1/29/96

SANDIA REPORT

SAND95-2981 • UC-906
Unlimited Release
Printed January 1996

Performance Evaluation of the BostoMatic 300 Machining Center

E. Anthony Bryce, Dennis E. Clingan, Lane D. Harwell, Naomi G. Christensen

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-94AL85000

SF2900Q(8-81)

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Available to the public from
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NTIS price codes
Printed copy: A08
Microfiche copy: A01

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Distribution
Category UC-906

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Abstract

On-Machine Acceptance (OMA) is a new agile manufacturing concept being developed for machine tools at SNL. The concept behind OMA is the integration of product design, fabrication, and qualification processes. To achieve the OMA integration of design, fabrication and qualification processes, a Boston Digital BostoMatic 300 machining center will function as a fabrication and inspection tool. This report documents the condition of the machining center prior to its use as an inspection device.

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1.0 Introduction

The BostoMatic 300 (BM300) machining center is an integral part of an ongoing Laboratory Directed Research & Development (LDRD) project at Sandia National Laboratories (SNL) titled "Intelligent Tools for On-Machine Acceptance of Precision Machined Components". On-Machine Acceptance (OMA) is a new agile manufacturing concept being developed for machine tools at SNL.. The concept behind OMA is the integration of product design, fabrication, and qualification processes. To achieve the OMA integration of design, fabrication and qualification processes, the BM300 will function as a fabrication and inspection tool.

Along with machining capabilities the BM300 is equipped with a Renishaw TP1-S Touch Trigger Probe (TTP). The TTP allows the BM300 to function as an inspection center for precision components. The BM300 utilizes a length measuring system of encoders capable of resolving linear movement to 0.000020 inches. The functional envelope of the BM300 is 18.00 inches X 12.00 inches X 12.00 inches for the X, Y, and Z axes, respectively.

Before OMA testing began, an evaluation of the BM300 was required to identify and quantify errors in the machining center. Conducting an evaluation of the BM300 provided valuable information about the status of the machining center, such as linear and angular displacement accuracy of the X, Y, and Z axes, squareness of the axes to each other, and accuracy of the spindle rotation at various speeds.

The evaluation process serves three purposes. First, the information allows machine-based errors to be isolated from the data collected by the machine so that the true measuring capability of the machine can be evaluated. The evaluation information could be used to isolate machine-based error from the data.

Second, it allows an error budget for the machine tool to be calculated. The error budget can be used to implement an error correction map over the entire working volume of the machining center as is done in some Coordinate Measuring Machines (CMM)s. The error correction map interacts with the machining centers own coordinate system and corrects that coordinate system for known errors. This method of error correction is also known as Computer Aided Accuracy, or CAA.

Last, identifying and quantifying the errors in the machine tool allows users to determine the type of the work it is best suited for based on its capability.

2.0 Scope

The BM300 performance evaluation took place in July and August of 1994. Tests were conducted in the Advanced Manufacturing Process Laboratory (AMPL), Bldg. 878 , SNL/NM using a BM300 serial number MM-590. All testing was in accordance with ANSI/ASME B5.54-1992 "Performance Evaluation of Numerically Controlled Machining Centers", unless otherwise noted. The results of all tests were compiled and documented in Section 4.0. The ANSI B5.54 testing of the BM300 was divided into six areas. Those areas are linear displacement accuracy, angular displacement accuracy, axis of rotation (spindle), geometric accuracy, volumetric performance, and machine performance as a measuring tool. Details regarding the six tests and test equipment are documented in Section 4.0.

As of August 1994 testing of the BM300 in the area of "Machine Performance as a Measuring Tool" had not been completed. Future testing in this area may incorporate the LDRD test part along with the appropriate ANSI B5.54 specification in determining the BM300 accuracy.

3.0 Acronyms and Definitions

AMPL	AMPL is the acronym for Advanced Manufacturing Process Laboratory.
ANSI	ANSI is the acronym for American National Standard.
ASME	ASME is the acronym for American Society of Mechanical Engineers.
BM300	BM300 is the acronym for BostoMatic 300 machining center.
CMM	CMM is the acronym for Coordinate Measuring Machine.
CNC	CNC is the acronym for Computer Numerical Control.
LDRD	LDRD is the acronym for Laboratory Directed Research and Development.
OMA	OMA is the acronym for On-Machine Acceptance.
SNL/NM	SNL is the acronym for Sandia National Laboratories, New Mexico.
TTP	TTP is the acronym for touch trigger probe.

4.0 ASME B5.54 BostoMatic 300 Performance Evaluation

Sandia National Laboratories
Albuquerque, New Mexico 87185

Standards Laboratory Report

BostoMatic 300
Tested for: 2645 Serial No.: MM-590
Date tested: August 2, 1994

A performance evaluation was made on the BostoMatic 300 identified above. The tests performed are listed below. All tests were performed in accordance with ANSI B5.54-1992 unless otherwise noted.

Linear Displacement Accuracy (X,Y & Z Axes)

- Linear Positioning Error
- Periodic
- Bi-Directional Repeatability

Angular Displacement Accuracy (X,Y & Z Axes)

- Pitch & Yaw
- Roll (X&Y Axes Only)

Axis of Rotation (Spindle)

- Radial Error Motion
- Long Duration Spindle Thermal Stability
- Transient Shutoff Thermal Stability

Geometric Accuracy

- Straightness (X,Y & Z Axes)
- Squareness (XY,XZ & YZ Planes)

Volumetric Performance

- Laser Diagonal Displacement

Machine Performance as a Measuring Tool

- Repeatability and Feature Measurement Accuracy
- Probe Lobing

Tested by: E.A. Bryce and D.E. Clingan

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Linear Positioning Error

Periodic Error

3 Bi-Directional Repeatability

4 Pitch and Yaw

5 Roll

6 Radial Error Motion

7 Long Duration Spindle Thermal Stability

8 Transient Shutoff Thermal Stability

9 Straightness

10 Squareness

11 Laser Diagonal Displacement

12 Repeatability and Feature Measurement Accuracy

13 Probe Lobing

14 Plot Definitions and Pen Colors

15 Plots

Linear Displacement Accuracy

ANSI B5.54-1992 / Section 5.5.1 - 5.5.2.6

Linear Positioning Error (X,Y & Z Axes)

Tests were made using a HP 5528A laser measurement system. A series of six bi-directional runs was made using the following parameters:

	Range Tested	Increment
X-Axis	0 - 17.764 inches	.472 inch
Y- Axis	0 - (-11.8) inches	.472 inch
Z- Axis	0 - 7.552 inches	.472 inch

Test Results (Max. and Min. Values in Inches)

		Maximum	Minimum
X-Axis	Positve Direction	0.000103	-0.000032
	Negative Direction	0.000094	-0.000039
Y-Axis	Positive Direction	0.000109	-0.000003
	Negative Direction	0.000100	-0.000022
Z-Axis	Positive Direction	0.000020	-0.000038
	Negative Direction	0.000026	-0.000042

The test results for the individual runs and the average values are listed on the following pages.

*** ERRORS FOR EACH RUN ***		
RUN	TARGET	ERROR
1	0.000000	-0.000003
1	0.472000	-0.000007
1	0.944000	-0.000029
1	1.416000	0.000002
1	1.888000	-0.000068
1	2.360000	-0.000035
1	2.832000	0.000005
1	3.304000	-0.000051
1	3.776000	-0.000021
1	4.248000	-0.000077
1	4.720000	-0.000042
1	5.192000	-0.000028
1	5.664000	-0.000061
1	6.136000	-0.000079
1	6.608000	-0.000053
1	7.080000	-0.000071
1	7.552000	-0.000068
1	8.024000	-0.000046
1	8.496000	-0.000041
1	8.968000	-0.000046
1	9.440000	-0.000061
1	9.912000	-0.000020
1	10.384000	-0.000023
1	10.856000	-0.000033
1	11.328000	-0.000052
1	11.800000	-0.000012
1	12.272000	-0.000015
1	12.744000	-0.000020
1	13.216000	-0.000027
1	13.688000	-0.000043
1	14.160000	-0.000016
1	14.632000	-0.000027
1	15.104000	-0.000018
1	15.576000	0.000011
1	16.048000	-0.000037
1	16.520000	0.000010
1	16.992000	0.000053
1	17.464000	-0.000010
2	0.000000	0.000054
2	0.472000	0.000020
2	0.944000	-0.000002
2	1.416000	0.000015
2	1.888000	-0.000050
2	2.360000	-0.000019
2	2.832000	0.000016
2	3.304000	-0.000037
2	3.776000	-0.000006
2	4.248000	-0.000066
2	4.720000	-0.000031
2	5.192000	-0.000007
2	5.664000	-0.000057
2	6.136000	-0.000070
2	6.608000	-0.000030
2	7.080000	-0.000054
2	7.552000	-0.000059

BostoMatic 300
Linear Positioning Error
-X- Axis
0 - 17.764 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

2	8.024000	-0.000045
2	8.496000	-0.000042
2	8.968000	-0.000046
2	9.440000	-0.000068
2	9.912000	-0.000029
2	10.384000	-0.000040
2	10.856000	-0.000044
2	11.328000	-0.000056
2	11.800000	-0.000026
2	12.272000	-0.000038
2	12.744000	-0.000043
2	13.216000	-0.000053
2	13.688000	-0.000041
2	14.160000	-0.000007
2	14.632000	-0.000013
2	15.104000	-0.000006
2	15.576000	0.000015
2	16.048000	-0.000005
2	16.520000	0.000016
2	16.992000	0.000052
2	17.464000	0.000007
3	0.000000	0.000053
3	0.472000	0.000039
3	0.944000	0.000018
3	1.416000	0.000049
3	1.888000	-0.000024
3	2.360000	0.000014
3	2.832000	0.000059
3	3.304000	-0.000001
3	3.776000	0.000031
3	4.248000	-0.000024
3	4.720000	0.000013
3	5.192000	0.000022
3	5.664000	-0.000016
3	6.136000	-0.000021
3	6.608000	-0.000001
3	7.080000	-0.000015
3	7.552000	-0.000029
3	8.024000	0.000009
3	8.496000	0.000007
3	8.968000	-0.000003
3	9.440000	-0.000007
3	9.912000	0.000024
3	10.384000	0.000031
3	10.856000	0.000012
3	11.328000	0.000012
3	11.800000	0.000046
3	12.272000	0.000037
3	12.744000	0.000020
3	13.216000	0.000015
3	13.688000	0.000009
3	14.160000	0.000031
3	14.632000	0.000025
3	15.104000	0.000020
3	15.576000	0.000065
3	16.048000	0.000019
3	16.520000	0.000052
3	16.992000	0.000116
3	17.464000	0.000053

BostoMatic 300
Linear Positioning Error
-X- Axis
0 - 17.764 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

4	0.000000	0.000064
4	0.472000	0.000039
4	0.944000	0.000020
4	1.416000	0.000040
4	1.888000	-0.000020
4	2.360000	0.000011
4	2.832000	0.000053
4	3.304000	-0.000009
4	3.776000	0.000022
4	4.248000	-0.000034
4	4.720000	0.000005
4	5.192000	0.000036
4	5.664000	-0.000020
4	6.136000	-0.000033
4	6.608000	-0.000004
4	7.080000	-0.000019
4	7.552000	-0.000019
4	8.024000	-0.000002
4	8.496000	-0.000010
4	8.968000	-0.000007
4	9.440000	-0.000029
4	9.912000	0.000011
4	10.384000	0.000008
4	10.856000	-0.000010
4	11.328000	-0.000011
4	11.800000	0.000014
4	12.272000	0.000005
4	12.744000	-0.000005
4	13.216000	-0.000010
4	13.688000	0.000001
4	14.160000	0.000031
4	14.632000	0.000028
4	15.104000	0.000036
4	15.576000	0.000062
4	16.048000	0.000031
4	16.520000	0.000057
4	16.992000	0.000091
4	17.464000	0.000049
5	0.000000	0.000065
5	0.472000	0.000058
5	0.944000	0.000037
5	1.416000	0.000066
5	1.888000	-0.000005
5	2.360000	0.000036
5	2.832000	0.000072
5	3.304000	0.000017
5	3.776000	0.000064
5	4.248000	0.000004
5	4.720000	0.000037
5	5.192000	0.000059
5	5.664000	0.000007
5	6.136000	0.000002
5	6.608000	0.000016
5	7.080000	0.000013
5	7.552000	0.000003
5	8.024000	0.000047
5	8.496000	0.000045
5	8.968000	0.000041

BostoMatic 300
Linear Positioning Error
-X- Axis
0 - 17.764 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

5	9.440000	0.000025
5	9.912000	0.000061
5	10.384000	0.000067
5	10.856000	0.000050
5	11.328000	0.000036
5	11.800000	0.000070
5	12.272000	0.000074
5	12.744000	0.000054
5	13.216000	0.000054
5	13.688000	0.000045
5	14.160000	0.000069
5	14.632000	0.000064
5	15.104000	0.000053
5	15.576000	0.000100
5	16.048000	0.000054
5	16.520000	0.000094
5	16.992000	0.000141
5	17.464000	0.000085
6	0.000000	0.000071
6	0.472000	0.000046
6	0.944000	0.000027
6	1.416000	0.000043
6	1.888000	-0.000011
6	2.360000	0.000018
6	2.832000	0.000056
6	3.304000	0.000004
6	3.776000	0.000039
6	4.248000	-0.000015
6	4.720000	0.000022
6	5.192000	0.000053
6	5.664000	-0.000001
6	6.136000	-0.000015
6	6.608000	0.000027
6	7.080000	0.000004
6	7.552000	0.000001
6	8.024000	0.000022
6	8.496000	0.000019
6	8.968000	0.000013
6	9.440000	0.000014
6	9.912000	0.000043
6	10.384000	0.000032
6	10.856000	0.000026
6	11.328000	0.000008
6	11.800000	0.000049
6	12.272000	0.000036
6	12.744000	0.000035
6	13.216000	0.000026
6	13.688000	0.000026
6	14.160000	0.000076
6	14.632000	0.000071
6	15.104000	0.000069
6	15.576000	0.000100
6	16.048000	0.000057
6	16.520000	0.000097
6	16.992000	0.000138
6	17.464000	0.000079

BostoMatic 300
Linear Positioning Error
-X- Axis
0 - 17.764 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000051
0.472000	0.000033
0.944000	0.000012
1.416000	0.000036
1.888000	-0.000030
2.360000	0.000004
2.832000	0.000044
3.304000	-0.000013
3.776000	0.000022
4.248000	-0.000035
4.720000	0.000001
5.192000	0.000023
5.664000	-0.000025
6.136000	-0.000036
6.608000	-0.000008
7.080000	-0.000024
7.552000	-0.000029
8.024000	-0.000003
8.496000	-0.000004
8.968000	-0.000008
9.440000	-0.000021
9.912000	0.000015
10.384000	0.000013
10.856000	0.000000
11.328000	-0.000011
11.800000	0.000024
12.272000	0.000017
12.744000	0.000007
13.216000	0.000001
13.688000	-0.000001
14.160000	0.000031
14.632000	0.000025
15.104000	0.000026
15.576000	0.000059
16.048000	0.000020
16.520000	0.000054
16.992000	0.000099
17.464000	0.000044

BostoMatic 300
Linear Positioning Error
-X- Axis
0 - 17.764 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

CURRENT LABELS:
Machine: BostoMatic 300
Number: Serial # MM-590
Date: 8/2/94
By: E.A. Bryce
Axis: -X-
Location: Bldg. 878/Rm. Y352
Miscell.: 0-17.764"/.472" Inc.

BostoMatic 300
Linear Positioning Error
-X- Axis
0 - 17.764 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000038
0.472000	0.000030
0.944000	0.000009
1.416000	0.000039
1.888000	-0.000032
2.360000	0.000005
2.832000	0.000045
3.304000	-0.000012
3.776000	0.000025
4.248000	-0.000032
4.720000	0.000003
5.192000	0.000018
5.664000	-0.000023
6.136000	-0.000033
6.608000	-0.000013
7.080000	-0.000024
7.552000	-0.000031
8.024000	0.000003
8.496000	0.000004
8.968000	-0.000003
9.440000	-0.000014
9.912000	0.000022
10.384000	0.000025
10.856000	0.000010
11.328000	-0.000001
11.800000	0.000035
12.272000	0.000032
12.744000	0.000018
13.216000	0.000014
13.688000	0.000004
14.160000	0.000028
14.632000	0.000021
15.104000	0.000018
15.576000	0.000059
16.048000	0.000012
16.520000	0.000052
16.992000	0.000103
17.464000	0.000043

BostoMatic 300
Linear Positioning Error
-X- Axis
0 - 17.764 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000063
0.472000	0.000035
0.944000	0.000015
1.416000	0.000033
1.888000	-0.000027
2.360000	0.000003
2.832000	0.000042
3.304000	-0.000014
3.776000	0.000018
4.248000	-0.000038
4.720000	-0.000001
5.192000	0.000027
5.664000	-0.000026
6.136000	-0.000039
6.608000	-0.000002
7.080000	-0.000023
7.552000	-0.000026
8.024000	-0.000008
8.496000	-0.000011
8.968000	-0.000013
9.440000	-0.000028
9.912000	0.000008
10.384000	0.000000
10.856000	-0.000009
11.328000	-0.000020
11.800000	0.000012
12.272000	0.000001
12.744000	-0.000004
13.216000	-0.000012
13.688000	-0.000005
14.160000	0.000033
14.632000	0.000029
15.104000	0.000033
15.576000	0.000059
16.048000	0.000028
16.520000	0.000057
16.992000	0.000094
17.464000	0.000045

*** ERRORS FOR EACH RUN ***		
RUN	TARGET	ERROR
1	0.000000	-0.000003
1	-0.472000	0.000082
1	-0.944000	0.000032
1	-1.416000	0.000069
1	-1.888000	0.000062
1	-2.360000	0.000082
1	-2.832000	0.000036
1	-3.304000	0.000038
1	-3.776000	0.000046
1	-4.248000	0.000018
1	-4.720000	0.000024
1	-5.192000	0.000014
1	-5.664000	-0.000014
1	-6.136000	0.000012
1	-6.608000	-0.000025
1	-7.080000	0.000035
1	-7.552000	-0.000013
1	-8.024000	-0.000011
1	-8.496000	0.000014
1	-8.968000	0.000000
1	-9.440000	0.000025
1	-9.912000	0.000030
1	-10.384000	0.000008
1	-10.856000	0.000044
1	-11.328000	0.000061
1	-11.800000	0.000078
2	0.000000	0.000028
2	-0.472000	0.000032
2	-0.944000	0.000008
2	-1.416000	0.000027
2	-1.888000	0.000016
2	-2.360000	0.000046
2	-2.832000	0.000015
2	-3.304000	0.000015
2	-3.776000	0.000051
2	-4.248000	0.000017
2	-4.720000	0.000021
2	-5.192000	-0.000021
2	-5.664000	-0.000024
2	-6.136000	-0.000042
2	-6.608000	-0.000034
2	-7.080000	-0.000003
2	-7.552000	-0.000043
2	-8.024000	-0.000025
2	-8.496000	-0.000023
2	-8.968000	-0.000041
2	-9.440000	-0.000009
2	-9.912000	-0.000017
2	-10.384000	-0.000035
2	-10.856000	0.000005
2	-11.328000	0.000016
2	-11.800000	0.000097
3	0.000000	0.000026
3	-0.472000	0.000108

BostoMatic 300
Linear Positioning Error
-Y- Axis
0 - (-11.8) Inches
.472 Inch Increments
6 Runs "Bi-Directional"

3	-0.944000	0.000072
3	-1.416000	0.000092
3	-1.888000	0.000082
3	-2.360000	0.000101
3	-2.832000	0.000075
3	-3.304000	0.000058
3	-3.776000	0.000074
3	-4.248000	0.000041
3	-4.720000	0.000063
3	-5.192000	0.000029
3	-5.664000	0.000021
3	-6.136000	0.000009
3	-6.608000	0.000008
3	-7.080000	0.000023
3	-7.552000	0.000014
3	-8.024000	0.000003
3	-8.496000	0.000034
3	-8.968000	0.000015
3	-9.440000	0.000042
3	-9.912000	0.000045
3	-10.384000	0.000010
3	-10.856000	0.000041
3	-11.328000	0.000052
3	-11.800000	0.000102
4	0.000000	0.000052
4	-0.472000	0.000054
4	-0.944000	0.000031
4	-1.416000	0.000056
4	-1.888000	0.000043
4	-2.360000	0.000069
4	-2.832000	0.000047
4	-3.304000	0.000040
4	-3.776000	0.000057
4	-4.248000	0.000033
4	-4.720000	0.000046
4	-5.192000	0.000010
4	-5.664000	-0.000013
4	-6.136000	0.000020
4	-6.608000	-0.000016
4	-7.080000	0.000011
4	-7.552000	-0.000019
4	-8.024000	-0.000023
4	-8.496000	-0.000003
4	-8.968000	-0.000023
4	-9.440000	0.000010
4	-9.912000	0.000002
4	-10.384000	-0.000013
4	-10.856000	0.000007
4	-11.328000	0.000024
4	-11.800000	0.000097
5	0.000000	0.000052
5	-0.472000	0.000136
5	-0.944000	0.000099
5	-1.416000	0.000107
5	-1.888000	0.000109
5	-2.360000	0.000122
5	-2.832000	0.000097
5	-3.304000	0.000079

BostoMatic 300
Linear Positioning Error
-Y- Axis
0 - (-11.8) Inches
.472 Inch Increments
6 Runs "Bi-Directional"

5	-3.776000	0.000094
5	-4.248000	0.000054
5	-4.720000	0.000078
5	-5.192000	0.000060
5	-5.664000	0.000014
5	-6.136000	0.000034
5	-6.608000	0.000007
5	-7.080000	0.000080
5	-7.552000	0.000034
5	-8.024000	0.000026
5	-8.496000	0.000045
5	-8.968000	0.000032
5	-9.440000	0.000065
5	-9.912000	0.000066
5	-10.384000	0.000036
5	-10.856000	0.000071
5	-11.328000	0.000072
5	-11.800000	0.000112
6	0.000000	0.000077
6	-0.472000	0.000079
6	-0.944000	0.000054
6	-1.416000	0.000075
6	-1.888000	0.000067
6	-2.360000	0.000098
6	-2.832000	0.000061
6	-3.304000	0.000066
6	-3.776000	0.000083
6	-4.248000	0.000056
6	-4.720000	0.000061
6	-5.192000	0.000058
6	-5.664000	0.000013
6	-6.136000	0.000053
6	-6.608000	0.000005
6	-7.080000	0.000034
6	-7.552000	0.000009
6	-8.024000	-0.000011
6	-8.496000	0.000008
6	-8.968000	-0.000002
6	-9.440000	0.000024
6	-9.912000	0.000018
6	-10.384000	0.000003
6	-10.856000	0.000020
6	-11.328000	0.000045
6	-11.800000	0.000105

BostoMatic 300
Linear Positioning Error
-Y- Axis
0 - (-11.8) Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000039
-0.472000	0.000082
-0.944000	0.000049
-1.416000	0.000071
-1.888000	0.000063
-2.360000	0.000086
-2.832000	0.000055
-3.304000	0.000049
-3.776000	0.000068
-4.248000	0.000037

-4.720000	0.000049
-5.192000	0.000025
-5.664000	-0.000001
-6.136000	0.000014
-6.608000	-0.000009
-7.080000	0.000030
-7.552000	-0.000003
-8.024000	-0.000007
-8.496000	0.000013
-8.968000	-0.000003
-9.440000	0.000026
-9.912000	0.000024
-10.384000	0.000002
-10.856000	0.000031
-11.328000	0.000045
-11.800000	0.000099

BostoMatic 300
Linear Positioning Error
-Y- Axis
0 - (-11.8) Inches
.472 Inch Increments
6 Runs "Bi-Directional"

CURRENT LABELS:

Machine:	BostoMatic 300
Number:	Serial # MM-590
Date:	8/2/94
By:	E.A. Bryce
Axis:	-Y-
Location:	Bldg.878/Rm. Y352
Miscell.:	0-(-11.8")/.472" Inc.

BostoMatic 300
Linear Positioning Error
-Y- Axis
0 - (-11.8) Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000025
-0.472000	0.000109
-0.944000	0.000068
-1.416000	0.000089
-1.888000	0.000084
-2.360000	0.000102
-2.832000	0.000069
-3.304000	0.000058
-3.776000	0.000071
-4.248000	0.000038
-4.720000	0.000055
-5.192000	0.000034
-5.664000	0.000007
-6.136000	0.000018
-6.608000	-0.000003
-7.080000	0.000046
-7.552000	0.000012
-8.024000	0.000006
-8.496000	0.000031
-8.968000	0.000016
-9.440000	0.000044
-9.912000	0.000047
-10.384000	0.000018
-10.856000	0.000052
-11.328000	0.000062
-11.800000	0.000097

BostoMatic 300
Linear Positioning Error
-Y- Axis
0 - (-11.8) Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000052
-0.472000	0.000055
-0.944000	0.000031
-1.416000	0.000053
-1.888000	0.000042
-2.360000	0.000071
-2.832000	0.000041
-3.304000	0.000040
-3.776000	0.000064
-4.248000	0.000035
-4.720000	0.000043
-5.192000	0.000016
-5.664000	-0.000008
-6.136000	0.000010
-6.608000	-0.000015
-7.080000	0.000014
-7.552000	-0.000018
-8.024000	-0.000020
-8.496000	-0.000006
-8.968000	-0.000022
-9.440000	0.000008
-9.912000	0.000001
-10.384000	-0.000015
-10.856000	0.000011
-11.328000	0.000028
-11.800000	0.000100

BostoMatic 300
Linear Positioning Error
-Z- Axis
0 - 7.552 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** ERRORS FOR EACH RUN ***		
RUN	TARGET	ERROR
1	0.000000	0.000000
1	0.472000	0.000002
1	0.944000	0.000013
1	1.416000	0.000005
1	1.888000	-0.000027
1	2.360000	-0.000044
1	2.832000	-0.000023
1	3.304000	-0.000037
1	3.776000	-0.000004
1	4.248000	-0.000024
1	4.720000	-0.000028
1	5.192000	-0.000008
1	5.664000	-0.000009
1	6.136000	-0.000021
1	6.608000	-0.000001
1	7.080000	-0.000025
1	7.552000	-0.000035
2	0.000000	0.000018
2	0.472000	0.000030
2	0.944000	0.000016
2	1.416000	0.000003
2	1.888000	0.000020
2	2.360000	-0.000003
2	2.832000	0.000022
2	3.304000	-0.000004
2	3.776000	-0.000012
2	4.248000	-0.000011
2	4.720000	-0.000001
2	5.192000	-0.000012
2	5.664000	-0.000037
2	6.136000	0.000004
2	6.608000	0.000016
2	7.080000	-0.000041
2	7.552000	-0.000043
3	0.000000	0.000010
3	0.472000	0.000000
3	0.944000	0.000023
3	1.416000	0.000008
3	1.888000	-0.000016
3	2.360000	-0.000033
3	2.832000	-0.000025
3	3.304000	-0.000025
3	3.776000	-0.000005
3	4.248000	-0.000008
3	4.720000	-0.000028
3	5.192000	0.000007
3	5.664000	-0.000006
3	6.136000	-0.000028
3	6.608000	-0.000004
3	7.080000	-0.000008
3	7.552000	-0.000039
4	0.000000	0.000003
4	0.472000	0.000026

4	0.944000	0.000009
4	1.416000	-0.000011
4	1.888000	0.000008
4	2.360000	-0.000013
4	2.832000	0.000012
4	3.304000	-0.000002
4	3.776000	-0.000021
4	4.248000	-0.000032
4	4.720000	0.000007
4	5.192000	-0.000013
4	5.664000	-0.000020
4	6.136000	-0.000010
4	6.608000	0.000017
4	7.080000	-0.000038
4	7.552000	-0.000042
5	0.000000	0.000001
5	0.472000	0.000000
5	0.944000	0.000025
5	1.416000	0.000007
5	1.888000	-0.000011
5	2.360000	-0.000037
5	2.832000	-0.000020
5	3.304000	-0.000030
5	3.776000	-0.000009
5	4.248000	-0.000011
5	4.720000	-0.000029
5	5.192000	-0.000002
5	5.664000	-0.000014
5	6.136000	-0.000023
5	6.608000	-0.000005
5	7.080000	-0.000014
5	7.552000	-0.000039
6	0.000000	0.000002
6	0.472000	0.000023
6	0.944000	0.000002
6	1.416000	-0.000002
6	1.888000	0.000020
6	2.360000	-0.000009
6	2.832000	0.000002
6	3.304000	-0.000012
6	3.776000	-0.000019
6	4.248000	-0.000037
6	4.720000	0.000004
6	5.192000	-0.000008
6	5.664000	-0.000029
6	6.136000	0.000001
6	6.608000	0.000022
6	7.080000	-0.000037
6	7.552000	-0.000041

BostoMatic 300
Linear Positioning Error
-Z- Axis
0 - 7.552 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000006
0.472000	0.000014
0.944000	0.000015
1.416000	0.000002

1.888000	-0.000001
2.360000	-0.000023
2.832000	-0.000005
3.304000	-0.000018
3.776000	-0.000012
4.248000	-0.000021
4.720000	-0.000013
5.192000	-0.000006
5.664000	-0.000019
6.136000	-0.000013
6.608000	0.000008
7.080000	-0.000027
7.552000	-0.000040

BostoMatic 300
Linear Positioning Error
-Z- Axis
0 - 7.552 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

CURRENT LABELS:

Machine:	BostoMatic 300
Number:	Serial # MM-590
Date:	8/2/94
By:	E.A. Bryce
Axis:	-Z-
Location:	Bldg.878/Rm. Y352
Miscell.:	0-7.552"/.472" Inc.

BostoMatic 300
Linear Positioning Error
Z-Axis
0 - 7.552 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000004
0.472000	0.000001
0.944000	0.000020
1.416000	0.000007
1.888000	-0.000018
2.360000	-0.000038
2.832000	-0.000023
3.304000	-0.000031
3.776000	-0.000006
4.248000	-0.000014
4.720000	-0.000028
5.192000	-0.000001
5.664000	-0.000010
6.136000	-0.000024
6.608000	-0.000003
7.080000	-0.000016
7.552000	-0.000038

BostoMatic 300
Linear Positioning Error
Z-Axis
0 - 7.552 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000008
0.472000	0.000026
0.944000	0.000009
1.416000	-0.000003
1.888000	0.000016
2.360000	-0.000008
2.832000	0.000012
3.304000	-0.000006
3.776000	-0.000017
4.248000	-0.000027
4.720000	0.000003
5.192000	-0.000011
5.664000	-0.000029
6.136000	-0.000002
6.608000	0.000018
7.080000	-0.000039
7.552000	-0.000042

Linear Displacement Accuracy

ANSI B5.54-1992 / Section 5.5.2.7

Periodic Error (X,Y & Z Axes)

Tests were made using a HP 5528A laser measurement system. A series of three uni-directional runs was made using the following parameters:

	Range Tested	**Increment**
X-Axis	0 - .320 inch	.016 inch
Y- Axis	0 - (-.320) inch	.016 inch
Z- Axis	0 - .320 inch	.016 inch

Test Results (Max. and Min. Values in Inches)

	Maximum	**Minimum**
X-Axis	0.000026	-0.000043
Y-Axis	0.000069	-0.000025
Z-Axis	0.000034	-0.000025

The test results for the individual runs and the average values are listed on the following pages.

***	ERRORS FOR EACH RUN	***
RUN	TARGET	ERROR
1	0.000000	0.000002
1	0.016000	-0.000009
1	0.032000	0.000023
1	0.048000	-0.000003
1	0.064000	0.000002
1	0.080000	0.000005
1	0.096000	-0.000009
1	0.112000	0.000021
1	0.128000	-0.000002
1	0.144000	-0.000030
1	0.160000	-0.000008
1	0.176000	-0.000007
1	0.192000	0.000025
1	0.208000	0.000000
1	0.224000	0.000001
1	0.240000	0.000003
1	0.256000	0.000007
1	0.272000	0.000022
1	0.288000	-0.000007
1	0.304000	-0.000012
1	0.320000	-0.000049
2	0.000000	0.000010
2	0.016000	0.000002
2	0.032000	0.000027
2	0.048000	-0.000002
2	0.064000	0.000006
2	0.080000	0.000008
2	0.096000	0.000011
2	0.112000	0.000026
2	0.128000	-0.000006
2	0.144000	0.000001
2	0.160000	-0.000007
2	0.176000	-0.000007
2	0.192000	0.000024
2	0.208000	-0.000003
2	0.224000	0.000002
2	0.240000	0.000005
2	0.256000	0.000010
2	0.272000	0.000023
2	0.288000	-0.000007
2	0.304000	-0.000005
2	0.320000	-0.000038
3	0.000000	0.000021
3	0.016000	0.000003
3	0.032000	0.000028
3	0.048000	0.000005
3	0.064000	0.000007
3	0.080000	0.000013
3	0.096000	-0.000008
3	0.112000	0.000025
3	0.128000	-0.000002
3	0.144000	-0.000006
3	0.160000	0.000002
3	0.176000	-0.000004

BostoMatic 300
Periodic Error
-X- Axis
0 - .320 Inches
.016 Inch Increments
3 Runs "Uni-Directional"

3	0.192000	0.000025
3	0.208000	0.000001
3	0.224000	-0.000003
3	0.240000	0.000008
3	0.256000	0.000013
3	0.272000	0.000020
3	0.288000	-0.000009
3	0.304000	-0.000005
3	0.320000	-0.000043

BostoMatic 300
Periodic Error
-X- Axis
0 - .320 Inches
.016 Inch Increments
3 Runs "Uni-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000011
0.016000	-0.000001
0.032000	0.000026
0.048000	0.000000
0.064000	0.000005
0.080000	0.000009
0.096000	-0.000002
0.112000	0.000024
0.128000	-0.000003
0.144000	-0.000012
0.160000	-0.000004
0.176000	-0.000006
0.192000	0.000025
0.208000	-0.000001
0.224000	0.000000
0.240000	0.000005
0.256000	0.000010
0.272000	0.000022
0.288000	-0.000008
0.304000	-0.000007
0.320000	-0.000043

CURRENT LABELS:

Machine:	BostoMatic 300
Number:	Serial # MM-590
Date:	8/2/94
By:	E.A. Bryce
Axis:	-X- "Periodic Error"
Location:	Bldg. 878/Rm. Y352
Miscell.:	0-.320"/ .016" Inc.

BostoMatic 300
Periodic Error
-Y- Axis
0 - (-.320) Inches
.016 Inch Increments
3 Runs "Uni-Directional"

*** ERRORS FOR EACH RUN ***		
RUN	TARGET	ERROR
1	0.000000	0.000001
1	-0.016000	0.000043
1	-0.032000	0.000031
1	-0.048000	0.000042
1	-0.064000	0.000008
1	-0.080000	0.000057
1	-0.096000	0.000015
1	-0.112000	0.000034
1	-0.128000	0.000021
1	-0.144000	0.000042
1	-0.160000	0.000064
1	-0.176000	0.000048
1	-0.192000	0.000072
1	-0.208000	0.000035
1	-0.224000	0.000057
1	-0.240000	0.000054
1	-0.256000	0.000019
1	-0.272000	0.000030
1	-0.288000	0.000014
1	-0.304000	0.000030
1	-0.320000	0.000064
2	0.000000	-0.000034
2	-0.016000	0.000038
2	-0.032000	0.000024
2	-0.048000	0.000051
2	-0.064000	0.000019
2	-0.080000	0.000056
2	-0.096000	0.000017
2	-0.112000	0.000033
2	-0.128000	0.000002
2	-0.144000	0.000040
2	-0.160000	0.000063
2	-0.176000	0.000057
2	-0.192000	0.000074
2	-0.208000	0.000039
2	-0.224000	0.000062
2	-0.240000	0.000046
2	-0.256000	0.000014
2	-0.272000	0.000027
2	-0.288000	0.000002
2	-0.304000	0.000030
2	-0.320000	0.000057
3	0.000000	-0.000041
3	-0.016000	0.000030
3	-0.032000	0.000018
3	-0.048000	0.000040
3	-0.064000	0.000006
3	-0.080000	0.000058
3	-0.096000	0.000009
3	-0.112000	0.000033
3	-0.128000	0.000005
3	-0.144000	0.000034
3	-0.160000	0.000057
3	-0.176000	0.000044

3	-0.192000	0.000062
3	-0.208000	0.000031
3	-0.224000	0.000038
3	-0.240000	0.000051
3	-0.256000	0.000018
3	-0.272000	0.000030
3	-0.288000	0.000015
3	-0.304000	0.000023
3	-0.320000	0.000053

BostoMatic 300
Periodic Error
-Y- Axis
0 - (-.320) Inches
.016 Inch Increments
3 Runs "Uni-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	-0.000025
-0.016000	0.000037
-0.032000	0.000024
-0.048000	0.000044
-0.064000	0.000011
-0.080000	0.000057
-0.096000	0.000014
-0.112000	0.000033
-0.128000	0.000009
-0.144000	0.000039
-0.160000	0.000061
-0.176000	0.000050
-0.192000	0.000069
-0.208000	0.000035
-0.224000	0.000052
-0.240000	0.000050
-0.256000	0.000017
-0.272000	0.000029
-0.288000	0.000010
-0.304000	0.000028
-0.320000	0.000058

CURRENT LABELS:
Machine: BostoMatic 300
Number: Serial # MM-590
Date: 8/2/94
By: E.A. Bryce
Axis: -Y- "Periodic Error"
Location: Bldg.878/Rm. Y352
Miscell.: 0-(-.320")/.016" Inc.

BostoMatic 300
Periodic Error
-Z- Axis
0 - .320 Inches
.016 Inch Increments
3 Runs "Uni-Directional"

*** ERRORS FOR EACH RUN ***		
RUN	TARGET	ERROR
1	0.000000	0.000002
1	0.016000	0.000015
1	0.032000	-0.000016
1	0.048000	0.000005
1	0.064000	-0.000012
1	0.080000	-0.000030
1	0.096000	0.000010
1	0.112000	0.000001
1	0.128000	0.000031
1	0.144000	0.000020
1	0.160000	0.000000
1	0.176000	0.000019
1	0.192000	-0.000014
1	0.208000	0.000003
1	0.224000	-0.000014
1	0.240000	-0.000023
1	0.256000	0.000011
1	0.272000	0.000005
1	0.288000	0.000038
1	0.304000	0.000028
1	0.320000	0.000007
2	0.000000	0.000035
2	0.016000	0.000023
2	0.032000	-0.000002
2	0.048000	0.000011
2	0.064000	-0.000011
2	0.080000	-0.000018
2	0.096000	0.000016
2	0.112000	-0.000001
2	0.128000	0.000039
2	0.144000	0.000020
2	0.160000	-0.000003
2	0.176000	0.000016
2	0.192000	-0.000009
2	0.208000	0.000003
2	0.224000	-0.000009
2	0.240000	-0.000021
2	0.256000	0.000013
2	0.272000	0.000002
2	0.288000	0.000034
2	0.304000	0.000019
2	0.320000	0.000006
3	0.000000	0.000035
3	0.016000	0.000024
3	0.032000	-0.000005
3	0.048000	0.000008
3	0.064000	-0.000010
3	0.080000	-0.000028
3	0.096000	0.000008
3	0.112000	0.000000
3	0.128000	0.000031
3	0.144000	0.000027
3	0.160000	-0.000002
3	0.176000	0.000018

3	0.192000	-0.000012
3	0.208000	0.000000
3	0.224000	-0.000011
3	0.240000	-0.000030
3	0.256000	0.000008
3	0.272000	0.000007
3	0.288000	0.000029
3	0.304000	0.000021
3	0.320000	-0.000004

BostoMatic 300
Periodic Error
-Z- Axis
0 - .320 Inches
.016 Inch Increments
3 Runs "Uni-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000024
0.016000	0.000021
0.032000	-0.000008
0.048000	0.000008
0.064000	-0.000011
0.080000	-0.000025
0.096000	0.000011
0.112000	0.000000
0.128000	0.000034
0.144000	0.000022
0.160000	-0.000002
0.176000	0.000018
0.192000	-0.000012
0.208000	0.000002
0.224000	-0.000011
0.240000	-0.000025
0.256000	0.000011
0.272000	0.000005
0.288000	0.000034
0.304000	0.000023
0.320000	0.000003

CURRENT LABELS:
Machine: BostoMatic 300
Number: Serial # MM-590
Date: 8/2/94
By: E.A. Bryce
Axis: -Z- "Periodic Error"
Location: Bldg.878/Rm. Y352
Miscell.: 0-.320"/ .016" Inc.

Linear Displacement Accuracy

ANSI B5.54-1992 / Section 5.5.2.8

Bi-Directional Repeatability (X,Y & Z Axes)

Tests were made using a HP 5528A laser measurement system. A series of ten runs was made in the center of travel for each axes, using a one inch movement in both directions.

Test Results (Max. and Min. Values in Inches)

	Maximum	**Minimum**
X-Axis	0.000028	0.000012
Y-Axis	0.000000	-0.000015
Z-Axis	-0.000019	-0.000030

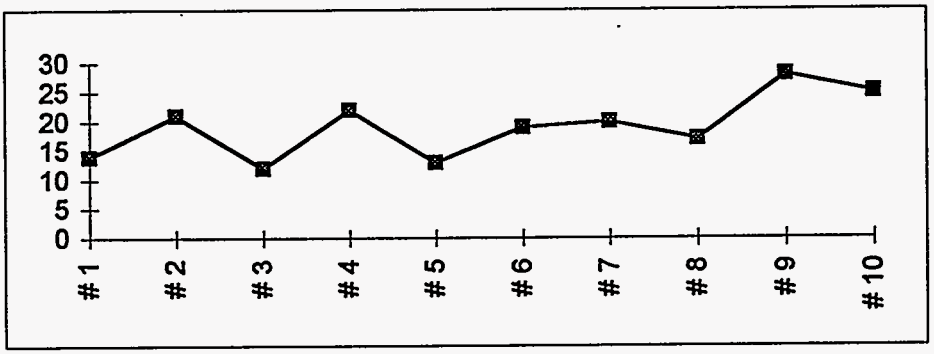
The test results for the individual runs are listed on the following pages.

Bi-Directional Repeatability

X Axis

All Results Are In Microinches

Run #	Reading
# 1	14
# 2	21
# 3	12
# 4	22
# 5	13
# 6	19
# 7	20
# 8	17
# 9	28
# 10	25

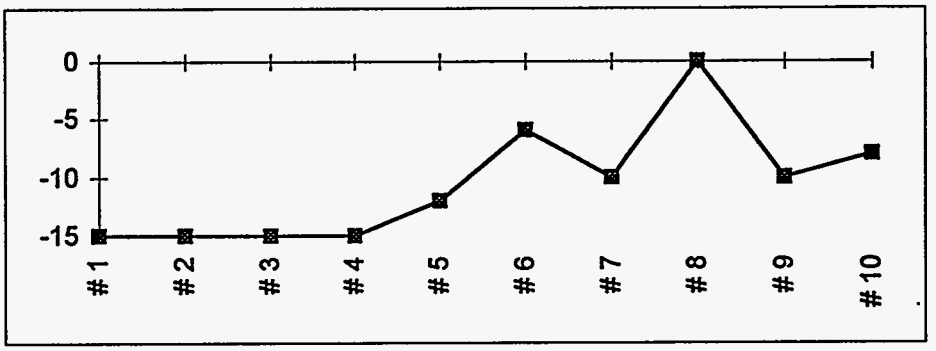


Bi-Directional Repeatability

Y Axis

All Results Are In Microinches

Run #	Reading
# 1	-15
# 2	-15
# 3	-15
# 4	-15
# 5	-12
# 6	-6
# 7	-10
# 8	0
# 9	-10
# 10	-8

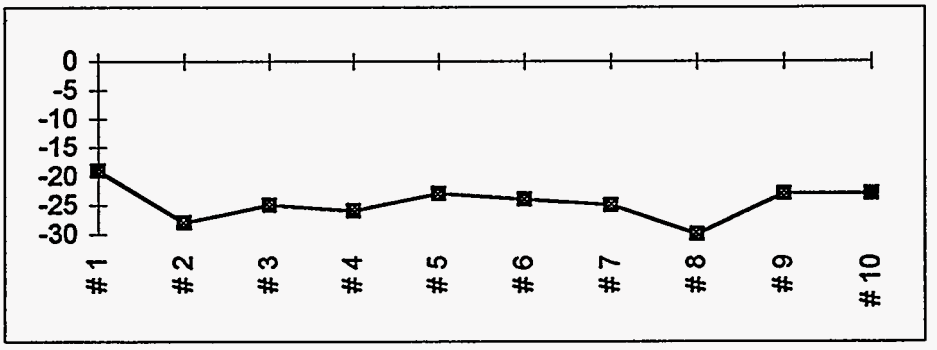


Bi-Directional Repeatability

Z Axis

All Results Are In Microinches

Run #	Reading
# 1	-19
# 2	-28
# 3	-25
# 4	-26
# 5	-23
# 6	-24
# 7	-25
# 8	-30
# 9	-23
# 10	-23



Angular Displacement Accuracy

ANSI B5.54-1992 / Section 5.8.2.3

Pitch and Yaw (X,Y & Z Axes)

Tests were made using a HP 5528A laser measurement system. A series of six bi-directional runs was made using the following parameters:

	Range Tested	Increment
X-Axis	0 - 17 inches	1 inch
Y- Axis	0 - 11 inches	1 inch
Z- Axis	0 - 7 inches	1 inch

Sign Convention for Measurements

When viewed from the axis listed below, clockwise angular rotation will be designated as positive.

X- Axis Pitch - negative Y-Axis
X- Axis Yaw - positive Z- Axis

Y- Axis Pitch - negative X- Axis
Y- Axis Yaw - positive Z- Axis

Z- Axis Pitch is designated as rotation about the X- Axis (Front to Back)
Z- Axis Pitch - negative X- Axis

Z- Axis Yaw is designated as rotation about the Y- Axis (Side to Side)
Z- Axis Yaw - negative Y- Axis

Angular Displacement Accuracy

Test Results (Max. and Min. Values in Arc-Seconds)

			Maximum	Minimum
Pitch				
	X-Axis	Positive Direction	11.6	0.4
		Negative Direction	12.1	0.6
	Y-Axis	Positive Direction	0.1	-1.2
		Negative Direction	0.4	-1.1
	Z-Axis	Positive Direction	-0.2	-0.7
		Negative Direction	-0.1	-0.9
Yaw				
	X-Axis	Positive Direction	-2.0	-6.8
		Negative Direction	-3.4	-7.2
	Y-Axis	Positive Direction	5.0	-0.1
		Negative Direction	4.7	0.7
	Z-Axis	Positive Direction	0.6	0.0
		Negative Direction	0.3	-0.3

The test results for the individual runs and the average values are listed on the following pages.

ERRORS IN arcseconds

RUN	POSITION	ERROR
1	0.000000	0.1
1	1.000000	0.2
1	2.000000	0.4
1	3.000000	0.5
1	4.000000	0.9
1	5.000000	1.0
1	6.000000	1.4
1	7.000000	1.8
1	8.000000	2.5
1	9.000000	3.2
1	10.000000	4.4
1	11.000000	5.2
1	12.000000	5.9
1	13.000000	7.3
1	14.000000	8.0
1	15.000000	8.9
1	16.000000	10.1
1	17.000000	11.4
2	0.000000	0.4
2	1.000000	0.6
2	2.000000	0.8
2	3.000000	1.1
2	4.000000	1.4
2	5.000000	1.6
2	6.000000	2.2
2	7.000000	2.6
2	8.000000	3.2
2	9.000000	4.0
2	10.000000	5.2
2	11.000000	6.1
2	12.000000	7.0
2	13.000000	7.7
2	14.000000	8.7
2	15.000000	10.2
2	16.000000	11.0
2	17.000000	11.8
3	0.000000	0.4
3	1.000000	0.5
3	2.000000	0.7
3	3.000000	1.0
3	4.000000	1.4
3	5.000000	1.7
3	6.000000	2.1
3	7.000000	2.5
3	8.000000	2.9
3	9.000000	3.6
3	10.000000	4.5
3	11.000000	5.4
3	12.000000	6.6
3	13.000000	7.2
3	14.000000	8.3
3	15.000000	9.4
3	16.000000	10.4
3	17.000000	11.7

BostoMatic 300
Angular Displacement Accuracy
X Axis
Pitch
0 - 17 Inches
1 Inch Increments
6 Runs "Bi-Directional"

4	0.000000	0.7
4	1.000000	0.9
4	2.000000	1.3
4	3.000000	1.6
4	4.000000	1.9
4	5.000000	2.2
4	6.000000	2.5
4	7.000000	3.2
4	8.000000	4.0
4	9.000000	4.9
4	10.000000	5.8
4	11.000000	6.7
4	12.000000	7.5
4	13.000000	8.4
4	14.000000	9.3
4	15.000000	10.4
4	16.000000	11.7
4	17.000000	12.2
5	0.000000	0.7
5	1.000000	0.8
5	2.000000	1.1
5	3.000000	1.2
5	4.000000	1.4
5	5.000000	1.8
5	6.000000	2.2
5	7.000000	2.7
5	8.000000	3.3
5	9.000000	4.2
5	10.000000	5.2
5	11.000000	5.7
5	12.000000	6.4
5	13.000000	7.5
5	14.000000	8.8
5	15.000000	9.7
5	16.000000	11.1
5	17.000000	11.8
6	0.000000	0.8
6	1.000000	1.0
6	2.000000	1.3
6	3.000000	1.7
6	4.000000	1.8
6	5.000000	2.3
6	6.000000	2.7
6	7.000000	3.3
6	8.000000	4.1
6	9.000000	4.7
6	10.000000	5.8
6	11.000000	6.9
6	12.000000	7.7
6	13.000000	8.4
6	14.000000	9.8
6	15.000000	11.0
6	16.000000	11.7
6	17.000000	12.4

BostoMatic 300
Angular Displacement Accuracy
X Axis
Pitch
0 - 17 Inches
1 Inch Increments
6 Runs "Bi-Directional"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	0.5
1.000000	0.7
2.000000	0.9
3.000000	1.2
4.000000	1.5
5.000000	1.8
6.000000	2.2
7.000000	2.7
8.000000	3.3
9.000000	4.1
10.000000	5.2
11.000000	6.0
12.000000	6.9
13.000000	7.8
14.000000	8.8
15.000000	9.9
16.000000	11.0
17.000000	11.9

BostoMatic 300
Angular Displacement Accuracy
X Axis
Pitch
0 - 17 Inches
1 Inch Increments
6 Runs "Bi-Directional"

BostoMatic 300
Angular Displacement Accuracy
X-Axis
Pitch
0 - 17 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	0.4
1.000000	0.5
2.000000	0.7
3.000000	0.9
4.000000	1.2
5.000000	1.5
6.000000	1.9
7.000000	2.3
8.000000	2.9
9.000000	3.7
10.000000	4.7
11.000000	5.4
12.000000	6.3
13.000000	7.3
14.000000	8.4
15.000000	9.3
16.000000	10.5
17.000000	11.6

BostoMatic 300
Angular Displacement Accuracy
X-Axis
Pitch
0 - 17 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	0.6
1.000000	0.8
2.000000	1.1
3.000000	1.5
4.000000	1.7
5.000000	2.0
6.000000	2.5
7.000000	3.0
8.000000	3.8
9.000000	4.5
10.000000	5.6
11.000000	6.6
12.000000	7.4
13.000000	8.2
14.000000	9.3
15.000000	10.5
16.000000	11.5
17.000000	12.1

BostoMatic 300
Angular Displacement Accuracy
Y Axis
Pitch
0 - 11 Inches
1 Inch Increments
6 Runs "Bi-Directional"

ERRORS IN arcseconds

RUN	POSITION	ERROR
1	0.000000	-0.3
1	1.000000	-0.5
1	2.000000	-0.1
1	3.000000	-1.3
1	4.000000	-1.6
1	5.000000	0.0
1	6.000000	-0.6
1	7.000000	-1.1
1	8.000000	-1.2
1	9.000000	-1.4
1	10.000000	-0.7
1	11.000000	-0.1
2	0.000000	-0.2
2	1.000000	-0.1
2	2.000000	-0.2
2	3.000000	-0.3
2	4.000000	-1.1
2	5.000000	-0.3
2	6.000000	-0.8
2	7.000000	-0.9
2	8.000000	-0.4
2	9.000000	-0.8
2	10.000000	-0.4
2	11.000000	0.1
3	0.000000	-0.2
3	1.000000	0.7
3	2.000000	-1.5
3	3.000000	0.1
3	4.000000	-0.6
3	5.000000	-0.2
3	6.000000	0.5
3	7.000000	-0.2
3	8.000000	-0.2
3	9.000000	-0.9
3	10.000000	-0.5
3	11.000000	0.2
4	0.000000	0.3
4	1.000000	0.5
4	2.000000	-0.6
4	3.000000	-0.7
4	4.000000	-1.0
4	5.000000	-0.2
4	6.000000	-0.8
4	7.000000	-0.6
4	8.000000	-1.1
4	9.000000	0.2
4	10.000000	-1.2
4	11.000000	-0.1
5	0.000000	-0.3
5	1.000000	0.2
5	2.000000	-0.6
5	3.000000	0.1

5	4.000000	0.5
5	5.000000	-1.4
5	6.000000	0.0
5	7.000000	-1.6
5	8.000000	0.1
5	9.000000	-1.3
5	10.000000	-2.0
5	11.000000	-1.0
6	0.000000	0.0
6	1.000000	0.9
6	2.000000	0.0
6	3.000000	-0.8
6	4.000000	-0.6
6	5.000000	0.9
6	6.000000	-1.8
6	7.000000	-1.0
6	8.000000	0.7
6	9.000000	-0.4
6	10.000000	0.5
6	11.000000	0.5

BostoMatic 300
Angular Displacement Accuracy
Y Axis
Pitch
0 - 11 Inches
1 Inch Increments
6 Runs "Bi-Directional"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-0.1
1.000000	0.3
2.000000	-0.5
3.000000	-0.5
4.000000	-0.7
5.000000	-0.2
6.000000	-0.6
7.000000	-0.9
8.000000	-0.4
9.000000	-0.8
10.000000	-0.7
11.000000	-0.1

BostoMatic 300
Angular Displacement Accuracy
Y-Axis
Pitch
0 - 11 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-0.3
1.000000	0.1
2.000000	-0.7
3.000000	-0.4
4.000000	-0.6
5.000000	-0.5
6.000000	-0.0
7.000000	-1.0
8.000000	-0.4
9.000000	-1.2
10.000000	-1.1
11.000000	-0.3

BostoMatic 300
Angular Displacement Accuracy
Y-Axis
Pitch
0 - 11 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	0.0
1.000000	0.4
2.000000	-0.3
3.000000	-0.6
4.000000	-0.9
5.000000	0.1
6.000000	-1.1
7.000000	-0.8
8.000000	-0.3
9.000000	-0.3
10.000000	-0.4
11.000000	0.2

ERRORS IN arcseconds

RUN	POSITION	ERROR
1	0.000000	0.0
1	1.000000	-0.2
1	2.000000	-0.5
1	3.000000	-0.5
1	4.000000	-0.4
1	5.000000	-0.8
1	6.000000	-0.5
1	7.000000	-0.7
2	0.000000	-0.7
2	1.000000	-0.6
2	2.000000	-0.2
2	3.000000	-0.2
2	4.000000	-0.5
2	5.000000	-0.3
2	6.000000	-0.4
2	7.000000	-0.7
3	0.000000	-0.3
3	1.000000	-0.2
3	2.000000	-0.3
3	3.000000	0.1
3	4.000000	-0.3
3	5.000000	-0.6
3	6.000000	-0.9
3	7.000000	-1.0
4	0.000000	-0.4
4	1.000000	-0.1
4	2.000000	-0.1
4	3.000000	-0.1
4	4.000000	-0.7
4	5.000000	-0.1
4	6.000000	-0.2
4	7.000000	-1.0
5	0.000000	-0.2
5	1.000000	-0.2
5	2.000000	-0.6
5	3.000000	-0.3
5	4.000000	-0.3
5	5.000000	-0.7
5	6.000000	-0.6
5	7.000000	-0.9
6	0.000000	-0.3
6	1.000000	-0.5
6	2.000000	-0.1
6	3.000000	-0.5
6	4.000000	-0.3
6	5.000000	-0.1
6	6.000000	-0.4
6	7.000000	-1.0

BostoMatic 300
Angular Displacement Accuracy
Z Axis
Pitch
0 - 7 Inches
1 Inch Increments
6 Runs "Bi-Directional"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-0.3
1.000000	-0.3
2.000000	-0.3
3.000000	-0.3
4.000000	-0.4
5.000000	-0.4
6.000000	-0.5
7.000000	-0.9

BostoMatic 300
Angular Displacement Accuracy
Z Axis
Pitch
0 - 7 Inches
1 Inch Increments
6 Runs "Bi-Directional"

BostoMatic 300
Angular Displacement Accuracy
Z-Axis
Pitch
0 - 7 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-0.2
1.000000	-0.2
2.000000	-0.5
3.000000	-0.2
4.000000	-0.3
5.000000	-0.7
6.000000	-0.7
7.000000	-0.2

BostoMatic 300
Angular Displacement Accuracy
Z-Axis
Pitch
0 - 7 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-0.5
1.000000	-0.4
2.000000	-0.1
3.000000	-0.3
4.000000	-0.5
5.000000	-0.2
6.000000	-0.3
7.000000	-0.9

BostoMatic 300
Angular Displacement Accuracy
X Axis
Yaw
0 - 17 Inches
1 Inch Increments
6 Runs "Bi-Directional"

ERRORS IN arcseconds

RUN	POSITION	ERROR
1	0.000000	0.2
1	1.000000	-1.7
1	2.000000	-3.2
1	3.000000	-2.9
1	4.000000	-3.0
1	5.000000	-4.1
1	6.000000	-4.8
1	7.000000	-4.1
1	8.000000	-3.8
1	9.000000	-4.4
1	10.000000	-4.8
1	11.000000	-5.0
1	12.000000	-5.5
1	13.000000	-6.0
1	14.000000	-5.0
1	15.000000	-6.3
1	16.000000	-5.7
1	17.000000	-6.5
2	0.000000	-3.0
2	1.000000	-3.2
2	2.000000	-3.5
2	3.000000	-4.3
2	4.000000	-5.7
2	5.000000	-4.6
2	6.000000	-4.6
2	7.000000	-5.2
2	8.000000	-5.8
2	9.000000	-5.8
2	10.000000	-6.2
2	11.000000	-6.6
2	12.000000	-5.5
2	13.000000	-6.1
2	14.000000	-6.9
2	15.000000	-6.1
2	16.000000	-7.2
2	17.000000	-6.3
3	0.000000	-3.0
3	1.000000	-2.9
3	2.000000	-3.3
3	3.000000	-4.0
3	4.000000	-4.0
3	5.000000	-4.0
3	6.000000	-4.8
3	7.000000	-6.5
3	8.000000	-5.4
3	9.000000	-5.0
3	10.000000	-5.3
3	11.000000	-6.6
3	12.000000	-5.9
3	13.000000	-6.2
3	14.000000	-7.1
3	15.000000	-6.4
3	16.000000	-6.5
3	17.000000	-6.8

4	0.000000	-3.5
4	1.000000	-4.6
4	2.000000	-4.0
4	3.000000	-4.0
4	4.000000	-4.9
4	5.000000	-4.9
4	6.000000	-5.3
4	7.000000	-6.7
4	8.000000	-6.3
4	9.000000	-5.5
4	10.000000	-5.7
4	11.000000	-6.7
4	12.000000	-6.0
4	13.000000	-6.2
4	14.000000	-7.4
4	15.000000	-8.0
4	16.000000	-6.8
4	17.000000	-6.8
5	0.000000	-3.2
5	1.000000	-3.7
5	2.000000	-4.4
5	3.000000	-4.2
5	4.000000	-4.9
5	5.000000	-5.0
5	6.000000	-6.1
5	7.000000	-5.6
5	8.000000	-5.6
5	9.000000	-5.6
5	10.000000	-6.1
5	11.000000	-6.0
5	12.000000	-5.7
5	13.000000	-7.6
5	14.000000	-7.3
5	15.000000	-7.2
5	16.000000	-7.1
5	17.000000	-7.1
6	0.000000	-3.7
6	1.000000	-4.1
6	2.000000	-4.5
6	3.000000	-4.8
6	4.000000	-5.1
6	5.000000	-5.5
6	6.000000	-5.8
6	7.000000	-5.9
6	8.000000	-6.0
6	9.000000	-6.4
6	10.000000	-6.4
6	11.000000	-6.5
6	12.000000	-7.0
6	13.000000	-7.1
6	14.000000	-7.3
6	15.000000	-7.4
6	16.000000	-7.6
6	17.000000	-7.1

BostoMatic 300
Angular Displacement Accuracy
X Axis
Yaw
0 - 17 Inches
1 Inch Increments
6 Runs "Bi-Directional"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-2.7
1.000000	-3.4
2.000000	-3.8
3.000000	-4.0
4.000000	-4.6
5.000000	-4.7
6.000000	-5.2
7.000000	-5.7
8.000000	-5.5
9.000000	-5.5
10.000000	-5.8
11.000000	-6.2
12.000000	-5.9
13.000000	-6.5
14.000000	-6.8
15.000000	-6.9
16.000000	-6.8
17.000000	-6.8

BostoMatic 300
Angular Displacement Accuracy
X Axis
Yaw
0 - 17 Inches
1 Inch Increments
6 Runs "Bi-Directional"

BostoMatic 300
Angular Displacement Accuracy
X-Axis
Yaw
0 - 17 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-2.0
1.000000	-2.8
2.000000	-3.6
3.000000	-3.7
4.000000	-4.0
5.000000	-4.4
6.000000	-5.2
7.000000	-5.4
8.000000	-4.9
9.000000	-5.0
10.000000	-5.4
11.000000	-5.9
12.000000	-5.7
13.000000	-6.6
14.000000	-6.5
15.000000	-6.6
16.000000	-6.4
17.000000	-6.8

BostoMatic 300
Angular Displacement Accuracy
X-Axis
Yaw
0 - 17 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-3.4
1.000000	-4.0
2.000000	-4.0
3.000000	-4.4
4.000000	-5.2
5.000000	-5.0
6.000000	-5.2
7.000000	-5.9
8.000000	-6.0
9.000000	-5.9
10.000000	-6.1
11.000000	-6.6
12.000000	-6.2
13.000000	-6.5
14.000000	-7.2
15.000000	-7.2
16.000000	-7.2
17.000000	-6.7

ERRORS IN arcseconds

RUN	POSITION	ERROR
1	0.000000	-0.2
1	1.000000	2.4
1	2.000000	3.9
1	3.000000	5.0
1	4.000000	4.5
1	5.000000	3.0
1	6.000000	4.1
1	7.000000	4.0
1	8.000000	5.3
1	9.000000	3.7
1	10.000000	4.5
1	11.000000	5.3
2	0.000000	0.5
2	1.000000	1.4
2	2.000000	3.8
2	3.000000	3.7
2	4.000000	3.5
2	5.000000	3.8
2	6.000000	4.5
2	7.000000	5.4
2	8.000000	4.0
2	9.000000	4.9
2	10.000000	4.0
2	11.000000	4.5
3	0.000000	0.0
3	1.000000	2.3
3	2.000000	3.5
3	3.000000	4.4
3	4.000000	4.6
3	5.000000	4.4
3	6.000000	3.9
3	7.000000	3.5
3	8.000000	5.4
3	9.000000	4.5
3	10.000000	4.5
3	11.000000	4.2
4	0.000000	1.4
4	1.000000	0.8
4	2.000000	3.8
4	3.000000	3.1
4	4.000000	3.6
4	5.000000	4.7
4	6.000000	4.9
4	7.000000	4.9
4	8.000000	5.8
4	9.000000	4.9
4	10.000000	6.0
4	11.000000	4.6
5	0.000000	0.0
5	1.000000	1.1
5	2.000000	3.3
5	3.000000	4.2

BostoMatic 300
Angular Displacement Accuracy
Y Axis
Yaw
0 - 11 Inches
1 Inch Increments
6 Runs "Bi-Directional"

5	4.000000	4.4
5	5.000000	3.3
5	6.000000	4.4
5	7.000000	5.1
5	8.000000	4.4
5	9.000000	4.0
5	10.000000	4.6
5	11.000000	4.1
6	0.000000	0.3
6	1.000000	1.4
6	2.000000	3.5
6	3.000000	4.0
6	4.000000	4.6
6	5.000000	4.5
6	6.000000	4.0
6	7.000000	3.6
6	8.000000	4.4
6	9.000000	4.2
6	10.000000	4.0
6	11.000000	4.7

BostoMatic 300
Angular Displacement Accuracy
Y Axis
Yaw
0 - 11 Inches
1 Inch Increments
6 Runs "Bi-Directional"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	0.3
1.000000	1.6
2.000000	3.6
3.000000	4.1
4.000000	4.2
5.000000	4.0
6.000000	4.3
7.000000	4.4
8.000000	4.9
9.000000	4.4
10.000000	4.6
11.000000	4.6

BostoMatic 300
Angular Displacement Accuracy
Y-Axis
Yaw
0 - 11 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-0.1
1.000000	1.9
2.000000	3.6
3.000000	4.5
4.000000	4.5
5.000000	3.6
6.000000	4.1
7.000000	4.2
8.000000	5.0
9.000000	4.1
10.000000	4.5
11.000000	4.5

BostoMatic 300
Angular Displacement Accuracy
Y-Axis
Yaw
0 - 11 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	0.7
1.000000	1.2
2.000000	3.7
3.000000	3.6
4.000000	3.9
5.000000	4.3
6.000000	4.5
7.000000	4.6
8.000000	4.7
9.000000	4.7
10.000000	4.7
11.000000	4.6

BostoMatic 300
Angular Displacement Accuracy
Z Axis
Yaw
0 - 7 Inches
1 Inch Increments
6 Runs "Bi-Directional"

ERRORS IN arcseconds

RUN	POSITION	ERROR
1	0.000000	-0.1
1	1.000000	-0.2
1	2.000000	0.0
1	3.000000	0.2
1	4.000000	0.2
1	5.000000	0.4
1	6.000000	0.6
1	7.000000	0.3
2	0.000000	-0.1
2	1.000000	0.0
2	2.000000	0.2
2	3.000000	0.2
2	4.000000	0.3
2	5.000000	-0.1
2	6.000000	-0.2
2	7.000000	-0.2
3	0.000000	0.3
3	1.000000	0.0
3	2.000000	0.1
3	3.000000	0.2
3	4.000000	0.3
3	5.000000	0.2
3	6.000000	0.6
3	7.000000	-0.1
4	0.000000	-0.2
4	1.000000	0.2
4	2.000000	0.1
4	3.000000	0.2
4	4.000000	0.2
4	5.000000	-0.2
4	6.000000	-0.4
4	7.000000	-0.3
5	0.000000	0.0
5	1.000000	0.1
5	2.000000	0.1
5	3.000000	0.3
5	4.000000	0.2
5	5.000000	0.4
5	6.000000	0.7
5	7.000000	0.1
6	0.000000	-0.1
6	1.000000	0.0
6	2.000000	0.1
6	3.000000	0.5
6	4.000000	0.2
6	5.000000	-0.1
6	6.000000	-0.2
6	7.000000	0.3

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-0.0
1.000000	0.0
2.000000	0.1
3.000000	0.3
4.000000	0.2
5.000000	0.1
6.000000	0.2
7.000000	0.0

BostoMatic 300
Angular Displacement Accuracy
Z Axis
Yaw
0 - 7 Inches
1 Inch Increments
6 Runs "Bi-Directional"

BostoMatic 300
Angular Displacement Accuracy
Z-Axis
Yaw
0 - 7 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

** AVERAGES AT EACH POSITION **	
POSITION	AVERAGE ERROR
0.000000	0.1
1.000000	-0.0
2.000000	0.1
3.000000	0.2
4.000000	0.2
5.000000	0.3
6.000000	0.6
7.000000	0.1

BostoMatic 300
Angular Displacement Accuracy
Z-Axis
Yaw
0 - 7 Inches
1 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-0.1
1.000000	0.1
2.000000	0.1
3.000000	0.3
4.000000	0.2
5.000000	-0.1
6.000000	-0.3
7.000000	-0.1

Angular Displacement Accuracy

ANSI B5.54-1992 / Section 5.8.2.3

Roll (X & Y Axes)

Tests were made using Federal electronic levels. A series of three uni-directional runs was made using the following parameters:

	Range Tested	Increment
X- Axis	0 - 17 inches	1 inch
Y- Axis	0 - 11 inches	1 inch

Sign Convention for Measurements

When viewed from the negative axis being tested, clockwise angular rotaion is designated as positive.

Test Results (Max. and Min. Values in Arc-Seconds)

	Maximum	**Minimum**
X-Axis	1.9	-3.7
Y-Axis	0.0	-0.6

The test results for the individual runs and the average values are listed on the following pages.

ERRORS IN arcseconds

RUN	POSITION	ERROR
1	0.000000	-4.0
1	1.000000	-2.9
1	2.000000	-2.5
1	3.000000	-2.5
1	4.000000	-2.1
1	5.000000	-1.3
1	6.000000	-0.3
1	7.000000	0.1
1	8.000000	0.4
1	9.000000	0.8
1	10.000000	1.2
1	11.000000	1.4
1	12.000000	1.7
1	13.000000	1.8
1	14.000000	1.8
1	15.000000	1.6
1	16.000000	1.8
1	17.000000	1.9
2	0.000000	-3.5
2	1.000000	-2.7
2	2.000000	-2.2
2	3.000000	-2.3
2	4.000000	-2.0
2	5.000000	-1.2
2	6.000000	-0.9
2	7.000000	-0.1
2	8.000000	0.2
2	9.000000	-0.1
2	10.000000	0.7
2	11.000000	1.2
2	12.000000	1.3
2	13.000000	1.6
2	14.000000	1.6
2	15.000000	1.7
2	16.000000	2.0
2	17.000000	1.9
3	0.000000	-3.5
3	1.000000	-2.7
3	2.000000	-2.1
3	3.000000	-2.1
3	4.000000	-1.9
3	5.000000	-1.2
3	6.000000	-0.9
3	7.000000	-0.1
3	8.000000	-0.3
3	9.000000	0.4
3	10.000000	0.8
3	11.000000	1.2
3	12.000000	1.5
3	13.000000	1.7
3	14.000000	1.8
3	15.000000	1.9
3	16.000000	2.0
3	17.000000	2.0

BostoMatic 300
Angular Displacement Accuracy
X Axis
Roll
0 - 17 Inches
1 Inch Increments
3 Runs "Uni-Directional"

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	-3.7
1.000000	-2.8
2.000000	-2.3
3.000000	-2.3
4.000000	-2.0
5.000000	-1.2
6.000000	-0.7
7.000000	-0.0
8.000000	0.1
9.000000	0.4
10.000000	0.9
11.000000	1.3
12.000000	1.5
13.000000	1.7
14.000000	1.7
15.000000	1.7
16.000000	1.9
17.000000	1.9

BostoMatic 300
Angular Displacement Accuracy
X Axis
Roll
0 - 17 Inches
1 Inch Increments
3 Runs "Uni-Directional"

BostoMatic 300
Angular Displacement Accuracy
Y Axis
Roll
0 - 11 Inches
1 Inch Increments
3 Runs "Uni-Directional"

ERRORS IN arcseconds

RUN	POSITION	ERROR
1	0.000000	0.0
1	1.000000	-0.4
1	2.000000	-0.5
1	3.000000	-0.7
1	4.000000	-0.6
1	5.000000	-0.6
1	6.000000	-0.5
1	7.000000	-0.7
1	8.000000	-0.7
1	9.000000	-0.6
1	10.000000	-0.5
1	11.000000	-0.4
2	0.000000	0.0
2	1.000000	-0.2
2	2.000000	-0.3
2	3.000000	-0.5
2	4.000000	-0.4
2	5.000000	-0.4
2	6.000000	-0.4
2	7.000000	-0.5
2	8.000000	-0.5
2	9.000000	-0.5
2	10.000000	-0.3
2	11.000000	-0.3
3	0.000000	0.0
3	1.000000	-0.3
3	2.000000	-0.5
3	3.000000	-0.5
3	4.000000	-0.5
3	5.000000	-0.5
3	6.000000	-0.7
3	7.000000	-0.6
3	8.000000	-0.5
3	9.000000	-0.7
3	10.000000	-0.6
3	11.000000	-0.5

** AVERAGES AT EACH POSITION **

POSITION	AVERAGE ERROR
0.000000	0.0
1.000000	-0.3
2.000000	-0.4
3.000000	-0.6
4.000000	-0.5
5.000000	-0.5
6.000000	-0.5
7.000000	-0.6
8.000000	-0.6
9.000000	-0.6
10.000000	-0.5
11.000000	-0.4

Axis of Rotation (Spindle)

ANSI B5.54-1992 / Section 5.7.2

Radial Error Motion

Tests were made using a spindle rotational analyzer manufactured by Automated Precision Inc. (API). Three (3) runs were made at the spindle speeds specified in ANSI B5.54-1992 Section 5.7.2. The results of these tests are listed below. It should be noted that the analyzer used is not in the Sandia recall system and thus calibration is not verified to a traceable standard.

Run #	Spindle Speed	Asynchronous Error	Average Radial Error
10 % of maximum			
1	714.37 rpm	0.00039 inches	0.00029 inches
2	710.91 rpm	0.00047 inches	0.00029 inches
3	714.36 rpm	0.00040 inches	0.00029 inches
50% of maximum			
1	3515.29 rpm	0.00050 inches	0.00063 inches
2	3516.26 rpm	0.00049 inches	0.00061 inches
3	3516.26 rpm	0.00046 inches	0.00062 inches
100 % of maximum			
1	6887.45 rpm	0.00037 inches	0.00037 inches
2	6925.03 rpm	0.00064 inches	0.00030 inches
3	6910.14 rpm	0.00063 inches	0.00031 inches

Axis of Rotation (Spindle)

ANSI B5.54-1992 / Section 5.7.3.2

Long Duration Spindle Thermal Stability

Tests were made using a thermal analyzer manufactured by Automated Precision Inc. (API). The test conditions and parameters used are listed below. It should be noted that the analyzer used is not in the Sandia recall system and thus calibration is not verified to a traceable standard.

Sample Interval Time = 60 seconds
Test Duration = 8 hours
Sensors 1 and 4 were aligned along -X- axis
Sensors 2 and 5 were aligned along -Y- axis
Sensor 3 was aligned along -Z- axis

Sensors 1 and 2 were positioned closest to the spindle.
Sensors 4 and 5 were positioned closest to the table.

Spindle Tilt Error:

Approximate Values Derived From Plots

Sensors 1-4 - within 16.9 arc seconds
Sensors 2-5 - within 47.7 arc seconds

Spindle Linear Error:

Approximate Values Derived From Plots

Sensor 1 - within .00028 inches
Sensor 2 - within .00033 inches
Sensor 3 - within .00090 inches
Sensor 4 - within .00030 inches
Sensor 5 - within .00050 inches

Axis of Rotation (Spindle)

ANSI B5.54-1992 / Section 5.7.3.3

Transient Shutoff Thermal Stability

Tests were made using a thermal analyzer manufactured by Automated Precision Inc. (API). The test conditions and parameters used are listed below. It should be noted that the analyzer used is not in the Sandia recall system and thus calibration is not verified to a traceable standard.

Sample Interval Time = 60 seconds
Test Duration = 1 hour
Sensors 1 and 4 were aligned along -X- axis
Sensors 2 and 5 were aligned along -Y- axis
Sensor 3 was aligned along -Z- axis

Sensors 1 and 2 were positioned closest to the spindle.
Sensors 4 and 5 were positioned closest to the table.

Spindle Tilt Error:

Approximate Values Derived From Plots

Sensors 1-4 - within 187.7 arc seconds
Sensors 2-5 - within 844.8 arc seconds

Spindle Linear Error:

Approximate Values Derived From Plots

Sensor 1 - within .00020 inches
Sensor 2 - within .00100 inches
Sensor 3 - within .00010 inches
Sensor 4 - within .00020 inches
Sensor 5 - within .00040 inches

Geometric Accuracy

ANSI B5.54-1992 / Section 5.8.2.2

Straightness (X,Y & Z Axes)

Tests were made using a Mahr Supramesss dial indicator along with a Rahn granite straightedge for the X and Y axes and a Rahn granite square for the Z axis. Straightness was tested in two directions for each axis. A series of three uni-directional runs was made using the following parameters:

	Range Tested	**Increment**
X-Axis	0 - 10 inches	.5 inch
Y-Axis	0 - 10 inches	.5 inch
Z-Axis	0 - 1 inches	.4 inch

Test Results (Max. and Min. Values in Inches)

	Maximum	**Minimum**
X-Axis Vertical	0.000032	-0.000028
X-Axis Horizontal	0.000013	-0.000010
Y-Axis Vertical	0.000019	-0.000016
Y-Axis Horizontal	0.000028	-0.000031
Z-Axis "Along -X-"	0.000023	-0.000026
Z-Axis "Along -Y-"	0.000029	-0.000017

The test result average values are listed on the following pages.

*** AVERAGES AT EACH TARGET ***

TARGET	ERROR	95% CONF.
0.00000	0.000032	0.000031
0.50000	0.000015	0.000031
1.00000	0.000018	0.000012
1.50000	0.000011	0.000009
2.00000	0.000011	0.000010
2.50000	0.000004	0.000019
3.00000	-0.000010	0.000020
3.50000	-0.000017	0.000025
4.00000	-0.000027	0.000012
4.50000	-0.000028	0.000020
5.00000	-0.000028	0.000017
5.50000	-0.000025	0.000022
6.00000	-0.000022	0.000007
6.50000	-0.000009	0.000015
7.00000	-0.000010	0.000006
7.50000	0.000003	0.000024
8.00000	0.000006	0.000010
8.50000	0.000009	0.000004
9.00000	0.000016	0.000004
9.50000	0.000022	0.000004
10.00000	0.000028	0.000004

BostoMatic 300
Geometric Accuracy
X Axis
Vertical Straightness
0 - 10 Inches
.5 Inch Increments
3 Runs "Uni-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	ERROR	95% CONF.
0.00000	0.000007	0.000005
0.50000	0.000003	0.000005
1.00000	-0.000001	0.000021
1.50000	0.000005	0.000025
2.00000	-0.000002	0.000025
2.50000	-0.000003	0.000008
3.00000	-0.000000	0.000006
3.50000	0.000006	0.000021
4.00000	-0.000002	0.000013
4.50000	-0.000009	0.000017
5.00000	-0.000010	0.000017
5.50000	-0.000000	0.000002
6.00000	-0.000001	0.000013
6.50000	-0.000008	0.000001
7.00000	-0.000006	0.000014
7.50000	0.000000	0.000014
8.00000	0.000013	0.000057
8.50000	0.000003	0.000015
9.00000	-0.000011	0.000015
9.50000	0.000005	0.000016
10.00000	0.000011	0.000011

BostoMatic 300
Geometric Accuracy
X Axis
Horizontal Straightness
0 - 10 Inches
.5 Inch Increments
3 Runs "Uni-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	ERROR	95% CONF.
0.00000	-0.000008	0.000014
0.50000	-0.000006	0.000001
1.00000	-0.000013	0.000016
1.50000	0.000002	0.000010
2.00000	0.000002	0.000006
2.50000	0.000001	0.000021
3.00000	0.000013	0.000008
3.50000	0.000006	0.000005
4.00000	0.000011	0.000003
4.50000	-0.000003	0.000002
5.00000	-0.000007	0.000025
5.50000	-0.000001	0.000024
6.00000	0.000005	0.000022
6.50000	0.000000	0.000004
7.00000	0.000003	0.000033
7.50000	0.000019	0.000008
8.00000	0.000008	0.000019
8.50000	0.000000	0.000021
9.00000	-0.000007	0.000012
9.50000	-0.000008	0.000024
10.00000	-0.000016	0.000028

BostoMatic 300
Geometric Accuracy
Y Axis
Vertical Straightness
0 - 10 Inches
.5 Inch Increments
3 Runs "Uni-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	ERROR	95% CONF.
0.00000	0.000024	0.000046
0.50000	0.000011	0.000027
1.00000	0.000004	0.000030
1.50000	0.000004	0.000013
2.00000	0.000004	0.000028
2.50000	0.000007	0.000043
3.00000	0.000000	0.000041
3.50000	-0.000003	0.000030
4.00000	-0.000004	0.000024
4.50000	-0.000007	0.000030
5.00000	-0.000014	0.000027
5.50000	-0.000021	0.000023
6.00000	-0.000024	0.000035
6.50000	-0.000031	0.000033
7.00000	-0.000021	0.000017
7.50000	-0.000011	0.000006
8.00000	-0.000002	0.000007
8.50000	0.000015	0.000014
9.00000	0.000018	0.000026
9.50000	0.000025	0.000016
10.00000	0.000028	0.000044

BostoMatic 300
Geometric Accuracy
Y Axis
Horizontal Straightness
0 - 10 Inches
.5 Inch Increments
3 Runs "Uni-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	ERROR	95% CONF.
0.00000	0.000023	0.000012
0.40000	-0.000004	0.000009
0.80000	-0.000022	0.000018
1.20000	-0.000026	0.000014
1.60000	-0.000014	0.000013
2.00000	-0.000012	0.000020
2.40000	0.000008	0.000003
2.80000	0.000003	0.000003
3.20000	0.000009	0.000008
3.60000	0.000011	0.000009
4.00000	0.000010	0.000019

BostoMatic 300
Geometric Accuracy
Z Axis
Straightness (Along -X- Axis)
0 - 4 Inches
.4 Inch Increments
3 Runs "Uni-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	ERROR	95% CONF.
0.00000	0.000008	0.000017
0.40000	-0.000000	0.000007
0.80000	0.000001	0.000006
1.20000	-0.000000	0.000020
1.60000	-0.000008	0.000020
2.00000	-0.000017	0.000008
2.40000	-0.000015	0.000006
2.80000	-0.000003	0.000005
3.20000	0.000009	0.000003
3.60000	0.000017	0.000016
4.00000	0.000029	0.000018

BostoMatic 300
Geometric Accuracy
Z Axis
Straightness (Along -Y- Axis)
0 - 4 Inches
.4 Inch Increments
3 Runs "Uni-Directional"

Geometric Accuracy

ANSI B5.54-1992 / Section 5.8.4.1

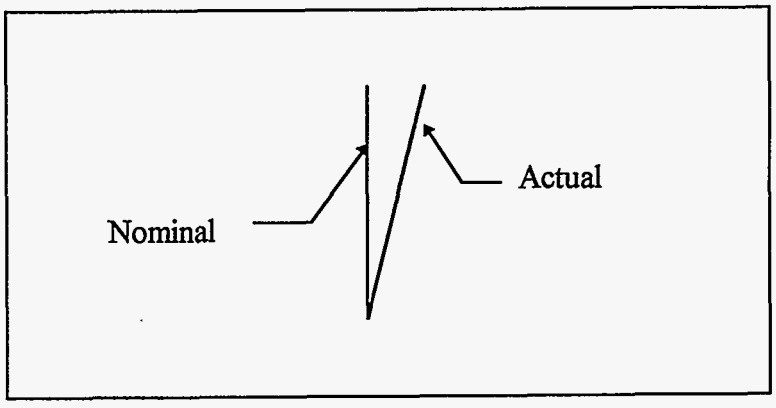
Squareness (XY, XZ & YZ Planes)

Tests were made using a Mahr Supramess dial indicator along with a Rahn granite square. Measurements were made using the reversal technique to eliminate deviations in the square.

Geometric Accuracy

Squareness XY Plane Result = 1.6 arc-seconds

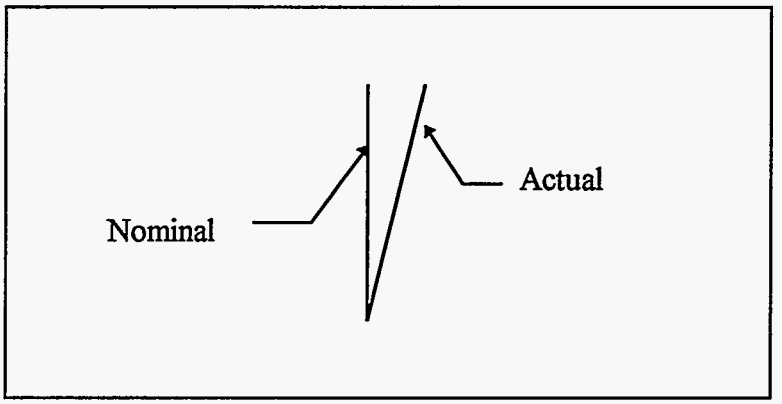
Viewed From
Positive -Z-



Geometric Accuracy

Squareness XZ Plane Result = 1.0 arc-seconds

Viewed From
Positive -Y-



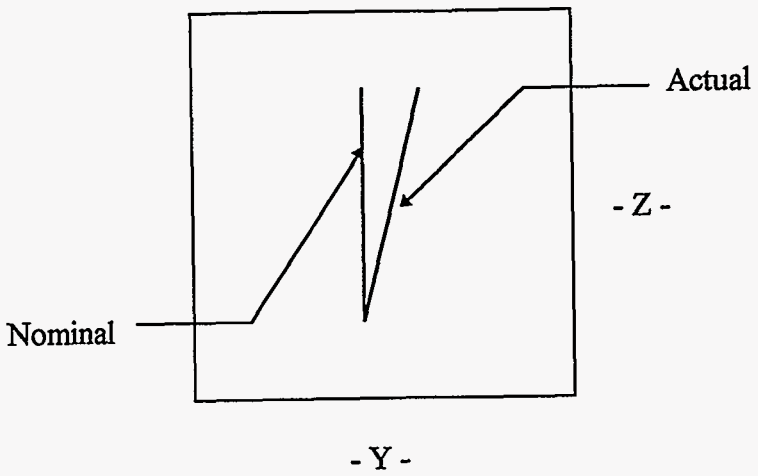
- Z -

- X -

Geometric Accuracy

Squareness YZ Plane Result = 2.6 arc-seconds

Viewed From
Positive -Z-



Volumetric Performance

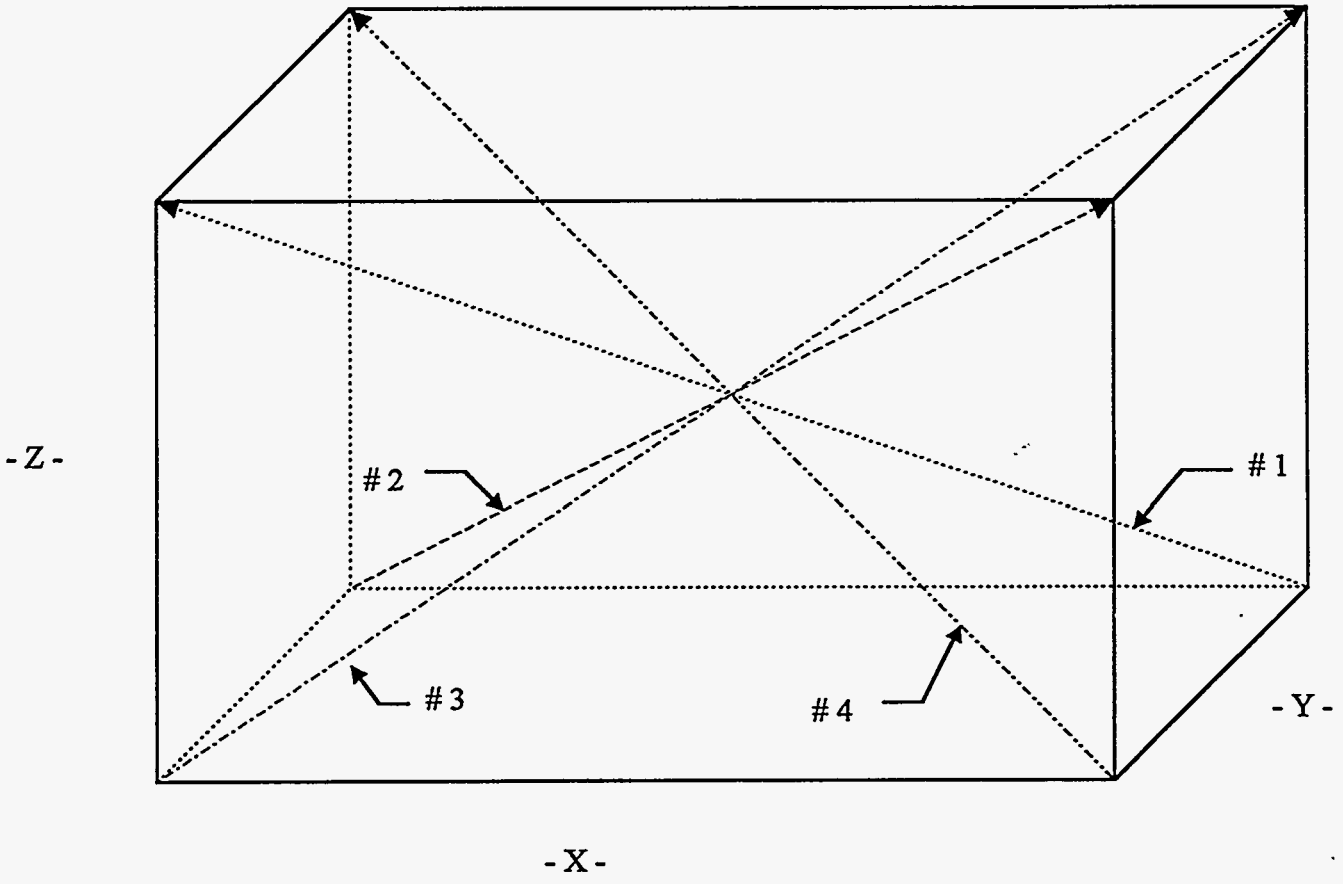
ANSI B5.54-1992 / Section 5.9.1 - 5.9.2.1

Laser Diagonal Displacement

Tests were made using a HP 5528A laser measurement system. A series of six bi-directional runs was made using the following parameters:

	Range Tested	Increment
Diagonals 1,2,3 & 4	0 - 17.464 inches	.472 inch

Diagonal Locations:



Volumetric Performance

Laser Diagonal Displacement

Test Results (Max. and Min. Values in Inches)

		Maximum	Minimum
Diagonal # 1	Positive Direction	0.000187	-0.000012
	Negative Direction	0.000243	0.000003
Diagonal # 2	Positive Direction	0.000120	-0.000078
	Negative Direction	0.000200	-0.000056
Diagonal # 3	Positive Direction	-0.000036	-0.000460
	Negative Direction	-0.000082	-0.000450
Diagonal # 4	Positive Direction	-0.000004	-0.000134
	Negative Direction	0.000040	-0.000134

The test results for the individual runs and average values are listed on the following pages.

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #1
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** ERRORS FOR EACH RUN ***

RUN	TARGET	ERROR
1	0.000000	-0.000009
1	0.472000	-0.000026
1	0.944000	0.000017
1	1.416000	-0.000017
1	1.888000	0.000015
1	2.360000	0.000002
1	2.832000	0.000087
1	3.304000	0.000041
1	3.776000	0.000053
1	4.248000	0.000017
1	4.720000	0.000024
1	5.192000	0.000038
1	5.664000	0.000060
1	6.136000	0.000064
1	6.608000	0.000071
1	7.080000	0.000102
1	7.552000	0.000129
1	8.024000	0.000137
1	8.496000	0.000152
1	8.968000	0.000154
1	9.440000	0.000148
1	9.912000	0.000137
1	10.384000	0.000140
1	10.856000	0.000160
1	11.328000	0.000150
1	11.800000	0.000100
1	12.272000	0.000150
1	12.744000	0.000150
1	13.216000	0.000150
1	13.688000	0.000160
1	14.160000	0.000100
1	14.632000	0.000120
1	15.104000	0.000160
1	15.576000	0.000130
1	16.048000	0.000150
1	16.520000	0.000090
1	16.992000	0.000050
1	17.464000	0.000140
2	0.000000	-0.000007
2	0.472000	0.000014
2	0.944000	0.000028
2	1.416000	0.000007
2	1.888000	-0.000013
2	2.360000	0.000010
2	2.832000	0.000028
2	3.304000	0.000039
2	3.776000	-0.000009
2	4.248000	0.000012
2	4.720000	0.000013
2	5.192000	0.000028
2	5.664000	0.000083
2	6.136000	0.000055
2	6.608000	0.000060
2	7.080000	0.000141
2	7.552000	0.000116

2	8.024000	0.000109
2	8.496000	0.000174
2	8.968000	0.000103
2	9.440000	0.000151
2	9.912000	0.000139
2	10.384000	0.000110
2	10.856000	0.000120
2	11.328000	0.000150
2	11.800000	0.000080
2	12.272000	0.000140
2	12.744000	0.000130
2	13.216000	0.000160
2	13.688000	0.000160
2	14.160000	0.000150
2	14.632000	0.000160
2	15.104000	0.000200
2	15.576000	0.000150
2	16.048000	0.000180
2	16.520000	0.000220
2	16.992000	0.000100
2	17.464000	0.000140
3	0.000000	-0.000004
3	0.472000	0.000005
3	0.944000	0.000027
3	1.416000	-0.000008
3	1.888000	0.000017
3	2.360000	0.000002
3	2.832000	0.000084
3	3.304000	0.000061
3	3.776000	0.000033
3	4.248000	0.000056
3	4.720000	0.000047
3	5.192000	0.000068
3	5.664000	0.000083
3	6.136000	0.000079
3	6.608000	0.000084
3	7.080000	0.000166
3	7.552000	0.000116
3	8.024000	0.000172
3	8.496000	0.000188
3	8.968000	0.000158
3	9.440000	0.000162
3	9.912000	0.000106
3	10.384000	0.000080
3	10.856000	0.000140
3	11.328000	0.000160
3	11.800000	0.000100
3	12.272000	0.000190
3	12.744000	0.000130
3	13.216000	0.000160
3	13.688000	0.000170
3	14.160000	0.000120
3	14.632000	0.000160
3	15.104000	0.000150
3	15.576000	0.000140
3	16.048000	0.000170
3	16.520000	0.000170
3	16.992000	0.000040
3	17.464000	0.000180

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #1
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

4	0.000000	0.000017
4	0.472000	0.000042
4	0.944000	0.000047
4	1.416000	0.000015
4	1.888000	0.000007
4	2.360000	0.000036
4	2.832000	0.000053
4	3.304000	0.000070
4	3.776000	0.000077
4	4.248000	0.000045
4	4.720000	0.000056
4	5.192000	0.000045
4	5.664000	0.000092
4	6.136000	0.000066
4	6.608000	0.000100
4	7.080000	0.000138
4	7.552000	0.000119
4	8.024000	0.000146
4	8.496000	0.000221
4	8.968000	0.000144
4	9.440000	0.000176
4	9.912000	0.000152
4	10.384000	0.000150
4	10.856000	0.000190
4	11.328000	0.000180
4	11.800000	0.000120
4	12.272000	0.000190
4	12.744000	0.000150
4	13.216000	0.000180
4	13.688000	0.000190
4	14.160000	0.000170
4	14.632000	0.000170
4	15.104000	0.000240
4	15.576000	0.000180
4	16.048000	0.000190
4	16.520000	0.000240
4	16.992000	0.000120
4	17.464000	0.000190
5	0.000000	0.000014
5	0.472000	-0.000014
5	0.944000	0.000047
5	1.416000	0.000020
5	1.888000	0.000025
5	2.360000	0.000017
5	2.832000	0.000093
5	3.304000	0.000098
5	3.776000	0.000044
5	4.248000	0.000083
5	4.720000	0.000068
5	5.192000	0.000091
5	5.664000	0.000108
5	6.136000	0.000092
5	6.608000	0.000122
5	7.080000	0.000177
5	7.552000	0.000146
5	8.024000	0.000164
5	8.496000	0.000195
5	8.968000	0.000149

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #1
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

5	9.440000	0.000180
5	9.912000	0.000181
5	10.384000	0.000130
5	10.856000	0.000180
5	11.328000	0.000210
5	11.800000	0.000110
5	12.272000	0.000190
5	12.744000	0.000160
5	13.216000	0.000200
5	13.688000	0.000220
5	14.160000	0.000170
5	14.632000	0.000170
5	15.104000	0.000180
5	15.576000	0.000170
5	16.048000	0.000190
5	16.520000	0.000170
5	16.992000	0.000120
5	17.464000	0.000240
6	0.000000	0.000028
6	0.472000	0.000049
6	0.944000	0.000060
6	1.416000	0.000038
6	1.888000	0.000015
6	2.360000	0.000049
6	2.832000	0.000066
6	3.304000	0.000084
6	3.776000	0.000069
6	4.248000	0.000054
6	4.720000	0.000062
6	5.192000	0.000083
6	5.664000	0.000117
6	6.136000	0.000101
6	6.608000	0.000108
6	7.080000	0.000172
6	7.552000	0.000154
6	8.024000	0.000134
6	8.496000	0.000229
6	8.968000	0.000177
6	9.440000	0.000190
6	9.912000	0.000191
6	10.384000	0.000170
6	10.856000	0.000210
6	11.328000	0.000210
6	11.800000	0.000170
6	12.272000	0.000240
6	12.744000	0.000190
6	13.216000	0.000200
6	13.688000	0.000200
6	14.160000	0.000180
6	14.632000	0.000220
6	15.104000	0.000250
6	15.576000	0.000220
6	16.048000	0.000250
6	16.520000	0.000270
6	16.992000	0.000170
6	17.464000	0.000220

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #1
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000007
0.472000	0.000012
0.944000	0.000038
1.416000	0.000009
1.888000	0.000011
2.360000	0.000019
2.832000	0.000069
3.304000	0.000066
3.776000	0.000045
4.248000	0.000045
4.720000	0.000045
5.192000	0.000059
5.664000	0.000091
6.136000	0.000076
6.608000	0.000091
7.080000	0.000149
7.552000	0.000130
8.024000	0.000144
8.496000	0.000193
8.968000	0.000148
9.440000	0.000168
9.912000	0.000151
10.384000	0.000130
10.856000	0.000167
11.328000	0.000177
11.800000	0.000113
12.272000	0.000183
12.744000	0.000152
13.216000	0.000175
13.688000	0.000183
14.160000	0.000148
14.632000	0.000167
15.104000	0.000197
15.576000	0.000165
16.048000	0.000188
16.520000	0.000193
16.992000	0.000100
17.464000	0.000185

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #1
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

CURRENT LABELS:
Machine: BostoMatic 300
Number: Serial # MM-590
Date: 8/8/94
By: E.A. Bryce
Axis: Diagonal #1
Location: Bldg.878/ Rm. Y352
Miscell.: 0-17.464" / .472" Inc.

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal # 1
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000000
0.472000	-0.000012
0.944000	0.000030
1.416000	-0.000002
1.888000	0.000019
2.360000	0.000007
2.832000	0.000088
3.304000	0.000067
3.776000	0.000043
4.248000	0.000052
4.720000	0.000046
5.192000	0.000066
5.664000	0.000084
6.136000	0.000078
6.608000	0.000092
7.080000	0.000148
7.552000	0.000130
8.024000	0.000158
8.496000	0.000178
8.968000	0.000154
9.440000	0.000163
9.912000	0.000141
10.384000	0.000117
10.856000	0.000160
11.328000	0.000173
11.800000	0.000103
12.272000	0.000177
12.744000	0.000147
13.216000	0.000170
13.688000	0.000183
14.160000	0.000130
14.632000	0.000150
15.104000	0.000163
15.576000	0.000147
16.048000	0.000170
16.520000	0.000143
16.992000	0.000070
17.464000	0.000187

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal # 1
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	0.000013
0.472000	0.000035
0.944000	0.000045
1.416000	0.000020
1.888000	0.000003
2.360000	0.000032
2.832000	0.000049
3.304000	0.000064
3.776000	0.000046
4.248000	0.000037
4.720000	0.000044
5.192000	0.000052
5.664000	0.000097
6.136000	0.000074
6.608000	0.000089
7.080000	0.000150
7.552000	0.000130
8.024000	0.000130
8.496000	0.000208
8.968000	0.000141
9.440000	0.000172
9.912000	0.000161
10.384000	0.000143
10.856000	0.000173
11.328000	0.000180
11.800000	0.000123
12.272000	0.000190
12.744000	0.000157
13.216000	0.000180
13.688000	0.000183
14.160000	0.000167
14.632000	0.000183
15.104000	0.000230
15.576000	0.000183
16.048000	0.000207
16.520000	0.000243
16.992000	0.000130
17.464000	0.000183

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #2
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** ERRORS FOR EACH RUN ***		
RUN	TARGET	ERROR
1	0.000000	0.000021
1	0.472000	0.000001
1	0.944000	-0.000116
1	1.416000	-0.000021
1	1.888000	-0.000017
1	2.360000	-0.000032
1	2.832000	0.000024
1	3.304000	0.000015
1	3.776000	0.000042
1	4.248000	0.000012
1	4.720000	0.000087
1	5.192000	0.000073
1	5.664000	0.000020
1	6.136000	0.000051
1	6.608000	0.000025
1	7.080000	0.000068
1	7.552000	0.000003
1	8.024000	0.000034
1	8.496000	0.000082
1	8.968000	0.000041
1	9.440000	0.000071
1	9.912000	0.000045
1	10.384000	0.000070
1	10.856000	0.000120
1	11.328000	-0.000040
1	11.800000	0.000070
1	12.272000	0.000100
1	12.744000	0.000100
1	13.216000	0.000070
1	13.688000	0.000040
1	14.160000	0.000060
1	14.632000	0.000120
1	15.104000	0.000130
1	15.576000	0.000050
1	16.048000	0.000060
1	16.520000	0.000150
1	16.992000	0.000110
1	17.464000	0.000060
2	0.000000	-0.000026
2	0.472000	0.000035
2	0.944000	0.000036
2	1.416000	0.000026
2	1.888000	0.000024
2	2.360000	0.000039
2	2.832000	0.000026
2	3.304000	0.000064
2	3.776000	0.000037
2	4.248000	0.000009
2	4.720000	0.000028
2	5.192000	0.000014
2	5.664000	0.000004
2	6.136000	0.000035
2	6.608000	-0.000033
2	7.080000	0.000022
2	7.552000	-0.000009

2	8.024000	0.000006
2	8.496000	0.000017
2	8.968000	0.000002
2	9.440000	0.000048
2	9.912000	-0.000019
2	10.384000	0.000070
2	10.856000	0.000040
2	11.328000	0.000020
2	11.800000	0.000050
2	12.272000	0.000120
2	12.744000	0.000080
2	13.216000	0.000090
2	13.688000	-0.000010
2	14.160000	0.000090
2	14.632000	0.000150
2	15.104000	0.000180
2	15.576000	0.000080
2	16.048000	0.000110
2	16.520000	0.000200
2	16.992000	0.000140
2	17.464000	0.000120
3	0.000000	-0.000035
3	0.472000	-0.000008
3	0.944000	0.000000
3	1.416000	-0.000062
3	1.888000	-0.000056
3	2.360000	-0.000067
3	2.832000	0.000002
3	3.304000	-0.000033
3	3.776000	-0.000003
3	4.248000	-0.000018
3	4.720000	0.000051
3	5.192000	0.000090
3	5.664000	-0.000015
3	6.136000	0.000031
3	6.608000	-0.000011
3	7.080000	0.000057
3	7.552000	0.000032
3	8.024000	0.000004
3	8.496000	0.000067
3	8.968000	0.000060
3	9.440000	0.000044
3	9.912000	0.000027
3	10.384000	0.000080
3	10.856000	0.000050
3	11.328000	-0.000030
3	11.800000	0.000050
3	12.272000	0.000050
3	12.744000	0.000090
3	13.216000	0.000070
3	13.688000	0.000030
3	14.160000	0.000050
3	14.632000	0.000100
3	15.104000	0.000120
3	15.576000	0.000030
3	16.048000	0.000020
3	16.520000	0.000130
3	16.992000	0.000130
3	17.464000	0.000100

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #2
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #2
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

4	0.000000	-0.000060
4	0.472000	0.000020
4	0.944000	0.000032
4	1.416000	-0.000030
4	1.888000	0.000004
4	2.360000	-0.000006
4	2.832000	0.000005
4	3.304000	-0.000007
4	3.776000	0.000014
4	4.248000	-0.000018
4	4.720000	0.000019
4	5.192000	-0.000020
4	5.664000	0.000000
4	6.136000	-0.000014
4	6.608000	-0.000061
4	7.080000	0.000005
4	7.552000	-0.000060
4	8.024000	-0.000039
4	8.496000	-0.000018
4	8.968000	-0.000038
4	9.440000	0.000008
4	9.912000	-0.000034
4	10.384000	0.000010
4	10.856000	0.000030
4	11.328000	0.000000
4	11.800000	0.000030
4	12.272000	0.000030
4	12.744000	0.000060
4	13.216000	0.000020
4	13.688000	0.000010
4	14.160000	0.000030
4	14.632000	0.000110
4	15.104000	0.000160
4	15.576000	0.000070
4	16.048000	0.000090
4	16.520000	0.000230
4	16.992000	0.000140
4	17.464000	0.000030
5	0.000000	-0.000060
5	0.472000	-0.000053
5	0.944000	-0.000117
5	1.416000	-0.000094
5	1.888000	-0.000031
5	2.360000	-0.000079
5	2.832000	-0.000022
5	3.304000	-0.000001
5	3.776000	-0.000022
5	4.248000	-0.000040
5	4.720000	0.000027
5	5.192000	0.000015
5	5.664000	-0.000042
5	6.136000	0.000005
5	6.608000	-0.000021
5	7.080000	-0.000022
5	7.552000	-0.000084
5	8.024000	-0.000057
5	8.496000	-0.000005
5	8.968000	-0.000017

5	9.440000	0.000052
5	9.912000	-0.000010
5	10.384000	0.000030
5	10.856000	-0.000020
5	11.328000	-0.000050
5	11.800000	0.000040
5	12.272000	0.000040
5	12.744000	0.000080
5	13.216000	0.000020
5	13.688000	-0.000010
5	14.160000	0.000000
5	14.632000	0.000050
5	15.104000	0.000110
5	15.576000	0.000020
5	16.048000	-0.000020
5	16.520000	0.000080
5	16.992000	0.000080
5	17.464000	0.000020
6	0.000000	-0.000068
6	0.472000	-0.000011
6	0.944000	-0.000003
6	1.416000	-0.000042
6	1.888000	-0.000043
6	2.360000	-0.000003
6	2.832000	-0.000019
6	3.304000	-0.000071
6	3.776000	0.000023
6	4.248000	-0.000002
6	4.720000	-0.000018
6	5.192000	-0.000029
6	5.664000	-0.000039
6	6.136000	-0.000050
6	6.608000	-0.000074
6	7.080000	-0.000017
6	7.552000	-0.000056
6	8.024000	-0.000045
6	8.496000	-0.000025
6	8.968000	-0.000058
6	9.440000	-0.000010
6	9.912000	-0.000055
6	10.384000	-0.000010
6	10.856000	-0.000010
6	11.328000	-0.000030
6	11.800000	0.000020
6	12.272000	0.000060
6	12.744000	0.000070
6	13.216000	0.000000
6	13.688000	0.000010
6	14.160000	0.000040
6	14.632000	0.000070
6	15.104000	0.000150
6	15.576000	0.000030
6	16.048000	0.000110
6	16.520000	0.000170
6	16.992000	0.000140
6	17.464000	0.000000

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #2
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	-0.000038
0.472000	-0.000003
0.944000	-0.000028
1.416000	-0.000037
1.888000	-0.000020
2.360000	-0.000025
2.832000	0.000003
3.304000	-0.000006
3.776000	0.000015
4.248000	-0.000010
4.720000	0.000032
5.192000	0.000024
5.664000	-0.000012
6.136000	0.000010
6.608000	-0.000029
7.080000	0.000019
7.552000	-0.000029
8.024000	-0.000016
8.496000	0.000020
8.968000	-0.000002
9.440000	0.000036
9.912000	-0.000008
10.384000	0.000042
10.856000	0.000035
11.328000	-0.000022
11.800000	0.000043
12.272000	0.000067
12.744000	0.000080
13.216000	0.000045
13.688000	0.000012
14.160000	0.000045
14.632000	0.000100
15.104000	0.000142
15.576000	0.000047
16.048000	0.000062
16.520000	0.000160
16.992000	0.000123
17.464000	0.000055

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #2
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

CURRENT LABELS:
Machine: BostoMatic 300
Number: Serial # MM-590
Date: 8/4/94
By: E.A. Bryce
Axis: Diagonal #2
Location: Bldg.878/ Rm. Y352
Miscell.: 0-17.464" / .472" Inc.

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal # 2
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	-0.000025
0.472000	-0.000020
0.944000	-0.000078
1.416000	-0.000059
1.888000	-0.000035
2.360000	-0.000059
2.832000	0.000001
3.304000	-0.000006
3.776000	0.000006
4.248000	-0.000015
4.720000	0.000055
5.192000	0.000059
5.664000	-0.000012
6.136000	0.000029
6.608000	-0.000002
7.080000	0.000034
7.552000	-0.000016
8.024000	-0.000006
8.496000	0.000048
8.968000	0.000028
9.440000	0.000056
9.912000	0.000021
10.384000	0.000060
10.856000	0.000050
11.328000	-0.000040
11.800000	0.000053
12.272000	0.000063
12.744000	0.000090
13.216000	0.000053
13.688000	0.000020
14.160000	0.000037
14.632000	0.000090
15.104000	0.000120
15.576000	0.000033
16.048000	0.000020
16.520000	0.000120
16.992000	0.000107
17.464000	0.000060

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal # 2
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	-0.000051
0.472000	0.000015
0.944000	0.000022
1.416000	-0.000015
1.888000	-0.000005
2.360000	0.000010
2.832000	0.000004
3.304000	-0.000005
3.776000	0.000025
4.248000	-0.000004
4.720000	0.000010
5.192000	-0.000012
5.664000	-0.000012
6.136000	-0.000010
6.608000	-0.000056
7.080000	0.000003
7.552000	-0.000042
8.024000	-0.000026
8.496000	-0.000009
8.968000	-0.000031
9.440000	0.000015
9.912000	-0.000036
10.384000	0.000023
10.856000	0.000020
11.328000	-0.000003
11.800000	0.000033
12.272000	0.000070
12.744000	0.000070
13.216000	0.000037
13.688000	0.000003
14.160000	0.000053
14.632000	0.000110
15.104000	0.000163
15.576000	0.000060
16.048000	0.000103
16.520000	0.000200
16.992000	0.000140
17.464000	0.000050

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #3
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** ERRORS FOR EACH RUN ***

RUN	TARGET	ERROR
1	0.000000	0.000018
1	0.472000	-0.000130
1	0.944000	-0.000174
1	1.416000	-0.000178
1	1.888000	-0.000169
1	2.360000	-0.000243
1	2.832000	-0.000234
1	3.304000	-0.000220
1	3.776000	-0.000224
1	4.248000	-0.000261
1	4.720000	-0.000279
1	5.192000	-0.000248
1	5.664000	-0.000264
1	6.136000	-0.000282
1	6.608000	-0.000300
1	7.080000	-0.000327
1	7.552000	-0.000311
1	8.024000	-0.000314
1	8.496000	-0.000369
1	8.968000	-0.000324
1	9.440000	-0.000322
1	9.912000	-0.000379
1	10.384000	-0.000360
1	10.856000	-0.000350
1	11.328000	-0.000350
1	11.800000	-0.000390
1	12.272000	-0.000390
1	12.744000	-0.000420
1	13.216000	-0.000400
1	13.688000	-0.000400
1	14.160000	-0.000440
1	14.632000	-0.000410
1	15.104000	-0.000350
1	15.576000	-0.000450
1	16.048000	-0.000390
1	16.520000	-0.000360
1	16.992000	-0.000420
1	17.464000	-0.000390
2	0.000000	-0.000039
2	0.472000	-0.000059
2	0.944000	-0.000105
2	1.416000	-0.000124
2	1.888000	-0.000136
2	2.360000	-0.000186
2	2.832000	-0.000185
2	3.304000	-0.000141
2	3.776000	-0.000173
2	4.248000	-0.000233
2	4.720000	-0.000235
2	5.192000	-0.000273
2	5.664000	-0.000284
2	6.136000	-0.000304
2	6.608000	-0.000309
2	7.080000	-0.000360
2	7.552000	-0.000345

2	8.024000	-0.000393
2	8.496000	-0.000405
2	8.968000	-0.000345
2	9.440000	-0.000380
2	9.912000	-0.000417
2	10.384000	-0.000390
2	10.856000	-0.000420
2	11.328000	-0.000410
2	11.800000	-0.000400
2	12.272000	-0.000420
2	12.744000	-0.000430
2	13.216000	-0.000380
2	13.688000	-0.000410
2	14.160000	-0.000420
2	14.632000	-0.000410
2	15.104000	-0.000340
2	15.576000	-0.000420
2	16.048000	-0.000360
2	16.520000	-0.000350
2	16.992000	-0.000420
2	17.464000	-0.000390
3	0.000000	-0.000053
3	0.472000	-0.000176
3	0.944000	-0.000213
3	1.416000	-0.000205
3	1.888000	-0.000196
3	2.360000	-0.000284
3	2.832000	-0.000251
3	3.304000	-0.000264
3	3.776000	-0.000244
3	4.248000	-0.000296
3	4.720000	-0.000296
3	5.192000	-0.000293
3	5.664000	-0.000274
3	6.136000	-0.000281
3	6.608000	-0.000329
3	7.080000	-0.000351
3	7.552000	-0.000339
3	8.024000	-0.000348
3	8.496000	-0.000386
3	8.968000	-0.000341
3	9.440000	-0.000368
3	9.912000	-0.000429
3	10.384000	-0.000380
3	10.856000	-0.000390
3	11.328000	-0.000390
3	11.800000	-0.000400
3	12.272000	-0.000400
3	12.744000	-0.000480
3	13.216000	-0.000400
3	13.688000	-0.000390
3	14.160000	-0.000440
3	14.632000	-0.000430
3	15.104000	-0.000390
3	15.576000	-0.000430
3	16.048000	-0.000420
3	16.520000	-0.000390
3	16.992000	-0.000440
3	17.464000	-0.000390

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #3
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #3
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

4	0.000000	-0.000088
4	0.472000	-0.000090
4	0.944000	-0.000122
4	1.416000	-0.000151
4	1.888000	-0.000152
4	2.360000	-0.000217
4	2.832000	-0.000222
4	3.304000	-0.000171
4	3.776000	-0.000209
4	4.248000	-0.000259
4	4.720000	-0.000268
4	5.192000	-0.000315
4	5.664000	-0.000305
4	6.136000	-0.000317
4	6.608000	-0.000354
4	7.080000	-0.000371
4	7.552000	-0.000399
4	8.024000	-0.000377
4	8.496000	-0.000432
4	8.968000	-0.000380
4	9.440000	-0.000416
4	9.912000	-0.000453
4	10.384000	-0.000410
4	10.856000	-0.000420
4	11.328000	-0.000420
4	11.800000	-0.000430
4	12.272000	-0.000460
4	12.744000	-0.000440
4	13.216000	-0.000410
4	13.688000	-0.000450
4	14.160000	-0.000450
4	14.632000	-0.000390
4	15.104000	-0.000340
4	15.576000	-0.000440
4	16.048000	-0.000390
4	16.520000	-0.000360
4	16.992000	-0.000440
4	17.464000	-0.000390
5	0.000000	-0.000072
5	0.472000	-0.000201
5	0.944000	-0.000238
5	1.416000	-0.000241
5	1.888000	-0.000235
5	2.360000	-0.000313
5	2.832000	-0.000287
5	3.304000	-0.000276
5	3.776000	-0.000272
5	4.248000	-0.000336
5	4.720000	-0.000345
5	5.192000	-0.000309
5	5.664000	-0.000334
5	6.136000	-0.000335
5	6.608000	-0.000367
5	7.080000	-0.000387
5	7.552000	-0.000362
5	8.024000	-0.000377
5	8.496000	-0.000425
5	8.968000	-0.000360

5	9.440000	-0.000389
5	9.912000	-0.000428
5	10.384000	-0.000390
5	10.856000	-0.000410
5	11.328000	-0.000420
5	11.800000	-0.000420
5	12.272000	-0.000440
5	12.744000	-0.000480
5	13.216000	-0.000420
5	13.688000	-0.000430
5	14.160000	-0.000470
5	14.632000	-0.000440
5	15.104000	-0.000400
5	15.576000	-0.000480
5	16.048000	-0.000410
5	16.520000	-0.000360
5	16.992000	-0.000420
5	17.464000	-0.000420
6	0.000000	-0.000120
6	0.472000	-0.000119
6	0.944000	-0.000168
6	1.416000	-0.000194
6	1.888000	-0.000183
6	2.360000	-0.000251
6	2.832000	-0.000254
6	3.304000	-0.000219
6	3.776000	-0.000256
6	4.248000	-0.000293
6	4.720000	-0.000294
6	5.192000	-0.000336
6	5.664000	-0.000340
6	6.136000	-0.000350
6	6.608000	-0.000388
6	7.080000	-0.000411
6	7.552000	-0.000424
6	8.024000	-0.000432
6	8.496000	-0.000452
6	8.968000	-0.000384
6	9.440000	-0.000441
6	9.912000	-0.000453
6	10.384000	-0.000440
6	10.856000	-0.000450
6	11.328000	-0.000450
6	11.800000	-0.000430
6	12.272000	-0.000470
6	12.744000	-0.000480
6	13.216000	-0.000480
6	13.688000	-0.000430
6	14.160000	-0.000470
6	14.632000	-0.000440
6	15.104000	-0.000380
6	15.576000	-0.000440
6	16.048000	-0.000390
6	16.520000	-0.000380
6	16.992000	-0.000420
6	17.464000	-0.000400

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #3
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	-0.000059
0.472000	-0.000129
0.944000	-0.000170
1.416000	-0.000182
1.888000	-0.000179
2.360000	-0.000249
2.832000	-0.000239
3.304000	-0.000215
3.776000	-0.000230
4.248000	-0.000280
4.720000	-0.000286
5.192000	-0.000296
5.664000	-0.000300
6.136000	-0.000312
6.608000	-0.000341
7.080000	-0.000368
7.552000	-0.000363
8.024000	-0.000374
8.496000	-0.000412
8.968000	-0.000356
9.440000	-0.000386
9.912000	-0.000427
10.384000	-0.000395
10.856000	-0.000407
11.328000	-0.000407
11.800000	-0.000412
12.272000	-0.000430
12.744000	-0.000455
13.216000	-0.000415
13.688000	-0.000418
14.160000	-0.000448
14.632000	-0.000420
15.104000	-0.000367
15.576000	-0.000443
16.048000	-0.000393
16.520000	-0.000367
16.992000	-0.000427
17.464000	-0.000397

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #3
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

CURRENT LABELS:
Machine: BostoMatic 300
Number: Serial # MM-590
Date: 8/4/94
By: E.A. Bryce
Axis: Diagonal #3
Location: Bldg.878/ Rm. Y352
Miscell.: 0-17.464" / .472" Inc.

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal # 3
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	-0.000036
0.472000	-0.000169
0.944000	-0.000208
1.416000	-0.000208
1.888000	-0.000200
2.360000	-0.000280
2.832000	-0.000257
3.304000	-0.000253
3.776000	-0.000247
4.248000	-0.000298
4.720000	-0.000307
5.192000	-0.000283
5.664000	-0.000291
6.136000	-0.000299
6.608000	-0.000332
7.080000	-0.000355
7.552000	-0.000337
8.024000	-0.000346
8.496000	-0.000393
8.968000	-0.000342
9.440000	-0.000360
9.912000	-0.000412
10.384000	-0.000377
10.856000	-0.000383
11.328000	-0.000387
11.800000	-0.000403
12.272000	-0.000410
12.744000	-0.000460
13.216000	-0.000407
13.688000	-0.000407
14.160000	-0.000450
14.632000	-0.000427
15.104000	-0.000380
15.576000	-0.000453
16.048000	-0.000407
16.520000	-0.000370
16.992000	-0.000427
17.464000	-0.000400

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal # 3
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	-0.000082
0.472000	-0.000089
0.944000	-0.000132
1.416000	-0.000156
1.888000	-0.000157
2.360000	-0.000218
2.832000	-0.000220
3.304000	-0.000177
3.776000	-0.000213
4.248000	-0.000262
4.720000	-0.000266
5.192000	-0.000308
5.664000	-0.000310
6.136000	-0.000324
6.608000	-0.000350
7.080000	-0.000381
7.552000	-0.000389
8.024000	-0.000401
8.496000	-0.000430
8.968000	-0.000370
9.440000	-0.000412
9.912000	-0.000441
10.384000	-0.000413
10.856000	-0.000430
11.328000	-0.000427
11.800000	-0.000420
12.272000	-0.000450
12.744000	-0.000450
13.216000	-0.000423
13.688000	-0.000430
14.160000	-0.000447
14.632000	-0.000413
15.104000	-0.000353
15.576000	-0.000433
16.048000	-0.000380
16.520000	-0.000363
16.992000	-0.000427
17.464000	-0.000393

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #4
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** ERRORS FOR EACH RUN ***		
RUN	TARGET	ERROR
1	0.000000	0.000002
1	0.472000	-0.000030
1	0.944000	-0.000033
1	1.416000	-0.000072
1	1.888000	-0.000064
1	2.360000	-0.000091
1	2.832000	-0.000115
1	3.304000	-0.000103
1	3.776000	-0.000082
1	4.248000	-0.000081
1	4.720000	-0.000087
1	5.192000	-0.000078
1	5.664000	-0.000115
1	6.136000	-0.000082
1	6.608000	-0.000089
1	7.080000	-0.000099
1	7.552000	-0.000095
1	8.024000	-0.000067
1	8.496000	-0.000086
1	8.968000	-0.000097
1	9.440000	-0.000081
1	9.912000	-0.000143
1	10.384000	-0.000060
1	10.856000	-0.000070
1	11.328000	-0.000090
1	11.800000	-0.000080
1	12.272000	-0.000050
1	12.744000	-0.000110
1	13.216000	-0.000070
1	13.688000	-0.000120
1	14.160000	-0.000080
1	14.632000	-0.000120
1	15.104000	-0.000110
1	15.576000	-0.000100
1	16.048000	-0.000150
1	16.520000	-0.000080
1	16.992000	-0.000090
1	17.464000	-0.000080
2	0.000000	-0.000013
2	0.472000	-0.000002
2	0.944000	0.000000
2	1.416000	-0.000065
2	1.888000	-0.000032
2	2.360000	-0.000065
2	2.832000	-0.000081
2	3.304000	-0.000078
2	3.776000	-0.000110
2	4.248000	-0.000078
2	4.720000	-0.000092
2	5.192000	-0.000098
2	5.664000	-0.000105
2	6.136000	-0.000118
2	6.608000	-0.000106
2	7.080000	-0.000103
2	7.552000	-0.000137

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #4
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

2	8.024000	-0.000101
2	8.496000	-0.000108
2	8.968000	-0.000098
2	9.440000	-0.000120
2	9.912000	-0.000155
2	10.384000	-0.000080
2	10.856000	-0.000100
2	11.328000	-0.000080
2	11.800000	-0.000100
2	12.272000	-0.000070
2	12.744000	-0.000100
2	13.216000	-0.000100
2	13.688000	-0.000120
2	14.160000	-0.000090
2	14.632000	-0.000150
2	15.104000	-0.000090
2	15.576000	-0.000090
2	16.048000	-0.000080
2	16.520000	-0.000040
2	16.992000	0.000020
2	17.464000	-0.000060
3	0.000000	-0.000006
3	0.472000	-0.000033
3	0.944000	-0.000051
3	1.416000	-0.000076
3	1.888000	-0.000068
3	2.360000	-0.000071
3	2.832000	-0.000129
3	3.304000	-0.000073
3	3.776000	-0.000083
3	4.248000	-0.000043
3	4.720000	-0.000080
3	5.192000	-0.000089
3	5.664000	-0.000102
3	6.136000	-0.000084
3	6.608000	-0.000063
3	7.080000	-0.000096
3	7.552000	-0.000090
3	8.024000	-0.000063
3	8.496000	-0.000087
3	8.968000	-0.000081
3	9.440000	-0.000076
3	9.912000	-0.000137
3	10.384000	-0.000050
3	10.856000	-0.000070
3	11.328000	-0.000070
3	11.800000	-0.000070
3	12.272000	-0.000050
3	12.744000	-0.000120
3	13.216000	-0.000060
3	13.688000	-0.000110
3	14.160000	-0.000060
3	14.632000	-0.000140
3	15.104000	-0.000100
3	15.576000	-0.000090
3	16.048000	-0.000140
3	16.520000	-0.000050
3	16.992000	-0.000060
3	17.464000	-0.000050

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #4
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

4	0.000000	-0.000010
4	0.472000	-0.000003
4	0.944000	0.000005
4	1.416000	-0.000057
4	1.888000	-0.000020
4	2.360000	-0.000057
4	2.832000	-0.000083
4	3.304000	-0.000068
4	3.776000	-0.000111
4	4.248000	-0.000060
4	4.720000	-0.000079
4	5.192000	-0.000073
4	5.664000	-0.000093
4	6.136000	-0.000107
4	6.608000	-0.000107
4	7.080000	-0.000100
4	7.552000	-0.000126
4	8.024000	-0.000082
4	8.496000	-0.000095
4	8.968000	-0.000076
4	9.440000	-0.000096
4	9.912000	-0.000115
4	10.384000	-0.000040
4	10.856000	-0.000090
4	11.328000	-0.000070
4	11.800000	-0.000100
4	12.272000	-0.000060
4	12.744000	-0.000090
4	13.216000	-0.000080
4	13.688000	-0.000130
4	14.160000	-0.000060
4	14.632000	-0.000090
4	15.104000	-0.000050
4	15.576000	-0.000090
4	16.048000	-0.000080
4	16.520000	-0.000030
4	16.992000	0.000060
4	17.464000	-0.000060
5	0.000000	-0.000007
5	0.472000	-0.000034
5	0.944000	-0.000035
5	1.416000	-0.000087
5	1.888000	-0.000065
5	2.360000	-0.000079
5	2.832000	-0.000103
5	3.304000	-0.000099
5	3.776000	-0.000083
5	4.248000	-0.000041
5	4.720000	-0.000073
5	5.192000	-0.000078
5	5.664000	-0.000090
5	6.136000	-0.000084
5	6.608000	-0.000070
5	7.080000	-0.000088
5	7.552000	-0.000100
5	8.024000	-0.000069
5	8.496000	-0.000068
5	8.968000	-0.000089

5	9.440000	-0.000058
5	9.912000	-0.000121
5	10.384000	-0.000050
5	10.856000	-0.000070
5	11.328000	-0.000090
5	11.800000	-0.000080
5	12.272000	-0.000050
5	12.744000	-0.000080
5	13.216000	-0.000080
5	13.688000	-0.000130
5	14.160000	-0.000070
5	14.632000	-0.000110
5	15.104000	-0.000070
5	15.576000	-0.000060
5	16.048000	-0.000110
5	16.520000	-0.000070
5	16.992000	-0.000010
5	17.464000	-0.000050
6	0.000000	-0.000015
6	0.472000	-0.000005
6	0.944000	-0.000011
6	1.416000	-0.000062
6	1.888000	-0.000014
6	2.360000	-0.000061
6	2.832000	-0.000082
6	3.304000	-0.000062
6	3.776000	-0.000083
6	4.248000	-0.000066
6	4.720000	-0.000111
6	5.192000	-0.000088
6	5.664000	-0.000098
6	6.136000	-0.000096
6	6.608000	-0.000087
6	7.080000	-0.000093
6	7.552000	-0.000128
6	8.024000	-0.000100
6	8.496000	-0.000103
6	8.968000	-0.000081
6	9.440000	-0.000115
6	9.912000	-0.000132
6	10.384000	-0.000060
6	10.856000	-0.000080
6	11.328000	-0.000070
6	11.800000	-0.000080
6	12.272000	-0.000050
6	12.744000	-0.000110
6	13.216000	-0.000070
6	13.688000	-0.000100
6	14.160000	-0.000060
6	14.632000	-0.000090
6	15.104000	-0.000050
6	15.576000	-0.000070
6	16.048000	-0.000070
6	16.520000	-0.000020
6	16.992000	0.000040
6	17.464000	-0.000060

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #4
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	-0.000008
0.472000	-0.000018
0.944000	-0.000021
1.416000	-0.000070
1.888000	-0.000044
2.360000	-0.000071
2.832000	-0.000099
3.304000	-0.000081
3.776000	-0.000092
4.248000	-0.000062
4.720000	-0.000087
5.192000	-0.000084
5.664000	-0.000101
6.136000	-0.000095
6.608000	-0.000087
7.080000	-0.000097
7.552000	-0.000113
8.024000	-0.000080
8.496000	-0.000091
8.968000	-0.000087
9.440000	-0.000091
9.912000	-0.000134
10.384000	-0.000057
10.856000	-0.000080
11.328000	-0.000078
11.800000	-0.000085
12.272000	-0.000055
12.744000	-0.000102
13.216000	-0.000077
13.688000	-0.000118
14.160000	-0.000070
14.632000	-0.000117
15.104000	-0.000078
15.576000	-0.000083
16.048000	-0.000105
16.520000	-0.000048
16.992000	-0.000007
17.464000	-0.000060

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal #4
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

CURRENT LABELS:
Machine: BostoMatic 300
Number: Serial # MM-590
Date: 8/4/94
By: E.A. Bryce
Axis: Diagonal #4
Location: Bldg.878/ Rm. Y352
Miscell.: 0-17.464" / .472" Inc.

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal # 4
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Positive Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	-0.000004
0.472000	-0.000032
0.944000	-0.000040
1.416000	-0.000078
1.888000	-0.000066
2.360000	-0.000080
2.832000	-0.000116
3.304000	-0.000092
3.776000	-0.000083
4.248000	-0.000055
4.720000	-0.000080
5.192000	-0.000082
5.664000	-0.000102
6.136000	-0.000083
6.608000	-0.000074
7.080000	-0.000094
7.552000	-0.000095
8.024000	-0.000066
8.496000	-0.000080
8.968000	-0.000089
9.440000	-0.000072
9.912000	-0.000134
10.384000	-0.000053
10.856000	-0.000070
11.328000	-0.000083
11.800000	-0.000077
12.272000	-0.000050
12.744000	-0.000103
13.216000	-0.000070
13.688000	-0.000120
14.160000	-0.000070
14.632000	-0.000123
15.104000	-0.000093
15.576000	-0.000083
16.048000	-0.000133
16.520000	-0.000067
16.992000	-0.000053
17.464000	-0.000060

BostoMatic 300
Volumetric Performance
Laser Diagonal Displacement
Diagonal # 4
0 - 17.464 Inches
.472 Inch Increments
6 Runs "Bi-Directional"

"Negative Direction"

*** AVERAGES AT EACH TARGET ***

TARGET	AVERAGE ERROR
0.000000	-0.000013
0.472000	-0.000003
0.944000	-0.000002
1.416000	-0.000061
1.888000	-0.000022
2.360000	-0.000061
2.832000	-0.000082
3.304000	-0.000069
3.776000	-0.000101
4.248000	-0.000068
4.720000	-0.000094
5.192000	-0.000086
5.664000	-0.000099
6.136000	-0.000107
6.608000	-0.000100
7.080000	-0.000099
7.552000	-0.000130
8.024000	-0.000094
8.496000	-0.000102
8.968000	-0.000085
9.440000	-0.000110
9.912000	-0.000134
10.384000	-0.000060
10.856000	-0.000090
11.328000	-0.000073
11.800000	-0.000093
12.272000	-0.000060
12.744000	-0.000100
13.216000	-0.000083
13.688000	-0.000117
14.160000	-0.000070
14.632000	-0.000110
15.104000	-0.000063
15.576000	-0.000083
16.048000	-0.000077
16.520000	-0.000030
16.992000	0.000040
17.464000	-0.000060

Error Band and Non-Repeatability Definition

Error Band:

The difference between the most-positive 3-sigma point and the most-negative 3-sigma point.

Non-Repeat:

The difference between the most-positive 3-sigma and negative 3-sigma limits at the point at which this difference is greatest.

Note:

The point at which the difference between the positive 3-sigma limit and the negative 3-sigma limit is greatest can be very difficult to find by just examining the graph, since it can occur at a point that is not an extreme value for either of these limits.

The sigma limits on a straightness plot represent a 95% confidence level.

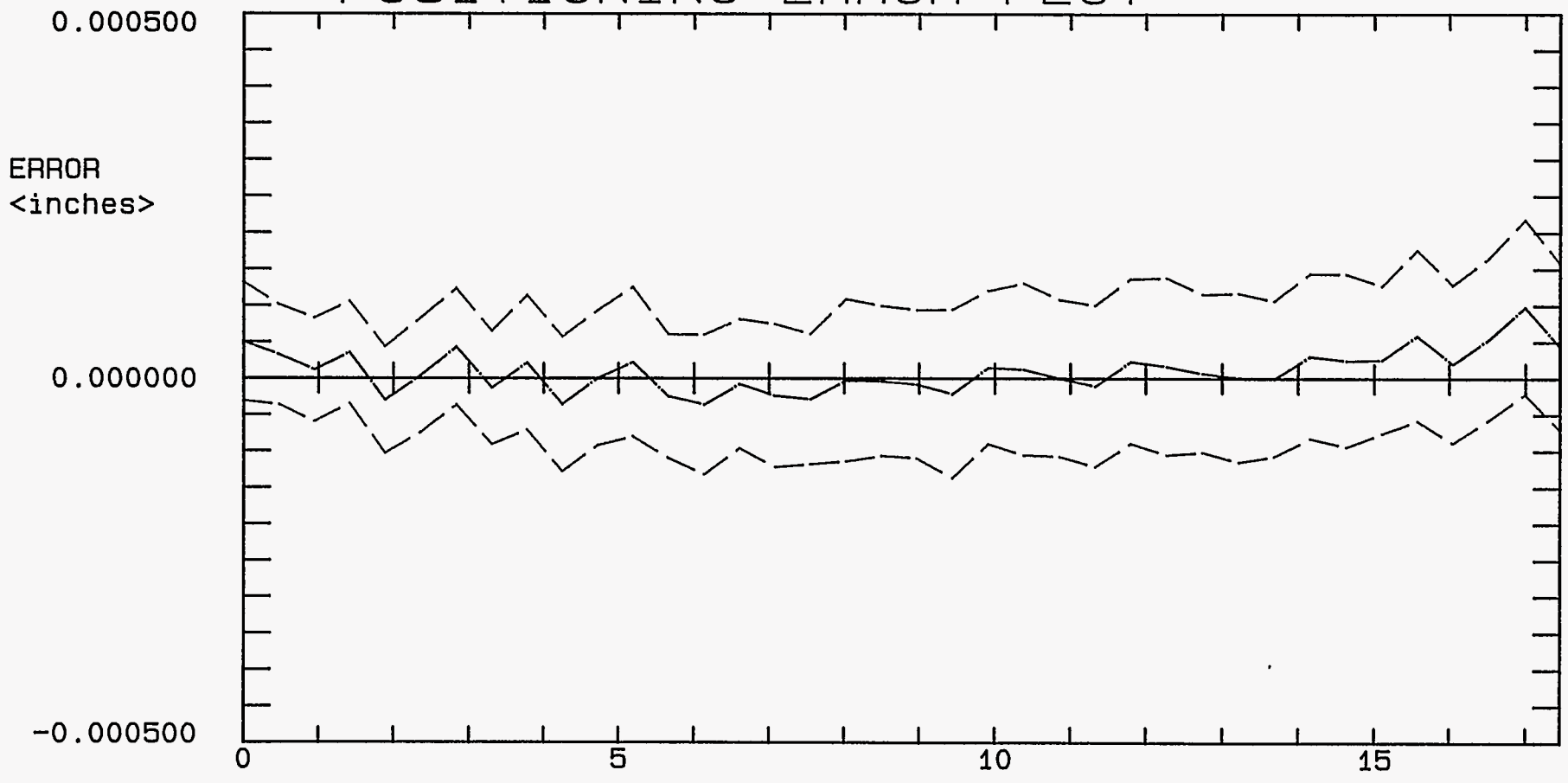
Graph Pen Colors

Pen Color Designations (Color Plots Only)

Linear, Angular and Straightness Plots

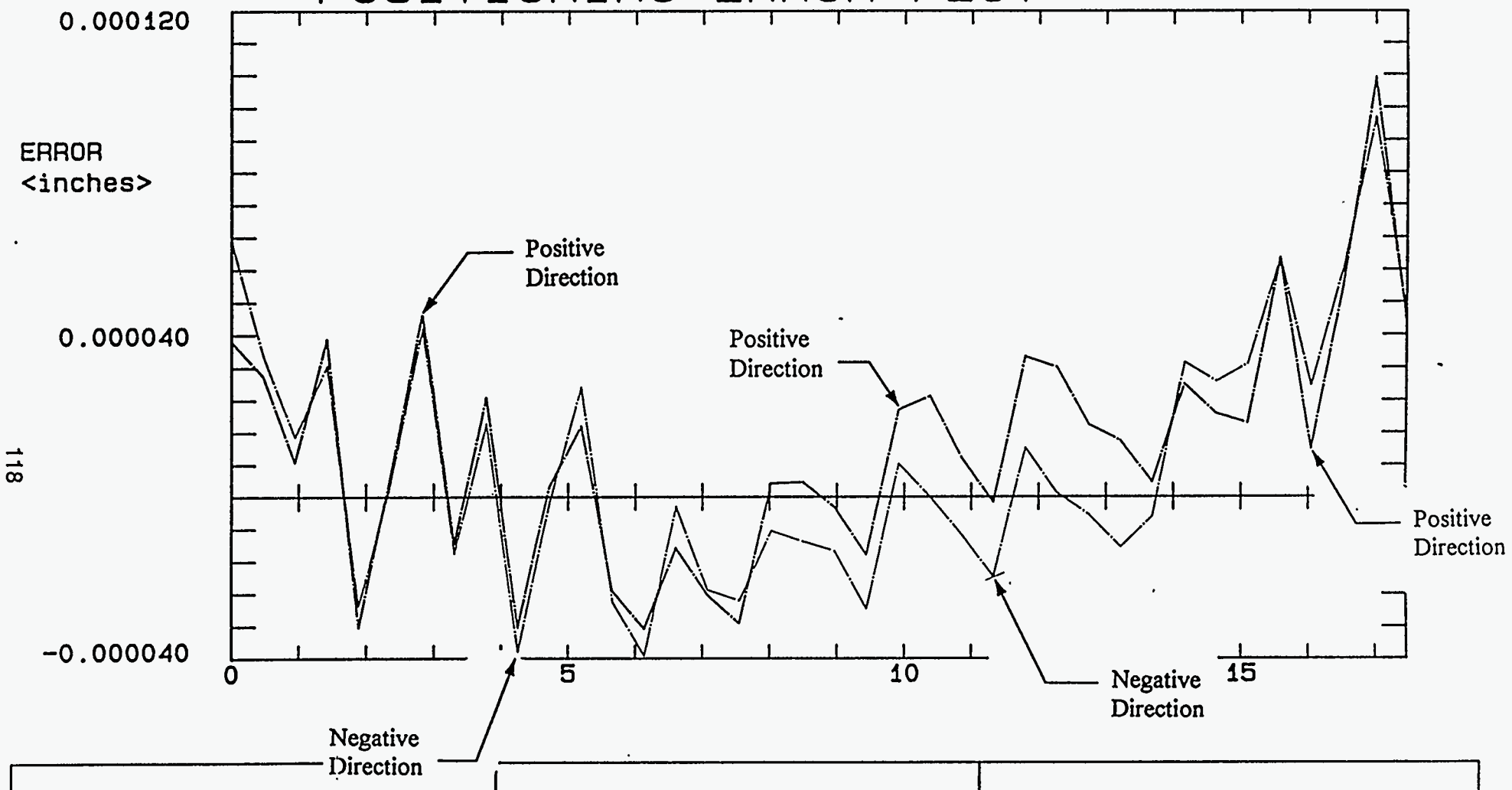
Mean	Red
3-Sigma	Blue

POSITIONING ERROR PLOT



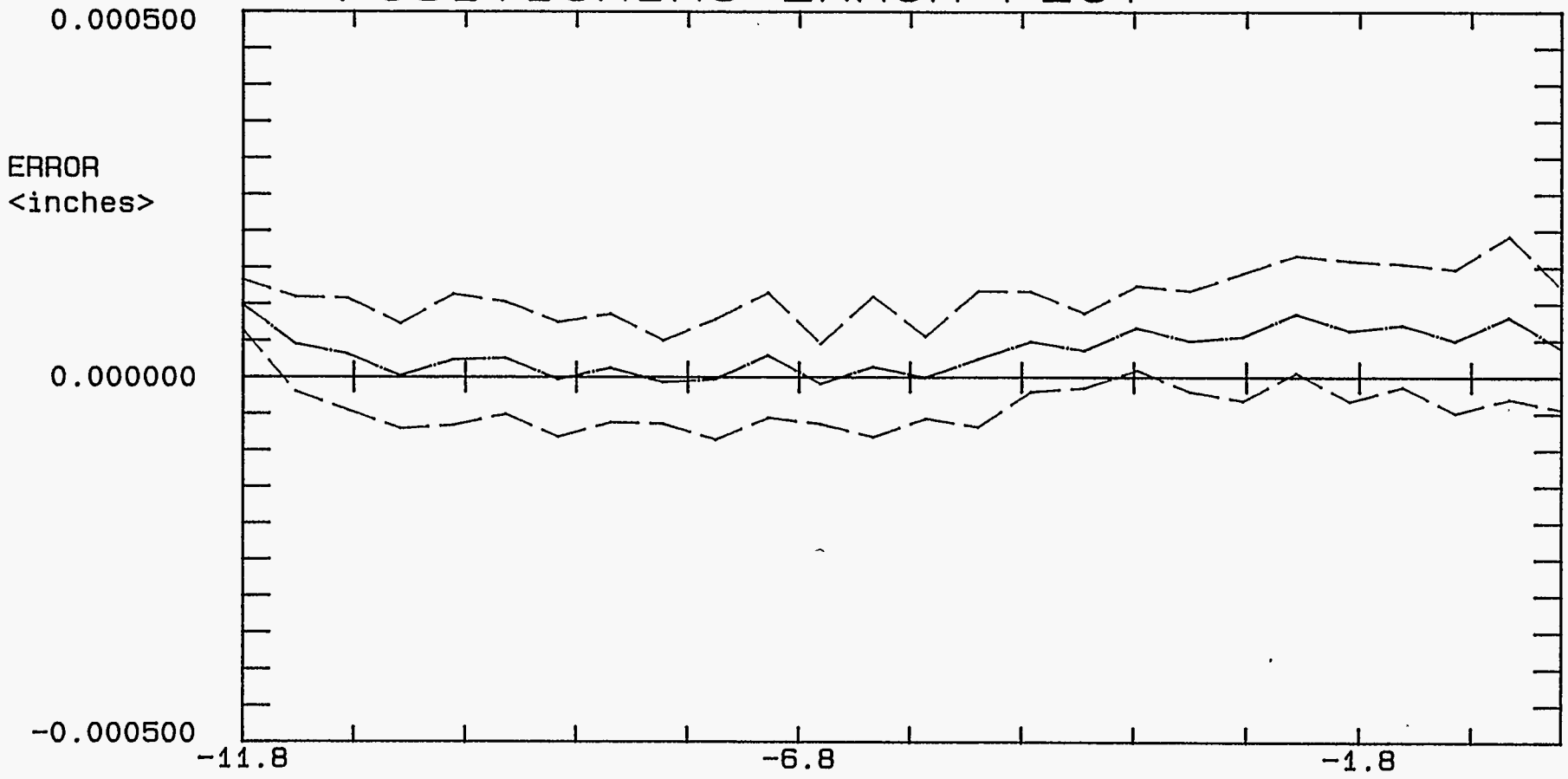
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -X-	DATE: 8/2/94 LOCATION: Bldg. 878/Rm. Y352 0-17.764"/.472" Inc. FILE: BOS-X-.LIN	ERROR BAND: 0.000355 NON REPEAT: 0.000243

POSITIONING ERROR PLOT



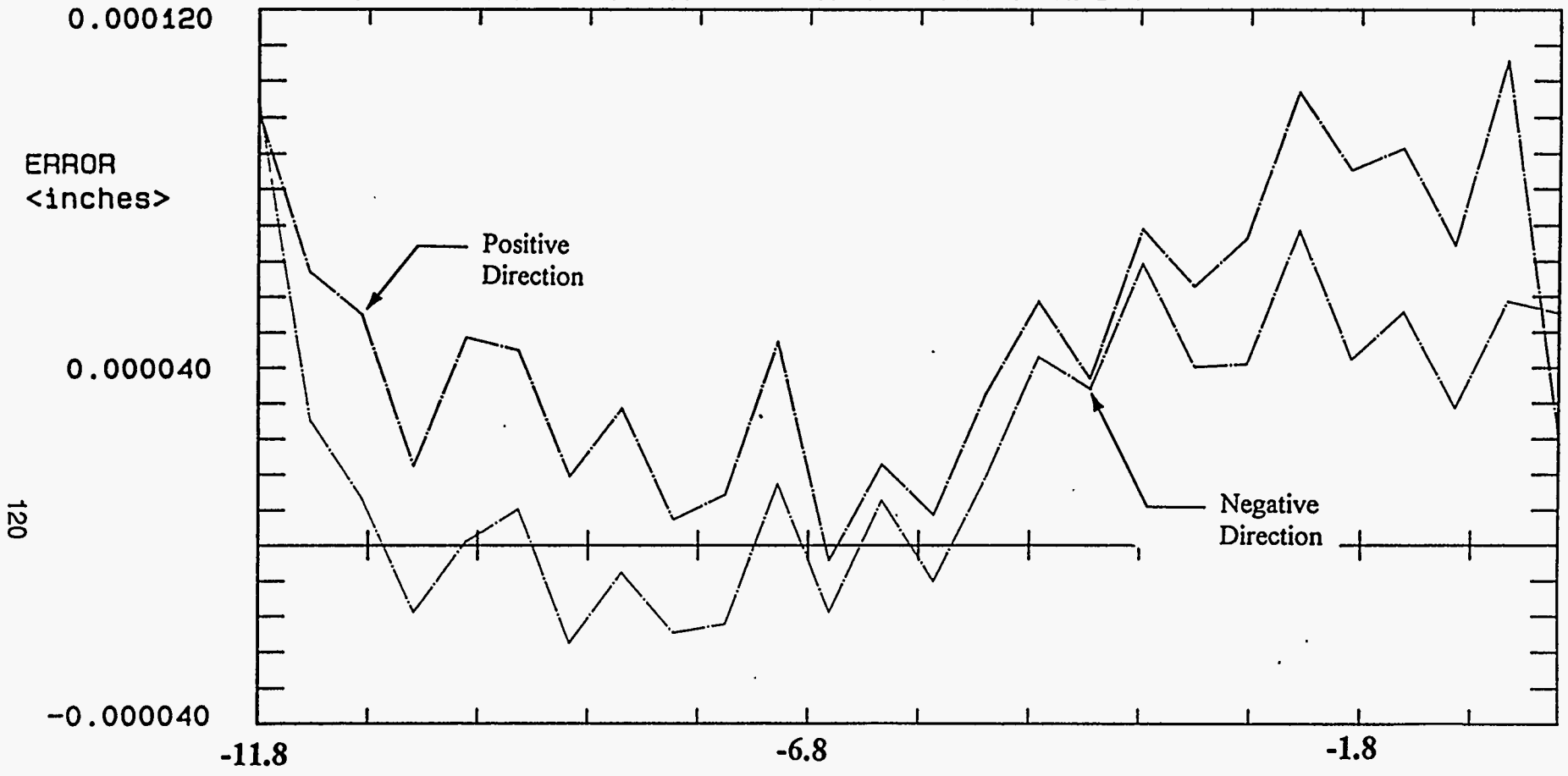
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -X-	DATE: 8/2/94 LOCATION: Bldg. 878/Rm. Y352 0-17.764"/.472" Inc.	

POSITIONING ERROR PLOT



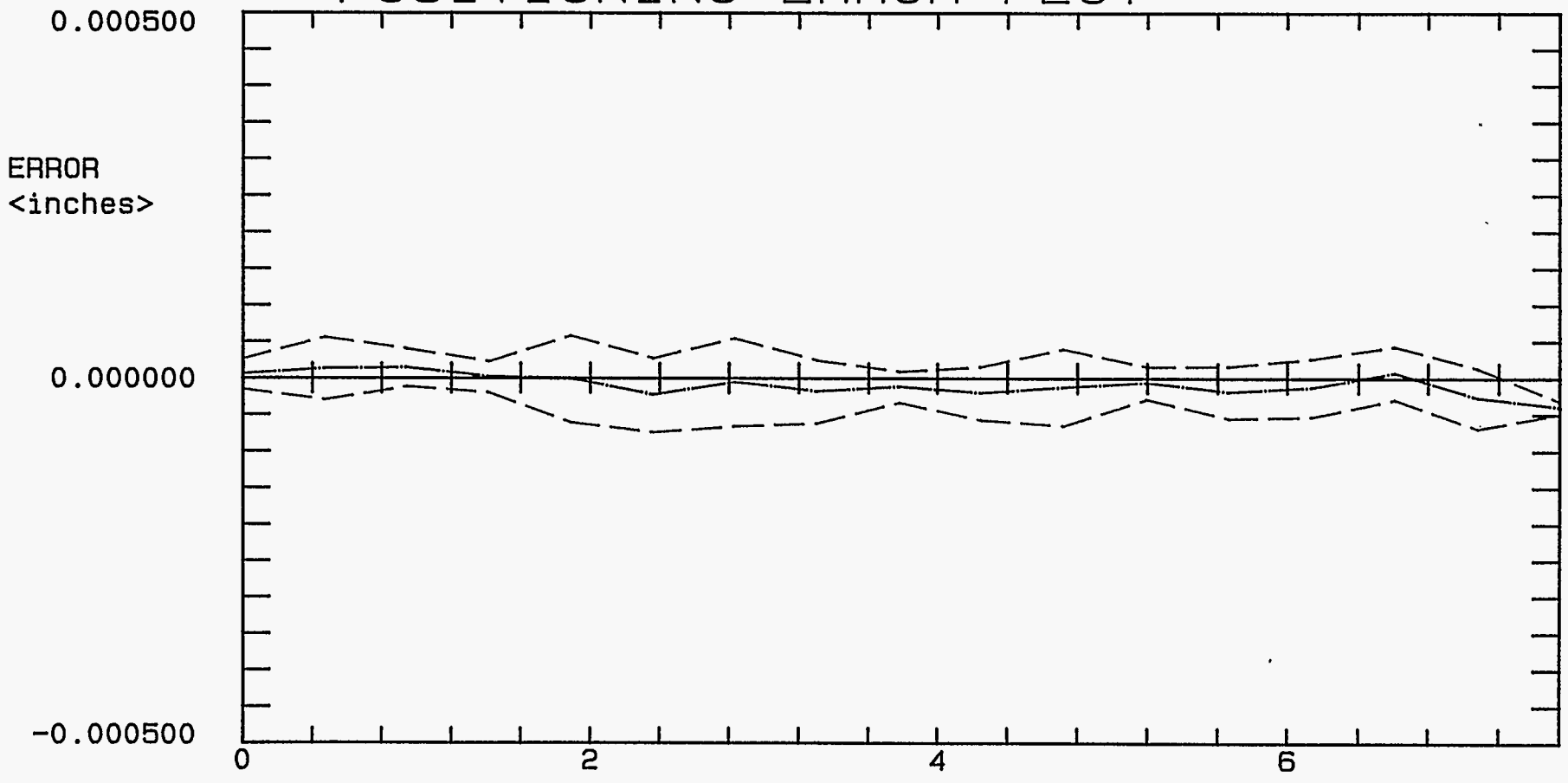
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Y-	DATE: 8/2/94 LOCATION: Bldg.878/Rm. Y352 0-(-11.8")/.472" Inc. FILE: BOS-Y-.LIN	ERROR BAND: 0.000278 NON REPEAT: 0.000223

POSITIONING ERROR PLOT

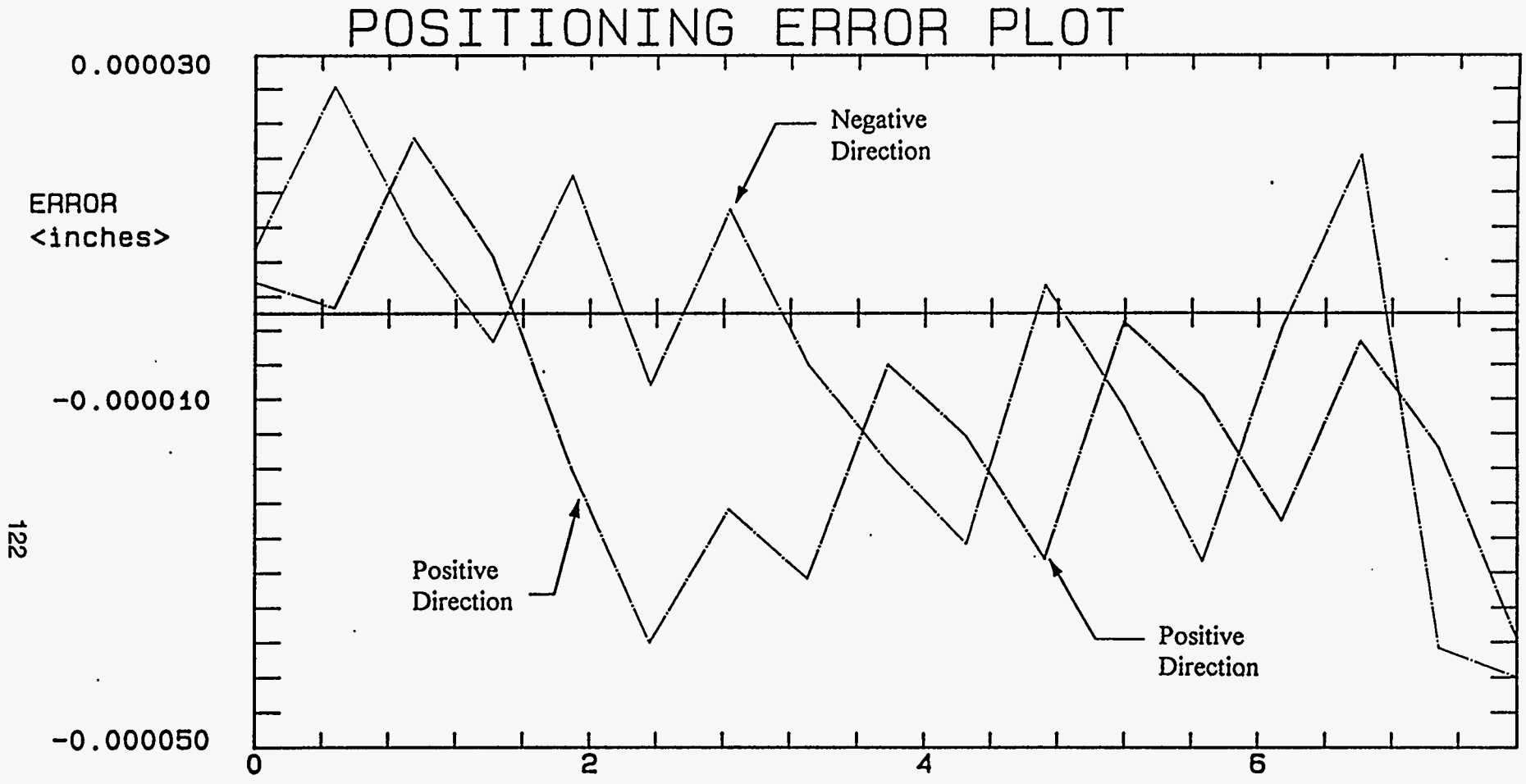


MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Y-	DATE: 8/2/94 LOCATION: Bldg.878/Rm. Y352 0-(-11.8")/.472" Inc.	

POSITIONING ERROR PLOT

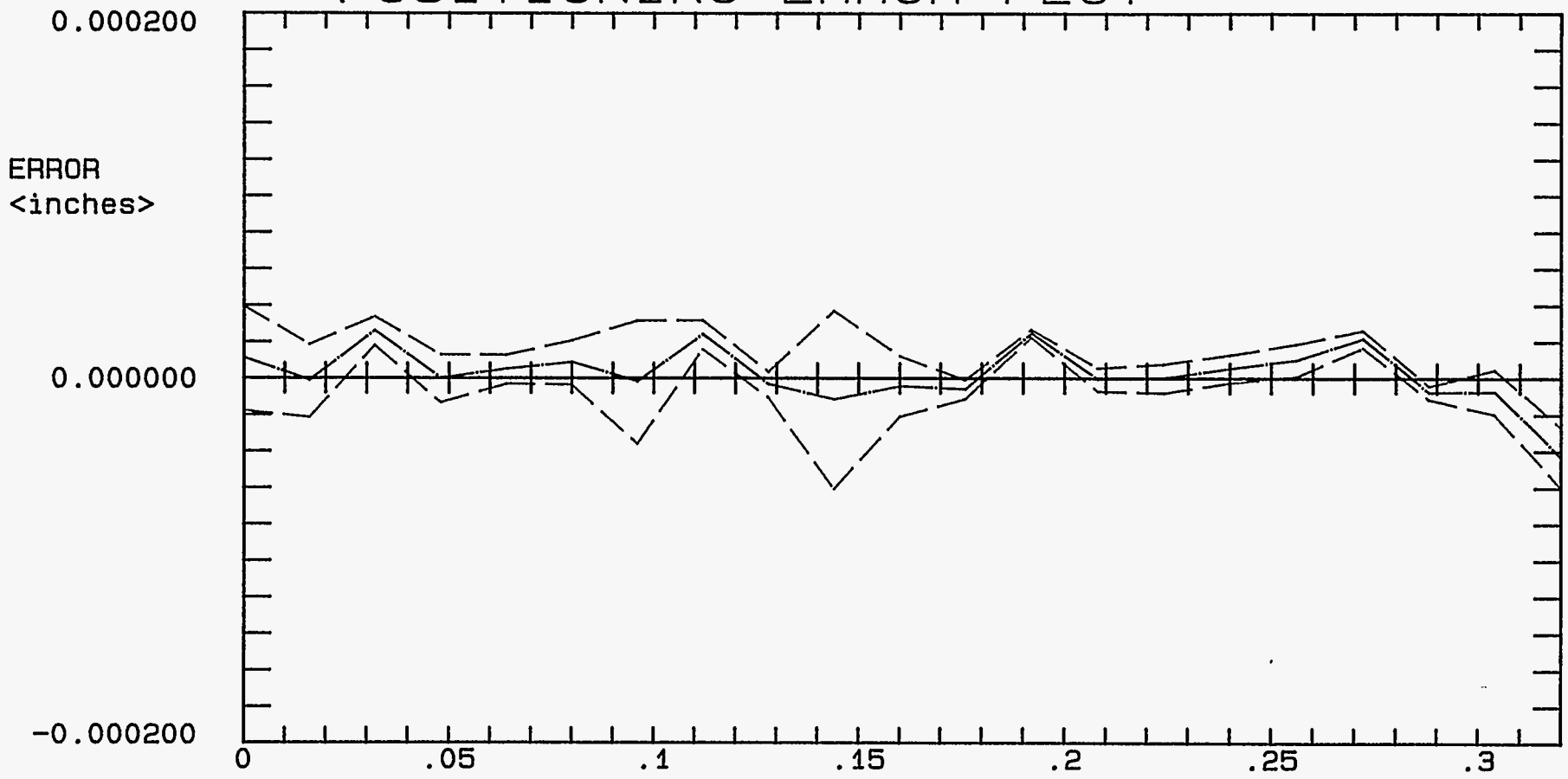


MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Z-	DATE: 8/2/94 LOCATION: Bldg.878/Rm. Y352 0-7.552"/.472" Inc. FILE: BOS-Z-.LIN	ERROR BAND: 0.000132 NON REPEAT: 0.000120



MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Z-	DATE: 8/2/94 LOCATION: Bldg.878/Rm. Y352 0-7.552"/.472" Inc.	

POSITIONING ERROR PLOT



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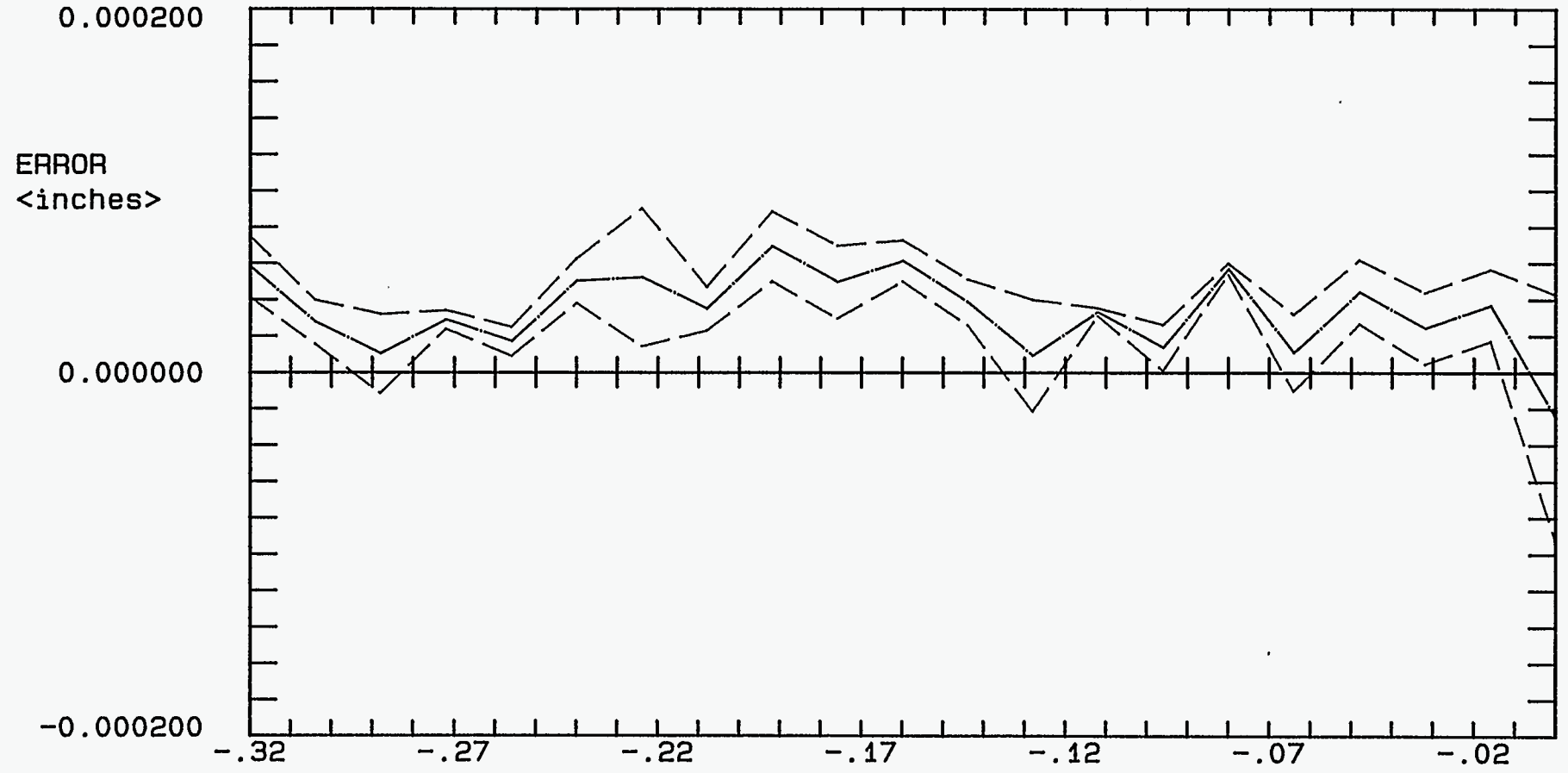
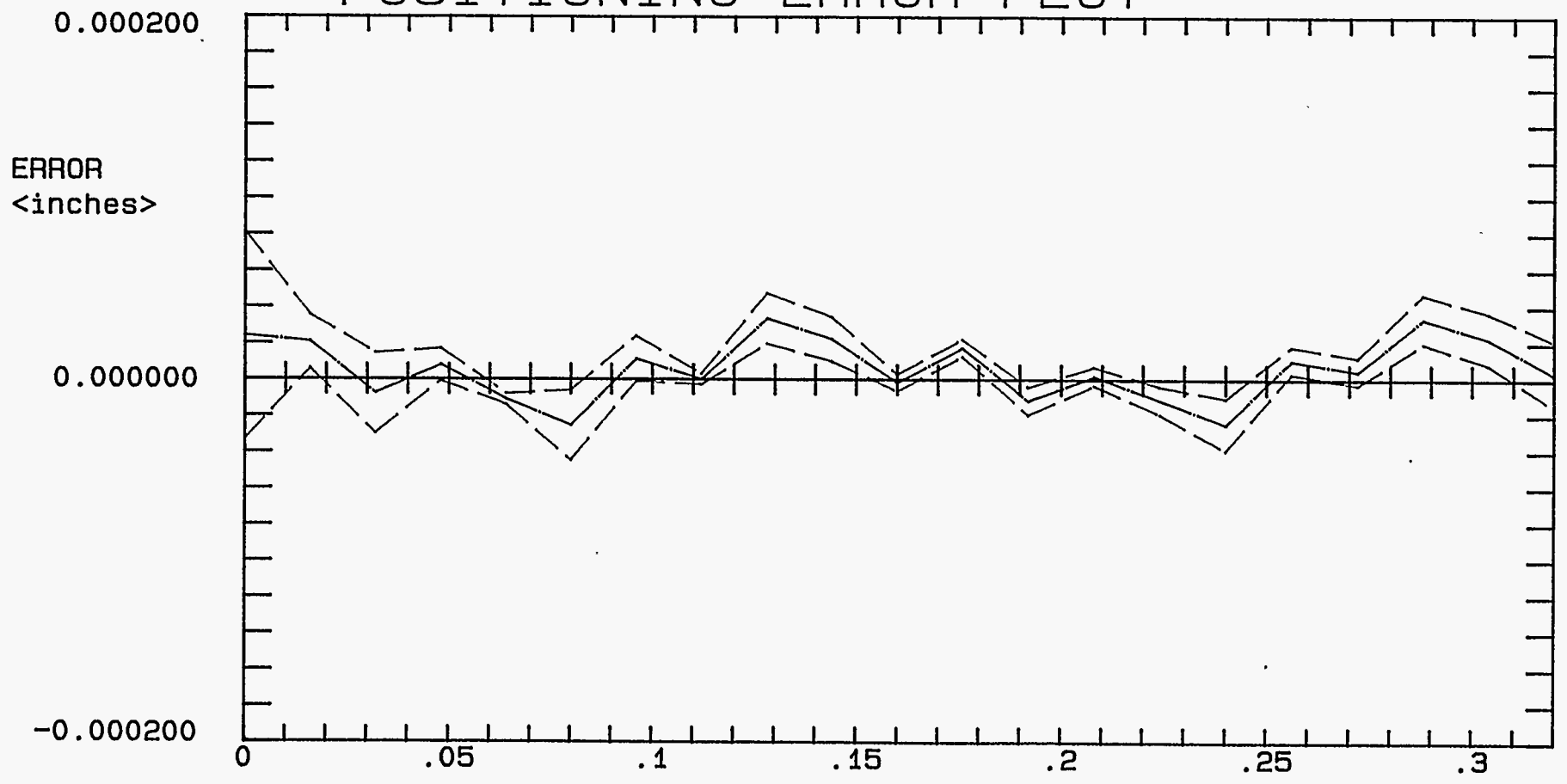
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -X- "Periodic Error"	DATE: 8/2/94 LOCATION: Bldg. 878/Rm. Y352 0-.320"/ .016" Inc. FILE: BOSXP.LIN	ERROR BAND: 0.000100 NON REPEAT: 0.000098

POSITIONING ERROR PLOT



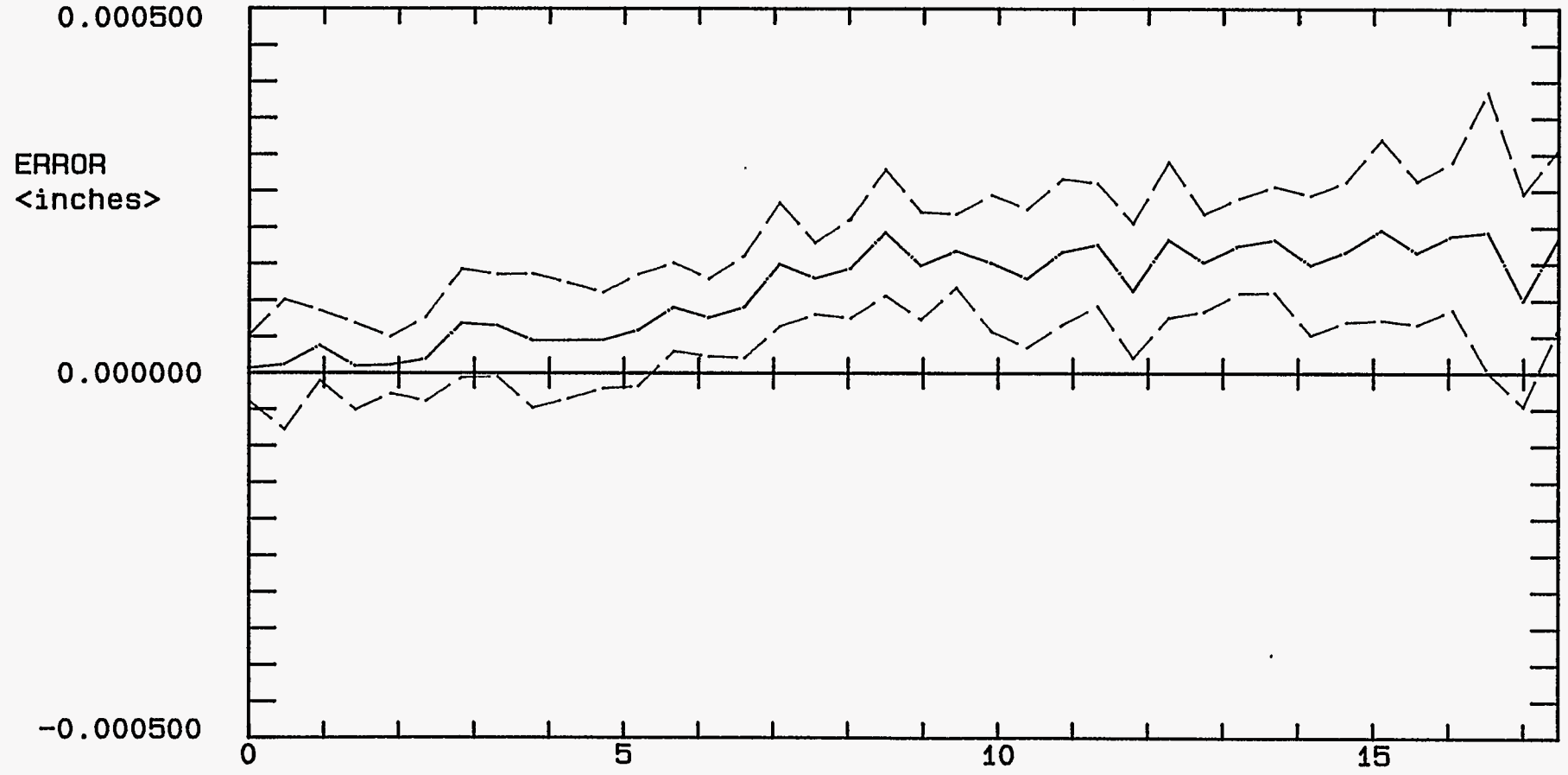
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Y- "Periodic Error"	DATE: 8/2/94 LOCATION: Bldg.878/Rm. Y352 0-(-.320")/.016" Inc. FILE: BOSYP.LIN	ERROR BAND: 0.000183 NON REPEAT: 0.000135

POSITIONING ERROR PLOT

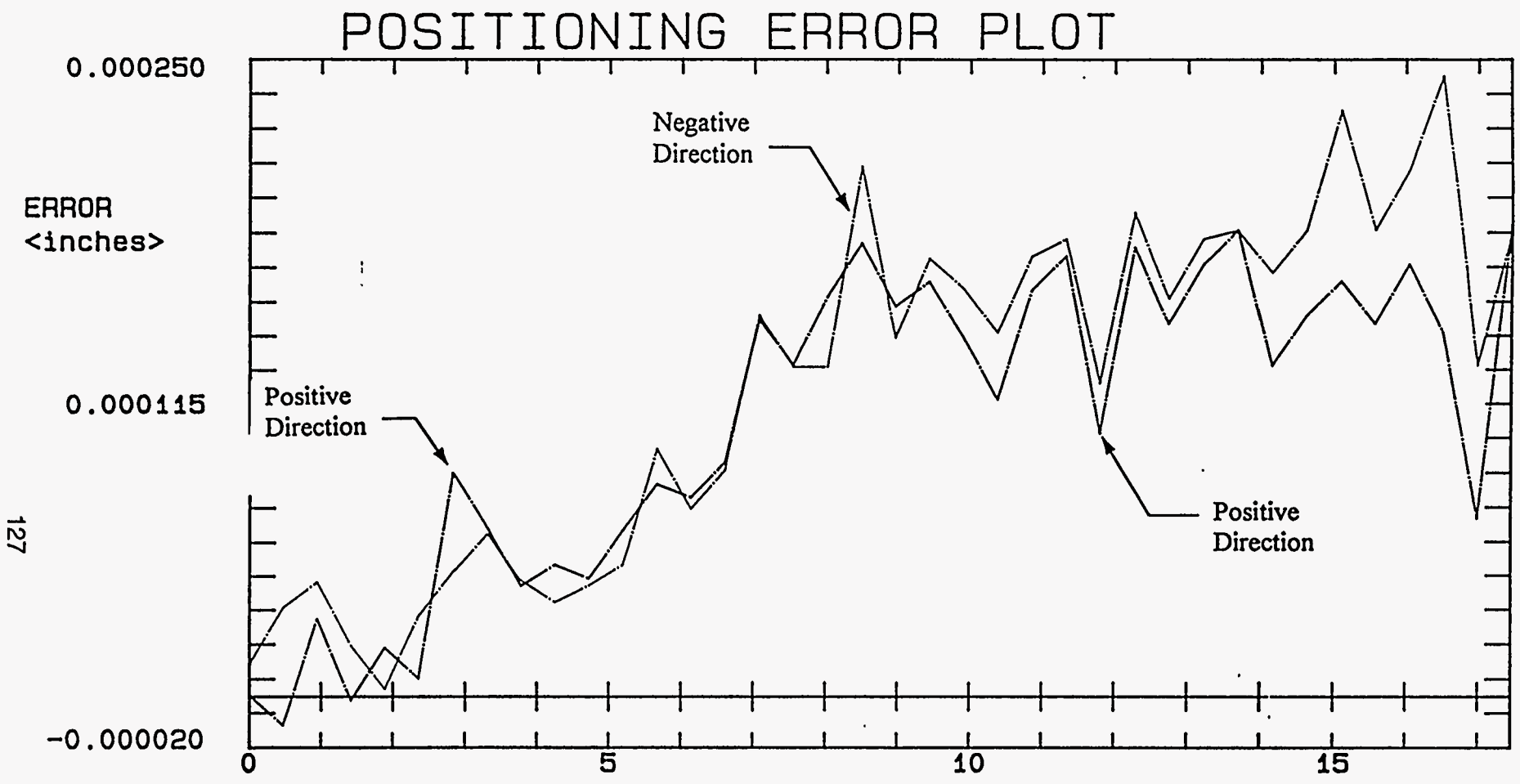


MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Z- "Periodic Error"	DATE: 8/2/94 LOCATION: Bldg.878/Rm. Y352 0-.320"/ .016" Inc. FILE: BOSZP.LIN	ERROR BAND: 0.000126 NON REPEAT: 0.000114

POSITIONING ERROR PLOT

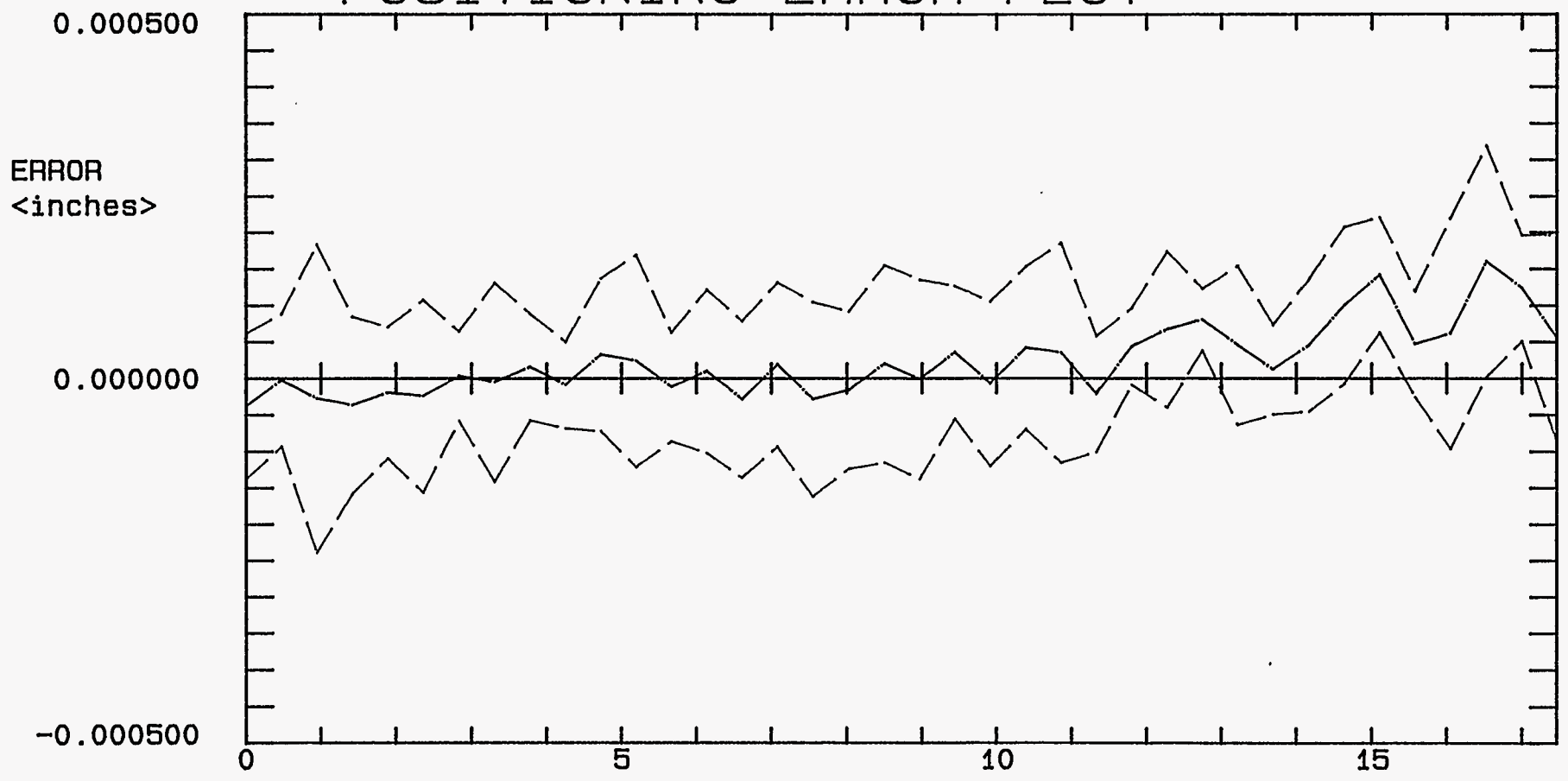


MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: Diagonal #1	DATE: 8/8/94 LOCATION: Bldg.878/ Rm. Y352 0-17.464" / .472" Inc. FILE: DIAG_1.LIN	ERROR BAND: 0.000463 NON REPEAT: 0.000384

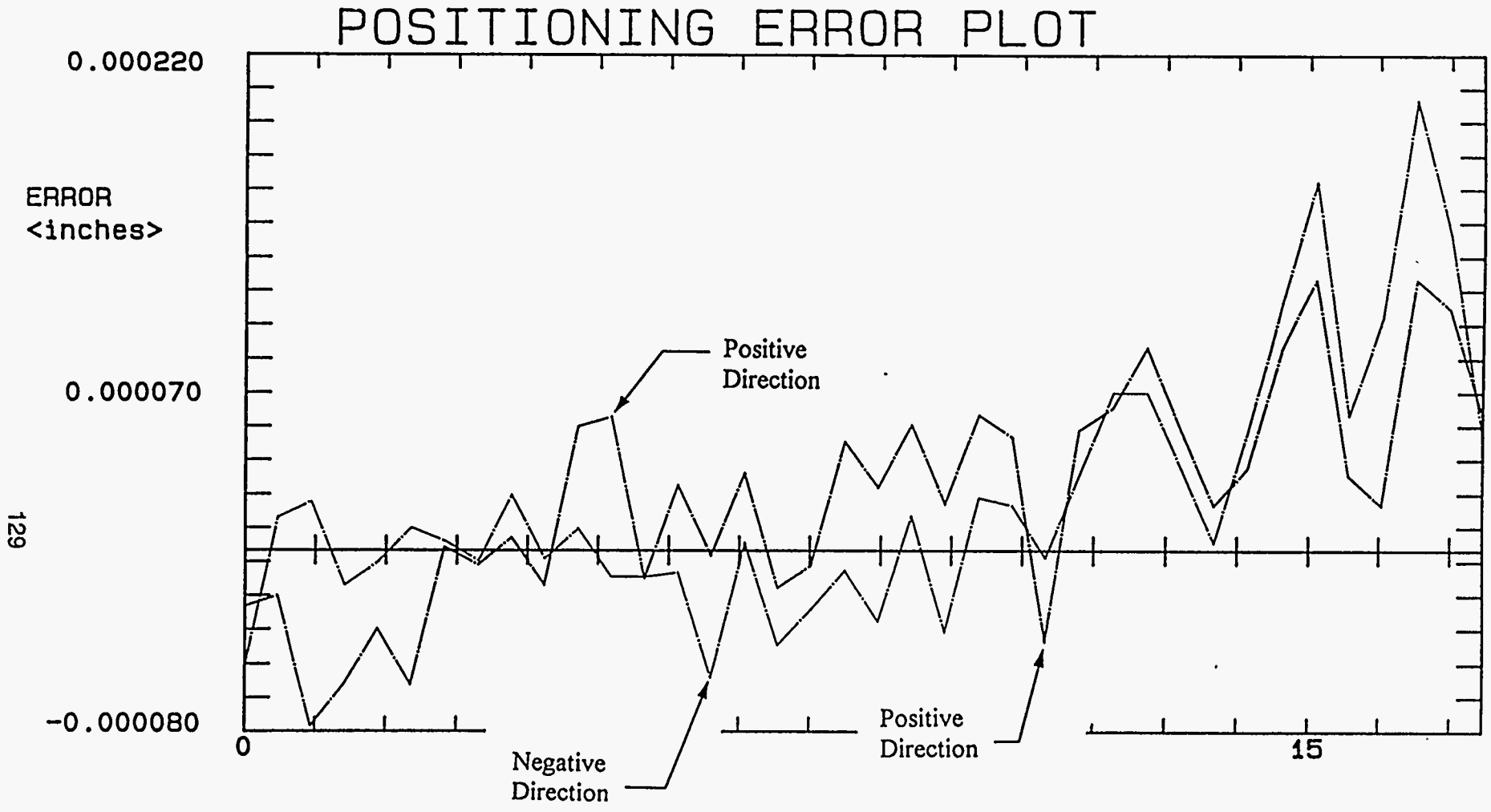


MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: Diagonal #1	DATE: 8/8/94 LOCATION: Bldg. 878/Rm. Y352 0-17.464"/.472" Inc.	

POSITIONING ERROR PLOT



MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: Diagonal #2	DATE: 8/4/94 LOCATION: Bldg.878/ Rm. Y352 0-17.464" / .472" Inc. FILE: DIAG_2.LIN	ERROR BAND: 0.000558 NON REPEAT: 0.000422



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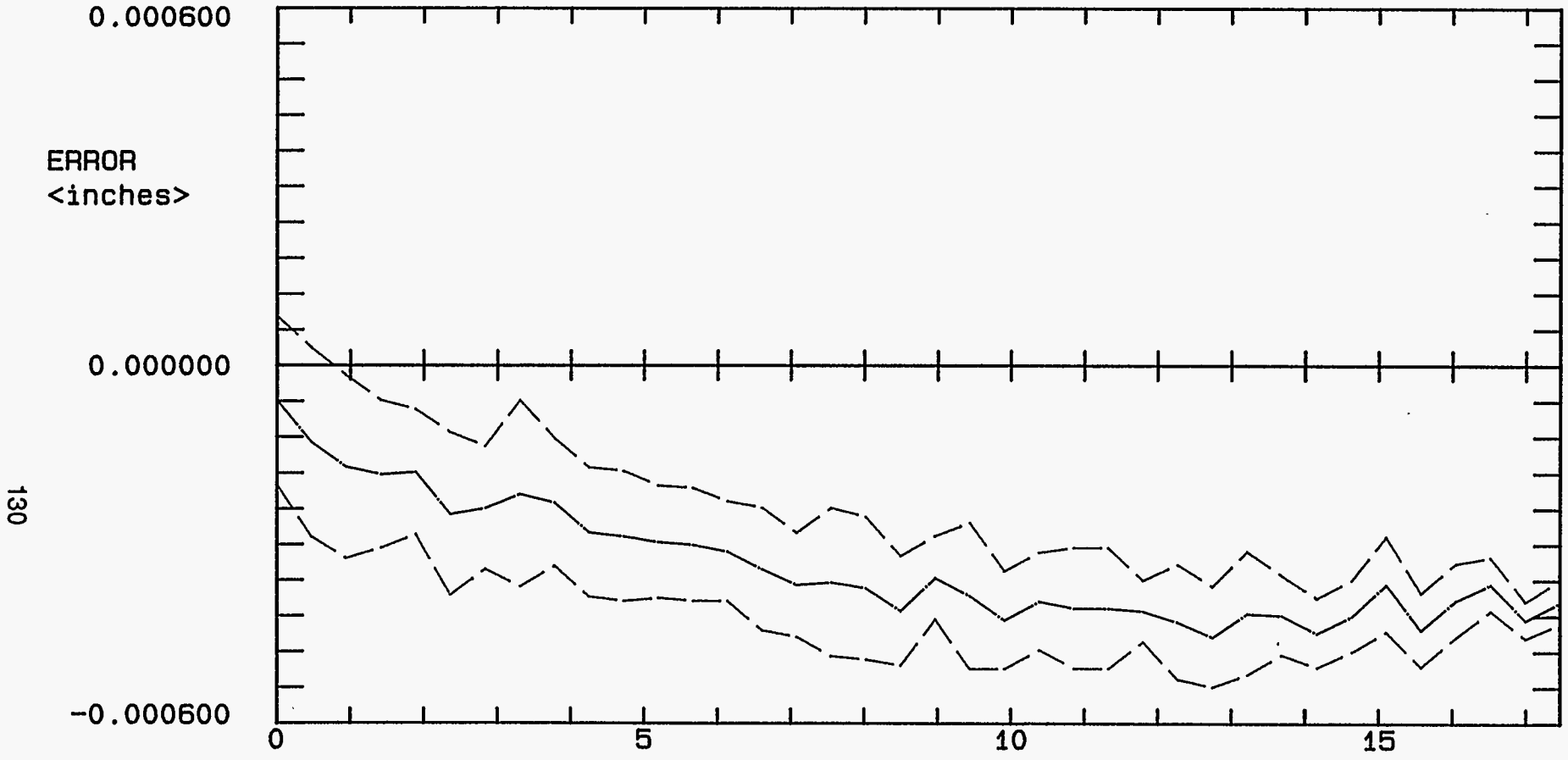
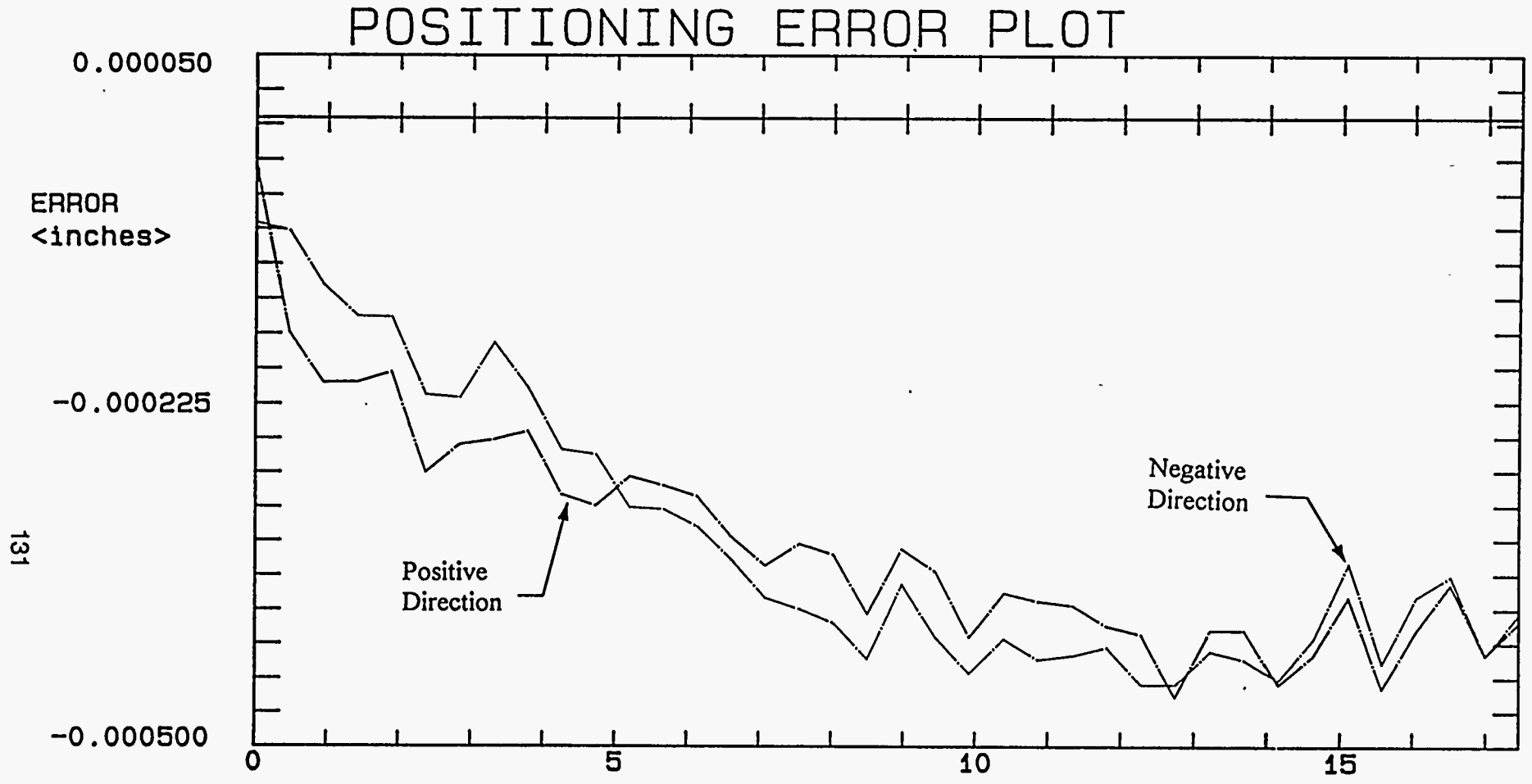
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: Diagonal #2	DATE: 8/4/94 LOCATION: Bldg.878/ Rm. Y352 "0-17.464"" / .472""Inc."	

POSITIONING ERROR PLOT



MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: Diagonal #3	DATE: 8/4/94 LOCATION: Bldg.878/ Rm. Y352 0-17.464" / .472" Inc. FILE: BOSDM3.LIN	ERROR BAND: 0.000622 NON REPEAT: 0.000317



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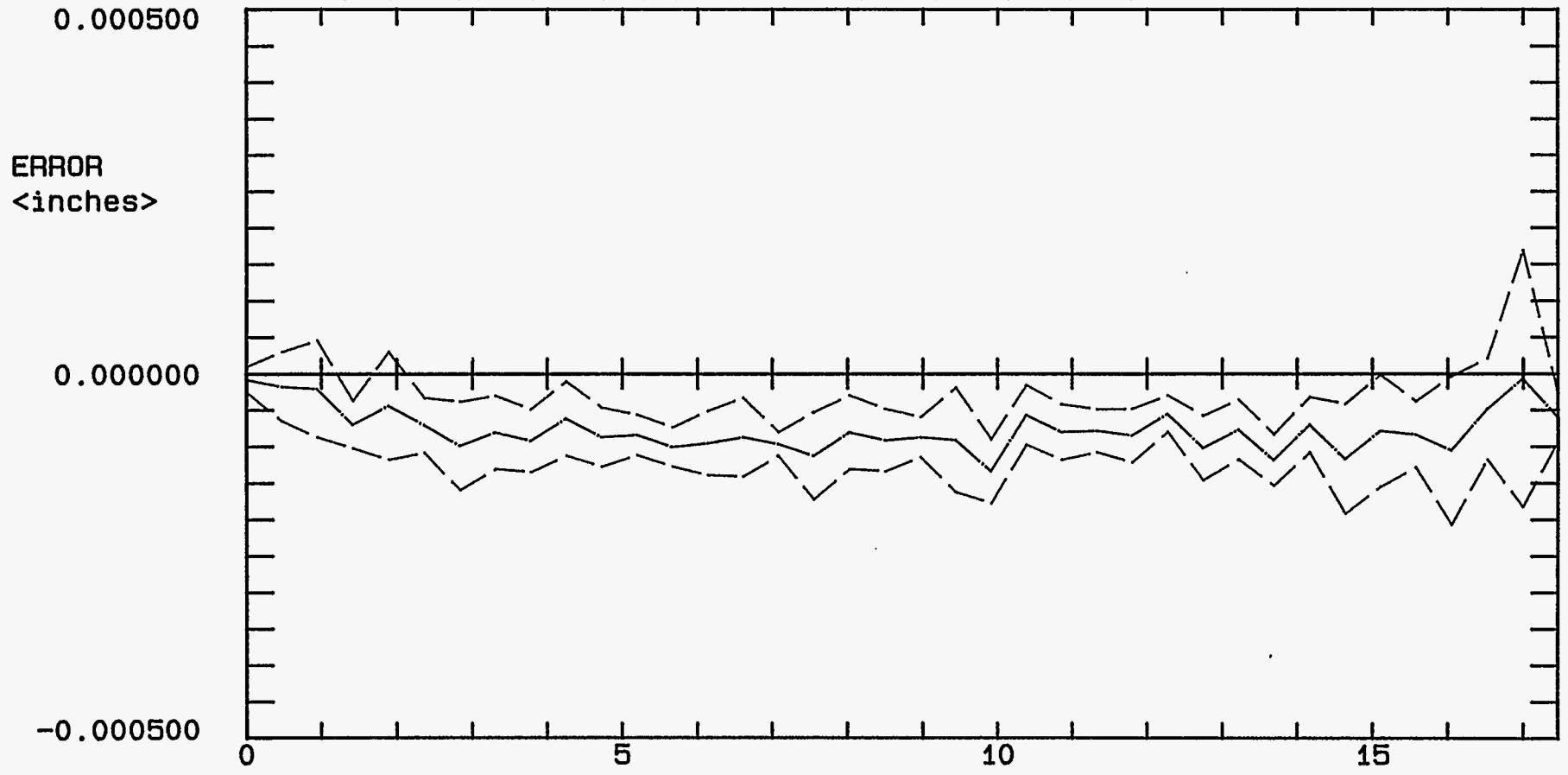
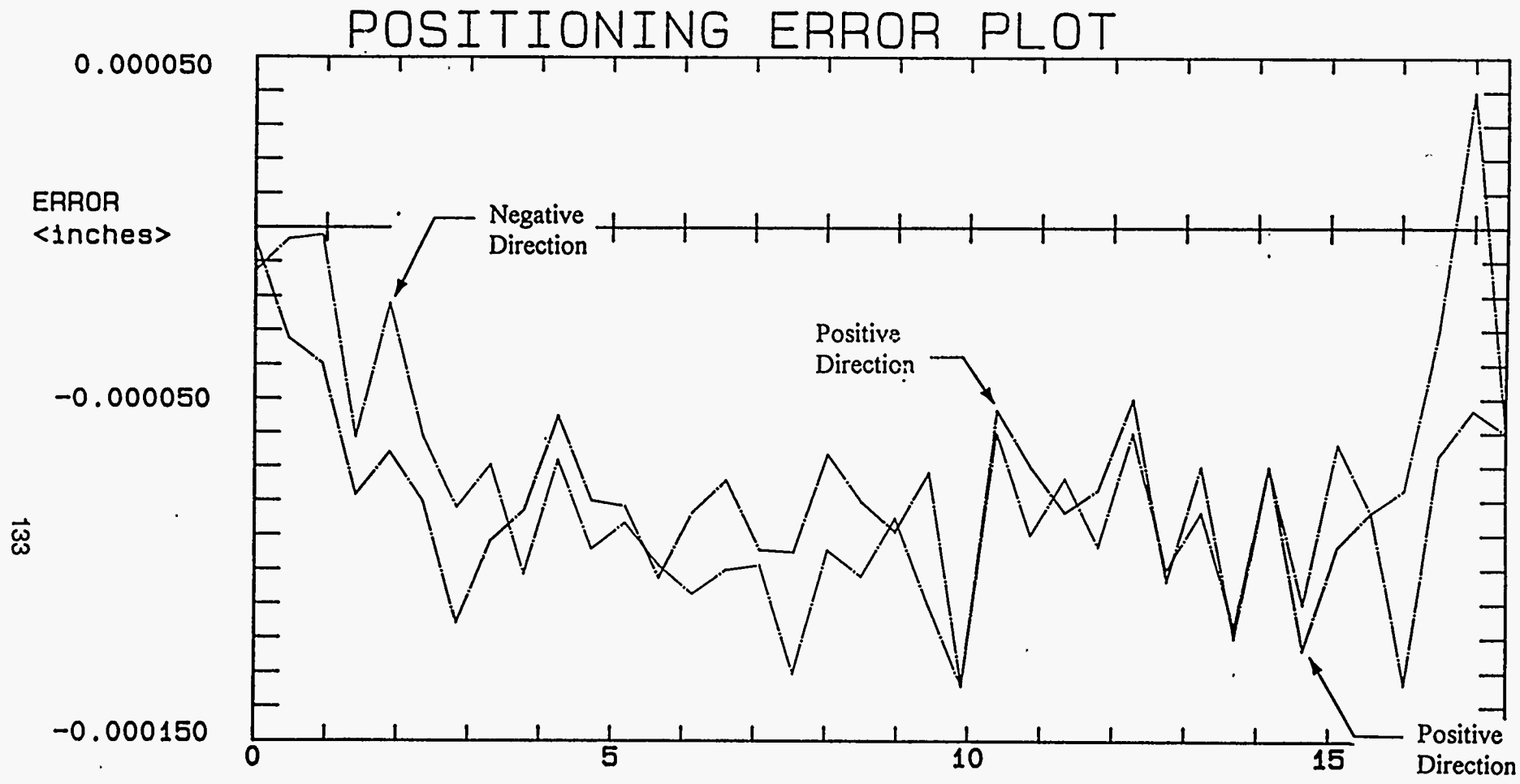
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: Diagonal #3	DATE: 8/4/94 LOCATION: Bldg.878/ Rm. Y352 "0-17.464"" / .472""Inc." _	

POSITIONING ERROR PLOT

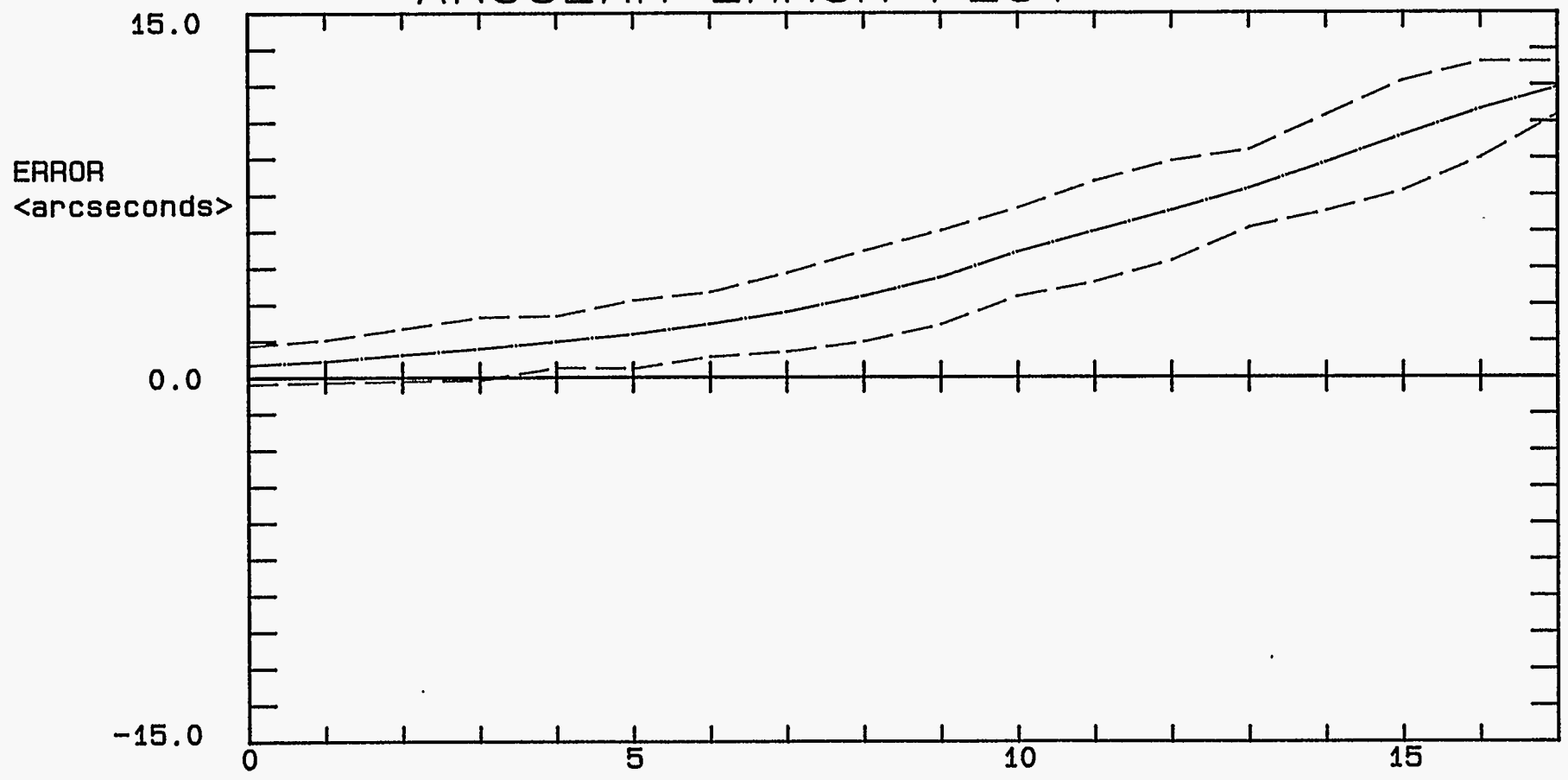


MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: Diagonal #4	DATE: 8/4/94 LOCATION: Bldg.878/ Rm. Y352 0-17.464" / .472" Inc. FILE: BOSDM4.LIN	ERROR BAND: 0.000376 NON REPEAT: 0.000351



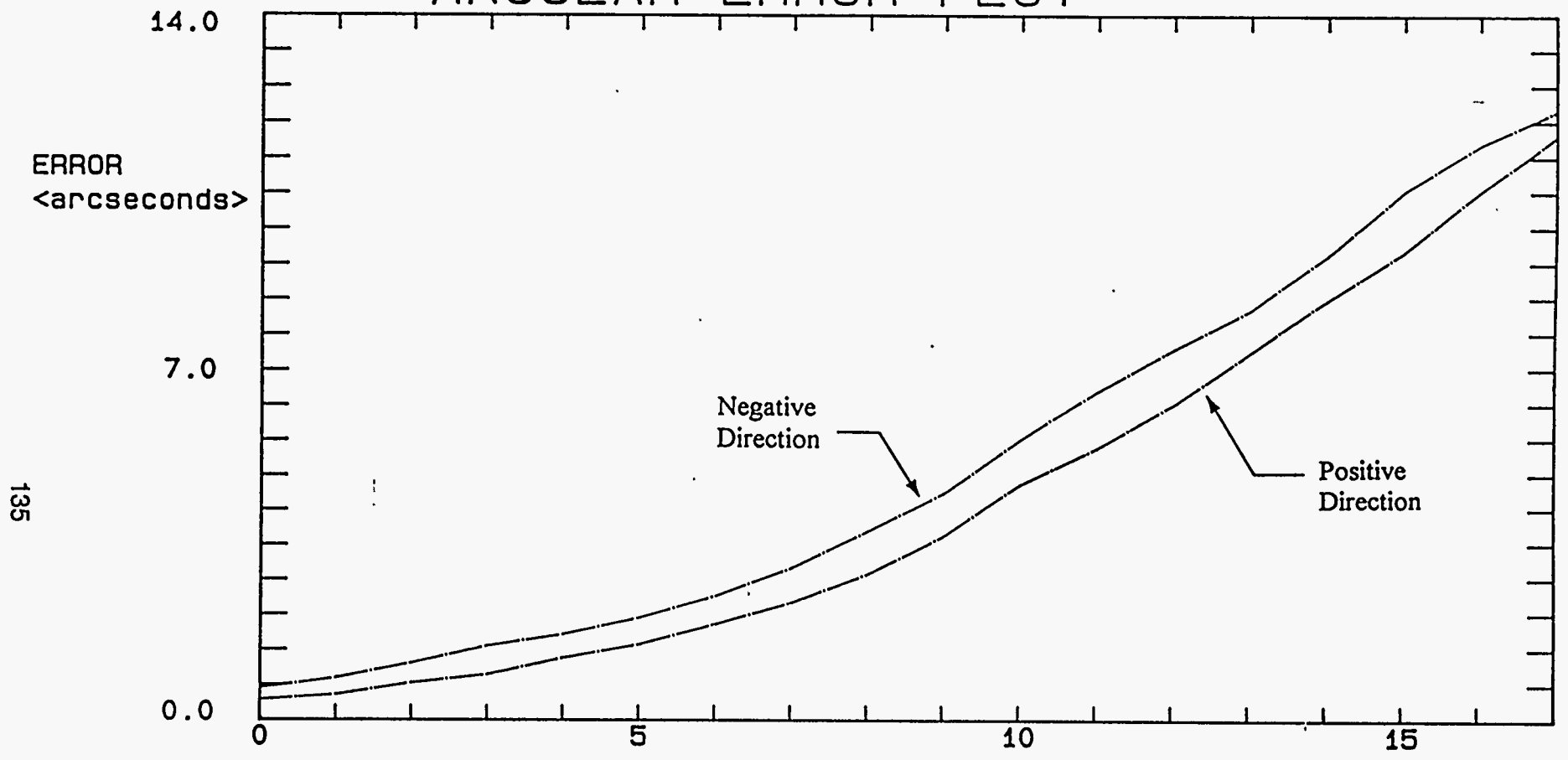
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: Diagonal #4	DATE: 8/4/94 LOCATION: Bldg.878/ Rm. Y352 "0-17.464"" / .472""Inc."	

ANGULAR ERROR PLOT



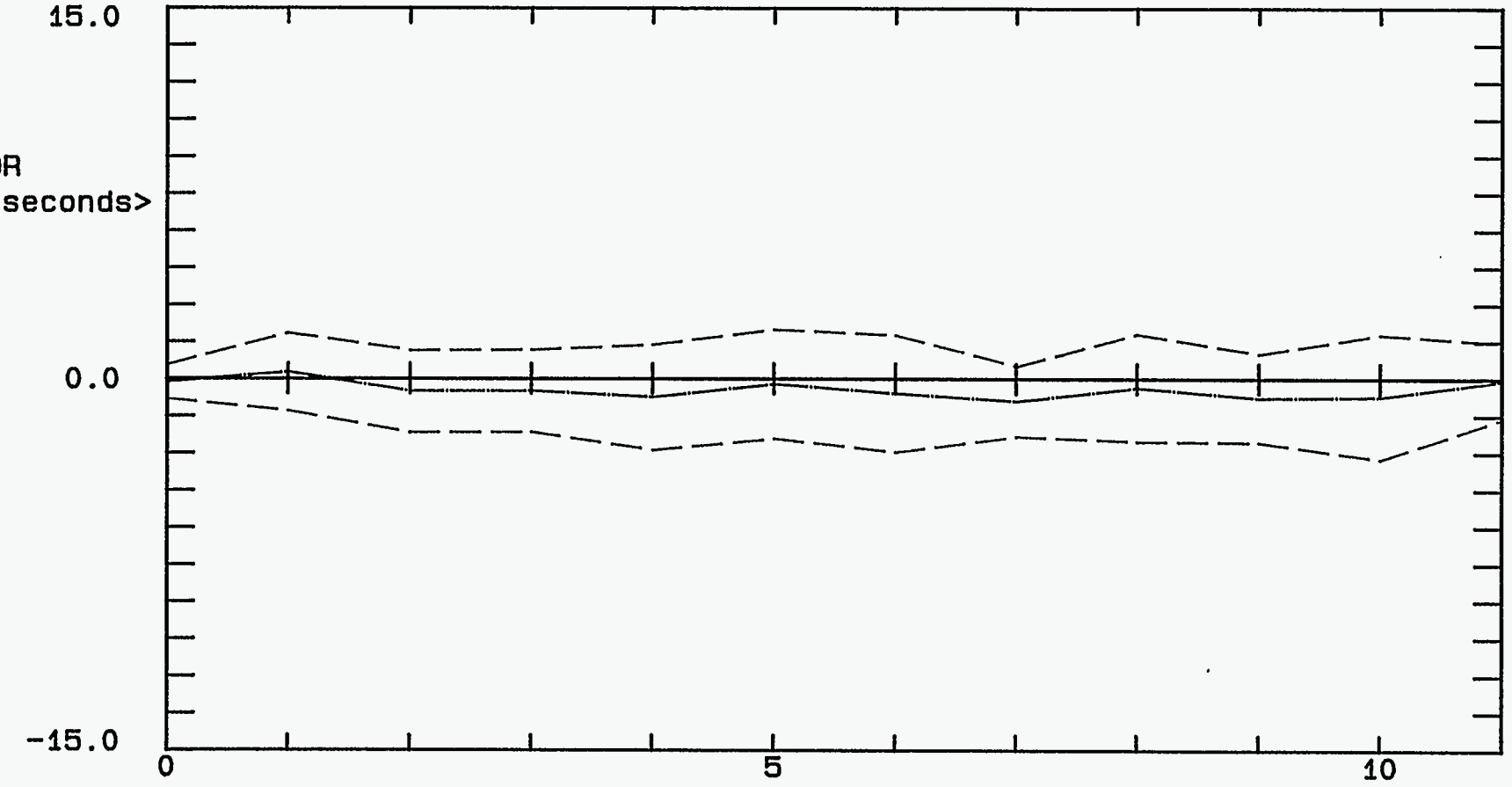
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -X- "Pitch"	DATE: 8/3/94 LOCATION: Bldg.878/Rm. Y352 0-17" / 1" Inc. FILE: BOSXPIT.ANG	+/- 3 SIGMA ERROR BAND: 13.2 NON REPEAT: 4.5

ANGULAR ERROR PLOT

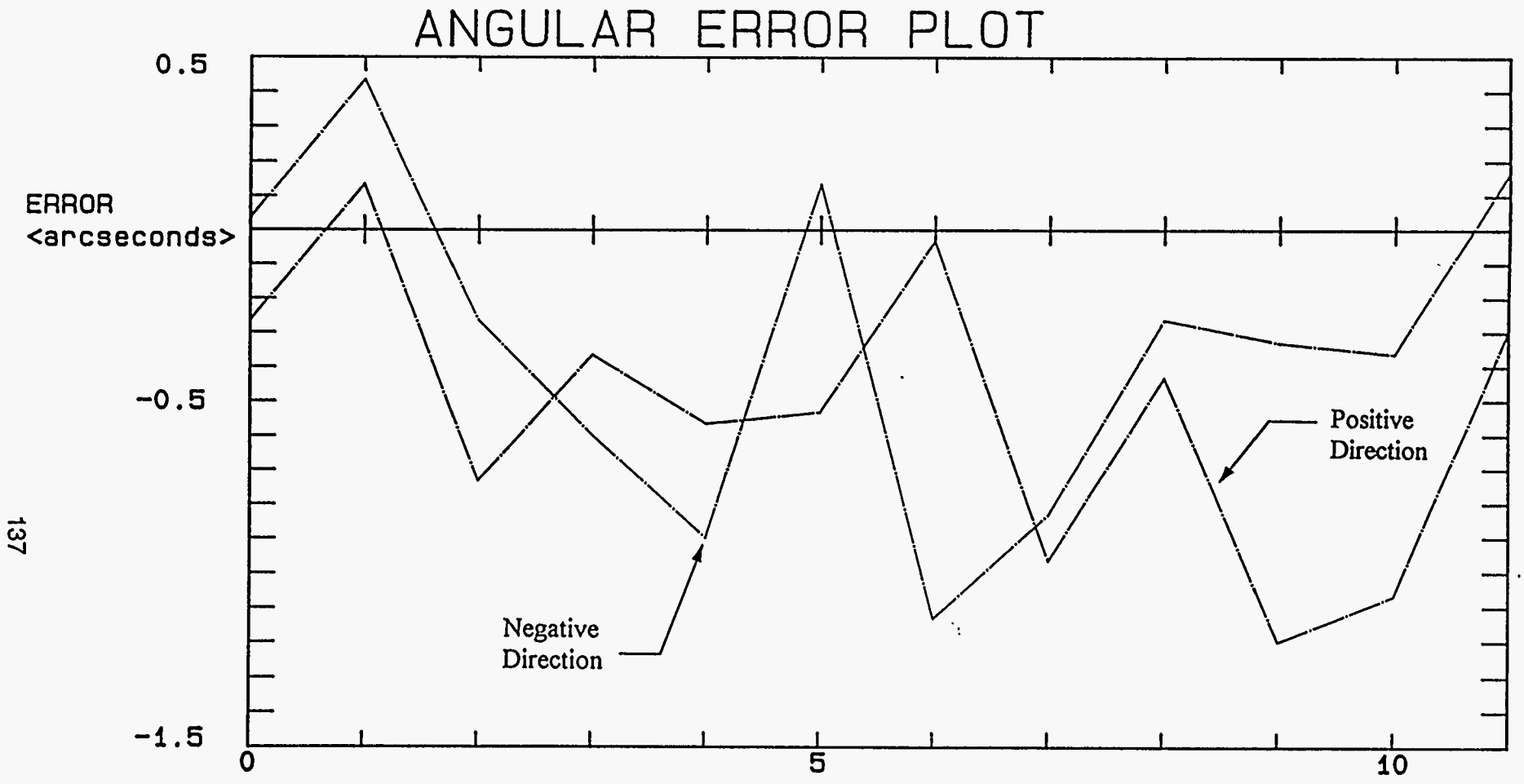


MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -X- "Pitch"	DATE: 8/3/94 LOCATION: Bldg.878/Rm. Y352 0-17" / 1" Inc.	

ANGULAR ERROR PLOT

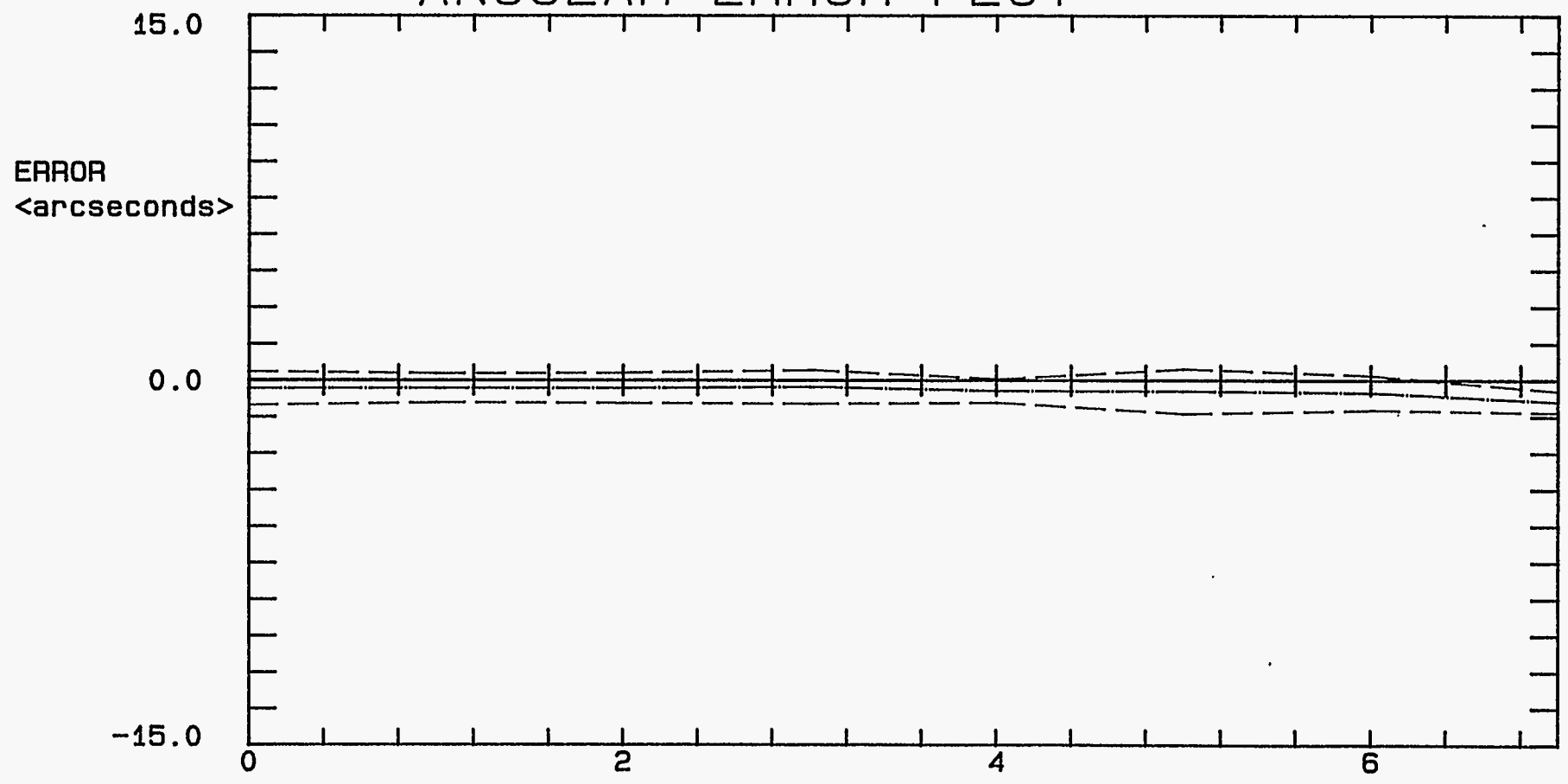


MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Y- "Pitch"	DATE: 8/3/94 LOCATION: Bldg.878/ Rm. Y352 0-11" / 1" Inc. FILE: BOSYPIT.ANG	+/- 3 SIGMA ERROR BAND: 5.2 NON REPEAT: 5.0



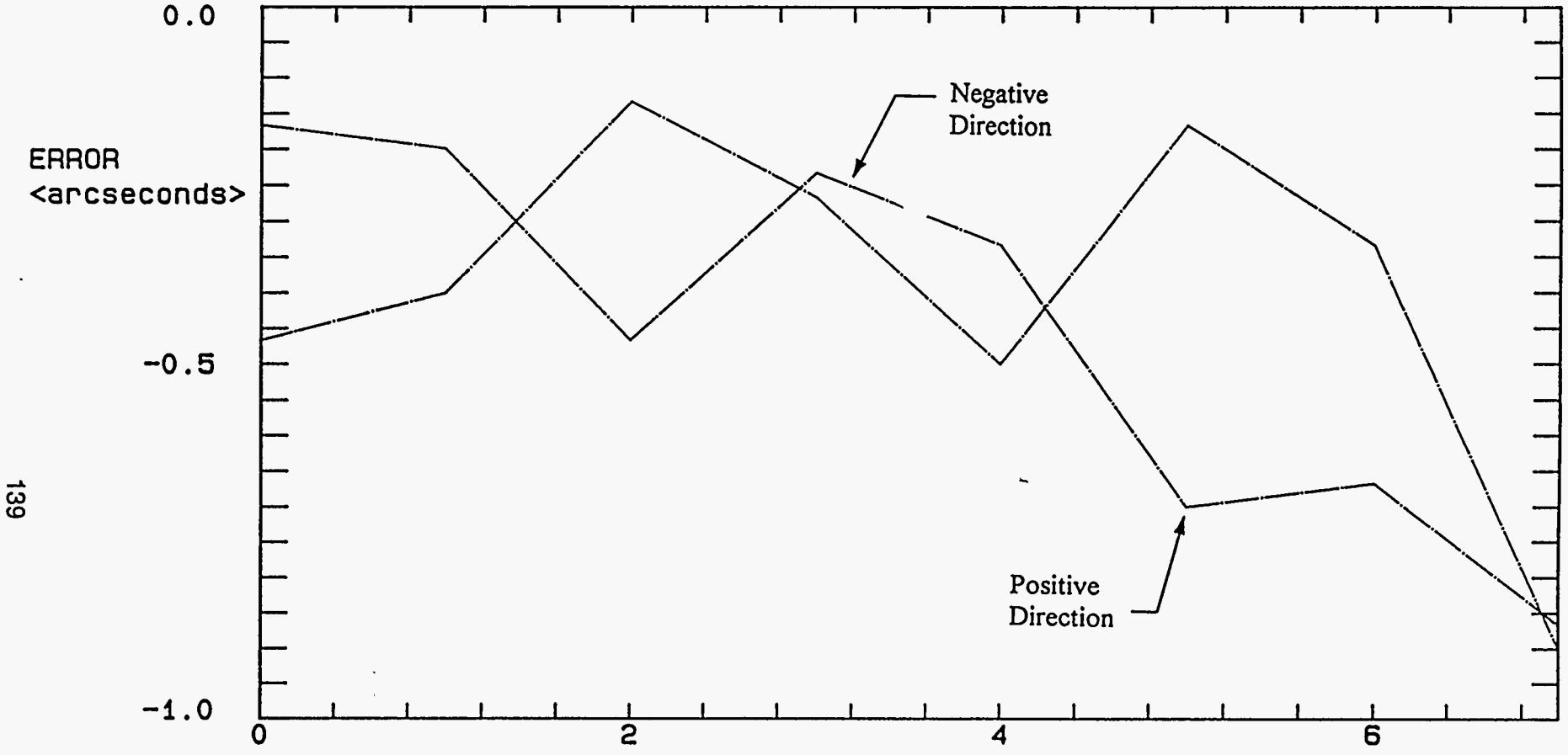
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Y- "Pitch"	DATE: 8/3/94 LOCATION: Bldg.878/ Rm. Y352 0-11" / 1" Inc.	

ANGULAR ERROR PLOT



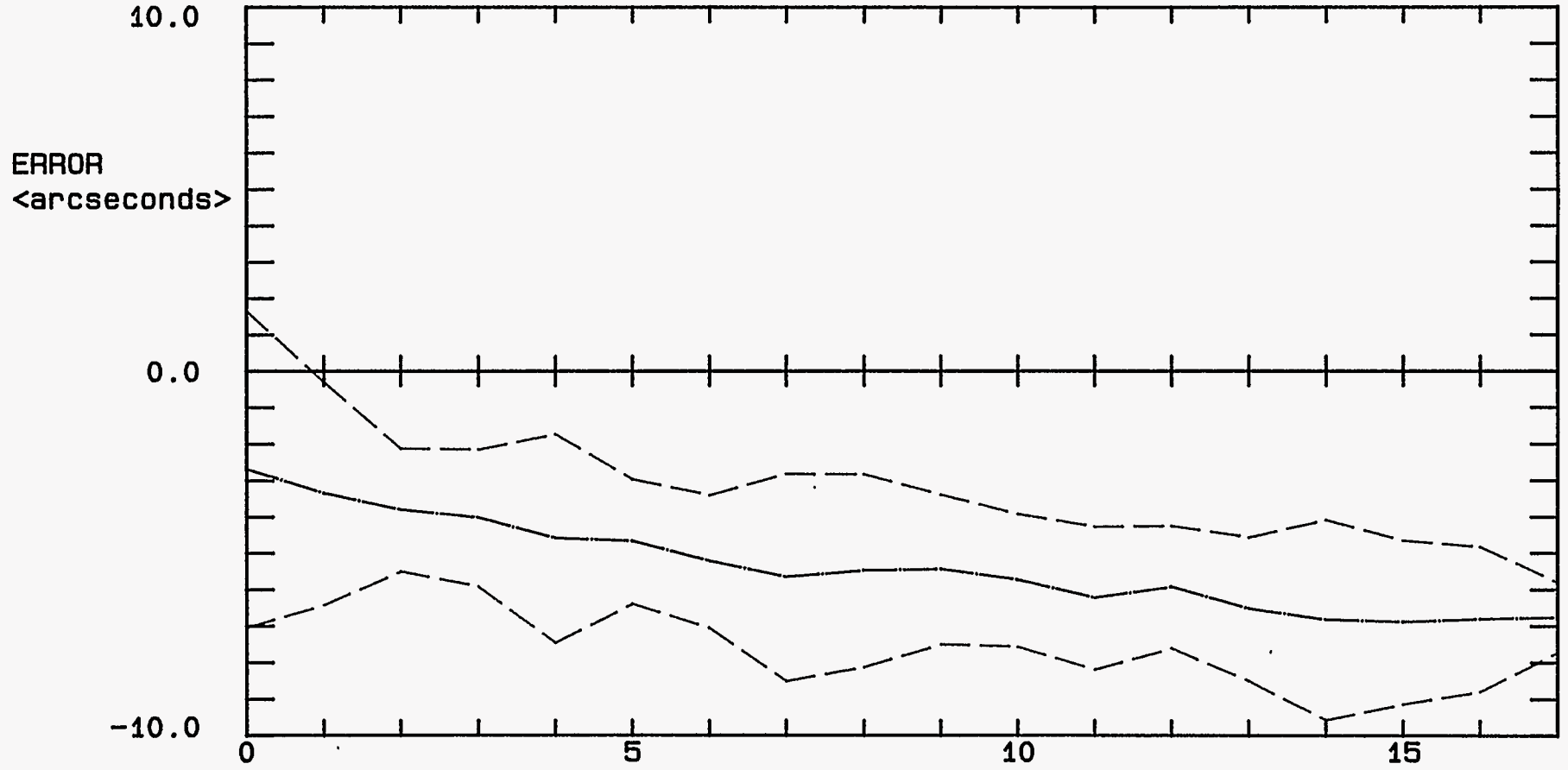
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Z- "Pitch"	DATE: 8/3/94 LOCATION: Bldg.878/ Rm. Y352 0-7" / 1" Inc. FILE: BOSZPIT.ANG	+/- 3 SIGMA ERROR BAND: 1.8 NON REPEAT: 1.8

ANGULAR ERROR PLOT

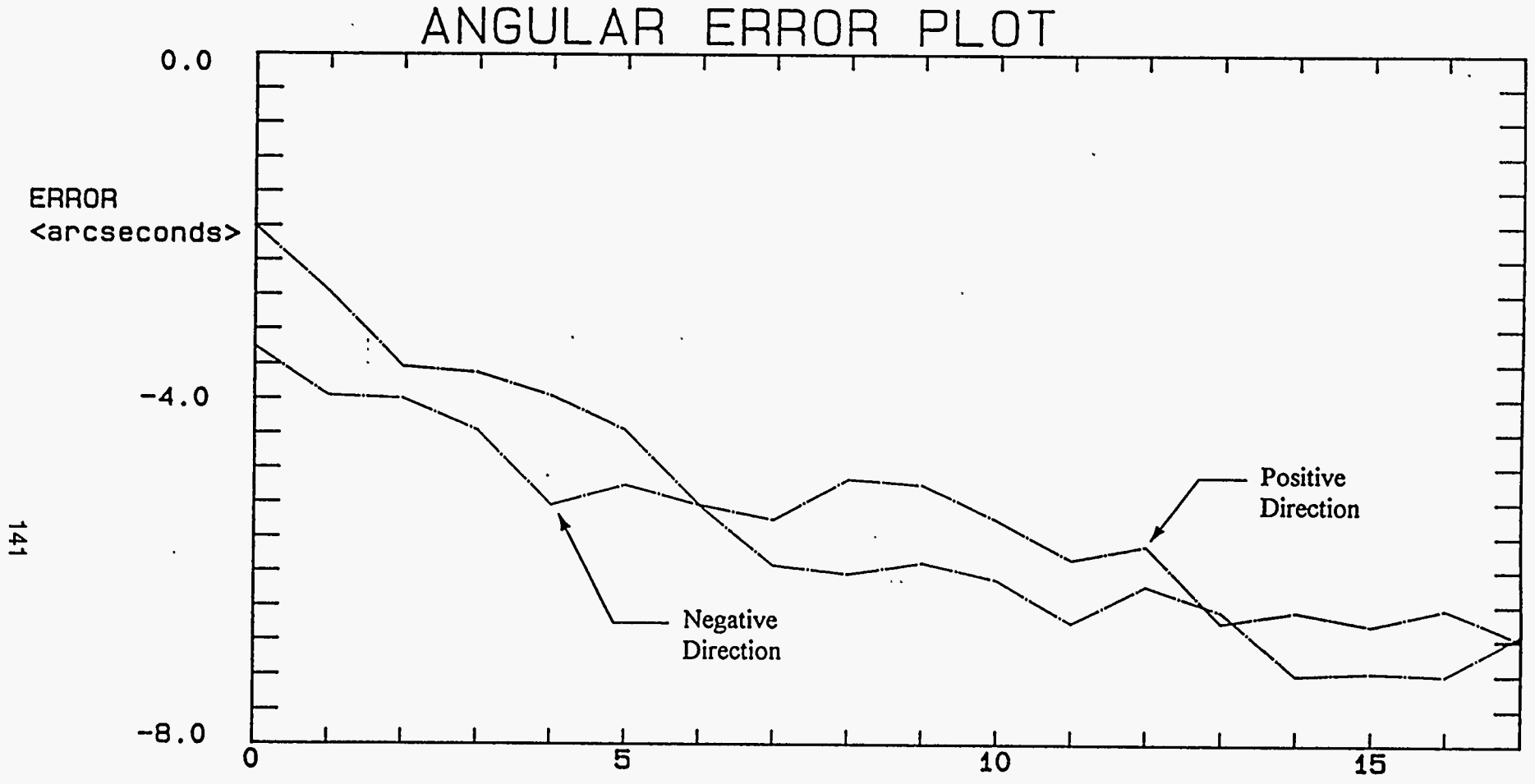


MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Z- "Pitch"	DATE: 8/3/94 LOCATION: Bldg.878/ Rm. Y352 0-7" / 1" Inc.	

ANGULAR ERROR PLOT

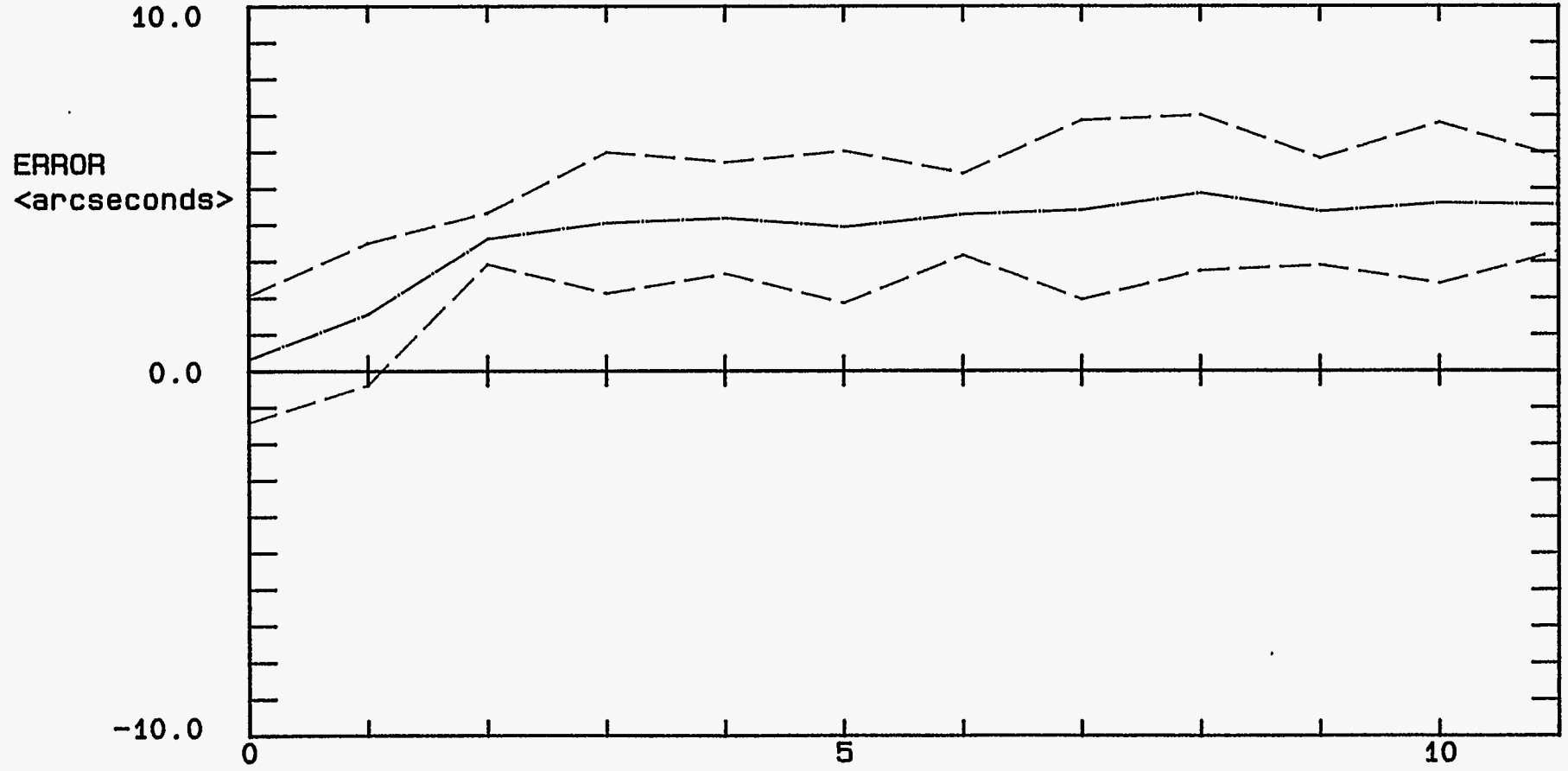


MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -X- "Yaw"	DATE: 8/3/94 LOCATION: Bldg.878/ Rm. Y352 0-17" / 1" Inc. FILE: BOSXYAW.ANG	+/- 3 SIGMA ERROR BAND: 11.2 NON REPEAT: 8.7



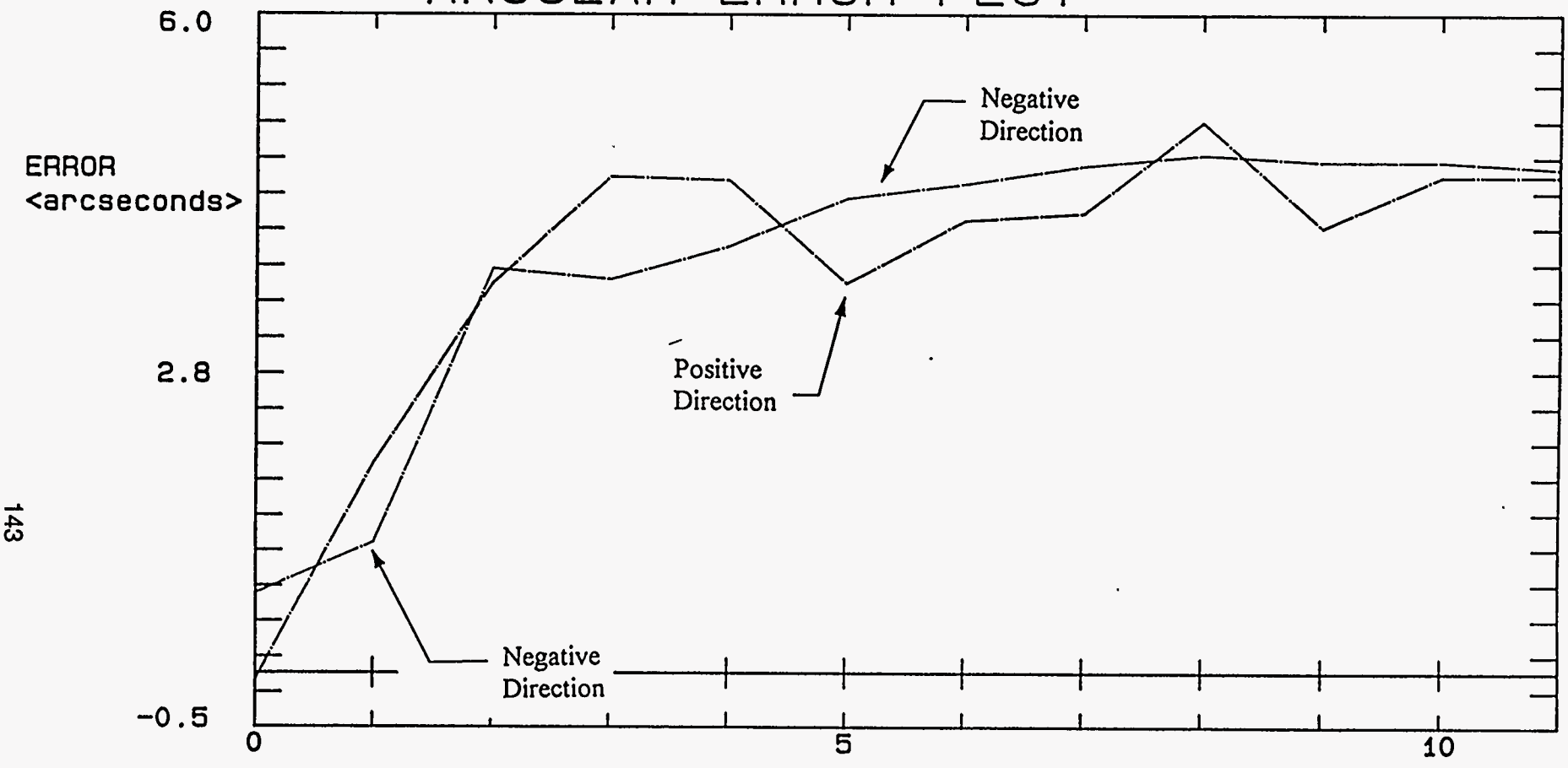
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -X- "Yaw"	DATE: 8/3/94 LOCATION: Bldg.878/ Rm. Y352 0-17" / 1" Inc.	

ANGULAR ERROR PLOT



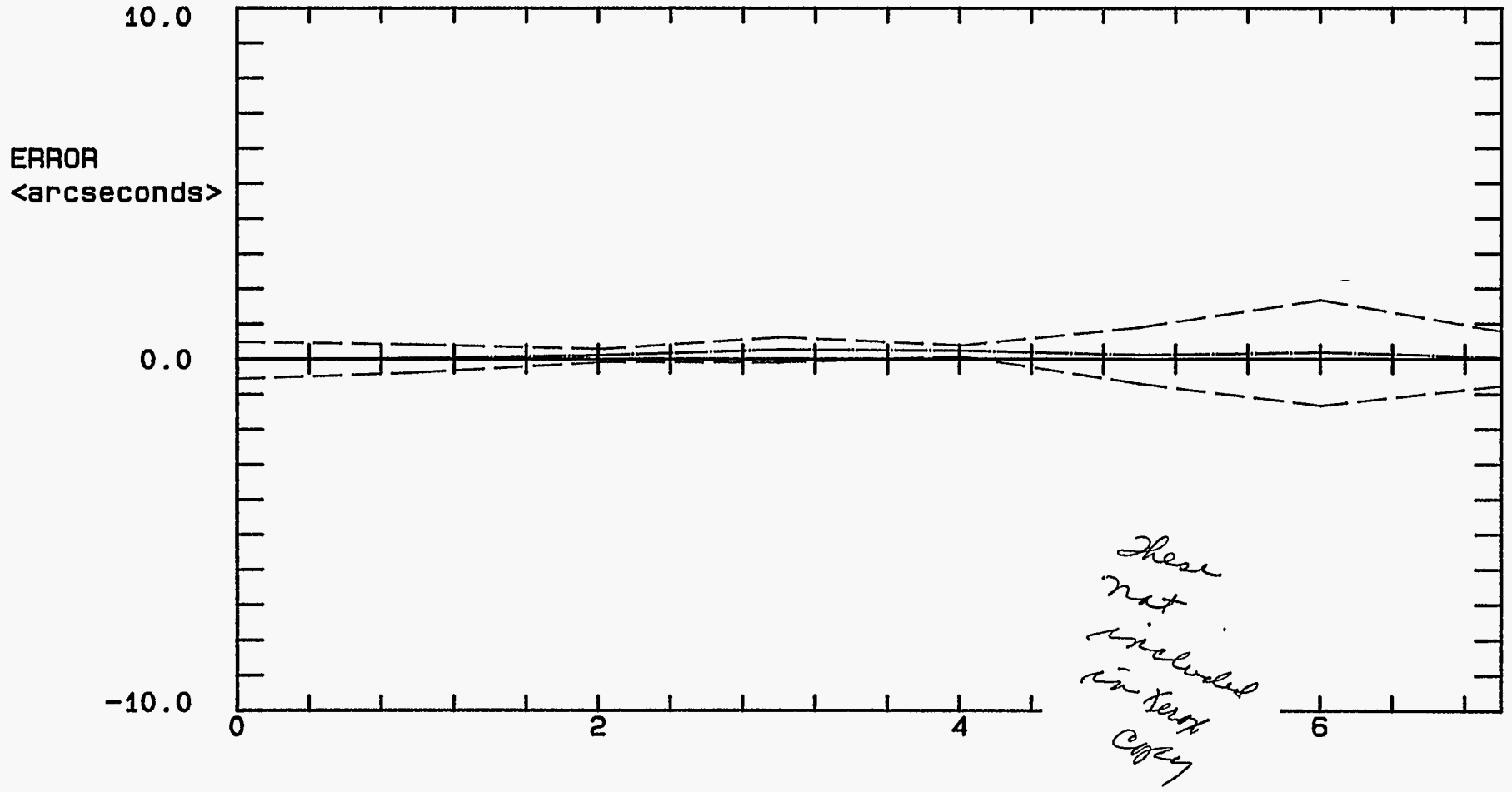
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Y- "Yaw"	DATE: 8/3/94 LOCATION: Bldg.878/ Rm. Y352 0-11" / 1" Inc. FILE: BOSYYAW.ANG	+/- 3 SIGMA ERROR BAND: 8.4 NON REPEAT: 4.9

ANGULAR ERROR PLOT



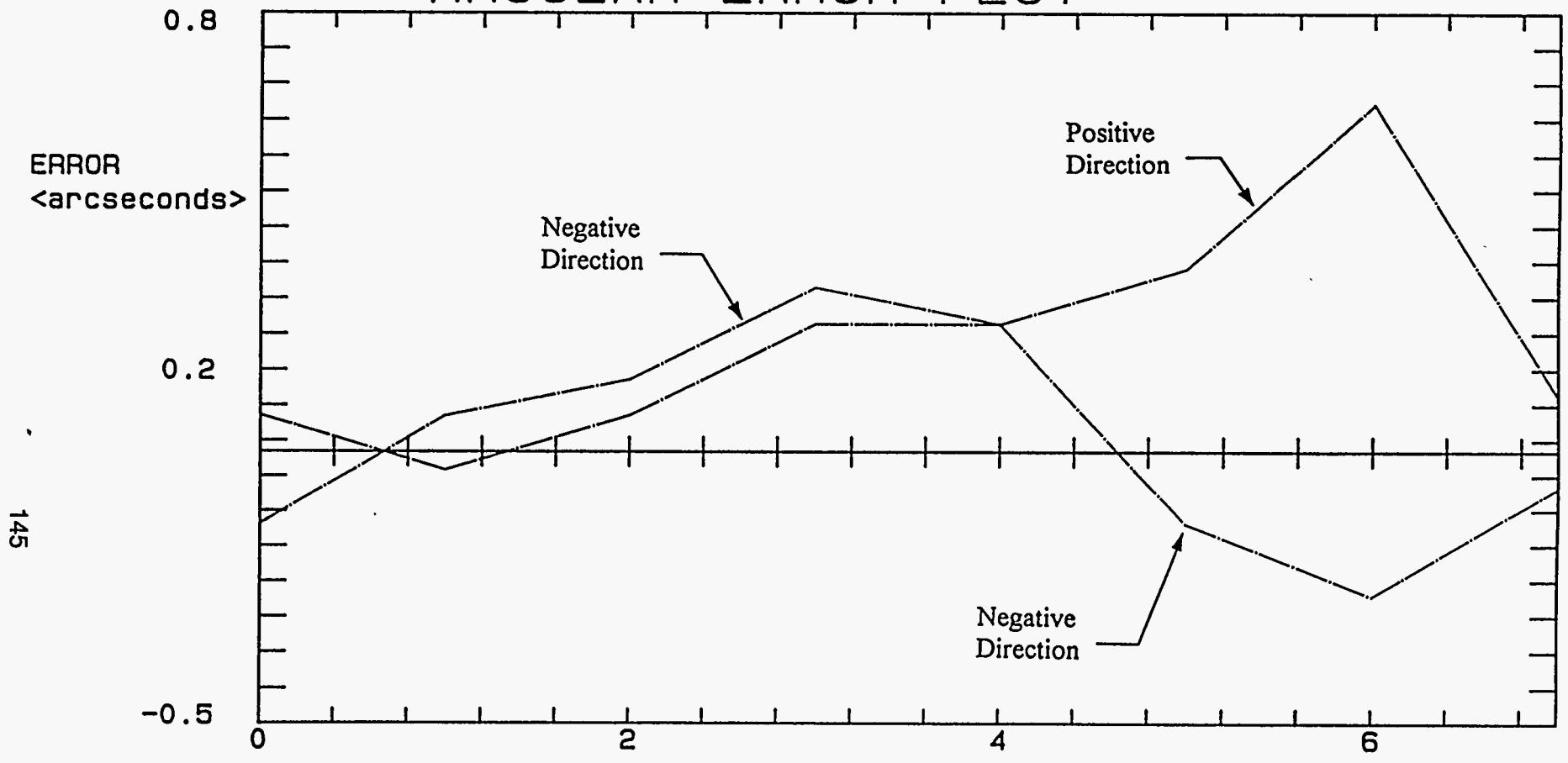
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Y- "Yaw"	DATE: 8/3/94 LOCATION: Bldg.878/ Rm. Y352 .0-11" / 1" Inc.	

ANGULAR ERROR PLOT



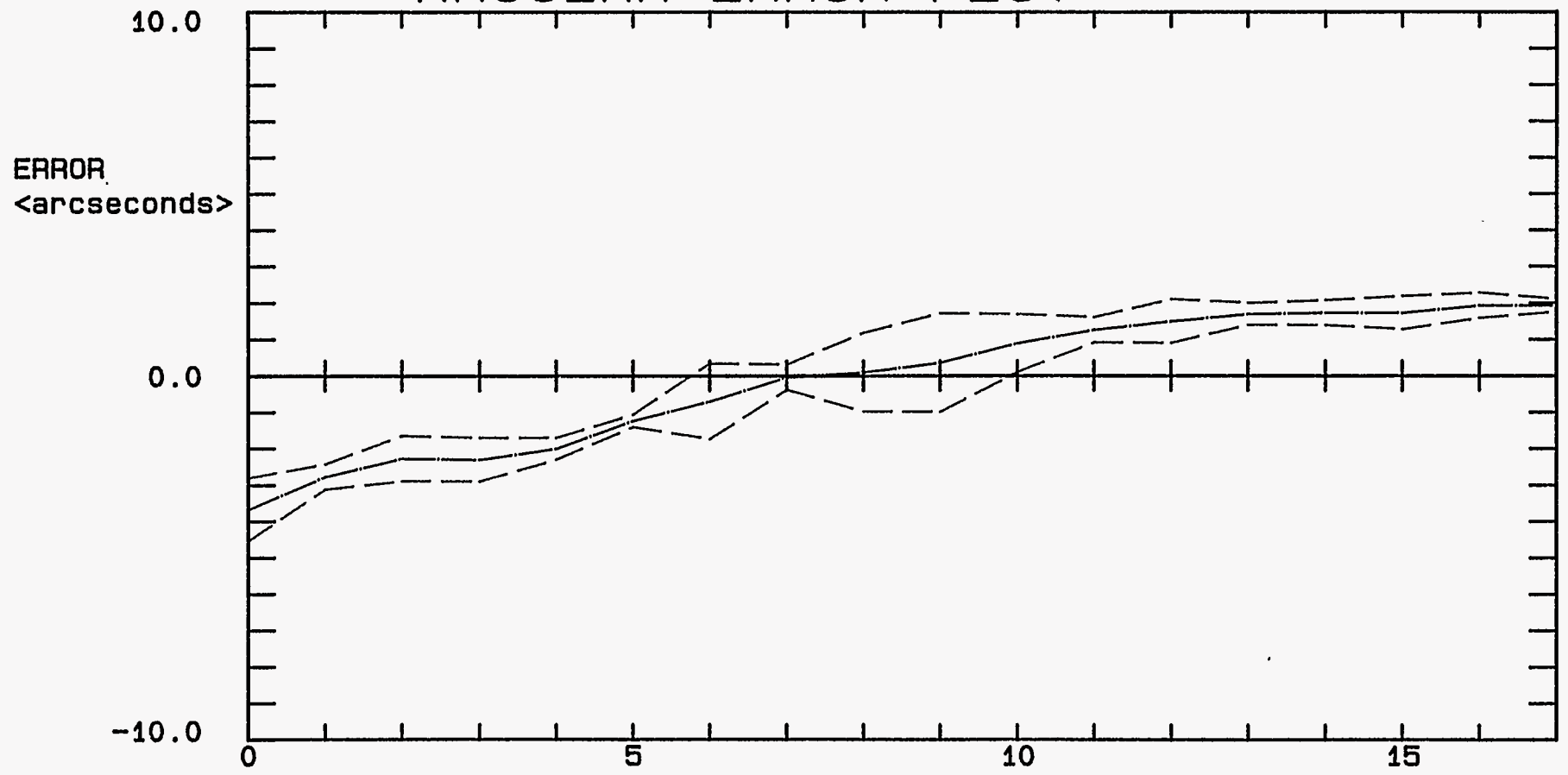
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Z- "Yaw"	DATE: 8/3/94 LOCATION: Bldg.878/ Rm. Y352 0-7" / 1" Inc. FILE: BOSZYAW.ANG	+/- 3 SIGMA ERROR BAND: 3.0 NON REPEAT: 3.0

ANGULAR ERROR PLOT



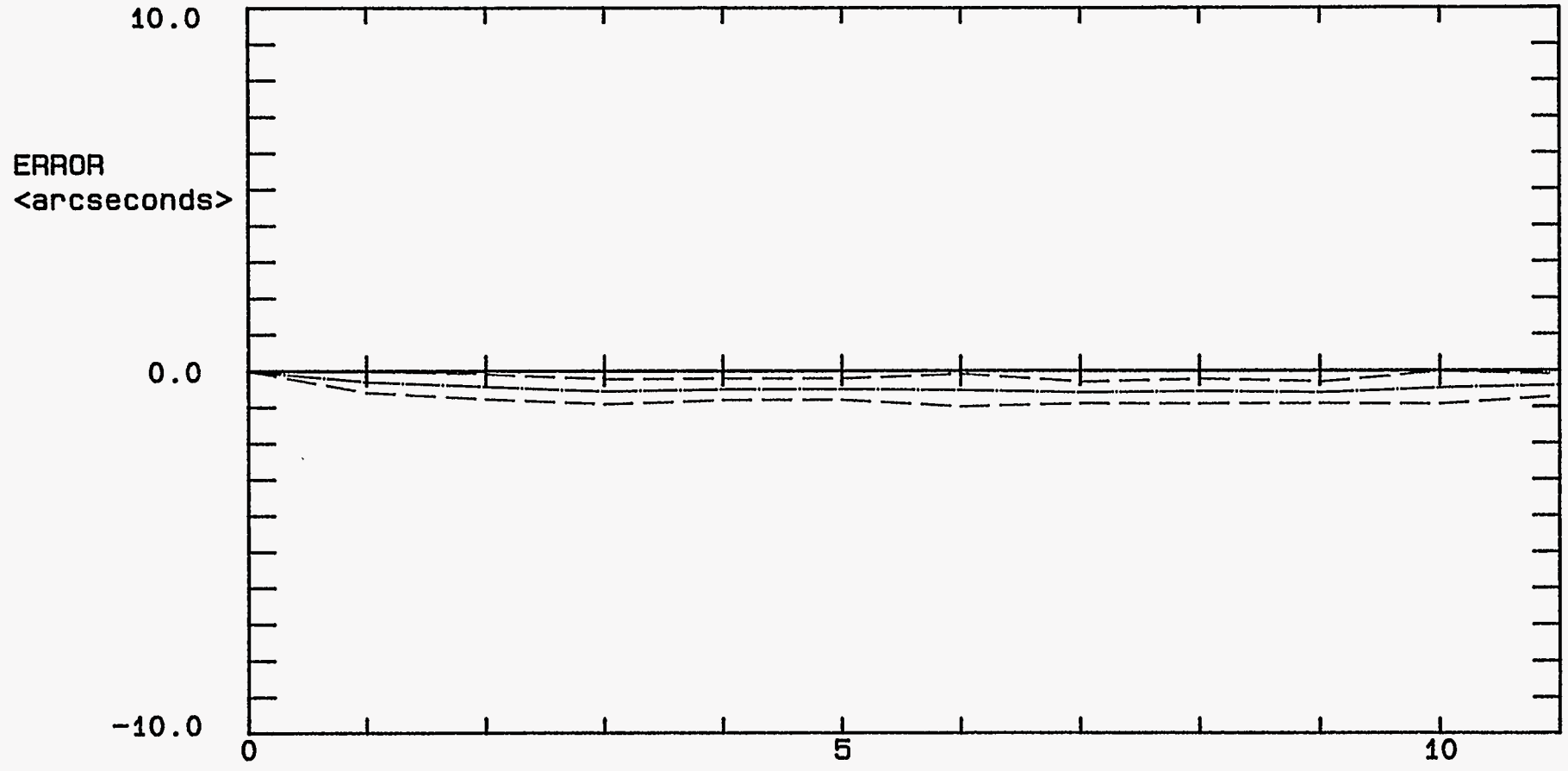
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Z- "Yaw"	DATE: 8/3/94 LOCATION: Bldg.878/ Rm. Y352 0-7" / 1" Inc.	

ANGULAR ERROR PLOT



MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -X- "Roll"	DATE: 8/4/94 LOCATION: Bldg.878/ Rm. Y352 0-17" / 1" Inc. FILE: BOSXROLL.ANG	+/- 3 SIGMA ERROR BAND: 6.8 NON REPEAT: 2.7

ANGULAR ERROR PLOT



MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Y- "Roll"	DATE: 8/4/94 LOCATION: Bldg.878/ Rm. Y352 0 - 11" / 1" Inc. FILE: BOSYROLL.ANG	+/- 3 SIGMA ERROR BAND: 1.0 NON REPEAT: 0.9

API

WINNER 2.03 – SPINCHECK

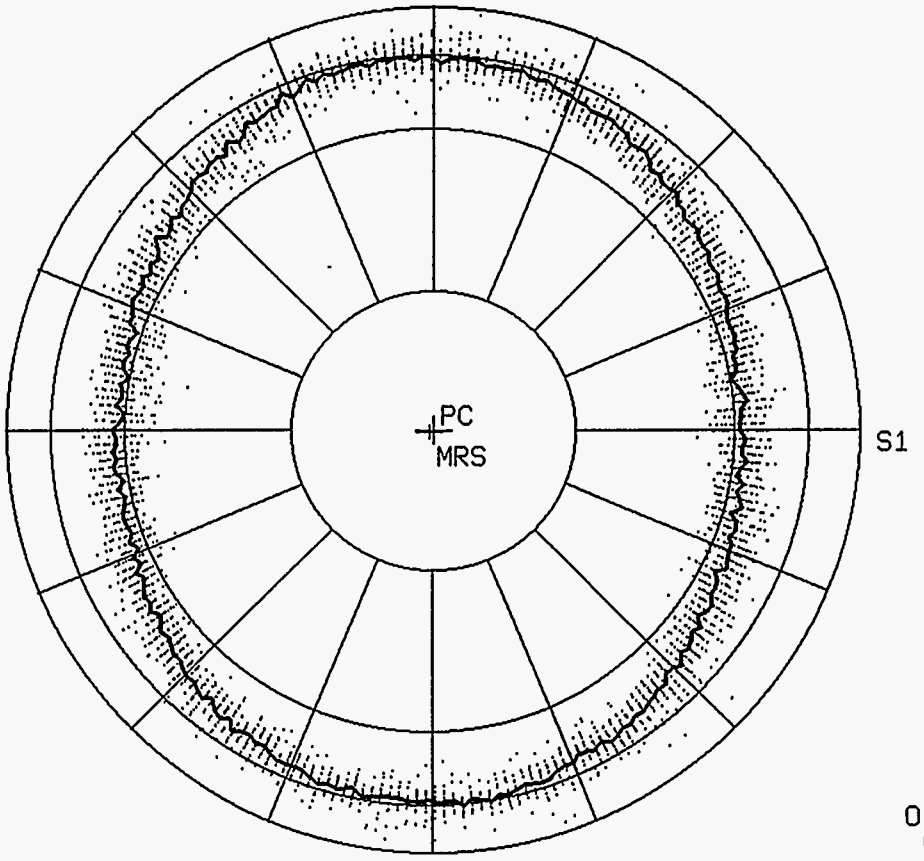
Asyn. Error:

0.00039 (in)

Average Radial Error:

0.00029 (in)

Total Error Motion Polar Plot
(rotating sensitive direction)



Legend:

_____ average radial motion

0.0003 (in)

Data File: r1_10

Machine Type: Run #1 10%

# of Run: 20

Test Date: 8/30/94

Test Speed: 714.37 (rpm)

API

WINNER 2.03 – SPINCHECK

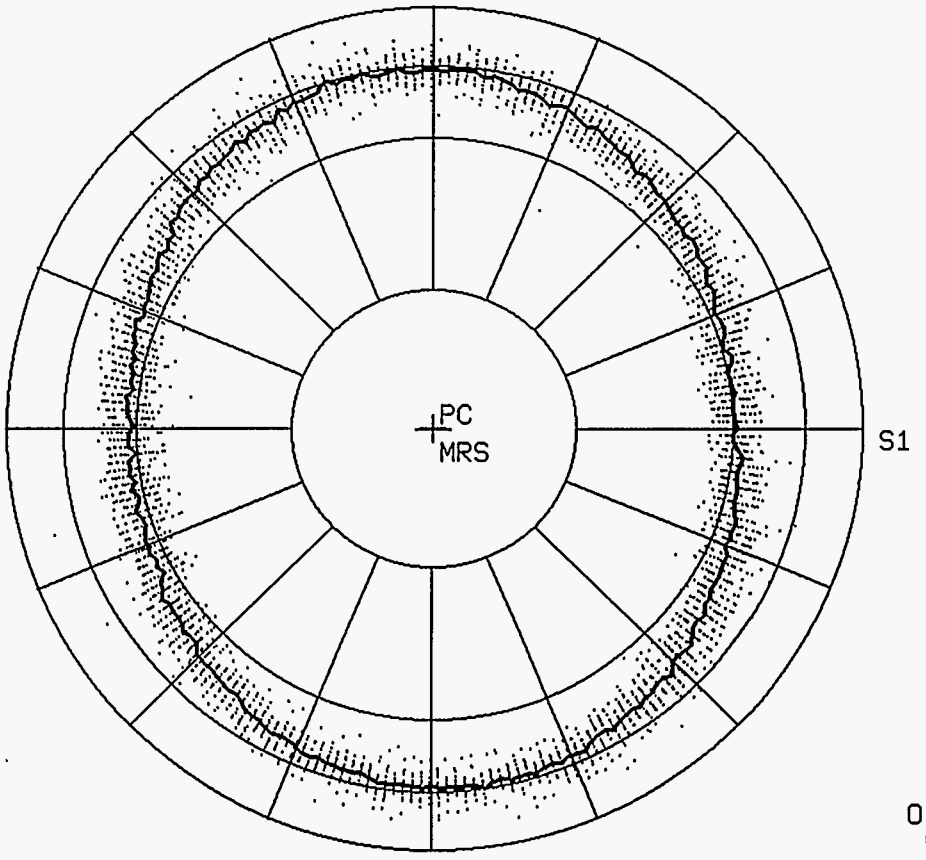
Asyn. Error:

0.00047 (in)

Average Radial Error:

0.00029 (in)

Total Error Motion Polar Plot
(rotating sensitive direction)



Legend:

_____ average radial motion

0.0003 (in)

Data File: r2_10

Machine Type: Run #2 10%

# of Run: 20

Test Date: 8/30/94

Test Speed: 710.91 (rpm)

API

WINNER 2.03 – SPINCHECK

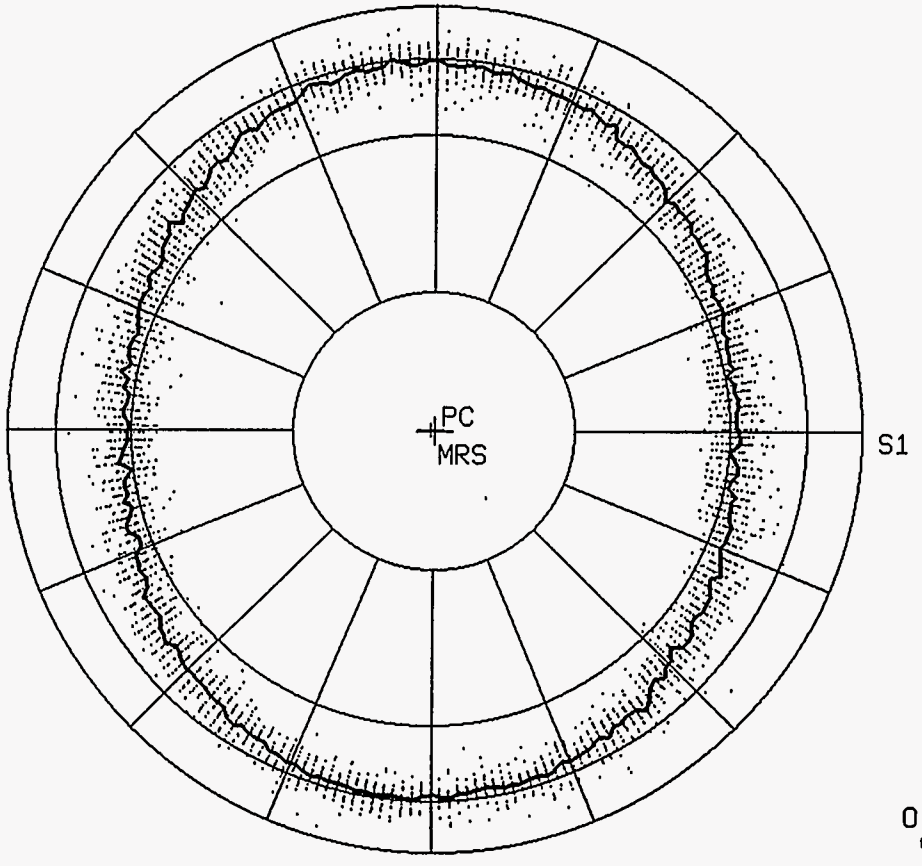
Asyn. Error:

0.00040 (in)

Average Radial Error:

0.00029 (in)

Total Error Motion Polar Plot
(rotating sensitive direction)



Legend:

_____ average radial motion

0.0003 (in)

Data File:	r3_10	Test Date:	8/30/94
Machine Type:	Run #3 10%	Test Speed:	714.36 (rpm)
# of Run:	20		

API

WINNER 2.03 – SPINCHECK

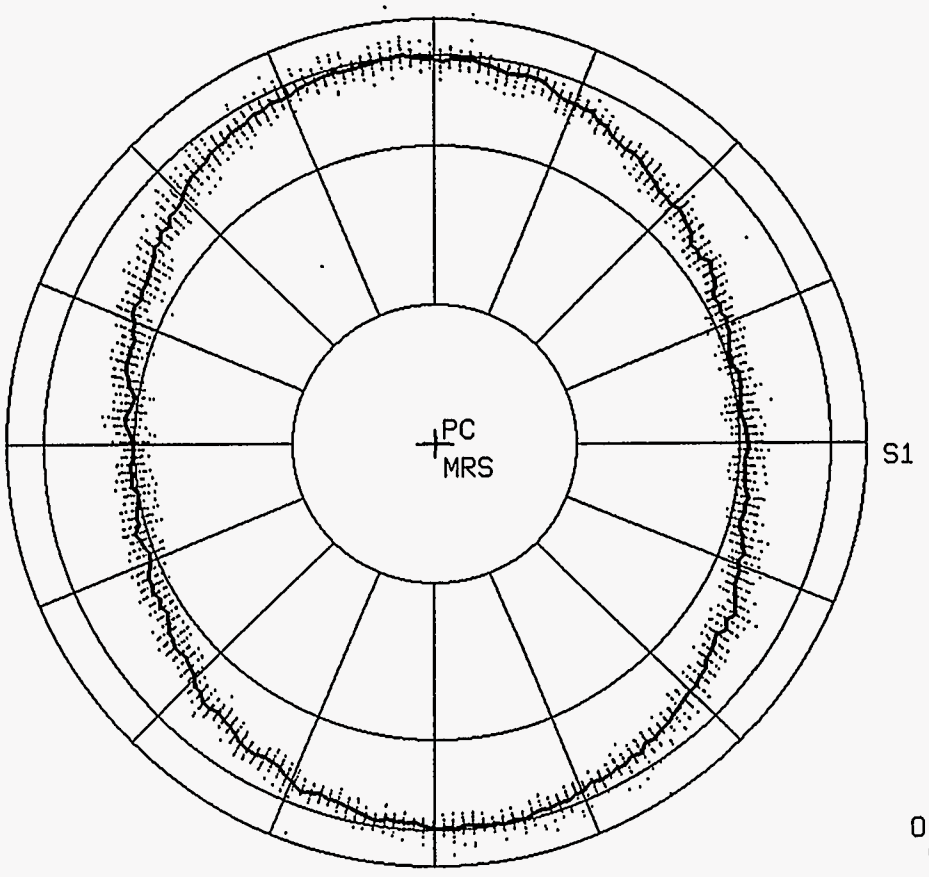
Asyn. Error:

0.00050 (in)

Average Radial Error:

0.00063 (in)

Total Error Motion Polar Plot
(rotating sensitive direction)



Legend:

_____ average radial motion

Data File: r1_50

Machine Type: Run #1 50 %

# of Run: 20

Test Date: 8/30/94

Test Speed: 3515.29 (rpm)

API

WINNER 2.03 – SPINCHECK

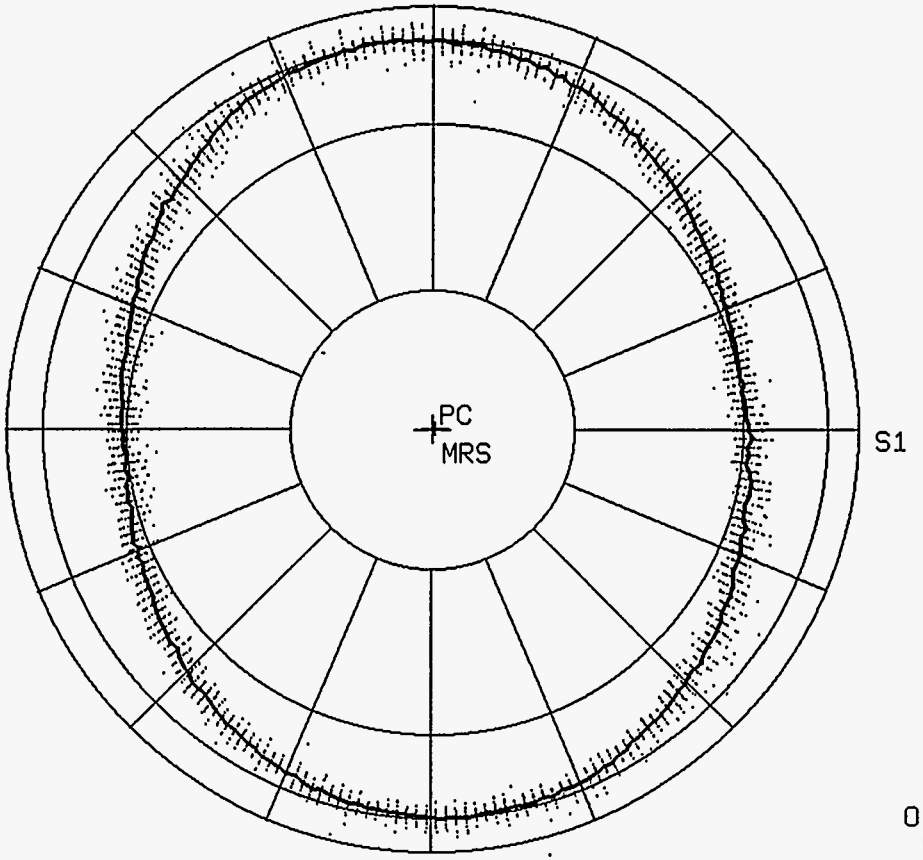
Asyn. Error:

0.00049 (in)

Average Radial Error:

0.00061 (in)

Total Error Motion Polar Plot
(rotating sensitive direction)



Legend:

_____ average radial motion

Data File:	r2_50	Test Date:	8/30/94
Machine Type:	Run #2 50%	Test Speed:	3516.26 (rpm)
# of Run:	20		

API

WINNER 2.03 – SPINCHECK

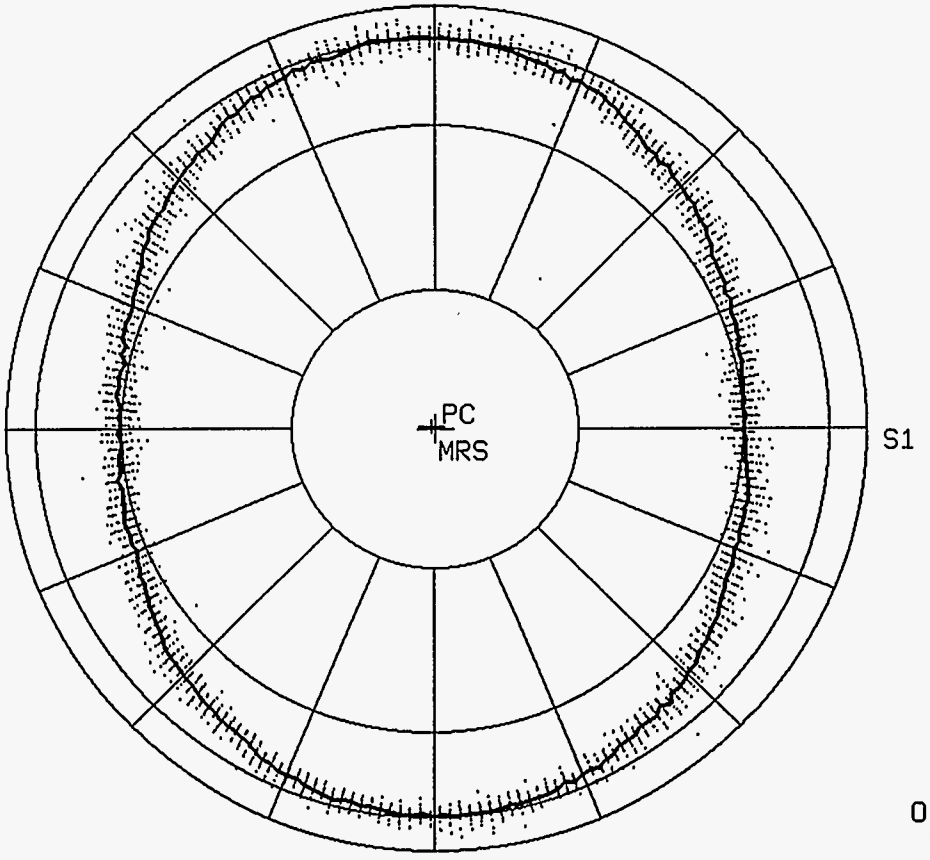
Asyn. Error:

0.00046 (in)

Average Radial Error:

0.00062 (in)

Total Error Motion Polar Plot
(rotating sensitive direction)



0.0006 (in)

Legend:

_____ average radial motion

Data File: r3_50

Machine Type: Run #3 50%

# of Run: 20

Test Date: 8/30/94

Test Speed: 3516.26 (rpm)

API

WINNER 2.03 – SPINCHECK

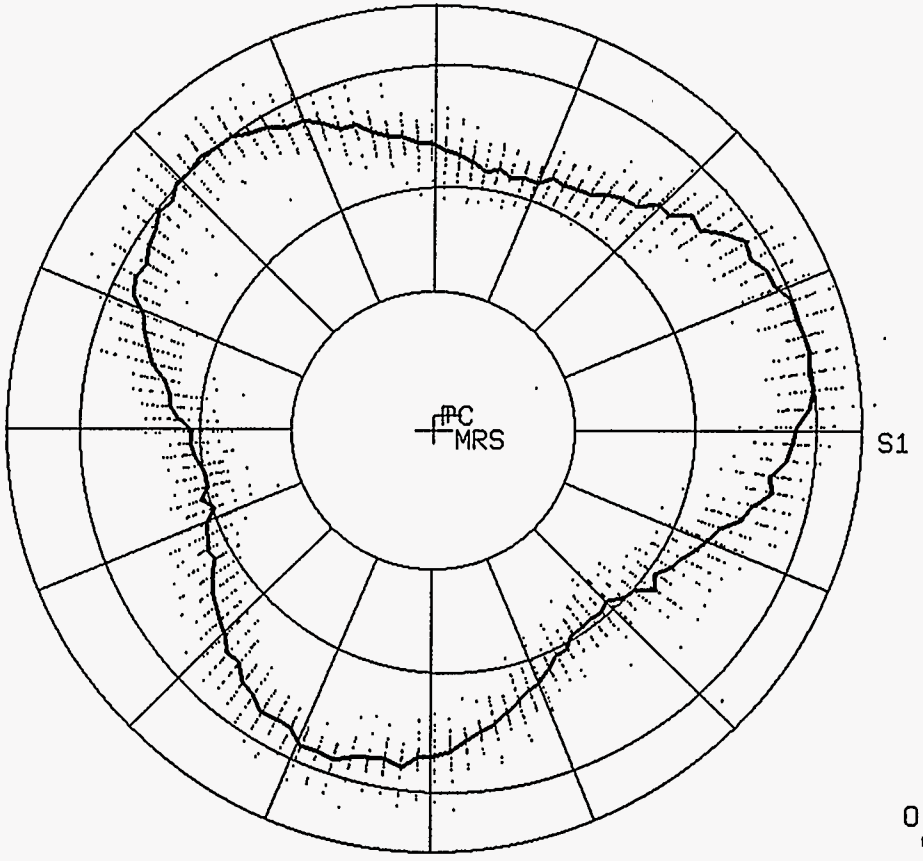
Asyn. Error:

0.00037 (in)

Average Radial Error:

0.00037 (in)

Total Error Motion Polar Plot
(rotating sensitive direction)



Legend:

_____ average radial motion

0.0003 (in)

Data File:	r1_100	Test Date:	8/30/94
Machine Type:	Run #1 100%	Test Speed:	6887.45 (rpm)
# of Run:	20		

API

WINNER 2.03 – SPINCHECK

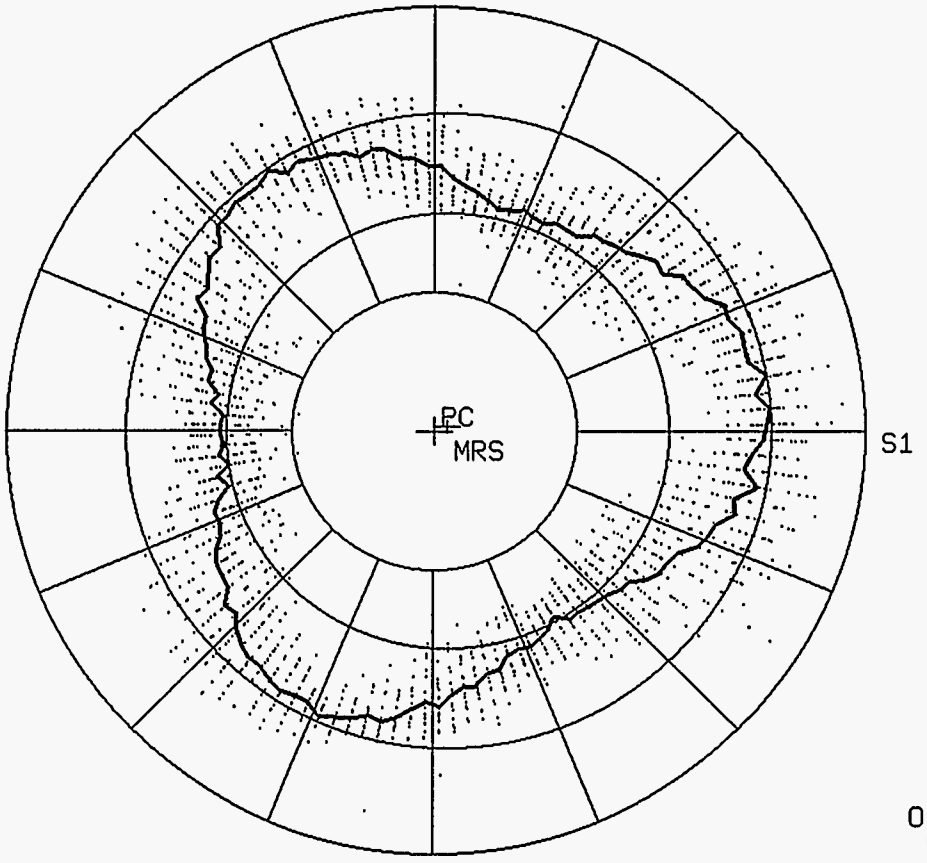
Asyn. Error:

0.00064 (in)

Average Radial Error:

0.00030 (in)

Total Error Motion Polar Plot
(rotating sensitive direction)



0.0003 (in)

Legend:

_____ average radial motion

Data File:	r2_100	Test Date:	8/30/94
Machine Type:	Run #2 100%	Test Speed:	6925.03 (rpm)
# of Run:	20		

API

WINNER 2.03 – SPINCHECK

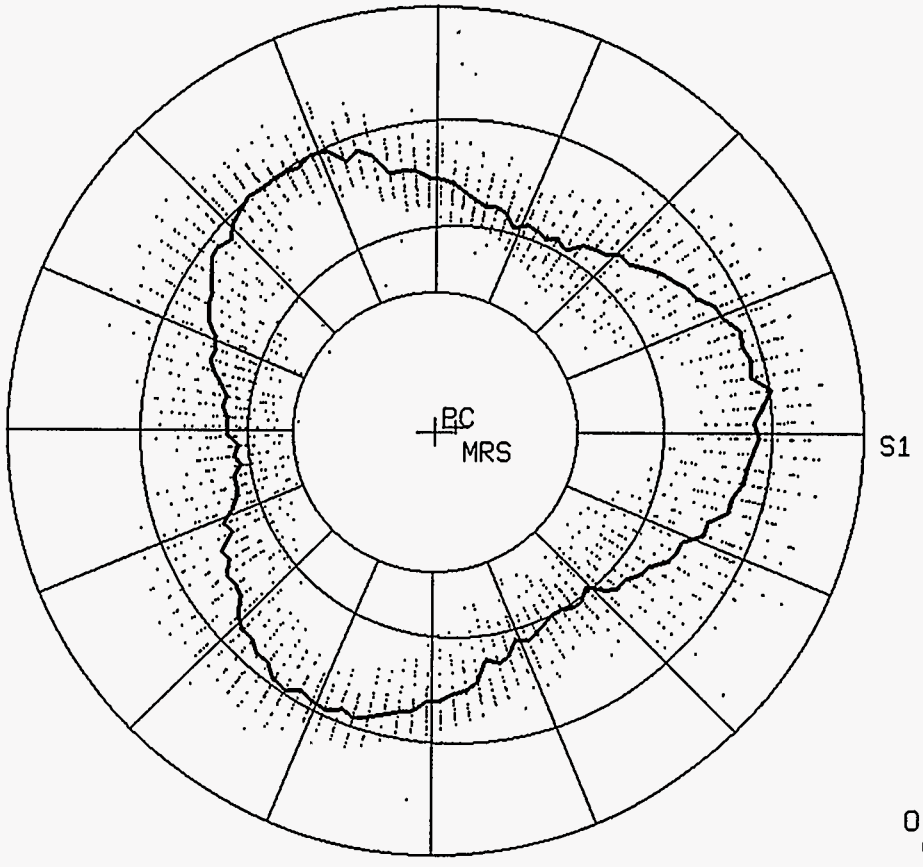
Asyn. Error:

0.00063 (in)

Average Radial Error:

0.00031 (in)

Total Error Motion Polar Plot
(rotating sensitive direction)



Legend:

_____ average radial motion

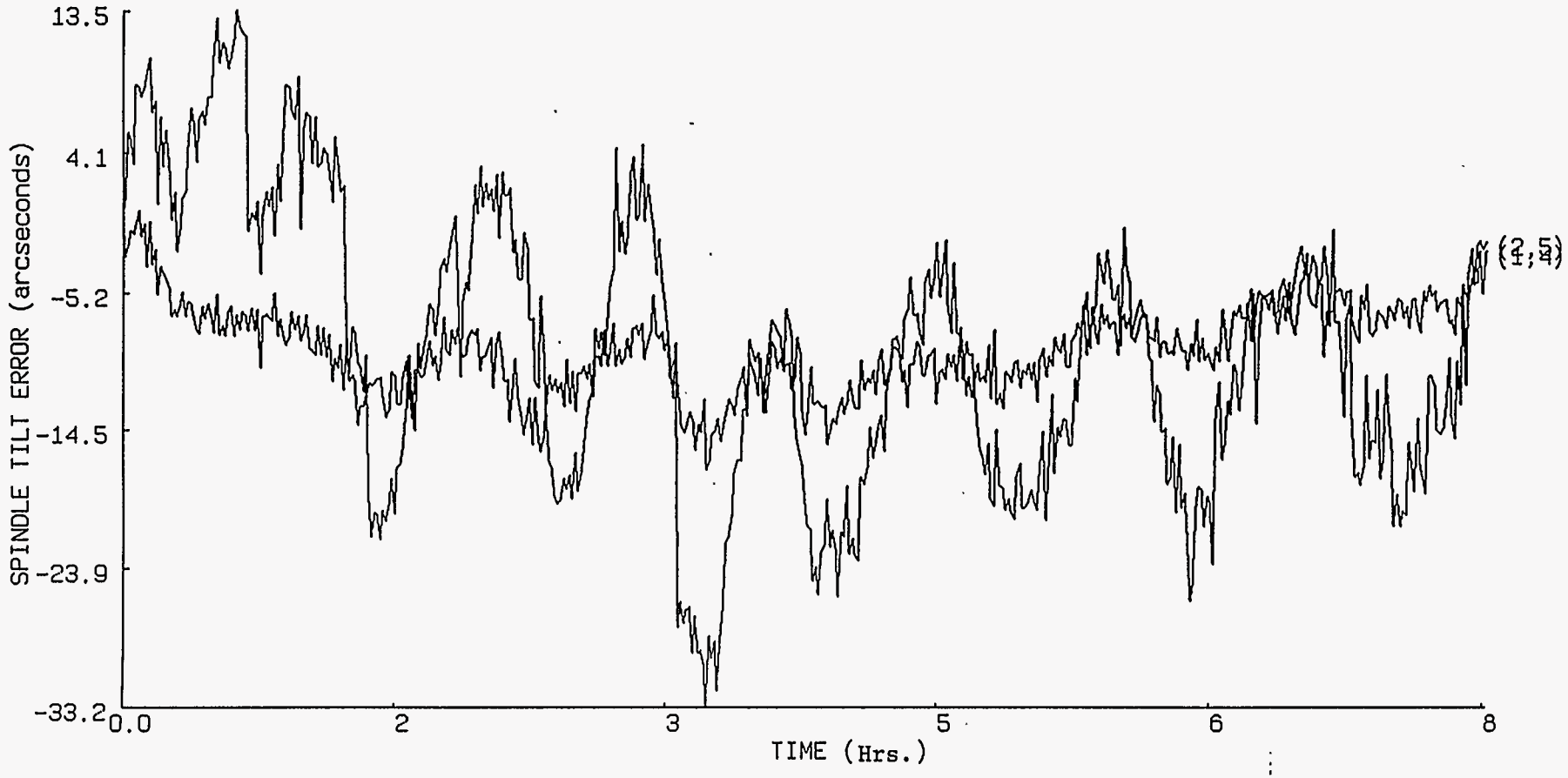
0.0002 (in)

Data File:	r3_100	Test Date:	8/30/94
Machine Type:	Run #3 100%	Test Speed:	6910.14 (rpm)
# of Run:	20		

API

WINNER 2.08 – THERMCHECK

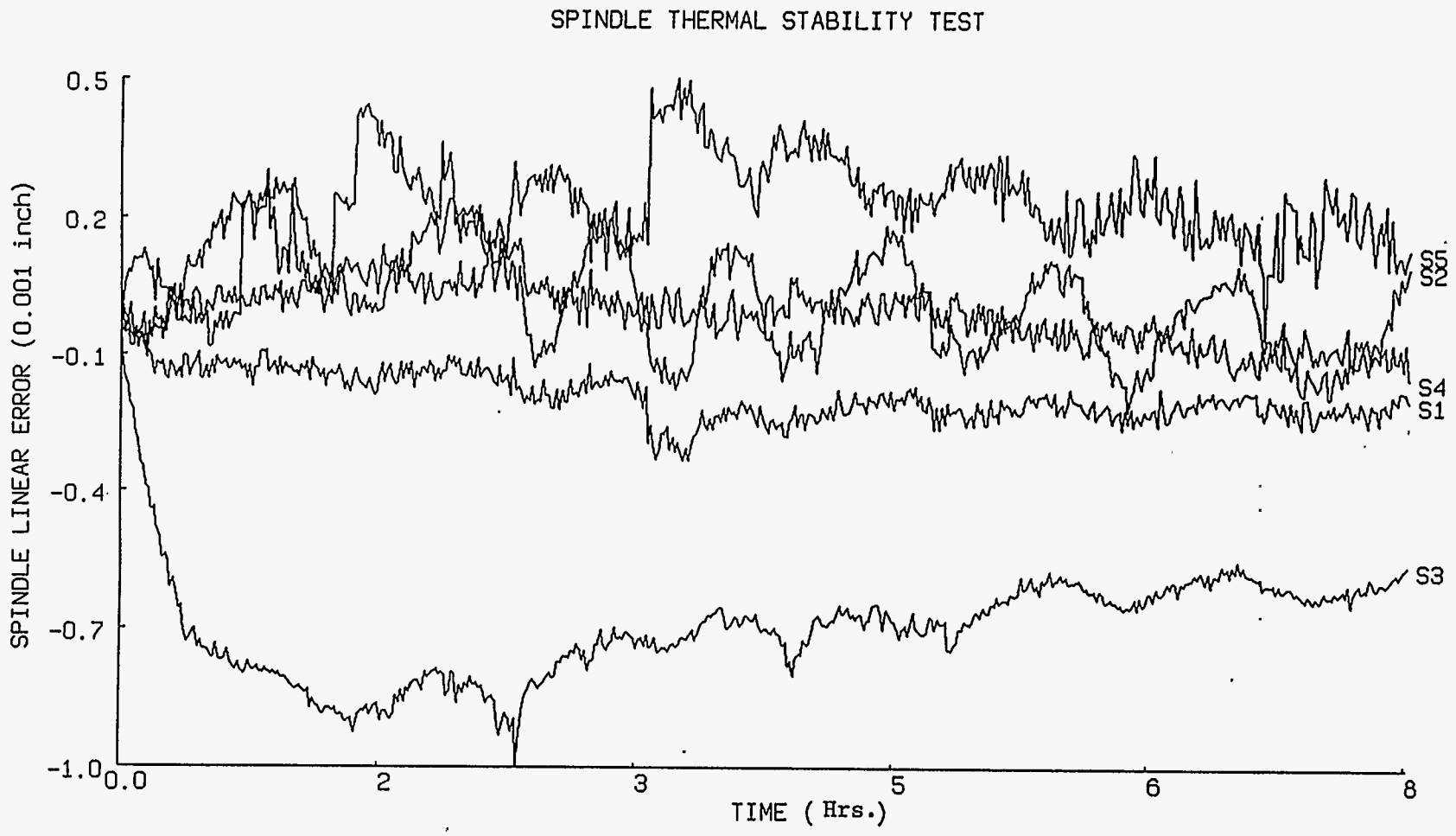
SPINDLE THERMAL STABILITY TEST



Data File:	BoMa	Test Date:	9/1/94
Machine Type:	BostoMatic 300	Test Speed:	5274.3 rpm
Comments:	60 Second Sample Intervals		
	480 Minute Test Duration		

API

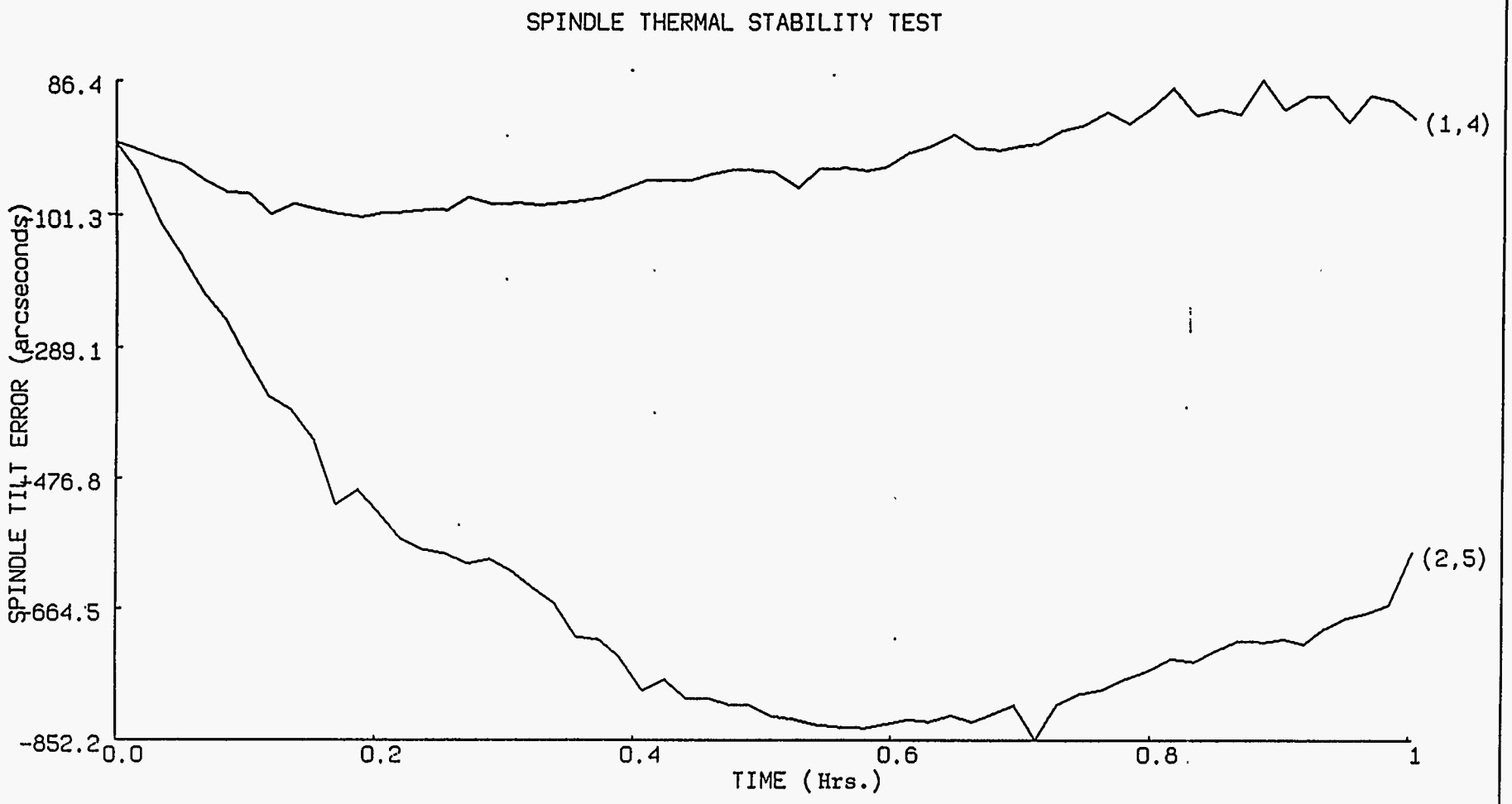
WINNER 2.08 – THERMCHECK



Data File:	BoMa	Test Date:	9/1/94
Machine Type:	BostoMatic 300	Test Speed:	5274.3 rpm
Comments:	60 Second Sample Intervals		
	480 Minute Test Duration		

API

WINNER 2.08 - THERMCHECK



Data File: BoMal

Test Date: 9/1/94

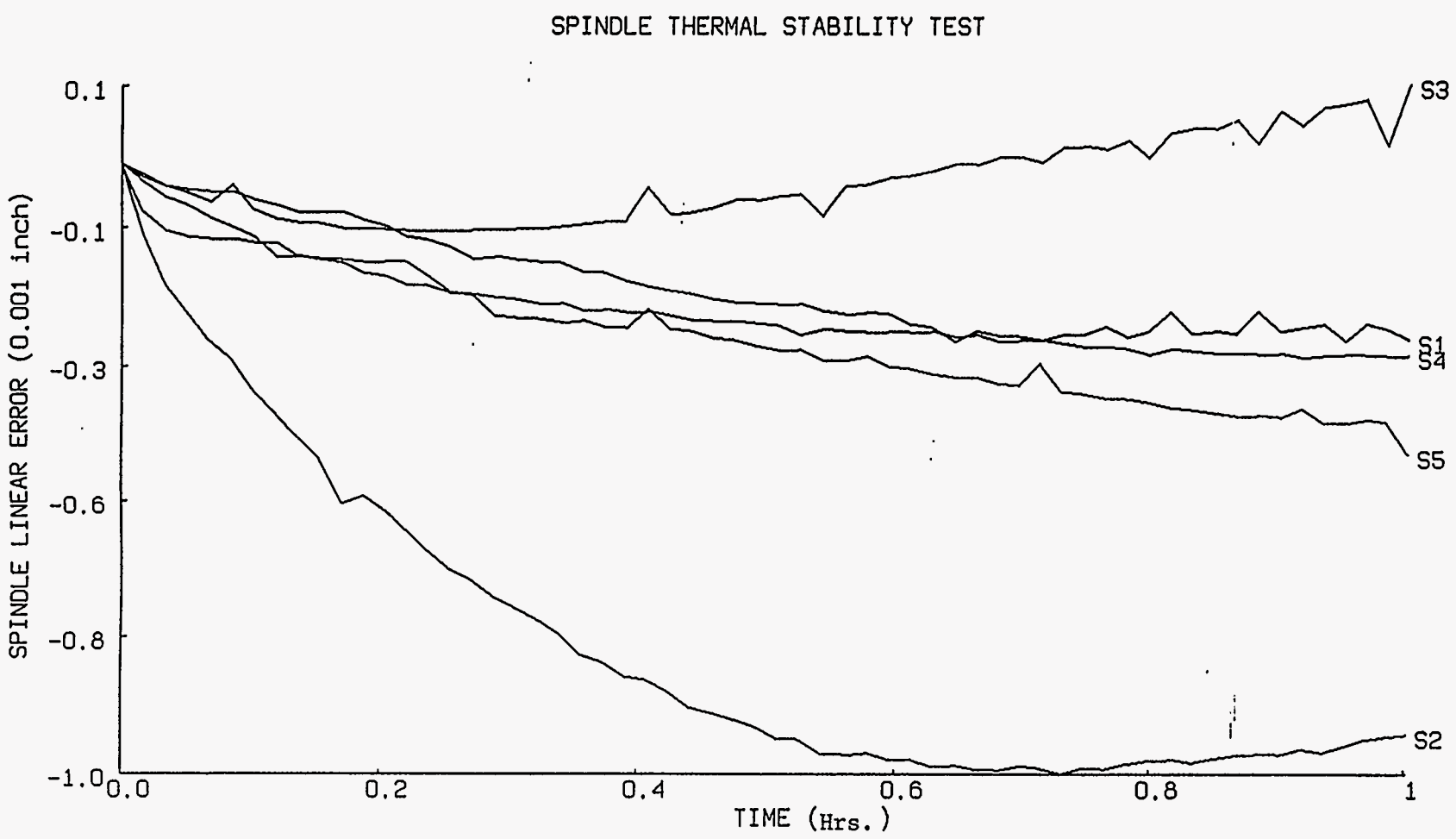
Machine Type: BostoMatic 300

Test Speed: 0.0 rpm

Comments: Transient Shutoff Thermal Stability

API

WINNER 2.08 - THERMCHECK

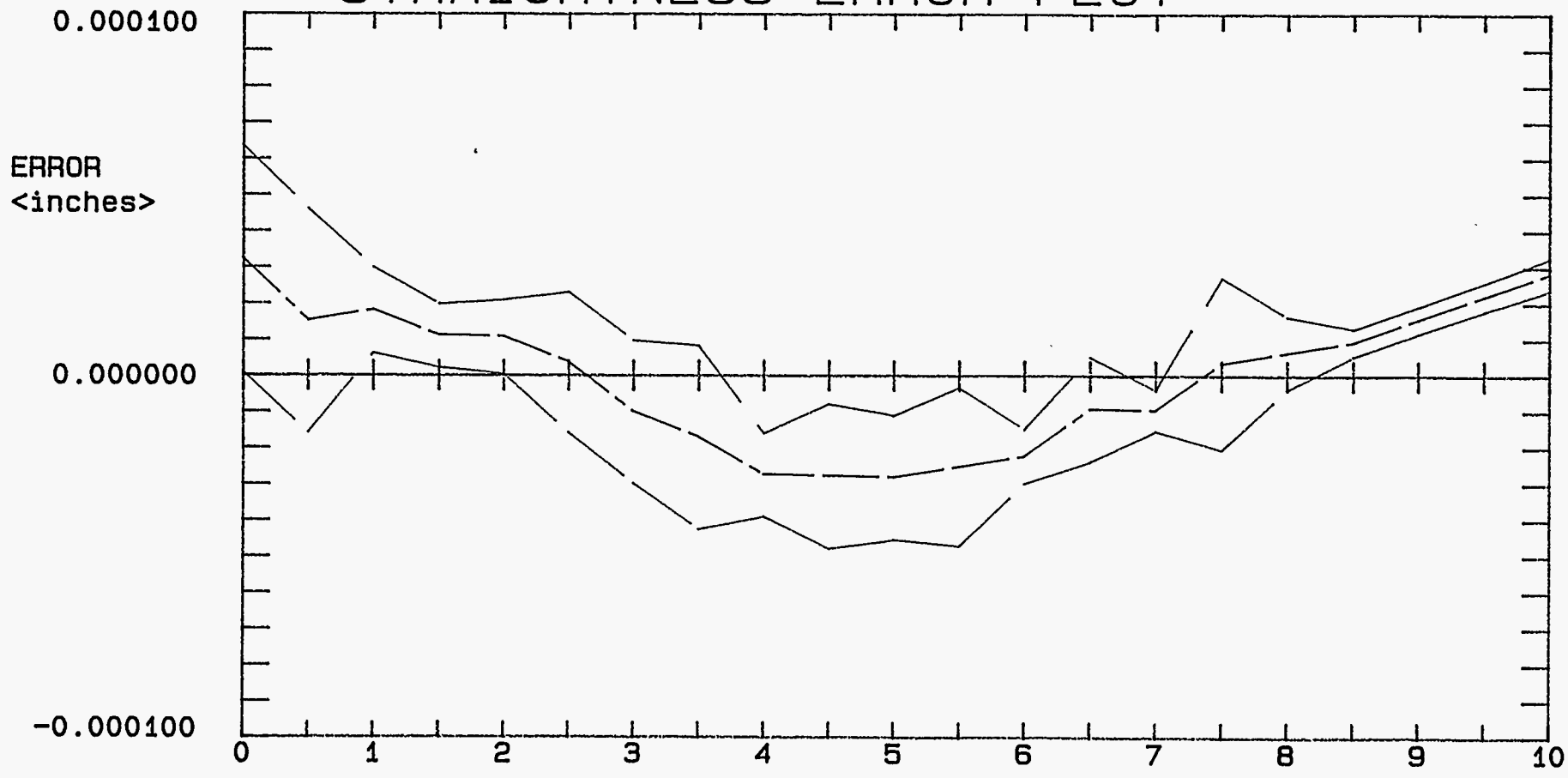


Data File: BoMal Test Date: 9/1/94

Machine Type: BostoMatic 300 Test Speed: 0.0 rpm

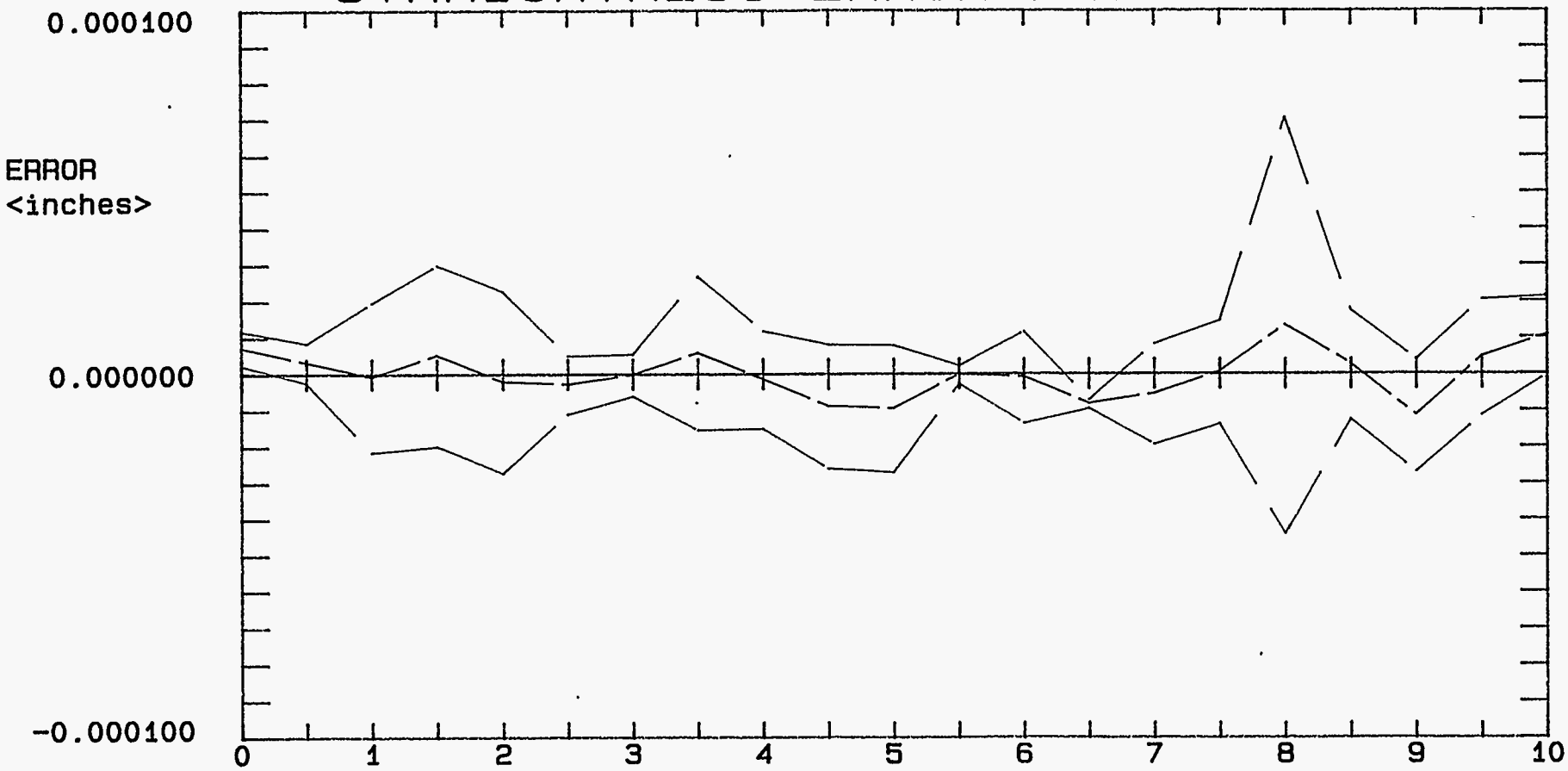
Comments: Transient Shutoff Thermal Stability

STRAIGHTNESS ERROR PLOT



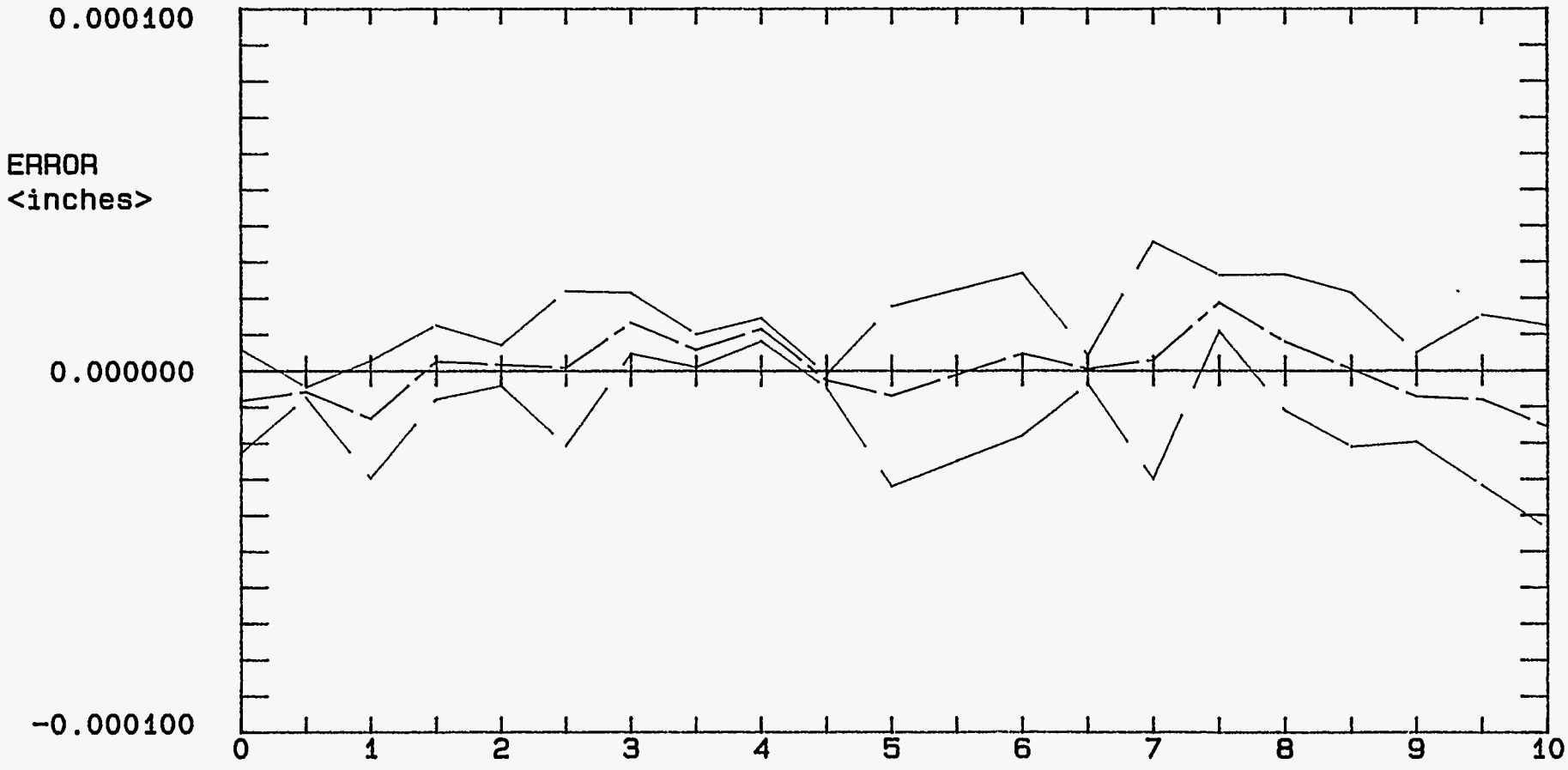
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -X- Vertical	DATE: 8/8/94 LOCATION: Bldg.878/ Rm. Y352 0-10" / .5" Inc. FILE: BOSXVER.ST	+/- 95% CONFIDENCE ERROR BAND: 0.00011 NON REPEAT: 0.00006

STRAIGHTNESS ERROR PLOT



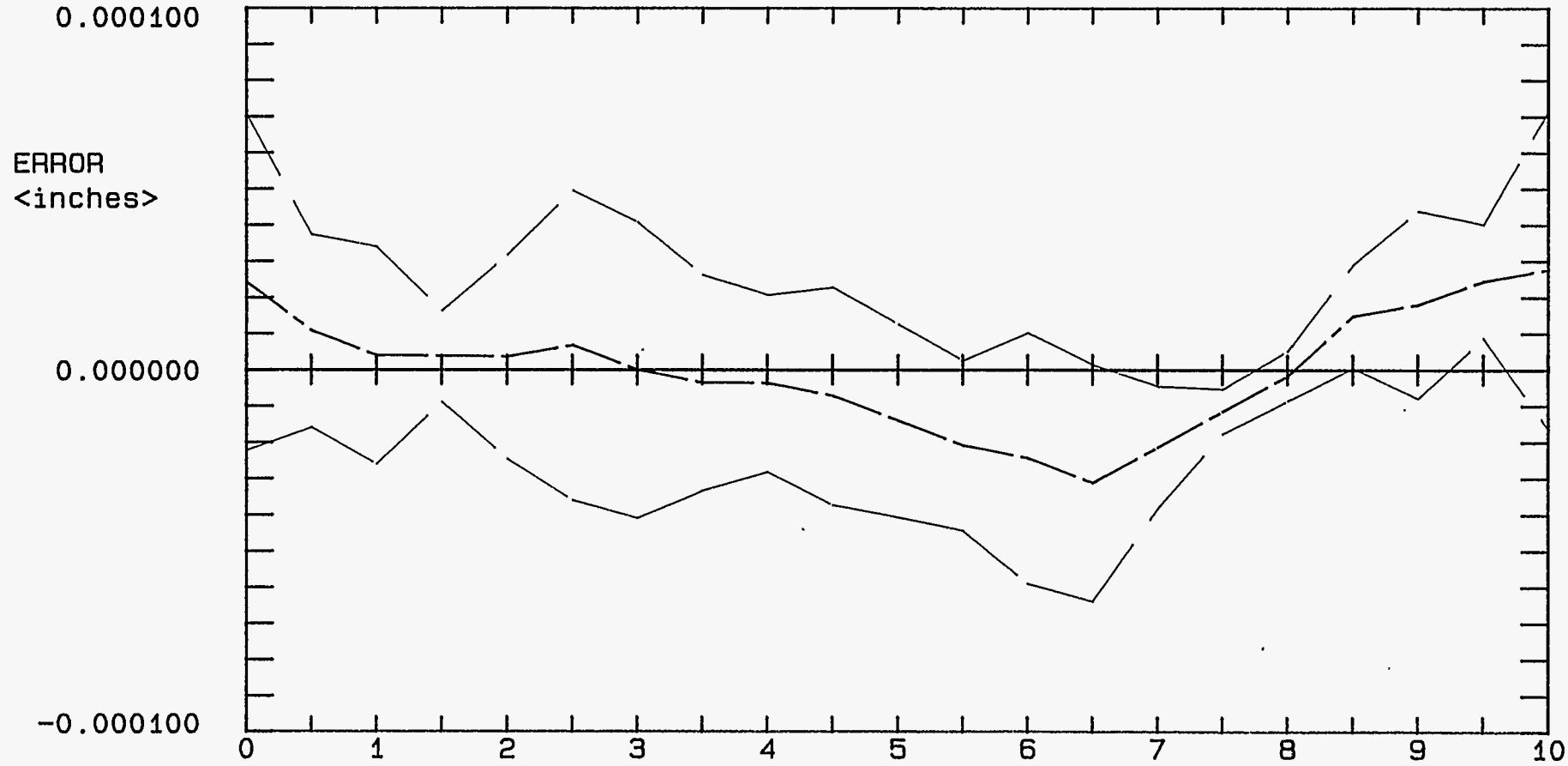
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -X- Horizontal	DATE: 8/8/94 LOCATION: Bldg.878/ Rm. Y352 0-10" / .5" Inc. FILE: BOSXHOR.ST	+/- 95% CONFIDENCE ERROR BAND: 0.00011 NON REPEAT: 0.00011

STRAIGHTNESS ERROR PLOT



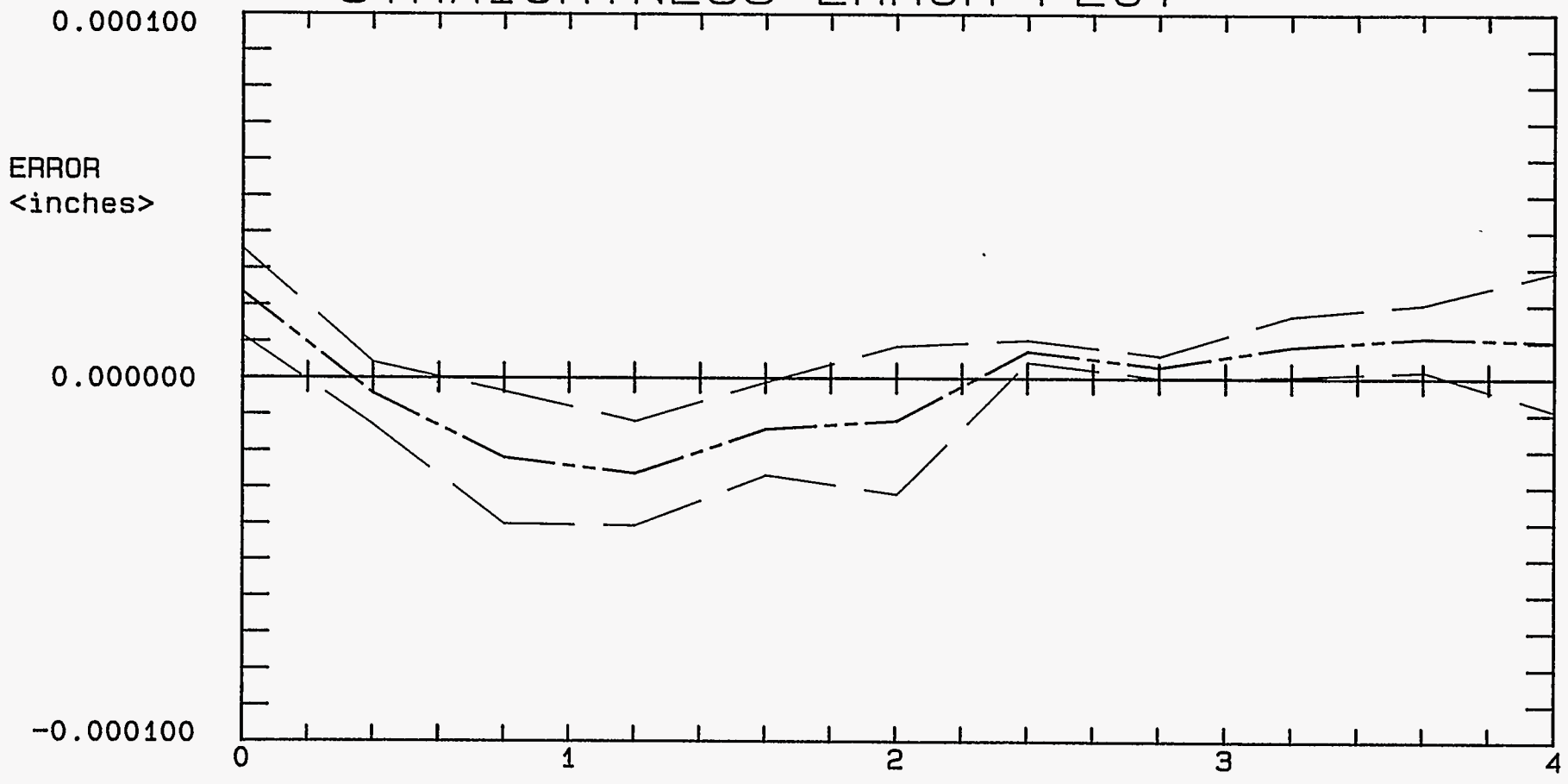
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Y- Vertical	DATE: 8/8/94 LOCATION: Bldg.878/ Rm. Y352 0-10" / .5" Inc. FILE: BOSYVER.ST	+/- 95% CONFIDENCE ERROR BAND: 0.00008 NON REPEAT: 0.00007

STRAIGHTNESS ERROR PLOT



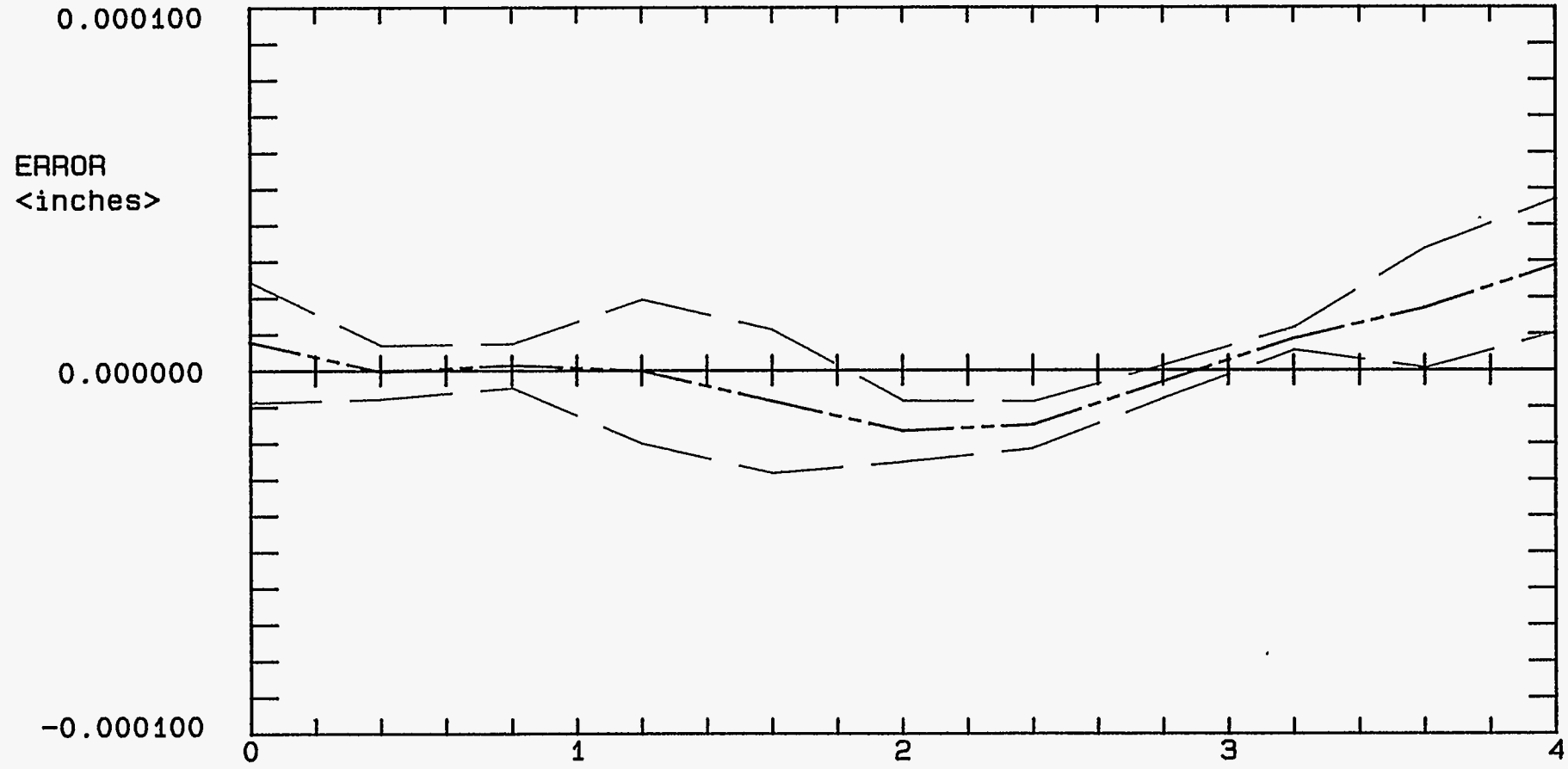
MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Y- Horizontal	DATE: 8/8/94 LOCATION: Bldg.878/ Rm. Y352 0-10" / .5" Inc. FILE: BOSYHOR.ST	+/- 95% CONFIDENCE ERROR BAND: 0.00014 NON REPEAT: 0.00009

STRAIGHTNESS ERROR PLOT



MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Z- Along -X- Axis	DATE: 8/8/94 LOCATION: Bldg.878/ Rm. Y352 0-4" / .4" Inc. FILE: BOSZ-X-.ST	+/- 95% CONFIDENCE ERROR BAND: 0.00008 NON REPEAT: 0.00004

STRAIGHTNESS ERROR PLOT



MACHINE: BostoMatic 300 NUMBER: Serial # MM-590 BY: E.A. Bryce AXIS: -Z- Along -Y- Axis	DATE: 8/8/94 LOCATION: Bldg.878/ Rm. Y352 0-4" / .4" Inc. FILE: BOSZ-Y-.ST	+/- 95% CONFIDENCE ERROR BAND: 0.00008 NON REPEAT: 0.00004

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