Different SiPMs performance studies for the dRICH

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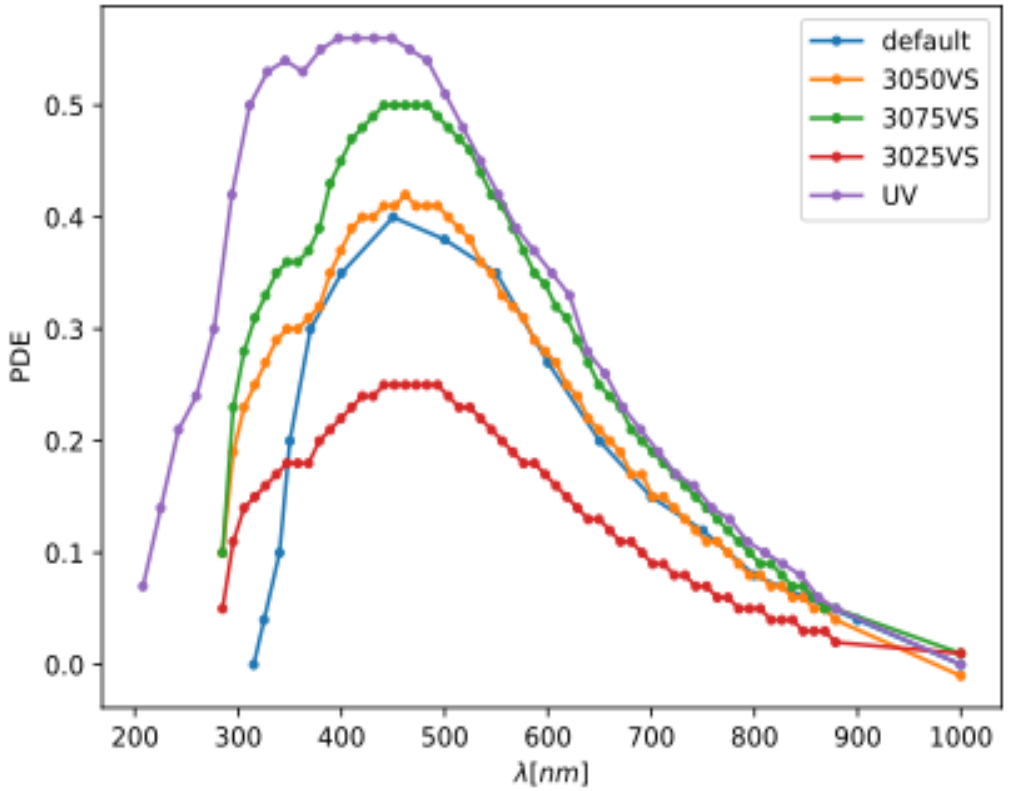
Summary

We are comparing the performance of different SiPMs in the dRICH

- Default (3050VS)
  - 30mmX30mm active area
  - 50um pitch between pixels
- 3075VS
  - Same model of the default, but with 75um pitch SiPMs
  - Bigger pixels -> Less pixel -> Bigger fill factor (82% instead of 74%)->Bigger PDE
- Extended UV SiPMs
  - PDE extended in the UV range
  - !! The protective window of this was changed. The PDE will not be the one reported on the datasheet



PDE curves for different SiPMs

Summary

- 1000 π+, K+ single particle events
- Fixed momentum (different points 40GeV/C to 50 GeV/c) (±0.1GeV/c)
- Three pseudorapidities range (2.0 - 2.5)

  (2.5 - 3.0)

  (3.0 - 3.5)
- $\phi \in [0,2\pi]$ (not fixed anymore)
- Default and Extended UV SiPMs were studied

Summary

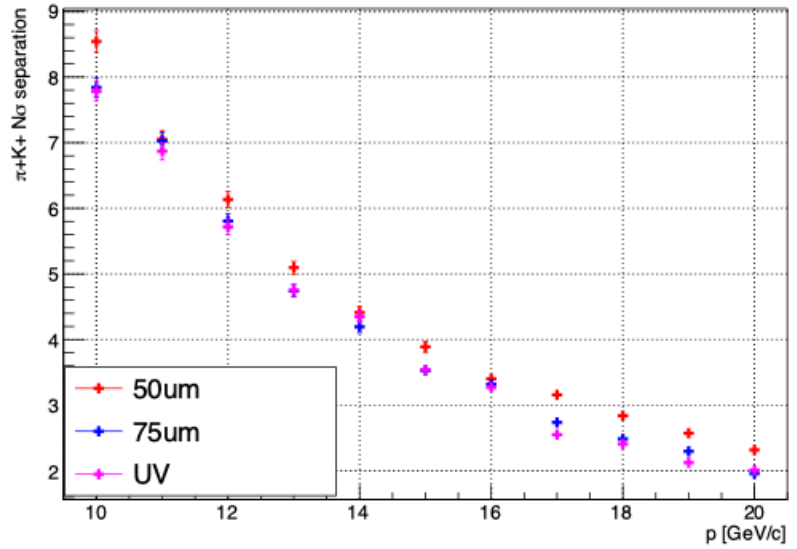
What we saw?

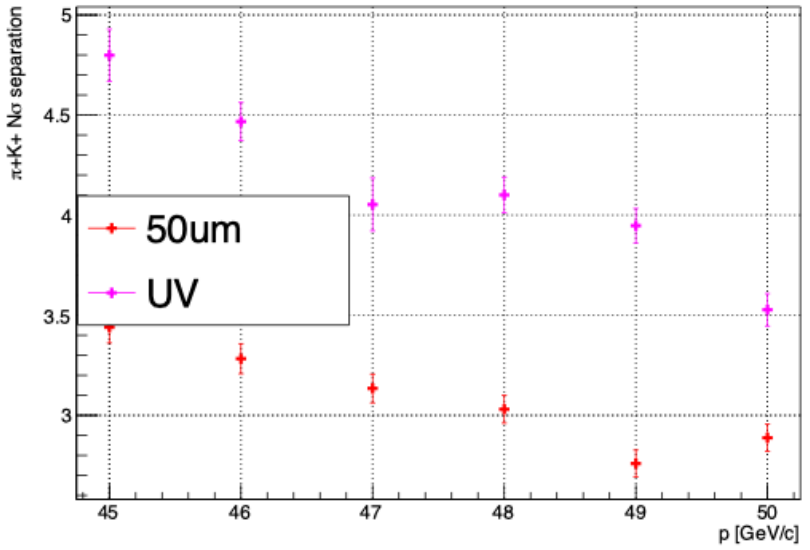
- Same aerogel ring resolution

  (more photons, but worse single photon resolution due to rayleigh scattering)

- Better gas ring resolution

  (more photons and negligiable rayleigh in gas, it's not simulated)





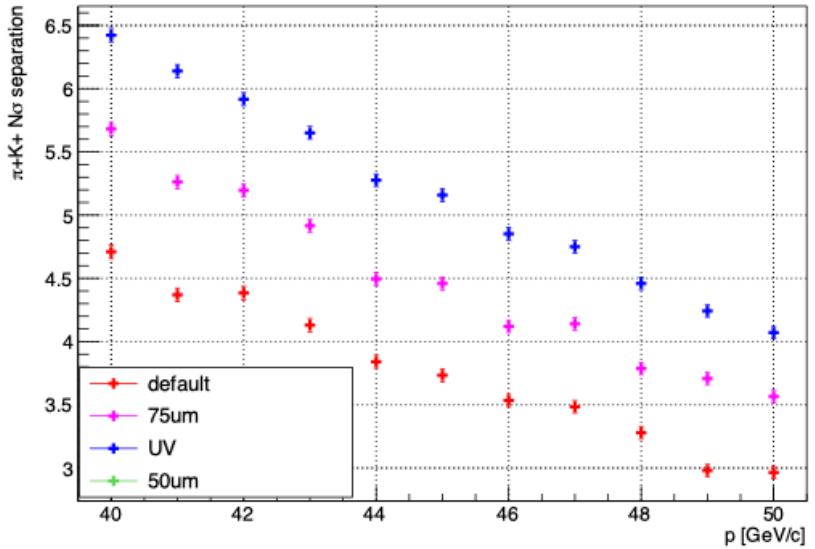
3σ pi-k separation in aerogel and gas at η=2.5

Summary

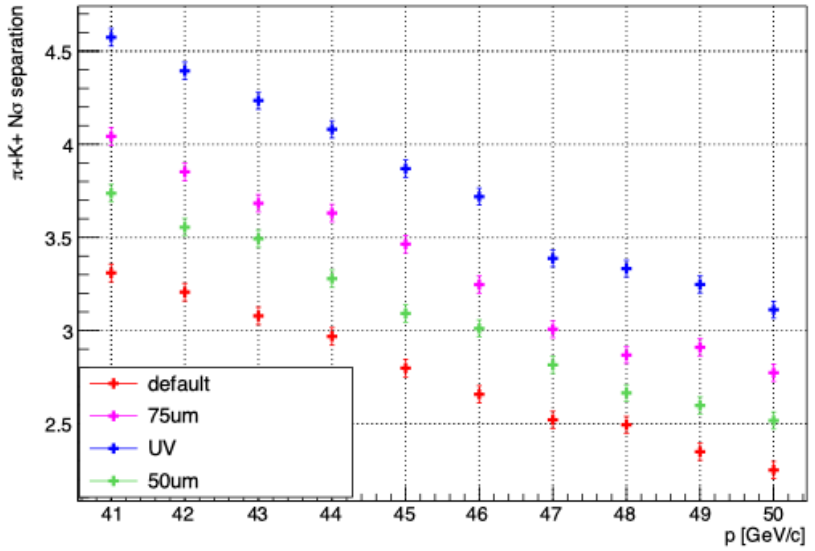
We saw the performances using different sipms with C4F10 instead of C2F6

- They are worse, but the new SiPMS recover part of the loss
- We can go up to 47GeV/c in 3σ separation using C4F10
  - The noise it's not simulated, this will lower the upper limit in 3σ separation
  - We don't expect a big difference because the gas ring it's small (less noise under the peak)
  - The bigger yield of photons using the new sipms will grant us a bigger signal/noise ratio

C2F6, η∈[2.0 ; 2.5]



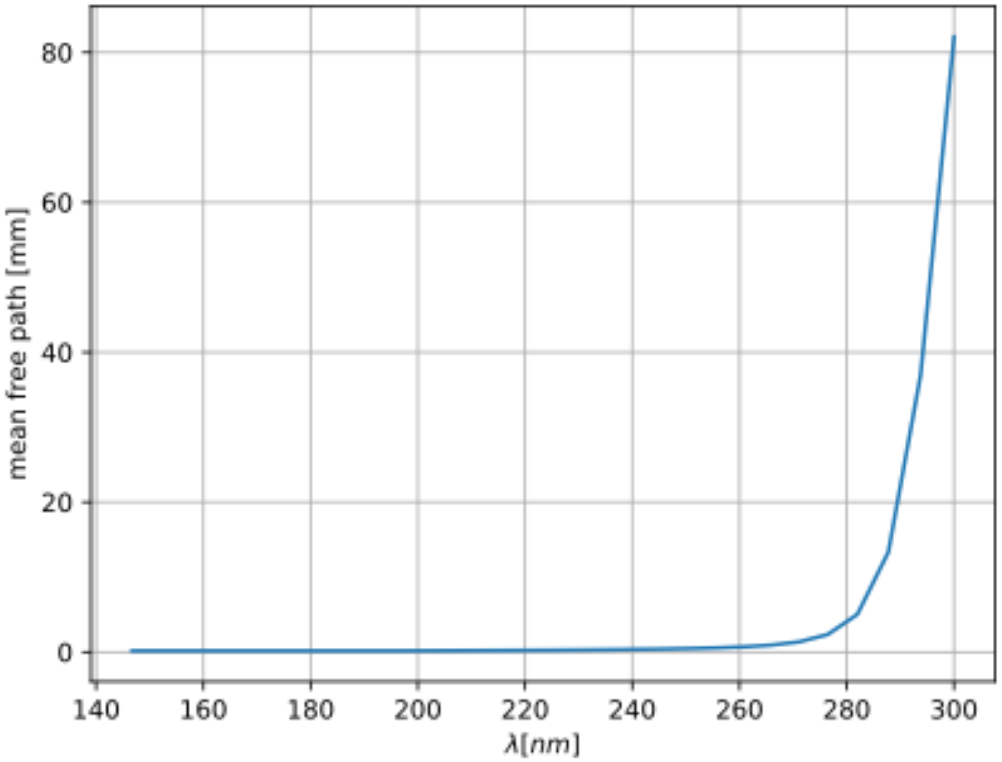
C4F10, η∈[2.0 ; 2.5]



Acrylic filter

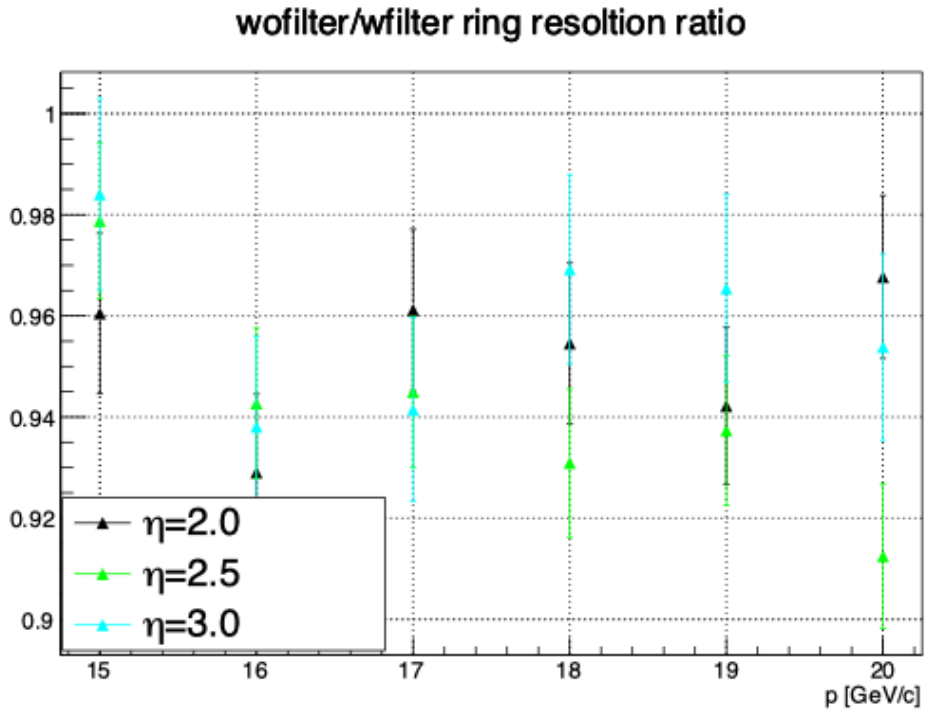
In the current design of the dRICH there is an acrylic filter between the two radiators

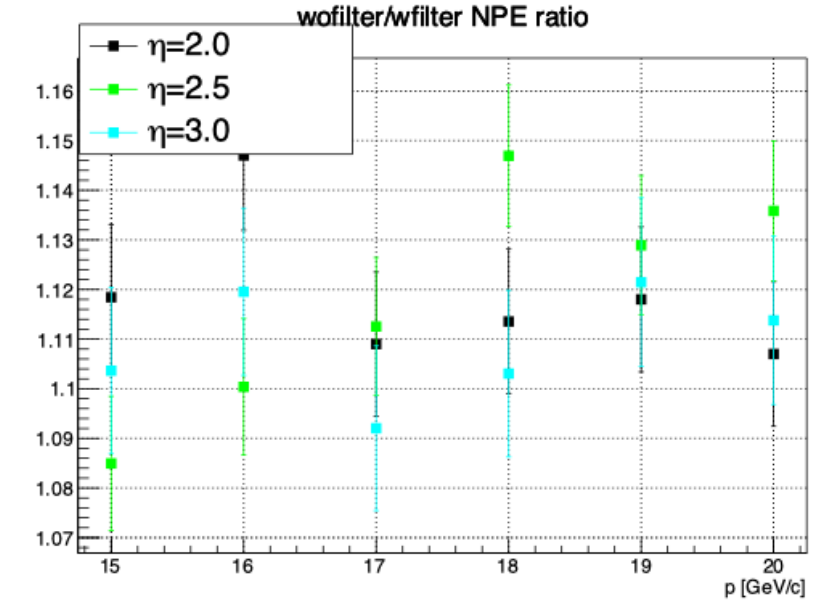
- It’s 3mm thick
- There is a small airgap between the filter and the aerogel
- It’s presence cuts the photons in the UV range for absorption (and for reflection at every wavelenght)

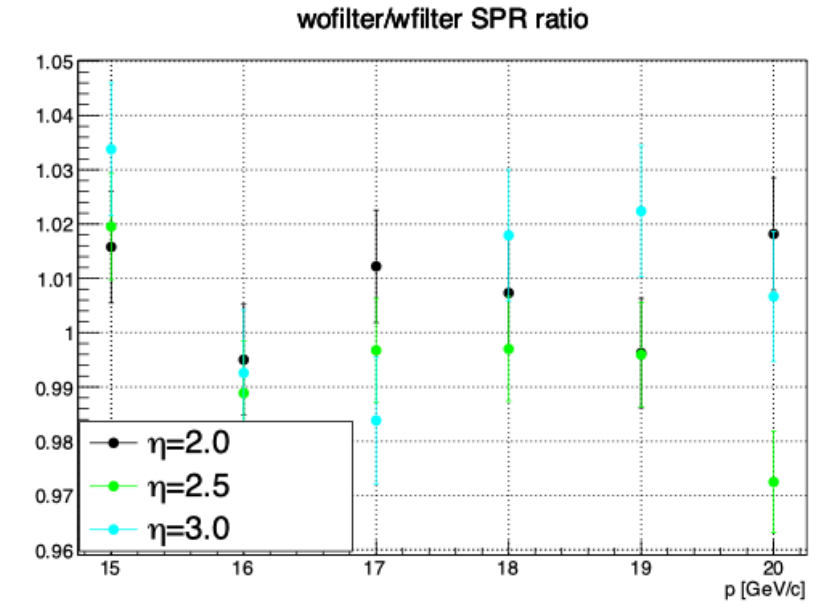


How does it affect the Aerogel performance?

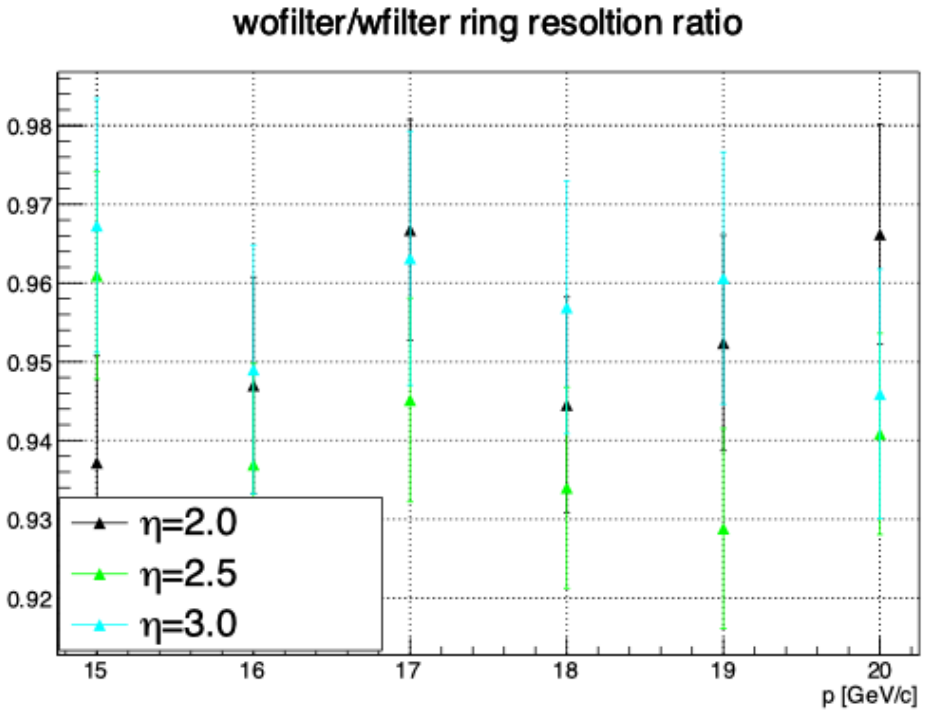
Default sipms

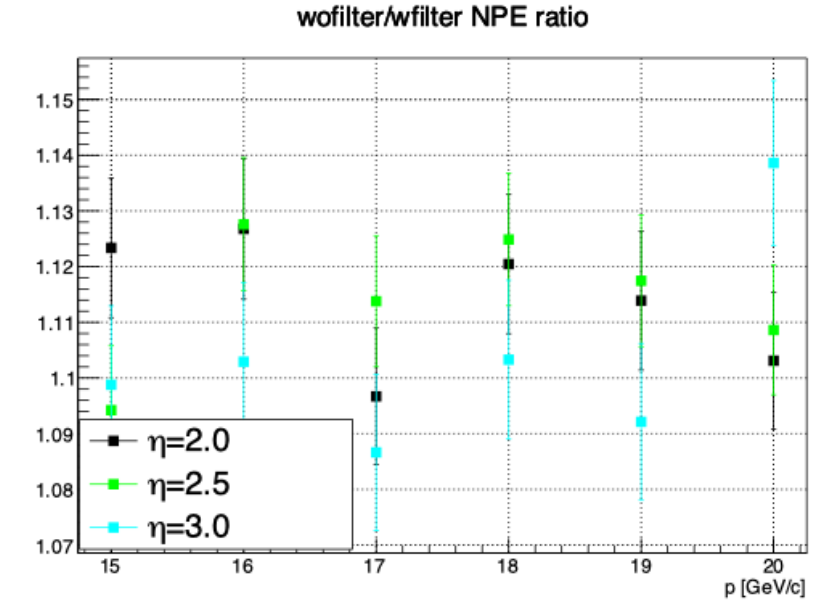


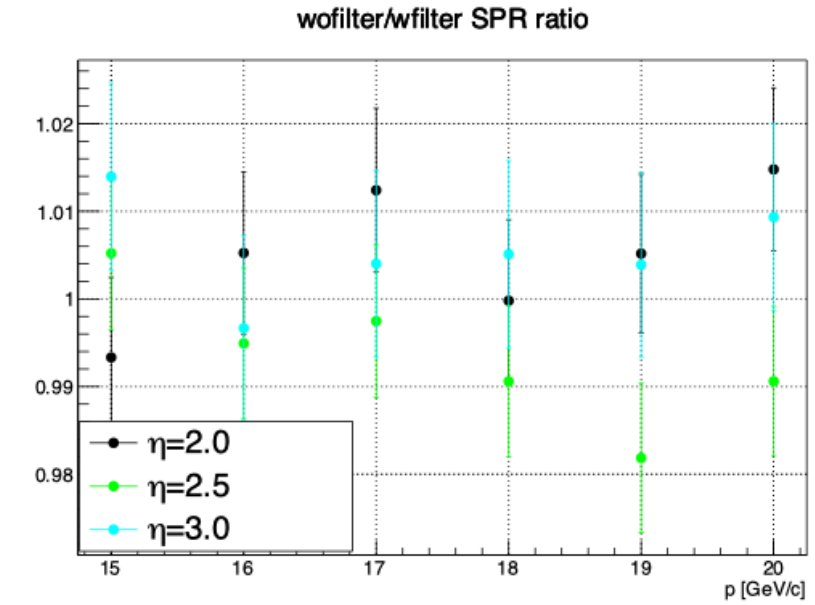




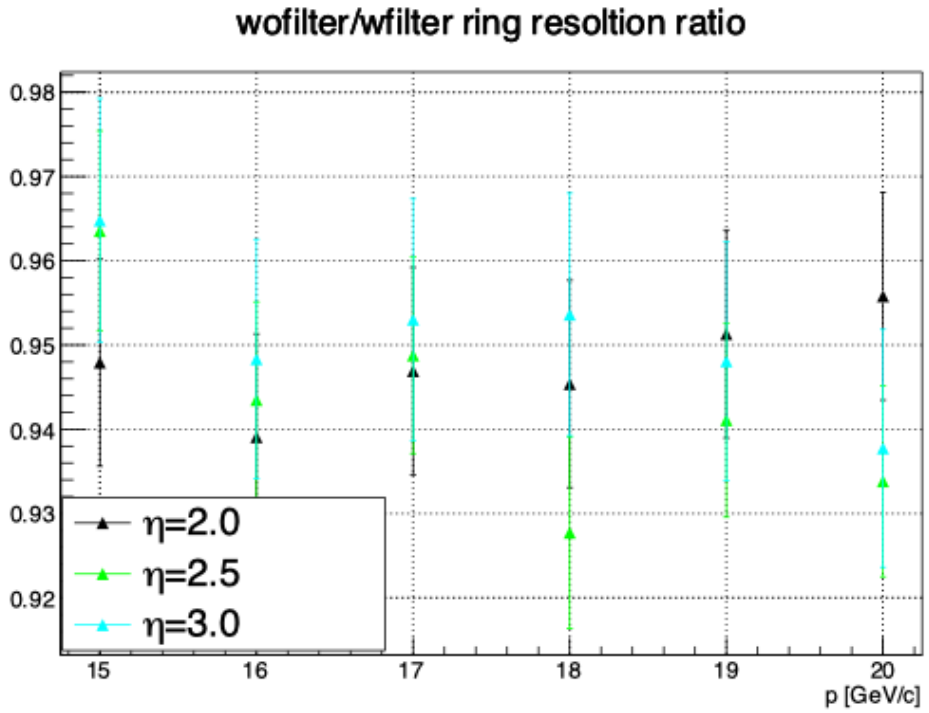
75um sipms


wofilter/wfilter ring resoltion ratio
0.98
0.97
0.96
0.95
0.94
0.93
0.92
η=2.0
η=2.5
η=3.0
15
16
17
18
19
20
p [GeV/c]


wofilter/wfilter NPE ratio
1.15
1.14
1.13
1.12
1.11
1.1
1.09
1.08
1.07
η=2.0
η=2.5
η=3.0
15
16
17
18
19
20
p [GeV/c]


wofilter/wfilter SPR ratio
1.02
1.01
1
0.99
0.98
η=2.0
η=2.5
η=3.0
15
16
17
18
19
20
p [GeV/c]

UV sipms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0.93
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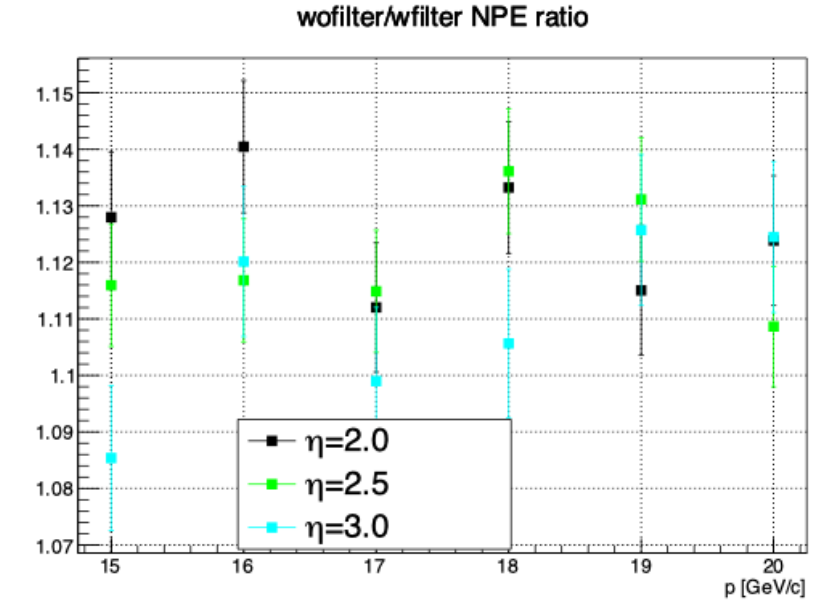
η=2.0
η=2.5
η=3.0
15
16
17
18
19
20
p [GeV/c]


wofilter/wfilter NPE ratio
1.15
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1.09
1.08
1.07
η=2.0
η=2.5
η=3.0
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16
17
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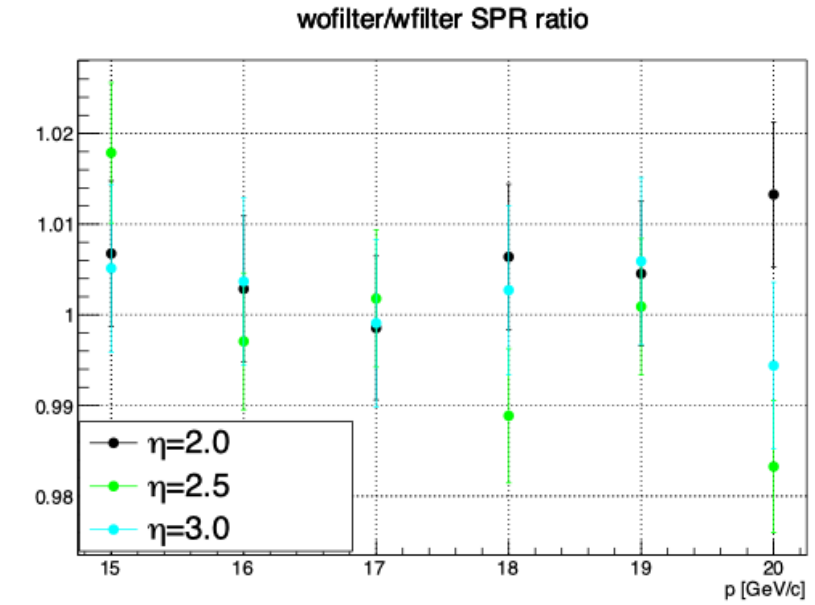
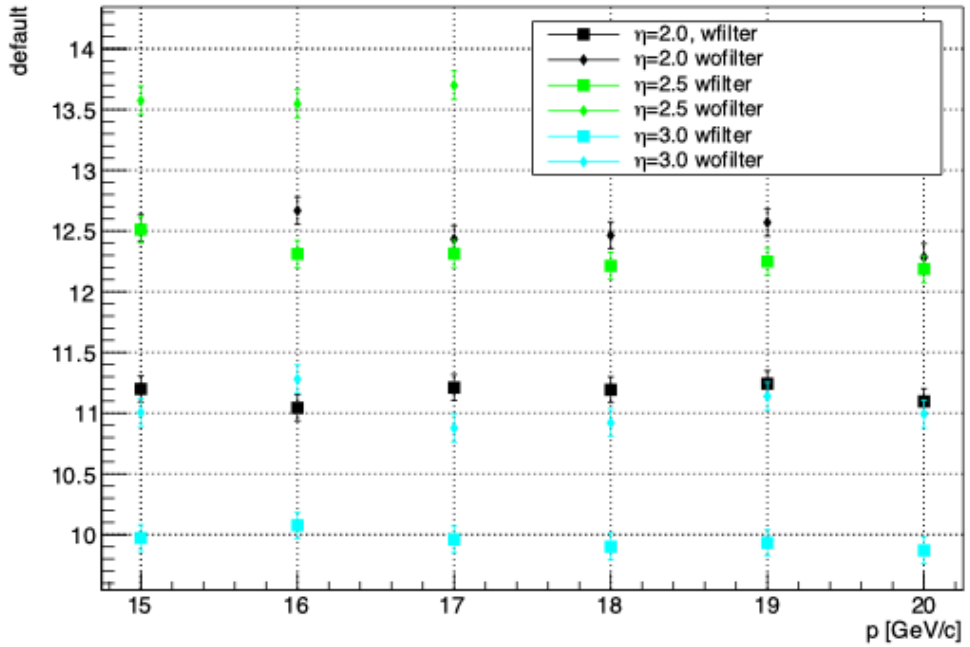
19
20
p [GeV/c]

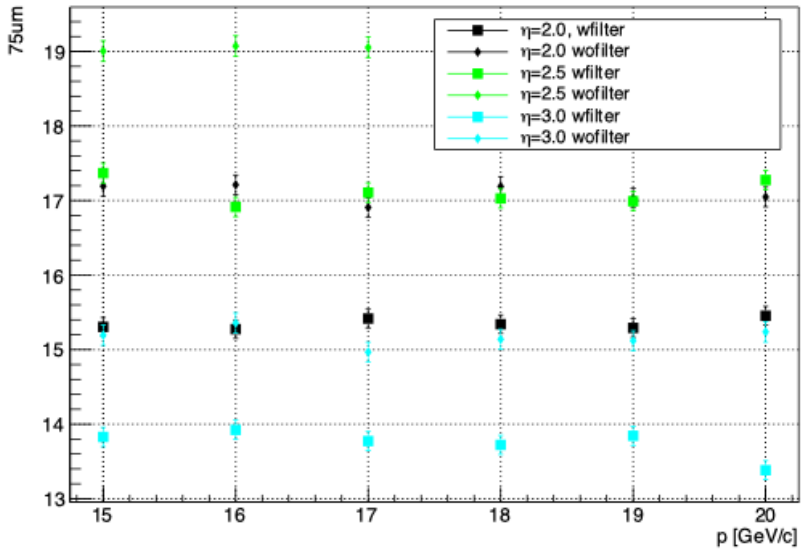

wofilter/wfilter SPR ratio
1.02
1.01
1
0.99
0.98
η=2.0
η=2.5
η=3.0
15
16
17
18
19
20
p [GeV/c]

NPE

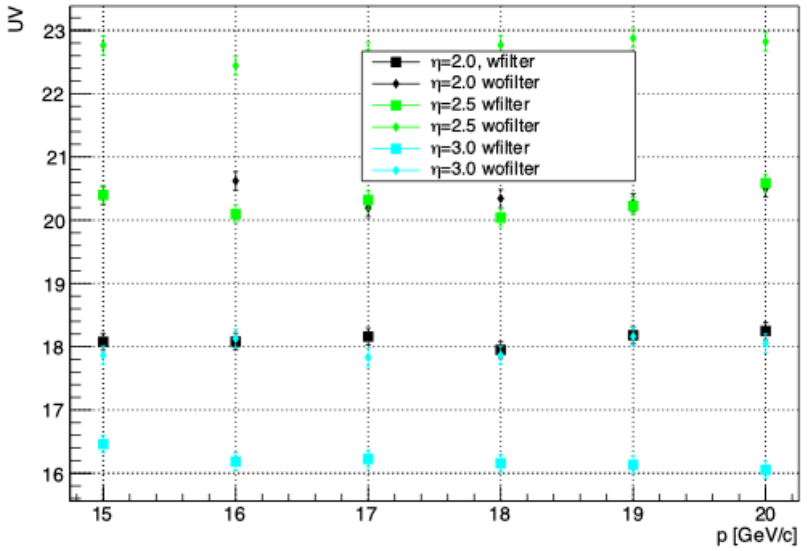
Default



75um



UV

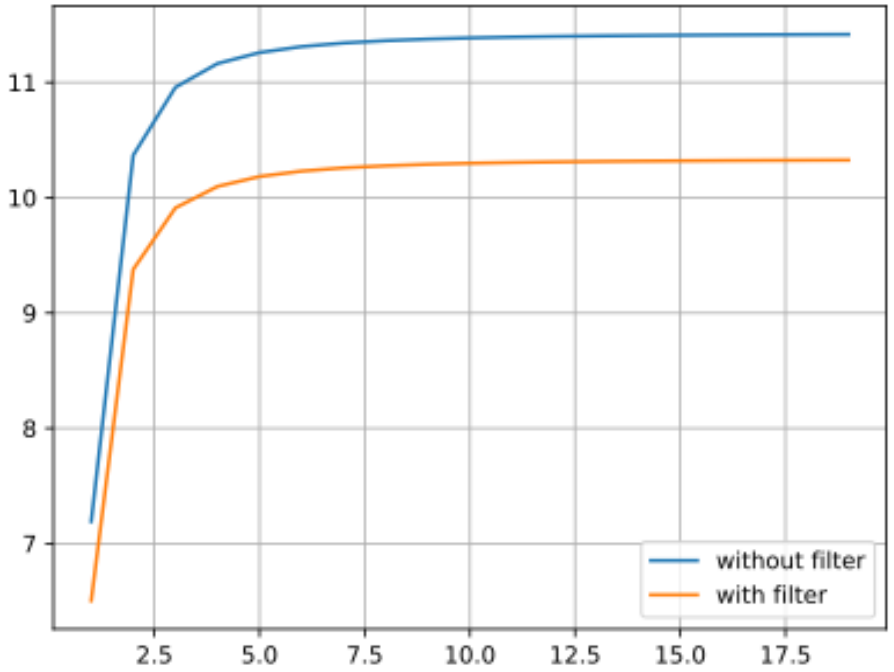


There is an increment of 1.5/2 photons.

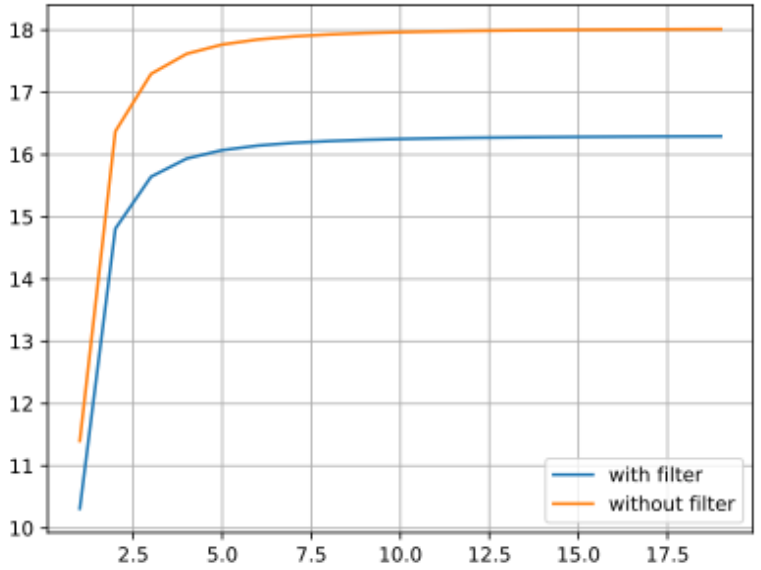
NPE

$$N = 2\pi\alpha \int_{n\beta>1} \left(1 - \frac{1}{(n(\lambda)\beta)^2}\right) \frac{1}{\lambda^2} c(\lambda) d\lambda$$

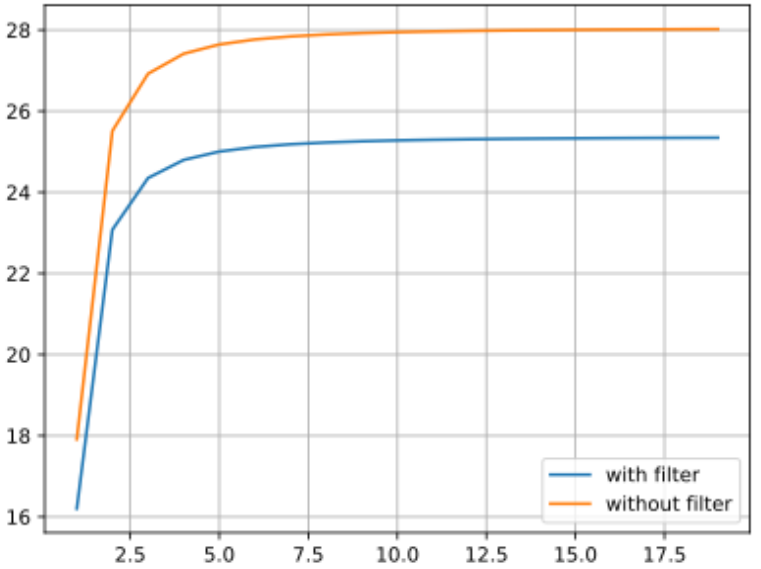
default



75um



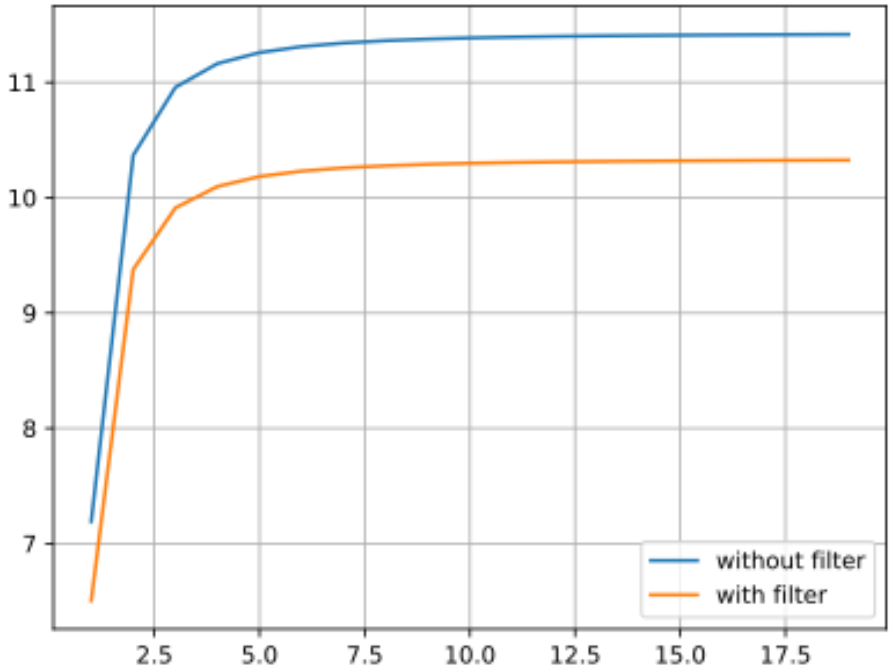
UV

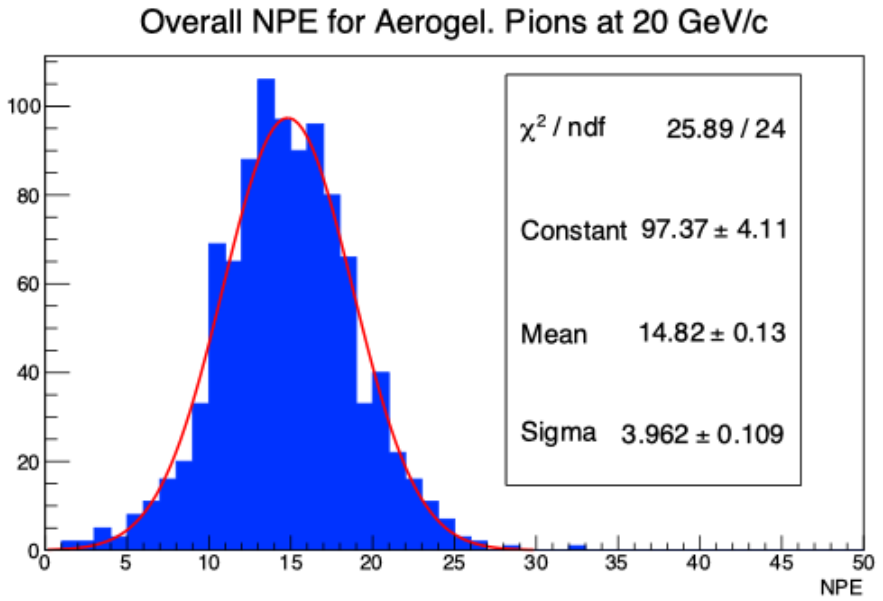


For default and 75um the numbers are underestimated, but the difference of ~2 photons it's there

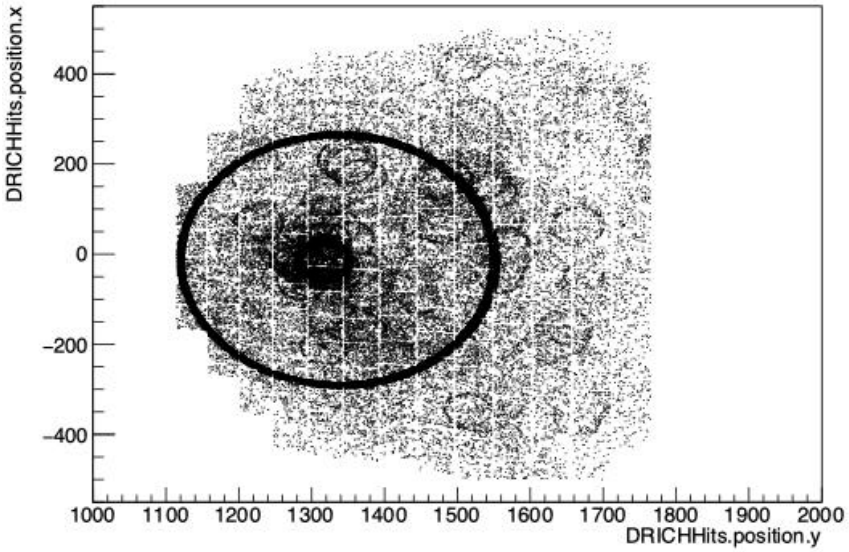
NPE

default





Hitmap and NPE distribution with filter



To compare the prediction with the simulation I run 1000 single events at fixed phi to get a full ring

NPE

NPE wo filter	Predicted	Observed
default	~11.5	~17
75um	~18	~23.5
UV	~28	~28

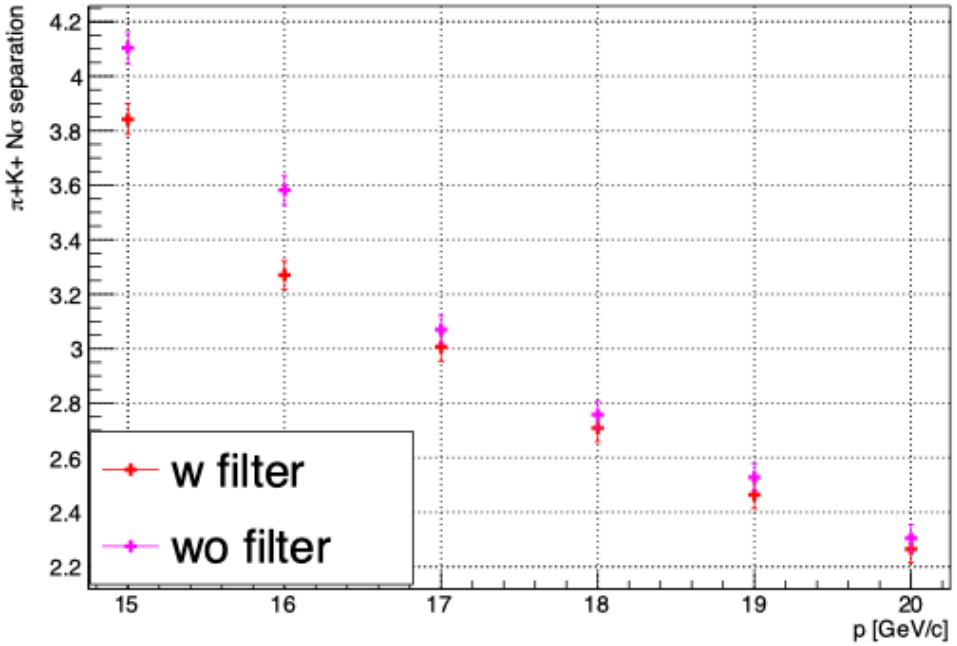
NPE with filter	Predicted	Observed
default	~10.5	~15
75um	~16.5	~21
UV	~25	~25

NPE difference	Predicted	Observed
default	1	2
75um	1.5	2.5
UV	3	3

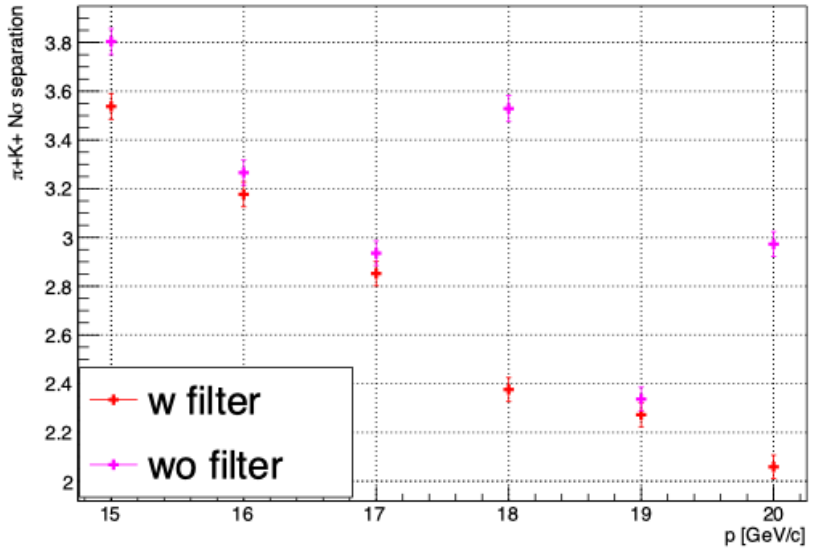
We can conclude that the result are compatible with the expectations

Filter: 3σ πK separation

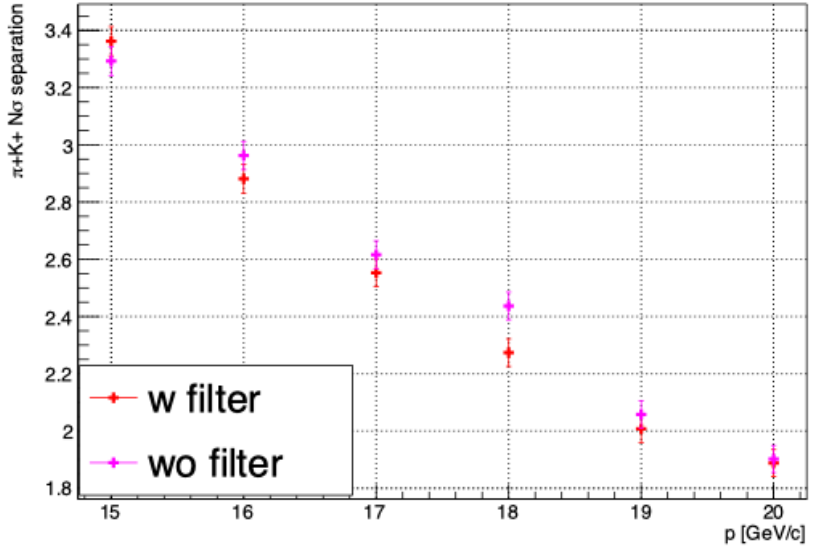
default



75um



UV



At the end what we see is that the 3sigma speration curves are compatible in 1σ

Conclusions

- The usage of other sipms doesn’t affect the Aerogel performances
  - The noise affects the performance of the aerogel, a bigger yield may help in reduce this granting a better signal/noise ratio
- The usage of other sipms improves the Gas performance
  - 3σ πK separation up to 47GeV/c using C4F10 with 75um sipms
- The acrylic filter doesn’t affect the Aerogel performances visibly