Optimization of dRICH aerogel: simulation studies

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Requirements from aerogel

- Perform positive identifications of hadrons with momentum below threshold momentum in the gas.
- Substantial performance overlap in momentum region with gas radiator.
- Provide electron/pion separation to boost/aid calorimeter performance.
- Kaon threshold in C_2F_6 is around 12 GeV/c.

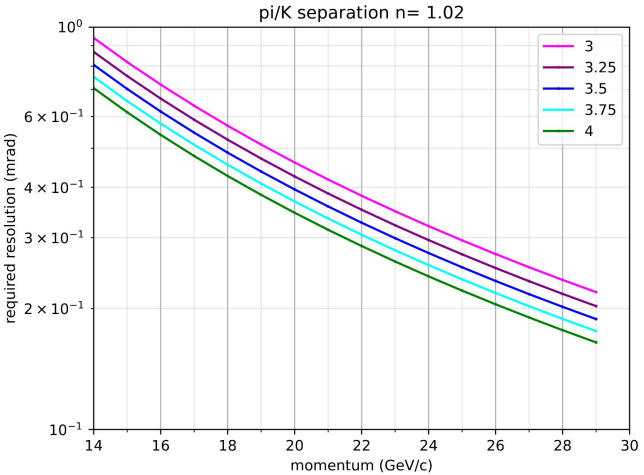
Caveats:

- Large ring diameter. Rings split into different sensor sectors. → Difficult pattern recognition for single event.

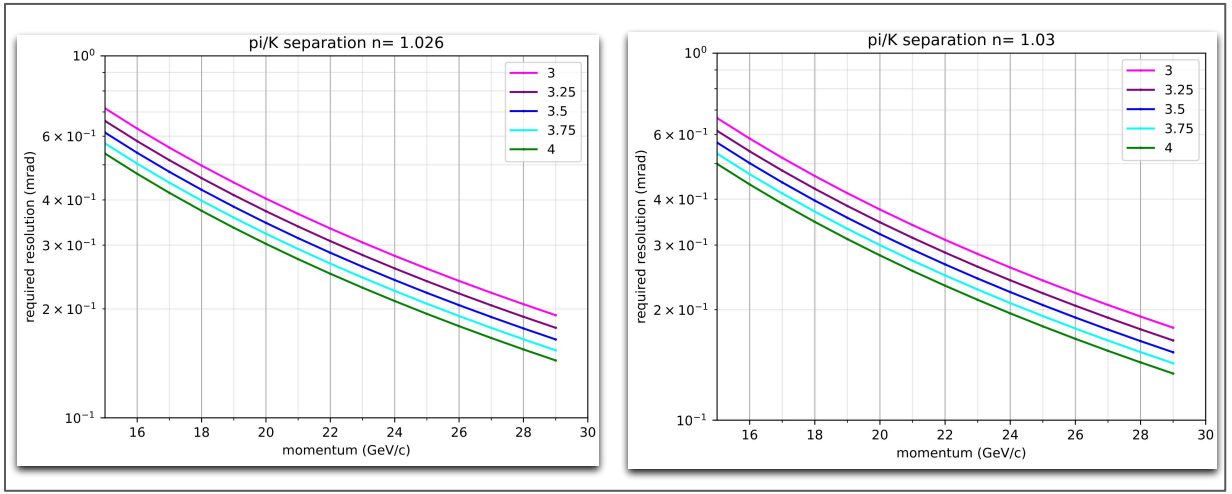
Therefore:

- Optimized optical parameters
  → Improved single photon resolution
- Increase number of detected photons.
  → Improved ring resolution

Requirements from aerogel



Baseline

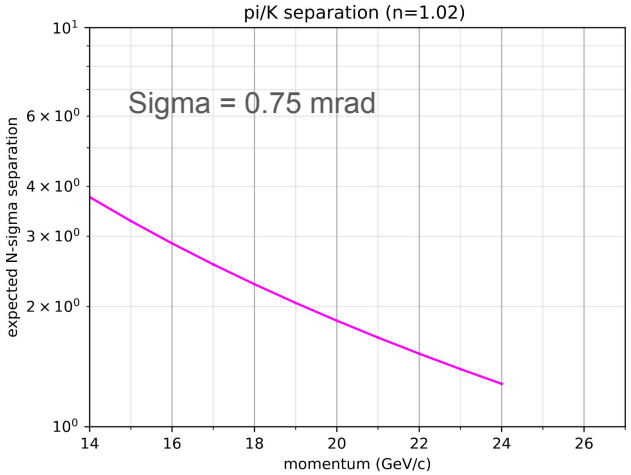


Type-1 Type-2

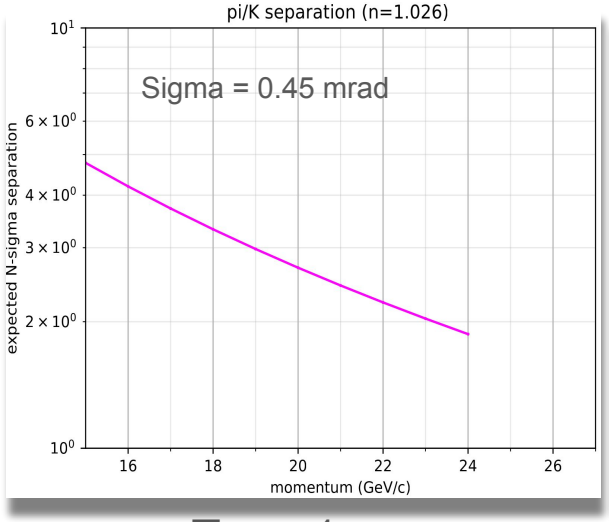
New Aerogels

- Higher refractive index brings angle closer for two hypothesis. Better resolution is required.
- Higher refractive index ~ Higher Photon yield

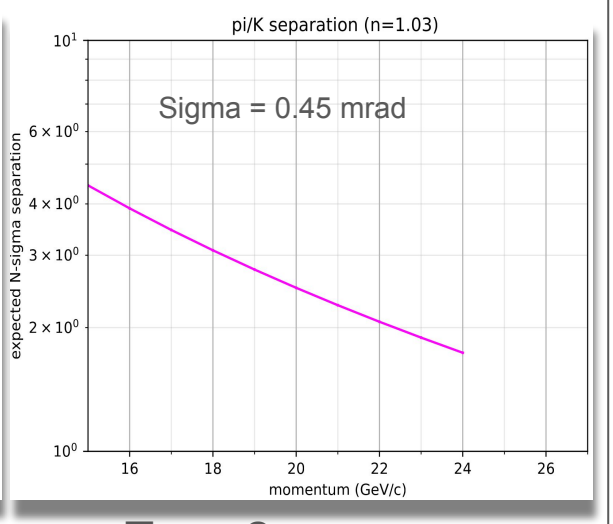
Expectations from different aerogel types



Baseline



Type-1

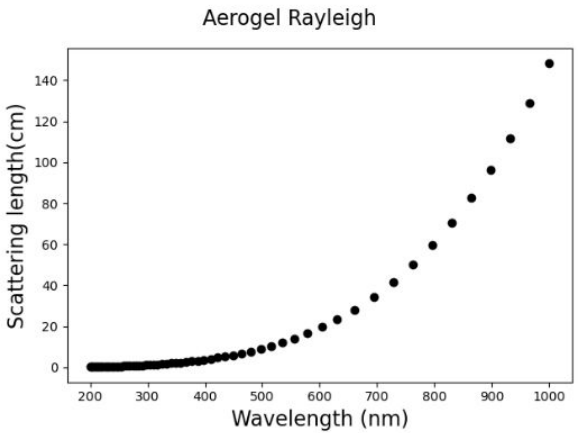


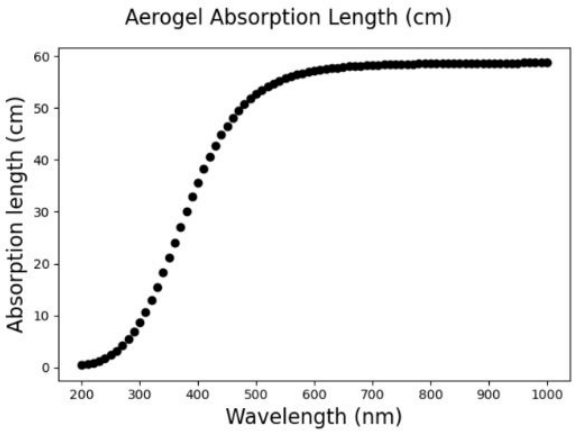
Type-2

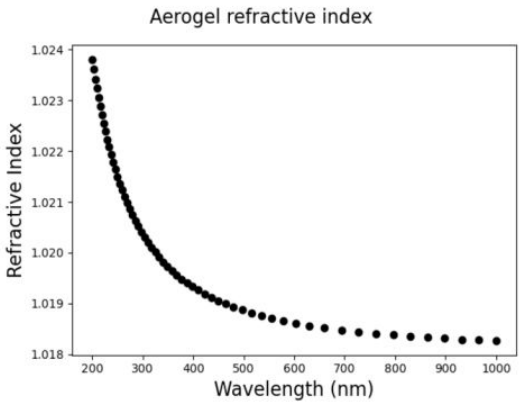
New Aerogels

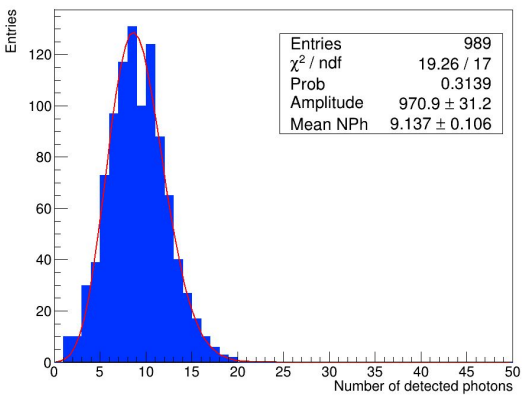
- The new aerogel types have better optical parameters. Resulting into better single photon resolution.
- Larger number of photons.

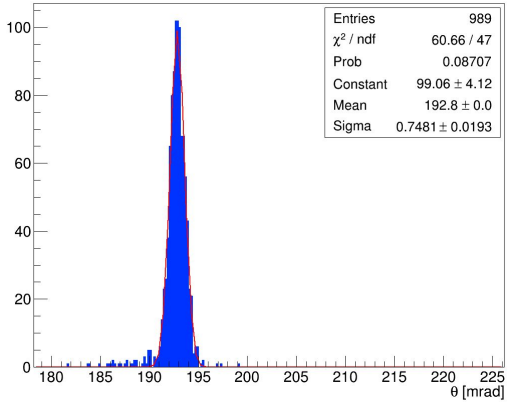
Baseline Aerogel

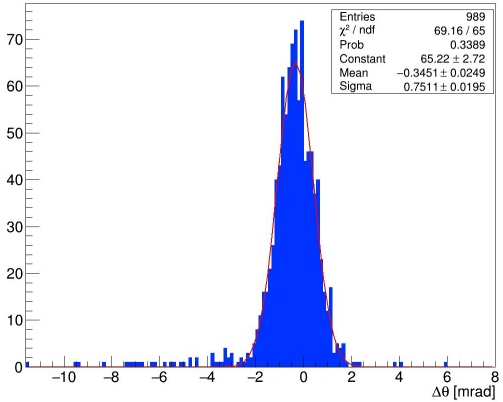




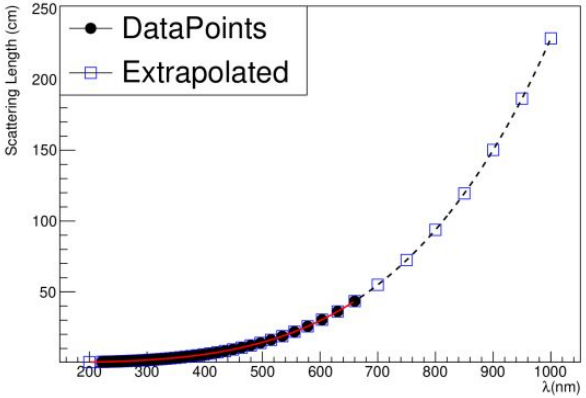


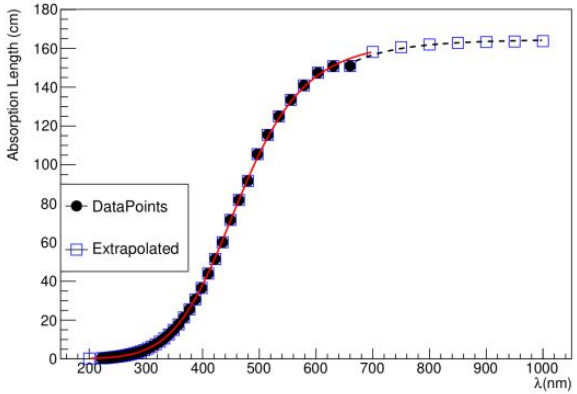


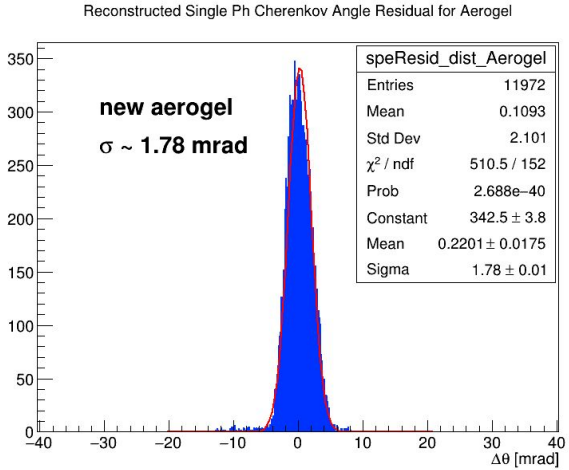


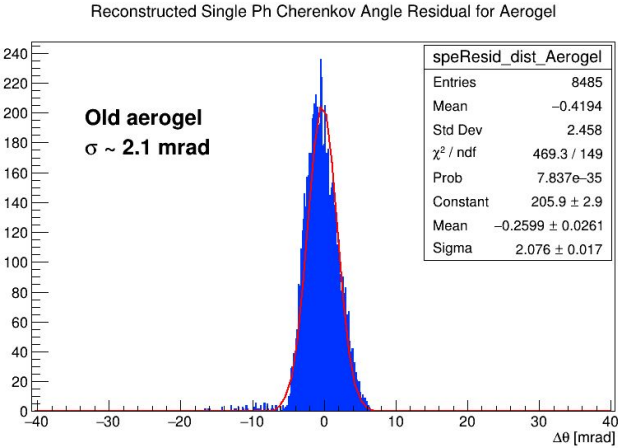


Parameters for New Aerogel-1 (1.026)



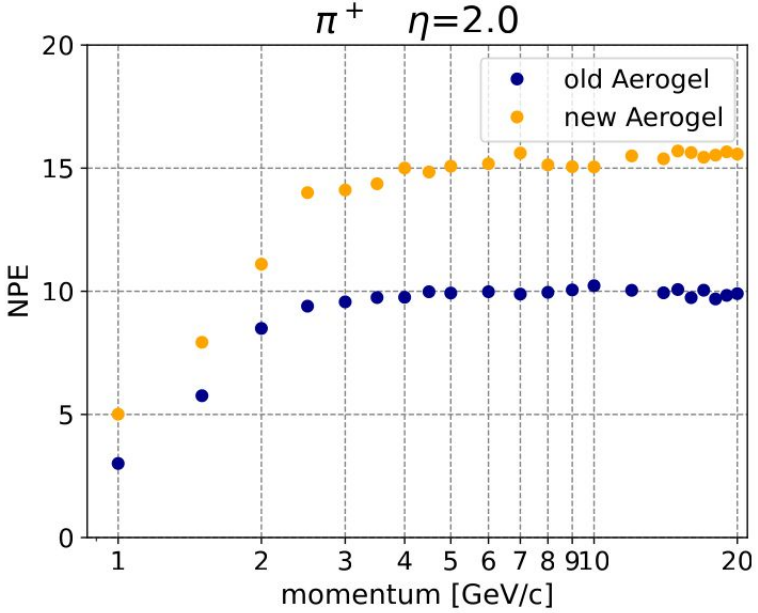


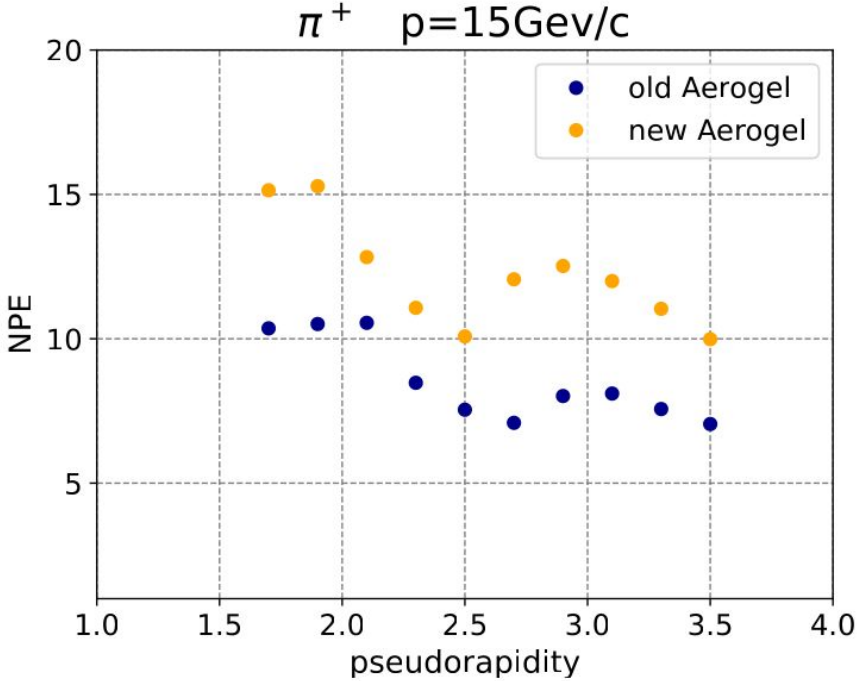




Better optical parameters!
→ Improved single photon resolution in new (type-1) aerogel!

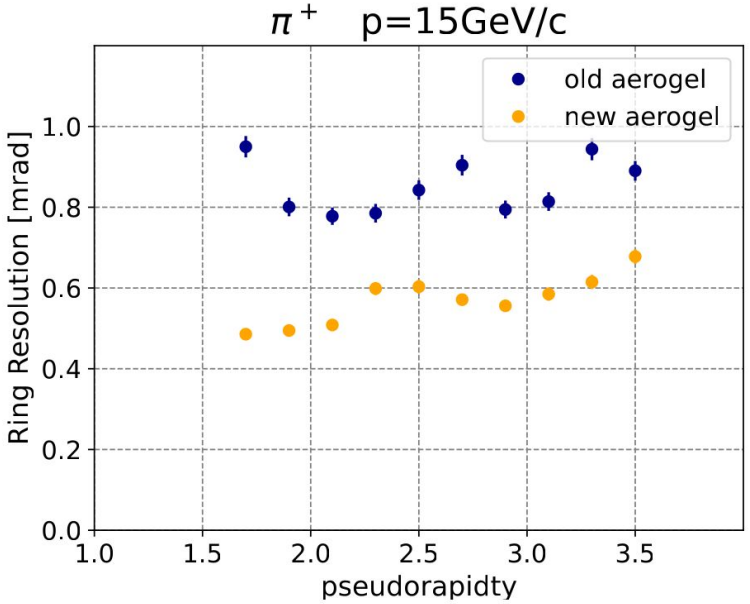
Number of detected photons for New Aerogel-1 (1.026)

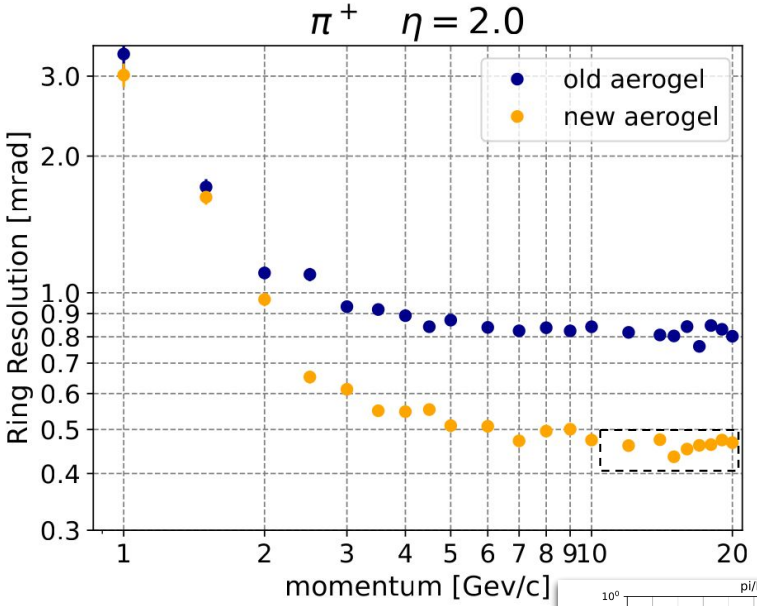




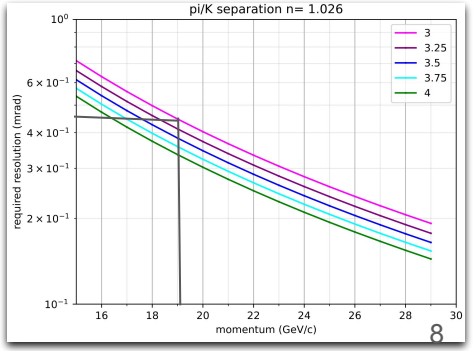
Significantly larger number of photons!
Convolution of Acceptance and ring size give rise to pseudorapidity dependency in Nph for a given azimuthal angle!

Resolution Comparison of new Aerogel type-1

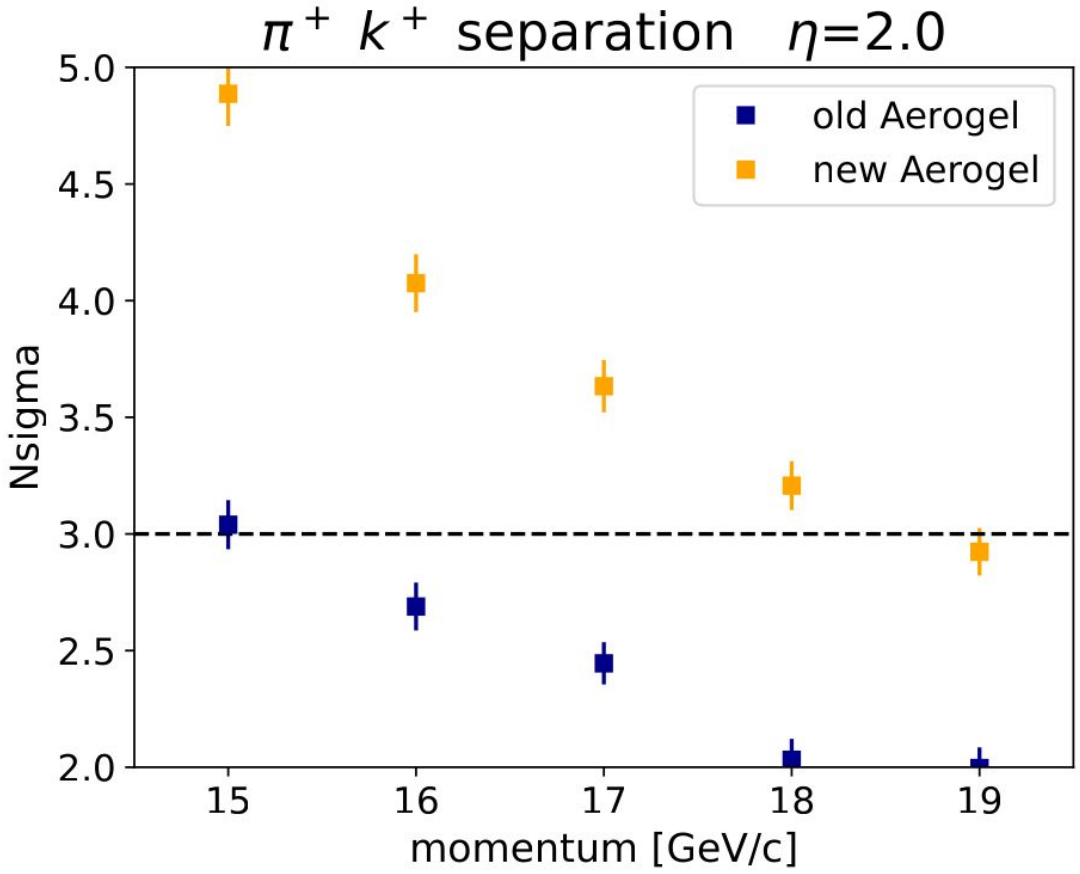




New type-1 Aerogel provides ring resolution capable to perform PID ~ 18-19 GeV (@eta=2.0), baseline aerogel is limited only upto 15-16 GeV



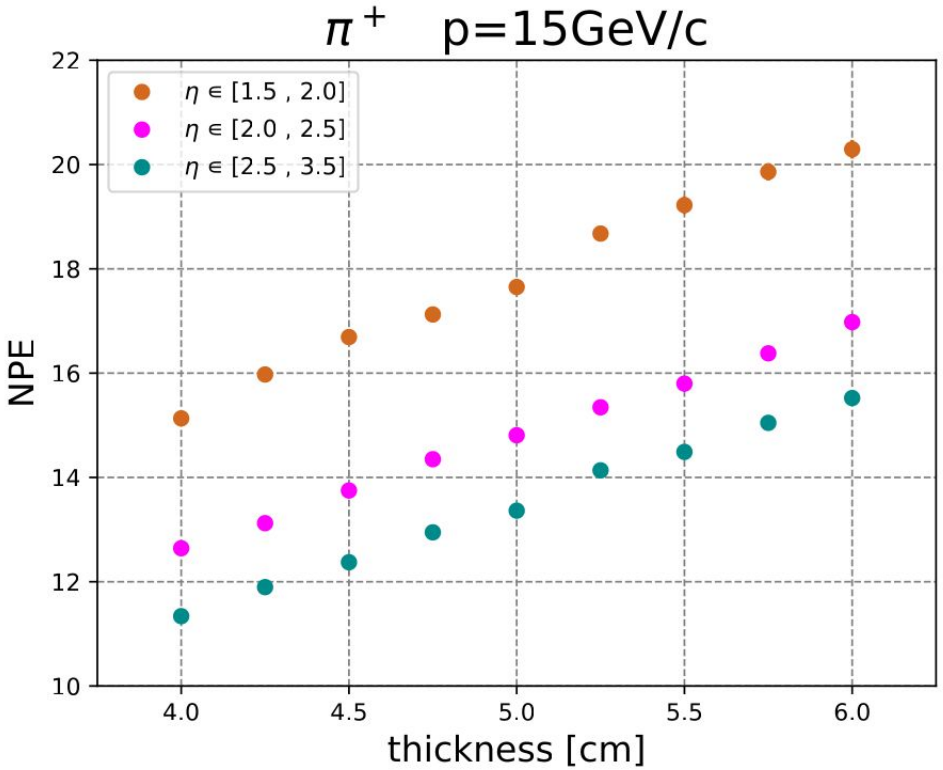
Performance Comparison of new Aerogel type-1



Detailed study of Tiziano has demonstrated aerogel with <n> = 1.026 out performs baseline aerogel!!

Gain in performance (wrt baseline) ~ 3.5-4 GeV/c, 1.5 times more Nph!

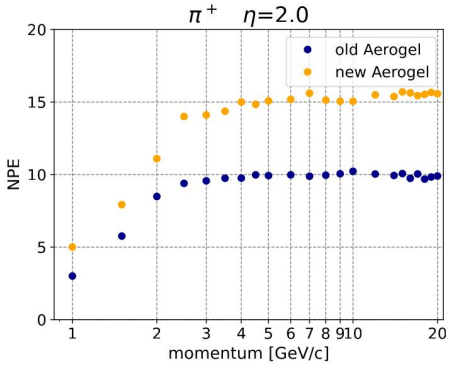
Thickness studies

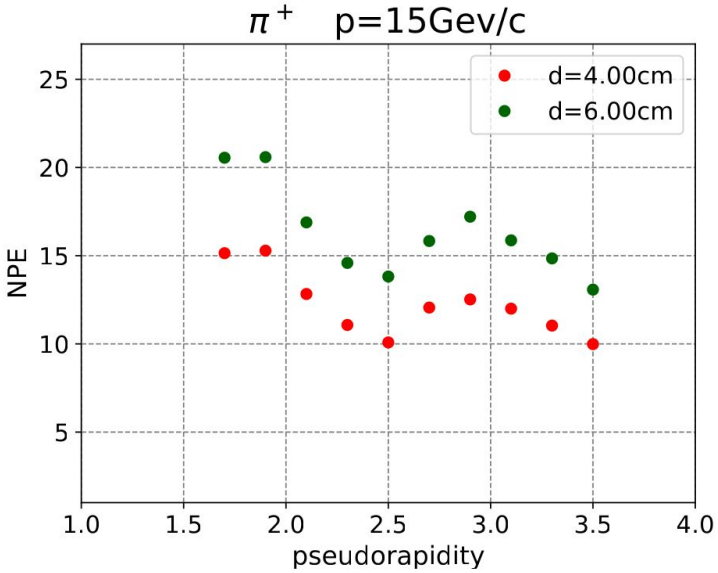


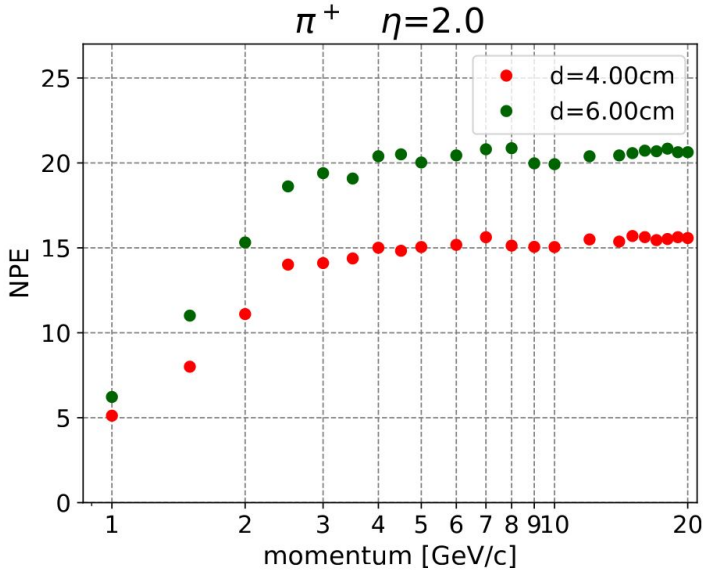
Gaining Nph even more!
→ Increase aerogel thickness!
→ Caveat: irreducible border effect!

6 cm aerogel comparison

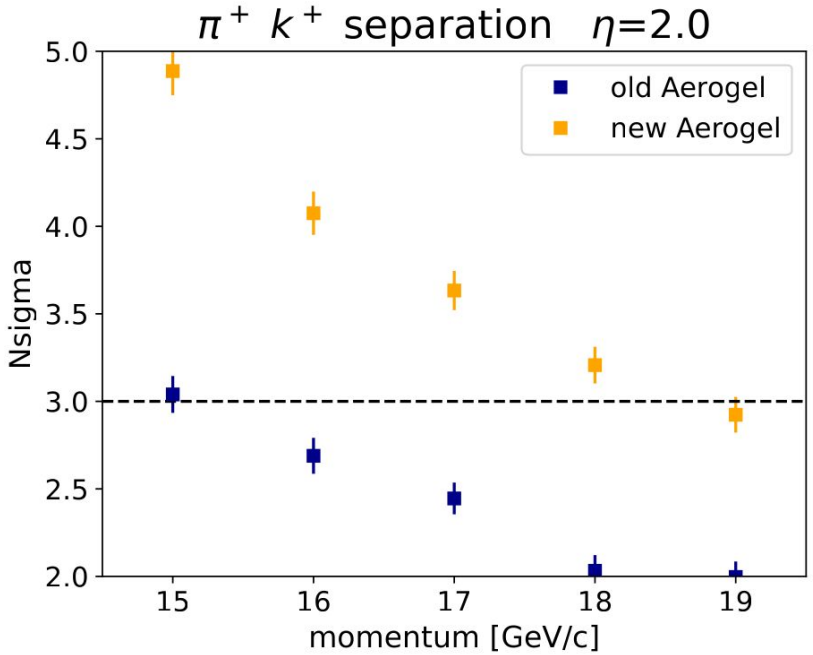
Assuming, best aerogel parameters can be obtained with multiple of 2 cm!

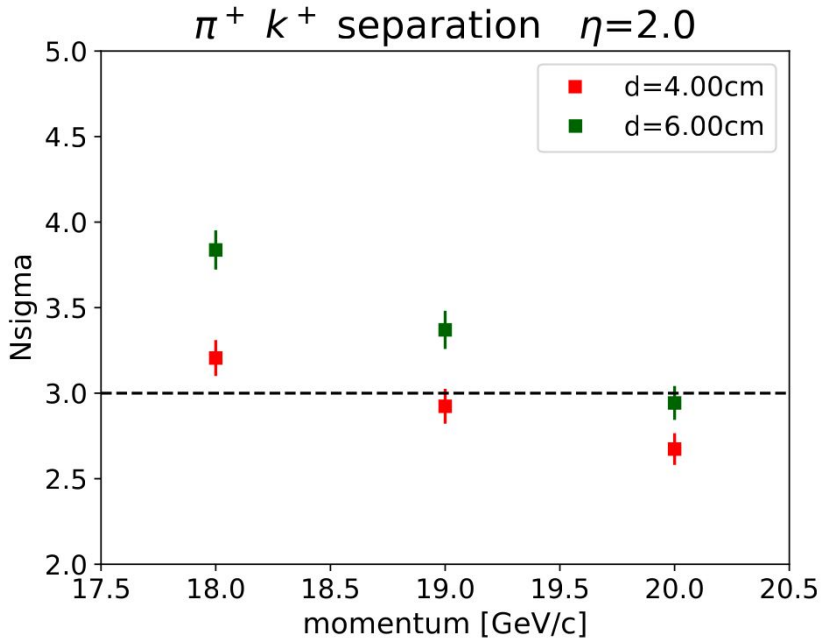






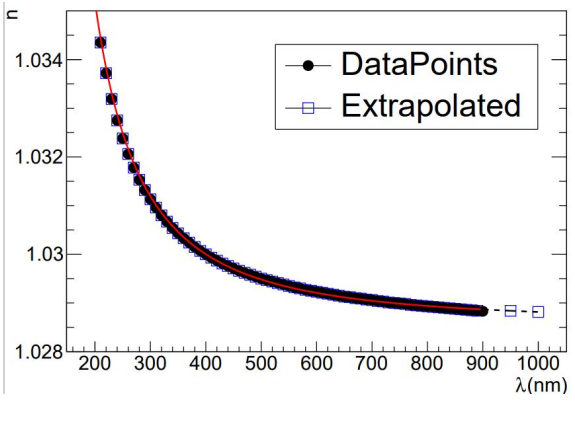
6 cm aerogel performance comparison

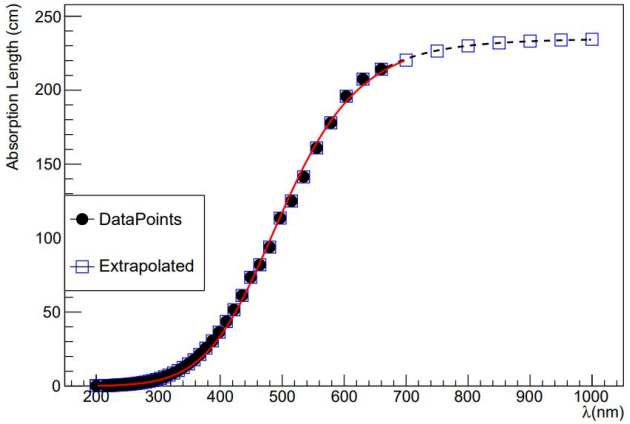


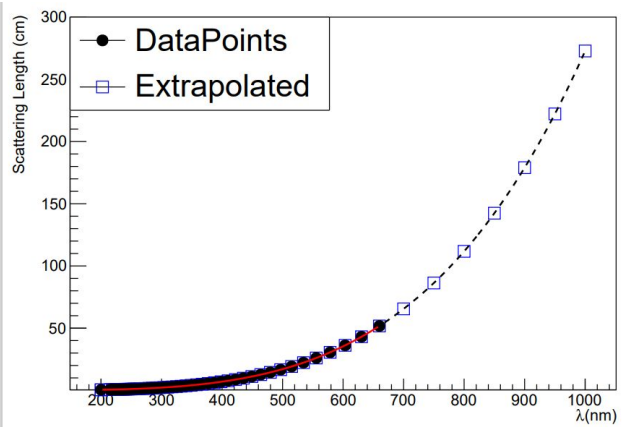


Gain in performance (wrt baseline) ~ 5 GeV/c,
factor 2 more Nph!

New Aerogel type-2 (n = 1.03)

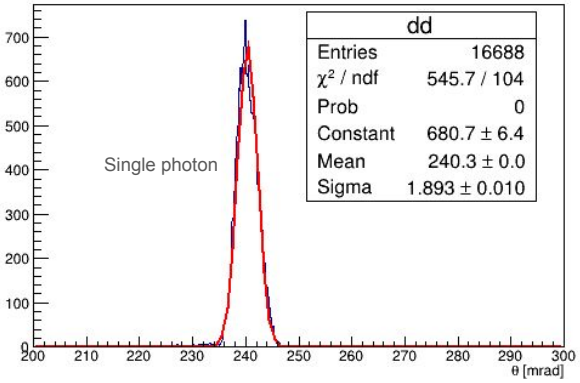


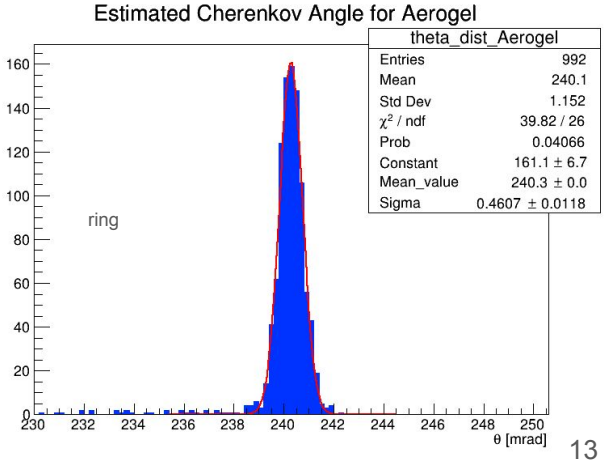




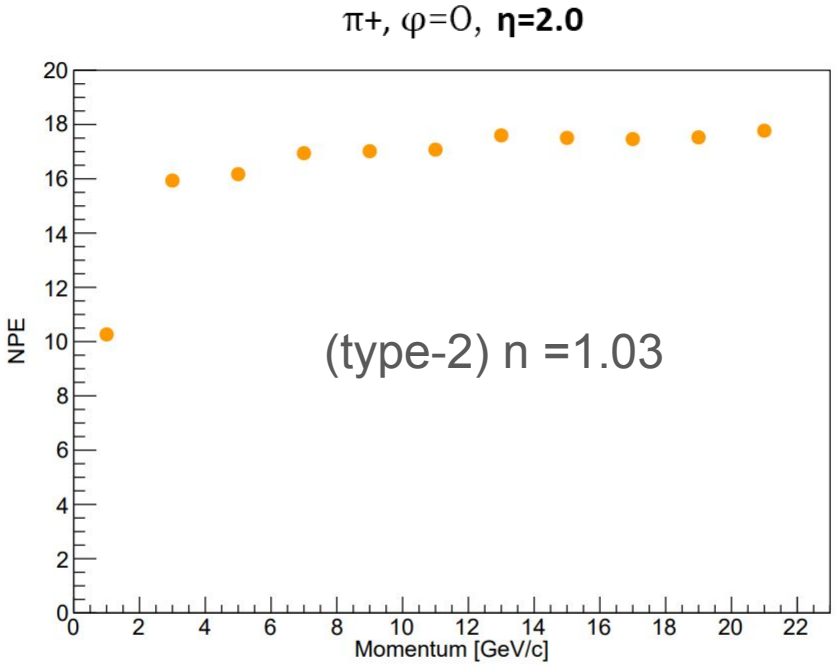
New studies!
Luisa (ongoing!)

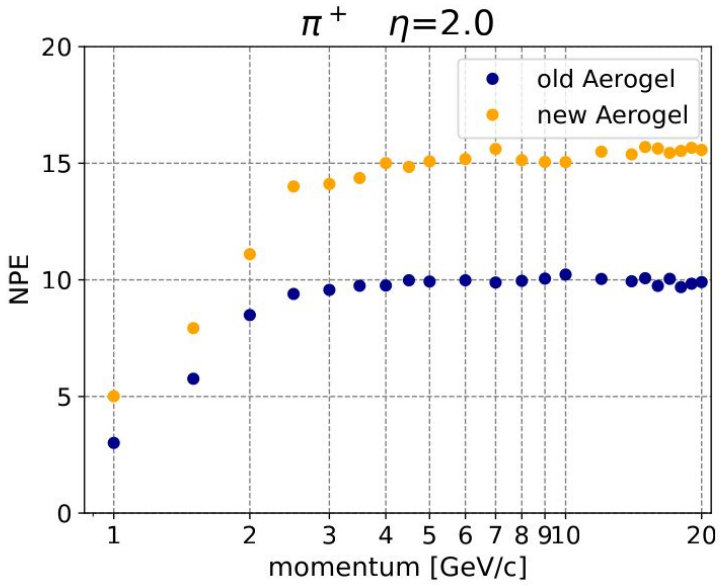
Sph(*ring*) Res type-2/type-1/b.l.:
1.89/1.78/2.1 (*0.46/0.45/0.8*)
mrad





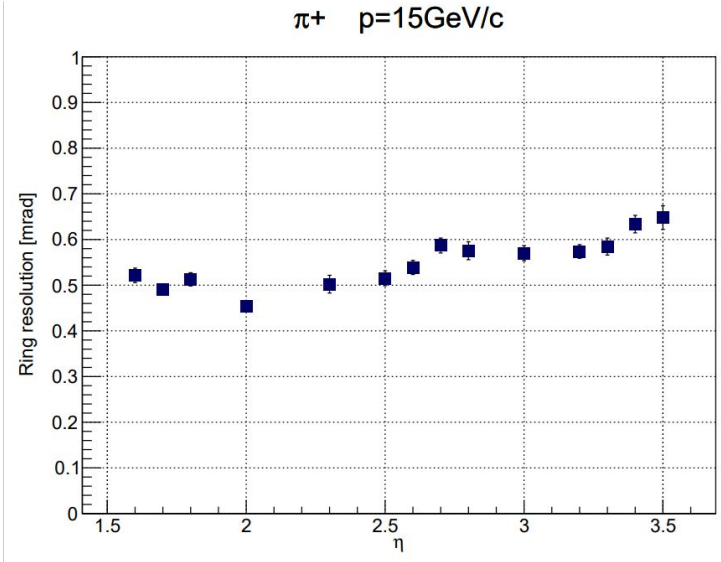
Number of photons comparison of new Aerogels and baseline

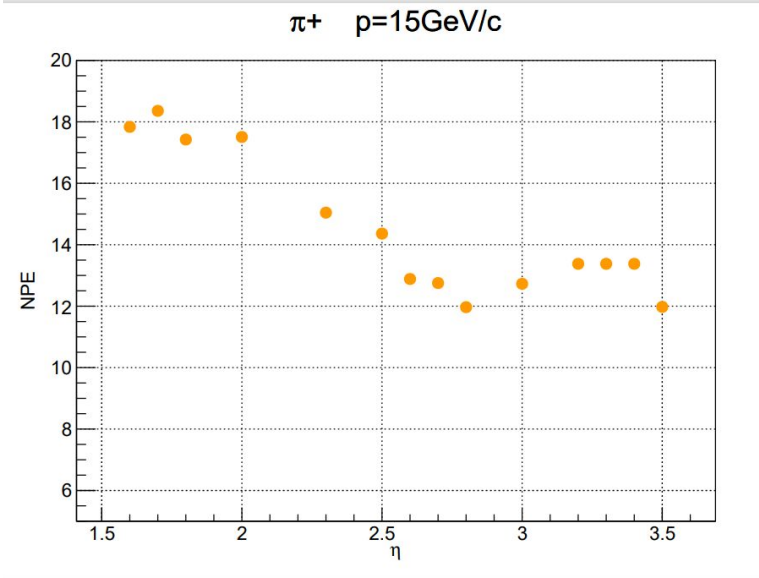




We gain 1-2 photons in the similar phasespace!
Can be important for ring recognition for split rings!

Performance of new Aerogel type-2

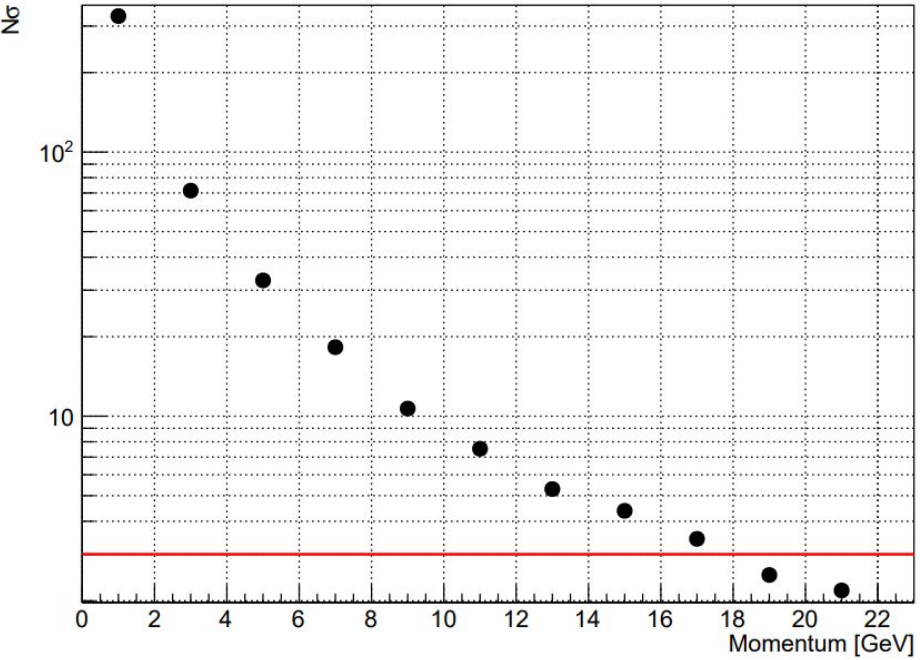


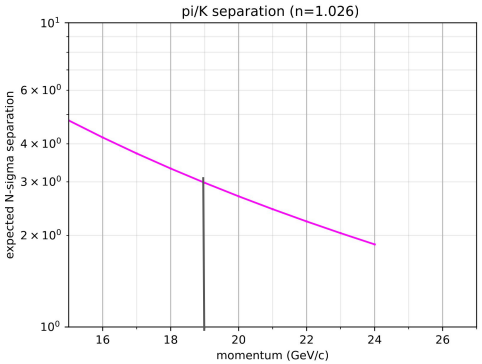


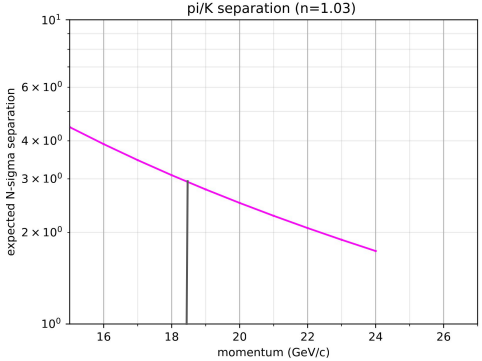
Pseudorapidity dependency is seen also for type-2 aerogel for fixed azimuthal angle. (Deep at different value).

In view of LUT binning of phi, type of aerogel will be important!

Performance of new Aerogel type-2







Despite higher Nph, comparable resolution,
First indication is that
1.03 underperforms 1.026

Difference in ring angle is smaller for 1.03.

Summary

- A systematic simulation study to optimize the aerogel parameters for the ePIC dRICH is in advanced phase.
- Clearly the baseline aerogel is not the optimal aerogel.
- Two different samples has been studied by T.Boasso and L. Occhiuto.
- The studies indicate that new type-1 (n= 1.026) could be the most optimal aerogel in terms of separation.
- New aerogel type-2, provides similar ring resolution thanks to slightly higher number of photons.
- The type-2 aerogel pi/K separation seems to be underperforming the type-1 aerogel less than a GeV.
- Type-2 Aerogel has larger photons, that can even be enhanced by increasing thickness (to be studied soon) may improve image reconstruction for split rings and pushing down the low momentum PID (will be studied soon).
- On compilation of the studies, shall we consider a technical note/ small paper?