Update on GEANT4 Simulation

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LUXE S&A Meeting
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HDF5 MC final-state group

Implemented G4 input of HDF5 MC

Option in mac file:

```
#/lxphoton/gun/beamType          mc
/lxphoton/gun/beamType           mchdf5
/lxphoton/gun/MCParticlesFile    1.00_particles.h5
```

```
h5dump -n /nfs/dust/luxe/group/MCProduction/Signal/ptarmigan-v0.7-preview/e_laser/phase0/1.00_particles.h5
.....
group      /final-state
 group      /final-state/electron
 dataset    /final-state/electron/momentum
 dataset    /final-state/electron/n_gamma
 dataset    /final-state/electron/position
 dataset    /final-state/electron/weight
 group      /final-state/photon
 dataset    /final-state/photon/a0_at_creation
 dataset    /final-state/photon/momentum
 dataset    /final-state/photon/n_pos
 dataset    /final-state/photon/position
 dataset    /final-state/photon/weight
 link       /final-state/photon/xi -> a0_at_creation
 group      /final-state/positron
 dataset    /final-state/positron/momentum
 dataset    /final-state/positron/n_gamma
 dataset    /final-state/positron/position
 dataset    /final-state/positron/weight
```

- In out files we had GeV and um;
- Seems particleID is not available in final-state group. (corresponding file: 1.00_particles.h5 has it)

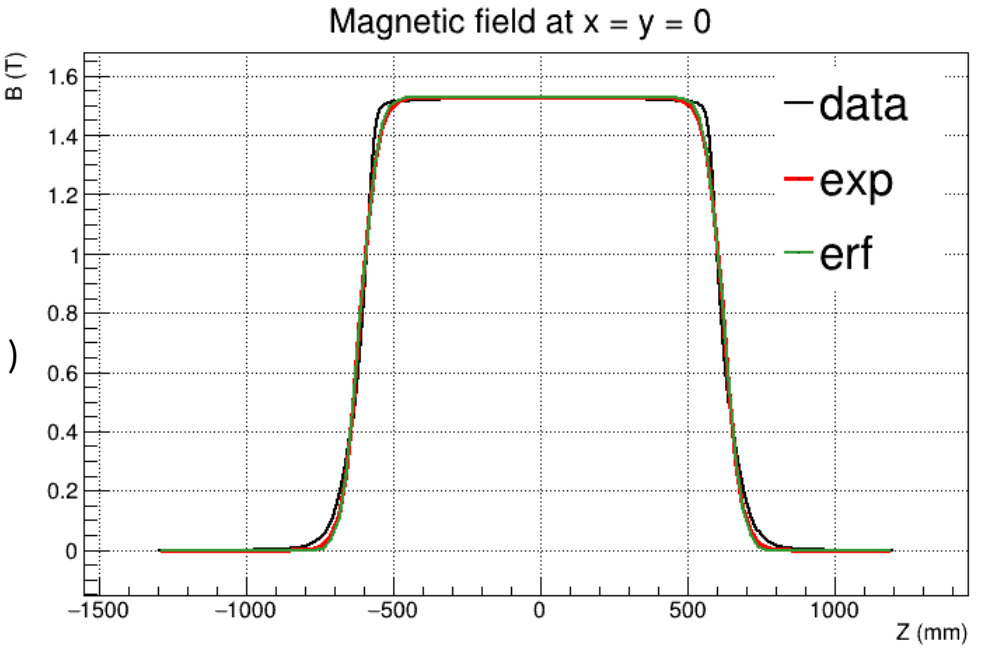
Approximation of the field measurements

[0] / ((1.0 + exp(([1]-x)/[2])) * (1.0 + exp((x-[3])/[4])))

```
****************************************
Minimizer is Minuit / Migrad
Chi2                      =     0.334513
NDf                       =          496
Edm                       =  7.19831e-09
NCalls                    =          166
p0                        =      1.52962   +/-   0.00179954
p1                        =     -615.371   +/-   0.513627
p2                        =      28.9891   +/-   0.456426
p3                        =      621.238   +/-   0.516122
p4                        =      29.2464   +/-   0.458235
```

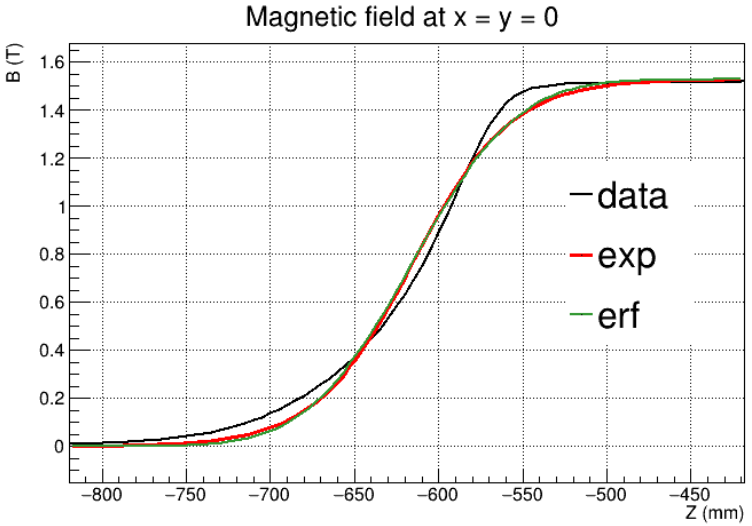
I = 380 A

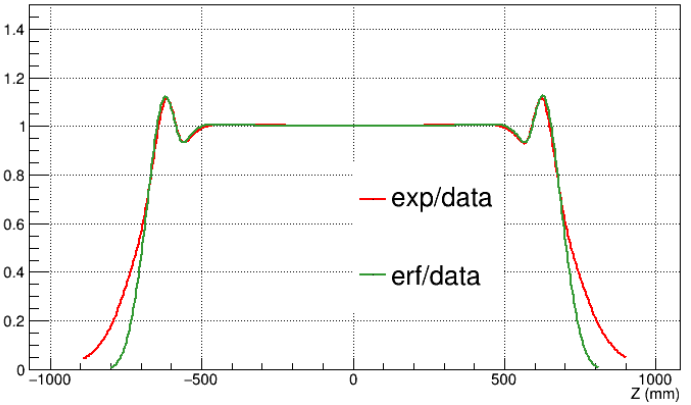
Magnet current I = 380 A



[0] * ((1.0 + TMath::Erf((x-[1])/[2])) * (1.0 + TMath::Erf(([3]-x)/[4])))

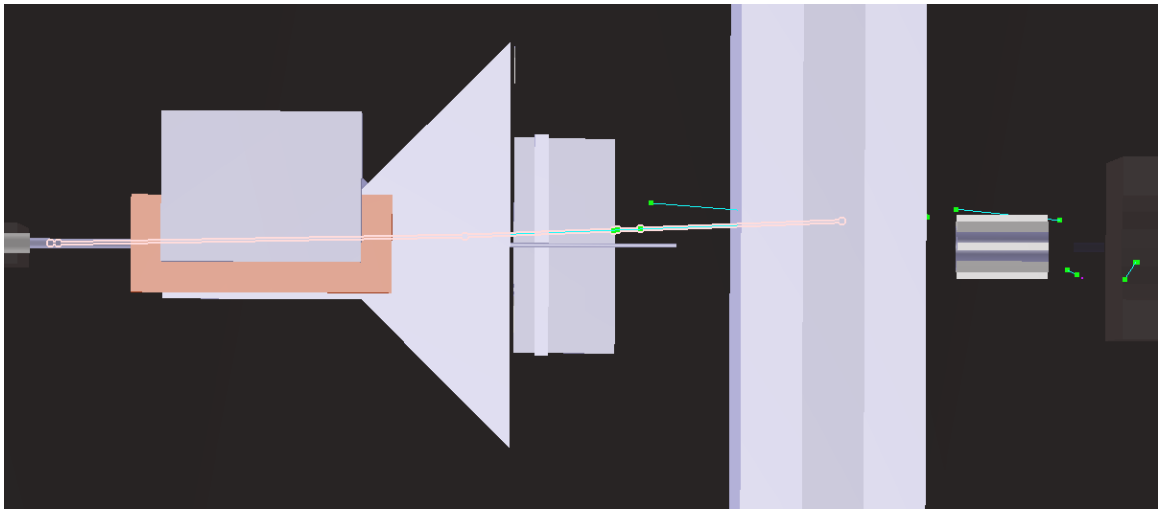
```
****************************************
Minimizer is Minuit / Migrad
Chi2                      =     0.360549
NDf                       =          496
Edm                       =   6.6431e-07
NCalls                    =          192
p0                        =     0.381775   +/-   0.000464131
p1                        =     -615.852   +/-   0.5342
p2                        =      69.1129   +/-   1.10464
p3                        =      621.732   +/-   0.536833
p4                        =      69.7404   +/-   1.1092
```

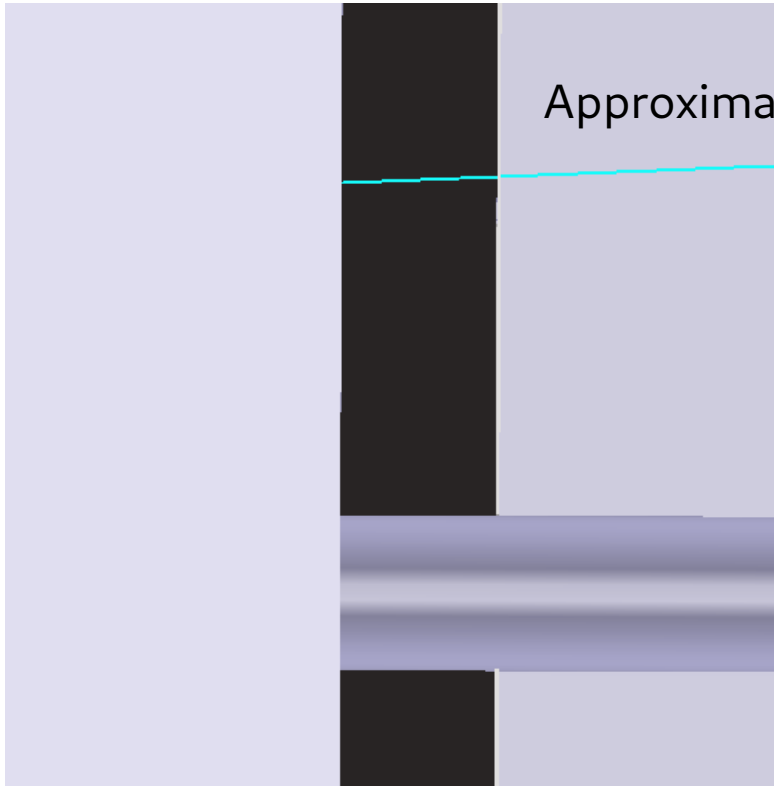




10 GeV electron, 300A field

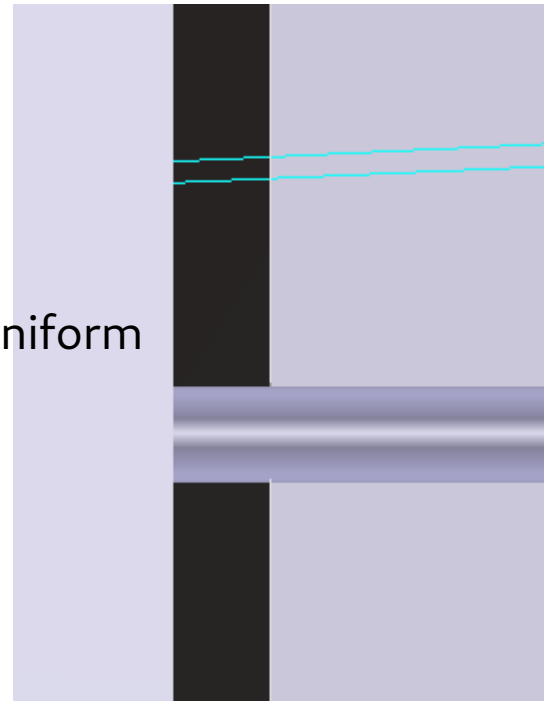
- Uniform field
- Approximation using fit function in z and x
- Interpolated data (measurements) in z and approximation in x





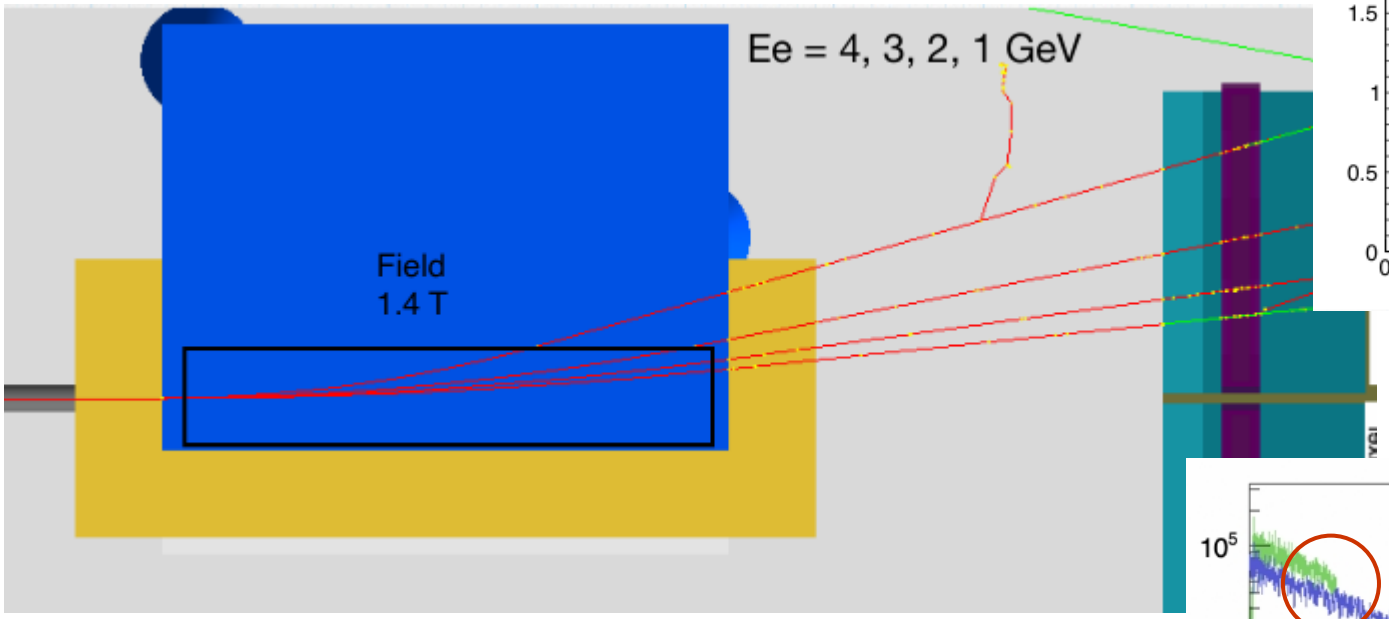
Approximated vs measured

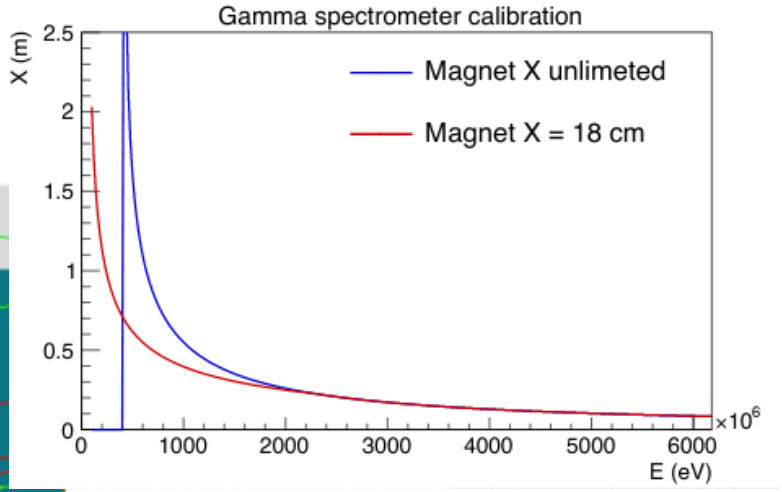
Approximated vs uniform

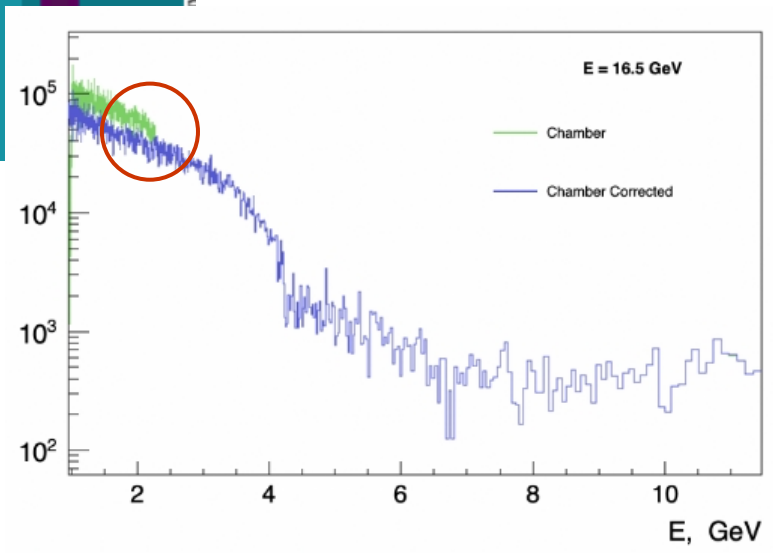


Effect of limited transverse size of the field

- Field dependence on X might be important;
- Should be taken into account in calibration.

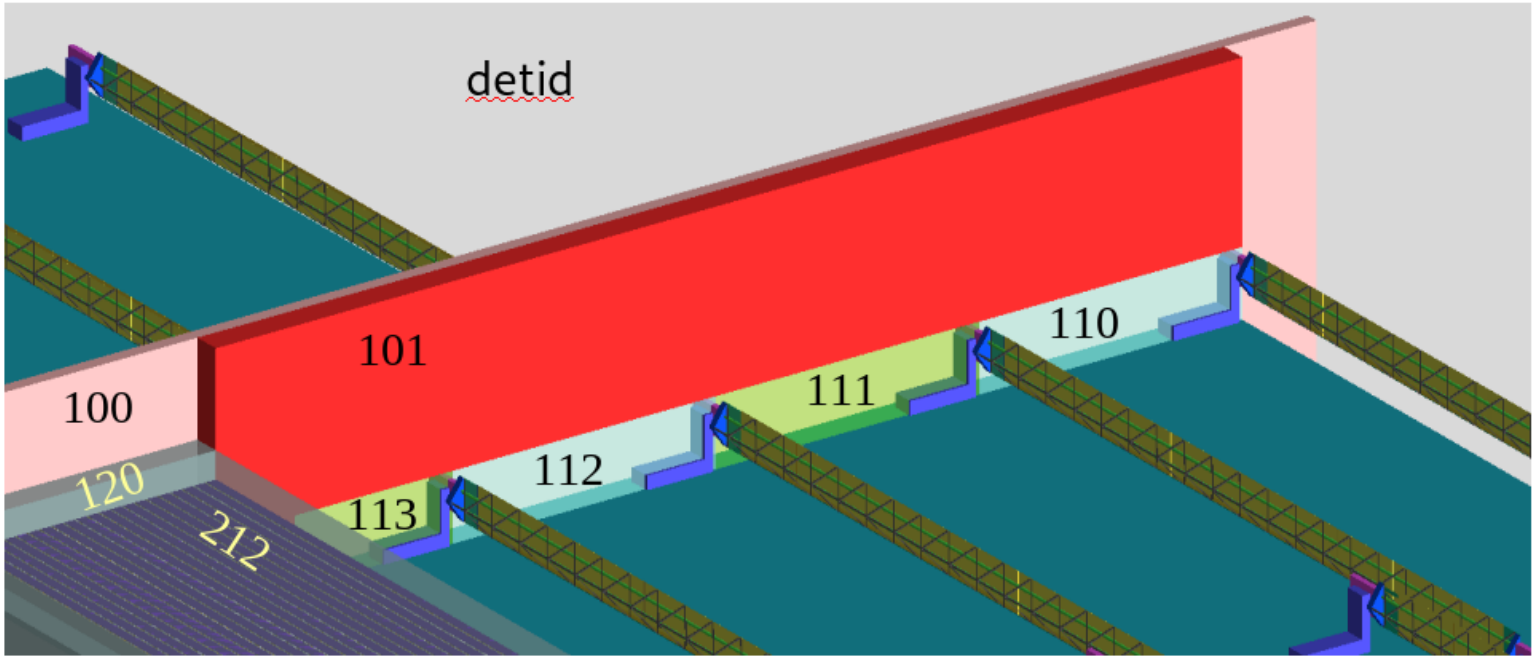






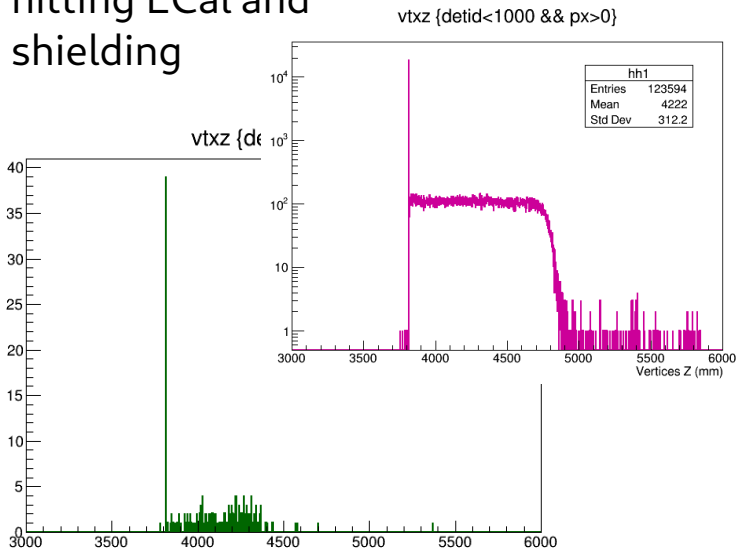
Additional shielding

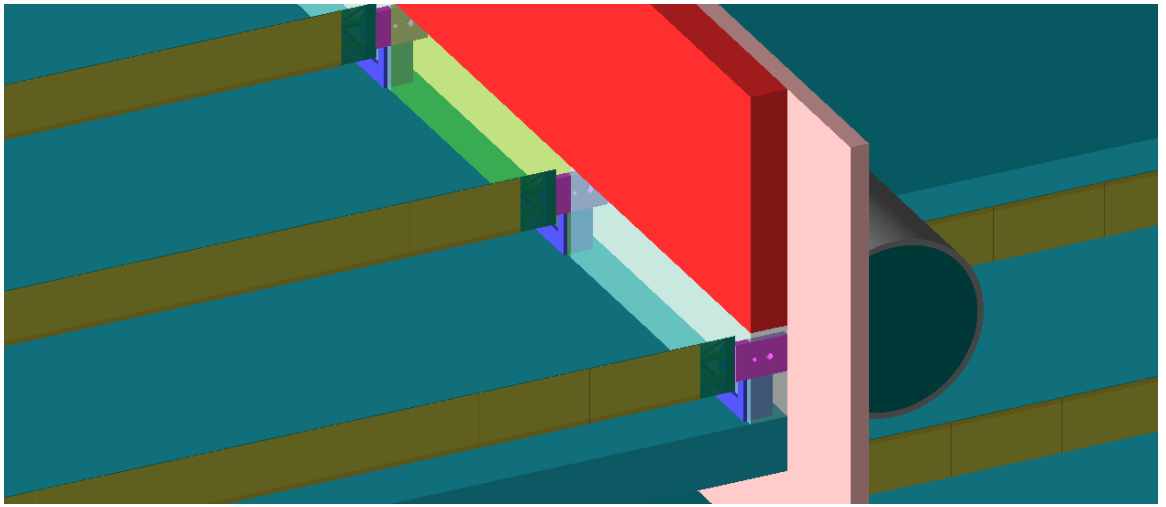
All shielding material is changed to tungsten including ECal casing



~10^3 suppression factor

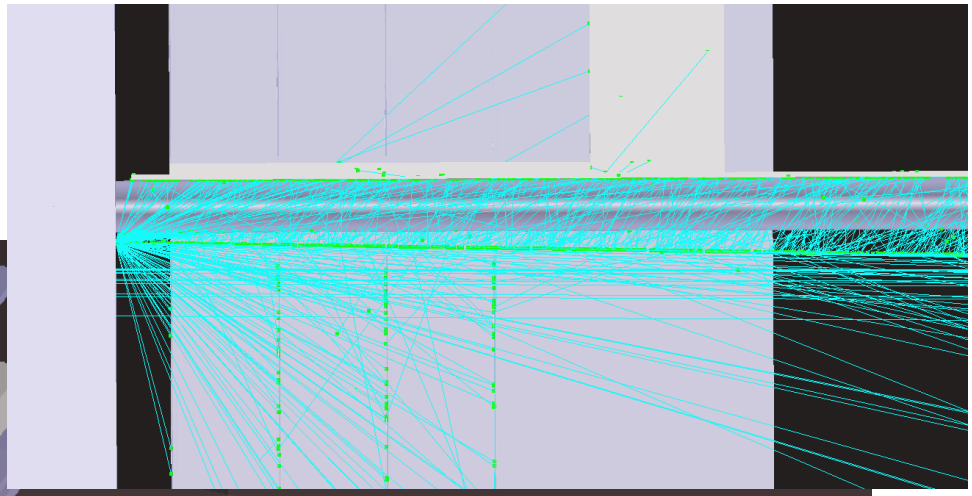
Vertices of particles hitting ECal and shielding

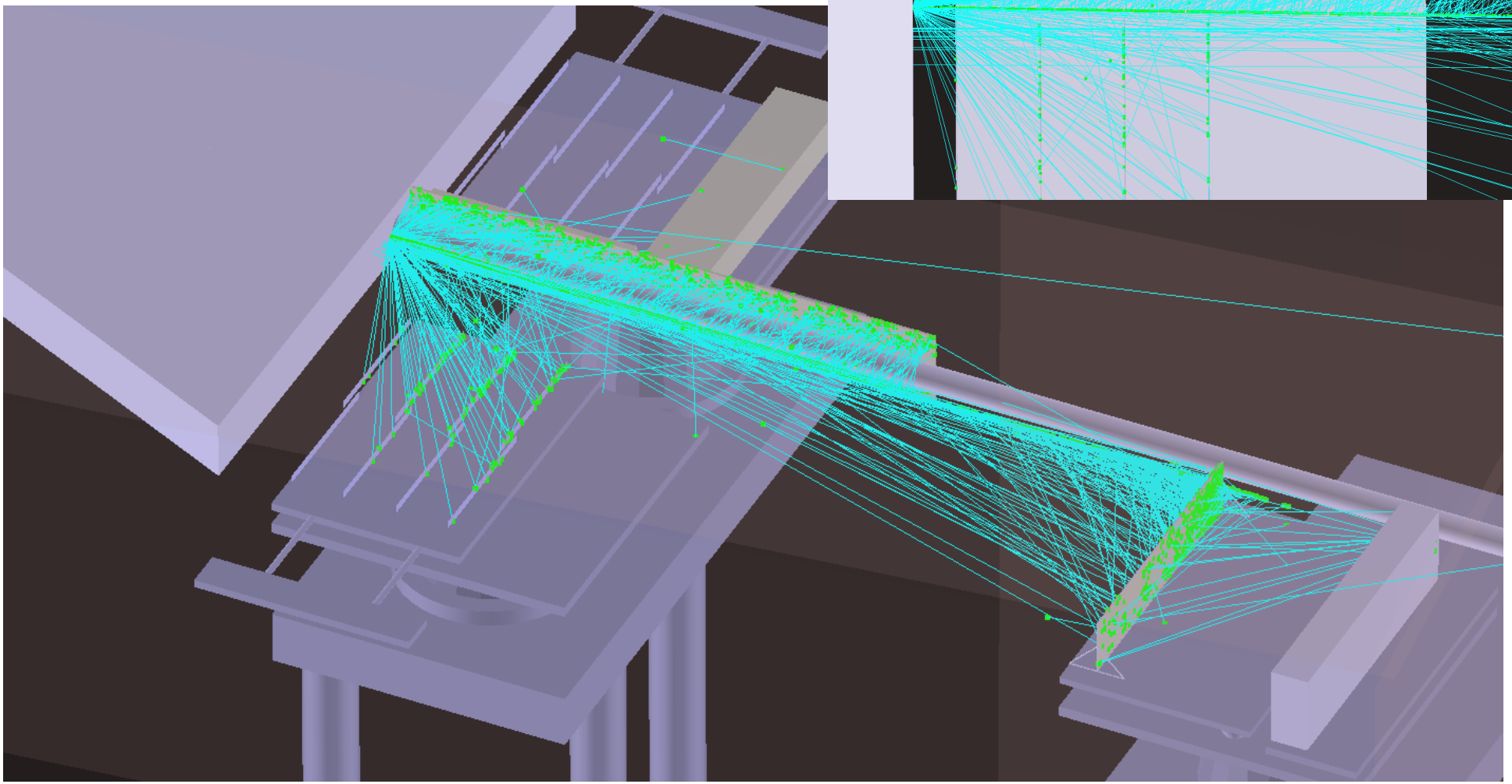




Simulated 100 k electrons of 16.5 GeV

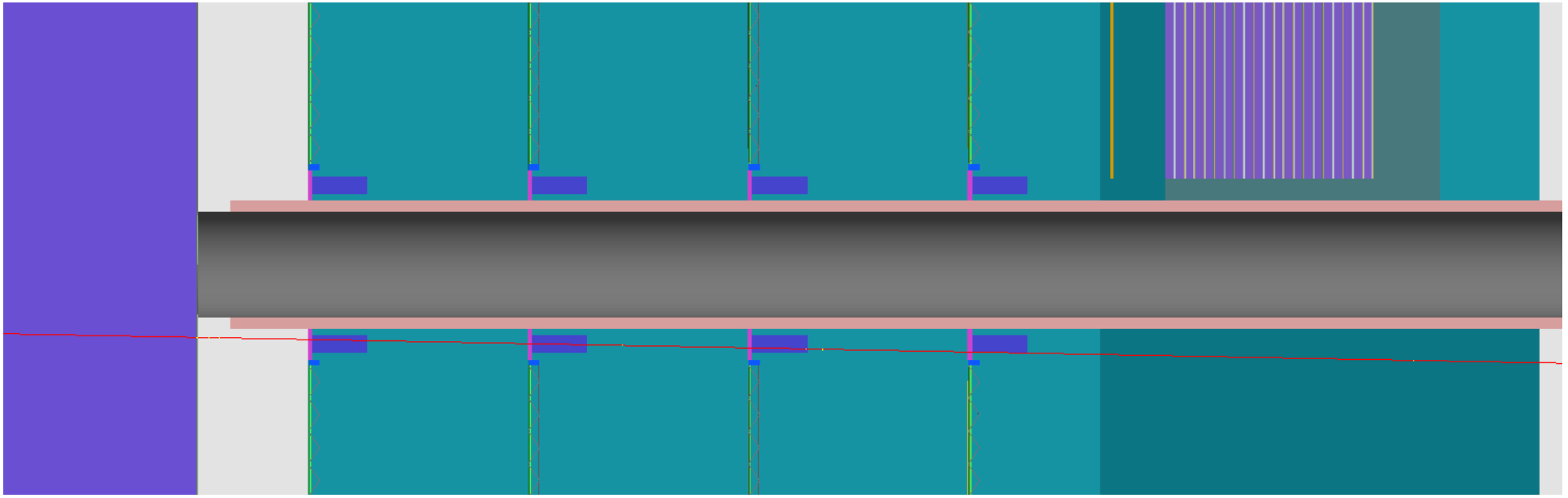
- It would be interesting to check the deposited energy (absorbed dose) in tracking staves on electron side;
- Probably some shielding will be needed;



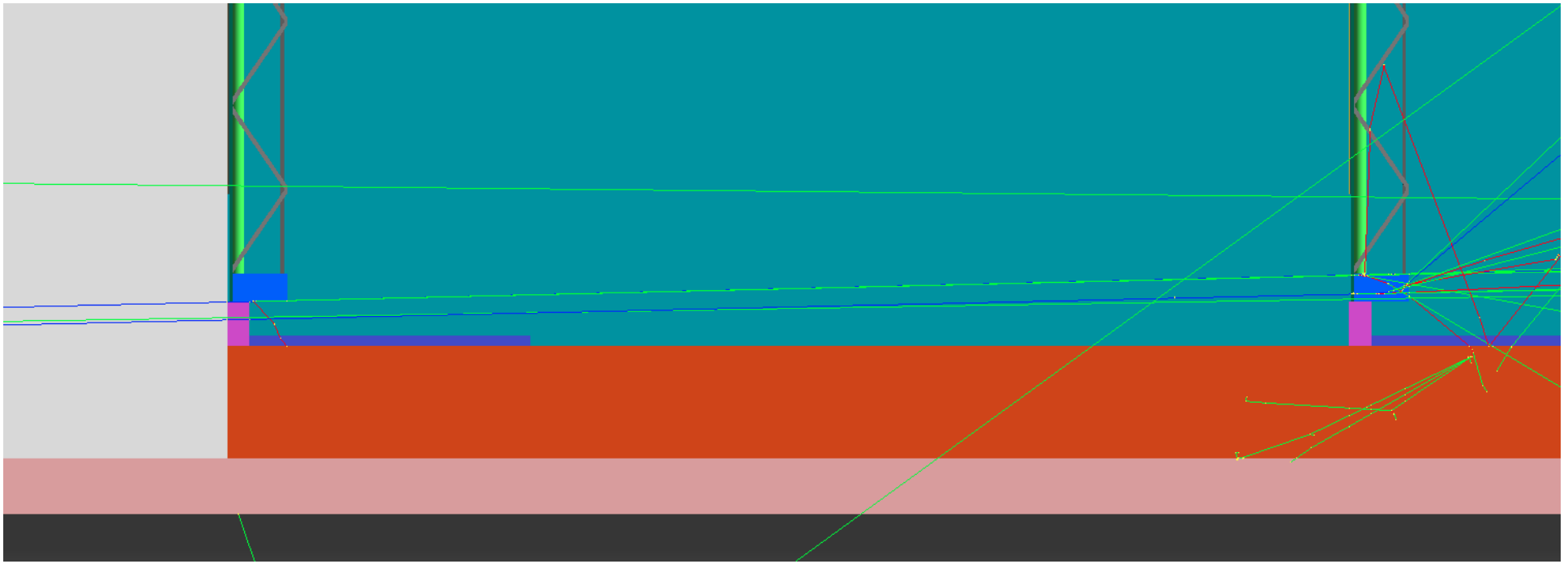


Alternative shielding geometry

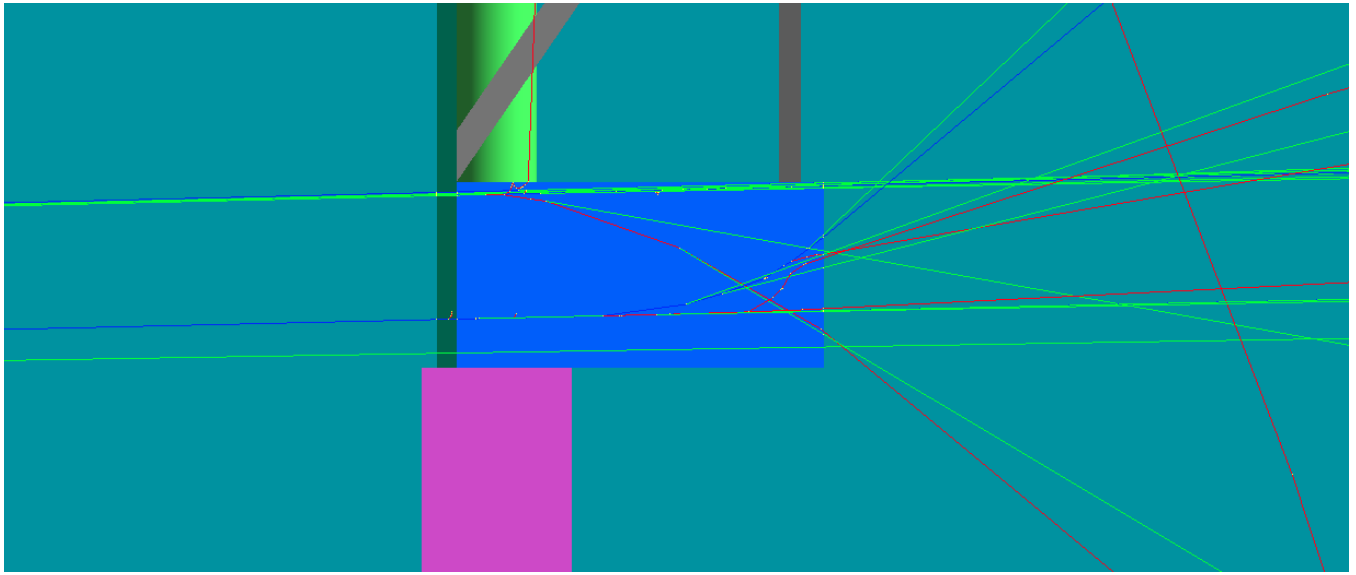
- Implemented;
- Simulation is not run yet.



Change material of the stave endcap



PEEK CA 30:
PolyEtherEtherKetone
with 30% carbon fiber



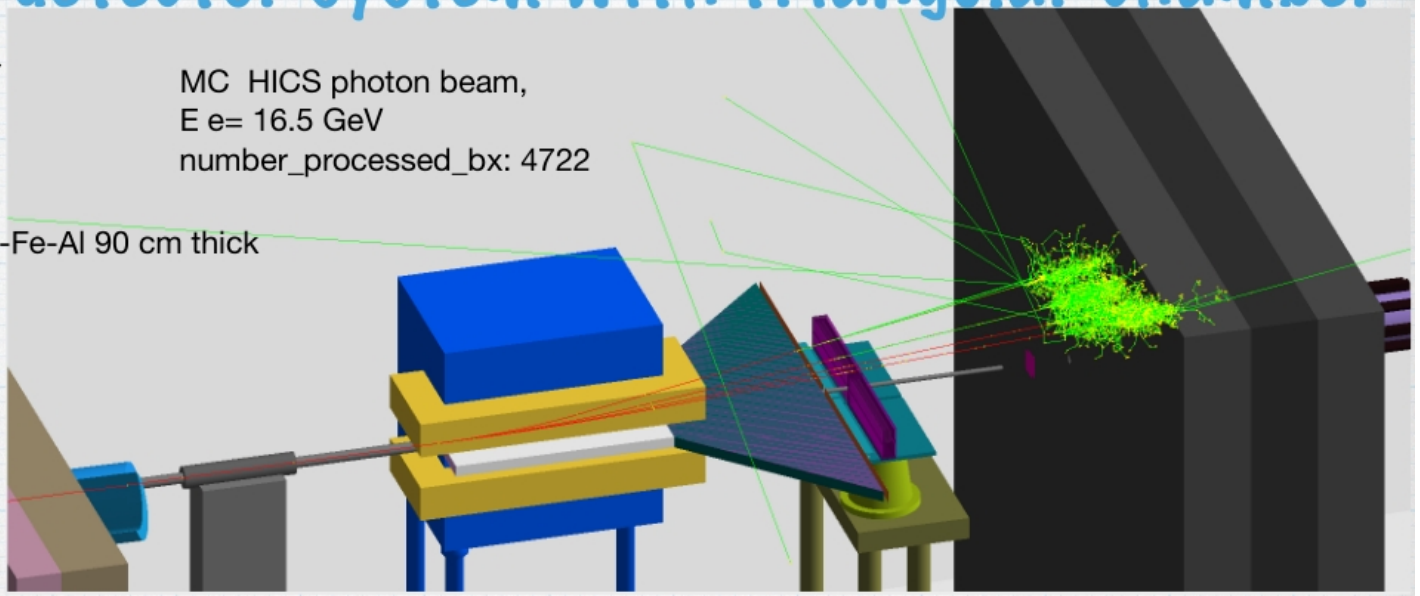
Shielding optimization

Forward detector system with triangular chamber

Beam Pipe 4.2 cm +
Triang chamber
Al window 0.5 mm

MC HICS photon beam,
E e= 16.5 GeV
number_processed_bx: 4722

Shielding - 3-layer Al-Fe-Al 90 cm thick



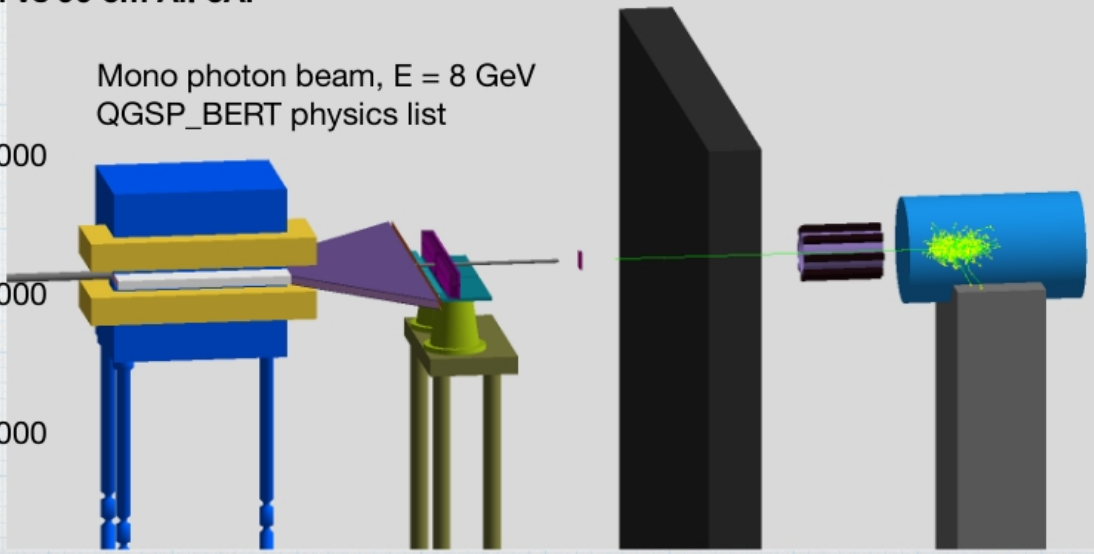
Shielding - Concrete 30 cm vs 80 cm vs 90 cm AlFeAl

Mono photon beam, E = 8 GeV
QGSP_BERT physics list

30 cm shielding
number_processed_events: 68500000
=> 4% of BX

80 cm shielding
number_processed_events: 18290000
=> 1% of BX

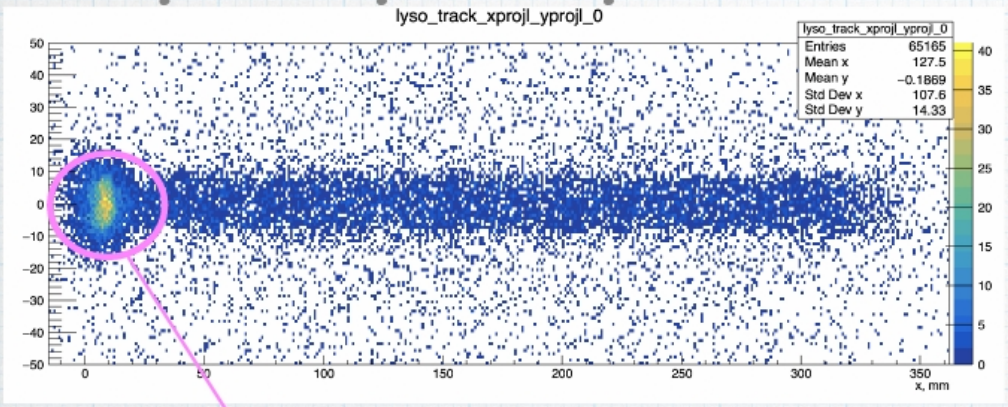
90 cm AlFeAl shielding
number_processed_events: 40100000
=> 2% of BX

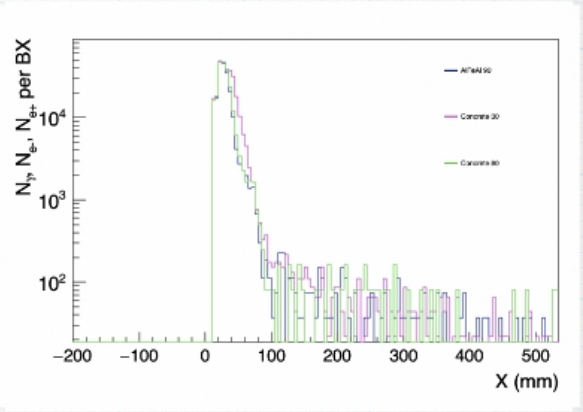


Efect of the shilding

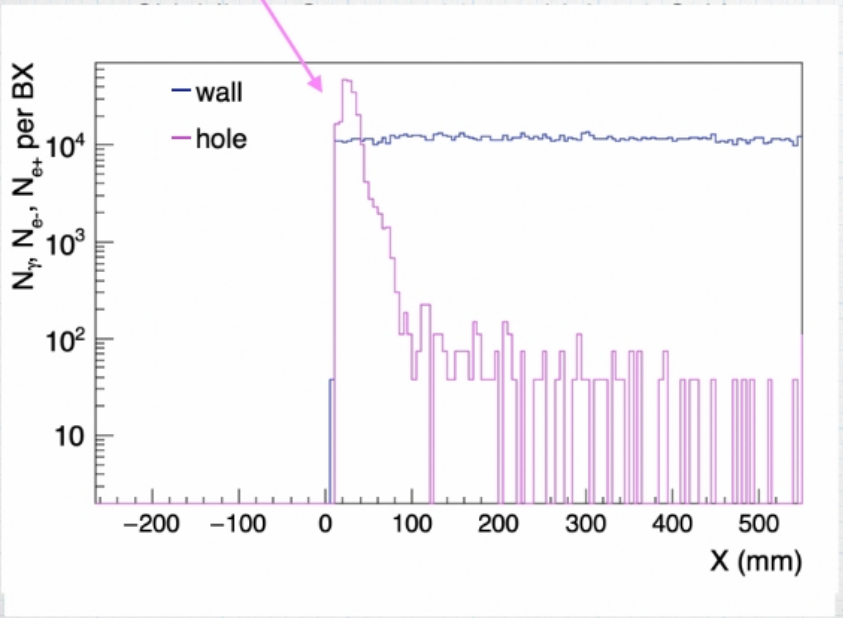
Simulation of 8 GeV Photons

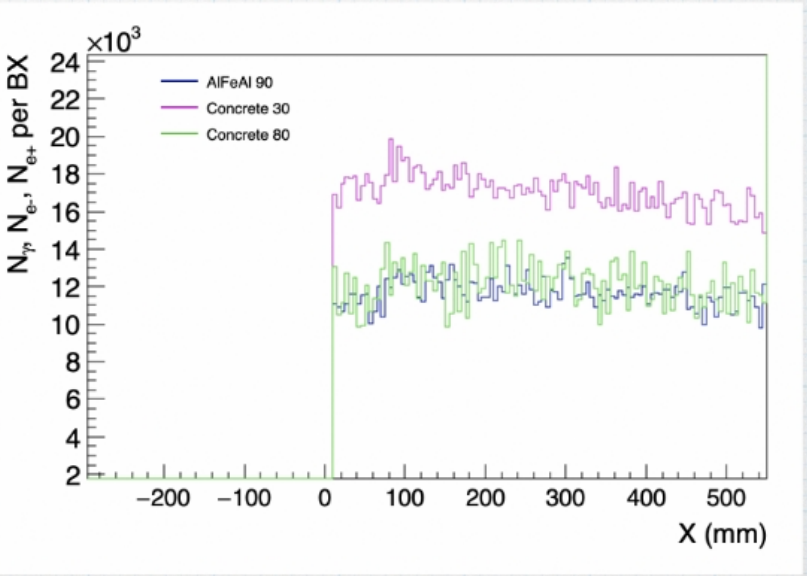
Extrapolated particle positions:





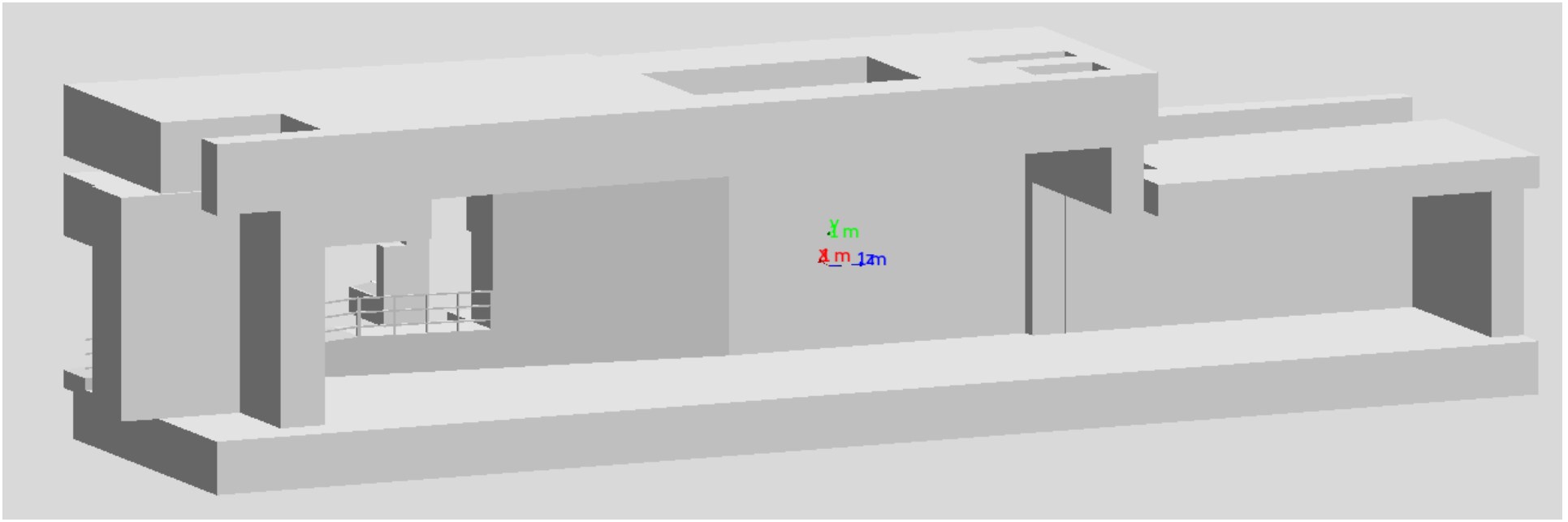
Particles coming to the LANEX through the hole

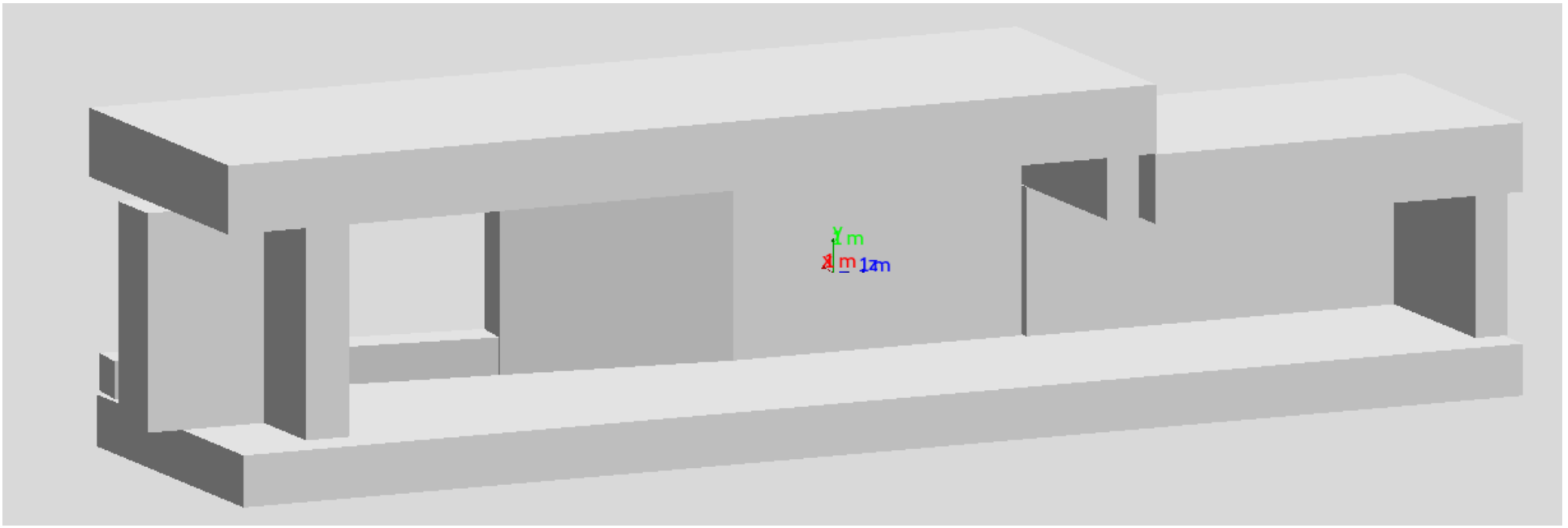




Particles coming to the LANEX through the wall

UG03 STL vs CSG

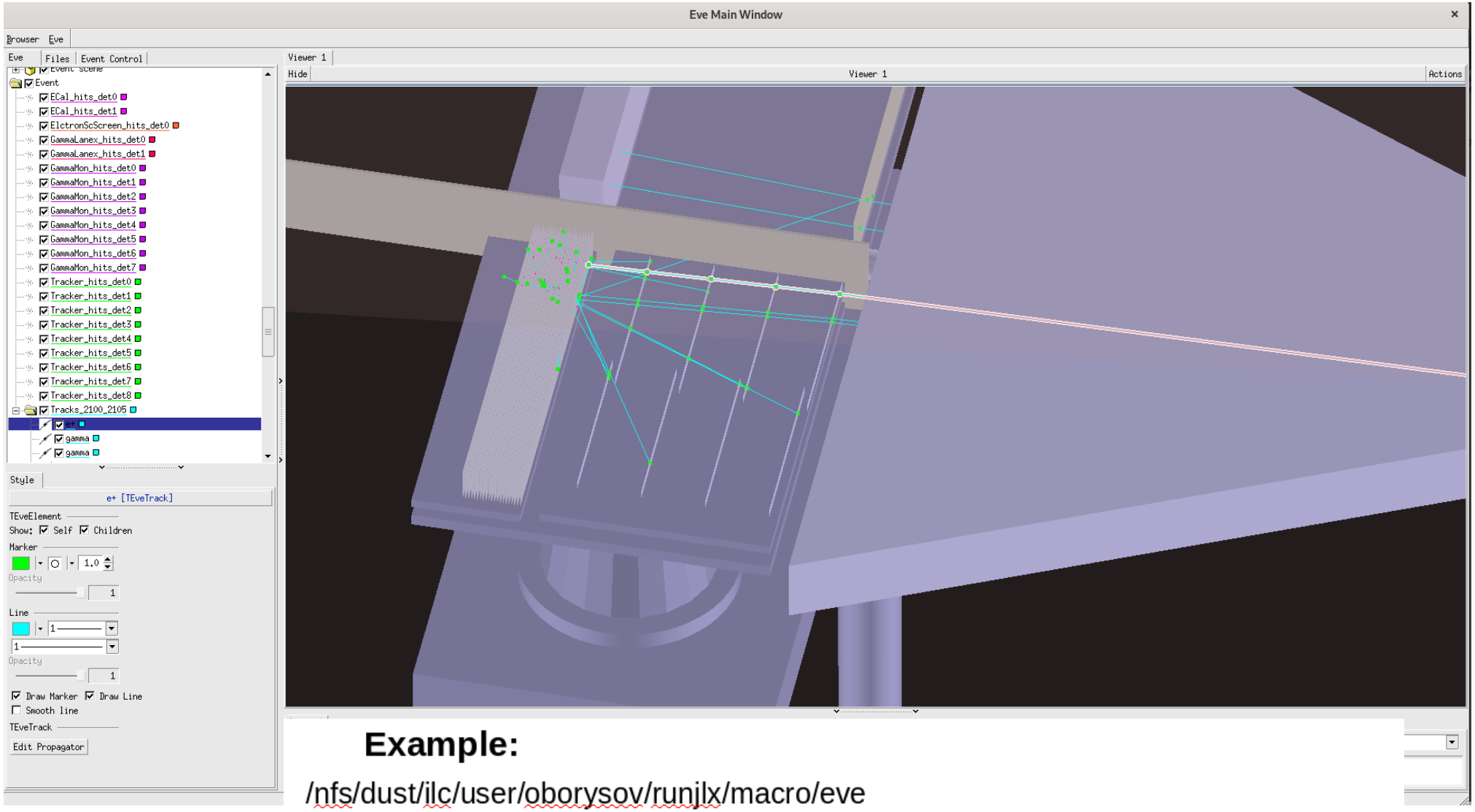




Event display with hits and tracks

Combined hits and tracks of events 2100-2105

w0_3000nm_vc_al_window/luxe_hics_signal_165gev_3000nm_jeti40_cv12_em0_alw_1mu_cut_tv4_hv1_1.root



Example:

/nfs/dust/ilc/user/oborysov/runjlx/macro/eve

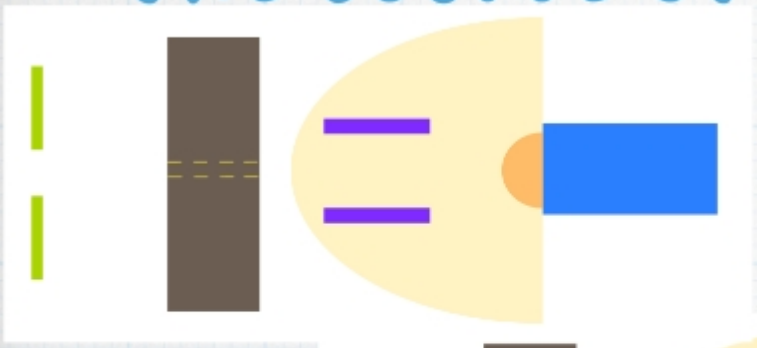
```
root -l lxeve_geom_tree_gui.C'("lxgeomdump_hics_91c0c7ee_nc_dump_no_incerts.gdml",
                               "luxe_hics_signal_165gev_3000nm_jeti40_cv12_em0_alw_1mu_cut_tv4_hv1_1.root")'
```

Summary

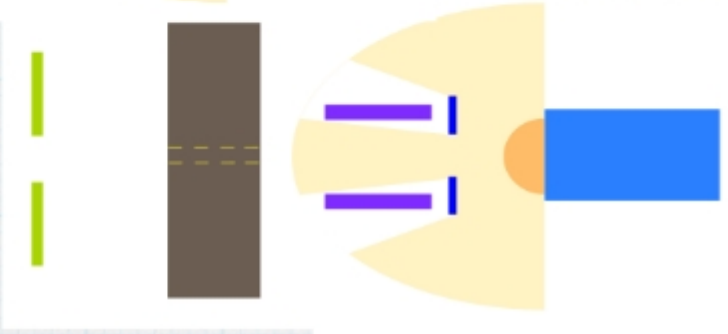
- Magnetic field models based on measurements and functional approximation are implemented;
- HDF5 MC reading is implemented;
- ECal shielding design needs to be finalized;
- Concrete looks good as a material for gamma spectrometer shielding; with a thickness of 0.8 m it shows identical performance as previously used Al-Fe-Al;
- Switched to CSG implementation of the infrastructure;
- Studied diamond and Be as a possible alternative for the window material. Diamond shows almost no change, Be generates ~30% less background, but rather complicated for real usage.
- Several geometry components need to be implemented or modified:
  - Interaction chamber,
  - Profiler,
  - Vacuum chamber;
  - Add electronics to Ecal;
  - Magnet

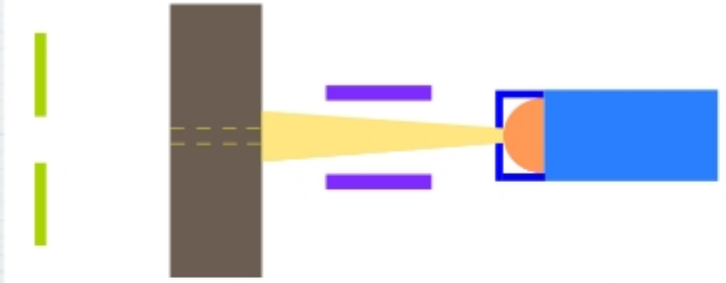
Backup

The source of background in FDS

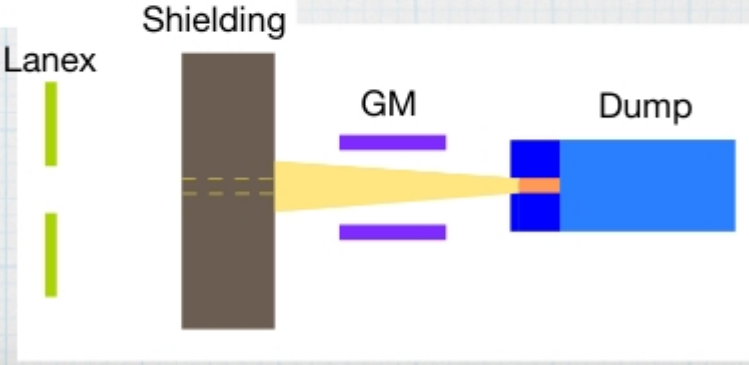


* Background in the photon spectrometer depends on combined influence of the shielding and the design of the beam dump





Gamma dump modifications



Tracks xy, rear surface

Shielding - Concrete 80 cm thick , 8 GeV