Fermilab

SSC DETECTOR SOLENOID DESIGN NOTE #111

TITLE: Progress Report Prepared for Presentation at the Collaboration Meeting in Dallas, Mar 12-13, 1990

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DATE: Mar 13, 1990

ABSTRACT: This Design Note consists of the viewgraphs prepared for presentation in the magnet working group session of the collaboration meeting in Dallas on March 12 and 13, 1990. None of the Fermilab authors attended the meeting and so the viewgraphs were shown by Taka Kondo.

FERMILAB SOLENOID DESIGN TEAM

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(1)

PAST WORK INCLUDES COMPARISON OF TYPE-L (LONG) IRON RETURN SOLENOIDS AND TYPE-S (SHORT) AIR CORE SOLENOIDS FOR CONDUCTOR T_{max}, FIELD UNIFORMITY, CONDUCTOR STRESS, AND TOTAL PHYSICAL AND RADIATION LENGTH THICKNESS. RESULTS PRESENTED AT PREVIOUS MEETINGS.

RECENT WORK DESCRIBED HERE INCLUDES:

- COMPARISON OF LARGE SOLENOID DESIGN PARAMETERS
- OPTIMIZATION OF TYPE-S AIR-CORE SOLENOID WITH TWO CURRENT DENSITIES
- TYPE-L AIR CORE SOLENOID
- DISCREET COIL TOROID GEOMETRY.

(2)

WE HAVE COMPARED A NUMBER OF DIFFERENT SOLENOID COIL DESIGNS WITH DIFFERENT RADII, FIELDS, LENGTHS, AND RETURN YOKES.

RANGE OF SOLENOID PARAMETERS AND DIMENSIONS FOR DESIGNS STUDIED SO FAR

Parameter	Magnet Type					
Overall I.R. (m)	1.7	1.7	2.0	2.0	2.25	1.7
Central field (T)	2.0	2.0	1.7	1.7	1.7	2.0
Tracker length (m)	8	8	9	9	9	15
Overall length (m)	8	15	9	15	15	15
Iron yoke (yes/no)	no	yes	no	yes	yes	no
Radial thickness (m)	0.35 +/- 0.05 for all types					
Stored energy (MJ)	120	240	140	240	300	220
Radiation thickness at 90°	1.2 +/- 0.2 X_0 for all					

T_{max} IN CONDUCTOR:

FUNCTION OF:

1. STORED ENERGY
2. CURRENT
3. DISCHARGE VOLTAGE
4. AMOUNT OF STABILIZER AND IT'S RRR VALUE

SURVEYED RRR VALUES OF PAST MAGNETS. CONCLUDE THAT RRR=1000-1600 SEEMS REASONABLE. (NOTE THAT RRR OF ALUMINUM IS DEGRADED WHEN ACTUALLY MADE INTO CABLE AND AT B>0 BY MAGNETORESISTIVITY)

RRR OF ALUMINUM STABILIZED SUPERCONDUCTORS AT ZERO FIELD

Magnet	Design	Measured
CDF	1000	1885
Topaz-KEK	2500	2500
Venus-KEK	1000	1800
Aleph-LEP	1000	2000
Delphi-LEP	500	1160
Cleo II-Cornell	500	1000
Zeus-HERA	1000	1400
H1-HERA	500	1160
Average	1000	1613

SSC Det. Solnd 1000 to 1600

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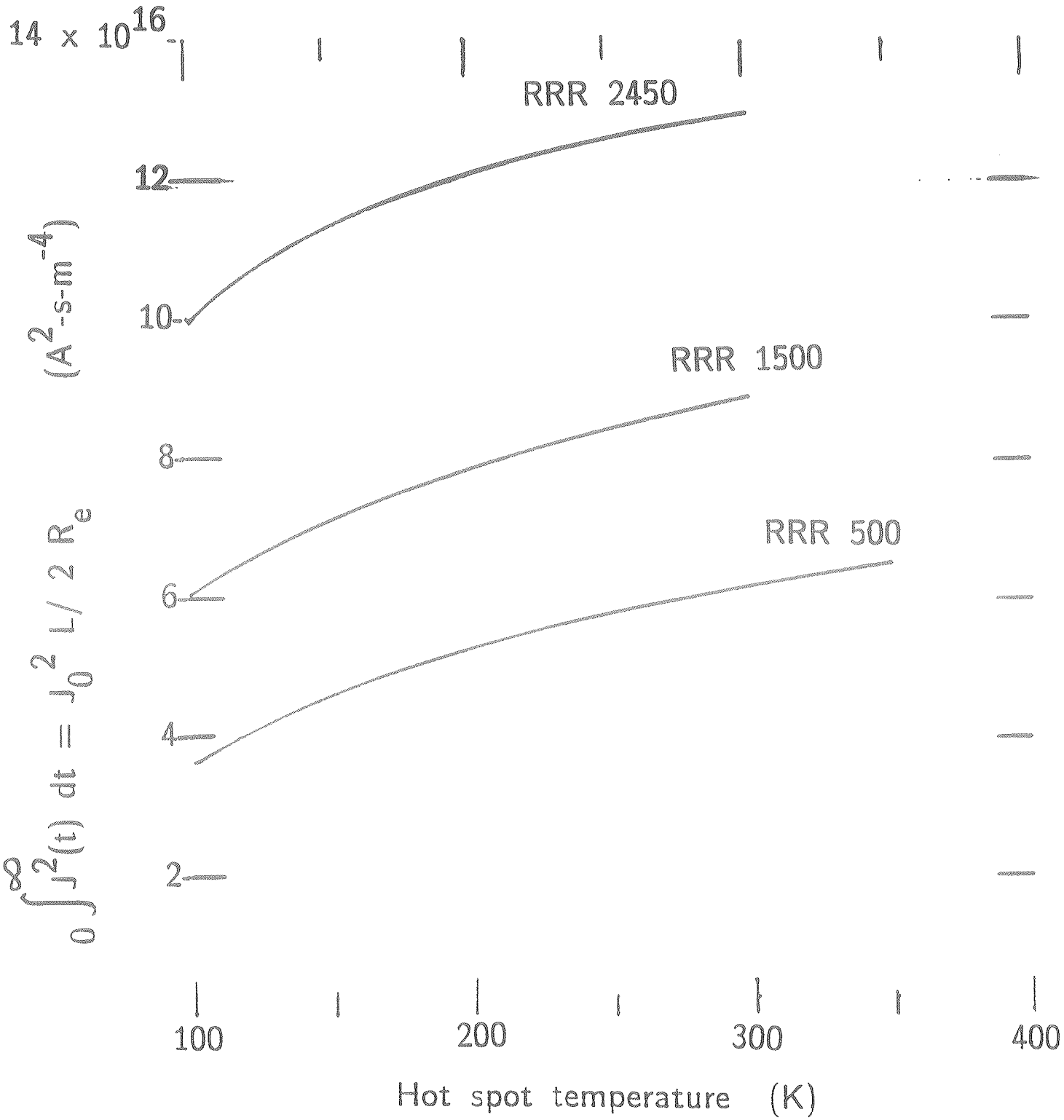
CONSEQUENCES OF RRR VALUE ON T_{max} FOR FIXED AMOUNT OF CONDUCTOR STABILIZER

T_{MAX} DECREASES WITH INCREASING RRR

HOT SPOT TEMPERATURE IS INFLUENCED BY RRR OF CONDUCTOR



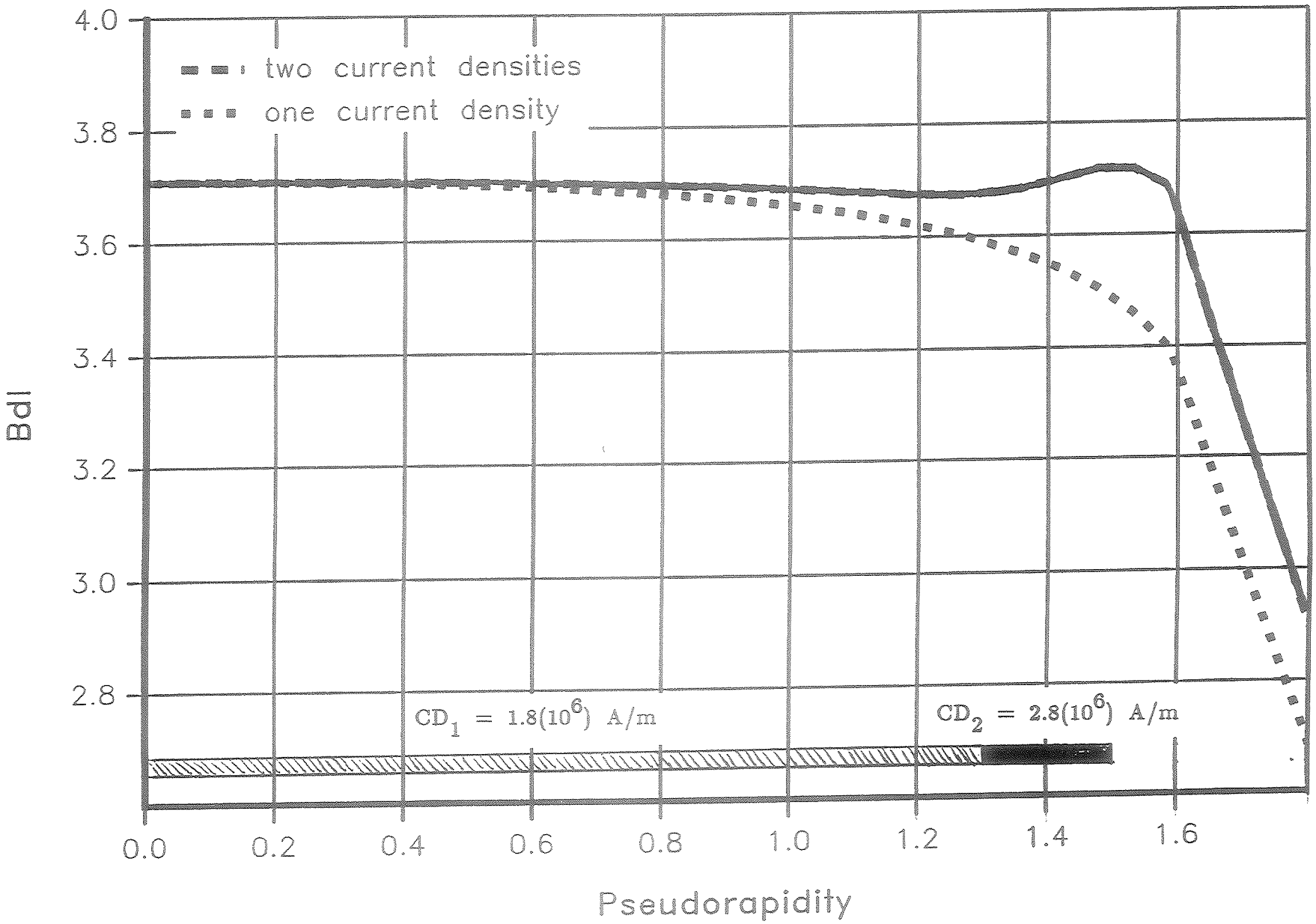
SHORT AIR-CORE (TYPE S) SOLENOID DESIGN STUDIES

USE TWO REGIONS OF DIFFERENT CURRENT DENSITIES. PERFORM AN OPTIMIZATION USING ANSYS TO MINIMIZE VARIATION OF INTEGRAL BDL. PARAMETERS ARE CURRENT DENSITIES AND Z LOCATION OF CURRENT DENSITY TRANSITION.

CONCLUDE THAT FIELD INTEGRAL CAN BE MADE MORE UNIFORM FOR TYPE-S COIL BUT THAT COMPRESSIVE FORCES ARE 20% LARGER THAN THE CASE USING ONE CURRENT DENSITY. ALSO LINEAR CURRENT DENSITY REQUIRED IS HIGHER.

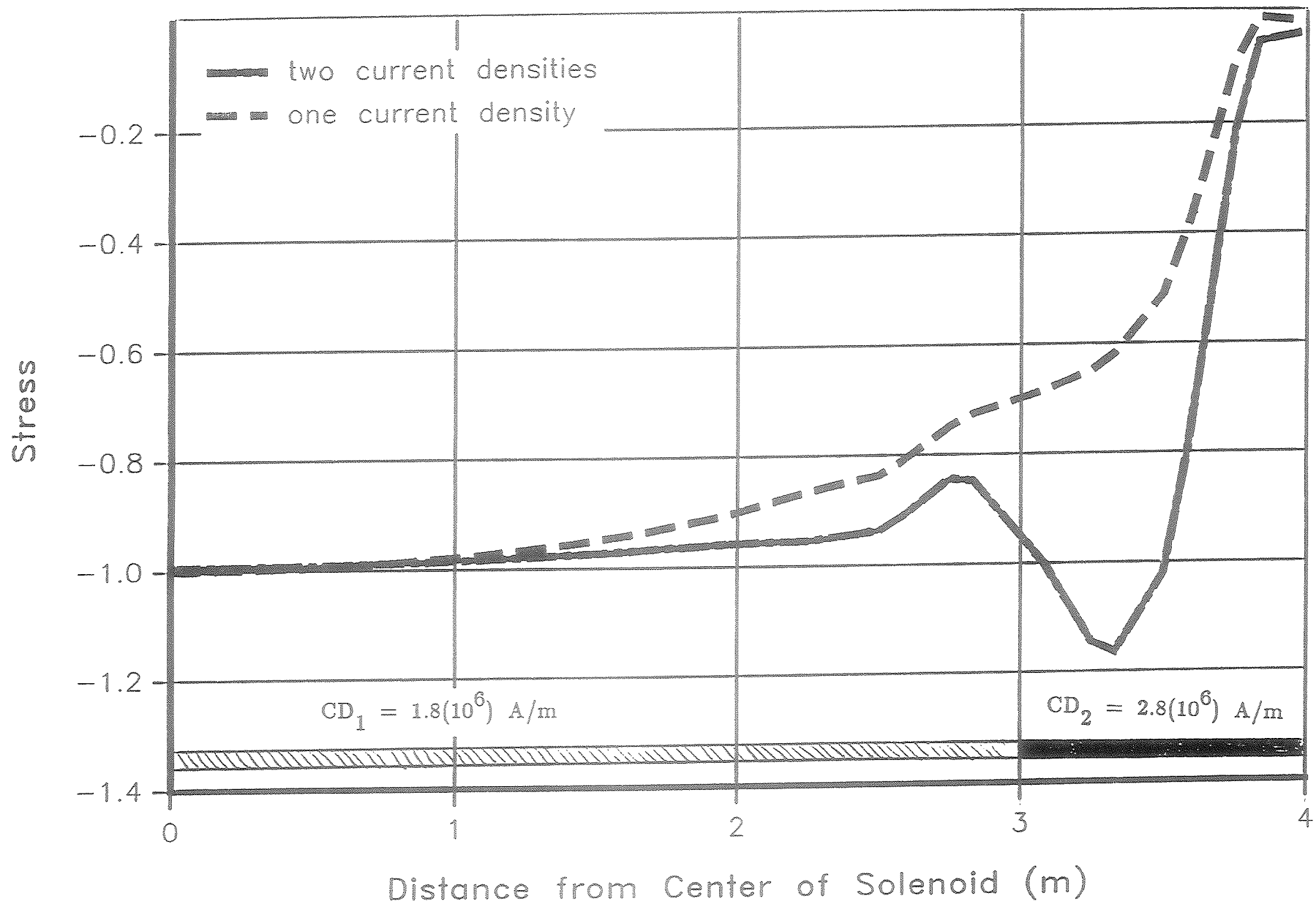
Air Core Solenoid, 1.7-m rad, 8-m long, 2.0 T

comparison of one and two current densities



Air Core Solenoid, 1.7-m rad, 8-m long, 2.0 T

comparison of axial conductor stress

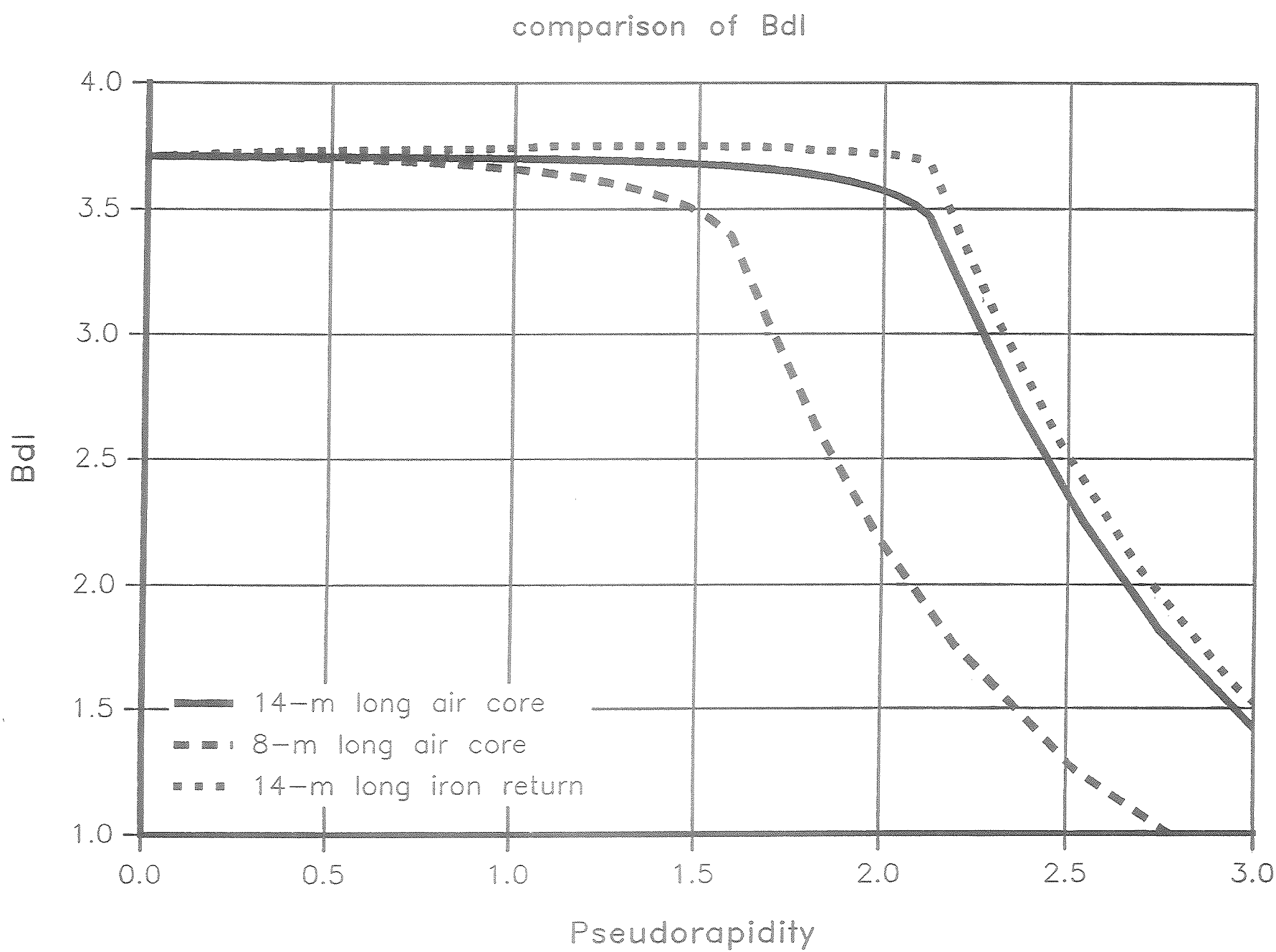


(6)

FOR COMPLETENESS, FNAL EXAMINED THE CASE OF A LONG TYPE-S SOLENOID.

AS EXPECTED THIS DESIGN HAS LARGER PSEUDO-RAPIDITY COVERAGE, AND BETTER FIELD UNIFORMITY THAN THE SHORTER COIL

1.7-m Radius, 2.0 T Central Field Solenoids



FNAL EXAMINED AIR CORE TOROID OPTION. WE EXAMINED A NOVEL DESIGN SCHEME:

DISCRETE COILS

NO MULTIPLE SCATTERING BETWEEN COILS

>90% OPEN AREA

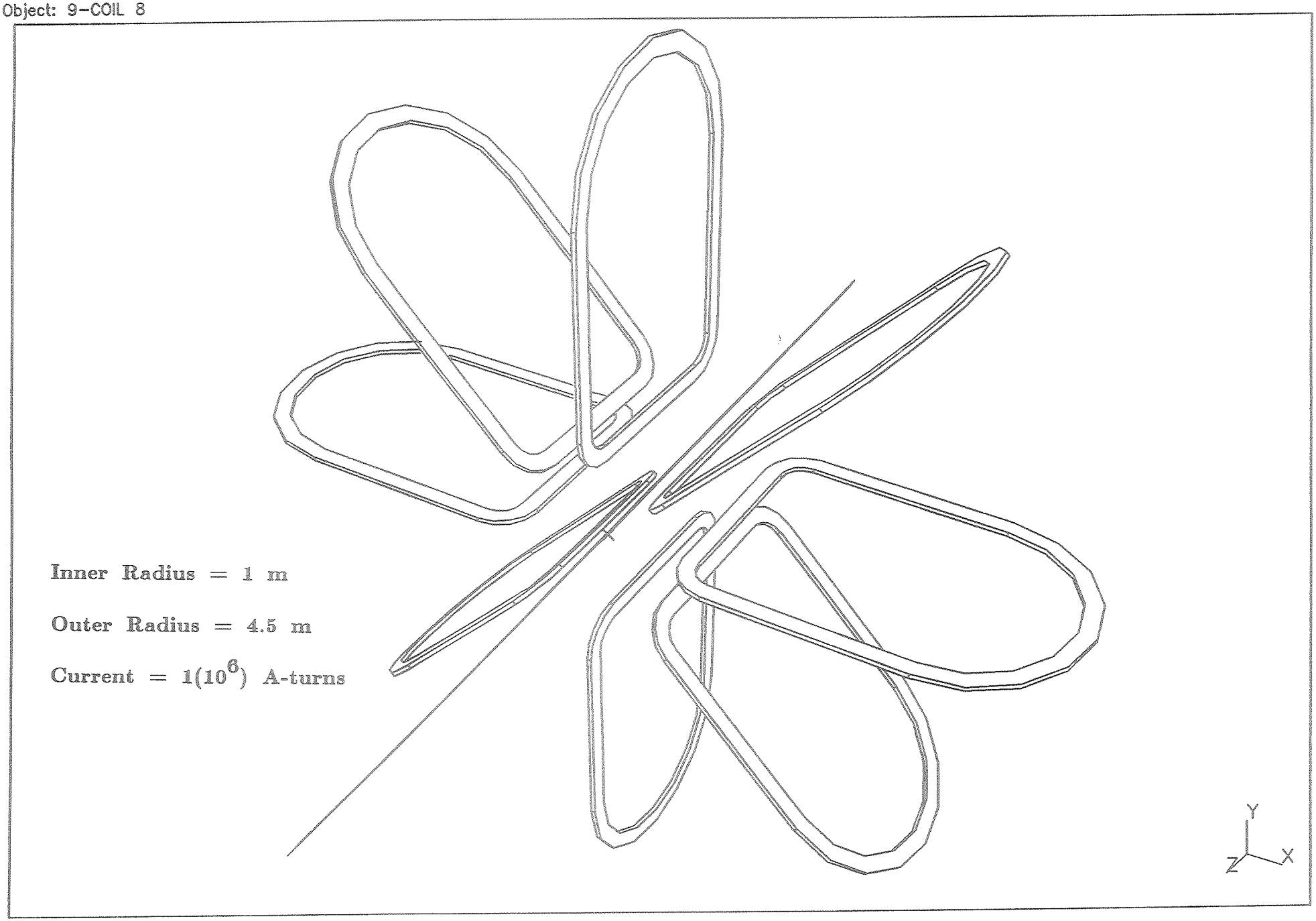
ALUMINUM CONSTRUCTION BUILT UP ON AL PLATE FINS. (IDEA IS THAT EVEN IF MUON PASSES THROUGH COIL, STILL MAKES REASONABLE MOMENTUM MEASUREMENT)

SDRC I-DEAS 4.1: Object Modeling

7-MAR-90 07:49:34

DATABASE: TOROID
VIEW : No stored VIEW
Task: OBJECT
Object: 9-COIL 8

UNITS : SI
DISPLAY : No stored OPTION
Bin: 1-MAIN



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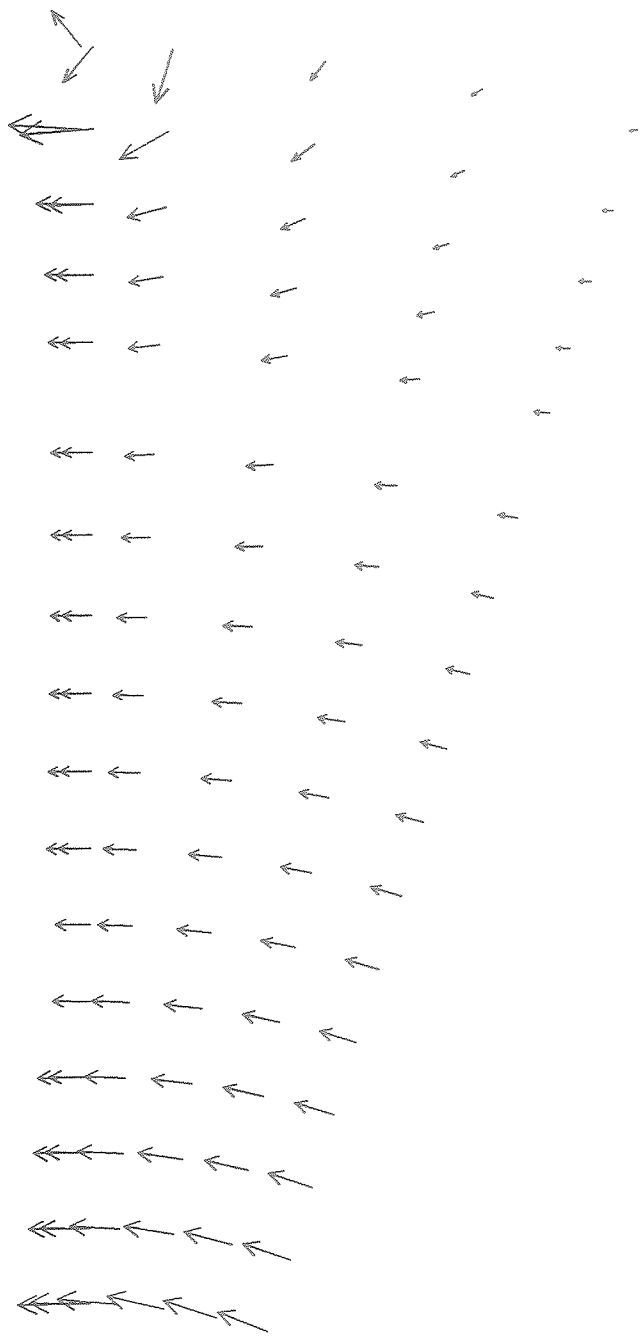

ANSYS 4.4
MAR 6 1990
10:51:00
PLOT NO. 2
POST1 VECTOR
STEP=1
ITER=3
BMAG
ELEM=1549
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0.329615
0.494422
0.65923
0.824037
0.988845
1.154
1.318
1.483

ZV =1
DIST=1.783
XF =0.936576
YF =2.877
ZF =1.309

B-field vector plot