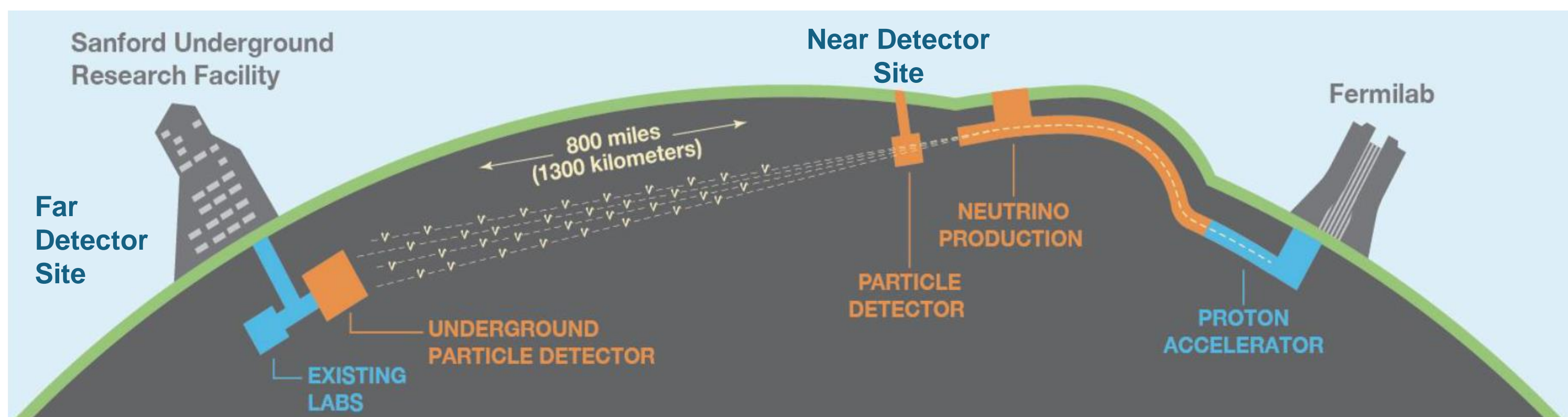


Francesco Chiapponi, on behalf of the DUNE collaboration

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## The Deep Underground Neutrino Experiment



### The physics:

- Determine CP violation for the leptonic sector
- Determine neutrino *mass ordering*
- Precision measurement of mixing angles
- Detect solar and supernovae neutrinos
- BSM physics studies

### The Far Detector:

- 1500 m underground (4850 mwe)
- Multi-kiloton detector based on liquid Argon TPC
- 2 modules (Phase I) with 20kt total fiducial mass

## GRAIN detector

GRAIN will use an innovative approach based on the detection of Argon scintillation light, ensuring cross-calibration with the other ND components to constrain systematic uncertainties from nuclear effects.

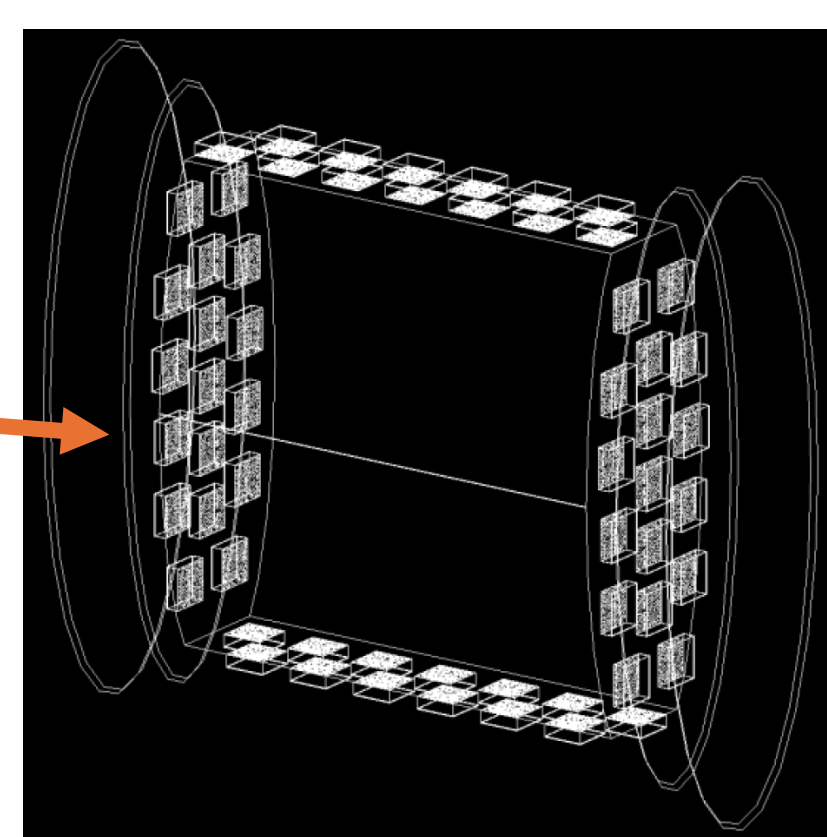
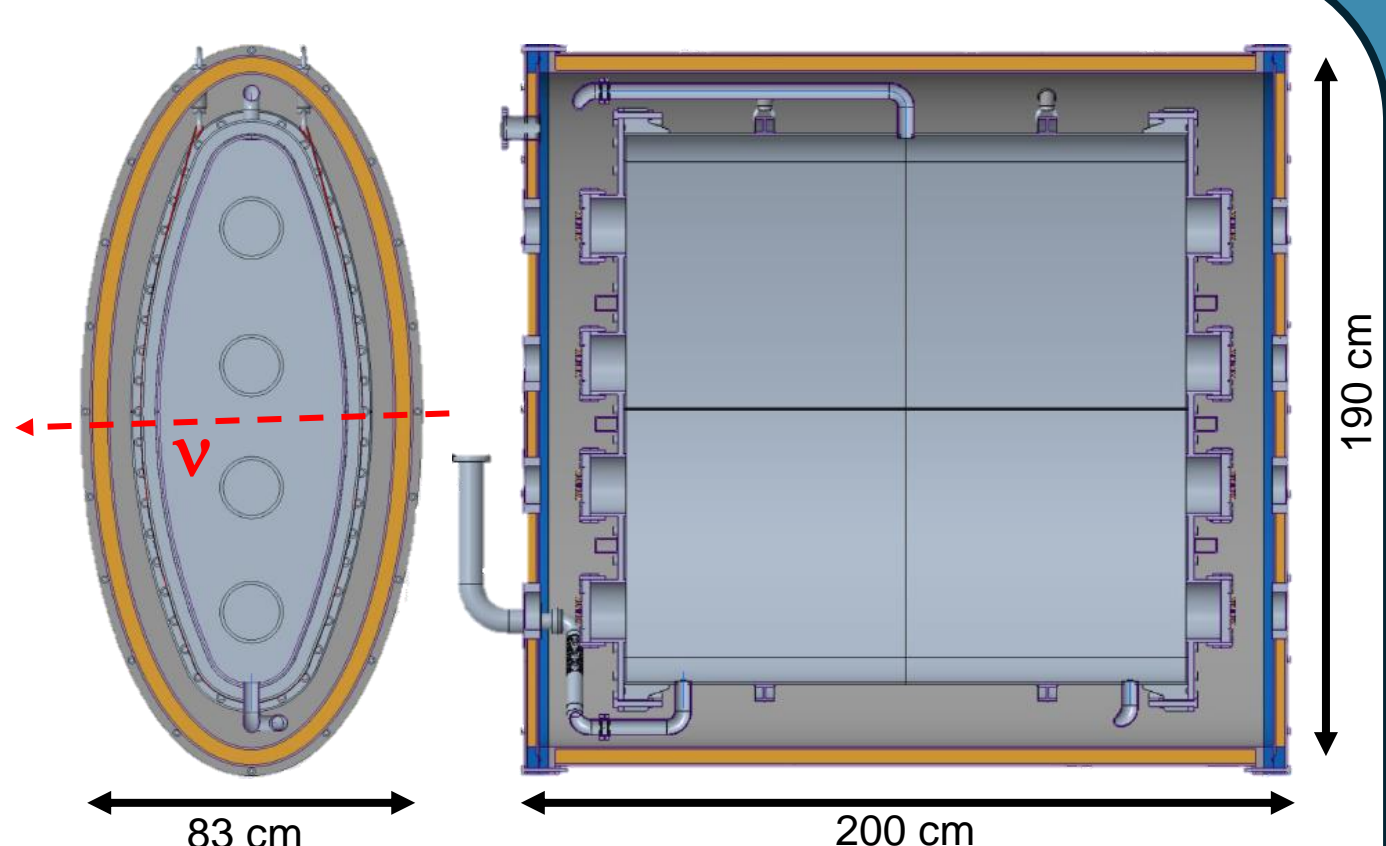
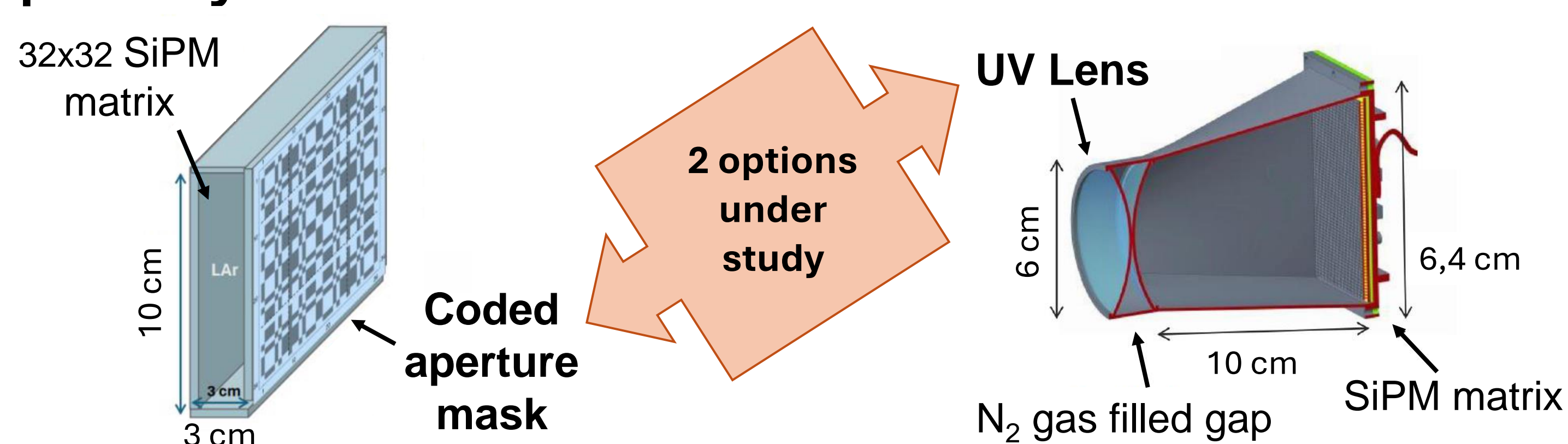
### Objective

- Reconstruct particle tracks *using only scintillation light*

### Requirements

- *Segmented* sensors on the inner cryostat walls
- Resolution <1cm
- Time resolution < 1 ns
- Light sensors operating in the *VUV range* (127nm)
- Sensors and electronics operating in LAr (87K)

### Optical system

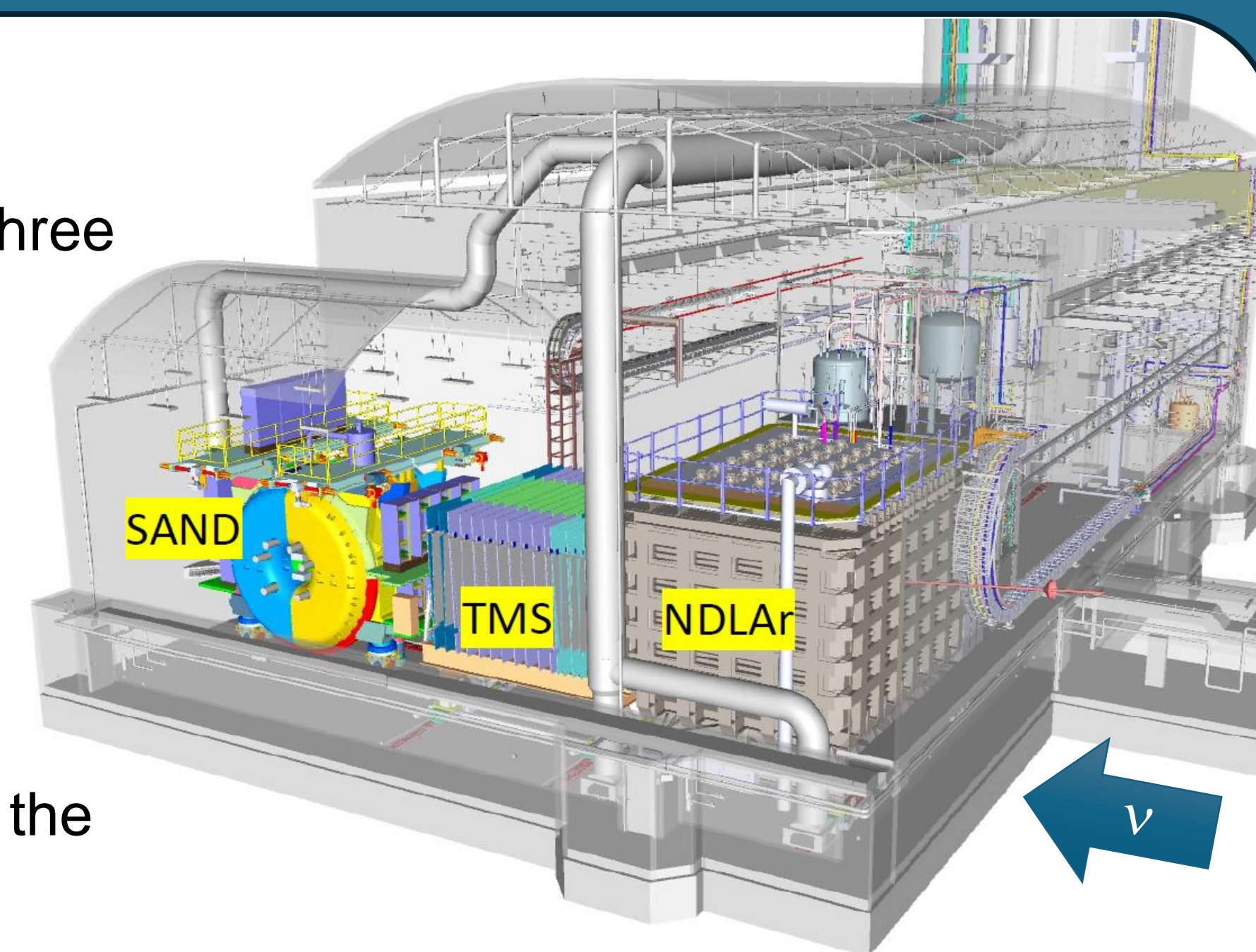


## Near Detector

During Phase I, it will include three primary detector components:

- ND-LAr
- Muon Spectrometer
- SAND

ND-LAr and TMS will move off-axis in order to "scan" over the spectrum of  $\nu$  energies

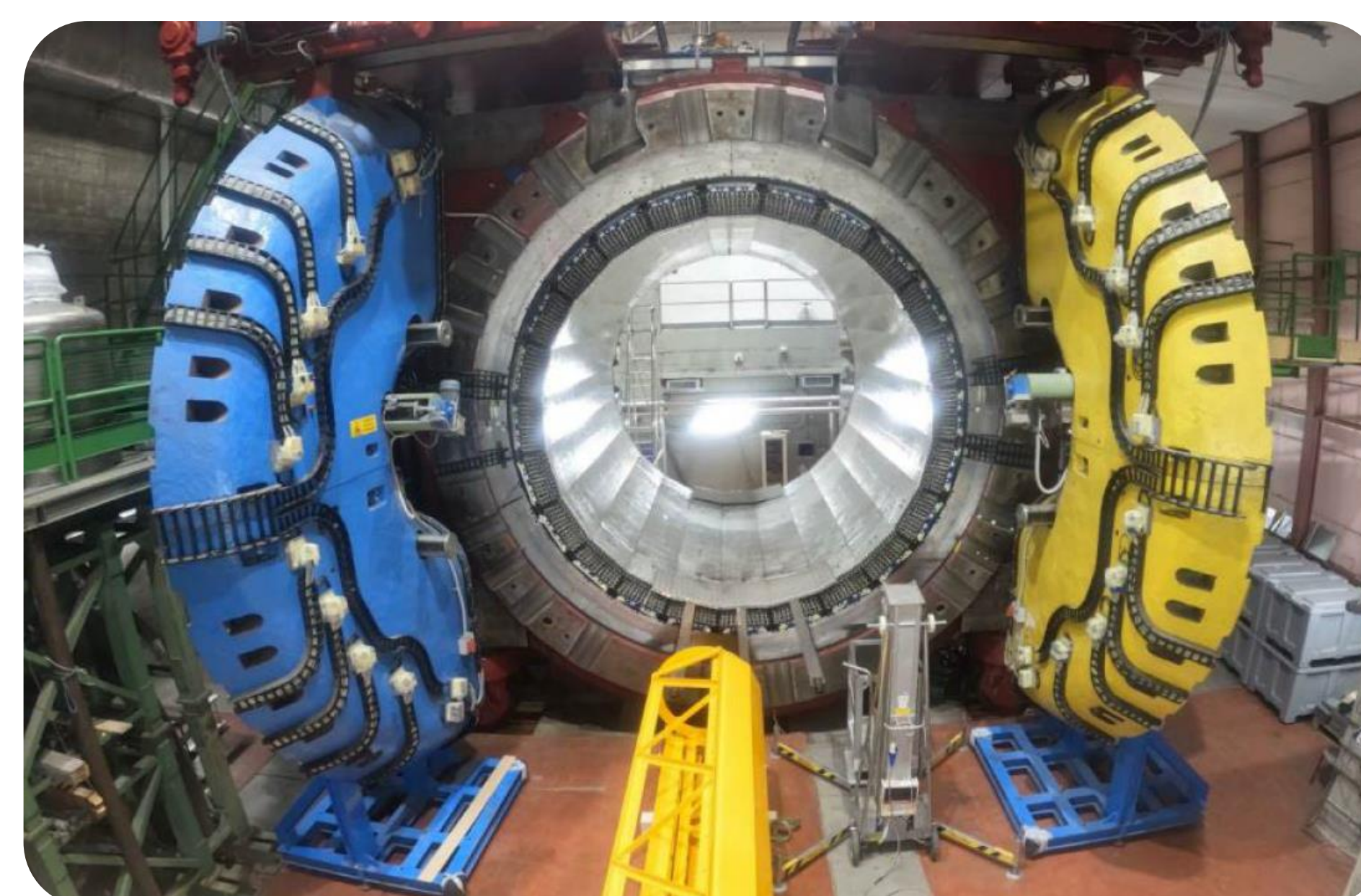
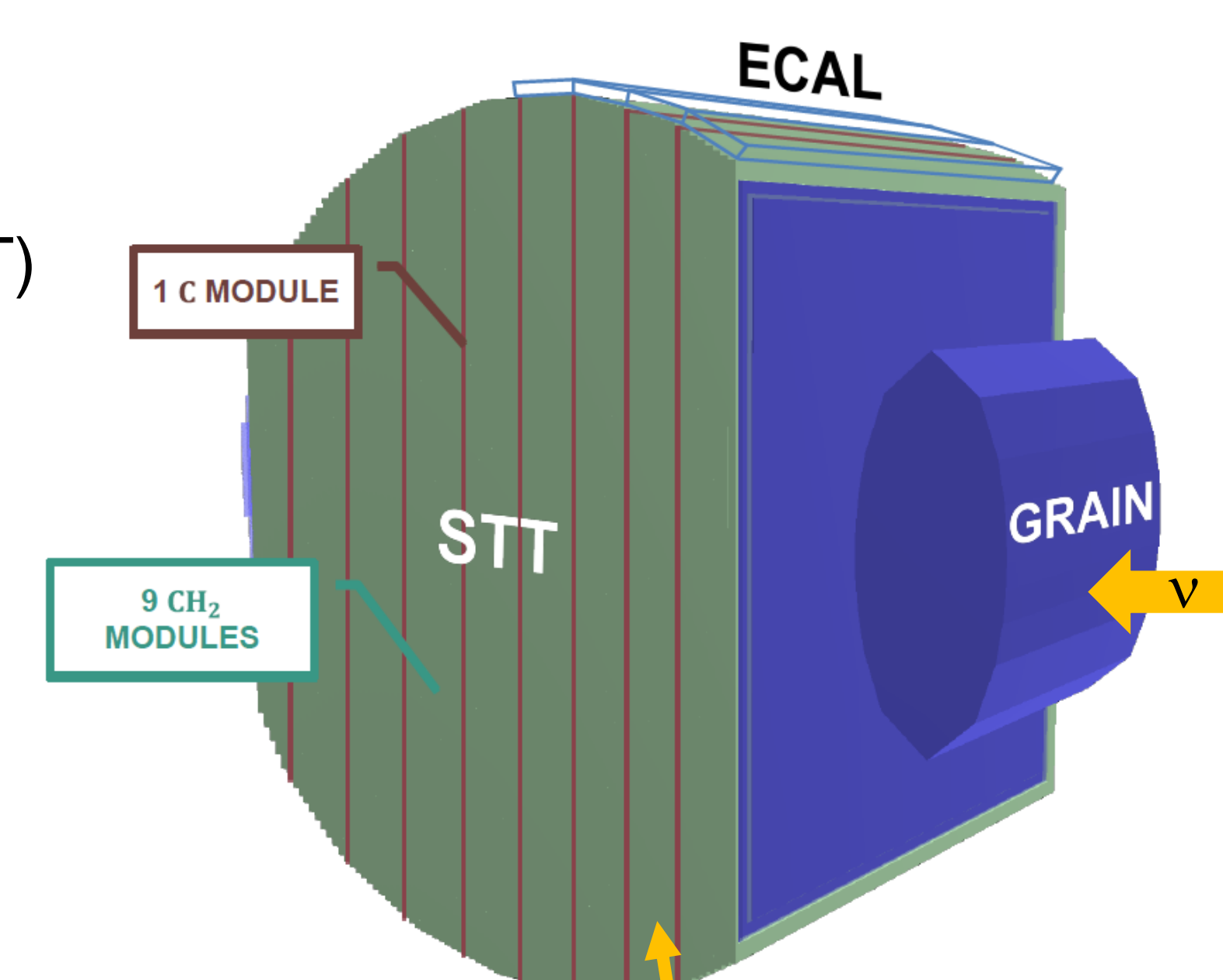


## System for on-Axis Neutrino Detection (SAND)

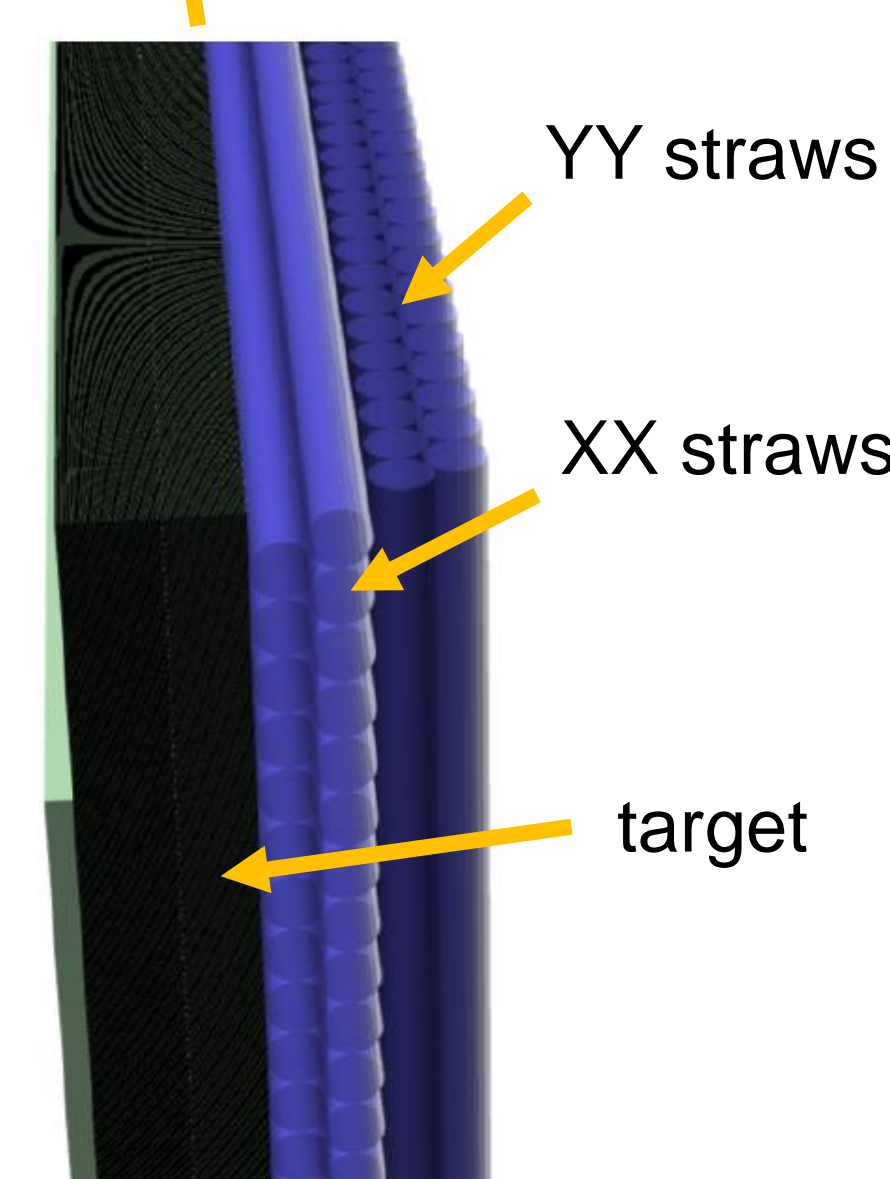
**Multipurpose detector:** its physics goals include *monitoring* of the on-axis  $\nu$ - $\bar{\nu}$  spectra to detect beam variations on a weekly basis, and perform *neutrino cross section studies* on different nuclear targets, together with on-axis *flux measurement* for a robust analysis in combination with other ND detectors.

It is composed by:

- Superconducting solenoid (0,6 T)
- Electromagnetic calorimeter  
 $\sigma_E/E \approx 5\%/\sqrt{E(GeV)}$   
 $\sigma_t \approx 40ps/\sqrt{E(GeV)}$
- GRAIN (1t LAr active target)
- Light Straw Tube Tracker (STT) with distributed CH<sub>2</sub> and C targets



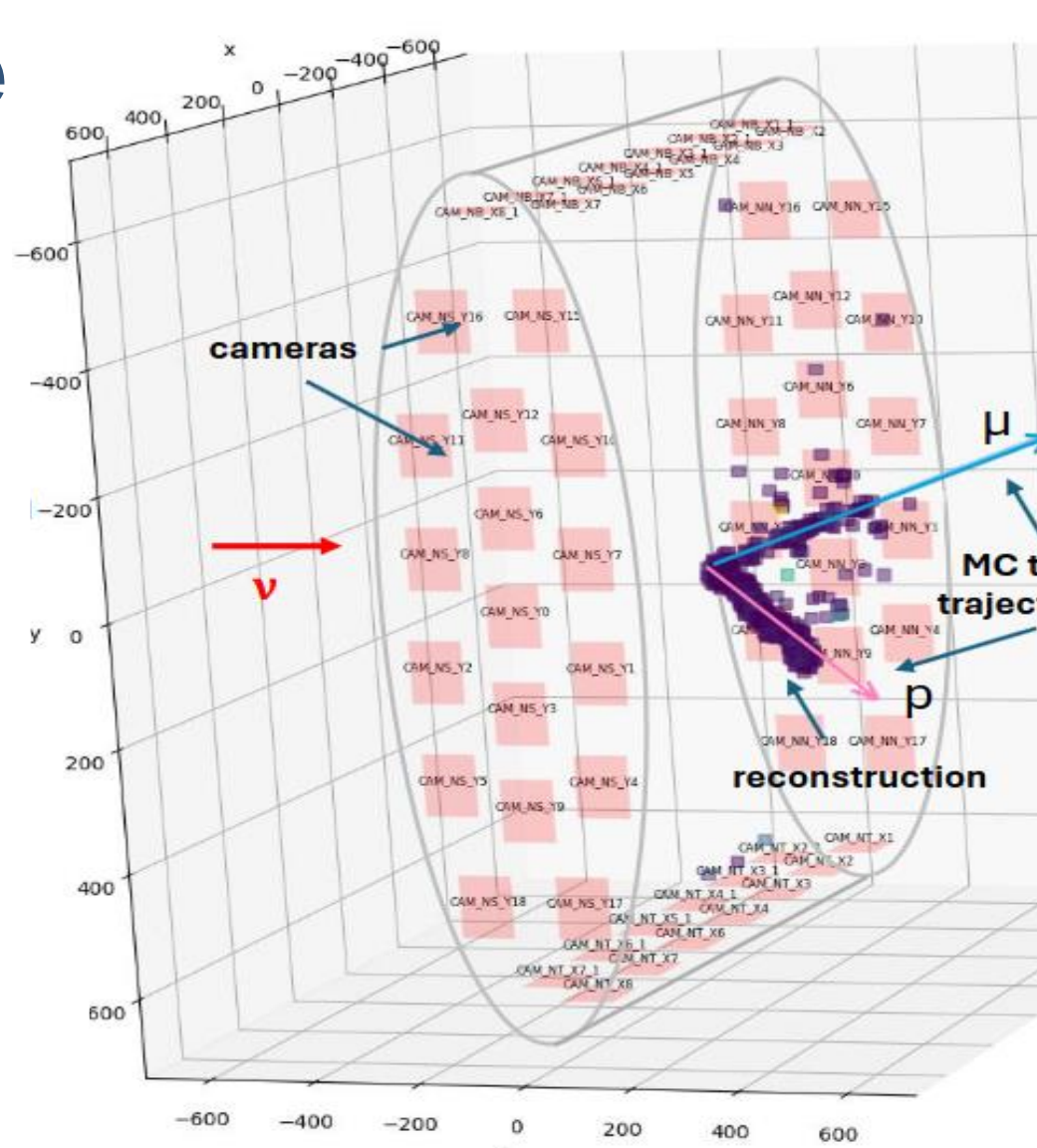
SC magnet and em calorimeter from KLOE experiment



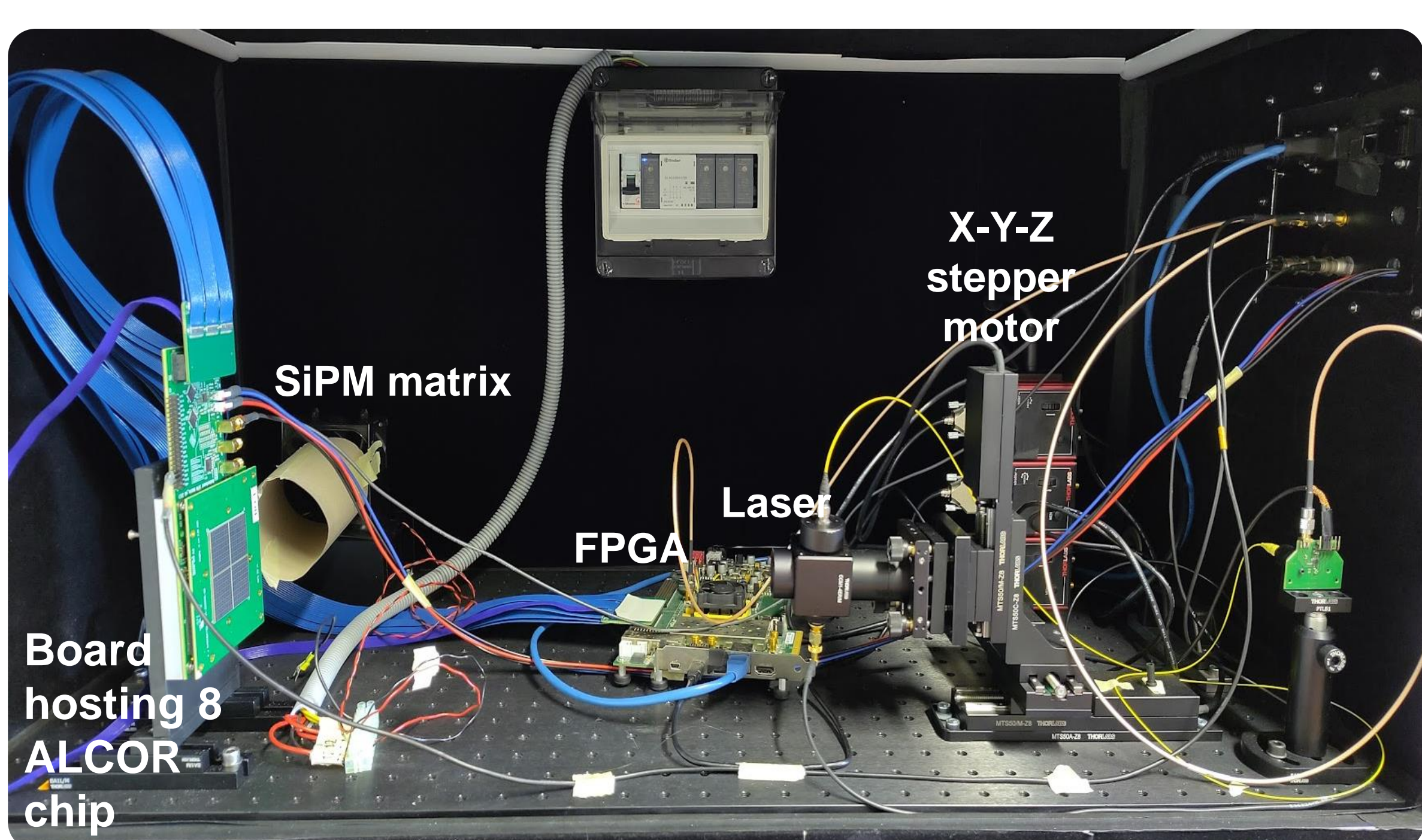
## Current work and perspectives

### 1. 3D event reconstruction with coded aperture masks systems

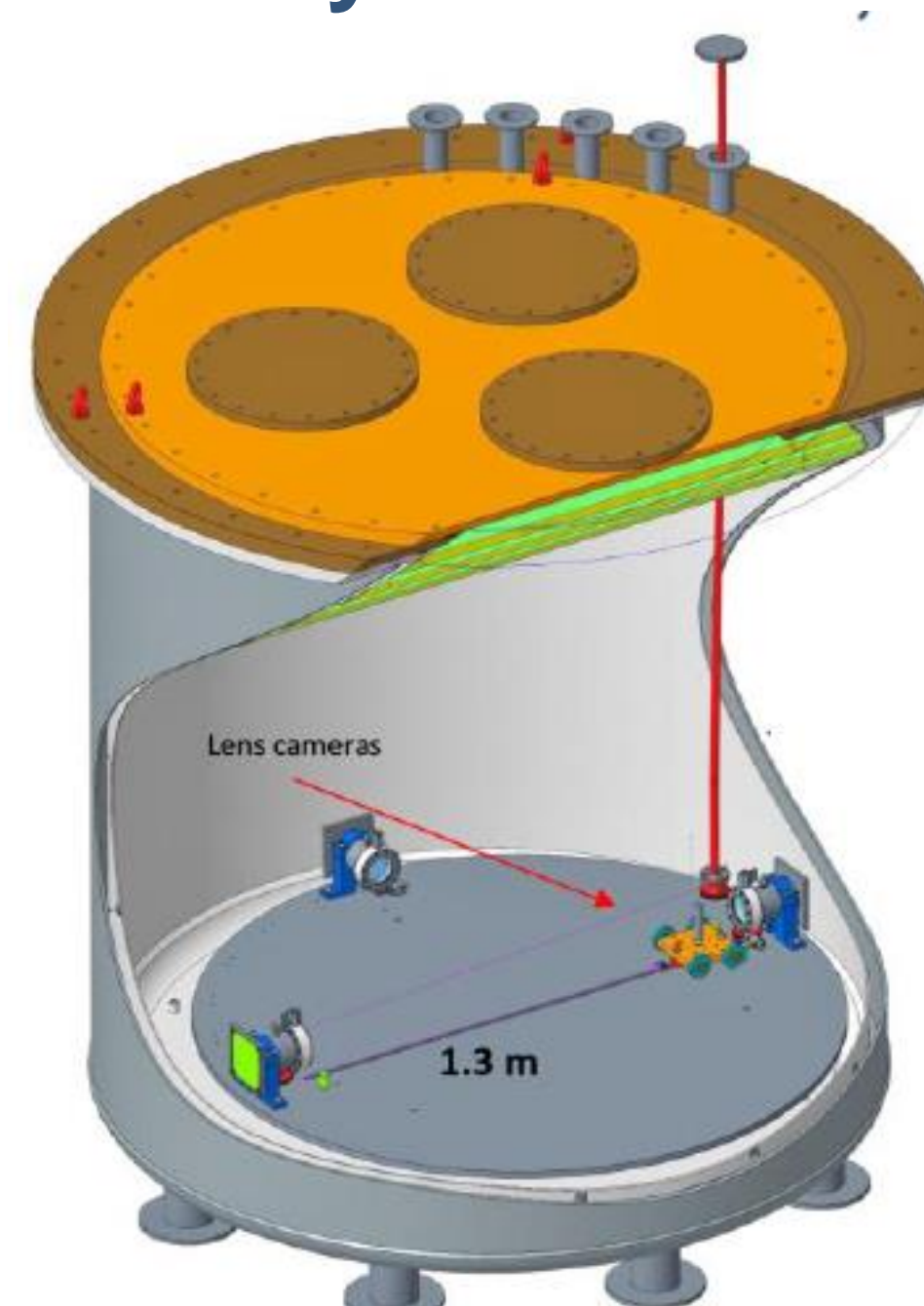
- Iterative algorithm based on *Maximum Likelihood - Expectation Maximization*
- Directly reconstructs in 3D the initial photon source distribution in a segmented volume (voxels)
- Maximizes the likelihood that an initial distribution density can produce the observed data
- Requires significant GPU resources



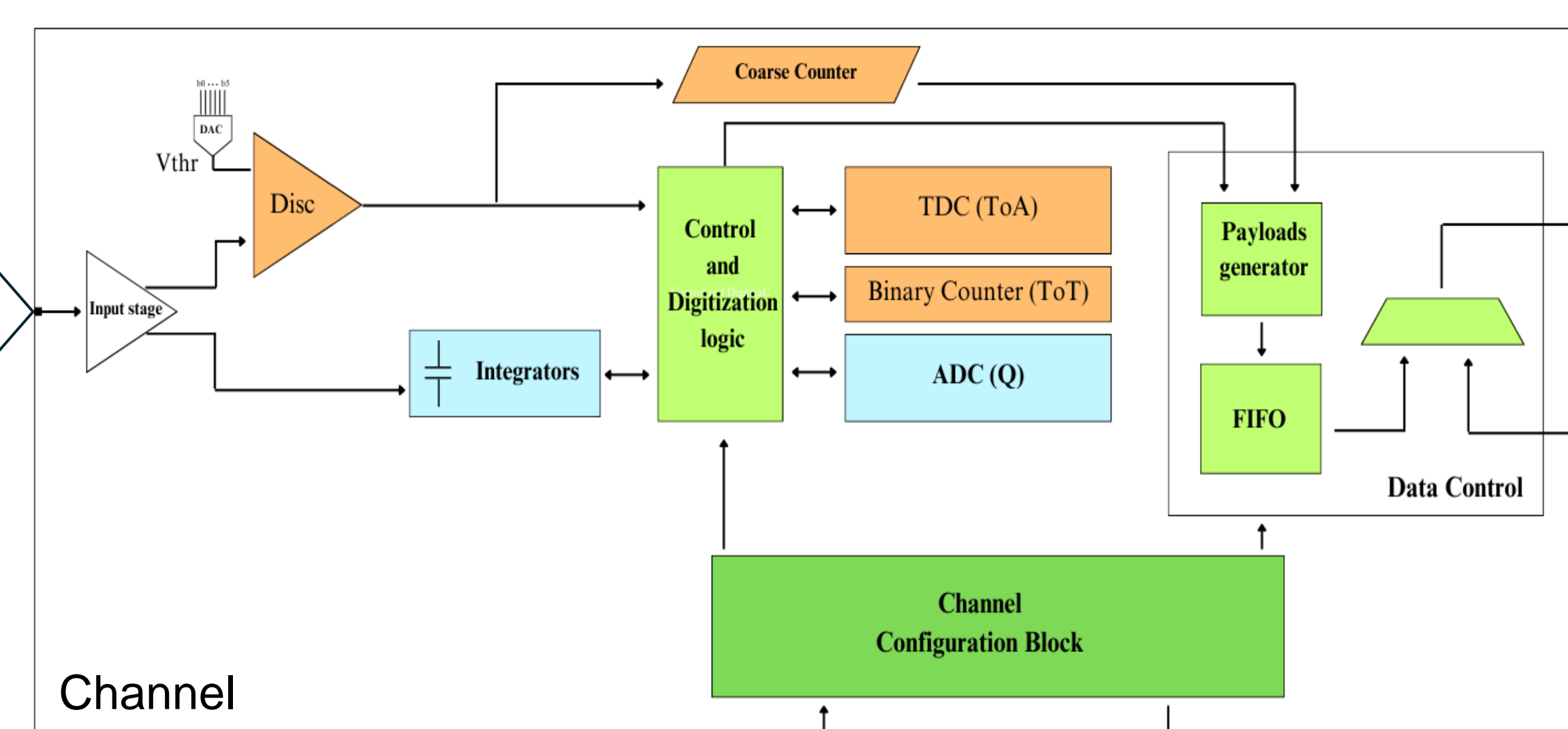
### 2. Tests with hardware demonstrator



### 3. Cold tests at the ARTIC facility in Genova



### 4. Development of 1024 channel ASIC



Upgrade of ALCOR ASIC (32 channels) :

- 1024 channels
- Operated at cryogenic and room temperature
- Power consumption < 5 mW/ch
- E branch : charge integrators + Wilkinson ADC
- T branch : Time-to-Amplitude Converters + Wilkinson ADC
- Front-End structure is currently under study

### References

- Cicero V., *Study of the tracking performance of a liquid Argon detector based on a novel optical imaging concept*, Ph.D Thesis, Alma Mater Studiorum - Università di Bologna (2023)
- NU@FNAL collaboration, *Coded masks for imaging of neutrino events*, Eur. Phys. J. C, **81** (2021) 1011
- Kugathasan R., *A low-power mixed-signal ASIC for readout of SiPM at cryogenic temperature*, PoS(TWEPP2019), **370** 011