CURRENT STATUS OF TEV INJ. BEAMLINES

7/21/93

PHYSICAL LAYOUT / MODEL

- current drawings based on
  P150 v13
  A150 v8
  in FTP AREA

- All drawings based on lattice files with most accurate description of elements (flange-flange geometry)

- All devices have been modled in 3d using Ideas (currently ≈ 68 devices)

- Standard plan & elevation sheets at 1/4" to foot. with additional sheets for interface details

- As each device (magnet, correctors, beam values, etc) ~~are~~ location is determined → inserted into lattice file and modeled.

- All modeling done by Tony Parker and AD Drafting (Mech. Support)

- P150 stable geometry
- A150 stable geometry (needs more device detail)
- FØ-F11 devices not yet stable
- AØ has not been modeled.

- Magnet interfaces
- Stands
- Location of cable trays & utilities in tunnel. need to be included in model.

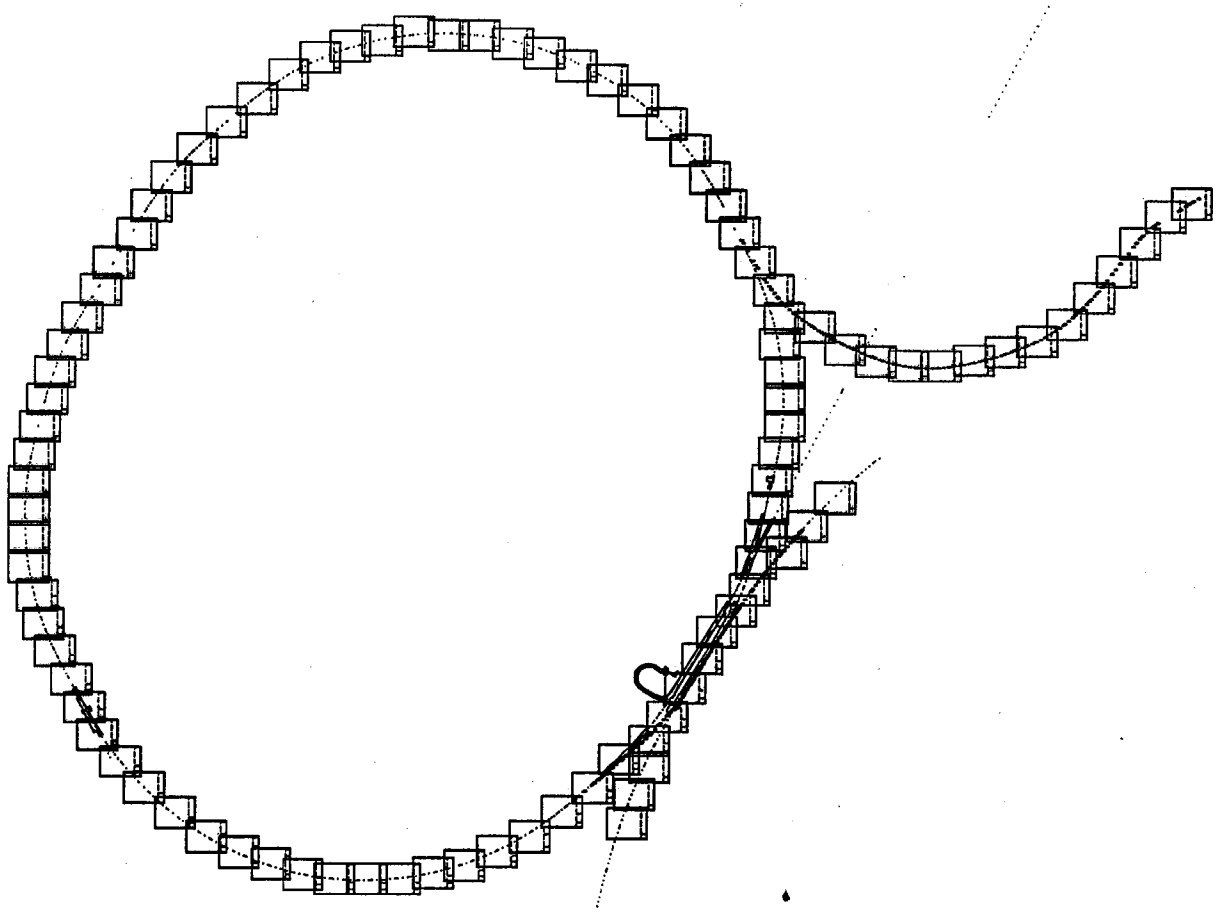
SEC.1.6 Finished Magnet Naming (Sub Assemblies)

ASSEMBLY BIN 2 NAME: MAGNETS_FIN

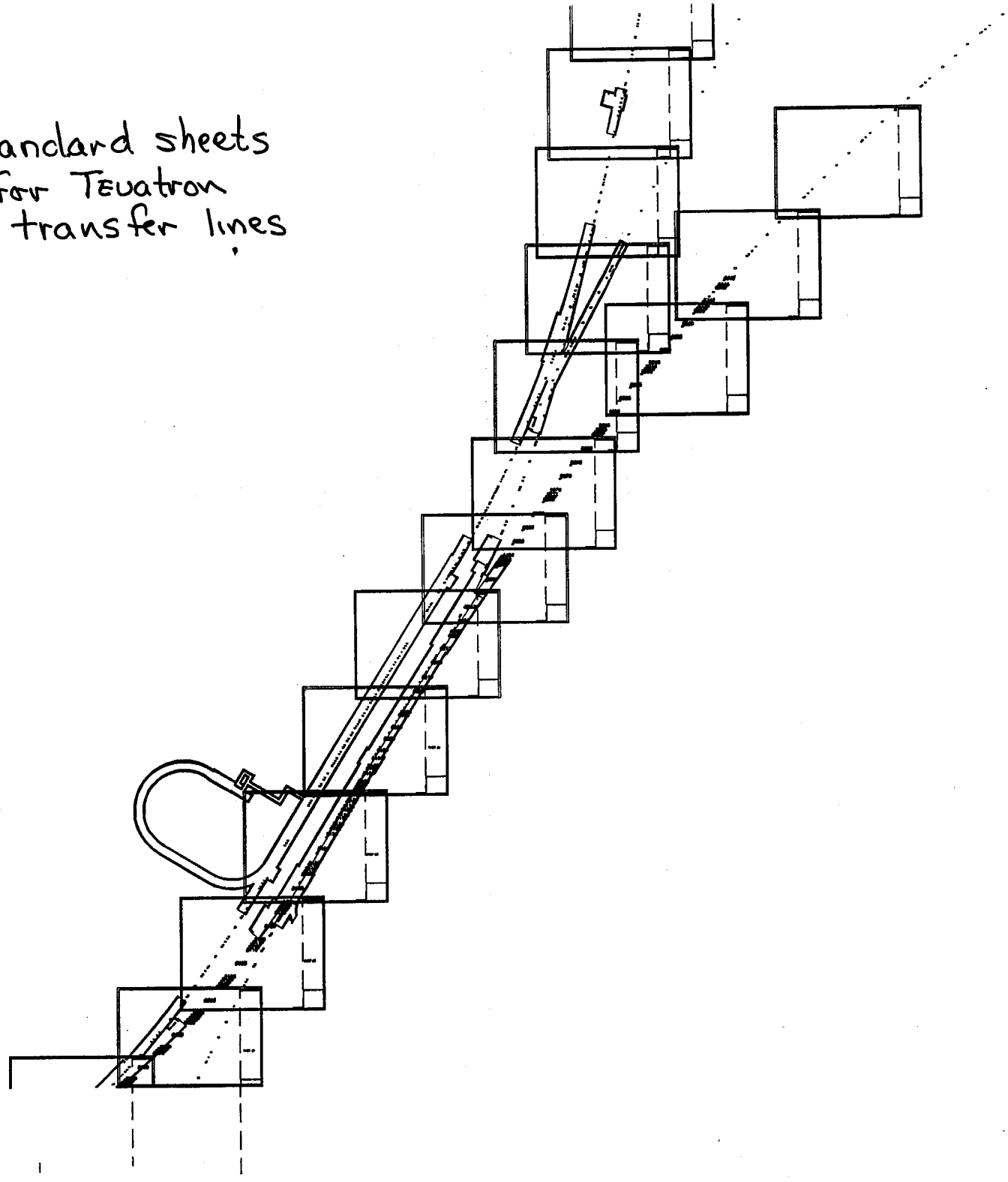
OBJECT	NAME	COLOR	Description	ID Drawing
1	3Q52	Blue	MR Quad –	MB–305055
2	3Q84	Cyan	MR Quad	MB–305056
3	3Q100	Dk.Green	MI Quad (New)	MB–305057
4	3Q116	Green	MI Quad (New)	MB–305058
5	SQA	Yellow	Tev 1 Style A Quad	MB–305059
6	SQB	Gldn.Orange	Tev 1 Style B Quad	MB–305091
7	3Q120	Red	Ext. Beamline 10' Quad	MB–305060
8	TVQL	(Uses TQ66)	Tev Normal Quad	
9	TVQS	(Uses TQ32)	Tev Short Quad	
10	TVQ1	(Uses TQ82)	Tev Quad Q1	
11	TVQ2	(Uses TQ99)	Tev Quad Q2	
12	TB241	Magenta	Tev Dipole 20'	MB–305061
13	TQ25	Blue	Tev Quad 25"	MB–305062
14	TQ32	Cyan	Tev Quad 32"	MB–305063
15	TQ54	Dk.Green	Tev Quad 54"	MB–305064
16	TQ66	Green	Tev Quad 66"	MB–305065
17	TQ82	Yellow	Tev Quad 82"	MB–305066
18	TQ90	Gldn.Orange	Tev Quad 90"	MB–305067
19	TQ99	Red	Tev Quad 99"	MB–305068
20	TQ132A	Magenta	Tev Quad 132" (Q4)	MB–306069
21	TQ232	Blue	Tev Quad 232"	MB–305070
22	B2	Cyan	MR Dipole 20'	MB–305071
23	2B2	Dk.Green	MR Dipole 20' (Dbl. Fld.)	MB–305072
24	B3	Green	MR Dipole 20'	MB–305073
25	VB3	Yellow	MR Dipole 20'	MB–305074
26	MIDA	Gldn.Orange	MI Dipole	MB–305076
27	MIDB	Red	MI Dipole 2/3	MB–305075
28	EPB	Magenta	External Beamline Dipole	MB–305077
29	SDB	Blue	Tev 1 Style Dipole	MB–305078
30	TVD	(Uses TB241)	Tev Dipole	
31	A0LAM	Cyan	A0 8Gev Inj. Lambertson	MB–305083
32	F17LAM	Dk.Green	F17 Lambertson	MB–305084
33	F17CMGT	Green	F17 C Magnet	MB–305081
34	MILAM7	Yellow	MI Lambertson (New)	MB–305085
35	MILAM8	Gldn.Orange	MI Lambertson (New)	MB–305086
36	MILAM16	Red	MI Lambertson (New)	MB–305100
37	TRFC	Magenta	Tev RF Cavity	MB–305101
38	RF_CAV	Blue	MI RF Cavity	MB–305102

MIDX_END1.SYM
INSERTION POINT
21
MIDX
16
MIDX_OUTER.SYM
INSERTION POINT
MIDX
7 1/2
7 1/2
16
MIDX_PLAN.SYM
INSERTION POINT
MIDX
29 7/8
1 1/16
MIDX_INNER.SYM
INSERTION POINT
MIDX
32
MIDX
MIDX_END2.SYM
INSERTION POINT
ITEM
PART NO.
DESCRIPTION OR SIZE
QTY.
PARTS LIST
ORIGINATOR
DRAWN
CHECKED
APPROVED
USED ON
MATERIAL
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
MAIN INJECTOR
MIDX
SYMBOL ID DRAWING
SCALE
FILING
DRAWING NUMBER
9502-MB-305130
REV.
CREATED WITH I-DEAS_V1
USER NAME:DBRIDGMANDEES
CADFILE:[MI_300]305130.dwg

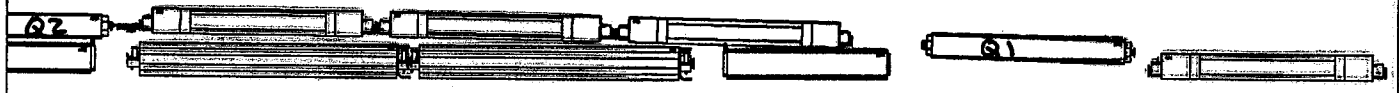
Location of "Standard" Sheets at 1/4" = 1'
for MI project.



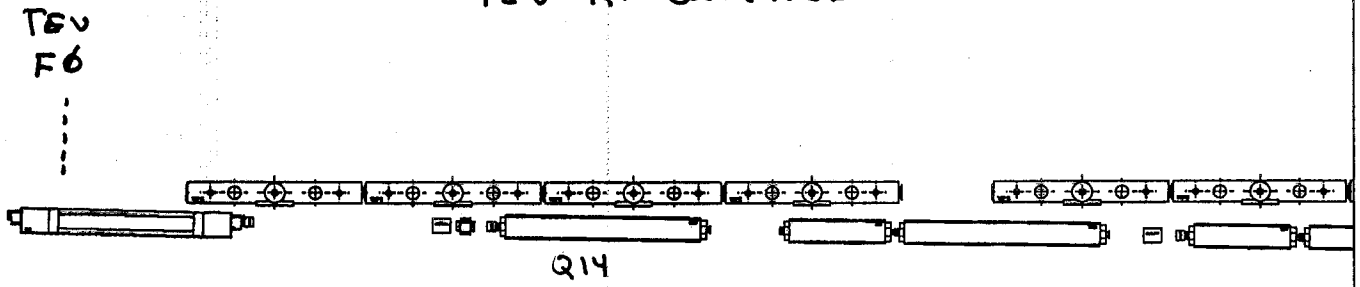
Standard sheets
for Tevatron
transfer lines



Elevation of MI-52 extracton
from model.



Elevation of P1 line ~~at~~ under
TEV RF cavities



SCALE
1/2"=1'

REV.	DESCRIPTION		

PARTS LIST

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

CREATED WITH I-DEAS.V1

MI EXTRACTION

- Locations: MI52 - MI62 - MI40 - (MI60)

- Layout of extraction devices (figure)
  - common to all straight sections
  - kickers
  - septa 200 μr, 10', 1cm gap, 5cm wire plane
    15-85 kv/cm, "need cost est"
  - Lambertsons const bend angle 6 mr = (0.72 kG)
  - C-magnets constant bend 8.4 mr (12.6 kG)

- Changes since Title I:
  - 2.4/4.8 m lambertsons → 3 2.8m lambertsons
  - septa length increase from 22' → 30' (300→600 μr)
    (3 modules instead of 2)
  - ~~[illegible]~~

- Do we <u>need</u> a Large Aperture Quad

  - determined by:
    1. location of lambertson septa in quad aperture
    2. MI closed orbit
    3. Extraction orbit (H/V)
    4. Emittance

- Separation of circulating/extracted beam determined by kicker (septa) strength <u>and</u> angle through kicker (septa)

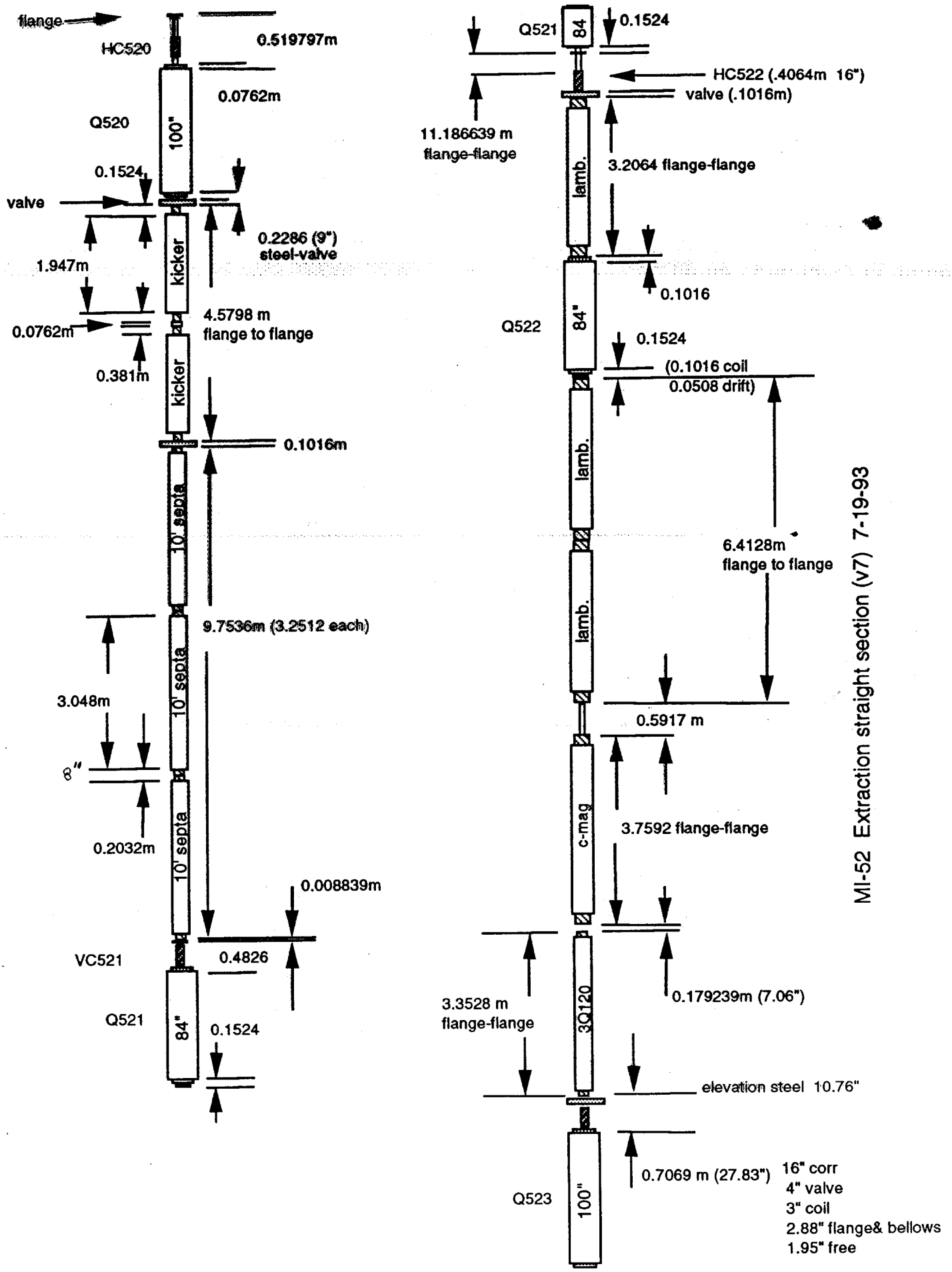
- Want to MAXIMIZE aperture for (lamb) circulating beam ⇒ moving the septum as far as possible to the <u>outside</u>.

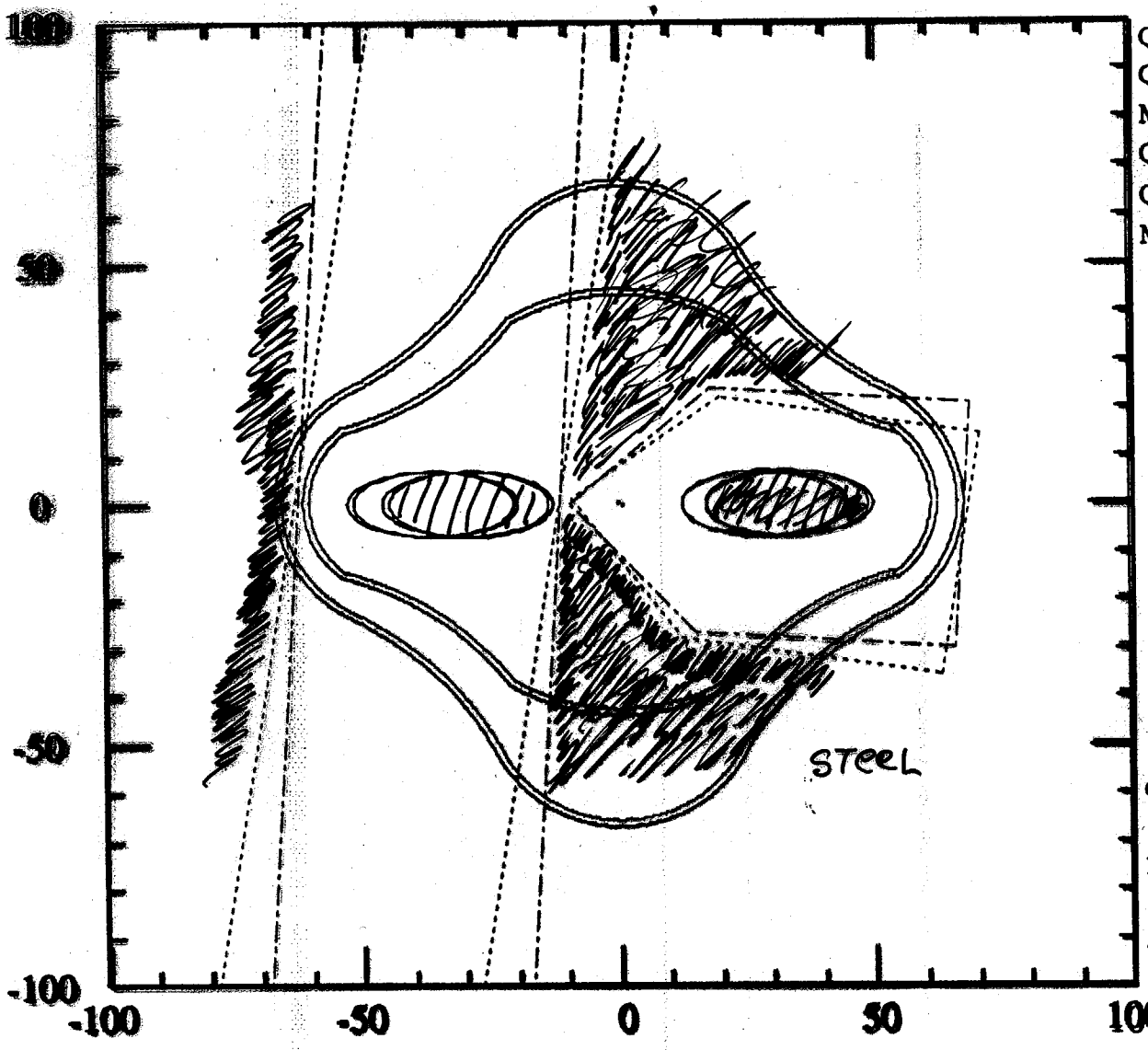
- The maximum position for the location of the lamb. septum is determined by:
  - trajectory of 8 Gev inj/ext beam
  - trajectory of 150 Gev ext beam
  - trajectory of slow spill

  These trajectories are determined by:
  - kicker (septa) strength
  - CLOSED ORBIT CORRECTORS
  - LAMB/CMAGNET STRENGTH
  - LAMB/CMAGNET ROLL

(See Illustration)

3Q84 aperture
4Q120 aperture
Lambertson (10° tilt)
8/150 Gev at Q522 : inside
8/150 Gev at Q522 : outside


flange
HC520
0.519797m
0.0762m
Q520
100"
0.1524
valve
0.2286 (9")
steel-valve
1.947m
kicker
0.0762m
4.5798 m
flange to flange
0.381m
kicker
0.1016m
10' septa
9.7536m (3.2512 each)
3.048m
10' septa
8"
0.2032m
10' septa
0.008839m
VC521
0.4826
Q521
84"
0.1524
Q521
84
0.1524
HC522 (.4064m 16")
valve (.1016m)
11.186639 m
flange-flange
lamb.
3.2064 flange-flange
0.1016
Q522
84"
0.1524
(0.1016 coil
0.0508 drift)
lamb.
6.4128m
flange to flange
lamb.
0.5917 m
c-mag
3.7592 flange-flange
3.3528 m
flange-flange
3Q120
0.179239m (7.06")
elevation steel 10.76"
0.7069 m (27.83")
Q523
100"
16" corr
4" valve
3" coil
2.88" flange& bellows
1.95" free
MI-52 Extraction straight section (v7) 7-19-93

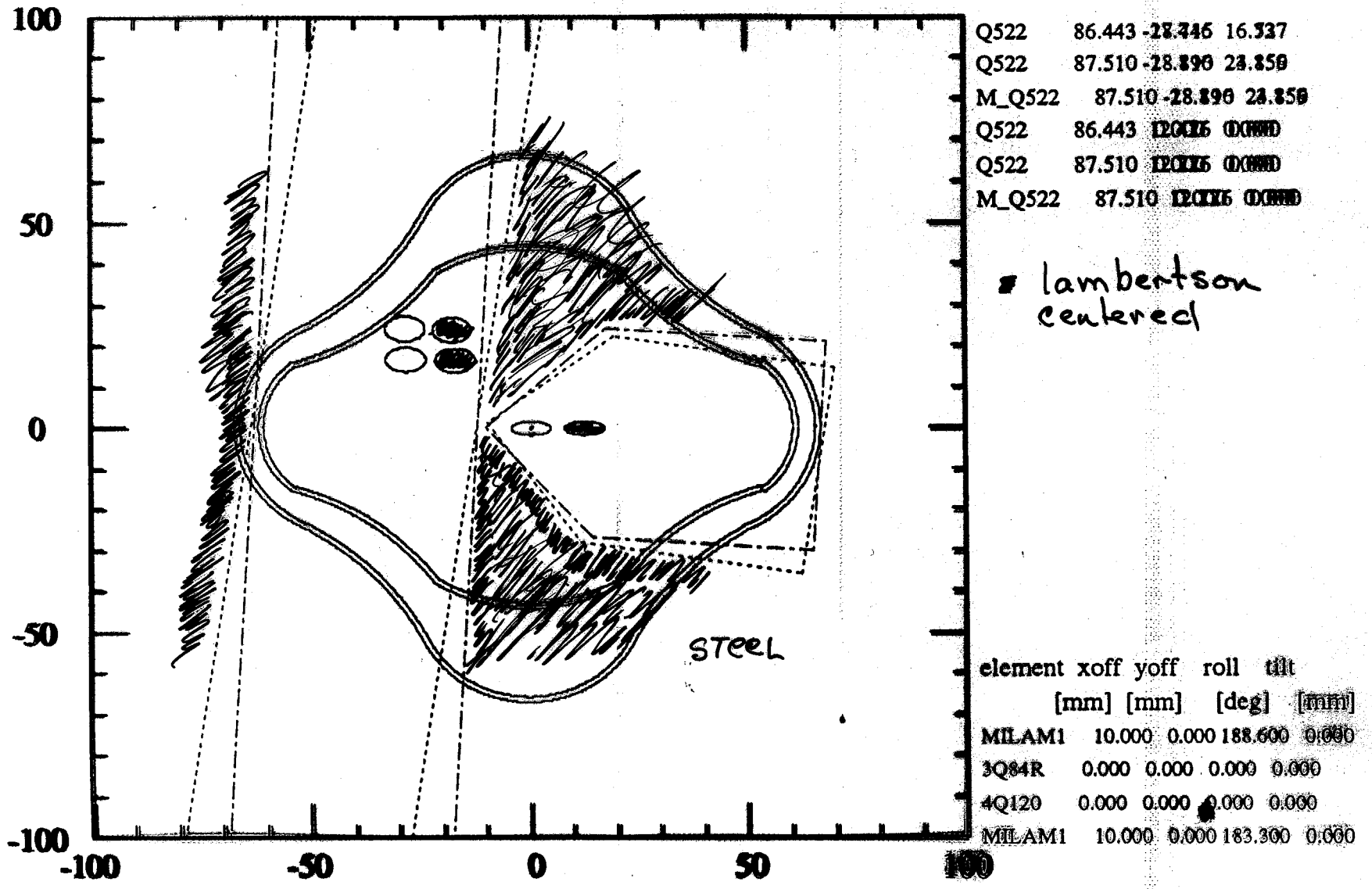


Q522	86.443	-30.508	0.003
Q522	87.510	-38.858	0.004
M_Q522	87.510	-38.858	0.004
Q522	86.443	38.030	0.000
Q522	87.510	38.500	0.000
M_Q522	87.510	38.500	0.000

= lambertson centered

element	xoff [mm]	yoff [mm]	roll [deg]	tilt [mm]
MILAM1	10.000	0.000	188.600	0.000
3Q84R	0.000	0.000	0.000	0.000
4Q120	0.000	0.000	0.000	0.000
MILAM1	10.000	0.000	183.300	0.000

Tue Jul 20 12:52:28 1993 FILE: [illegible]pv4



Tue Jul 20 10:52:58 1993 FILE: 4522gen_beam

- CORRECTORS AROUND EXTRACTION S.S.
  - TITLE I SPECIFICATIONS:

    $\int_{H/V} B \cdot dl$ .06 / .04 T-m ; 12" steel

    $\theta_{H/V}(8)$ 2.26mr / 1.5mr ⇒ 113/75 mm

    $\theta_{H/V}(150)$ 120 / 80 μr ⇒ 6/4 mm

    P.S.: 5 A rms - 12 A max
  - Ideal orbit control would give independent POSITION <u>and</u> ANGLE control at SEPTA (KICKER) AND LAMBERTSON.
  - KICKER (SEPTA) AND LAMBERTSON ARE ≈ 90° apart in phase advance ⇒ that we cannot have independent POS & ANG at both locations.
  - Currently use

520	3BMP (518:520:522)	POS KICKERS
522	3BMP (520:522:524)	ANG KICKERS
		POS LAMBERTSON
524	3BMP (522:524:526)	ANG LAMBERTSON

  - Assume CORRECTORS ARE IN STANDARD MI CORR. LOCATIONS WHICH IMPLIES THAT THE MI and HIGH FIELD correctors are the SAME MAGNET with different Power Supplies. (HFC may or may not have same coil pack as STD)

- Look at four solutions which place the extracted beam on the center orbit of Q1 for all energies.

  - For 8 and 150 GeV: ray trace central trajectory at $x = x' = 0$ and calculate beam envelope. ~~PLOT FLTRS~~.

  - Slow spill: ~~ray trace~~ (for circulating beam)
    - start with phase space at Q516 (mid) half way through extraction. identify particles that would be extracted if septa were on and (min, max & 0 X). (see figure)
      raytrace these 4 particles

    - track entire ensamble and plot x-y distribution.

SOLUTION

Omnc_V5 1. LAMB SEPTUM ~ CENTERED QUAD APER.

- requires HFB at all energies
- No LAQ required
- x@Q522 18 mm
- Max Lam roll ~10°

_V4 2. LAMB SEPTUM ~ 10 mm to outside

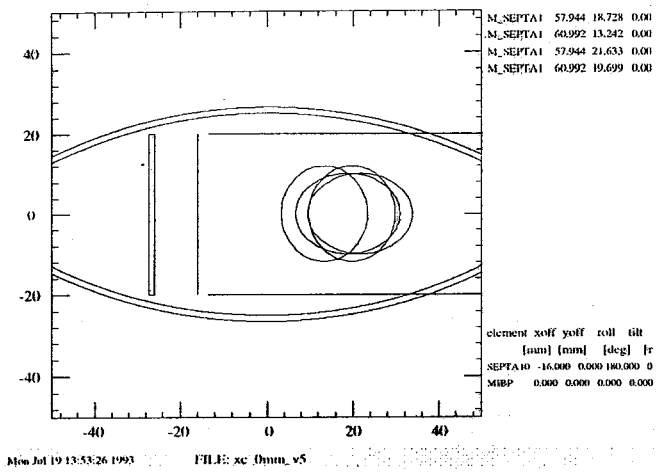
- ORBIT centered at 150 Gev (No HFB)
- requires LAQ
- x@Q522 ≈ 29 mm
- Max Lam roll ~8.6°

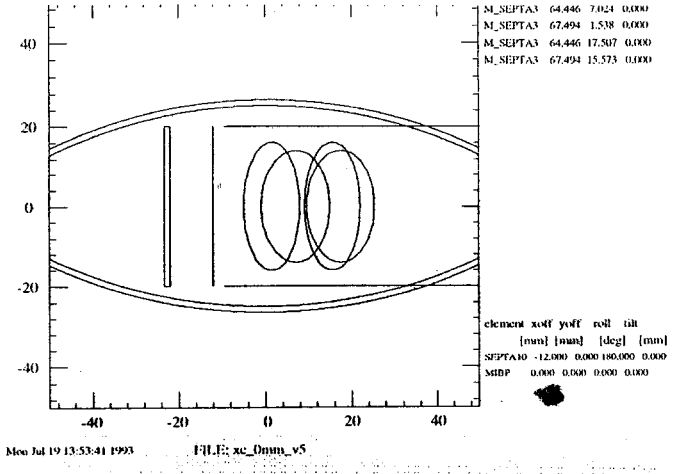
_V3 3. LAMB SEPTUM ~ 10 mm to outside

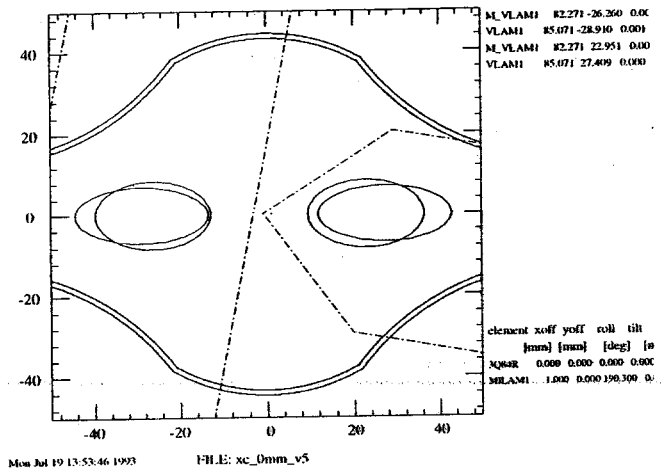
- Bump @ 150 using STD MI corr.
- Slow spill requires HFB (~320 μr)
- x @ Q522 ≈ 28 mm
- max. Lam roll ~ 12°

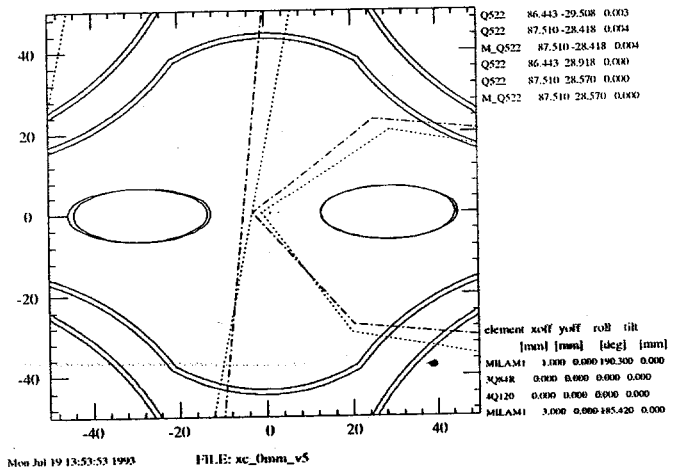
_V1 4. LAMB SEPTUM ~ 10 mm outside

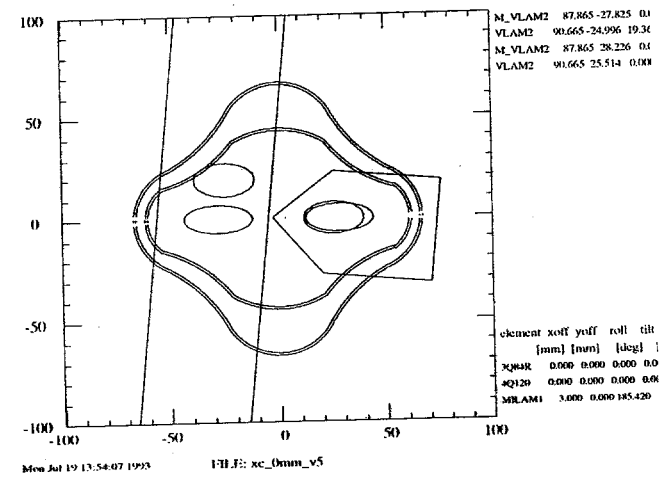
- Bump at 150 req STD < corr < HFB
- slow spill requires HFB (~300 μr)

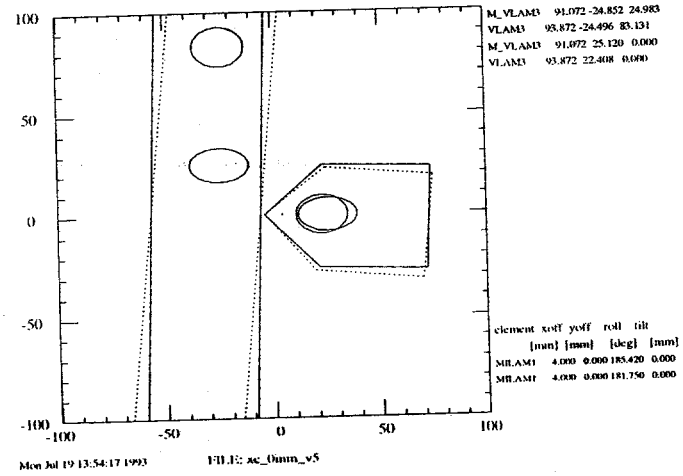


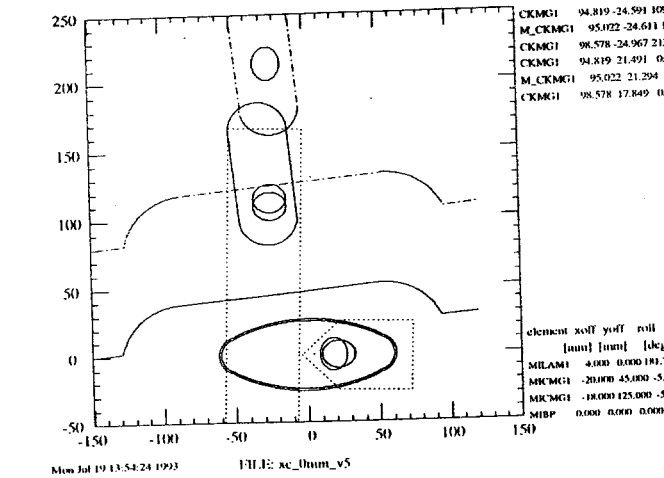


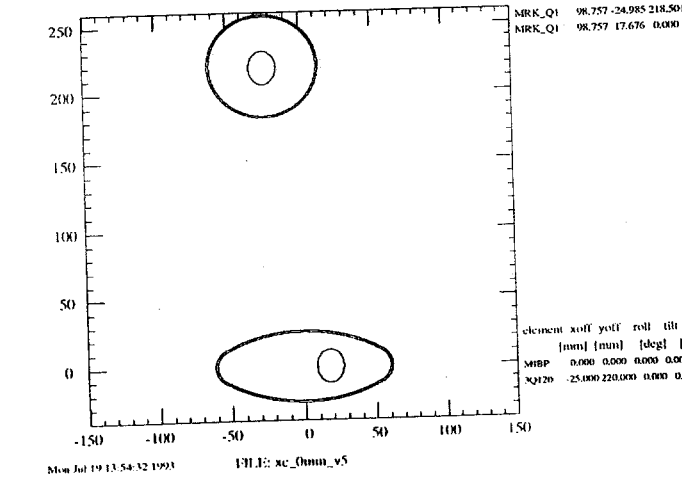




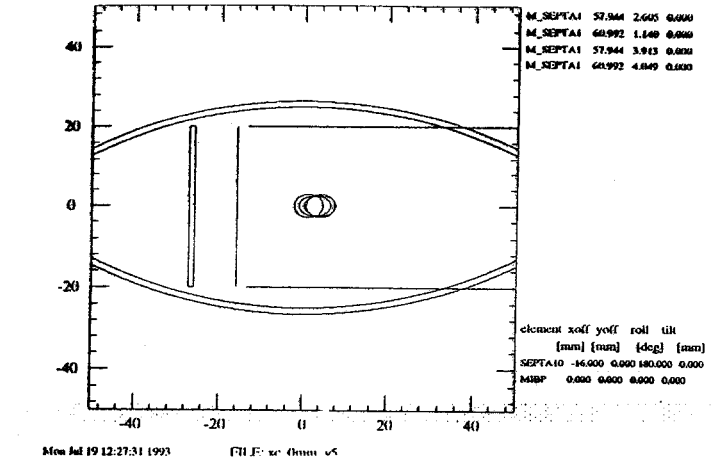


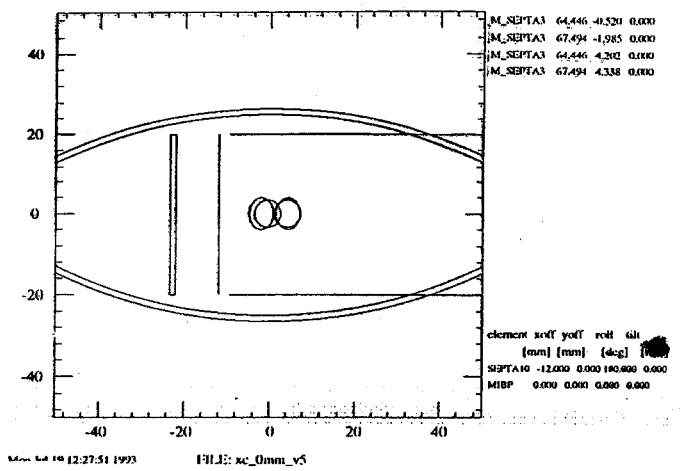


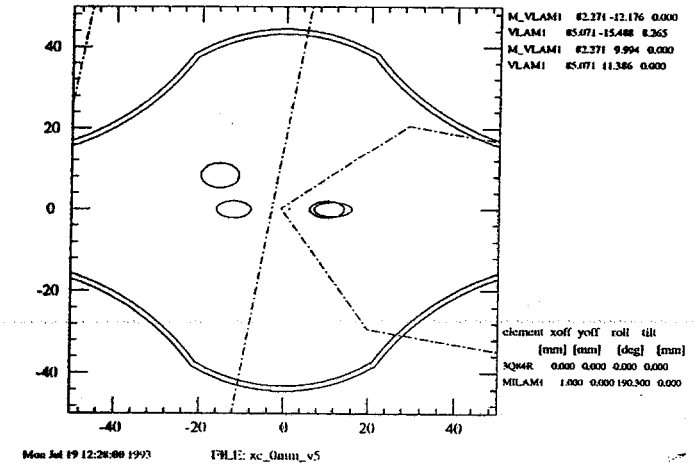


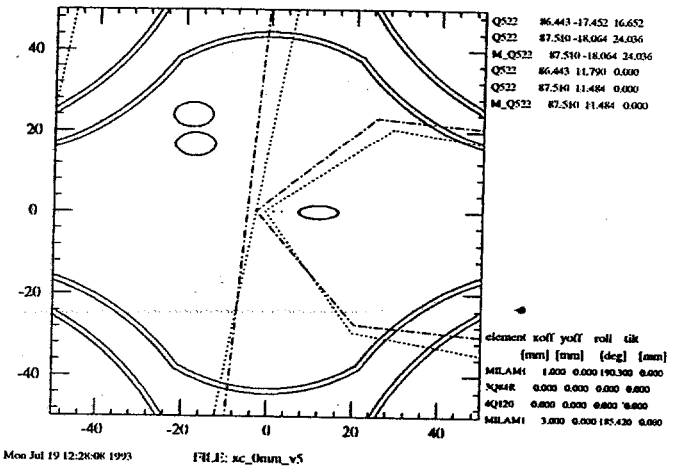


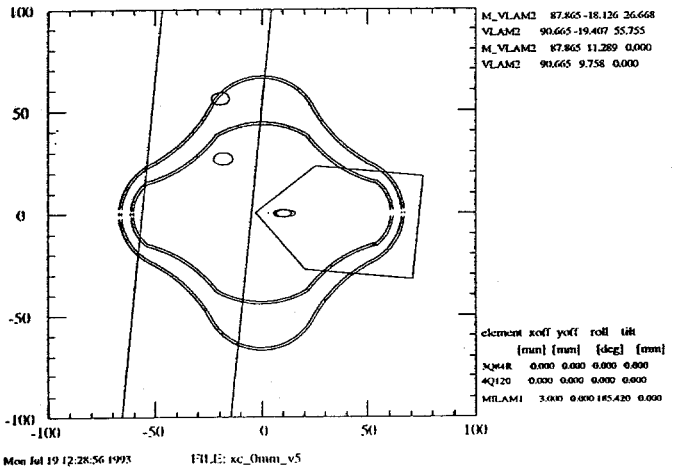
CROSS-SECTIONS FOR 8 GeV solution of ~~SEPTA 0mm~~ lambertson centred 8_0mm_V5

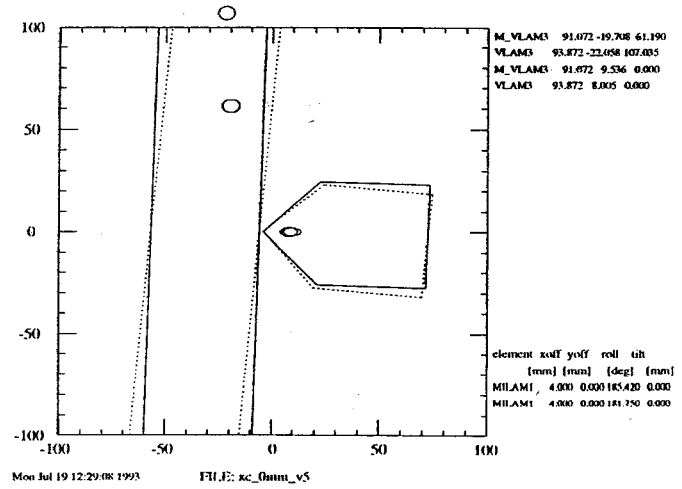


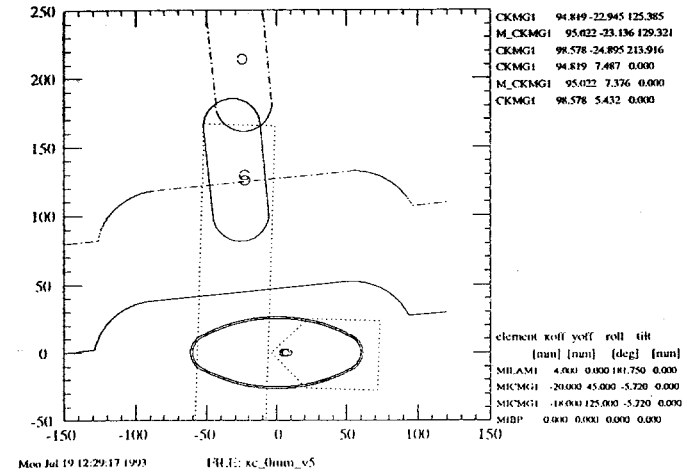


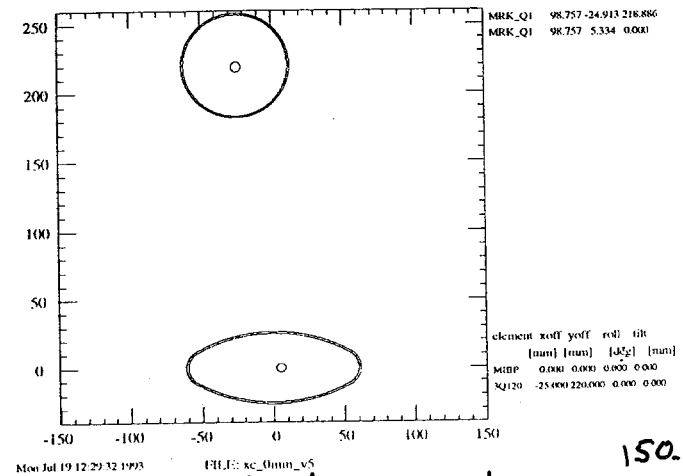












150.0mm_v5

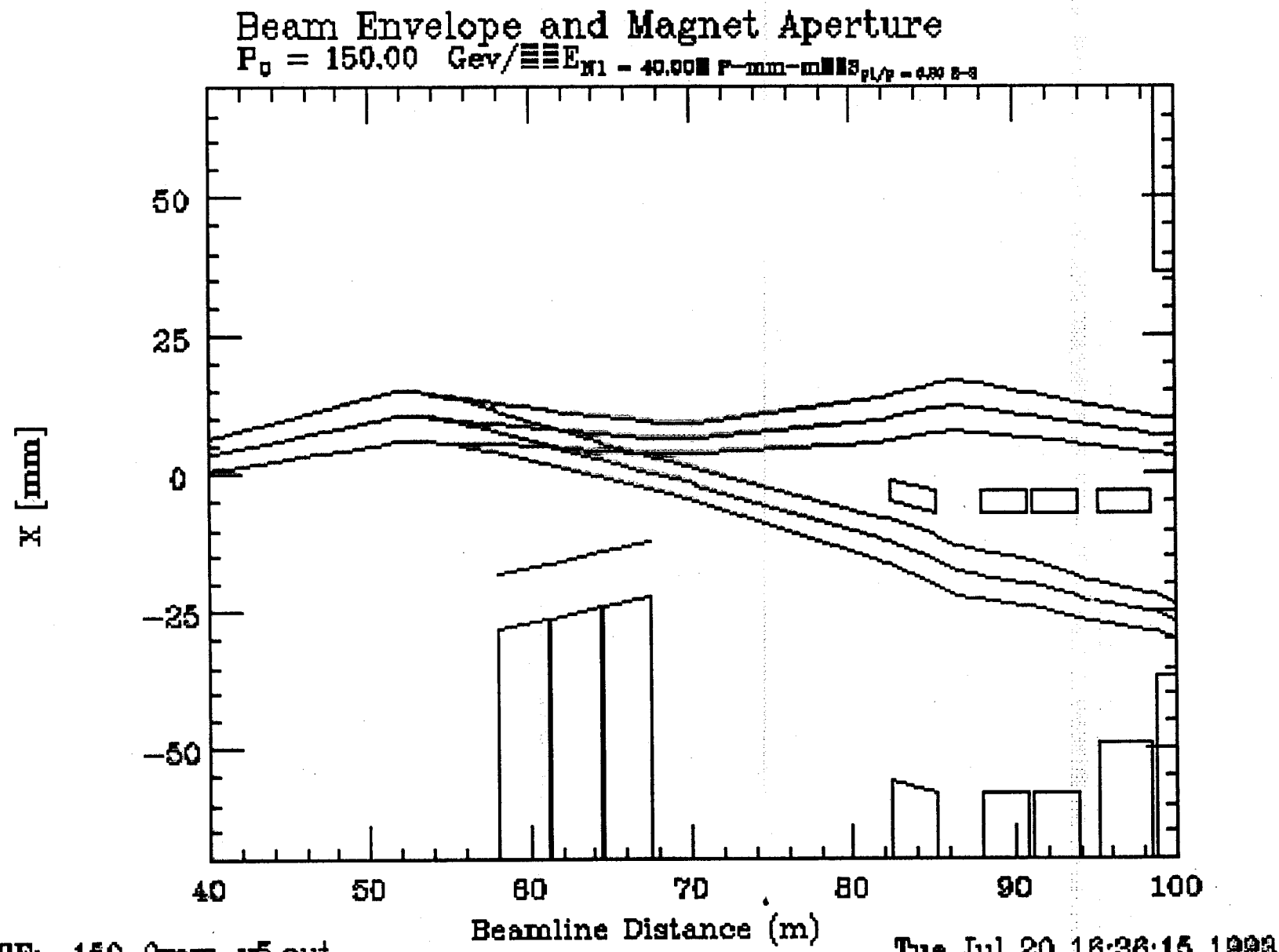
CROSS SECTIONS FOR 150 GeV lambertson centered

SOLUTION # 1

LAMBERTSON SEPTA AT 1-4 mm

start q516 : _0mm_v5

	8 Gev	120 Gev	150 Gev
EX DEV ANG [mr]			
vlam1_ang	off	6	6
vlam2_ang	13.86	6	6
vlam3_ang	13.86	6	6
cmg1_ang	off	8.4	8.4
kick_ang	-1.165	off	-0.525
es_ang	off	-0.5298	off
EX DEV TILT [rad]			
vlam1_tilt	NA	-0.1798	-0.1798
vlam2_tilt	-0.09463	-0.09463	-0.09463
vlam3_tilt	-0.03272	-0.03272	-0.03272
cmg1_tilt	NA	0.0998	0.0998
C.O. BUMPS [mm]			
pos_520	23.065	0	3.055
pos_522	22.77	12	9.994
pos_524	17.065	-12	-4.687
M_Q522	-28.418	-18.914	-18.064
MRK_Q1			
x	-24.985	-24.945	-24.913
xp	-0.1	-0.028	-0.1
y	218.501	218.887	218.886
yp	27.707	27.73	27.73
CORR ANGLES [ur]			
cor 518	602.05	0	79.75
corr 520	604.92	262.42	232.72
corr 522	975.94	-280.65	73.16
corr 524	761.45	170.65	246.75
corr 526	445.62	-313.34	-12.24



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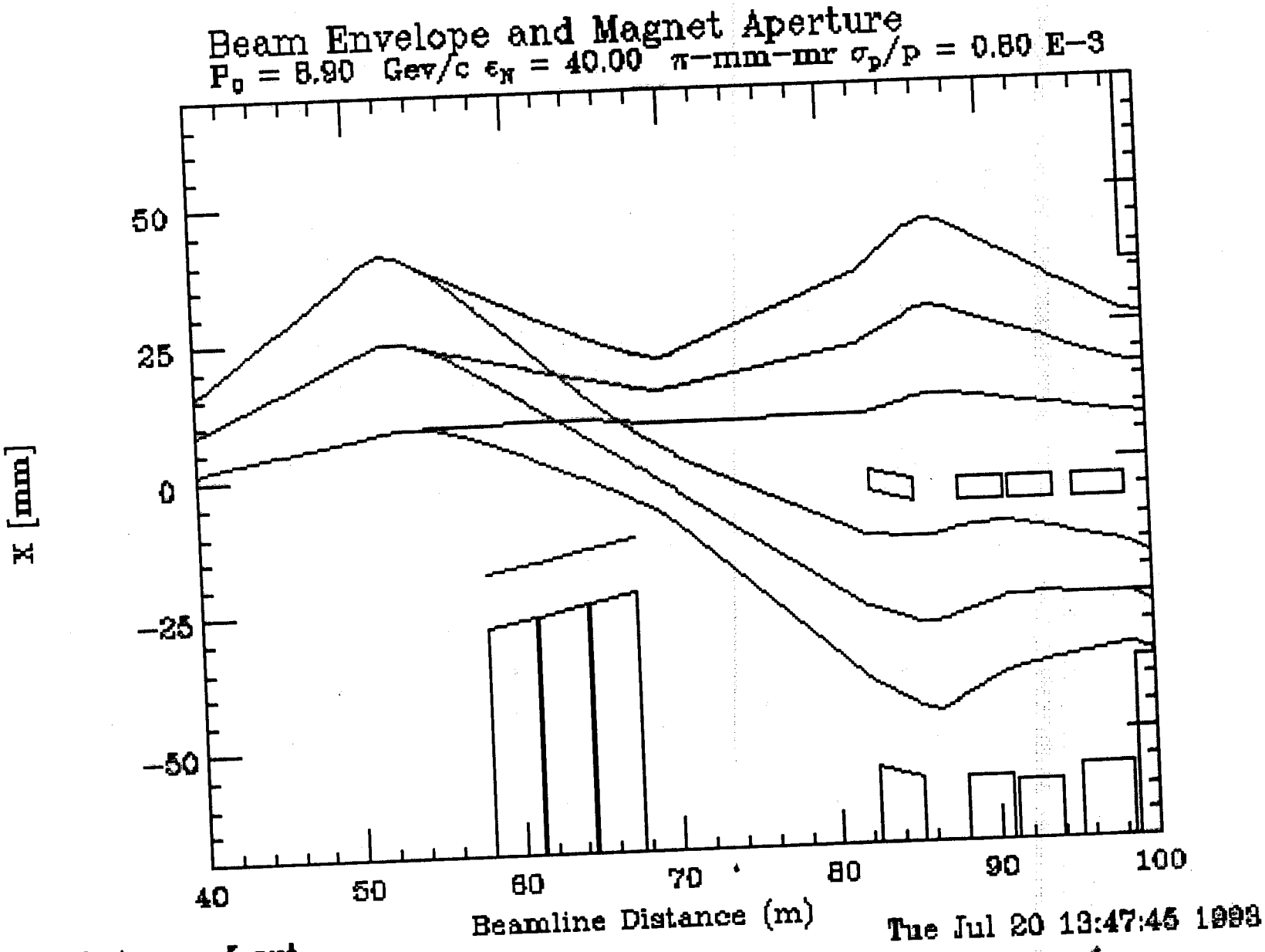
COMMENT:

Tue Jul 20 16:36:15 1993



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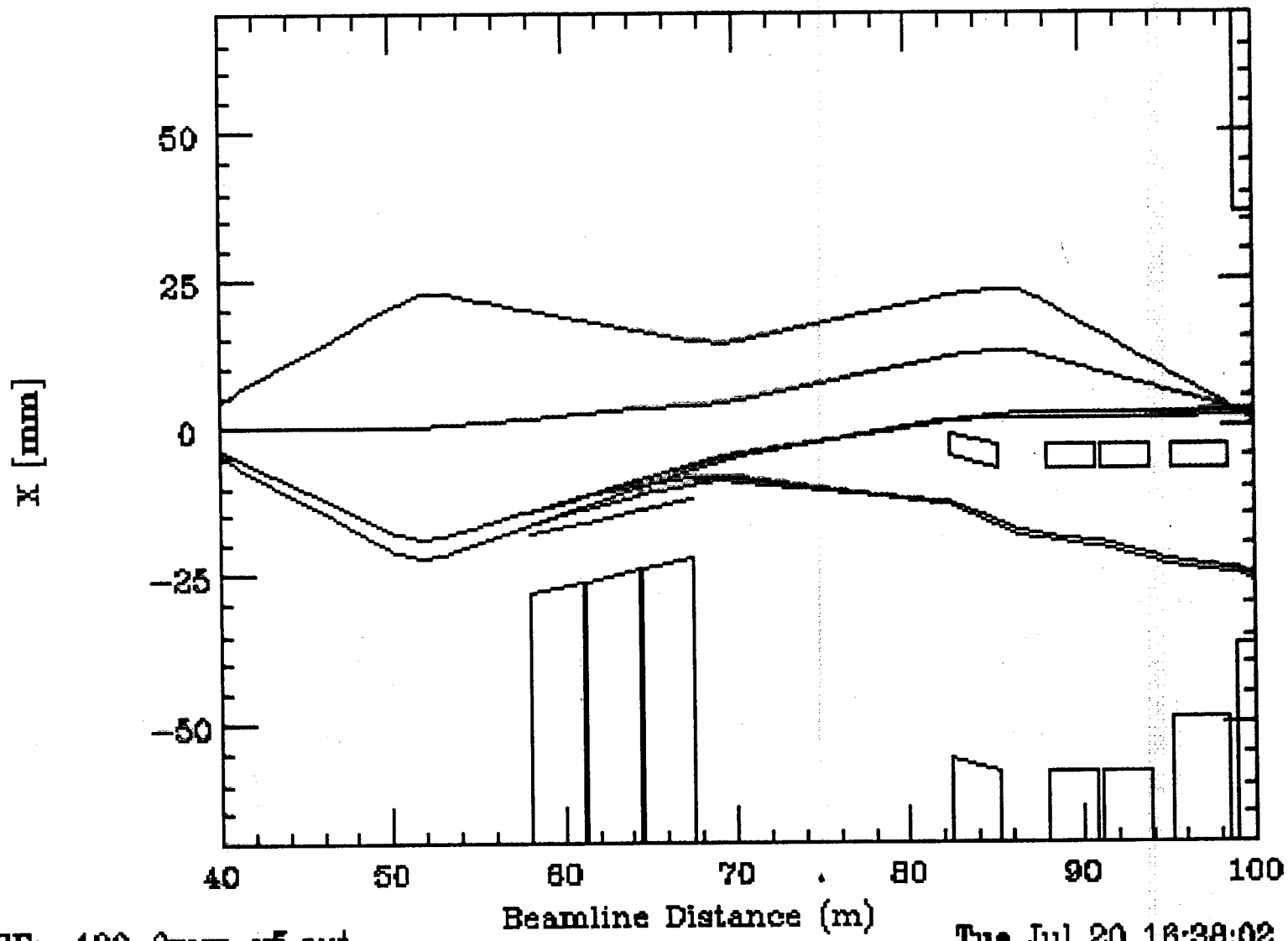
COMMENT:

Beamline Central Trajectory and Magnet Aperture



FILE: 120_0mm_v5.out
COMMENT:

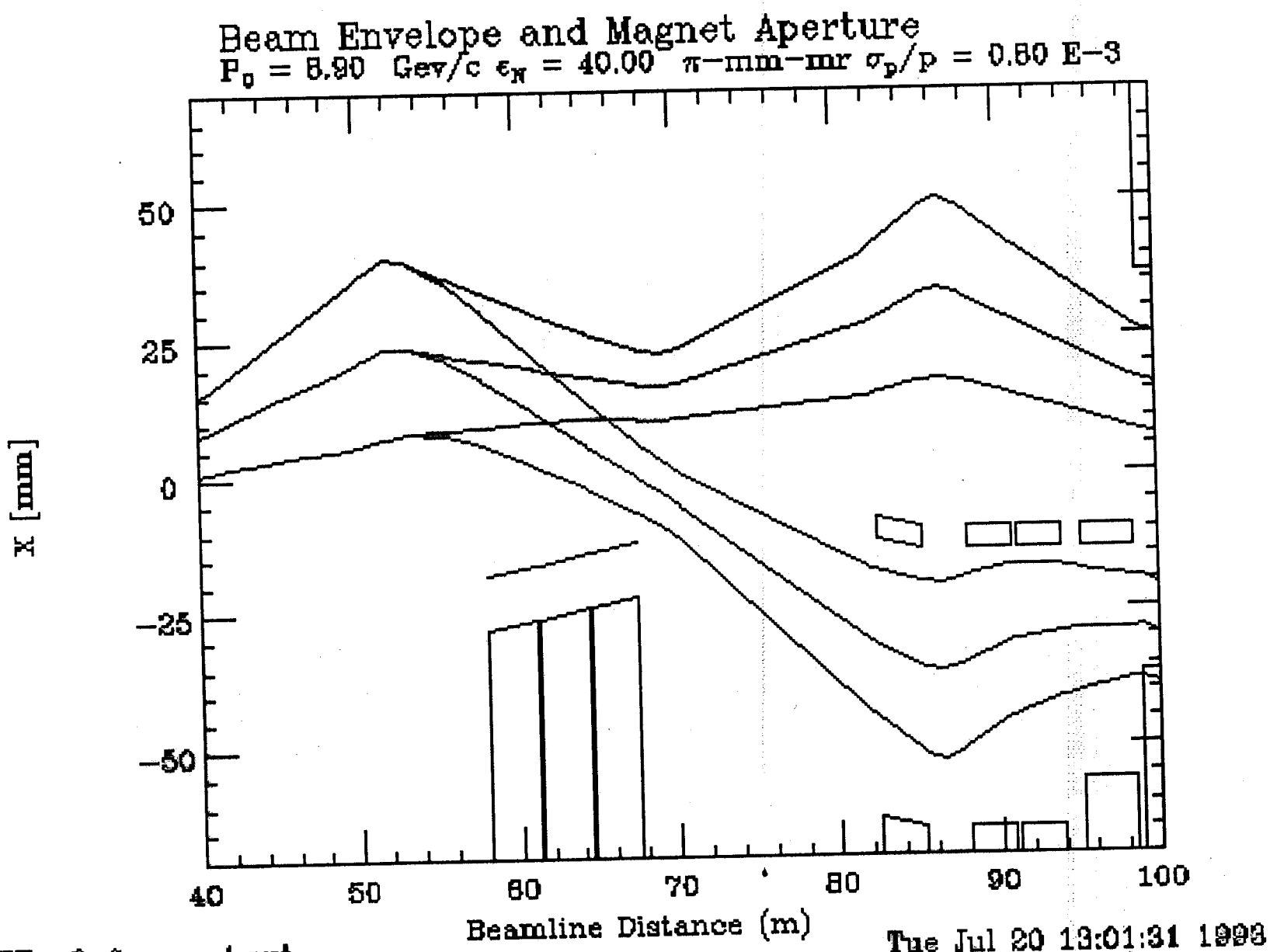
Tue Jul 20 16:38:02 1993

SOLUTION #2

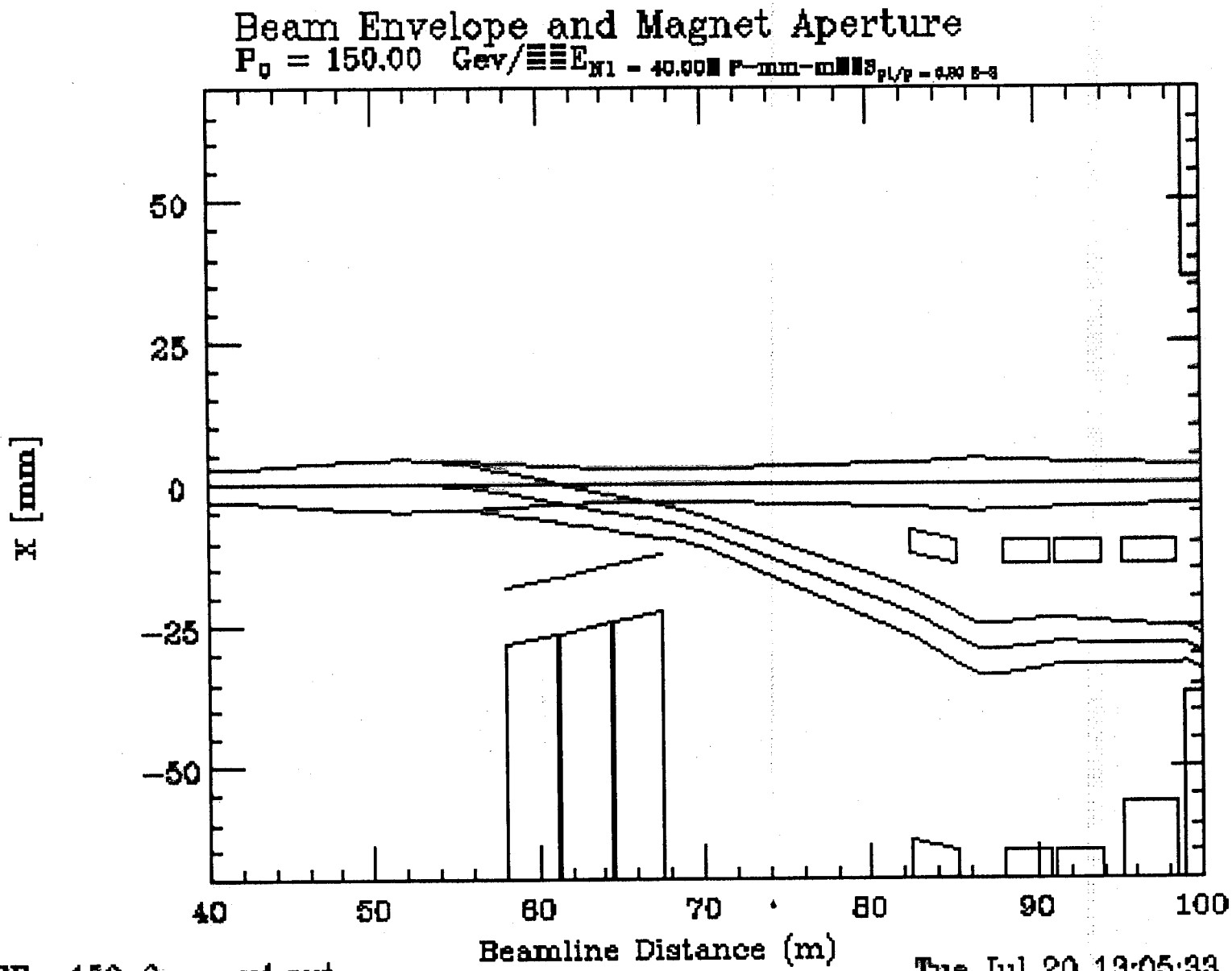
LAMBERTSON SEPTA AT 1-4 mm

start q516 : 10 _0mm_v4

	8 Gev	120 Gev	150 Gev
EX DEV ANG [mr]			
vlam1_ang	off	6	6
vlam2_ang	13.86	6	6
vlam3_ang	13.86	6	6
cmg1_ang	off	8.4	8.4
kick_ang	-1.4	off	-0.50247
es_ang	off	-0.605	off
EX DEV TILT [rad]			
vlam1_tilt	NA	-0.149	-0.149 76°
vlam2_tilt	-0.0587	-0.0587	-0.0587
vlam3_tilt	-0.0587	-0.0587	-0.0587
cmg1_tilt	NA	0.03489	0.03489
C.O. BUMPS [mm]			
pos_520	22	0	0
pos_522	28	4.179	0
pos_524	5.65	-12	0
M_Q522	-35.355	-29.655	-28.89
MRK_Q1			
x	-28.636	-28.332	-28.092
xp	0.111	0.147	0.1
y	218.76	219.624	219.624
yp	27.729	27.814	27.814
CORR ANGLES [ur]			
cor 518	574.24	0	0
corr 520	714.26	91.41	0
corr 522	674.47	-294.87	0
corr 524	767.81	-26.45	0
corr 526	147.6	-313.34	0



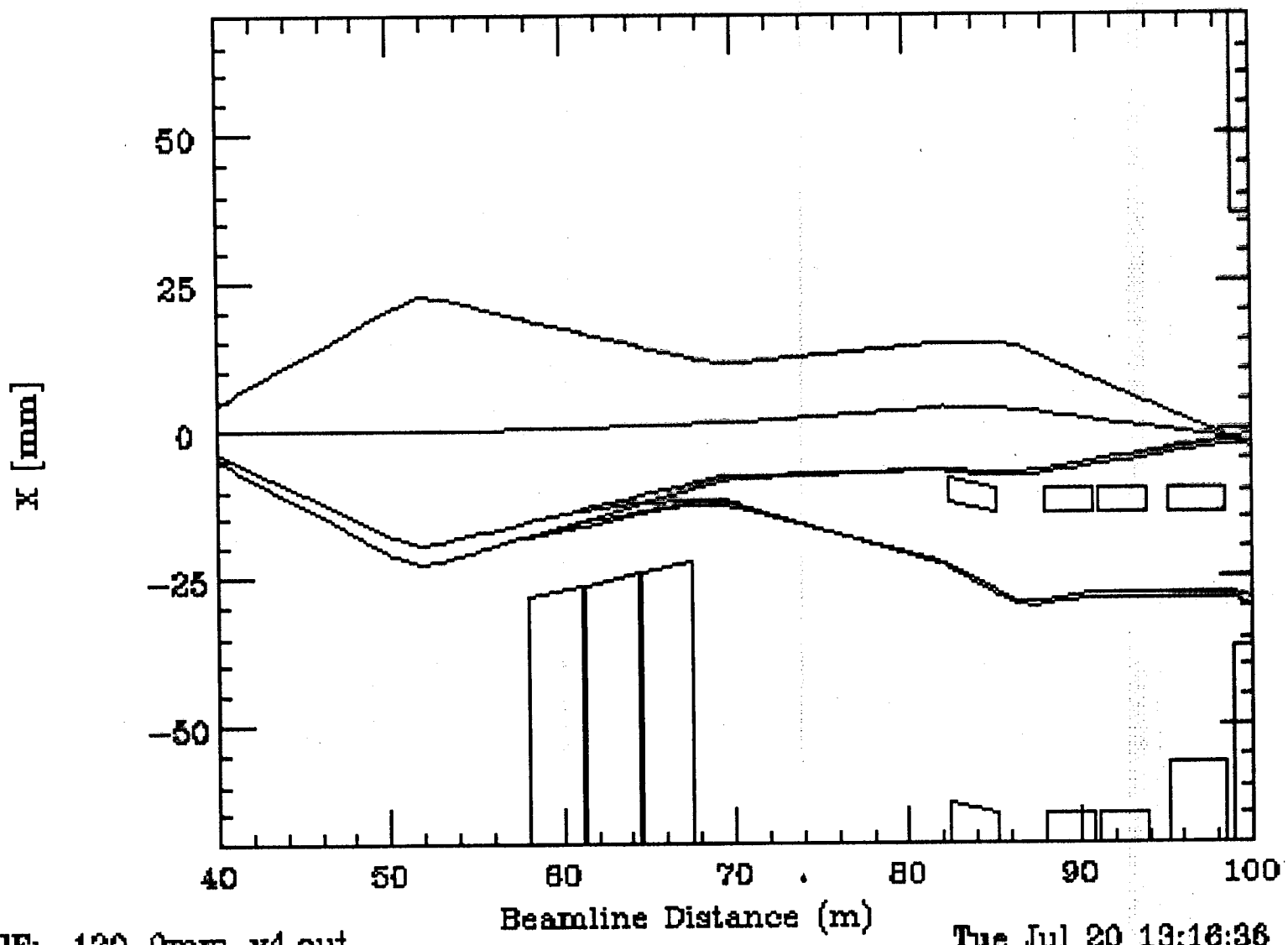
FILE: 8_0mm_v4.out
COMMENT:



FILE: 150_0mm_v4.out
COMMENT:

Tue Jul 20 13:05:33 1993

Beamline Central Trajectory and Magnet Apert



FILE: 120_0mm_v4.out
COMMENT:

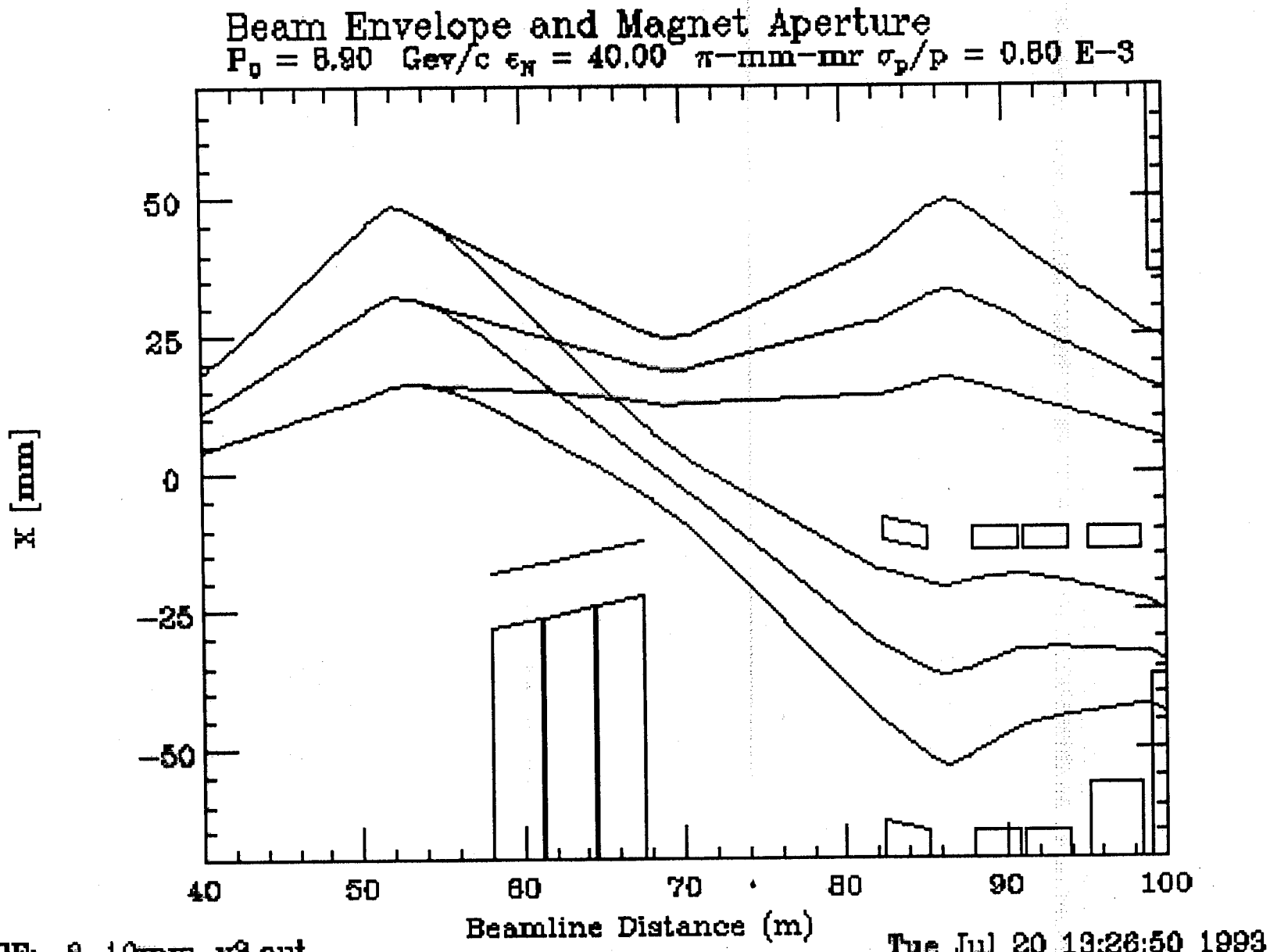
Tue Jul 20 13:16:36 1993

SOLUTION #3

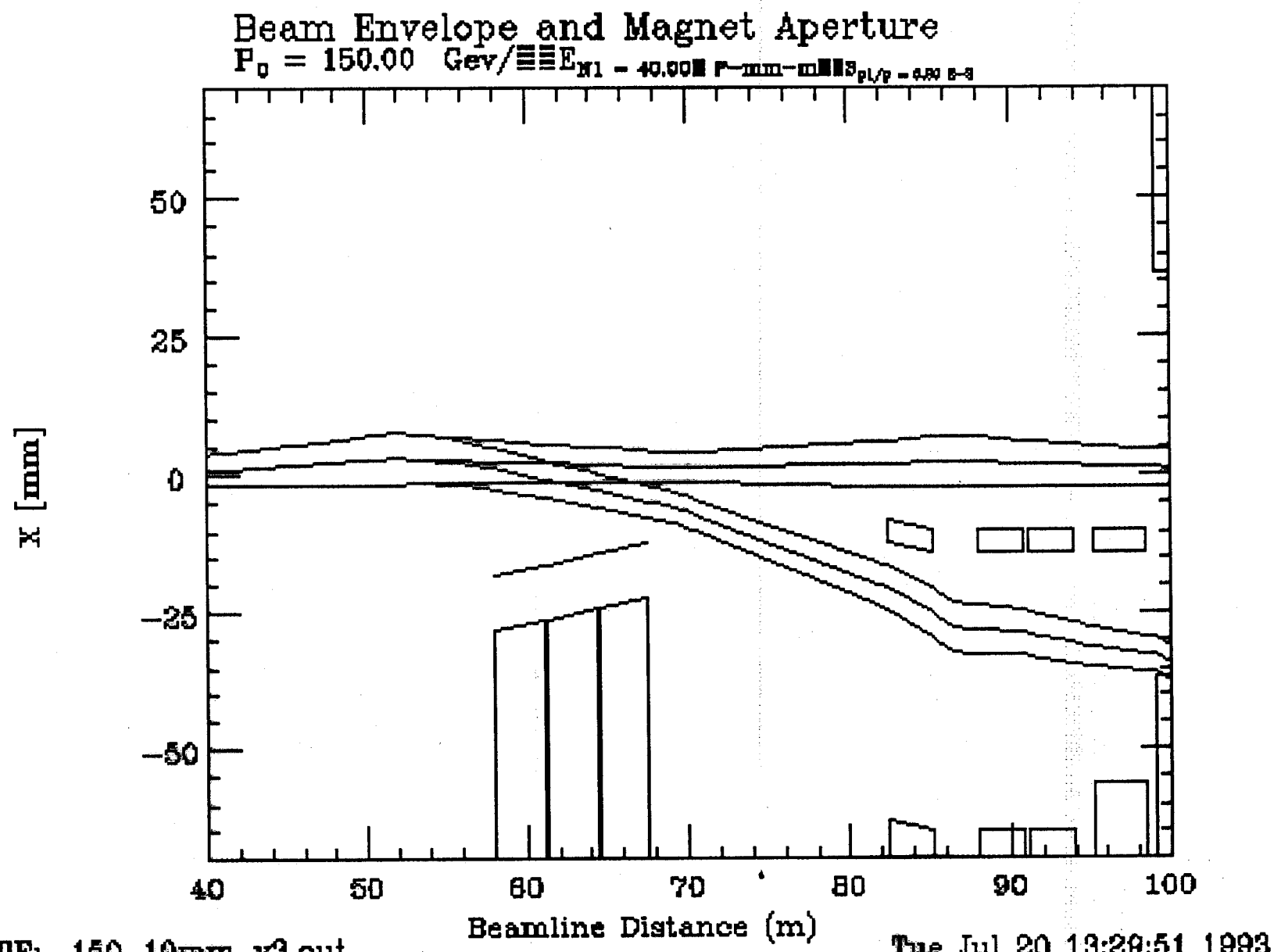
LAMBERTSON SEPTA AT 10mm

start q516 : _10mm_v3

	8 Gev	120 Gev	150 Gev
EX DEV ANG [mr]			
vlam1_ang	off	6	6
vlam2_ang	13.7743	6	6
vlam3_ang	13.7743	6	6
cmg1_ang	off	8.4	8.4
kick_ang	-1.4	off	-0.525
es_ang	off	-0.605	off
EX DEV TILT [rad]			
vlam1_tilt	NA	-0.22	-0.22
vlam2_tilt	-0.098656	-0.098656	-0.098656
vlam3_tilt	-0.037	-0.037	-0.037
cmg1_tilt	NA	0.07196	0.07196
C.O. BUMPS [mm]			
pos_520	30	0	3
pos_522	28	~~-12~~ 6.54	2
pos_524	3.97	~~6.54~~ -12	1
M_Q522	-35.718	-28.249	-27.972
MRK_Q1			
x	-32.578	-32.89	-32.593
xp	-0.161	-0.104	-0.108
y	218.437	218.03	218.03
yp	27.7	27.686	27.686
CORR ANGLES [ur]			
cor 518	783.05	0	78.3
corr 520	751.3	143.14	57.63
corr 522	807.1	-290.56	94.46
corr 524	749.4	31.78	61.39
corr 526	103.75	-313.34	26.11

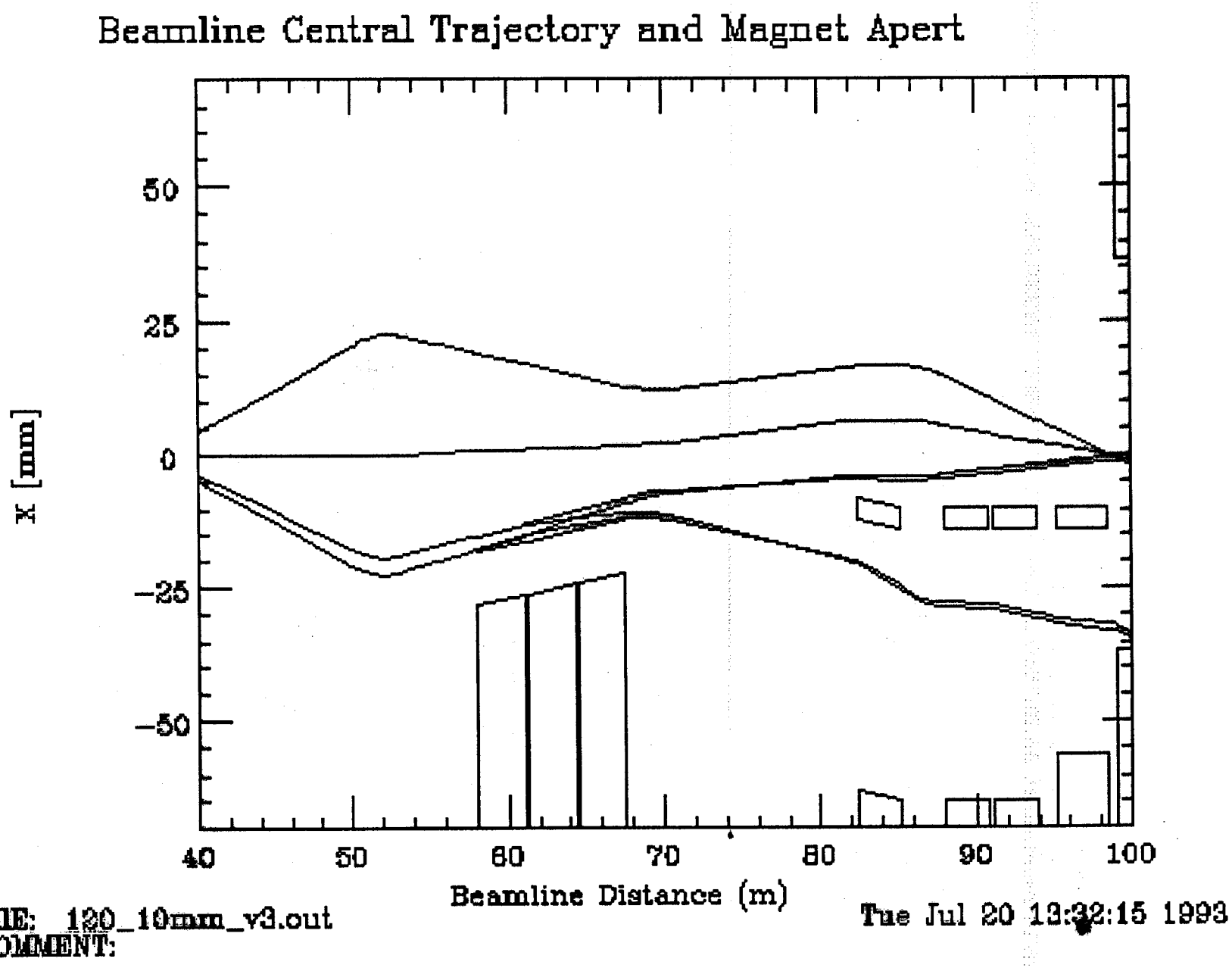


FILE: 8_10mm_v3.out
COMMENT:



FILE: 150_10mm_v3.out
COMMENT:

Tue Jul 20 13:29:51 1993

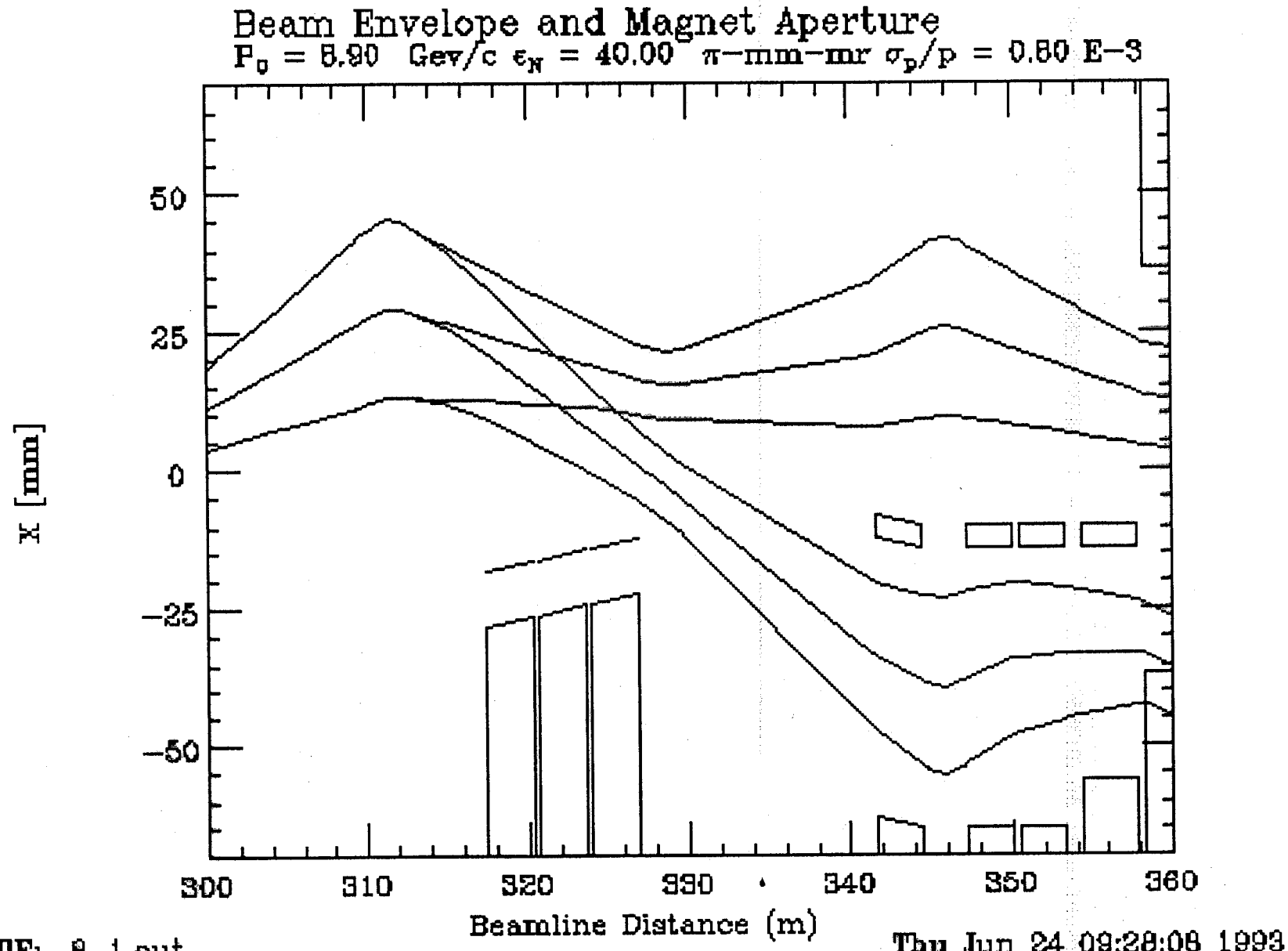

Beamline Central Trajectory and Magnet Apert
50
25
0
−25
−50
X [mm]
40
50
60
70
80
90
100
Beamline Distance (m)
FILE: 120_10mm_v3.out
COMMENT:
Tue Jul 20 13:32:15 1993

beamline stat Files stored Q501

SOLUTION #4

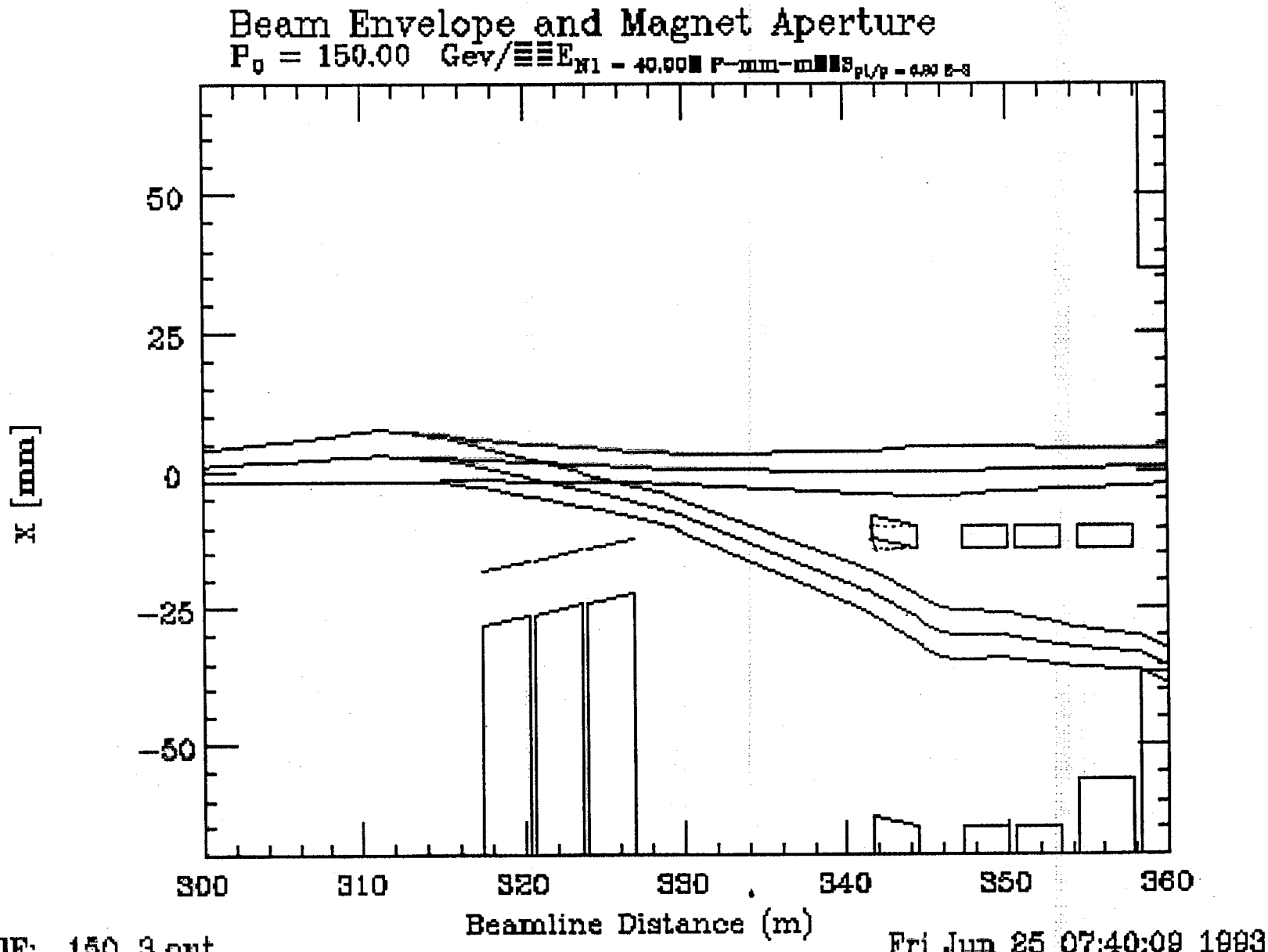
LAMBERTSON SEPTA AT 10mm

	8 Gev	120 Gev	150 Gev
EX DEV ANG [mr]			
vlam1_ang	off	6	6
vlam2_ang	13.7743	6	6
vlam3_ang	13.7743	6	6
cmg1_ang	off	8.4	8.4
kick_ang	-1.299	off	-0.521
es_ang	off	-0.60435	off
EX DEV TILT [rad]			
vlam1_tilt	NA	-0.22	-0.22
vlam2_tilt	-0.098656	-0.098656	-0.098656
vlam3_tilt	-0.037	-0.037	-0.037
cmg1_tilt	NA	0.07196	0.07196
C.O. BUMPS [mm]			
pos_520	29.8987	-1.6	3.070975
pos_522	29.7616	-9.8022	0
pos_524	21.3508	-6.122	3.098
MRK_Q1			
x	-32.964	-32.91	-33
xp	0.011	0.007	0.01
y	218.437	218.03	218.03
yp	27.7	27.686	27.703
CORR ANGLES [ur]			
cor 518	715.9236	-41.76	80.158
corr 520	594.689	-141.294	14.229
corr 522	810.6037	-293.18	145.25
corr 524	723.362	-261.96	34.028
corr 526	561.525	-255.95	80.9



FILE: 8_1.out
COMMENT: move outside

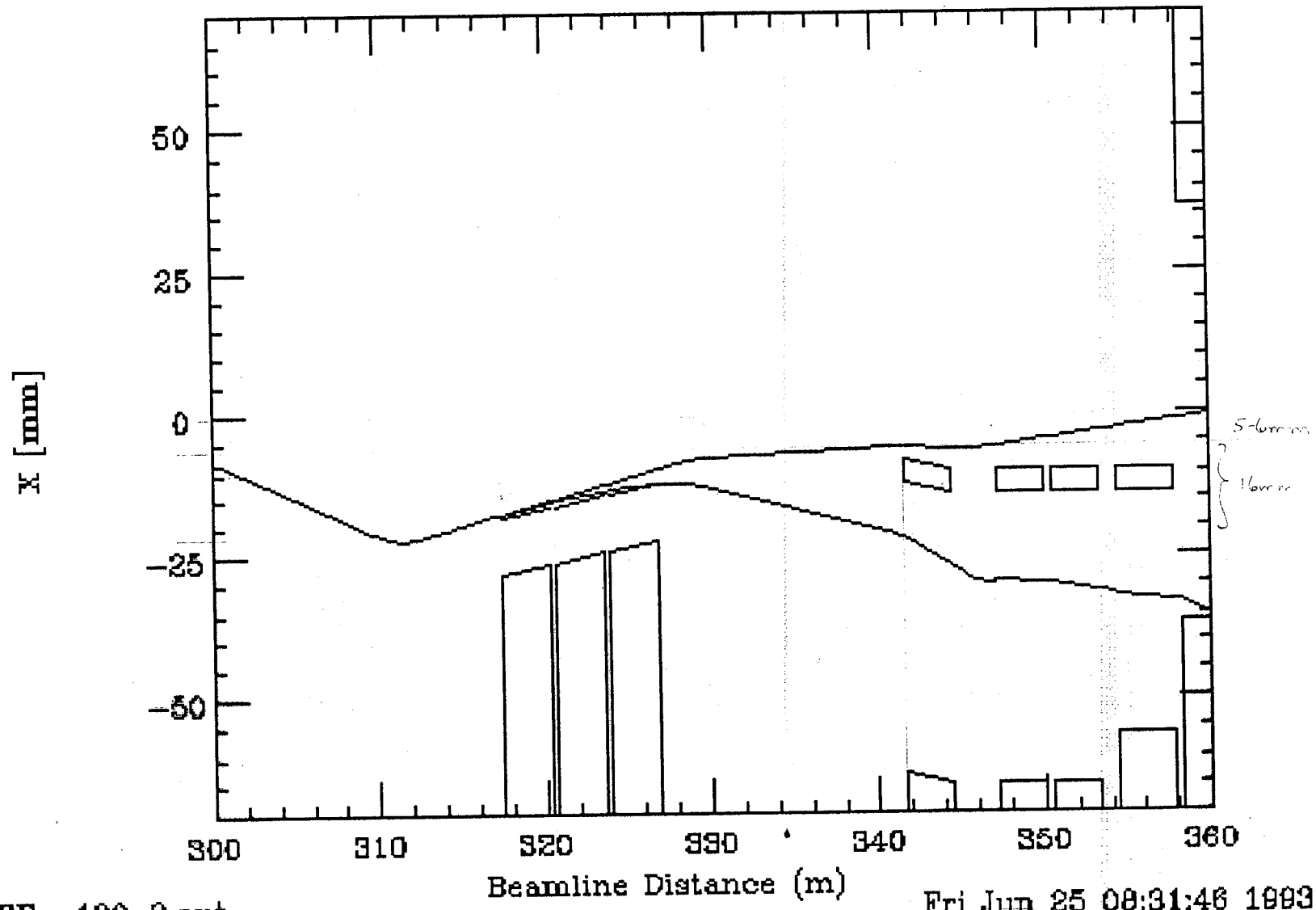
Thu Jun 24 09:28:08 1993



FILE: 150_3.out
COMMENT: move outside

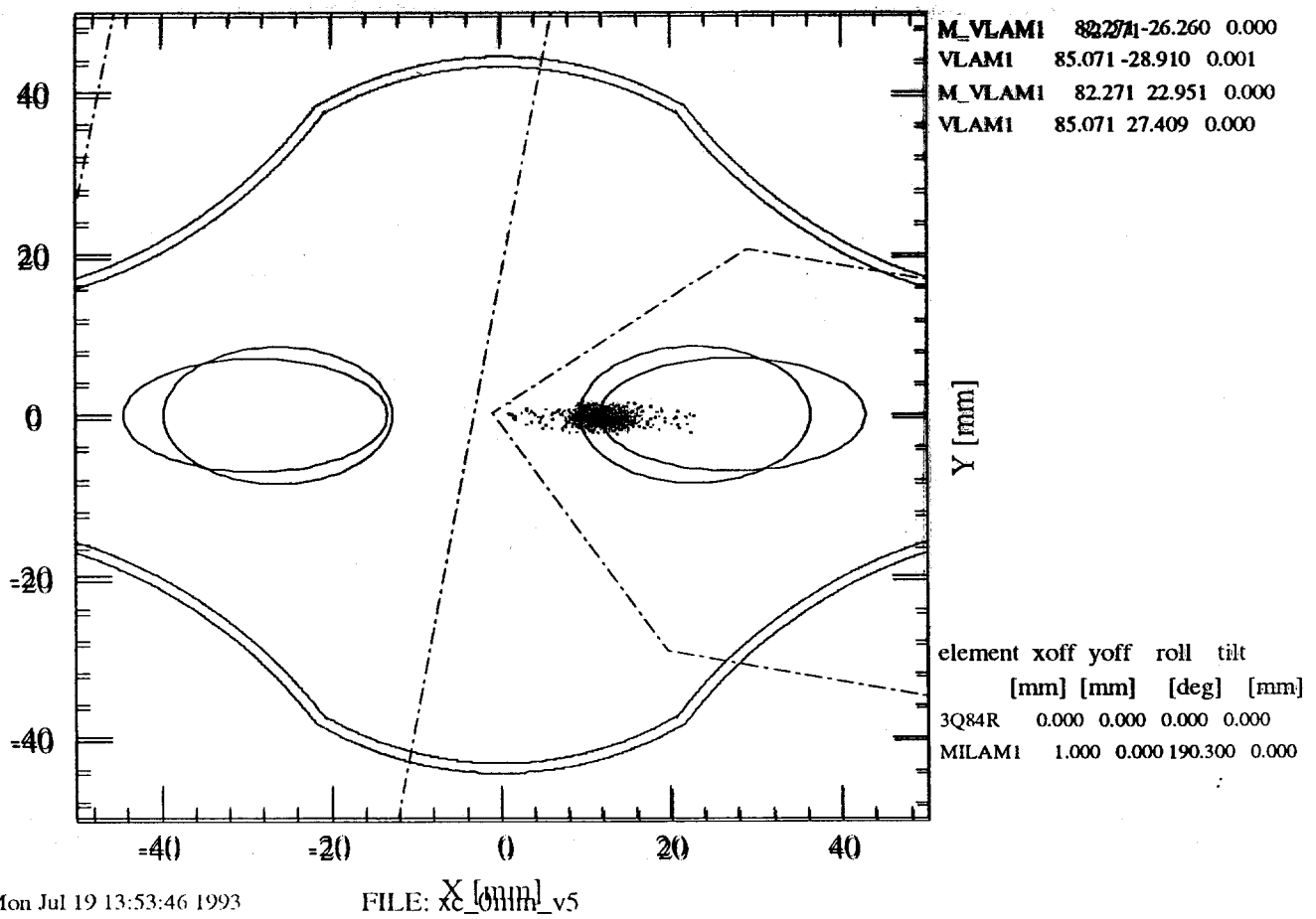
Fri Jun 25 07:40:09 1993

Beamline Central Trajectory and Magnet Apert



FILE: 120_2.out
COMMENT: move outside

Fri Jun 25 08:31:46 1993



Mon Jul 19 13:53:46 1993 FILE: xc_0mm_v5

BEAMLINE POWER SUPPLIES

TITLE I identified six Bend supplies and eight Quad supplies

ECR44 Since TITLE I 7 Quad supplies (4000A)* have been replaced with 500 A (50 kW) supplies

— POWER SUPPLY LOCATIONS:

B1 : extraction lambertsons } MI52 or FØ
B2 : extraction c-magnets }

B3 : Bend string (14 B2's) } FØ
B4 : single B2 }
B5 : tev injection c-magnet }
B6 : tev injection lambertson }

Q1 : Quad P1Q1 (~523) (3Q120) } MI52-FØ
Q2 : Quad P1Q2 (3Q120) }

Q3 : cell quads (P1Q3-P1Q9) (7-3Q84's) } FØ
Q4-Q8 : Quads P1Q10-P1Q14 (3Q120 & 60) }

The location of B1, B2, Q1, Q2 is dependent on cable runs (yet to be finalized)

- Cable vs Bus
  - All circuits at FØ will have cable to the tunnel
  - Q1, Q2, Q4-Q8 should have cable to magnets (500 MCM is costed but we may select something smaller for final installation)
  - Q3 cable to quad string with bus connecting quads and cable return.
  - B1, B2 all cable.
  - B3 cable to ~~quad~~ bend string with bus connecting bends and cable return.
  - B4-B6 all cable.

- 8 Gev level supplies for P1 (MI52)
  - This line is required to be at 8 Gev for injection of pbars and on the same cycle the A1 (MI62) is required to ramp to 150 Gev level.

  - 8 Gev supplies included for individual quad supplies in ECR

  - Do we need 8 Gev supplies for cell quad string and bend string?
    - dependent on 8 Gev ripple specs, nominal operating point, required tuning range, and time line.

- Lambertson supply
  - Do we put it on quad bus (MI) and use trim supplies or are they powered with a stand alone supply?
    - Title I has a 500kW Transrex
    - Trim supply on trim coil → USE HOPS, can be done but complicated.
    - Stick with Transrex. ~~with~~

RECOMENDATIONS:

1. DESIGN Large Aperture Quad -
   - initial parameters have been determined
     - # TURNS
     - POLE TIP radius
     - current
     - Gradient ...
   - Look at field quality
   - Can lamination off 4Q120 be used?
   - Cost estimate ??

2. High field correctors are needed for slow spill. They are not absolutely needed for 150 GeV extraction.

   Try to make MI corrector such that they could produce required field with a different power supply. (Alternately use same laminations with different coil pack (water cooled?).

3. Need to do a better estimate (cost) for slow extraction septa.