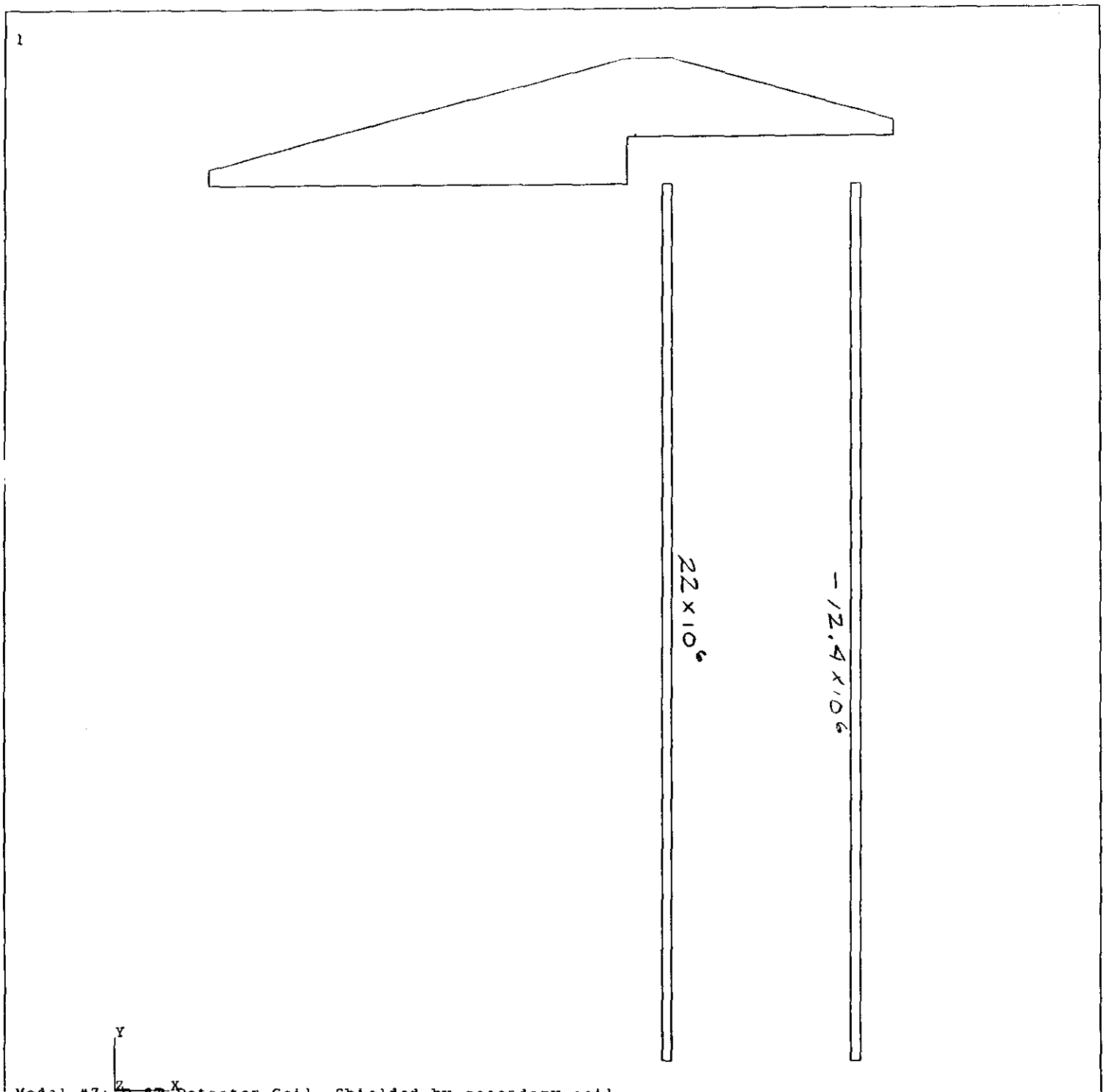
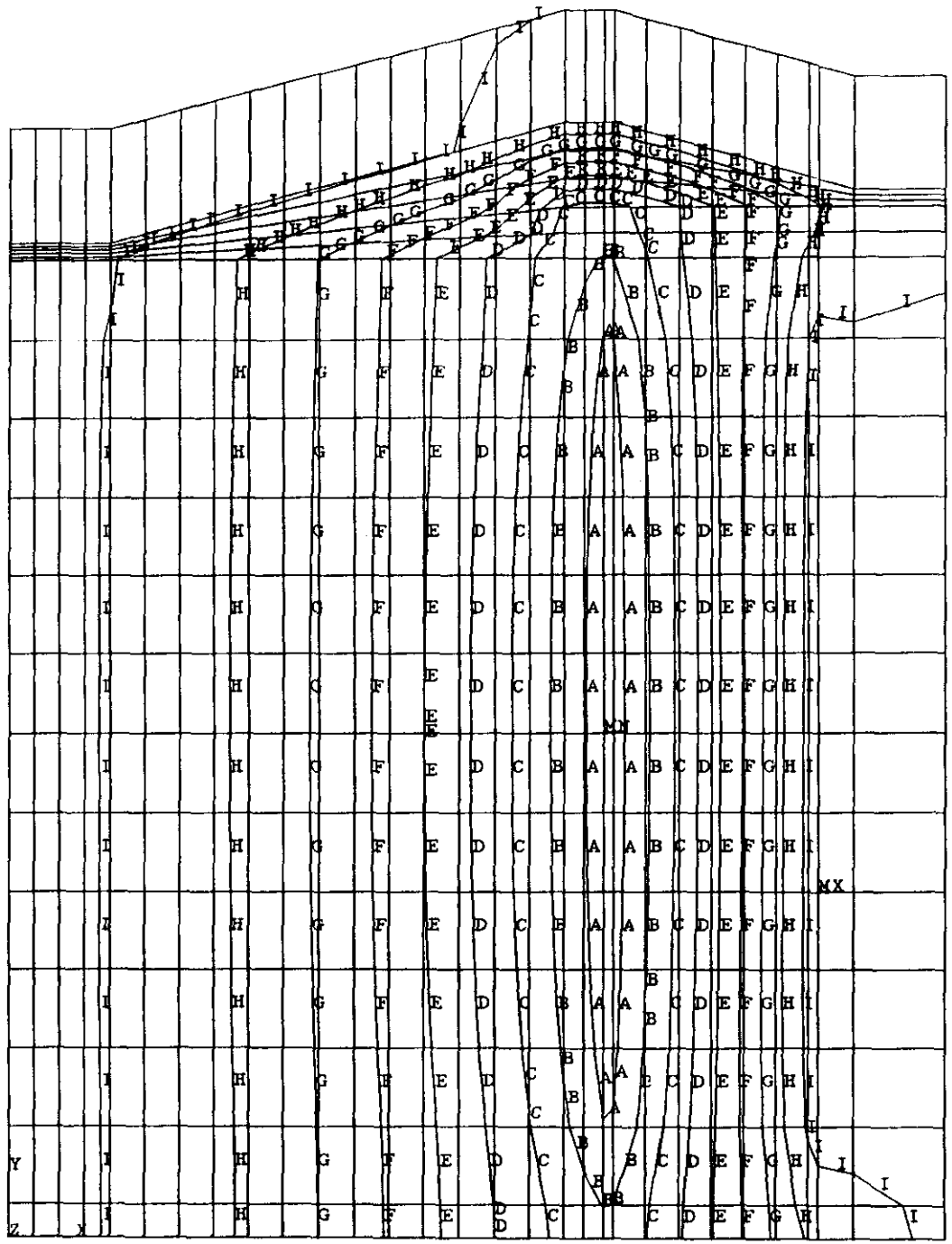


ANSYS 4.4A
AUG 14 1991
14:03:45
PLOT NO. 1
POST1 ELEMENTS
TYPE NUM

ZV =1
DIST=8.8
XF =7
YF =8.5
EDGE

Model #3: 0.81 Detector Coil, Shielded by secondary coil

1



ANSYS 4.4A

AUG 14 1991

14:03:47

PLOT NO. 2

POST1 STRESS

STEP=2

ITER=10

MAG

SMN =-32.771

SMX =1.13

ZV =1

DIST=9.992

XF =6.922

YF =9.084

A =-30.888

B =-27.121

C =-23.354

D =-19.587

E =-15.821

F =-12.054

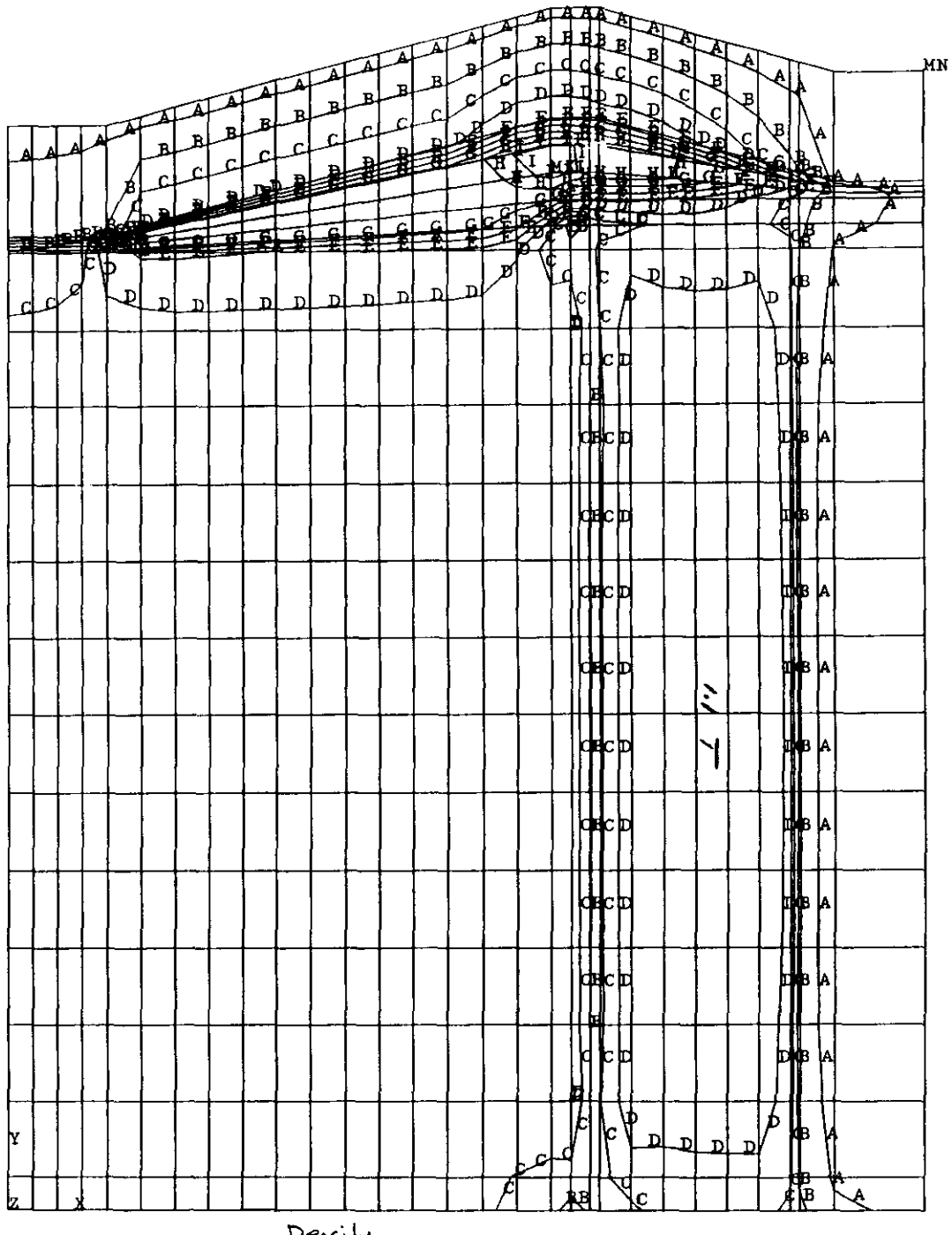
G =-8.287

H =-4.521

I =-0.753782

0.8T Detector Dual Coil,Poles,Flux (rA)

1

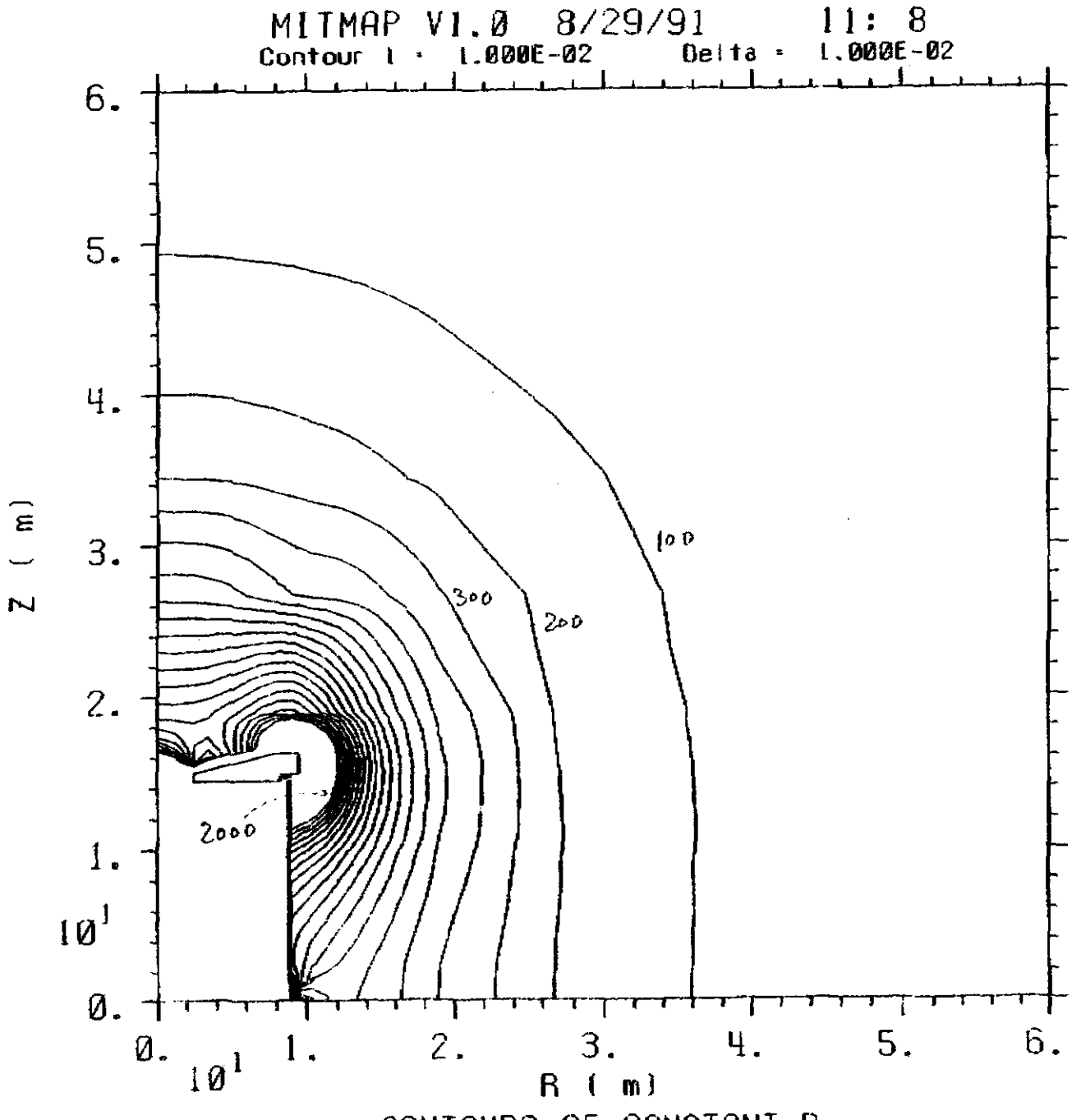


ANSYS 4.4A
AUG 14 1991
14:03:55
PLOT NO. 3
POST1 STRESS
STEP=2
ITER=10
BSUM (AVG)
SMN =0.010228
SMX =2.283

ZV =1
DIST=9.992
XF =6.922
YF =9.084
A =0.136509
B =0.389071
C =0.641633
D =0.894195
E =1.147
F =1.399
G =1.652
H =1.904
I =2.157

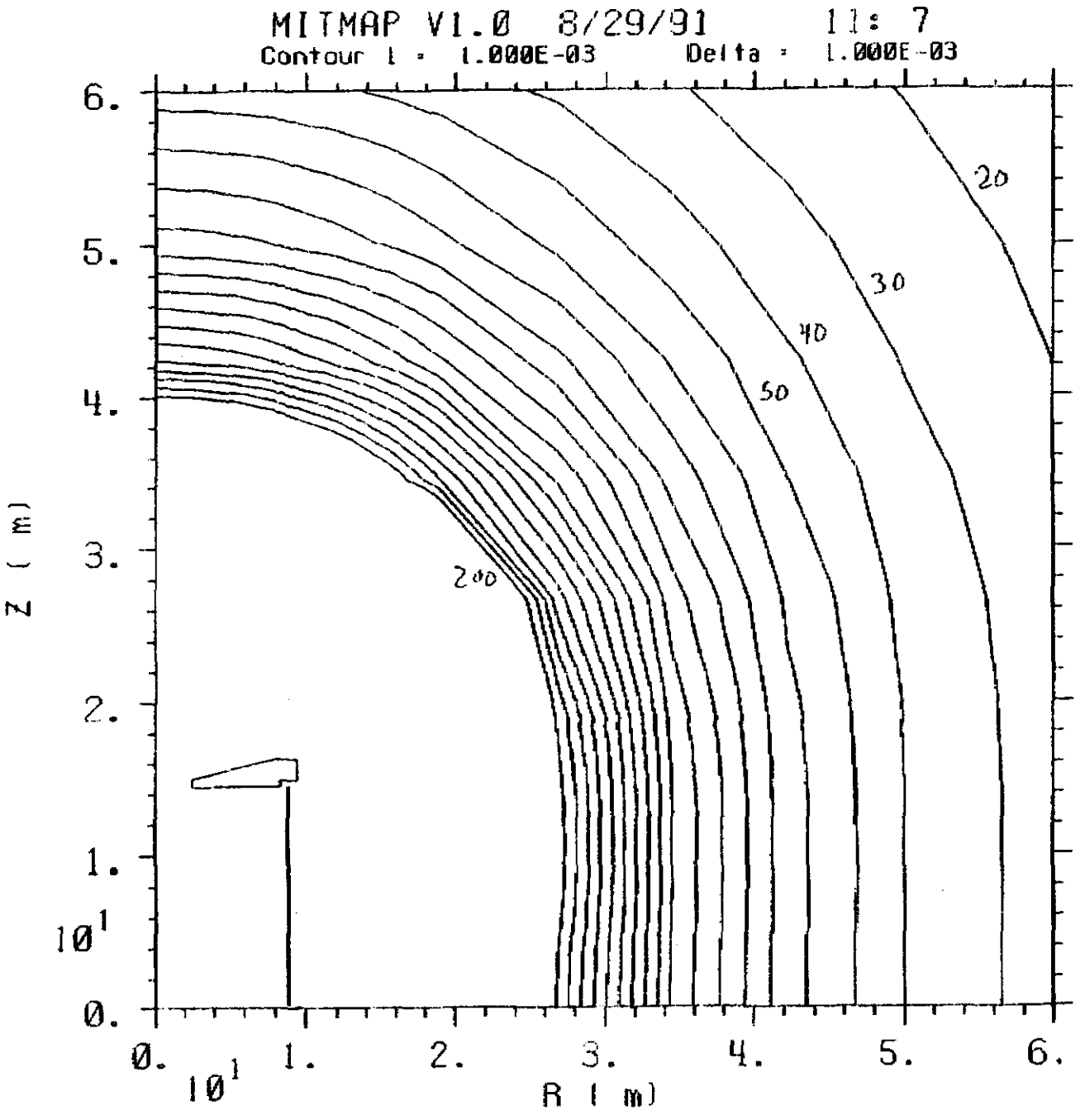
0.8T Detector Dual Coil, Poles, Flux ~~Intensity~~ Density (T)

GEM I --- Baseline with Full Pole

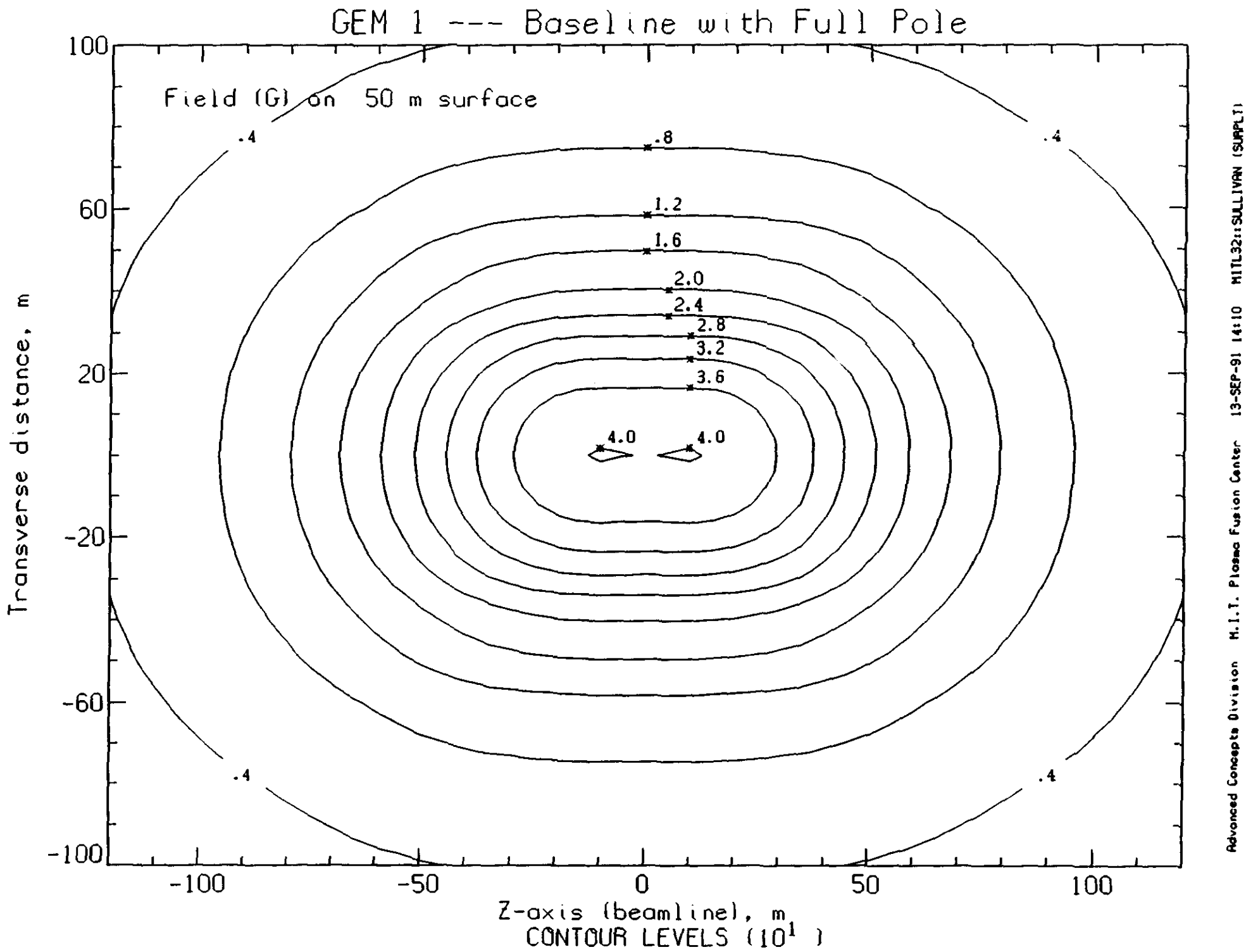


CONTOURS OF CONSTANT B

GEM 1 --- Baseline with Full Pole



CONTOURS OF CONSTANT B


GEM 1 --- Baseline with Full Pole
Field (G) on 50 m surface
.4
.8
1.2
1.6
2.0
2.4
2.8
3.2
3.6
4.0
4.0
.4
.4
.4
100
60
20
-20
-60
-100
-100
-50
0
50
100
Transverse distance, m
Z-axis (beamline), m
CONTOUR LEVELS (10^1)
Advanced Concepts Division M.I.T. Plasma Fusion Center 13-SEP-91 14:10 MITL32::SULLIVAN (SURPLT)

GEM Detector Coil Shielding

- **Concept:**

  Optimally Sized Iron Plate Located at Ground Elevation

- **Objective** - To Determine The Optimum Plate Dimensions Such That:

  - The Fringe Field in the Air at Ground Elevation is < 10 G
  - The Iron Plate Material Costs are Minimized

- **Analysis Methodology:**

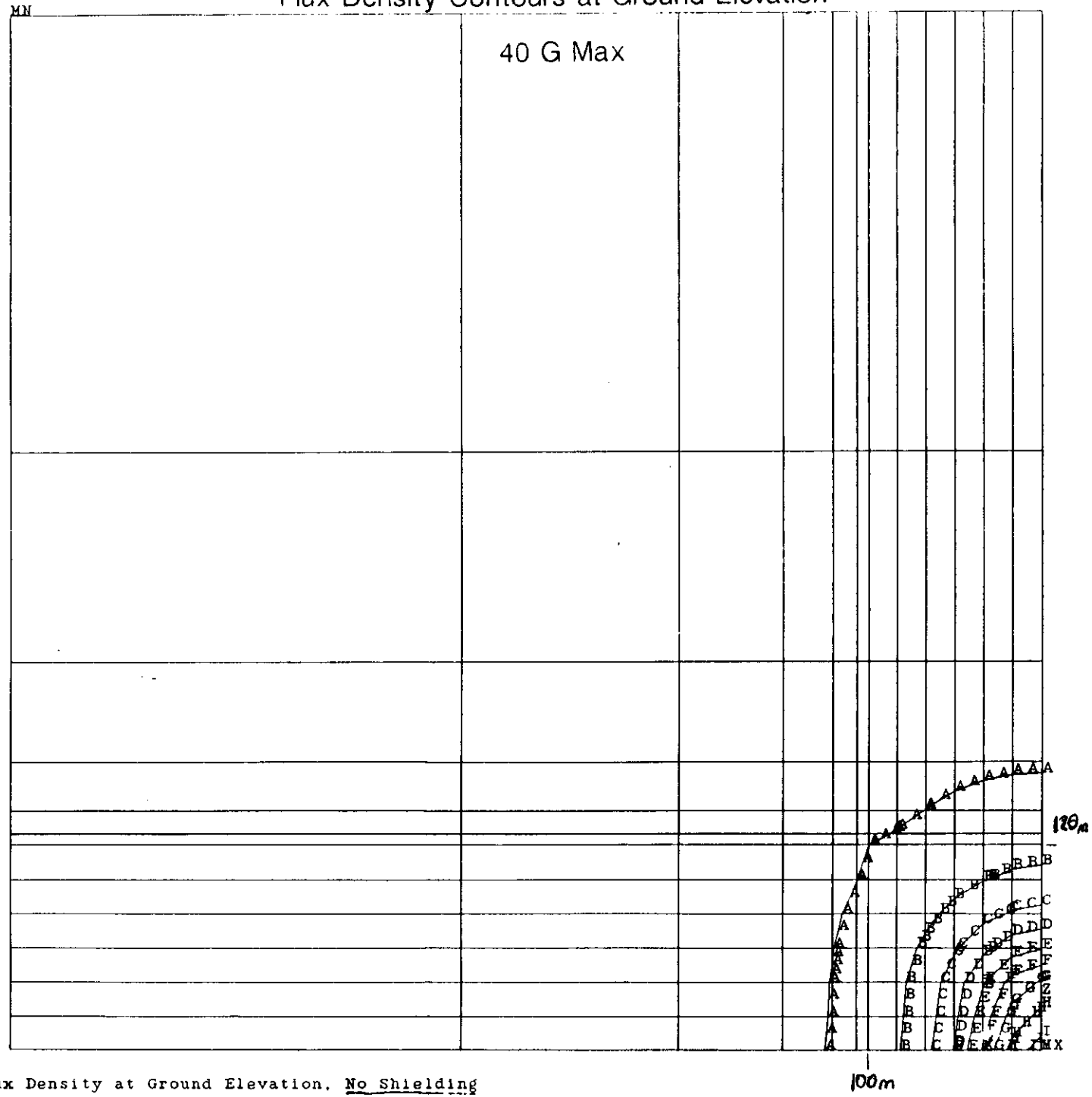
  - Detailed Finite Element Analysis Using ANSYS Magnetics
  - 3-D Modeling Uses Actual Nonlinear Iron Material Property

- **Preliminary Results:**

Plate Dimensions [m]	B_{max}/B_{min} (Plate)	B_{max} (Air)	B_{edge}	Weight of Iron Plate
240L x 200W 0.15 thk (Stepped)	1.38/0.05 Tesla	14 G	< 3 G	40,000 Metric Tons
192L x 160W 0.15 thk (Stepped)	1.44/0.10 Tesla	14 G	< 5 G	25,000 Metric Tons
L x W x thk To Be Determined	?/? Tesla	10 G	< 10 G	??

1

Flux Density Contours at Ground Elevation



ANSYS 4.4A
AUG 28 1991
14:30:37
PLOT NO. 1
POST1 STRESS
STEP=1
ITER=1
BSUM (AVG)
SMN =0.300E-05
SMX =0.003976

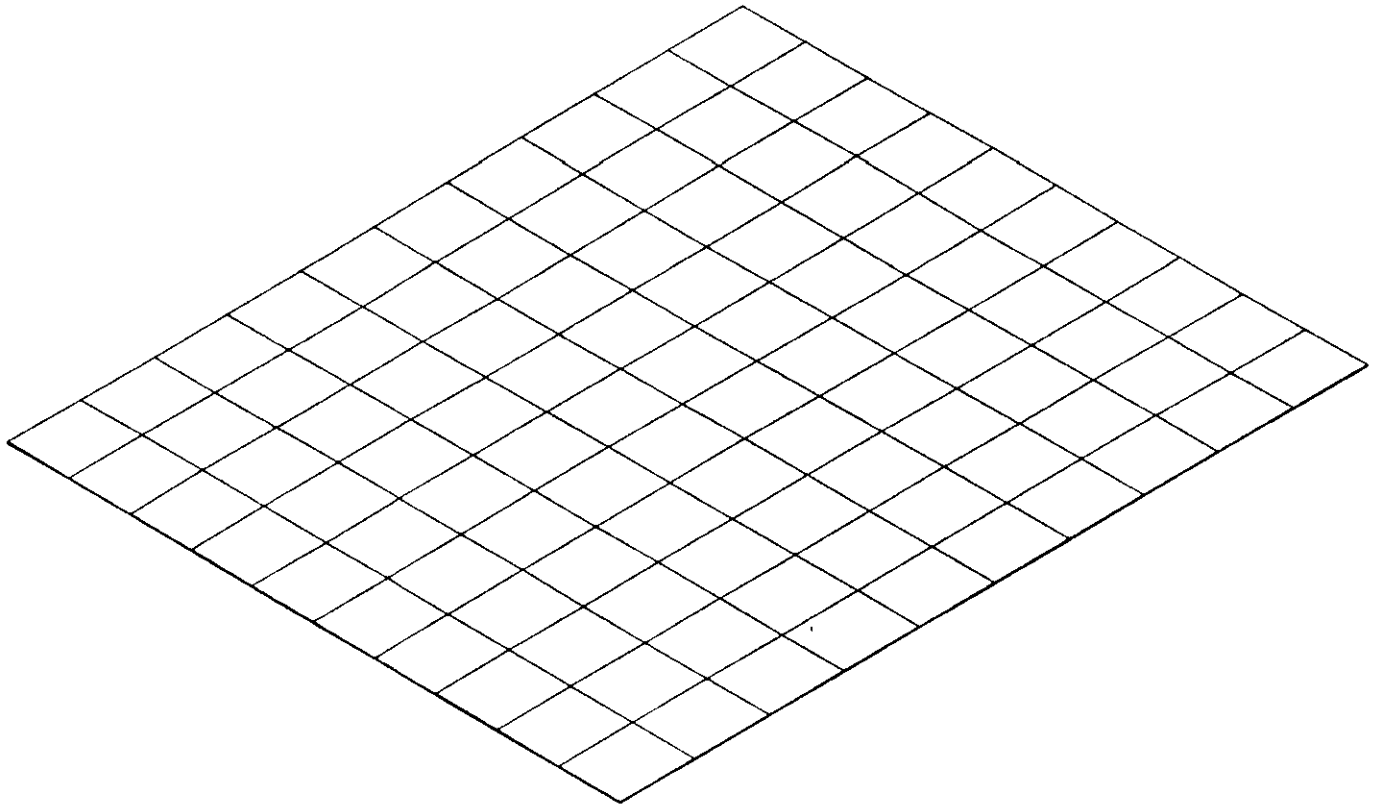
YV =1
DIST=330
XF =300
ZF =300
VUP =Z
A =0.224E-03 [T]
B =0.665E-03
C =0.001107
D =0.001548
E =0.00199
F =0.002431
G =0.002873
H =0.003314
I =0.003755

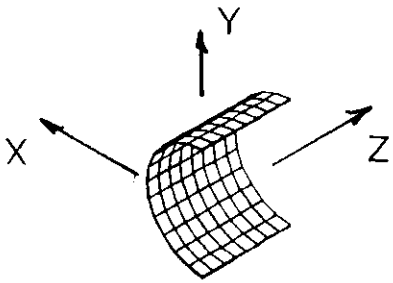
PROPOSED PIT SIZE:
200m wide
×
240m LONG
×
THK
(TO BE DETERMINED)

Flux Density at Ground Elevation, No Shielding

1

Quarter Model of Plate & Coil





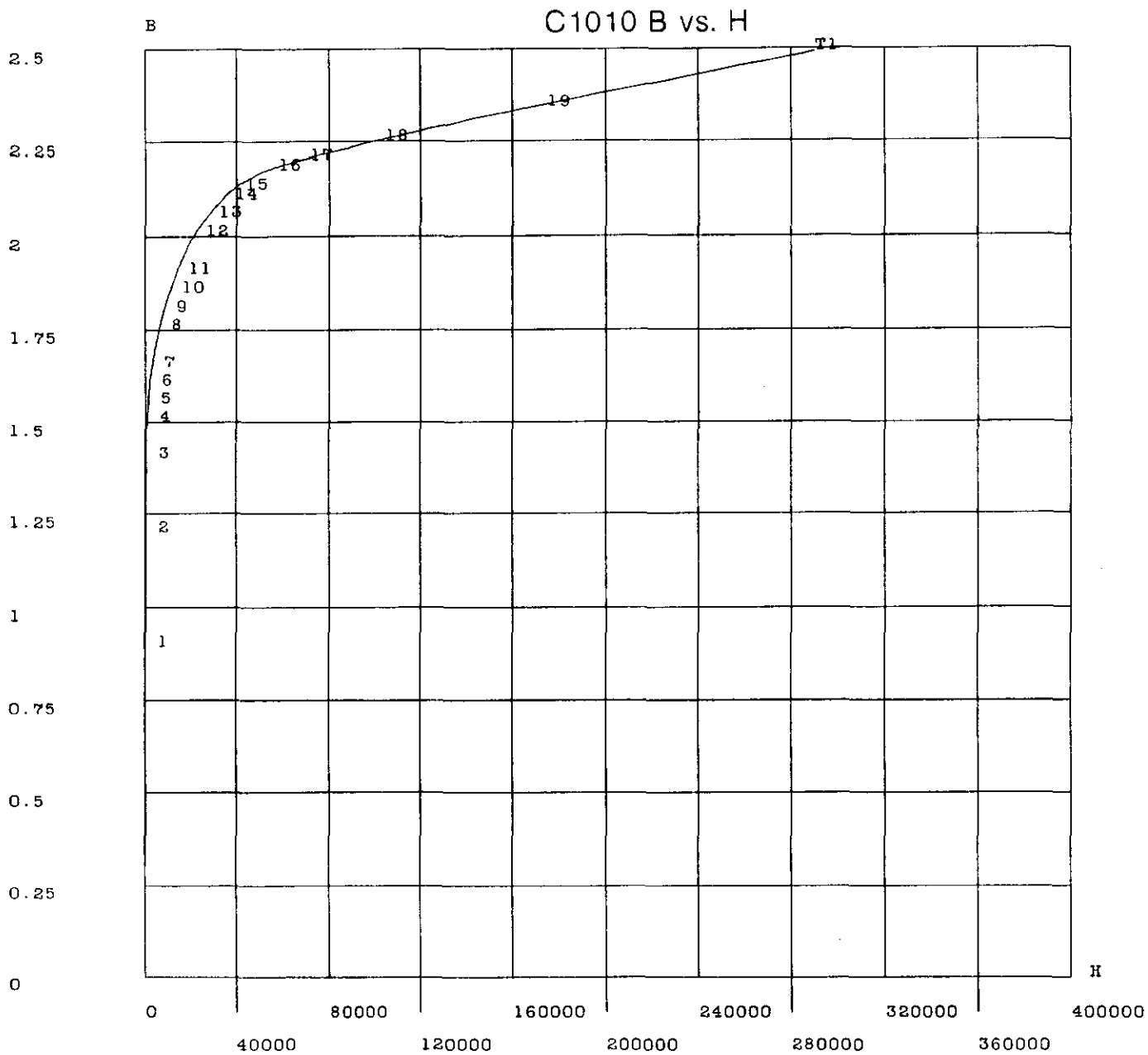
ANSYS 4.4A
AUG 30 1991
12:32:32
PLOT NO. 1
PREP7 ELEMENTS
MAT NUM

XV =-1
YV =1
ZV =-1
DIST=85.56
XF =50
YF =-29.438
ZF =60
PRECISE HIDDEN

22.6 MA Equiv. Solenoid, 240x200x0.15m Iron Plate for shielding

1

BH FOR MATERIAL 3



ANSYS 4.4A

SEP 17 1991

16:01:56

PLOT NO. 1

PREP7 MATERIALS

T1=0.00

ZV =1

DIST=0.6666

XF =0.5

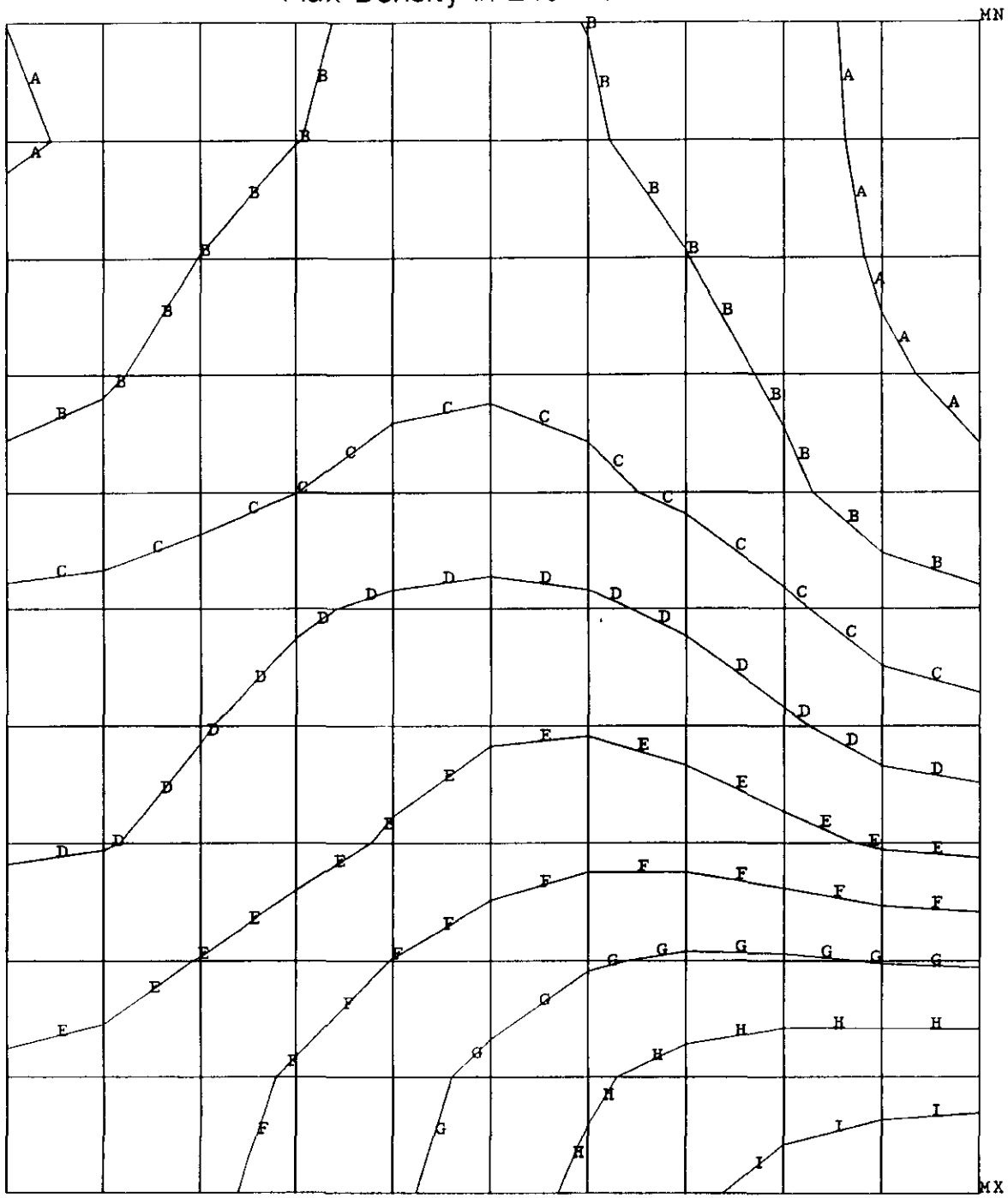
YF =0.5

ZF =0.5

Iron Material Property Curve

1

Flux Density in 240x200x0.15m Plate



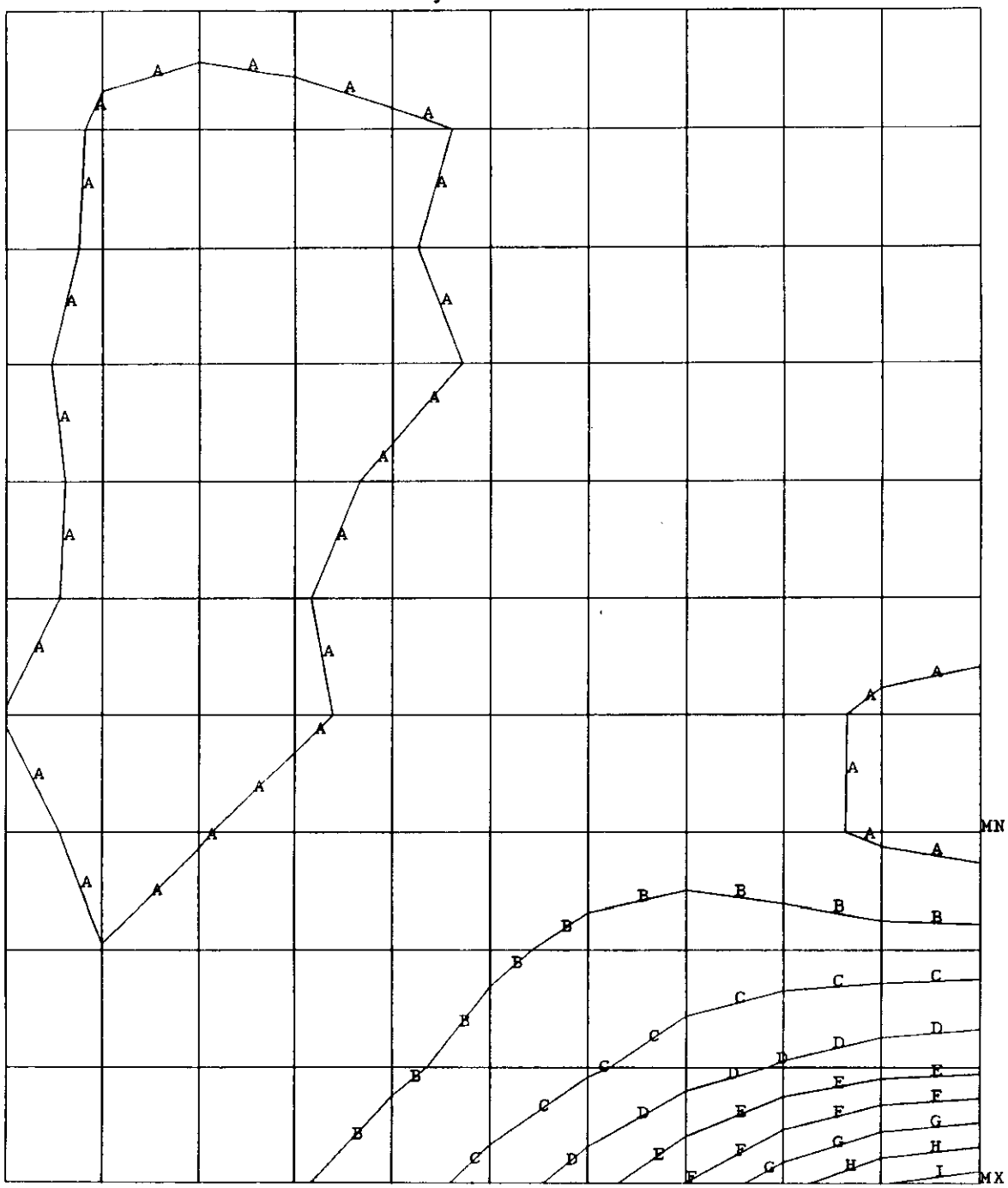
ANSYS 4.4A
SEP 3 1991
10:19:16
PLOT NO. 1
POST1 STRESS
STEP=1
ITER=20
BSUM (AVG)
SMN =0.04619
SMX =1.378

YV =1
DIST=66
XF =50
ZF =60
VUP =Z
PRECISE HIDDEN
A =0.120207
B =0.268239
C =0.416272
D =0.564305
E =0.712337
F =0.86037
G =1.008
H =1.156
I =1.304

Flux Density in the 240x200x0.15m Stepped Iron Plate

1

Flux Density in Air Elements Above Plate



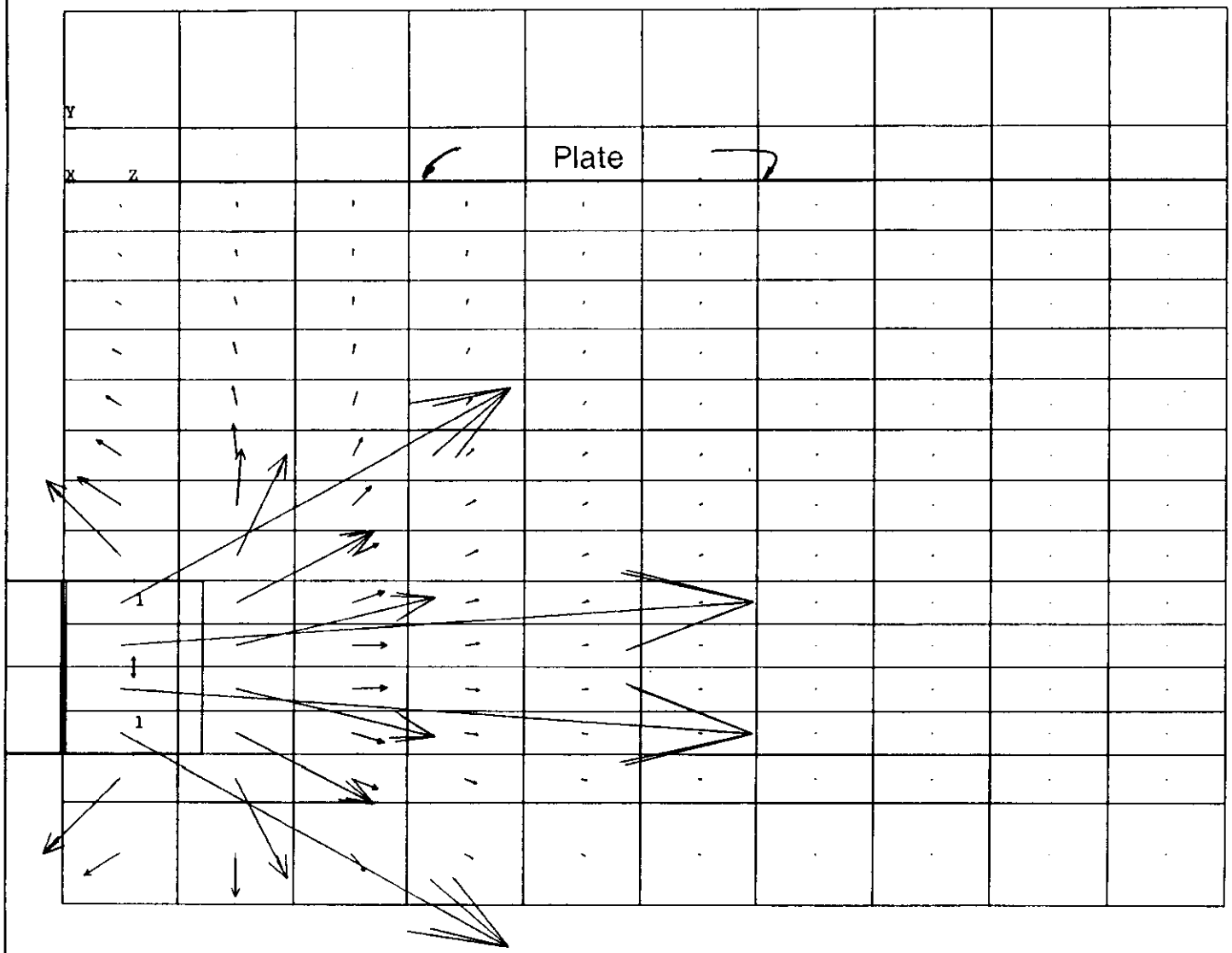
ANSYS 4.4A
SEP 3 1991
10:19:28
PLOT NO. 2
POST1 STRESS
STEP=1
ITER=20
BSUM (AVG)
SMN =0.111E-03
SMX =0.001405

YV =1
DIST=66
XF =50
YF =2.813
ZF =60
VUP =Z
PRECISE HIDDEN
A =0.183E-03
B =0.327E-03
C =0.471E-03
D =0.614E-03
E =0.758E-03
F =0.902E-03
G =0.001046
H =0.00119
I =0.001333

Flux Density in the Air Directly Above 240x200x0.15m Stepped Iron Plate

1

Field Vectors From Coil, Elevation View



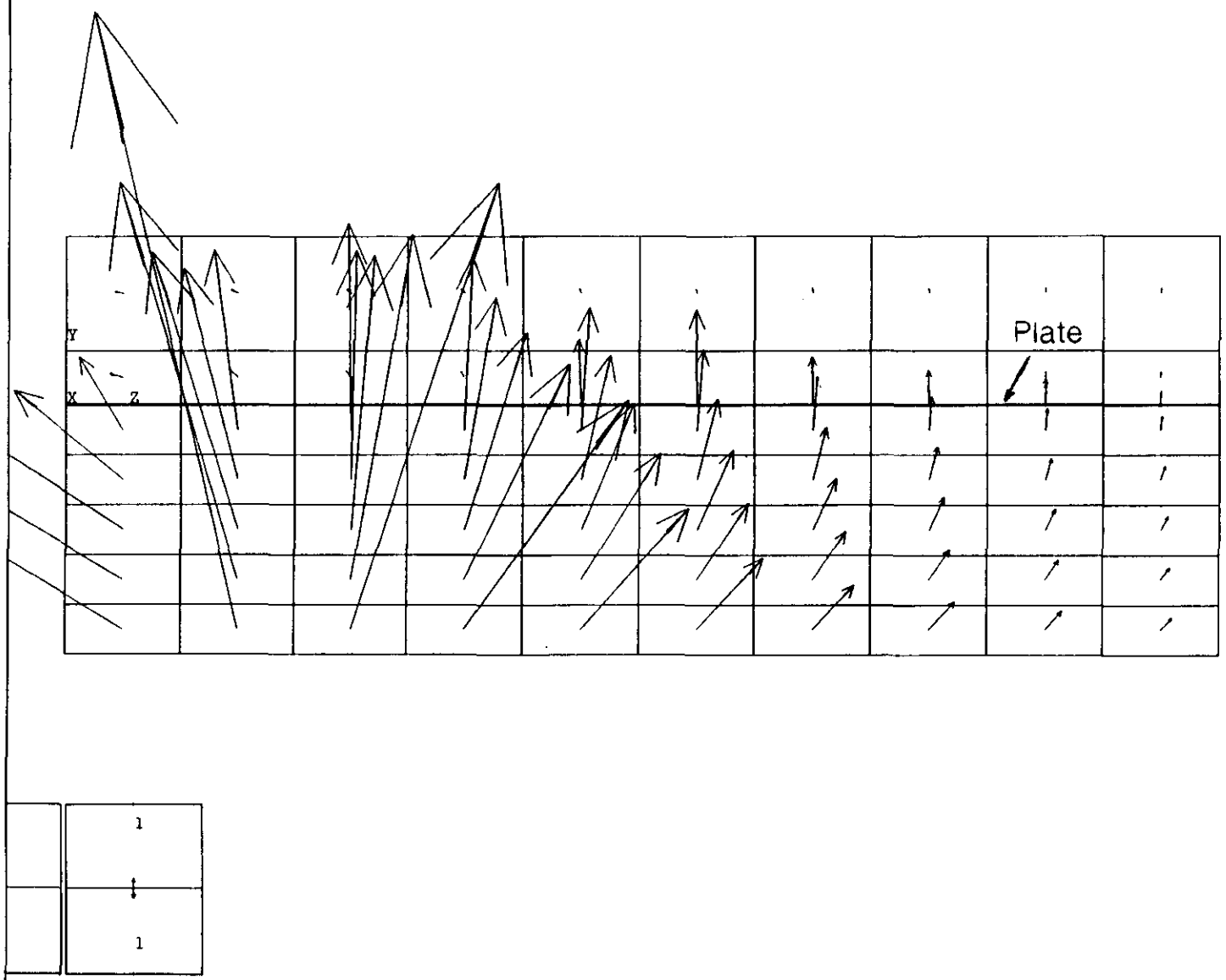
ANSYS 4.4A
SEP 3 1991
10:19:37
PLOT NO. 3
POST1 VECTOR
STEP=1
ITER=20
BMAG
ELEM=129
0.087357
0.17453
0.261703
0.348876
0.436049
0.523222
0.610395
0.697568
0.784741
SOUR

XV =-1
DIST=66
XF =5
YF =-28.386
ZF =60
VSCA=10

Flux Density Between Coil and 240x200x0.15m Stepped Iron Plate

1

Field Vectors Near Plate, Elevation View



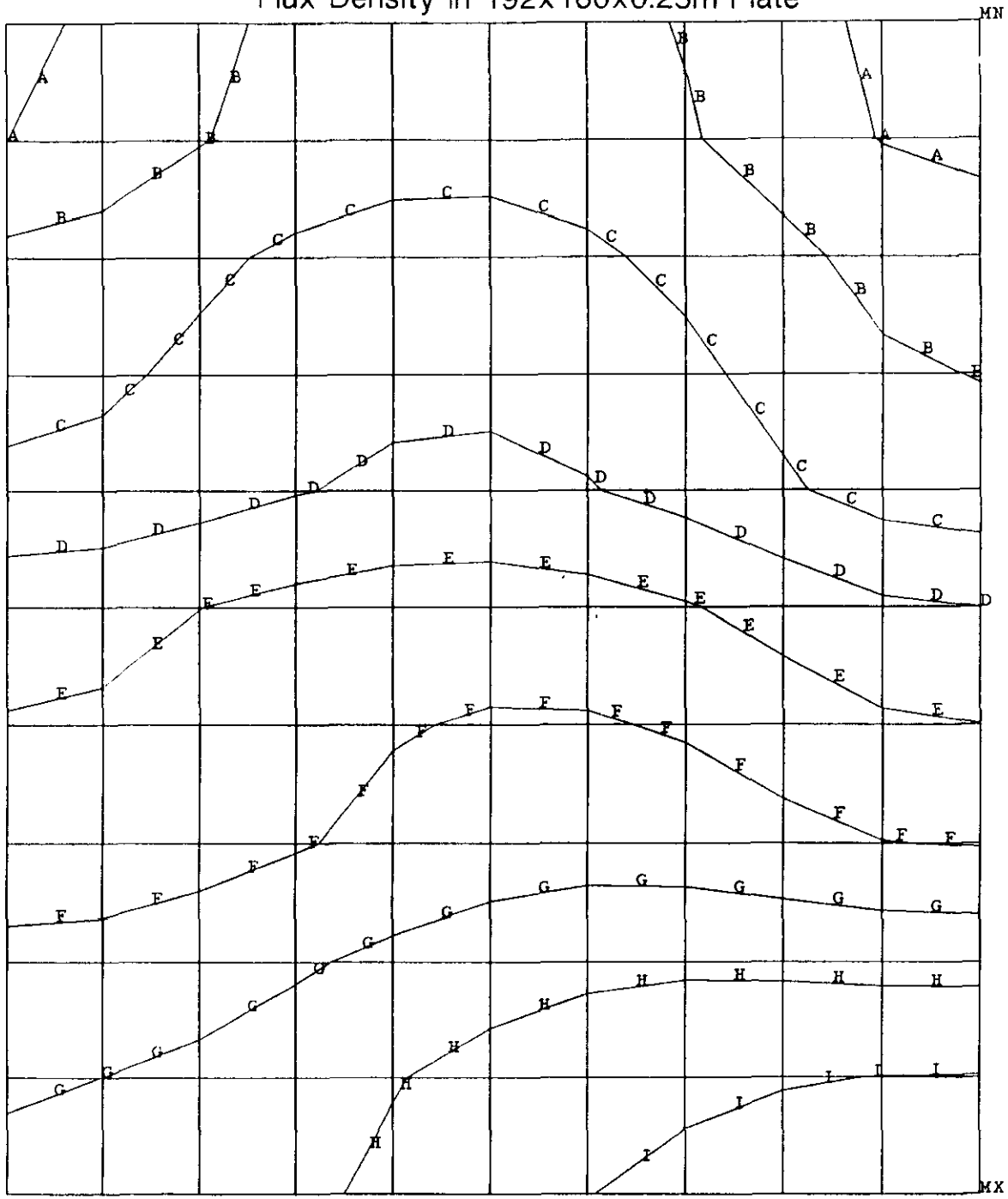
ANSYS 4.4A
SEP 3 1991
10:19:53
PLOT NO. 4
POST1 VECTOR
STEP=1
ITER=20
BMAG
ELEM=641
0.002836
0.005487
0.008139
0.010791
0.013443
0.016095
0.018747
0.021399
0.024051
SOUR

XV =-1
DIST=66
XF =5
YF =-4.095
ZF =60
VSCA=10

Flux Density Between Coil and 240x200x0.15m Stepped Iron Plate

1

Flux Density in 192x160x0.25m Plate



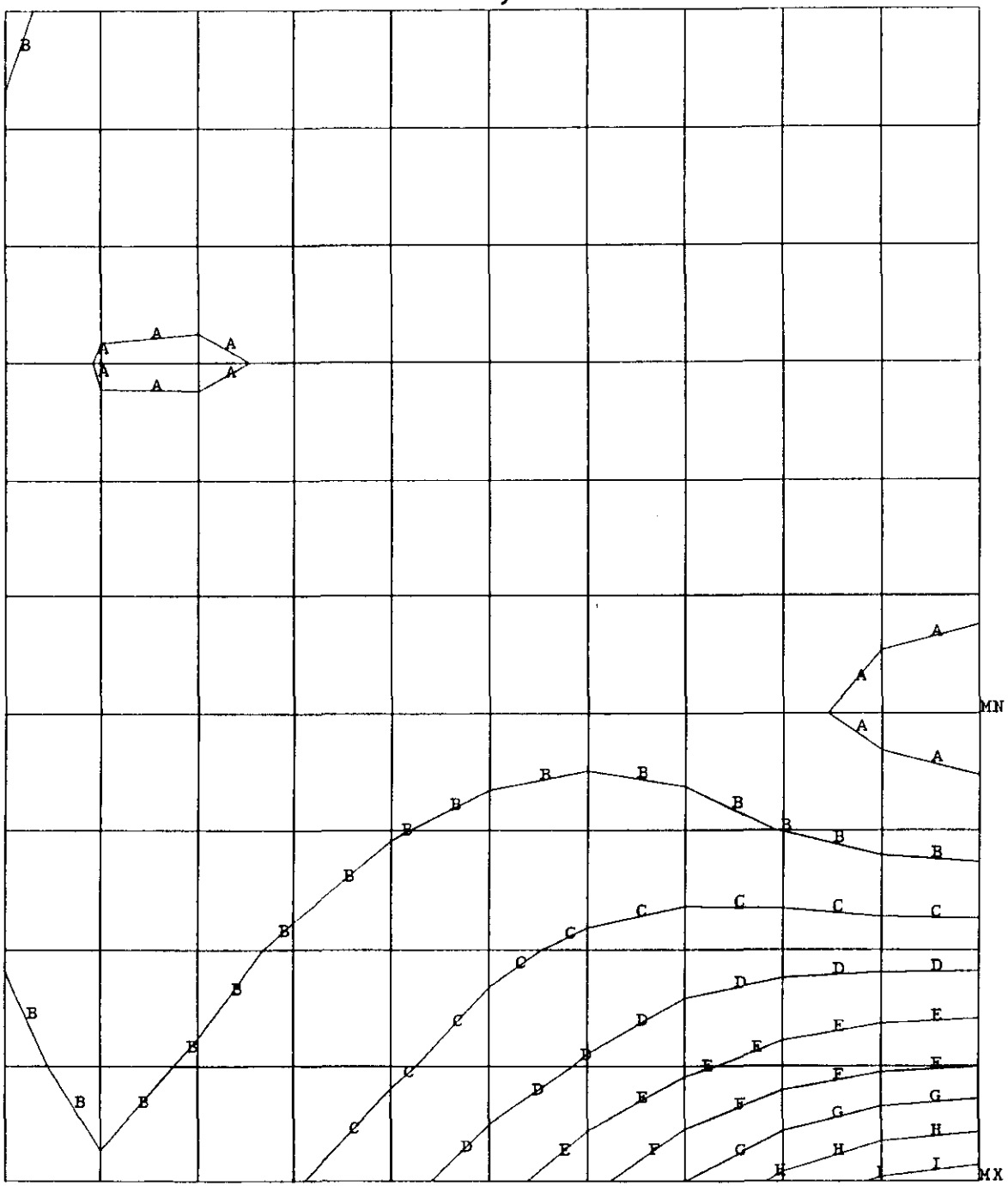
ANSYS 4.4A
SEP 17 1991
8:29:50
PLOT NO. 1
POST1 STRESS
STEP=1
ITER=20
BSUM (AVG)
SMN =0.101027
SMX =1.435

YV =1
DIST=52.8
XF =40
ZF =48
VUP =Z
PRECISE HIDDEN
A =0.175155
B =0.32341
C =0.471665
D =0.619919
E =0.768174
F =0.916429
G =1.065
H =1.213
I =1.361

Flux Density in 192x160x0.15m Stepped Iron Plate

1

Flux Density in Air Above Plate



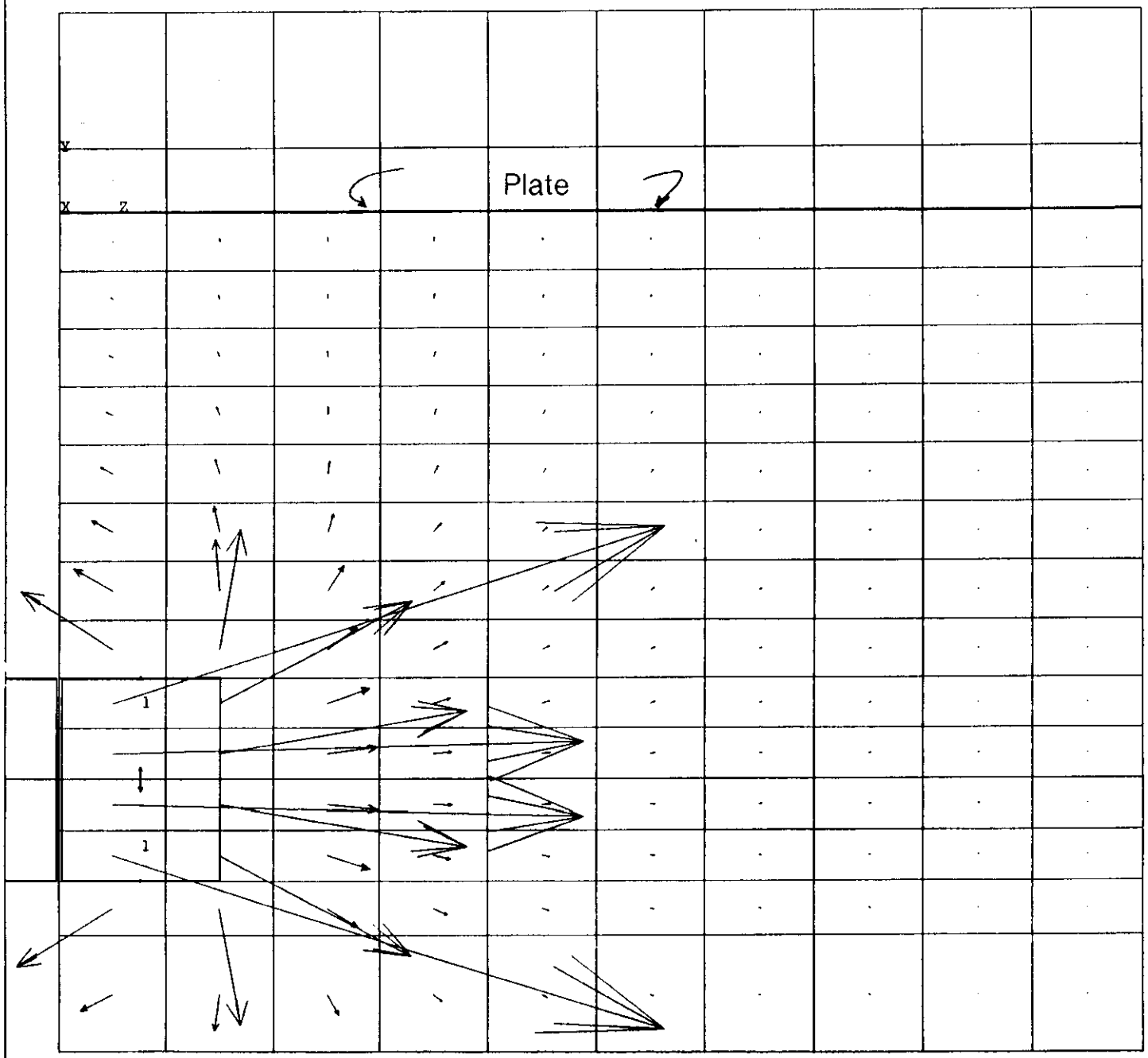
ANSYS 4.4A
SEP 17 1991
8:30:01
PLOT NO. 2
POST1 STRESS
STEP=1
ITER=20
BSUM (AVG)
SMN =0.138E-03
SMX =0.001356

YV =1
DIST=52.8
XF =40
YF =2.813
ZF =48
VUP =Z
PRECISE HIDDEN
A =0.206E-03
B =0.341E-03
C =0.477E-03
D =0.612E-03
E =0.747E-03
F =0.883E-03
G =0.001018
H =0.001153
I =0.001289

Flux Density in Air Directly Above 192x160x0.15m Stepped Iron Plate

1

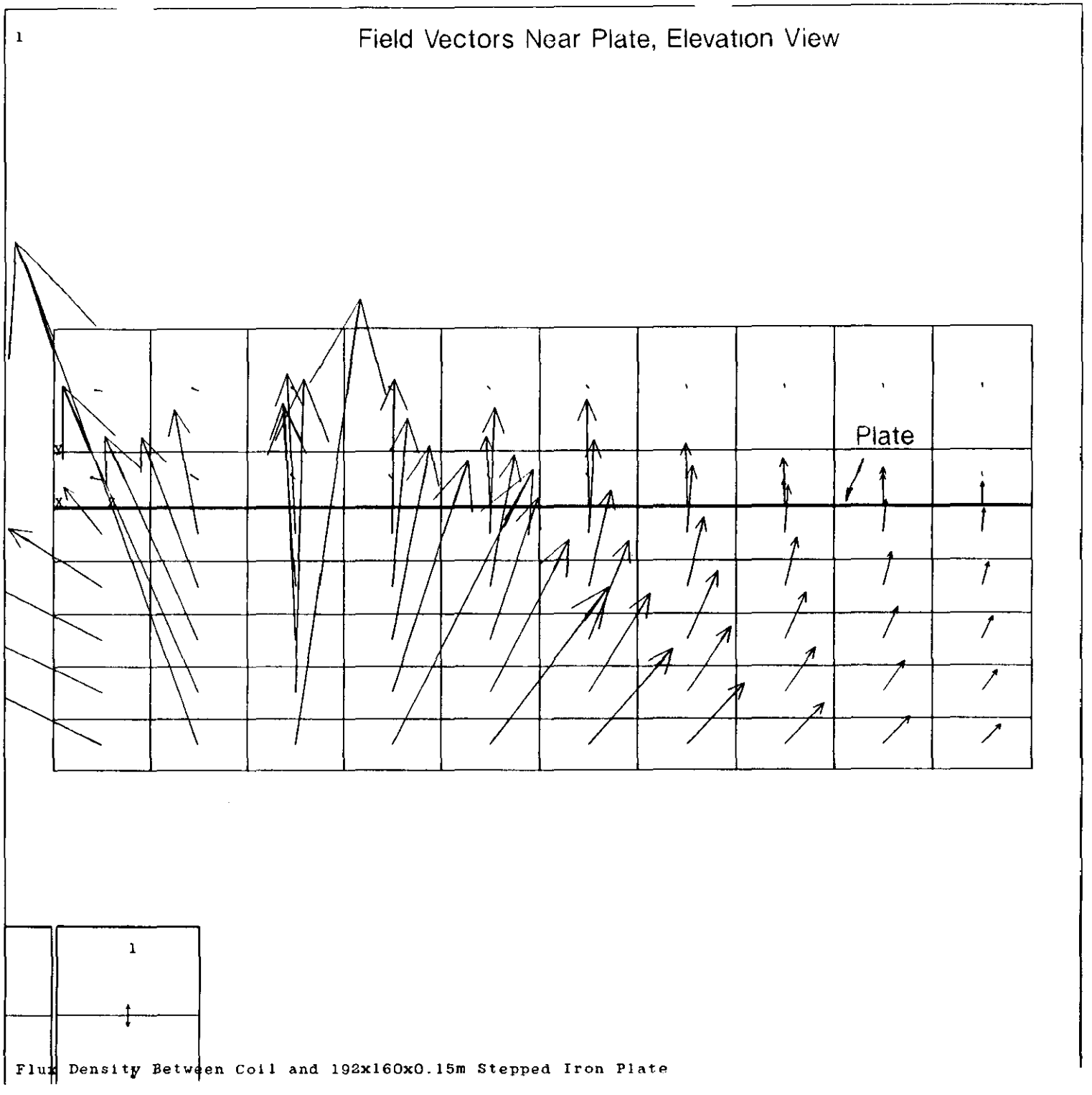
Field Vectors From Coil, Elevation View



ANSYS 4.4A
SEP 17 1991
8:30:11
PLOT NO. 3
POST1 VECTOR
STEP=1
ITER=20
BMAG
ELEM=145
0.12026
0.240286
0.360312
0.480338
0.600364
0.72039
0.840415
0.960441
1.08
SOUR

XV =-1
DIST=52.8
XF =4
YF =-28.386
ZF =48
VSCA=10

Flux Density Between Coil and 192x160x0.15m Stepped Iron Plate



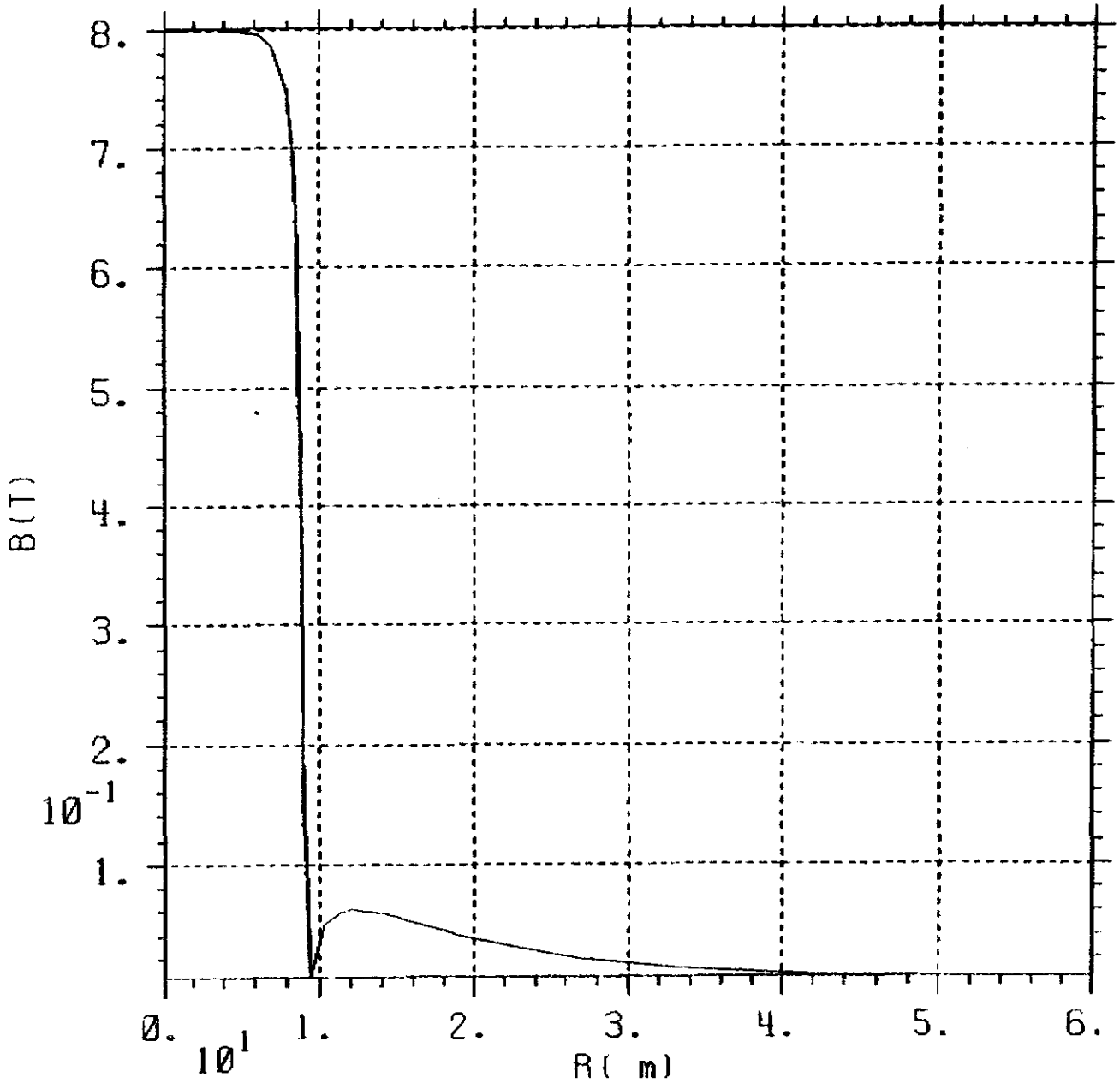
ANSYS 4.4A
SEP 17 1991
8:30:27
PLOT NO. 4
POST1 VECTOR
STEP=1
ITER=20
BMAG
ELEM=641
0.003246
0.006257
0.009269
0.01228
0.015292
0.018303
0.021314
0.024326
0.027337
SOUR

XV =-1
DIST=52.8
XF =4
YF =-4.095
ZF =48
VSCA=10

Flux Density Between Coil and 192x160x0.15m Stepped Iron Plate

GEM I --- Baseline with Full Pole

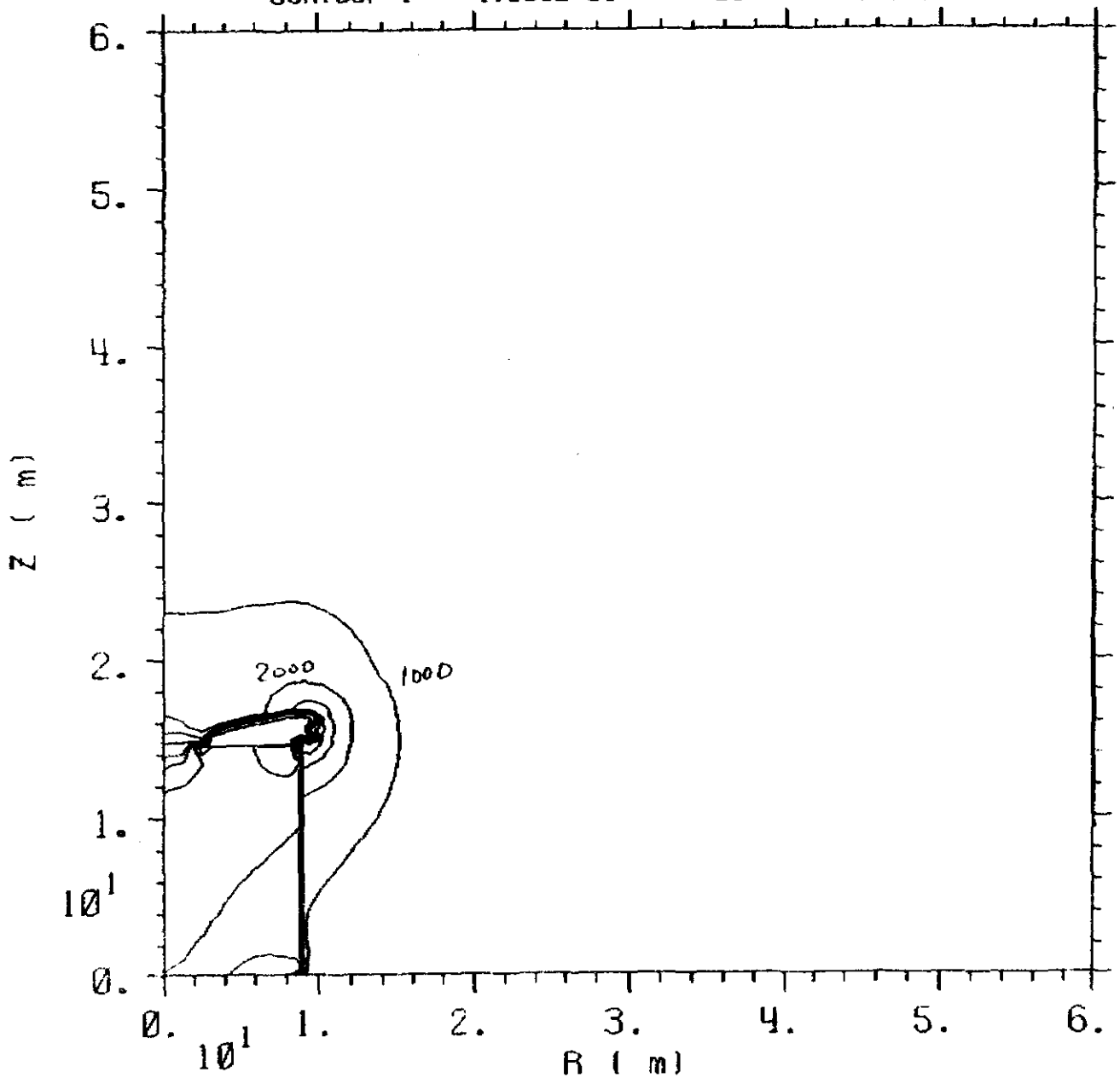
MITMAP V1.0 8/29/91 11: 8



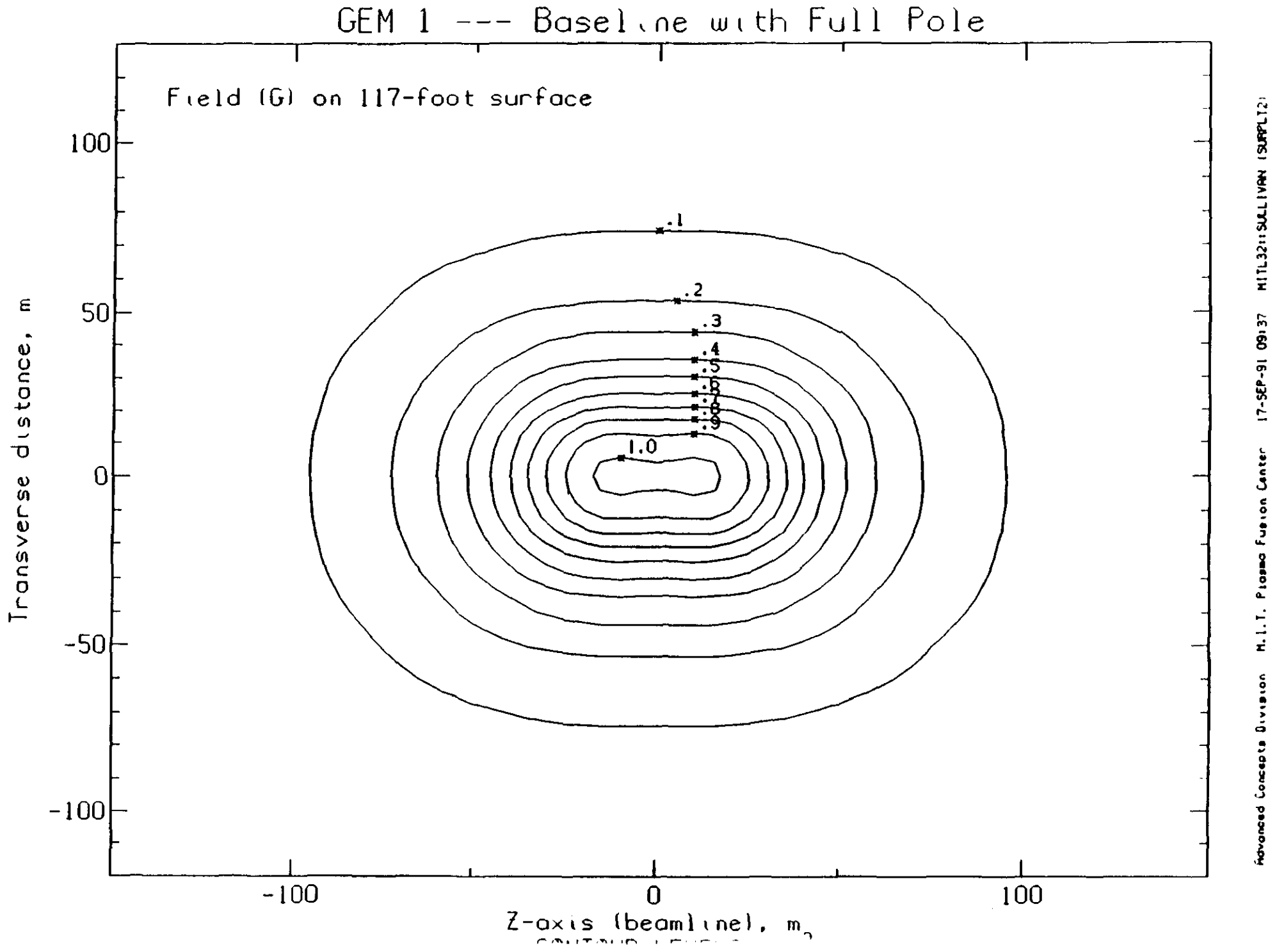
GEM 1 --- Baseline with Full Pole

MITMAP V1.0 8/29/91 11: 8

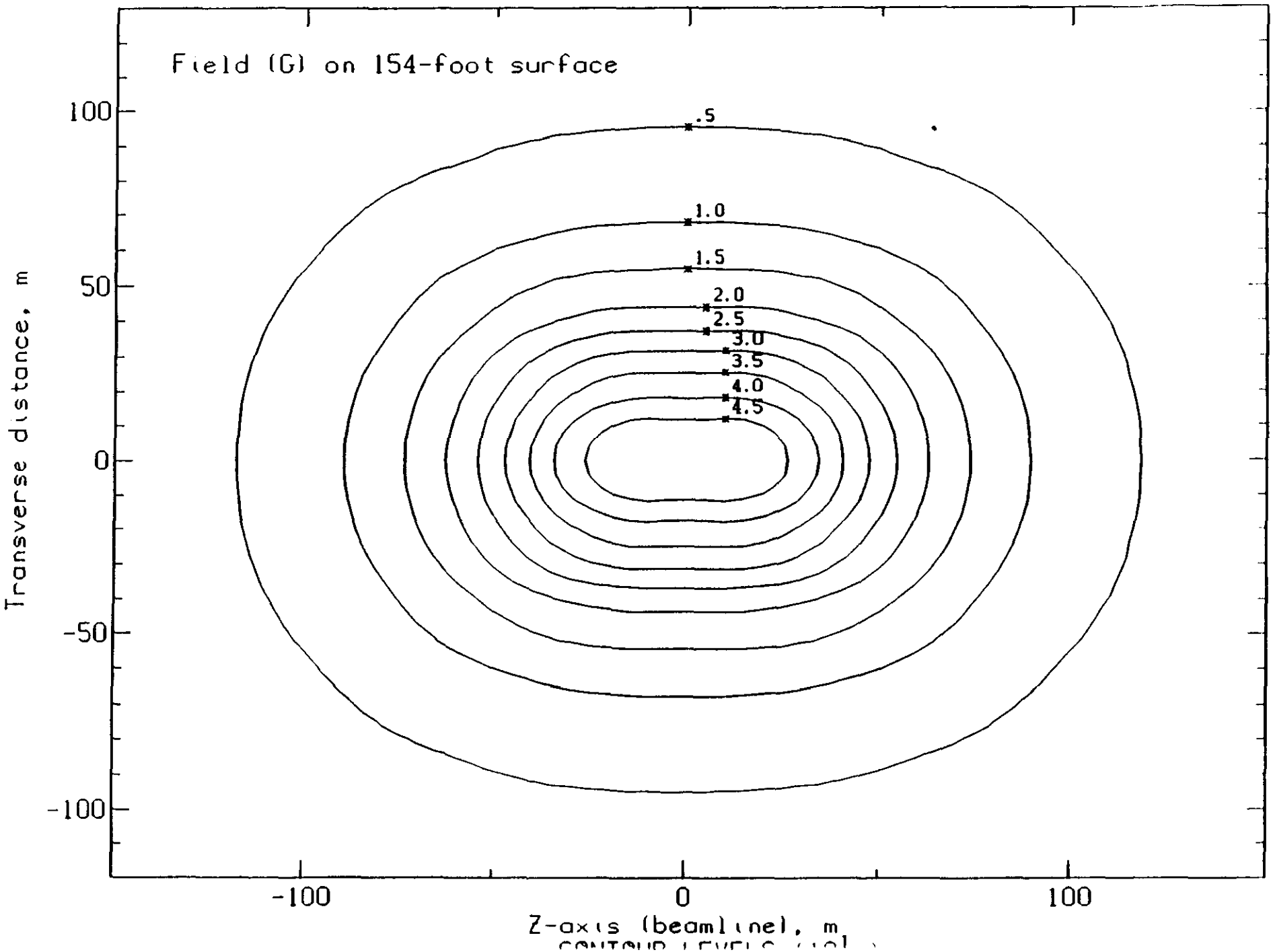
Contour 1 = 1.000E-01 Delta = 1.000E-01



CONTOURS OF CONSTANT B

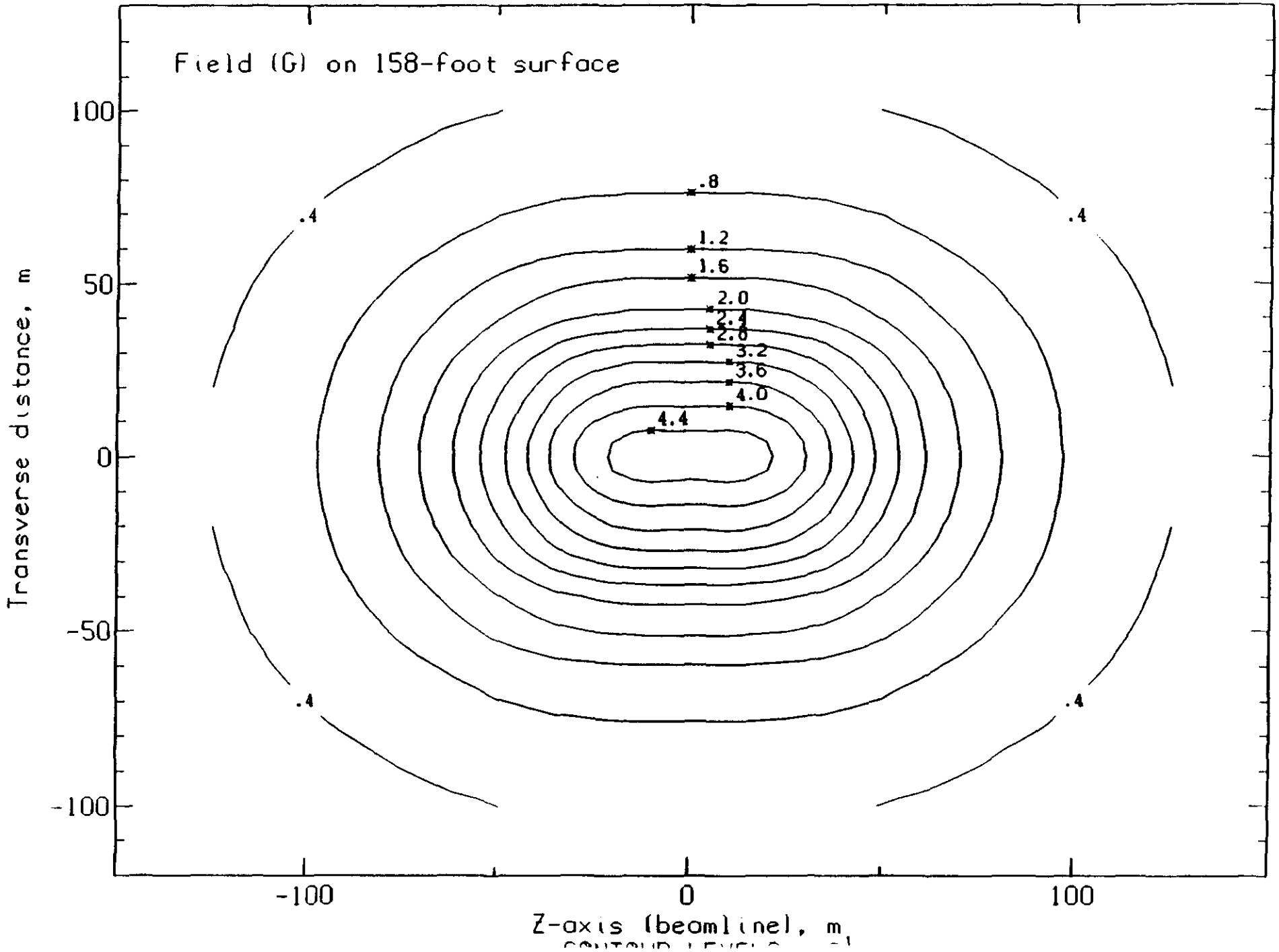

GEM 1 --- Baseline with Full Pole
Field (G) on 117-foot surface
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
100
50
0
-50
-100
Transverse distance, m
-100
0
100
Z-axis (beamline), m
Advanced Concepts Division M.I.T. Plasma Fusion Center 17-SEP-91 09:37 MITL32::SULLIVAN (SURPLT2)

GEM 1 --- Baseline with Full Pole

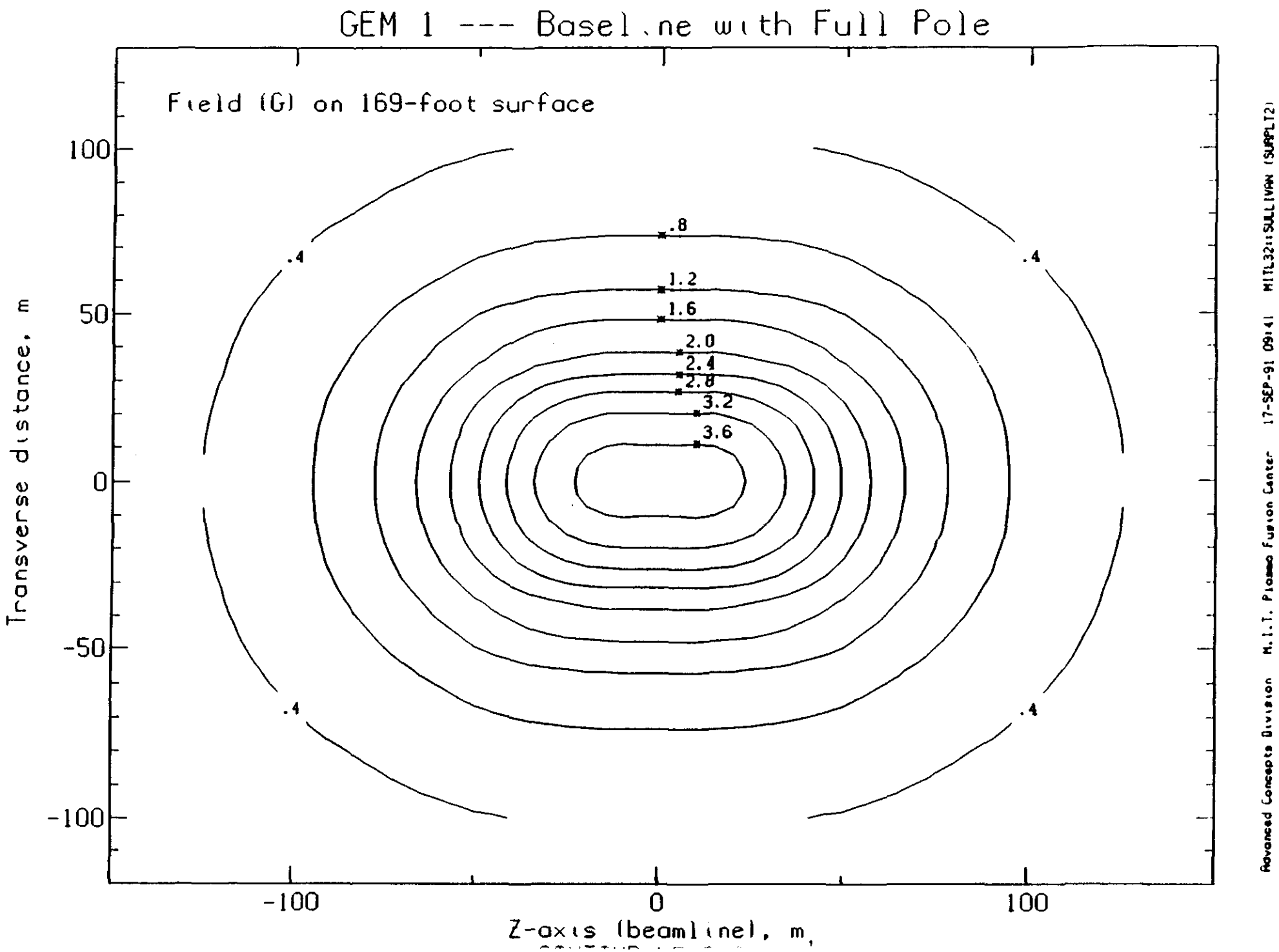


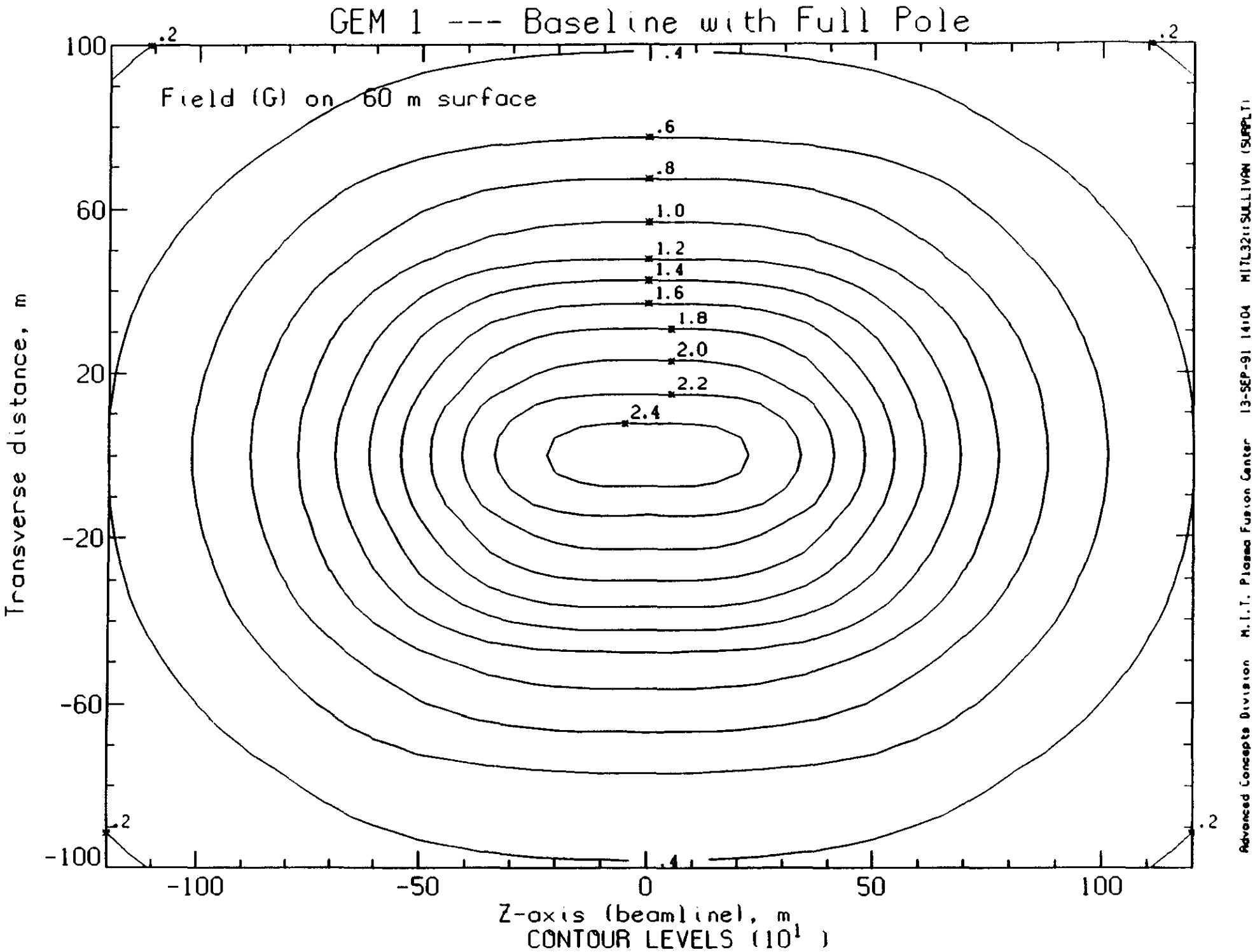
Advanced Concepts Division M.I.T. Plasma Fusion Center 17-SEP-91 09:34 MITL32::SULLIVAN (SURPLT2)

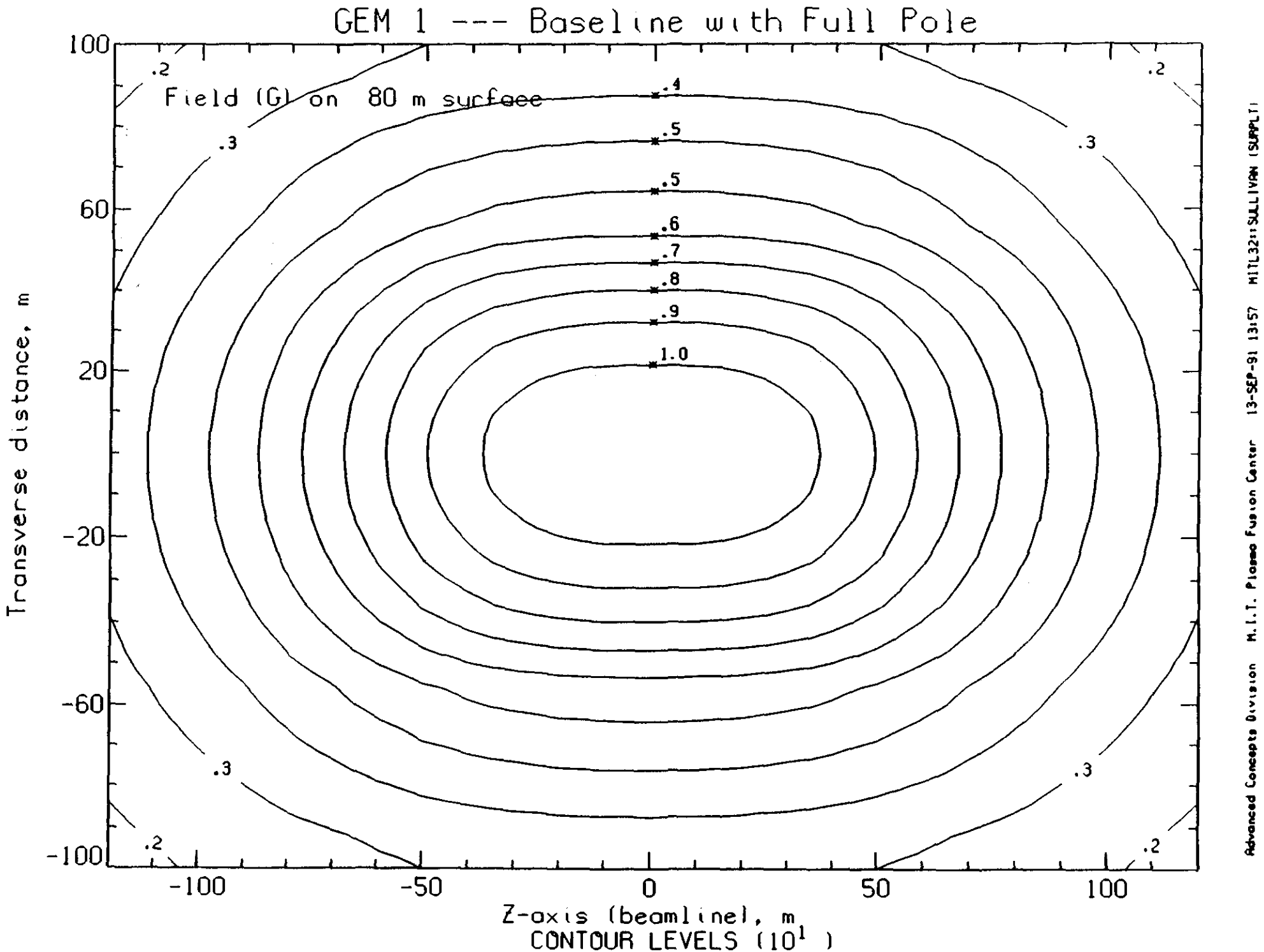
GEM 1 --- Baseline with Full Pole

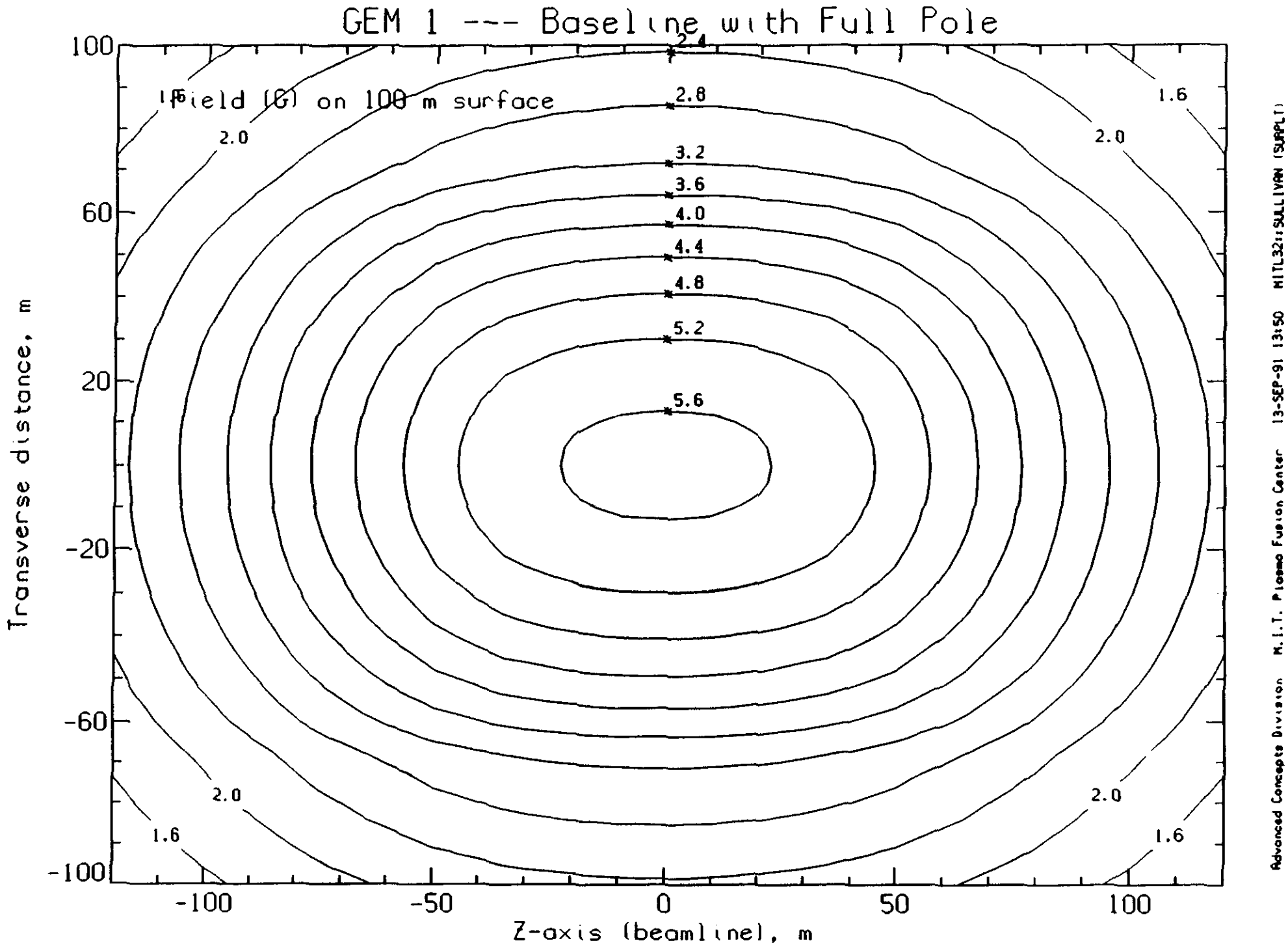


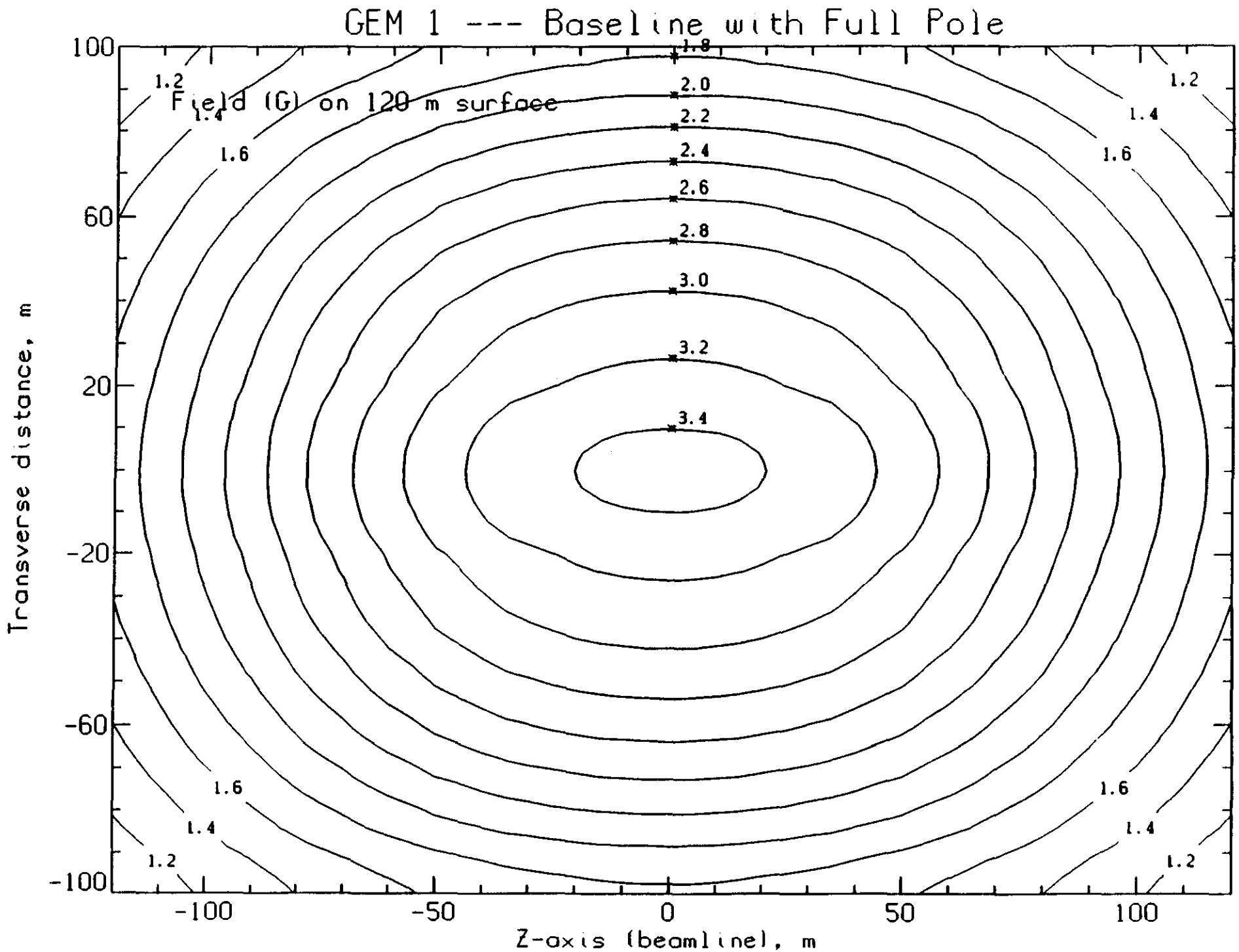
Advanced Concepts Division M.I.T. Plasma Fusion Center 17-SEP-91 09:45 HITL32::SULLIVAN (SURPLT2)


GEM 1 --- Baseline with Full Pole
Field (G) on 169-foot surface
.8
1.2
1.6
2.0
2.4
2.8
3.2
3.6
.4
.4
.4
.4
100
50
0
-50
-100
-100
0
100
Transverse distance, m
Z-axis (beamline), m
Advanced Concepts Division M.I.T. Plasma Fusion Center 17-SEP-91 09:41 MITL32::SULLIVAN (SUPPLT2)

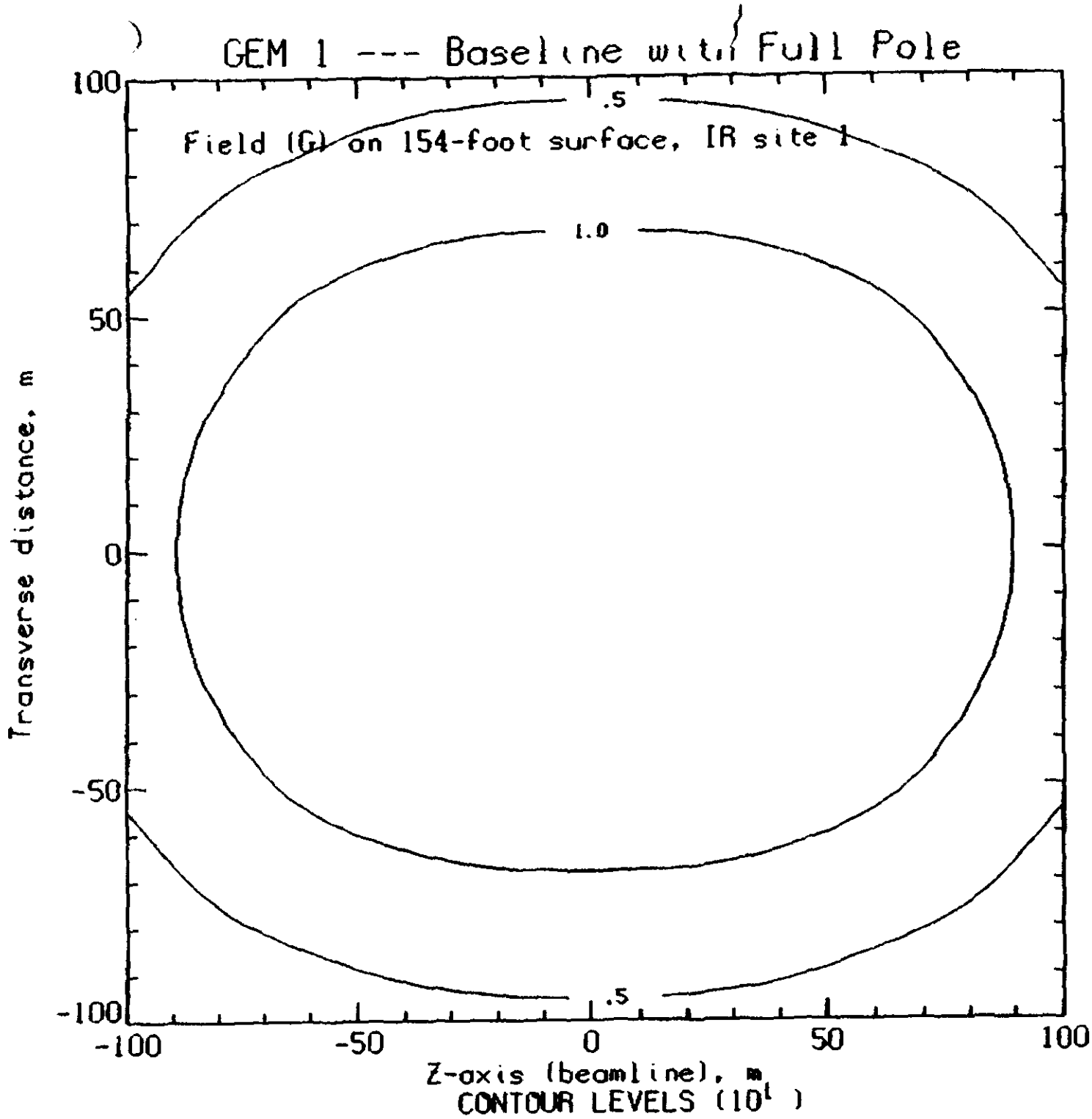

GEM 1 --- Baseline with Full Pole
Field (G) on 60 m surface
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
100
60
20
-20
-60
-100
-100
-50
0
50
100
Transverse distance, m
Z-axis (beamline), m
CONTOUR LEVELS (10^1)
Advanced Concepts Division M.I.T. Plasma Fusion Center 13-SEP-91 14:04 MITL32::SULLIVAN (SURPLT)

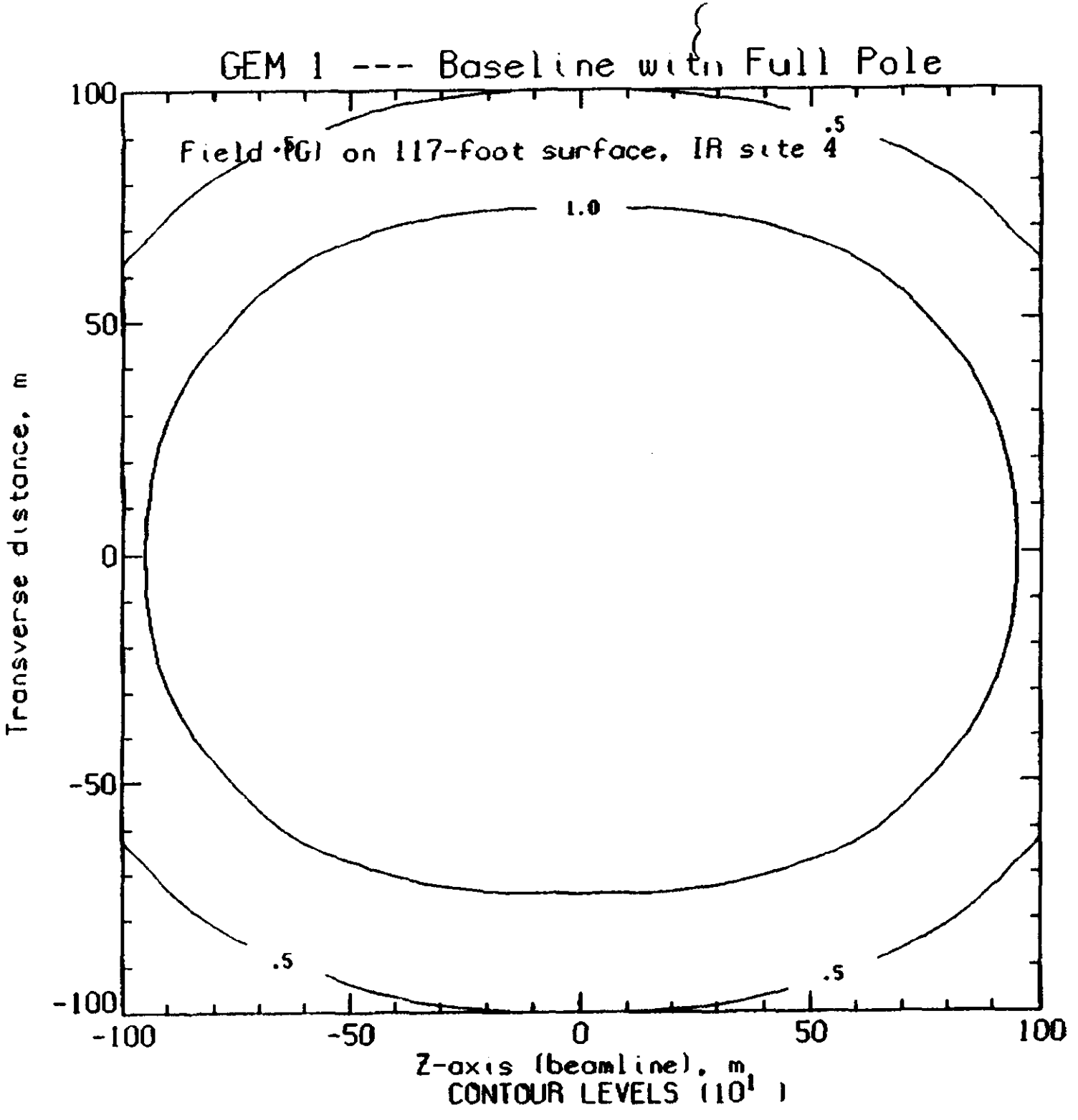

GEM 1 --- Baseline with Full Pole
Field (G) on 80 m surface
.2
.3
.4
.5
.5
.6
.7
.8
.9
1.0
.3
.2
100
60
20
-20
-60
-100
-100
-50
0
50
100
Transverse distance, m
Z-axis (beamline), m
CONTOUR LEVELS (10^1)
Advanced Concepts Division M.I.T. Plasma Fusion Center 13-SEP-91 13:57 HITL32::SULLIVAN (SURPLT)

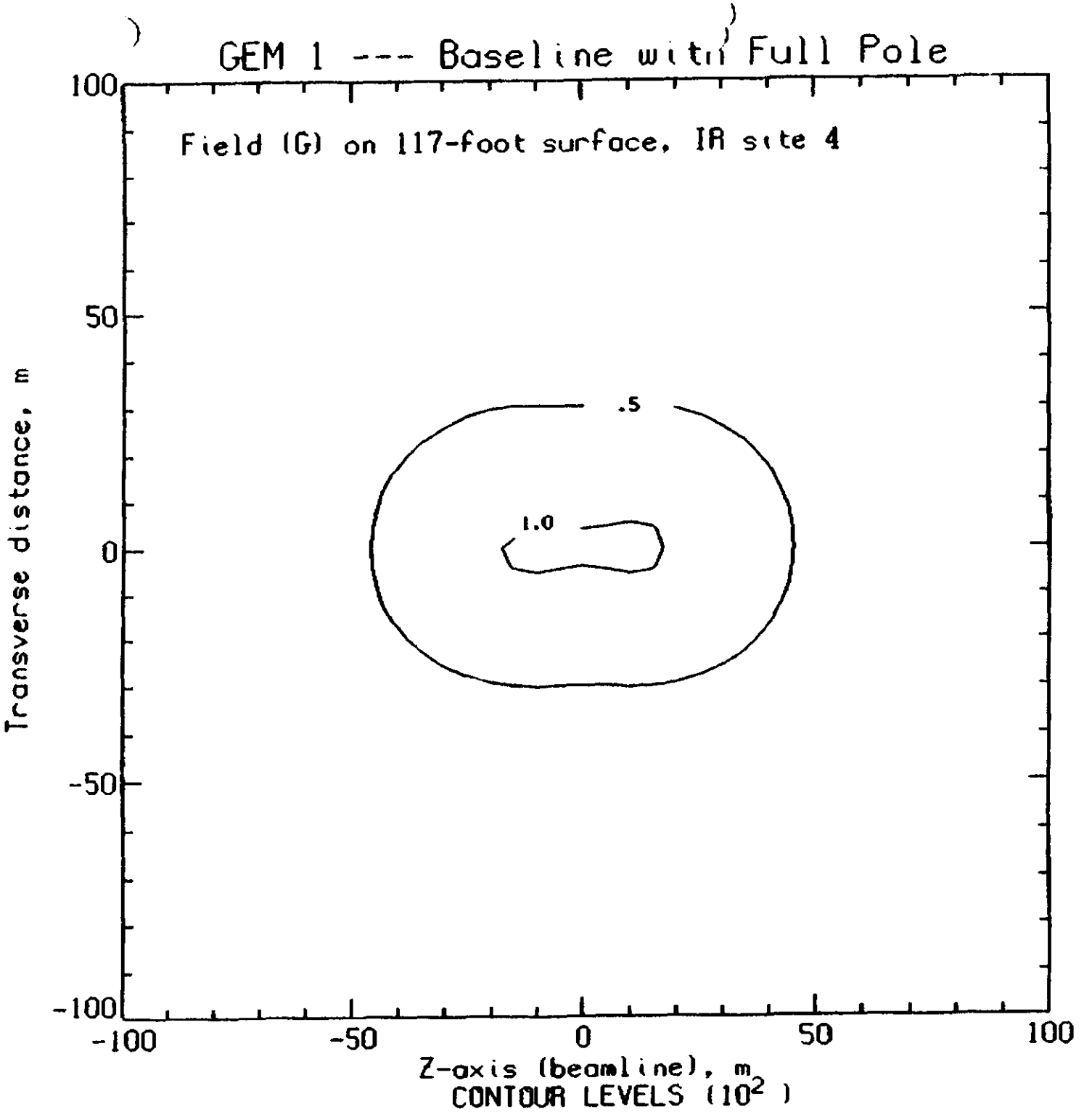

GEM 1 --- Baseline with Full Pole
Field (G) on 100 m surface
2.4
2.8
3.2
3.6
4.0
4.4
4.8
5.2
5.6
2.0
1.6
Transverse distance, m
Z-axis (beamline), m
100
60
20
-20
-60
-100
-100
-50
0
50
100
Advanced Concepts Division M.I.T. Plasma Fusion Center 13-SEP-91 13:50 MITL32::SULLIVAN (SURPLT)

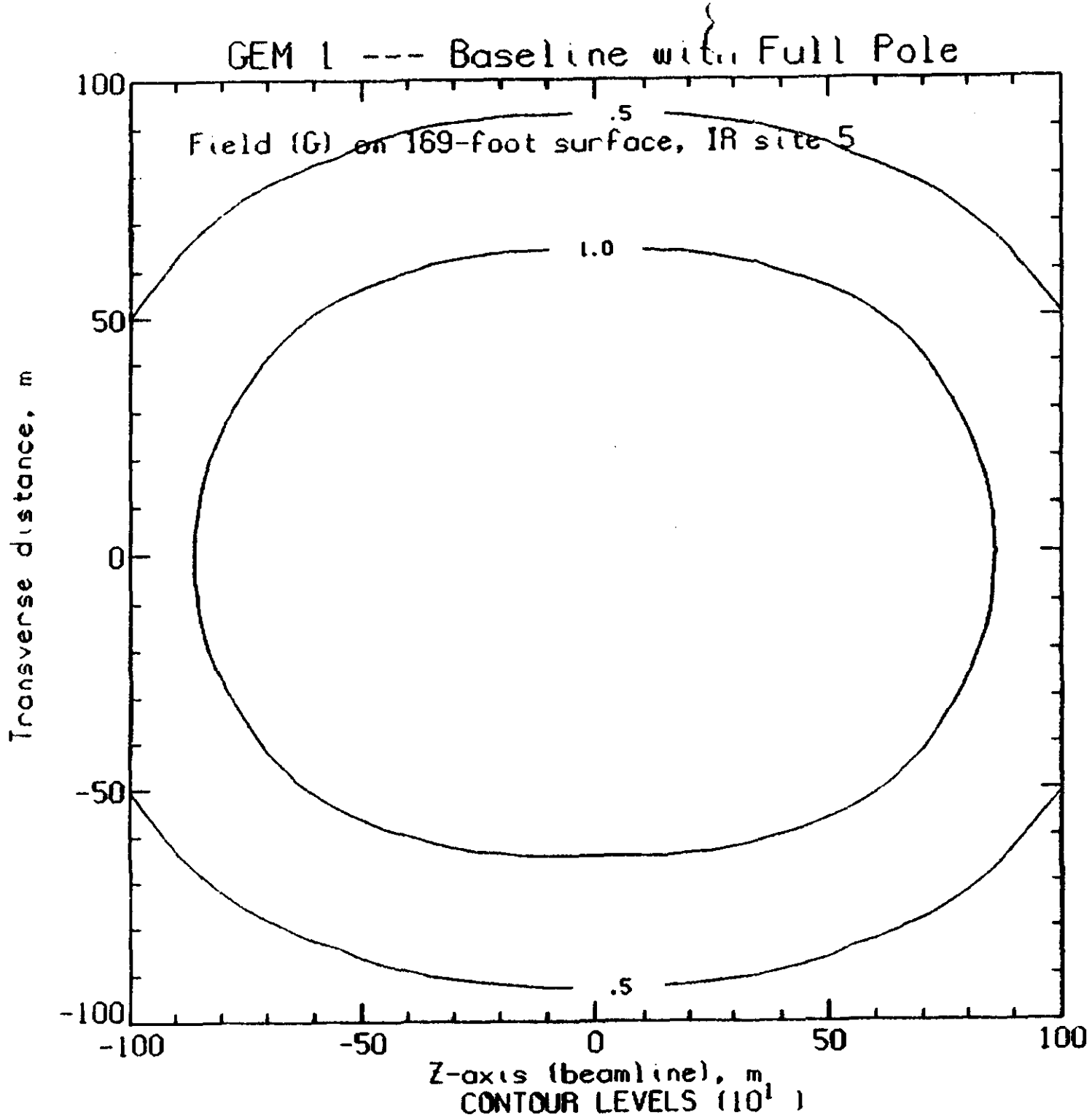


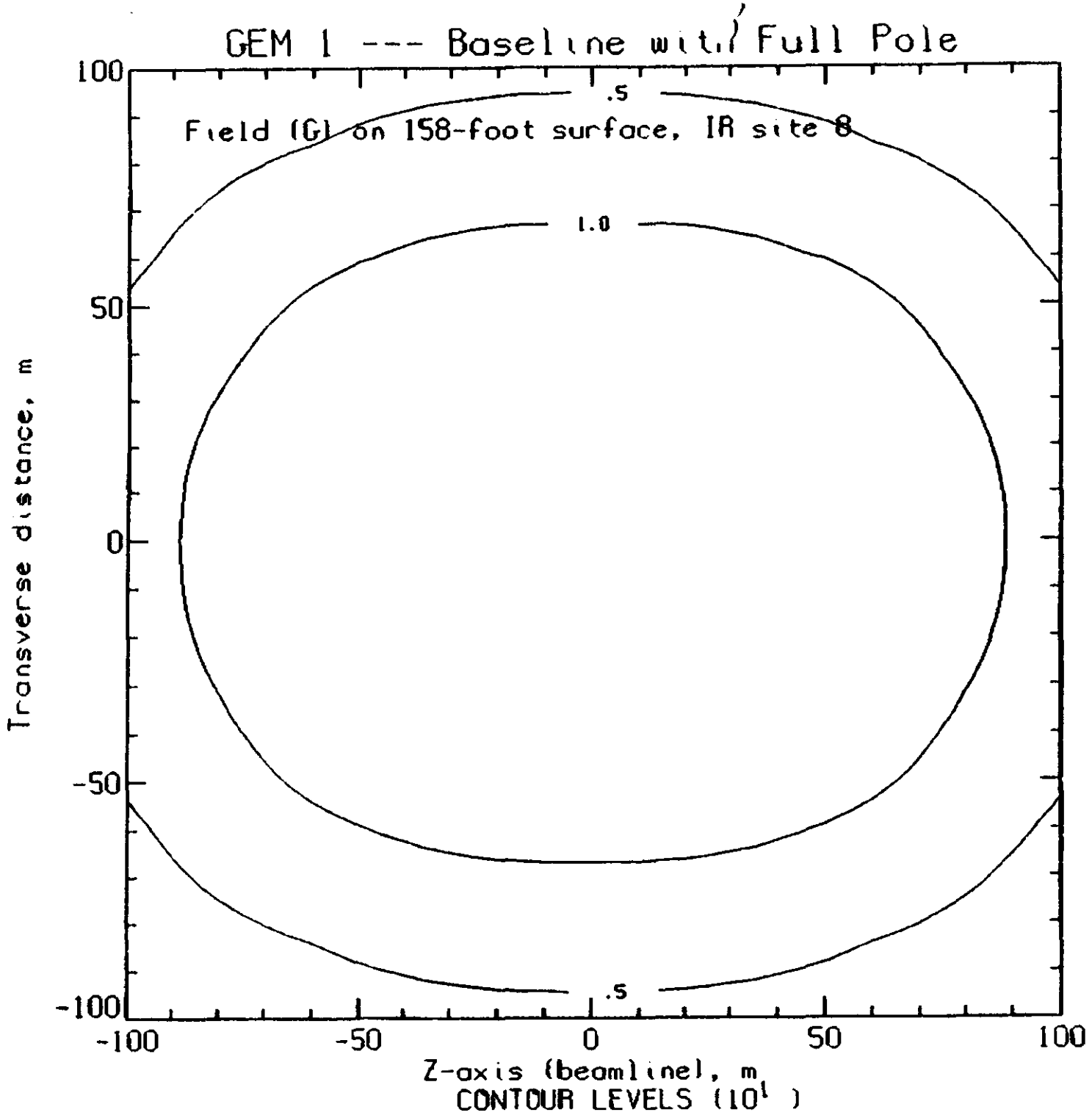
Advanced Concepts Division M.I.T. Plasma Fusion Center 13-SEP-91 13:37 MITL32::SULLIVAN (SURPLT)


GEM 1 --- Baseline with Full Pole
Field (G) on 154-foot surface, IR site 1
.5
1.0
.5
100
50
0
-50
-100
-100
-50
0
50
100
Transverse distance, m
Z-axis (beamline), m
CONTOUR LEVELS (10^t)


GEM 1 --- Baseline with Full Pole
Field |G| on 117-foot surface, IR site 4
.5
1.0
.5
.5
100
50
0
-50
-100
-100
-50
0
50
100
Transverse distance, m
Z-axis (beamline), m
CONTOUR LEVELS (10^1)


GEM 1 --- Baseline with Full Pole
Field (G) on 117-foot surface, IR site 4
.5
1.0
100
50
0
-50
-100
-100
-50
0
50
100
Transverse distance, m
Z-axis (beamline), m
CONTOUR LEVELS (10^2)


GEM 1 --- Baseline with Full Pole
Field (G) on 169-foot surface, IR site 5
.5
1.0
.5
100
50
0
-50
-100
-100
-50
0
50
100
Transverse distance, m
Z-axis (beamline), m
CONTOUR LEVELS (10^1)


GEM 1 --- Baseline with Full Pole
Field (G) on 158-foot surface, IR site 8
.5
1.0
.5
100
50
0
-50
-100
-100
-50
0
50
100
Transverse distance, m
Z-axis (beamline), m
CONTOUR LEVELS (10¹)

GEM Magnet Subsystem

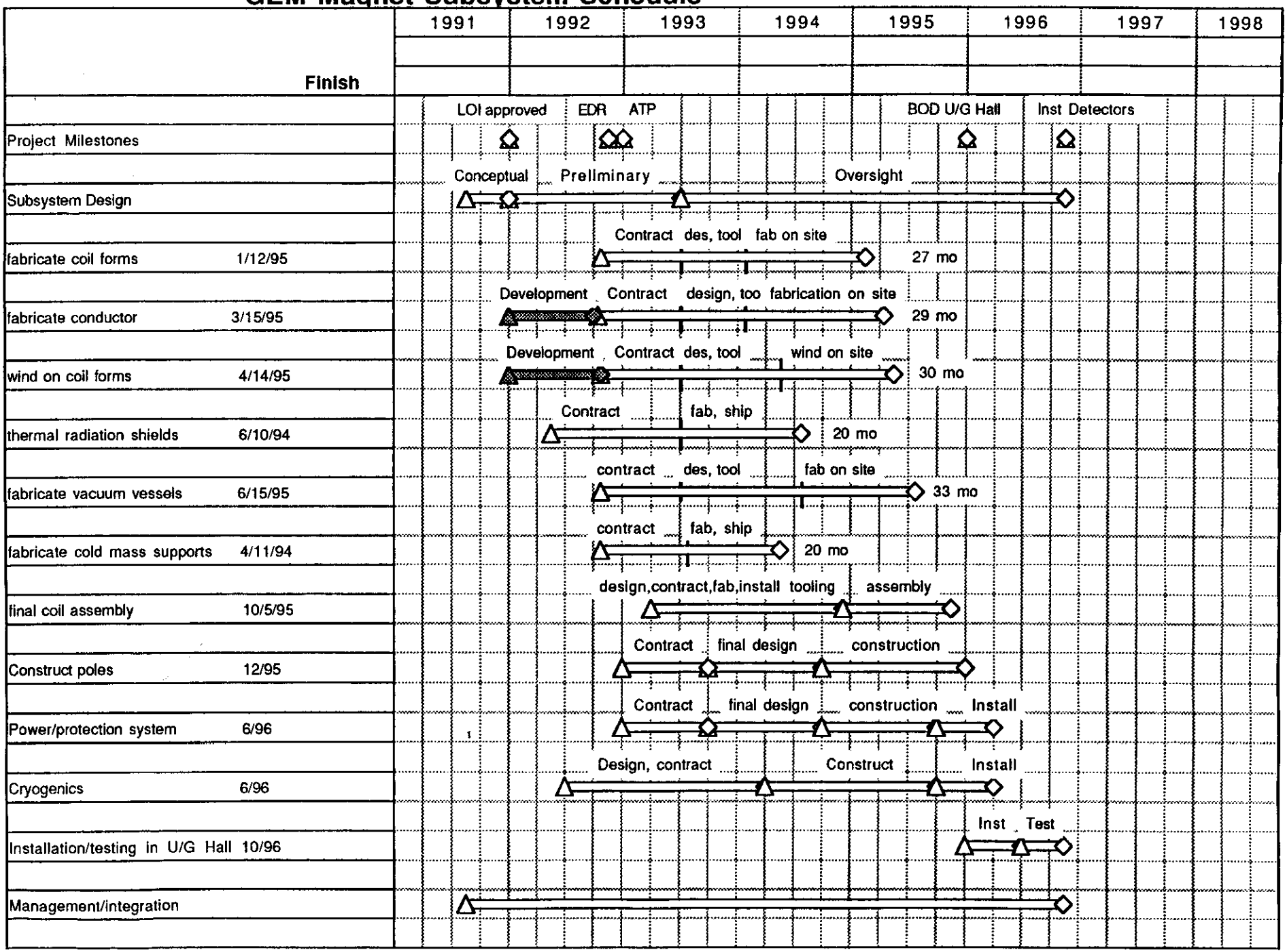
Cost Profile

Gary Deis, LLNL and Peter Marston, MIT/PFC

GEM Magnet Technical Panel Meeting
25-26 September, 1991

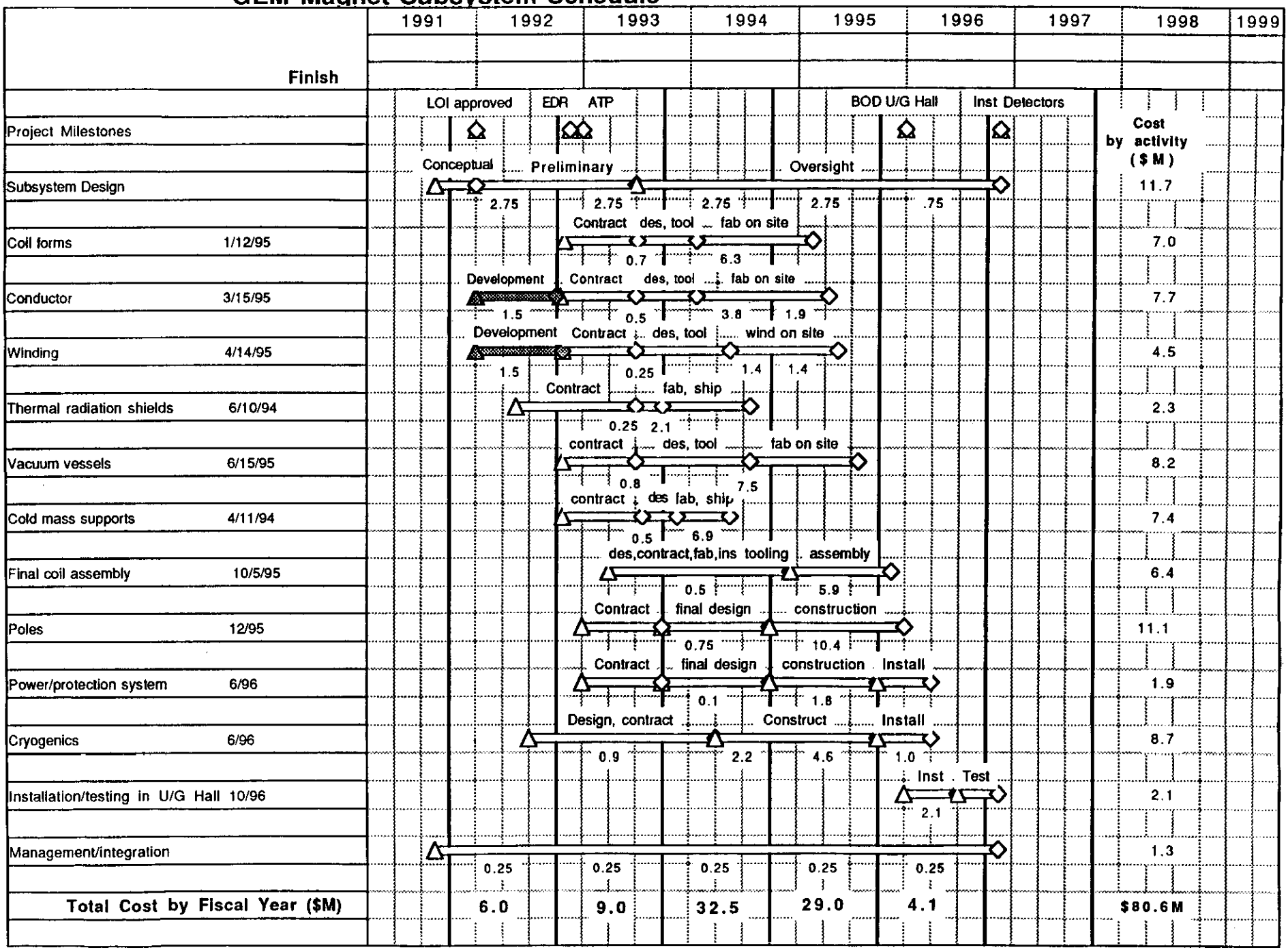
gdxxxxxx-8
9/24/91

GEM Magnet Subsystem Schedule



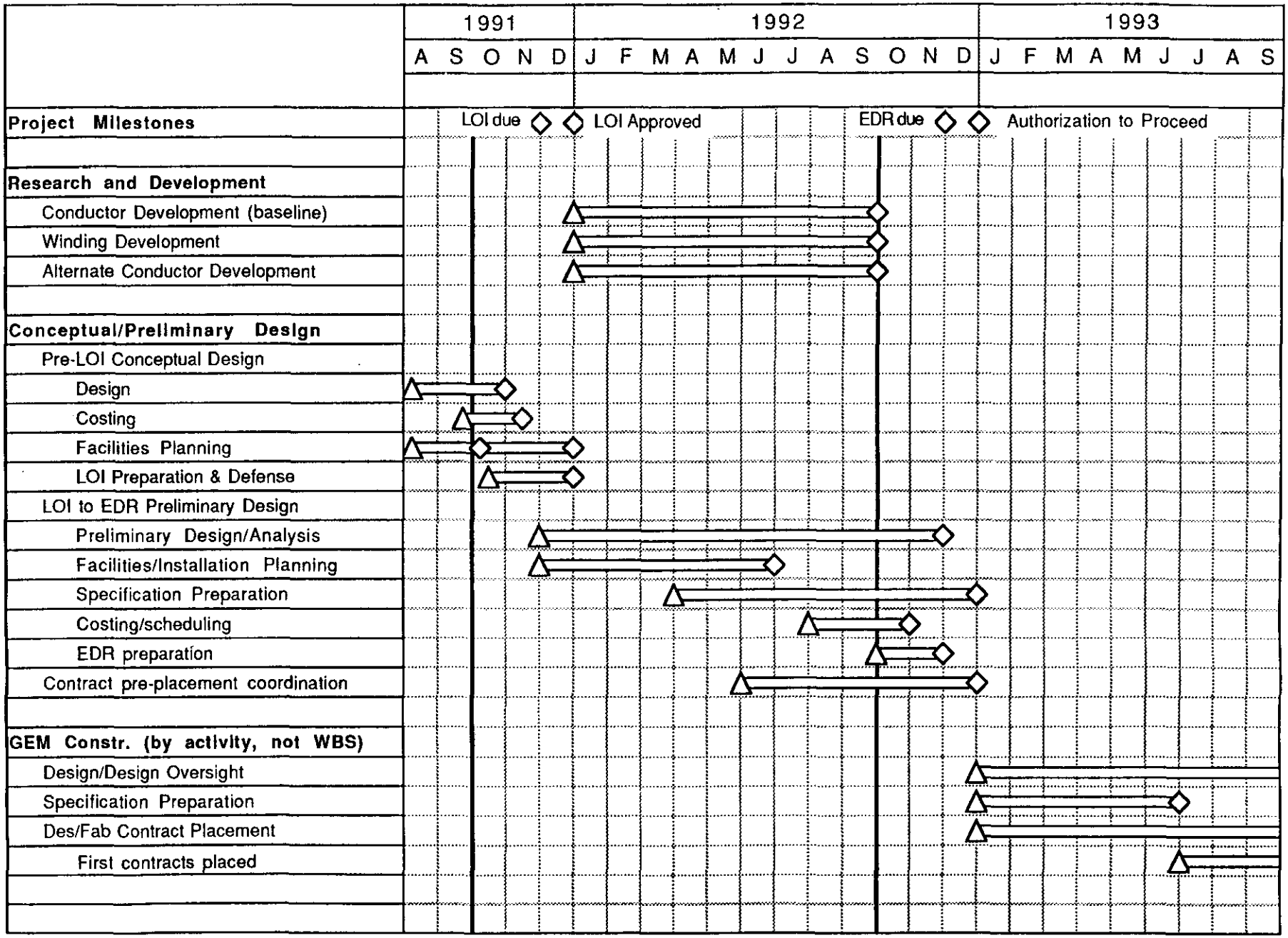
Sunday, September 22, 1991

GEM Magnet Subsystem Schedule

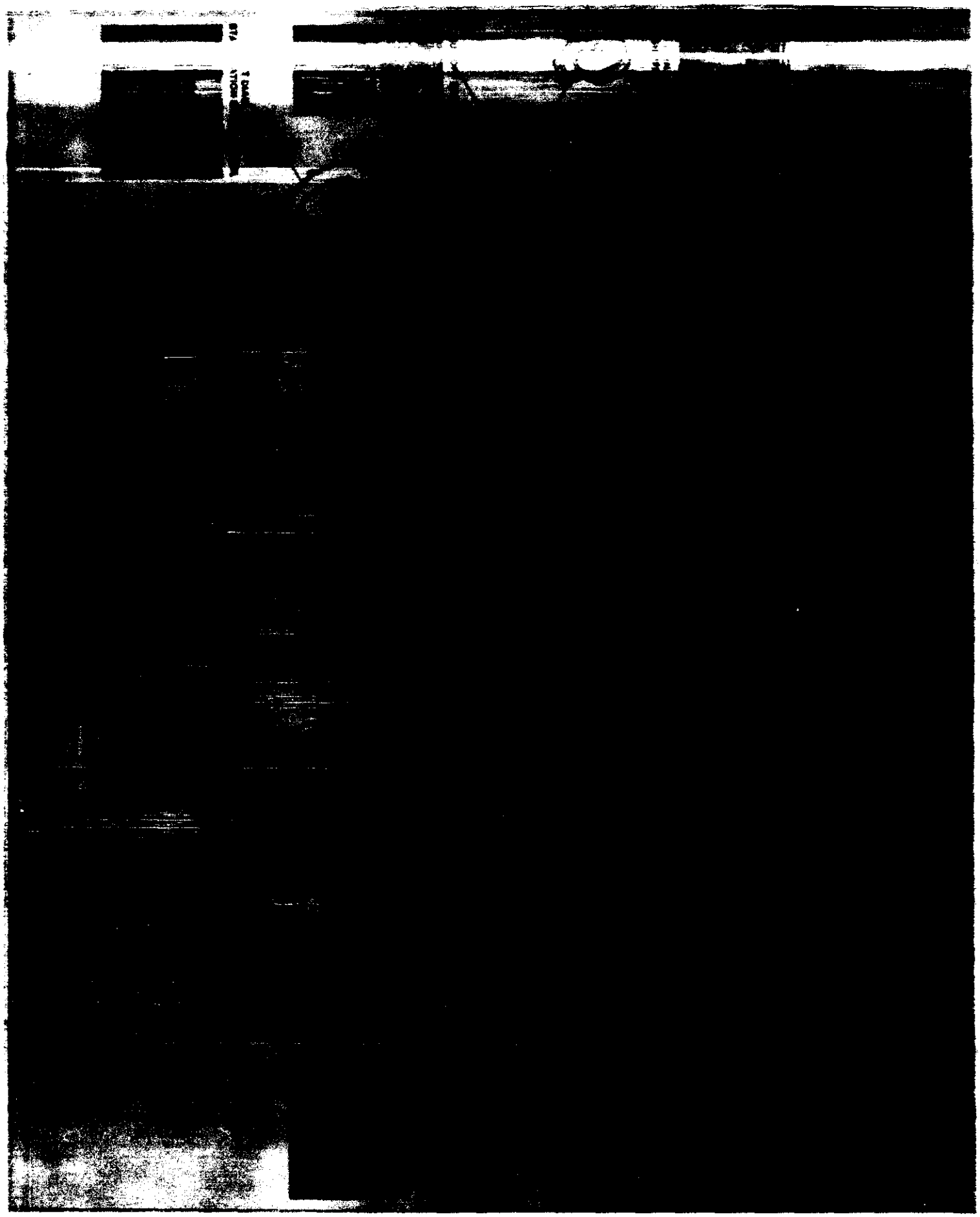


Sunday, September 22, 1991

Gem Magnet Subsystem - Near-term Schedule



Sunday, September 22, 1991



GEM Magnet Manufacturing Scheme

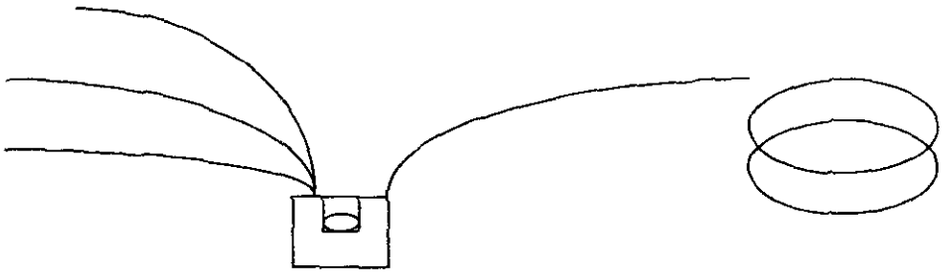
- Conceptual Design leading to LOI submittal
- Preliminary Design leading to Technical Proposal

  — bring design to level necessary to specify top level components (coils, vacuum vessels, etc.)

  — perform necessary R&D (i.e., conductor fab, joining)

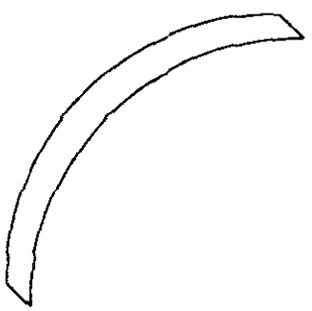
  — prepare specifications for design and fabricate contracts

- Bid and Award contracts
- Industrial Contractors design, fabricate, and install necessary tooling on site
- Contractors pre-fabricate large parts for sub-assemblies at plants
- Contractors put together large sub-assemblies on site
- Sub-assemblies are integrated into final coil half assemblies
- Coil half assemblies lowered into Hall, integrated with membrane

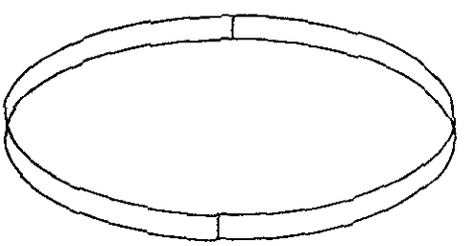


Fabricate conductor

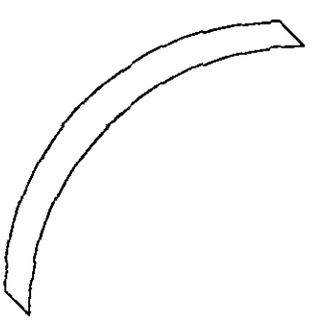
store on transfer spools
24@ with 1 km on each,
2 km per mo



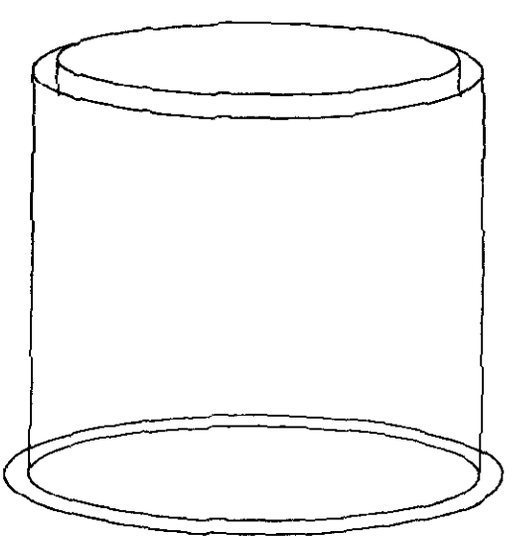
Receive Coil Form
pre-fabed parts



Join parts to form Coil Forms
at 2@ Stations, 2 per mo



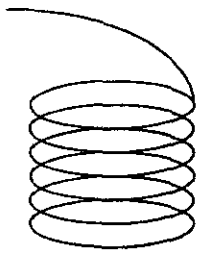
Receive Vacuum Vessel
pre-fabed parts



Join parts to form 2@ Vacuum
Vessel sub-assemblies

Wind

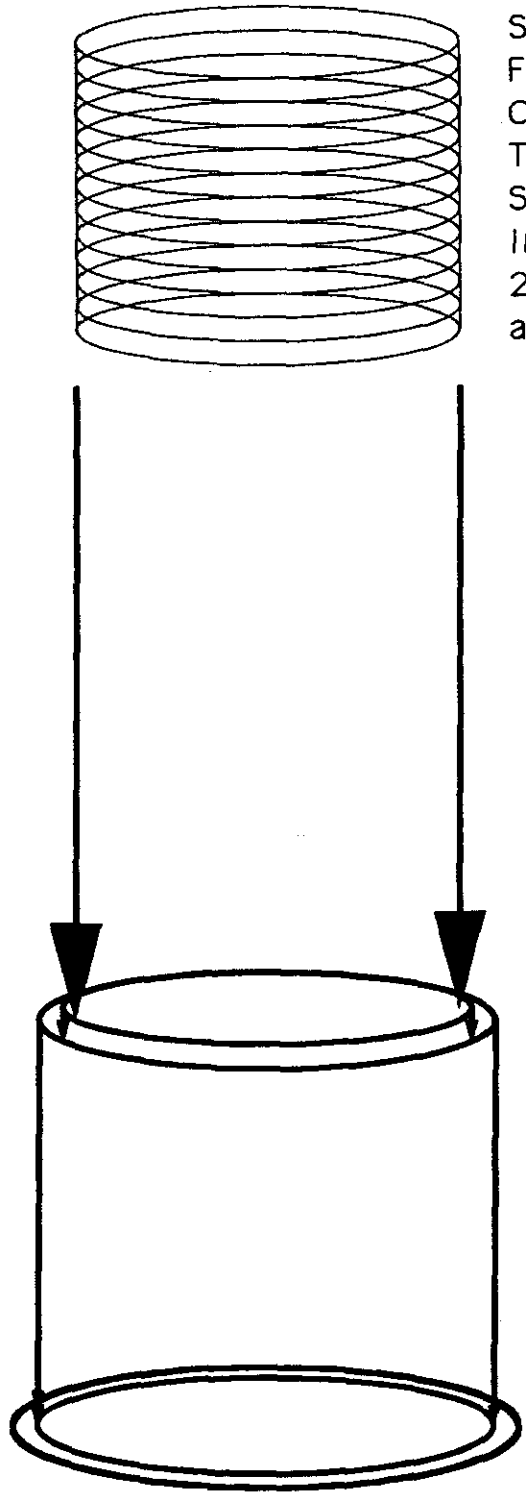
Conductor



Into

Coil Forms,

24 @

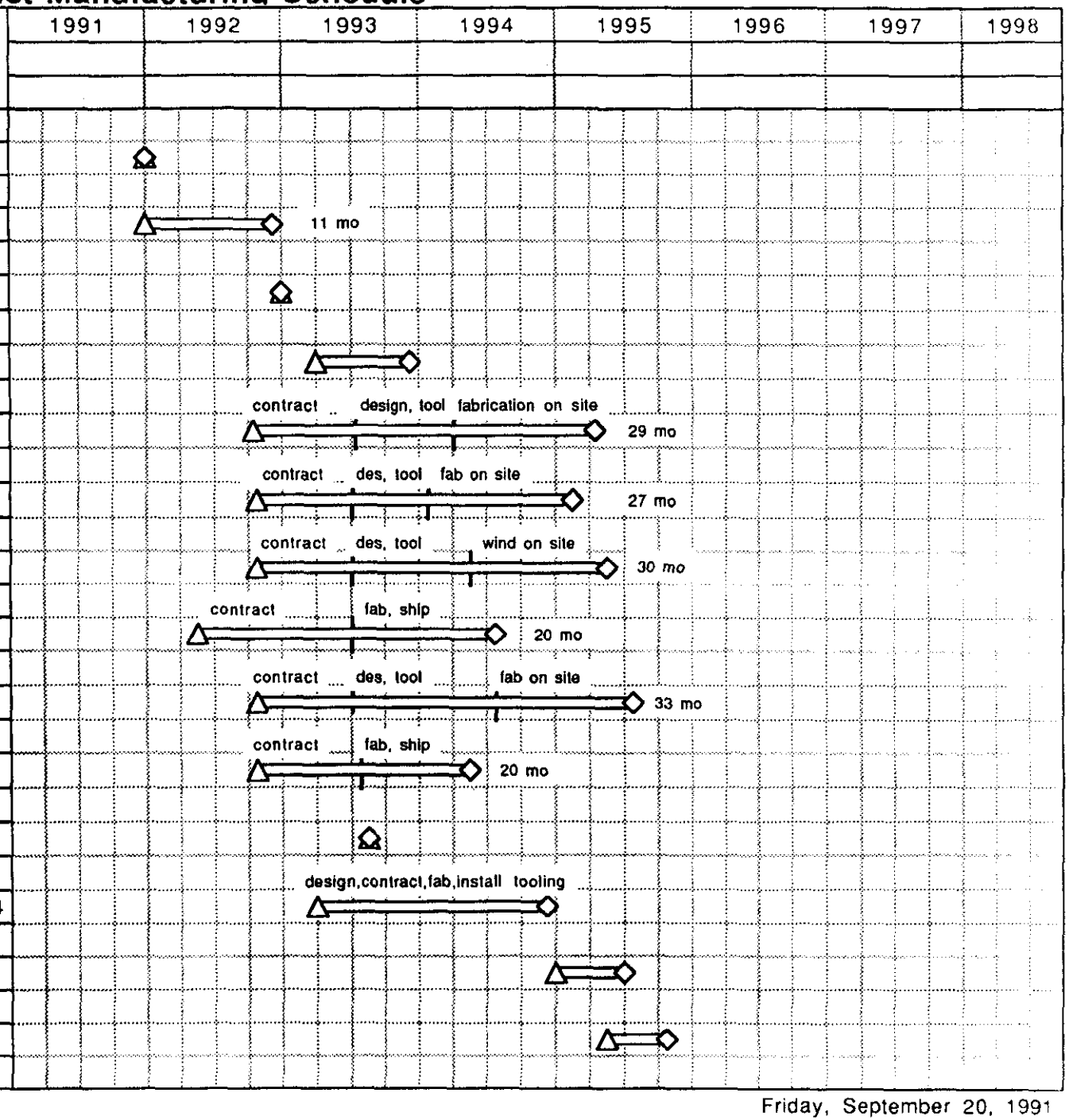


Stack 12 Coil Forms, integrate Cold Mass Supports Thermal Radiation Shields, Super Insulation, etc, at 2 different assembly stations

Integrate Coil Form Sub-assemblies with Vacuum Vessel Sub-assemblies, add End Flange, complete assembly, perform Above Ground Tests, ready.

GEM Magnet Manufacturing Schedule

	Finish
LOI Approved	1/1/92
tech proposal design	12/3/93
ATP	1/4/93
temporary facilities avail	12/8/93
fabricate conductor	3/15/95
fabricate coil forms	1/12/95
wind on coil forms	4/14/95
thermal radiation shields	6/10/94
fabricate vacuum vessels	6/15/95
fabricate cold mass supports	4/11/94
BOD Coil Manufacturing Bldg	11/1/93
final assembly station	12/13/94
assemble first magnet half	6/4/95
assemble second magnet half	10/5/95



Friday, September 20, 1991

GEM Magnet Subsystem

September Progress at LLNL

Gary Deis, LLNL

GEM Engineering Meeting
24 September, 1991

Gem Magnet Design/September Progress

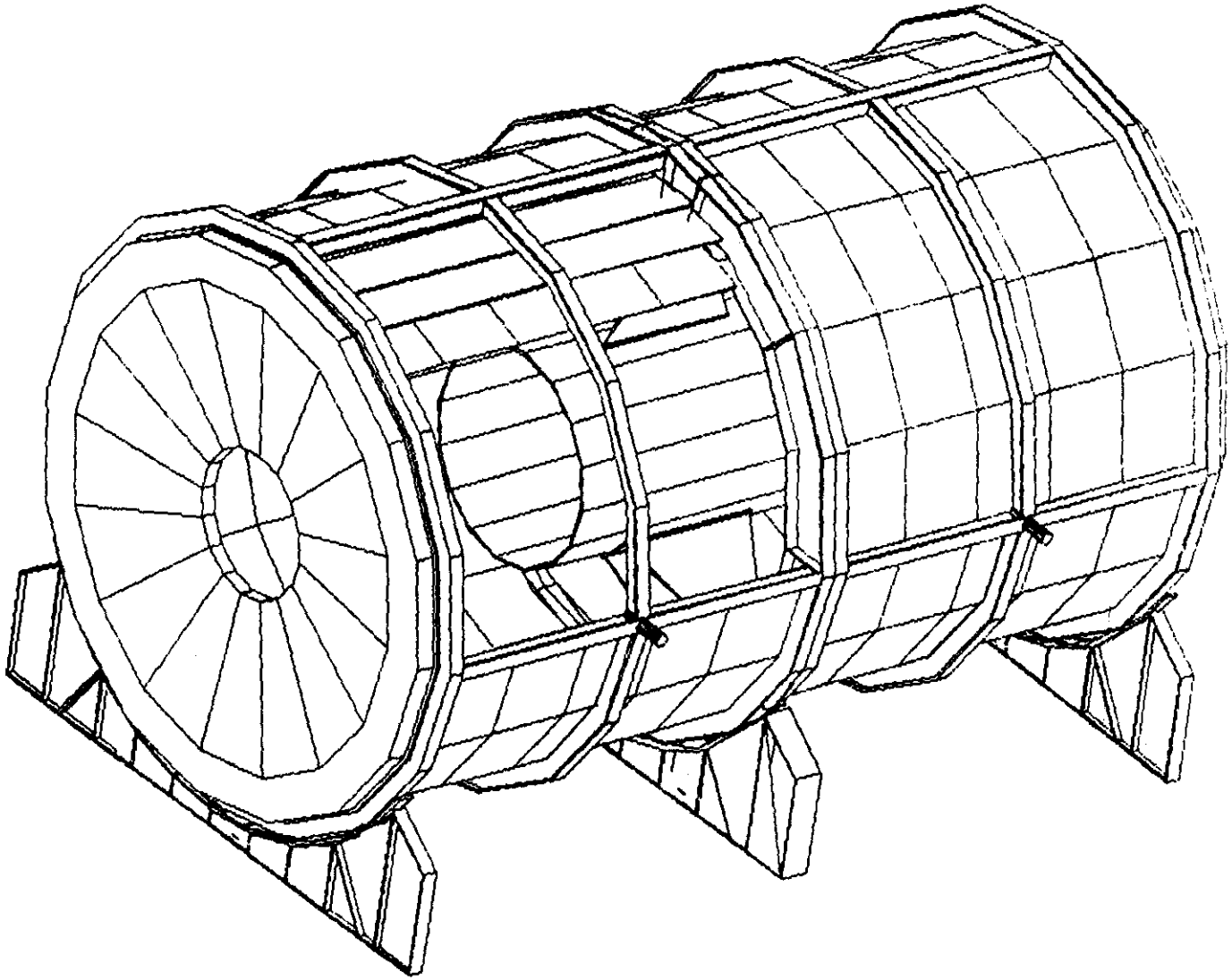
Summary

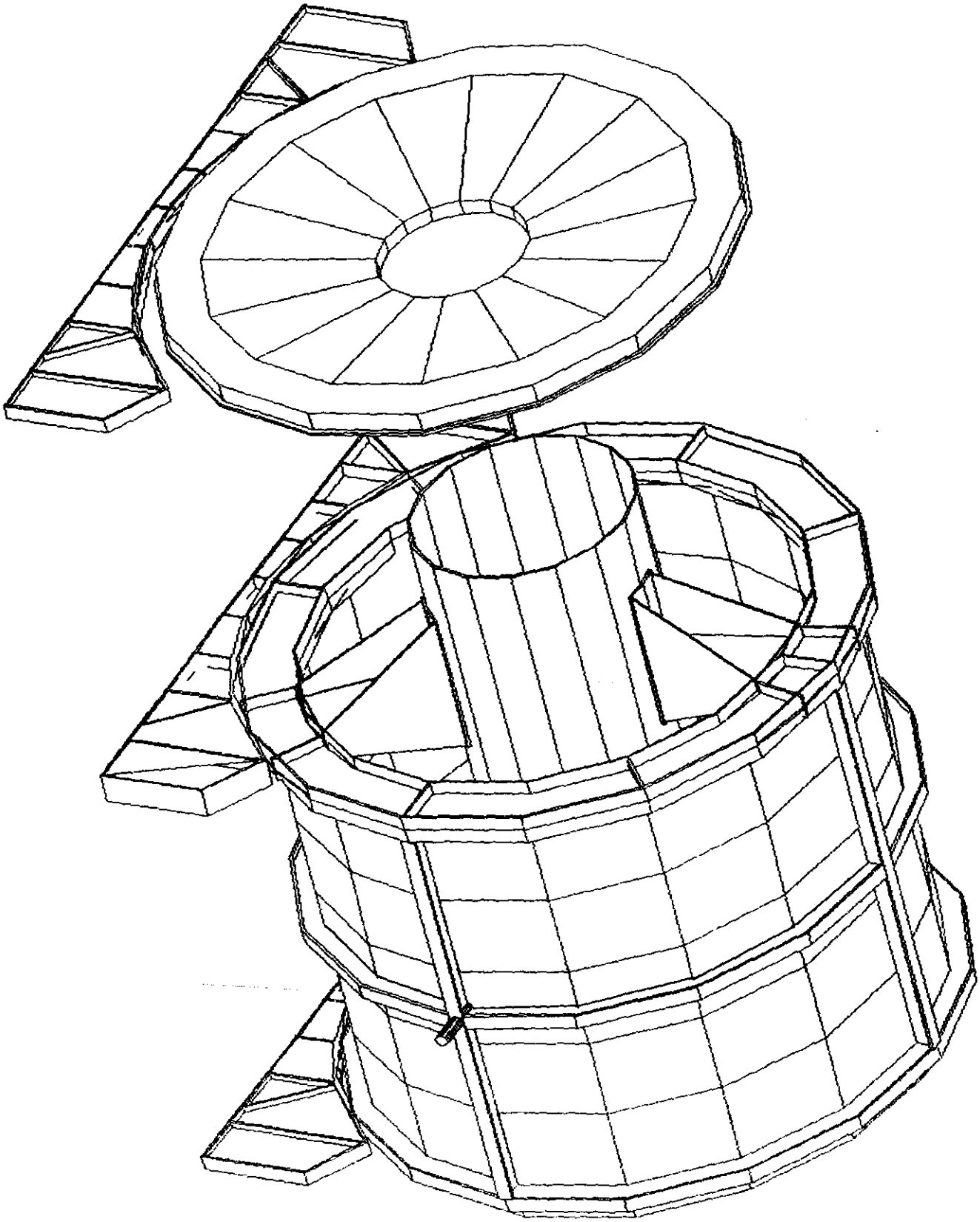
- Ready for "LOI-design" freeze on vacuum vessels, saddles, cold-mass supports. Detail dwgs, cost estimates in progress
- Design of conductor, bobbin, coil winding, etc, on "front-burner" this week.
- Conceptual designs and costing for power/protection and cryogenics is in progress

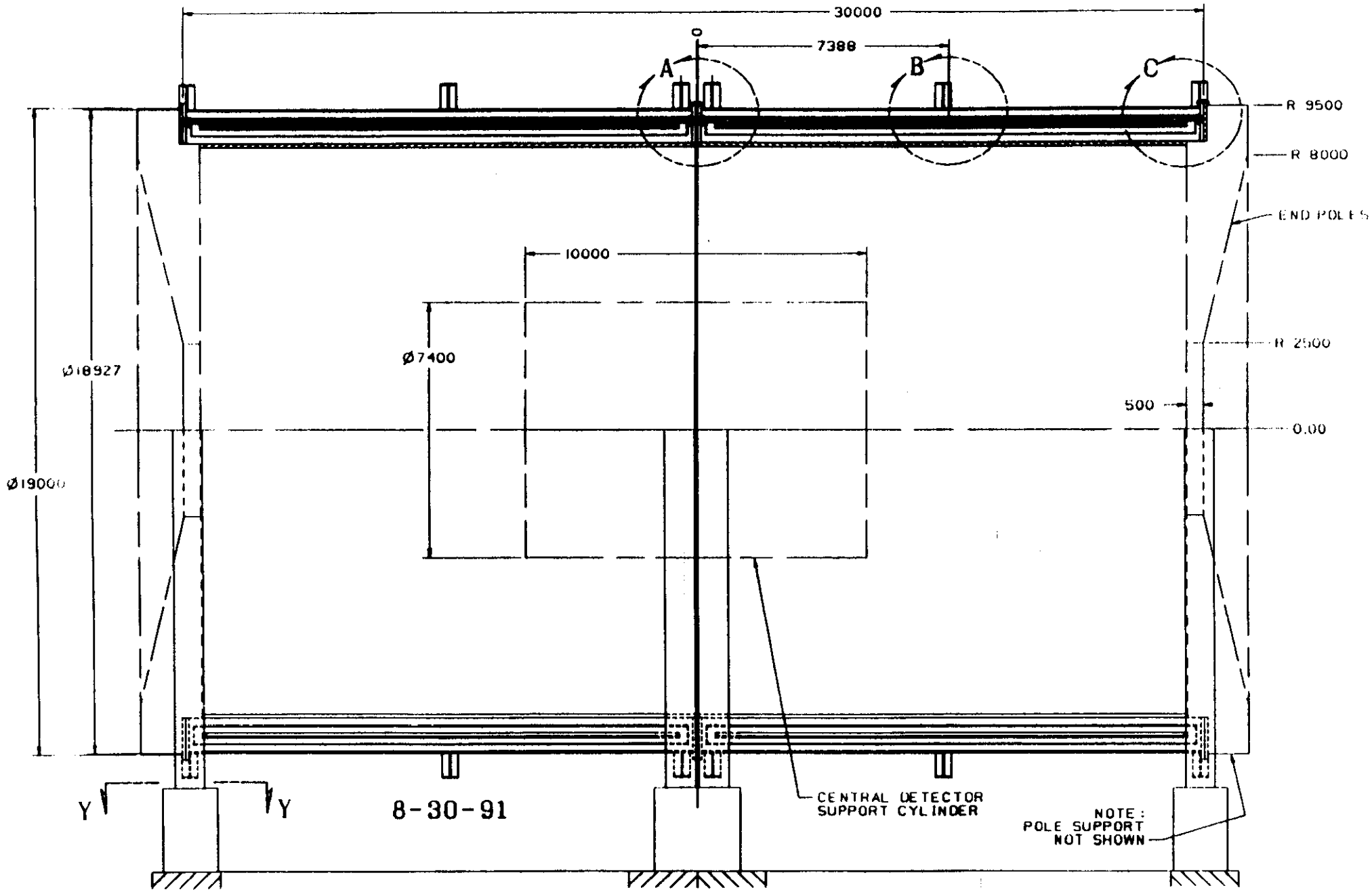
- *WBS revised slightly, first-draft of dictionary completed.* Most costing responsibilities assigned

Most important work:

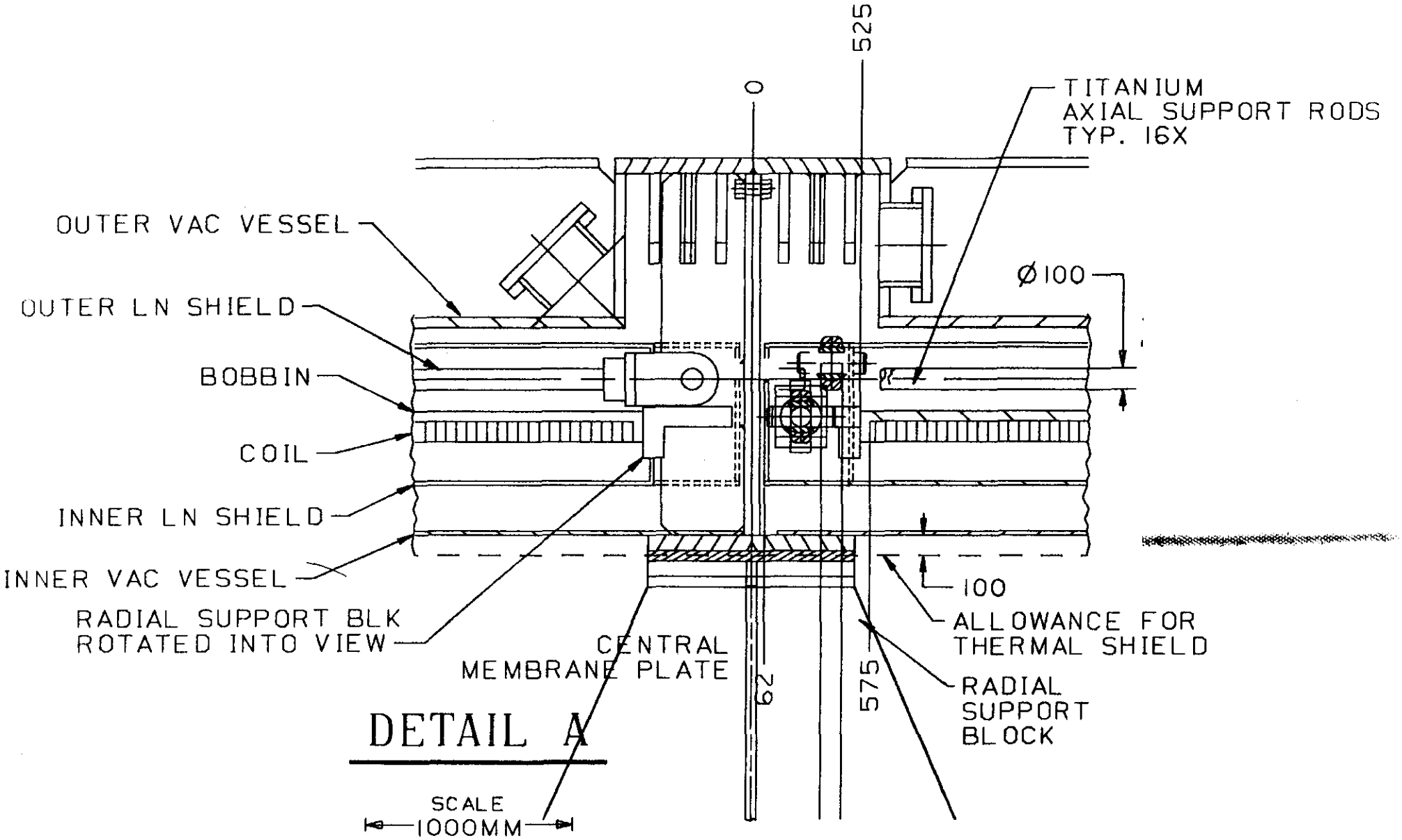
- *SIGNIFICANT vendor contacts this month*





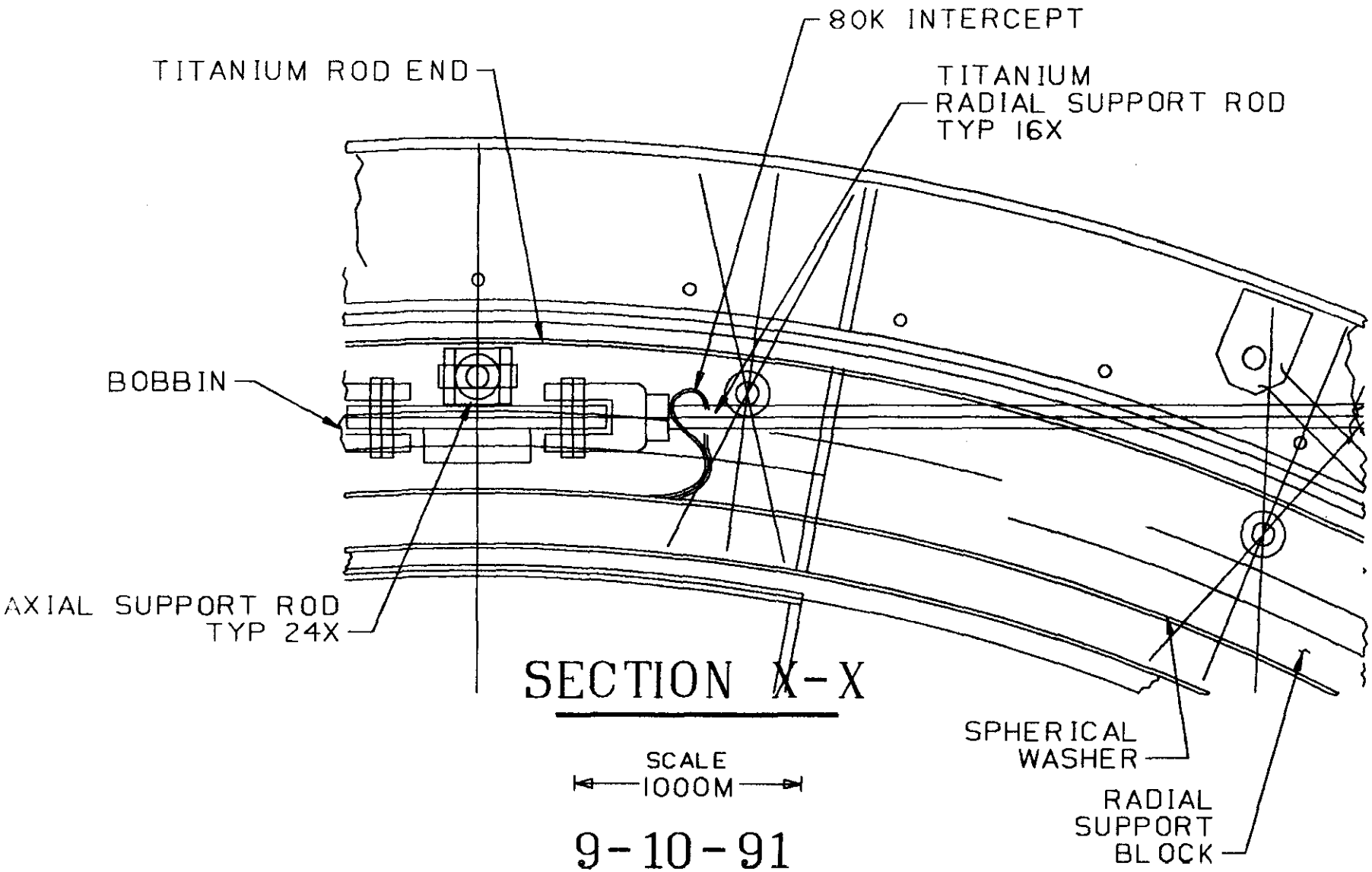

30000
7388
A
B
C
R 9500
R 8000
END POLES
10000
Ø7400
R 2500
Ø18927
500
0.00
Ø19000
Y
Y
8-30-91
CENTRAL DETECTOR
SUPPORT CYLINDER
NOTE:
POLE SUPPORT
NOT SHOWN

29
38
38.1
29
5059
8-30-91
19327
18927
20427
1698



DETAIL A

9-10-91

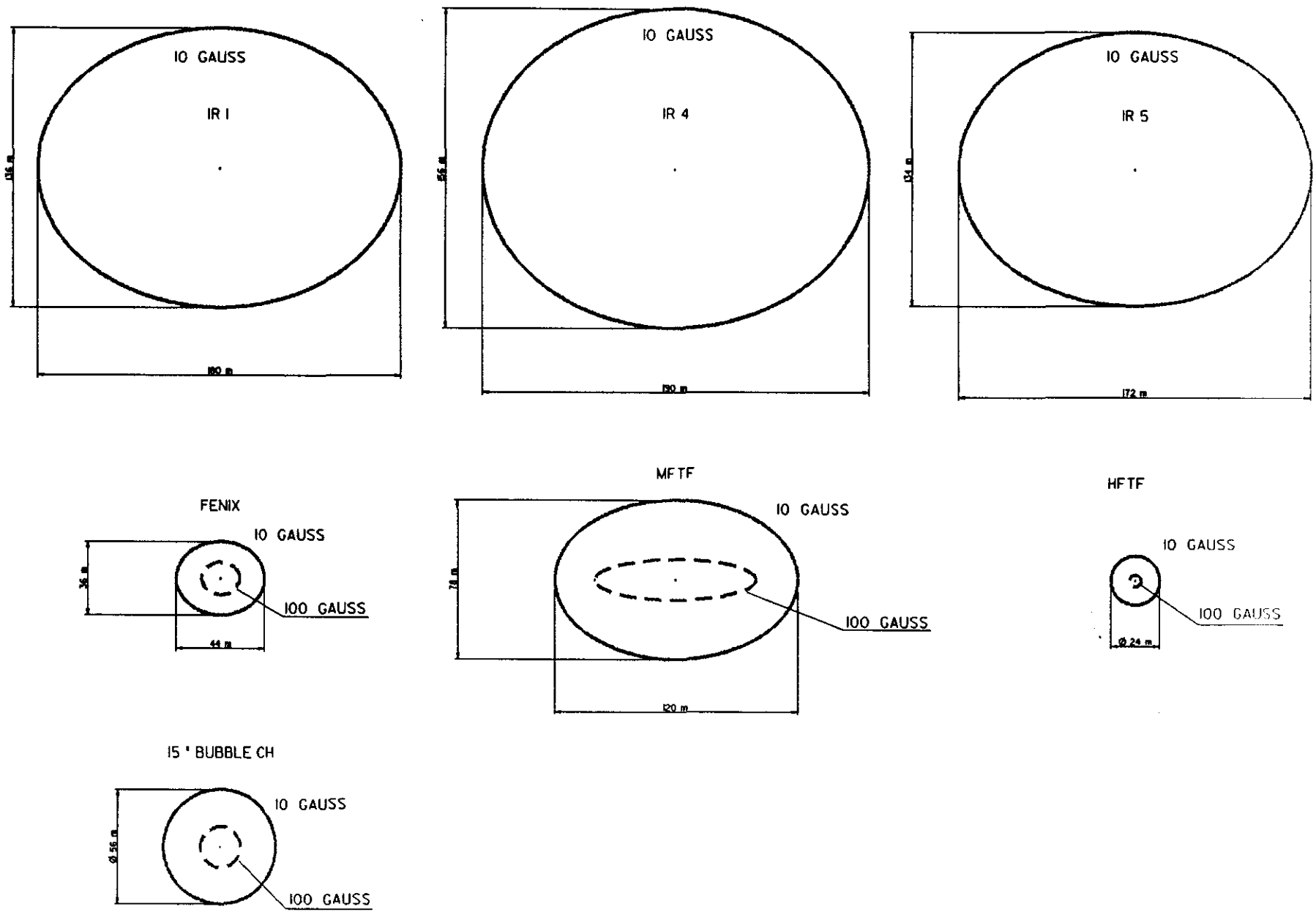


SECTION X-X

9-10-91

FACILITIES FRINGE FIELDS COMPARISON

Date: September 23, 1991

	LAB FACILITY	Years in Operation	Magnet Strength	Type of Shielding	Magnet Elevation	Surface Area 10 gauss (pacemaker)	Surface Area 5 gauss (instrumentation sensitivity)	Surface Area 1 gauss (no issue)	Altitude of 5 gauss Field	Above-ground volume at 5 gauss	Regulatory Compliance To.....	Δ EIS	Health Effects Reported
1	SSC - GEM	New	0.8 T	unknown	<47m>	~26,800m2	~43,000m2	~110,000m2	71m	~1,550,000m3	DOE et al.	unknown	n/a
2	LLNL - FENIX	~0.5	14.0 T	none	<3 m>	4,976m2	6,464m2	?	23m	~22,850m3	DOE et al	none	none
3	LLNL - HFTF	~10	~11 T	none	<2 m>	452m2	804m2	?	16m	~6,434m3	DOE only	none	none
4	LLNL - MFTF	<1 week	~ 7 T	none	~3.5 m	7,350m2	~13,000m2	?	50m	?	DOE only	n/a	none
5	15'BBL.CH-FNAL	15	~3.2 T	none	2 m	2,463m2	~5,000m2	?	~40m	~100,500m3	OSHA	n/a	one future move
6	LCT - ORNL	2	8 T	none	3m	n/a	n/a	n/a	n/a	n/a	DOE	none	no verifiable
7	Tohoku/Chicago Sync.-FNAL	~20-25	~ 3.0 T ea.	none	?	?	?	?	?	?	?	?	?

FIELD SIZE COMPARISON