FastSim Parametrization of Beam Dump: Comparing random generation with original distribution

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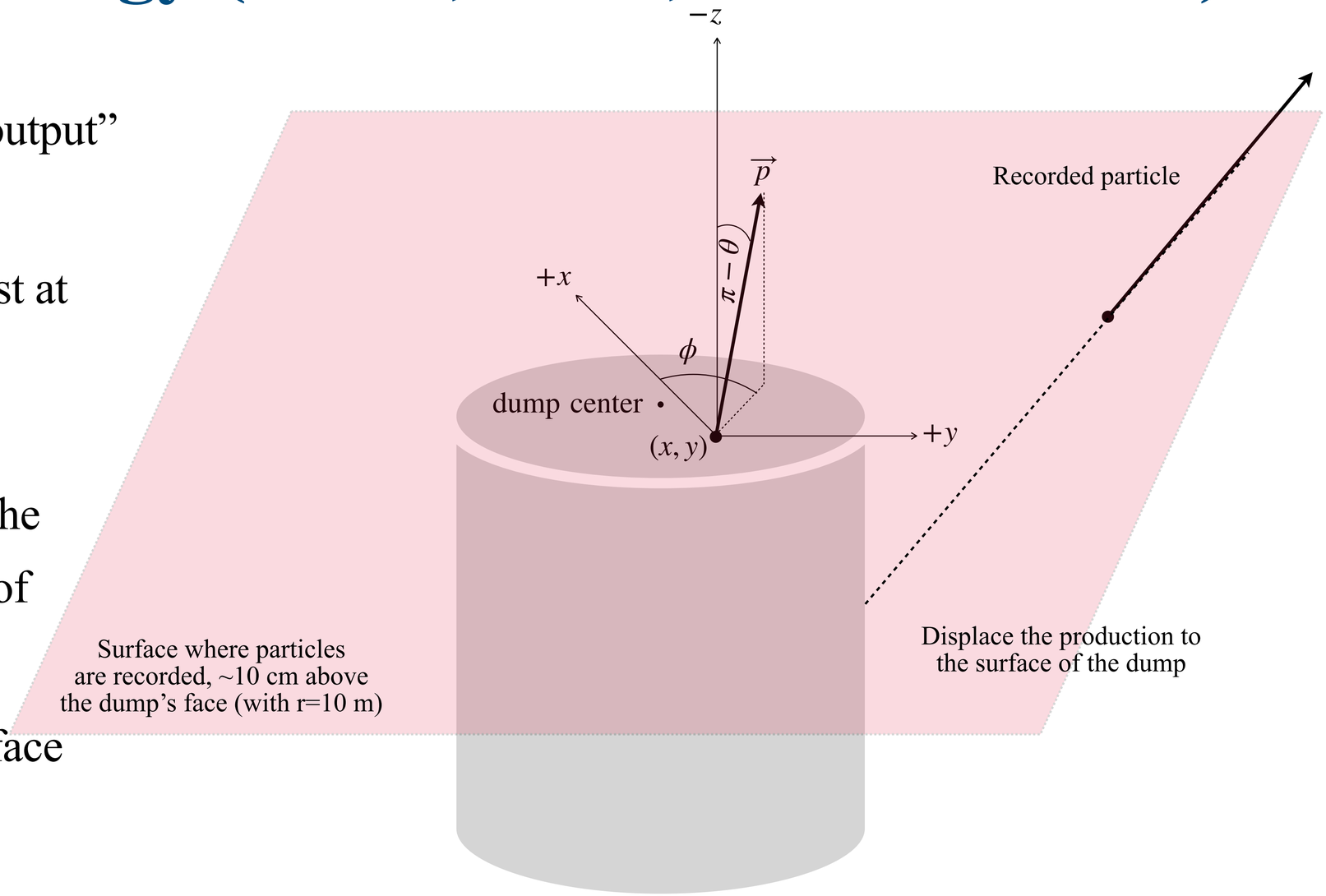
Fast simulation strategy (Sasha, Arka, Shan & Noam)

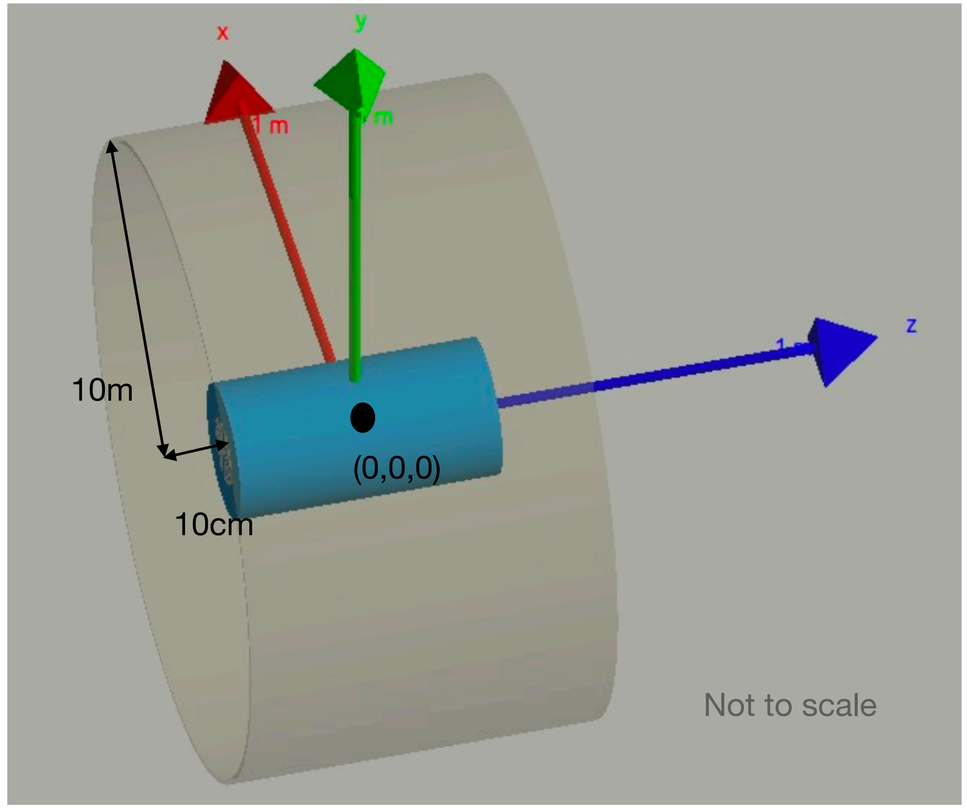
- Disable the dump and replace all its “output” by source-like particles
- Look at the dummy volume located just at the surface of the dump
  - Arka will plot $\frac{dN}{dE}, \frac{d^2N}{drd\theta_p}$
    - r is just $\sqrt{x^2+y^2}$ and θ_p, ϕ_p is the polar angle and azimuthal angle of momentum-> representative of direction of the particle.
  - Later: generate from the dump surface according to these plots

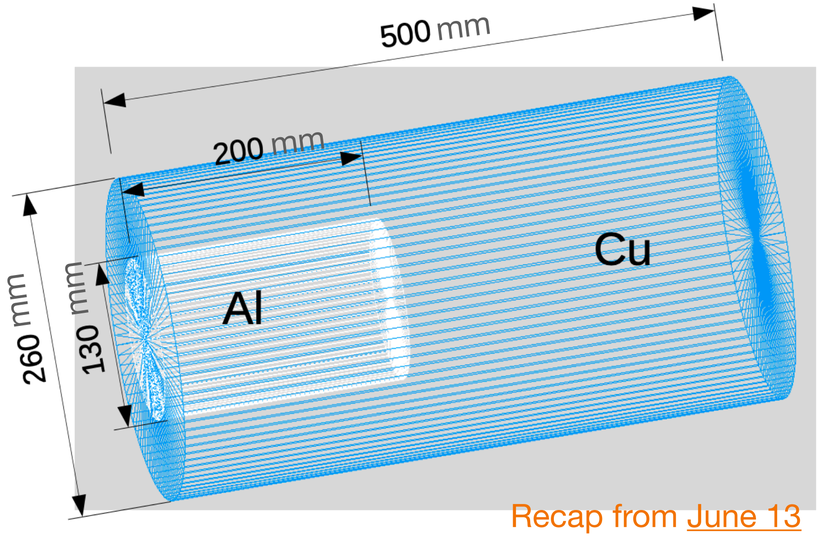


Recap from June 13

Simulation for dump only geometry:

- Sasha produced 10BX of dump only simulation
- Electron beam of 16.5 GeV directly hitting the dump
- Dump is made of Aluminum and Copper
  - The origin is at the center of the dump.
  - The face of the dump is at z = -250mm
- The surface which records particles is at z=-350mm, 100 mm away from dump face.
- Previous discussion was here.





Recap from June 13

Input tree for Geant4 simulation

- Putting the distributions in tree branches for Geant4 input

- The name of the branches are same as the Tracks tree used by Sasha

  - Branch details:

```
Int_t           eventid;
vector<int>     trackid;
vector<int>     detid;
vector<int>     pdg;
vector<int>     physproc;
vector<double>  t;
vector<double>  vtxz;
vector<double>  vtxy;
vector<double>  vtxx;
vector<double>  E;
vector<double>  px;
vector<double>  py;
vector<double>  pz;
vector<double>  theta;
vector<double>  phi;
Double_t        weight;
vector<int>     ptrackid;
```

For photons and neutrons, track id from 0 to number of generated particles.

detid==-10 —> assignment to particles randomly generated from dump distributions

physproc==7000 for particles randomly generated from dump distributions.

Uniformly generated from 0 to 1000 ns

Constant at the dump surface

Randomly generated from dump distributions

weight==1, for background particles

ptrackid==-10 —> assignment to particles randomly generated from dump distributions

In these slides

1. Plots labelled “original” are those that are directly taken from the dump only Geant4 simulation, particle recorded at z=-350mm.

2. Plots labelled “generated” are those that are randomly generated from the distributions from 1.

    i. These are used in the Geant4 simulation as a replacement of dump in the next step.

3. Plots labelled “From Geant4” are those coming from FastSim simulation of dump, implementing 2. as a particle source in Geant4.

    i. One where z=-350mm and other one where z=-5000mm

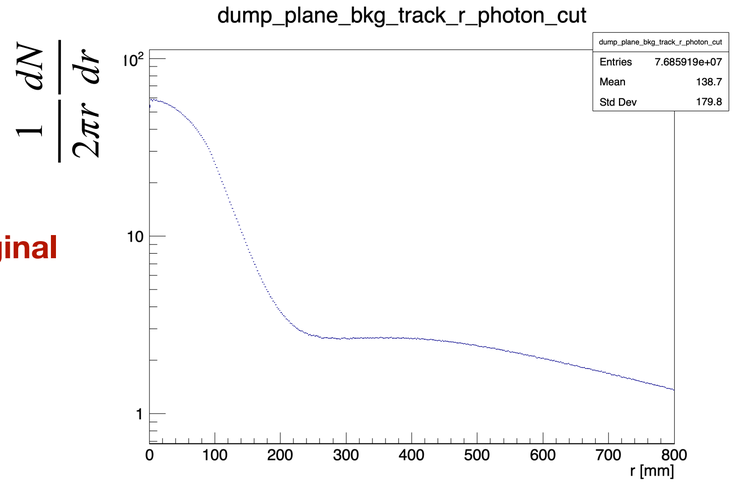
    ii. z=-350mm is chosen to see the distributions exactly at the position from where we began (kind of sanity check).

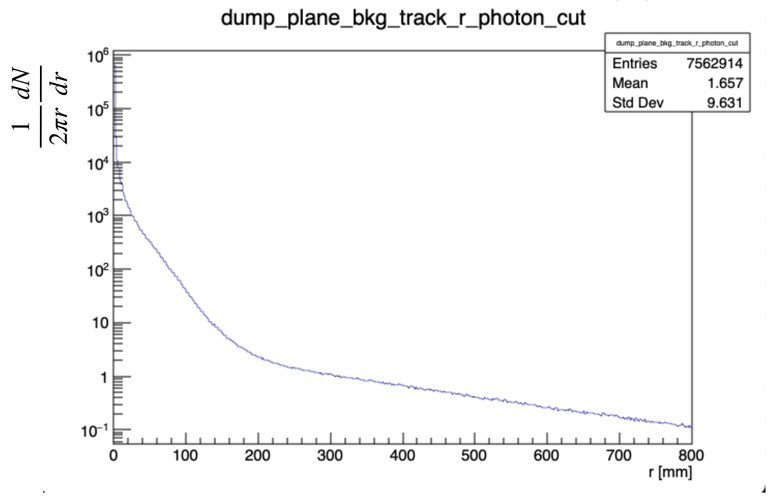
4. Photon distributions today, neutron distributions will be shown soon.

Some distributions: photon

X and Y position of tracks per BX

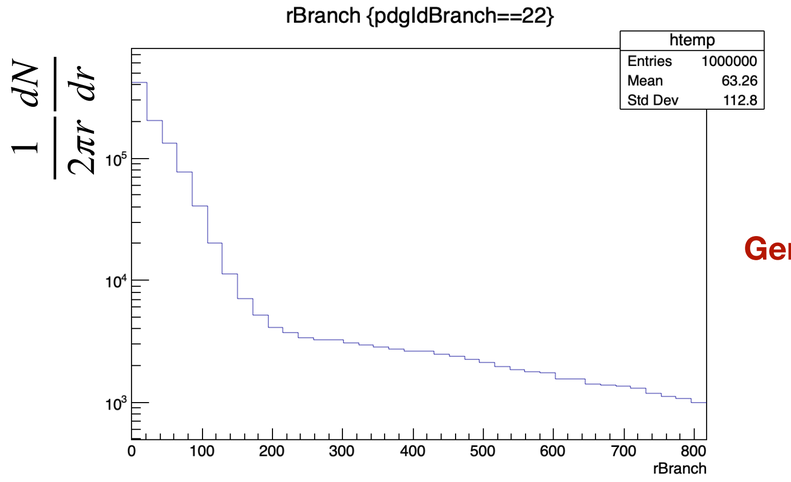
Original

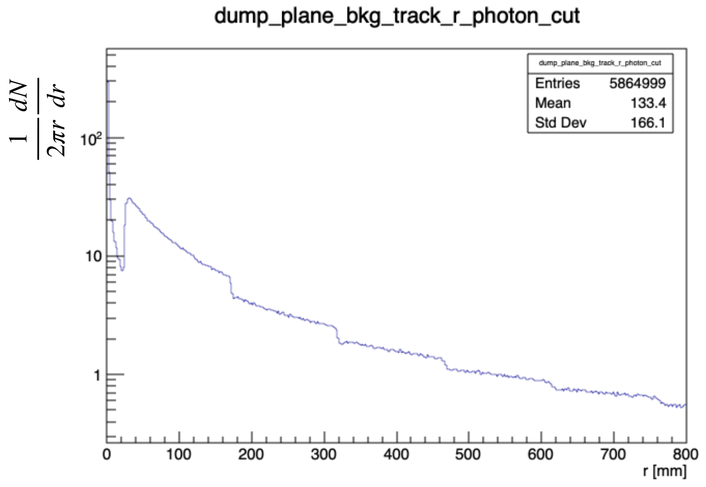




From Geant4 prepared by Sasha, z=-350mm

Generated





From Geant4 prepared by Sasha, z=-5000mm

The r values are generated from the $\theta_{momentum}$ vs r 2D plots shown on slide 8

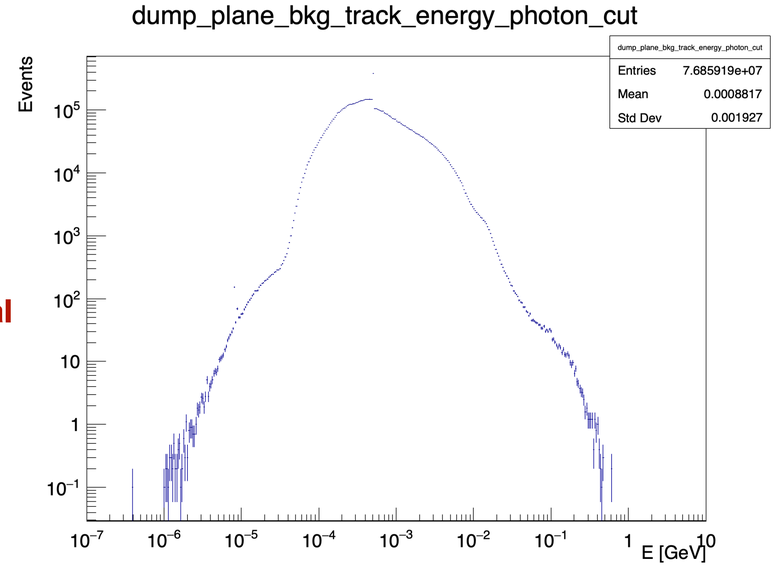
Shape looks okay.

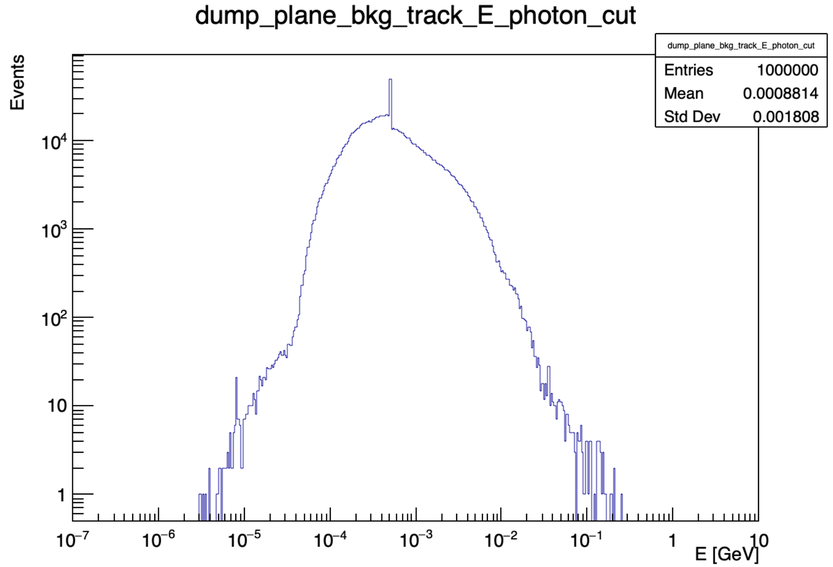
$r=\sqrt{x^2+y^2}$

Some distributions: photon

Energy per BX

Original

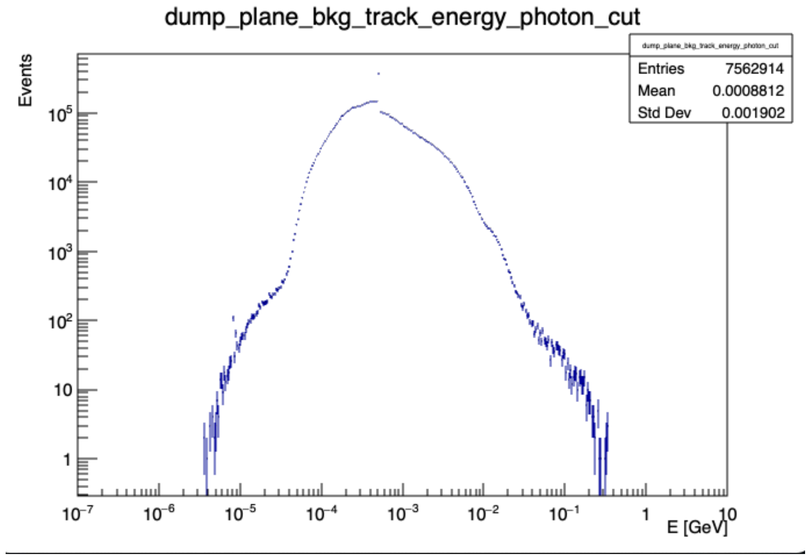


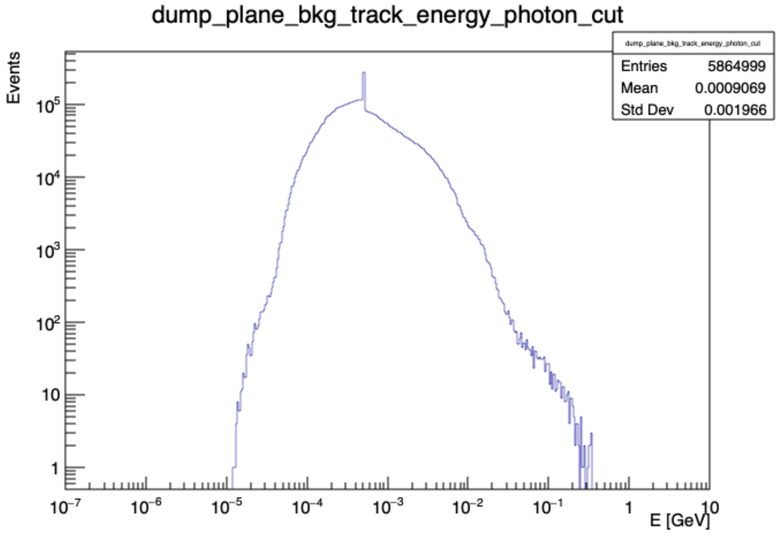


Generated

Shape looks okay.

From Geant4 prepared by Sasha, z=-350mm





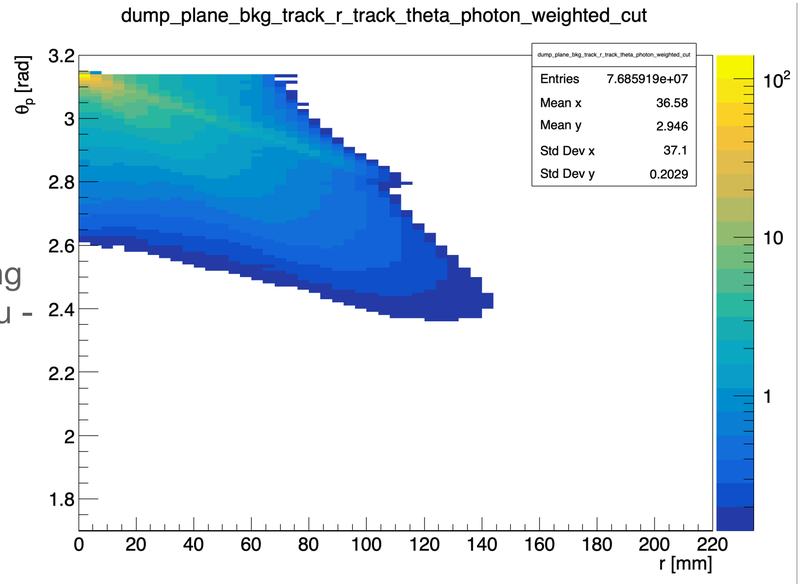
From Geant4 prepared by Sasha, z=-5000mm

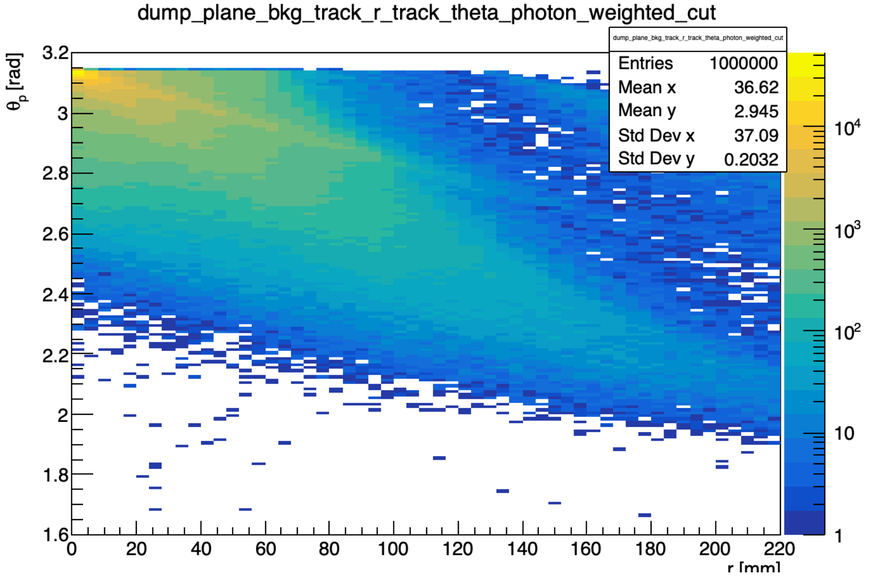
Correlation plots: photon

Original

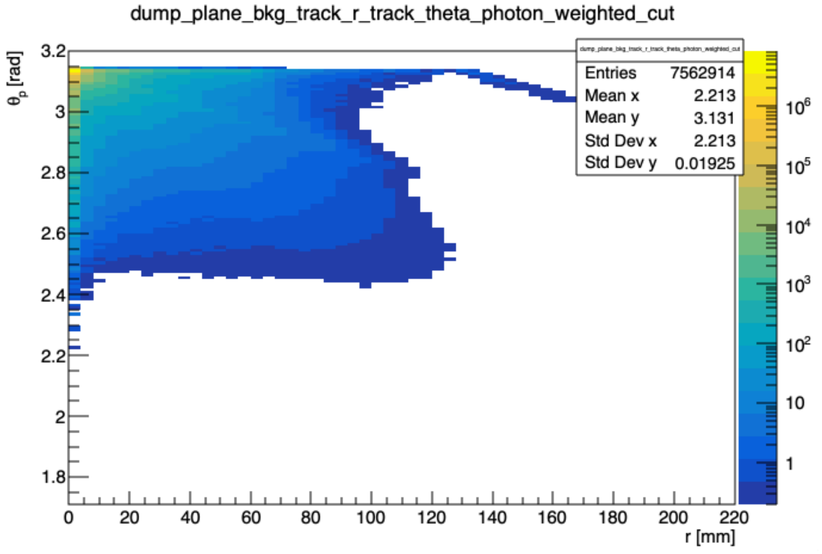
Generated

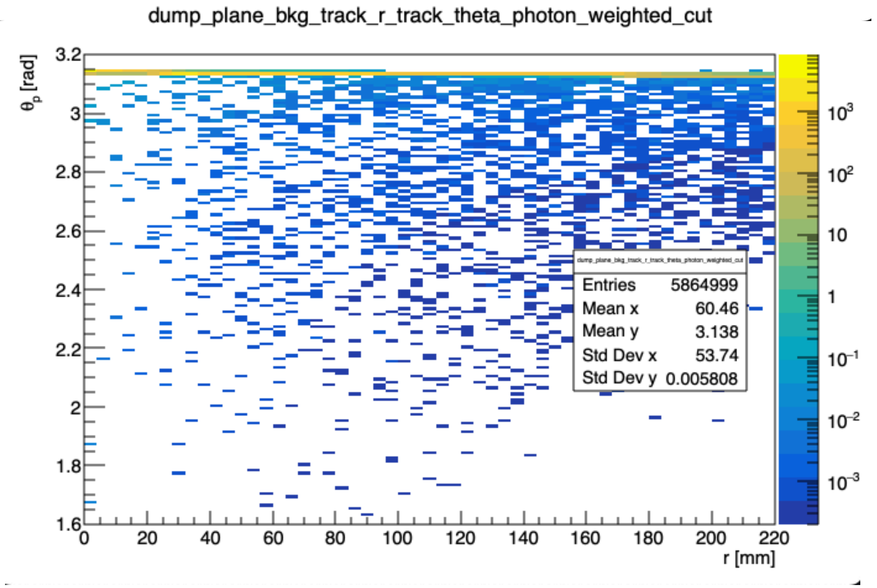
Two legs coming due to Al and Cu - two dump materials





From Geant4 prepared by Sasha, z=-350mm



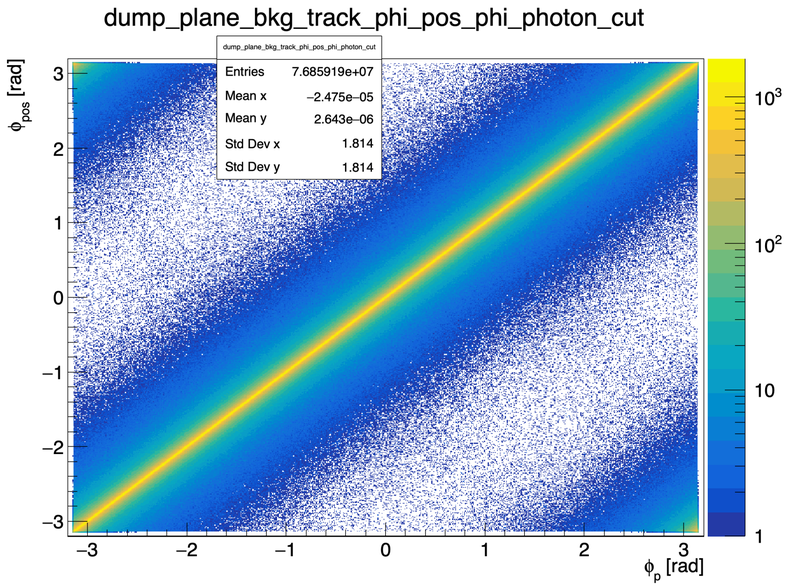


From Geant4 prepared by Sasha, z=-5000mm

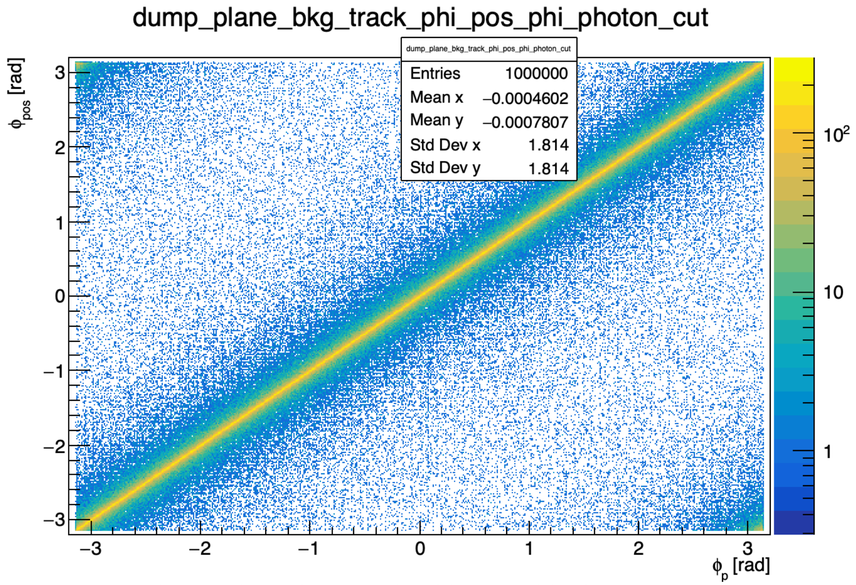
Correlation between ϕ_p and ϕ_{pos}

Photon

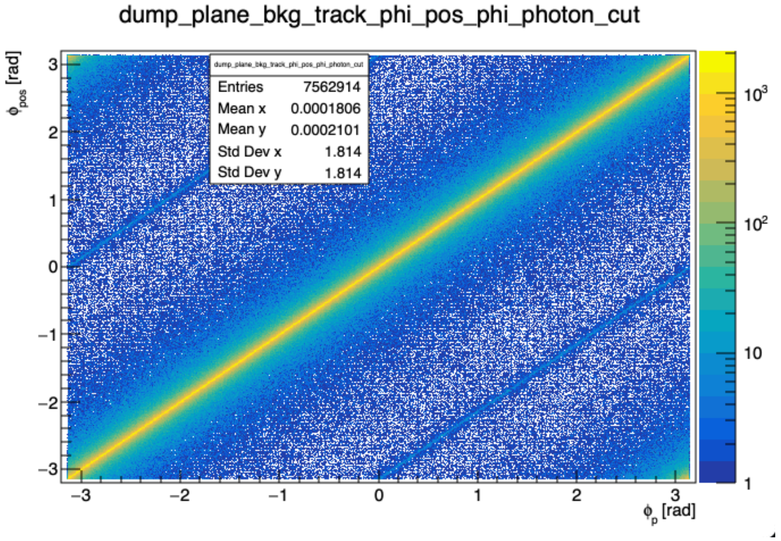
Original



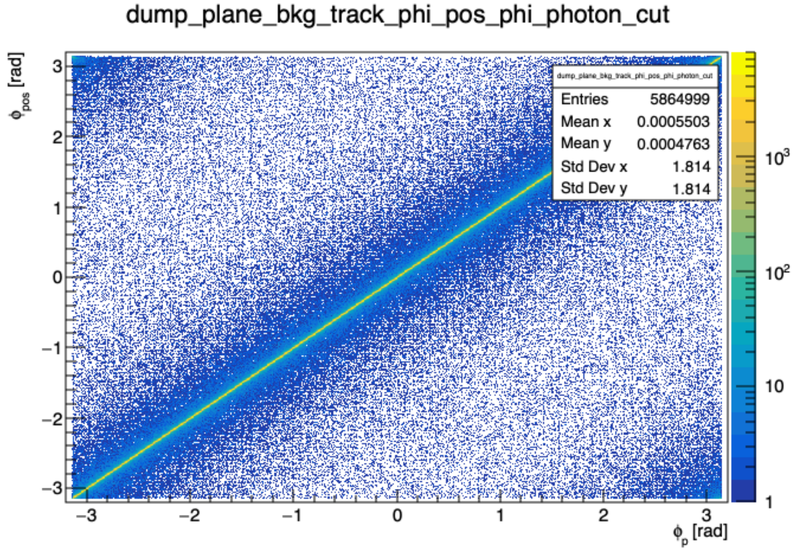
Generated



From Geant4 prepared by Sasha, z=-350mm



From Geant4 prepared by Sasha, z=-5000mm

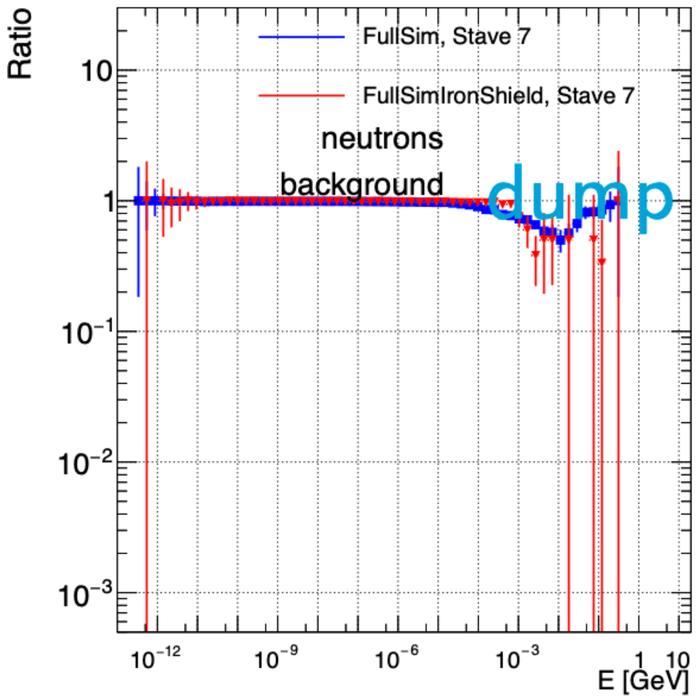


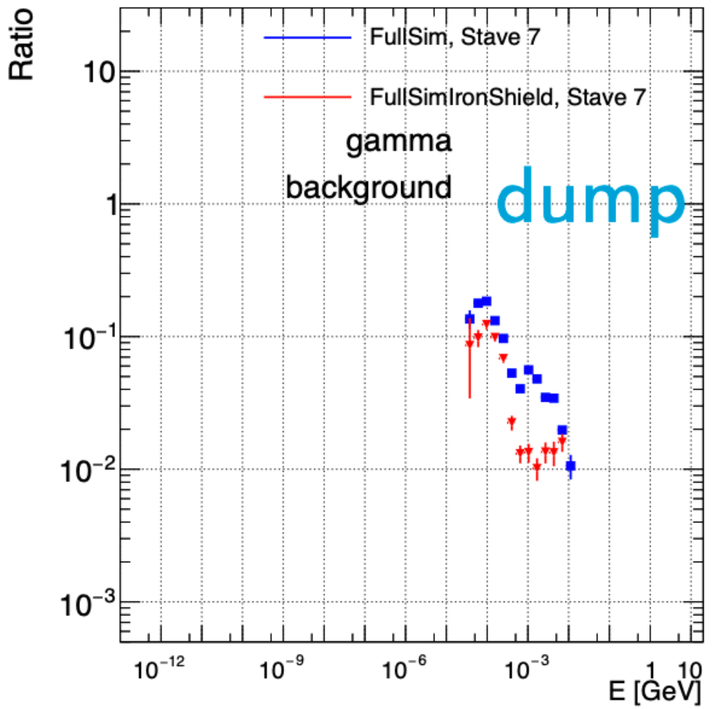
Summary and to do:

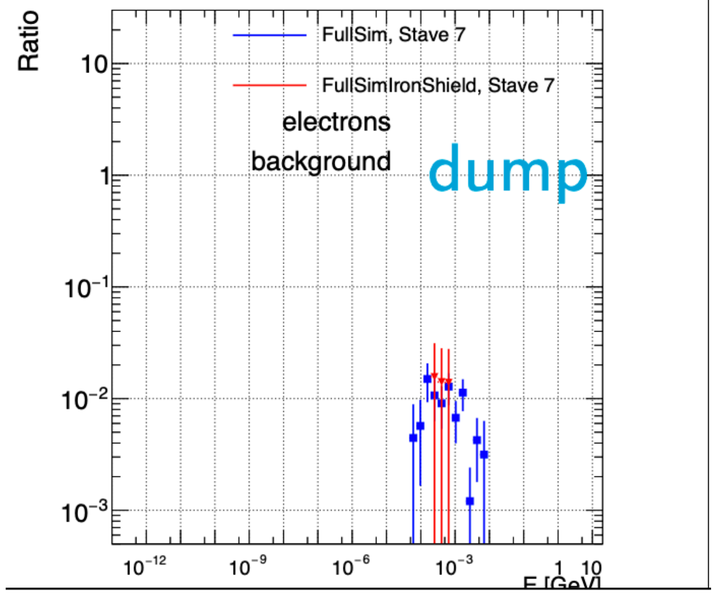
- Photon distribution shapes look okay, normalization is different.
  - For the normalization, the average number of photons per BX (N_γ) is 7686000 from the dump only simulation.
  - Will generate N photons per BX, where N is randomly drawn from a Gaussian with a mean of N_γ and std dev of 500.
- Need to look at distributions of neutron
  - For this round of Geant4 processing, there was a bug in neutron energy.
  - Once this is fixed, the neutron distributions will also be looked at.

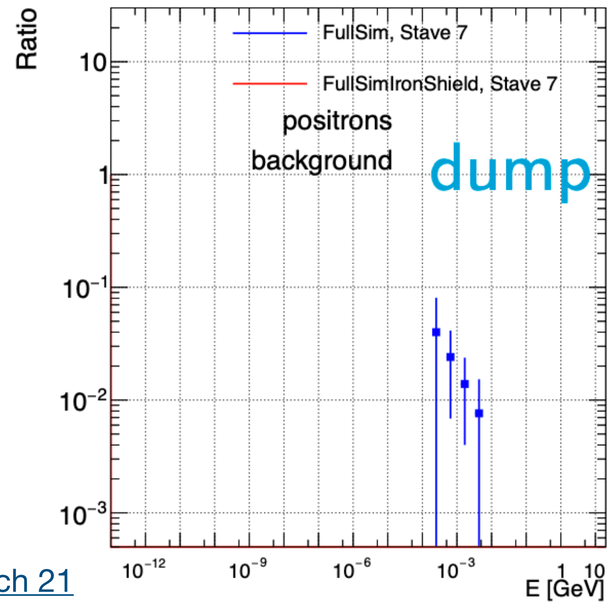
Back up

Different particles generated from dump:









Y-axis is ratio of particle coming from dump over all the sources to the tracker last layer.

★At the tracker last layer
- ★100% of the neutron come from dump
- ★>10% of the photons come from dump
- ★~1% of the electrons and positrons from the dump

Plots shown on March 21