dRICH simulation studies update

acceptance, snout length, aerogel size

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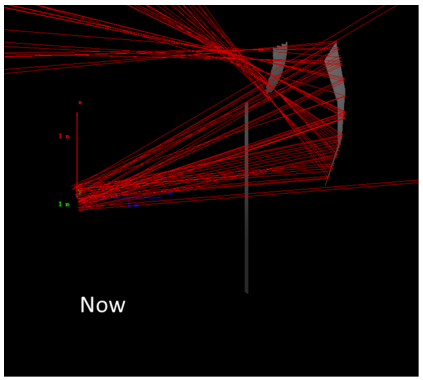
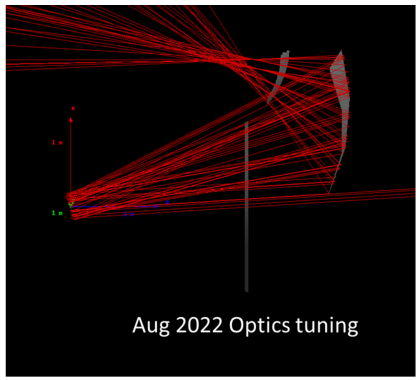
Outline

1. Recap the problem
2. The principles of Optics tuning
3. Newly tuned situation
   - Acceptance
   - performance
4. Updated Geometry
5. Packup and TBD

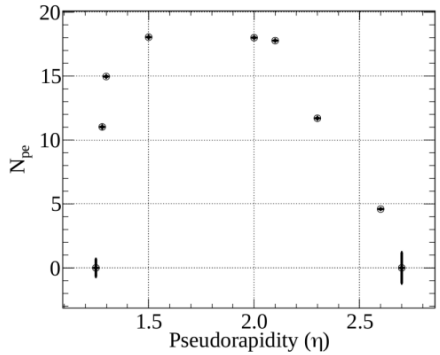
Motivation

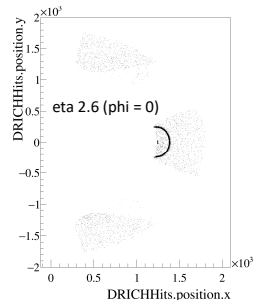
- We have observed and reported on several occasions that the dRICH acceptance has shrunk both for the gas and aerogel.
- The optics were well tuned in August 2022 and after the November 2022 campaign the acceptance went wrong.
- **The cause has been identified, and reported in the last GD/I and dRICH software meeting**





Acceptance





Simulated hits! Low Npe is not an effect of reconstruction.

Optics has been recovered

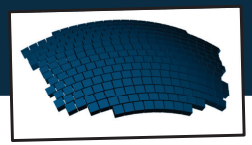
Couple of words on Optics tuning

- The petals of the mirror are slices of a sphere of a given radius.
- Each sensor sector too is a section of a sensor sphere with a certain radius.
- The parameters to select these objects inside the dRICH volume take into account the geometric constraints.
- The idea is to tune these parameters to have 'best' optics possible

Couple of words on Optics tuning contd...

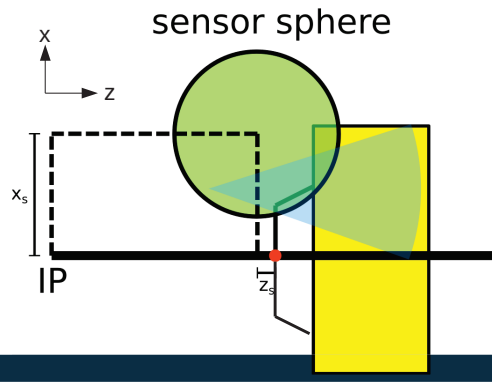
Slides from C.Dilks

Sensor Parameterization



- **Sensor sphere**: sensors are tiled on a sphere with specified radius and center coordinates (z_s,x_s), defined with signs specified with respect to vessel snout front (red point)
- "spherical patch" cuts are used to take a subset of the sphere within the vessel

```
<sphere
  centerz="-70.0*cm"
  centerx="220.0*cm"
  radius="140.0*cm"
  />
<sphericalpatch
  phiw="18*degree"
  rmin="DRICH_rmax1 + 1.0*cm"
  rmax="DRICH_rmax2 - 4.0*cm"
  zmin="DRICH_snout_length + 3.0*cm"
  />
```



Mirror Parameterization

Spherical Mirror: Need 3 numbers: center position (2 numbers) and a radius

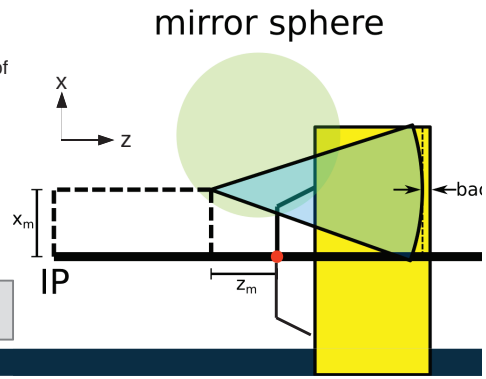
In practice: reparameterize in terms of 3 other numbers

Mirror position (z_m,x_m) determined with the help of "tune" parameters (see next slide)

Radius r_m determined from z_m, given a fixed "backplane" distance: the minimum distance between the mirror and the vessel backplane

```
irror
ackplane="DRICH_window_thickness + 2.0*cm"
rmin="DRICH_rmin1 + DRICH_wall_thickness - 1.0*cm"
rmax="DRICH_rmax2 - DRICH_wall_thickness - 3.0*cm"
phiw="59.5*degree"
thickness="0.2*cm"
focus_tune_x="-5.0*cm"
focus_tune_z="0.0*cm"
/>
```

```
radius   = 218.5 cm
center_z = -100.6 cm
center_x = 113.9
```

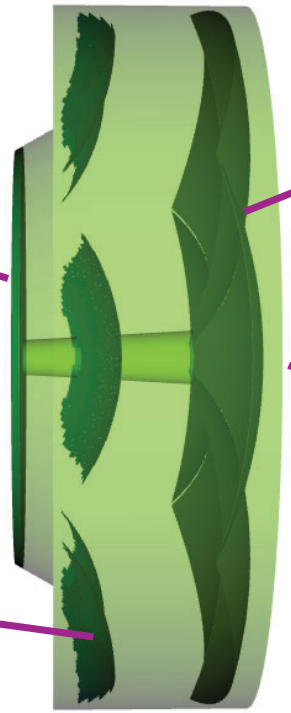


The sensor positioning depends on the placement of the aerogel

dRICH Geometry: Aerogel and the snout in particular

Geometry - Details

- **4 cm of aerogel**
- 0.01 mm air gap
- 0.3 mm acrylic filter

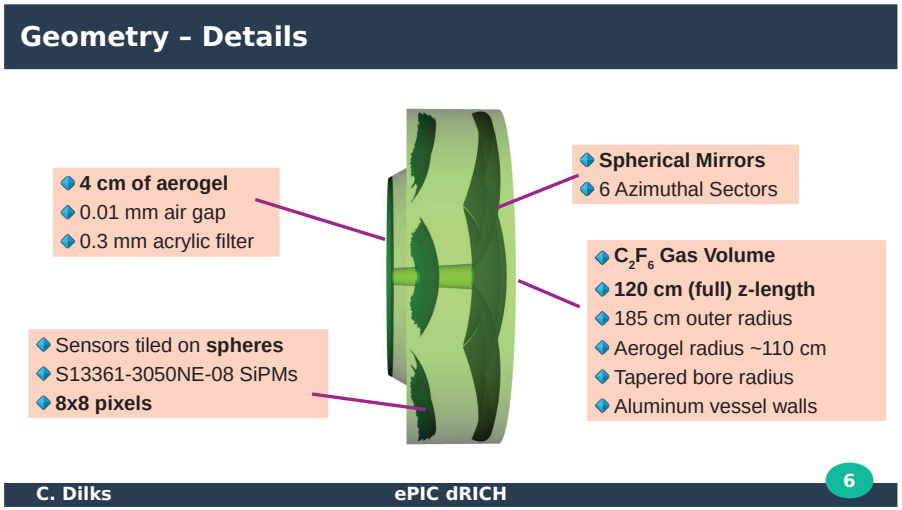


- **Spherical Mirrors**
- 6 Azimuthal Sectors

- **C_2F_6 Gas Volume**
- **120 cm (full) z-length**
- 185 cm outer radius
- Aerogel radius ~110 cm
- Tapered bore radius
- Aluminum vessel walls

- Sensors tiled on **spheres**
- S13361-3050NE-08 SiPMs
- **8x8 pixels**

dRICH Geometry: Aerogel and the snout in particular



- The dRICH geometry has essentially three radii defining the envelope.
- At the start of the dRICH (195 cm) *rmax*0, at the end of the snout (215 cm) *rmax*1 and the cylindrical one extended up to the end (315 cm) *rmax*2.
- This *rmax*0 is also the starting size of the aerogel. Previously used as 95 cm. Later it was set to 110 cm.
- Reduces the available place for sensor placement.

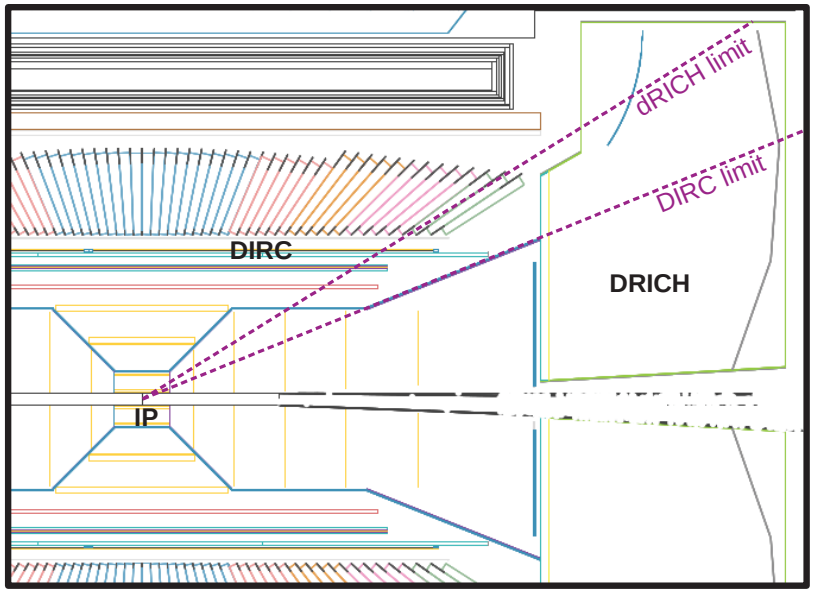
Setting back to previous aerogel size and optics retuning

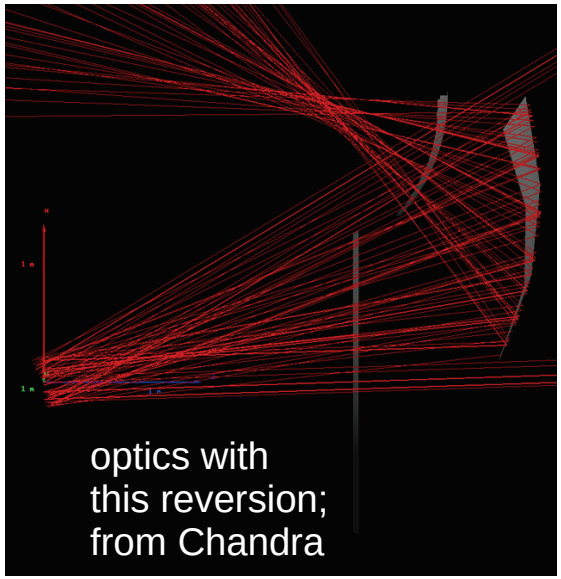
We placed back the aerogel to the previous size and the optics retuning was made. Reported in **GD/I** meeting.

Aerogel Radius

- Consider reverting this change: 110 → 95 cm
- Overlap of DIRC and dRICH aerogel (?)
- Adds room for services

Aerogel radius currently at 110 cm (at entrance)
Magenta dashed lines for projective reference





Acceptance after tuning

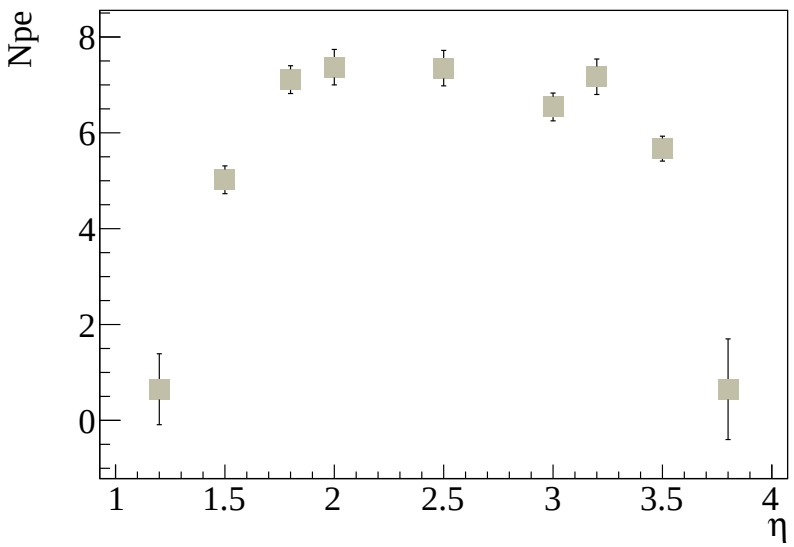


Figure: Aerogel

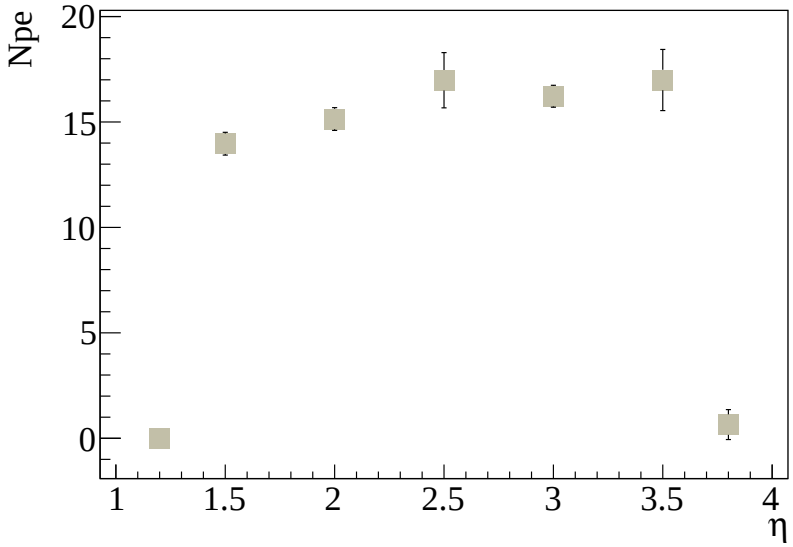


Figure: Gas

- The Number of photons detected over different η values are restored.
- The aerogel is providing around 7-8 photons and 18 photons are coming from the gas for saturated particles.

But...

Performance of the gaseous photons at different pseudorapidity

NOT UNIFORM. We don't have optics able to provide good resolution at small, mid and large pseudorapidity.

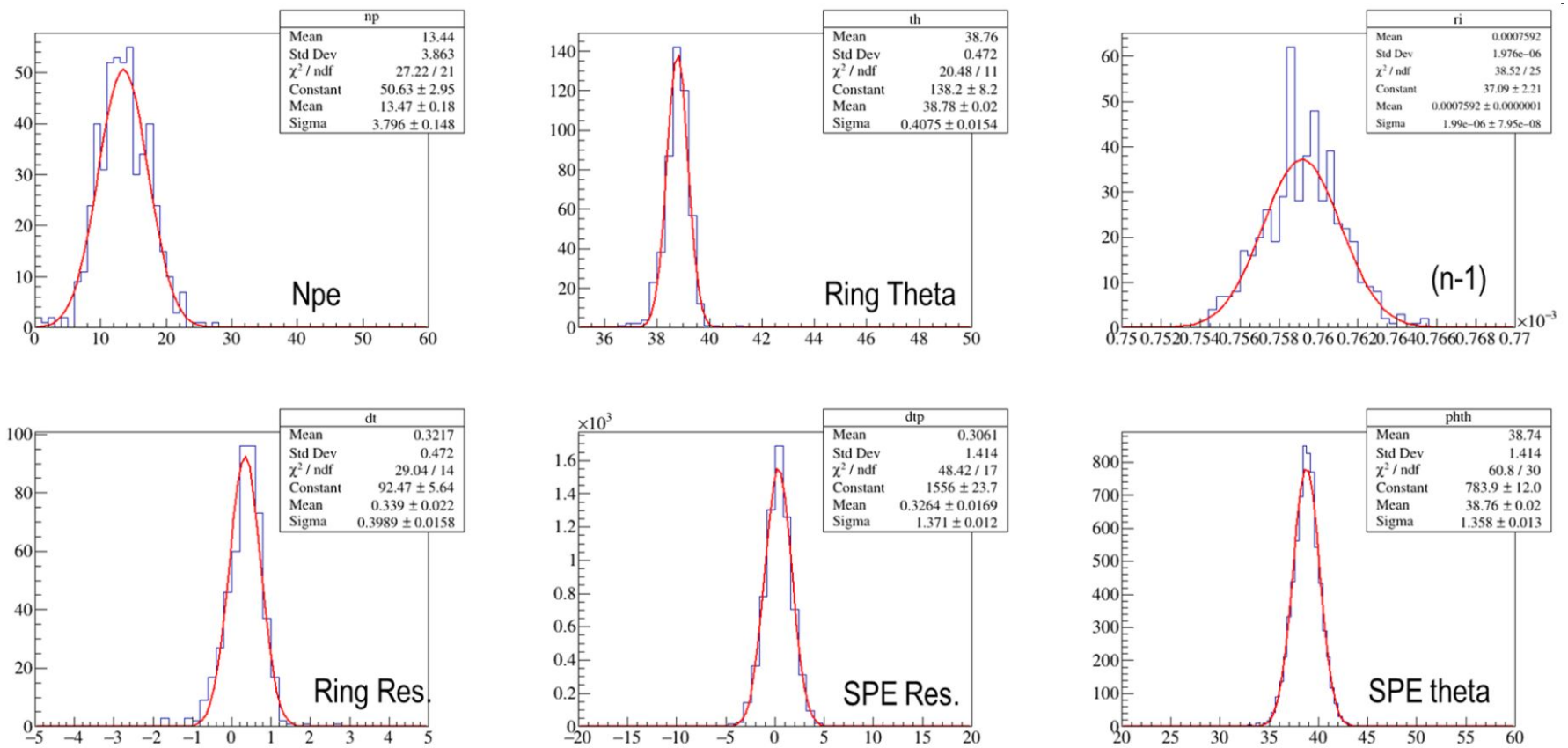


Figure: pseudorapidity 3.5, 50 GeV π

Performance of the gaseous photons at different pseudorapidity

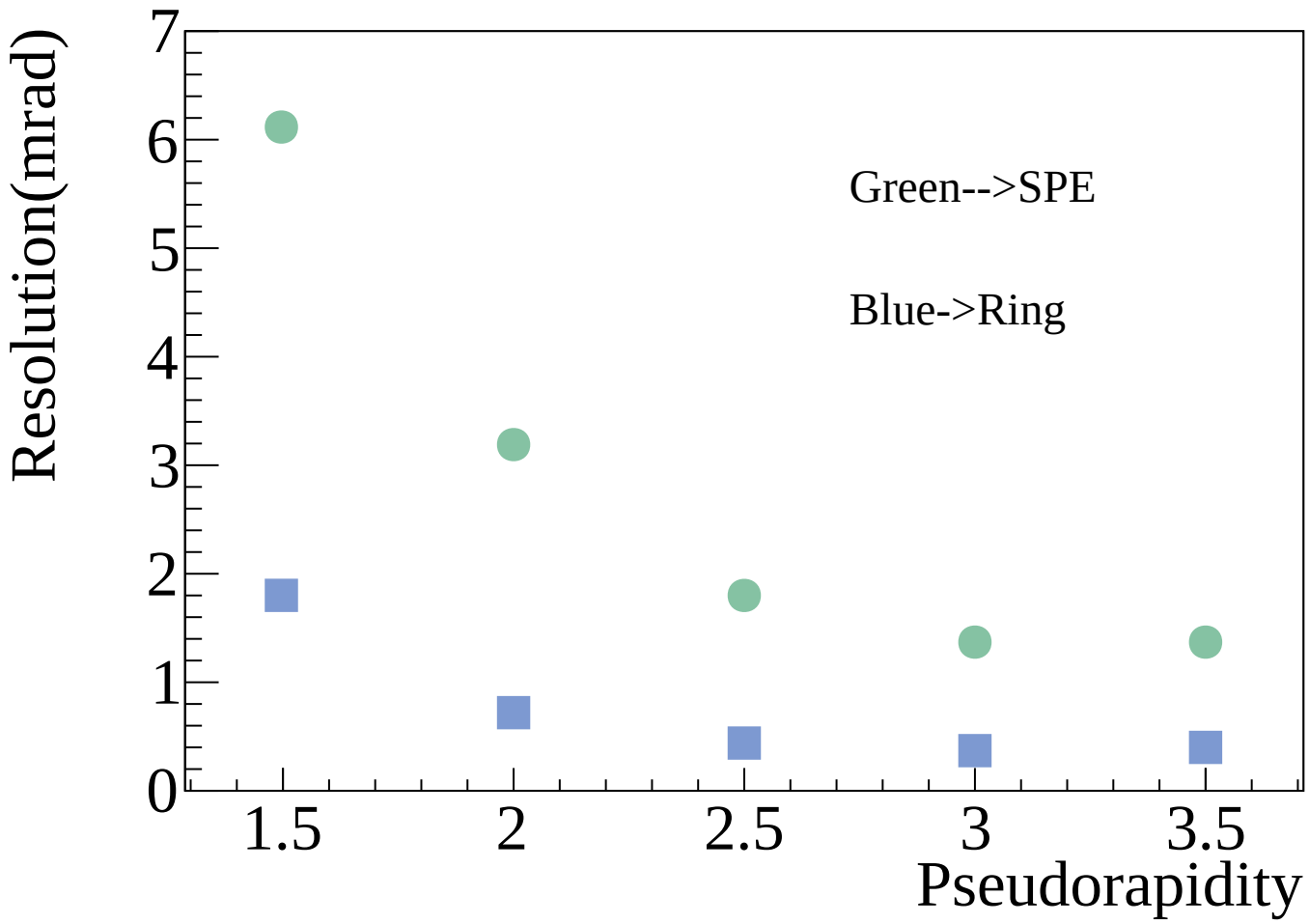


Figure: SPE and Ring Resolutions as a function of Pseudorapidity for 50 GeV π

Performance of the Aerogel photons at pseudorapidity 3.5

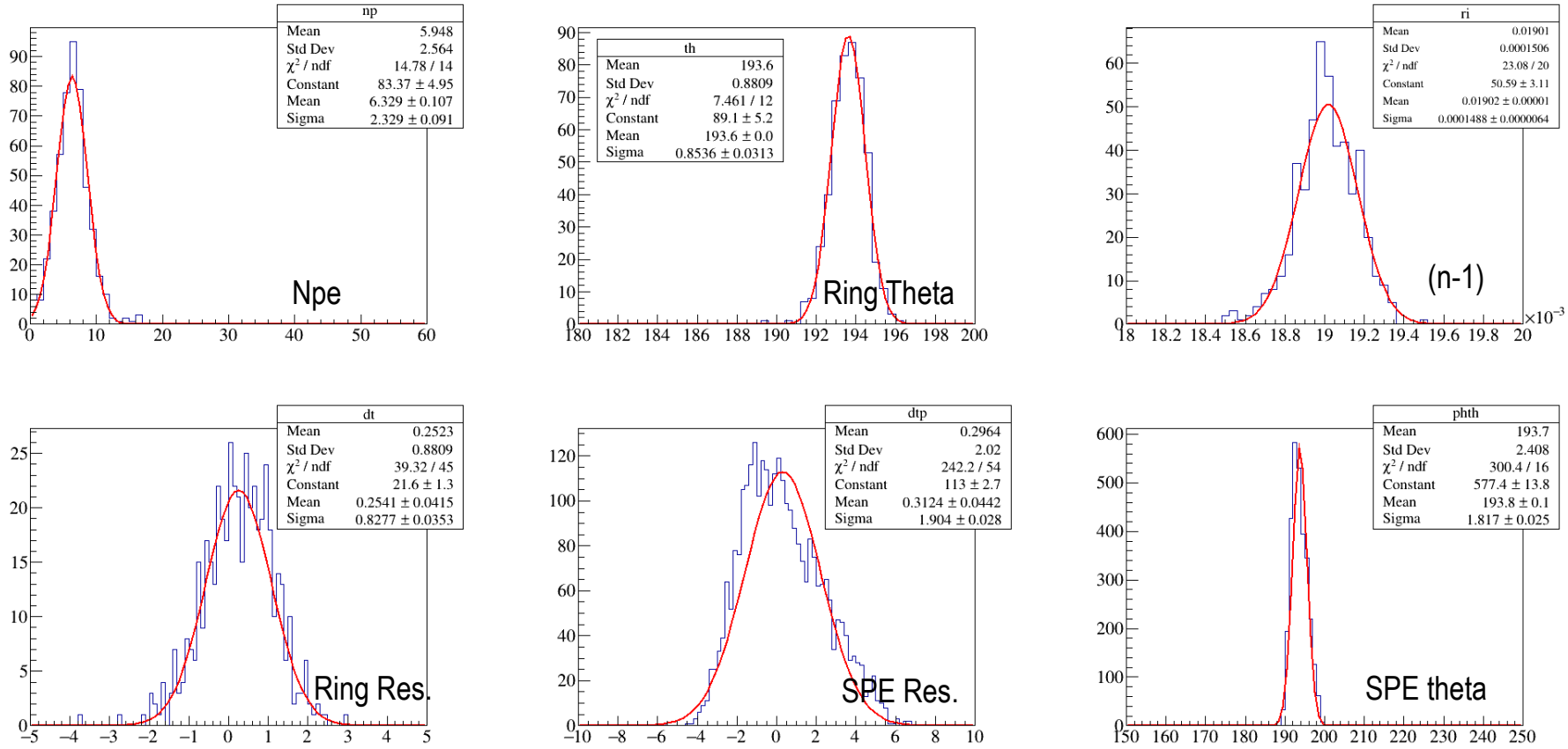
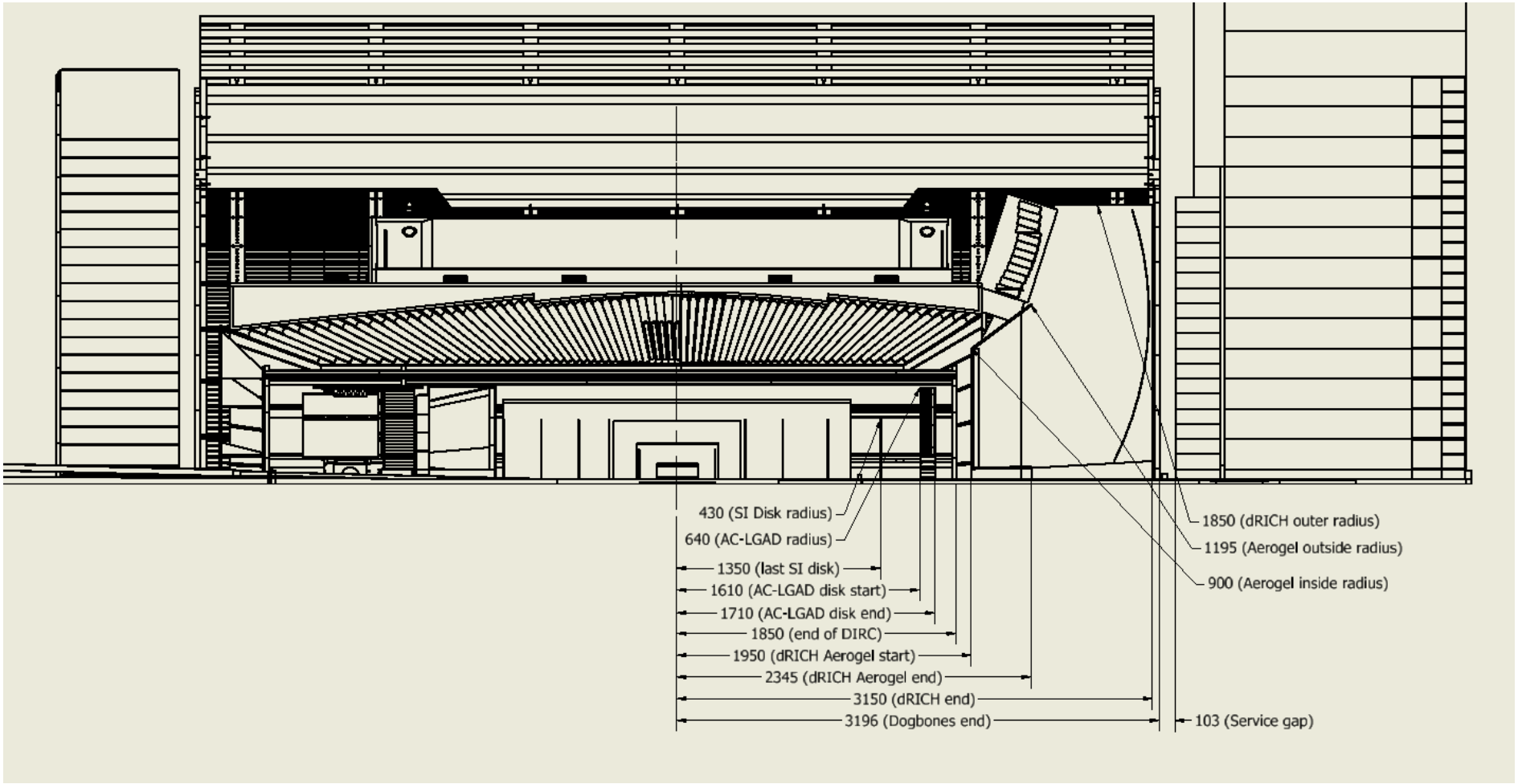


Figure: pseudorapidity 3.5, 10 GeV π

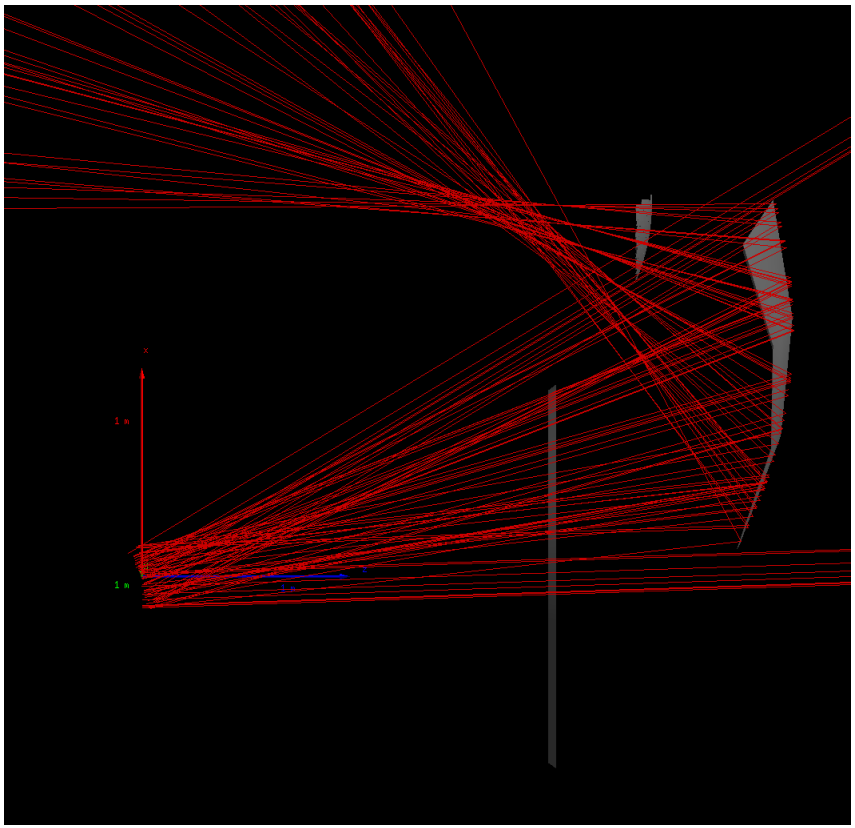
Snout Length issue

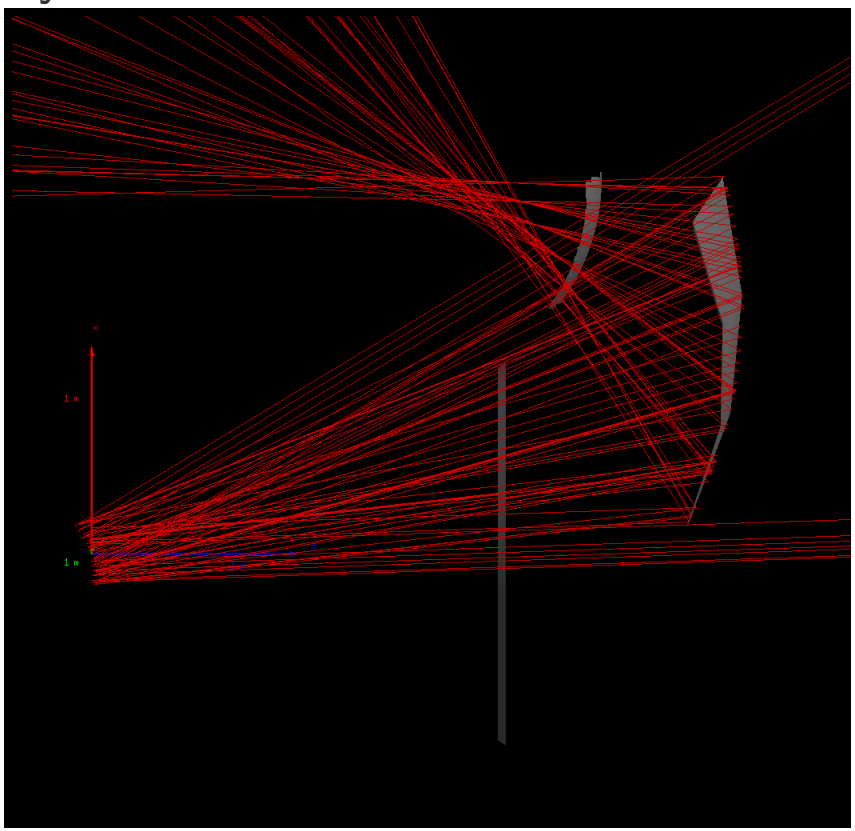
A new geometry: Double the size of 'snout' length and 90 cm aerogel. 20 cm became ∼40 cm. A clarification is ongoing.



Snout Length issue

With the new updated geometry a work around can be envisaged. The sensor placement can be made such that sensors are covering the whole photon impinging region. We are putting the sensor sphere centre much downstream the 'snout-length'. But, this can counter the geometrical constraints. Sensor can be shadowed by the 'snout'.





dRICH Geometry: Aerogel and the snout in particular

Before the end of the snout was defined as:

$$rmax1 = rmax0 + snout\_length * snout\_slope \quad (1)$$

Has been changed to

$$rmax1 = rmax0 + snout\_length * arctan((200mrad + tan(snout\_slope))) \quad (2)$$

snout_slope is projective:

$$snout\_slope = rmax0/(195.0\ cm) \quad (3)$$

With 90 cm aerogel (*rmax*0) and 'updated' geometry *rmax*1 is ∼113 cm. With 20 cm snout we get ∼100 cm. Currently we are using the same slope mentioned in this image with 20 cm snout and 90 cm aerogel. Aerogel acceptance study is ongoing.

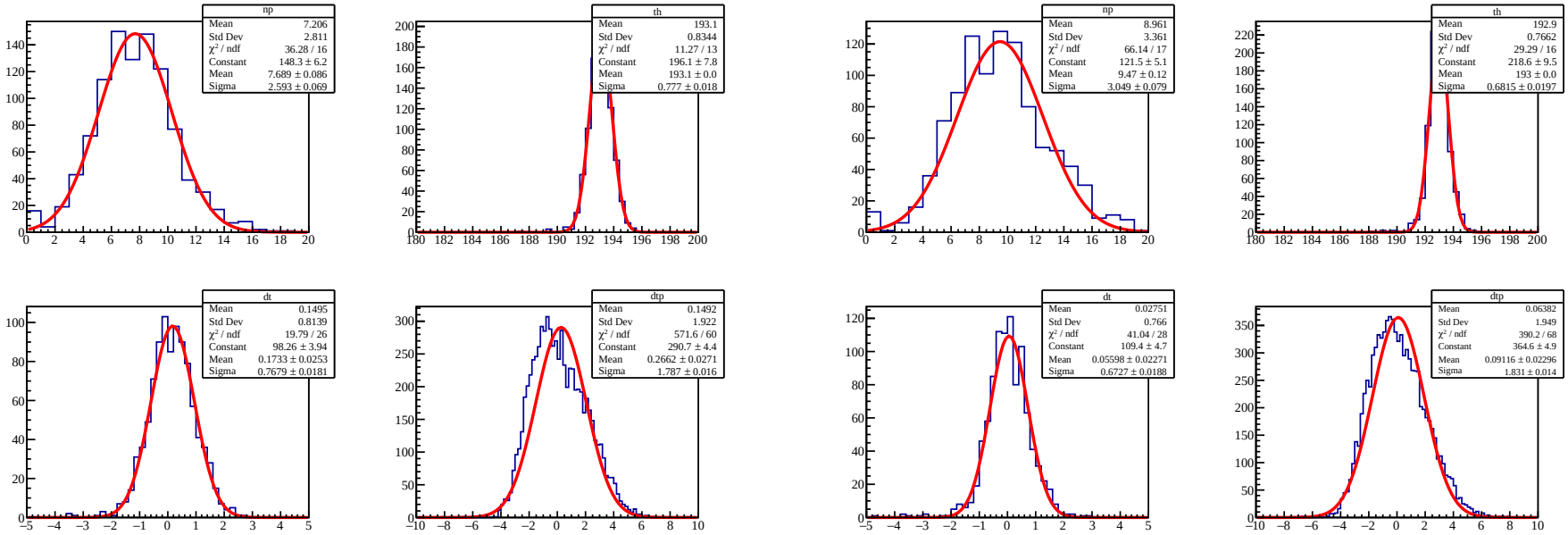
Status and Open questions?

Where we stand now:

1. Geometrical acceptance restored.
2. A new geometry is on the floor. Clarification ongoing.
3. With a trade-off between last and latest configuration; performance checked and expected results observed.
4. Chris told me that the 'IRT' code is now working in 'EICRecon'. I will give a look the performances in this week.

What should we do next and how to do?

- *Dual or multi-mirror configuration? Associated difficulty in geometry description and implementation in the DD4Hep. Porting from ATHENA?* (**Work Ongoing**)
- *Low number of photons from aerogel rings over a large perimeter. How to perform PID in real life? Increase (n-1)? Which values? What are the physics requirements?* **I checked by increasing the aerogel size from 4 cm to 6 cm.**



1. The average number of detected photons increases from $\sim$ 7.7 to $\sim$ 9.5.
2. The average SPE resolution gets worsen by $\sim$40 μrad ($\sim$ 1.79 mrad becomes $\sim$1.83 mrad).
3. The average ring resolution all in all remains same with a slight tendency of improvement.
4. Reconstructed ring angle remains same.