FastSim Parametrization of Beam Dump

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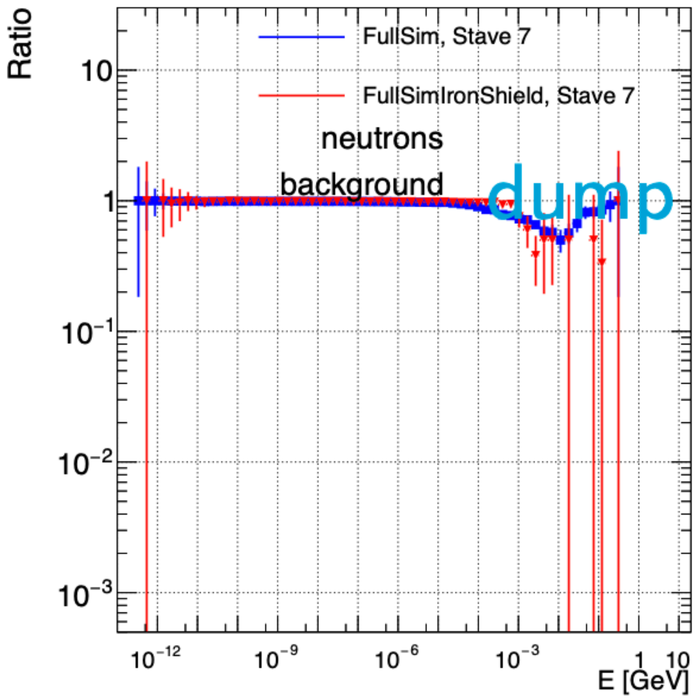
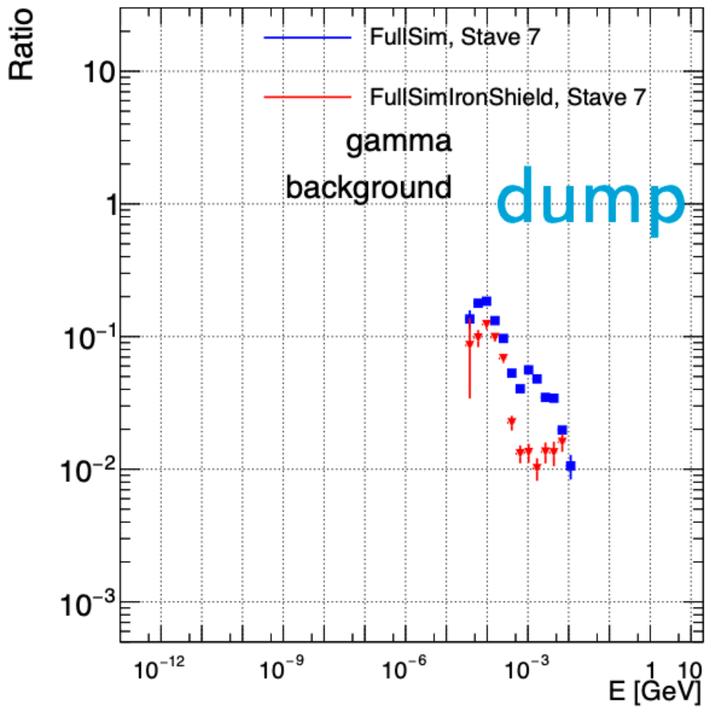
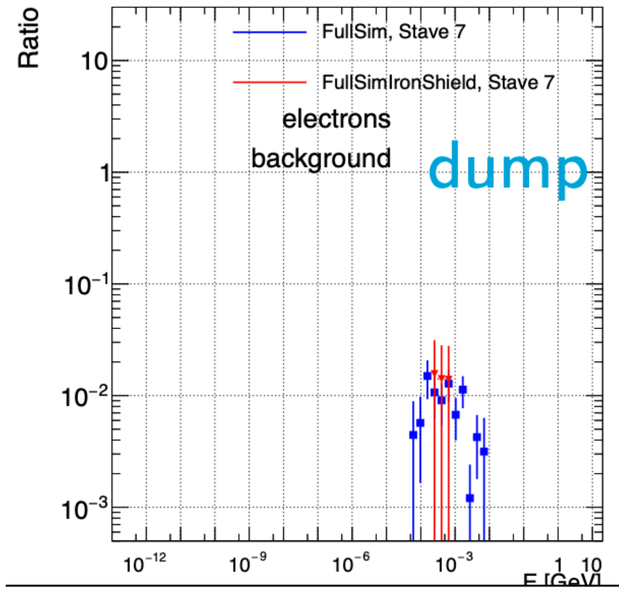
Parametrization of beam dump: Why do we need this?

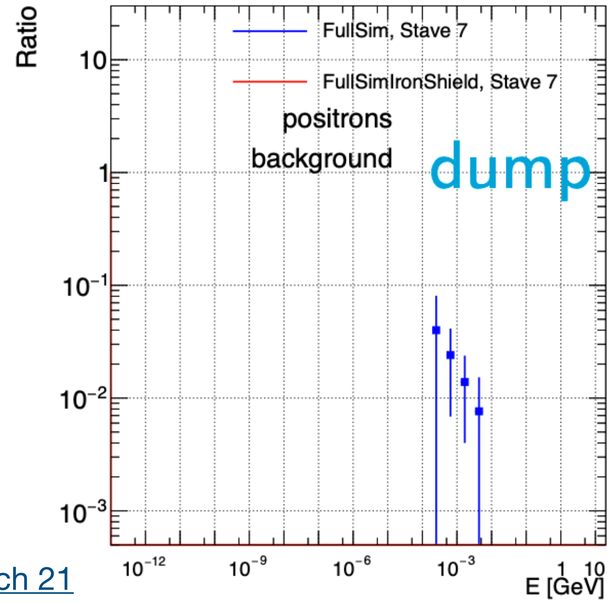
- Need many BXs of samples to characterize the detector performances
  - Otherwise the results are statistically limited.
- Geant4 simulation using LUXE geometry
  - Simulation inside the beam-dump is computationally expensive
    - Limits the number of BXs we can generate.
    - Have 2 BX of e+laser background only sample.
    - For CDR, we had ~300BX of background only sample.
- Way out:
  - Not properly simulate the dump in Geant4, but try to parametrize the response of the dump.
  - This may be faster by 100x.
    - Can overcome the computation challenge.

Different particles generated from dump:









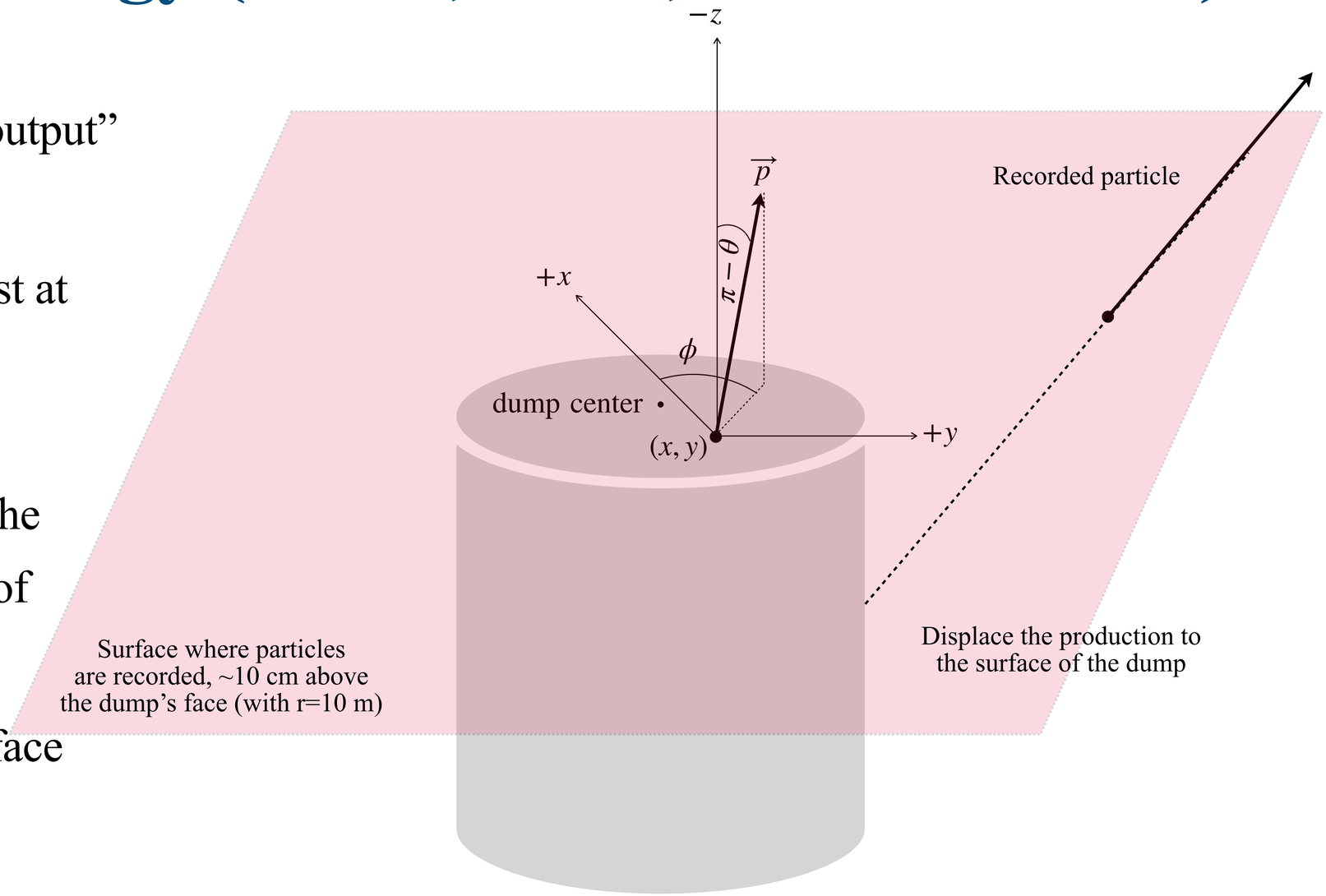
Y-axis is ratio of particle coming from dump over all the sources to the tracker last layer.

★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

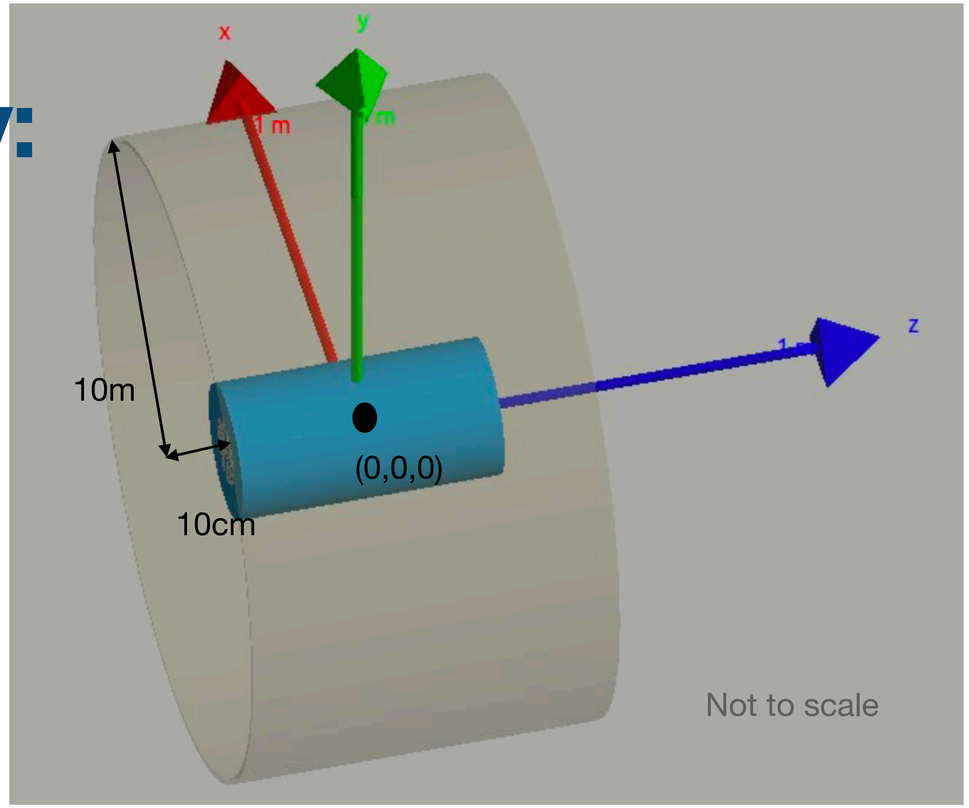
Fast simulation strategy (Sasha, Arka, Shan & Noam)

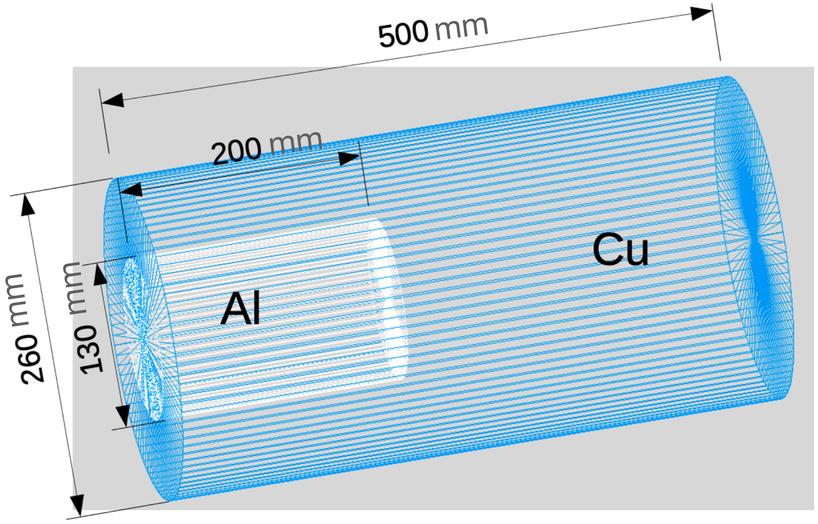
- Disable the dump and replace all its “output” by source-like particles
- Look at the dummy volume located just at the surface of the dump
  - Arka will plot $\frac{dN}{dE}, \frac{d^2N}{drd\theta_p}$
    - r is just $\sqrt{x^2+y^2}$ and θ_p, ϕ_p is the polar angle and azimuthal angle of momentum-> representative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



Simulation for dump only geometry:

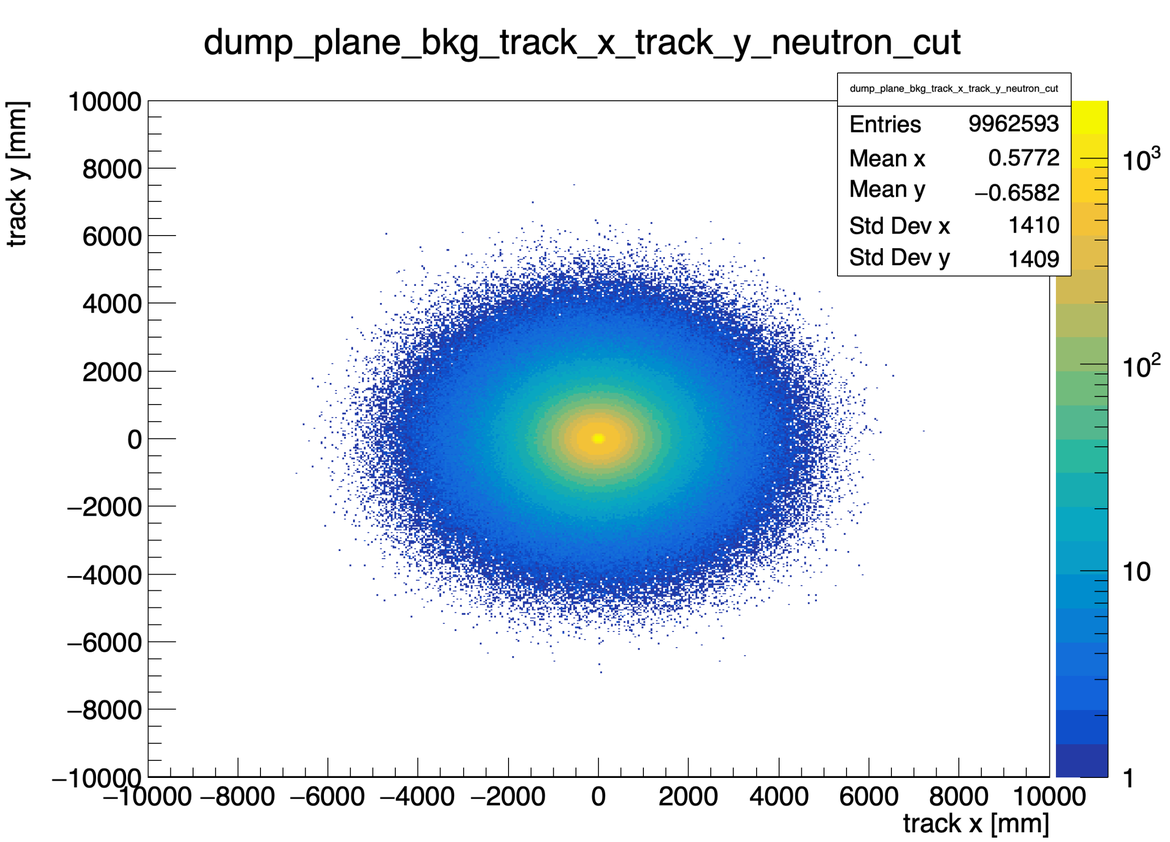
- Sasha produced 10BX of dump only simulation
- Electron beam of 16.5 GeV directly hitting the dump
- Dump is made of Aluminum and Copper
  - The origin is at the center of the dump.
  - The face of the dump is at z = -250mm
- The surface which records particles is at z=-350mm, 100 mm away from dump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

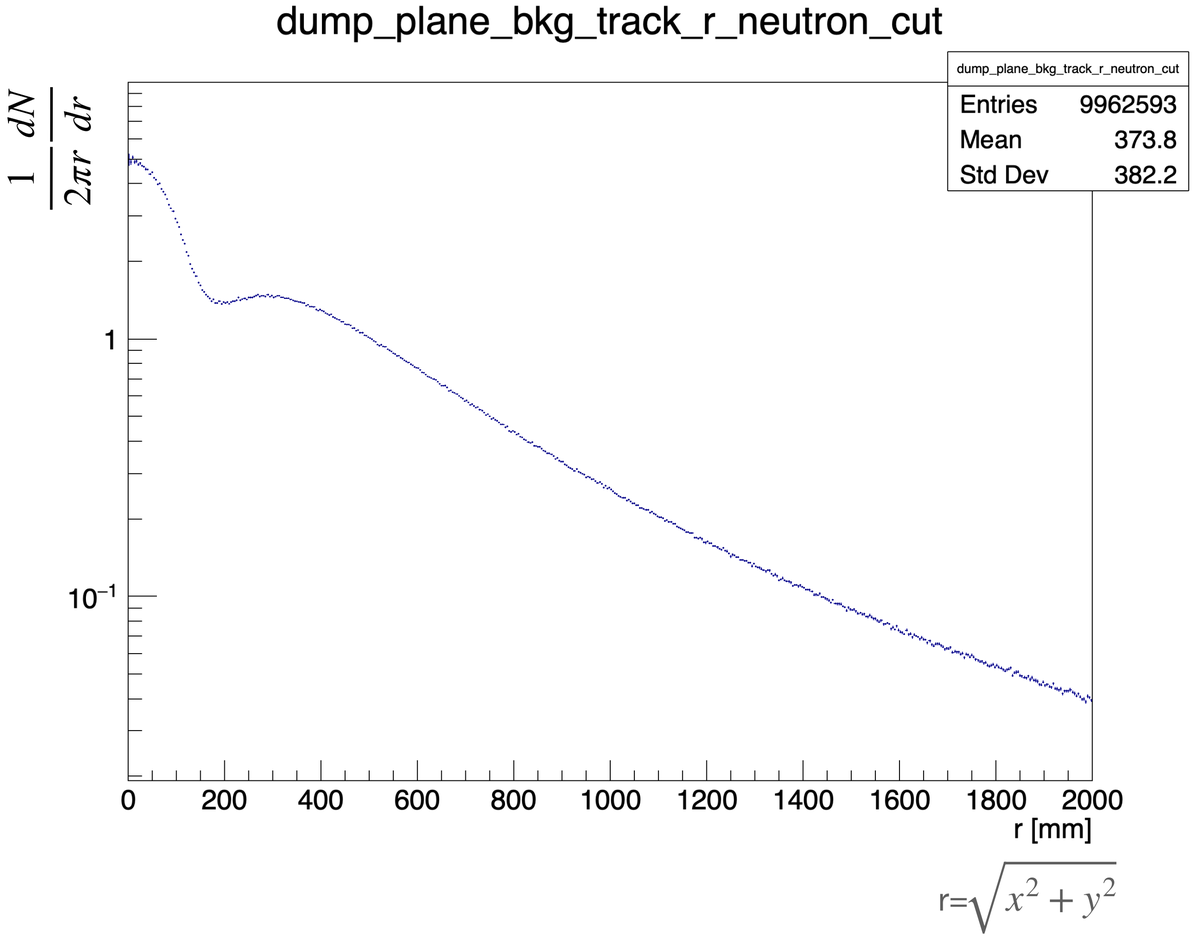




Some distributions: neutron

X and Y position of tracks





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

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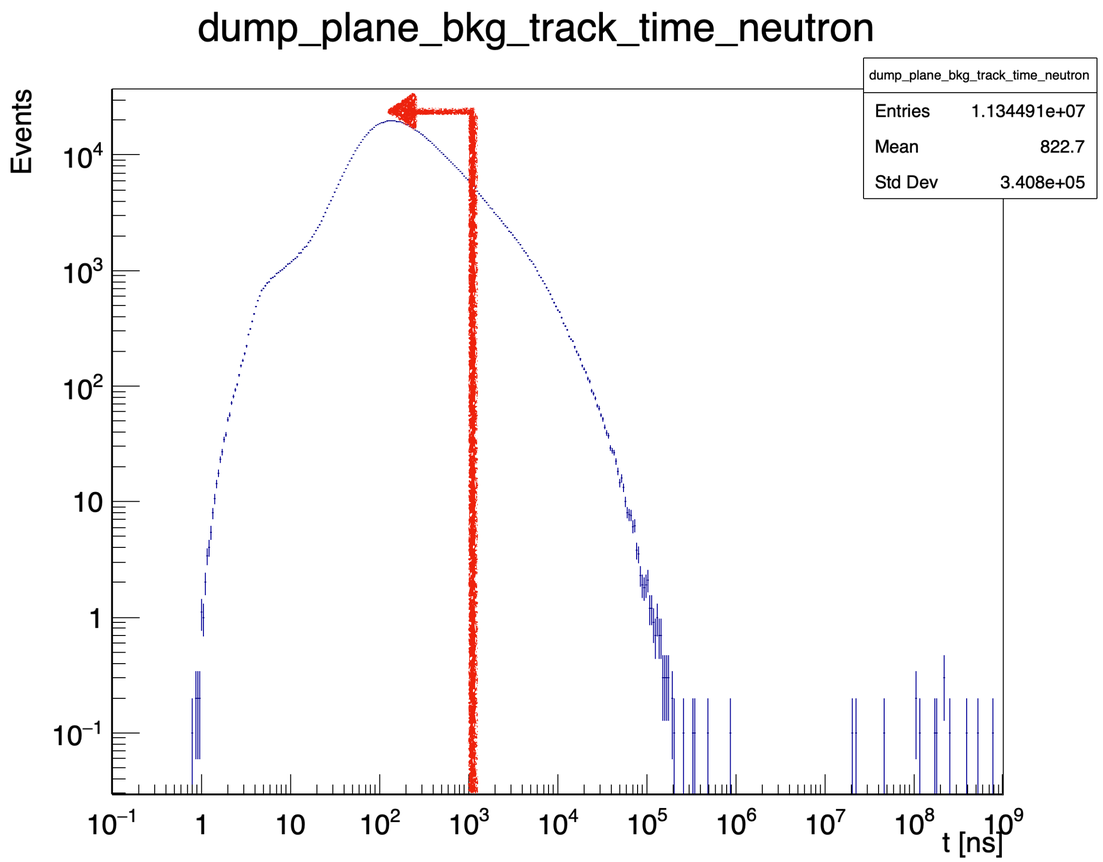
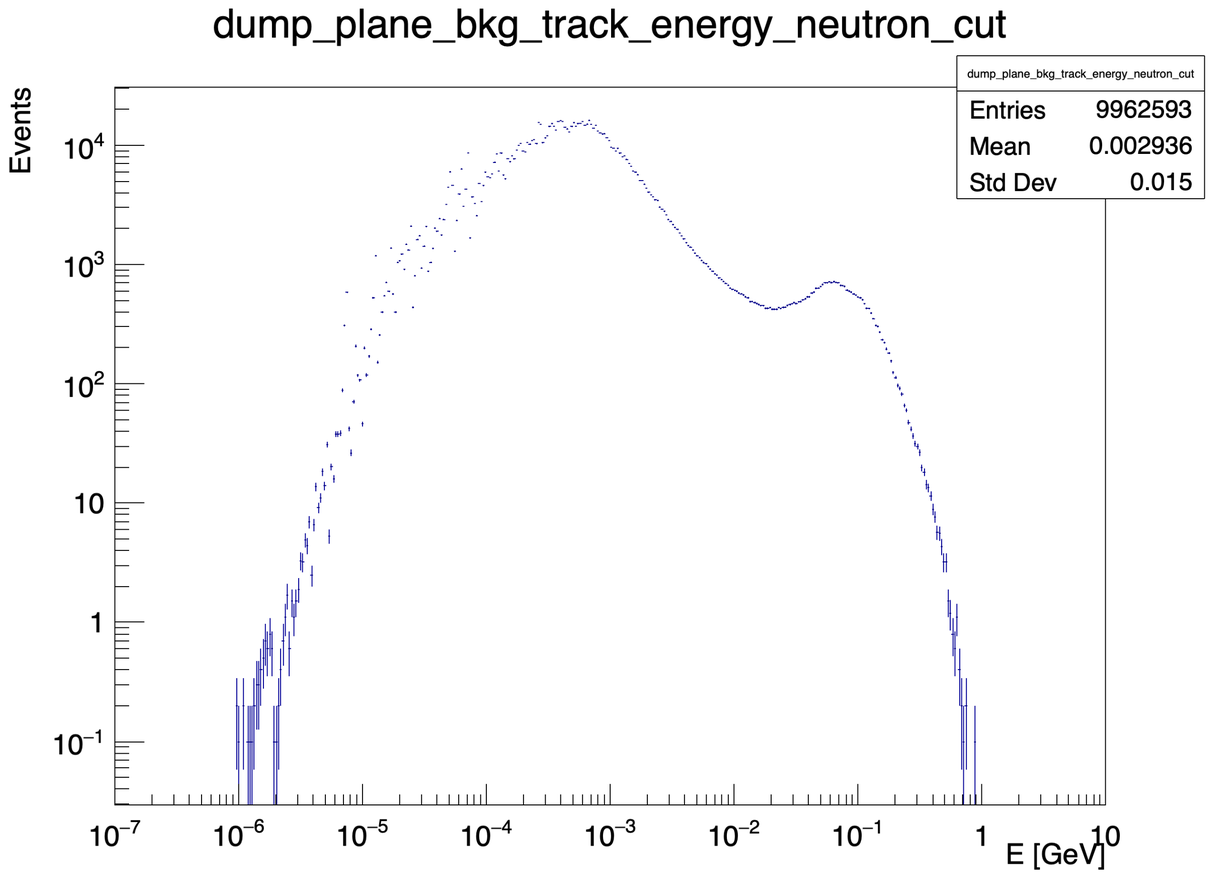
Time and energy





Restrict ourselves to 1 μs as detector timing resolution is ~1 μs.

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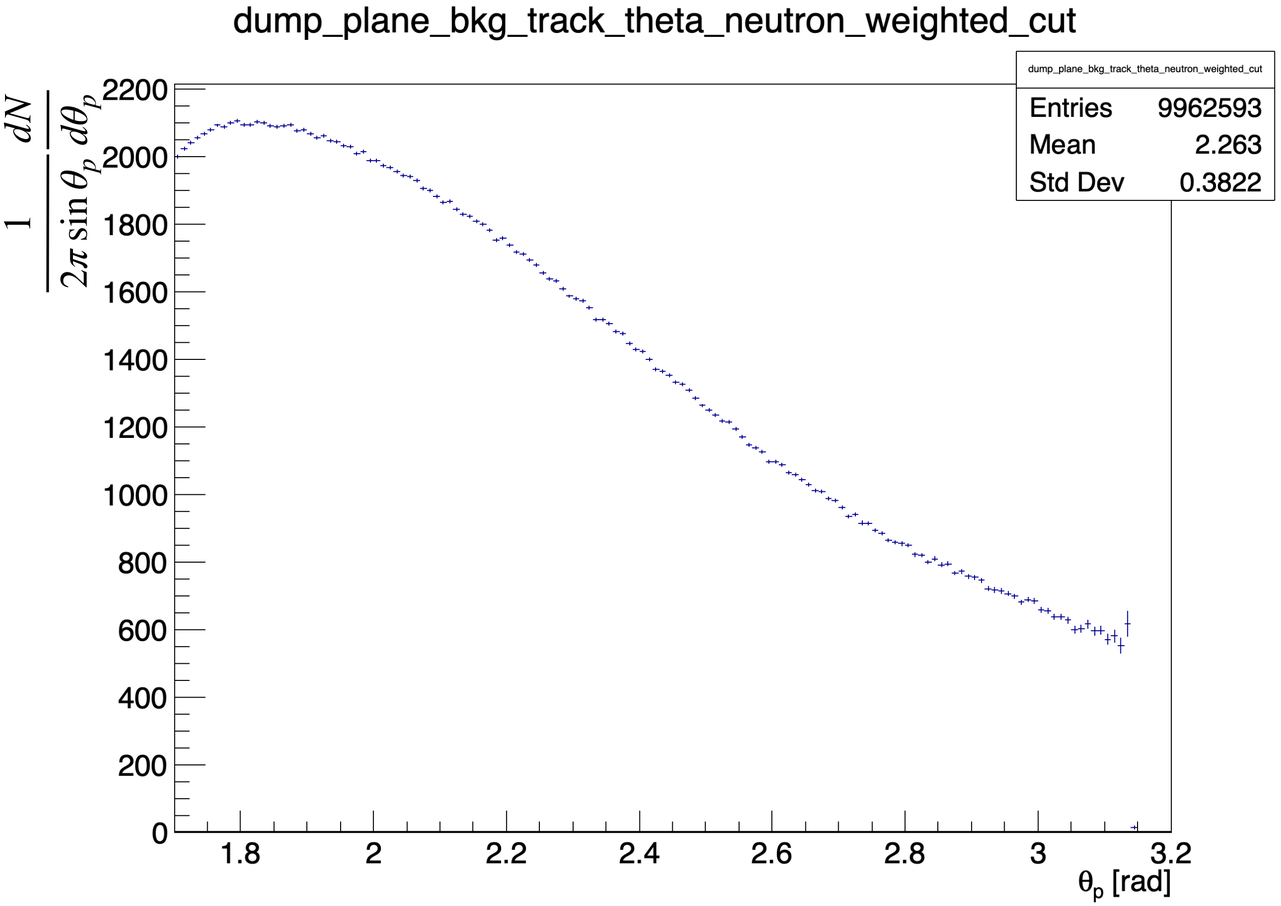
Momentum direction



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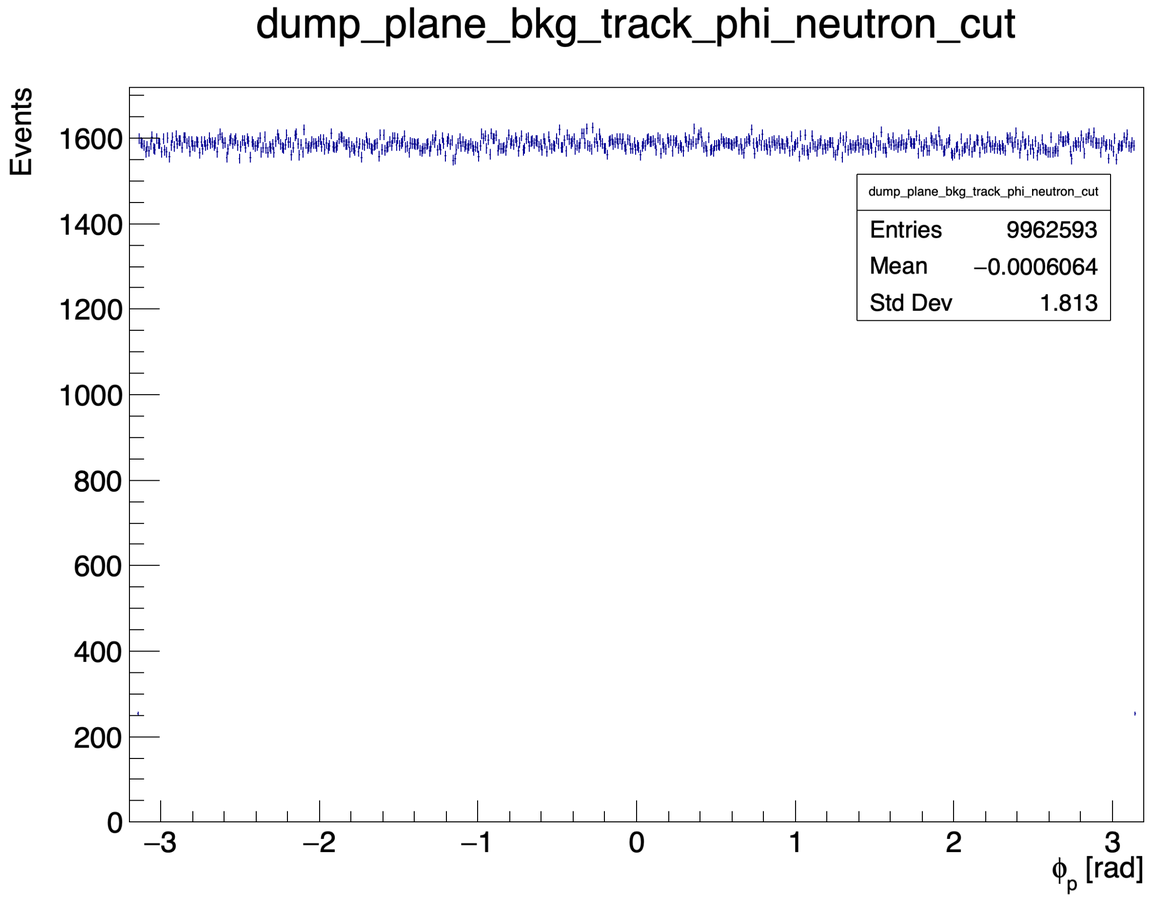
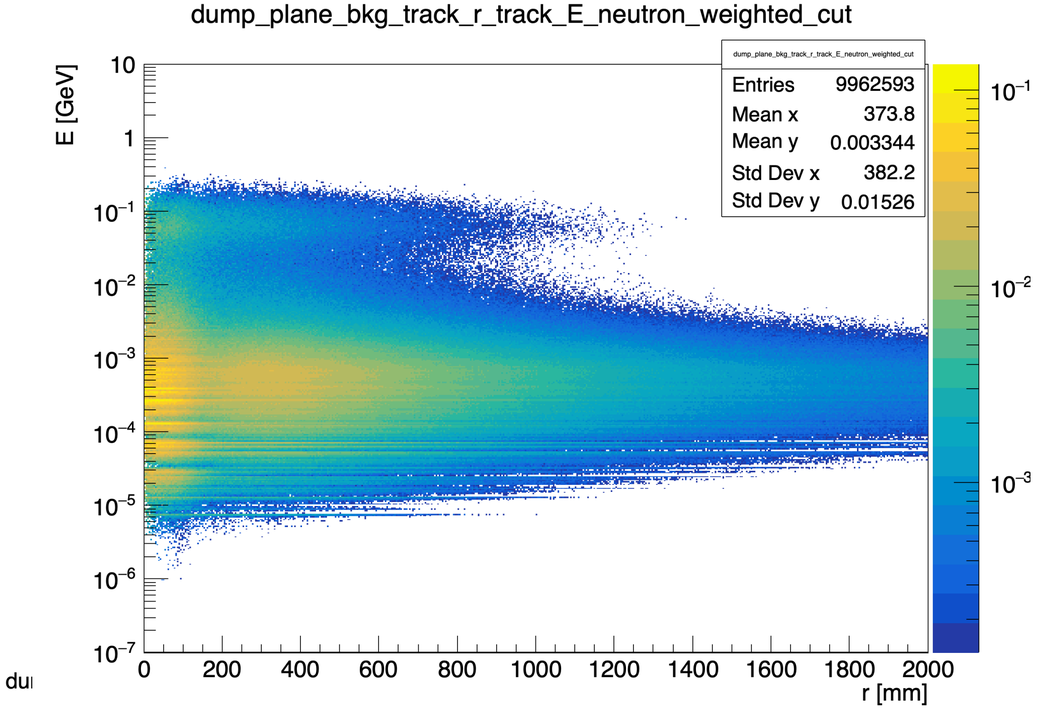
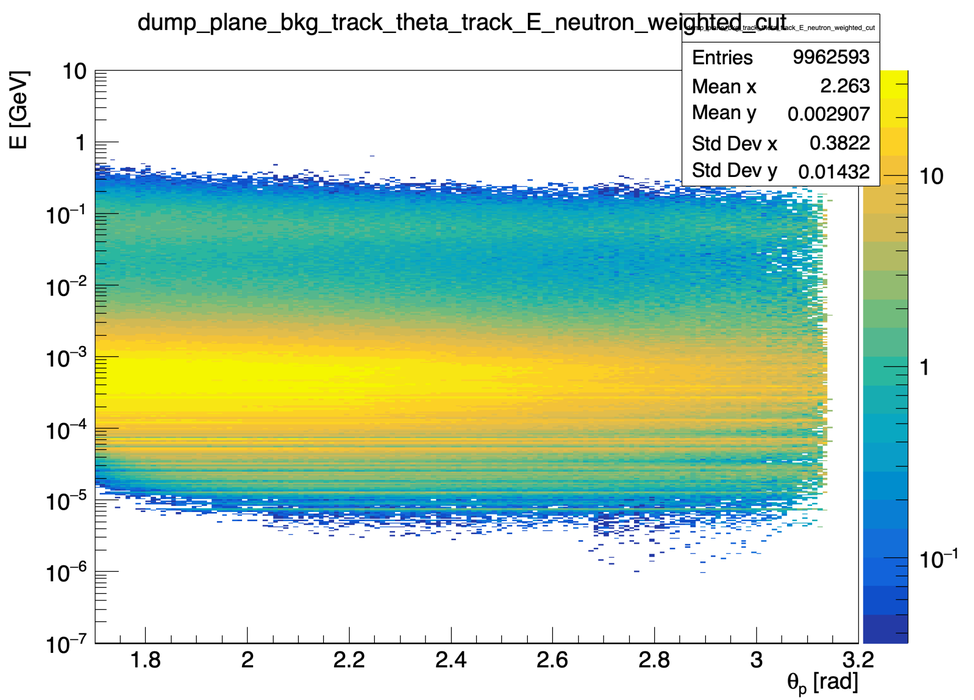
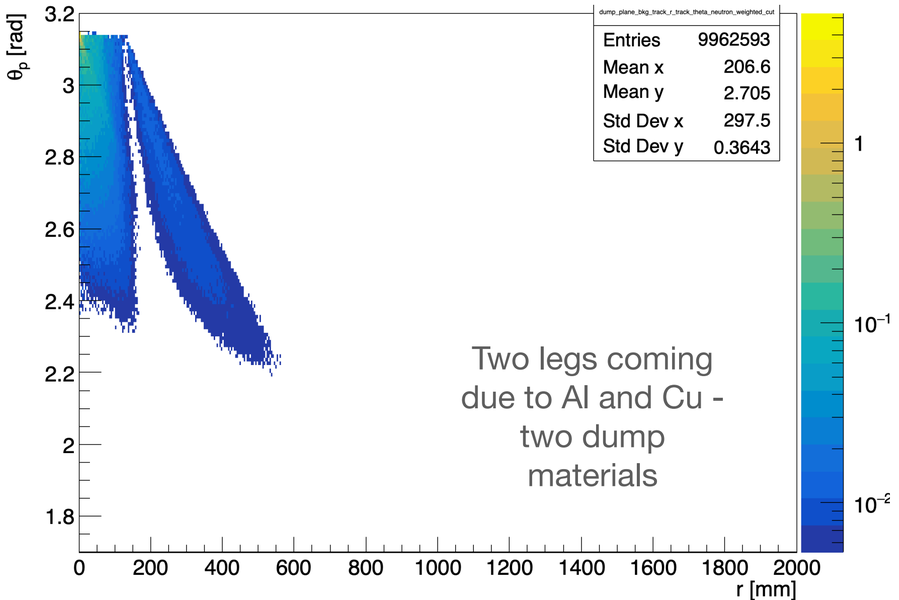


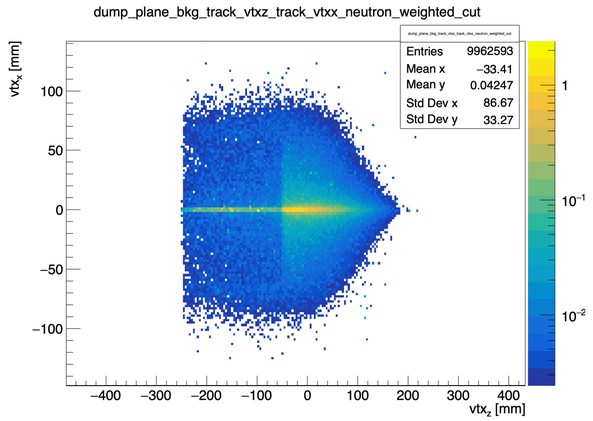
Uniform in azimuthal angle

Correlation plots: neutron









★θ_p and r are correlated.

★E and r, E and θ_p are not correlated.

★To parametrize the neutrons from dump, we can utilize

- ★Correlation of θ_p and r
- ★1D distribution of E
- ★ Will use uniform timing distribution upto 1us.

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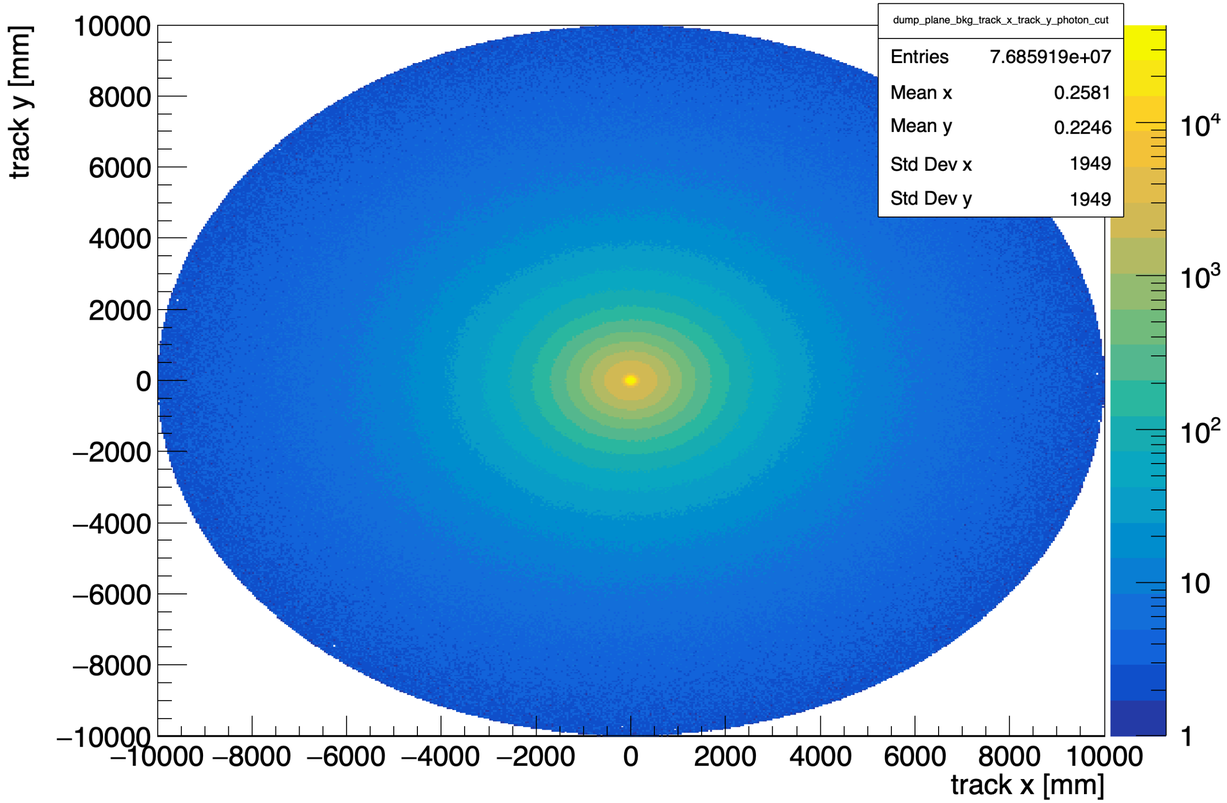

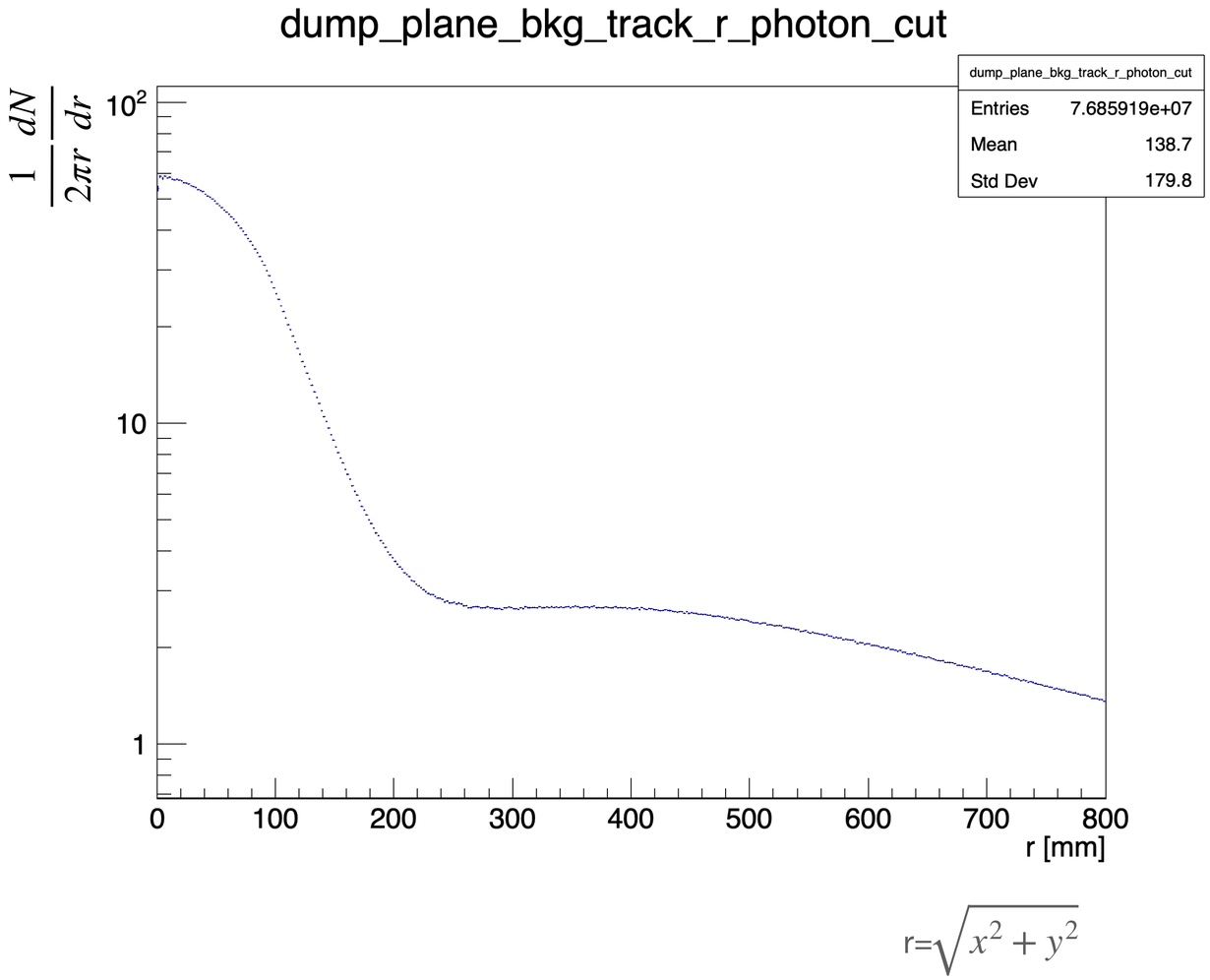

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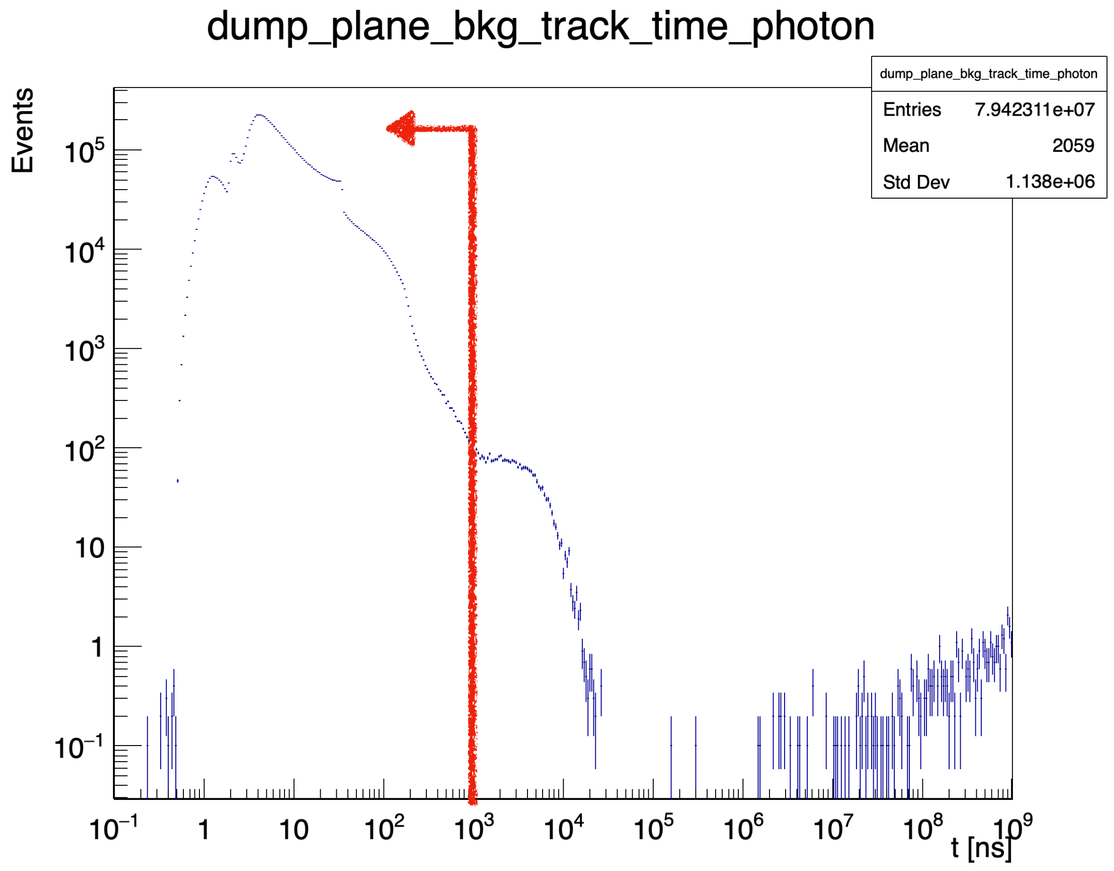

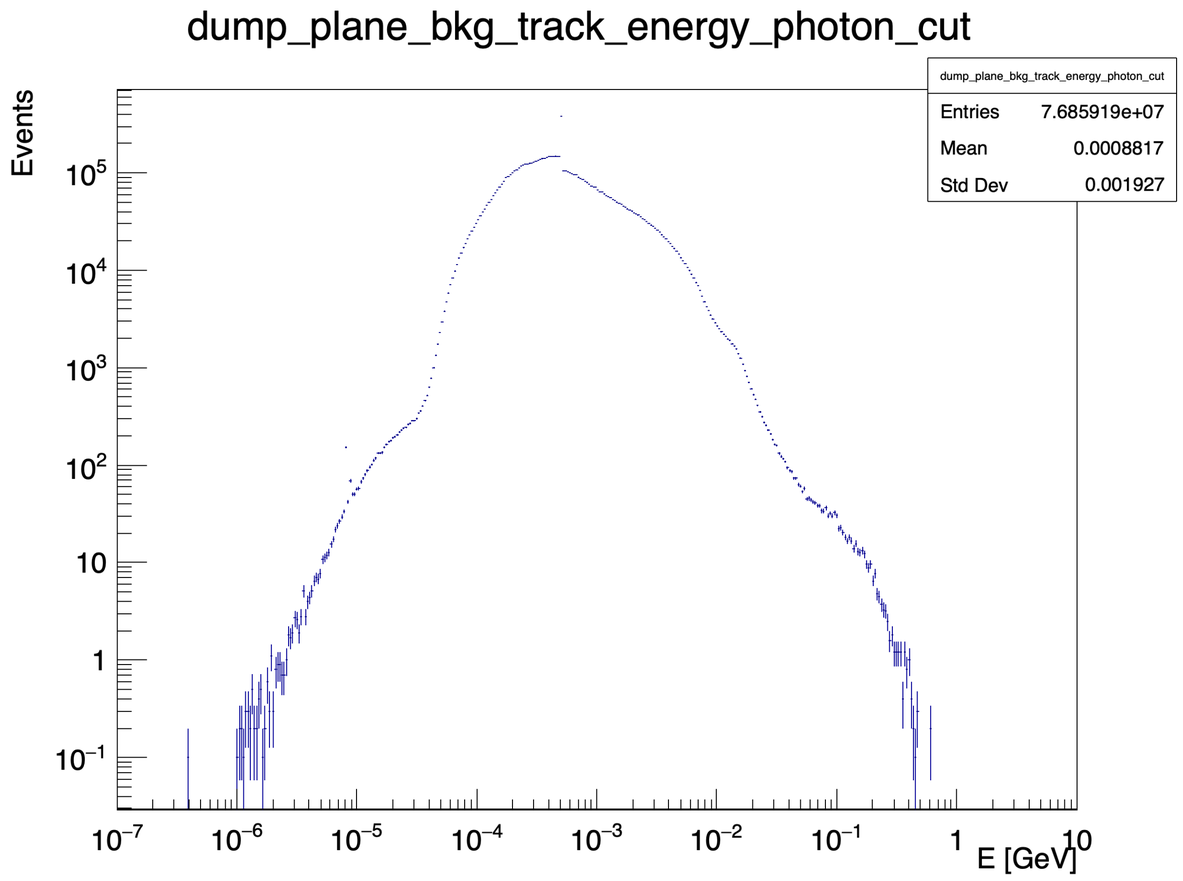

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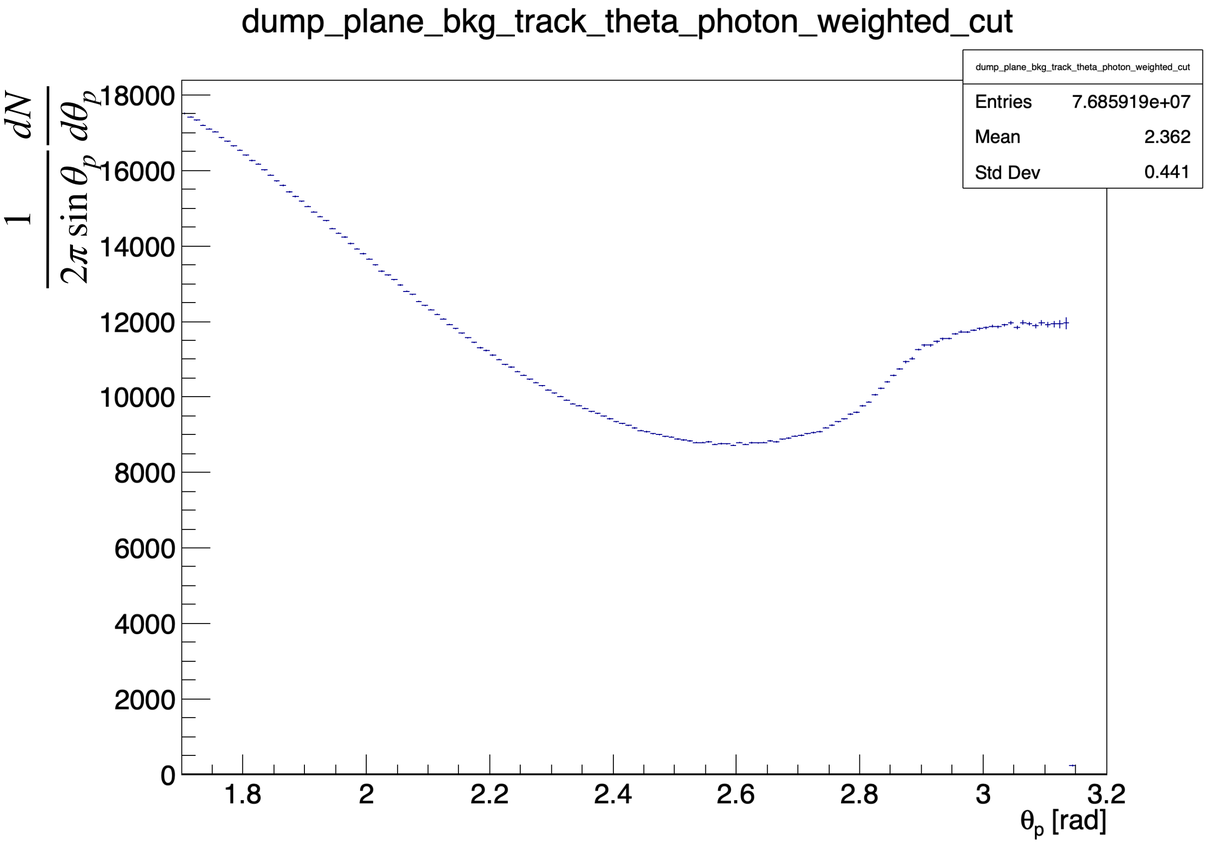

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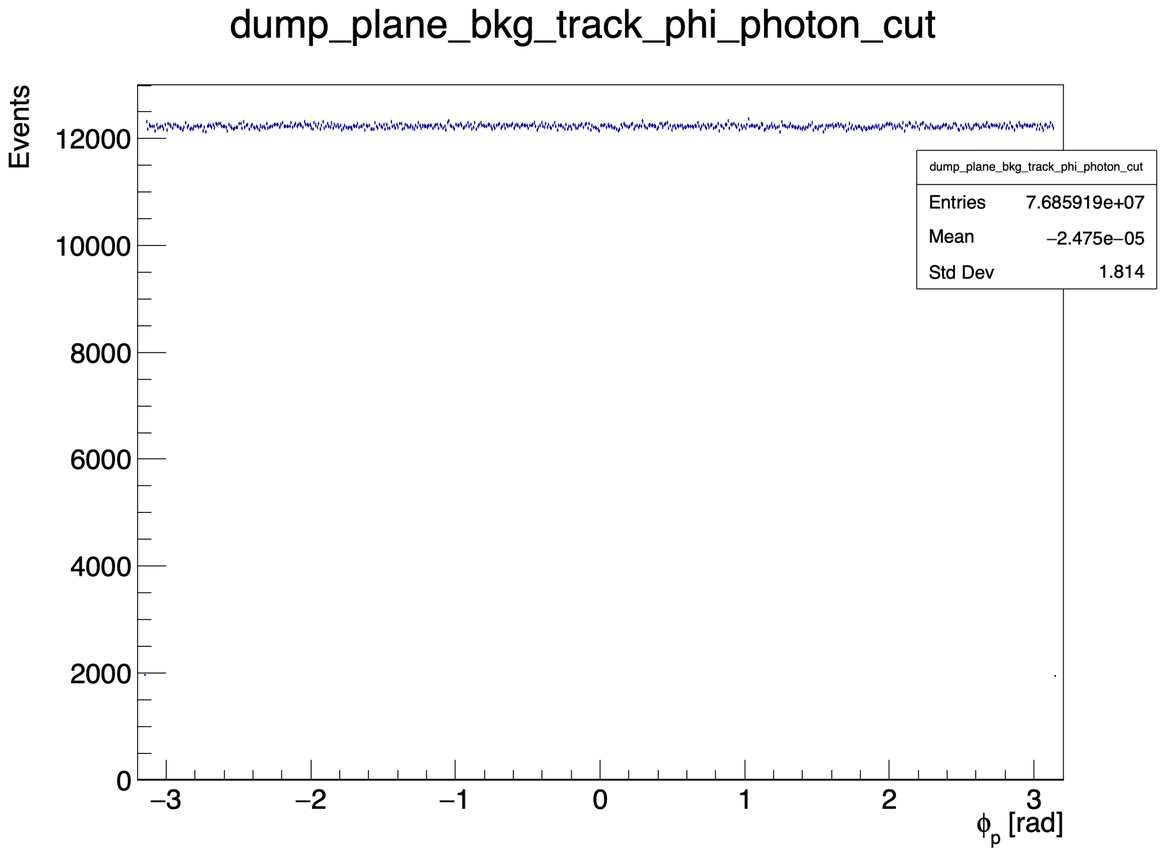

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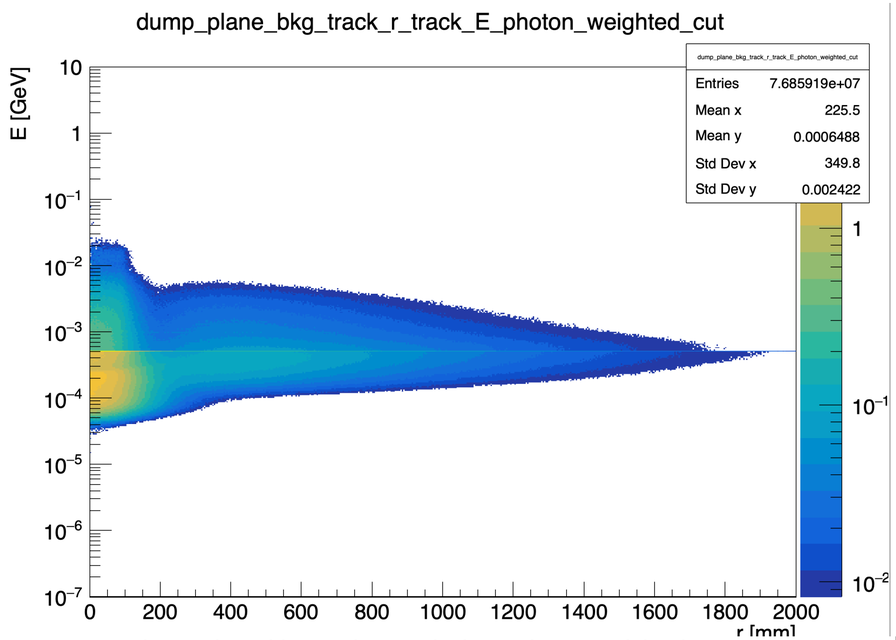

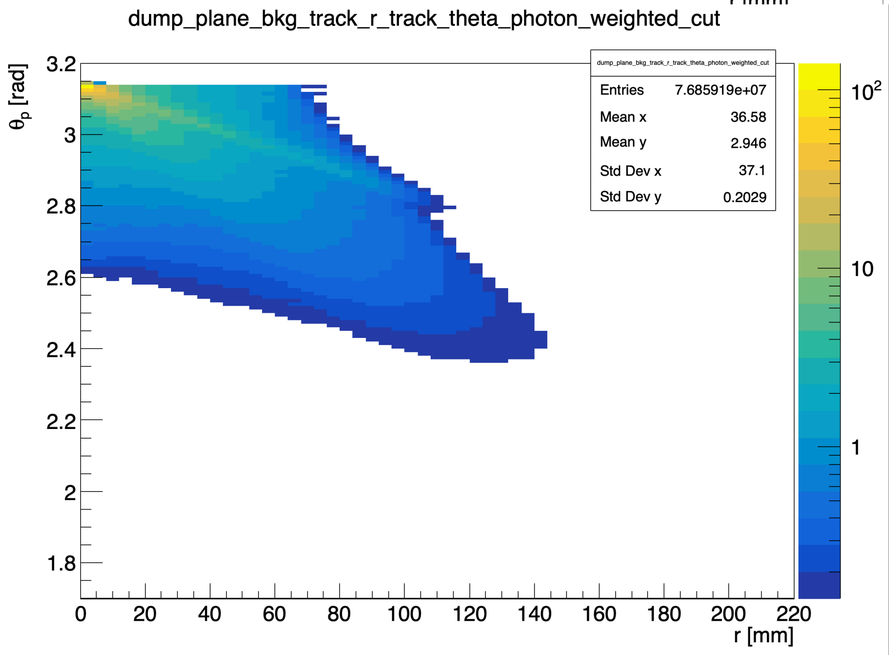

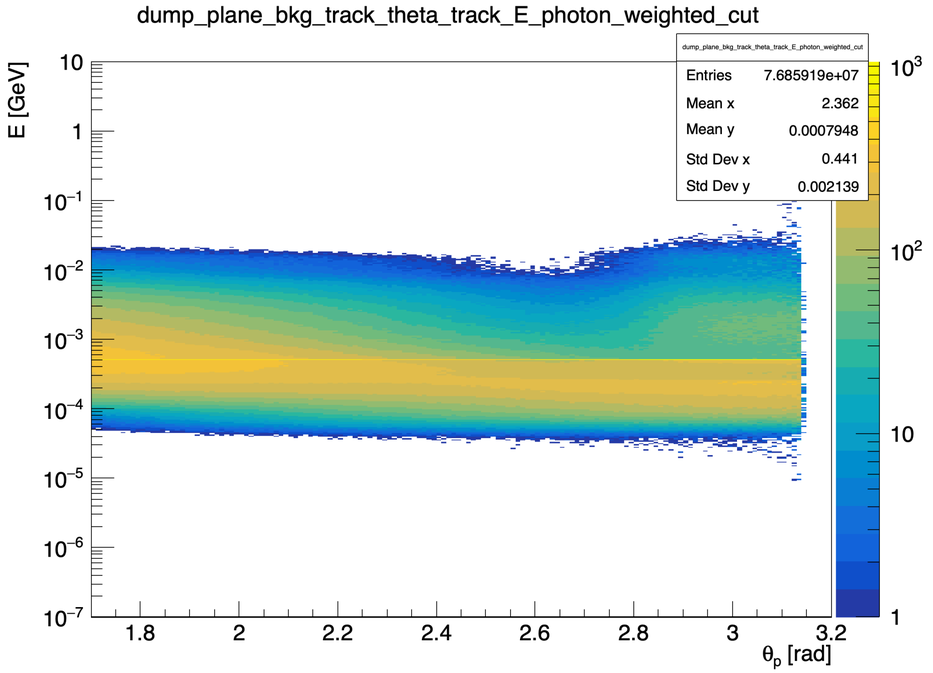

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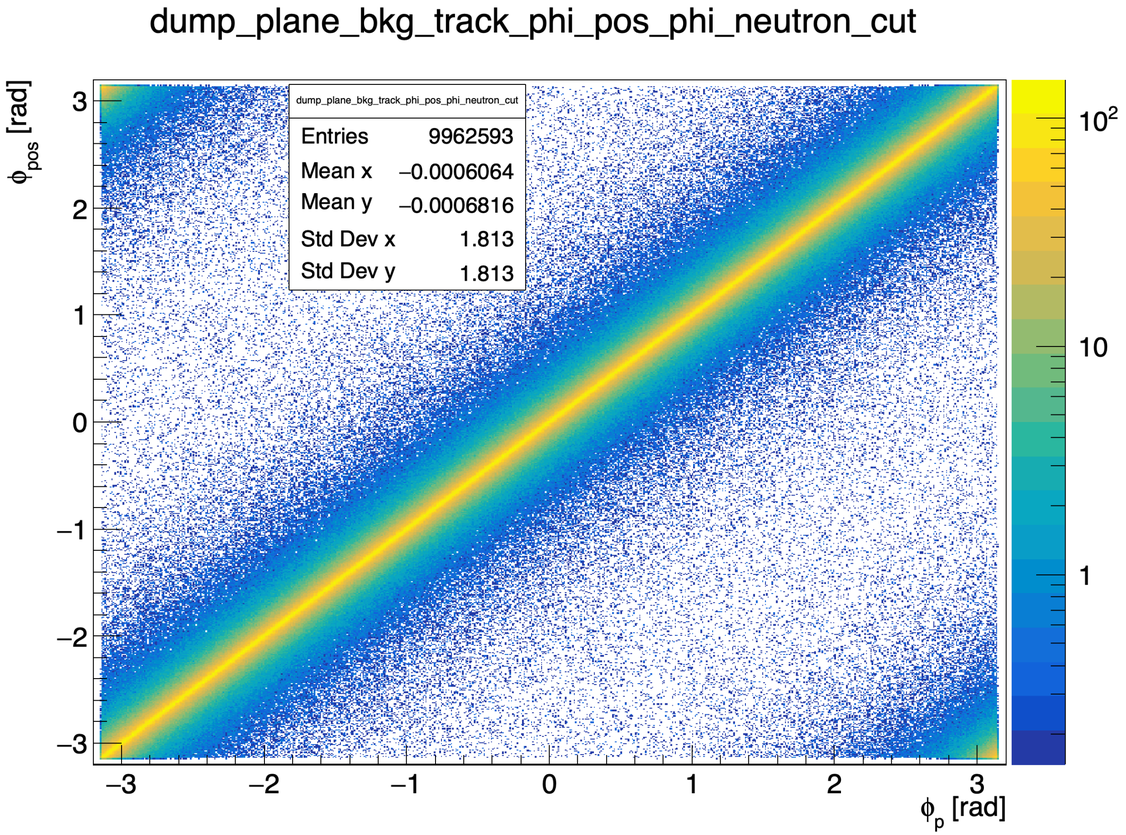
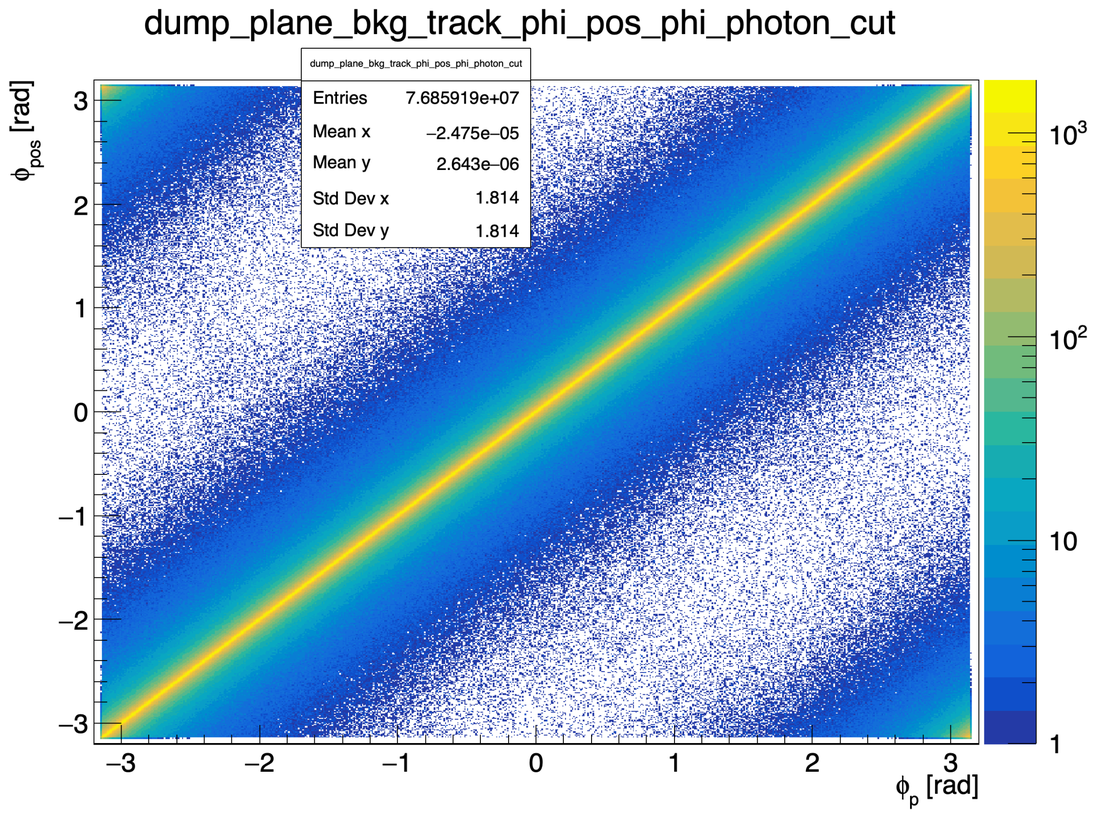
Summary

- It is possible to parametrize the response of the dump
  - Will replace the dump with “particle gun” generating neutrons and photons
  - Generate r (find θ_p using correlation) and E given the distribution.
  - Validation of this by comparing result with FullSim sample with dump.
- Will provide the E, pdgId, p_x, p_y, p_z, r distributions to Sasha to implement dump parametrization in Geant4 simulation.
  - Need to carefully translate to LUXE coordinate system.

Backup

Correlation between ϕ_p and ϕ_{pos}





Correlation between θ_p and θ_{pos}