PBAR Note 648
Optimization of the 8 GeV AP3-P1 Lattice for Antiproton Transfers

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INTRODUCTION

During 8 GeV antiproton transfers between the Accumulator to the Main Injector, the antiprotons must travel through four separate beam lines, AP3, AP1, P2, and P1. This note describes the optimization of a single lattice that describes these beam lines for 8 GeV antiproton transfers from the Accumulator to the Main Injector and 8 GeV proton transfers from the Main Injector to the Accumulator.

LATTICE OPTIMIZATION

In theory, it is only necessary to consider a lattice for the beam travelling in one direction only and match the beta functions of the transfer line to the beta functions of the synchrotrons at the both ends of the transfer line. In this case, the lattice in the forward direction will be identical to the lattice in the reverse direction. However, with the present configuration of magnets and power supplies in the AP3-P1 transfer line, an exact match at both ends of the transfer line will result in extremely large beta and dispersion functions in the transfer line. This note will take the approach of not matching the transfer line to the synchrotrons exactly, but to obtain a lattice that results in reasonable beta functions and acceptable emittance dilutions (< 10%) for beams traveling in both antiproton and proton directions.

This note will designate the forward lattice in the antiproton direction and the reverse lattice in the proton direction. The forward lattice is listed in Appendix 2. The initial phase space for both lattices is listed in Table 1. The description of the initial phase space and the lattices follow the sign convention described in Chapter 1 of the MAD 8.19 User's Reference Manual.

The forward and reverse lattices were optimized simultaneously using the same magnet strengths for both lattices. The optimization program (TUNE_LATTICE) used a SIMPLEX optimization procedure (Numerical Recipes in C) and MAD 8.19 as the lattice solver. The optimization goals and results are listed in Table 3. A description of the optimization goal names is listed in Appendix 1. The definition of emittance dilution is taken from PBAR Note 639 "Phase Space Matching Errors". The quadrupole bus currents that give the optimization results tabulated in Table 3 are listed in Table 2. The lattice functions for the antiproton direction are shown in Figures 1-3. The lattice functions for the proton direction are shown in Figures 4-6.

	Pbar	Proton	
BETAX	33.25	32.96	meters
ALPHAX	-0.5335	-1.784	
DISPX	0.6188	-0.001	meters
DISPPX	-0.0739	-0.005	
BETAY	5.573	17.59	meters
ALPHAY	0.4928	1.183	
DISPY	0	0	meters
DISPPY	0	0	
EMITH	2	2	unnormalized
EMITV	2	2	unnormalized
DP_P	0.3	0.3	percent

Table 1. Input Phase Space

Name	Amps
M:Q201	10.81
M:Q202	-5.86
M:Q203	7.54
M:Q204	19.91
M:Q205	3.36
M:Q206	15.05
M:Q207	22.68
D:Q926	354.04
D:Q924	160.08
D:Q919	100.53
D:Q917	365.31
D:Q916	264.79

Name	Amps
D:Q914	185.50
D:Q913	121.97
D:Q909	161.48
D:Q907	87.39
D:Q903	509.00
D:Q901	373.87
D:QS928	1.36
D:QS926	39.13
D:QS925	16.39
D:QS919	8.24
D:QS917	50.00
D:QS915	2.88

Name	Amps
I:Q701	13.81
I:Q702	15.25
I:Q703	216.19
I:Q710	15.19
I:Q711	16.44
I:Q712	11.30
I:Q713	13.76
I:Q714	17.55
I:QF11A	33.24
I:QF11B	18.14
I:QF12	99.44

Table 2. Quadrupole Power Supply Settings

Name	Desired	Actual	Op.	Sigma	Chi	Range Start	Range Stop
BXE	32.96	33.167	=	200	0.00		
AXE	1.784	1.861	=	200	0.00		
DXE	0.001	-0.691	=	200	0.00		
DPXE	-0.005	-0.001	=	200	0.00		
BYE	17.59	18.046	=	200	0.00		
AYE	-1.183	-1.213	=	200	0.00		
DYE	0	-0.576	=	200	0.00		
DPYE	0	0.015	=	200	0.00		
DXM	6	5.449	<	1	0.00		
DYM	6	2.777	<	1	0.00		
BWH	30	43.255	<	2	0.95		
BWV	30	44.097	<	2	1.08		
BWH	22	37.240	<	2	1.26	AP3START	HC522
BWV	22	40.335	<	2	1.83	AP3START	HC522
BWH	13	20.684	<	2	0.32	Q702	P150_START
BWH	13	19.962	<	2	0.26	QF11A	Q714
BWH	13	21.547	<	2	0.40	DRIFT005	F17LAM3
BWV	13	14.424	<	2	0.01	DRIFT005	F17LAM3
BWV	13	25.240	<	2	0.81	DRIFT010	HV2001
BWV	13	17.591	<	2	0.11	DRIFT019	HV2021
BWH	13	13.630	<	2	0.00	Q2061	SM105
EMITH	10	7.967	<	1	0.00		
EMITV	10	4.342	<	1	0.00		
R_BXE	33.25	31.148	=	200	0.00		
R_AXE	0.5335	0.507	=	200	0.00		
R_DXE	-0.6188	-0.444	=	200	0.00		
R_DPXE	-0.0739	-0.036	=	200	0.00		
R_BYE	5.573	5.433	=	200	0.00		
R_AYE	-0.4928	-0.484	=	200	0.00		
R_DYE	0	-0.361	=	200	0.00		
R_DPYE	0	-0.124	=	200	0.00		
R_DXM	6	4.907	<	1	0.00		
R_DYM	6	4.009	<	1	0.00		
R_BWH	30	25.794	<	2	0.00		
R_BWV	30	29.789	<	2	0.00		
R_BWH	22	23.686	<	2	0.02	P150_START	AP1END
R_BWV	22	24.631	<	2	0.04	P150_START	AP1END
R_BWH	13	12.459	<	2	0.00	P150_START	Q702
R_BWH	13	12.092	<	2	0.00	Q714	QF11A
R_BWH	13	17.170	<	2	0.09	B3D	F17LAM4D
R_BWV	13	9.322	<	2	0.00	B3D	F17LAM4D
R_BWV	13	16.977	<	2	0.09	DRIFT006	HV2004D
R_BWV	13	11.017	<	2	0.00	DRIFT015	HV2024D
R_BWH	13	10.087	<	2	0.00	SM105	Q2061
R_EMITH	10	8.520	<	1	0.00		
R_EMITV	10	10.554	<	1	0.01		

Table 3. Optimization Goals and Results

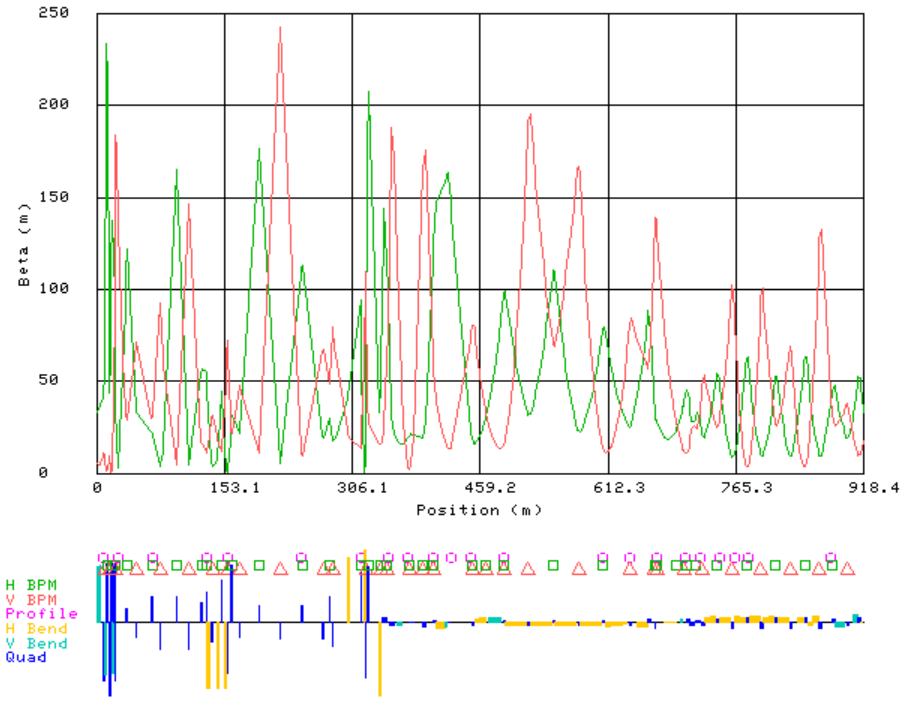

Figure 1. Antiproton Beta Functions.
Green is horizontal. Red is vertical

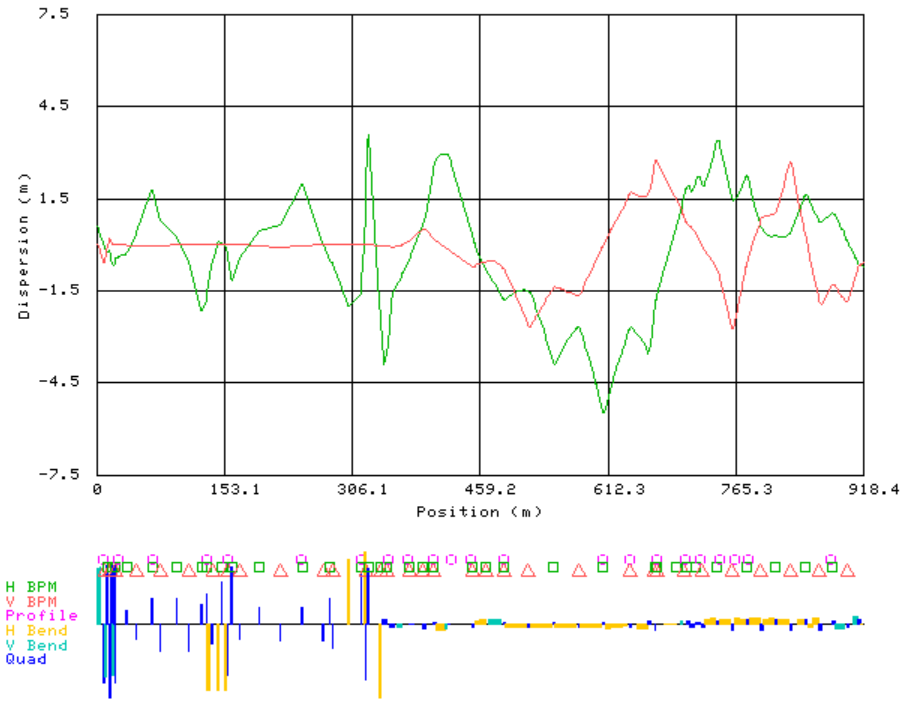

Figure 2. Antiproton Dispersion Functions.
Green is horizontal. Red is vertical

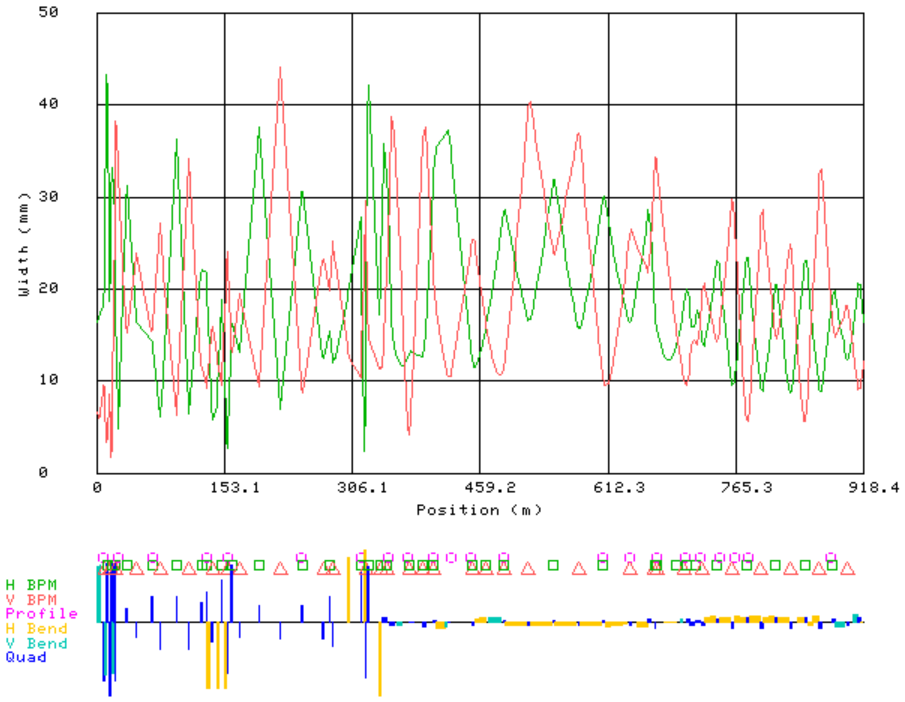

Figure 3. Antiproton Beam Widths
Green is horizontal. Red is vertical

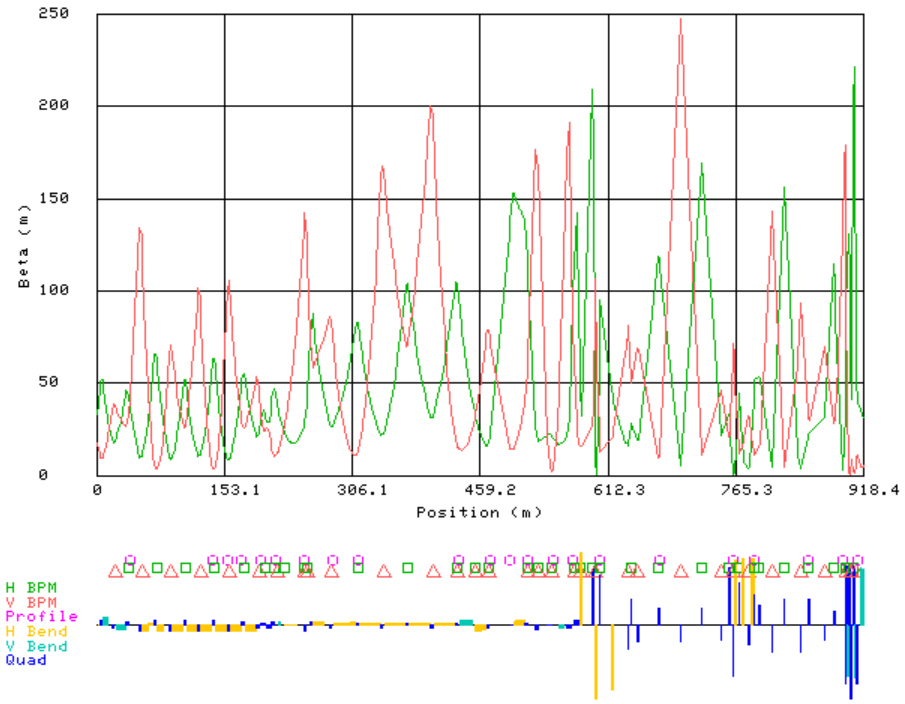

Figure 4. Proton Beta Functions
Green is horizontal. Red is vertical

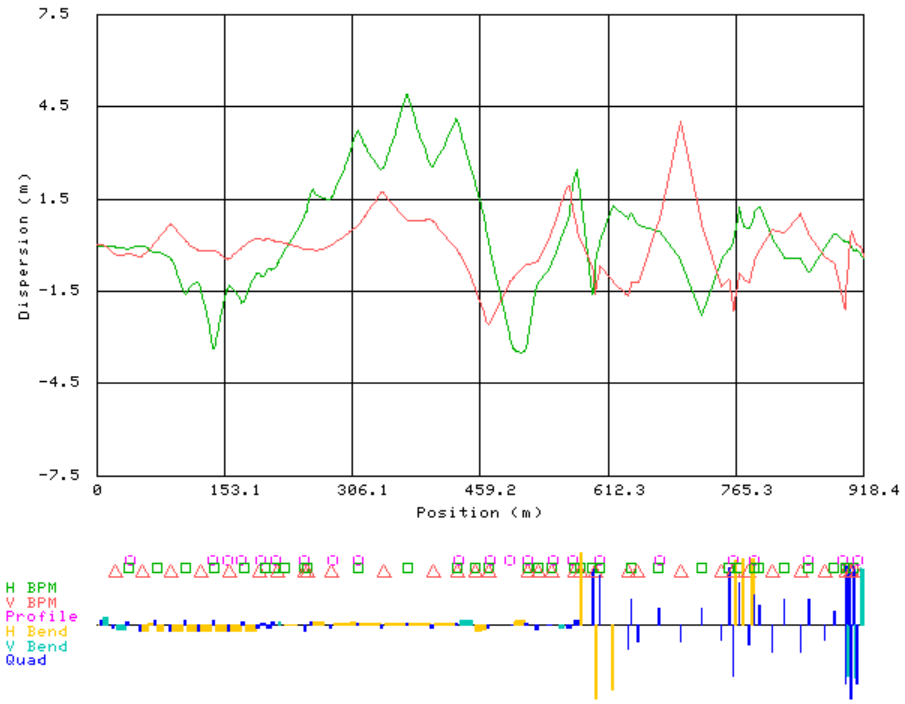

Figure 5. Proton Dispersion Functions
Green is horizontal. Red is vertical

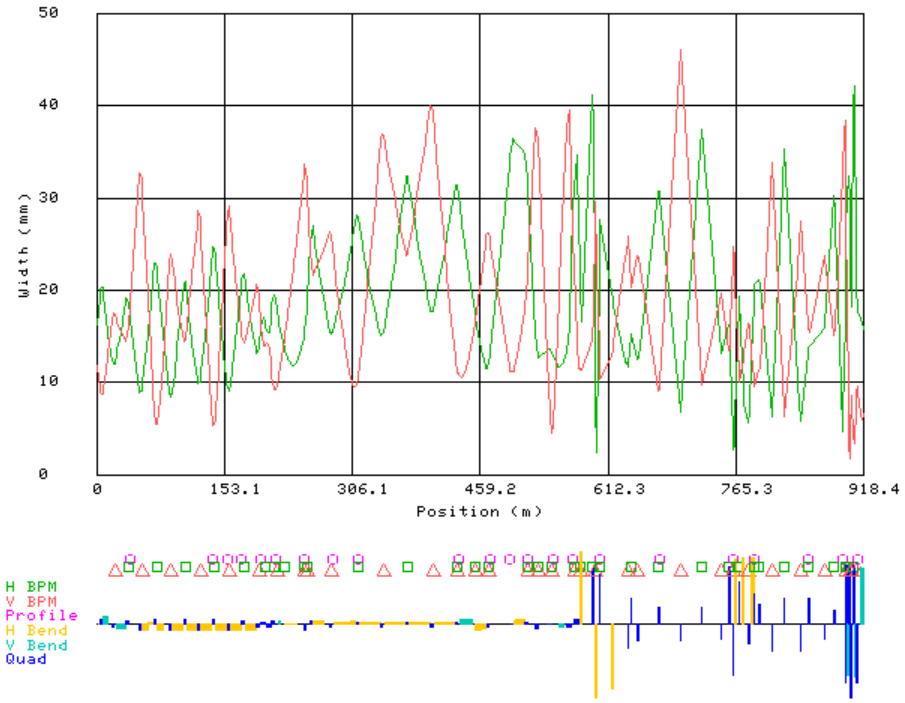

Figure 6. Proton Beam Widths
Green is horizontal. Red is vertical

Appendix 1.
Definition of Optimization Goals

Name	Description
BXE	Horz end beta function
AXE	Horz end alpha function
DXE	Horz end Disp function
DPXE	Horz end D' function
BYE	Vert end beta function
AYE	Vert end alpha function
DYE	Vert end Disp function
DPYE	Vert end D' function
BXM	Horz max beta function
AXM	Horz max alpha function
DXM	Horz max Disp function
DPXM	Horz max D' function
BYM	Vert max beta function
AYM	Vert max alpha function
DYM	Vert max Disp function
DPYM	Vert max D' function
EMITH	Horz Emit blowup percent
EMITV	Vert Emit blowup percent
BWH	Horz Beam Width in mm
BWV	Vert Beam Width in mm

Name	Description
R_BXE	Rev. Horz end beta function
R_AXE	Rev. Horz end alpha function
R_DXE	Rev. Horz end Disp function
R_DPXE	Rev. Horz end D' function
R_BYE	Rev. Vert end beta function
R_AYE	Rev. Vert end alpha function
R_DYE	Rev. Vert end Disp function
R_DPYE	Rev. Vert end D' function
R_BXM	Rev. Horz max beta function
R_AXM	Rev. Horz max alpha function
R_DXM	Rev. Horz max Disp function
R_DPXM	Rev. Horz max D' function
R_BYM	Rev. Vert max beta function
R_AYM	Rev. Vert max alpha function
R_DYM	Rev. Vert max Disp function
R_DPYM	Rev. Vert max D' function
R_EMITH	Rev. Horz Emit blowup percent
R_EMITV	Rev. Vert Emit blowup percent
R_BWH	Rev. Horz Beam Width in mm
R_BWV	Rev. Vert Beam Width in mm

Appendix 2.
Antiproton Lattice AP3 - P1

```
!AP1-3 8 GeV lattice
!( Central orbit - Pbeam = 8.827385 GeV/c )
!
!        1         2         3         4         5         6         7         8
!2345678901234567890123456789012345678901234567809123456789012345678901234567890
!
!
Pb      :=      8.8788339           !GeV
Brho    :=      Pb / 0.2997925      !Tesla - meters
Mp      :=      0.93827231          ! GeV/c^2
Eb      :=      SQRT(Pb*Pb + Mp*Mp) ! Total Energy
DEG_TO_RAD :=   3.141592654 / 180.0
BRHOT   :=      Brho
PI      :=      3.141592654
!
CALL, FILENAME=APX_QUAD_SETTINGS.DAT
CALL, FILENAME=APX_QUAD_FUDGE.DAT
CALL, FILENAME=APX_QUAD_EXCITATION.DAT
!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!  Quads
! TF [kG/A] =  G * dL [kG]/ I [A]
!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!
! Main Injector
TF_QF       :=   1.0
TF_QD       :=   1.0
! P1 line checked 3/16/00
Q701_a0     :=   1.5195
Q701_b0     :=   0.0
Q701_c0     :=   0.0
TF_Q701     :=   1.5195
TF_Q702     :=   1.5316
TF_Q703     :=   0.122228
TF_Q710     :=   1.5109
TF_Q711     :=   1.5213
TF_Q712     :=   1.575
TF_Q713     :=   1.5342
TF_Q714     :=   1.5013
! P2 line
TF_QF11A    :=   0.72639
TF_QF11B    :=   1.5013
TF_QF12     :=   0.12228
! BEAMLINE QUADS
L3Q84  := 2.1336
L3Q60  := 1.524
L3Q120 := 3.048
L3Q120E:= 3.0286
!
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
K1Q1     :=  -TF_Q701*IQ701K/(10.0 * BRHOT*L3Q120E)
K1Q2     :=   TF_Q702*IQ702K/(10.0 * BRHOT*L3Q120E)
K1Q3     :=  -TF_Q703*IQ703K/(10.0 * BRHOT*L3Q84)
K1Q4     :=   TF_Q703*IQ703K/(10.0 * BRHOT*L3Q84)
K1Q5     :=  -TF_Q703*IQ703K/(10.0 * BRHOT*L3Q84)
K1Q6     :=   TF_Q703*IQ703K/(10.0 * BRHOT*L3Q84)
K1Q7     :=  -TF_Q703*IQ703K/(10.0 * BRHOT*L3Q84)
K1Q8     :=   TF_Q703*IQ703K/(10.0 * BRHOT*L3Q84)
K1Q9     :=  -TF_Q703*IQ703K/(10.0 * BRHOT*L3Q84)
K1Q10    :=   TF_Q710*IQ710K/(10.0 * BRHOT*L3Q120E)
K1Q11    :=  -TF_Q711*IQ711K/(10.0 * BRHOT*L3Q120E)
K1Q12A   :=   TF_Q712*IQ712K/(10.0 * BRHOT*L3Q120E)
K1Q12B   :=   TF_Q712*IQ712K/(10.0 * BRHOT*L3Q120)
K1Q13A   :=  -TF_Q713*IQ713K/(10.0 * BRHOT*L3Q120E)
K1Q13B   :=  -TF_Q713*IQ713K/(10.0 * BRHOT*L3Q120)
K1Q14    :=   TF_Q714*IQ714K/(10.0 * BRHOT*L3Q120E)
K1QF11A  :=  -TF_QF11A*IQF11AK/(10.0 * BRHOT*L3Q60)
K1QF11B  :=   TF_QF11B*IQF11BK/(10.0 * BRHOT*L3Q120)
K1QF12   :=  -TF_QF12*IQF12K/(10.0 * BRHOT*L3Q84)
K1QF13   :=   TF_QF12*IQF12K/(10.0 * BRHOT*L3Q84)
K1QF14   :=  -TF_QF12*IQF12K/(10.0 * BRHOT*L3Q84)
K1QF15   :=   TF_QF12*IQF12K/(10.0 * BRHOT*L3Q84)
K1QF16   :=  -TF_QF12*IQF12K/(10.0 * BRHOT*L3Q84)
K1QF17   :=   TF_QF12*IQF12K/(10.0 * BRHOT*L3Q84)
!
P150_START  : MARKER
HC522       : KICKER, L=0.304801, TYPE=MI_Htrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00002     : DRIFT, L=0.152399
HC522       : KICKER, L=0.304801, TYPE=MI_Htrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00003     : DRIFT, L=0.420899
LAM52_1     : RBEND, L=2.800000, TYPE= MI_Lamb   , ANGLE=0.000000, &
              TILT=PI-4.932390, E1=0.000000, E2= 0.000000
D_00004     : DRIFT, L=0.395427
Q522        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=0.039553, &
              TILT=0.000000
D_00005     : DRIFT, L=0.568460
LAM52_2     : RBEND, L=2.800000, TYPE= MI_Lamb   , ANGLE=0.014808, &
              TILT=PI-4.810389, E1=0.000000, E2= 0.000000
D_00006     : DRIFT, L=0.613132
LAM52_3     : RBEND, L=2.800000, TYPE= MI_Lamb   , ANGLE=0.014808, &
              TILT=PI-4.749390, E1=0.000000, E2= 0.000000
!
MI52        : LINE = ( &
              P150_START  ,HC522       ,D_00002     ,HC522       ,D_00003     ,&
              LAM52_1     ,D_00004     ,Q522        ,D_00005     ,LAM52_2     ,&
              D_00006     ,LAM52_3     )
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
D_00007     : DRIFT, L=4.268877
MRK_Q1      : MARKER
Q701        : QUADRUPOLE, L=3.048006, TYPE=MI_3Q120  , K1=K1Q1, &
              TILT=0.000000
D_00009     : DRIFT, L=0.152395
VP701       : VMONITOR, L=0.203200, TYPE= BPM
D_00010     : DRIFT, L=0.175098
VT701       : KICKER, L=0.327415, TYPE=MR_VTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00012     : DRIFT, L=0.289680
HT701       : KICKER, L=0.000000, TYPE=MR_Htrim2 , &
              HKICK=0.000000, VKICK=0.000000
D_00013     : DRIFT, L=0.914413
V701AH      : RBEND, L=3.352800/2.0, TYPE= MI_ICA, ANGLE=0.008401/2.0, &
              TILT=PI-1.570796, E1=0.000000, E2= 0.000000
MV701A      : MARKER
D_00014     : DRIFT, L=0.533400
V701BH      : RBEND, L=3.352800/2.0, TYPE= MI_ICA, ANGLE=0.008401/2.0, &
              TILT=PI-1.570796, E1=0.000000, E2= 0.000000
MV701B      : MARKER
D_00015     : DRIFT, L=0.533400
V701CH      : RBEND, L=3.352800/2.0, TYPE= MI_ICA, ANGLE=0.008401/2.0, &
              TILT=PI-1.570796, E1=0.000000, E2= 0.000000
MV701C      : MARKER
D_00016     : DRIFT, L=0.495804
M_Q702      : MARKER
Q702        : QUADRUPOLE, L=3.048006, TYPE=MI_3Q120  , K1=K1Q2, &
              TILT=0.000000
D_00018     : DRIFT, L=0.152388
HP702       : HMONITOR, L=0.203200, TYPE= BPM
D_00019     : DRIFT, L=0.142877
HT702       : KICKER, L=0.000000, TYPE=MR_Htrim2 , &
              HKICK=0.000000, VKICK=0.000000
D_00020     : DRIFT, L=1.182243
MW702       : MONITOR, L=0.406400, TYPE= SWIC
D_00021     : DRIFT, L=11.815387
M_Q703      : MARKER
Q703        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1Q3, &
              TILT=0.000000
D_00023     : DRIFT, L=0.134996
VP703       : VMONITOR, L=0.152400, TYPE= BPM
D_00024     : DRIFT, L=0.246068
VT703       : KICKER, L=0.339722, TYPE=MR_VTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00026     : DRIFT, L=0.553024
HV7031H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-3.025687, E1=0.000000, E2= 0.000000
MHV7031     : MARKER
D_00027     : DRIFT, L=0.352901
HV7032H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.007873/2.0, &
              TILT=PI-0.000000, E1=0.000000, E2= 0.000000
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
MHV7032     : MARKER
D_00028     : DRIFT, L=0.000015
B3ERR       : MARKER
D_00029     : DRIFT, L=1.426193
M_Q704      : MARKER
Q704        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1Q4, &
              TILT=0.000000
D_00031     : DRIFT, L=0.134996
HP704       : HMONITOR, L=0.152400, TYPE= BPM
D_00032     : DRIFT, L=0.219075
HT704       : KICKER, L=0.000000, TYPE=MR_Htrim2 , &
              HKICK=0.000000, VKICK=0.000000
D_00033     : DRIFT, L=0.919724
HV704H      : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-3.298506, E1=0.000000, E2= 0.000000
MHV704      : MARKER
D_00034     : DRIFT, L=7.852413
M_Q705      : MARKER
Q705        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1Q5, &
              TILT=0.000000
D_00036     : DRIFT, L=0.134996
VP705       : VMONITOR, L=0.152400, TYPE= BPM
D_00037     : DRIFT, L=0.246068
VT705       : KICKER, L=0.339722, TYPE=MR_VTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00039     : DRIFT, L=0.553009
HV7051H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.022897/2.0, &
              TILT=PI-3.351700, E1=0.000000, E2= 0.000000
MHV7051     : MARKER
D_00040     : DRIFT, L=0.352916
HV7052H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.022897/2.0, &
              TILT=PI-3.298506, E1=0.000000, E2= 0.000000
MHV7052     : MARKER
D_00041     : DRIFT, L=1.426204
M_Q706      : MARKER
Q706        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1Q6, &
              TILT=0.000000
D_00043     : DRIFT, L=0.134996
HP706       : HMONITOR, L=0.152400, TYPE= BPM
D_00044     : DRIFT, L=0.219075
HT706       : KICKER, L=0.000000, TYPE=MR_Htrim2 , &
              HKICK=0.000000, VKICK=0.000000
D_00045     : DRIFT, L=0.919724
HV7061H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-3.141593, E1=0.000000, E2= 0.000000
MHV7061     : MARKER
D_00046     : DRIFT, L=0.352916
HV7062H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-2.733047, E1=0.000000, E2= 0.000000
MHV7062     : MARKER
D_00047     : DRIFT, L=1.426204
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
M_Q707      : MARKER
Q707        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1Q7, &
              TILT=0.000000
D_00049     : DRIFT, L=0.134996
VP707       : VMONITOR, L=0.152400, TYPE= BPM
D_00050     : DRIFT, L=0.246053
VT707       : KICKER, L=0.339737, TYPE=MR_VTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00052     : DRIFT, L=0.553017
HV7071H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-3.257498, E1=0.000000, E2= 0.000000
MHV7071     : MARKER
D_00053     : DRIFT, L=0.352886
HV7072H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-3.141593, E1=0.000000, E2= 0.000000
MHV7072     : MARKER
D_00054     : DRIFT, L=0.783275
MW708       : MONITOR, L=0.406400, TYPE= SWIC
D_00055     : DRIFT, L=0.236544
M_Q708      : MARKER
Q708        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1Q8, &
              TILT=0.000000
D_00057     : DRIFT, L=0.134996
HP708       : HMONITOR, L=0.152400, TYPE= BPM
D_00058     : DRIFT, L=0.219075
HT708       : KICKER, L=0.000000, TYPE=MR_Htrim2 , &
              HKICK=0.000000, VKICK=0.000000
D_00059     : DRIFT, L=0.919724
HV7081H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-3.298506, E1=0.000000, E2= 0.000000
MHV7081     : MARKER
D_00060     : DRIFT, L=0.352916
HV7082H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-3.141593, E1=0.000000, E2= 0.000000
MHV7082     : MARKER
D_00061     : DRIFT, L=0.783260
MW709       : MONITOR, L=0.406400, TYPE= SWIC
D_00062     : DRIFT, L=0.236544
M_Q709      : MARKER
Q709        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1Q9, &
              TILT=0.000000
D_00064     : DRIFT, L=0.134996
VP709       : VMONITOR, L=0.152400, TYPE= BPM
D_00065     : DRIFT, L=0.246053
VT709       : KICKER, L=0.339737, TYPE=MR_VTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00067     : DRIFT, L=0.553009
HV7091H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-2.931485, E1=0.000000, E2= 0.000000
MHV7091     : MARKER
D_00068     : DRIFT, L=0.352901
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
HV7092H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-3.298506, E1=0.000000, E2= 0.000000
MHV7092     : MARKER
D_00069     : DRIFT, L=0.447139
MW710       : MONITOR, L=0.406400, TYPE= SWIC
D_00070     : DRIFT, L=0.194979
M_Q710      : MARKER
Q710        : QUADRUPOLE, L=3.048006, TYPE=MI_3Q120  , K1=K1Q10, &
              TILT=0.000000
D_00072     : DRIFT, L=0.152372
HP710       : HMONITOR, L=0.203200, TYPE= BPM
D_00073     : DRIFT, L=0.168290
HT710       : KICKER, L=0.000000, TYPE=MR_Htrim2 , &
              HKICK=0.000000, VKICK=0.000000
D_00074     : DRIFT, L=0.534821
HV7101H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-3.141593, E1=0.000000, E2= 0.000000
MHV7101     : MARKER
D_00075     : DRIFT, L=0.352901
HV7102H     : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.022897/2.0, &
              TILT=PI-3.550139, E1=0.000000, E2= 0.000000
MHV7102     : MARKER
D_00076     : DRIFT, L=0.183010
MRK_1       : MARKER
D_00077     : DRIFT, L=0.700836
M_Q711      : MARKER
Q711        : QUADRUPOLE, L=3.048006, TYPE=MI_3Q120  , K1=K1Q11, &
              TILT=0.000000
D_00079     : DRIFT, L=0.152403
VP711       : VMONITOR, L=0.203200, TYPE= BPM
D_00080     : DRIFT, L=0.195268
VT711       : KICKER, L=0.339722, TYPE=MR_VTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00082     : DRIFT, L=1.452942
MW712       : MONITOR, L=0.406400, TYPE= SWIC
D_00083     : DRIFT, L=0.192355
M_Q712A     : MARKER
Q712A       : QUADRUPOLE, L=3.048006, TYPE=MI_3Q120  , K1=K1Q12A, &
              TILT=0.000000
D_00085     : DRIFT, L=0.304808
M_Q712B     : MARKER
Q712B       : QUADRUPOLE, L=1.524003, TYPE=MI_3Q60   , K1=K1Q12B, &
              TILT=0.000000
D_00087     : DRIFT, L=0.152389
HP712       : HMONITOR, L=0.203200, TYPE= BPM
D_00088     : DRIFT, L=0.168290
HT712       : KICKER, L=0.000000, TYPE=MR_Htrim2 , &
              HKICK=0.000000, VKICK=0.000000
D_00089     : DRIFT, L=0.980621
M_Q713A     : MARKER
Q713A       : QUADRUPOLE, L=3.048006, TYPE=MI_3Q120  , K1=K1Q13A, &
              TILT=0.000000
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
D_00091     : DRIFT, L=0.304777
M_Q713B     : MARKER
Q713B       : QUADRUPOLE, L=1.524003, TYPE=MI_3Q60   , K1=K1Q13B, &
              TILT=0.000000
D_00093     : DRIFT, L=0.617721
VT713       : KICKER, L=0.339722, TYPE=MR_VTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00095     : DRIFT, L=0.449280
Q714        : QUADRUPOLE, L=3.048006, TYPE=MI_3Q120  , K1=K1Q14, &
              TILT=0.000000
D_00096     : DRIFT, L=0.152372
M_Q714      : MARKER
HP714       : HMONITOR, L=0.203200, TYPE= BPM
D_00098     : DRIFT, L=0.438157
MW714       : MONITOR, L=0.406400, TYPE= SWIC
D_00099     : DRIFT, L=1.880709
HT714       : KICKER, L=0.000000, TYPE=MR_Htrim2 , &
              HKICK=0.000000, VKICK=0.000000
D_00100     : DRIFT, L=0.853943
MKU         : MARKER
VP714       : VMONITOR, L=0.203200, TYPE= BPM
D_00102     : DRIFT, L=0.203203
V714H       : RBEND, L=3.352800/2.0, TYPE= MI_ICA, ANGLE=0.008105/2.0, &
              TILT=PI-4.712389, E1=0.000000, E2= 0.000000
MV714       : MARKER
D_00103     : DRIFT, L=4.968580
HP714B      : HMONITOR, L=0.203200, TYPE= BPM
MRK_0       : MARKER
D_00105     : DRIFT, L=0.306580
LAMF0AH     : RBEND, L=2.800000/2.0, TYPE= MI_Lamb, ANGLE=0.000000/2.0, &
              TILT=PI-1.570796, E1=0.000000, E2= 0.000000
MLAMF0A     : MARKER
D_00106     : DRIFT, L=0.613116
LAMF0BH     : RBEND, L=2.800000/2.0, TYPE= MI_Lamb, ANGLE=0.000000/2.0, &
              TILT=PI-1.570796, E1=0.000000, E2= 0.000000
MLAMF0B     : MARKER
D_00107     : DRIFT, L=0.306567
TEVF0_US    : MARKER
!
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
P1          : LINE = ( &
              D_00007     ,MRK_Q1      ,Q701        ,D_00009     ,VP701       ,&
              D_00010     ,VT701       ,D_00012     ,HT701       ,D_00013     ,&
              V701AH      ,MV701A      ,V701AH      ,D_00014     ,V701BH      ,&
              MV701B      ,V701BH      ,D_00015     ,V701CH      ,MV701C      ,&
              V701CH      ,D_00016     ,M_Q702      ,Q702        ,D_00018     ,&
              HP702       ,D_00019     ,HT702       ,D_00020     ,MW702       ,&
              D_00021     ,M_Q703      ,Q703        ,D_00023     ,VP703       ,&
              D_00024     ,VT703       ,D_00026     ,HV7031H     ,MHV7031     ,&
              HV7031H     ,D_00027     ,HV7032H     ,MHV7032     ,HV7032H     ,&
              D_00028     ,B3ERR       ,D_00029     ,M_Q704      ,Q704        ,&
              D_00031     ,HP704       ,D_00032     ,HT704       ,D_00033     ,&
              HV704H      ,MHV704      ,HV704H      ,D_00034     ,M_Q705      ,&
              Q705        ,D_00036     ,VP705       ,D_00037     ,VT705       ,&
              D_00039     ,HV7051H     ,MHV7051     ,HV7051H     ,D_00040     ,&
              HV7052H     ,MHV7052     ,HV7052H     ,D_00041     ,M_Q706      ,&
              Q706        ,D_00043     ,HP706       ,D_00044     ,HT706       ,&
              D_00045     ,HV7061H     ,MHV7061     ,HV7061H     ,D_00046     ,&
              HV7062H     ,MHV7062     ,HV7062H     ,D_00047     ,M_Q707      ,&
              Q707        ,D_00049     ,VP707       ,D_00050     ,VT707       ,&
              D_00052     ,HV7071H     ,MHV7071     ,HV7071H     ,D_00053     ,&
              HV7072H     ,MHV7072     ,HV7072H     ,D_00054     ,MW708       ,&
              D_00055     ,M_Q708      ,Q708        ,D_00057     ,HP708       ,&
              D_00058     ,HT708       ,D_00059     ,HV7081H     ,MHV7081     ,&
              HV7081H     ,D_00060     ,HV7082H     ,MHV7082     ,HV7082H     ,&
              D_00061     ,MW709       ,D_00062     ,M_Q709      ,Q709        ,&
              D_00064     ,VP709       ,D_00065     ,VT709       ,D_00067     ,&
              HV7091H     ,MHV7091     ,HV7091H     ,D_00068     ,HV7092H     ,&
              MHV7092     ,HV7092H     ,D_00069     ,MW710       ,D_00070     ,&
              M_Q710      ,Q710        ,D_00072     ,HP710       ,D_00073     ,&
              HT710       ,D_00074     ,HV7101H     ,MHV7101     ,HV7101H     ,&
              D_00075     ,HV7102H     ,MHV7102     ,HV7102H     ,D_00076     ,&
              MRK_1       ,D_00077     ,M_Q711      ,Q711        ,D_00079     ,&
              VP711       ,D_00080     ,VT711       ,D_00082     ,MW712       ,&
              D_00083     ,M_Q712A     ,Q712A       ,D_00085     ,M_Q712B     ,&
              Q712B       ,D_00087     ,HP712       ,D_00088     ,HT712       ,&
              D_00089     ,M_Q713A     ,Q713A       ,D_00091     ,M_Q713B     ,&
              Q713B       ,D_00093     ,VT713       ,D_00095     ,Q714        ,&
              D_00096     ,M_Q714      ,HP714       ,D_00098     ,MW714       ,&
              D_00099     ,HT714       ,D_00100     ,MKU         ,VP714       ,&
              D_00102     ,V714H       ,MV714       ,V714H       ,D_00103     ,&
              HP714B      ,MRK_0       ,D_00105     ,LAMF0AH     ,MLAMF0A     ,&
              LAMF0AH     ,D_00106     ,LAMF0BH     ,MLAMF0B     ,LAMF0BH     ,&
              D_00107     ,TEVF0_US    )
D_00108     : DRIFT, L=0.000015
TEVF0       : MARKER
D_00109     : DRIFT, L=0.306564
LAMF0CH     : RBEND, L=2.800000/2.0, TYPE= MI_Lamb, ANGLE=0.000000/2.0, &
              TILT=PI-1.570796, E1=0.000000, E2= 0.000000
MLAMF0C     : MARKER
D_00110     : DRIFT, L=0.613116
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
LAMF0DH     : RBEND, L=2.800000/2.0, TYPE= MI_Lamb, ANGLE=0.000000/2.0, &
              TILT=PI-1.570796, E1=0.000000, E2= 0.000000
MLAMF0D     : MARKER
D_00111     : DRIFT, L=0.230365
MRK_LAM     : MARKER
D_00112     : DRIFT, L=8.904541
MKD         : MARKER
HPRF11      : HMONITOR, L=0.311150, TYPE= BPM
MWF11       : MONITOR, L=0.406400, TYPE= SWIC
VPRF11      : VMONITOR, L=0.311150, TYPE= BPM
D_00116     : DRIFT, L=0.050788
MKF11A      : MARKER
D_00117     : DRIFT, L=0.152405
QF11A       : QUADRUPOLE, L=1.524003, TYPE=MI_3Q60   , K1=K1QF11A, &
              TILT=0.000000
D_00118     : DRIFT, L=0.152404
HPF11       : HMONITOR, L=0.203200, TYPE= BPM
VPF11       : VMONITOR, L=0.203200, TYPE= BPM
D_00120     : DRIFT, L=0.068254
VTF11       : KICKER, L=0.288925, TYPE=MR_VTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00122     : DRIFT, L=0.261932
HTF11       : KICKER, L=0.000000, TYPE=MR_HTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00123     : DRIFT, L=3.437393
QF11B       : QUADRUPOLE, L=3.048006, TYPE=MI_3Q120  , K1=K1QF11B, &
              TILT=0.000000
D_00124     : DRIFT, L=0.324980
F11AH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.019150/2.0, &
              TILT=PI-0.654934, E1=0.000000, E2= 0.000000
MF11A       : MARKER
D_00125     : DRIFT, L=0.352901
F11BH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.019150/2.0, &
              TILT=PI-0.654934, E1=0.000000, E2= 0.000000
MF11B       : MARKER
D_00126     : DRIFT, L=7.353939
QF12        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1QF12, &
              TILT=0.000000
D_00127     : DRIFT, L=0.126985
VPF12       : VMONITOR, L=0.203200, TYPE= BPM
D_00128     : DRIFT, L=0.120683
MWF12       : MONITOR, L=0.406400, TYPE= SWIC
D_00129     : DRIFT, L=0.100009
VTF12       : KICKER, L=0.288910, TYPE=MR_VTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00131     : DRIFT, L=1.889709
F12AH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.008111/2.0, &
              TILT=PI-0.662934, E1=0.000000, E2= 0.000000
MF12A       : MARKER
MKBF12A     : MARKER
D_00133     : DRIFT, L=0.352905
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
F12BH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.008111/2.0, &
              TILT=PI-0.400000, E1=0.000000, E2= 0.000000
MF12B       : MARKER
D_00134     : DRIFT, L=0.352931
F12CH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.008111/2.0, &
              TILT=PI-0.256305, E1=0.000000, E2= 0.000000
MF12C       : MARKER
D_00135     : DRIFT, L=0.410030
F12DH       : RBEND, L=6.070591/2.0, TYPE= B3_dipole , ANGLE=0.016222/2.0, &
              TILT=PI-5.631374, E1=0.000000, E2= 0.000000
MF12D       : MARKER
D_00136     : DRIFT, L=0.209560
MK12D       : MARKER
D_00137     : DRIFT, L=1.157684
QF13        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1QF13, &
              TILT=0.000000
D_00138     : DRIFT, L=0.152376
HPF13       : HMONITOR, L=0.203200, TYPE= BPM
D_00139     : DRIFT, L=0.152421
MWF13       : MONITOR, L=0.406400, TYPE= SWIC
D_00140     : DRIFT, L=0.041262
HTF13       : KICKER, L=0.285736, TYPE=MR_HTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00142     : DRIFT, L=0.244476
M_F13       : MARKER
M_F13B      : MARKER
LEVEL       : MARKER
D_00145     : DRIFT, L=0.622345
F13AH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF13A       : MARKER
D_00146     : DRIFT, L=0.304805
F13BH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF13B       : MARKER
D_00147     : DRIFT, L=0.304805
F13CH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF13C       : MARKER
D_00148     : DRIFT, L=0.304805
F13DH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole, ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF13D       : MARKER
D_00149     : DRIFT, L=0.304805
QF14        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1QF14, &
              TILT=0.000000
D_00150     : DRIFT, L=0.126985
VPF14       : VMONITOR, L=0.203200, TYPE= BPM
D_00151     : DRIFT, L=0.220659
VTF14       : KICKER, L=0.288940, TYPE=MR_VTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00153     : DRIFT, L=1.268433
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
F14AH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF14A       : MARKER
D_00154     : DRIFT, L=0.304805
F14BH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF14B       : MARKER
D_00155     : DRIFT, L=0.304805
F14CH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF14C       : MARKER
D_00156     : DRIFT, L=0.304805
F14DH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF14D       : MARKER
D_00157     : DRIFT, L=0.127010
MK14D       : MARKER
D_00158     : DRIFT, L=0.177795
QF15        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1QF15, &
              TILT=0.000000
D_00159     : DRIFT, L=0.126985
HPF15       : HMONITOR, L=0.203200, TYPE= BPM
D_00160     : DRIFT, L=0.193681
HTF15       : KICKER, L=0.285767, TYPE=MR_HTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00162     : DRIFT, L=1.298645
F15AH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF15A       : MARKER
D_00163     : DRIFT, L=0.304805
F15BH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF15B       : MARKER
D_00164     : DRIFT, L=0.304805
F15CH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF15C       : MARKER
D_00165     : DRIFT, L=0.304805
F15DH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF15D       : MARKER
D_00166     : DRIFT, L=0.304805
QF16        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1QF16, &
              TILT=0.000000
D_00167     : DRIFT, L=0.127016
VPF16       : VMONITOR, L=0.203200, TYPE= BPM
D_00168     : DRIFT, L=0.220659
VTF16       : KICKER, L=0.288910, TYPE=MR_VTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00170     : DRIFT, L=1.268433
F16AH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
MF16A       : MARKER
D_00171     : DRIFT, L=0.304805
F16BH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF16B       : MARKER
D_00172     : DRIFT, L=0.304805
F16CH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF16C       : MARKER
D_00173     : DRIFT, L=0.304805
F16DH       : RBEND, L=6.070591/2.0, TYPE= B2_dipole , ANGLE=0.008111/2.0, &
              TILT=180.0*DEG_TO_RAD, E1=0.000000, E2= 0.000000
MF16D       : MARKER
D_00174     : DRIFT, L=0.304805
QF17        : QUADRUPOLE, L=2.133604, TYPE=MIQB      , K1=K1QF17, &
              TILT=0.000000
D_00175     : DRIFT, L=0.127016
HPF17       : HMONITOR, L=0.152400, TYPE= BPM
VPF17       : VMONITOR, L=0.000000, TYPE= BPM
HPRF17      : HMONITOR, L=0.311150, TYPE= BPM
MWF17       : MONITOR, L=0.406400, TYPE= SWIC
D_00179     : DRIFT, L=0.333813
HTF17       : KICKER, L=0.000000, TYPE=MR_HTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00180     : DRIFT, L=0.644
VTF17       : KICKER, L=0.000000, TYPE=MR_HTrim  , &
              HKICK=0.000000, VKICK=0.000000
D_00181     : DRIFT, L=0.971
!
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
MR_F1       : LINE = ( &
                D_00108     ,TEVF0       ,D_00109     ,LAMF0CH     ,MLAMF0C     ,&
                LAMF0CH     ,D_00110     ,LAMF0DH     ,MLAMF0D     ,LAMF0DH     ,&
                D_00111     ,MRK_LAM     ,D_00112     ,MKD         ,HPRF11      ,&
                MWF11       ,VPRF11      ,D_00116     ,MKF11A      ,D_00117     ,&
                QF11A       ,D_00118     ,HPF11       ,VPF11       ,D_00120     ,&
                VTF11       ,D_00122     ,HTF11       ,D_00123     ,QF11B       ,&
                D_00124     ,F11AH       ,MF11A       ,F11AH       ,D_00125     ,&
                F11BH       ,MF11B       ,F11BH       ,D_00126     ,QF12        ,&
                D_00127     ,VPF12       ,D_00128     ,MWF12       ,D_00129     ,&
                VTF12       ,D_00131     ,F12AH       ,MF12A       ,F12AH       ,&
                MKBF12A     ,D_00133     ,F12BH       ,MF12B       ,F12BH       ,&
                D_00134     ,F12CH       ,MF12C       ,F12CH       ,D_00135     ,&
                F12DH       ,MF12D       ,F12DH       ,D_00136     ,MK12D       ,&
                D_00137     ,QF13        ,D_00138     ,HPF13       ,D_00139     ,&
                MWF13       ,D_00140     ,HTF13       ,D_00142     ,M_F13       ,&
                M_F13B      ,LEVEL       ,D_00145     ,F13AH       ,MF13A       ,&
                F13AH       ,D_00146     ,F13BH       ,MF13B       ,F13BH       ,&
                D_00147     ,F13CH       ,MF13C       ,F13CH       ,D_00148     ,&
                F13DH       ,MF13D       ,F13DH       ,D_00149     ,QF14        ,&
                D_00150     ,VPF14       ,D_00151     ,VTF14       ,D_00153     ,&
                F14AH       ,MF14A       ,F14AH       ,D_00154     ,F14BH       ,&
                MF14B       ,F14BH       ,D_00155     ,F14CH       ,MF14C       ,&
                F14CH       ,D_00156     ,F14DH       ,MF14D       ,F14DH       ,&
                D_00157     ,MK14D       ,D_00158     ,QF15        ,D_00159     ,&
                HPF15       ,D_00160     ,HTF15       ,D_00162     ,F15AH       ,&
                MF15A       ,F15AH       ,D_00163     ,F15BH       ,MF15B       ,&
                F15BH       ,D_00164     ,F15CH       ,MF15C       ,F15CH       ,&
                D_00165     ,F15DH       ,MF15D       ,F15DH       ,D_00166     ,&
                QF16        ,D_00167     ,VPF16       ,D_00168     ,VTF16       ,&
                D_00170     ,F16AH       ,MF16A       ,F16AH       ,D_00171     ,&
                F16BH       ,MF16B       ,F16BH       ,D_00172     ,F16CH       ,&
                MF16C       ,F16CH       ,D_00173     ,F16DH       ,MF16D       ,&
                F16DH       ,D_00174     ,QF17        ,D_00175     ,HPF17       ,&
                VPF17       ,HPRF17      ,MWF17       ,D_00179     ,HTF17       ,&
                D_00180     ,VTF17       ,D_00181     )
MI522_P2    : LINE = ( &
                MI52        ,P1          ,MR_F1       )
!
!
IQ102R  := -1.0   !quad 202 is focusing when curent is neg and flipper is
!                 !negative
!
IQ928  :=  IQ926 - IQS928
IQ926T :=  IQ926 - IQS926
IQ925  :=  IQ924 - IQS925
IQ919T :=  IQ919 - IQS919
IQ917T :=  IQ917 - IQS917
IQ915  :=  IQ913 - IQS915
!
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
IH925  := IH914 - IHS925
IV904  := IV901 - IVS904
IV901T := IV901 - IVS901
!
PQ_L   :=  3.0480
!
SQA_L  :=  0.4572
SQB_L  :=  0.6401
SQC_L  :=  0.7010
SQD_L  :=  0.8280
SQE_L  :=  1.3117
!
a0_SQA :=  0.0059986
a1_SQA :=  0.0196560
a2_SQA := -1.0731E-5
a3_SQA :=  5.5532E-8
a4_SQA := -9.9466E-11
!
a0_SQB :=  0.014858
a1_SQB :=  0.024831
a2_SQB :=  0.12345E-4
a3_SQB := -0.27278E-7
!
a0_SQC :=  0.044196
a1_SQC :=  0.026956
a2_SQC :=  0.13396E-4
a3_SQC := -0.28171E-7
!
a0_SQD := -0.011663
a1_SQD :=  0.033110
a2_SQD :=  0.88878E-5
a3_SQD := -0.21208E-7
!
a0_SQE := -0.057908
a1_SQE :=  0.053748
a2_SQE :=  0.16593E-5
a3_SQE := -0.00000E-7
!
KPQ1 :=  (1.0 + FPQ1) * 2.0 * ( 0.05858 + 0.07042   *IQ201 &
                                        + 0.2795E-4 *IQ201*IQ201)/PQ_L/Brho
KPQ2 :=  (1.0 + FPQ2) * 2.0 * (-0.03000 + 0.07048   *IQ202 &
                                        - 0.2773E-4 *IQ202*IQ202)/PQ_L/Brho
!
KPQ3 :=  (1.0 + FPQ3) * 2.0 * ( 0.18214 + 0.06650   *IQ203 &
                                        + 0.6254E-4 *IQ203*IQ203)/PQ_L/Brho
KPQ4 :=  (1.0 + FPQ4) * 2.0 * ( 0.19744 + 0.06634   *IQ204 &
                                        + 0.6273E-4 *IQ204*IQ204)/PQ_L/Brho
KPQ5 :=  (1.0 + FPQ5) * 2.0 * ( 0.18214 + 0.06650   *IQ205 &
                                        + 0.6254E-4 *IQ205*IQ205)/PQ_L/Brho
KPQ6 :=  (1.0 + FPQ6) * 2.0 * ( 0.07515 + 0.07012   *IQ206 &
                                        + 0.2903E-4 *IQ206*IQ206)/PQ_L/Brho
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
KPQ7 :=  (1.0 + FPQ7) * 2.0 * ( 0.07108 + 0.07022   *IQ207 &
                                        + 0.2866E-4 *IQ207*IQ207)/PQ_L/Brho
KPQ8 :=  (1.0 + FPQ8) * 0.1 * (-2.15500 + 1.57830   *IQ208 &
                                        - 0.000429  *IQ208*IQ208)/PQ_L/Brho
KPQ9 :=  (1.0 + FPQ9) * 0.1 * (-2.15500 + 1.57830   *IQ209 &
                                        - 0.000429  *IQ209*IQ209)/PQ_L/Brho
!
KQ924  := (1.0 + FQ924 ) * ( a0_SQA + a1_SQA * IQ924    + a2_SQA * IQ924^2    &
                  + a3_SQA * IQ924^3  + a4_SQA * IQ924^4) / SQA_L / Brho
KQ925  := (1.0 + FQ925 ) * ( a0_SQA + a1_SQA * IQ925    + a2_SQA * IQ925^2   &
                  + a3_SQA * IQ925^3 + a4_SQA * IQ925^4) / SQA_L / Brho
KQ919A := (1.0 + FQ919A) * ( a0_SQA + a1_SQA * IQ919    + a2_SQA * IQ919^2   &
                  + a3_SQA * IQ919^3  + a4_SQA * IQ919^4)  / SQA_L / Brho
KQ918  := (1.0 + FQ918 ) * ( a0_SQA + a1_SQA * IQ917    + a2_SQA * IQ917^2   &
                  + a3_SQA * IQ917^3  + a4_SQA * IQ917^4)  / SQA_L / Brho
KQ917  := (1.0 + FQ917 ) * ( a0_SQA + a1_SQA * IQ917T    + a2_SQA * IQ917T^2  &
                  + a3_SQA * IQ917T^3 + a4_SQA * IQ917T^4) / SQA_L / Brho
KQ914  := (1.0 + FQ914 ) * ( a0_SQA + a1_SQA * IQ914    + a2_SQA * IQ914^2   &
                  + a3_SQA * IQ914^3  + a4_SQA * IQ914^4)  / SQA_L / Brho
KQ913  := (1.0 + FQ913 ) * ( a0_SQA + a1_SQA * IQ913    + a2_SQA * IQ913^2   &
                  + a3_SQA * IQ913^3  + a4_SQA * IQ913^4)  / SQA_L / Brho
KQ909  := (1.0 + FQ909 ) * ( a0_SQA + a1_SQA * IQ909    + a2_SQA * IQ909^2   &
                  + a3_SQA * IQ909^3  + a4_SQA * IQ909^4)  / SQA_L / Brho
KQ908  := (1.0 + FQ908 ) * ( a0_SQA + a1_SQA * IQ907    + a2_SQA * IQ907^2   &
                  + a3_SQA * IQ907^3  + a4_SQA * IQ907^4)  / SQA_L / Brho
!
KQ926  := (1.0 + FQ926 ) * ( a0_SQB + a1_SQB * IQ926T     + a2_SQB * IQ926T^2 &
                  + a3_SQB * IQ926T^3  )  / SQB_L / Brho
KQ919  := (1.0 + FQ919 ) * ( a0_SQB + a1_SQB * IQ919T     + a2_SQB * IQ919T^2 &
                  + a3_SQB * IQ919T^3  )  / SQB_L / Brho
KQ904  := (1.0 + FQ904 ) * ( a0_SQB + a1_SQB * IQ901     + a2_SQB * IQ901^2  &
                  + a3_SQB * IQ901^3   )  / SQB_L / Brho
!
KQ927  := (1.0 + FQ927 ) * ( a0_SQC + a1_SQC * IQ926     + a2_SQC * IQ926^2  &
                  + a3_SQC * IQ926^3   )  / SQC_L / Brho
KQ916  := (1.0 + FQ916 ) * ( a0_SQC + a1_SQC * IQ916     + a2_SQC * IQ916^2  &
                  + a3_SQC * IQ916^3   )  / SQC_L / Brho
KQ915  := (1.0 + FQ915 ) * ( a0_SQC + a1_SQC * IQ915      + a2_SQC * IQ915^2 &
                  + a3_SQC * IQ915^3   )  / SQC_L / Brho
KQ901C := (1.0 + FQ901C) * ( a0_SQC + a1_SQC * IQ901     + a2_SQC * IQ901^2  &
                  + a3_SQC * IQ901^3   )  / SQC_L / Brho
!
KQ928  := (1.0 + FQ928 ) * ( a0_SQD + a1_SQD * IQ928      + a2_SQD * IQ928^2 &
                  + a3_SQD * IQ928^3   )  / SQD_L / Brho
KQ901D := (1.0 + FQ901D) * ( a0_SQD + a1_SQD * IQ901     + a2_SQD * IQ901^2  &
                  + a3_SQD * IQ901^3   )  / SQD_L / Brho
KQ903  := (1.0 + FQ903 ) * ( a0_SQD + a1_SQD * IQ903     + a2_SQD * IQ903^2  &
                  + a3_SQD * IQ903^3   )  / SQD_L / Brho
!
KQ907  := (1.0 + FQ907 ) * ( a0_SQE + a1_SQE * IQ907     + a2_SQE * IQ907^2  &
                  + a3_SQE * IQ907^3   )  / SQE_L / Brho
!
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
!
VALUE KPQ1
VALUE KPQ2
VALUE KPQ3
VALUE KPQ4
VALUE KPQ5
VALUE KPQ6
VALUE KPQ7
VALUE KPQ8
VALUE KPQ9
!
VALUE KQ928
VALUE KQ927
VALUE KQ926
VALUE KQ924
VALUE KQ925
VALUE KQ919A
VALUE KQ919
VALUE KQ918
VALUE KQ917
VALUE KQ916
VALUE KQ914
VALUE KQ915
VALUE KQ913
VALUE KQ909
VALUE KQ908
VALUE KQ907
VALUE KQ903
VALUE KQ904
VALUE KQ901C
VALUE KQ901D
!
Q201 :    QUADRUPOLE, L= PQ_L,  K1= -KPQ1
Q202 :    QUADRUPOLE, L= PQ_L,  K1=  KPQ2 * IQ102R
Q203 :    QUADRUPOLE, L= PQ_L,  K1=  KPQ3
Q204 :    QUADRUPOLE, L= PQ_L,  K1= -KPQ4
Q2051:    QUADRUPOLE, L= PQ_L,  K1=  KPQ5
Q2052:    QUADRUPOLE, L= PQ_L,  K1=  KPQ5
Q2061:    QUADRUPOLE, L= PQ_L,  K1= -KPQ6
Q2062:    QUADRUPOLE, L= PQ_L,  K1= -KPQ6
Q2071:    QUADRUPOLE, L= PQ_L,  K1=  KPQ7
Q2072:    QUADRUPOLE, L= PQ_L,  K1=  KPQ7
Q2081:    QUADRUPOLE, L= PQ_L,  K1= -KPQ8
Q2082:    QUADRUPOLE, L= PQ_L,  K1= -KPQ8
Q2091:    QUADRUPOLE, L= PQ_L,  K1=  KPQ9
Q2092:    QUADRUPOLE, L= PQ_L,  K1=  KPQ9
!
Q925 :    QUADRUPOLE, L= SQA_L, K1= -KQ925
Q924 :    QUADRUPOLE, L= SQA_L, K1=  KQ924
Q923 :    QUADRUPOLE, L= SQA_L, K1= -KQ919A
Q922 :    QUADRUPOLE, L= SQA_L, K1=  KQ919A
Q921 :    QUADRUPOLE, L= SQA_L, K1= -KQ919A
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
Q920 :    QUADRUPOLE, L= SQA_L, K1=  KQ919A
Q918 :    QUADRUPOLE, L= SQA_L, K1=  KQ918
Q917 :    QUADRUPOLE, L= SQA_L, K1= -KQ917
Q914 :    QUADRUPOLE, L= SQA_L, K1=  KQ914
Q913 :    QUADRUPOLE, L= SQA_L, K1=  KQ913
Q912 :    QUADRUPOLE, L= SQA_L, K1= -KQ909
Q911 :    QUADRUPOLE, L= SQA_L, K1=  KQ909
Q910 :    QUADRUPOLE, L= SQA_L, K1= -KQ909
Q909 :    QUADRUPOLE, L= SQA_L, K1=  KQ909
Q908 :    QUADRUPOLE, L= SQA_L, K1= -KQ908
Q926 :    QUADRUPOLE, L= SQB_L, K1=  KQ926
Q919 :    QUADRUPOLE, L= SQB_L, K1= -KQ919
Q904 :    QUADRUPOLE, L= SQB_L, K1=  KQ904
Q927 :    QUADRUPOLE, L= SQC_L, K1= -KQ927
Q916 :    QUADRUPOLE, L= SQC_L, K1=  KQ916
Q915 :    QUADRUPOLE, L= SQC_L, K1= -KQ915
Q905 :    QUADRUPOLE, L= SQC_L, K1=  KQ901C
Q901 :    QUADRUPOLE, L= SQC_L, K1= -KQ901C
Q928 :    QUADRUPOLE, L= SQD_L, K1=  KQ928
Q906 :    QUADRUPOLE, L= SQD_L, K1= -KQ901D
Q903B:    QUADRUPOLE, L= SQD_L, K1= -KQ903
Q903A:    QUADRUPOLE, L= SQD_L, K1= -KQ903
Q902 :    QUADRUPOLE, L= SQD_L, K1=  KQ901D
Q907 :    QUADRUPOLE, L= SQE_L, K1=  KQ907
!
B3_L    :=  6.016625
C118_L  :=  3.011
EPB_L   :=  3.048
NDB_L   :=  0.506
SXBMP_L :=  0.890
!
SDD_L   :=  1.628
SDE_L   :=  2.451
MWGB_L  :=  1.506
C033_L  :=  0.762
LM080_L :=  2.030
NDB_L   :=  0.506
SXBMP_L :=  0.890
!
!           P138_S    * BRHO      / AMPS
B3_S    :=  0.0027977 * 29.616598 / 203.818
C118_S  :=  0.0029049 * 29.616598 / 236.1
EPB_S   :=  0.0031949 * 29.616598 / 91.1
!
!           P138_S    * BRHO      / AMPS
SDD_S   :=  0.0473288 * 29.616598 / 956.4
SDE_S   :=  0.0427316 * 29.616598 / 861.4
MWGB_S  :=  0.0329430 * 29.616598 / 669.1
C033_S  :=  0.0367579 * 29.616598 / 1146.1
LM080_S :=  0.0359147 * 29.616598 / 1146.1
!
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
B3:         RBEND, L= 0.5 * B3_L,                                    &
            ANGLE= -B3_S  * IF17DC  * 0.5 * B3_L / Brho, TILT
B3D:        RBEND, L= 0.5 * B3_L,                                    &
            ANGLE= -B3_S  * IF17DC  * 0.5 * B3_L / Brho, TILT
F17LAM2:    RBEND, L= 0.5 * LM162_L,                                 &
            ANGLE= -LM162_S * IF17DC  * 0.5 * LM162_L / Brho, TILT
F17LAM2D:   RBEND, L= 0.5 * LM162_L,                                 &
            ANGLE= -LM162_S * IF17DC  * 0.5 * LM162_L / Brho, TILT
F17LAM3:    RBEND, L= 0.5 * C118_L,                                  &
            ANGLE= -C118_S  * IF17DC  * 0.5 * C118_L / Brho, TILT
F17LAM3D:   RBEND, L= 0.5 * C118_L,                                  &
            ANGLE= -C118_S  * IF17DC  * 0.5 * C118_L / Brho, TILT
F17LAM4:    RBEND, L= 0.5 * C118_L,                                  &
            ANGLE= -C118_S  * IF17DC  * 0.5 * C118_L / Brho, TILT
F17LAM4D:   RBEND, L= 0.5 * C118_L,                                  &
            ANGLE= -C118_S  * IF17DC  * 0.5 * C118_L / Brho, TILT
HV2001:     RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE= -EPB_S  * IHV200 * 0.5 * EPB_L / Brho,TILT= 180.0*DEG_TO_RAD
HV2001D:    RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE= -EPB_S  * IHV200 * 0.5 * EPB_L / Brho,TILT= 180.0*DEG_TO_RAD
HV2002:     RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE= -EPB_S  * IHV200 * 0.5 * EPB_L / Brho,TILT= 180.0*DEG_TO_RAD
HV2002D:    RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE= -EPB_S  * IHV200 * 0.5 * EPB_L / Brho,TILT= 180.0*DEG_TO_RAD
HV2003:     RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE= -EPB_S  * IHV200 * 0.5 * EPB_L / Brho,TILT=142.0*DEG_TO_RAD
HV2003D:    RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE= -EPB_S  * IHV200 * 0.5 * EPB_L / Brho,TILT=142.0*DEG_TO_RAD
HV2004:     RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE= -EPB_S  * IHV200 * 0.5 * EPB_L / Brho,TILT=142.0*DEG_TO_RAD
HV2004D:    RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE= -EPB_S  * IHV200 * 0.5 * EPB_L / Brho,TILT=142.0*DEG_TO_RAD
HV2021:     RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE=  EPB_S  * IHV202 * 0.5 * EPB_L / Brho,TILT=135.0*DEG_TO_RAD
HV2021D:    RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE=  EPB_S  * IHV202 * 0.5 * EPB_L / Brho,TILT=135.0*DEG_TO_RAD
HV2022:     RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE=  EPB_S  * IHV202 * 0.5 * EPB_L / Brho,TILT= 180.0*DEG_TO_RAD
HV2022D:    RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE=  EPB_S  * IHV202 * 0.5 * EPB_L / Brho,TILT= 180.0*DEG_TO_RAD
HV2023:     RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE=  EPB_S  * IHV202 * 0.5 * EPB_L / Brho,TILT= 180.0*DEG_TO_RAD
HV2023D:    RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE=  EPB_S  * IHV202 * 0.5 * EPB_L / Brho,TILT= 180.0*DEG_TO_RAD
HV2024:     RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE=  EPB_S  * IHV202 * 0.5 * EPB_L / Brho,TILT= 180.0*DEG_TO_RAD
HV2024D:    RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE=  EPB_S  * IHV202 * 0.5 * EPB_L / Brho,TILT= 180.0*DEG_TO_RAD
V2051:      RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE=  EPB_S  * IV205 * 0.5 * EPB_L / Brho,  TILT
V2051D:     RBEND, L= 0.5 * EPB_L,                                   &
            ANGLE=  EPB_S  * IV205 * 0.5 * EPB_L / Brho,  TILT
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
V2052:      RBEND, L= 0.5 * EPB_L,                                  &
            ANGLE=  EPB_S  * IV205 * 0.5 * EPB_L / Brho,  TILT
V2052D:     RBEND, L= 0.5 * EPB_L,                                  &
            ANGLE=  EPB_S  * IV205 * 0.5 * EPB_L / Brho,  TILT
!
H928:       RBEND, L= 0.5 * (SDD_L-0.006),                          &
            ANGLE= SDD_S  * IH926 * 0.5 * SDD_L / Brho,TILT= 180.0*DEG_TO_RAD
H928D:      RBEND, L= 0.5 * (SDD_L-0.006),                          &
            ANGLE= SDD_S  * IH926 * 0.5 * SDD_L / Brho,TILT= 180.0*DEG_TO_RAD
H926:       RBEND, L= 0.5 * (SDD_L+0.006),                          &
            ANGLE= -SDD_S  * IH926 * 0.5 * SDD_L / Brho,TILT= 180.0*DEG_TO_RAD
H926D:      RBEND, L= 0.5 * (SDD_L+0.006),                          &
            ANGLE= -SDD_S  * IH926 * 0.5 * SDD_L / Brho,TILT= 180.0*DEG_TO_RAD
H925 :      RBEND, L= 0.5 * SDE_L,                                  &
            ANGLE= -SDE_S  * IH925 * 0.5 * SDE_L / Brho,TILT= 180.0*DEG_TO_RAD
H925D:      RBEND, L= 0.5 * SDE_L,                                  &
            ANGLE= -SDE_S  * IH925 * 0.5 * SDE_L / Brho,TILT= 180.0*DEG_TO_RAD
H916:       RBEND, L= 0.5 * (SDE_L + 0.009),                        &
            ANGLE= SDE_S  * IH914 * 0.5 * SDE_L / Brho,TILT= 180.0*DEG_TO_RAD
H916D:      RBEND, L= 0.5 * (SDE_L + 0.009),                        &
            ANGLE= SDE_S  * IH914 * 0.5 * SDE_L / Brho,TILT= 180.0*DEG_TO_RAD
H915:       RBEND, L= 0.5 * SDE_L,                                  &
            ANGLE= SDE_S  * IH914 * 0.5 * SDE_L / Brho,TILT= 180.0*DEG_TO_RAD
H915D:      RBEND, L= 0.5 * SDE_L,                                  &
            ANGLE= SDE_S  * IH914 * 0.5 * SDE_L / Brho,TILT= 180.0*DEG_TO_RAD
H914:       RBEND, L= 0.5 * SDE_L,                                  &
            ANGLE= SDE_S  * IH914 * 0.5 * SDE_L / Brho,TILT= 180.0*DEG_TO_RAD
H914D:      RBEND, L= 0.5 * SDE_L,                                  &
            ANGLE= SDE_S  * IH914 * 0.5 * SDE_L / Brho,TILT= 180.0*DEG_TO_RAD
V904:       RBEND, L= 0.5 * (MWGB_L + 0.003),                       &
            ANGLE= MWGB_S  * IV904 * 0.5 * MWGB_L / Brho,   TILT
V904D:      RBEND, L= 0.5 * (MWGB_L + 0.003),                       &
            ANGLE= MWGB_S  * IV904 * 0.5 * MWGB_L / Brho,   TILT
V901:       RBEND, L= 0.5 * MWGB_L,                                 &
            ANGLE= MWGB_S  * IV901T * 0.5 * MWGB_L / Brho,   TILT
V901D:      RBEND, L= 0.5 * MWGB_L,                                 &
            ANGLE= MWGB_S  * IV901T * 0.5 * MWGB_L / Brho,   TILT
CMAG:       RBEND, L= 0.5 * C033_L,                                 &
            ANGLE= -C033_S  * IELAM * 0.5 * C033_L / Brho,   TILT
CMAGD:      RBEND, L= 0.5 * C033_L,                                 &
            ANGLE= -C033_S  * IELAM * 0.5 * C033_L / Brho,   TILT
ELAM:       RBEND, L= 0.5 * LM080_L,                                 &
            ANGLE= -LM080_S  * IELAM * 0.5 * LM080_L / Brho,   TILT
ELAMD:      RBEND, L= 0.5 * LM080_L,                                 &
            ANGLE= -LM080_S  * IELAM * 0.5 * LM080_L / Brho,   TILT
!
AP1START:   MARKER
VVF17:      MARKER
HHF17:      MARKER
VB3:        MARKER
VF17LAM3:   MARKER
VF17LAM4:   MARKER
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
HHV2001:    MARKER
HHV2002:    MARKER
HHV2003:    MARKER
VHV2003:    MARKER
HHV2004:    MARKER
VHV2004:    MARKER
SM100:      MARKER
SM101:      MARKER
HHV2021:    MARKER
VHV2021:    MARKER
HHV2022:    MARKER
HHV2023:    MARKER
HHV2024:    MARKER
SM103:      MARKER
SM105:      MARKER
VV2051:     MARKER
VV2052:     MARKER
SM106:      MARKER
BPH100:     MARKER
BPV100:     MARKER
BPH101:     MARKER
BPV101:     MARKER
BPH103:     MARKER
BPV103:     MARKER
BPH104:     MARKER
BPV104:     MARKER
BPH105:     MARKER
BPV105:     MARKER
BPH106:     MARKER
BPV106:     MARKER
BPH107:     MARKER
BPV107:     MARKER
BPH108:     MARKER
BPV108:     MARKER
AP1END:     MARKER
!
AP3START:   MARKER
HH928:      MARKER
HH926:      MARKER
HS925:      MARKER
HH916:      MARKER
HH915:      MARKER
HH914:      MARKER
VV904:      MARKER
VV901:      MARKER
VCMAG:      MARKER
VELAM:      MARKER
SM926:      MARKER
SM921:      MARKER
SM917:      MARKER
SM913:      MARKER
SM909:      MARKER
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
SM906:      MARKER
SM900:      MARKER
BPH929:     MARKER
BPH928:     MARKER
BPH926:     MARKER
BPH924:     MARKER
BPH922:     MARKER
BPH920:     MARKER
BPH918:     MARKER
BPH916:     MARKER
BPH914:     MARKER
BPH913:     MARKER
BPH911:     MARKER
BPH909:     MARKER
BPH907:     MARKER
BPH905:     MARKER
BPH904:     MARKER
BPH902:     MARKER
BPV929:     MARKER
BPV927:     MARKER
BPV925:     MARKER
BPV923:     MARKER
BPV921:     MARKER
BPV919:     MARKER
BPV917:     MARKER
BPV915:     MARKER
BPV912:     MARKER
BPV910:     MARKER
BPV908:     MARKER
BPV906:     MARKER
BPV93B:     MARKER
BPV93A:     MARKER
BPV901:     MARKER
!
HT100:      DRIFT, L= 0.5 * 0.506
HT100D:     DRIFT, L= 0.5 * 0.506
VT101A:     DRIFT, L= 0.5 * 0.506
VT101AD:    DRIFT, L= 0.5 * 0.506
VT101:      DRIFT, L= 0.5 * SXBMP_L
VT101D:     DRIFT, L= 0.5 * SXBMP_L
HT105:      DRIFT, L= 0.5 * SXBMP_L
HT105D:     DRIFT, L= 0.5 * SXBMP_L
HT107:      DRIFT, L= 0.5 * 0.889
HT107D:     DRIFT, L= 0.5 * 0.889
VT108:      DRIFT, L= 0.5 * 0.889
VT108D:     DRIFT, L= 0.5 * 0.889
DRIFT001:   DRIFT, L= 2.3971
DRIFT01A:   DRIFT, L= 0.6444
DRIFT002:   DRIFT, L= 0.9718
DRIFT003:   DRIFT, L= 2.0591
DRIFT004:   DRIFT, L= 0.5430
DRIFT005:   DRIFT, L= 3.1670
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
DRIFT006:   DRIFT, L= 0.4180
DRIFT007:   DRIFT, L= 0.3110
DRIFT008:   DRIFT, L= 0.3110
DRIFT009:   DRIFT, L= 0.2990
DRIFT010:   DRIFT, L= 0.3200
DRIFT011:   DRIFT, L= 0.8780
DRIFTA12:   DRIFT, L= 0.4500                      ! A guess
DRIFT012:   DRIFT, L= 23.2180 - 0.450 - 0.506     ! - DRIFTA12 - VT101A
DRIFT013:   DRIFT, L= 0.3630
DRIFT014:   DRIFT, L= 0.3840
DRIFT015:   DRIFT, L= 0.3050
DRIFT016:   DRIFT, L= 0.3020
DRIFT017:   DRIFT, L= 0.4360
DRIFT018:   DRIFT, L= 0.3900
DRIFT019:   DRIFT, L= 0.4080
DRIFT020:   DRIFT, L= 0.7320
DRIFT021:   DRIFT, L= 9.4000
DRIFT022:   DRIFT, L=10.2200
DRIFT023:   DRIFT, L= 0.2900
DRIFT024:   DRIFT, L= 0.7160
DRIFT025:   DRIFT, L= 5.4380
DRIFT026:   DRIFT, L= 0.3380
DRIFT027:   DRIFT, L= 0.2930
DRIFT028:   DRIFT, L= 3.2030
DRIFT029:   DRIFT, L= 0.2960
DRIFT030:   DRIFT, L= 1.7770
DRIFT031:   DRIFT, L= 0.7650
DRIFT032:   DRIFT, L= 0.3170
DRIFTA32:   DRIFT, L= 0.6460
DRIFT033:   DRIFT, L= 4.0968 - 0.6460
DRIFT034:   DRIFT, L= 3.5282
DRIFT035:   DRIFT, L= 0.3581
DRIFT036:   DRIFT, L= 0.3099
DRIFT037:   DRIFT, L= 0.6661
DRIFT038:   DRIFT, L= 0.9870 - 0.2159             ! 8.5 inch move in oct 99
DRIFT039:   DRIFT, L= 0.3070
DR_SEM  :   DRIFT, L= 3.8050 + 0.2159 - 0.2921    ! 8.5 inch move in oct 99
DR_TARG :   DRIFT, L= 0.2921
DR_LENS :   DRIFT, L= 0.2921
DR_LENFL:   DRIFT, L= 0.3100
!
VT925:      DRIFT, L= 0.5 * 0.466
VT925D:     DRIFT, L= 0.5 * 0.466
VT917:      DRIFT, L= 0.5 * 0.466
VT917D:     DRIFT, L= 0.5 * 0.466
HT910:      DRIFT, L= 0.5 * 0.466
HT910D:     DRIFT, L= 0.5 * 0.466
HT906B:     DRIFT, L= 0.5 * 0.466
HT906BD:    DRIFT, L= 0.5 * 0.466
VT906:      DRIFT, L= 0.5 * 0.466
VT906D:     DRIFT, L= 0.5 * 0.466
HT901:      DRIFT, L= 0.5 * 0.466
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
HT901D:     DRIFT, L= 0.5 * 0.466
HT906A:     DRIFT, L= 0.5 * 1.018
HT906AD:    DRIFT, L= 0.5 * 1.018
DR928A  :   DRIFT, L= 13.4540
DR927A  :   DRIFT, L= 1.6000
DR926C  :   DRIFT, L= 0.6880
DR926B  :   DRIFT, L= 2.5570
DR926A  :   DRIFT, L= 0.6145
DR925C  :   DRIFT, L= 13.6475
DR925B  :   DRIFT, L= 14.295
DR925A  :   DRIFT, L= 2.8764
DR924A  :   DRIFT, L= 3.0850
DR923A  :   DRIFT, L= 7.1630
DR922A  :   DRIFT, L= 24.9360
DR921B  :   DRIFT, L= 0.5194
DR921A  :   DRIFT, L= 24.4464
DR920A  :   DRIFT, L= 24.9520
DR919A  :   DRIFT, L= 22.6400
DR918A  :   DRIFT, L= 9.8580
DR917C  :   DRIFT, L= 0.4654
DR917B  :   DRIFT, L= 2.7860
DR917A  :   DRIFT, L= 0.5224
DR916B  :   DRIFT, L= 0.5104
DR916A  :   DRIFT, L= 2.8430
DR915B  :   DRIFT, L= 3.9160
DR915A  :   DRIFT, L= 5.0590
DR914B  :   DRIFT, L= 2.6134
DR914A  :   DRIFT, L= 0.5564
DR913B  :   DRIFT, L= 0.5104
DR913A  :   DRIFT, L= 5.2624
DR912A  :   DRIFT, L= 14.7040
DR911A  :   DRIFT, L= 14.1590
DR910B  :   DRIFT, L= 16.0564
DR910A  :   DRIFT, L= 3.1964
DR909B  :   DRIFT, L= 8.3924
DR909A  :   DRIFT, L= 0.4685
DR908A  :   DRIFT, L= 18.2550
DR907A  :   DRIFT, L= 11.0300
DR906E  :   DRIFT, L= 1.0385
DR906D  :   DRIFT, L= 7.6720
DR906C  :   DRIFT, L= 0.4880
DR906B  :   DRIFT, L= 0.6100
DR906A  :   DRIFT, L= 0.4510
DR905A  :   DRIFT, L= 0.4930
DR904B  :   DRIFT, L= 0.8160
DR904A  :   DRIFT, L= 0.7335
DR903B  :   DRIFT, L= 0.7860
DR903A  :   DRIFT, L= 0.2900
DR902A  :   DRIFT, L= 1.5860
DR901C  :   DRIFT, L= 0.2720
DR901B  :   DRIFT, L= 0.3020
DR901A  :   DRIFT, L= 0.5900
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
DR900D  :   DRIFT, L= 0.6230
DR900C  :   DRIFT, L= 2.7220
DR900B  :   DRIFT, L= 1.1280
DR900A  :   DRIFT, L= 0.4450
ACUMSTRT:   MARKER
!
AP101: LINE(B3      ,VB3     )
AP102: LINE(B3D     ,DRIFT003,F17LAM3 ,VF17LAM3,F17LAM3D,DRIFT004,F17LAM4 )
AP103: LINE(VF17LAM4,F17LAM4D,DRIFT005,BPH100  ,BPV100  ,HT100   ,HT100D  ,&
            DRIFT006,HV2001  )
AP104: LINE(HHV2001 ,HV2001D ,DRIFT007,HV2002  ,HHV2002 ,HV2002D ,DRIFT008)
AP105: LINE(HV2003  ,HHV2003 ,VHV2003 ,HV2003D ,DRIFT009,HV2004  ,HHV2004 )
AP106: LINE(VHV2004 ,HV2004D ,DRIFT010,Q201    ,BPH101  ,BPV101  ,DRIFT011,&
            SM100   ,DRIFTA12,VT101A  ,VT101AD ,DRIFT012)
AP107: LINE(VT101   ,VT101D  ,DRIFT013,SM101   ,DRIFT014,Q202    ,DRIFT015)
AP108: LINE(HV2021  ,HHV2021 ,VHV2021 ,HV2021D ,DRIFT016,HV2022  ,HHV2022 )
AP109: LINE(HV2022D ,DRIFT017,HV2023  ,HHV2023 ,HV2023D ,DRIFT018,HV2024  )
AP110: LINE(HHV2024 ,HV2024D ,DRIFT019,Q203    ,BPH103  ,BPV103  ,DRIFT020,&
            SM103   ,DRIFT021)
AP111: LINE(Q204    ,BPH104  ,BPV104  ,DRIFT022,Q2051   ,DRIFT023,Q2052   ,&
            BPH105  ,BPV105  ,DRIFT024,SM105   )
AP112: LINE(DRIFT025,HT105   ,HT105D  ,DRIFT026,V2051   ,VV2051  ,V2051D  )
AP113: LINE(DRIFT027,V2052   ,VV2052  ,V2052D  ,DRIFT028,Q2061   ,DRIFT029)
AP114: LINE(Q2062   ,DRIFT030,SM106   ,DRIFT031,BPH106  ,BPV106  ,Q2071   ,&
            DRIFT032,Q2072   ,DRIFTA32,AP1END)
AP115: LINE(DRIFT033,BPH107  ,BPV107  ,DRIFT034,HT107   ,HT107D  ,DRIFT035,&
            Q2081   ,DRIFT036,Q2082   )
AP116: LINE(DRIFT037,VT108   ,VT108D  ,DRIFT038,BPH108  ,BPV108  ,Q2091   ,&
            DRIFT039,Q2092   )
APTAR: LINE(DR_SEM  ,DR_TARG ,DR_LENS ,DR_LENFL)
AP1  : LINE(AP101,AP102,AP103,AP104,AP105,AP106,AP107,&
            AP108,AP109,AP110,AP111,AP112,AP113,AP114)
!
AP301: LINE(AP3START,BPH929  ,BPV929  ,H928    ,HH928   ,H928D   ,DR928A  ,&
            BPH928  ,Q928    ,DR927A  )
AP302: LINE(BPV927  ,Q927    ,DR926C  ,H926    ,HH926   ,H926D   ,DR926B  ,&
            SM926   )
AP303: LINE(DR926A  ,BPH926  ,Q926    ,DR925C  ,H925    ,HS925   ,H925D   ,&
            DR925B  )
AP304: LINE(VT925   ,VT925D  ,DR925A  ,BPV925  ,Q925    ,DR924A  ,BPH924  ,&
            Q924    ,DR923A  )
AP305: LINE(BPV923  ,Q923    ,DR922A  ,BPH922  ,Q922    ,DR921B  ,SM921   ,&
            DR921A  ,BPV921  ,Q921    )
AP306: LINE(DR920A  ,BPH920  ,Q920    ,DR919A  ,BPV919  ,Q919    ,DR918A  ,&
            BPH918  ,Q918    ,DR917C  )
AP307: LINE(VT917   ,VT917D  ,DR917B  ,SM917   ,DR917A  ,BPV917  ,Q917    ,&
            DR916B  )
AP308: LINE(H916    ,HH916   ,H916D   ,DR916A  ,BPH916  ,Q916    ,DR915B  ,&
            H915    )
AP309: LINE(HH915   ,H915D   ,DR915A  ,BPV915  ,Q915    ,DR914B  ,H914    ,&
            HH914   )
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
AP310: LINE(H914D   ,DR914A  ,BPH914  ,Q914    ,DR913B  ,SM913   ,DR913A  ,&
            BPH913  ,Q913    )
AP311: LINE(DR912A  ,BPV912  ,Q912    ,DR911A  ,BPH911  ,Q911    ,DR910B  ,&
            HT910   ,HT910D  )
AP312: LINE(DR910A  ,BPV910  ,Q910    ,DR909B  ,SM909   ,DR909A  ,BPH909  ,&
            Q909    ,DR908A  )
AP313: LINE(BPV908  ,Q908    ,DR907A  ,BPH907  ,Q907    ,DR906E  ,HT906B  ,&
            HT906BD ,DR906D  )
AP314: LINE(VT906   ,VT906D  ,DR906C  ,SM906   ,DR906B  ,HT906A  ,HT906AD ,&
            DR906A  )
AP315: LINE(BPV906  ,Q906    ,DR905A  ,BPH905  ,Q905    ,DR904B  ,V904    ,&
            VV904  ,V904D    ,DR904A  ,BPH904  ,Q904    )
AP316: LINE(DR903B  ,BPV93B  ,Q903B   ,DR903A  ,BPV93A  ,Q903A   ,DR902A  ,&
            BPH902  ,Q902    ,DR901C  )
AP317: LINE(HT901   ,HT901D  ,DR901B  ,V901    ,VV901   ,V901D   ,DR901A  )
AP318: LINE(BPV901  ,Q901    ,DR900D  ,SM900   ,DR900C  ,CMAG    ,VCMAG   ,&
            CMAGD   )
AP319: LINE(DR900B  ,ELAM    ,VELAM   ,ELAMD   ,DR900A  )
AP3  : LINE(AP301,AP302,AP303,AP304,AP305,AP306,AP307,AP308,AP309,AP310,&
            AP311,AP312,AP313,AP314,AP315,AP316,AP317,AP318,AP319)
!
AP1_3: LINE(AP1,BPH107,BPV107,BPH108,BPV108,AP3)
!
P1_AP3: LINE(MI522_P2,AP1_3)
AP3_P1: LINE(ACUMSTRT,-P1_AP3)
USE,        AP3_P1
BEAM, PARTICLE=PROTON,ENERGY=Eb,EX=4.0E-6,EY=4.0E-6
PRINT, #S/#E
TWISS, BETX= BETAX, ALFX= ALPHAX, DX= DISPX, DPX= DISPPX,&
       BETY= BETAY, ALFY= ALPHAY, DY= DISPY, DPY= DISPPY,TAPE=APXLINE.TWS
SURVEY, X0=0.0,Y0=0.0,Z0=0.0,TAPE=APXLINE.XYZ
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
FILENAME APX_QUAD_EXCITATION.DAT
!
BETAX  :=    33.250
ALPHAX :=    -0.5335
DISPX  :=     0.6188
DISPPX :=    -0.0739
BETAY  :=     5.573
ALPHAY :=     0.4928
DISPY  :=     0.000
DISPPY :=     0.000
EMITH  :=    2.00
EMITV  :=    2.00
DP_P   :=    0.3000
!
RETURN

FILENAME APX_QUAD_FUDGE.DAT
!
FPQ1   :=   0.0000000
FPQ2   :=   0.0000000
FPQ3   :=   0.0000000
FPQ4   :=   0.0000000
FPQ5   :=   0.0000000
FPQ6   :=   0.0000000
FPQ7   :=   0.0000000
FPQ8   :=   0.0000000
FPQ9   :=   0.0000000
!
FQ928  :=   0.0004450
FQ927  :=   0.0000000
FQ926  :=   0.0000000
FQ925  :=   0.0000000
FQ924  :=   0.0000000
FQ919A :=   0.0000000
FQ919  :=   0.0331667
FQ918  :=   0.0000000
FQ917  :=   0.0000000
FQ916  :=   0.0176314
FQ914  :=   0.0000000
FQ915  :=   0.0196142
FQ913  :=   0.0000000
FQ909  :=   0.0000000
FQ908  :=   0.0000000
FQ907  :=   0.0294238
FQ903  :=  -0.0538229
FQ904  :=   0.0000000
FQ901C :=   0.0000000
FQ901D :=  -0.0027299
!
RETURN
```

Appendix 2.
Antiproton Lattice AP3 - P1

```
FILENAME APX_QUAD_SETTINGS.DAT
! Quad Shunt Settings
!
IQ201     :=     10.811903
IQ202     :=     -5.856999
IQ203     :=     7.536034
IQ204     :=     19.906607
IQ205     :=     3.357114
IQ206     :=     15.046574
IQ207     :=     22.681040
IQ208     :=     14.479828
IQ209     :=     15.899963
IF17DC     :=     238.394165
IHV200     :=     96.499634
IHV202     :=     91.448975
IV205     :=     57.852173
IQ926     :=     354.038422
IQ924     :=     160.077087
IQ919     :=     100.525246
IQ917     :=     365.306885
IQ916     :=     264.786835
IQ914     :=     185.501541
IQ913     :=     121.971535
IQ909     :=     161.478043
IQ907     :=     87.393829
IQ903     :=     508.995758
IQ901     :=     373.867340
IQS928     :=     1.356726
IQS926     :=     39.125389
IQS925     :=     16.387962
IQS919     :=     8.239764
IQS917     :=     50.000000
IQS915     :=     2.881736
IH926     :=     947.351074
IH914     :=     858.691406
IHS925     :=     18.250313
IV901     :=     679.321289
IVS901     :=     1.000000
IVS904     :=     19.099609
IELAM     :=     1153.869629
IQ701K     :=     13.814475
IQ702K     :=     15.248804
IQ703K     :=     216.188248
IQ710K     :=     15.192030
IQ711K     :=     16.441998
IQ712K     :=     11.303133
IQ713K     :=     13.762095
IQ714K     :=     17.549036
IQF11AK     :=     33.243805
IQF11BK     :=     18.144815
IQF12K     :=     99.435997
!
RETURN
```