# Noise studies

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We wanted to see how the spe_Theta_signal/total ratio changes with different rate of noise injected.

We define as signal: the photons emitted by the charged particle;

Total: the sum of the noise and the signal.

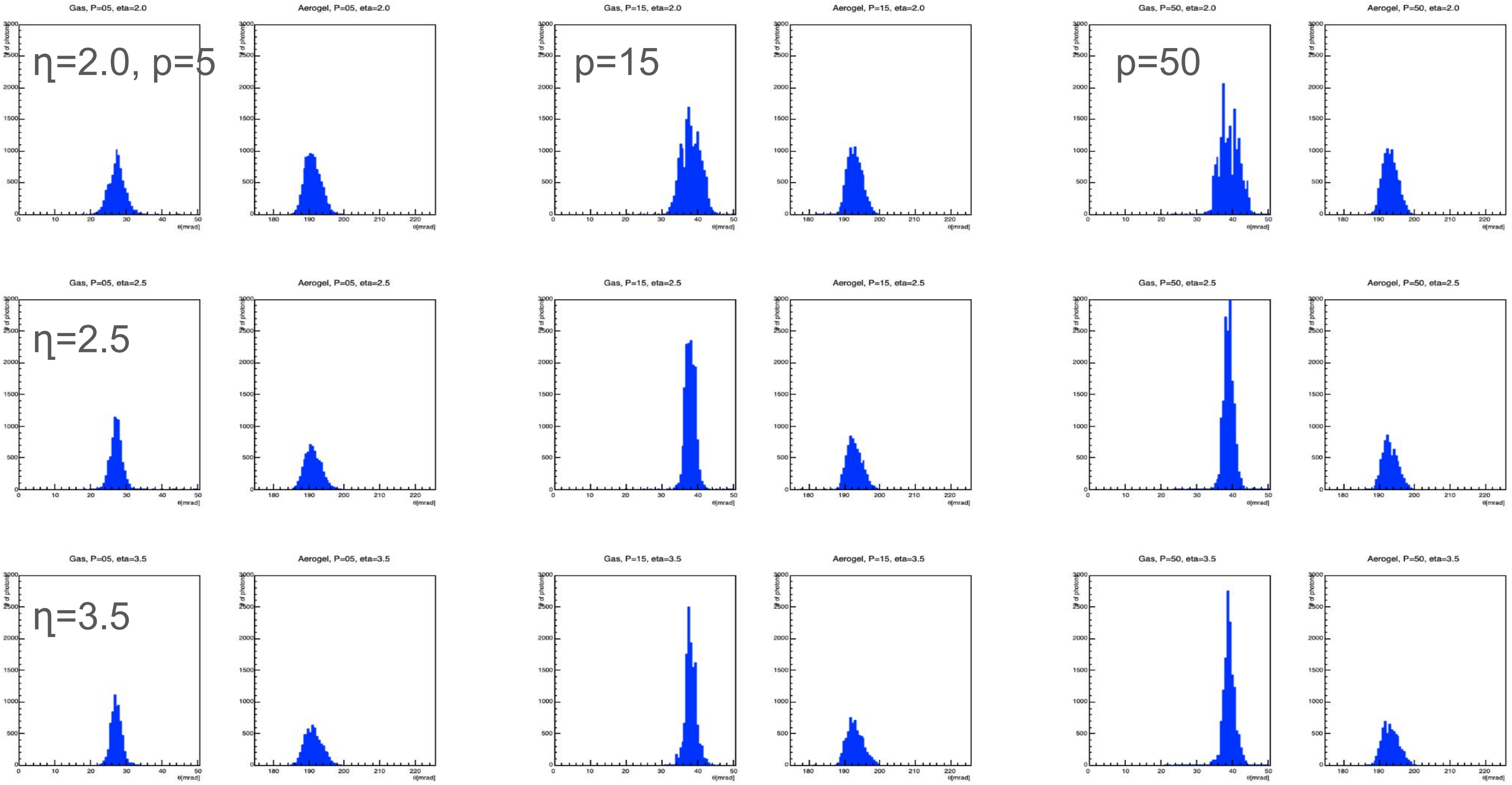
- The rate of noise it’s defined for every pixel and every event;

  Given noise rate=500kHz the program will add: **500k * n_events * time_window** noise hits on each pixel of the detector.

  We kept the time window fixed at 1ns.

- the program is blind to signal and noise hits
- we can compute signal fraction in two ways
  - Fit of the merged spetheta distribution with a gaussian+pol1 fit **(pol1 shape important)**
  - Comparing the spetheta distribution with and without the noise **(fluctuations near signal peak)**
- We launched 1000 single pi+ particle varying η and P

# How distribution looks like without the noise:



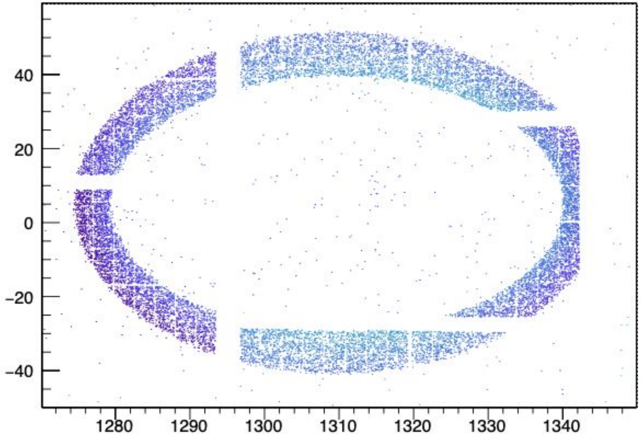
How distribution looks like without the noise:

- The gas ring it’s at smaller angles
- The gas ring have more photons
- Larger η (above 2.5) the distribution is sharper
    - optimal focalization

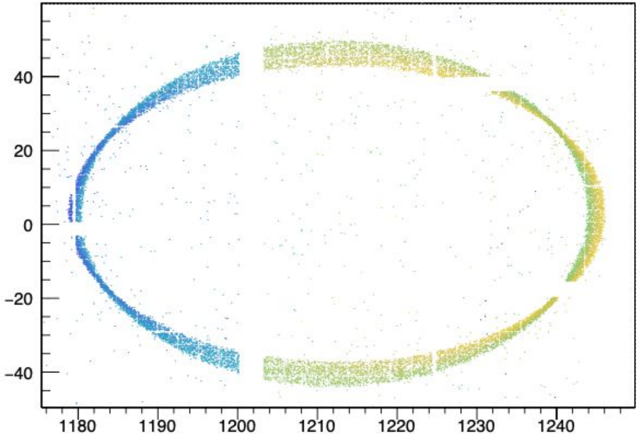
The images show how the gas ring became sharper increasing eta.

Momentum it’s fixed at 15 GeV, the colors are not important.

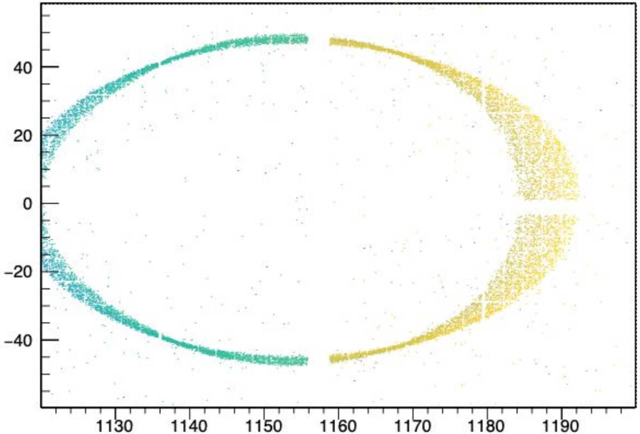
eta=2.0



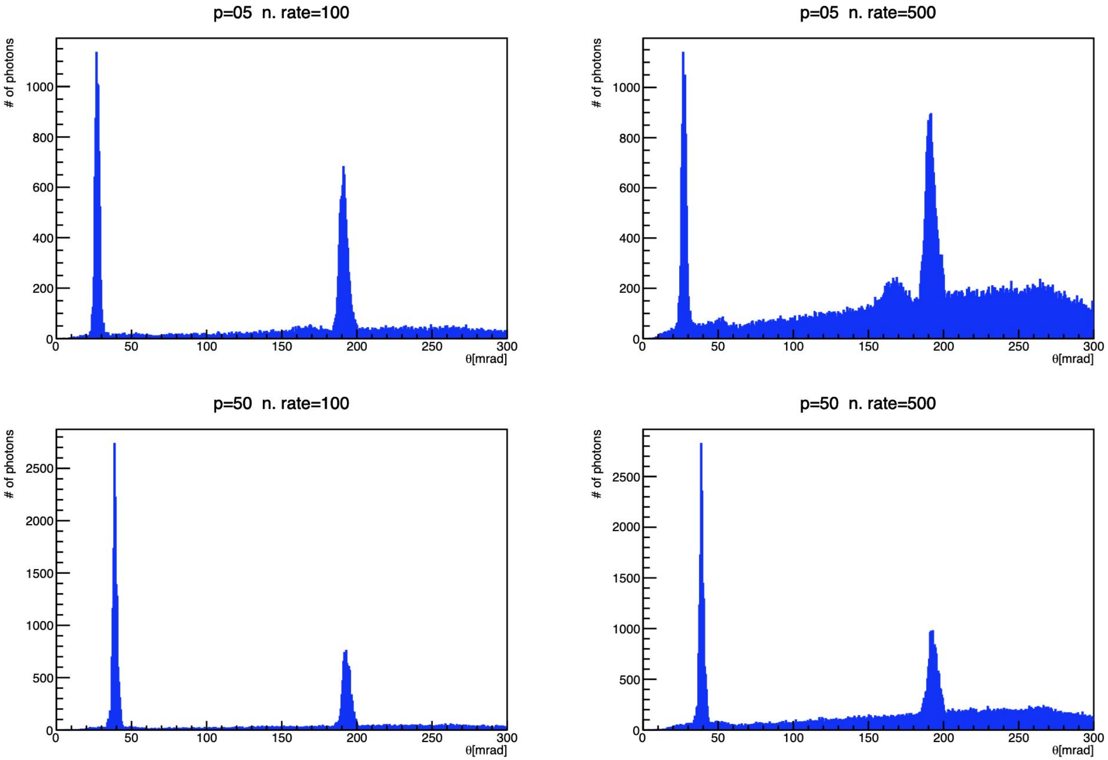

eta=2.5




eta=3.5



With noise what we expect it's a distribution like this:




The noise increases with angle because theta=0 is the center of the ring.

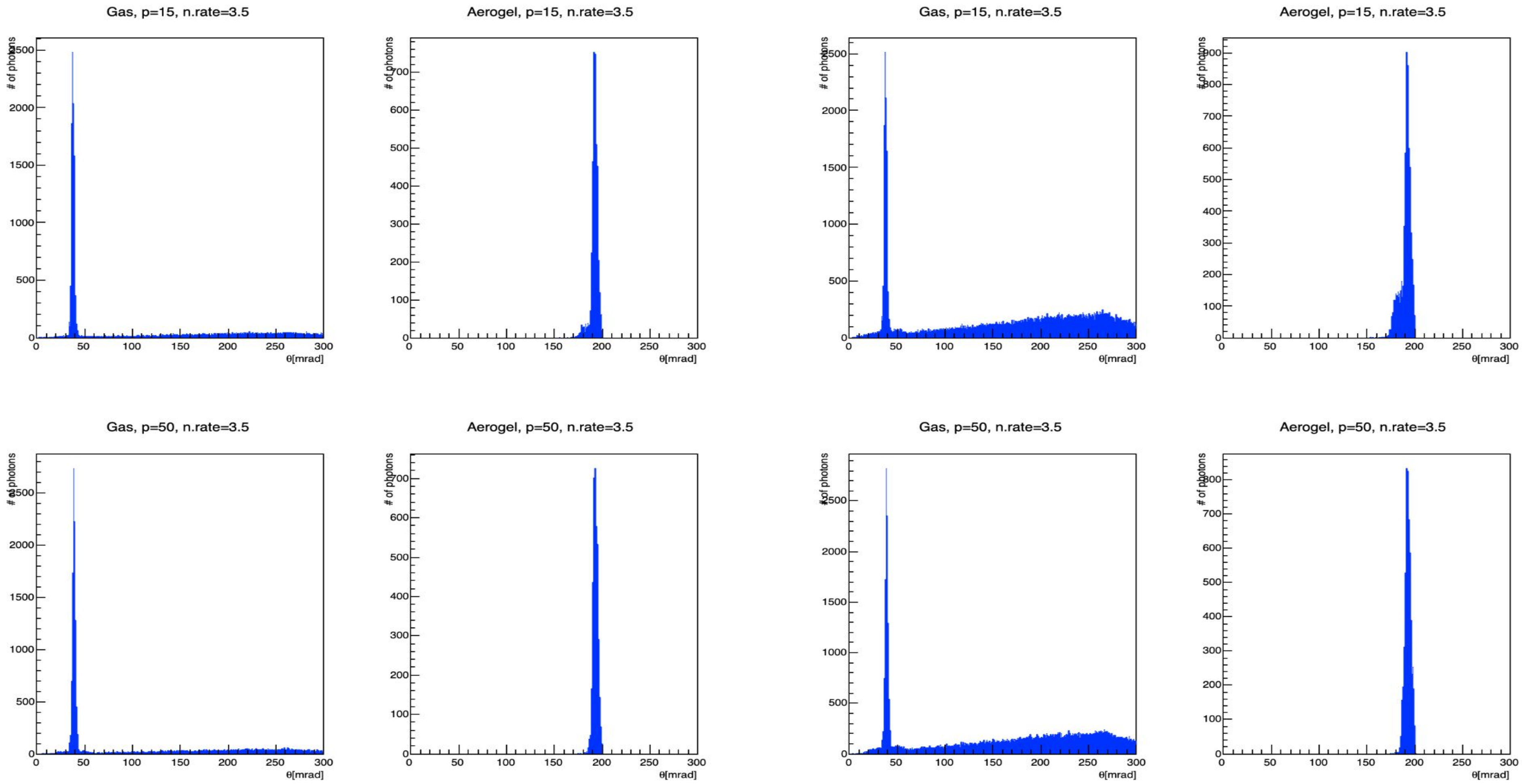
Higher the radius, higher the noise

Until the circumference reach the point where it goes out of the acceptance of the detector and it stops growing.

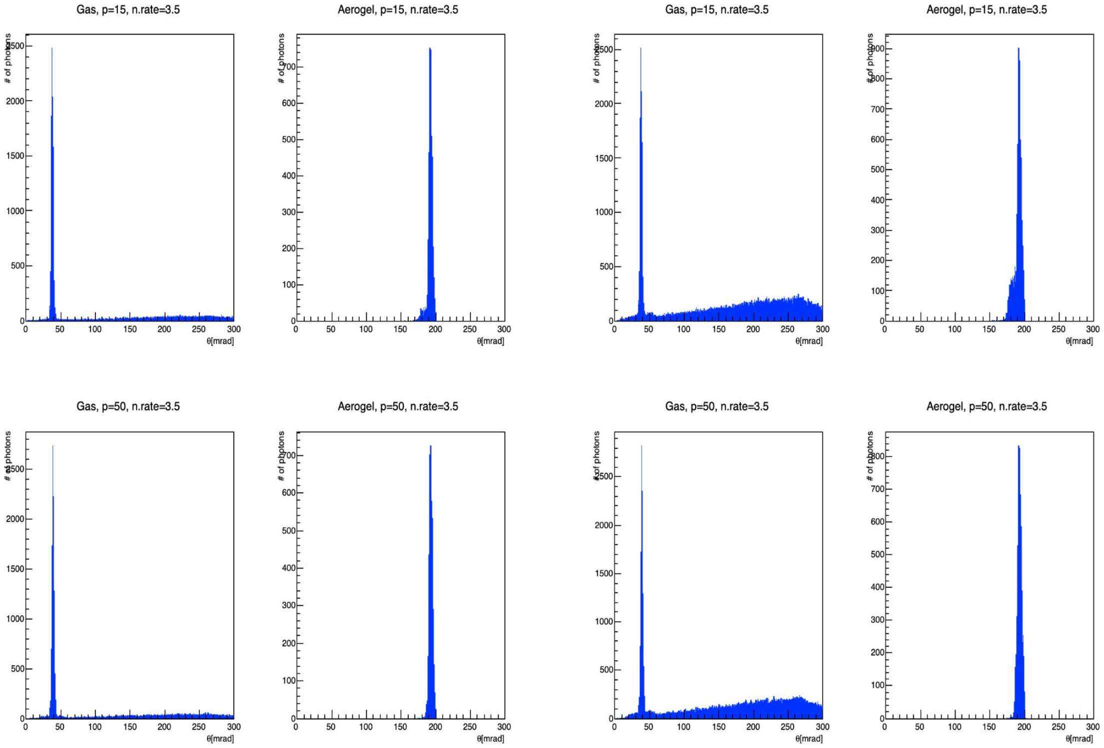
Also the emission point uncertainty prefers small background region for Aerogel and large background region for gas

These are at $\eta=3.5$

# 1) Fit the merged distribution with a gaus+pol1 function



# 1) Fit the merged distribution with a gaus+pol1 function

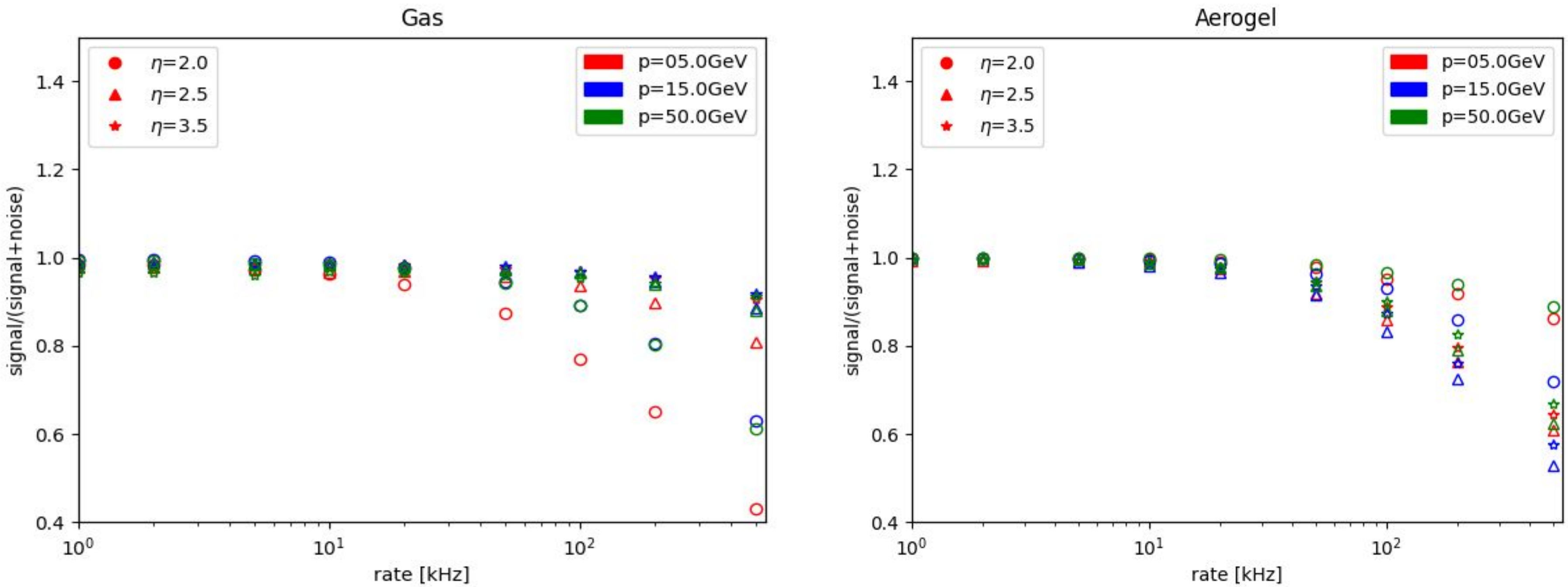



The reconstruction program associate at each photon one emission angle finding a possible emission point, but the Aerogel, being thin, has smaller emission point uncty.

The asymmetry in the Aerogel makes the fit difficult to compute the noise and can be misleading, when all the noise fall under the peak, it can’t be compute at all.

These aere the plots resulting from this method.

At η=2.5,3.5, in Aerogel the ratio goes down more than the gas, as expected, due to having a bigger ring (more noise under the ring) and smaller number of photons emitted, this makes sense. (opt. foc. region)

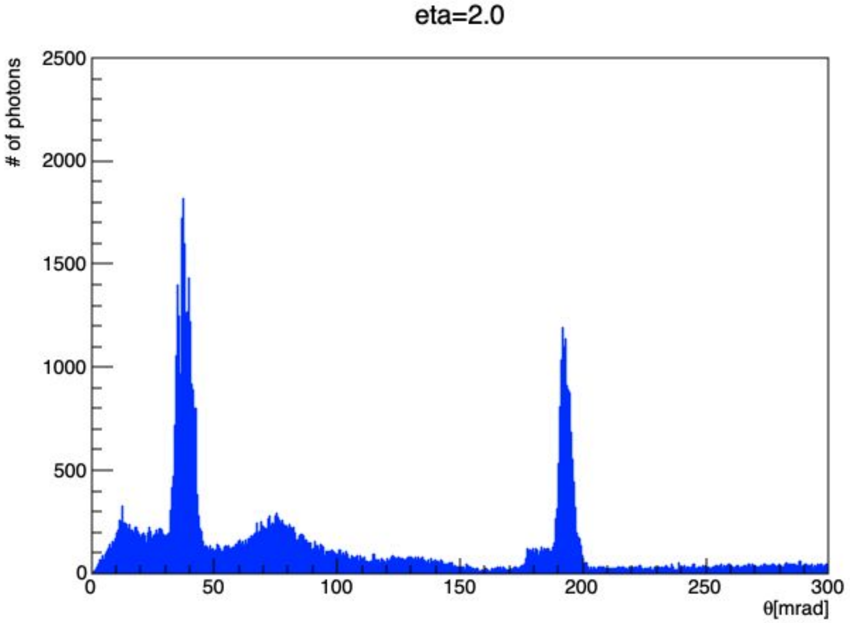


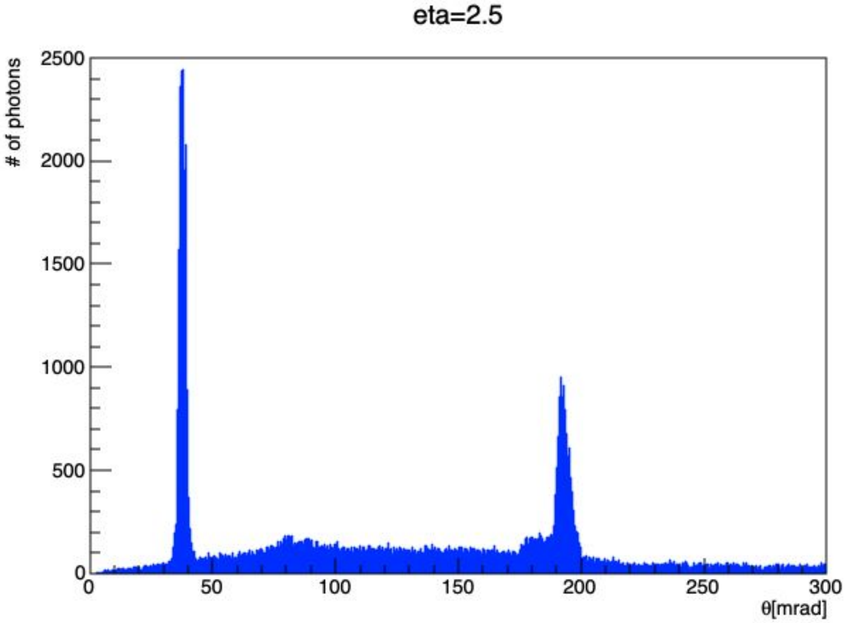

distribution

2.0 behaves very differently from the others.

- In Gas the ratio goes down more
- In Aerogel the ratio is greater than the others

We have to look at the spe theta of emission histogram




We have totally different distributions, both are at p=15Gev, noise rate 200KHz

2) Subtracting the signal from the histogram

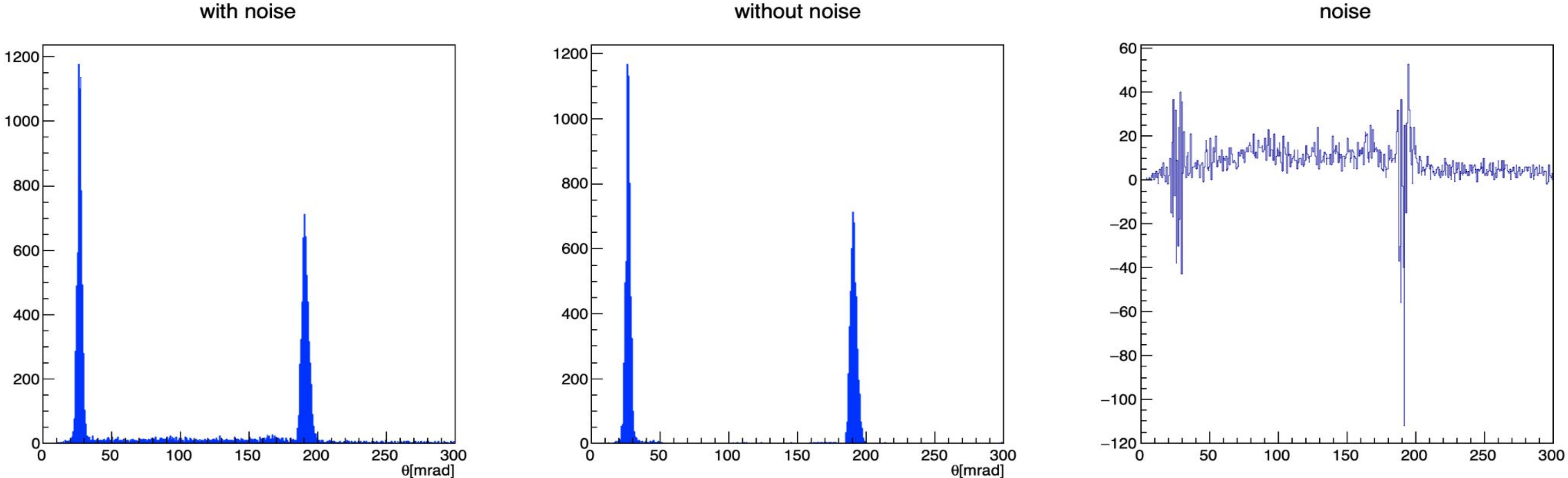
- To compute the noise we subtract bin by bin the content of the speTheta distribution without noise from the one with noise. Then we do the ratio of the sum content within +- 3 sigma
- The simulation is the same, the noise is added at the reconstruction level.

The method is sensitive to bin content systematics which increases larger spe sigma when noise is added.

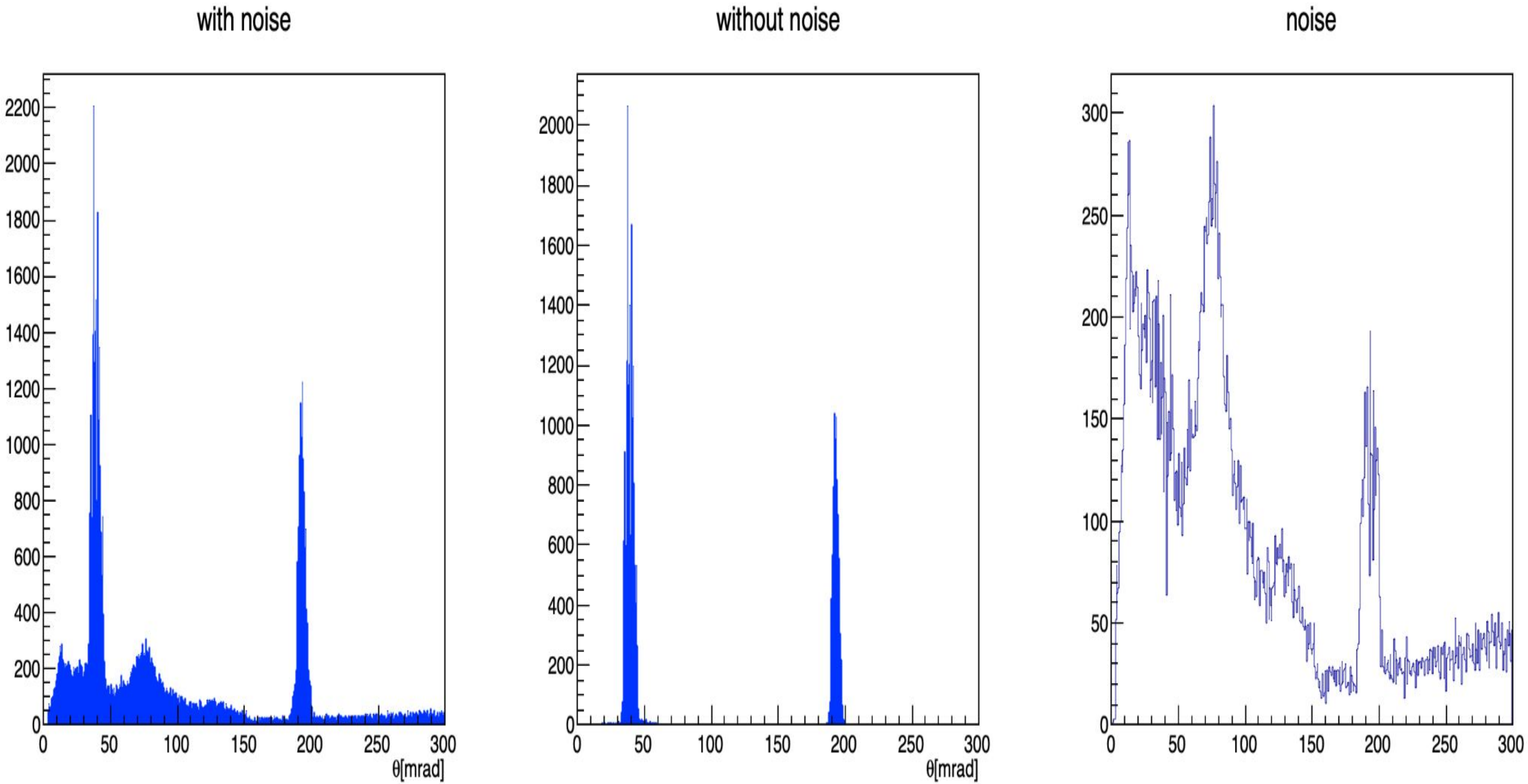
We can have bins in which the signal content it’s bigger than the signal+noise one.

From this we can have some bins  in the signal region where subtracted bin content can be negative, outside it we subtract 0.

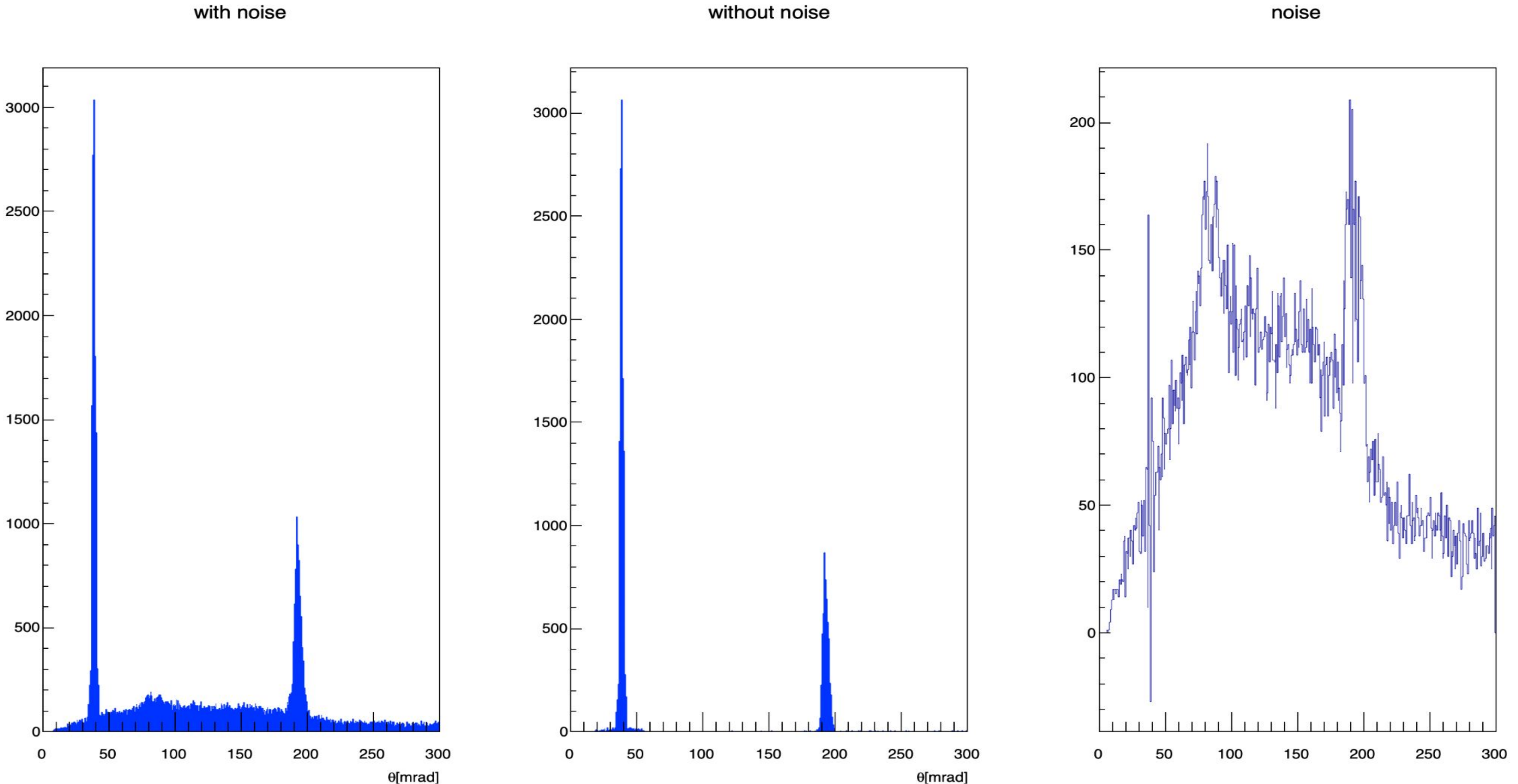
This fluctuations are visible only at low noise rate, on an average the fluctuations cancel out



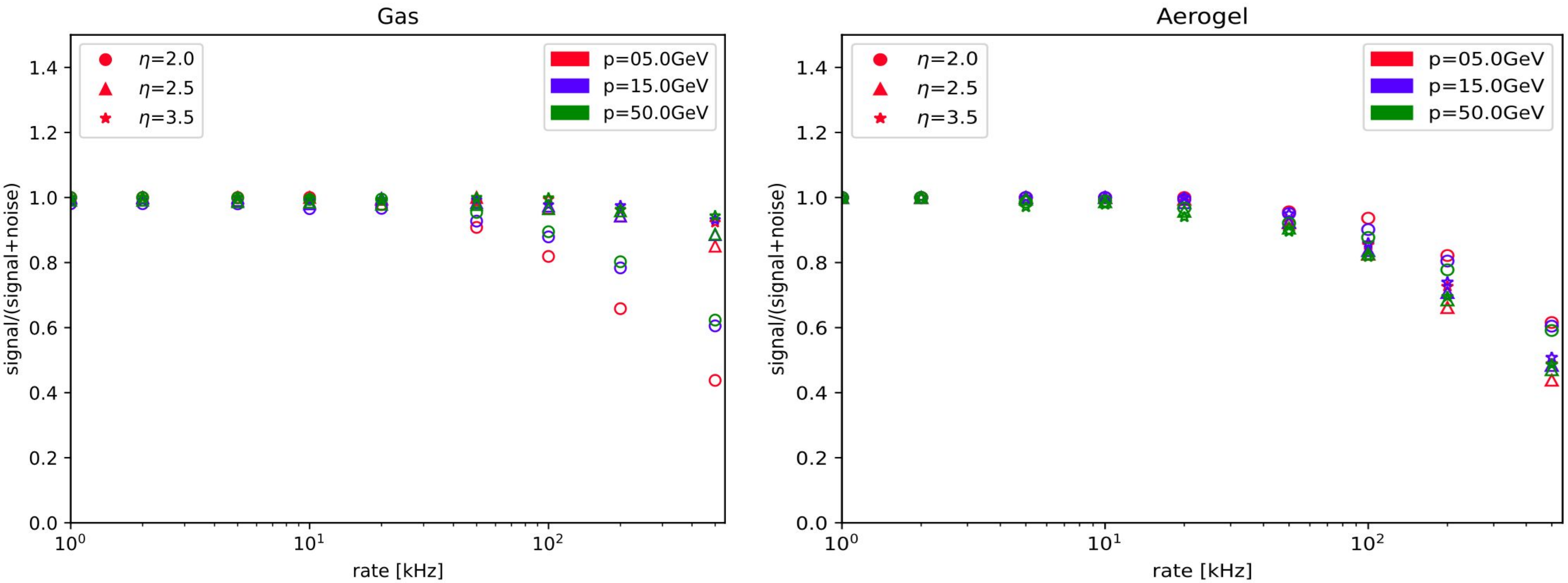
P=50GeV, η=2.0, n.r.=200kHz



# P=50GeV, η=2.5, n.r.=200kHz, linear shape



# With this method we should get better results avoiding the asymmetry of the distribuition

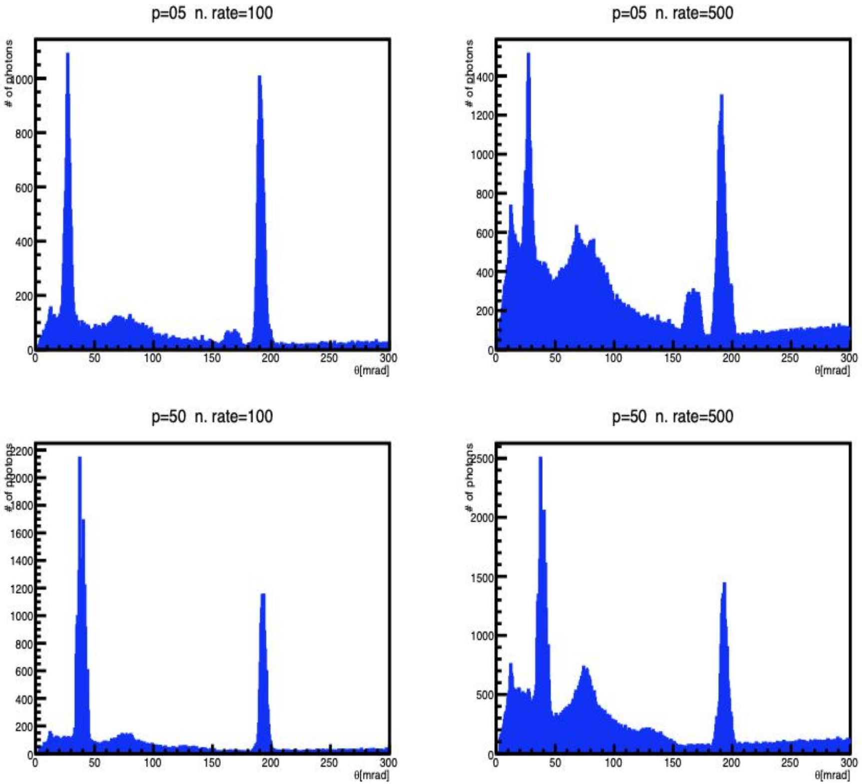



- The Gas distribution it’s the same, as we expected, the problem was in Aerogel
- Even in Aerogel thing get better, but still 2.0 it’s above the others
- We can do an average of the noise before and after the peak to compute it better

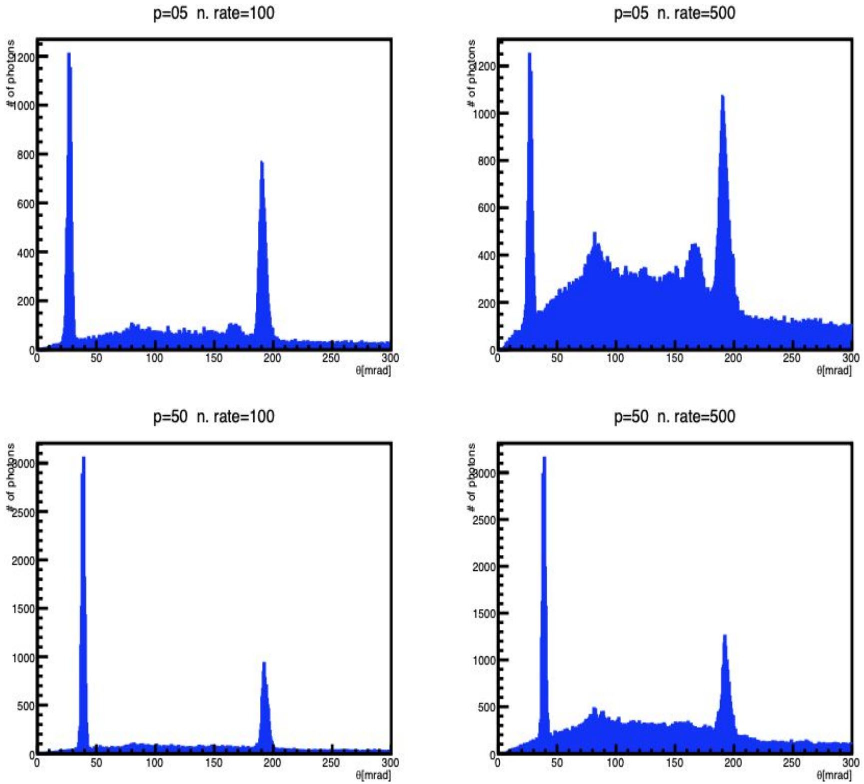
The shape marginally depends on the momentum and the noise rate

Strongly depends on eta

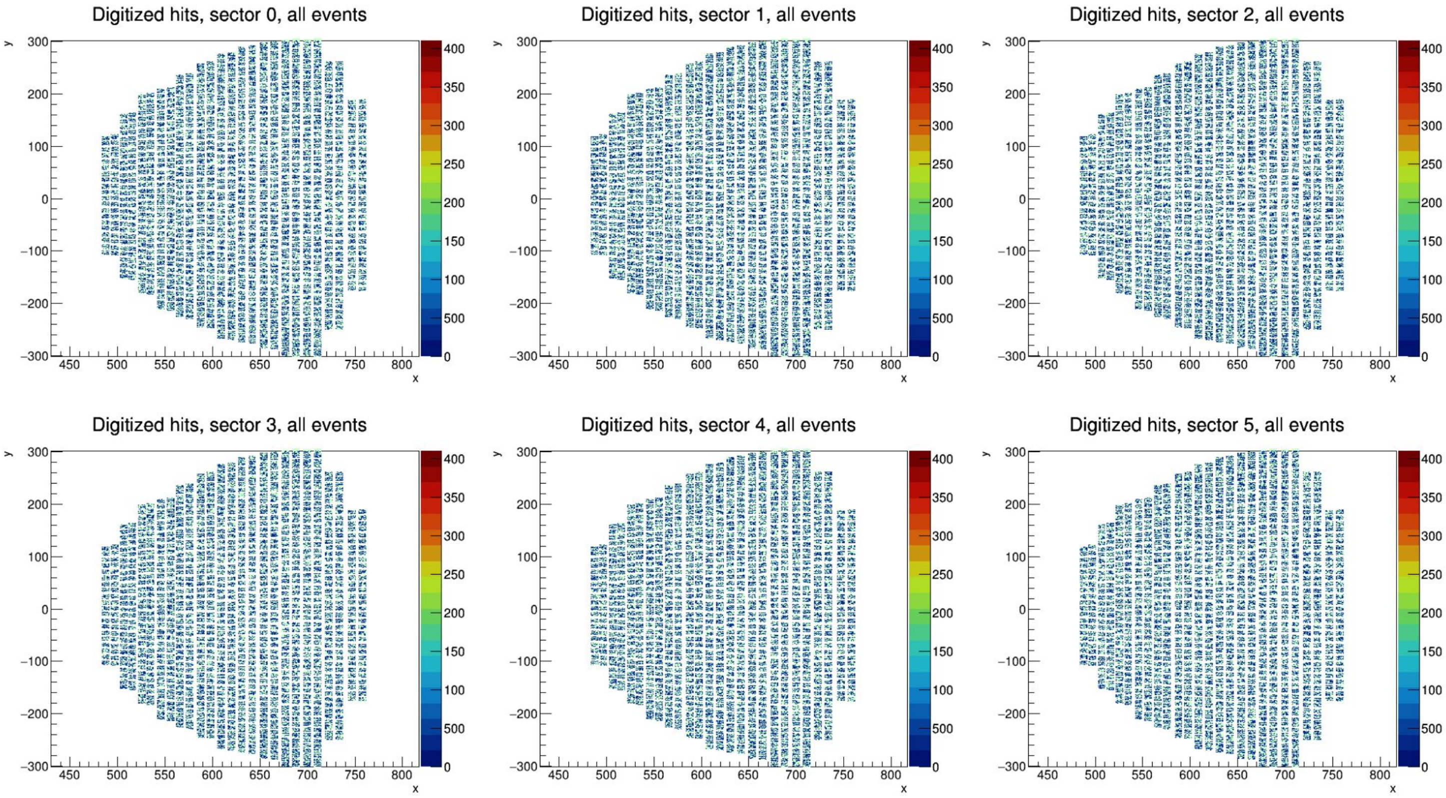
η=2.0




η=2.5

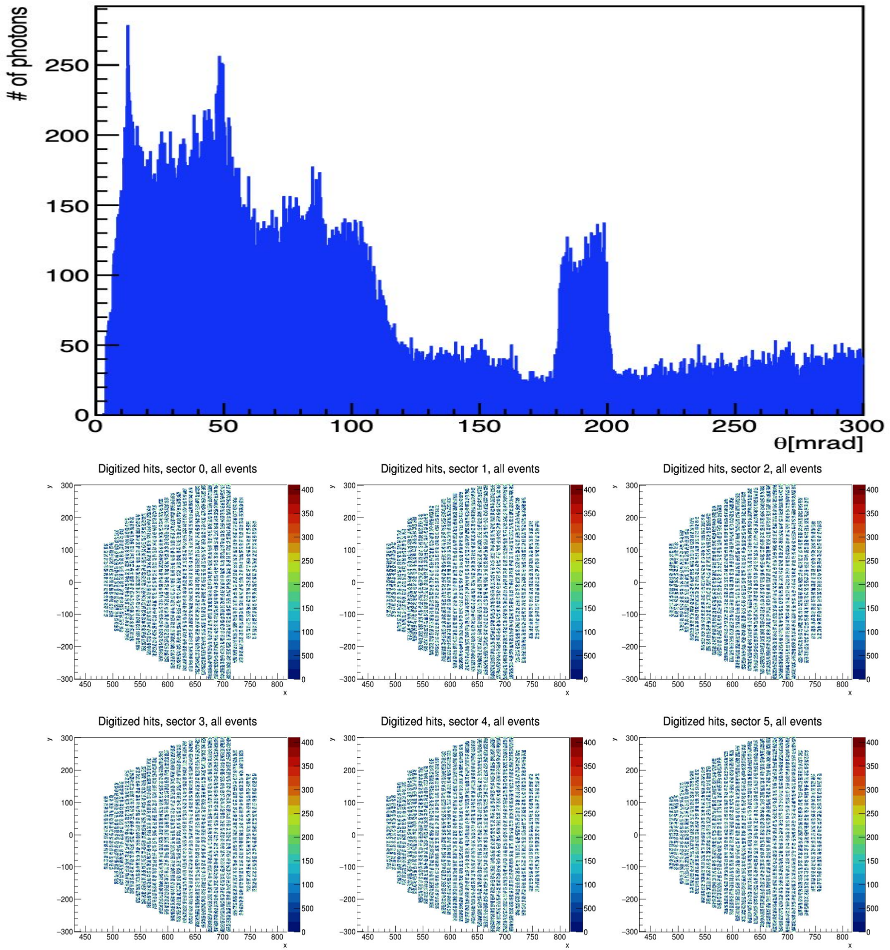


It’s not caused from the simulation of the noise algorithm, it is homogeneous and the number of photons matches the expected one.(Simulation using Proton under threshold)

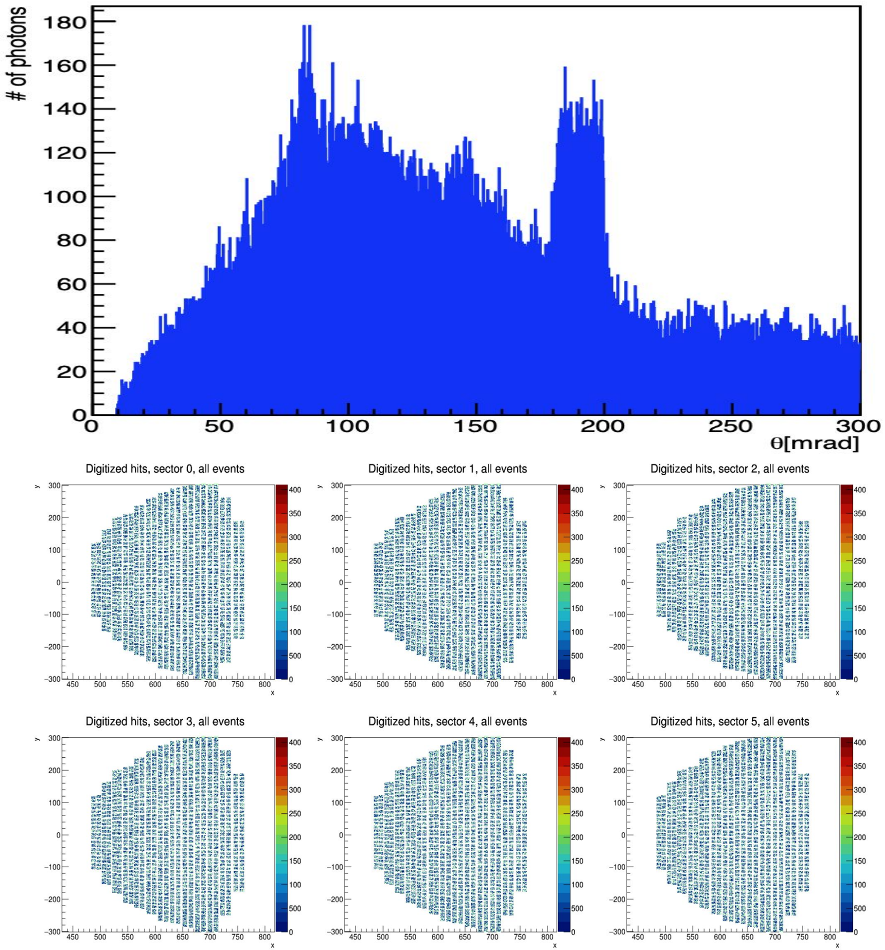


# noise rate= 500kHz, Proton, P=3Gev

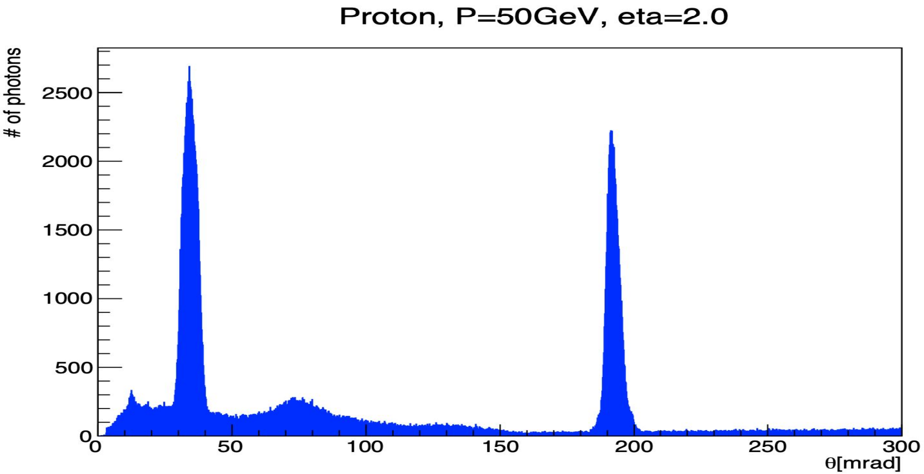
eta=2.0

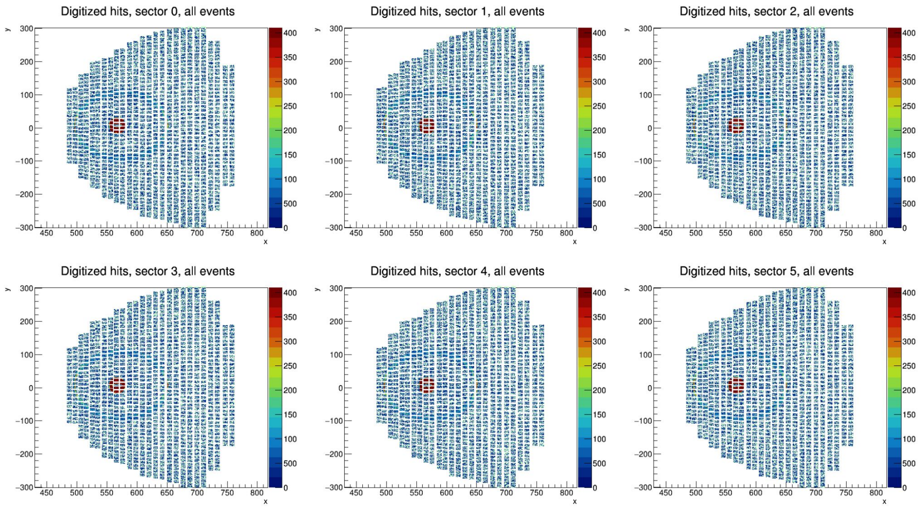



eta=2.5



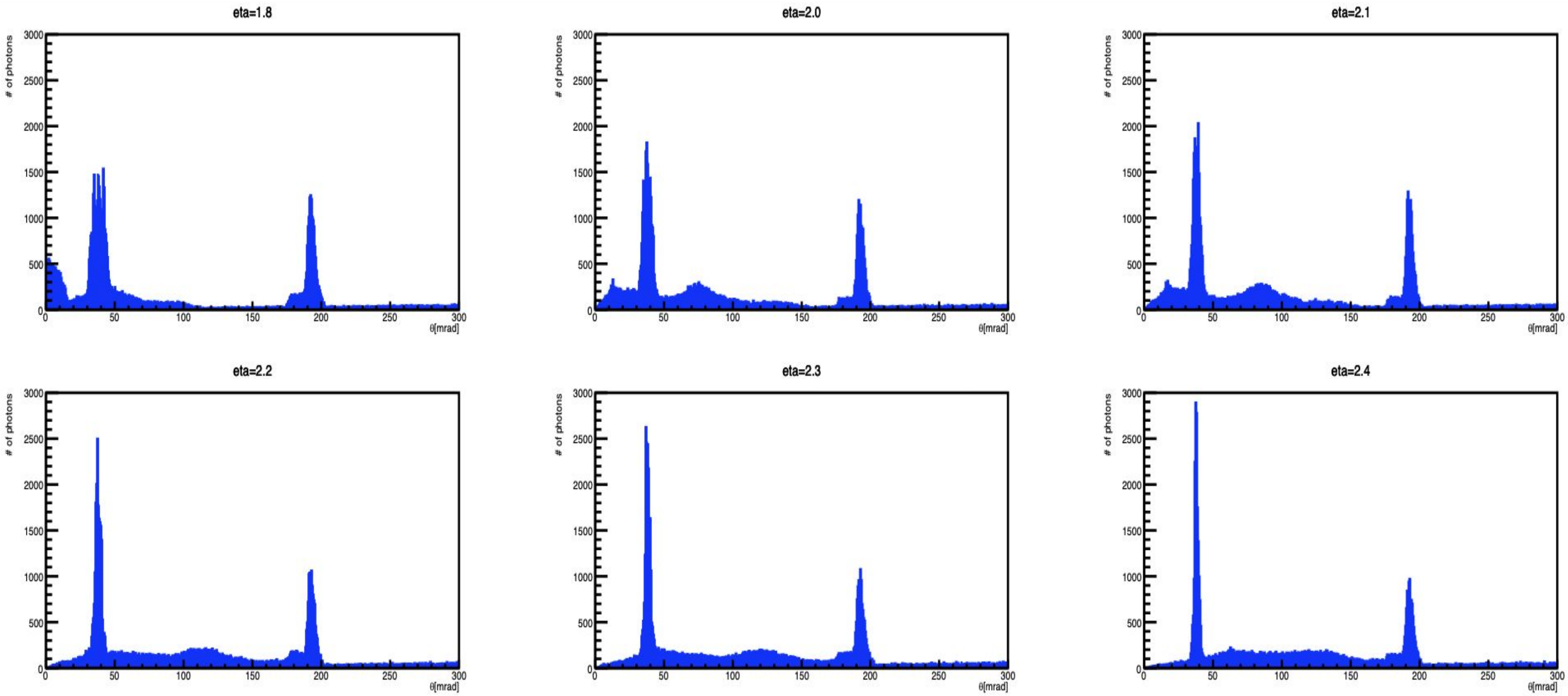
# It’s not caused from photons on other detectors nor the type of particle




We launched 1000 protons on each sector at 50Gev, we can see the two rings in each sector, but the distribution shape is similar

We kept the noise rate fixed and launched fine scan of etas (2.0 to 2.4). All of these are 1000 single pions at P=15GeV, n. rate=200kHz




We can see that the distribution changes

# Conclusions

- The signal/total is close to 1 up to 50kHz (both methods)
- It can be useful to check which photons are signal and which one not, or at least see a picture of how these emission angle are distributed on the detector

Next step is to repeat the study changing the thickness of the Aerogel radiator, more photons means

- higher ratio signal/total(?)
- more sigma of separation between particles(?)

They are both needed at higher rates, simulation with th=5.5cm  currently running