Dual-radiator RICH: update
EIC PID consortium meeting

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Outline

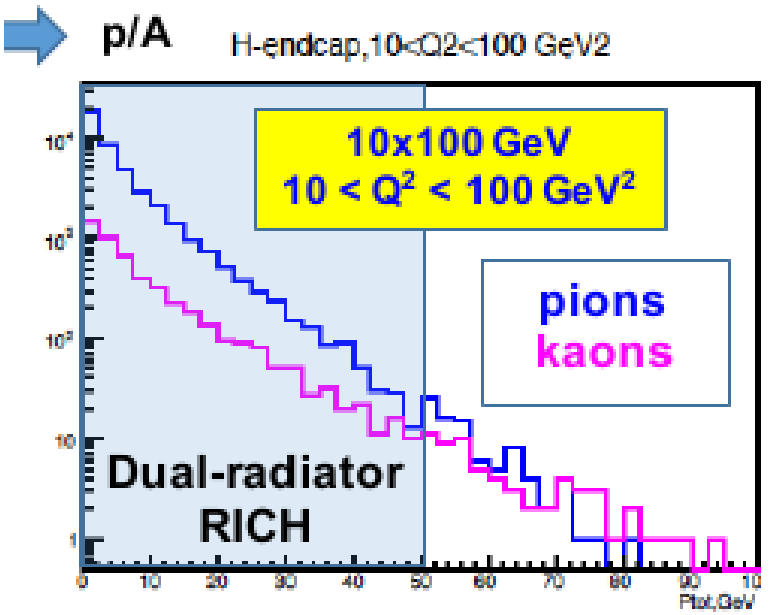
- Why a dual-radiator RICH (dRICH) in the h-endcup

- Some detail on the simulation:
  - established baseline
  - recent results and developments
- Future developments

Why a dRICH in the hadron side

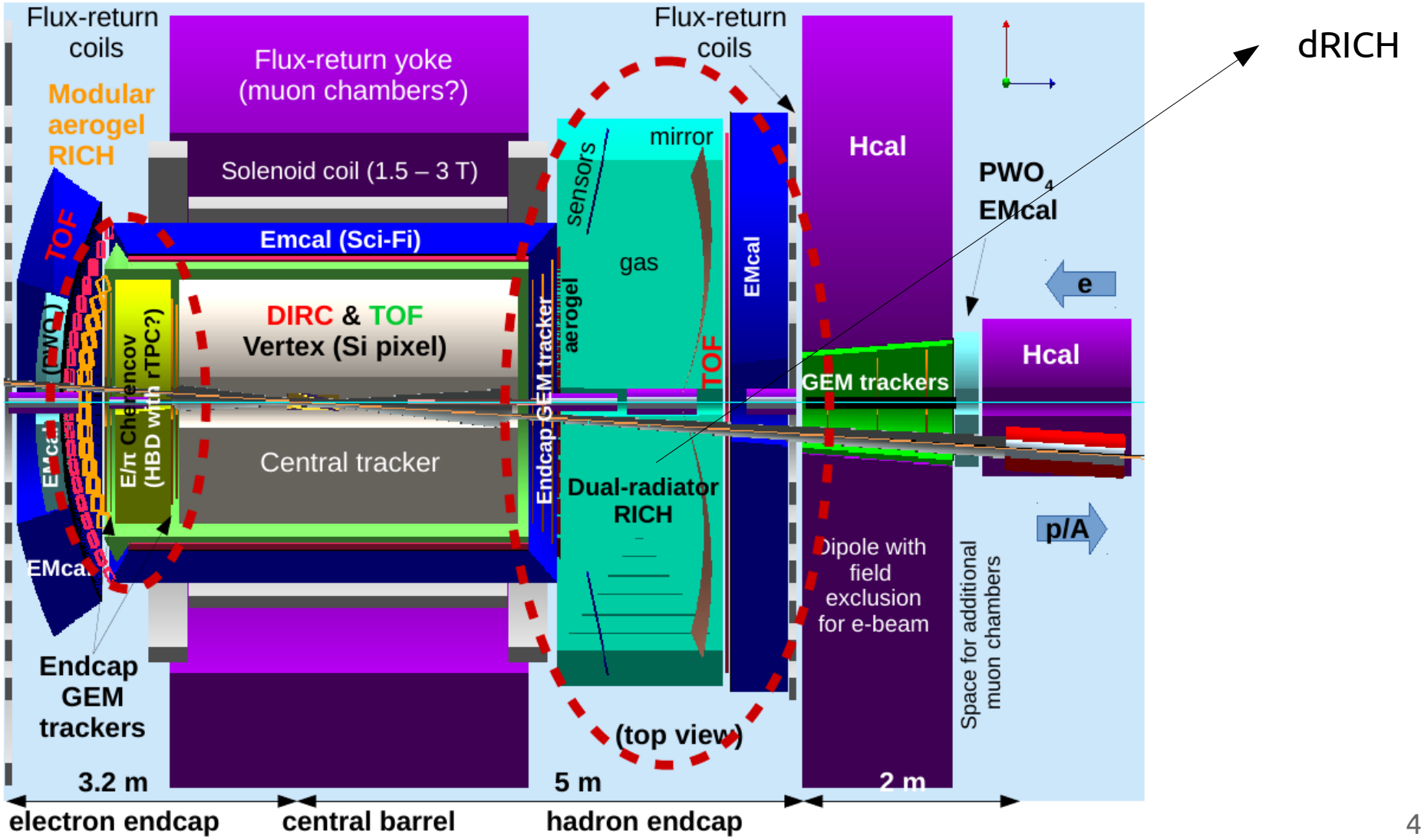
We want to study several processes where the capability of PID is extremely important.

- Common configuration Jlab/BNL (***e* 10 GeV x *p* 100 GeV**)



- The high momentum region contains important physics (i.e. SIDIS)
- We want to have hadron-PID capability in the range [~3,50]

dRICH in the JLab EIC detector



Mirror focused aerogel & gas

Goal: pi/K/p ID from 2.5 to 50 GeV/c

e/pi ID up to 20 GeV/c

polar angular coverage [5°,25°]

- Aerogel

  - 4 cm thickness

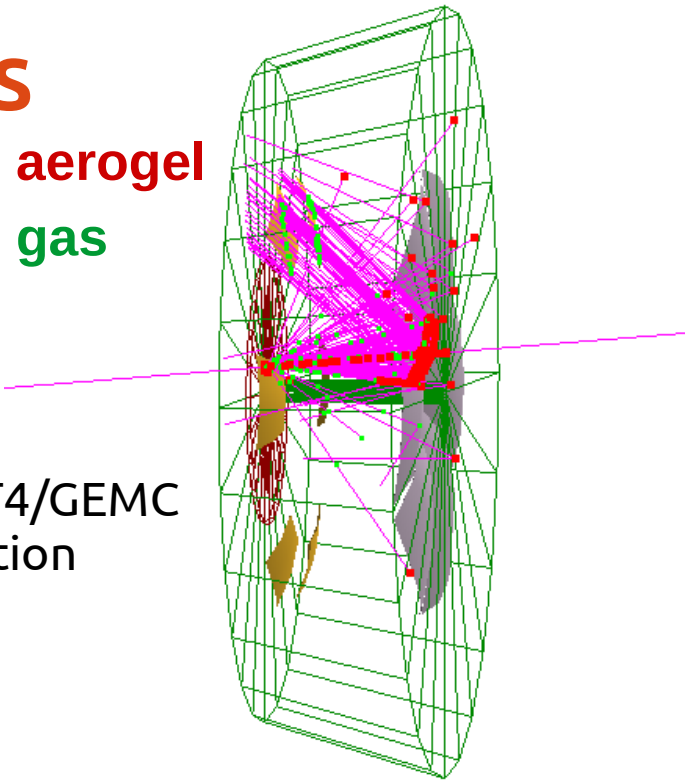
  - index of refraction 1.02 (lower than the usual 1.03)

- Gas (C_2F_6 or CF_4) about 160 cm

  - C_2F_6 guarantee a good momentum matching with the aerogel

  - CF_4 a larger momentum coverage

The **dRICH is in magnetic field** (3T central field in the simulation)



GEANT4/GEMC simulation

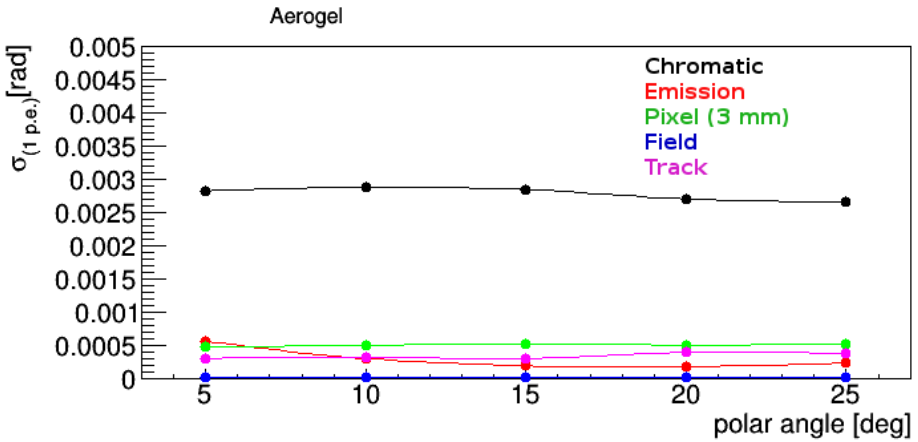
Photo-detector: spherical shape *8500 cm²* (per sector)

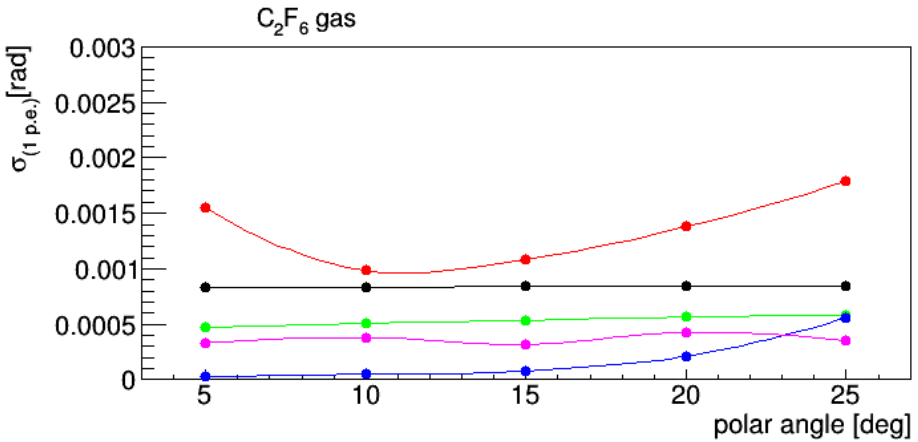
6 sectors of 60° in azimuthal angle

Single p.e. error contributions

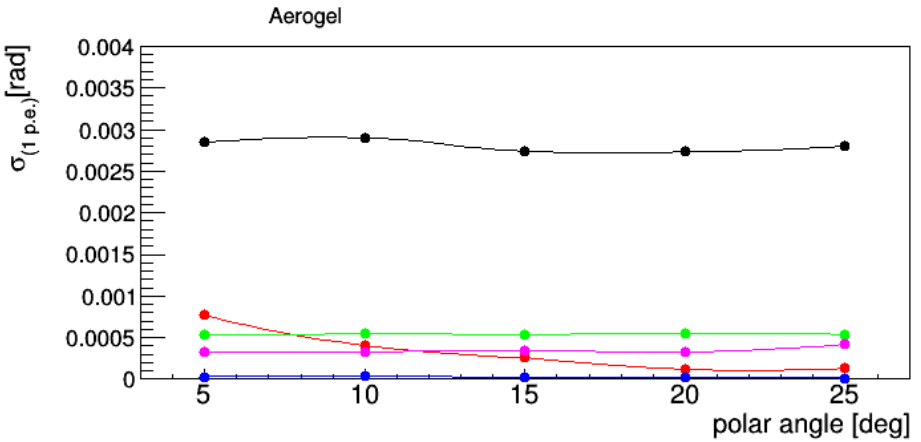
The *Idirect Ray Tracing* alghoritm has been used as an analysis tool!
Photons coming from aerogel with wavelength below 300 nm cut by software.

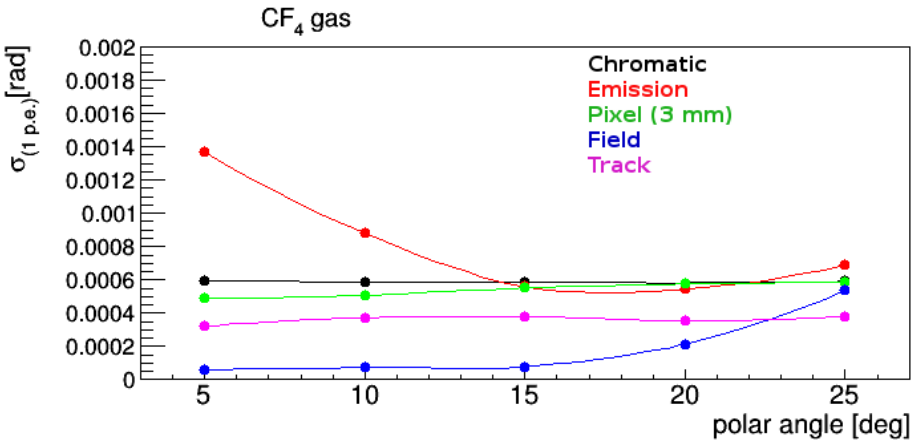
Aerogel & C_2F_6





Aerogel & CF_4



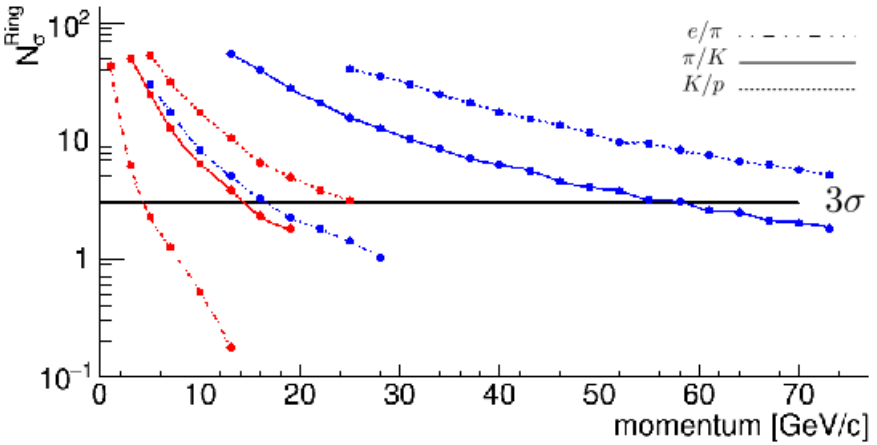


Assumed angular error on the track: $\Delta\theta = \Delta\phi = 0.5\ mrad$

PID at 15° (polar angle)

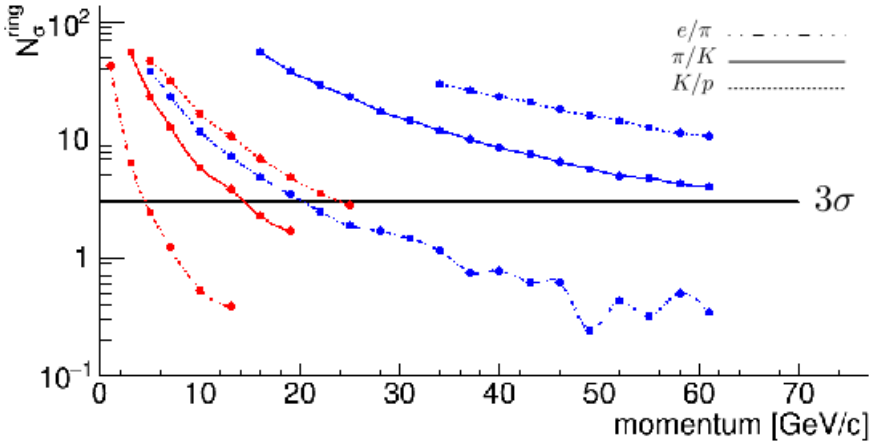
Aerogel & C_2F_6

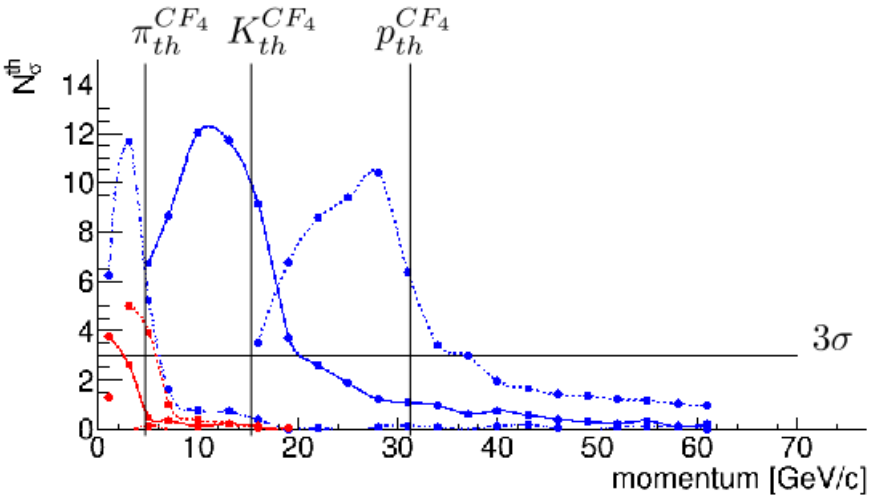
$Aerogerl(n = 1.015)$ | $e_{th}(GeV/c) = 0.0029$ | $\pi_{th}(GeV/c) = 0.80$ | $K_{th}(GeV/c) = 2.84$ | $p_{th}(GeV/c) = 5.40$
$C_2F_6(n = 1.00082)$ | $e_{th}(GeV/c) = 0.0123$ | $\pi_{th}(GeV/c) = 3.48$ | $K_{th}(GeV/c) = 12.3$ | $p_{th}(GeV/c) = 23.4$



Aerogel & CF_4

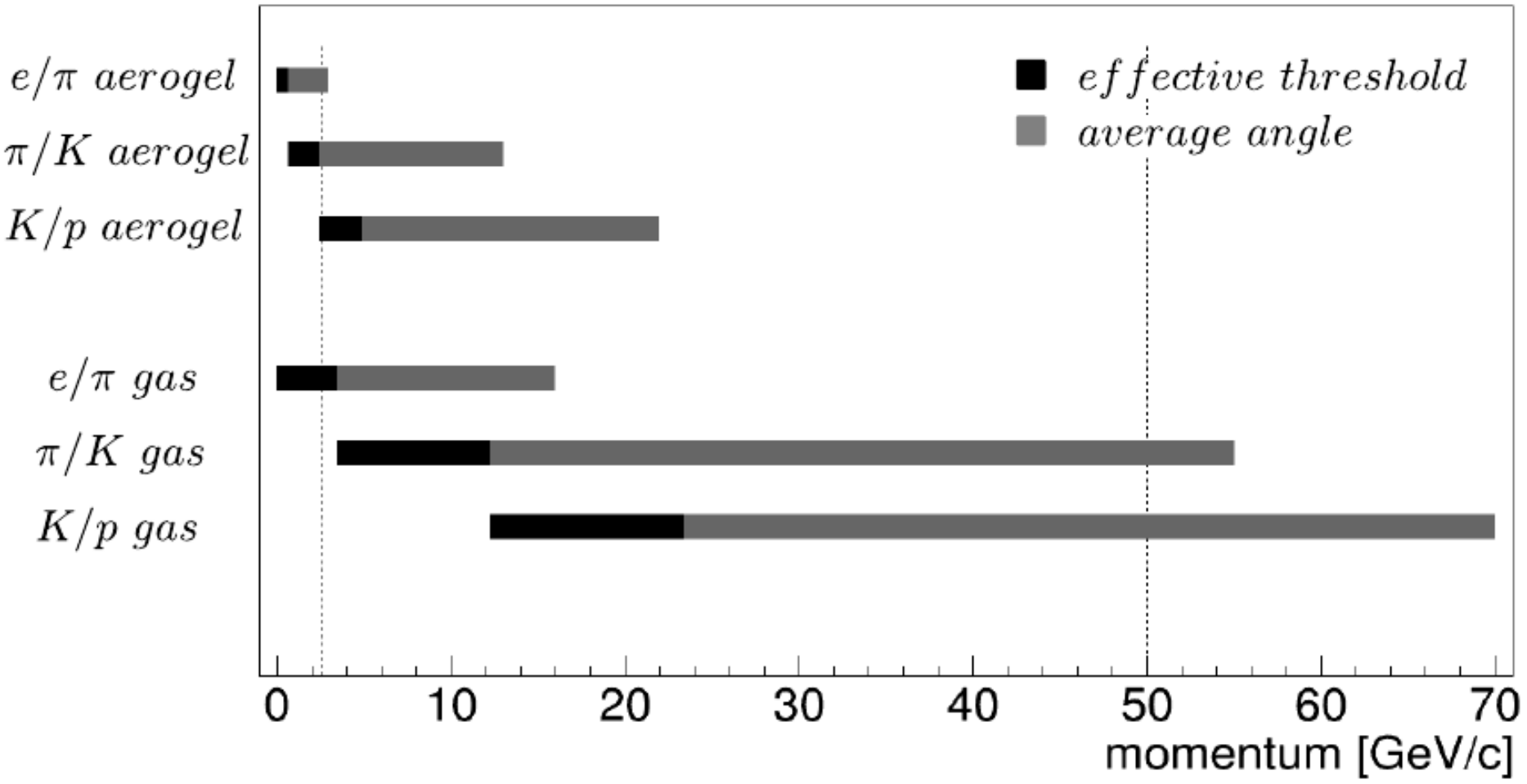
$Aerogerl$ | $e_{th}(GeV/c) = 0.002542$ | $\pi_{th}(GeV/c) = 0.67$ | $K_{th}(GeV/c) = 2.46$ | $p_{th}(GeV/c) = 4.89$
CF_4 | $e_{th}(GeV/c) = 0.016457$ | $\pi_{th}(GeV/c) = 4.35$ | $K_{th}(GeV/c) = 15.94$ | $p_{th}(GeV/c) = 31.66$



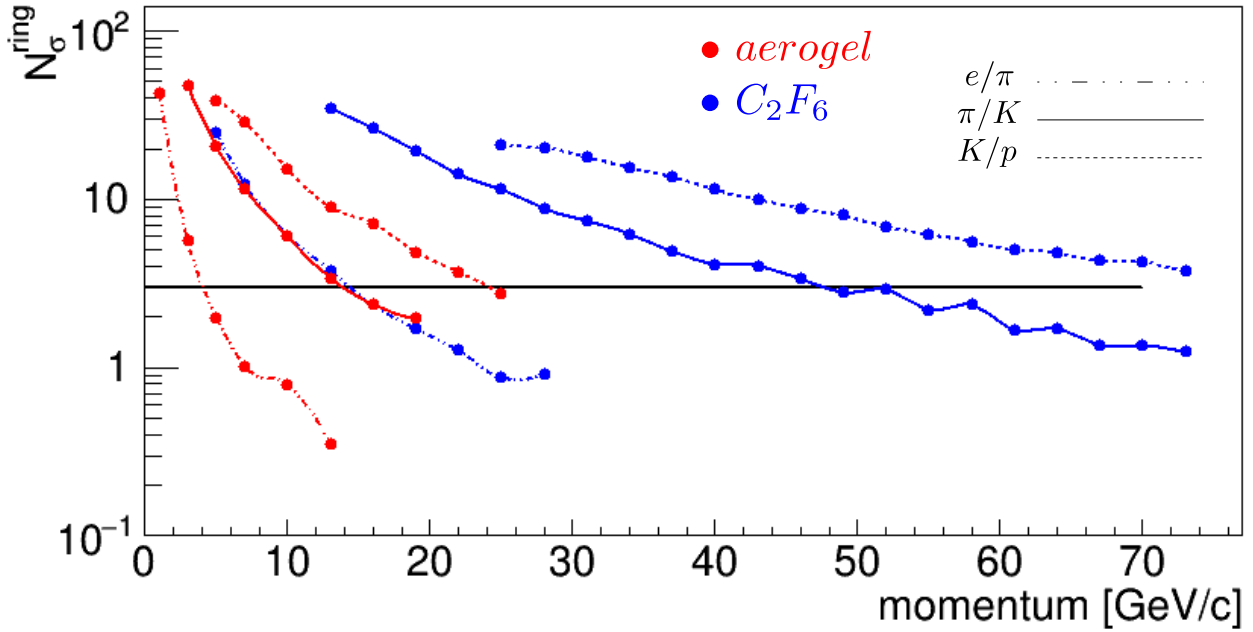


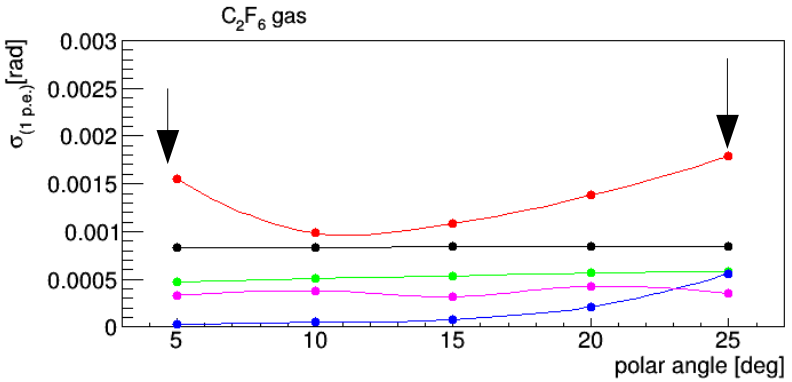
- Aerogel & C_2F_6 can be considered the optimal solution for our momentum range!
- QE curve - H12700

C_2F_6 & Aerogel PID table (15°)



PID at 5° polar angle





- Similar behaviour for a polar angle of 25°
- The dominant error for the gas is the emission error

FY17 – proposed activities

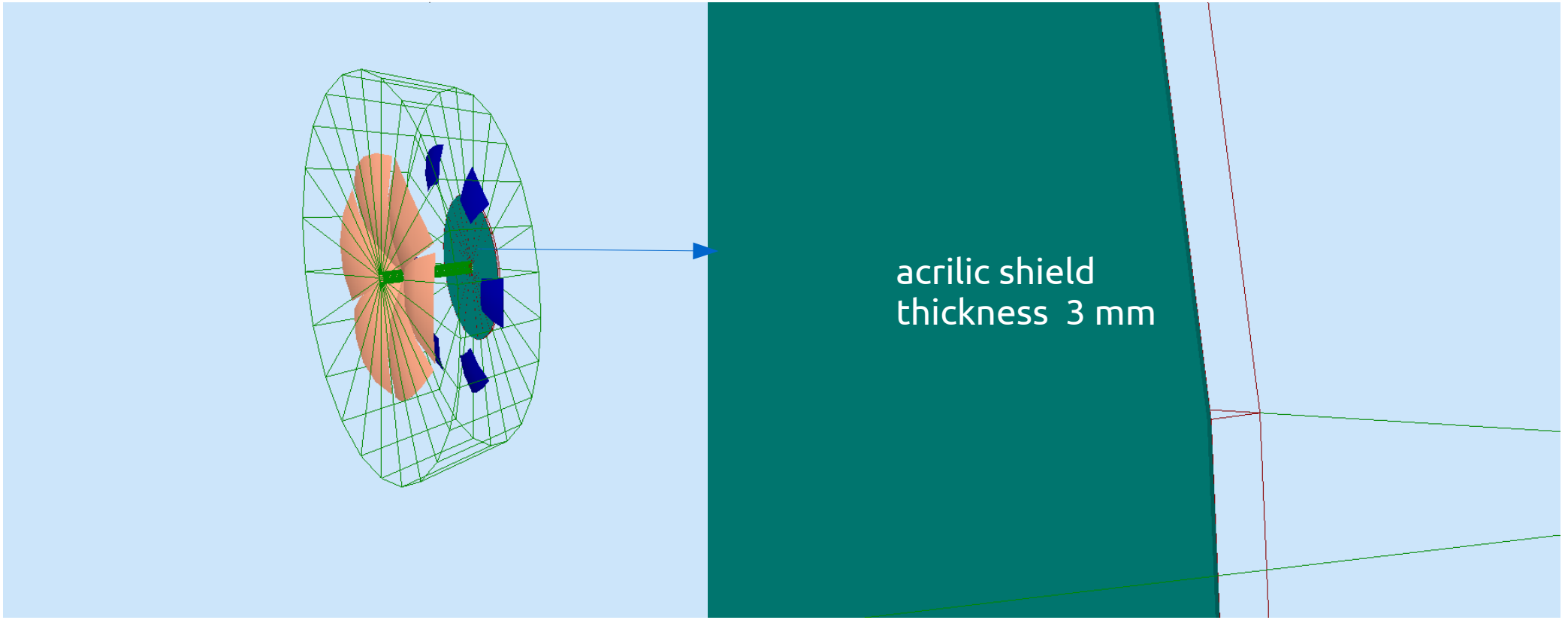
- Study of the background, and acrylic shield between aerogel and gas **[under study]**
- Reconstruction algorithm improvement and comparison
- GEMC based digitalization of the photon-detector
- Formulation of requirements (magnetic field, track reconstruction, etc …) **[essentially carried out]**
- Study of the feasibility of the dRICH to fit the BNL version of EIC detector

<u>Toward the first dRICH prototype:</u>

- Identification of the baseline candidate as photo-detector (in magnetic field)
- Study and definition of the prototype

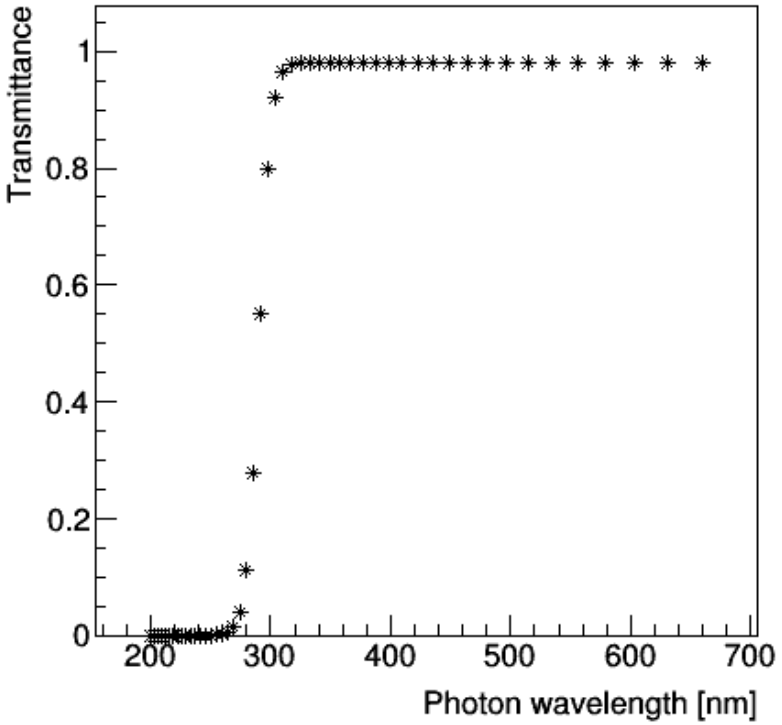
Study of the acrylic shield

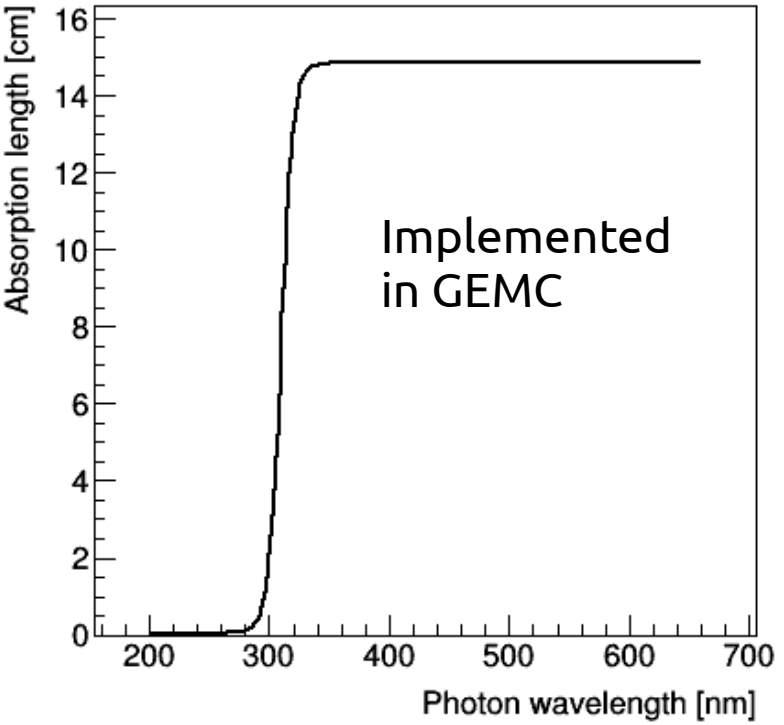
Aerogel and C_2F_6 dual-radiator RICH with a shield to separate the aerogel from the gas, and to filter photons below about 300 nm



Transmittance and Absorption length

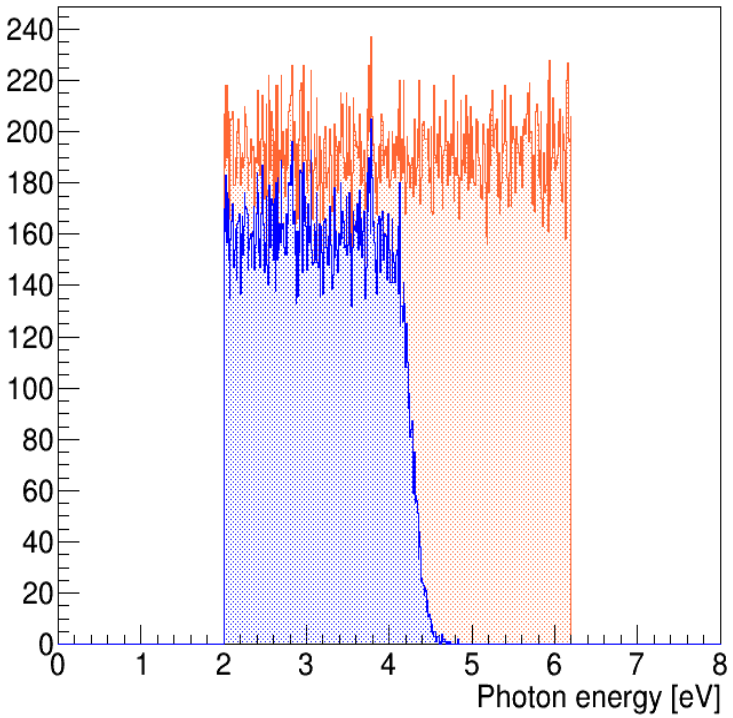
Transmittance is defined by a sigmoid function, and the Absorbtion length is $A = d/\ln T$ with d = 0.3 cm

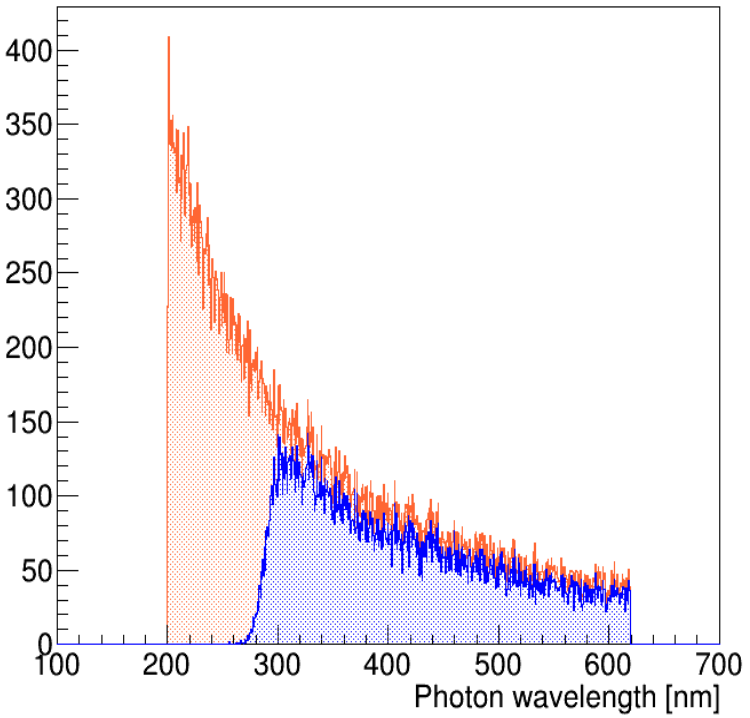




Filtered spectrum

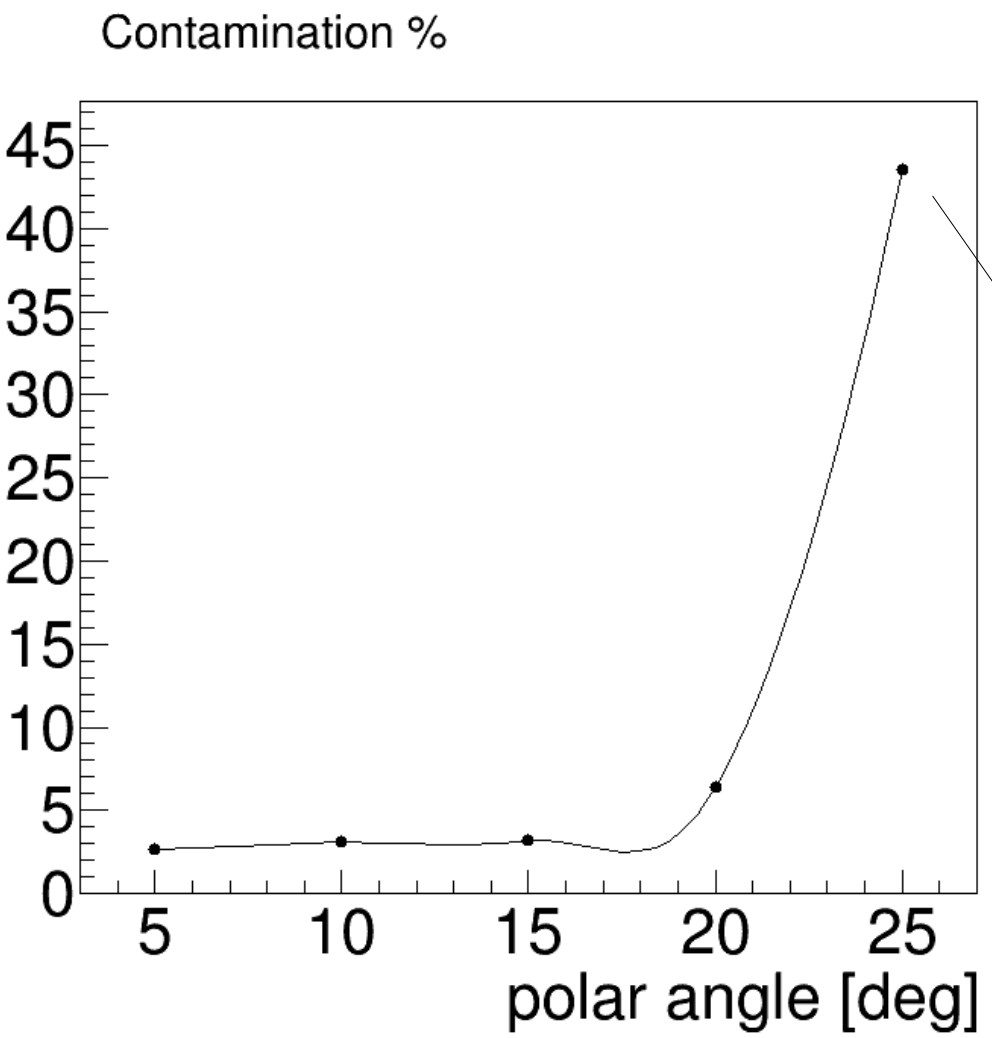
This is the effect of the shield on a beam of photons of
E = [2,6.2] eV





With the shield there is an additional absorption of photons, even in the good range!
A trade off is needed!

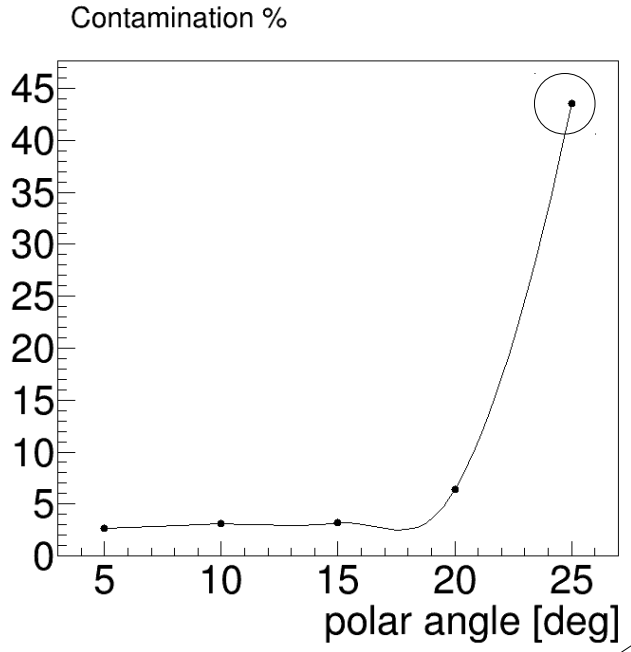
Shield & background for aerogel

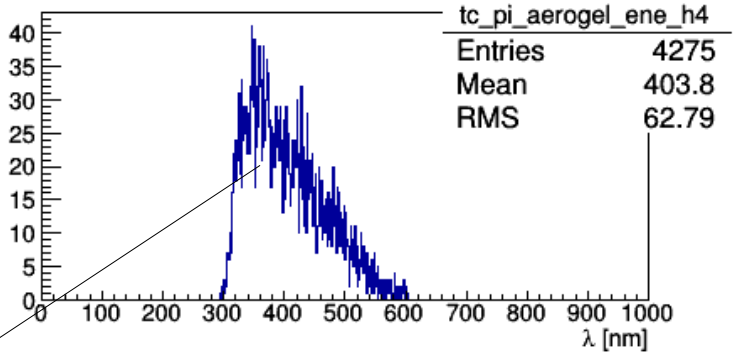


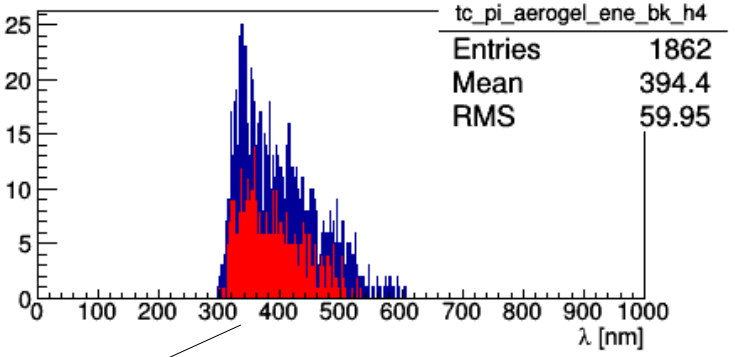
S/B % estimated reconstructing the angular distributions with the Indirect Ray Tracing alghoritm

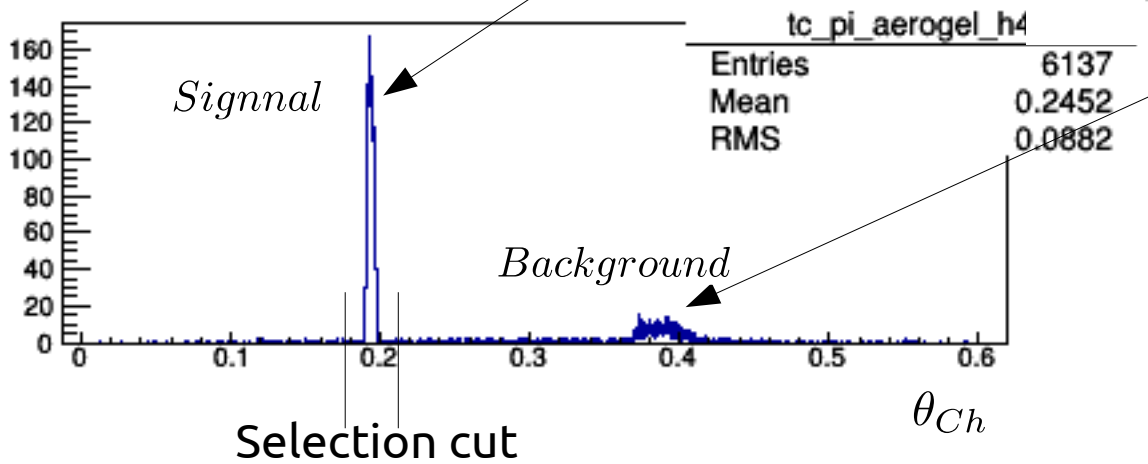
The background increase at polar angles higher than 20°!
Optical alignment?
Photons produced in the acrylic escape the edge?

S/B at 25° (polar angle)









The background can be eliminated with a selection cut!

To do next

- **Study of the background, and acrylic shield between [continue the study: 1p.e. errors and PID performances]**
- Reconstruction algorithm improvement and comparison
- GEMC based digitalization of the photon-detector
- Formulation of requirements (magnetic field, track reconstruction, etc …) [essentially carried out]
- **Study of the feasibility of the dRICH to fit the BNL version of EIC detector [to be addressed in the next month]**

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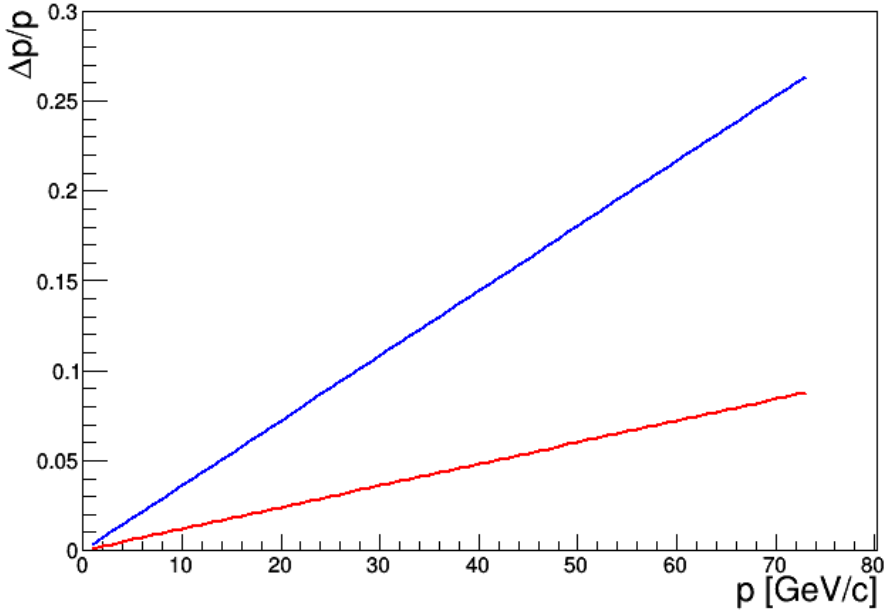
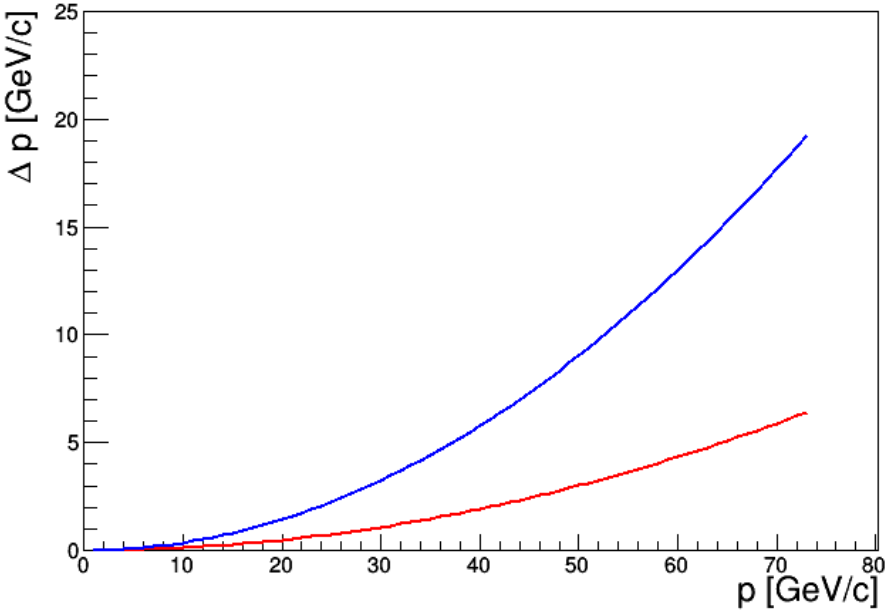
Backup: Momentum and angular uncertainties of the tracks





Traks generated in GEMC in this way, i.e. at 31 GeV/c : $p =< p > \pm \Delta p$

<option name="BEAM_P" value="pi+, 31*GeV, 15*deg, 0*deg"/>
<option name="SPREAD_P" value="1.16*GeV,0*deg,180*deg"/>
<option name="SPREAD_P" value="3.48*GeV,0*deg,180*deg"/>

In addition an angular smearing has been added to the versor of the track entering the RICH, in both polar and azimuthal angle

$$\Delta\theta = \Delta\phi = 0.5\ mrad$$