# DRAFT IR-Parameters-6 Post Cost Review

File 190222-IR2.pdf

Robert B.Palmer

02/22/2019

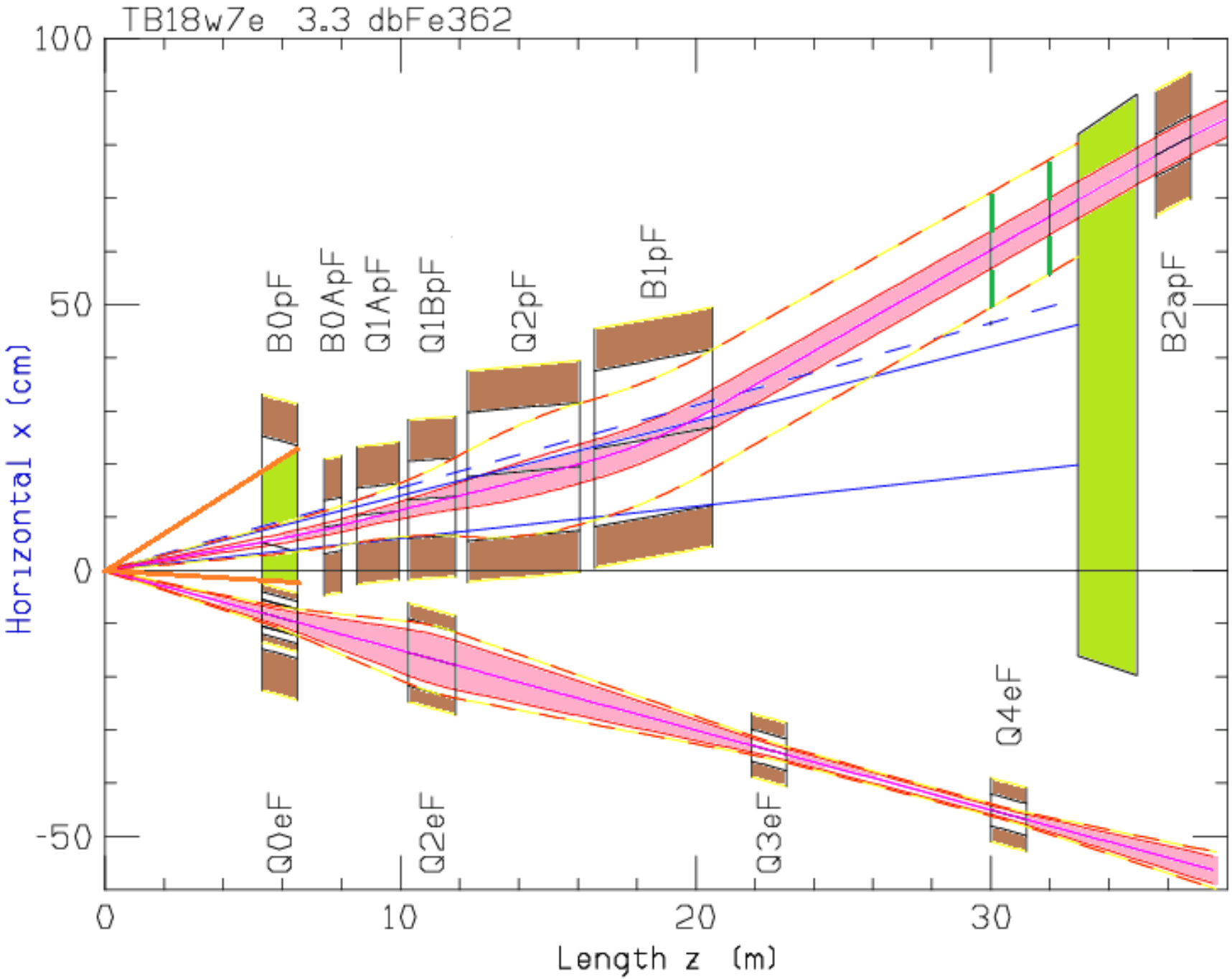
- This is a first iteration on the 'Cost Review Forward Design' (from 1/25/19) responding to priorities defined by Brett:
  1. Eliminates side-by-side magnets for the most difficult case of Q2pF.
  2. First order Corrects beam displacements from B0pF at lower energies.
  3. Allows space (90 cm) after B0 for access to forward spectrometer detectors and a possible corrector magnet.

- It addresses the Q2pF problem in the 'Cost Review Design' identified by Holger, by increasing the e-p beam spacing without changing the crossing angle.

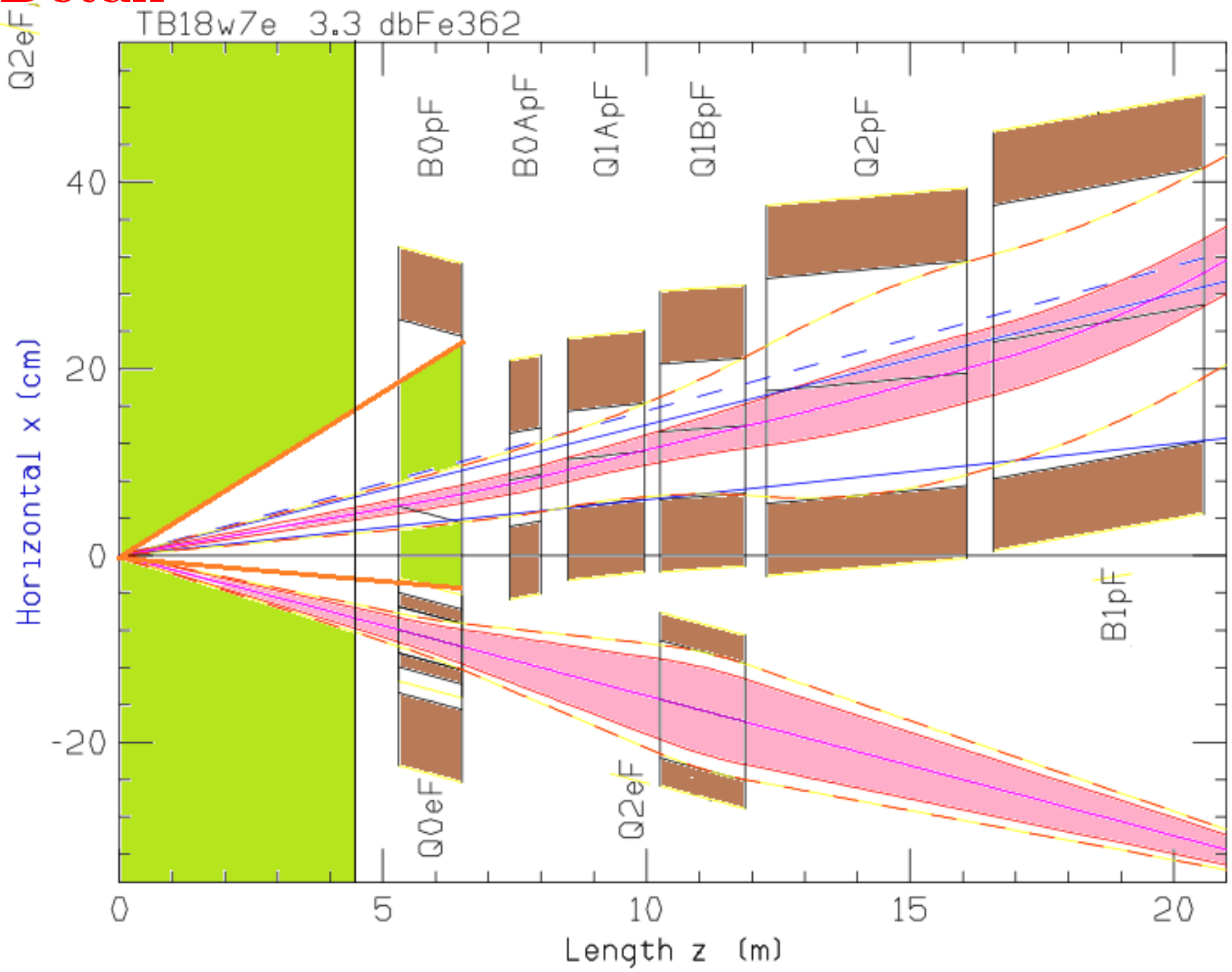
# Steps taken

1. Simplified the electron forward lattice
   - Keeps the same SR fan dimensions used in Electron Rear apertures ($x_{SR} = 7.510^{-3}\ (L\ +\ 3.5)$), and thus keeps the same strength of Q0eF.
   - Uses a single (vs. 2 in Cost Estimate Design) short Q2eF as close as possible to the IP to minimize the maximum beta x and avoid overlapping Q2pF.
2. Move Q1ApF, Q1BpF, and Q2pF downstream to increase beam-beam separation and pair Q2eF with the relatively easier Q1BpF instead of Q2pF.
3. Introduce a short dipole B0ApF between B0pF and Q1ApF to bend the protons away from the neutron cone and allow first order correction of the large B0pF deflections with lower energy operation.
4. Lower field and lengthen B1pF

# Layout


TB18w7e 3.3 dbFe362
100
50
0
-50
Horizontal x (cm)
B0pF
B0ApF
Q1ApF
Q1BpF
Q2pF
B1pF
B2apF
Q0eF
Q2eF
Q3eF
Q4eF
0
10
20
30
Length z (m)

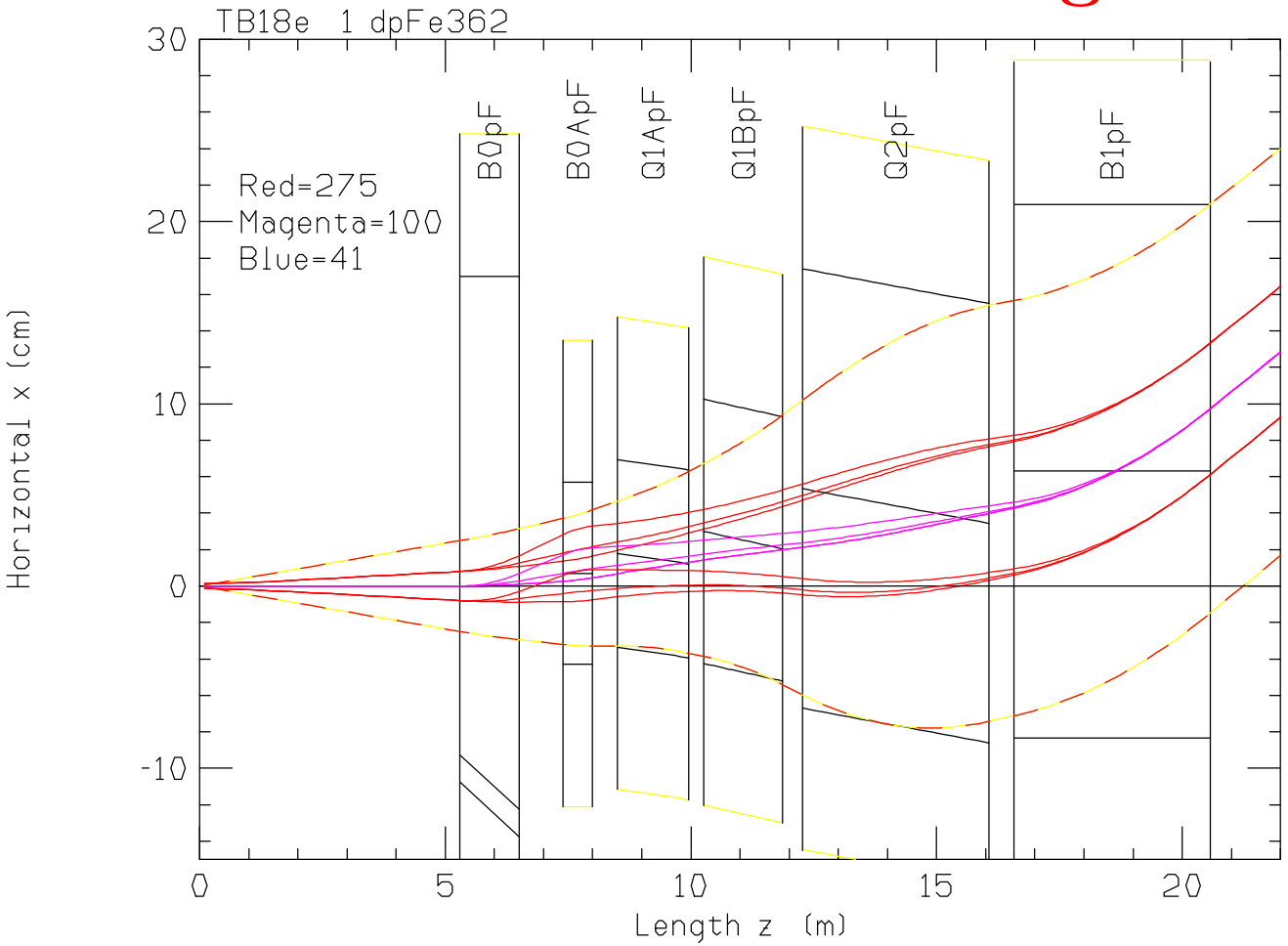
# Detail


TB18w7e 3.3 dbFe362
Q2eF
B0pF
B0ApF
Q1ApF
Q1BpF
Q2pF
B1pF
Q0eF
Q2eF
Horizontal x (cm)
40
20
0
-20
0
5
10
15
20
Length z (m)

```
#
# ------------------------------------
# TB18w7e  zbFe362 Hadron forward  275
#
# beta*_x  beta*_y  gm emit_x gm emit_y  angle_x  angle_y    mom
#  [m]       [m]       [nm]      [nm]      [mrad]    [mrad]     GeV/c
 0.9000   0.0430     20.0000    6.1000       25       0        275
#
# name    center_z center_x rad1  rad2  length  angle     B      grad  ap x grad    x1       x2
#           [m]      [m]     {m}   [m]    [m]   [mrad]    [T]    [T/m]     [T]     [m]      [m]
  B0pF    5.900  -0.0150  0.200  0.200   1.20  -25.0  -1.30     0.000     0.000   0.0000  -0.0300
  B0ApF    7.700   0.0070  0.050  0.050   0.60    0.0  -4.55     0.000     0.000   0.0070   0.0070
  Q1ApF    9.230   0.0151  0.052  0.052   1.46   -4.0   0.00   -72.608    -3.739   0.0180   0.0122
  Q1BpF   11.065   0.0252  0.072  0.072   1.61   -6.0   0.00   -66.180    -4.798   0.0300   0.0203
  Q2pF   14.170   0.0440  0.121  0.121   3.80   -5.0   0.00    40.737     4.909   0.0535   0.0345
  B1pF   18.570   0.0630  0.147  0.147   4.00    0.0  -3.71     0.000     0.000   0.0630   0.0630
  B2apF   36.170   0.4361  0.040  0.040   1.20   19.8   3.00     0.000     0.000   0.4242   0.4479
#
# name    center_z    x(beam)  theta   Bdist1   Bdist2    alphax    betax    alphay      betay
#           [m]         [m]     (mrad)    (T)      (T)                 [m]                   [m]
  B0pF    5.900    0.0003     0.851     0.000     0.000    -6.546    39.567  -123.503   742.602
  B0ApF    7.700    0.0033     3.191     0.000     0.000    -8.541    66.722  -160.477  1253.766
  Q1ApF    9.230    0.0100     4.214     0.585     0.148   -15.888    99.301   -91.099  1722.641
  Q1BpF   11.065    0.0173     3.414     0.776     0.273   -41.763   198.363   109.055  1680.591
  Q2pF   14.170    0.0293     5.183    -0.969    -0.191   -49.176   578.695    65.625   850.979
  B1pF   18.570    0.0619    13.667     0.000     0.000     2.444   660.513    -2.651   750.176
  B2apF   36.170    0.4361    19.791     0.000     0.000     2.258   577.751    -2.839   846.797
#----------------------------------
#
```

```
# ----------------------------------
# TB18w7e  zbFe362 Electron Forward  18
#
# beta*_x  beta*_y  gm emit_x gm emit_y  angle_x  angle_y    mom
#  [m]       [m]       [nm]      [nm]      [mrad]    [mrad]     GeV/c
 0.8300   0.0800     22.0000    3.3000       25       0         18
#
# name    center_z center_x rad1  rad2  length  angle     B       grad  ap x grad    x1       x2
#           [m]       [m]     {m}   [m]    [m]    [mrad]    [T]     [T/m]      [T]      [m]       [m]
  Q0eF    5.900  -0.1475  0.025  0.025   1.20   25.0   0.00   -13.540    -0.338   0.0000   0.0000
  Q2AeF    7.730  -0.1933  0.030  0.042   1.46   25.0   0.00     0.000     0.000   0.0000   0.0000
  Q2eF   11.065  -0.2766  0.063  0.063   1.61   25.0   0.00     8.008     0.505   0.0000   0.0000
  Q2CeF   14.570  -0.3642  0.068  0.068   3.60   25.0   0.00     0.000     0.000   0.0000   0.0000
  Q3eF   22.470  -0.5617  0.030  0.030   1.20   25.0   0.00   -11.627    -0.349   0.0000   0.0000
  Q4eF   30.600  -0.7650  0.030  0.030   1.20   25.0   0.00   -15.400    -0.462   0.0000   0.0000
  Q5eF   39.500  -0.9875  0.050  0.050   1.20   25.0   0.00     4.023     0.201   0.0000   0.0000
#
# name    center_z    x(beam)  theta   Bdist1   Bdist2    alphax    betax    alphay      betay
#           [m]         [m]     (mrad)    (T)      (T)                 [m]                   [m]
  Q0eF    5.900    0.0000     0.000     0.000     0.000   -13.149    46.060   -14.487   394.869
  Q2AeF    7.730    0.0000     0.000     0.000     0.000   -35.034   140.924    33.430   292.532
  Q2eF   11.065    0.0000     0.000     0.000     0.000   -16.194   434.984     7.913   123.004
  Q2CeF   14.570    0.0000     0.000     0.776     0.273    24.360   276.420    -5.712   149.956
  Q3eF   22.470    0.0000     0.000     0.000     0.000     4.244    27.775    20.746   237.224
  Q4eF   30.600    0.0000     0.000     0.000     0.000    -1.854    15.118    -5.930    64.369
  Q5eF   39.500    0.0000     0.000     0.000     0.000    -8.152   184.947     1.192    16.337
#----------------------------------
#
```

# Central obits for other energies




| Momentum GeV/c | B0pF T | B0ApF T | B1pF T |
|---|---|---|---|
| 275 | 1.3 | -4.55 | -3.71 |
| 100 | 1.3 | +.554 | -1.40 |
| 41 | 1.3 | +2.26 | -0.61 |

Orbits superimposed after B1pF.

Dashed lines are for $p \perp = 1.3$ GeV/c at 275 GeV/c.

The largest orbit displacements for 41 GeV/c could be reduced by lowering B0pF at that energy.

# Conclusion

- Such studies can give us fast looks at magnet or other problems.
- As Brett defines other parameters and priorities, I can put them into this program.
- The current version is not exact but gives a good visual and parameter output.
- If requested, the program could be adapted to use accurate matrix $\alpha$, $\beta$, and $\gamma$ calculations.