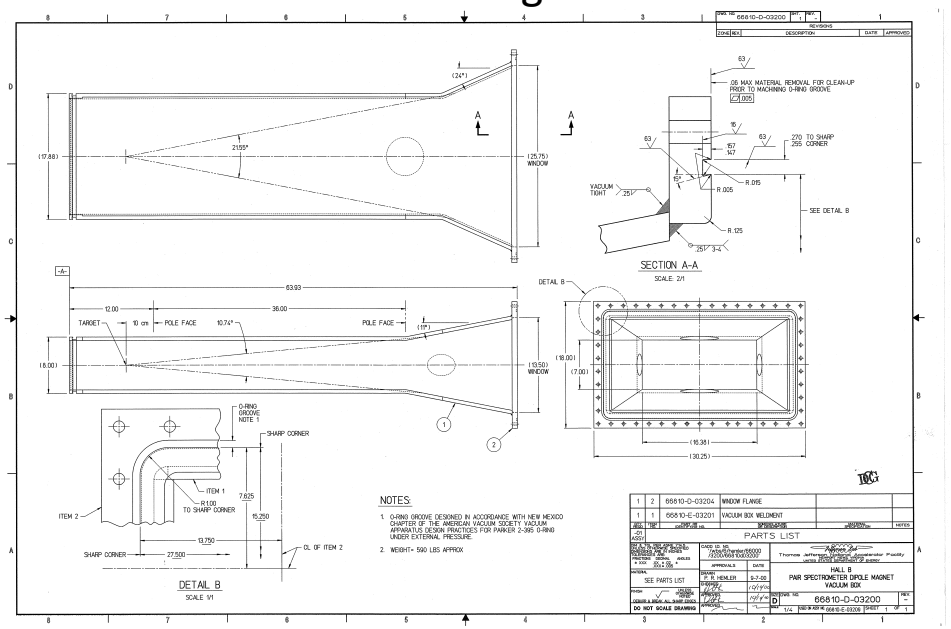
HPS Beamline:
Background Simulation

Goals:

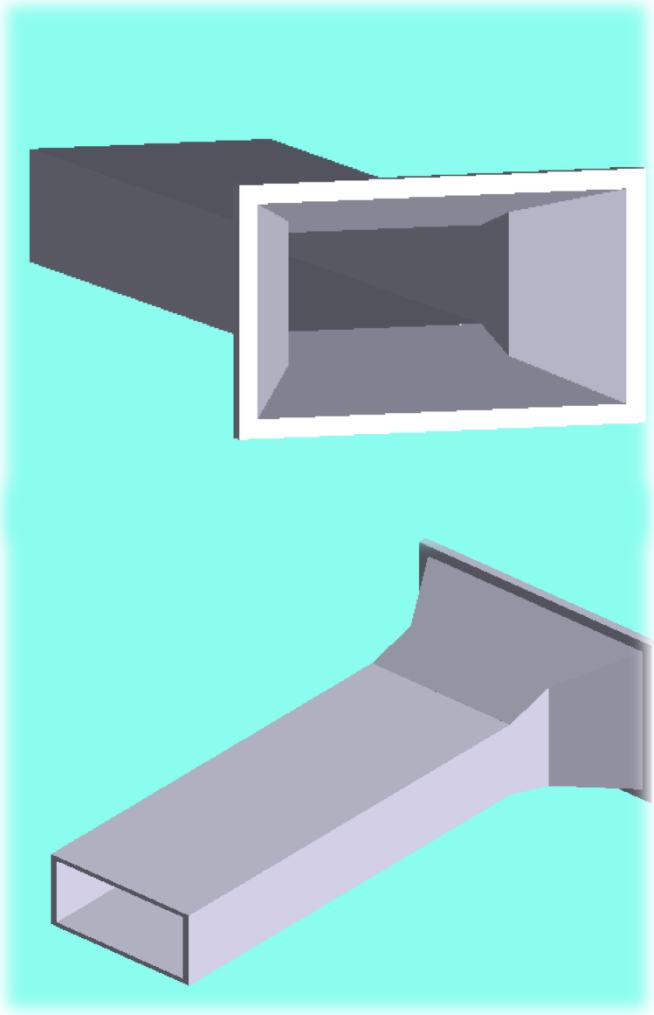
1. Realistic and precise geant4 simulation of the beamline elements and magnetic fields
2. Identify sources of background
3. Shield background until it's "reasonable" for EC

HPS Test Vacuum Box

Design

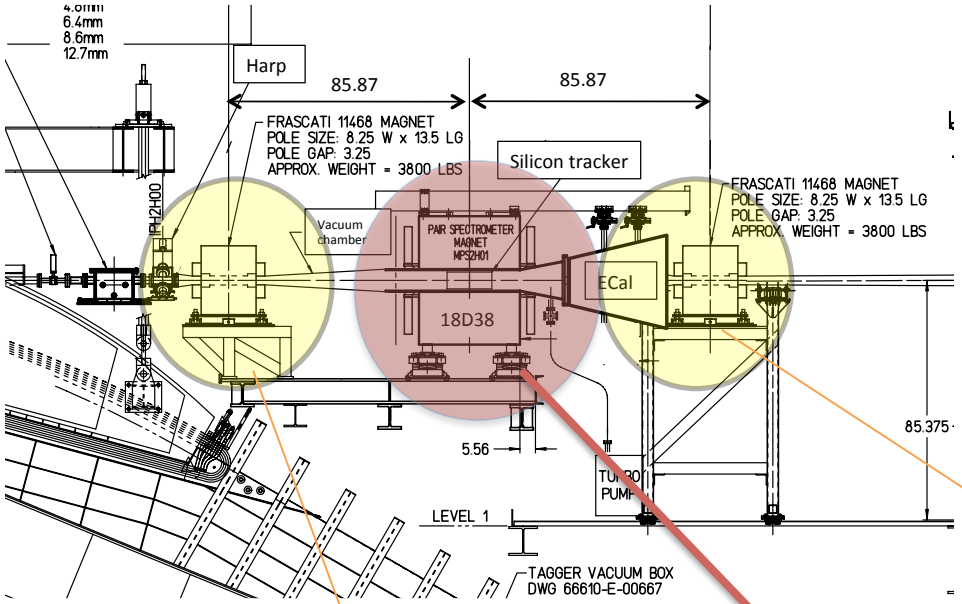


Gemc implementation

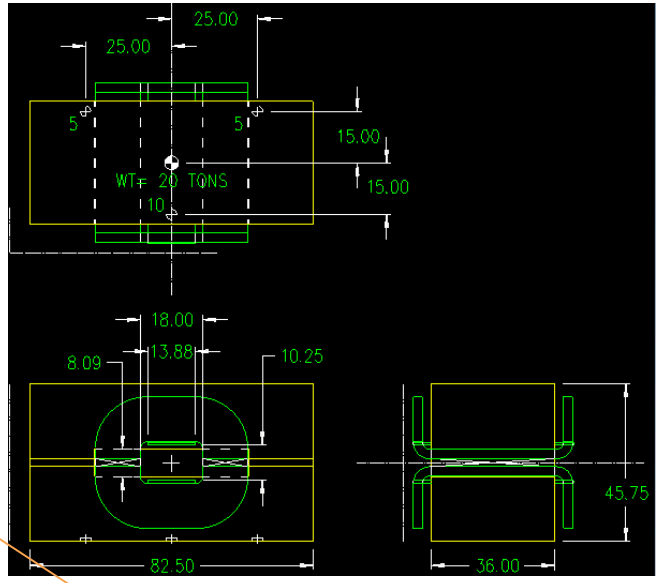


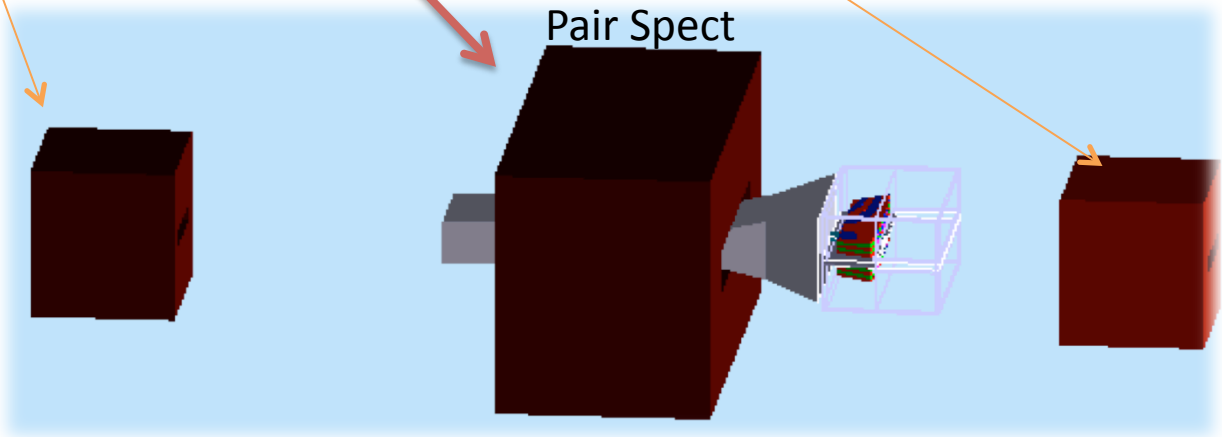
Stainless Steel 304
½ inch thick (x)
¾ inch thick (y)
63.93'' long
Flange:
1'' thick

HPS Test Magnets



Pair Spectrometer





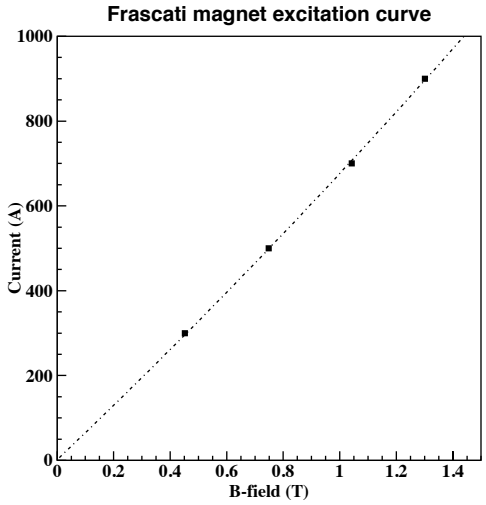
Frasc. Magn. 1

Frasc. Magn. 2

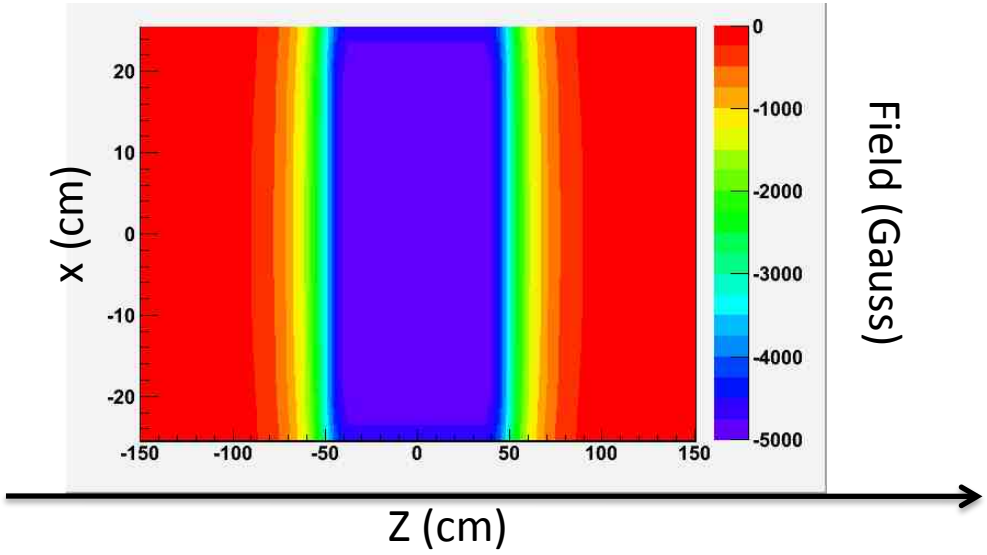
HPS Test Magnets Field Maps

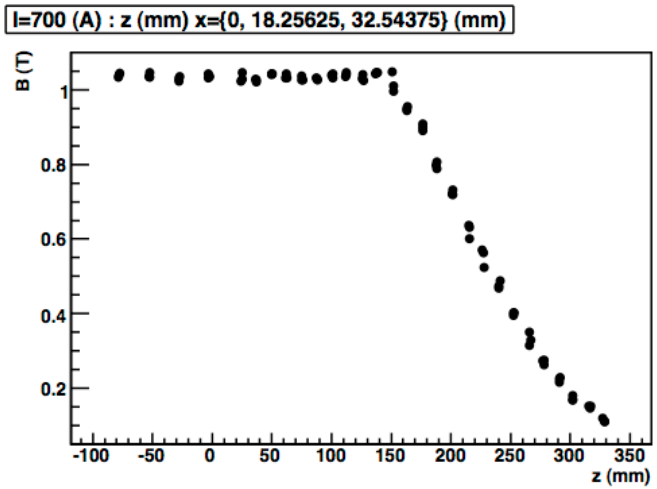
Provided by Stepan, CLAS Note 2011-2
Measurements of Frascati, PS Magnets

Frascati Magnets Current for 0.25 Tm:
335.9 A (based on max field value)



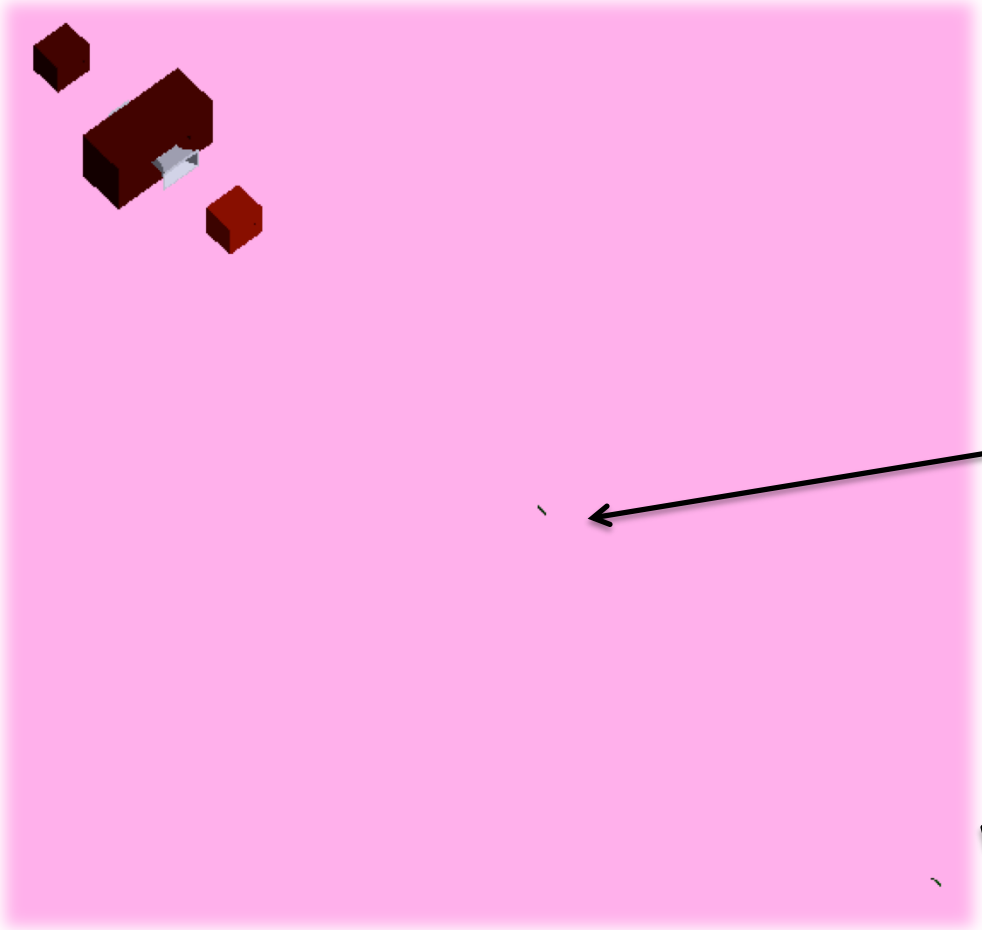
Pair Spectrometer Field: 0.5 T field





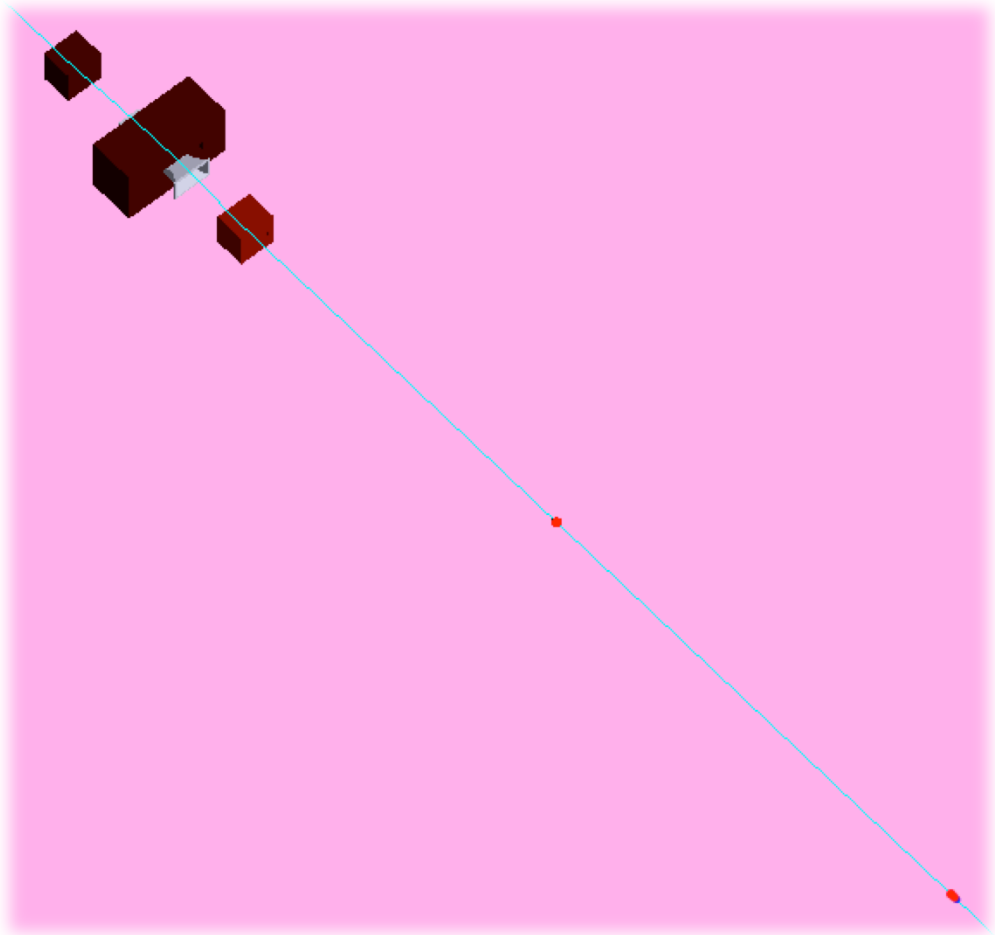
Frascati Magnet Measurement

HPS Test Chicane Alignment



2cm radius "bulls eye" tubes
Located 10m and 20m from
PS magnet

HPS Test Chicane Alignment



2.2 GeV Electron (cyan)

2cm radius "bulls eye" tubes
Located 10m and 20m from
PS magnet

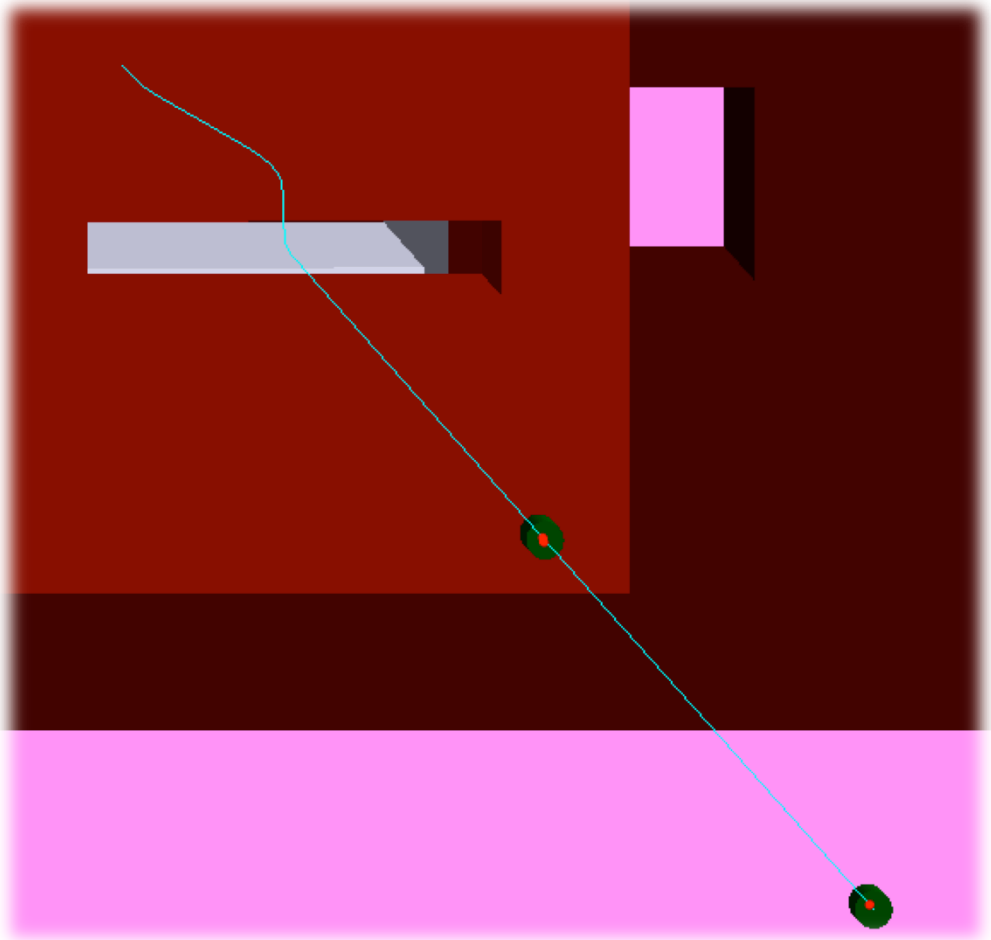
2.2 GeV electron (cyan)

Red Dot = hit

PS at 0.5T

Frascati Magnet at 1/0.8316
Or 120.3%

HPS Test Chicane Alignment



2.2 GeV Electron (cyan) Zoomed in

2cm radius “bulls eye” tubes
Located 10m and 20m from
PS magnet

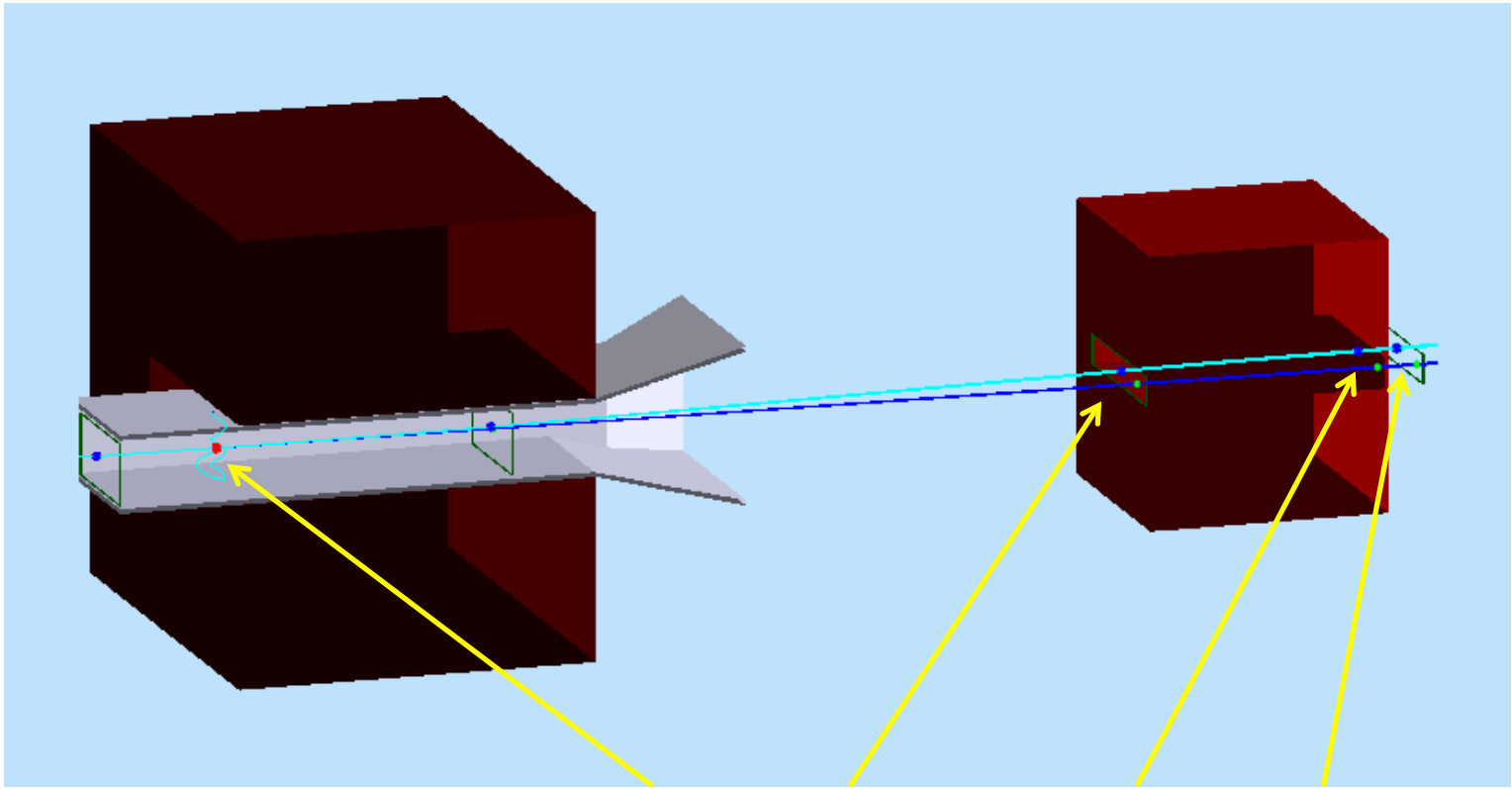
2.2 GeV electron (cyan)

Red Dot = hit

PS at 0.5T

Frascati Magnet at 1/0.8316
Or 120.3%

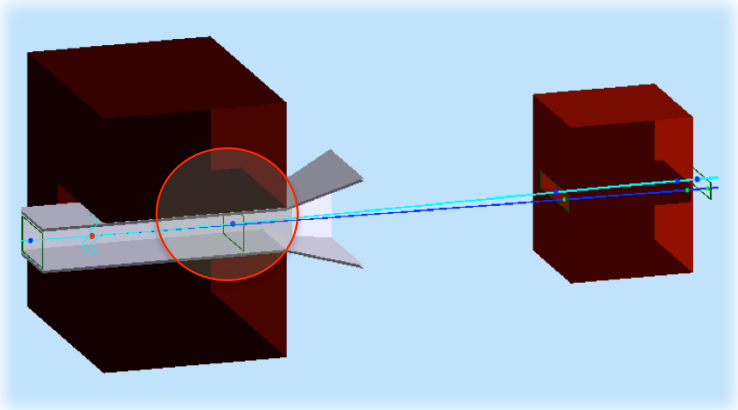
HPS Test Chicane Alignment



Flux Detectors to get the x,y distribution at various z locations

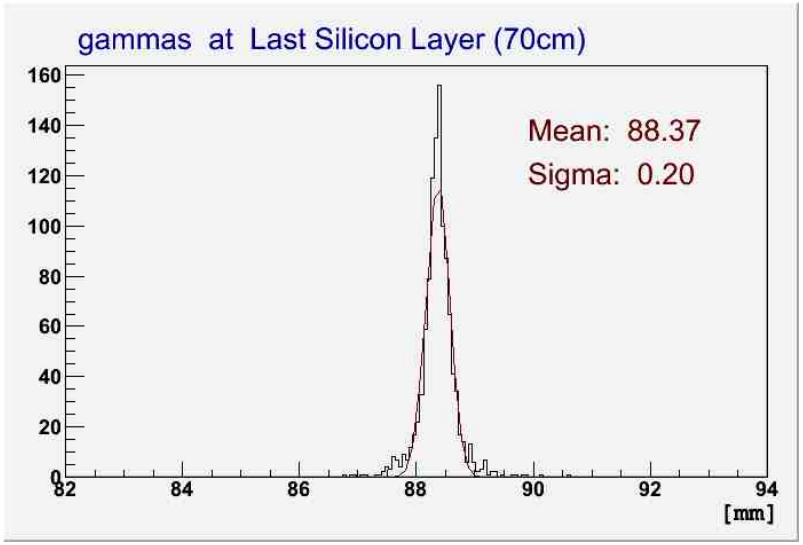
HPS Test Chicane Alignment

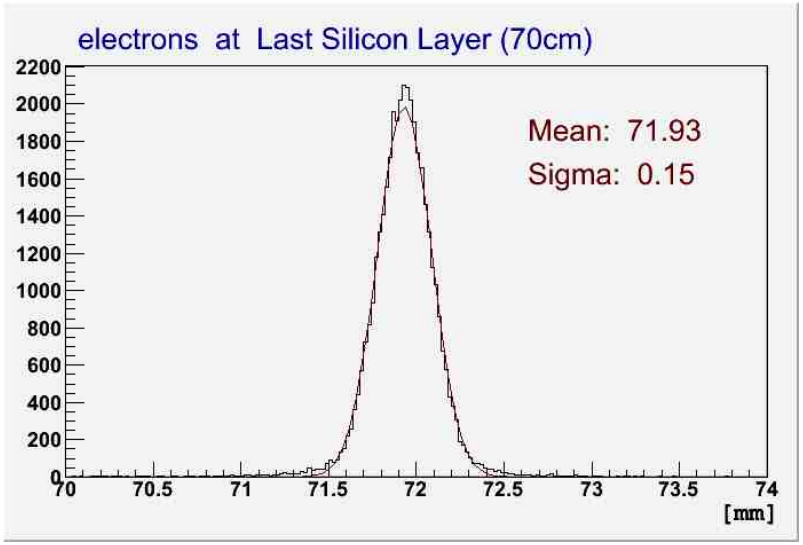
Last Silicon Layer Beam Profile



40K 2.2GeV e- on 0.125% W target

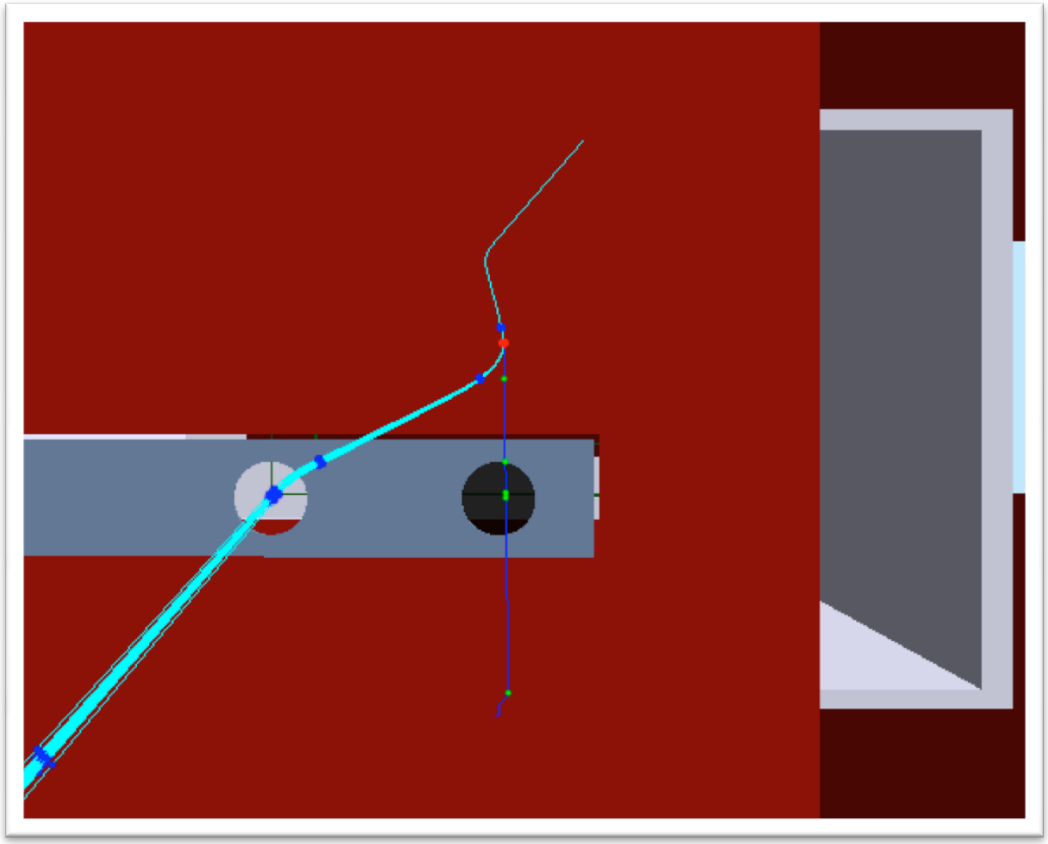
Electrons x: μ=71.93 mm σ=0.15
Gammas x: μ=88.37 mm σ=0.20



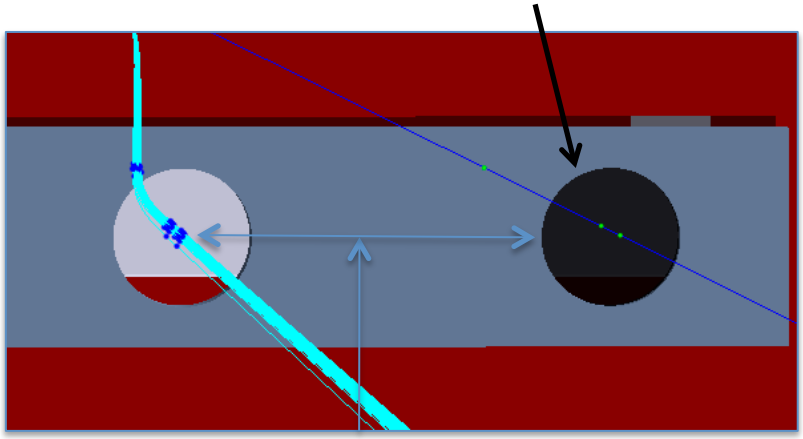


HPS Test Beamline

Vacuum Flange at Exit of 2nd Dipole



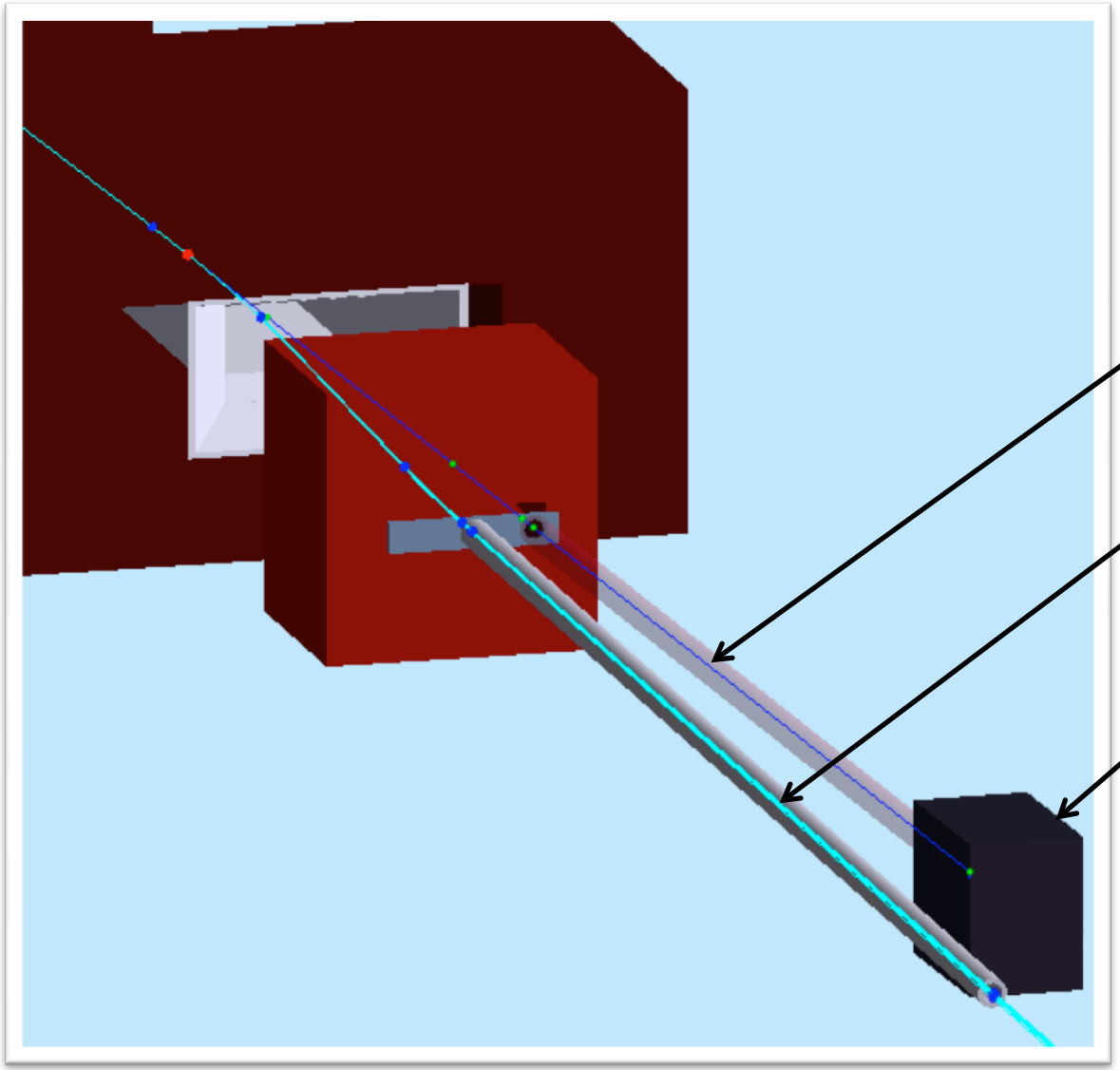
Kapton Window 100 μm



Holes Separation: 157.0 mm
ID: 2''

2 cm Stainless Steel.
Heigth: 3.1''

HPS Test Beamline

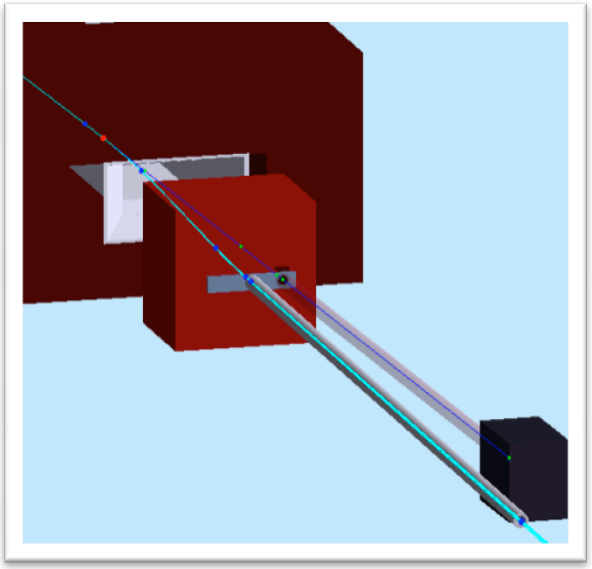


150'' Helium Bag
D=2''

200'' Steel Pipe
ID = 2''
OD = 3''

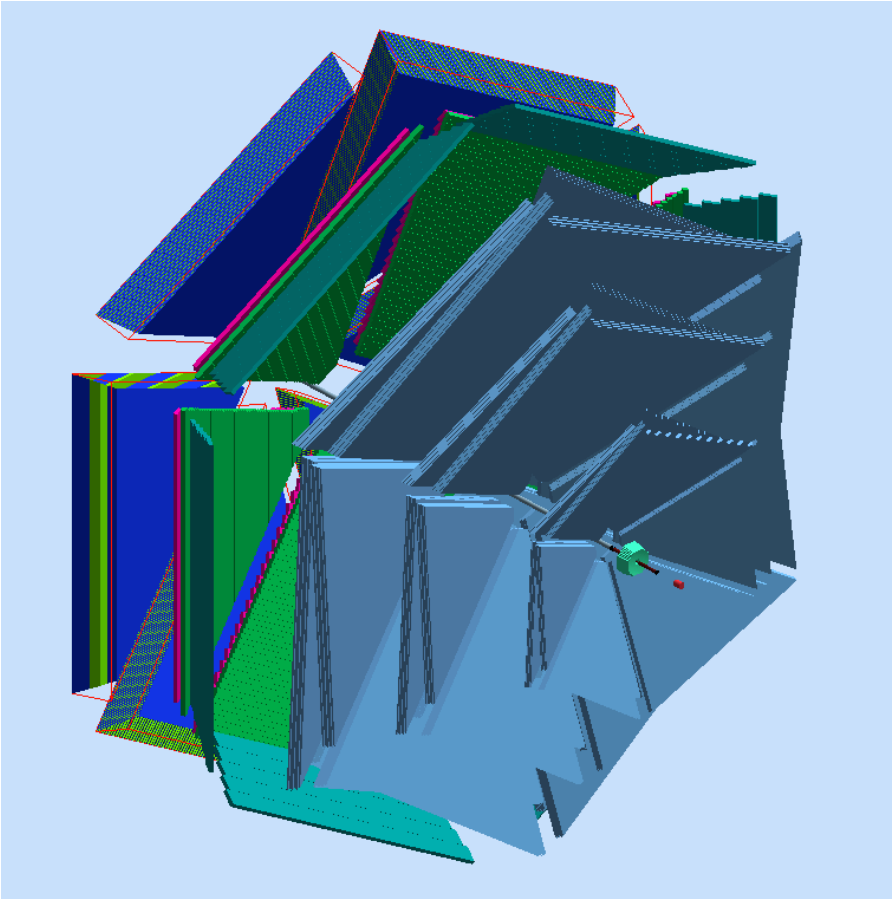
Photon Absorber:
30cmx40cmx50xcm W

HPS Test Beamline



1. Identify Background
2. Compare with eg1-dvcs experiment rates (carbon Target, $2x10^{34}$ luminosity)
3. Shield Background Sources until Doses on EC are comparable with eg1-dvcs (that's "reasonable")

Eg1-dvcs setup



(DC12, not DC but it's ok)

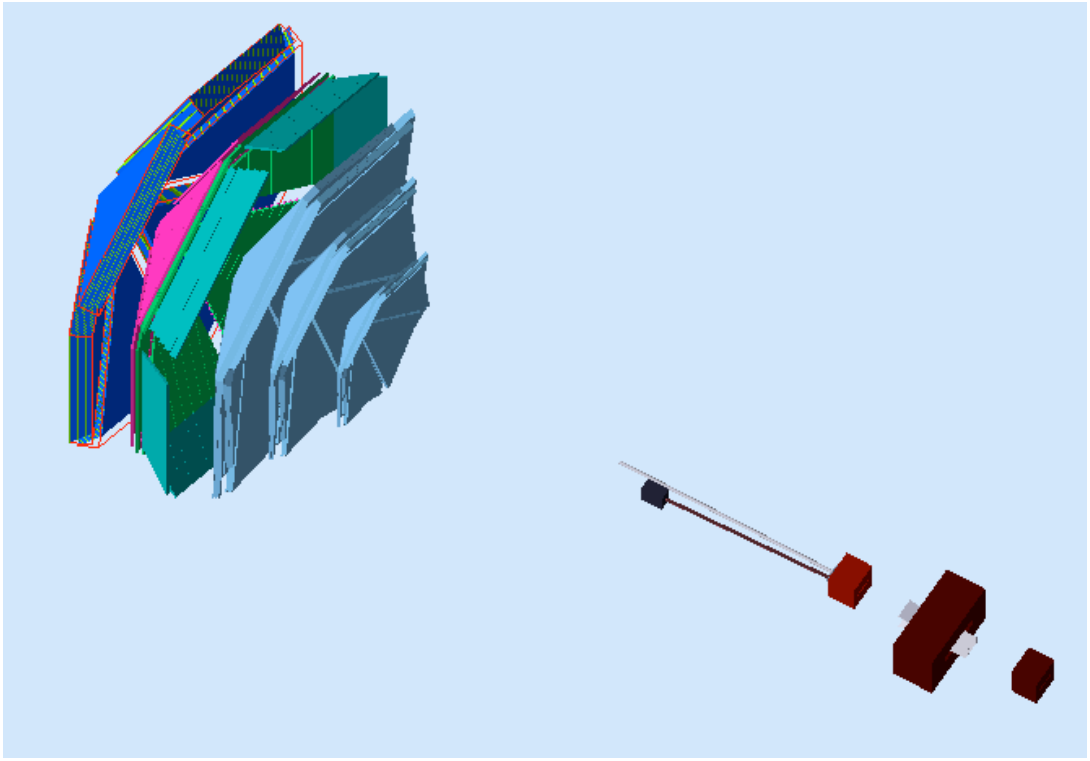
EC, TOF

IC

Helium Bag
Vacuum Pipe
Vac. Windows

1.5mm Carbon Target
Scattering Chamber

HPS Test Setup

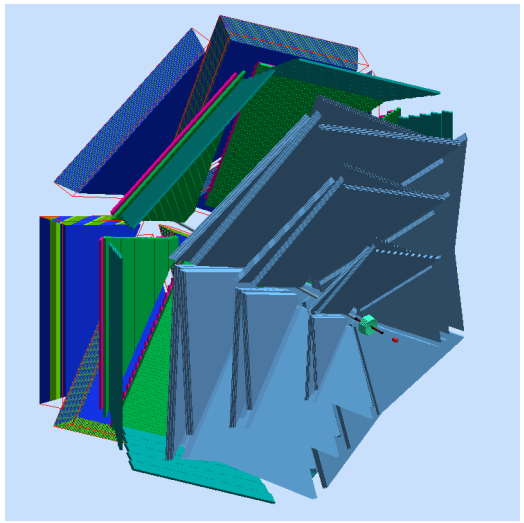


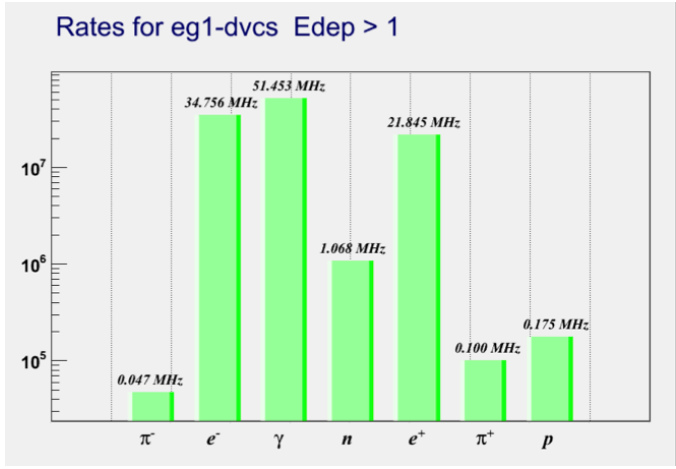
EC, TOF

HPS Test Beamline (w and w/o Photon absorber)

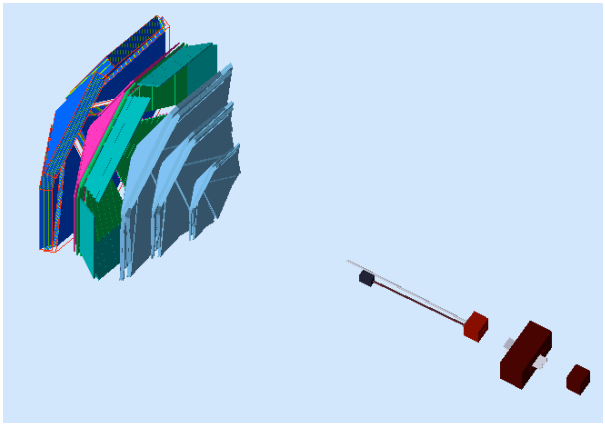
HPS Test Setup

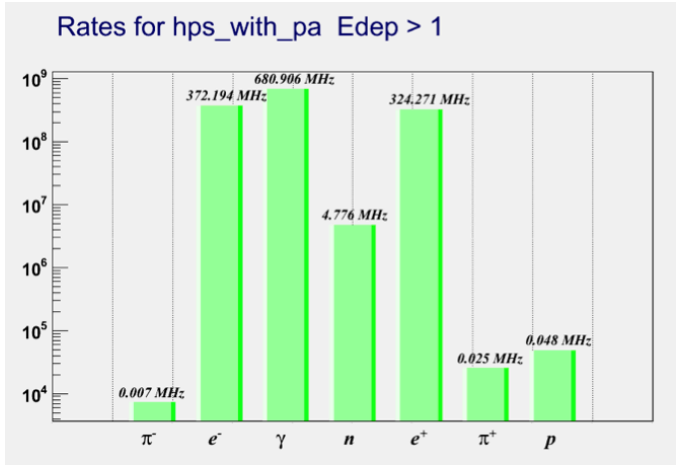
Eg1-dvcs



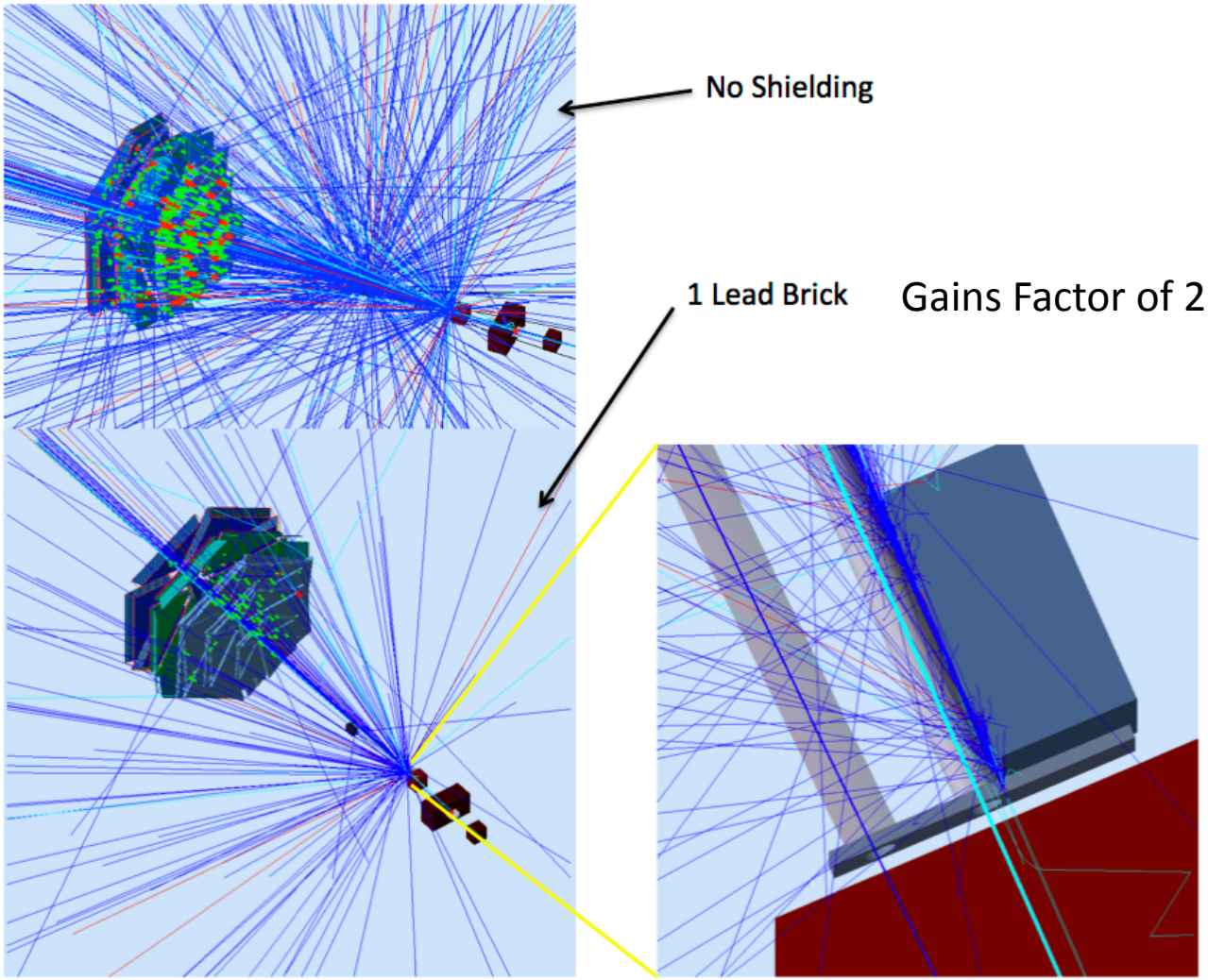


HPS test

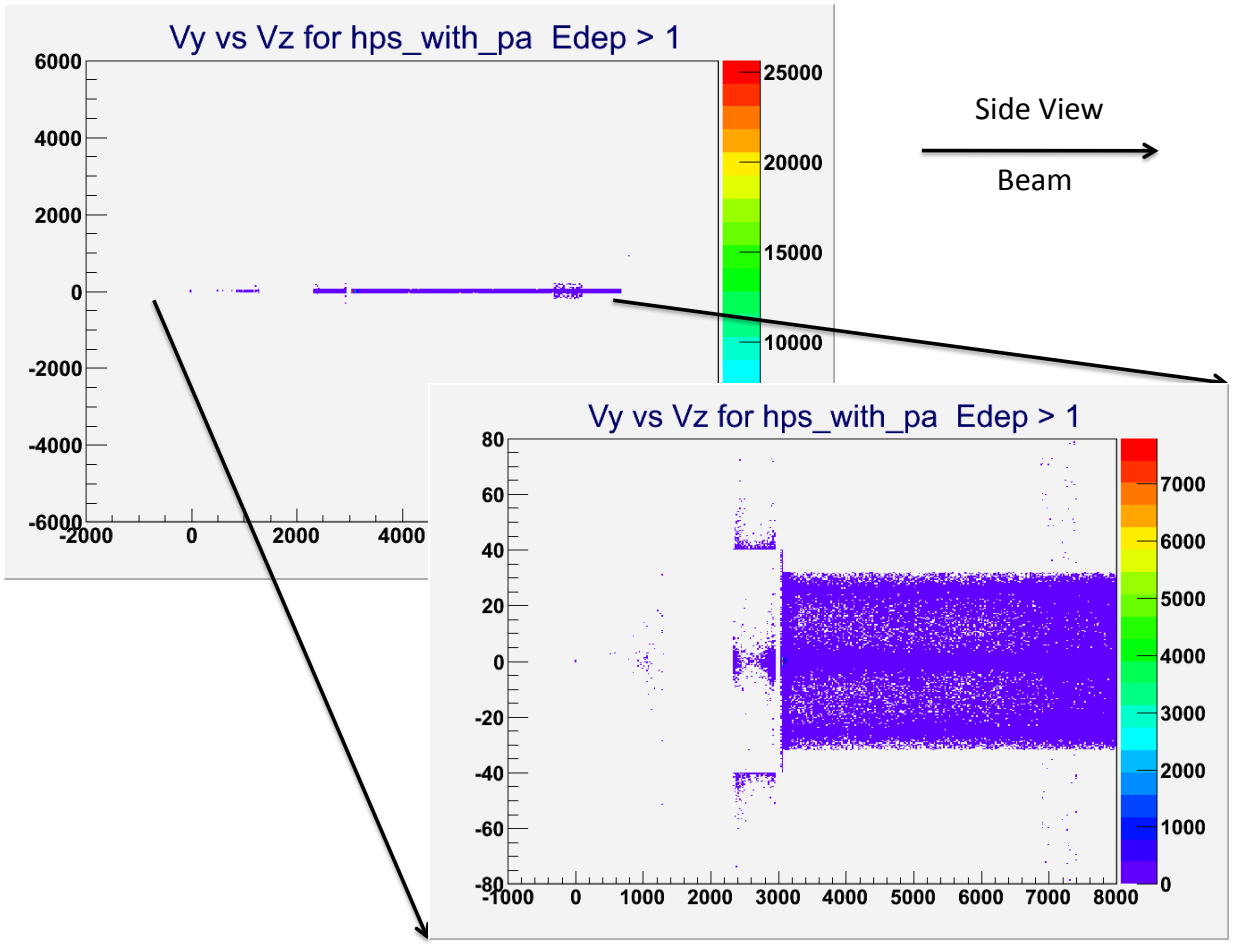




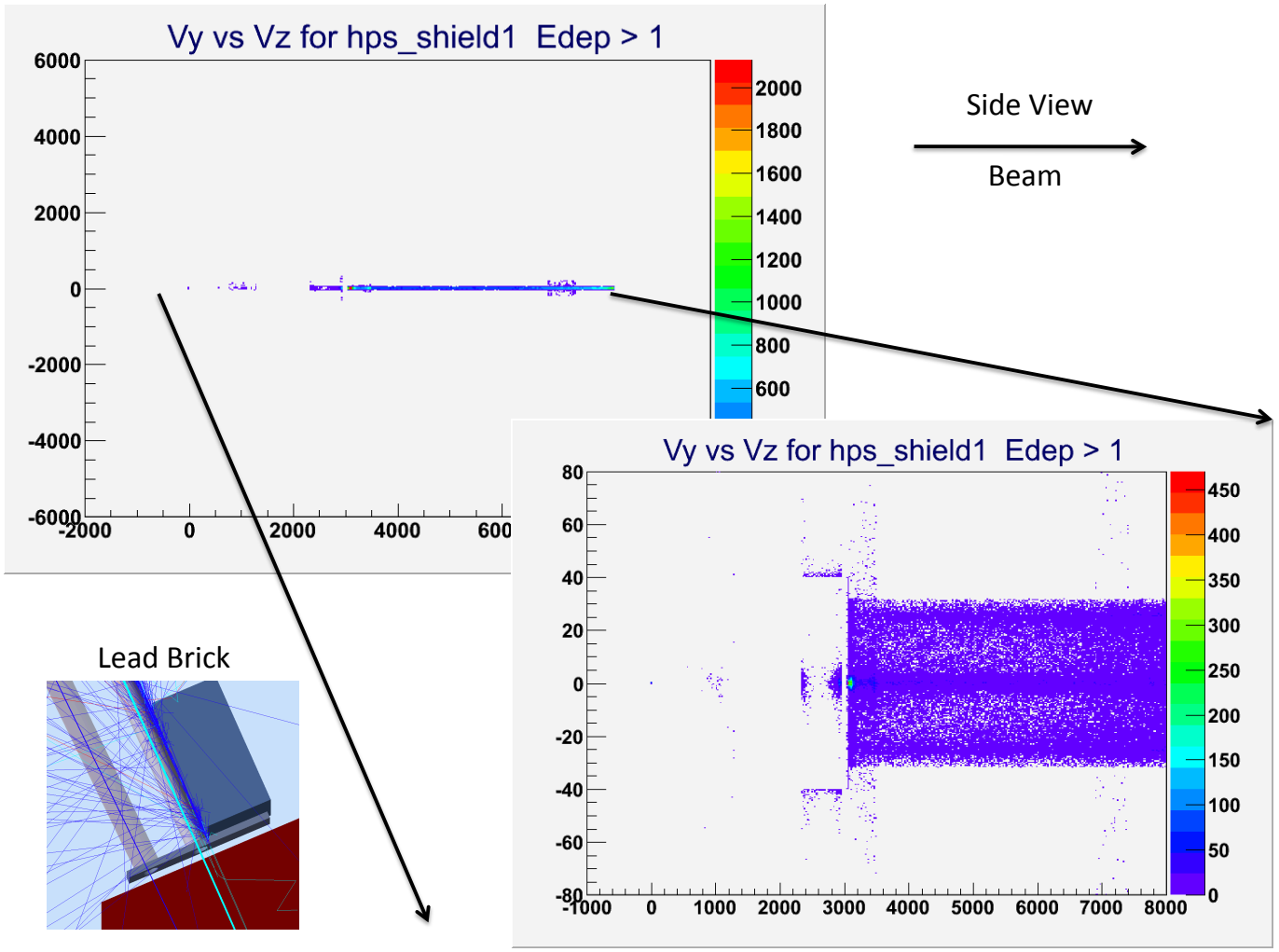
HPS Beamline Background



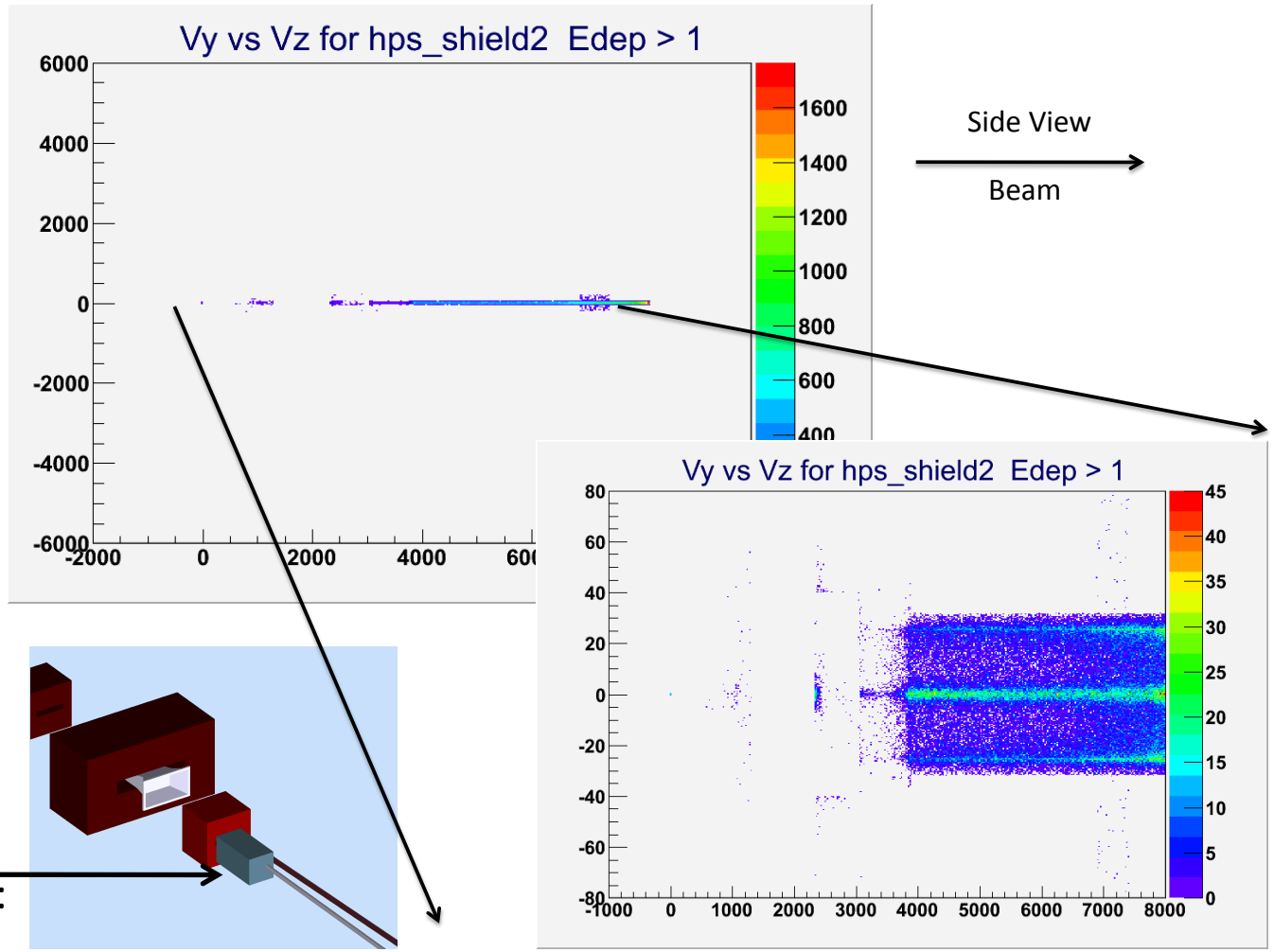
HPS Beamline Background



HPS Beamline Background

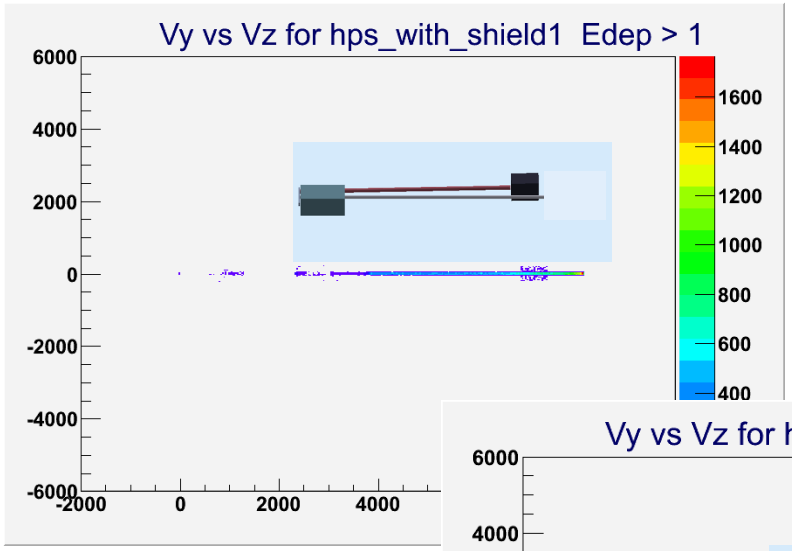


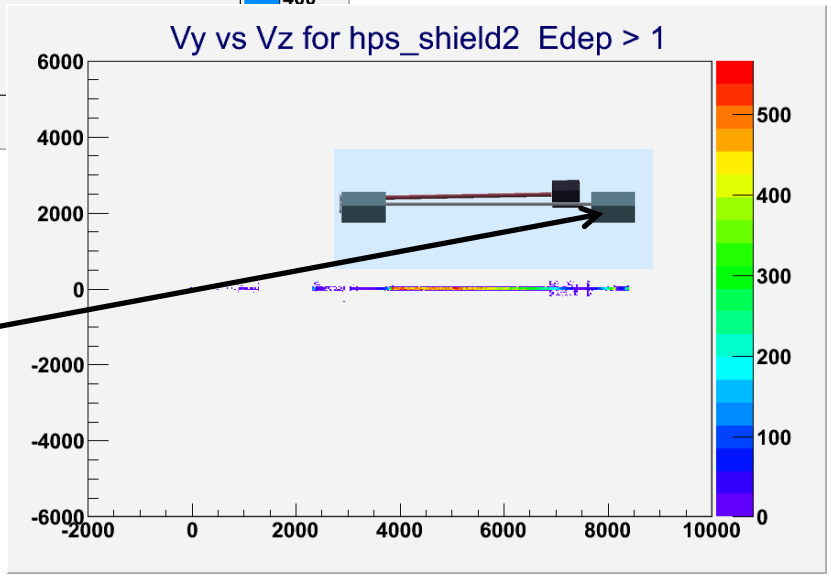
HPS Beamline Background



40x40x80cm
Lead Bricks
Factor Gained:
1.5

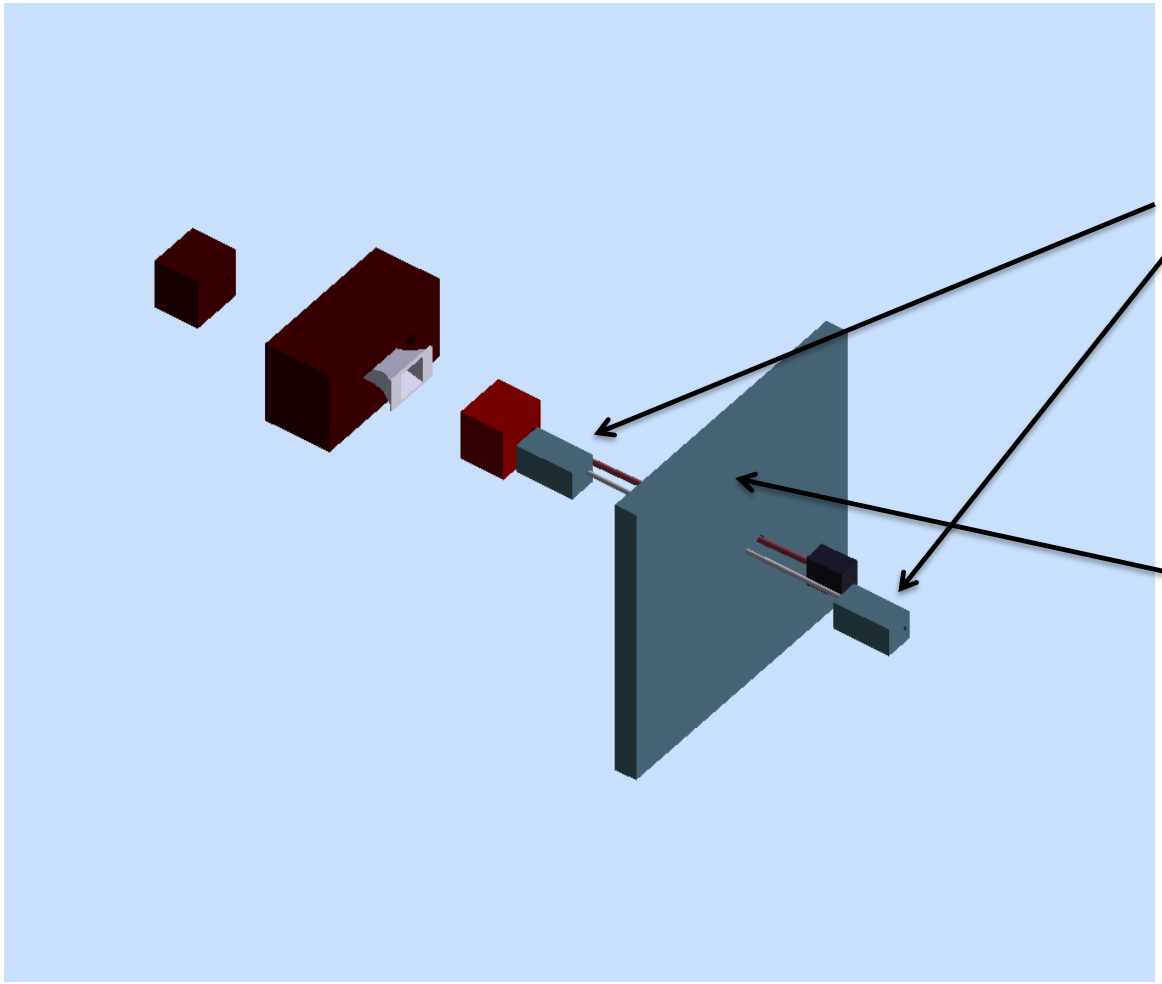
HPS Beamline Background



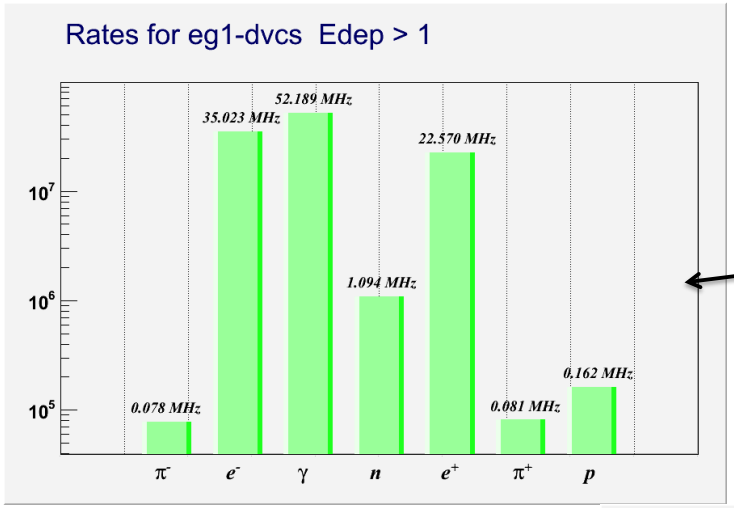


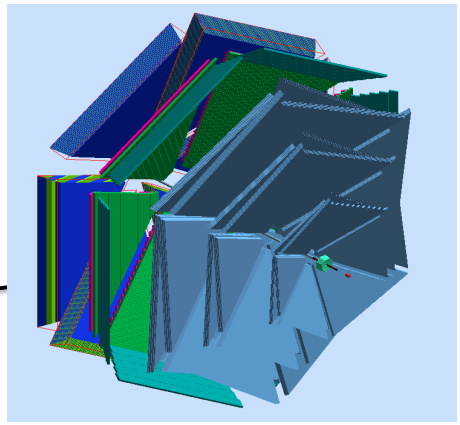
40x40x80cm
Lead Bricks
Factor Gained:
2

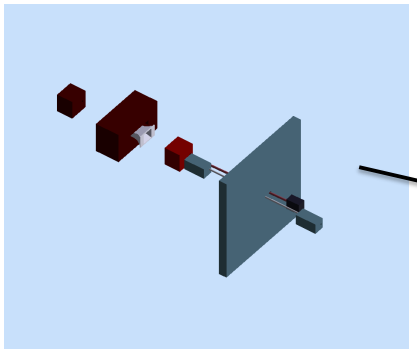
HPS Beamline Background

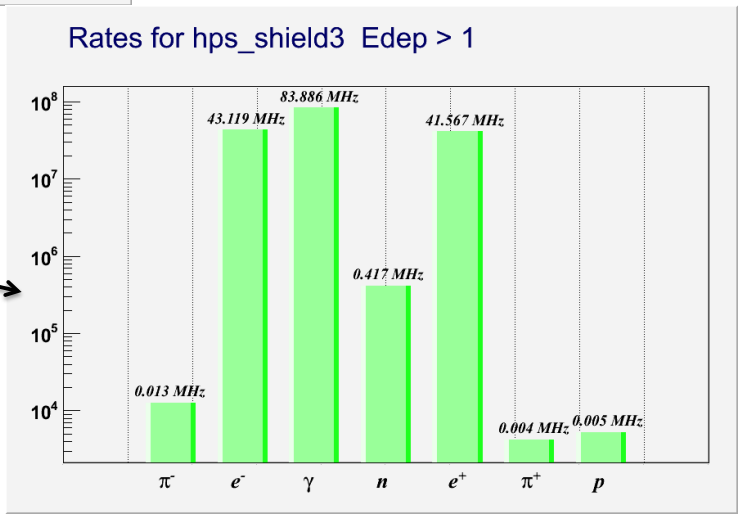


HPS Beamline Background



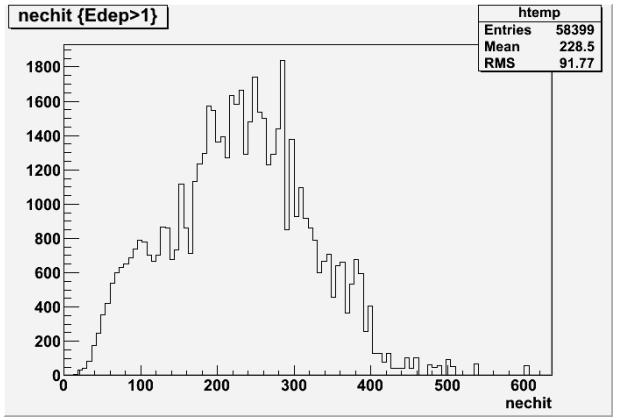


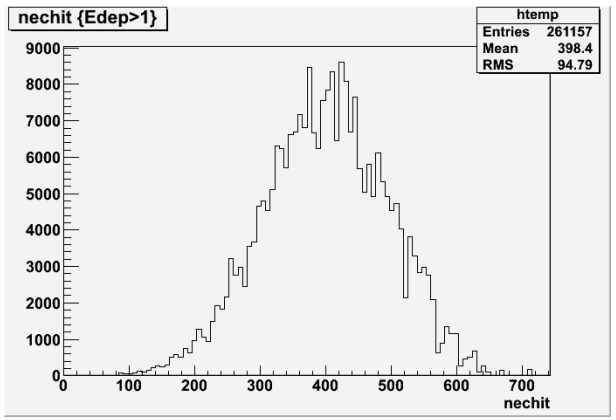


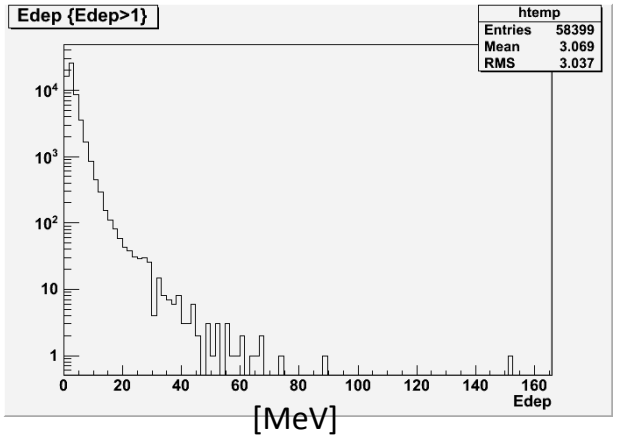


HPS Beamline Background

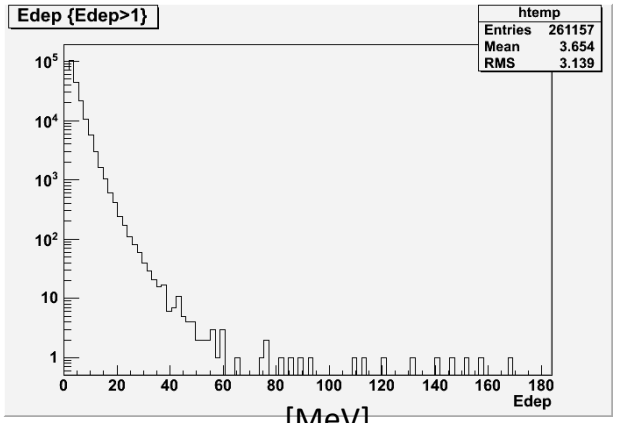
eg1-dvcs Edep > 1 MeV HPS test shield2







[MeV]



[MeV]

HPS Beamline Background

```
------
eg1-dvcs
------
particle     GeV/s   GeV/(s cm2)     nrad/s     nrad/(scm2)   rad/year

   pi-        583   0.0137487      0.467442    1.10166e-05   0.0147413
    e-     141187     3.32748       113.131     0.00266625      3.5677
 gamma     215632     5.08199       172.783     0.00407211     5.44887
     n       4741    0.111756       3.79958     8.9548e-05    0.119824
    e+      95408     2.24857       76.4491     0.00180174      2.4109
   pi+        678   0.0159916      0.543697    1.28137e-05    0.017146



------
hps_shield3
------
particle     GeV/s   GeV/(s cm2)     nrad/s     nrad/(scm2)   rad/year

   pi-         76   0.0018035     0.0613171    1.44511e-06  0.00193369
    e-     158993     3.74713       127.399     0.00300251     4.01764
 gamma     320927     7.56356       257.153     0.00606055     8.10959
     n       1334   0.0314524       1.06935    2.52023e-05    0.033723
    e+     165769     3.90682       132.828     0.00313046     4.18886
   pi+          0   1.197e-06   4.06967e-05    9.59133e-10 1.28341e-06
```

Conclusions

1. Background sources are identified (easily, and predictably)
2. Radiation doses on EC can be maintained at eg1-dvcs levels (or lower)

To do:

- Optimize shielding configuration
- Backsplash radiation on ECAL