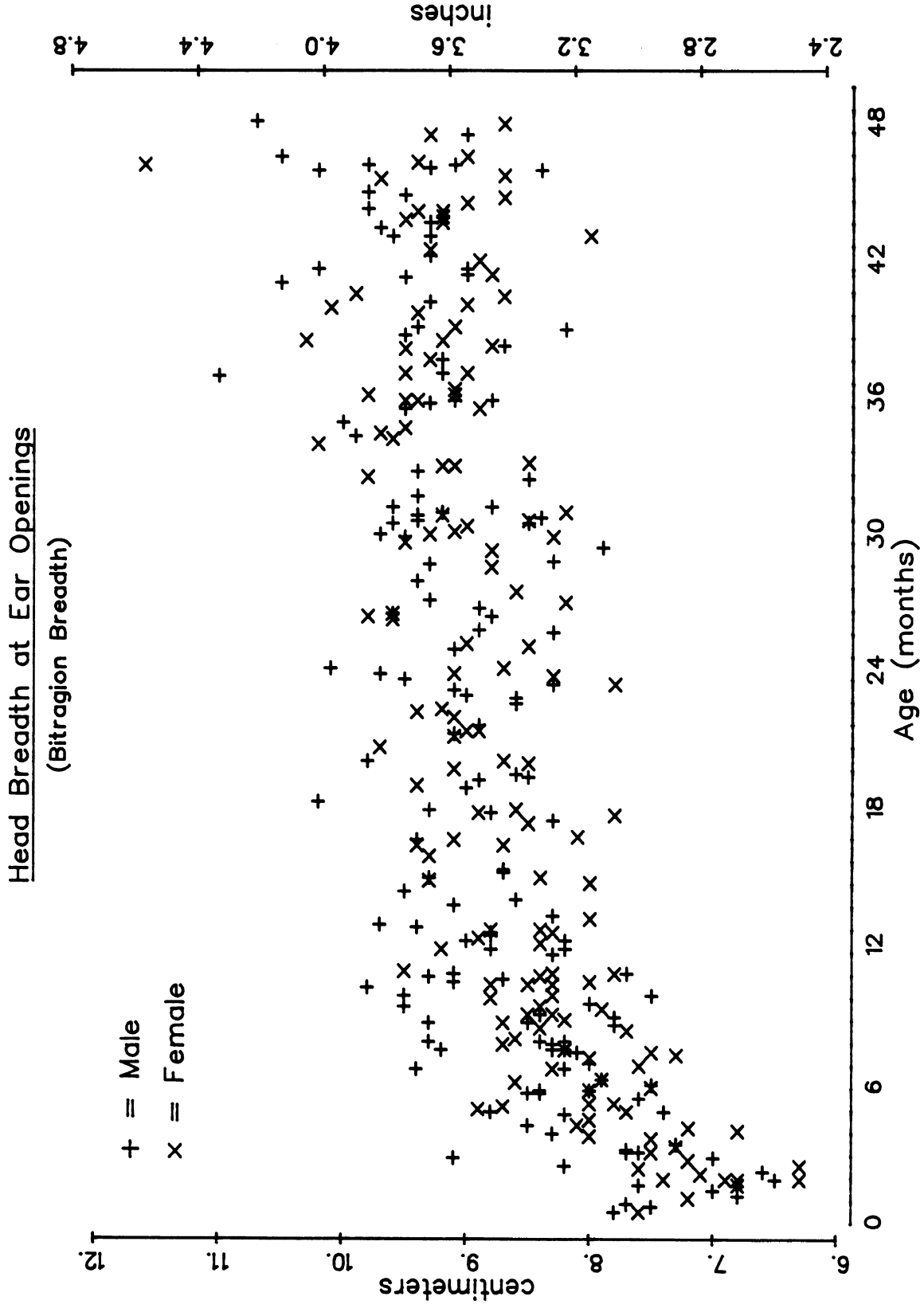
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	7.3	0.6	6.3	6.3	7.3	8.0	9.1
4-6	30	8.1	0.5	6.8	6.8	8.0	8.8	9.4
7-9	30	8.3	0.5	7.3	7.3	8.3	9.3	9.5
10-12	30	8.6	0.6	7.5	7.5	8.7	9.5	9.8
13-18	30	8.8	0.6	7.8	7.8	8.7	9.5	10.2
19-24	30	9.0	0.5	7.8	7.8	9.0	9.7	10.1
25-30	31	9.0	0.5	7.9	8.2	9.0	9.6	9.8
31-36	30	9.3	0.5	8.2	8.2	9.3	9.9	10.2
37-42	30	9.4	0.6	8.2	8.2	9.3	10.3	11.0
43-48	30	9.4	0.7	8.0	8.0	9.3	10.5	11.6

Head Breadth at Ear Openings (in)
(Bitragion Breadth)

(Males and Females)

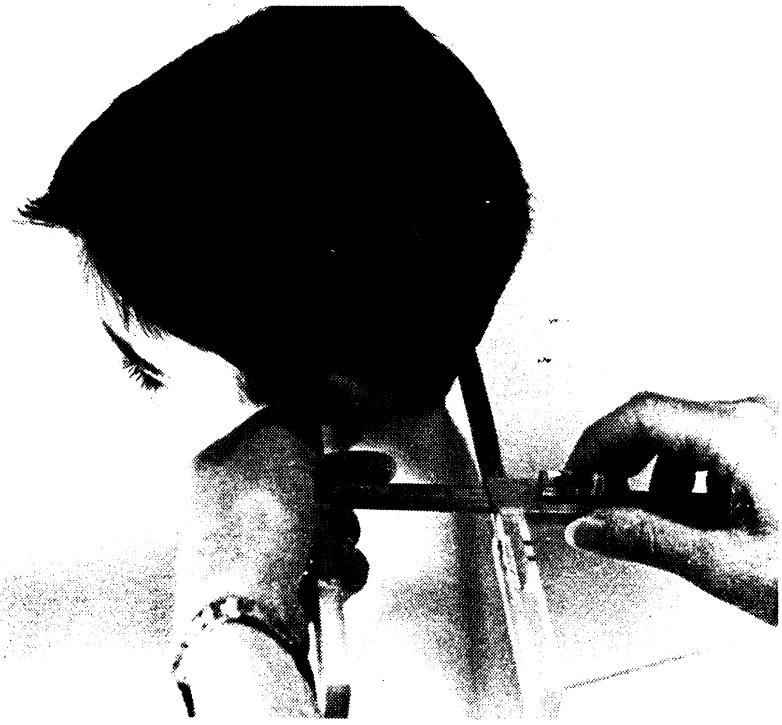
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	2.9	0.2	2.5	2.5	2.9	3.1	3.6
4-6	30	3.2	0.2	2.7	2.7	3.1	3.5	3.7
7-9	30	3.3	0.2	2.9	2.9	3.3	3.7	3.7
10-12	30	3.4	0.2	3.0	3.0	3.4	3.7	3.9
13-18	30	3.5	0.2	3.1	3.1	3.4	3.7	4.0
19-24	30	3.5	0.2	3.1	3.1	3.5	3.8	4.0
25-30	31	3.5	0.2	3.1	3.2	3.5	3.8	3.9
31-36	30	3.6	0.2	3.2	3.2	3.7	3.9	4.0
37-42	30	3.7	0.2	3.2	3.2	3.7	4.1	4.3
43-48	30	3.7	0.3	3.1	3.1	3.7	4.1	4.6

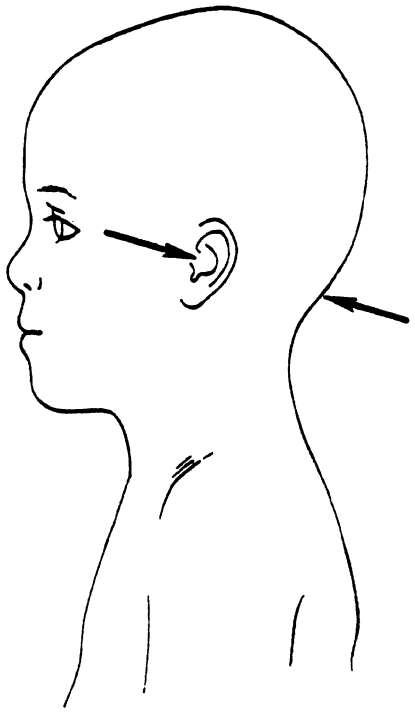

Head Breadth at Ear Openings
(Bitragion Breadth)
+ = Male
× = Female
centimeters
6.
7.
8.
9.
10.
11.
12.
inches
2.4
2.8
3.2
3.6
4.0
4.4
4.8
Age (months)
0
6
12
18
24
30
36
42
48

(15)

EAR TO HEAD/NECK–JUNCTION DISTANCE
(Tragion to Head/Neck–Junction Distance)

The subject is placed or held in a seated position. With sliding calipers equipped with an extension on one blade, measure the distance from the notch on the ear just forward of the ear opening (tragion) to the lowest point on the skull palpated on the back of the head at the junction of the head and neck (head/neck junction). The measurement is made parallel to the midsagittal plane.





Ear to Head/Neck Junction Distance (cm)
(Tragion to Head/Neck Junction Distance)

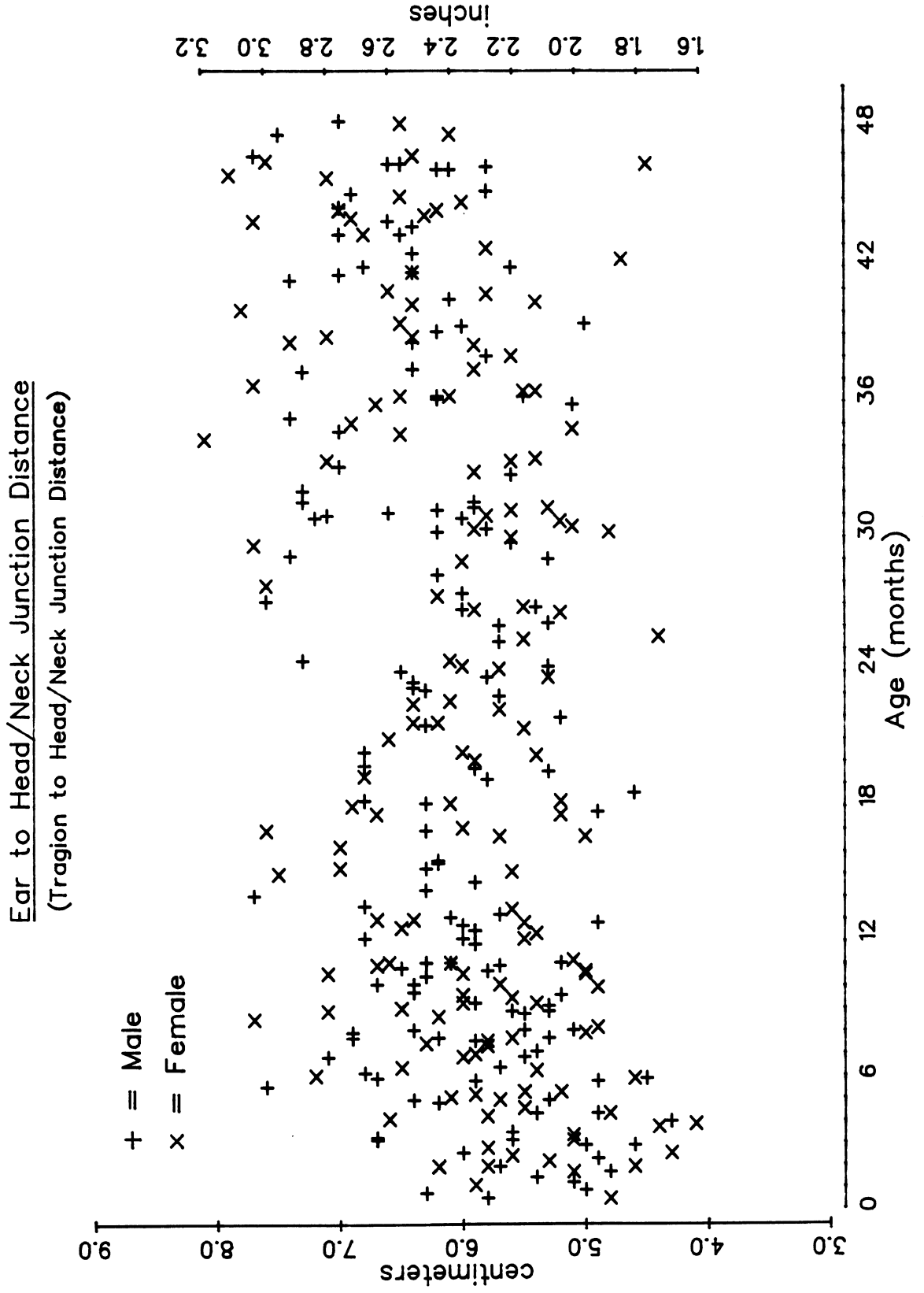
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	5.4	0.7	4.1	4.1	5.3	6.3	6.7
4-6	30	5.8	0.8	4.3	4.3	5.7	7.1	7.6
7-9	30	5.9	0.7	4.9	4.9	5.8	6.9	7.7
10-12	30	5.9	0.6	4.9	4.9	5.9	6.7	7.1
13-18	30	6.2	0.8	4.6	4.6	6.2	7.5	7.7
19-24	30	6.1	0.5	5.2	5.2	6.0	6.8	7.3
25-30	31	6.0	0.8	4.4	4.8	5.8	7.6	7.7
31-36	30	6.3	0.8	5.1	5.1	6.2	7.4	8.1
37-42	30	6.3	0.7	4.7	4.7	6.4	7.4	7.8
43-48	30	6.6	0.7	4.5	4.5	6.5	7.7	7.9

Ear to Head/Neck Junction Distance (in)
(Tragion to Head/Neck Junction Distance)

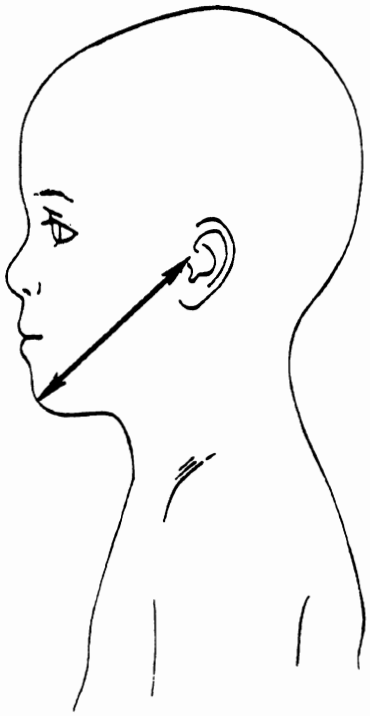
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	2.1	0.3	1.6	1.6	2.1	2.5	2.6
4-6	30	2.3	0.3	1.7	1.7	2.2	2.8	3.0
7-9	30	2.3	0.3	1.9	1.9	2.3	2.7	3.0
10-12	30	2.3	0.2	1.9	1.9	2.3	2.6	2.8
13-18	30	2.4	0.3	1.8	1.8	2.4	3.0	3.0
19-24	30	2.4	0.2	2.0	2.0	2.4	2.7	2.9
25-30	31	2.3	0.3	1.7	1.9	2.3	3.0	3.0
31-36	30	2.5	0.3	2.0	2.0	2.4	2.9	3.2
37-42	30	2.5	0.3	1.9	1.9	2.5	2.9	3.1
43-48	30	2.6	0.3	1.8	1.8	2.6	3.0	3.1


Ear to Head/Neck Junction Distance
(Tragion to Head/Neck Junction Distance)
+ = Male
× = Female
centimeters
3.0
4.0
5.0
6.0
7.0
8.0
9.0
inches
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
Age (months)
0
6
12
18
24
30
36
42
48

EAR TO TIP-OF-CHIN DISTANCE
(Tragion-to-Menton Distance)

The subject is placed or held in a seated position. With sliding calipers equipped with an extension blade, measure the distance between the notch on the ear just forward of the ear opening (tragion) and the tip of the chin (menton). The measurement is made parallel to the midsagittal plane.



(16)

Ear to Tip-of-Chin Distance (cm)
(Tragion to Menton Distance)

(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	6.6	0.5	5.6	5.6	6.6	7.3	7.8
4-6	30	7.1	0.5	6.0	6.0	7.1	7.7	8.2
7-9	30	7.6	0.6	6.5	6.5	7.7	8.3	9.0
10-12	30	8.0	0.7	6.6	6.6	8.0	8.9	9.3
13-18	30	8.3	0.7	7.2	7.2	8.1	9.3	9.4
19-24	30	8.6	0.7	7.3	7.3	8.5	9.6	10.1
25-30	31	9.0	0.6	8.2	8.2	8.9	10.1	10.7
31-36	30	9.1	0.5	7.7	7.7	9.1	9.7	10.3
37-42	30	9.5	0.5	8.4	8.4	9.5	10.2	10.5
43-48	30	9.6	0.5	8.6	8.6	9.5	10.3	11.0

Ear to Tip-of-Chin Distance (in)
(Tragion to Menton Distance)

(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	2.6	0.2	2.2	2.2	2.6	2.9	3.1
4-6	30	2.8	0.2	2.4	2.4	2.8	3.0	3.2
7-9	30	3.0	0.2	2.6	2.6	3.0	3.3	3.5
10-12	30	3.1	0.3	2.6	2.6	3.1	3.5	3.7
13-18	30	3.3	0.3	2.8	2.8	3.2	3.7	3.7
19-24	30	3.4	0.3	2.9	2.9	3.3	3.8	4.0
25-30	31	3.6	0.2	3.2	3.2	3.5	4.0	4.2
31-36	30	3.6	0.2	3.0	3.0	3.6	3.8	4.1
37-42	30	3.7	0.2	3.3	3.3	3.7	4.0	4.1
43-48	30	3.8	0.2	3.4	3.4	3.7	4.1	4.3

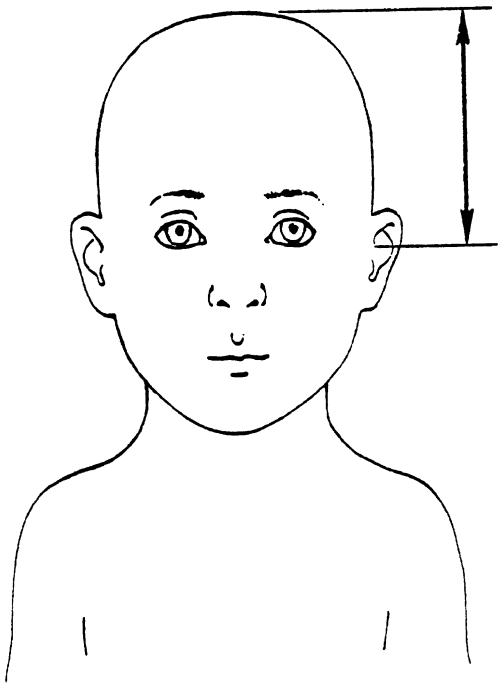
Ear to Tip-of-Chin Distance

(Tragion to Menton Distance)

(17)

EAR TO TOP-OF-HEAD DISTANCE
(Tragion-to-Vertex Distance)

The subject is positioned lying on the back and looking upward so that the Frankfort plane is approximately vertical and the top of the head is against a vertical plexiglass reference plate. With an anthropometer equipped with paddle blades, measure the distance, parallel to the long axis of the body, from the back of the reference plate to the notch on the ear just forward of the ear opening (tragion) and subtract off the thickness of the plexiglass plate.



Ear to Top-of-Head Distance (cm)
(Tragion to Vertex Distance)

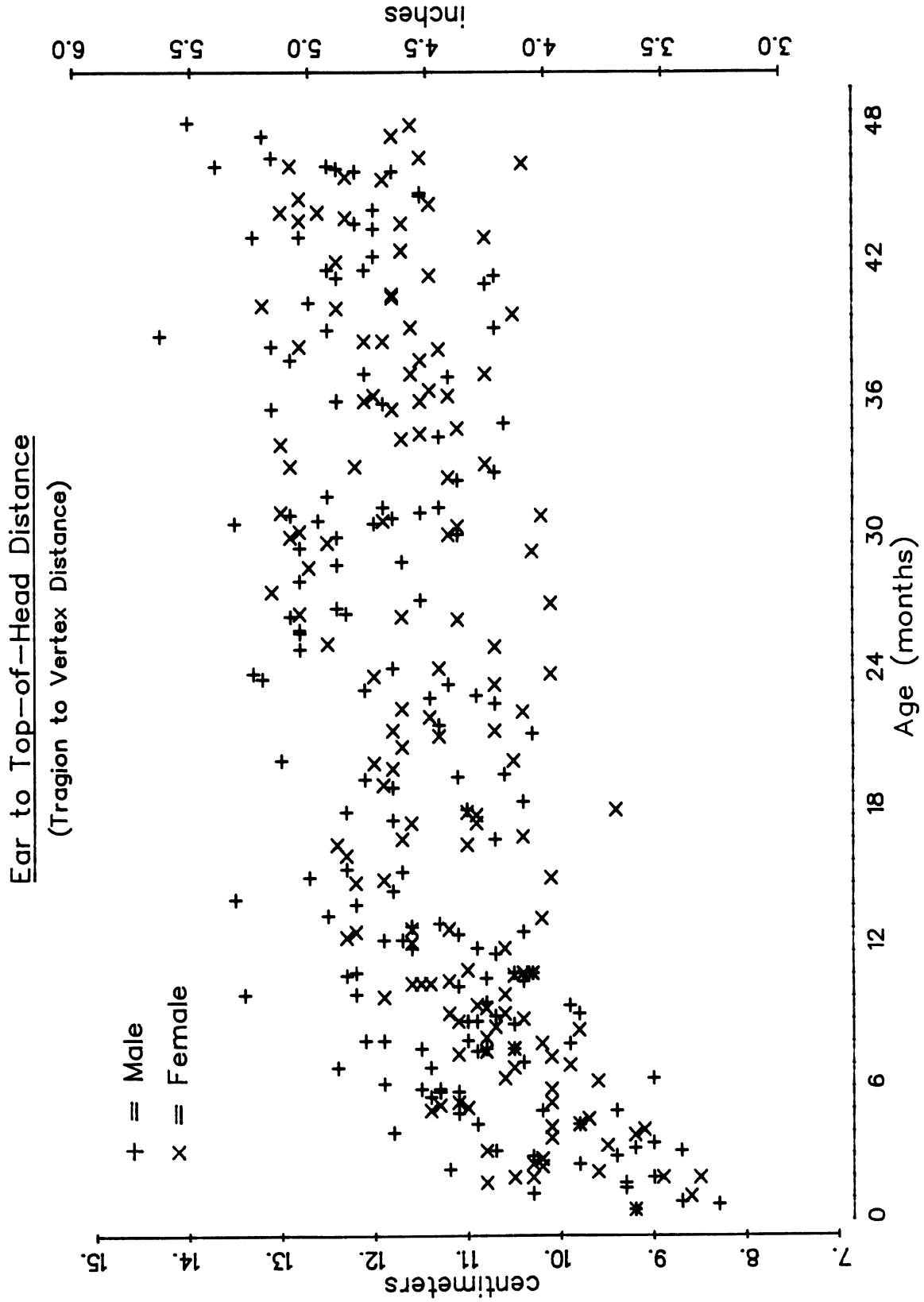
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	9.6	0.8	8.3	8.3	9.4	10.8	11.2
4-6	29	10.6	0.9	9.0	9.0	10.9	11.9	12.4
7-9	30	10.7	0.6	9.8	9.8	10.8	11.5	12.1
10-12	30	11.3	0.8	10.3	10.3	11.1	12.3	13.4
13-18	30	11.5	0.9	9.4	9.4	11.6	12.5	13.5
19-24	30	11.5	0.8	10.1	10.1	11.4	13.0	13.3
25-30	31	12.1	0.9	10.1	10.3	12.4	12.9	13.5
31-36	30	11.8	0.8	10.2	10.2	11.7	13.0	13.1
37-42	30	12.0	0.9	10.5	10.5	11.9	13.1	14.3
43-48	30	12.3	0.8	10.4	10.4	12.2	13.3	14.0

Ear to Top-of-Head Distance (in)
(Tragion to Vertex Distance)

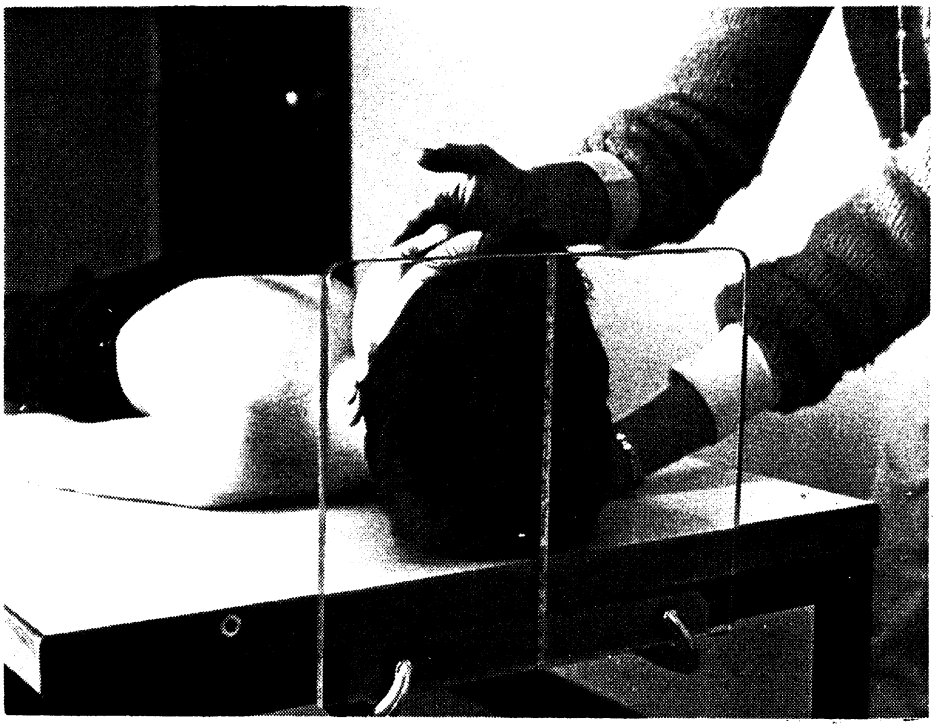
(Males and Females)

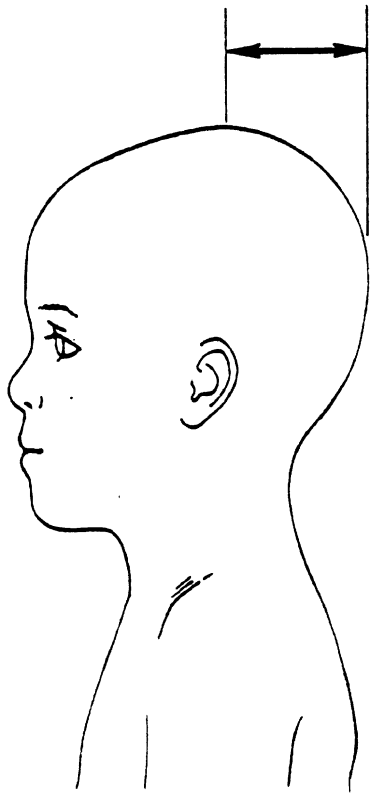
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	3.8	0.3	3.3	3.3	3.7	4.3	4.4
4-6	29	4.2	0.4	3.5	3.5	4.3	4.7	4.9
7-9	30	4.2	0.2	3.9	3.9	4.3	4.5	4.8
10-12	30	4.4	0.3	4.1	4.1	4.4	4.8	5.3
13-18	30	4.5	0.4	3.7	3.7	4.6	4.9	5.3
19-24	30	4.5	0.3	4.0	4.0	4.5	5.1	5.2
25-30	31	4.8	0.3	4.0	4.1	4.9	5.1	5.3
31-36	30	4.6	0.3	4.0	4.0	4.6	5.1	5.2
37-42	30	4.7	0.3	4.1	4.1	4.7	5.2	5.6
43-48	30	4.8	0.3	4.1	4.1	4.8	5.2	5.5


Ear to Top-of-Head Distance
(Tragion to Vertex Distance)
+ = Male
× = Female
centimeters
7. 8. 9. 10. 11. 12. 13. 14. 15.
inches
3.0 3.5 4.0 4.5 5.0 5.5 6.0
Age (months)
0 6 12 18 24 30 36 42 48

TOP-OF-HEAD TO BACK-OF-HEAD DISTANCE
(Vertex-to-Opisthocranion Distance)

The subject is positioned lying on the back and looking upward so that the Frankfort plane is approximately vertical and the top of the head is against a vertical plexiglass reference plate. The vertical distance from the table surface to the point at which the top of the head (vertex) contacts the vertical reference plate is read from a measurement tape on the plate.





(18)

Top-of-Head to Back-of-Head Distance (cm)
(Vertex to Opisthocranion Distance)

(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	5.7	0.7	4.0	4.0	5.8	6.5	7.0
4-6	30	6.7	0.7	5.0	5.0	6.8	7.5	8.0
7-9	30	6.2	0.7	4.0	4.0	6.2	7.0	8.0
10-12	30	6.4	0.9	4.5	4.5	6.5	7.5	8.2
13-18	30	7.0	0.7	5.5	5.5	7.0	7.8	8.5
19-24	30	6.7	0.8	5.0	5.0	6.5	7.7	8.5
25-30	31	7.4	0.8	5.5	6.0	7.5	8.5	8.6
31-36	30	6.9	0.9	5.0	5.0	7.0	8.0	8.1
37-42	30	7.0	0.7	5.5	5.5	7.0	8.0	8.2
43-48	30	7.5	1.0	5.9	5.9	7.5	9.0	9.9

Top-of-Head to Back-of-Head Distance (in)
(Vertex to Opisthocranion Distance)

(Males and Females)

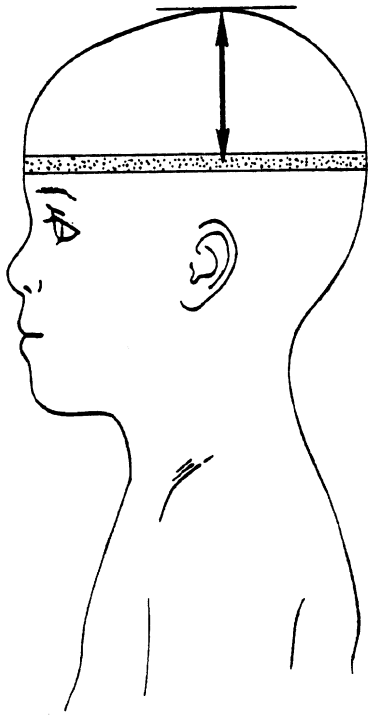
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	2.2	0.3	1.6	1.6	2.3	2.6	2.8
4-6	30	2.6	0.3	2.0	2.0	2.7	3.0	3.1
7-9	30	2.5	0.3	1.6	1.6	2.4	2.8	3.1
10-12	30	2.5	0.3	1.8	1.8	2.6	3.0	3.2
13-18	30	2.8	0.3	2.2	2.2	2.8	3.1	3.3
19-24	30	2.6	0.3	2.0	2.0	2.6	3.0	3.3
25-30	31	2.9	0.3	2.2	2.4	3.0	3.3	3.4
31-36	30	2.7	0.3	2.0	2.0	2.8	3.1	3.2
37-42	30	2.8	0.3	2.2	2.2	2.8	3.1	3.2
43-48	30	3.0	0.4	2.3	2.3	3.0	3.5	3.9

Top-of-Head to Back-of-Head Distance
(Vertex to Opisthocranion Distance)
+ = Male
× = Female
centimeters
3.
4.
5.
6.
7.
8.
9.
10.
11.
inches
1.4
1.8
2.2
2.6
3.0
3.4
3.8
4.2
Age (months)
0
6
12
18
24
30
36
42
48

(19)

TOP-OF-HEAD TO HEAD CIRCUMFERENCE DISTANCE
(Vertex to Head Circumference Distance)

The subject is placed or held in a seated position. With sliding calipers equipped with an extension blade, measure the distance perpendicular to the Frankfort plane from the highest point on the top of the head (vertex) to the head circumference band.



Top-of-Head to Head Circumference Distance (cm)
(Vertex to Head Circumference Distance)

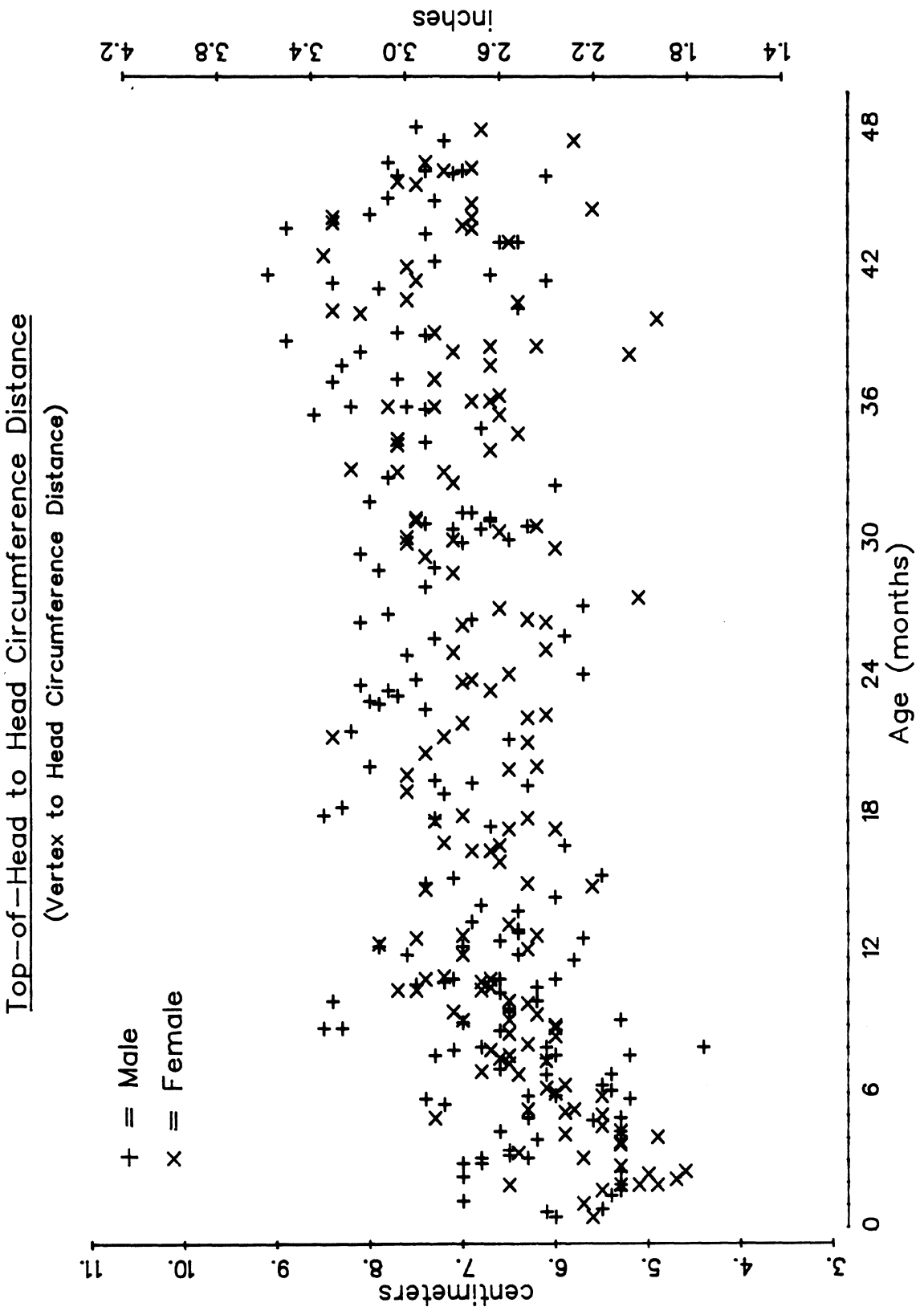
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	5.8	0.7	4.6	4.6	5.5	7.0	7.0
4-6	30	6.0	0.6	4.9	4.9	5.9	7.2	7.4
7-9	30	6.5	0.8	4.4	4.4	6.5	7.3	8.5
10-12	30	6.9	0.7	5.7	5.7	6.8	7.9	8.4
13-18	30	6.7	0.7	5.5	5.5	6.6	7.4	8.5
19-24	30	7.1	0.7	5.7	5.7	7.2	8.1	8.4
25-30	31	6.9	0.7	5.1	5.7	7.0	7.9	8.1
31-36	30	7.3	0.6	6.0	6.0	7.3	8.2	8.6
37-42	30	7.4	1.0	4.9	4.9	7.4	8.5	9.1
43-48	30	7.2	0.7	5.6	5.6	7.2	8.4	8.9

Top-of-Head to Head Circumference Distance (in)
(Vertex to Head Circumference Distance)

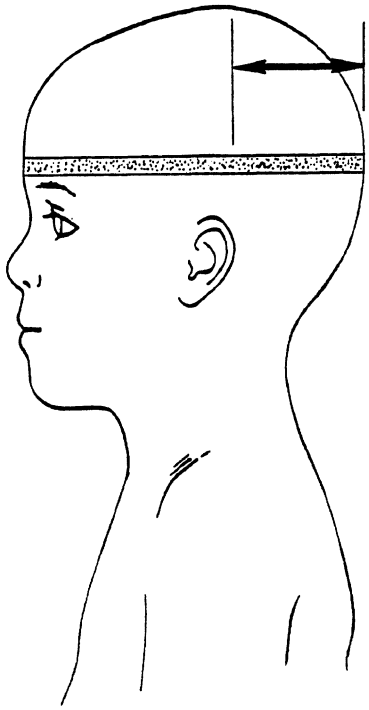
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	2.3	0.3	1.8	1.8	2.2	2.8	2.8
4-6	30	2.3	0.3	1.9	1.9	2.3	2.8	2.9
7-9	30	2.5	0.3	1.7	1.7	2.6	2.9	3.3
10-12	30	2.7	0.3	2.2	2.2	2.7	3.1	3.3
13-18	30	2.6	0.3	2.2	2.2	2.6	2.9	3.3
19-24	30	2.8	0.3	2.2	2.2	2.8	3.2	3.3
25-30	31	2.7	0.3	2.0	2.2	2.8	3.1	3.2
31-36	30	2.9	0.2	2.4	2.4	2.9	3.2	3.4
37-42	30	2.9	0.4	1.9	1.9	2.9	3.3	3.6
43-48	30	2.8	0.3	2.2	2.2	2.8	3.3	3.5


Top-of-Head to Head Circumference Distance
(Vertex to Head Circumference Distance)
+ = Male
× = Female
centimeters
3. 4. 5. 6. 7. 8. 9. 10. 11.
inches
1.4 1.8 2.2 2.6 3.0 3.4 3.8 4.2
Age (months)
0 6 12 18 24 30 36 42 48

BACK-OF-HEAD to HEAD-BREADTH-POINT DISTANCE
(Opisthocranion to Head-Breadth-Point Distance)

The subject is placed or held in a seated position. With sliding calipers equipped with an extension blade, measure the distance from the point of maximum breadth on the head circumference band to the point of greatest protrusion at the back of the head (opisthocranion). The measurement is made parallel to the midsagittal plane.



(20)

Back-of-Head to Head Breadth Point Distance (cm)
(Opisthocranion to Head Breadth Point Distance)

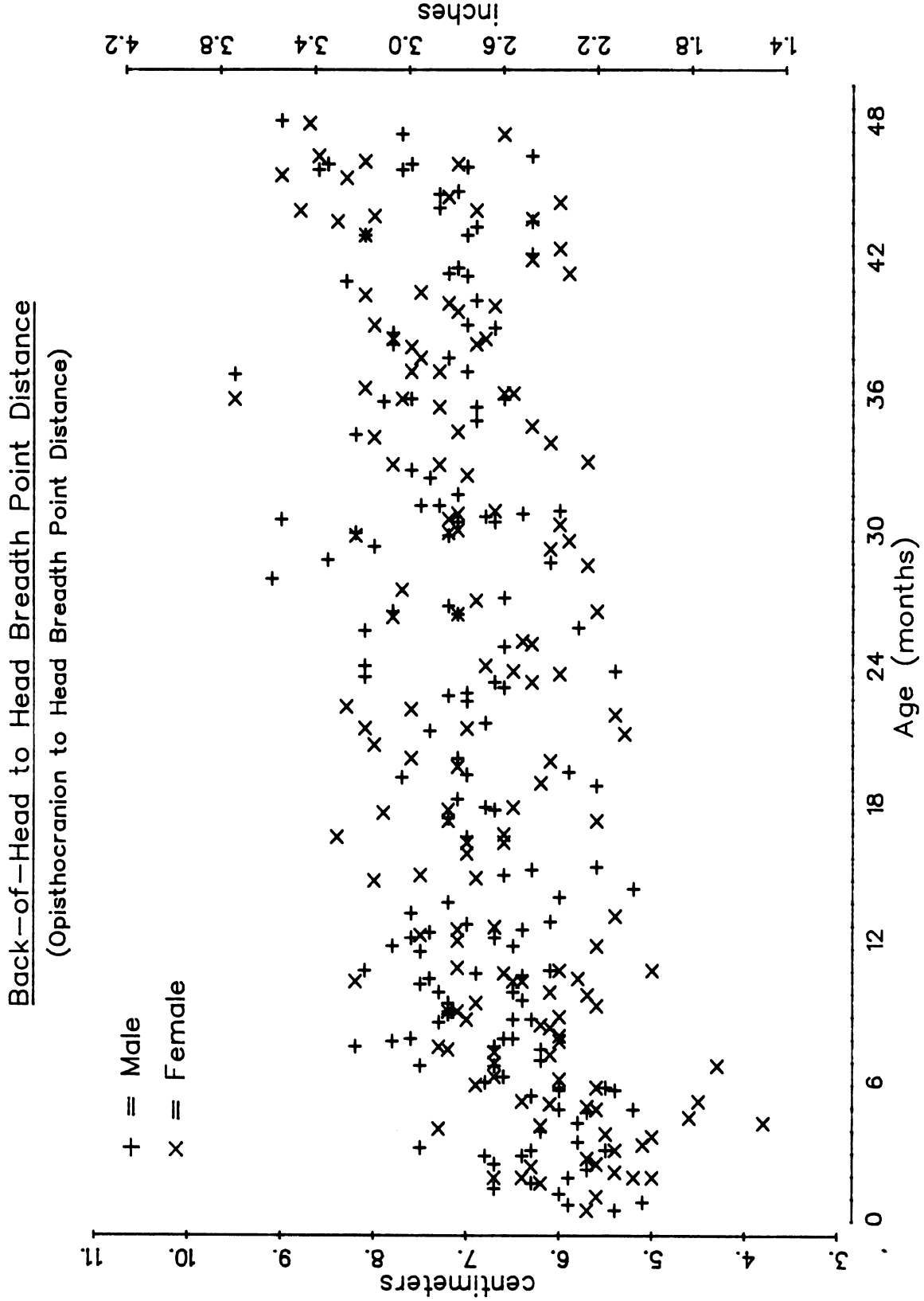
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	5.9	0.6	5.0	5.0	5.7	6.7	7.5
4-6	30	5.9	0.9	3.8	3.8	6.0	6.9	7.5
7-9	30	6.7	0.6	5.6	5.6	6.7	7.6	8.2
10-12	30	6.8	0.8	5.0	5.0	6.6	7.8	8.2
13-18	30	6.8	0.7	5.2	5.2	6.8	7.9	8.4
19-24	30	6.9	0.9	5.3	5.3	7.0	8.1	8.3
25-30	31	7.1	1.0	5.6	5.7	7.1	8.5	9.1
31-36	30	7.2	0.8	5.7	5.7	7.1	8.1	9.5
37-42	30	7.2	0.7	5.9	5.9	7.1	8.1	9.5
43-48	30	7.6	0.9	6.0	6.0	7.6	8.8	9.0

Back-of-Head to Head Breadth Point Distance (in)
(Opisthocranion to Head Breadth Point Distance)

(Males and Females)

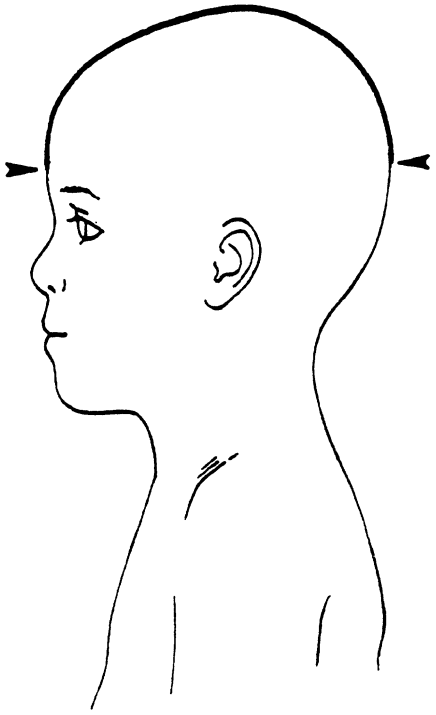
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	2.3	0.2	2.0	2.0	2.2	2.6	3.0
4-6	30	2.3	0.3	1.5	1.5	2.4	2.7	3.0
7-9	30	2.7	0.2	2.2	2.2	2.6	3.0	3.2
10-12	30	2.7	0.3	2.0	2.0	2.6	3.1	3.2
13-18	30	2.7	0.3	2.0	2.0	2.7	3.1	3.3
19-24	30	2.7	0.3	2.1	2.1	2.8	3.2	3.3
25-30	31	2.8	0.4	2.2	2.2	2.8	3.3	3.6
31-36	30	2.8	0.3	2.2	2.2	2.8	3.2	3.7
37-42	30	2.9	0.3	2.3	2.3	2.8	3.2	3.7
43-48	30	3.0	0.3	2.4	2.4	3.0	3.5	3.5


Back-of-Head to Head Breadth Point Distance
(Opisthocranion to Head Breadth Point Distance)
+ = Male
× = Female
centimeters
3. 4. 5. 6. 7. 8. 9. 10. 11.
inches
1.4 1.8 2.2 2.6 3.0 3.4 3.8 4.2
Age (months)
0 6 12 18 24 30 36 42 48

(21)

FOREHEAD TO BACK-OF-HEAD ARC LENGTH
(Glabella to Opisthocranion Arc Length)

The subject is placed or held in a seated position. With a cloth measuring tape, measure the arc length in the midsagittal plane from the point of greatest protrusion of the forehead (glabella), along the top of the head, to the point of greatest protrusion at the back of the head (opisthocranion).



Forehead to Back-of-Head Arc Length (cm)
(Glabella to Opisthocranion Arc Length)

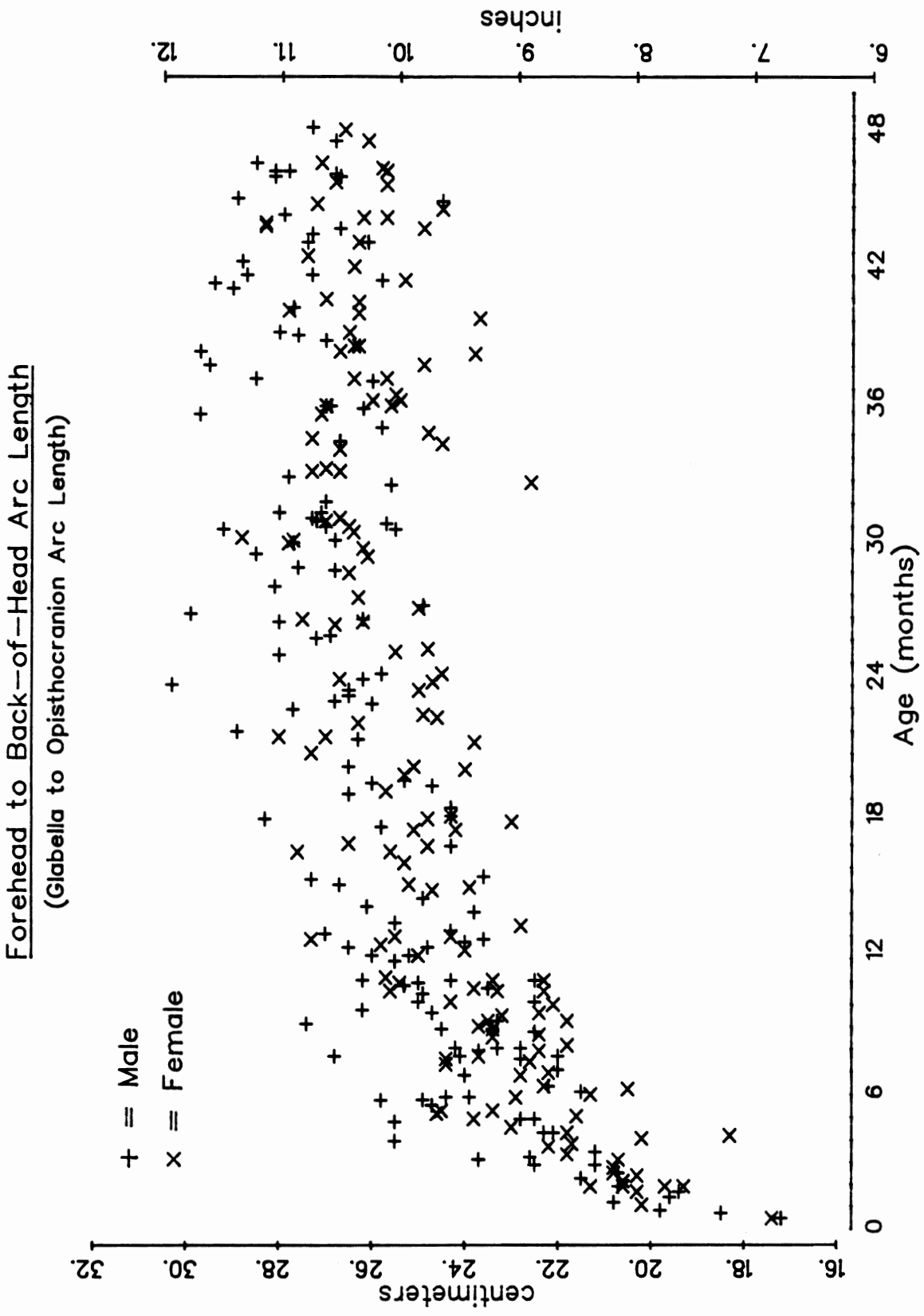
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	20.7	1.5	17.2	17.2	20.7	22.6	23.7
4-6	30	23.0	1.7	18.3	18.3	22.8	25.5	25.8
7-9	30	23.6	1.4	21.8	21.8	23.4	26.2	27.4
10-12	30	24.5	1.4	22.1	22.1	24.8	26.2	27.3
13-18	30	25.1	1.3	22.8	22.8	24.8	27.3	28.3
19-24	30	26.1	1.4	23.8	23.8	26.0	28.0	30.3
25-30	31	27.0	1.2	24.8	24.9	26.8	28.8	29.9
31-36	30	26.5	1.3	22.6	22.6	26.7	27.8	29.7
37-42	30	27.0	1.6	23.7	23.7	26.7	29.4	29.7
43-48	30	26.8	1.2	24.5	24.5	26.8	28.3	28.9

Forehead to Back-of-Head Arc Length (in)
(Glabella to Opisthocranion Arc Length)

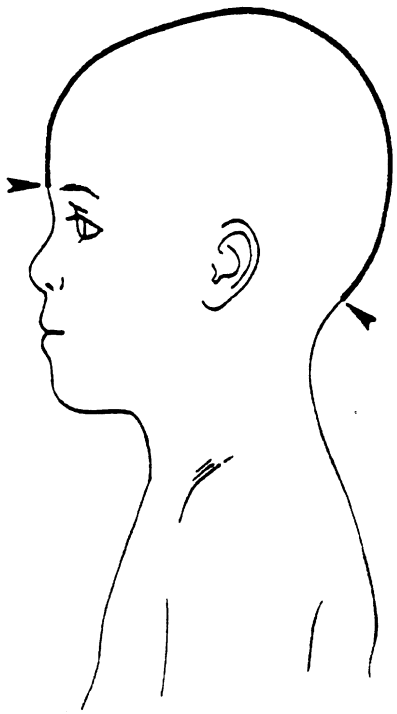
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	8.1	0.6	6.8	6.8	8.1	8.9	9.3
4-6	30	9.0	0.7	7.2	7.2	9.0	10.0	10.2
7-9	30	9.3	0.5	8.6	8.6	9.2	10.3	10.8
10-12	30	9.6	0.5	8.7	8.7	9.8	10.3	10.7
13-18	30	9.9	0.5	9.0	9.0	9.8	10.7	11.1
19-24	30	10.3	0.6	9.4	9.4	10.2	11.0	11.9
25-30	31	10.6	0.5	9.8	9.8	10.6	11.3	11.8
31-36	30	10.4	0.5	8.9	8.9	10.5	10.9	11.7
37-42	30	10.6	0.6	9.3	9.3	10.5	11.6	11.7
43-48	30	10.6	0.5	9.6	9.6	10.6	11.1	11.4


Forehead to Back-of-Head Arc Length
(Glabella to Opisthocranion Arc Length)
+ = Male
× = Female
centimeters
16.
18.
20.
22.
24.
26.
28.
30.
32.
inches
6.
7.
8.
9.
10.
11.
12.
Age (months)
0
6
12
18
24
30
36
42
48

FOREHEAD TO HEAD/NECK JUNCTION ARC LENGTH
(Glabella to Head/Neck–Junction Arc Length)

The subject is placed or held in a seated position. With a cloth measuring tape, measure the length of the arc in the midsagittal plane from the point of greatest protrusion on the forehead (glabella), along the top of the head, to the lowest point on the back of the skull palpated at the junction of the head and neck (head/neck junction).



(22)

Forehead to Head/Neck Junction Arc Length (cm)
(Glabella to Head/Neck Junction Arc Length)

(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	25.5	1.8	21.8	21.8	25.3	27.7	28.8
4-6	30	28.2	1.5	25.0	25.0	28.2	30.6	30.7
7-9	30	29.5	1.4	26.7	26.7	29.3	31.8	32.2
10-12	30	30.6	1.7	27.7	27.7	30.3	33.1	34.1
13-18	30	30.8	1.7	28.0	28.0	30.6	34.0	34.5
19-24	30	32.4	1.8	28.3	28.3	32.4	34.4	37.9
25-30	31	33.6	1.4	30.5	31.5	33.6	35.8	36.3
31-36	30	33.9	1.7	30.4	30.4	34.2	35.8	36.7
37-42	30	34.0	1.5	29.9	29.9	33.8	35.8	36.7
43-48	30	33.9	1.3	32.2	32.2	33.6	36.1	36.5

Forehead to Head/Neck Junction Arc Length (in)
(Glabella to Head/Neck Junction Arc Length)

(Males and Females)

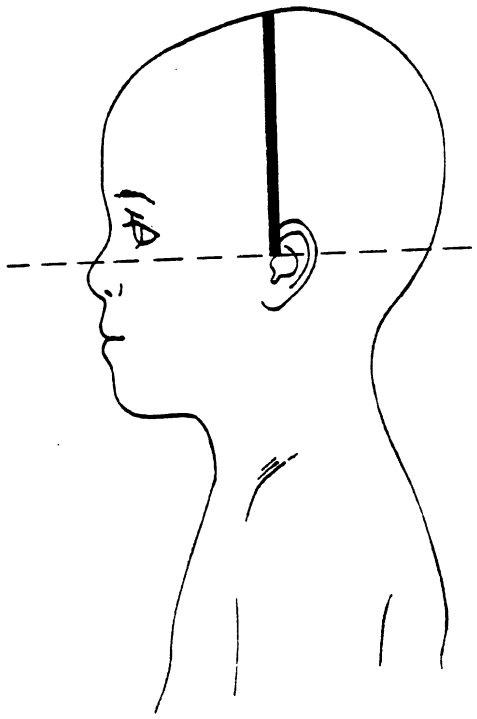
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	10.0	0.7	8.6	8.6	10.0	10.9	11.3
4-6	30	11.1	0.6	9.8	9.8	11.1	12.0	12.1
7-9	30	11.6	0.6	10.5	10.5	11.5	12.5	12.7
10-12	30	12.0	0.7	10.9	10.9	11.9	13.0	13.4
13-18	30	12.1	0.7	11.0	11.0	12.0	13.4	13.6
19-24	30	12.8	0.7	11.1	11.1	12.8	13.5	14.9
25-30	31	13.2	0.5	12.0	12.4	13.2	14.1	14.3
31-36	30	13.3	0.7	12.0	12.0	13.5	14.1	14.4
37-42	30	13.4	0.6	11.8	11.8	13.3	14.1	14.4
43-48	30	13.4	0.5	12.7	12.7	13.2	14.2	14.4

Forehead to Head/Neck Junction Arc Length
(Glabella to Head/Neck Junction Arc Length)
+ = Male
× = Female
centimeters
20.
24.
28.
32.
36.
40.
inches
8.
9.
10.
11.
12.
13.
14.
15.
16.
Age (months)
0
6
12
18
24
30
36
42
48

(23)

EAR-TO-EAR OVER TOP-OF-HEAD ARC LENGTH
(Bitragion Over Top-of-Head Arc Length)

The subject is placed or held in a seated position. With a cloth measuring tape, measure the length of the arc across the top of the head and in a plane approximately perpendicular to the Frankfort plane from the notch on the left ear just forward of the ear opening (left tragion) to a similar point on the right ear (right tragion). The tape does not necessarily pass through the highest point on the top of the head (vertex).



Ear-to-Ear over Top-of-Head Arc Length (cm)
(Bitragion over Top-of-Head Arc Length)

(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	23.6	1.2	21.1	21.1	23.6	25.1	26.4
4-6	30	26.5	1.3	23.6	23.6	26.6	28.1	28.8
7-9	30	27.4	1.3	25.6	25.6	27.2	29.4	31.4
10-12	30	28.0	1.5	25.7	25.7	27.9	30.3	31.4
13-18	30	29.2	1.4	25.7	25.7	29.3	30.9	31.7
19-24	30	30.2	1.3	27.5	27.5	30.0	32.0	33.1
25-30	31	30.7	1.3	27.9	28.6	30.5	32.8	33.3
31-36	30	30.9	1.4	28.6	28.6	30.5	32.6	35.0
37-42	30	30.9	1.2	28.9	28.9	30.7	32.6	33.1
43-48	30	31.4	1.3	28.5	28.5	31.6	33.2	34.1

Ear-to-Ear over Top-of-Head Arc Length (in)
(Bitragion over Top-of-Head Arc Length)

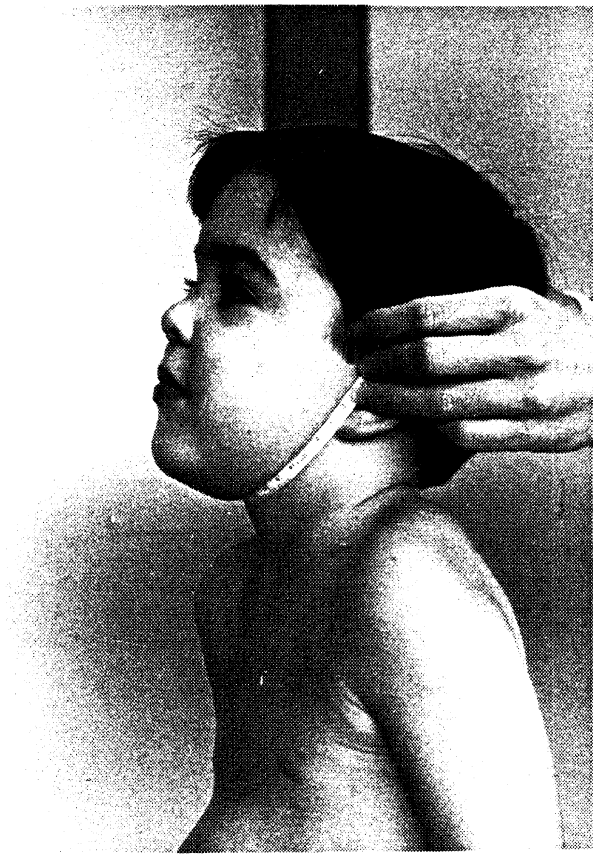
(Males and Females)

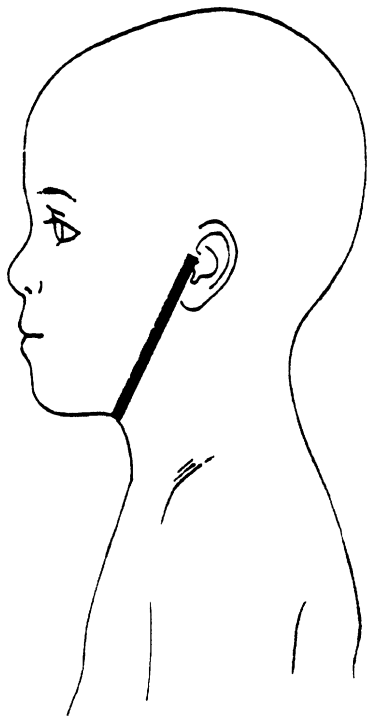
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	9.3	0.5	8.3	8.3	9.3	9.9	10.4
4-6	30	10.5	0.5	9.3	9.3	10.5	11.1	11.3
7-9	30	10.8	0.5	10.1	10.1	10.7	11.6	12.4
10-12	30	11.0	0.6	10.1	10.1	11.0	11.9	12.4
13-18	30	11.5	0.6	10.1	10.1	11.5	12.2	12.5
19-24	30	11.9	0.5	10.8	10.8	11.8	12.6	13.0
25-30	31	12.1	0.5	11.0	11.3	12.0	12.9	13.1
31-36	30	12.1	0.6	11.3	11.3	12.0	12.8	13.8
37-42	30	12.2	0.5	11.4	11.4	12.1	12.8	13.0
43-48	30	12.4	0.5	11.2	11.2	12.4	13.1	13.4

Ear-to-Ear over Top-of-Head Arc Length
(Bitragion over Top-of-Head Arc Length)
+ = Male
× = Female
centimeters
20.
24.
28.
32.
36.
40.
inches
8.
9.
10.
11.
12.
13.
14.
15.
16.
Age (months)
0
6
12
18
24
30
36
42
48

EAR-TO-EAR UNDER CHIN ARC LENGTH
(Bitragion Under Chin Arc Length)

The subject is placed or held in a seated position with the neck in slight extension to raise the chin up approximately ten degrees. With a cloth measuring tape, measure the length of the arc beginning at the notch on the left ear just forward of the ear opening (left tragion), passing under the chin just forward of where the neck and the chin join, and continuing to the notch on the right ear, just forward of the ear opening (right tragion). Enough tension is applied to the tape to assure even contact with and slight compression of the soft tissue.





(24)

Ear-to-Ear Under Chin Arc Length (cm)
(Bitragion Under Chin Arc Length)

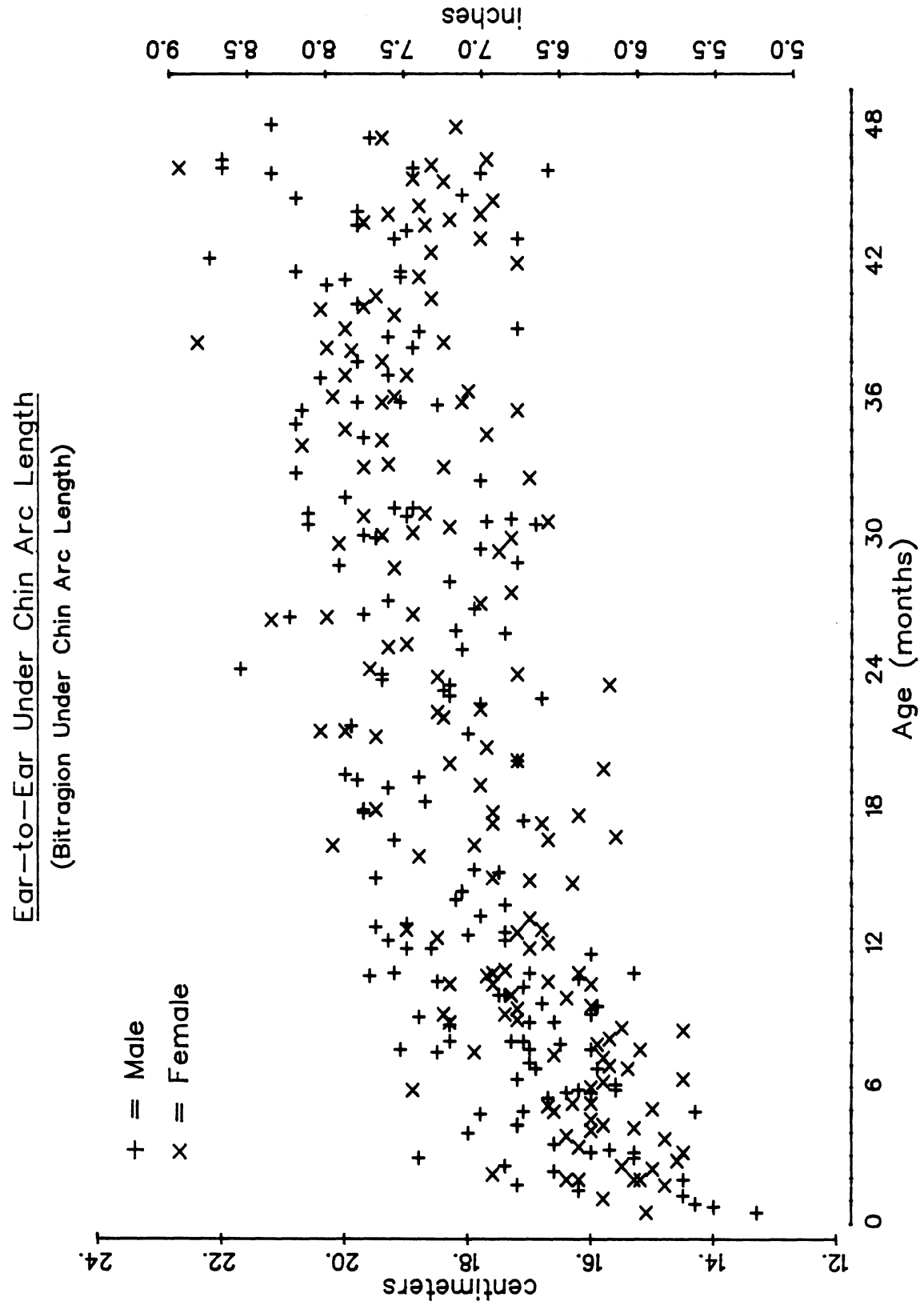
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	15.6	1.2	13.3	13.3	15.3	17.4	18.8
4-6	30	16.3	1.0	14.3	14.3	16.0	17.8	18.9
7-9	30	16.9	1.2	14.5	14.5	17.0	18.5	19.1
10-12	30	17.5	1.1	15.3	15.3	17.4	19.2	19.6
13-18	30	18.0	1.2	15.6	15.6	17.8	19.7	20.2
19-24	30	18.5	1.3	15.7	15.7	18.4	20.0	21.7
25-30	31	18.7	1.2	16.7	16.9	18.9	20.6	21.2
31-36	30	19.2	1.1	17.0	17.0	19.2	20.7	20.8
37-42	30	19.5	1.1	17.2	17.2	19.4	20.8	22.4
43-48	30	19.2	1.5	16.7	16.7	18.9	22.0	22.7

Ear-to-Ear Under Chin Arc Length (in)
(Bitragion Under Chin Arc Length)

(Males and Females)

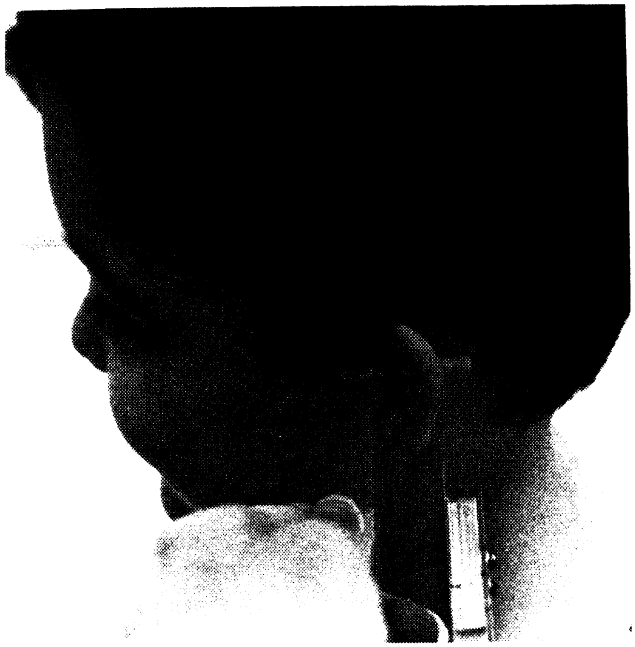
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	6.2	0.5	5.2	5.2	6.0	6.9	7.4
4-6	30	6.4	0.4	5.6	5.6	6.3	7.0	7.4
7-9	30	6.7	0.5	5.7	5.7	6.7	7.3	7.5
10-12	30	6.9	0.4	6.0	6.0	6.9	7.6	7.7
13-18	30	7.1	0.5	6.1	6.1	7.0	7.8	8.0
19-24	30	7.3	0.5	6.2	6.2	7.2	7.9	8.5
25-30	31	7.4	0.5	6.6	6.7	7.4	8.1	8.3
31-36	30	7.5	0.4	6.7	6.7	7.6	8.1	8.2
37-42	30	7.7	0.4	6.8	6.8	7.6	8.2	8.8
43-48	30	7.5	0.6	6.6	6.6	7.4	8.7	8.9

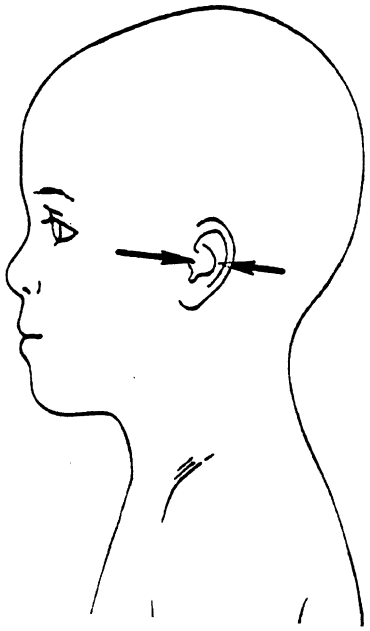

Ear-to-Ear Under Chin Arc Length
(Bitragion Under Chin Arc Length)
+ = Male
× = Female
centimeters
12.
14.
16.
18.
20.
22.
24.
inches
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
Age (months)
0
6
12
18
24
30
36
42
48

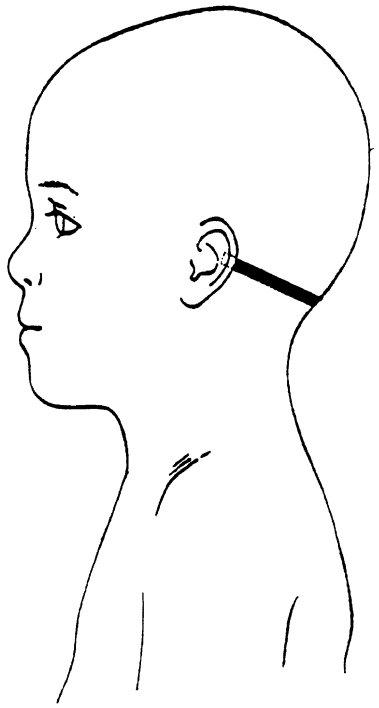
(25)

EAR-TO-EAR AROUND BACK-OF-HEAD ARC LENGTH
(Bitragion through Head/Neck–Junction Arc Length)

Because of the difficulty in measuring an accurate arc length over the ears, this measurement was made by taking two separate measurements and adding the results. The subject is placed or held in a seated position. With sliding calipers equipped with paddle blades, measure the distance from the notch on the left ear just forward of the ear opening (tragion) to the junction of the back of the ear and the head. Also, with a cloth measuring tape, measure the length of an arc from this point just behind the left ear, passing through the lowest point on the back of the skull at the junction of the head and neck (head/neck junction) to a comparable point behind the right ear. Multiply the first measurement taken across the ear by two and add the result to the arc length measured.







Ear-to-Ear around Back-of-Head Arc Length (cm)
(Bitragion through Head/Neck Junction Arc Length)

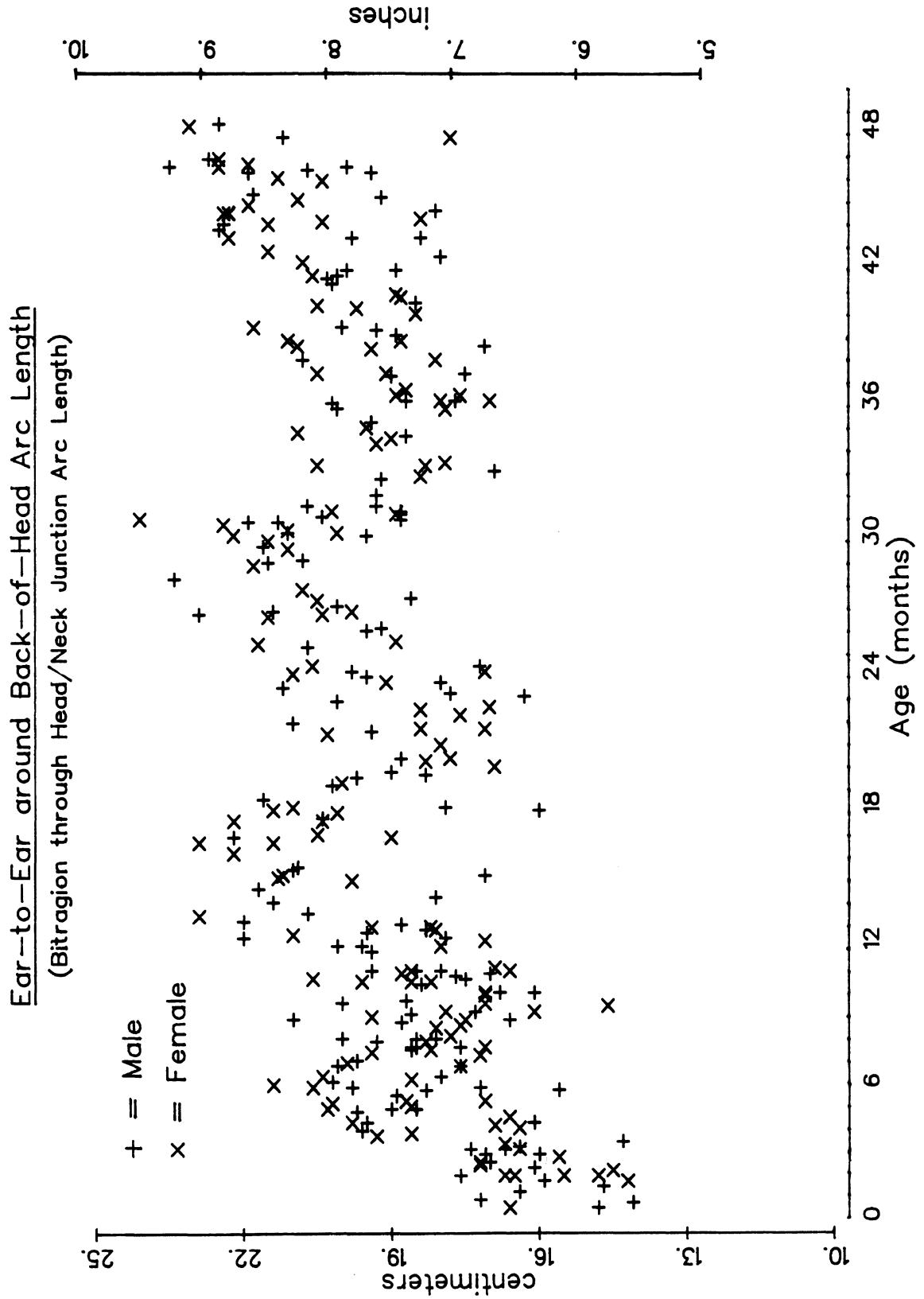
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	16.1	1.0	14.1	14.1	16.4	17.2	17.6
4-6	30	19.0	1.3	15.6	15.6	19.3	20.4	21.4
7-9	30	17.9	1.2	14.6	14.6	17.9	19.4	21.0
10-12	30	18.4	1.1	16.6	16.6	18.2	20.0	20.6
13-18	30	20.7	1.6	16.0	16.0	21.0	22.2	22.9
19-24	30	18.8	1.4	16.3	16.3	18.8	21.0	21.2
25-30	31	21.0	1.3	18.6	18.8	21.1	22.9	24.1
31-36	30	19.0	1.1	16.9	16.9	18.9	20.8	21.1
37-42	30	19.5	1.2	17.1	17.1	19.4	21.1	21.8
43-48	30	21.1	1.6	17.8	17.8	21.5	22.7	23.5

Ear-to-Ear around Back-of-Head Arc Length (in)
(Bitragion through Head/Neck Junction Arc Length)

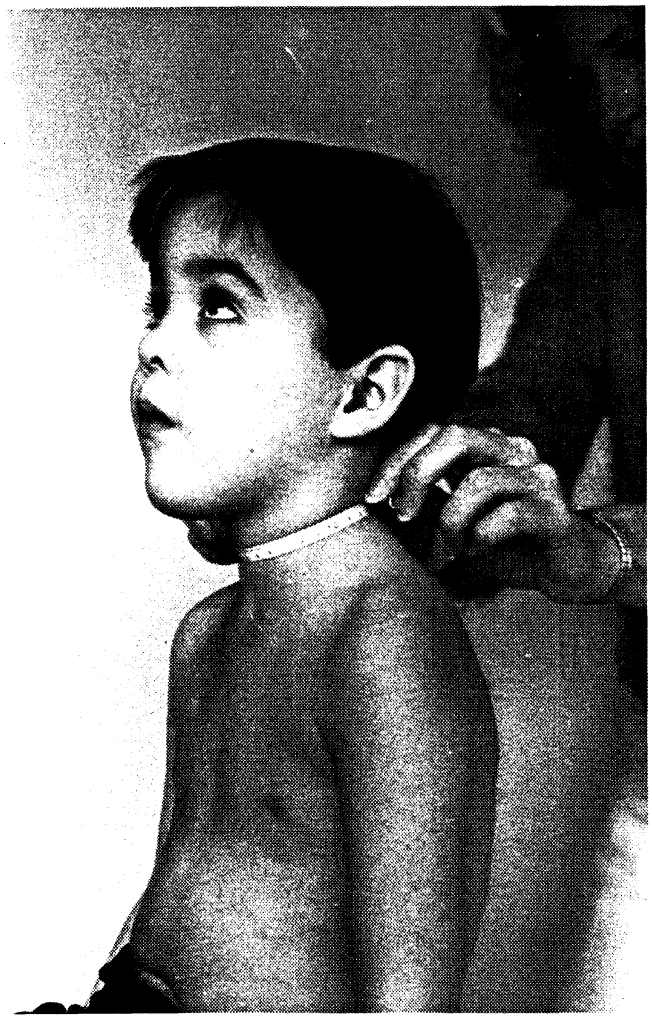
(Males and Females)

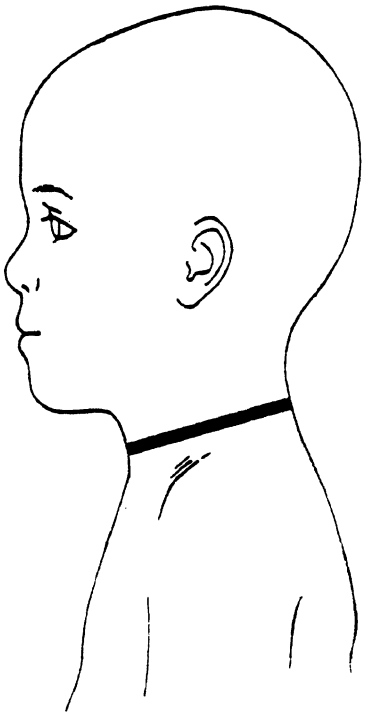
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	6.3	0.4	5.6	5.6	6.5	6.8	6.9
4-6	30	7.5	0.5	6.1	6.1	7.6	8.0	8.4
7-9	30	7.1	0.5	5.7	5.7	7.0	7.6	8.3
10-12	30	7.2	0.4	6.5	6.5	7.2	7.9	8.1
13-18	30	8.1	0.6	6.3	6.3	8.3	8.7	9.0
19-24	30	7.4	0.5	6.4	6.4	7.4	8.3	8.3
25-30	31	8.3	0.5	7.3	7.4	8.3	9.0	9.5
31-36	30	7.5	0.4	6.7	6.7	7.4	8.2	8.3
37-42	30	7.7	0.5	6.7	6.7	7.6	8.3	8.6
43-48	30	8.3	0.6	7.0	7.0	8.5	8.9	9.3


Ear-to-Ear around Back-of-Head Arc Length
(Bitragion through Head/Neck Junction Arc Length)
+ = Male
× = Female
centimeters
10.
13.
16.
19.
22.
25.
inches
5.
6.
7.
8.
9.
10.
Age (months)
0
6
12
18
24
30
36
42
48

NECK CIRCUMFERENCE

The subject is placed or held in a seated position. With a cloth measuring tape, measure the circumference of the neck in a plane perpendicular to the long axis of the neck at the approximate midpoint.





(26)

Neck Circumference (cm)

(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	21.4	2.1	18.2	18.2	21.1	24.7	26.7
4-6	30	21.4	1.1	19.2	19.2	21.1	23.4	24.4
7-9	30	21.8	1.9	18.7	18.7	21.4	24.7	27.2
10-12	30	21.9	1.3	18.6	18.6	22.0	23.9	24.0
13-18	30	21.9	1.2	18.6	18.6	22.0	23.5	24.0
19-24	30	22.3	1.2	20.5	20.5	22.0	24.0	25.3
25-30	31	22.8	1.5	20.0	20.2	22.7	24.8	27.0
31-36	30	22.9	1.2	20.7	20.7	22.8	24.7	26.3
37-42	30	23.2	1.1	20.3	20.3	23.3	24.8	25.0
43-48	30	24.1	1.3	22.0	22.0	24.1	25.8	25.9

Neck Circumference (in)

(Males and Females)

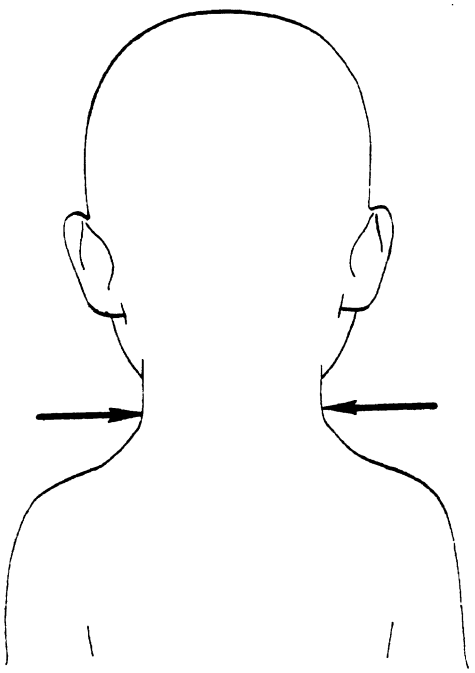
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	8.4	0.8	7.2	7.2	8.3	9.7	10.5
4-6	30	8.4	0.4	7.6	7.6	8.3	9.2	9.6
7-9	30	8.6	0.8	7.4	7.4	8.4	9.7	10.7
10-12	30	8.6	0.5	7.3	7.3	8.7	9.4	9.4
13-18	30	8.6	0.5	7.3	7.3	8.7	9.3	9.4
19-24	30	8.8	0.5	8.1	8.1	8.7	9.4	10.0
25-30	31	9.0	0.6	7.9	8.0	8.9	9.8	10.6
31-36	30	9.0	0.5	8.1	8.1	9.0	9.7	10.4
37-42	30	9.1	0.4	8.0	8.0	9.2	9.8	9.8
43-48	30	9.5	0.5	8.7	8.7	9.5	10.2	10.2

Neck Circumference
+ = Male
× = Female
centimeters
15.
18.
21.
24.
27.
30.
inches
6.
7.
8.
9.
10.
11.
Age (months)
0
6
12
18
24
30
36
42
48

(27)

NECK BREADTH

The subject is placed or held in a seated position. With sliding calipers, measure the breadth of the neck at the level of neck circumference.



Neck Breadth (cm)

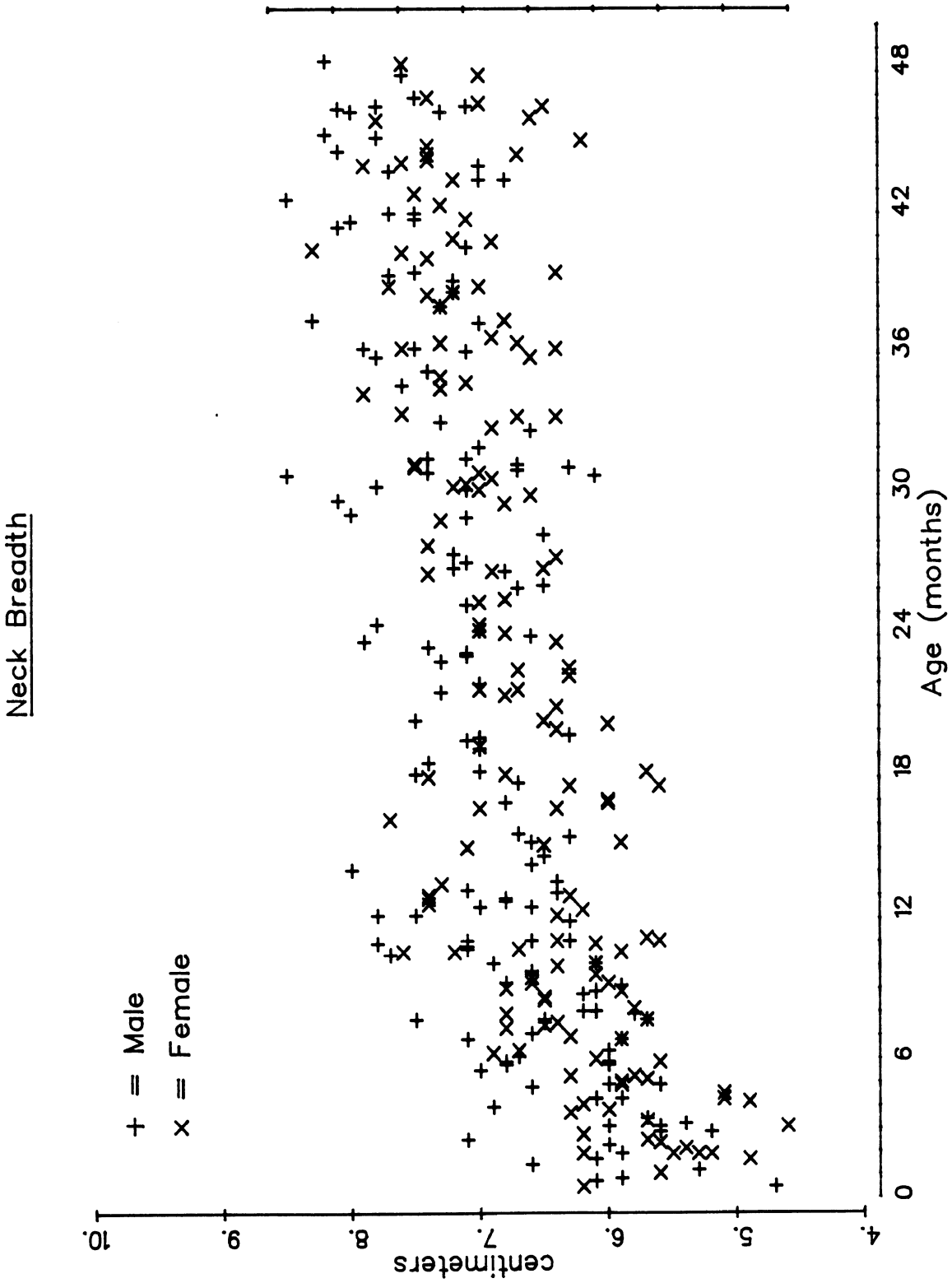
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	5.7	0.5	4.6	4.6	5.7	6.3	7.1
4-6	30	6.1	0.6	4.9	4.9	6.0	6.9	7.1
7-9	30	6.3	0.4	5.7	5.7	6.4	6.8	7.5
10-12	30	6.8	0.6	5.6	5.6	6.7	7.7	7.8
13-18	30	6.7	0.6	5.6	5.6	6.6	7.5	8.0
19-24	30	6.9	0.5	6.0	6.0	7.0	7.5	7.9
25-30	31	7.1	0.5	6.1	6.4	7.1	8.0	8.5
31-36	30	7.1	0.5	6.3	6.3	7.1	7.8	7.9
37-42	30	7.4	0.5	6.4	6.4	7.3	8.3	8.5
43-48	30	7.4	0.5	6.2	6.2	7.4	8.1	8.2

Neck Breadth (in)

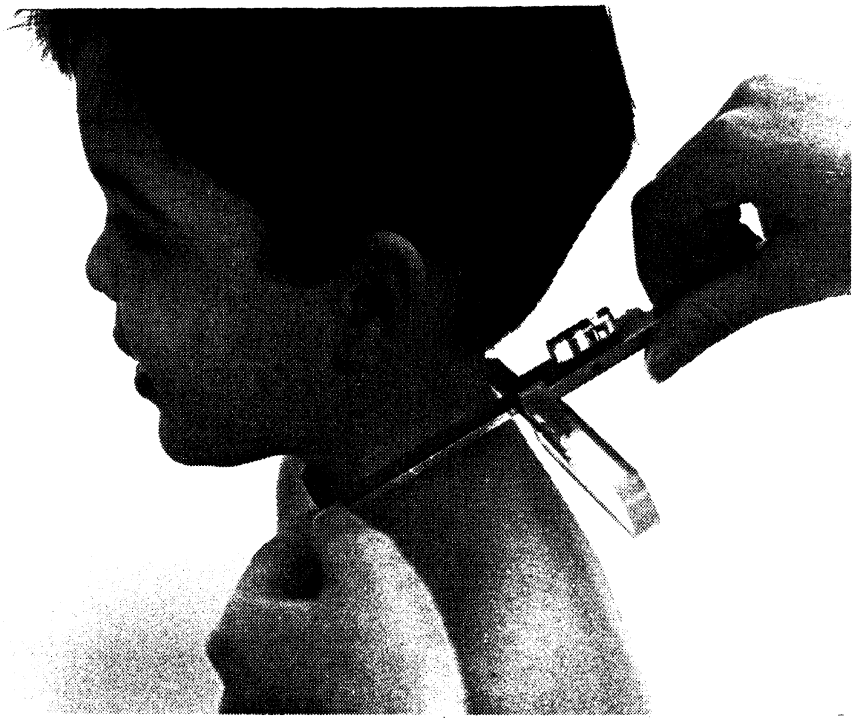
(Males and Females)

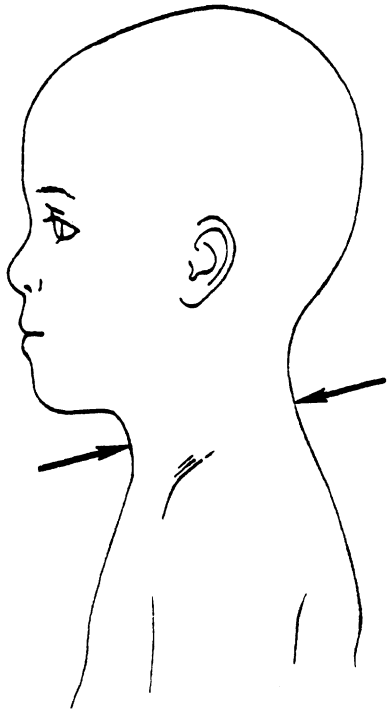
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	2.3	0.2	1.8	1.8	2.2	2.5	2.8
4-6	30	2.4	0.2	1.9	1.9	2.4	2.7	2.8
7-9	30	2.5	0.2	2.2	2.2	2.5	2.7	3.0
10-12	30	2.7	0.2	2.2	2.2	2.6	3.0	3.1
13-18	30	2.6	0.2	2.2	2.2	2.6	3.0	3.1
19-24	30	2.7	0.2	2.4	2.4	2.8	3.0	3.1
25-30	31	2.8	0.2	2.4	2.5	2.8	3.1	3.3
31-36	30	2.8	0.2	2.5	2.5	2.8	3.1	3.1
37-42	30	2.9	0.2	2.5	2.5	2.9	3.3	3.3
43-48	30	2.9	0.2	2.4	2.4	2.9	3.2	3.2


Neck Breadth
+ = Male
× = Female
centimeters
4. 5. 6. 7. 8. 9. 10.
inches
1.8 2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4
Age (months)
0 6 12 18 24 30 36 42 48

NECK DEPTH

The subject is placed or held in a seated position. With sliding calipers, measure the distance perpendicular to the long axis of the neck from the front of the neck to the back of the neck in the plane of neck circumference.





(28)

Neck Depth (cm)

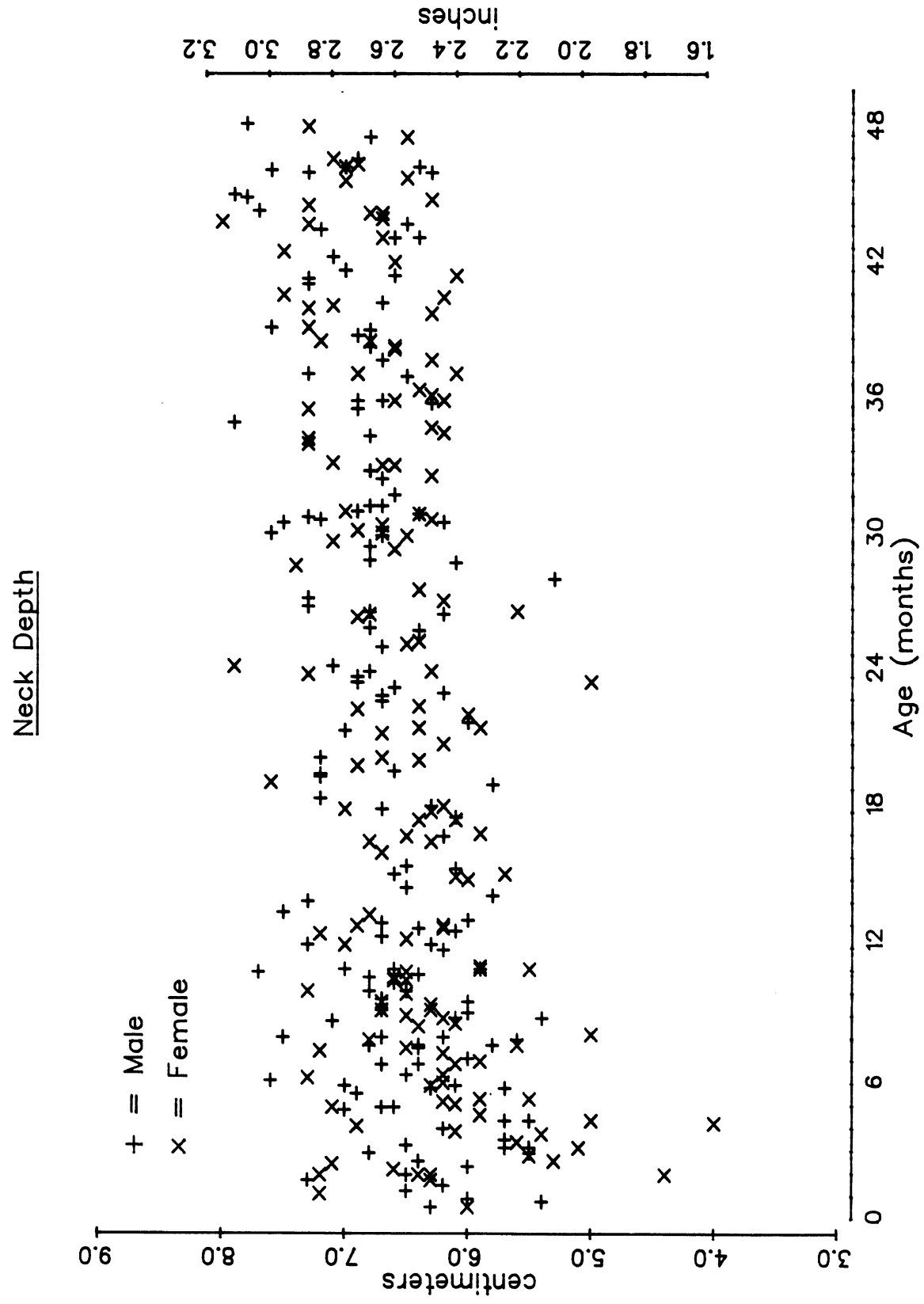
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	6.1	0.7	4.4	4.4	6.1	7.2	7.3
4-6	30	6.2	0.7	4.0	4.0	6.2	7.1	7.6
7-9	30	6.3	0.5	5.0	5.0	6.3	7.1	7.5
10-12	30	6.6	0.5	5.5	5.5	6.5	7.3	7.7
13-18	30	6.4	0.4	5.7	5.7	6.3	7.2	7.5
19-24	30	6.6	0.6	5.0	5.0	6.7	7.3	7.9
25-30	31	6.7	0.5	5.3	5.6	6.7	7.4	7.6
31-36	30	6.7	0.4	6.2	6.2	6.7	7.3	7.9
37-42	30	6.9	0.4	6.1	6.1	6.8	7.5	7.6
43-48	30	7.0	0.5	6.3	6.3	6.9	7.8	8.0

Neck Depth (in)

(Males and Females)

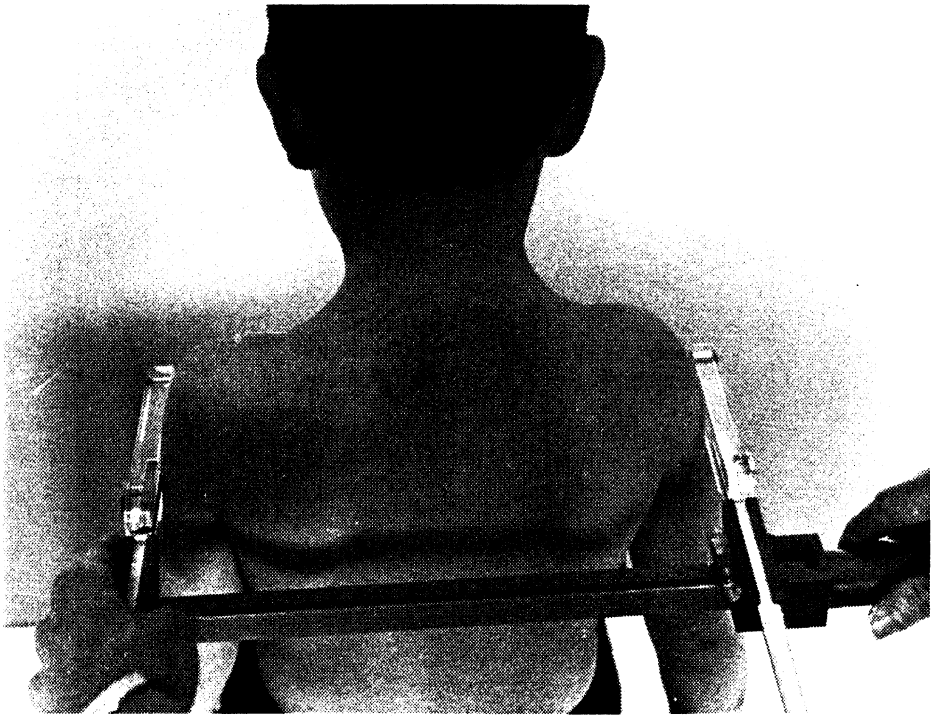
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	2.4	0.3	1.7	1.7	2.4	2.8	2.9
4-6	30	2.5	0.3	1.6	1.6	2.4	2.8	3.0
7-9	30	2.5	0.2	2.0	2.0	2.5	2.8	3.0
10-12	30	2.6	0.2	2.2	2.2	2.6	2.9	3.0
13-18	30	2.5	0.2	2.2	2.2	2.5	2.8	3.0
19-24	30	2.6	0.2	2.0	2.0	2.6	2.9	3.1
25-30	31	2.6	0.2	2.1	2.2	2.6	2.9	3.0
31-36	30	2.7	0.2	2.4	2.4	2.6	2.9	3.1
37-42	30	2.7	0.2	2.4	2.4	2.7	3.0	3.0
43-48	30	2.8	0.2	2.5	2.5	2.7	3.1	3.1

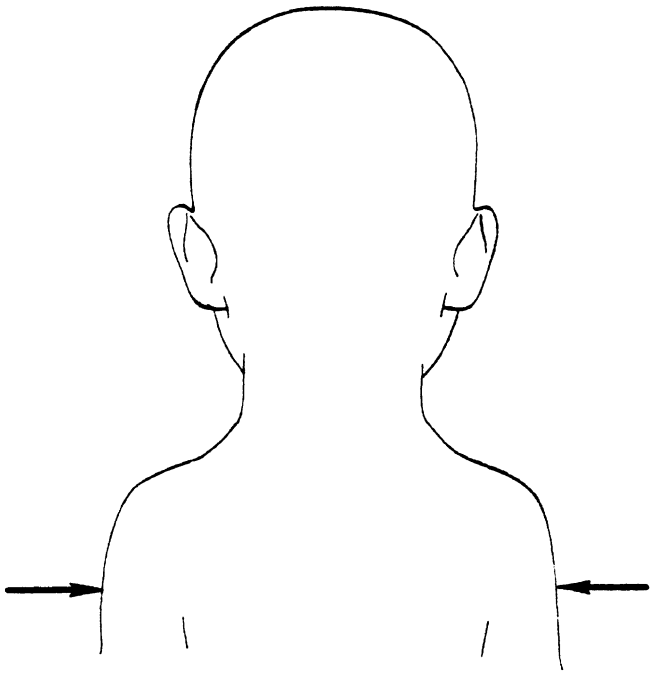

Neck Depth
+ = Male
× = Female
centimeters
3.0
4.0
5.0
6.0
7.0
8.0
9.0
inches
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
Age (months)
0
6
12
18
24
30
36
42
48

(29)

SHOULDER BREADTH

The subject is placed or held in a seated position with arms at the sides. With an anthropometer equipped with paddle blades, measure the breadth of the shoulders at the level of the greatest lateral protrusions of the deltoid muscles. For very small infants, the measurement is taken with the infant lying on the back and the arms held to the sides. Enough pressure is applied to assure even contact between the paddle blades and the skin.





Shoulder Breadth (cm)

(Males and Females)

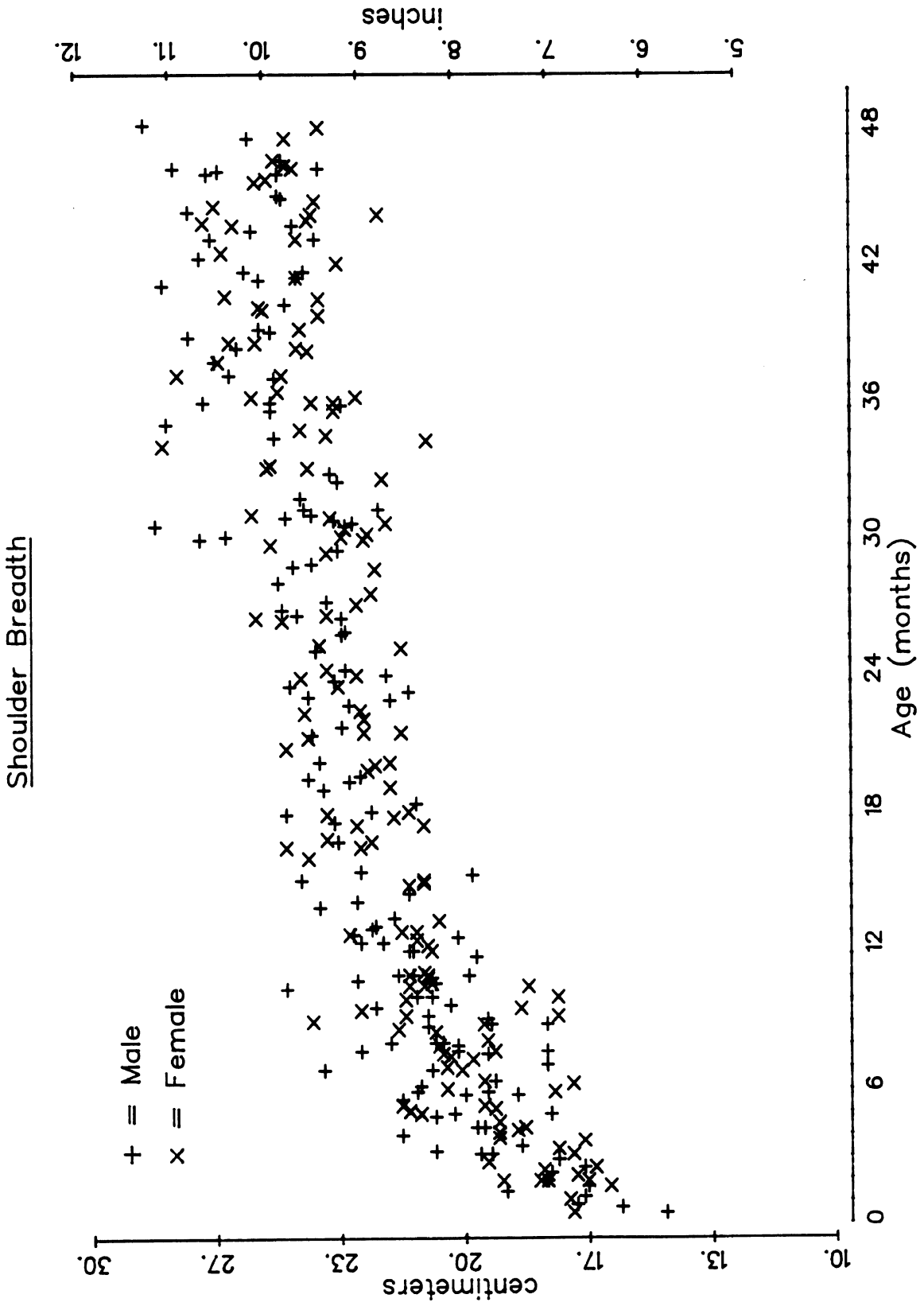
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	17.6	1.3	14.6	14.6	17.5	19.4	20.8
4-6	30	20.0	1.5	17.1	17.1	19.7	21.7	23.8
7-9	30	20.3	1.6	17.5	17.5	20.4	22.8	24.1
10-12	30	21.2	1.4	17.5	17.5	21.1	23.0	24.8
13-18	30	22.5	1.3	19.8	19.8	22.5	24.4	24.8
19-24	30	23.2	0.9	21.5	21.5	23.1	24.4	24.8
25-30	31	23.9	1.5	21.7	22.1	23.7	26.4	28.3
31-36	30	24.4	1.6	21.0	21.0	24.2	27.0	28.1
37-42	30	25.5	1.2	23.4	23.4	25.5	27.4	28.1
43-48	30	25.4	1.4	22.3	22.3	25.0	27.4	28.6

Shoulder Breadth (in)

(Males and Females)

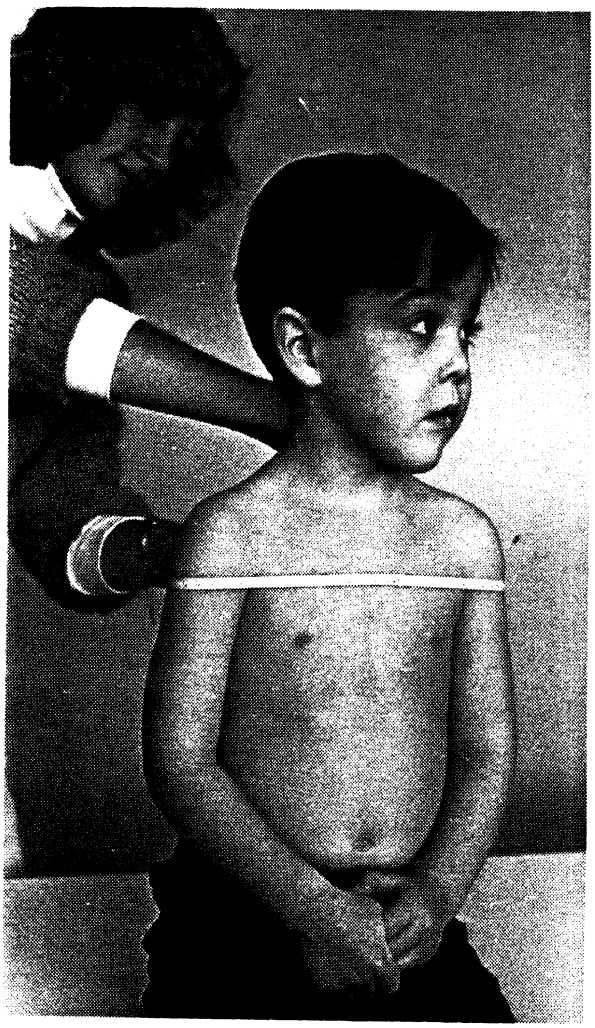
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	6.9	0.5	5.7	5.7	6.9	7.6	8.2
4-6	30	7.9	0.6	6.7	6.7	7.8	8.5	9.4
7-9	30	8.0	0.6	6.9	6.9	8.0	9.0	9.5
10-12	30	8.4	0.5	6.9	6.9	8.3	9.1	9.8
13-18	30	8.8	0.5	7.8	7.8	8.9	9.6	9.8
19-24	30	9.1	0.4	8.5	8.5	9.1	9.6	9.8
25-30	31	9.4	0.6	8.5	8.7	9.3	10.4	11.1
31-36	30	9.6	0.6	8.3	8.3	9.5	10.6	11.1
37-42	30	10.1	0.5	9.2	9.2	10.0	10.8	11.1
43-48	30	10.0	0.5	8.8	8.8	9.8	10.8	11.3

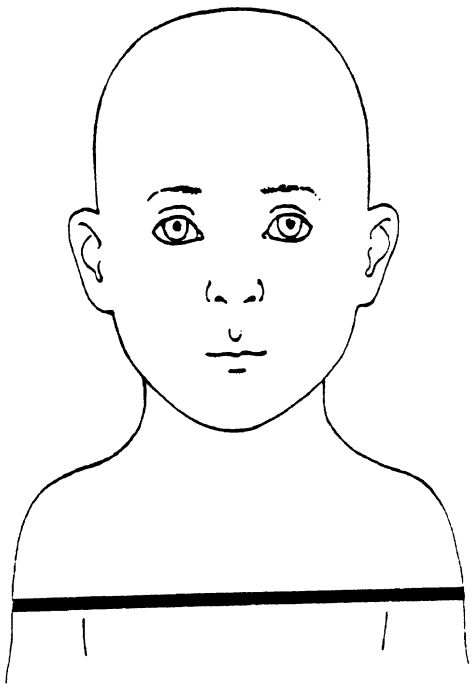
(29)


Shoulder Breadth
+ = Male
× = Female
centimeters
10. 13. 17. 20. 23. 27. 30.
inches
5. 6. 7. 8. 9. 10. 11. 12.
Age (months)
0 6 12 18 24 30 36 42 48

SHOULDER CIRCUMFERENCE

The subject is placed or held in a seated position with the arms at the sides. With a cloth measuring tape, measure the circumference around the shoulders at the level of the greatest lateral protrusions of the deltoid muscles. The measurement plane is perpendicular to the long axis of the torso.





(30)

Shoulder Circumference (cm)

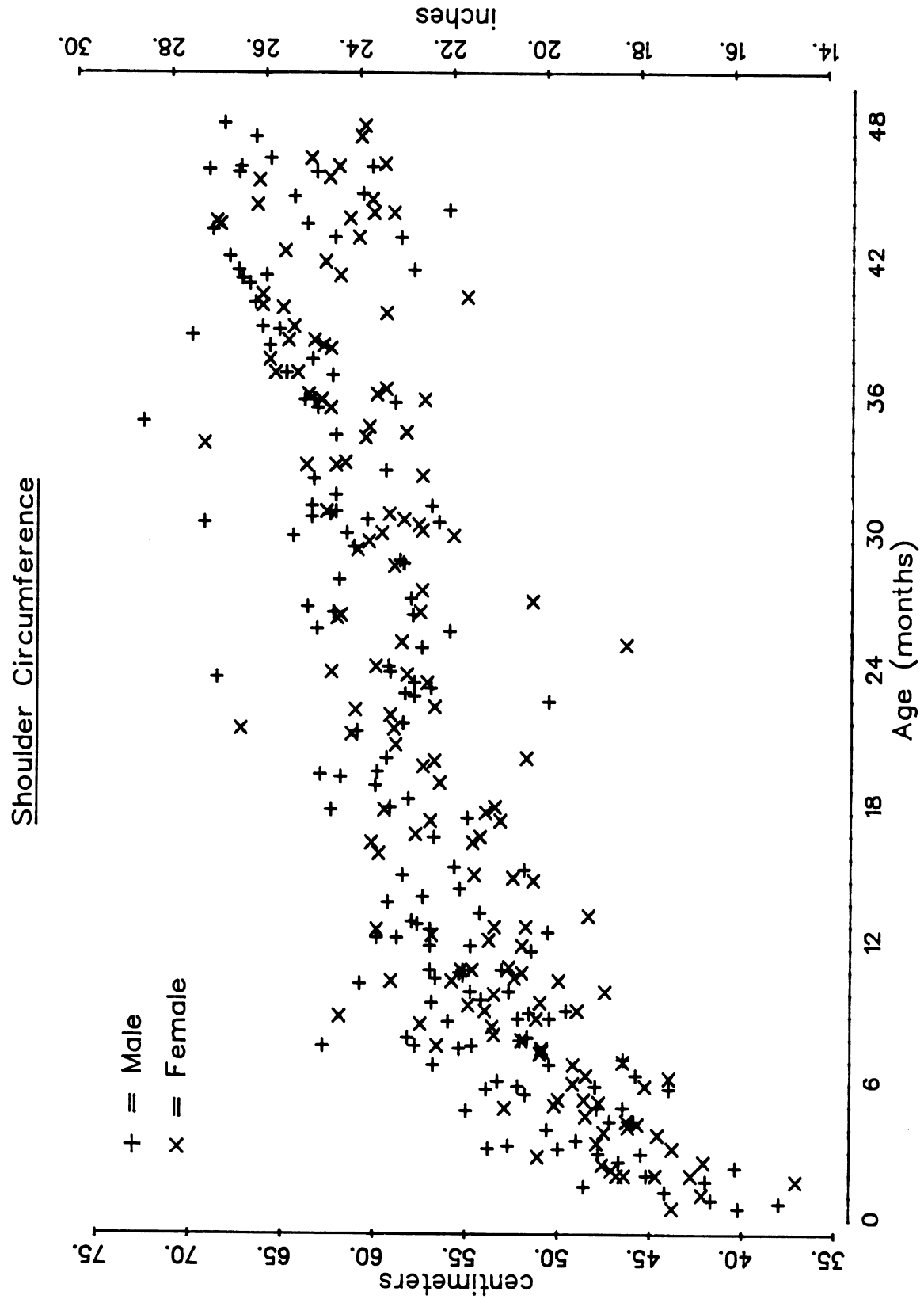
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	45.4	4.0	37.1	37.1	45.2	51.1	53.8
4-6	30	48.9	3.3	44.0	44.0	48.5	53.9	56.8
7-9	30	53.7	3.7	46.5	46.5	52.2	58.2	62.8
10-12	30	54.9	3.1	47.5	47.5	54.8	59.9	60.8
13-18	30	55.9	3.2	48.4	48.4	55.4	59.8	62.4
19-24	30	59.2	3.5	50.6	50.6	59.0	63.0	68.6
25-30	31	59.3	4.0	46.4	51.5	58.7	63.7	69.3
31-36	30	62.0	3.2	57.0	57.0	62.2	63.9	72.6
37-42	30	64.5	3.0	55.1	55.1	65.0	67.5	70.0
43-48	30	63.5	3.6	56.1	56.1	62.6	68.7	69.1

Shoulder Circumference (in)

(Males and Females)

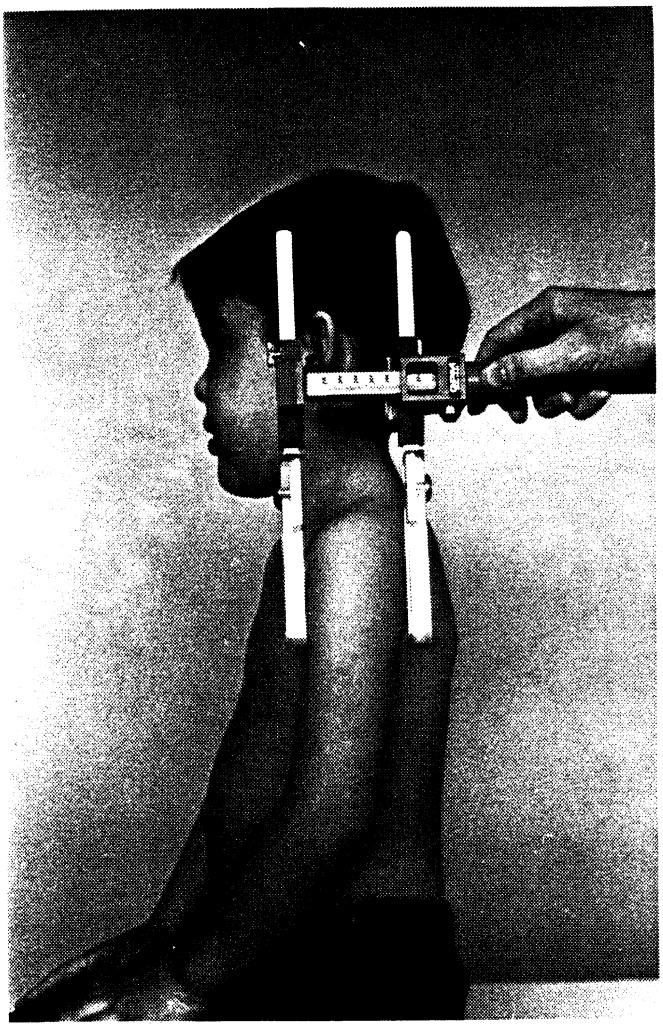
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	17.9	1.6	14.6	14.6	17.8	20.1	21.2
4-6	30	19.3	1.3	17.3	17.3	19.1	21.2	22.4
7-9	30	21.1	1.4	18.3	18.3	20.6	22.9	24.7
10-12	30	21.6	1.2	18.7	18.7	21.6	23.6	23.9
13-18	30	22.0	1.2	19.1	19.1	21.8	23.5	24.6
19-24	30	23.3	1.4	19.9	19.9	23.2	24.8	27.0
25-30	31	23.3	1.6	18.3	20.3	23.1	25.1	27.3
31-36	30	24.4	1.3	22.4	22.4	24.5	25.2	28.6
37-42	30	25.4	1.2	21.7	21.7	25.6	26.6	27.6
43-48	30	25.0	1.4	22.1	22.1	24.6	27.0	27.2

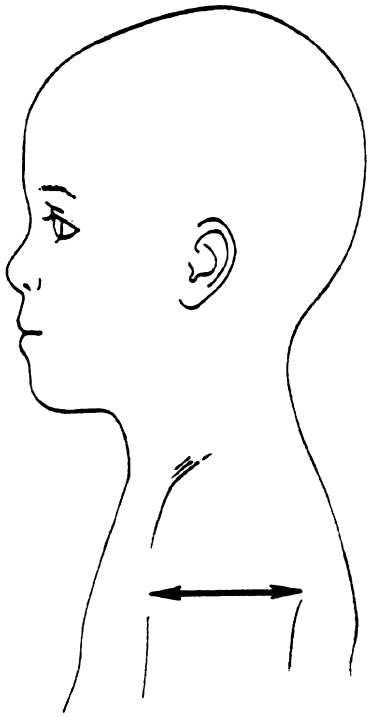

Shoulder Circumference
+ = Male
× = Female
centimeters
35. 40. 45. 50. 55. 60. 65. 70. 75.
inches
14. 16. 18. 20. 22. 24. 26. 28. 30.
Age (months)
0 6 12 18 24 30 36 42 48

(31)

SHOULDER DEPTH

The subject is placed or held in a seated position with the arms at the sides. With an anthropometer equipped with paddle blades, measure the front to back depth of the shoulder across the top of the upper arm and at the level of the greatest lateral protrusion of the deltoid muscle.





Shoulder Depth (cm)

(Males and Females)

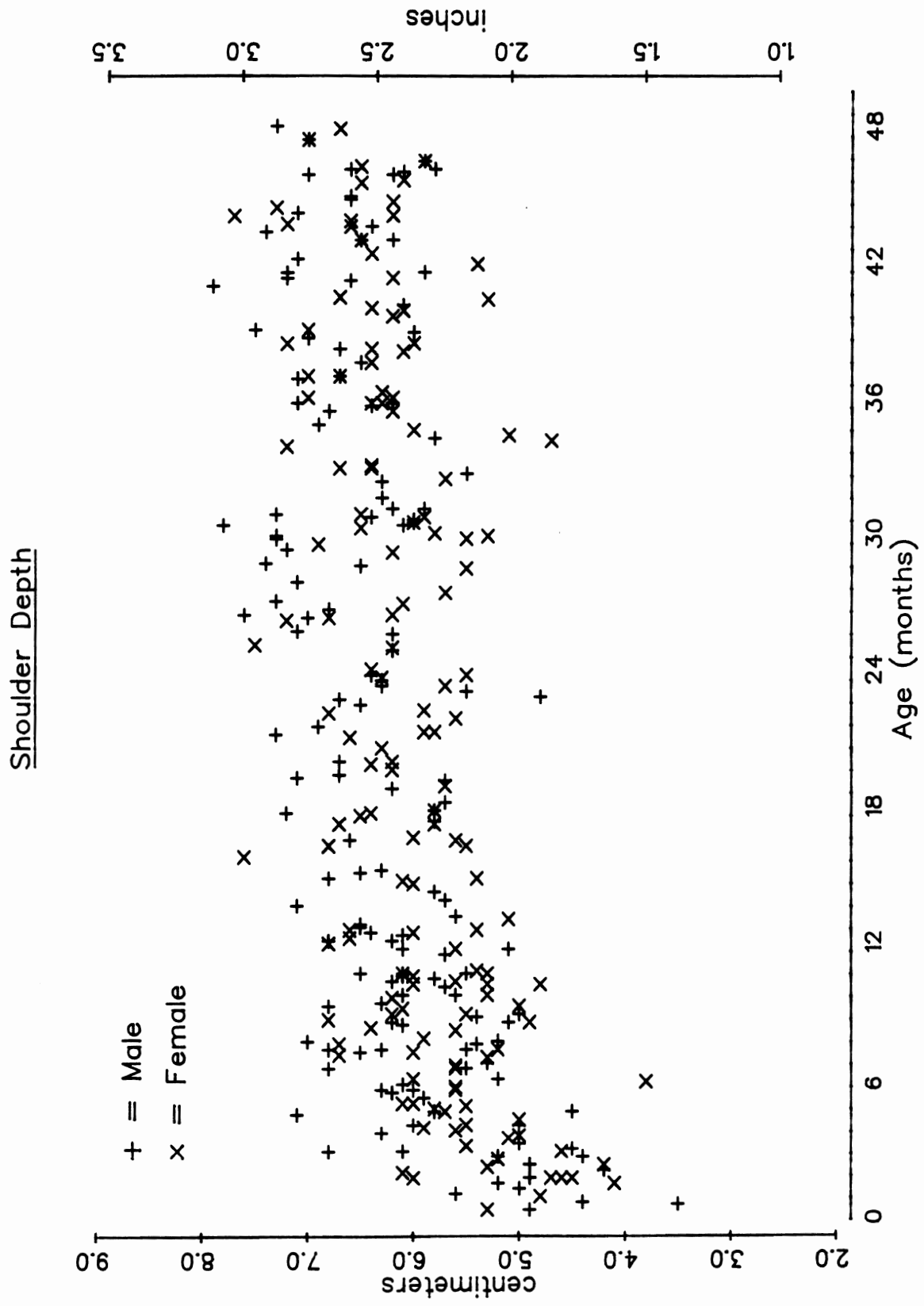
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	5.0	0.7	3.5	3.5	4.9	6.1	6.8
4-6	30	5.7	0.6	3.8	3.8	5.8	6.3	7.1
7-9	30	5.9	0.7	4.9	4.9	5.9	6.8	7.0
10-12	30	5.9	0.5	4.8	4.8	6.0	6.6	6.8
13-18	30	6.2	0.6	5.1	5.1	6.0	7.1	7.6
19-24	29	6.2	0.5	4.8	4.8	6.3	7.1	7.3
25-30	31	6.6	0.7	5.3	5.5	6.5	7.5	7.8
31-36	30	6.3	0.6	4.7	4.7	6.3	7.1	7.3
37-42	30	6.6	0.6	5.3	5.3	6.5	7.2	7.9
43-48	29	6.6	0.5	5.8	5.8	6.6	7.4	7.7

Shoulder Depth (in)

(Males and Females)

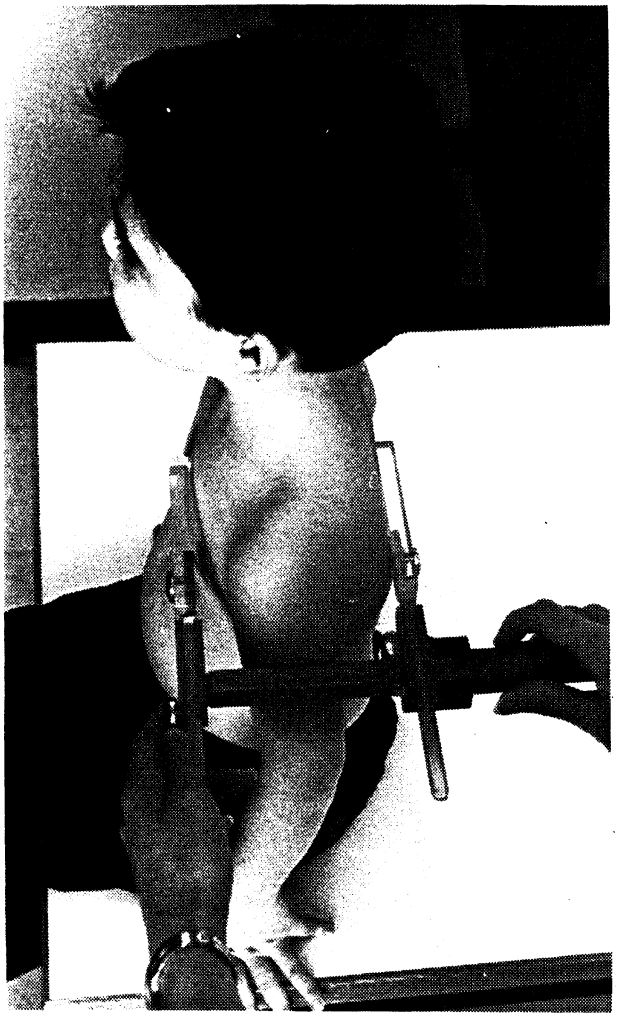
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	2.0	0.3	1.4	1.4	1.9	2.4	2.7
4-6	30	2.3	0.2	1.5	1.5	2.3	2.5	2.8
7-9	30	2.3	0.3	1.9	1.9	2.3	2.7	2.8
10-12	30	2.3	0.2	1.9	1.9	2.4	2.6	2.7
13-18	30	2.4	0.2	2.0	2.0	2.4	2.8	3.0
19-24	29	2.4	0.2	1.9	1.9	2.5	2.8	2.9
25-30	31	2.6	0.3	2.1	2.2	2.6	3.0	3.1
31-36	30	2.5	0.2	1.9	1.9	2.5	2.8	2.9
37-42	30	2.6	0.2	2.1	2.1	2.6	2.8	3.1
43-48	29	2.6	0.2	2.3	2.3	2.6	2.9	3.0

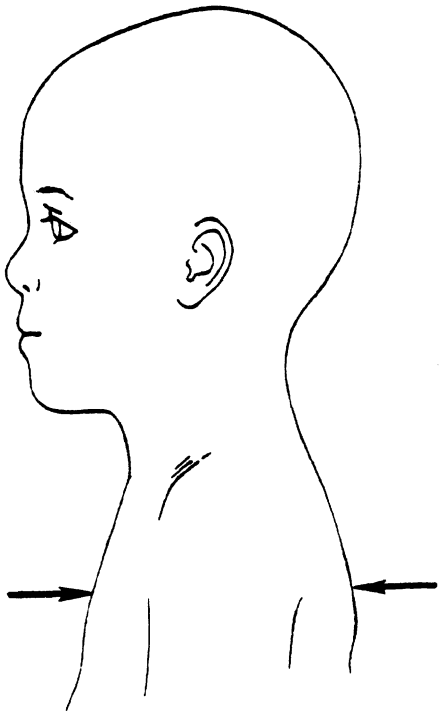
(31)


Shoulder Depth
+ = Male
× = Female
centimeters
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
inches
1.0
1.5
2.0
2.5
3.0
3.5
0
6
12
18
24
30
36
42
48
Age (months)

TORSO DEPTH

The subject is placed or held in a seated position with the arms at the sides. With an anthropometer equipped with paddle blades, measure the front to back depth of the torso in the midsagittal plane at the level of *Shoulder Circumference* measurement.





(32)

Torso Depth (cm)

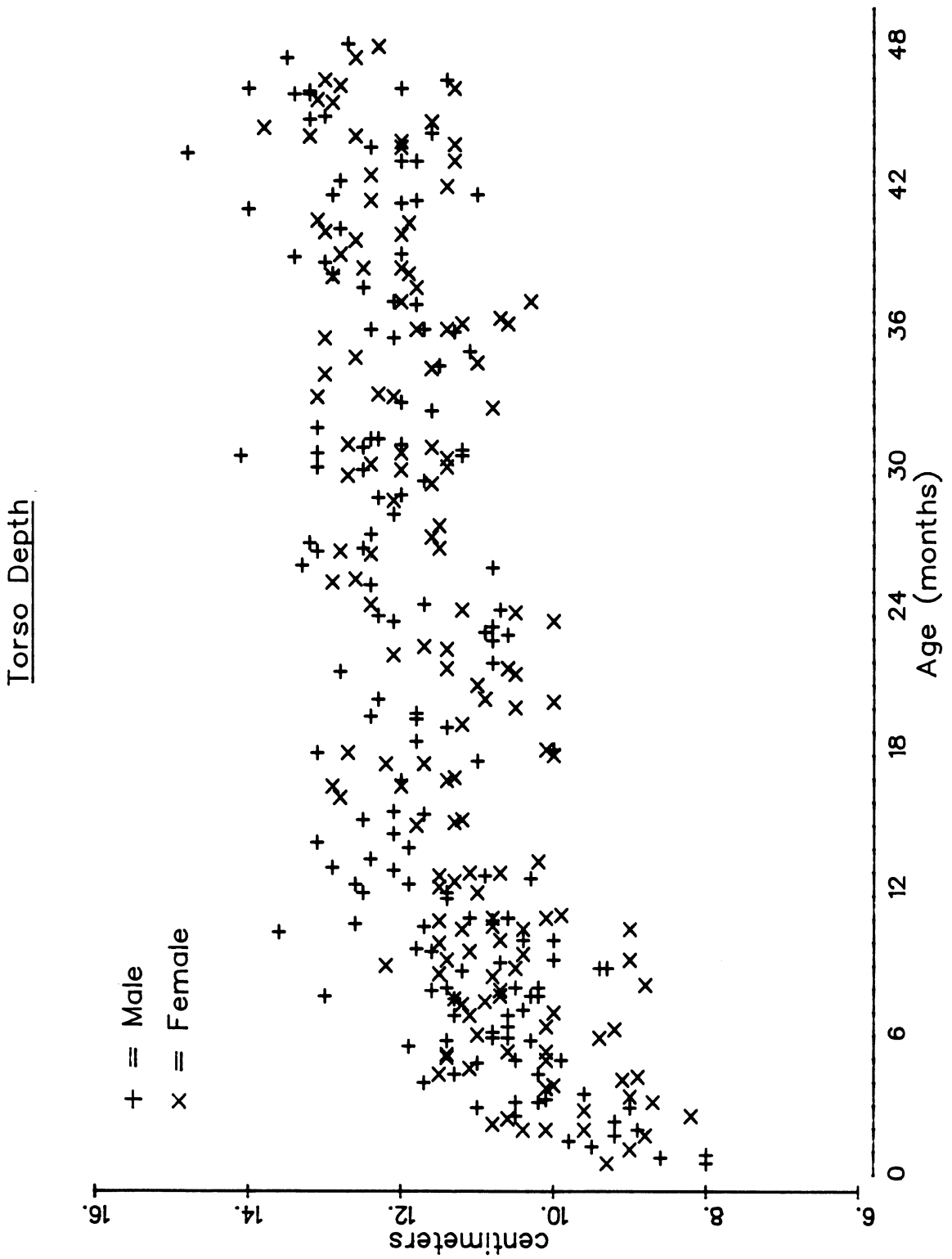
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	9.5	0.8	8.0	8.0	9.6	10.6	11.0
4-6	30	10.6	0.8	8.9	8.9	10.6	11.5	11.9
7-9	30	10.8	0.9	8.8	8.8	10.7	11.8	13.0
10-12	30	11.1	0.9	9.0	9.0	11.0	12.6	13.6
13-18	30	11.7	0.9	10.0	10.0	11.8	12.9	13.1
19-24	30	11.3	0.8	10.0	10.0	11.2	12.4	12.8
25-30	31	12.3	0.7	10.8	11.2	12.4	13.2	14.1
31-36	30	11.9	0.7	10.6	10.6	11.8	13.0	13.1
37-42	30	12.3	0.7	10.3	10.3	12.4	13.1	14.0
43-48	30	12.6	0.9	11.3	11.3	12.6	13.8	14.8

Torso Depth (in)

(Males and Females)

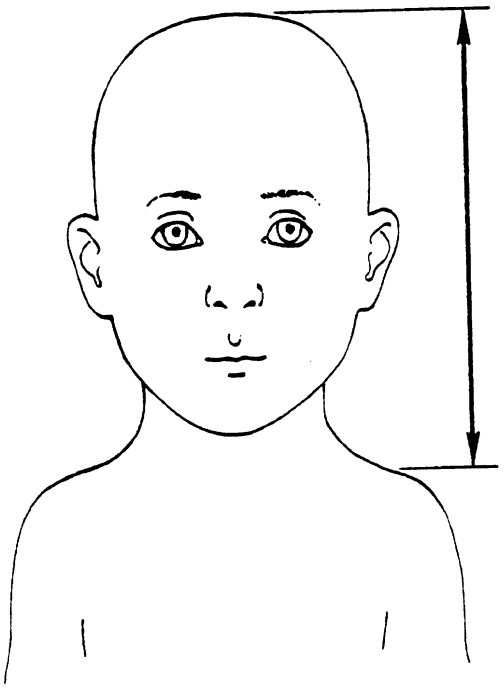
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	3.8	0.3	3.1	3.1	3.8	4.2	4.3
4-6	30	4.2	0.3	3.5	3.5	4.2	4.5	4.7
7-9	30	4.2	0.4	3.5	3.5	4.2	4.6	5.1
10-12	30	4.4	0.4	3.5	3.5	4.3	5.0	5.4
13-18	30	4.6	0.4	3.9	3.9	4.6	5.1	5.2
19-24	30	4.4	0.3	3.9	3.9	4.4	4.9	5.0
25-30	31	4.8	0.3	4.3	4.4	4.9	5.2	5.6
31-36	30	4.7	0.3	4.2	4.2	4.6	5.1	5.2
37-42	30	4.9	0.3	4.1	4.1	4.9	5.2	5.5
43-48	30	5.0	0.3	4.4	4.4	5.0	5.4	5.8


Torso Depth
+ = Male
× = Female
centimeters
6.
8.
10.
12.
14.
16.
inches
3.0
3.5
4.0
4.5
5.0
5.5
6.0
Age (months)
0
6
12
18
24
30
36
42
48

(33)

TOP-OF-SHOULDER TO TOP-OF-HEAD DISTANCE
(Top-of-Shoulder to Vertex Distance)

The subject is positioned lying on the back looking upward so that the Frankfort plane is approximately vertical and with the top of the head against a vertical plexiglass reference plate. The arms are positioned at the sides with the shoulders in a normal and relaxed position. With an anthropometer equipped with paddle blades, place the outside edge of one blade against the top of the shoulder at the position where shoulder depth was taken and measure the distance parallel to the long axis of the body to the back side of the reference plate. Subtract the thickness of the reference plate and add the thickness of the paddle blade to the distance read.



Top-of-Shoulder to Top-of-Head Distance (cm)
(Top-of-Shoulder to Vertex Distance)

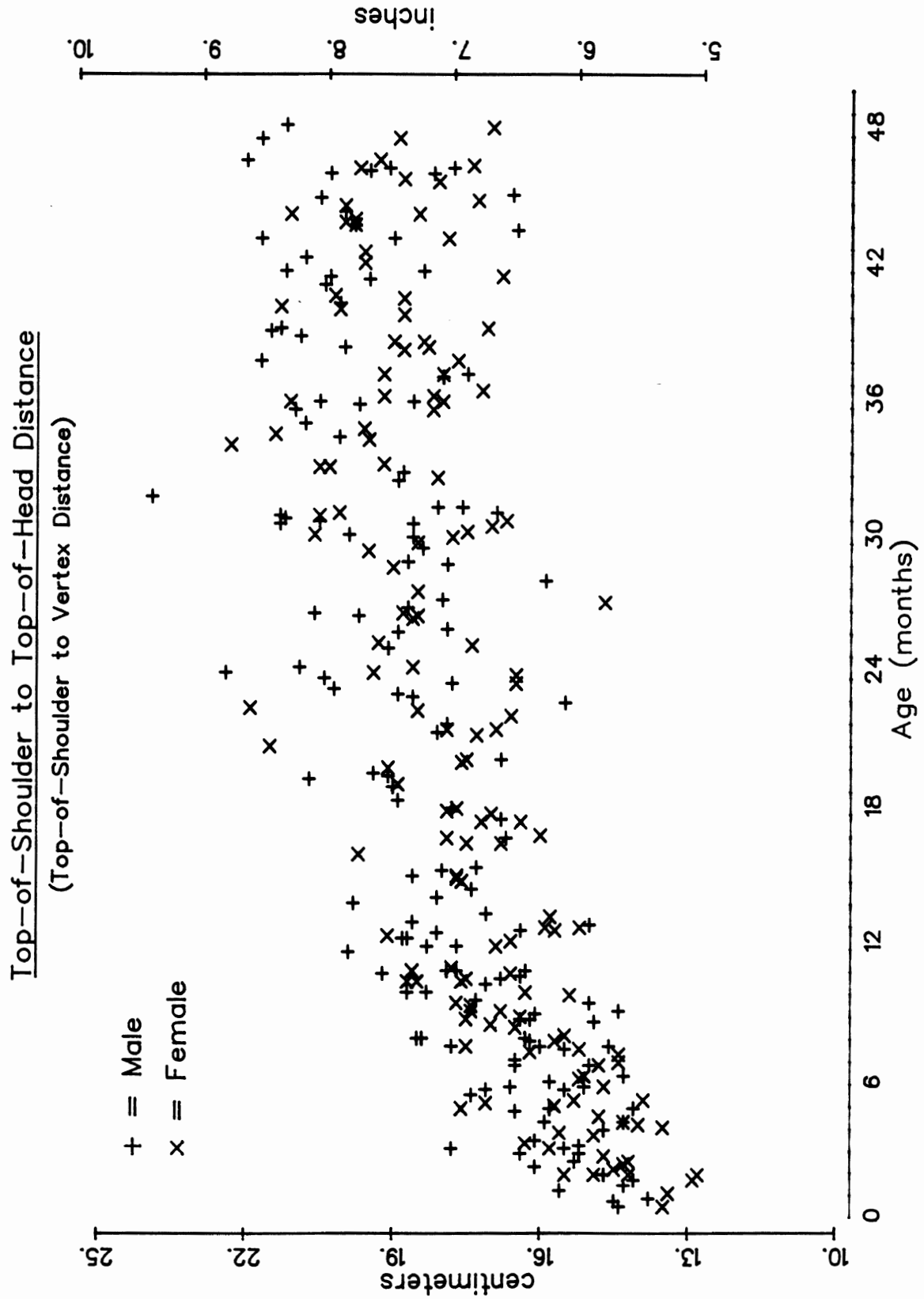
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	14.9	1.1	12.8	12.8	14.7	16.3	17.8
4-6	29	15.3	1.1	13.5	13.5	15.1	17.4	17.6
7-9	30	16.4	1.1	14.4	14.4	16.3	17.8	18.5
10-12	30	17.7	1.1	15.4	15.4	17.7	19.1	19.9
13-18	30	17.4	1.1	15.0	15.0	17.5	18.9	19.8
19-24	30	18.7	1.7	15.5	15.5	18.6	21.5	22.4
25-30	31	18.6	1.4	14.7	15.9	18.6	20.6	21.3
31-36	30	19.7	1.6	16.9	16.9	19.6	21.4	23.9
37-42	30	19.4	1.4	16.8	16.8	19.5	21.3	21.7
43-48	30	19.2	1.5	16.5	16.5	19.3	21.7	22.0

Top-of-Shoulder to Top-of-Head Distance (in)
(Top-of-Shoulder to Vertex Distance)

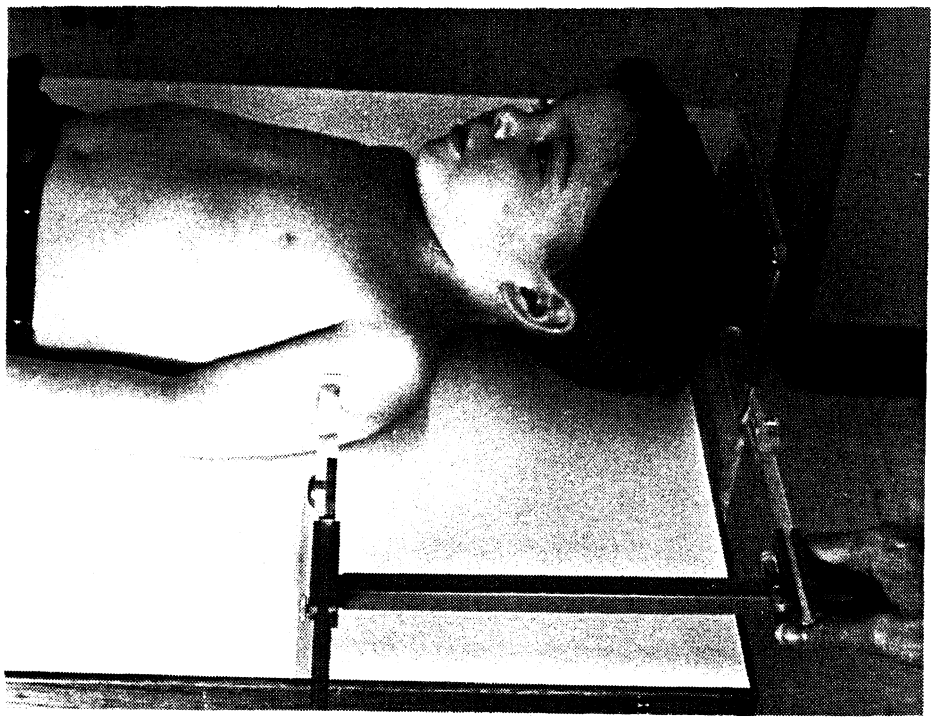
(Males and Females)

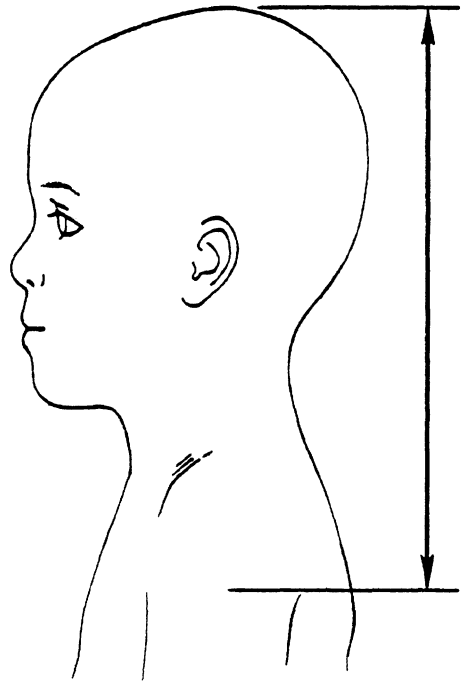
Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	5.9	0.4	5.0	5.0	5.8	6.4	7.0
4-6	29	6.0	0.4	5.3	5.3	5.9	6.9	6.9
7-9	30	6.4	0.4	5.7	5.7	6.4	7.0	7.3
10-12	30	7.0	0.4	6.1	6.1	7.0	7.5	7.8
13-18	30	6.8	0.5	5.9	5.9	6.9	7.4	7.8
19-24	30	7.4	0.7	6.1	6.1	7.3	8.5	8.8
25-30	31	7.3	0.5	5.8	6.3	7.3	8.1	8.4
31-36	30	7.8	0.6	6.7	6.7	7.7	8.4	9.4
37-42	30	7.7	0.5	6.6	6.6	7.7	8.4	8.5
43-48	30	7.6	0.6	6.5	6.5	7.6	8.5	8.7


Top-of-Shoulder to Top-of-Head Distance
(Top-of-Shoulder to Vertex Distance)
+ = Male
× = Female
centimeters
10.
13.
16.
19.
22.
25.
inches
5.
6.
7.
8.
9.
10.
Age (months)
0
6
12
18
24
30
36
42
48

SHOULDER-CIRCUMFERENCE-POINT TO TOP-OF-HEAD DISTANCE
(Shoulder-Circumference-Point to Vertex Distance)

The subject is positioned lying on the back looking upward so that the Frankfort plane is approximately vertical and with the top of the head against a vertical plexiglass reference plate. The arms are positioned at the sides with the shoulders in a normal and relaxed position. With an anthropometer equipped with paddle blades measure the distance parallel to the long axis of the body from the level of greatest lateral protrusion of the deltoid muscle on the shoulder to the back side of the reference plate. Subtract the thickness of the reference plate from the distance read.





(34)

Shoulder Circumference Point to Top-of-Head Distance (cm)
(Shoulder Circumference Point to Vertex Distance)

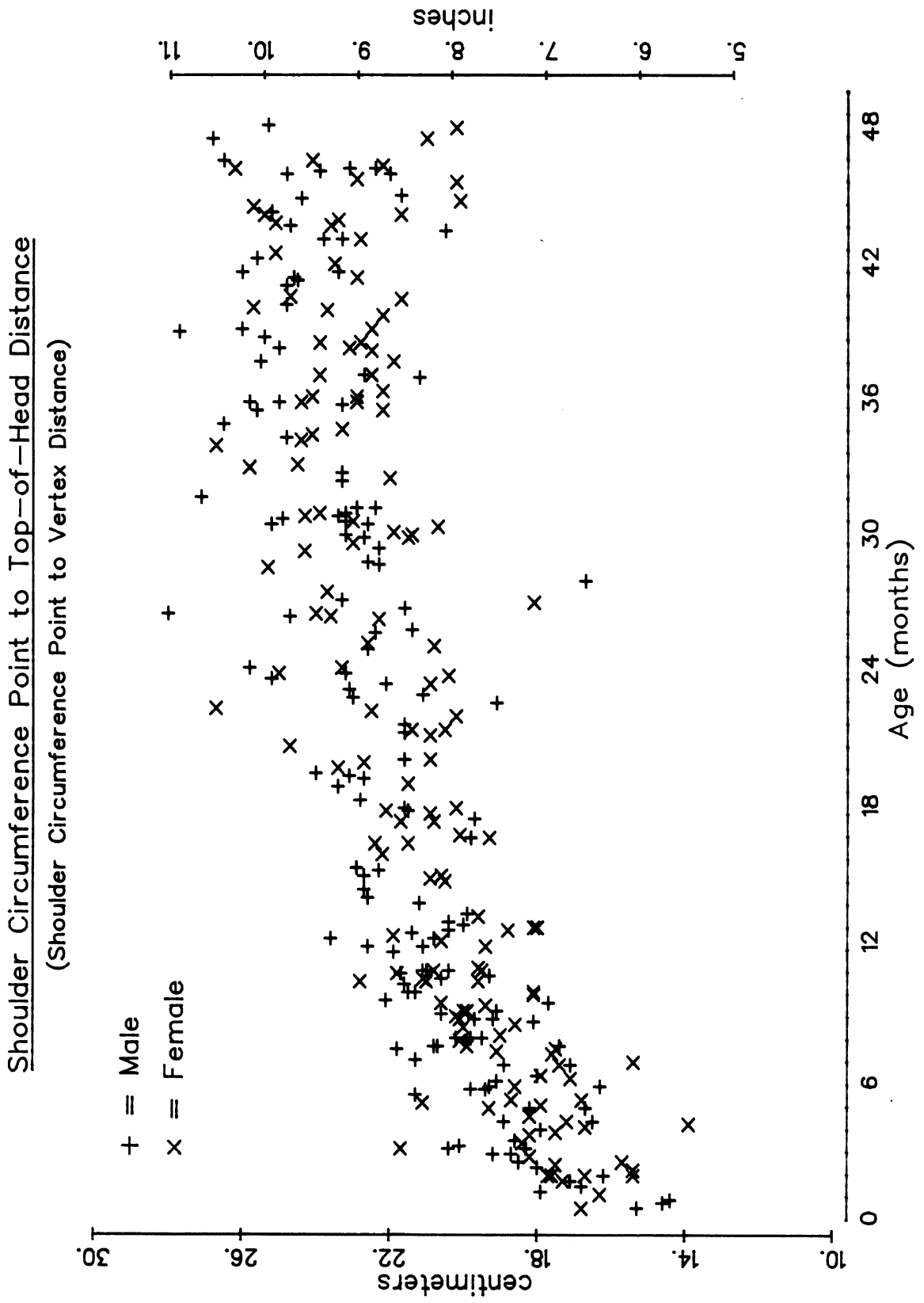
(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	17.5	1.7	14.4	14.4	17.5	20.1	21.7
4-6	29	18.0	1.6	13.9	13.9	18.0	21.1	21.3
7-9	30	19.7	1.2	17.4	17.4	19.9	21.3	22.1
10-12	30	20.8	1.3	18.1	18.1	21.0	22.6	23.6
13-18	30	21.0	1.3	18.0	18.0	20.9	22.7	22.9
19-24	30	22.5	1.8	19.1	19.1	22.5	25.2	26.7
25-30	31	22.6	2.0	16.7	18.1	22.6	25.2	28.0
31-36	30	24.2	1.4	22.0	22.0	24.1	26.5	27.1
37-42	30	24.0	1.5	21.2	21.2	23.9	26.0	27.7
43-48	30	23.4	1.9	20.1	20.1	23.4	26.2	26.8

Shoulder Circumference Point to Top-of-Head Distance (in)
(Shoulder Circumference Point to Vertex Distance)

(Males and Females)

Ages (mo)	N	Mean	S.D.	Min	5th	50th	95th	Max
0-3	30	6.9	0.7	5.7	5.7	6.9	7.9	8.5
4-6	29	7.1	0.6	5.5	5.5	7.1	8.3	8.4
7-9	30	7.7	0.5	6.9	6.9	7.8	8.4	8.7
10-12	30	8.2	0.5	7.1	7.1	8.3	8.9	9.3
13-18	30	8.3	0.5	7.1	7.1	8.2	8.9	9.0
19-24	30	8.9	0.7	7.5	7.5	8.9	9.9	10.5
25-30	31	8.9	0.8	6.6	7.1	8.9	9.9	11.0
31-36	30	9.5	0.6	8.7	8.7	9.5	10.4	10.7
37-42	30	9.4	0.6	8.3	8.3	9.4	10.2	10.9
43-48	30	9.2	0.8	7.9	7.9	9.2	10.3	10.6


Shoulder Circumference Point to Top-of-Head Distance
(Shoulder Circumference Point to Vertex Distance)
+ = Male
× = Female
centimeters
10.
14.
18.
22.
26.
30.
inches
5.
6.
7.
8.
9.
10.
11.
Age (months)
0
6
12
18
24
30
36
42
48

II.B.2. RESULTS BY AGE GROUP

The following pages present the sample statisitics of the manual measurements by age group. For each age group, a table of values in metric units is followed by a table of values in English units. In each table, the measurements are numbered as in the previous section. For those measurements for which two names have been used, only the name with common terminology is given in the tables of this section.

Anthropometric Data for Males and Females Ages 0-3 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (Kg)	30	5.7	1.0	4.0	4.0	5.7	7.3	7.5
2	Stature (cm)	30	58.3	3.4	49.7	49.7	58.4	63.2	64.8
3	Sitting Height (cm)	30	40.0	2.6	34.0	34.0	40.2	43.1	45.4
4	Maximum Head Breadth (cm)	30	10.6	0.5	10.0	10.0	10.5	11.5	11.7
5	Head Circumference (cm)	30	39.5	1.4	37.0	37.0	39.5	42.0	42.3
6	Head Breadth at Circumference (cm)	30	10.4	0.5	9.4	9.4	10.4	11.2	11.5
7	Head Length (cm)	30	13.9	0.6	12.8	12.8	14.1	14.6	14.8
8	Head Height (cm)	30	13.6	1.0	11.8	11.8	13.5	14.8	15.7
9	Tip-of-Chin to Back-of-Head Distance (cm)	30	16.1	0.6	14.8	14.8	16.1	17.0	17.3
10	Tip-of-Chin to Back-of-Head Circumferenc (cm)	30	43.3	1.5	39.6	39.6	43.5	45.0	47.0
11	Lower Face Height (cm)	30	6.1	0.5	5.3	5.3	6.1	6.9	7.0
12	Maximum Face Breadth (cm)	30	8.8	0.5	8.0	8.0	8.7	9.4	9.8
13	Maximum Jaw Breadth (cm)	30	6.9	0.5	5.7	5.7	6.8	7.5	7.7
14	Head Breadth at Ear Openings (cm)	30	7.3	0.6	6.3	6.3	7.3	8.0	9.1
15	Ear to Head/Neck Junction Distance (cm)	30	5.4	0.7	4.1	4.1	5.3	6.3	6.7
16	Ear to Tip-of-Chin Distance (cm)	30	6.6	0.5	5.6	5.6	6.6	7.3	7.8
17	Ear to Top-of-Head Distance (cm)	30	9.6	0.8	8.3	8.3	9.4	10.8	11.2
18	Top-of-Head to Back-of-Head Distance (cm)	30	5.7	0.7	4.0	4.0	5.8	6.5	7.0
19	Top-of-Head to Head Circumference Distan (cm)	30	5.8	0.7	4.6	4.6	5.5	7.0	7.0
20	Back-of-Head to Head Breadth Point Dista (cm)	30	5.9	0.6	5.0	5.0	5.7	6.7	7.5
21	Forehead to Back-of-Head Arc Length (cm)	30	20.7	1.5	17.2	17.2	20.7	22.6	23.7
22	Forehead to Head/Neck Junction Arc Lengt (cm)	30	25.5	1.8	21.8	21.8	25.3	27.7	28.8
23	Ear-to-Ear over Top-of-Head Arc Length (cm)	30	23.6	1.2	21.1	21.1	23.6	25.1	26.4
24	Ear-to-Ear Under Chin Arc Length (cm)	30	15.6	1.2	13.3	13.3	15.3	17.4	18.8
25	Ear-to-Ear around Back-of-Head Arc Lengt (cm)	30	16.1	1.0	14.1	14.1	16.4	17.2	17.6
26	Neck Circumference (cm)	30	21.4	2.1	18.2	18.2	21.1	24.7	26.7
27	Neck Breadth (cm)	30	5.7	0.5	4.6	4.6	5.7	6.3	7.1
28	Neck Depth (cm)	30	6.1	0.7	4.4	4.4	6.1	7.2	7.3
29	Shoulder Breadth (cm)	30	17.6	1.3	14.6	14.6	17.5	19.4	20.8
30	Shoulder Circumference (cm)	30	45.4	4.0	37.1	37.1	45.2	51.1	53.8
31	Shoulder Depth (cm)	30	5.0	0.7	3.5	3.5	4.9	6.1	6.8
32	Torso Depth (cm)	30	9.5	0.8	8.0	8.0	9.6	10.6	11.0
33	Top-of-Shoulder to Top-of-Head Distance (cm)	30	14.9	1.1	12.8	12.8	14.7	16.3	17.8
34	Shoulder Circumference Point to Top-of-H (cm)	30	17.5	1.7	14.4	14.4	17.5	20.1	21.7

Anthropometric Data for Males and Females Ages 0-3 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (lb)	30	12.5	2.3	8.8	8.8	12.5	16.0	16.5
2	Stature (in)	30	23.0	1.4	19.6	19.6	23.0	24.9	25.5
3	Sitting Height (in)	30	15.7	1.0	13.4	13.4	15.8	17.0	17.9
4	Maximum Head Breadth (in)	30	4.2	0.2	3.9	3.9	4.1	4.5	4.6
5	Head Circumference (in)	30	15.6	0.6	14.6	14.6	15.6	16.5	16.7
6	Head Breadth at Circumference (in)	30	4.1	0.2	3.7	3.7	4.1	4.4	4.5
7	Head Length (in)	30	5.5	0.3	5.0	5.0	5.6	5.7	5.8
8	Head Height (in)	30	5.4	0.4	4.6	4.6	5.3	5.8	6.2
9	Tip-of-Chin to Back-of-Head Distance (in)	30	6.3	0.2	5.8	5.8	6.3	6.7	6.8
10	Tip-of-Chin to Back-of-Head Circumferenc (in)	30	17.0	0.6	15.6	15.6	17.1	17.7	18.5
11	Lower Face Height (in)	30	2.4	0.2	2.1	2.1	2.4	2.7	2.8
12	Maximum Face Breadth (in)	30	3.5	0.2	3.1	3.1	3.4	3.7	3.9
13	Maximum Jaw Breadth (in)	30	2.7	0.2	2.2	2.2	2.7	3.0	3.0
14	Head Breadth at Ear Openings (in)	30	2.9	0.2	2.5	2.5	2.9	3.1	3.6
15	Ear to Head/Neck Junction Distance (in)	30	2.1	0.3	1.6	1.6	2.1	2.5	2.6
16	Ear to Tip-of-Chin Distance (in)	30	2.6	0.2	2.2	2.2	2.6	2.9	3.1
17	Ear to Top-of-Head Distance (in)	30	3.8	0.3	3.3	3.3	3.7	4.3	4.4
18	Top-of-Head to Back-of-Head Distance (in)	30	2.2	0.3	1.6	1.6	2.3	2.6	2.8
19	Top-of-Head to Head Circumference Distan (in)	30	2.3	0.3	1.8	1.8	2.2	2.8	2.8
20	Back-of-Head to Head Breadth Point Dista (in)	30	2.3	0.2	2.0	2.0	2.2	2.6	3.0
21	Forehead to Back-of-Head Arc Length (in)	30	8.1	0.6	6.8	6.8	8.1	8.9	9.3
22	Forehead to Head/Neck Junction Arc Lengt (in)	30	10.0	0.7	8.6	8.6	10.0	10.9	11.3
23	Ear-to-Ear over Top-of-Head Arc Length (in)	30	9.3	0.5	8.3	8.3	9.3	9.9	10.4
24	Ear-to-Ear Under Chin Arc Length (in)	30	6.2	0.5	5.2	5.2	6.0	6.9	7.4
25	Ear-to-Ear around Back-of-Head Arc Lengt (in)	30	6.3	0.4	5.6	5.6	6.5	6.8	6.9
26	Neck Circumference (in)	30	8.4	0.8	7.2	7.2	8.3	9.7	10.5
27	Neck Breadth (in)	30	2.3	0.2	1.8	1.8	2.2	2.5	2.8
28	Neck Depth (in)	30	2.4	0.3	1.7	1.7	2.4	2.8	2.9
29	Shoulder Breadth (in)	30	6.9	0.5	5.7	5.7	6.9	7.6	8.2
30	Shoulder Circumference (in)	30	17.9	1.6	14.6	14.6	17.8	20.1	21.2
31	Shoulder Depth (in)	30	2.0	0.3	1.4	1.4	1.9	2.4	2.7
32	Torso Depth (in)	30	3.8	0.3	3.1	3.1	3.8	4.2	4.3
33	Top-of-Shoulder to Top-of-Head Distance (in)	30	5.9	0.4	5.0	5.0	5.8	6.4	7.0
34	Shoulder Circumference Point to Top-of-H (in)	30	6.9	0.7	5.7	5.7	6.9	7.9	8.5

Anthropometric Data for Males and Females Ages 4-6 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (Kg)	30	7.5	1.0	6.1	6.1	7.3	8.8	10.9
2	Stature (cm)	30	66.0	3.2	60.8	60.8	66.0	70.0	73.5
3	Sitting Height (cm)	30	43.2	2.1	39.3	39.3	42.6	46.8	48.0
4	Maximum Head Breadth (cm)	30	11.7	0.5	10.5	10.5	11.6	12.5	12.8
5	Head Circumference (cm)	30	43.5	1.6	40.3	40.3	43.5	45.7	46.3
6	Head Breadth at Circumference (cm)	30	11.5	0.6	10.4	10.4	11.4	12.4	12.7
7	Head Length (cm)	30	15.4	0.6	14.1	14.1	15.3	16.3	16.5
8	Head Height (cm)	30	14.5	0.8	12.5	12.5	14.4	15.7	16.4
9	Tip-of-Chin to Back-of-Head Distance (cm)	30	17.7	0.7	16.2	16.2	17.7	18.6	18.8
10	Tip-of-Chin to Back-of-Head Circumferenc (cm)	29	47.5	1.6	43.2	43.2	48.0	49.2	49.6
11	Lower Face Height (cm)	30	7.0	0.5	6.1	6.1	7.0	7.7	7.9
12	Maximum Face Breadth (cm)	30	9.5	0.5	8.5	8.5	9.5	10.2	10.3
13	Maximum Jaw Breadth (cm)	30	7.6	0.6	5.8	5.8	7.6	8.4	8.8
14	Head Breadth at Ear Openings (cm)	30	8.1	0.5	6.8	6.8	8.0	8.8	9.4
15	Ear to Head/Neck Junction Distance (cm)	30	5.8	0.8	4.3	4.3	5.7	7.1	7.6
16	Ear to Tip-of-Chin Distance (cm)	30	7.1	0.5	6.0	6.0	7.1	7.7	8.2
17	Ear to Top-of-Head Distance (cm)	29	10.6	0.9	9.0	9.0	10.9	11.9	12.4
18	Top-of-Head to Back-of-Head Distance (cm)	30	6.7	0.7	5.0	5.0	6.8	7.5	8.0
19	Top-of-Head to Head Circumference Distan (cm)	30	6.0	0.6	4.9	4.9	5.9	7.2	7.4
20	Back-of-Head to Head Breadth Point Dista (cm)	30	5.9	0.9	3.8	3.8	6.0	6.9	7.5
21	Forehead to Back-of-Head Arc Length (cm)	30	23.0	1.7	18.3	18.3	22.8	25.5	25.8
22	Forehead to Head/Neck Junction Arc Lengt (cm)	30	28.2	1.5	25.0	25.0	28.2	30.6	30.7
23	Ear-to-Ear over Top-of-Head Arc Length (cm)	30	26.5	1.3	23.6	23.6	26.6	28.1	28.8
24	Ear-to-Ear Under Chin Arc Length (cm)	30	16.3	1.0	14.3	14.3	16.0	17.8	18.9
25	Ear-to-Ear around Back-of-Head Arc Lengt (cm)	30	19.0	1.3	15.6	15.6	19.3	20.4	21.4
26	Neck Circumference (cm)	30	21.4	1.1	19.2	19.2	21.1	23.4	24.4
27	Neck Breadth (cm)	30	6.1	0.6	4.9	4.9	6.0	6.9	7.1
28	Neck Depth (cm)	30	6.2	0.7	4.0	4.0	6.2	7.1	7.6
29	Shoulder Breadth (cm)	30	20.0	1.5	17.1	17.1	19.7	21.7	23.8
30	Shoulder Circumference (cm)	30	48.9	3.3	44.0	44.0	48.5	53.9	56.8
31	Shoulder Depth (cm)	30	5.7	0.6	3.8	3.8	5.8	6.3	7.1
32	Torso Depth (cm)	30	10.6	0.8	8.9	8.9	10.6	11.5	11.9
33	Top-of-Shoulder to Top-of-Head Distance (cm)	29	15.3	1.1	13.5	13.5	15.1	17.4	17.6
34	Shoulder Circumference Point to Top-of-H (cm)	29	18.0	1.6	13.9	13.9	18.0	21.1	21.3

Anthropometric Data for Males and Females Ages 4-6 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (lb)	30	16.6	2.3	13.5	13.5	16.0	19.5	24.0
2	Stature (in)	30	26.0	1.2	23.9	23.9	26.0	27.6	28.9
3	Sitting Height (in)	30	17.0	0.8	15.5	15.5	16.8	18.4	18.9
4	Maximum Head Breadth (in)	30	4.6	0.2	4.1	4.1	4.6	4.9	5.0
5	Head Circumference (in)	30	17.1	0.6	15.9	15.9	17.1	18.0	18.2
6	Head Breadth at Circumference (in)	30	4.5	0.2	4.1	4.1	4.5	4.9	5.0
7	Head Length (in)	30	6.1	0.2	5.6	5.6	6.0	6.4	6.5
8	Head Height (in)	30	5.7	0.3	4.9	4.9	5.7	6.2	6.5
9	Tip-of-Chin to Back-of-Head Distance (in)	30	7.0	0.3	6.4	6.4	7.0	7.3	7.4
10	Tip-of-Chin to Back-of-Head Circumferenc (in)	29	18.7	0.6	17.0	17.0	18.9	19.4	19.5
11	Lower Face Height (in)	30	2.8	0.2	2.4	2.4	2.8	3.0	3.1
12	Maximum Face Breadth (in)	30	3.7	0.2	3.3	3.3	3.7	4.0	4.1
13	Maximum Jaw Breadth (in)	30	3.0	0.2	2.3	2.3	3.0	3.3	3.5
14	Head Breadth at Ear Openings (in)	30	3.2	0.2	2.7	2.7	3.1	3.5	3.7
15	Ear to Head/Neck Junction Distance (in)	30	2.3	0.3	1.7	1.7	2.2	2.8	3.0
16	Ear to Tip-of-Chin Distance (in)	30	2.8	0.2	2.4	2.4	2.8	3.0	3.2
17	Ear to Top-of-Head Distance (in)	29	4.2	0.4	3.5	3.5	4.3	4.7	4.9
18	Top-of-Head to Back-of-Head Distance (in)	30	2.6	0.3	2.0	2.0	2.7	3.0	3.1
19	Top-of-Head to Head Circumference Distan (in)	30	2.3	0.3	1.9	1.9	2.3	2.8	2.9
20	Back-of-Head to Head Breadth Point Dista (in)	30	2.3	0.3	1.5	1.5	2.4	2.7	3.0
21	Forehead to Back-of-Head Arc Length (in)	30	9.0	0.7	7.2	7.2	9.0	10.0	10.2
22	Forehead to Head/Neck Junction Arc Lengt (in)	30	11.1	0.6	9.8	9.8	11.1	12.0	12.1
23	Ear-to-Ear over Top-of-Head Arc Length (in)	30	10.5	0.5	9.3	9.3	10.5	11.1	11.3
24	Ear-to-Ear Under Chin Arc Length (in)	30	6.4	0.4	5.6	5.6	6.3	7.0	7.4
25	Ear-to-Ear around Back-of-Head Arc Lengt (in)	30	7.5	0.5	6.1	6.1	7.6	8.0	8.4
26	Neck Circumference (in)	30	8.4	0.4	7.6	7.6	8.3	9.2	9.6
27	Neck Breadth (in)	30	2.4	0.2	1.9	1.9	2.4	2.7	2.8
28	Neck Depth (in)	30	2.5	0.3	1.6	1.6	2.4	2.8	3.0
29	Shoulder Breadth (in)	30	7.9	0.6	6.7	6.7	7.8	8.5	9.4
30	Shoulder Circumference (in)	30	19.3	1.3	17.3	17.3	19.1	21.2	22.4
31	Shoulder Depth (in)	30	2.3	0.2	1.5	1.5	2.3	2.5	2.8
32	Torso Depth (in)	30	4.2	0.3	3.5	3.5	4.2	4.5	4.7
33	Top-of-Shoulder to Top-of-Head Distance (in)	29	6.0	0.4	5.3	5.3	5.9	6.9	6.9
34	Shoulder Circumference Point to Top-of-H (in)	29	7.1	0.6	5.5	5.5	7.1	8.3	8.4

Anthropometric Data for Males and Females Ages 7-9 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (Kg)	30	8.5	1.1	7.0	7.0	8.3	10.7	11.3
2	Stature (cm)	30	69.6	2.9	65.1	65.1	69.3	74.5	76.8
3	Sitting Height (cm)	30	46.0	1.7	42.2	42.2	45.3	48.7	49.6
4	Maximum Head Breadth (cm)	30	12.3	0.4	11.6	11.6	12.3	12.9	13.1
5	Head Circumference (cm)	30	44.8	1.3	42.8	42.8	44.5	46.6	48.0
6	Head Breadth at Circumference (cm)	30	12.1	0.4	11.3	11.3	12.1	12.8	12.9
7	Head Length (cm)	30	15.8	0.5	14.9	14.9	15.6	16.3	17.0
8	Head Height (cm)	30	15.1	0.9	13.2	13.2	14.9	16.3	17.1
9	Tip-of-Chin to Back-of-Head Distance (cm)	30	18.0	0.7	16.3	16.3	17.9	19.1	20.1
10	Tip-of-Chin to Back-of-Head Circumferenc (cm)	30	49.0	1.7	46.0	46.0	48.7	51.2	52.6
11	Lower Face Height (cm)	30	6.8	0.6	5.8	5.8	6.8	7.5	8.3
12	Maximum Face Breadth (cm)	30	9.5	0.7	7.5	7.5	9.5	10.6	11.3
13	Maximum Jaw Breadth (cm)	30	7.5	0.6	6.2	6.2	7.4	8.2	9.1
14	Head Breadth at Ear Openings (cm)	30	8.3	0.5	7.3	7.3	8.3	9.3	9.5
15	Ear to Head/Neck Junction Distance (cm)	30	5.9	0.7	4.9	4.9	5.8	6.9	7.7
16	Ear to Tip-of-Chin Distance (cm)	30	7.6	0.6	6.5	6.5	7.7	8.3	9.0
17	Ear to Top-of-Head Distance (cm)	30	10.7	0.6	9.8	9.8	10.8	11.5	12.1
18	Top-of-Head to Back-of-Head Distance (cm)	30	6.2	0.7	4.0	4.0	6.2	7.0	8.0
19	Top-of-Head to Head Circumference Distan (cm)	30	6.5	0.8	4.4	4.4	6.5	7.3	8.5
20	Back-of-Head to Head Breadth Point Dista (cm)	30	6.7	0.6	5.6	5.6	6.7	7.6	8.2
21	Forehead to Back-of-Head Arc Length (cm)	30	23.6	1.4	21.8	21.8	23.4	26.2	27.4
22	Forehead to Head/Neck Junction Arc Lengt (cm)	30	29.5	1.4	26.7	26.7	29.3	31.8	32.2
23	Ear-to-Ear over Top-of-Head Arc Length (cm)	30	27.4	1.3	25.6	25.6	27.2	29.4	31.4
24	Ear-to-Ear Under Chin Arc Length (cm)	30	16.9	1.2	14.5	14.5	17.0	18.5	19.1
25	Ear-to-Ear around Back-of-Head Arc Lengt (cm)	30	17.9	1.2	14.6	14.6	17.9	19.4	21.0
26	Neck Circumference (cm)	30	21.8	1.9	18.7	18.7	21.4	24.7	27.2
27	Neck Breadth (cm)	30	6.3	0.4	5.7	5.7	6.4	6.8	7.5
28	Neck Depth (cm)	30	6.3	0.5	5.0	5.0	6.3	7.1	7.5
29	Shoulder Breadth (cm)	30	20.3	1.6	17.5	17.5	20.4	22.8	24.1
30	Shoulder Circumference (cm)	30	53.7	3.7	46.5	46.5	52.2	58.2	62.8
31	Shoulder Depth (cm)	30	5.9	0.7	4.9	4.9	5.9	6.8	7.0
32	Torso Depth (cm)	30	10.8	0.9	8.8	8.8	10.7	11.8	13.0
33	Top-of-Shoulder to Top-of-Head Distance (cm)	30	16.4	1.1	14.4	14.4	16.3	17.8	18.5
34	Shoulder Circumference Point to Top-of-H (cm)	30	19.7	1.2	17.4	17.4	19.9	21.3	22.1

Anthropometric Data for Males and Females Ages 7-9 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (lb)	30	18.8	2.3	15.5	15.5	18.2	23.5	25.0
2	Stature (in)	30	27.4	1.1	25.6	25.6	27.3	29.3	30.2
3	Sitting Height (in)	30	18.1	0.7	16.6	16.6	17.8	19.2	19.5
4	Maximum Head Breadth (in)	30	4.8	0.2	4.6	4.6	4.8	5.1	5.2
5	Head Circumference (in)	30	17.6	0.5	16.9	16.9	17.5	18.3	18.9
6	Head Breadth at Circumference (in)	30	4.8	0.2	4.4	4.4	4.8	5.0	5.1
7	Head Length (in)	30	6.2	0.2	5.9	5.9	6.1	6.4	6.7
8	Head Height (in)	30	5.9	0.4	5.2	5.2	5.9	6.4	6.7
9	Tip-of-Chin to Back-of-Head Distance (in)	30	7.1	0.3	6.4	6.4	7.0	7.5	7.9
10	Tip-of-Chin to Back-of-Head Circumferenc (in)	30	19.3	0.7	18.1	18.1	19.2	20.2	20.7
11	Lower Face Height (in)	30	2.7	0.2	2.3	2.3	2.7	3.0	3.3
12	Maximum Face Breadth (in)	30	3.8	0.3	3.0	3.0	3.7	4.2	4.4
13	Maximum Jaw Breadth (in)	30	3.0	0.2	2.4	2.4	2.9	3.2	3.6
14	Head Breadth at Ear Openings (in)	30	3.3	0.2	2.9	2.9	3.3	3.7	3.7
15	Ear to Head/Neck Junction Distance (in)	30	2.3	0.3	1.9	1.9	2.3	2.7	3.0
16	Ear to Tip-of-Chin Distance (in)	30	3.0	0.2	2.6	2.6	3.0	3.3	3.5
17	Ear to Top-of-Head Distance (in)	30	4.2	0.2	3.9	3.9	4.3	4.5	4.8
18	Top-of-Head to Back-of-Head Distance (in)	30	2.5	0.3	1.6	1.6	2.4	2.8	3.1
19	Top-of-Head to Head Circumference Distan (in)	30	2.5	0.3	1.7	1.7	2.6	2.9	3.3
20	Back-of-Head to Head Breadth Point Dista (in)	30	2.7	0.2	2.2	2.2	2.6	3.0	3.2
21	Forehead to Back-of-Head Arc Length (in)	30	9.3	0.5	8.6	8.6	9.2	10.3	10.8
22	Forehead to Head/Neck Junction Arc Lengt (in)	30	11.6	0.6	10.5	10.5	11.5	12.5	12.7
23	Ear-to-Ear over Top-of-Head Arc Length (in)	30	10.8	0.5	10.1	10.1	10.7	11.6	12.4
24	Ear-to-Ear Under Chin Arc Length (in)	30	6.7	0.5	5.7	5.7	6.7	7.3	7.5
25	Ear-to-Ear around Back-of-Head Arc Lengt (in)	30	7.1	0.5	5.7	5.7	7.0	7.6	8.3
26	Neck Circumference (in)	30	8.6	0.8	7.4	7.4	8.4	9.7	10.7
27	Neck Breadth (in)	30	2.5	0.2	2.2	2.2	2.5	2.7	3.0
28	Neck Depth (in)	30	2.5	0.2	2.0	2.0	2.5	2.8	3.0
29	Shoulder Breadth (in)	30	8.0	0.6	6.9	6.9	8.0	9.0	9.5
30	Shoulder Circumference (in)	30	21.1	1.4	18.3	18.3	20.6	22.9	24.7
31	Shoulder Depth (in)	30	2.3	0.3	1.9	1.9	2.3	2.7	2.8
32	Torso Depth (in)	30	4.2	0.4	3.5	3.5	4.2	4.6	5.1
33	Top-of-Shoulder to Top-of-Head Distance (in)	30	6.4	0.4	5.7	5.7	6.4	7.0	7.3
34	Shoulder Circumference Point to Top-of-H (in)	30	7.7	0.5	6.9	6.9	7.8	8.4	8.7

Anthropometric Data for Males and Females Ages 10-12 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (Kg)	30	9.8	1.2	7.9	7.9	9.5	11.6	12.5
2	Stature (cm)	30	74.8	3.2	70.1	70.1	74.7	79.2	81.8
3	Sitting Height (cm)	30	48.3	2.2	43.4	43.4	47.9	51.2	51.9
4	Maximum Head Breadth (cm)	30	12.5	0.6	11.5	11.5	12.4	13.4	13.9
5	Head Circumference (cm)	30	46.1	1.8	42.0	42.0	46.0	48.5	50.3
6	Head Breadth at Circumference (cm)	30	12.3	0.5	11.4	11.4	12.1	13.0	13.8
7	Head Length (cm)	30	16.3	0.8	14.9	14.9	16.3	17.6	18.0
8	Head Height (cm)	30	15.8	0.9	14.4	14.4	15.8	17.2	17.4
9	Tip-of-Chin to Back-of-Head Distance (cm)	30	18.9	0.7	17.7	17.7	18.8	20.0	20.9
10	Tip-of-Chin to Back-of-Head Circumferenc (cm)	30	50.6	2.0	45.7	45.7	50.3	53.4	55.7
11	Lower Face Height (cm)	30	7.0	0.6	5.2	5.2	7.1	7.8	8.0
12	Maximum Face Breadth (cm)	30	9.8	0.6	8.6	8.6	9.7	10.4	11.2
13	Maximum Jaw Breadth (cm)	30	7.6	0.5	6.7	6.7	7.7	8.2	8.9
14	Head Breadth at Ear Openings (cm)	30	8.6	0.6	7.5	7.5	8.7	9.5	9.8
15	Ear to Head/Neck Junction Distance (cm)	30	5.9	0.6	4.9	4.9	5.9	6.7	7.1
16	Ear to Tip-of-Chin Distance (cm)	30	8.0	0.7	6.6	6.6	8.0	8.9	9.3
17	Ear to Top-of-Head Distance (cm)	30	11.3	0.8	10.3	10.3	11.1	12.3	13.4
18	Top-of-Head to Back-of-Head Distance (cm)	30	6.4	0.9	4.5	4.5	6.5	7.5	8.2
19	Top-of-Head to Head Circumference Distan (cm)	30	6.9	0.7	5.7	5.7	6.8	7.9	8.4
20	Back-of-Head to Head Breadth Point Dista (cm)	30	6.8	0.8	5.0	5.0	6.6	7.8	8.2
21	Forehead to Back-of-Head Arc Length (cm)	30	24.5	1.4	22.1	22.1	24.8	26.2	27.3
22	Forehead to Head/Neck Junction Arc Lengt (cm)	30	30.6	1.7	27.7	27.7	30.3	33.1	34.1
23	Ear-to-Ear over Top-of-Head Arc Length (cm)	30	28.0	1.5	25.7	25.7	27.9	30.3	31.4
24	Ear-to-Ear Under Chin Arc Length (cm)	30	17.5	1.1	15.3	15.3	17.4	19.2	19.6
25	Ear-to-Ear around Back-of-Head Arc Lengt (cm)	30	18.4	1.1	16.6	16.6	18.2	20.0	20.6
26	Neck Circumference (cm)	30	21.9	1.3	18.6	18.6	22.0	23.9	24.0
27	Neck Breadth (cm)	30	6.8	0.6	5.6	5.6	6.7	7.7	7.8
28	Neck Depth (cm)	30	6.6	0.5	5.5	5.5	6.5	7.3	7.7
29	Shoulder Breadth (cm)	30	21.2	1.4	17.5	17.5	21.1	23.0	24.8
30	Shoulder Circumference (cm)	30	54.9	3.1	47.5	47.5	54.8	59.9	60.8
31	Shoulder Depth (cm)	30	5.9	0.5	4.8	4.8	6.0	6.6	6.8
32	Torso Depth (cm)	30	11.1	0.9	9.0	9.0	11.0	12.6	13.6
33	Top-of-Shoulder to Top-of-Head Distance (cm)	30	17.7	1.1	15.4	15.4	17.7	19.1	19.9
34	Shoulder Circumference Point to Top-of-H (cm)	30	20.8	1.3	18.1	18.1	21.0	22.6	23.6

Anthropometric Data for Males and Females Ages 10-12 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (lb)	30	21.5	2.6	17.5	17.5	21.0	25.5	27.5
2	Stature (in)	30	29.4	1.3	27.6	27.6	29.4	31.2	32.2
3	Sitting Height (in)	30	19.0	0.9	17.1	17.1	18.9	20.2	20.4
4	Maximum Head Breadth (in)	30	4.9	0.2	4.5	4.5	4.9	5.3	5.5
5	Head Circumference (in)	30	18.1	0.7	16.5	16.5	18.1	19.1	19.8
6	Head Breadth at Circumference (in)	30	4.8	0.2	4.5	4.5	4.8	5.1	5.4
7	Head Length (in)	30	6.4	0.3	5.9	5.9	6.4	6.9	7.1
8	Head Height (in)	30	6.2	0.3	5.7	5.7	6.2	6.8	6.9
9	Tip-of-Chin to Back-of-Head Distance (in)	30	7.4	0.3	7.0	7.0	7.4	7.9	8.2
10	Tip-of-Chin to Back-of-Head Circumferenc (in)	30	19.9	0.8	18.0	18.0	19.8	21.0	21.9
11	Lower Face Height (in)	30	2.8	0.3	2.0	2.0	2.8	3.1	3.1
12	Maximum Face Breadth (in)	30	3.8	0.2	3.4	3.4	3.8	4.1	4.4
13	Maximum Jaw Breadth (in)	30	3.0	0.2	2.6	2.6	3.0	3.2	3.5
14	Head Breadth at Ear Openings (in)	30	3.4	0.2	3.0	3.0	3.4	3.7	3.9
15	Ear to Head/Neck Junction Distance (in)	30	2.3	0.2	1.9	1.9	2.3	2.6	2.8
16	Ear to Tip-of-Chin Distance (in)	30	3.1	0.3	2.6	2.6	3.1	3.5	3.7
17	Ear to Top-of-Head Distance (in)	30	4.4	0.3	4.1	4.1	4.4	4.8	5.3
18	Top-of-Head to Back-of-Head Distance (in)	30	2.5	0.3	1.8	1.8	2.6	3.0	3.2
19	Top-of-Head to Head Circumference Distan (in)	30	2.7	0.3	2.2	2.2	2.7	3.1	3.3
20	Back-of-Head to Head Breadth Point Dista (in)	30	2.7	0.3	2.0	2.0	2.6	3.1	3.2
21	Forehead to Back-of-Head Arc Length (in)	30	9.6	0.5	8.7	8.7	9.8	10.3	10.7
22	Forehead to Head/Neck Junction Arc Lengt (in)	30	12.0	0.7	10.9	10.9	11.9	13.0	13.4
23	Ear-to-Ear over Top-of-Head Arc Length (in)	30	11.0	0.6	10.1	10.1	11.0	11.9	12.4
24	Ear-to-Ear Under Chin Arc Length (in)	30	6.9	0.4	6.0	6.0	6.9	7.6	7.7
25	Ear-to-Ear around Back-of-Head Arc Lengt (in)	30	7.2	0.4	6.5	6.5	7.2	7.9	8.1
26	Neck Circumference (in)	30	8.6	0.5	7.3	7.3	8.7	9.4	9.4
27	Neck Breadth (in)	30	2.7	0.2	2.2	2.2	2.6	3.0	3.1
28	Neck Depth (in)	30	2.6	0.2	2.2	2.2	2.6	2.9	3.0
29	Shoulder Breadth (in)	30	8.4	0.5	6.9	6.9	8.3	9.1	9.8
30	Shoulder Circumference (in)	30	21.6	1.2	18.7	18.7	21.6	23.6	23.9
31	Shoulder Depth (in)	30	2.3	0.2	1.9	1.9	2.4	2.6	2.7
32	Torso Depth (in)	30	4.4	0.4	3.5	3.5	4.3	5.0	5.4
33	Top-of-Shoulder to Top-of-Head Distance (in)	30	7.0	0.4	6.1	6.1	7.0	7.5	7.8
34	Shoulder Circumference Point to Top-of-H (in)	30	8.2	0.5	7.1	7.1	8.3	8.9	9.3

Anthropometric Data for Males and Females Ages 13-18 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (Kg)	30	10.9	1.5	7.7	7.7	10.9	12.9	13.6
2	Stature (cm)	30	79.0	4.1	70.1	70.1	79.5	84.1	86.9
3	Sitting Height (cm)	30	49.3	2.7	44.1	44.1	49.2	53.3	54.9
4	Maximum Head Breadth (cm)	30	12.8	0.4	11.9	11.9	12.8	13.4	13.7
5	Head Circumference (cm)	30	47.8	1.5	45.4	45.4	47.8	50.3	51.0
6	Head Breadth at Circumference (cm)	30	12.7	0.4	11.8	11.8	12.7	13.4	13.5
7	Head Length (cm)	30	16.8	0.6	15.9	15.9	16.8	17.6	18.4
8	Head Height (cm)	30	16.3	0.8	15.0	15.0	16.2	17.5	17.8
9	Tip-of-Chin to Back-of-Head Distance (cm)	30	19.3	0.7	18.2	18.2	19.3	20.5	20.7
10	Tip-of-Chin to Back-of-Head Circumferenc (cm)	30	52.0	1.7	48.5	48.5	51.8	54.4	55.9
11	Lower Face Height (cm)	30	7.5	0.6	6.3	6.3	7.5	8.1	8.4
12	Maximum Face Breadth (cm)	30	9.9	0.6	8.7	8.7	9.8	10.8	11.3
13	Maximum Jaw Breadth (cm)	30	8.1	0.6	6.0	6.0	8.0	8.9	9.0
14	Head Breadth at Ear Openings (cm)	30	8.8	0.6	7.8	7.8	8.7	9.5	10.2
15	Ear to Head/Neck Junction Distance (cm)	30	6.2	0.8	4.6	4.6	6.2	7.5	7.7
16	Ear to Tip-of-Chin Distance (cm)	30	8.3	0.7	7.2	7.2	8.1	9.3	9.4
17	Ear to Top-of-Head Distance (cm)	30	11.5	0.9	9.4	9.4	11.6	12.5	13.5
18	Top-of-Head to Back-of-Head Distance (cm)	30	7.0	0.7	5.5	5.5	7.0	7.8	8.5
19	Top-of-Head to Head Circumference Distan (cm)	30	6.7	0.7	5.5	5.5	6.6	7.4	8.5
20	Back-of-Head to Head Breadth Point Dista (cm)	30	6.8	0.7	5.2	5.2	6.8	7.9	8.4
21	Forehead to Back-of-Head Arc Length (cm)	30	25.1	1.3	22.8	22.8	24.8	27.3	28.3
22	Forehead to Head/Neck Junction Arc Lengt (cm)	30	30.8	1.7	28.0	28.0	30.6	34.0	34.5
23	Ear-to-Ear over Top-of-Head Arc Length (cm)	30	29.2	1.4	25.7	25.7	29.3	30.9	31.7
24	Ear-to-Ear Under Chin Arc Length (cm)	30	18.0	1.2	15.6	15.6	17.8	19.7	20.2
25	Ear-to-Ear around Back-of-Head Arc Lengt (cm)	30	20.7	1.6	16.0	16.0	21.0	22.2	22.9
26	Neck Circumference (cm)	30	21.9	1.2	18.6	18.6	22.0	23.5	24.0
27	Neck Breadth (cm)	30	6.7	0.6	5.6	5.6	6.6	7.5	8.0
28	Neck Depth (cm)	30	6.4	0.4	5.7	5.7	6.3	7.2	7.5
29	Shoulder Breadth (cm)	30	22.5	1.3	19.8	19.8	22.5	24.4	24.8
30	Shoulder Circumference (cm)	30	55.9	3.2	48.4	48.4	55.4	59.8	62.4
31	Shoulder Depth (cm)	30	6.2	0.6	5.1	5.1	6.0	7.1	7.6
32	Torso Depth (cm)	30	11.7	0.9	10.0	10.0	11.8	12.9	13.1
33	Top-of-Shoulder to Top-of-Head Distance (cm)	30	17.4	1.1	15.0	15.0	17.5	18.9	19.8
34	Shoulder Circumference Point to Top-of-H (cm)	30	21.0	1.3	18.0	18.0	20.9	22.7	22.9

Anthropometric Data for Males and Females Ages 13-18 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (lb)	30	24.0	3.3	17.0	17.0	24.0	28.5	30.0
2	Stature (in)	30	31.1	1.6	27.6	27.6	31.3	33.1	34.2
3	Sitting Height (in)	30	19.4	1.1	17.4	17.4	19.4	21.0	21.6
4	Maximum Head Breadth (in)	30	5.0	0.2	4.7	4.7	5.0	5.3	5.4
5	Head Circumference (in)	30	18.8	0.6	17.9	17.9	18.8	19.8	20.1
6	Head Breadth at Circumference (in)	30	5.0	0.2	4.6	4.6	5.0	5.3	5.3
7	Head Length (in)	30	6.6	0.2	6.3	6.3	6.6	6.9	7.2
8	Head Height (in)	30	6.4	0.3	5.9	5.9	6.4	6.9	7.0
9	Tip-of-Chin to Back-of-Head Distance (in)	30	7.6	0.3	7.2	7.2	7.6	8.1	8.1
10	Tip-of-Chin to Back-of-Head Circumferenc (in)	30	20.5	0.7	19.1	19.1	20.4	21.4	22.0
11	Lower Face Height (in)	30	2.9	0.2	2.5	2.5	3.0	3.2	3.3
12	Maximum Face Breadth (in)	30	3.9	0.2	3.4	3.4	3.9	4.3	4.4
13	Maximum Jaw Breadth (in)	30	3.2	0.3	2.4	2.4	3.1	3.5	3.5
14	Head Breadth at Ear Openings (in)	30	3.5	0.2	3.1	3.1	3.4	3.7	4.0
15	Ear to Head/Neck Junction Distance (in)	30	2.4	0.3	1.8	1.8	2.4	3.0	3.0
16	Ear to Tip-of-Chin Distance (in)	30	3.3	0.3	2.8	2.8	3.2	3.7	3.7
17	Ear to Top-of-Head Distance (in)	30	4.5	0.4	3.7	3.7	4.6	4.9	5.3
18	Top-of-Head to Back-of-Head Distance (in)	30	2.8	0.3	2.2	2.2	2.8	3.1	3.3
19	Top-of-Head to Head Circumference Distan (in)	30	2.6	0.3	2.2	2.2	2.6	2.9	3.3
20	Back-of-Head to Head Breadth Point Dista (in)	30	2.7	0.3	2.0	2.0	2.7	3.1	3.3
21	Forehead to Back-of-Head Arc Length (in)	30	9.9	0.5	9.0	9.0	9.8	10.7	11.1
22	Forehead to Head/Neck Junction Arc Lengt (in)	30	12.1	0.7	11.0	11.0	12.0	13.4	13.6
23	Ear-to-Ear over Top-of-Head Arc Length (in)	30	11.5	0.6	10.1	10.1	11.5	12.2	12.5
24	Ear-to-Ear Under Chin Arc Length (in)	30	7.1	0.5	6.1	6.1	7.0	7.8	8.0
25	Ear-to-Ear around Back-of-Head Arc Lengt (in)	30	8.1	0.6	6.3	6.3	8.3	8.7	9.0
26	Neck Circumference (in)	30	8.6	0.5	7.3	7.3	8.7	9.3	9.4
27	Neck Breadth (in)	30	2.6	0.2	2.2	2.2	2.6	3.0	3.1
28	Neck Depth (in)	30	2.5	0.2	2.2	2.2	2.5	2.8	3.0
29	Shoulder Breadth (in)	30	8.8	0.5	7.8	7.8	8.9	9.6	9.8
30	Shoulder Circumference (in)	30	22.0	1.2	19.1	19.1	21.8	23.5	24.6
31	Shoulder Depth (in)	30	2.4	0.2	2.0	2.0	2.4	2.8	3.0
32	Torso Depth (in)	30	4.6	0.4	3.9	3.9	4.6	5.1	5.2
33	Top-of-Shoulder to Top-of-Head Distance (in)	30	6.8	0.5	5.9	5.9	6.9	7.4	7.8
34	Shoulder Circumference Point to Top-of-H (in)	30	8.3	0.5	7.1	7.1	8.2	8.9	9.0

Anthropometric Data for Males and Females Ages 19-24 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (Kg)	30	12.0	1.1	10.4	10.4	12.0	13.4	15.0
2	Stature (cm)	30	85.0	3.1	76.8	76.8	85.1	89.2	93.7
3	Sitting Height (cm)	30	51.2	2.1	45.8	45.8	51.1	53.8	55.9
4	Maximum Head Breadth (cm)	30	13.2	0.6	12.2	12.2	13.2	14.0	14.2
5	Head Circumference (cm)	30	48.5	1.4	46.0	46.0	48.2	50.2	52.3
6	Head Breadth at Circumference (cm)	30	13.1	0.6	12.1	12.1	12.9	14.0	14.1
7	Head Length (cm)	30	17.2	0.6	16.2	16.2	17.2	18.2	18.3
8	Head Height (cm)	30	16.8	0.6	15.6	15.6	16.8	17.7	17.8
9	Tip-of-Chin to Back-of-Head Distance (cm)	30	19.8	0.6	18.6	18.6	19.7	20.5	21.3
10	Tip-of-Chin to Back-of-Head Circumferenc (cm)	30	52.9	1.6	49.9	49.9	52.6	55.0	57.3
11	Lower Face Height (cm)	30	7.2	0.5	5.8	5.8	7.2	8.0	8.4
12	Maximum Face Breadth (cm)	30	10.0	0.5	9.1	9.1	10.0	10.7	11.1
13	Maximum Jaw Breadth (cm)	30	7.7	0.5	6.6	6.6	7.8	8.1	9.1
14	Head Breadth at Ear Openings (cm)	30	9.0	0.5	7.8	7.8	9.0	9.7	10.1
15	Ear to Head/Neck Junction Distance (cm)	30	6.1	0.5	5.2	5.2	6.0	6.8	7.3
16	Ear to Tip-of-Chin Distance (cm)	30	8.6	0.7	7.3	7.3	8.5	9.6	10.1
17	Ear to Top-of-Head Distance (cm)	30	11.5	0.8	10.1	10.1	11.4	13.0	13.3
18	Top-of-Head to Back-of-Head Distance (cm)	30	6.7	0.8	5.0	5.0	6.5	7.7	8.5
19	Top-of-Head to Head Circumference Distan (cm)	30	7.1	0.7	5.7	5.7	7.2	8.1	8.4
20	Back-of-Head to Head Breadth Point Dista (cm)	30	6.9	0.9	5.3	5.3	7.0	8.1	8.3
21	Forehead to Back-of-Head Arc Length (cm)	30	26.1	1.4	23.8	23.8	26.0	28.0	30.3
22	Forehead to Head/Neck Junction Arc Lengt (cm)	30	32.4	1.8	28.3	28.3	32.4	34.4	37.9
23	Ear-to-Ear over Top-of-Head Arc Length (cm)	30	30.2	1.3	27.5	27.5	30.0	32.0	33.1
24	Ear-to-Ear Under Chin Arc Length (cm)	30	18.5	1.3	15.7	15.7	18.4	20.0	21.7
25	Ear-to-Ear around Back-of-Head Arc Lengt (cm)	30	18.8	1.4	16.3	16.3	18.8	21.0	21.2
26	Neck Circumference (cm)	30	22.3	1.2	20.5	20.5	22.0	24.0	25.3
27	Neck Breadth (cm)	30	6.9	0.5	6.0	6.0	7.0	7.5	7.9
28	Neck Depth (cm)	30	6.6	0.6	5.0	5.0	6.7	7.3	7.9
29	Shoulder Breadth (cm)	30	23.2	0.9	21.5	21.5	23.1	24.4	24.8
30	Shoulder Circumference (cm)	30	59.2	3.5	50.6	50.6	59.0	63.0	68.6
31	Shoulder Depth (cm)	29	6.2	0.5	4.8	4.8	6.3	7.1	7.3
32	Torso Depth (cm)	30	11.3	0.8	10.0	10.0	11.2	12.4	12.8
33	Top-of-Shoulder to Top-of-Head Distance (cm)	30	18.7	1.7	15.5	15.5	18.6	21.5	22.4
34	Shoulder Circumference Point to Top-of-H (cm)	30	22.5	1.8	19.1	19.1	22.5	25.2	26.7

Anthropometric Data for Males and Females Ages 19-24 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (lb)	30	26.5	2.4	23.0	23.0	26.5	29.5	33.0
2	Stature (in)	30	33.5	1.2	30.2	30.2	33.5	35.1	36.9
3	Sitting Height (in)	30	20.2	0.8	18.0	18.0	20.1	21.2	22.0
4	Maximum Head Breadth (in)	30	5.2	0.2	4.8	4.8	5.2	5.5	5.6
5	Head Circumference (in)	30	19.1	0.6	18.1	18.1	19.0	19.8	20.6
6	Head Breadth at Circumference (in)	30	5.1	0.2	4.8	4.8	5.1	5.5	5.6
7	Head Length (in)	30	6.8	0.2	6.4	6.4	6.8	7.2	7.2
8	Head Height (in)	30	6.6	0.2	6.1	6.1	6.6	7.0	7.0
9	Tip-of-Chin to Back-of-Head Distance (in)	30	7.8	0.2	7.3	7.3	7.8	8.1	8.4
10	Tip-of-Chin to Back-of-Head Circumferenc (in)	30	20.8	0.6	19.6	19.6	20.7	21.7	22.6
11	Lower Face Height (in)	30	2.8	0.2	2.3	2.3	2.8	3.1	3.3
12	Maximum Face Breadth (in)	30	4.0	0.2	3.6	3.6	3.9	4.2	4.4
13	Maximum Jaw Breadth (in)	30	3.0	0.2	2.6	2.6	3.1	3.2	3.6
14	Head Breadth at Ear Openings (in)	30	3.5	0.2	3.1	3.1	3.5	3.8	4.0
15	Ear to Head/Neck Junction Distance (in)	30	2.4	0.2	2.0	2.0	2.4	2.7	2.9
16	Ear to Tip-of-Chin Distance (in)	30	3.4	0.3	2.9	2.9	3.3	3.8	4.0
17	Ear to Top-of-Head Distance (in)	30	4.5	0.3	4.0	4.0	4.5	5.1	5.2
18	Top-of-Head to Back-of-Head Distance (in)	30	2.6	0.3	2.0	2.0	2.6	3.0	3.3
19	Top-of-Head to Head Circumference Distan (in)	30	2.8	0.3	2.2	2.2	2.8	3.2	3.3
20	Back-of-Head to Head Breadth Point Dista (in)	30	2.7	0.3	2.1	2.1	2.8	3.2	3.3
21	Forehead to Back-of-Head Arc Length (in)	30	10.3	0.6	9.4	9.4	10.2	11.0	11.9
22	Forehead to Head/Neck Junction Arc Lengt (in)	30	12.8	0.7	11.1	11.1	12.8	13.5	14.9
23	Ear-to-Ear over Top-of-Head Arc Length (in)	30	11.9	0.5	10.8	10.8	11.8	12.6	13.0
24	Ear-to-Ear Under Chin Arc Length (in)	30	7.3	0.5	6.2	6.2	7.2	7.9	8.5
25	Ear-to-Ear around Back-of-Head Arc Lengt (in)	30	7.4	0.5	6.4	6.4	7.4	8.3	8.3
26	Neck Circumference (in)	30	8.8	0.5	8.1	8.1	8.7	9.4	10.0
27	Neck Breadth (in)	30	2.7	0.2	2.4	2.4	2.8	3.0	3.1
28	Neck Depth (in)	30	2.6	0.2	2.0	2.0	2.6	2.9	3.1
29	Shoulder Breadth (in)	30	9.1	0.4	8.5	8.5	9.1	9.6	9.8
30	Shoulder Circumference (in)	30	23.3	1.4	19.9	19.9	23.2	24.8	27.0
31	Shoulder Depth (in)	29	2.4	0.2	1.9	1.9	2.5	2.8	2.9
32	Torso Depth (in)	30	4.4	0.3	3.9	3.9	4.4	4.9	5.0
33	Top-of-Shoulder to Top-of-Head Distance (in)	30	7.4	0.7	6.1	6.1	7.3	8.5	8.8
34	Shoulder Circumference Point to Top-of-H (in)	30	8.9	0.7	7.5	7.5	8.9	9.9	10.5

Anthropometric Data for Males and Females Ages 25-30 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (Kg)	31	12.9	1.5	10.7	10.9	12.7	15.0	18.1
2	Stature (cm)	31	89.2	3.8	83.7	83.9	88.2	95.3	99.5
3	Sitting Height (cm)	31	52.0	2.6	47.8	48.2	51.8	55.8	58.4
4	Maximum Head Breadth (cm)	31	13.3	0.4	12.3	12.6	13.4	14.0	14.2
5	Head Circumference (cm)	31	49.9	1.7	46.0	47.6	49.7	52.5	53.9
6	Head Breadth at Circumference (cm)	31	13.1	0.4	12.3	12.5	13.1	13.8	14.1
7	Head Length (cm)	31	17.7	0.7	16.2	16.2	17.7	19.1	19.2
8	Head Height (cm)	31	17.3	0.9	14.6	16.0	17.3	18.6	19.3
9	Tip-of-Chin to Back-of-Head Distance (cm)	31	20.3	0.8	18.8	19.1	20.1	21.6	22.8
10	Tip-of-Chin to Back-of-Head Circumferenc (cm)	31	54.4	1.8	50.0	51.6	54.2	57.0	58.5
11	Lower Face Height (cm)	31	7.8	0.7	6.3	6.4	7.9	8.8	8.9
12	Maximum Face Breadth (cm)	31	10.2	0.5	9.2	9.3	10.1	10.8	11.5
13	Maximum Jaw Breadth (cm)	31	8.2	0.4	7.2	7.5	8.2	8.6	9.3
14	Head Breadth at Ear Openings (cm)	31	9.0	0.5	7.9	8.2	9.0	9.6	9.8
15	Ear to Head/Neck Junction Distance (cm)	31	6.0	0.8	4.4	4.8	5.8	7.6	7.7
16	Ear to Tip-of-Chin Distance (cm)	31	9.0	0.6	8.2	8.2	8.9	10.1	10.7
17	Ear to Top-of-Head Distance (cm)	31	12.1	0.9	10.1	10.3	12.4	12.9	13.5
18	Top-of-Head to Back-of-Head Distance (cm)	31	7.4	0.8	5.5	6.0	7.5	8.5	8.6
19	Top-of-Head to Head Circumference Distan (cm)	31	6.9	0.7	5.1	5.7	7.0	7.9	8.1
20	Back-of-Head to Head Breadth Point Dista (cm)	31	7.1	1.0	5.6	5.7	7.1	8.5	9.1
21	Forehead to Back-of-Head Arc Length (cm)	31	27.0	1.2	24.8	24.9	26.8	28.8	29.9
22	Forehead to Head/Neck Junction Arc Lengt (cm)	31	33.6	1.4	30.5	31.5	33.6	35.8	36.3
23	Ear-to-Ear over Top-of-Head Arc Length (cm)	31	30.7	1.3	27.9	28.6	30.5	32.8	33.3
24	Ear-to-Ear Under Chin Arc Length (cm)	31	18.7	1.2	16.7	16.9	18.9	20.6	21.2
25	Ear-to-Ear around Back-of-Head Arc Lengt (cm)	31	21.0	1.3	18.6	18.8	21.1	22.9	24.1
26	Neck Circumference (cm)	31	22.8	1.5	20.0	20.2	22.7	24.8	27.0
27	Neck Breadth (cm)	31	7.1	0.5	6.1	6.4	7.1	8.0	8.5
28	Neck Depth (cm)	31	6.7	0.5	5.3	5.6	6.7	7.4	7.6
29	Shoulder Breadth (cm)	31	23.9	1.5	21.7	22.1	23.7	26.4	28.3
30	Shoulder Circumference (cm)	31	59.3	4.0	46.4	51.5	58.7	63.7	69.3
31	Shoulder Depth (cm)	31	6.6	0.7	5.3	5.5	6.5	7.5	7.8
32	Torso Depth (cm)	31	12.3	0.7	10.8	11.2	12.4	13.2	14.1
33	Top-of-Shoulder to Top-of-Head Distance (cm)	31	18.6	1.4	14.7	15.9	18.6	20.6	21.3
34	Shoulder Circumference Point to Top-of-H (cm)	31	22.6	2.0	16.7	18.1	22.6	25.2	28.0

Anthropometric Data for Males and Females Ages 25-30 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (lb)	31	28.5	3.4	23.5	24.0	28.0	33.0	40.0
2	Stature (in)	31	35.1	1.5	33.0	33.0	34.7	37.5	39.2
3	Sitting Height (in)	31	20.5	1.0	18.8	19.0	20.4	22.0	23.0
4	Maximum Head Breadth (in)	31	5.2	0.2	4.8	5.0	5.3	5.5	5.6
5	Head Circumference (in)	31	19.6	0.7	18.1	18.7	19.6	20.7	21.2
6	Head Breadth at Circumference (in)	31	5.2	0.2	4.8	4.9	5.2	5.4	5.6
7	Head Length (in)	31	7.0	0.3	6.4	6.4	7.0	7.5	7.6
8	Head Height (in)	31	6.8	0.4	5.7	6.3	6.8	7.3	7.6
9	Tip-of-Chin to Back-of-Head Distance (in)	31	8.0	0.3	7.4	7.5	7.9	8.5	9.0
10	Tip-of-Chin to Back-of-Head Circumferenc (in)	31	21.4	0.7	19.7	20.3	21.3	22.4	23.0
11	Lower Face Height (in)	31	3.1	0.3	2.5	2.5	3.1	3.5	3.5
12	Maximum Face Breadth (in)	31	4.0	0.2	3.6	3.7	4.0	4.3	4.5
13	Maximum Jaw Breadth (in)	31	3.2	0.2	2.8	3.0	3.2	3.4	3.7
14	Head Breadth at Ear Openings (in)	31	3.5	0.2	3.1	3.2	3.5	3.8	3.9
15	Ear to Head/Neck Junction Distance (in)	31	2.3	0.3	1.7	1.9	2.3	3.0	3.0
16	Ear to Tip-of-Chin Distance (in)	31	3.6	0.2	3.2	3.2	3.5	4.0	4.2
17	Ear to Top-of-Head Distance (in)	31	4.8	0.3	4.0	4.1	4.9	5.1	5.3
18	Top-of-Head to Back-of-Head Distance (in)	31	2.9	0.3	2.2	2.4	3.0	3.3	3.4
19	Top-of-Head to Head Circumference Distan (in)	31	2.7	0.3	2.0	2.2	2.8	3.1	3.2
20	Back-of-Head to Head Breadth Point Dista (in)	31	2.8	0.4	2.2	2.2	2.8	3.3	3.6
21	Forehead to Back-of-Head Arc Length (in)	31	10.6	0.5	9.8	9.8	10.6	11.3	11.8
22	Forehead to Head/Neck Junction Arc Lengt (in)	31	13.2	0.5	12.0	12.4	13.2	14.1	14.3
23	Ear-to-Ear over Top-of-Head Arc Length (in)	31	12.1	0.5	11.0	11.3	12.0	12.9	13.1
24	Ear-to-Ear Under Chin Arc Length (in)	31	7.4	0.5	6.6	6.7	7.4	8.1	8.3
25	Ear-to-Ear around Back-of-Head Arc Lengt (in)	31	8.3	0.5	7.3	7.4	8.3	9.0	9.5
26	Neck Circumference (in)	31	9.0	0.6	7.9	8.0	8.9	9.8	10.6
27	Neck Breadth (in)	31	2.8	0.2	2.4	2.5	2.8	3.1	3.3
28	Neck Depth (in)	31	2.6	0.2	2.1	2.2	2.6	2.9	3.0
29	Shoulder Breadth (in)	31	9.4	0.6	8.5	8.7	9.3	10.4	11.1
30	Shoulder Circumference (in)	31	23.3	1.6	18.3	20.3	23.1	25.1	27.3
31	Shoulder Depth (in)	31	2.6	0.3	2.1	2.2	2.6	3.0	3.1
32	Torso Depth (in)	31	4.8	0.3	4.3	4.4	4.9	5.2	5.6
33	Top-of-Shoulder to Top-of-Head Distance (in)	31	7.3	0.5	5.8	6.3	7.3	8.1	8.4
34	Shoulder Circumference Point to Top-of-H (in)	31	8.9	0.8	6.6	7.1	8.9	9.9	11.0

Anthropometric Data for Males and Females Ages 31-36 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (Kg)	30	13.5	1.5	11.6	11.6	13.4	15.9	17.9
2	Stature (cm)	30	93.0	4.0	85.0	85.0	91.7	98.6	101.0
3	Sitting Height (cm)	30	53.8	2.6	48.6	48.6	53.6	57.2	59.2
4	Maximum Head Breadth (cm)	30	13.4	0.3	12.8	12.8	13.4	13.8	14.2
5	Head Circumference (cm)	30	49.7	1.5	46.7	46.7	49.5	51.3	55.0
6	Head Breadth at Circumference (cm)	30	13.3	0.4	12.4	12.4	13.2	13.7	14.0
7	Head Length (cm)	30	17.7	0.6	16.2	16.2	17.7	18.5	18.8
8	Head Height (cm)	30	17.5	0.9	15.9	15.9	17.6	18.9	19.6
9	Tip-of-Chin to Back-of-Head Distance (cm)	30	20.5	0.6	19.2	19.2	20.4	21.1	21.9
10	Tip-of-Chin to Back-of-Head Circumferenc (cm)	30	54.4	1.6	50.0	50.0	54.5	56.0	58.3
11	Lower Face Height (cm)	30	7.7	0.5	6.7	6.7	7.6	8.3	8.8
12	Maximum Face Breadth (cm)	30	10.4	0.5	8.9	8.9	10.4	10.9	11.4
13	Maximum Jaw Breadth (cm)	30	8.1	0.5	7.0	7.0	8.1	8.7	9.3
14	Head Breadth at Ear Openings (cm)	30	9.3	0.5	8.2	8.2	9.3	9.9	10.2
15	Ear to Head/Neck Junction Distance (cm)	30	6.3	0.8	5.1	5.1	6.2	7.4	8.1
16	Ear to Tip-of-Chin Distance (cm)	30	9.1	0.5	7.7	7.7	9.1	9.7	10.3
17	Ear to Top-of-Head Distance (cm)	30	11.8	0.8	10.2	10.2	11.7	13.0	13.1
18	Top-of-Head to Back-of-Head Distance (cm)	30	6.9	0.9	5.0	5.0	7.0	8.0	8.1
19	Top-of-Head to Head Circumference Distan (cm)	30	7.3	0.6	6.0	6.0	7.3	8.2	8.6
20	Back-of-Head to Head Breadth Point Dista (cm)	30	7.2	0.8	5.7	5.7	7.1	8.1	9.5
21	Forehead to Back-of-Head Arc Length (cm)	30	26.5	1.3	22.6	22.6	26.7	27.8	29.7
22	Forehead to Head/Neck Junction Arc Lengt (cm)	30	33.9	1.7	30.4	30.4	34.2	35.8	36.7
23	Ear-to-Ear over Top-of-Head Arc Length (cm)	30	30.9	1.4	28.6	28.6	30.5	32.6	35.0
24	Ear-to-Ear Under Chin Arc Length (cm)	30	19.2	1.1	17.0	17.0	19.2	20.7	20.8
25	Ear-to-Ear around Back-of-Head Arc Lengt (cm)	30	19.0	1.1	16.9	16.9	18.9	20.8	21.1
26	Neck Circumference (cm)	30	22.9	1.2	20.7	20.7	22.8	24.7	26.3
27	Neck Breadth (cm)	30	7.1	0.5	6.3	6.3	7.1	7.8	7.9
28	Neck Depth (cm)	30	6.7	0.4	6.2	6.2	6.7	7.3	7.9
29	Shoulder Breadth (cm)	30	24.4	1.6	21.0	21.0	24.2	27.0	28.1
30	Shoulder Circumference (cm)	30	62.0	3.2	57.0	57.0	62.2	63.9	72.6
31	Shoulder Depth (cm)	30	6.3	0.6	4.7	4.7	6.3	7.1	7.3
32	Torso Depth (cm)	30	11.9	0.7	10.6	10.6	11.8	13.0	13.1
33	Top-of-Shoulder to Top-of-Head Distance (cm)	30	19.7	1.6	16.9	16.9	19.6	21.4	23.9
34	Shoulder Circumference Point to Top-of-H (cm)	30	24.2	1.4	22.0	22.0	24.1	26.5	27.1

Anthropometric Data for Males and Females Ages 31-36 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (lb)	30	29.9	3.2	25.5	25.5	29.5	35.0	39.5
2	Stature (in)	30	36.6	1.6	33.5	33.5	36.1	38.8	39.8
3	Sitting Height (in)	30	21.2	1.0	19.1	19.1	21.1	22.5	23.3
4	Maximum Head Breadth (in)	30	5.3	0.1	5.0	5.0	5.3	5.4	5.6
5	Head Circumference (in)	30	19.6	0.6	18.4	18.4	19.5	20.2	21.7
6	Head Breadth at Circumference (in)	30	5.2	0.2	4.9	4.9	5.2	5.4	5.5
7	Head Length (in)	30	7.0	0.3	6.4	6.4	7.0	7.3	7.4
8	Head Height (in)	30	6.9	0.3	6.3	6.3	6.9	7.4	7.7
9	Tip-of-Chin to Back-of-Head Distance (in)	30	8.1	0.2	7.6	7.6	8.0	8.3	8.6
10	Tip-of-Chin to Back-of-Head Circumferenc (in)	30	21.4	0.6	19.7	19.7	21.5	22.0	23.0
11	Lower Face Height (in)	30	3.0	0.2	2.6	2.6	3.0	3.3	3.5
12	Maximum Face Breadth (in)	30	4.1	0.2	3.5	3.5	4.1	4.3	4.5
13	Maximum Jaw Breadth (in)	30	3.2	0.2	2.8	2.8	3.2	3.4	3.7
14	Head Breadth at Ear Openings (in)	30	3.6	0.2	3.2	3.2	3.7	3.9	4.0
15	Ear to Head/Neck Junction Distance (in)	30	2.5	0.3	2.0	2.0	2.4	2.9	3.2
16	Ear to Tip-of-Chin Distance (in)	30	3.6	0.2	3.0	3.0	3.6	3.8	4.1
17	Ear to Top-of-Head Distance (in)	30	4.6	0.3	4.0	4.0	4.6	5.1	5.2
18	Top-of-Head to Back-of-Head Distance (in)	30	2.7	0.3	2.0	2.0	2.8	3.1	3.2
19	Top-of-Head to Head Circumference Distan (in)	30	2.9	0.2	2.4	2.4	2.9	3.2	3.4
20	Back-of-Head to Head Breadth Point Dista (in)	30	2.8	0.3	2.2	2.2	2.8	3.2	3.7
21	Forehead to Back-of-Head Arc Length (in)	30	10.4	0.5	8.9	8.9	10.5	10.9	11.7
22	Forehead to Head/Neck Junction Arc Lengt (in)	30	13.3	0.7	12.0	12.0	13.5	14.1	14.4
23	Ear-to-Ear over Top-of-Head Arc Length (in)	30	12.1	0.6	11.3	11.3	12.0	12.8	13.8
24	Ear-to-Ear Under Chin Arc Length (in)	30	7.5	0.4	6.7	6.7	7.6	8.1	8.2
25	Ear-to-Ear around Back-of-Head Arc Lengt (in)	30	7.5	0.4	6.7	6.7	7.4	8.2	8.3
26	Neck Circumference (in)	30	9.0	0.5	8.1	8.1	9.0	9.7	10.4
27	Neck Breadth (in)	30	2.8	0.2	2.5	2.5	2.8	3.1	3.1
28	Neck Depth (in)	30	2.7	0.2	2.4	2.4	2.6	2.9	3.1
29	Shoulder Breadth (in)	30	9.6	0.6	8.3	8.3	9.5	10.6	11.1
30	Shoulder Circumference (in)	30	24.4	1.3	22.4	22.4	24.5	25.2	28.6
31	Shoulder Depth (in)	30	2.5	0.2	1.9	1.9	2.5	2.8	2.9
32	Torso Depth (in)	30	4.7	0.3	4.2	4.2	4.6	5.1	5.2
33	Top-of-Shoulder to Top-of-Head Distance (in)	30	7.8	0.6	6.7	6.7	7.7	8.4	9.4
34	Shoulder Circumference Point to Top-of-H (in)	30	9.5	0.6	8.7	8.7	9.5	10.4	10.7

Anthropometric Data for Males and Females Ages 37-42 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (Kg)	30	15.1	1.4	12.2	12.2	15.0	17.2	18.6
2	Stature (cm)	30	97.8	3.9	90.7	90.7	97.6	104.0	105.5
3	Sitting Height (cm)	30	55.1	3.0	50.0	50.0	55.5	58.7	60.5
4	Maximum Head Breadth (cm)	30	13.5	0.4	12.5	12.5	13.5	14.1	14.3
5	Head Circumference (cm)	30	50.0	1.2	48.0	48.0	50.0	52.0	52.2
6	Head Breadth at Circumference (cm)	30	13.4	0.5	12.1	12.1	13.4	14.1	14.4
7	Head Length (cm)	30	17.8	0.6	17.0	17.0	17.6	18.8	19.1
8	Head Height (cm)	30	17.9	1.1	15.4	15.4	17.8	19.7	20.4
9	Tip-of-Chin to Back-of-Head Distance (cm)	30	20.9	0.7	20.0	20.0	20.6	21.9	22.2
10	Tip-of-Chin to Back-of-Head Circumferenc (cm)	30	55.1	1.7	51.2	51.2	55.3	57.6	58.3
11	Lower Face Height (cm)	30	7.9	0.5	7.0	7.0	8.0	8.4	9.2
12	Maximum Face Breadth (cm)	30	10.4	0.4	9.6	9.6	10.5	11.0	11.1
13	Maximum Jaw Breadth (cm)	30	8.0	0.7	6.5	6.5	8.0	9.0	9.6
14	Head Breadth at Ear Openings (cm)	30	9.4	0.6	8.2	8.2	9.3	10.3	11.0
15	Ear to Head/Neck Junction Distance (cm)	30	6.3	0.7	4.7	4.7	6.4	7.4	7.8
16	Ear to Tip-of-Chin Distance (cm)	30	9.5	0.5	8.4	8.4	9.5	10.2	10.5
17	Ear to Top-of-Head Distance (cm)	30	12.0	0.9	10.5	10.5	11.9	13.1	14.3
18	Top-of-Head to Back-of-Head Distance (cm)	30	7.0	0.7	5.5	5.5	7.0	8.0	8.2
19	Top-of-Head to Head Circumference Distan (cm)	30	7.4	1.0	4.9	4.9	7.4	8.5	9.1
20	Back-of-Head to Head Breadth Point Dista (cm)	30	7.2	0.7	5.9	5.9	7.1	8.1	9.5
21	Forehead to Back-of-Head Arc Length (cm)	30	27.0	1.6	23.7	23.7	26.7	29.4	29.7
22	Forehead to Head/Neck Junction Arc Lengt (cm)	30	34.0	1.5	29.9	29.9	33.8	35.8	36.7
23	Ear-to-Ear over Top-of-Head Arc Length (cm)	30	30.9	1.2	28.9	28.9	30.7	32.6	33.1
24	Ear-to-Ear Under Chin Arc Length (cm)	30	19.5	1.1	17.2	17.2	19.4	20.8	22.4
25	Ear-to-Ear around Back-of-Head Arc Lengt (cm)	30	19.5	1.2	17.1	17.1	19.4	21.1	21.8
26	Neck Circumference (cm)	30	23.2	1.1	20.3	20.3	23.3	24.8	25.0
27	Neck Breadth (cm)	30	7.4	0.5	6.4	6.4	7.3	8.3	8.5
28	Neck Depth (cm)	30	6.9	0.4	6.1	6.1	6.8	7.5	7.6
29	Shoulder Breadth (cm)	30	25.5	1.2	23.4	23.4	25.5	27.4	28.1
30	Shoulder Circumference (cm)	30	64.5	3.0	55.1	55.1	65.0	67.5	70.0
31	Shoulder Depth (cm)	30	6.6	0.6	5.3	5.3	6.5	7.2	7.9
32	Torso Depth (cm)	30	12.3	0.7	10.3	10.3	12.4	13.1	14.0
33	Top-of-Shoulder to Top-of-Head Distance (cm)	30	19.4	1.4	16.8	16.8	19.5	21.3	21.7
34	Shoulder Circumference Point to Top-of-H (cm)	30	24.0	1.5	21.2	21.2	23.9	26.0	27.7

Anthropometric Data for Males and Females Ages 37-42 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (lb)	30	33.2	3.2	27.0	27.0	33.0	38.0	41.0
2	Stature (in)	30	38.5	1.5	35.7	35.7	38.4	40.9	41.5
3	Sitting Height (in)	30	21.7	1.2	19.7	19.7	21.9	23.1	23.8
4	Maximum Head Breadth (in)	30	5.3	0.2	4.9	4.9	5.3	5.6	5.6
5	Head Circumference (in)	30	19.7	0.5	18.9	18.9	19.7	20.5	20.6
6	Head Breadth at Circumference (in)	30	5.3	0.2	4.8	4.8	5.3	5.6	5.7
7	Head Length (in)	30	7.0	0.2	6.7	6.7	6.9	7.4	7.5
8	Head Height (in)	30	7.0	0.4	6.1	6.1	7.0	7.8	8.0
9	Tip-of-Chin to Back-of-Head Distance (in)	30	8.2	0.3	7.9	7.9	8.1	8.6	8.7
10	Tip-of-Chin to Back-of-Head Circumferenc (in)	30	21.7	0.7	20.2	20.2	21.8	22.7	23.0
11	Lower Face Height (in)	30	3.1	0.2	2.8	2.8	3.1	3.3	3.6
12	Maximum Face Breadth (in)	30	4.1	0.2	3.8	3.8	4.1	4.3	4.4
13	Maximum Jaw Breadth (in)	30	3.1	0.3	2.6	2.6	3.1	3.5	3.8
14	Head Breadth at Ear Openings (in)	30	3.7	0.2	3.2	3.2	3.7	4.1	4.3
15	Ear to Head/Neck Junction Distance (in)	30	2.5	0.3	1.9	1.9	2.5	2.9	3.1
16	Ear to Tip-of-Chin Distance (in)	30	3.7	0.2	3.3	3.3	3.7	4.0	4.1
17	Ear to Top-of-Head Distance (in)	30	4.7	0.3	4.1	4.1	4.7	5.2	5.6
18	Top-of-Head to Back-of-Head Distance (in)	30	2.8	0.3	2.2	2.2	2.8	3.1	3.2
19	Top-of-Head to Head Circumference Distan (in)	30	2.9	0.4	1.9	1.9	2.9	3.3	3.6
20	Back-of-Head to Head Breadth Point Dista (in)	30	2.9	0.3	2.3	2.3	2.8	3.2	3.7
21	Forehead to Back-of-Head Arc Length (in)	30	10.6	0.6	9.3	9.3	10.5	11.6	11.7
22	Forehead to Head/Neck Junction Arc Lengt (in)	30	13.4	0.6	11.8	11.8	13.3	14.1	14.4
23	Ear-to-Ear over Top-of-Head Arc Length (in)	30	12.2	0.5	11.4	11.4	12.1	12.8	13.0
24	Ear-to-Ear Under Chin Arc Length (in)	30	7.7	0.4	6.8	6.8	7.6	8.2	8.8
25	Ear-to-Ear around Back-of-Head Arc Lengt (in)	30	7.7	0.5	6.7	6.7	7.6	8.3	8.6
26	Neck Circumference (in)	30	9.1	0.4	8.0	8.0	9.2	9.8	9.8
27	Neck Breadth (in)	30	2.9	0.2	2.5	2.5	2.9	3.3	3.3
28	Neck Depth (in)	30	2.7	0.2	2.4	2.4	2.7	3.0	3.0
29	Shoulder Breadth (in)	30	10.1	0.5	9.2	9.2	10.0	10.8	11.1
30	Shoulder Circumference (in)	30	25.4	1.2	21.7	21.7	25.6	26.6	27.6
31	Shoulder Depth (in)	30	2.6	0.2	2.1	2.1	2.6	2.8	3.1
32	Torso Depth (in)	30	4.9	0.3	4.1	4.1	4.9	5.2	5.5
33	Top-of-Shoulder to Top-of-Head Distance (in)	30	7.7	0.5	6.6	6.6	7.7	8.4	8.5
34	Shoulder Circumference Point to Top-of-H (in)	30	9.4	0.6	8.3	8.3	9.4	10.2	10.9

Anthropometric Data for Males and Females Ages 43-48 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (Kg)	30	15.7	1.8	13.2	13.2	15.2	17.9	20.0
2	Stature (cm)	30	99.5	3.8	94.1	94.1	98.4	106.8	108.2
3	Sitting Height (cm)	30	55.6	3.0	50.3	50.3	55.4	61.7	62.4
4	Maximum Head Breadth (cm)	30	13.6	0.5	12.3	12.3	13.6	14.4	14.4
5	Head Circumference (cm)	30	50.9	1.4	48.0	48.0	51.0	53.5	53.7
6	Head Breadth at Circumference (cm)	30	13.4	0.4	12.0	12.0	13.4	14.1	14.2
7	Head Length (cm)	30	18.1	0.5	16.9	16.9	18.1	18.8	19.5
8	Head Height (cm)	30	17.7	0.9	15.5	15.5	17.6	18.8	20.4
9	Tip-of-Chin to Back-of-Head Distance (cm)	30	21.0	0.7	19.6	19.6	20.9	22.0	22.5
10	Tip-of-Chin to Back-of-Head Circumferenc (cm)	30	55.4	1.9	51.5	51.5	55.1	58.0	58.8
11	Lower Face Height (cm)	30	8.1	0.5	7.2	7.2	8.0	9.0	9.1
12	Maximum Face Breadth (cm)	30	10.3	0.5	9.0	9.0	10.4	11.0	11.0
13	Maximum Jaw Breadth (cm)	30	8.4	0.4	7.6	7.6	8.3	9.0	9.2
14	Head Breadth at Ear Openings (cm)	30	9.4	0.7	8.0	8.0	9.3	10.5	11.6
15	Ear to Head/Neck Junction Distance (cm)	30	6.6	0.7	4.5	4.5	6.5	7.7	7.9
16	Ear to Tip-of-Chin Distance (cm)	30	9.6	0.5	8.6	8.6	9.5	10.3	11.0
17	Ear to Top-of-Head Distance (cm)	30	12.3	0.8	10.4	10.4	12.2	13.3	14.0
18	Top-of-Head to Back-of-Head Distance (cm)	30	7.5	1.0	5.9	5.9	7.5	9.0	9.9
19	Top-of-Head to Head Circumference Distan (cm)	30	7.2	0.7	5.6	5.6	7.2	8.4	8.9
20	Back-of-Head to Head Breadth Point Dista (cm)	30	7.6	0.9	6.0	6.0	7.6	8.8	9.0
21	Forehead to Back-of-Head Arc Length (cm)	30	26.8	1.2	24.5	24.5	26.8	28.3	28.9
22	Forehead to Head/Neck Junction Arc Lengt (cm)	30	33.9	1.3	32.2	32.2	33.6	36.1	36.5
23	Ear-to-Ear over Top-of-Head Arc Length (cm)	30	31.4	1.3	28.5	28.5	31.6	33.2	34.1
24	Ear-to-Ear Under Chin Arc Length (cm)	30	19.2	1.5	16.7	16.7	18.9	22.0	22.7
25	Ear-to-Ear around Back-of-Head Arc Lengt (cm)	30	21.1	1.6	17.8	17.8	21.5	22.7	23.5
26	Neck Circumference (cm)	30	24.1	1.3	22.0	22.0	24.1	25.8	25.9
27	Neck Breadth (cm)	30	7.4	0.5	6.2	6.2	7.4	8.1	8.2
28	Neck Depth (cm)	30	7.0	0.5	6.3	6.3	6.9	7.8	8.0
29	Shoulder Breadth (cm)	30	25.4	1.4	22.3	22.3	25.0	27.4	28.6
30	Shoulder Circumference (cm)	30	63.5	3.6	56.1	56.1	62.6	68.7	69.1
31	Shoulder Depth (cm)	29	6.6	0.5	5.8	5.8	6.6	7.4	7.7
32	Torso Depth (cm)	30	12.6	0.9	11.3	11.3	12.6	13.8	14.8
33	Top-of-Shoulder to Top-of-Head Distance (cm)	30	19.2	1.5	16.5	16.5	19.3	21.7	22.0
34	Shoulder Circumference Point to Top-of-H (cm)	30	23.4	1.9	20.1	20.1	23.4	26.2	26.8

Anthropometric Data for Males and Females Ages 43-48 Months

Table	Measurement (units)	N	Mean	S.D.	Min	5th	50th	95th	Max
1	Weight (lb)	30	34.5	3.9	29.0	29.0	33.5	39.5	44.0
2	Stature (in)	30	39.2	1.5	37.0	37.0	38.7	42.0	42.6
3	Sitting Height (in)	30	21.9	1.2	19.8	19.8	21.8	24.3	24.6
4	Maximum Head Breadth (in)	30	5.4	0.2	4.8	4.8	5.4	5.7	5.7
5	Head Circumference (in)	30	20.1	0.6	18.9	18.9	20.1	21.1	21.1
6	Head Breadth at Circumference (in)	30	5.3	0.2	4.7	4.7	5.3	5.6	5.6
7	Head Length (in)	30	7.1	0.2	6.7	6.7	7.1	7.4	7.7
8	Head Height (in)	30	7.0	0.4	6.1	6.1	6.9	7.4	8.0
9	Tip-of-Chin to Back-of-Head Distance (in)	30	8.3	0.3	7.7	7.7	8.2	8.7	8.9
10	Tip-of-Chin to Back-of-Head Circumferenc (in)	30	21.8	0.8	20.3	20.3	21.7	22.8	23.1
11	Lower Face Height (in)	30	3.2	0.2	2.8	2.8	3.1	3.5	3.6
12	Maximum Face Breadth (in)	30	4.1	0.2	3.5	3.5	4.1	4.3	4.3
13	Maximum Jaw Breadth (in)	30	3.3	0.2	3.0	3.0	3.3	3.5	3.6
14	Head Breadth at Ear Openings (in)	30	3.7	0.3	3.1	3.1	3.7	4.1	4.6
15	Ear to Head/Neck Junction Distance (in)	30	2.6	0.3	1.8	1.8	2.6	3.0	3.1
16	Ear to Tip-of-Chin Distance (in)	30	3.8	0.2	3.4	3.4	3.7	4.1	4.3
17	Ear to Top-of-Head Distance (in)	30	4.8	0.3	4.1	4.1	4.8	5.2	5.5
18	Top-of-Head to Back-of-Head Distance (in)	30	3.0	0.4	2.3	2.3	3.0	3.5	3.9
19	Top-of-Head to Head Circumference Distan (in)	30	2.8	0.3	2.2	2.2	2.8	3.3	3.5
20	Back-of-Head to Head Breadth Point Dista (in)	30	3.0	0.3	2.4	2.4	3.0	3.5	3.5
21	Forehead to Back-of-Head Arc Length (in)	30	10.6	0.5	9.6	9.6	10.6	11.1	11.4
22	Forehead to Head/Neck Junction Arc Lengt (in)	30	13.4	0.5	12.7	12.7	13.2	14.2	14.4
23	Ear-to-Ear over Top-of-Head Arc Length (in)	30	12.4	0.5	11.2	11.2	12.4	13.1	13.4
24	Ear-to-Ear Under Chin Arc Length (in)	30	7.5	0.6	6.6	6.6	7.4	8.7	8.9
25	Ear-to-Ear around Back-of-Head Arc Lengt (in)	30	8.3	0.6	7.0	7.0	8.5	8.9	9.3
26	Neck Circumference (in)	30	9.5	0.5	8.7	8.7	9.5	10.2	10.2
27	Neck Breadth (in)	30	2.9	0.2	2.4	2.4	2.9	3.2	3.2
28	Neck Depth (in)	30	2.8	0.2	2.5	2.5	2.7	3.1	3.1
29	Shoulder Breadth (in)	30	10.0	0.5	8.8	8.8	9.8	10.8	11.3
30	Shoulder Circumference (in)	30	25.0	1.4	22.1	22.1	24.6	27.0	27.2
31	Shoulder Depth (in)	29	2.6	0.2	2.3	2.3	2.6	2.9	3.0
32	Torso Depth (in)	30	5.0	0.3	4.4	4.4	5.0	5.4	5.8
33	Top-of-Shoulder to Top-of-Head Distance (in)	30	7.6	0.6	6.5	6.5	7.6	8.5	8.7
34	Shoulder Circumference Point to Top-of-H (in)	30	9.2	0.8	7.9	7.9	9.2	10.3	10.6

II.C. STEREOPHOTOGRAMMETRY MEASUREMENT RESULTS

Three-dimensional coordinate data were collected for subjects in four of the ten age groups including the 4-to-6 month, 13-to-18 month, 25-to-30 month, and 43-to-48 month groups. Table II.5 lists the landmark targets and head contours for which these coordinate data are presented. It will be noted that these landmark target numbers are different from those of Table I.4 in Part I of this report which lists the landmark targets placed on the subjects for data collection purposes. There are two reason for this. First, landmark points denoting similar anatomical points on the right and left sides of the head (e.g., right and left gonion) have been averaged to produce symmetry in results. Second, the three right shoulder points were deleted and the left shoulder points have been reflected to the right side.

Coordinates of targets placed on the six head contours provide information about the shape as well as the size, location, and orientation of these contours, while coordinate values of targets placed at anatomical landmarks provide information about the relative locations of these landmarks and thus the relative locations and orientations of the manual measurements which used them. This section presents these results in both graphical and tabular form and contains sub-sections II.C.1 through II.C.6 listed and illustrated in Table II.6.

Figures II.4 through II.6 identify the landmarks and contours for the composite plots of sections II.C.1 and II.C.2. The numbers correspond to those in Table II.5. In the contour plots of sections II.C.3 through II.C.6, it should be remembered that all contours except the "Top-of-Head Midline Arc" have been rotated into the appropriate reference system plane to allow presenation and comparison of sizes and shapes of these contours between subject groups and between different subjects within each group. Results in sections II.C.1 and II.C.2 have been reduced to 65% and 55% of actual size respectively in order to fit the plots on the report-size pages. Plots in sections II.C.3 through II.C.6 are shown actual size. While further reproductions of these pages may alter the scaling somewhat, exact scaling can be determined from the metric or English values on the coordinate axes of each plot.

Table 11.5

Index to Surface Landmarks and Contours

No.	Name	Explanation and/or Comment
	Landmarks	
1	Tragion	Ear Notch
2	Infraorbitale	Lower rim of eye socket
3	Sellion	Indentation above nose
4	Glabella	Front of Forehead
5	Vertex	Top of head
6	Opisthocranion	Back of head
7	Menton	Tip of chin
8	Head/Neck Junction	Bottom of skull at back
9	Zygion	Upper cheek
10	Gonion	Lower back of jaw
11	Maximum Head Brdth Point	-----
12	Head Brdth @ Circum. Point	-----
13	Anterior Neck Depth Point	Front of Neck
14	Suprasternale	Top of sternum (breast bone)
15	Anterior Torso #1	Front of torso point #1
16	Anterior Torso #2	Front of torso point #2
17	Anterior torso Depth Point	Front of torso at depth measure
18	Posterior Neck Depth	Back of Neck at depth measure
19	Cervicale (C_7)	Process of 7th cervical vertebra
20	Posterior Torso Point #1	Back of torso #1
21	Posterior Torso Point #2	Back of torso #2
22	Posterior Torso Depth Point	Back of torso at depth measure
23	Neck Breadth Point	Side of neck at breadth measure
24	Shoulder #1	-----
25	Shoulder #2	-----
26	Top of Shoulder	-----
27	Shoulder #3	-----
28	Shoulder Circum. Point	-----
	Contours	
1	Top-of-Head Midline Arc	
2	Head Circumference Arc	
3	Ear-to-Ear over Top-of-Head Arc	
4	Ear-to-Ear through Tip-of-Chin Arc	
5	Ear-to-Ear Under Chin Arc	
6	Ear-to-Ear Around Back-of-Head Arc	

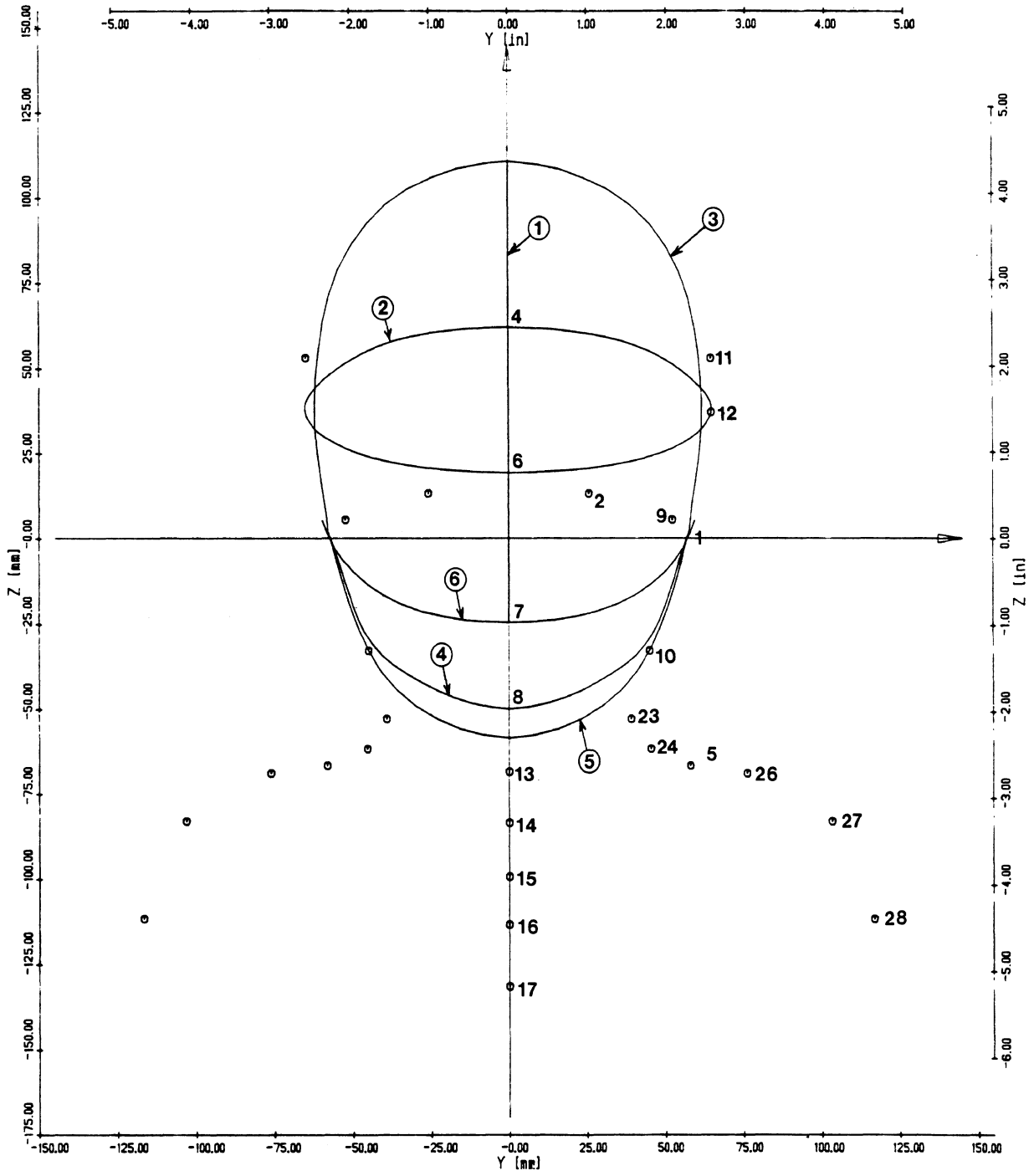


Figure 11.4. Surface landmarks and contours identified in front view. Numbers correspond to Table 11.5. Circled numbers indicate contours.

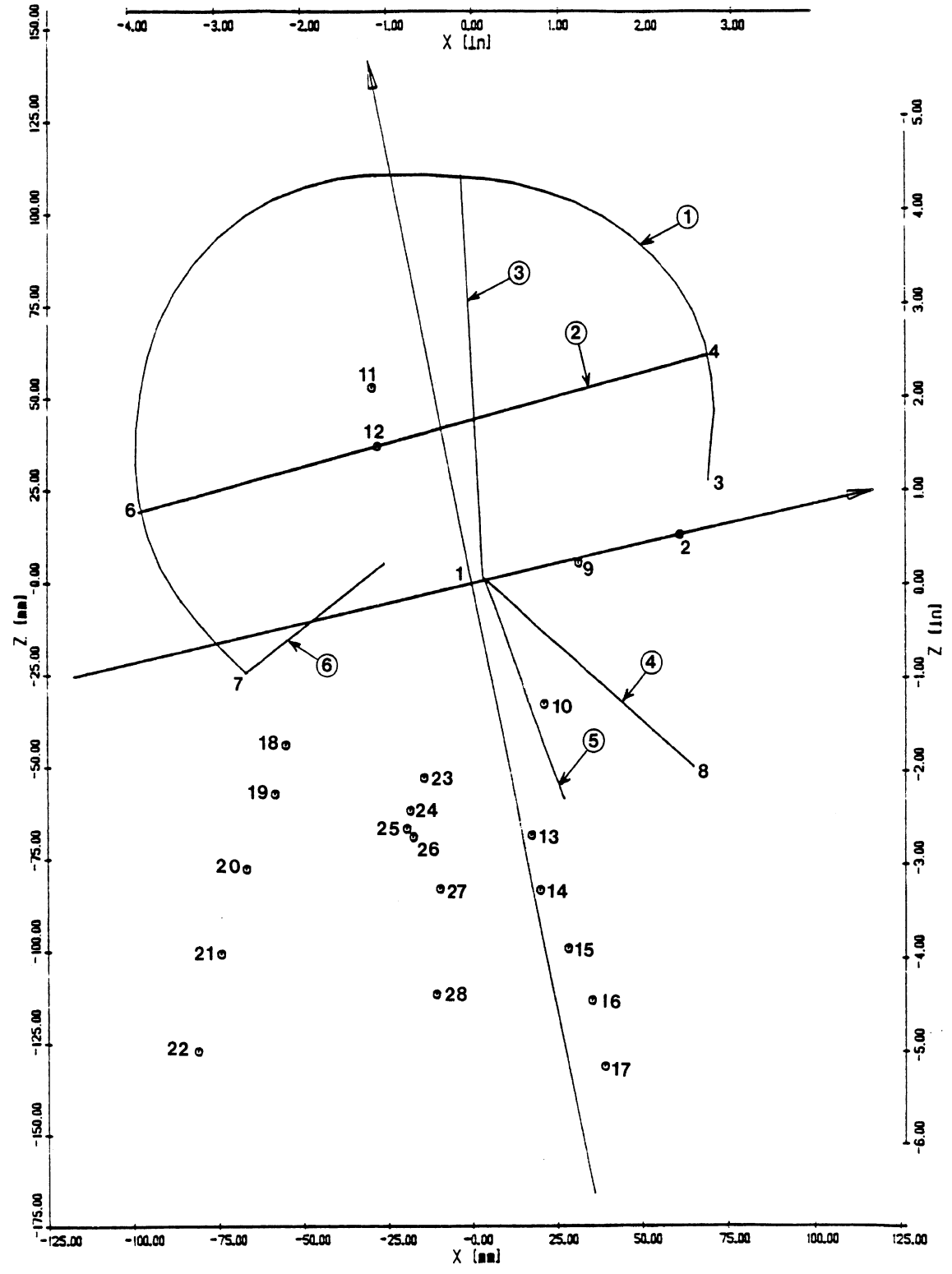


Figure 11.5. Surface landmarks and contours identified in side view. Numbers correspond to Table 11.5. Circled numbers indicate contours.

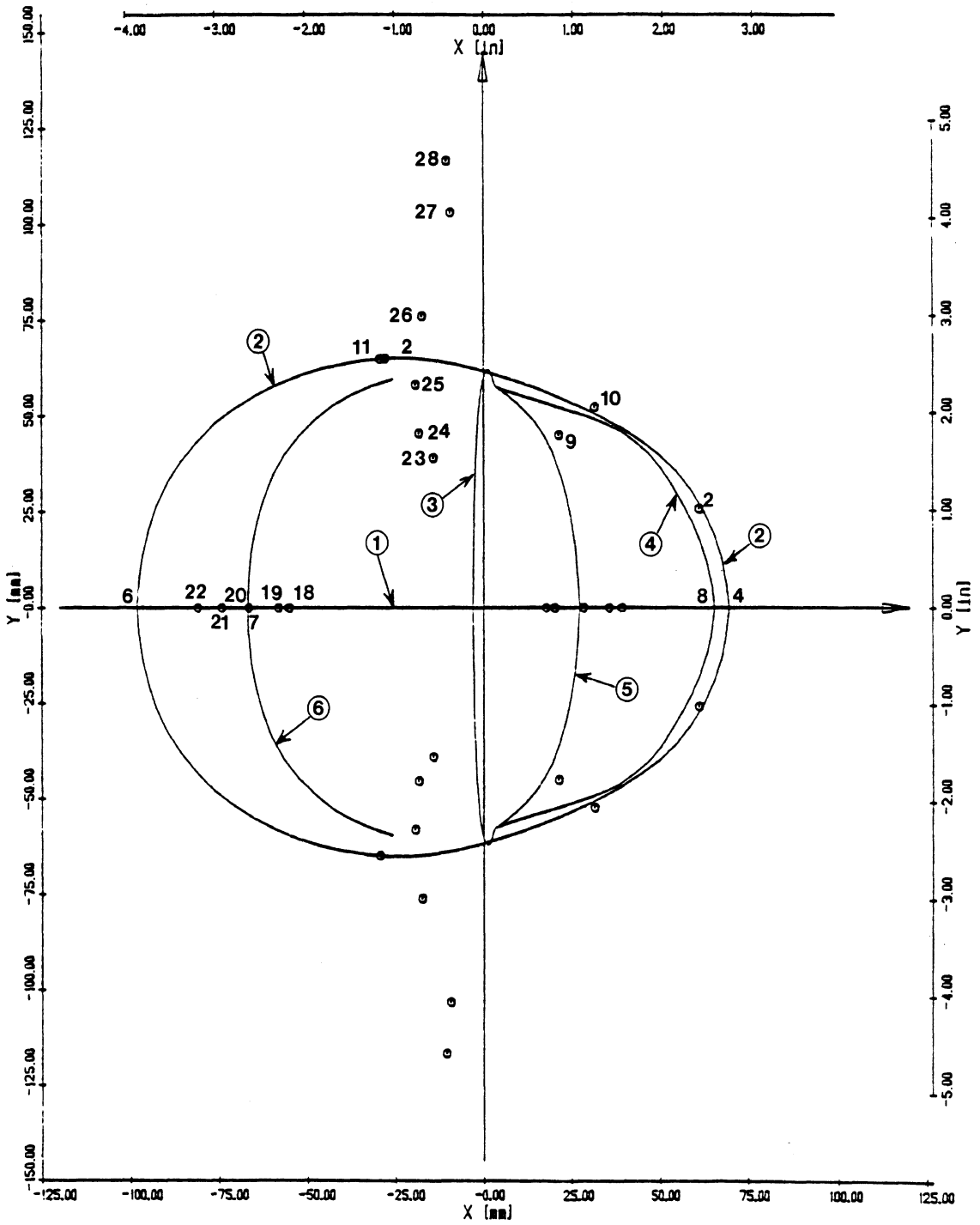
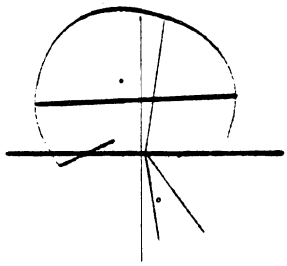
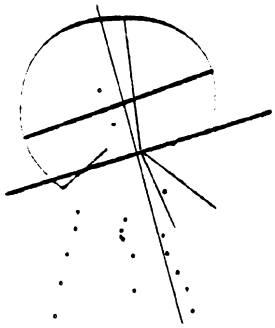
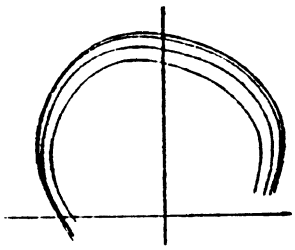
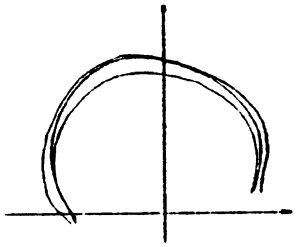
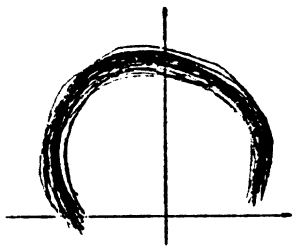


Figure 11.6. Surface landmarks and contours identified in top view. Numbers correspond to Table 11.5. Circled numbers indicate contours.

Table II.6

Index to Stereophotogrammetric Results

Section #	Page	Contents	Illustration
1.	193	Head Landmarks and Contours - Tabular Data and Composite Computer Plots	
2.	315	Head Landmarks and Contours relative to Neck and Torso Landmarks - Tabular Data and Composite Computer Plots	
3.	365	Group Average Landmark and Contour Results - Tabular Data and Computer Plots of Average Head Contours	
4.	395	Small and Large Subject Results with Group Averages - Computer Plots of Head Contours	
5.	417	Overlay Plots of Individual Head Contours by Subject Group	
6.	459	Overlay Plots of Individual Head Contours By Subject Group Merged on a Common Point in the Contour	

II.C.1

HEAD LANDMARKS AND CONTOURS
(Tabular data and composite computer plots)

In this section, the coordinates of head landmarks and contours are presented in head anatomical reference system coordinates for the representative small and large subjects in each group (see section I.B.4.h) as well as the group average. In each case, a table of landmark coordinate values is followed by tables of the points that constitute the head contour arcs. Values for Y-coordinates are given as plus and minus when the target does not lie on the midline. Tabular data are followed by computer plots showing the front (Y-Z plane), top (X-Y plane), and side (X-Z plane) views of the composite head landmark and contour results for each size subject in each group. For purposes of presentation in this report, these plots have been reduced to 65% of actual size.

In each plot, head contours are presented as solid lines without identification of the individual contour points shown in the tables. Anatomical landmark points not otherwise identifiable on a contour or by the intersection of two contours, are denoted by the symbol "o". Figures 4a through 4c illustrate the head landmarks for the different views.

Index to Section Results

Group/Subject		Page No.
4 TO 6 MONTHS:	SMALL	194
	AVERAGE	204
	LARGE	214
13 TO 18 MONTHS:	SMALL	224
	AVERAGE	234
	LARGE	244
25 TO 30 MONTHS:	SMALL	254
	AVERAGE	264
	LARGE	274
43 TO 48 MONTHS:	SMALL	284
	AVERAGE	294
	LARGE	304

HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

4-6 MONTHS SMALL SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 49.6	0.0
2. Under Eye (Infraorbitale)	56.0	± 22.1	-0.0
3. Above Nose (Sellion)	64.6	0.0	13.2
4. Forehead (Glabella)	68.5	0.0	44.2
5. Top of Head (Vertex)	-18.3	0.0	95.9
6. Back of Head (Opisthocranion)	-82.1	0.0	38.9
7. Head/Neck Junction	-66.4	0.0	-6.2
8. Tip of Chin (Menton)	n/a	n/a	n/a
9. Upper Cheek (Zygion)	28.4	± 47.2	3.6
10. Back of Jaw (Gonion)	12.9	± 46.4	-25.4
11. Maximum Head Breadth Point	-27.8	± 51.9	63.5
12. Head Breadth @ Circumference Point .	-22.7	± 53.3	41.1

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Sellion)	64.6	0.0	13.2
2	67.1	0.0	21.5
3	68.6	0.0	31.6
4	69.3	0.0	37.7
5	66.6	0.0	52.0
6	61.8	0.0	61.3
7	56.4	0.0	68.5
8	49.8	0.0	74.5
9	42.0	0.0	80.1
10	33.6	0.0	84.4
11	25.9	0.0	88.9
12	17.4	0.0	91.0
13	9.9	0.0	92.9
14	-2.5	0.0	95.1
15	-9.7	0.0	95.8
16	-18.4	0.0	96.2
17	-27.9	0.0	95.3
18	-36.0	0.0	93.6
19	-44.0	0.0	90.5
20	-51.6	0.0	86.1
21	-59.4	0.0	80.1
22	-66.0	0.0	73.1
23	-71.5	0.0	67.1
24	-76.5	0.0	58.9
25	-79.5	0.0	50.9
26	-82.0	0.0	44.3
27	-82.7	0.0	31.6
28	-81.8	0.0	25.1
29	-79.5	0.0	16.6
30	-76.3	0.0	10.2
31	-71.5	0.0	3.0
32 (Head/Neck Junction)	-66.4	0.0	-6.2

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Glabella)	68.5	0.0	44.2
2	67.6	± 5.7	43.9
3	65.2	± 15.7	43.8
4	60.9	± 24.8	43.7
5	54.4	± 32.8	43.4
6	46.2	± 38.3	43.1
7	35.0	± 42.9	42.8
8	26.1	± 45.7	42.4
9	16.6	± 48.7	42.1
10	5.6	± 51.5	41.7
11	-4.0	± 52.6	41.4
12	-13.1	± 53.3	41.1
13	-22.7	± 53.2	40.8
14	-32.1	± 52.2	40.4
15	-41.8	± 50.6	40.1
16	-49.9	± 48.4	39.8
17	-57.6	± 44.7	39.6
18	-64.4	± 39.3	39.3
19	-71.1	± 33.0	39.1
20	-76.0	± 25.5	38.9
21	-80.1	± 15.7	38.8
22	-81.8	± 7.8	38.7
23 (Opisthocranion) ...	-82.1	0.0	38.9

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 49.6	0.0
2	0.2	± 49.1	4.7
3	0.5	± 51.2	15.4
4	0.8	± 51.6	24.9
5	1.0	± 51.7	34.3
6	1.3	± 52.2	47.0
7	1.6	± 51.9	56.5
8	1.8	± 50.3	65.8
9	2.1	± 45.2	74.0
10	2.3	± 37.8	81.7
11	2.4	± 30.1	86.4
12	2.5	± 21.4	90.5
13	2.6	± 10.8	93.5
14 (Midline)	2.6	0.0	95.0

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 49.6	0.0
2	5.7	± 46.0	-7.3
3	10.6	± 44.4	-13.4
4	16.8	± 43.9	-21.2
5	23.0	± 41.4	-29.1
6	29.6	± 38.2	-37.3
7	35.3	± 32.6	-44.5
8	39.4	± 26.8	-49.6
9	42.8	± 17.0	-53.9
10	44.7	± 9.0	-56.3
11 (Menton)	n/a	n/a	n/a

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

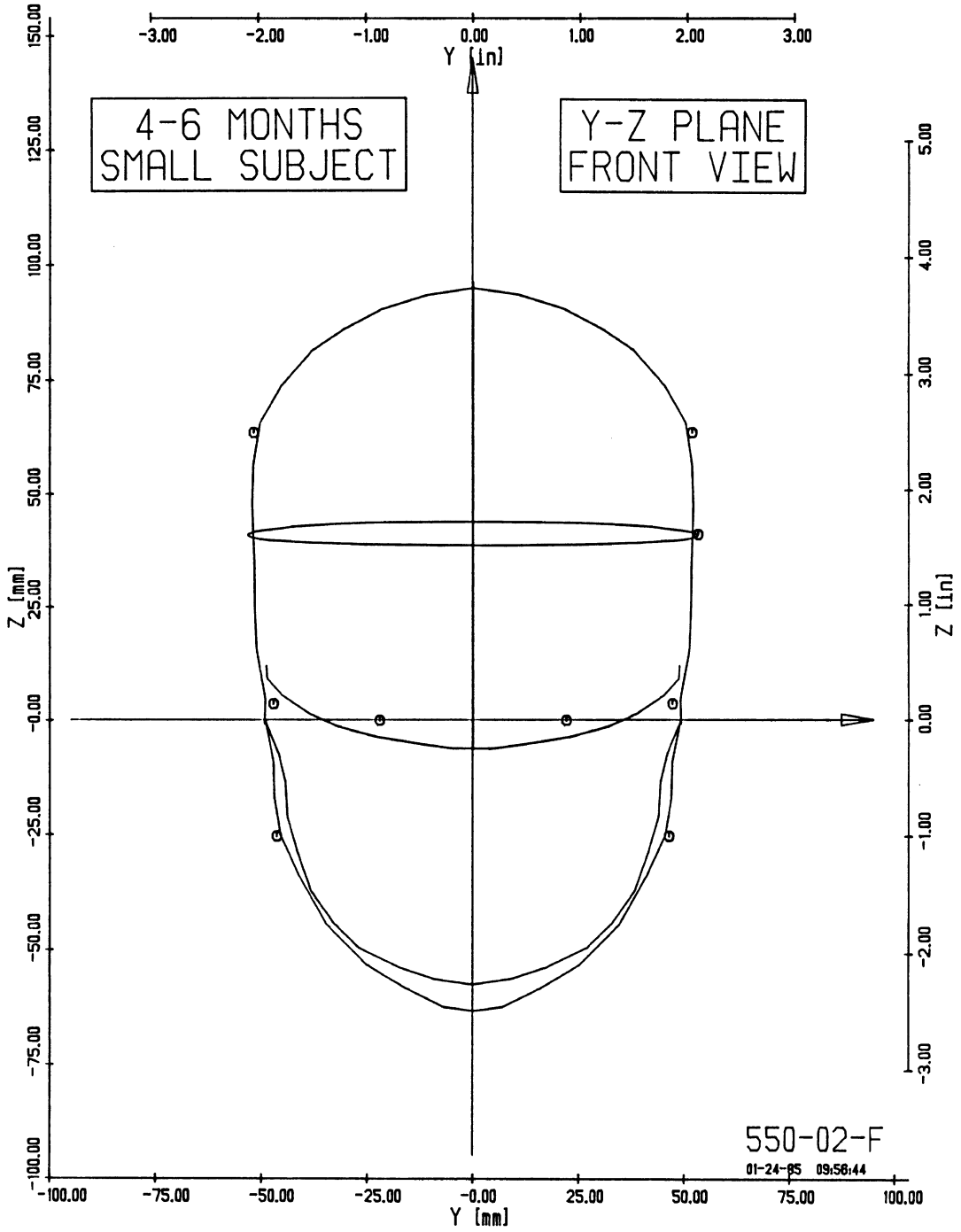
4-6 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 49.6	0.0
2	3.0	± 47.2	-9.1
3	5.3	± 47.0	-17.0
4	7.7	± 45.5	-25.2
5	10.3	± 41.0	-34.1
6	13.4	± 34.5	-44.6
7	16.0	± 25.0	-53.3
8	17.5	± 15.5	-58.5
9	18.6	± 7.0	-62.4
10 (Midline)	18.9	0.0	-63.3

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1.	-27.1	± 48.9	11.9
2	-33.1	± 48.7	9.1
3	-41.4	± 44.8	5.3
4	-50.2	± 38.3	1.3
5	-56.1	± 31.8	-1.4
6	-60.9	± 23.0	-3.7
7	-64.4	± 12.3	-5.3
8	-66.6	± 4.6	-6.3
9 (Head/Neck Junction)	-66.4	0.0	-6.2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SMALL SUBJECT
Y-Z PLANE
FRONT VIEW
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-1.00
0.00
1.00
2.00
3.00
Z [mm]
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125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [in]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Y [mm]
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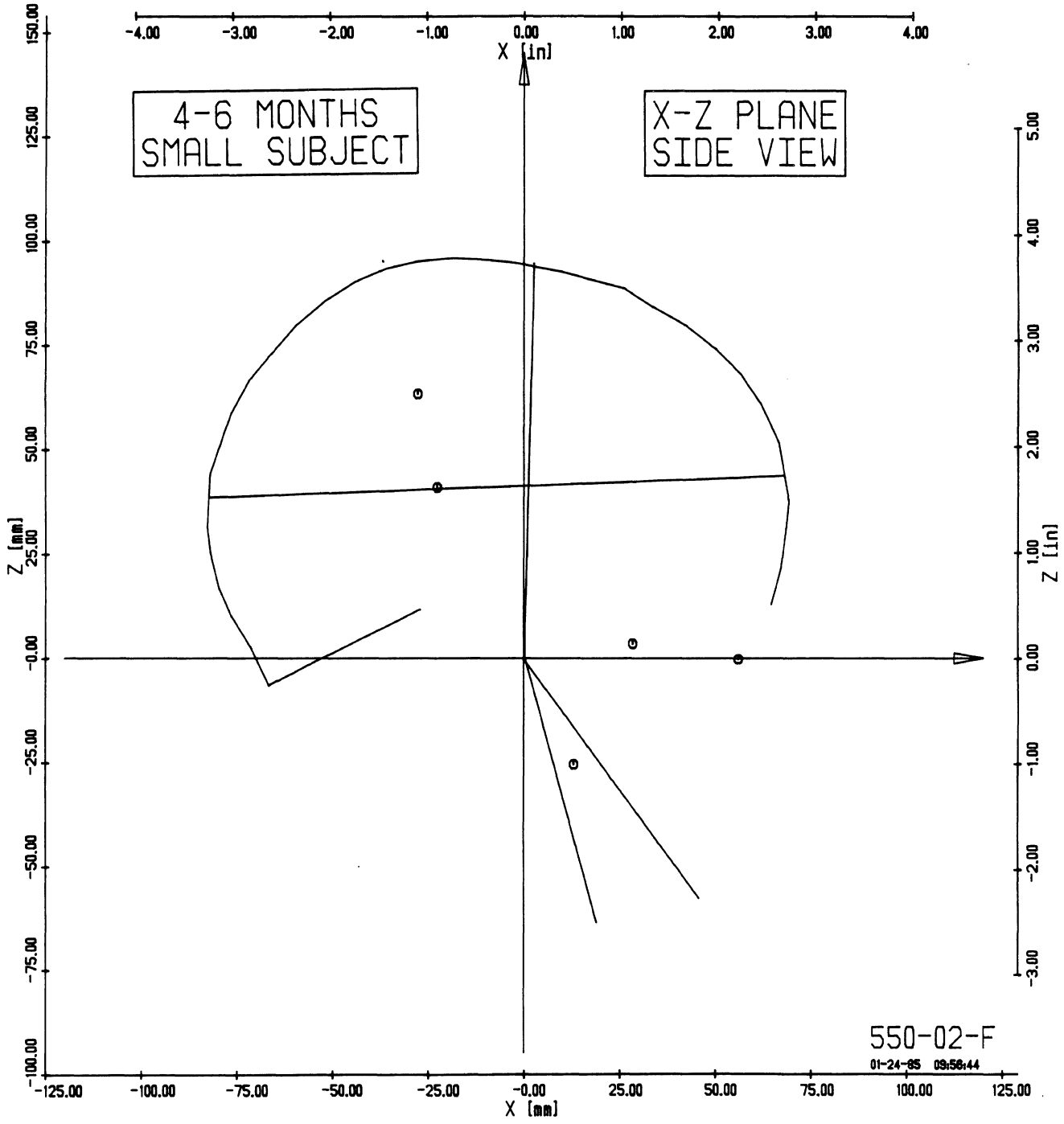
4-6 MONTHS
SMALL SUBJECT
X-Z PLANE
SIDE VIEW
X [in]
-4.00
-3.00
-2.00
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1.00
2.00
3.00
4.00
Z [mm]
150.00
125.00
100.00
75.00
50.00
25.00
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-25.00
-50.00
-75.00
-100.00
Z [in]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
X [mm]
-125.00
-100.00
-75.00
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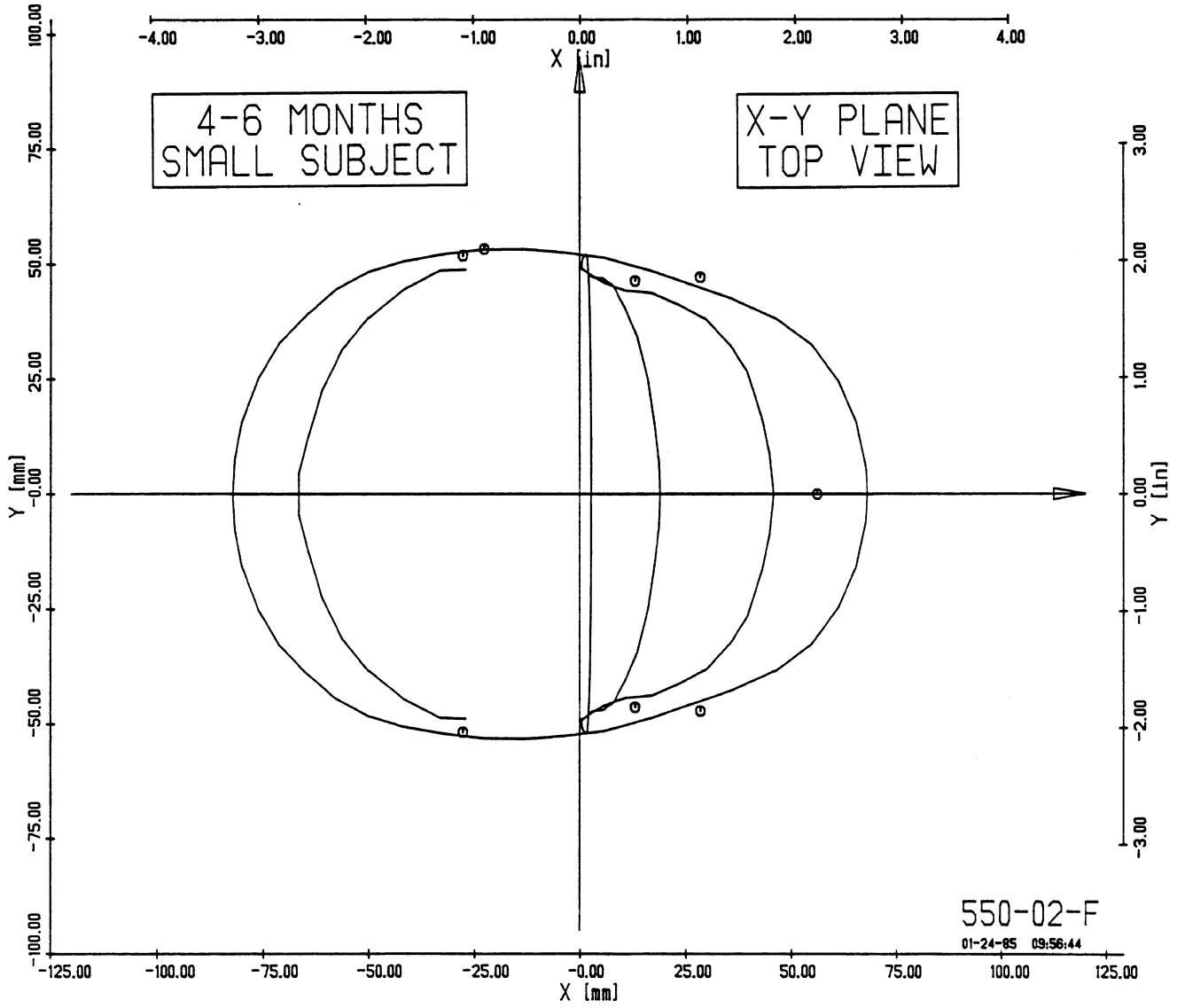
4-6 MONTHS
SMALL SUBJECT
X-Y PLANE
TOP VIEW
X [in]
-4.00
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-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
Y [mm]
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Y [in]
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
X [mm]
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HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

4-6 MONTHS GROUP AVERAGE

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 52.5	0.0
2. Under Eye (Infraorbitale)	58.1	± 24.0	0.0
3. Above Nose (Sellion)	67.0	0.0	14.6
4. Forehead (Glabella)	72.5	0.0	42.6
5. Top of Head (Vertex)	-14.1	0.0	106.7
6. Back of Head (Opisthocranion)	-83.9	0.0	39.9
7. Head/Neck Junction	-66.6	0.0	-3.7
8. Tip of Chin (Menton)	42.1	0.0	-57.8
9. Upper Cheek (Zygion)	28.3	± 49.4	1.5
10. Back of Jaw (Gonion)	10.0	± 43.4	-29.8
11. Maximum Head Breadth Point	-18.9	± 58.4	64.9
12. Head Breadth @ Circumference Point .	-21.4	± 59.2	40.8

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Sellion)	67.0	0.0	14.6
2	68.9	0.0	22.5
3	71.0	0.0	30.5
4	72.2	0.0	38.7
5	71.9	0.0	47.0
6	70.3	0.0	55.3
7	66.7	0.0	62.8
8	62.1	0.0	69.4
9	56.9	0.0	75.5
10	51.0	0.0	81.0
11	44.7	0.0	86.0
12	38.0	0.0	90.3
13	30.9	0.0	94.0
14	23.7	0.0	96.8
15	16.5	0.0	99.5
16	9.1	0.0	102.0
17	1.7	0.0	103.9
18	-5.9	0.0	105.5
19	-13.6	0.0	106.5
20	-22.2	0.0	106.7
21	-30.7	0.0	105.9
22	-39.0	0.0	103.6
23	-46.9	0.0	100.2
24	-54.3	0.0	95.8
25	-61.0	0.0	90.4
26	-67.1	0.0	83.9
27	-72.4	0.0	76.8
28	-77.0	0.0	69.2
29	-80.4	0.0	61.0
30	-83.1	0.0	52.5
31	-84.4	0.0	43.6
32	-84.1	0.0	35.0
33	-82.6	0.0	26.5
34	-79.9	0.0	18.3
35	-76.1	0.0	10.6
36	-71.7	0.0	3.3
37 (Head/Neck Junction)	-66.6	0.0	-3.7

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Glabella)	72.5	0.0	42.6
2	71.5	± 6.0	42.7
3	70.3	± 12.0	42.6
4	68.5	± 17.8	42.6
5	65.8	± 23.3	42.5
6	62.5	± 28.5	42.5
7	58.6	± 33.2	42.4
8	54.1	± 37.3	42.3
9	49.3	± 40.9	42.2
10	44.0	± 43.8	42.1
11	38.6	± 46.4	42.0
12	33.1	± 48.7	41.9
13	27.4	± 50.8	41.8
14	21.9	± 52.6	41.6
15	16.3	± 54.3	41.5
16	10.7	± 55.8	41.4
17	5.1	± 57.1	41.3
18	-0.6	± 58.2	41.2
19	-6.4	± 59.0	41.1
20	-12.4	± 59.4	41.0
21	-18.4	± 59.4	40.8
22	-24.4	± 59.0	40.7
23	-30.4	± 58.1	40.6
24	-36.3	± 56.9	40.5
25	-42.1	± 55.2	40.3
26	-48.0	± 52.9	40.2
27	-53.7	± 50.3	40.1
28	-59.2	± 47.3	40.0
29	-64.4	± 43.8	39.9
30	-69.1	± 39.6	39.8
31	-73.3	± 34.9	39.7
32	-76.8	± 29.7	39.6
33	-79.7	± 24.2	39.6
34	-82.0	± 18.4	39.5
35	-83.6	± 12.3	39.5
36	-84.5	± 6.2	39.5
37 (Opisthocranion) ...	-83.9	0.0	39.9

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 52.5	0.0
2	4.3	± 51.6	-2.8
3	7.3	± 50.5	-7.1
4	10.3	± 49.4	-11.3
5	13.1	± 48.3	-15.5
6	16.0	± 47.1	-19.6
7	18.9	± 45.7	-23.7
8	21.8	± 44.1	-27.8
9	24.6	± 42.2	-31.9
10	27.4	± 39.8	-35.9
11	30.0	± 36.9	-39.6
12	32.4	± 33.4	-43.0
13	34.5	± 29.4	-46.0
14	36.4	± 25.1	-48.8
15	38.0	± 20.5	-51.2
16	39.5	± 15.6	-53.2
17	40.7	± 10.6	-54.9
18	41.5	± 5.4	-56.2
19 (Menton)	42.1	0.0	-57.8

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 52.5	0.0
2	2.9	± 53.3	8.2
3	4.6	± 54.4	15.0
4	6.2	± 55.3	21.9
5	7.8	± 55.9	28.5
6	9.4	± 55.8	35.1
7	11.0	± 55.4	41.7
8	12.7	± 54.8	48.6
9	14.4	± 53.9	55.6
10	16.0	± 52.2	62.4
11	17.6	± 49.5	69.3
12	19.2	± 45.7	75.6
13	20.5	± 40.9	81.2
14	21.6	± 35.1	85.8
15	22.6	± 28.7	89.7
16	23.3	± 21.8	92.9
17	23.8	± 14.7	95.0
18	24.1	± 7.4	96.1
19 (Midline)	24.3	0.0	96.7

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

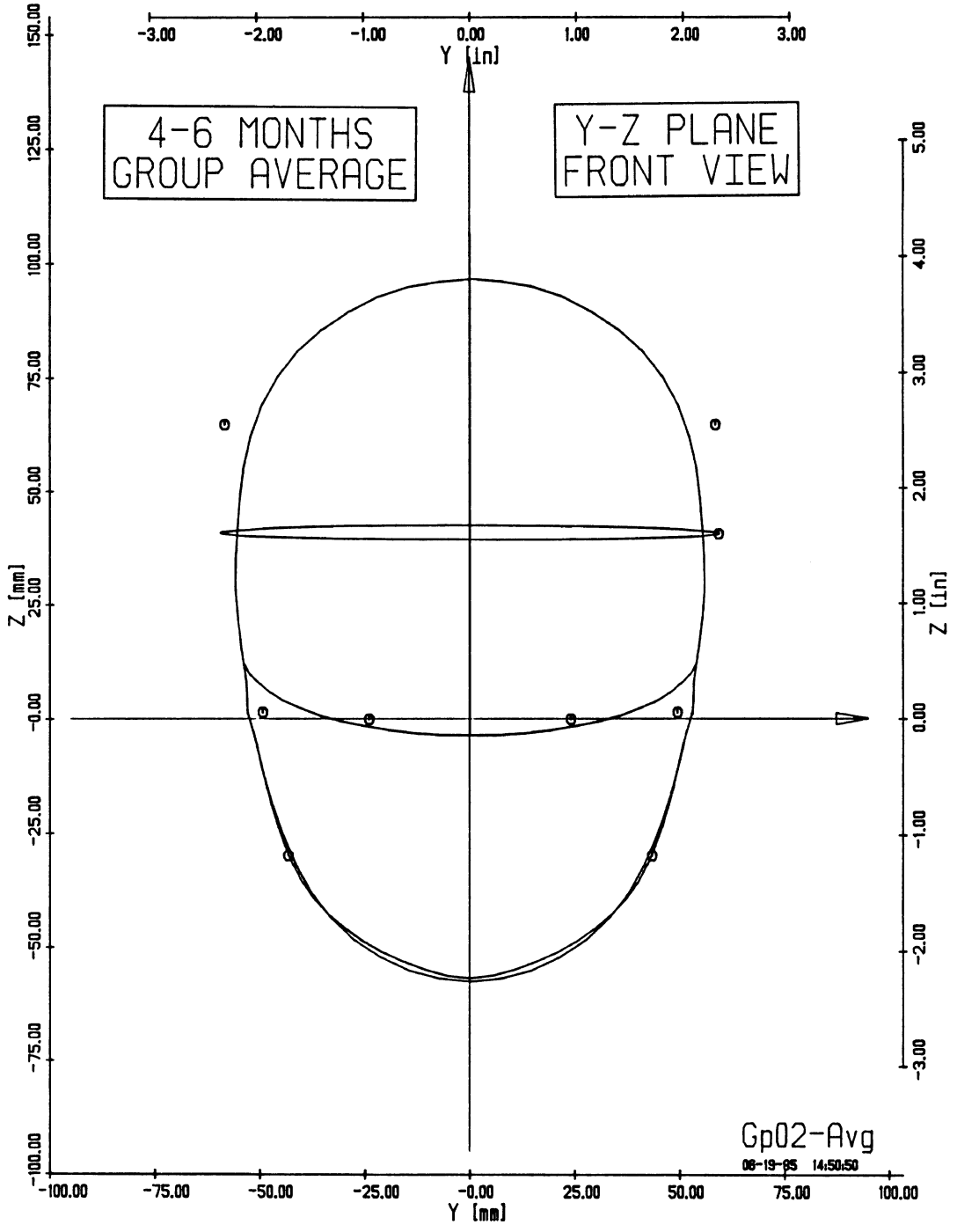
4-6 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 52.5	0.0
2	2.1	± 50.8	-5.6
3	3.1	± 49.1	-12.4
4	4.1	± 47.0	-19.0
5	5.0	± 44.5	-25.5
6	6.0	± 41.4	-32.0
7	6.9	± 37.7	-38.1
8	7.7	± 33.0	-43.6
9	8.4	± 27.5	-48.4
10	9.0	± 21.2	-52.2
11	9.4	± 14.4	-55.1
12	9.7	± 7.3	-56.8
13 (Midline)	9.8	0.0	-57.5

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1.	-22.5	± 53.8	12.0
2	-28.5	± 52.5	9.9
3	-34.2	± 50.2	7.9
4	-39.8	± 47.6	5.9
5	-45.0	± 44.3	4.0
6	-49.7	± 40.2	2.4
7	-54.0	± 35.7	0.8
8	-57.7	± 30.5	-0.5
9	-60.7	± 24.9	-1.5
10	-63.2	± 19.0	-2.4
11	-65.0	± 12.8	-3.1
12	-66.2	± 6.5	-3.5
13 (Head/Neck Junction)	-66.6	0.0	-3.7


4-6 MONTHS
GROUP AVERAGE
Y-Z PLANE
FRONT VIEW
Y [in]
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-2.00
-1.00
0.00
1.00
2.00
3.00
Z [mm]
150.00
125.00
100.00
75.00
50.00
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1.00
0.00
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Y [mm]
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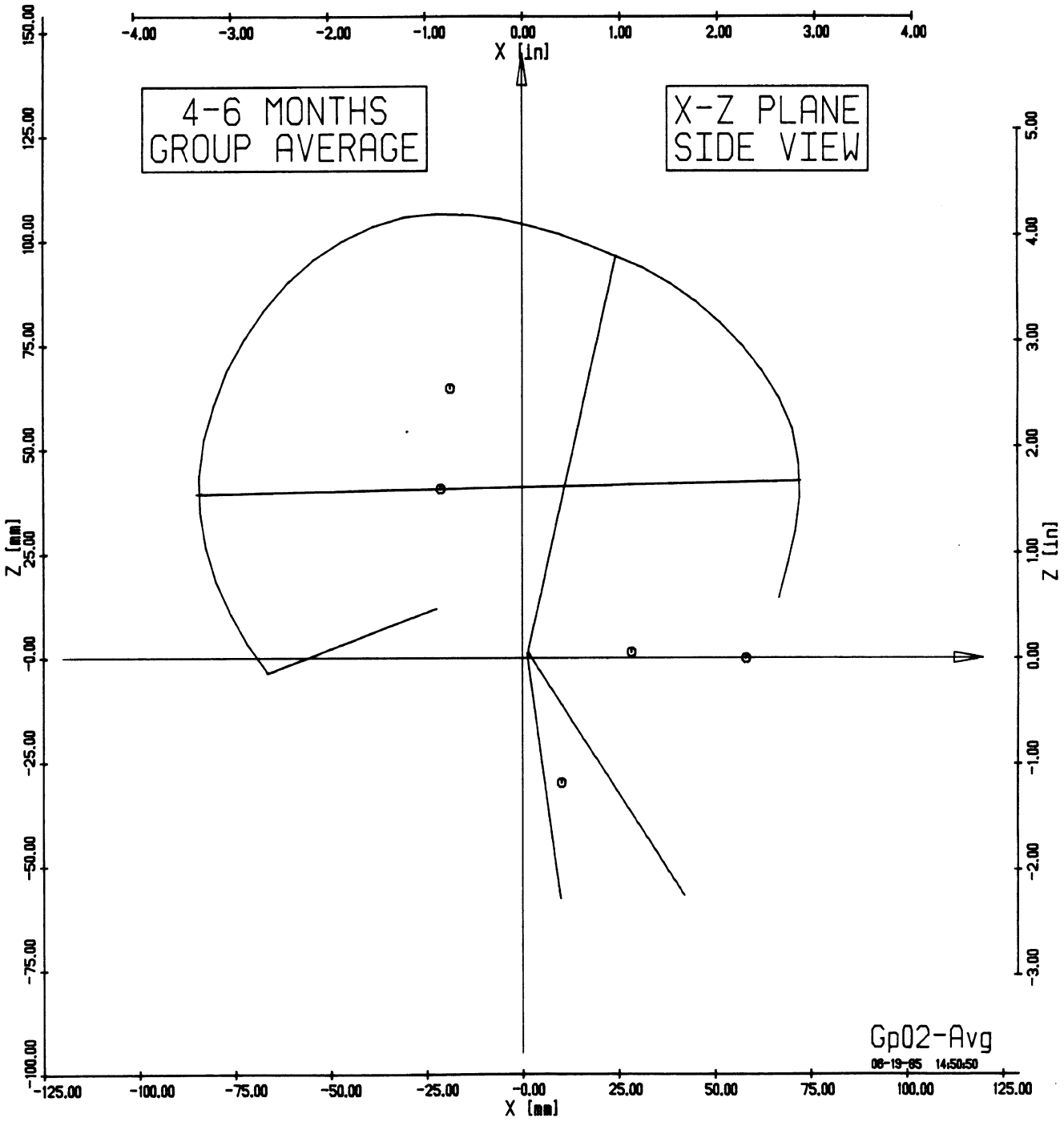
4-6 MONTHS
GROUP AVERAGE
X-Z PLANE
SIDE VIEW
X [in]
Z [mm]
Z [in]
X [mm]
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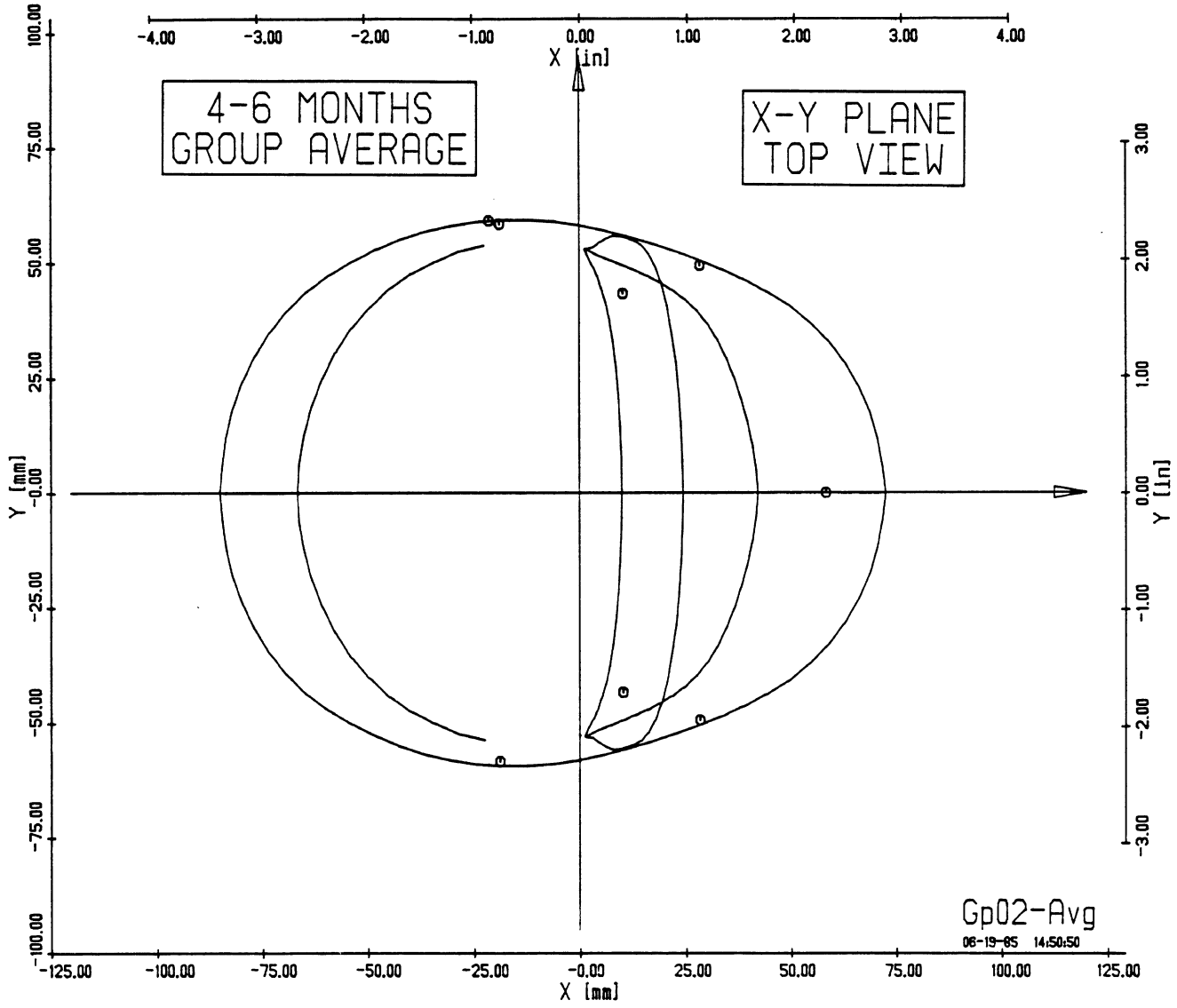
4-6 MONTHS
GROUP AVERAGE
X-Y PLANE
TOP VIEW
X [in]
Y [mm]
Y [in]
X [mm]
Gp02-Avg
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HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

4-6 MONTHS LARGE SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 54.5	0.0
2. Under Eye (Infraorbitale)	63.2	± 23.8	-0.0
3. Above Nose (Sellion)	72.7	0.0	13.9
4. Forehead (Glabella)	76.6	0.0	44.1
5. Top of Head (Vertex)	-26.3	0.0	108.1
6. Back of Head (Opisthocranion)	-90.2	0.0	20.4
7. Head/Neck Junction	-69.5	0.0	-7.1
8. Tip of Chin (Menton)	43.8	0.0	-65.4
9. Upper Cheek (Zygion)	20.8	± 50.9	0.3
10. Back of Jaw (Gonion)	10.8	± 46.9	-33.4
11. Maximum Head Breadth Point	-27.5	± 59.2	59.4
12. Head Breadth @ Circumference Point .	-26.4	± 57.8	30.7

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Sellion)	72.7	0.0	13.9
2	73.4	0.0	24.3
3	75.2	0.0	32.7
4	77.2	0.0	39.9
5	76.1	0.0	52.2
6	73.7	0.0	61.3
7	68.7	0.0	69.4
8	61.8	0.0	76.6
9	54.9	0.0	82.7
10	46.6	0.0	88.2
11	38.2	0.0	92.4
12	28.7	0.0	95.9
13	24.1	0.0	98.0
14	9.5	0.0	102.9
15	3.5	0.0	103.9
16	-6.0	0.0	106.4
17	-13.2	0.0	107.3
18	-25.4	0.0	108.3
19	-32.5	0.0	107.8
20	-40.4	0.0	104.6
21	-48.7	0.0	101.5
22	-56.5	0.0	97.0
23	-62.5	0.0	92.8
24	-68.7	0.0	86.2
25	-74.8	0.0	78.1
26	-79.7	0.0	70.3
27	-83.3	0.0	62.5
28	-87.4	0.0	54.1
29	-88.8	0.0	46.6
30	-90.8	0.0	38.3
31	-91.0	0.0	30.8
32	-90.2	0.0	25.0
33	-88.1	0.0	14.1
34	-84.6	0.0	6.9
35	-78.7	0.0	0.8
36 (Head/Neck Junction)	-69.5	0.0	-7.1

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Glabella)	76.6	0.0	44.1
2	73.7	± 13.2	43.2
3	69.9	± 21.7	42.7
4	65.2	± 29.6	42.0
5	59.9	± 35.1	41.3
6	52.0	± 41.2	40.3
7	42.6	± 45.7	39.0
8	33.8	± 48.3	37.8
9	25.0	± 50.8	36.6
10	16.0	± 52.8	35.4
11	7.8	± 54.8	34.3
12	-1.7	± 56.8	33.0
13	-10.3	± 57.5	31.9
14	-18.5	± 57.8	30.8
15	-27.4	± 58.0	29.6
16	-37.0	± 56.9	28.3
17	-46.7	± 55.4	26.9
18	-54.3	± 53.0	25.9
19	-61.4	± 50.0	25.0
20	-67.2	± 45.7	24.2
21	-73.9	± 41.2	23.3
22	-80.2	± 33.9	22.4
23	-85.2	± 26.7	21.8
24	-88.9	± 18.4	21.2
25	-91.1	± 9.5	21.0
26 (Opisthocranion) ...	-90.2	0.0	20.4

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 54.5	0.0
2	4.4	± 53.6	18.3
3	5.8	± 54.7	27.2
4	7.3	± 54.2	37.8
5	9.2	± 54.6	50.2
6	10.0	± 53.7	55.9
7	11.5	± 52.5	65.8
8	12.8	± 49.6	74.7
9	13.9	± 44.6	82.2
10	14.9	± 36.4	88.7
11	15.7	± 28.4	94.2
12	16.2	± 20.3	97.6
13	16.5	± 11.1	99.5
14 (Midline)	16.6	0.0	100.3

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 54.5	0.0
2	8.4	± 51.0	-10.2
3	13.3	± 49.3	-17.9
4	18.0	± 47.5	-25.2
5	21.8	± 44.8	-31.3
6	26.9	± 41.5	-39.2
7	31.6	± 36.3	-46.7
8	35.0	± 30.0	-52.0
9	37.3	± 22.5	-55.7
10	40.2	± 13.5	-60.2
11	41.7	± 6.7	-62.5
12 (Menton)	43.8	0.0	-65.4

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

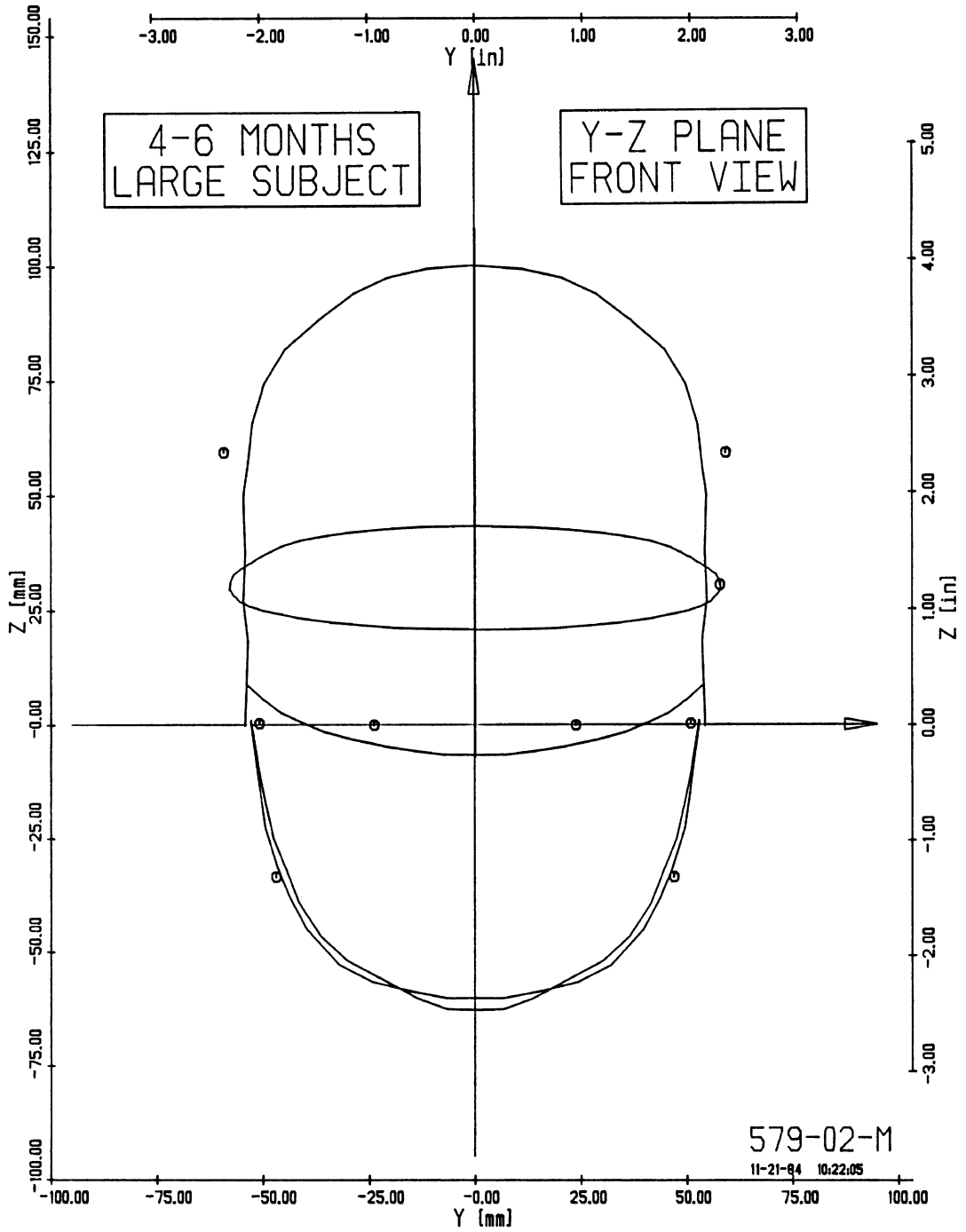
4-6 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 54.5	0.0
2	5.1	± 50.9	-13.8
3	7.6	± 49.5	-22.8
4	10.1	± 46.6	-31.5
5	11.9	± 43.7	-38.0
6	13.9	± 39.6	-45.2
7	16.1	± 32.0	-52.9
8	17.1	± 24.2	-56.6
9	17.7	± 15.1	-58.6
10	18.1	± 6.0	-60.2
11 (Midline)	18.1	0.0	-60.1

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

4-6 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1.	-21.6	± 53.6	8.6
2	-31.4	± 49.6	5.4
3	-39.5	± 45.6	2.7
4	-46.4	± 40.6	0.5
5	-52.5	± 35.6	-1.5
6	-57.4	± 28.9	-3.2
7	-62.5	± 20.9	-4.8
8	-65.4	± 13.9	-5.8
9	-67.9	± 7.2	-6.6
10 (Head/Neck Junction)	-69.5	0.0	-7.1


4-6 MONTHS
LARGE SUBJECT
Y-Z PLANE
FRONT VIEW
Y [in]
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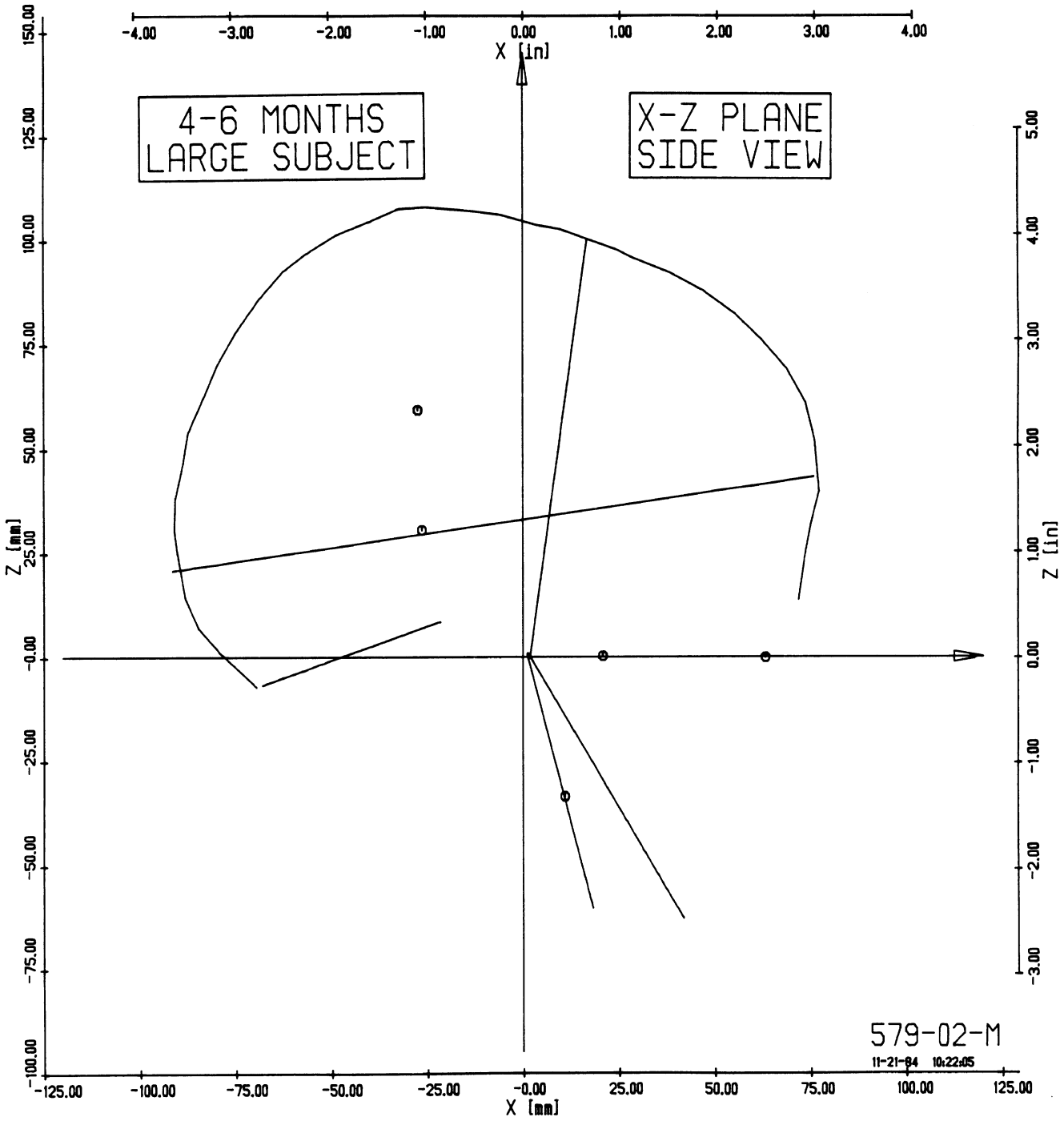
-2.00
-1.00
0.00
1.00
2.00
3.00
Z [mm]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [in]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Y [mm]
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
579-02-M
11-21-84 10:22:05


4-6 MONTHS
LARGE SUBJECT
X-Z PLANE
SIDE VIEW
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
Z [mm]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [in]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
X [mm]
-125.00
-100.00
-75.00
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579-02-M
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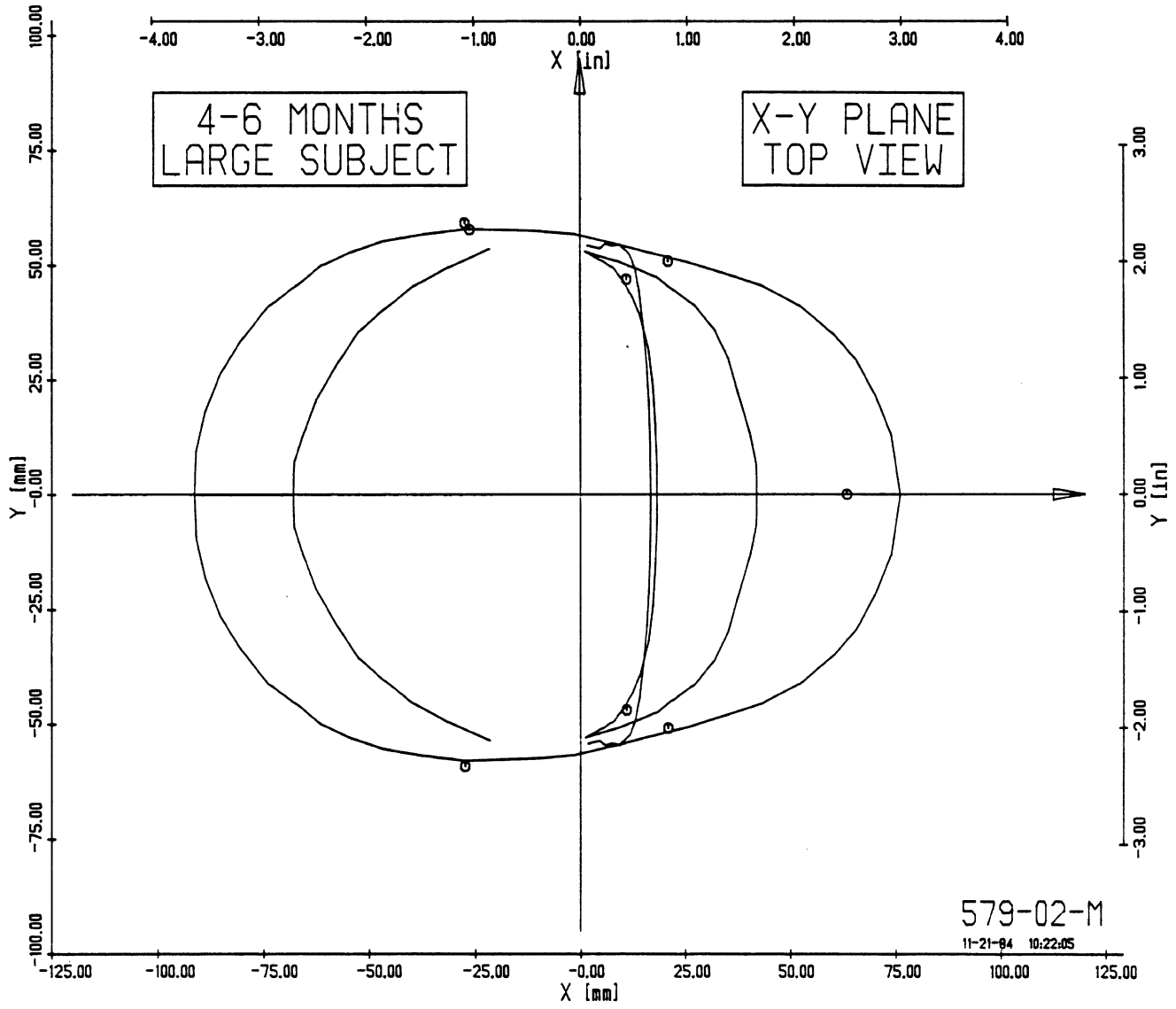

4-6 MONTHS
LARGE SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [mm]
Y [in]
X [mm]
579-02-M
11-21-84 10:22:05

HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

13-18 MONTHS SMALL SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 53.1	0.0
2. Under Eye (Infraorbitale)	57.6	± 21.8	-0.0
3. Above Nose (Sellion)	67.6	0.0	12.9
4. Forehead (Glabella)	73.5	0.0	44.3
5. Top of Head (Vertex)	-24.1	0.0	109.4
6. Back of Head (Opisthocranion)	-90.5	0.0	35.3
7. Head/Neck Junction	-69.3	0.0	-9.7
8. Tip of Chin (Menton)	45.0	0.0	-61.9
9. Upper Cheek (Zygion)	29.3	± 45.4	-7.1
10. Back of Jaw (Gonion)	7.3	± 42.9	-30.4
11. Maximum Head Breadth Point	-27.8	± 58.5	74.4
12. Head Breadth @ Circumference Point .	-24.6	± 58.3	38.2

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Sellion)	67.6	0.0	12.9
2	69.7	0.0	24.4
3	71.9	0.0	34.2
4	73.1	0.0	48.1
5	71.2	0.0	53.3
6	68.3	0.0	59.7
7	64.0	0.0	68.1
8	59.3	0.0	75.4
9	52.0	0.0	81.5
10	43.0	0.0	88.2
11	32.2	0.0	93.8
12	26.0	0.0	96.6
13	13.2	0.0	100.3
14	6.0	0.0	103.3
15	-3.1	0.0	106.0
16	-13.4	0.0	109.2
17	-23.8	0.0	110.0
18	-33.7	0.0	110.6
19	-43.5	0.0	108.3
20	-52.5	0.0	103.5
21	-60.7	0.0	97.6
22	-67.7	0.0	91.8
23	-74.1	0.0	83.2
24	-78.5	0.0	75.6
25	-82.2	0.0	66.7
26	-86.0	0.0	58.2
27	-89.1	0.0	48.8
28	-90.3	0.0	43.4
29	-90.5	0.0	29.4
30	-88.9	0.0	22.4
31	-86.5	0.0	13.6
32	-83.2	0.0	5.6
33	-75.4	0.0	-1.2
34	-69.0	0.0	-8.2
35 (Head/Neck Junction)	-69.3	0.0	-9.7

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Glabella)	73.5	0.0	44.3
2	72.5	± 9.4	44.2
3	68.2	± 18.3	44.0
4	63.7	± 27.1	43.7
5	58.0	± 33.7	43.4
6	50.3	± 40.0	43.0
7	41.7	± 44.7	42.5
8	31.7	± 49.3	42.0
9	23.0	± 52.4	41.5
10	13.0	± 55.0	41.0
11	3.0	± 57.5	40.4
12	-7.0	± 59.7	39.8
13	-17.6	± 61.0	39.3
14	-24.5	± 60.2	38.9
15	-36.8	± 58.3	38.2
16	-46.8	± 54.4	37.6
17	-54.3	± 51.1	37.2
18	-62.9	± 46.5	36.8
19	-71.1	± 40.7	36.3
20	-77.6	± 33.9	35.9
21	-83.4	± 25.7	35.6
22	-87.5	± 15.1	35.4
23	-90.3	± 5.1	35.2
24 (Opisthocranion) ...	-90.5	0.0	35.3

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 53.1	0.0
2	4.5	± 58.5	25.7
3	6.7	± 58.5	36.4
4	8.2	± 57.8	43.6
5	10.6	± 55.8	55.5
6	12.6	± 53.3	64.9
7	14.3	± 49.2	73.1
8	16.1	± 42.7	81.8
9	17.3	± 33.5	87.8
10	18.3	± 23.2	92.8
11	18.7	± 11.5	94.6
12 (Midline)	18.8	0.0	95.0

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 53.1	0.0
2	7.0	± 51.9	-4.8
3	11.6	± 50.0	-11.8
4	16.6	± 47.7	-19.3
5	21.5	± 44.7	-26.5
6	27.0	± 40.8	-34.8
7	31.5	± 36.5	-41.5
8	35.2	± 29.8	-47.1
9	38.7	± 23.4	-52.4
10	42.1	± 15.8	-57.4
11	44.2	± 7.5	-60.5
12 (Menton)	45.0	0.0	-61.9

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

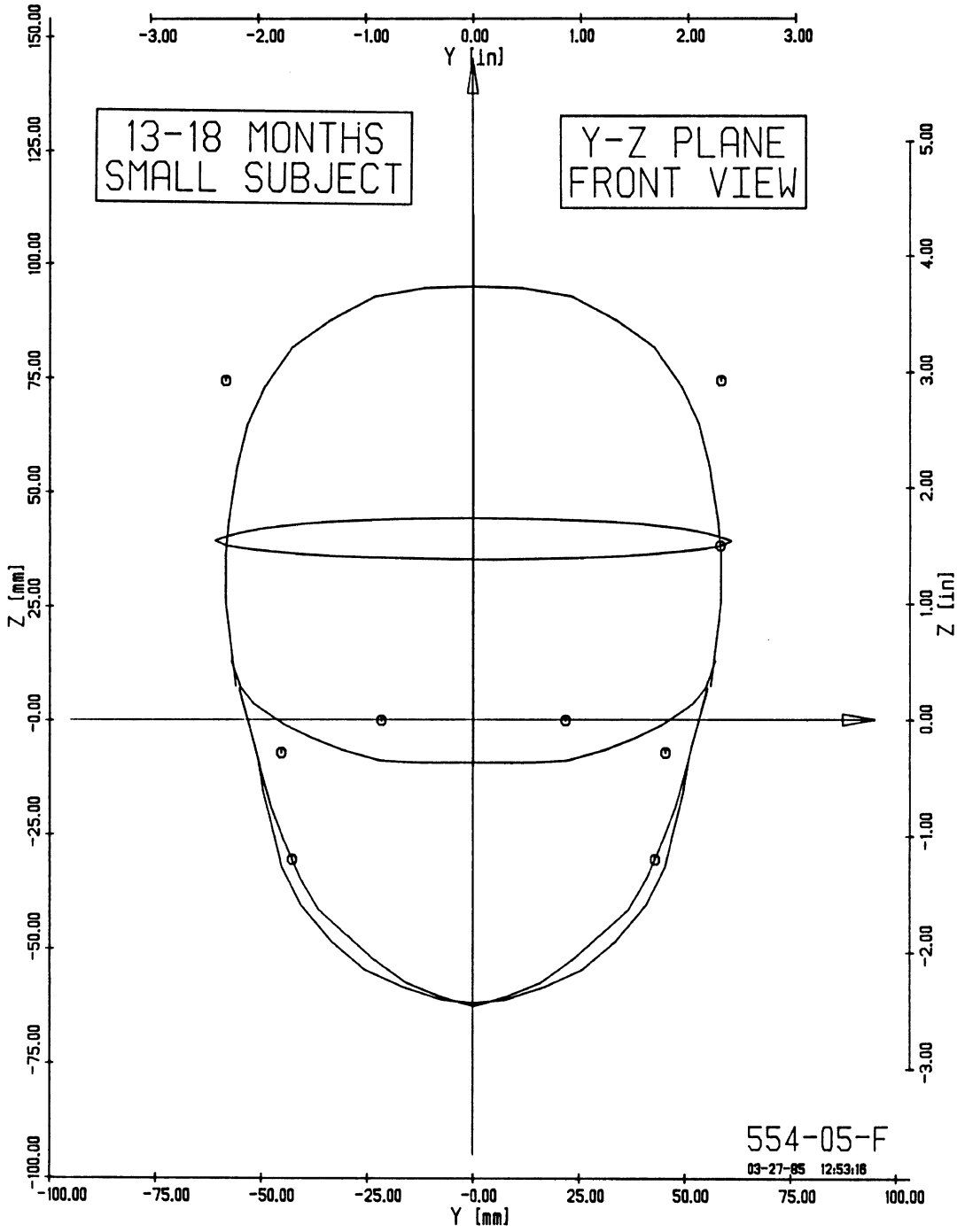
13-18 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 53.1	0.0
2	2.0	± 51.0	-8.1
3	2.9	± 49.6	-16.0
4	3.9	± 47.1	-25.2
5	4.7	± 45.3	-32.1
6	5.7	± 40.7	-40.5
7	6.6	± 33.3	-48.6
8	7.3	± 25.6	-54.6
9	7.7	± 16.7	-58.3
10	8.0	± 7.4	-61.1
11 (Midline)	8.1	0.0	-61.8

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1.	-29.7	± 57.2	13.0
2	-40.0	± 54.9	7.1
3	-46.2	± 51.7	3.5
4	-54.2	± 44.4	-1.1
5	-59.2	± 37.9	-4.0
6	-63.6	± 31.0	-6.5
7	-67.6	± 22.1	-8.8
8	-68.3	± 12.3	-9.3
9 (Head/Neck Junction)	-69.3	0.0	-9.7


13-18 MONTHS
SMALL SUBJECT
Y-Z PLANE
FRONT VIEW
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Z [in]
Z [mm]
Y [mm]
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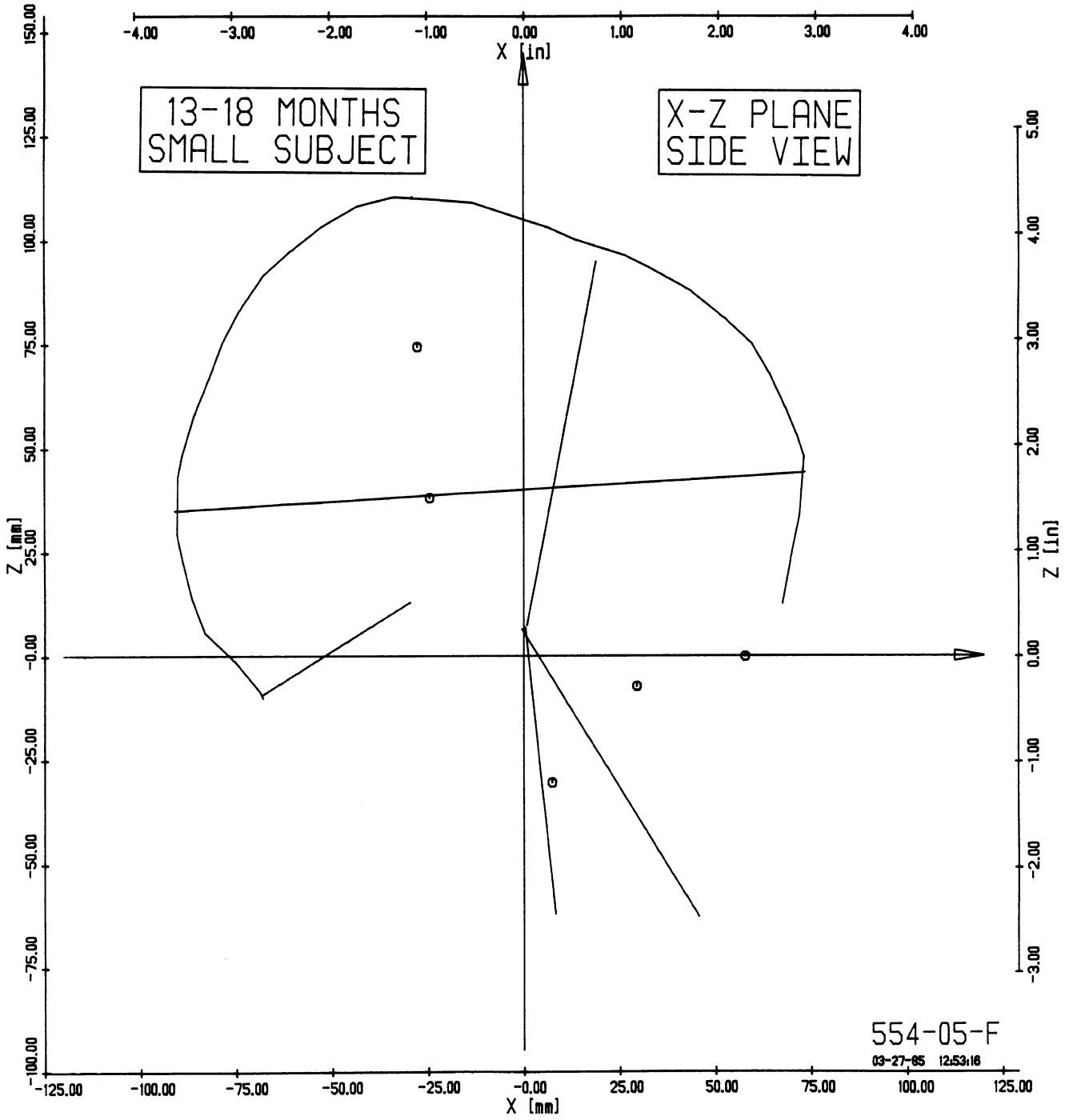
13-18 MONTHS
SMALL SUBJECT
X-Z PLANE
SIDE VIEW
X [in]
Z [mm]
Z [in]
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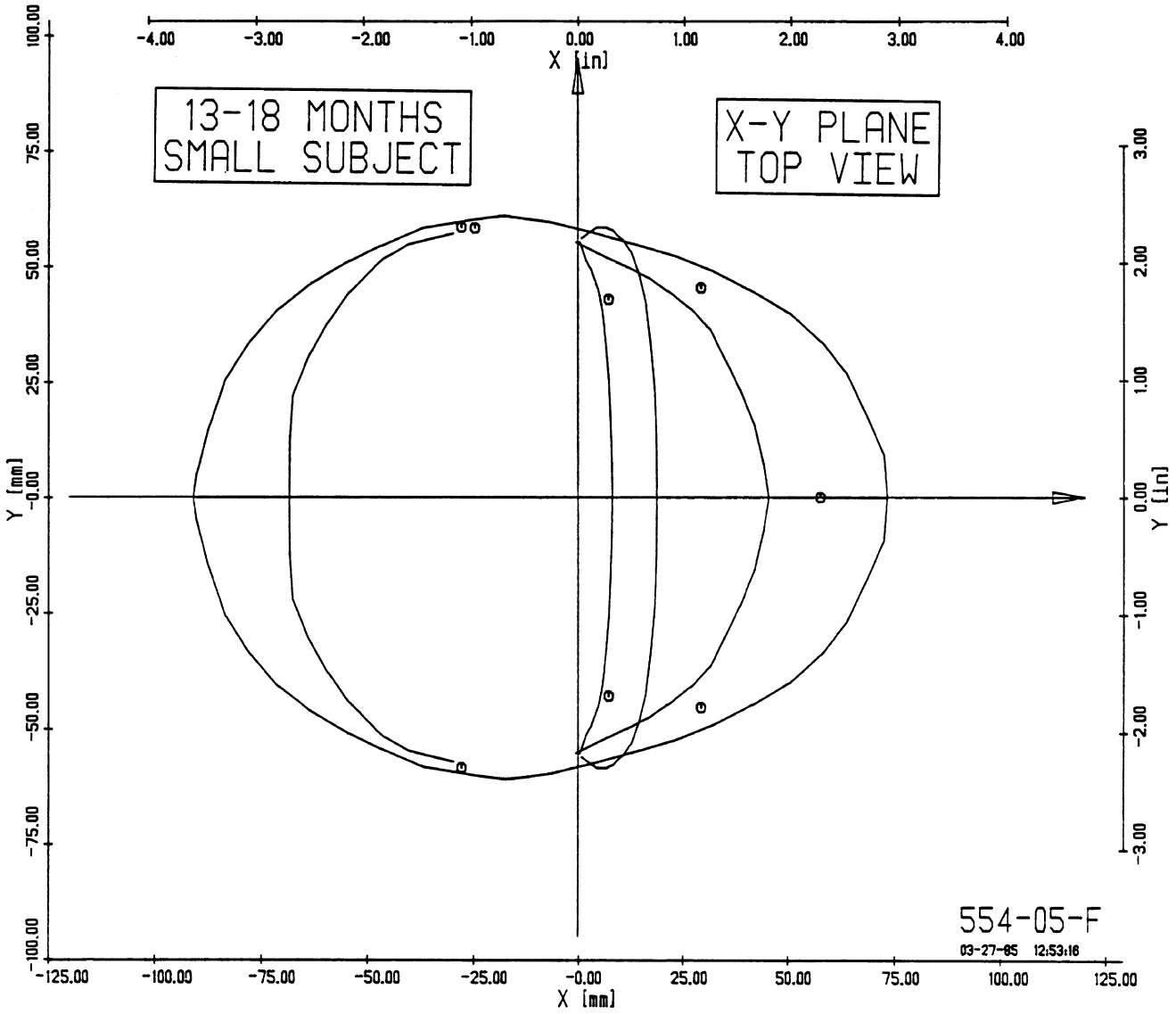
13-18 MONTHS
SMALL SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [in]
X [mm]
Y [mm]
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HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

13-18 MONTHS GROUP AVERAGE

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 57.9	0.0
2. Under Eye (Infraorbitale)	62.4	± 25.8	0.0
3. Above Nose (Sellion)	73.9	0.0	12.7
4. Forehead (Glabella)	81.2	0.0	46.0
5. Top of Head (Vertex)	-20.4	0.0	116.3
6. Back of Head (Opisthocranion)	-91.2	0.0	39.5
7. Head/Neck Junction	-70.3	0.0	-9.7
8. Tip of Chin (Menton)	53.2	0.0	-62.4
9. Upper Cheek (Zygion)	31.8	± 52.3	-1.2
10. Back of Jaw (Gonion)	13.9	± 45.0	-36.6
11. Maximum Head Breadth Point	-17.6	± 64.9	58.1
12. Head Breadth @ Circumference Point .	-19.7	± 64.7	42.1

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Sellion)	73.9	0.0	12.7
2	76.5	0.0	21.6
3	79.4	0.0	30.5
4	80.6	0.0	39.9
5	80.8	0.0	49.4
6	79.1	0.0	58.7
7	75.6	0.0	67.5
8	70.9	0.0	75.5
9	65.1	0.0	82.7
10	58.6	0.0	89.2
11	51.3	0.0	94.8
12	43.3	0.0	99.5
13	35.0	0.0	103.5
14	26.8	0.0	106.6
15	18.4	0.0	109.1
16	9.9	0.0	111.4
17	1.4	0.0	113.2
18	-7.2	0.0	114.9
19	-16.0	0.0	115.7
20	-25.6	0.0	115.4
21	-35.2	0.0	114.2
22	-44.5	0.0	111.6
23	-53.3	0.0	107.6
24	-61.5	0.0	102.4
25	-68.8	0.0	96.1
26	-75.3	0.0	88.6
27	-80.5	0.0	80.1
28	-84.6	0.0	71.1
29	-87.8	0.0	61.8
30	-90.1	0.0	52.2
31	-91.2	0.0	42.4
32	-90.7	0.0	32.8
33	-88.8	0.0	23.5
34	-85.4	0.0	14.5
35	-80.9	0.0	6.2
36	-75.9	0.0	-1.8
37 (Head/Neck Junction)	-70.3	0.0	-9.7

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Glabella)	81.2	0.0	46.0
2	80.1	± 6.6	46.1
3	78.8	± 13.1	46.1
4	76.5	± 19.4	46.0
5	73.5	± 25.4	45.9
6	69.8	± 30.9	45.7
7	65.4	± 35.9	45.5
8	60.3	± 40.1	45.3
9	54.9	± 43.7	45.1
10	49.2	± 47.0	44.9
11	43.3	± 49.8	44.7
12	37.3	± 52.4	44.5
13	31.3	± 54.8	44.2
14	25.3	± 56.9	44.0
15	19.3	± 58.8	43.8
16	13.2	± 60.6	43.5
17	7.1	± 62.2	43.3
18	0.9	± 63.5	43.1
19	-5.4	± 64.5	42.8
20	-12.0	± 65.1	42.6
21	-18.6	± 65.1	42.3
22	-25.2	± 64.6	42.1
23	-31.7	± 63.6	41.8
24	-38.2	± 62.4	41.6
25	-44.6	± 60.6	41.3
26	-51.1	± 58.2	41.1
27	-57.4	± 55.4	40.9
28	-63.4	± 52.0	40.6
29	-69.1	± 48.1	40.4
30	-74.2	± 43.5	40.2
31	-78.9	± 38.4	40.0
32	-82.9	± 32.8	39.9
33	-86.1	± 26.7	39.8
34	-88.5	± 20.3	39.7
35	-90.3	± 13.6	39.6
36	-91.3	± 6.9	39.6
37 (Opisthocranion) ...	-91.2	0.0	39.5

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 57.9	0.0
2	4.6	± 58.6	8.3
3	5.9	± 59.9	16.1
4	7.1	± 61.1	23.8
5	8.3	± 61.9	31.4
6	9.4	± 62.0	38.9
7	10.6	± 61.6	46.4
8	11.8	± 60.7	54.3
9	13.1	± 59.4	62.0
10	14.3	± 57.5	69.7
11	15.5	± 54.5	77.4
12	16.6	± 50.4	84.5
13	17.6	± 45.2	90.9
14	18.5	± 38.9	96.5
15	19.1	± 31.8	101.0
16	19.7	± 24.1	104.3
17	20.1	± 16.3	106.8
18	20.3	± 8.2	108.3
19 (Midline)	20.4	0.0	109.1

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 57.9	0.0
2	7.2	± 56.0	-3.8
3	10.7	± 54.7	-8.3
4	14.3	± 53.5	-12.9
5	17.8	± 52.3	-17.3
6	21.2	± 51.0	-21.7
7	24.7	± 49.7	-26.1
8	28.2	± 48.1	-30.6
9	31.7	± 46.2	-35.0
10	34.9	± 43.5	-39.2
11	38.1	± 40.4	-43.3
12	41.0	± 36.5	-46.9
13	43.6	± 32.1	-50.2
14	46.0	± 27.4	-53.3
15	48.2	± 22.5	-56.1
16	50.1	± 17.3	-58.5
17	51.6	± 11.8	-60.5
18	52.7	± 6.0	-61.8
19 (Menton)	53.2	0.0	-62.4

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

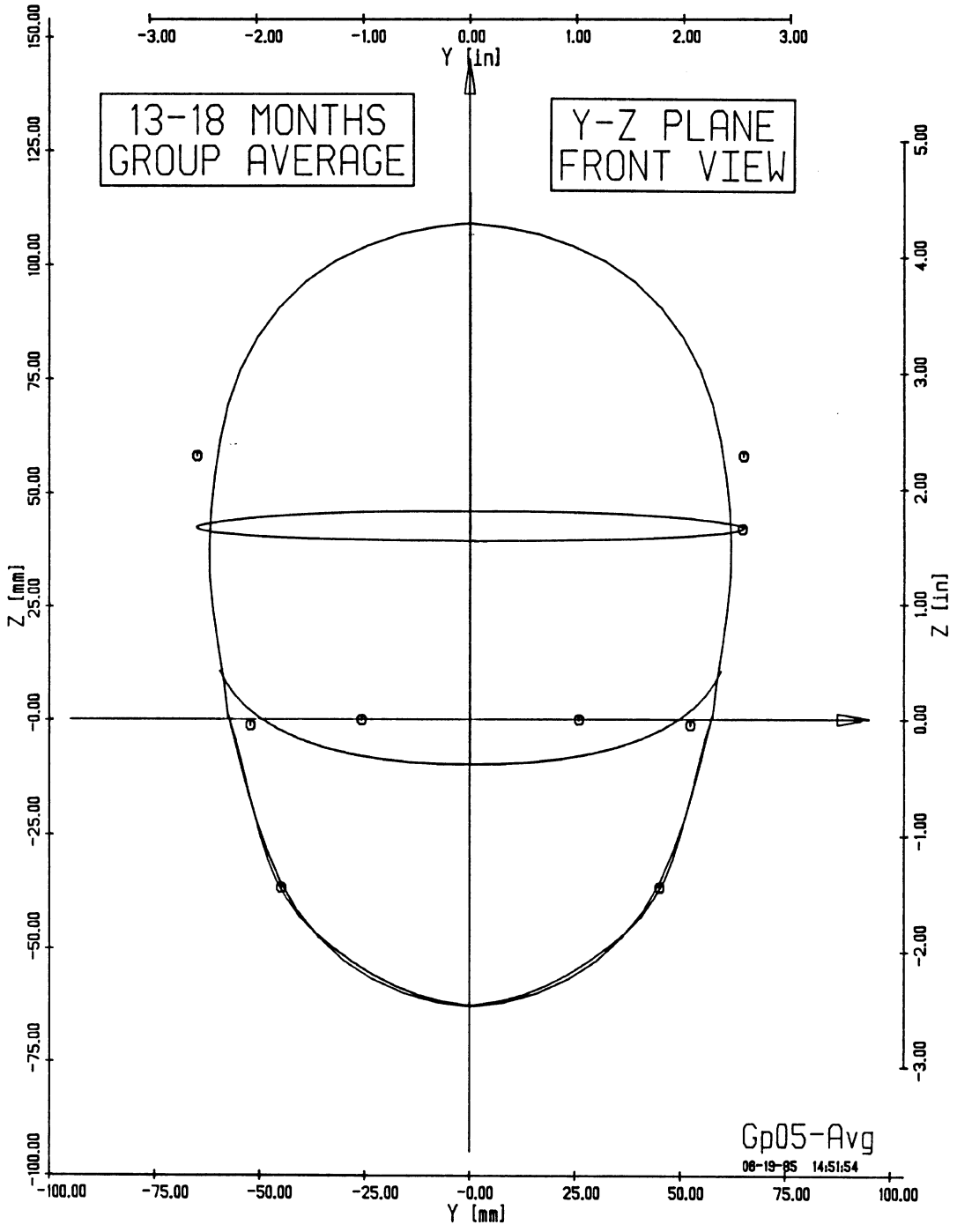
13-18 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 57.9	0.0
2	5.0	± 55.5	-6.7
3	6.2	± 53.4	-14.1
4	7.3	± 51.1	-21.3
5	8.5	± 48.4	-28.3
6	9.6	± 45.1	-35.3
7	10.7	± 41.0	-41.9
8	11.6	± 35.8	-47.8
9	12.4	± 29.8	-52.9
10	13.1	± 23.0	-56.9
11	13.6	± 15.5	-60.0
12	13.9	± 7.9	-61.9
13 (Midline)	14.1	0.0	-62.9

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1.	-24.3	± 59.6	10.7
2	-30.7	± 57.9	7.9
3	-36.9	± 55.7	5.1
4	-42.9	± 52.9	2.5
5	-48.5	± 49.4	-0.0
6	-53.8	± 45.1	-2.3
7	-58.5	± 40.1	-4.4
8	-62.5	± 34.4	-6.2
9	-65.6	± 28.0	-7.6
10	-67.9	± 21.3	-8.6
11	-69.5	± 14.3	-9.3
12	-70.3	± 7.1	-9.7
13 (Head/Neck Junction)	-70.3	0.0	-9.7


13-18 MONTHS
GROUP AVERAGE
Y-Z PLANE
FRONT VIEW
Y [in]
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
Z [mm]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [in]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Y [mm]
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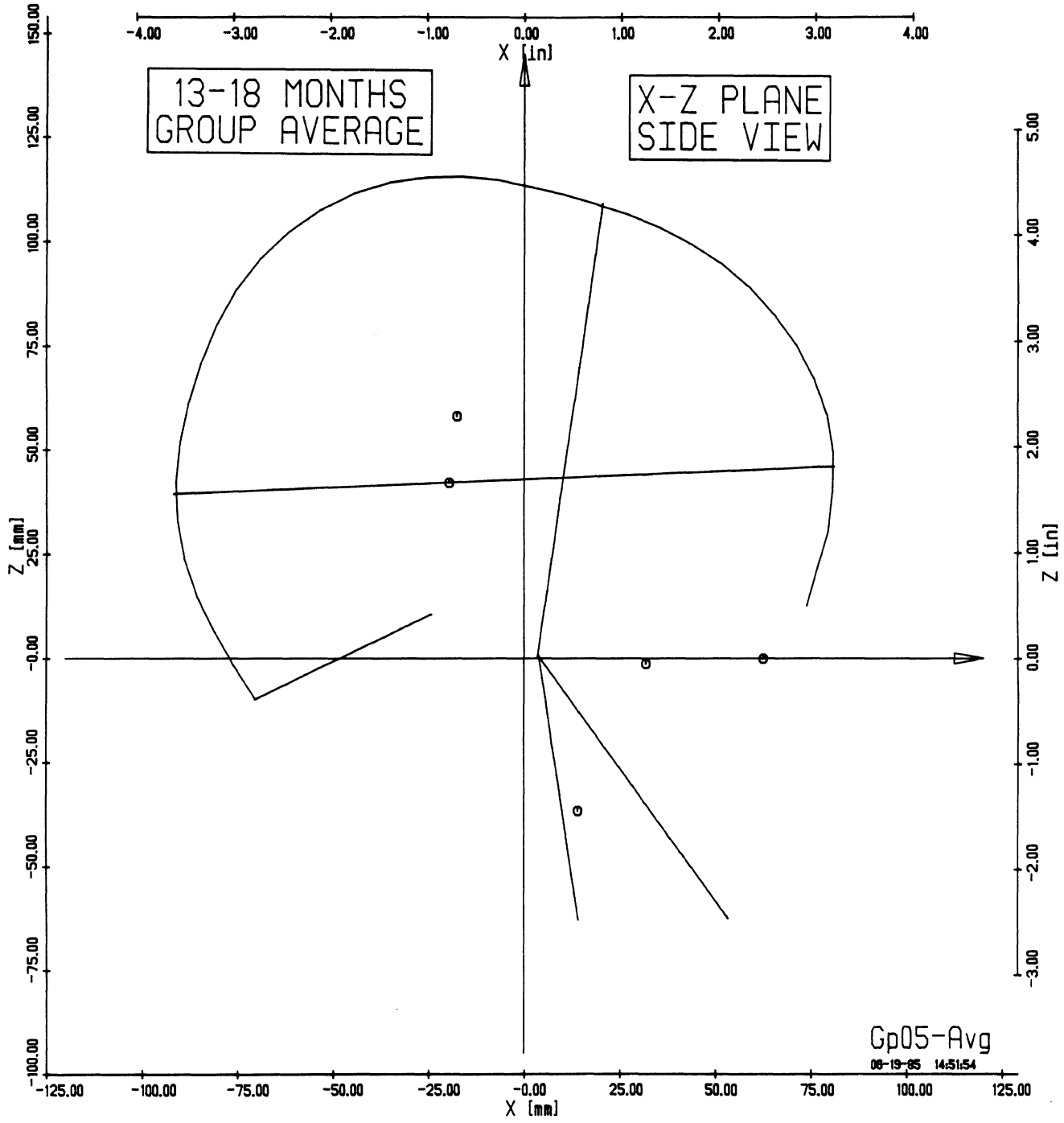
13-18 MONTHS
GROUP AVERAGE
X-Z PLANE
SIDE VIEW
X [in]
Z [mm]
Z [in]
X [mm]
Gp05-Avg
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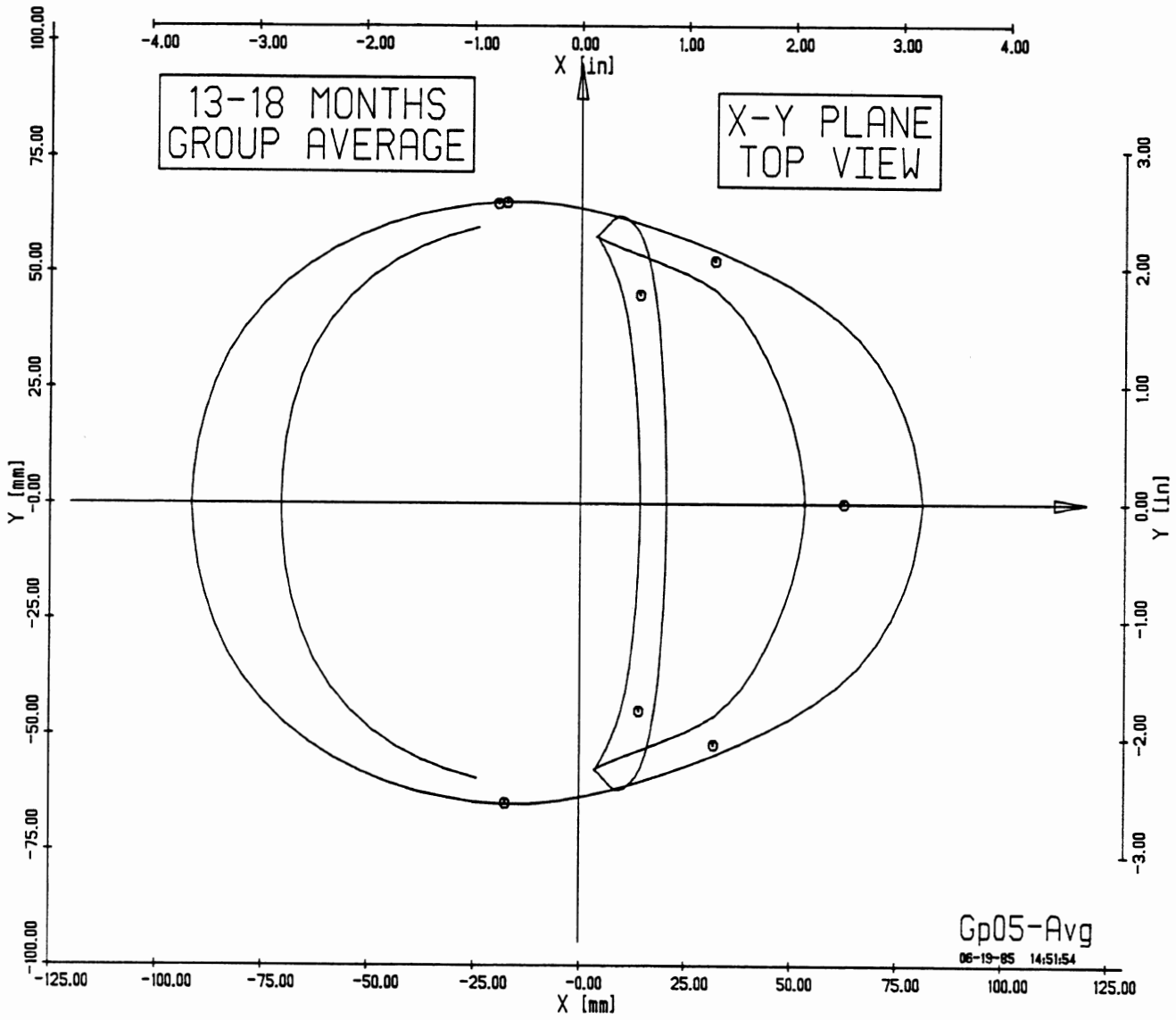
13-18 MONTHS
GROUP AVERAGE
X-Y PLANE
TOP VIEW
X [in]
Y [in]
X [mm]
Y [mm]
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HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

13-18 MONTHS LARGE SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 63.1	0.0
2. Under Eye (Infraorbitale)	69.1	± 26.0	0.0
3. Above Nose (Sellion)	82.1	0.0	9.7
4. Forehead (Glabella)	91.4	0.0	43.3
5. Top of Head (Vertex)	-16.4	0.0	126.8
6. Back of Head (Opisthocranion)	-87.5	0.0	40.8
7. Head/Neck Junction	-65.8	0.0	-12.3
8. Tip of Chin (Menton)	54.5	0.0	-67.9
9. Upper Cheek (Zygion)	37.1	± 56.6	-0.1
10. Back of Jaw (Gonion)	12.8	± 46.8	-33.6
11. Maximum Head Breadth Point	-6.0	± 68.8	70.7
12. Head Breadth @ Circumference Point .	-12.3	± 66.0	42.0

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Sellion)	82.1	0.0	9.7
2	84.3	0.0	21.3
3	87.6	0.0	29.4
4	90.2	0.0	36.4
5	92.9	0.0	49.0
6	93.1	0.0	56.8
7	90.3	0.0	65.4
8	86.1	0.0	73.6
9	81.0	0.0	83.3
10	73.9	0.0	91.7
11	65.8	0.0	99.5
12	58.9	0.0	104.5
13	50.3	0.0	109.5
14	44.1	0.0	113.1
15	29.8	0.0	118.3
16	21.1	0.0	121.6
17	12.5	0.0	124.5
18	4.1	0.0	125.4
19	-7.2	0.0	126.8
20	-16.5	0.0	126.7
21	-27.9	0.0	126.1
22	-40.4	0.0	122.7
23	-50.2	0.0	116.5
24	-56.7	0.0	110.3
25	-65.5	0.0	102.4
26	-71.0	0.0	94.4
27	-75.7	0.0	86.0
28	-80.4	0.0	76.3
29	-83.3	0.0	66.0
30	-85.7	0.0	56.4
31	-86.8	0.0	48.2
32	-87.0	0.0	33.8
33	-85.0	0.0	26.4
34	-81.0	0.0	16.4
35	-77.2	0.0	7.2
36	-74.7	0.0	-1.6
37 (Head/Neck Junction)	-65.8	0.0	-12.3

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Glabella)	91.4	0.0	43.3
2	91.0	± 7.0	43.6
3	89.2	± 15.8	43.6
4	85.5	± 26.8	43.5
5	80.3	± 34.3	43.4
6	74.4	± 40.6	43.4
7	65.1	± 47.0	43.2
8	56.7	± 51.2	43.1
9	46.7	± 55.5	43.0
10	35.2	± 59.5	42.8
11	24.8	± 63.0	42.7
12	16.0	± 65.2	42.5
13	7.5	± 67.2	42.4
14	-2.5	± 68.1	42.3
15	-12.2	± 68.1	42.2
16	-23.8	± 66.0	42.0
17	-33.9	± 63.4	41.9
18	-43.0	± 59.8	41.7
19	-52.8	± 54.7	41.6
20	-61.3	± 48.7	41.5
21	-68.3	± 42.5	41.4
22	-76.7	± 32.9	41.3
23	-81.7	± 24.5	41.2
24	-85.0	± 16.2	41.1
25	-87.6	± 5.9	41.1
26 (Opisthocranion) ...	-87.5	0.0	40.8

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 63.1	0.0
2	5.1	± 63.5	15.2
3	7.9	± 64.7	24.3
4	11.2	± 65.2	34.8
5	14.0	± 64.8	43.6
6	17.2	± 63.5	54.0
7	19.9	± 62.8	62.9
8	22.6	± 60.8	71.4
9	25.6	± 57.4	81.3
10	28.6	± 51.9	90.9
11	31.1	± 44.6	98.8
12	33.0	± 36.9	104.9
13	34.2	± 29.3	108.8
14	35.4	± 20.2	112.6
15	36.2	± 10.1	115.2
16 (Midline)	36.4	0.0	115.9

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 63.1	0.0
2	6.2	± 57.2	-7.3
3	12.6	± 54.5	-15.2
4	18.9	± 51.6	-23.1
5	24.8	± 49.7	-30.5
6	30.6	± 48.1	-37.8
7	36.9	± 45.0	-45.6
8	41.3	± 38.2	-51.2
9	45.5	± 30.8	-56.4
10	49.2	± 20.5	-61.1
11	53.1	± 10.3	-65.9
12 (Menton)	54.5	0.0	-67.9

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

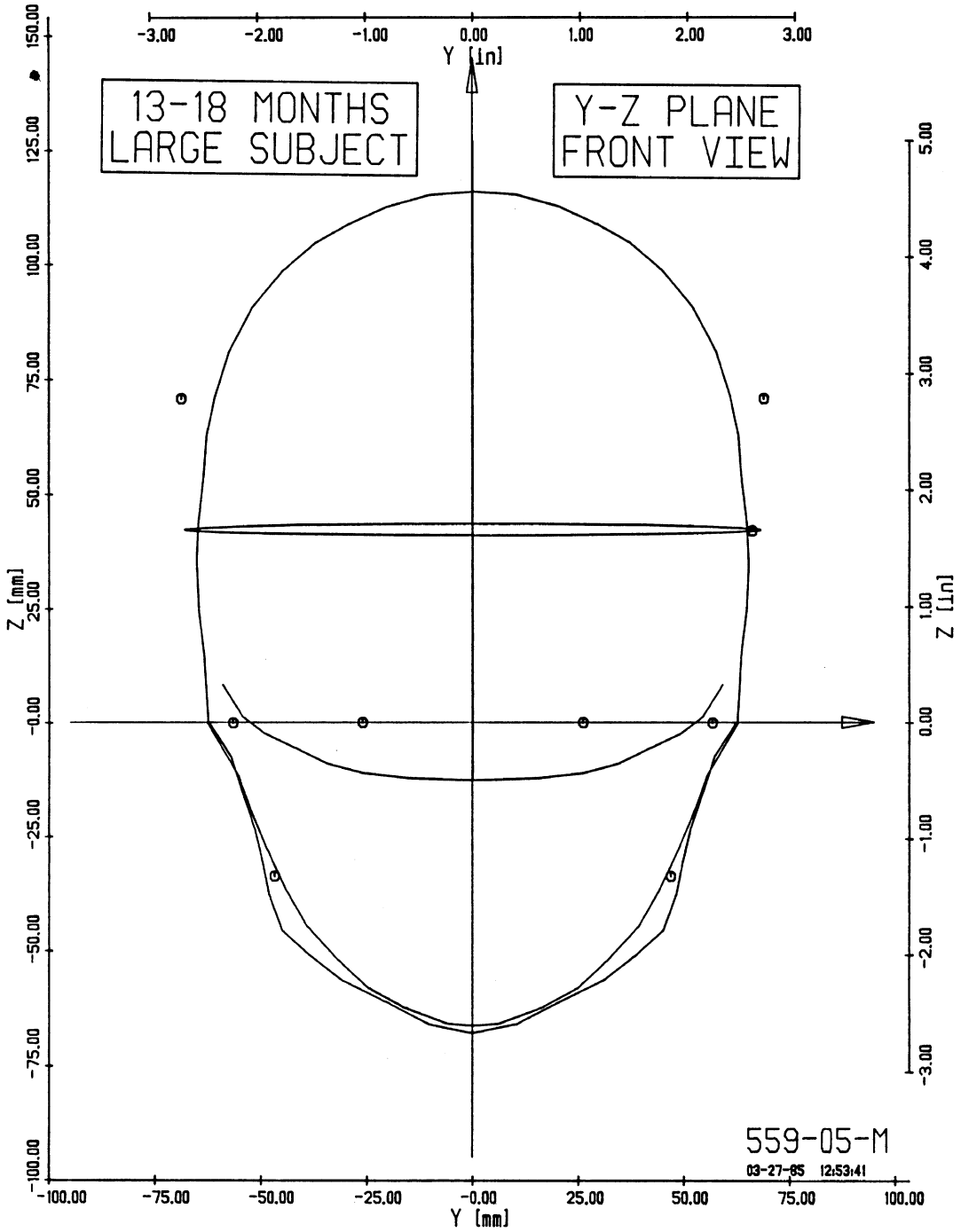
13-18 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 63.1	0.0
2	4.2	± 55.5	-11.4
3	6.7	± 52.6	-18.9
4	9.6	± 48.6	-27.8
5	12.7	± 43.9	-37.0
6	15.2	± 39.1	-44.7
7	17.7	± 31.7	-52.1
8	19.6	± 24.6	-58.1
9	21.0	± 15.9	-62.4
10	22.1	± 6.1	-65.7
11 (Midline)	22.3	0.0	-66.2

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

13-18 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1.	-26.8	± 59.1	8.4
2	-39.9	± 54.3	1.3
3	-46.9	± 49.1	-2.4
4	-52.7	± 41.9	-5.6
5	-58.9	± 34.2	-9.0
6	-62.6	± 25.9	-11.0
7	-64.6	± 15.1	-12.1
8	-65.2	± 5.4	-12.4
9 (Head/Neck Junction)	-65.8	0.0	-12.3


13-18 MONTHS
LARGE SUBJECT
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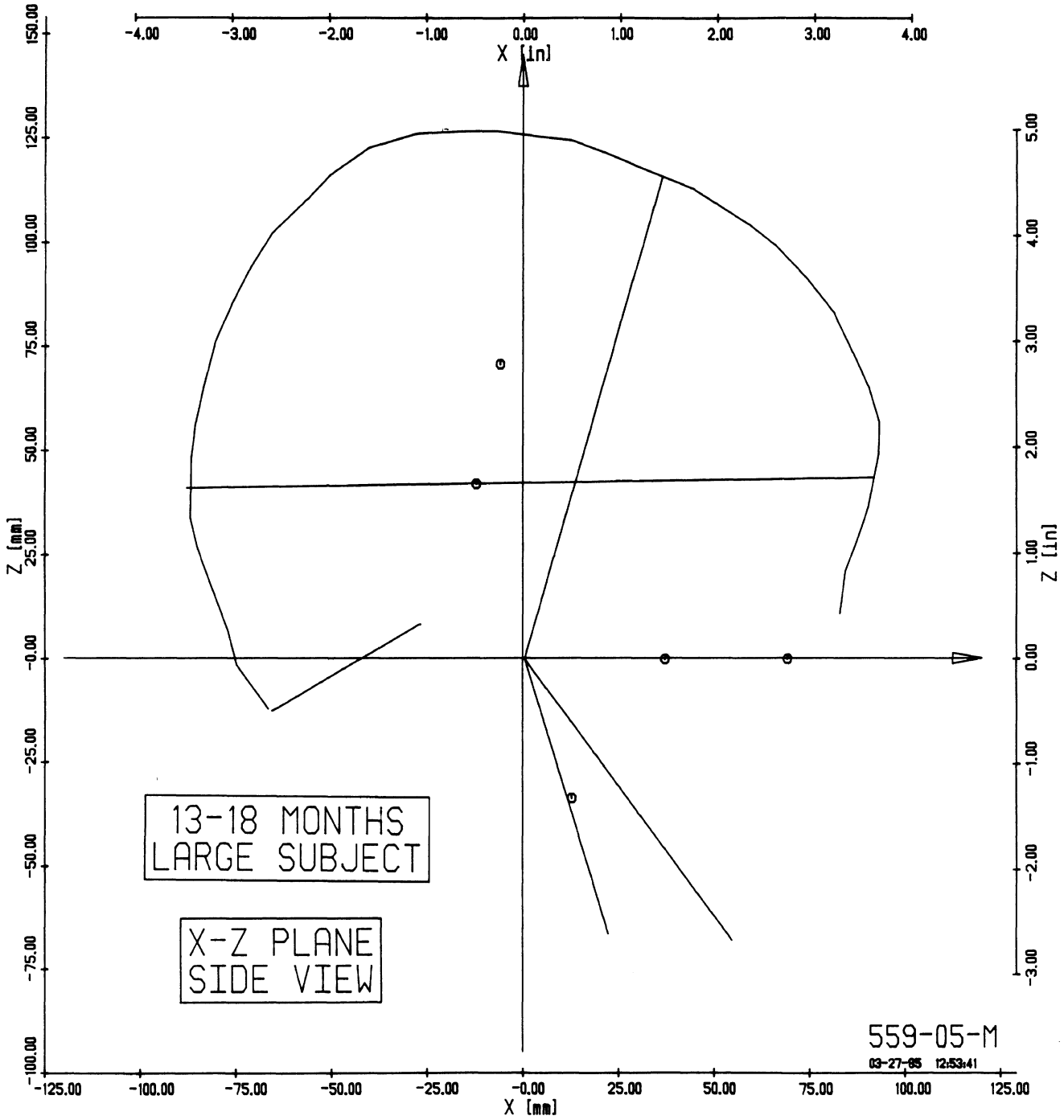
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13-18 MONTHS
LARGE SUBJECT
X-Z PLANE
SIDE VIEW
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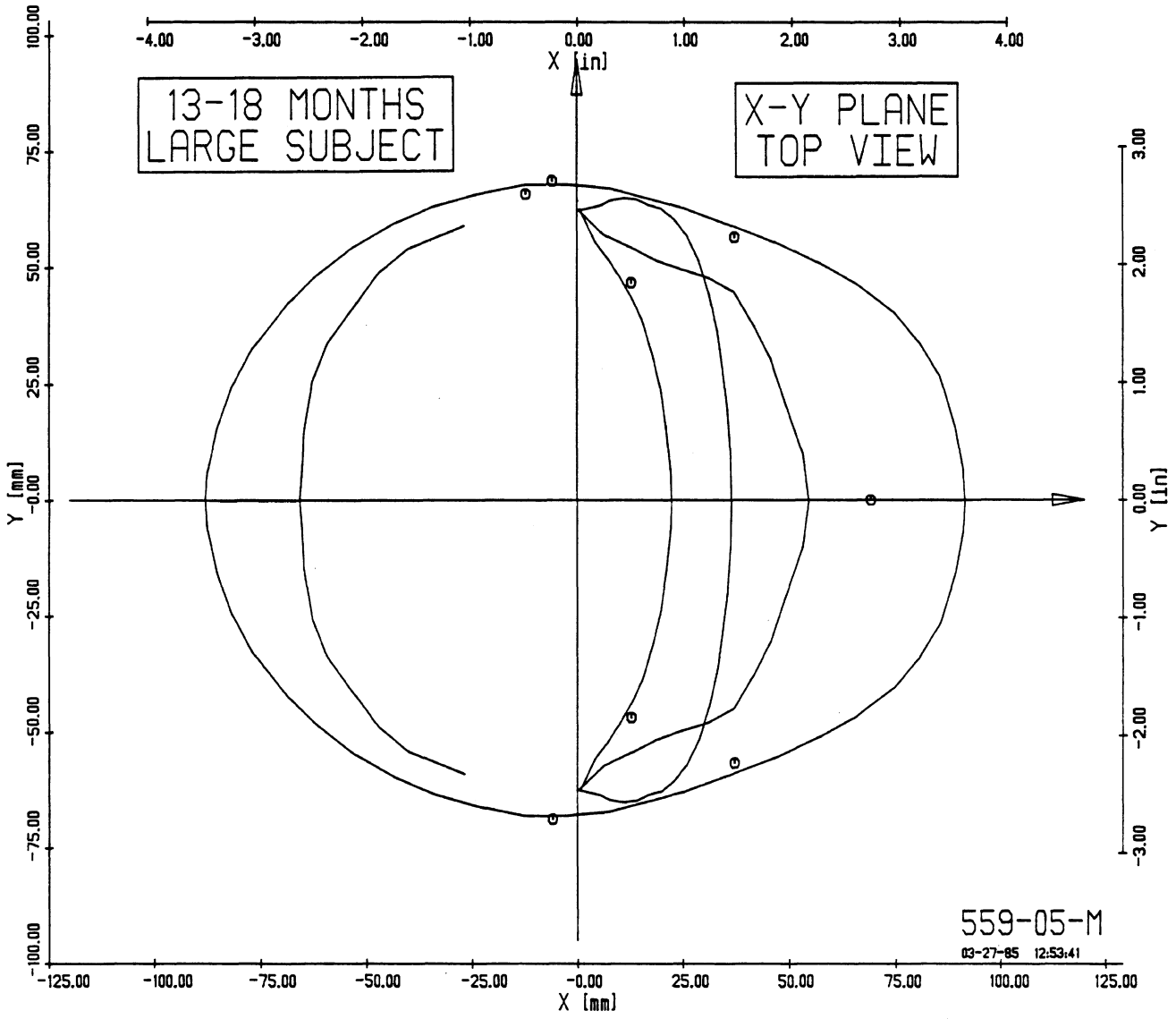
13-18 MONTHS
LARGE SUBJECT
X-Y PLANE
TOP VIEW
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HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

25-30 MONTHS SMALL SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 53.7	0.0
2. Under Eye (Infraorbitale)	62.2	± 22.2	0.1
3. Above Nose (Sellion)	75.3	0.0	15.2
4. Forehead (Glabella)	81.7	0.0	36.6
5. Top of Head (Vertex)	-19.5	0.0	114.9
6. Back of Head (Opisthocranion)	-86.6	0.0	47.3
7. Head/Neck Junction	-68.0	0.0	-8.3
8. Tip of Chin (Menton)	55.2	0.0	-59.7
9. Upper Cheek (Zygion)	32.3	± 46.8	-4.1
10. Back of Jaw (Gonion)	8.1	± 37.5	-40.7
11. Maximum Head Breadth Point	-24.4	± 62.3	66.2
12. Head Breadth @ Circumference Point .	-12.0	± 58.5	40.9

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Sellion)	75.3	0.0	15.2
2	79.8	0.0	25.5
3	82.0	0.0	46.3
4	80.2	0.0	53.9
5	75.0	0.0	66.1
6	67.1	0.0	78.6
7	55.5	0.0	90.7
8	42.3	0.0	99.9
9	28.1	0.0	105.5
10	7.6	0.0	110.4
11	-7.3	0.0	113.2
12	-20.0	0.0	115.2
13	-37.3	0.0	112.6
14	-51.9	0.0	107.5
15	-63.0	0.0	97.7
16	-73.0	0.0	85.3
17	-81.0	0.0	71.3
18	-84.7	0.0	56.0
19	-86.6	0.0	39.4
20	-85.0	0.0	26.5
21	-78.3	0.0	12.7
22 (Head/Neck Junction)	-68.0	0.0	-8.3

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Glabella)	81.7	0.0	36.6
2	80.4	± 6.5	36.0
3	77.4	± 13.1	36.2
4	71.8	± 25.9	36.6
5	62.8	± 34.9	37.2
6	50.2	± 42.5	38.0
7	35.9	± 48.4	39.0
8	21.0	± 53.6	40.0
9	6.8	± 58.5	40.9
10	-12.1	± 62.7	42.2
11	-22.9	± 61.5	42.9
12	-38.7	± 58.9	44.0
13	-55.6	± 51.5	45.1
14	-67.2	± 43.3	45.9
15	-76.2	± 31.5	46.5
16	-83.2	± 17.6	47.0
17	-86.0	± 4.8	47.2
18 (Opisthocranion) ...	-86.6	0.0	47.3

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 53.7	0.0
2	7.2	± 55.4	20.4
3	8.6	± 56.0	34.5
4	9.8	± 56.5	46.8
5	11.3	± 54.7	61.8
6	12.7	± 50.8	76.1
7	14.4	± 40.2	92.7
8	15.3	± 26.4	101.9
9	15.8	± 12.1	107.5
10 (Midline)	16.0	0.0	109.1

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 53.7	0.0
2	21.8	± 44.8	-18.8
3	29.4	± 41.8	-29.8
4	37.8	± 36.5	-41.8
5	43.7	± 27.3	-50.3
6	47.6	± 17.8	-55.9
7	49.6	± 9.0	-58.8
8 (Menton)	55.2	0.0	-59.7

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

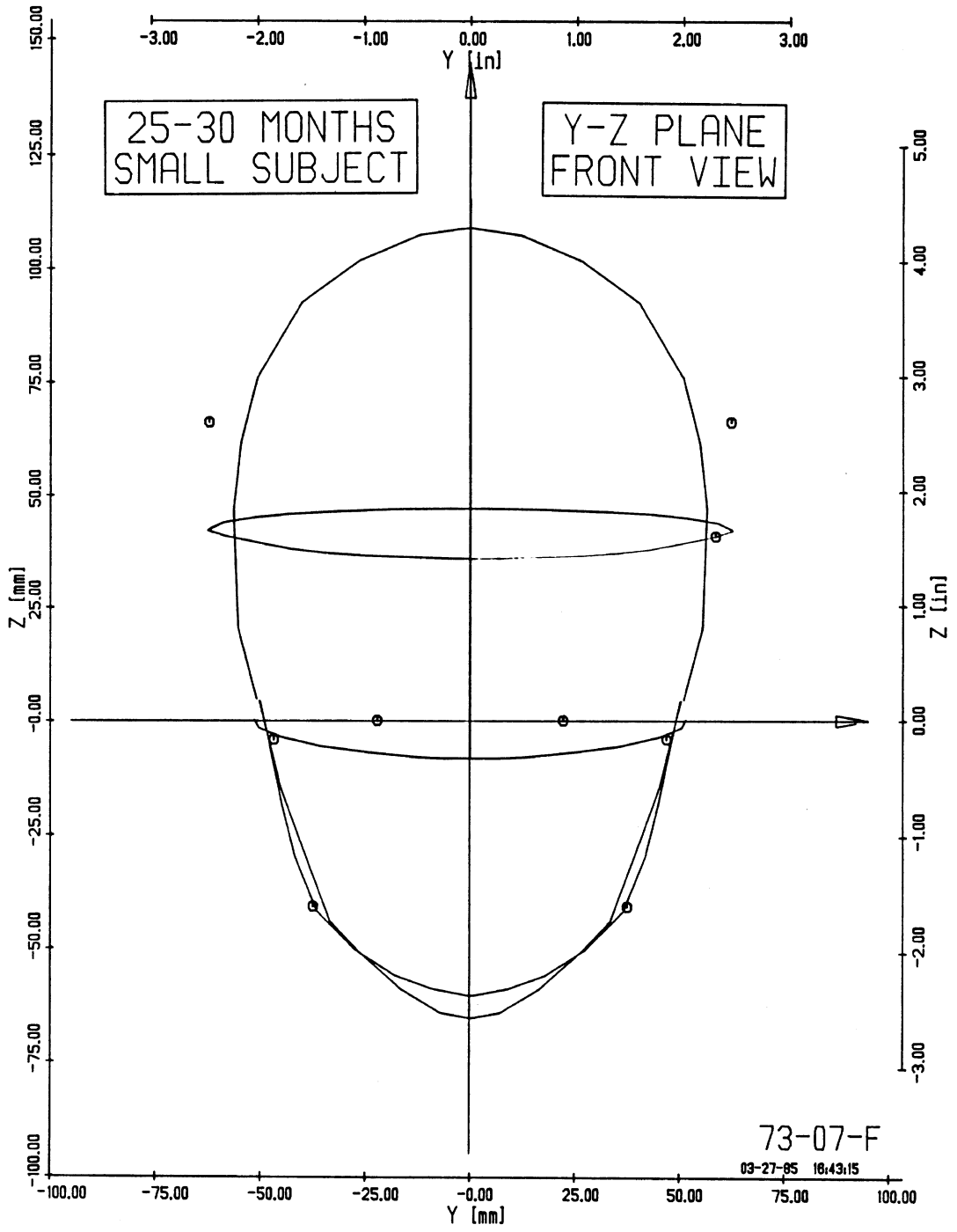
25-30 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 53.7	0.0
2	7.4	± 45.2	-14.6
3	8.4	± 40.5	-26.5
4	9.8	± 33.4	-44.0
5	10.4	± 26.2	-50.9
6	11.1	± 16.3	-59.0
7	11.5	± 7.1	-64.1
8 (Midline)	11.6	0.0	-65.3

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1.	-24.8	± 51.5	0.3
2	-33.9	± 50.4	-1.5
3	-44.5	± 44.8	-3.6
4	-54.8	± 35.6	-5.6
5	-61.3	± 24.4	-6.9
6	-66.5	± 13.3	-7.9
7	-68.4	± 6.2	-8.3
8 (Head/Neck Junction)	-68.0	0.0	-8.3


25-30 MONTHS
SMALL SUBJECT
Y-Z PLANE
FRONT VIEW
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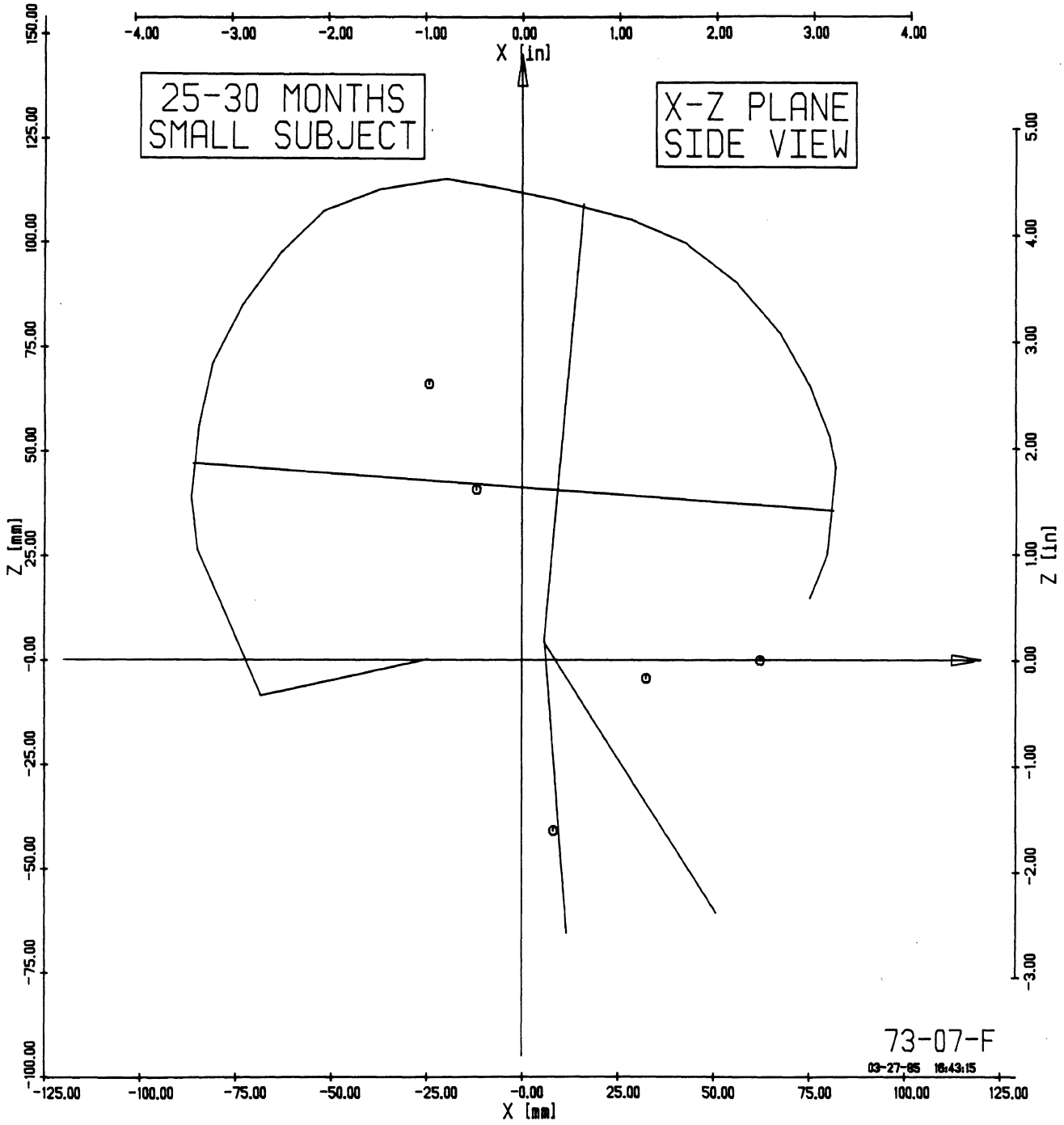
25-30 MONTHS
SMALL SUBJECT
X-Z PLANE
SIDE VIEW
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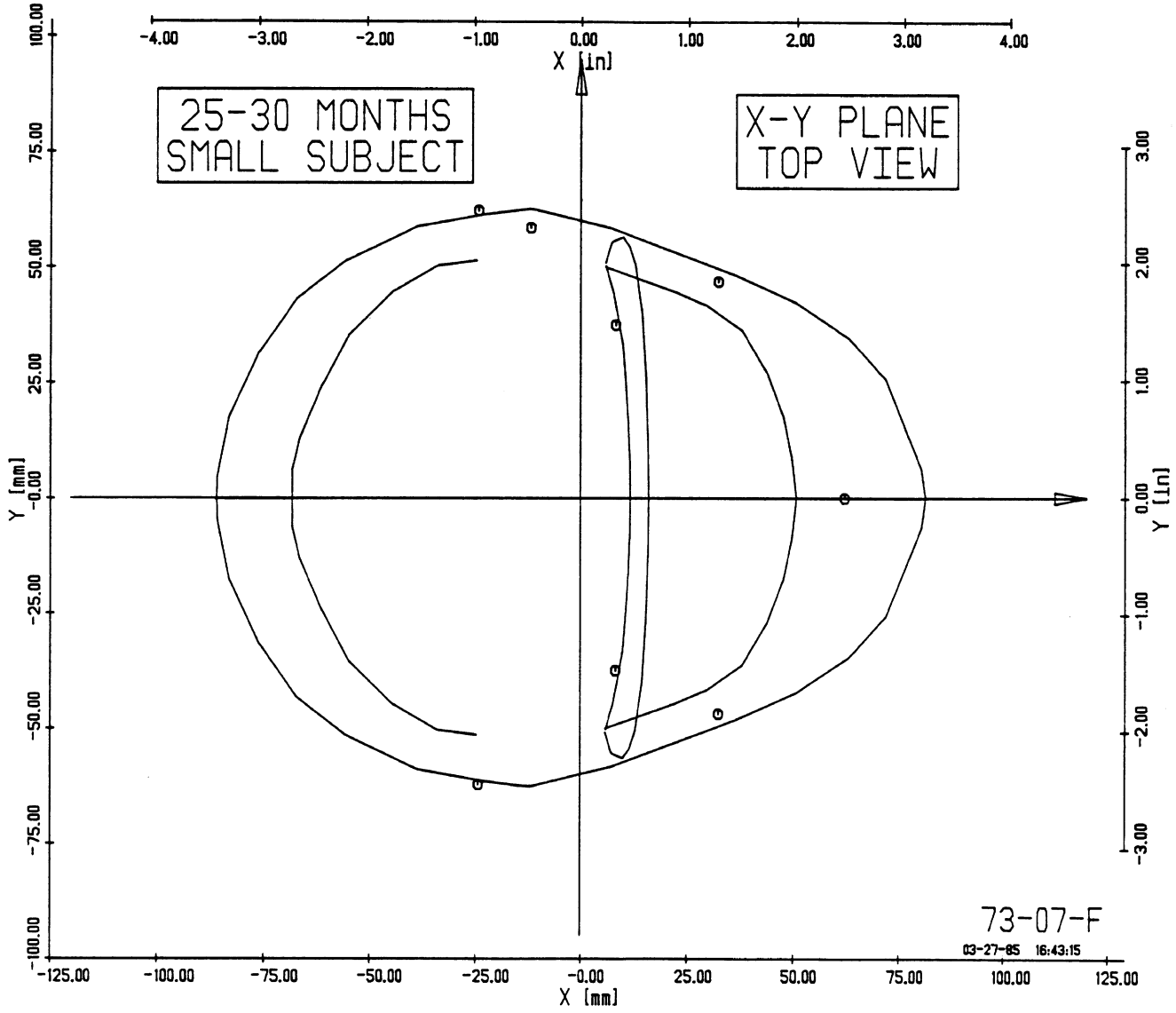
25-30 MONTHS
SMALL SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [in]
X [mm]
Y [mm]
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HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

25-30 MONTHS GROUP AVERAGE

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 58.4	0.0
2. Under Eye (Infraorbitale)	66.6	± 26.8	0.0
3. Above Nose (Sellion)	78.6	0.0	13.5
4. Forehead (Glabella)	87.1	0.0	45.4
5. Top of Head (Vertex)	-18.9	0.0	122.7
6. Back of Head (Opisthocranion)	-94.0	0.0	43.5
7. Head/Neck Junction	-68.4	0.0	-12.9
8. Tip of Chin (Menton)	55.7	0.0	-65.8
9. Upper Cheek (Zygion)	33.3	± 53.1	-0.3
10. Back of Jaw (Gonion)	11.9	± 44.3	-38.0
11. Maximum Head Breadth Point	-20.0	± 67.3	72.9
12. Head Breadth @ Circumference Point .	-20.4	± 66.5	44.4

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Sellion)	78.6	0.0	13.5
2	81.8	0.0	22.5
3	85.0	0.0	32.1
4	86.6	0.0	42.1
5	86.9	0.0	52.3
6	85.0	0.0	62.4
7	81.1	0.0	71.8
8	76.0	0.0	80.2
9	69.8	0.0	87.9
10	62.8	0.0	94.8
11	55.0	0.0	100.8
12	46.6	0.0	106.0
13	37.7	0.0	110.2
14	28.9	0.0	113.5
15	20.0	0.0	116.2
16	10.9	0.0	118.6
17	1.8	0.0	120.6
18	-7.5	0.0	122.2
19	-16.9	0.0	122.8
20	-27.2	0.0	122.3
21	-37.4	0.0	120.4
22	-47.2	0.0	117.2
23	-56.4	0.0	112.5
24	-64.9	0.0	106.6
25	-72.4	0.0	99.5
26	-79.0	0.0	91.2
27	-84.5	0.0	82.1
28	-88.9	0.0	72.5
29	-92.0	0.0	62.3
30	-93.7	0.0	51.8
31	-94.0	0.0	41.1
32	-92.5	0.0	31.1
33	-89.7	0.0	21.3
34	-85.3	0.0	12.1
35	-80.2	0.0	3.3
36	-74.8	0.0	-5.3
37 (Head/Neck Junction)	-68.4	0.0	-12.9

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Glabella)	87.1	0.0	45.4
2	85.8	± 6.8	45.4
3	84.1	± 13.4	45.4
4	81.6	± 19.9	45.3
5	78.4	± 26.0	45.3
6	74.3	± 31.6	45.3
7	69.5	± 36.5	45.2
8	64.2	± 40.7	45.2
9	58.5	± 44.3	45.1
10	52.6	± 47.6	45.1
11	46.5	± 50.5	45.0
12	40.3	± 53.1	45.0
13	33.9	± 55.4	44.9
14	27.8	± 57.6	44.9
15	21.6	± 59.8	44.8
16	15.3	± 61.8	44.8
17	9.0	± 63.4	44.7
18	2.6	± 64.8	44.7
19	-3.9	± 65.8	44.6
20	-10.8	± 66.5	44.6
21	-17.7	± 66.7	44.5
22	-24.6	± 66.3	44.4
23	-31.4	± 65.5	44.4
24	-38.2	± 64.2	44.3
25	-44.9	± 62.4	44.3
26	-51.6	± 59.9	44.2
27	-58.1	± 56.9	44.2
28	-64.4	± 53.5	44.1
29	-70.4	± 49.6	44.1
30	-76.0	± 45.0	44.0
31	-80.9	± 39.8	44.0
32	-85.2	± 34.0	43.9
33	-88.6	± 27.7	43.9
34	-91.3	± 21.1	43.9
35	-93.2	± 14.2	43.9
36	-94.3	± 7.1	43.9
37 (Opisthocranion) ...	-94.0	0.0	43.5

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 58.4	0.0
2	5.0	± 58.9	9.3
3	6.6	± 60.5	17.2
4	8.1	± 61.9	25.2
5	9.6	± 62.7	32.9
6	11.2	± 62.8	40.7
7	12.7	± 62.5	48.4
8	14.2	± 61.7	56.5
9	15.8	± 60.5	64.5
10	17.3	± 58.7	72.4
11	18.9	± 55.8	80.5
12	20.3	± 51.7	87.9
13	21.6	± 46.4	94.6
14	22.8	± 40.0	100.5
15	23.7	± 32.8	105.3
16	24.4	± 25.0	109.1
17	25.0	± 16.9	111.8
18	25.3	± 8.5	113.5
19 (Midline)	25.5	0.0	114.4

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 58.4	0.0
2	8.2	± 57.0	-4.4
3	11.0	± 55.0	-8.0
4	14.6	± 53.6	-12.7
5	18.0	± 52.0	-17.2
6	21.5	± 50.4	-21.6
7	24.9	± 48.9	-26.0
8	28.4	± 47.2	-30.5
9	31.9	± 45.2	-35.1
10	35.3	± 42.8	-39.4
11	38.5	± 39.7	-43.6
12	41.5	± 35.9	-47.5
13	44.3	± 31.7	-51.1
14	46.8	± 27.2	-54.4
15	49.3	± 22.5	-57.7
16	51.6	± 17.5	-60.5
17	53.3	± 11.9	-62.8
18	54.6	± 6.1	-64.5
19 (Menton)	55.7	0.0	-65.8

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

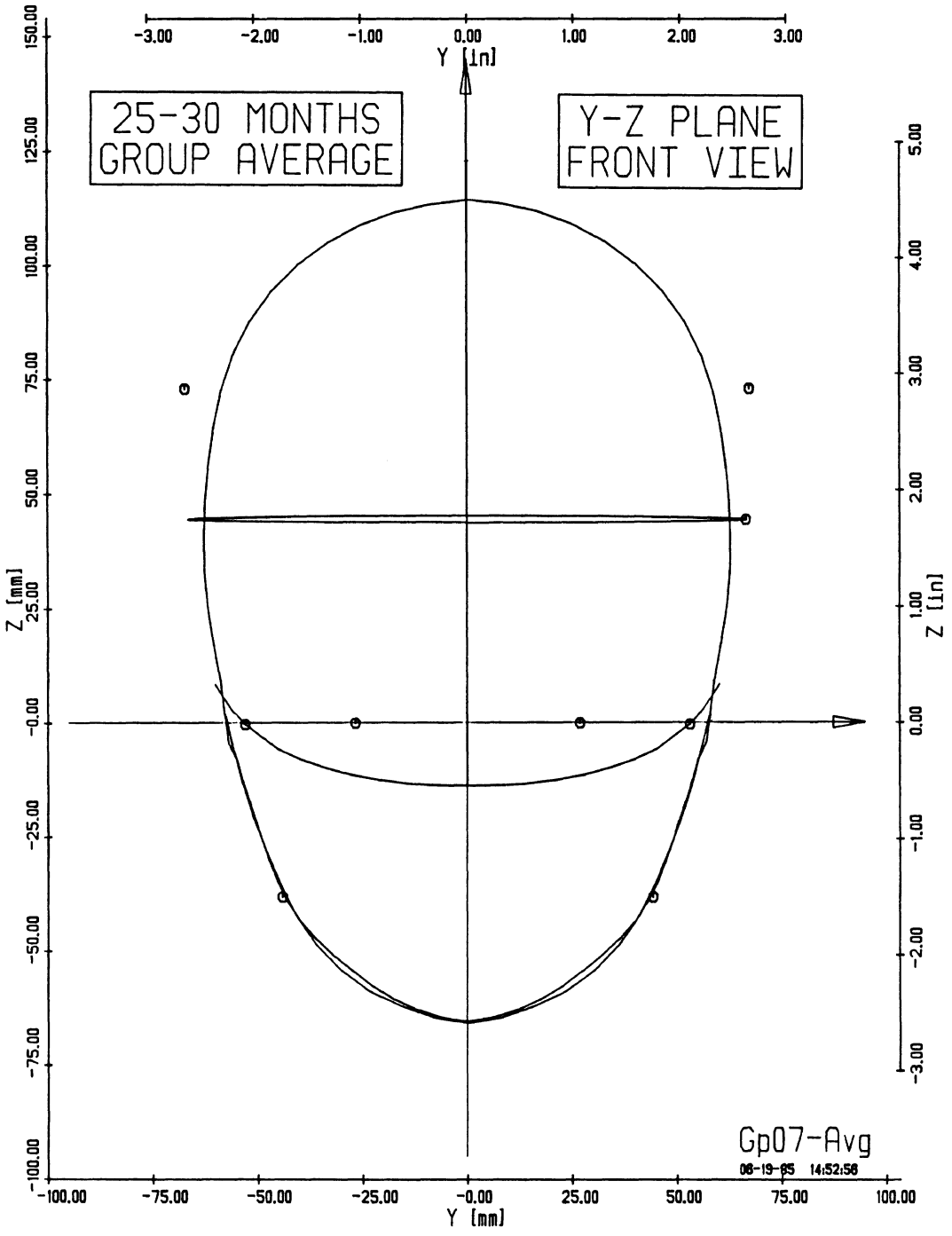
25-30 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 58.4	0.0
2	4.8	± 55.7	-6.1
3	5.9	± 53.5	-13.7
4	6.8	± 51.0	-20.9
5	7.8	± 48.0	-28.1
6	8.7	± 44.7	-35.2
7	9.6	± 40.9	-42.2
8	10.5	± 36.0	-48.7
9	11.3	± 30.1	-54.2
10	11.9	± 23.3	-58.8
11	12.3	± 15.8	-62.0
12	12.6	± 8.0	-64.5
13 (Midline)	12.8	0.0	-65.7

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1.	-25.2	± 60.2	8.5
2	-31.1	± 58.0	5.4
3	-37.0	± 55.7	2.4
4	-42.5	± 52.6	-0.5
5	-47.7	± 48.9	-3.1
6	-53.0	± 45.0	-5.8
7	-57.1	± 39.6	-8.0
8	-60.6	± 33.8	-9.8
9	-63.5	± 27.5	-11.3
10	-65.7	± 20.9	-12.4
11	-67.1	± 14.1	-13.2
12	-68.0	± 7.1	-13.6
13 (Head/Neck Junction)	-68.4	0.0	-12.9


25-30 MONTHS
GROUP AVERAGE
Y-Z PLANE
FRONT VIEW
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-1.00
0.00
1.00
2.00
3.00
Z [mm]
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125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [in]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Y [mm]
-100.00
-75.00
-50.00
-25.00
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50.00
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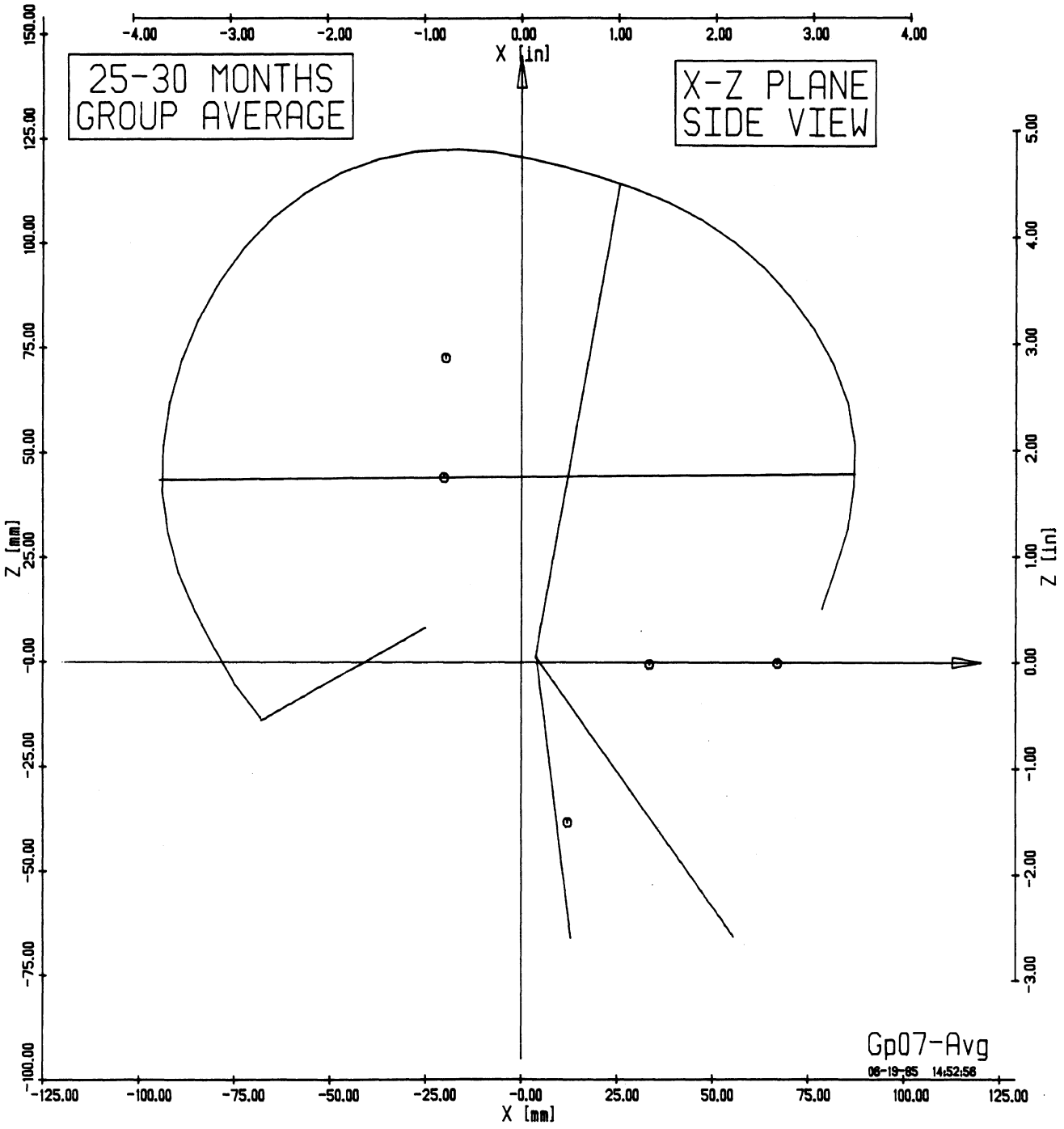
25-30 MONTHS
GROUP AVERAGE
X-Z PLANE
SIDE VIEW
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
Z [mm]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [in]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
X [mm]
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-100.00
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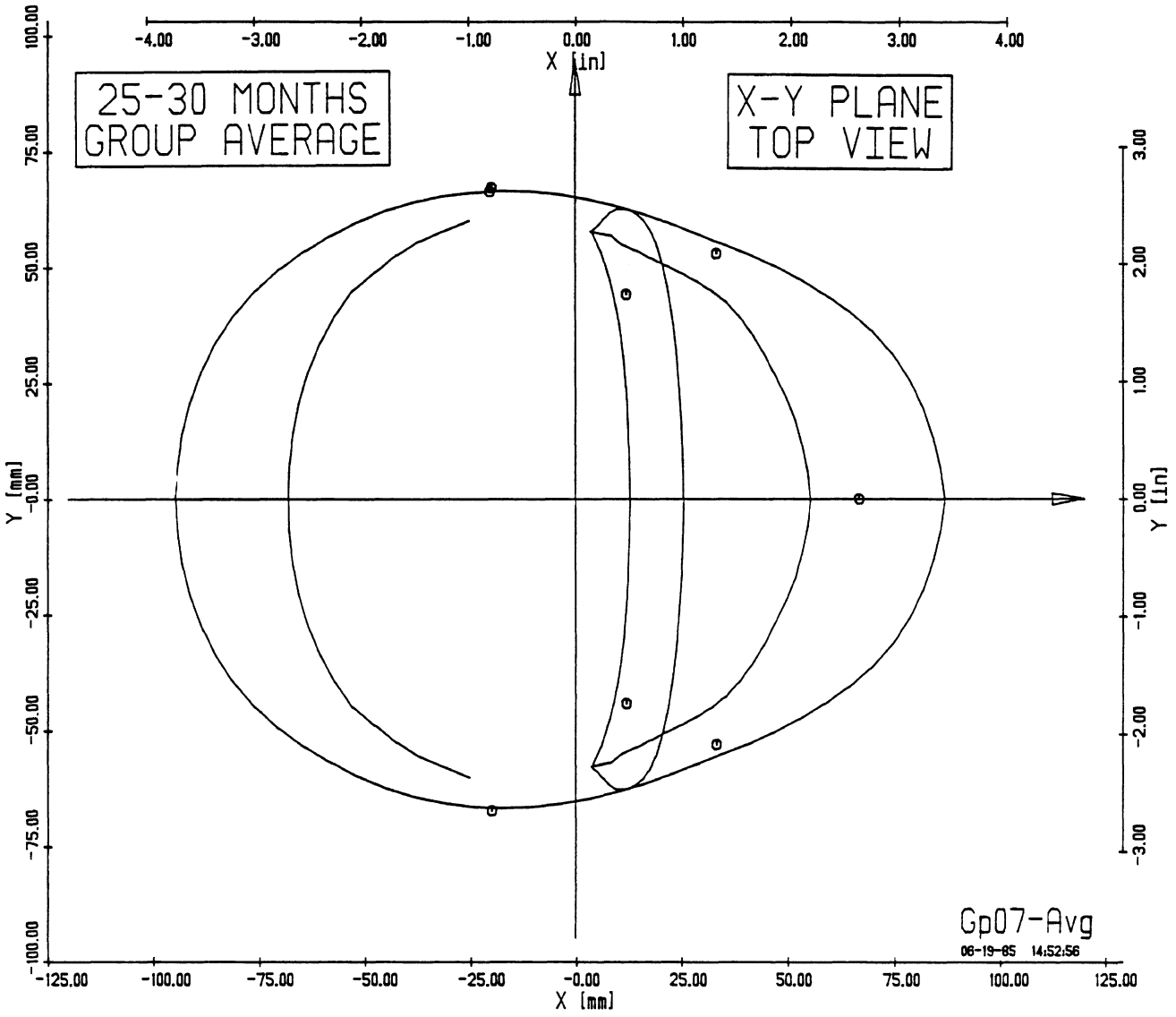

25-30 MONTHS
GROUP AVERAGE
X-Y PLANE
TOP VIEW
X [in]
Y [mm]
Y [in]
X [mm]
Gp07-Avg
06-19-85 14:52:56

HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

25-30 MONTHS LARGE SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 63.4	0.0
2. Under Eye (Infraorbitale)	70.3	± 28.2	0.0
3. Above Nose (Sellion)	84.1	0.0	11.9
4. Forehead (Glabella)	93.9	0.0	36.2
5. Top of Head (Vertex)	-9.3	0.0	131.9
6. Back of Head (Opisthocranion)	-100.1	0.0	51.1
7. Head/Neck Junction	-77.5	0.0	-15.5
8. Tip of Chin (Menton)	55.2	0.0	-75.0
9. Upper Cheek (Zygion)	36.7	± 55.8	-1.4
10. Back of Jaw (Gonion)	13.0	± 46.6	-46.6
11. Maximum Head Breadth Point	-15.0	± 72.9	78.3
12. Head Breadth @ Circumference Point .	-23.2	± 71.1	44.1

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Sellion)	84.1	0.0	11.9
2	89.7	0.0	24.2
3	92.8	0.0	31.4
4	95.3	0.0	43.9
5	95.7	0.0	52.1
6	96.1	0.0	60.9
7	92.2	0.0	70.4
8	88.5	0.0	77.1
9	82.6	0.0	85.1
10	76.7	0.0	92.9
11	70.7	0.0	98.9
12	64.6	0.0	104.7
13	55.0	0.0	111.5
14	46.7	0.0	116.0
15	39.9	0.0	119.6
16	28.2	0.0	122.8
17	21.6	0.0	125.2
18	12.2	0.0	127.5
19	1.8	0.0	129.9
20	-8.7	0.0	132.1
21	-17.4	0.0	132.8
22	-27.2	0.0	132.2
23	-36.2	0.0	130.4
24	-45.3	0.0	127.7
25	-53.8	0.0	124.1
26	-60.7	0.0	119.7
27	-67.4	0.0	113.1
28	-75.1	0.0	105.0
29	-81.1	0.0	97.1
30	-86.2	0.0	88.6
31	-92.0	0.0	79.7
32	-94.7	0.0	71.8
33	-98.5	0.0	63.5
34	-100.4	0.0	57.5
35	-101.7	0.0	44.3
36	-100.1	0.0	36.4
37	-97.6	0.0	27.2
38	-94.3	0.0	18.6
39	-89.1	0.0	9.7
40	-85.8	0.0	0.8
41	-82.0	0.0	-8.3
42 (Head/Neck Junction)	-77.5	0.0	-15.5

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Glabella)	93.9	0.0	36.2
2	93.0	± 10.9	36.0
3	90.3	± 19.5	36.2
4	85.6	± 29.3	36.6
5	80.1	± 36.7	37.0
6	73.8	± 42.0	37.5
7	65.6	± 47.5	38.1
8	58.0	± 51.7	38.7
9	49.3	± 55.4	39.3
10	40.8	± 58.7	40.0
11	32.7	± 61.4	40.6
12	24.4	± 64.2	41.2
13	14.7	± 67.2	42.0
14	5.4	± 69.5	42.7
15	-3.0	± 70.6	43.3
16	-14.1	± 71.1	44.1
17	-23.2	± 71.3	44.8
18	-32.5	± 70.1	45.5
19	-42.2	± 68.4	46.3
20	-50.5	± 65.9	46.9
21	-59.2	± 62.2	47.6
22	-67.6	± 58.3	48.2
23	-75.2	± 53.4	48.8
24	-82.5	± 47.2	49.3
25	-89.7	± 38.0	49.9
26	-93.9	± 30.6	50.2
27	-98.1	± 20.7	50.5
28	-100.1	± 9.7	50.7
29 (Opisthocranion) ...	-100.1	0.0	51.1

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 63.4	0.0
2	8.2	± 62.2	7.1
3	10.3	± 62.9	16.0
4	12.5	± 63.9	25.5
5	14.8	± 64.7	35.2
6	16.9	± 64.8	43.9
7	19.1	± 65.2	53.2
8	21.0	± 65.5	61.4
9	22.9	± 65.1	69.4
10	25.2	± 63.8	79.0
11	27.1	± 61.0	87.1
12	28.8	± 56.5	94.5
13	30.8	± 49.5	102.8
14	32.2	± 42.2	108.9
15	33.2	± 34.5	113.0
16	34.2	± 25.2	117.1
17	34.7	± 16.5	119.2
18 (Midline)	35.2	0.0	121.4

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 63.4	0.0
2	15.0	± 58.3	-11.8
3	20.3	± 55.8	-20.2
4	24.8	± 53.5	-27.2
5	29.6	± 51.0	-34.8
6	34.5	± 47.1	-42.4
7	38.5	± 41.9	-48.8
8	42.2	± 36.3	-54.7
9	44.9	± 30.2	-58.9
10	49.2	± 22.8	-65.6
11	51.6	± 15.8	-69.4
12	54.1	± 8.4	-73.2
13 (Menton)	55.2	0.0	-75.0

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

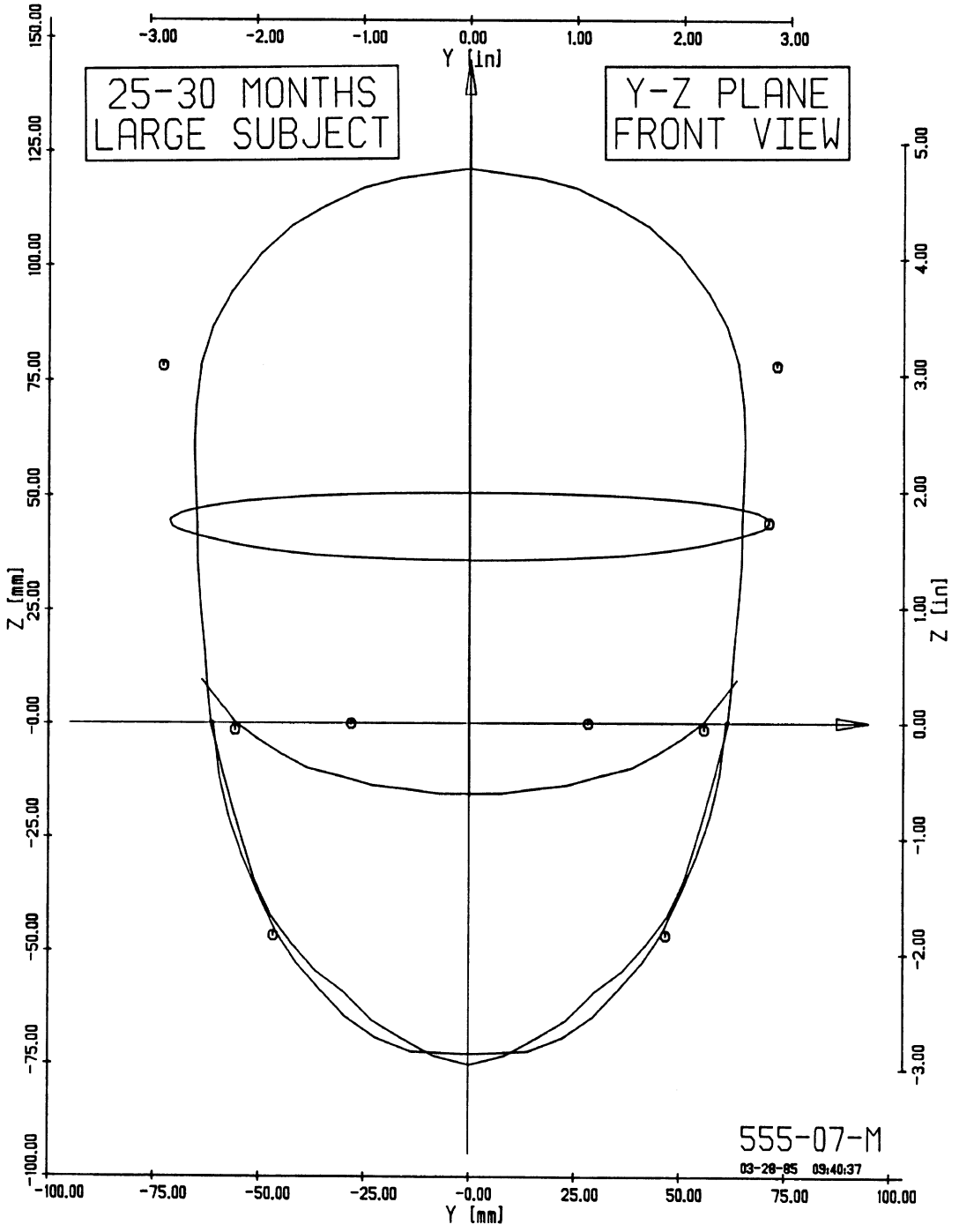
25-30 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 63.4	0.0
2	8.4	± 59.5	-11.6
3	9.1	± 57.2	-20.7
4	9.9	± 53.9	-29.5
5	10.5	± 50.3	-37.3
6	11.2	± 45.7	-46.3
7	11.8	± 40.9	-53.0
8	12.3	± 35.2	-59.0
9	12.7	± 29.2	-64.8
10	13.1	± 22.2	-69.2
11	13.3	± 13.9	-72.2
12 (Midline)	13.4	0.0	-72.8

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

25-30 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1.	-23.7	± 63.6	9.7
2	-36.5	± 58.4	3.6
3	-43.6	± 55.5	0.2
4	-51.7	± 49.9	-3.7
5	-58.5	± 44.2	-7.0
6	-64.4	± 38.5	-9.8
7	-68.0	± 31.1	-11.5
8	-72.3	± 23.0	-13.6
9	-74.1	± 15.2	-14.4
10	-76.2	± 7.5	-15.4
11 (Head/Neck Junction)	-77.5	0.0	-15.5


25-30 MONTHS
LARGE SUBJECT
Y-Z PLANE
FRONT VIEW
Y [in]
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-2.00
-1.00
0.00
1.00
2.00
3.00
Z [mm]
150.00
125.00
100.00
75.00
50.00
25.00
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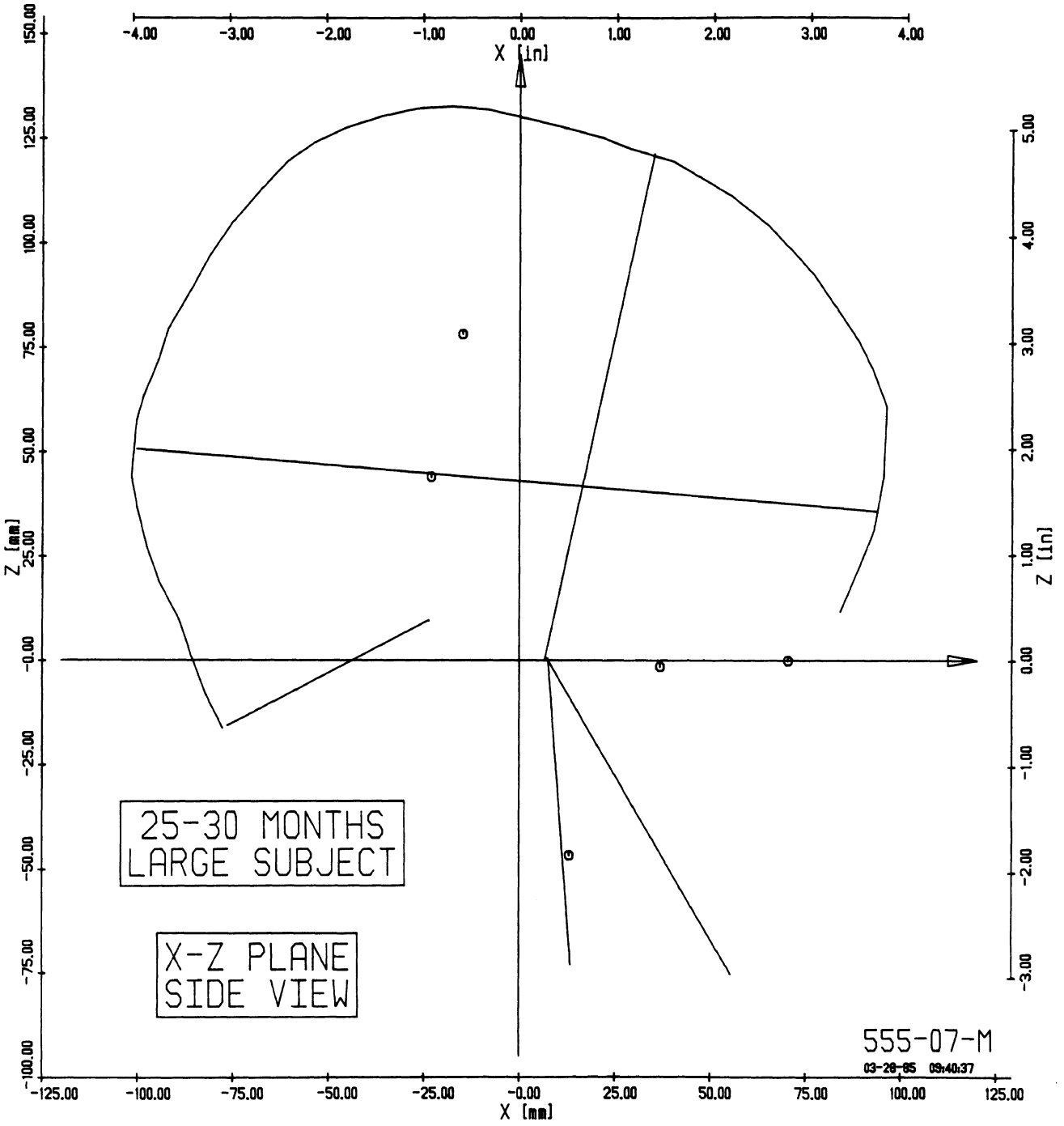
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25-30 MONTHS
LARGE SUBJECT
X-Z PLANE
SIDE VIEW
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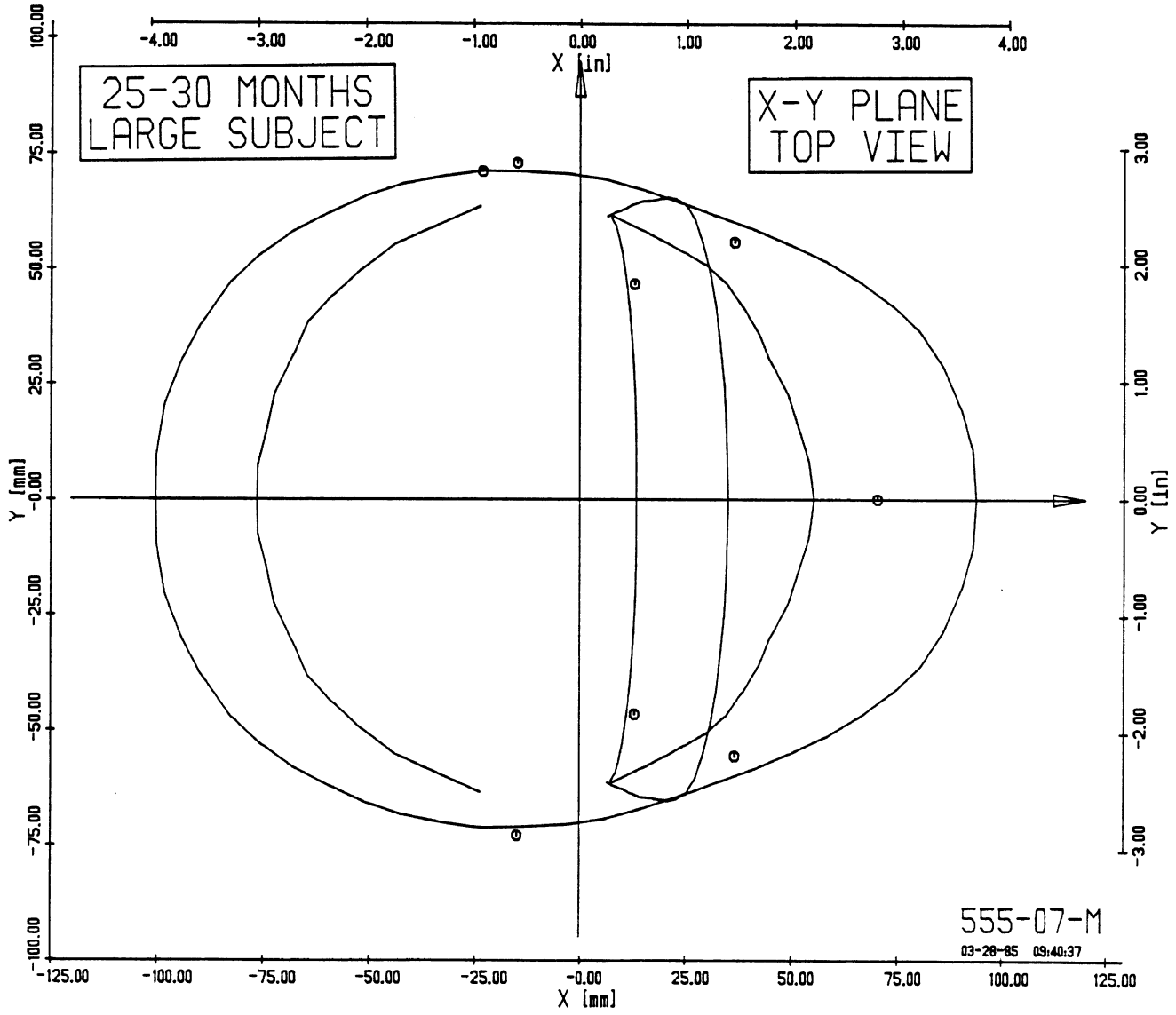
25-30 MONTHS
LARGE SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [mm]
Y [in]
X [mm]
555-07-M
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HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

43-48 MONTHS SMALL SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 59.5	0.0
2. Under Eye (Infraorbitale)	62.3	± 30.0	0.0
3. Above Nose (Sellion)	75.1	0.0	17.6
4. Forehead (Glabella)	81.2	0.0	44.4
5. Top of Head (Vertex)	-19.3	0.0	119.2
6. Back of Head (Opisthocranion)	-96.0	0.0	40.1
7. Head/Neck Junction	-70.7	0.0	-21.0
8. Tip of Chin (Menton)	53.6	0.0	-66.2
9. Upper Cheek (Zygion)	36.5	± 53.3	1.8
10. Back of Jaw (Gonion)	16.3	± 44.3	-40.4
11. Maximum Head Breadth Point	-24.7	± 64.0	72.3
12. Head Breadth @ Circumference Point .	-21.2	± 65.7	41.5

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Sellion)	75.1	0.0	17.6
2	77.9	0.0	27.3
3	79.8	0.0	36.4
4	80.6	0.0	52.7
5	79.2	0.0	60.4
6	75.7	0.0	70.2
7	69.5	0.0	78.0
8	62.1	0.0	87.2
9	53.0	0.0	95.7
10	42.0	0.0	101.5
11	33.8	0.0	106.0
12	23.6	0.0	108.9
13	9.6	0.0	113.0
14	2.0	0.0	114.5
15	-7.7	0.0	117.5
16	-19.2	0.0	118.9
17	-31.8	0.0	118.6
18	-42.9	0.0	116.2
19	-54.5	0.0	109.8
20	-63.3	0.0	104.6
21	-70.4	0.0	96.6
22	-77.7	0.0	86.8
23	-83.3	0.0	78.0
24	-88.2	0.0	69.4
25	-93.0	0.0	60.7
26	-95.4	0.0	51.8
27	-95.5	0.0	45.4
28	-95.7	0.0	29.1
29	-91.8	0.0	18.2
30	-89.1	0.0	7.4
31	-80.9	0.0	-4.2
32	-74.6	0.0	-13.6
33 (Head/Neck Junction)	-70.7	0.0	-21.0

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Glabella)	81.2	0.0	44.4
2	80.8	± 3.5	43.5
3	79.6	± 13.3	43.5
4	76.0	± 23.1	43.4
5	70.0	± 32.3	43.3
6	62.7	± 40.1	43.1
7	55.4	± 46.7	42.9
8	46.6	± 51.5	42.8
9	37.6	± 55.6	42.6
10	28.1	± 59.2	42.4
11	17.2	± 61.7	42.1
12	9.3	± 63.9	42.0
13	-0.6	± 66.1	41.8
14	-10.9	± 65.7	41.5
15	-21.6	± 65.1	41.3
16	-31.0	± 63.5	41.1
17	-41.2	± 61.1	40.9
18	-51.3	± 58.0	40.7
19	-59.1	± 54.4	40.5
20	-67.6	± 49.6	40.3
21	-75.2	± 44.0	40.2
22	-82.7	± 36.2	40.0
23	-88.7	± 28.6	39.9
24	-93.2	± 18.0	39.8
25	-95.9	± 6.4	39.7
26 (Opisthocranion) ...	-96.0	0.0	40.1

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 59.5	0.0
2	8.1	± 61.3	15.4
3	9.1	± 62.8	26.4
4	10.0	± 64.1	37.0
5	10.7	± 63.1	44.8
6	12.0	± 60.7	59.4
7	12.9	± 58.6	68.5
8	13.7	± 54.1	77.6
9	14.5	± 49.9	86.9
10	15.2	± 42.9	94.6
11	15.7	± 34.6	100.5
12	16.1	± 26.4	104.1
13	16.3	± 15.9	107.0
14	16.6	± 4.1	110.0
15 (Midline)	16.6	0.0	110.0

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 59.5	0.0
2	15.3	± 55.5	-10.3
3	20.6	± 54.5	-18.2
4	26.0	± 51.5	-26.3
5	31.6	± 47.8	-34.7
6	36.8	± 43.3	-42.6
7	41.6	± 37.1	-49.7
8	45.4	± 28.1	-55.5
9	48.1	± 21.0	-59.6
10	51.4	± 10.9	-64.6
11 (Menton)	53.6	0.0	-66.2

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

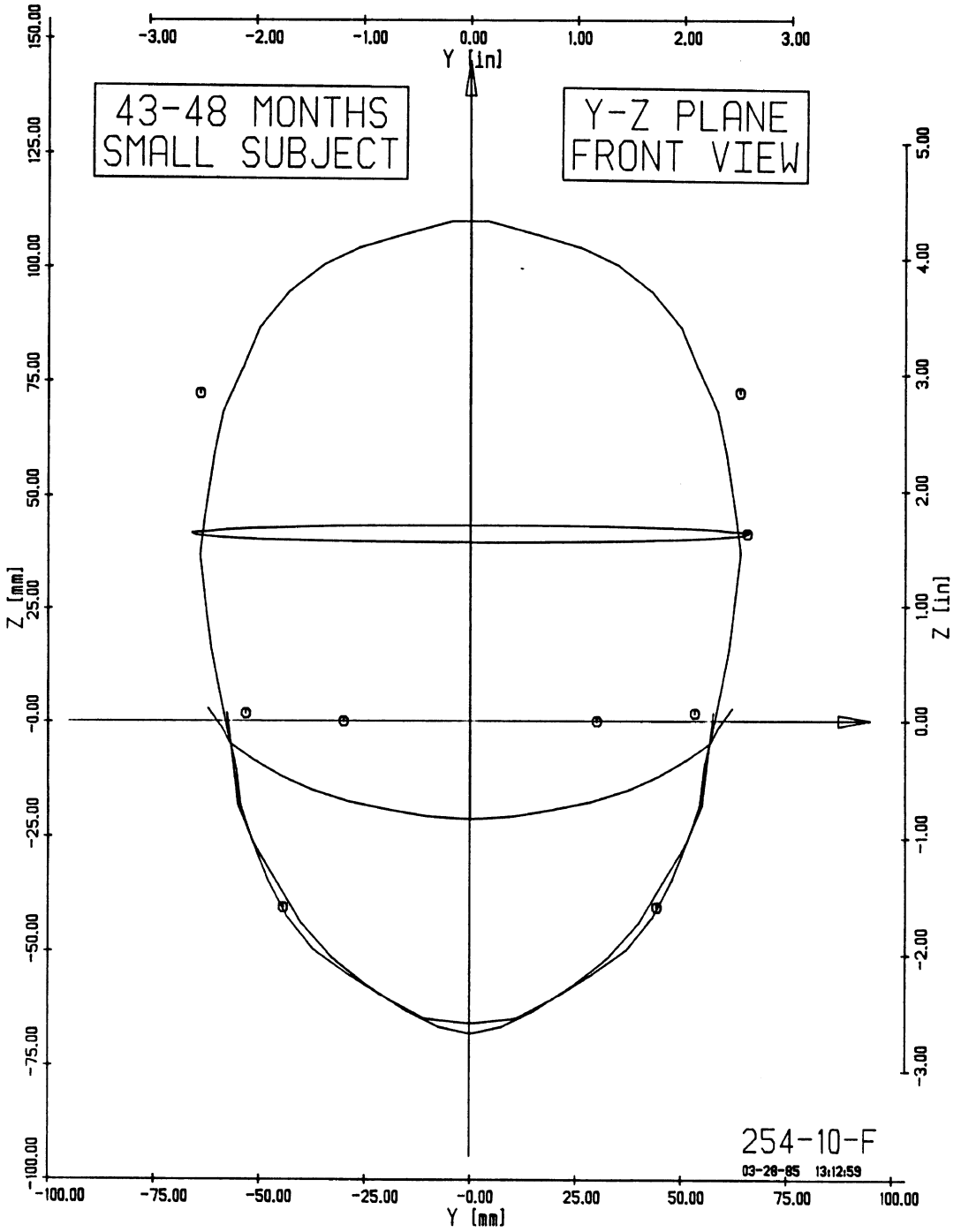
43-48 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 59.5	0.0
2	10.0	± 55.1	-18.2
3	11.3	± 51.3	-26.5
4	12.6	± 45.8	-34.9
5	14.0	± 40.0	-43.9
6	15.2	± 32.6	-51.5
7	16.1	± 24.3	-57.5
8	17.0	± 14.9	-63.1
9	17.5	± 7.5	-66.4
10 (Midline)	17.7	0.0	-67.9

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS SMALL SUBJECT

Target number (name)	X	Y	Z
1.	-25.7	± 62.2	2.9
2	-33.3	± 59.1	-1.1
3	-40.4	± 56.9	-4.9
4	-47.4	± 51.0	-8.6
5	-54.0	± 44.2	-12.1
6	-59.2	± 37.3	-14.9
7	-64.0	± 28.6	-17.4
8	-67.4	± 18.8	-19.2
9	-69.9	± 10.4	-20.5
10 (Head/Neck Junction)	-70.7	0.0	-21.0


43-48 MONTHS
SMALL SUBJECT
Y-Z PLANE
FRONT VIEW
Y [in]
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-2.00
-1.00
0.00
1.00
2.00
3.00
Z [mm]
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125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [in]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Y [mm]
-100.00
-75.00
-50.00
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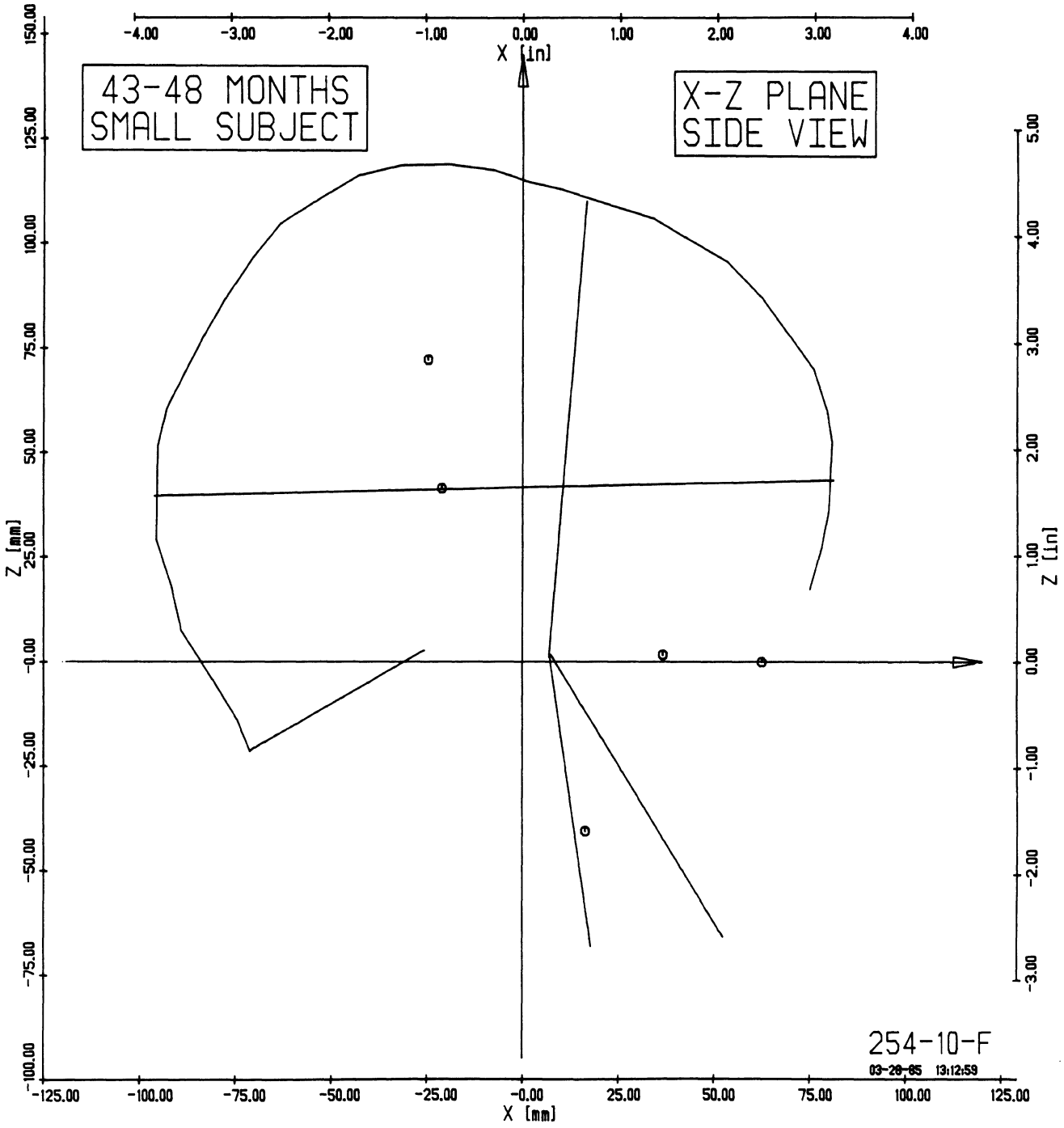
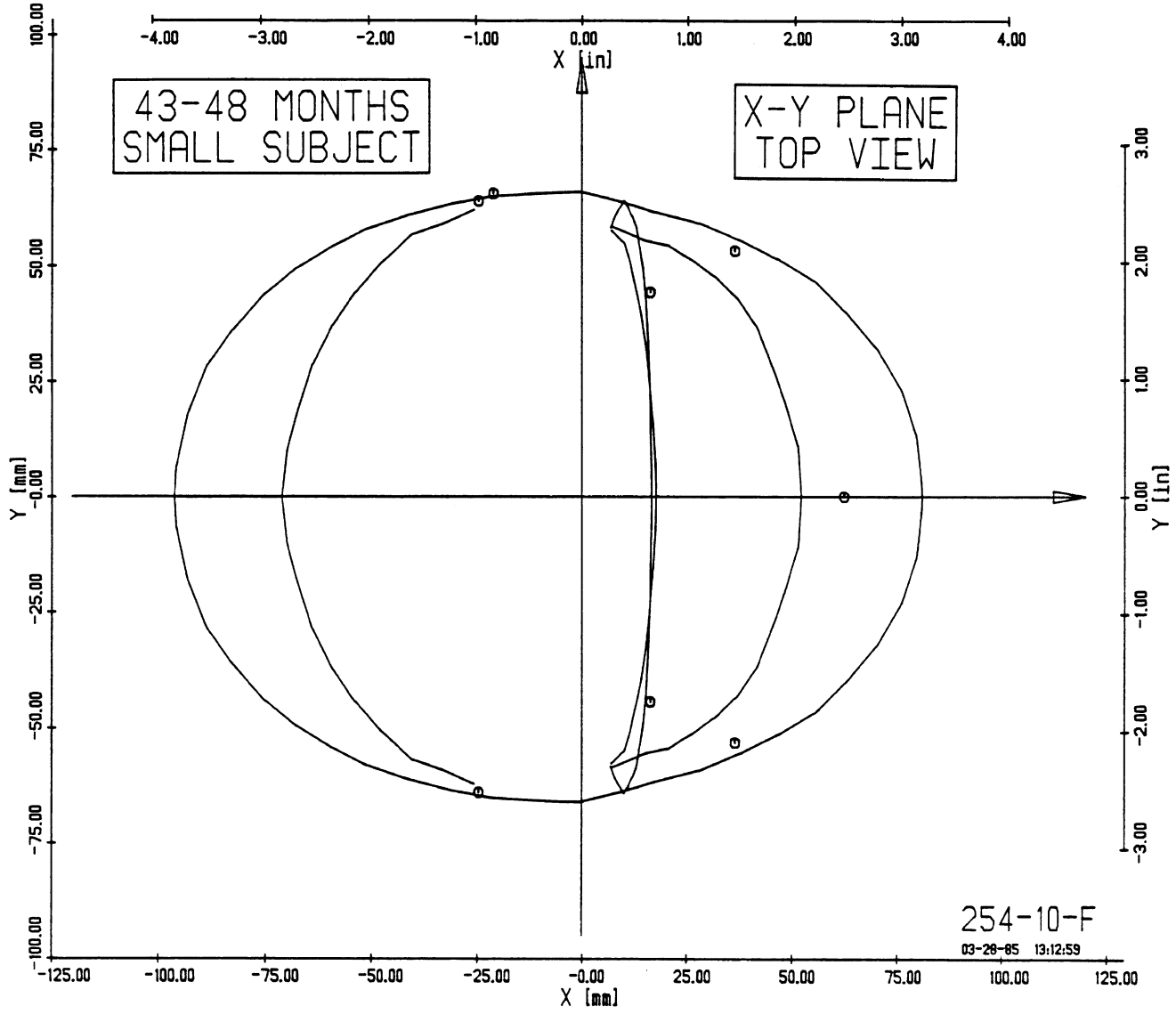

43-48 MONTHS
SMALL SUBJECT
X-Z PLANE
SIDE VIEW
X [in]
Z [mm]
Z [in]
X [mm]
254-10-F
03-28-85 13:12:59


43-48 MONTHS
SMALL SUBJECT
X-Y PLANE
TOP VIEW
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
Y [mm]
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Y [in]
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
X [mm]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
125.00
254-10-F
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HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

43-48 MONTHS GROUP AVERAGE

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 60.0	0.0
2. Under Eye (Infraorbitale)	67.7	± 28.3	0.0
3. Above Nose (Sellion)	82.0	0.0	14.9
4. Forehead (Glabella)	90.1	0.0	48.3
5. Top of Head (Vertex)	-15.4	0.0	125.5
6. Back of Head (Opisthocranion)	-95.2	0.0	47.7
7. Head/Neck Junction	-68.0	0.0	-16.5
8. Tip of Chin (Menton)	60.5	0.0	-67.3
9. Upper Cheek (Zygion)	36.5	± 53.9	-0.9
10. Back of Jaw (Gonion)	14.9	± 45.4	-40.8
11. Maximum Head Breadth Point	-20.3	± 68.3	73.4
12. Head Breadth @ Circumference Point .	-14.5	± 68.7	48.2

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Sellion)	82.0	0.0	14.9
2	85.0	0.0	24.7
3	88.0	0.0	34.7
4	89.4	0.0	45.0
5	89.3	0.0	55.5
6	87.1	0.0	65.8
7	82.8	0.0	75.5
8	77.1	0.0	83.8
9	70.4	0.0	91.4
10	62.9	0.0	98.2
11	54.8	0.0	104.2
12	46.0	0.0	109.3
13	36.8	0.0	113.5
14	27.7	0.0	116.8
15	18.5	0.0	119.7
16	9.1	0.0	122.1
17	-0.4	0.0	124.0
18	-10.0	0.0	125.1
19	-19.7	0.0	125.4
20	-30.1	0.0	124.3
21	-40.4	0.0	121.9
22	-50.2	0.0	118.1
23	-59.2	0.0	112.6
24	-67.4	0.0	106.0
25	-74.8	0.0	98.5
26	-81.3	0.0	89.9
27	-86.8	0.0	80.7
28	-91.2	0.0	70.8
29	-94.1	0.0	60.4
30	-95.3	0.0	49.6
31	-95.1	0.0	38.8
32	-93.3	0.0	28.6
33	-89.7	0.0	18.9
34	-85.1	0.0	9.7
35	-79.8	0.0	0.9
36	-74.8	0.0	-8.1
37 (Head/Neck Junction)	-68.0	0.0	-16.5

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Glabella)	90.1	0.0	48.3
2	88.5	± 6.9	48.5
3	86.8	± 13.7	48.5
4	84.1	± 20.3	48.5
5	80.8	± 26.5	48.4
6	76.6	± 32.1	48.4
7	71.6	± 37.2	48.4
8	66.2	± 41.6	48.4
9	60.6	± 45.4	48.4
10	54.6	± 48.9	48.4
11	48.4	± 51.9	48.3
12	42.1	± 54.7	48.3
13	35.7	± 57.3	48.3
14	29.4	± 59.6	48.3
15	23.0	± 61.7	48.3
16	16.6	± 63.6	48.2
17	10.1	± 65.3	48.2
18	3.5	± 66.8	48.2
19	-3.1	± 67.9	48.2
20	-10.2	± 68.6	48.2
21	-17.3	± 68.8	48.1
22	-24.3	± 68.4	48.1
23	-31.4	± 67.7	48.1
24	-38.4	± 66.4	48.1
25	-45.2	± 64.6	48.1
26	-52.2	± 62.1	48.0
27	-58.9	± 59.1	48.0
28	-65.4	± 55.5	48.0
29	-71.5	± 51.3	48.0
30	-77.0	± 46.4	48.0
31	-82.0	± 41.0	47.9
32	-86.3	± 35.1	47.9
33	-89.8	± 28.6	47.9
34	-92.5	± 21.7	47.9
35	-94.3	± 14.6	47.9
36	-95.5	± 7.3	47.9
37 (Opisthocranion) ...	-95.2	0.0	47.7

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 60.0	0.0
2	5.7	± 60.4	6.9
3	7.2	± 62.2	15.2
4	8.8	± 63.5	23.5
5	10.4	± 64.4	31.6
6	11.9	± 64.7	39.7
7	13.5	± 64.3	47.8
8	15.1	± 63.4	56.2
9	16.7	± 62.0	64.4
10	18.2	± 60.1	72.6
11	19.8	± 57.1	80.8
12	21.3	± 52.9	88.6
13	22.6	± 47.6	95.7
14	23.8	± 41.1	101.9
15	24.8	± 33.8	107.0
16	25.6	± 25.8	111.1
17	26.1	± 17.5	114.1
18	26.5	± 8.8	116.0
19 (Midline)	26.7	0.0	117.0

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 60.0	0.0
2	7.9	± 57.5	-5.6
3	11.8	± 56.0	-10.2
4	15.7	± 54.7	-14.8
5	19.5	± 53.5	-19.3
6	23.3	± 52.1	-23.7
7	27.1	± 50.6	-28.2
8	30.9	± 48.8	-32.7
9	34.6	± 46.6	-37.1
10	38.3	± 43.9	-41.3
11	41.7	± 40.7	-45.4
12	45.0	± 36.9	-49.2
13	48.0	± 32.6	-52.8
14	50.8	± 28.0	-56.0
15	53.4	± 23.1	-59.1
16	55.8	± 17.9	-61.9
17	57.8	± 12.3	-64.3
18	59.1	± 6.3	-65.8
19 (Menton)	60.5	0.0	-67.3

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

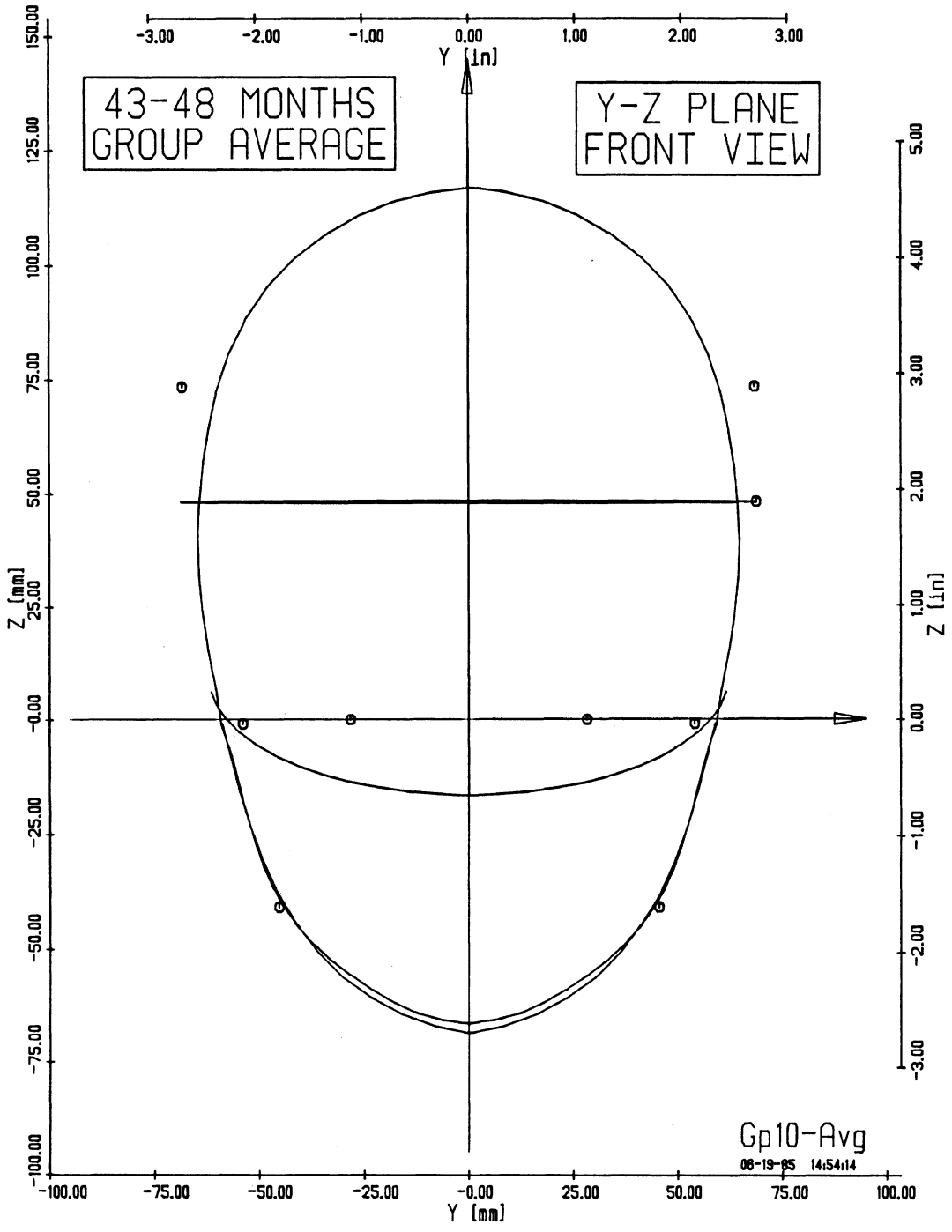
43-48 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 60.0	0.0
2	5.6	± 56.8	-8.6
3	6.9	± 54.6	-16.2
4	8.2	± 52.1	-23.7
5	9.4	± 49.1	-31.0
6	10.7	± 45.5	-38.1
7	11.8	± 41.1	-44.7
8	12.9	± 35.9	-51.0
9	13.8	± 29.9	-56.5
10	14.6	± 23.1	-61.0
11	15.2	± 15.8	-64.6
12	15.7	± 8.0	-67.2
13 (Midline)	15.9	0.0	-68.7

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS GROUP AVERAGE

Target number (name)	X	Y	Z
1.	-23.6	± 61.5	6.2
2	-29.9	± 60.1	3.0
3	-36.1	± 57.7	-0.1
4	-41.9	± 54.5	-3.0
5	-47.2	± 50.4	-5.7
6	-52.1	± 45.6	-8.2
7	-56.4	± 40.2	-10.4
8	-60.0	± 34.2	-12.2
9	-63.0	± 27.9	-13.7
10	-65.2	± 21.1	-14.8
11	-66.9	± 14.2	-15.7
12	-67.9	± 7.1	-16.2
13 (Head/Neck Junction)	-68.0	0.0	-16.5


43-48 MONTHS
GROUP AVERAGE
Y-Z PLANE
FRONT VIEW
Y [in]
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
Z [mm]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [in]
5.00
4.00
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2.00
1.00
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-1.00
-2.00
-3.00
Y [mm]
-100.00
-75.00
-50.00
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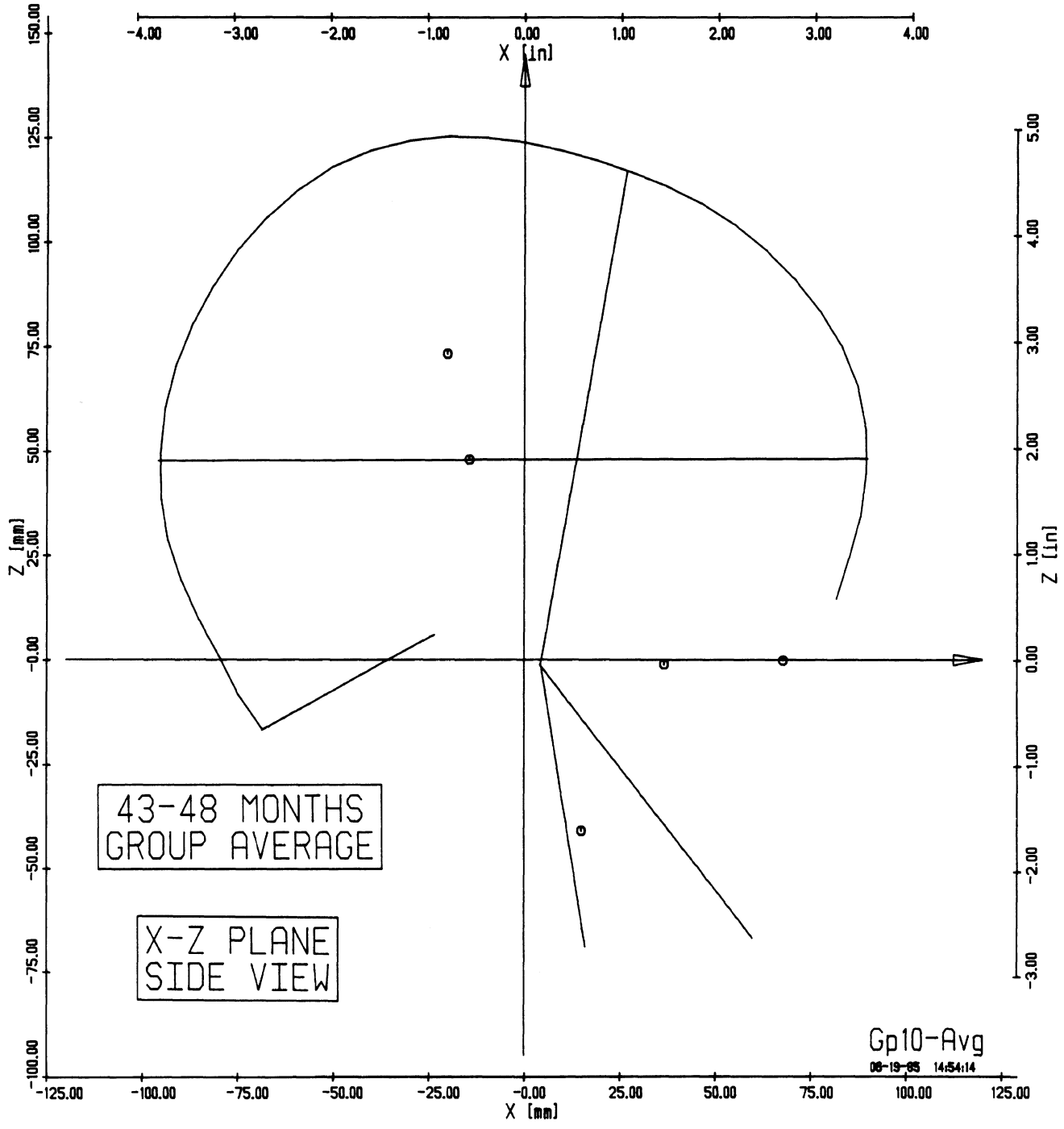
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X [in]
150.00
125.00
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Z [mm]
5.00
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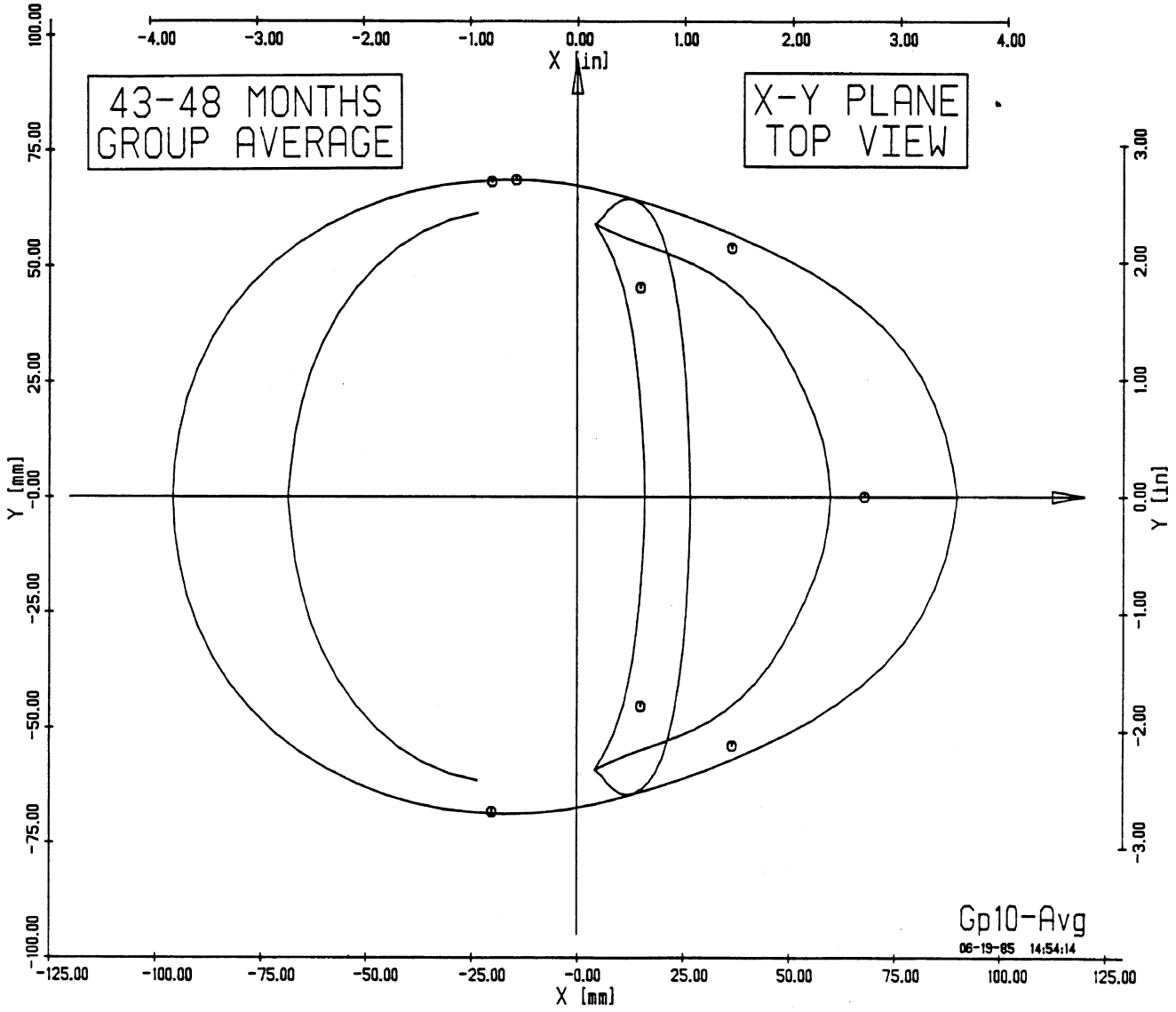
25.00
50.00
75.00
100.00
125.00
X [mm]
43-48 MONTHS
GROUP AVERAGE
X-Z PLANE
SIDE VIEW
Gp10-Avg
06-19-95 14:54:14


43-48 MONTHS
GROUP AVERAGE
X-Y PLANE
TOP VIEW
X [in]
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-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
Y [mm]
100.00
75.00
50.00
25.00
-0.00
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-50.00
-75.00
-100.00
Y [in]
3.00
2.00
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-1.00
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X [mm]
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125.00
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HEAD LANDMARK COORDINATES
re Head Anatomical Axis System

43-48 MONTHS LARGE SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 59.9	0.0
2. Under Eye (Infraorbitale)	67.4	± 30.4	0.0
3. Above Nose (Sellion)	86.0	0.0	16.3
4. Forehead (Glabella)	95.0	0.0	45.2
5. Top of Head (Vertex)	-16.3	0.0	133.0
6. Back of Head (Opisthocranion)	-98.8	0.0	57.2
7. Head/Neck Junction	-72.1	0.0	-9.4
8. Tip of Chin (Menton)	48.8	0.0	-70.5
9. Upper Cheek (Zygion)	31.3	± 54.4	-4.1
10. Back of Jaw (Gonion)	10.1	± 46.9	-33.4
11. Maximum Head Breadth Point	-19.0	± 72.5	79.9
12. Head Breadth @ Circumference Point .	-26.2	± 72.2	52.2

TOP-OF-HEAD MIDLINE ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Sellion)	86.0	0.0	16.3
2	88.8	0.0	27.1
3	92.0	0.0	34.1
4	95.9	0.0	54.1
5	94.9	0.0	63.7
6	93.0	0.0	72.7
7	88.6	0.0	80.2
8	84.3	0.0	86.9
9	77.8	0.0	95.3
10	70.6	0.0	101.9
11	62.9	0.0	107.9
12	55.2	0.0	112.3
13	46.6	0.0	116.8
14	41.8	0.0	119.1
15	29.1	0.0	123.4
16	21.6	0.0	126.2
17	13.1	0.0	127.6
18	2.3	0.0	129.6
19	-6.9	0.0	131.7
20	-16.5	0.0	133.1
21	-27.4	0.0	132.0
22	-36.8	0.0	130.8
23	-46.1	0.0	129.5
24	-56.3	0.0	125.9
25	-64.8	0.0	120.9
26	-70.7	0.0	114.4
27	-77.3	0.0	106.2
28	-83.0	0.0	98.6
29	-89.0	0.0	88.8
30	-92.2	0.0	80.3
31	-96.2	0.0	69.7
32	-97.9	0.0	63.0
33	-99.9	0.0	47.0
34	-99.9	0.0	40.6
35	-98.8	0.0	32.6
36	-95.9	0.0	21.0
37	-89.7	0.0	12.1
38	-82.8	0.0	5.4
39	-76.6	0.0	-3.0
40 (Head/Neck Junction)	-72.1	0.0	-9.4

HEAD CIRCUMFERENCE ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Glabella)	95.0	0.0	45.2
2	94.3	± 6.2	45.5
3	93.1	± 13.3	45.6
4	88.9	± 22.8	45.8
5	83.0	± 32.0	46.2
6	76.7	± 39.2	46.5
7	69.1	± 44.4	47.0
8	61.8	± 48.8	47.4
9	53.3	± 52.7	47.9
10	43.4	± 56.7	48.5
11	34.9	± 59.9	49.1
12	26.9	± 62.8	49.5
13	17.6	± 66.0	50.1
14	9.5	± 68.5	50.6
15	0.7	± 70.8	51.1
16	-9.6	± 71.9	51.7
17	-17.9	± 72.2	52.2
18	-26.2	± 72.2	52.7
19	-37.6	± 70.9	53.4
20	-46.2	± 69.2	53.9
21	-54.8	± 66.1	54.4
22	-64.7	± 60.8	55.0
23	-72.5	± 55.2	55.5
24	-80.6	± 48.0	56.0
25	-86.4	± 40.4	56.3
26	-91.3	± 32.8	56.6
27	-95.7	± 22.3	56.9
28	-98.0	± 12.5	57.0
29 (Opisthocranion) ...	-98.8	0.0	57.2

EAR-TO-EAR OVER TOP-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 59.9	0.0
2	10.2	± 62.2	16.5
3	12.8	± 63.8	27.6
4	15.4	± 64.5	38.3
5	17.7	± 64.5	47.4
6	20.5	± 64.5	59.2
7	21.6	± 63.1	63.8
8	23.7	± 61.9	72.4
9	25.8	± 59.1	80.9
10	28.0	± 54.9	89.9
11	29.8	± 49.6	97.4
12	31.4	± 42.7	104.0
13	32.8	± 35.4	109.9
14	33.7	± 28.2	113.8
15	34.6	± 18.9	117.3
16	35.3	± 10.4	120.1
17 (Midline)	35.5	0.0	121.0

EAR-TO-EAR THROUGH TIP-OF-CHIN ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 59.9	0.0
2	8.8	± 59.0	-1.2
3	14.4	± 53.7	-10.4
4	19.1	± 50.7	-18.3
5	23.5	± 48.0	-25.6
6	28.8	± 45.0	-34.6
7	34.3	± 40.3	-43.8
8	38.8	± 35.0	-51.3
9	42.2	± 28.0	-57.0
10	45.9	± 20.4	-63.2
11	48.8	± 12.3	-68.1
12 (Menton)	48.8	0.0	-70.5

EAR-TO-EAR UNDER CHIN ARC
Target Coordinates re Head Anatomical Axis System

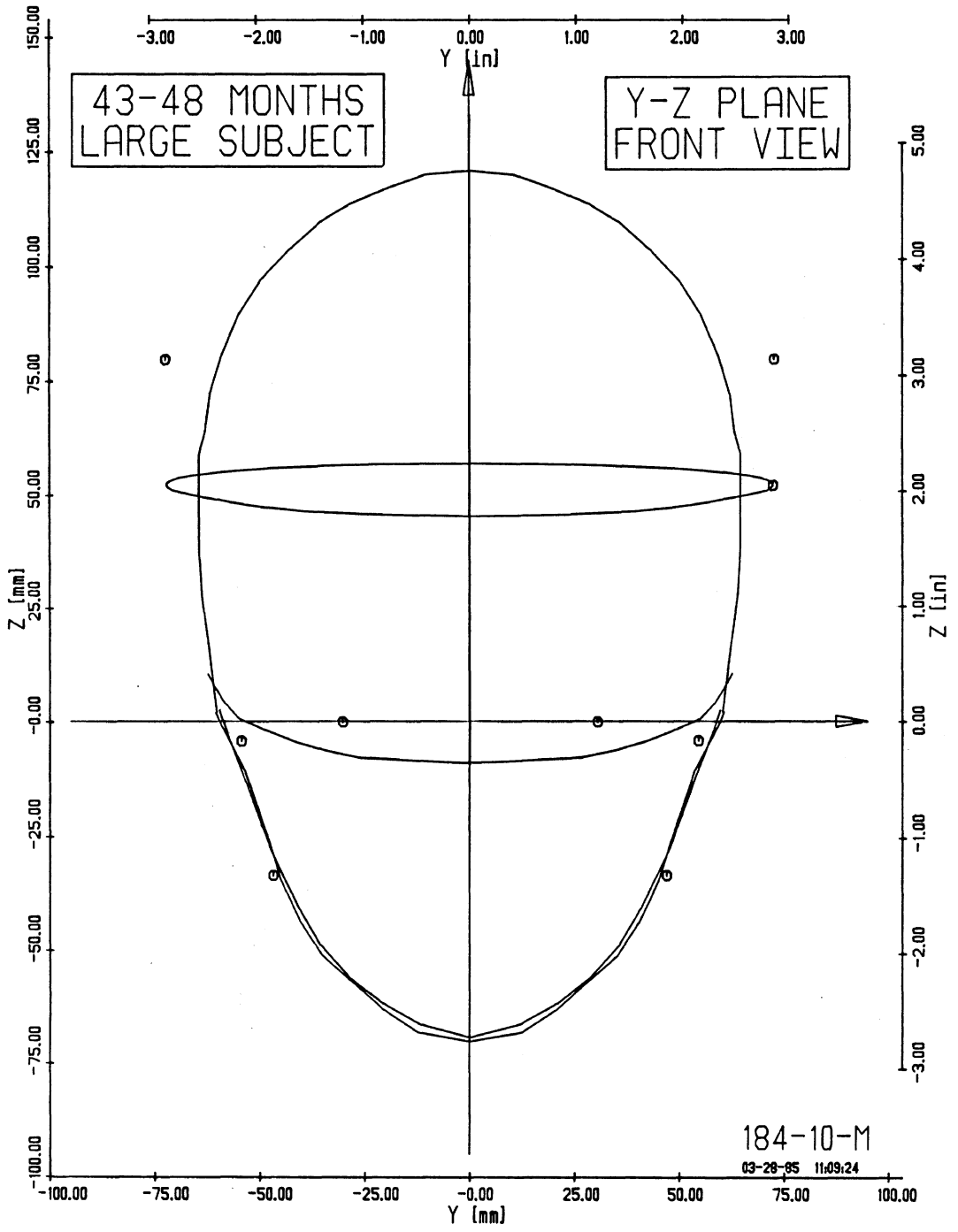
43-48 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1 (Tragion)	0.0	± 59.9	0.0
2	7.1	± 57.1	-4.3
3	7.8	± 53.4	-13.0
4	8.7	± 49.4	-23.0
5	9.1	± 47.3	-28.2
6	10.2	± 40.7	-40.7
7	10.9	± 35.5	-48.9
8	11.5	± 28.3	-56.3
9	12.0	± 20.7	-61.7
10	12.3	± 11.8	-66.3
11 (Midline)	12.6	0.0	-69.2

BACK-OF-HEAD ARC
Target Coordinates re Head Anatomical Axis System

43-48 MONTHS LARGE SUBJECT

Target number (name)	X	Y	Z
1.	-21.8	± 62.5	10.6
2	-30.3	± 60.5	7.3
3	-38.6	± 58.3	4.1
4	-47.4	± 54.8	0.7
5	-53.7	± 48.8	-1.7
6	-60.3	± 41.6	-4.3
7	-65.5	± 34.3	-6.2
8	-69.3	± 26.5	-7.7
9	-70.2	± 18.1	-8.1
10	-71.6	± 8.1	-8.6
11 (Head/Neck Junction)	-72.1	0.0	-9.4


43-48 MONTHS
LARGE SUBJECT
Y-Z PLANE
FRONT VIEW
Y [in]
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-2.00
-1.00
0.00
1.00
2.00
3.00
Z [mm]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [in]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Y [mm]
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
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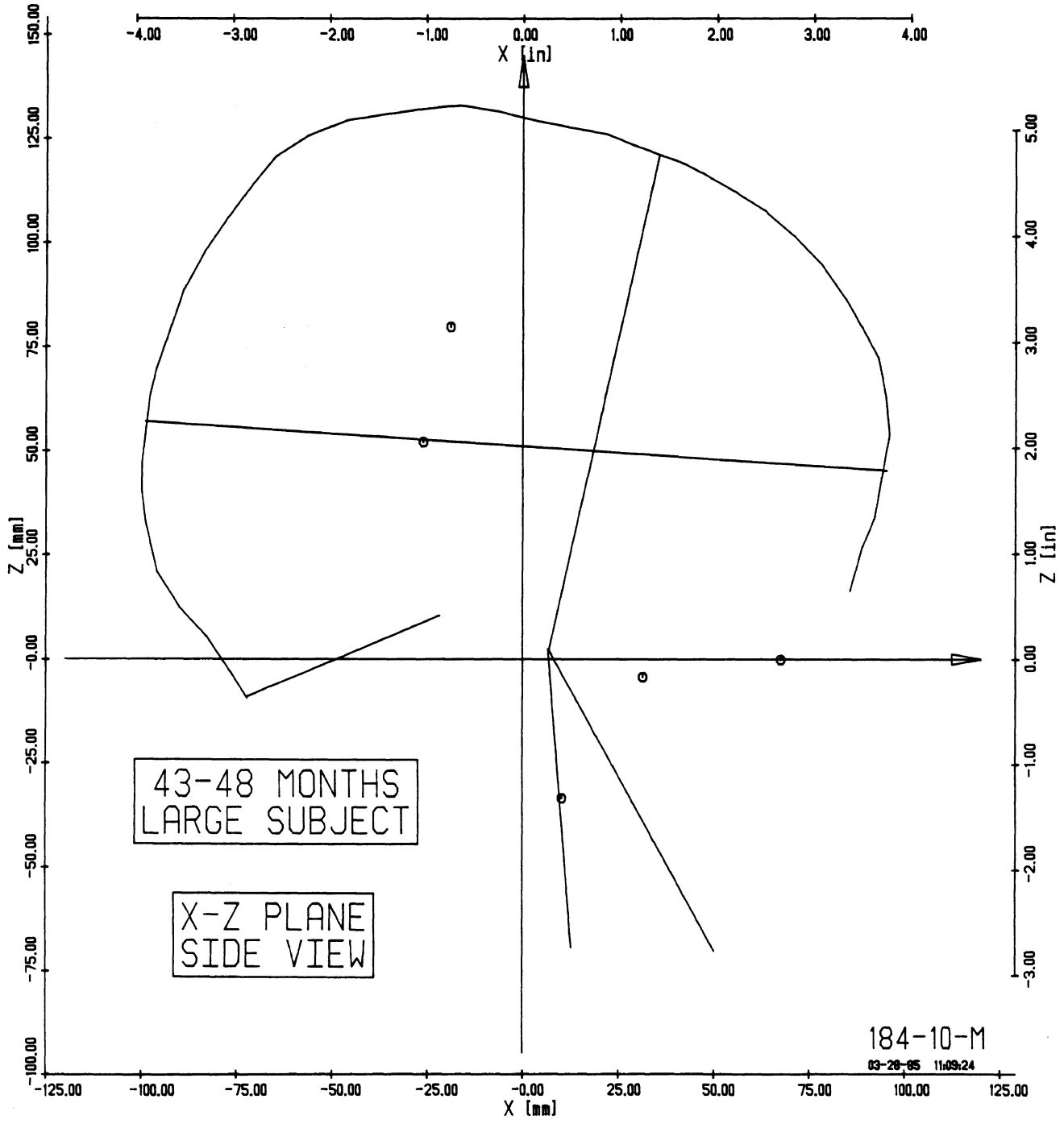
184-10-M
03-28-85 11:09:24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Z [mm]
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Z [in]
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X [mm]
43-48 MONTHS
LARGE SUBJECT
X-Z PLANE
SIDE VIEW
184-10-M
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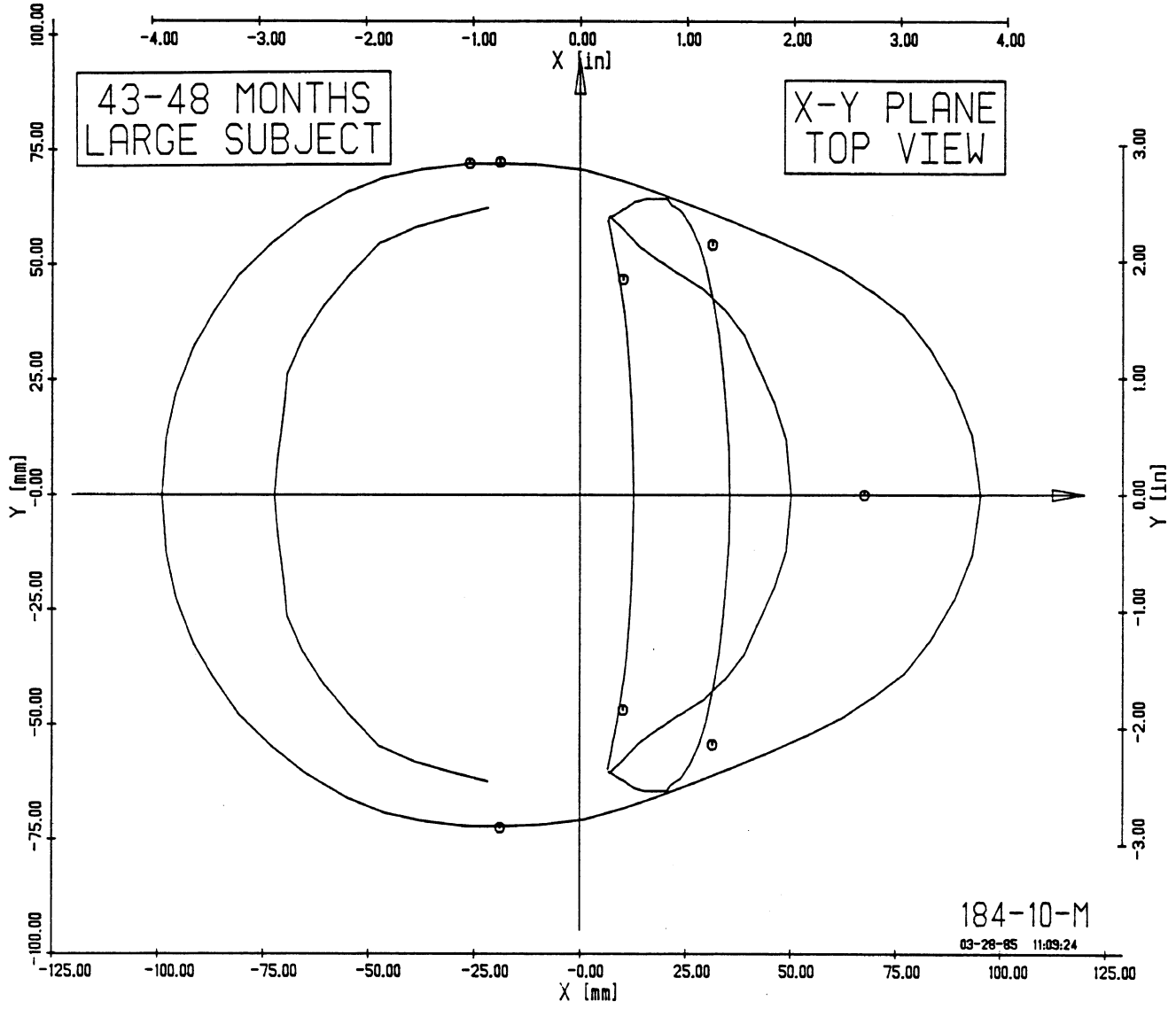
43-48 MONTHS
LARGE SUBJECT
X-Y PLANE
TOP VIEW
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-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
Y [mm]
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Y [in]
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
X [mm]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
125.00
184-10-M
03-28-85 11:09:24

HEAD LANDMARKS AND CONTOURS RELATIVE TO NECK AND TORSO LANDMARKS
(Tabular data and composite computer plots)

In this section, the coordinates of head landmark and contour targets are given with respect to those of neck and torso landmark targets using the translated laboratory reference system with origin at the head anatomical reference system origin. Results are presented for the representative small and large subjects of each group as well as the group average. For each size subject in each group, a table of coordinate values for head, neck, and torso landmark targets is followed by computer plots showing the front (Y-Z plane), side (X-Z plane), and top (X-Y plane) views of the composite landmark and contour results. Plots have been reduced to 55% of actual size to fit on the report pages.

In each plot, head contours are presented as solid lines without identification of the individual contour points shown in the tables. Anatomical landmark points not otherwise identifiable on a contour or by the intersection of two contours, are denoted by the symbol "⊙".

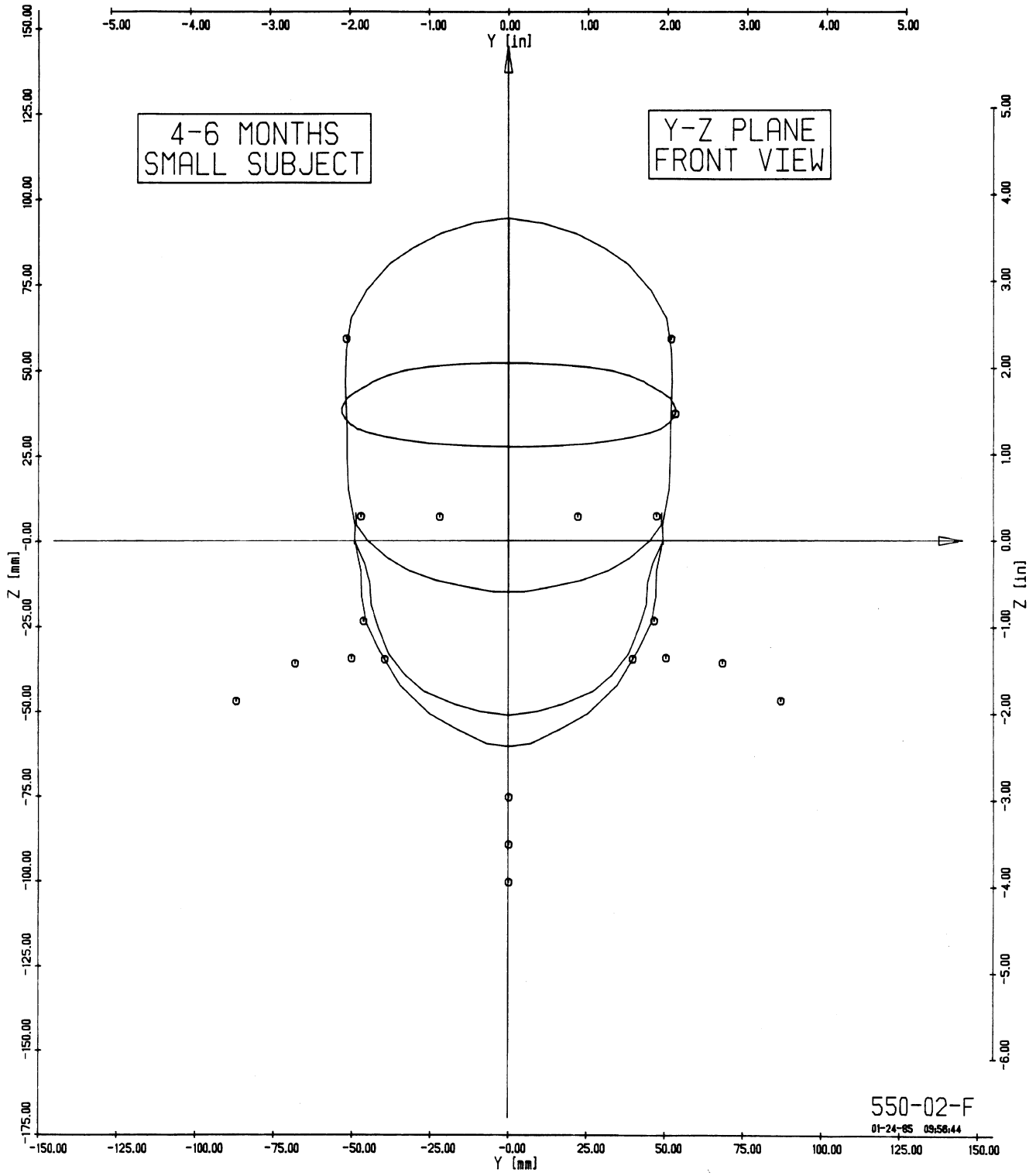
Index to Section Results

Group/Subject		Page No.
4 TO 6 MONTHS:	SMALL	316
	AVERAGE	320
	LARGE	324
13 TO 18 MONTHS:	SMALL	328
	AVERAGE	332
	LARGE	336
25 TO 30 MONTHS:	SMALL	340
	AVERAGE	344
	LARGE	348
43 TO 48 MONTHS:	SMALL	352
	AVERAGE	356
	LARGE	360

HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

4-6 MONTHS SMALL SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 49.6	0.0
2. Under Eye (Infraorbitale)	55.5	± 22.1	7.2
3. Above Nose (Sellion)	62.3	0.0	21.4
4. Forehead (Glabella)	62.2	0.0	52.7
5. Top of Head (Vertex)	-30.6	0.0	92.7
6. Back of Head (Opisthocranion)	-86.4	0.0	27.9
7. Head/Neck Junction	-65.0	0.0	-14.7
8. Tip of Chin (Menton)	n/a	n/a	n/a
9. Upper Cheek (Zygion)	27.6	± 47.2	7.3
10. Back of Jaw (Gonion)	16.1	± 46.4	-23.4
11. Maximum Head Breadth Point	-35.8	± 51.9	59.3
12. Head Breadth @ Circumference Point	-27.8	± 53.3	39.1
13. Neck Depth Point at Front	n/a	n/a	n/a
14. Suprasternale	n/a	n/a	n/a
15. Front Torso # 1	34.7	0.0	-75.3
16. Front Torso # 2	35.3	0.0	-89.2
17. Torso Depth Point at Front	35.6	0.0	-100.3
18. Neck Depth Point at Back	-54.8	0.0	-32.8
19. 7th Cervical Vertebra (Cervicale)	-54.7	0.0	-38.9
20. Back Torso # 1	-61.5	0.0	-52.1
21. Back Torso # 2	-63.0	0.0	-60.6
22. Torso Depth Point at Back	n/a	n/a	n/a
23. Neck Breadth Point at Side	n/a	n/a	n/a
24. Shoulder # 1	n/a	n/a	n/a
25. Shoulder # 2	-5.4	± 39.6	-34.6
26. Top of Shoulder	-2.0	± 50.2	-34.3
27. Shoulder # 3	4.0	± 68.2	-35.8
28. Shoulder Circumference Point	9.5	± 86.9	-46.9


4-6 MONTHS
SMALL SUBJECT
Y-Z PLANE
FRONT VIEW
Y [in]
Z [mm]
Z [in]
Y [mm]
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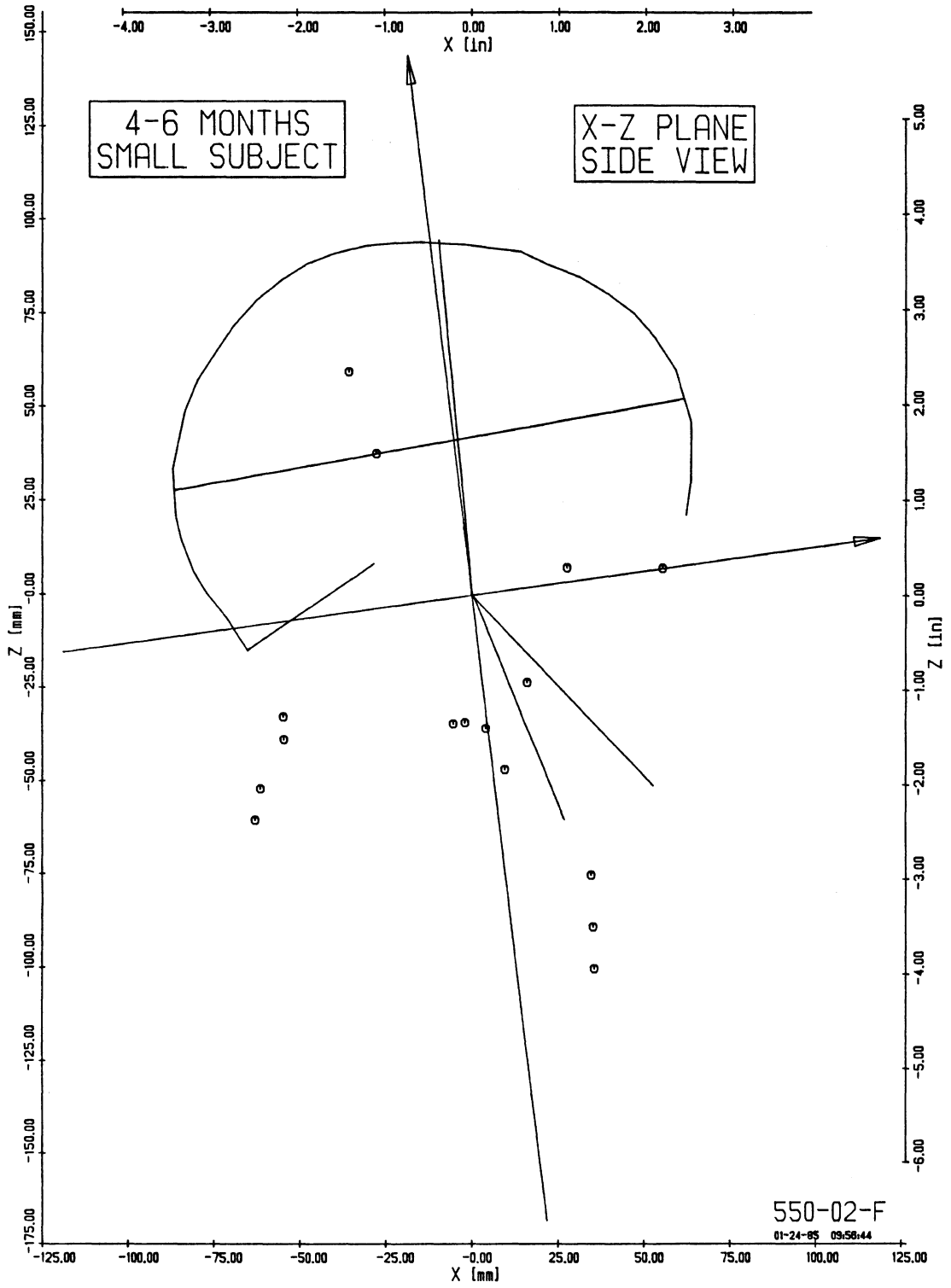
4-6 MONTHS
SMALL SUBJECT
X-Z PLANE
SIDE VIEW
X [in]
Z [mm]
Z [in]
X [mm]
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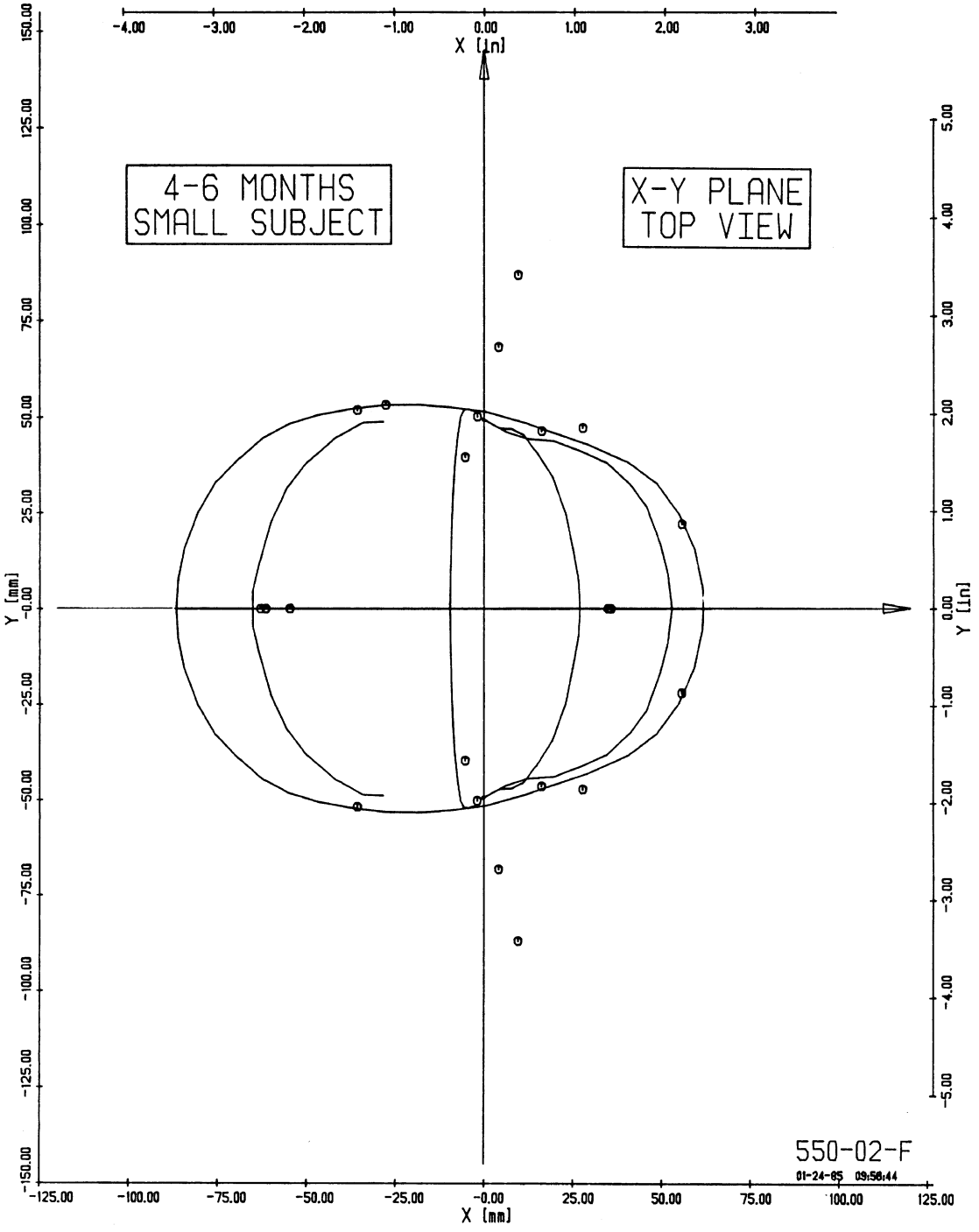
4-6 MONTHS
SMALL SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [in]
X [mm]
Y [mm]
550-02-F
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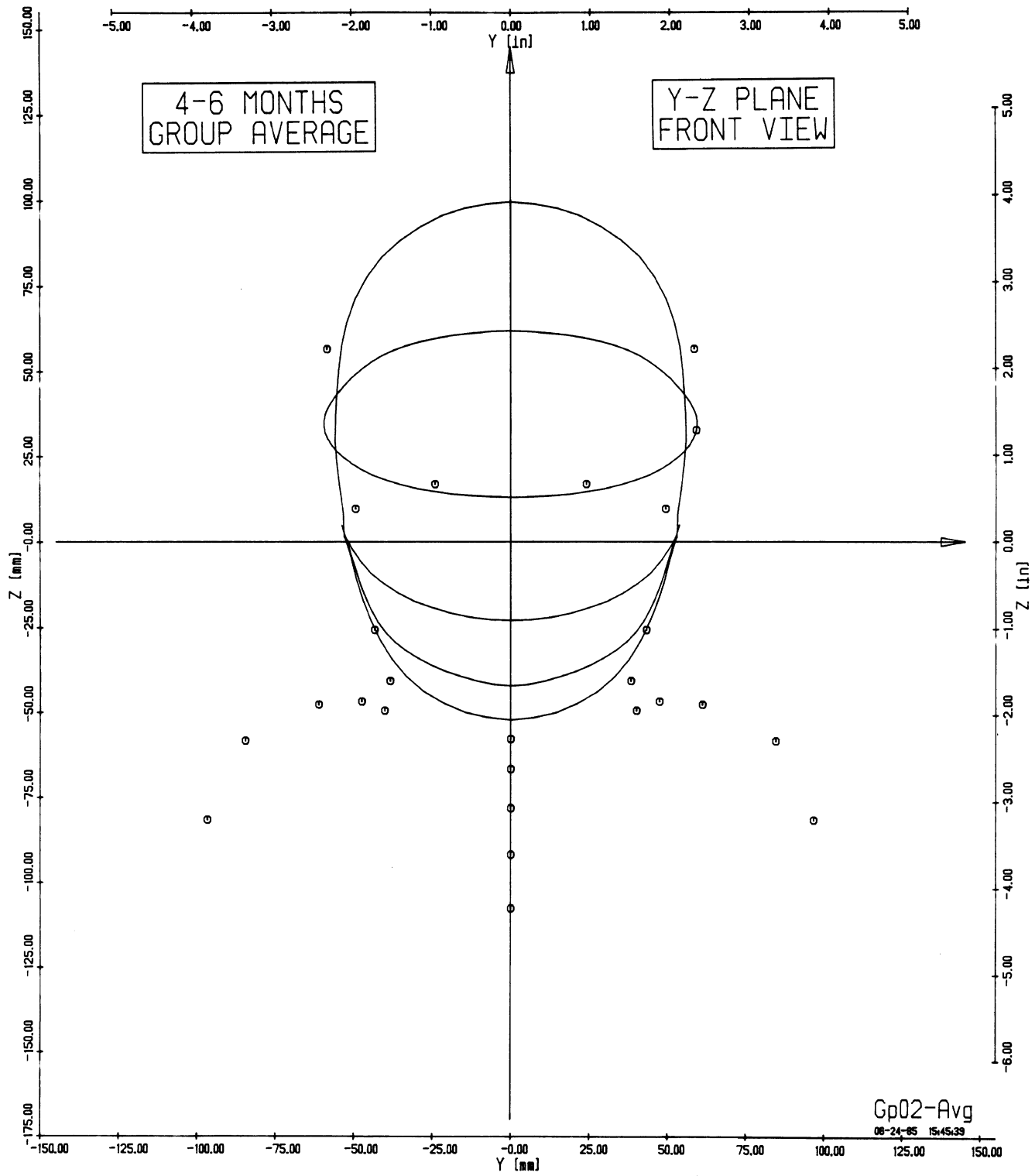
HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

4-6 MONTHS GROUP AVERAGE

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 52.5	0.0
2. Under Eye (Infraorbitale)	55.6	± 24.0	16.9
3. Above Nose (Sellion)	59.9	0.0	33.5
4. Forehead (Glabella)	57.0	0.0	61.9
5. Top of Head (Vertex)	-44.5	0.0	98.0
6. Back of Head (Opisthocranion)	-91.9	0.0	13.8
7. Head/Neck Junction	-62.6	0.0	-22.9
8. Tip of Chin (Menton)	57.1	0.0	-43.1
9. Upper Cheek (Zygion)	26.6	± 49.4	9.6
10. Back of Jaw (Gonion)	18.3	± 43.4	-25.6
11. Maximum Head Breadth Point	-36.9	± 58.4	56.5
12. Head Breadth @ Circumference Point	-32.3	± 59.2	32.7
13. Neck Depth Point at Front	17.4	0.0	-57.8
14. Suprasternale	24.1	0.0	-66.6
15. Front Torso # 1	28.4	0.0	-78.1
16. Front Torso # 2	32.2	0.0	-91.7
17. Torso Depth Point at Front	33.5	0.0	-107.5
18. Neck Depth Point at Back	-57.1	0.0	-34.0
19. 7th Cervical Vertebra (Cervicale)	-58.5	0.0	-44.5
20. Back Torso # 1	-64.0	0.0	-58.9
21. Back Torso # 2	-69.5	0.0	-74.5
22. Torso Depth Point at Back	-75.3	0.0	-91.4
23. Neck Breadth Point at Side	-14.8	± 38.3	-40.6
24. Shoulder # 1	-20.6	± 40.1	-49.4
25. Shoulder # 2	-20.5	± 47.4	-46.7
26. Top of Shoulder	-19.7	± 61.1	-47.6
27. Shoulder # 3	-14.3	± 84.5	-58.3
28. Shoulder Circumference Point	-16.0	± 96.6	-81.5


4-6 MONTHS
GROUP AVERAGE
Y-Z PLANE
FRONT VIEW
Y [in]
Z [mm]
Z [in]
Y [mm]
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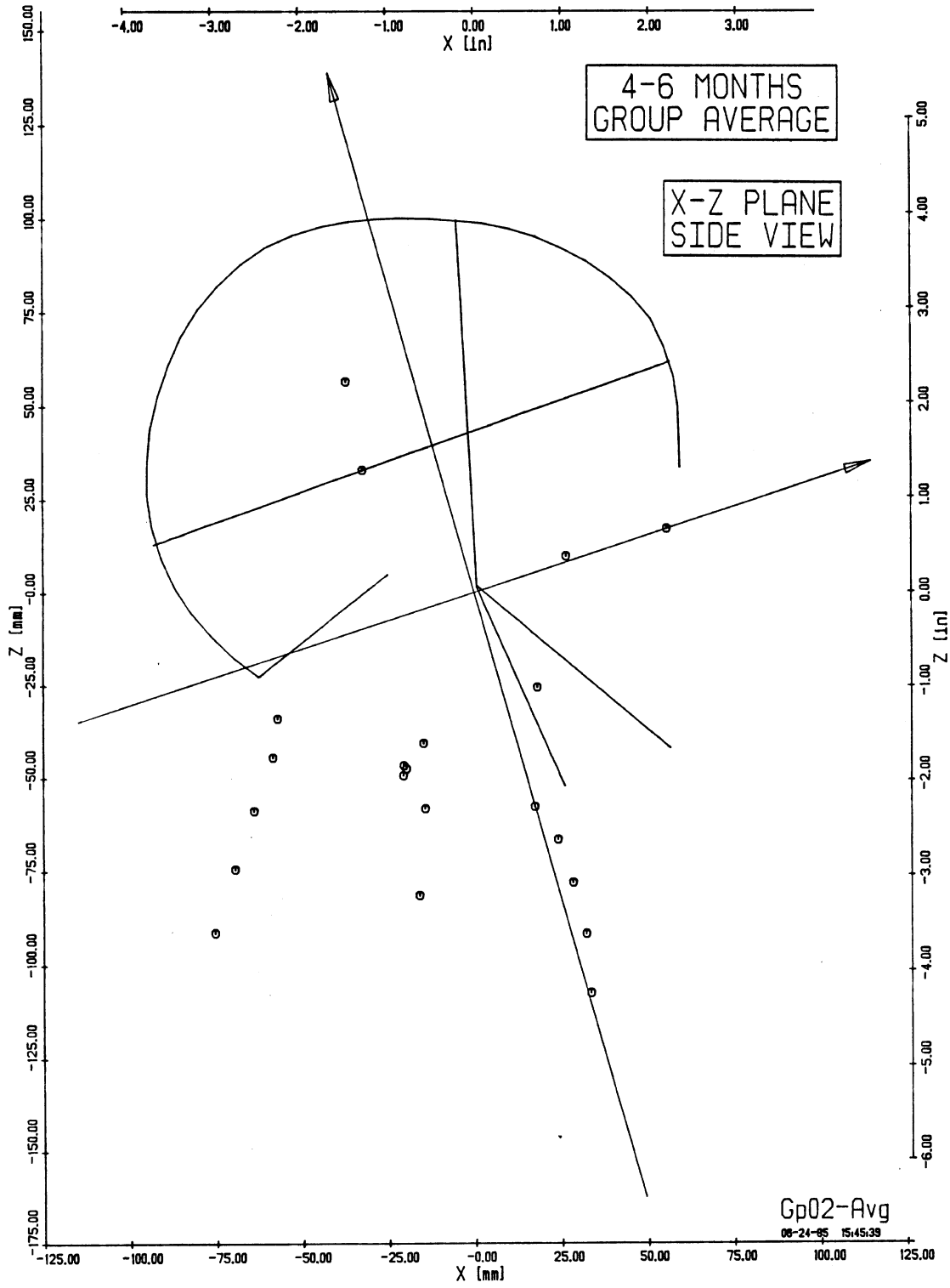
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GROUP AVERAGE
X-Z PLANE
SIDE VIEW
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Z [in]
X [mm]
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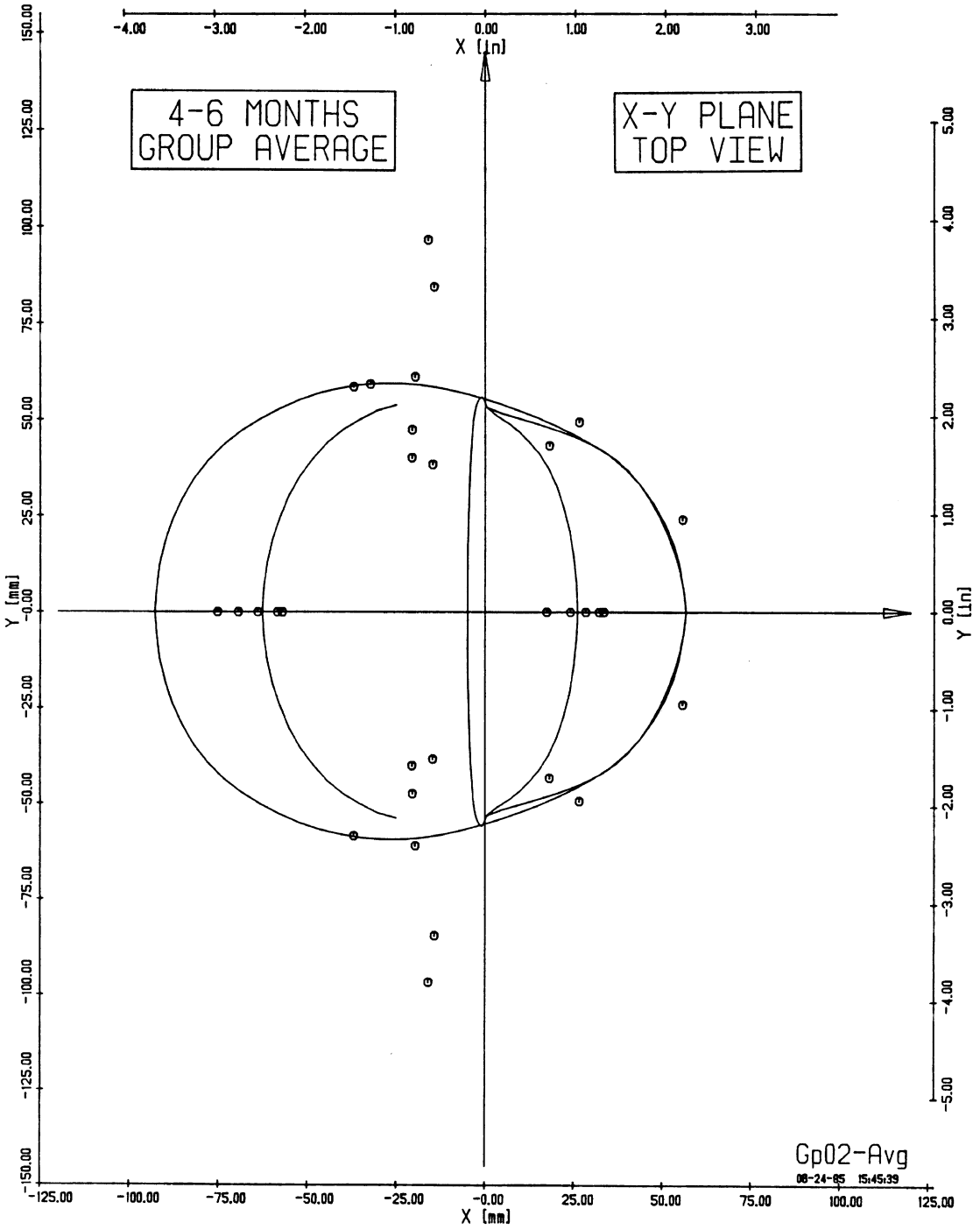
4-6 MONTHS
GROUP AVERAGE
X-Y PLANE
TOP VIEW
X [in]
Y [mm]
Y [in]
X [mm]
Gp02-Avg
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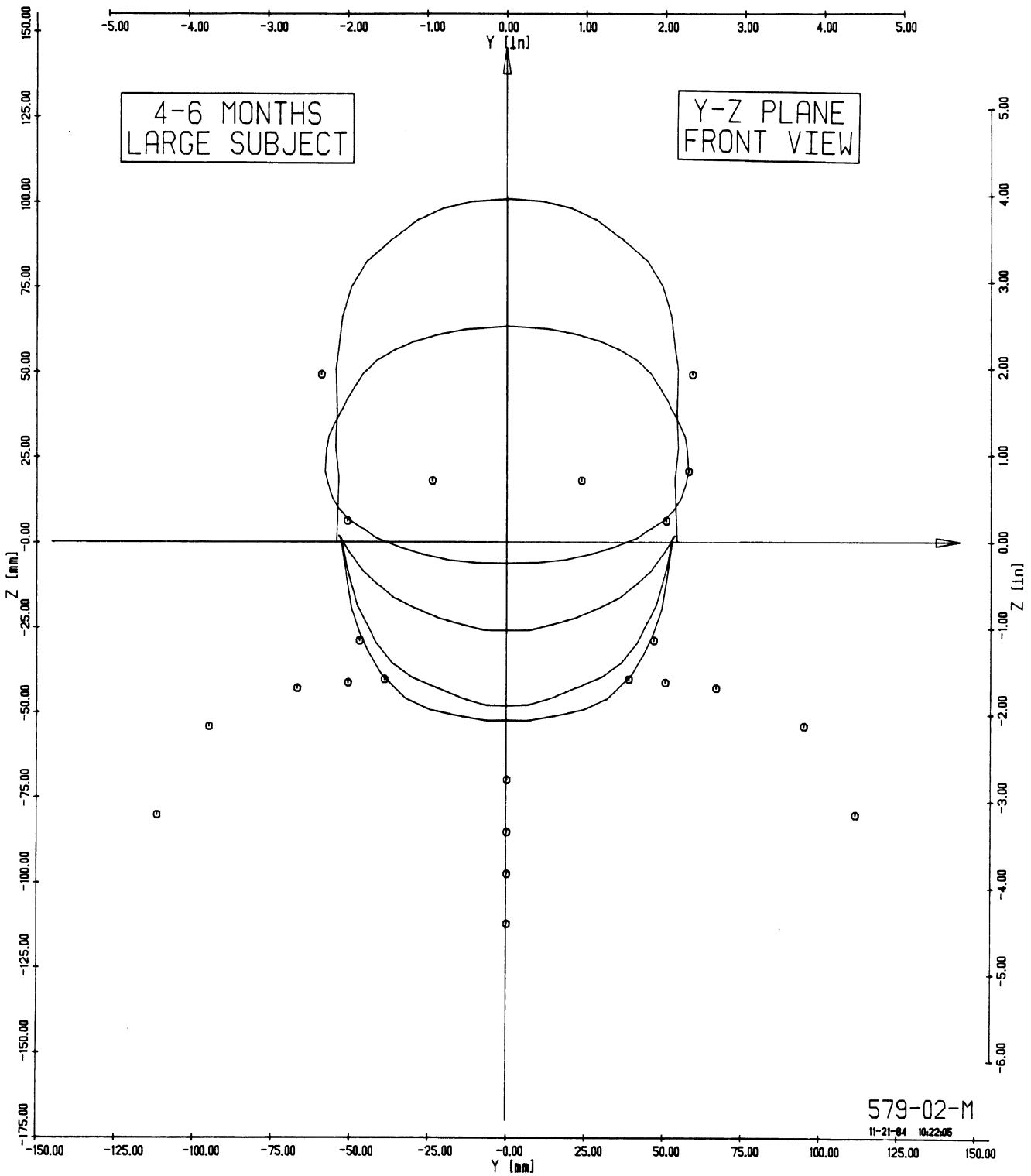
HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

4-6 MONTHS LARGE SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 54.5	0.0
2. Under Eye (Infraorbitale)	60.6	± 23.8	18.1
3. Above Nose (Sellion)	65.7	0.0	34.2
4. Forehead (Glabella)	60.7	0.0	64.2
5. Top of Head (Vertex)	-56.2	0.0	96.0
6. Back of Head (Opisthocranion)	-92.3	0.0	-6.3
7. Head/Neck Junction	-64.5	0.0	-26.7
8. Tip of Chin (Menton)	60.7	0.0	-50.1
9. Upper Cheek (Zygion)	19.7	± 50.9	6.3
10. Back of Jaw (Gonion)	19.9	± 46.9	-28.9
11. Maximum Head Breadth Point	-43.4	± 59.2	49.1
12. Head Breadth @ Circumference Point	-34.1	± 57.8	23.9
13. Neck Depth Point at Front	n/a	n/a	n/a
14. Suprasternale	26.7	0.0	-69.8
15. Front Torso # 1	30.2	0.0	-85.1
16. Front Torso # 2	31.5	0.0	-97.4
17. Torso Depth Point at Front	33.3	0.0	-112.1
18. Neck Depth Point at Back	n/a	n/a	n/a
19. 7th Cervical Vertebra (Cervicale)	-60.4	0.0	-44.1
20. Back Torso # 1	-69.1	0.0	-64.8
21. Back Torso # 2	n/a	n/a	n/a
22. Torso Depth Point at Back	n/a	n/a	n/a
23. Neck Breadth Point at Side	-12.0	± 39.0	-40.3
24. Shoulder # 1	n/a	n/a	n/a
25. Shoulder # 2	-20.4	± 50.6	-41.3
26. Top of Shoulder	-23.0	± 66.8	-42.9
27. Shoulder # 3	-18.1	± 94.9	-54.1
28. Shoulder Circumference Point	-28.0	±111.5	-80.1


4-6 MONTHS
LARGE SUBJECT
Y-Z PLANE
FRONT VIEW
Y [in]
Z [mm]
Z [in]
Y [mm]
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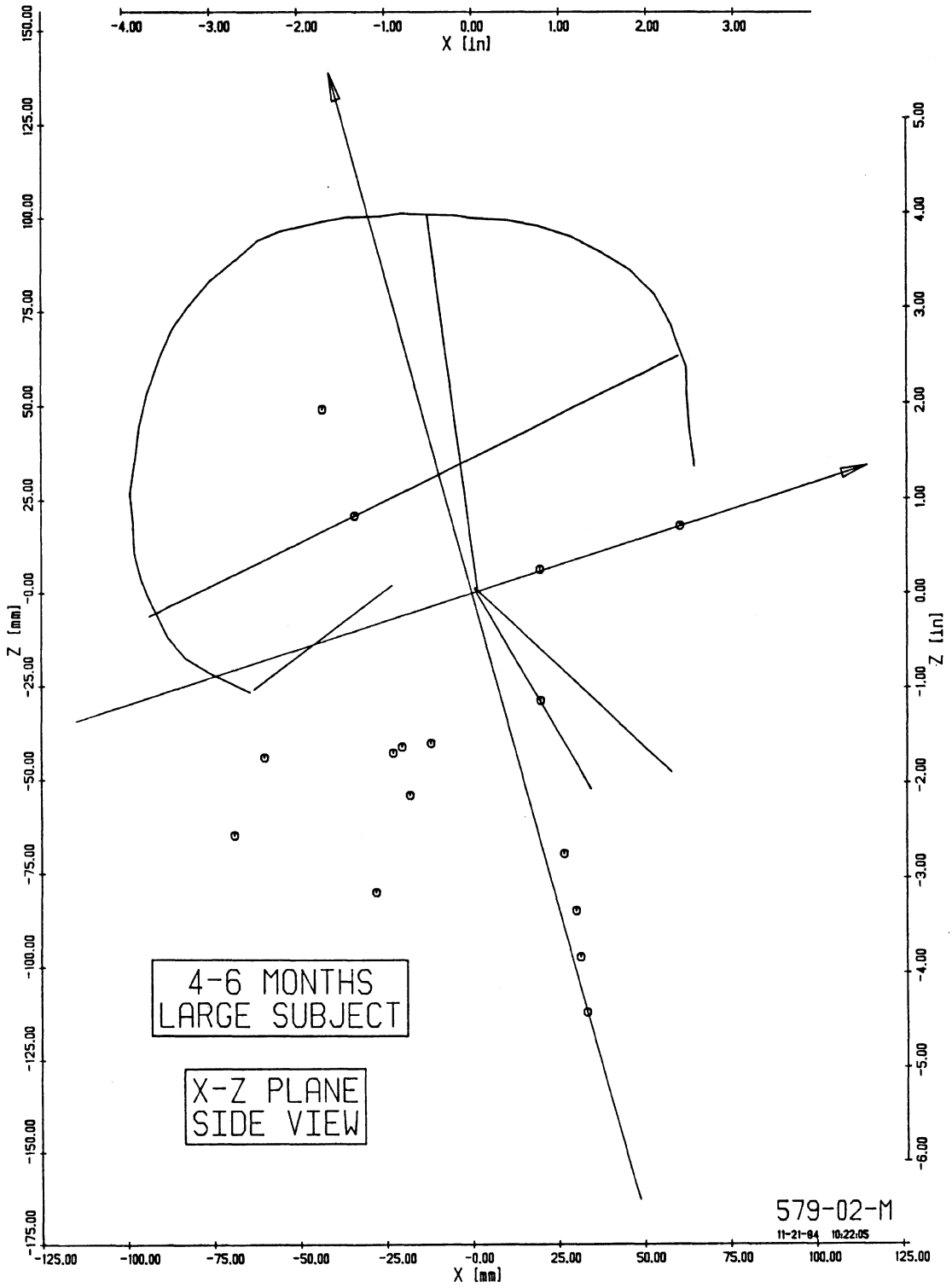
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X [mm]
4-6 MONTHS
LARGE SUBJECT
X-Z PLANE
SIDE VIEW
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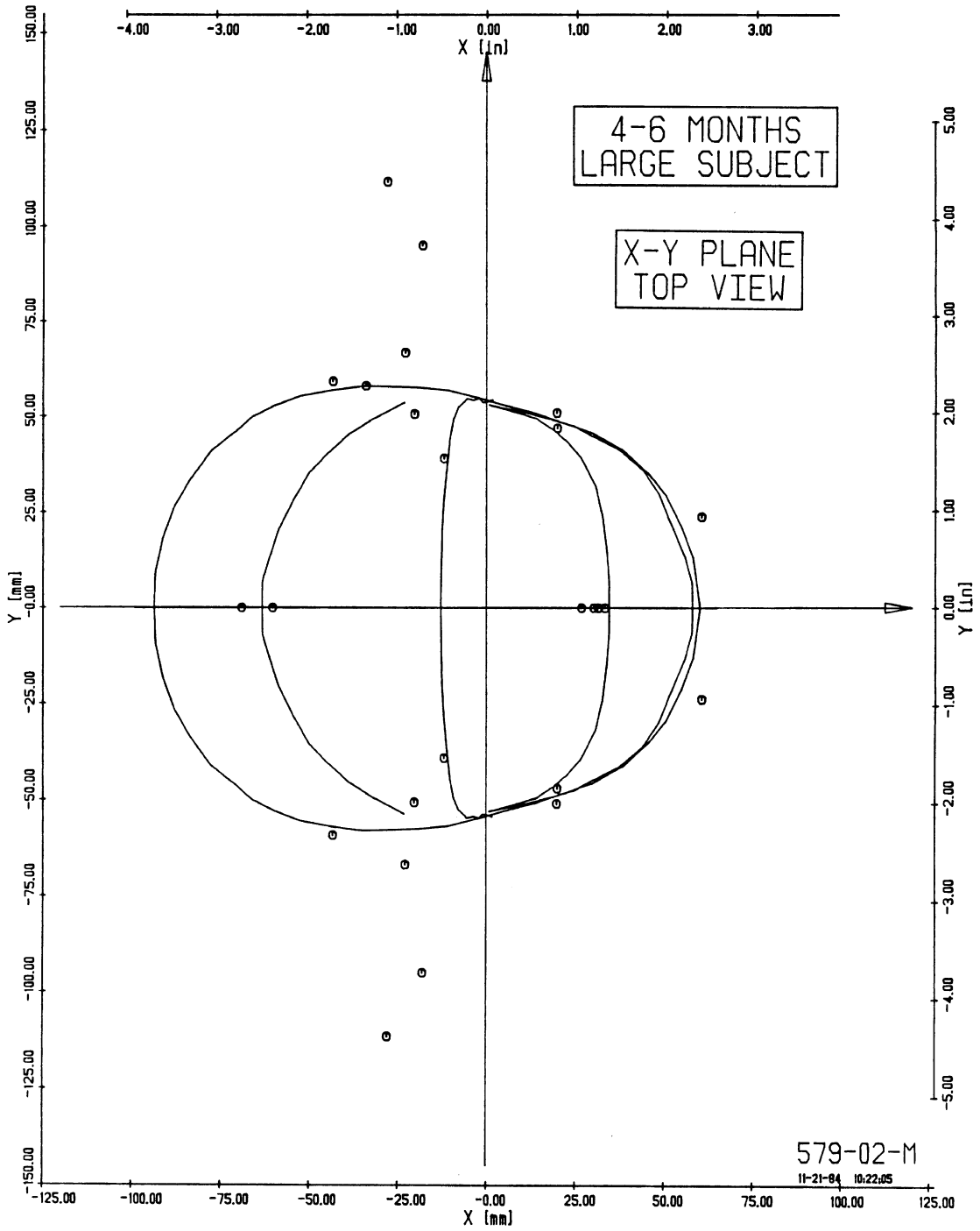
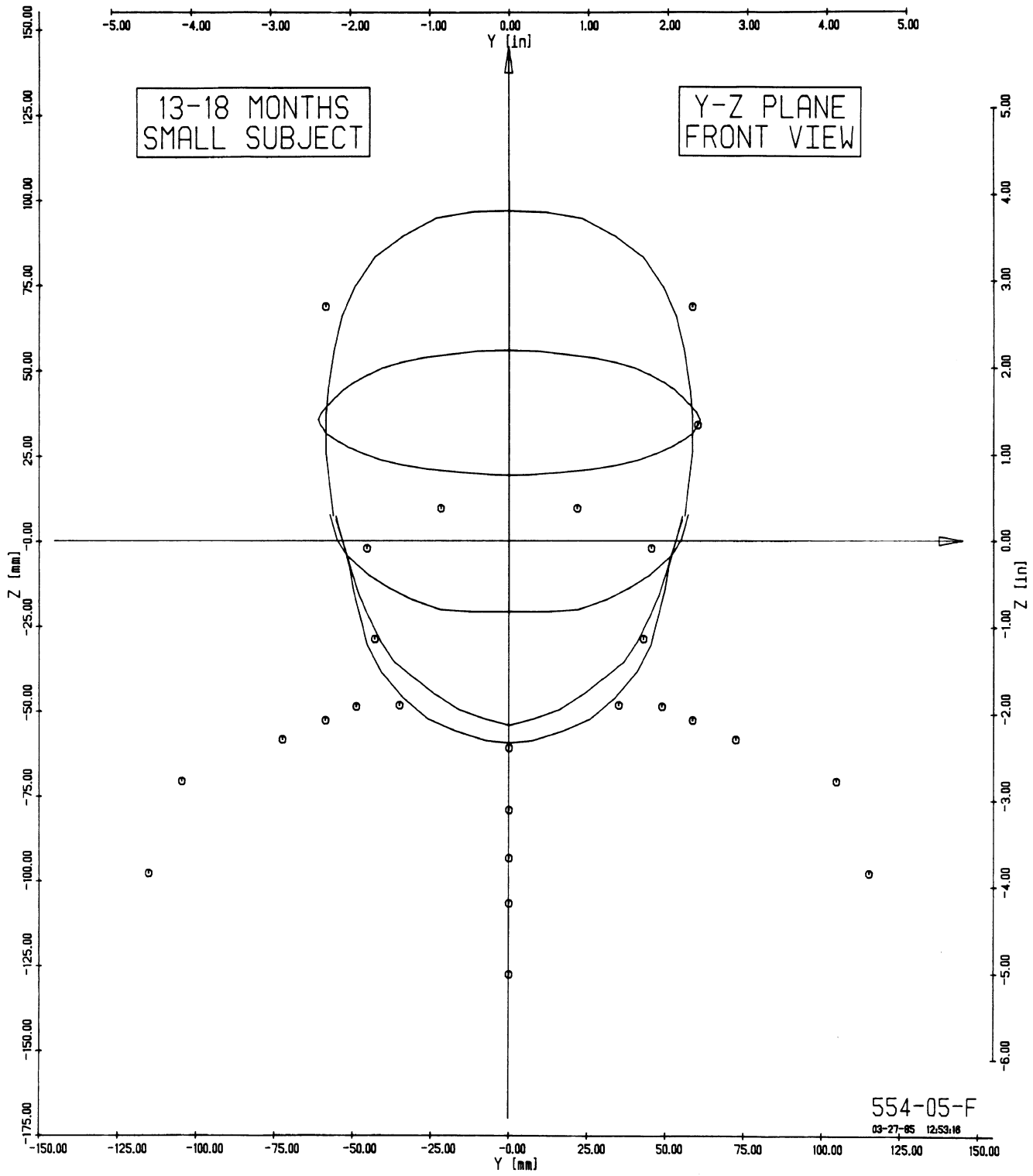

4-6 MONTHS
LARGE SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [in]
X [mm]
Y [mm]
579-02-M
11-21-94 10:22:05

HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

13-18 MONTHS SMALL SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 53.1	0.0
2. Under Eye (Infraorbitale)	56.8	± 21.8	9.7
3. Above Nose (Sellion)	64.5	0.0	24.1
4. Forehead (Glabella)	65.0	0.0	56.0
5. Top of Head (Vertex)	-42.2	0.0	103.8
6. Back of Head (Opisthocranion)	-95.1	0.0	19.6
7. Head/Neck Junction	-66.7	0.0	-21.2
8. Tip of Chin (Menton)	54.8	0.0	-53.4
9. Upper Cheek (Zygion)	30.1	± 45.4	-2.1
10. Back of Jaw (Gonion)	12.3	± 42.9	-28.8
11. Maximum Head Breadth Point	-39.9	± 58.5	68.7
12. Head Breadth @ Circumference Point .	-30.7	± 61.0	35.8
13. Neck Depth Point at Front	11.9	0.0	-60.7
14. Suprasternale	13.4	0.0	-79.0
15. Front Torso # 1	20.4	0.0	-93.2
16. Front Torso # 2	22.2	0.0	-106.5
17. Torso Depth Point at Front	25.1	0.0	-127.3
18. Neck Depth Point at Back	-50.3	0.0	-40.1
19. 7th Cervical Vertebra (Cervicale) ..	-52.9	0.0	-47.2
20. Back Torso # 1	-62.0	0.0	-61.6
21. Back Torso # 2	-68.0	0.0	-80.8
22. Torso Depth Point at Back	-75.8	0.0	-106.0
23. Neck Breadth Point at Side	-14.1	± 35.0	-48.2
24. Shoulder # 1	-13.5	± 48.8	-48.6
25. Shoulder # 2	-11.0	± 58.6	-52.6
26. Top of Shoulder	-0.8	± 72.3	-58.2
27. Shoulder # 3	4.2	±104.5	-70.5
28. Shoulder Circumference Point	6.7	±115.0	-97.7


13-18 MONTHS
SMALL SUBJECT
Y-Z PLANE
FRONT VIEW
Y [in]
Z [in]
Z [mm]
Y [mm]
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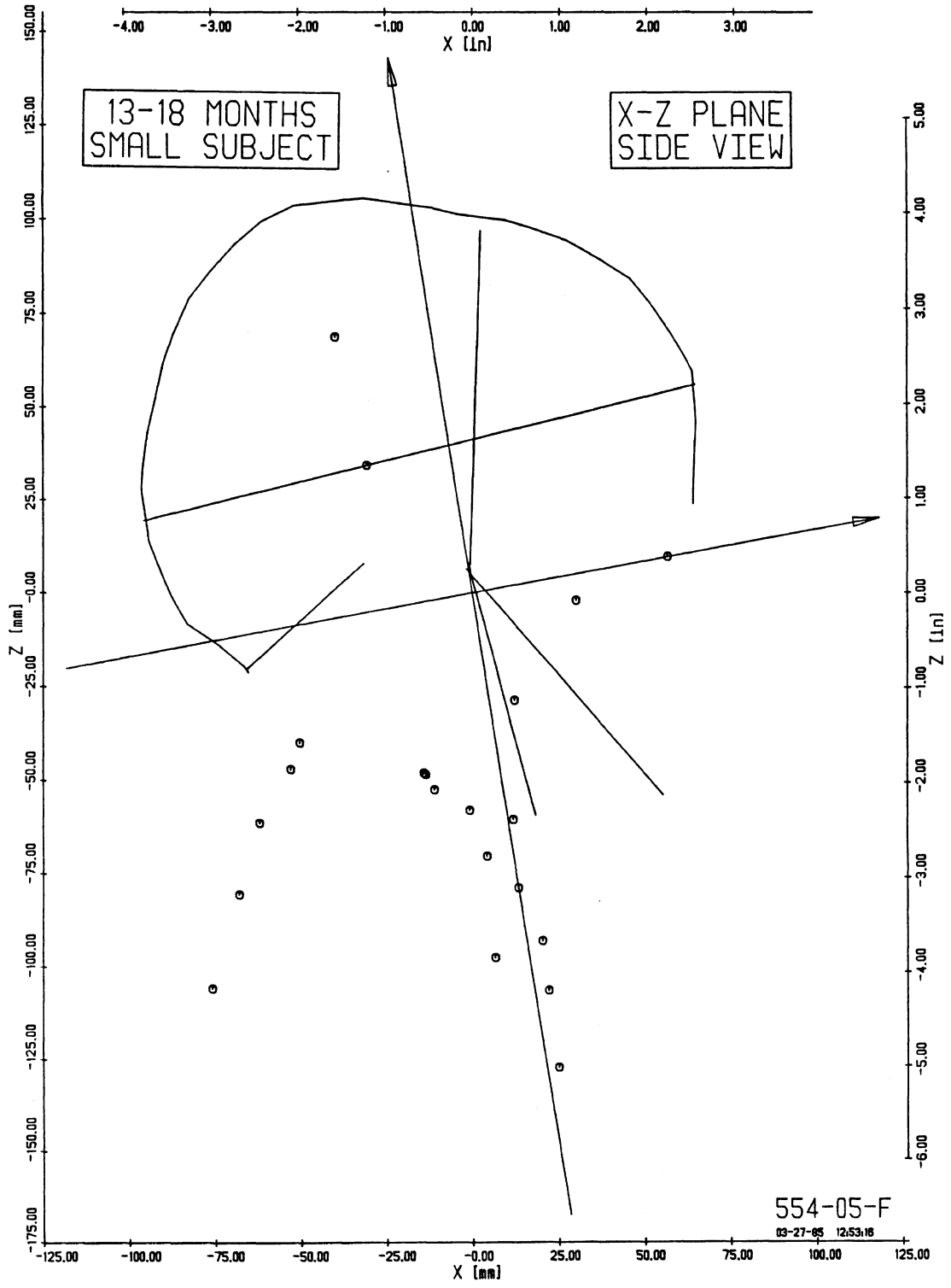
13-18 MONTHS
SMALL SUBJECT
X-Z PLANE
SIDE VIEW
X [in]
Z [mm]
Z [in]
X [mm]
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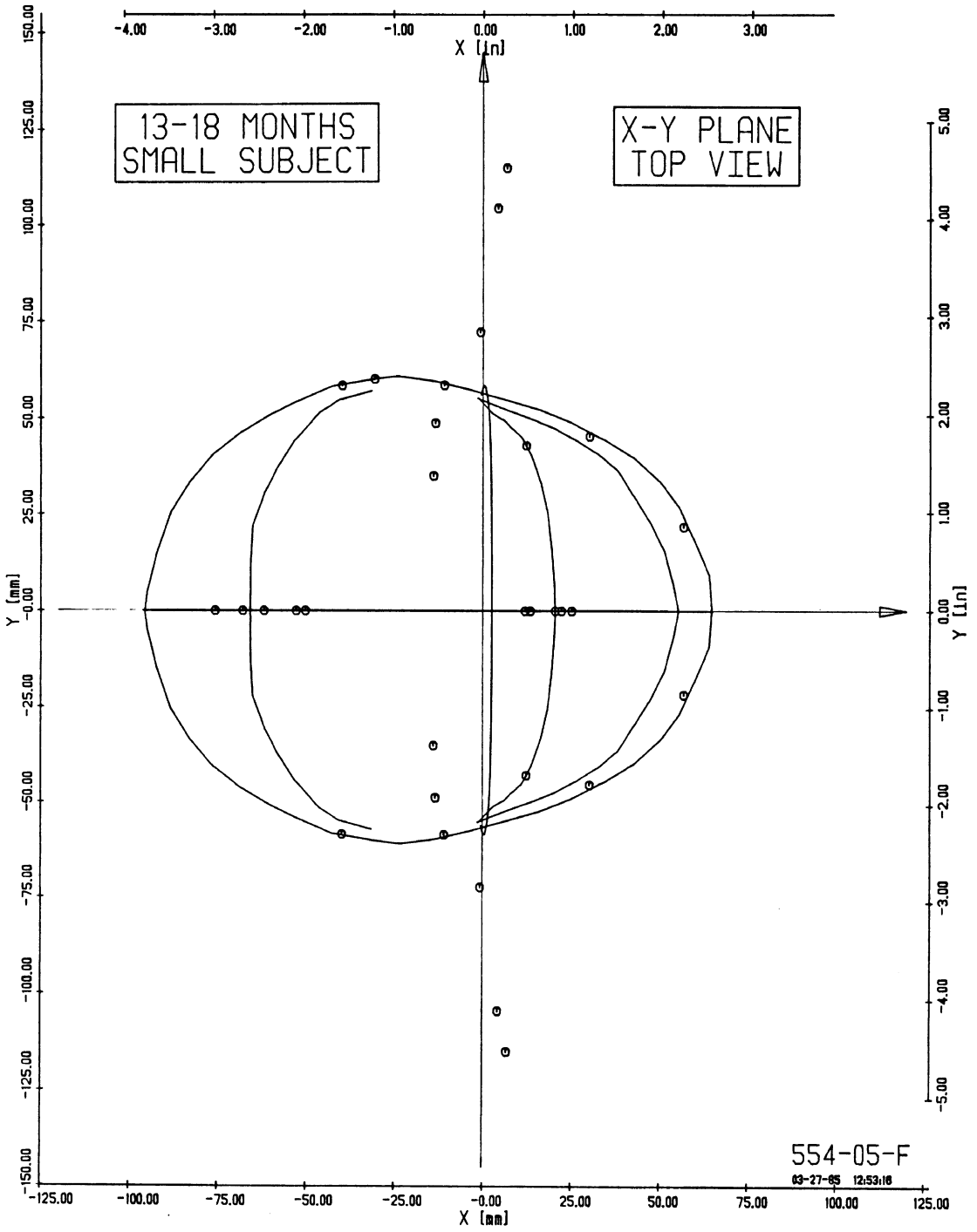
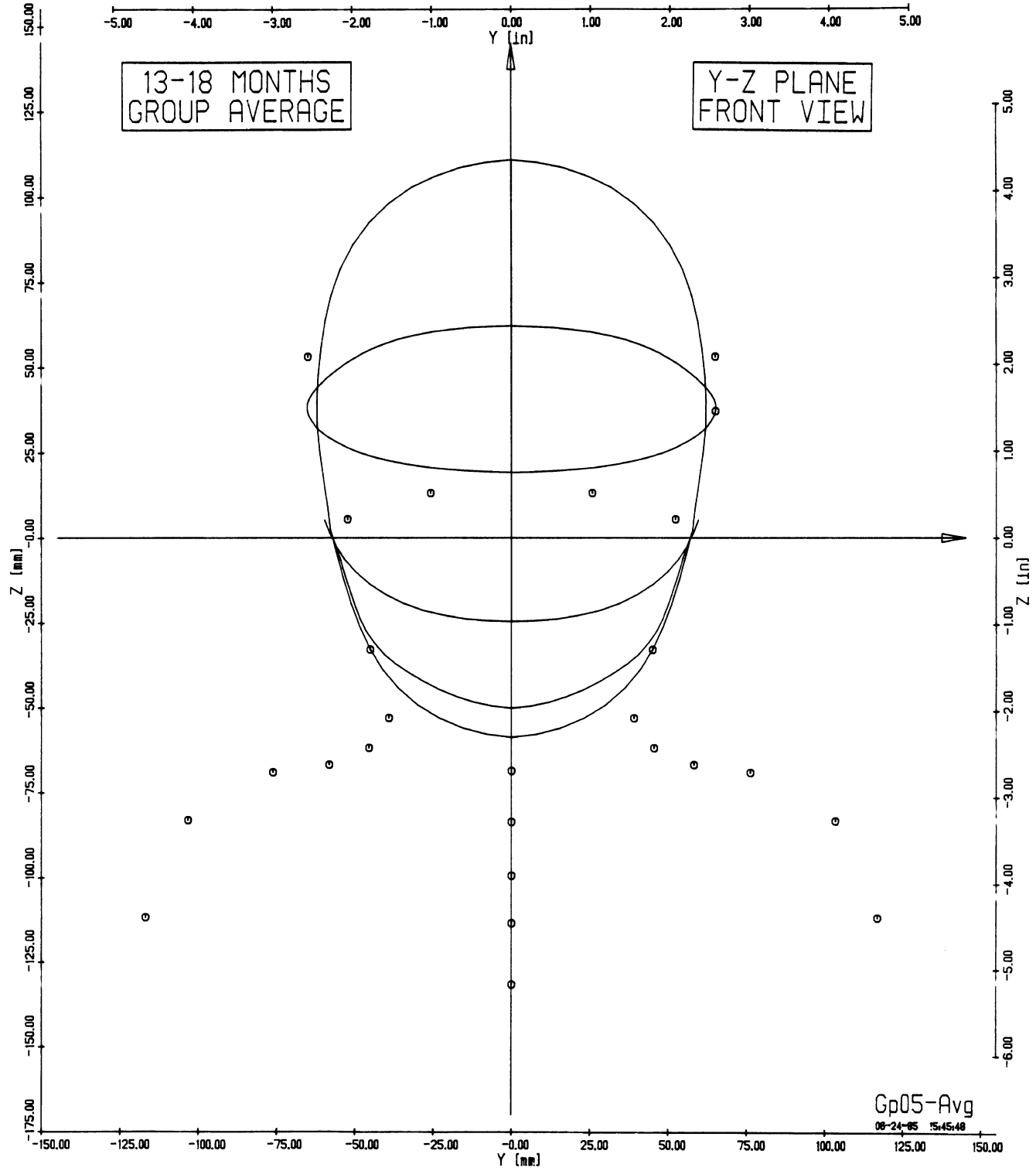

13-18 MONTHS
SMALL SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [in]
X [mm]
Y [mm]
554-05-F
03-27-85 12:53:16

HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

13-18 MONTHS GROUP AVERAGE

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 57.9	0.0
2. Under Eye (Infraorbitale)	61.0	± 25.8	13.2
3. Above Nose (Sellion)	69.6	0.0	28.0
4. Forehead (Glabella)	69.7	0.0	62.1
5. Top of Head (Vertex)	-44.5	0.0	109.4
6. Back of Head (Opisthocranion)	-97.5	0.0	19.4
7. Head/Neck Junction	-66.7	0.0	-24.3
8. Tip of Chin (Menton)	65.2	0.0	-49.8
9. Upper Cheek (Zygion)	31.3	± 52.3	5.5
10. Back of Jaw (Gonion)	21.3	± 45.0	-32.9
11. Maximum Head Breadth Point	-29.6	± 64.9	53.1
12. Head Breadth @ Circumference Point .	-28.1	± 64.7	36.0
13. Neck Depth Point at Front	17.6	0.0	-68.4
14. Suprasternale	20.2	0.0	-83.4
15. Front Torso # 1	28.2	0.0	-99.2
16. Front Torso # 2	35.3	0.0	-113.3
17. Torso Depth Point at Front	39.0	0.0	-131.4
18. Neck Depth Point at Back	-55.1	0.0	-43.9
19. 7th Cervical Vertebra (Cervicale) ..	-58.2	0.0	-57.2
20. Back Torso # 1	-66.7	0.0	-77.6
21. Back Torso # 2	-74.2	0.0	-100.6
22. Torso Depth Point at Back	-81.0	0.0	-127.1
23. Neck Breadth Point at Side	-14.3	± 39.0	-52.8
24. Shoulder # 1	-18.4	± 45.4	-61.7
25. Shoulder # 2	-19.4	± 58.1	-66.6
26. Top of Shoulder	-17.5	± 76.1	-68.9
27. Shoulder # 3	-9.5	±103.2	-83.0
28. Shoulder Circumference Point	-10.6	±116.7	-111.6


13-18 MONTHS
GROUP AVERAGE
Y-Z PLANE
FRONT VIEW
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Z [mm]
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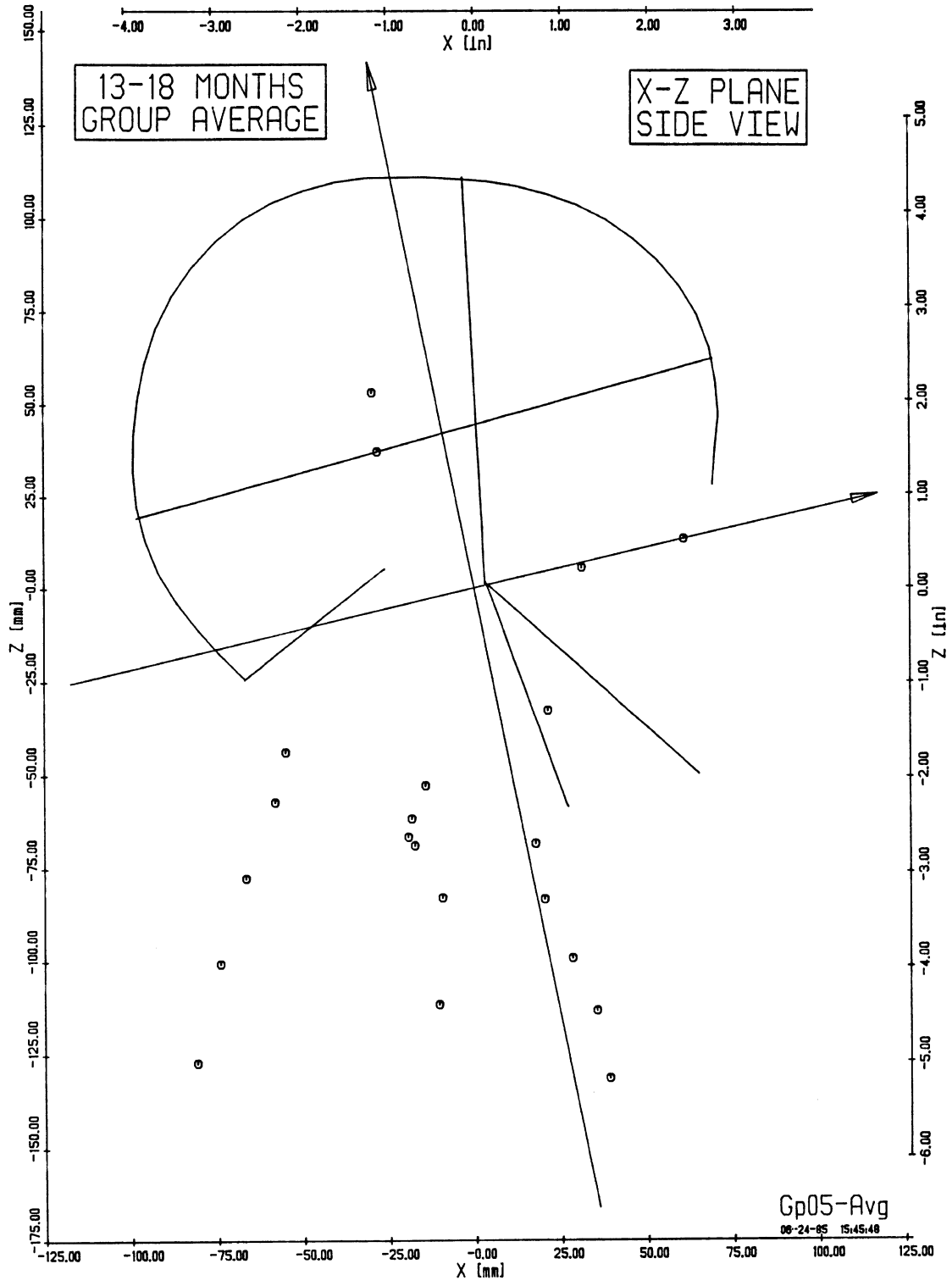
13-18 MONTHS
GROUP AVERAGE
X-Z PLANE
SIDE VIEW
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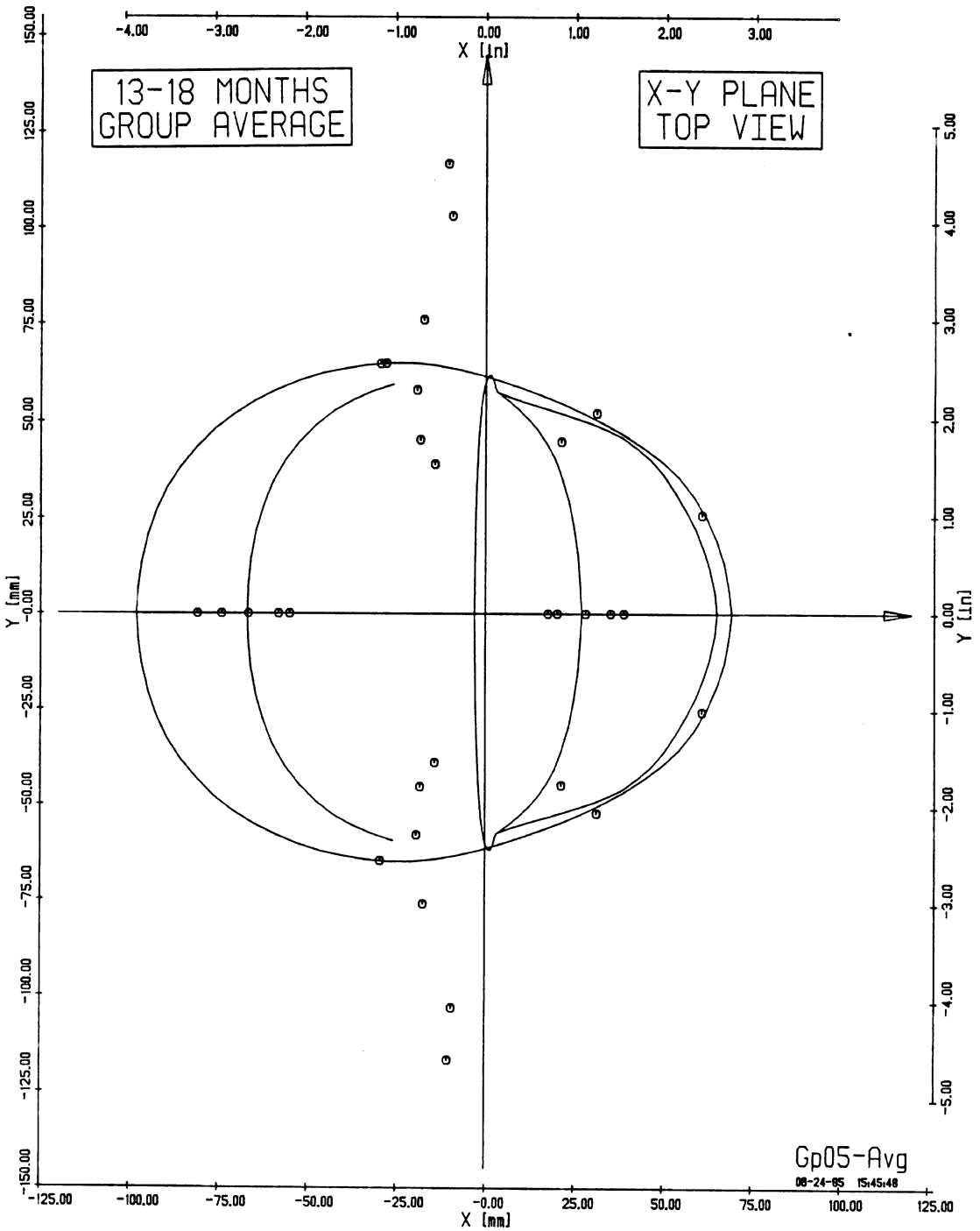
13-18 MONTHS
GROUP AVERAGE
X-Y PLANE
TOP VIEW
X [in]
Y [in]
X [mm]
Y [mm]
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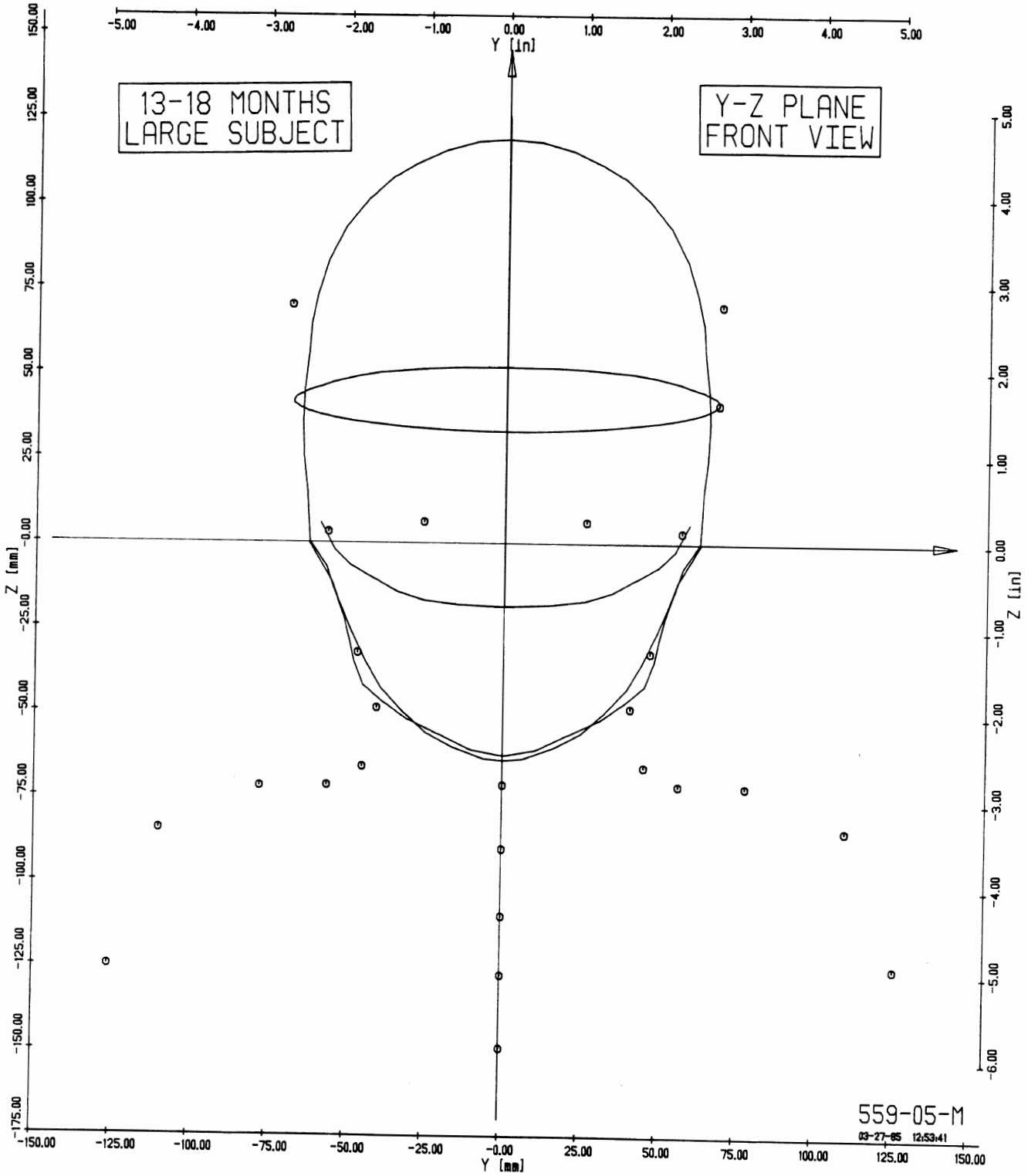
08-24-05 15:45:48

HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

13-18 MONTHS LARGE SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 63.1	0.0
2. Under Eye (Infraorbitale)	68.8	± 26.0	6.3
3. Above Nose (Sellion)	80.9	0.0	17.2
4. Forehead (Glabella)	87.1	0.0	51.5
5. Top of Head (Vertex)	-27.9	0.0	124.8
6. Back of Head (Opisthocranion)	-90.9	0.0	32.6
7. Head/Neck Junction	-64.4	0.0	-18.3
8. Tip of Chin (Menton)	60.5	0.0	-62.6
9. Upper Cheek (Zygion)	36.9	± 56.6	3.3
10. Back of Jaw (Gonion)	15.8	± 46.8	-32.3
11. Maximum Head Breadth Point	-12.4	± 68.8	69.8
12. Head Breadth @ Circumference Point	-16.1	± 66.0	39.7
13. Neck Depth Point at Front	18.2	0.0	-71.2
14. Suprasternale	19.3	0.0	-89.9
15. Front Torso # 1	27.7	0.0	-109.8
16. Front Torso # 2	34.9	0.0	-127.3
17. Torso Depth Point at Front	40.3	0.0	-148.9
18. Neck Depth Point at Back	-54.7	0.0	-37.1
19. 7th Cervical Vertebra (Cervicale)	-59.1	0.0	-63.7
20. Back Torso # 1	-67.6	0.0	-88.2
21. Back Torso # 2	-76.5	0.0	-114.0
22. Torso Depth Point at Back	-86.1	0.0	-142.2
23. Neck Breadth Point at Side	-21.3	± 40.6	-48.6
24. Shoulder # 1	-22.6	± 45.1	-65.9
25. Shoulder # 2	-29.3	± 56.3	-71.4
26. Top of Shoulder	-37.4	± 77.7	-71.7
27. Shoulder # 3	-44.4	±109.9	-84.4
28. Shoulder Circumference Point	-56.3	±125.9	-124.9


13-18 MONTHS
LARGE SUBJECT
Y-Z PLANE
FRONT VIEW
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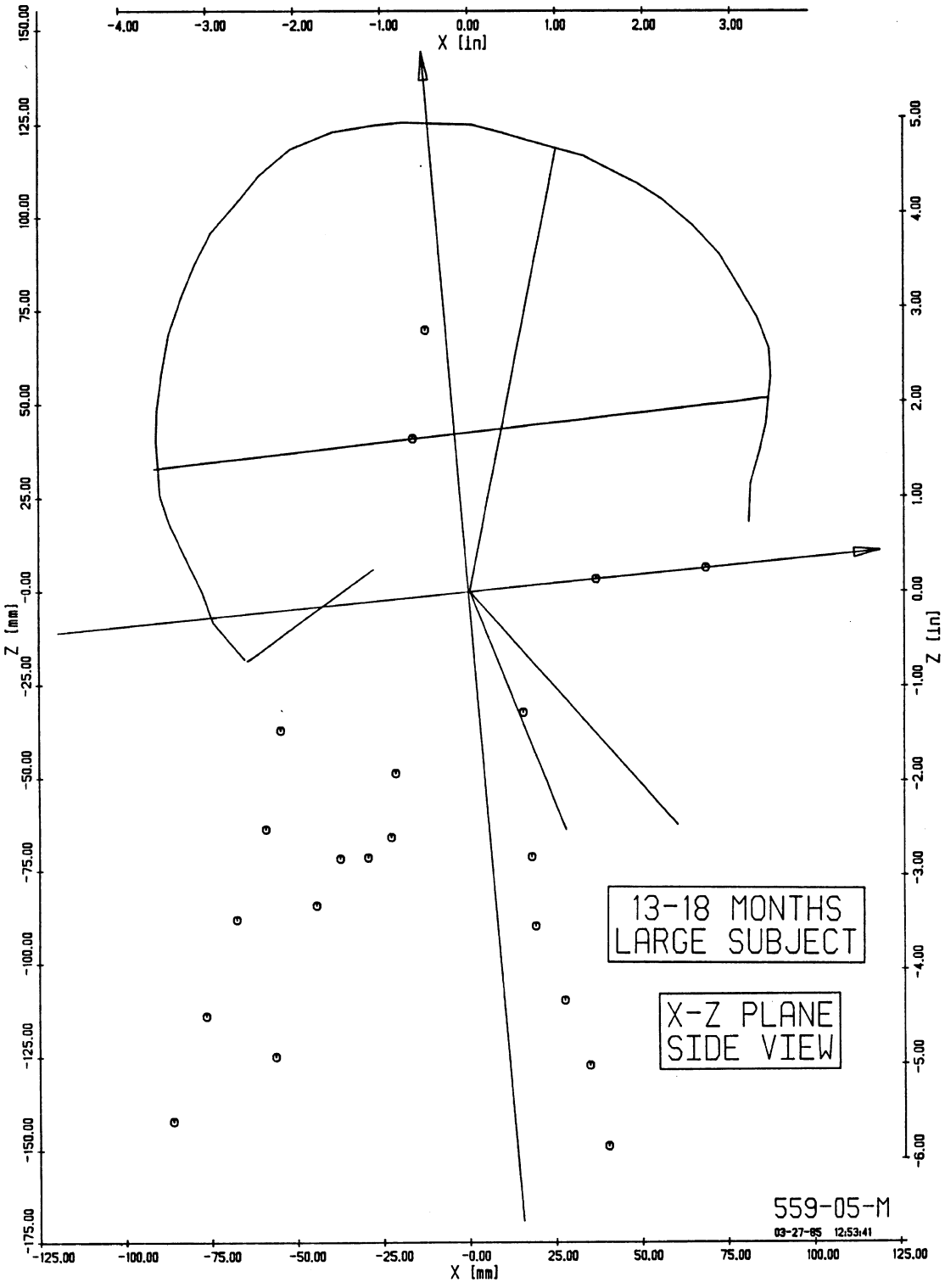
Z [mm]
Z [in]
Y [mm]
559-05-M
03-27-05 12:53:41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X [mm]
13-18 MONTHS
LARGE SUBJECT
X-Z PLANE
SIDE VIEW
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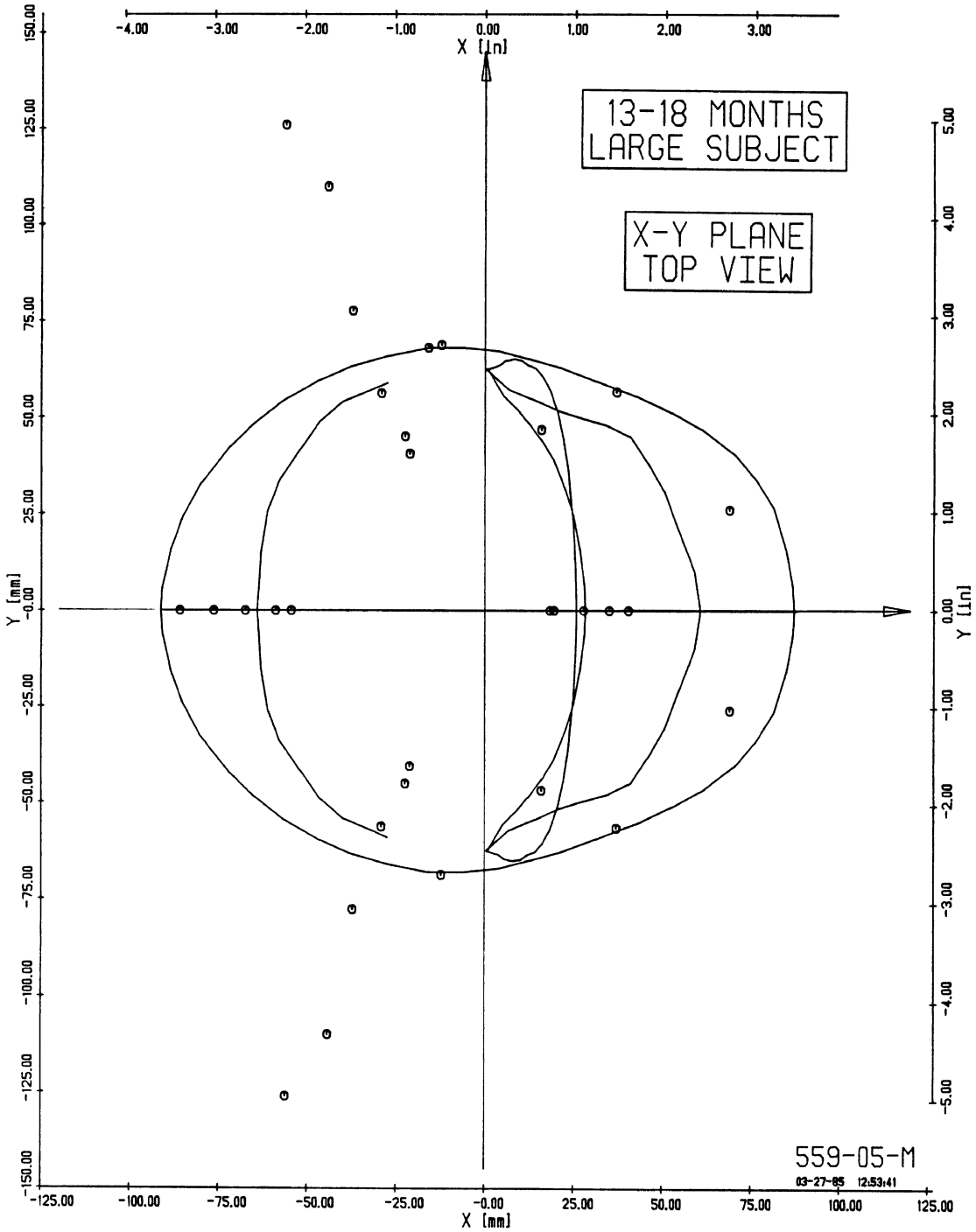
13-18 MONTHS
LARGE SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [in]
X [mm]
Y [mm]
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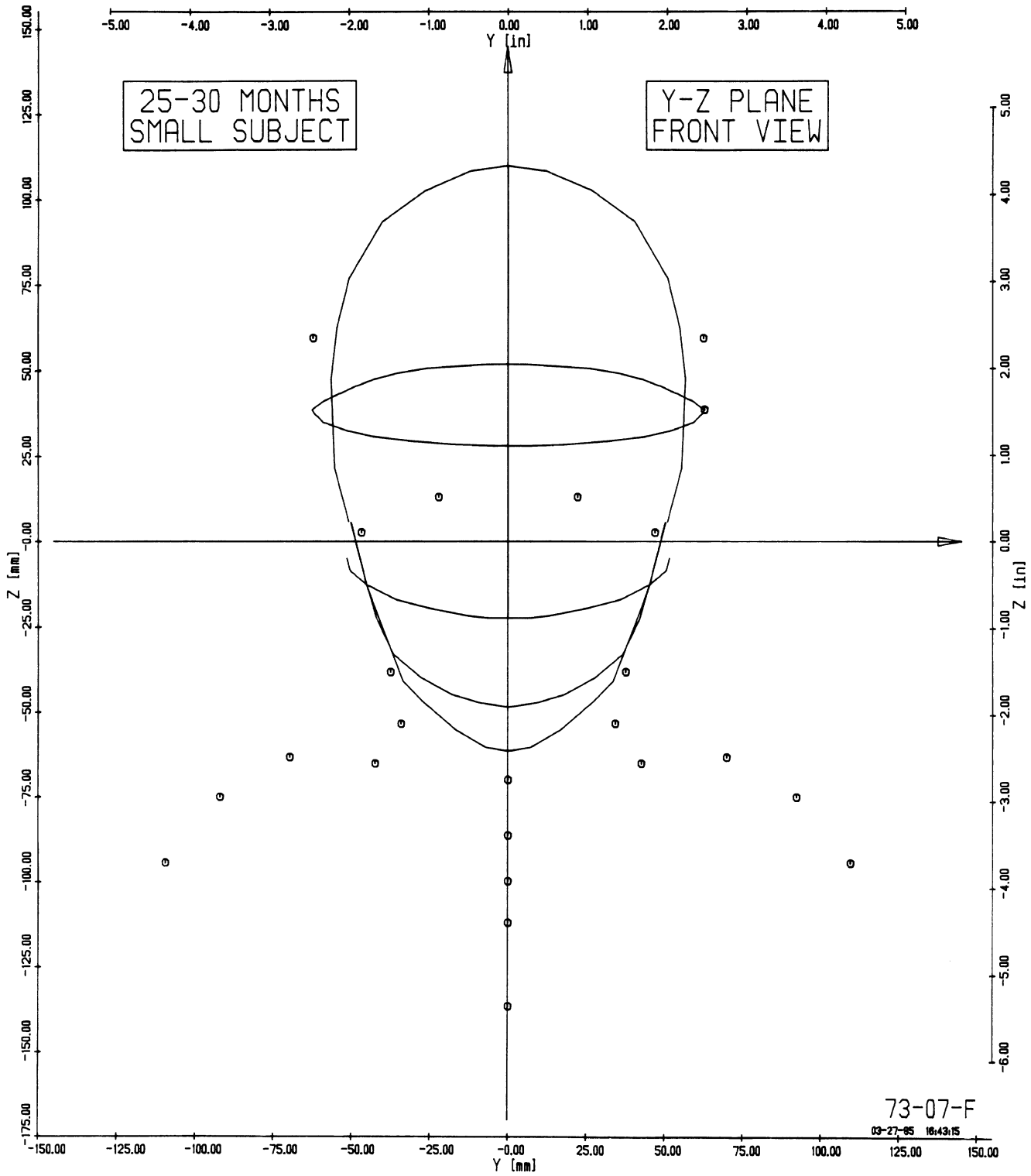
03-27-85 12:53:41

HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

25-30 MONTHS SMALL SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 53.7	0.0
2. Under Eye (Infraorbitale)	60.8	± 22.2	13.1
3. Above Nose (Sellion)	70.4	0.0	30.6
4. Forehead (Glabella)	72.2	0.0	52.9
5. Top of Head (Vertex)	-43.1	0.0	108.3
6. Back of Head (Opisthocranion)	-94.6	0.0	28.1
7. Head/Neck Junction	-64.8	0.0	-22.4
8. Tip of Chin (Menton)	66.5	0.0	-46.8
9. Upper Cheek (Zygion)	32.5	± 46.8	2.7
10. Back of Jaw (Gonion)	16.5	± 37.5	-38.1
11. Maximum Head Breadth Point	-37.7	± 62.3	59.6
12. Head Breadth @ Circumference Point	-20.3	± 58.6	41.3
13. Neck Depth Point at Front	13.5	0.0	-69.9
14. Suprasternale	15.9	0.0	-86.2
15. Front Torso # 1	23.4	0.0	-99.6
16. Front Torso # 2	30.3	0.0	-111.8
17. Torso Depth Point at Front	35.9	0.0	-136.2
18. Neck Depth Point at Back	n/a	n/a	n/a
19. 7th Cervical Vertebra (Cervicale)	-58.4	0.0	-63.6
20. Back Torso # 1	-65.9	0.0	-76.7
21. Back Torso # 2	-73.3	0.0	-92.9
22. Torso Depth Point at Back	-79.4	0.0	-107.4
23. Neck Breadth Point at Side	-14.2	± 34.2	-53.4
24. Shoulder # 1	n/a	n/a	n/a
25. Shoulder # 2	-16.0	± 42.5	-65.1
26. Top of Shoulder	-6.5	± 69.7	-63.2
27. Shoulder # 3	7.0	± 92.0	-74.9
28. Shoulder Circumference Point	12.7	±109.4	-94.2


25-30 MONTHS
SMALL SUBJECT
Y-Z PLANE
FRONT VIEW
Y [in]
Z [in]
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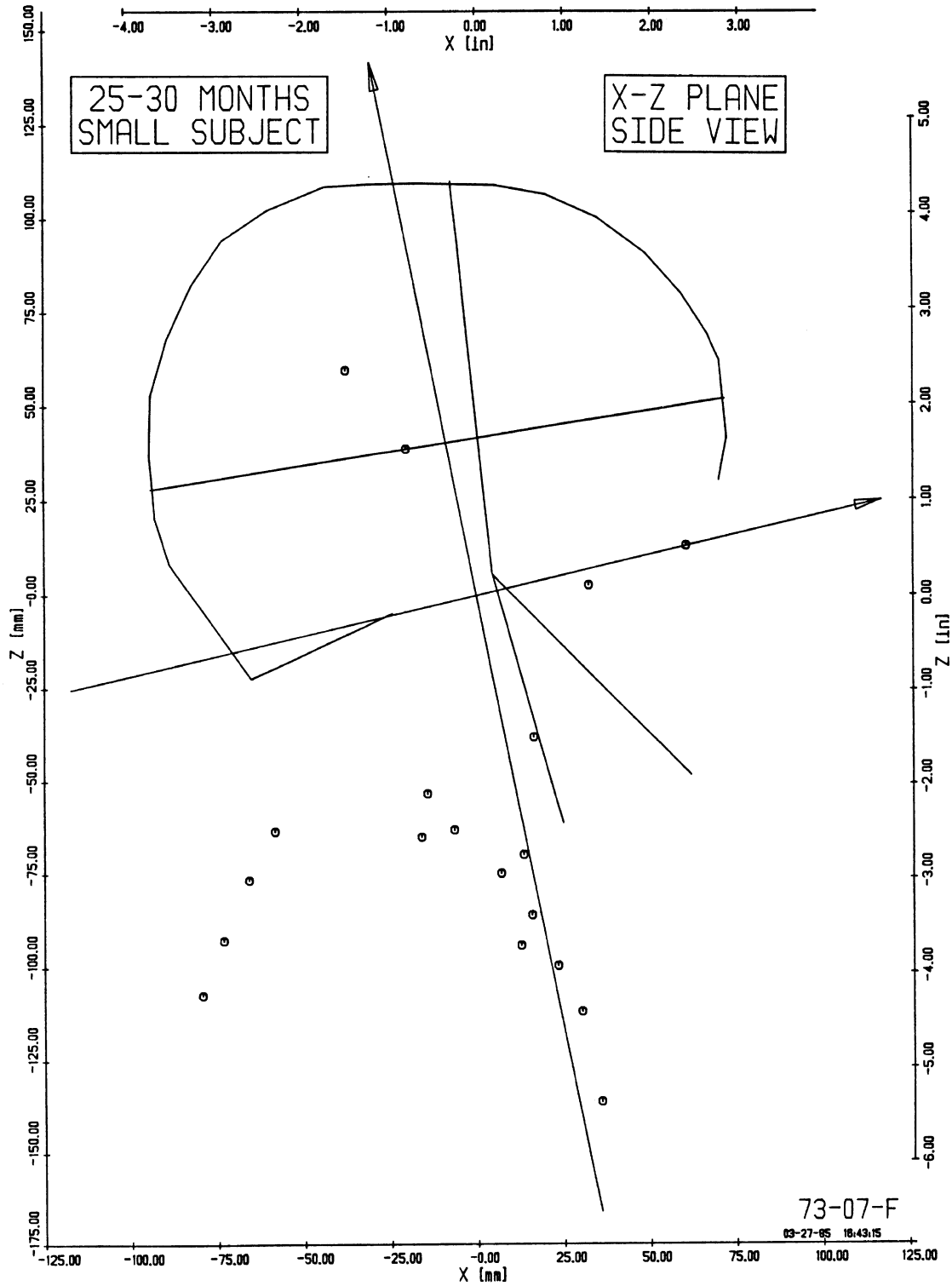
25-30 MONTHS
SMALL SUBJECT
X-Z PLANE
SIDE VIEW
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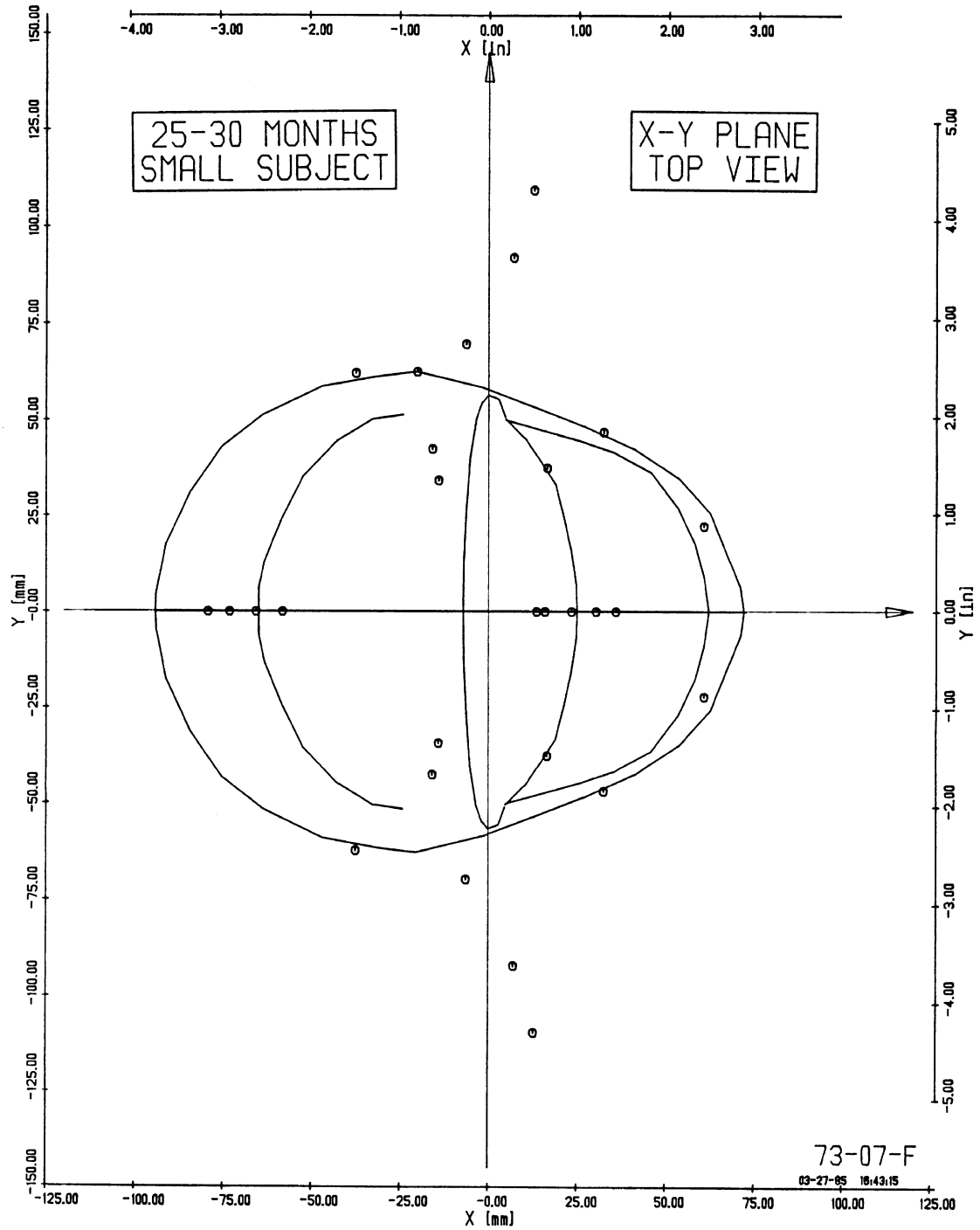
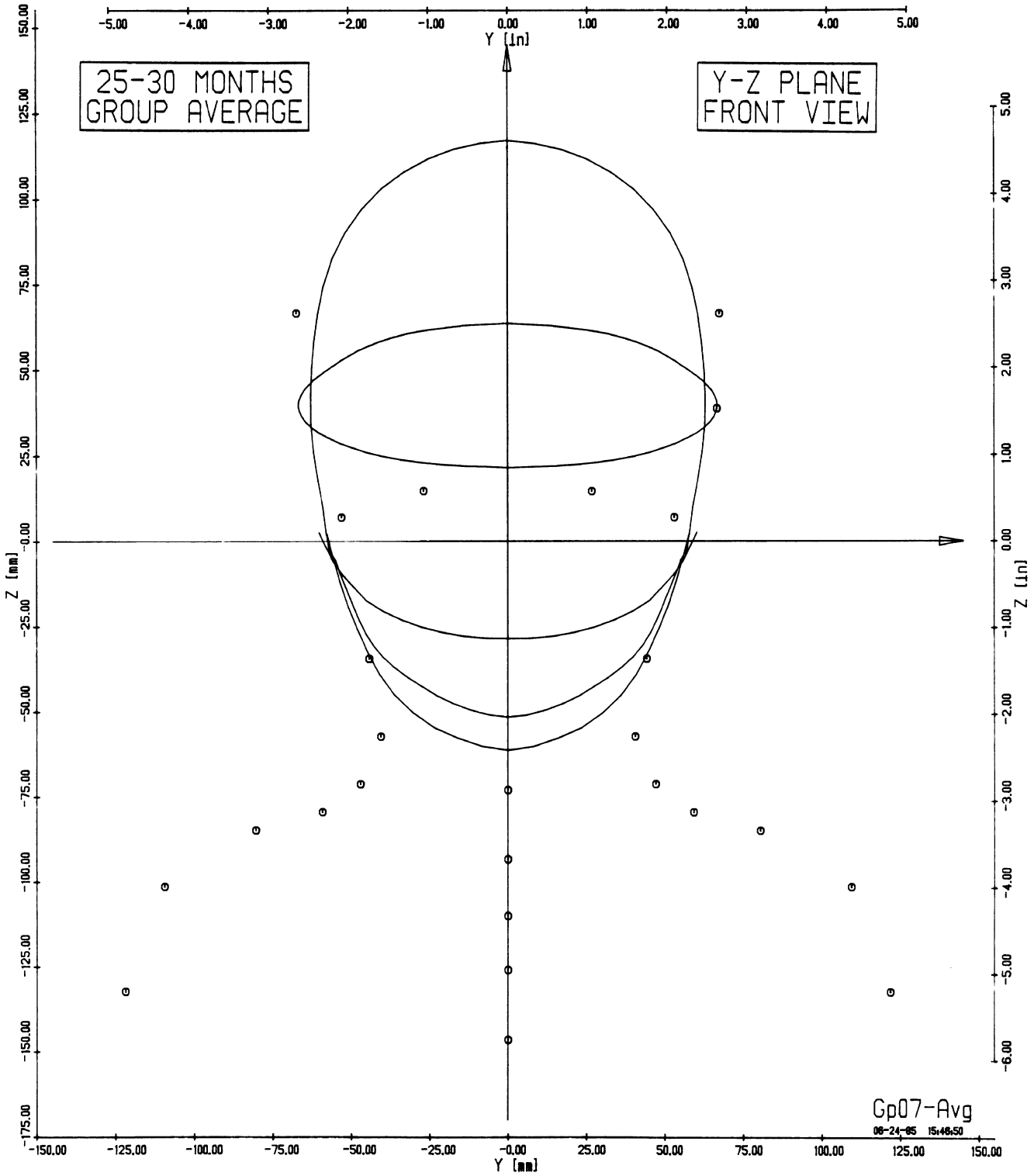

25-30 MONTHS
SMALL SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [in]
Y [mm]
X [mm]
73-07-F
03-27-85 16:43:15

HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

25-30 MONTHS GROUP AVERAGE

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 58.4	0.0
2. Under Eye (Infraorbitale)	64.9	± 26.8	14.8
3. Above Nose (Sellion)	73.6	0.0	30.6
4. Forehead (Glabella)	74.8	0.0	63.6
5. Top of Head (Vertex)	-45.7	0.0	115.4
6. Back of Head (Opisthocranion)	-101.3	0.0	21.5
7. Head/Neck Junction	-63.8	0.0	-27.8
8. Tip of Chin (Menton)	68.9	0.0	-51.8
9. Upper Cheek (Zygion)	32.4	± 53.1	7.1
10. Back of Jaw (Gonion)	20.1	± 44.3	-34.4
11. Maximum Head Breadth Point	-35.7	± 67.3	66.6
12. Head Breadth @ Circumference Point .	-29.8	± 66.5	38.5
13. Neck Depth Point at Front	17.9	0.0	-72.9
14. Suprasternale	18.4	0.0	-93.2
15. Front Torso # 1	28.2	0.0	-109.8
16. Front Torso # 2	35.4	0.0	-125.7
17. Torso Depth Point at Front	41.7	0.0	-146.4
18. Neck Depth Point at Back	-53.6	0.0	-47.0
19. 7th Cervical Vertebra (Cervicale) ..	-58.0	0.0	-61.6
20. Back Torso # 1	-68.3	0.0	-86.4
21. Back Torso # 2	-76.5	0.0	-116.0
22. Torso Depth Point at Back	-83.8	0.0	-142.4
23. Neck Breadth Point at Side	-14.3	± 40.5	-57.2
24. Shoulder # 1	-20.7	± 47.0	-71.1
25. Shoulder # 2	-22.2	± 59.1	-79.3
26. Top of Shoulder	-21.5	± 80.3	-84.7
27. Shoulder # 3	-9.0	±109.3	-101.3
28. Shoulder Circumference Point	-6.6	±121.8	-132.2


25-30 MONTHS
GROUP AVERAGE
Y-Z PLANE
FRONT VIEW
Y [in]
Z [mm]
Z [in]
Y [mm]
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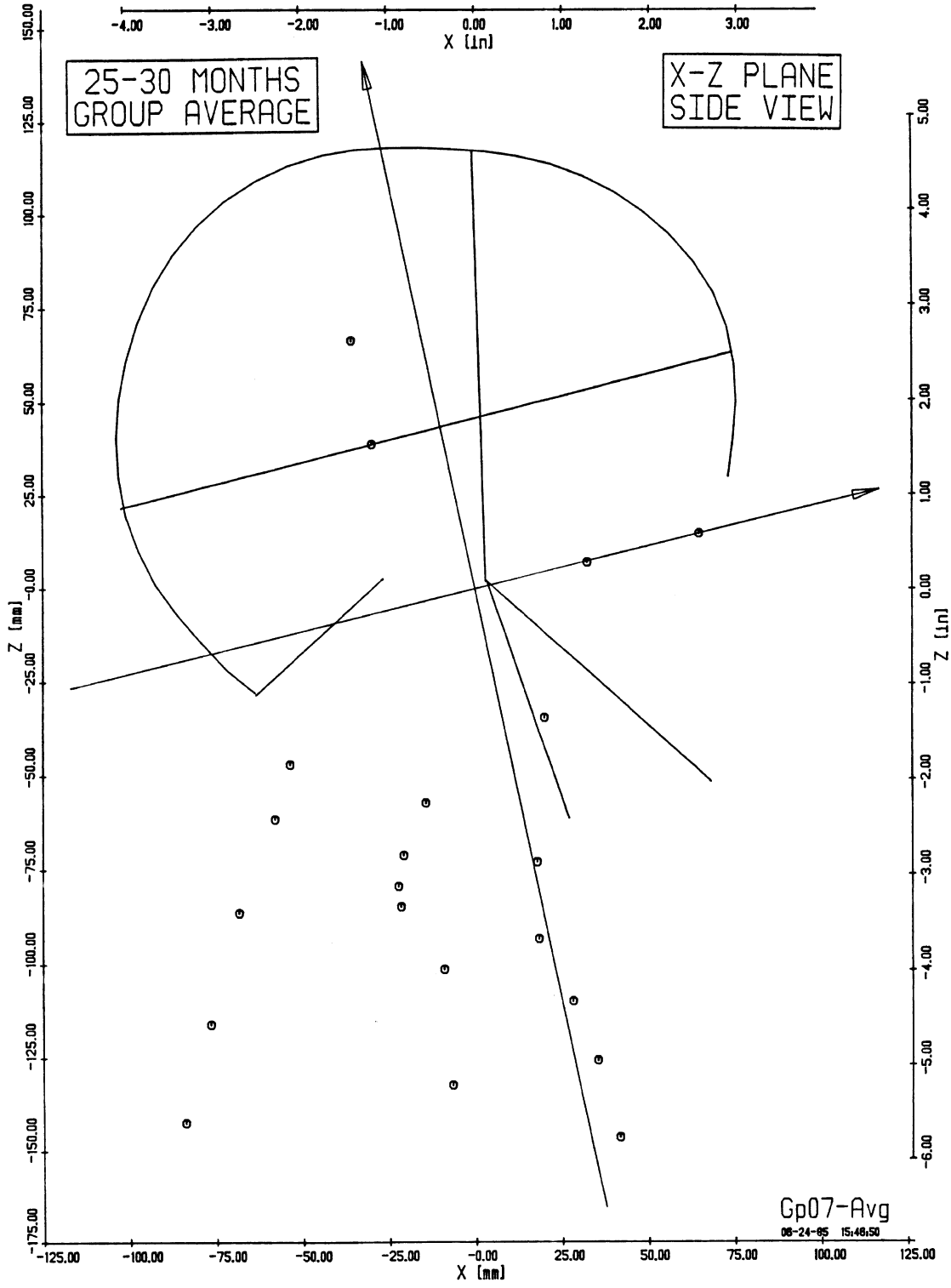
25-30 MONTHS
GROUP AVERAGE
X-Z PLANE
SIDE VIEW
X [in]
Z [mm]
Z [in]
X [mm]
Gp07-Avg
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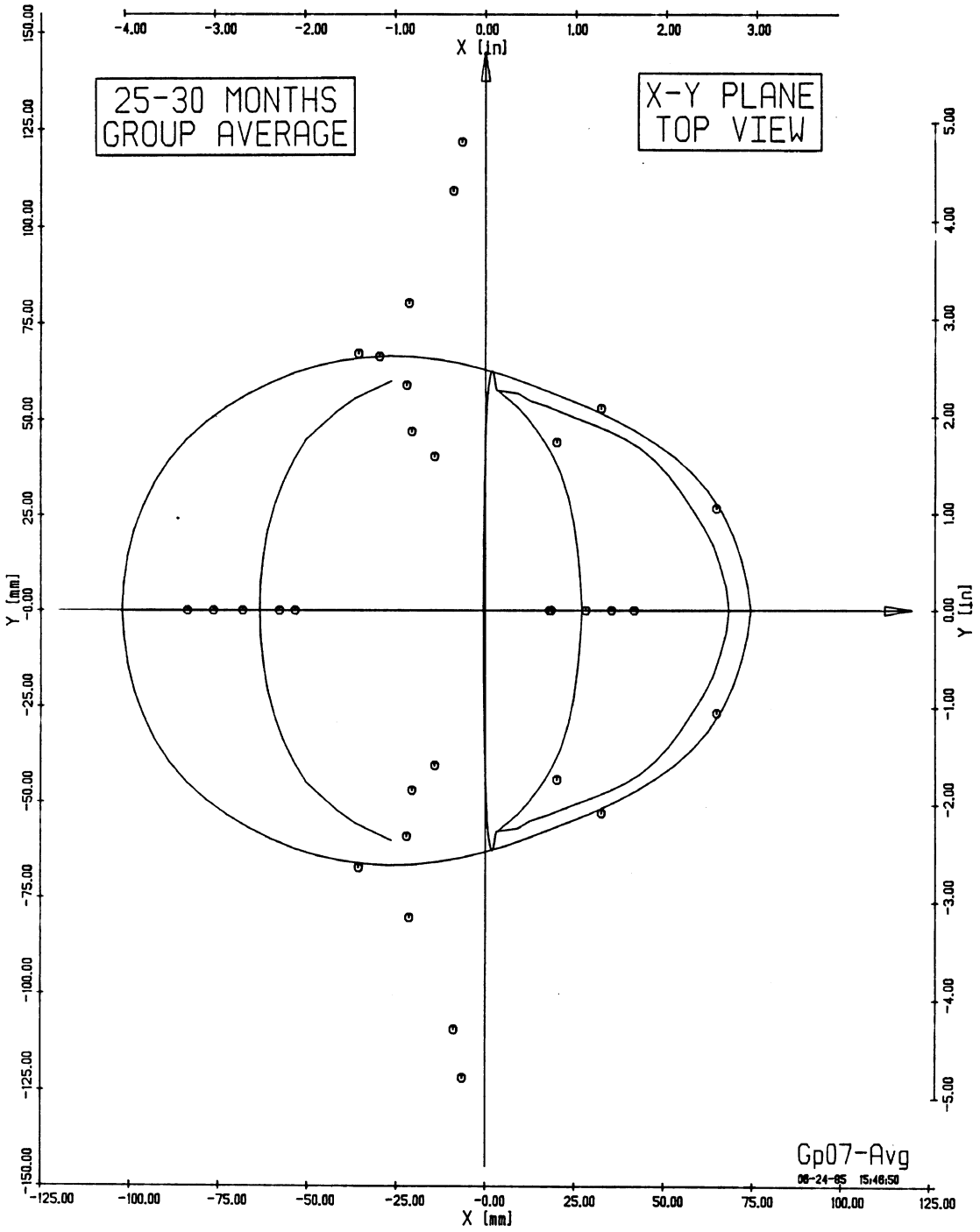
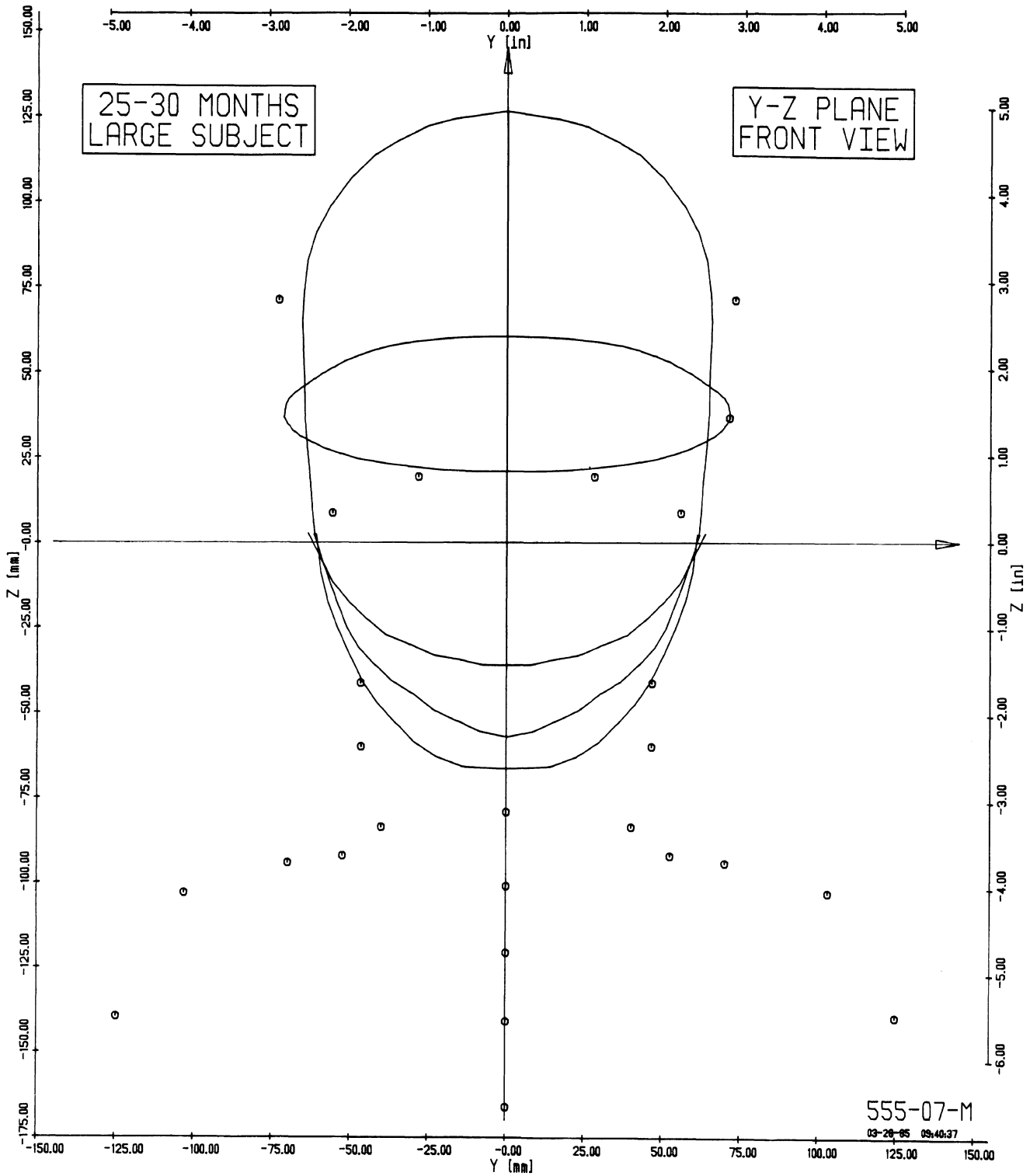

25-30 MONTHS
GROUP AVERAGE
X-Y PLANE
TOP VIEW
X [in]
Y [mm]
Y [in]
X [mm]
Gp07-Avg
08-24-95 15:46:50

HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

25-30 MONTHS LARGE SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 63.4	0.0
2. Under Eye (Infraorbitale)	67.5	± 28.2	19.4
3. Above Nose (Sellion)	77.5	0.0	34.7
4. Forehead (Glabella)	80.2	0.0	60.8
5. Top of Head (Vertex)	-45.4	0.0	124.2
6. Back of Head (Opisthocranion)	-110.3	0.0	21.4
7. Head/Neck Junction	-70.2	0.0	-36.3
8. Tip of Chin (Menton)	73.8	0.0	-56.8
9. Upper Cheek (Zygion)	35.6	± 55.8	8.8
10. Back of Jaw (Gonion)	25.4	± 46.6	-41.2
11. Maximum Head Breadth Point	-36.1	± 72.9	71.1
12. Head Breadth @ Circumference Point	-34.5	± 71.1	38.5
13. Neck Depth Point at Front	24.0	0.0	-79.1
14. Suprasternale	22.3	0.0	-100.9
15. Front Torso # 1	34.4	0.0	-120.5
16. Front Torso # 2	43.6	0.0	-140.8
17. Torso Depth Point at Front	51.3	0.0	-166.1
18. Neck Depth Point at Back	-59.3	0.0	-53.2
19. 7th Cervical Vertebra (Cervicale)	-63.4	0.0	-70.2
20. Back Torso # 1	-75.8	0.0	-108.0
21. Back Torso # 2	-83.3	0.0	-147.0
22. Torso Depth Point at Back	-84.9	0.0	-177.8
23. Neck Breadth Point at Side	-10.7	± 46.5	-59.8
24. Shoulder # 1	-26.0	± 40.0	-83.5
25. Shoulder # 2	-31.0	± 52.4	-91.9
26. Top of Shoulder	-32.4	± 69.9	-94.0
27. Shoulder # 3	-32.1	±103.0	-102.9
28. Shoulder Circumference Point	-23.8	±124.7	-139.5


25-30 MONTHS
LARGE SUBJECT
Y-Z PLANE
FRONT VIEW
Y [in]
Z [mm]
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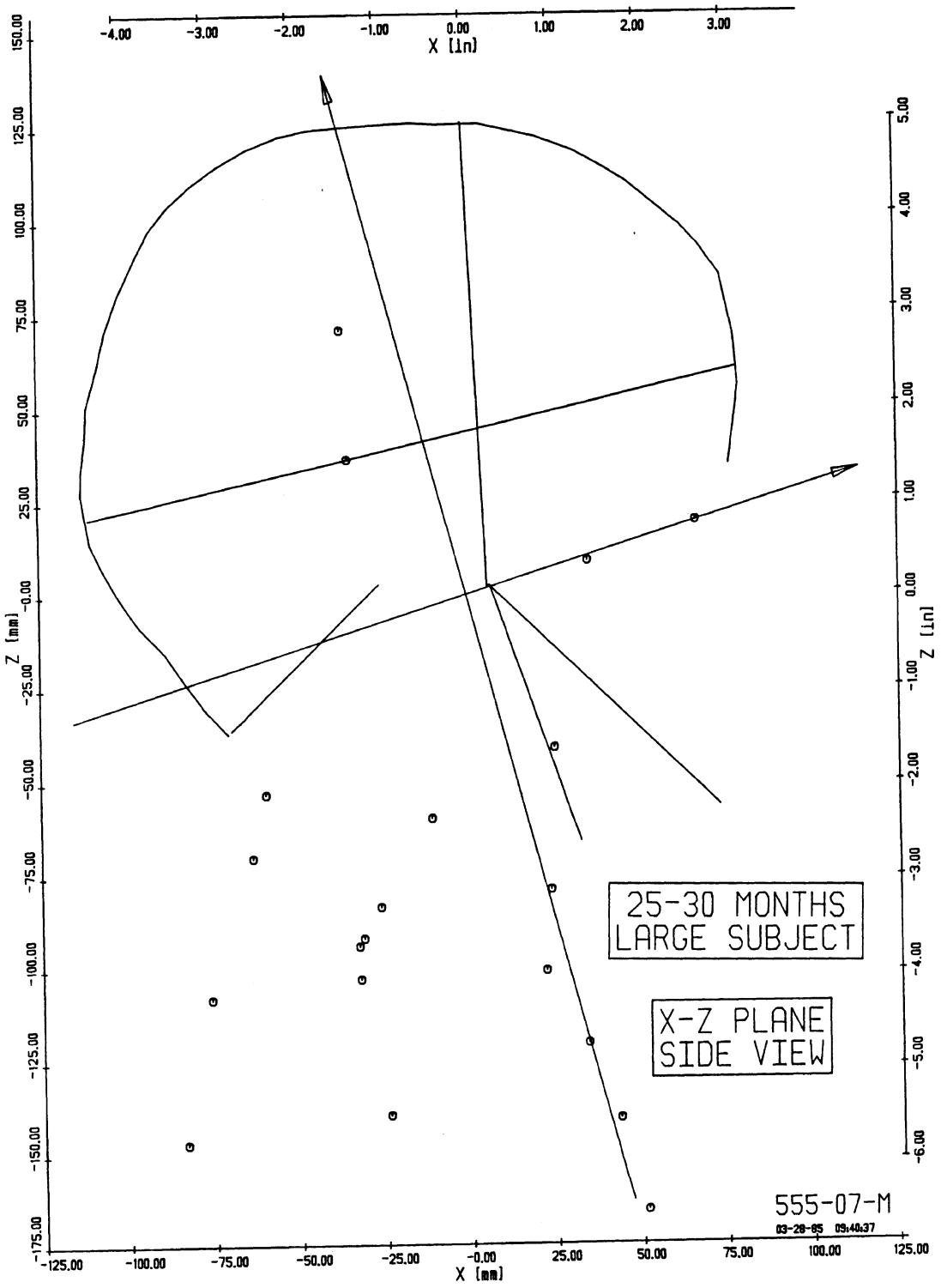
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25-30 MONTHS
LARGE SUBJECT
X-Z PLANE
SIDE VIEW
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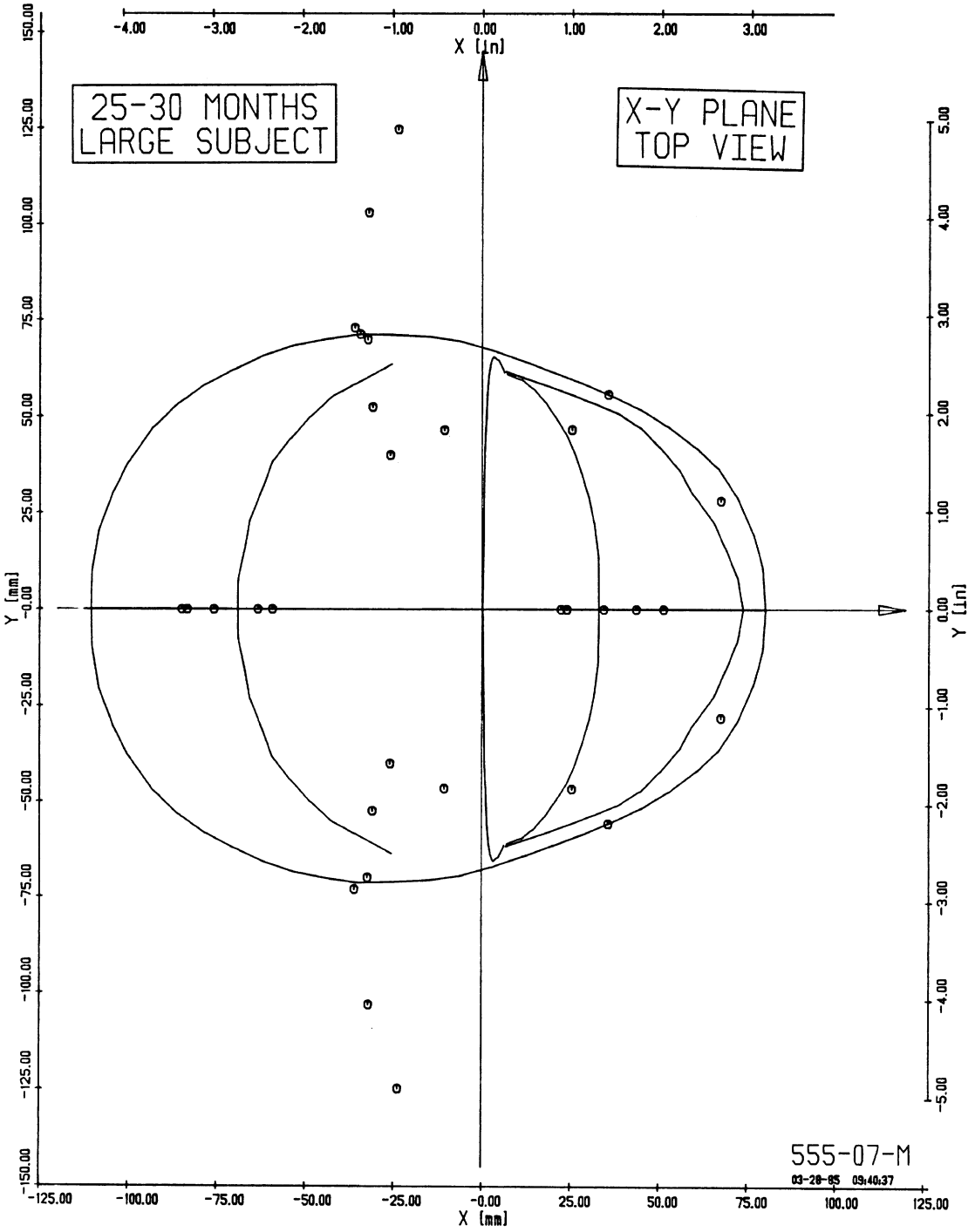
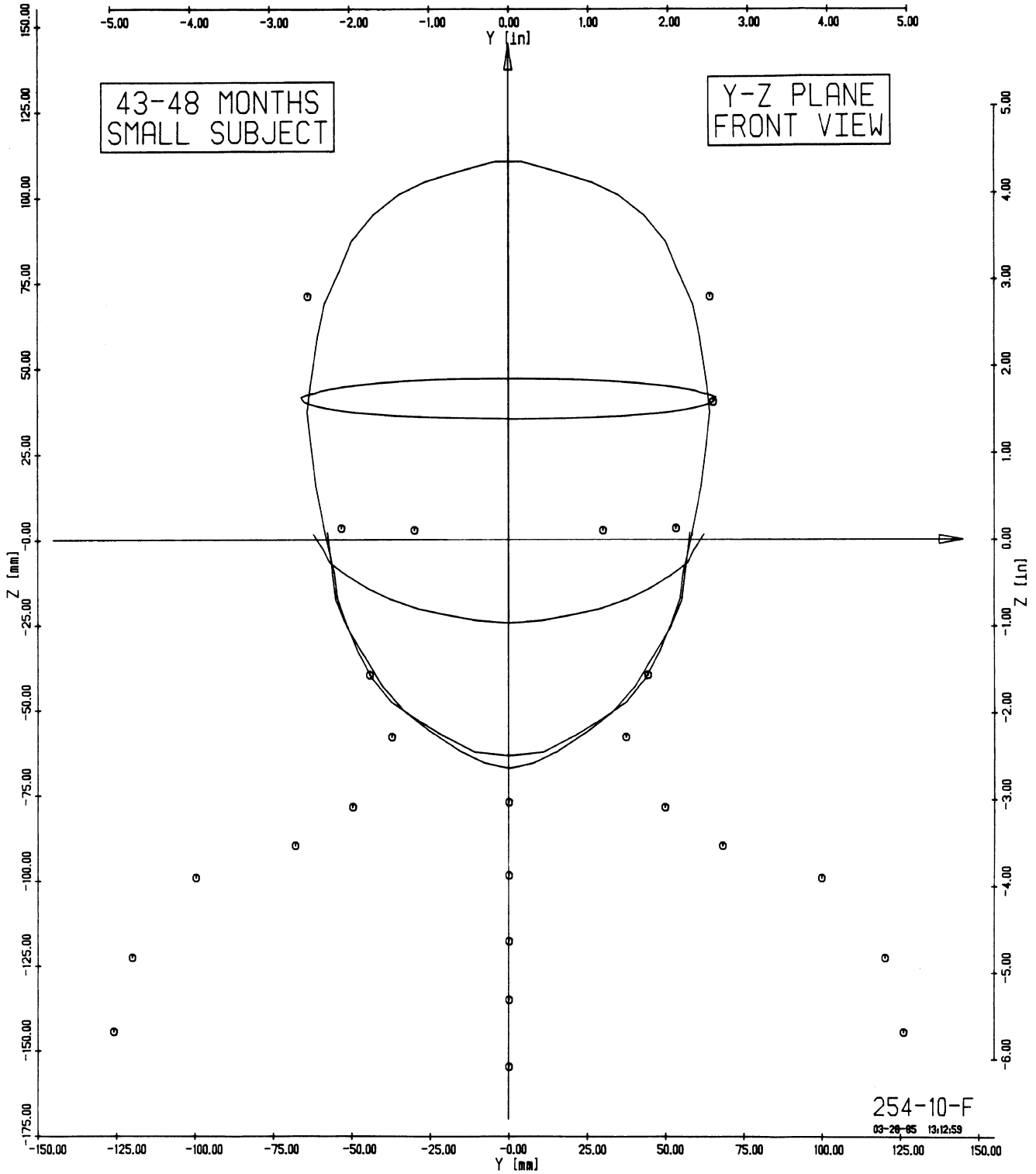

25-30 MONTHS
LARGE SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [in]
X [mm]
Y [mm]
555-07-M
03-28-85 09:40:37

HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

43-48 MONTHS SMALL SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 59.5	0.0
2. Under Eye (Infraorbitale)	62.3	± 30.0	2.8
3. Above Nose (Sellion)	74.2	0.0	21.0
4. Forehead (Glabella)	79.1	0.0	48.0
5. Top of Head (Vertex)	-24.6	0.0	118.2
6. Back of Head (Opisthocranion)	-97.7	0.0	35.7
7. Head/Neck Junction	-69.7	0.0	-24.2
8. Tip of Chin (Menton)	56.5	0.0	-63.7
9. Upper Cheek (Zygion)	36.4	± 53.3	3.4
10. Back of Jaw (Gonion)	18.1	± 44.3	-39.6
11. Maximum Head Breadth Point	-27.9	± 64.0	71.1
12. Head Breadth @ Circumference Point	-23.0	± 65.7	41.0
13. Neck Depth Point at Front	12.3	0.0	-77.0
14. Suprasternale	16.8	0.0	-98.3
15. Front Torso # 1	28.4	0.0	-117.6
16. Front Torso # 2	36.4	0.0	-134.8
17. Torso Depth Point at Front	43.7	0.0	-154.6
18. Neck Depth Point at Back	-60.5	0.0	-58.7
19. 7th Cervical Vertebra (Cervicale)	-67.2	0.0	-70.6
20. Back Torso # 1	-78.1	0.0	-100.1
21. Back Torso # 2	-84.5	0.0	-126.3
22. Torso Depth Point at Back	-89.8	0.0	-156.9
23. Neck Breadth Point at Side	-21.6	± 37.3	-57.8
24. Shoulder # 1	-33.3	± 49.7	-78.4
25. Shoulder # 2	-38.5	± 68.0	-89.6
26. Top of Shoulder	-33.4	± 99.6	-99.0
27. Shoulder # 3	-36.1	±120.0	-122.6
28. Shoulder Circumference Point	-43.1	±125.9	-144.5


43-48 MONTHS
SMALL SUBJECT
Y-Z PLANE
FRONT VIEW
Y [in]
Z [mm]
Z [in]
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254-10-F
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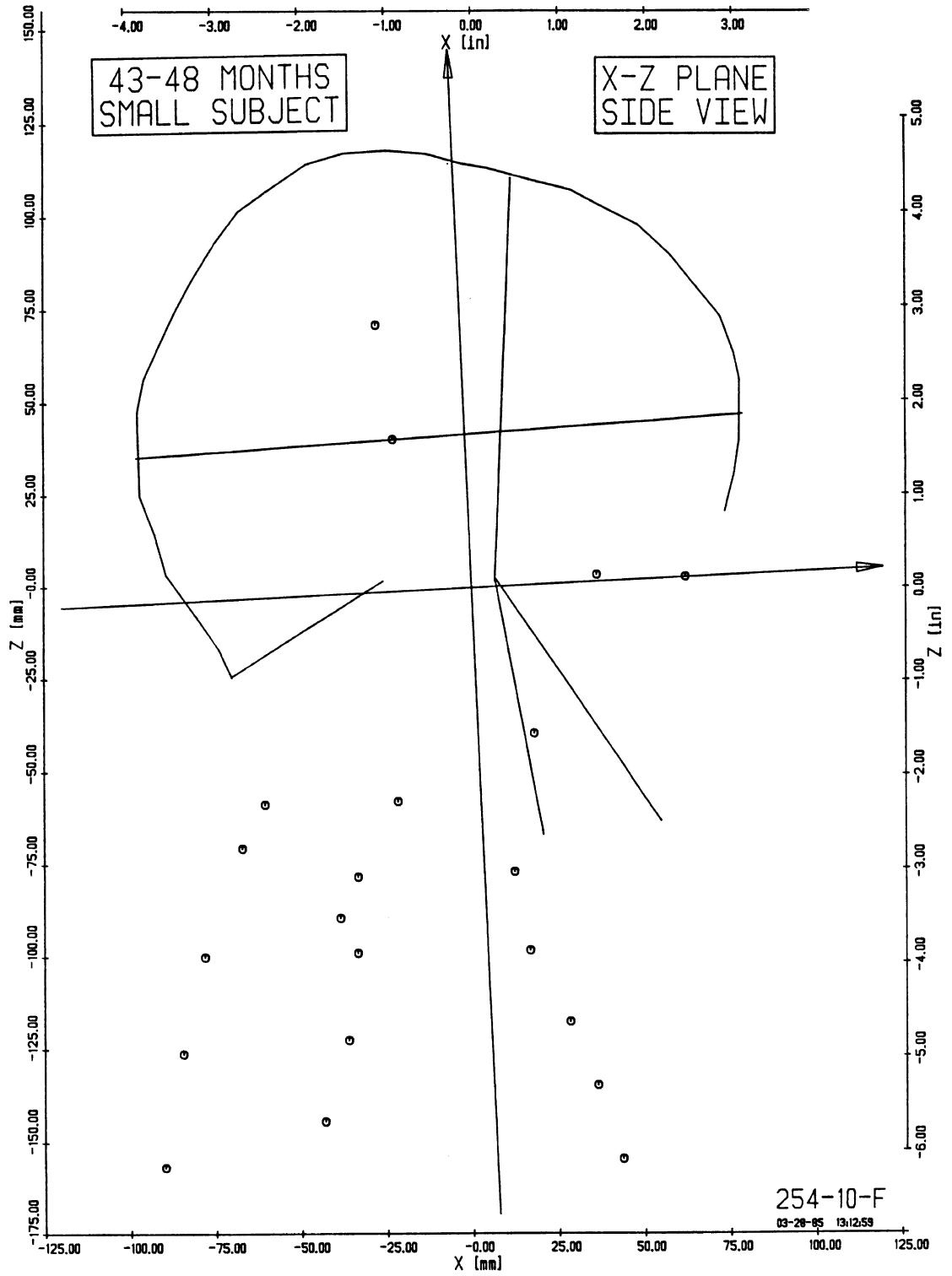
43-48 MONTHS
SMALL SUBJECT
X-Z PLANE
SIDE VIEW
X [in]
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X [mm]
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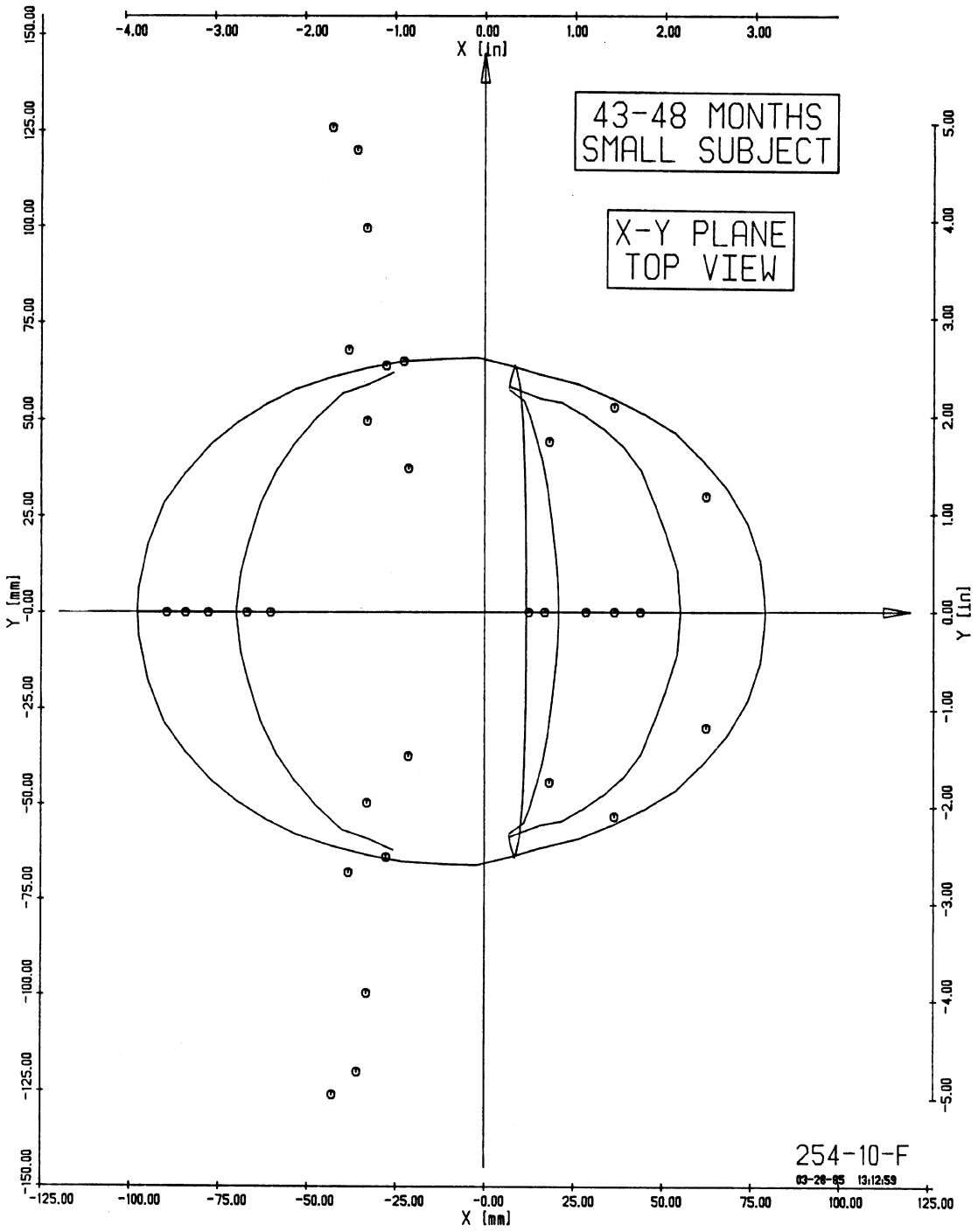
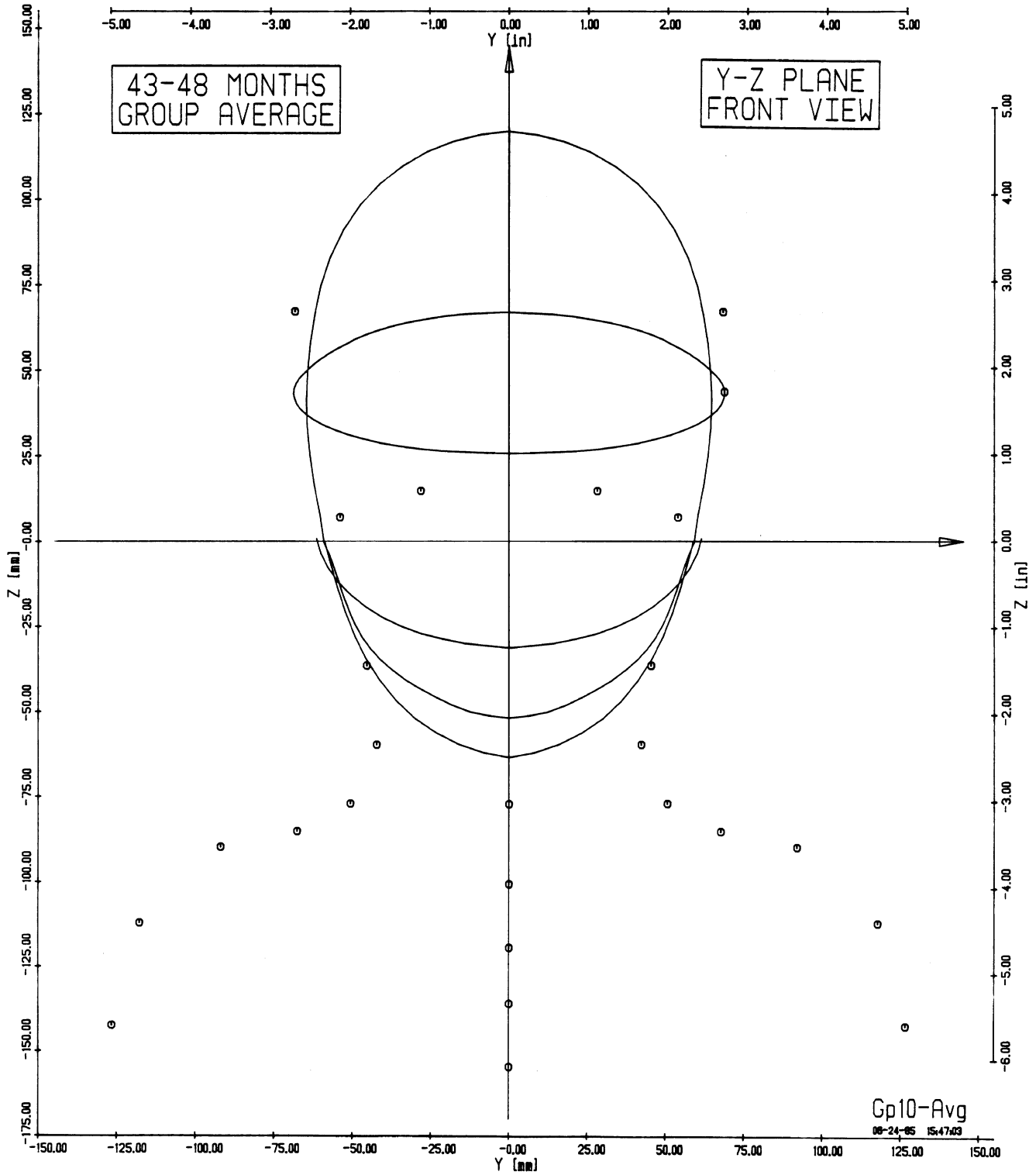

43-48 MONTHS
SMALL SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [in]
X [mm]
Y [mm]
254-10-F
03-28-85 13:12:59

HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

43-48 MONTHS GROUP AVERAGE

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 60.0	0.0
2. Under Eye (Infraorbitale)	66.0	± 28.3	14.8
3. Above Nose (Sellion)	76.7	0.0	32.5
4. Forehead (Glabella)	77.3	0.0	66.9
5. Top of Head (Vertex)	-42.6	0.0	119.1
6. Back of Head (Opisthocranion)	-103.3	0.0	25.7
7. Head/Neck Junction	-62.7	0.0	-31.0
8. Tip of Chin (Menton)	73.8	0.0	-52.4
9. Upper Cheek (Zygion)	35.8	± 53.9	7.1
10. Back of Jaw (Gonion)	23.4	± 45.4	-36.5
11. Maximum Head Breadth Point	-35.8	± 68.3	67.1
12. Head Breadth @ Circumference Point	-24.7	± 68.7	44.1
13. Neck Depth Point at Front	22.6	0.0	-77.2
14. Suprasternale	23.6	0.0	-100.6
15. Front Torso # 1	35.0	0.0	-119.4
16. Front Torso # 2	43.4	0.0	-135.9
17. Torso Depth Point at Front	48.9	0.0	-154.6
18. Neck Depth Point at Back	-51.1	0.0	-53.2
19. 7th Cervical Vertebra (Cervicale)	-56.2	0.0	-69.3
20. Back Torso # 1	-67.6	0.0	-100.7
21. Back Torso # 2	-74.8	0.0	-132.5
22. Torso Depth Point at Back	-78.5	0.0	-157.6
23. Neck Breadth Point at Side	-9.2	± 42.3	-59.7
24. Shoulder # 1	-17.1	± 50.6	-77.0
25. Shoulder # 2	-18.5	± 67.6	-85.1
26. Top of Shoulder	-14.8	± 91.9	-89.7
27. Shoulder # 3	-5.2	±117.7	-112.1
28. Shoulder Circumference Point	-2.3	±126.6	-142.4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FRONT VIEW
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Z [mm]
Z [in]
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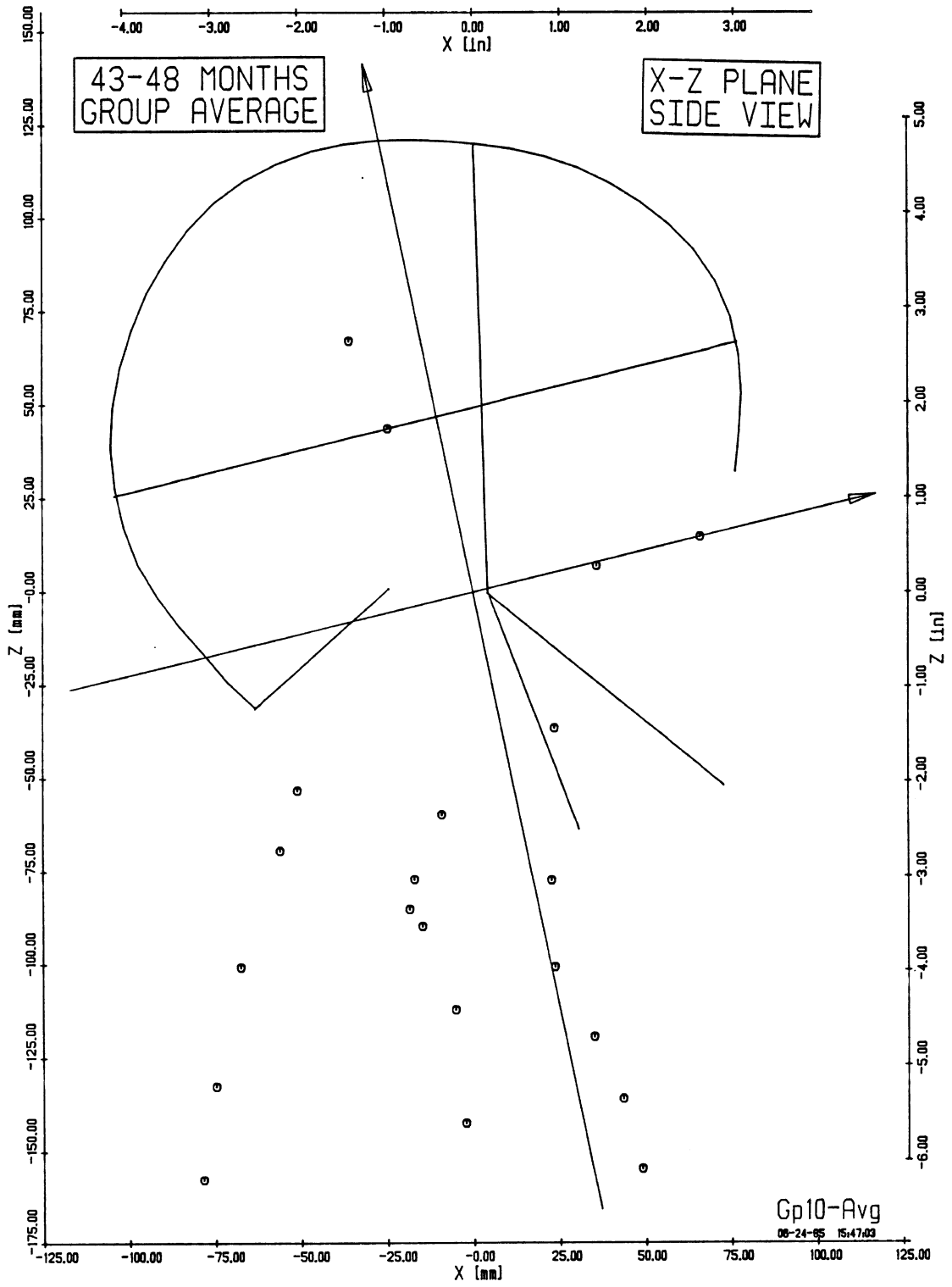
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X-Z PLANE
SIDE VIEW
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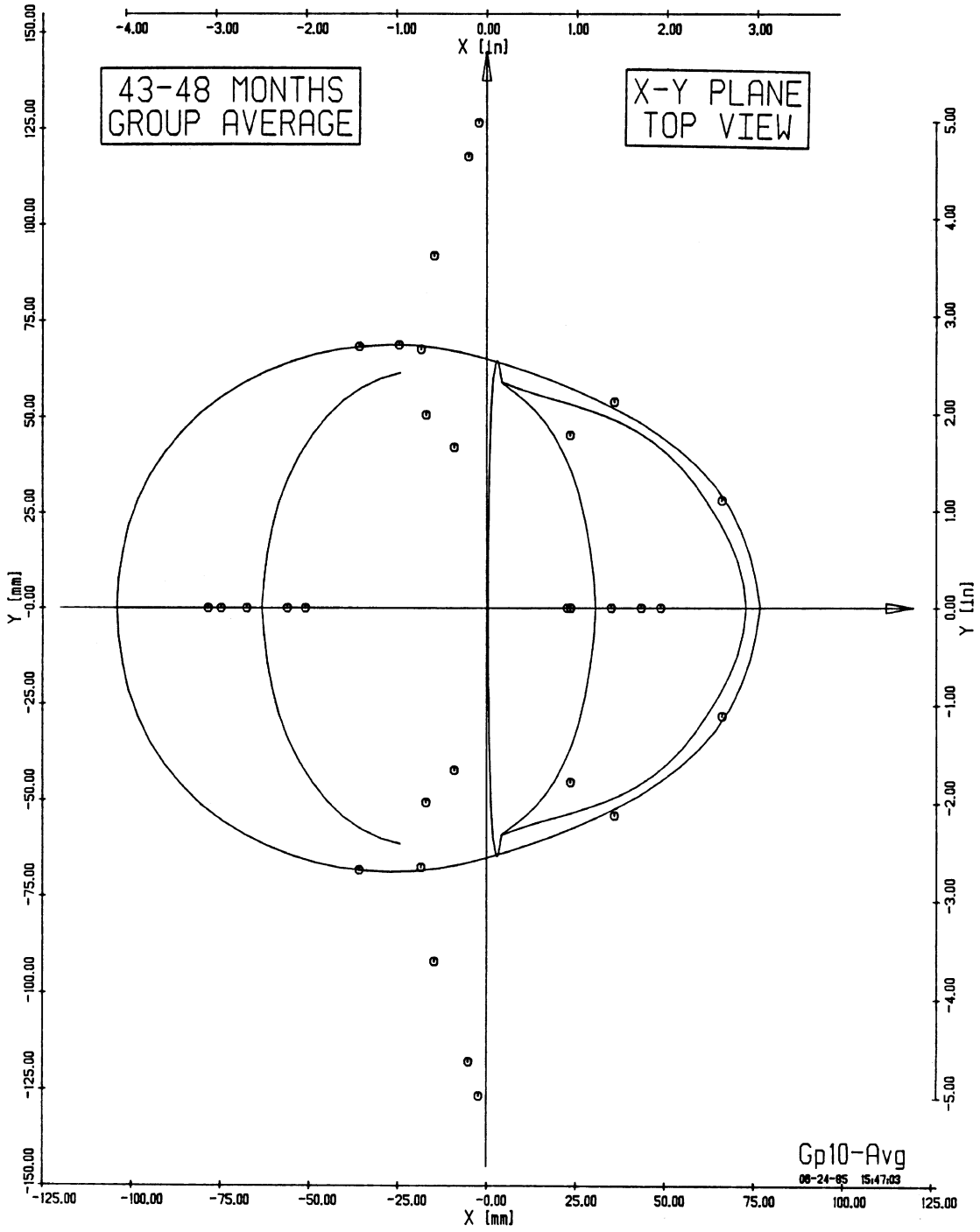
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GROUP AVERAGE
X-Y PLANE
TOP VIEW
X [in]
Y [in]
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Y [mm]
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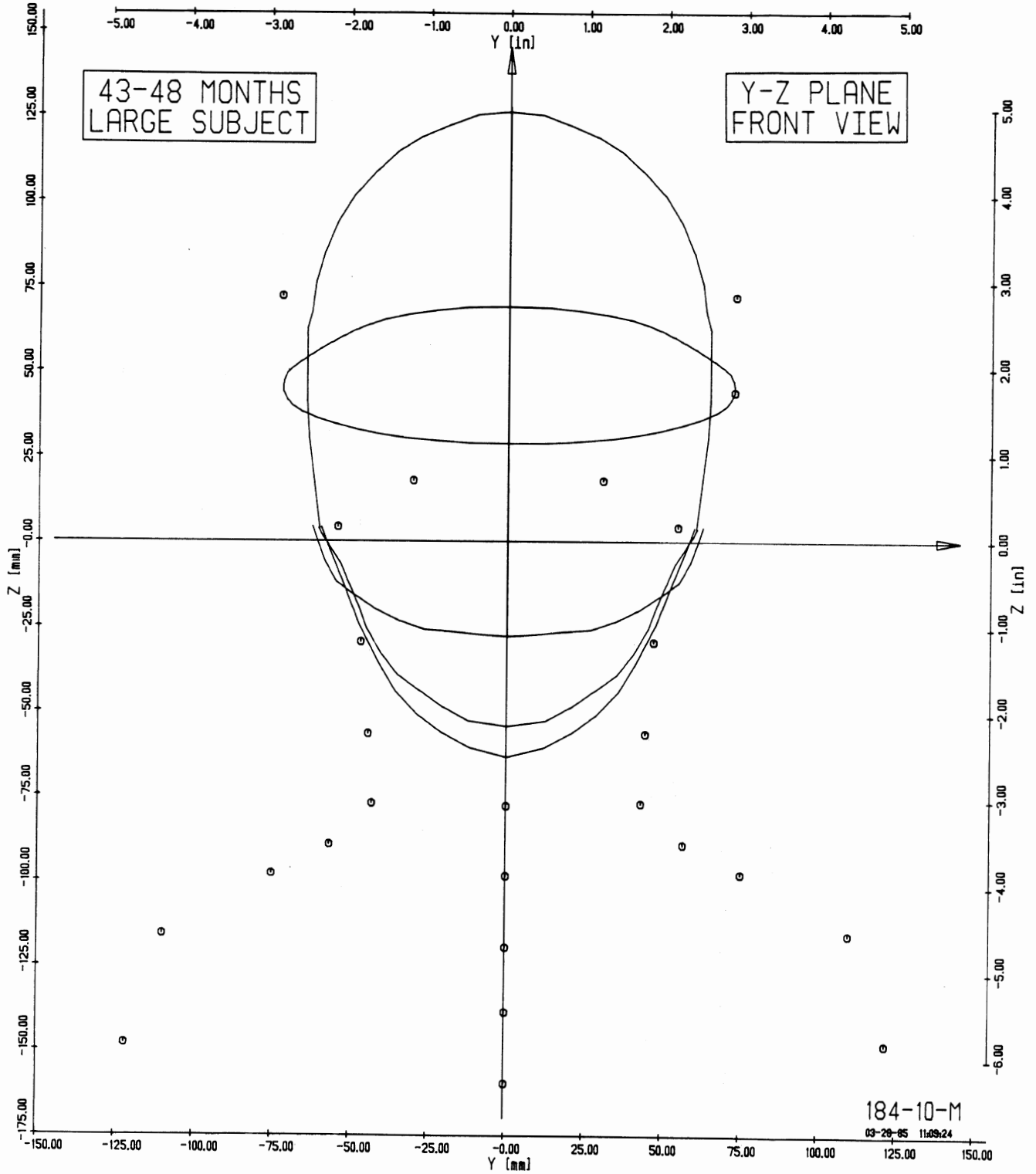
08-24-85 15:47:03

HEAD, NECK AND TORSO LANDMARK COORDINATES
re Translated Laboratory Reference System

43-48 MONTHS LARGE SUBJECT

Landmark	X	Y	Z
1. Ear Notch (Tragion)	0.0	± 59.9	0.0
2. Under Eye (Infraorbitale)	65.0	± 30.4	17.9
3. Above Nose (Sellion)	78.6	0.0	38.5
4. Forehead (Glabella)	79.6	0.0	68.8
5. Top of Head (Vertex)	-51.0	0.0	123.9
6. Back of Head (Opisthocranion)	-110.4	0.0	28.9
7. Head/Neck Junction	-67.0	0.0	-28.2
8. Tip of Chin (Menton)	65.8	0.0	-55.0
9. Upper Cheek (Zygion)	31.3	± 54.4	4.3
10. Back of Jaw (Gonion)	18.6	± 46.9	-29.5
11. Maximum Head Breadth Point	-39.6	± 72.5	71.9
12. Head Breadth @ Circumference Point	-39.1	± 72.2	45.6
13. Neck Depth Point at Front	21.4	0.0	-77.9
14. Suprasternale	19.9	0.0	-98.4
15. Front Torso # 1	32.9	0.0	-119.5
16. Front Torso # 2	39.9	0.0	-138.6
17. Torso Depth Point at Front	42.2	0.0	-159.7
18. Neck Depth Point at Back	-54.1	0.0	-48.5
19. 7th Cervical Vertebra (Cervicale)	-58.1	0.0	-58.3
20. Back Torso # 1	-71.1	0.0	-87.7
21. Back Torso # 2	-81.9	0.0	-120.4
22. Torso Depth Point at Back	-86.9	0.0	-156.1
23. Neck Breadth Point at Side	-8.3	± 44.3	-56.6
24. Shoulder # 1	-13.1	± 43.1	-77.1
25. Shoulder # 2	-16.4	± 56.6	-89.1
26. Top of Shoulder	-8.1	± 75.0	-97.7
27. Shoulder # 3	0.1	±109.8	-115.6
28. Shoulder Circumference Point	3.2	±121.8	-148.0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LARGE SUBJECT
Y-Z PLANE
FRONT VIEW
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Z [mm]
Z [in]
Y [mm]
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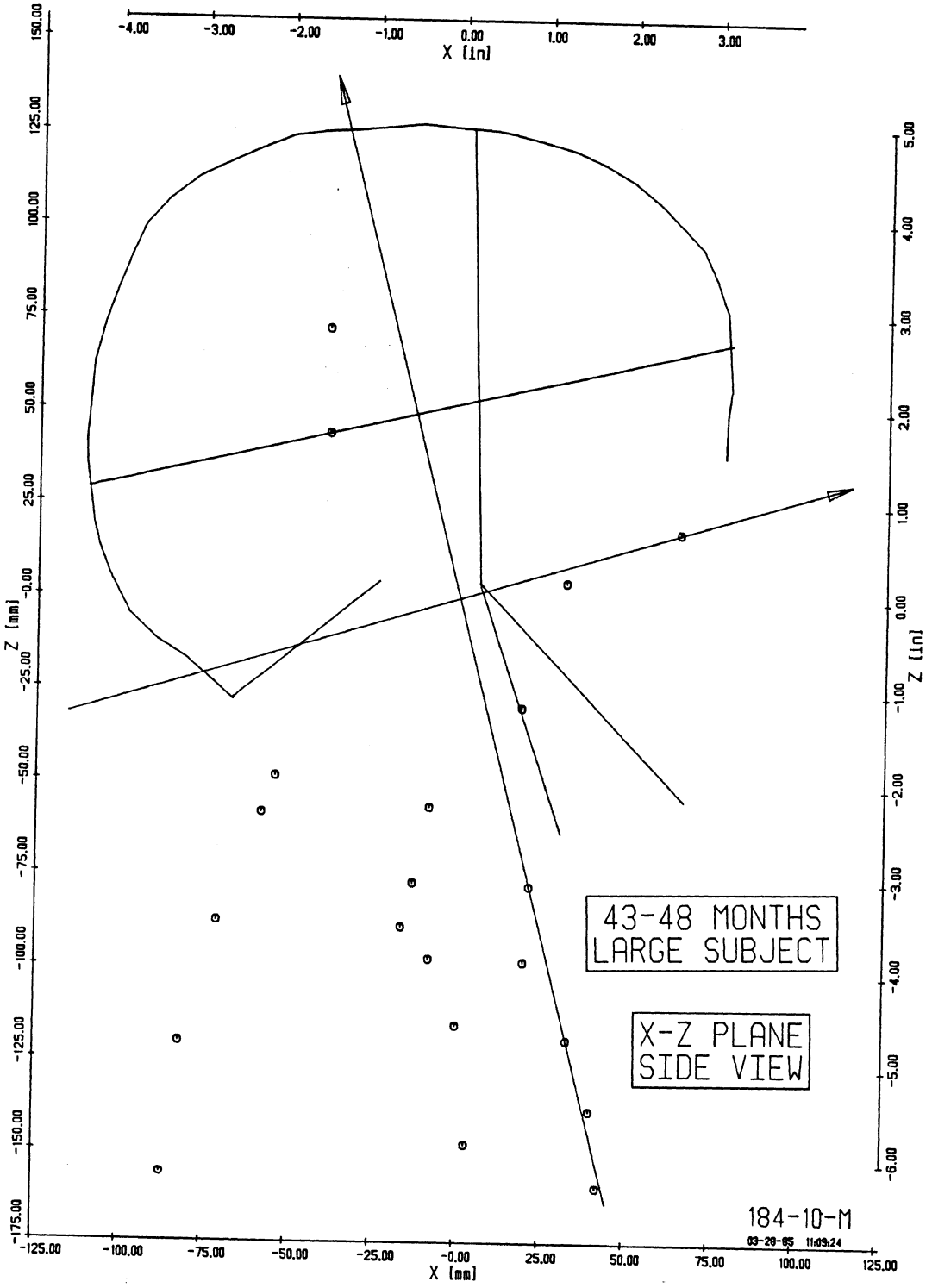
03-28-85 11:09:24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LARGE SUBJECT
X-Z PLANE
SIDE VIEW
184-10-M
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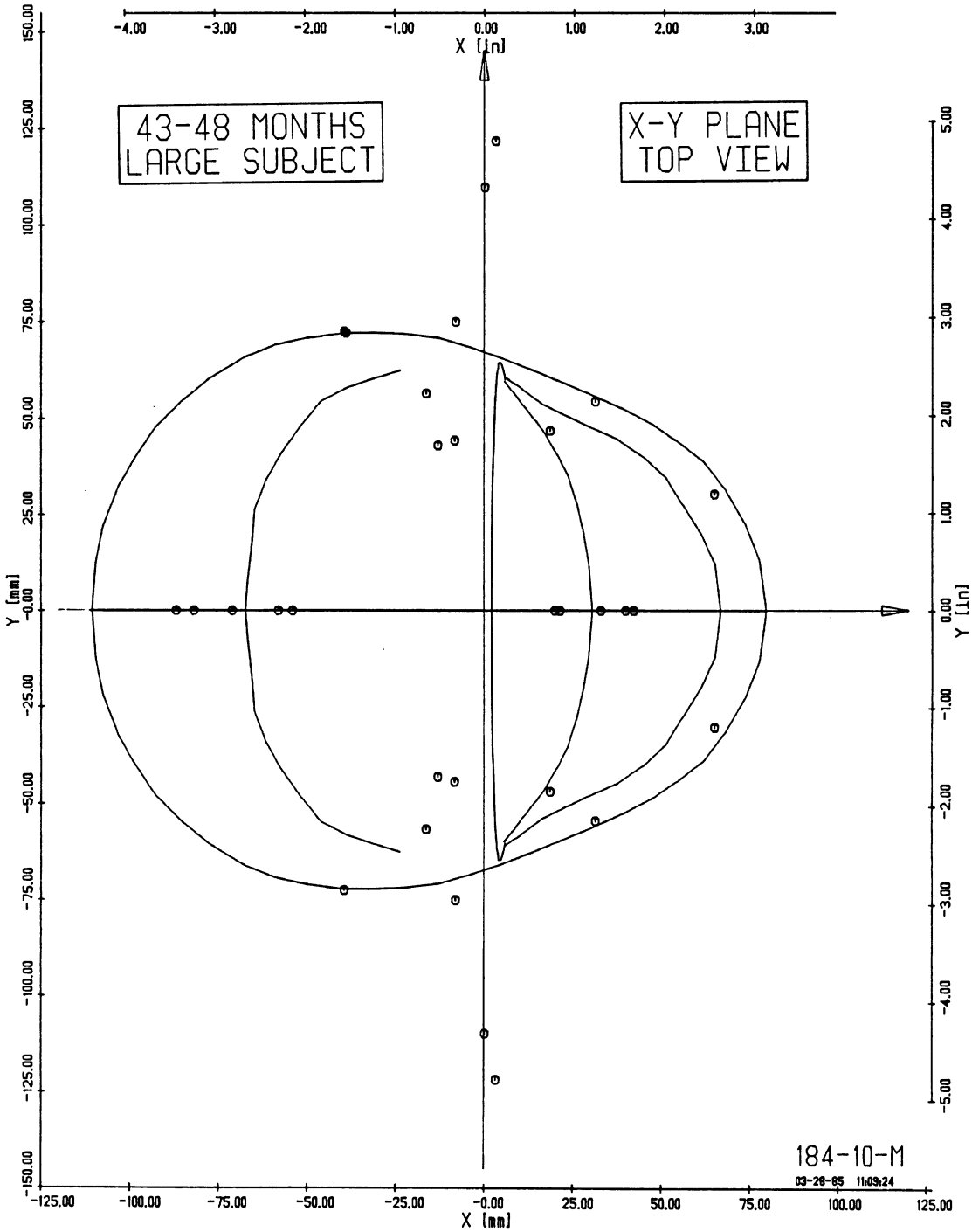
Z [mm]
X [in]
Z [in]


43-48 MONTHS
LARGE SUBJECT
X-Y PLANE
TOP VIEW
X [in]
Y [in]
X [mm]
Y [mm]
184-10-M
03-28-85 11:09:24

II.C.3

GROUP AVERAGED LANDMARK AND CONTOUR RESULTS
(Tabular data and Computer Plots of Average Head Contours)

This section presents the average landmark and contour results for the four subject groups. A table of average head landmark coordinate values in the head anatomical reference system is followed by a table of average head, neck, and torso landmark coordinate values in the translated laboratory reference system with origin at the head anatomical reference system origin. These tables are followed by computer plots of the six average head contours that have been rotated into the appropriate reference planes so that the full, undistorted view of each average contour is presented.

The first set of plots compares averaged head contours for the four age groups. These are followed by plots of the different contours plotted separately by subject group. In each case, the different head contours have been plotted on separate graphs except for "Ear-to-Ear Over Top-of-Head Arc" and "Ear-to-Ear Under Chin Arc" which have been plotted together as an approximation to head circumference taken in a frontal plane just forward of the ears. All plots in this section are shown actual size.

Index to Section Results

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Head, Neck, and Torso Landmark Coordinate Values re Translated Laboratory Reference System	367
Comparison of Average Contours for Different Age Groups	370
4 to 6 Month Average Contours	375
13 to 18 Month Average Contours	380
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Head Landmark Coordinates (mm)
re Head Anatomical Reference System

Group Averages

Landmark	Axis	Subject Group Number			
		2	5	7	10
Ear Notch (Tragion)	X	0.0	0.0	0.0	0.0
	Y	± 52.5	± 57.9	± 58.4	± 60.0
	Z	0.0	0.0	0.0	0.0
Under Eye (Infraorbitale)	X	58.1	62.4	66.6	67.7
	Y	± 24.0	± 25.8	± 26.8	± 28.3
	Z	0.0	0.0	0.0	0.0
Above Nose (Sellion)	X	67.0	73.9	78.6	82.0
	Y	0.0	0.0	0.0	0.0
	Z	14.6	12.7	13.5	14.9
Forehead (Glabella)	X	72.5	81.2	87.1	90.1
	Y	0.0	0.0	0.0	0.0
	Z	42.6	46.0	45.4	48.3
Top of Head (Vertex)	X	-14.1	-20.4	-18.9	-15.4
	Y	0.0	0.0	0.0	0.0
	Z	106.7	116.3	122.7	125.5
Back of Head (Opisthocranion)	X	-83.9	-91.2	-94.0	-95.2
	Y	0.0	0.0	0.0	0.0
	Z	39.9	39.5	43.5	47.7
Head/Neck Junction	X	-66.6	-70.3	-68.4	-68.0
	Y	0.0	0.0	0.0	0.0
	Z	-3.7	-9.7	-12.9	-16.5
Tip of Chin (Menton)	X	42.1	53.2	55.7	60.5
	Y	0.0	0.0	0.0	0.0
	Z	-57.8	-62.4	-65.8	-67.3
Upper Cheek (Zygion)	X	28.3	31.8	33.3	36.5
	Y	± 49.4	± 52.3	± 53.1	± 53.9
	Z	1.5	-1.2	-0.3	-0.9
Back of Jaw (Gonion)	X	10.0	13.9	11.9	14.9
	Y	± 43.4	± 45.0	± 44.3	± 45.4
	Z	-29.8	-36.6	-38.0	-40.8
Maximum Head Breadth Point	X	-18.9	-17.6	-20.0	-20.3
	Y	± 58.4	± 64.9	± 67.3	± 68.3
	Z	64.9	58.1	72.9	73.4
Head Breadth at Circumference Point	X	-21.4	-19.7	-20.4	-14.5
	Y	± 59.2	± 64.7	± 66.5	± 68.7
	Z	40.8	42.1	44.4	48.2

Average Landmark Coordinates for Head, Neck, and Torso
re Translated Laboratory Coordinate System

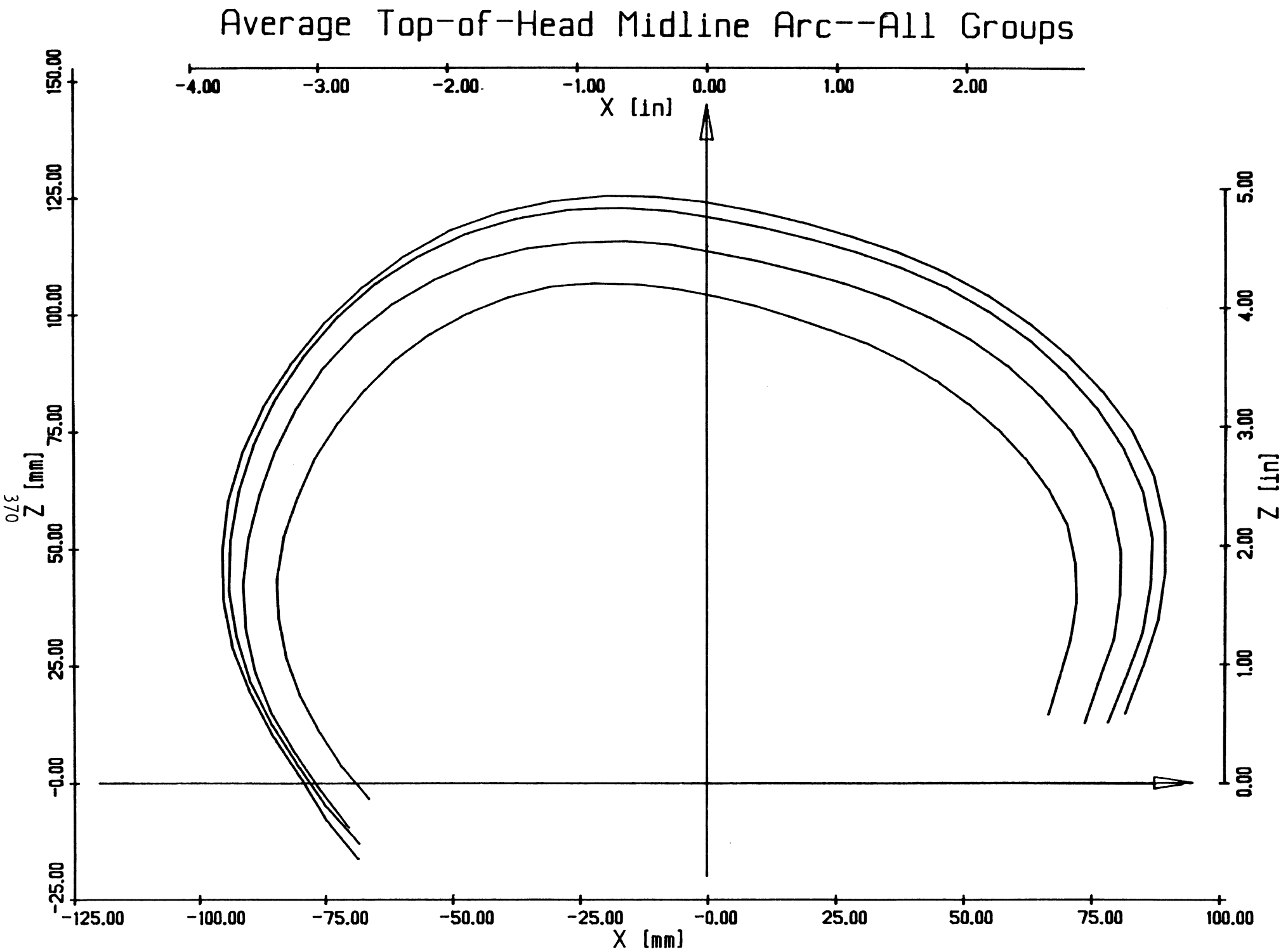
No.	Landmark	Coord	Age Group (Months)			
			4-7	13-18	25-30	43-48
1.	Ear Notch (Tragion)	x	0.0	0.0	0.0	0.0
		Y	±52.5	±57.9	±58.4	±60.0
		Z	0.0	0.0	0.0	0.0
2.	Under Eye (Infraorbitale)	X	55.6	61.0	64.9	66.0
		Y	±24.0	±25.8	±26.8	±28.3
		Z	16.9	13.2	14.8	14.8
3.	Above Nose (Sellion)	X	59.9	69.6	73.6	76.7
		Y	0.0	0.0	0.0	0.0
		Z	33.5	28.0	30.6	32.5
4.	Forehead (Glabella)	X	57.0	69.7	74.8	77.3
		Y	0.0	0.0	0.0	0.0
		Z	61.9	62.1	63.6	66.9
5.	Top of Head (Vertex)	X	-44.5	-44.5	-45.7	-42.6
		Y	0.0	0.0	0.0	0.0
		Z	98.0	109.4	115.4	119.1
6.	Back of Head (Opisthocranion)	X	-91.9	-97.5	-101.3	-103.3
		Y	0.0	0.0	0.0	0.0
		Z	13.8	19.4	21.5	25.7
7.	Head/Neck Junction	X	-62.6	-66.7	-63.8	-62.7
		Y	0.0	0.0	0.0	0.0
		Z	-22.9	-24.3	-27.8	-31.0
8.	Tip of Chin (Menton)	X	57.1	65.2	68.9	73.8
		Y	0.0	0.0	0.0	0.0
		Z	-43.1	-49.8	-51.8	-52.4
9.	Under Cheek (Zygion)	X	26.6	31.3	32.4	35.8
		Y	±49.4	±52.3	±53.1	±53.9
		Z	9.6	5.5	7.1	7.1
10.	Back of Jaw (Gonion)	X	18.3	21.3	20.1	23.4
		Y	±43.4	±45.0	±44.3	±45.4
		Z	-25.6	-32.9	-34.4	-36.5
11.	Maximum Head Breadth Point	X	-36.9	-29.6	-35.7	-35.8
		Y	±58.4	±64.9	±67.3	±68.3
		Z	56.5	53.1	66.6	67.1

Average Landmark Coordinates for Head, Neck, and Torso
re Translated Laboratory Reference System
(Continued)

No.	Landmark	Coord	Age Group (Months)			
			4-7	13-18	25-30	43-48
12.	Head Breadth at Circumference Point	X	-32.3	-28.1	-29.8	-24.7
		Y	±59.2	±64.7	±66.5	±68.7
		Z	32.7	36.0	38.5	44.1
13.	Neck Depth at Front	X	17.4	17.6	17.9	22.6
		Y	0.0	0.0	0.0	0.0
		Z	-57.8	-68.4	-72.9	-77.2
14.	Suprasternale	X	24.1	20.2	18.4	23.6
		Y	0.0	0.0	0.0	0.0
		Z	-66.6	-83.4	-93.2	-100.6
15.	Front Torso #1	X	28.4	28.2	28.2	35.0
		Y	0.0	0.0	0.0	0.0
		Z	-78.1	-99.2	-109.8	-119.4
16.	Front Torso #2	X	32.2	35.3	35.4	43.4
		Y	0.0	0.0	0.0	0.0
		Z	-91.7	-113.3	-125.7	-135.9
17.	Torso Depth Point at Point	X	33.5	39.0	41.7	48.9
		Y	0.0	0.0	0.0	0.0
		Z	-107.5	-131.4	-146.4	-154.6
18.	Neck Depth Point at Back	X	-57.1	-55.1	-53.6	-51.1
		Y	0.0	0.0	0.0	0.0
		Z	-34.0	-43.9	-47.0	-53.2
19.	7th Cervical Vertebra	X	-58.5	-58.2	-58.0	-56.2
		Y	0.0	0.0	0.0	0.0
		Z	-44.5	-57.2	-61.6	-69.3
20.	Back of Torso Point #1	X	-64.0	-66.7	-68.3	-67.6
		Y	0.0	0.0	0.0	0.0
		Z	-58.9	-77.6	-84.4	-100.7
21.	Back of Torso Point #2	X	-69.5	-74.2	-76.5	-74.8
		Y	0.0	0.0	0.0	0.0
		Z	-74.5	-100.6	-116.0	-132.5
22.	Torso Depth Point at Back	X	-75.3	-81.0	-83.8	-78.5
		Y	0.0	0.0	0.0	0.0
		Z	-91.4	-127.1	-142.4	-157.6

Average Landmark Coordinates for Head, Neck, and Torso
re Translated Laboratory Reference System
(Continued)

No.	Landmark	Coord	Age Group (Months)			
			4-7	13-18	25-30	43-48
23.	Neck Breadth Point	X	-14.8	-14.3	-14.3	-9.2
		Y	±38.3	±39.0	±40.5	±42.3
		Z	-40.6	-52.8	-57.2	-59.7
24.	Shoulder #1	X	-20.6	-18.4	-20.7	-17.1
		Y	±40.1	±45.4	±47.0	±50.6
		Z	49.4	-61.7	-71.1	-77.0
25.	Shoulder #2	X	-20.5	-19.4	-22.2	-18.5
		Y	±47.4	±58.1	±59.1	±67.6
		Z	-46.7	-66.6	-79.3	-85.1
26.	Top of Shoulder	X	-19.7	-17.5	-21.5	-14.8
		Y	±61.1	±76.1	±80.3	±91.9
		Z	-47.6	-68.9	-84.7	-89.7
27.	Shoulder #3	X	-14.3	-9.5	-9.0	-5.2
		Y	±84.5	±103.2	±109.3	±117.7
		Z	-58.3	-83.0	-101.3	-112.1
28.	Shoulder Circumference Point	X	-16.0	-10.6	-6.6	-2.3
		Y	±96.6	±116.7	±121.8	±126.6
		Z	-81.5	-111.6	-132.2	-142.4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-1.00
0.00
1.00
2.00
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150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
Z [in]
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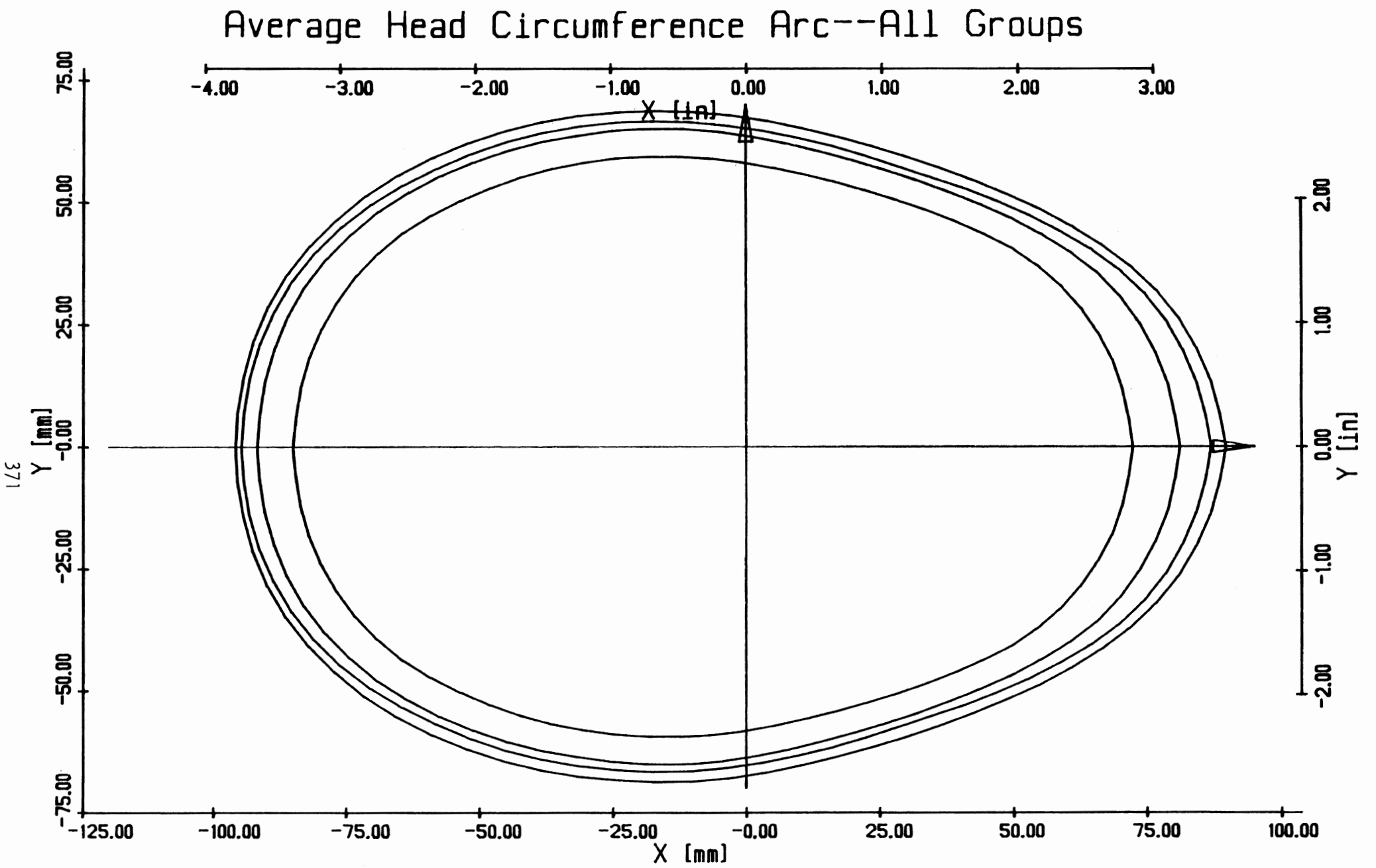
100.00
X [mm]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3.00
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50.00
25.00
-0.00
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-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
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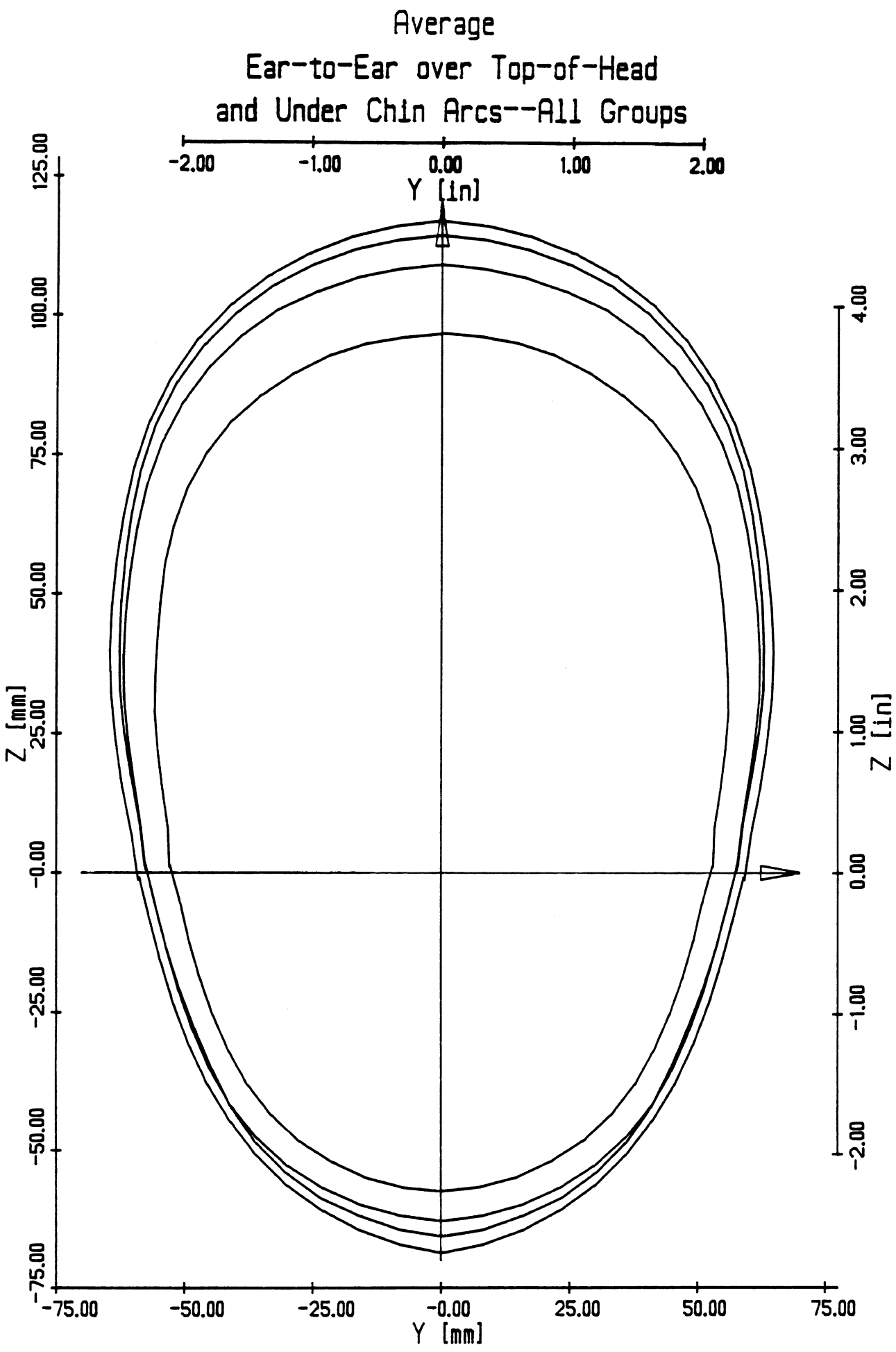
X [mm]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and Under Chin Arcs--All Groups
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-1.00
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
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-50.00
-25.00
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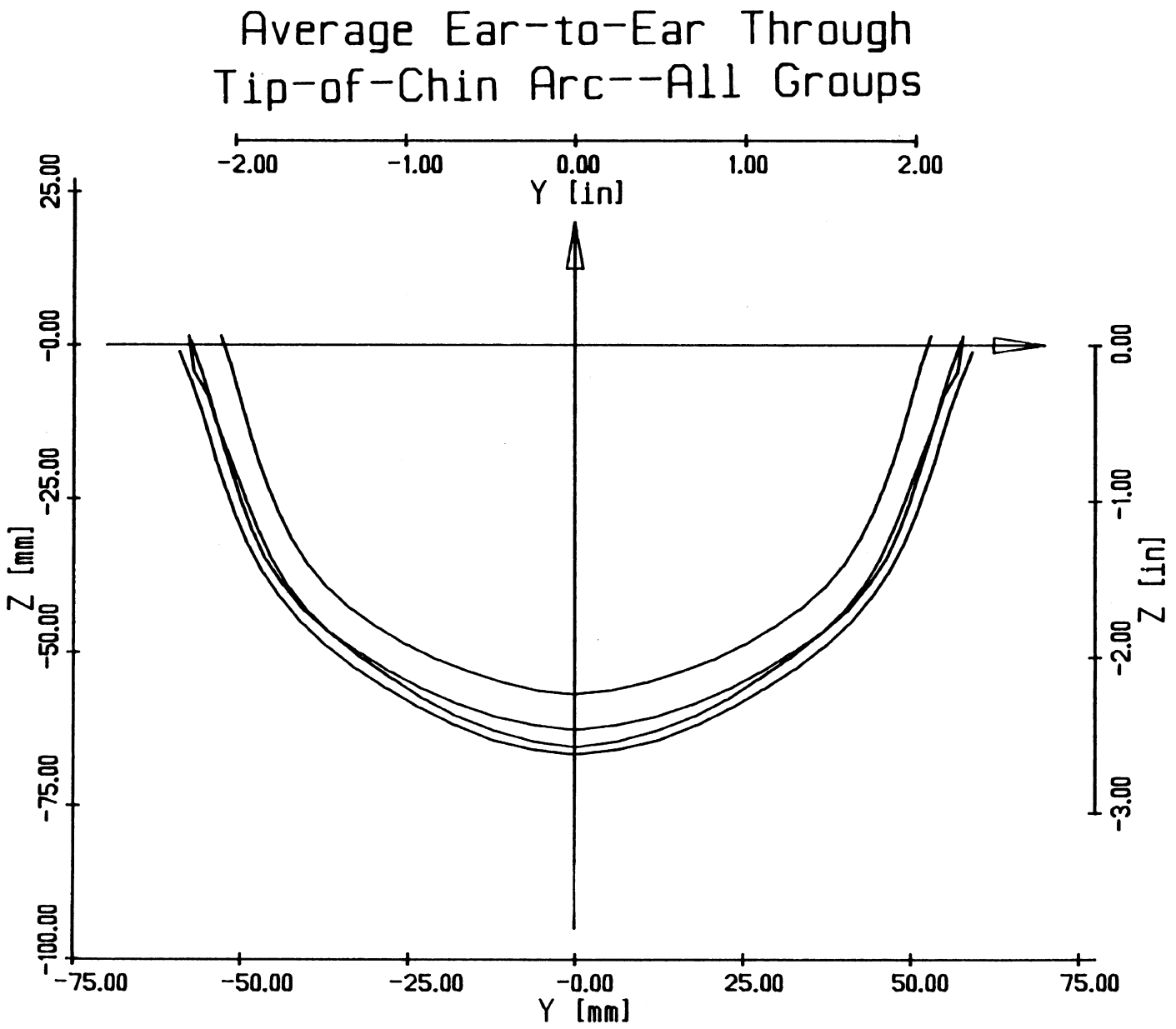
25.00
50.00
75.00
Y [mm]


Average Ear-to-Ear Through
Tip-of-Chin Arc--All Groups
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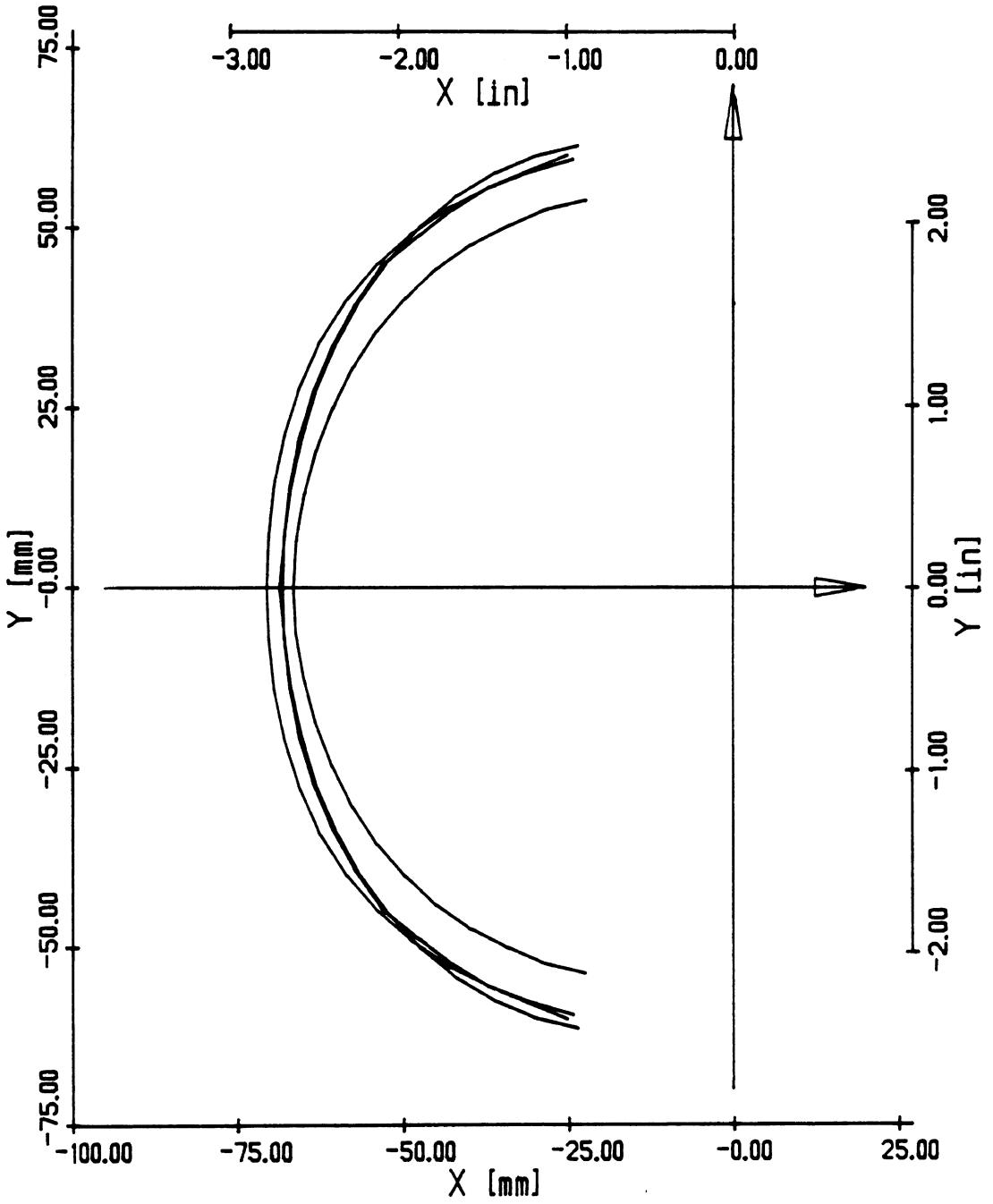
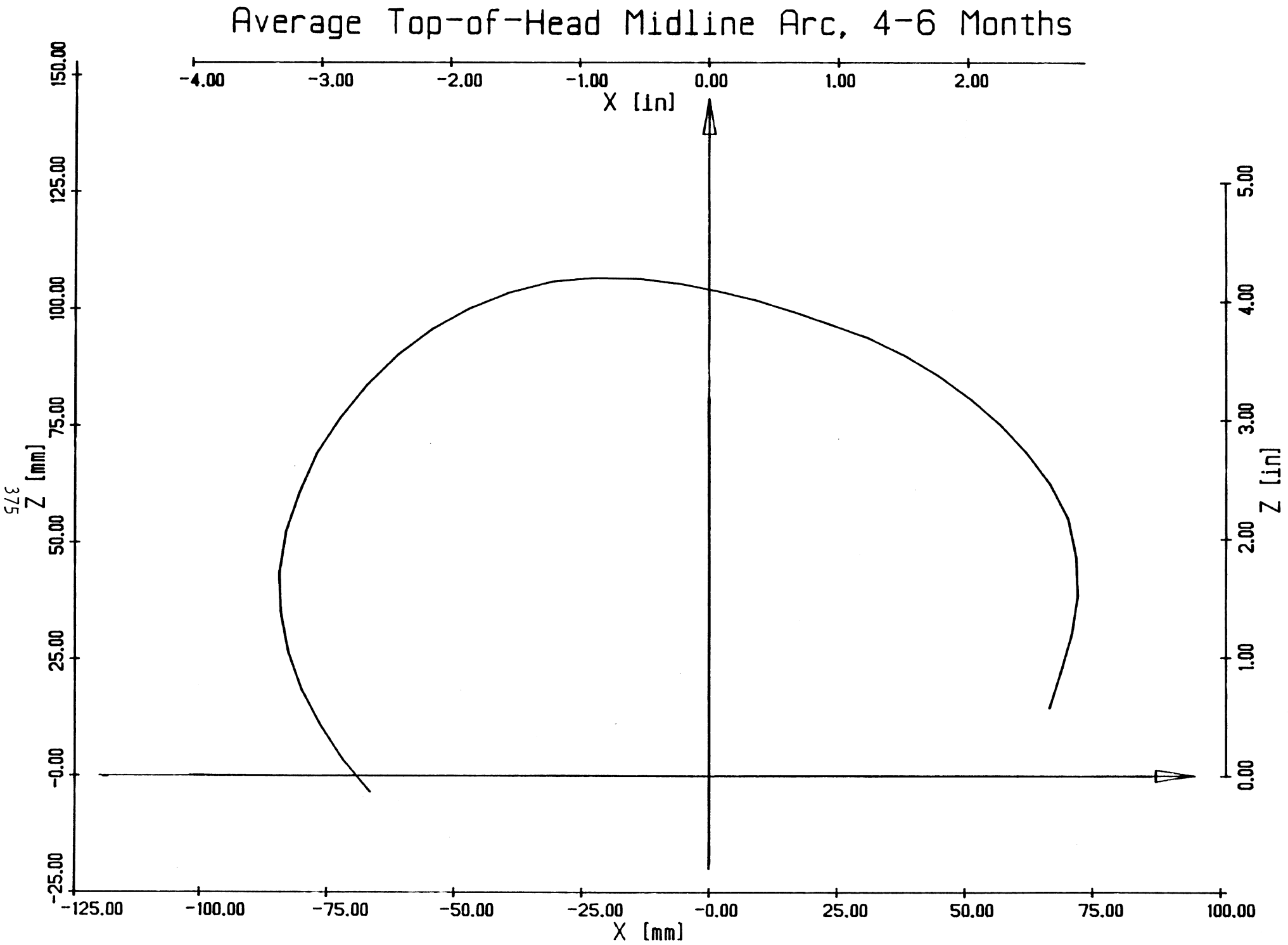
0.00
1.00
2.00
Y [in]
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

Average Back-of-Head Arc--All Groups

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-1.00
0.00
1.00
2.00
X [in]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
Z [in]
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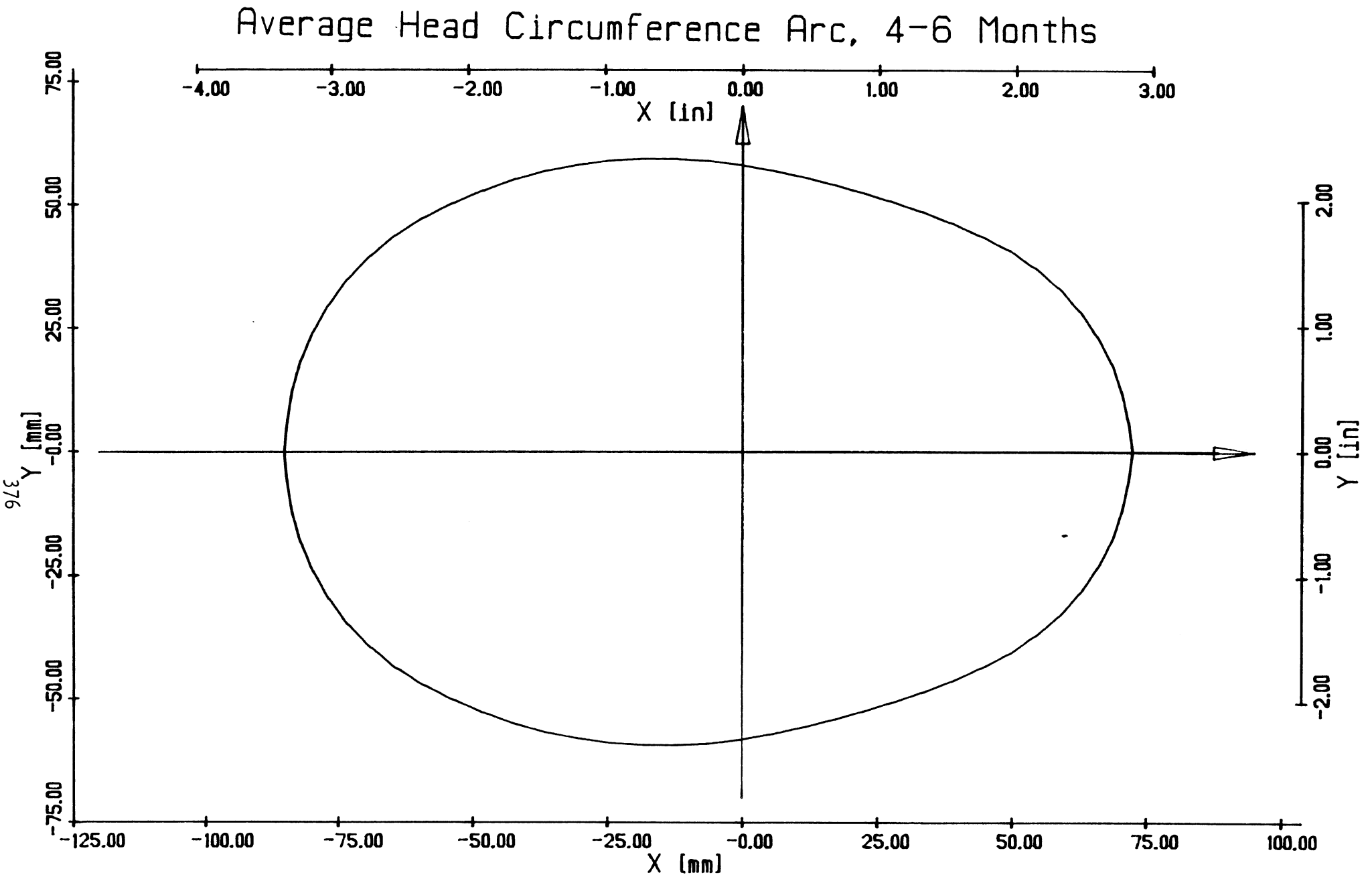
25.00
50.00
75.00
100.00
X [mm]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0.00
1.00
2.00
3.00
X [in]
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50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
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50.00
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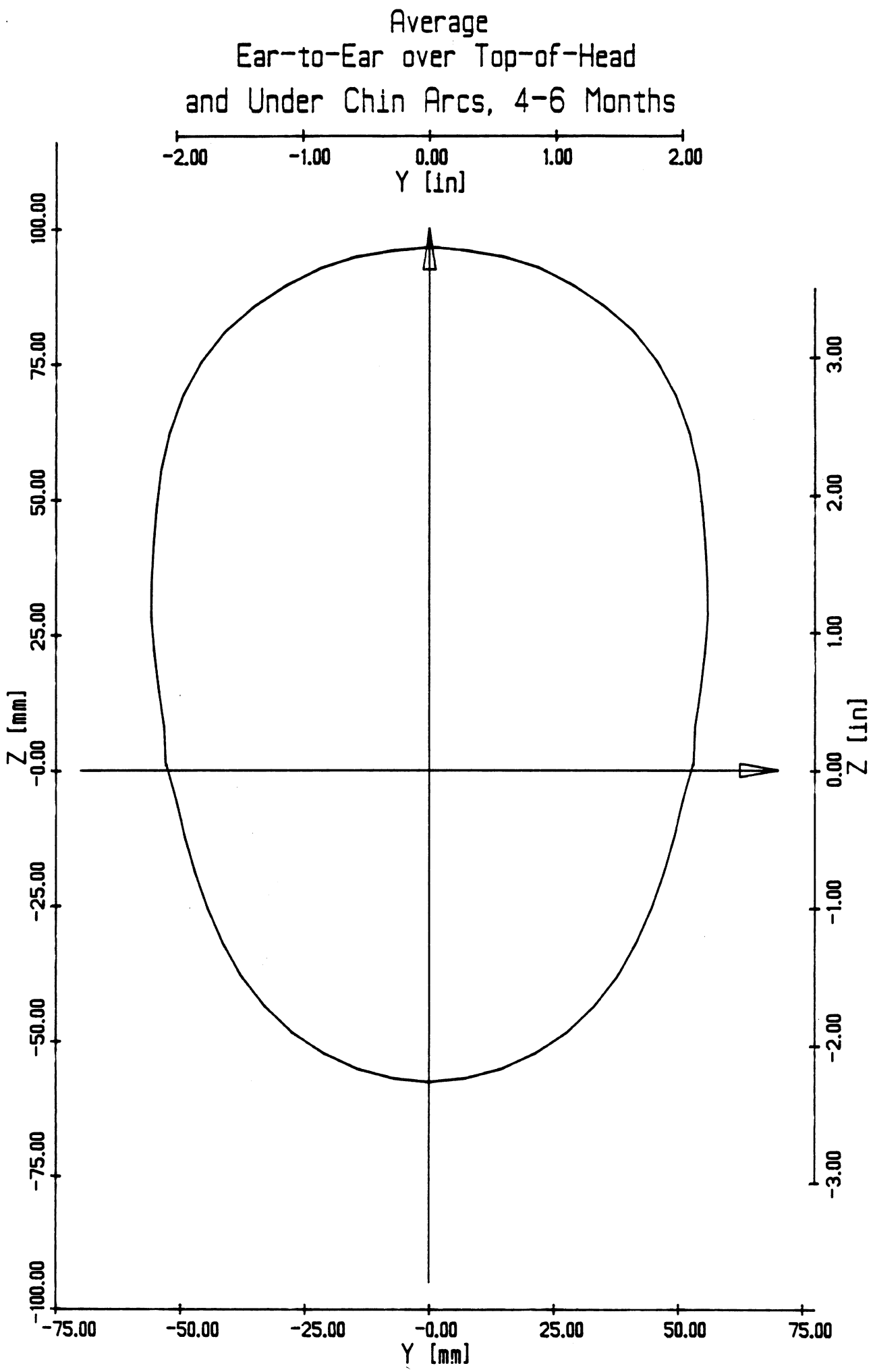
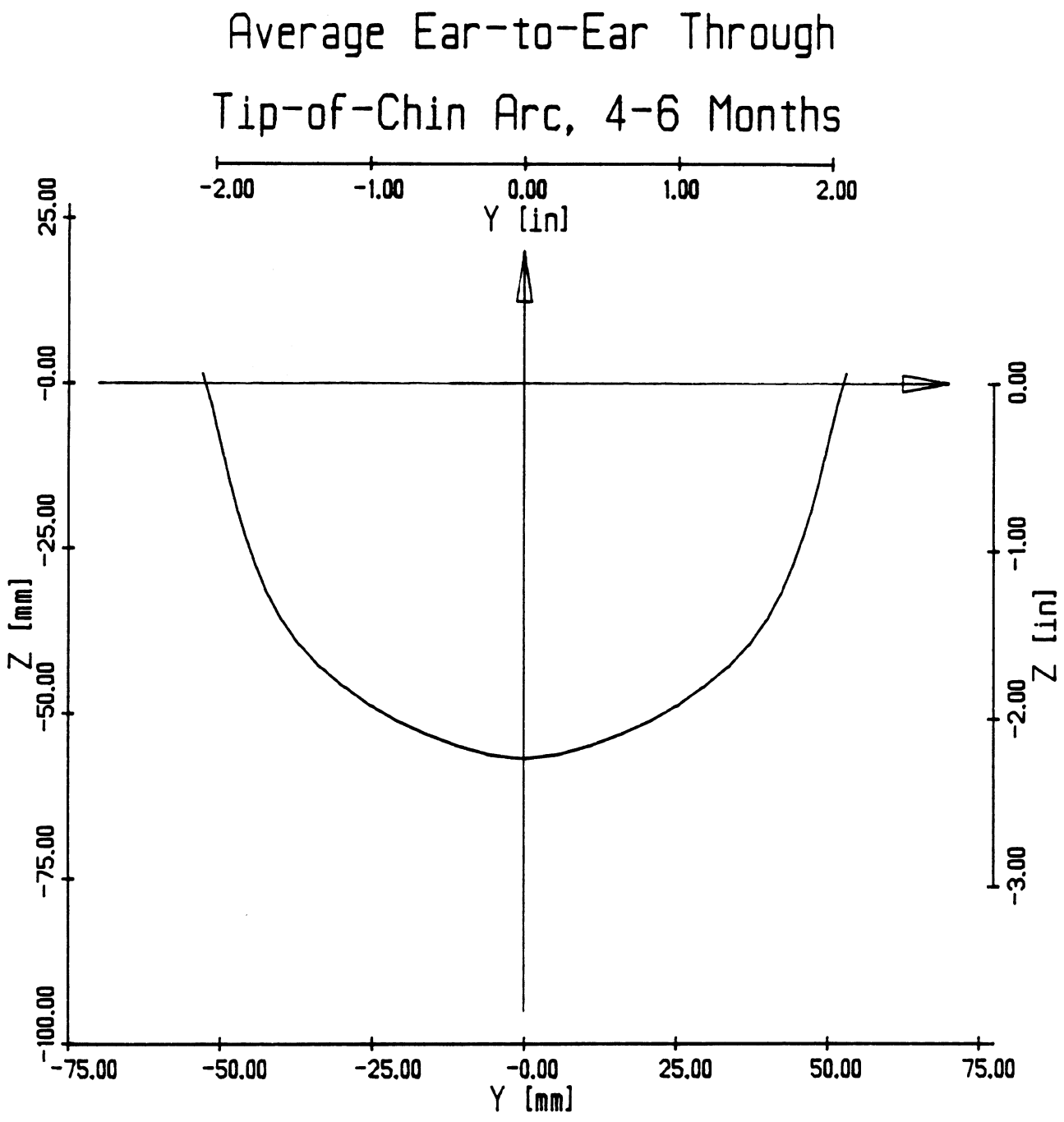
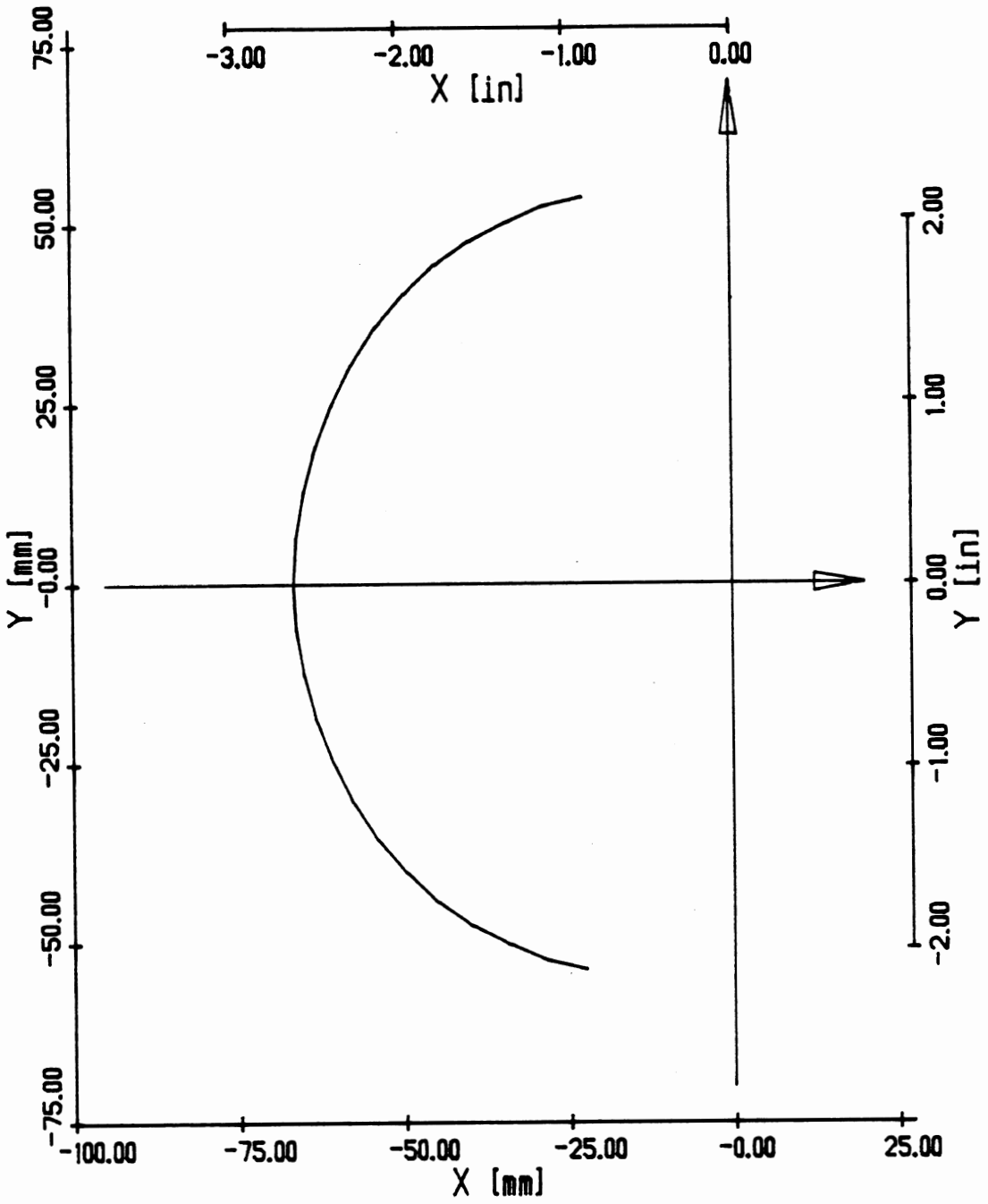
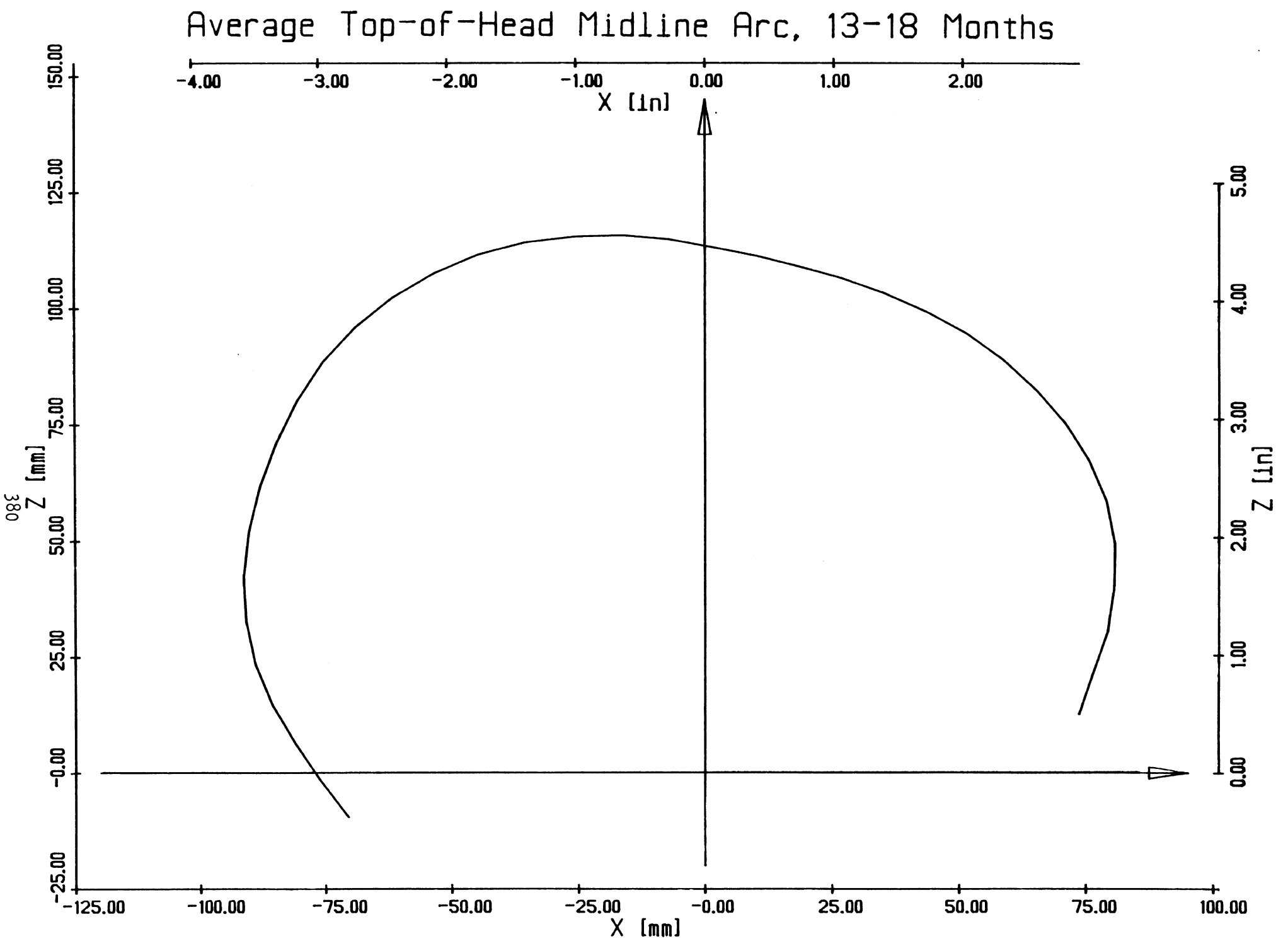
X [mm]

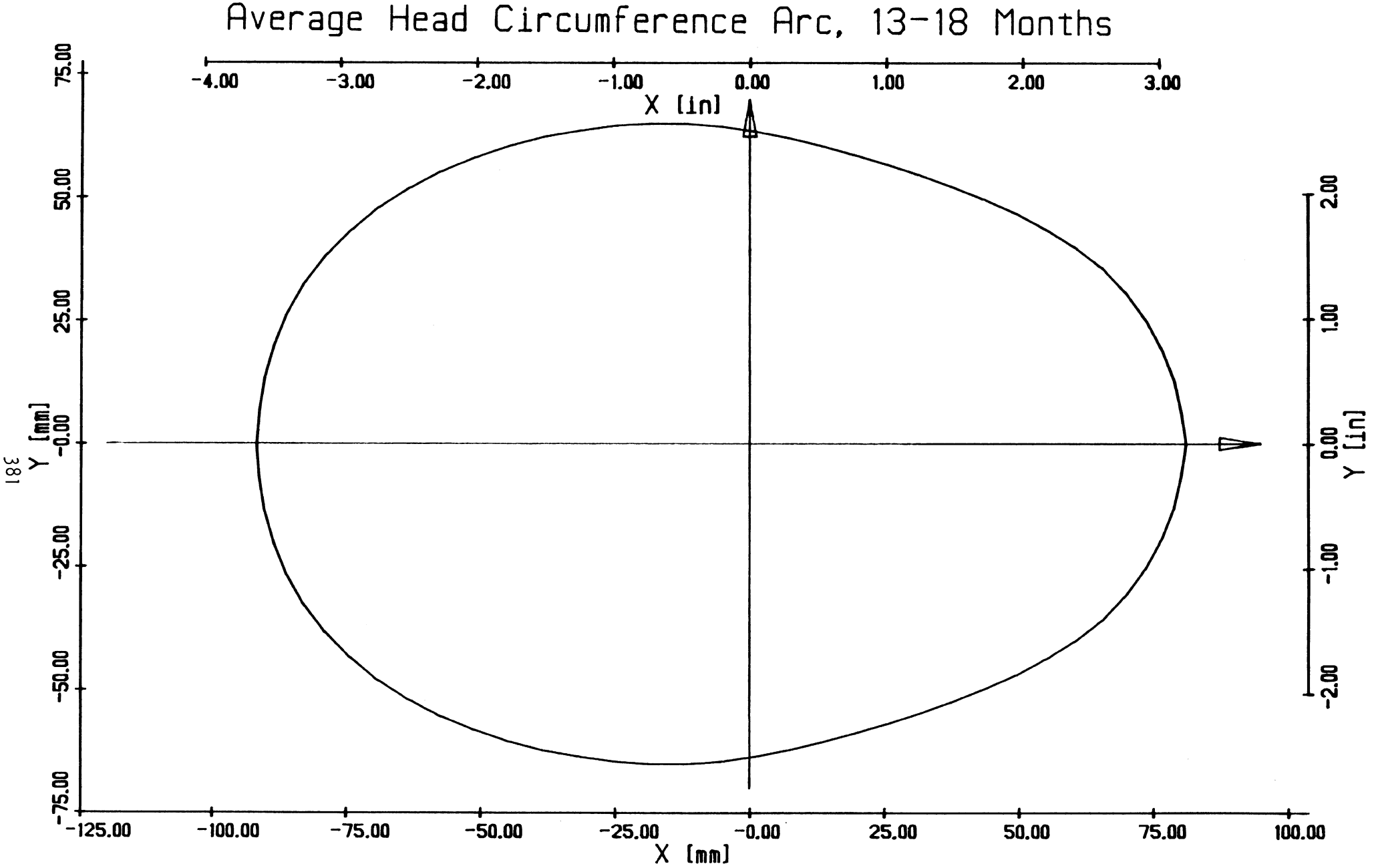

Average
Ear-to-Ear over Top-of-Head
and Under Chin Arcs, 4-6 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]


Average Ear-to-Ear Through
Tip-of-Chin Arc, 4-6 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

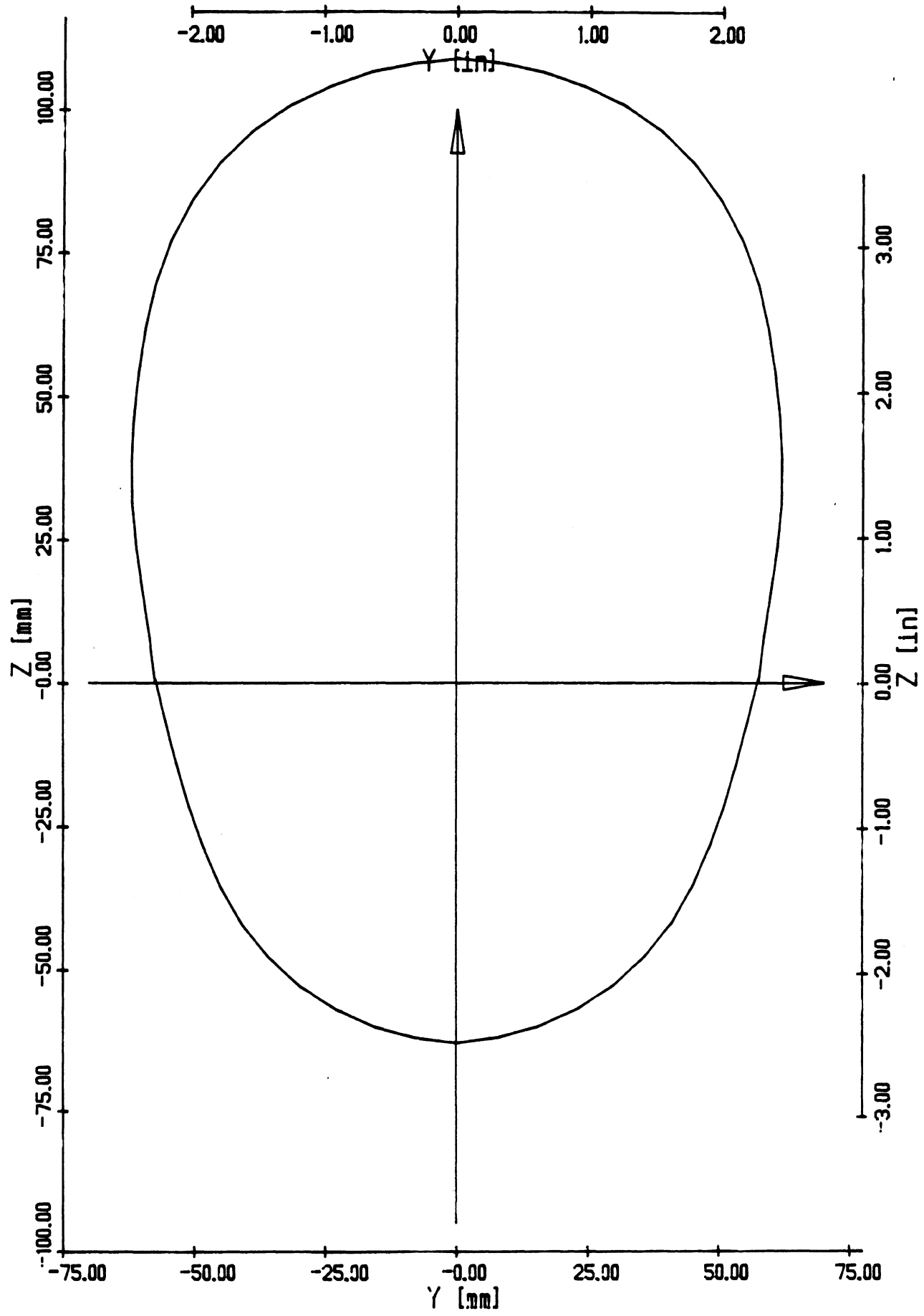
Average Back-of-Head Arc, 4-6 Months

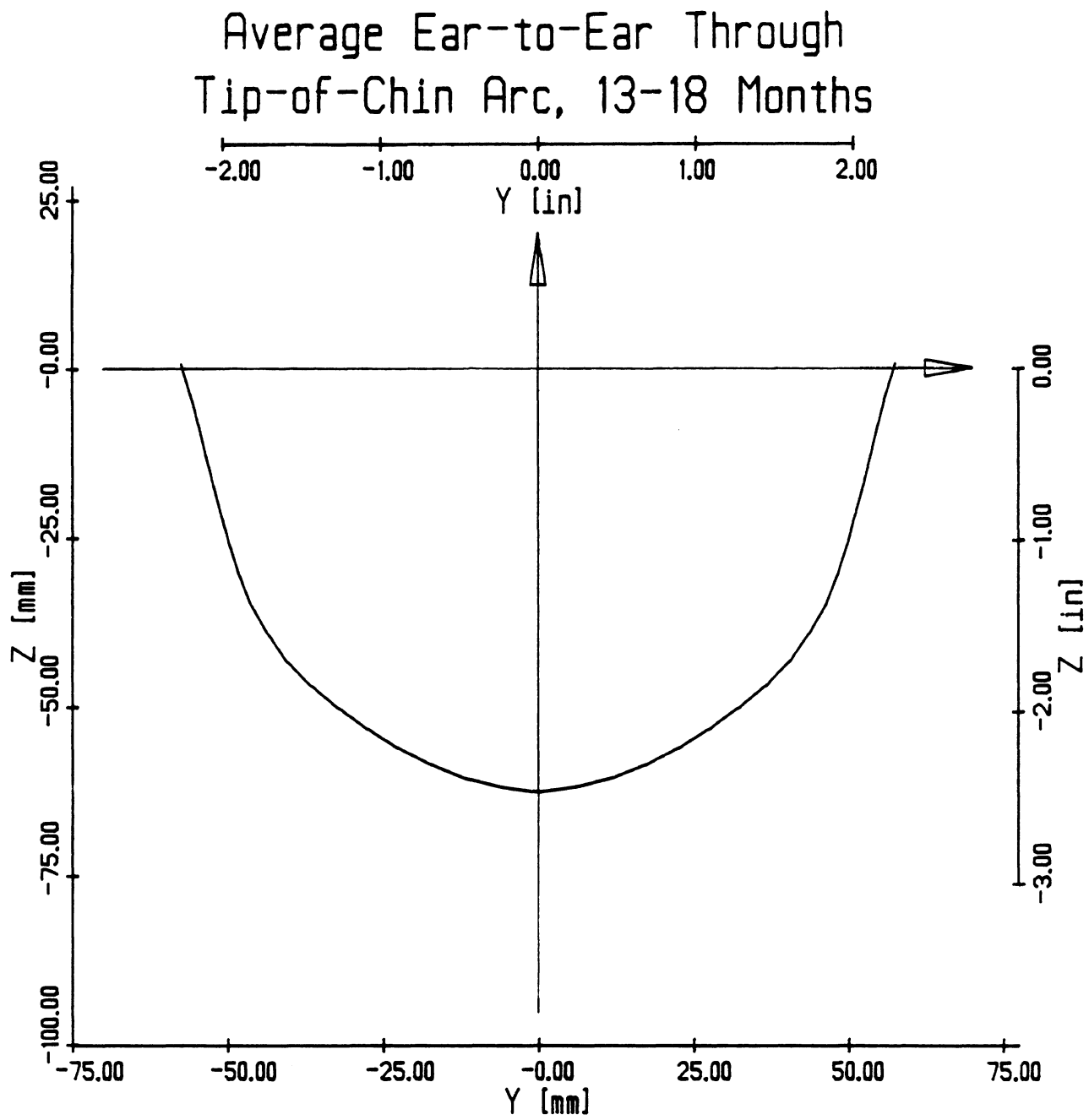



Average Top-of-Head Midline Arc, 13-18 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
X [in]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

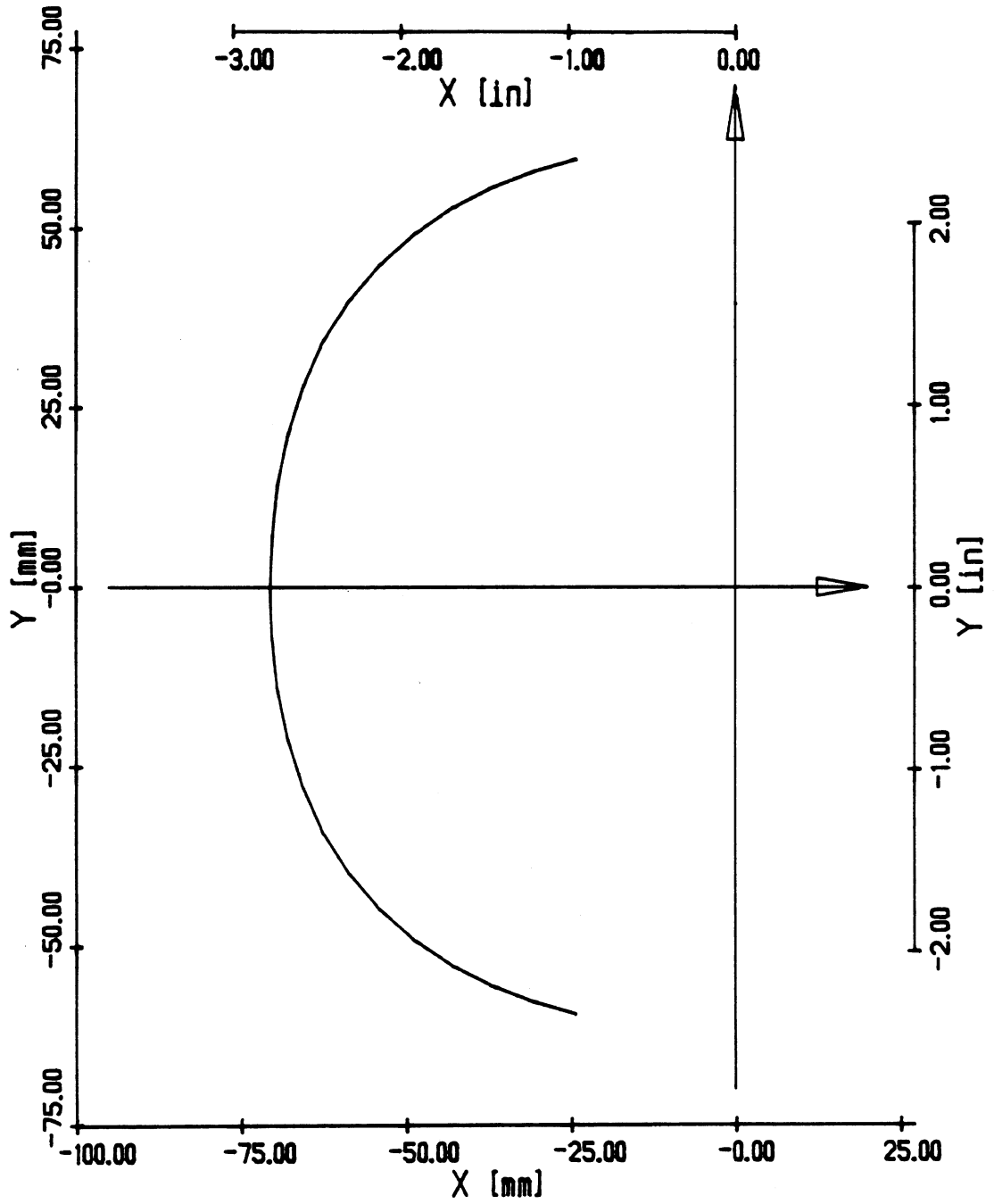

Average Head Circumference Arc, 13-18 Months
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
Y [mm]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [in]
2.00
1.00
0.00
-1.00
-2.00
X [mm]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00

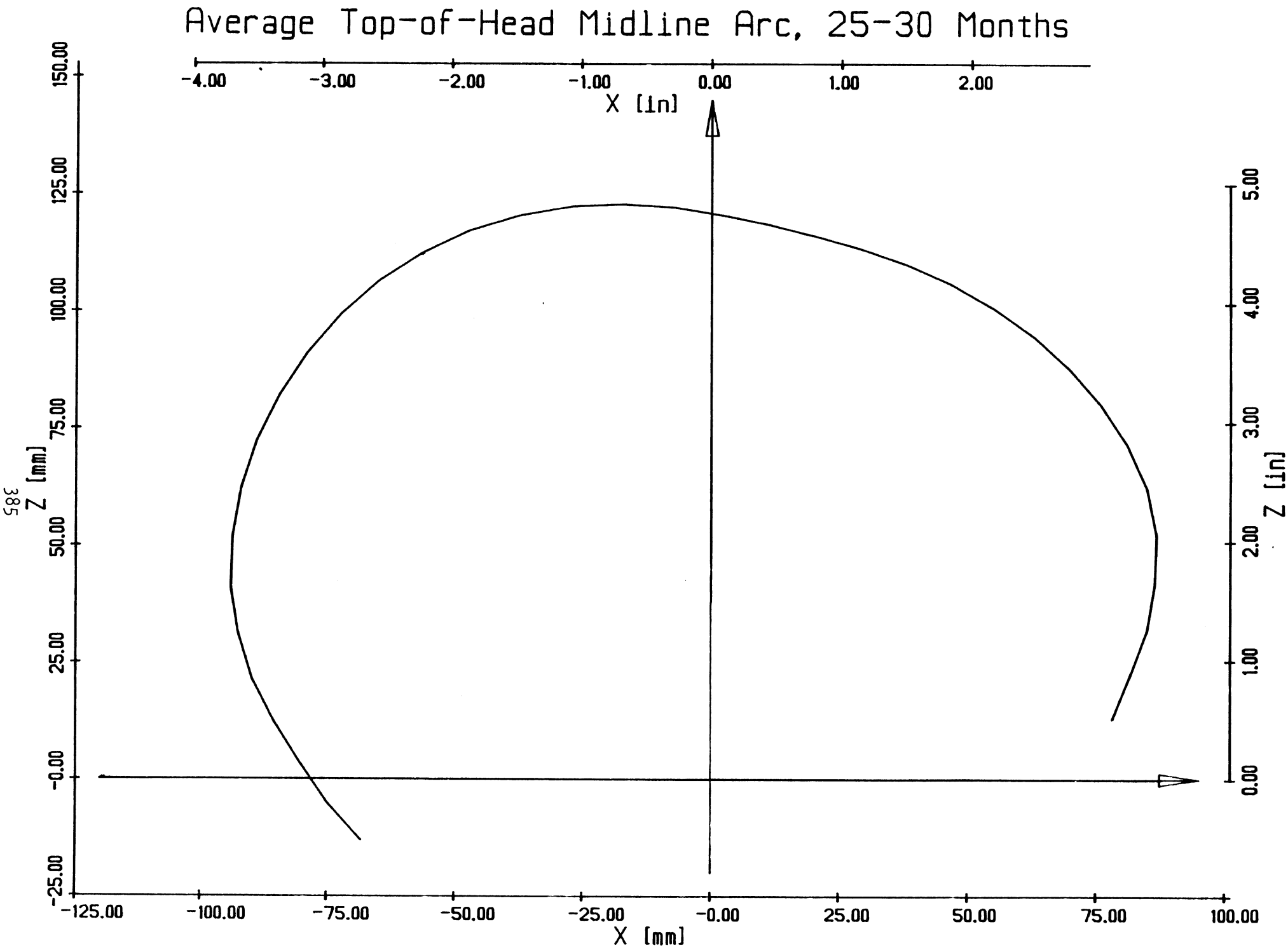
Average
Ear-to-Ear over Top-of-Head
and Under Chin Arcs, 13-18 Months

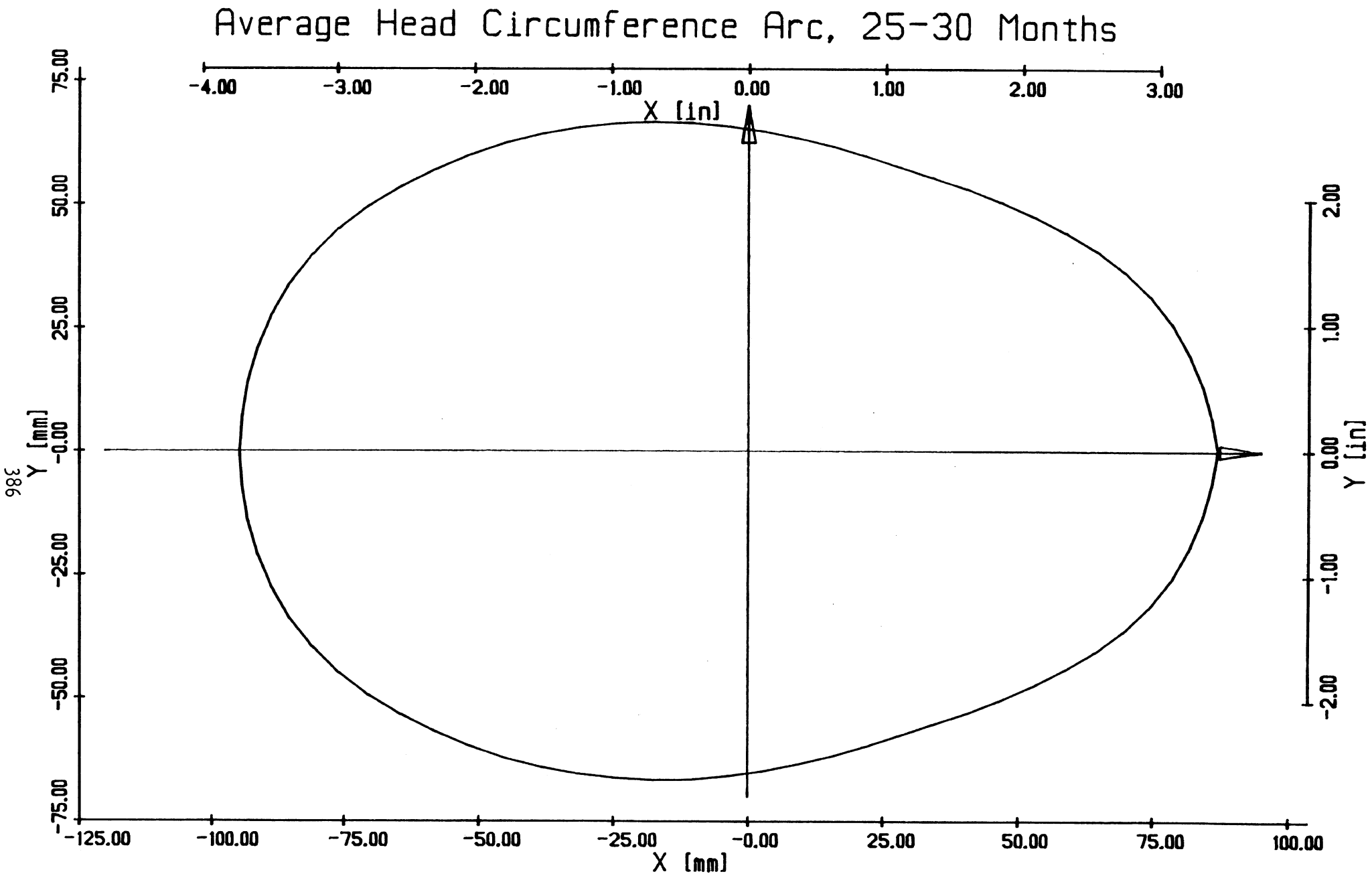



Average Ear-to-Ear Through
Tip-of-Chin Arc, 13-18 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

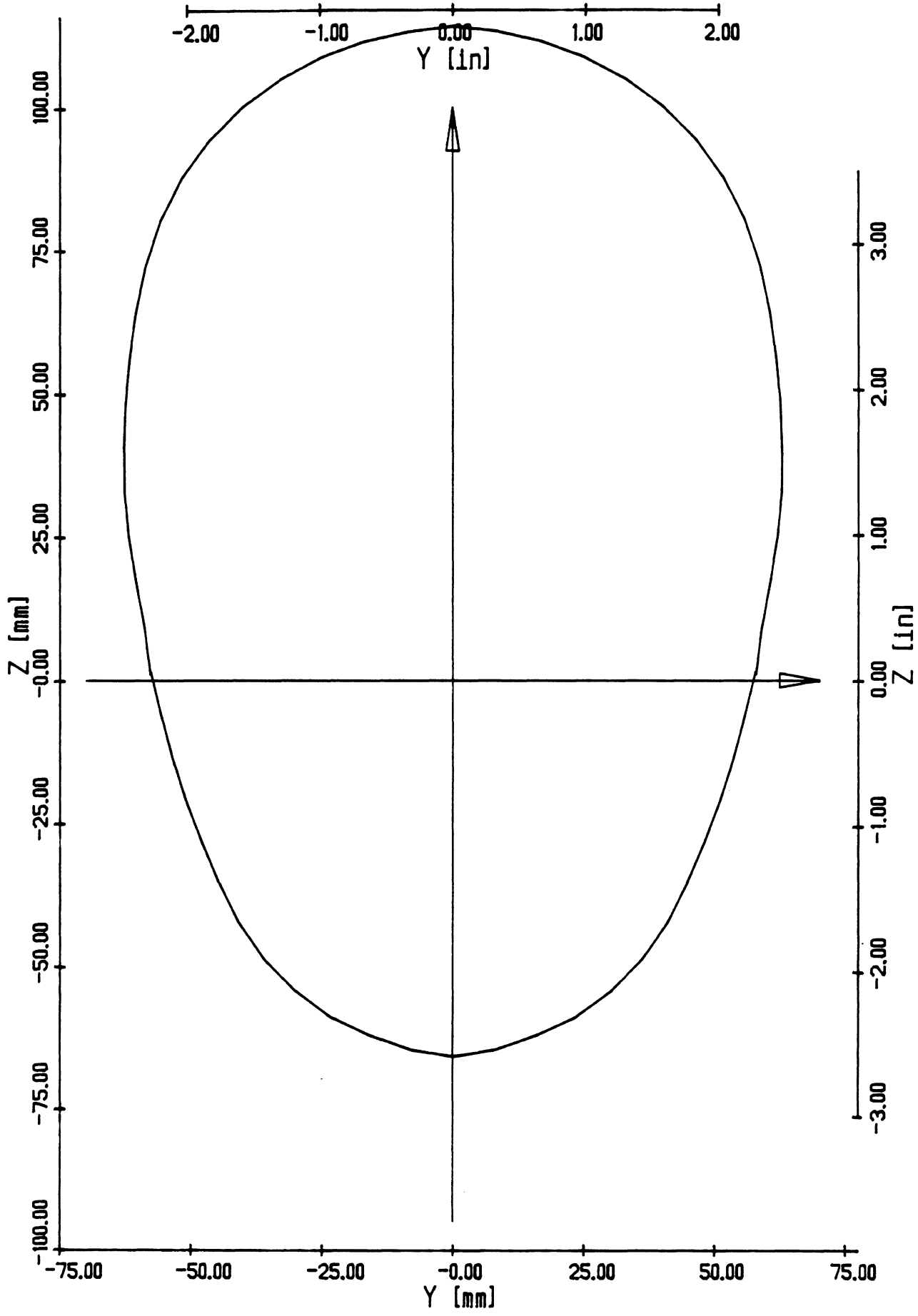
Average Back-of-Head Arc, 13-18 Months

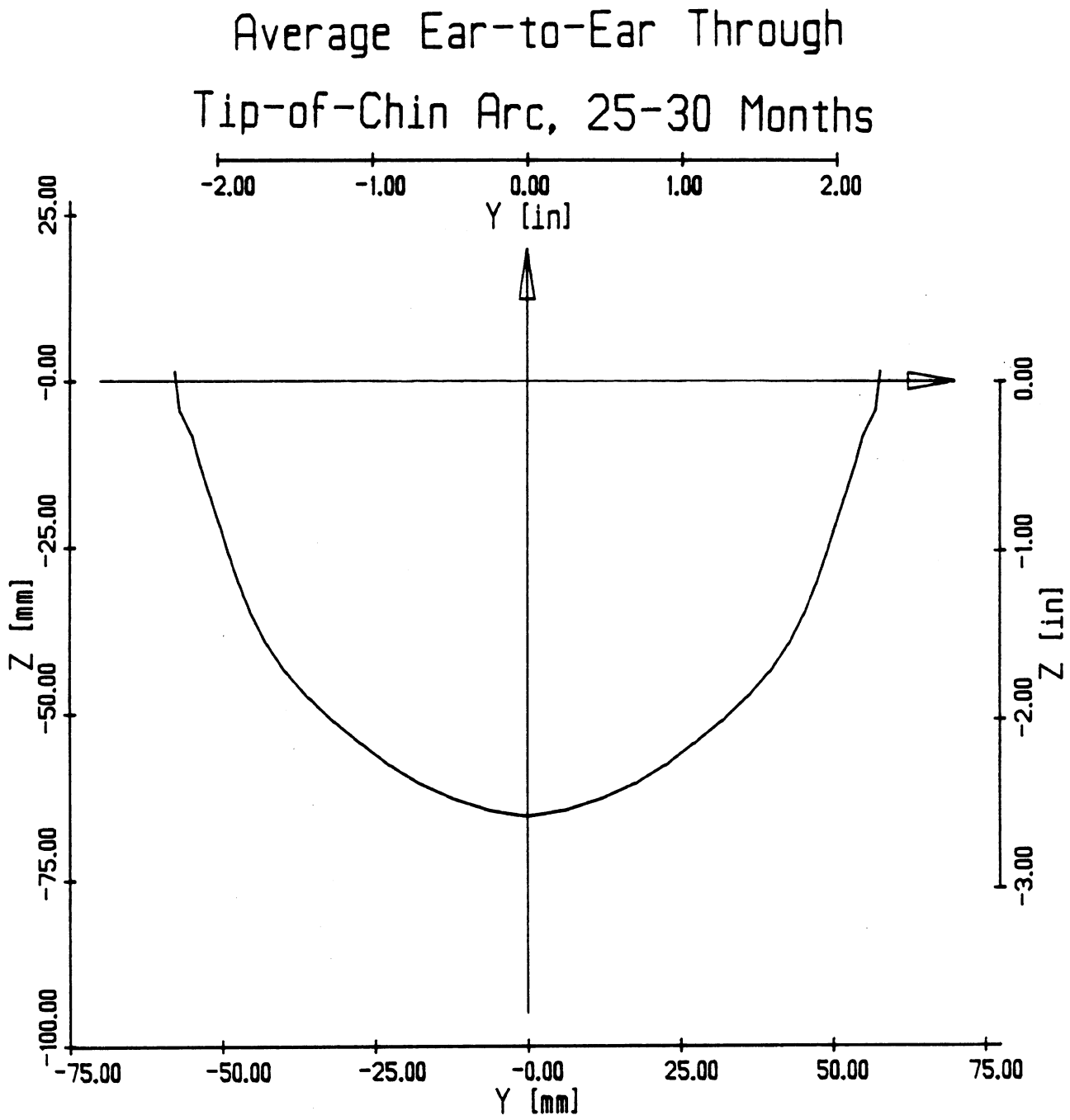



Average Top-of-Head Midline Arc, 25-30 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
X [in]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

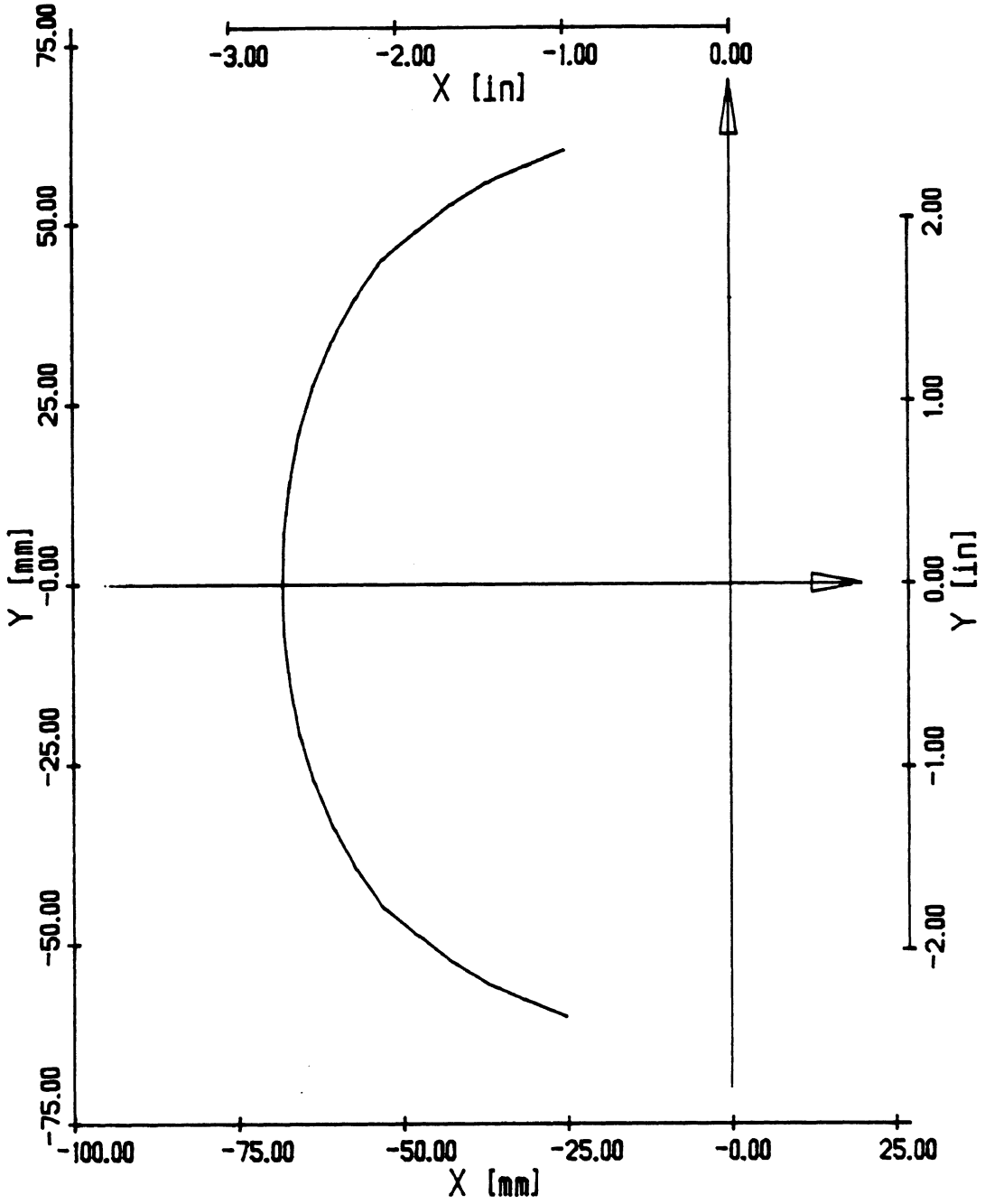

Average Head Circumference Arc, 25-30 Months
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
Y [mm]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [in]
2.00
1.00
0.00
-1.00
-2.00
X [mm]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00

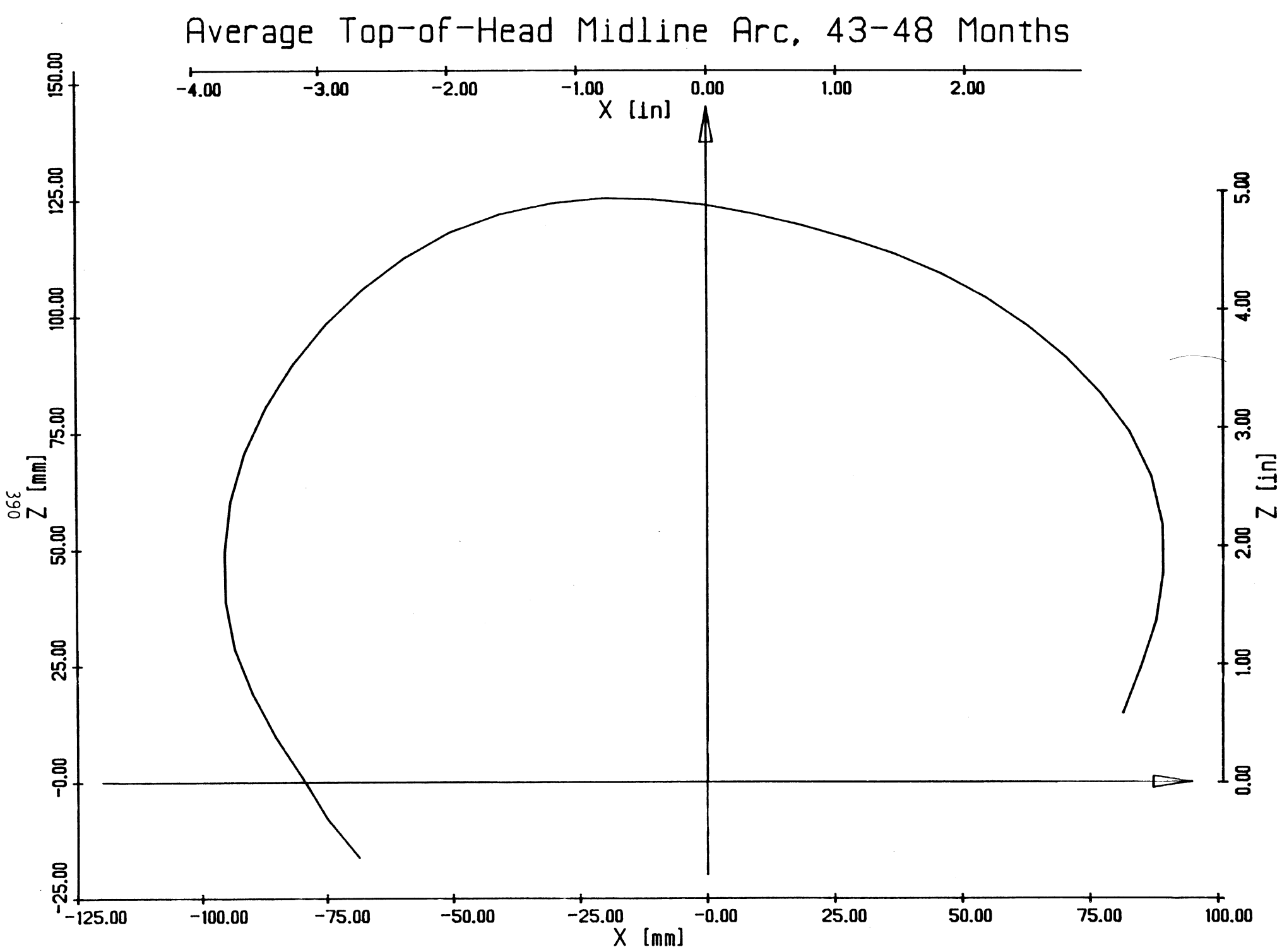
Average
Ear-to-Ear over Top-of-Head
and Under Chin Arcs, 25-30 Months

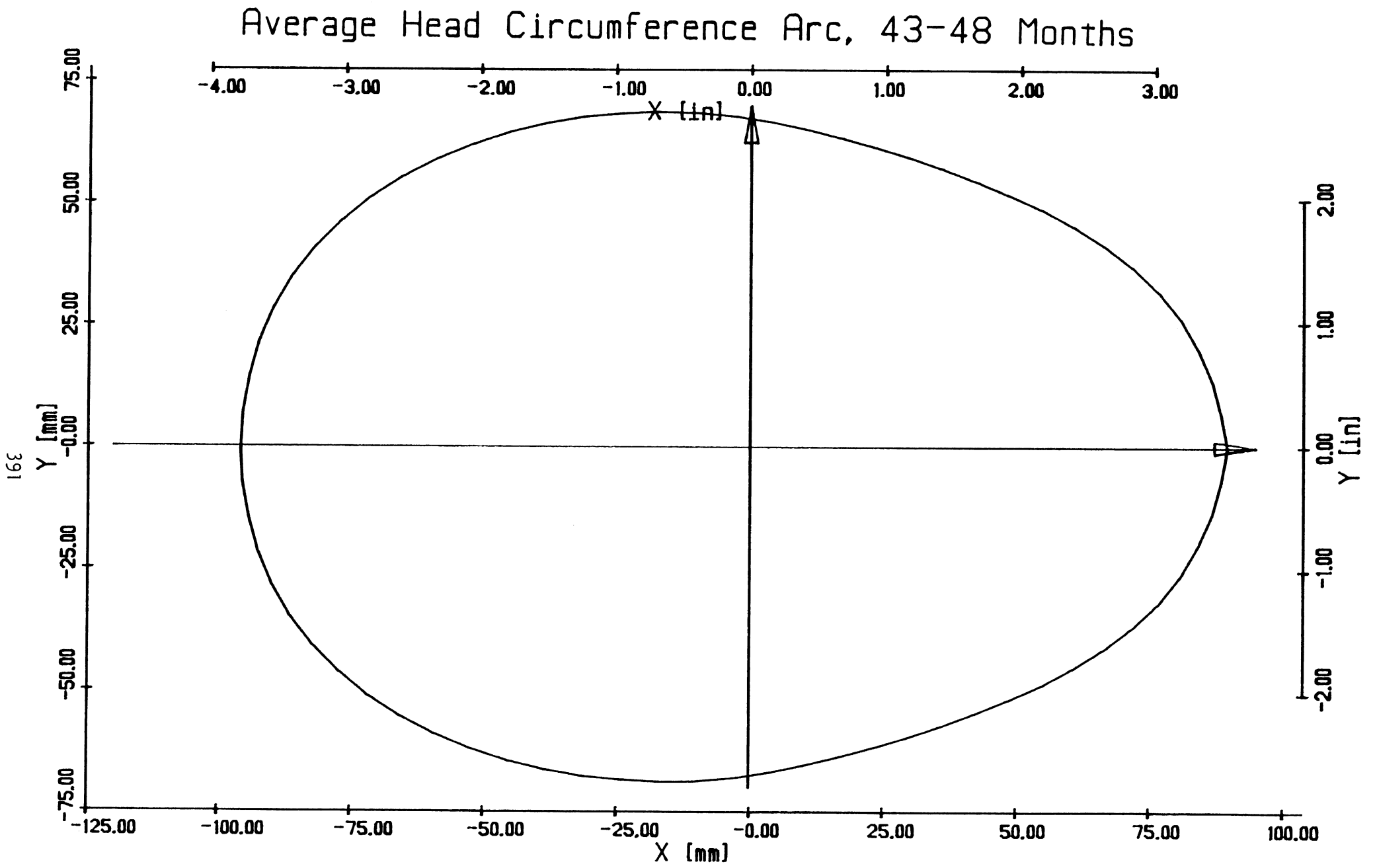



Average Ear-to-Ear Through
Tip-of-Chin Arc, 25-30 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

Average Back-of-Head Arc, 25-30 Months



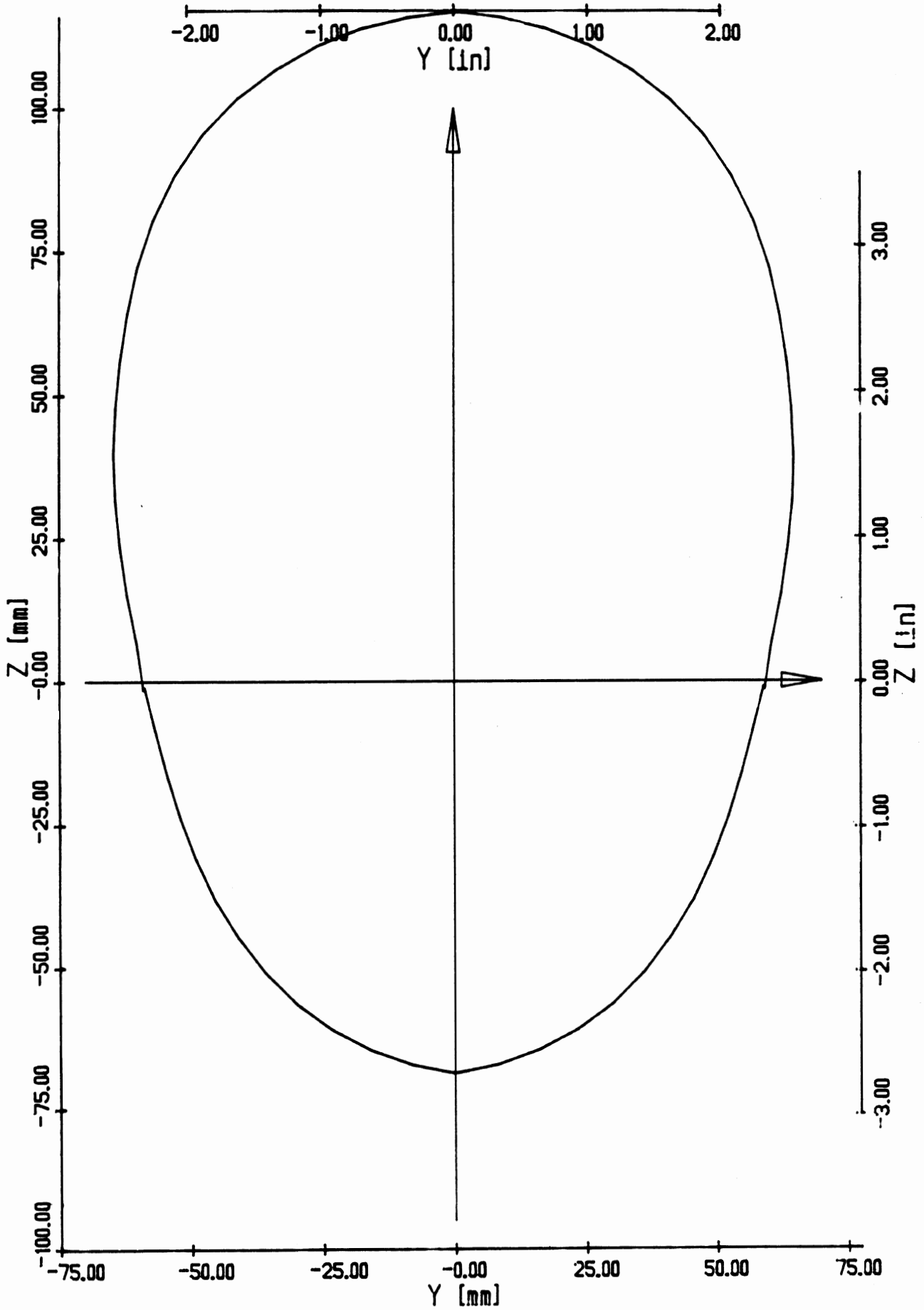

Average Top-of-Head Midline Arc, 43-48 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
X [in]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]


Average Head Circumference Arc, 43-48 Months
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
Y [mm]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [in]
2.00
1.00
0.00
-1.00
-2.00
X [mm]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00

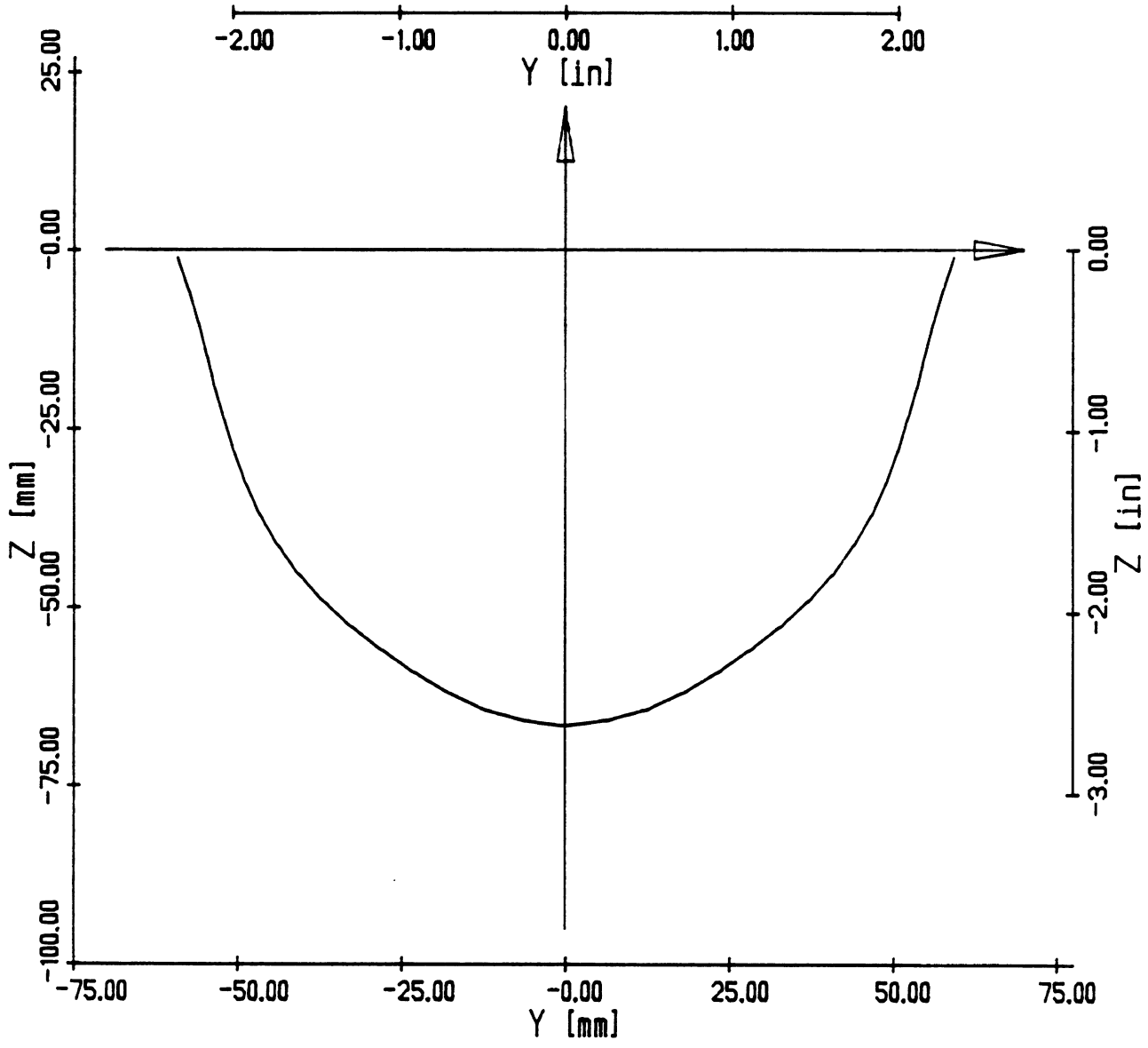
Average

Ear-to-Ear over Top-of-Head

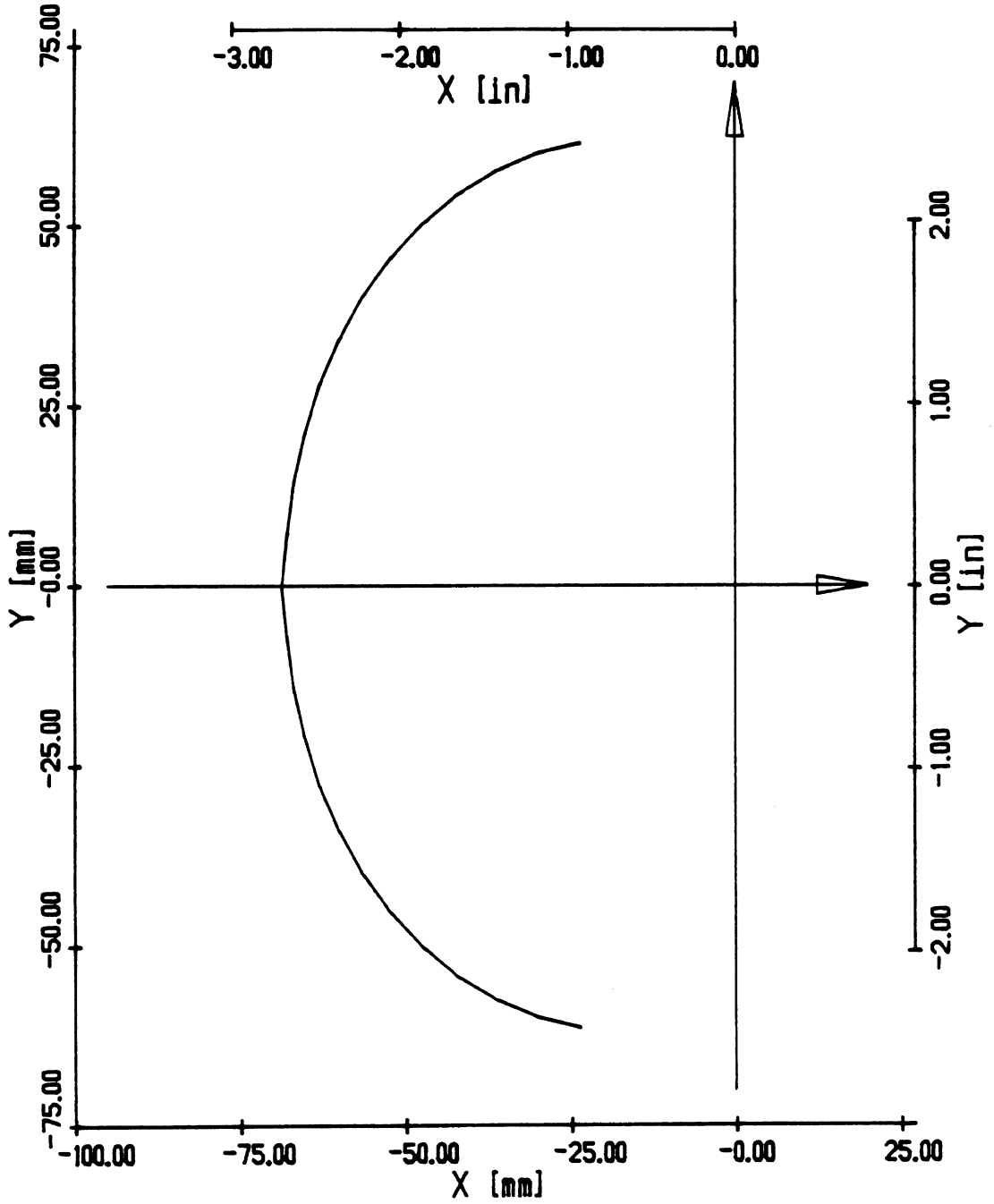
and Under Chin Arcs, 43-48 Months



Average Ear-to-Ear Through Tip-of-Chin Arc, 43-48 Months



Average Back-of-Head Arc, 43-48 Months



II.C.4

SMALL AND LARGE SUBJECT RESULTS WITH GROUP AVERAGES
(Computer Plots of Head Contours)

This section separately compares plots of the six different head contours for the representative small and large subjects from each group with the group average contours. Where necessary, the contours have been rotated into the appropriate head reference plane so that the full, undistorted view of each contour is presented. In each case, the different head contours have been plotted on separate graphs except for "Ear-to-Ear Over Top-of-Head Arc" and "Ear-to-Ear Under Chin Arc" which have been plotted together as an approximation to head circumference taken in a frontal plane just forward of the ears. All plots in this section are shown actual size.

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Contents	Page No.
4 to 6 Month Contours	396
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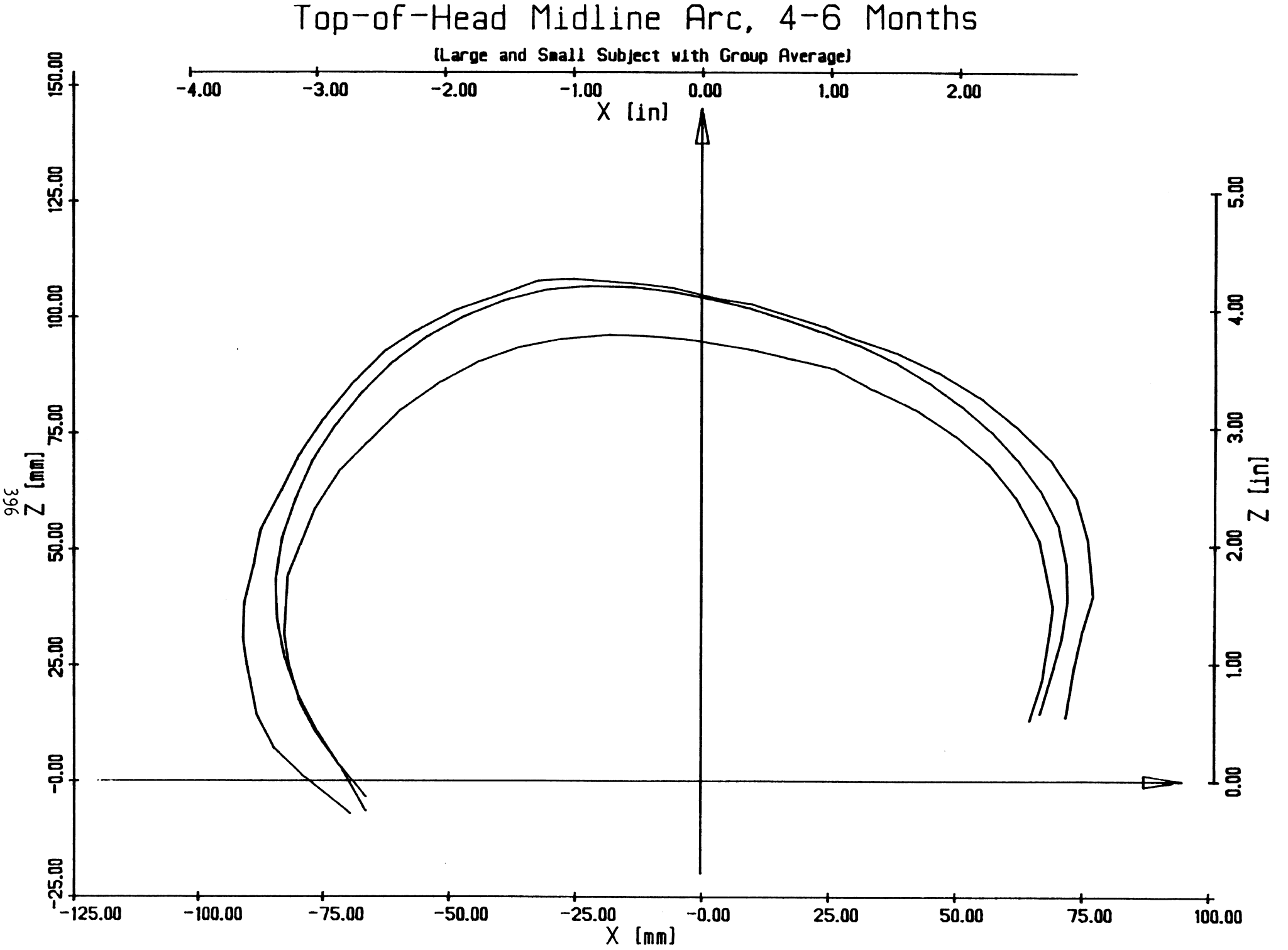
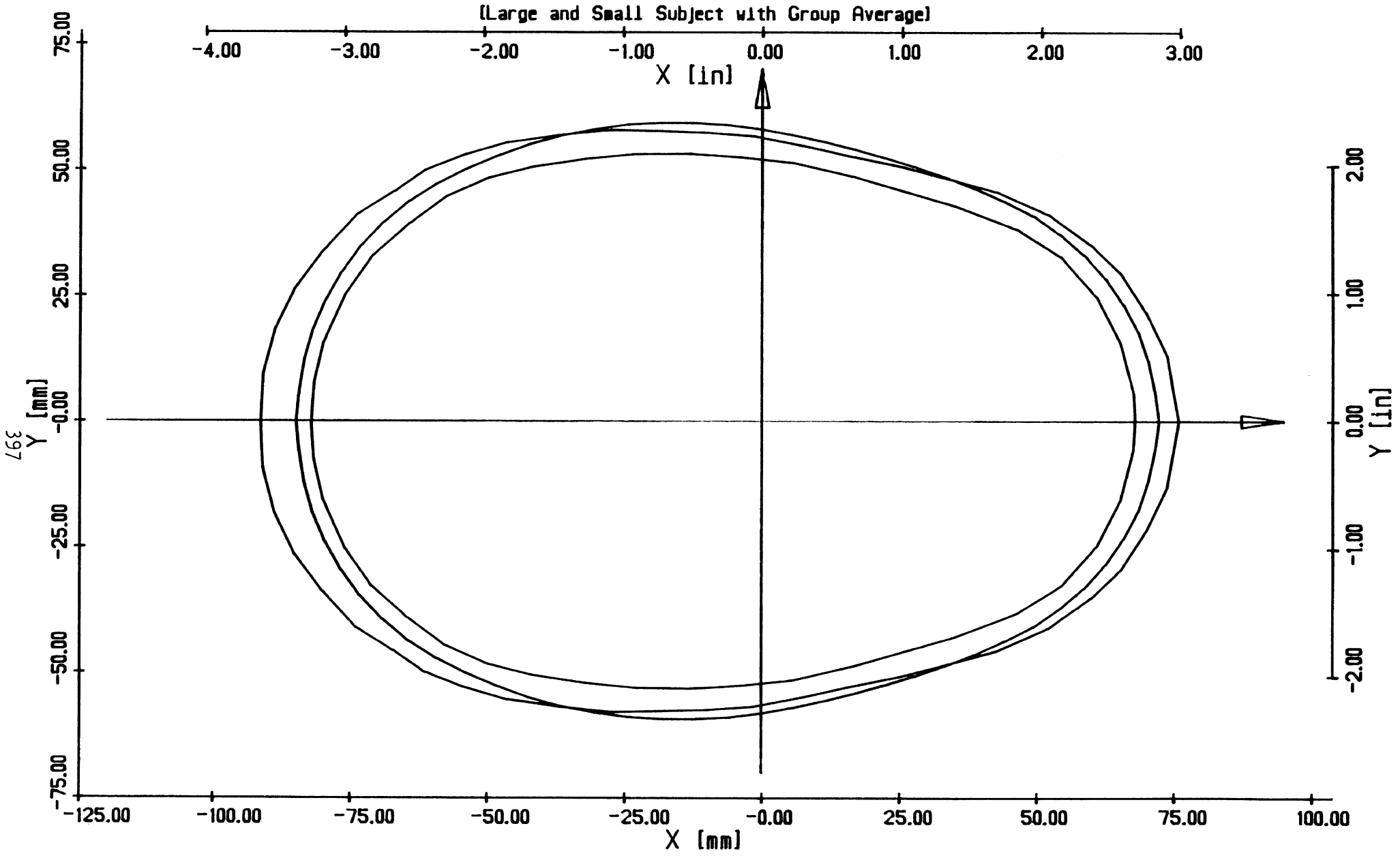
25 to 30 Month Contours	406
43 to 48 Month Contours	411

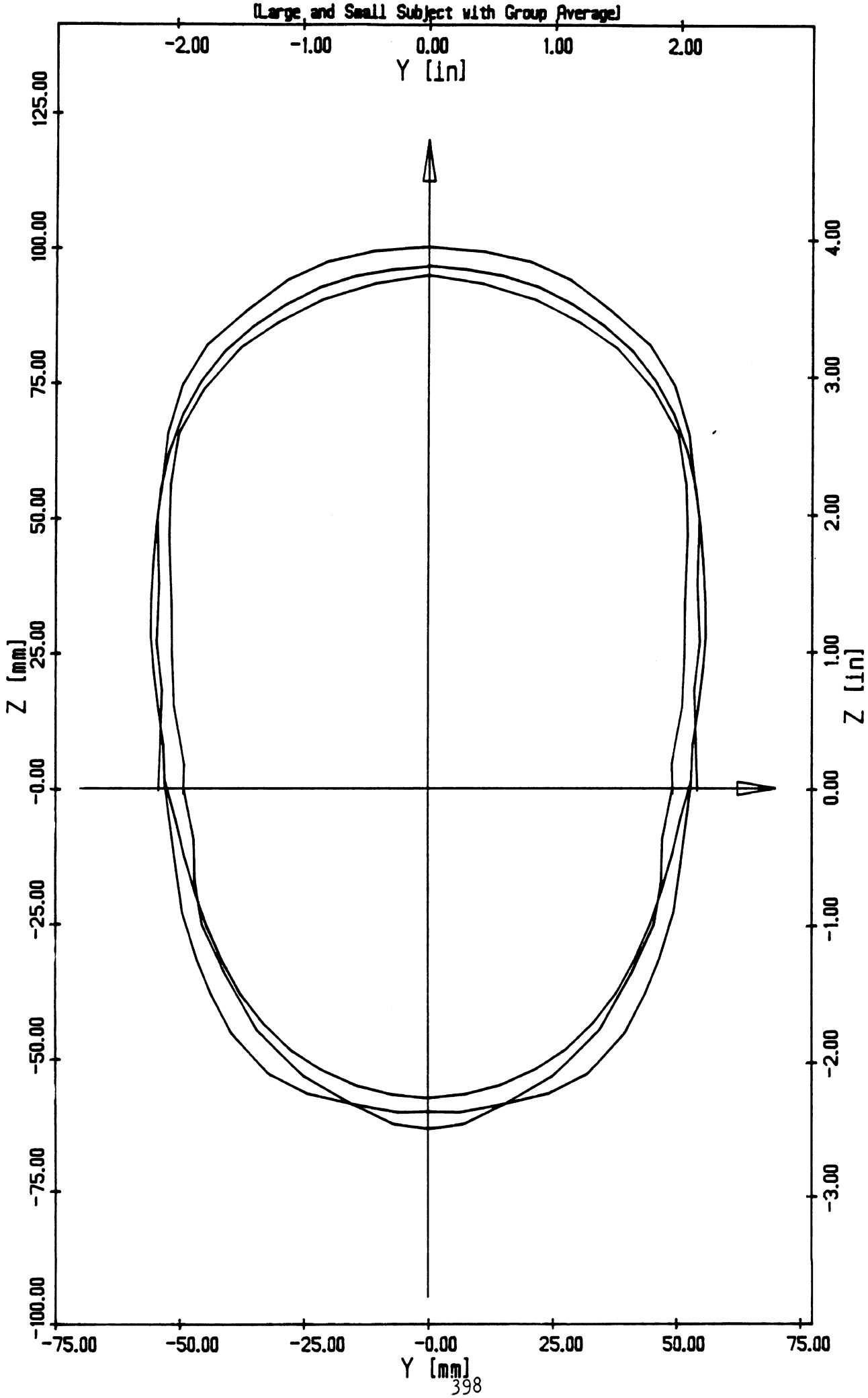

Top-of-Head Midline Arc, 4-6 Months
(Large and Small Subject with Group Average)
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
X [in]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

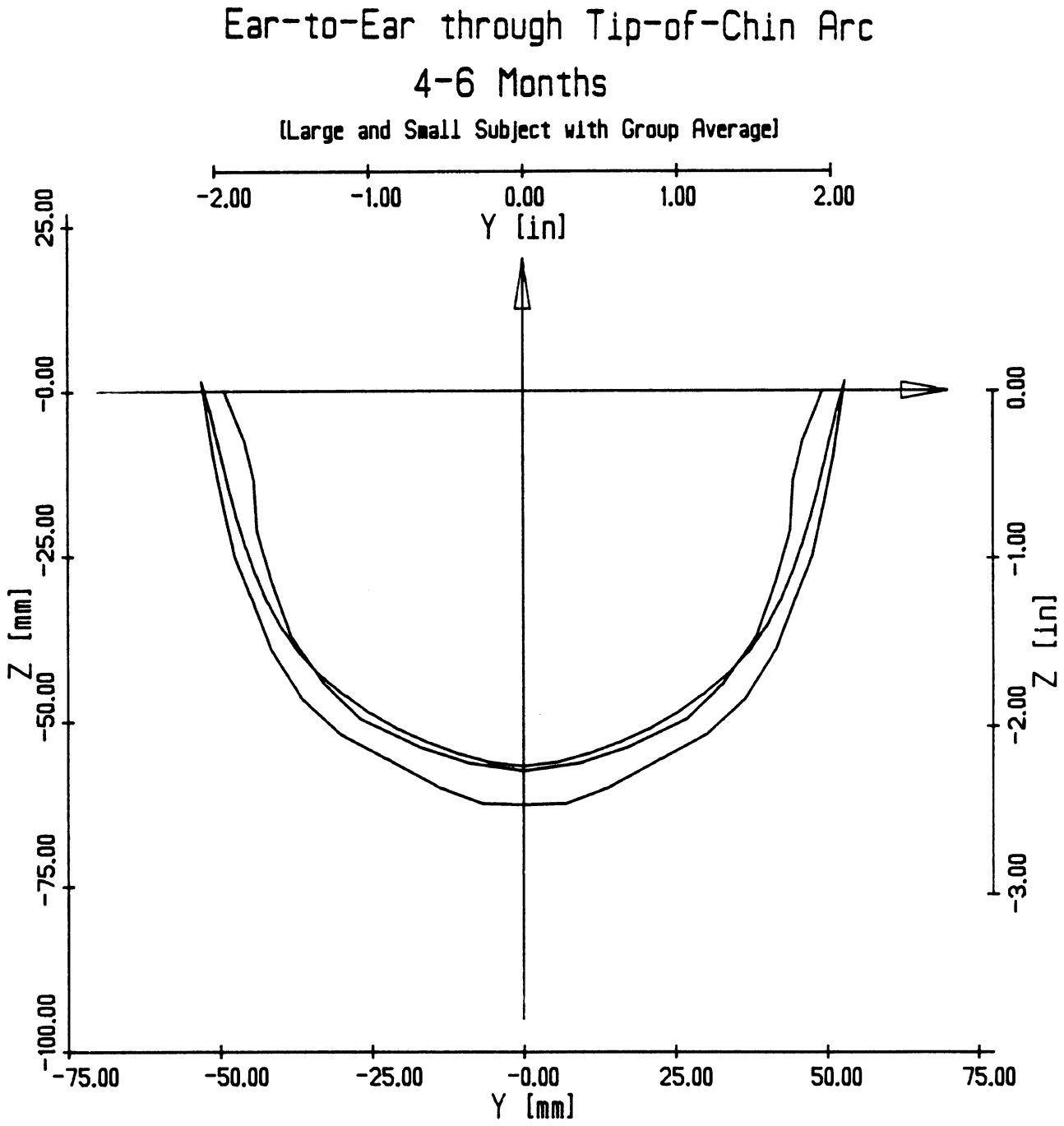
Head Circumference Arc, 4-6 Months



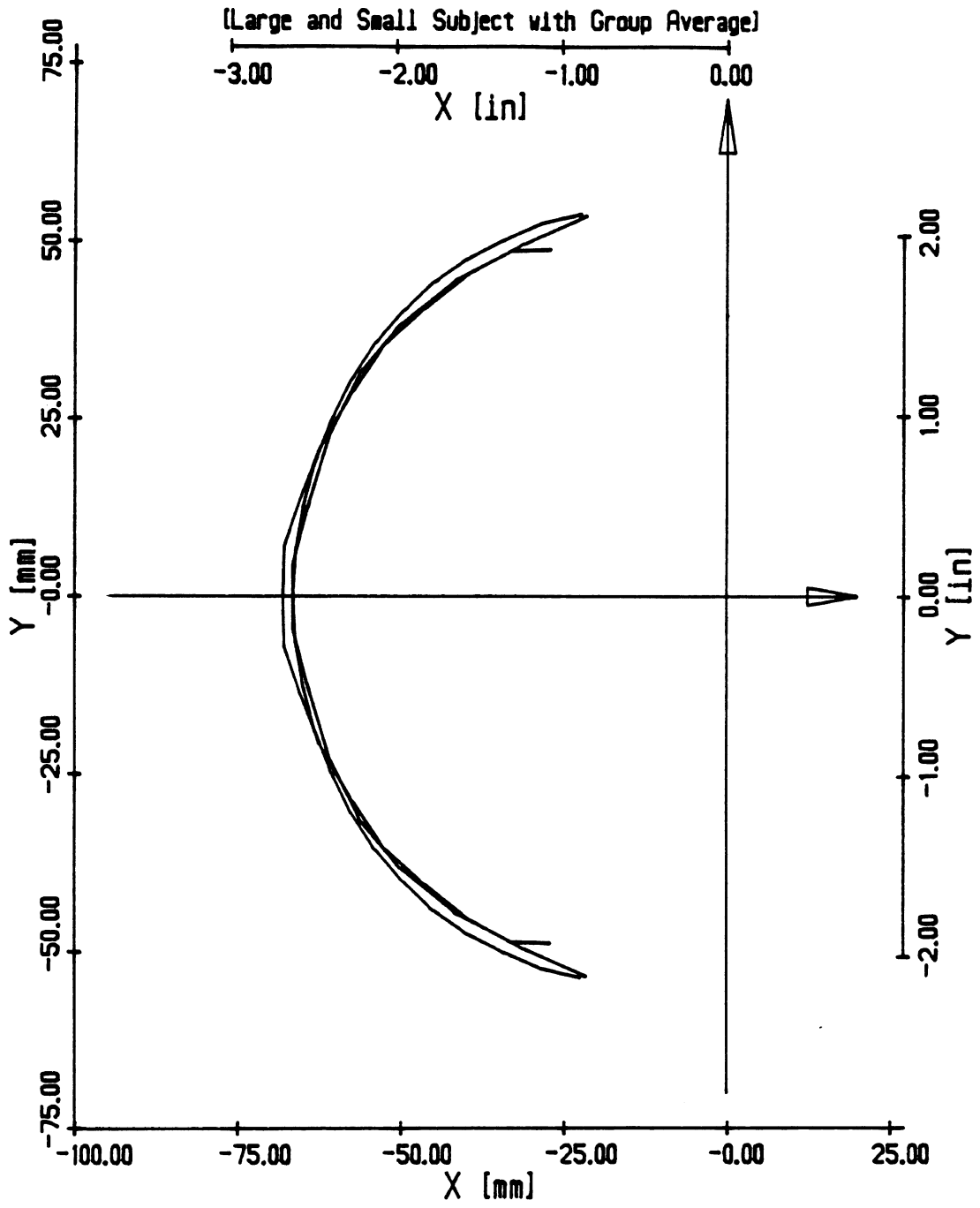
Ear-to-Ear over Top-of-Head and Under Chin Arc, 4-6 Months

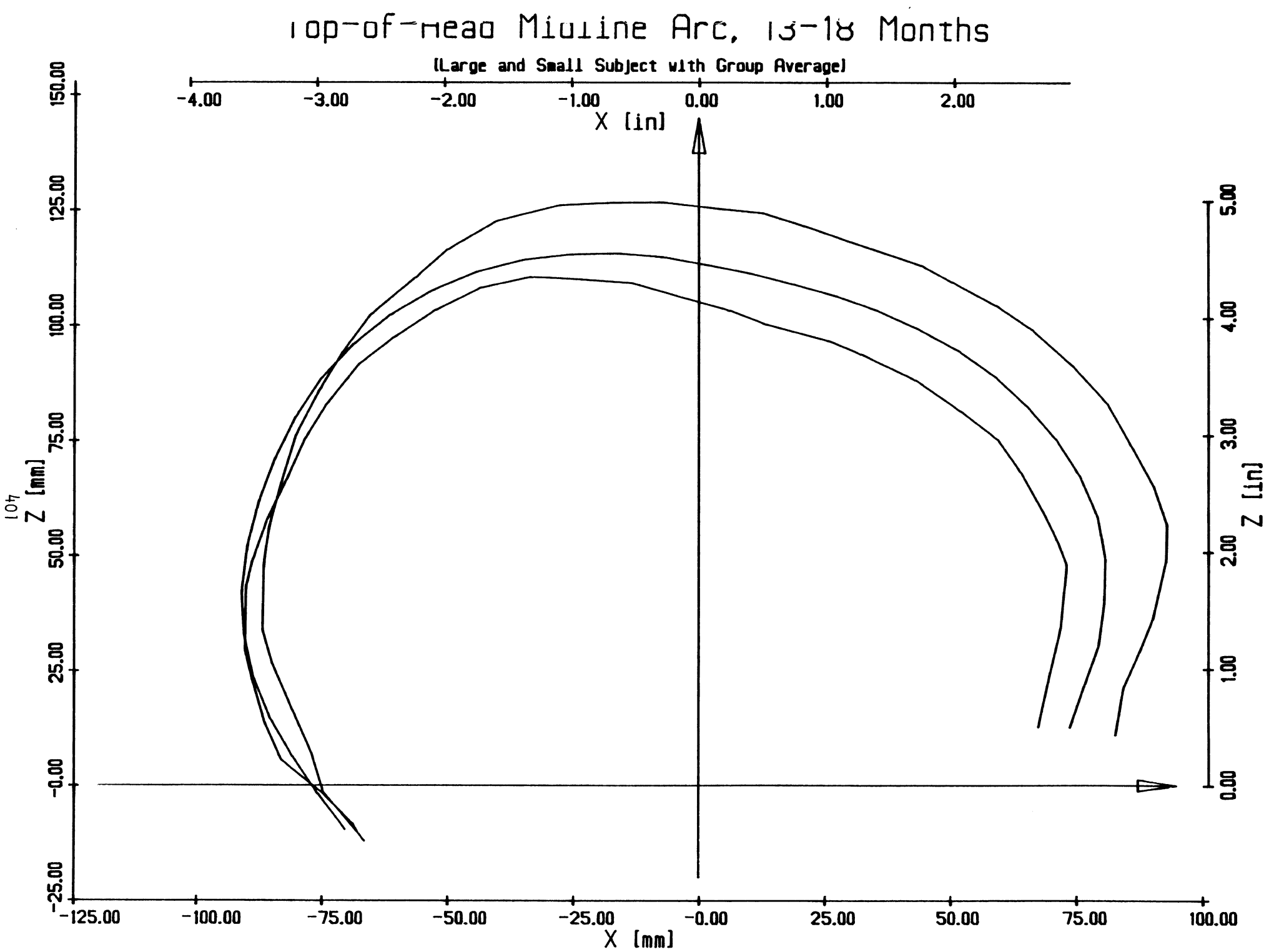
[Large and Small Subject with Group Average]

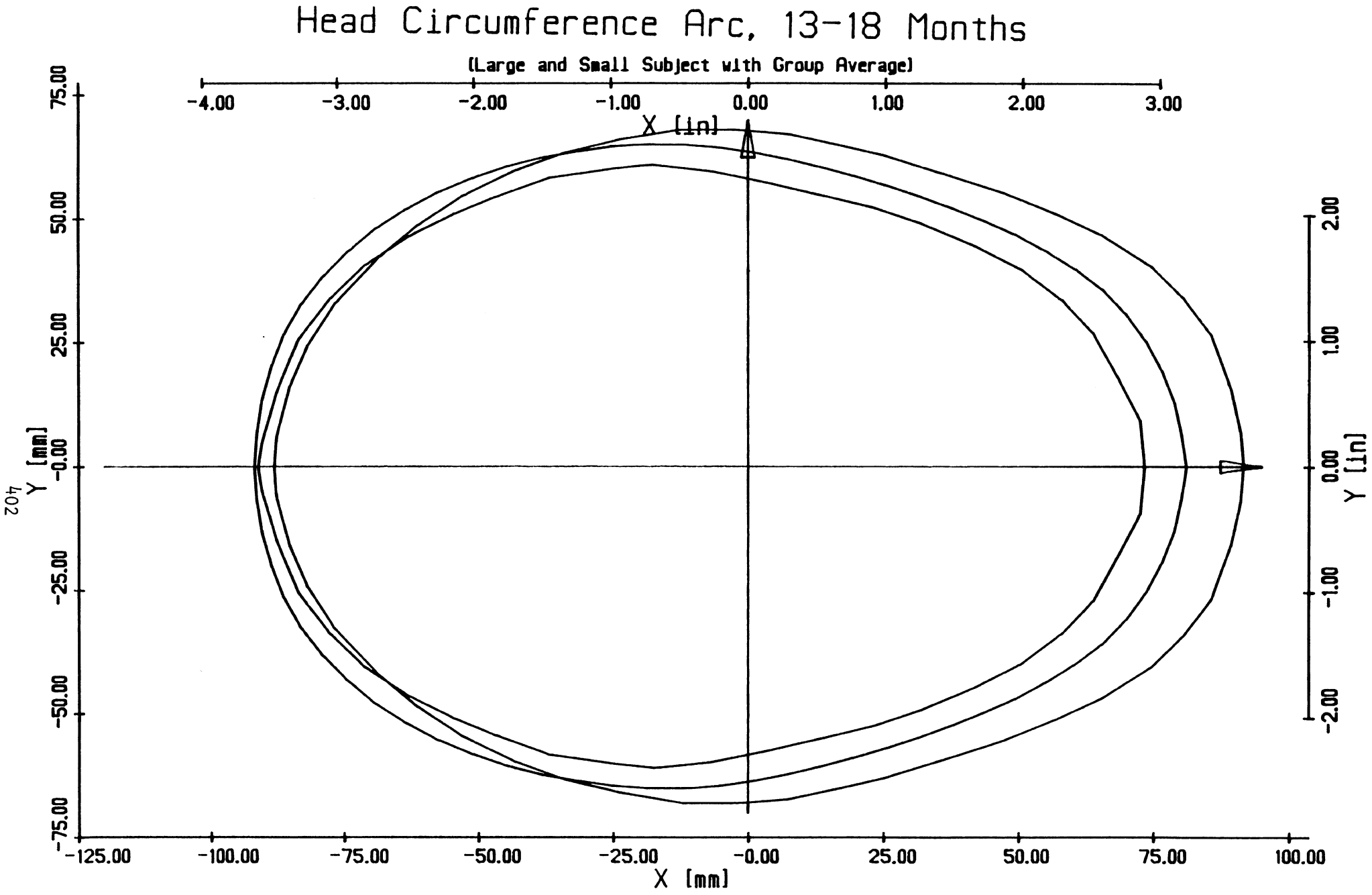



Ear-to-Ear through Tip-of-Chin Arc
4-6 Months
(Large and Small Subject with Group Average)
-2.00
-1.00
0.00
1.00
2.00
Y [in]
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

Back-of-Head Arc, 4-6 Months

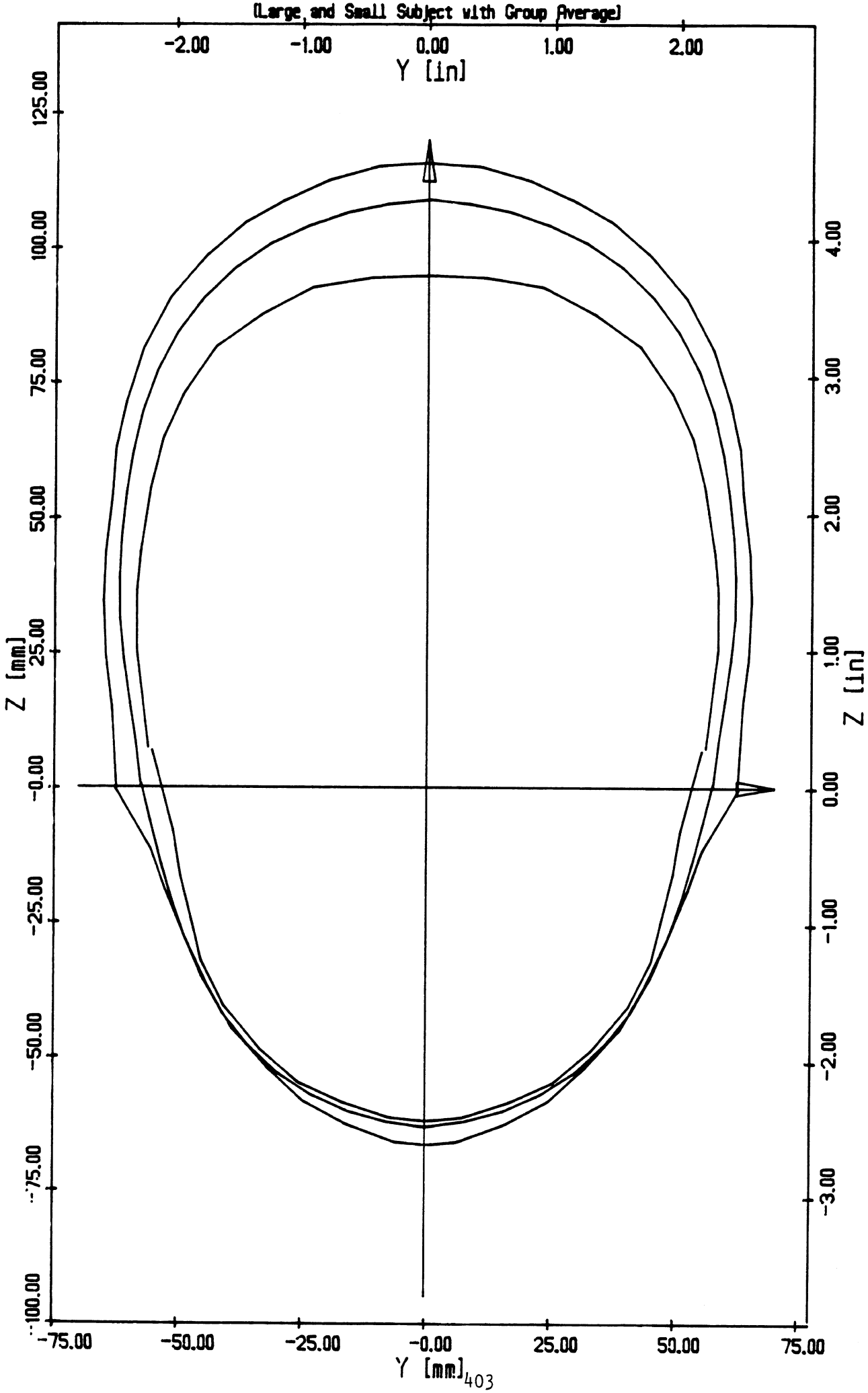



Top-of-Head Midline Arc, 13-18 Months
(Large and Small Subject with Group Average)
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
Z [mm]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [in]
5.00
4.00
3.00
2.00
1.00
0.00
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

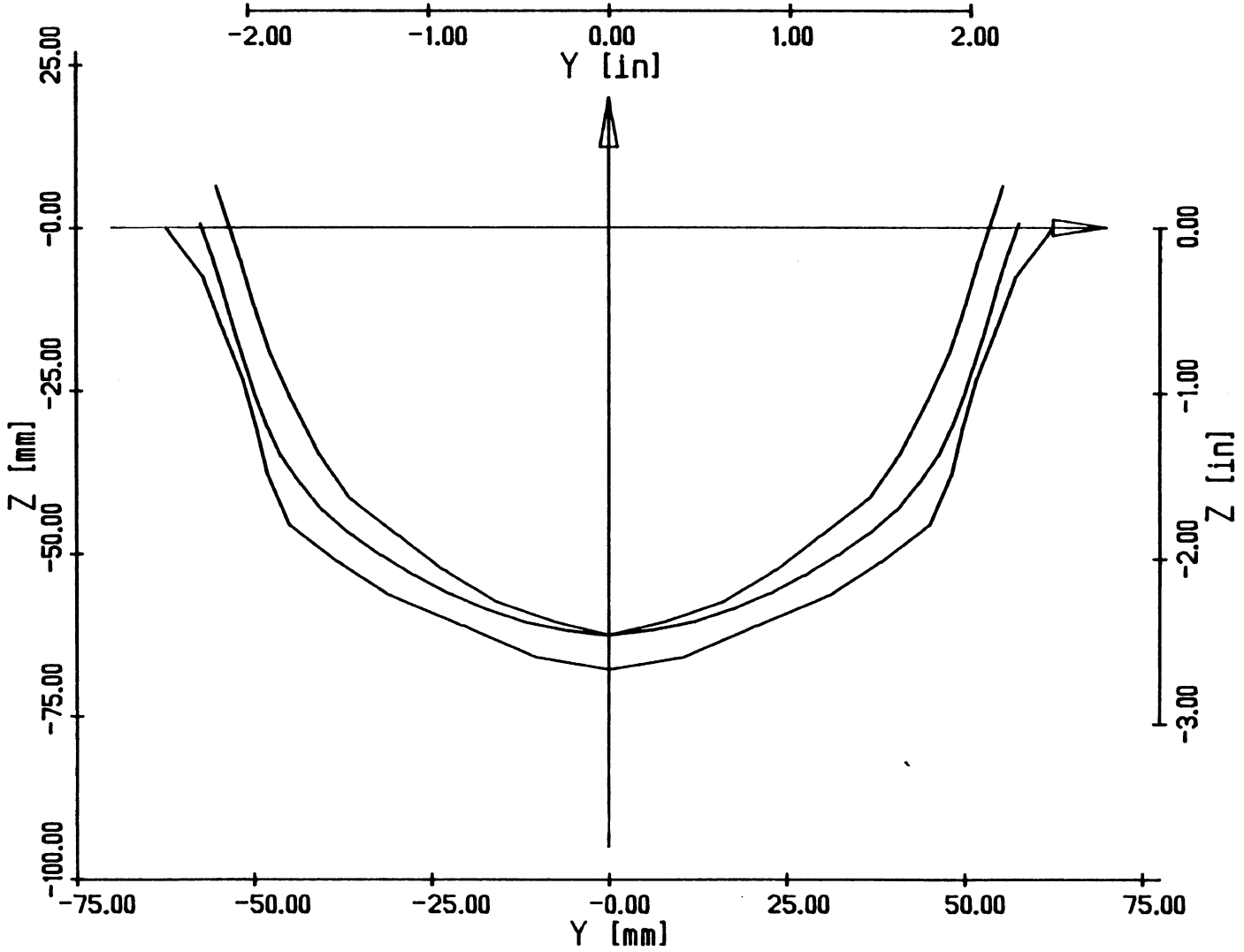

Head Circumference Arc, 13-18 Months
(Large and Small Subject with Group Average)
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
X [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

Ear-to-Ear over Top-of-Head and Under Chin Arc, 13-18 Months

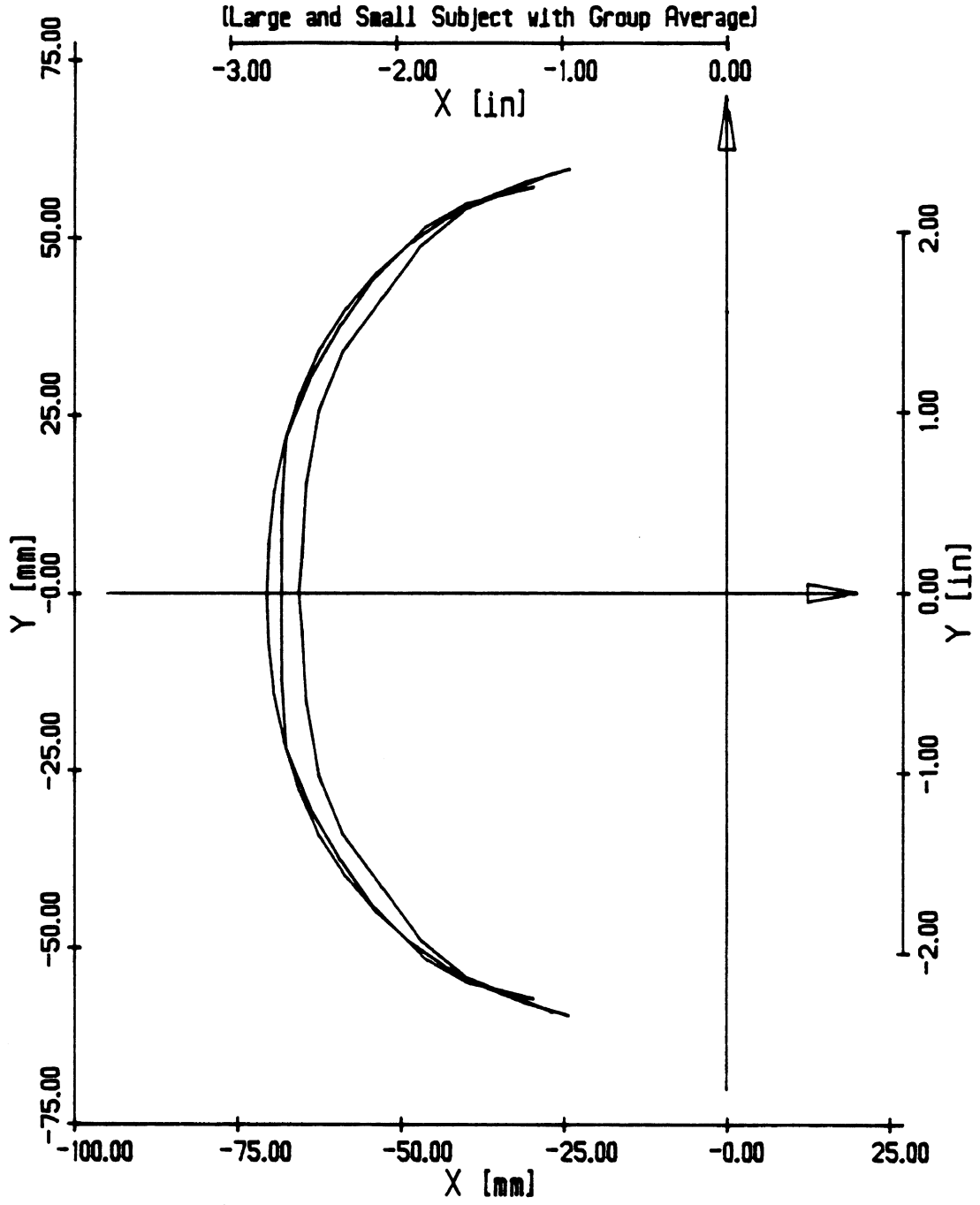
(Large and Small Subject with Group Average)

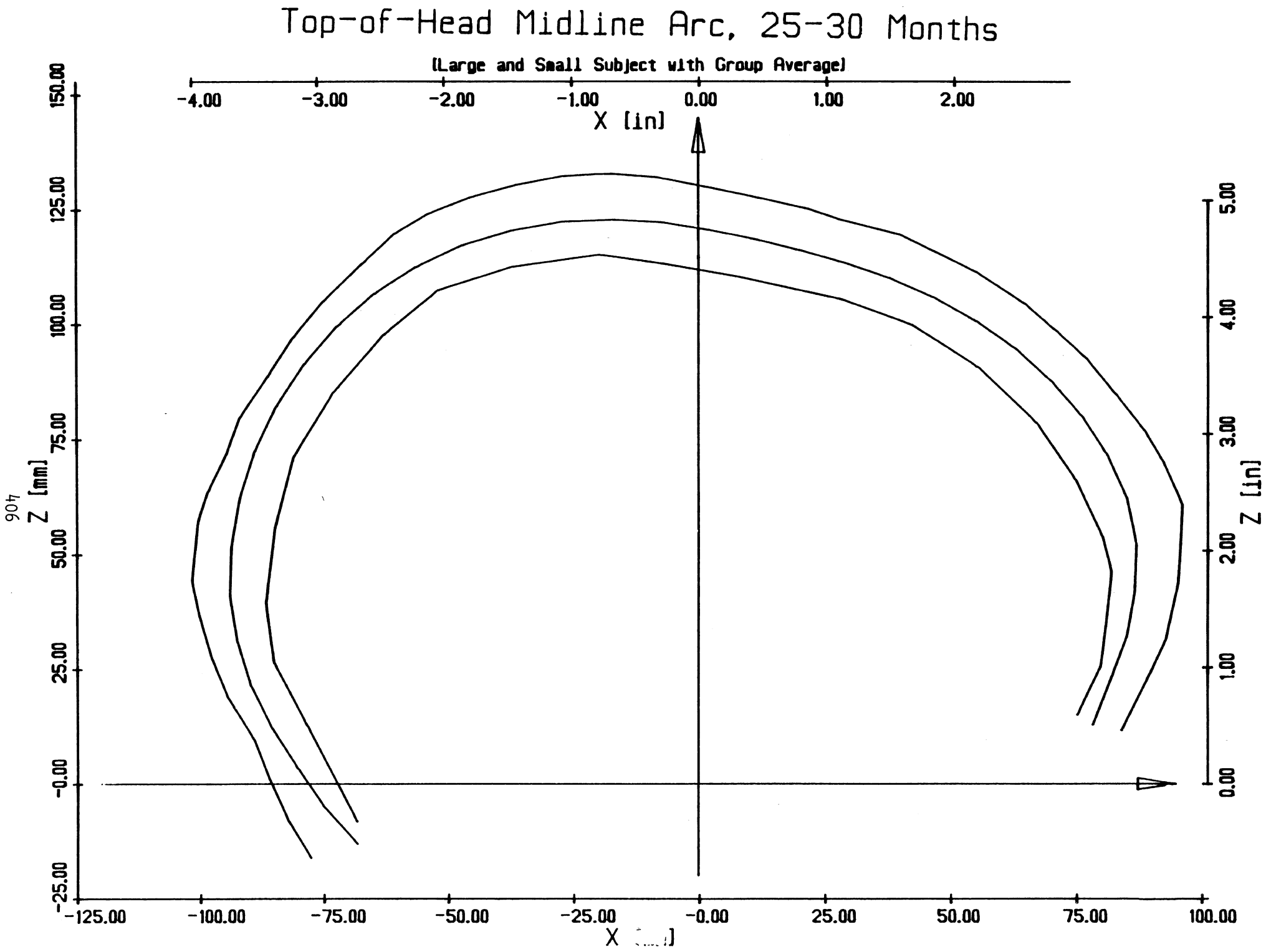


Ear-to-Ear through Tip-of-Chin Arc
13-18 Months
[Large and Small Subject with Group Average]

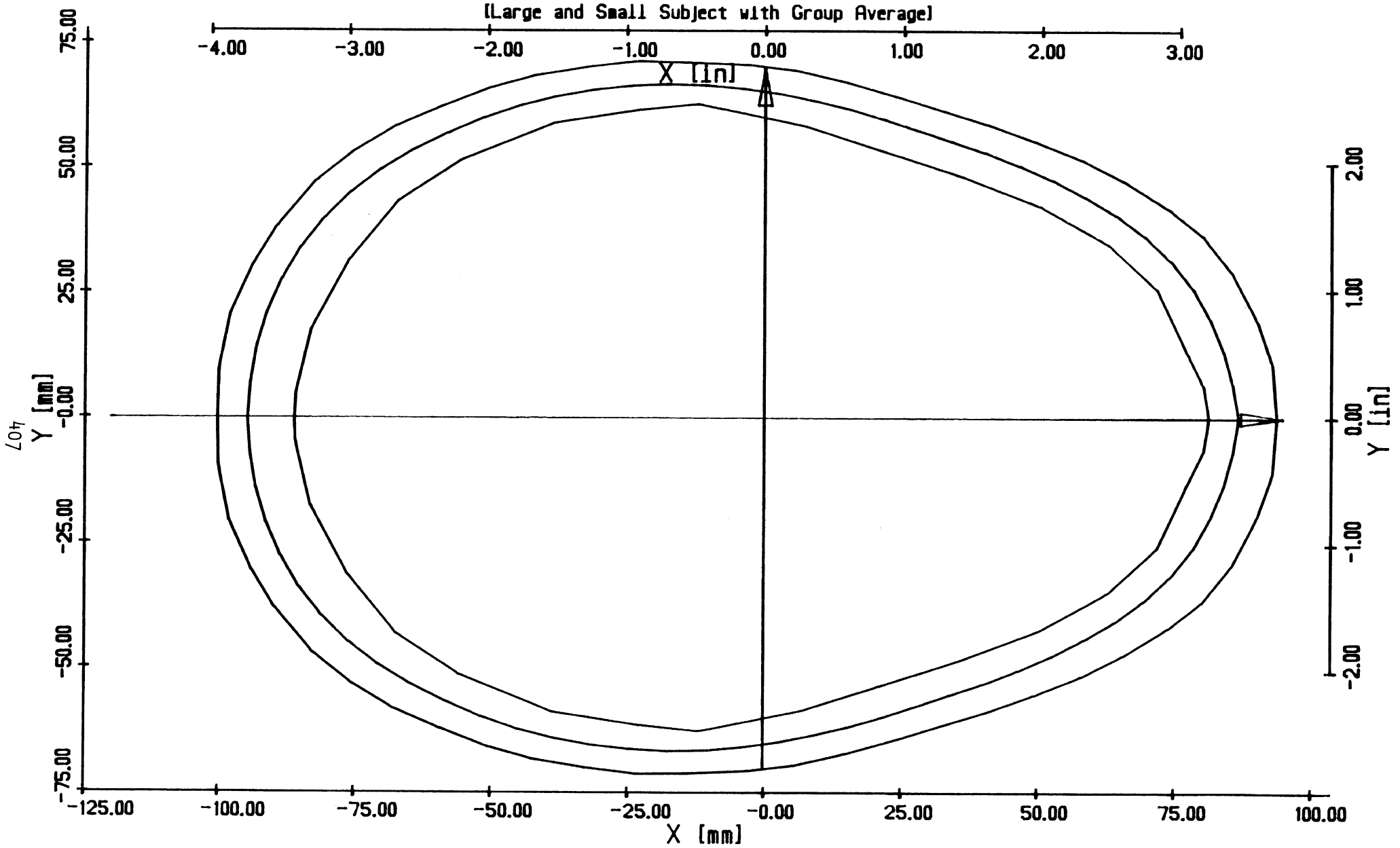


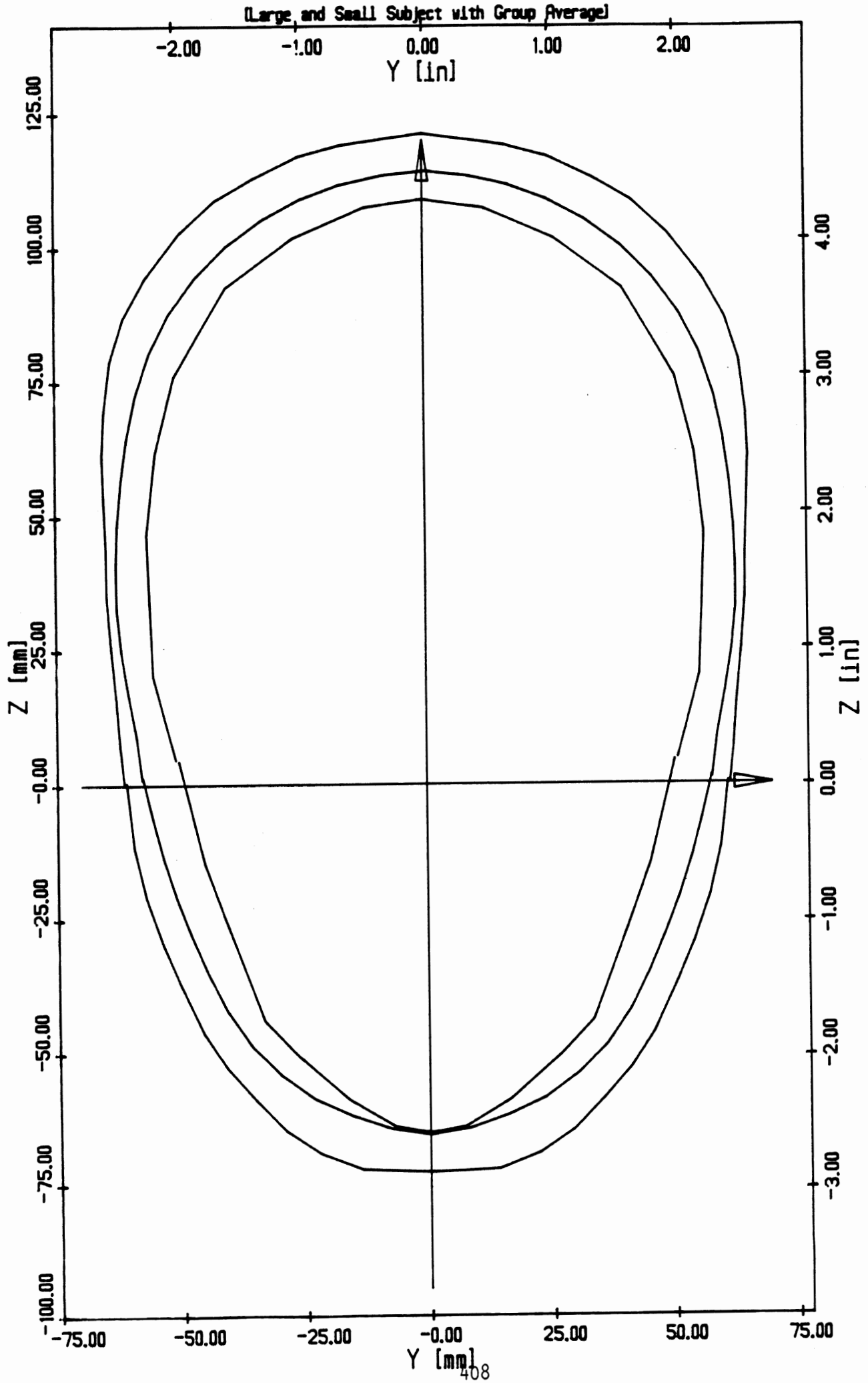
Back-of-Head Arc, 13-18 Months

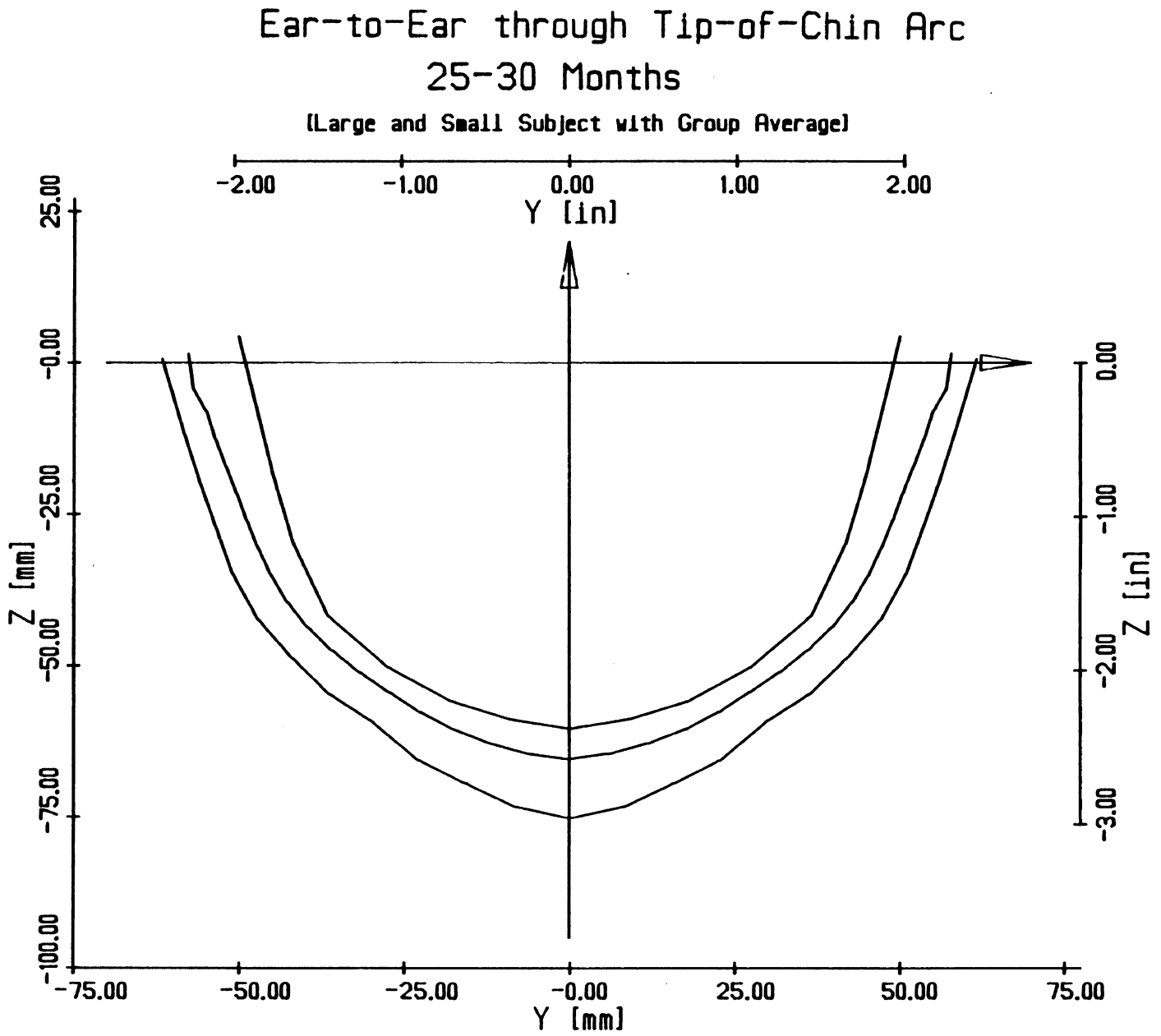



Top-of-Head Midline Arc, 25-30 Months
(Large and Small Subject with Group Average)
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
Z [mm]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [in]
5.00
4.00
3.00
2.00
1.00
0.00
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

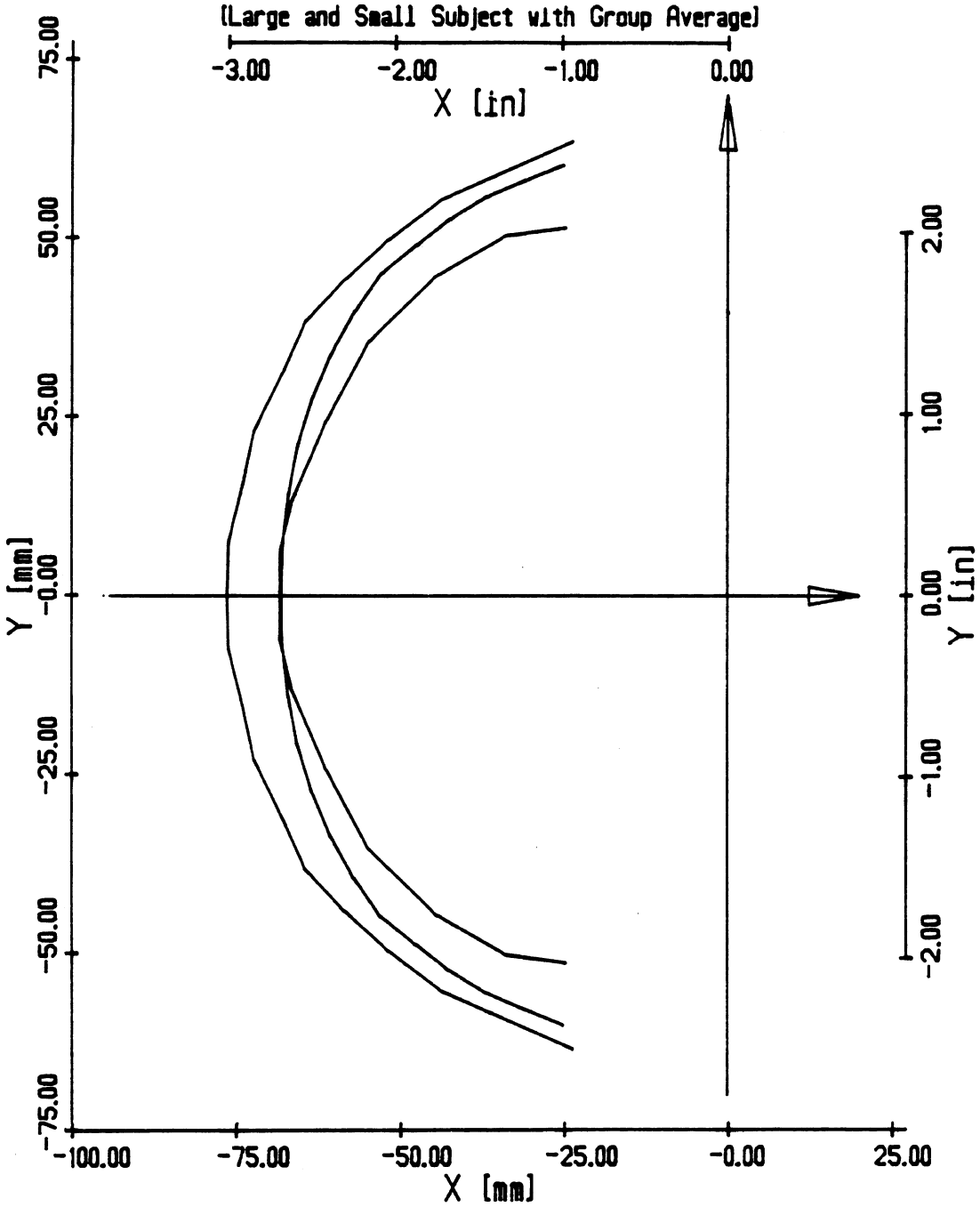
Head Circumference Arc, 25-30 Months

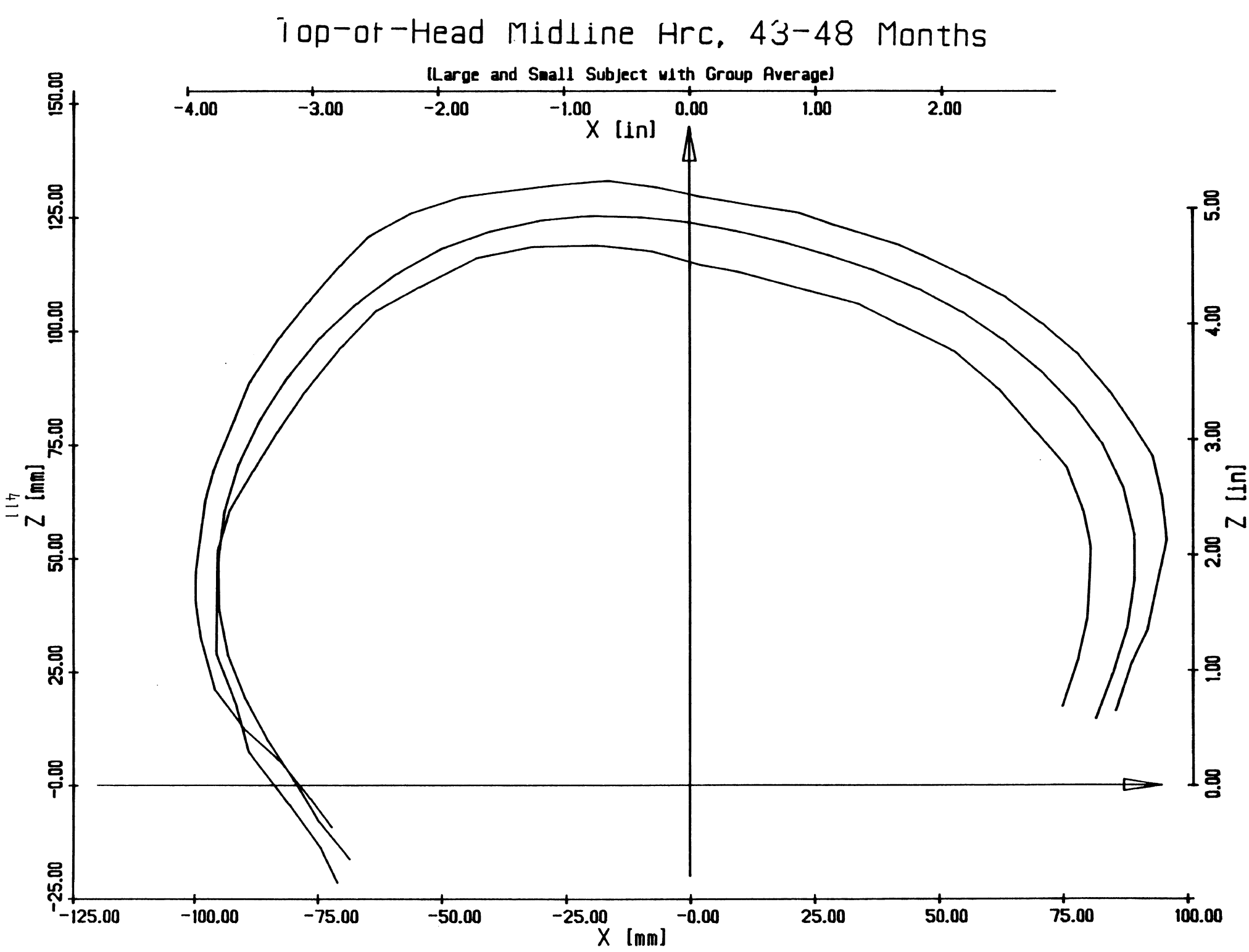



Ear-to-Ear over Top-of-Head
and Under Chin Arc, 25-30 Months
(Large and Small Subject with Group Average)
-2.00
-1.00
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

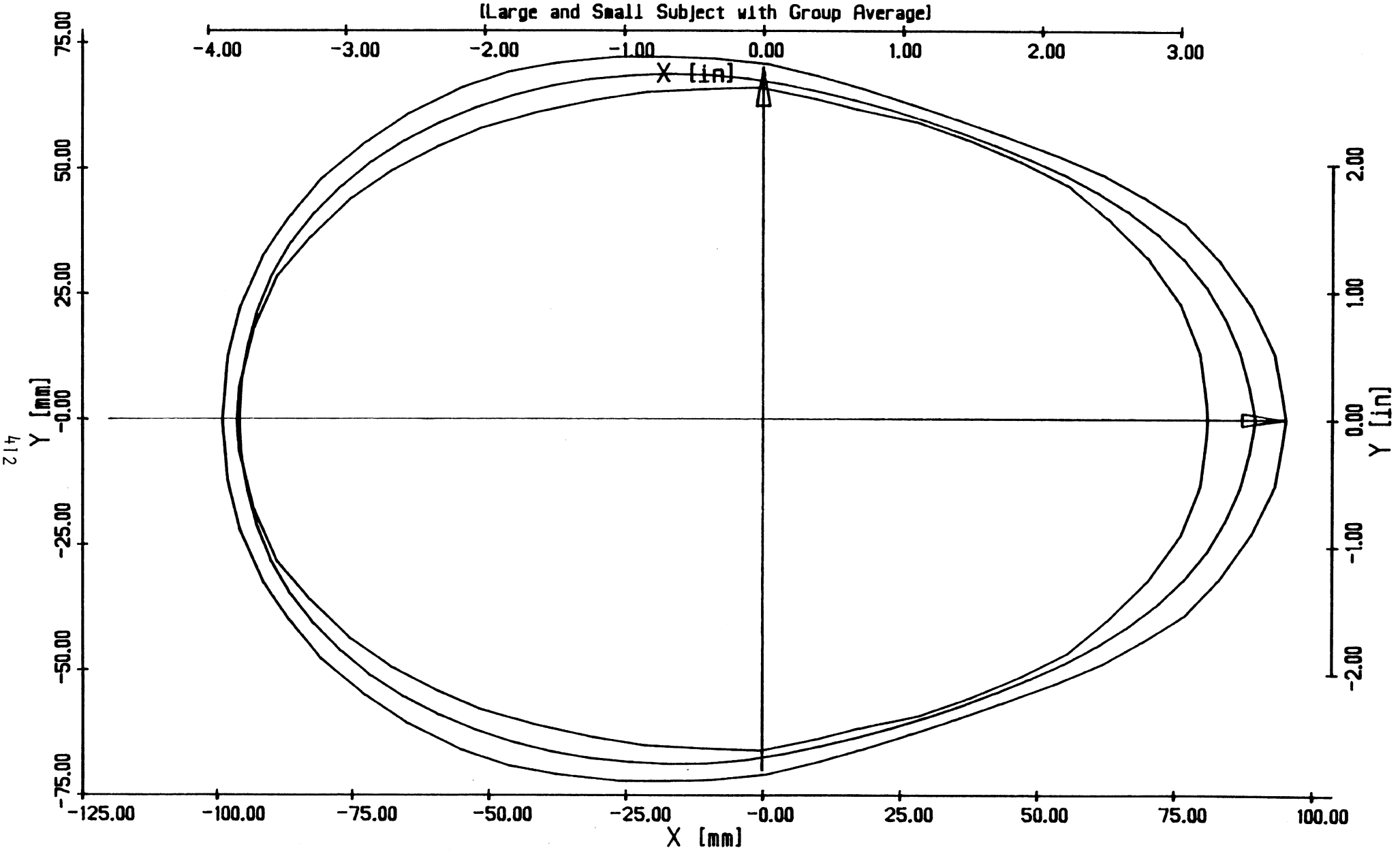

Ear-to-Ear through Tip-of-Chin Arc
25-30 Months
(Large and Small Subject with Group Average)
-2.00
-1.00
0.00
1.00
2.00
Y [in]
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

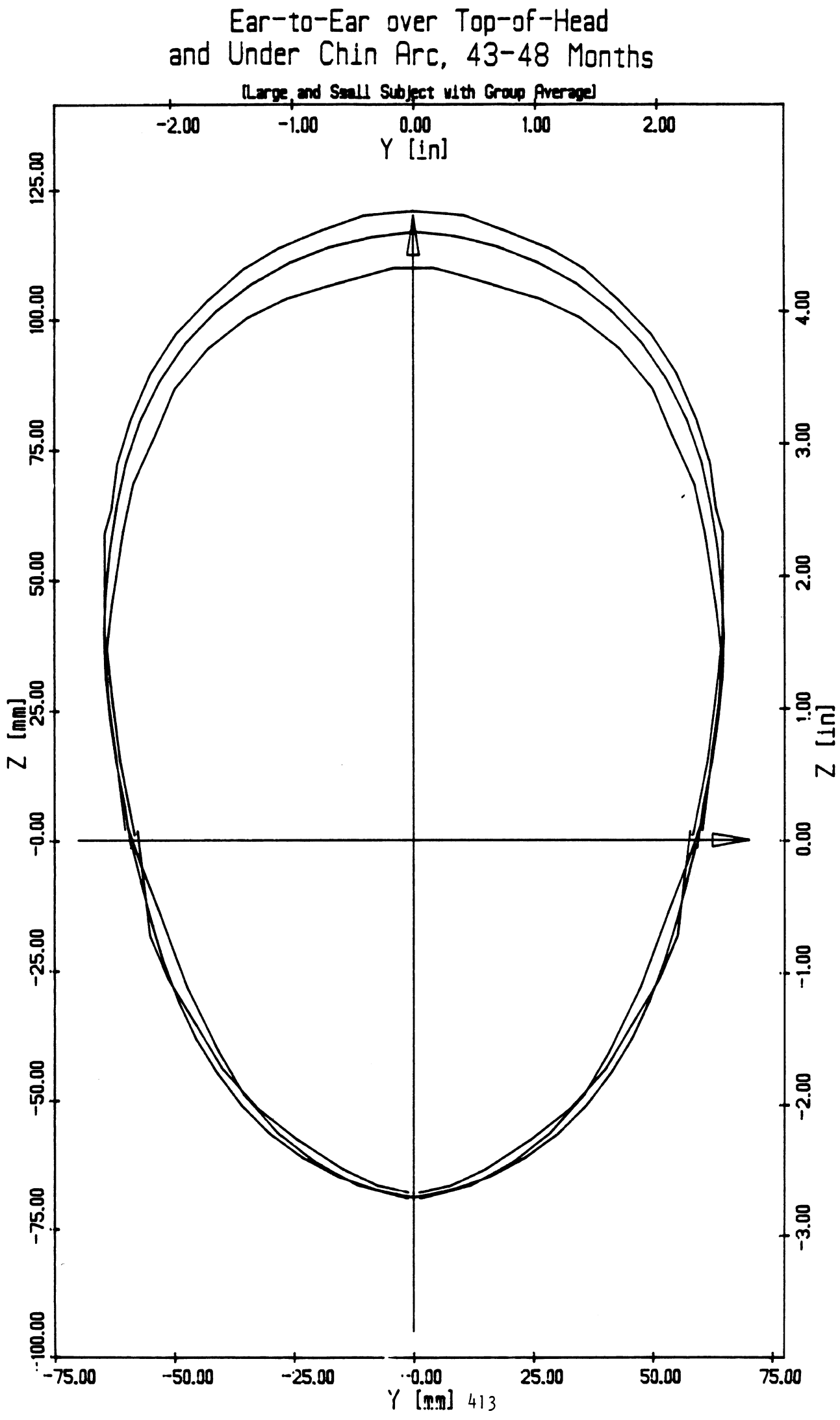
Back-of-Head Arc, 25-30 Months

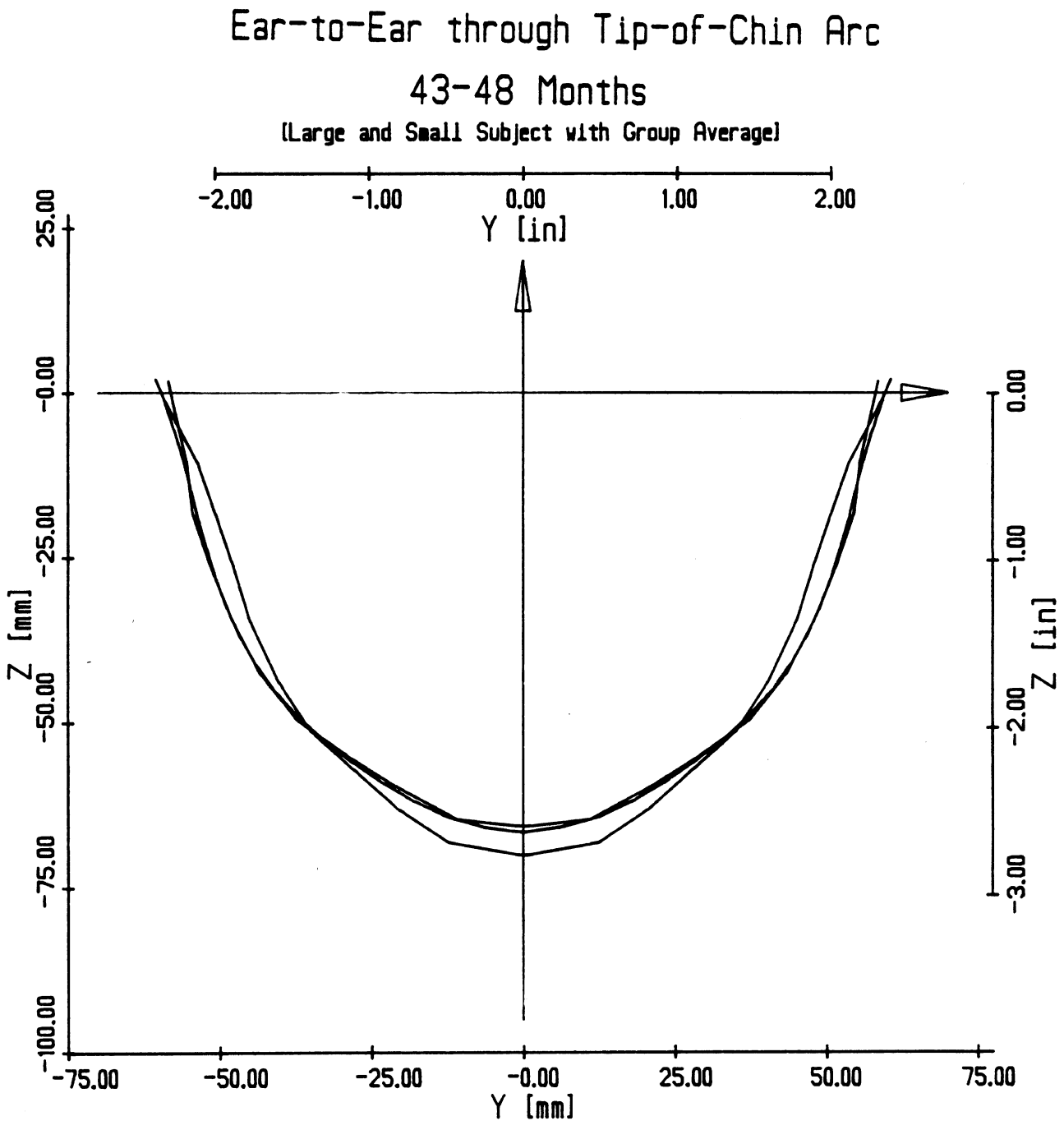



Top-of-Head Midline Hrc, 43-48 Months
(Large and Small Subject with Group Average)
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
X [in]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

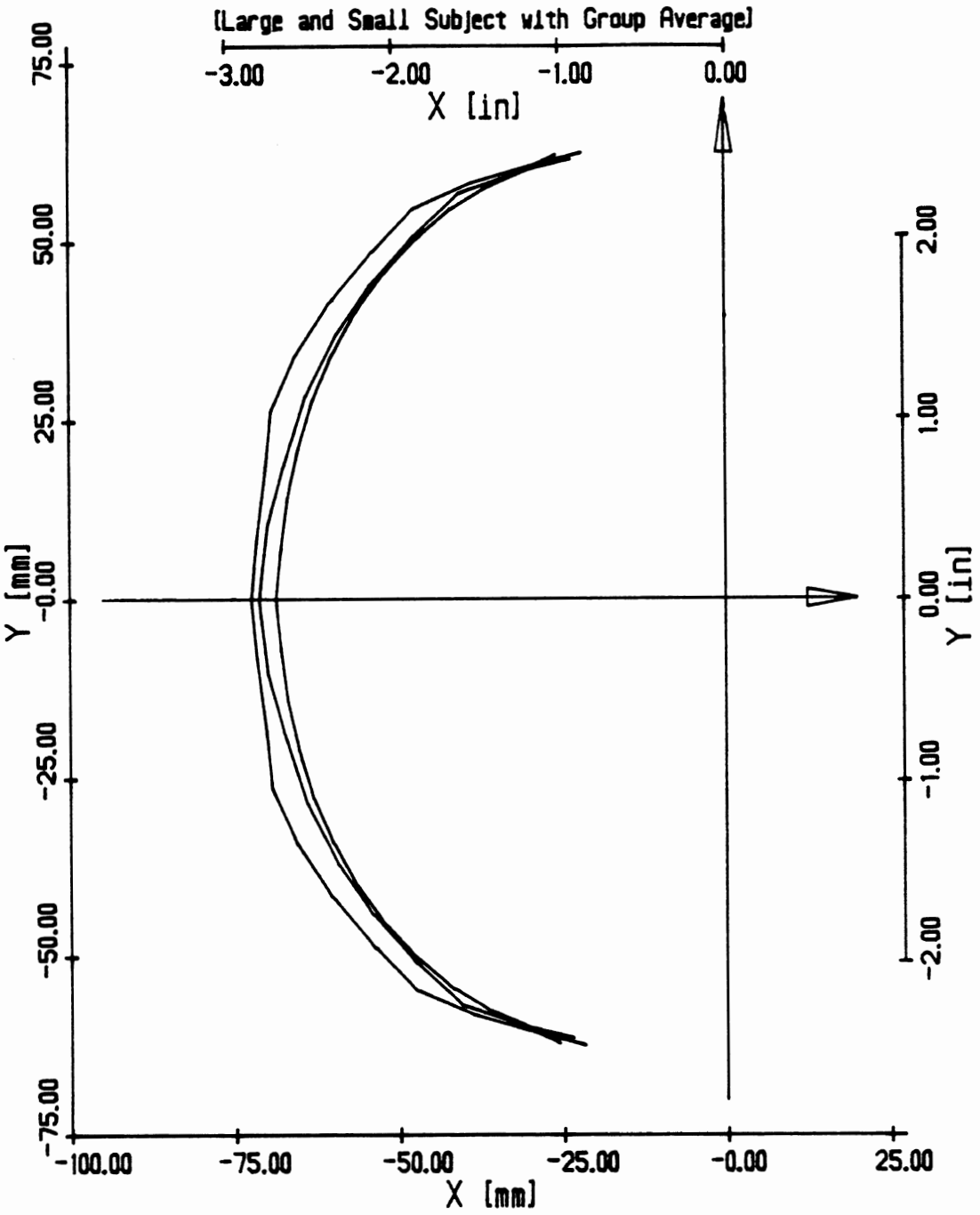
Head Circumference Arc, 43-48 Months




Ear-to-Ear over Top-of-Head
and Under Chin Arc, 43-48 Months
(Large and Small Subject with Group Average)
-2.00
-1.00
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]


Ear-to-Ear through Tip-of-Chin Arc
43-48 Months
(Large and Small Subject with Group Average)
-2.00
-1.00
0.00
1.00
2.00
Y [in]
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

Back-of-Head Arc, 43-48 Months



II.C.5

OVERLAY PLOTS OF INDIVIDUAL HEAD CONTOURS BY SUBJECT GROUP

This section presents overlay plots of the six different head contours for all subjects (N= 25) in each age group and thereby provides information on the range and distribution of head sizes with respect to the head anatomical reference system. In each case, except for "Top-of-Head Midline Arc", two views are shown. First, the full, undistorted views of similar contours for the subjects in each group are plotted together after rotating each contour into the same reference system plane. In addition, side, or X-Z plane views, of the contours are shown prior to rotation to illustrate the range of orientations of the contours relative to the head anatomical reference system. As in the two previous sections, the different head contours have been plotted on separate graphs except for "Ear-to-Ear Over Top-of-Head Arc" and "Ear-to-Ear Under Chin Arc" which have been plotted together as an approximation to head circumference taken in a frontal plane just forward of the ears. All plots in this section are shown actual size.

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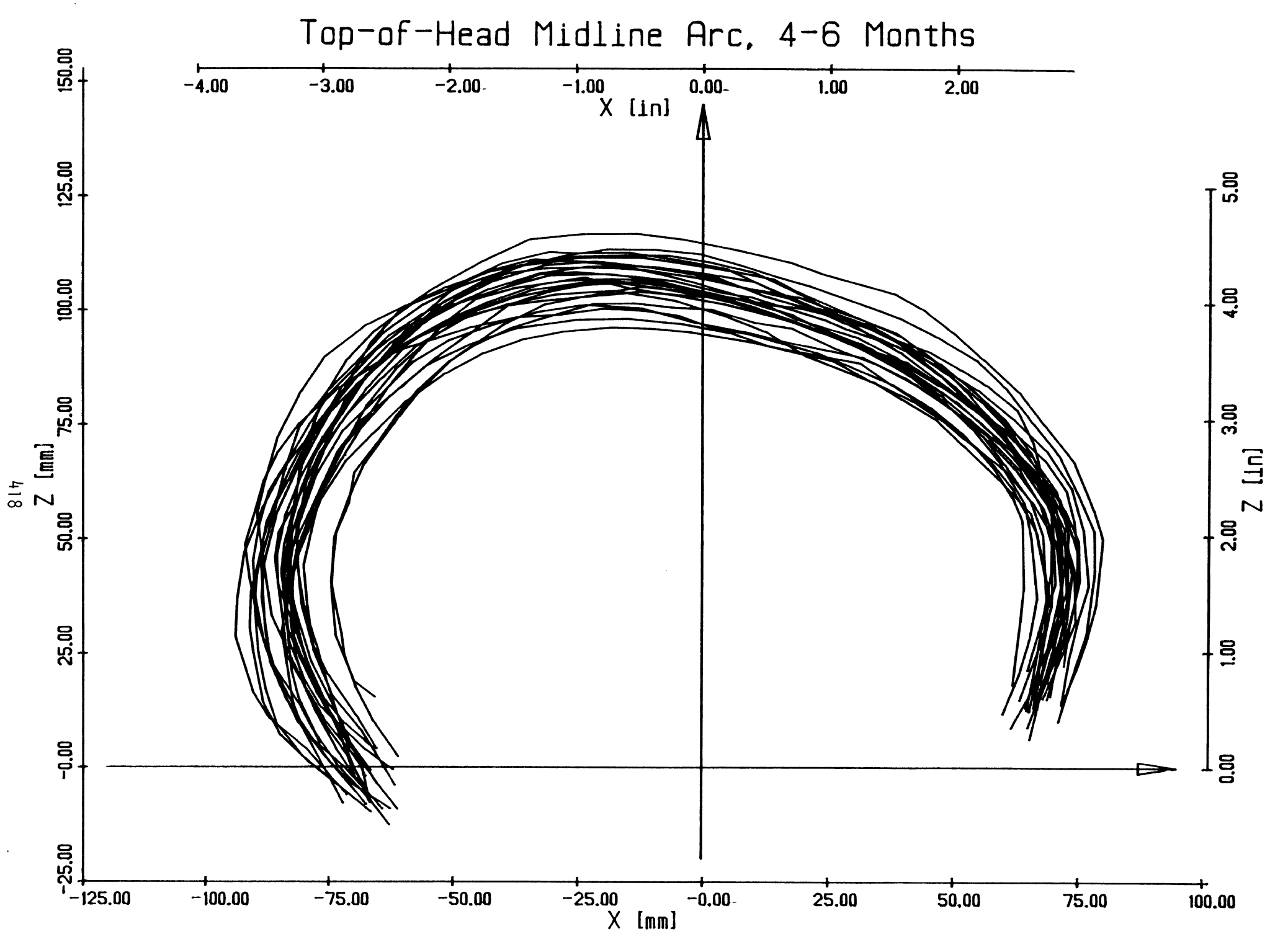
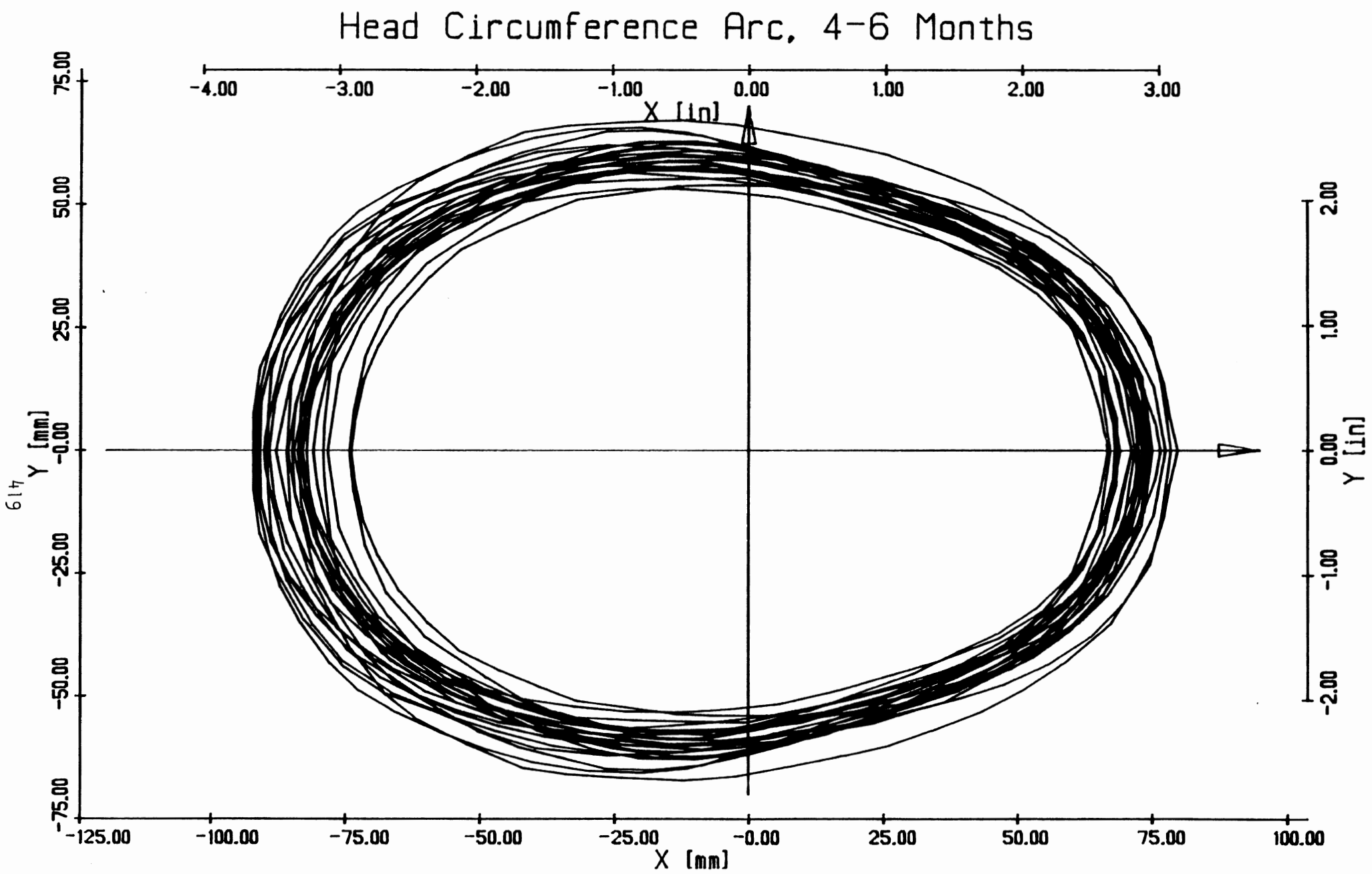
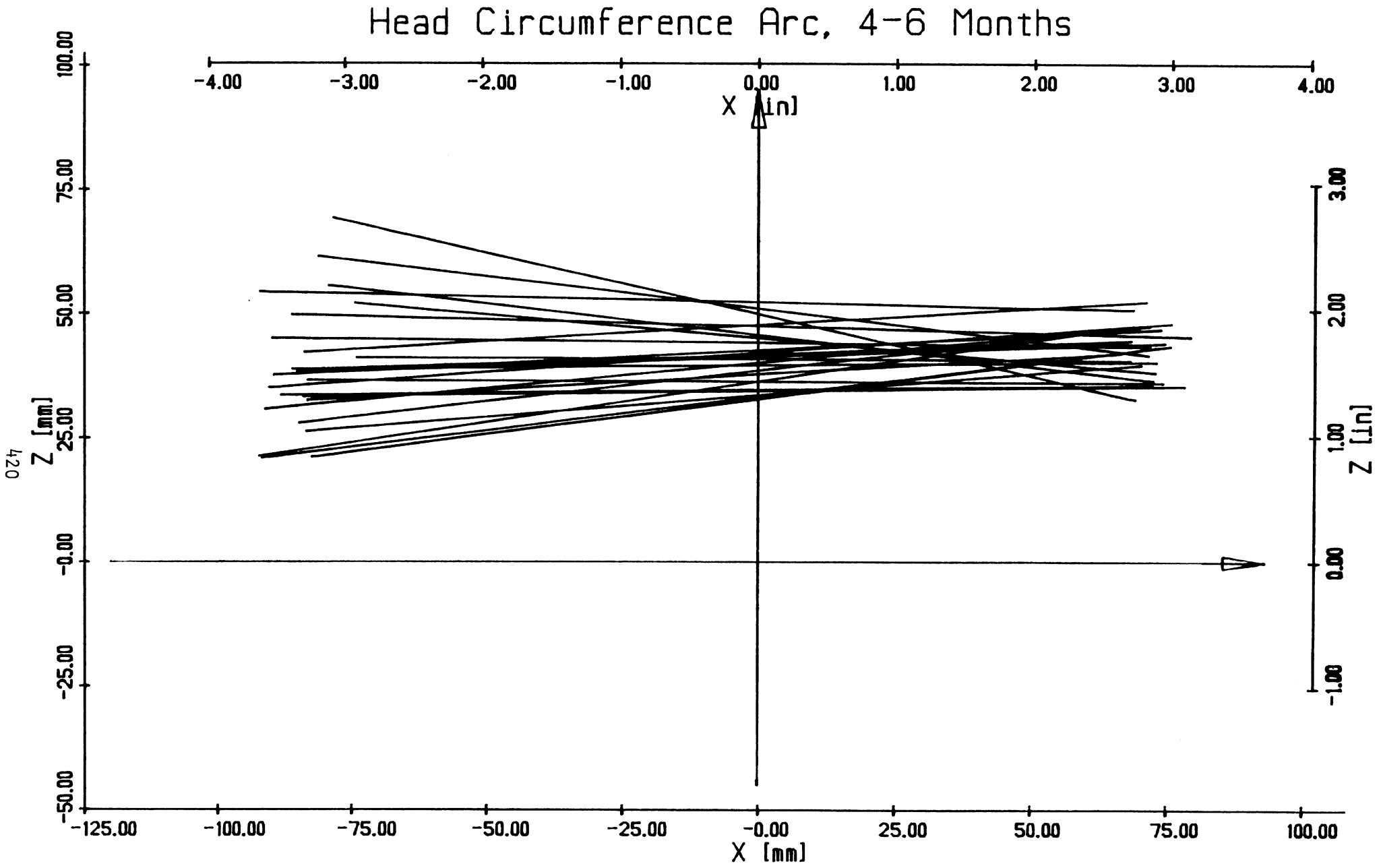
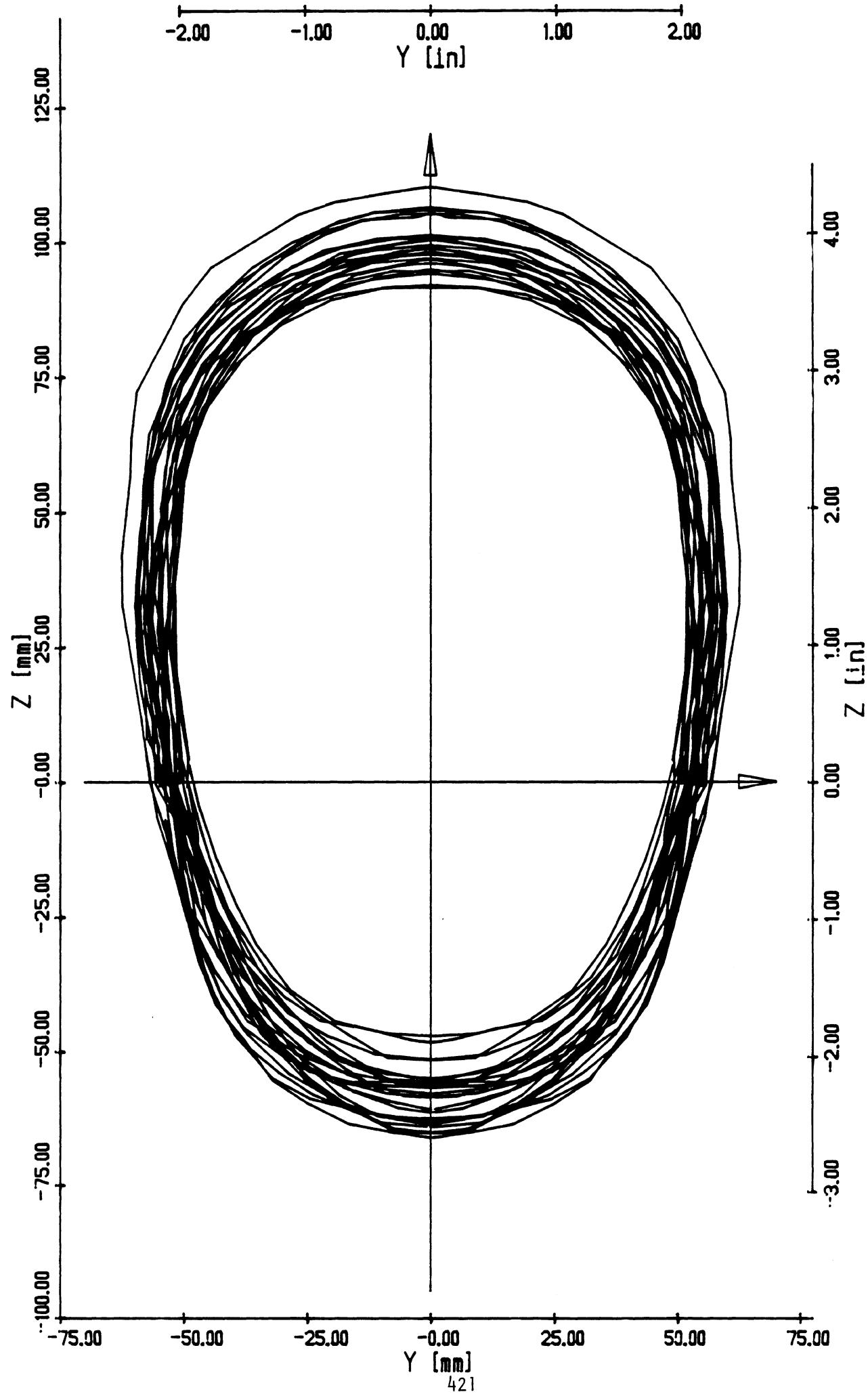
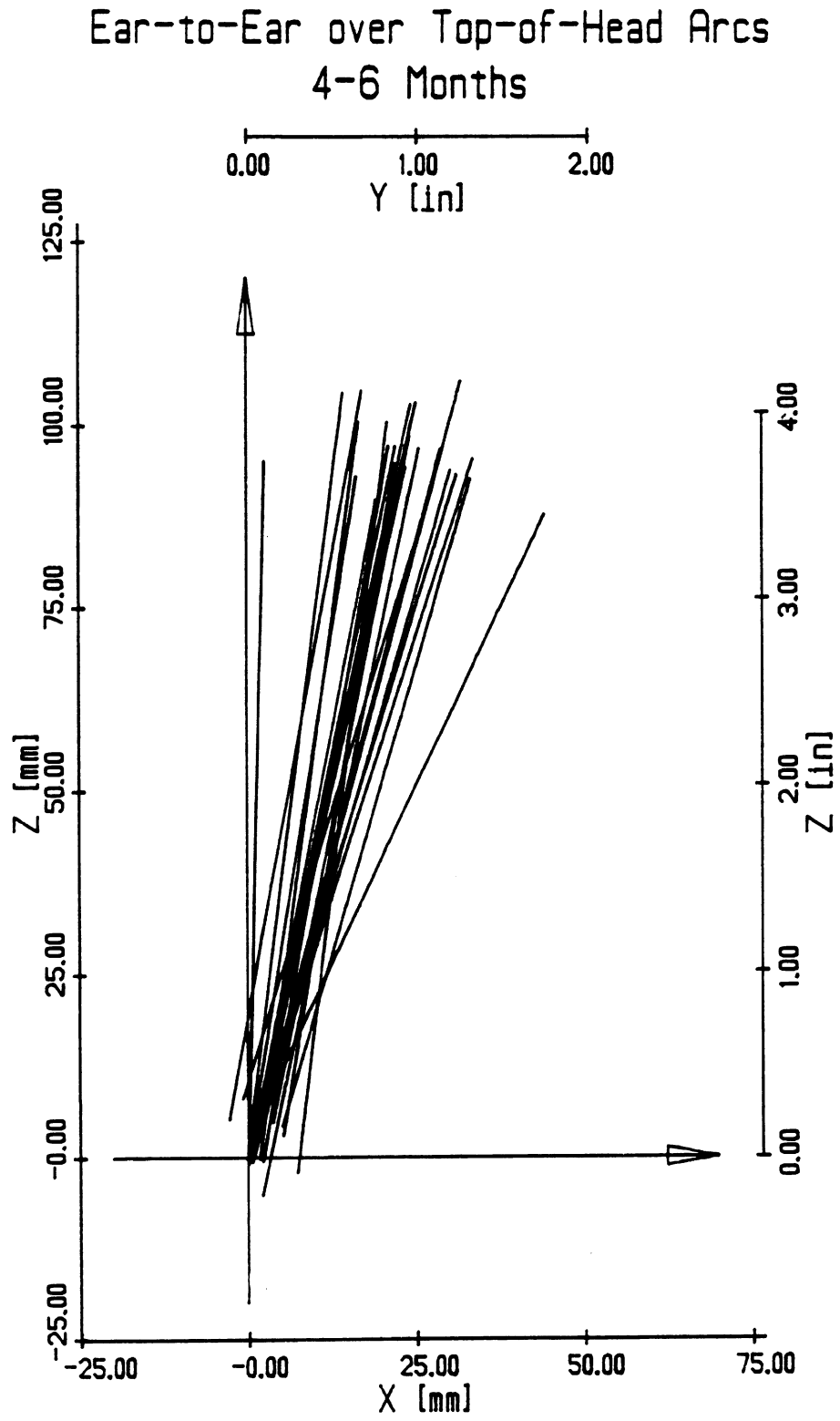

Top-of-Head Midline Arc, 4-6 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
X [in]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]


Head Circumference Arc, 4-6 Months
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

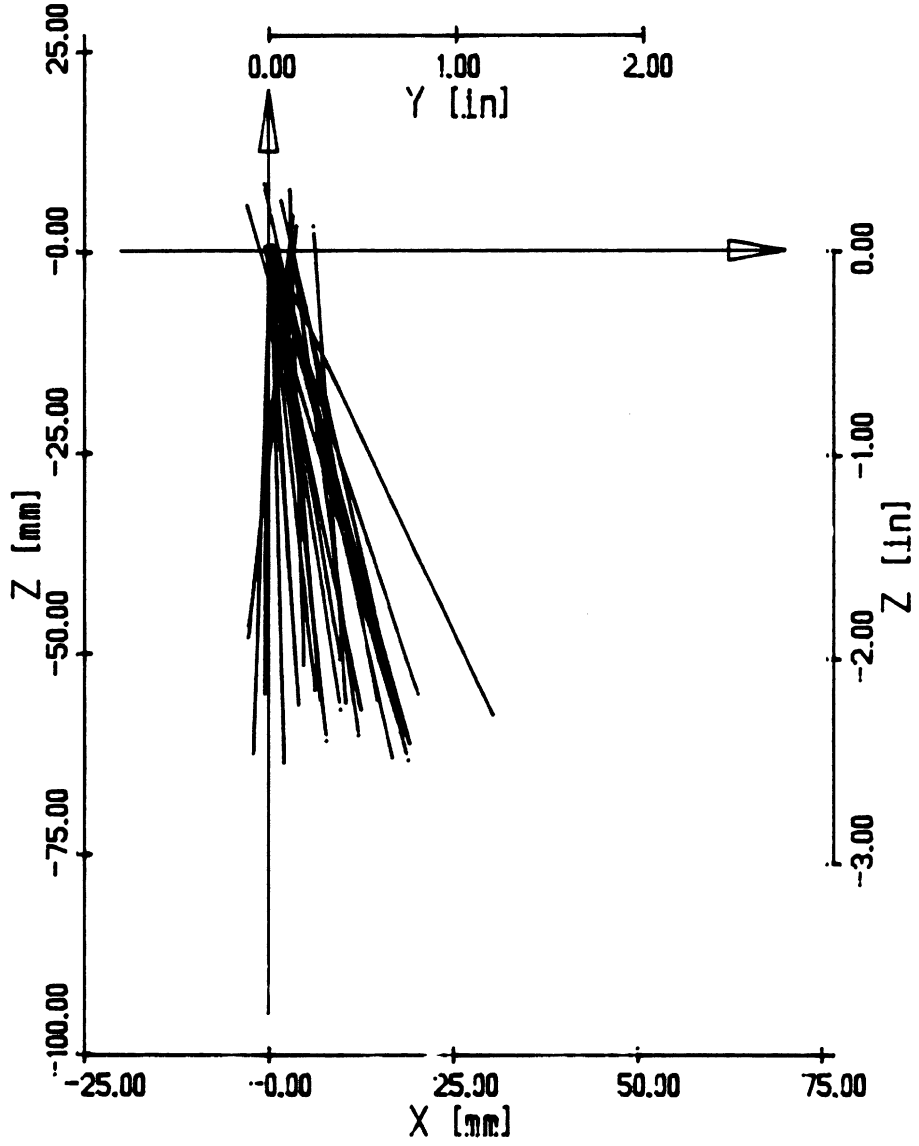

Head Circumference Arc, 4-6 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
X [in]
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
Z [mm]
3.00
2.00
1.00
0.00
-1.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

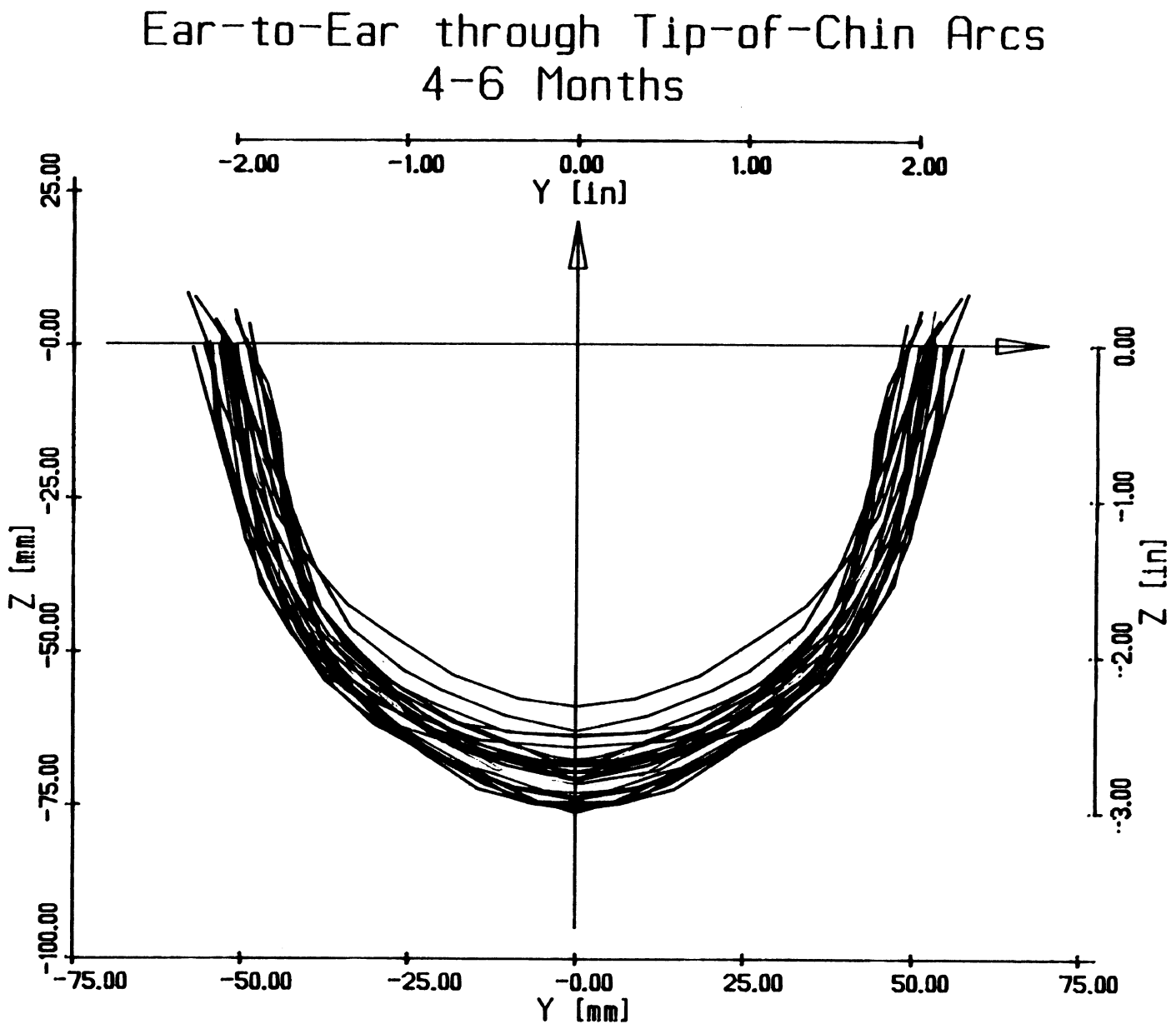

Ear-to-Ear over Top-of-Head
and Under Chin Arcs, 4-6 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]


Ear-to-Ear over Top-of-Head Arcs
4-6 Months
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
Z [in]
-25.00
-0.00
25.00
50.00
75.00
X [mm]

Ear-to-Ear Under Chin Arcs

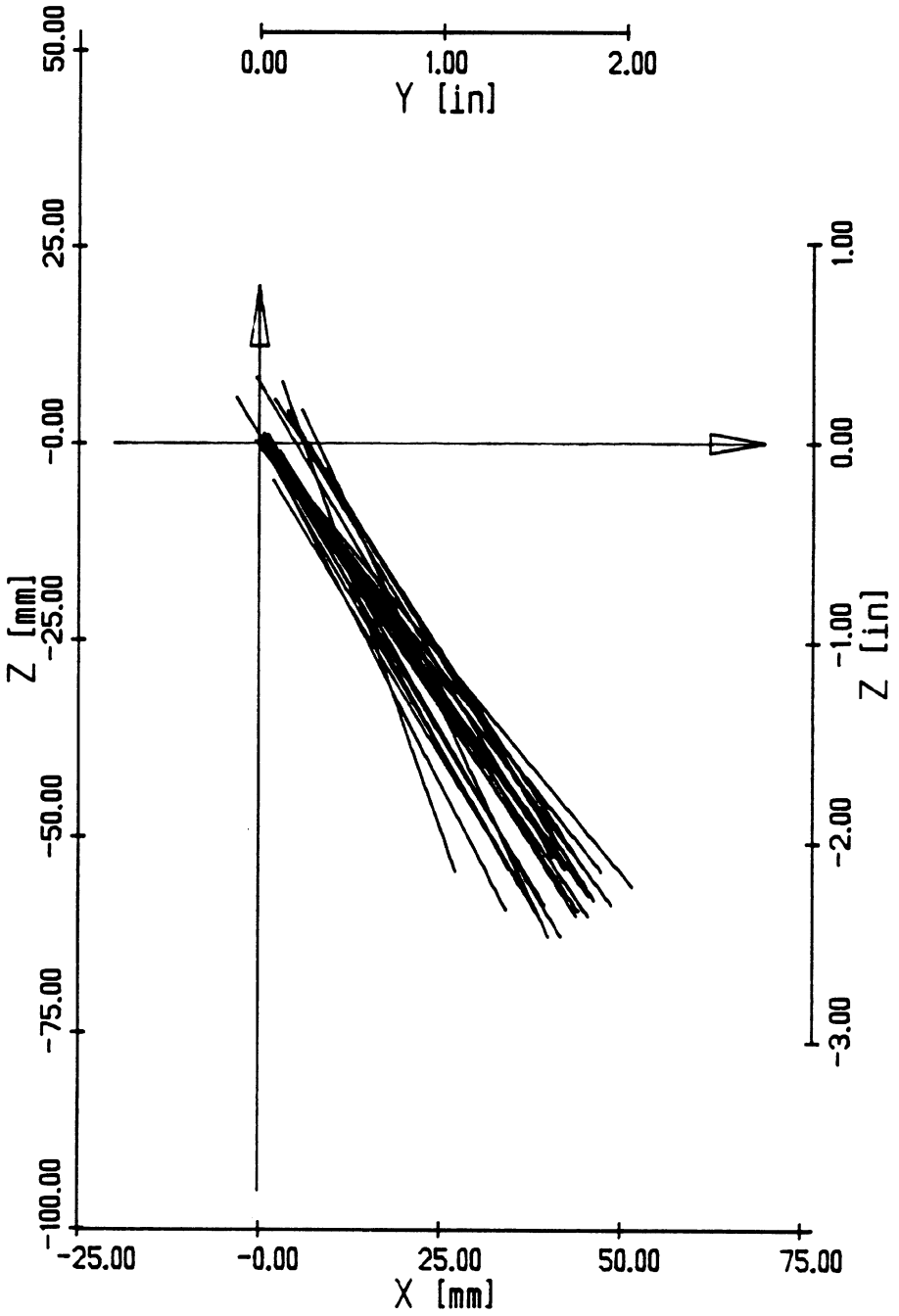
4-6 Months

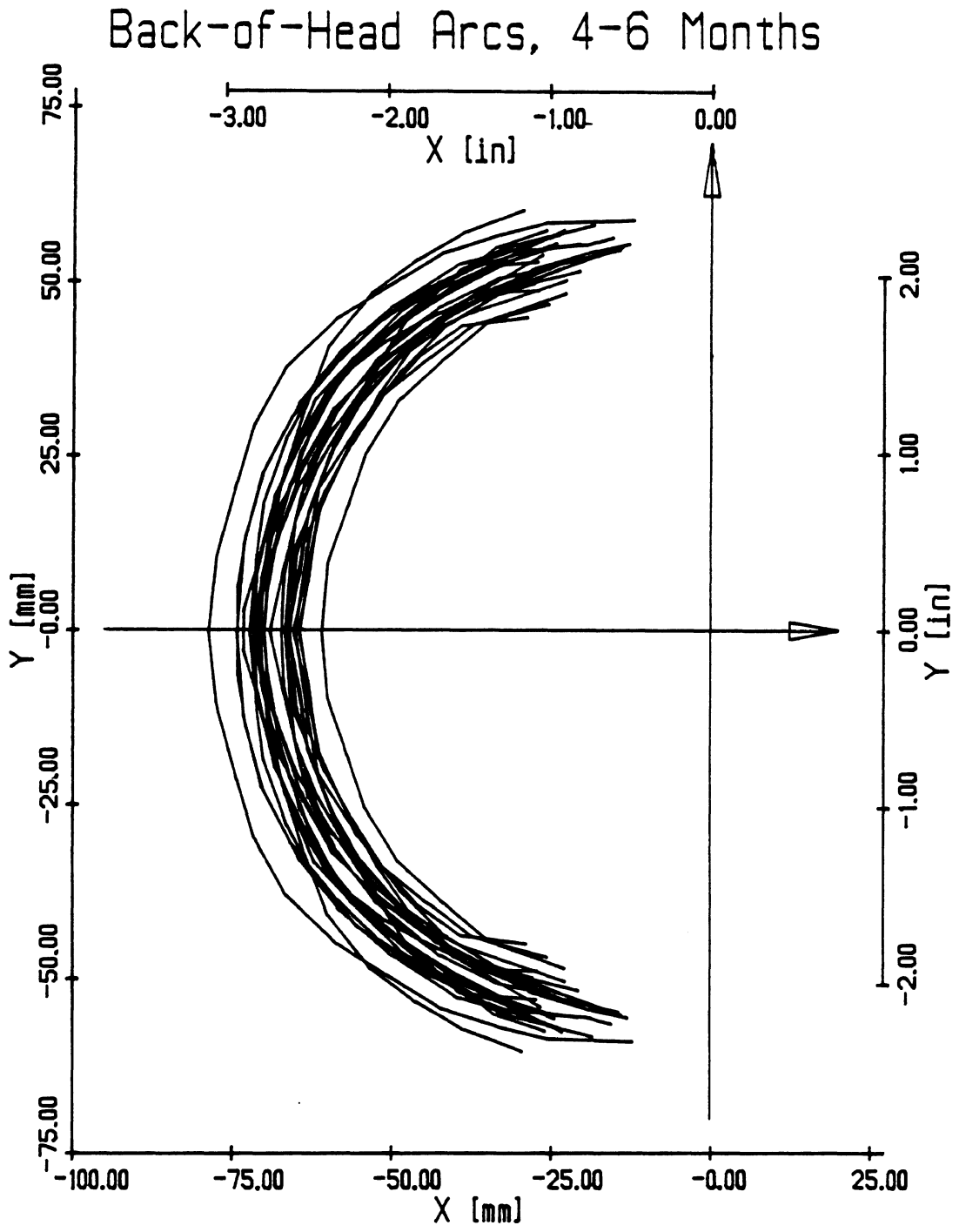


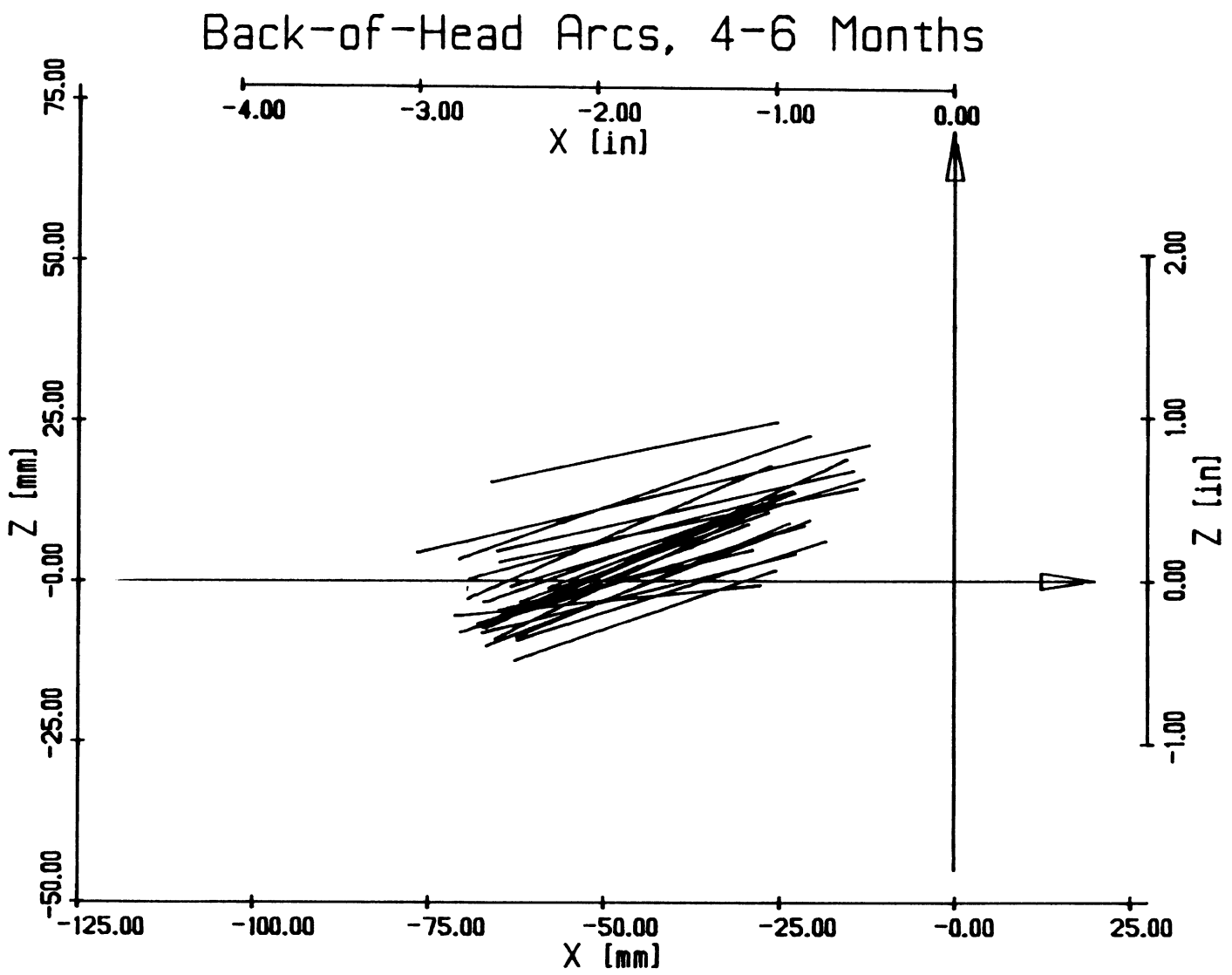

Ear-to-Ear through Tip-of-Chin Arcs
4-6 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

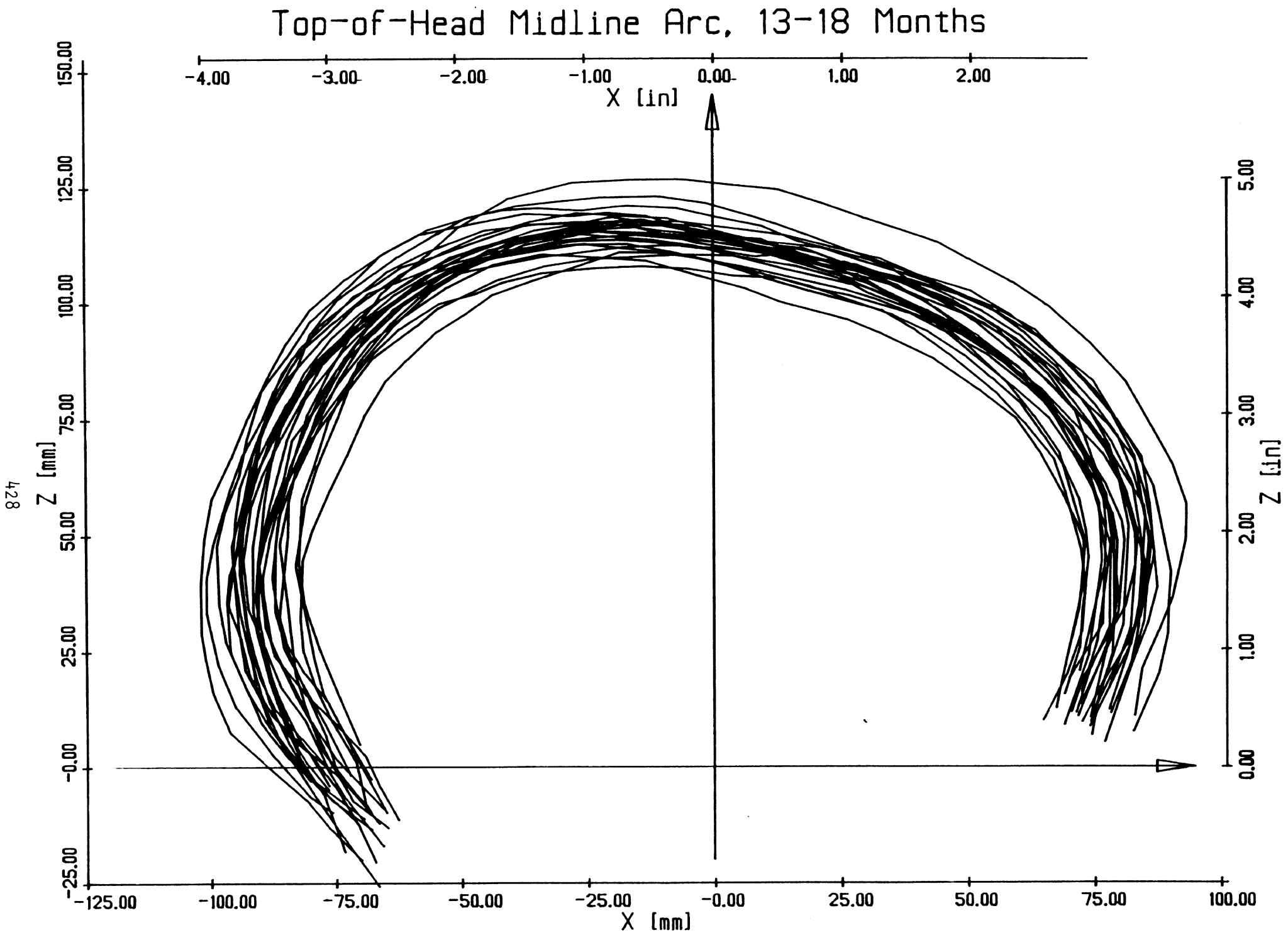
Ear-to-Ear through Tip-of-Chin Arc

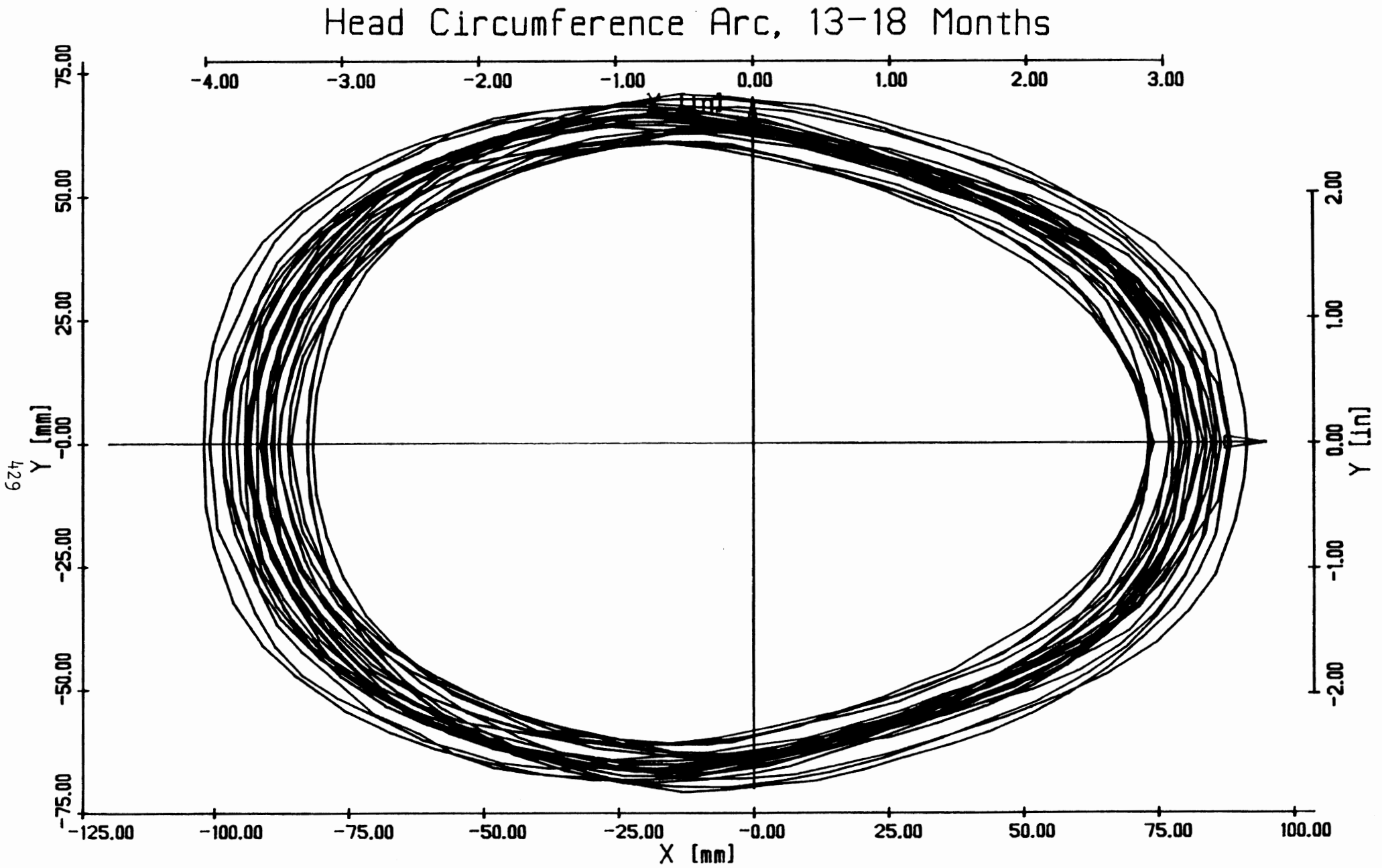
4-6 Months

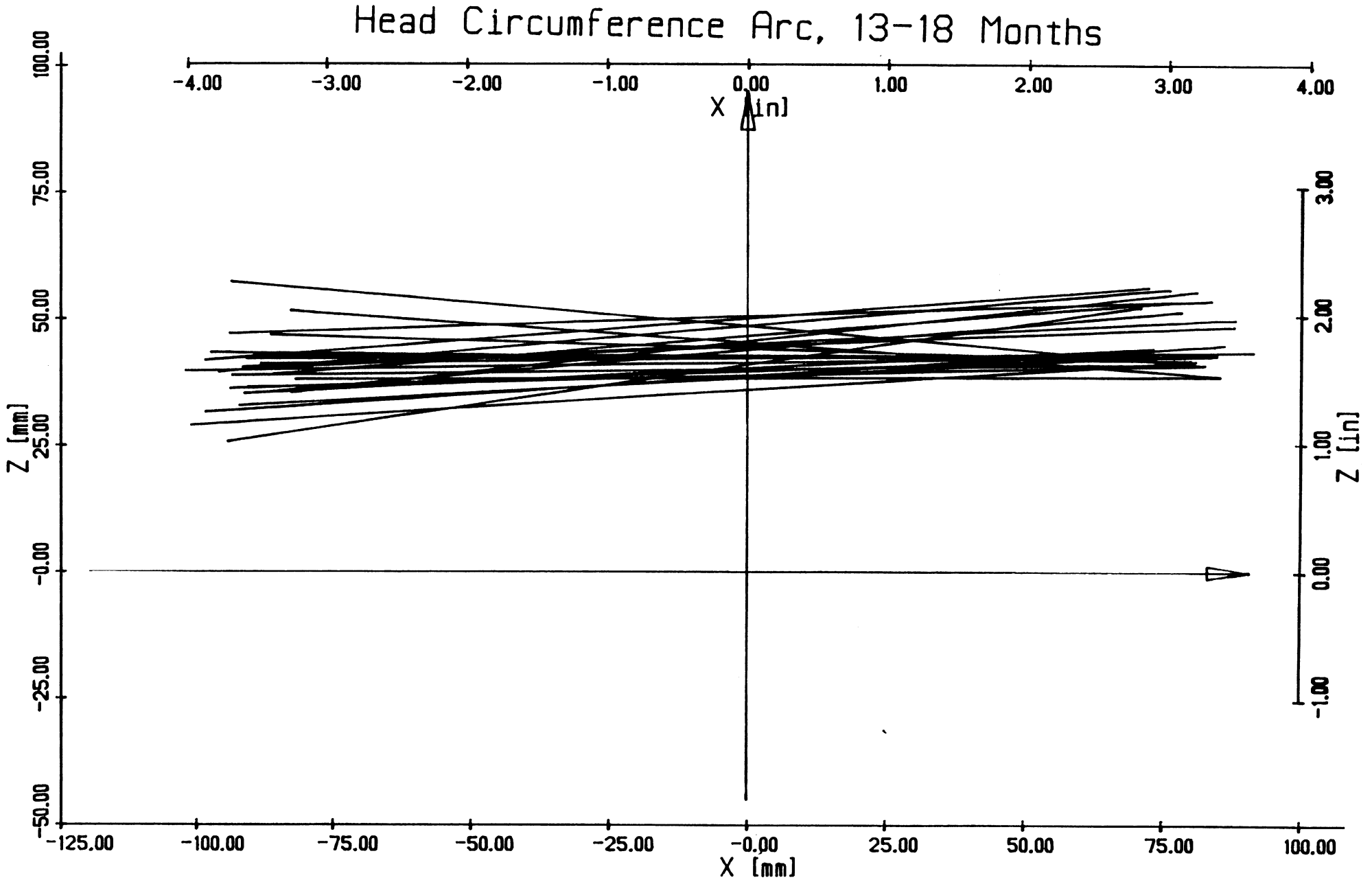


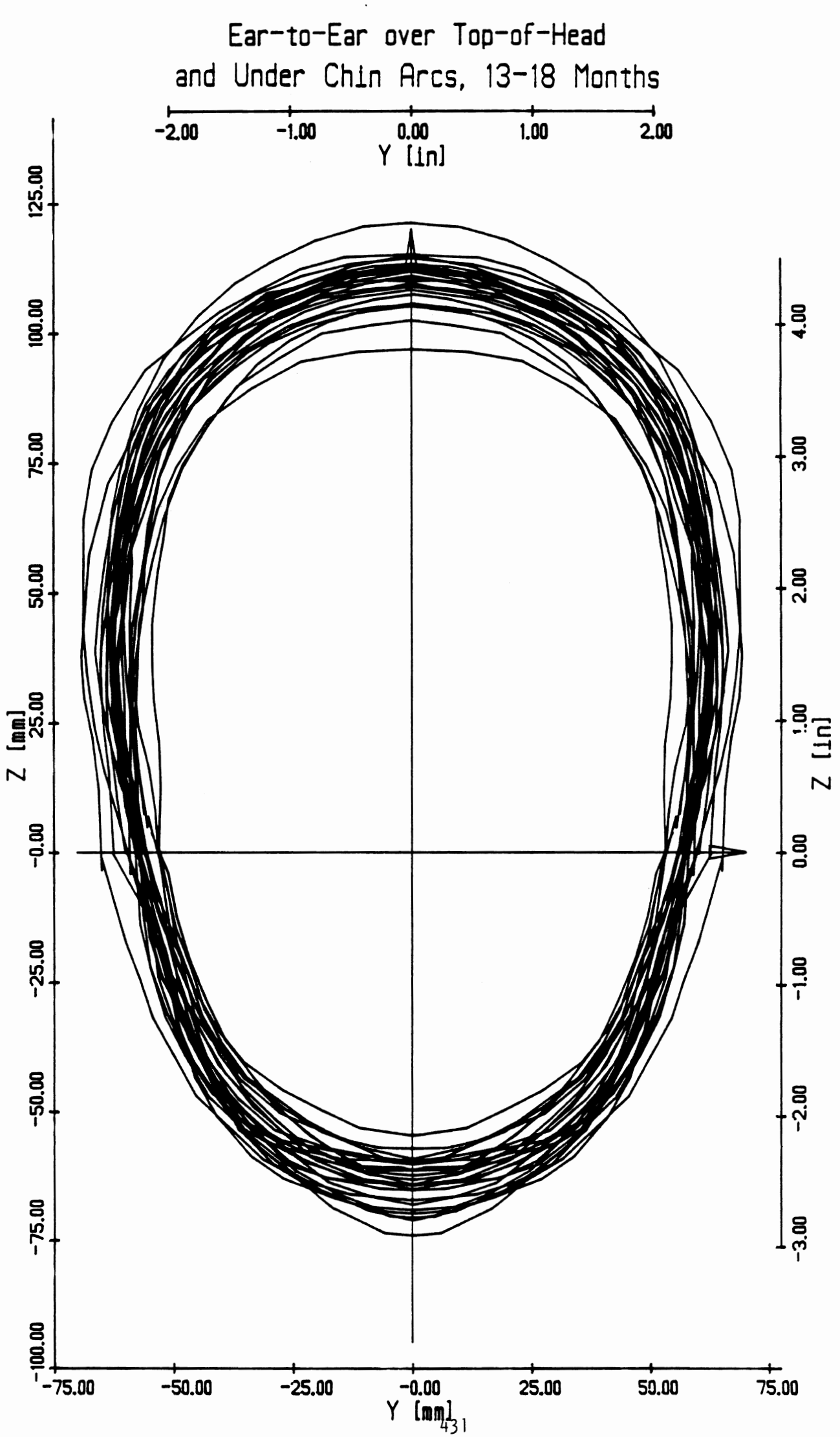

Back-of-Head Arcs, 4-6 Months
-3.00
-2.00
-1.00
0.00
X [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
X [mm]

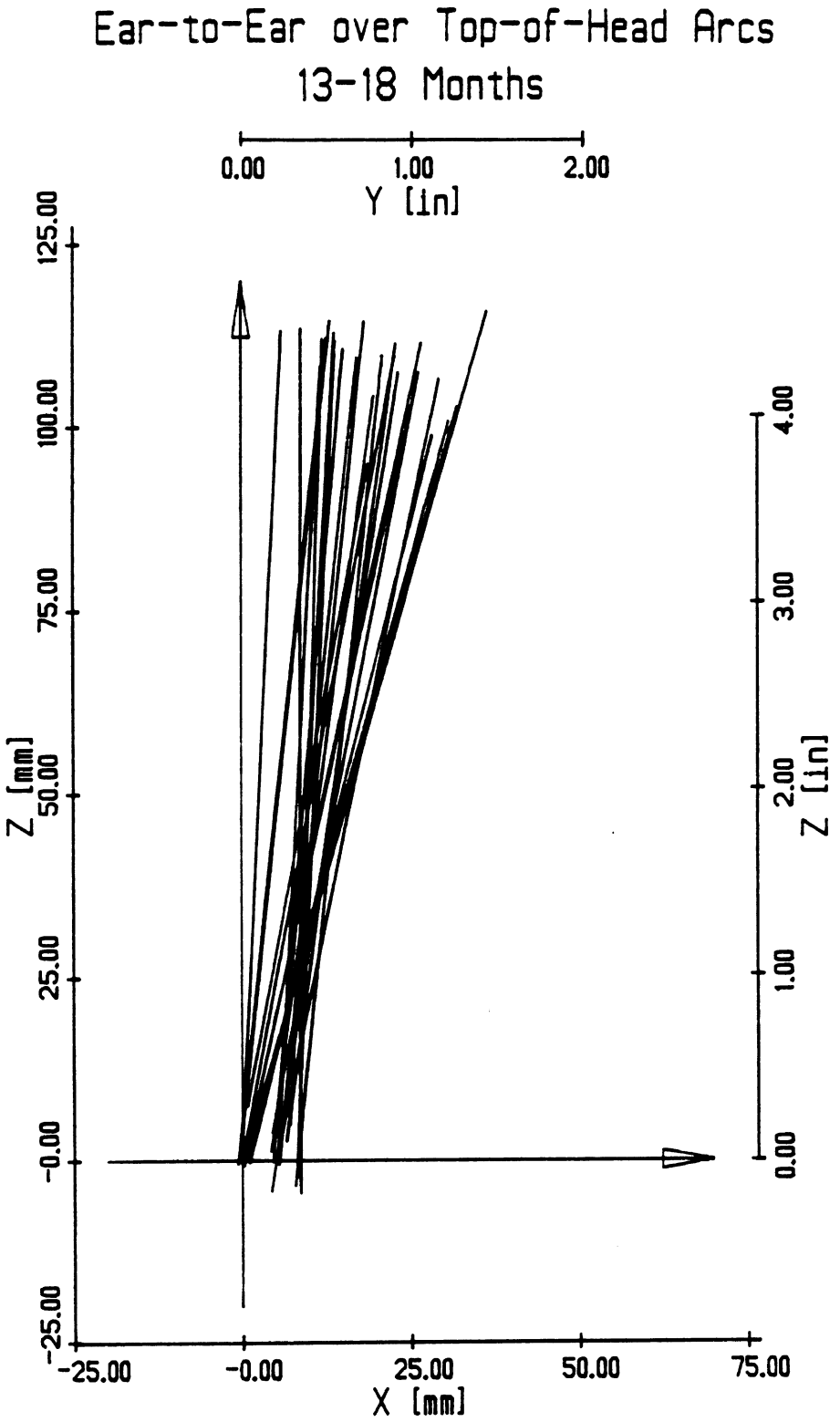

Back-of-Head Arcs, 4-6 Months
-4.00
-3.00
-2.00
-1.00
0.00
X [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
Z [mm]
2.00
1.00
0.00
-1.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
X [mm]


Top-of-Head Midline Arc, 13-18 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
X [in]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

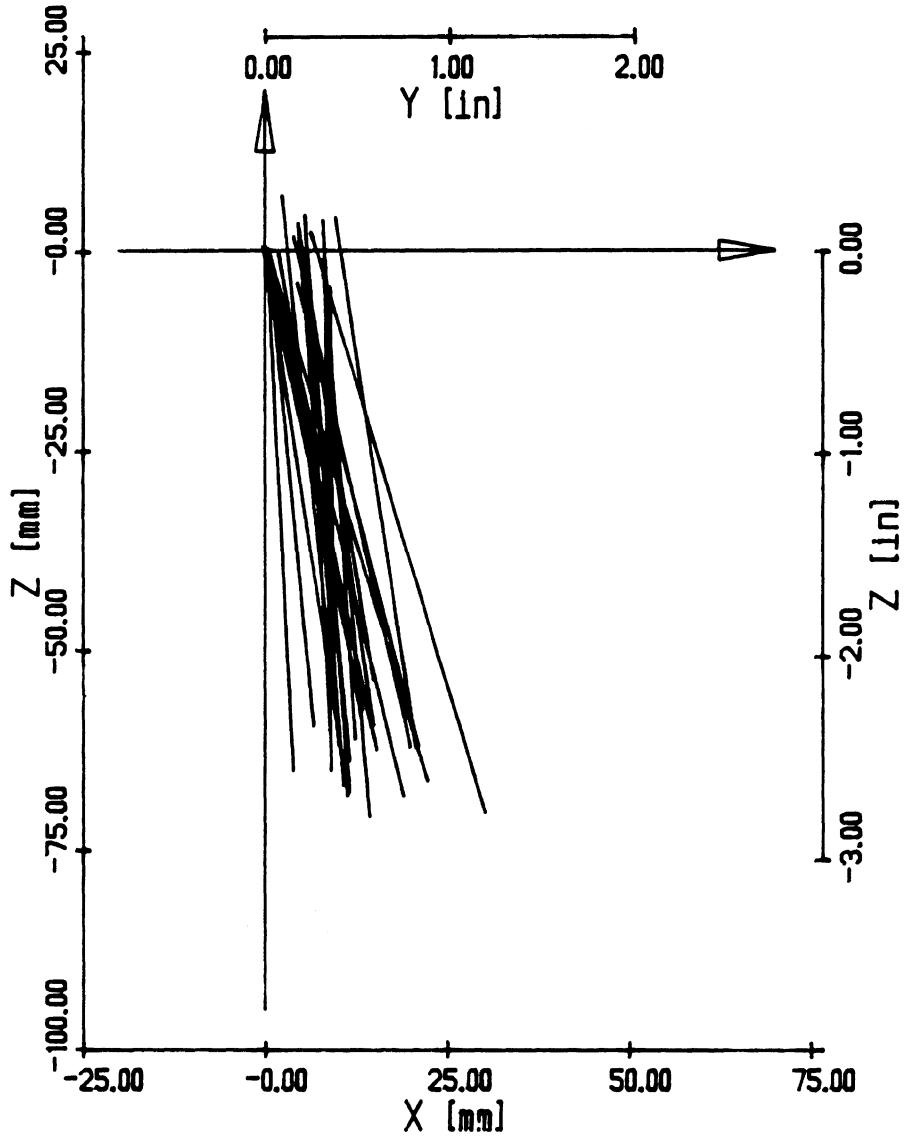

Head Circumference Arc, 13-18 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

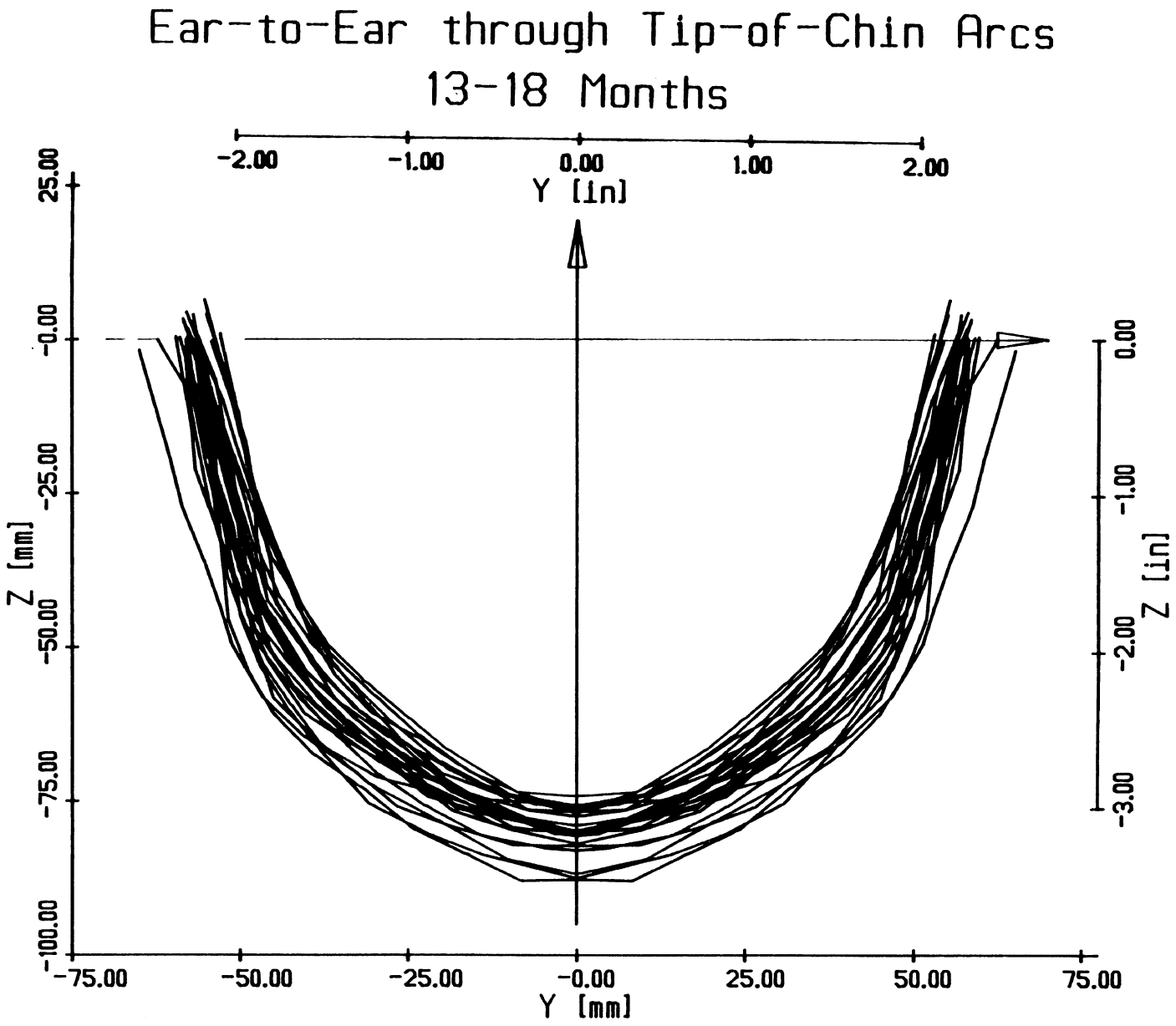

Head Circumference Arc, 13-18 Months
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
Z [mm]
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
Z [in]
3.00
2.00
1.00
0.00
-1.00
X [mm]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00


Ear-to-Ear over Top-of-Head
and Under Chin Arcs, 13-18 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]


Ear-to-Ear over Top-of-Head Arcs
13-18 Months
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
Z [in]
-25.00
-0.00
25.00
50.00
75.00
X [mm]

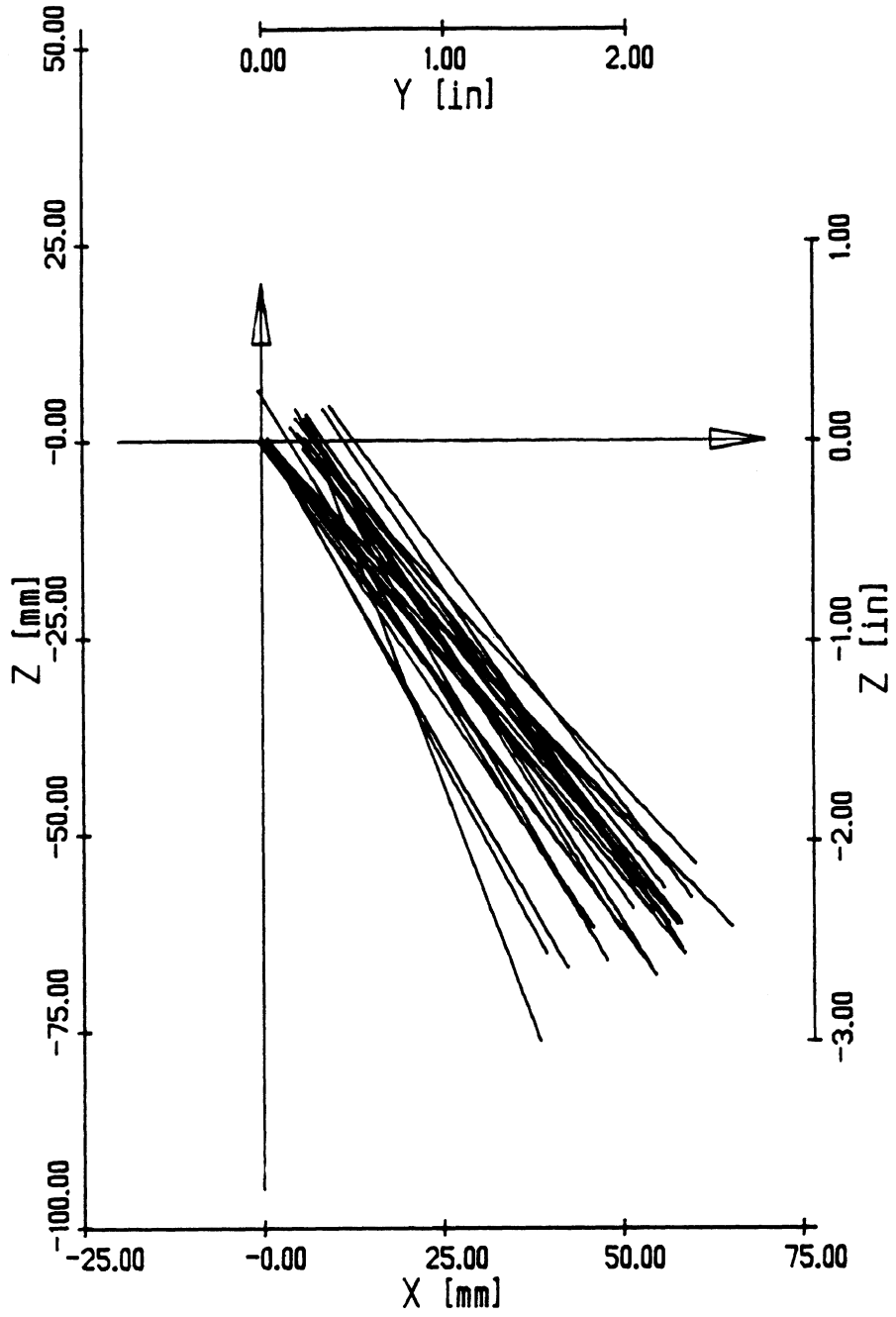
Ear-to-Ear Under Chin Arcs
13-18 Months

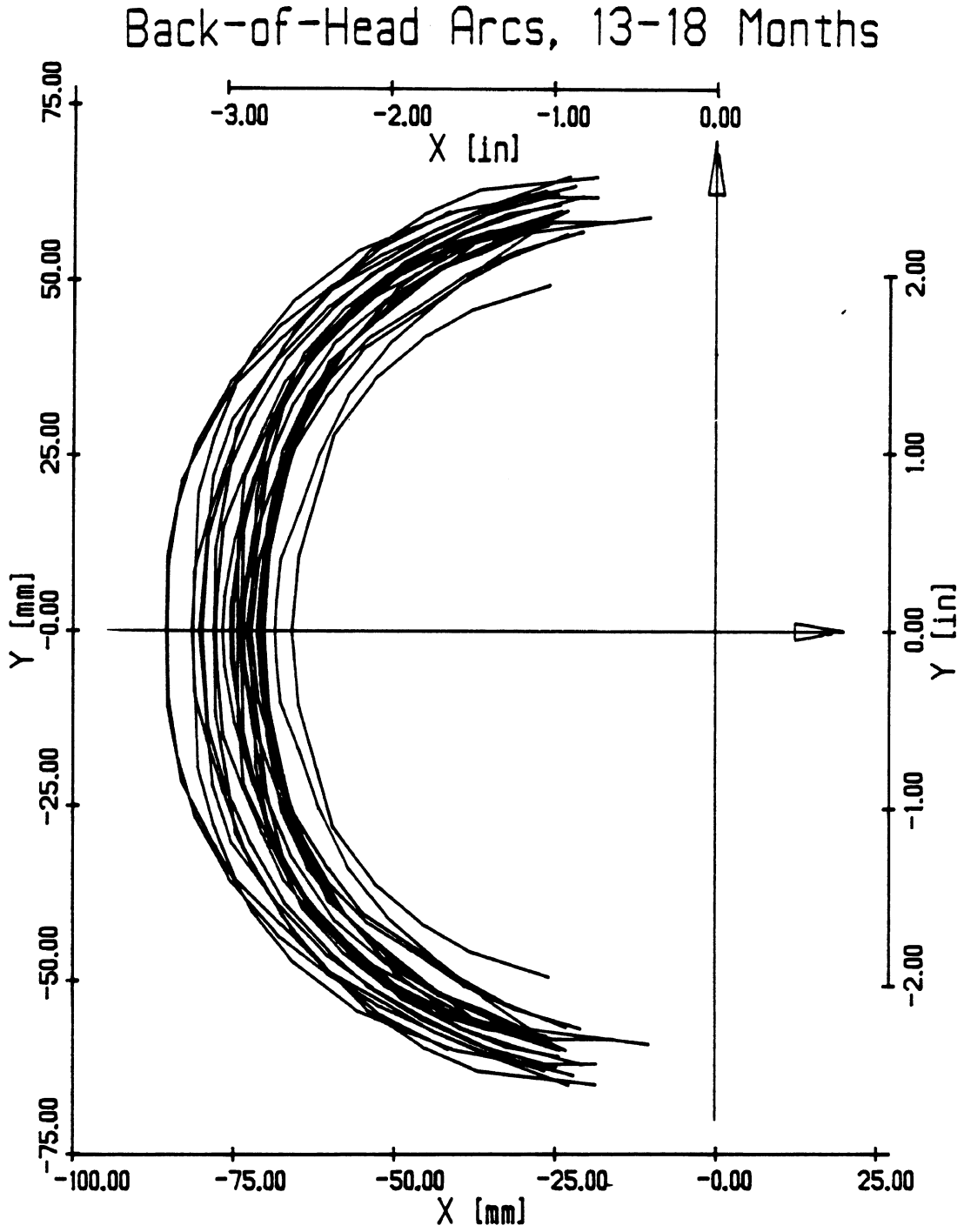


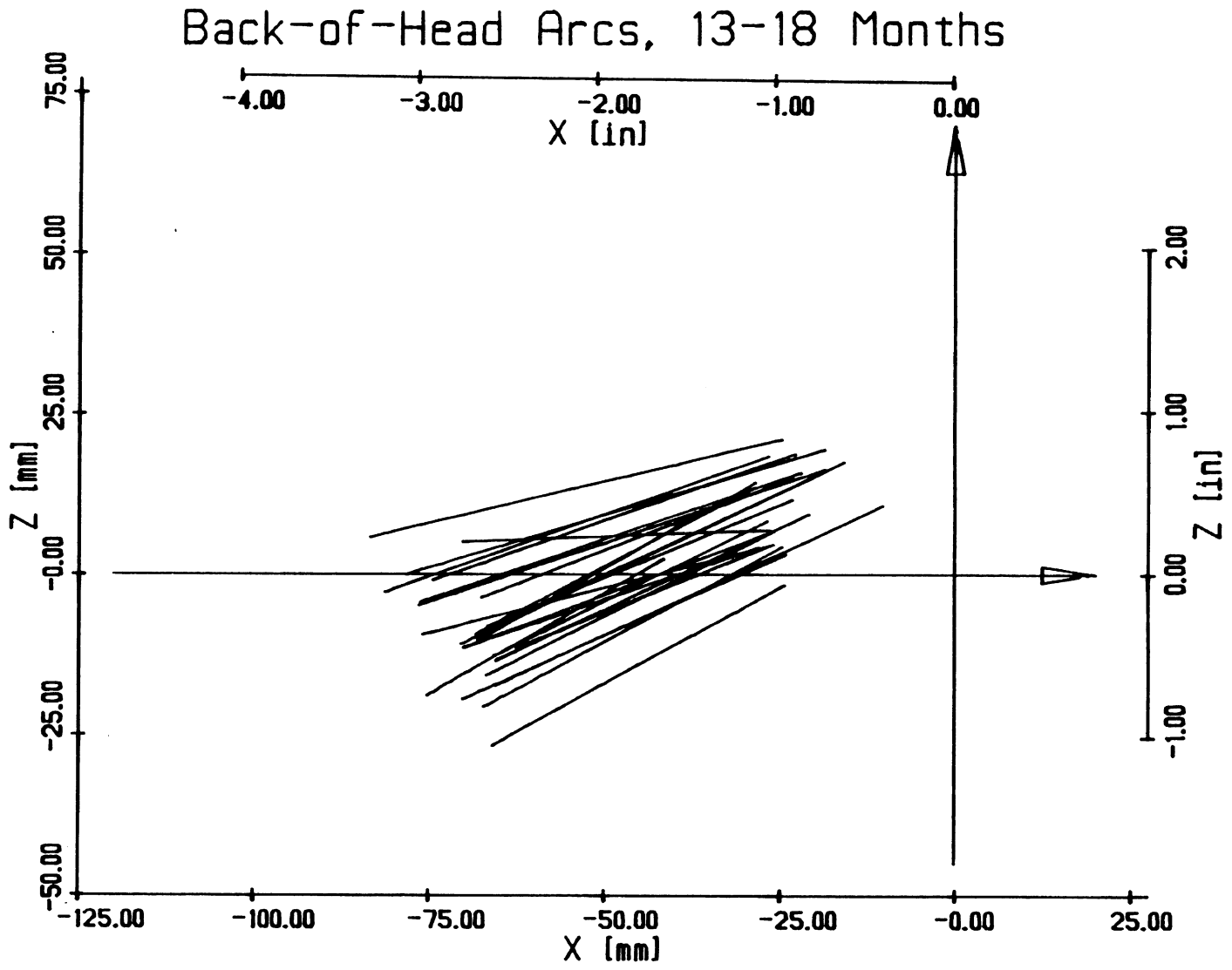

Ear-to-Ear through Tip-of-Chin Arcs
13-18 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

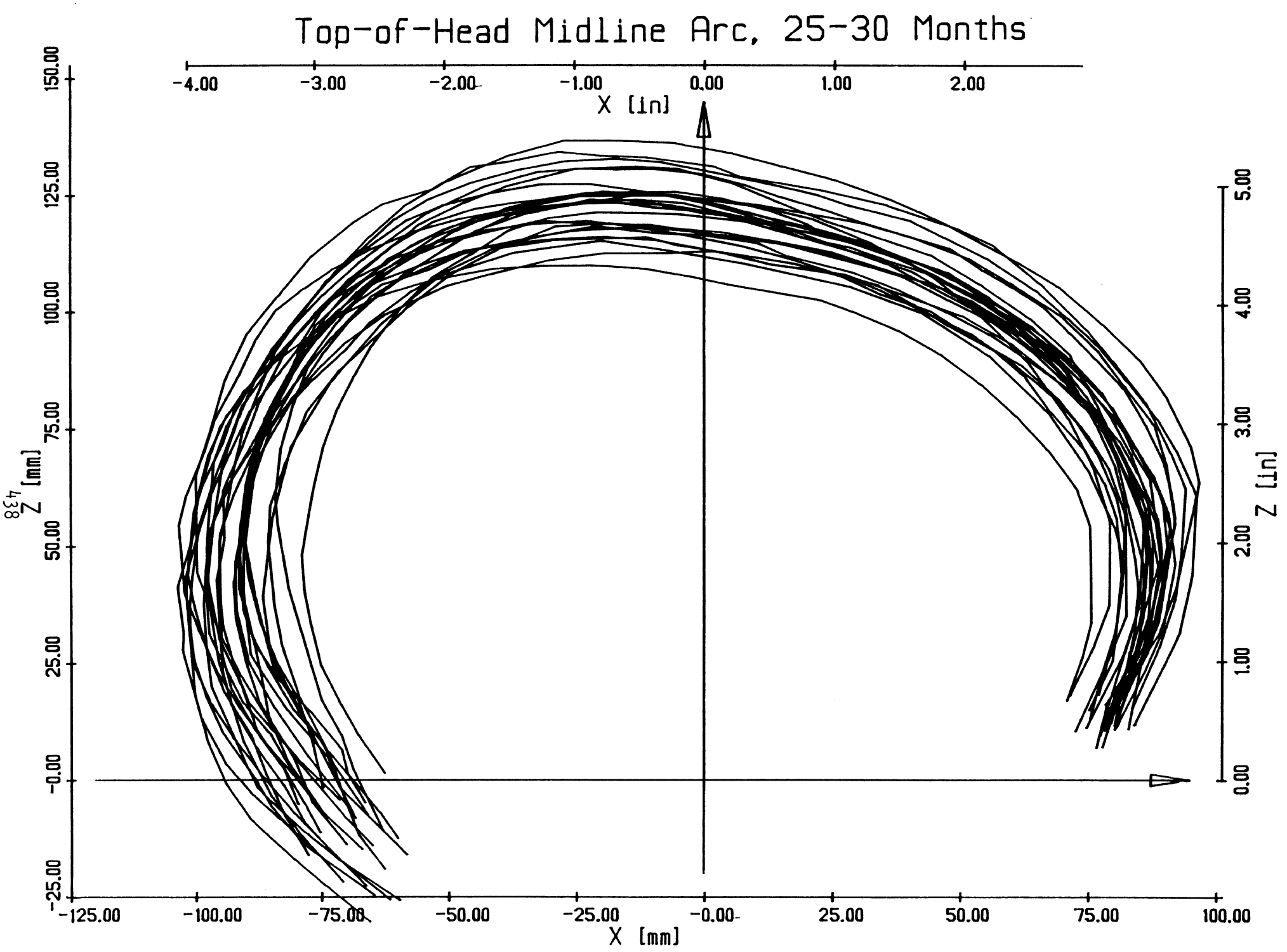
Ear-to-Ear through Tip-of-Chin Arc

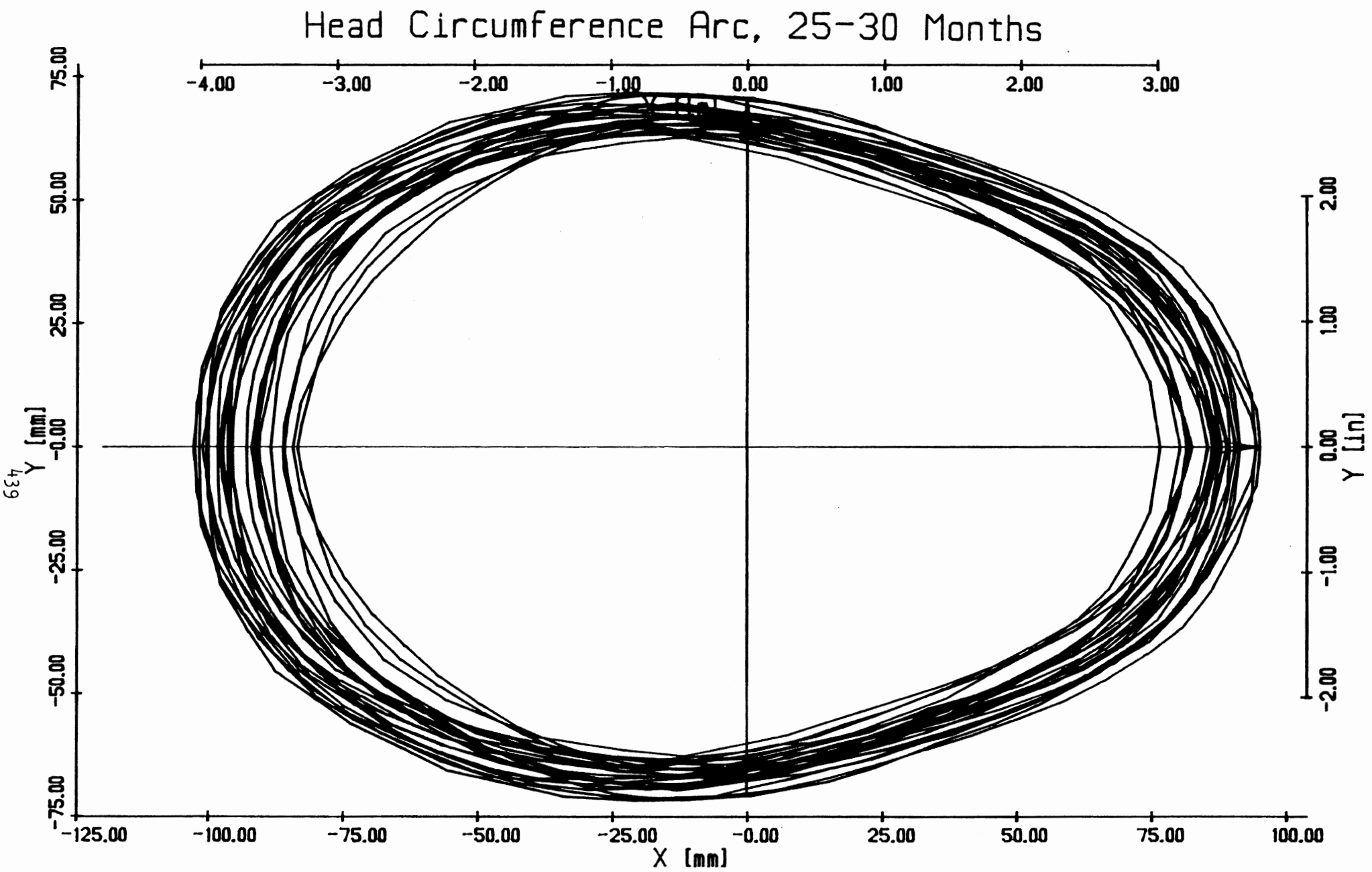
13-18 Months

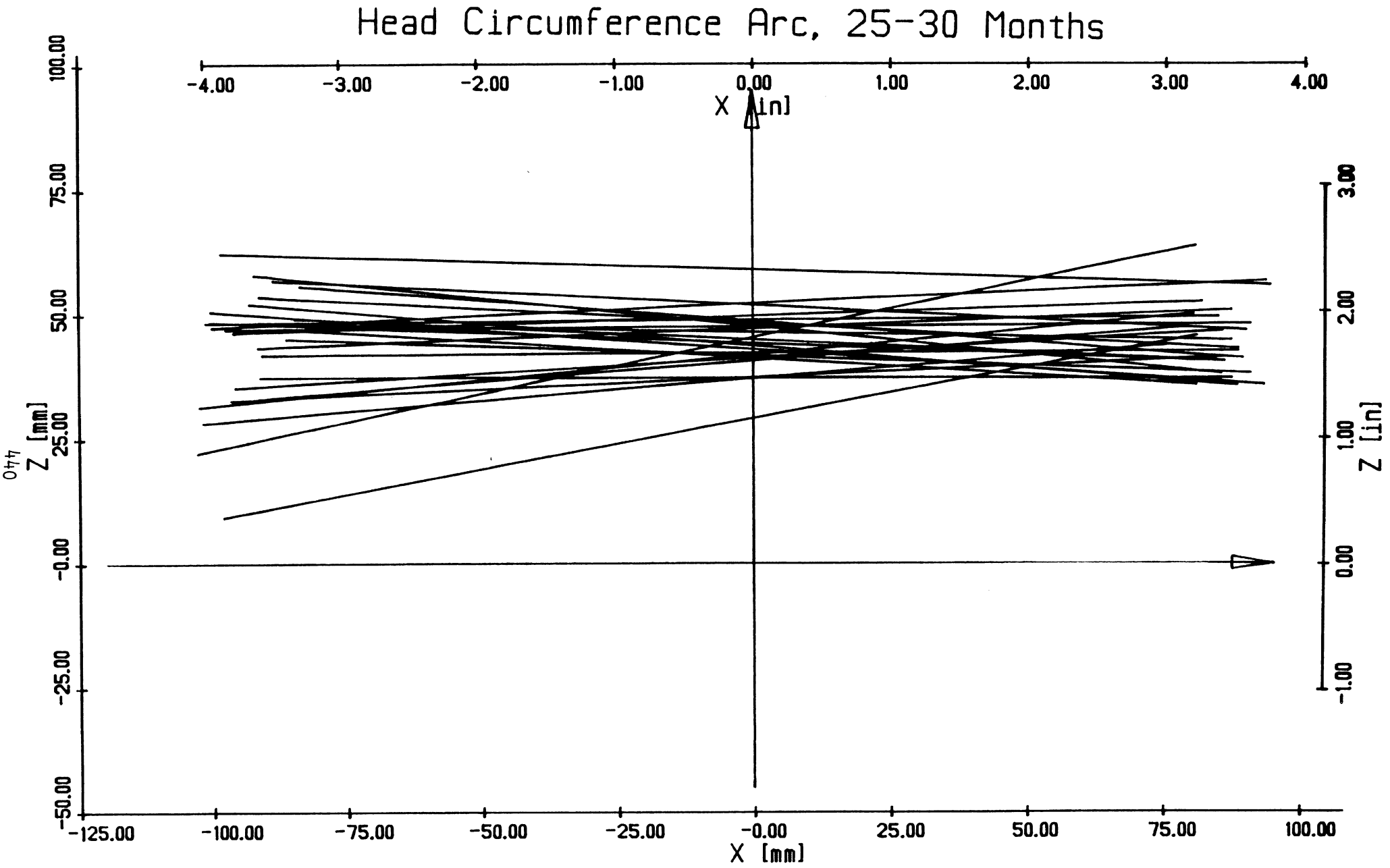


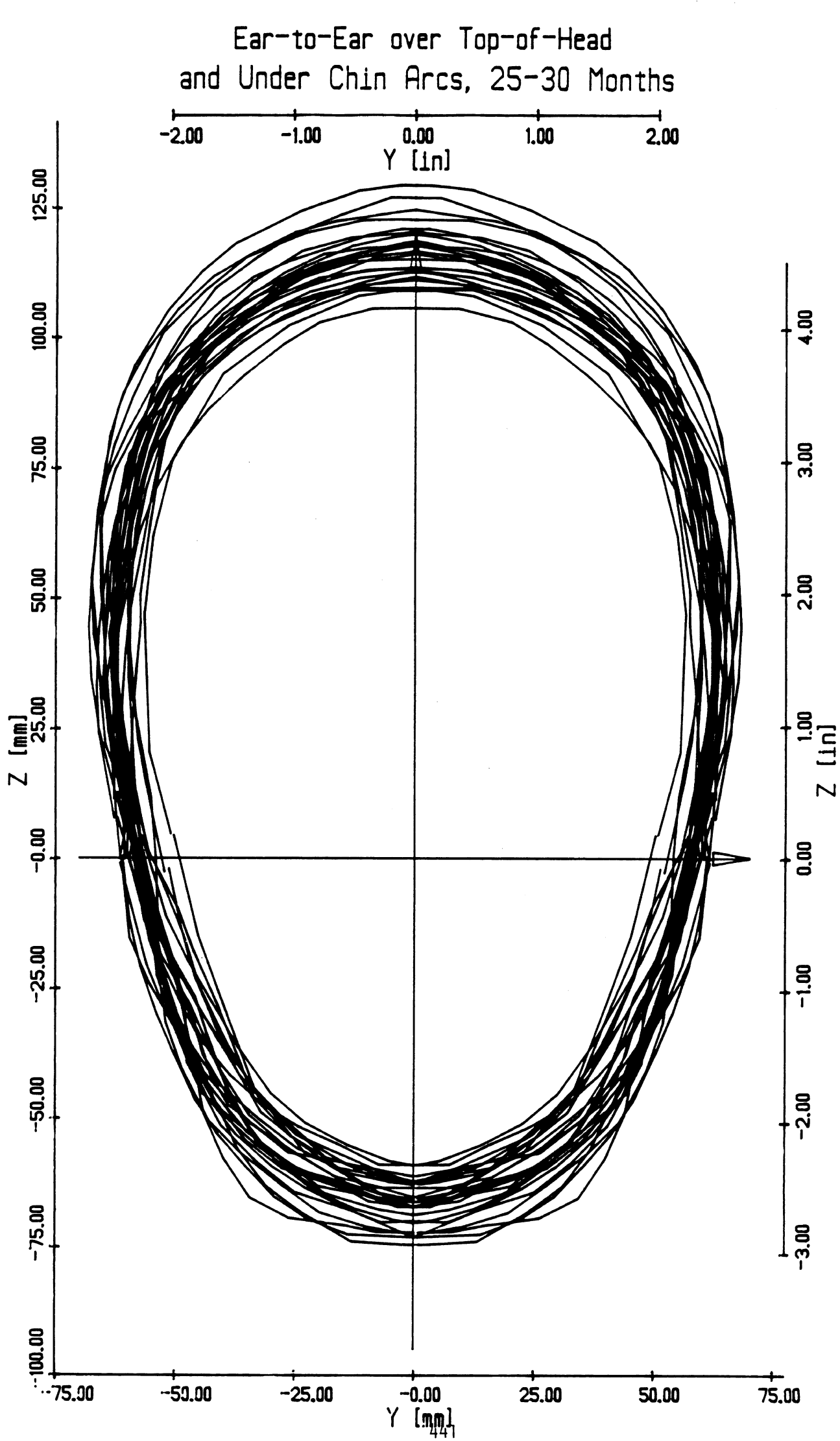

Back-of-Head Arcs, 13-18 Months
-3.00
-2.00
-1.00
0.00
X [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
X [mm]

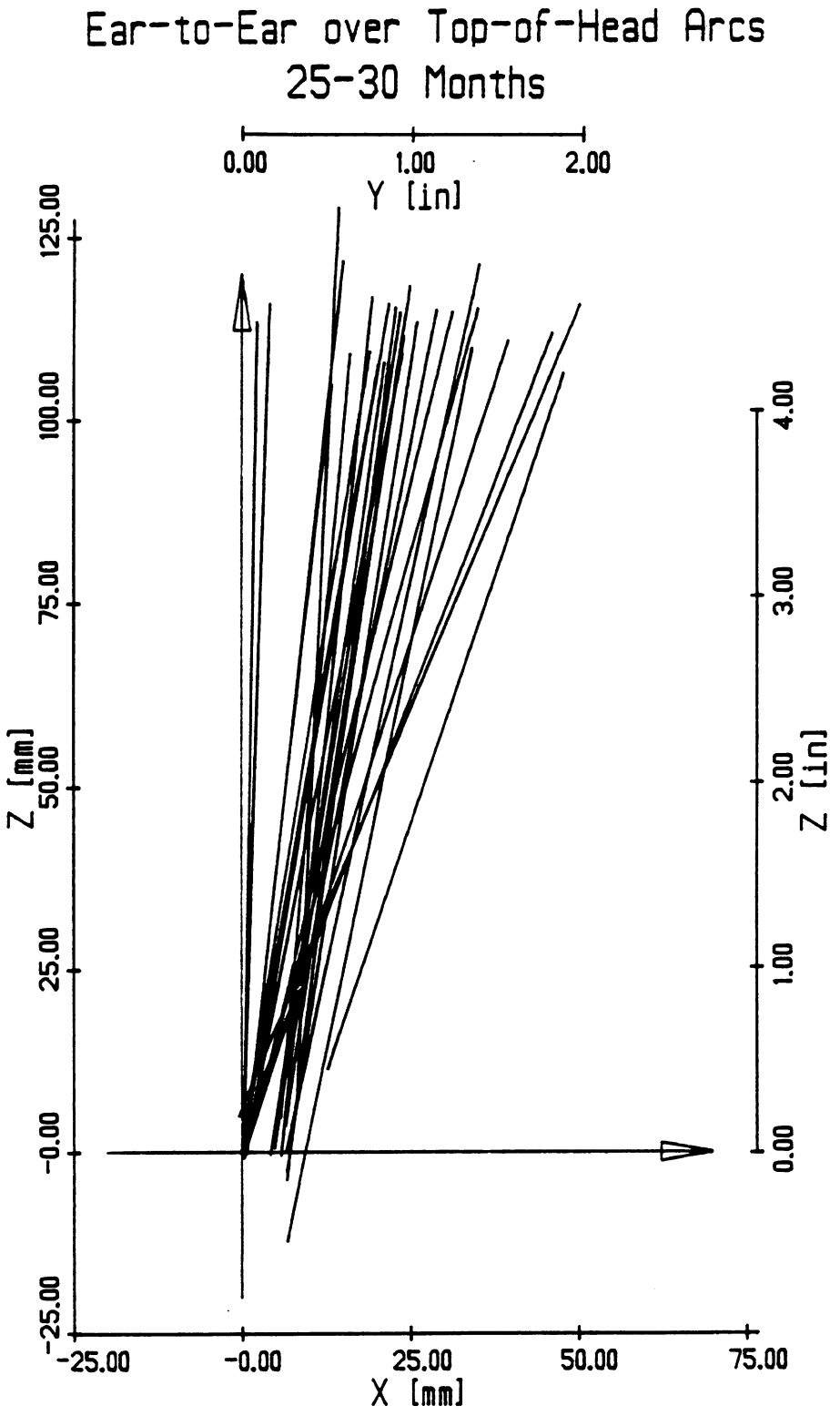

Back-of-Head Arcs, 13-18 Months
-4.00
-3.00
-2.00
-1.00
0.00
X [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
Z [mm]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
X [mm]
2.00
1.00
0.00
-1.00
Z [in]


Top-of-Head Midline Arc, 25-30 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
X [in]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

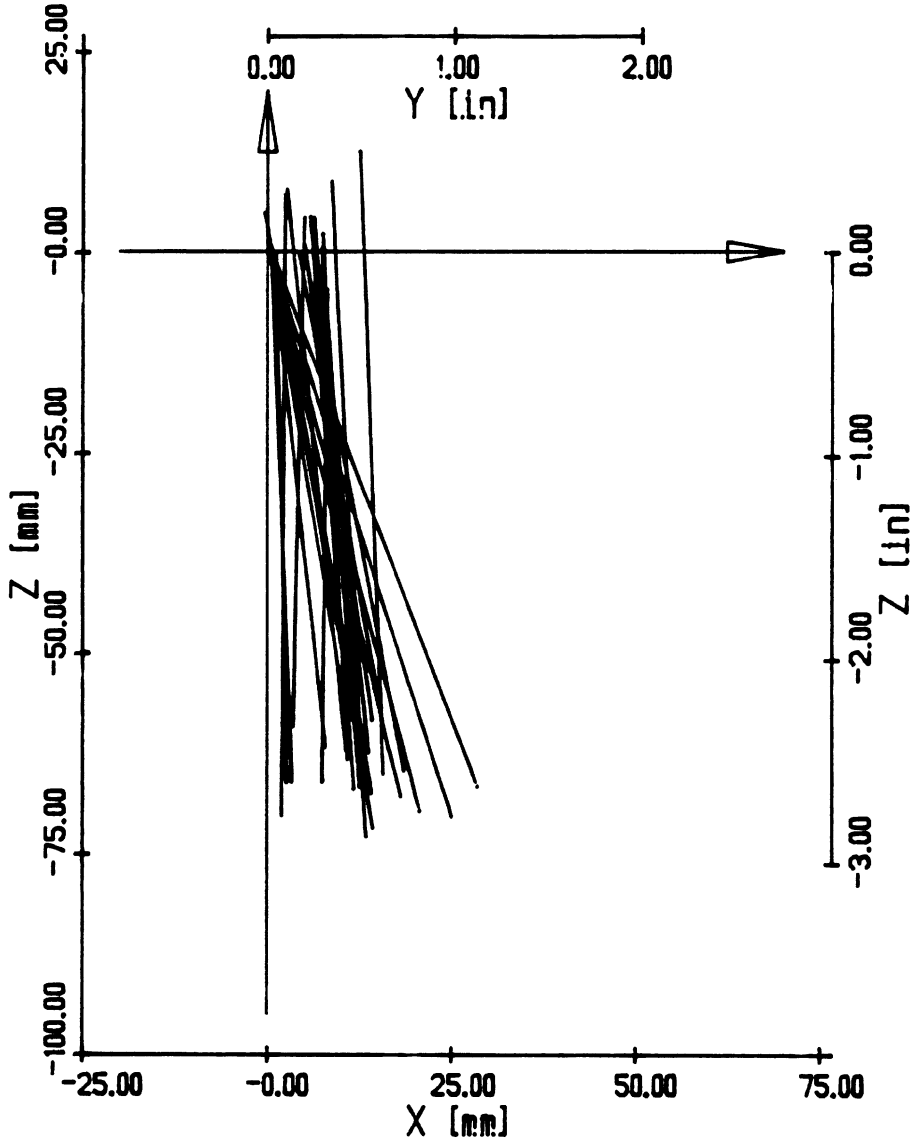

Head Circumference Arc, 25-30 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

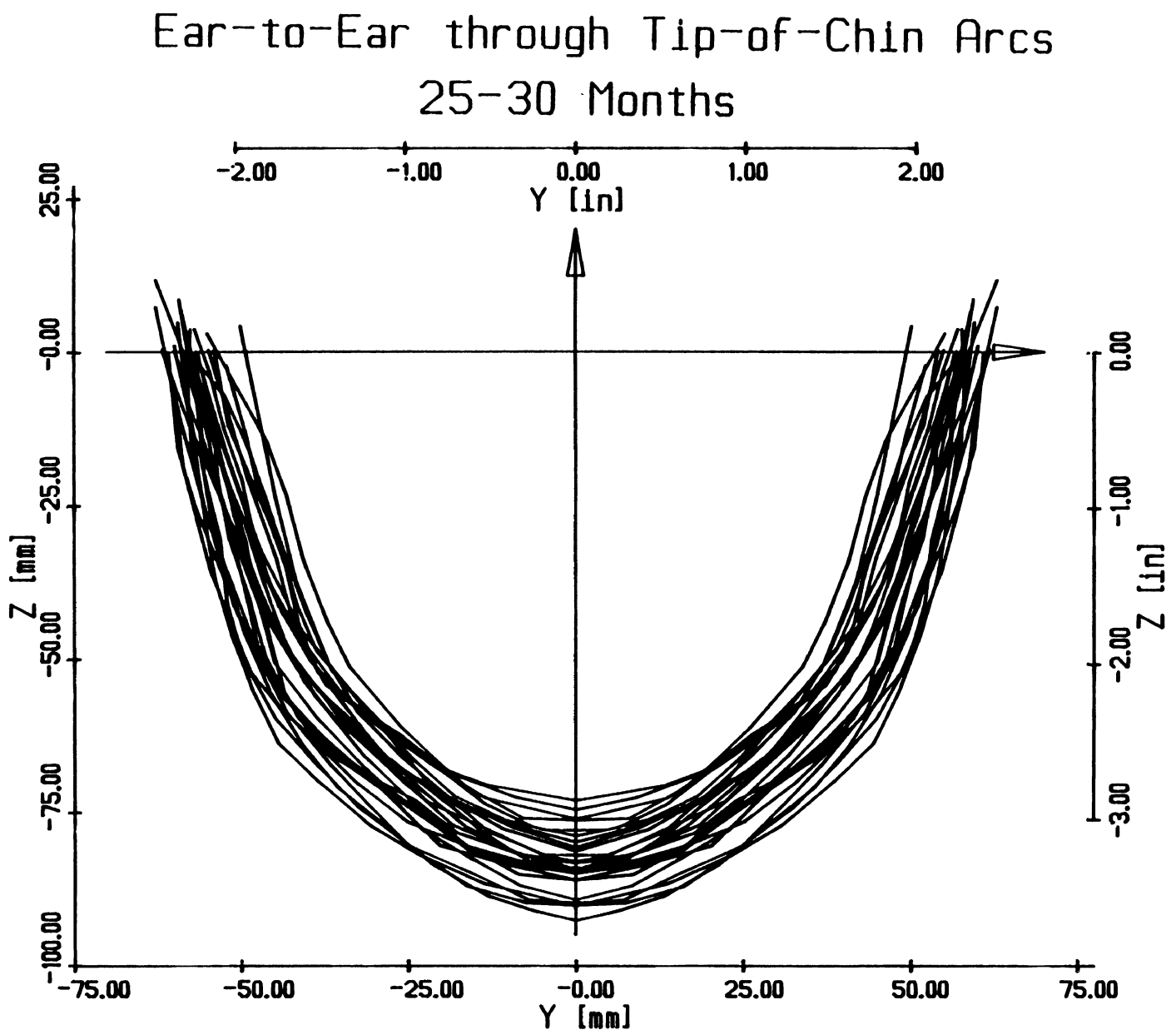

Head Circumference Arc, 25-30 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
X [in]
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
Z [mm]
3.00
2.00
1.00
0.00
-1.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]


Ear-to-Ear over Top-of-Head
and Under Chin Arcs, 25-30 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]


Ear-to-Ear over Top-of-Head Arcs
25-30 Months
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
Z [in]
-25.00
-0.00
25.00
50.00
75.00
X [mm]

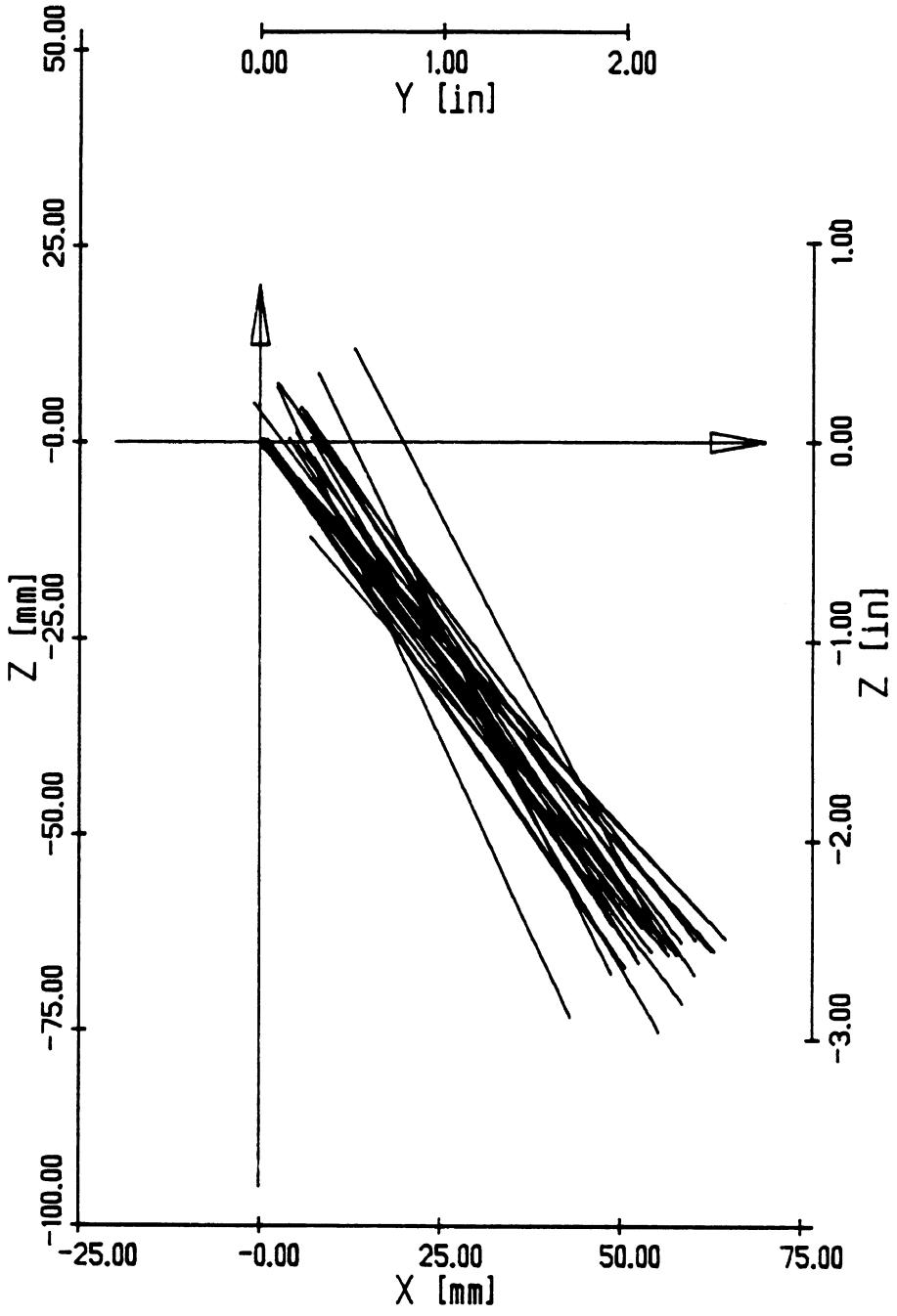
Ear-to-Ear Under Chin Arcs
25-30 Months

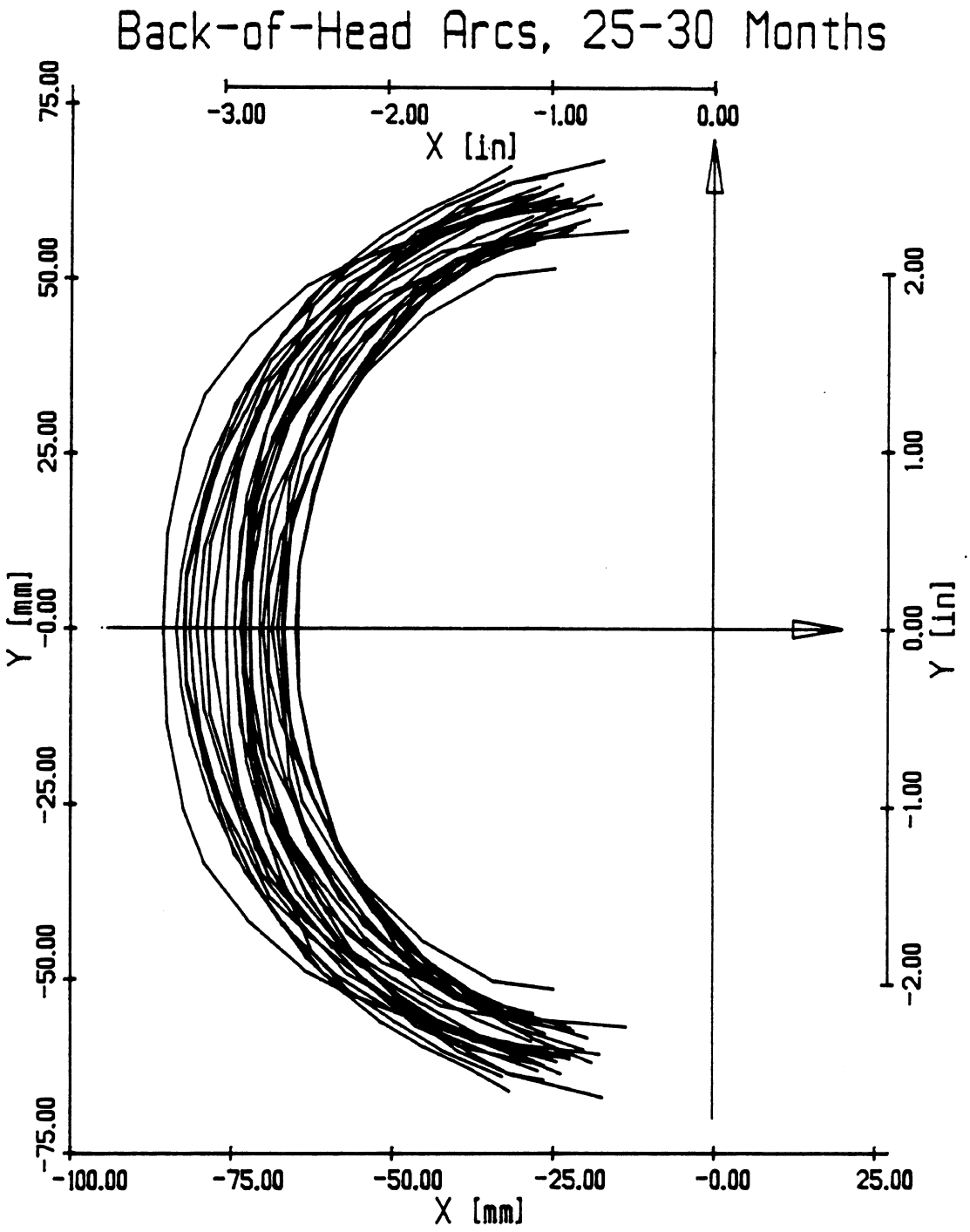


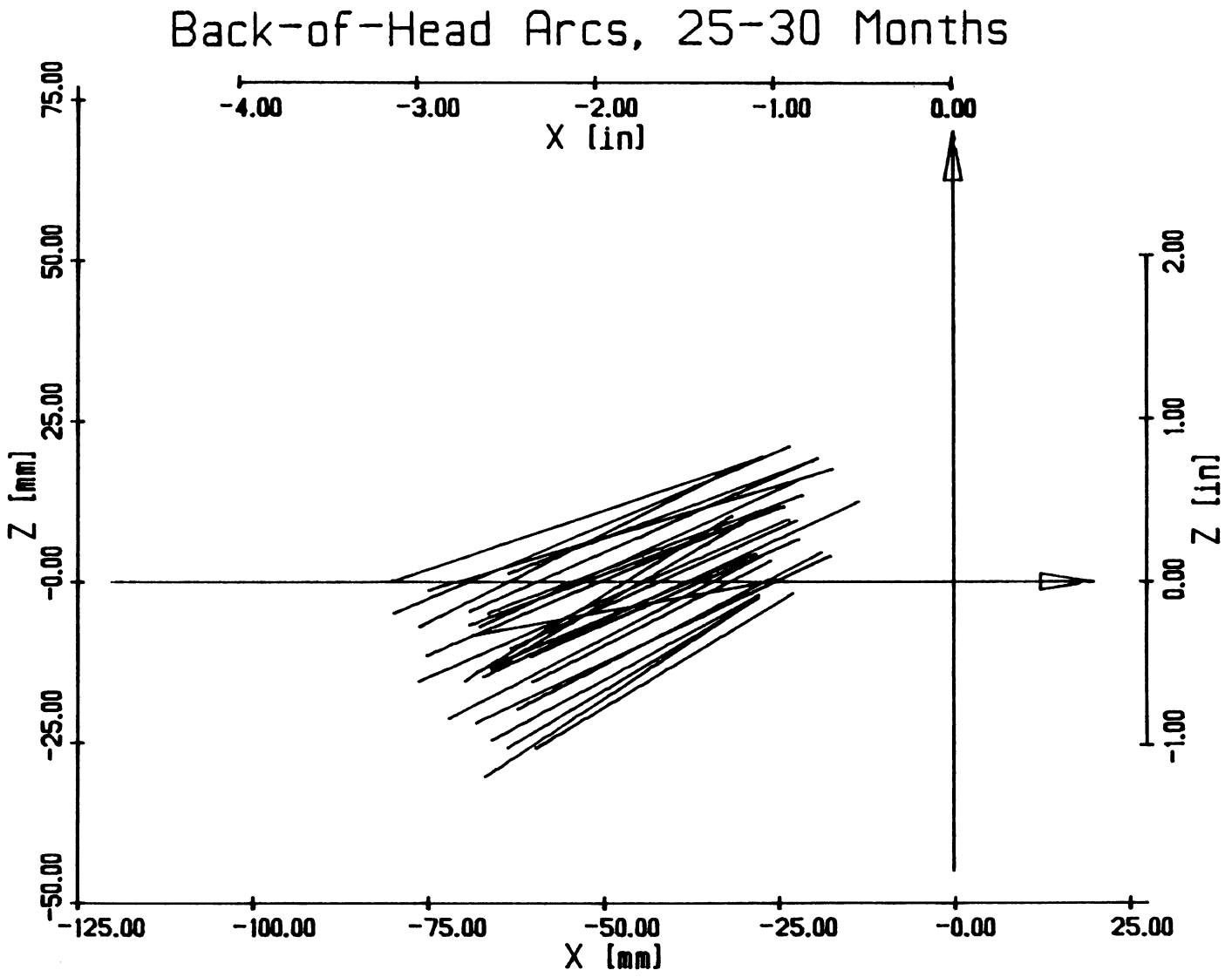

Ear-to-Ear through Tip-of-Chin Arcs
25-30 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

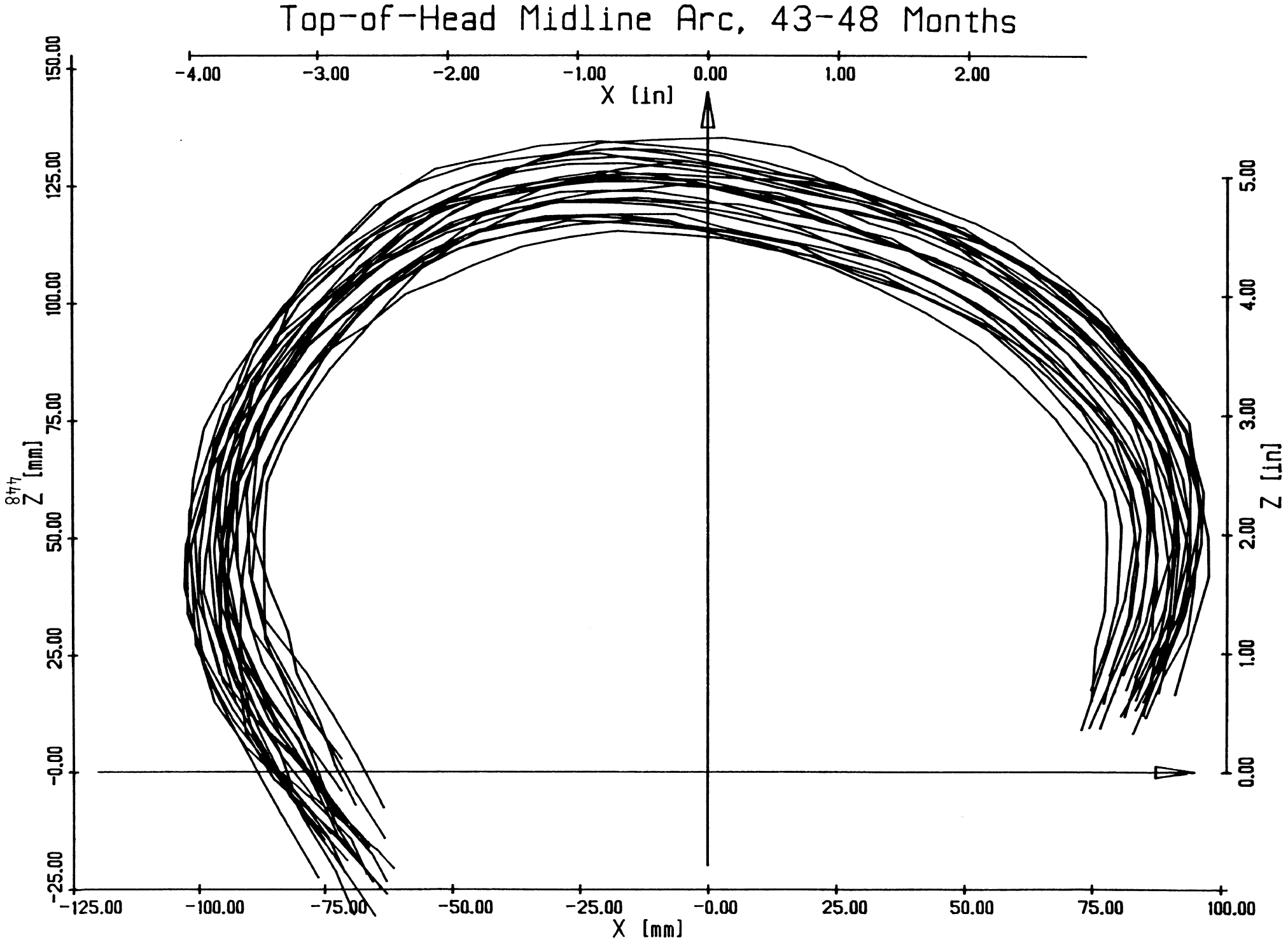
Ear-to-Ear through Tip-of-Chin Arc

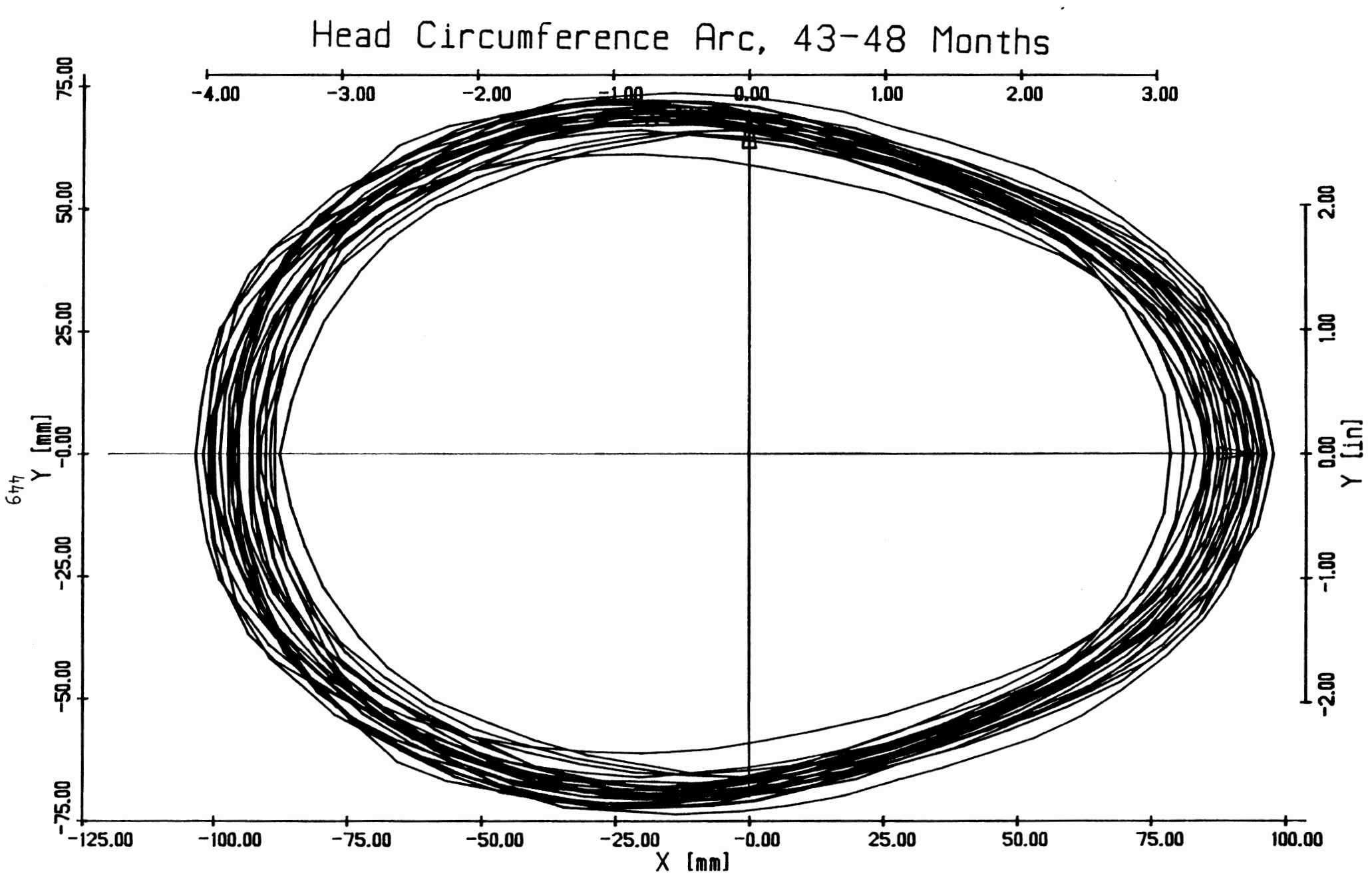
25-30 Months

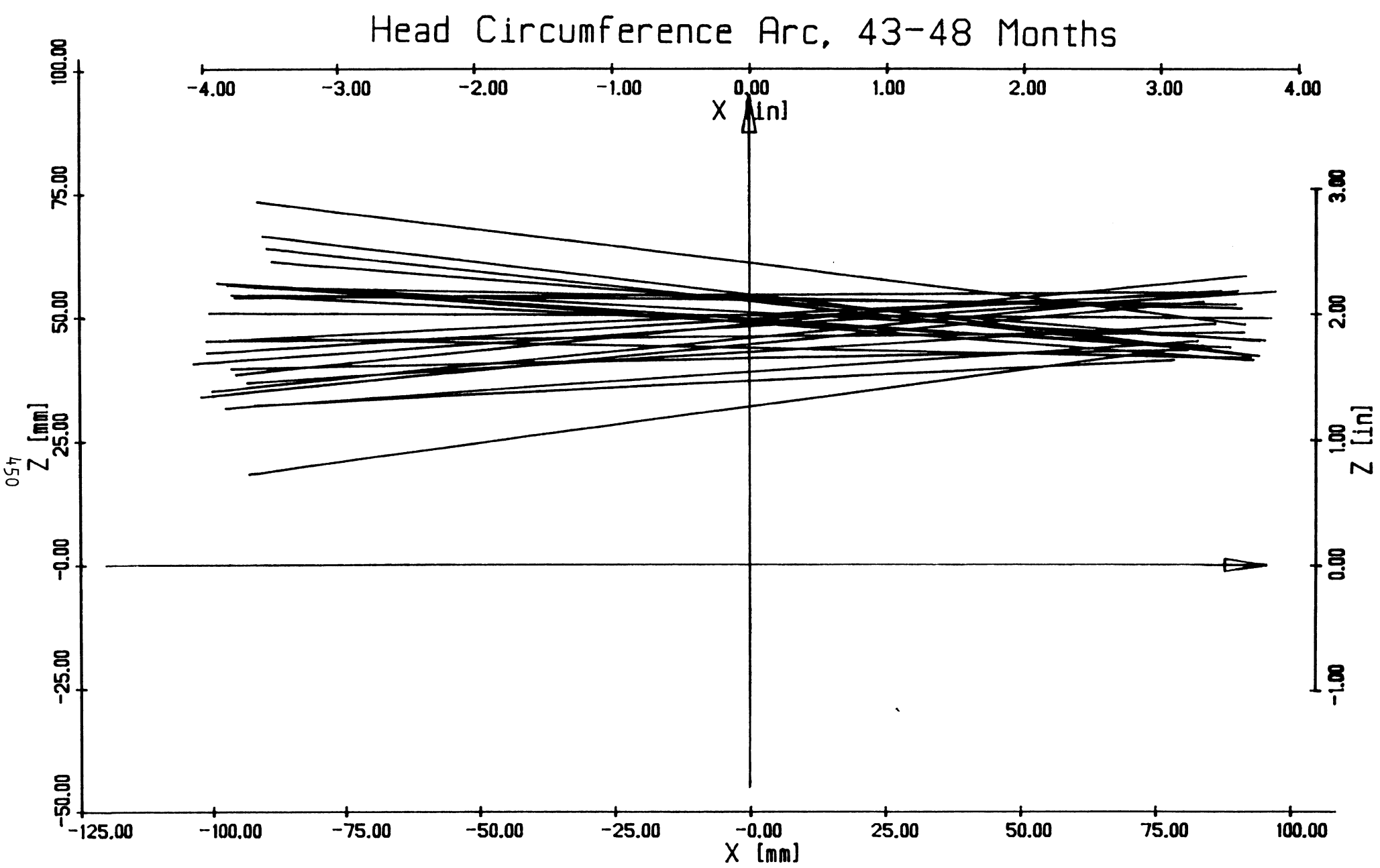


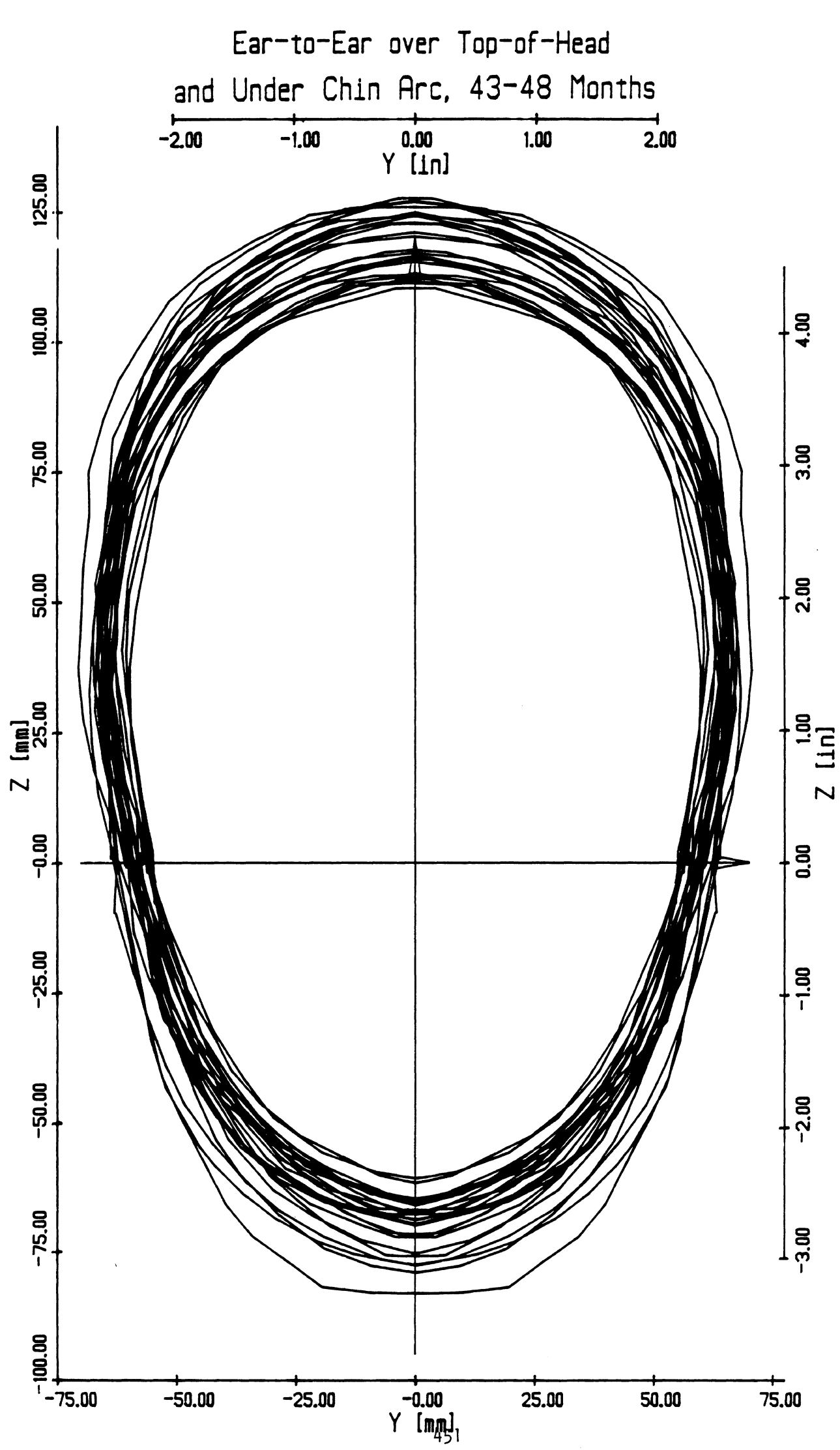

Back-of-Head Arcs, 25-30 Months
-3.00
-2.00
-1.00
0.00
X [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
X [mm]

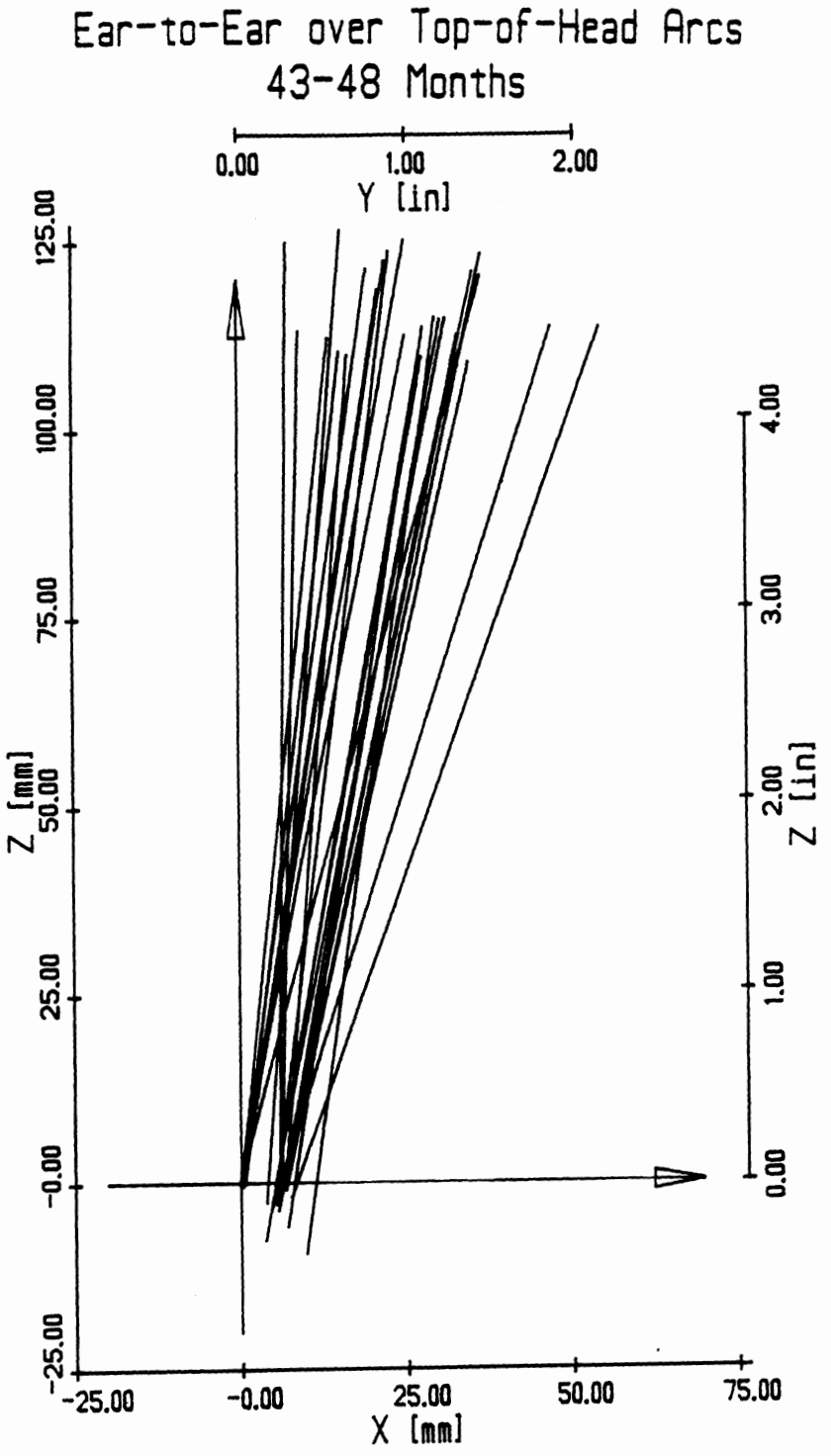

Back-of-Head Arcs, 25-30 Months
-4.00
-3.00
-2.00
-1.00
0.00
X [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
Z [mm]
2.00
1.00
0.00
-1.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
X [mm]


Top-of-Head Midline Arc, 43-48 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
X [in]
150.00
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]


Head Circumference Arc, 43-48 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

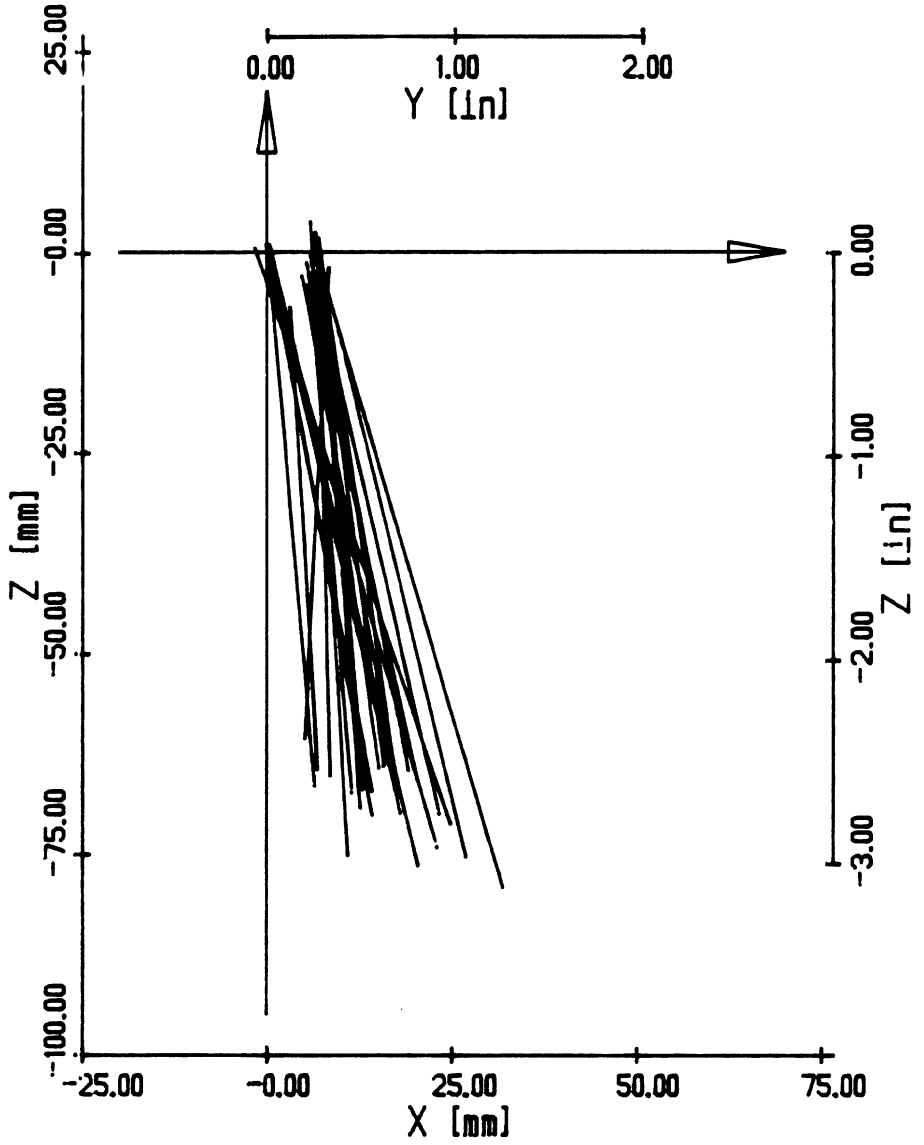

Head Circumference Arc, 43-48 Months
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
Z [mm]
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
Z [in]
3.00
2.00
1.00
0.00
-1.00
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]


Ear-to-Ear over Top-of-Head
and Under Chin Arc, 43-48 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]


Ear-to-Ear over Top-of-Head Arcs
43-48 Months
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
Z [in]
-25.00
-0.00
25.00
50.00
75.00
X [mm]

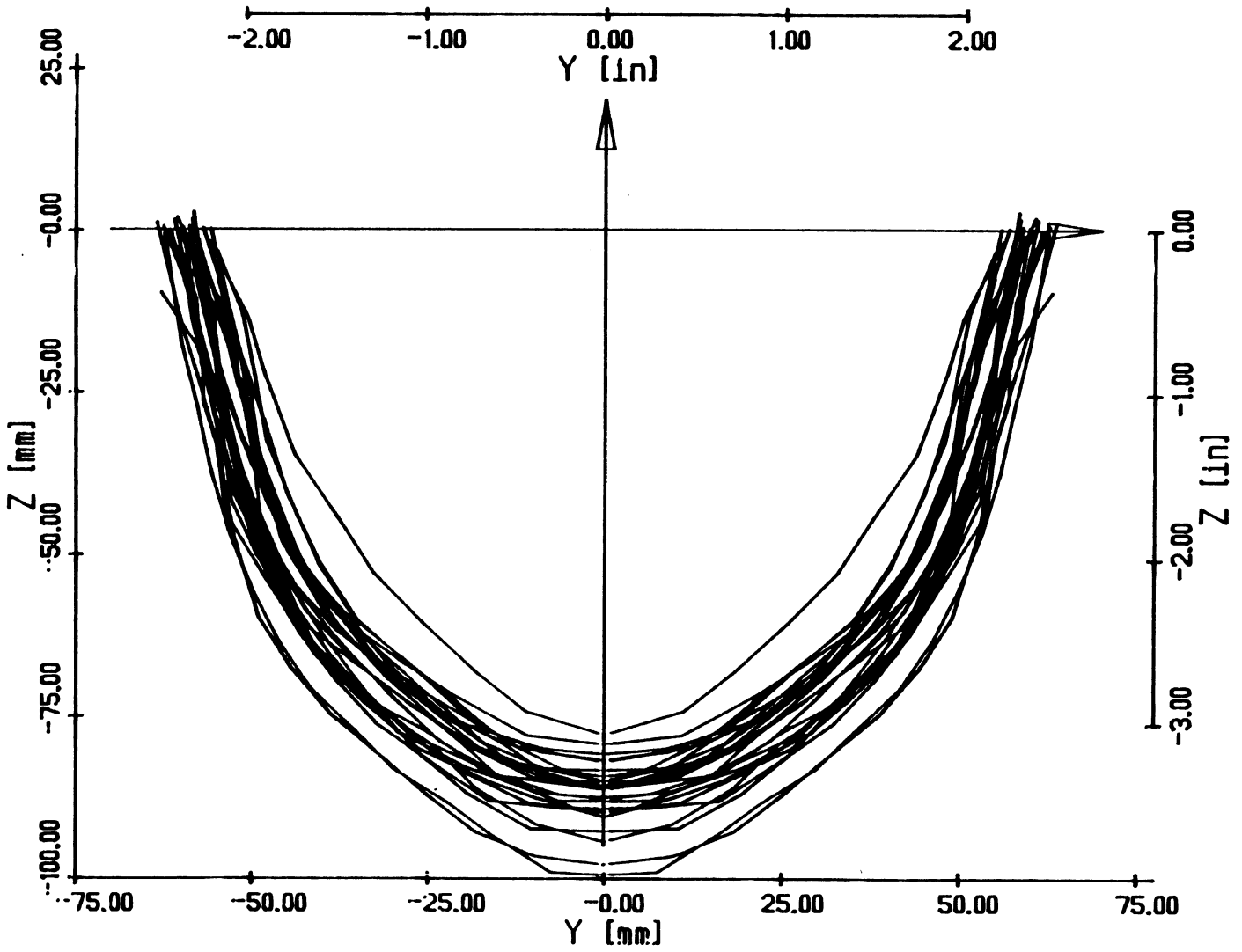
Ear-to-Ear Under Chin Arcs

43-48 Months



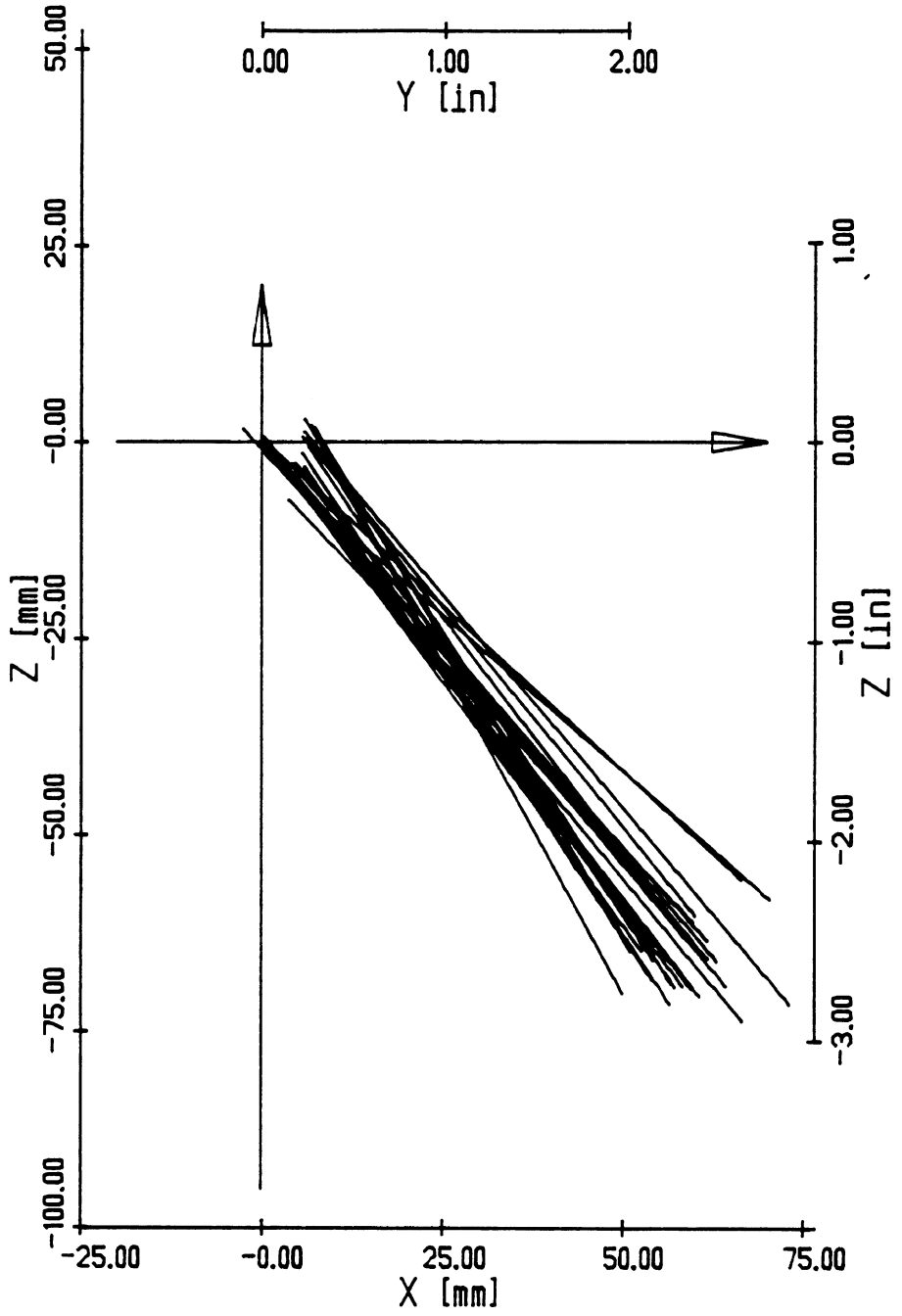
Ear-to-Ear through Tip-of-Chin Arcs

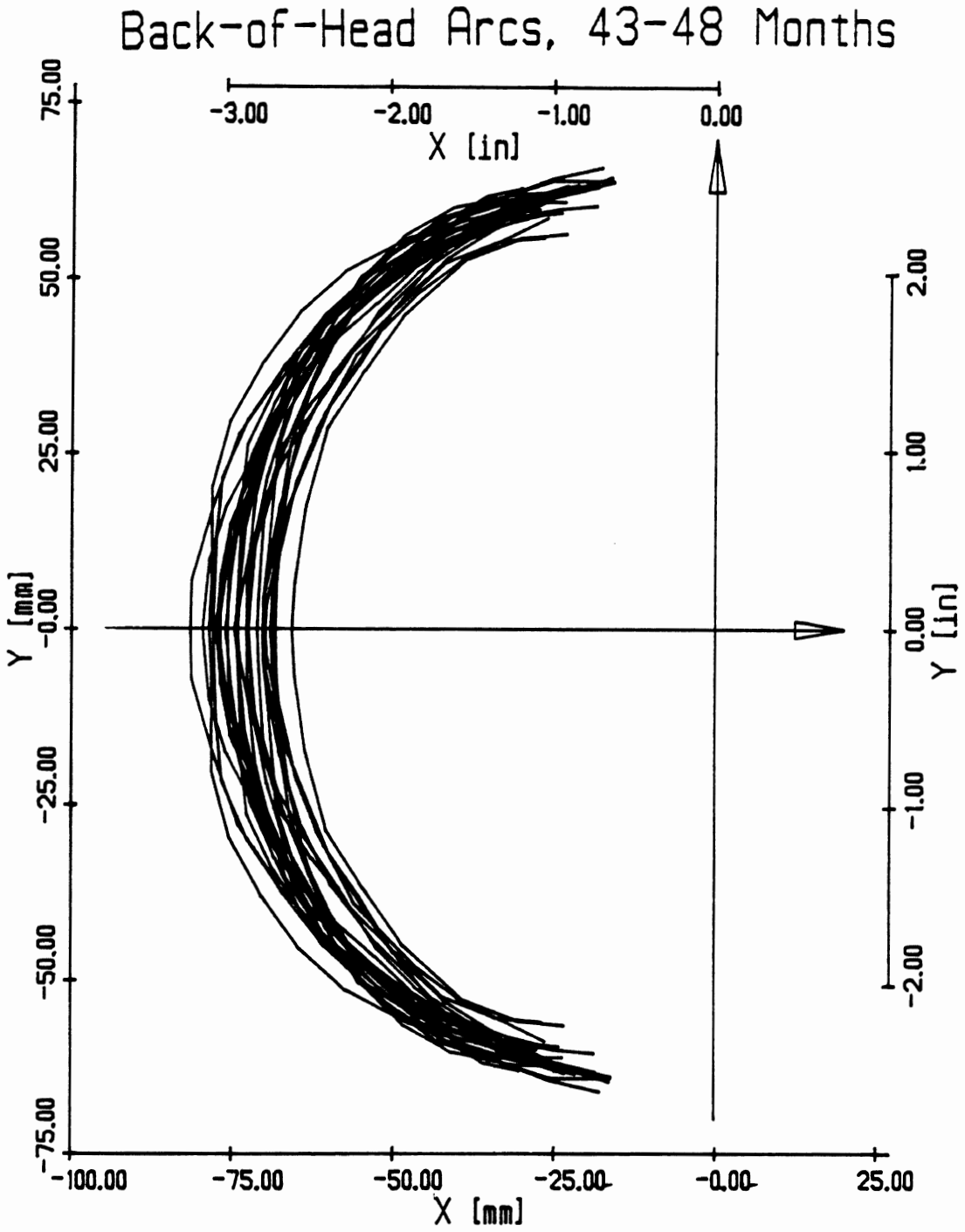
43-48 Months

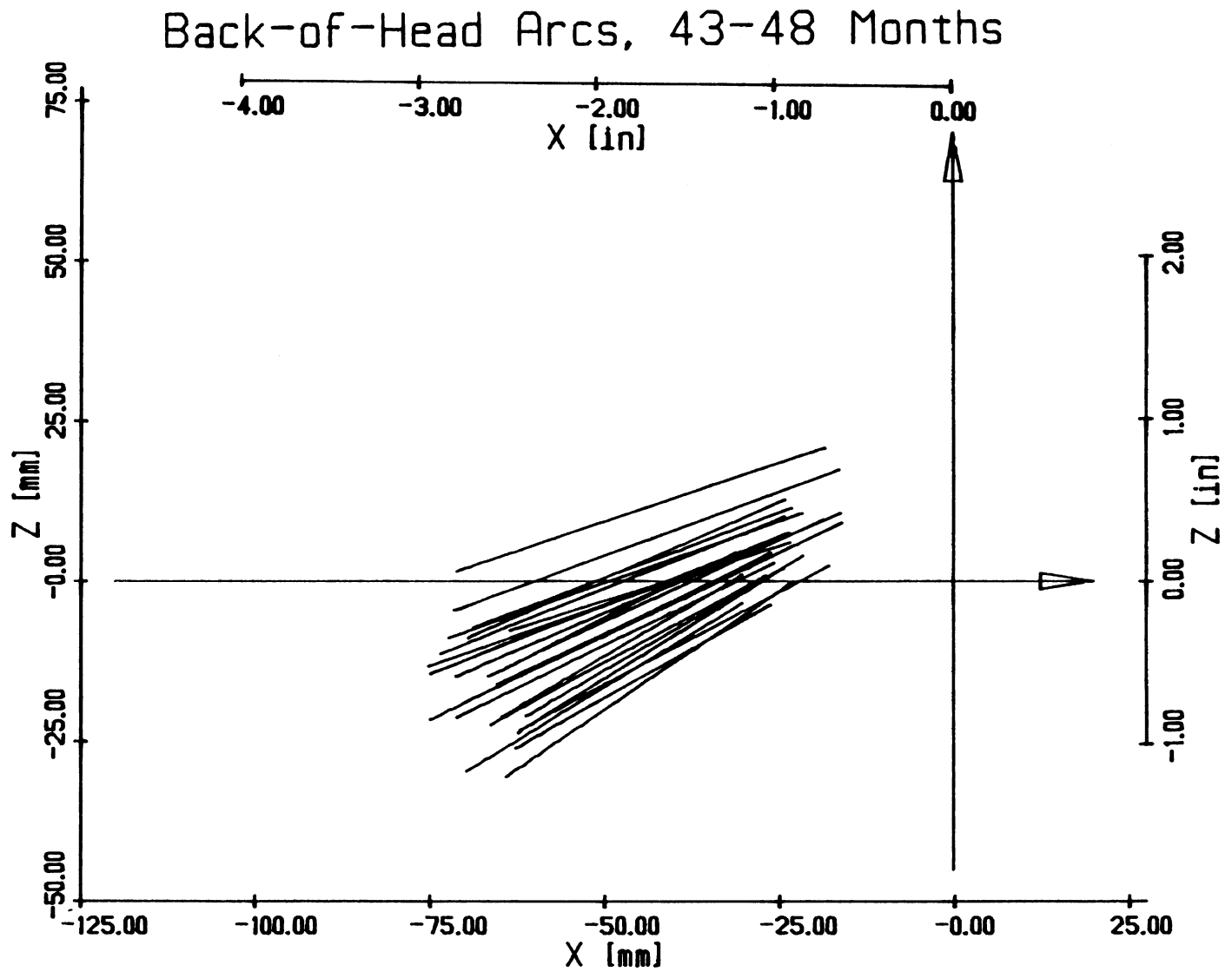


Ear-to-Ear through Tip-of-Chin Arc

43-48 Months




Back-of-Head Arcs, 43-48 Months
-3.00
-2.00
-1.00
0.00
X [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
X [mm]


Back-of-Head Arcs, 43-48 Months
-4.00
-3.00
-2.00
-1.00
0.00
X [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
Z [mm]
2.00
1.00
0.00
-1.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
X [mm]

OVERLAY PLOTS OF INDIVIDUAL HEAD CONTOURS BY SUBJECT GROUP MERGED ON A COMMON POINT IN THE CONTOUR

This section presents overlay plots of the six different head contours for all subjects in each age group after rotating each contour into the appropriate reference plane to obtain the full, undistored view, and after shifting each contour so that similar contours are merged on a common point in the contour. The intent is to better illustrate the range of sizes and shapes for each head contour than is revealed by the plots in the previous section where crossings of contour lines tend to obscure the contours for the individual subjects. Table II.7 gives the merging point for each of the six head contours. The head anatomical axes are not shown in plots of this section since the positions of the contours are no longer correct relative to this reference system. All computer plots in this section are shown actual size.

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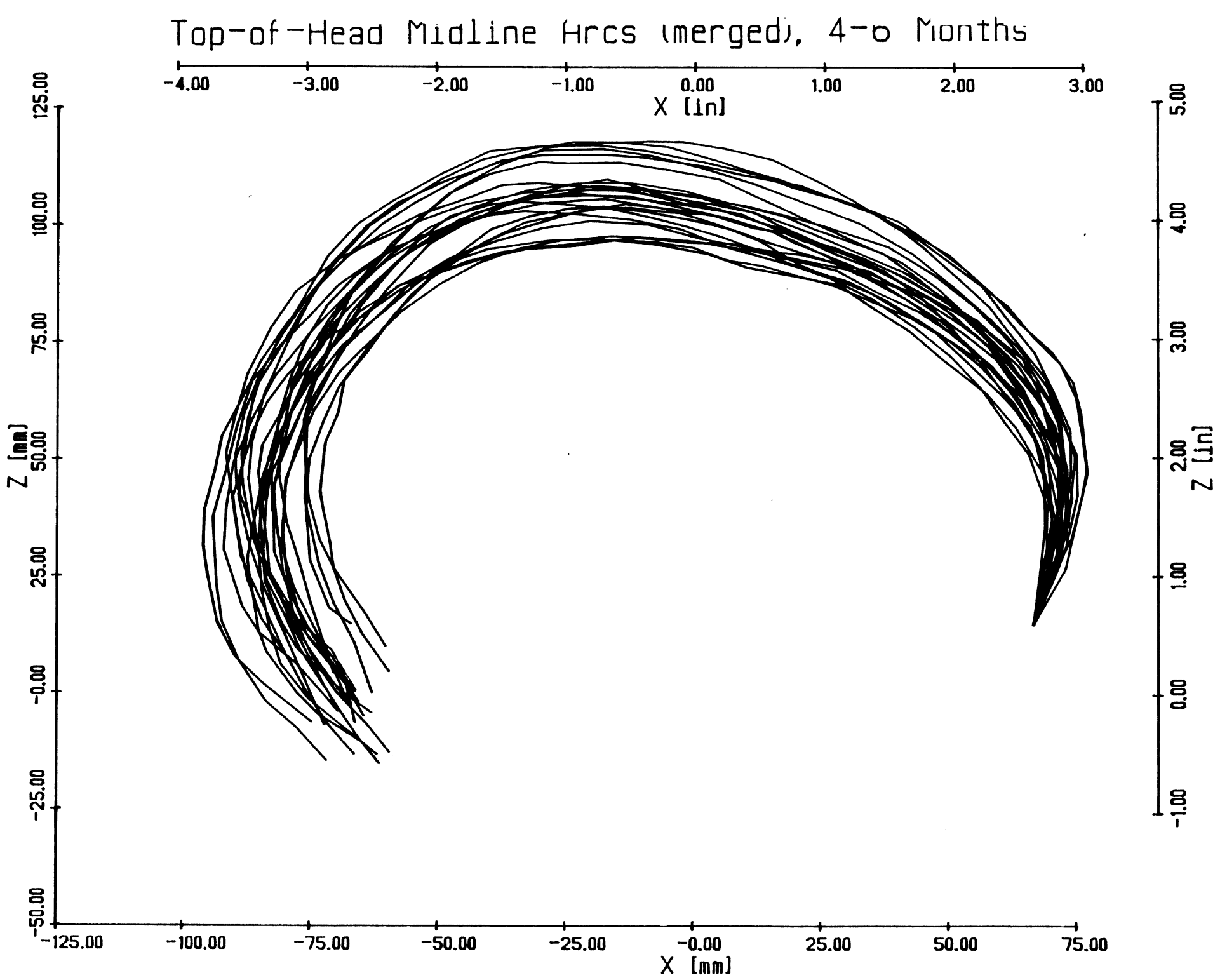
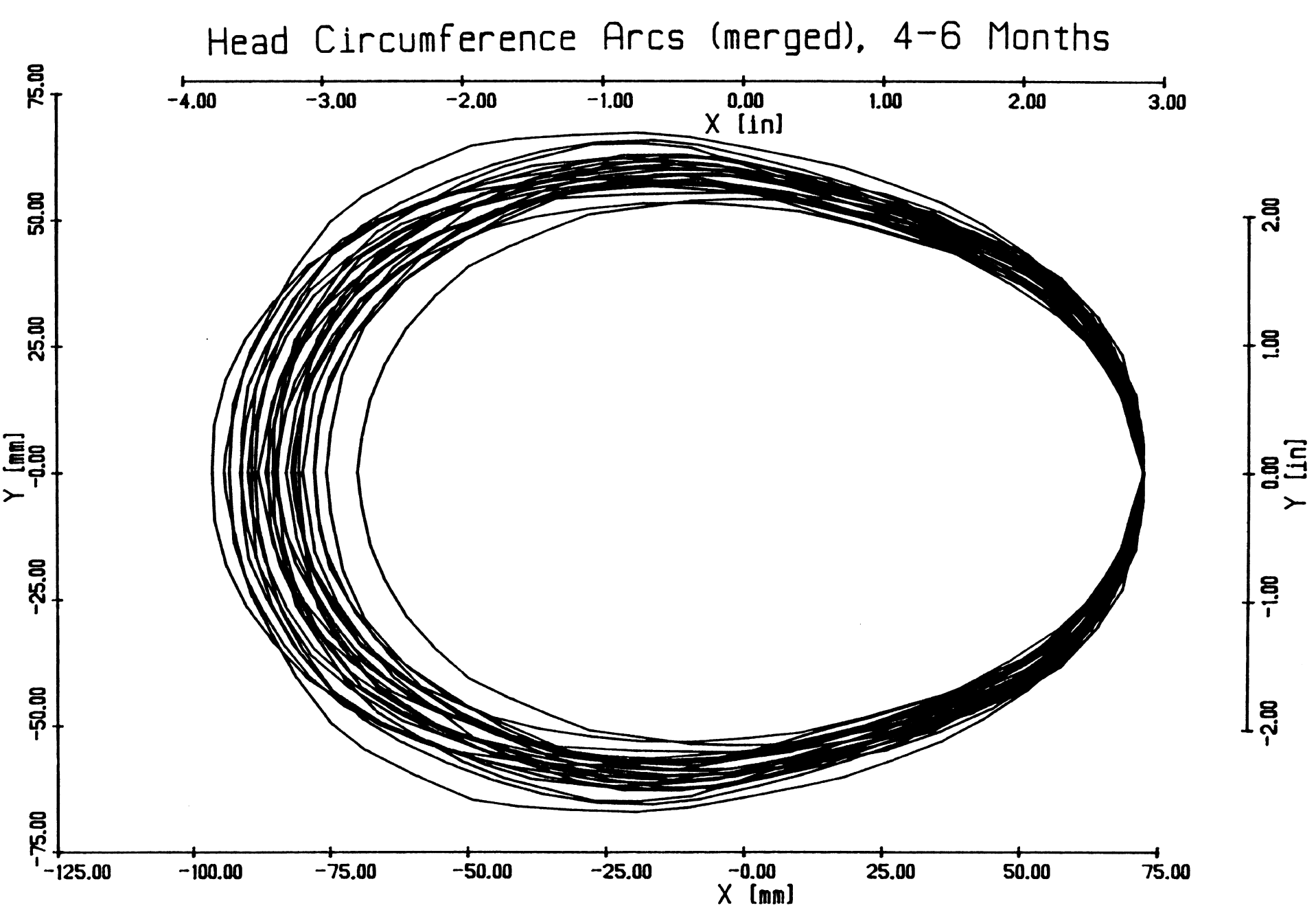
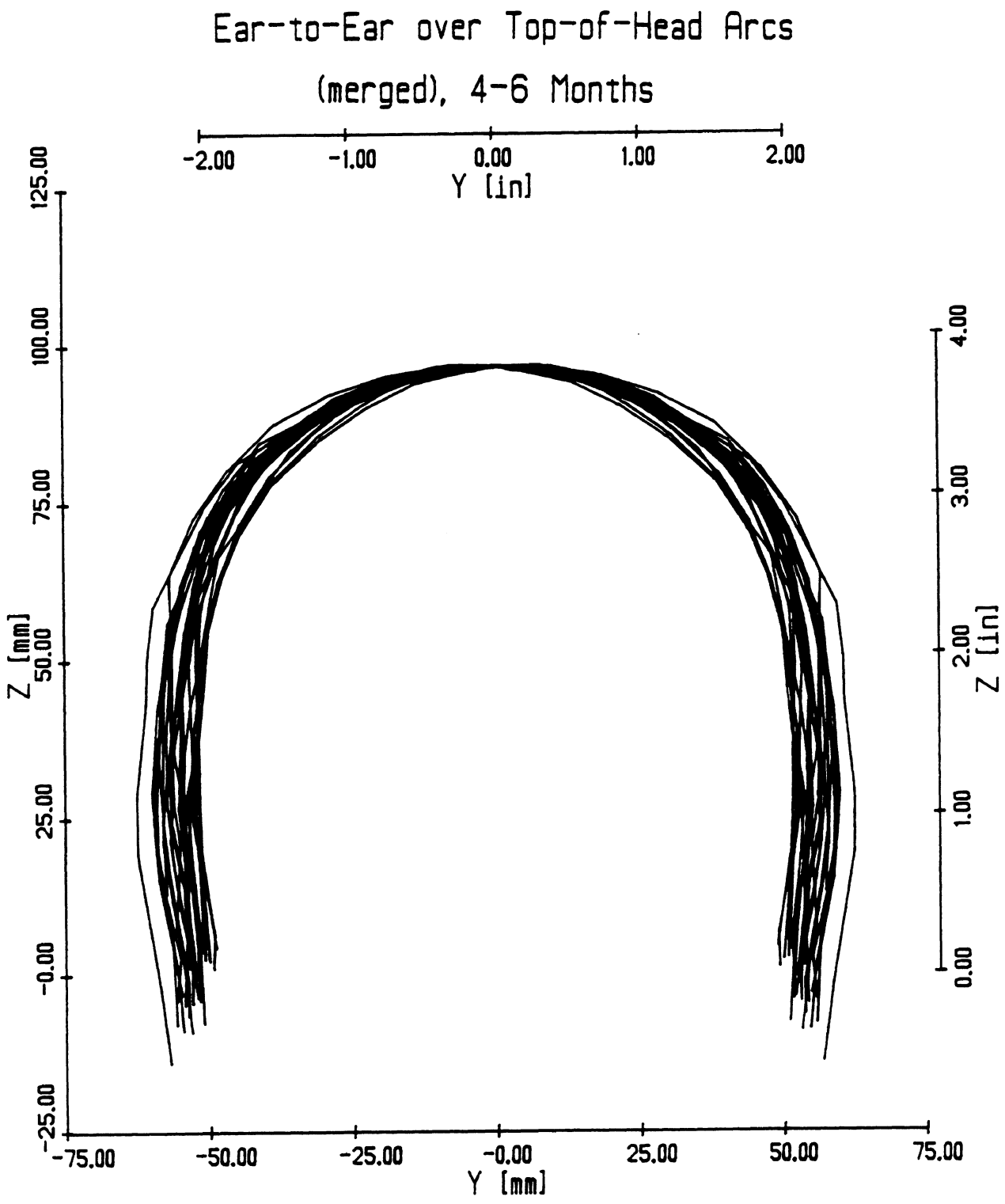
Table II.7

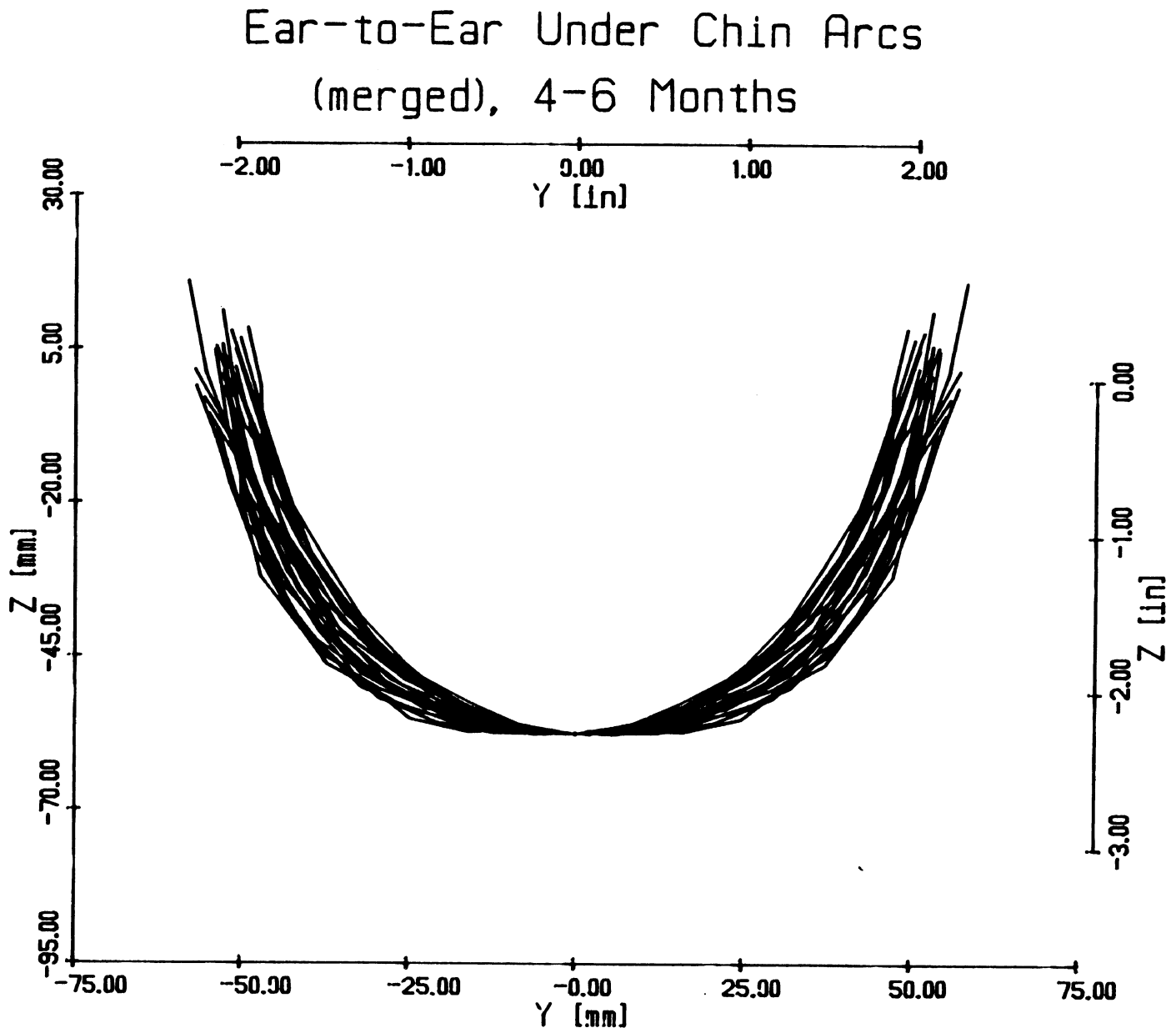
Merging Points for Composite Plots
of Individual Contours

Head Contour	Merging Point
Top of Head Midline Arc	Indentation above the nose (sellion)
Head Circumference Arc	Most forward point on forehead (glabella)
Ear-to-Ear Over Top-of-Head Arc	Top of head point
Ear-to-Ear Through Tip-of-Chin Arc	Tip of chin (menton)
Ear-to-Ear Under Chin Arc	Under chin point
Back-of-Head Arc	Back of head point (head/neck junction)

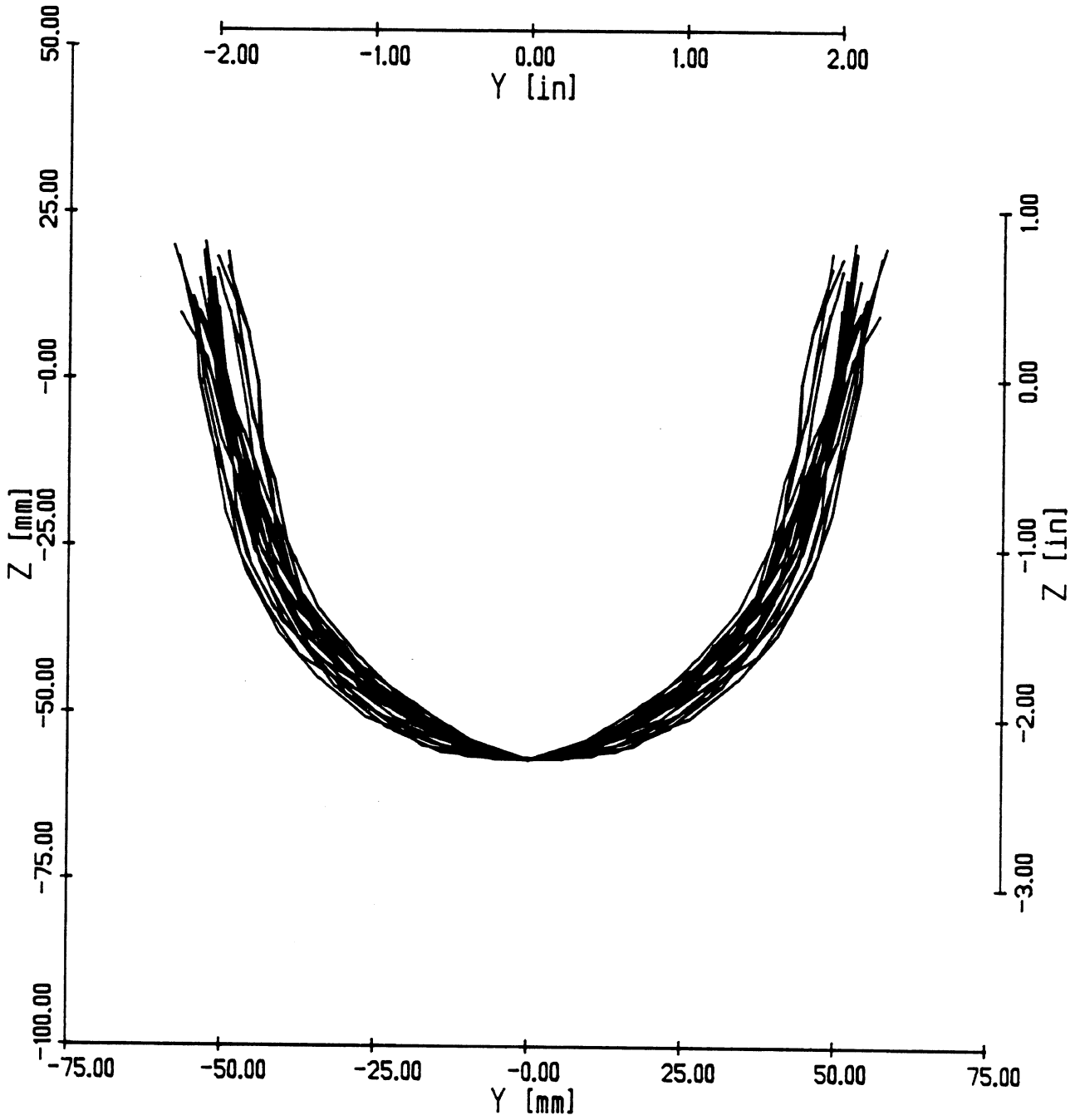

Top-of-Head Midline Hrcs (merged), 4-6 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
X [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
-50.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
X [mm]


Head Circumference Arcs (merged), 4-6 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
X [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
X [mm]

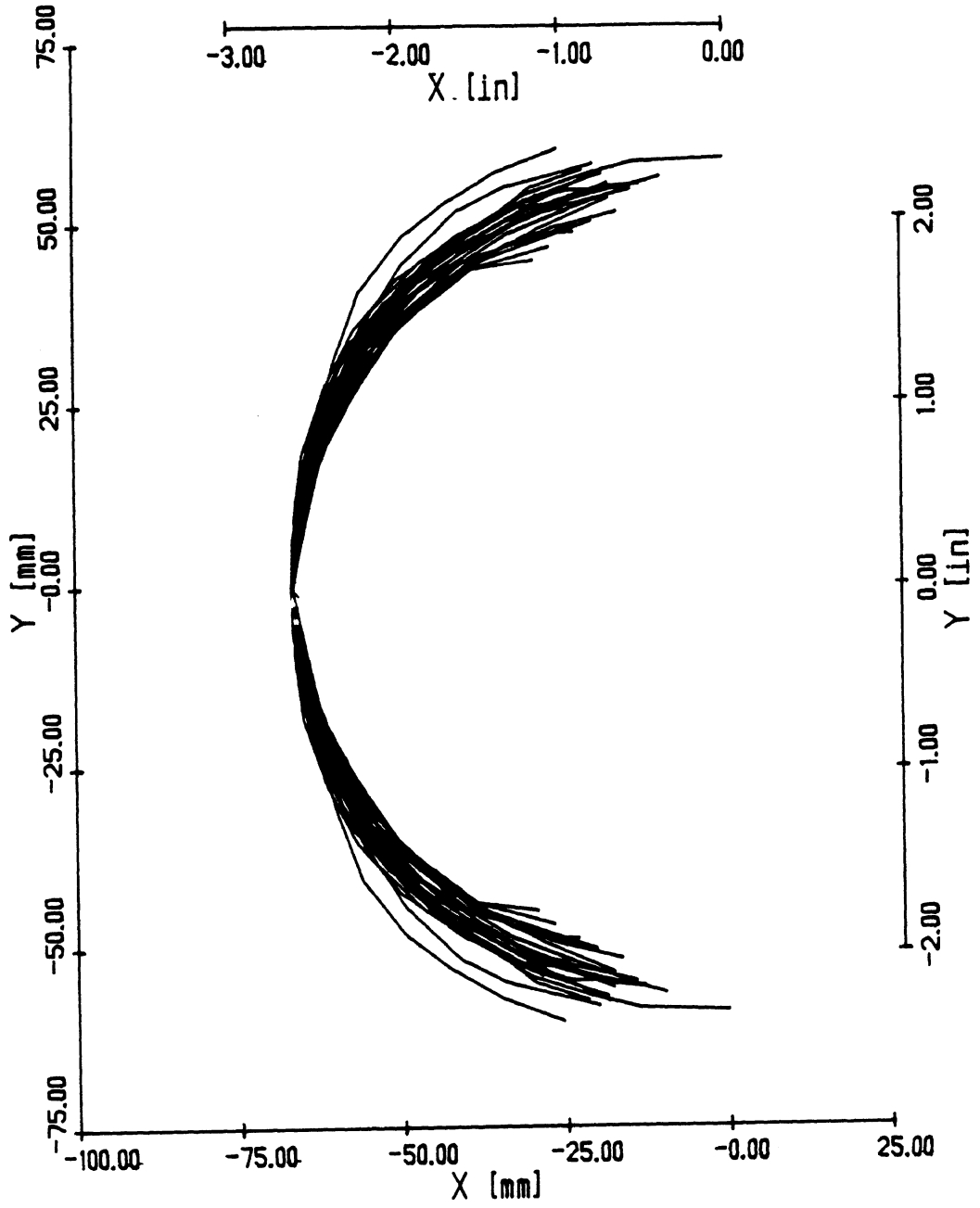

Ear-to-Ear over Top-of-Head Arcs
(merged), 4-6 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

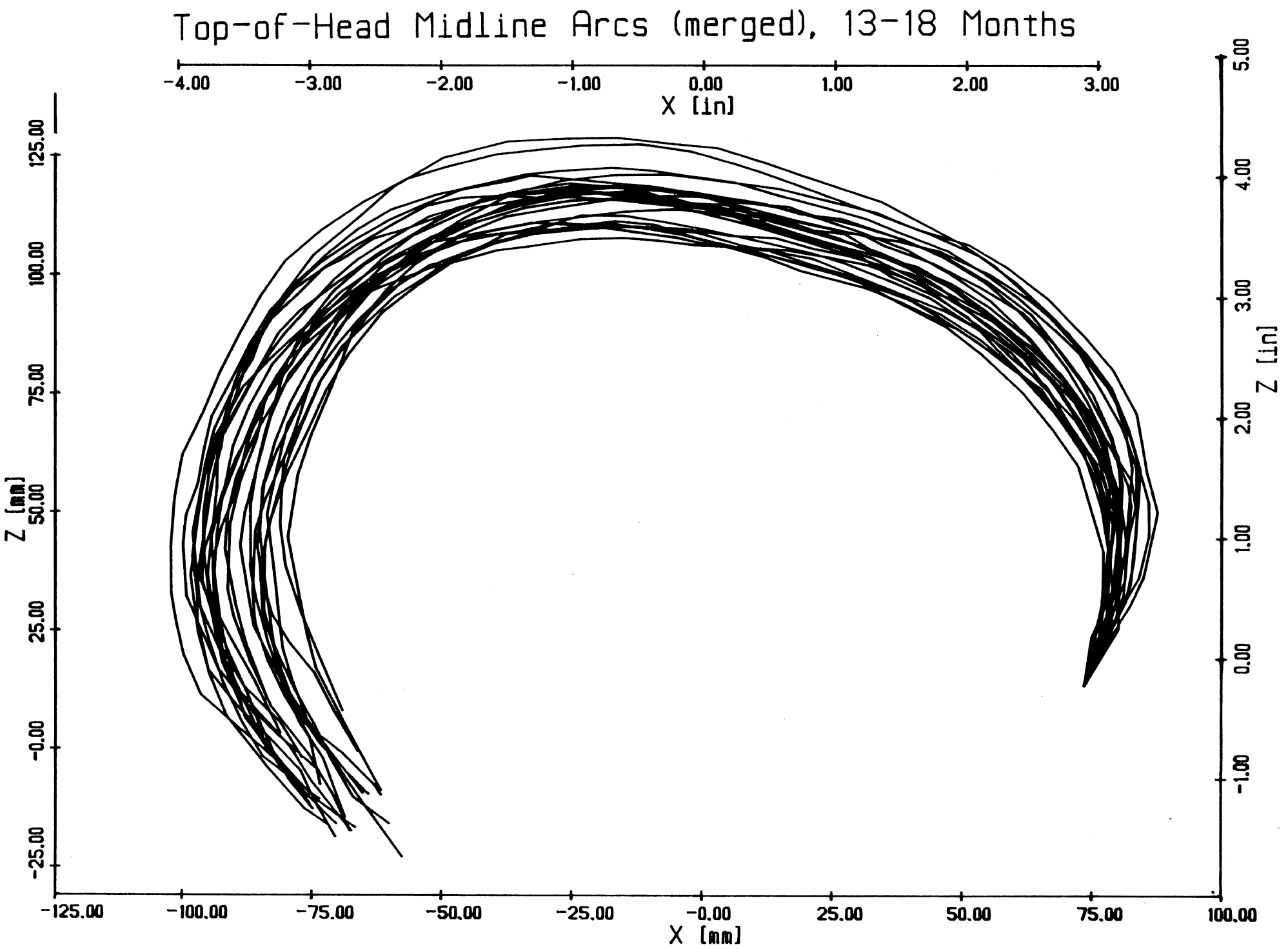

Ear-to-Ear Under Chin Arcs
(merged), 4-6 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
30.00
5.00
-20.00
-45.00
-70.00
-95.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

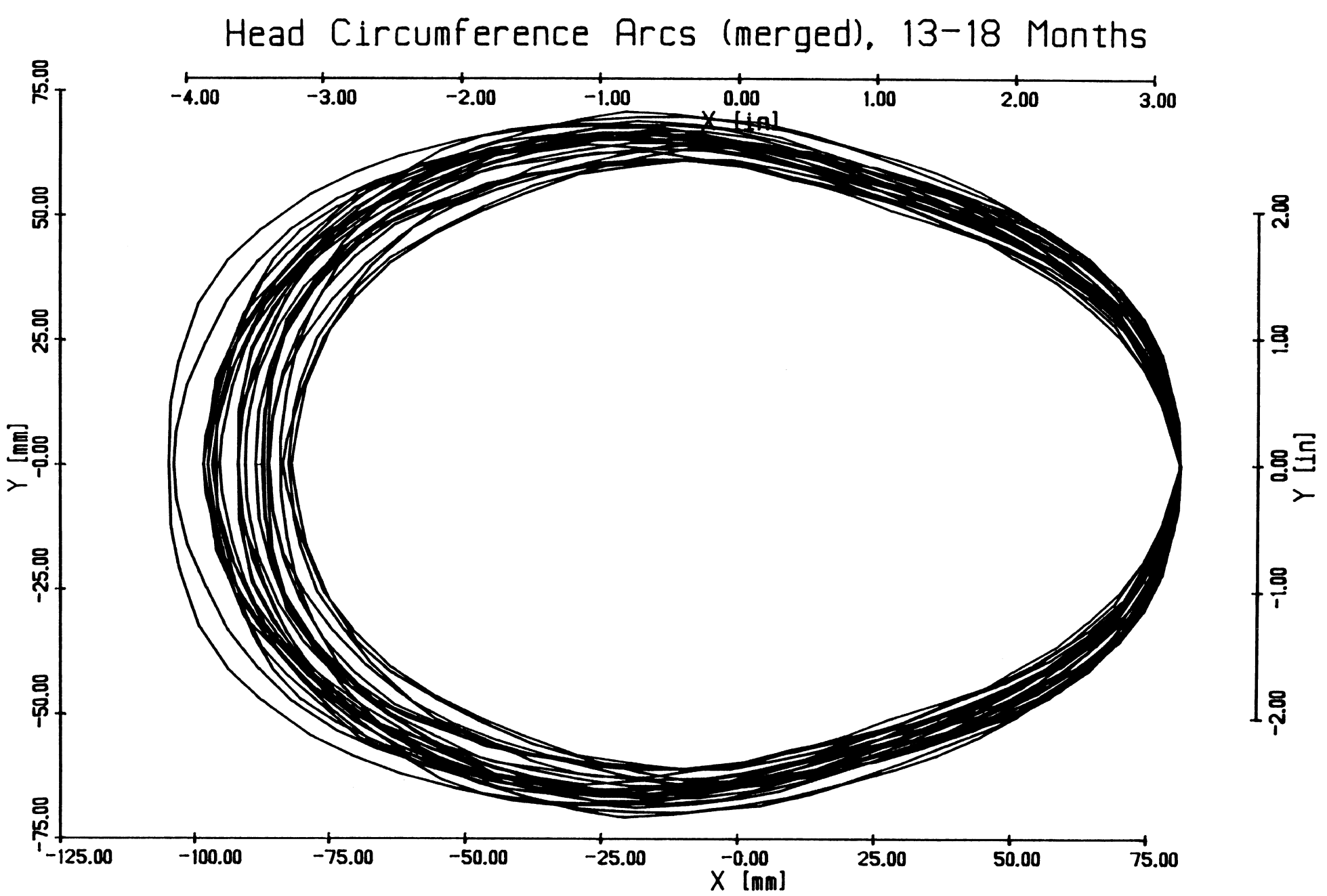
Ear-to-Ear through Tip-of-Chin Arcs (merged), 4-6 Months

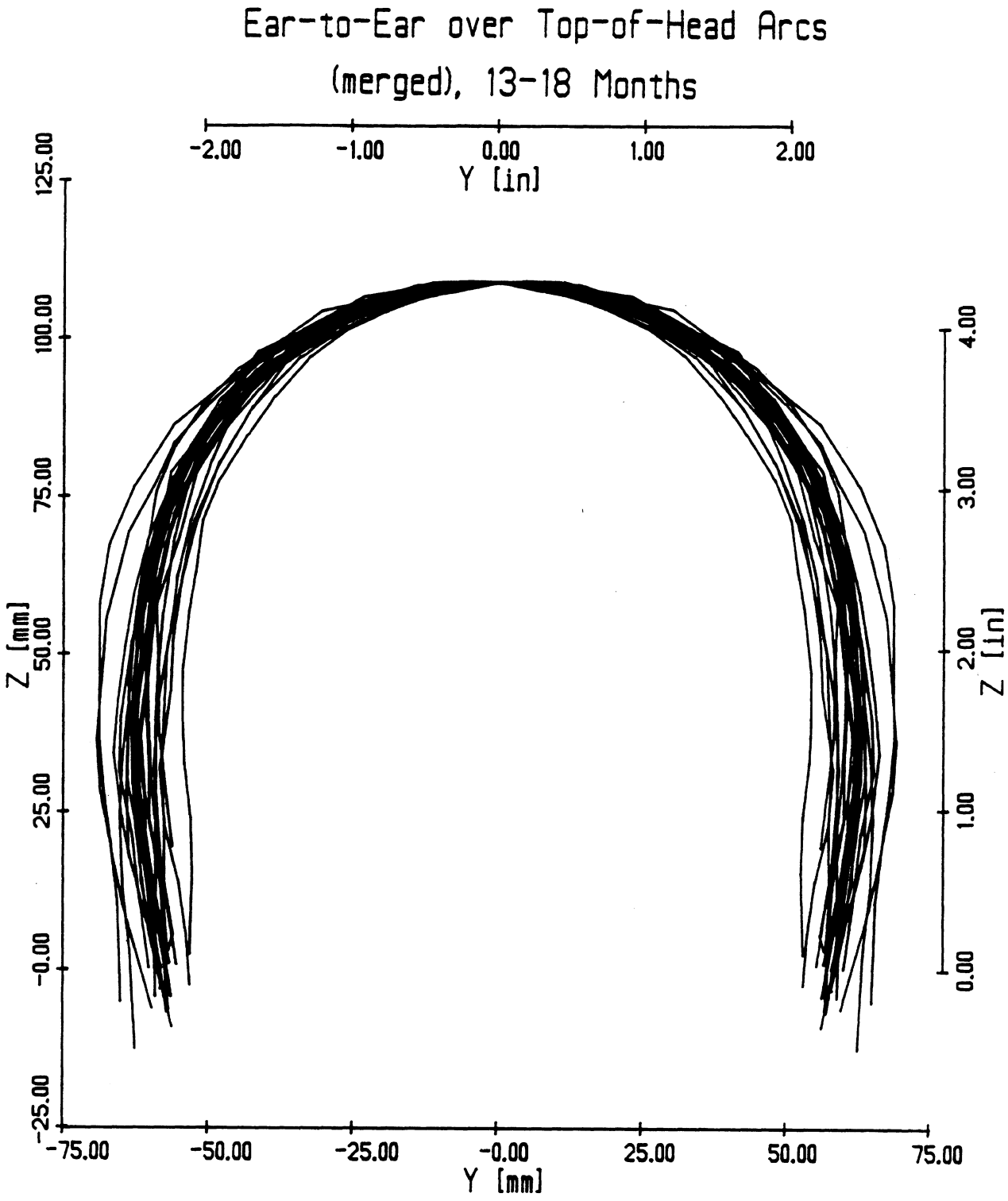


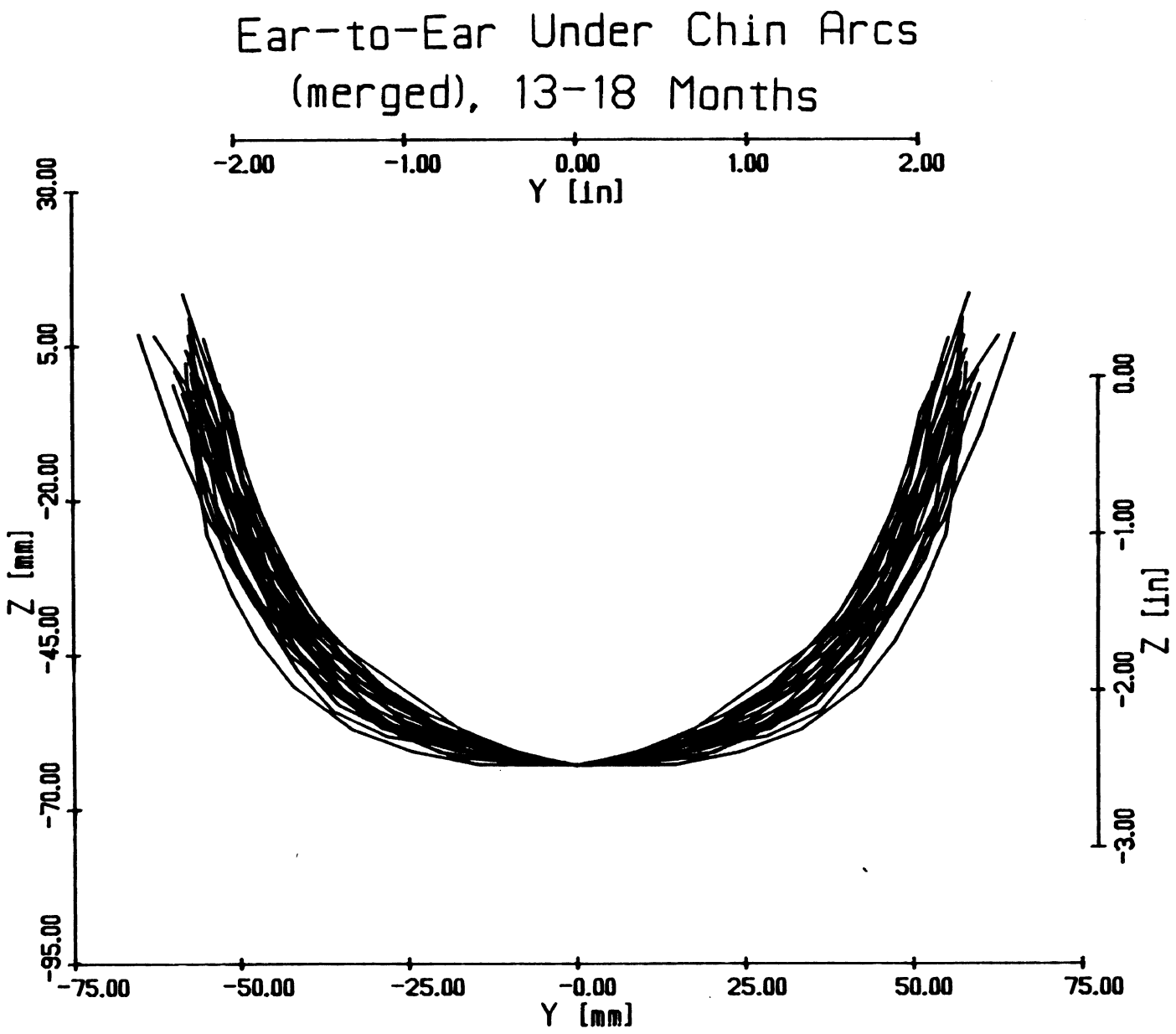
Back-of-Head Arcs (merged), 4-6 Months



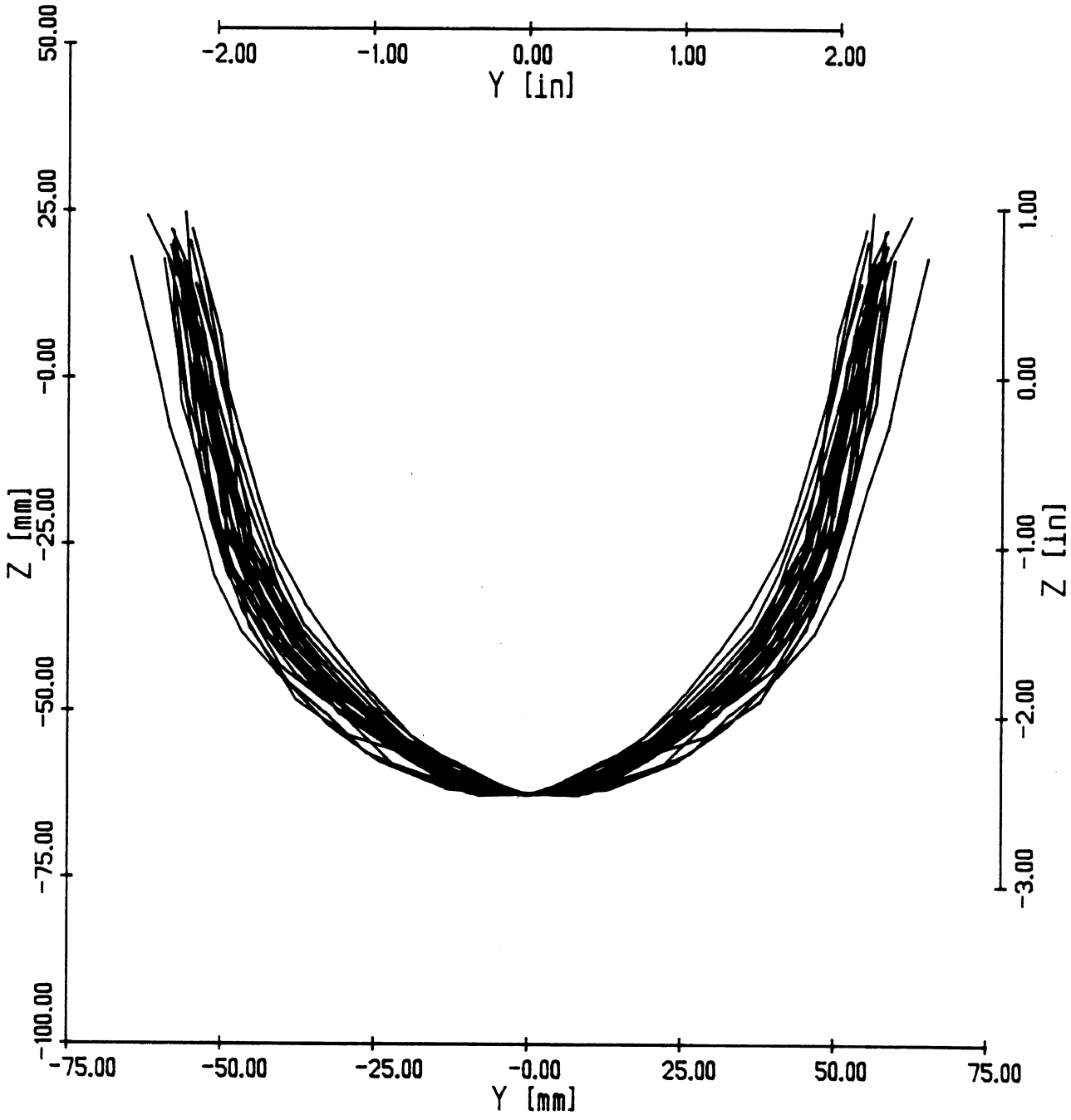

Top-of-Head Midline Arcs (merged), 13-18 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
X [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]


Head Circumference Arcs (merged), 13-18 Months
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
Y [mm]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
X [mm]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [in]
2.00
1.00
0.00
-1.00
-2.00

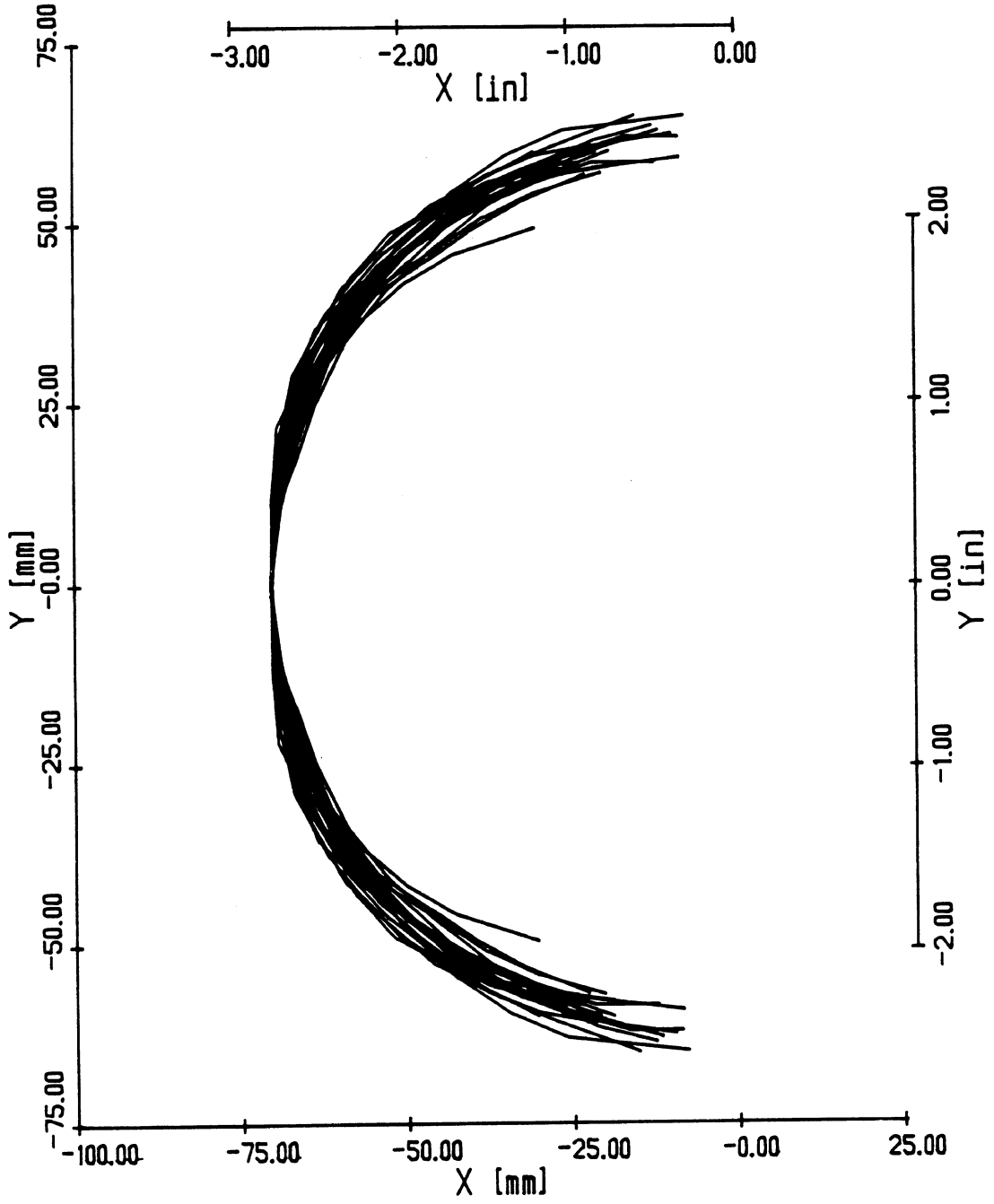

Ear-to-Ear over Top-of-Head Arcs
(merged), 13-18 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]


Ear-to-Ear Under Chin Arcs
(merged), 13-18 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
30.00
5.00
-20.00
-45.00
-70.00
-95.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

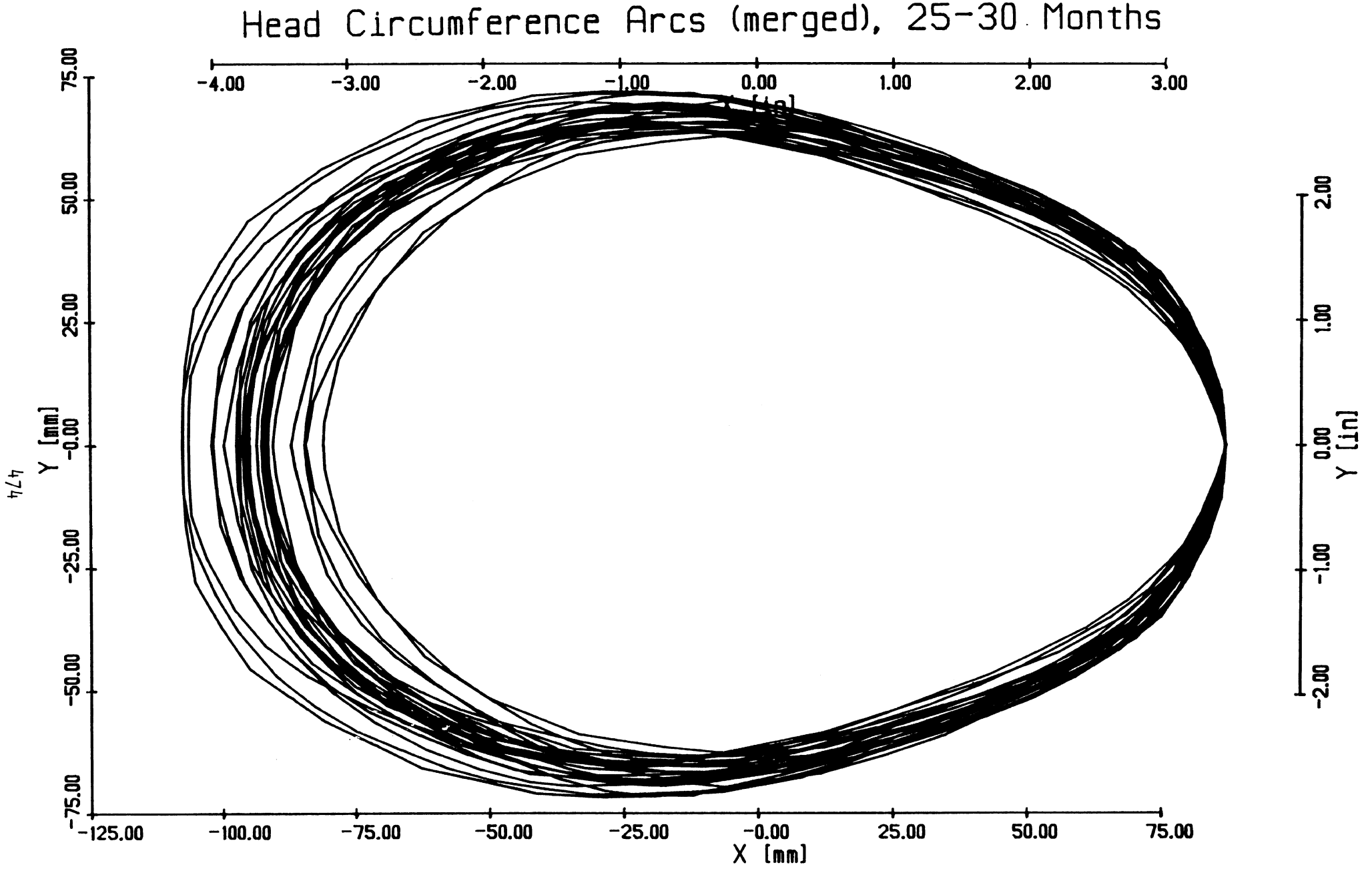
Ear-to-Ear through Tip-of-Chin Arcs (merged), 13-18 Months

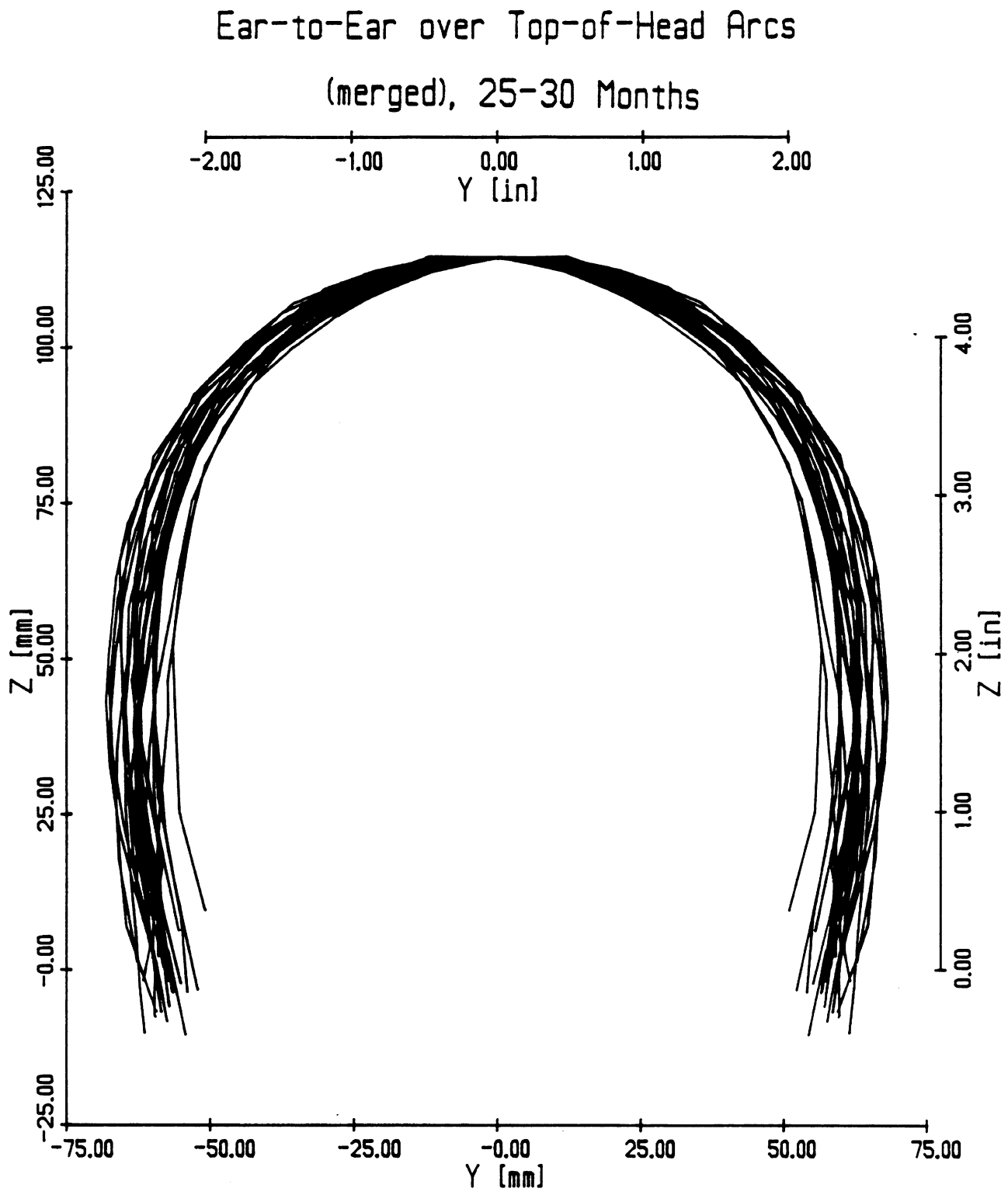


Back-of-Head Arcs (merged), 13-18 Months

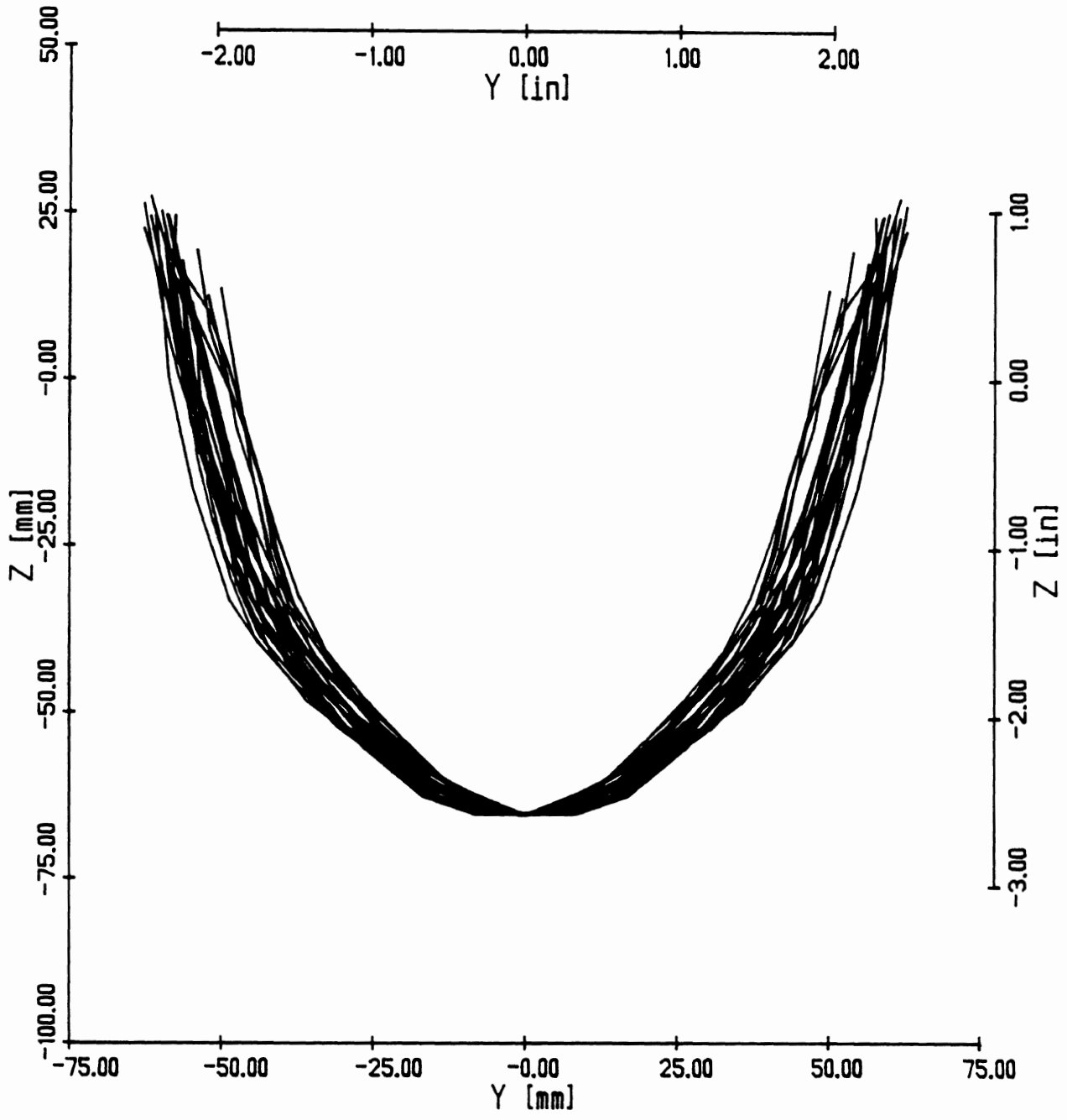


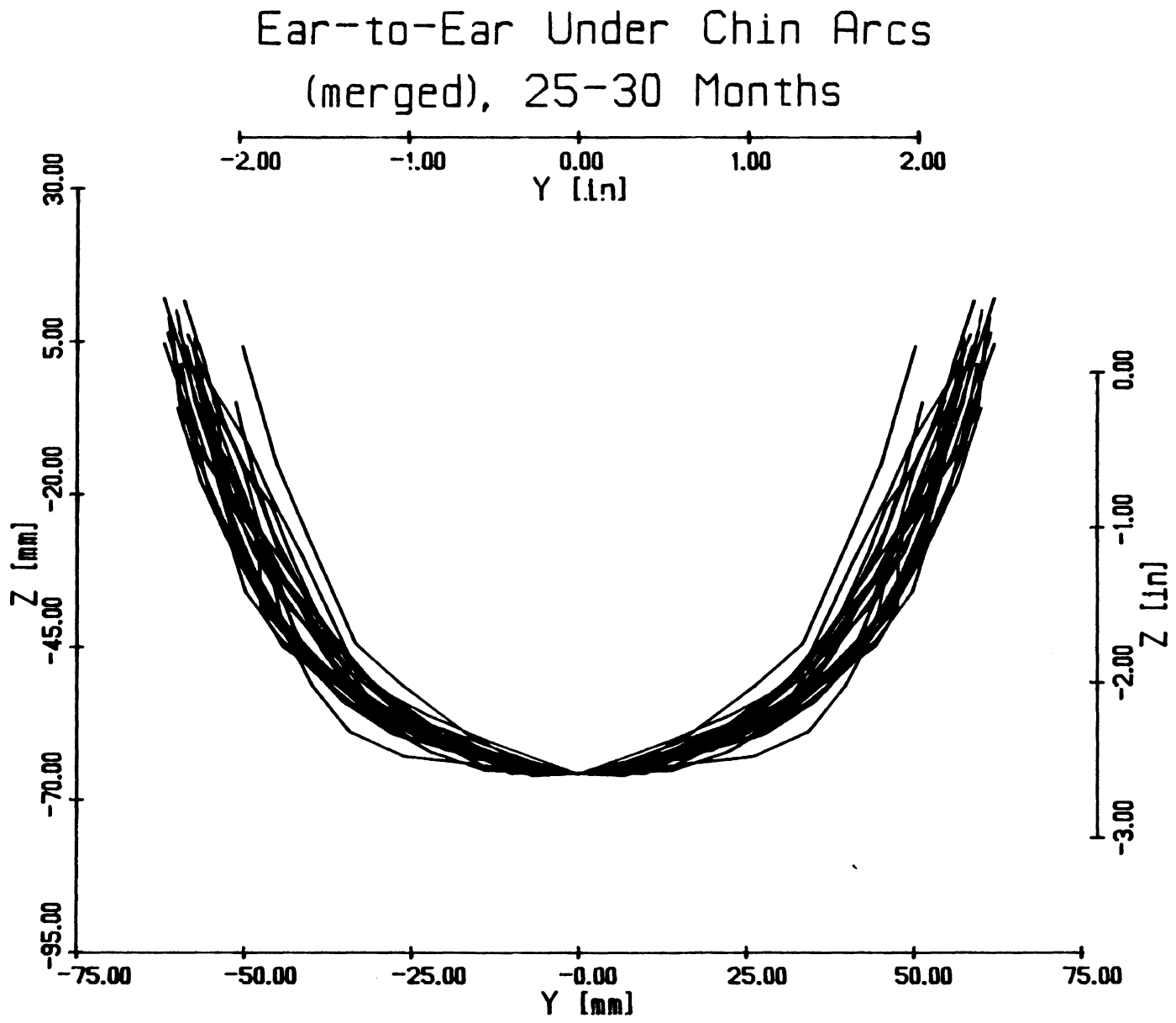
Top of Meau Mitral Ring submerged, 25 30 iterations
Z [mm]
-25.00
-0.00
25.00
50.00
75.00
100.00
125.00
X [in]
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
Z [in]
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
X [mm]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00

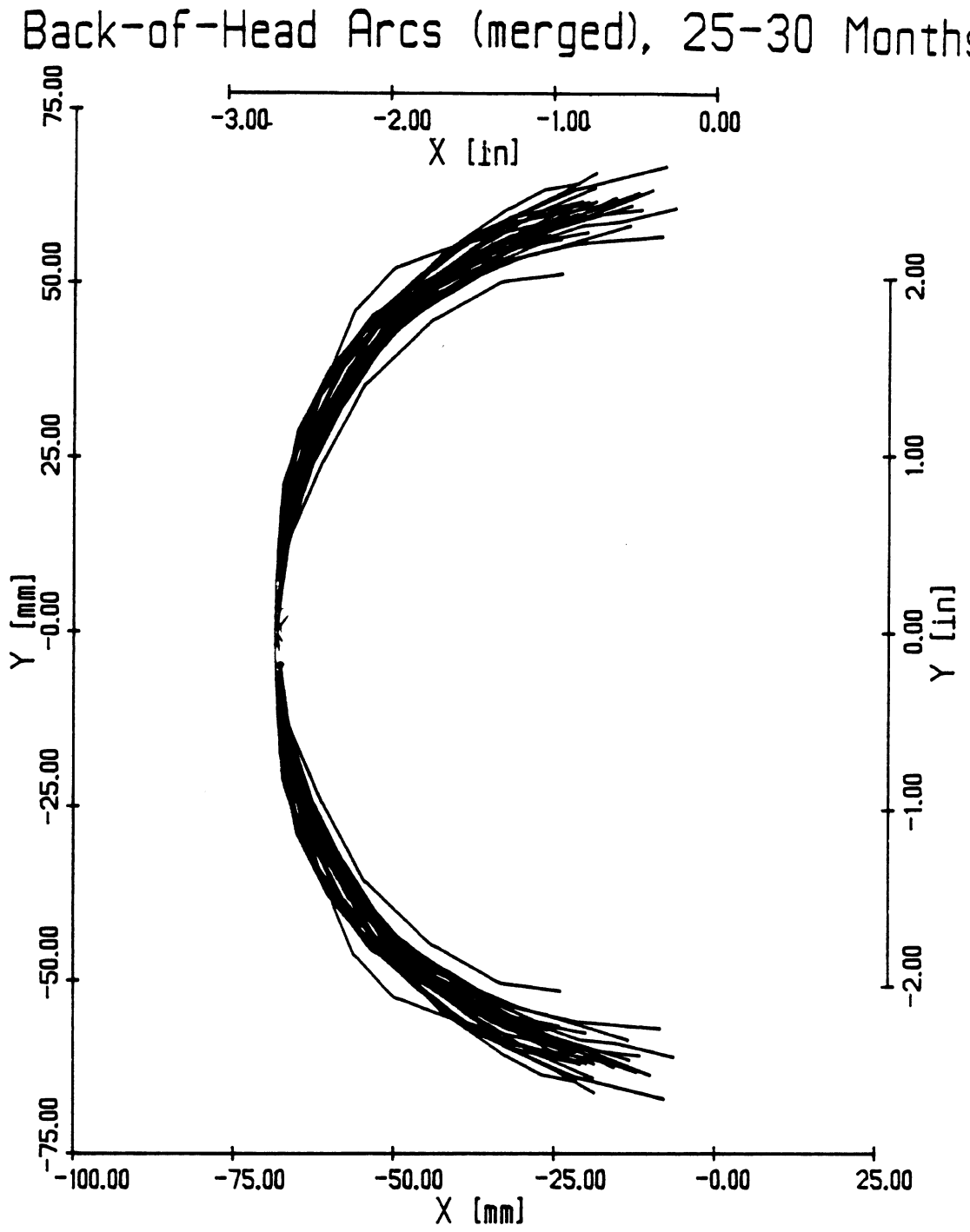

Head Circumference Arcs (merged), 25-30 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
[in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
X [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]

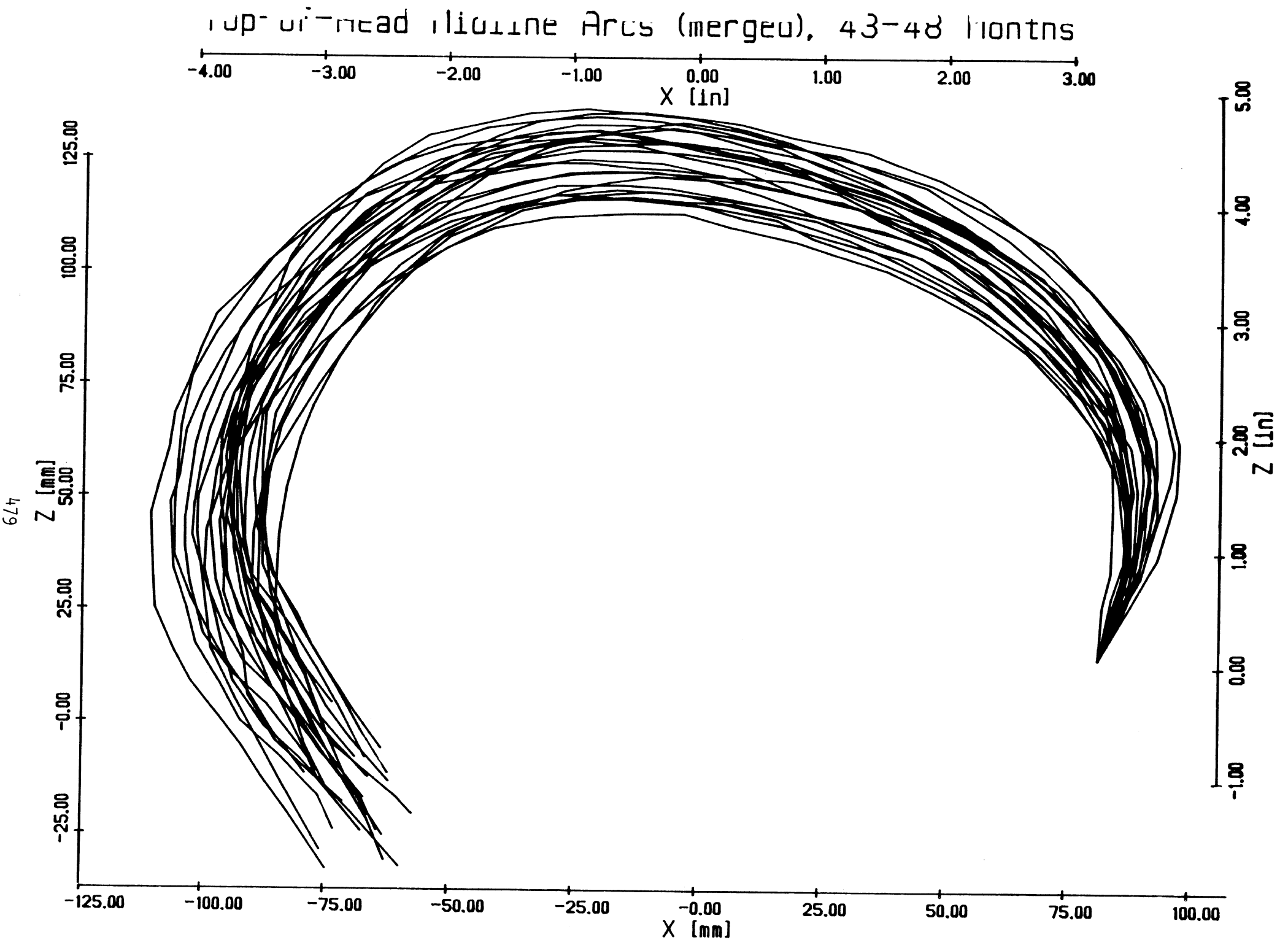

Ear-to-Ear over Top-of-Head Arcs
(merged), 25-30 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

Ear-to-Ear through Tip-of-Chin Arcs (merged), 25-30 Months

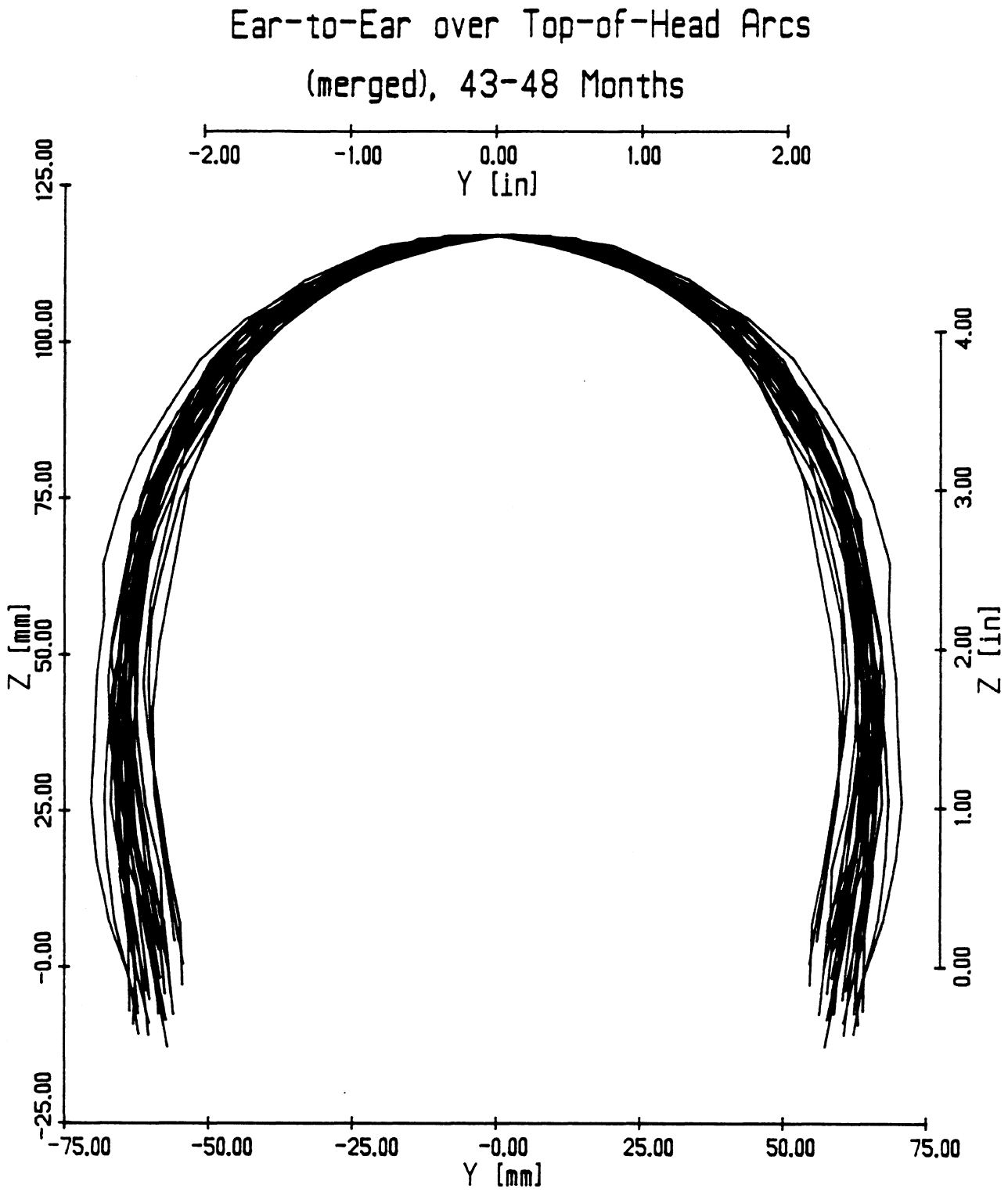


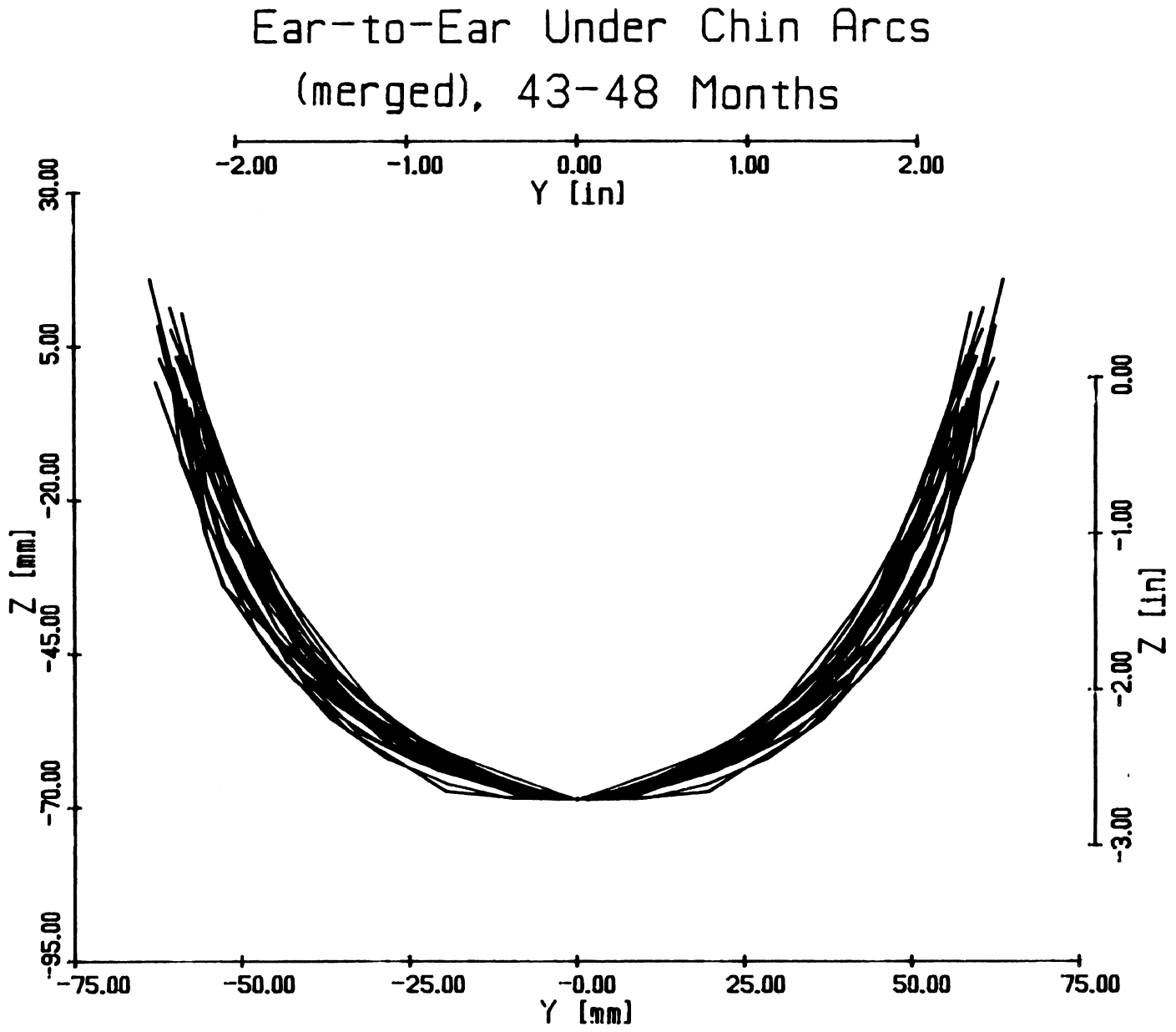

Ear-to-Ear Under Chin Arcs
(merged), 25-30 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
30.00
5.00
-20.00
-45.00
-70.00
-95.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]


Back-of-Head Arcs (merged), 25-30 Months
-3.00
-2.00
-1.00
0.00
X [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
Y [mm]
2.00
1.00
0.00
-1.00
-2.00
Y [in]
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
X [mm]

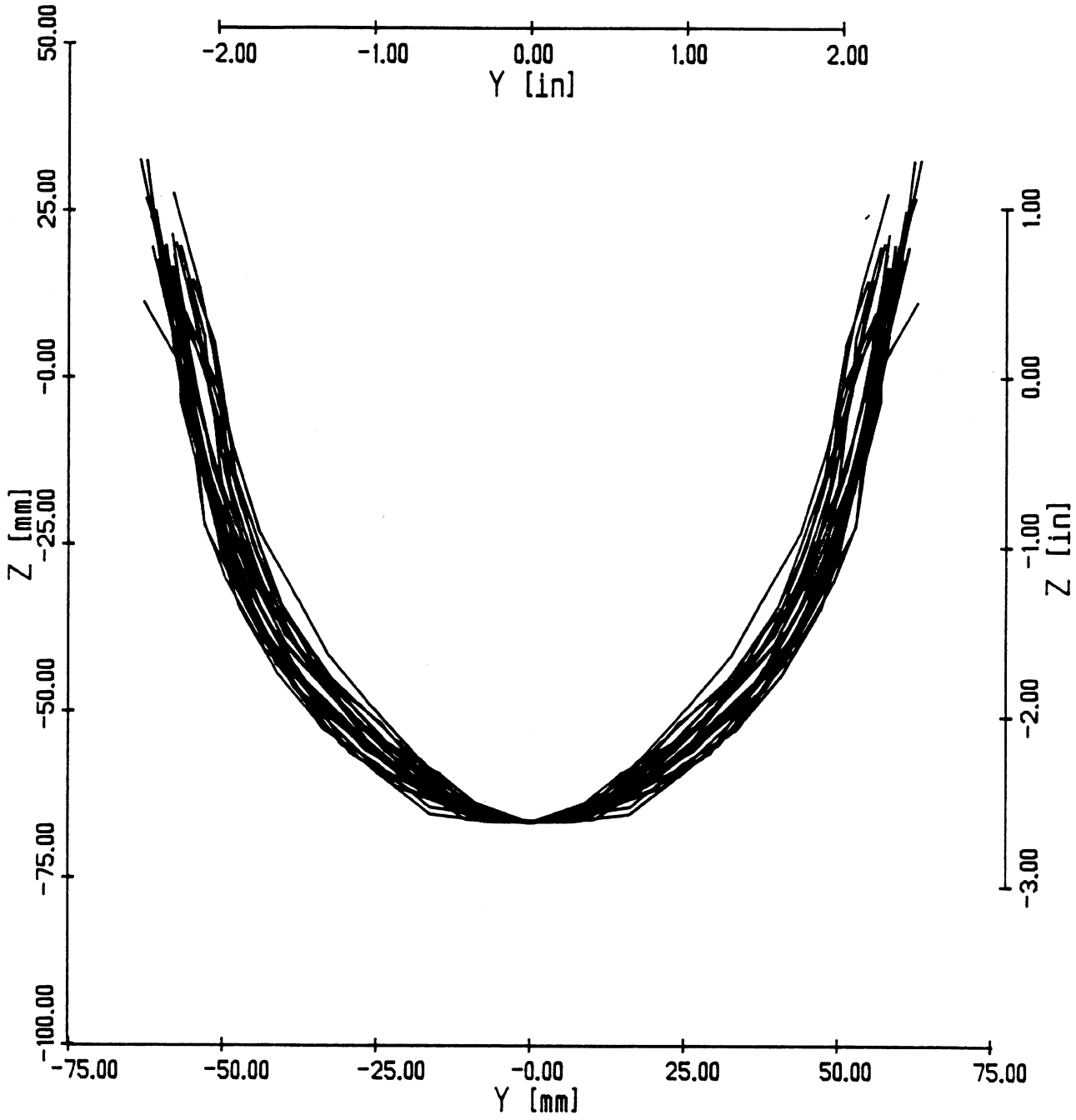

Top of Head Midline Arcs (merged), 43-48 Months
-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00
X [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
Z [in]
-125.00
-100.00
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
100.00
X [mm]

Head Circumference Arcs (merged), 43-48 Months
Y [mm]
X [mm]
Y [in]
75.00
50.00
25.00
-0.00
-25.00
-50.00
-75.00
-100.00
-125.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
2.00
1.00
0.00
-1.00
-2.00

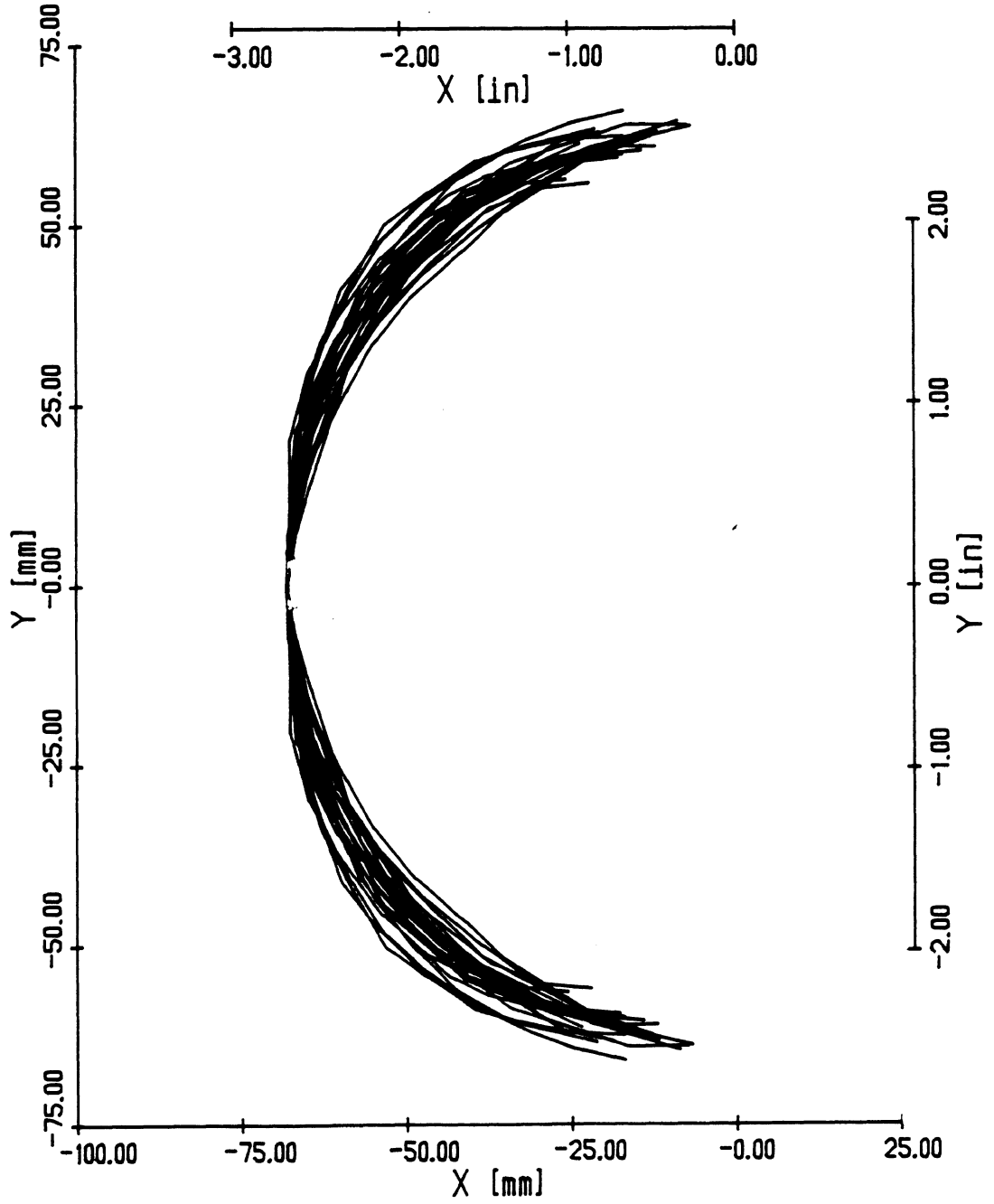

Ear-to-Ear over Top-of-Head Arcs
(merged), 43-48 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
125.00
100.00
75.00
50.00
25.00
-0.00
-25.00
Z [mm]
4.00
3.00
2.00
1.00
0.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]


Ear-to-Ear Under Chin Arcs
(merged), 43-48 Months
-2.00
-1.00
0.00
1.00
2.00
Y [in]
30.00
5.00
-20.00
-45.00
-70.00
-95.00
Z [mm]
0.00
-1.00
-2.00
-3.00
Z [in]
-75.00
-50.00
-25.00
-0.00
25.00
50.00
75.00
Y [mm]

Ear-to-Ear through Tip-of-Chin Arcs (merged), 43-48 Months



Back-of-Head Arcs (merged), 43-48 Months



II.D. COMPARISONS OF MANUAL AND STEREOPHOTOGRAMMETRY RESULTS

It is possible to calculate the distances between two landmark points on the head by taking the square root of the sum of the squared differences between the corresponding coordinate values as shown below:

$$\text{Distance} = \sqrt{(X_1 - X_2)^2 + (Y_1 - Y_2)^2 + (Z_1 - Z_2)^2}$$

Since these landmarks represent the end points for many of the manual measurements, the calculation of vector distances between selected head landmarks should give results that correspond to the dimensions measured with anthropometers and calipers. Similarly, it is possible to sum the distances between target points on the head contours to obtain arc length measures that can be compared with the arc length and circumference measurements taken manually.

Tables II.8 through II.11 compare the average or mean values of selected manual measurements for the twenty five subjects used for stereophotogrammetry in each of the four groups, with the mean values of distances calculated from the stereophotogrammetry data. It will be noted that the sample sizes for neck depth and neck breadth calculated from stereophotogrammetry results for the younger age groups are small, but otherwise the sample sizes for manual and stereophotogrammetry are equal or differ by only one.

In general, there is excellent agreement between the manual and stereophotogrammetry results. Where consistent differences exist (e.g., neck depth and neck breadth) the stereophotogrammetry data generally give larger distances due to compression of soft tissue in the manual measurements. One of the largest differences is for "Head Breadth at Ear Openings" for which the stereophotogrammetry data give distances that are about an inch larger in the mean for all groups. This is due to the fact that the manual measurement was obtained by applying a significant amount of pressure with the tips of the spreading calipers to the soft tissue just forward of the ear openings. In contrast, the targets for stereophotogrammetry rested on the undepressed skin.

The relatively large differences for Head Height are most likely due to the inability to accurately determine vertex (top of head) in the manual measurement. In the stereophotogrammetry data, vertex was accurately defined as the point in the Top-of-Head Midline Arc with the largest Z-coordinate value when the data were expressed in head anatomical reference system coordinates. This point generally lies behind the ears and it is believed that a point futher forward, and therefore lower, was generally used in the manual measurement. It is also possible that compression of the tissue under the chin in the manual measurement could account for some of the differences but this should also cause differences in Lower Face Height values which are not consistently observed.

As indicated in the tables, there was excellent agreement in arc lengths and circumferences determined by manual and stereophotogrammetry procedures. The largest differences are for Ear-to-Ear Under Chin Arc where tissue compression in the manual measurement is probably the primary cause.

Table 11.8

Comparison of Measurement Values in mm
from Manual and Photogrammetry Procedures
(4 - 6 MONTHS)

Measurement	Photo N	Photo Mean	Manual N	Manual Mean	Difference in Means
4. Maximum Head Breadth	25	116.8	25	117.0	-0.2
5. Head Circumference	25	439.8	25	436.2	3.6
6. Head Brdth at Circ.	25	118.4	25	115.7	-2.7
7. Head Length	25	156.4	25	154.5	-1.9
8. Head Height	24	164.5	25	144.1	20.4
11. Lower Face Height	24	72.4	25	69.7	2.7
12. Maximum Face Breadth	25	98.8	25	95.5	3.3
13. Maximum Jaw Breadth	23	86.8	25	76.8	10.0
14. Head Brdth at Ears	25	105.0	25	81.3	23.7
15. Ear to Head/Neck Junct.	25	66.7	25	57.5	9.2
16. Ear to Tip-of-Chin	24	71.5	25	70.8	0.7
17. Ear to Top-of-Head	25	106.7	24	106.3	0.4
18. Head Top to Head Back Dist.	25	69.8	25	67.4	2.4
20. Head Back to Head-Brdth Pt.	25	62.5	25	59.3	3.2
21. Front to Back Head Arc Ln.	25	227.3	25	228.8	-1.5
22. Front to H/N Junct. Arc Ln.	25	274.2	25	282.0	-7.8
23. Ear-to-Ear Over Head Arc Ln.	25	263.3	25	265.2	-1.9
24. Ear-to-Ear Under Chin Arc Ln.	25	175.1	25	162.8	12.3
25. Ear-to-Ear by H/N Junct Arc Ln.	25	156.0	25	157.7	-1.7
27. Neck Breadth	13	76.0	25	60.7	15.3
28. Neck Depth	5	78.2	25	61.0	17.2

Table II.9

Comparison of Measurement Values in mm
from Manual and Photogrammetry Procedures
(13 - 18 MONTHS)

Measurement	Photo N	Photo Mean	Manual N	Manual Mean	Difference in Means
4. Maximum Head Breadth	25	129.8	25	128.5	1.3
5. Head Circumference	25	481.3	25	479.1	2.2
6. Head Brdth at Circ.	23	129.4	25	127.3	2.1
7. Head Length	25	172.5	25	168.4	4.1
8. Head Height	24	178.7	25	163.4	15.3
11. Lower Face Height	25	75.1	25	69.7	5.4
12. Maximum Face Breadth	25	104.6	25	100.2	4.6
13. Maximum Jaw Breadth	24	90.0	25	82.0	8.0
14. Head Brdth at Ears	25	115.8	25	87.9	27.9
15. Ear to Head/Neck Junct.	25	71.0	25	62.6	8.4
16. Ear to Tip-of-Chin	25	82.0	25	82.5	-0.5
17. Ear to Top-of-Head	24	116.3	24	117.1	-0.8
18. Head Top to Head Back Dist.	24	70.8	25	71.3	-0.5
20. Head Back to Head-Brdth Pt.	23	71.6	25	67.4	4.2
21. Front to Back Head Arc Ln.	25	251.2	25	252.4	-1.2
22. Front to H/N Junct. Arc Ln.	25	306.7	25	309.5	-2.8
23. Ear-to-Ear Over Head Arc Ln.	25	292.6	25	293.2	-0.6
24. Ear-to-Ear Under Chin Arc Ln.	25	189.8	25	178.7	11.1
25. Ear-to-Ear by H/N Junct Arc Ln.	25	173.1	25	175.4	-2.3
27. Neck Breadth	20	78.0	25	67.4	10.6
28. Neck Depth	5	76.7	25	64.4	12.3

Table 11.10

Comparison of Measurement Values in mm
from Manual and Photogrammetry Procedures
(25 - 30 MONTHS)

Measurement	Photo N	Photo Mean	Manual N	Manual Mean	Difference in Means
4. Maximum Head Breadth	26	134.6	26	132.9	1.7
5. Head Circumference	26	499.2	26	500.1	-0.9
6. Head Brdth at Circ.	26	133.0	26	131.2	1.8
7. Head Length	26	181.1	26	177.4	3.7
8. Head Height	26	188.5	26	173.7	14.8
11. Lower Face Height	26	79.3	26	78.9	0.4
12. Maximum Face Breadth	26	106.2	26	102.2	4.0
13. Maximum Jaw Breadth	25	88.6	26	82.0	6.6
14. Head Brdth at Ears	26	116.8	26	90.3	26.5
15. Ear to Head/Neck Junct.	26	69.6	26	59.3	10.3
16. Ear to Tip-of-Chin	26	86.2	26	89.7	-3.5
17. Ear to Top-of-Head	26	122.7	26	122.0	-0.7
18. Head Top to Head Back Dist.	26	75.1	26	73.8	1.3
20. Head Back to Head-Brdth Pt.	26	73.6	26	71.7	1.9
21. Front to Back Head Arc Ln.	26	268.9	26	269.2	-0.3
22. Front to H/N Junct. Arc Ln.	26	332.0	26	335.6	-3.6
23. Ear-to-Ear Over Head Arc Ln.	26	303.6	26	307.1	-3.5
24. Ear-to-Ear Under Chin Arc Ln.	26	194.9	26	188.0	6.3
25. Ear-to-Ear by H/N Junct Arc Ln.	26	171.9	26	175.1	-3.2
27. Neck Breadth	24	81.0	26	71.2	9.8
28. Neck Depth	23	76.0	26	66.7	9.3

Table 11.11

Comparison of Measurement Values in mm
from Manual and Photogrammetry Procedures
(43 - 48 MONTHS)

Measurement	Photo N	Photo Mean	Manual N	Manual Mean	Difference in Means
4. Maximum Head Breadth	25	136.6	25	136.5	0.1
5. Head Circumference	25	511.8	25	510.2	1.6
6. Head Brdth at Circ.	25	137.4	25	134.2	3.2
7. Head Length	25	185.3	25	181.3	4.0
8. Head Height	25	192.8	25	178.1	14.7
11. Lower Face Height	25	82.2	25	81.2	1.0
12. Maximum Face Breadth	25	107.8	25	103.5	4.3
13. Maximum Jaw Breadth	24	90.8	25	83.6	7.2
14. Head Brdth at Ears	25	120.0	25	92.9	27.1
15. Ear to Head/Neck Junct.	25	71.0	25	66.6	4.4
16. Ear to Tip-of-Chin	24	90.5	25	95.1	-4.6
17. Ear to Top-of-Head	25	125.5	25	122.2	3.3
18. Head Top to Head Back Dist.	25	79.8	25	76.1	3.7
20. Head Back to Head-Brdth Pt.	25	80.7	25	78.1	2.6
21. Front to Back Head Arc Ln.	25	270.5	25	268,2	2.3
22. Front to H/N Junct. Arc Ln.	25	339.1	25	340.3	-1.2
23. Ear-to-Ear Over Head Arc Ln.	25	314.3	25	312.8	1.5
24. Ear-to-Ear Under Chin Arc Ln.	25	195.8	25	188.1	7.7
25. Ear-to-Ear by H/N Junct Arc Ln.	25	174.4	25	179.4	-5.0
27. Neck Breadth	25	84.6	25	74.2	10.2
28. Neck Depth	24	77.5	25	69.0	8.5