Updates on the simulation status of the dual RICH

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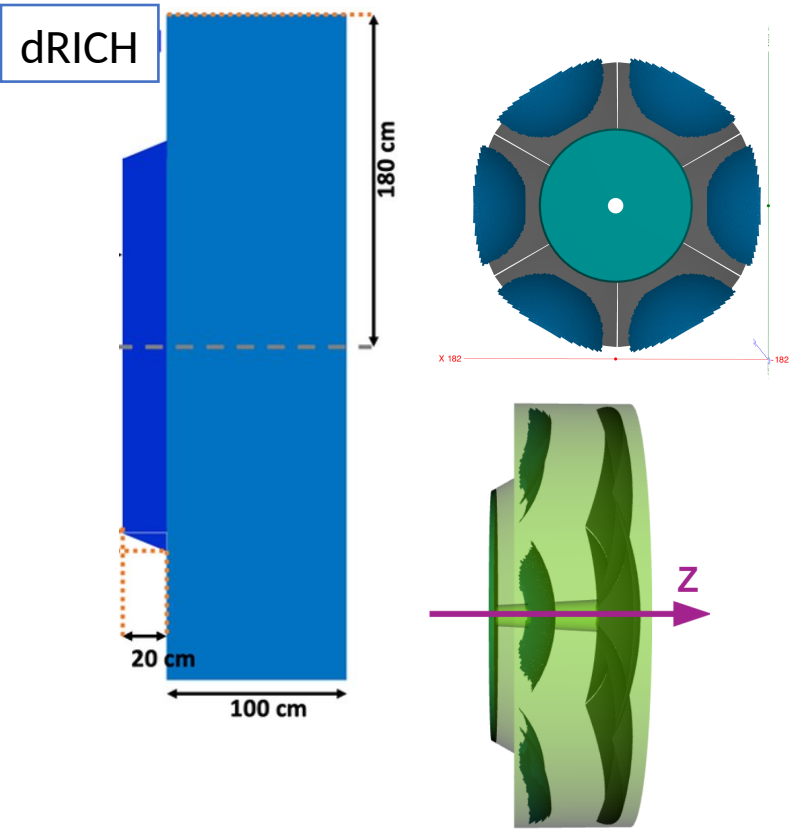
on behalf of ePIC dRICH simulation team

Forward particle identification

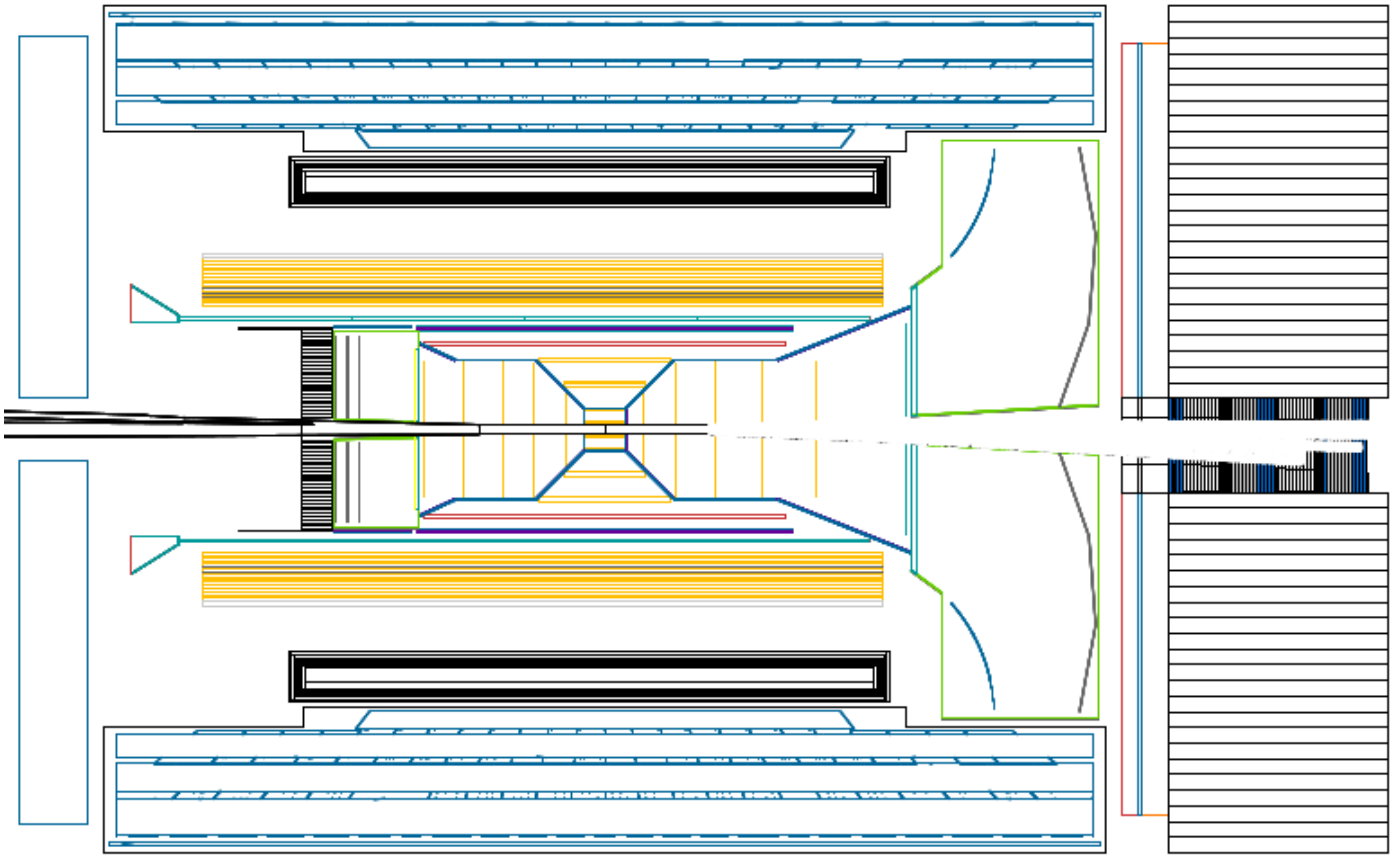
- Recapitulations
- Modifications made in dual RICH
  - Optical modifications
  - Geometrical modifications
- Required resolutions
- Simulations outcomes
- Conclusions and plannings

Forward particle identification

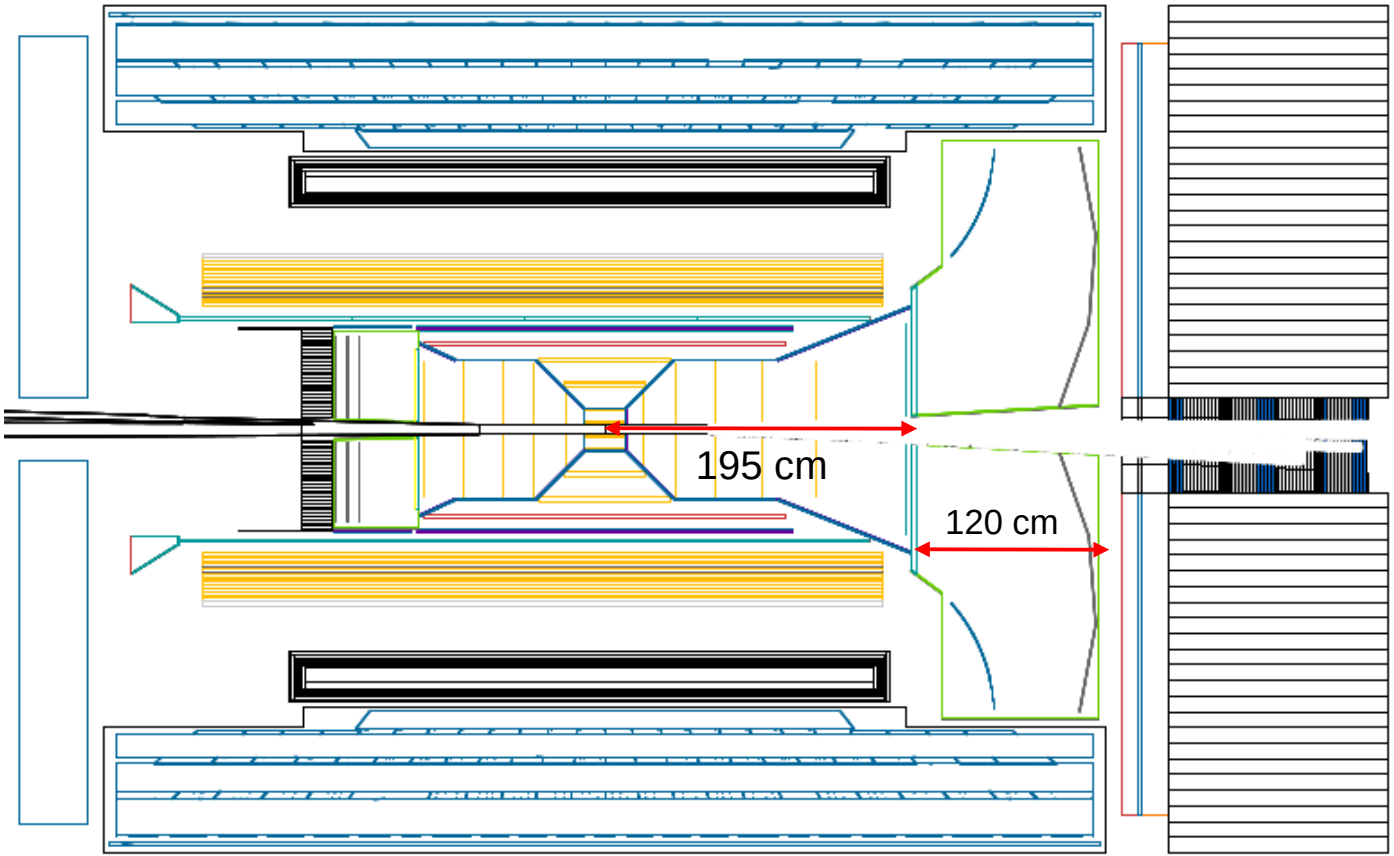


- Requirements:
  - Wide acceptance (*+- 300 mrad/ 1.5<η≤3.5*)
  - High momentum coverage up to *50 GeV/c π-K*
    - ⋆ Dual radiator (aerogel (n ~1.02)+ C_2F_6 gas (n~1.0008))
- Compact geometry: short radiator space available
  - Smaller number of detected photons → Critical optical tuning and control over background hits.
- Large sensor surface to be covered in magnetic field.
  - Limited choice of photon-sensor (SiPM as a cheap solution)
- Simulation contains: 6 identical sectors
  - Spherical mirror with radius 220 cm
  - SiPM sensors with realistic PDE and additional 70% safety factor.
  - Realistic parameters for aerogel and C_2F_6

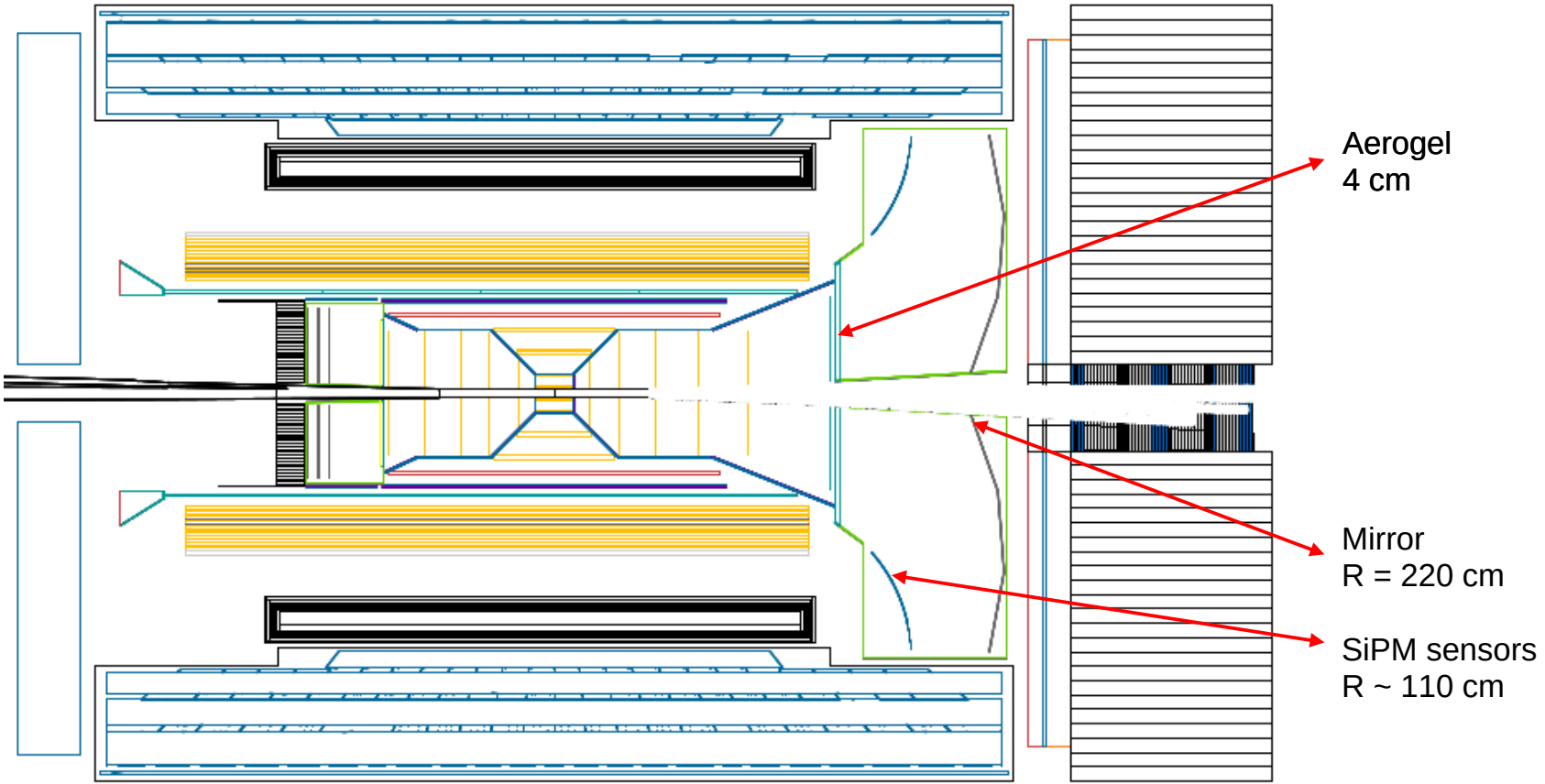
Forward particle identification



Forward particle identification



Forward particle identification



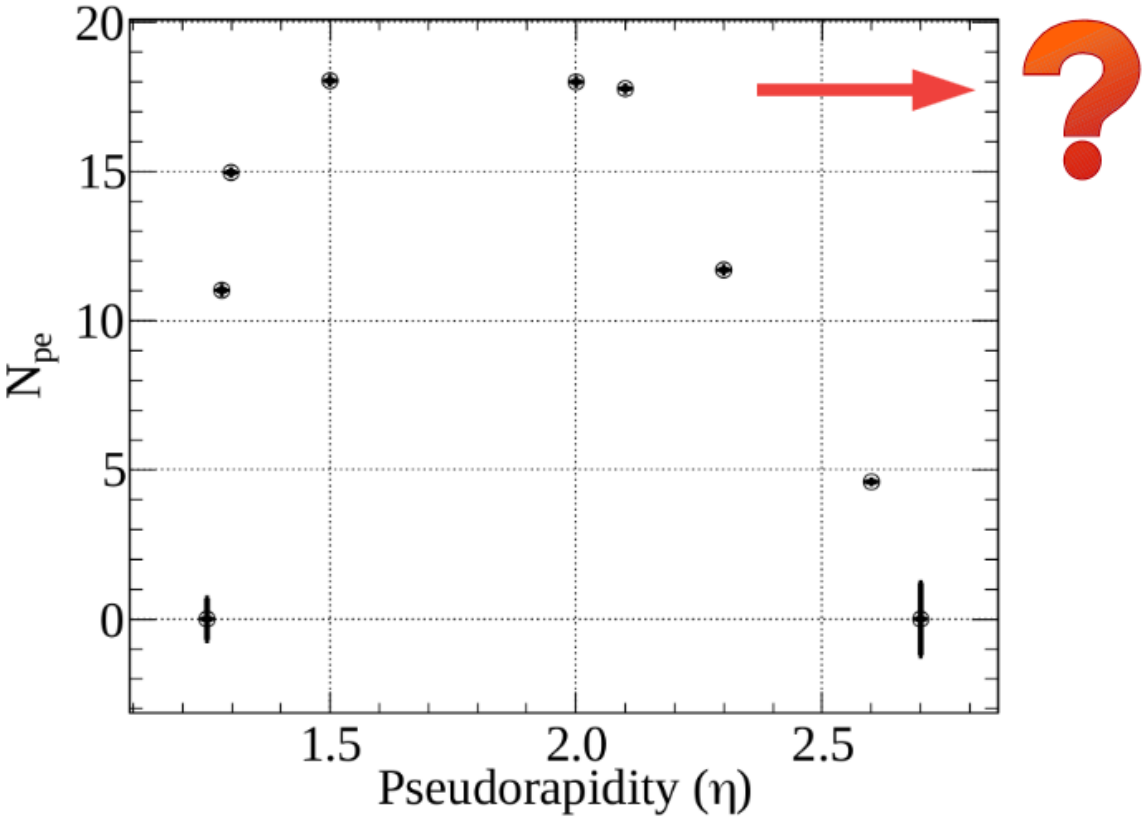
Tuning of parameters (why crucial?)

- 50 GeV pions
- Number of Photoelectrons (NPE) from gas radiator
- Acceptance limits:

  $1.3 < \eta < 2.3$

  $11.5° < \theta < 30°$

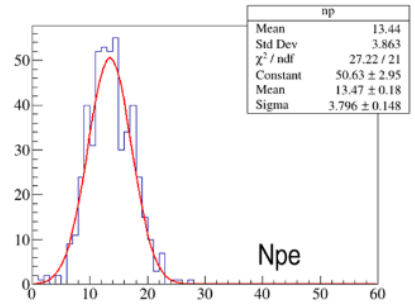
  Integrated over ϕ
- Optics could be improved…

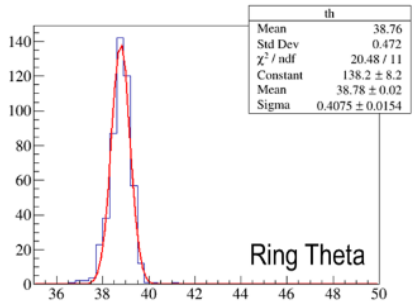


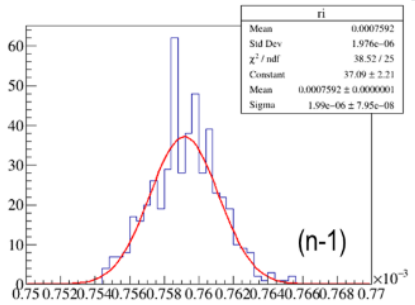
Tuning of parameters (why crucial?)

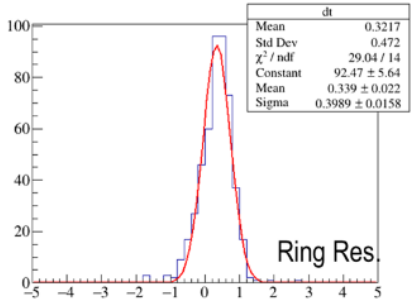
High η (gas)

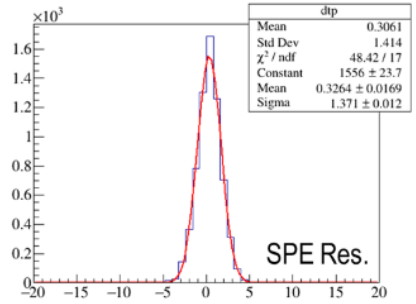
Study from Chandra
Reduce aerogel radius 110 → 95 cm
Thrown 30 GeV pions, **at η=3.5**

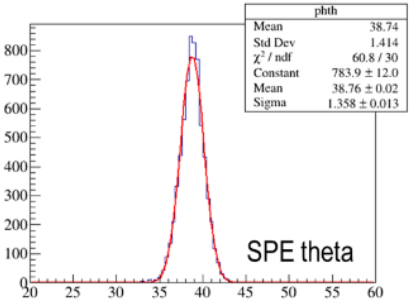






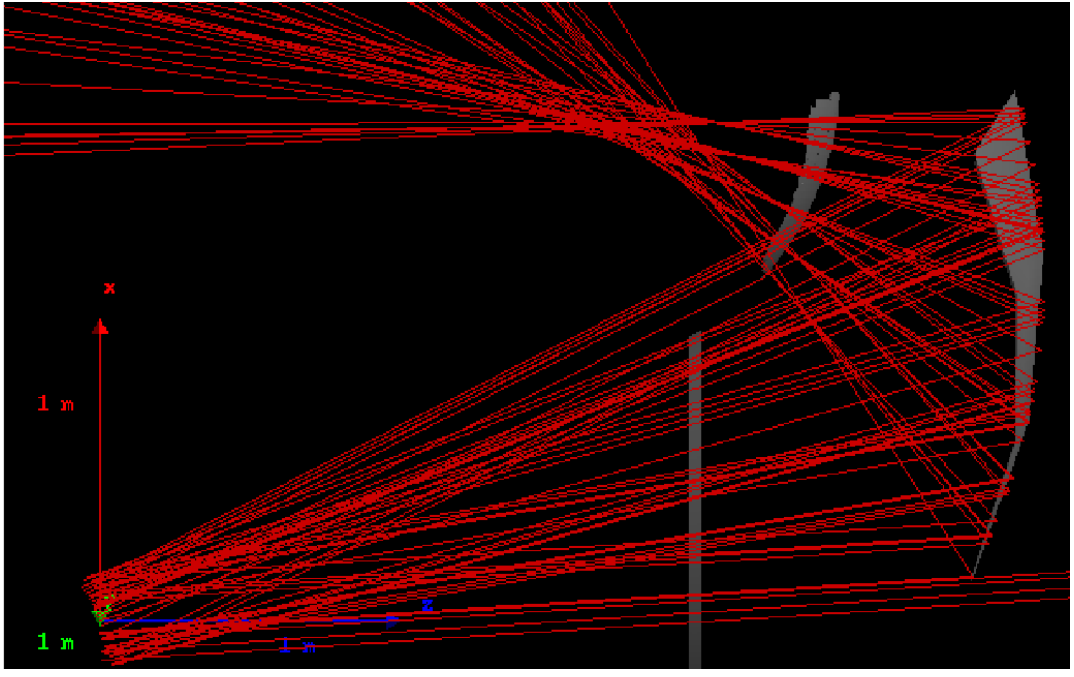


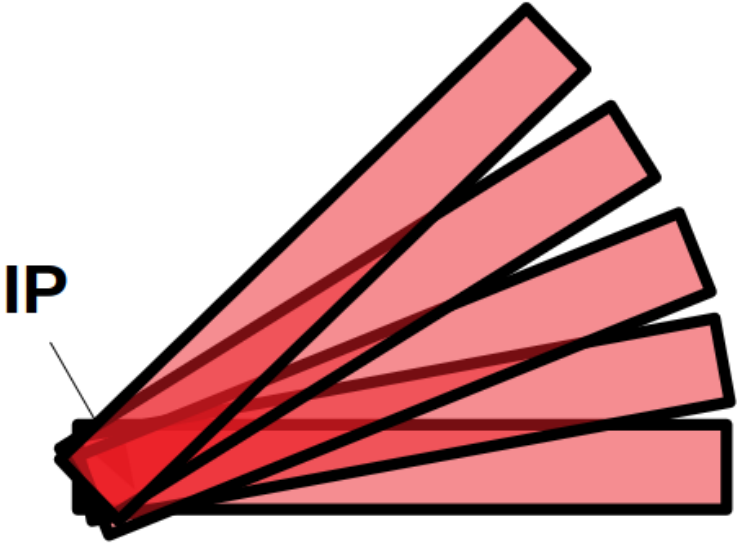




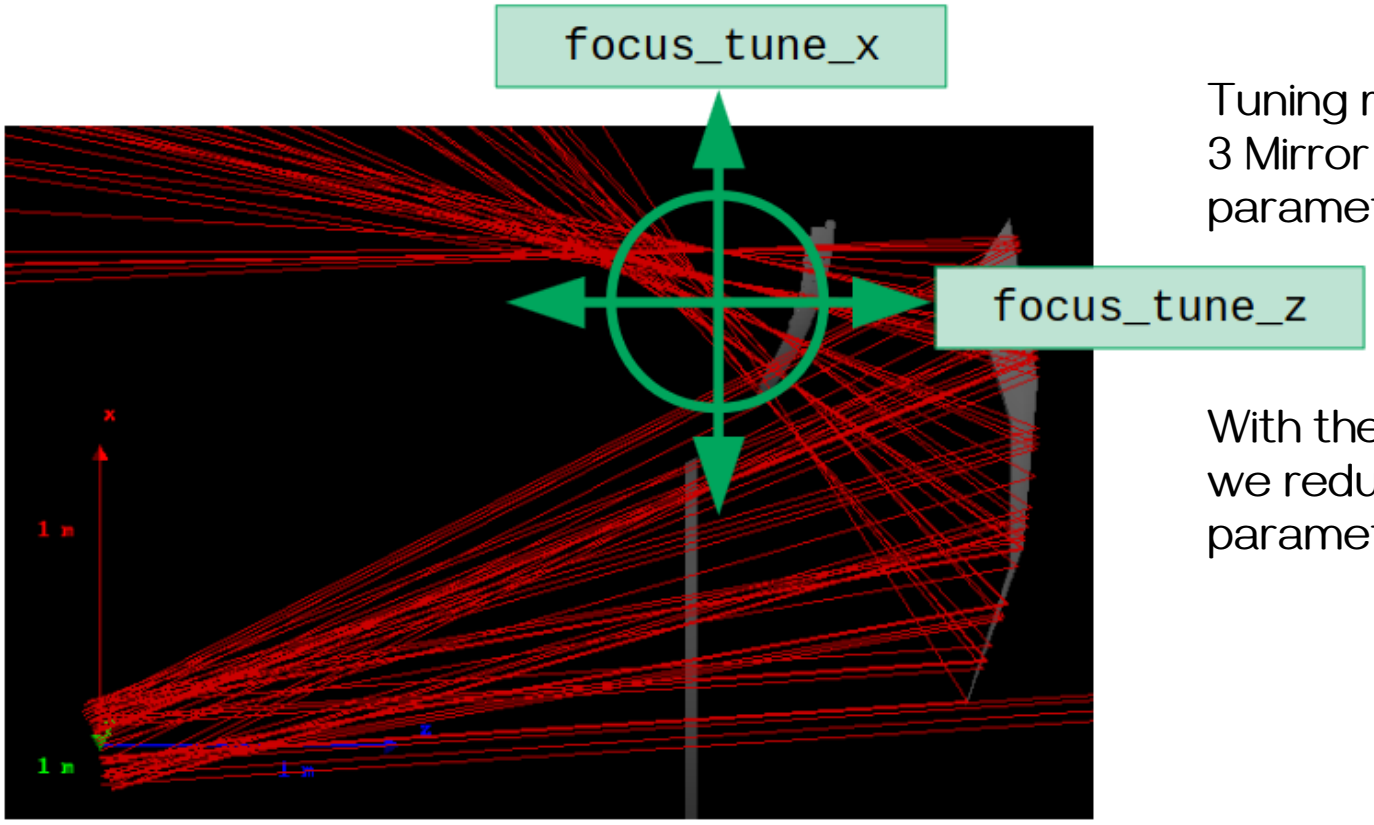
Complicated and inter-related geometrical parameters if changed can either cause loss in number of detected photons or worsen resolutions.

Tuning of parameters (Visualizations)





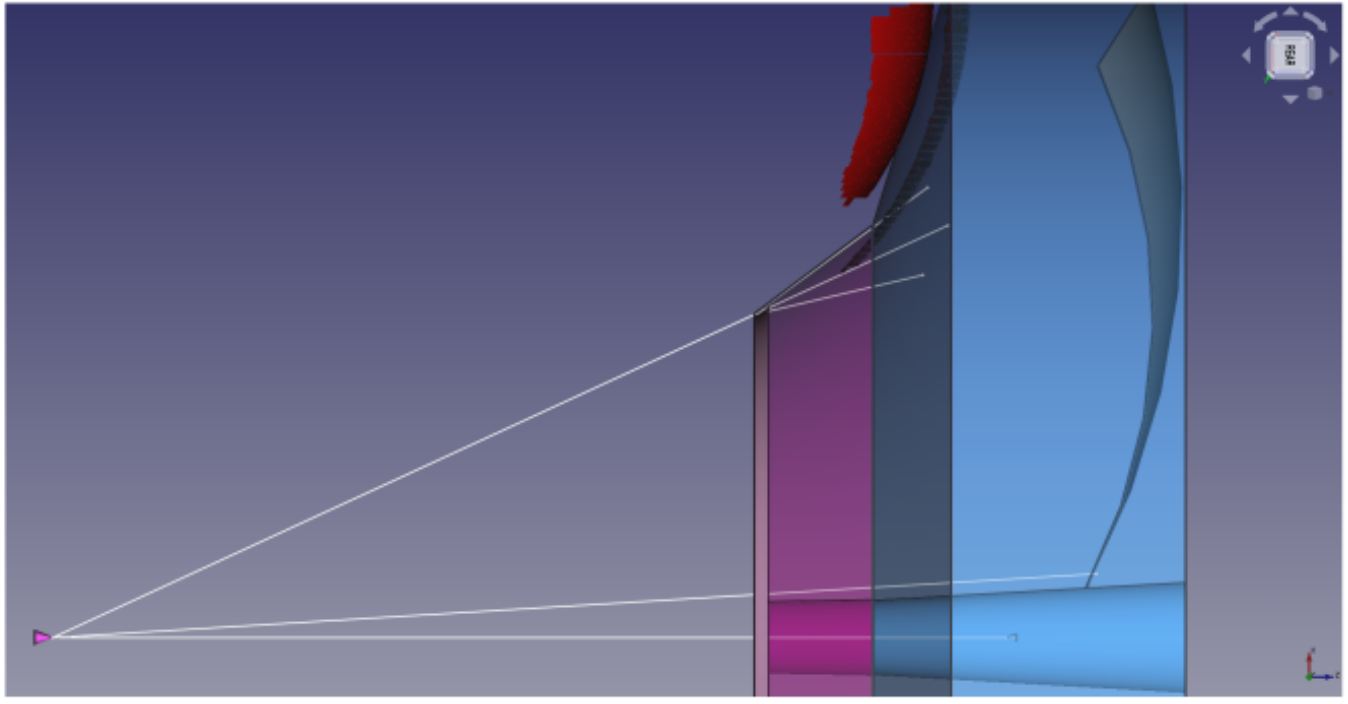
Tuning of parameters (Visualizations)

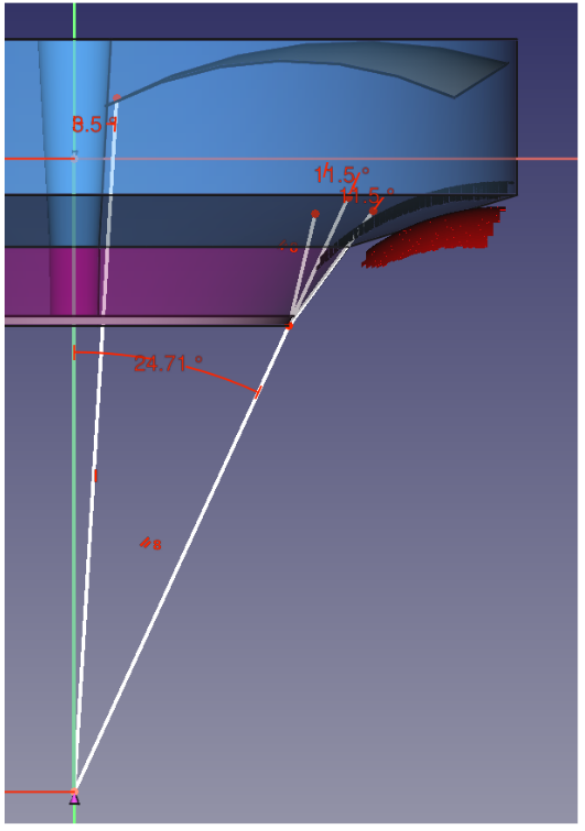


Tuning requires adjustments of 3 Mirror and 3 sensor parameters

With the focus tune parameters we reduce this to 5 independent parameters.

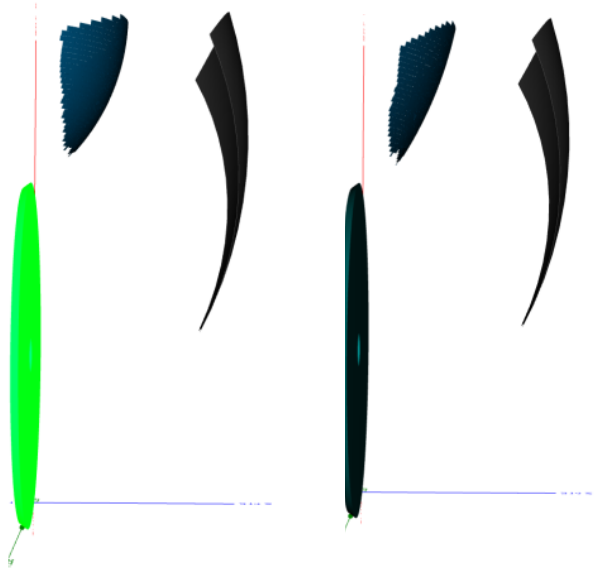
Tuning of parameters (CAD supports)



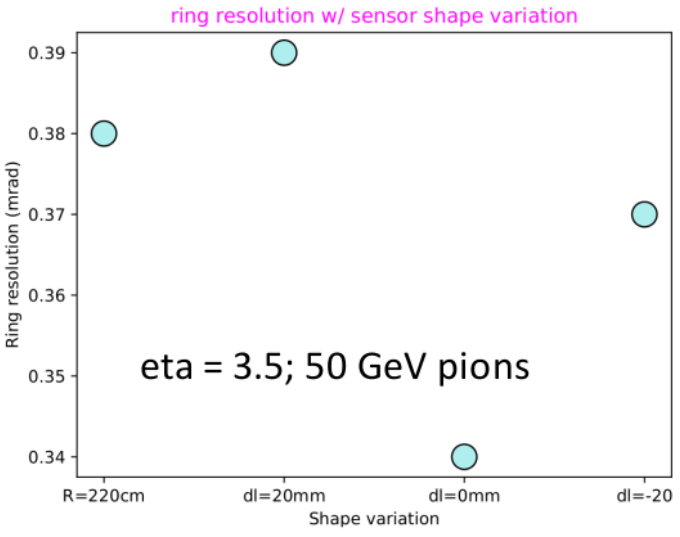


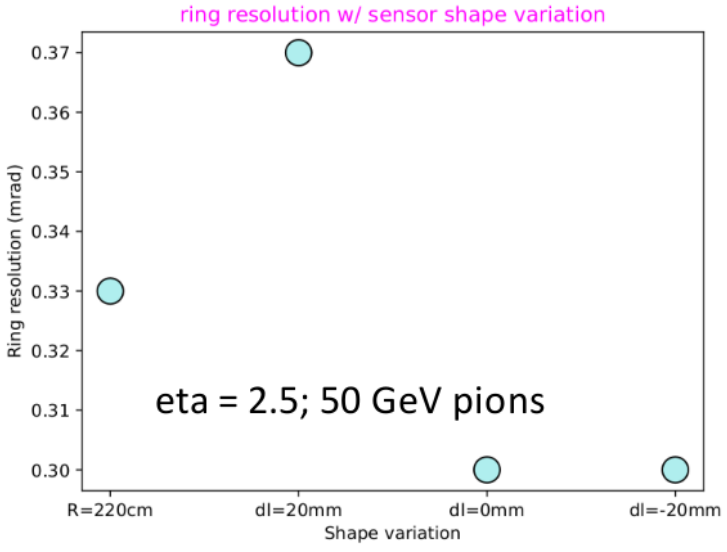
Reasonable optical tunings, mechanical feasibility from CAD images

Tuning of parameters (distortion studies)

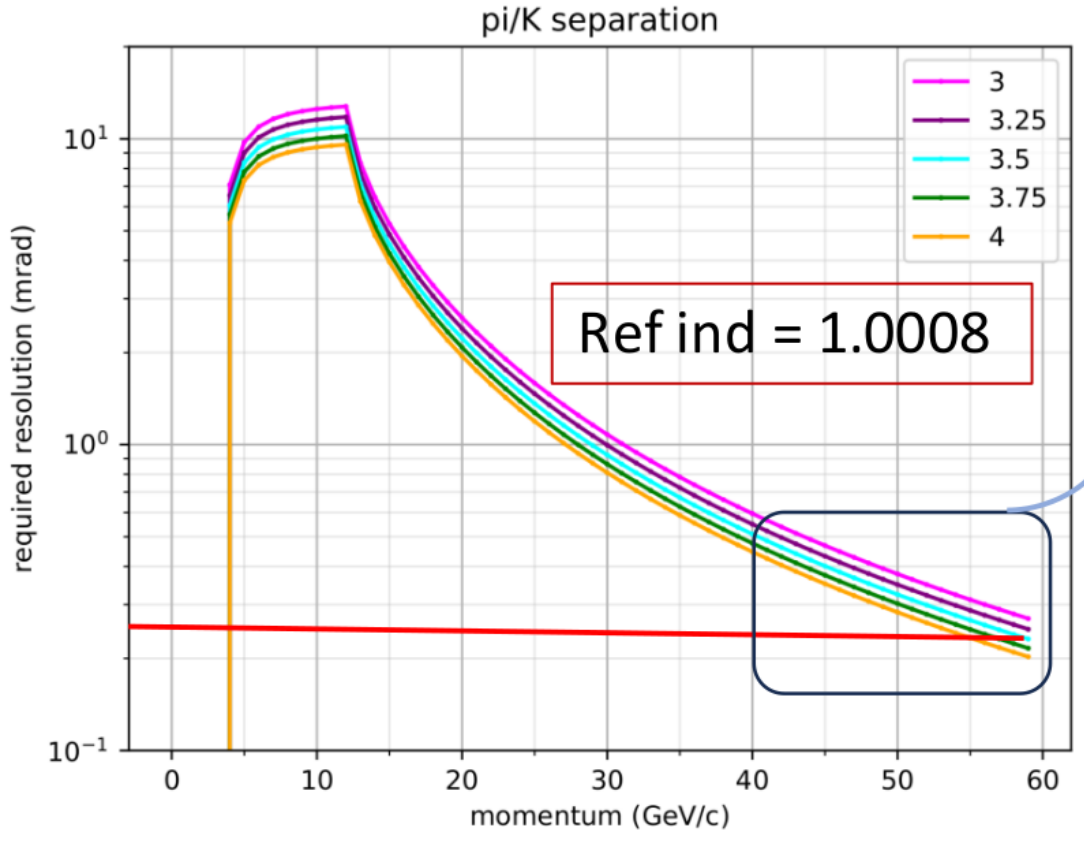


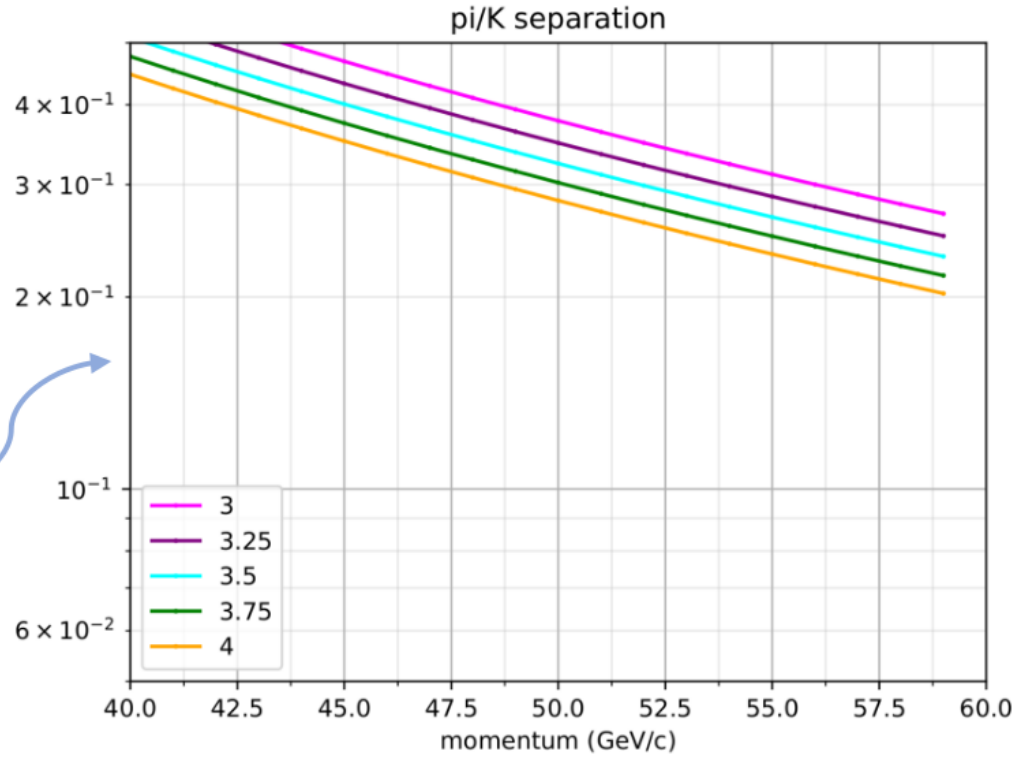
Small added displacements in sensor parameters
Sensor surface changed to planer.
→ Performance worsen!!!



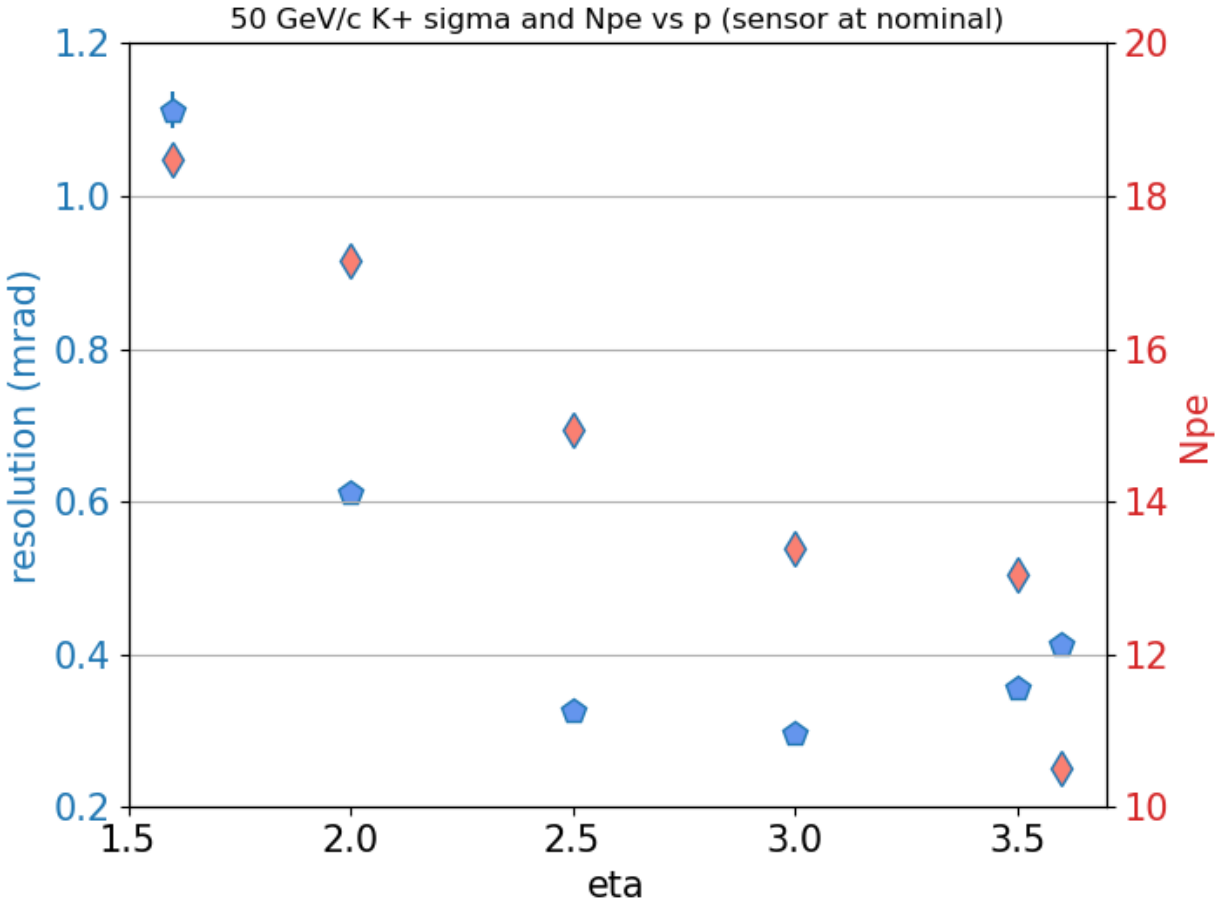


Required resolutions



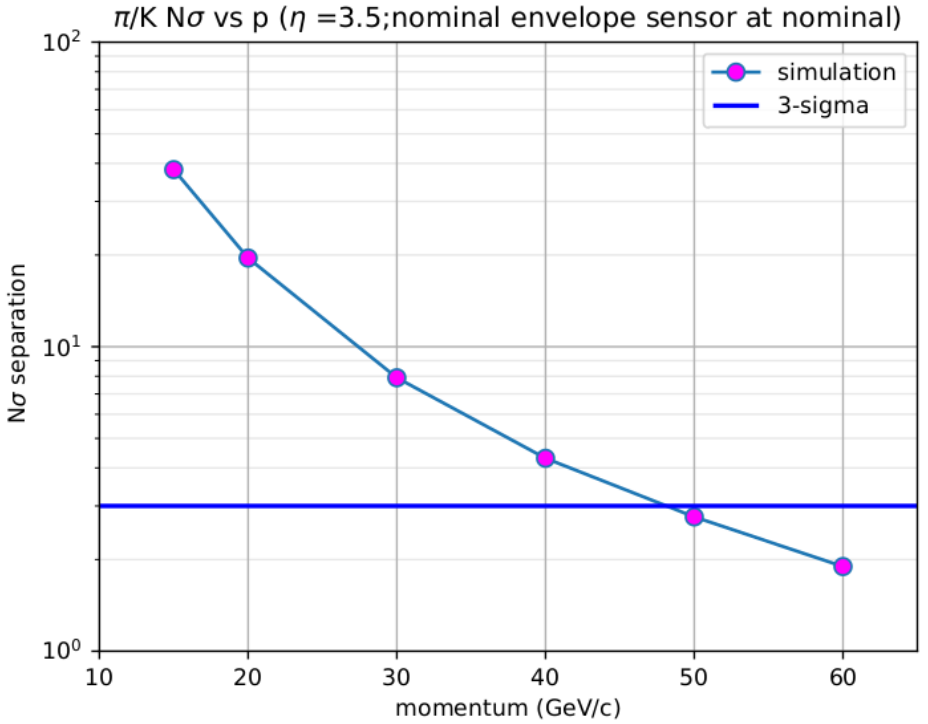


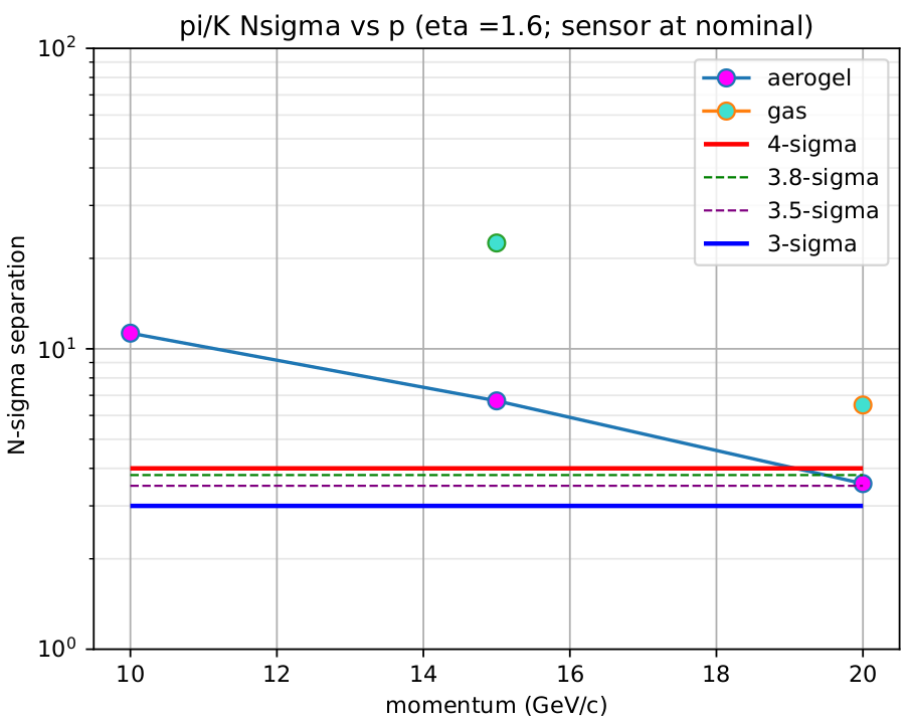
Obtained resolutions



The unavoidable spherical aberration.
Angular resolution is constant and uniform in the tuned region.
dRICH is not fully uniform in acceptance!

N sigma separations

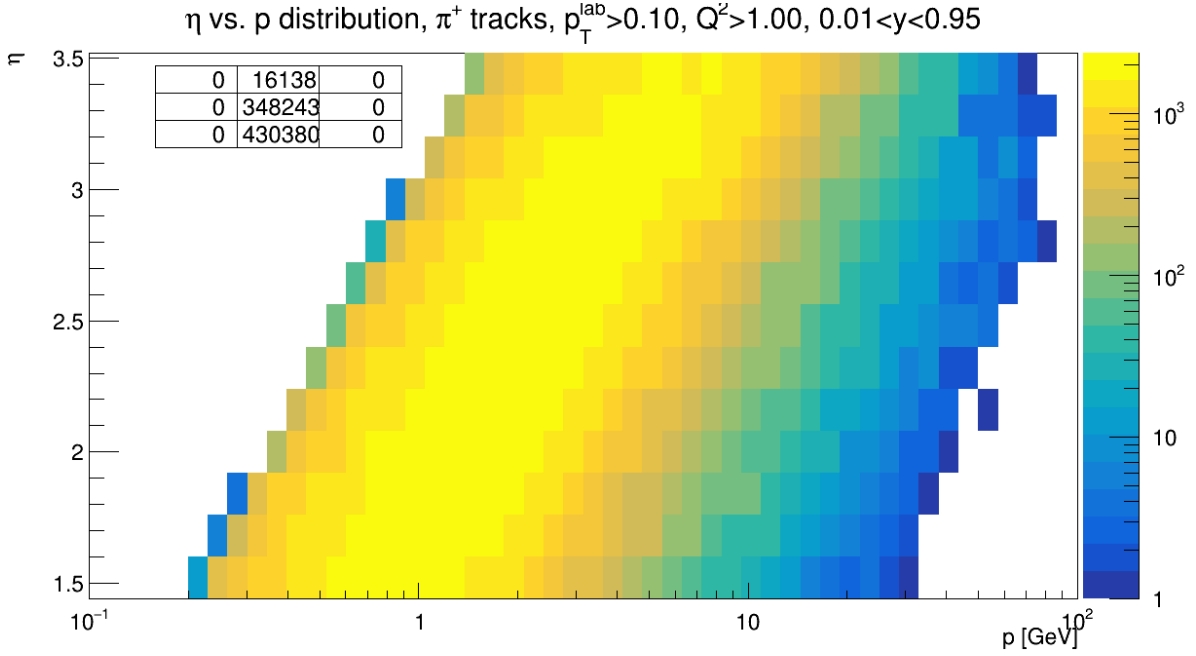


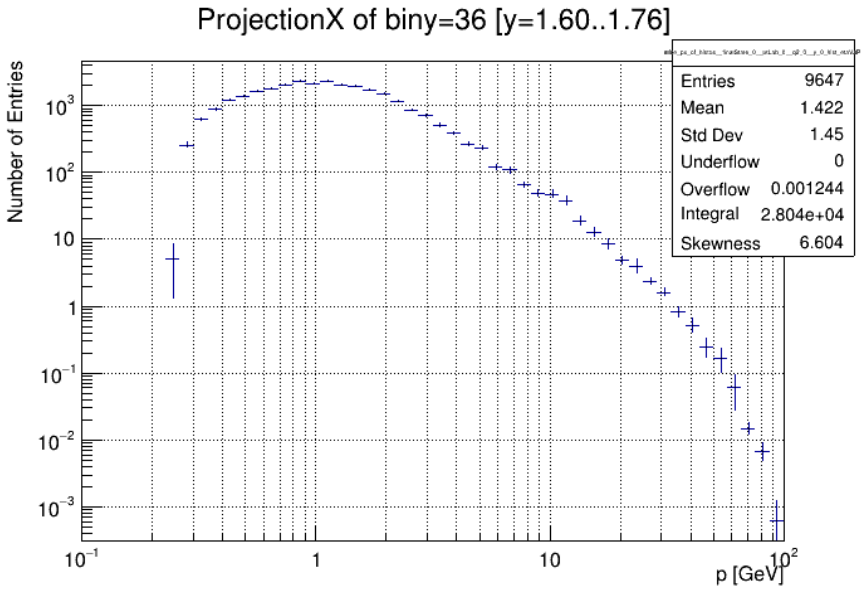


3 sigma limit

- 3.5 => 50 GeV/c
- 1.6 ~ 30 GeV/c

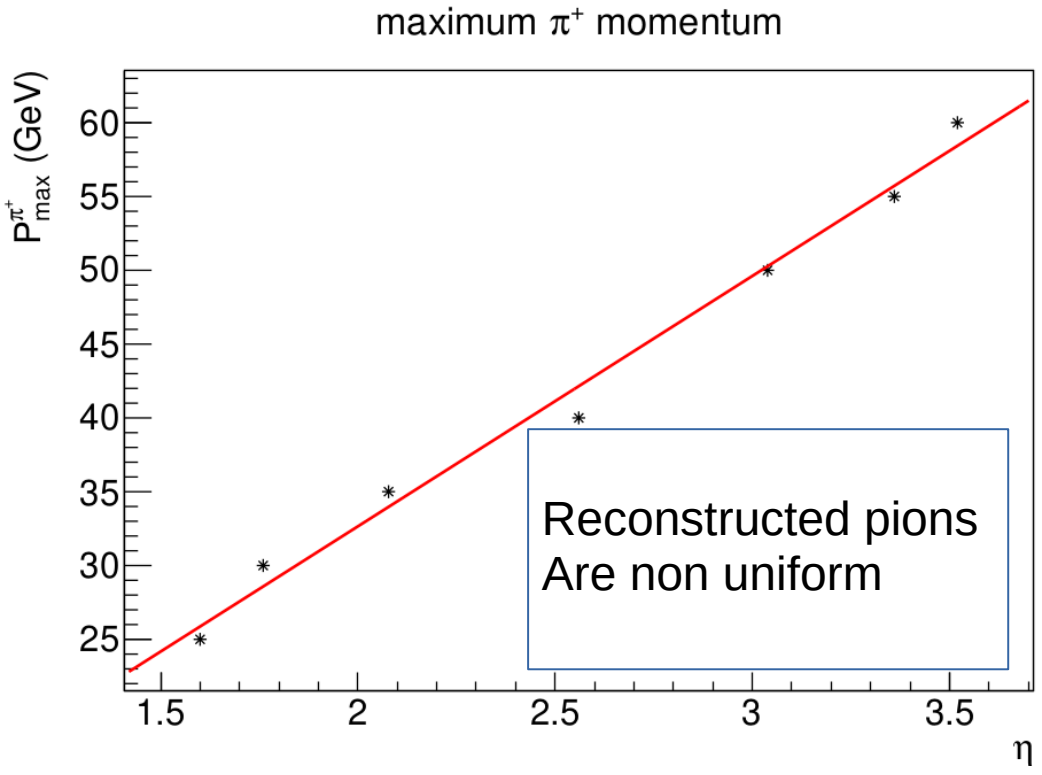
Requirement of uniform performance:



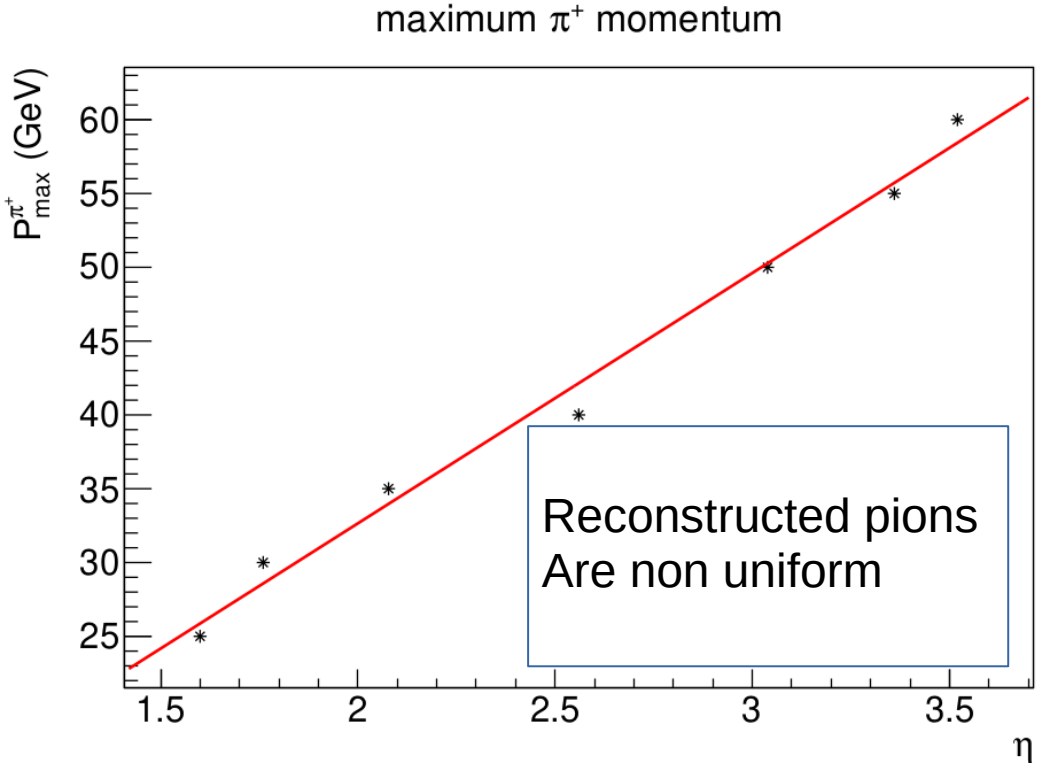


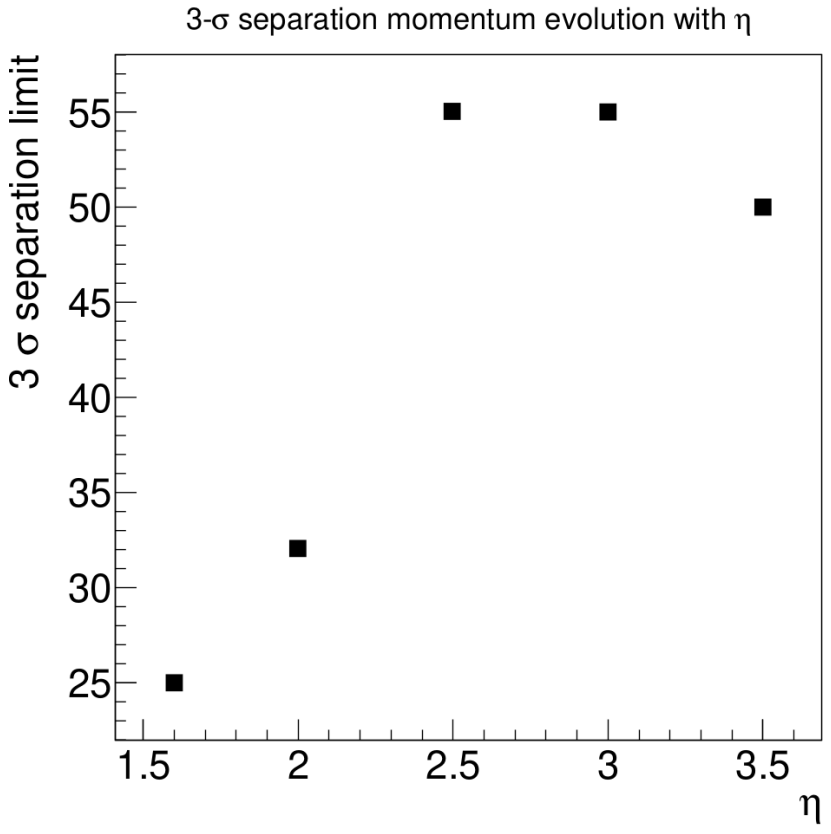
99.95% of total counts defines the maximum momentum!

Requirement of uniform performance:

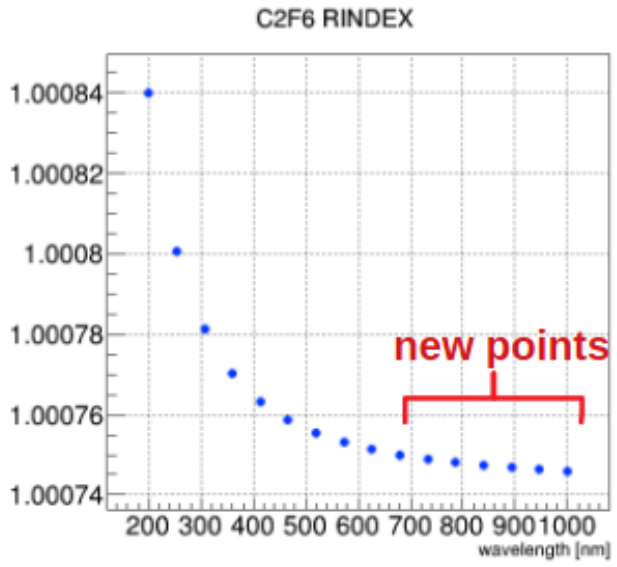


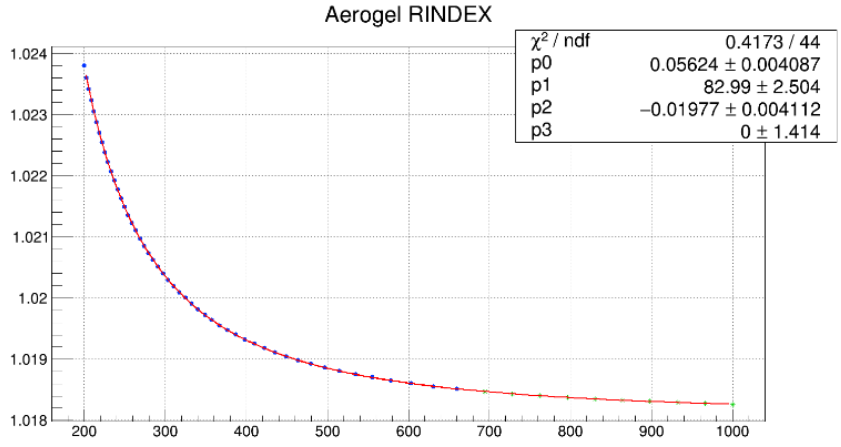
Requirement of uniform performance:





Fine adjustment of material properties



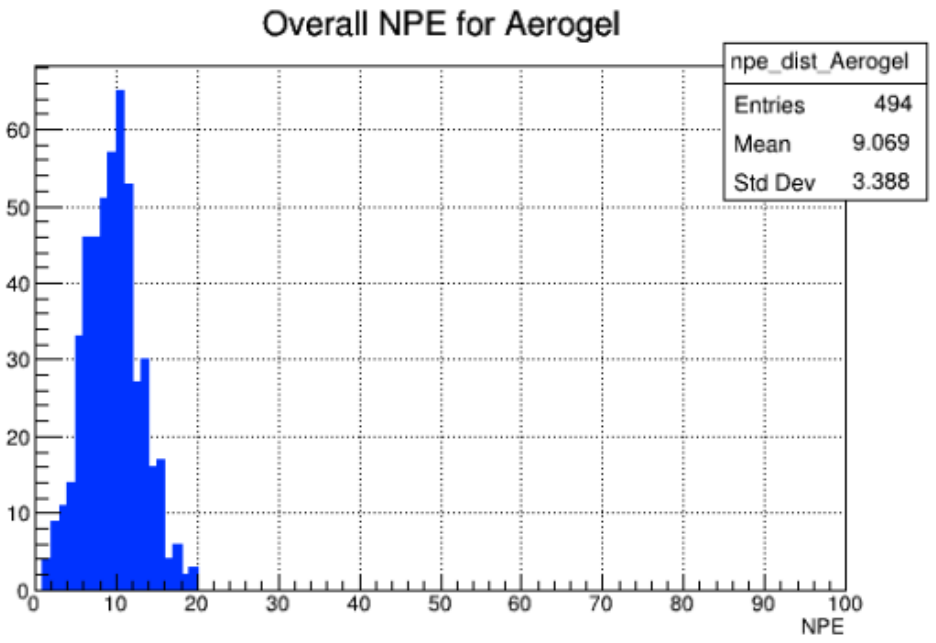


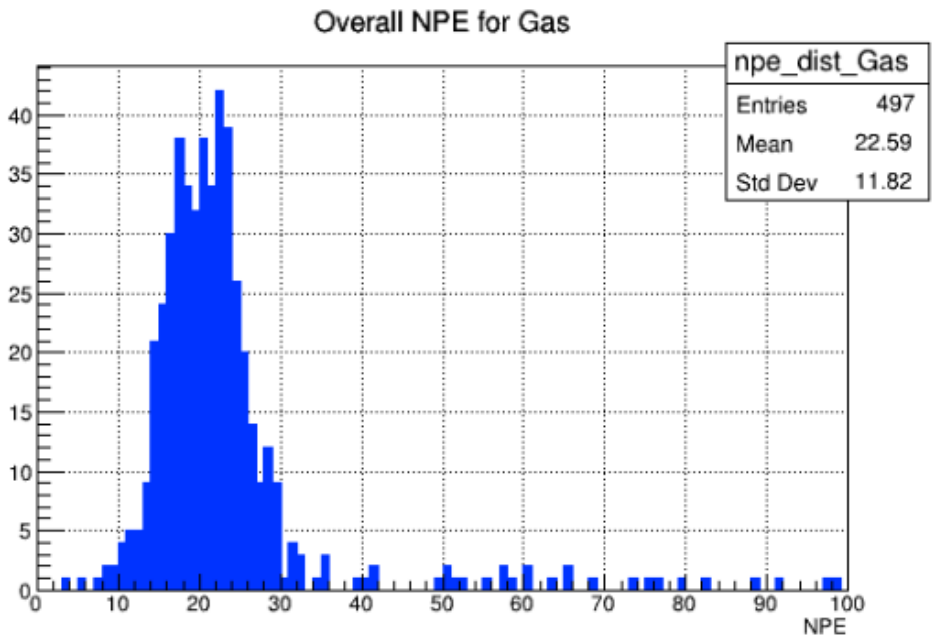
Fit to 2nd order Sellmeier function

$$n^2(\lambda) = 1 + \frac{p_0\lambda^2}{\lambda^2 - p_1^2} + \frac{p_2\lambda^2}{\lambda^2 - p_3^2}$$

Previously dimensions of parameters were not uniform. New points added. Pessimistic Absorption lengths are changed.

Fine adjustment of material properties

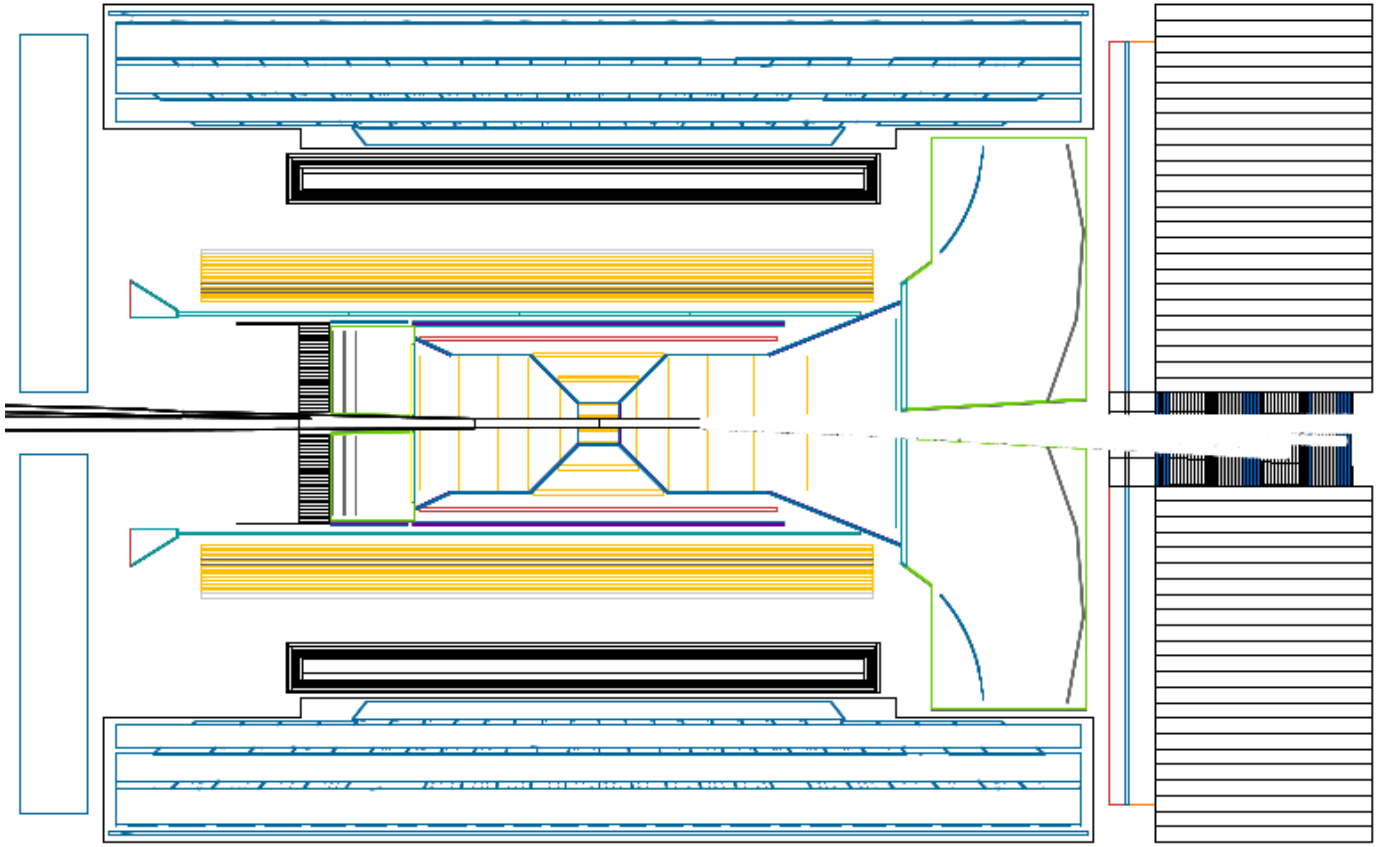




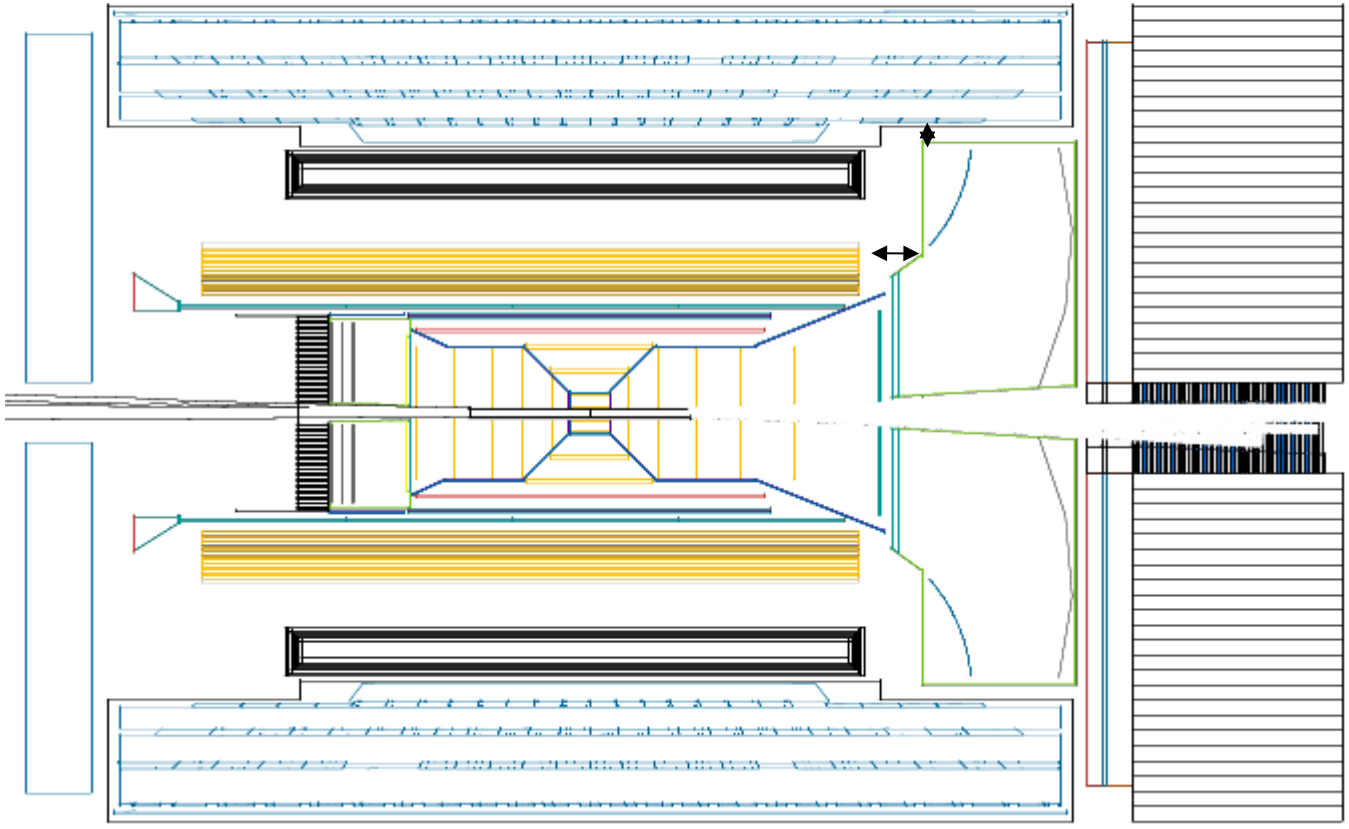
Increase in Npe observed.

Improved resolutions are expected and hence an improved separation in high eta.

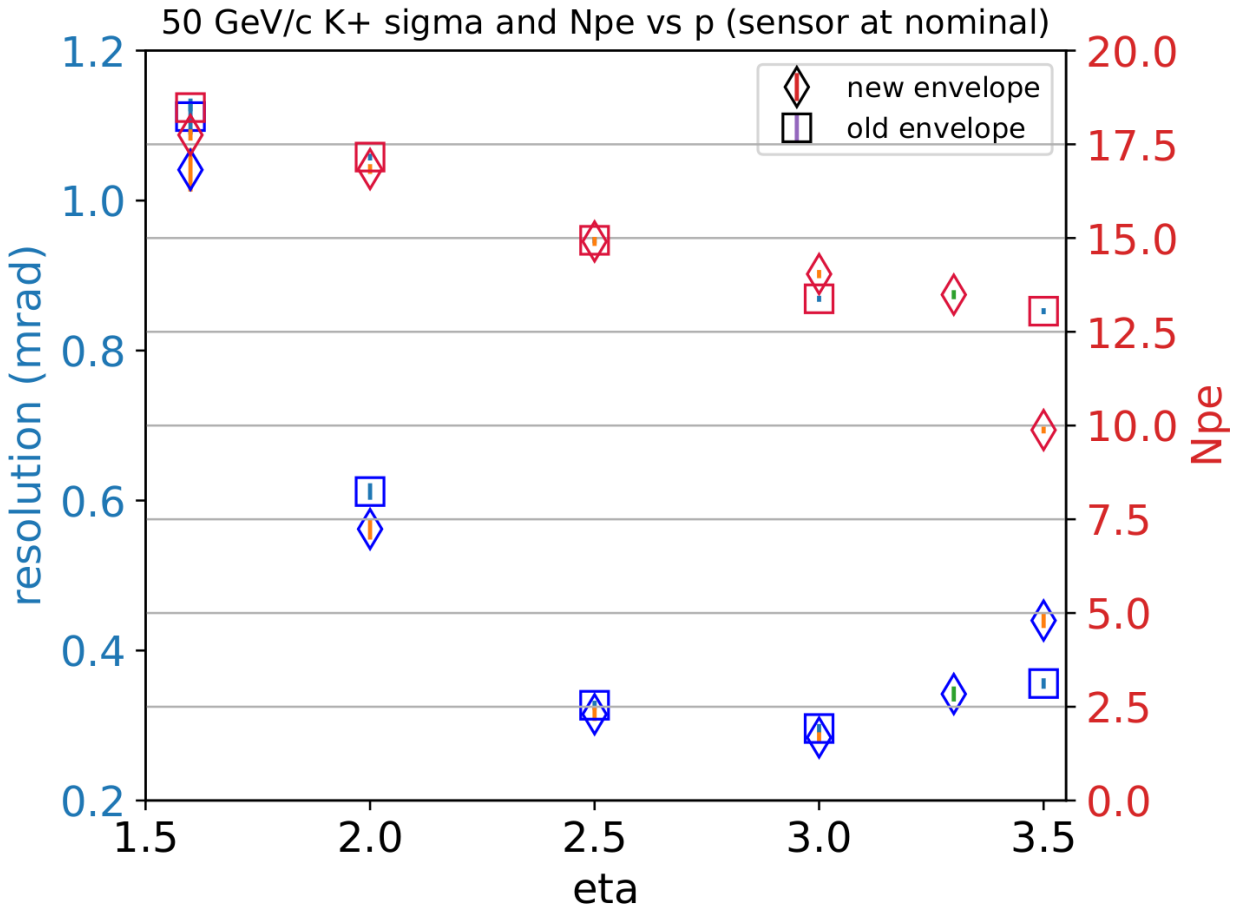
Alternative locations



Alternative locations



Alternative locations



Summarizing

- We have an well defined geometrical shape for nominal studies.
- We are doing realistic simulations on this nominal geometry.
- Current single mirror dRICH choice suffers spherical aberration at low eta. This is not a stopping point. Physics is limited there.
- Material tables have been updated now, with more extended points.

  This allows us to achieve few more extra photons. Improved resolutions.
- Alternative placement locations are also considered to reduce mechanical tensions. Performances are similar.
- Recently random noise has been injected in the simulation chain. Currently we are studying to understand it.