LUXE GEANT4 Simulation towards comparison with FLUKA

Oleksandr Borysov

LUXE S&A Meeting
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Geant4 simulation

- Simulation with γ-laser geometry;
- 2.3499e+07 e- of 16.5 GeV (~1.57% BX).

Geant4 offers **Command-based scoring**

- It is realized as parallel geometry;
- Step size limited by the histogram bin;
- Each histogram is saved to ascii file;
- Long simulation time;
- Huge output files and it takes substantial time to save them (2h of simulation and 0.5h writing);

```
##########################################
/score/create/boxMesh boxMesh_XFELDumpPLC
#
/score/mesh/boxSize 2000.0 1500.0 800.0 mm
/score/mesh/translate/xyz  -3400 -1478 -13500 mm
/score/mesh/rotate/rotateY  0.115366 radian
/score/mesh/nBin 400 300 160
#
/score/quantity/cellFlux gFlux
/score/filter/particle gammaFilter gamma
#
/score/close
```

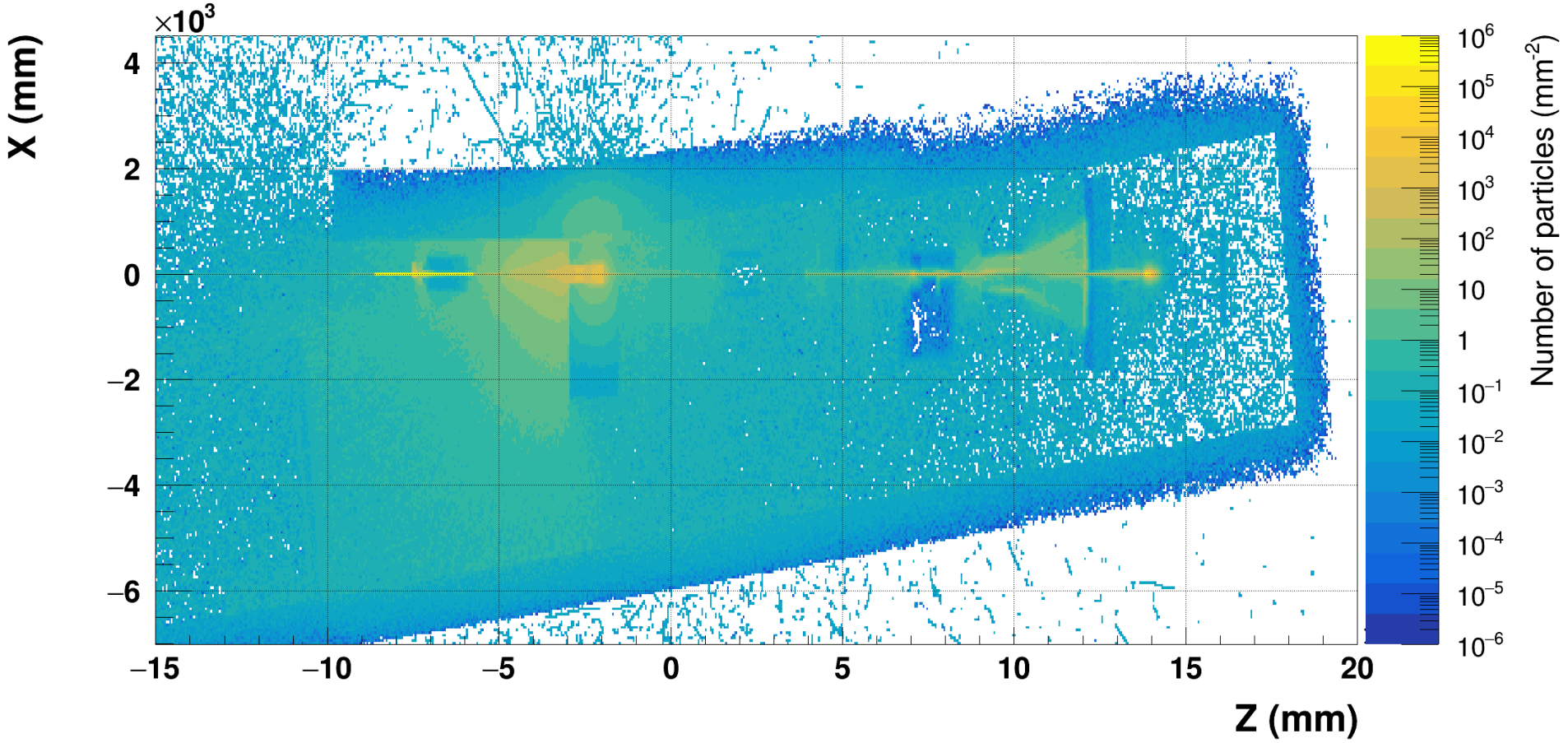
Another approach was used:

- The area of interest was covered by regular 3D histograms;
- In UserSteppingAction action function each step was tested to belong to the region of 3D hist;
- Each bin was filled along the step;
- 10 times faster and final histograms are in the same root file (with TTrees).

In both approaches the fluence histograms are filled with a weight: L/V,
where L – step length within the bin of volume V. It gives units 1/area. (mm^{-2}).

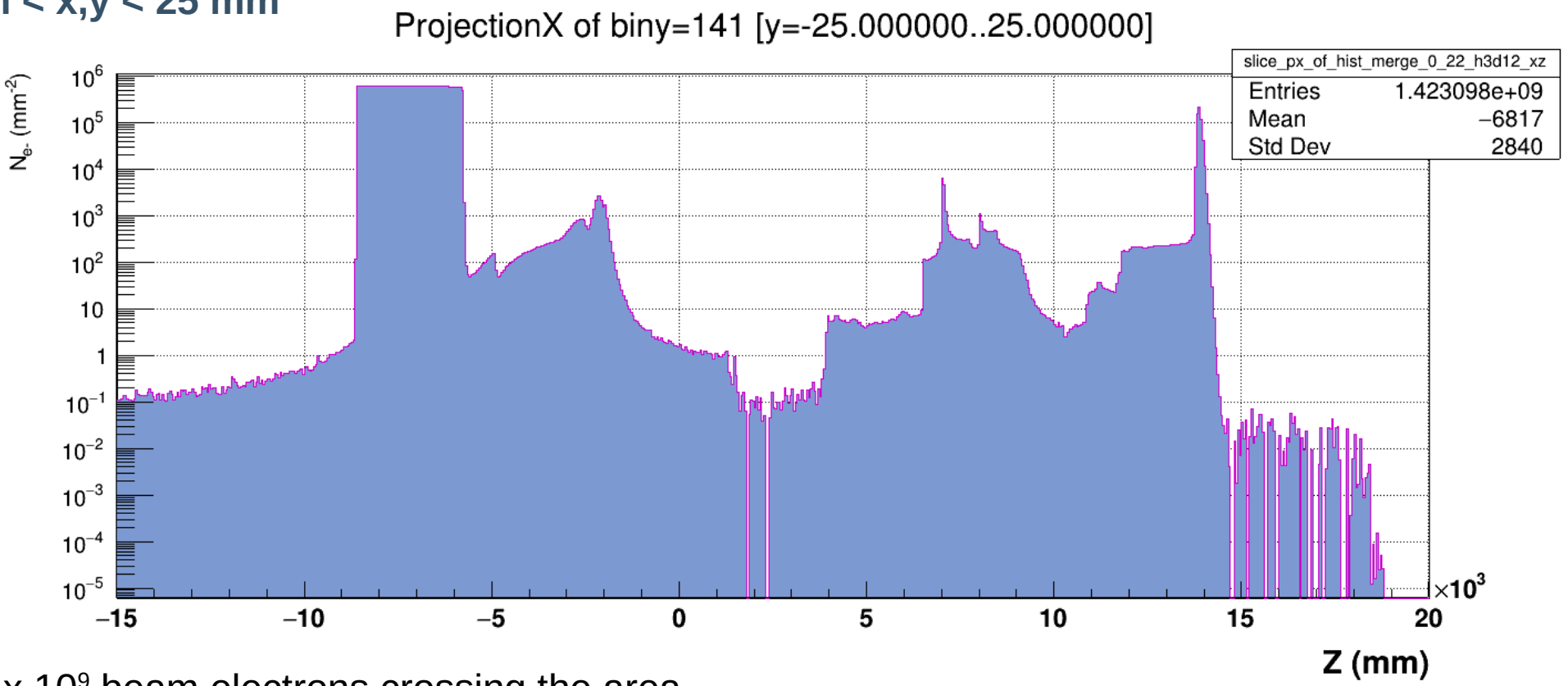
Electrons fluence in the beam line plane

-25 mm < y < 25 mm



Electrons fluence along the beam line

-25 mm < x,y < 25 mm



1.5 x 10^9 beam electrons crossing the area of the bin 50 by 50 mm^2 give fluence:

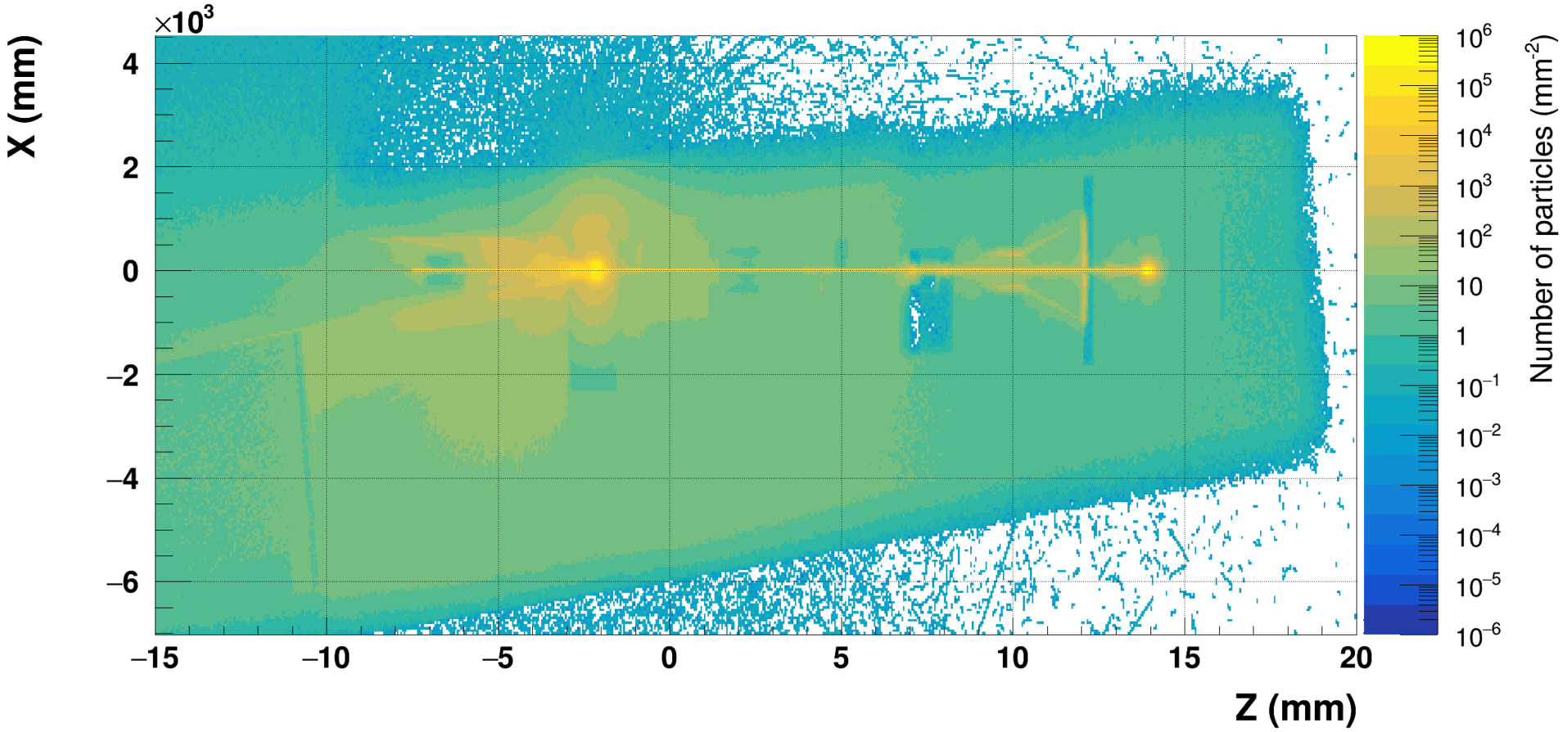
1.5 x 10^9 / 2500 = 600000

- It matches well the numbers in the histogram downstream electron initial position and till the magnet deflects them.
- Then they “move” to another slice of the 3D histogram.

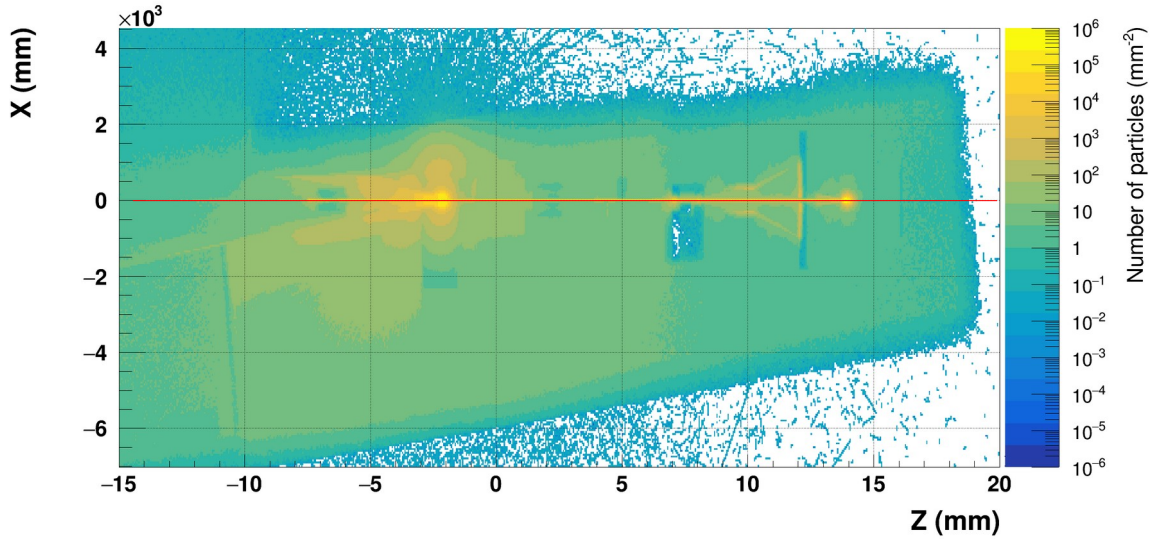
…
fSumw[125][141]=1.8042, x=-8775, y=0, error=0.208542
fSumw[126][141]=1.96096, x=-8725, y=0, error=0.213718
fSumw[127][141]=2.14466, x=-8675, y=0, error=0.223576
fSumw[128][141]=117.076, x=-8625, y=0, error=0.231883
fSumw[129][141]=599888, x=-8575, y=0, error=123.75
fSumw[130][141]=600003, x=-8525, y=0, error=123.773
fSumw[131][141]=600003, x=-8475, y=0, error=123.773
fSumw[132][141]=600003, x=-8425, y=0, error=123.774
fSumw[133][141]=600004, x=-8375, y=0, error=123.774
…

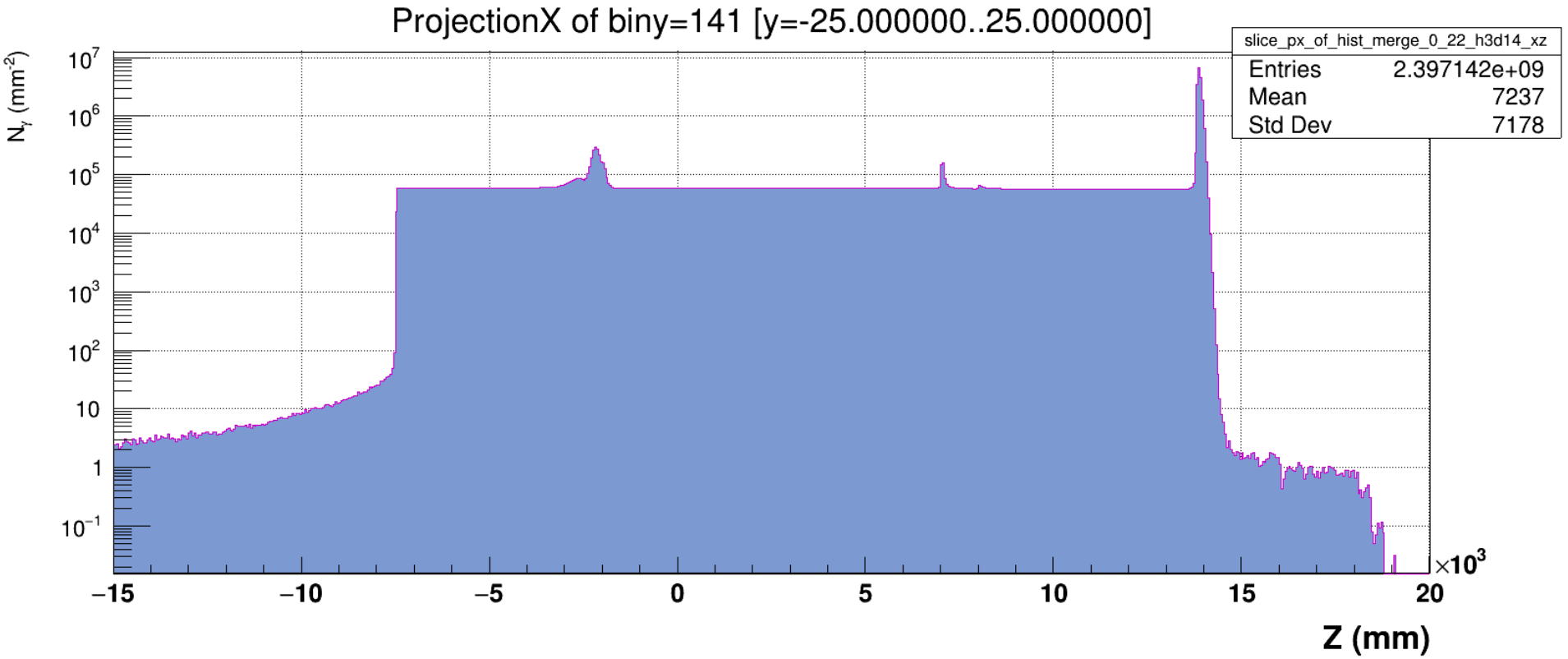
Photon fluence in the beam line plane

-25 mm < y < 25 mm



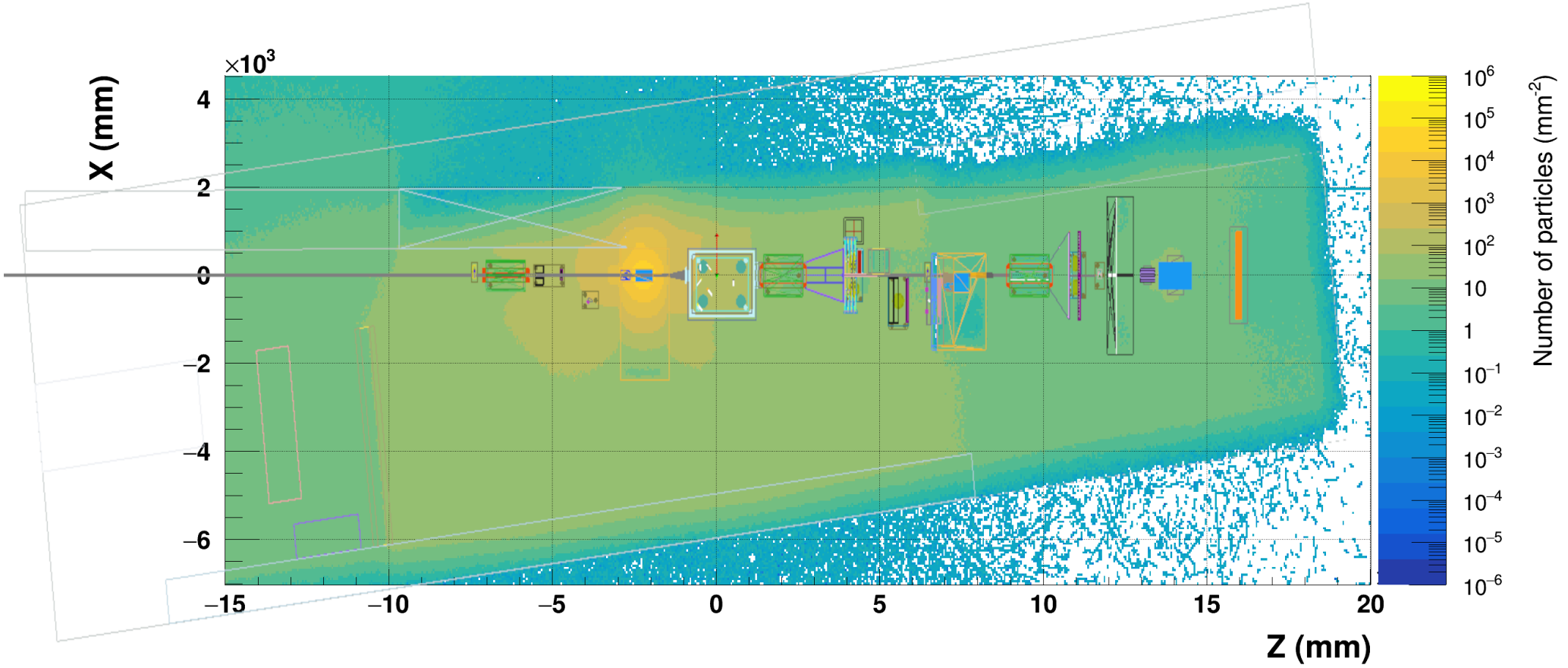
Photon fluence along the beam line





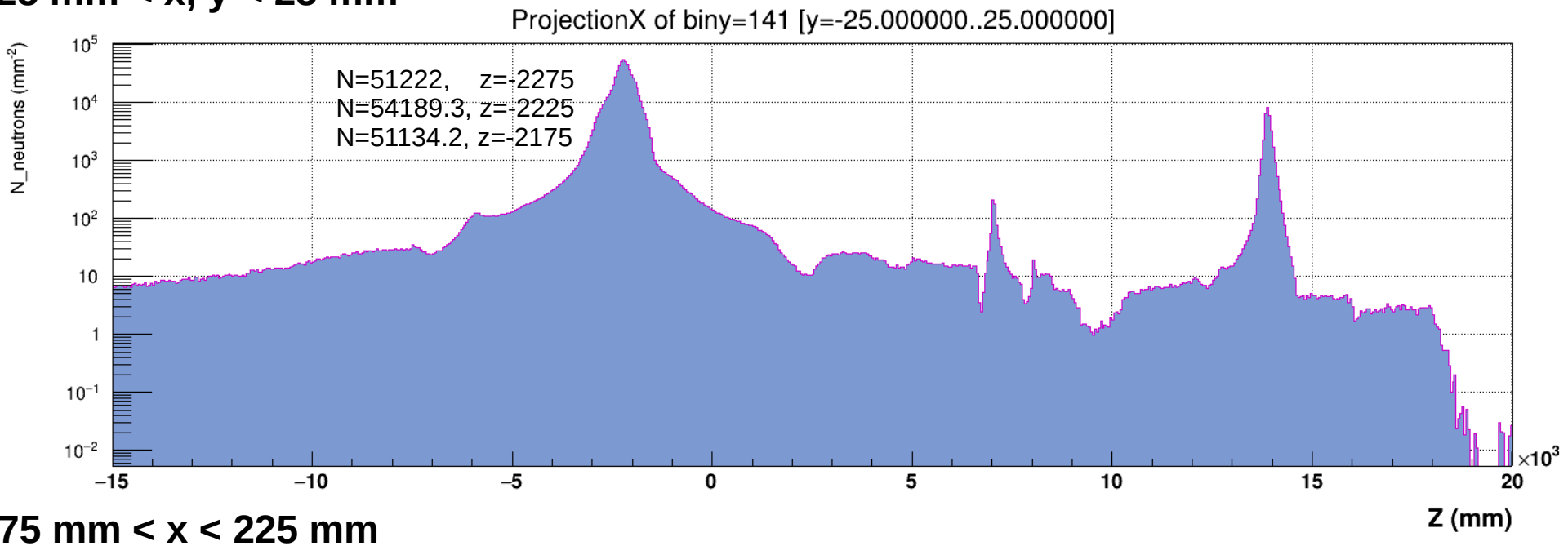
Neutron fluence in the beam line plane

-25 mm < y < 25 mm

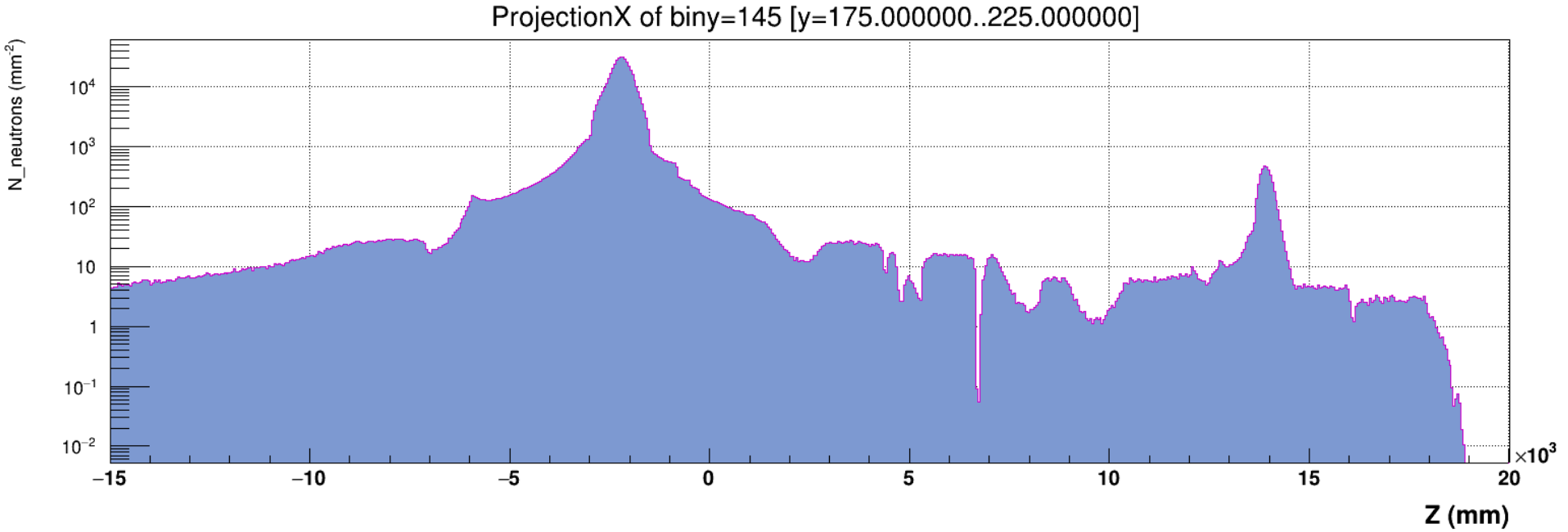


Neutron fluence

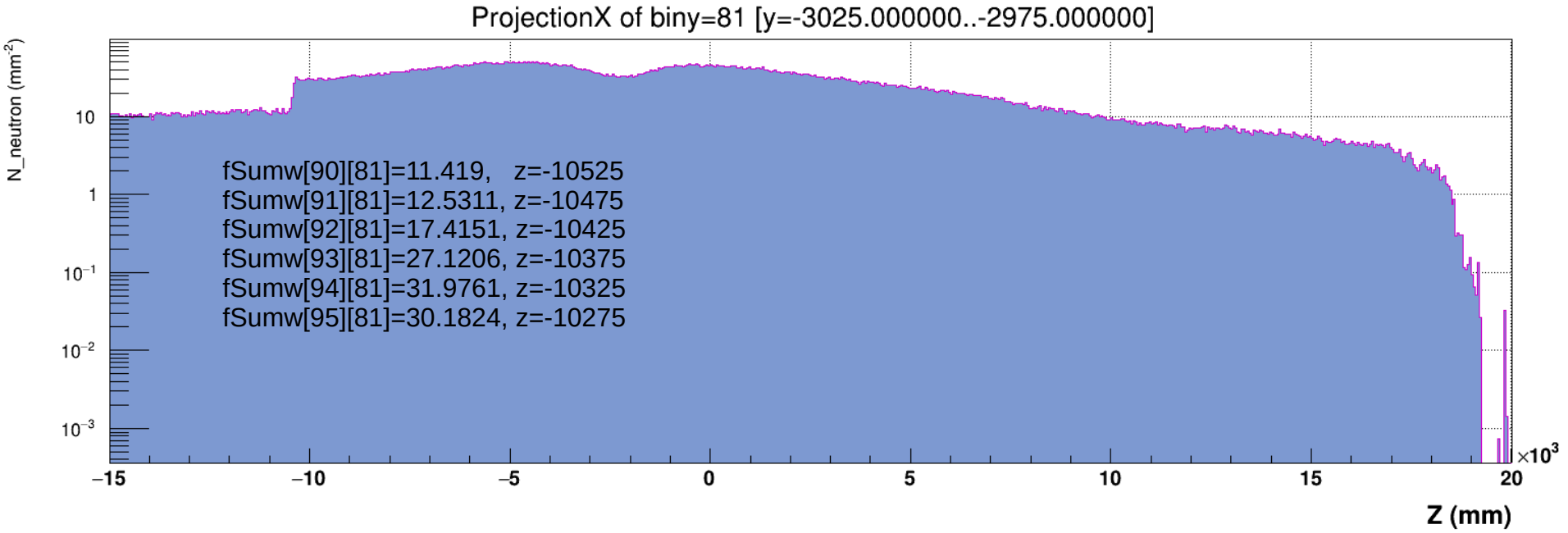
-25 mm < x, y < 25 mm



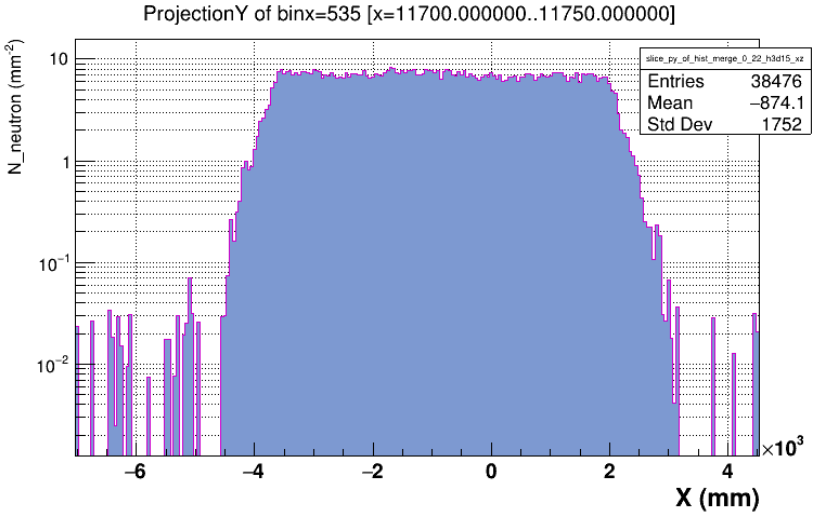
175 mm < x < 225 mm

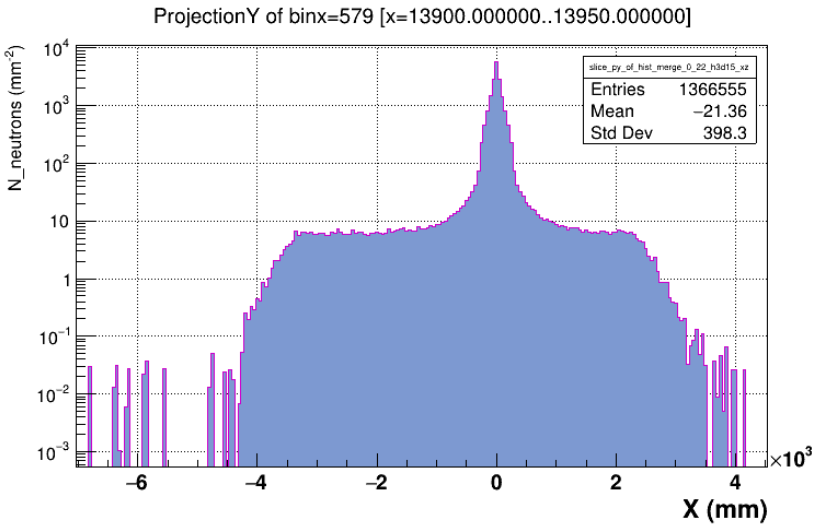


Neutron fluence, projections in y and x directions



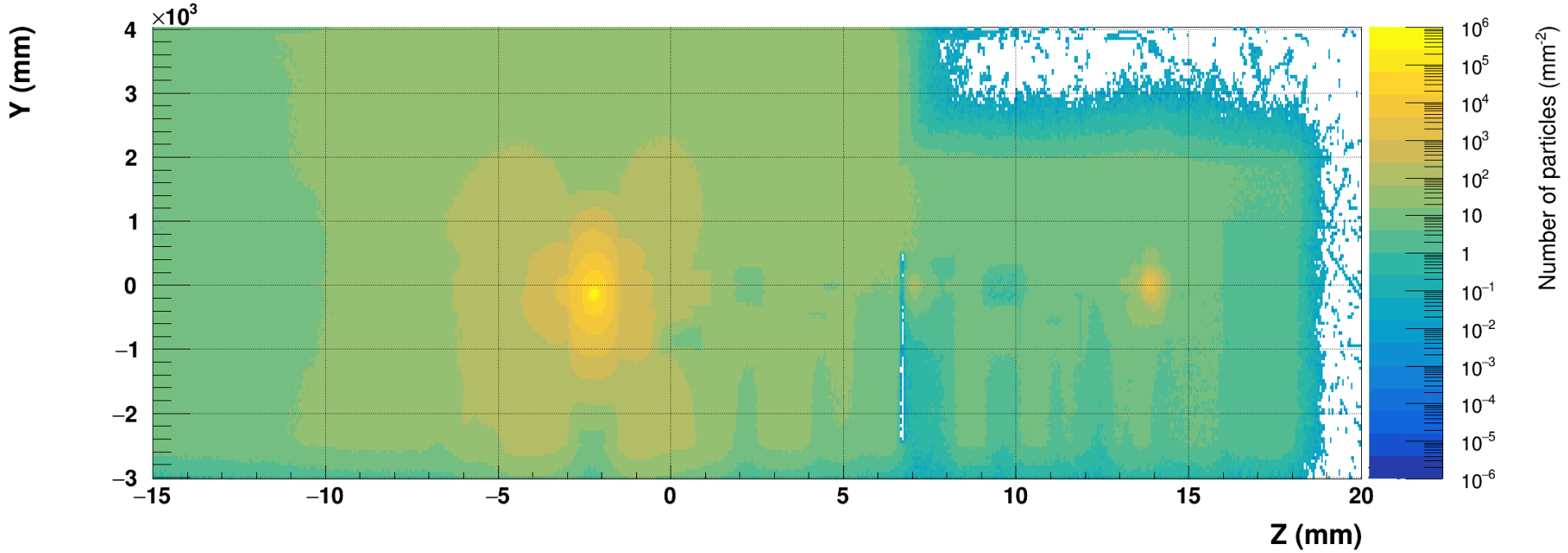
Projections in x direction z = 11.7 m and z = 13.9 m in beam plane y = 0.

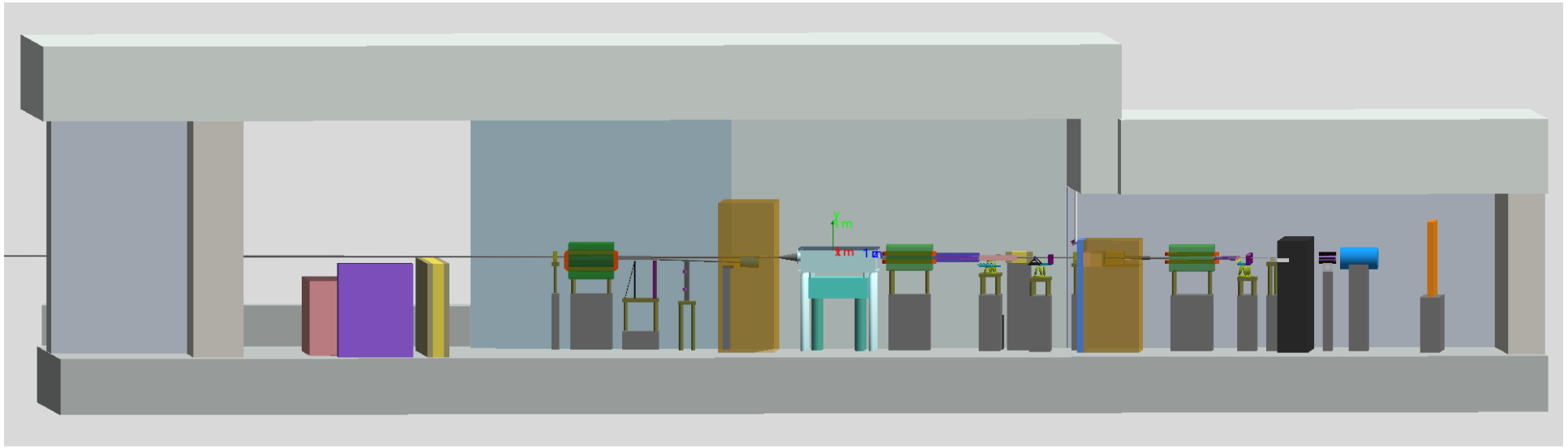




Neutron fluence in the beam line plane

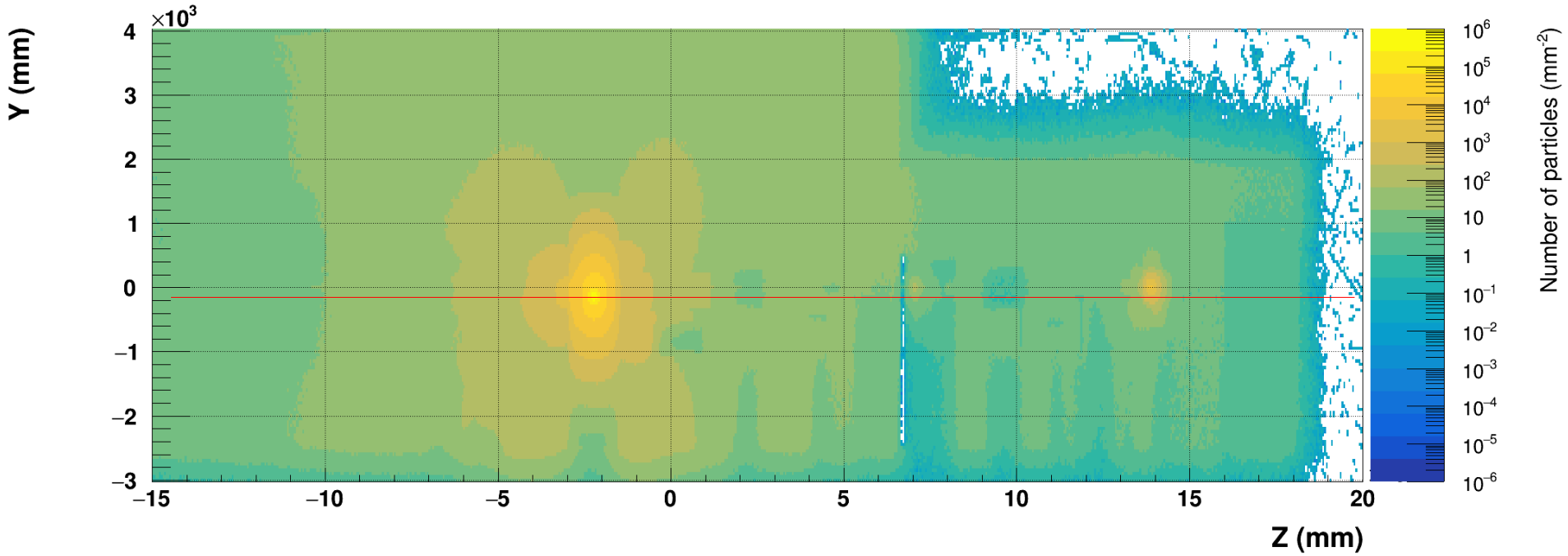
-25 mm < x < 25 mm

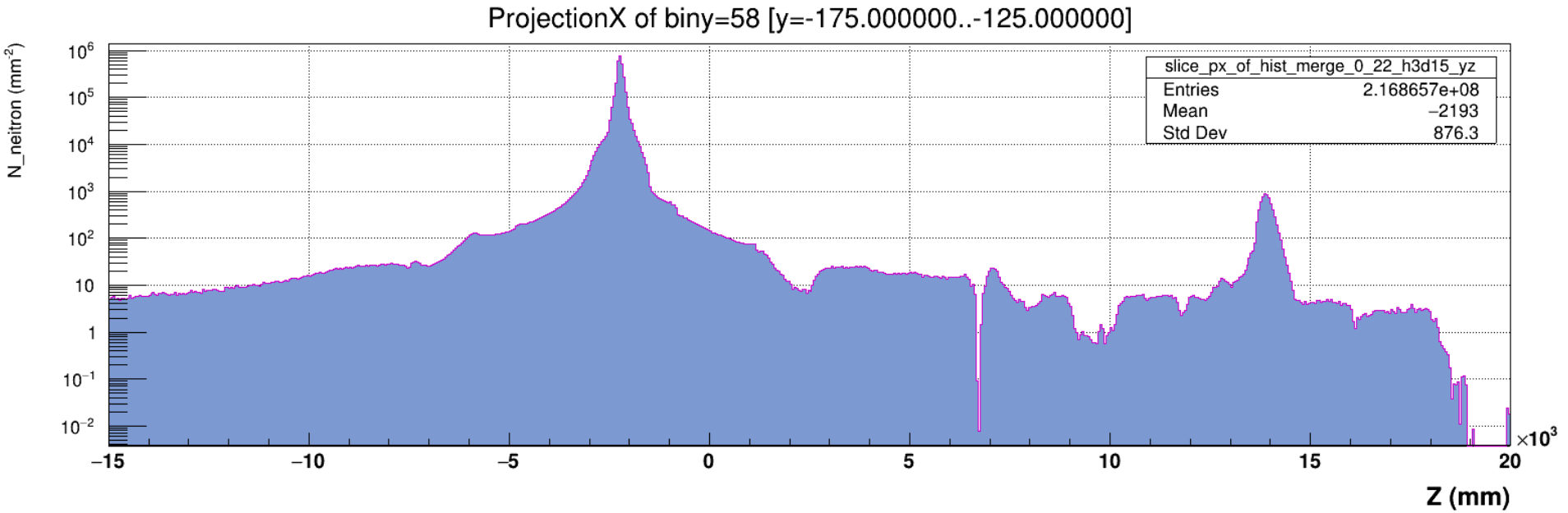




Neutron fluence in the beam line plane

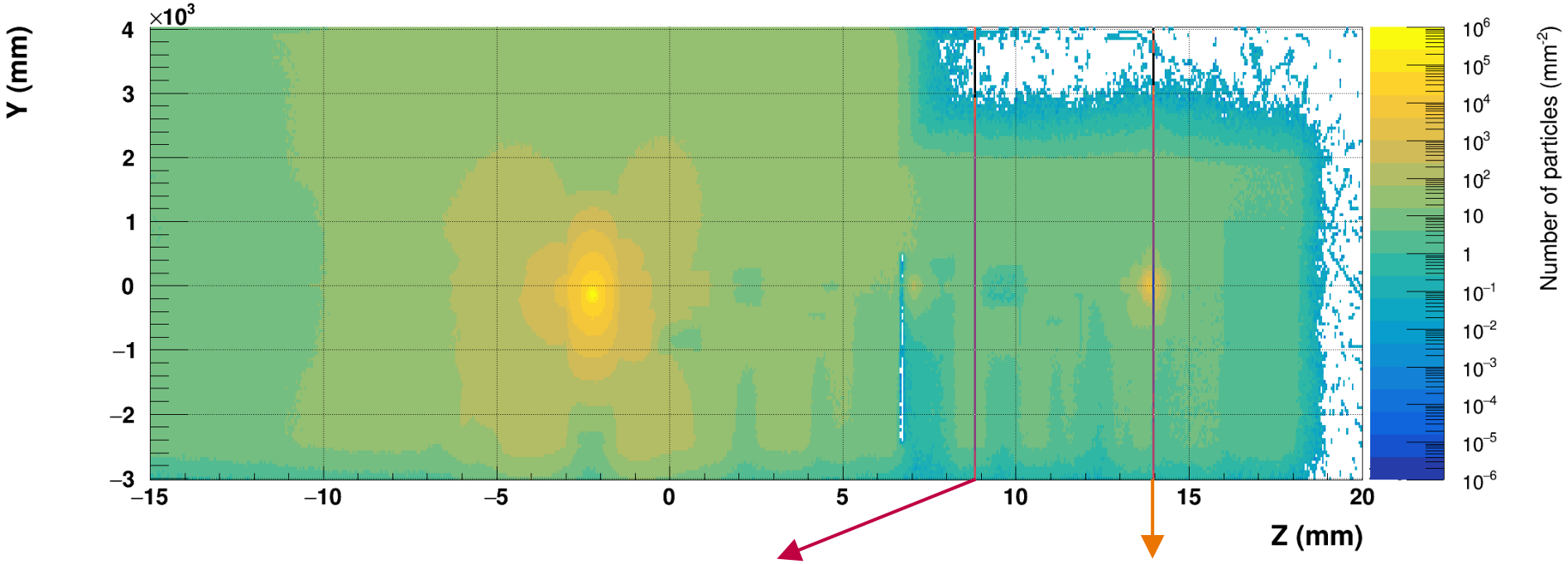
-25 mm < x < 25 mm

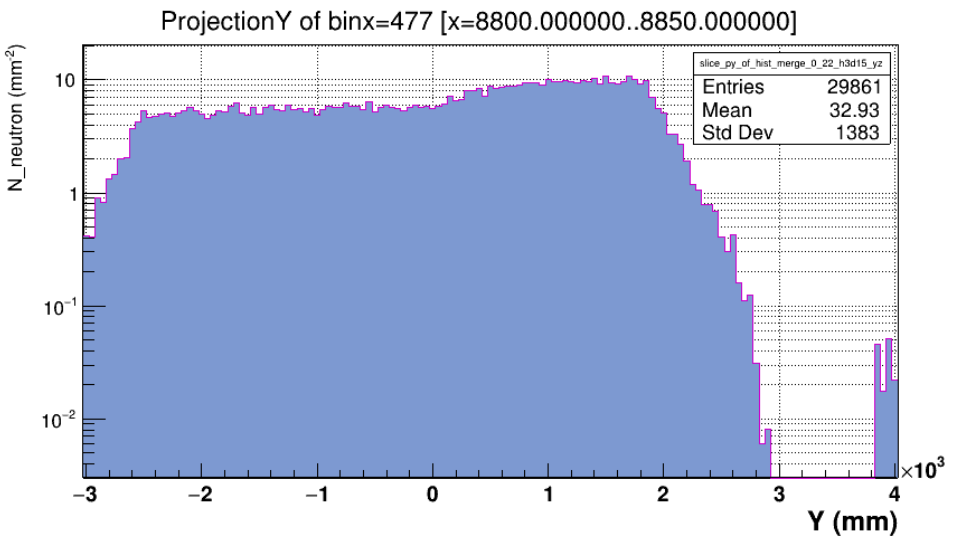


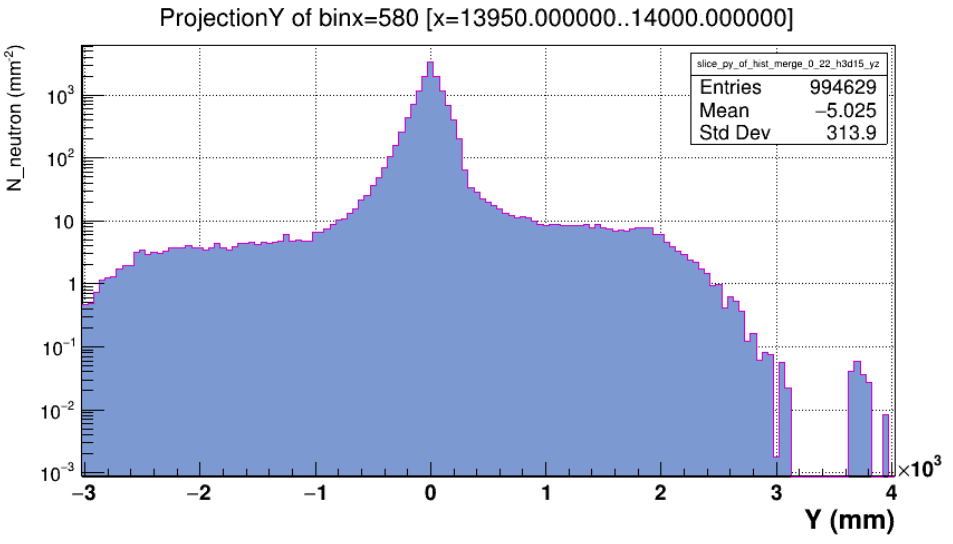


Neutrons, projection CeilingB

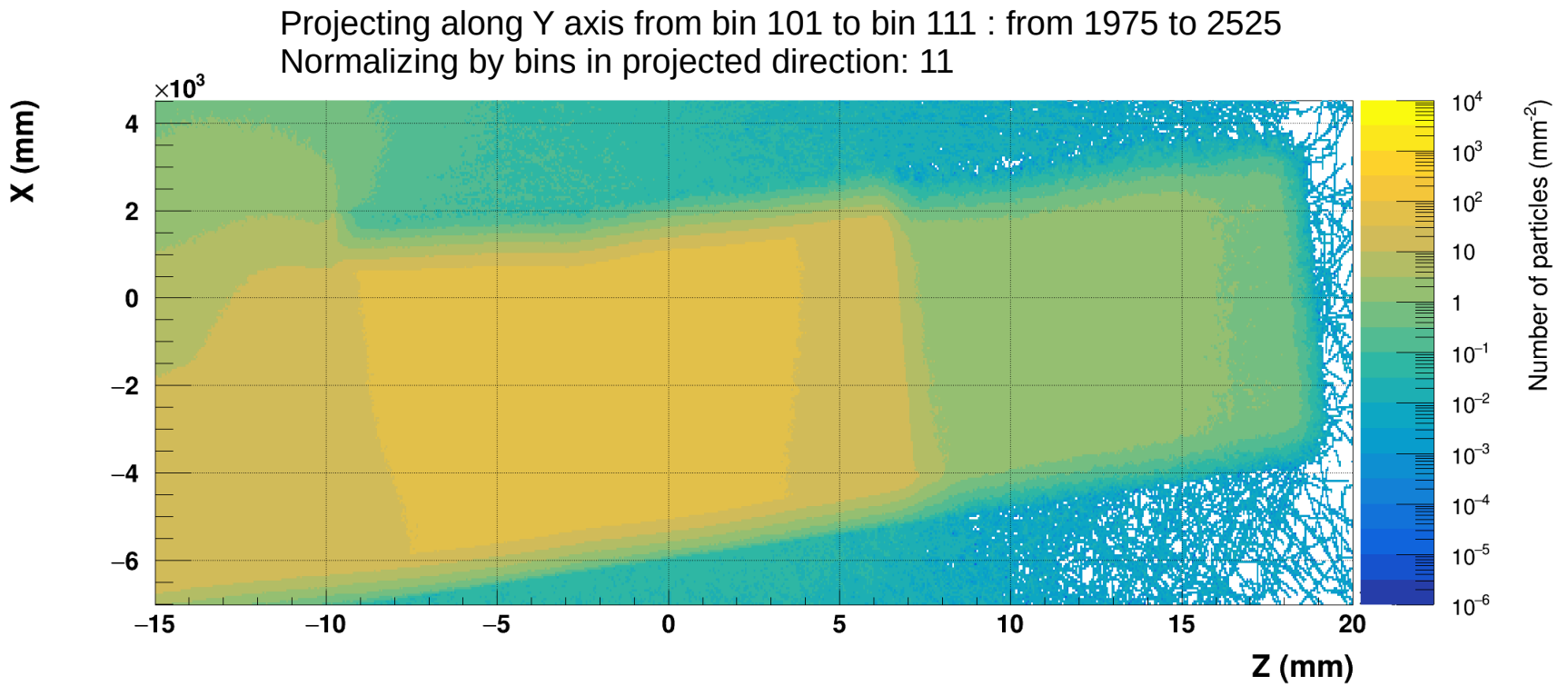
-25 mm < x < 25 mm

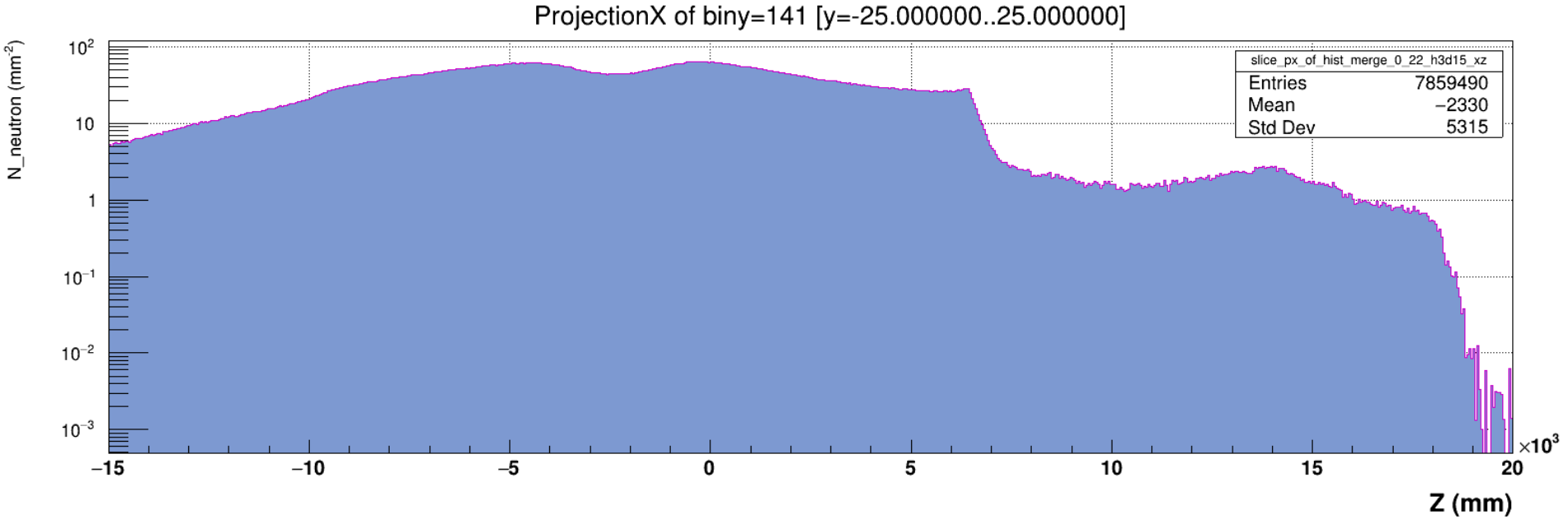




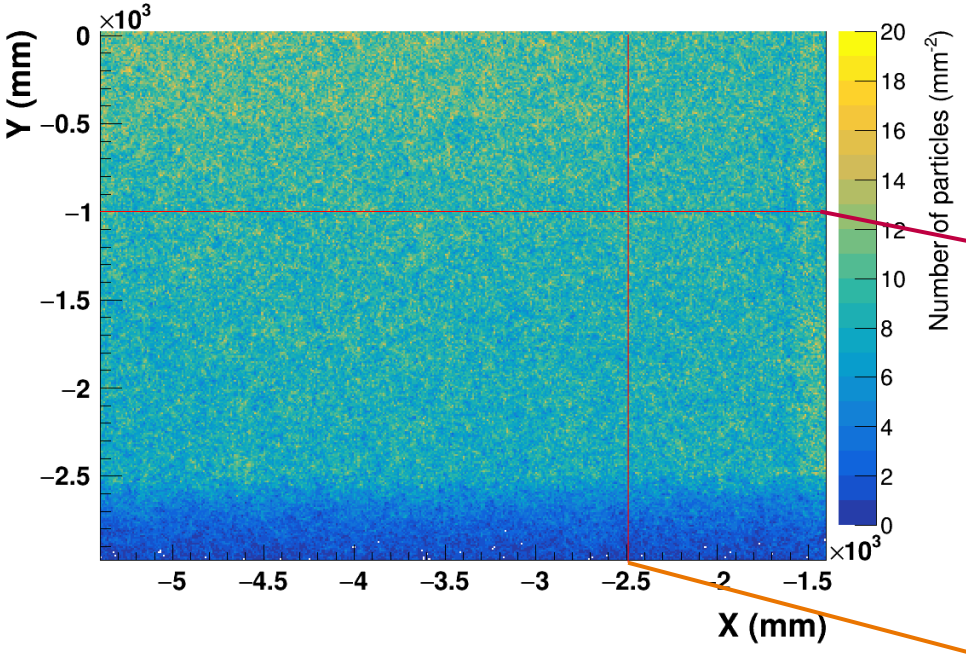


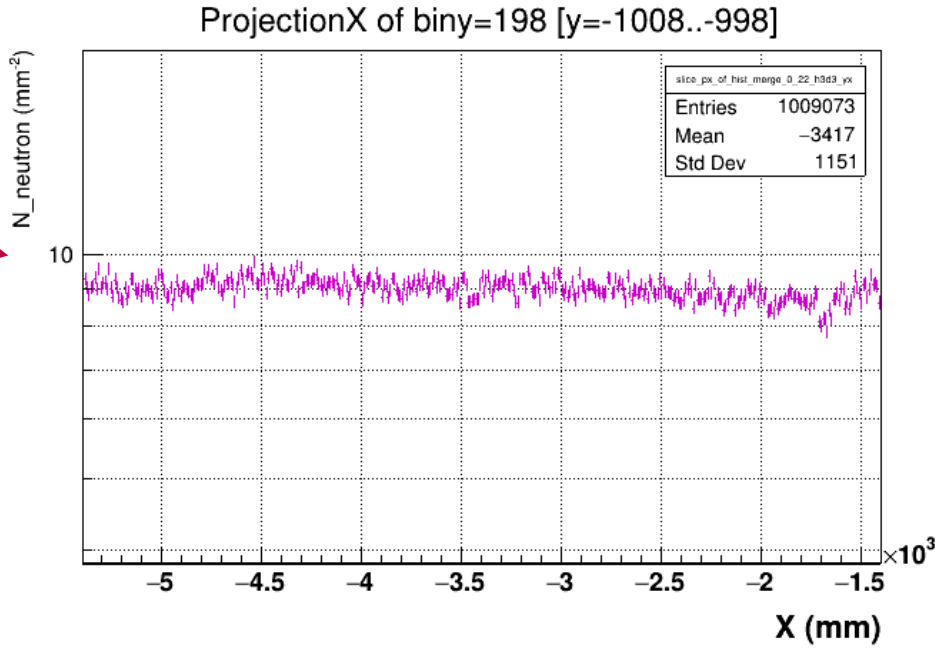
Neutrons, projection CeilingB

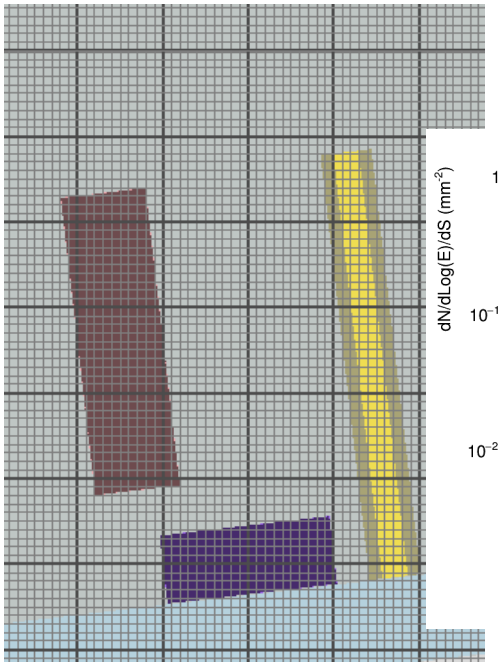


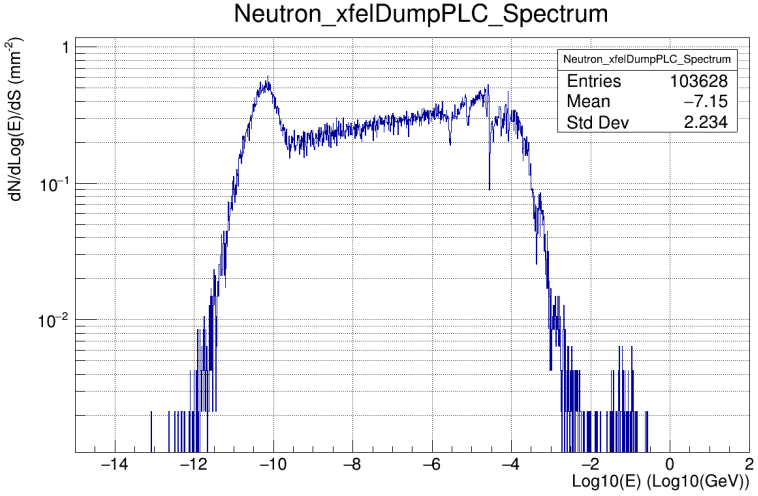


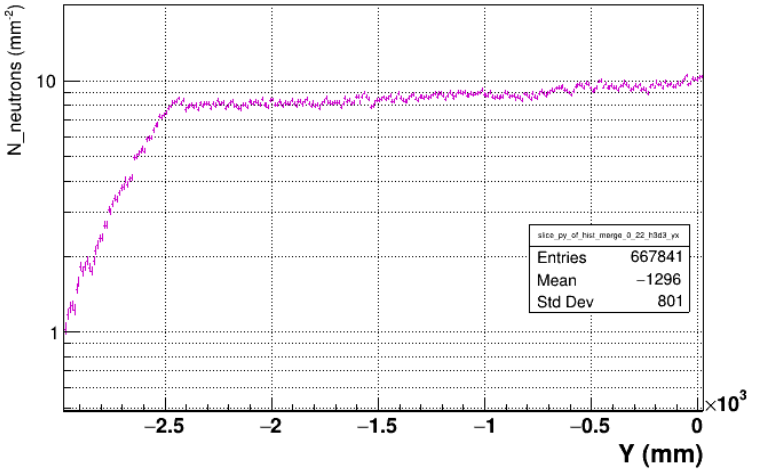
Neutron fluene in XFELDumpPLC



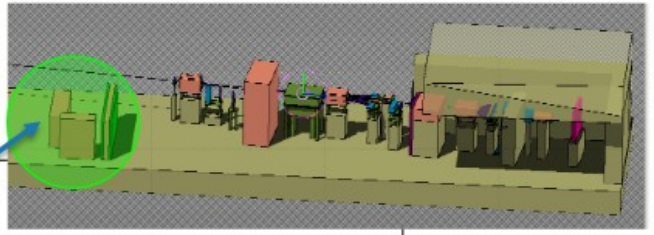


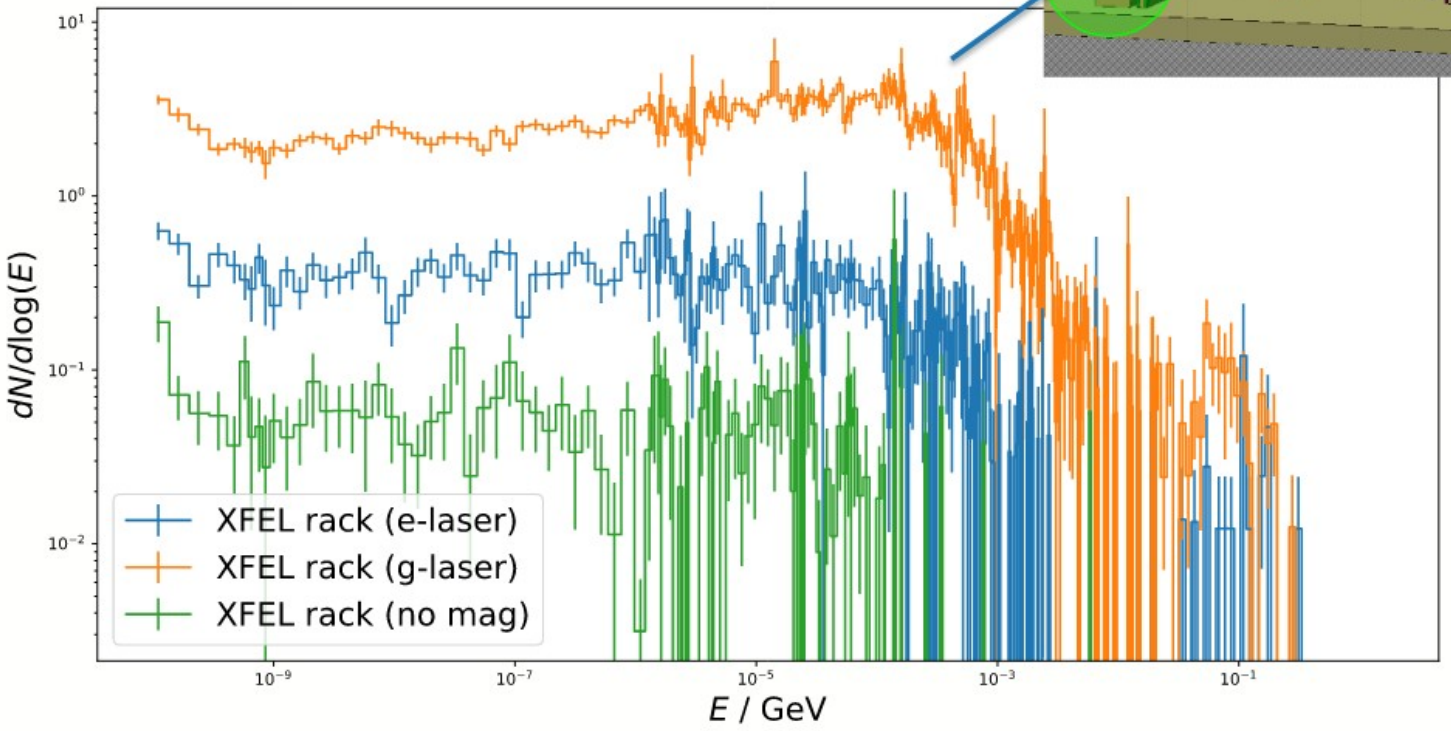






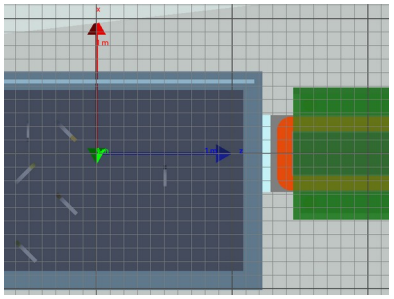
XFEL rack neutron lethargy

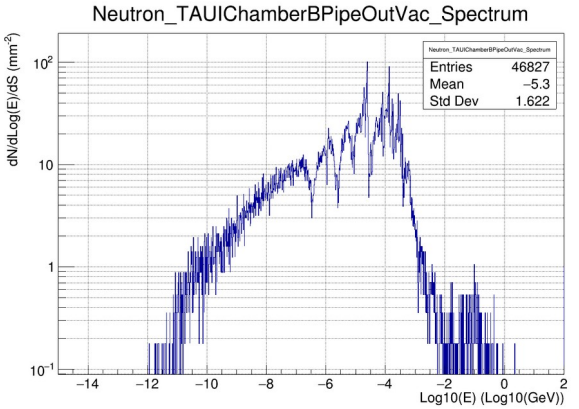


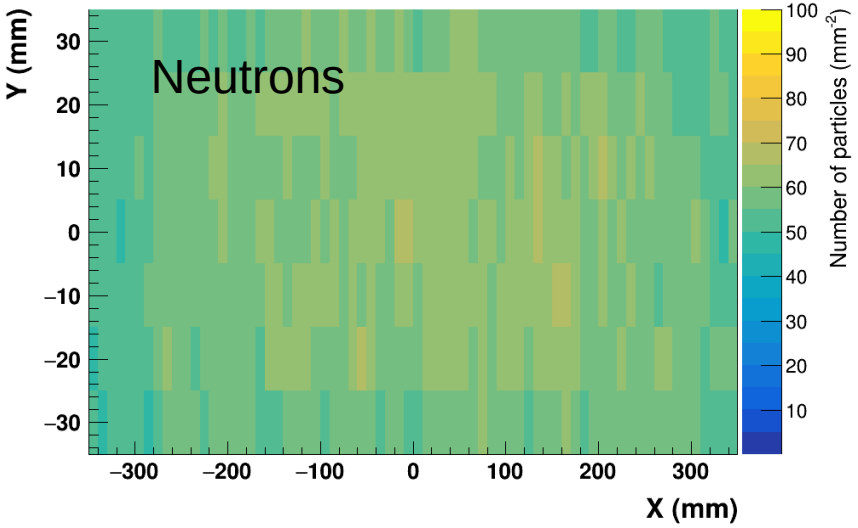


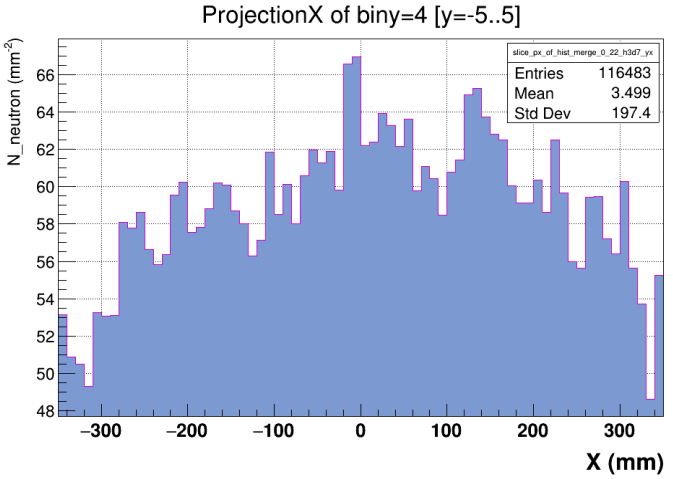
Note error is on plots

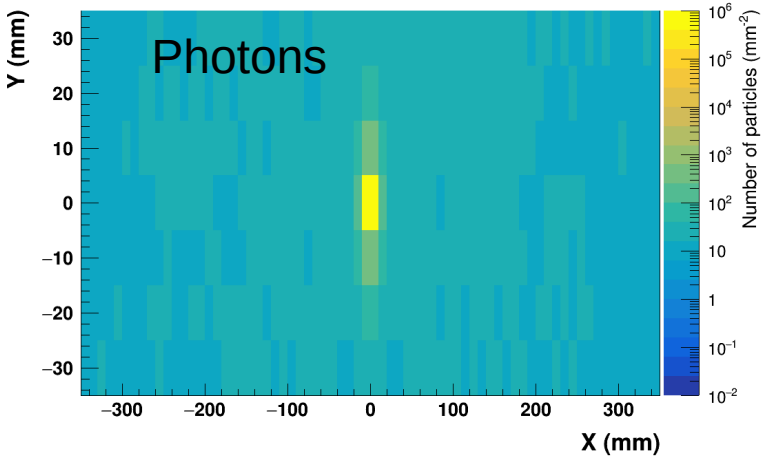
Neutrons, photons in vacuum chamber

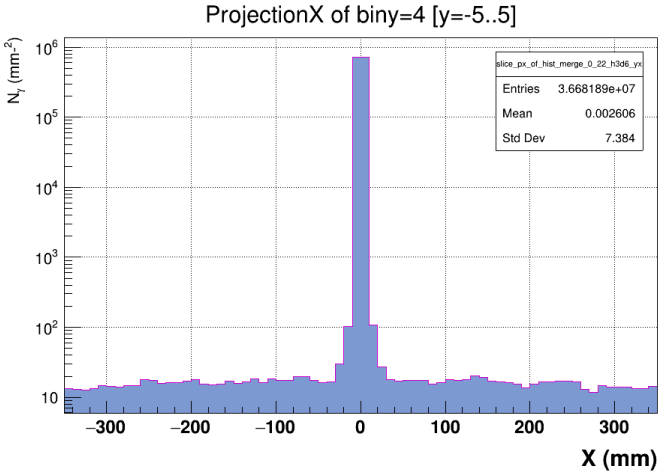




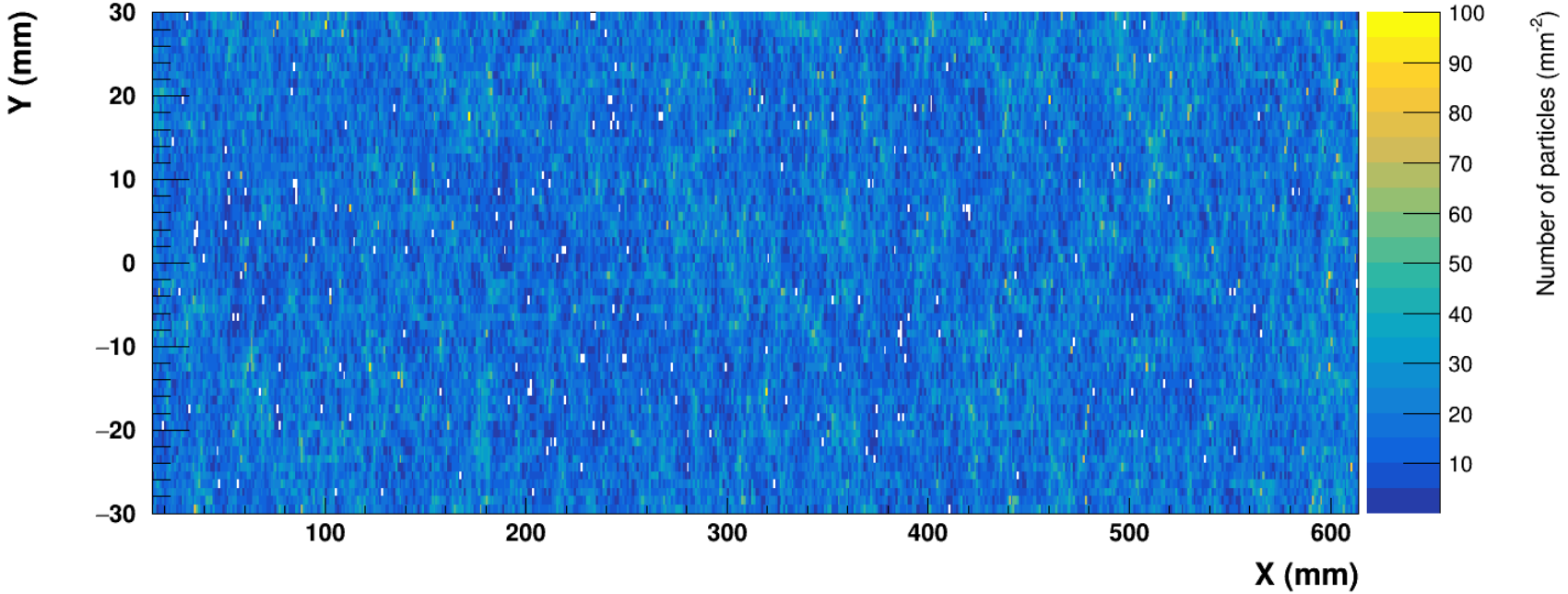


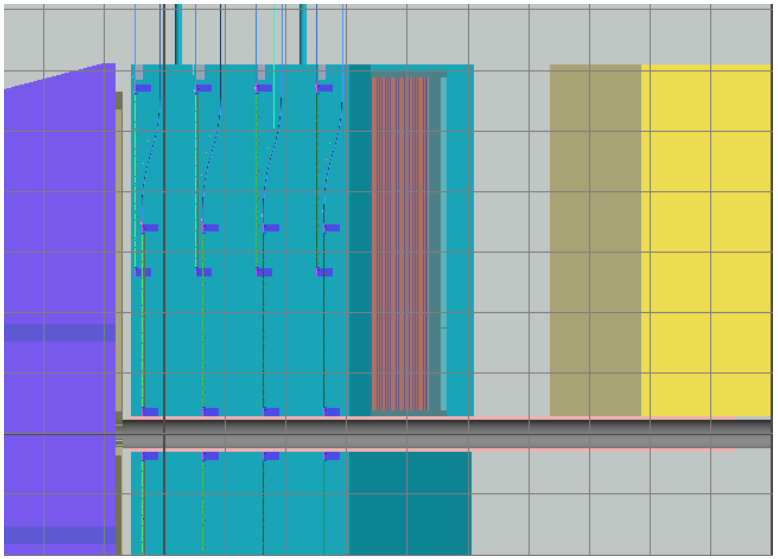


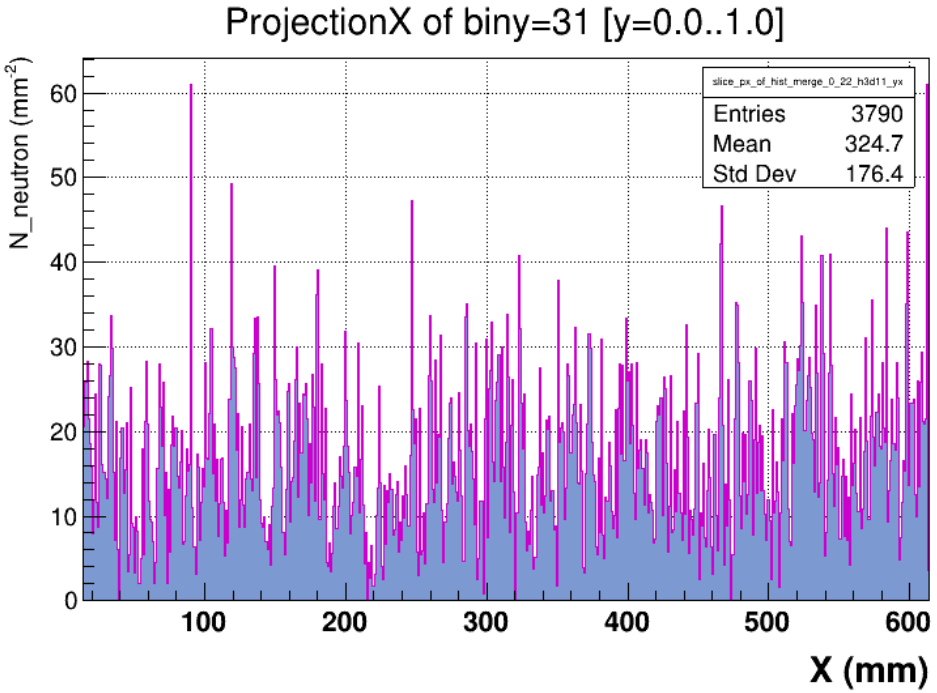




Neutrons in ECAL absorber layer 0







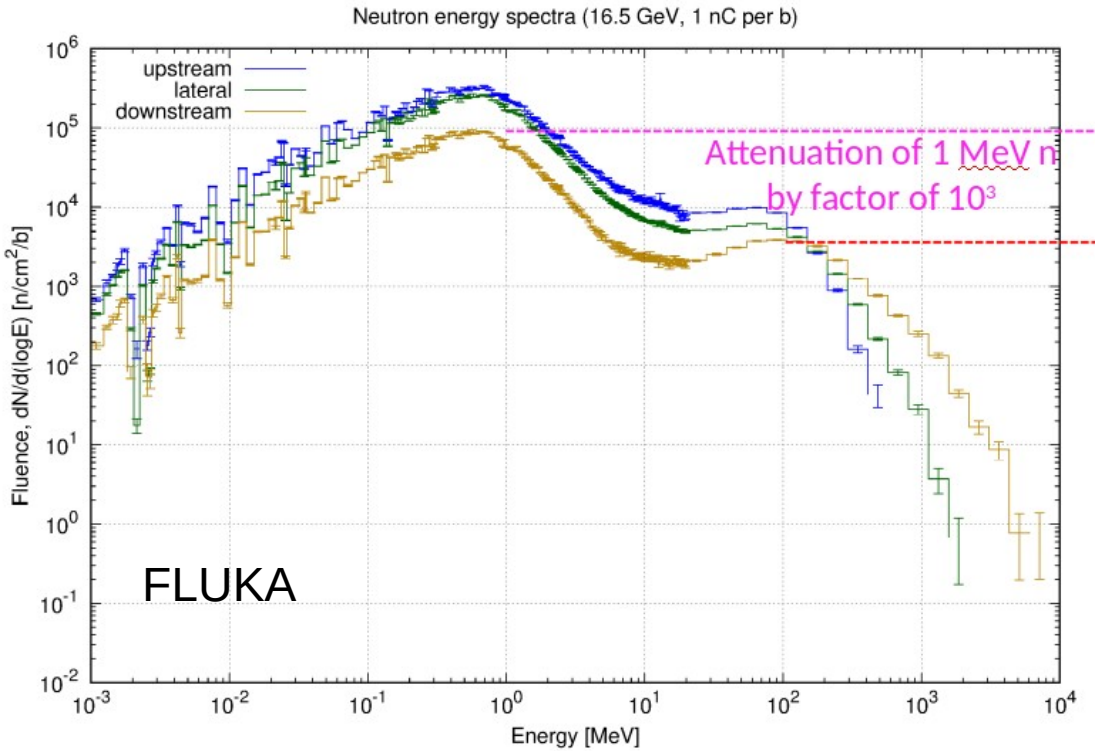
Summary

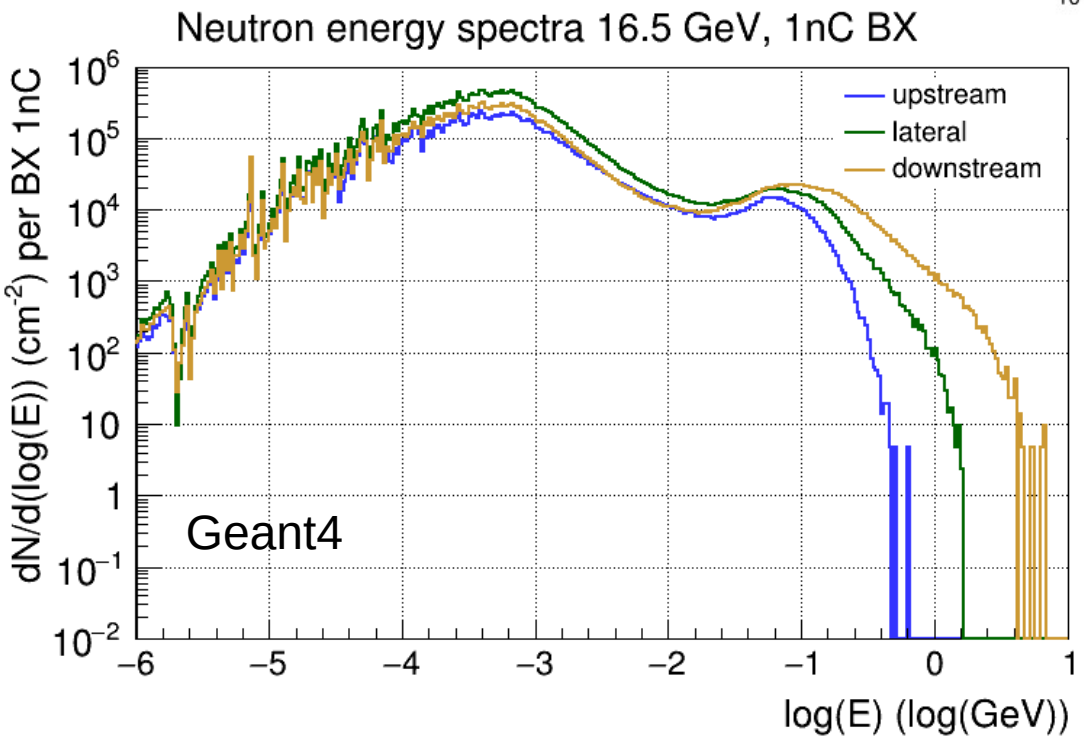
- Simulation results do not include any timing selection;
- Good agreement between results obtained from different histograms covering the same area;
- About 40% discrepancy between fluence estimation form the 3D histograms and Tracks tree. Can be attributed to specific weight used to fill histograms in simulation.
- Good agreement with previous G4 results ran with just one beam dump.
- Complete comparison with command type scoring of Geant4.
- Consider to run simulation with newer version of Geant4.

Backup

Neutron spectra

Without Fe + PE shell





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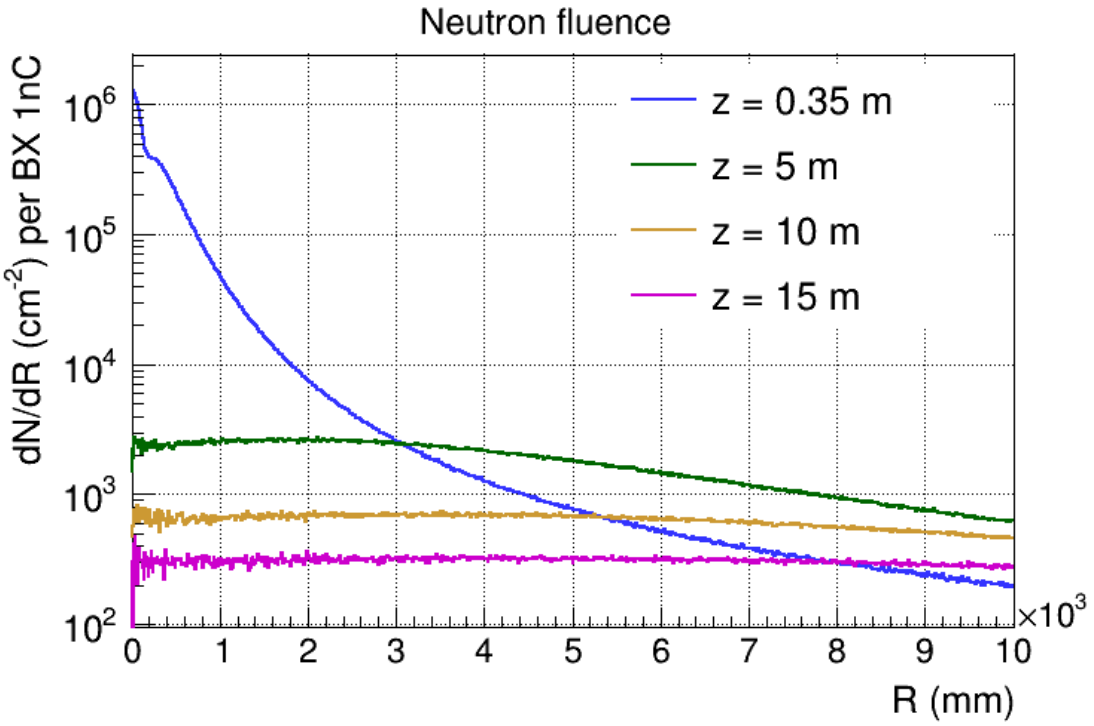
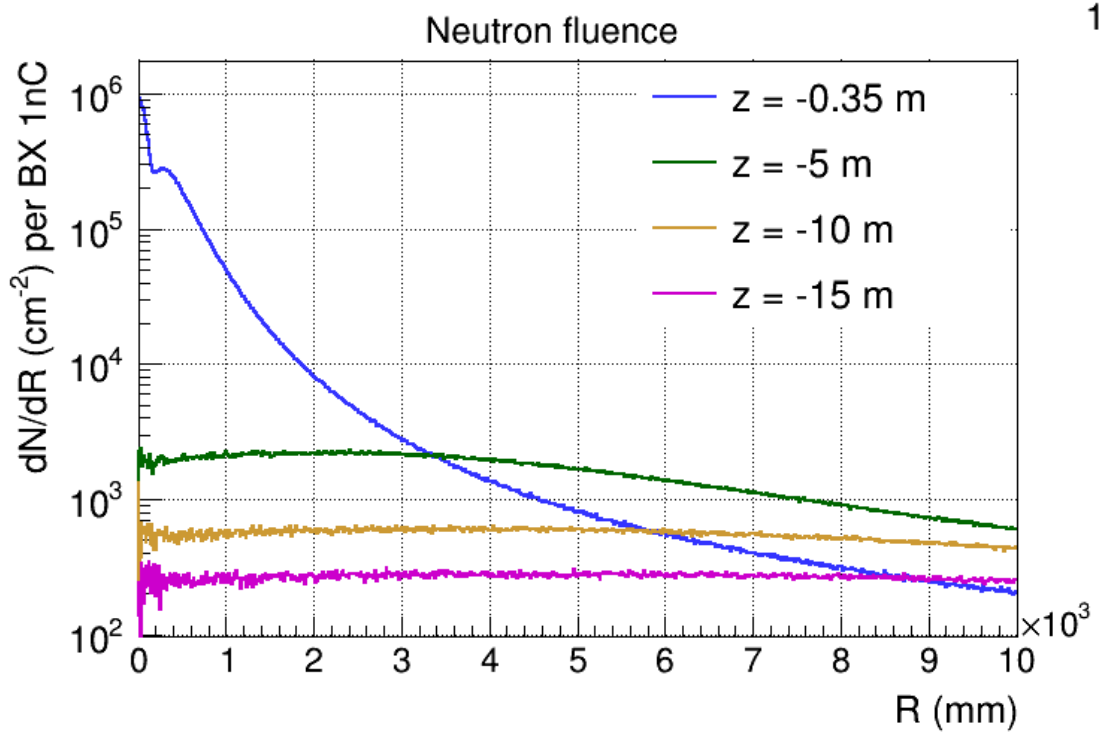
Neutron fluence in different distances from the beam dump (z)





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Neutron fluence in the beam line plane

-25 mm < y < 25 mm