LU-178

400 MeV Linac Diagnostic Line

M. Popovic

March 18, 1991

1 Introduction

In this note I will describe the 400 MeV Linac diagnostic line. The primary roles of the existing and new diagnostic line are to safely dump the unused part of the linac beam and to measure beam momentum and emittance. The present Diagnostic Line starts at septum S1 and is the straight ahead continuation of the Linac exit line. The beam is then transported using two quadrupoles to the spectrometer magnet. During normal operation and Momentum measurement the spectrometer magnet bends the beam 40^0 and the beam is dumped into the Momentum Dump (Dump 2). During emittance measurements (emittance measurements are usually made only during linac studies), the spectrometer magnet is off and the beam is dumped into the straight ahead dump, Dump 1. The wires W2, W3, and W4 are used for the emittance measurements and wire W5 for momentum measurements.

The new line can be made as a carbon copy of the existing one except for spectrometer magnet. Due to the increased magnetic stripping of H^- with energy increase I have considered two possibilities. One is to strip H^- to protons before bending the proton beam 40^0. The spectrometer magnet in this case will be relatively short (about 1.5 meters) and will have a magnetic field $\sim$ 15 kG. The second option that I have considered is to bend and dump H^- and have a long (about 3 meters) Spectrometer Magnet with magnetic field about 7.5 kG. Based on the cost estimates (see Appendix A) and studies made on the Linac Dumps (see Appendix B), I will present the

beam optics design assuming that the existing dumps will be used and that the spectrometer magnet will be a long one with 7.5 kG field.

2 Beam Optics

The new Diagnostics line starts at the end of the Lambertson magnet and has two Loma Linda type quadrupoles (Q2 and Q3) positioned as closly to the Lambertson magnet as was possible. The spectrometer magnet has a magnetic field of 7.5 kG and magnetic length of 2.96 cm so that the H^- beam is bent 40^0, see Fig 1. In all beam optics calculations I have taken Carol Johnstone's input[1] for elements for the 400 MeV line up to the Lambertson magnet and turned off the currents in the Chopper and Lambertson so that the beam coming to the Diagnostic line has all the characteristics of the beam coming from the Linac. Figures 2-7 and Appendices C, D, E are results of the Transport runs for;

- normal operation setting (quadrupoles field, Q2=-2.2 kG, Q3=1.15 kG),
- momentum measurement setting (Q2=-2.80 kG, Q3=2.27 kG) and
- forward dump setting (Q2=2.84 kG, Q3=-3.03 kG).

Figures 2, 3 and 4 show β functions in two transverse directions and positions of the beam line elements. Figure 5, 6 and 7 show the half width of the beam as function of position and beam line elements. I have assumed that the Linac beam will have normalized emittance $\epsilon^* = 10\pi$ mm mrad in both transverse directions. I am assuming that emittance is define as[2]

$$\epsilon = \pi \frac{x^2}{\beta},$$

where x is half width of the beam (of the 98% of the beam assuming that beam will have Gaussian distribution) and $\epsilon^* = \beta\gamma\epsilon$. Quadrupoles field setting are fixed assuming that

- the beam pipes have radius $r = 4.127$ cm (diameter 3.25'),
- Loma Linda quadrupoles have radius $r = 4.127$ cm (diameter 3.25'),

- spectrometer magnet has a good field half width of 4.0 cm horizontal,
- spectrometer magnet has a half gap of 2.0 cm vertical,
- the straight through pipe that passes through the Spectrometer magnet has radius=2.0 cm

3 Spectrometer Magnet

Based on the cost estimates (see Appendix A) and safety issues I am assuming that H^- beam will be dumped in the Momentum Dump. Due to the electron stripping of H^- by magnetic fields which increases with beam energy, the magnetic field in the spectrometer magnet must be kept below the present value. The final number, $N_F(H^-)$ of the H^- after passing distance s in magnetic field can be written as[3] a function of the initial number $N_I(H^-)$ of H^-,

$$N_F(H^-) = N_I(H^-)\frac{s}{c\beta\gamma\tau}$$

where c, β and γ are the usual relativistic quantities. The τ is the mean life of an ion H^- in the magnetic field B and is given as

$$\tau = \frac{A}{E}\exp(\frac{D}{E})$$

where $A = 1.05 \times 10^{-14}$ sec MV/cm, $D = 49.25$ MV/cm and $E = 0.3\beta\gamma B$ MV/cm. The magnetic field B is in kilogauss.

To keep electron stripping at the preset level ($\sim 0.1\%$ of the H^- beam is stripped presently) it was suggested[4] and can be seen from Figures 8 and 9 that the spectrometer magnet should have magnetic field $\sim 7.5kG$. Figures 8 and 9 show efficiency of stripping as a function of magnetic field for 200 MeV and 400 MeV beam.

Based on the preliminary design of the Spectrometer magnet done by C. Schmidt[4], I have made a number of Poisson runs. Figure 10 shows the poletip shape, magnetic field lines and the cross section (one quater) of the magnet with relevant dimensions. Table 1. lists values of the magnetic field in the middle plane of the magnet. As can be seen, the good field half width extends up to 4.0 cm. I am defininig "good field region" where $\frac{\Delta B}{B_0} \leq 3. \times 10^{-4}$.

4 References

1. Carol Johnstone 400 MeV line, report
2. Sho Ohnuma, The Beam Emittance, EXP-111, November 28,1983
3. G. M. Stinson at al., Nuclear Instruments and Methodes, 74 (1969) 333-341
4. C. Schmidt, Fermilab, unpublished.

400 MeV DIAGNOSTIC LINE

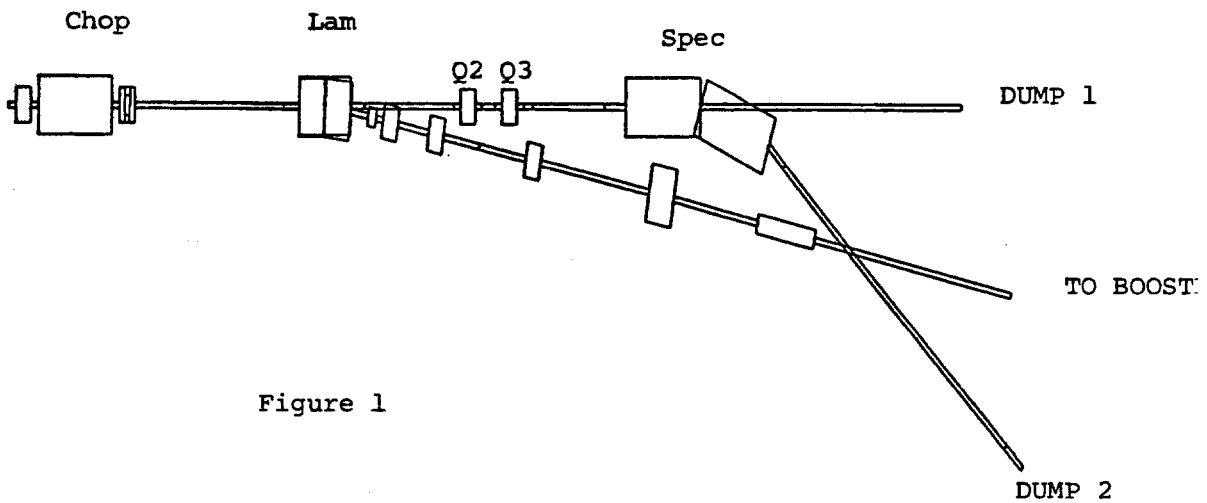


Figure 1

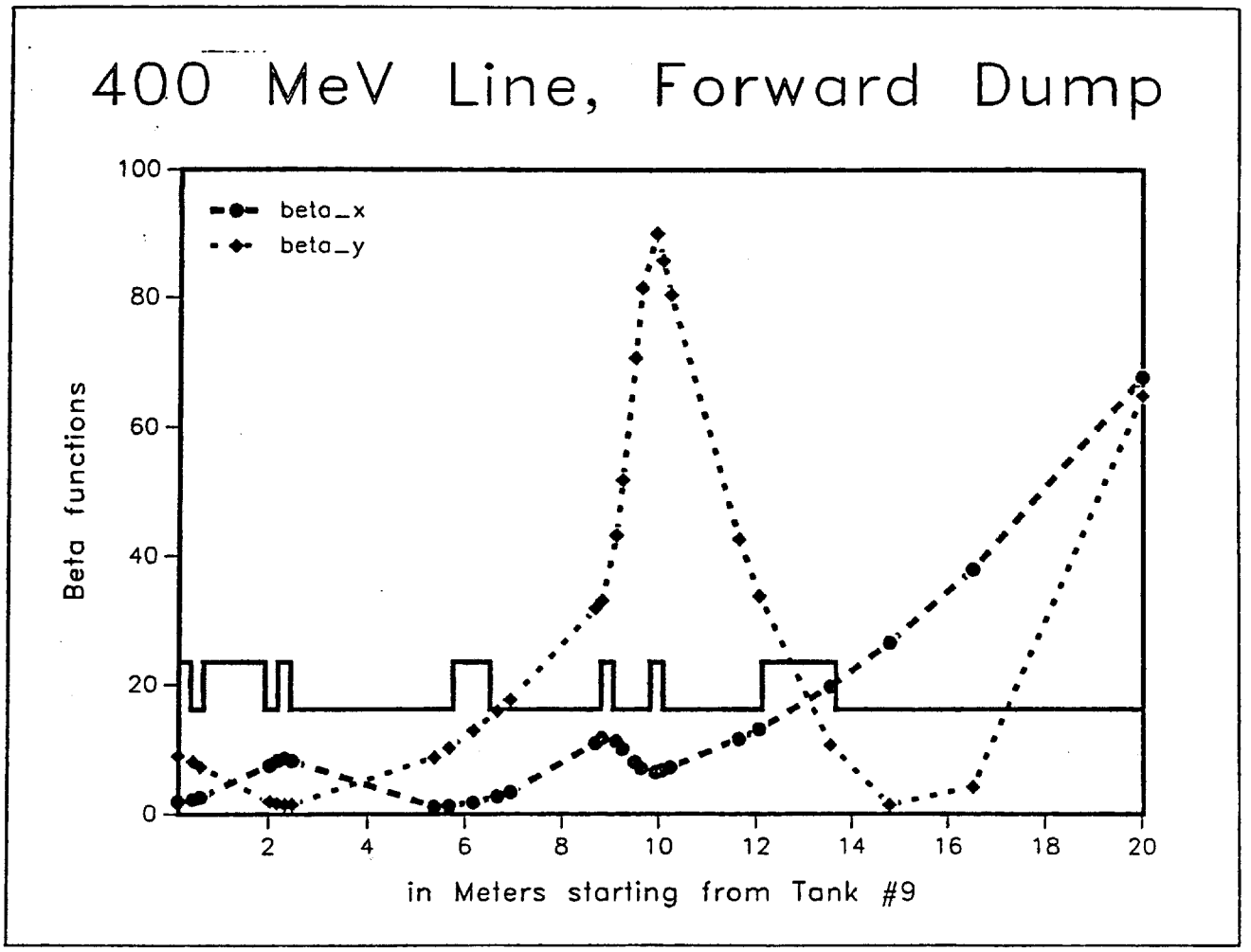


Figure 2

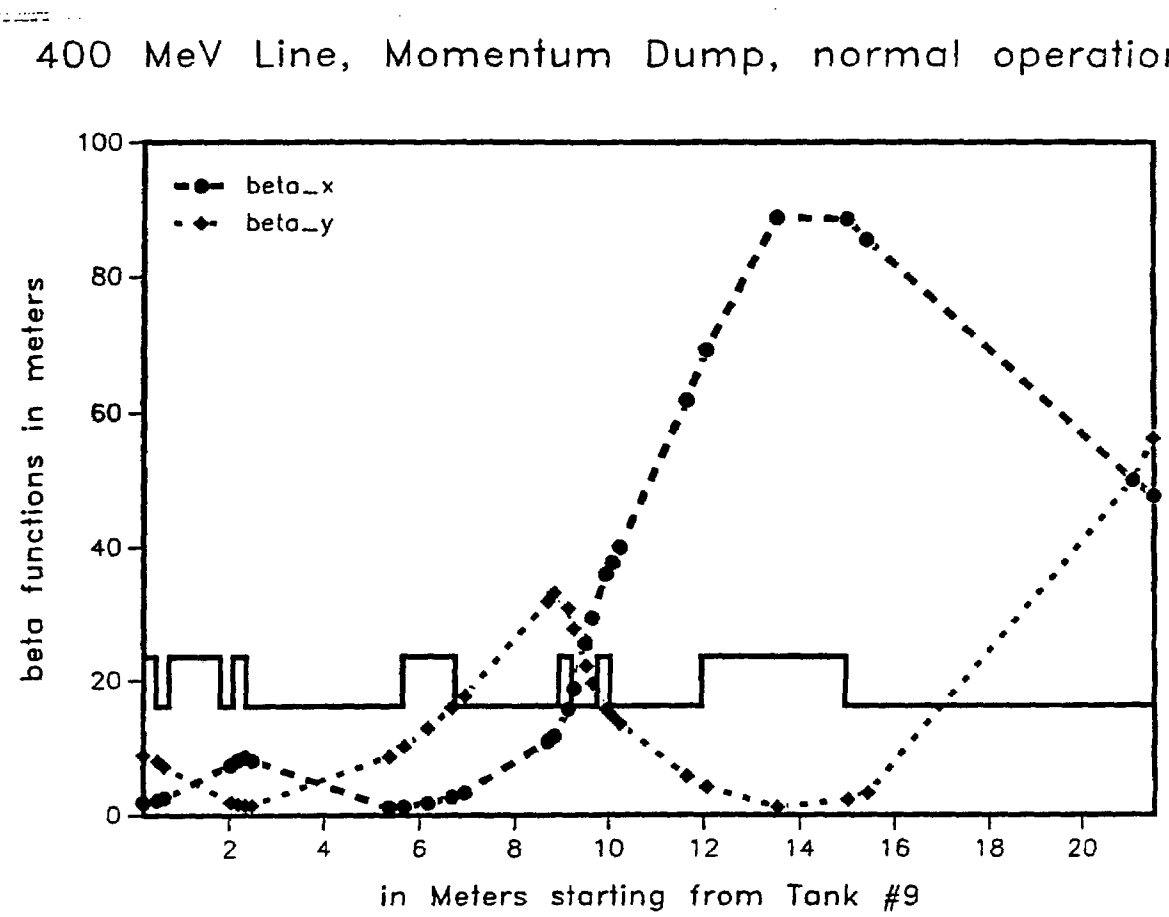


Figure 3

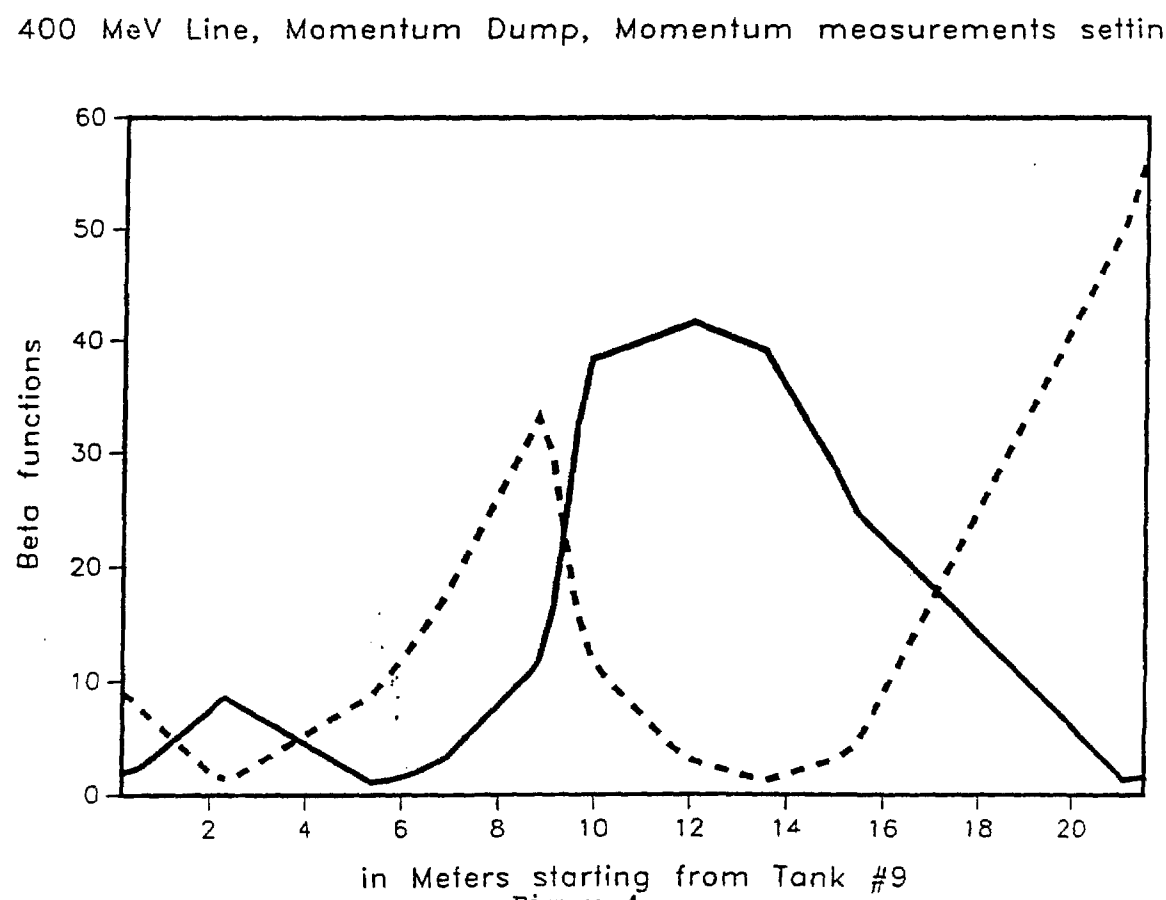


Figure 4

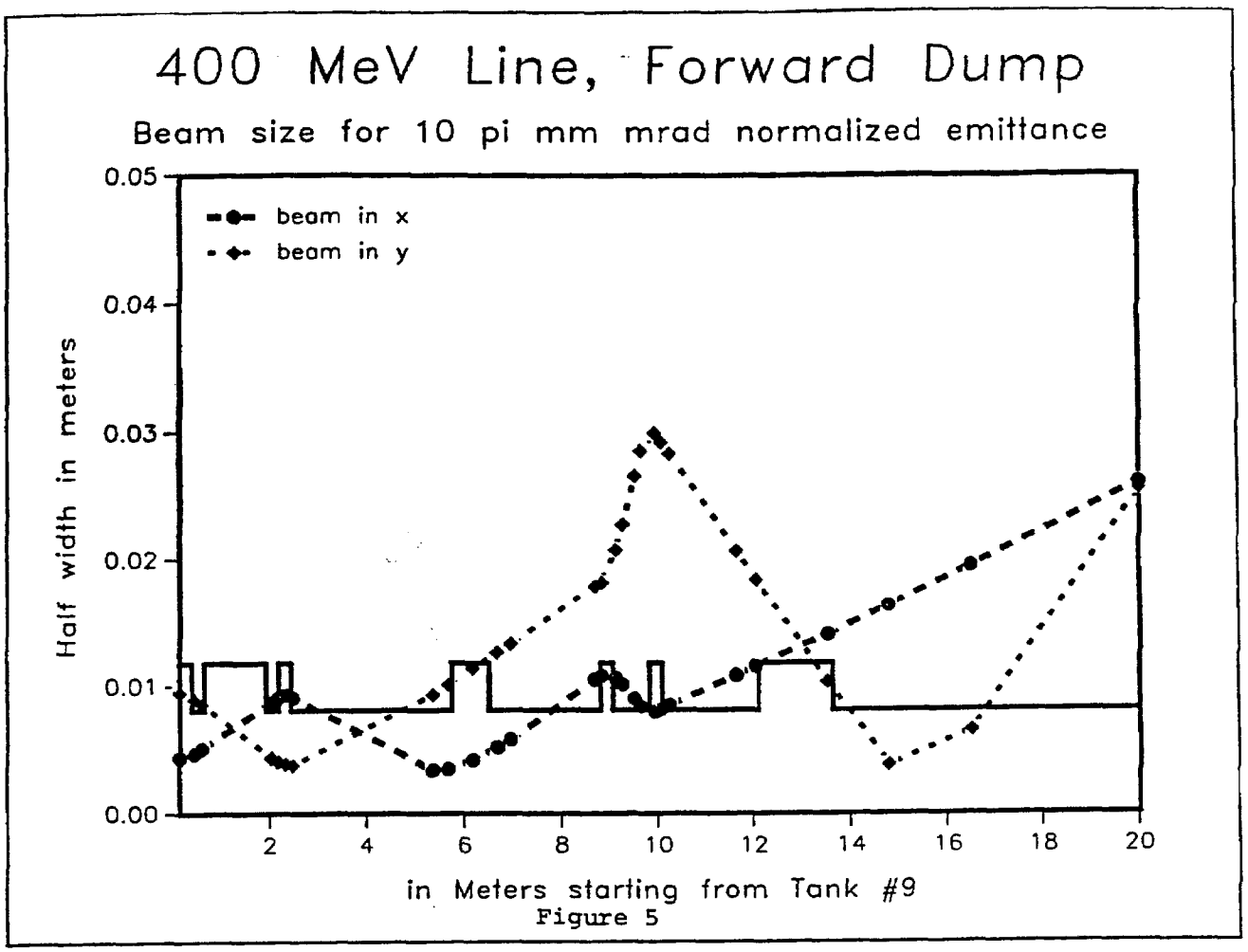


Figure 5

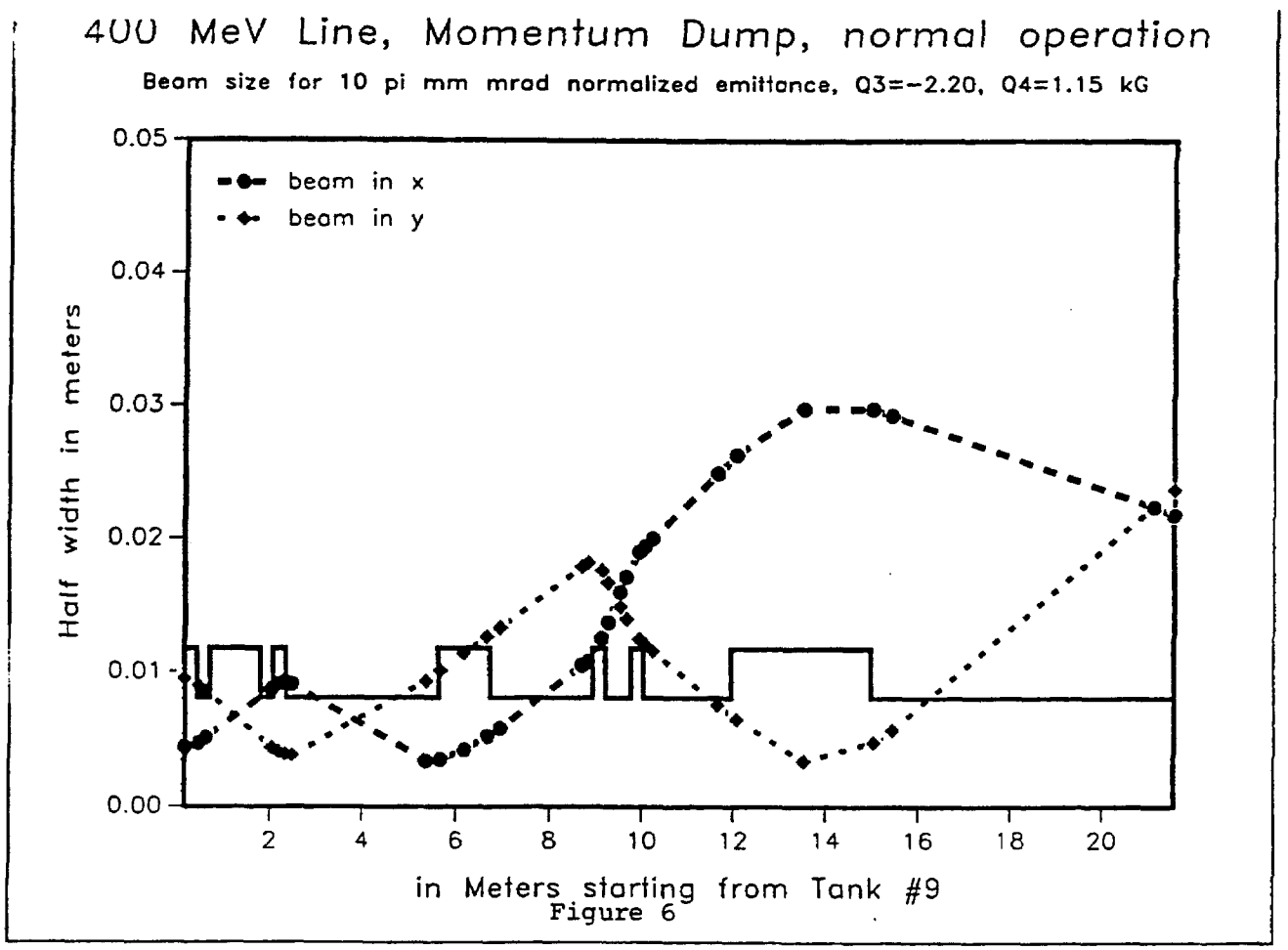


Figure 6

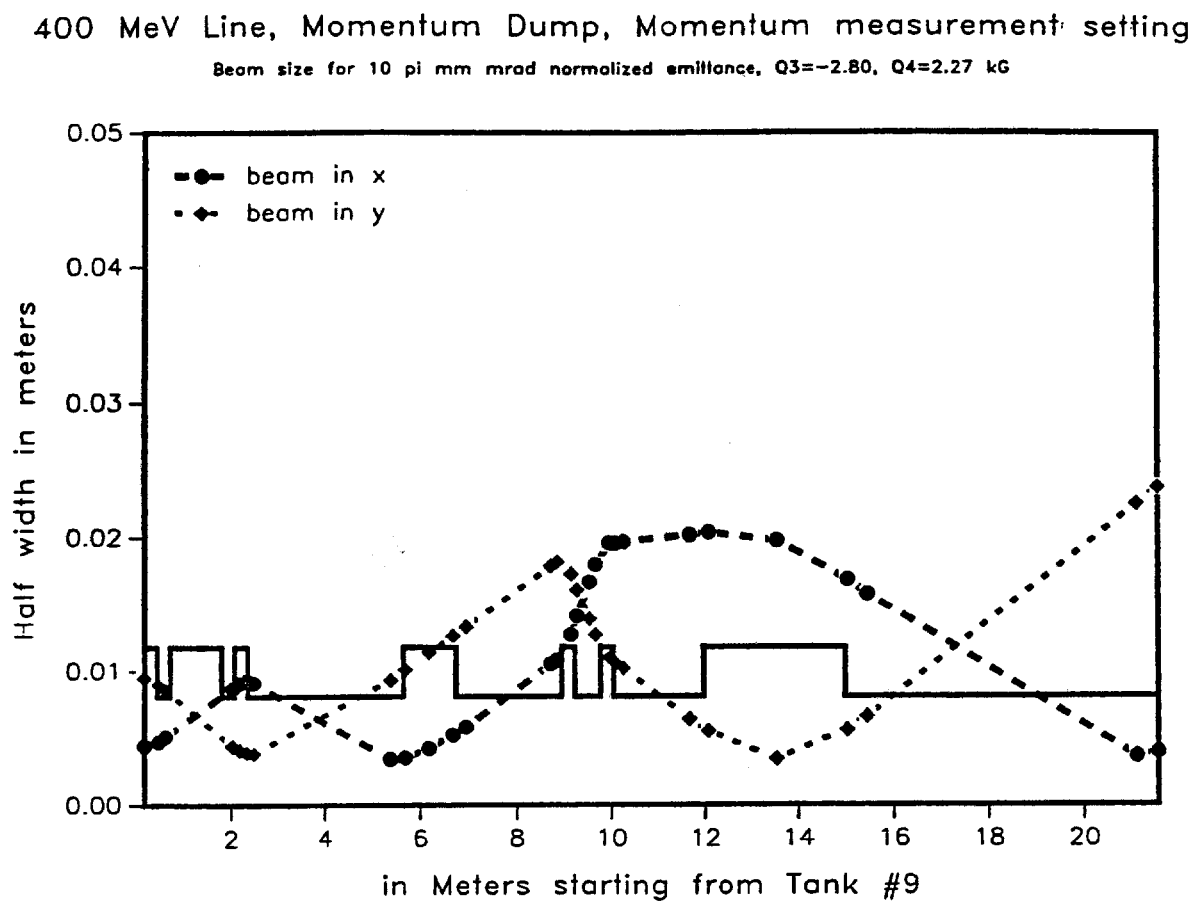
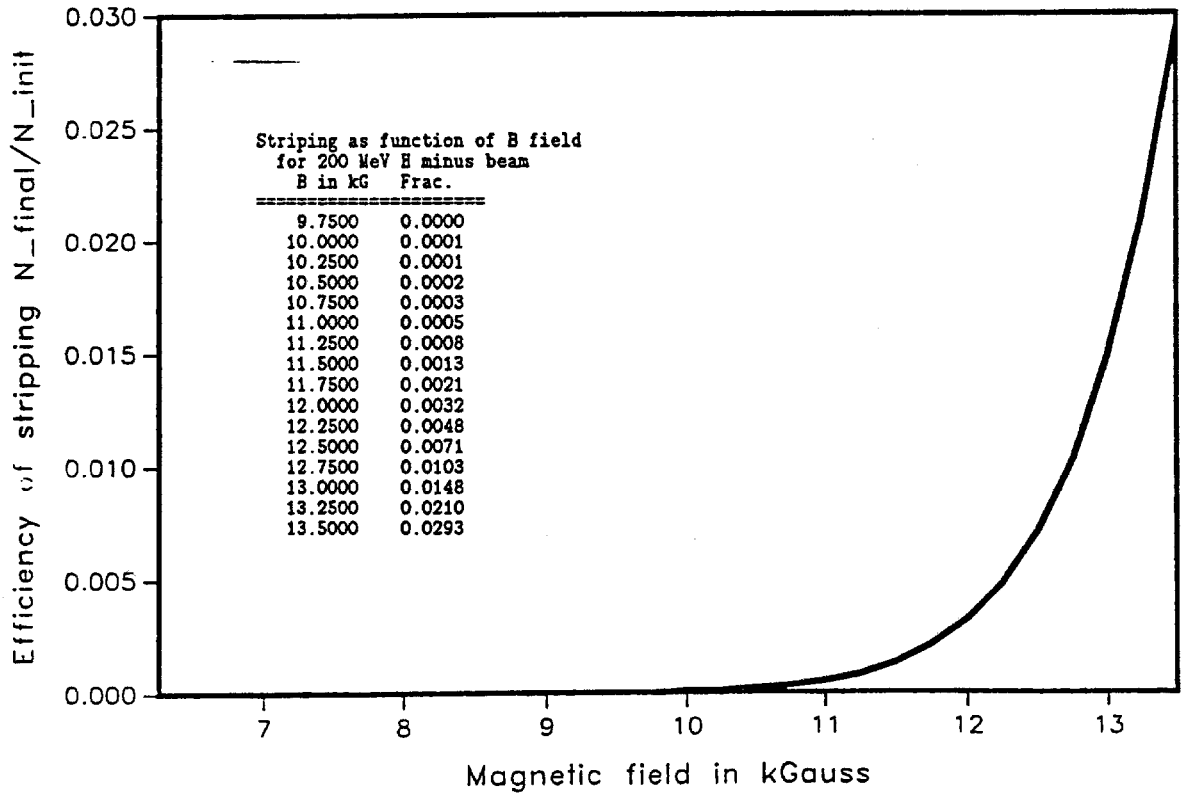


Figure 7



Striping as function of B field
for 200 MeV H minus beam

B in kG	Frac.
9.7500	0.0000
10.0000	0.0001
10.2500	0.0001
10.5000	0.0002
10.7500	0.0003
11.0000	0.0005
11.2500	0.0008
11.5000	0.0013
11.7500	0.0021
12.0000	0.0032
12.2500	0.0048
12.5000	0.0071
12.7500	0.0103
13.0000	0.0148
13.2500	0.0210
13.5000	0.0293

Figure 8

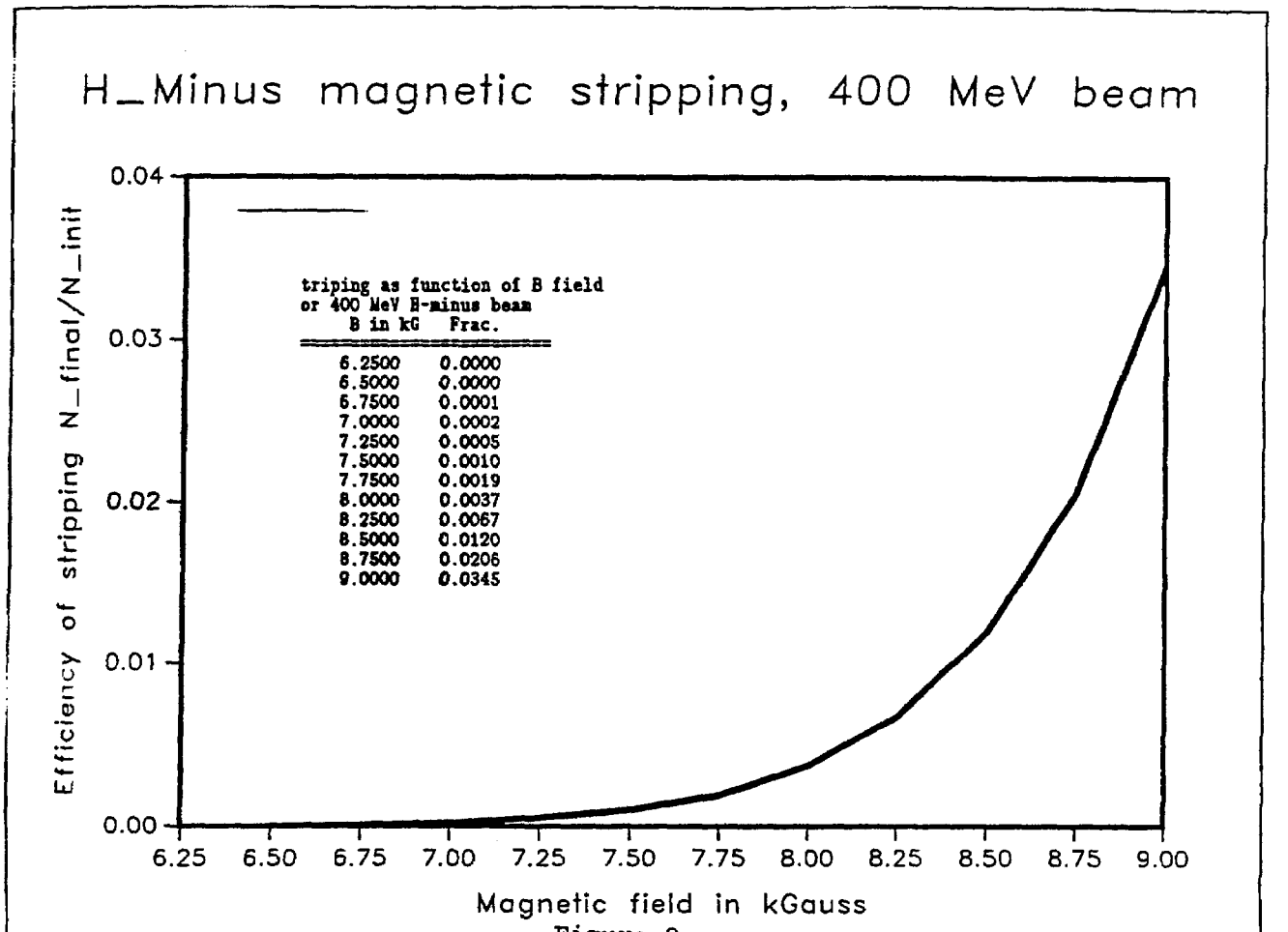


Figure 9

SPECTROMETER 400 MEV MAGNET, UNI; Poisson cycle number 590

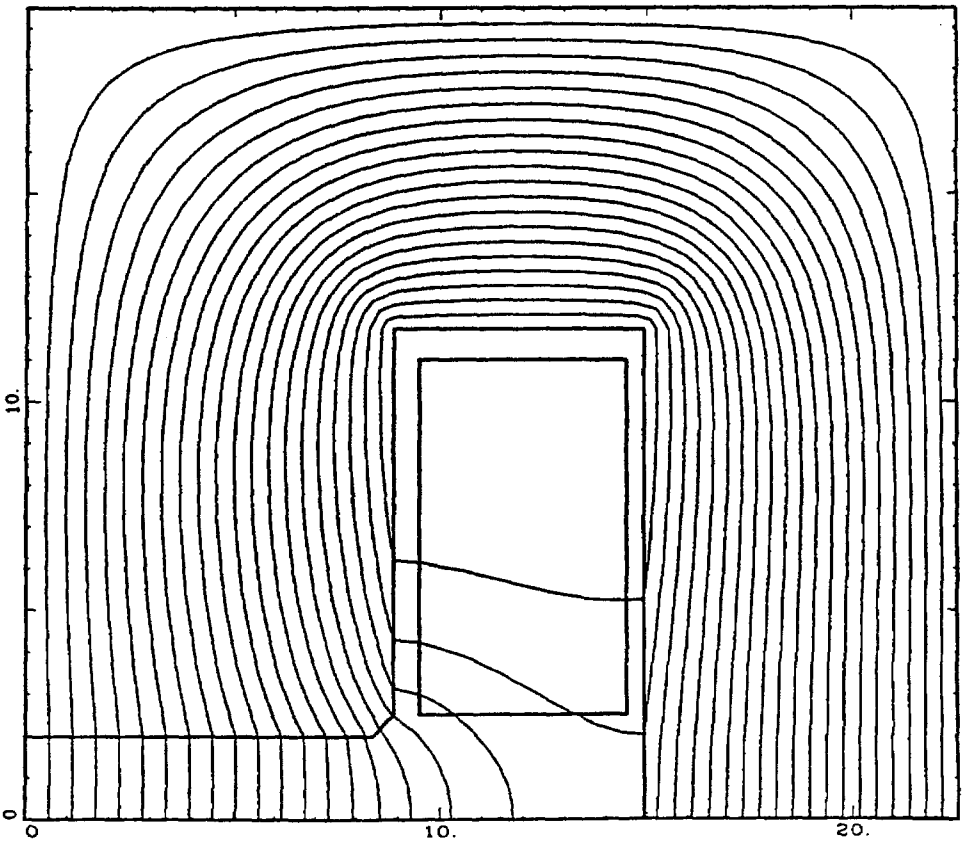


Figure 10

TABLE 1

LEAST SQUARES EDIT OF PROBLEM , CYCLE 600

'H' MAG SYMMETRY TYPE

STORED ENERGY = 5.0843E+02 JOULES / METER OR RADIAN

********** WARNING **********
THE ENERGY IS CALCULATED AS THE VOLUME INTEGRAL OF 0.5*B*H
A CORRECT CALCULATION IS THE INTEGRAL OF B*DH OVER THE
VOLUME FOR HIGHLY NONLINEAR MAGNETIC MATERIALS.

THE PRINTED ENERGY MAY BE SIGNIFICANTLY IN ERROR.
CORRECTION IS PENDING.

XJFACT= 1.000000

K	L	A(VECTOR)	X	Y	BX(GAUSS)	BY(GAUSS)	BT(GAUSS)	DBY/DY(GAUSS/CM)	DBY/DX(GAUSS/CM)	AFIT
1	1	0.000000E+00	0.00000	0.00000	0.000	7482.233	7482.233	0.0000E+00	0.0000E+00	1.2E-04
2	1	-3.372990E+03	0.45080	0.00000	0.000	7482.225	7482.225	0.0000E+00	-3.0837E-02	4.2E-05
3	1	-6.745974E+03	0.90160	0.00000	0.000	7482.207	7482.207	0.0000E+00	-6.4058E-02	-2.3E-04
4	1	-1.011894E+04	1.35240	0.00000	0.000	7482.167	7482.167	0.0000E+00	-1.0946E-01	-5.6E-05
5	1	-1.349189E+04	1.80320	0.00000	0.000	7482.103	7482.103	0.0000E+00	-1.7944E-01	-1.9E-03
6	1	-1.686480E+04	2.25400	0.00000	0.000	7481.999	7481.999	0.0000E+00	-2.9615E-01	8.8E-03
7	1	-2.023765E+04	2.70480	0.00000	0.000	7481.822	7481.822	0.0000E+00	-5.2115E-01	9.0E-04
8	1	-2.361039E+04	3.15560	0.00000	0.000	7481.505	7481.505	0.0000E+00	-9.3261E-01	3.3E-03
9	1	-2.698294E+04	3.60640	0.00000	0.000	7480.928	7480.928	0.0000E+00	-1.7503E+00	1.5E-03
10	1	-3.035512E+04	4.05720	0.00000	0.000	7479.820	7479.820	0.0000E+00	-3.3617E+00	9.5E-03
11	1	-3.372659E+04	4.50800	0.00000	0.000	7477.665	7477.665	0.0000E+00	-6.6054E+00	6.4E-03
12	1	-3.709666E+04	4.95880	0.00000	0.000	7473.410	7473.410	0.0000E+00	-1.3090E+01	6.0E-03
13	1	-4.046398E+04	5.40960	0.00000	0.000	7464.941	7464.941	0.0000E+00	-2.6070E+01	2.4E-02
14	1	-4.382580E+04	5.86040	0.00000	0.000	7448.089	7448.089	0.0000E+00	-5.1795E+01	1.8E-02
15	1	-4.717673E+04	6.31120	0.00000	0.000	7414.753	7414.753	0.0000E+00	-1.0186E+02	3.5E-02
16	1	-5.050625E+04	6.76200	0.00000	0.000	7349.855	7349.855	0.0000E+00	-1.9590E+02	4.5E-02
17	1	-5.379480E+04	7.21280	0.00000	0.000	7227.597	7227.597	0.0000E+00	-3.6096E+02	1.0E-01
18	1	-5.700846E+04	7.66360	0.00000	0.000	7010.578	7010.578	0.0000E+00	-6.1754E+02	9.2E-02
19	1	-6.009542E+04	8.11440	0.00000	0.000	6660.188	6660.188	0.0000E+00	-9.4433E+02	-7.7E-03
20	1	-6.299077E+04	8.56520	0.00000	0.000	6161.607	6161.607	0.0000E+00	-1.2573E+03	-1.1E-01
21	1	-6.563269E+04	9.01600	0.00000	0.000	5544.311	5544.311	0.0000E+00	-1.4563E+03	-7.2E-02
22	1	-6.798123E+04	9.46680	0.00000	0.000	4871.688	4871.688	0.0000E+00	-1.5013E+03	-1.0E-01
23	1	-7.002850E+04	9.91760	0.00000	0.000	4208.011	4208.011	0.0000E+00	-1.4257E+03	-2.7E-02

FERMI NATIONAL ACCELERATOR LABORATORY
ACCELERATOR DIVISION
MECHANICAL SUPPORT GROUP

March 18, 1991

To: Milorad Popovic

From: Stewart Mitchell

Subject: Spectometer magnet cost estimate

Budget Code: LYD

This is a cost estimate and cost comparison between two versions of the proposed spectometer or analysis magnet and is furnished at your request.

	Long version	Short version
Length(m)	2.97	1.485
Length(ft)	9.744	4.872
Length(in)	116.9289	58.464
Steel $	$4692	$2346
Coil $	$2314	$4628
Total $	$7006	$6974

These costs are for the material only and do not include labor.

WITH Labor (3.5xmaterial)	$24521	$24409

This estimate does not include labor assembling the magnet or other costs attendent to preparing it for service. When these costs are added, my best guess for these two magnets are:

$44521	$44409

Please note that the cost given for the coils is based on $6.60/lbs. If you decide to use the conductor shown on the attached dwg MA-186611, the price for only the coil material may vary by up to 200 per cent, depending on the price of the copper. You will be charged for the material based on the price when it was purchsed, not when you use it. Obviously, this can be good, or it can be bad, depending on the price of copper. Also attached for your information is a partial drawing of the pancake we are using on the Loma Linda quad.

cc: Carol Johnstone
Jim Lackey
Kay Weber
Debbie Cobb

APPENDIX C

CHANGEDATE(TRMAIN FORTRAN 19960807 12:17:31)

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"400-MEV DIAGNOSTIC LINE, NORMAL OPERATIONS, MOMENTUM DUMP - M. Popovic, 1-FEB-1 "

    0
15 1. 'MM' ;                                                                  (  1          )
(ALL TRANSVERSE DIM IN MM)                                                    (  1          )
13 3. ;                                                                       (  2 ELEMENTS)
(PRINT BEAM'S SIGMA AFTER EVERY ELEMENT)                                      (  2          )
13 12. ;                                                                      (  3          )
( COORDINATS OF LAYOUT OF THE LINE)                                           (  3          )
13. 7 ;                                                                       (  4          )
(USE ACCELERATOR NOTATION)                                                    (  4 ELEMENTS)
(13. 13. ;)                                                                   (  4          )
(15 8. 'CM' 0.01 ;)                                                           (  4          )
(**************************START FROM HERE*******************)                (  4          )
(The 0 of coordinat system will be assumed at Wire 1)                         (  4          )
(the first element is the end of the last linac tank 9)                       (  4 ELEMENTS)
(********BEAM CARD********)                                                   (  4          )
(1 1.9397 0. 9.0271 0. 0. 0. .954 ;LATTICE)                                   (  4          )
(1 3.6848 1.8997 7.9492 .7754 0. 0. .954 ;)                                   (  4          )
(1 16.9 9.25 7.5 6.01 0. 0. .6514 ; THIS IS X THETA)                          (  4          )
(1 16.2758  4.93 2.8989 -0.85, 0. 0. 0.6514 ;)                                (  4 ELEMENTS)
(THISE ARE BETAX,ALPHAX,BETAY,ALPHAY, ..., USED WITH 13 7 PRINT CODE)         (  4          )
(UNITS FOR BETA ARE RETION OF OF TRANSVERSE DIM, MM/MR=METER)                 (  4          )
(this numbers are from c.s)                                                   (  4          )
(SPECIAL ZBEGIN=-2.6987)                                                      (  4          )
(I have included corrected value from kicker to tank-9)                       (  4 ELEMENTS)
(Physical length OF QUADS is 25.4 cm. At each end of quad I am puting 6 )     (  4          )
(inches for bellows, so physicaly the quad is 2*6+10 inchies)                 (  4          )
(in Transport I am puting magnetic length=0.2985=2*14.925 as it is requered)  (  4          )
(the drift at each end should be 13.015 cm)                                   (  4          )
(diametar of the quads is 3.25 inches, each quad is cut on two pieces longit.) (  4 ELEMENTS)
(tank 9 out)                                                                  (  4          )
(=================================)                                           (  4          )
1 1.9397 0. 9.0271 0. 0. 0. .954 ;                                            (  5          )
( beta alfa ...)                                                              (  5          )
(1 3.6848 1.8997 7.9492 .7754 0. 0. .954 ;)                                   (  5 ELEMENTS)
ETA ETAX = 0., DETAX = 0., ETAY = 0., DETAY = 0., ETAL =0., ETAP = 1. ;       (  6          )
(beam data is taken from trace3d calculation of Jim MacLaughlin)              (  6          )
(******EXIT OF LAST LINAC QUAD IN TANK 9 IS BEGINNING OF LINE******)          (  6          )
SPECIAL ZBEGIN=-3.1284                                                        (  7          )
(******************)                                                          (  7 ELEMENTS)
3.  'DU1' .1524 ;                                                             (  8          )
5.0 'QC1' .2985 -1.5 41.275 ;                                                 (  9          )
3. 'DD1' .1524 ;                                                              (  10         )
(******************)                                                          (  10         )
4. 'CHOP' 1.43 0.0 0. ;                                                       (  11 ELEMENTS)
3. 'DU2' .1524 ;                                                              (  12         )
5. 'QCU2' .14825 2.64 41.275 ;                                                (  13         )
4.0 'QBD' .002 0.0 ;                                                          (  14         )
5.0 'QCD2' .14825 2.64 41.275 ;                                               (  15         )
(3. 'D4' 3.1981 ; this drift is now d4+wire+d41 so that i have)               (  15 ELEMENTS)
(wire at same position as in old 200 MeV line)                                (  15         )
(3.1981-0.039-0.2675)                                                         (  15         )
3. 'DR1' 2.8916 ;                                                             (  16         )
(this is position of wire 1)                                                  (  16         )
3. 'DR11' 0.3065 ;                                                            (  17 ELEMENTS)
2. 0 ;                                                                        (  18         )
4.0 'LAM' 0.5 0.0 ;                                                           (  19         )
4.0 'LAM' 0.5 0.0 ;                                                           (  20         )
2. 0. ;                                                                       (  21         )
(i am taking Carols input cuting lam on half and assuming)                    (  21 ELEMENTS)
(that centar of lam will be at same position as existing septum)              (  21         )
(this is place where w1 is)                                                   (  21         )
(3. 'DR3' 0.039 ;)                                                            (  21         )
```

```
      (4. 'SP1U' 0.7675 0 0. ;)                                                  ( 21          )
65    (4. 'SP1D' 0.7675 0 0. ;)                                                  ( 21 ELEMENTS)
      (dr21 is to make for difference between 0.5 of lam and 0.7675 of septum)   ( 21          )
      3. 'DR21' 0.2675 ;                                                         ( 22          )
      3. 'DR2' 1.7586 ;                                                          ( 23          )
      (quad 3-start)                                                             ( 23          )
70    3.  'DU3' 0.1301 ;                                                         ( 24 ELEMENTS)
      5.01 'QM3' 0.2985 -2.2 41.275 ;                                            ( 25          )
      3. 'DD3' 0.1301 ;                                                          ( 26          )
      (quad 3-end)                                                               ( 26          )
      3.  'DR3' 0.2553 ;                                                         ( 27          )
75    (quad 4-start)                                                             ( 27 ELEMENTS)
      3.  'DU4' 0.1301 ;                                                         ( 28          )
      5.01 'QM4' 0.2985 1.7 41.275 ;                                             ( 29          )
      3. 'DD4' 0.1301 ;                                                          ( 30          )
      (quad 4-end)                                                               ( 30          )
80    3.  'DR4' 0.1693 ;                                                         ( 31 ELEMENTS)
      (position of the wire W2)                                                  ( 31          )
      3.  'DR5' 1.408 ;                                                          ( 32          )
      (old drift was 2.204, i have shoreten this one for lenght of magnet)       ( 32          )
      (position of the wire W3)                                                  ( 32          )
85    3.  'DR6' 0.4143 ;                                                         ( 33 ELEMENTS)
      (position of the PHYSICAL ENTRANCE TO THE SPECTROMETAR)                    ( 33          )
      4. 1.480 7.500 0.0193 'SPEC' ;                                             ( 34          )
      (FIT  NAME=BETAX, VALUE=200.0, TOLER=1.;)                                  ( 34          )
      (FIT  NAME=BETAY, VALUE=9.00, TOLER=1.;)                                   ( 34          )
90    4. 1.480 7.500 0.0193 'SPEC' ;                                             ( 35 ELEMENTS)
      (HERE I HAVE PUT L=PHYSICAL=2*1.48=2.96, old mag=0.684)                    ( 35          )
      3.  'DR7' 0.4143 ;                                                         ( 36          )
      3.  'DR8' 5.6832 ;                                                         ( 37          )
      FIT  NAME=BETAX, VALUE=50.0, TOLER=1.;                                     ( 38          )
95    FIT  NAME=BETAY, VALUE=50.0, TOLER=1.;                                     ( 39 ELEMENTS)
      (position of the wire MW)                                                  ( 39          )
      3.  'DR9' 0.4445 ;                                                         ( 40          )
      (entrance to the dump-2)                                                   ( 40          )
      SENTINEL

 40 ELEMENTS USED OUT OF A MAXIMUM ALLOWABLE 1301
122 NUMBERS USED OUT OF A MAXIMUM ALLOWABLE  5001
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400-MEV DIAGNOSTIC LINE, NORMAL OPERATIONS, MOMENTUM DUMP - M. Popovic, 1-FEB-1

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                                        PSIX      PSIY      BETAX     BETAY     ALPHAX    ALPHAY    ETAX      ETAY      DETAX     DETAY
(   5)  *BEAM*                           0.95400 GEV
            0.000 M                      0.0000    0.0000    0.0000 M          0.000     0.000     0.000 DEG
                                        0.0000    0.0000    1.9397    9.0271    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
(   6)  *ETA*
          0.00000 MM       0.00000 MR       0.00000 MM       0.00000 MR       0.00000 CM       1.00000 PC
            0.000 M                      0.0000    0.0000    0.0000 M          0.000     0.000     0.000 DEG
                                        0.0000    0.0000    1.9397    9.0271    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
(   7)  *ZBEGIN*                        -0.31284E+01
(   8)  *DRIFT*          "DU1 "          0.15240 M
            0.152 M                      0.0000    0.0000   -2.9760 M          0.000     0.000     0.000 DEG
                                        4.4924    0.9672    1.9517    9.0297   -0.0786   -0.0169    0.0000    0.0000    0.0000    0.0000
(   9)  *QUAD*           "QC1 "          0.29850 M        -1.50000 KG       41.27500 MM    (   -2.88429 M   )
            0.451 M                      0.0000    0.0000   -2.6775 M          0.000     0.000     0.000 DEG
                                       12.8135    2.9263    2.2548    8.1605   -0.9710    2.8291    0.0000    0.0000    0.0000    0.0000
(  10)  *DRIFT*          "DD1 "          0.15240 M
            0.603 M                      0.0000    0.0000   -2.5251 M          0.000     0.000     0.000 DEG
                                       16.4428    4.0559    2.5708    7.3238   -1.1024    2.6610    0.0000    0.0000    0.0000    0.0000
(  11)  *BEND *          "CHOP"          1.43000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            2.033 M                      0.0000    0.0000   -1.0951 M          0.000     0.000     0.000 DEG
                                       35.4679   26.1731    7.4855    1.9697   -2.3346    1.0832    0.0000    0.0000    0.0000    0.0000
(  12)  *DRIFT*          "DU2 "          0.15240 M
            2.186 M                      0.0000    0.0000   -0.9427 M          0.000     0.000     0.000 DEG
                                       36.5813   31.0002    8.2171    1.6652   -2.4659    0.9150    0.0000    0.0000    0.0000    0.0000
(  13)  *QUAD*           "QCU2"          0.14825 M         2.64000 KG       41.27500 MM    (    3.38079 M   )
            2.334 M                      0.0000    0.0000   -0.7945 M          0.000     0.000     0.000 DEG
                                       37.5851   36.4499    8.5879    1.4851    0.0018    0.3177    0.0000    0.0000    0.0000    0.0000
(  14)  *BEND *          "QBD "          0.00200 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            2.336 M                      0.0000    0.0000   -0.7925 M          0.000     0.000     0.000 DEG
                                       37.5985   36.5270    8.5879    1.4838    0.0016    0.3162    0.0000    0.0000    0.0000    0.0000
(  15)  *QUAD*           "QCD2"          0.14825 M         2.64000 KG       41.27500 MM    (    3.38079 M   )
            2.484 M                      0.0000    0.0000   -0.6442 M          0.000     0.000     0.000 DEG
                                       38.6023   42.3302    8.2161    1.4703    2.4690   -0.2239    0.0000    0.0000    0.0000    0.0000
(  16)  *DRIFT*          "DR1 "          2.89160 M
            5.376 M                      0.0000    0.0000    2.2474 M          0.000     0.000     0.000 DEG
                                      108.1775   96.1136    1.1588    8.7368   -0.0284   -2.2891    0.0000    0.0000    0.0000    0.0000
(  17)  *DRIFT*          "DR11"          0.30650 M
            5.682 M                      0.0000    0.0000    2.5539 M          0.000     0.000     0.000 DEG
                                      122.8873   97.9736    1.2573   10.2071   -0.2931   -2.5080    0.0000    0.0000    0.0000    0.0000
(  18)  *ROTAT*                          0.00000 DEG
            5.682 M                      0.0000    0.0000    2.5539 M          0.000     0.000     0.000 DEG
                                      122.8873   97.9736    1.2573   10.2071   -0.2931   -2.5080    0.0000    0.0000    0.0000    0.0000
(  19)  *BEND *          "LAM "          0.50000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            6.182 M                      0.0000    0.0000    3.0539 M          0.000     0.000     0.000 DEG
                                      142.4913  100.4715    1.7663   12.8937   -0.7249   -2.8651    0.0000    0.0000    0.0000    0.0000
(  20)  *BEND *          "LAM "          0.50000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            6.682 M                      0.0000    0.0000    3.5539 M          0.000     0.000     0.000 DEG
                                      155.7094  102.4704    2.7071   15.9373   -1.1567   -3.2222    0.0000    0.0000    0.0000    0.0000
(  21)  *ROTAT*                          0.00000 DEG
            6.682 M                      0.0000    0.0000    3.5539 M          0.000     0.000     0.000 DEG
                                      155.7094  102.4704    2.7071   15.9373   -1.1567   -3.2222    0.0000    0.0000    0.0000    0.0000
(  22)  *DRIFT*          "DR21"          0.26750 M
            6.950 M                      0.0000    0.0000    3.8214 M          0.000     0.000     0.000 DEG
                                      160.7770  103.3827    3.3878   17.7123   -1.3878   -3.4133    0.0000    0.0000    0.0000    0.0000
(  23)  *DRIFT*          "DR2 "          1.75860 M
            8.708 M                      0.0000    0.0000    5.5800 M          0.000     0.000     0.000 DEG
                                      177.5675  107.6237   10.9398   31.9264   -2.9066   -4.6693    0.0000    0.0000    0.0000    0.0000
(  24)  *DRIFT*          "DU3 "          0.13010 M
            8.839 M                      0.0000    0.0000    5.7101 M          0.000     0.000     0.000 DEG
                                      178.2261  107.8529   11.7107   33.1534   -3.0189   -4.7622    0.0000    0.0000    0.0000    0.0000
(  25)  *QUAD*           "QM3 "          0.29850 M        -2.20000 KG       41.27500 MM    (   -1.95118 M   )
          VARY CODE =  0 1 0
            9.137 M                      0.0000    0.0000    6.0086 M          0.000     0.000     0.000 DEG
```

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                                179.5227  108.3725   15.6150   31.0758  -10.7053   11.3726    0.0000    0.0000    0.0000    0.0000
(  26)  *DRIFT*          "DD3 "     0.13010 M
            9.267 M                 0.0000     0.0000     6.1387 M        0.000     0.000     0.000 DEG
                                179.9609  108.6244   18.5258   28.1877  -11.6685   10.8270    0.0000    0.0000    0.0000    0.0000
(  27)  *DRIFT*          "DR3 "     0.25530 M
            9.522 M                 0.0000     0.0000     6.3940 M        0.000     0.000     0.000 DEG
                                180.6411  109.1997   24.9663   22.9328  -13.5585    9.7562    0.0000    0.0000    0.0000    0.0000
(  28)  *DRIFT*          "DU4 "     0.13010 M
            9.653 M                 0.0000     0.0000     6.5241 M        0.000     0.000     0.000 DEG
                                180.9200  109.5438   28.6196   20.4652  -14.5217    9.2105    0.0000    0.0000    0.0000    0.0000
(  29)  *QUAD*           "QM4 "     0.29850 M          1.70000 KG       41.27500 MM   (    2.63877 M   )
          VARY CODE =  0 1 0
            9.951 M                 0.0000     0.0000     6.8226 M        0.000     0.000     0.000 DEG
                                181.4570  110.4684   34.0968   17.3745   -3.1166    1.5387    0.0000    0.0000    0.0000    0.0000
(  30)  *DRIFT*          "DD4 "     0.13010 M
           10.081 M                 0.0000     0.0000     6.9527 M        0.000     0.000     0.000 DEG
                                181.6730  110.9024   34.9130   16.9774   -3.1574    1.5135    0.0000    0.0000    0.0000    0.0000
(  31)  *DRIFT*          "DR4 "     0.16930 M
           10.250 M                 0.0000     0.0000     7.1220 M        0.000     0.000     0.000 DEG
                                181.9467  111.4825   35.9911   16.4705   -3.2106    1.4807    0.0000    0.0000    0.0000    0.0000
(  32)  *DRIFT*          "DR5 "     1.40800 M
           11.658 M                 0.0000     0.0000     8.5300 M        0.000     0.000     0.000 DEG
                                183.9372  117.0725   45.6552   12.6852   -3.6530    1.2078    0.0000    0.0000    0.0000    0.0000
(  33)  *DRIFT*          "DR6 "     0.41430 M
           12.073 M                 0.0000     0.0000     8.9443 M        0.000     0.000     0.000 DEG
                                184.4405  119.0199   48.7360   11.7177   -3.7832    1.1275    0.0000    0.0000    0.0000    0.0000
(  34)  *BEND *          "SPEC"     1.48000 M          7.50000 KG        0.01930      (     4.243 M    ,  19.986 DEG )
           13.553 M                -0.2555     0.0000    10.3945 M       -19.986     0.000     0.000 DEG
                                186.0589  127.4055   54.1381    8.7824    0.2795    0.8543    2.5557    0.0000    3.4192    0.0000
(  35)  *BEND *          "SPEC"     1.48000 M          7.50000 KG        0.01930      (     4.243 M    ,  19.986 DEG )
           15.033 M                -0.9913     0.0000    11.6700 M       -39.971     0.000     0.000 DEG
                                187.7033  138.5523   47.2098    6.6681    4.2140    0.5732    9.9207    0.0000    6.4344    0.0000
(  36)  *DRIFT*          "DR7 "     0.41430 M
           15.447 M                -1.2574     0.0000    11.9875 M       -39.971     0.000     0.000 DEG
                                188.2254  142.2386   43.7862    6.2274    4.0494    0.4906   12.5865    0.0000    6.4344    0.0000
(  37)  *DRIFT*          "DR8 "     5.68320 M
           21.130 M                -4.9083     0.0000    16.3429 M       -39.971     0.000     0.000 DEG
                                203.5267  201.0592   10.5923    7.0858    1.7913   -0.6417   49.1547    0.0000    6.4344    0.0000
(  38)  *FIT*                       BETAX          50.00000 /1.00000        (    10.59226 )
(  39)  *FIT*                       BETAY          50.00000 /1.00000        (     7.08582 )
(  40)  *DRIFT*          "DR9 "     0.44450 M
           21.575 M                -5.1939     0.0000    16.6835 M       -39.971     0.000     0.000 DEG
                                206.1247  204.5102    9.0783    7.6956    1.6147   -0.7302   52.0148    0.0000    6.4344    0.0000

       *LENGTH*          21.57470 M

       *CORRECTIONS*
       *NUMBER OF VARIED PARAMETERS =      2 *
       *NUMBER OF CONSTRAINTS       =      2 *

 0.10000E+01 ( 0.33946E+04)   -0.0840   -0.2568
 0.10000E+01 ( 0.74928E+03)   -0.0514   -0.1314
 0.10000E+01 ( 0.35520E+02)    0.0163    0.0085
 0.10000E+01 ( 0.23752E-01)    0.0007   -0.0001

       *COVARIANCE  (FIT 0.10841E-07 )
      0.008
     -0.882       0.011
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400-MEV DIAGNOSTIC LINE, NORMAL OPERATIONS, MOMENTUM DUMP - M. Popovic, 1-FEB-1

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                                        PSIX      PSIY      BETAX     BETAY     ALPHAX    ALPHAY    ETAX      ETAY      DETAX     DETAY
(   5)  *BEAM*                           0.95400 GEV
          0.000 M                        0.0000    0.0000    0.0000 M          0.000     0.000     0.000 DEG
                                         0.0000    0.0000    1.9397    9.0271    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
(   6)  *ETA*
        0.00000 MM      0.00000 MR       0.00000 MM      0.00000 MR       0.00000 CM       1.00000 PC
          0.000 M                        0.0000    0.0000    0.0000 M          0.000     0.000     0.000 DEG
                                         0.0000    0.0000    1.9397    9.0271    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
(   7)  *ZBEGIN*                        -0.31284E+01
(   8)  *DRIFT*          "DU1 "          0.15240 M
          0.152 M                        0.0000    0.0000   -2.9760 M          0.000     0.000     0.000 DEG
                                         4.4924    0.9672    1.9517    9.0297   -0.0786   -0.0169    0.0000    0.0000    0.0000    0.0000
(   9)  *QUAD*           "QC1 "          0.29850 M        -1.50000 KG       41.27500 MM   (   -2.88429 M   )
          0.451 M                        0.0000    0.0000   -2.6775 M          0.000     0.000     0.000 DEG
                                        12.8135    2.9263    2.2548    8.1605   -0.9710    2.8291    0.0000    0.0000    0.0000    0.0000
(  10)  *DRIFT*          "DD1 "          0.15240 M
          0.603 M                        0.0000    0.0000   -2.5251 M          0.000     0.000     0.000 DEG
                                        16.4428    4.0559    2.5708    7.3238   -1.1024    2.6610    0.0000    0.0000    0.0000    0.0000
(  11)  *BEND *          "CHOP"          1.43000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
          2.033 M                        0.0000    0.0000   -1.0951 M          0.000     0.000     0.000 DEG
                                        35.4679   26.1731    7.4855    1.9697   -2.3346    1.0832    0.0000    0.0000    0.0000    0.0000
(  12)  *DRIFT*          "DU2 "          0.15240 M
          2.186 M                        0.0000    0.0000   -0.9427 M          0.000     0.000     0.000 DEG
                                        36.5813   31.0002    8.2171    1.6652   -2.4659    0.9150    0.0000    0.0000    0.0000    0.0000
(  13)  *QUAD*           "QCU2"          0.14825 M         2.64000 KG       41.27500 MM   (    3.38079 M   )
          2.334 M                        0.0000    0.0000   -0.7945 M          0.000     0.000     0.000 DEG
                                        37.5851   36.4499    8.5879    1.4851    0.0018    0.3177    0.0000    0.0000    0.0000    0.0000
(  14)  *BEND *          "QBD "          0.00200 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
          2.336 M                        0.0000    0.0000   -0.7925 M          0.000     0.000     0.000 DEG
                                        37.5985   36.5270    8.5879    1.4838    0.0016    0.3162    0.0000    0.0000    0.0000    0.0000
(  15)  *QUAD*           "QCD2"          0.14825 M         2.64000 KG       41.27500 MM   (    3.38079 M   )
          2.484 M                        0.0000    0.0000   -0.6442 M          0.000     0.000     0.000 DEG
                                        38.6023   42.3302    8.2161    1.4703    2.4690   -0.2239    0.0000    0.0000    0.0000    0.0000
(  16)  *DRIFT*          "DR1 "          2.89160 M
          5.376 M                        0.0000    0.0000    2.2474 M          0.000     0.000     0.000 DEG
                                       108.1775   96.1136    1.1588    8.7368   -0.0284   -2.2891    0.0000    0.0000    0.0000    0.0000
(  17)  *DRIFT*          "DR11"          0.30650 M
          5.682 M                        0.0000    0.0000    2.5539 M          0.000     0.000     0.000 DEG
                                       122.8873   97.9736    1.2573   10.2071   -0.2931   -2.5080    0.0000    0.0000    0.0000    0.0000
(  18)  *ROTAT*                          0.00000 DEG
          5.682 M                        0.0000    0.0000    2.5539 M          0.000     0.000     0.000 DEG
                                       122.8873   97.9736    1.2573   10.2071   -0.2931   -2.5080    0.0000    0.0000    0.0000    0.0000
(  19)  *BEND *          "LAM "          0.50000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
          6.182 M                        0.0000    0.0000    3.0539 M          0.000     0.000     0.000 DEG
                                       142.4913  100.4715    1.7663   12.8937   -0.7249   -2.8651    0.0000    0.0000    0.0000    0.0000
(  20)  *BEND *          "LAM "          0.50000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
          6.682 M                        0.0000    0.0000    3.5539 M          0.000     0.000     0.000 DEG
                                       155.7094  102.4704    2.7071   15.9373   -1.1567   -3.2222    0.0000    0.0000    0.0000    0.0000
(  21)  *ROTAT*                          0.00000 DEG
          6.682 M                        0.0000    0.0000    3.5539 M          0.000     0.000     0.000 DEG
                                       155.7094  102.4704    2.7071   15.9373   -1.1567   -3.2222    0.0000    0.0000    0.0000    0.0000
(  22)  *DRIFT*          "DR21"          0.26750 M
          6.950 M                        0.0000    0.0000    3.8214 M          0.000     0.000     0.000 DEG
                                       160.7770  103.3827    3.3878   17.7123   -1.3878   -3.4133    0.0000    0.0000    0.0000    0.0000
(  23)  *DRIFT*          "DR2 "          1.75860 M
          8.708 M                        0.0000    0.0000    5.5800 M          0.000     0.000     0.000 DEG
                                       177.5675  107.6237   10.9398   31.9264   -2.9066   -4.6693    0.0000    0.0000    0.0000    0.0000
(  24)  *DRIFT*          "DU3 "          0.13010 M
          8.839 M                        0.0000    0.0000    5.7101 M          0.000     0.000     0.000 DEG
                                       178.2261  107.8529   11.7107   33.1534   -3.0189   -4.7622    0.0000    0.0000    0.0000    0.0000
(  25)  *QUAD*           "QM3 "          0.29850 M        -2.31844 KG       41.27500 MM   (   -1.84905 M   )
        VARY CODE =  0 1 0
          9.137 M                        0.0000    0.0000    6.0086 M          0.000     0.000     0.000 DEG
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                                    179.5196  108.3740   15.7295   30.8214  -11.1430   12.1609    0.0000    0.0000    0.0000    0.0000
(  26)  *DRIFT*          "DD3 "        0.13010 M
            9.267 M                    0.0000     0.0000     6.1387 M        0.000     0.000     0.000 DEG
                                    179.9535  108.6289   18.7636   27.7389  -12.1783   11.5324    0.0000    0.0000    0.0000    0.0000
(  27)  *DRIFT*          "DR3 "        0.25530 M
            9.522 M                    0.0000     0.0000     6.3940 M        0.000     0.000     0.000 DEG
                                    180.6223  109.2188   25.5005   22.1653  -14.2099   10.2992    0.0000    0.0000    0.0000    0.0000
(  28)  *DRIFT*          "DU4 "        0.13010 M
            9.653 M                    0.0000     0.0000     6.5241 M        0.000     0.000     0.000 DEG
                                    180.8948  109.5768   29.3326   19.5672  -15.2451    9.6707    0.0000    0.0000    0.0000    0.0000
(  29)  *QUAD*           "QM4 "        0.29850 M          1.32008 KG       41.27500 MM    (     3.38353 M    )
          VARY CODE =  0 1 0
            9.951 M                    0.0000     0.0000     6.8226 M        0.000     0.000     0.000 DEG
                                    181.4130  110.5675   36.0390   15.6915   -6.5473    3.6984    0.0000    0.0000    0.0000    0.0000
(  30)  *DRIFT*          "DD4 "        0.13010 M
           10.081 M                    0.0000     0.0000     6.9527 M        0.000     0.000     0.000 DEG
                                    181.6151  111.0576   37.7632   14.7450   -6.7057    3.5767    0.0000    0.0000    0.0000    0.0000
(  31)  *DRIFT*          "DR4 "        0.16930 M
           10.250 M                    0.0000     0.0000     7.1220 M        0.000     0.000     0.000 DEG
                                    181.8645  111.7436   40.0687   13.5607   -6.9117    3.4183    0.0000    0.0000    0.0000    0.0000
(  32)  *DRIFT*          "DR5 "        1.40800 M
           11.658 M                    0.0000     0.0000     8.5300 M        0.000     0.000     0.000 DEG
                                    183.4839  120.8873   61.9451    5.7891   -8.6256    2.1013    0.0000    0.0000    0.0000    0.0000
(  33)  *DRIFT*          "DR6 "        0.41430 M
           12.073 M                    0.0000     0.0000     8.9443 M        0.000     0.000     0.000 DEG
                                    183.8462  125.7020   69.3012    4.2086   -9.1298    1.7137    0.0000    0.0000    0.0000    0.0000
(  34)  *BEND *          "SPEC"        1.48000 M          7.50000 KG        0.01930      (      4.243 M    ,   19.986 DEG )
           13.553 M                   -0.2555     0.0000    10.3945 M       -19.986     0.000     0.000 DEG
                                    184.9056  167.2675   88.8428    1.1814   -3.5445    0.3301    2.5557    0.0000    3.4192    0.0000
(  35)  *BEND *          "SPEC"        1.48000 M          7.50000 KG        0.01930      (      4.243 M    ,   19.986 DEG )
           15.033 M                   -0.9913     0.0000    11.6700 M       -39.971     0.000     0.000 DEG
                                    185.8423  232.2093   88.6548    2.2576    3.6664   -1.0567    9.9207    0.0000    6.4344    0.0000
(  36)  *DRIFT*          "DR7 "        0.41430 M
           15.447 M                   -1.2574     0.0000    11.9875 M       -39.971     0.000     0.000 DEG
                                    186.1147  240.9477   85.6448    3.2941    3.5989   -1.4451   12.5865    0.0000    6.4344    0.0000
(  37)  *DRIFT*          "DR8 "        5.68320 M
           21.130 M                   -4.9083     0.0000    16.3429 M       -39.971     0.000     0.000 DEG
                                    191.0970  267.2326   50.0000   50.0001    2.6731   -6.7732   49.1547    0.0000    6.4344    0.0000
(  38)  *FIT*                          BETAX          50.00000 /1.00000        (     50.00002 )
(  39)  *FIT*                          BETAY          50.00000 /1.00000        (     50.00010 )
(  40)  *DRIFT*          "DR9 "        0.44450 M
           21.575 M                   -5.1939     0.0000    16.6835 M       -39.971     0.000     0.000 DEG
                                    191.6187  267.7130   47.6558   56.2067    2.6007   -7.1899   52.0148    0.0000    6.4344    0.0000

        *LENGTH*         21.57470 M
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APPENDIX D

CHANGEDATE(TRMAIN FORTRAN 19900807 12:17:31)

```
"400-MEV DIAGNOSTIC LINE, MOMENTUM MEASUREMENTS - M. Popovic, 2-FEB-1991

    0
15 1. 'MM' ;                                                                  (   1          )
(ALL TRANSVERSE DIM IN MM)                                                    (   1          )
13 3. ;                                                                       (   2 ELEMENTS)
(PRINT BEAM'S SIGMA AFTER EVERY ELEMENT)                                      (   2          )
13 12. ;                                                                      (   3          )
( COORDINATS OF LAYOUT OF THE LINE)                                           (   3          )
13. 7 ;                                                                       (   4          )
(USE ACCELERATOR NOTATION)                                                    (   4 ELEMENTS)
(13. 13. ;)                                                                   (   4          )
(15 8. 'CM' 0.01 ;)                                                           (   4          )
(**************************START FROM HERE******************)                 (   4          )
(The 0 of coordinat system will be assumed at Wire 1)                         (   4          )
(the first element is the end of the last linac tank 9)                       (   4 ELEMENTS)
(********BEAM CARD********)                                                   (   4          )
(1 1.9397 0. 9.0271 0. 0. 0. .954 ;LATTICE)                                   (   4          )
(1 3.6848 1.8997 7.9492 .7754 0. 0. .954 ;)                                   (   4          )
(1 16.9 9.25 7.5 6.01 0. 0. .6514 ; THIS IS X THETA)                          (   4          )
(1 16.2758  4.93 2.8989 -0.85, 0. 0. 0.6514 ;)                                (   4 ELEMENTS)
(THISE ARE BETAX,ALPHAX,BETAY,ALPHAY, ..., USED WITH 13 7 PRINT CODE)         (   4          )
(UNITS FOR BETA ARE RETION OF OF TRANSVERSE DIM, MM/MR=METER)                 (   4          )
(this numbers are from c.s)                                                   (   4          )
(SPECIAL ZBEGIN=-2.6987)                                                      (   4          )
(I have included corrected value from kicker to tank-9)                       (   4 ELEMENTS)
(Physical length OF QUADS is 25.4 cm. At each end of quad I am puting 6 )     (   4          )
(inches for bellows, so physicaly the quad is 2*6+10 inchies)                 (   4          )
(in Transport I am puting magnetic length=0.2985=2*14.925 as it is requered)  (   4          )
(the drift at each end should be 13.015 cm)                                   (   4          )
(diametar of the quads is 3.25 inches, each quad is cut on two pieces longit.) (   4 ELEMENTS)
(tank 9 out)                                                                  (   4          )
(=================================)                                           (   4          )
1 1.9397 0. 9.0271 0. 0. 0. .954 ;                                            (   5          )
( beta alfa ...)                                                              (   5          )
(1 3.6848 1.8997 7.9492 .7754 0. 0. .954 ;)                                   (   5 ELEMENTS)
ETA ETAX = 0., DETAX = 0., ETAY = 0., DETAY = 0., ETAL =0., ETAP = 1. ;       (   6          )
(beam data is taken from trace3d calculation of Jim MacLaughlin)              (   6          )
(******EXIT OF LAST LINAC QUAD IN TANK 9 IS BEGINNING OF LINE******)          (   6          )
SPECIAL ZBEGIN=-3.1284                                                        (   7          )
(******************)                                                          (   7 ELEMENTS)
3.  'DU1' .1524 ;                                                             (   8          )
5.0 'QC1' .2985 -1.5 41.275 ;                                                 (   9          )
3. 'DD1' .1524 ;                                                              (  10          )
(******************)                                                          (  10          )
4. 'CHOP' 1.43 0.0 0. ;                                                       (  11 ELEMENTS)
3. 'DU2' .1524 ;                                                              (  12          )
5. 'QCU2' .14825 2.64 41.275 ;                                                (  13          )
4.0 'QBD' .002 0.0 ;                                                          (  14          )
5.0 'QCD2' .14825 2.64 41.275 ;                                               (  15          )
(3. 'D4' 3.1981 ; this drift is now d4+wire+d41 so that i have)               (  15 ELEMENTS)
(wire at same position as in old 200 MeV line)                                (  15          )
(3.1981-0.039-0.2675)                                                         (  15          )
3. 'DR1' 2.8916 ;                                                             (  16          )
(this is position of wire 1)                                                  (  16          )
3. 'DR11' 0.3065 ;                                                            (  17 ELEMENTS)
2. 0 ;                                                                        (  18          )
4.0 'LAM' 0.5 0.0 ;                                                           (  19          )
4.0 'LAM' 0.5 0.0 ;                                                           (  20          )
2. 0. ;                                                                       (  21          )
(i am taking Carols input cuting lam on half and assuming)                    (  21 ELEMENTS)
(that centar of lam will be at same position as existing septum)              (  21          )
(this is place where w1 is)                                                   (  21          )
                                                                              (  21          )
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      (4. 'SP1U' 0.7675 0 0. ;)                                                  ( 21          )
65    (4. 'SP1D' 0.7675 0 0. ;)                                                  ( 21 ELEMENTS)
      (dr21 is to make for difference between 0.5 of lam and 0.7675 of septum)   ( 21          )
      3. 'DR21' 0.2675 ;                                                         ( 22          )
      3. 'DR2' 1.7586 ;                                                          ( 23          )
      (quad 3-start)                                                             ( 23          )
70    3.  'DU3' 0.1301 ;                                                         ( 24 ELEMENTS)
      5.01 'QM3' 0.2985 -2.7 41.275 ;                                            ( 25          )
      3. 'DD3' 0.1301 ;                                                          ( 26          )
      (quad 3-end)                                                               ( 26          )
      3.  'DR3' 0.2553 ;                                                         ( 27          )
75    (quad 4-start)                                                             ( 27 ELEMENTS)
      3.  'DU4' 0.1301 ;                                                         ( 28          )
      5.01 'QM4' 0.2985 2.4 41.275 ;                                             ( 29          )
      3. 'DD4' 0.1301 ;                                                          ( 30          )
      (quad 4-end)                                                               ( 30          )
80    3.  'DR4' 0.1693 ;                                                         ( 31 ELEMENTS)
      (position of the wire W2)                                                  ( 31          )
      3.  'DR5' 1.408 ;                                                          ( 32          )
      (old drift was 2.204, i have shoreten this one for lenght of magnet)       ( 32          )
      (position of the wire W3)                                                  ( 32          )
85    3.  'DR6' 0.4143 ;                                                         ( 33 ELEMENTS)
      (position of the PHYSICAL ENTRANCE TO THE SPECTROMETAR)                    ( 33          )
      4. 1.480 7.500 0.0193 'SPEC' ;                                             ( 34          )
      (FIT  NAME=BETAX, VALUE=200.0, TOLER=1.;)                                  ( 34          )
      (FIT  NAME=BETAY, VALUE=9.00, TOLER=1.;)                                   ( 34          )
90    4. 1.480 7.500 0.0193 'SPEC' ;                                             ( 35 ELEMENTS)
      (HERE I HAVE PUT L=PHYSICAL=2*1.48=2.96, old mag=0.684)                    ( 35          )
      3.  'DR7' 0.4143 ;                                                         ( 36          )
      3.  'DR8' 5.6832 ;                                                         ( 37          )
      FIT  NAME=BETAX, VALUE=0.5, TOLER=0.05;                                    ( 38          )
95    FIT  NAME=BETAY, VALUE=50.0, TOLER=1.;                                     ( 39 ELEMENTS)
      (position of the wire MW)                                                  ( 39          )
      3.  'DR9' 0.4445 ;                                                         ( 40          )
      (entrance to the dump-2)                                                   ( 40          )
      SENTINEL

 40 ELEMENTS USED OUT OF A MAXIMUM ALLOWABLE 1301
122 NUMBERS USED OUT OF A MAXIMUM ALLOWABLE  5001
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400-MEV DIAGNOSTIC LINE, MOMENTUM MEASUREMENTS - M. Popovic, 2-FEB-1991

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                                          PSIX       PSIY       BETAX      BETAY      ALPHAX     ALPHAY     ETAX       ETAY       DETAX      DETAY
(   5)  *BEAM*                             0.95400 GEV
          0.000 M                          0.0000     0.0000     0.0000 M          0.000      0.000      0.000 DEG
                                          0.0000     0.0000     1.9397     9.0271    0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
(   6)  *ETA*
        0.00000 MM        0.00000 MR       0.00000 MM        0.00000 MR        0.00000 CM        1.00000 PC
          0.000 M                          0.0000     0.0000     0.0000 M          0.000      0.000      0.000 DEG
                                          0.0000     0.0000     1.9397     9.0271    0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
(   7)  *ZBEGIN*                          -0.31284E+01
(   8)  *DRIFT*            "DU1 "         0.15240 M
          0.152 M                          0.0000     0.0000    -2.9760 M          0.000      0.000      0.000 DEG
                                          4.4924     0.9672     1.9517     9.0297   -0.0786    -0.0169     0.0000     0.0000     0.0000     0.0000
(   9)  *QUAD*             "QC1 "         0.29850 M        -1.50000 KG        41.27500 MM    (    -2.88429 M    )
          0.451 M                          0.0000     0.0000    -2.6775 M          0.000      0.000      0.000 DEG
                                         12.8135     2.9263     2.2548     8.1605   -0.9710     2.8291     0.0000     0.0000     0.0000     0.0000
(  10)  *DRIFT*            "DD1 "         0.15240 M
          0.603 M                          0.0000     0.0000    -2.5251 M          0.000      0.000      0.000 DEG
                                         16.4428     4.0559     2.5708     7.3238   -1.1024     2.6610     0.0000     0.0000     0.0000     0.0000
(  11)  *BEND *            "CHOP"         1.43000 M         0.00000 KG         0.00000      (     0.000 M     ,     0.000 DEG )
          2.033 M                          0.0000     0.0000    -1.0951 M          0.000      0.000      0.000 DEG
                                         35.4679    26.1731     7.4855     1.9697   -2.3346     1.0832     0.0000     0.0000     0.0000     0.0000
(  12)  *DRIFT*            "DU2 "         0.15240 M
          2.186 M                          0.0000     0.0000    -0.9427 M          0.000      0.000      0.000 DEG
                                         36.5813    31.0002     8.2171     1.6652   -2.4659     0.9150     0.0000     0.0000     0.0000     0.0000
(  13)  *QUAD*             "QCU2"         0.14825 M         2.64000 KG        41.27500 MM    (     3.38079 M    )
          2.334 M                          0.0000     0.0000    -0.7945 M          0.000      0.000      0.000 DEG
                                         37.5851    36.4499     8.5879     1.4851    0.0018     0.3177     0.0000     0.0000     0.0000     0.0000
(  14)  *BEND *            "QBD "         0.00200 M         0.00000 KG         0.00000      (     0.000 M     ,     0.000 DEG )
          2.336 M                          0.0000     0.0000    -0.7925 M          0.000      0.000      0.000 DEG
                                         37.5985    36.5270     8.5879     1.4838    0.0016     0.3162     0.0000     0.0000     0.0000     0.0000
(  15)  *QUAD*             "QCD2"         0.14825 M         2.64000 KG        41.27500 MM    (     3.38079 M    )
          2.484 M                          0.0000     0.0000    -0.6442 M          0.000      0.000      0.000 DEG
                                         38.6023    42.3302     8.2161     1.4703    2.4690    -0.2239     0.0000     0.0000     0.0000     0.0000
(  16)  *DRIFT*            "DR1 "         2.89160 M
          5.376 M                          0.0000     0.0000     2.2474 M          0.000      0.000      0.000 DEG
                                        108.1775    96.1136     1.1588     8.7368   -0.0284    -2.2891     0.0000     0.0000     0.0000     0.0000
(  17)  *DRIFT*            "DR11"         0.30650 M
          5.682 M                          0.0000     0.0000     2.5539 M          0.000      0.000      0.000 DEG
                                        122.8873    97.9736     1.2573    10.2071   -0.2931    -2.5080     0.0000     0.0000     0.0000     0.0000
(  18)  *ROTAT*                           0.00000 DEG
          5.682 M                          0.0000     0.0000     2.5539 M          0.000      0.000      0.000 DEG
                                        122.8873    97.9736     1.2573    10.2071   -0.2931    -2.5080     0.0000     0.0000     0.0000     0.0000
(  19)  *BEND *            "LAM "         0.50000 M         0.00000 KG         0.00000      (     0.000 M     ,     0.000 DEG )
          6.182 M                          0.0000     0.0000     3.0539 M          0.000      0.000      0.000 DEG
                                        142.4913   100.4715     1.7663    12.8937   -0.7249    -2.8651     0.0000     0.0000     0.0000     0.0000
(  20)  *BEND *            "LAM "         0.50000 M         0.00000 KG         0.00000      (     0.000 M     ,     0.000 DEG )
          6.682 M                          0.0000     0.0000     3.5539 M          0.000      0.000      0.000 DEG
                                        155.7094   102.4704     2.7071    15.9373   -1.1567    -3.2222     0.0000     0.0000     0.0000     0.0000
(  21)  *ROTAT*                           0.00000 DEG
          6.682 M                          0.0000     0.0000     3.5539 M          0.000      0.000      0.000 DEG
                                        155.7094   102.4704     2.7071    15.9373   -1.1567    -3.2222     0.0000     0.0000     0.0000     0.0000
(  22)  *DRIFT*            "DR21"         0.28750 M
          6.950 M                          0.0000     0.0000     3.8214 M          0.000      0.000      0.000 DEG
                                        160.7770   103.3827     3.3878    17.7123   -1.3878    -3.4133     0.0000     0.0000     0.0000     0.0000
(  23)  *DRIFT*            "DR2 "         1.75860 M
          8.708 M                          0.0000     0.0000     5.5800 M          0.000      0.000      0.000 DEG
                                        177.5675   107.6237    10.9398    31.9264   -2.9066    -4.6693     0.0000     0.0000     0.0000     0.0000
(  24)  *DRIFT*            "DU3 "         0.13010 M
          8.839 M                          0.0000     0.0000     5.7101 M          0.000      0.000      0.000 DEG
                                        178.2261   107.8529    11.7107    33.1534   -3.0189    -4.7622     0.0000     0.0000     0.0000     0.0000
(  25)  *QUAD*             "QM3 "         0.29850 M        -2.70000 KG        41.27500 MM    (    -1.58099 M    )
        VARY CODE =  0 1 0
          9.137 M                          0.0000     0.0000     6.0086 M          0.000      0.000      0.000 DEG
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                                    179.5100  108.3787   16.1022   30.0110  -12.5804   14.6389    0.0000    0.0000    0.0000    0.0000
( 26)  *DRIFT*            "DD3 "      0.13010 M
            9.267 M                   0.0000     0.0000     6.1387 M        0.000     0.000     0.000 DEG
                                    179.9303  108.6439   19.5430   26.3234  -13.8673   13.7056    0.0000    0.0000    0.0000    0.0000
( 27)  *DRIFT*            "DR3 "      0.25530 M
            9.522 M                   0.0000     0.0000     6.3940 M        0.000     0.000     0.000 DEG
                                    180.5639  109.2847   27.2683   19.7929  -16.3925   11.8741    0.0000    0.0000    0.0000    0.0000
( 28)  *DRIFT*            "DU4 "      0.13010 M
            9.653 M                   0.0000     0.0000     6.5241 M        0.000     0.000     0.000 DEG
                                    180.8174  109.6932   31.7011   16.8247  -17.6793   10.9407    0.0000    0.0000    0.0000    0.0000
( 29)  *QUAD*             "QM4 "      0.29850 M          2.40000 KG       41.27500 MM   (    1.88412 M   )
        VARY CODE =  0 1 0
            9.951 M                   0.0000     0.0000     6.8226 M        0.000     0.000     0.000 DEG
                                    181.3028  110.8756   37.0941   13.1265    0.6037    2.1136    0.0000    0.0000    0.0000    0.0000
( 30)  *DRIFT*            "DD4 "      0.13010 M
           10.081 M                   0.0000     0.0000     6.9527 M        0.000     0.000     0.000 DEG
                                    181.5042  111.4556   36.9376   12.5836    0.5989    2.0594    0.0000    0.0000    0.0000    0.0000
( 31)  *DRIFT*            "DR4 "      0.16930 M
           10.250 M                   0.0000     0.0000     7.1220 M        0.000     0.000     0.000 DEG
                                    181.7675  112.2484   36.7359   11.8982    0.5927    1.9889    0.0000    0.0000    0.0000    0.0000
( 32)  *DRIFT*            "DR5 "      1.40800 M
           11.658 M                   0.0000     0.0000     8.5300 M        0.000     0.000     0.000 DEG
                                    184.0134  121.0458   35.1398    7.1232    0.5409    1.4025    0.0000    0.0000    0.0000    0.0000
( 33)  *DRIFT*            "DR6 "      0.41430 M
           12.073 M                   0.0000     0.0000     8.9443 M        0.000     0.000     0.000 DEG
                                    184.6932  124.6693   34.6980    6.0326    0.5256    1.2299    0.0000    0.0000    0.0000    0.0000
( 34)  *BEND *            "SPEC"      1.48000 M          7.50000 KG       0.01930      (     4.243 M    ,   19.986 DEG )
           13.553 M                  -0.2555     0.0000    10.3945 M       -19.986     0.000     0.000 DEG
                                    187.2983  144.0482   29.3621    3.2953    2.9351    0.6182    2.5557    0.0000    3.4192    0.0000
( 35)  *BEND *            "SPEC"      1.48000 M          7.50000 KG       0.01930      (     4.243 M    ,   19.986 DEG )
           15.033 M                  -0.9913     0.0000    11.6700 M       -39.971     0.000     0.000 DEG
                                    190.8505  175.9479   18.6718    2.3785    3.9985    0.0007    9.9207    0.0000    6.4344    0.0000
( 36)  *DRIFT*            "DR7 "      0.41430 M
           15.447 M                  -1.2574     0.0000    11.9875 M       -39.971     0.000     0.000 DEG
                                    192.2453  185.8299   15.5148    2.4501    3.6216   -0.1735   12.5865    0.0000    6.4344    0.0000
( 37)  *DRIFT*            "DR8 "      5.68320 M
           21.130 M                  -4.9083     0.0000    16.3429 M       -39.971     0.000     0.000 DEG
                                    323.9862  244.6740    3.7368   18.0010   -1.5491   -2.5628   49.1547    0.0000    6.4344    0.0000
( 38)  *FIT*                          BETAX          0.50000 /0.05000        (     3.73681 )
( 39)  *FIT*                          BETAY         50.00000 /1.00000        (    18.00097 )
( 40)  *DRIFT*            "DR9 "      0.44450 M
           21.575 M                  -5.1939     0.0000    16.6835 M       -39.971     0.000     0.000 DEG
                                    329.7019  246.0044    5.2938   20.3624   -1.9536   -2.7497   52.0148    0.0000    6.4344    0.0000

        *LENGTH*          21.57470 M

        *CORRECTIONS*
        *NUMBER OF VARIED PARAMETERS =     2 *
        *NUMBER OF CONSTRAINTS       =     2 *

 0.10000E+01 ( 0.52147E+04)   -0.2284   -0.0273
 0.10000E+01 ( 0.11455E+04)    0.1461   -0.1641
 0.10000E+01 ( 0.52769E+03)   -0.0452    0.1248
 0.50000E+00 ( 0.44049E+03)    0.0199   -0.0756
 0.50000E+00 ( 0.31094E+03)   -0.0153    0.0824
-0.50000E+00 ( 0.51801E+03)    0.0153   -0.0824
 0.25000E+00 ( 0.51801E+03)   -0.0007    0.0424
 0.25000E+00 ( 0.31020E+03)    0.0043   -0.0425
 0.12500E+00 ( 0.30165E+03)    0.0014    0.0224
 0.12500E+00 ( 0.27702E+03)    0.0001   -0.0077
 0.12500E+00 ( 0.27576E+03)    0.0002    0.0042
 0.12500E+00 ( 0.27537E+03)    0.0001   -0.0025
 0.12500E+00 ( 0.27525E+03)    0.0001    0.0014
 0.12500E+00 ( 0.27520E+03)    0.0001   -0.0009
 0.12500E+00 ( 0.27519E+03)    0.0001    0.0004
```

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 0.12500E+00 ( 0.27518E+03)    0.0000   -0.0003
 0.12500E+00 ( 0.27518E+03)    0.0000    0.0001
 0.12500E+00 ( 0.27518E+03)    0.0000   -0.0001
 0.12500E+00 ( 0.27518E+03)    0.0000    0.0000
 0.25000E+00 ( 0.27518E+03)    0.0000   -0.0001
 0.12500E+00 ( 0.27518E+03)    0.0000    0.0001
-0.12500E+00 ( 0.27518E+03)    0.0000   -0.0001
 0.62500E-01 ( 0.27518E+03)    0.0000    0.0000
 0.62500E-01 ( 0.27518E+03)    0.0000    0.0000
-0.62500E-01 ( 0.27518E+03)    0.0000    0.0000
 0.31250E-01 ( 0.27518E+03)    0.0000    0.0000
-0.31250E-01 ( 0.27518E+03)    0.0000    0.0000
 0.15625E-01 ( 0.27518E+03)    0.0000    0.0000
 0.15625E-01 ( 0.27518E+03)    0.0000    0.0000
 0.31250E-01 ( 0.27518E+03)    0.0000    0.0000
-0.31250E-01 ( 0.27518E+03)    0.0000    0.0000
 0.15625E-01 ( 0.27518E+03)    0.0000    0.0000
-0.15625E-01 ( 0.27518E+03)    0.0000    0.0000
 0.78125E-02 ( 0.27518E+03)    0.0000    0.0000

        *FAILED*

        *PLEASE SEND OUTPUT TO            *
        *DAVE CAREY                       *
        *FERMILAB, P.O. BOX 500           *
        *BATAVIA, ILL 60510, USA          *

        *COVARIANCE  (FIT 0.27518E+03 )
       0.004
       0.000       0.000
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400-MEV DIAGNOSTIC LINE, MOMENTUM MEASUREMENTS - M. Popovic, 2-FEB-1991

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                                          PSIX      PSIY      BETAX     BETAY     ALPHAX    ALPHAY    ETAX      ETAY      DETAX     DETAY
(   5)  *BEAM*                            0.95400 GEV
            0.000 M                       0.0000    0.0000    0.0000 M          0.000     0.000     0.000 DEG
                                          0.0000    0.0000    1.9397    9.0271  0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
(   6)  *ETA*
          0.00000 MM        0.00000 MR        0.00000 MM        0.00000 MR        0.00000 CM        1.00000 PC
            0.000 M                       0.0000    0.0000    0.0000 M          0.000     0.000     0.000 DEG
                                          0.0000    0.0000    1.9397    9.0271  0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
(   7)  *ZBEGIN*                          -0.31284E+01
(   8)  *DRIFT*           "DU1 "          0.15240 M
            0.152 M                       0.0000    0.0000   -2.9760 M          0.000     0.000     0.000 DEG
                                          4.4924    0.9672    1.9517    9.0297 -0.0786   -0.0169    0.0000    0.0000    0.0000    0.0000
(   9)  *QUAD*            "QC1 "          0.29850 M        -1.50000 KG       41.27500 MM   (   -2.88429 M   )
            0.451 M                       0.0000    0.0000   -2.6775 M          0.000     0.000     0.000 DEG
                                         12.8135    2.9263    2.2548    8.1605 -0.9710    2.8291    0.0000    0.0000    0.0000    0.0000
(  10)  *DRIFT*           "DD1 "          0.15240 M
            0.603 M                       0.0000    0.0000   -2.5251 M          0.000     0.000     0.000 DEG
                                         16.4428    4.0559    2.5708    7.3238 -1.1024    2.6610    0.0000    0.0000    0.0000    0.0000
(  11)  *BEND *           "CHOP"          1.43000 M         0.00000 KG        0.00000    (     0.000 M    ,    0.000 DEG )
            2.033 M                       0.0000    0.0000   -1.0951 M          0.000     0.000     0.000 DEG
                                         35.4679   26.1731    7.4855    1.9697 -2.3346    1.0832    0.0000    0.0000    0.0000    0.0000
(  12)  *DRIFT*           "DU2 "          0.15240 M
            2.186 M                       0.0000    0.0000   -0.9427 M          0.000     0.000     0.000 DEG
                                         36.5813   31.0002    8.2171    1.6652 -2.4659    0.9150    0.0000    0.0000    0.0000    0.0000
(  13)  *QUAD*            "QCU2"          0.14825 M         2.64000 KG       41.27500 MM   (    3.38079 M   )
            2.334 M                       0.0000    0.0000   -0.7945 M          0.000     0.000     0.000 DEG
                                         37.5851   36.4499    8.5879    1.4851  0.0018    0.3177    0.0000    0.0000    0.0000    0.0000
(  14)  *BEND *           "QBD "          0.00200 M         0.00000 KG        0.00000    (     0.000 M    ,    0.000 DEG )
            2.336 M                       0.0000    0.0000   -0.7925 M          0.000     0.000     0.000 DEG
                                         37.5985   36.5270    8.5879    1.4838  0.0016    0.3162    0.0000    0.0000    0.0000    0.0000
(  15)  *QUAD*            "QCD2"          0.14825 M         2.64000 KG       41.27500 MM   (    3.38079 M   )
            2.484 M                       0.0000    0.0000   -0.6442 M          0.000     0.000     0.000 DEG
                                         38.6023   42.3302    8.2161    1.4703  2.4690   -0.2239    0.0000    0.0000    0.0000    0.0000
(  16)  *DRIFT*           "DR1 "          2.89160 M
            5.376 M                       0.0000    0.0000    2.2474 M          0.000     0.000     0.000 DEG
                                        108.1775   96.1136    1.1588    8.7368 -0.0284   -2.2891    0.0000    0.0000    0.0000    0.0000
(  17)  *DRIFT*           "DR11"          0.30650 M
            5.682 M                       0.0000    0.0000    2.5539 M          0.000     0.000     0.000 DEG
                                        122.8873   97.9736    1.2573   10.2071 -0.2931   -2.5080    0.0000    0.0000    0.0000    0.0000
(  18)  *ROTAT*                           0.00000 DEG
            5.682 M                       0.0000    0.0000    2.5539 M          0.000     0.000     0.000 DEG
                                        122.8873   97.9736    1.2573   10.2071 -0.2931   -2.5080    0.0000    0.0000    0.0000    0.0000
(  19)  *BEND *           "LAM "          0.50000 M         0.00000 KG        0.00000    (     0.000 M    ,    0.000 DEG )
            6.182 M                       0.0000    0.0000    3.0539 M          0.000     0.000     0.000 DEG
                                        142.4913  100.4715    1.7863   12.8937 -0.7249   -2.8651    0.0000    0.0000    0.0000    0.0000
(  20)  *BEND *           "LAM "          0.50000 M         0.00000 KG        0.00000    (     0.000 M    ,    0.000 DEG )
            6.682 M                       0.0000    0.0000    3.5539 M          0.000     0.000     0.000 DEG
                                        155.7094  102.4704    2.7071   15.9373 -1.1567   -3.2222    0.0000    0.0000    0.0000    0.0000
(  21)  *ROTAT*                           0.00000 DEG
            6.682 M                       0.0000    0.0000    3.5539 M          0.000     0.000     0.000 DEG
                                        155.7094  102.4704    2.7071   15.9373 -1.1567   -3.2222    0.0000    0.0000    0.0000    0.0000
(  22)  *DRIFT*           "DR21"          0.26750 M
            6.950 M                       0.0000    0.0000    3.8214 M          0.000     0.000     0.000 DEG
                                        160.7770  103.3827    3.3878   17.7123 -1.3878   -3.4133    0.0000    0.0000    0.0000    0.0000
(  23)  *DRIFT*           "DR2 "          1.75860 M
            8.708 M                       0.0000    0.0000    5.5800 M          0.000     0.000     0.000 DEG
                                        177.5675  107.6237   10.9398   31.9264 -2.9066   -4.6693    0.0000    0.0000    0.0000    0.0000
(  24)  *DRIFT*           "DU3 "          0.13010 M
            8.839 M                       0.0000    0.0000    5.7101 M          0.000     0.000     0.000 DEG
                                        178.2261  107.8529   11.7107   33.1534 -3.0189   -4.7622    0.0000    0.0000    0.0000    0.0000
(  25)  *QUAD*            "QM3 "          0.29850 M        -2.80197 KG       41.27500 MM   (   -1.52172 M   )
          VARY CODE =  0 1 0
            9.137 M                       0.0000    0.0000    6.0086 M          0.000     0.000     0.000 DEG
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                                179.5075  108.3799   16.2028   29.7969  -12.9717   15.2854    0.0000    0.0000    0.0000    0.0000
( 26)  *DRIFT*          "DD3 "     0.13010 M
            9.267 M                 0.0000     0.0000     6.1387 M        0.000     0.000     0.000 DEG
                                179.9242  108.6480   19.7548   25.9529  -14.3308   14.2609    0.0000    0.0000    0.0000    0.0000
( 27)  *DRIFT*          "DR3 "     0.25530 M
            9.522 M                 0.0000     0.0000     6.3940 M        0.000     0.000     0.000 DEG
                                180.5489  109.3036   27.7530   19.1846  -16.9978   12.2504    0.0000    0.0000    0.0000    0.0000
( 28)  *DRIFT*          "DU4 "     0.13010 M
            9.653 M                 0.0000     0.0000     6.5241 M        0.000     0.000     0.000 DEG
                                180.7977  109.7273   32.3527   16.1303  -18.3569   11.2259    0.0000    0.0000    0.0000    0.0000
( 29)  *QUAD*           "QM4 "     0.29850 M          2.27467 KG       41.27500 MM   (    1.98508 M   )
          VARY CODE =  0 1 0
            9.951 M                 0.0000     0.0000     6.8226 M        0.000     0.000     0.000 DEG
                                181.2707  110.9846   38.3618   12.0756   -0.7279    3.0492    0.0000    0.0000    0.0000    0.0000
( 30)  *DRIFT*          "DD4 "     0.13010 M
           10.081 M                 0.0000     0.0000     6.9527 M        0.000     0.000     0.000 DEG
                                181.4646  111.6228   38.5518   11.2966   -0.7330    2.9382    0.0000    0.0000    0.0000    0.0000
( 31)  *DRIFT*          "DR4 "     0.16930 M
           10.250 M                 0.0000     0.0000     7.1220 M        0.000     0.000     0.000 DEG
                                181.7154  112.5210   38.8012   10.3262   -0.7398    2.7939    0.0000    0.0000    0.0000    0.0000
( 32)  *DRIFT*          "DR5 "     1.40800 M
           11.658 M                 0.0000     0.0000     8.5300 M        0.000     0.000     0.000 DEG
                                183.7393  124.9426   40.9635    4.1492   -0.7959    1.5932    0.0000    0.0000    0.0000    0.0000
( 33)  *DRIFT*          "DR6 "     0.41430 M
           12.073 M                 0.0000     0.0000     8.9443 M        0.000     0.000     0.000 DEG
                                184.3141  131.7141   41.6299    2.9755   -0.8125    1.2399    0.0000    0.0000    0.0000    0.0000
( 34)  *BEND *          "SPEC"     1.48000 M          7.50000 KG        0.01930     (     4.243 M    ,  19.986 DEG )
           13.553 M                -0.2555     0.0000    10.3945 M       -19.986     0.000     0.000 DEG
                                186.3733  184.1542   39.1589    1.1706    2.4151   -0.0213    2.5557    0.0000    3.4192    0.0000
( 35)  *BEND *          "SPEC"     1.48000 M          7.50000 KG        0.01930     (     4.243 M    ,  19.986 DEG )
           15.033 M                -0.9913     0.0000    11.6700 M       -39.971     0.000     0.000 DEG
                                188.8647  235.0915   28.4431    3.1014    4.5350   -1.2823    9.9207    0.0000    6.4344    0.0000
( 36)  *DRIFT*          "DR7 "     0.41430 M
           15.447 M                -1.2574     0.0000    11.9875 M       -39.971     0.000     0.000 DEG
                                189.7582  241.5978   24.8155    4.3103    4.2209   -1.6355   12.5865    0.0000    6.4344    0.0000
( 37)  *DRIFT*          "DR8 "     5.68320 M
           21.130 M                -4.9083     0.0000    16.3429 M       -39.971     0.000     0.000 DEG
                                271.4764  264.2690    1.3291   50.4389   -0.0883   -6.4811   49.1547    0.0000    6.4344    0.0000
( 38)  *FIT*                       BETAX          0.50000 /0.05000        (     1.32913 )
( 39)  *FIT*                       BETAY         50.00000 /1.00000        (    50.43889 )
( 40)  *DRIFT*          "DR9 "     0.44450 M
           21.575 M                -5.1939     0.0000    16.6835 M       -39.971     0.000     0.000 DEG
                                289.4720  264.7466    1.5575   56.3691   -0.4253   -6.8601   52.0148    0.0000    6.4344    0.0000

       *LENGTH*         21.57470 M
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APPENDIX E

CHANGEDATE(TRMAIN FORTRAN 19900807 12:17:31)

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"400-MEV DIAGNOSTIC LINE TO DUMP1, FORWARD DUMP - M. Popovic, 5-FEB-1991

    0
15 1. 'MM' ;                                                                  (  1          )
(ALL TRANSVERSE DIM IN MM)                                                    (  1          )
13 3. ;                                                                       (  2 ELEMENTS)
(PRINT BEAM'S SIGMA AFTER EVERY ELEMENT)                                      (  2          )
13 12. ;                                                                      (  3          )
( COORDINATS OF LAYOUT OF THE LINE)                                           (  3          )
13. 7 ;                                                                       (  4          )
(USE ACCELERATOR NOTATION)                                                    (  4 ELEMENTS)
(13. 13. ;)                                                                   (  4          )
(15 8. 'CM' 0.01 ;)                                                           (  4          )
(**************************START FROM HERE*******************)                (  4          )
(The 0 of coordinat system will be assumed at Wire 1)                         (  4          )
(the first element is the end of the last linac tank 9)                       (  4 ELEMENTS)
(********BEAM CARD********)                                                   (  4          )
(1 1.9397 0. 9.0271 0. 0. 0. .954 ;LATTICE)                                   (  4          )
(1 3.6848 1.8997 7.9492 .7754 0. 0. .954 ;)                                   (  4          )
(1 16.9 9.25 7.5 6.01 0. 0. .6514 ; THIS IS X THETA)                          (  4          )
(1 16.2758  4.93 2.8989 -0.85, 0. 0. 0.6514 ;)                                (  4 ELEMENTS)
(THISE ARE BETAX,ALPHAX,BETAY,ALPHAY, ..., USED WITH 13 7 PRINT CODE)         (  4          )
(UNITS FOR BETA ARE RETION OF OF TRANSVERSE DIM, MM/MR=METER)                 (  4          )
(this numbers are from c.s)                                                   (  4          )
(SPECIAL ZBEGIN=-2.6987)                                                      (  4          )
(I have included corrected value from kicker to tank-9)                       (  4 ELEMENTS)
(Physical length OF QUADS is 25.4 cm. At each end of quad I am puting 6 )     (  4          )
(inches for bellows, so physicaly the quad is 2*6+10 inchies)                 (  4          )
(in Transport I am puting magnetic length=0.2985=2*14.925 as it is requered)  (  4          )
(the drift at each end should be 13.015 cm)                                   (  4          )
(diametar of the quads is 3.25 inches, each quad is cut on two pieces longit.) (  4 ELEMENTS)
(tank 9 out)                                                                  (  4          )
(=================================)                                           (  4          )
1 1.9397 0. 9.0271 0. 0. 0. .954 ;                                            (  5          )
( beta alfa ...)                                                              (  5          )
(1 3.6848 1.8997 7.9492 .7754 0. 0. .954 ;)                                   (  5 ELEMENTS)
ETA ETAX = 0., DETAX = 0., ETAY = 0., DETAY = 0., ETAL =0., ETAP = 1. ;       (  6          )
(beam data is taken from trace3d calculation of Jim MacLaughlin)              (  6          )
(******EXIT OF LAST LINAC QUAD IN TANK 9 IS BEGINNING OF LINE******)          (  6          )
SPECIAL ZBEGIN=-3.1284                                                        (  7          )
(*****************)                                                           (  7 ELEMENTS)
3.  'DU1' .1524 ;                                                             (  8          )
5.0 'QC1' .2985 -1.5 41.275 ;                                                 (  9          )
3. 'DD1' .1524 ;                                                              (  10         )
(*****************)                                                           (  10         )
4. 'CHOP' 1.43 0.0 0. ;                                                       (  11 ELEMENTS)
3. 'DU2' .1524 ;                                                              (  12         )
5. 'QCU2' .14825 2.64 41.275 ;                                                (  13         )
4.0 'QBD' .002 0.0 ;                                                          (  14         )
5.0 'QCD2' .14825 2.64 41.275 ;                                               (  15         )
(3. 'D4' 3.1981 ; this drift is now d4+wire+d41 so that i have)               (  15 ELEMENTS)
(wire at same position as in old 200 MeV line)                                (  15         )
(3.1981-0.039-0.2675)                                                         (  15         )
3. 'DR1' 2.8916 ;                                                             (  16         )
(this is position of wire 1)                                                  (  16         )
3. 'DR11' 0.3065 ;                                                            (  17 ELEMENTS)
2. 0 ;                                                                        (  18         )
4.0 'LAM' 0.5 0.0 ;                                                           (  19         )
4.0 'LAM' 0.5 0.0 ;                                                           (  20         )
2. 0. ;                                                                       (  21         )
(i am taking Carols input cuting lam on half and assuming)                    (  21 ELEMENTS)
(that centar of lam will be at same position as existing septum)              (  21         )
(this is place where w1 is)                                                   (  21         )
(3. 'DR3' 0.039 ;)                                                            (  21         )
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      (4. 'SP1U' 0.7675 0 0. ;)                                                  ( 21          )
65    (4. 'SP1D' 0.7675 0 0. ;)                                                  ( 21 ELEMENTS)
      (dr21 is to make for difference between 0.5 of lam and 0.7675 of septum)   ( 21          )
      3. 'DR21' 0.2675 ;                                                         ( 22          )
      3. 'DR2' 1.7586 ;                                                          ( 23          )
      (quad 3-start)                                                             ( 23          )
70    3.  'DU3' 0.1301 ;                                                         ( 24 ELEMENTS)
      5.01 'QM3' 0.2985 2.0 41.275 ;                                             ( 25          )
      3. 'DD3' 0.1301 ;                                                          ( 26          )
      (quad 3-end)                                                               ( 26          )
      3.  'DR3' 0.2553 ;                                                         ( 27          )
75    (quad 4-start)                                                             ( 27 ELEMENTS)
      3.  'DU4' 0.1301 ;                                                         ( 28          )
      5.01 'QM4' 0.2985 -0.5 41.275 ;                                            ( 29          )
      3. 'DD4' 0.1301 ;                                                          ( 30          )
      (quad 4-end)                                                               ( 30          )
80    3.  'DR4' 0.1693 ;                                                         ( 31 ELEMENTS)
      (position of the wire W2)                                                  ( 31          )
      3.  'DR5' 1.408 ;                                                          ( 32          )
      (old drift was 2.204, i have shoreten this one for lenght of magnet)       ( 32          )
      (position of the wire W3)                                                  ( 32          )
85    3.  'DR6' 0.4143 ;                                                         ( 33 ELEMENTS)
      (position of the PHYSICAL ENTRANCE TO THE SPECTROMETAR)                    ( 33          )
      4. 1.480 0.0 0.0193 'SPEC' ;                                               ( 34          )
      FIT  NAME=BETAX, VALUE=7.0, TOLER=3.;                                      ( 35          )
      FIT  NAME=BETAY, VALUE=5.0, TOLER=3.;                                      ( 36          )
90    (position of the CENTER OF SPECTROMETAR)                                   ( 36 ELEMENTS)
      (HERE I HAVE PUT L=PHYSICAL=2*1.48=2.96, old mag=0.684)                    ( 36          )
      (4. 1.480 7.500 0.0193 'SPEC' ;)                                           ( 36          )
      3.  'DT9' 1.2478 ;                                                         ( 37          )
      (position of the wire W4)                                                  ( 37          )
95    3.  'DT10' 1.7335 ;                                                        ( 38 ELEMENTS)
      (entrance to the dump-1)                                                   ( 38          )
      3.  'DT11' 3.5 ;                                                           ( 39          )
      FIT  NAME=BETAX, VALUE=100.0, TOLER=10.;                                   ( 40          )
      FIT  NAME=BETAY, VALUE=55.0, TOLER=10.;                                    ( 41          )
100   SENTINEL

 41 ELEMENTS USED OUT OF A MAXIMUM ALLOWABLE 1301
128 NUMBERS USED OUT OF A MAXIMUM ALLOWABLE  5001
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400-MEV DIAGNOSTIC LINE TO DUMP1, FORWARD DUMP - M. Popovic, 5-FEB-1991

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                                          PSIX      PSIY      BETAX     BETAY     ALPHAX    ALPHAY    ETAX      ETAY      DETAX     DETAY
(   5)  *BEAM*                            0.95400 GEV
            0.000 M                       0.0000    0.0000    0.0000 M          0.000     0.000     0.000 DEG
                                          0.0000    0.0000    1.9397    9.0271  0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
(   6)  *ETA*
          0.00000 MM        0.00000 MR        0.00000 MM        0.00000 MR        0.00000 CM        1.00000 PC
            0.000 M                       0.0000    0.0000    0.0000 M          0.000     0.000     0.000 DEG
                                          0.0000    0.0000    1.9397    9.0271  0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
(   7)  *ZBEGIN*                          -0.31284E+01
(   8)  *DRIFT*           "DU1 "          0.15240 M
            0.152 M                       0.0000    0.0000   -2.9760 M          0.000     0.000     0.000 DEG
                                          4.4924    0.9672    1.9517    9.0297 -0.0786    -0.0169    0.0000    0.0000    0.0000    0.0000
(   9)  *QUAD*            "QC1 "          0.29850 M        -1.50000 KG       41.27500 MM    (   -2.88429 M   )
            0.451 M                       0.0000    0.0000   -2.6775 M          0.000     0.000     0.000 DEG
                                         12.8135    2.9263    2.2548    8.1605 -0.9710     2.8291    0.0000    0.0000    0.0000    0.0000
(  10)  *DRIFT*           "DD1 "          0.15240 M
            0.603 M                       0.0000    0.0000   -2.5251 M          0.000     0.000     0.000 DEG
                                         16.4428    4.0559    2.5708    7.3238 -1.1024     2.6610    0.0000    0.0000    0.0000    0.0000
(  11)  *BEND *           "CHOP"          1.43000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            2.033 M                       0.0000    0.0000   -1.0951 M          0.000     0.000     0.000 DEG
                                         35.4679   26.1731    7.4855    1.9697 -2.3346     1.0832    0.0000    0.0000    0.0000    0.0000
(  12)  *DRIFT*           "DU2 "          0.15240 M
            2.186 M                       0.0000    0.0000   -0.9427 M          0.000     0.000     0.000 DEG
                                         36.5813   31.0002    8.2171    1.6652 -2.4659     0.9150    0.0000    0.0000    0.0000    0.0000
(  13)  *QUAD*            "QCU2"          0.14825 M         2.64000 KG       41.27500 MM    (    3.38079 M   )
            2.334 M                       0.0000    0.0000   -0.7945 M          0.000     0.000     0.000 DEG
                                         37.5851   36.4499    8.5879    1.4851  0.0018     0.3177    0.0000    0.0000    0.0000    0.0000
(  14)  *BEND *           "QBD "          0.00200 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            2.336 M                       0.0000    0.0000   -0.7925 M          0.000     0.000     0.000 DEG
                                         37.5985   36.5270    8.5879    1.4838  0.0016     0.3162    0.0000    0.0000    0.0000    0.0000
(  15)  *QUAD*            "QCD2"          0.14825 M         2.64000 KG       41.27500 MM    (    3.38079 M   )
            2.484 M                       0.0000    0.0000   -0.6442 M          0.000     0.000     0.000 DEG
                                         38.6023   42.3302    8.2161    1.4703  2.4690    -0.2239    0.0000    0.0000    0.0000    0.0000
(  16)  *DRIFT*           "DR1 "          2.89160 M
            5.376 M                       0.0000    0.0000    2.2474 M          0.000     0.000     0.000 DEG
                                        108.1775   96.1136    1.1588    8.7368 -0.0284    -2.2891    0.0000    0.0000    0.0000    0.0000
(  17)  *DRIFT*           "DR11"          0.30650 M
            5.682 M                       0.0000    0.0000    2.5539 M          0.000     0.000     0.000 DEG
                                        122.8873   97.9736    1.2573   10.2071 -0.2931    -2.5080    0.0000    0.0000    0.0000    0.0000
(  18)  *ROTAT*                           0.00000 DEG
            5.682 M                       0.0000    0.0000    2.5539 M          0.000     0.000     0.000 DEG
                                        122.8873   97.9736    1.2573   10.2071 -0.2931    -2.5080    0.0000    0.0000    0.0000    0.0000
(  19)  *BEND *           "LAM "          0.50000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            6.182 M                       0.0000    0.0000    3.0539 M          0.000     0.000     0.000 DEG
                                        142.4913  100.4715    1.7663   12.8937 -0.7249    -2.8651    0.0000    0.0000    0.0000    0.0000
(  20)  *BEND *           "LAM "          0.50000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            6.682 M                       0.0000    0.0000    3.5539 M          0.000     0.000     0.000 DEG
                                        155.7094  102.4704    2.7071   15.9373 -1.1567    -3.2222    0.0000    0.0000    0.0000    0.0000
(  21)  *ROTAT*                           0.00000 DEG
            6.682 M                       0.0000    0.0000    3.5539 M          0.000     0.000     0.000 DEG
                                        155.7094  102.4704    2.7071   15.9373 -1.1567    -3.2222    0.0000    0.0000    0.0000    0.0000
(  22)  *DRIFT*           "DR21"          0.28750 M
            6.950 M                       0.0000    0.0000    3.8214 M          0.000     0.000     0.000 DEG
                                        160.7770  103.3827    3.3878   17.7123 -1.3878    -3.4133    0.0000    0.0000    0.0000    0.0000
(  23)  *DRIFT*           "DR2 "          1.75880 M
            8.708 M                       0.0000    0.0000    5.5800 M          0.000     0.000     0.000 DEG
                                        177.5675  107.6237   10.9398   31.9264 -2.9066    -4.6693    0.0000    0.0000    0.0000    0.0000
(  24)  *DRIFT*           "DU3 "          0.13010 M
            8.839 M                       0.0000    0.0000    5.7101 M          0.000     0.000     0.000 DEG
                                        178.2261  107.8529   11.7107   33.1534 -3.0189    -4.7622    0.0000    0.0000    0.0000    0.0000
(  25)  *QUAD*            "QM3 "          0.29850 M         2.00000 KG       41.27500 MM    (    2.25064 M   )
          VARY CODE =  0 1 0
            9.137 M                       0.0000    0.0000    6.0086 M          0.000     0.000     0.000 DEG
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                                    179.6419  108.3271   11.9096   41.0326    2.3830  -22.8166    0.0000    0.0000    0.0000    0.0000
( 26)  *DRIFT*          "DD3 "        0.13010 M
            9.267 M                   0.0000     0.0000     6.1387 M         0.000     0.000     0.000 DEG
                                    180.2845  108.4965   11.2990   47.1846    2.3101  -24.4704    0.0000    0.0000    0.0000    0.0000
( 27)  *DRIFT*          "DR3 "        0.25530 M
            9.522 M                   0.0000     0.0000     6.3940 M         0.000     0.000     0.000 DEG
                                    181.6501  108.7703   10.1560   60.5077    2.1669  -27.7157    0.0000    0.0000    0.0000    0.0000
( 28)  *DRIFT*          "DU4 "        0.13010 M
            9.653 M                   0.0000     0.0000     6.5241 M         0.000     0.000     0.000 DEG
                                    182.4050  108.8866    9.6017   67.9345    2.0939  -29.3695    0.0000    0.0000    0.0000    0.0000
( 29)  *QUAD*           "QM4 "        0.29850 M        -0.50000 KG       41.27500 MM   (   -8.75081 M   )
          VARY CODE =  0 1 0
            9.951 M                   0.0000     0.0000     6.8226 M         0.000     0.000     0.000 DEG
                                    184.2869  109.1118    8.7031   83.9159    0.9505  -23.5627    0.0000    0.0000    0.0000    0.0000
( 30)  *DRIFT*          "DD4 "        0.13010 M
           10.081 M                   0.0000     0.0000     6.9527 M         0.000     0.000     0.000 DEG
                                    185.1557  109.1975    8.4595   90.1591    0.9220  -24.4250    0.0000    0.0000    0.0000    0.0000
( 31)  *DRIFT*          "DR4 "        0.16930 M
           10.250 M                   0.0000     0.0000     7.1220 M         0.000     0.000     0.000 DEG
                                    186.3237  109.3004    8.1535   98.6194    0.8850  -25.5471    0.0000    0.0000    0.0000    0.0000
( 32)  *DRIFT*          "DR5 "        1.40800 M
           11.658 M                   0.0000     0.0000     8.5300 M         0.000     0.000     0.000 DEG
                                    197.8450  109.8997    6.0949  183.7001    0.5771  -34.8795    0.0000    0.0000    0.0000    0.0000
( 33)  *DRIFT*          "DR6 "        0.41430 M
           12.073 M                   0.0000     0.0000     8.9443 M         0.000     0.000     0.000 DEG
                                    201.8919  110.0195    5.6543  213.7389    0.4865  -37.6255    0.0000    0.0000    0.0000    0.0000
( 34)  *BEND *          "SPEC"        1.48000 M         0.00000 KG        0.01930      (     0.000 M     ,     0.000 DEG )
           13.553 M                   0.0000     0.0000    10.4243 M         0.000     0.000     0.000 DEG
                                    218.5880  110.3343    4.6934  339.6284    0.1628  -47.4350    0.0000    0.0000    0.0000    0.0000
( 35)  *FIT*                           BETAX          7.00000 /3.00000        (      4.69344 )
( 36)  *FIT*                           BETAY          5.00000 /3.00000        (    339.62842 )
( 37)  *DRIFT*          "DT9 "        1.24780 M
           14.801 M                   0.0000     0.0000    11.6721 M         0.000     0.000     0.000 DEG
                                    234.1178  110.5135    4.6278  468.3272   -0.1101  -55.7055    0.0000    0.0000    0.0000    0.0000
( 38)  *DRIFT*          "DT10"        1.73350 M
           16.534 M                   0.0000     0.0000    13.4056 M         0.000     0.000     0.000 DEG
                                    253.9038  110.6893    5.6668  681.3759   -0.4893  -67.1953    0.0000    0.0000    0.0000    0.0000
( 39)  *DRIFT*          "DT11"        3.50000 M
           20.034 M                   0.0000     0.0000    16.9056 M         0.000     0.000     0.000 DEG
                                    279.2789  110.9081   11.7709 1232.9368   -1.2547  -90.3936    0.0000    0.0000    0.0000    0.0000
( 40)  *FIT*                           BETAX        100.00000 /*******        (     11.77086 )
( 41)  *FIT*                           BETAY         55.00000 /*******        (   1232.93677 )

       *LENGTH*         20.03400 M

       *CORRECTIONS*
       *NUMBER OF VARIED PARAMETERS =     2 *
       *NUMBER OF CONSTRAINTS       =     4 *

 0.10000E+01 ( 0.26398E+05)   -1.0948   -0.1415
 0.10000E+01 ( 0.23532E+04)    1.4457   -1.7151
 0.10000E+01 ( 0.21890E+03)    0.2234   -0.2501
 0.10000E+01 ( 0.12969E+03)    0.2471   -0.3686
 0.10000E+01 ( 0.36096E+02)    0.0314   -0.0662
 0.10000E+01 ( 0.33097E+02)   -0.0061    0.0113
 0.10000E+01 ( 0.32993E+02)    0.0005   -0.0011

       *COVARIANCE  (FIT 0.32992E+02 )
      0.058
     -0.762       0.039
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400-MEV DIAGNOSTIC LINE TO DUMP1, FORWARD DUMP - M. Popovic, 5-FEB-1991

                                        PSIX      PSIY      BETAX     BETAY     ALPHAX    ALPHAY    ETAX      ETAY      DETAX     DETAY
(   5)  *BEAM*                           0.95400 GEV
            0.000 M                      0.0000    0.0000    0.0000 M          0.000     0.000     0.000 DEG
                                        0.0000    0.0000    1.9397    9.0271    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
(   6)  *ETA*
          0.00000 MM       0.00000 MR       0.00000 MM       0.00000 MR       0.00000 CM       1.00000 PC
            0.000 M                      0.0000    0.0000    0.0000 M          0.000     0.000     0.000 DEG
                                        0.0000    0.0000    1.9397    9.0271    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
(   7)  *ZBEGIN*                        -0.31284E+01
(   8)  *DRIFT*          "DU1 "          0.15240 M
            0.152 M                      0.0000    0.0000   -2.9760 M          0.000     0.000     0.000 DEG
                                        4.4924    0.9672    1.9517    9.0297   -0.0786   -0.0169    0.0000    0.0000    0.0000    0.0000
(   9)  *QUAD*           "QC1 "          0.29850 M        -1.50000 KG       41.27500 MM   (   -2.88429 M   )
            0.451 M                      0.0000    0.0000   -2.6775 M          0.000     0.000     0.000 DEG
                                       12.8135    2.9263    2.2548    8.1605   -0.9710    2.8291    0.0000    0.0000    0.0000    0.0000
(  10)  *DRIFT*          "DD1 "          0.15240 M
            0.603 M                      0.0000    0.0000   -2.5251 M          0.000     0.000     0.000 DEG
                                       16.4428    4.0559    2.5708    7.3238   -1.1024    2.6610    0.0000    0.0000    0.0000    0.0000
(  11)  *BEND *          "CHOP"          1.43000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            2.033 M                      0.0000    0.0000   -1.0951 M          0.000     0.000     0.000 DEG
                                       35.4679   26.1731    7.4855    1.9697   -2.3346    1.0832    0.0000    0.0000    0.0000    0.0000
(  12)  *DRIFT*          "DU2 "          0.15240 M
            2.186 M                      0.0000    0.0000   -0.9427 M          0.000     0.000     0.000 DEG
                                       36.5813   31.0002    8.2171    1.6652   -2.4659    0.9150    0.0000    0.0000    0.0000    0.0000
(  13)  *QUAD*           "QCU2"          0.14825 M         2.64000 KG       41.27500 MM   (    3.38079 M   )
            2.334 M                      0.0000    0.0000   -0.7945 M          0.000     0.000     0.000 DEG
                                       37.5851   36.4499    8.5879    1.4851    0.0018    0.3177    0.0000    0.0000    0.0000    0.0000
(  14)  *BEND *          "QBD "          0.00200 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            2.336 M                      0.0000    0.0000   -0.7925 M          0.000     0.000     0.000 DEG
                                       37.5985   36.5270    8.5879    1.4838    0.0016    0.3162    0.0000    0.0000    0.0000    0.0000
(  15)  *QUAD*           "QCD2"          0.14825 M         2.64000 KG       41.27500 MM   (    3.38079 M   )
            2.484 M                      0.0000    0.0000   -0.6442 M          0.000     0.000     0.000 DEG
                                       38.6023   42.3302    8.2161    1.4703    2.4690   -0.2239    0.0000    0.0000    0.0000    0.0000
(  16)  *DRIFT*          "DR1 "          2.89160 M
            5.376 M                      0.0000    0.0000    2.2474 M          0.000     0.000     0.000 DEG
                                      108.1775   96.1136    1.1588    8.7368   -0.0284   -2.2891    0.0000    0.0000    0.0000    0.0000
(  17)  *DRIFT*          "DR11"          0.30650 M
            5.682 M                      0.0000    0.0000    2.5539 M          0.000     0.000     0.000 DEG
                                      122.8873   97.9736    1.2573   10.2071   -0.2931   -2.5080    0.0000    0.0000    0.0000    0.0000
(  18)  *ROTAT*                          0.00000 DEG
            5.682 M                      0.0000    0.0000    2.5539 M          0.000     0.000     0.000 DEG
                                      122.8873   97.9736    1.2573   10.2071   -0.2931   -2.5080    0.0000    0.0000    0.0000    0.0000
(  19)  *BEND *          "LAM "          0.50000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            6.182 M                      0.0000    0.0000    3.0539 M          0.000     0.000     0.000 DEG
                                      142.4913  100.4715    1.7663   12.8937   -0.7249   -2.8651    0.0000    0.0000    0.0000    0.0000
(  20)  *BEND *          "LAM "          0.50000 M         0.00000 KG        0.00000     (     0.000 M    ,    0.000 DEG )
            6.682 M                      0.0000    0.0000    3.5539 M          0.000     0.000     0.000 DEG
                                      155.7094  102.4704    2.7071   15.9373   -1.1567   -3.2222    0.0000    0.0000    0.0000    0.0000
(  21)  *ROTAT*                          0.00000 DEG
            6.682 M                      0.0000    0.0000    3.5539 M          0.000     0.000     0.000 DEG
                                      155.7094  102.4704    2.7071   15.9373   -1.1567   -3.2222    0.0000    0.0000    0.0000    0.0000
(  22)  *DRIFT*          "DR21"          0.26750 M
            6.950 M                      0.0000    0.0000    3.8214 M          0.000     0.000     0.000 DEG
                                      160.7770  103.3827    3.3878   17.7123   -1.3878   -3.4133    0.0000    0.0000    0.0000    0.0000
(  23)  *DRIFT*          "DR2 "          1.75860 M
            8.708 M                      0.0000    0.0000    5.5800 M          0.000     0.000     0.000 DEG
                                      177.5875  107.6237   10.9398   31.9264   -2.9066   -4.6693    0.0000    0.0000    0.0000    0.0000
(  24)  *DRIFT*          "DU3 "          0.13010 M
            8.839 M                      0.0000    0.0000    5.7101 M          0.000     0.000     0.000 DEG
                                      178.2261  107.8529   11.7107   33.1534   -3.0189   -4.7622    0.0000    0.0000    0.0000    0.0000
(  25)  *QUAD*           "QM3 "          0.29850 M         2.84713 KG       41.27500 MM   (    1.59637 M   )
          VARY CODE =  0 1 0
            9.137 M                      0.0000    0.0000    6.0086 M          0.000     0.000     0.000 DEG
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                                  179.6693  108.3191   11.2419   43.2712    4.4869  -31.2879    0.0000    0.0000    0.0000    0.0000
(  26)  *DRIFT*          "DD3 "      0.13010 M
            9.267 M                   0.0000     0.0000     6.1387 M        0.000     0.000     0.000 DEG
                                  180.3687  108.4765   10.1062   51.7957    4.2423  -34.2342    0.0000    0.0000    0.0000    0.0000
(  27)  *DRIFT*          "DR3 "      0.25530 M
            9.522 M                   0.0000     0.0000     6.3940 M        0.000     0.000     0.000 DEG
                                  181.9893  108.7182    8.0626   70.7517    3.7624  -40.0158    0.0000    0.0000    0.0000    0.0000
(  28)  *DRIFT*          "DU4 "      0.13010 M
            9.653 M                   0.0000     0.0000     6.5241 M        0.000     0.000     0.000 DEG
                                  182.9736  108.8163    7.1154   81.5471    3.5179  -42.9620    0.0000    0.0000    0.0000    0.0000
(  29)  *QUAD*           "QM4 "      0.29850 M        -3.03148 KG       41.27500 MM   (   -1.40291 M   )
          VARY CODE =  0 1 0
            9.951 M                   0.0000     0.0000     6.8226 M        0.000     0.000     0.000 DEG
                                  185.5842  109.0091    6.4609   90.0525   -1.1770   16.4488    0.0000    0.0000    0.0000    0.0000
(  30)  *DRIFT*          "DD4 "      0.13010 M
           10.081 M                   0.0000     0.0000     6.9527 M        0.000     0.000     0.000 DEG
                                  186.7111  109.0939    6.7734   85.8235   -1.2250   16.0565    0.0000    0.0000    0.0000    0.0000
(  31)  *DRIFT*          "DR4 "      0.16930 M
           10.250 M                   0.0000     0.0000     7.1220 M        0.000     0.000     0.000 DEG
                                  188.1004  109.2106    7.1988   80.4733   -1.2875   15.5459    0.0000    0.0000    0.0000    0.0000
(  32)  *DRIFT*          "DR5 "      1.40800 M
           11.658 M                   0.0000     0.0000     8.5300 M        0.000     0.000     0.000 DEG
                                  196.9806  110.5874   11.5563   42.6743   -1.8073   11.3000    0.0000    0.0000    0.0000    0.0000
(  33)  *DRIFT*          "DR6 "      0.41430 M
           12.073 M                   0.0000     0.0000     8.9443 M        0.000     0.000     0.000 DEG
                                  198.9090  111.2122   13.1172   33.8287   -1.9603   10.0506    0.0000    0.0000    0.0000    0.0000
(  34)  *BEND *          "SPEC"      1.48000 M         0.00000 KG        0.01930      (     0.000 M    ,    0.000 DEG )
           13.553 M                   0.0000     0.0000    10.4243 M        0.000     0.000     0.000 DEG
                                  204.1878  115.6770   19.7282   10.6844   -2.5066    5.5875    0.0000    0.0000    0.0000    0.0000
(  35)  *FIT*                        BETAX          7.00000 /3.00000        (    19.72819 )
(  36)  *FIT*                        BETAY          5.00000 /3.00000        (    10.68438 )
(  37)  *DRIFT*          "DT9 "      1.24780 M
           14.801 M                   0.0000     0.0000    11.6721 M        0.000     0.000     0.000 DEG
                                  207.3127  134.2557   26.5586    1.4356   -2.9673    1.8246    0.0000    0.0000    0.0000    0.0000
(  38)  *DRIFT*          "DT10"      1.73350 M
           16.534 M                   0.0000     0.0000    13.4056 M        0.000     0.000     0.000 DEG
                                  210.4426  269.1541   37.9556    4.1717   -3.6073   -3.4030    0.0000    0.0000    0.0000    0.0000
(  39)  *DRIFT*          "DT11"      3.50000 M
           20.034 M                   0.0000     0.0000    16.9056 M        0.000     0.000     0.000 DEG
                                  214.4009  281.4321   67.7290   64.9336   -4.8994  -13.9576    0.0000    0.0000    0.0000    0.0000
(  40)  *FIT*                        BETAX        100.00000 /*******        (    67.72900 )
(  41)  *FIT*                        BETAY         55.00000 /*******        (    64.93362 )

        *LENGTH*         20.03400 M
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