Making a field map using zgoubi's 'FFAG' keyword

```
1/ To get a fieldmap from zgoubi :

1-a/ cp consty_impdev.dat  zgoubi.dat ; rzg

1-b/ ./impdev2FieldMap  (make sure jr and dR, kz and dZ are as in consty_impdev.dat, otherwise change and recompile)

2/ compare results with map to those from 'FFAG' keyword

gnuplot_tunesFromMATRIX.cmd can help...

3/ That's all folks
```

```
FFAG triplet. 150MeV machine. CPU time, analyt. : 11:01:35->
 'OBJET'
1839.090113 150MeV
1
241  1   41  1  1  1       ! radial mesh step of map will be 1cm, vertical 0.2cm
.5   0   .2  0  0  0       ! radial extent is 440-520. Vertical is +\-4cm
500.   0.   0.  0. 0.   0.273042677097  ! momentum does not matter since Y, Z forced to constnt

 'FAISCEAU'     ! shows how trajectories are organized thru FFAG

 'OPTIONS'
1  1
CONSTY ON

 'FFAG'
7                          ! save rays and fields to zgoubi.impdev.out
3   30.     540.           ! NMAG, AT=tetaF+2tetaD+2Atan(XFF/RO), RO (30deg at RO -> arc=282.743338823 cm)
6.465  0.  -1.21744691E+01  7.6              mag 1 : ACNT, dum, BO, K
6.3  03.                              EFB 1 : lambda, gap const/var=0/.ne.0
4  .1455   2.2670  -.6395  1.1558  0. 0.  0.
1.715 0.    1.E6  -1.E6  1.E6  1.E6
6.3  03.                              EFB 2
4  .1455   2.2670  -.6395  1.1558  0. 0.  0.
-1.715  0.    1.E6  -1.E6  1.E6  1.E6
0. -1                                 EFB 3 : inhibited by iop=0
0  0.      0.      0.      0.      0. 0.  0.
0.  0.   0.    0.    0. 0.
15.   0.   1.69055873E+01  7.6                   mag 2 : ACNT, dum, BO, K,dummies
6.3  03.                              EFB 1
4  .1455   2.2670  -.6395  1.1558  0. 0.  0.
5.12   0.    1.E6  -1.E6  1.E6  1.E6
6.3  03.                              EFB 2
4  .1455   2.2670  -.6395  1.1558  0. 0.  0.
-5.12   0.    1.E6  -1.E6  1.E6  1.E6
0. -1                                 EFB 3
0  0.      0.      0.      0.      0. 0.  0.
0.  0.   0.    0.    0. 0.
23.535  0.  -1.21744691E+01  7.6             mag 3 : ACNT, dum, BO, K
6.3  03.                              EFB 1
4  .1455   2.2670  -.6395  1.1558  0. 0.  0.
1.715 0.    1.E6  -1.E6  1.E6  1.E6
6.3  03.                              EFB 2
4  .1455   2.2670  -.6395  1.1558  0. 0.  0.
-1.715  0.    1.E6  -1.E6  1.E6  1.E6
0. -1                                 EFB 3
0  0.      0.      0.      0.      0. 0.  0.
0.  0.   0.    0.    0. 0.
0 2  125.              !     KIRD anal/num (=0/2,25,4), resol(mesh=step/resol)
0.282743338823         ! integration step size (cm) is arc/1000= RO * pi/6 /1000
2   0.  0. 0. 0.

 'FAISCEAU'      ! check that coordinates remained constant

 'END'
```

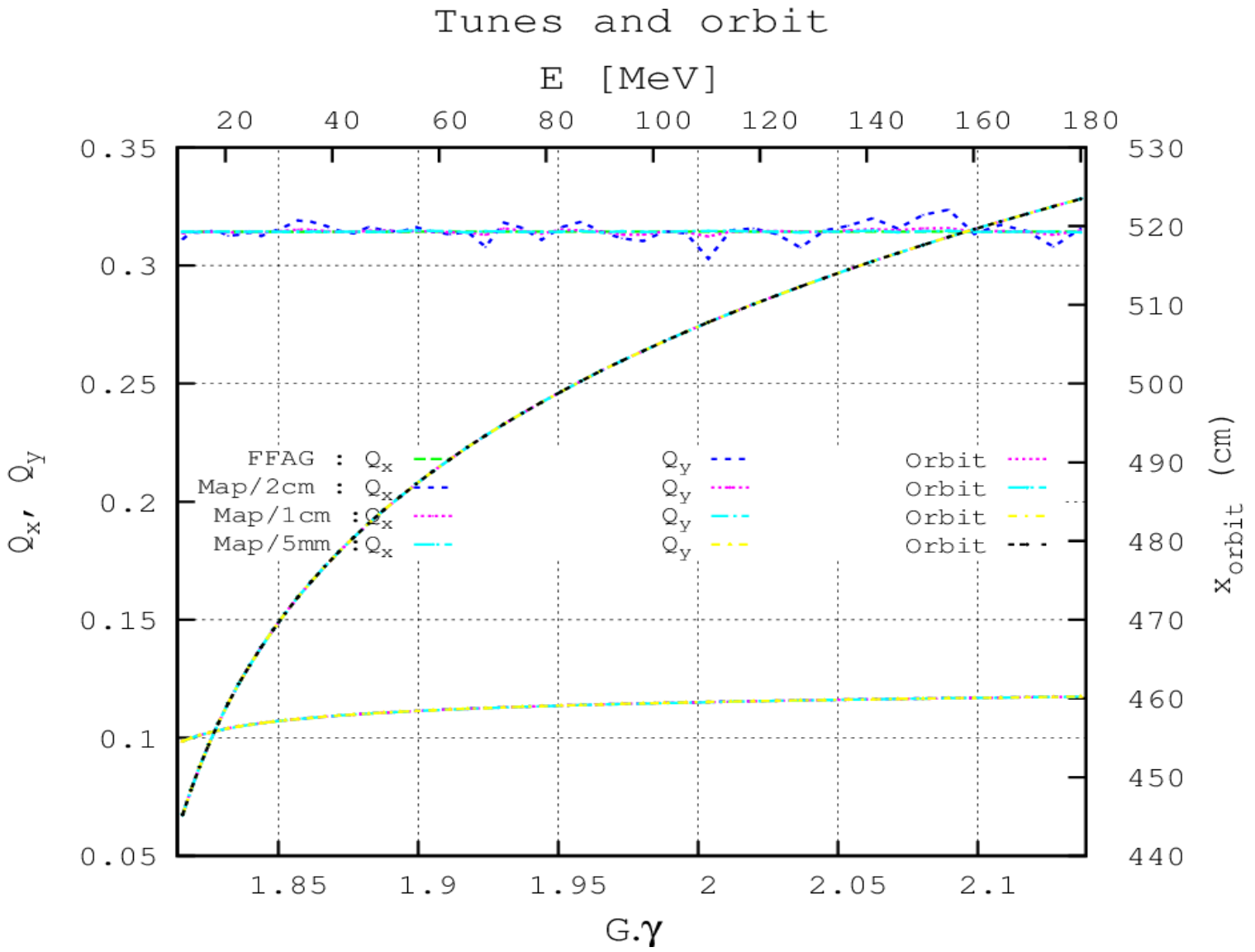
Run 'impdev2FieldMap.f' to go from zgoubi.impdev.out to a field map file which be readable by 'TOSCA' : impdev2FieldMap.out

```
  440.00    2.00    0.05300353356890    1.00       ! R_min (cm), DR (cm), DTTA (deg), DZ (cm)
# Field map generated using impdev2FieldMap
# AT/deg   RM/cm   xpas/cm  dR/cm  dZ/cm  ia jr  kz :
#  3.000000E+01   4.800000E+02   4.440414E-01   2.000000E+00   1.000000E+00   567    41     5
#  theta/rad    R/cm     Z/cm      B_theta    B_R     B_Z
  0.0000000000E+00   440.00000    -2.00000   2.2577000000E-15  -7.1779000000E-16   6.3236000000E-15     1     1     1
  9.2508617597E-04   440.00000    -2.00000   6.6972000000E-15  -2.1046000000E-15   1.8238000000E-14     2     1     1
  1.8501723519E-03   440.00000    -2.00000   1.9383000000E-14  -6.0198000000E-15   5.1297000000E-14     3     1     1
  2.7752585279E-03   440.00000    -2.00000   5.4751000000E-14  -1.6801000000E-14   1.4075000000E-13     4     1     1
  3.7003447039E-03   440.00000    -2.00000   1.5097000000E-13  -4.5770000000E-14   3.7681000000E-13     5     1     1
  4.6254308798E-03   440.00000    -2.00000   4.0652000000E-13  -1.2174000000E-13   9.8457000000E-13     6     1     1
  5.5505170558E-03   440.00000    -2.00000   1.0692000000E-12  -3.1621000000E-13   2.5115000000E-12     7     1     1
  6.4756032318E-03   440.00000    -2.00000   2.7476000000E-12  -8.0234000000E-13   6.2561000000E-12     8     1     1
  7.4006894077E-03   440.00000    -2.00000   6.9004000000E-12  -1.9893000000E-12   1.5221000000E-11     9     1     1
  8.3257755837E-03   440.00000    -2.00000   1.6942000000E-11  -4.8209000000E-12   3.6181000000E-11    10     1     1
  9.2508617597E-03   440.00000    -2.00000   4.0676000000E-11  -1.1422000000E-11   8.4044000000E-11    11     1     1
  1.0175947936E-02   440.00000    -2.00000   9.5526000000E-11  -2.6466000000E-11   1.9083000000E-10    12     1     1
  1.1101034112E-02   440.00000    -2.00000   2.1950000000E-10  -5.9987000000E-11   4.2361000000E-10    13     1     1
  1.2026120288E-02   440.00000    -2.00000   4.9363000000E-10  -1.3304000000E-10   9.1963000000E-10    14     1     1
  1.2951206464E-02   440.00000    -2.00000   1.0868000000E-09  -2.8879000000E-10   1.9528000000E-09    15     1     1
  1.3876292640E-02   440.00000    -2.00000   2.3431000000E-09  -6.1374000000E-10   4.0571000000E-09    16     1     1
  1.4801378815E-02   440.00000    -2.00000   4.9482000000E-09  -1.2773000000E-09   8.2482000000E-09    17     1     1
```

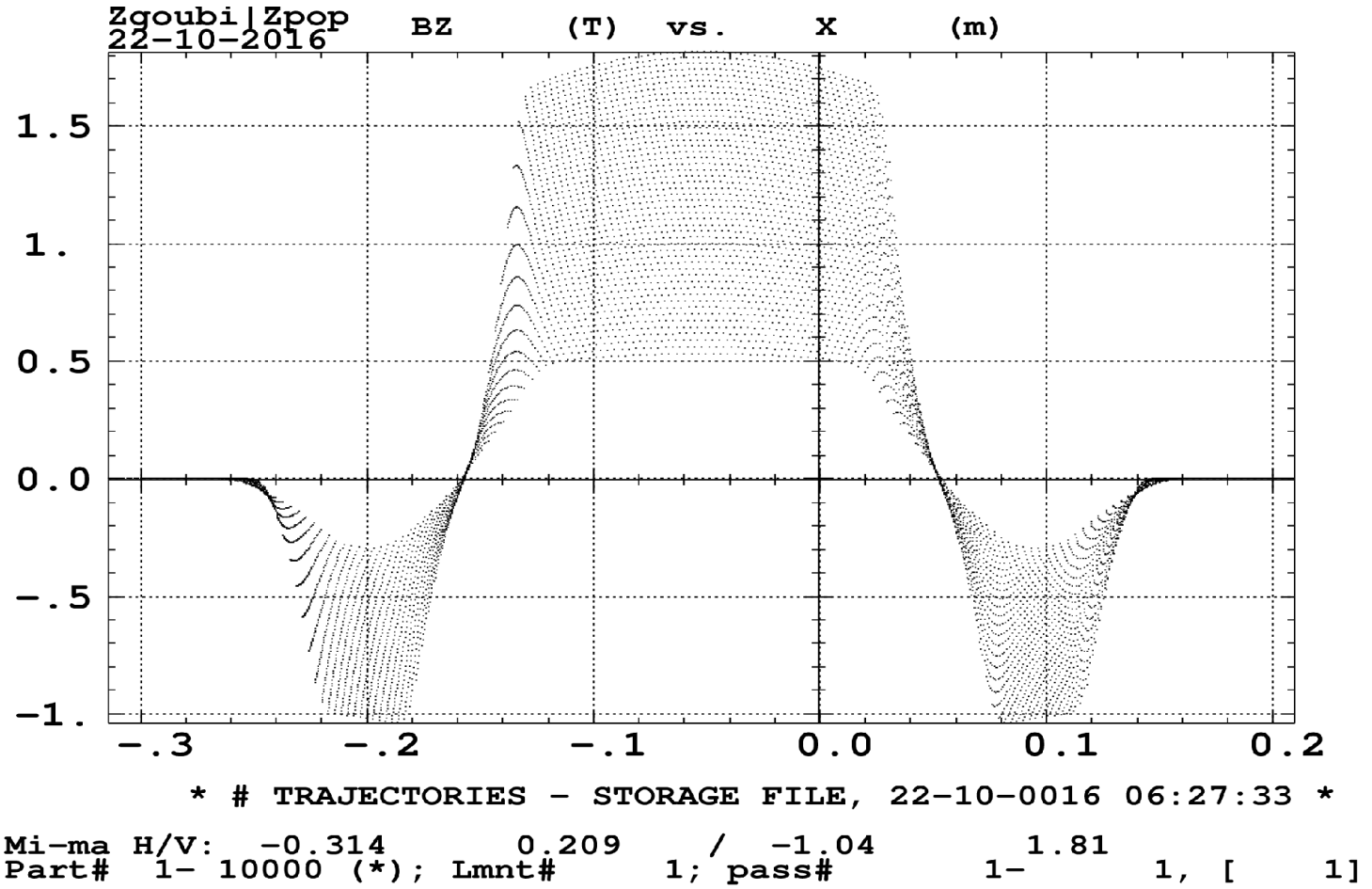
You're done !

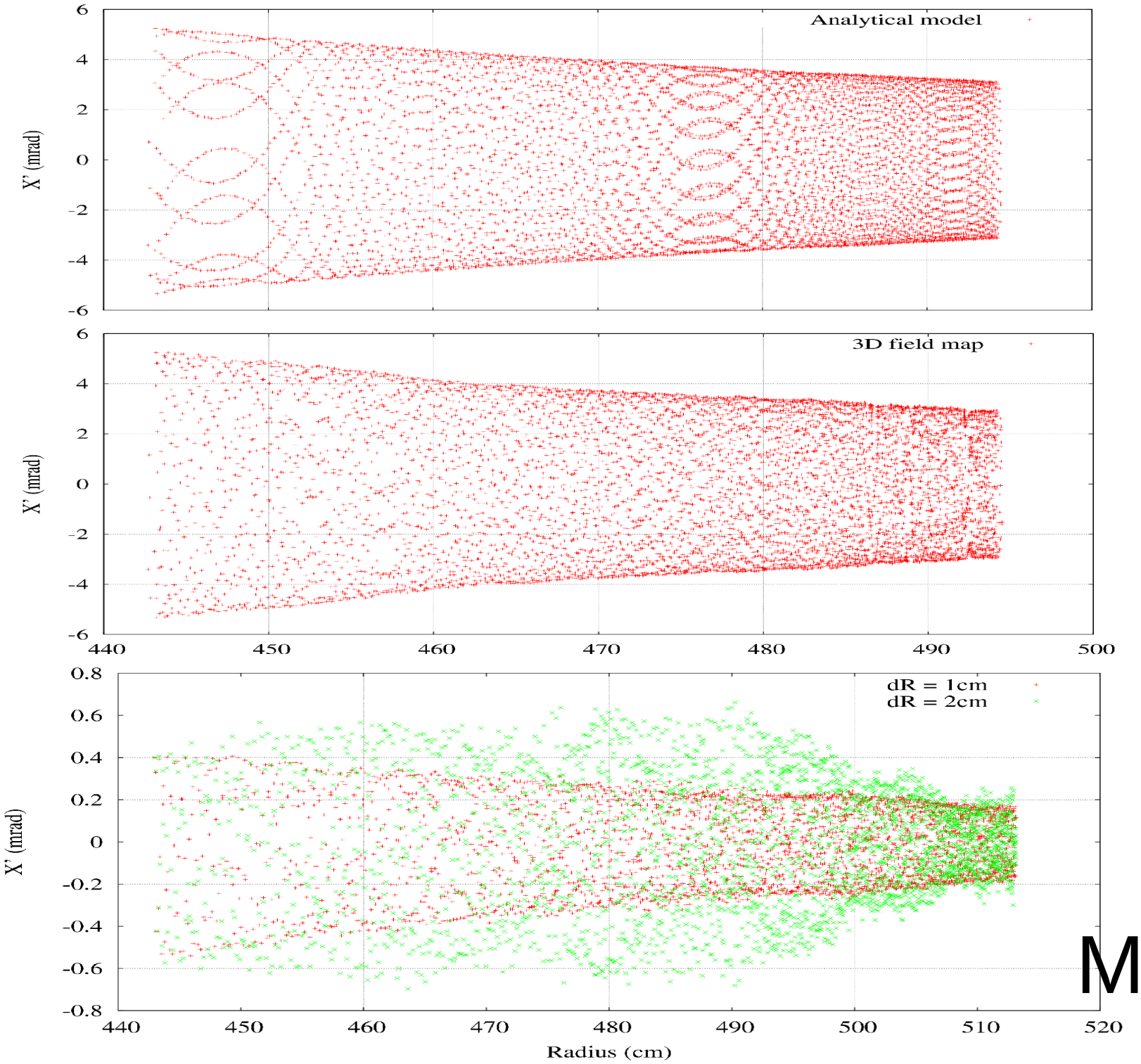
```
Test field map generated using impdev2FieldMap
 'OBJET'                                                                                                    1
1839.090113 150MeV
5.50
.01 .01 .01 .01 0. .0001
4.452339E+02 -5.469942E-05  0.0E+00  0.0  0.0    2.73043E-01  5.07794047E-02 'o'        12.00 MeV
4.483441E+02  1.038621E-06  0.0E+00  0.0  0.0    2.89991E-01  4.82243922E-02 'o'        13.53 MeV
4.512984E+02 -3.701966E-06  0.0E+00  0.0  0.0    3.06940E-01  4.59408608E-02 'o'        15.14 MeV
4.541126E+02 -2.635488E-05  0.0E+00  0.0  0.0    3.23888E-01  4.38877155E-02 'o'        16.84 MeV
4.568001E+02 -2.875109E-05  0.0E+00  0.0  0.0    3.40837E-01  4.20318179E-02 'o'        18.63 MeV

 'PARTICUL'                                                                                                 2
938.2723 1.60217733D-19 0. 0. 0.

!'FAISTORE'
!  zgoubi.fai #START
!1

 'TOSCA'    #START                                                                                          3
0  0
1.   1.   1. 1.     ! (convert B->kG, angle->rad, radius->cm, z->cm)
HEADER_5   FFAG 150MeV
1001 241 41   24      ! IX(angle) JY(radius) KZ  MOD(no symm)
./impdev2FieldMap.out
0 0 0 0
2
.15
2
0. 0. 0. 0.
 'DRIFT'                                                                                                    4
0.
 'FAISCEAU'   #END                                                                                          5

'MATRIX'
  1  11

 'END'                                                                                                      6
```

Using 'tunesFromMatrix' and 'gnuplot_tunesFromMATRIX.cmd' from zgoubi toolbox (could use Sam's 'pyZgoubi')



From either 'FFAG' or 'TOSCA'

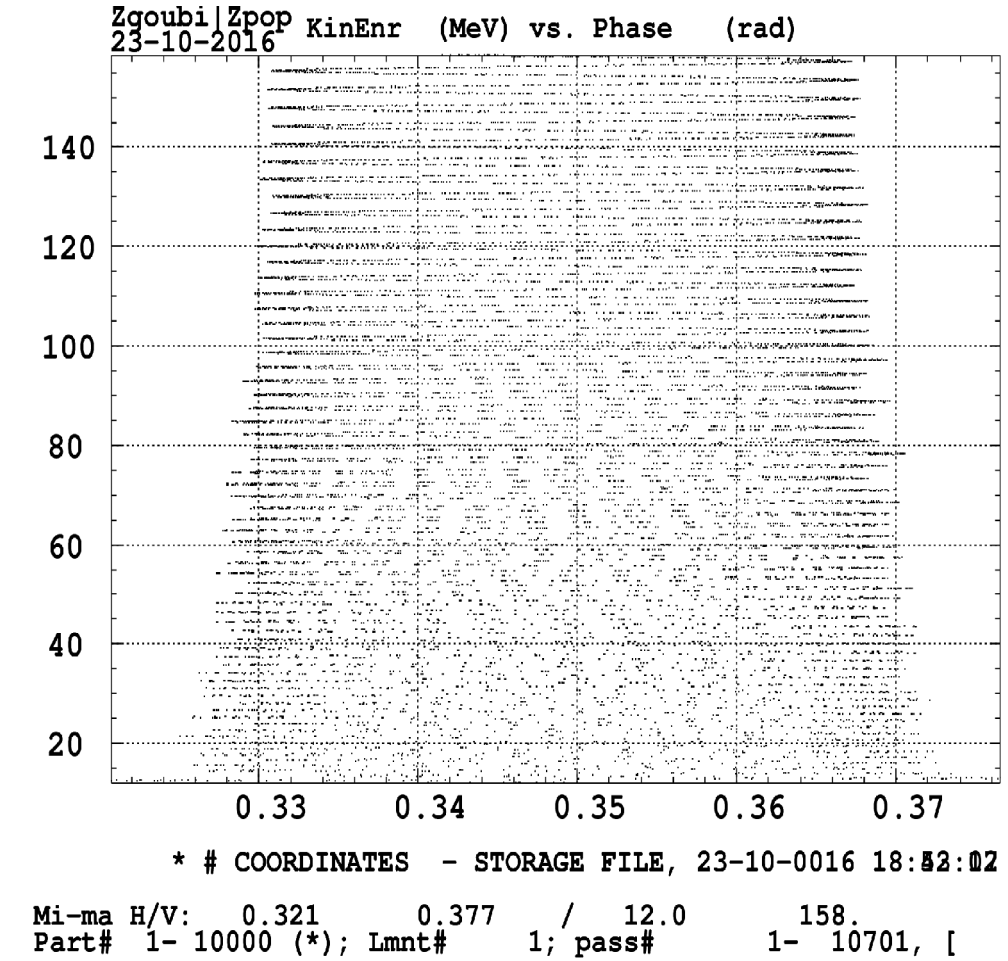




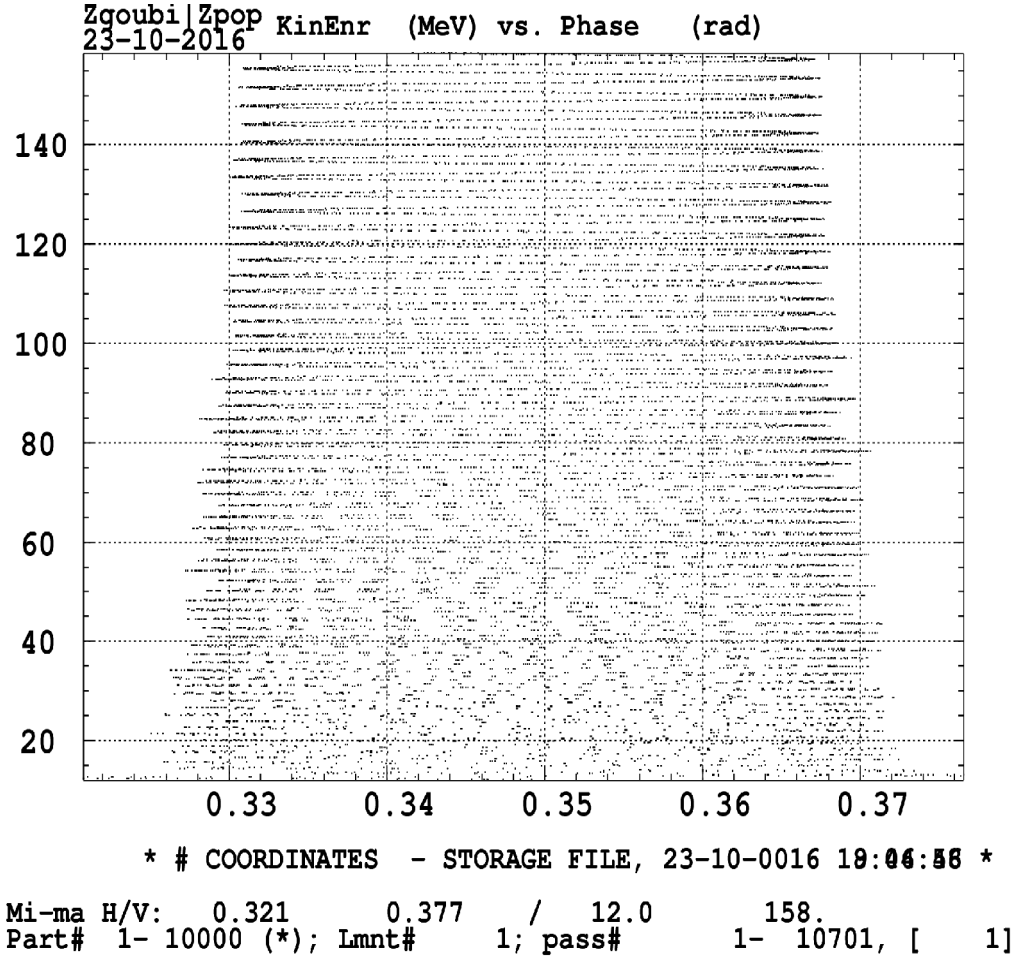
Malek

Longitudinal motion, 12 → 150 MeV

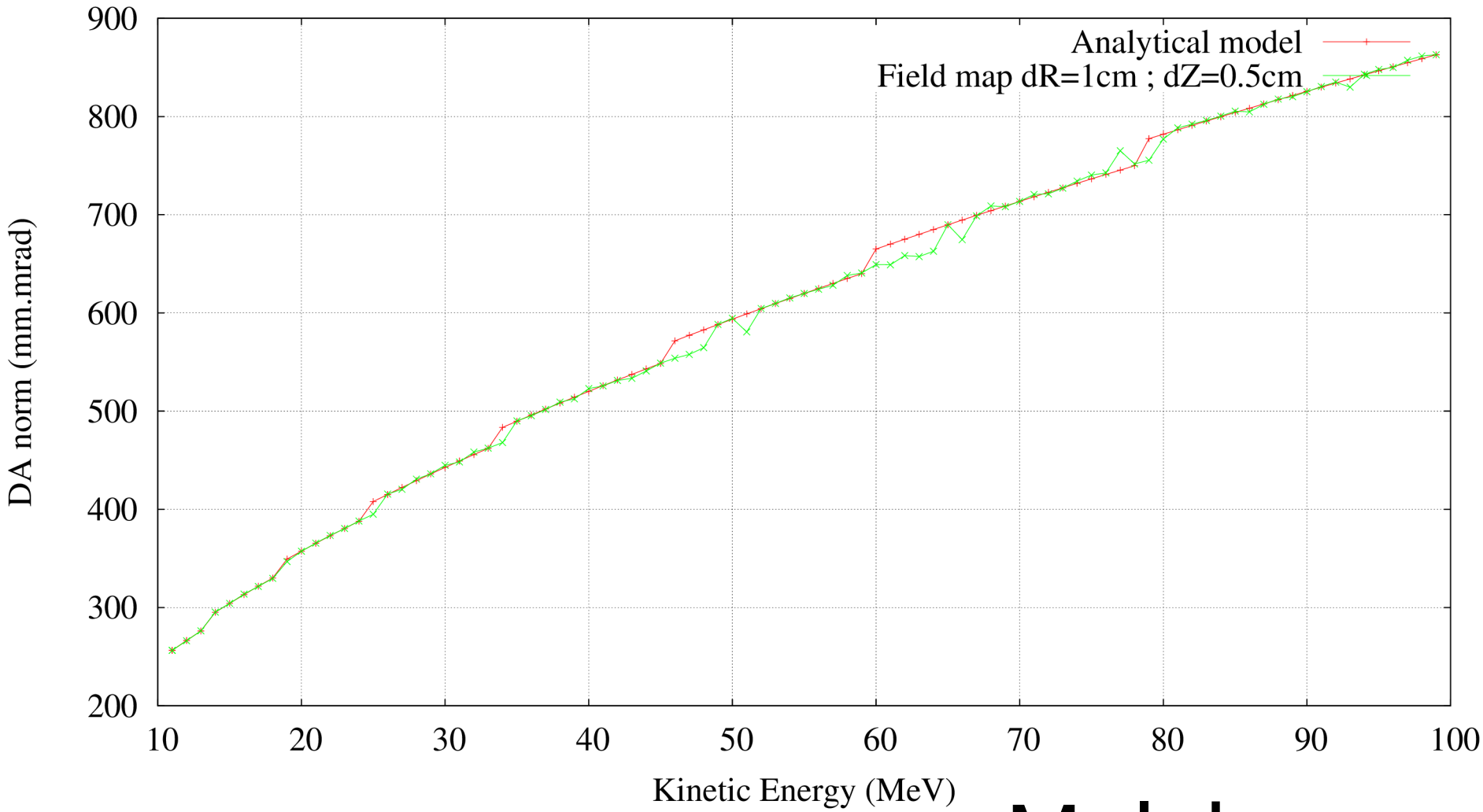
'FFAG'



'TOSCA'



DA


Analytical model
Field map dR=1cm ; dZ=0.5cm
DA norm (mm.mrad)
Kinetic Energy (MeV)
900
800
700
600
500
400
300
200
10
20
30
40
50
60
70
80
90
100

Malek