PROTOTYPE ACTIVITIES FOR GRAIN

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Meeting DUNE-IT

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ACTIVITIES IN 2022

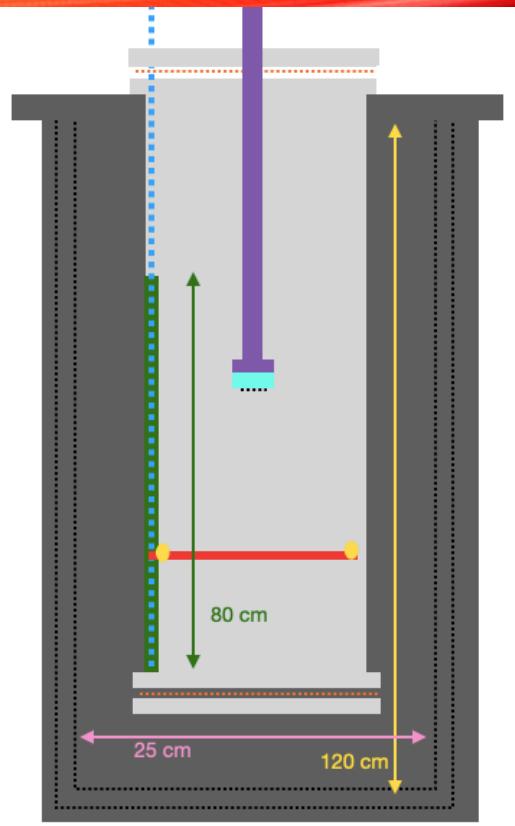
→ LAr **refractive index** measurement

→ Lens detector **prototyping and test**

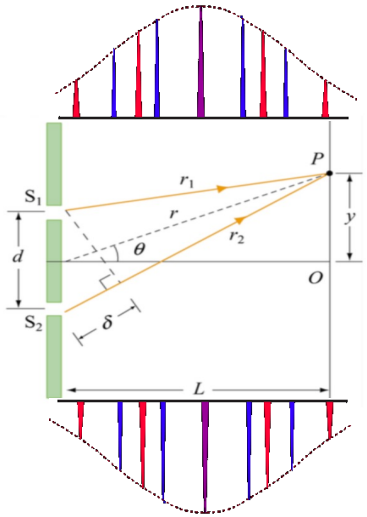
- 3 lens detector prototypes were build in order to be tested in water and in LAr
- 2 prototypes were tested in water
- **Installation of ARTIC in the DIFILab**

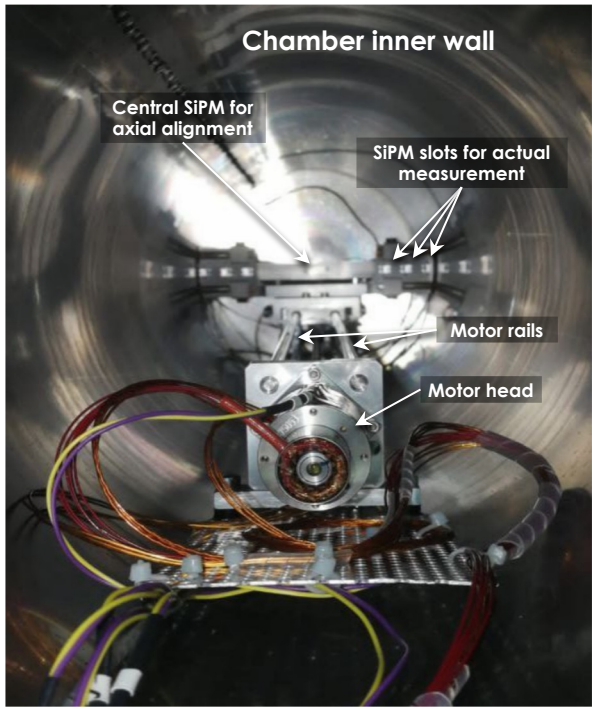
→Development of **simulations** and **reconstruction algorithms** for ν event interactions in GRAIN

LAR REFRACTIVE INDEX MEAS.



by an interferometric method: [https://www.osapublishing.org/oe/abstract.cfm?uri=oe-22-24-29899]
with Hg lamp, diffractive pattern, movable SiPM sensors

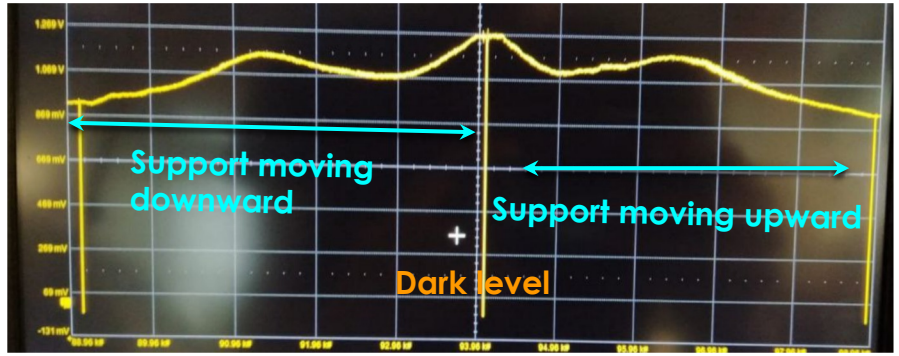




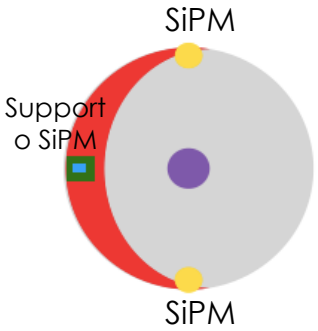
Picture from the top of the chamber

Set up completed!

- Optical chamber ready, Cooling and filling successfully done.
- Motor and SiPM support mounted and tested
- Good axial alignment obtained with 405 nm laser



SiPM integrated signal (luminosity) during support movement (40 cm):
signal is constant within ~30% and reproducible in the two directions.



by comparing the measurements in vacuum and in LAr

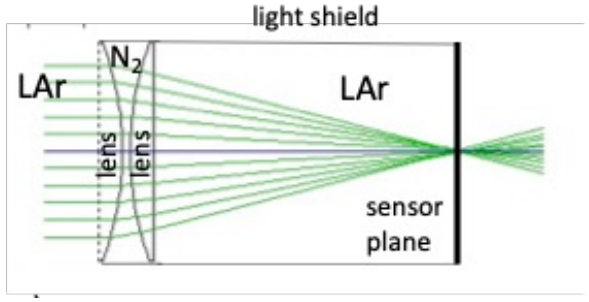
$$n = \frac{\lambda_0}{\lambda_L} = \frac{\sin(\mathrm{atan}(y_0/L))}{\sin(\mathrm{atan}(y_L/L))}$$

First measurements are starting soon!

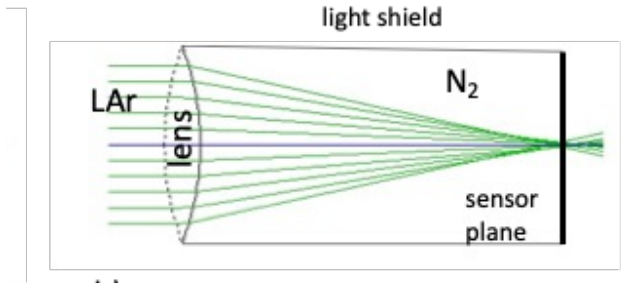
LENS PROTOTYPES

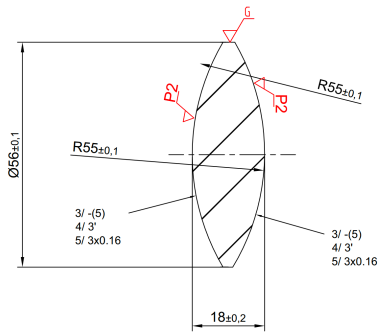
- 3 prototypes in fused Silica:
  - Type A: the same of the simulations (focal lenght 89 mm) Built and tested in water
  - Type A: similar (focal 89 mm) but bigger ø = 60 mm
  - Type B: Single bi-convex lens (focal 64 mm) Built and tested in water

TYPE A



TYPE B

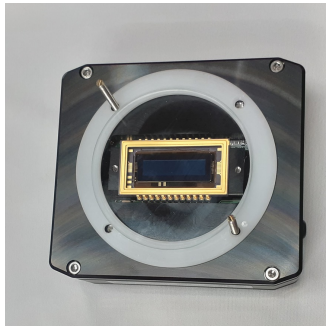




- 2 materials:
  - Fused Silica (high transmittance at 178 nm)
  - MgF_2 (high transmittance at 128 nm), already tested in LN2

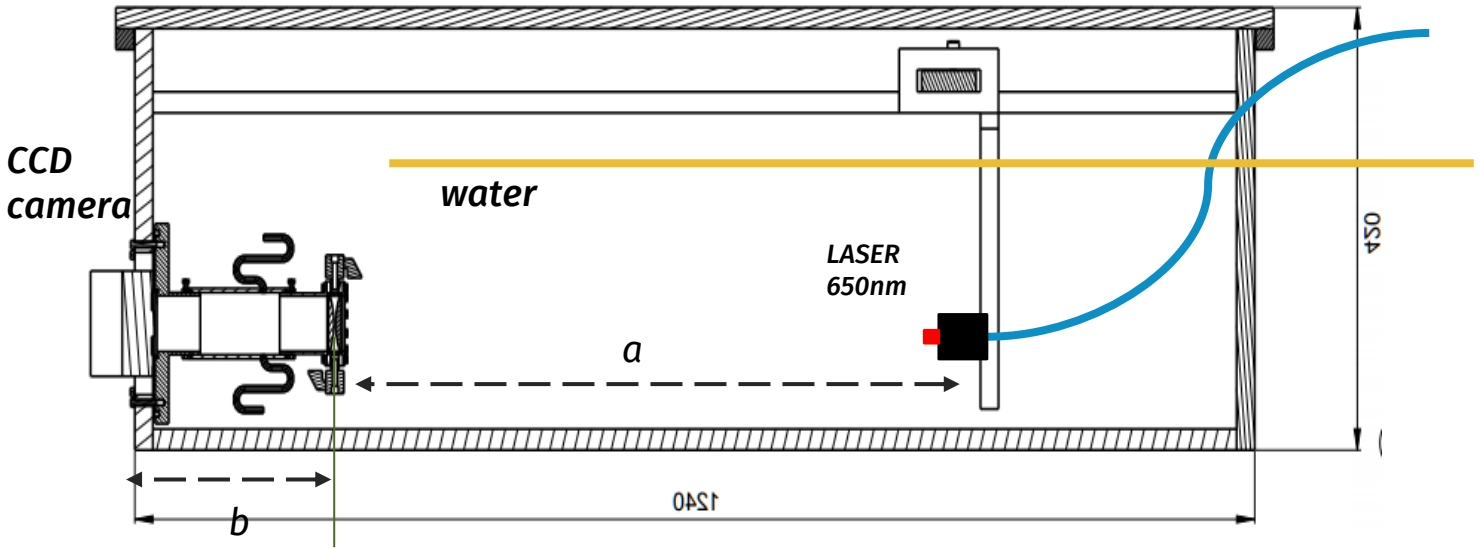
TESTS IN WATER

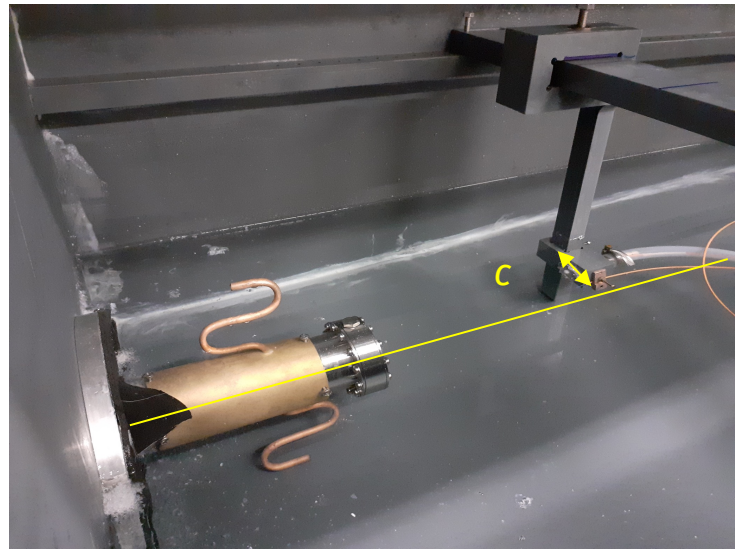
- **Visible light source (650 nm)**
  - trasported on fiber
  - movable position inside the box volume (a, b, c variable)
- **In water** → (n_lens=1.45 n_water=1.33, bigger focal length f=118 mm)
- **with a CCD camera** (sensible to UV or visible light)



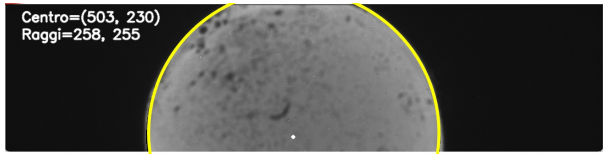
CCD (UV-visibile)
Dim: 24 mm x 12 mm

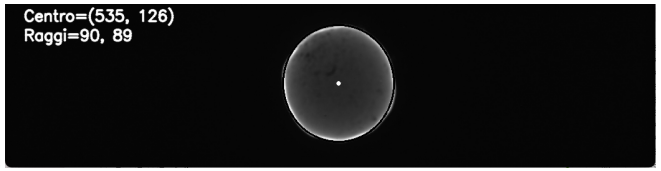
- **GOAL:** test simulations results in term of field of view and focusing

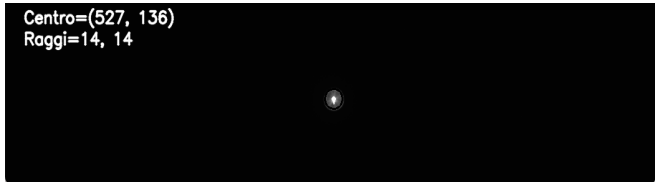


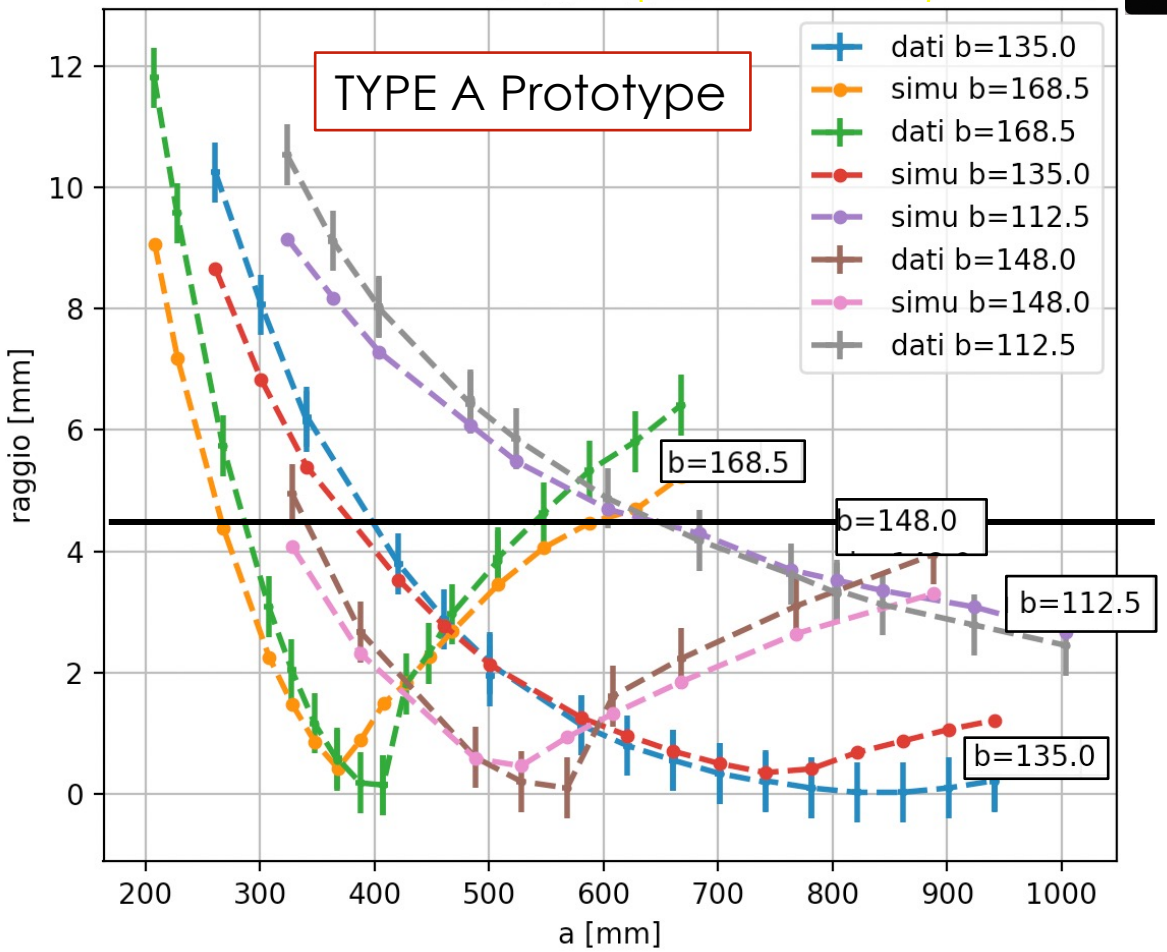


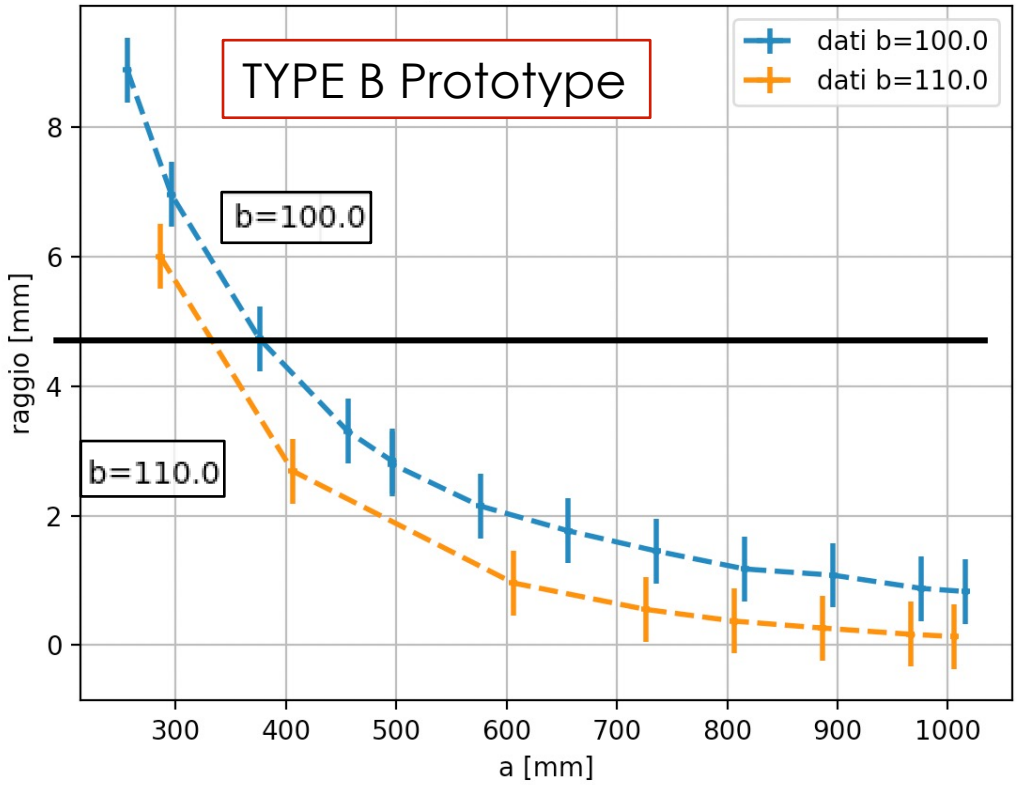
THE FOCUSING EFFECT









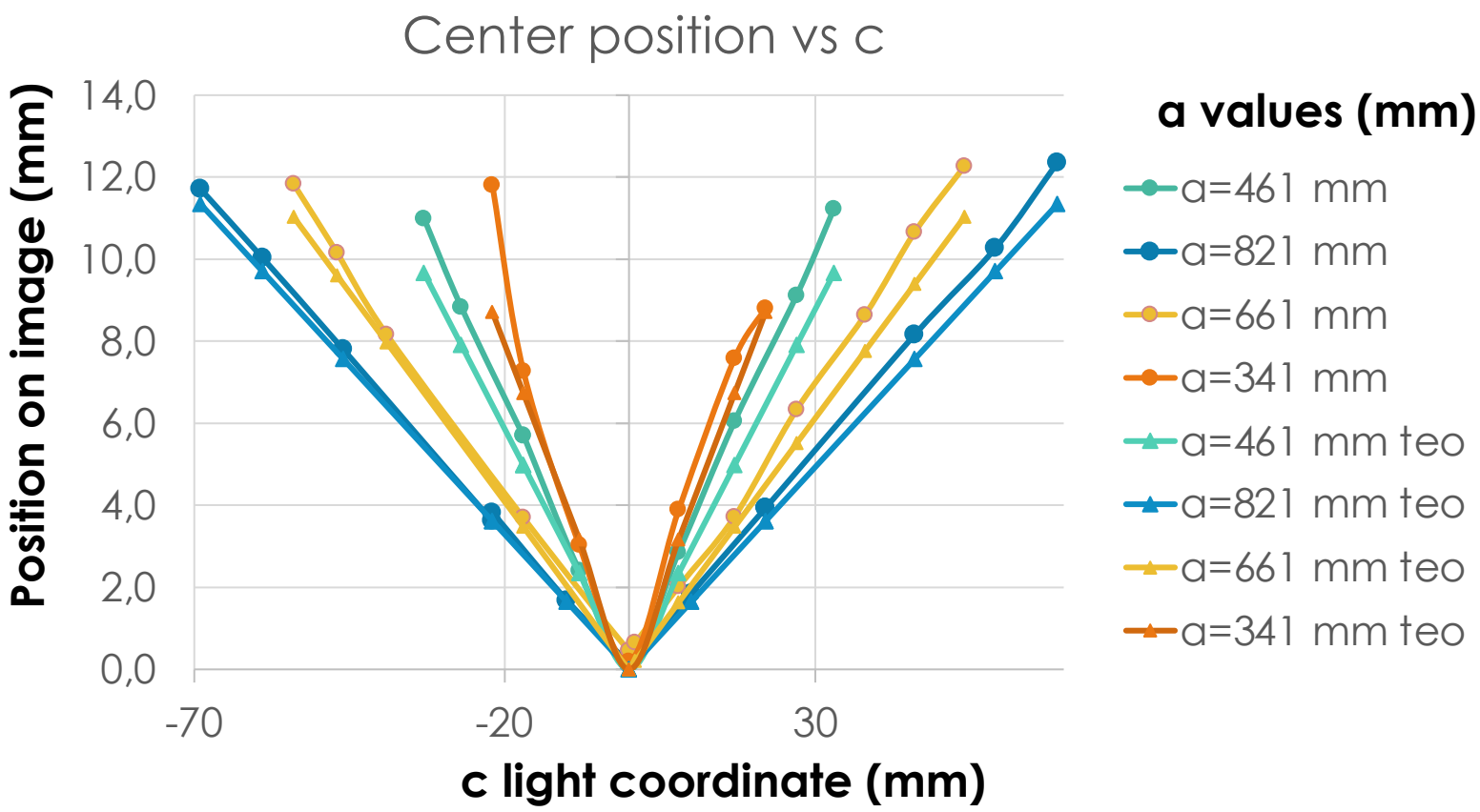


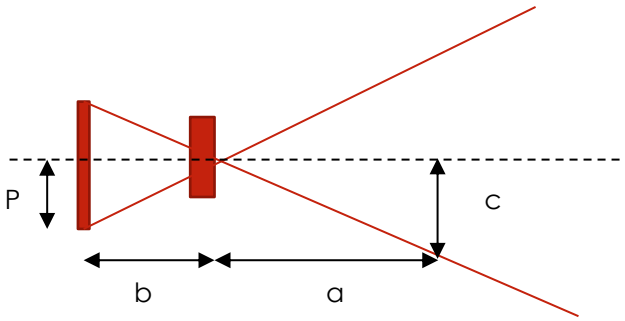
b=148 mm in water is expected to work as
b=10 cm in LAr with UV light

THE FIELD OF VIEW

for b= 135 mm

Comparison with the expected (teo) values

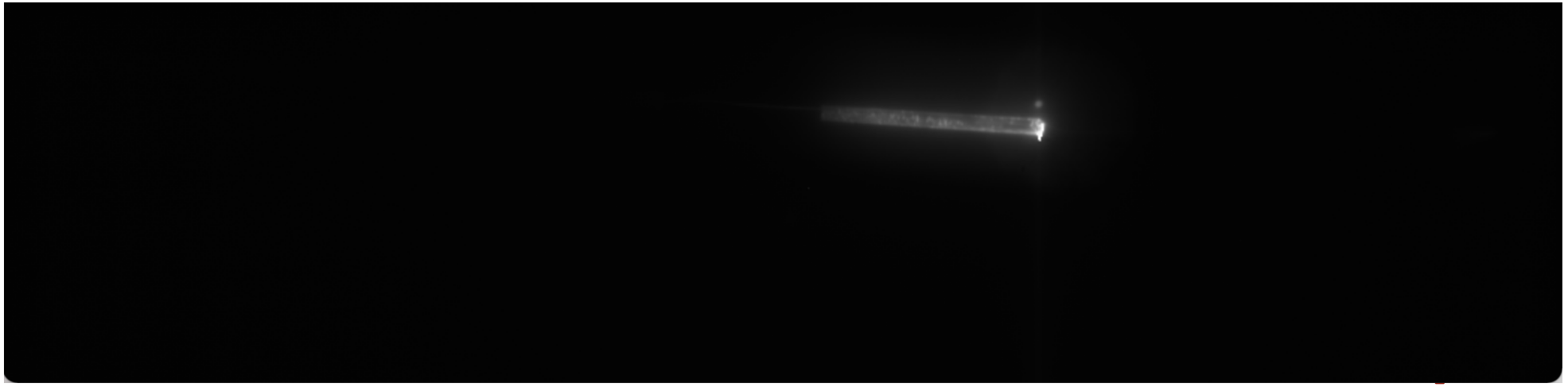


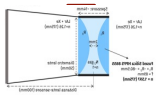


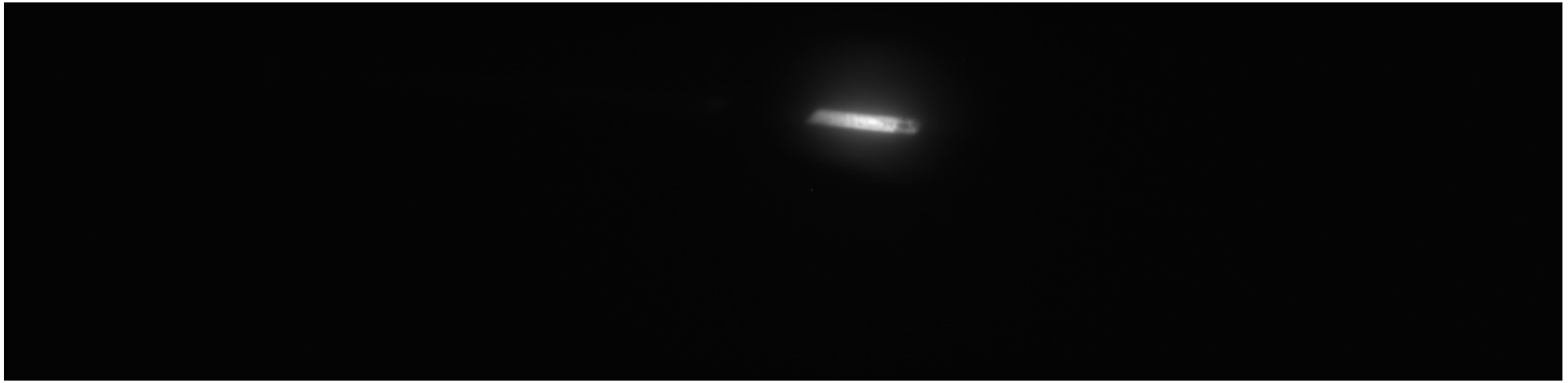
P=a/b*c

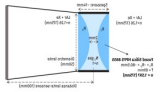
The data are in agreement with simulated/expected values
We can proceed to test in LAr and to optimize the system for GRAIN!

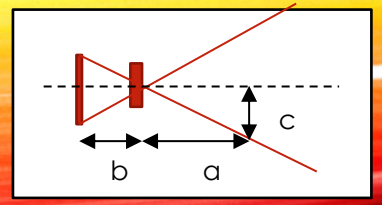
FIRST TRACK IMAGES



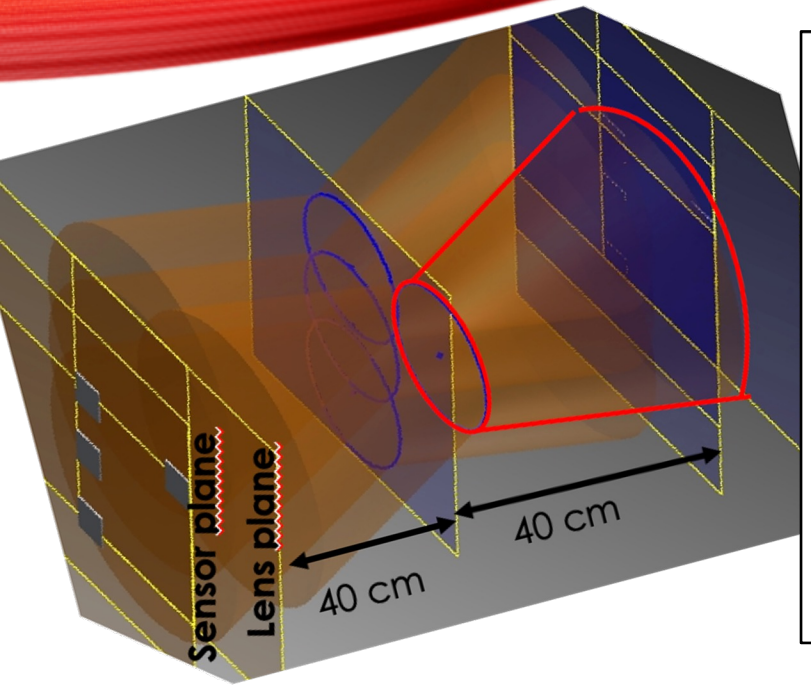


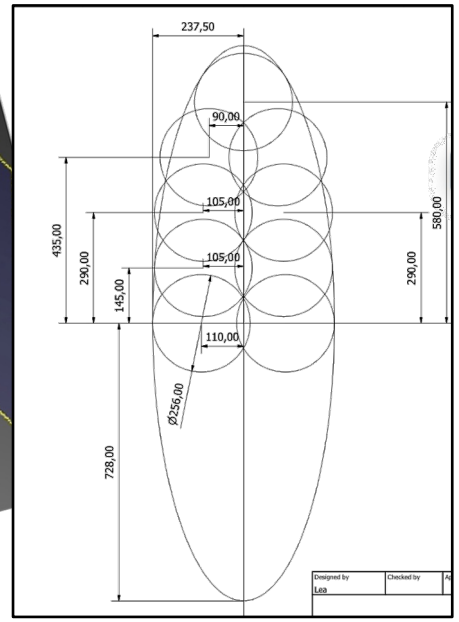


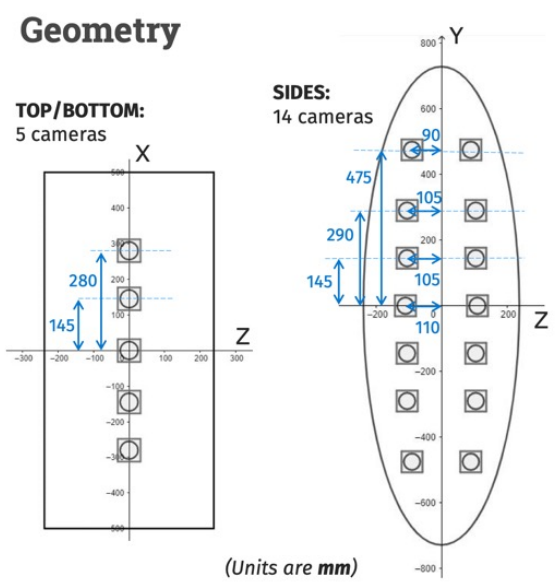


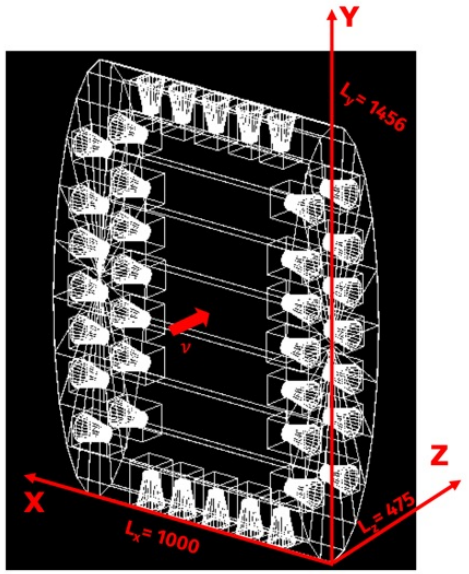


IN THE GRAIN GEOMETRY







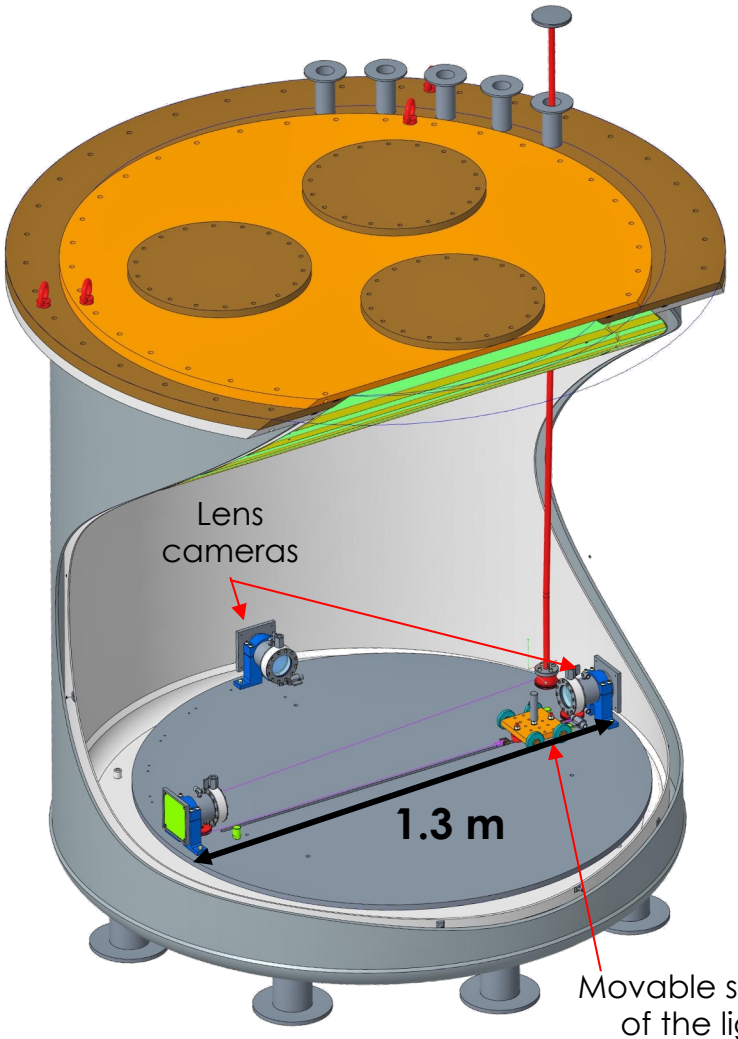


We need to increase the lens dimension

→Finalization of design with the new cryostat dimension

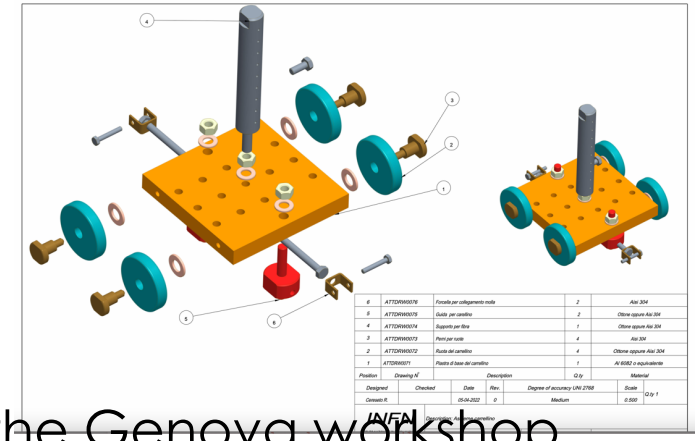
→Optimization of the detector layout with coded mask detector

FIRST TESTS IN LAR



Tests in **LAr** (150 l) with an **artificial light source** at 180 nm

The set up will be used **both for lens based** or **coded mask** based detectors

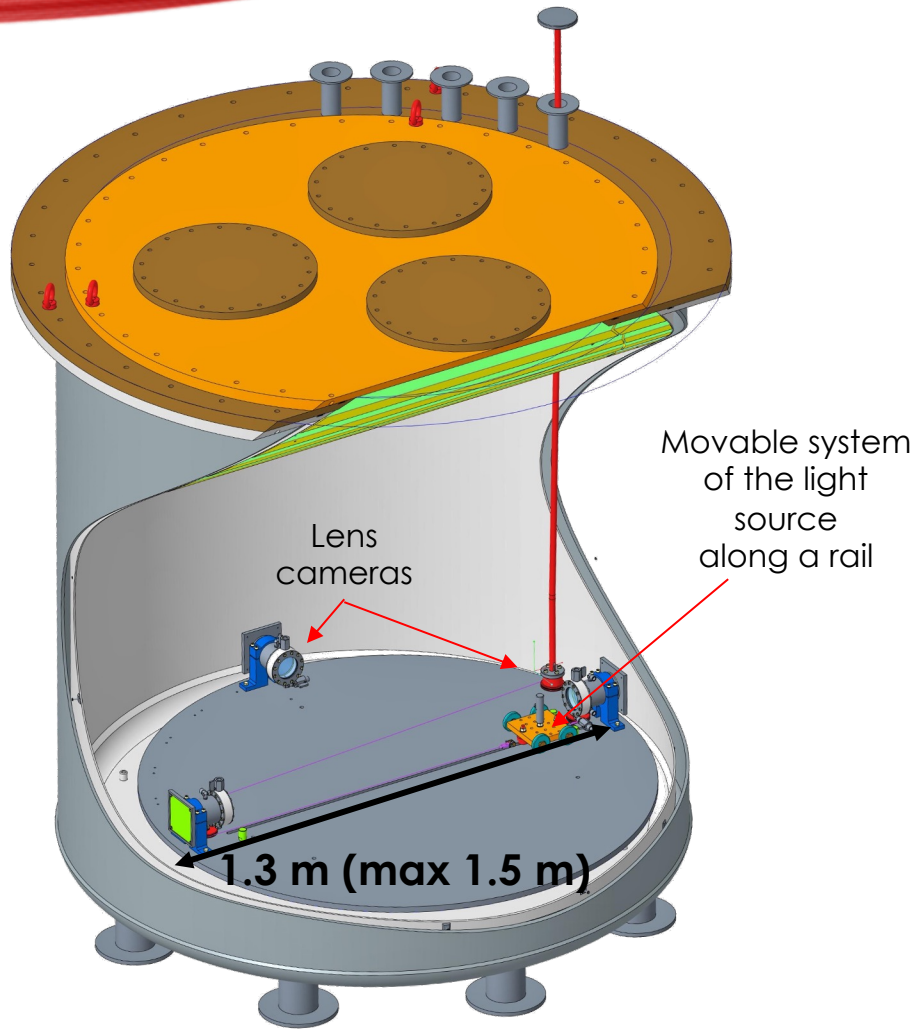


The design is completed

- mechanics production in the Genova workshop
- electronics under test in Bologna

We plan to complete the installation and to start first tests **by the end of 2022**

TESTS WITH COSMICS



- **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 if necessary)

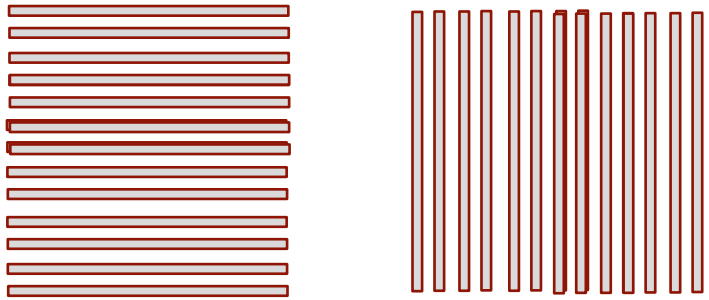
These tests:
- will validate the possibility to use the new detectors in GRAIN
- will allow us to design and test the final detectors and electronics
- will provide additional measurement of LAr properties

A SIMPLE COSMIC RAY TAGGER

by Lecce group

Trigger : four fold coincidence

48 cm x 48 cm

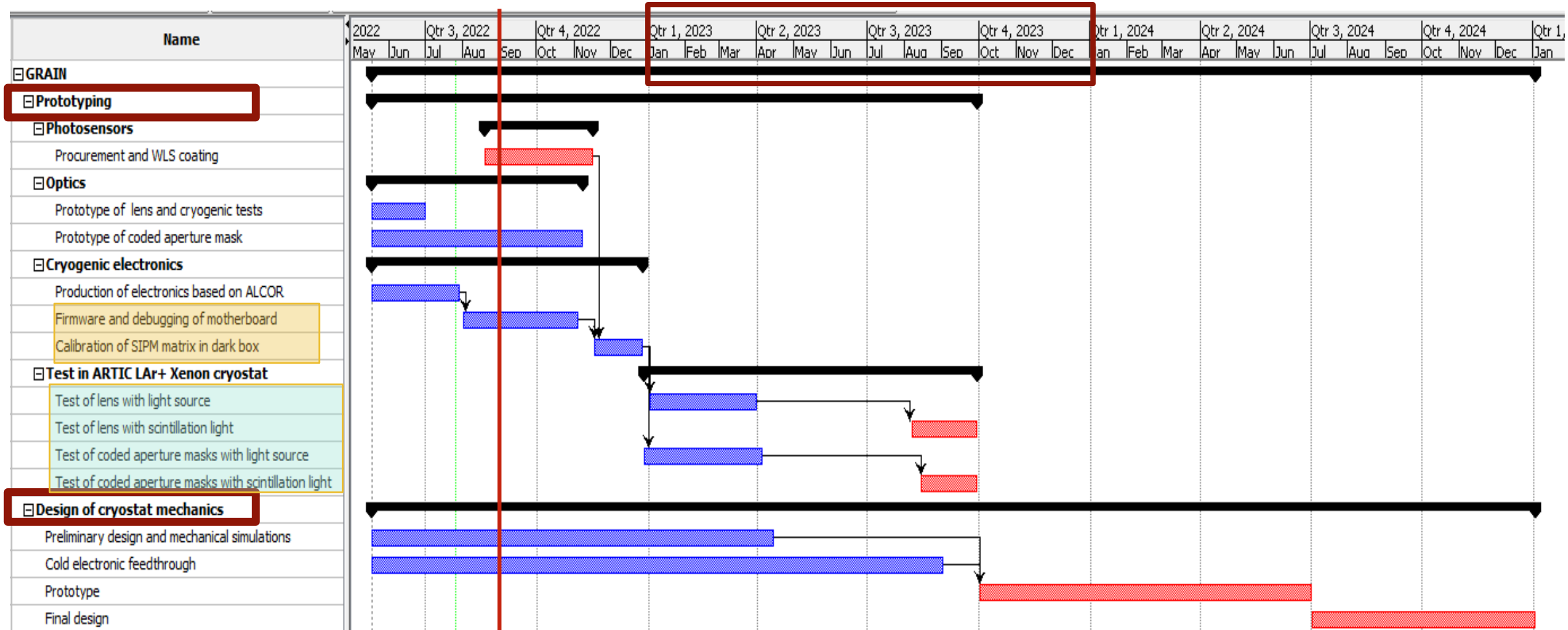


d = 3 cm 16 channels x 4 planes = 64
d = 4 cm 12 channels x 4 planes = 48

- Scintillator
  - Saint Gobain BC-408
  - thickness 1 cm
- Readout with SiPMs
  - Hamamatsu S14160-6050HS
  - 6 x 6 mm
  - 14331 pixels of 50 mm pitch

THE TIME LINE

1. **Prototyping:**
   - →set up a first readout system for SiPM matrix
   - →set up measurements in LAr (two phases)
2. Cryostat and sensor **design** in GRAIN



CONCLUSIONS

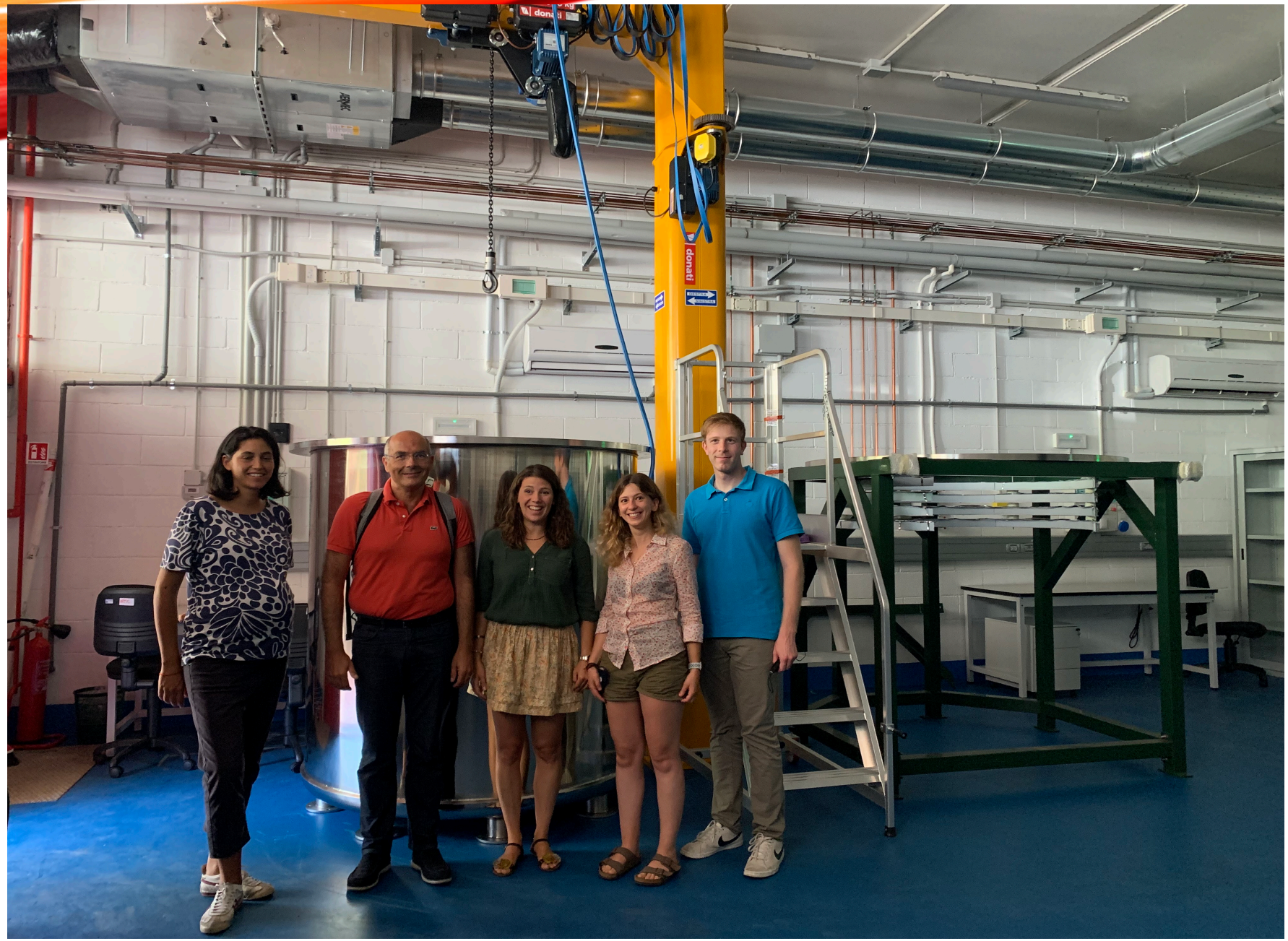
- The lens based optical detector seems to be promising

- We are close to the first tests in ARTIC with the prototypes (lens and coded masks)

  that will be necessary to finalize the GRAIN design in 2023:

- The design has to be finalized:
  - cryostat
  - detector layout
    - optimization for the cryostat dimension
    - integration between lens and coded mask detector
  - electronics

  for starting to build the first GRAIN prototype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