SDC-92-285

SDC
SOLENOIDAL DETECTOR NOTES

THE MAGNETIC ANALYSIS OF THE SDC MUON BARREL TOROID (MBT) (THE INFLUENCE OF THE COILS POSITIONS ON THE MAGNETIC FIELD DISTRIBUTIONS)

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The magnetic analysis of the SDC MBT was carried out using the PE2D program on SSCVX1.

The first results on magnetic analysis of the simplified configuration of the SDC MBT have been presented in (1,2). In that configuration we did not consider the dependence of the magnetic field distribution from the positions of the coils. Obviously, the magnetic field will be changed from the coils positions. So it is possible to choose the best coils positions. The results on the investigation of the influence of the coils positions on the magnetic field distribution in the MBT are presented here. The three cases were considered - the "middle" position of the coil (Y=1.5m), the "lower" position of the coil (Y=0.5m) and the "upper" position of the coil (Y=2.2m).

CONFIGURATION

The current configuration of the SDC MBT is presented in Fig.1-1. Using the symmetries of the MBT only 1/8 of the MBT was simulated (shown by the dotted line in Fig.1-1). The configuration that has been used for analysis is presented in Fig.2-1 - the "middle" position of the coil, Fig.3-1 - the "lower" position of the coil, Fig.4-1 - the "upper" position of the coil. The configuration as assumed has infinite length in Z-direction.

COILS

The current configuration of the coil is presented in Fig.1-2. For analysis eight turns of each coil were simulated by one turn with H=35mm and W=416mm.

STEEL

For this analysis A-87 steel (Russia) was taken. BH-curve of these steel is presented in Fig.1-3. This curve was based on the data provided by Westinghouse Electric Corporation.

PREPARATION of the PE2D MODEL of the SDC MBT.

PE2D is based on the Finite Elements Methods (FEM). For all regions type P-Polygon discretization of the model was used. The Dirichlet boundary condition (normal component of the flux density zero) was used to define the potential at the outer surfaces of the model. For all other boundaries the Neumann boundary condition (tangential component of the flux density is zero) was used.

ANALYSIS

For the analysis, the PE2D/ST non-linear magnetostatics analysis program was used. The tolerance value (which is the maximum relative change permitted for any nodal potential between successive non-linear iteration) was taken equal to 0.0001.

RESULTS

The total results for the "middle" position of the coil are presented in Fig.2-1 through Fig.2-9; for the "lower" position of the coil - in Fig.3-1 through Fig.3-9 and for the "upper" position of the coil in Fig.4-1 through Fig.4-9.

Fig.5-1 through Fig.5-6 present the comparison of the results for the different coil position.

At whole the coils position does not influence significantly on the magnetic field distribution. But if we have the choice the more uniform distribution with the minimum fringing field is possible to receive for the "middle" position of the coil. So the uniform placement of the coils around the MBT is preference.

LIST OF FIGURES:

Fig.1-1 The current configuration of the SDC MBT. The part that has been used for the magnetic analysis (1/8 part) is shown by the dotted line.

Fig.1-2 The current configuration of the coil.

Fig.1-3 The BH-curve of A-87 steel (Russia).

Fig.2 The "middle" position of the coil (the coil is placed at Y=1.5m)

Fig.2-1 The configuration of the MBT with the "middle" position of the coils.

Fig.2-2 The plot of the magnetic field.

Fig.2-3 The plot of the fringing magnetic field.

Fig.2-4 The distribution of the magn. field along the line Y=0.

Fig.2-5,6 The fringing magnetic field along the line Y=0.

Fig.2-7 The distribution of the magnetic field between the corners of the MBT.

Fig.2-8,9 The fringing magnetic field around the corners of the MBT.

Fig.3 The "lower" position of the coil (the coil is placed at Y=0.5m)

Fig.3-1 The configuration of the MBT with the "middle" position of the coils.

Fig.3-2 The plot of the magnetic field.

Fig.3-3 The plot of the fringing magnetic field.

Fig.3-4 The distribution of the magn. field along the line Y=0.

Fig.3-5,6 The fringing magnetic field along the line Y=0.

Fig.3-7 The distribution of the magnetic field between the corners of the MBT.

Fig.3-8,9 The fringing magnetic field around the corners of the MBT.

Fig.4 The "upper" position of the coil (the coil is placed at Y=2.2m)

Fig.4-1 The configuration of the MBT with the "middle" position of the coils.

Fig.4-2 The plot of the magnetic field.

Fig.4-3 The plot of the fringing magnetic field.

Fig.4-4 The distribution of the magn. field along the line Y=0.

Fig.4-5,6 The fringing magnetic field along the line Y=0.

Fig.4-7 The distribution of the magnetic field between the corners of the MBT.

Fig.4-8,9 The fringing magnetic field around the corners of the MBT.

Fig.5 The comparison of the "middle", the "lower" and the "upper" position of the coils.

Fig.5-1 The distribution of the magn. field along the line Y=0.

Fig.5-2,3 The fringing magnetic field along the line Y=0.

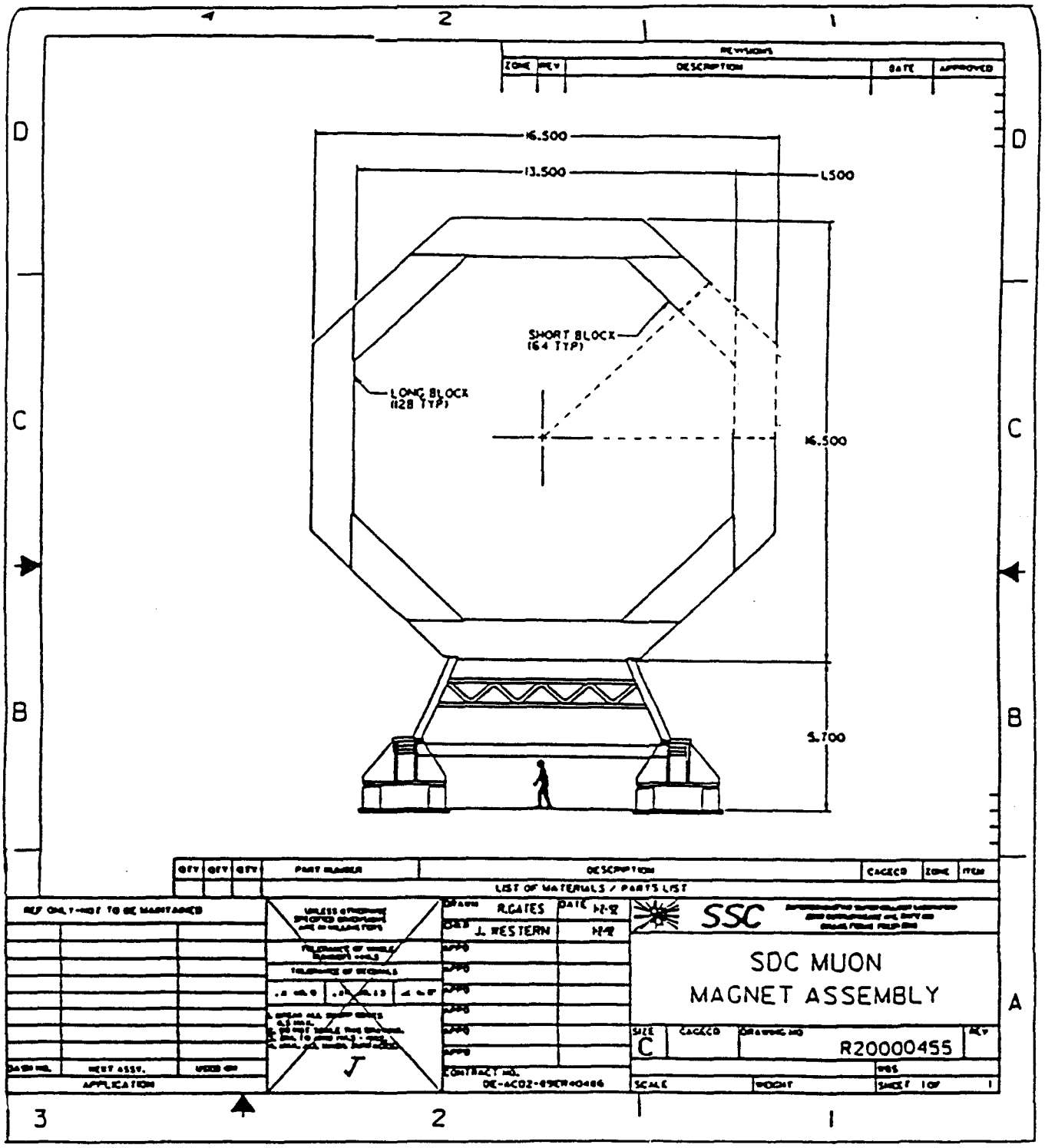
Fig.5-4 The distribution of the magnetic field between the corners of the MBT.

Fig.5-5,6 The fringing magnetic field around the corners of the MBT.

REFERENCES:

1. S.Timofeev "The magnetic analysis of the SDC Muon Barrel Toroid (MBT) (The simplified configuration)" SDC-92-266

2. S.Timofeev "The magnetic analysis of the SDC Muon Barrel Toroid (MBT) (The influence of the air gaps on the magnetic field distribution) SDC-92-280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(64 TYP)
LONG BLOCK
(128 TYP)
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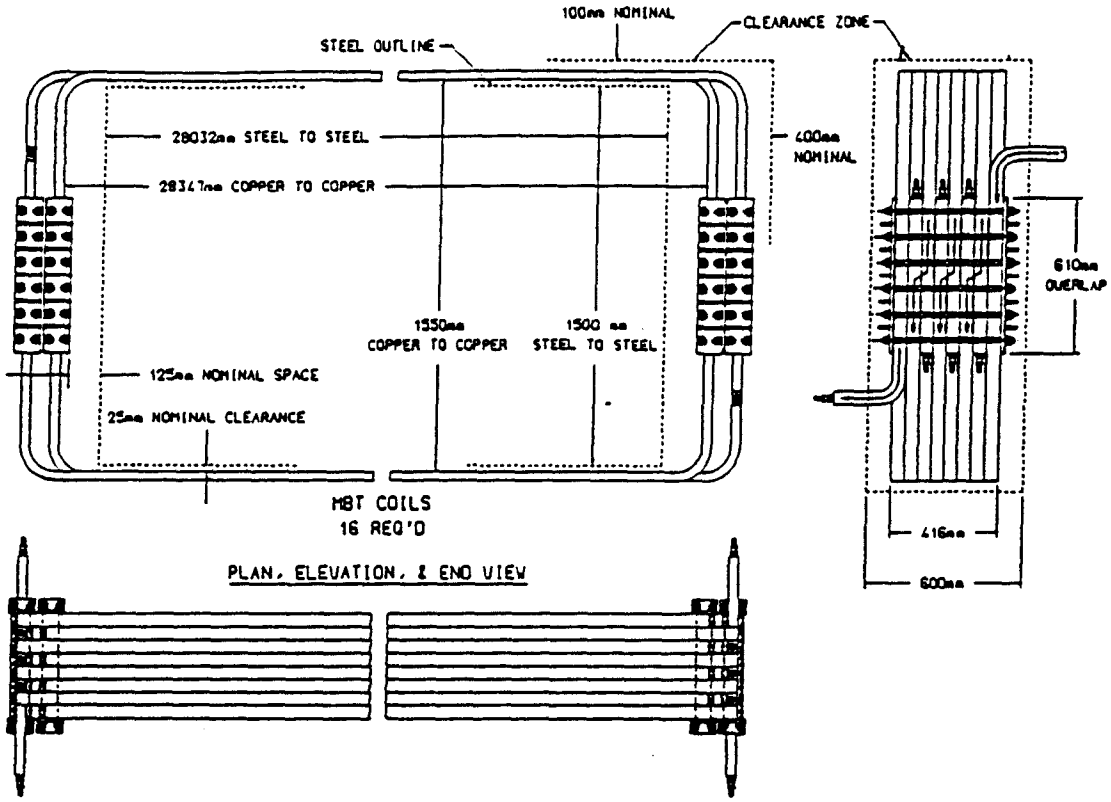
5.700
SSC
SDC MUON
MAGNET ASSEMBLY
R20000455
R.GATES
J. WESTERN
DE-AC02-89ER40486

Fig.1-1



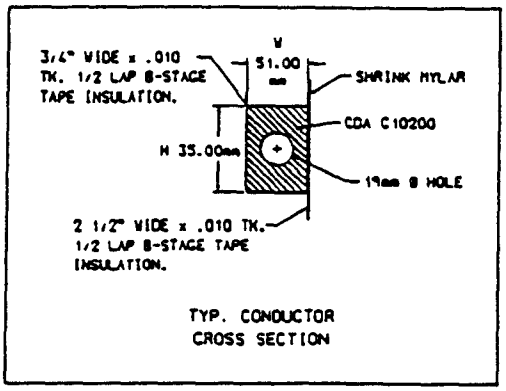


Fig.1-2

UNIVERSITY OF WISCONSIN
PHYSICAL SCIENCES LAB
J.J.C./G.M.G.
2-20-92

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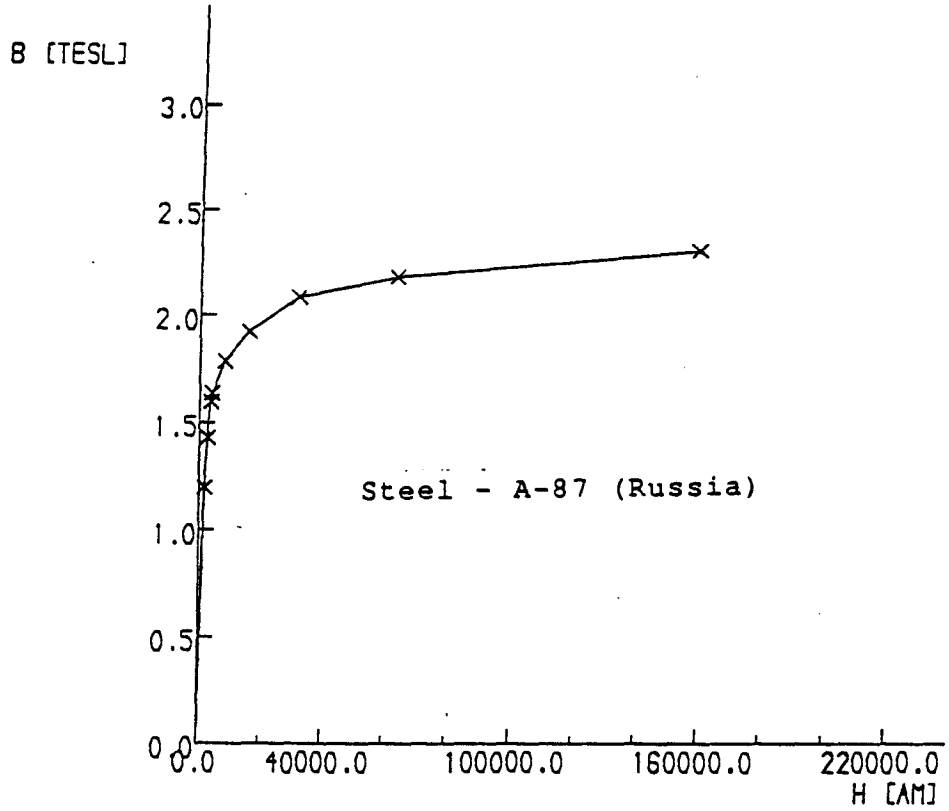

VF/PE2D.8

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5	1.639	3999.99
6	1.788	8000.0
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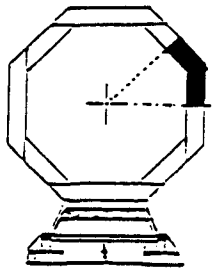
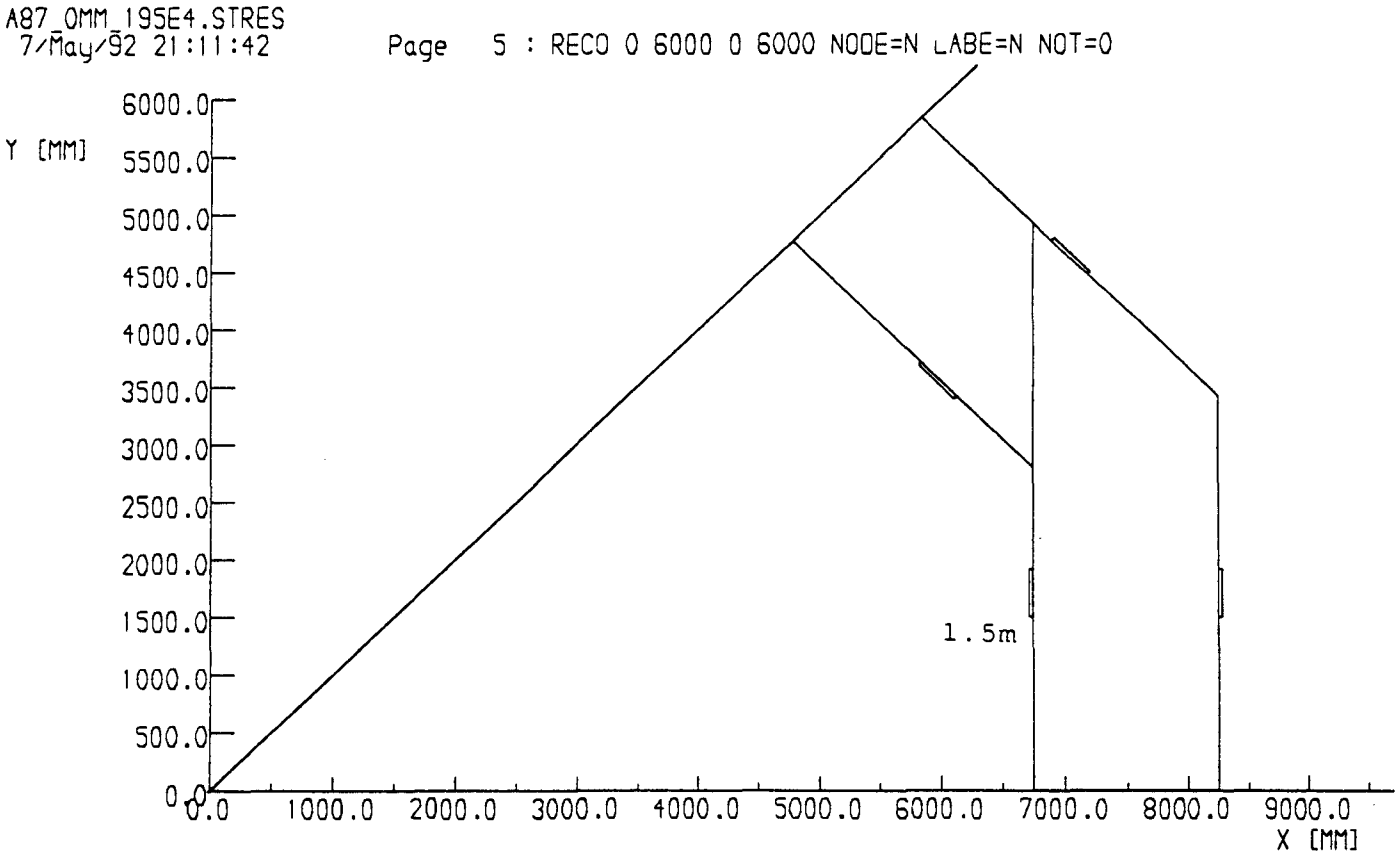
.Fig.1-3





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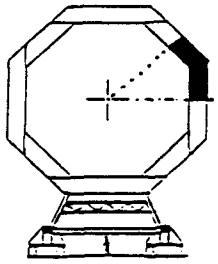
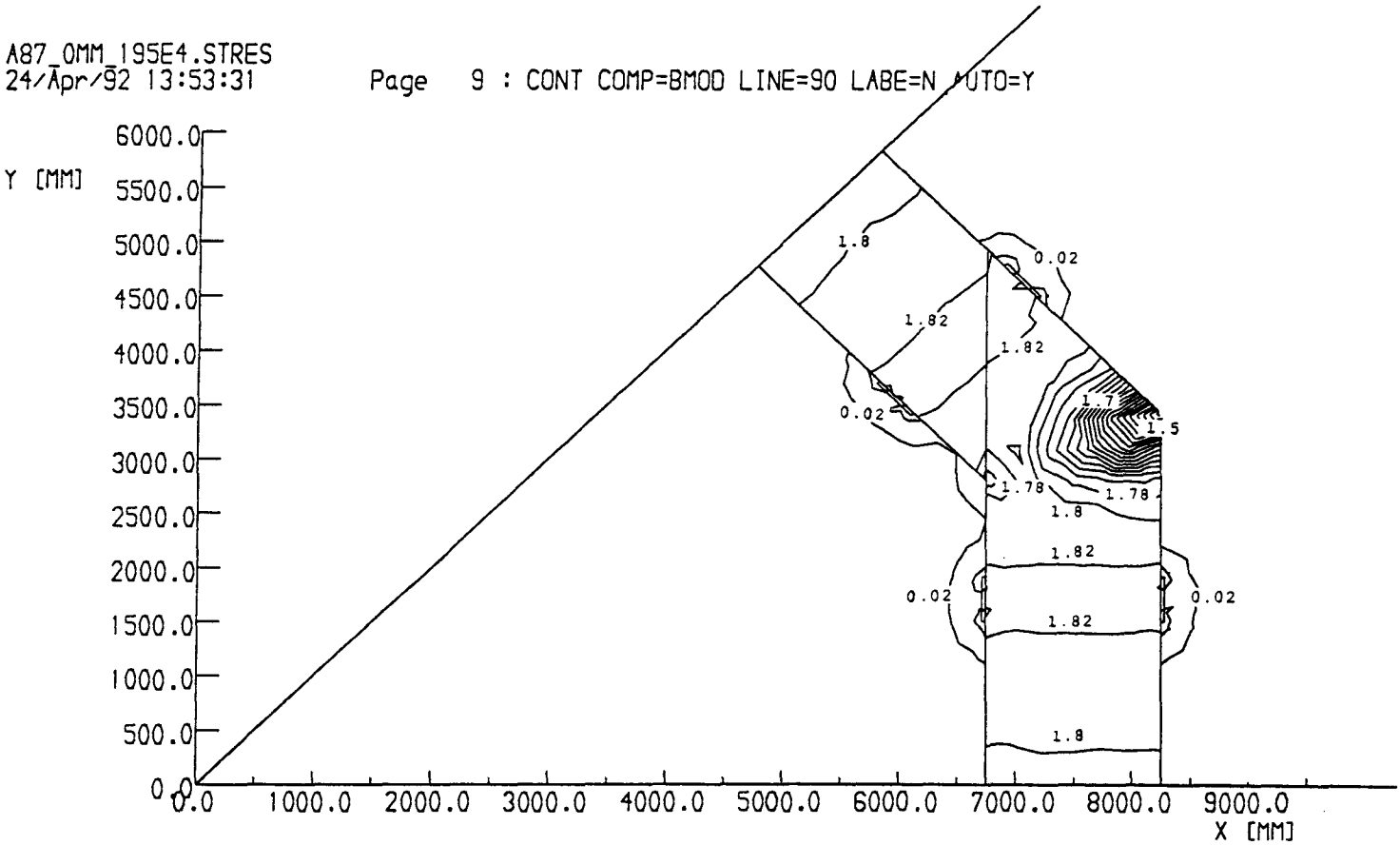
VF/PE2D.8

Fig.2-1





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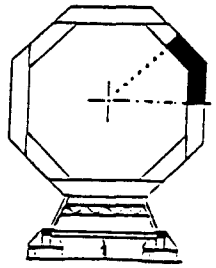
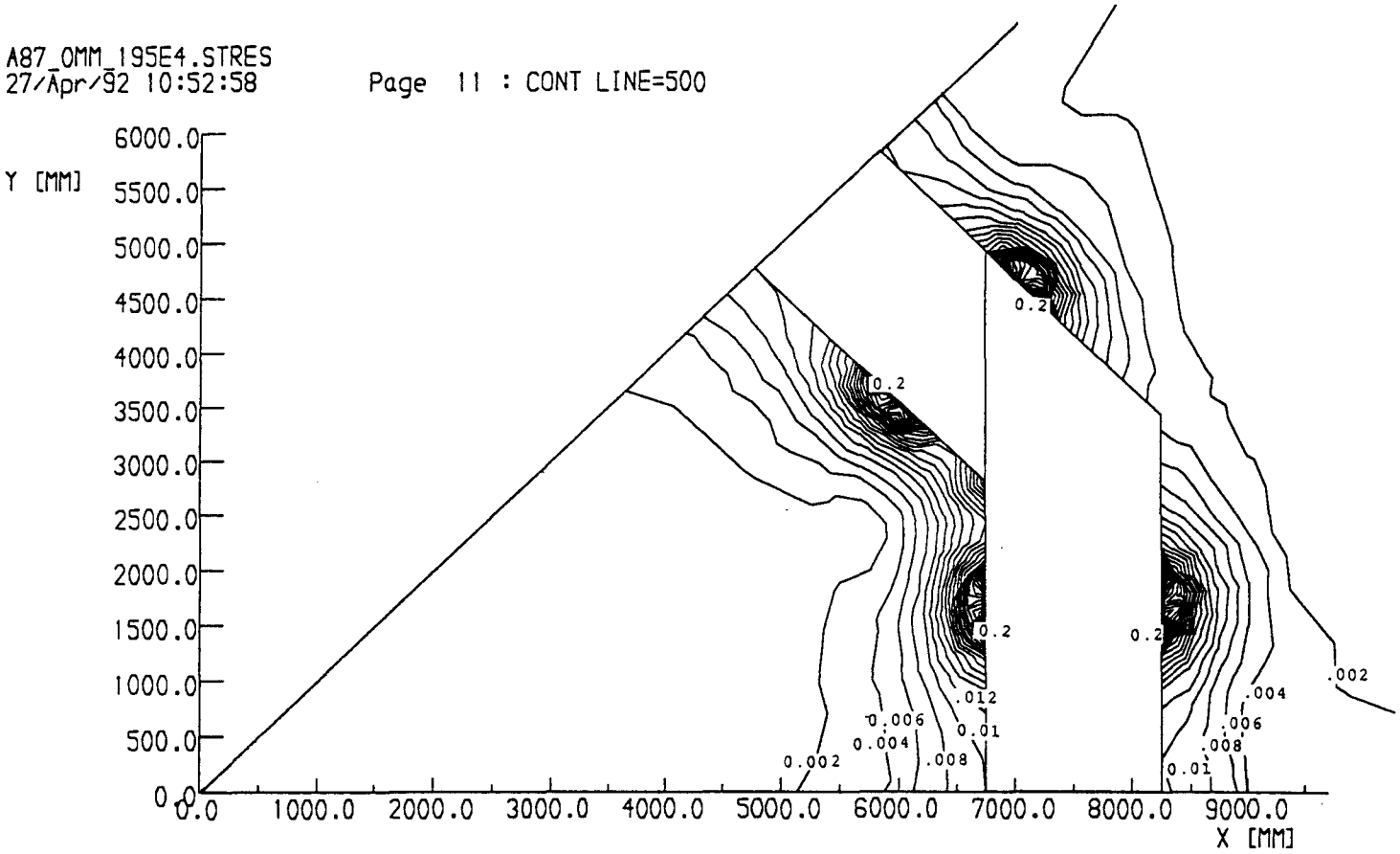
Static Solution Mesh 1056 Elements 11 Regions

VF/PE2D.8

Total current = 28392 A
Steel - A-87 (Russia)

Fig.2-2





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Static Solution Mesh 1056 Elements 11 Regions

VF/PE2D.8

Total current = 28392 A
Steel - A-87 (Russia)

Fig.2-3

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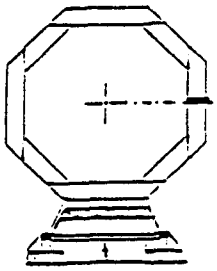

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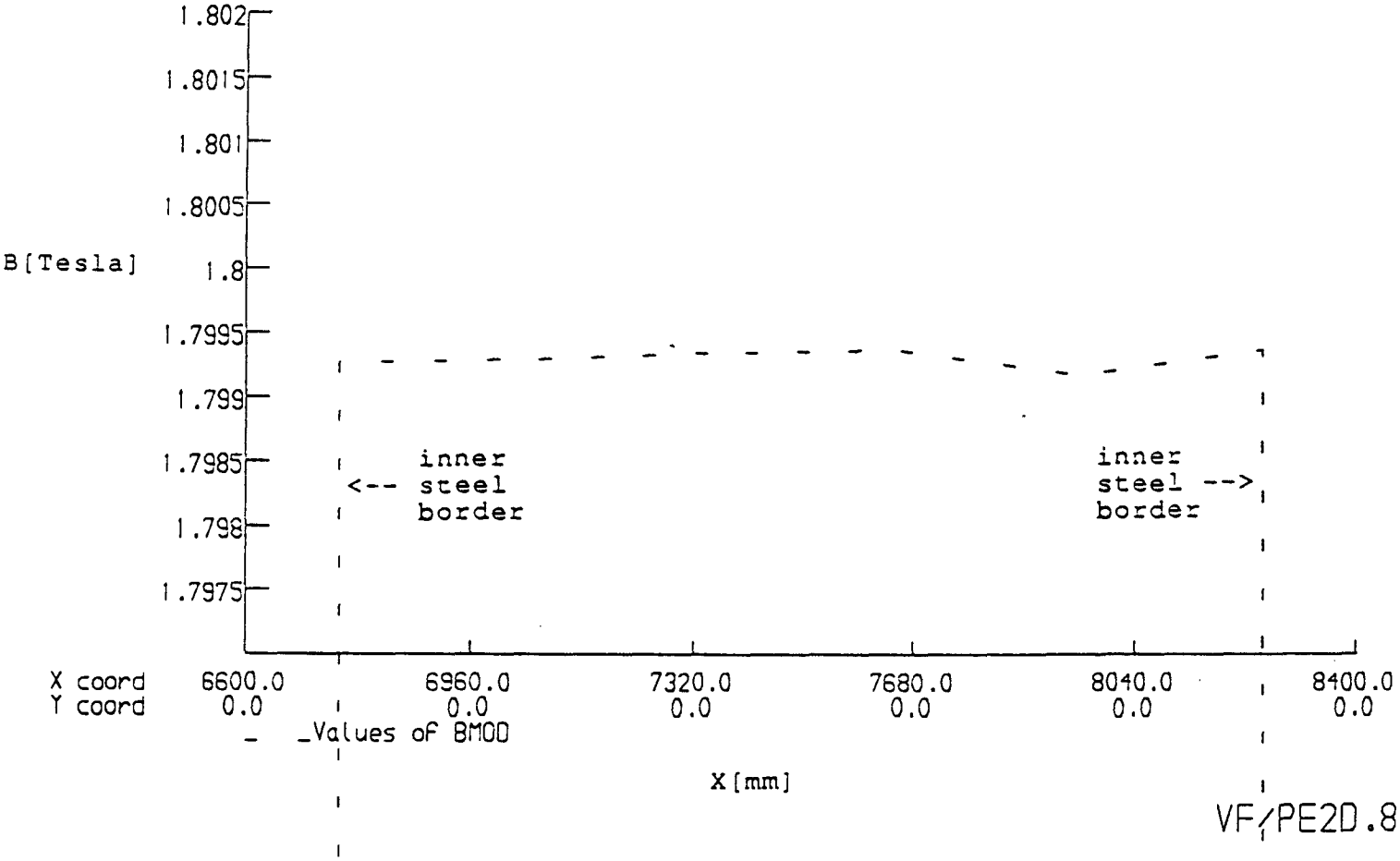
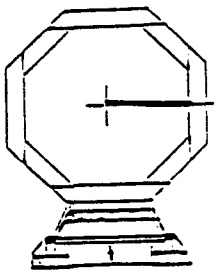
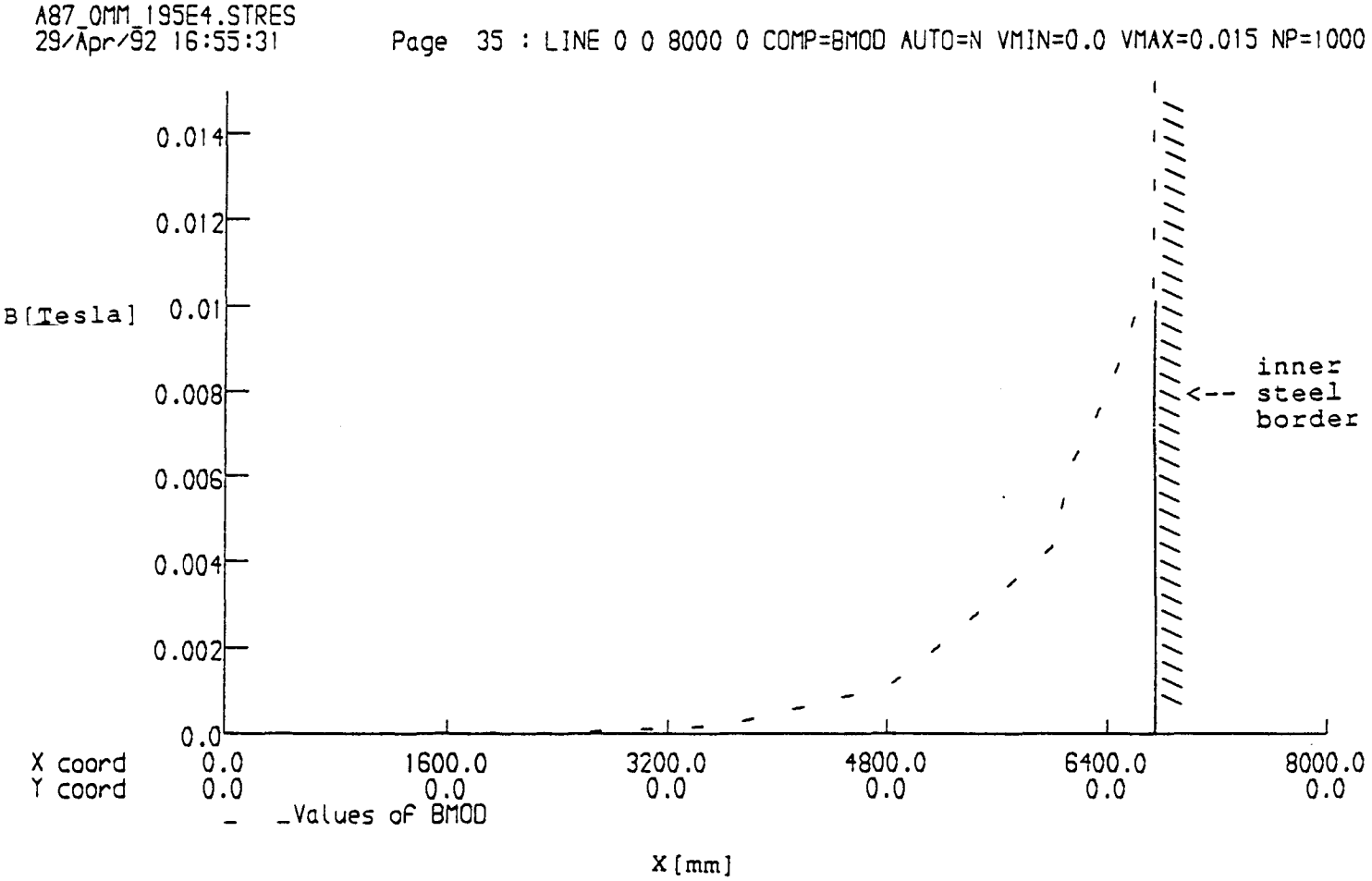


Total current = 28392 A
Steel - A-87 (Russia)

Fig.2-4





VF/PE2D.8

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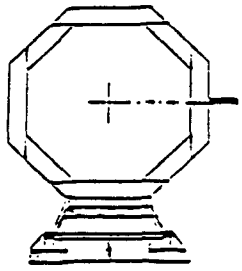

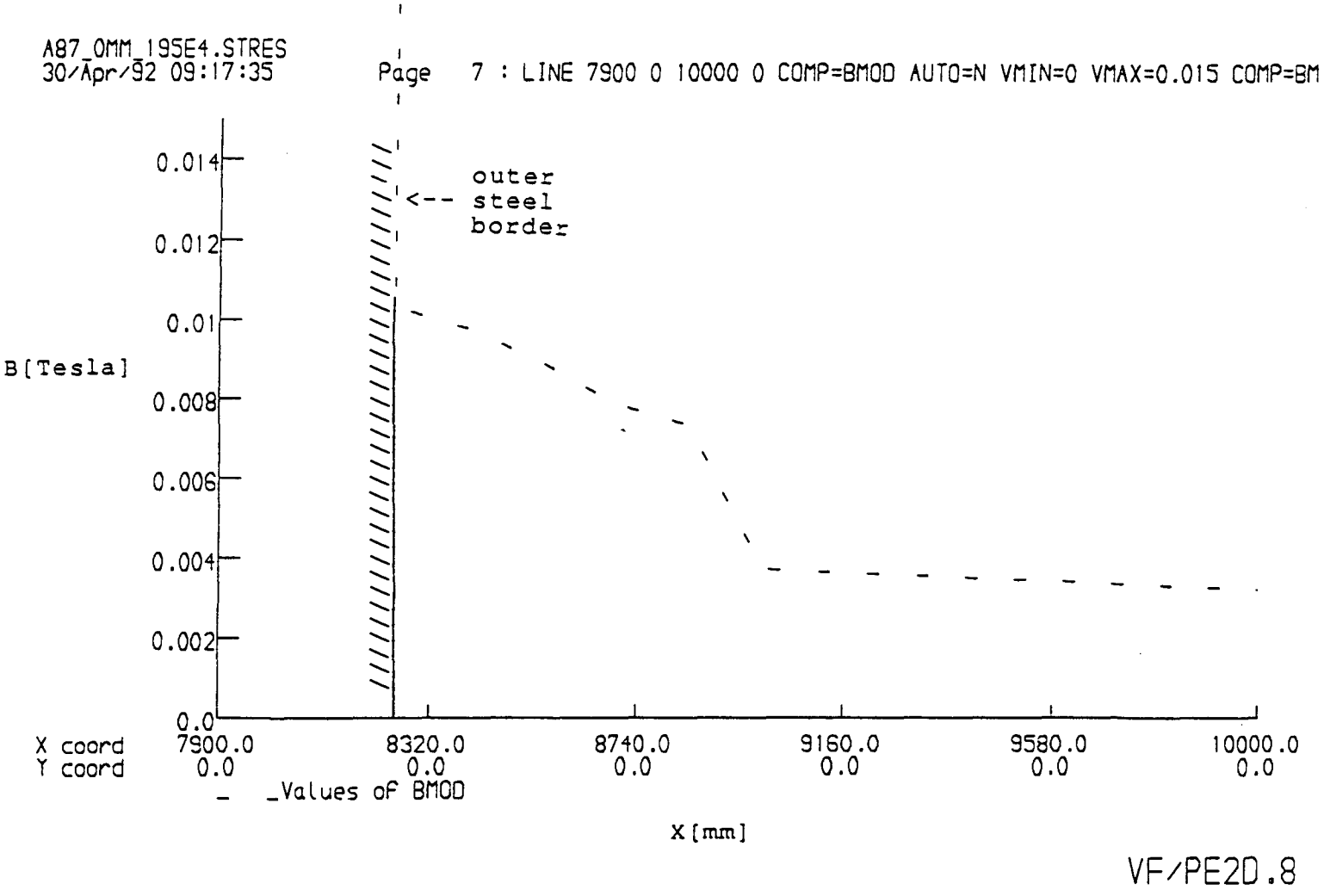
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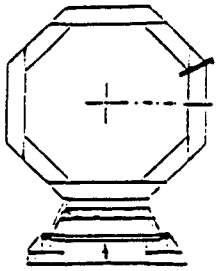
VF/PE2D.8

Fig.2-6



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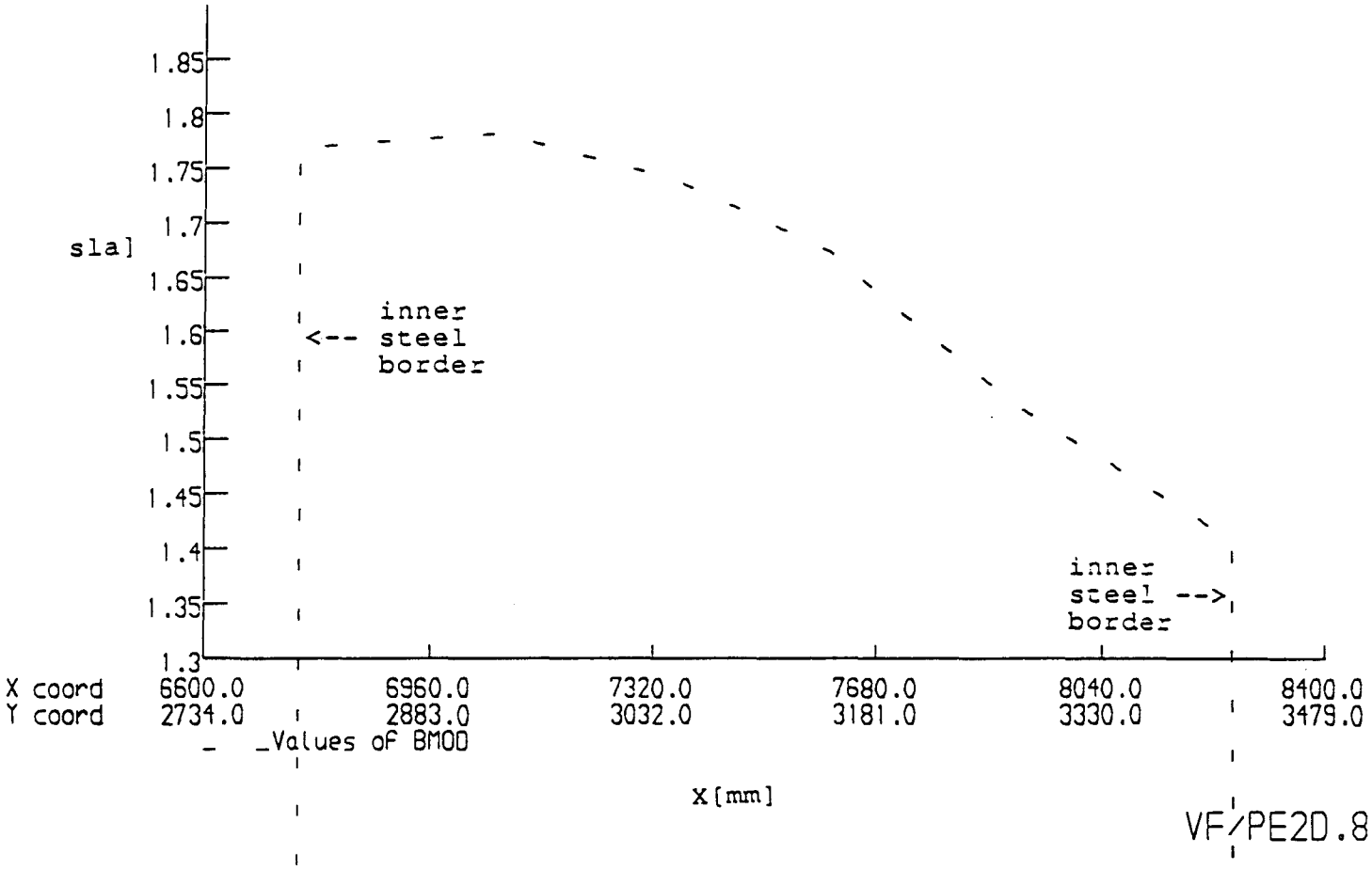

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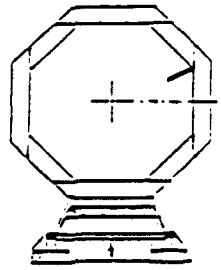

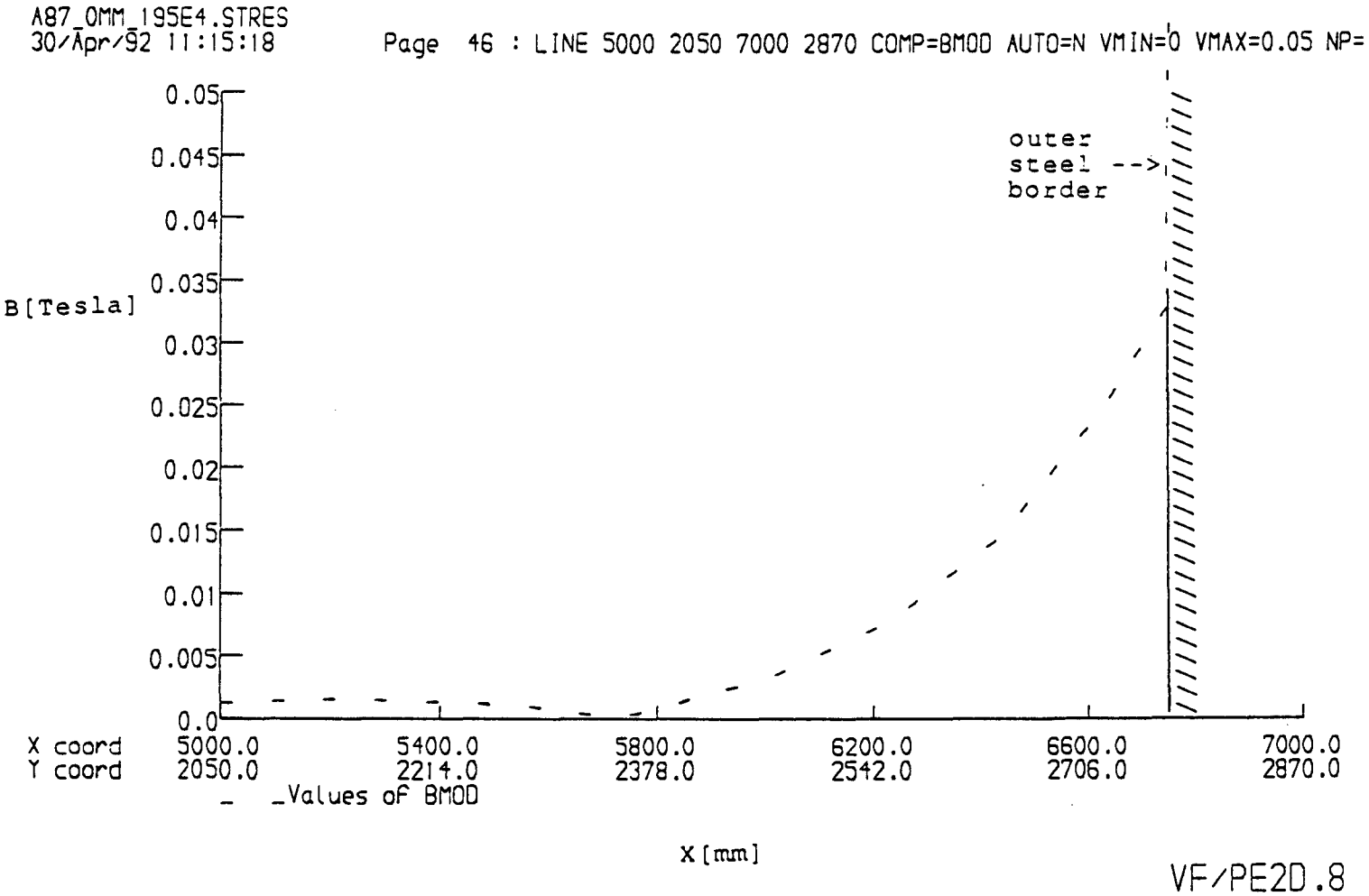
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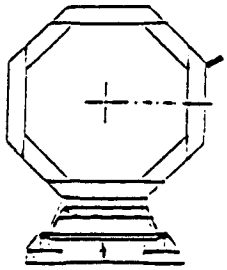
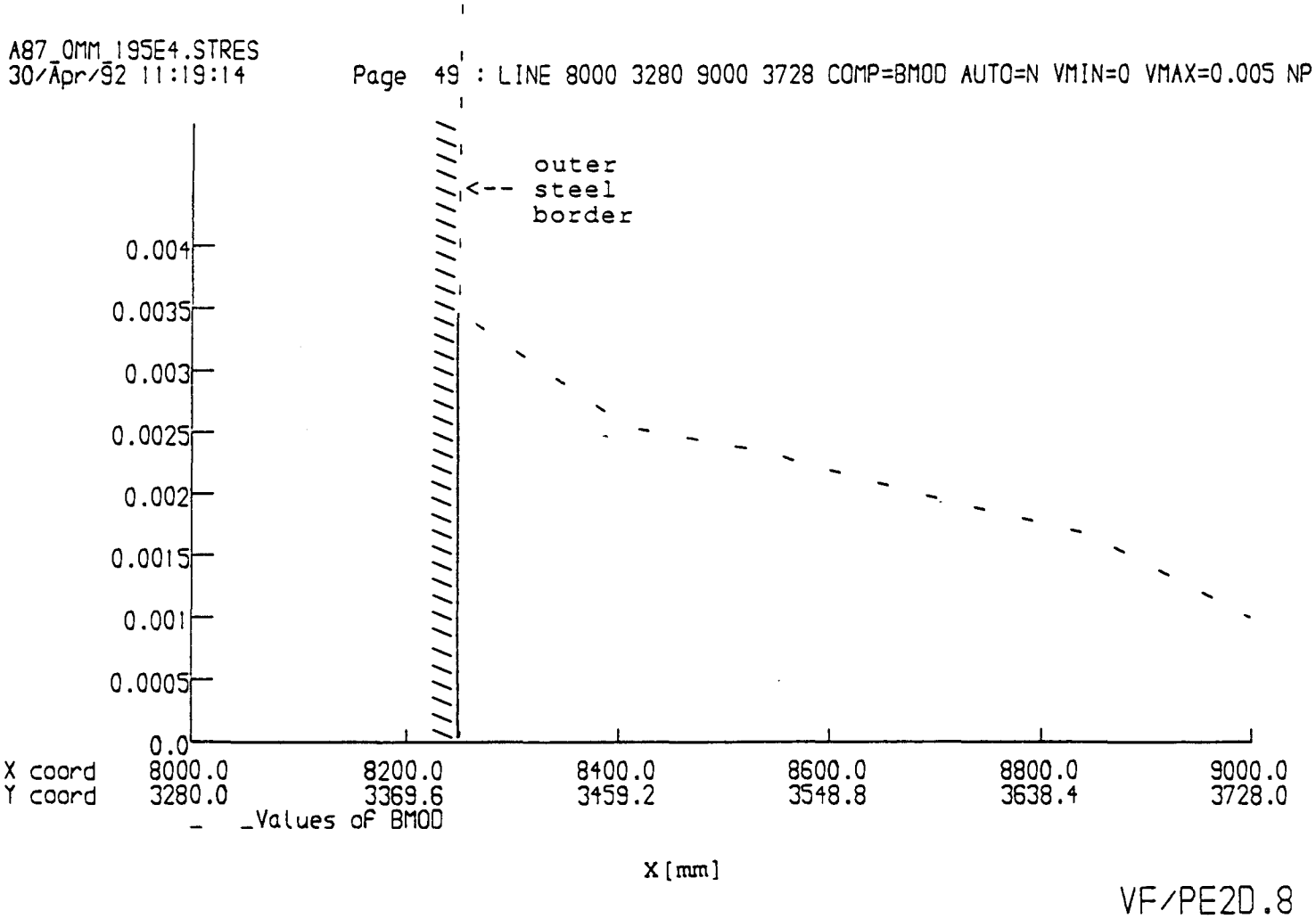
VF/PE2D.8

Fig.2-8

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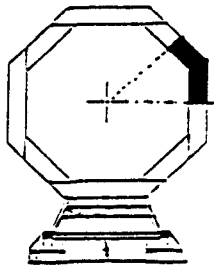
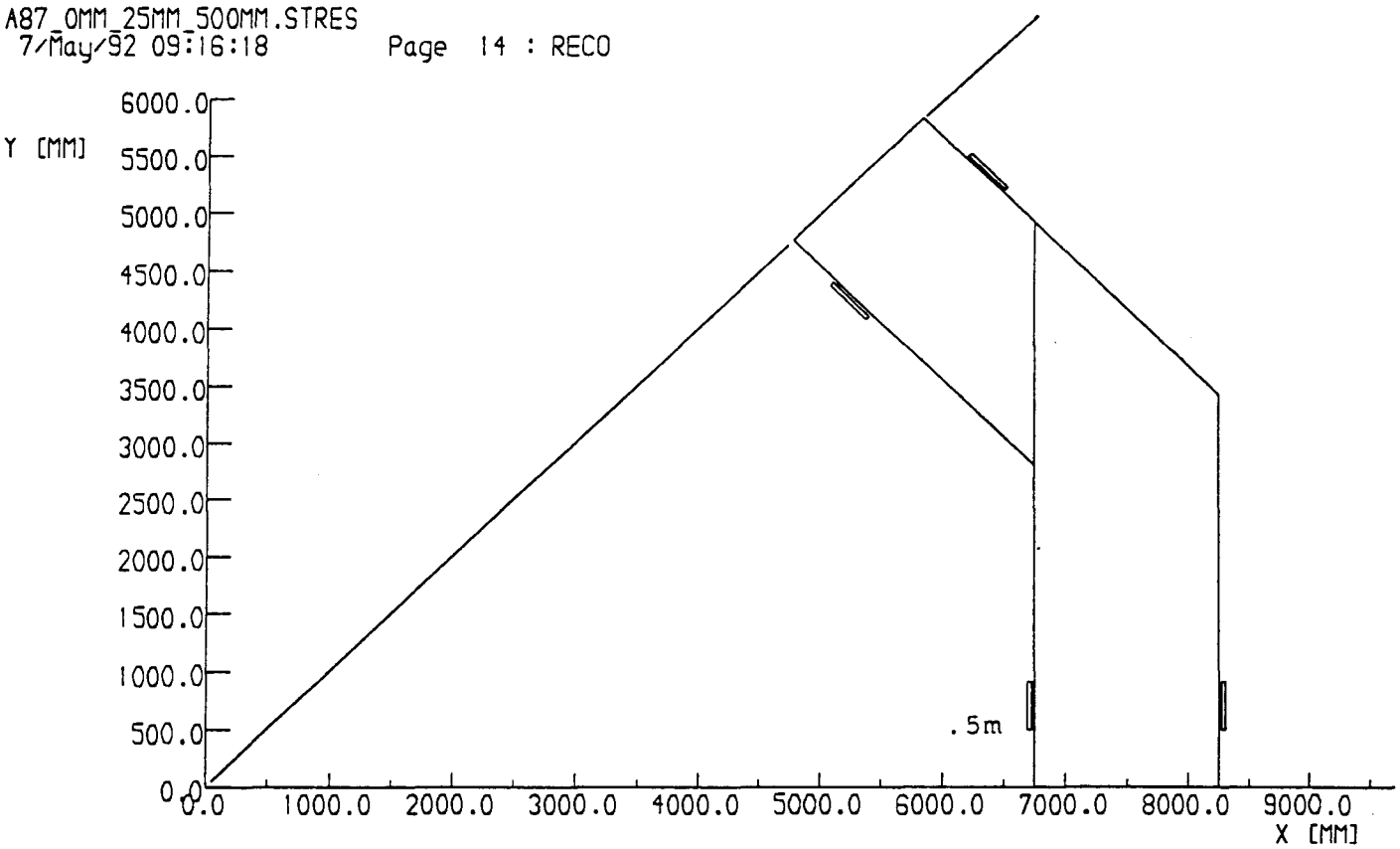
VF/PE2D.8

Fig.2-9





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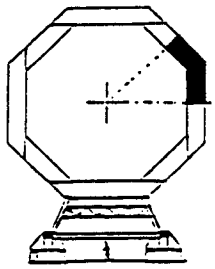

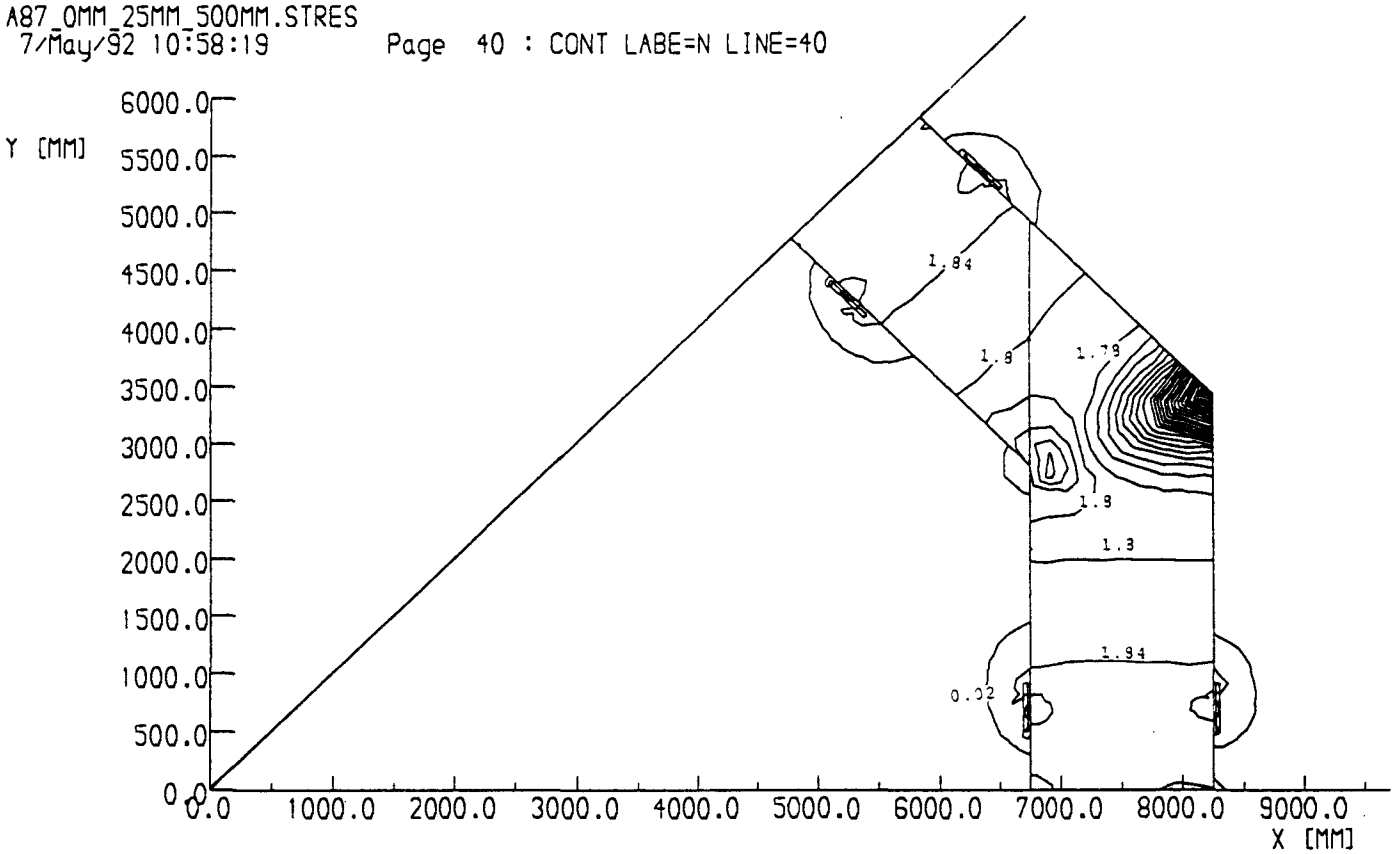

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VF/PE2D.8

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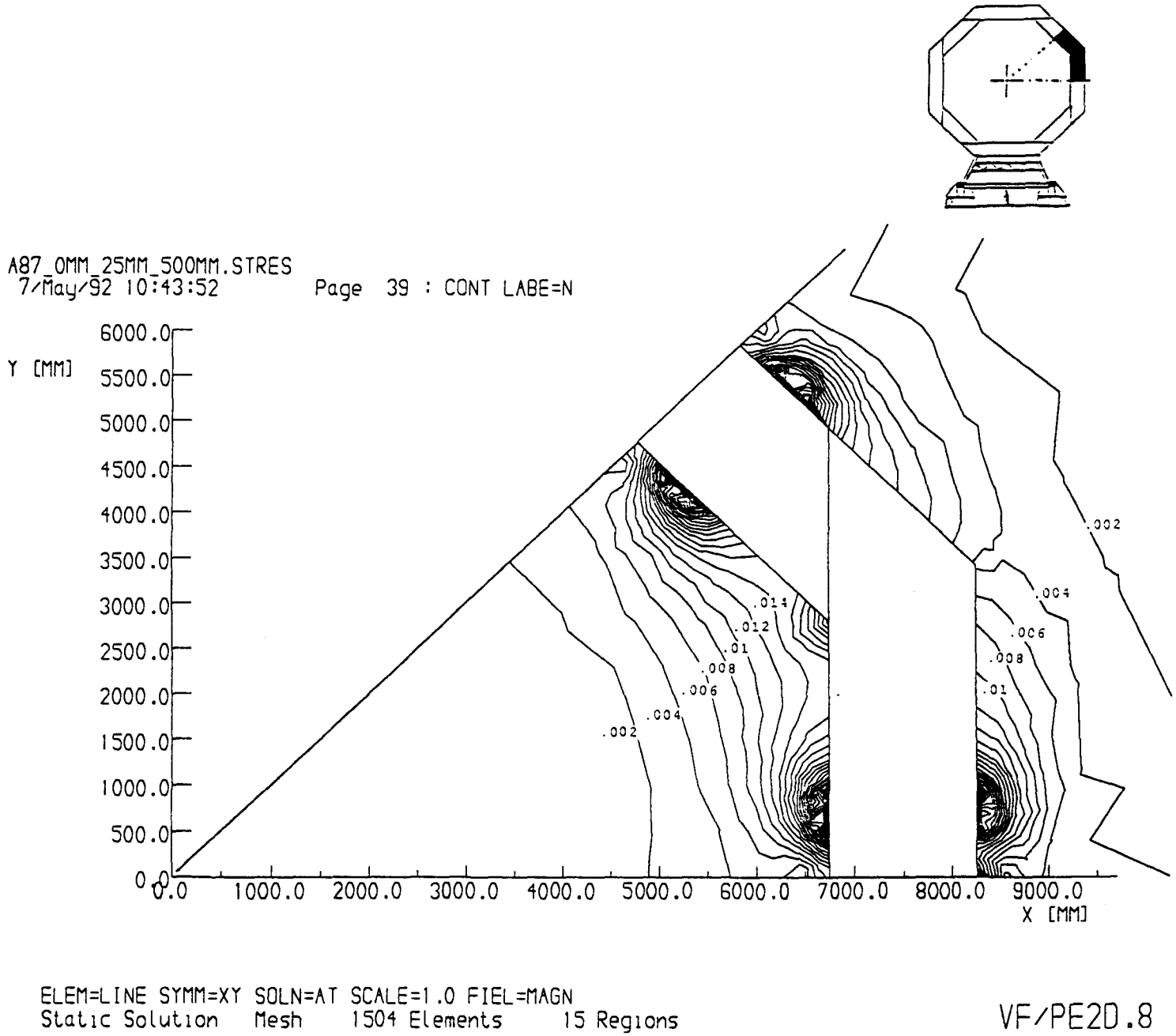
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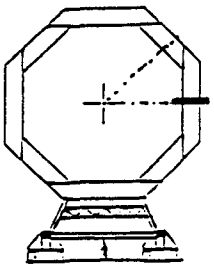
Static Solution Mesh 1504 Elements 15 Regions
VF/PE2D.8

Fig.3-3



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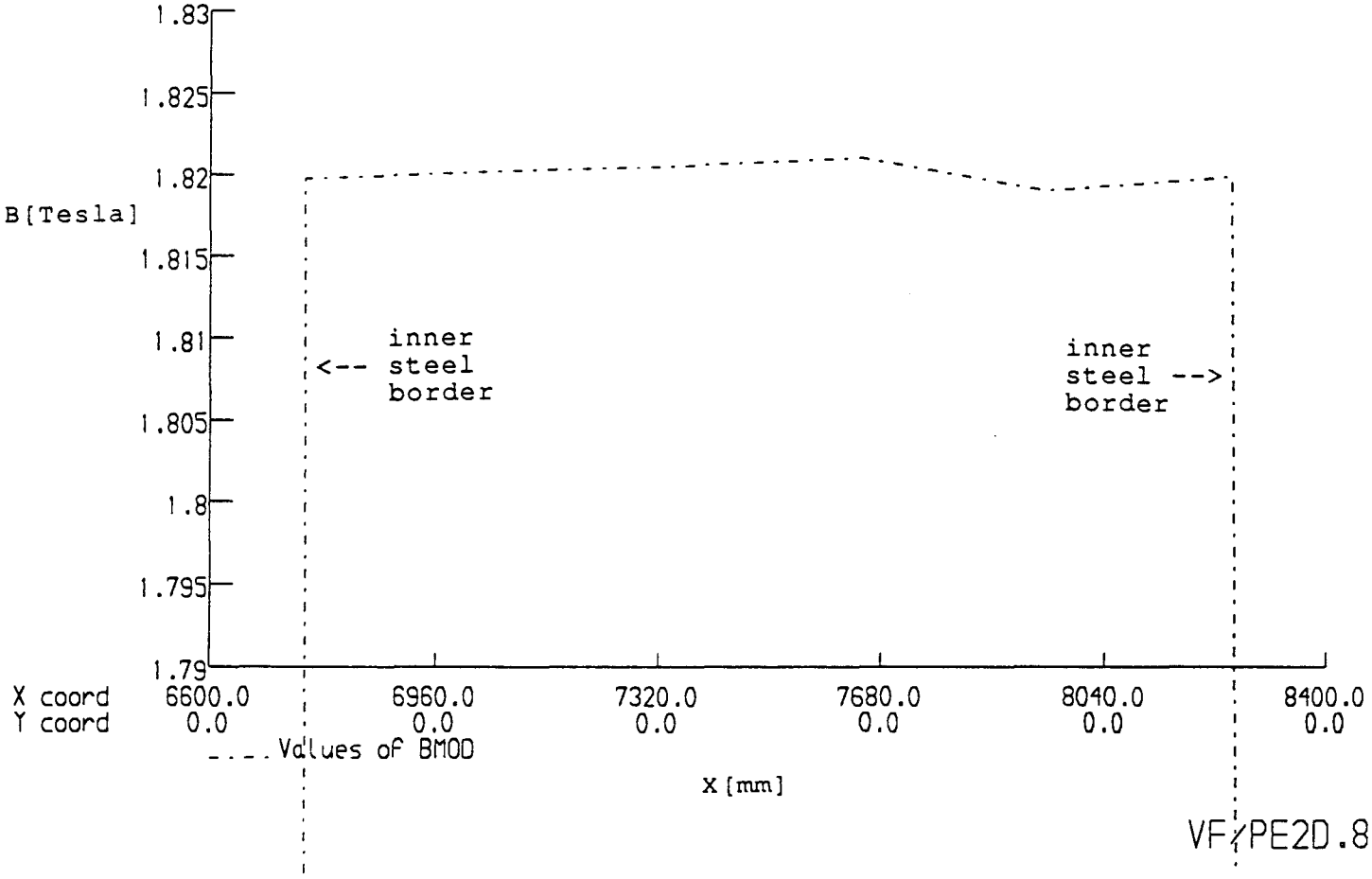

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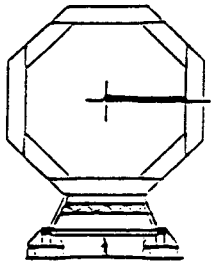

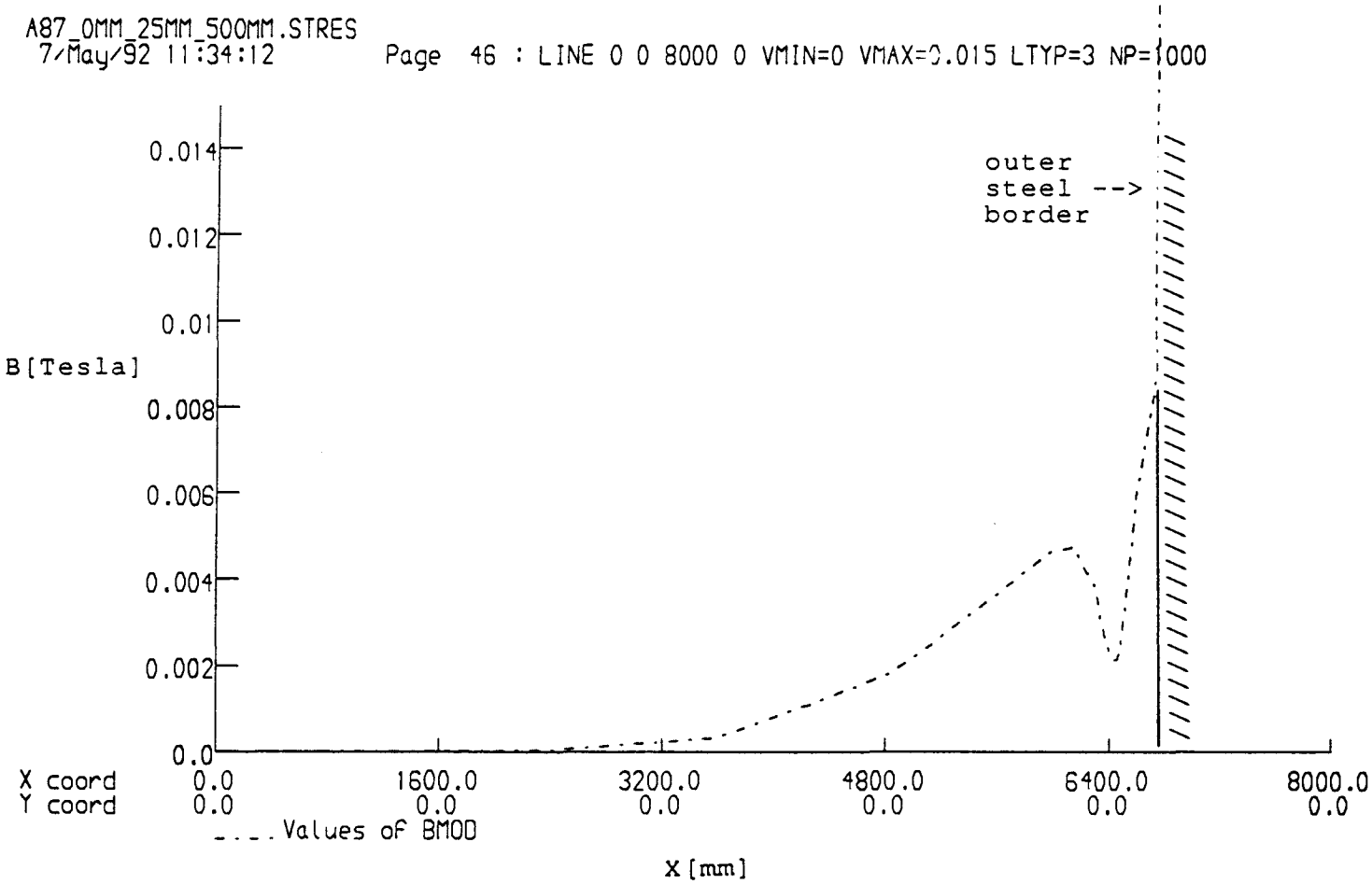

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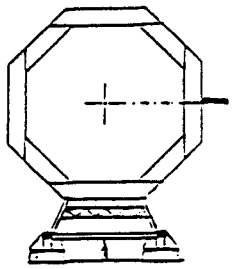

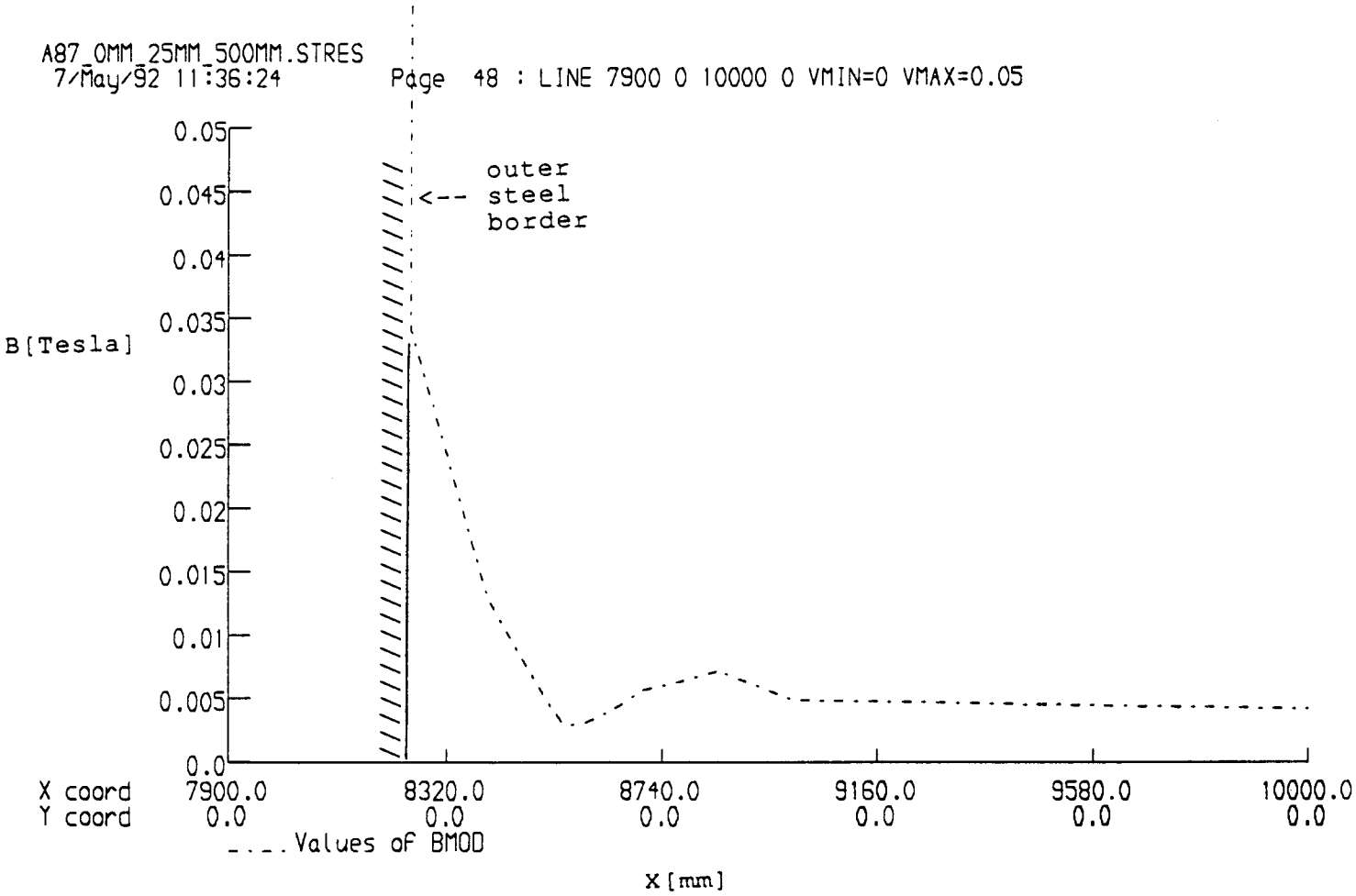

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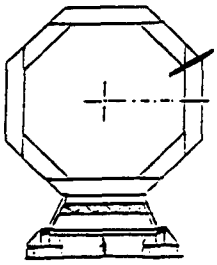
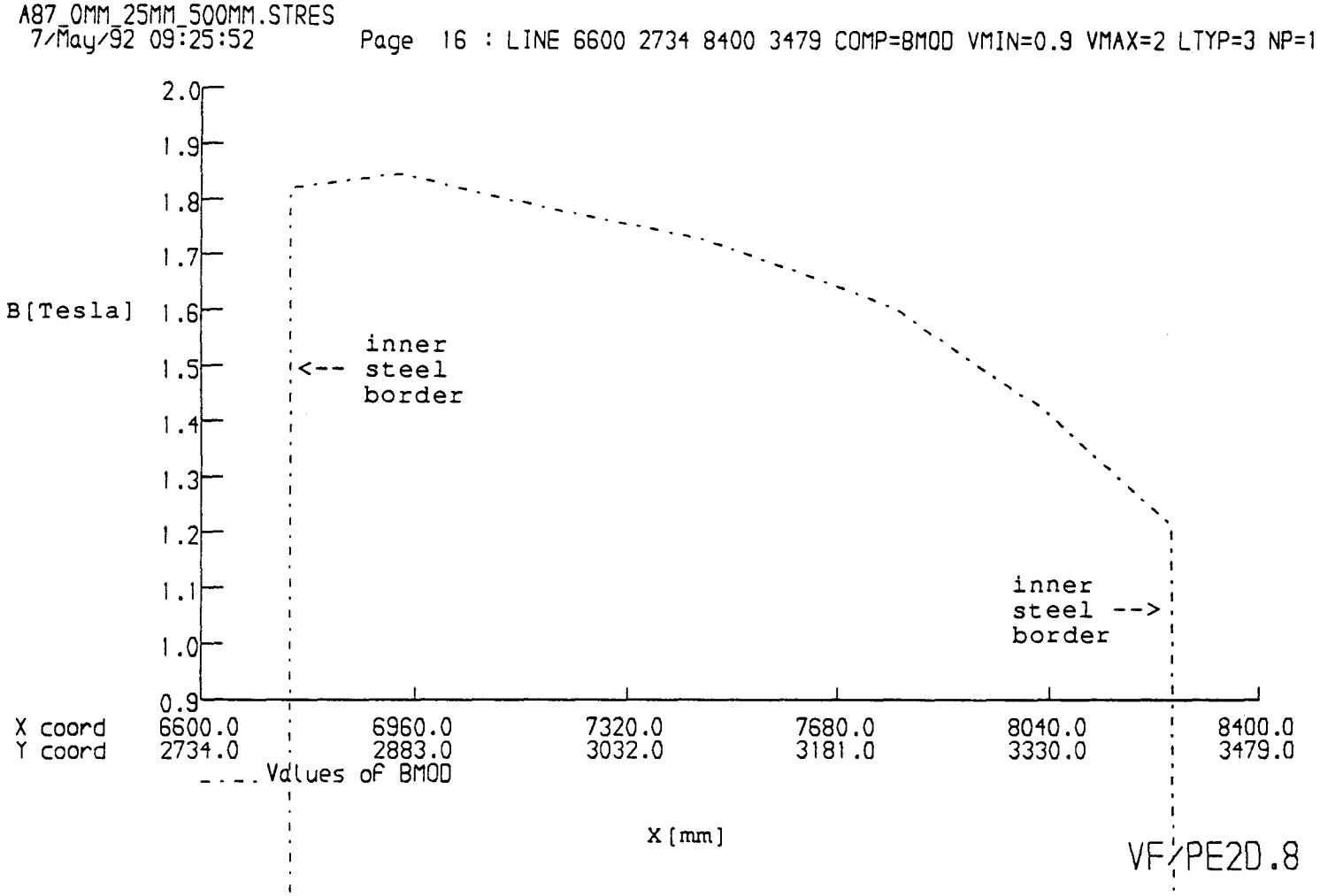
Fig.3-6

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0.9
inner
steel
border
inner
steel
border
X coord
Y coord
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2734.0
6960.0
2883.0
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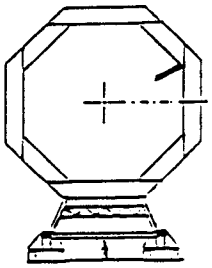
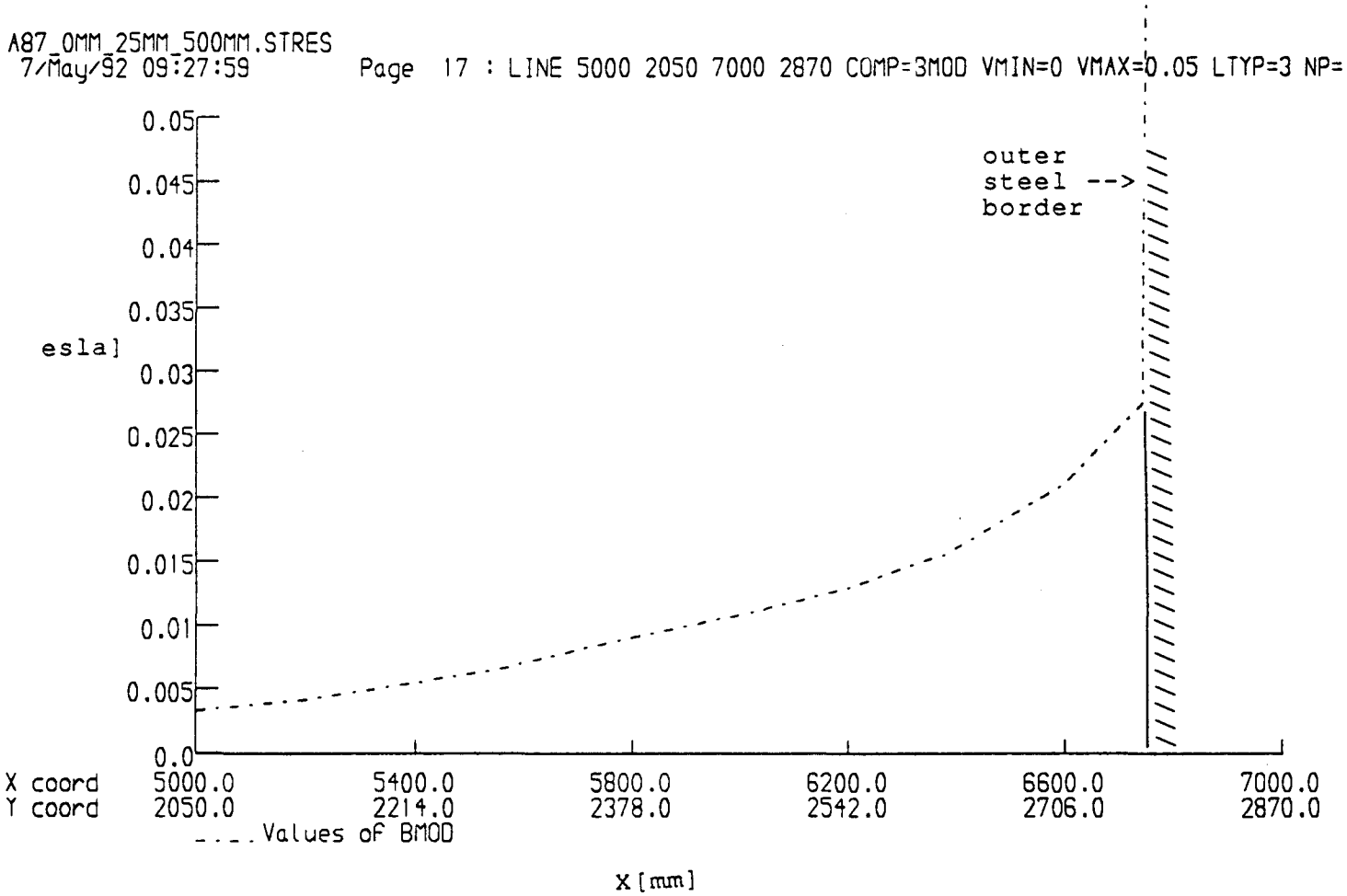
7680.0
3181.0
8040.0
3330.0
8400.0
3479.0
Values of BMOD
X [mm]
VF/PE2D.8

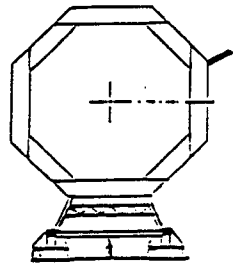
Fig.3-7

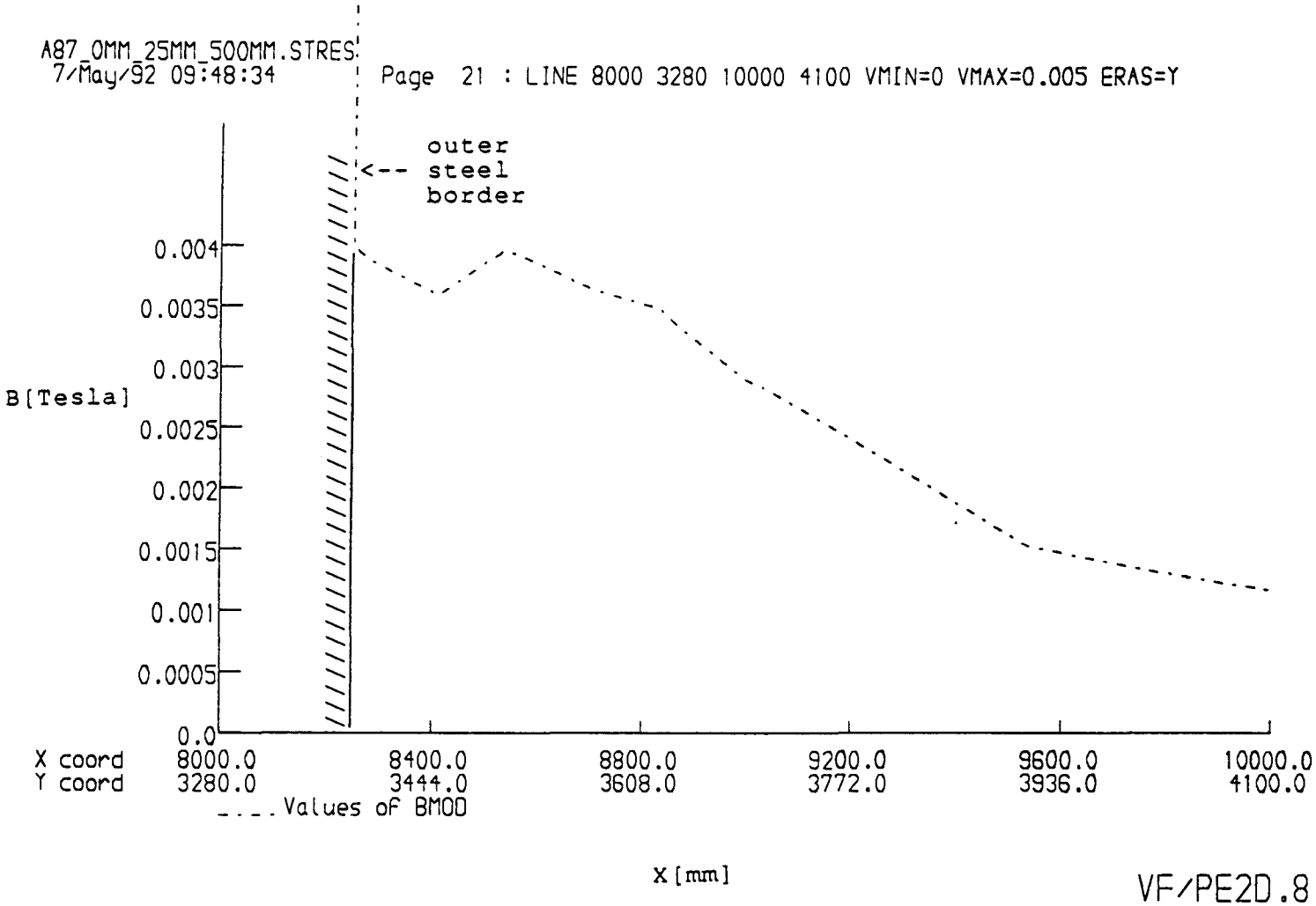




VF/PE2D.8

Fig.3-8

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7/May/92 09:48:34
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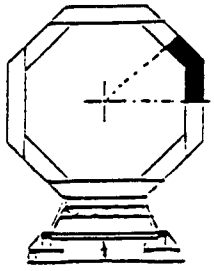
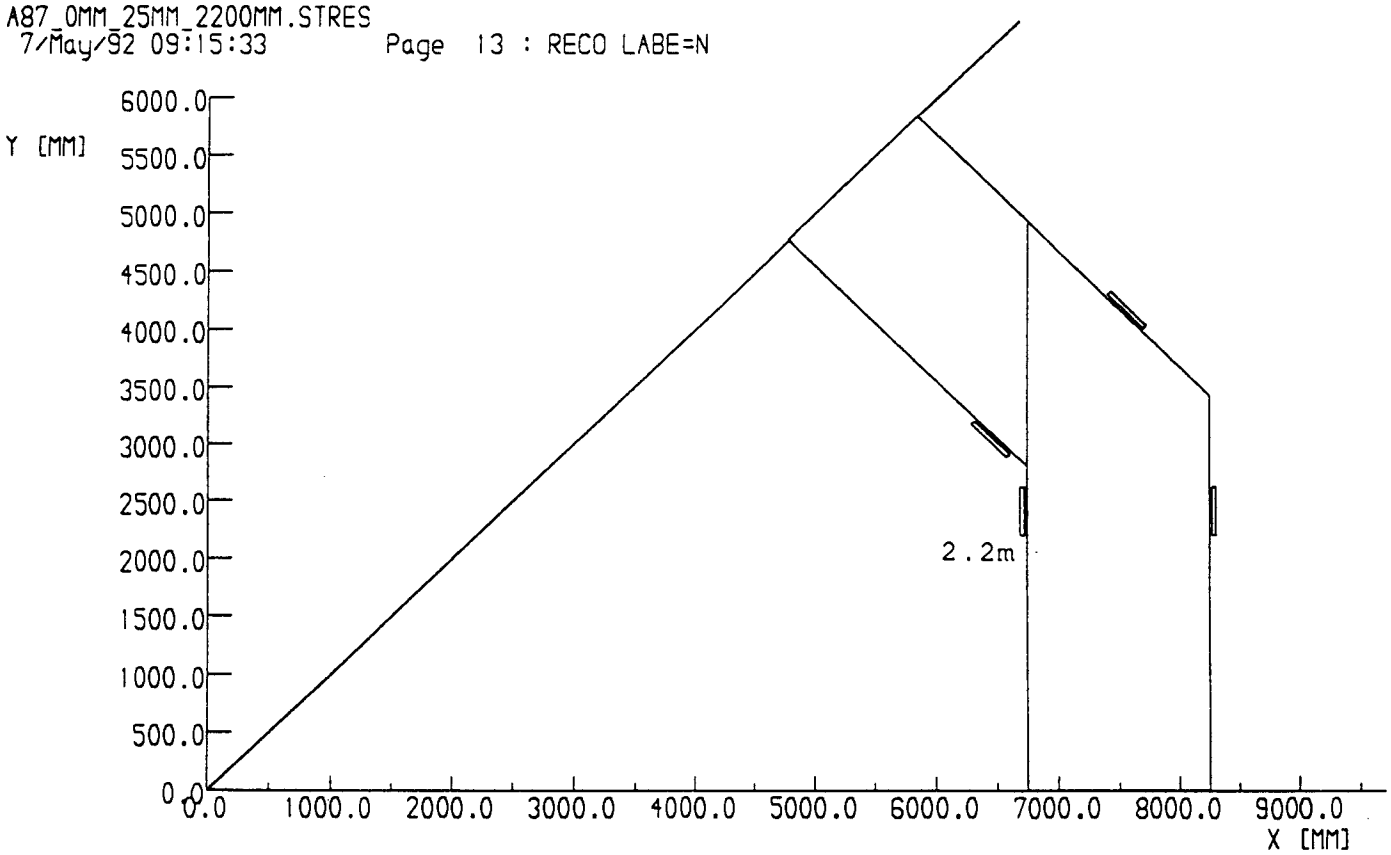
outer
steel
border
<--
B[Tesla]
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0.0
X coord 8000.0 8400.0 8800.0 9200.0 9600.0 10000.0
Y coord 3280.0 3444.0 3608.0 3772.0 3936.0 4100.0
Values of BMOD
X [mm]
VF/PE2D.8

Fig.3-9

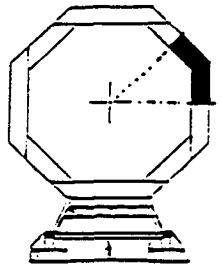


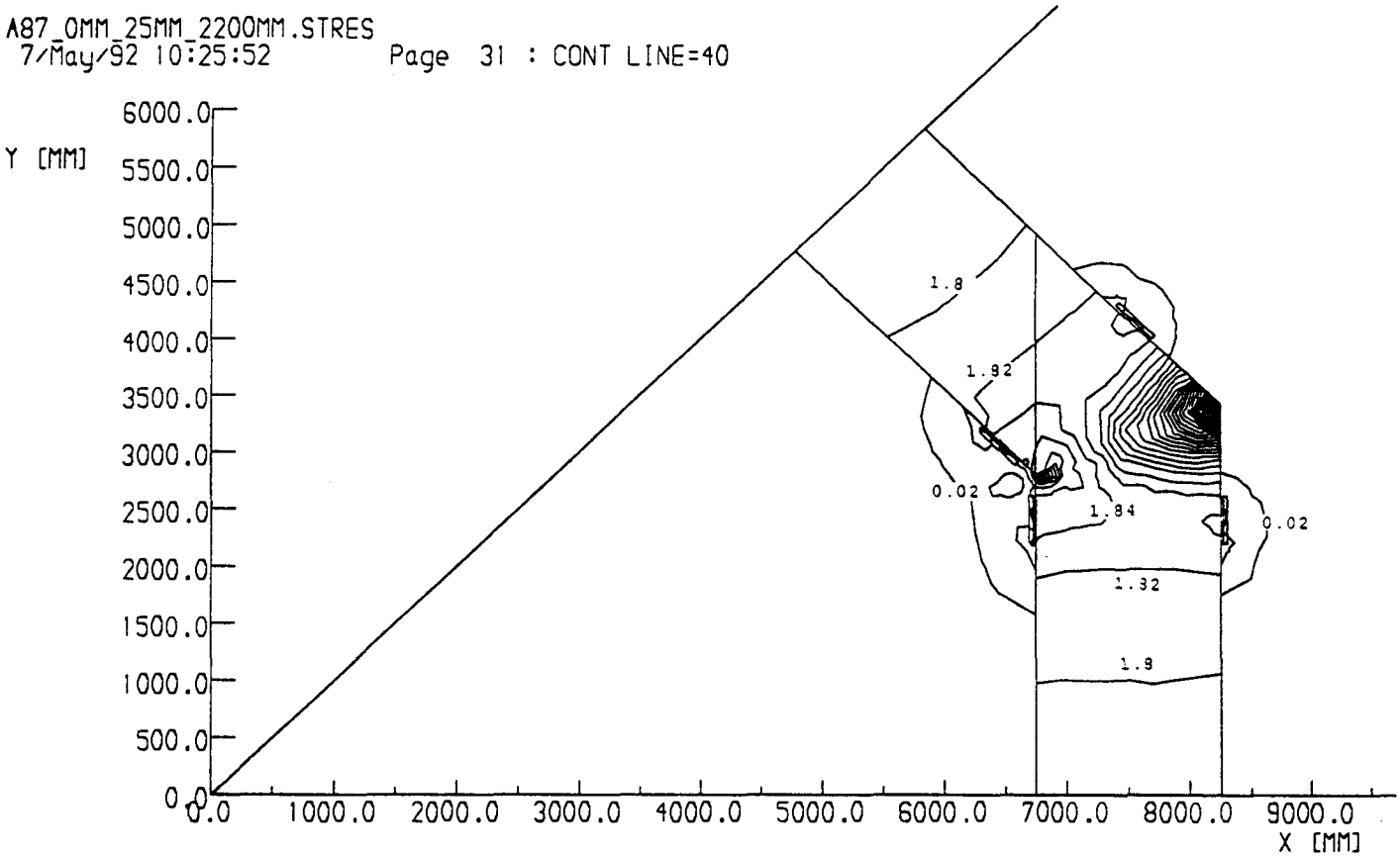


ELEM=LINE SYMM=XY SOLN=AT SCALE=1.0 FIEL=MAGN
Static Solution Mesh 1152 Elements 15 Regions

VF/PE2D.8

Fig.4-1

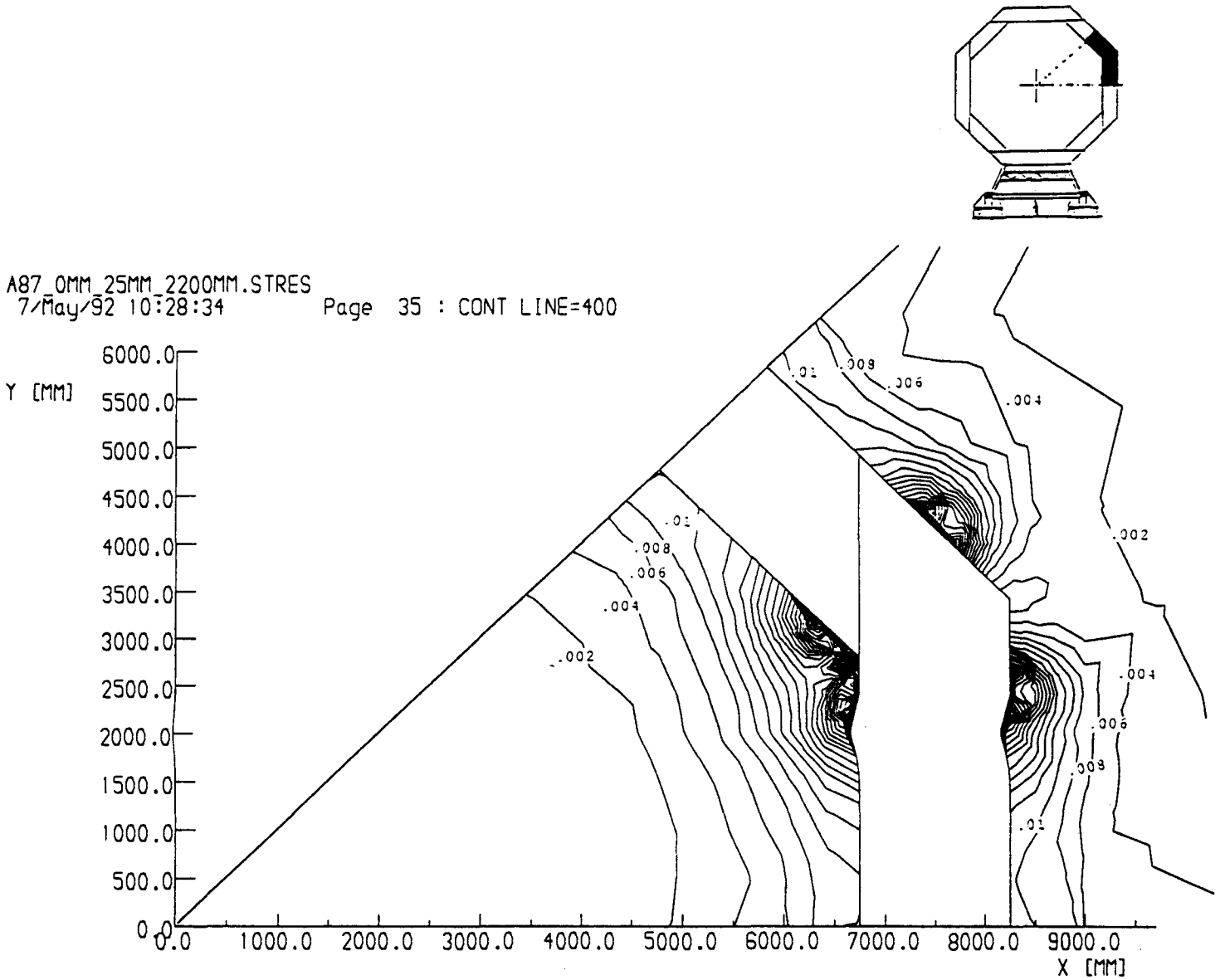




ELEM=LINE SYMM=XY SOLN=AT SCALE=1.0 FIEL=MAGN
Static Solution Mesh 1152 Elements 15 Regions

VF/PE2D.8

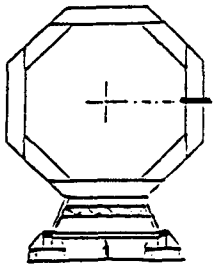
Fig.4-2

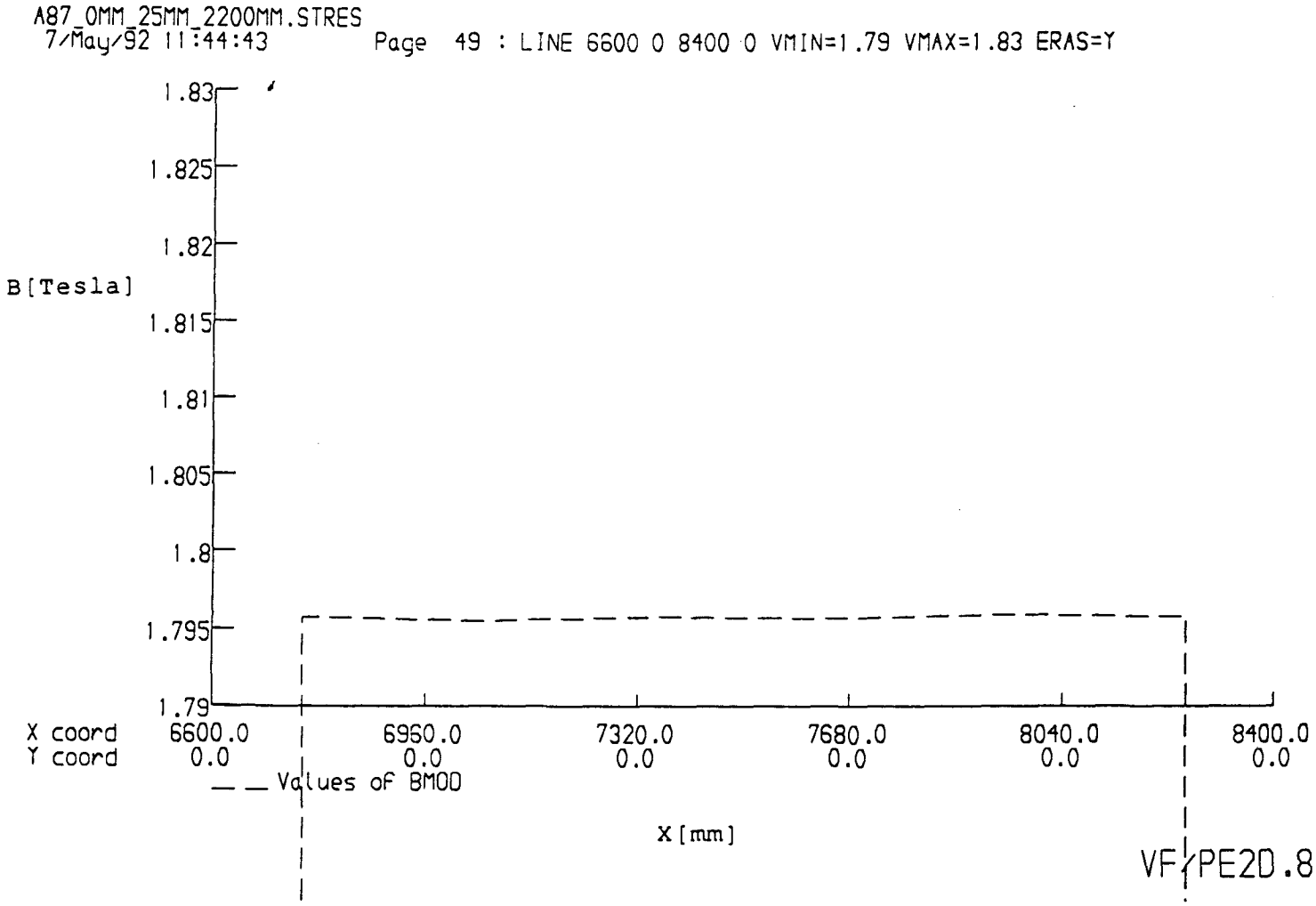


ELEM=LINE SYMM=XY SOLN=AT SCALE=1.0 FIEL=MAGN
Static Solution Mesh 1152 Elements 15 Regions

VF/PE2D.8

Fig.4-3

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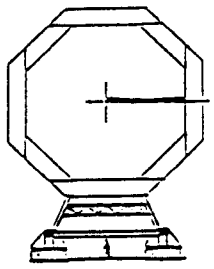
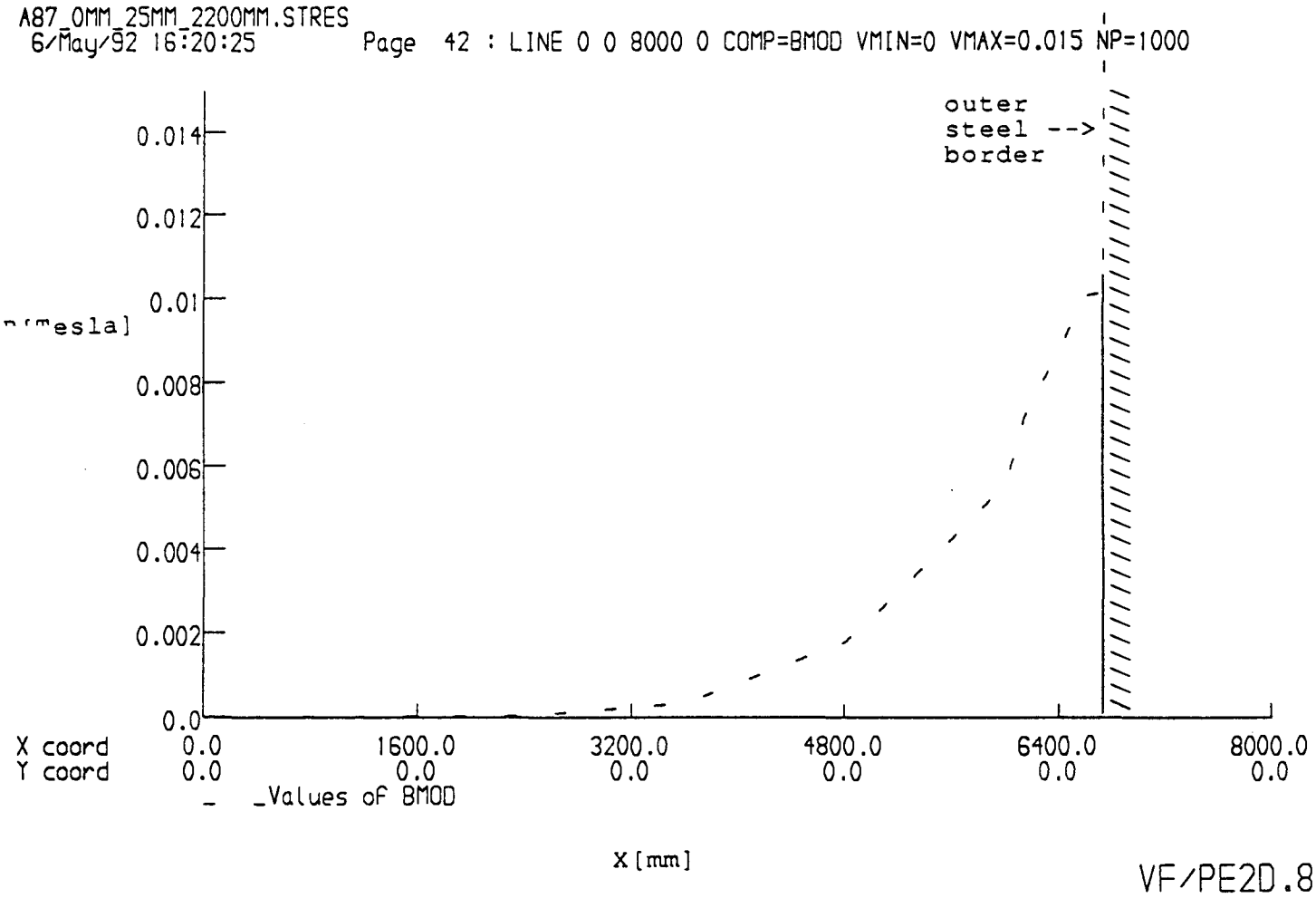
7/May/92 11:44:43
Page 49 : LINE 6600 0 8400 0 VMIN=1.79 VMAX=1.83 ERAS=Y
1.83
1.825
1.82
B[Tesla]
1.815
1.81
1.805
1.8
1.795
1.79
X coord
Y coord
6600.0
0.0
6960.0
0.0
7320.0
0.0
7680.0
0.0
8040.0
0.0
8400.0
0.0
Values of BMOD
X[mm]
VF/PE2D.8

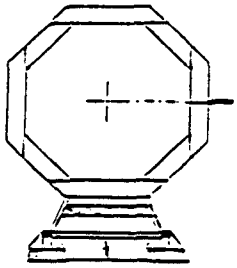
Fig.4-4

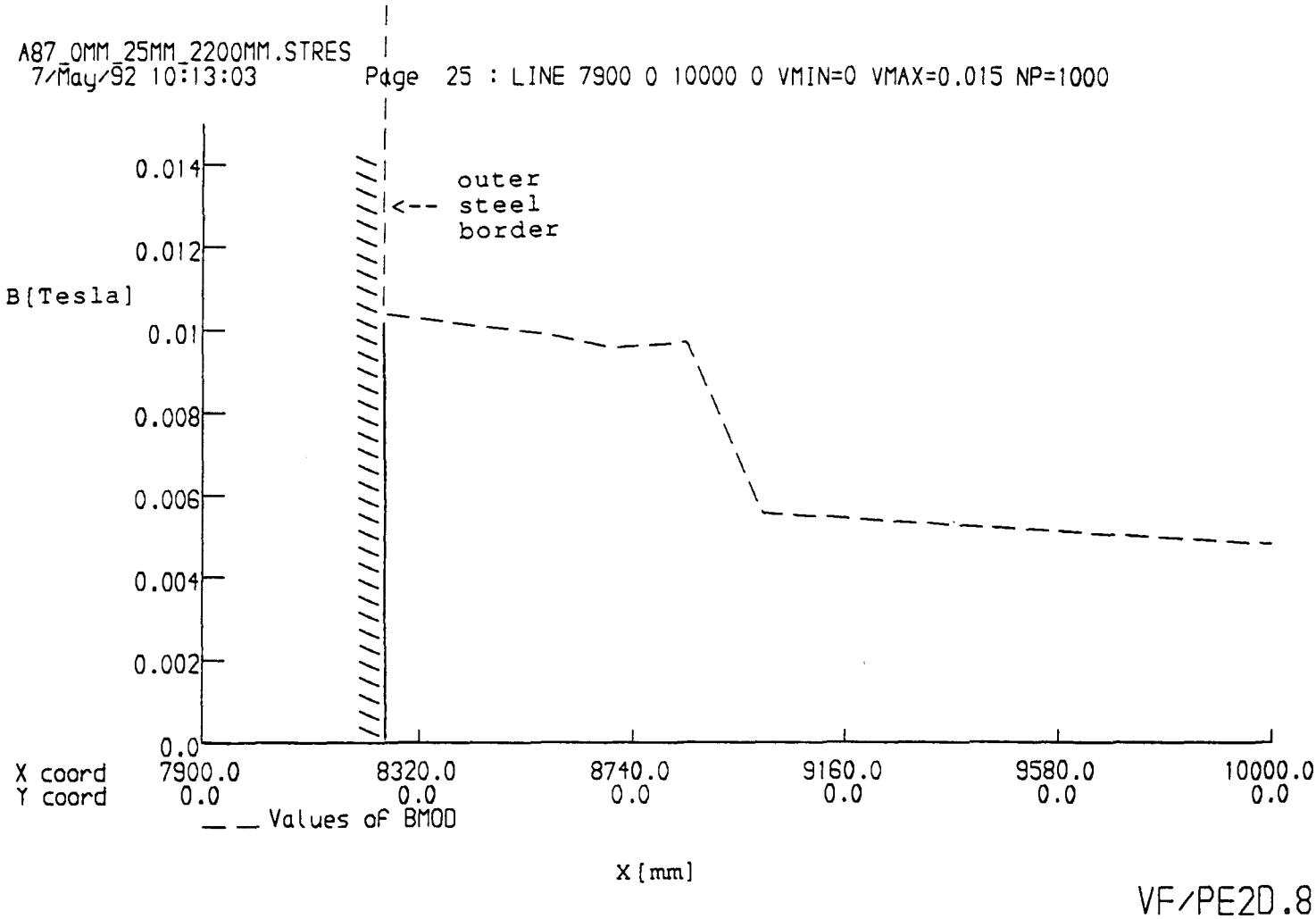




VF/PE2D.8

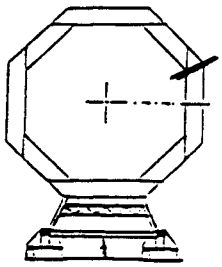
Fig.4-5

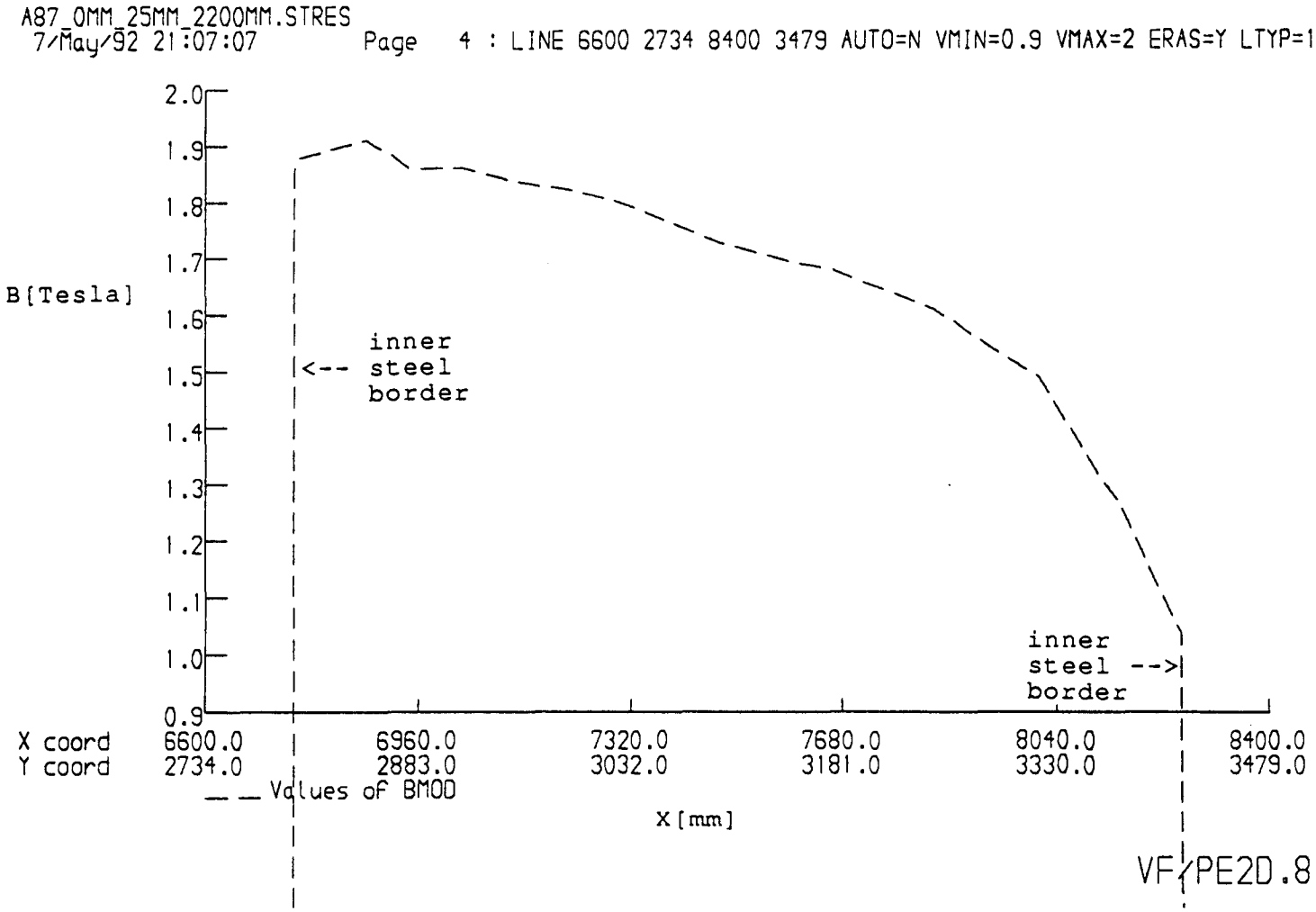




VF/PE2D.8

Fig.4-6

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7/May/92 21:07:07
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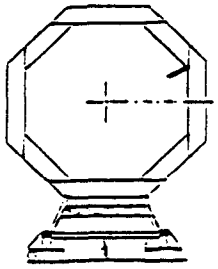
B[Tesla]
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
inner
steel
border
<--
inner
steel -->
border
X coord 6600.0 6960.0 7320.0 7680.0 8040.0 8400.0
Y coord 2734.0 2883.0 3032.0 3181.0 3330.0 3479.0
Values of BMOD
X [mm]
VF/PE2D.8

Fig.4-7



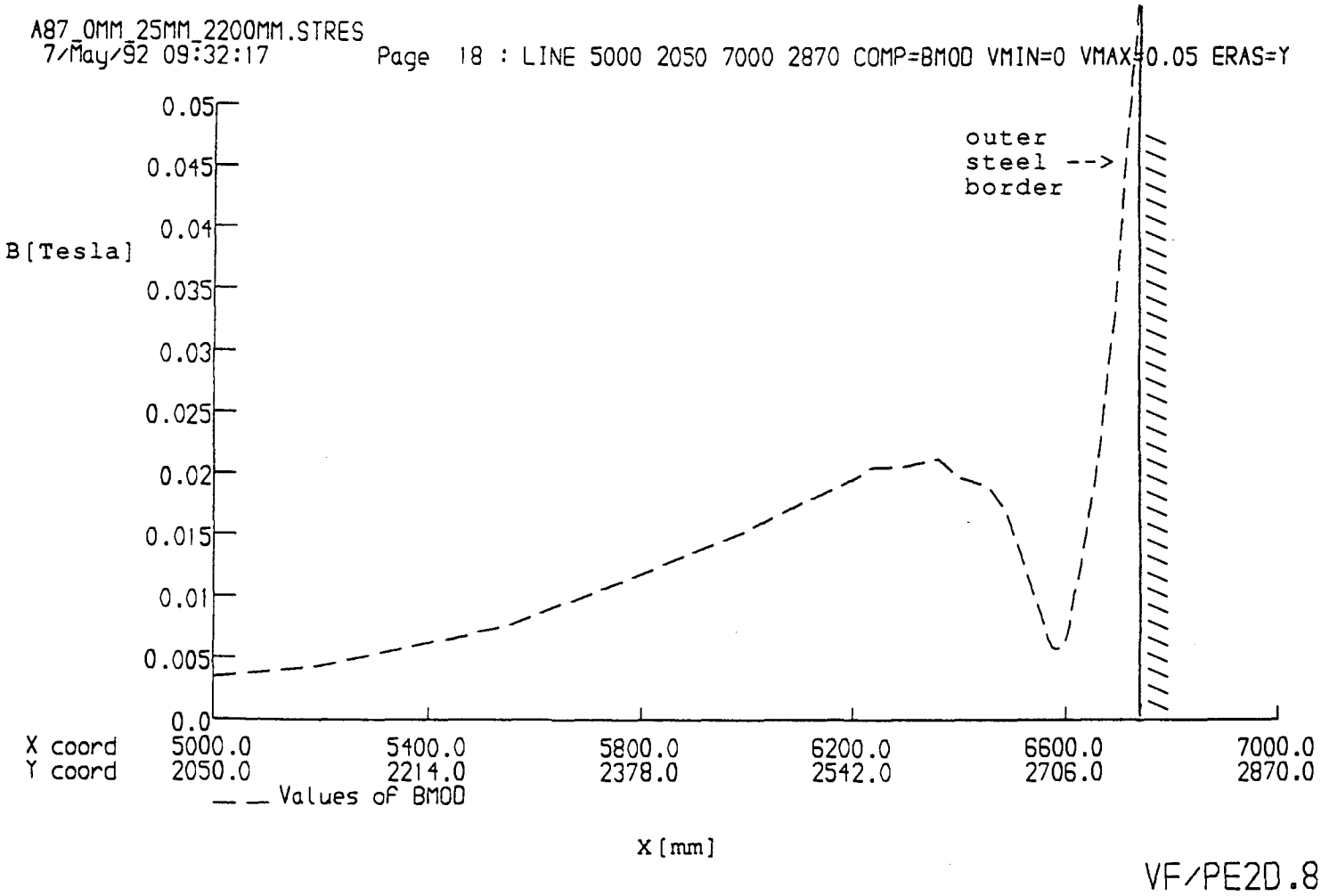
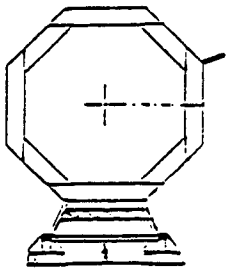
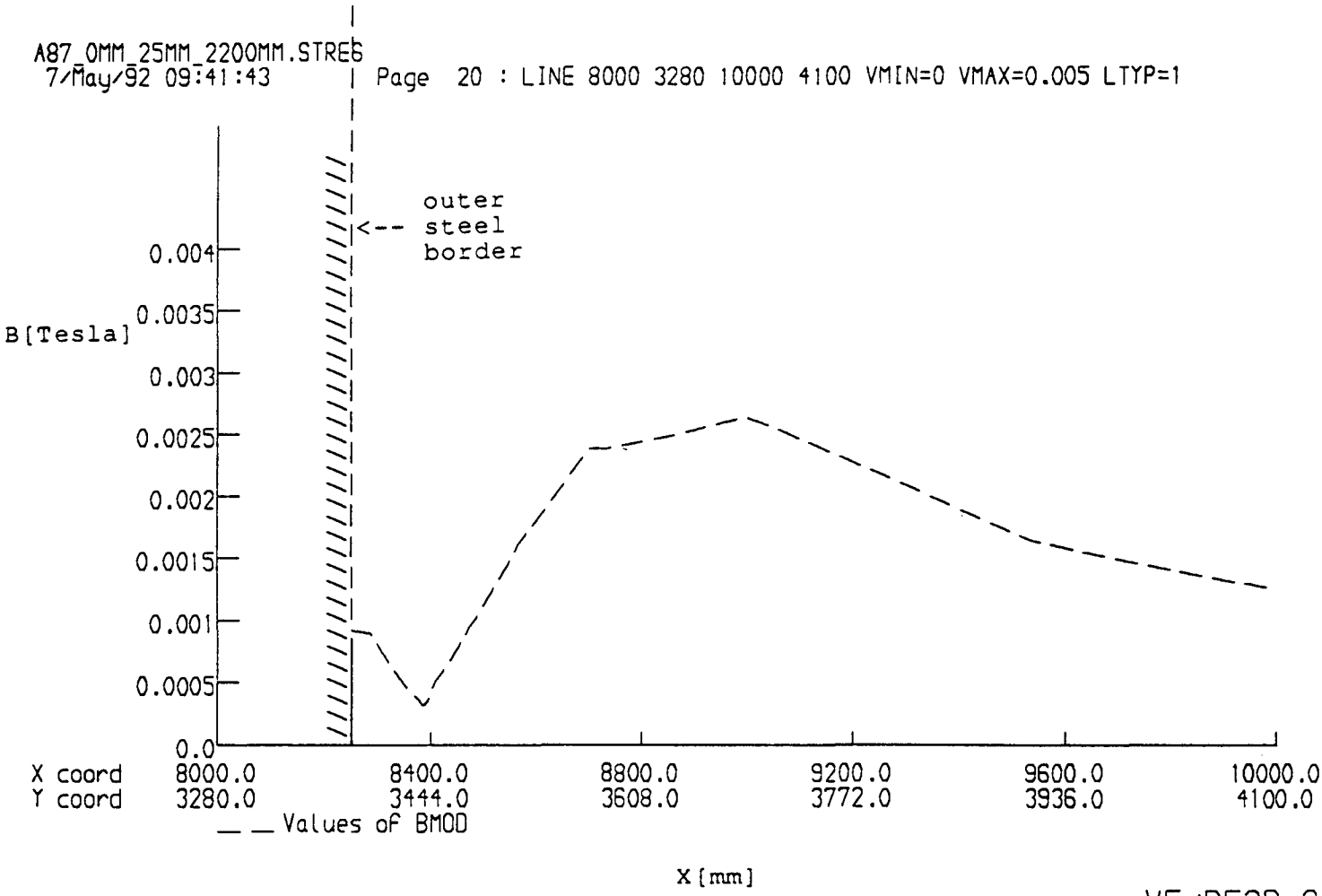

A87_0MM_25MM_2200MM.STRES
7/May/92 09:32:17
Page 18 : LINE 5000 2050 7000 2870 COMP=BMOD VMIN=0 VMAX=0.05 ERAS=Y
B[Tesla]
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0.0
outer
steel -->
border
X coord
Y coord
5000.0
2050.0
5400.0
2214.0
5800.0
2378.0
6200.0
2542.0
6600.0
2706.0
7000.0
2870.0
Values of BMOD
X [mm]
VF/PE2D.8

Fig.4-8

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7/May/92 09:41:43
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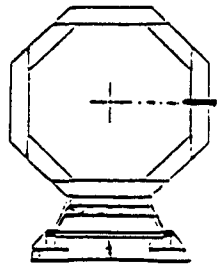
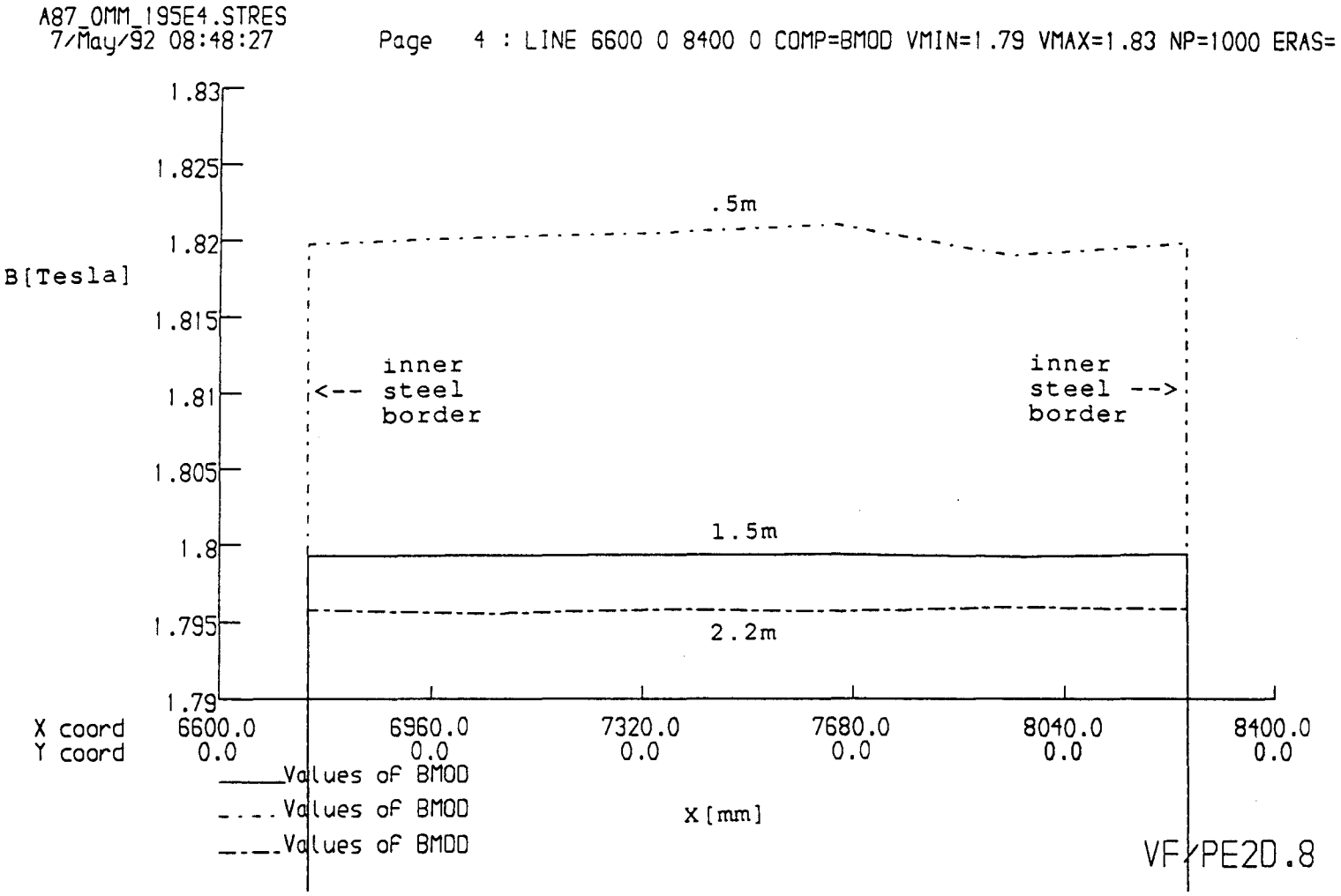
outer
steel
border
B[Tesla]
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0.0
X coord 8000.0 8400.0 8800.0 9200.0 9600.0 10000.0
Y coord 3280.0 3444.0 3608.0 3772.0 3936.0 4100.0
Values of BMOD
X[mm]
VF/PE2D.8

Fig.4-9

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7/May/92 08:48:27
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B[Tesla]
1.83
1.825
1.82
1.815
1.81
1.805
1.8
1.795
1.79
.5m
inner steel border
<--
inner steel border
-->
1.5m
2.2m
X coord
Y coord
6600.0 0.0
6960.0 0.0
7320.0 0.0
7680.0 0.0
8040.0 0.0
8400.0 0.0
Values of BMOD
Values of BMOD
Values of BMOD
X [mm]
VF/PE2D.8

Fig.5-1

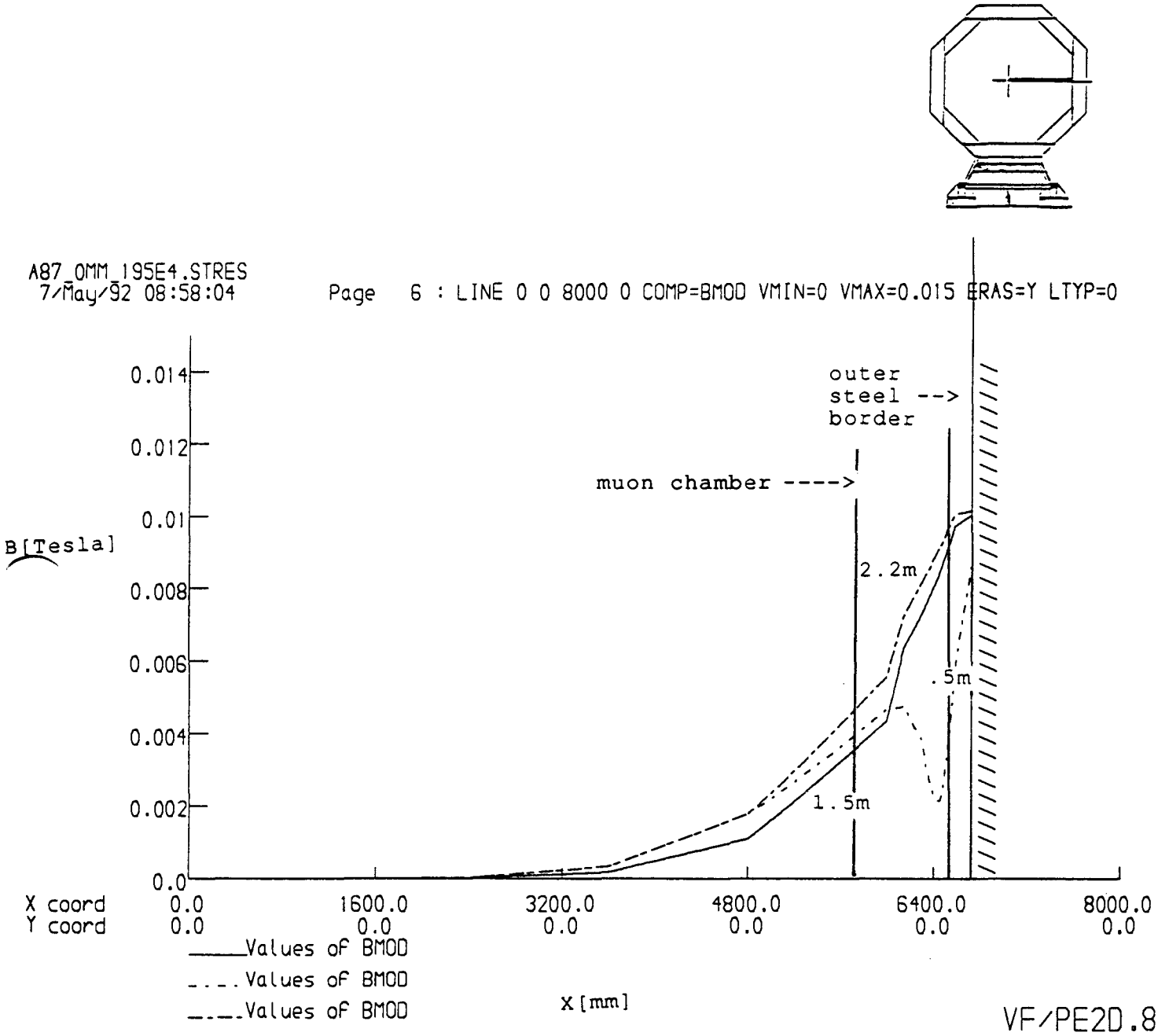
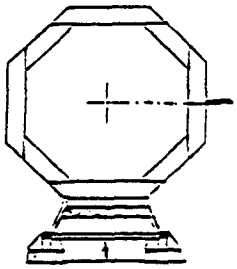

A87_0MM_195E4.STRES
7/May/92 08:58:04
Page 6 : LINE 0 0 8000 0 COMP=BMOD VMIN=0 VMAX=0.015 ERAS=Y LTYP=0
B[Tesla]
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0.0
outer
steel -->
border
muon chamber ---->
2.2m
.5m
1.5m
X coord 0.0 1600.0 3200.0 4800.0 6400.0 8000.0
Y coord 0.0 0.0 0.0 0.0 0.0 0.0
Values of BMOD
Values of BMOD
Values of BMOD
X [mm]
VF/PE2D.8

Fig.5-2



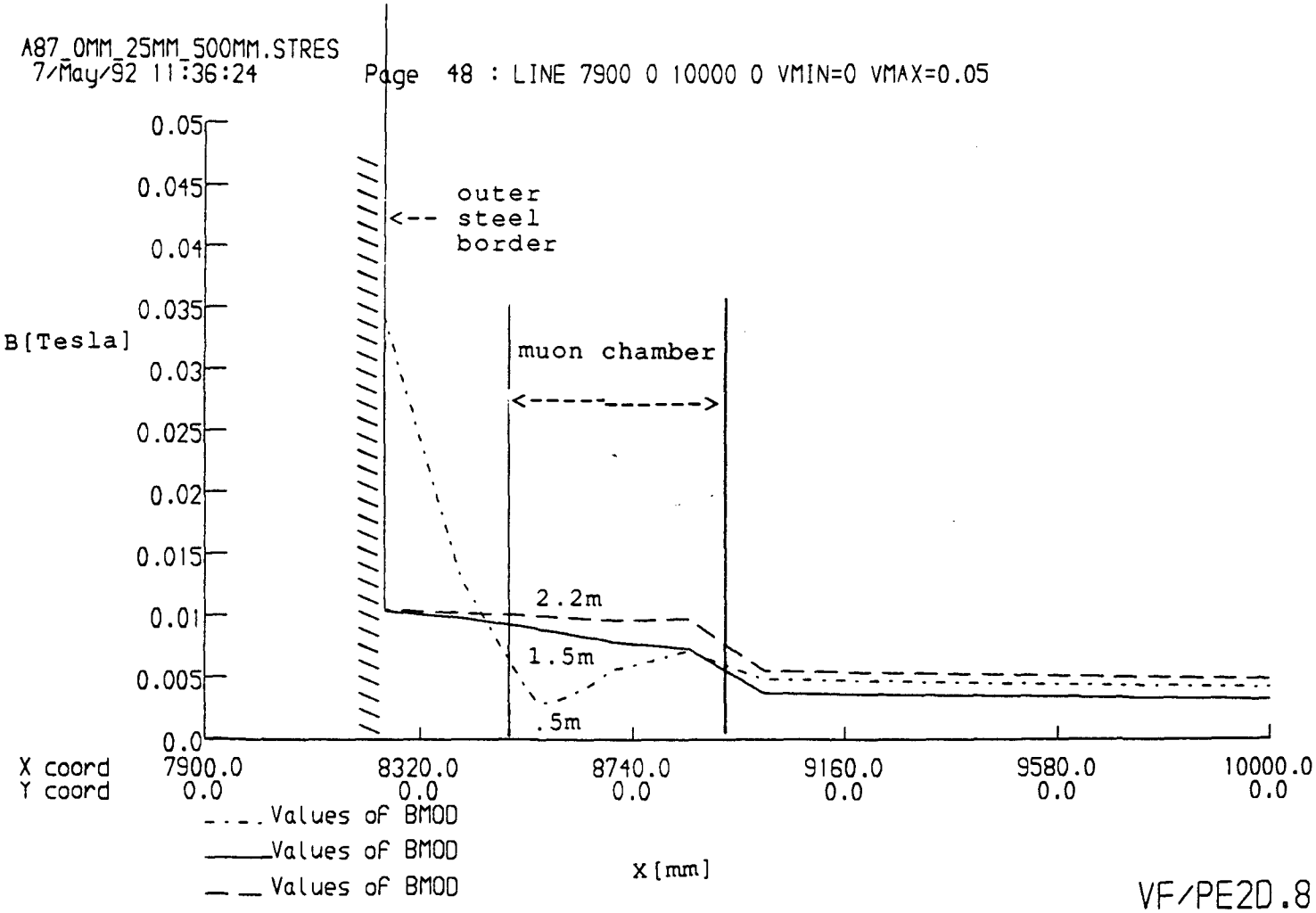
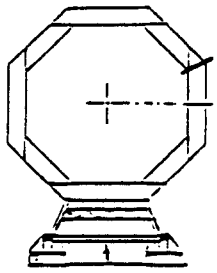
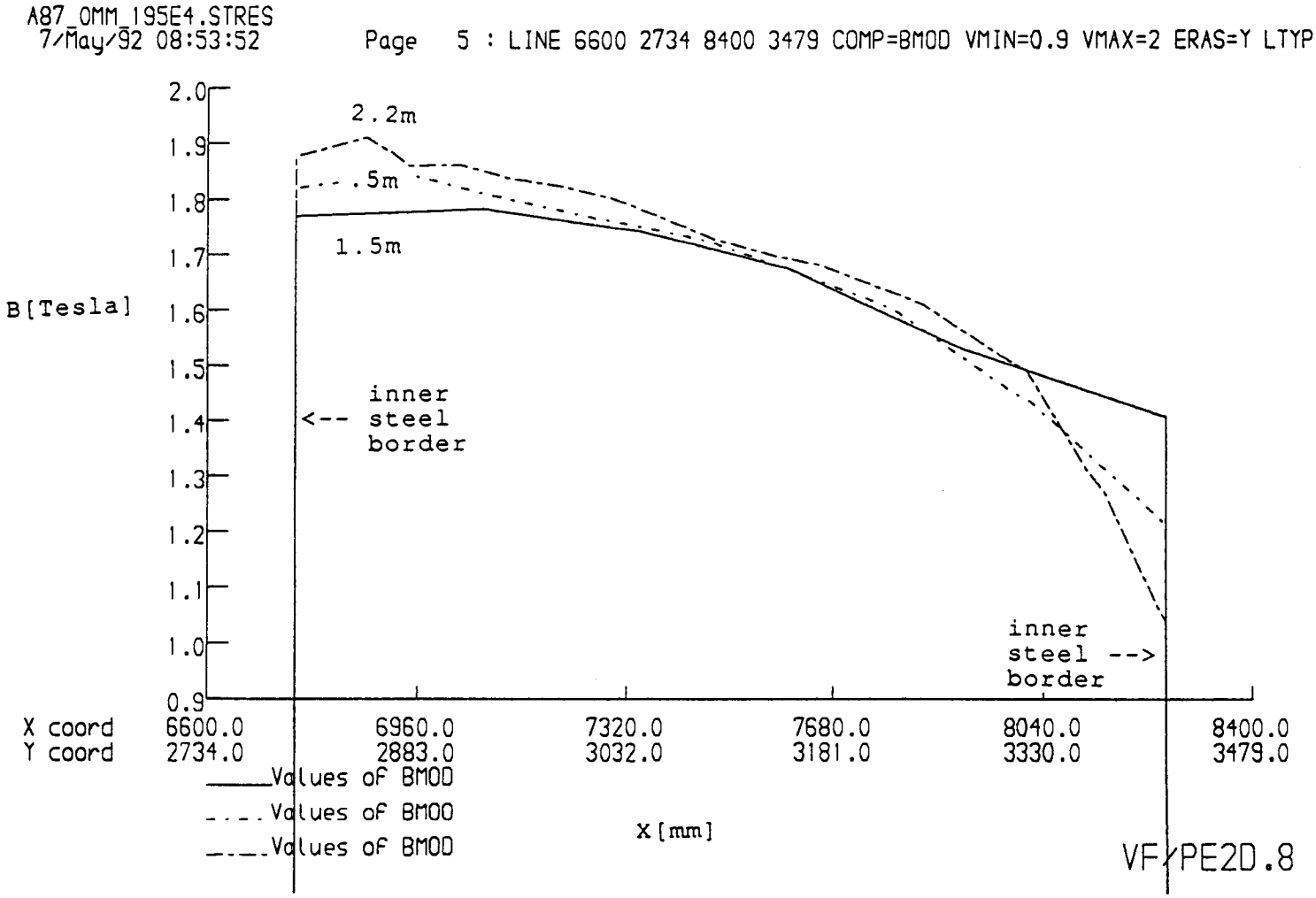

A87_0MM_25MM_500MM.STRES
7/May/92 11:36:24
Page 48 : LINE 7900 0 10000 0 VMIN=0 VMAX=0.05
B[Tesla]
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0.0
outer
steel
border
muon chamber
2.2m
1.5m
.5m
X coord 7900.0 8320.0 8740.0 9160.0 9580.0 10000.0
Y coord 0.0 0.0 0.0 0.0 0.0 0.0
Values of BMOD
Values of BMOD
Values of BMOD
X [mm]
VF/PE2D.8

Fig.5-3




A87_OMM_195E4.STRES
7/May/92 08:53:52
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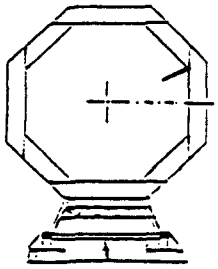
B[Tesla]
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
2.2m
.5m
1.5m
inner
steel
border
<--
inner
steel -->
border
X coord
Y coord
6600.0
2734.0
6960.0
2883.0
7320.0
3032.0
7680.0
3181.0
8040.0
3330.0
8400.0
3479.0
Values of BMOD
Values of BMOD
Values of BMOD
X[mm]
VF/PE2D.8

Fig.5-4



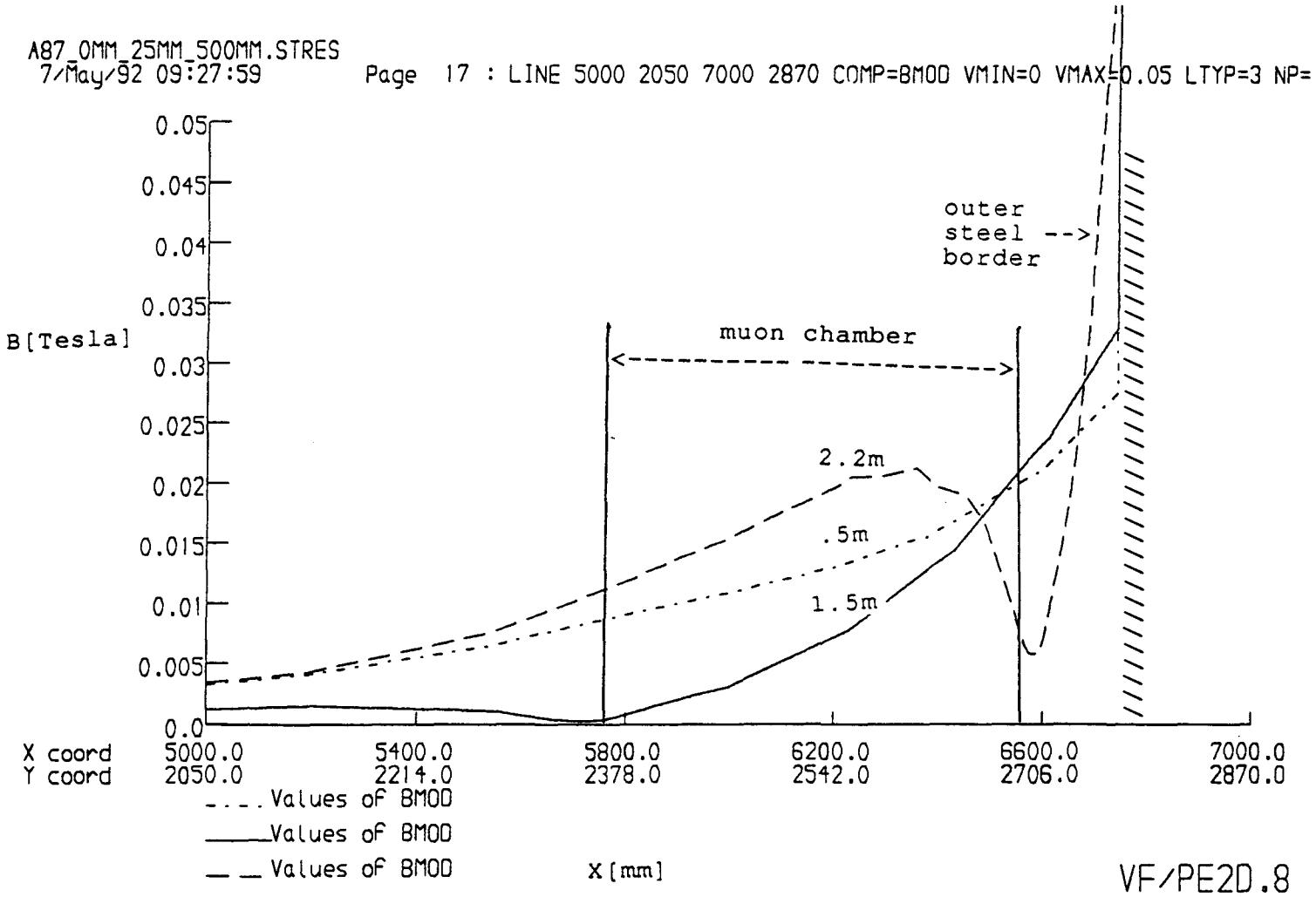
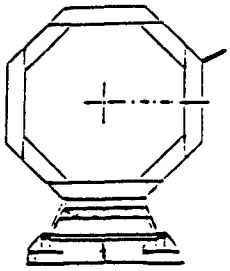

A87_0MM_25MM_500MM.STRES
7/May/92 09:27:59
Page 17 : LINE 5000 2050 7000 2870 COMP=BMOD VMIN=0 VMAX=0.05 LTYP=3 NP=
B[Tesla]
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0.0
outer
steel -->
border
muon chamber
2.2m
.5m
1.5m
X coord
Y coord
5000.0
2050.0
5400.0
2214.0
5800.0
2378.0
6200.0
2542.0
6600.0
2706.0
7000.0
2870.0
Values of BMOD
Values of BMOD
Values of BMOD
X[mm]
VF/PE2D.8

Fig.5-5



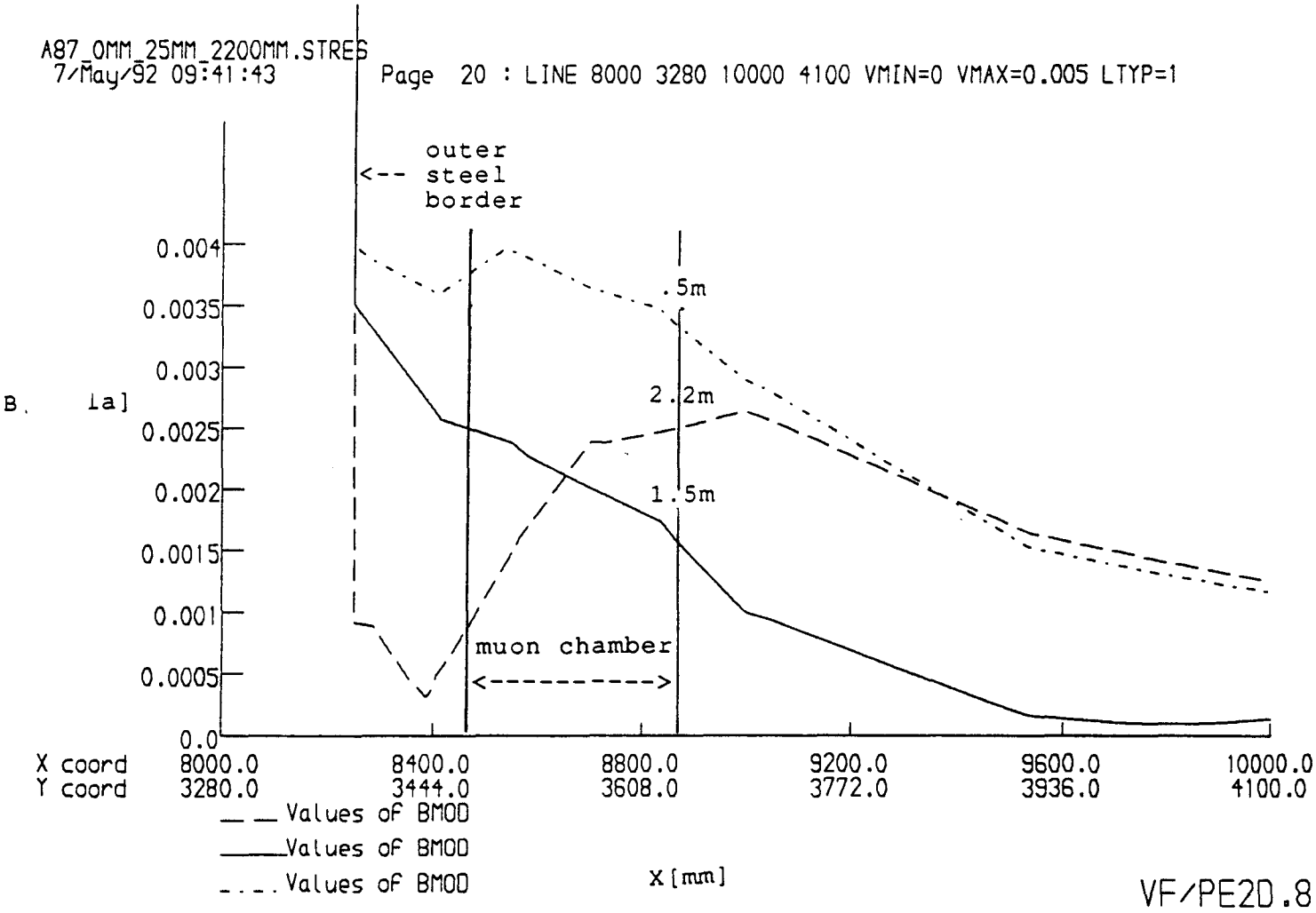

A87_0MM_25MM_2200MM.STRES
7/May/92 09:41:43
Page 20 : LINE 8000 3280 10000 4100 VMIN=0 VMAX=0.005 LTYP=1
outer
steel
border
.5m
2.2m
1.5m
muon chamber
B. [a]
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0.0
X coord 8000.0 8400.0 8800.0 9200.0 9600.0 10000.0
Y coord 3280.0 3444.0 3608.0 3772.0 3936.0 4100.0
Values of BMOD
Values of BMOD
Values of BMOD
X [mm]
VF/PE2D.8

Fig.5-6