ACTIVITIES AT GENOVA

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on behalf of the GENOVA group

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ACTIVITIES AT GENOVA

→Design of **lens system** readout

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

→ LAr **refractive index** measurement → B.Bottino

→ 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

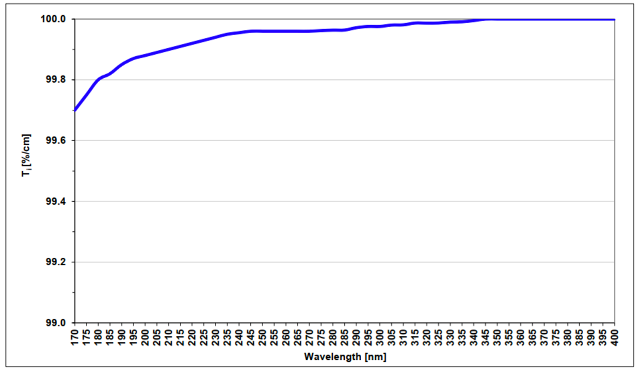
→ Set up for testing lenses and coded masks in **ARTIC** (cold demonstrator)

A LENS IN LIQUID ARGON

- The lens material must:
  - be suitable in cryogenic enviroment
  - have high transmittance
  - have refractive index different from LAr refractive index (1.26-1.4, not known precisely)

Option 1:
HPFS 8655 Fused Silica
extremely pure synthetic glass
n=1.57 at **178 nm**
→ we have to use Xe doped LAr

Internal Transmittance:



Under test

Option 2:
MgF2, tested in LN2
n=1.42

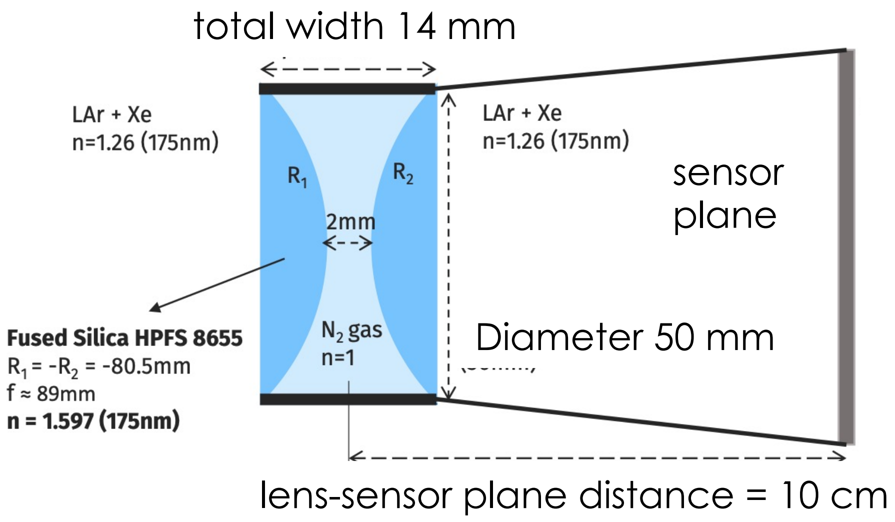
Transmission Range	0.11 - 7.5 μ

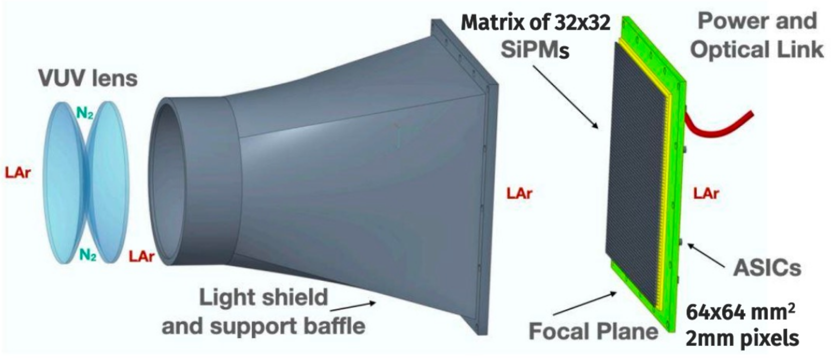
future tests

THE FIRST PROTOTYPE

- The radius of curvature, the sensor dimension, the material refractive index determine the focal lengh
- R smaller → focal length smaller but R>> lens radius

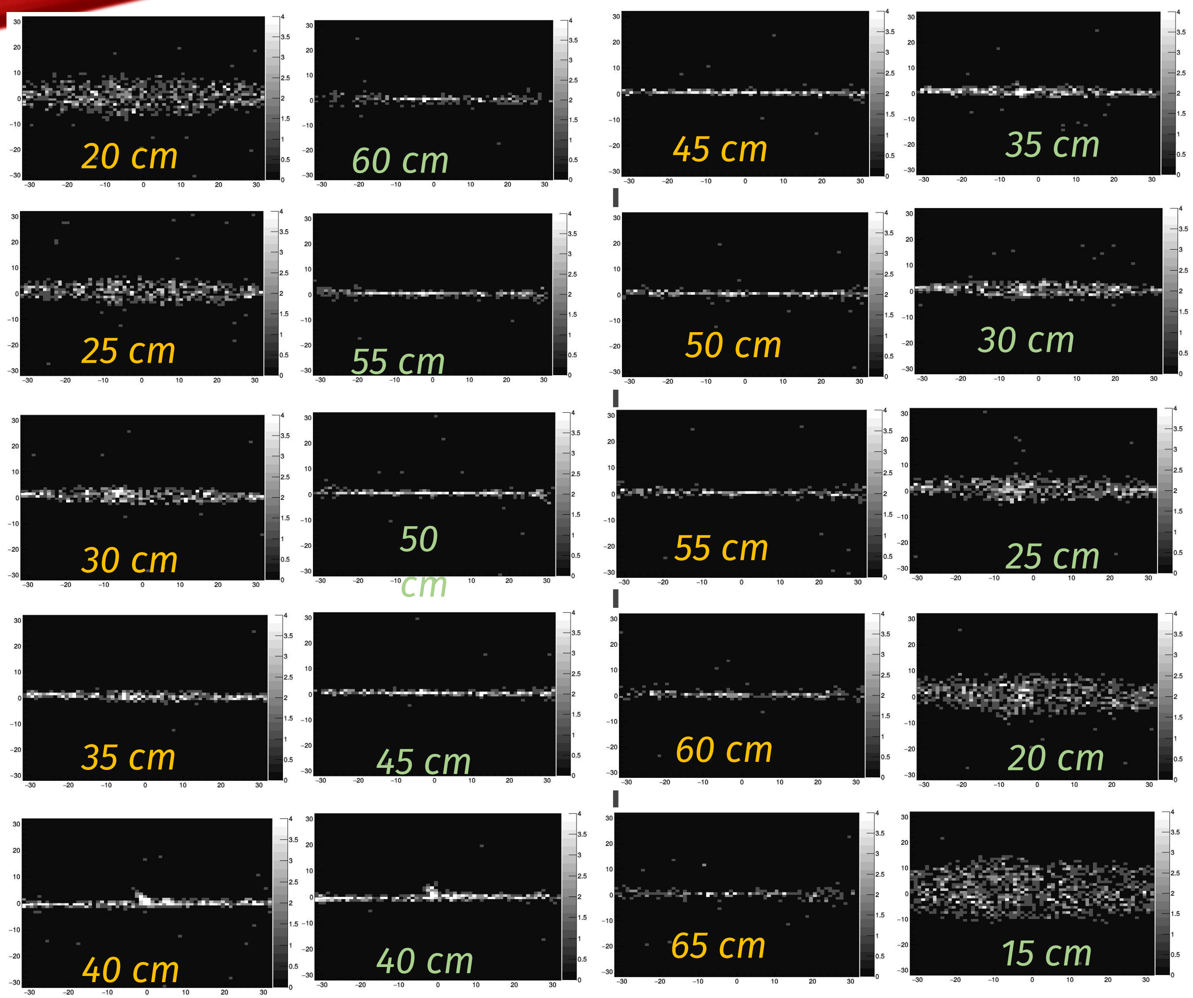
Lens radius 25-30 mm → R > 70 mm → focal length > 80 mm

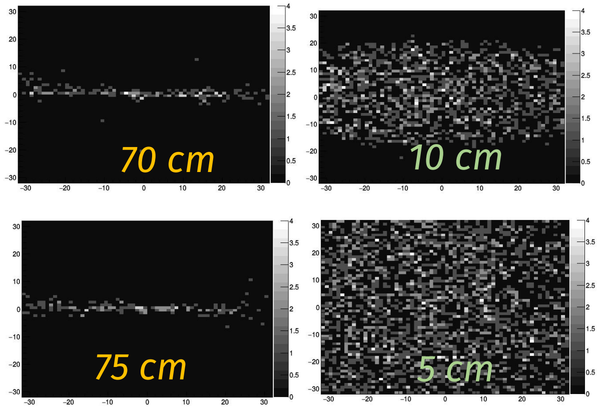


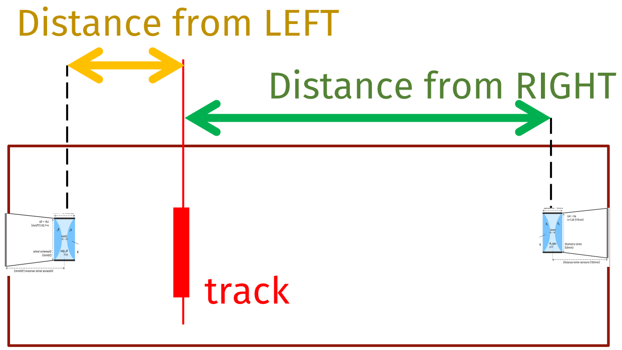


Focal length between 88 mm and 98 mm accordingly to LAr refractive index (1.26 or 1.4)

THE FOCUSING EFFECT







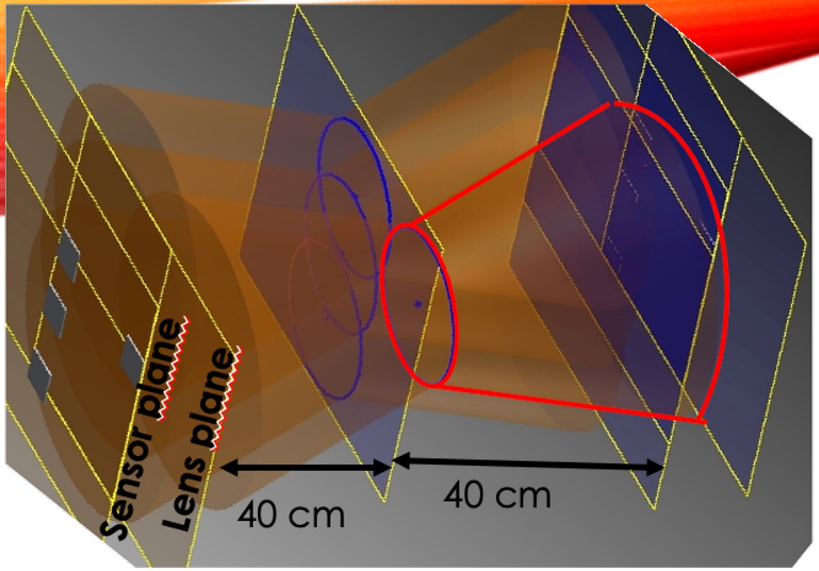
Sensor 64x64
SiPM 1mm²
SiPM QE: 20%

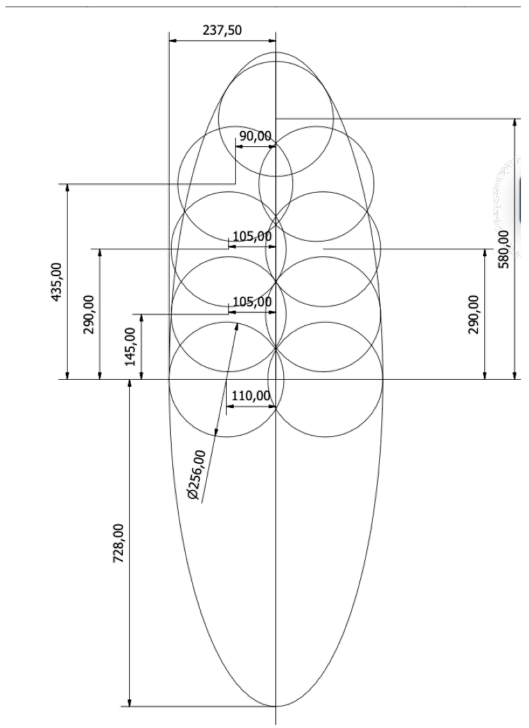
40cm track
175 nm
LY: $40000\ ph/MeV$

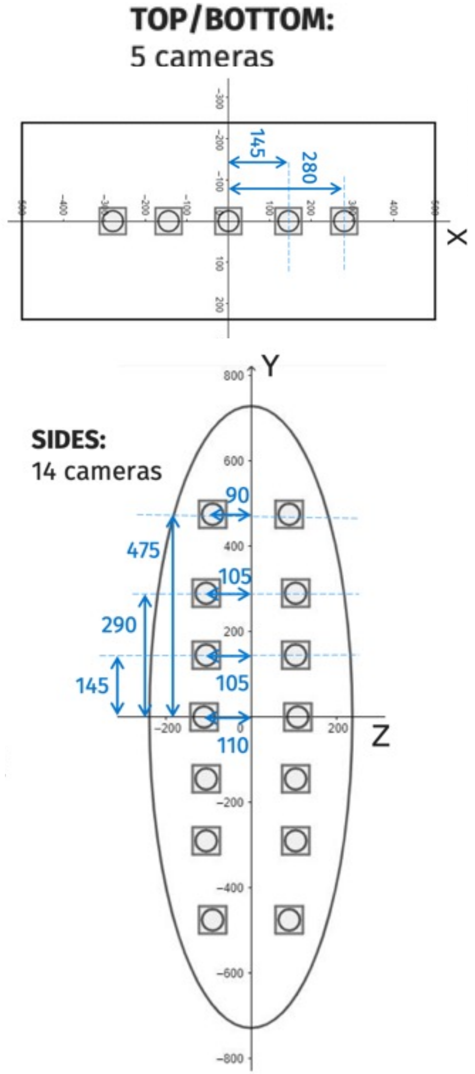
by using two sensors facing each other, the whole distance is covered

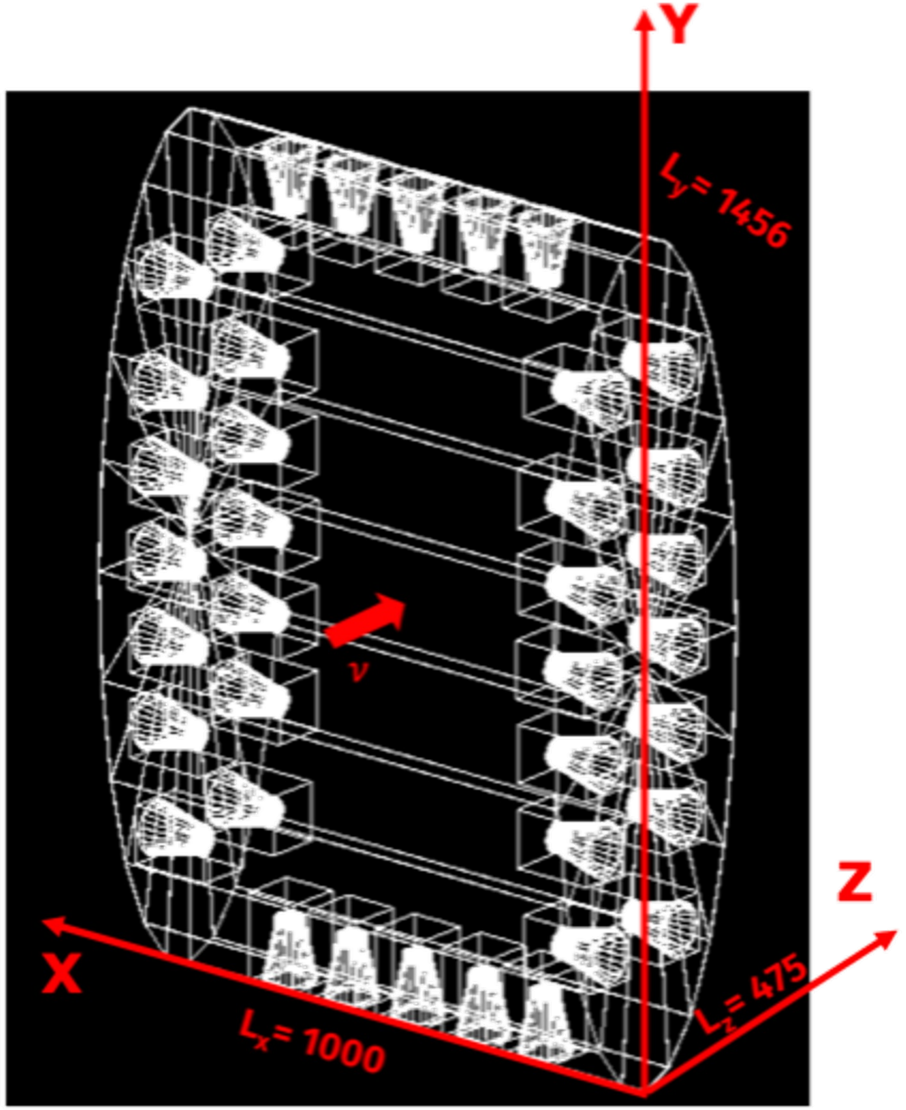
each sensor will detect the farest part (from 35 to 80 cm)

LENS SYSTEM IN GRAIN



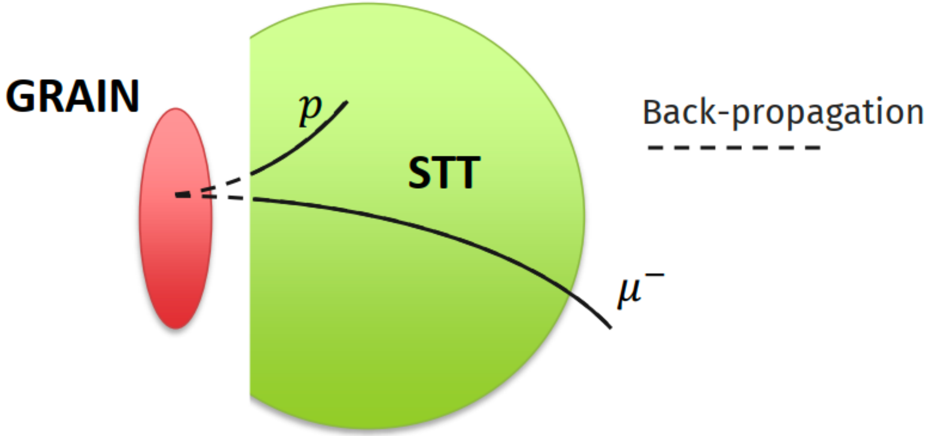


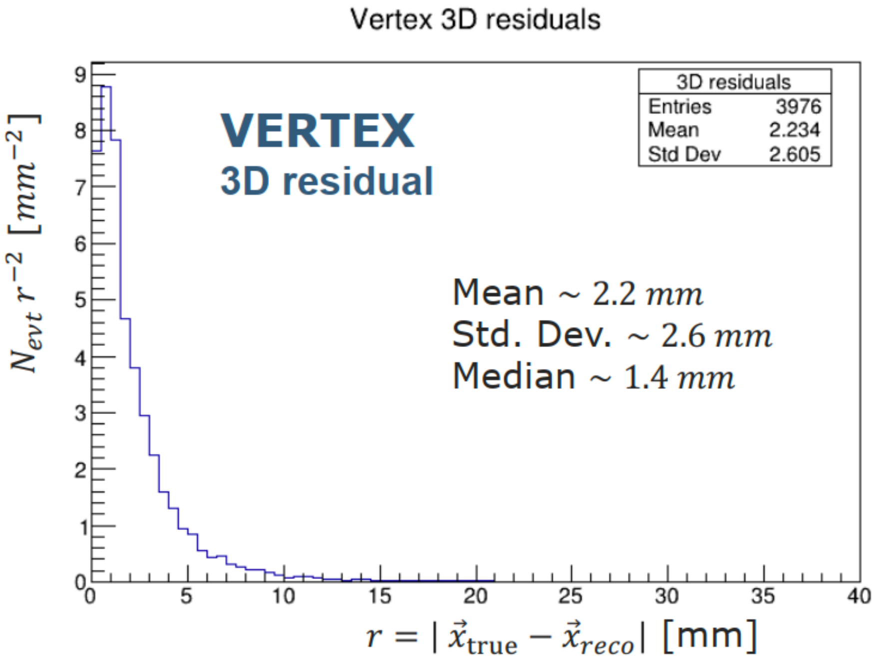


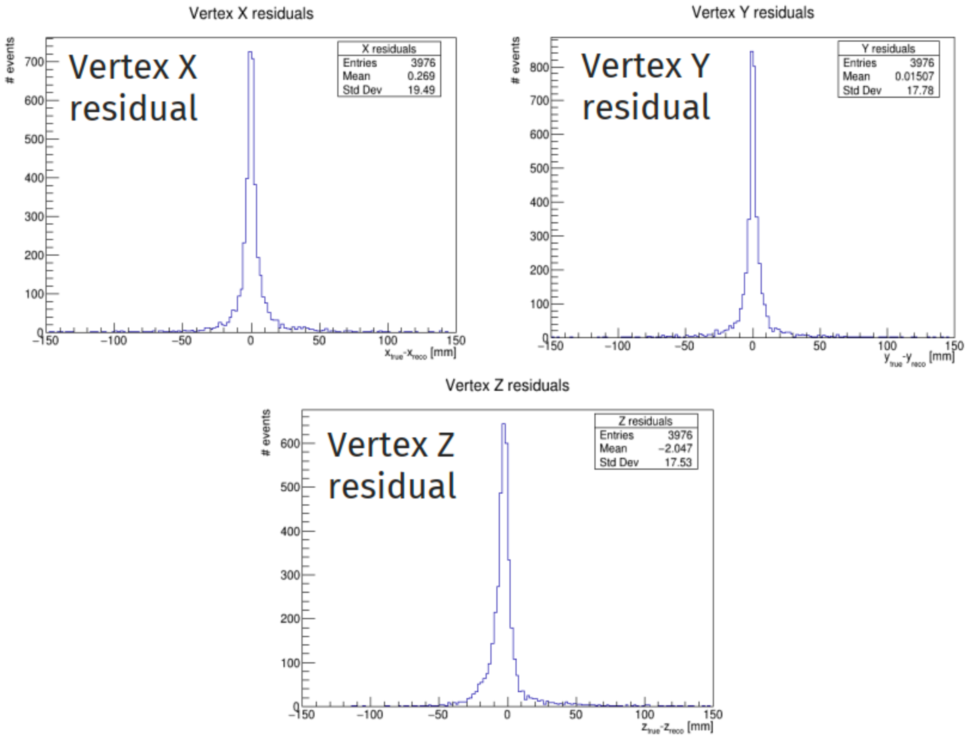


Vertex reconstruction

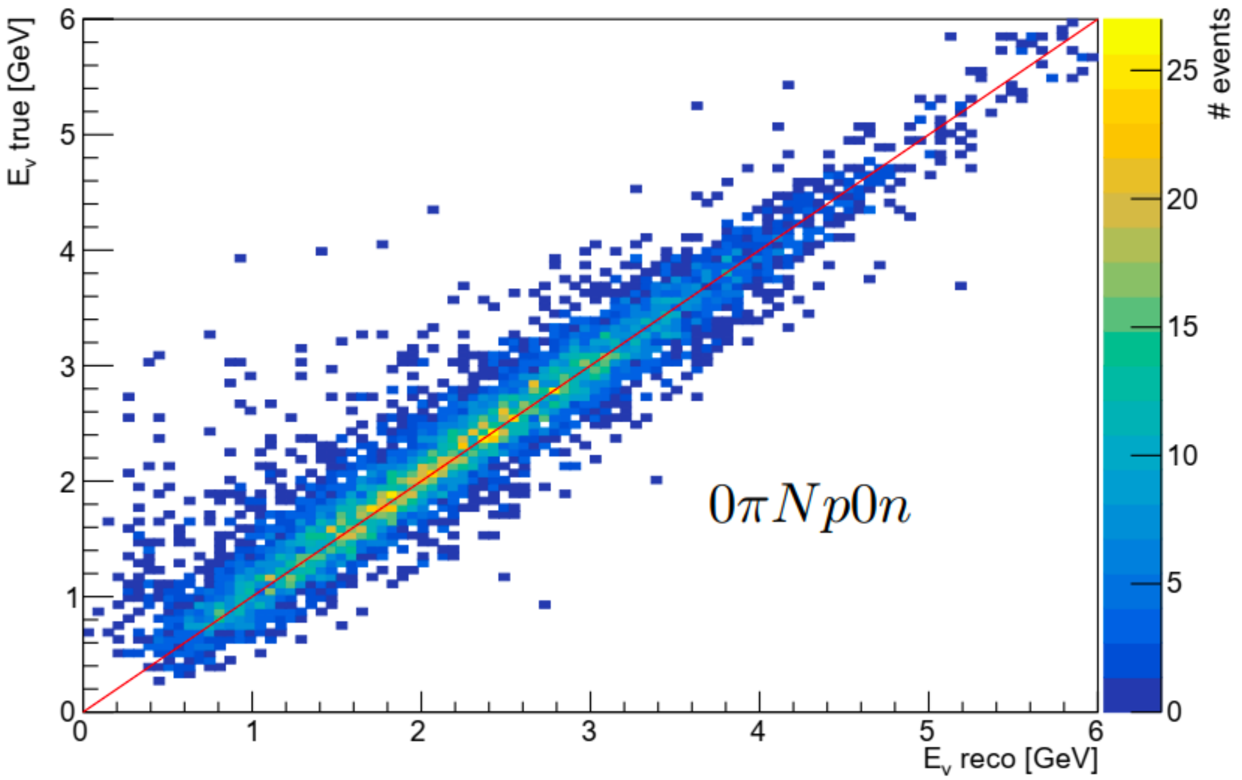
- Vertex can be found with back-propagated tracks (if available) from the STT tracker.
- GRAIN cameras allow an **independent vertex reconstruction**:
  - Rejecting backgrounds, passing-through particles, etc.



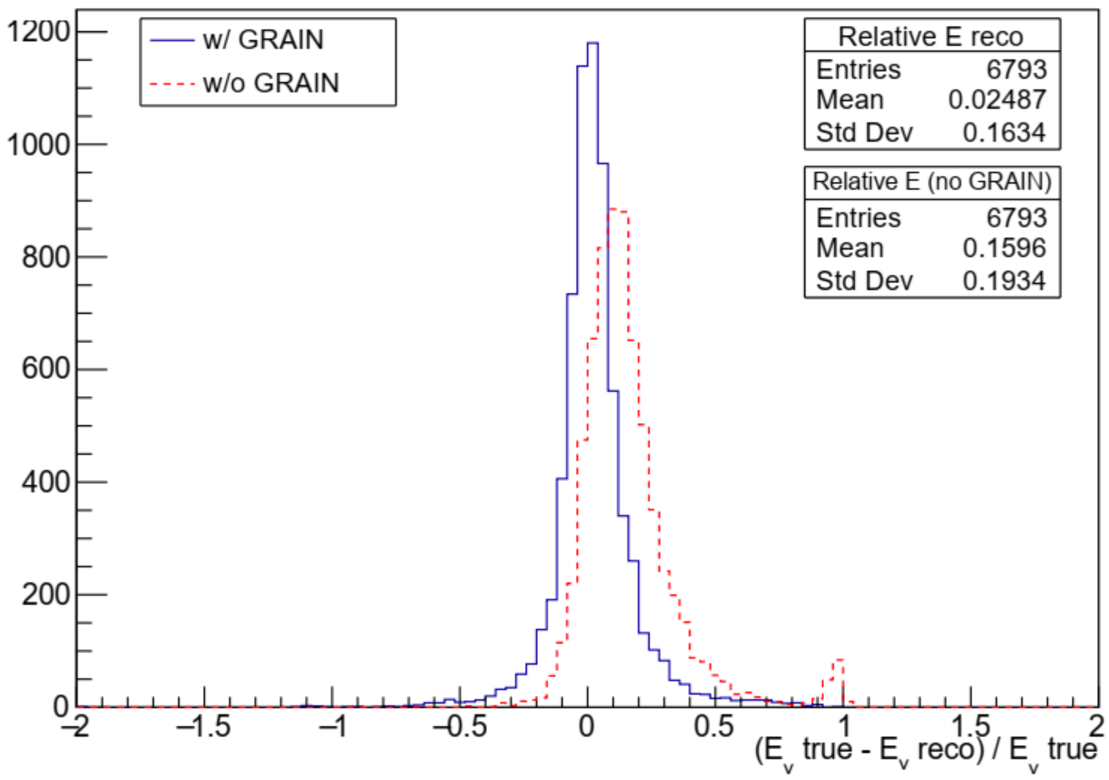




NEUTRINO ENERGY



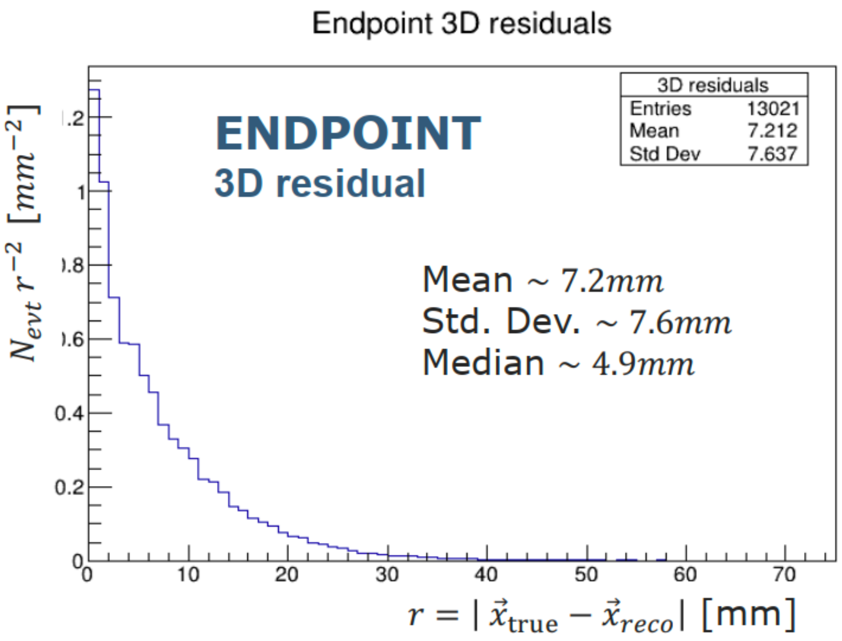
(a) $E_\nu^{\rm reco}$ vs $E_\nu^{\rm true}$

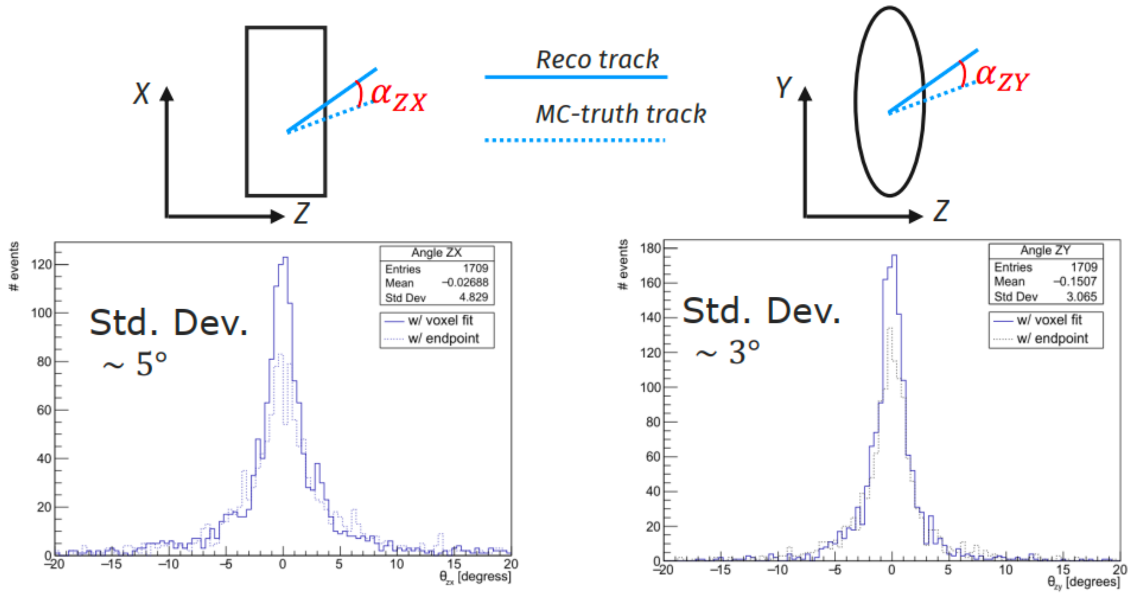


(b) $(E_\nu^{\rm reco} - E_\nu^{\rm true})/E_\nu^{\rm true}$

Track reconstruction

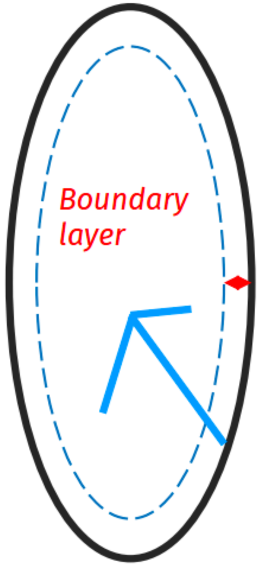
- 3D track reconstruction: track endpoint, track direction, matching with downstream tracker.





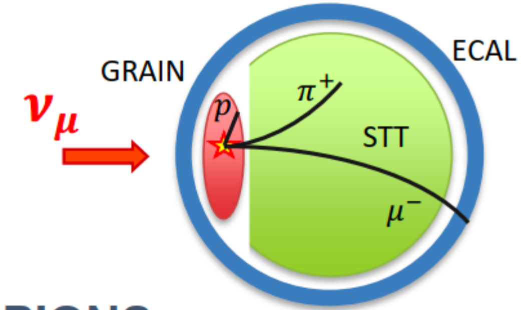
MATCHING with STT

TRUE \ RECO	Contained	Not contained
Entering STT	3%	97%
Not ent. STT	74%	26%



Acceptance

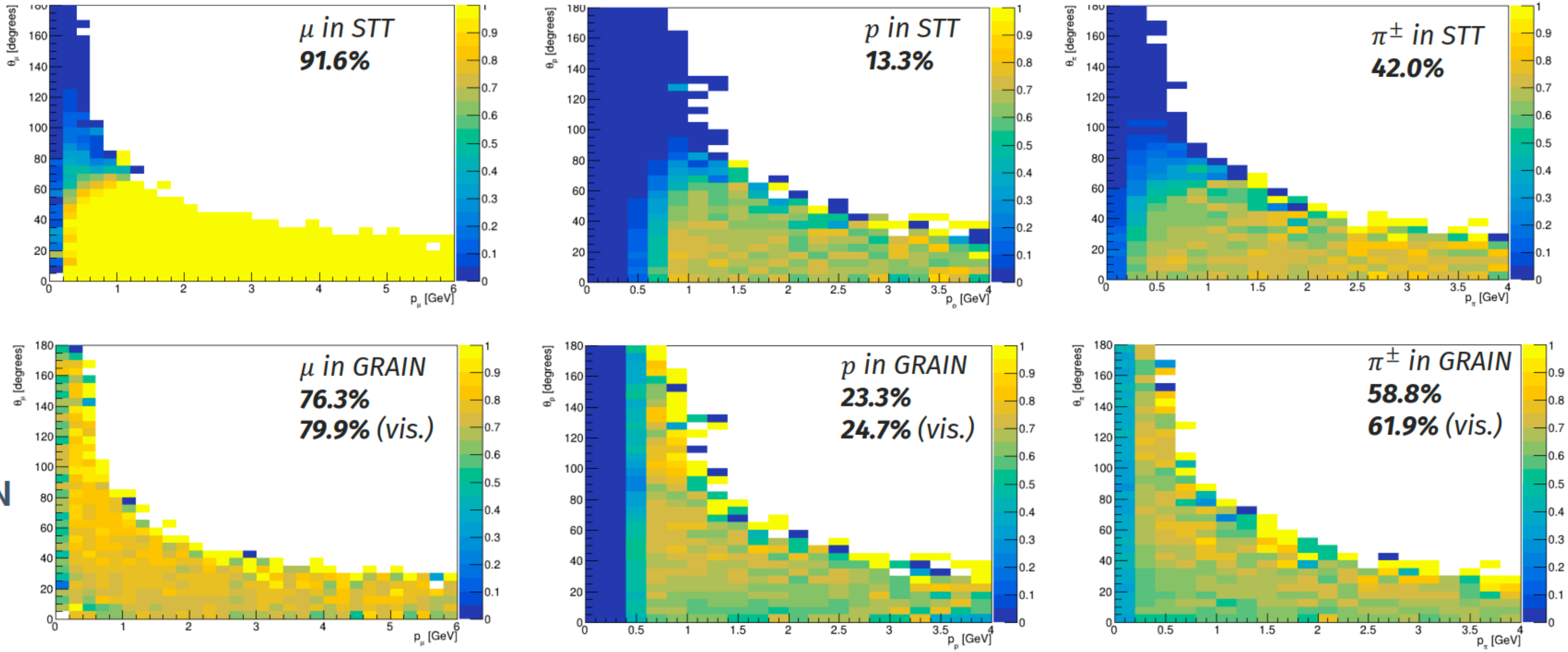
for particles produced in GRAIN (FHC sample)



MUONS PROTONS PIONS

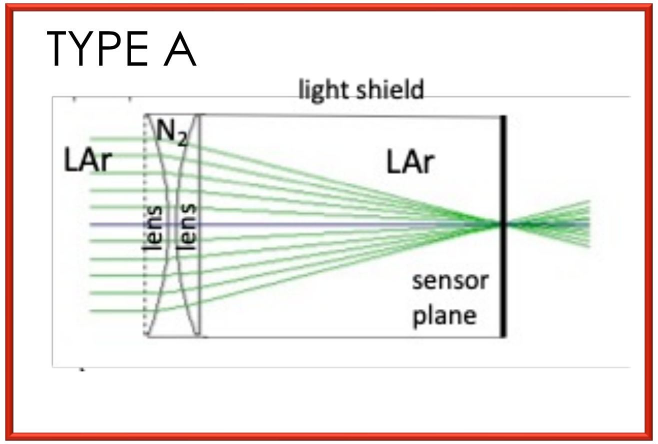
STT

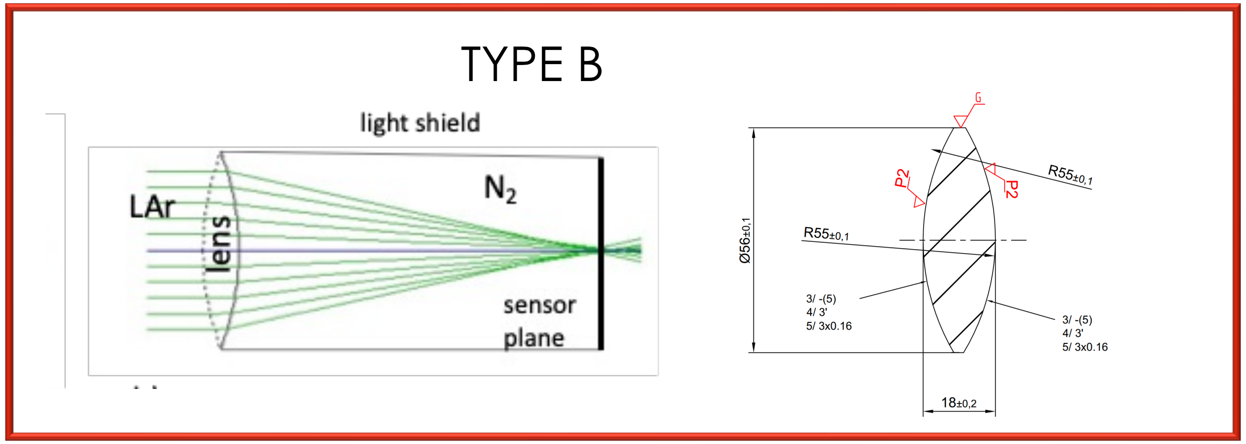
GRAIN



LENS PROTOTYPES

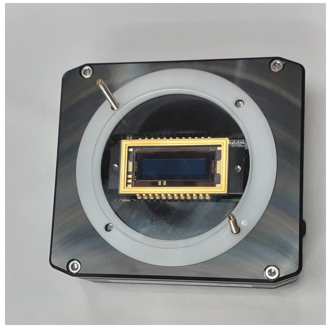
- 3 prototypes:
  - Type A: the same of the simulations (focal lenght 89 mm)
  - Type A: similar (focal 89 mm) but bigger ∅ = 60 mm
  - Type B: Single bi-convex lens (focal 64 mm)





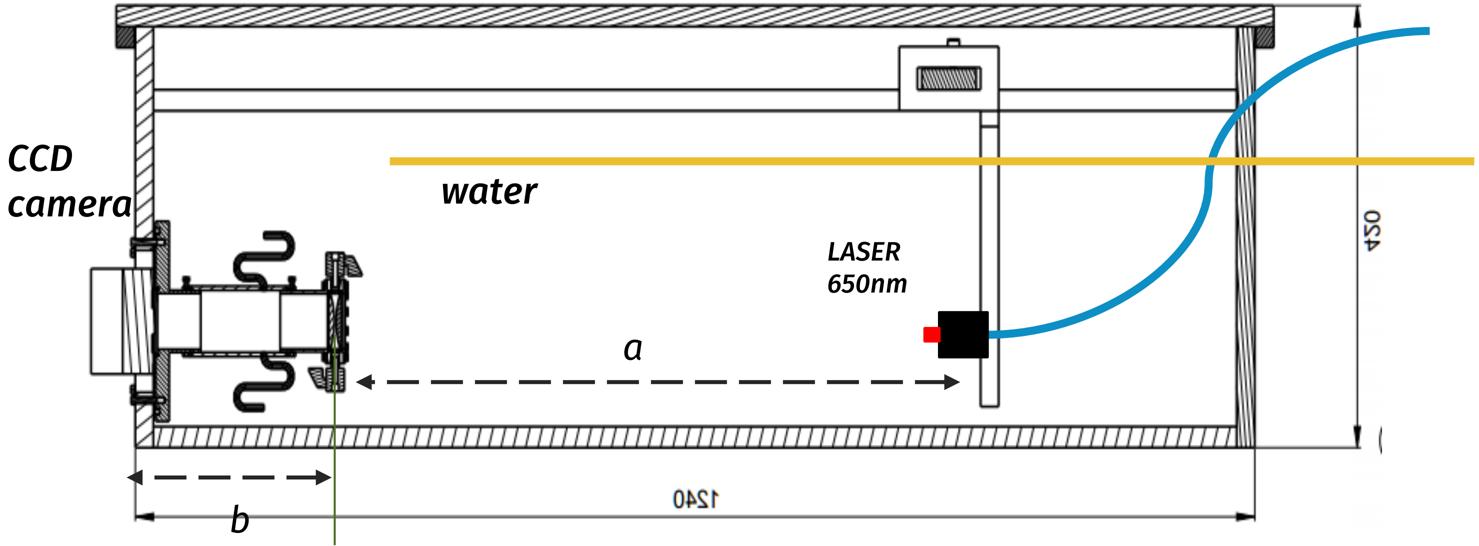
TESTS IN WATER

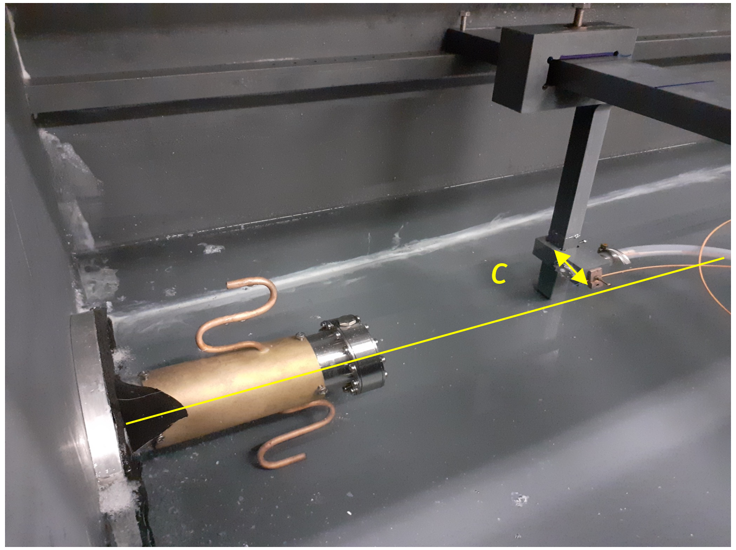
- **Visible light source (650 nm)**
  - trasported on fiber
  - movable position inside the box volume (a, b, c variable)
- **In water** → (n_lens=1.45 n_water=1.33, bigger focal length f=118 mm)
- **with a CCD camera** (sensible to UV or visible light)



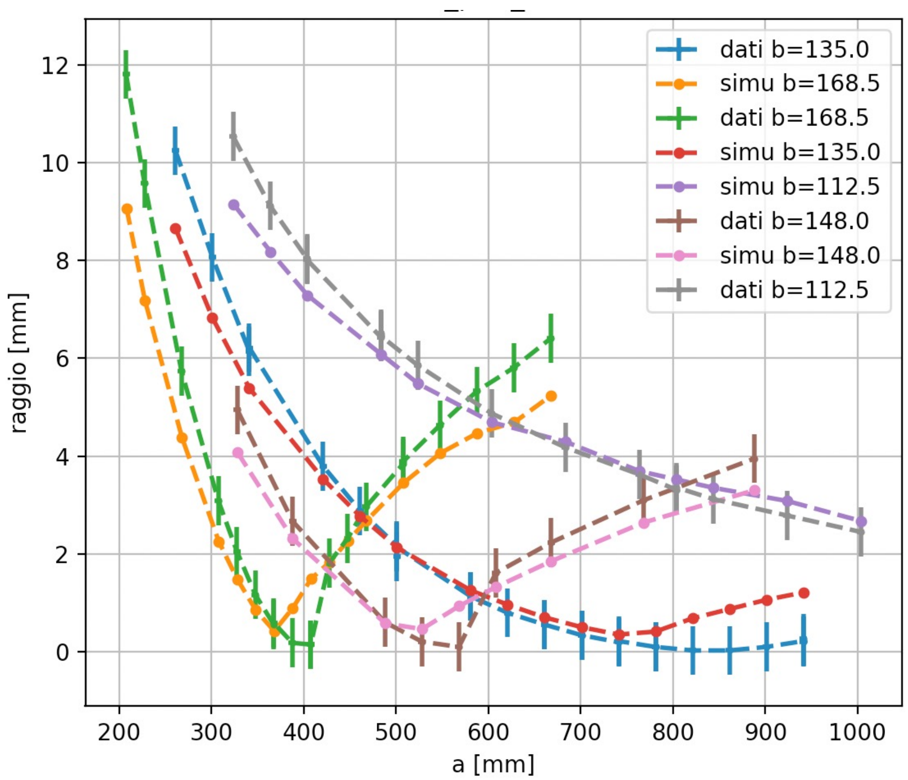
CCD (UV-visibile)
Dim: 24 mm x 12 mm

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





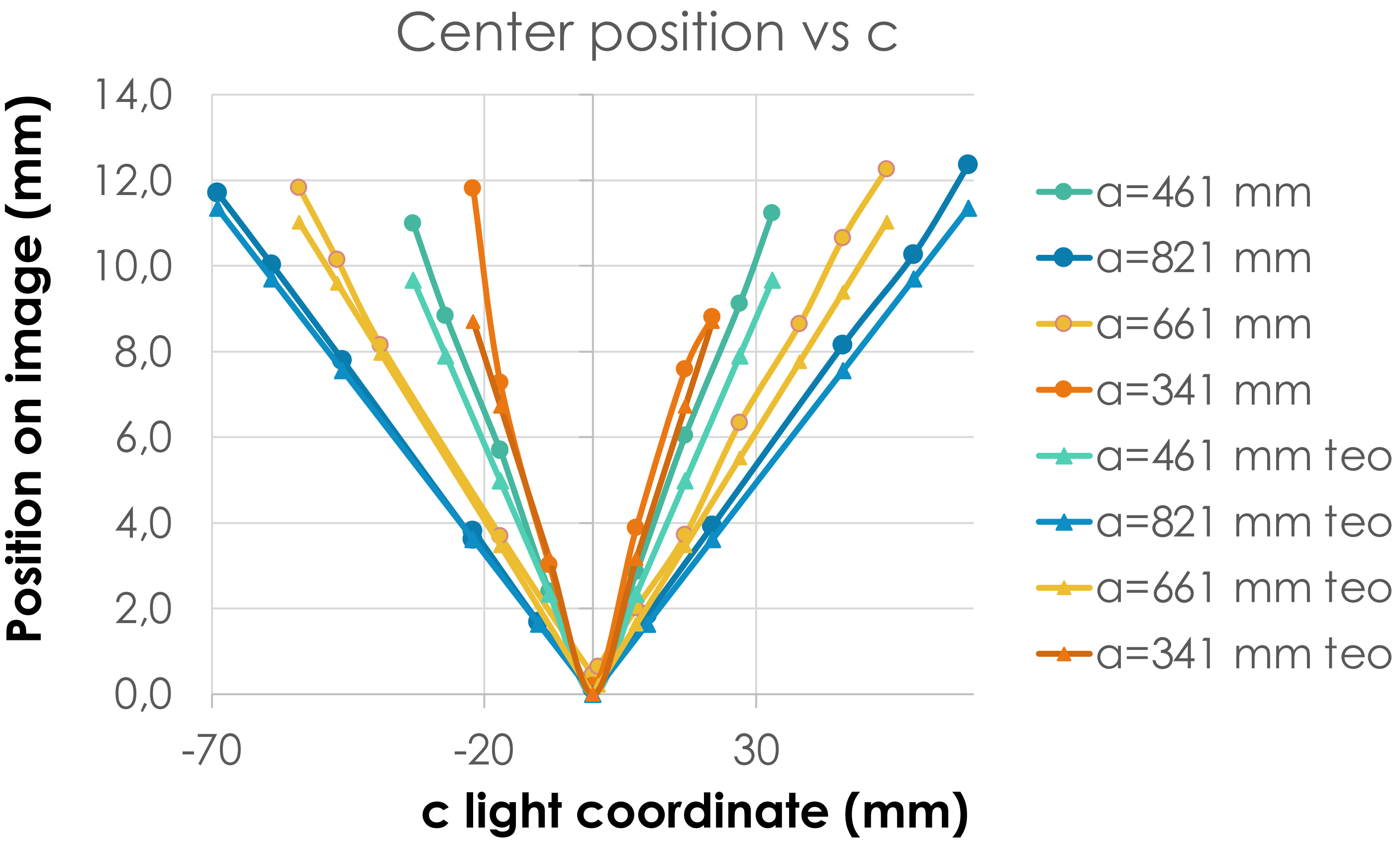
DATA & SIMULATION



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

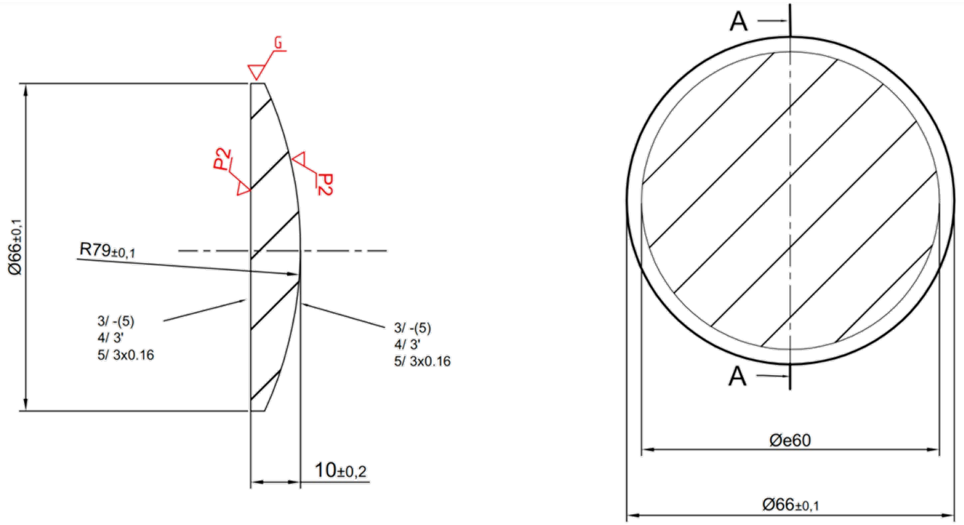
for b= 135 mm

Comparison with the expected (teo) values

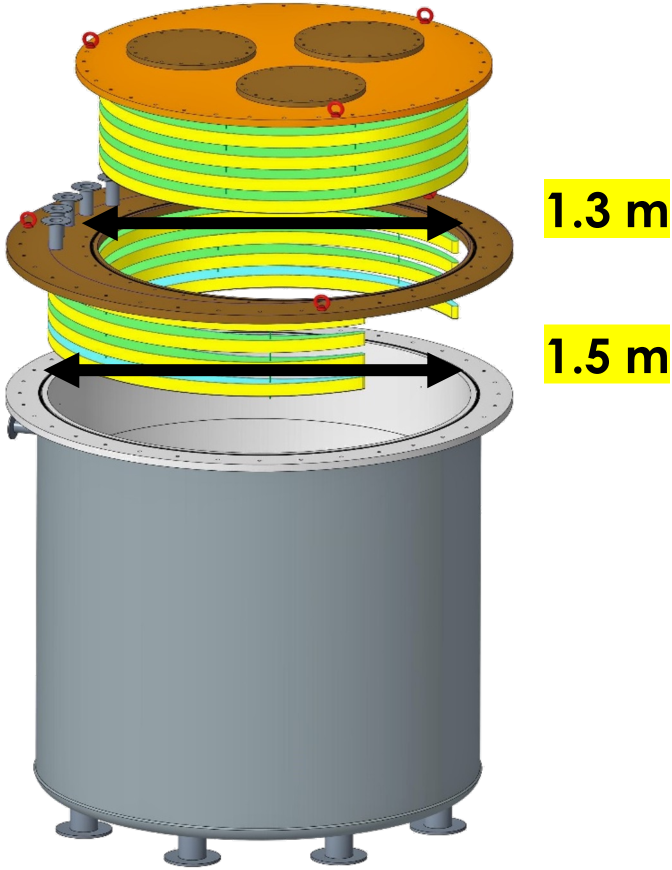


NEXT STEPS ON SIMULATIONS

- Improving track & energy reconstruction
- Update the GRAIN geometry with the current cryostat dimension and bigger lenses
- Evaluate the performance and optimize the lens geometry layout
- Study the time distribution of photons impinging on each SiPM

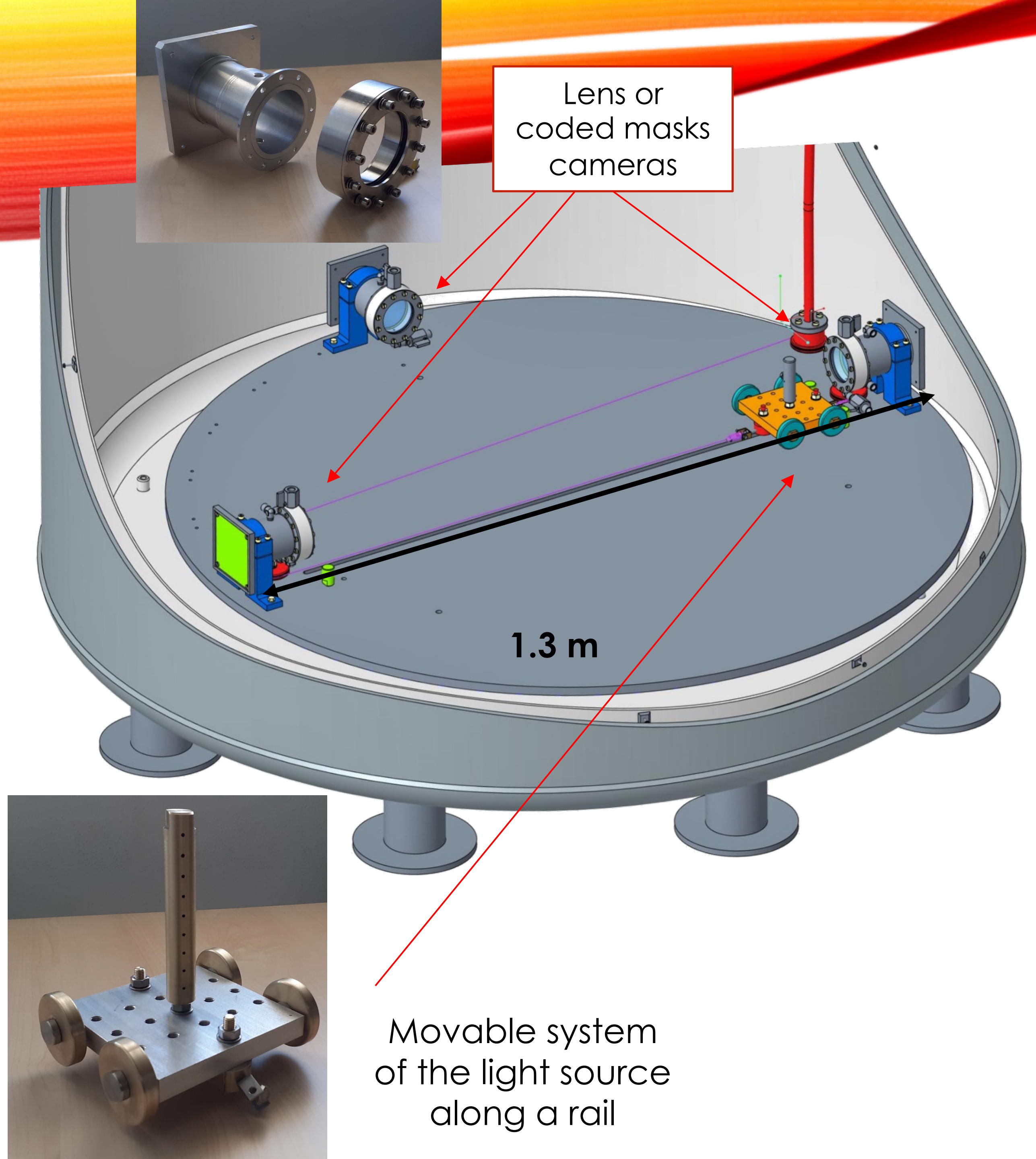


ARTIC
ARGON TEST INFRASTRUCTURE



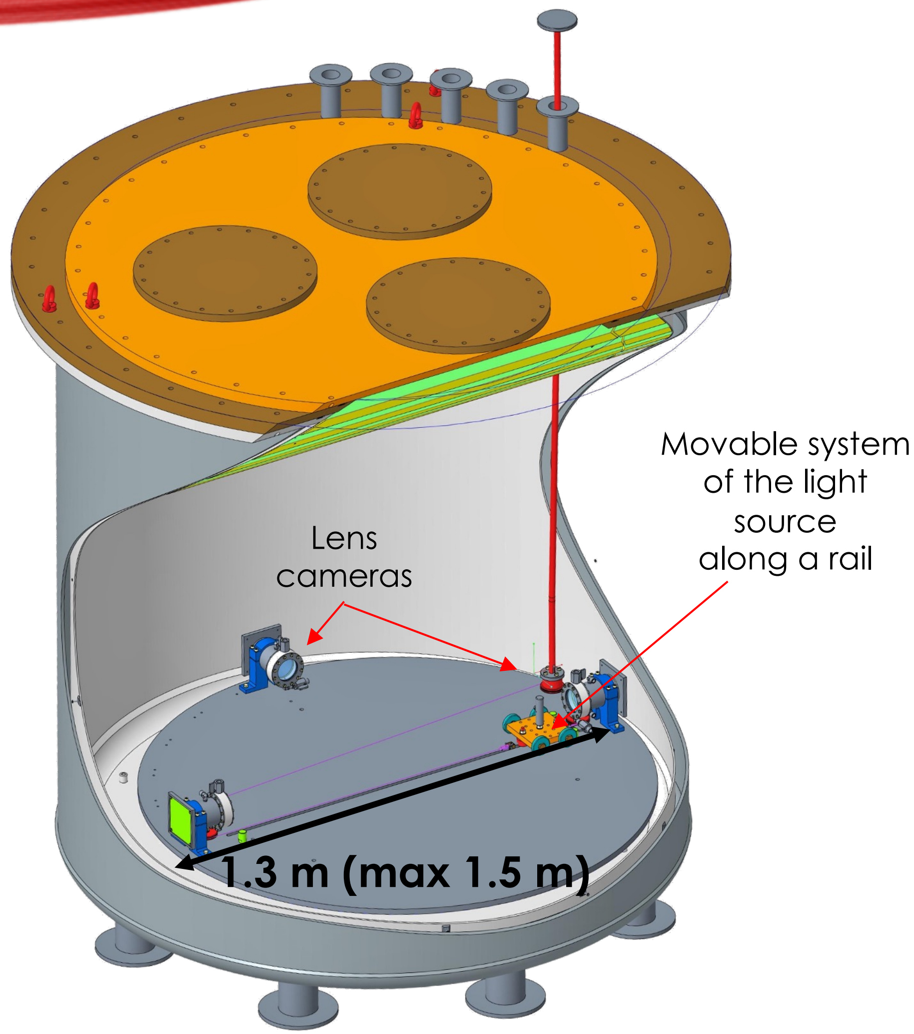
Evaporation rate
→ 0.7 l/h if the N2 level is at 10 cm
→ 2 l/h if the N2 level is at 1 m

FIRST TESTS IN LAR



- The same set up will be used **both for lens based** or **coded mask** based detectors
- SiPM matrix of 16x16 (1mm or 3 mm)
- ALCOR-ASIC with ToT and Xilinx FPGA for data acquisition
- Tests in **LAr** (150 l) with an **artificial light source** at 180 nm (Hg lamp+ monochromator + fiber)
- 200 l of liquid Argon
- First tests planned to start in March!!

FUTURE TESTS IN LAR



- **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)

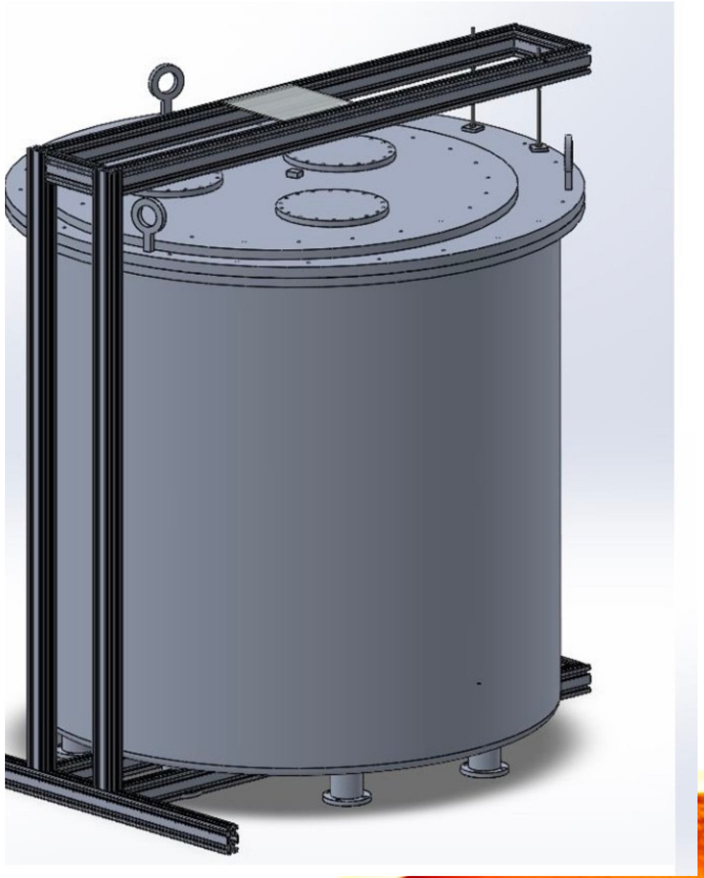
- **We are finalizing the design of the system:**
  - minimum system
  - 150-200 liters
  - for purifying Ar for light yield

These tests:

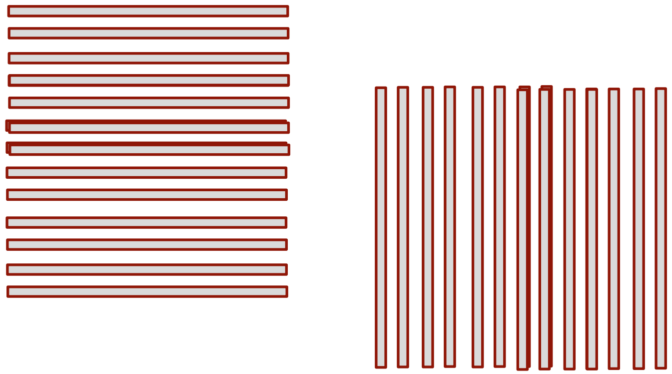
- will validate the possibility to use the new detectors in GRAIN
- will allow us to design and test the final detectors and electronics
- will provide additional measurement of LAr properties

CRT for ARTIC (by Lecce group)

Trigger : fourfold coincidence



48 cm x 48 cm



16 channels x 4 planes = 64
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 μm pitch