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A large-area prototype SiPM readout plane for the ePIC-dRICH detector at the EIC: realisation and beam test results

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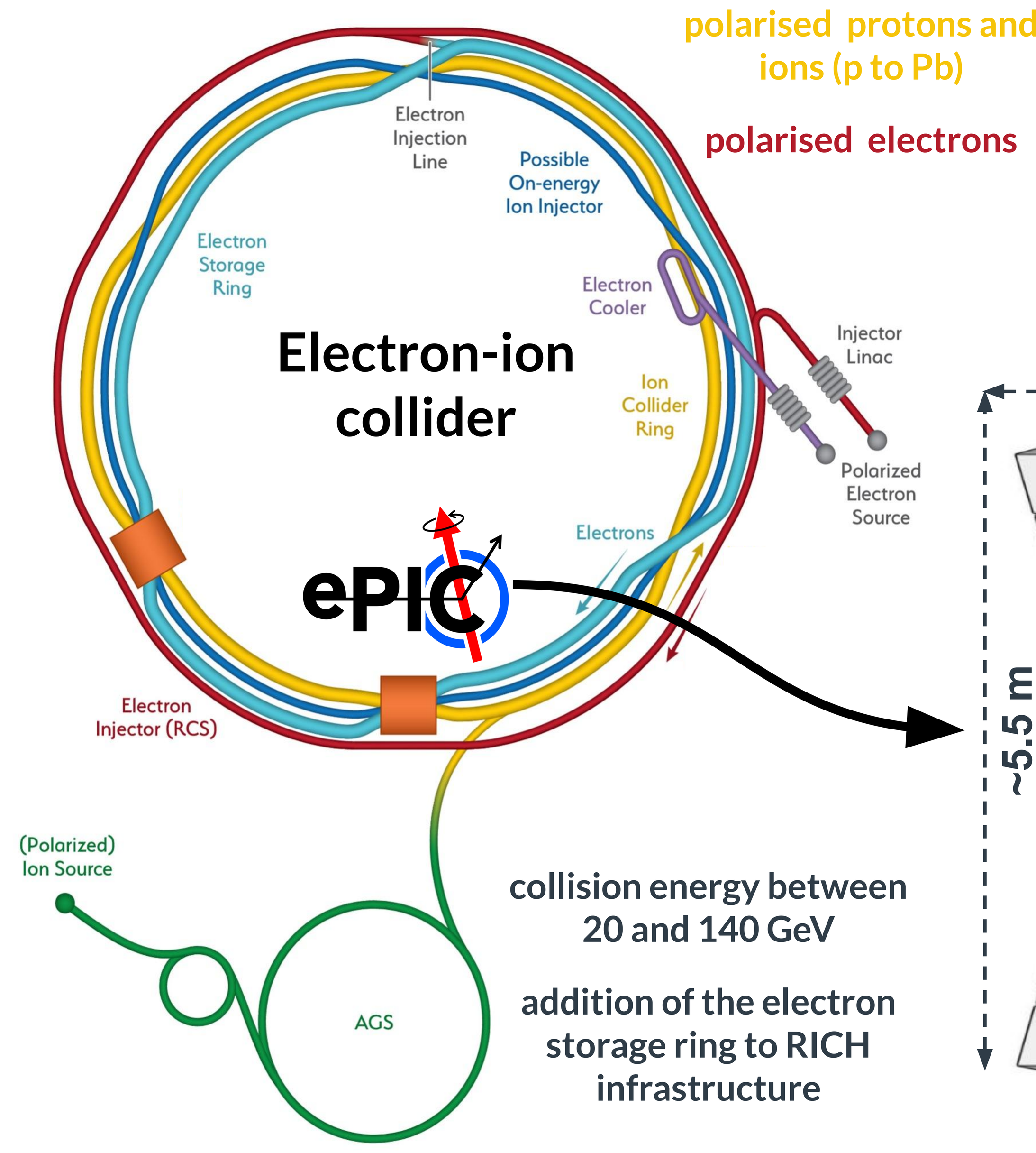
ePIC

INFN Istituto Nazionale di Fisica Nucleare

The electron-ion collider, ePIC collaboration and dRICH detector



collision energy between 20 and 140 GeV

addition of the electron storage ring to RICH infrastructure

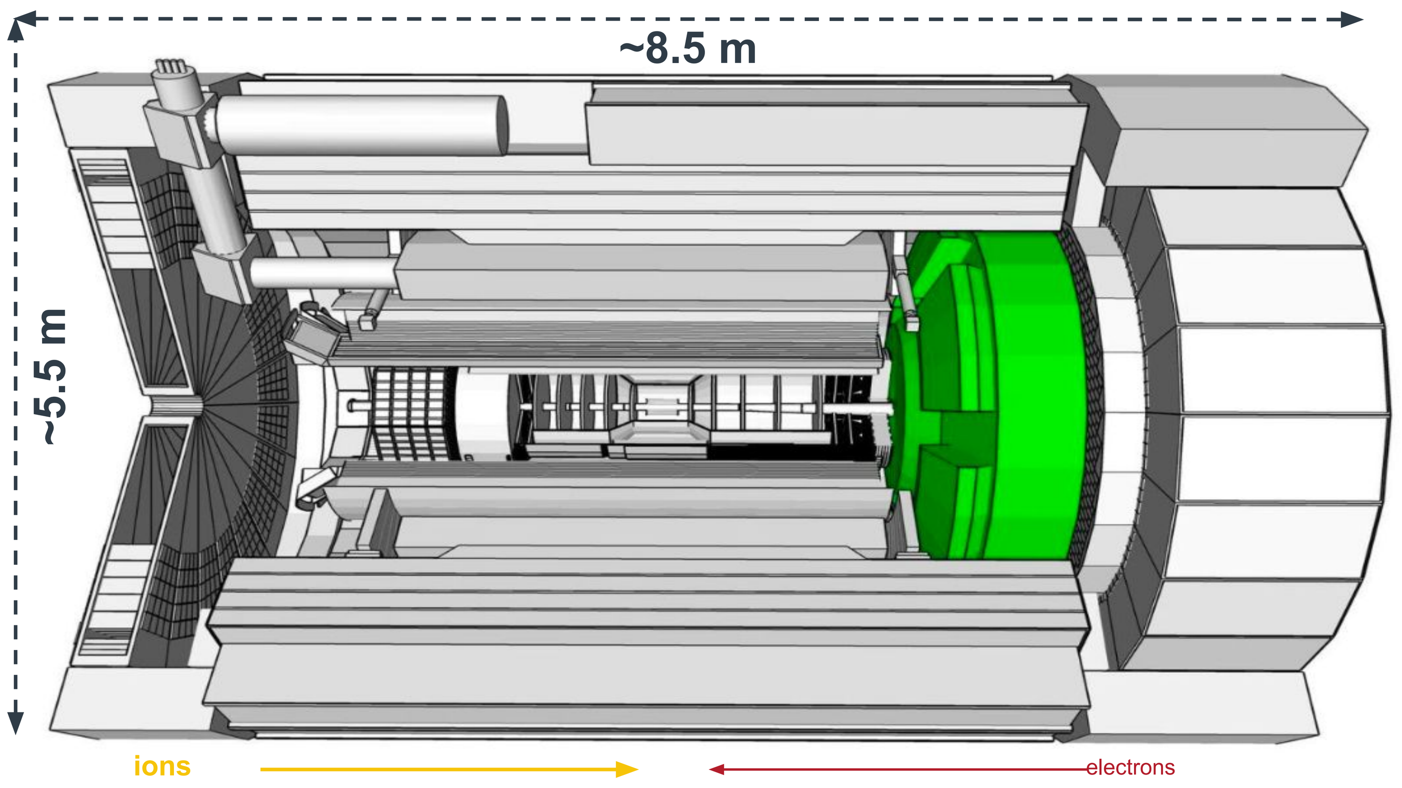
Calorimetry:
e-endcap: PbWO$_4$ EMCal
barrel: imaging EMCal
outer barrel: HCal
h-endcap: finely segmented

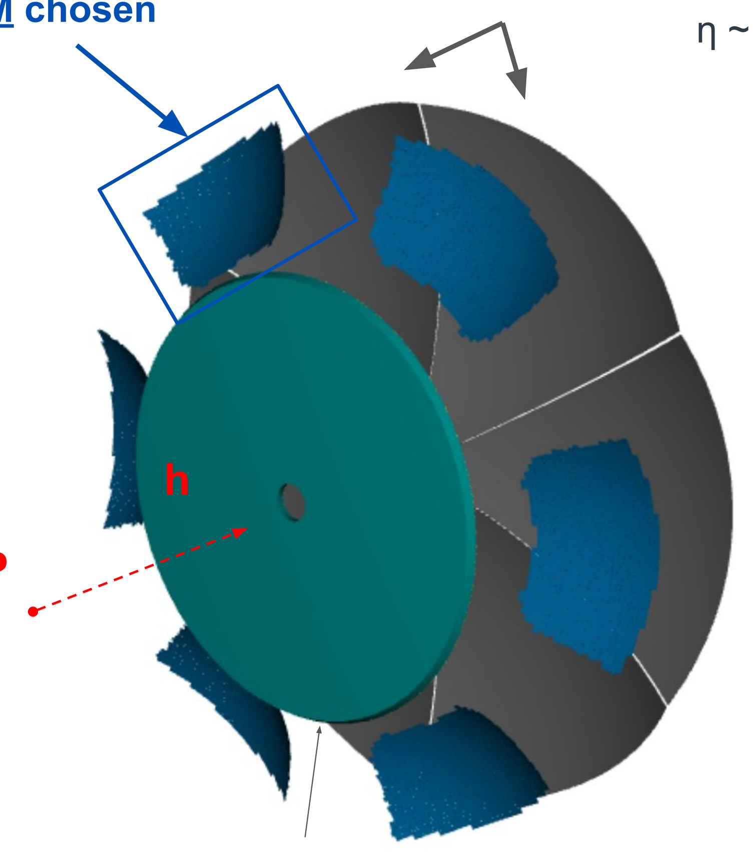
Tracking:
1.7 T magnet
Si-MAPS + MPGDs

PID:
AC-LGAD TOF
pfRICH
hpDIRC
dRICH

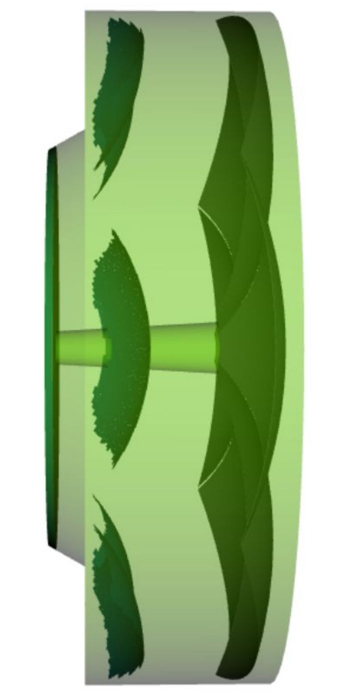
Photosensors:
- **3x3 mm^2 pixels**
- **0.5 m^2 per sector**
- **SiPM chosen**

PID
p ~ 3-50 GeV/c
eID up to 15 GeV/c
η ~ 1.5-3.5



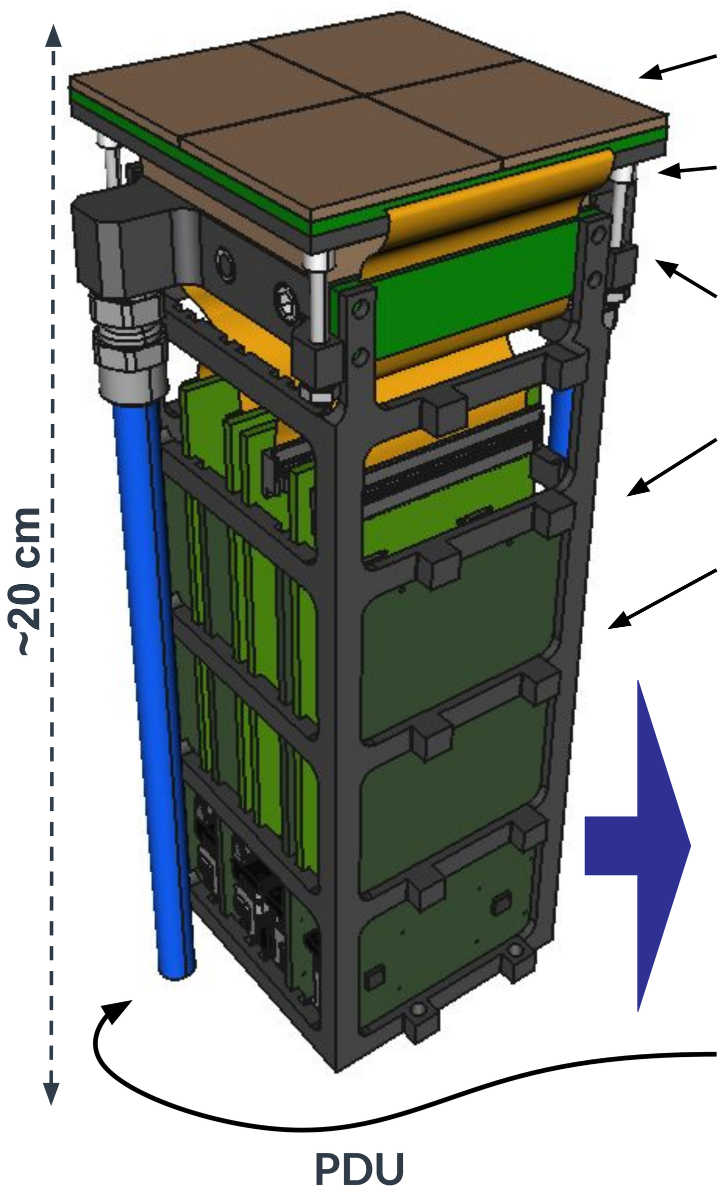


aerogel
4 cm
n ~1.02

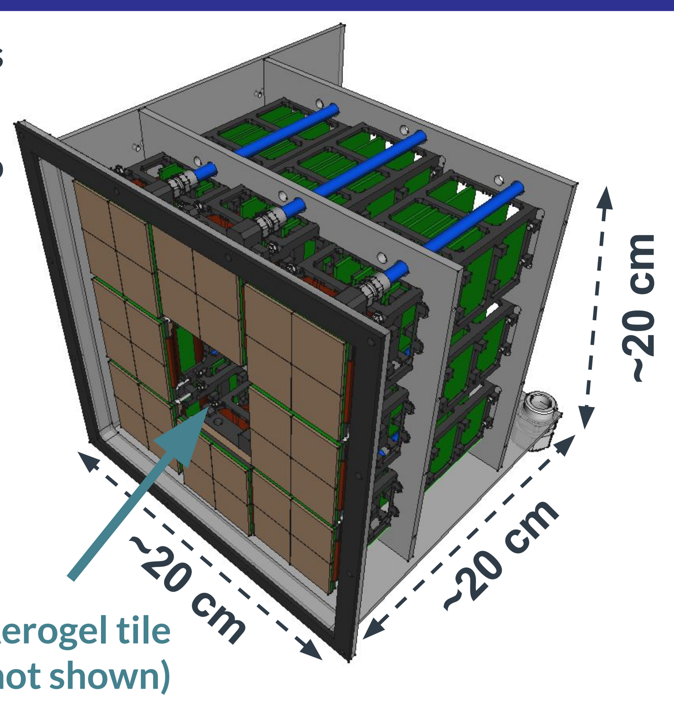


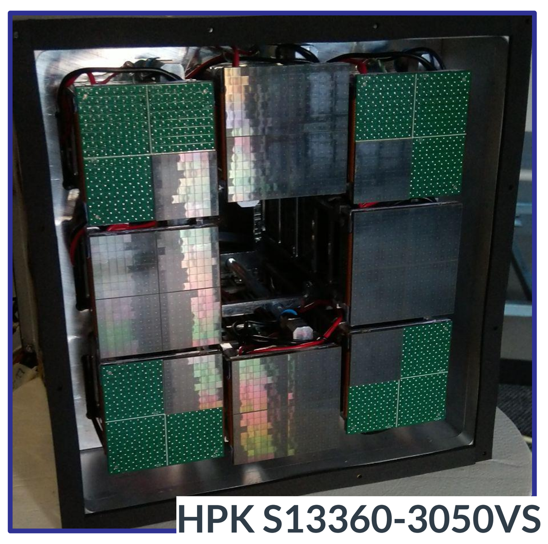
C_2F_6 gas volume
120 cm
n ~1.0008

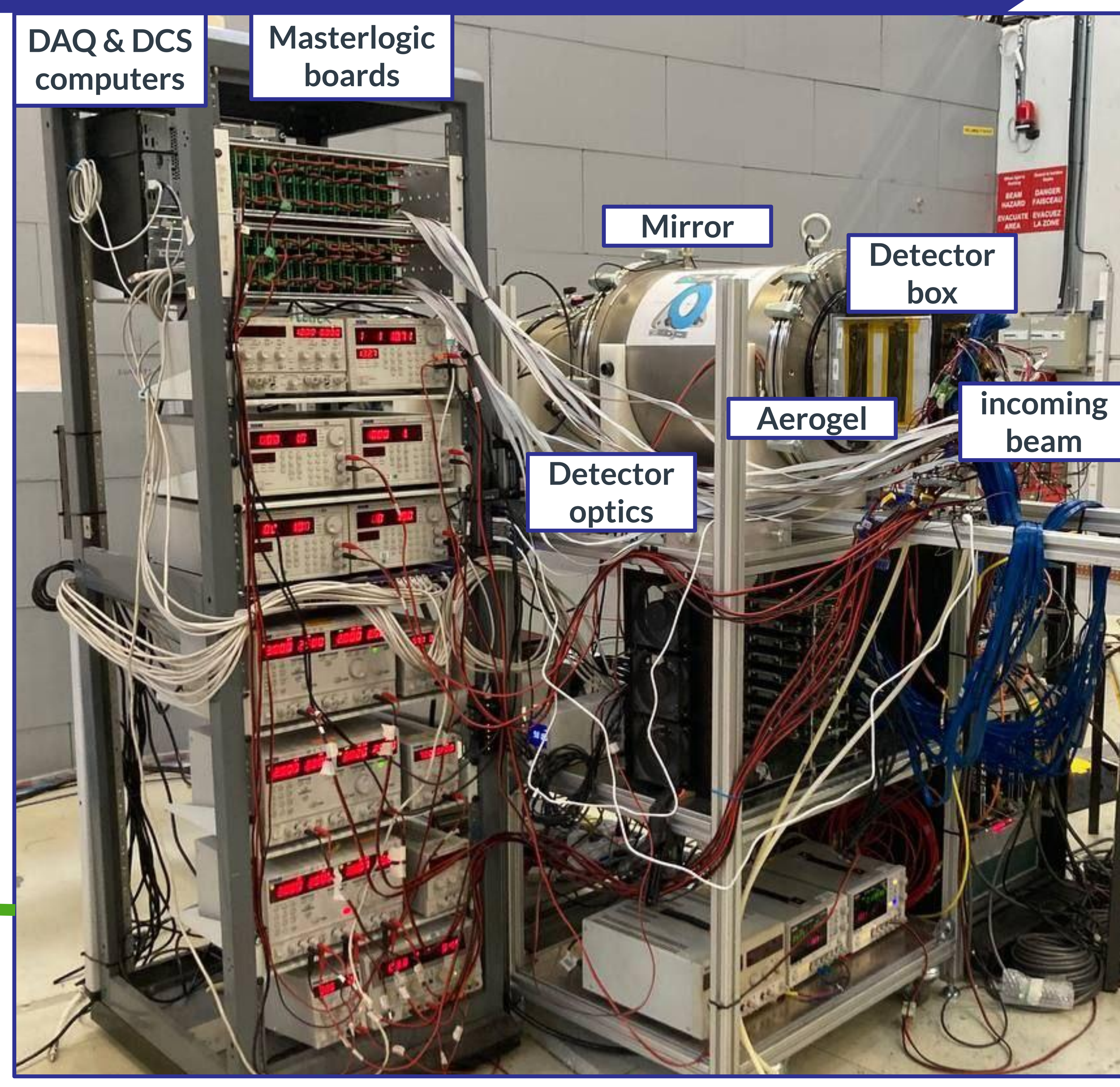
Photo-detection unit (PDU) design and R&D: the detector prototype



- 4x matrices of 8x8 SiPMs total 256 channels
- 2 peltier cells for subzero operating temperatures
- Temperature sensors both under the sensors and on the peltiers
- light-weight aluminium structure
- Front-end electronics featuring the ALCOR ASIC chip
- Externally provided: High voltage bias for sensors, low voltage power supply for electronics, T sensors piloting and read-out
- liquid heat exchange for temperature control of hot-face of peltiers



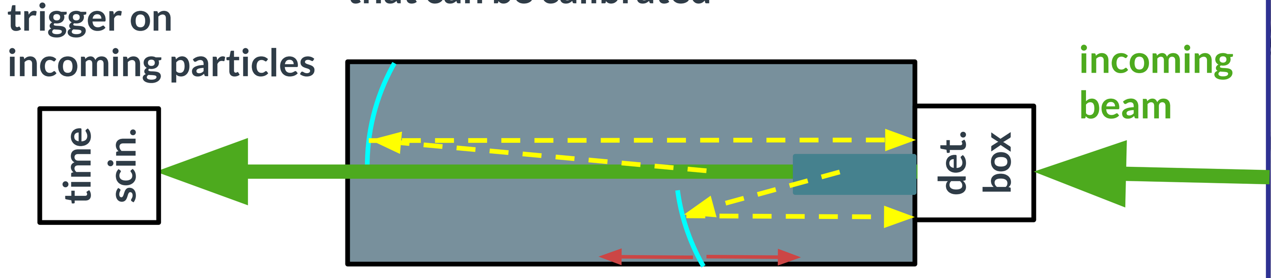




We set timing scintillators downstream of the detector to trigger on incoming particles

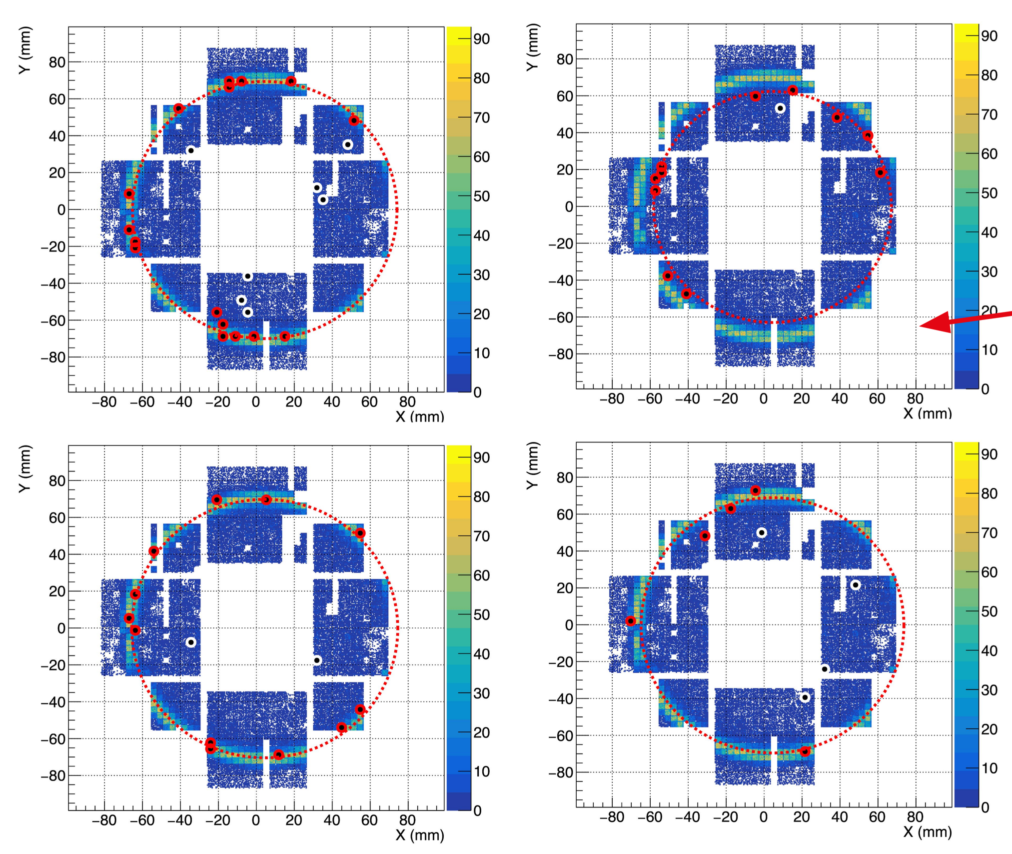
Inside the detector vessel there are two mirrors to focus aerogel and gas light that can be calibrated

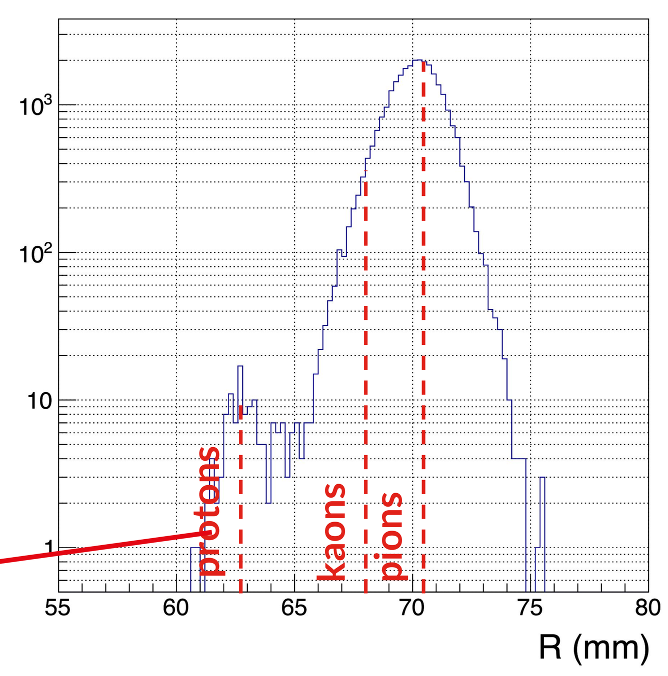
The beam could be set to positive or negative, delivering p, K, π



Beam test results

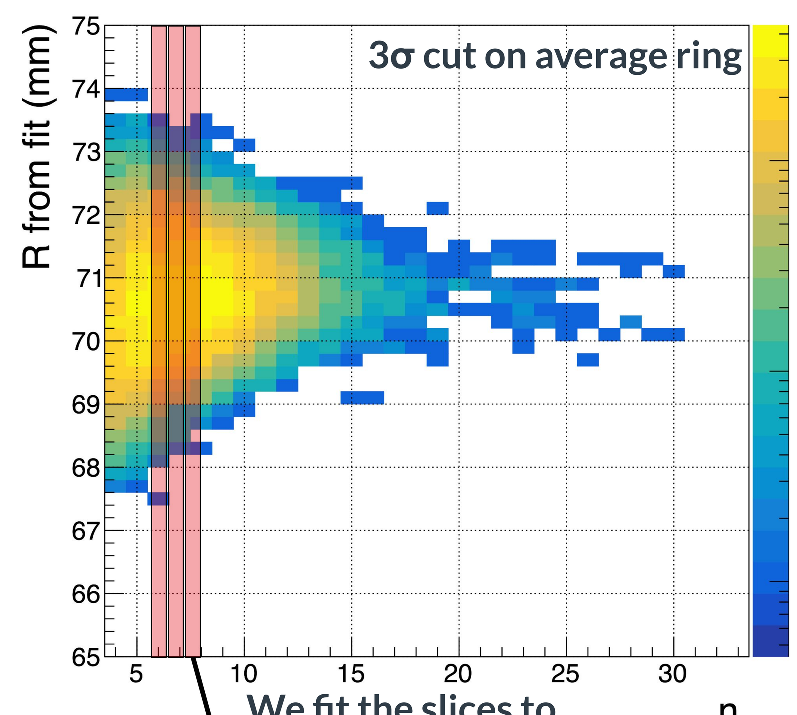
After the event selection (bottom right) we can consider a window based on the results of the average ring finder (bottom left).
Below some examples of the event-by-event ring fit.



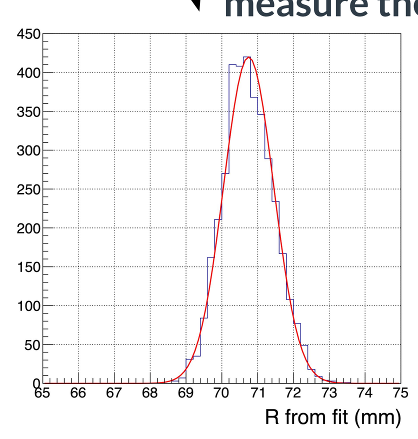


The radii found by the fit show a distribution where the particle species can already start to be seen. One can clearly distinguish (anti-)protons peak from the K/π peak.

Single-photon resolution



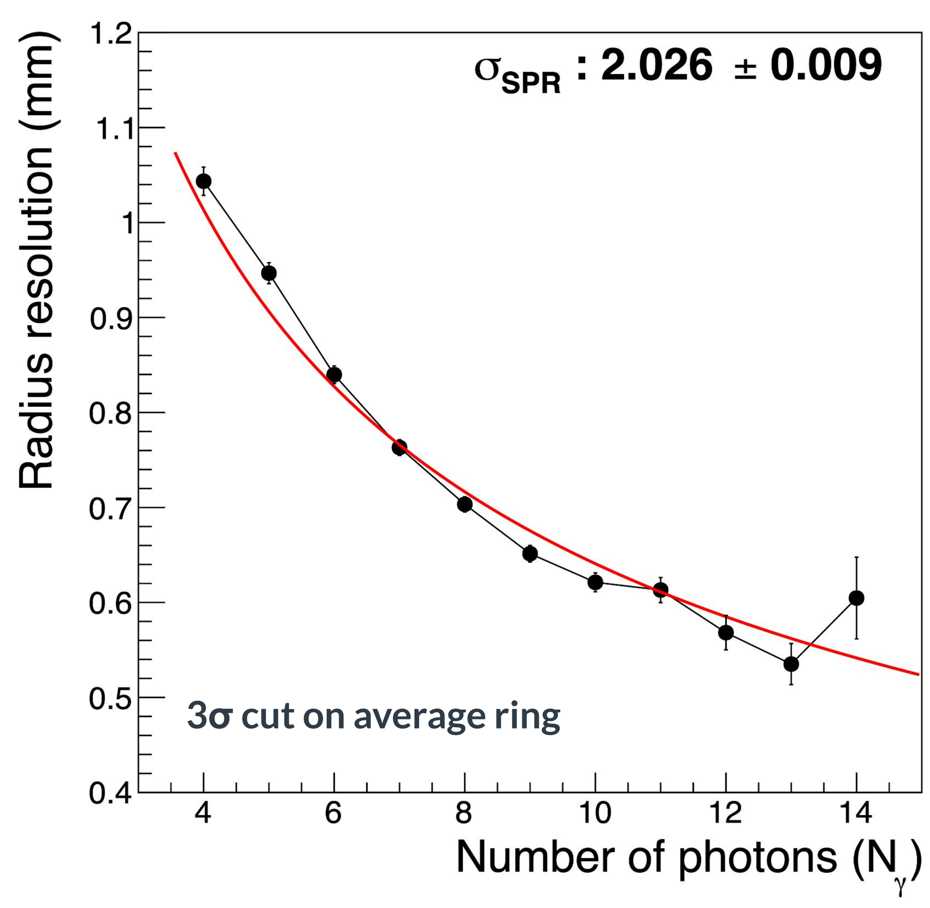
We fit the slices to measure the std. dev.



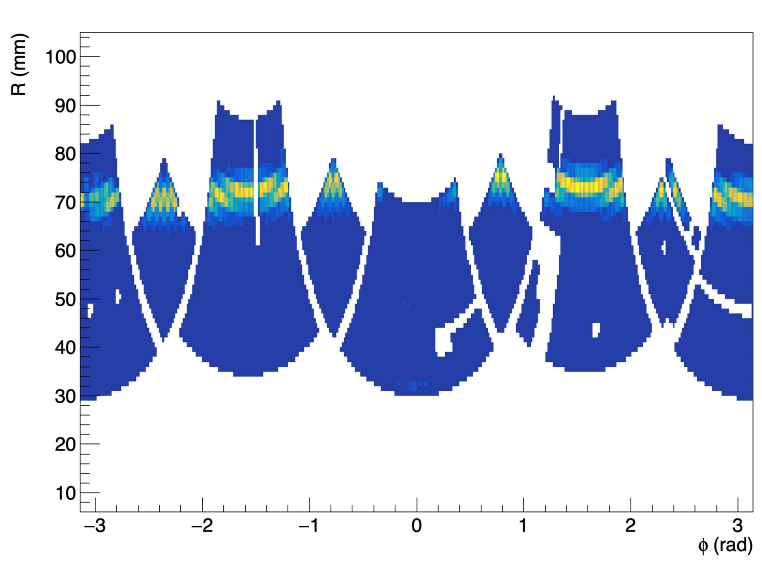
We find the radius resolution in each case, differentiating per number of participating photons

We can successfully find the Single-Photon Resolution from fitting the graph below with:

$$\sigma(n_\gamma) = \frac{\sigma_{\mathrm{SPR}}}{\sqrt{n_\gamma}}$$



My approach to determine the average ring



Projecting the hits in the R-φ we can fit the 2D map with:

$$F(\mathrm{R}, \phi) = e^{\frac{(\mathrm{R}-f(\phi))^2}{\sigma^2}}$$

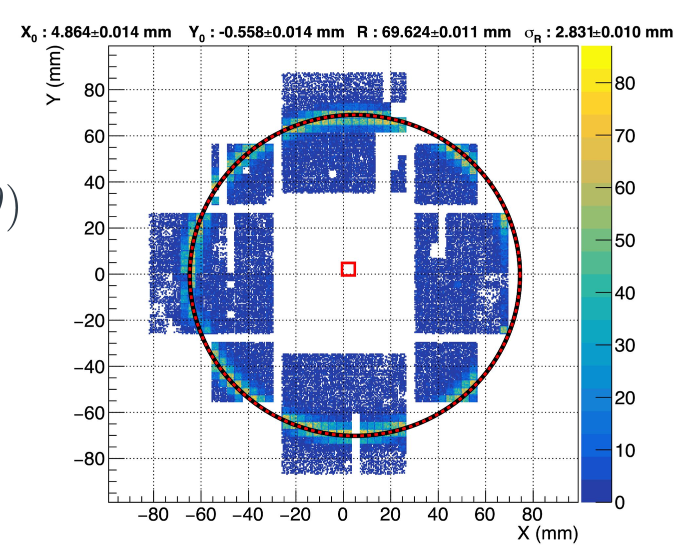
$$f(x) = R_0 + r_0 \cdot sin(\phi - \theta)$$

We can recover the ring center by the means of:

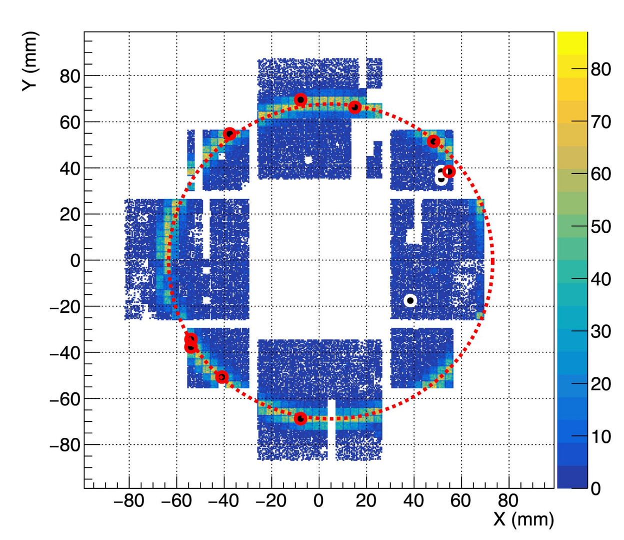
$$x_0 = r_0 \cdot cos(\theta)$$

$$y_0 = r_0 \cdot sin(\theta)$$

Then, R_0 is the ring radius



Event selection



Using the timing scintillators downstream our detector we can select signal hits in time with the incoming beam particle

We still have a few background hits that can be rejected (white points) with the average ring information