

Fermilab

TS-SSC 91-149

Long Magnet Construction Experience

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**Technology Transfer Presentation
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Status of Program

40 mm Aperture Magnets:

DC0300	Practice Magnet
DC0301	Practice Magnet
DC0302	Mid-Plane Short Developed in completed cold mass
DC0303	Mid-Plane Short Developed in completed cold mass
DC0304	Successfully Tested Disassembled
DC0305	Turn-to-Turn Short Developed during keying
DC0306	Successfully Tested

Status of Program

50 mm Aperture Magnets

DCA310	Practice Magnet Awaiting Shell Welding
DCA311	Awaiting Shell Welding
DCA312	End Can Installation
DCA313	Coil Packaging
DCA314	Coil winding completed
DCA315	Coils being wound

Irrecoverable Failure Modes for 40 mm Magnets

Mid-Plane Shorts

Cause: Insufficiently rigid keying press

Remedy: Rebuild press for 50 mm program

Turn-to-Turn Shorts

Cause: Metallic Chips

Cable problems

Unknown causes (Cable problems?)

Remedy: Maintain clean environment

Avoid reusing cable

Many other problems were caused or compounded by:

Insufficient specification of procedures

Inadequate record keeping

Inadequate transfer of experience from R&D program to production program

Ripple down effect of small changes from one production step to another

Remedy:

Incorporate detailed Traveler documentation of procedures and records

Closer physicist/engineer supervision

It is best to discover problems as early in the assembly process as possible so that corrections may be implemented more easily.

To make this possible it is necessary to invest time and effort in the development of sufficient in-process testing and monitoring capabilities and procedures.

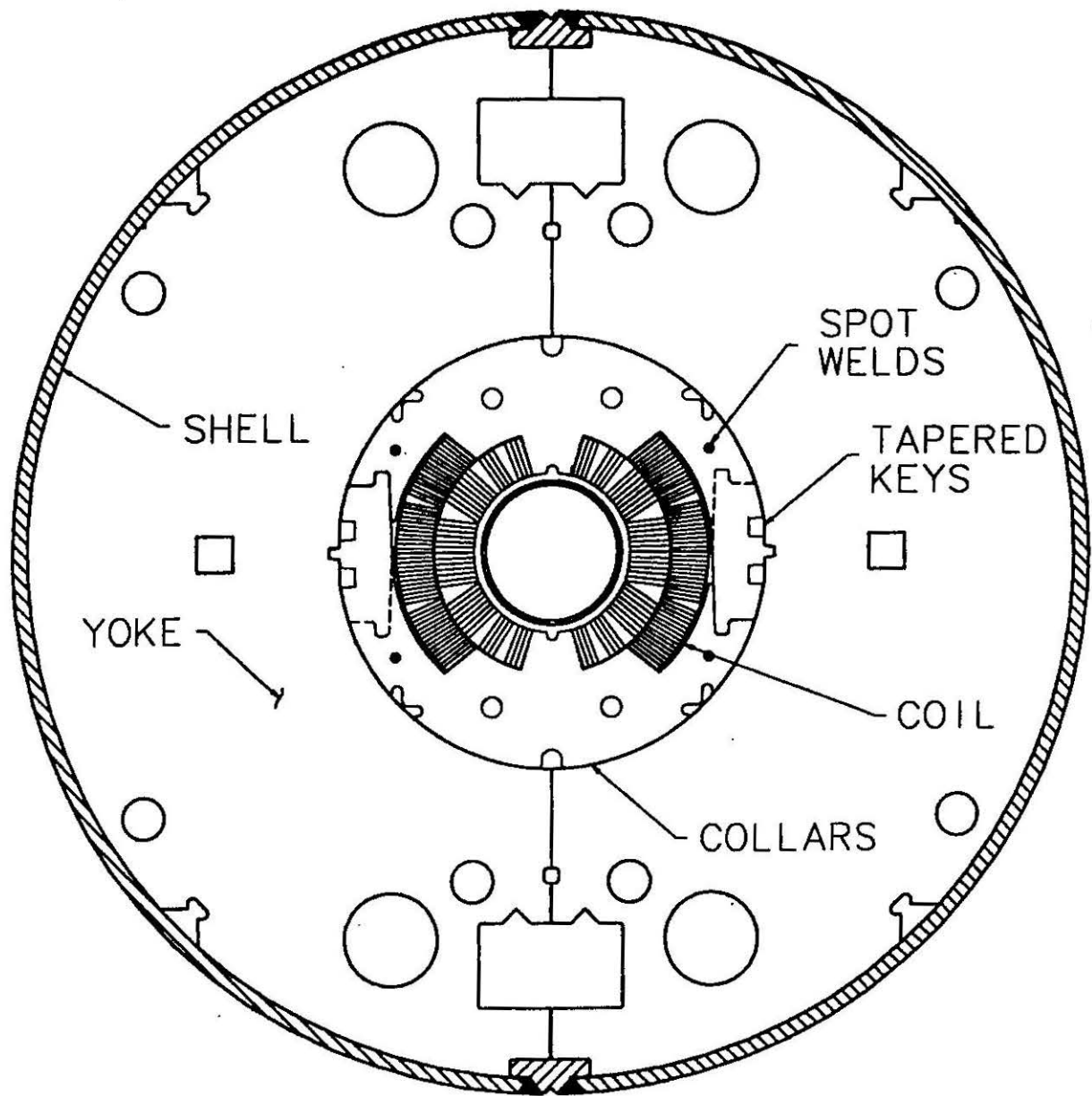


Figure 1
SSC Collider Dipole Magnet Cross Section

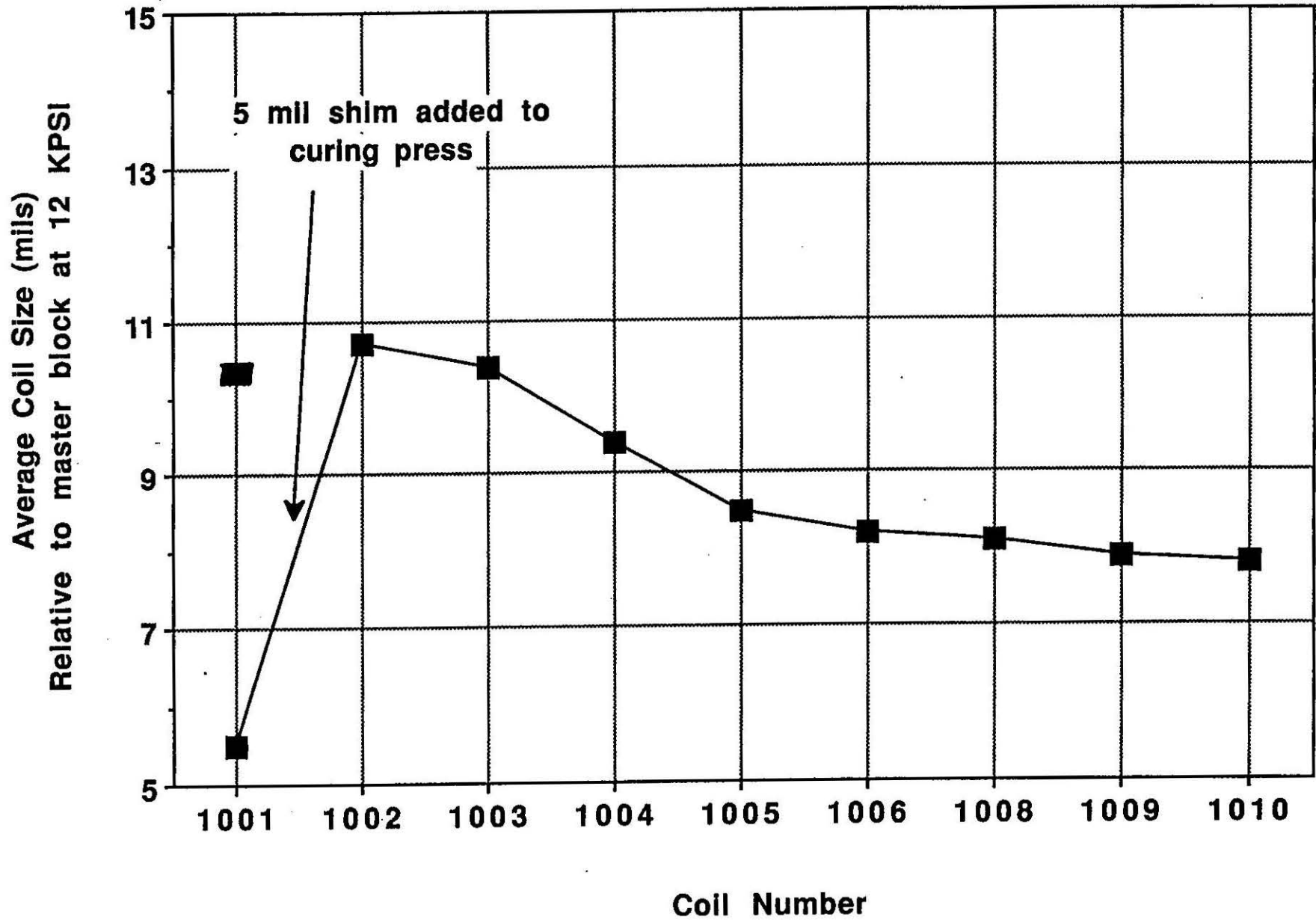
Production Stages:

**Coil Winding and Curing
Covered by R. Simms**

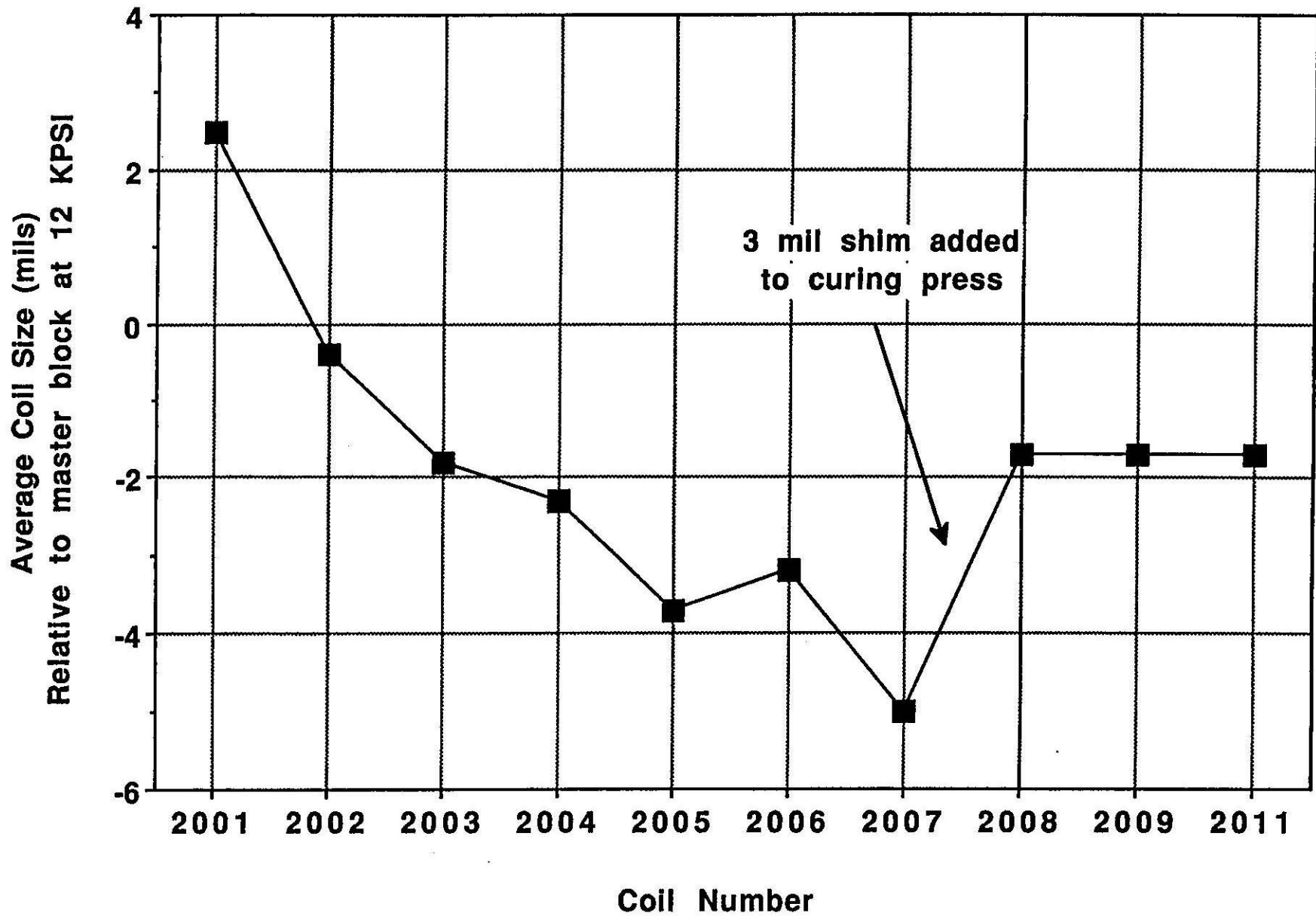
Coil Assembly and Collaring

**Collar Laminations
Kapton Pole Shims**

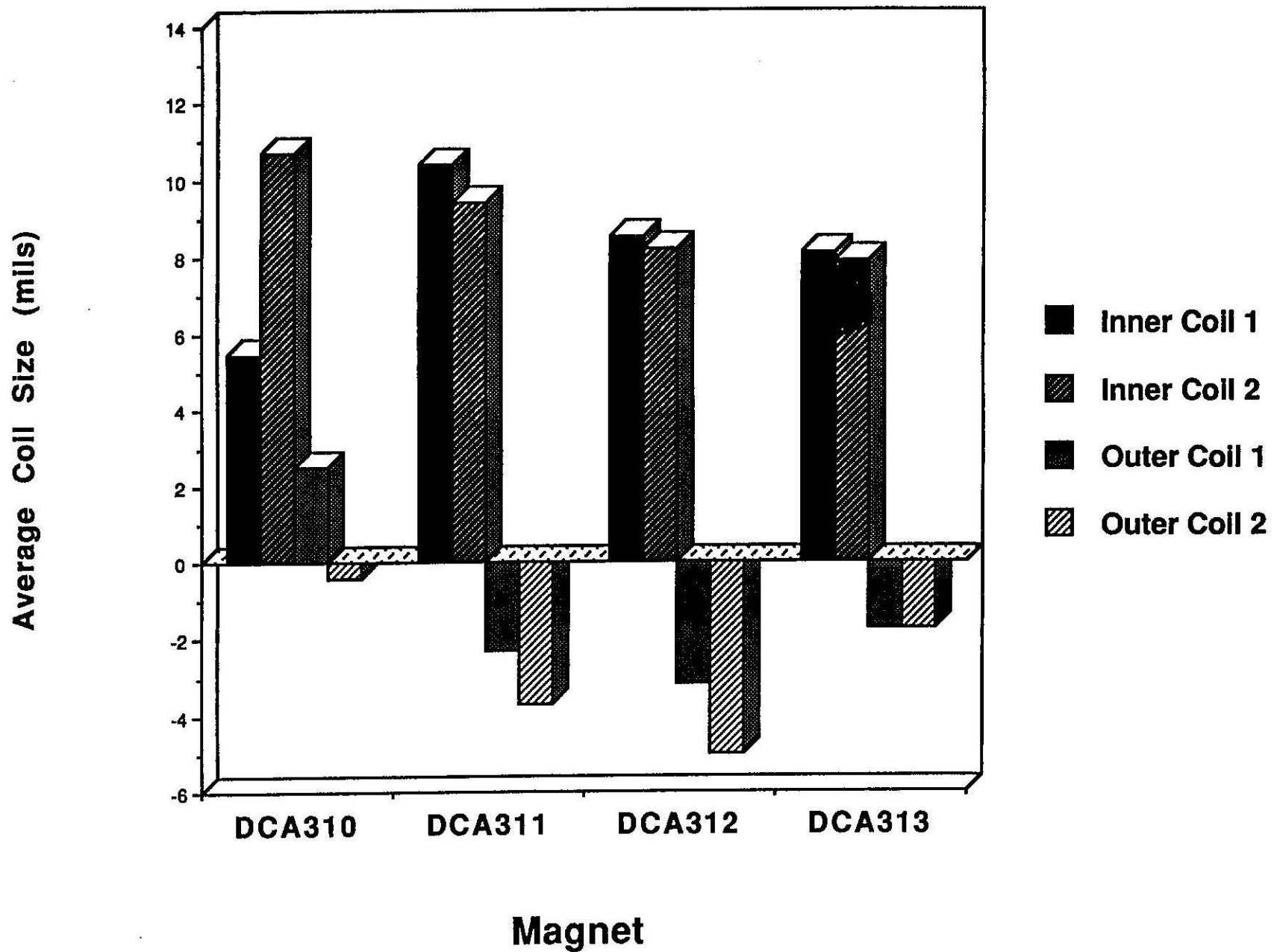
Average Inner Coil Size for Long 50mm Magnets



Average Outer Coil Size for Long 50 mm Magnets



Average Coil Sizes of the Coils Used in the 50 mm Long Magnets



Keying

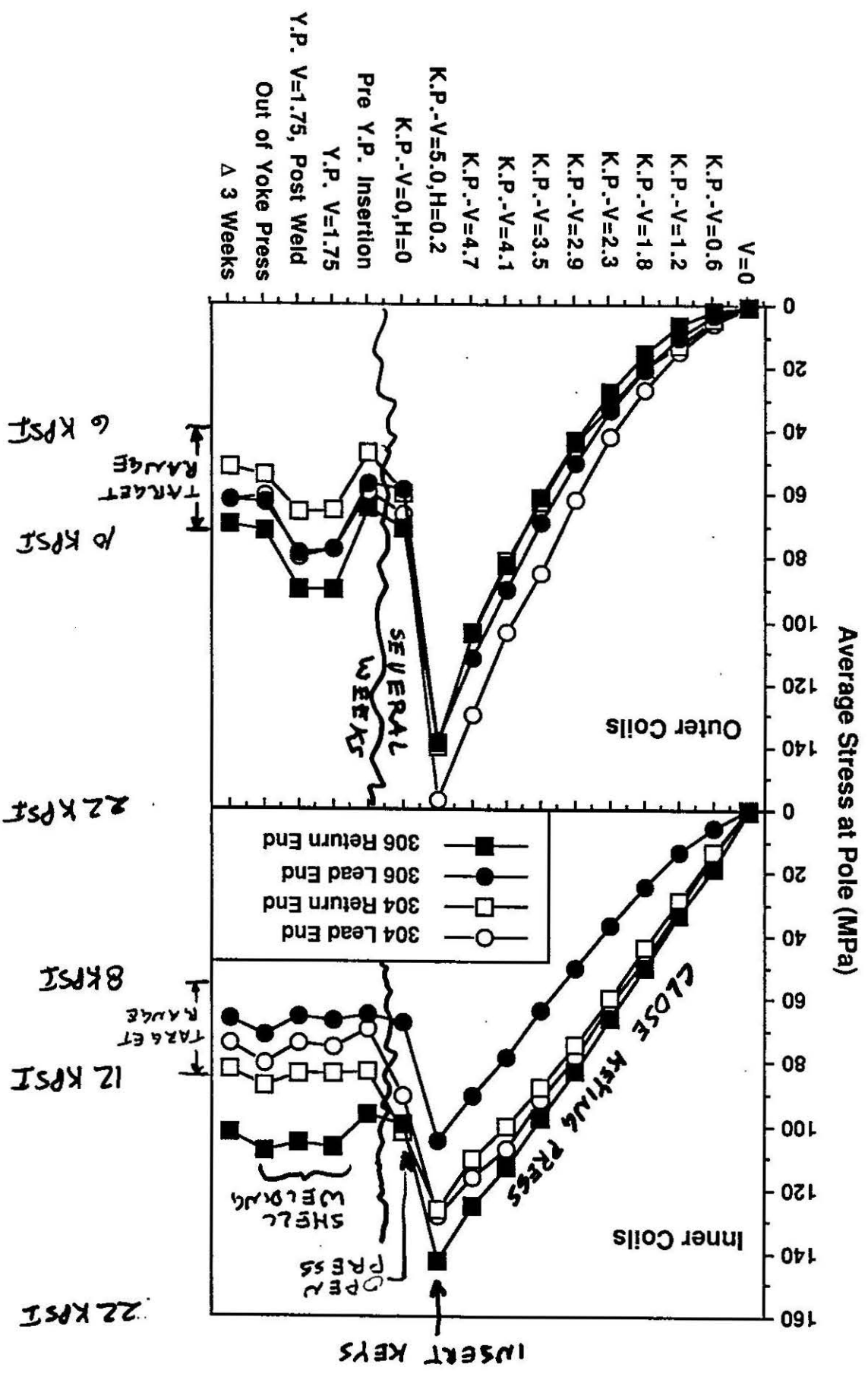
Collar coil alignment in press

Pole Stress

Press Closure

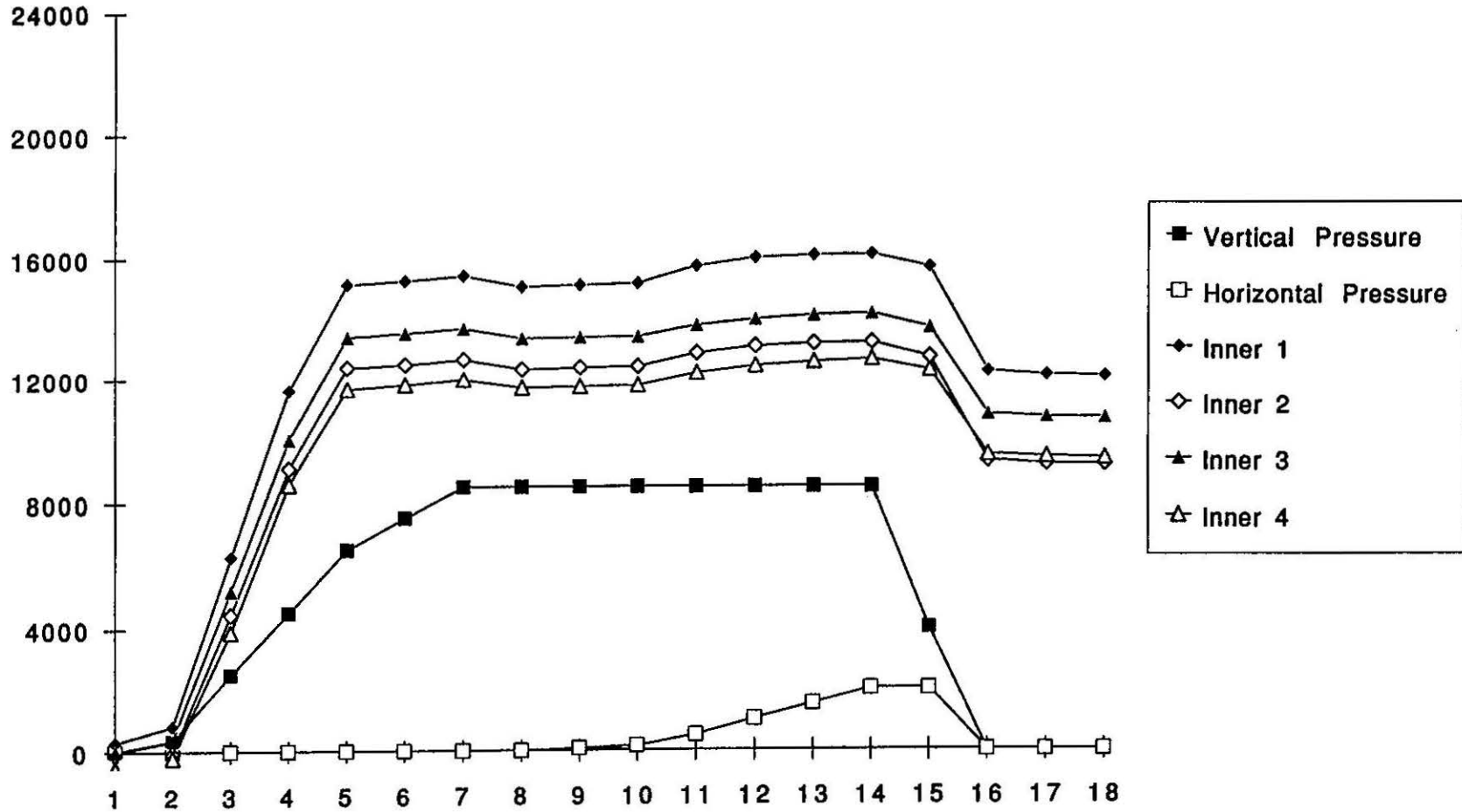
**Resistance monitoring during press operation and
hipot tests at maximum stress**

Key Insertion



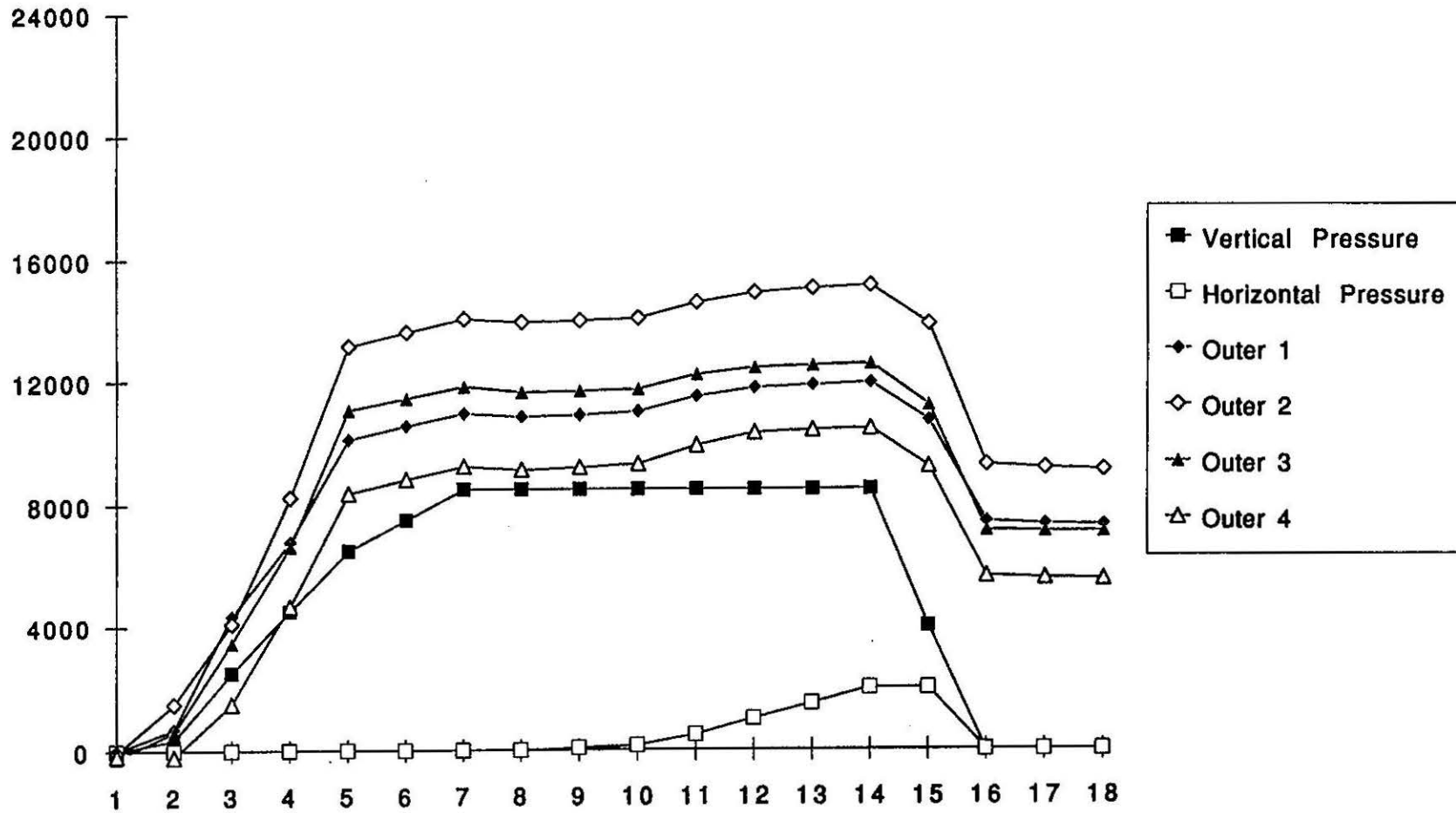
311 L.E. Inner Gauges

Lead End Inner Gauges

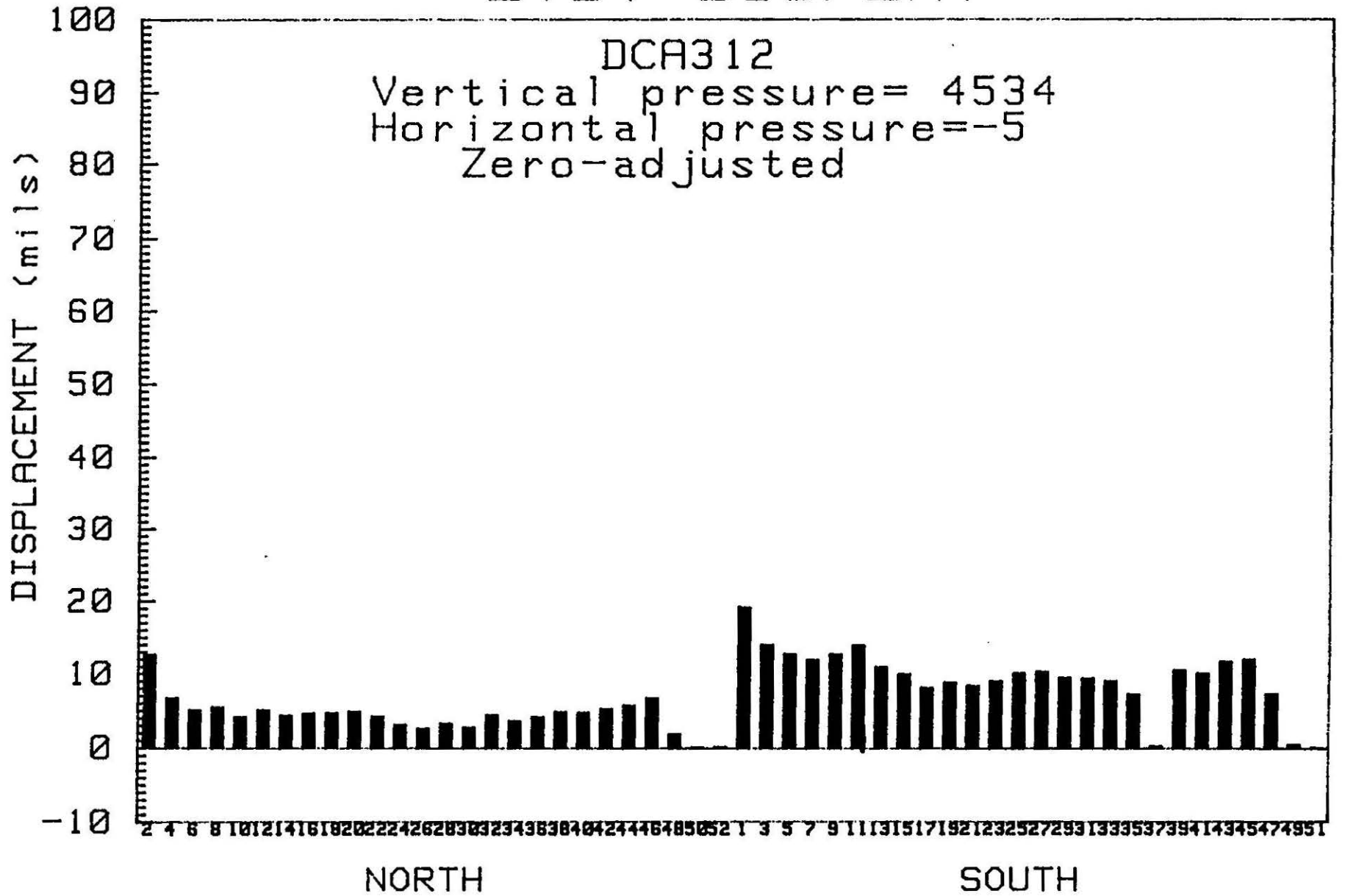


311 L.E. Outer Gauges

Lead End Outer Gauges



LVDT DISPLAY



Ave= .001 LINEAR POTENTIOMETER DATA

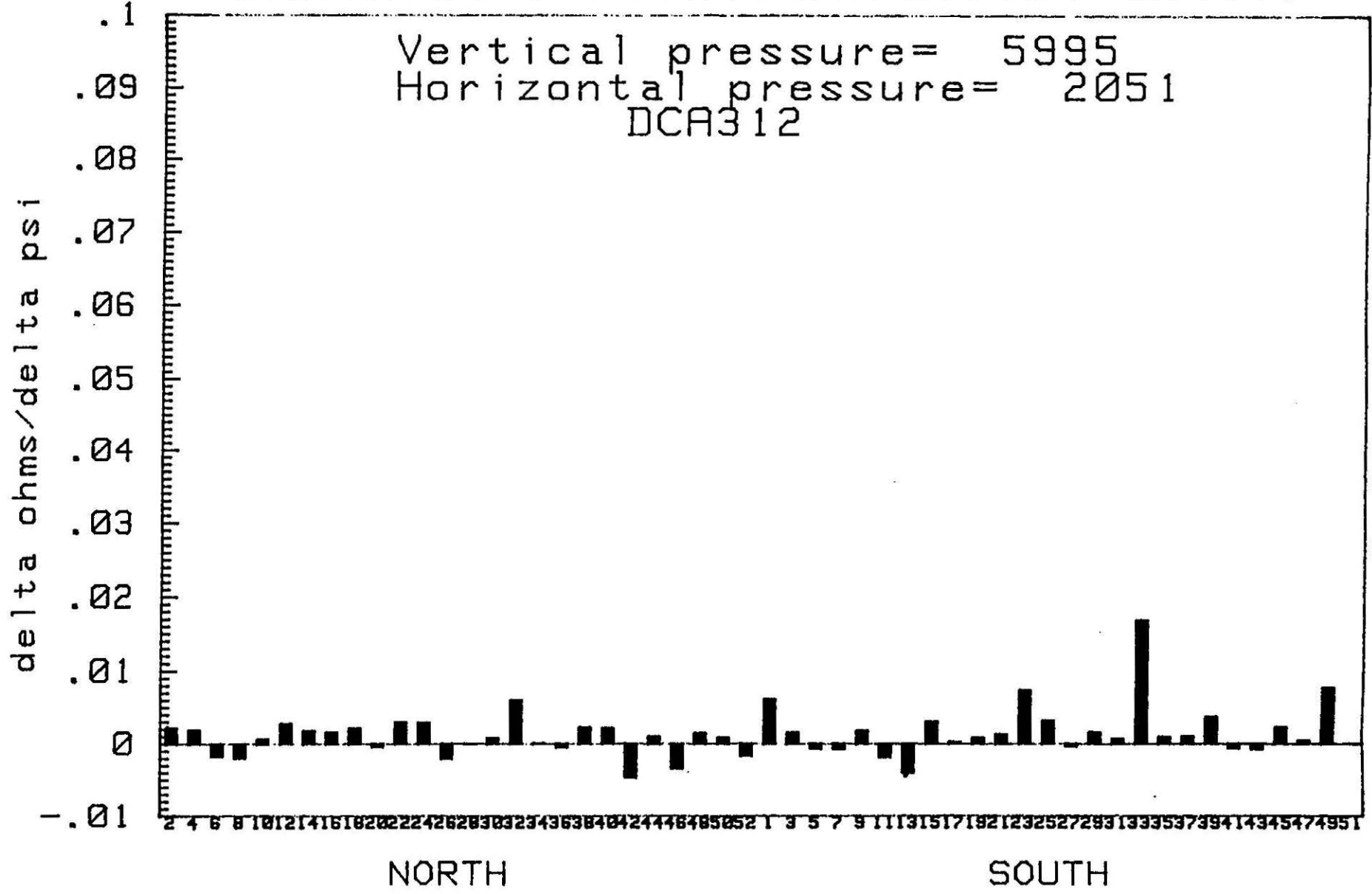
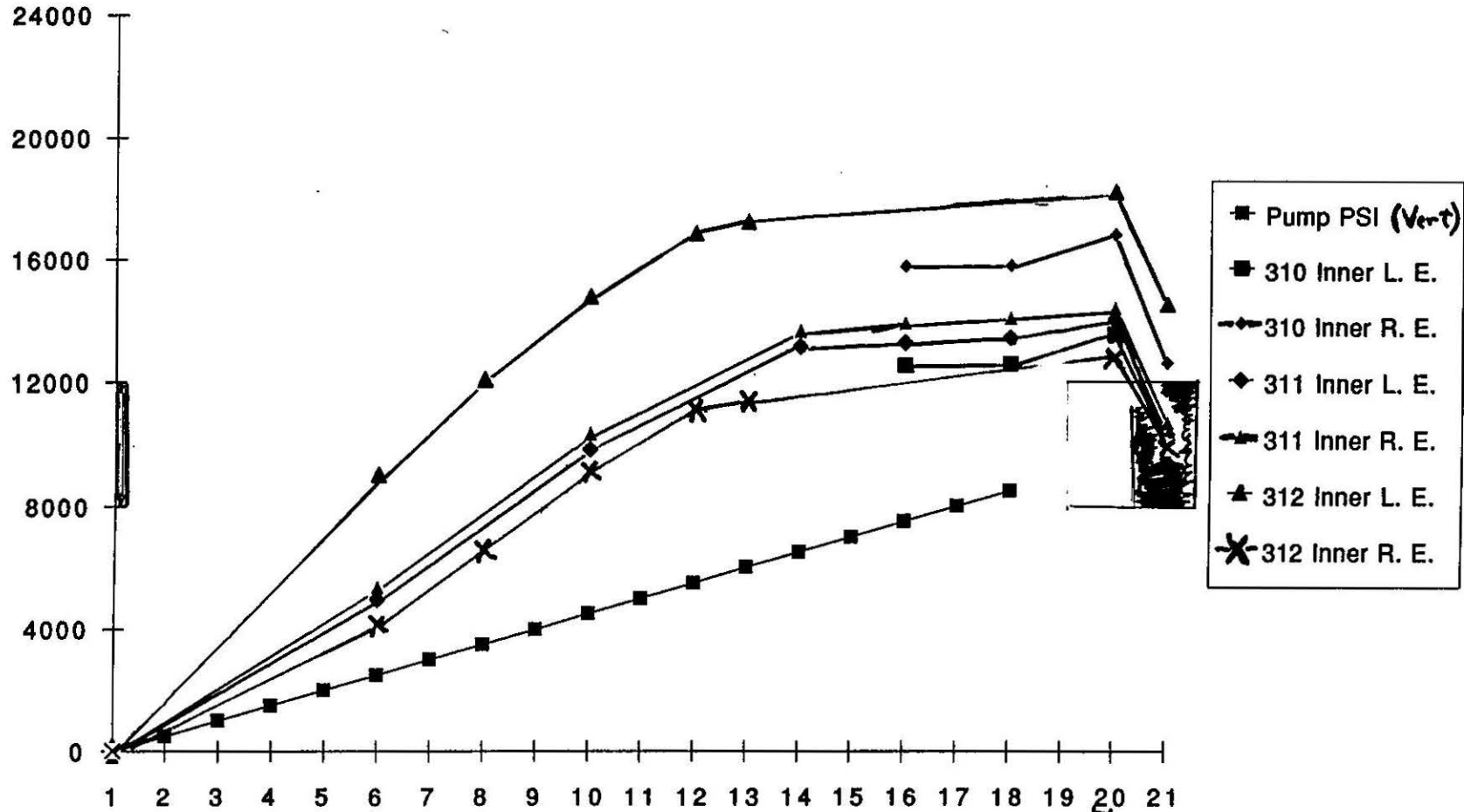


Chart13

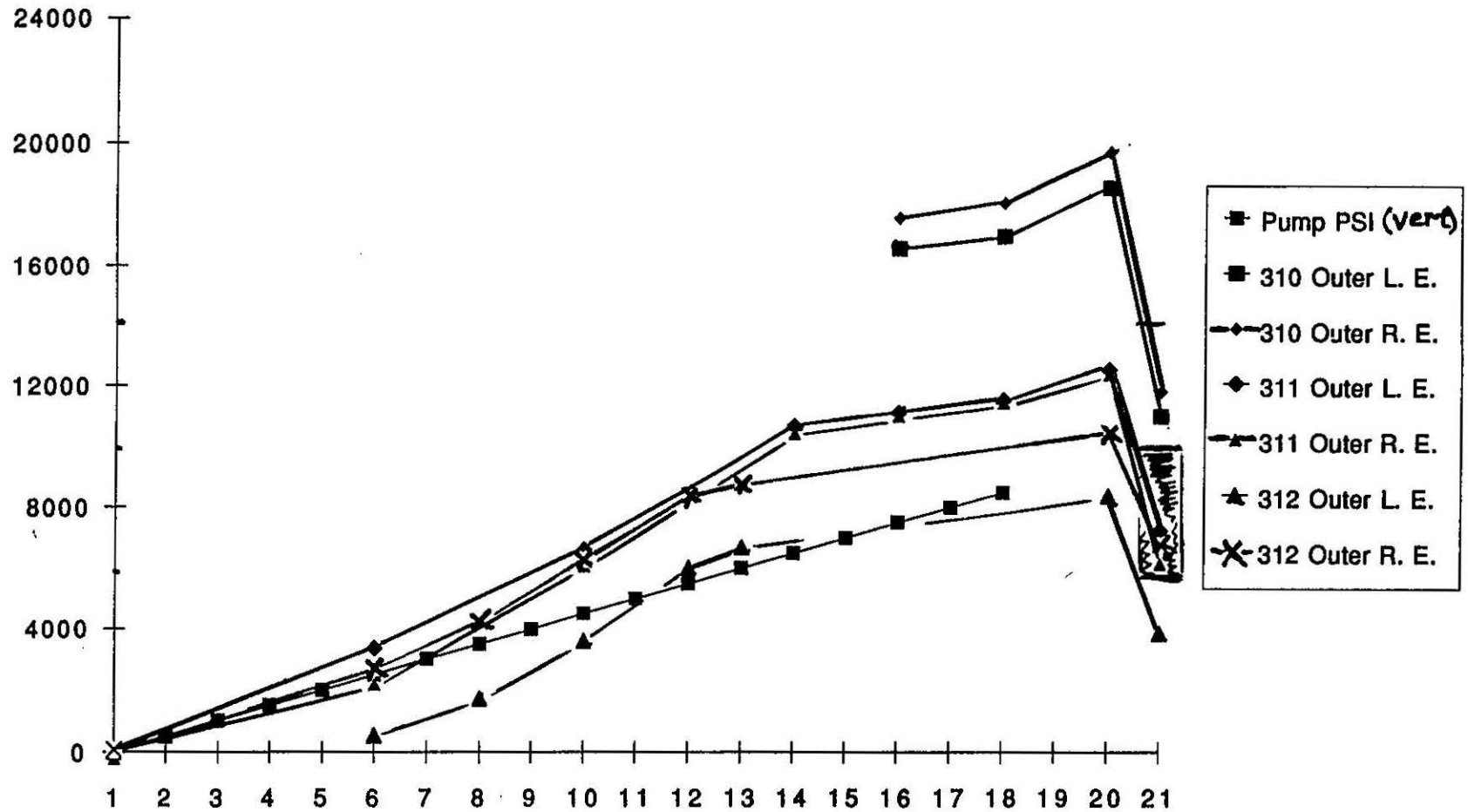
50 mm CDM Inner Coil Stress History



Horiz = 2.5KSI

Chart1

50 mm CDM Outer Coil Stress History



Hor 12
= 2.5 KSI

End Clamp Installation

Develop fixture which allows easy installation and removal of end can

Develop criteria for successful end clamp installation

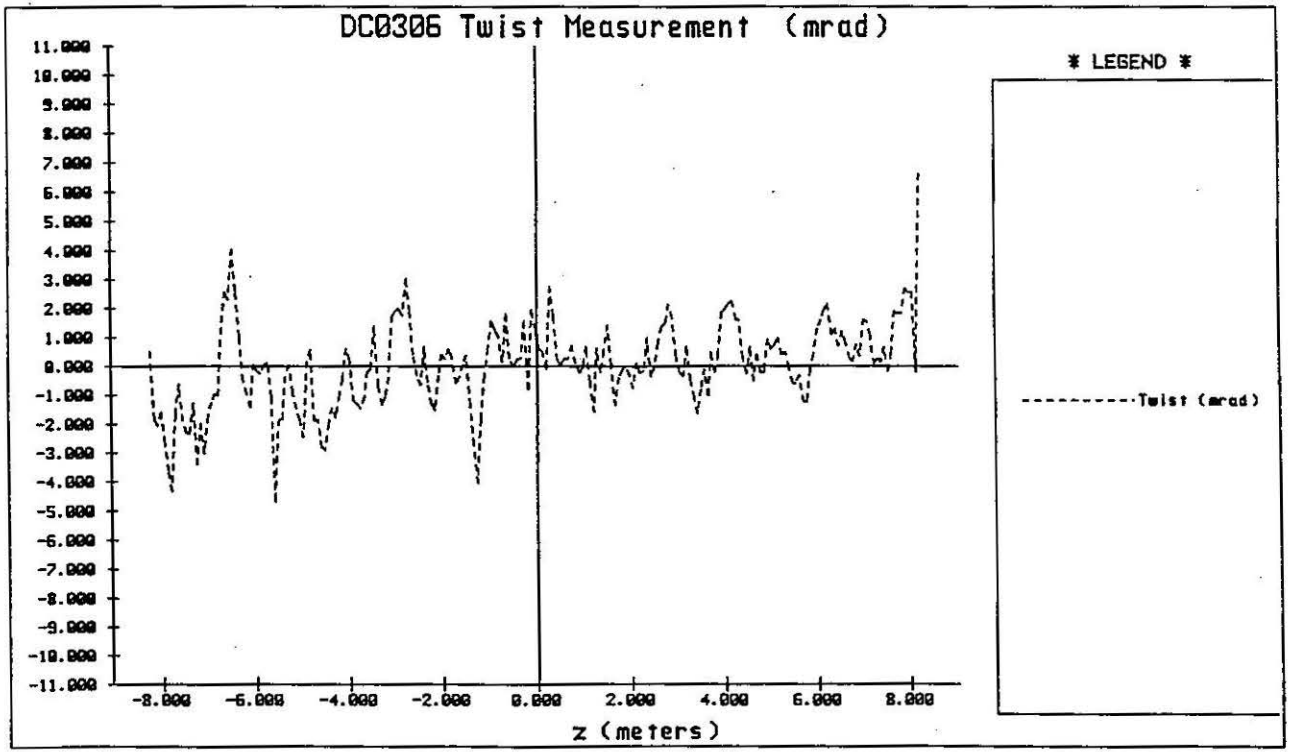
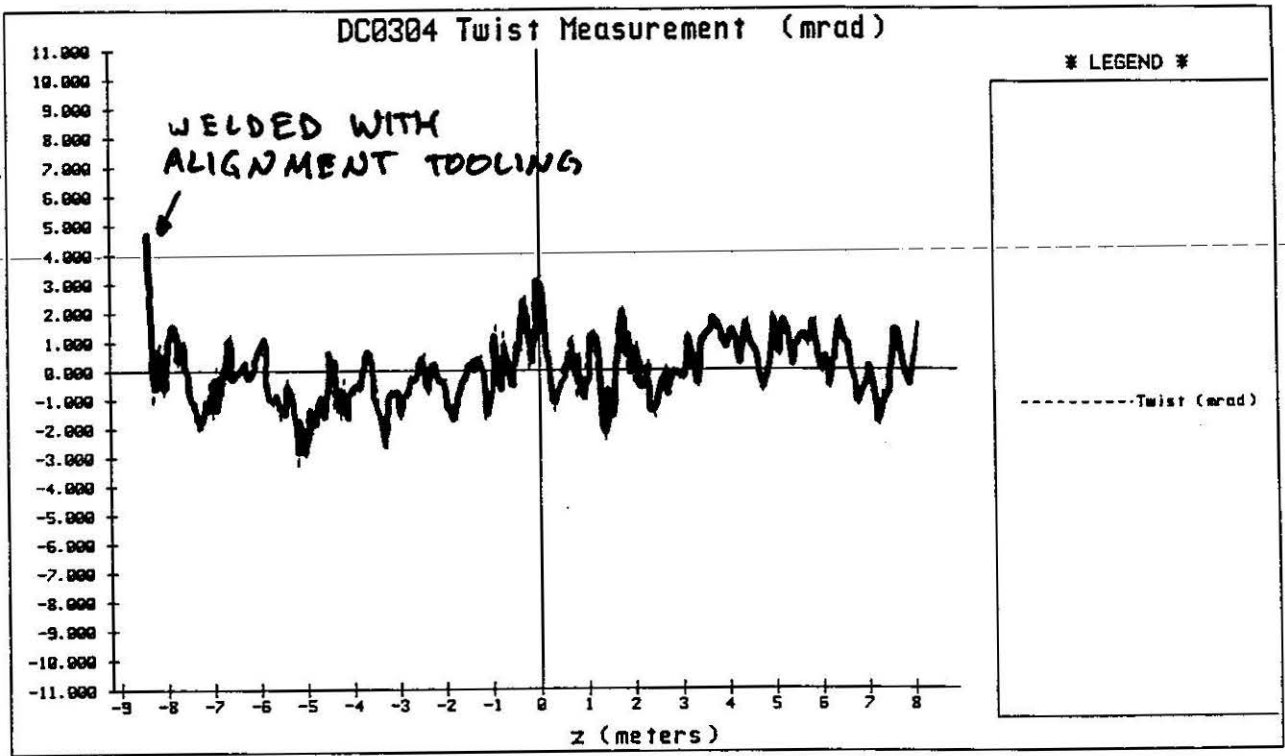
Yoke installation and shell welding

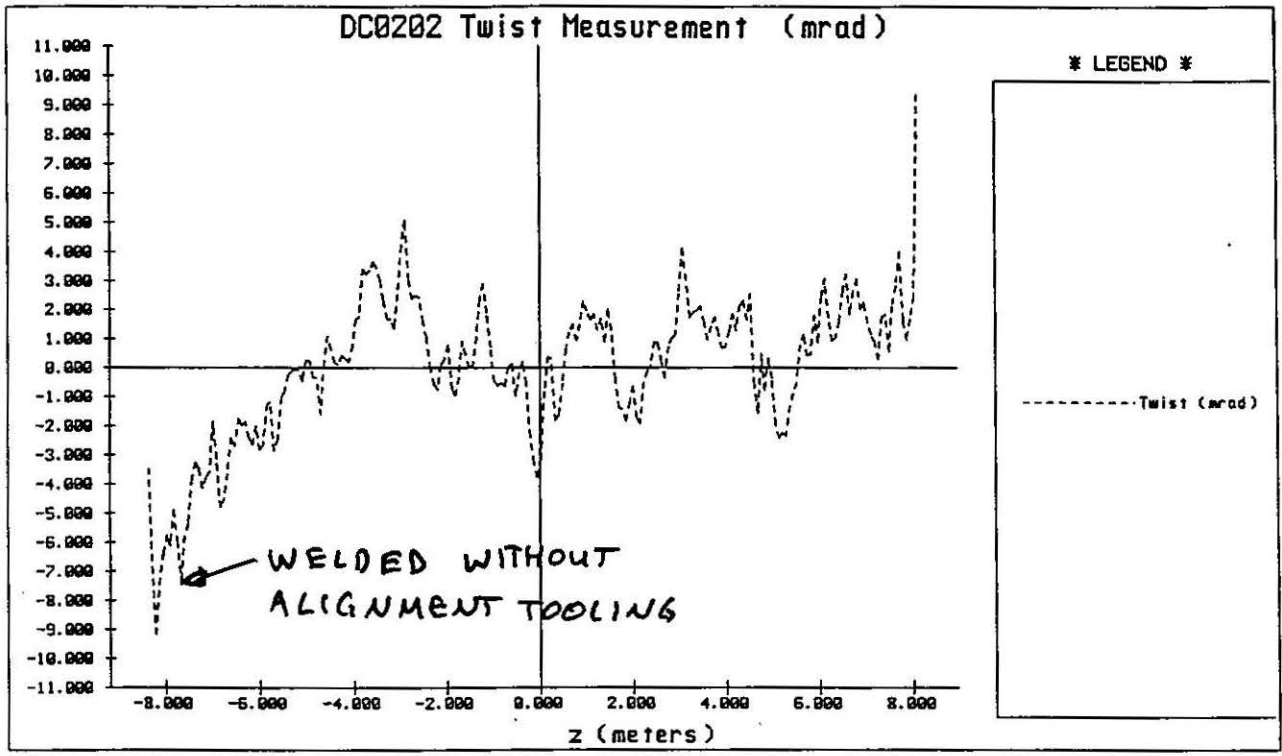
Chevroning of yoke laminations

Alignment key

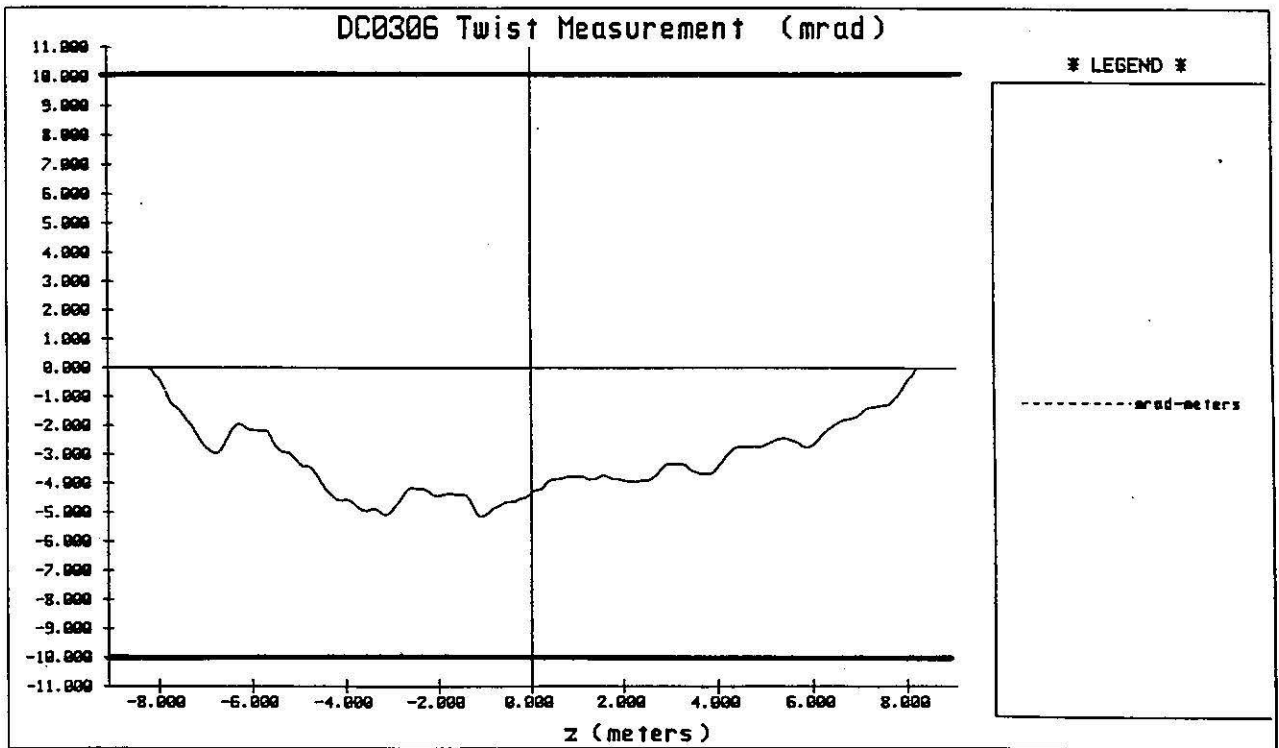
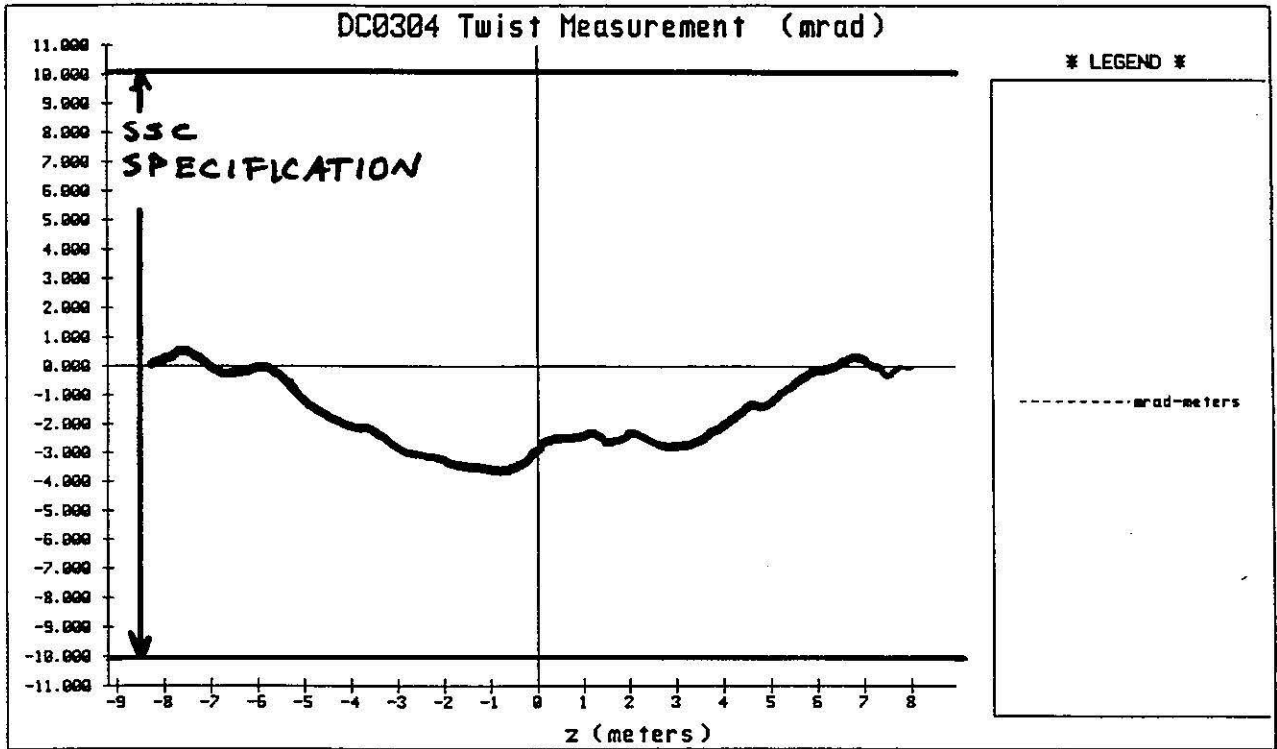
Field angle measurements

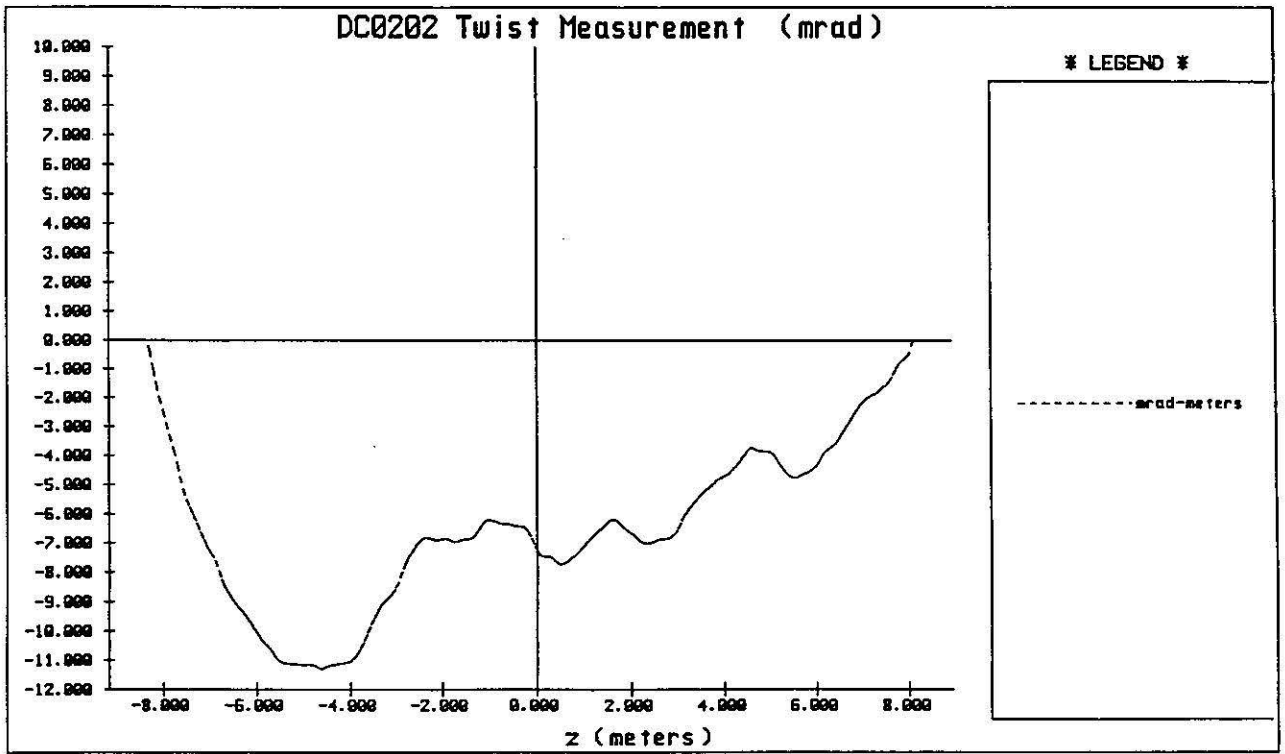
DIPOLE FIELD ANGLE (θ_B) [mrad]





$\int \rho_B dz$ (mrad-m)





Electrical Interconnect

Cryostating

Field measurements of collared and yoked coils

Summary

The 40 mm long CDM program brought to light several weaknesses in the production process:

- **Inadequate keying press**
- **Inadequate cleanliness**
- **Inadequate specification of procedures and documentation**
- **Inadequate monitoring of magnet properties during fabrication**

A great effort has been made to remedy these weaknesses prior to the 50 mm program:

- **Keying press has been rebuilt**
- **Production building has been thoroughly cleaned**
- **Detailed travelers for each assembly stage are used which specify procedures and require documentation of each production step**
- **Computerized data acquisition systems are used to control and monitor equipment during several production steps**
- **Electrical properties of the magnets are checked after all major assembly steps**

As a result of the learning process afforded by the 40 mm program, the 50 mm program is progressing quite smoothly.