Different SiPMs performance studies for the dRICH

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Different PDE for different SiPMs

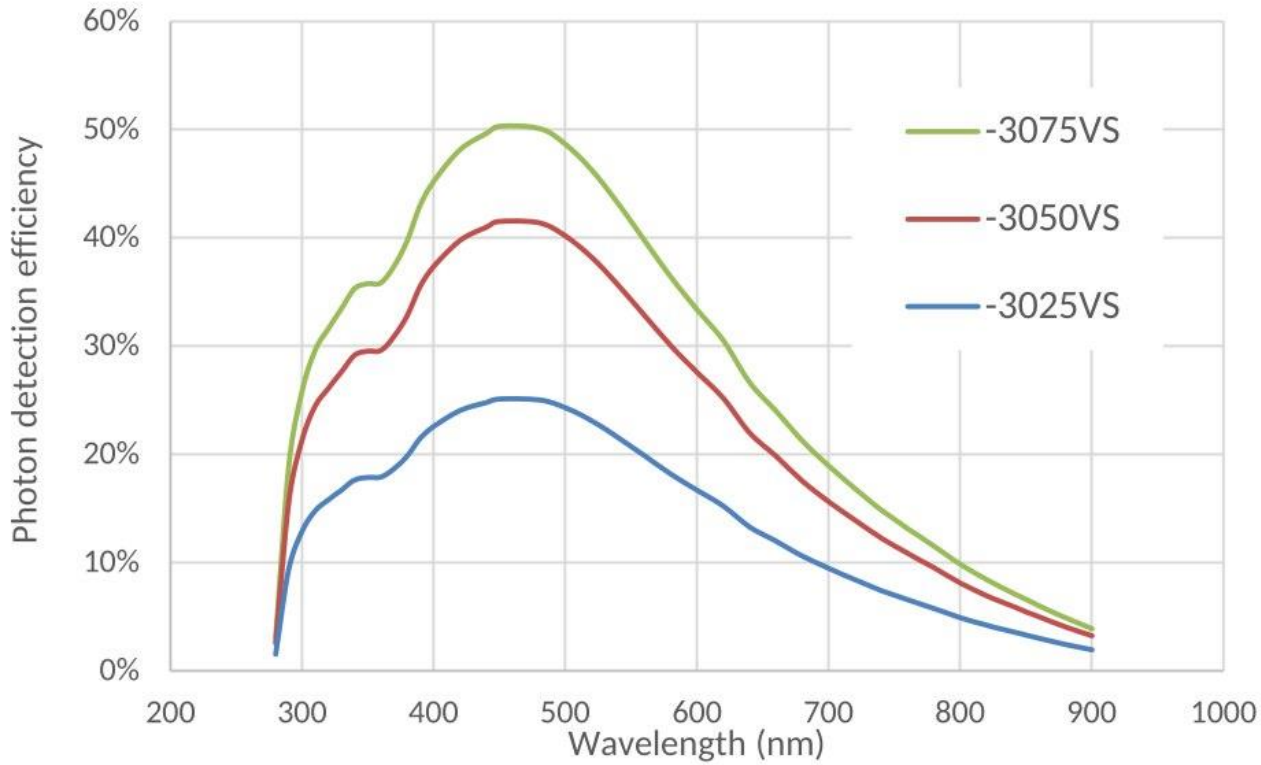
Currently 50µm pitch SiPMs are the default

With a different pitch the geometrical fill factor of the detector changes

Bigger the pixels (75µm), less space lost between the pixels

-> Bigger PDE

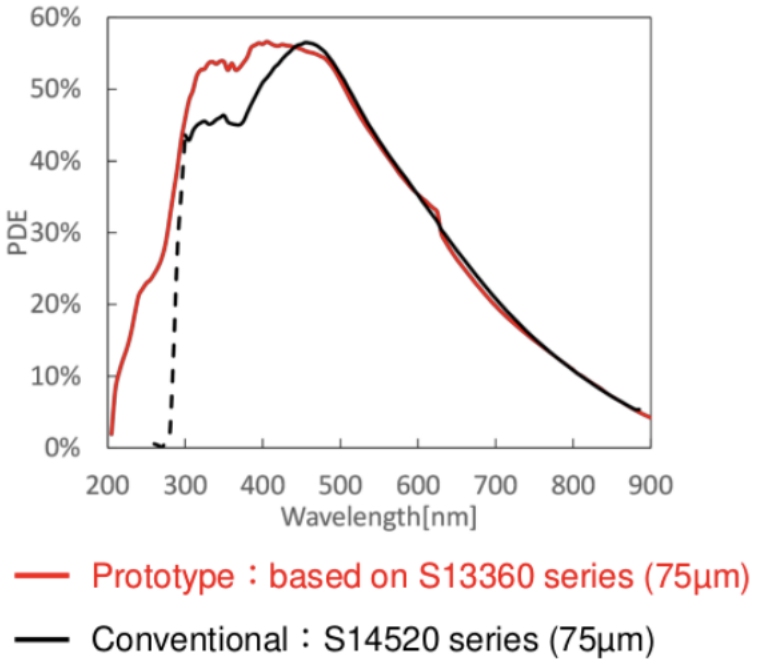
■ Photon detection efficiency v.s. Wavelength(typical example)



Hamamatsu MPPC S13360-30xxVS series datasheet

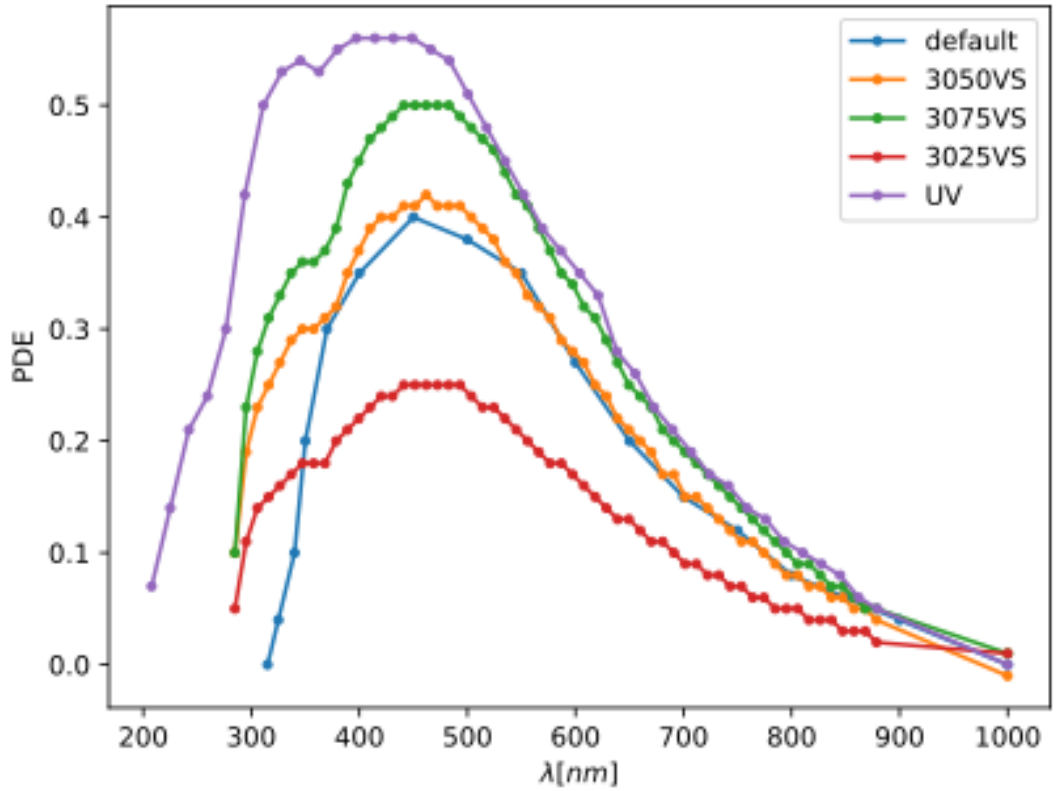
Different PDE for different SiPMs

We will see even the performance of SiPMs with the PDE range extended down to λ=200nm



Different PDE for different SiPMs

Scanning the previous pictures we can extract the PDE curves and compare them.



Simulations

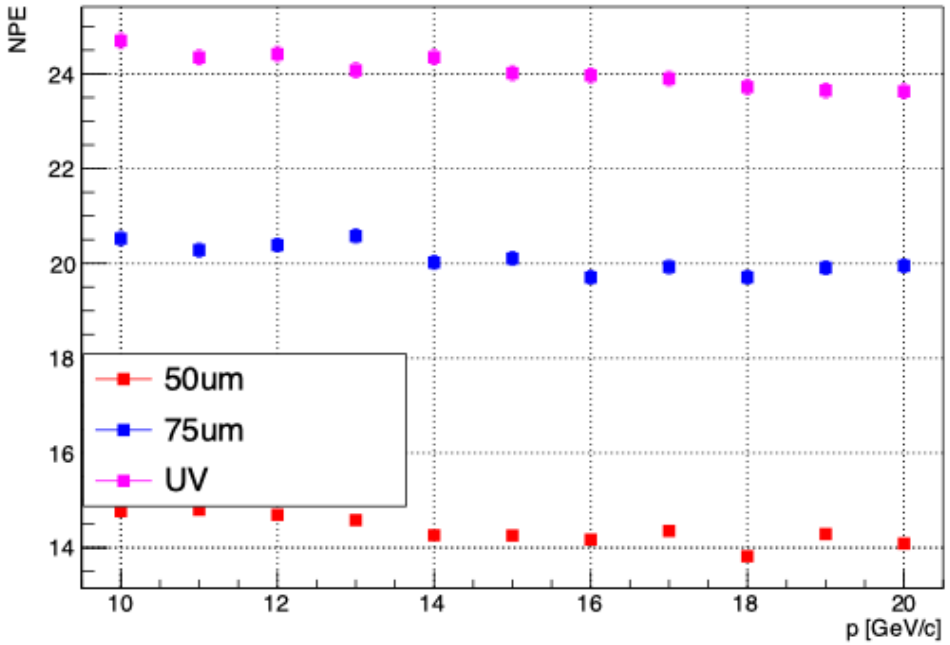
- Particle Gun
  - π+, K+
- Fixed momentum (different points 3GeV/C to 50 GeV/c)
- Fixed pseudorapidities (2.0, 2.5, 3.0, 3.5)

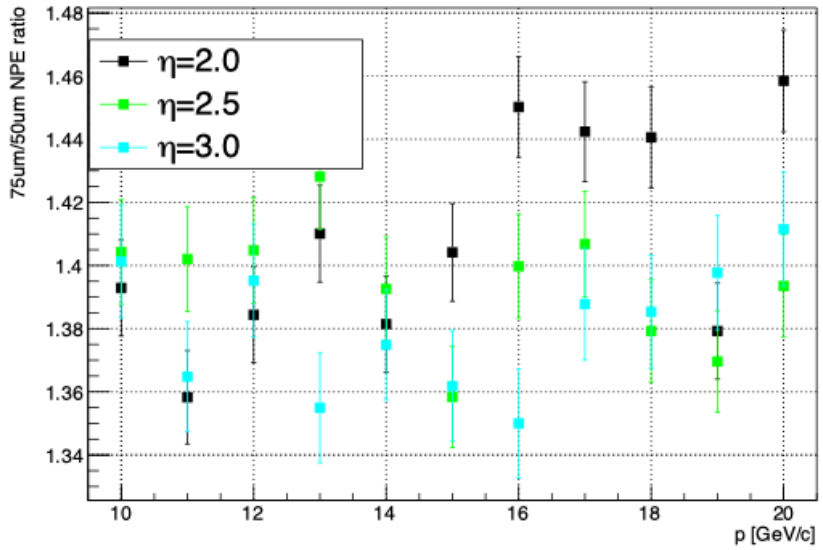
- Default, 75um and Extended UV SiPMs were studied

Aerogel: NPE

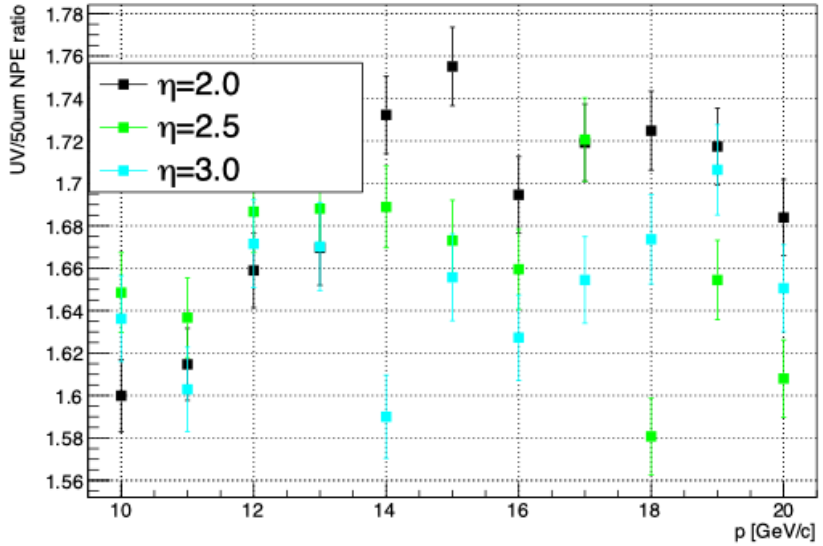
In all the pictures I'm showing pions, with kaons it's the same

η=2.0





~40% gain with the 75um SiPM ($\sigma_{r,75}$~0.85 $\sigma_{r,50}$)

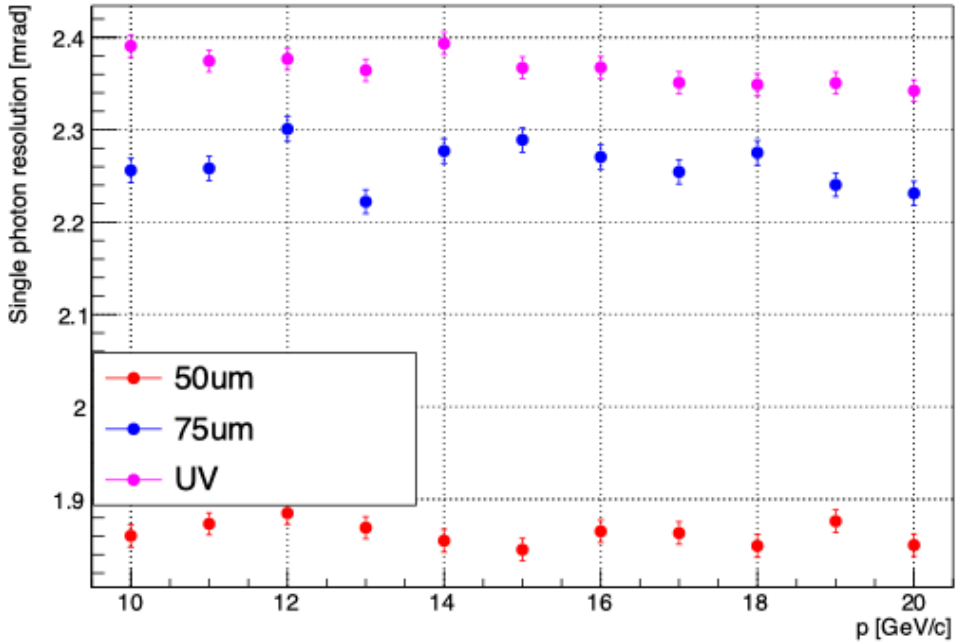


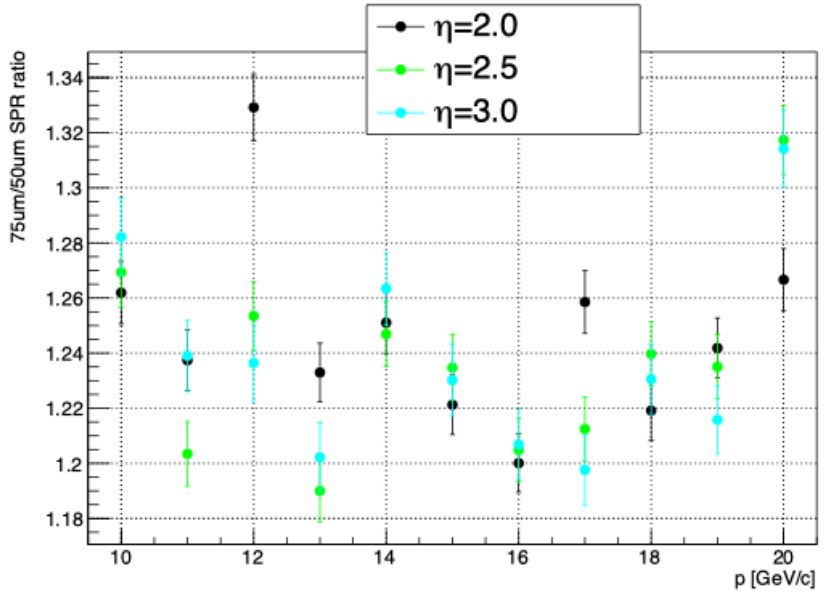
~68% gain with the UV extended SiPM ($\sigma_{r,uv}$~0.77 $\sigma_{r,50}$

Aerogel: SPR

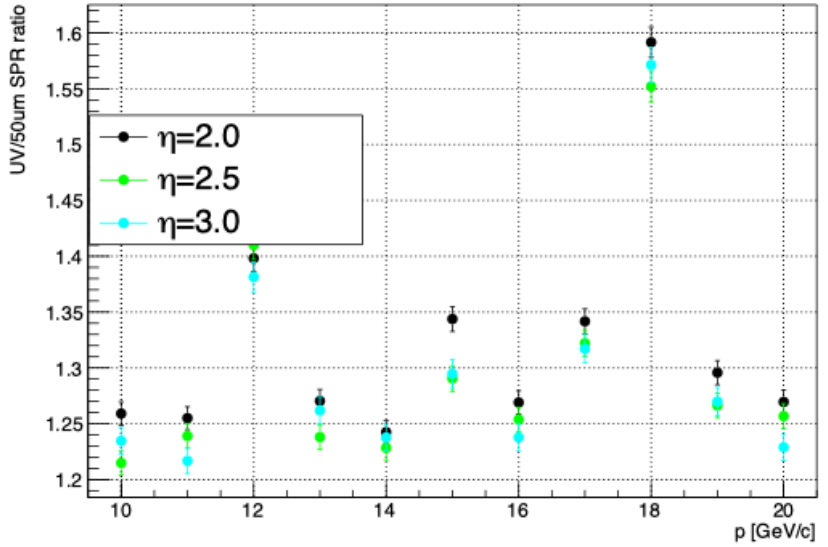
In all the pictures I'm showing pions, with kaons it's the same

η=2.0





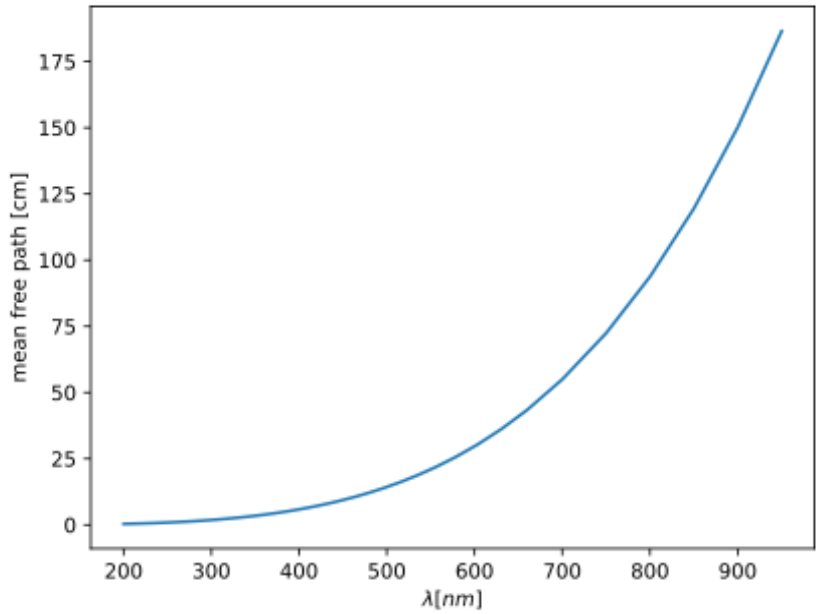
~23% loss with the 75um SiPM ($\sigma_{r,75}$~1.23 $\sigma_{r,50}$)



~30% loss with the UV extended SiPM ($\sigma_{r.uv}$~1.3 $\sigma_{r,50}$)

Aerogel: photon resolution

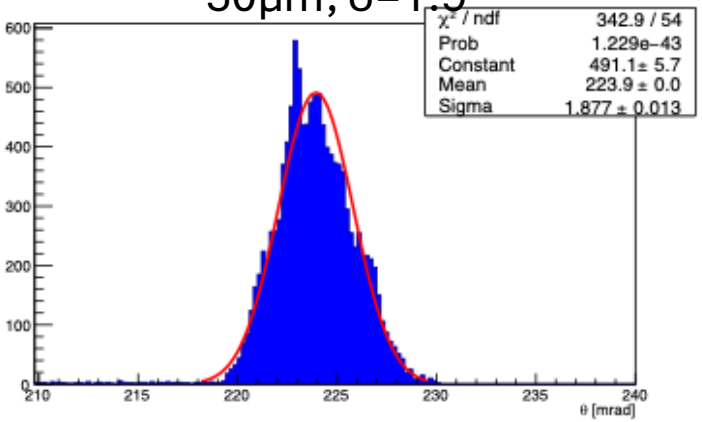
We are increasing the number of photons in the UV range where the Rayleigh scattering is bigger



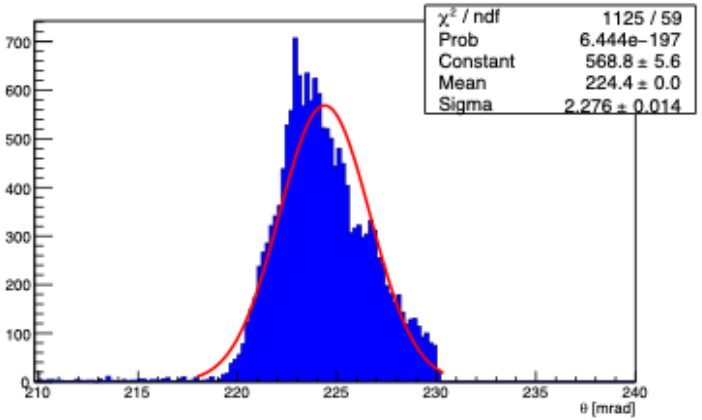
Mean free path in Aerogel for Rayleigh scattering as a function of wavelenght

On the right:
Single Photon Cherenkov Angle distribution for 1000 pi+ at p= 12Gev/c and η=2.5

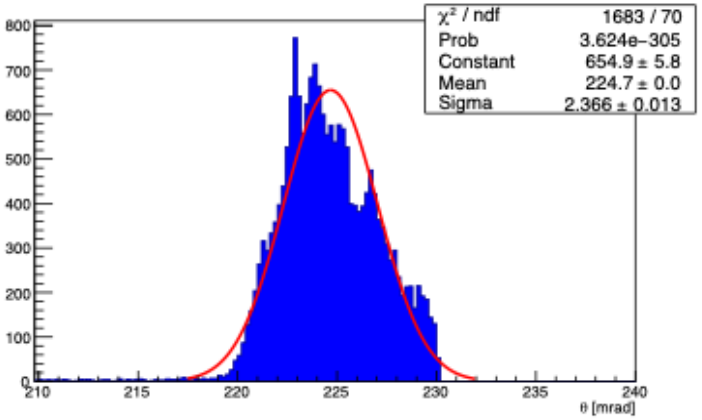
50μm, σ=1.9



75μm, σ=2.3



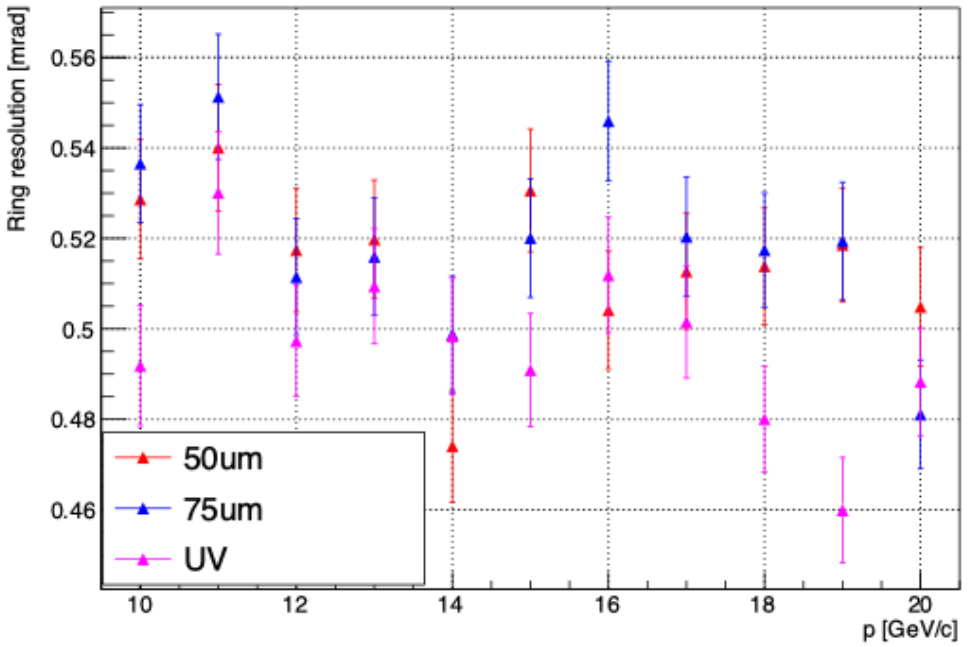
UV, σ=2.4



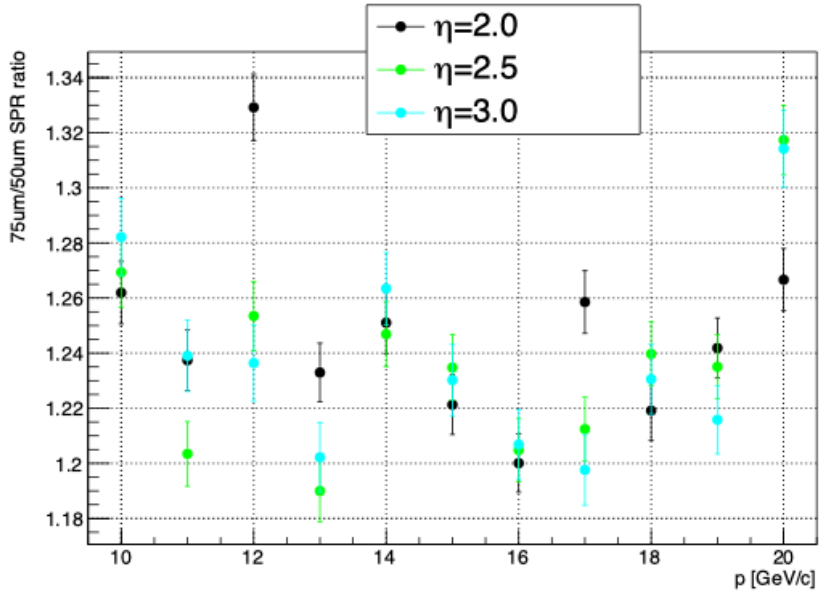
Aerogel: Ring Resolution

These two effects (increase in NPE and bigger SPR) compensate each other bringing to a similar ring resolution

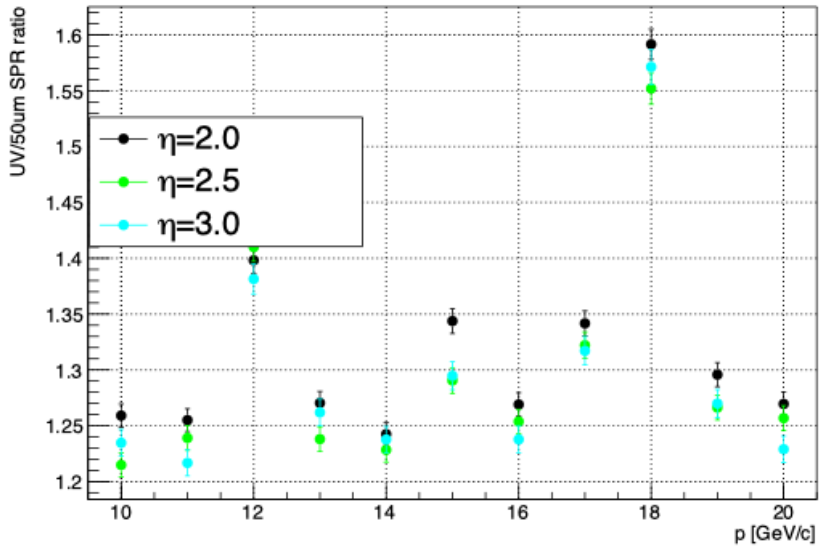
η=2.0



To have a quantitive estimation of the convoluted effect more points in the saturated range are needed



($\sigma_{r,75}$~0.85*1.23 $\sigma_{r,50}$~ $\sigma_{r,50}$) with the 75um SiPM

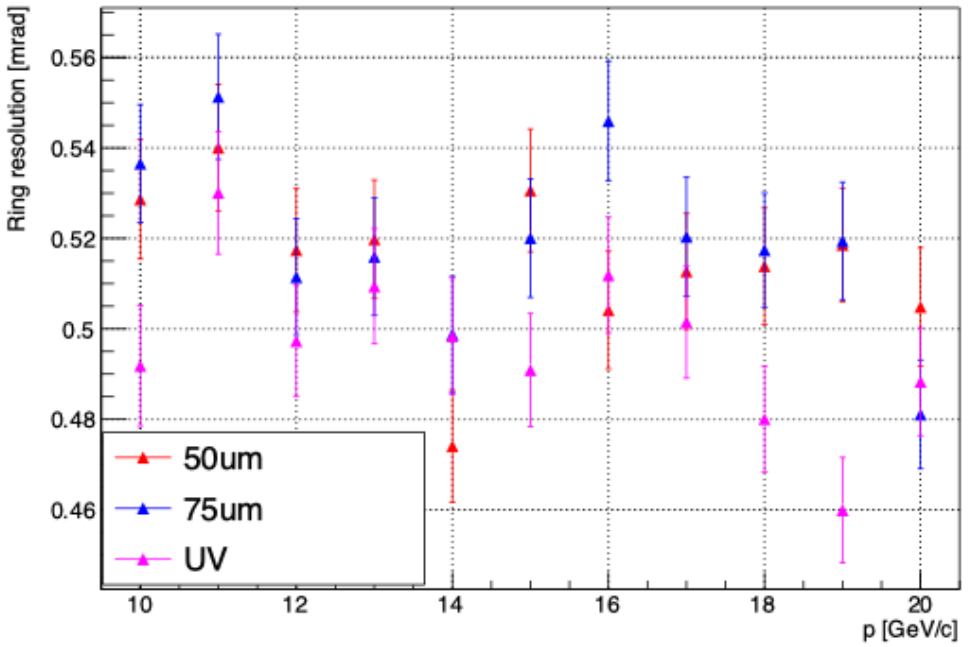


($\sigma_{r.uv}$~1.3 *0.77$\sigma_{r,50}$~$\sigma_{r,50}$) with the UV extended SiPM

Aerogel: Ring Resolution

These two effects (increase in NPE and bigger SPR) compensate each other bringing to a similar ring resolution

η=2.0



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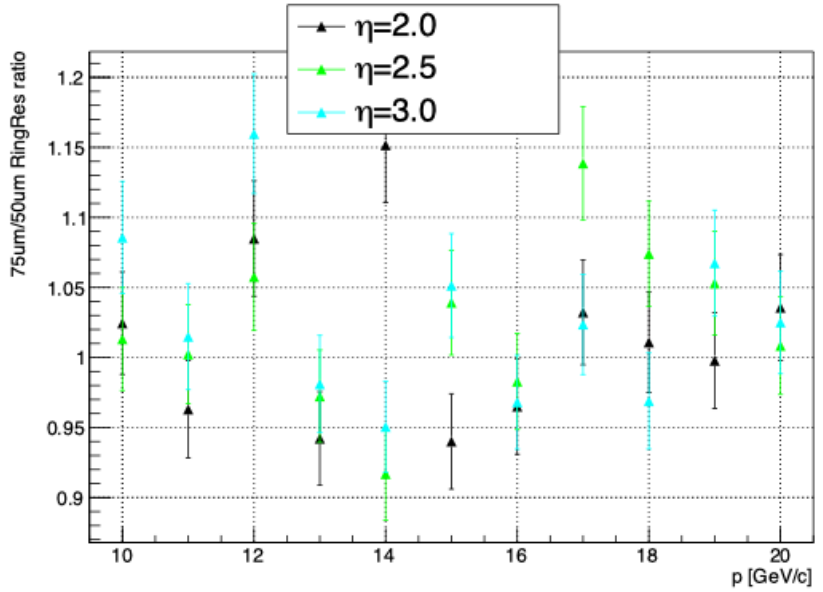
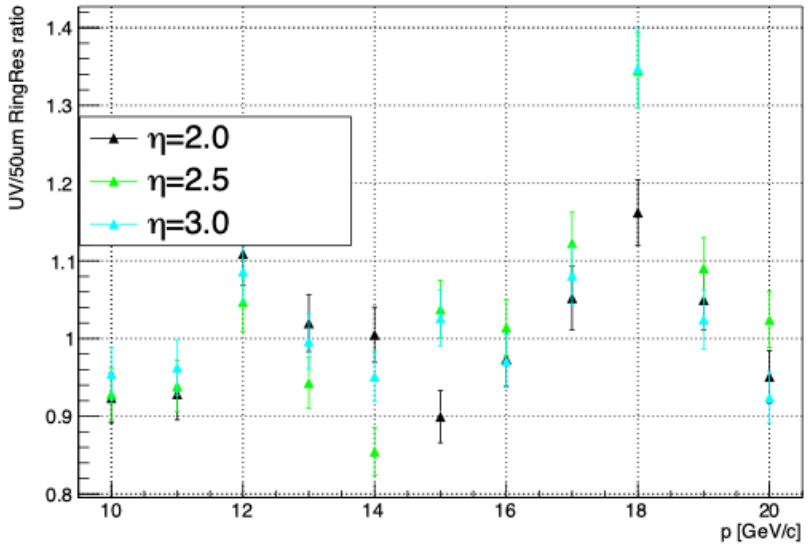


($\sigma_{r,75}$~0.85*1.23 $\sigma_{r,50}$~ $\sigma_{r,50}$) with the 75um SiPM

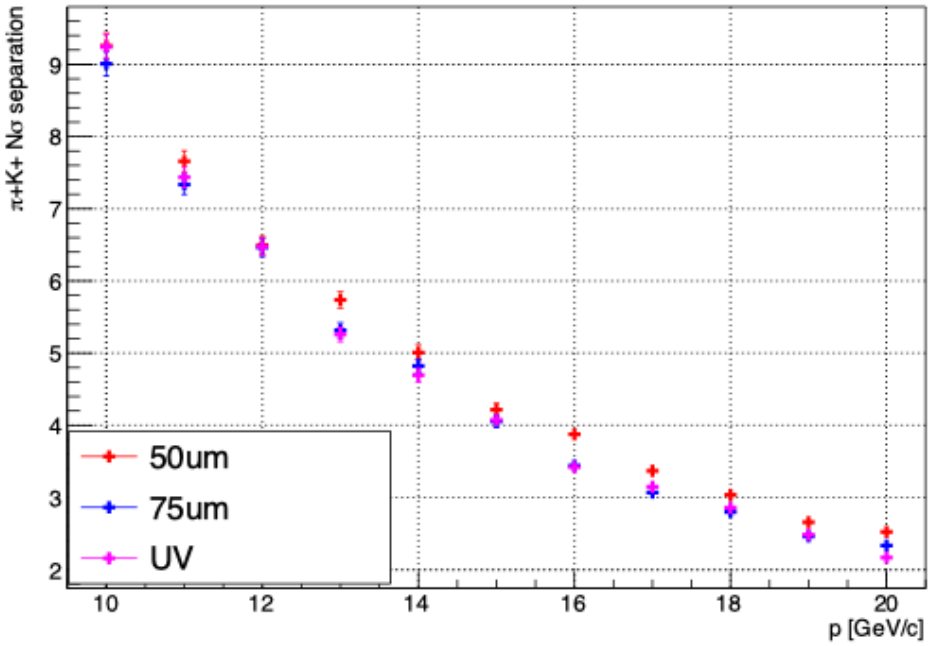


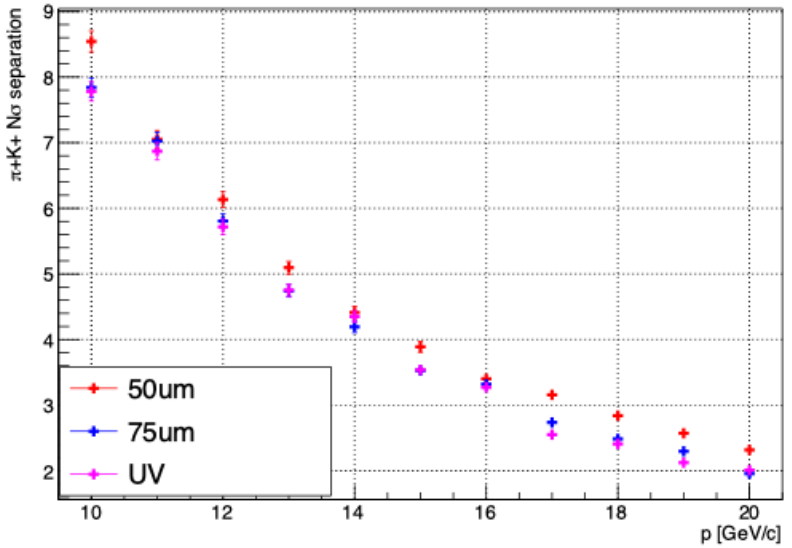
($\sigma_{r.uv}$~1.3 *0.77$\sigma_{r,50}$~$\sigma_{r,50}$) with the UV extended SiPM

Aerogel: Nsigma

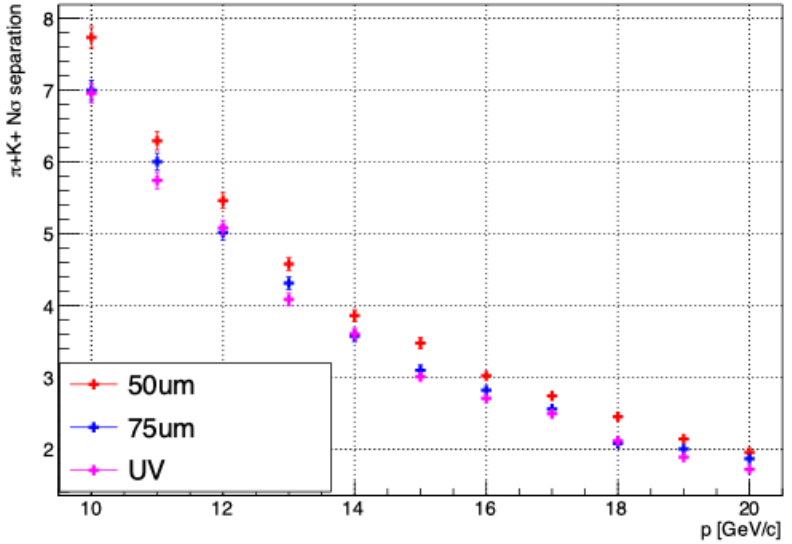
We don’t see any improvement in the number of π+K+ σ separation

η=2.0





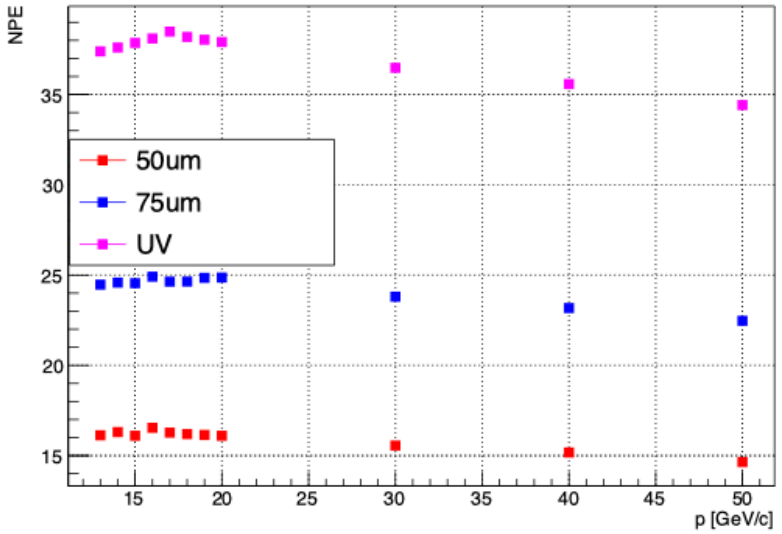
η=2.5



η=3.0

Gas:NPE

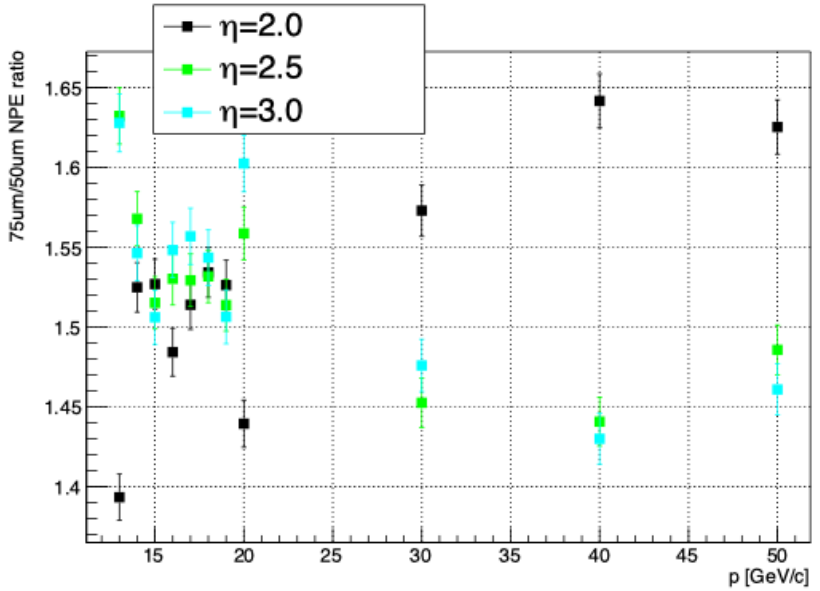
In both pitures I'm showing pions, with kaons it's the same



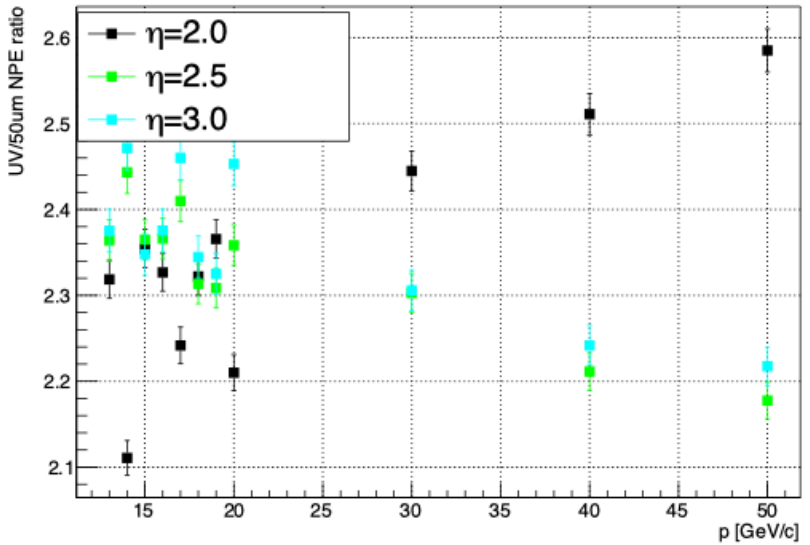
In Gas the gain is bigger. For the aerogel photons there is a quartz window between the aerogel and the gas radiator Which absorbs the low wavelenght photons reducing the gain in the Aerogel.

How does performance in Aerogel change if we remove it?

To be investigated



55% gain with the 75um SiPM

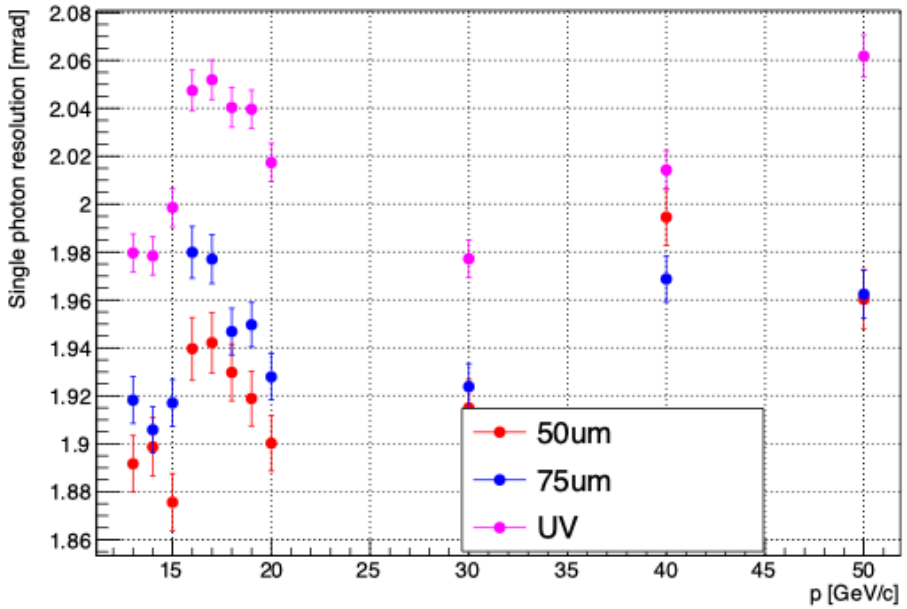


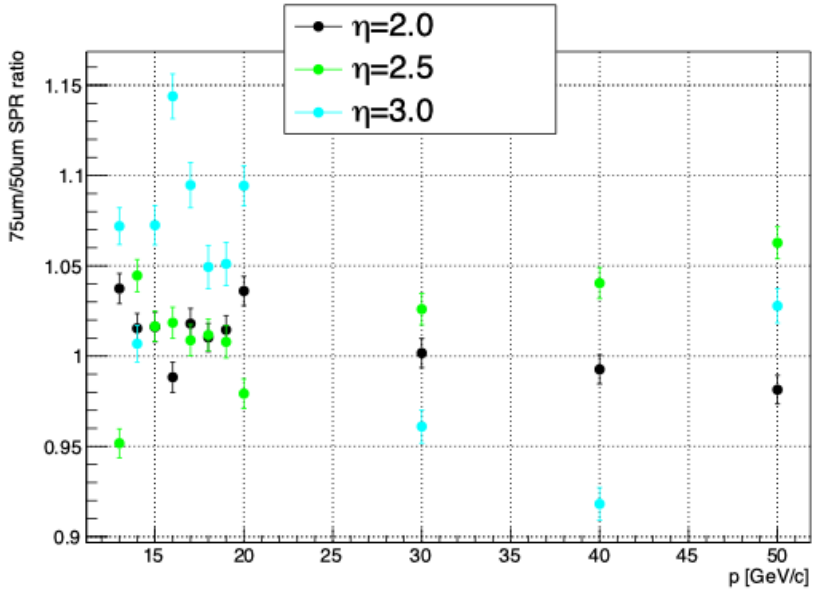
135% gain with the UV extended SiPM

Gas: photon resolution

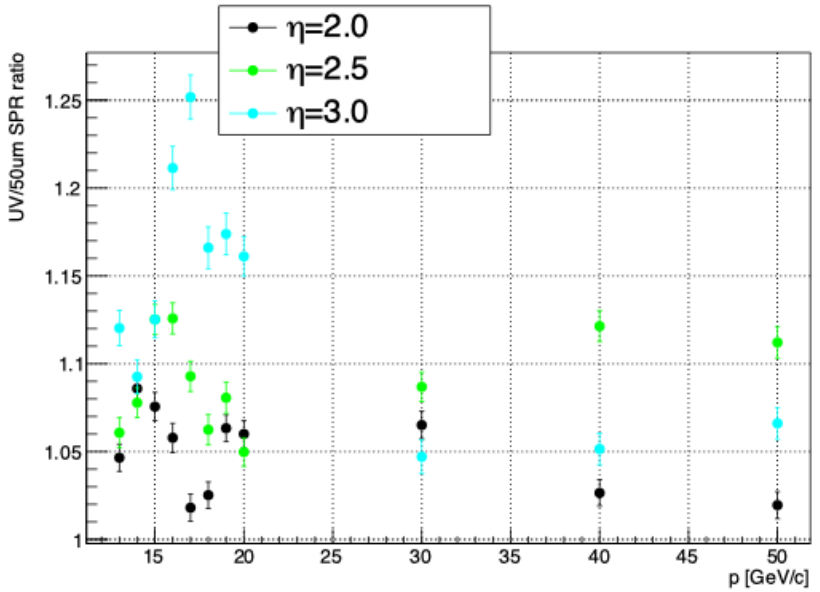
In all the pictures I'm showing pions, with kaons it's the same

η=2.0





75um



UV

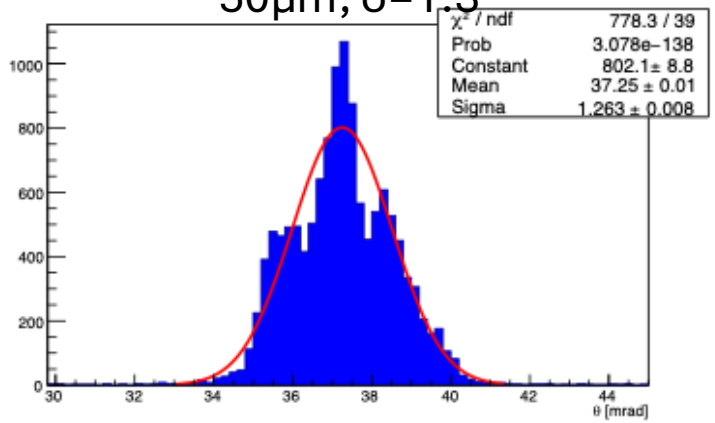
In gas the single photon resolution is worse, but only by a factor ~10%

Gas: photon resolution

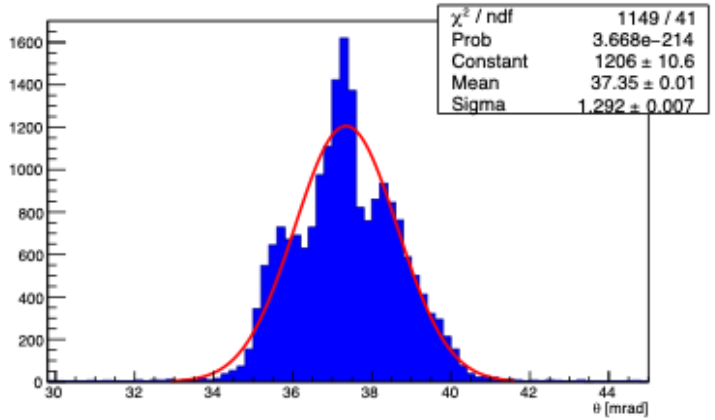
In gas the Rayleigh scattering is not simulated because it’s too low
We don’t lose in single photon resolution

On the right:
Single Photon Cherenkov Angle distribution for 1000 pi+ at p= 12Gev/c and η=2.5

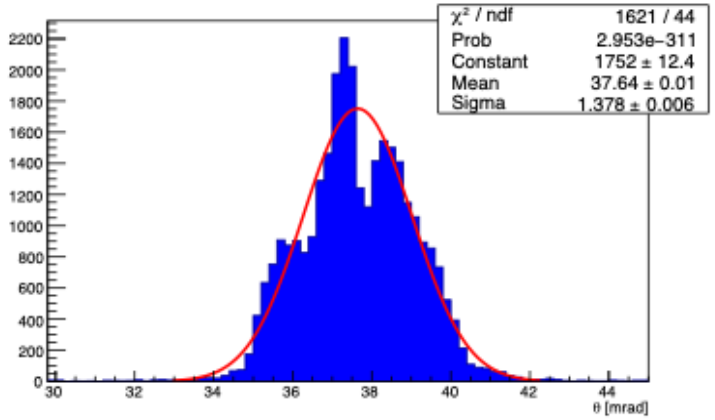
50μm, σ=1.3



75μm, σ=1.3



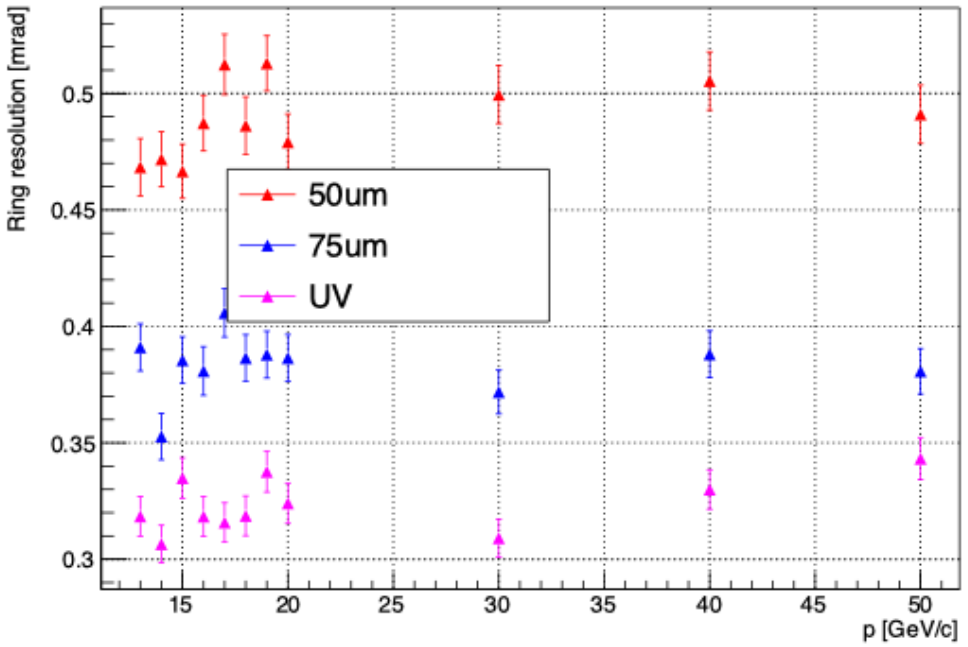
UV, σ=1.4

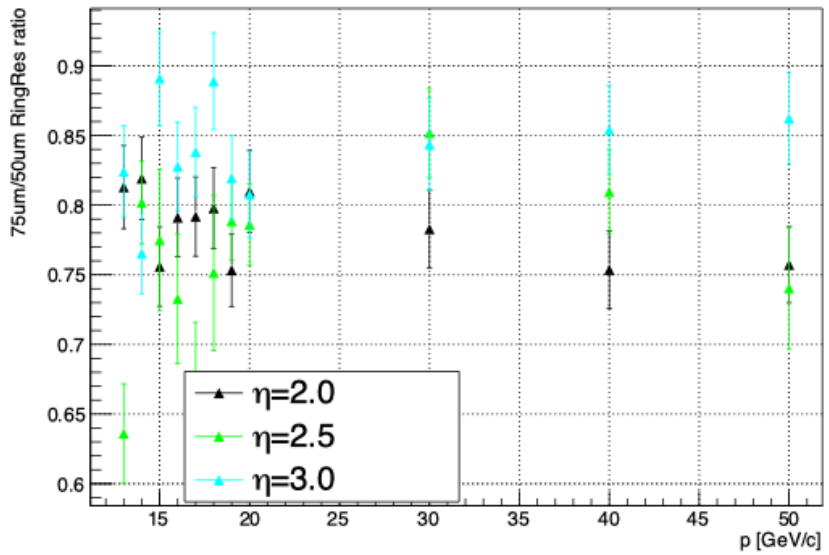


Gas: ring resolution

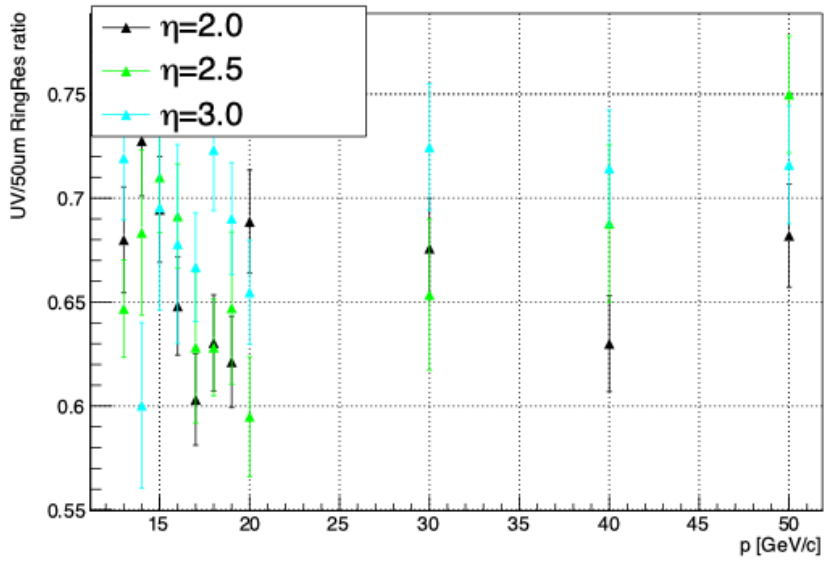
These effects combined gives us a better ring resolution for the gas ring

η=2.0





75um



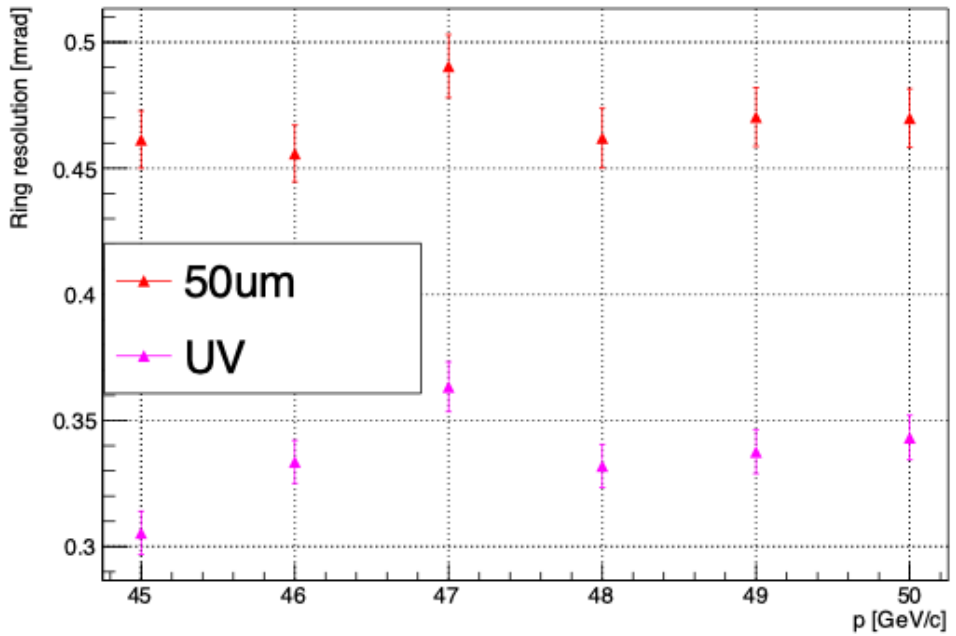
UV

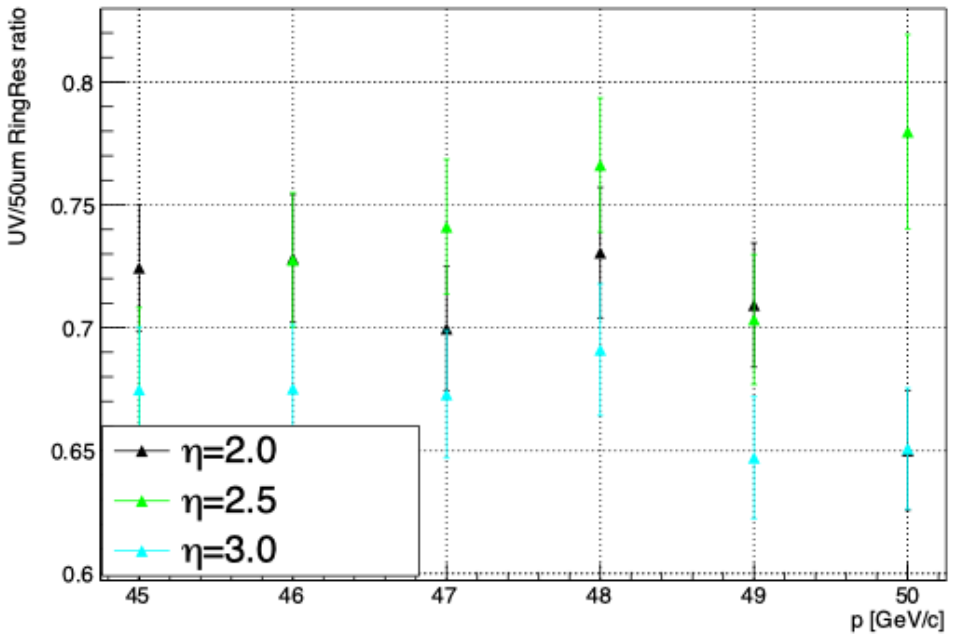
GAS

This improvement in ring resolution can be usefull to compensate the disadvantage in using C4F10 instead of C2F6

Can 3sigma pionkaon separation be achieve up to 50 Gev/c using C4F10 changing the SiPMs?

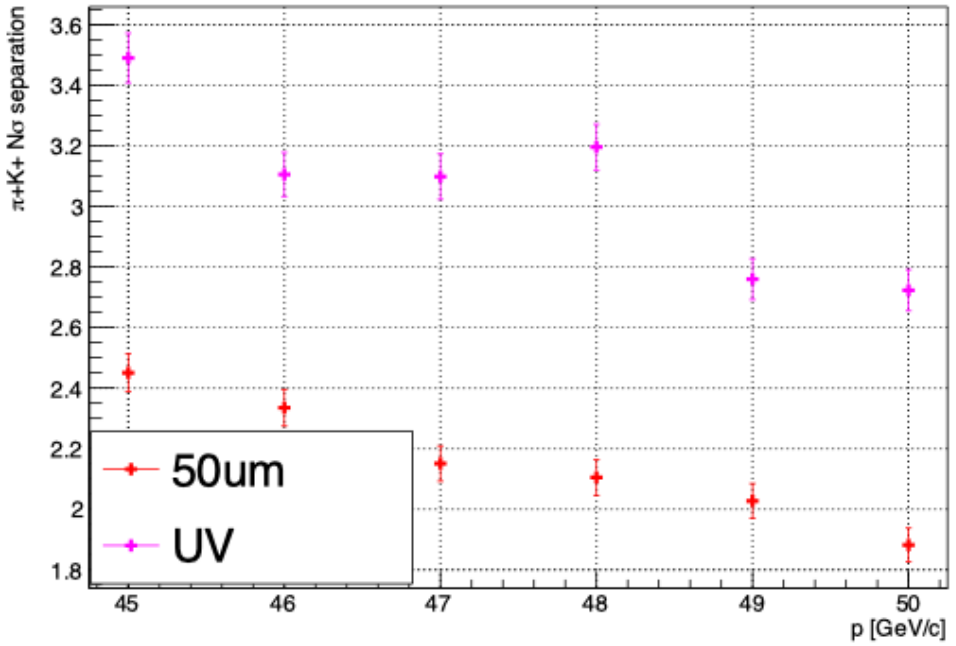
Gas C4F10: ring resolution

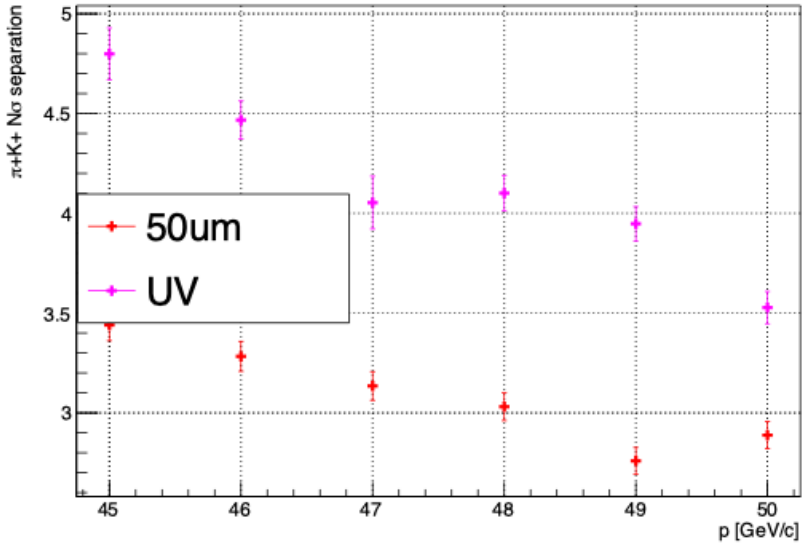




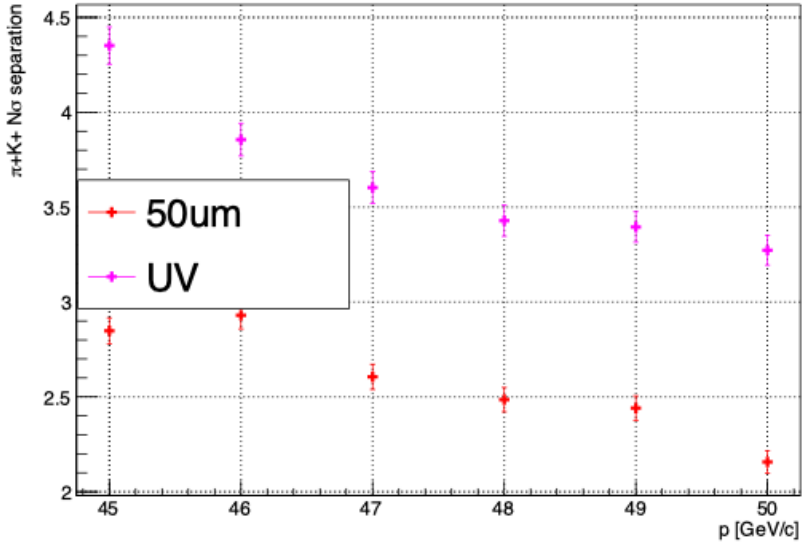
Gas C4F10: Nsigma

η=2.0





η=2.5



η=3.0