Tests in ARTIC

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DUNE CSN1 Review
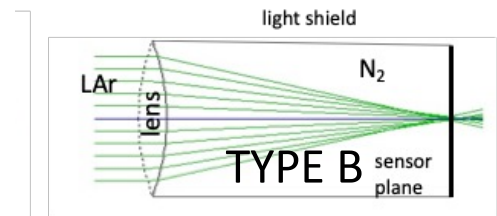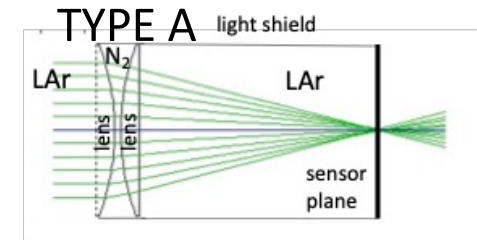
July, 11th 2024

The lens prototypes

– 2 types of **optical system:**

- Type A: Two plane-convex lenses → gas between the two lenses

- Type B: Single bi-convex lens → gas between the lens and the sensor

– 2 **different materials:**

- SILO Corning® HPFS 8655 glass → needs Xenon doping

- MgF_2 → does not need Xenon doping

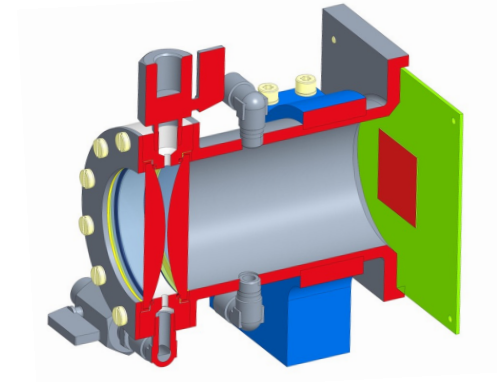*Both material samples succesfully tested in LN_2*

The lens prototypes
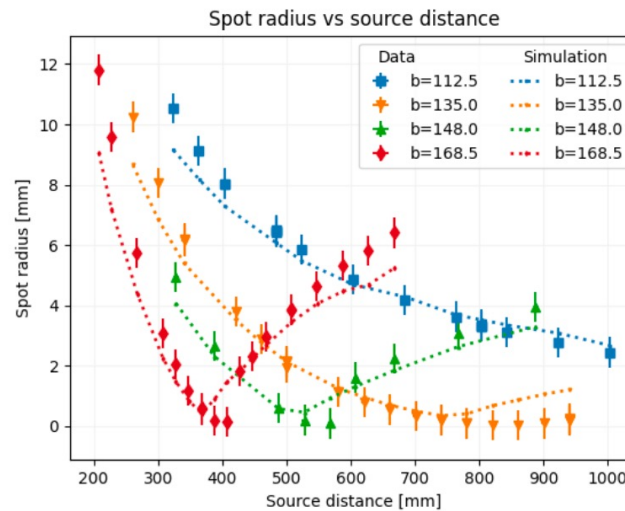
Material: Corning® HPFS 8655 glass

Focal lenght: 89 mm
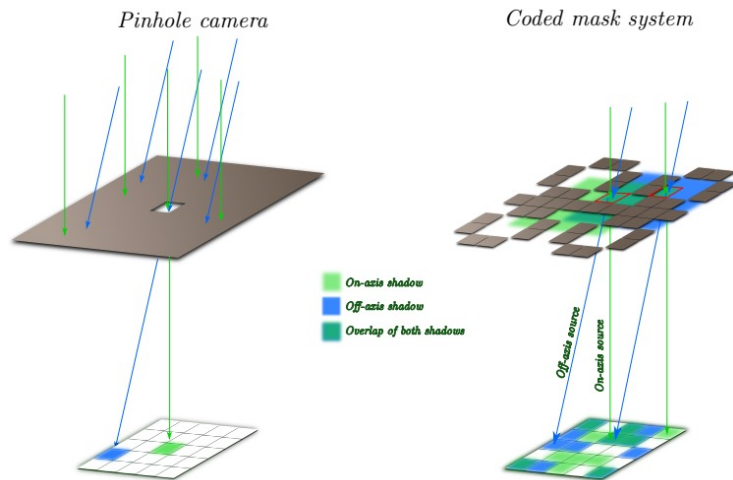
- 2 built prototypes:

- **smaller diameter 50 mm** with optimized curvature
    thickness: 12 mm

- **bigger diameter 60 mm** optimized for higher distance
        (up to 1.2 m)
   thickness: 20 mm

Tests in water in 2022-23

Spot radius vs source distance

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The coded mask prototype

Pinhole camera   Coded mask system

On-axis shadow
Off-axis shadow
Overlap of both shadows

Off-axis source
On-axis source

Coded aperture mask techniques were developed as the evolution of a single pinhole camera

- matrix of multiple pinholes to improve light collection and reduce exposure time

Image formed on sensor is the superimposition of multiple pinhole images ....
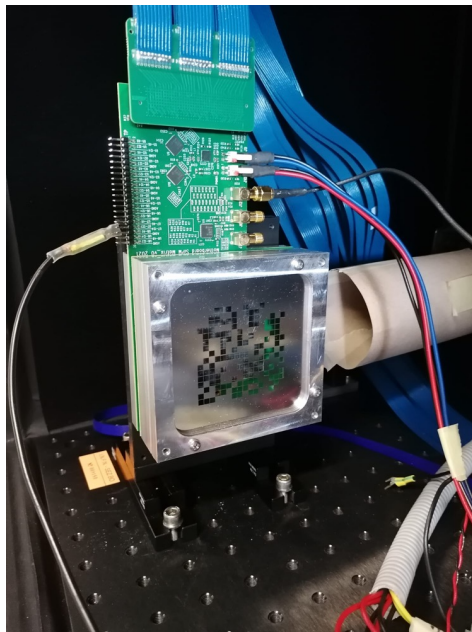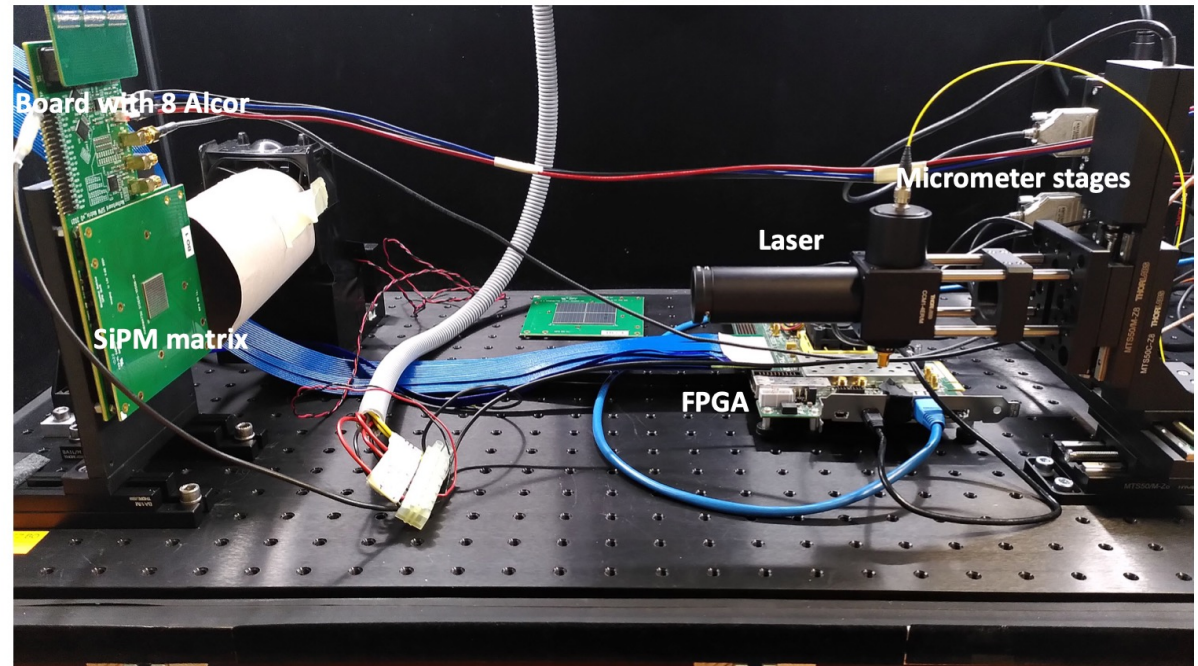
Advantages:

- Good light transmission (50%)
- Good depth of field
- Small required volume

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First readout

Sensors:

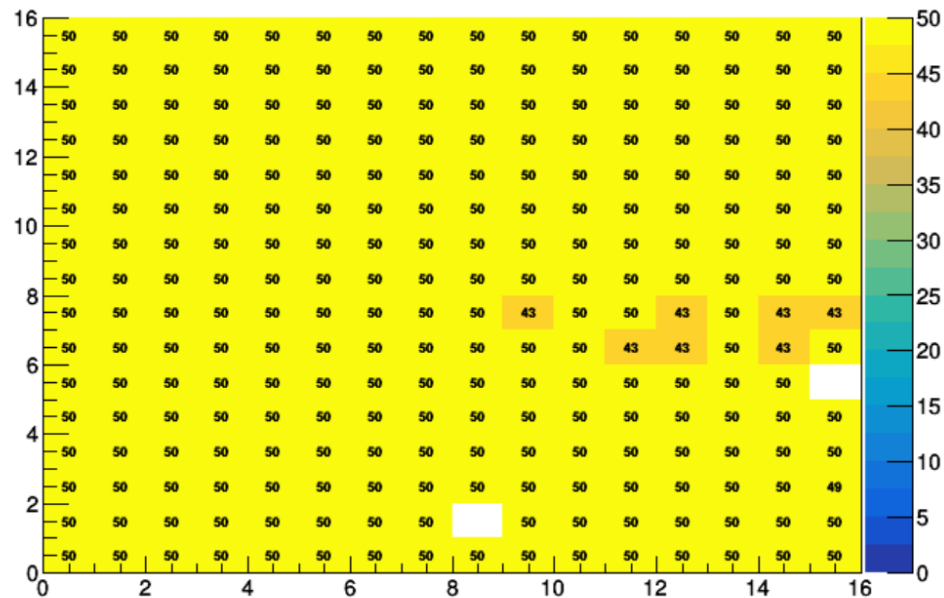Matrix with 16x16 SiPM with different sizes:
- 1 mm   available
- 3 mm   available
- 2 mm   in progress→ the baseline for lens

- The SiPM matrix is acquired by 8 Alcor chips:

    – For each channel, we can record:
    - Time of the over-threshold (TDC time)
    - TOT (Time over threshold)

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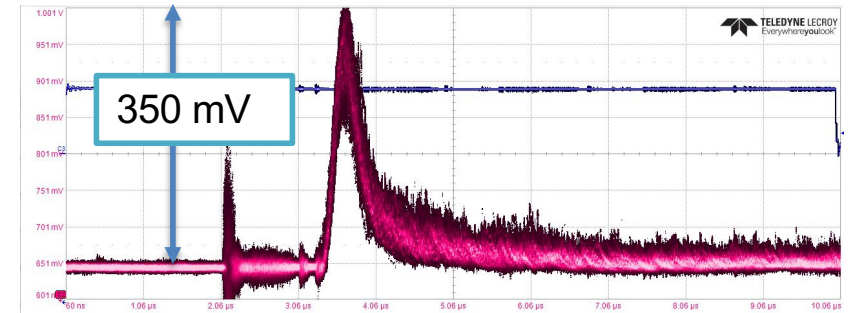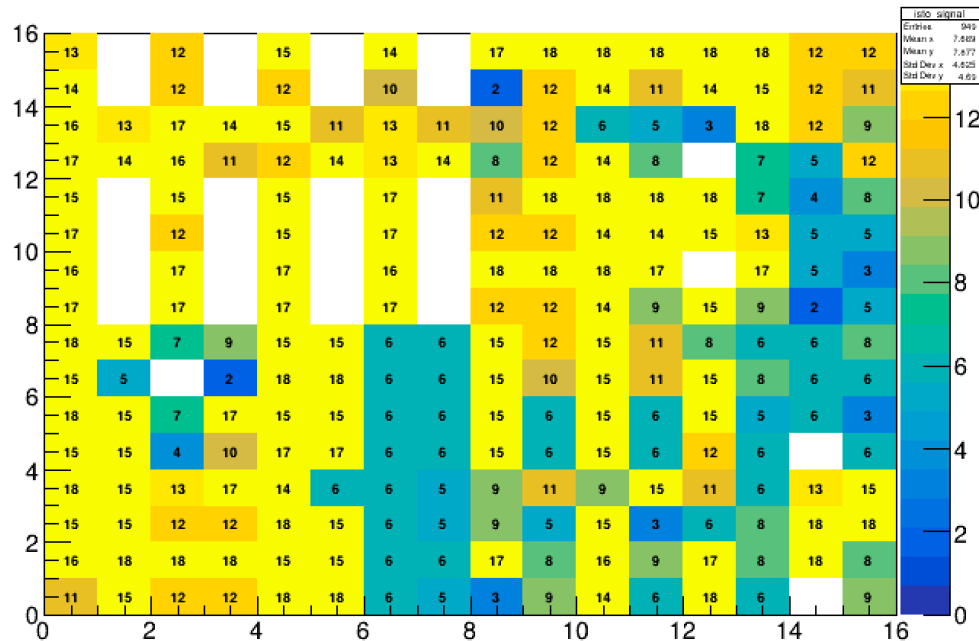# First tests with ALCOR

- **TDC ALCOR calibration signal**

For each channel the number of signal with ToT > 20 ns is counted,

50 counts were expected in each channel

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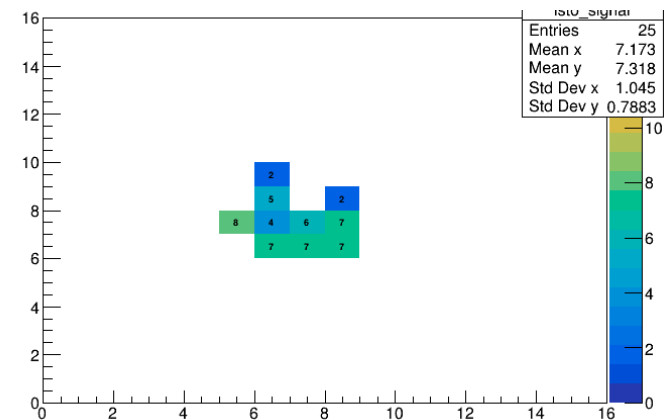
First tests with SiPM matrix

Pulsed light signal on all channels

18 counts are expected for each channels

350 mV

For each channel the number of signals with ToT > 200 ns and with the same period of the pulsed light is counted
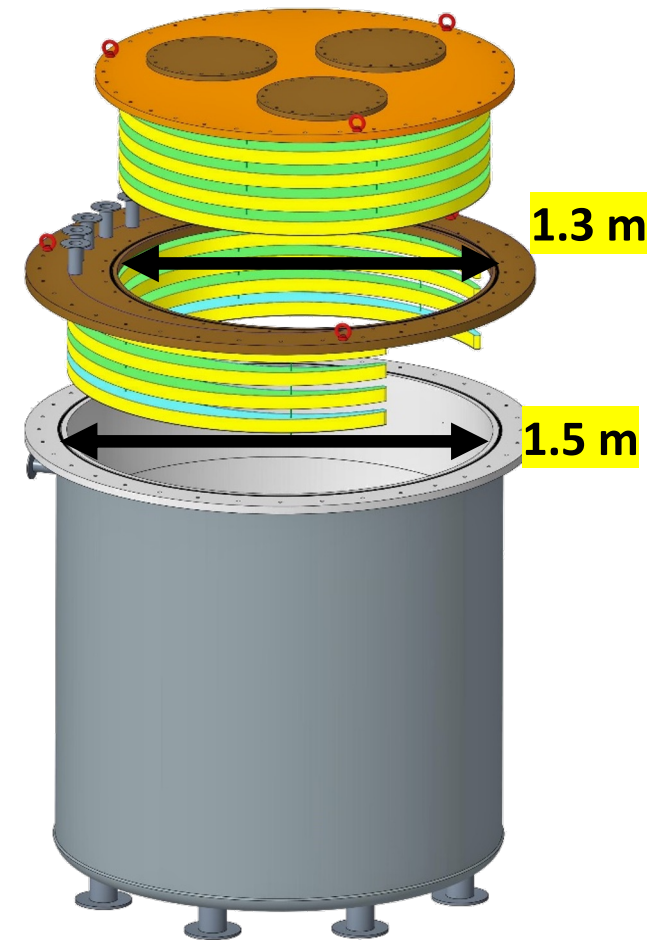
Pulsed light signal on few channels

– Few channels are broken (due to an ALCOR chip)

– Not same efficiency (the threshold have to be optimized

– Not good reproducibility (to be improved)

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ARTIC - Argon Test InfrastruCture

Thermal shields are hanging by the external top flanges

1.3 m

1.5 m

Installed since 2020

Evaporation rate

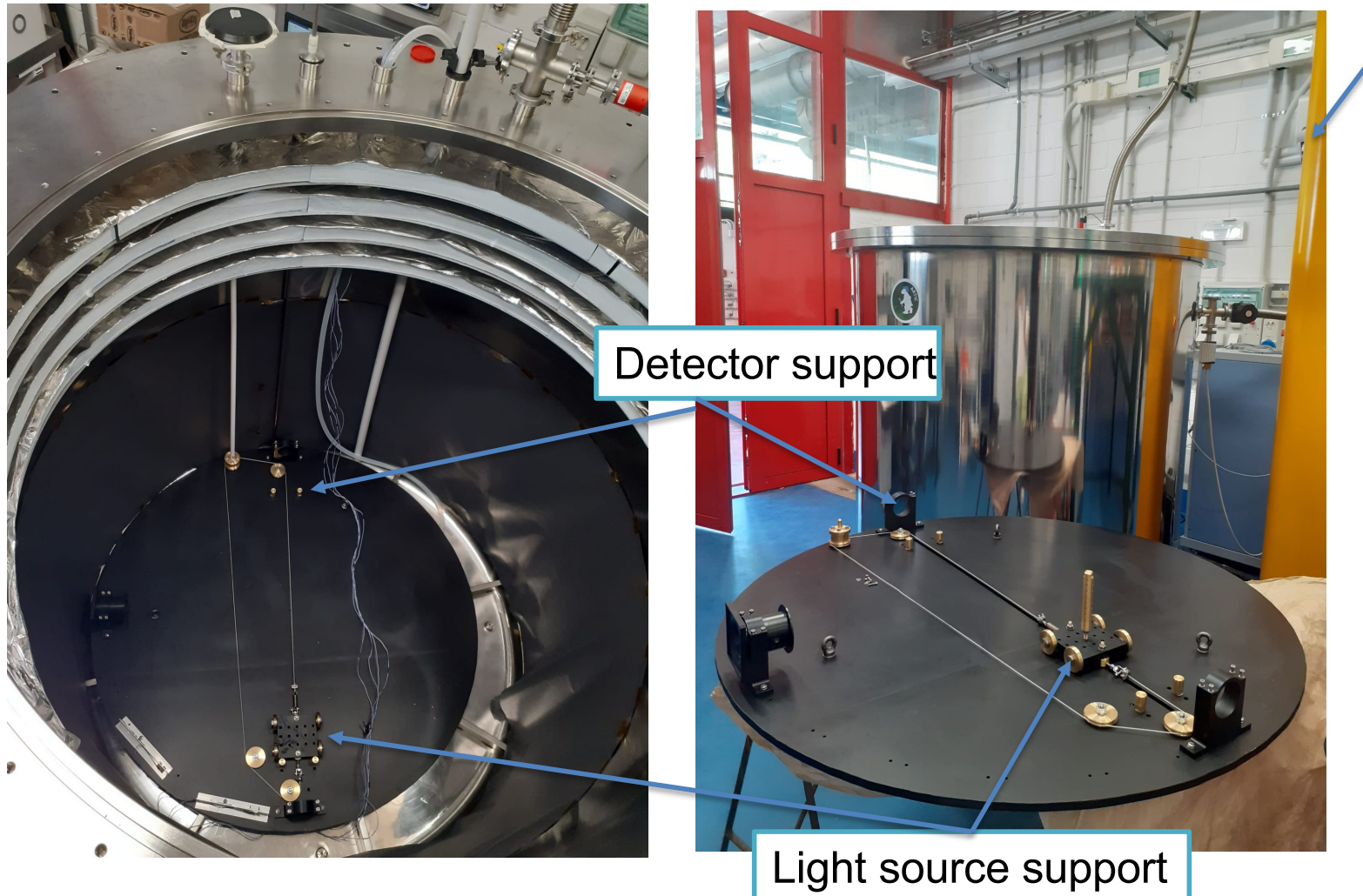→ 0.7 l/h if the N2 level is at 10 cm
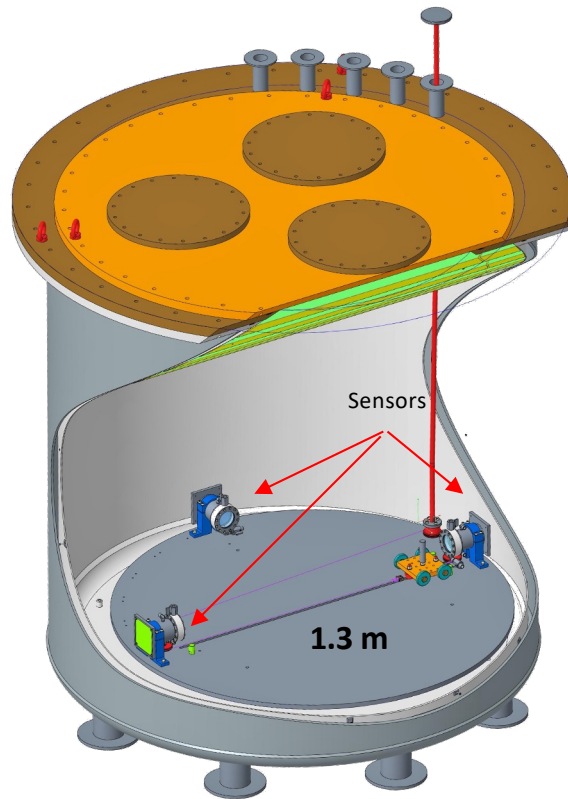
Tests in ARTIC at Genova

First phases: test with movable 200 nm light source in liquid Nitrogen and in liquid Argon

Detector support

Light source support

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Tests for sensor optimization

- Cosmic ray detection in LAr (+Xe) triggered by an external cosmic ray system

- In ARTIC we have to install a LAr recirculation (+ Xe doping system) for collecting scintillation light (by end 2024)

- An external CRT will be mounted on the top and on the bottom

- We plan to use 2 - 3 cameras for reconstructing the muon tracks

These tests:
- will validate the possibility to use the new detectors in GRAIN
- will allow us to design and test the final detectors and electronics
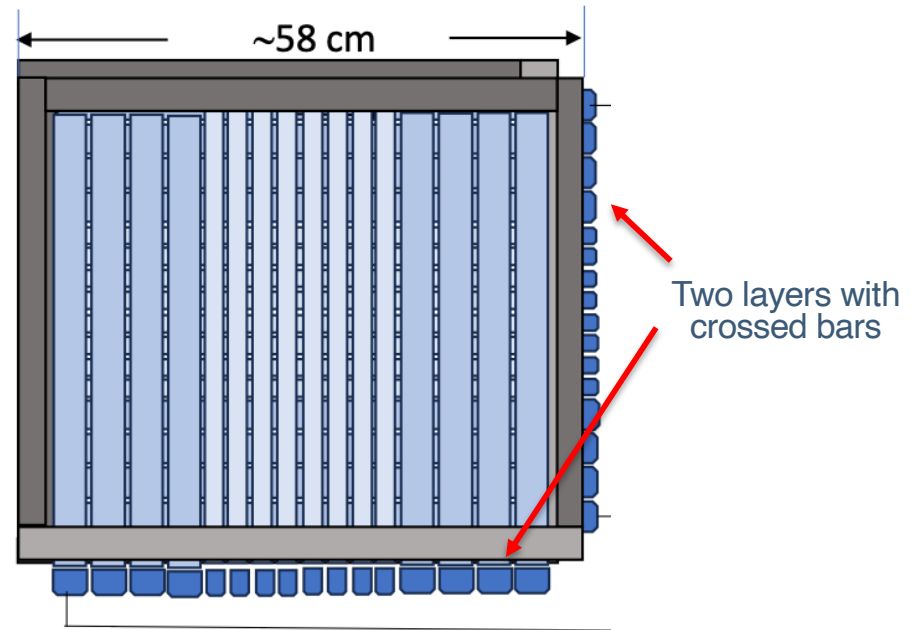- will provide additional measurement of LAr properties

CRT for ARTIC

TOP double plane

~58 cm

Two layers with crossed bars

CRT GOALS:

- Trigger for the LAr acquisition (fourfold coincidence)
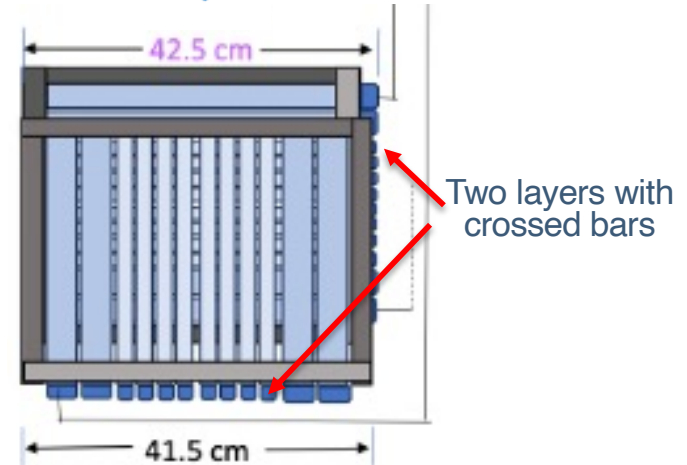- Two-view tracking to help the LAr event reconstruction

μ
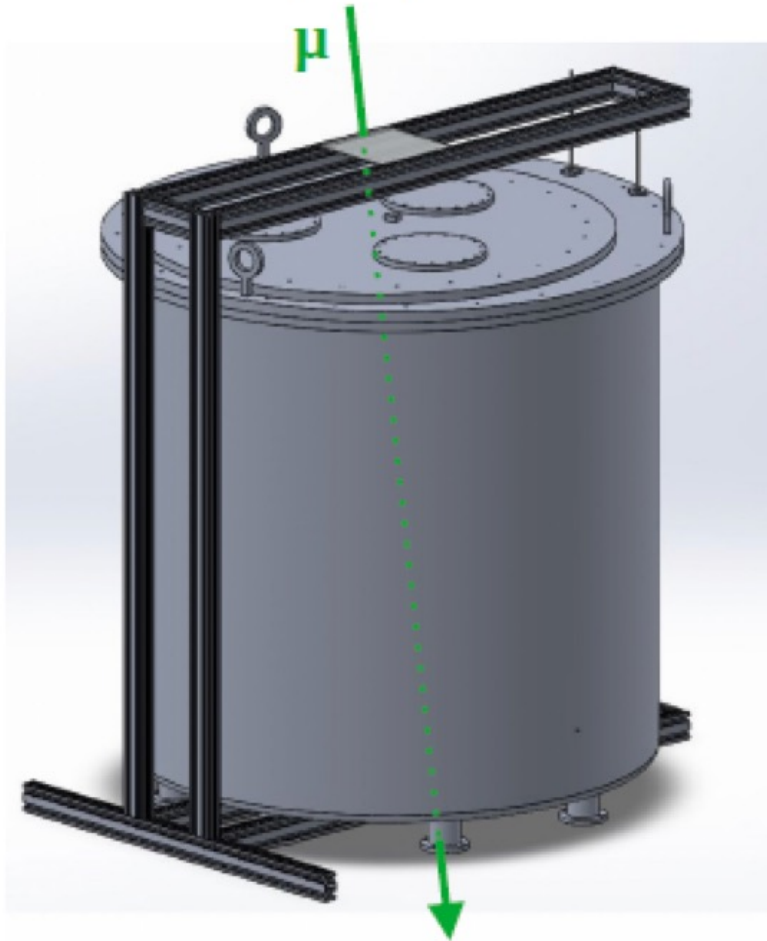
Trigger condition: Fourfold coincidence

BOTTOM double plane

42.5 cm

41.5 cm

Two layers with crossed bars
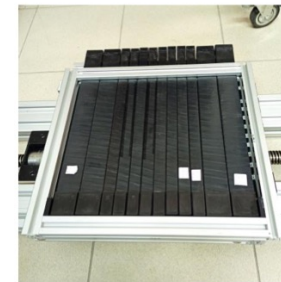
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CRT for ARTIC is completed

The CRT is in the commissioning phase at LECCE

TOP tray

BOTTOM tray

It will installed at GENOVA soon

Timeline and milestones

- Optical detector validation: end 2025

- Detector optimization and tests until the GRAIN assembly starts

mid 2025

Validate the optical design for lens and coded mask → Detector optimization and tests

↓

Design the **final detector layout** in GRAIN → Detector procurement → *Begin 2028* Detector **assembly and test** in the inner vessel at LNL

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