

Cosmic Ray Tagger for GRAIN

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on behalf of the Lecce group

DUNE Italian meeting
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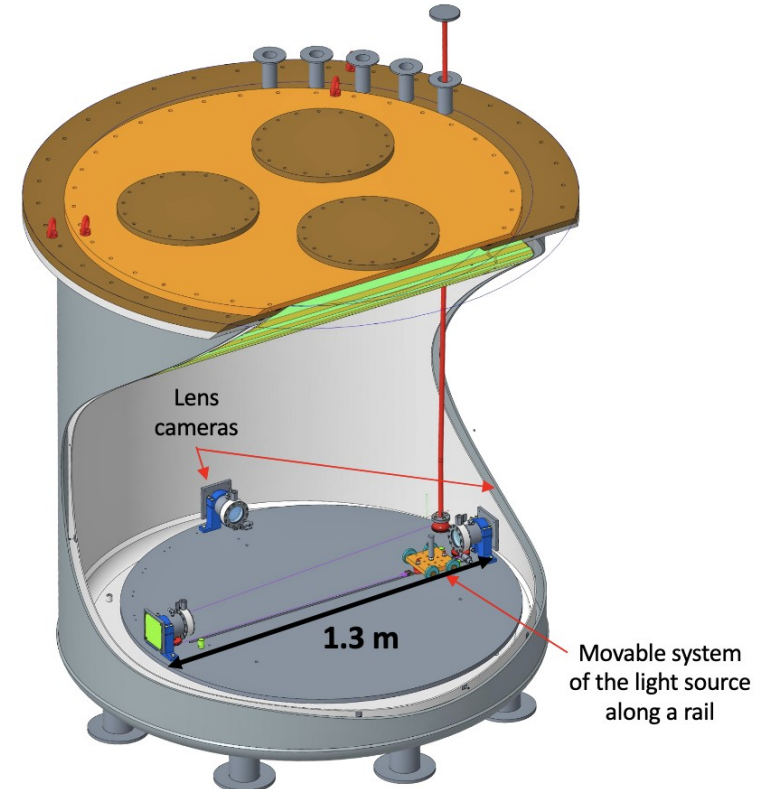
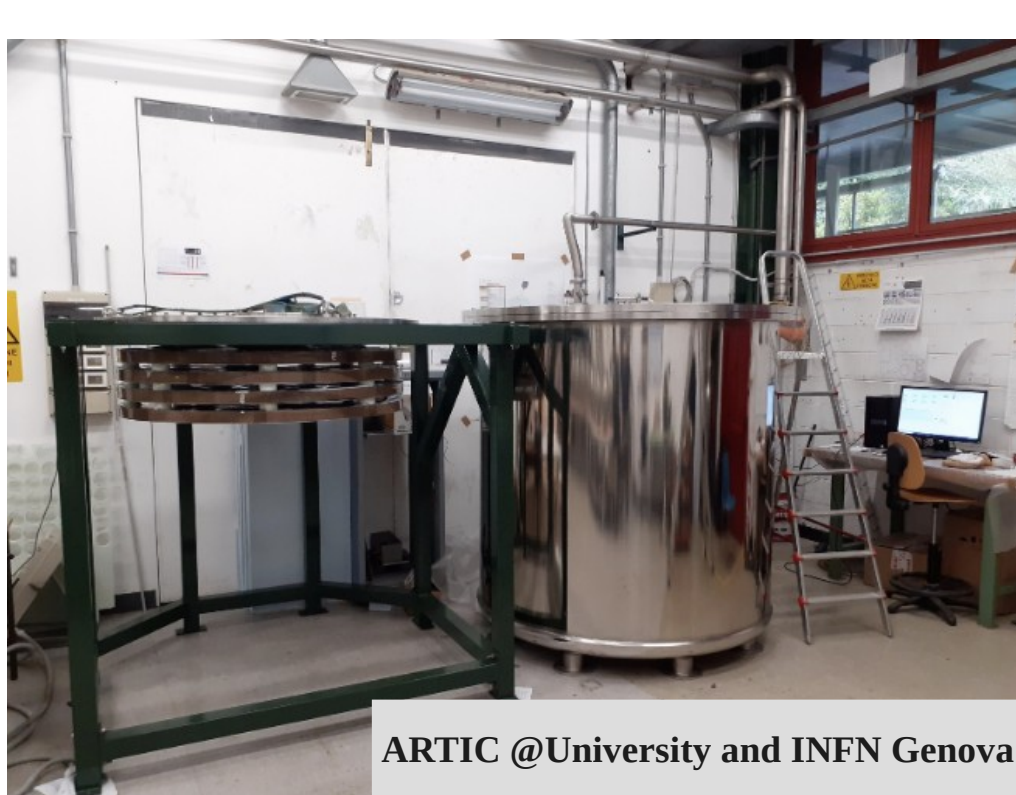


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ARTIC setup

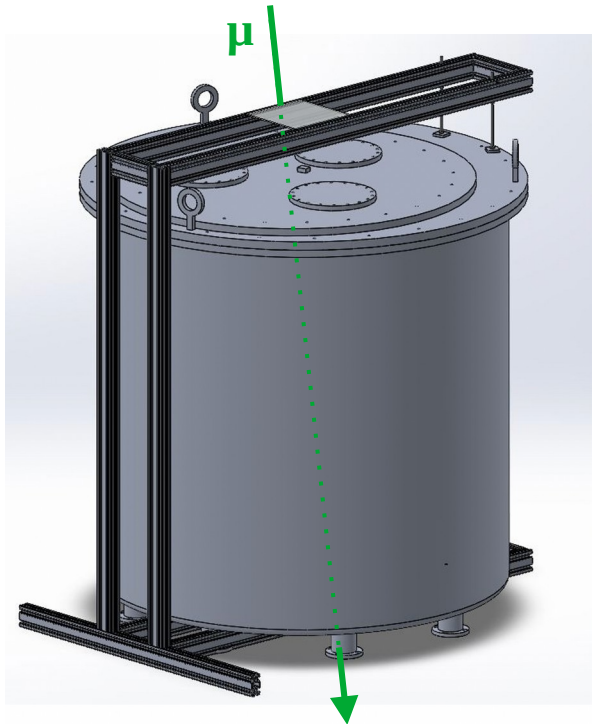
Facility to test the imaging of charged particle tracks
(and interaction vertexes), thanks to the scintillation light in liquid Ar,
by using lenses or coded masks coupled with SiPM matrices



Cosmic Ray Tagger (CRT) for ARTIC

CRT GOALS:

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



Trigger condition: Fourfold coincidence

CRT DESIGN:

TOP (48 cm x 48 cm active surface)

16 bars x 2 orthogonal planes:

- 8 bars (48 x 4 x 1) cm³

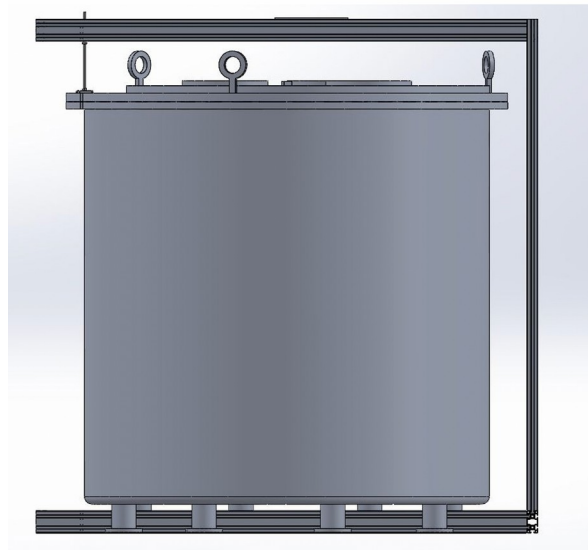
- 8 bars (48 x 2 x 1) cm³

BOTTOM (32 cm x 32 cm)

12 bars x 2 orthogonal planes:

- 4 bars (32 x 4 x 1) cm³

- 8 bars (32 x 2 x 1) cm³



SCINTILLATORS:

Saint Gobain BC-408

READ OUT:

6x6 mm² SiPMs

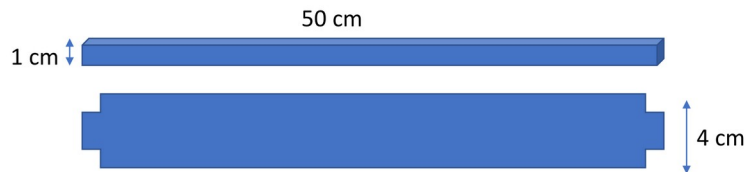
Hamamatsu S14160-6050HS

14331 pixels and 50 μm pitch



Scintillator bars configuration and readout

Preliminary configuration to define the optimal shape, wrapping, number of readout channels and end-caps

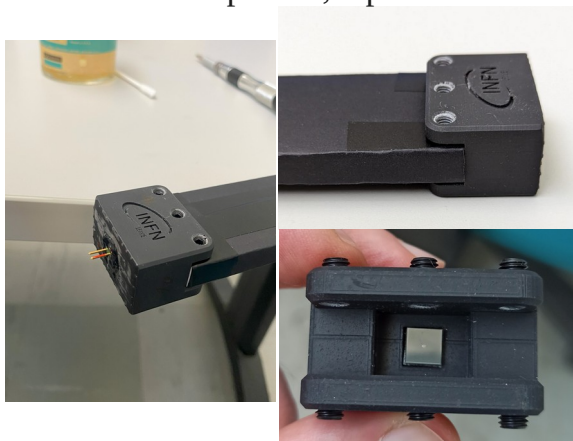


Wrapping:

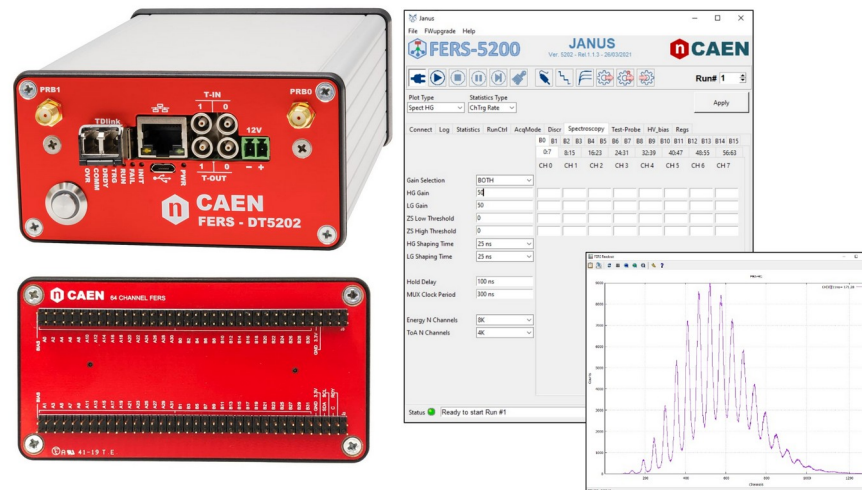
- 1) Mylar+Teflon+Black tape
- 2) Reflective painting+Black tape

Readout:

2 SiPMs per bar, 1 per side



CAEN FERS - DT5202



Output signal (NIM/TTL) for LAr setup trigger

Binary output \longrightarrow ROOT file

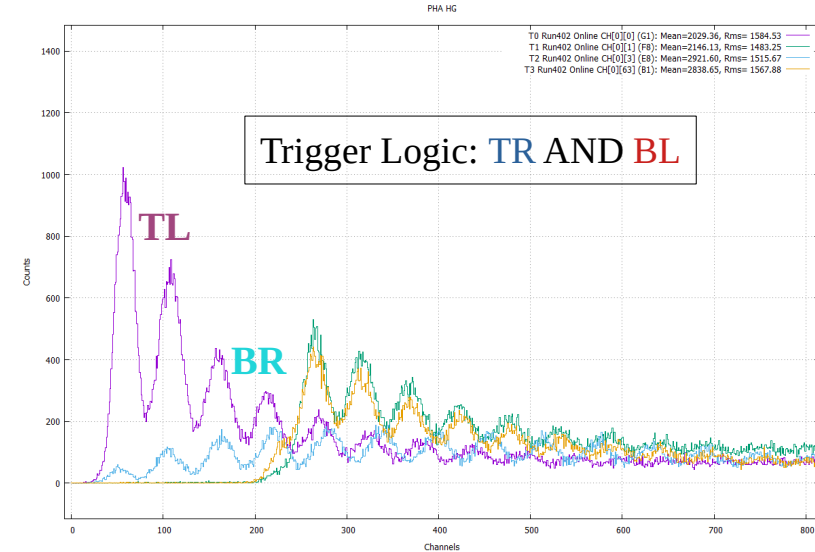
Equalization of the 4 SiPMs
in terms of self-trigger rate



Trigger logic	Rate (Hz)
TL AND TR	25
BL AND BR	60
(TL AND BL) AND TR	2.9
(TL AND BL) AND BR	3.7
(TR AND BR) AND TL	3.3
(TR AND BR) AND BL	3.6

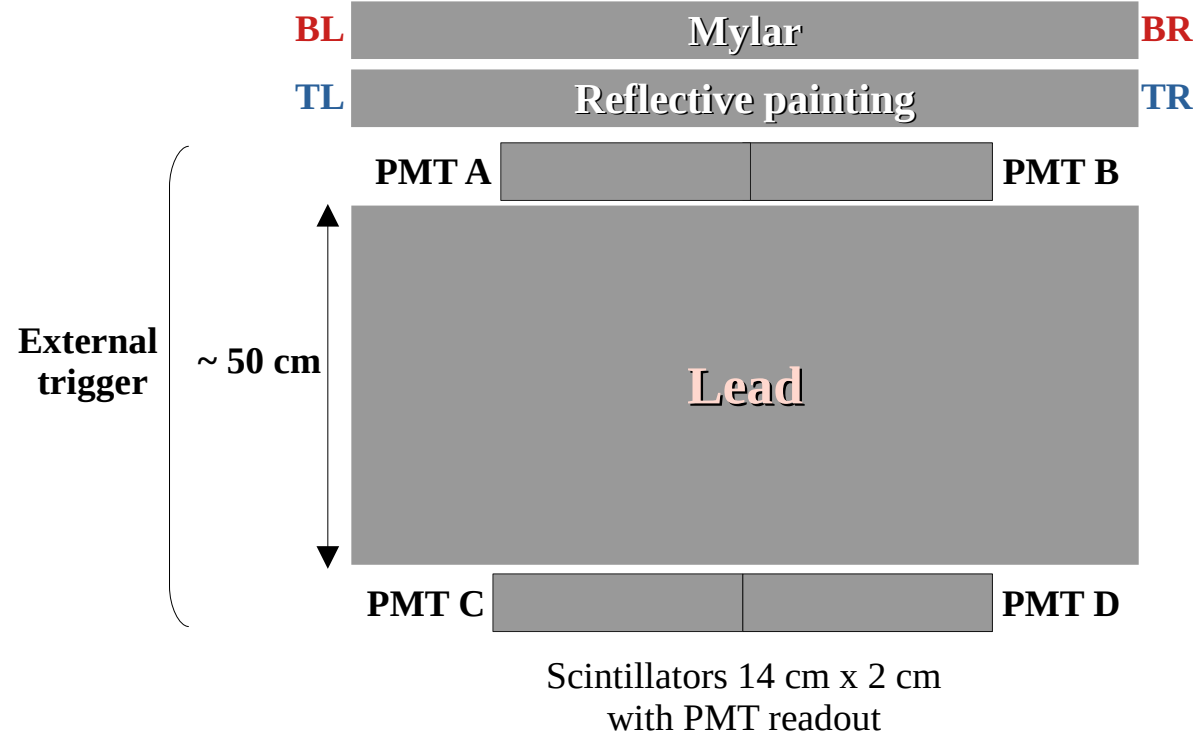
Higher rate when the wrapping with Mylar is considered

Indication of better efficiency in light reflection and propagation

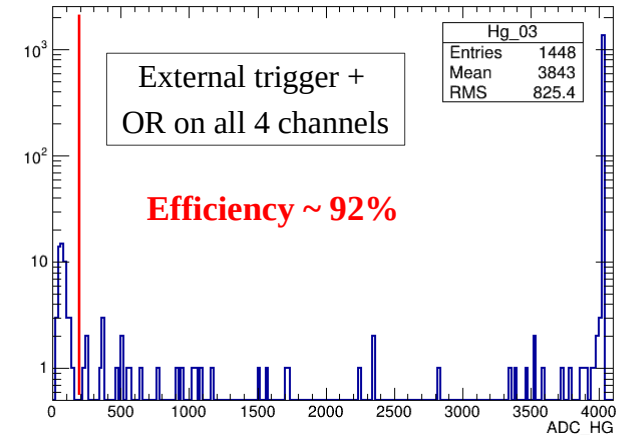
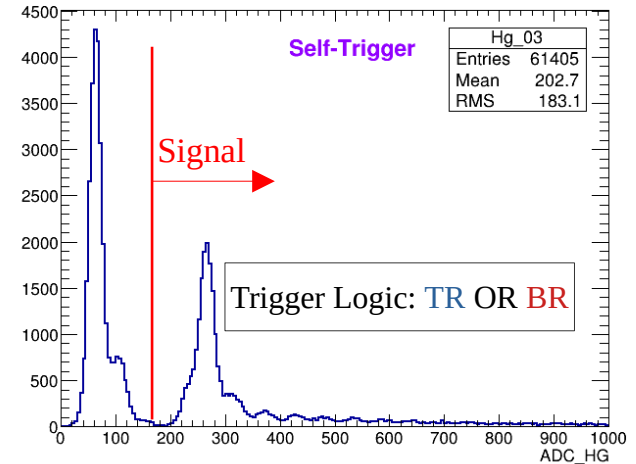


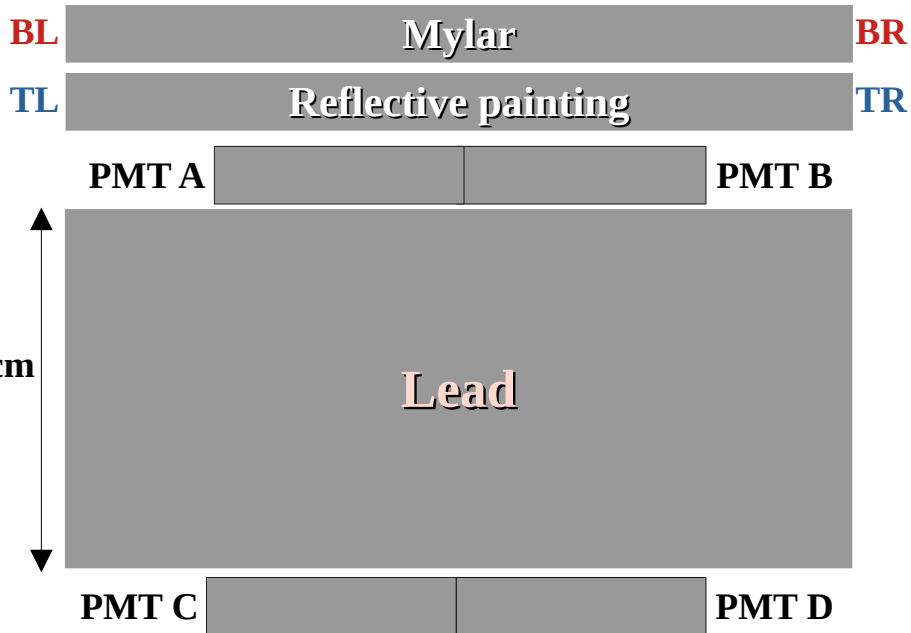
Higher signal for Mylar, higher noise for Reflective paint

Mylar selected as wrapping material for the next scintillators
although more studies are needed
to completely exclude the use of reflective painting

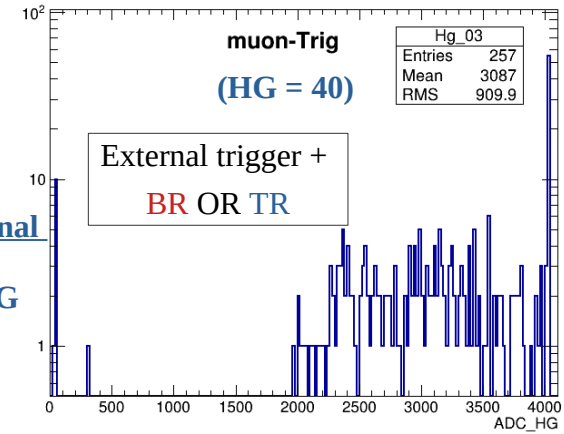


When the signal is taken from only one end of the bar the **efficiency is ~90%**
→ **1 SiPM per side is enough**

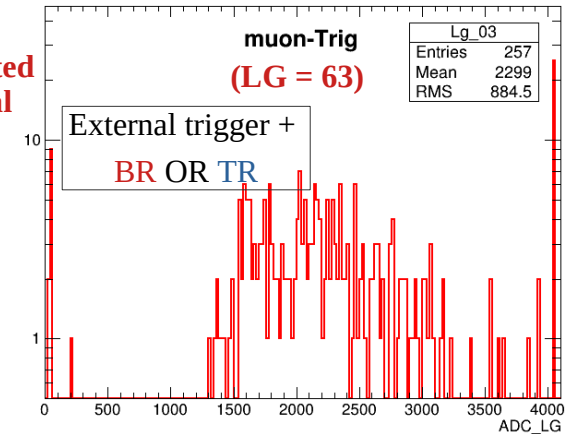




The cosmic ray signal
can be seen
setting a lower HG
or a high LG



Signal well separated
from the pedestal



Expected rate for the ARTIC CRT is ~ 0.6 Hz
Which becomes ~ 0.4 Hz considering the 90% efficiency

Optimized scintillator bars configuration

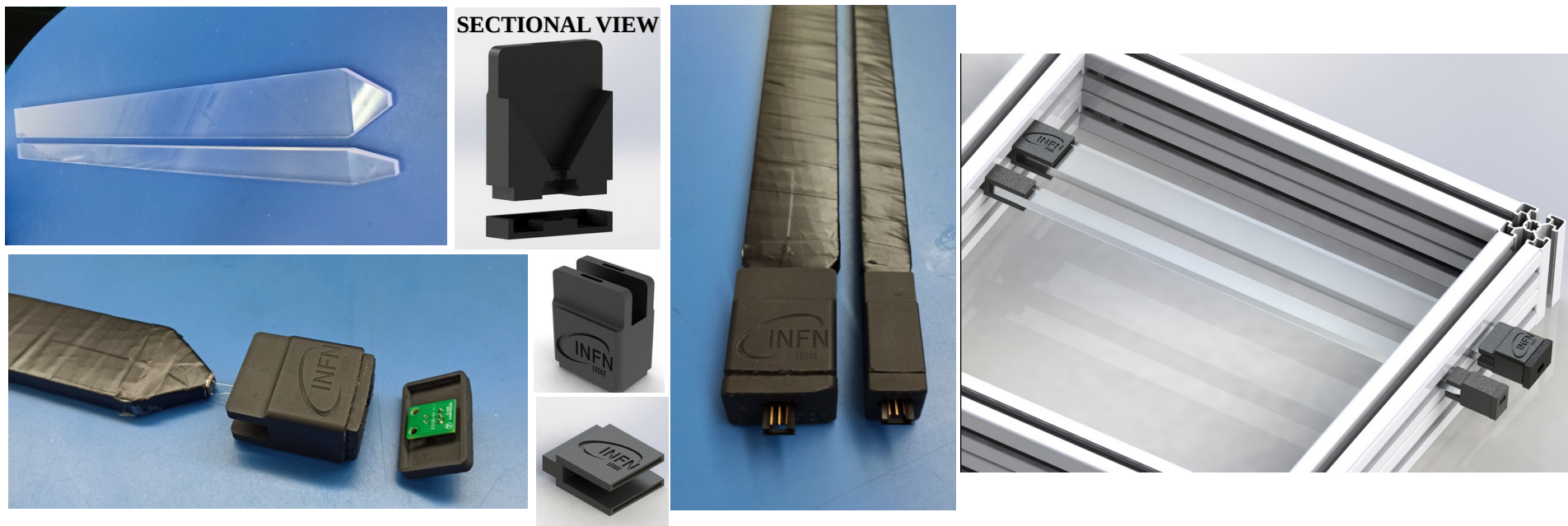
From the previous tests → **Wrapping with Mylar+Teflon+Black tape**

From 2 SiPMs to **1 SiPM per bar**, with one end shaped as a light guide

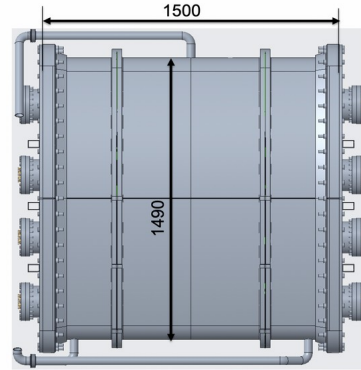
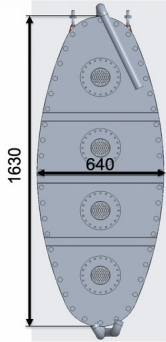
New 3D printed end caps to follow the light guide shape and to accommodate a custom PCB and the SiPM

Mechanics design + ongoing realization

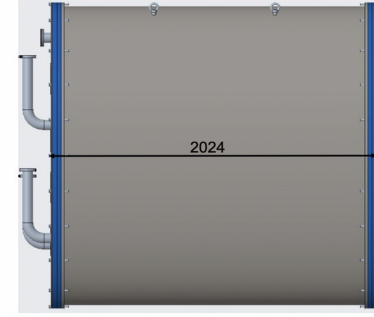
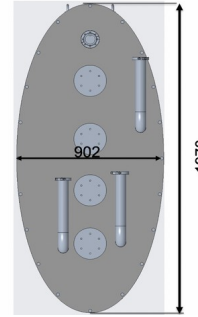
UNDER TEST



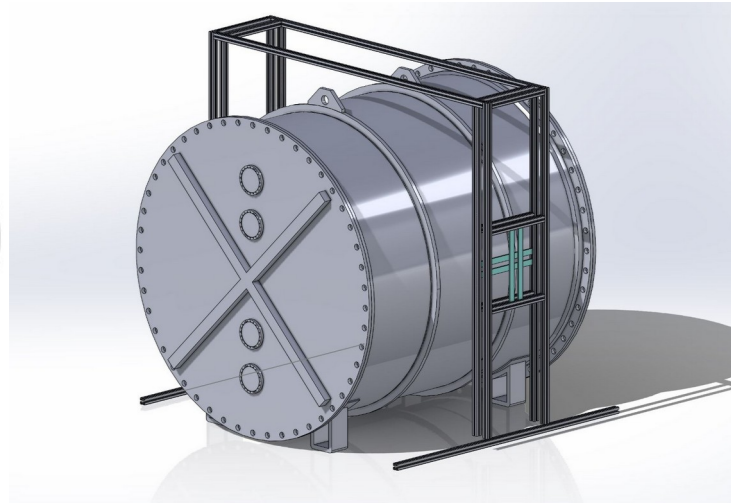
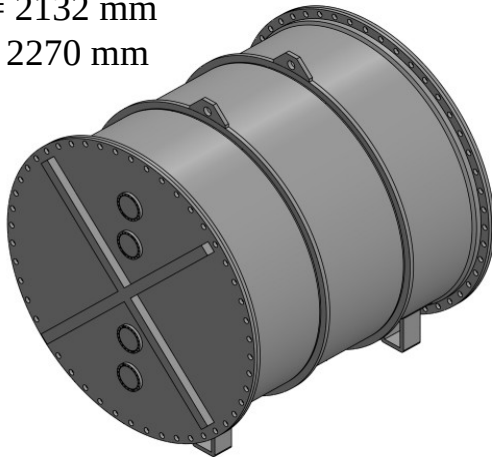
Inner vessel



Outer vessel



$\Phi = 2132 \text{ mm}$
 $l = 2270 \text{ mm}$



Low expected rate for quasi-horizontal muons

Evaluation of alternative configurations:

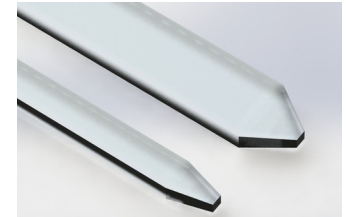
- Selection of different angles by placing the scintillators on different levels of the mechanical support (if $41.4^\circ < \theta < 55.7^\circ$ the rate is ~ 500 events/h);
- Larger CRT (e.g., 1 m long bars);

Summary and conclusions

- **Preliminary design scintillator bars** instrumented and **tested**
- Decision to proceed with **1 SiPM per bar** and **one end shaped as a light guide**
 - 3D printed end-caps with housing for SiPM and custom PCB
 - Software to decode the binary data from the **CAEN FERS board**
 - **Design of support mechanics** for the full ARTIC CRT

- **Ongoing tests** on a few optimized bars **and preparation of additional bars**
 - Improve the **software** implementing also the **trigger logic**

- **Realization CRT for the GRAIN full scale prototype at LNL** (under design)

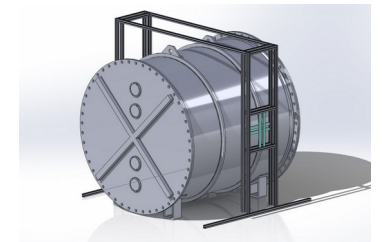


DONE



WORK IN PROGRESS

FUTURE PLANS



Thank you for the attention

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Salvatore Maggiore, Carlo Pinto, Giorgio Rizzo



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