

dRICH Prototype Beam Test: Overview and First Results

Nicola Rubini ⁽¹⁾

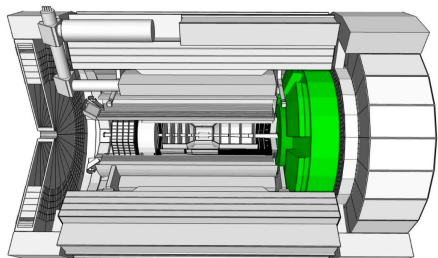
(1) INFN Bologna
22 July 2024

The dual-radiator (dRICH) for forward PID at ePIC

Particle ID

dRICH
 p ~3-50 GeV/c
 η ~1.5-3.5
 e-ID up to 15GeV/c

Broad momentum coverage thanks to dual refractive index:
 gas ~ 1.0008
 aerogel ~ 1.02



Photosensors:

- 3x3mm² pixels
- 0.5m² per sector
- SiPM chosen

Pros

1. Single photon sensitivity
2. Good timing performance
3. Insensitive to magnetic fields
4. Cheap

Cons

1. High dark count rate at room temperature
2. High radiation sensitivity

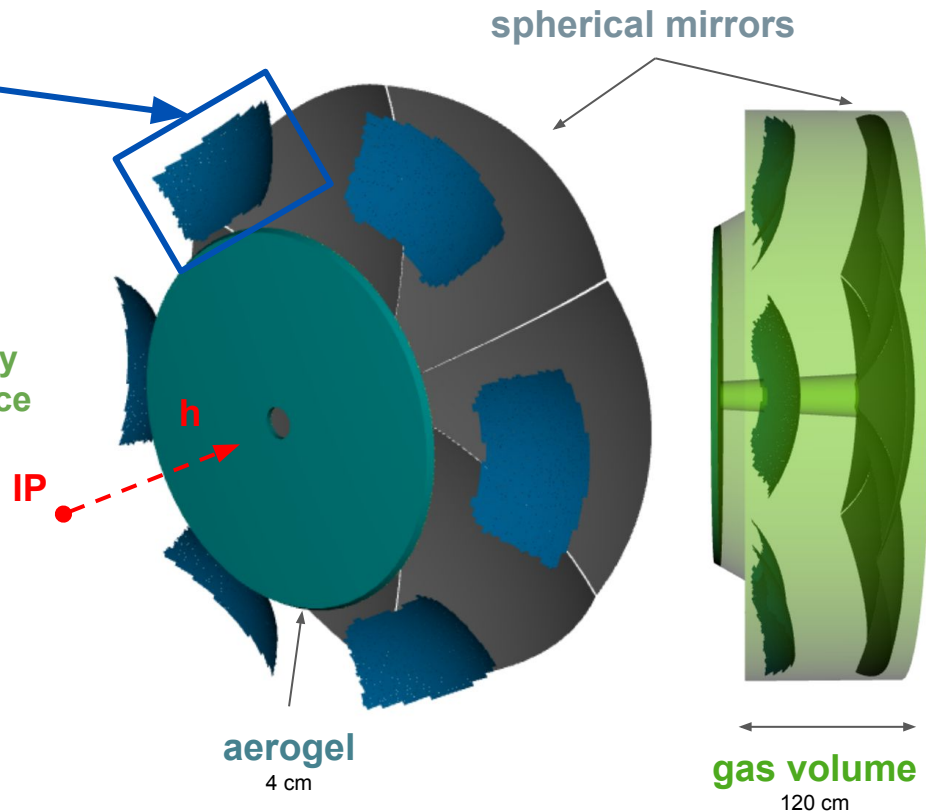
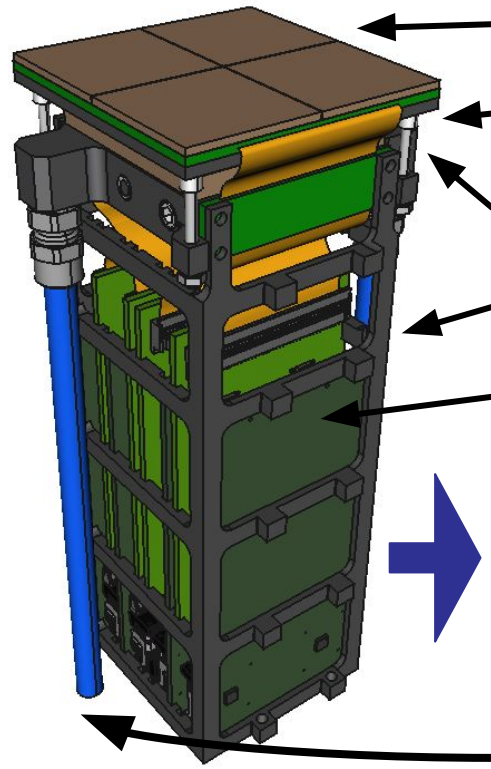


Photo Detection Unit (PDU)

~20 cm



4x matrices of 8x8 SiPMs
 3x3 mm², total 256 channels

2 peltier cells for subzero
 operating temperatures

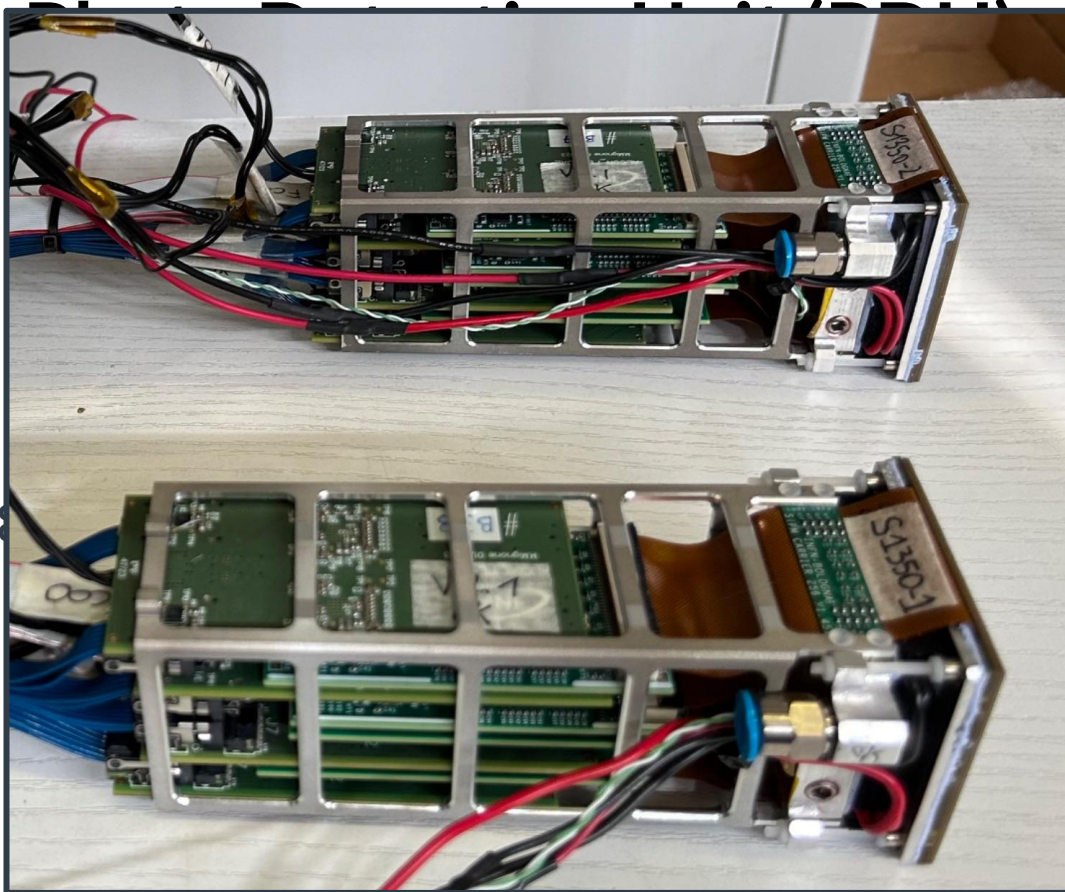
Temperature sensors both under
 the sensors and on the peltiers

light-weight aluminium
 structure

Front-end electronics featuring
 the ALCOR ASIC chip

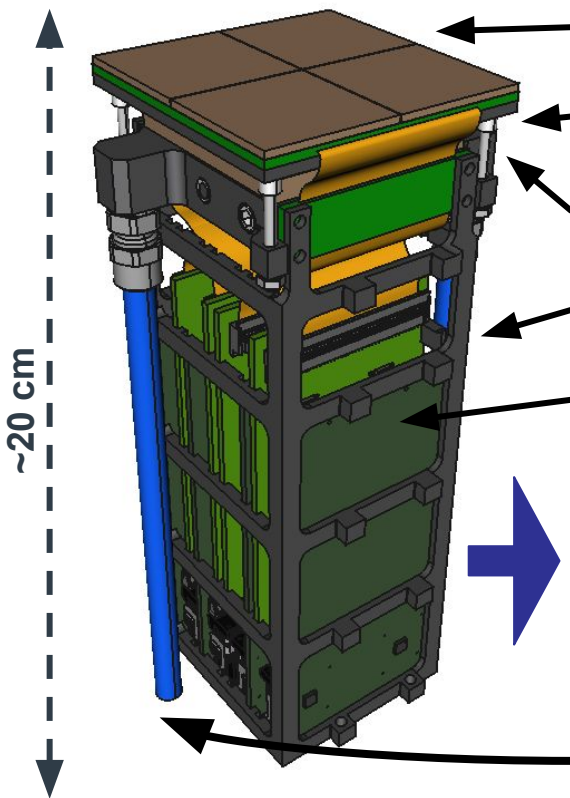
Externally provided:
 High voltage bias for sensors,
 low voltage power supply for
 electronics, T sensors piloting
 and read-out

liquid heat exchange for
 temperature control of hot-face
 of peltiers



operaters

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Prototype

Compact solution for a ~18 cm² of active area, reading 2048 channels

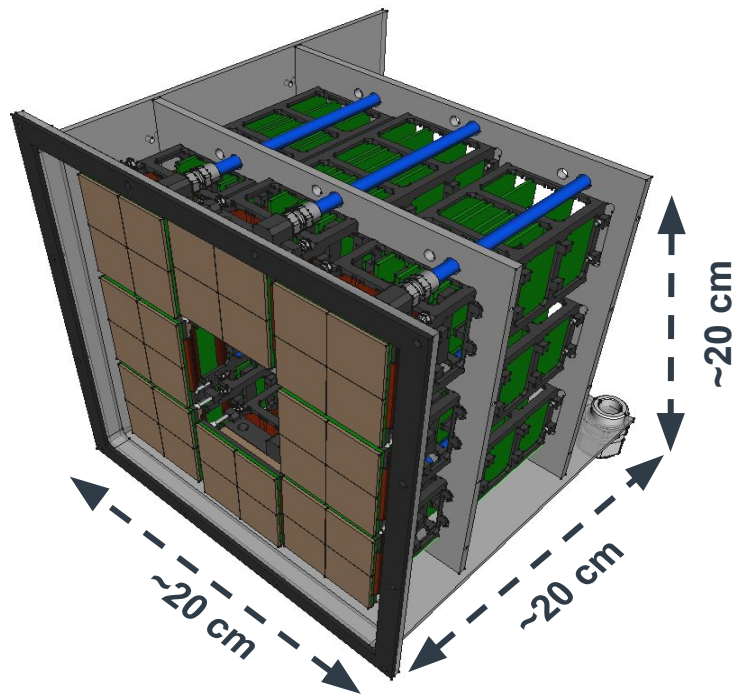
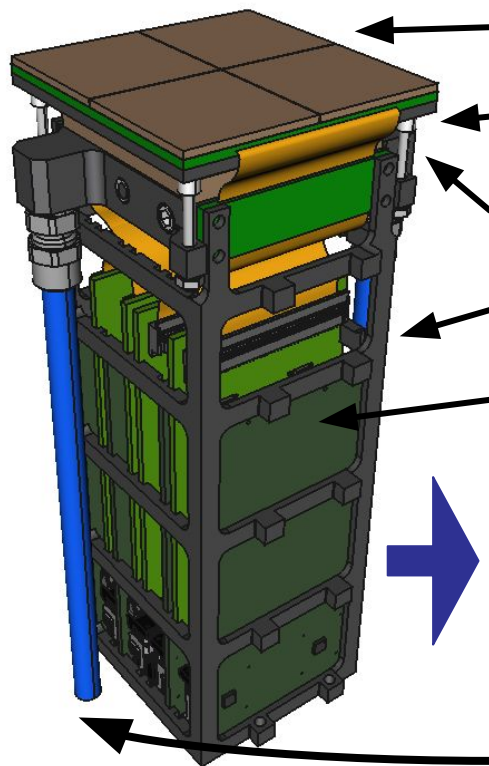


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Prototype

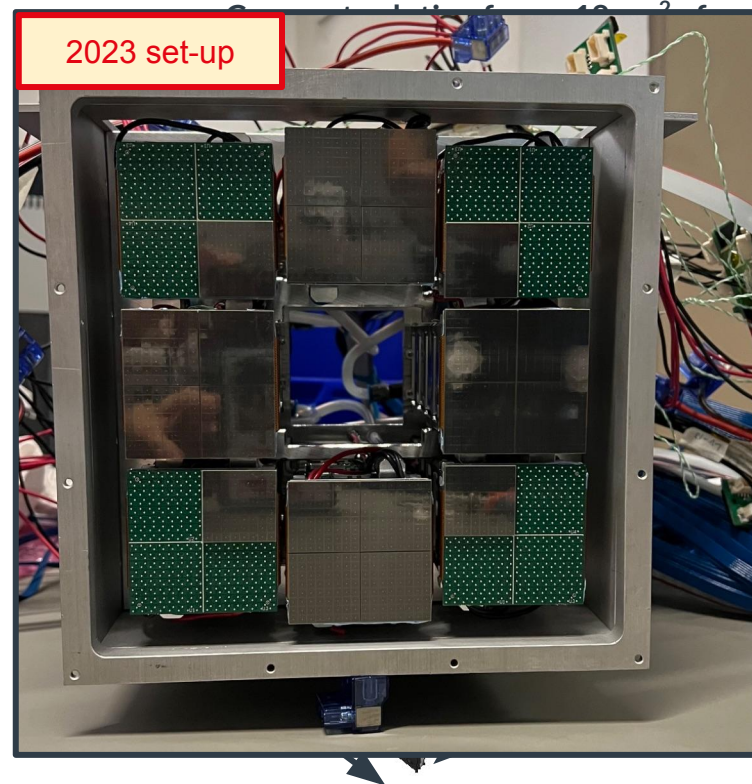
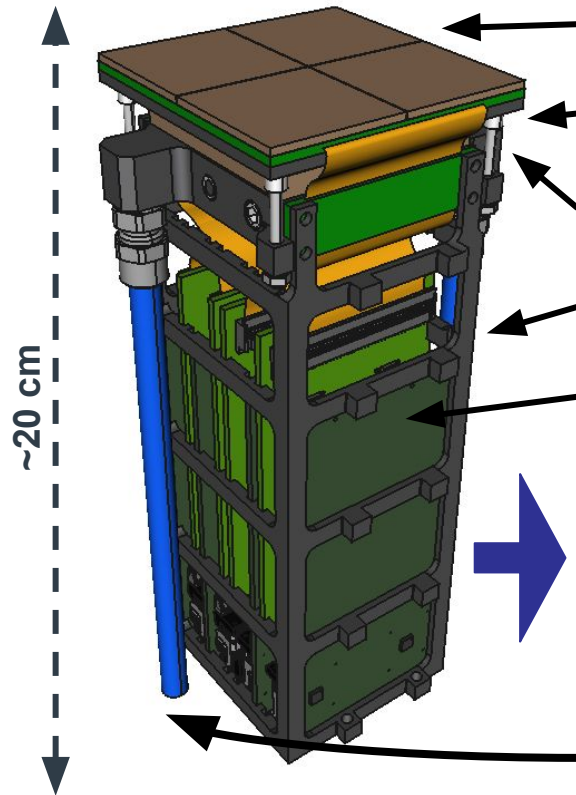


Photo Detection Unit (PDU)



4x matrices of 8x8 SiPMs
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2 peltier cells for **subzero operating temperatures**

studied in 2023

Temperature sensors both under the sensors and on the peltiers

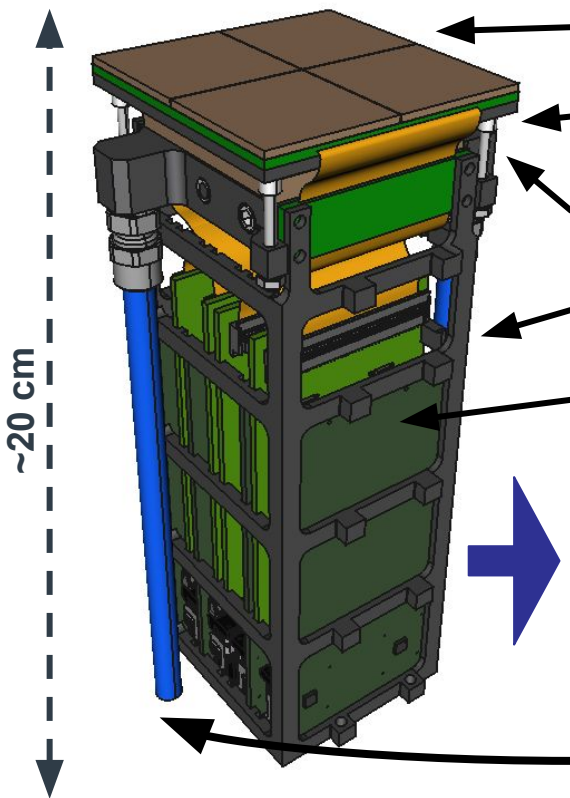
light-weight aluminium structure

Front-end electronics featuring the ALCOR ASIC chip

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improved 2024

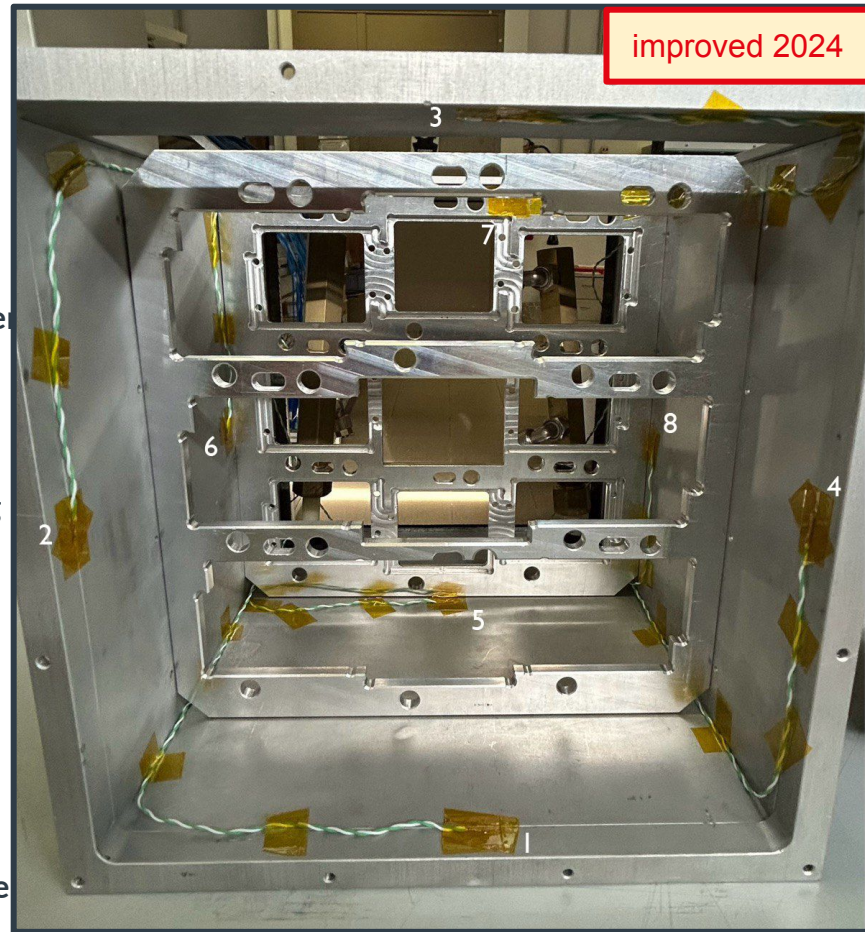
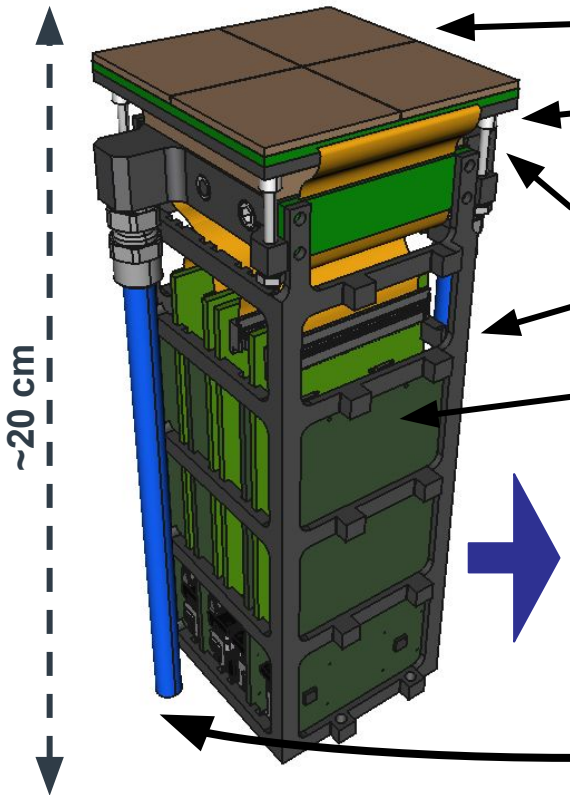


Photo Detection Unit (PDU)



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2 peltier cells for subzero
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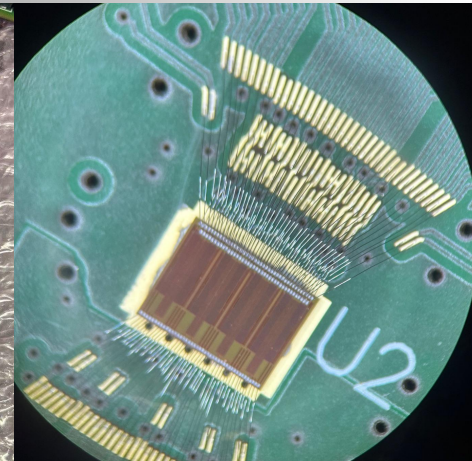
Temperature sensors both under
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light-weight aluminium
structure

Front-end electronics featuring
the **ALCOR ASIC** chip

Externally provided:
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liquid heat exchange for
temperature control of hot-face
of peltiers



improved 2024

we installed
ALCOR v2.1

studied in 2023

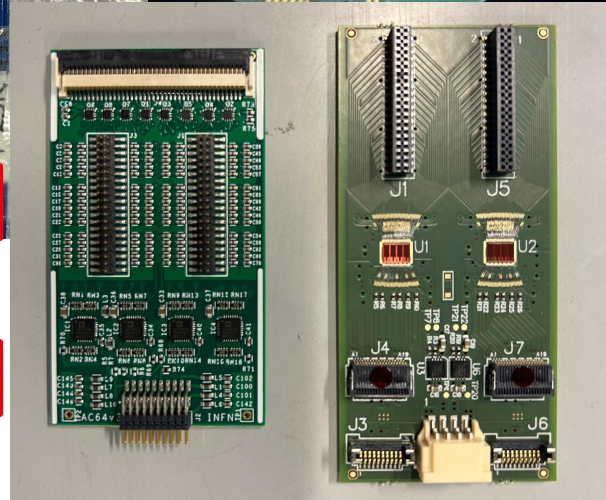
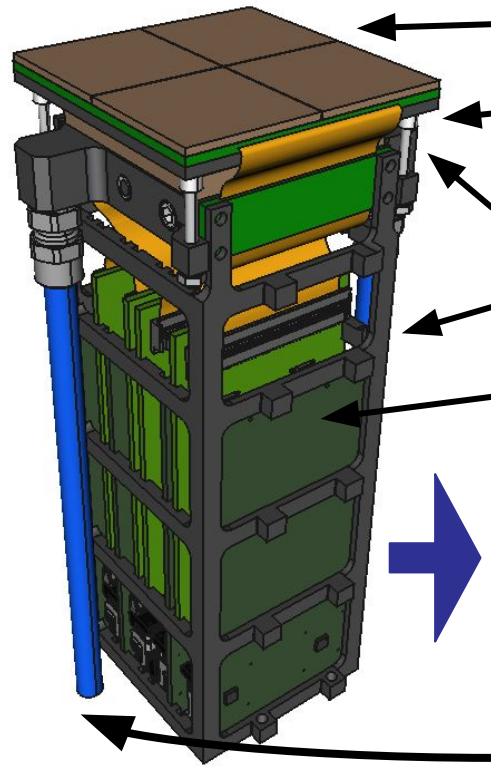


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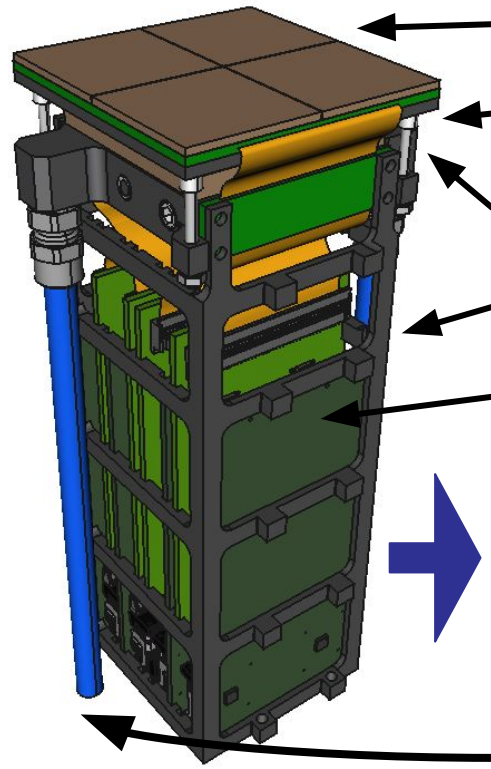
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liquid heat exchange for
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improving 2024

we tried to
 swap water
 with siliconic
 fluid

Photo Detection Unit (PDU)

Prototype

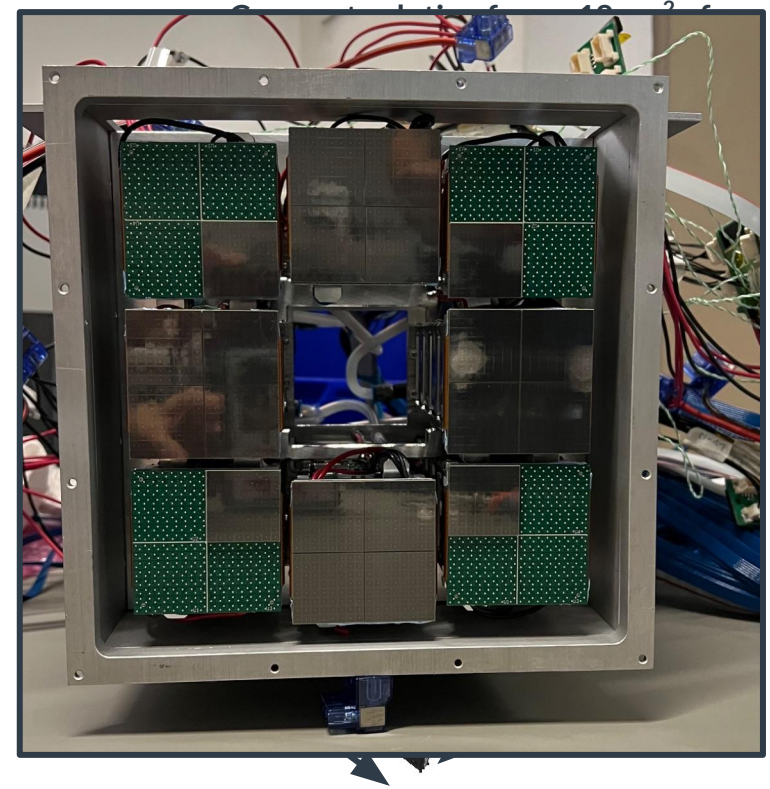
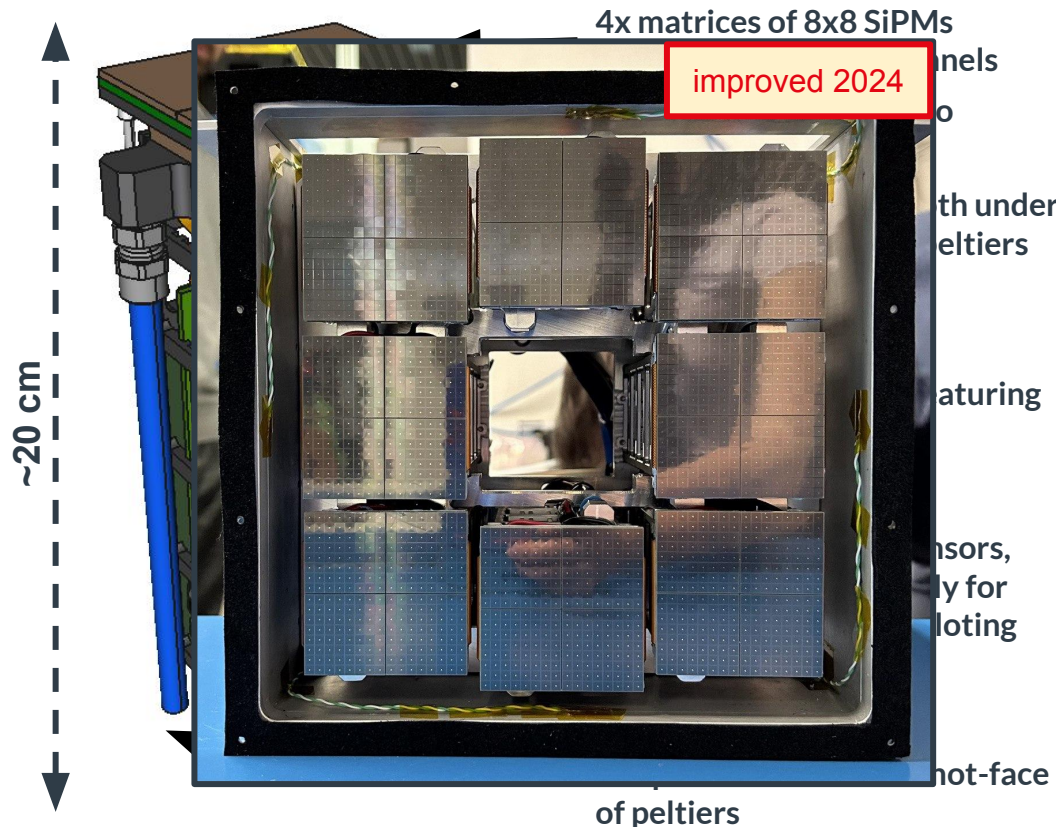
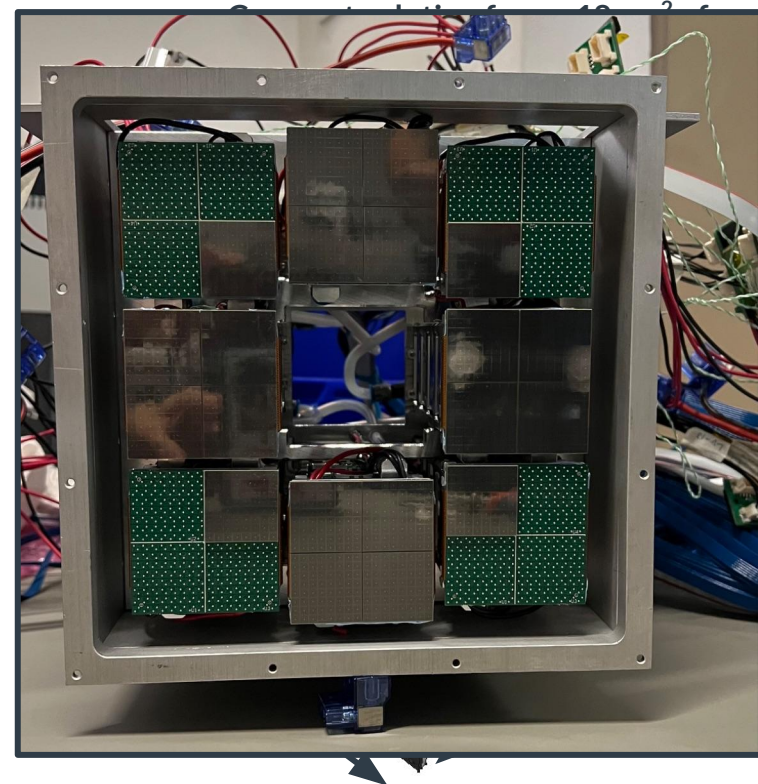
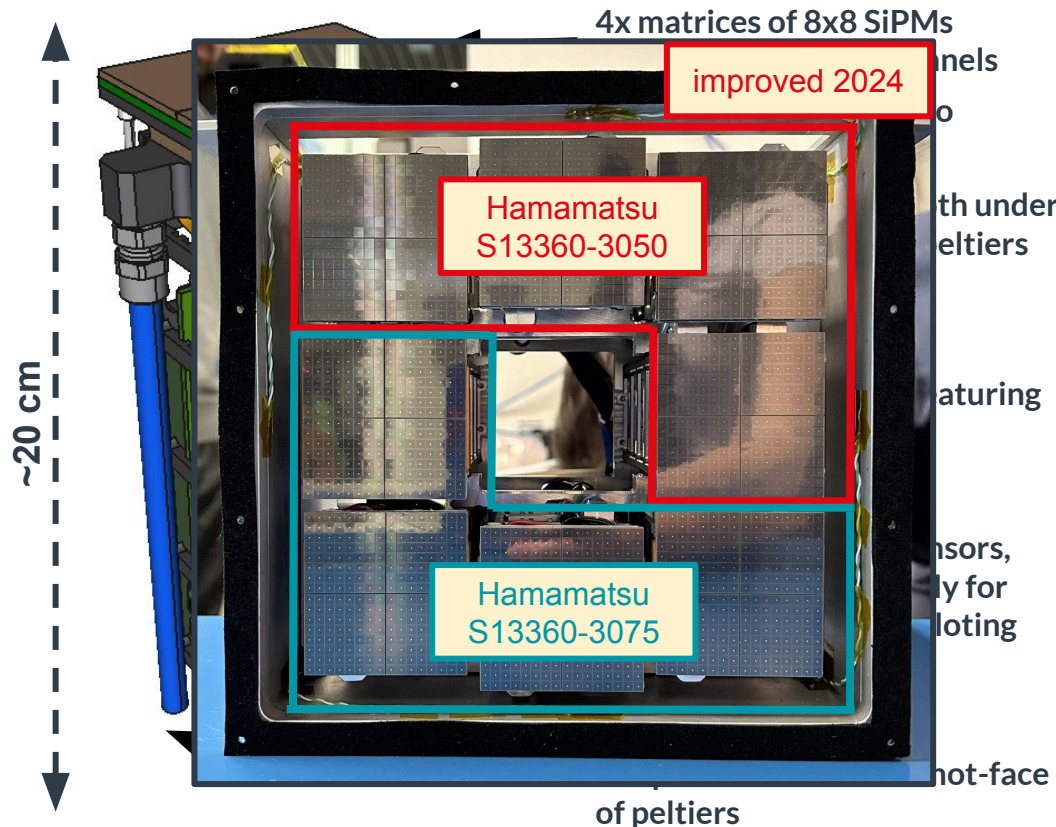


Photo Detection Unit (PDU)

Prototype



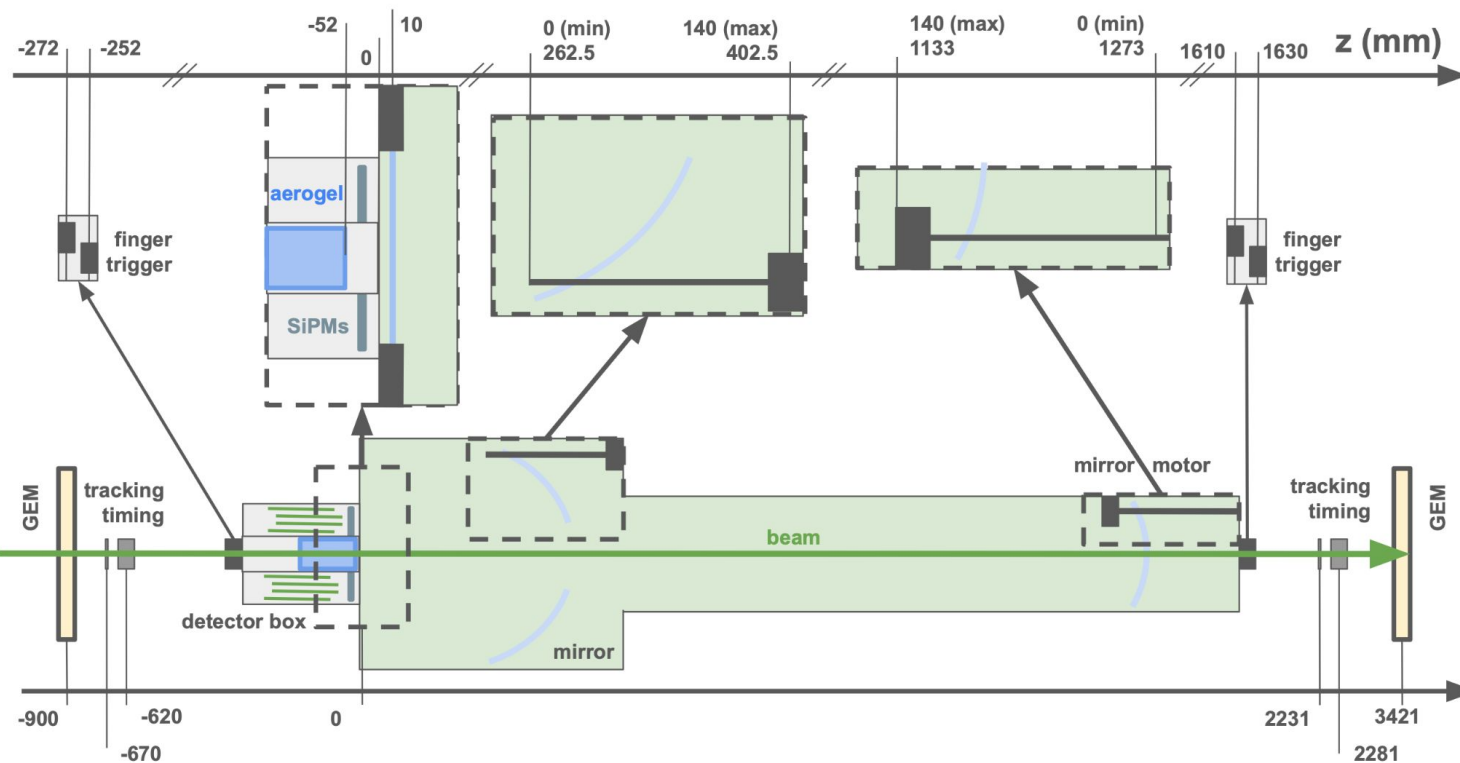
Disclaimer



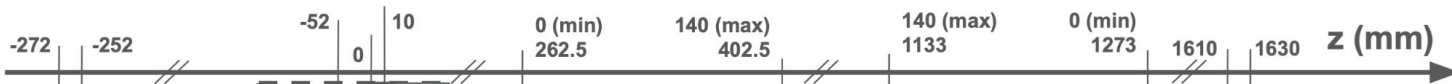
Still preliminary!



Experimental set-up



Experimental set-up

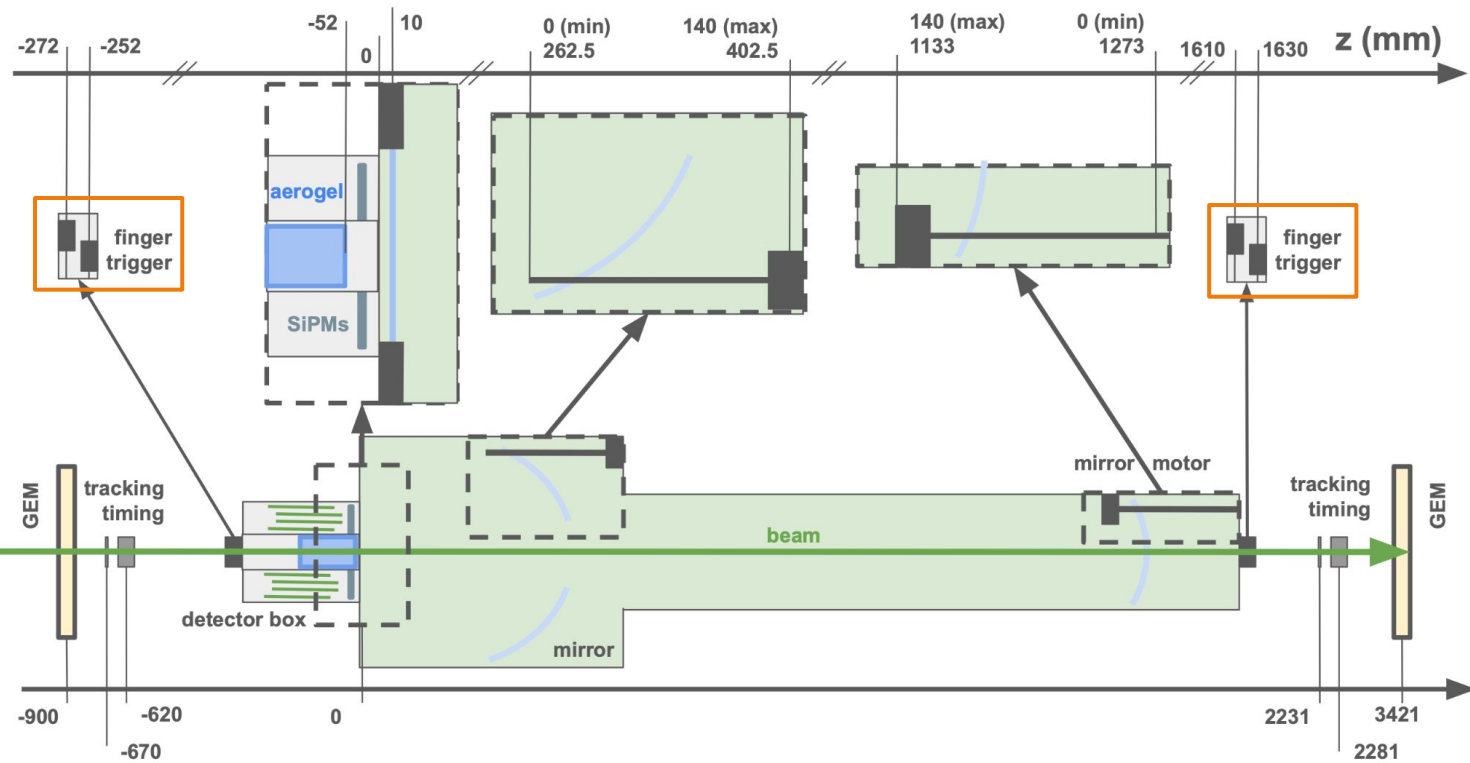


2281

Experimental set-up

SAME

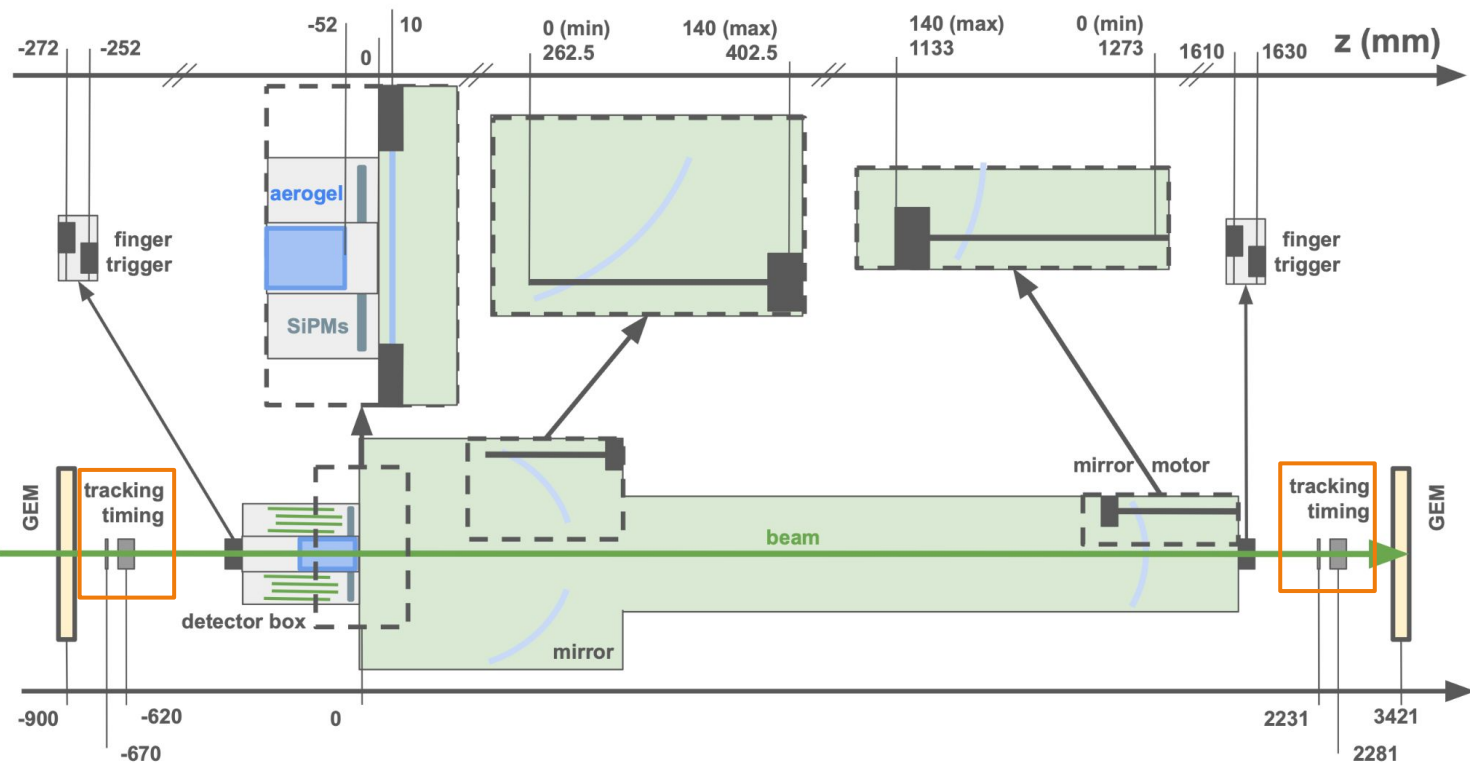
The main trigger was a finger scintillator positioned up- and down-stream



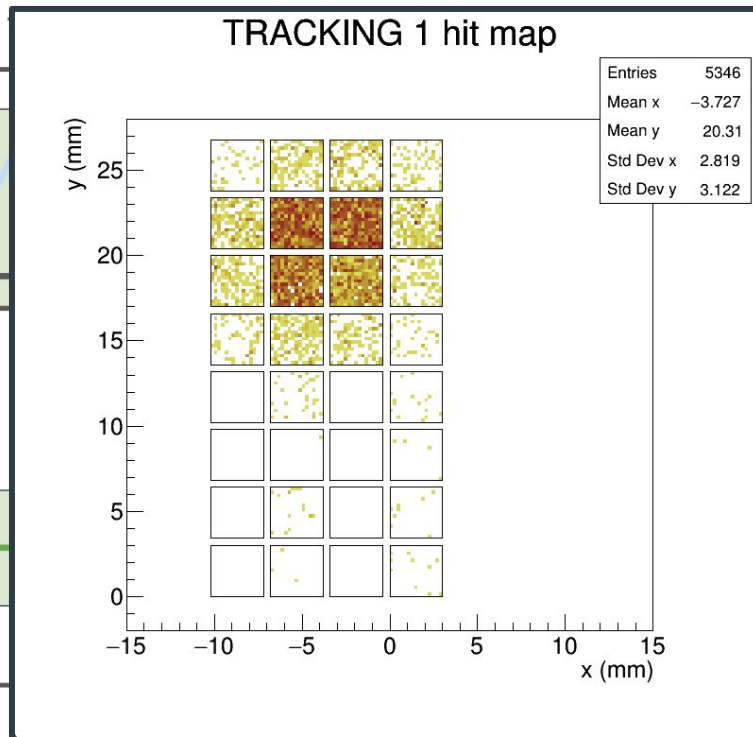
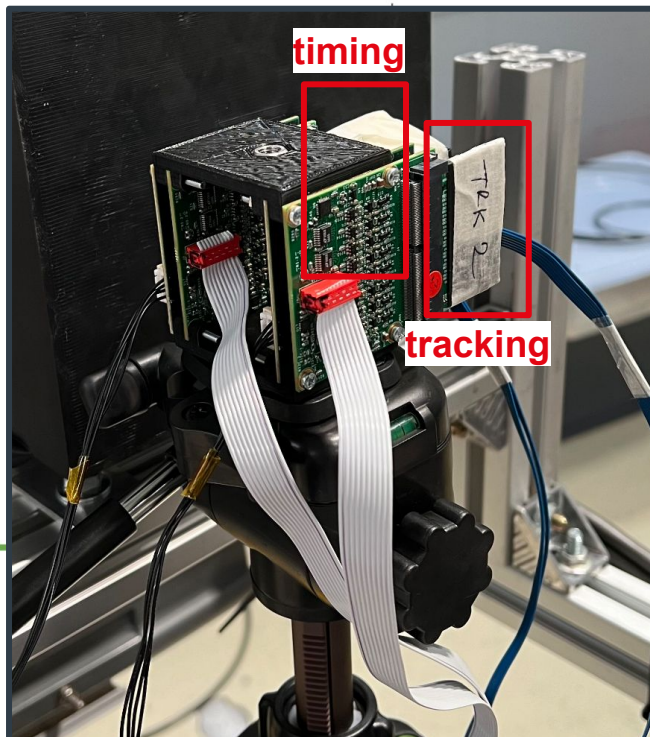
Experimental set-up

NEW

we installed a new timing and tracking system based on SiPM w/ ALCOR readout



Experimental set-up



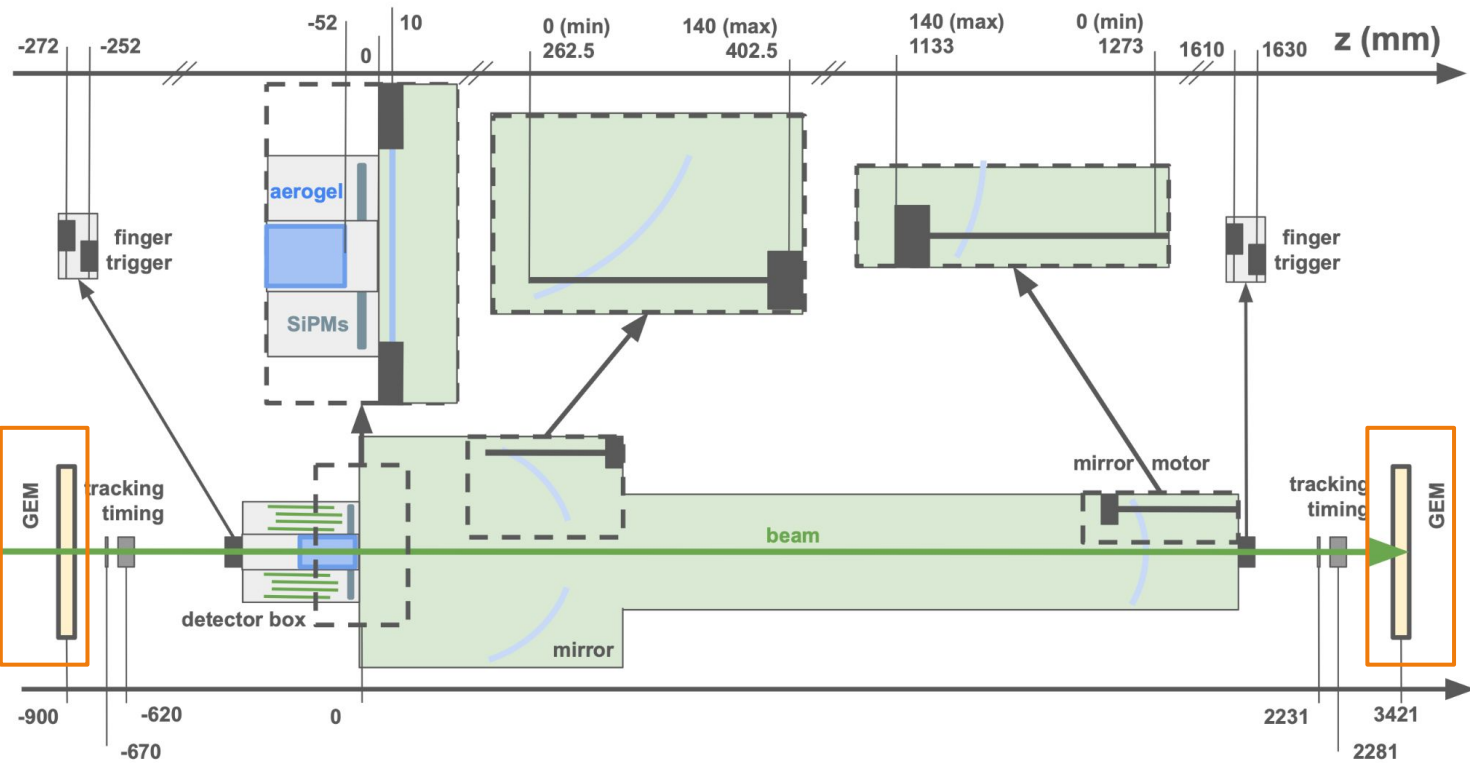
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Experimental set-up

NEW

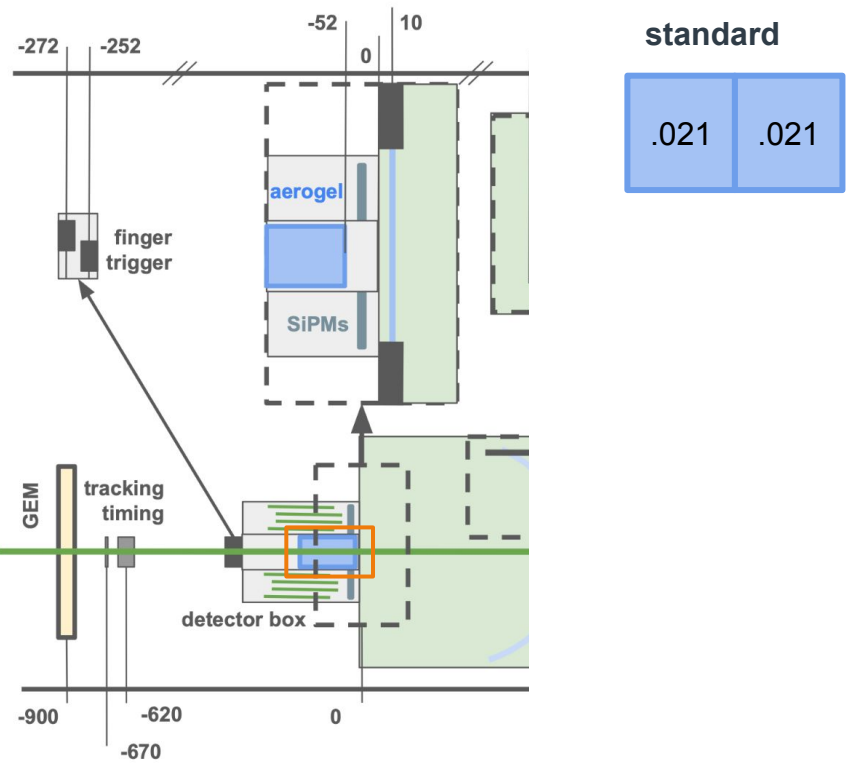
we now have a portion of the runs where the GEM information is available



Experimental set-up: aerogel

NEW

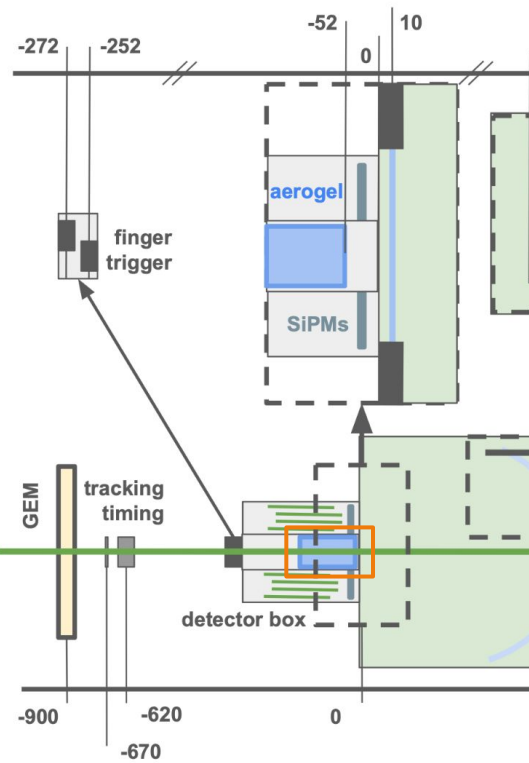
We worked on the aerogel radiator



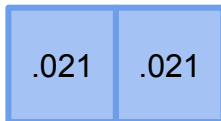
Experimental set-up: aerogel

NEW

We worked on the aerogel radiator:
 - different number of tiles



standard



background

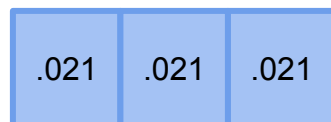


background analysis!

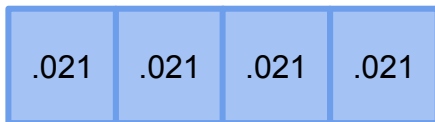
single



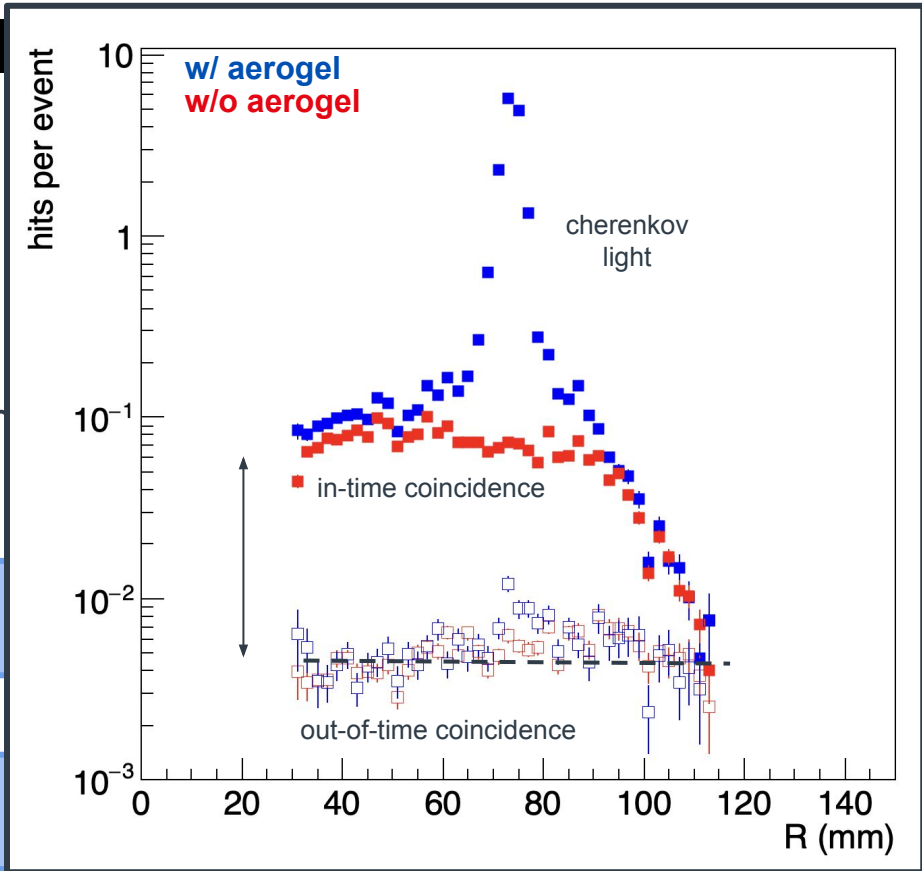
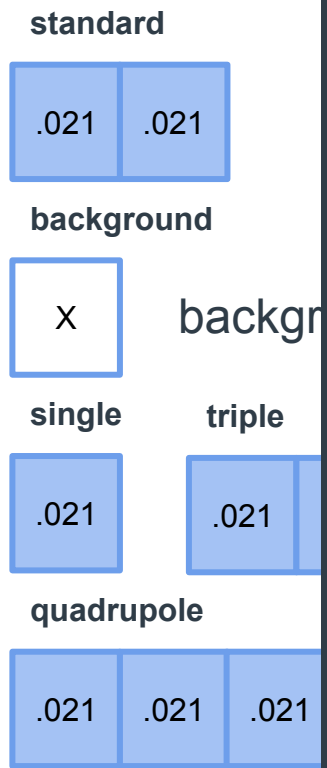
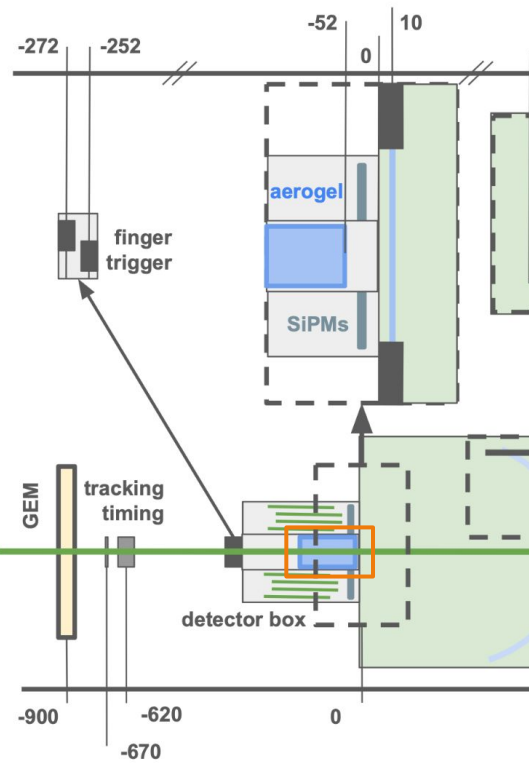
triple



quadrupole



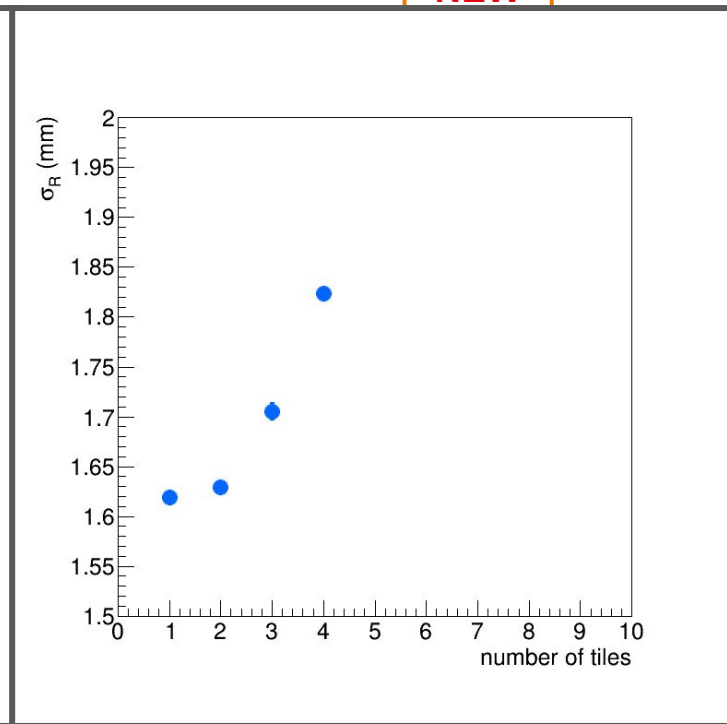
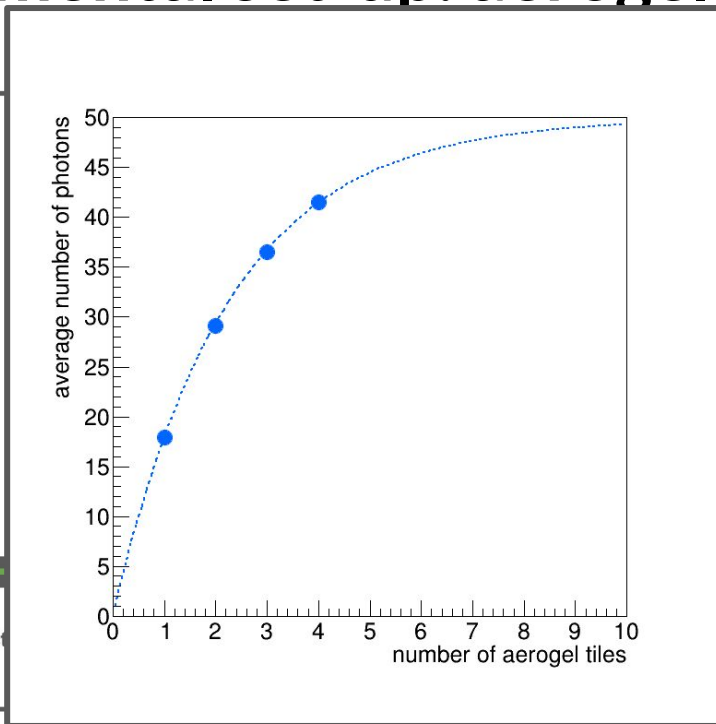
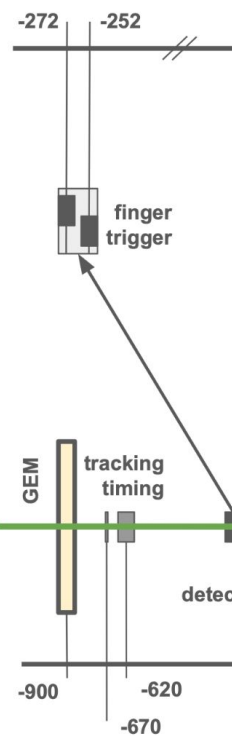
Experimental set-up: aerogel



Experimental set-up: aerogel

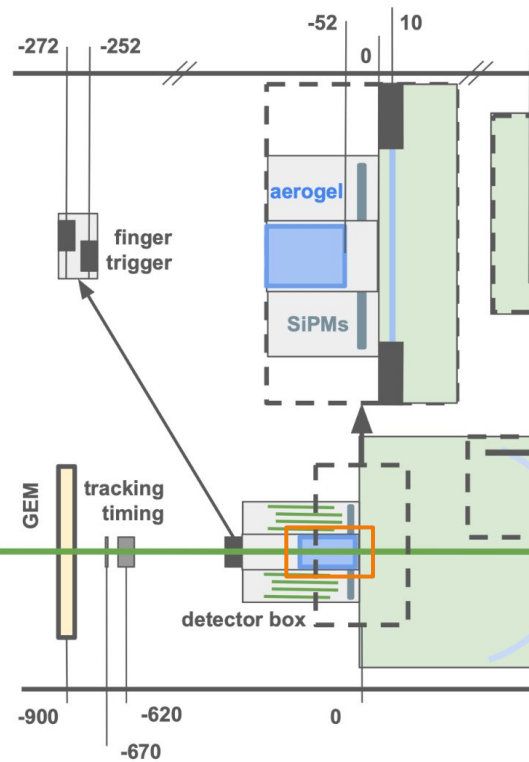
NEW

the
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 umber

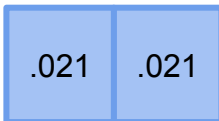


.021 .021 .021 .021

Experimental set-up: aerogel



standard



background

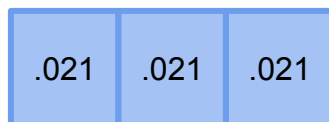


background analysis

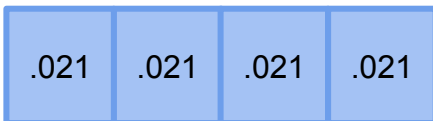
single



triple



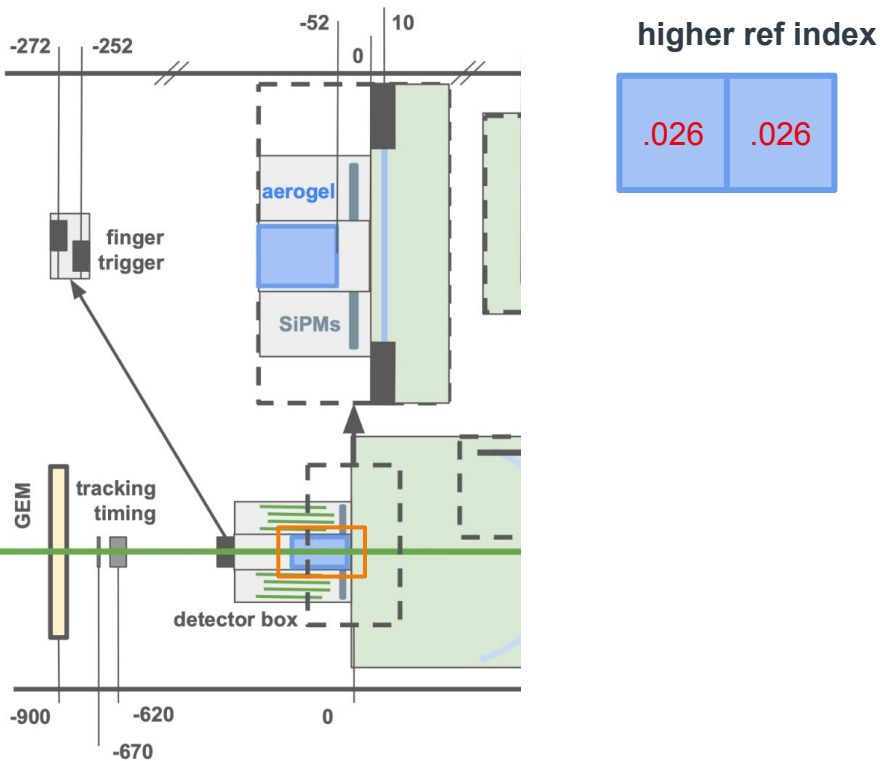
quadrupole



Experimental set-up: aerogel

NEW

- We worked on the aerogel radiator:
- different number of tiles
 - different ref index

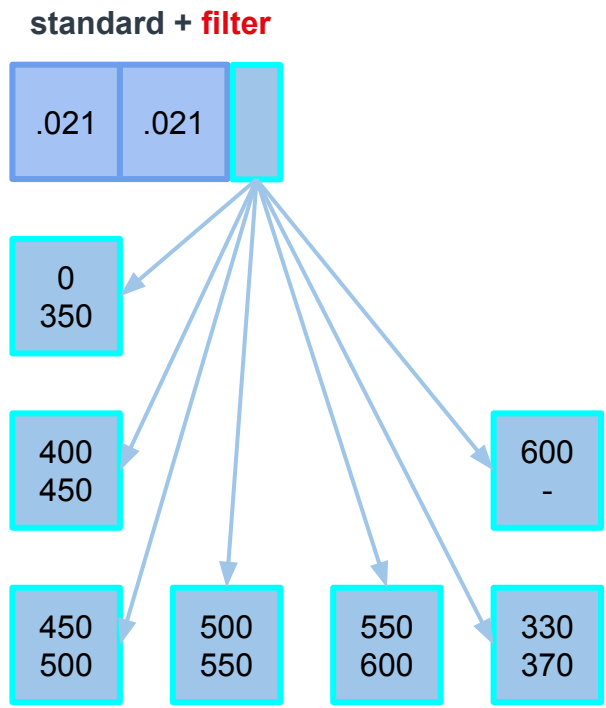
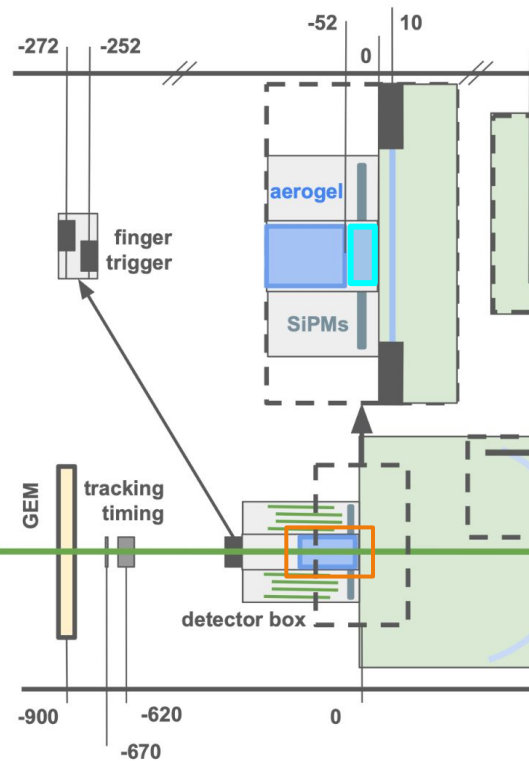


Experimental set-up: aerogel

NEW

We worked on the aerogel radiator:

- different number of tiles
- different ref index
- different filters for wavelength (nm)

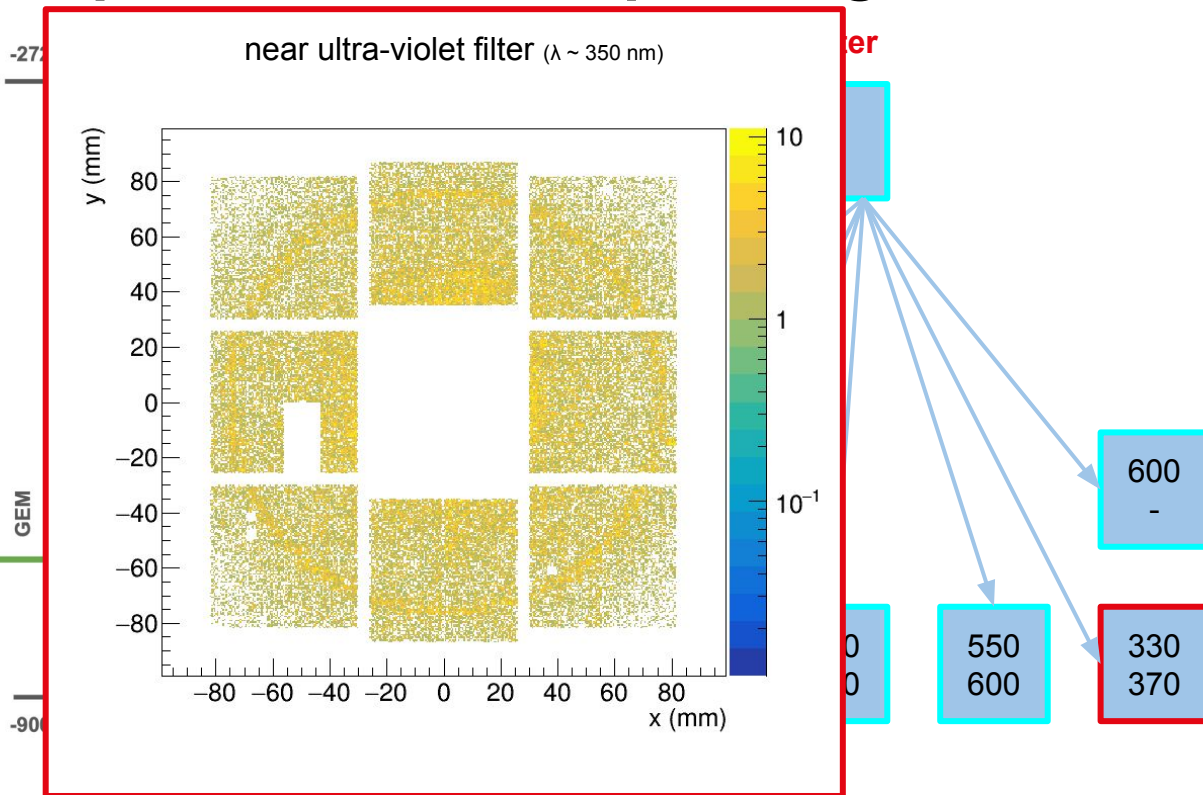


Experimental set-up: aerogel

NEW

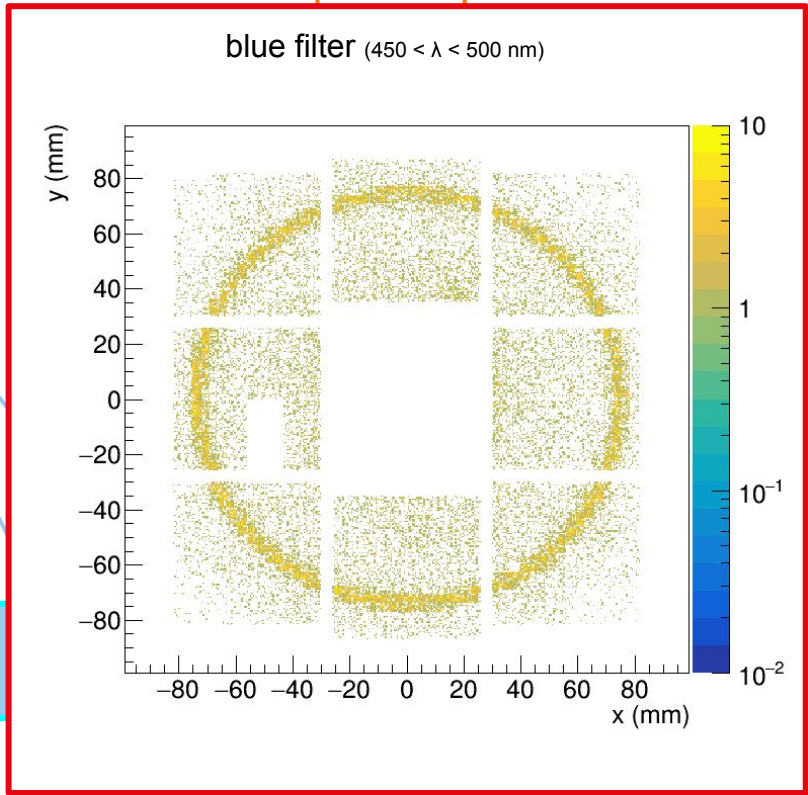
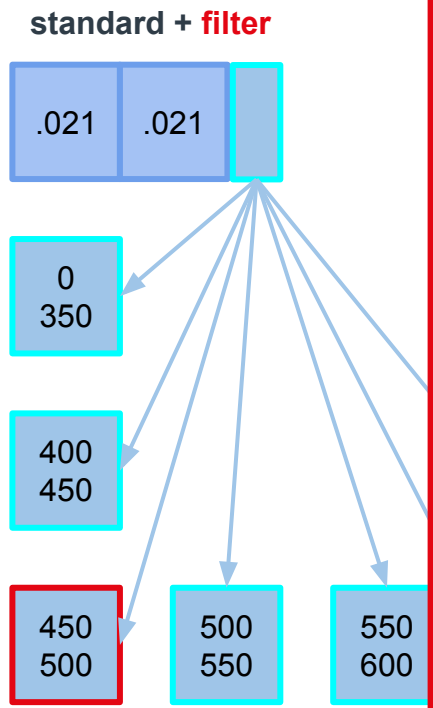
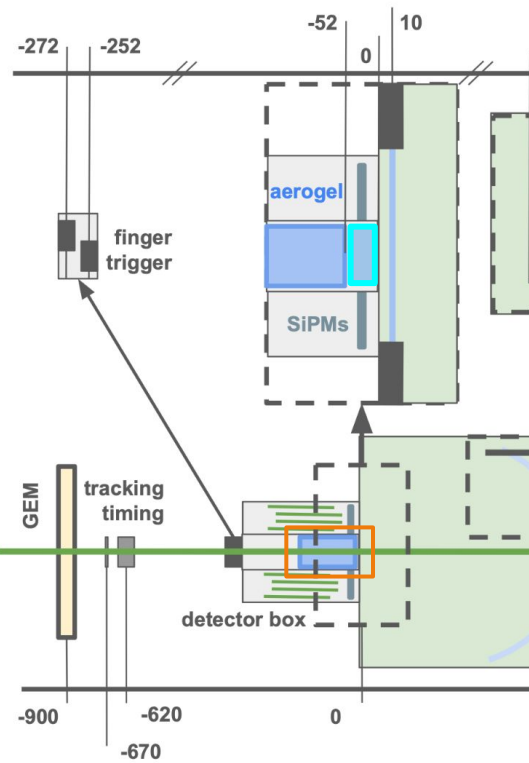
We worked on the aerogel radiator:

- different number of tiles
- different ref index
- different filters for wavelength (nm)

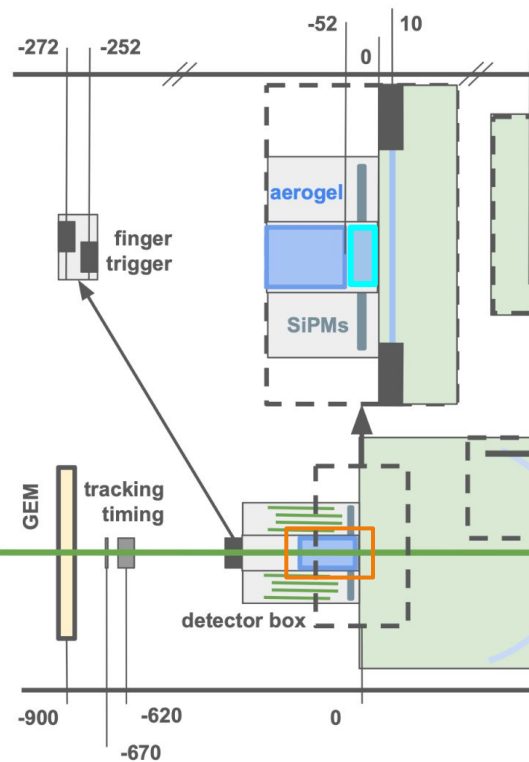


Experimental set-up: aerogel

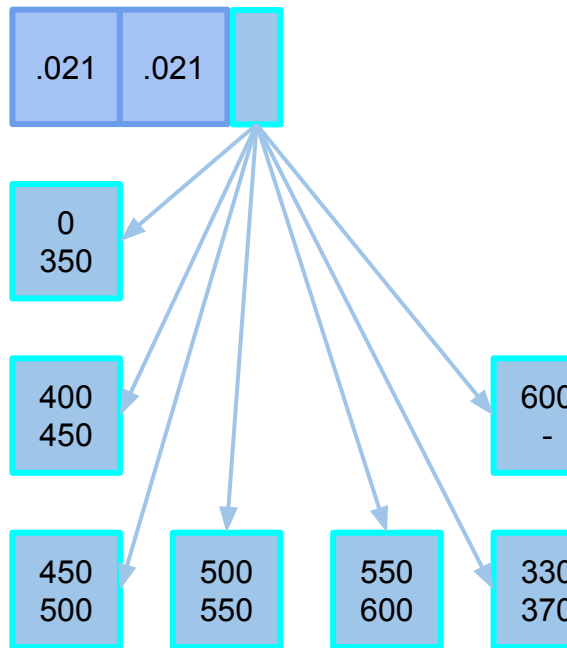
NEW



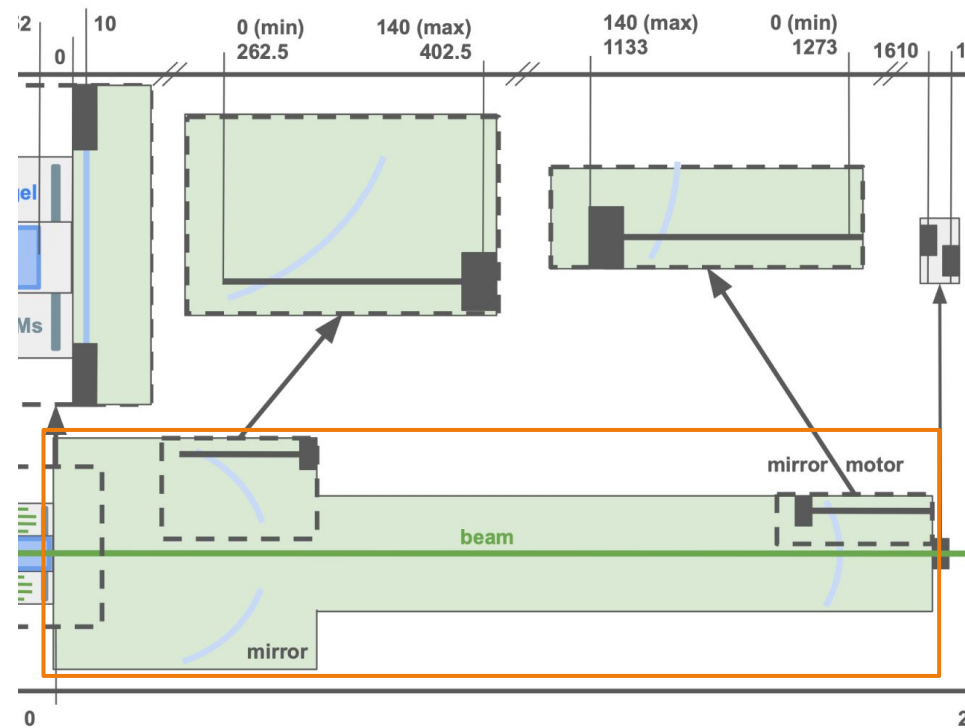
Experimental set-up: aerogel



standard + filter



Experimental set-up



NEW

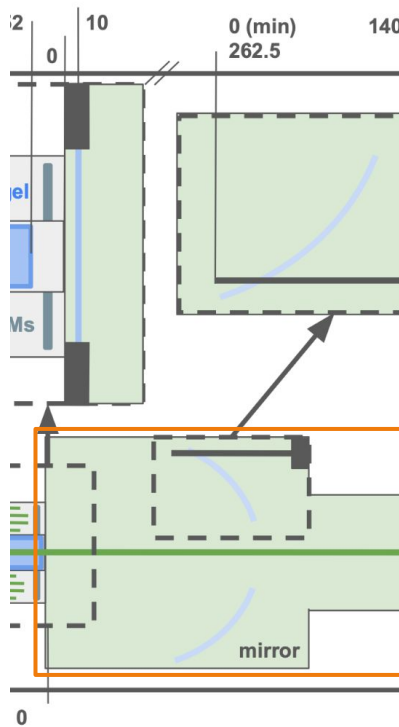
We worked on the gas radiator

standard
 C_2F_6
 1.0008

new gas
 C_4F_{10}
 1.0014

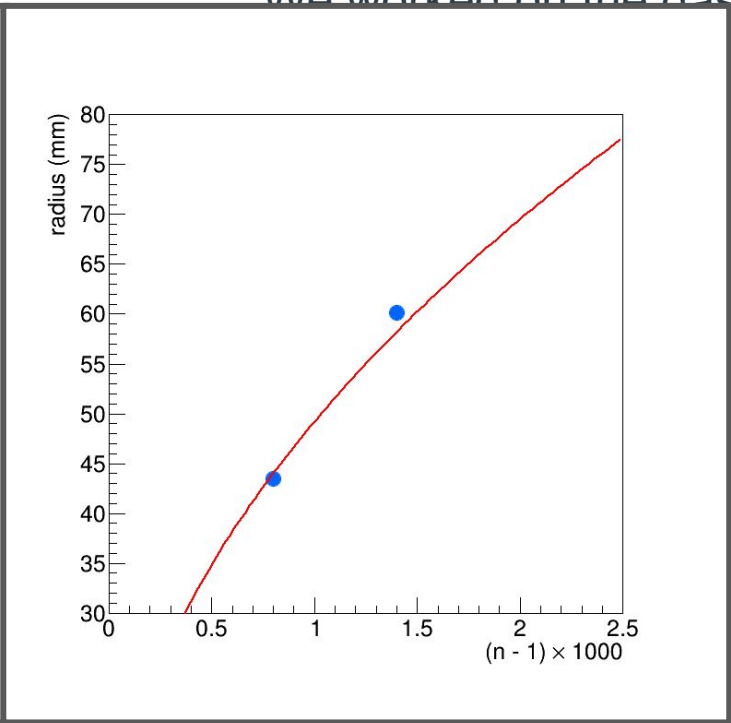
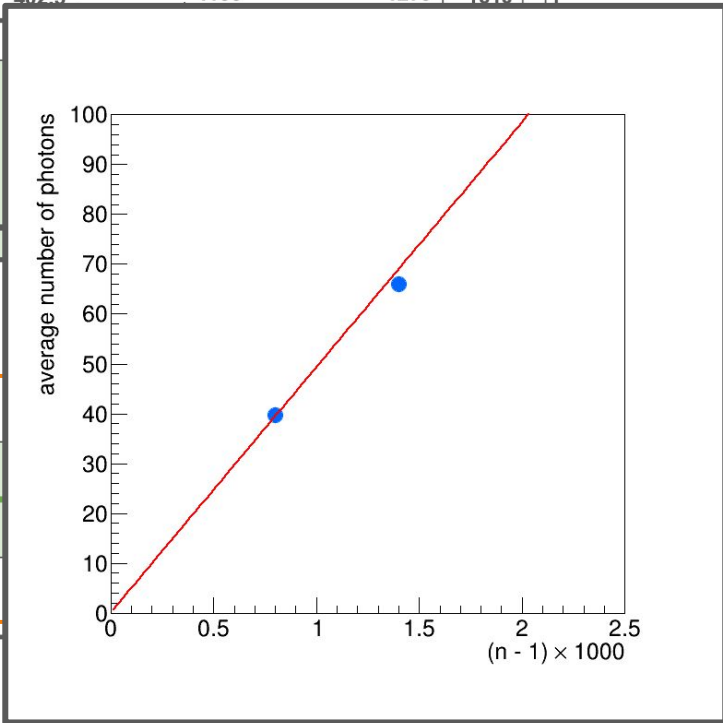
Experimental set-up

NEW



standard

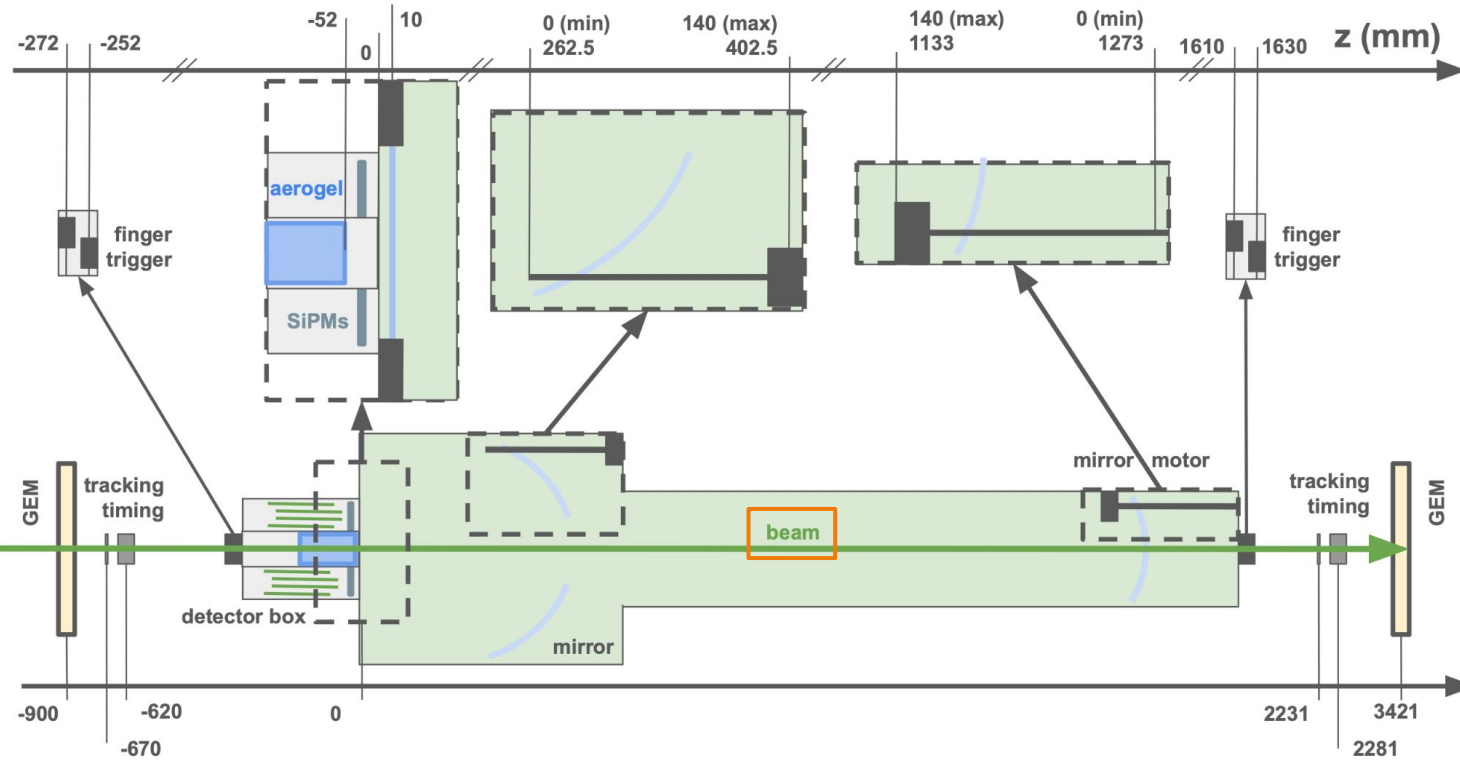
We worked on the gas



Experimental set-up

NEW

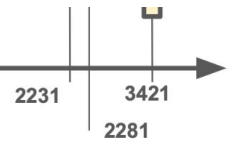
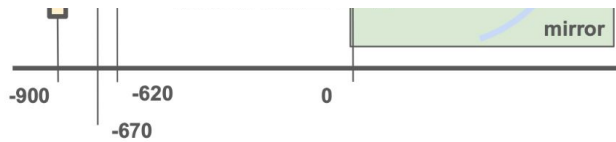
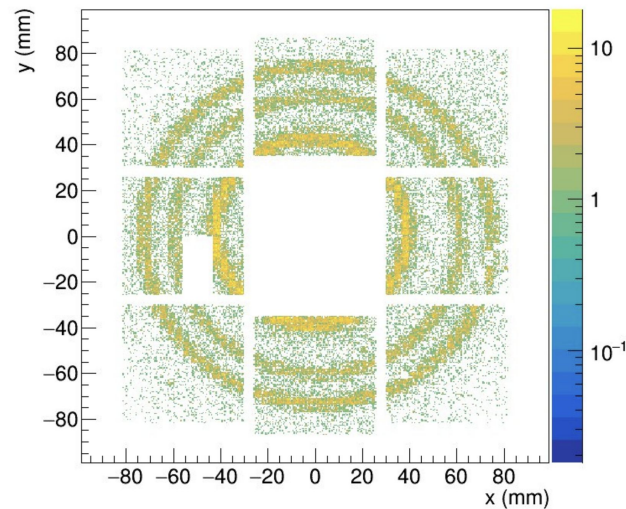
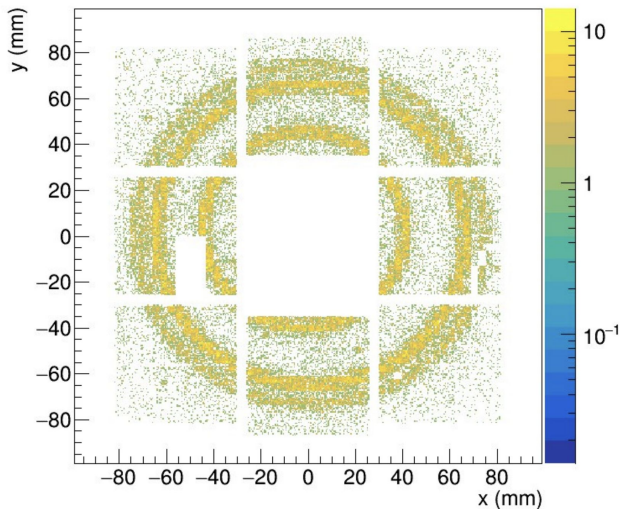
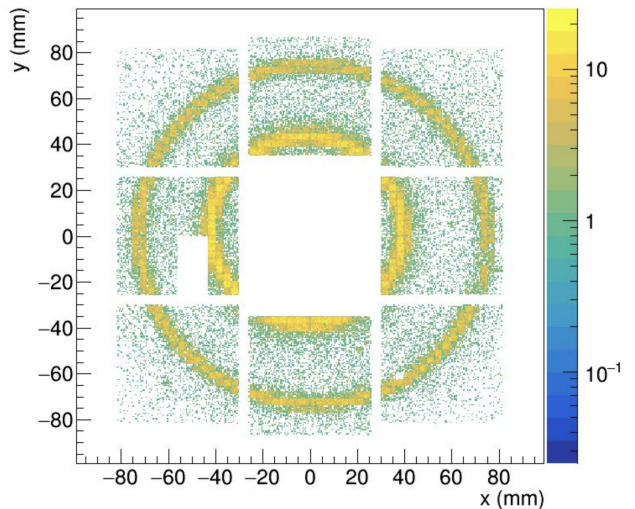
This year we were main users and we could control beam parameters i.e. momenta scans



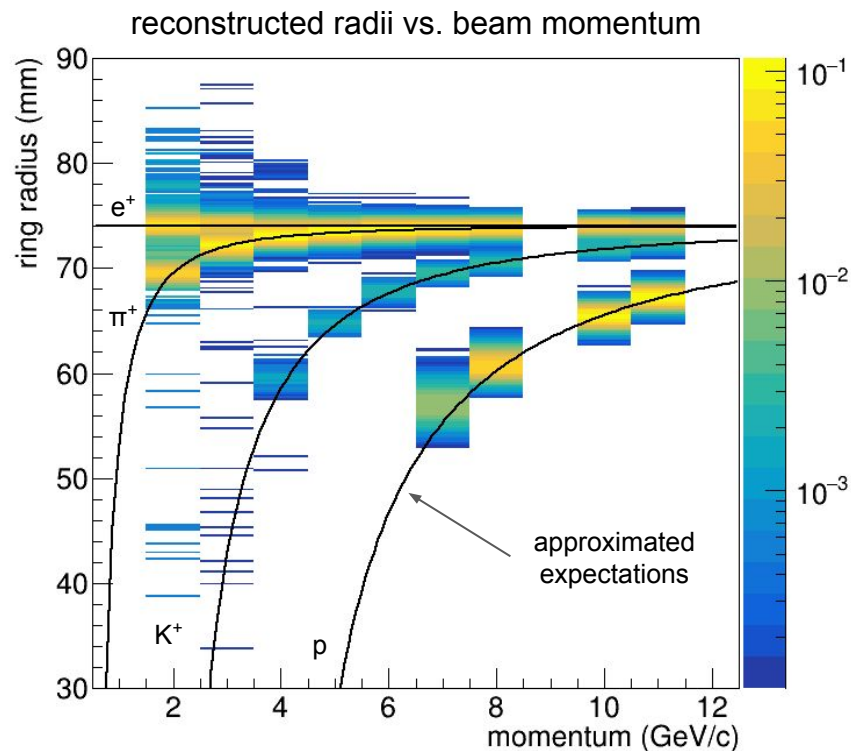
Experimental set-up

NEW

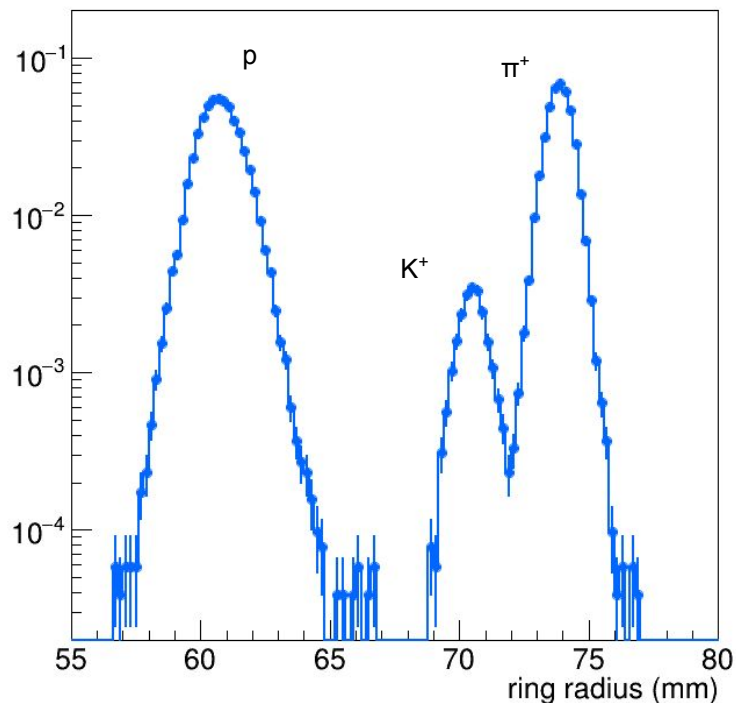
-272 | -252 | -52 | 10 | 0 (min) 262.5 | 140 (max) 402.5 | 140 (max) 1133 | 0 (min) 1273 | 1610 | 1630 z (mm) This year we



Momentum scan

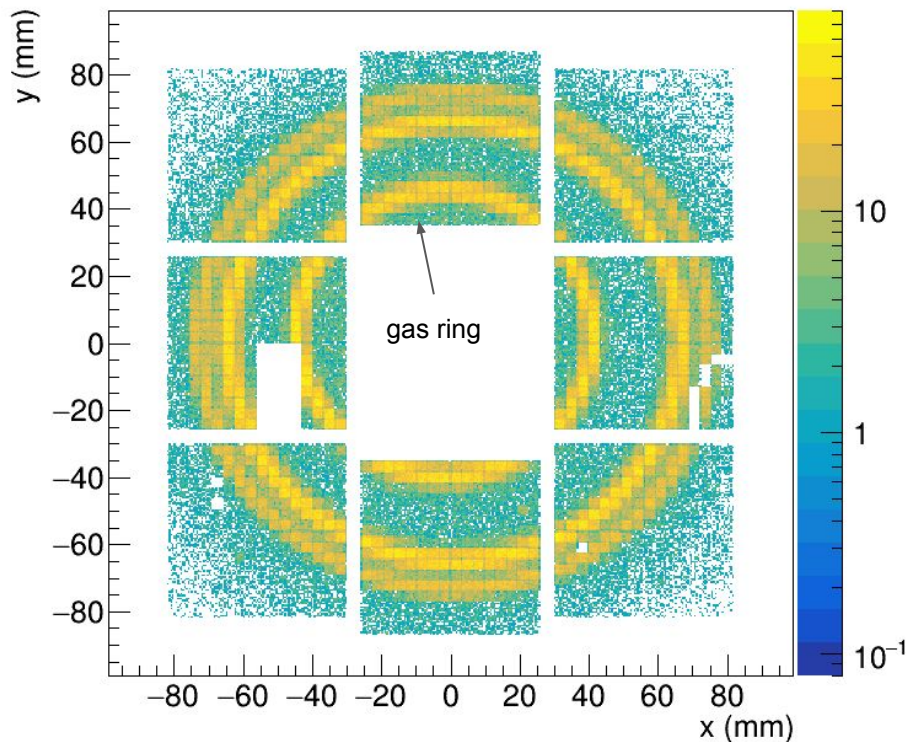


reconstructed radii at 8 GeV/c beam momentum

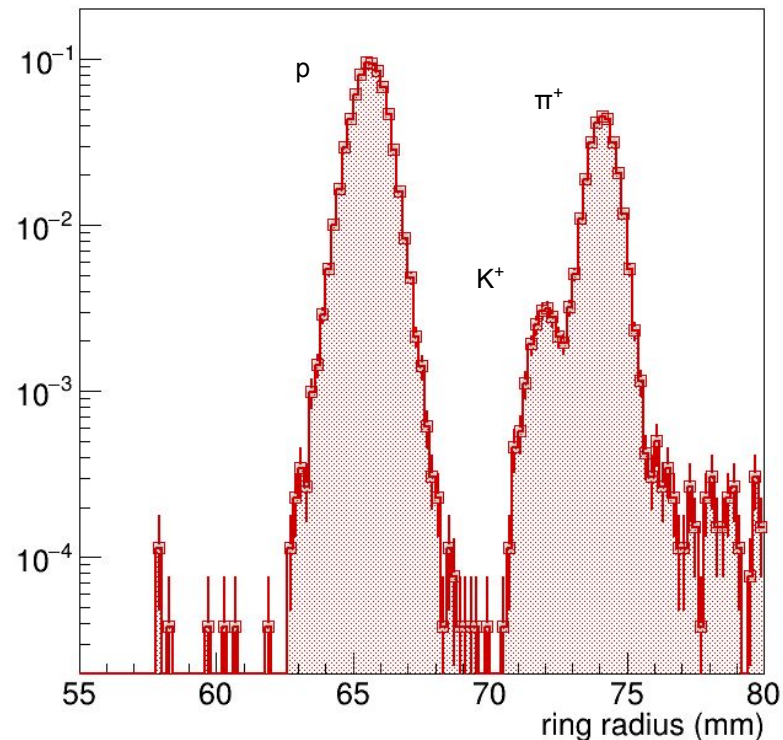


PID w/ Gas & Aerogel

10 GeV/c positive beam with no selection applied

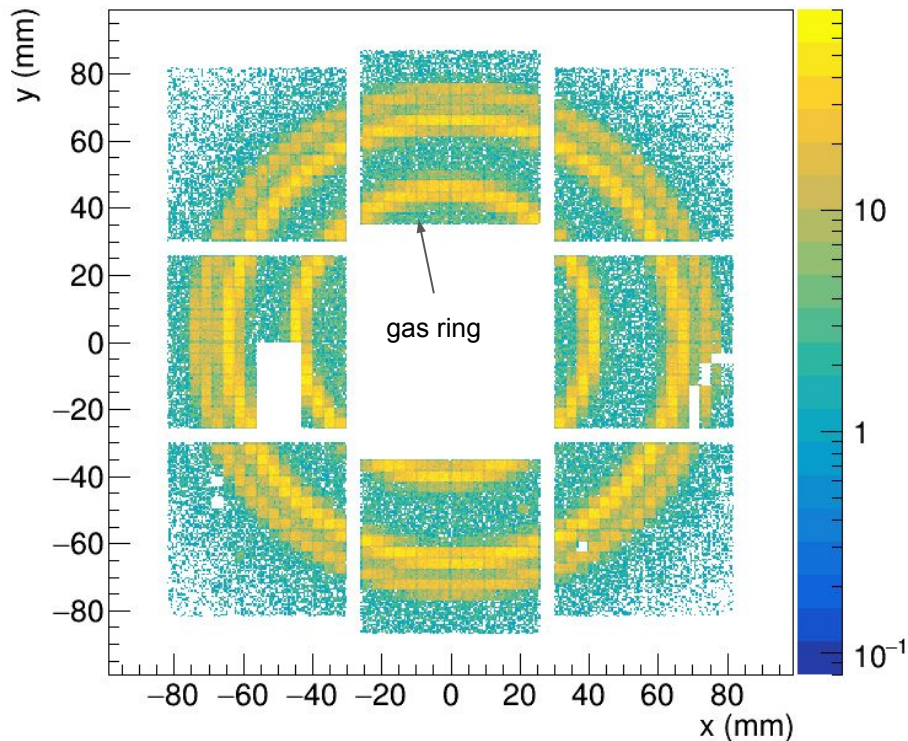


reconstructed radii at 10 GeV/c with no selection applied

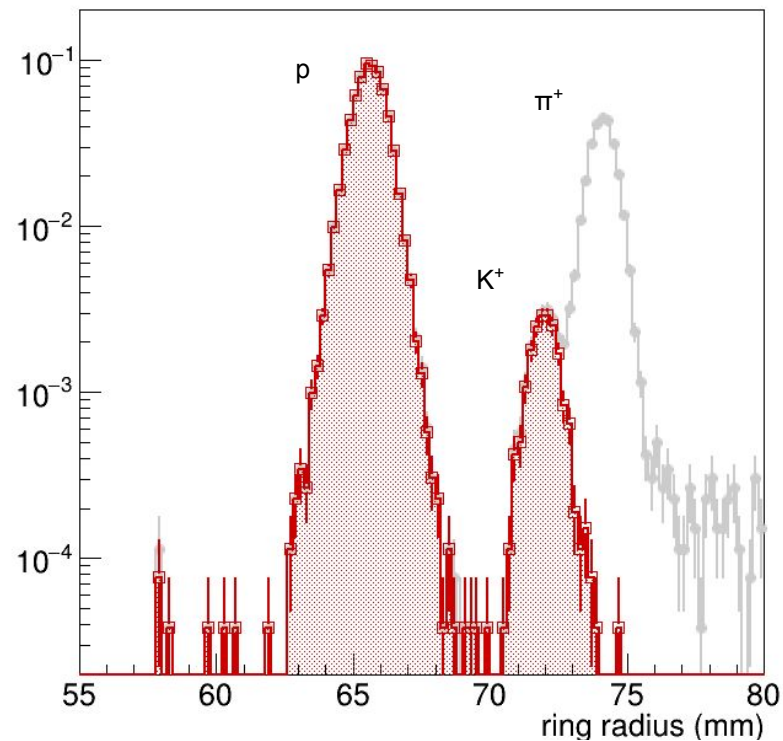


PID w/ Gas & Aerogel

10 GeV/c positive beam with no selection applied

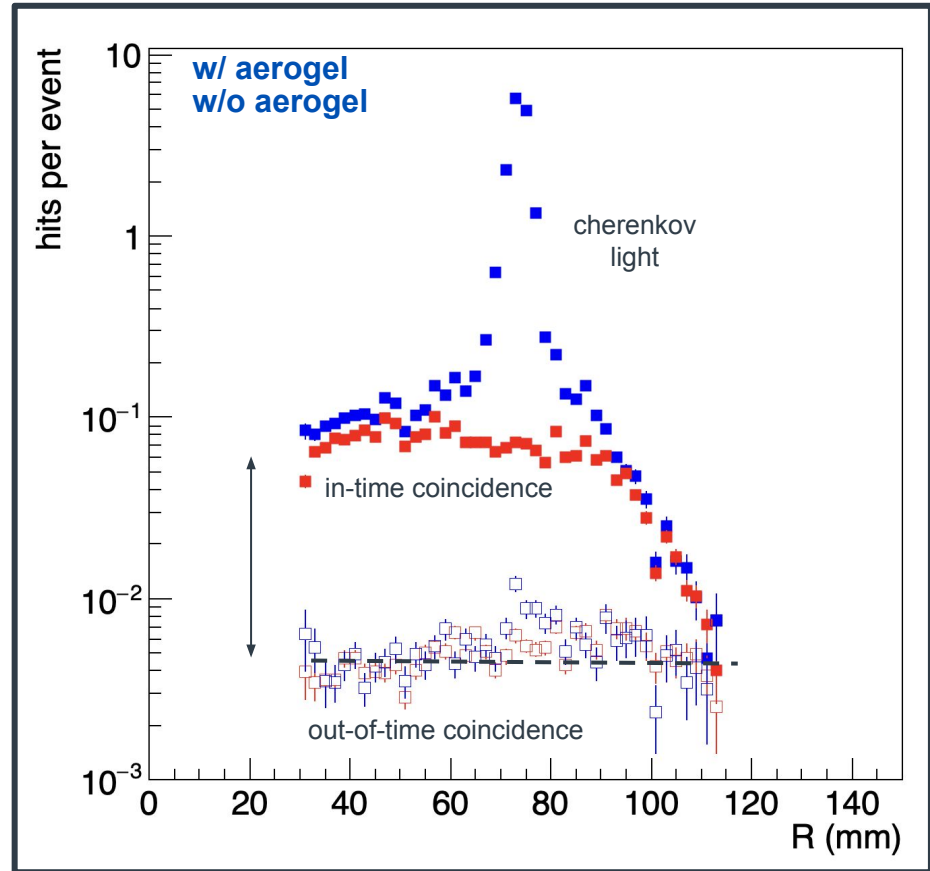


reconstructed radii at 10 GeV/c with no selection applied



A few missing pieces

All the results are preliminary and we still need some time to understand all the kinks we see in the data



Conclusions

The beam tests of October 2023 and May/June 2024 were very successful.

We are moving forward in the detector, sensors and light characterisation for a deeper understanding of the detector prototype.

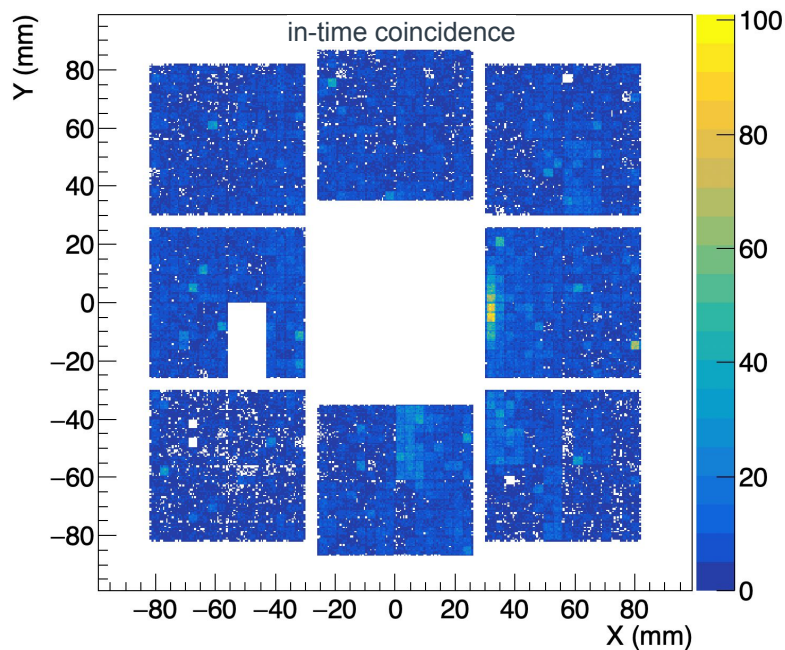
A LOT of data has been taken, if you wish to help there is plenty of room to join the data analysis task force

Thank you!
Any questions?

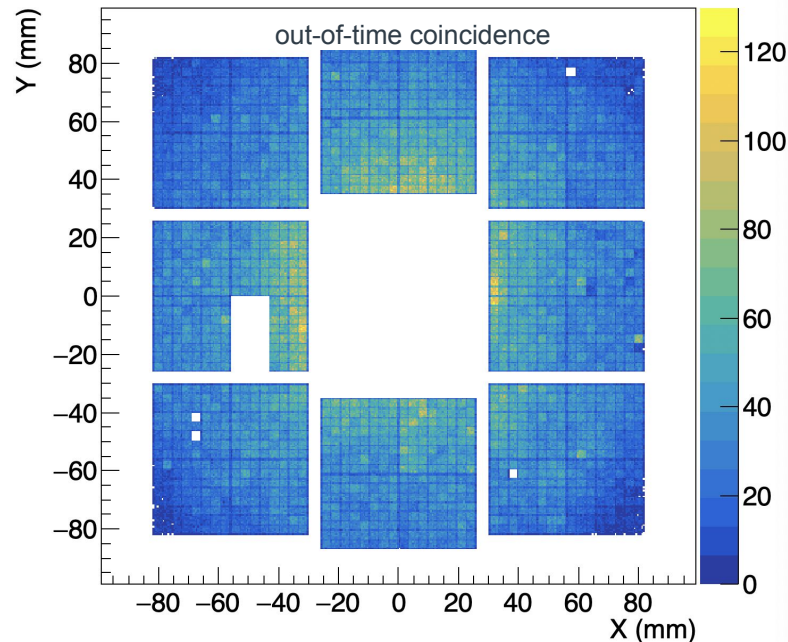
Back-up

Background investigation

First contribution: DCR (No aerogel)

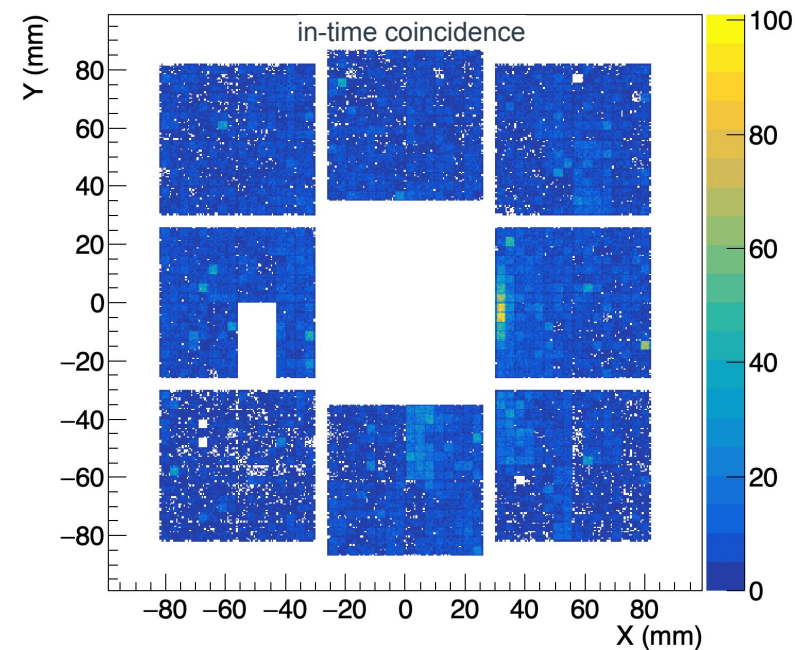


subtracted to

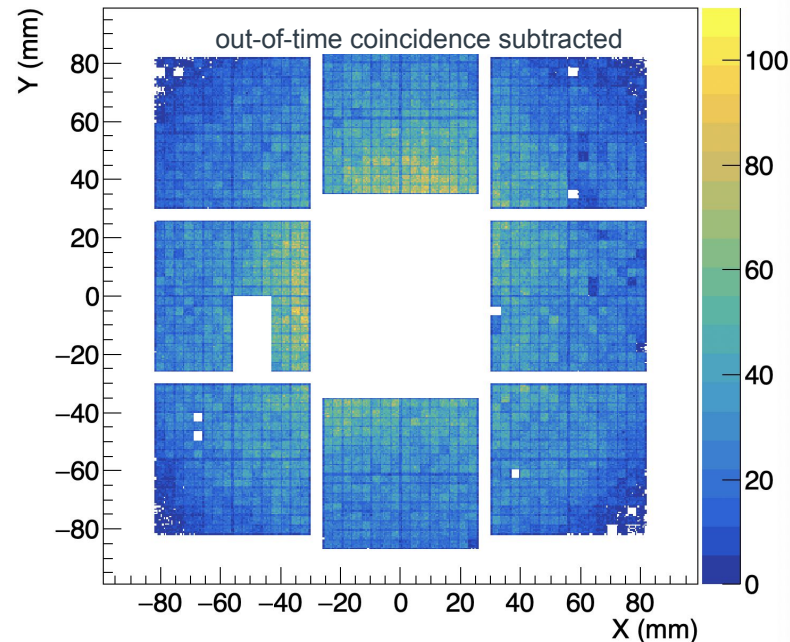


Background investigation

First contribution: DCR (No aerogel)



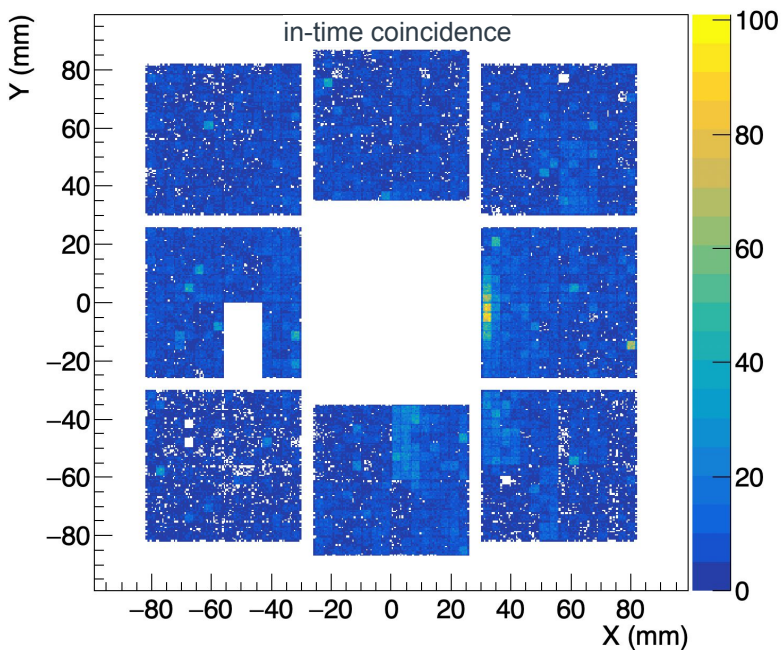
comes out as



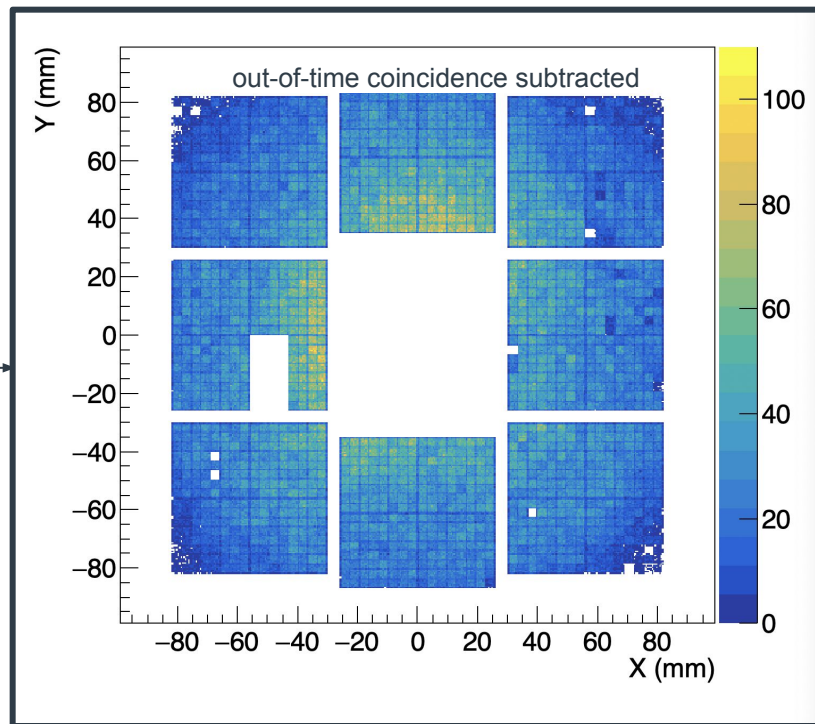
Background investigation

Second contribution: halo (unknown origin)

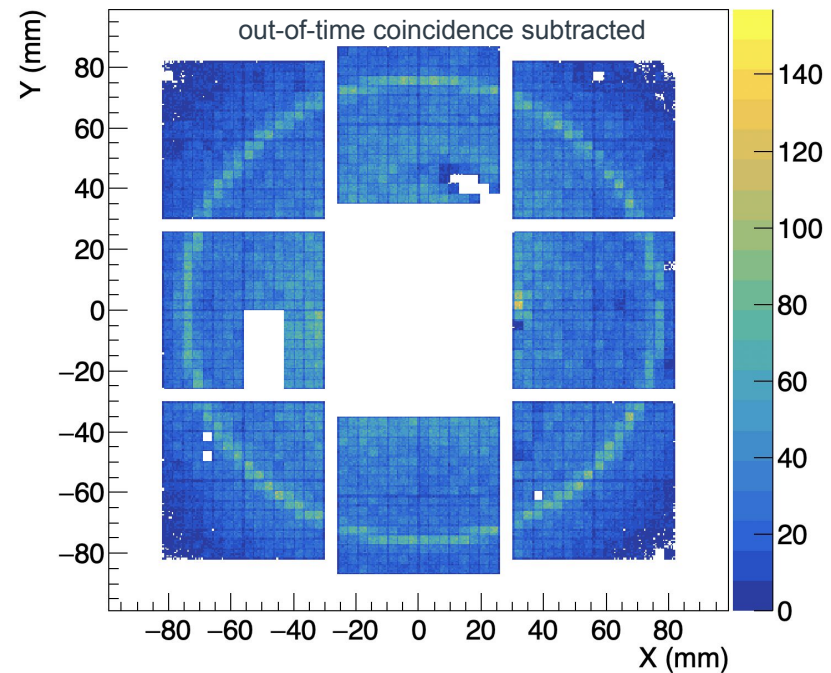
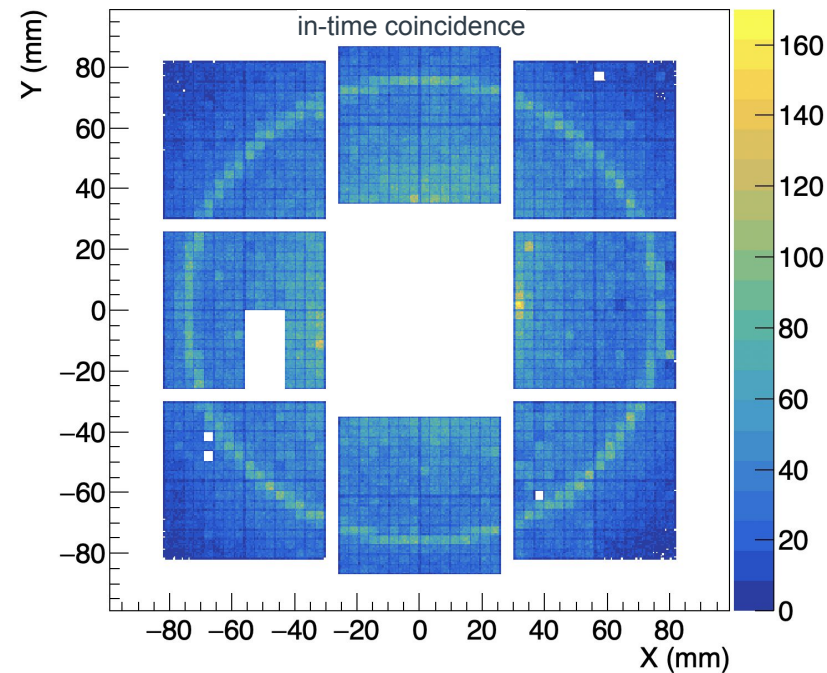
This can be used as a template to subtract in aerogel runs



comes out as



Background investigation



Background investigation

