PHYS5070 Project
Gamma+Jet study for R=1.0 and R=0.4 Jets using PYTHIA Python Interface

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Motivation Behind Project

- What is Quark-Gluon Plasma (QGP)?
  QGP is a state of matter where fundamental particles that make up nucleons, such as protons and neutrons, are no longer confined. They are free are to roam space!
- How can we make QGP and study it?
  We can create QGP by colliding heavy-ion particles and we can study it by looking at how particles interact with it. In our project we will use jets with the following radii: 0.4 and 1 to help us study QGP.
- What questions are your trying to answer in this project?
  Which jet, with radius 1 or 0.4, will loose more energy and why?
- What tools will you be using for this project?
  We will use PYTHIA which is a particle generator that can simulate colliding heavy-ions. We will also be using pyROOT to help us analyze our generated samples.

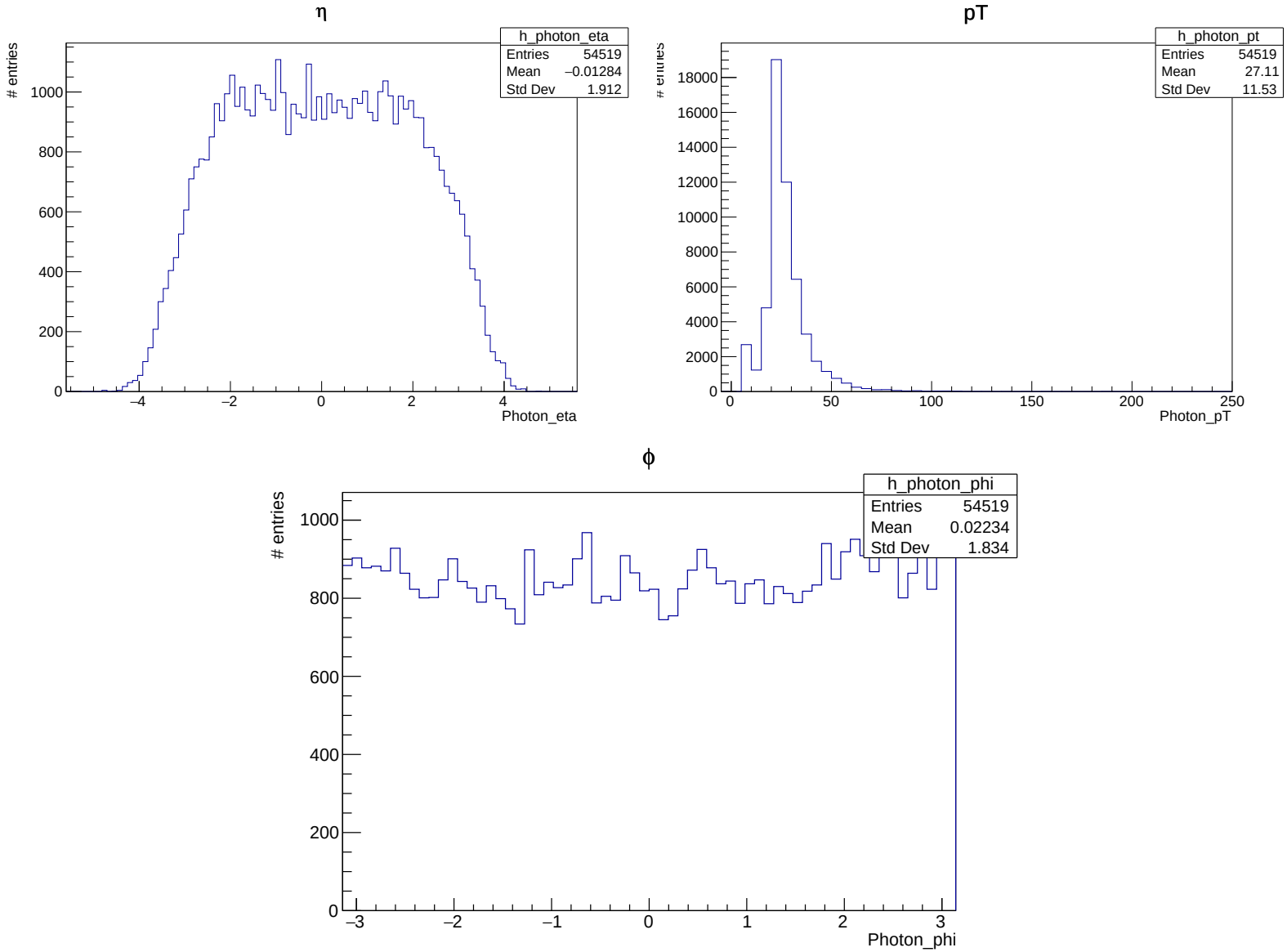
Observables

- Jets with Radii R=1.0 and R=0.4
- Photons
- Gluon jets
- Quark jets

Jet and Photon Cuts

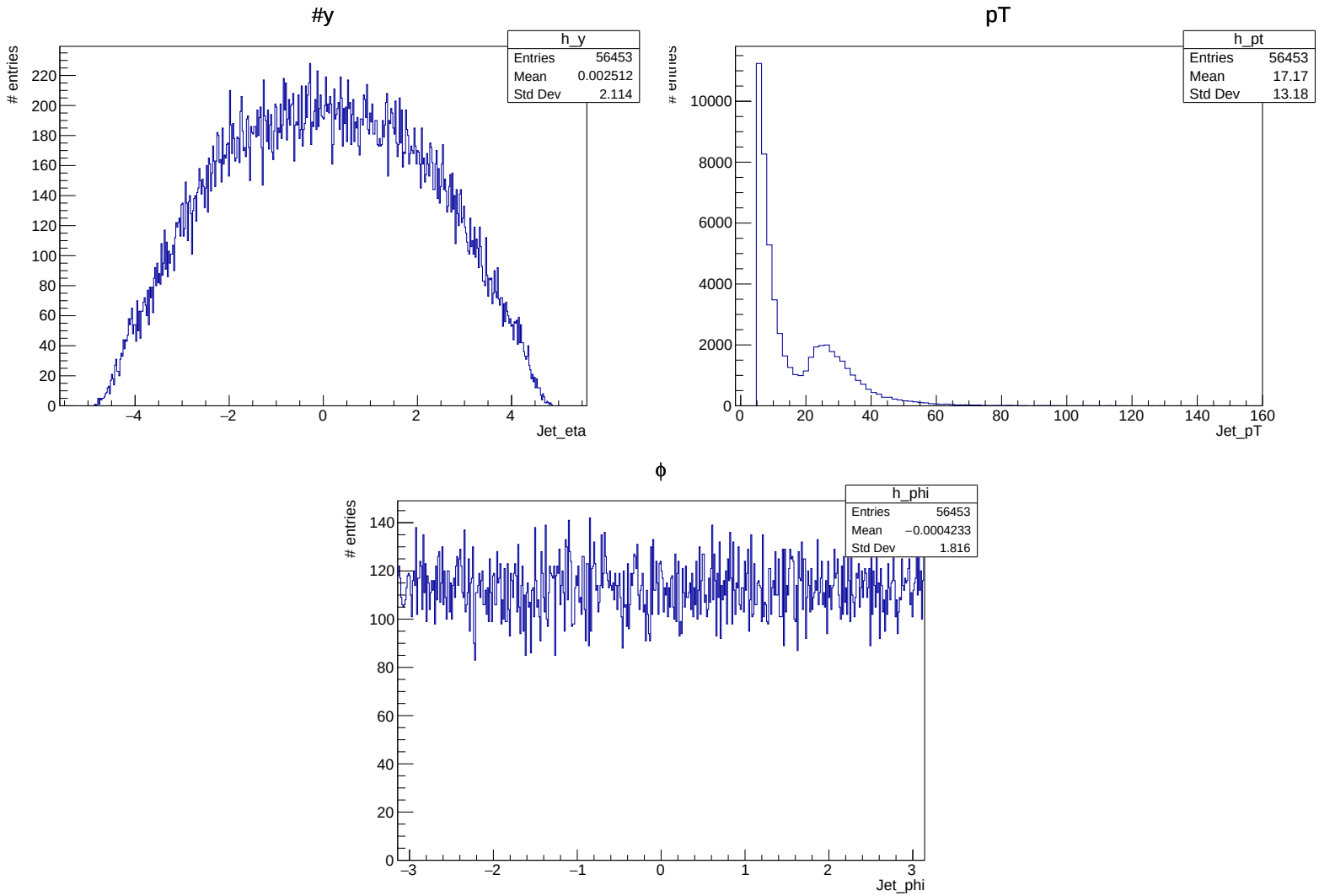
- $p_T^J > 20$ GeV
- 800 GeV $> p_T^\gamma > 5$ GeV

η, ϕ, p_T distribution of Photons



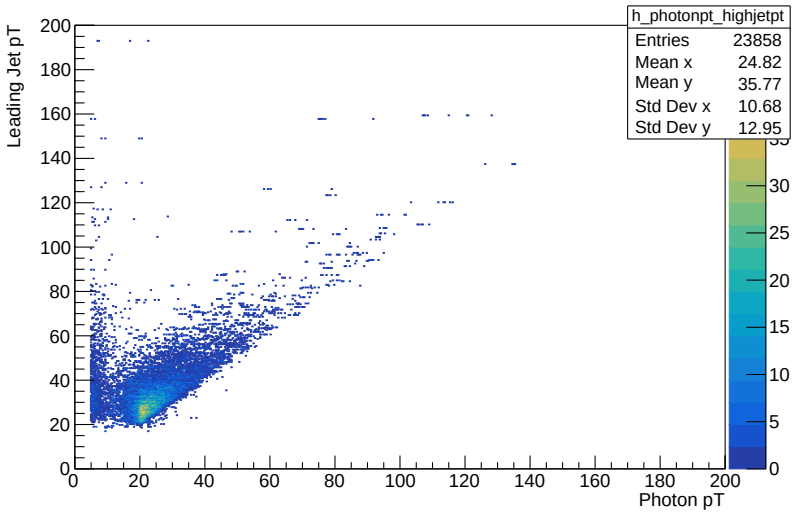
- Distributions looks as expected.

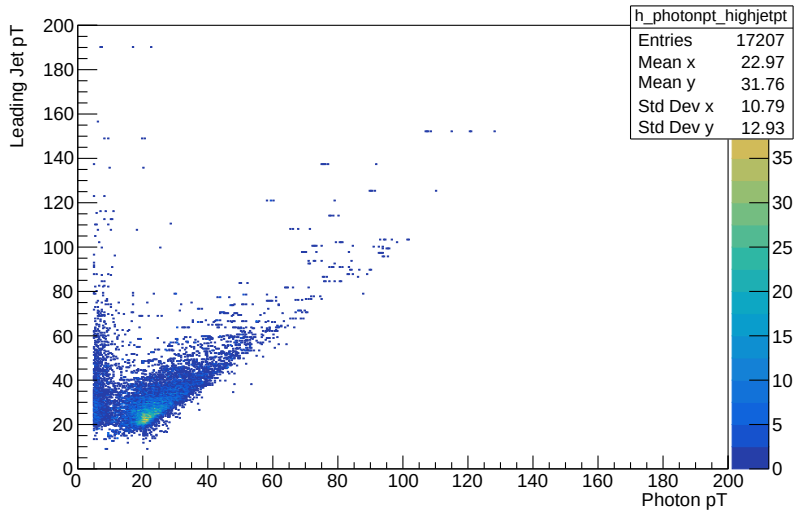
η, ϕ, p_T distribution of R=1.0 Jets from pp collisions



- Same plots are pp and Pb+Pb for R=1.0 jets and R=0.4 jets are included in the repository.

photon pT vs highest jet pT for pp

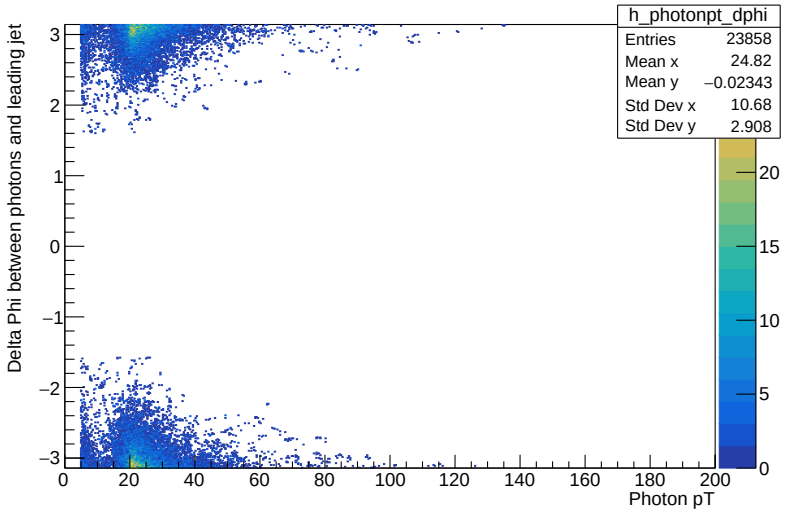


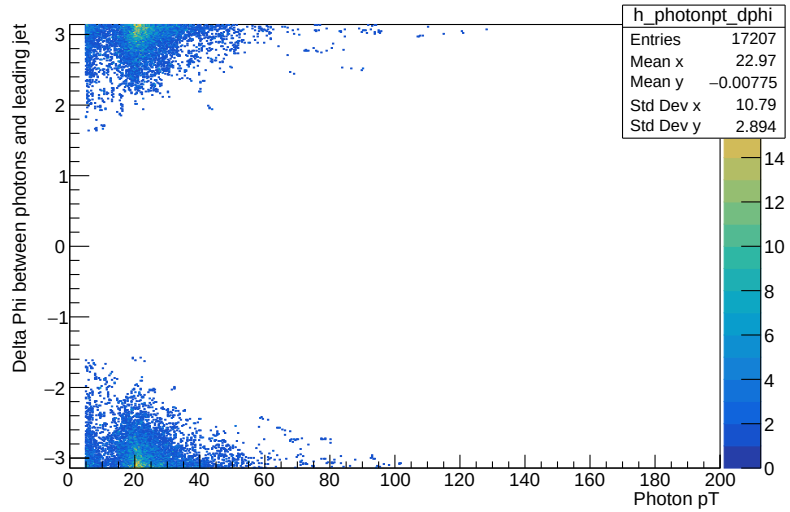


Left side: Jets with R =1.0 Right side: Jets with R =0.4.

- Similar plots for Pb+Pb are included in the repository.
- This plot is interesting. We see a linear correlation between photon pT and leading jet pT. This explains momentum conservation between jet pT and photon pT.

photon pT vs highest jet delta phi for pp





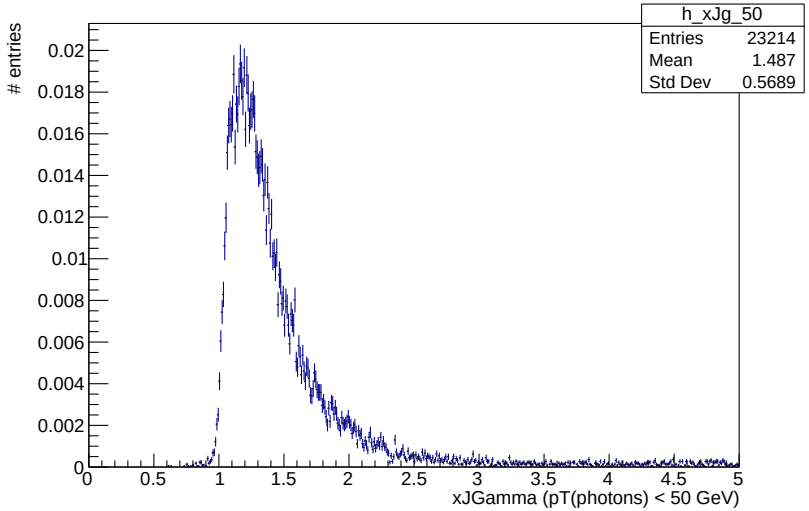
Left side: Jets with R =1.0 Right side: Jets with R =0.4.

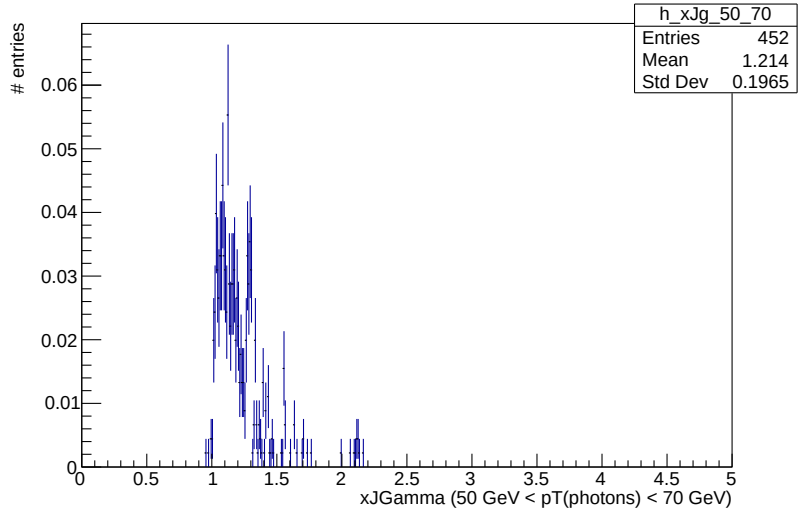
- Similar plots for Pb+Pb are included in the repository.
- We see a hot spot in the delta phi $\pm\pi$ region. This explains that the jets and photons were produced with a delta-phi $\pm\pi$, that is back to back collision, again confirming momentum conservation.

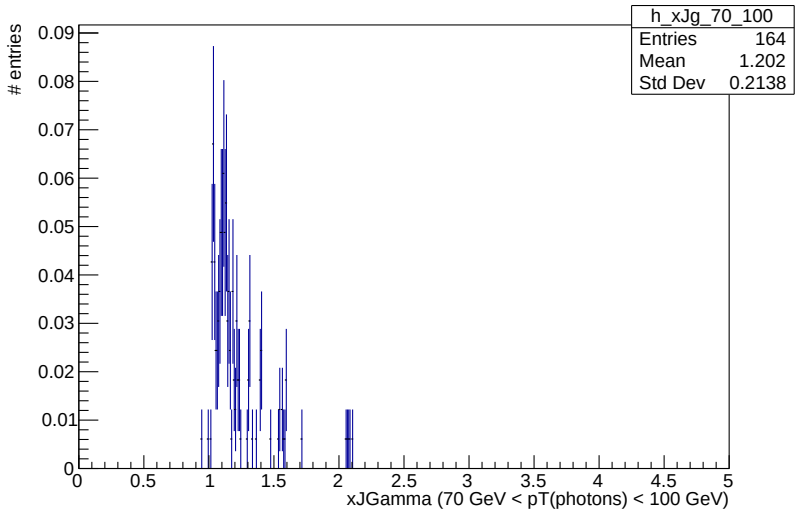
What is $x_{J_{Gamma}}$?

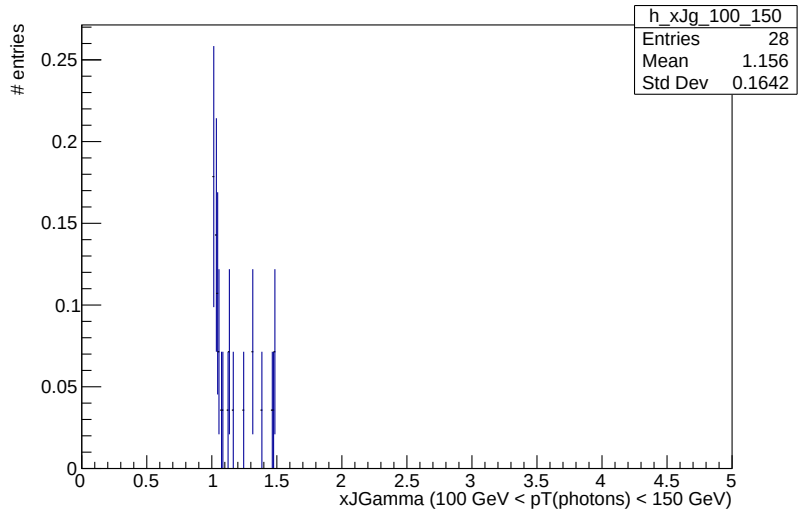
- We can model jets as a cone with a specified radius which would tell us exactly how many energy the jet contains.
- Jets created in association with a photon of high momentum can be used to study energy loss in QGP.
- The photon-jet observable called xJGamma tells us about the energy loss. We construct xJGamma for jets with radii R=0.4 and R=1.0 for both pp and Pb+Pb.
- xJGamma is constructed by taking the ratio of leading jet pT to the photon pT.
- If xJGamma is very much less than 1, that would mean jets lost energy and > 1 would imply otherwise.
- pp is a very small system. Jet quenching (energy loss) is not generally observed.

X_{Jg} = Leading jet pT/photon pT for R=1.0 Jets for pp

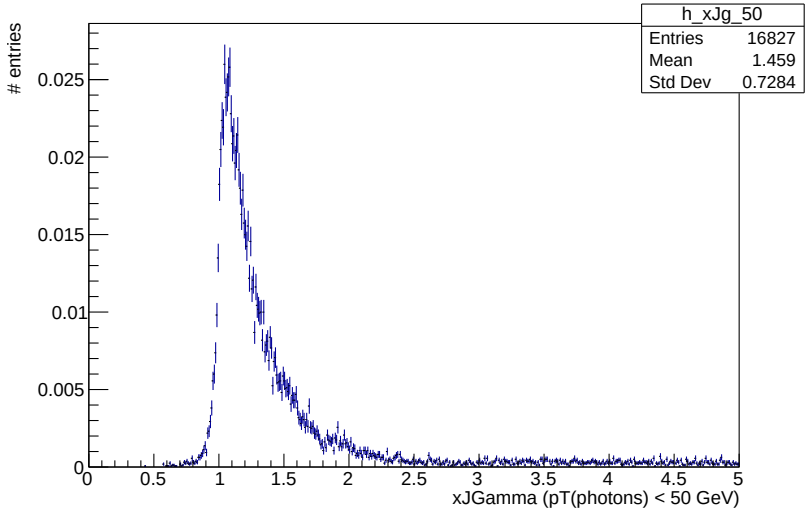


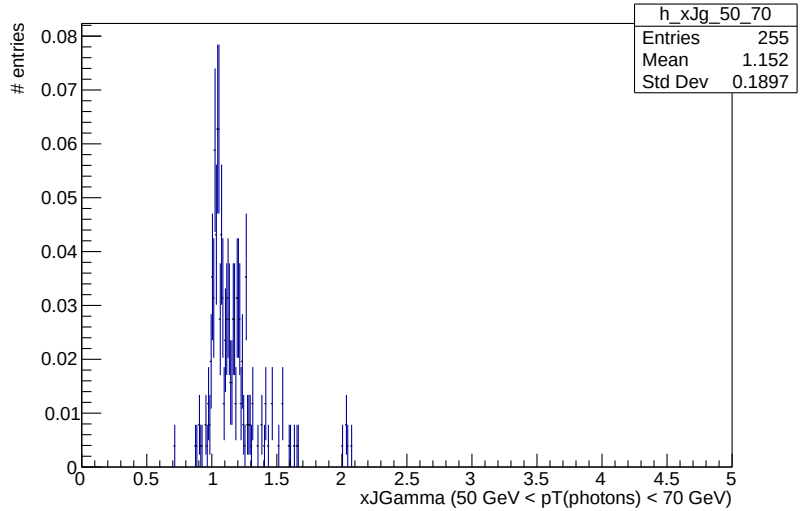


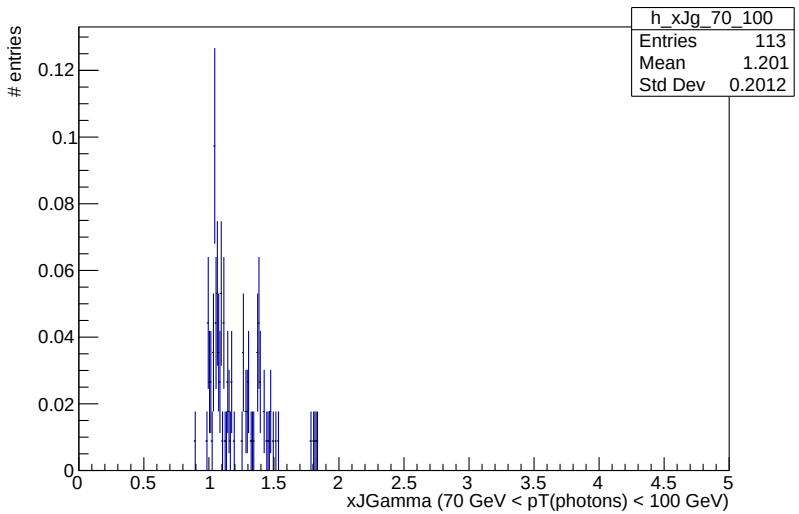


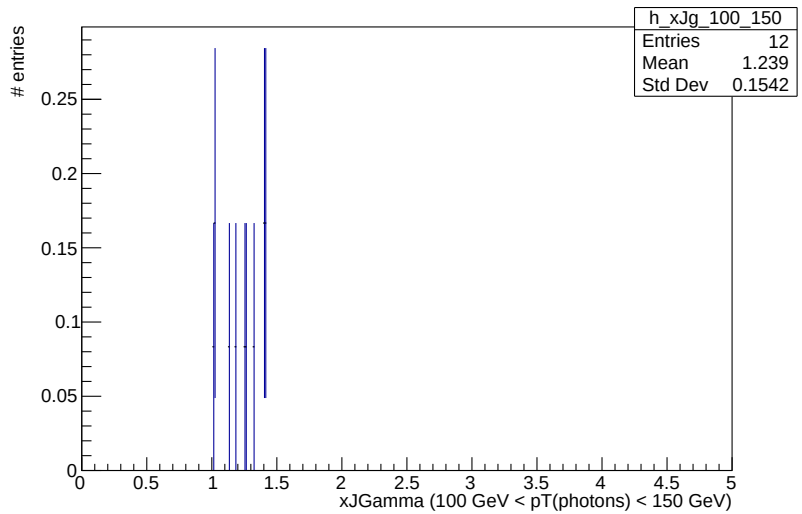


X_{Jg} = Leading jet pT/photon pT for R=0.4 Jets for pp









Conclusion

- As observed in the plots shown in the above slides for R=1.0 and R=0.4 jets, the xJgamma peaks very close to 1 as is generally observed.
- When comparing xJGamma for R=0.4 jets and R=1.0 jets we see R=0.4 jets stay close to 1 than R=1.0 jets. This implies that R=1.0 is at a higher risk of capturing energy that does not belong to the jet, which can lead it to be above one.
- Our study shows that jets with narrow radii grabs the highest pT particles whose momentum will be conserved better with the photons.

THANK YOU