GRAIN Progress Report

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for GRAIN Working Group

SAND General Meeting
26 Marzo 2024

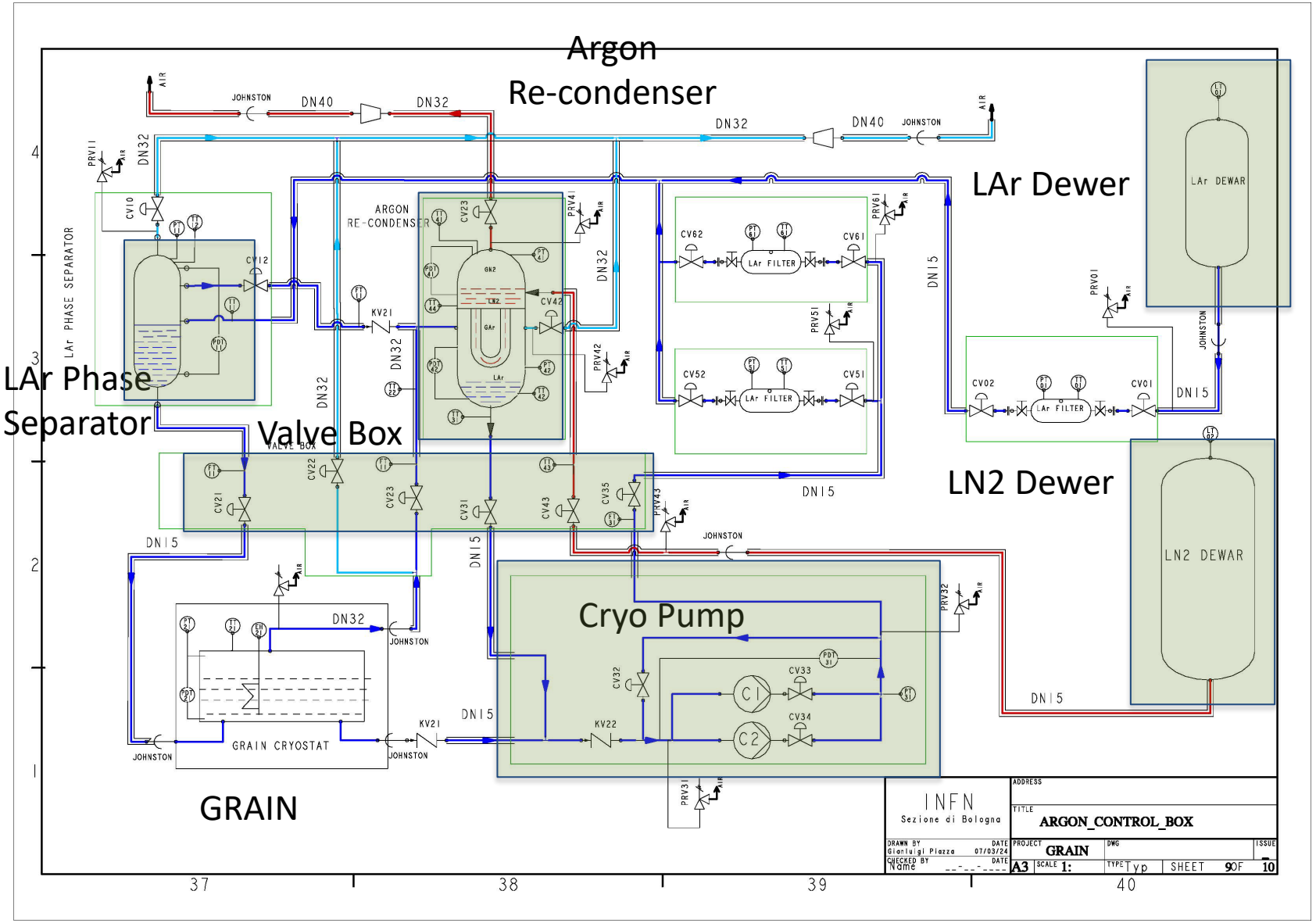
OUTLINE: selected hot topics

- **Test Facility** in Legnaro
- **Inner Vessel** Design and Issues
- **Cold Demonstrator**:
  - Hardware (Masks and Lenses)
  - DAQ and Slow Control for Demonstrator
- **Artic** Test Facility
- **New ASIC** development
- **Installation**…first thoughts

Test Facility in Legnaro

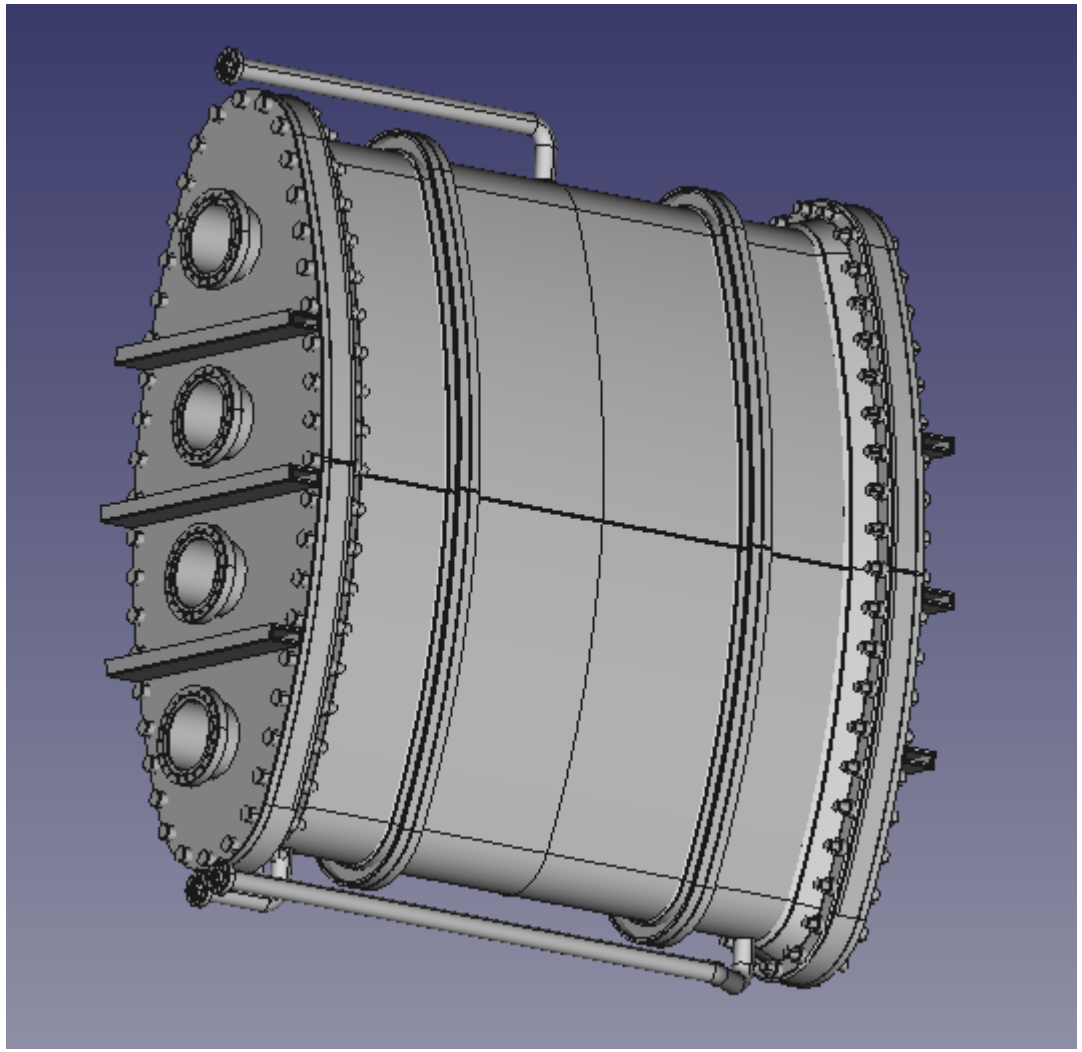
- Refurbishment of old lines is under way
- Components of Control System have been delivered. Assemply must be done by an electrician
- Criogenic complete scheme is designed:
  - What will be the initial configuration in Legnaro?
  - Is it possible to stage the system in order to better distribute the expenditures?

Proximity cryogenics

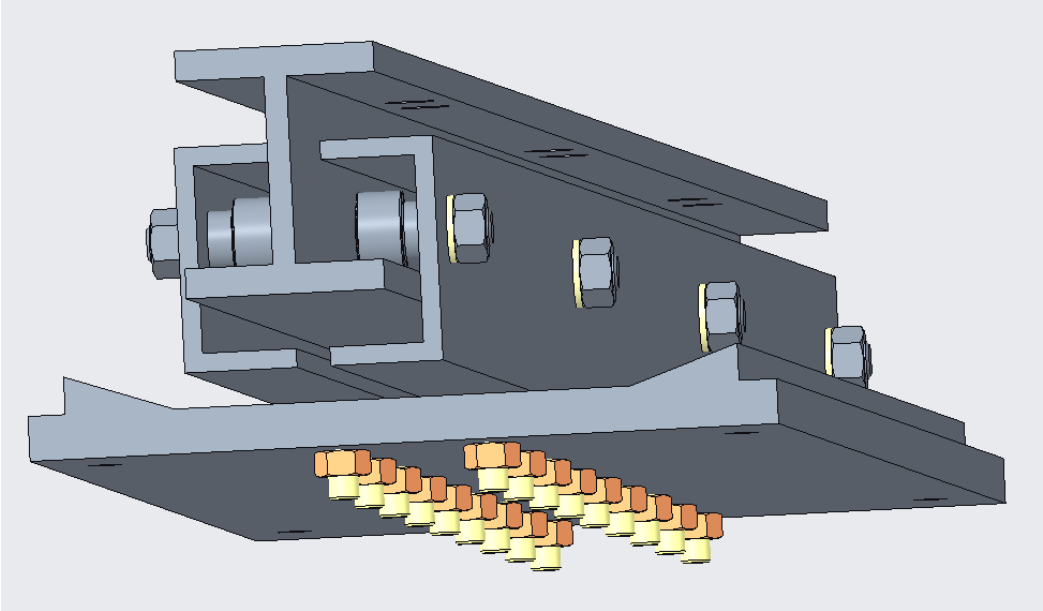


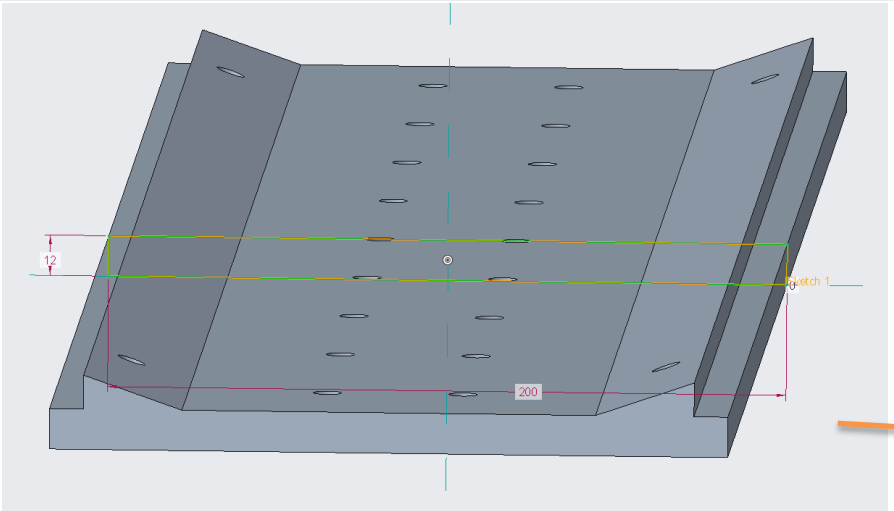
Inner Vessel Design

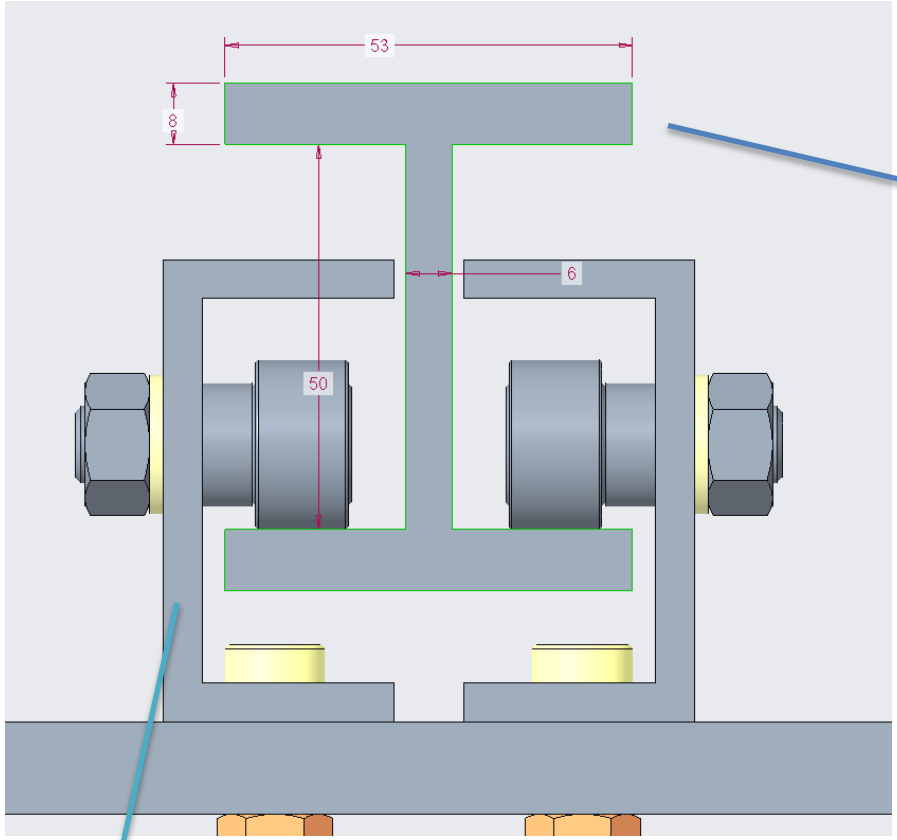
- R.Pengo has found Stainless Steal 316 LN:
  - Optimal mechanical robustness at cryogenic temperature (few Kelvin)
  - Fully amagnetic
- Still pending the decision about the thickness of the two cover:
  - Actual design is 20 mm, but the sealing of Helicoflex is not guaranted
  - Increase stiffness with more bars
  - Increase the thickness to 30 mm
- Later today we will discuss wiht Helicoflex vendors about the best solution



Sliding System







IPE beam like:

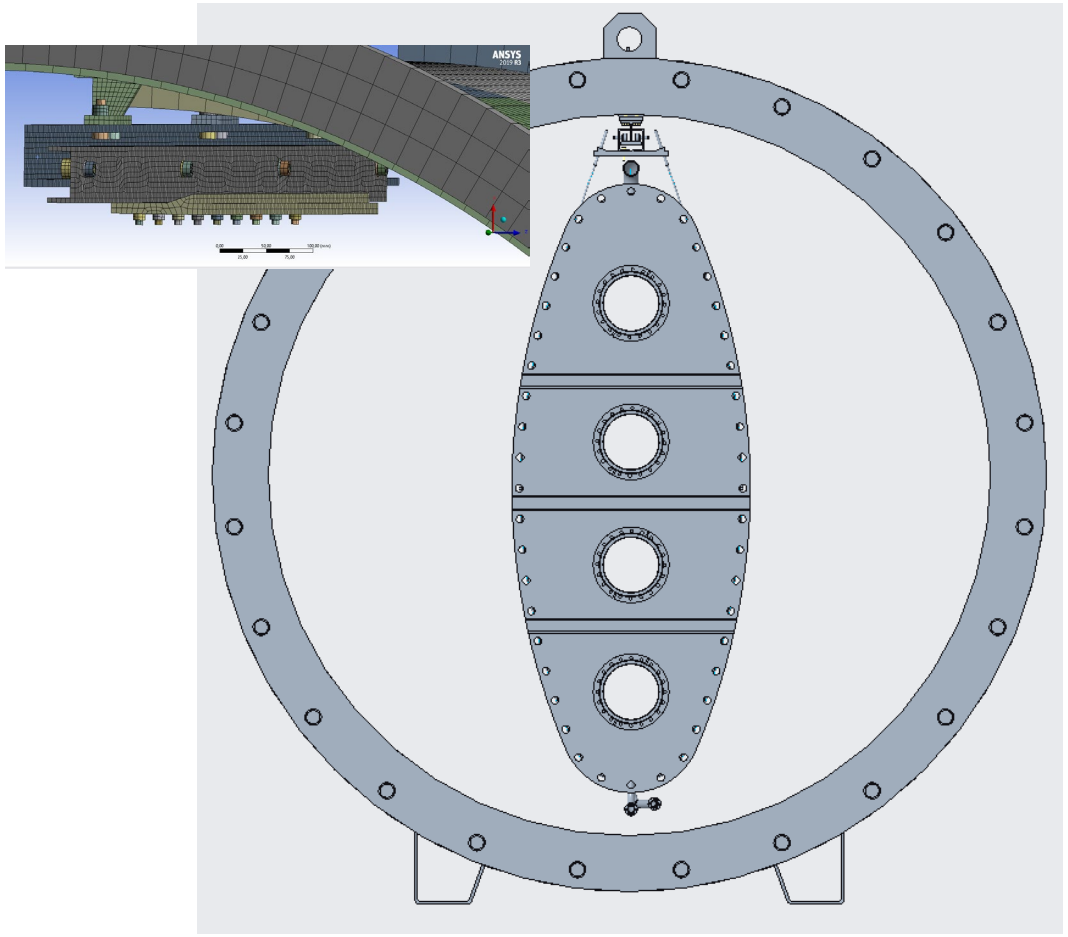
h=66 mm
b=53 mm
tf=8 mm
tw=6 mm
L=1800 mm

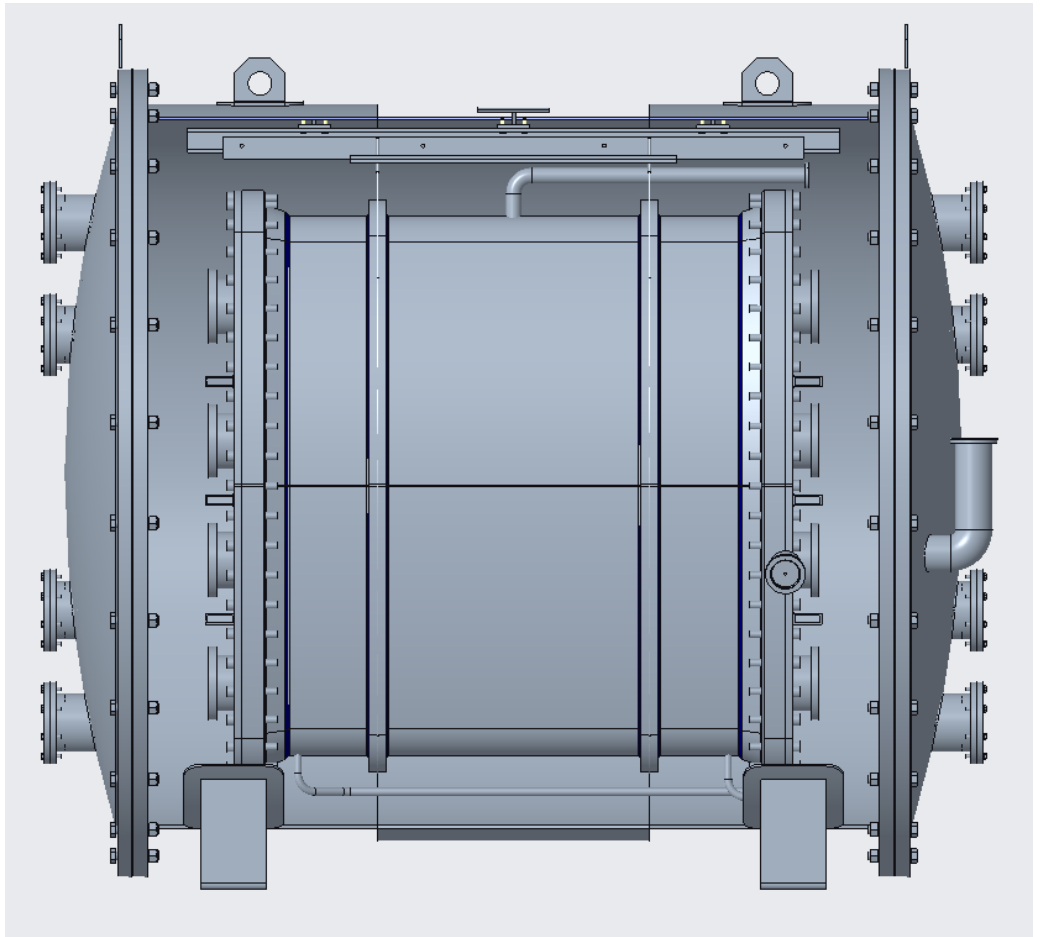
Montanstahl can produce laser welded customised profiles in 316L
1500 € for 3000 mm ca

C beam IPA hot rolled, dimensions: 60x30x5 mm, 1600 mm long

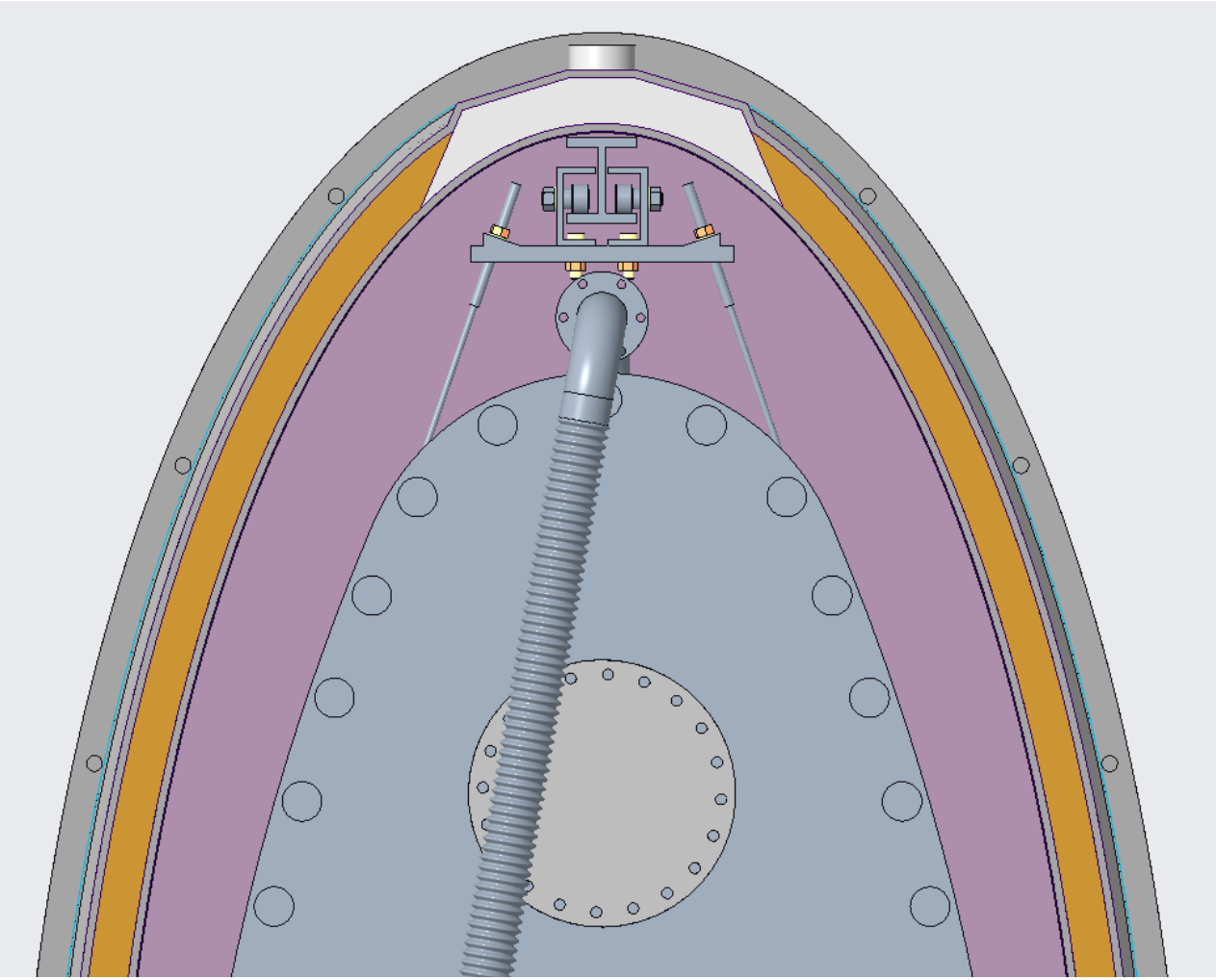
Plate 200x12x900 mm

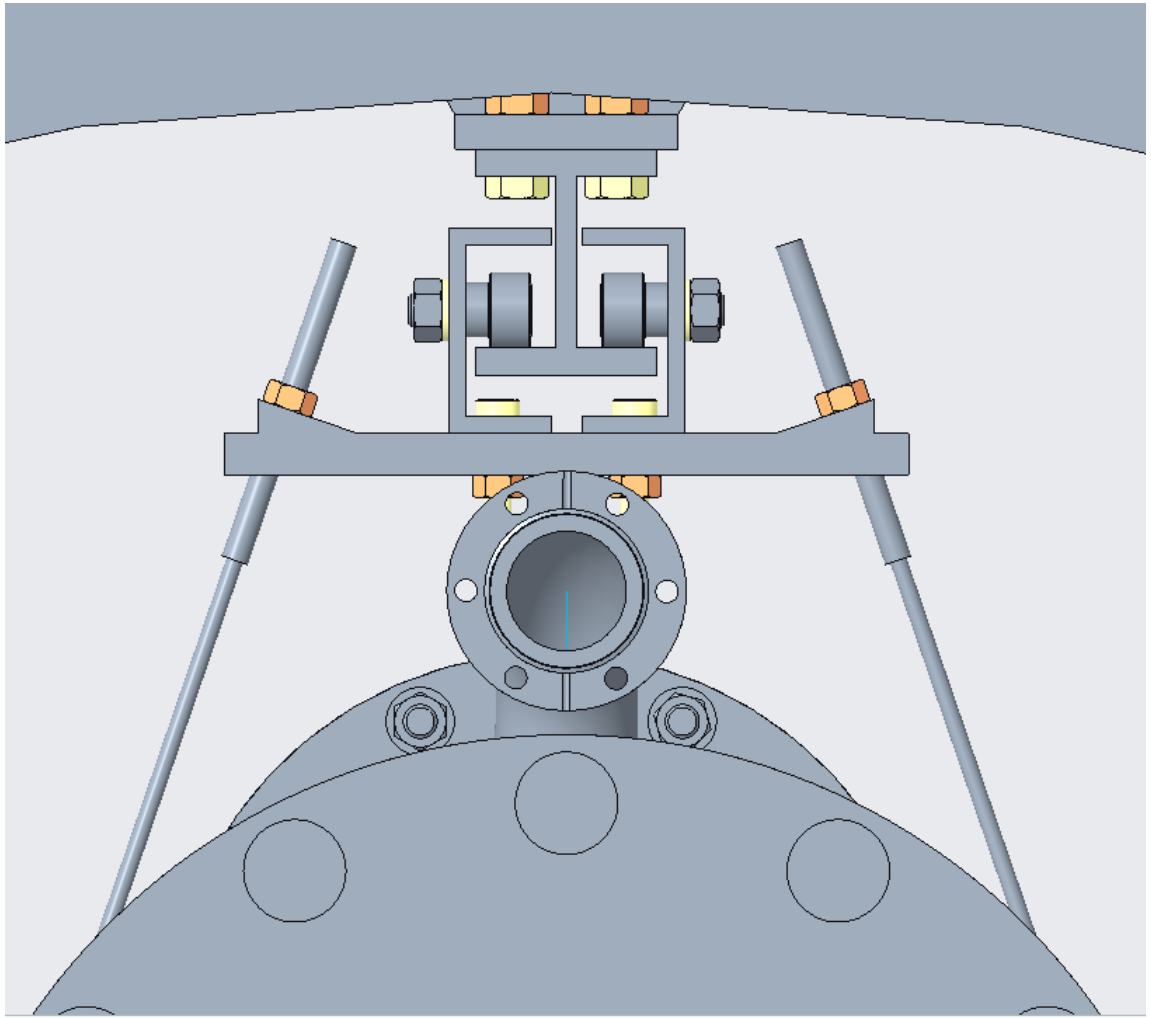
Sliding inside Vacuum Tank in Legnaro





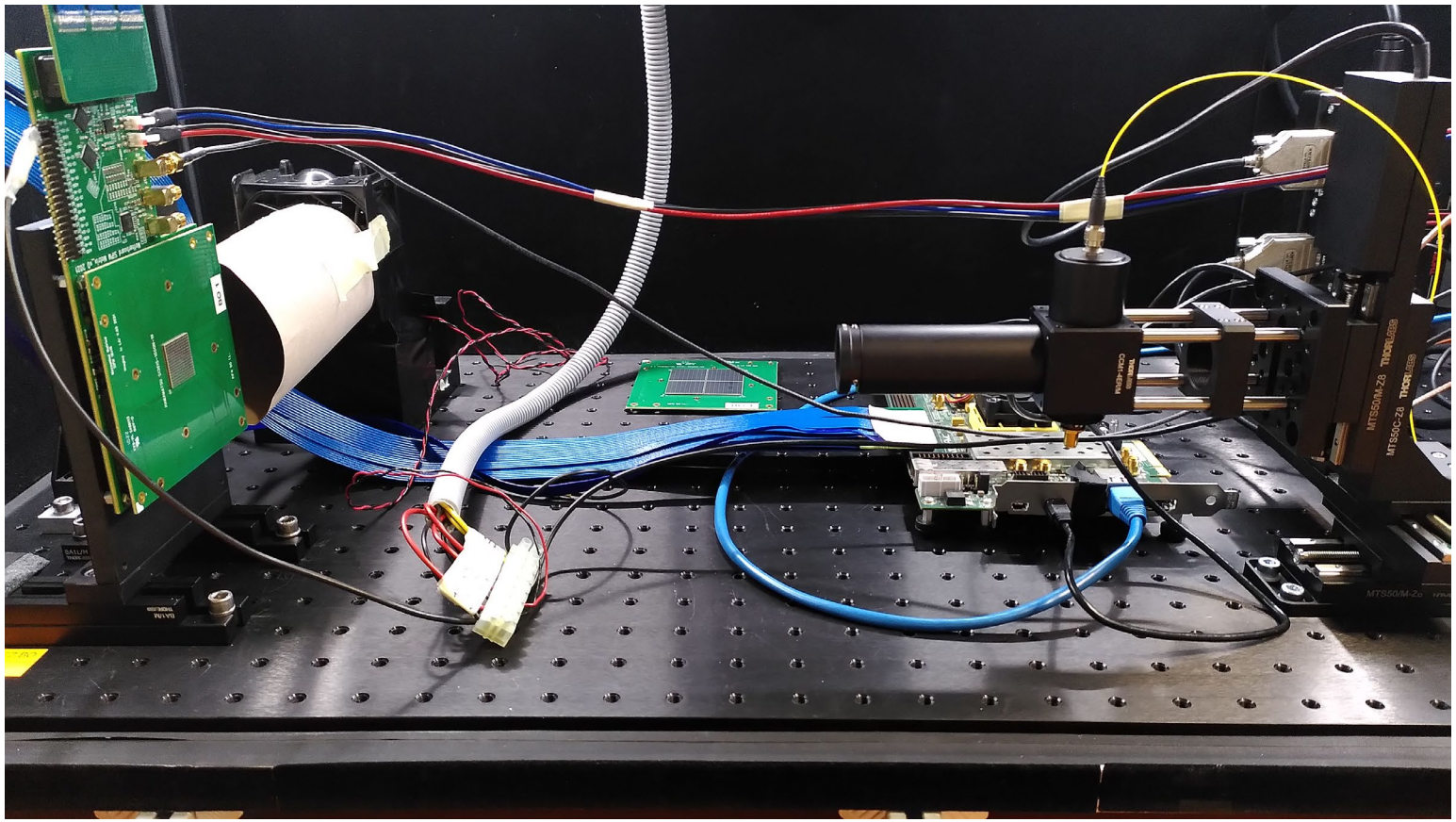
Sliding inside final External Vessel





Cold Demonstrator Hardware

- Sensor (16x16 matrix) + ASIC Readout was tested (8 x «Alcor»)
- SIPM matrix were calibrated (IV to determine $V_{breakdown}$ of each of 256)



Control and DAQ for Demonstrator

Control and Readout software is written so that it will be re-used in SAND

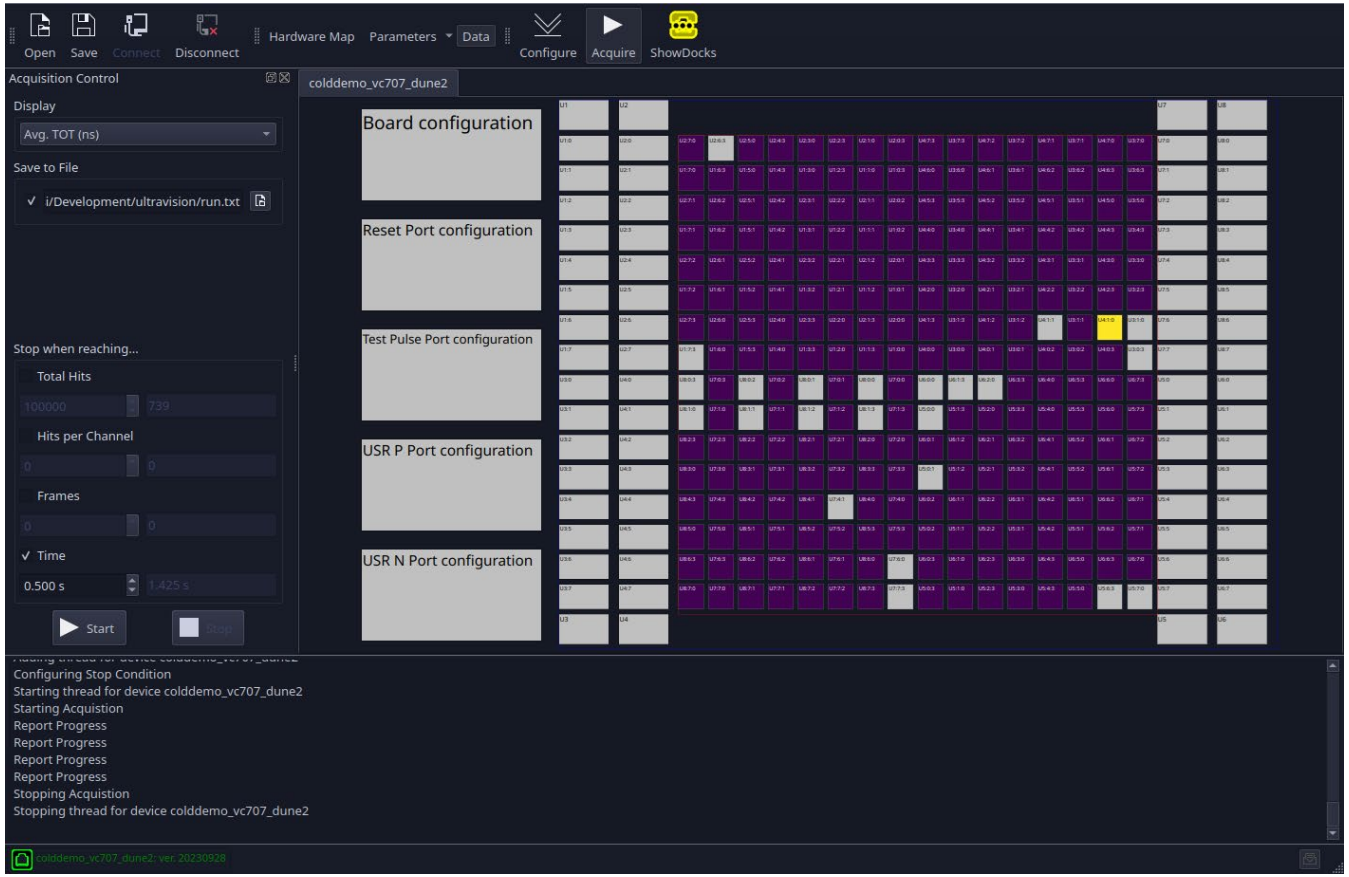
GUI usable for configuration and standard acquisitions

Configuration save/load to xml OK

Data saving to text files OK

Automatic parameter scans in progress

Other file formats in progress

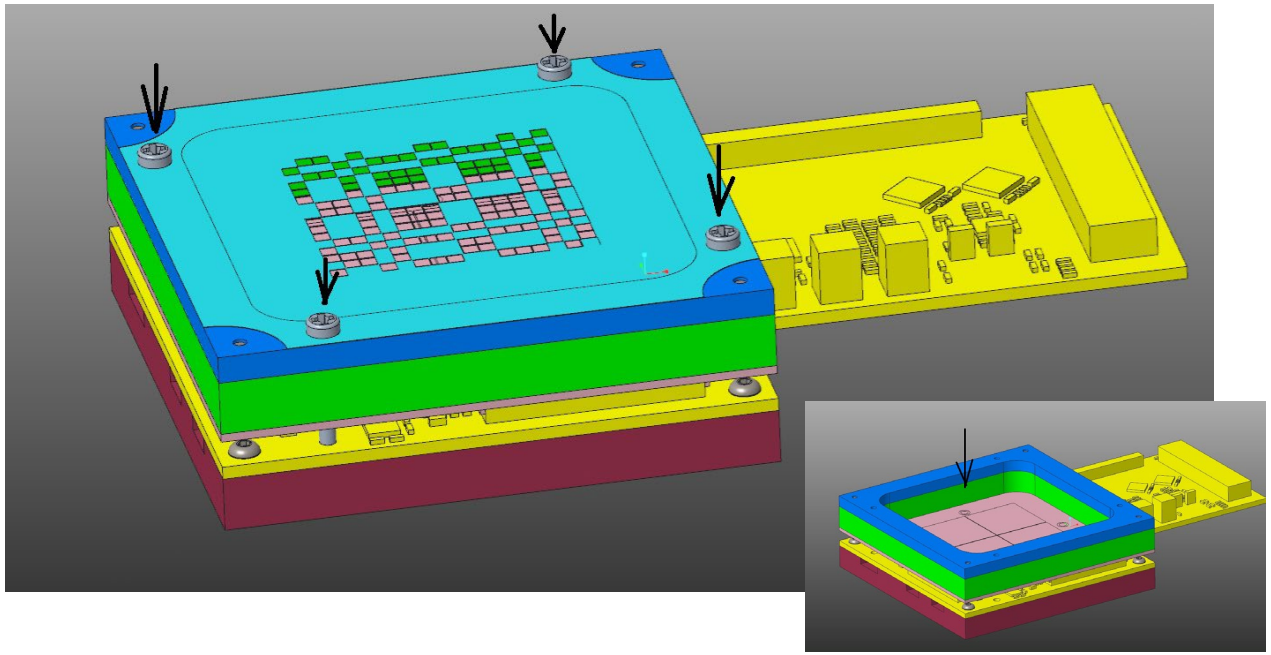


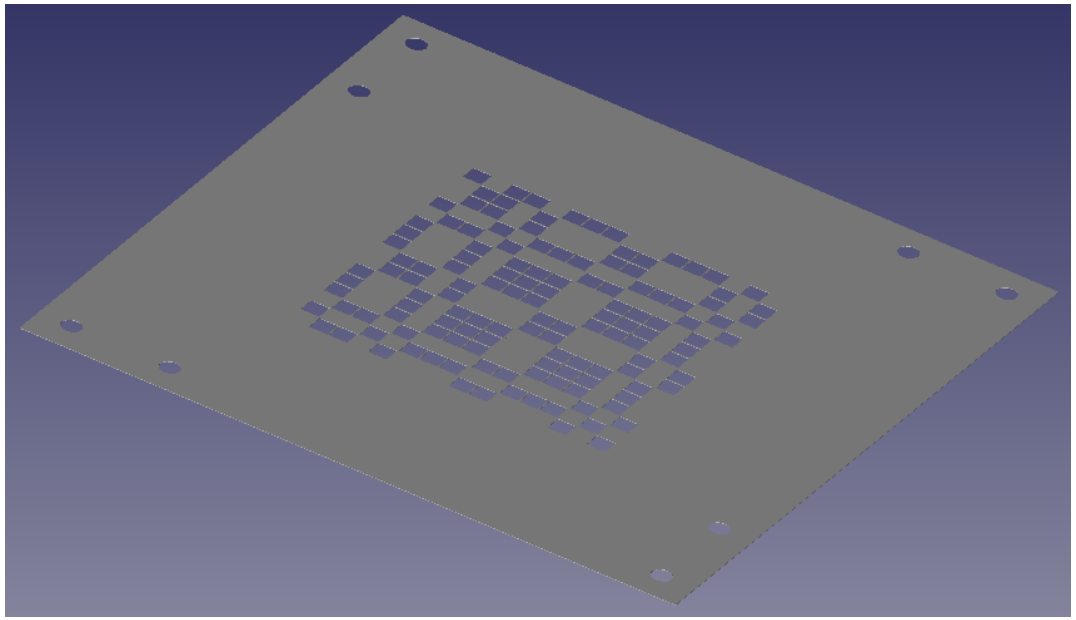
Identified issues:

- One double column broken
- A few SiPMs appear unresponsive, others particularly noisy: <90% good
- Erroneous data present in every hit, but does not cause actual problems

Optics with Masks

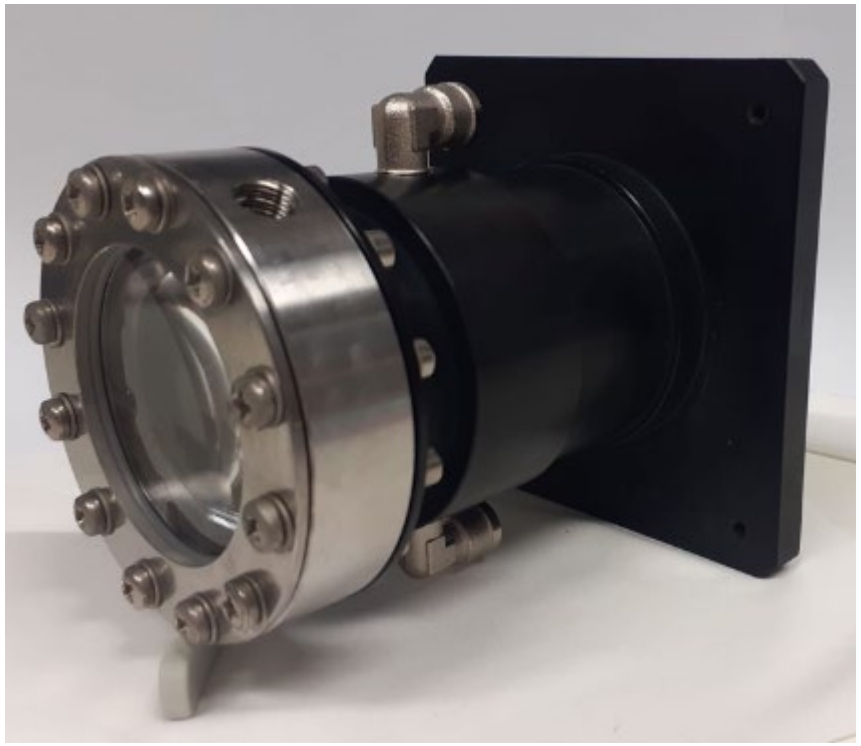
- Three type of masks have been purchased: Stainless Steal sheet 120 um thick, cut with laser
- Mechanics for coupling with sensor is ready





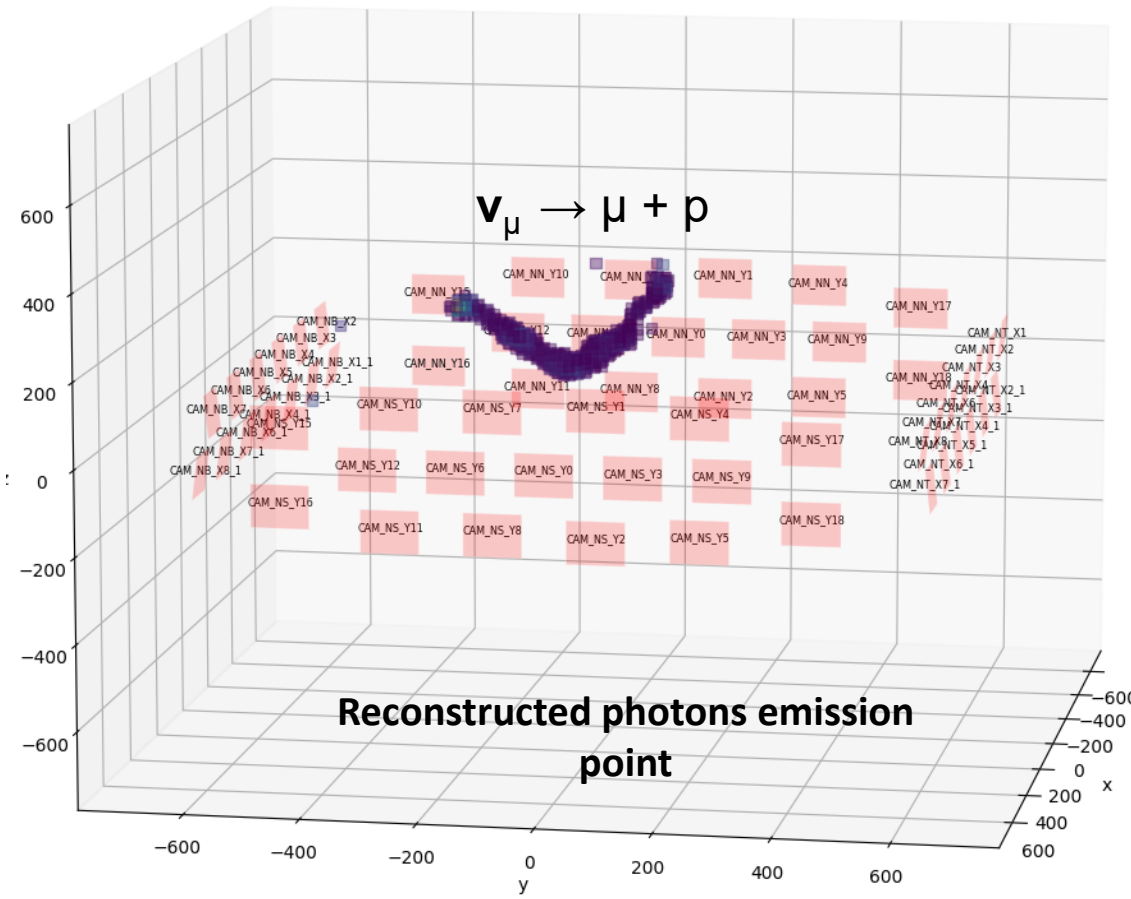
Optics with Lenses

- A second camera is under test in Genova:
  - Optimization of ASIC parameters for 16x16 SiPM (1x1 mm2) matrix in LN2



Coded aperture masks 3D reconstruction

- Iterative algorithm based on maximum likelihood expectation maximization
- Backpropagation of the detected photons in the LAr volume through all mask holes, weighted appropriately
- reconstruction output = estimated photon source distribution in voxelized volume
- Algorithm implemented in GRAIN using 4 GPUs and 120GB RAM to store weights

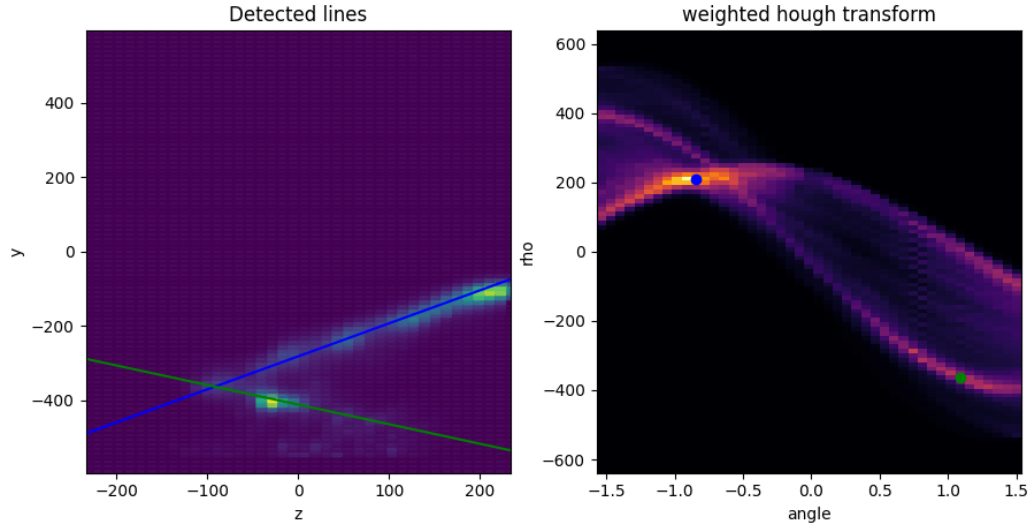


Coded aperture mask 3D reconstruction

Currently working on:

- improving reconstruction quality/runtime :
  - studying corrections to algorithm weights
  - studying effects of using bigger voxel size for first iterations
  - use data subset to perform reconstruction

- developing tools for reconstruction analysis:
  - apply image analysis techniques to 3D voxels
  - track detection algorithm : weighted Hough trasform (2D/3D)



ARTIC facility in Genova

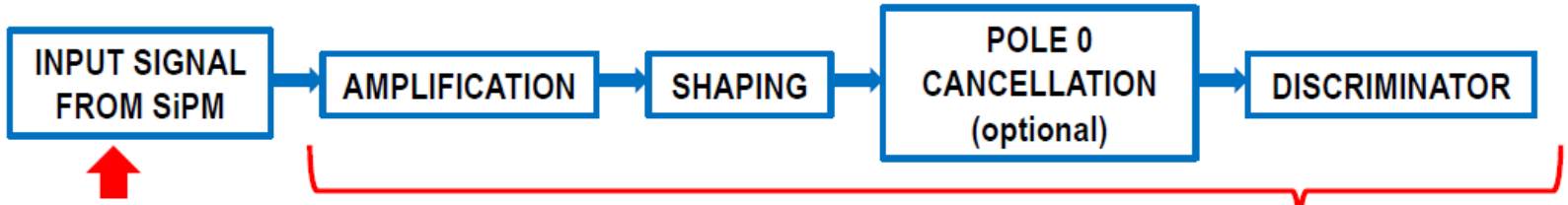
- Mechanics is ready to start first test with pointlike artificial light sources.

New ASIC development

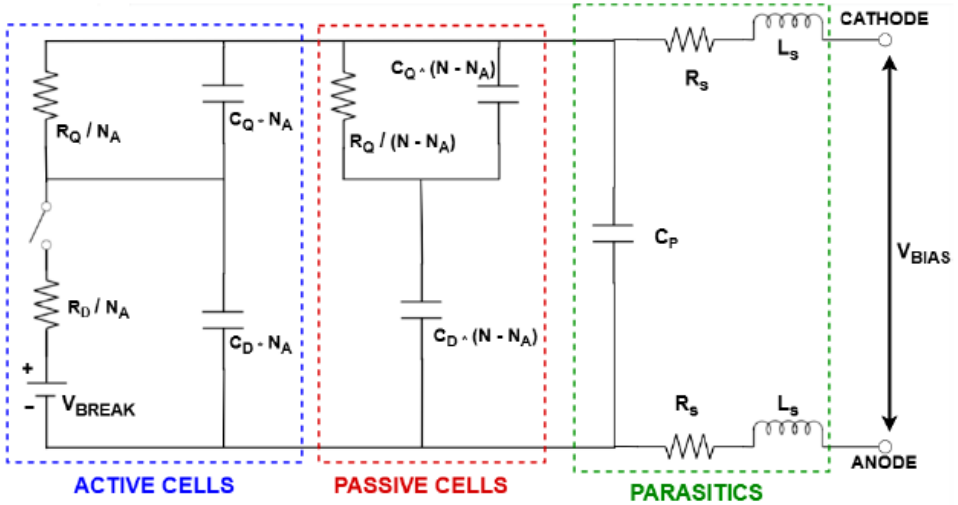
- Torino (Sofia Blua) is writing Python model of the present Alcor electronics

BEHAVIORAL MODEL: set of equations that capture the operation of a circuit from its terminals

PURPOSE: implementation of a time-based readout front end for the analysis of different cases



SiPM ELECTRICAL MODEL: Circuit implemented in virtuoso schematic (Cadence)



Implementation through a **python code in progress**

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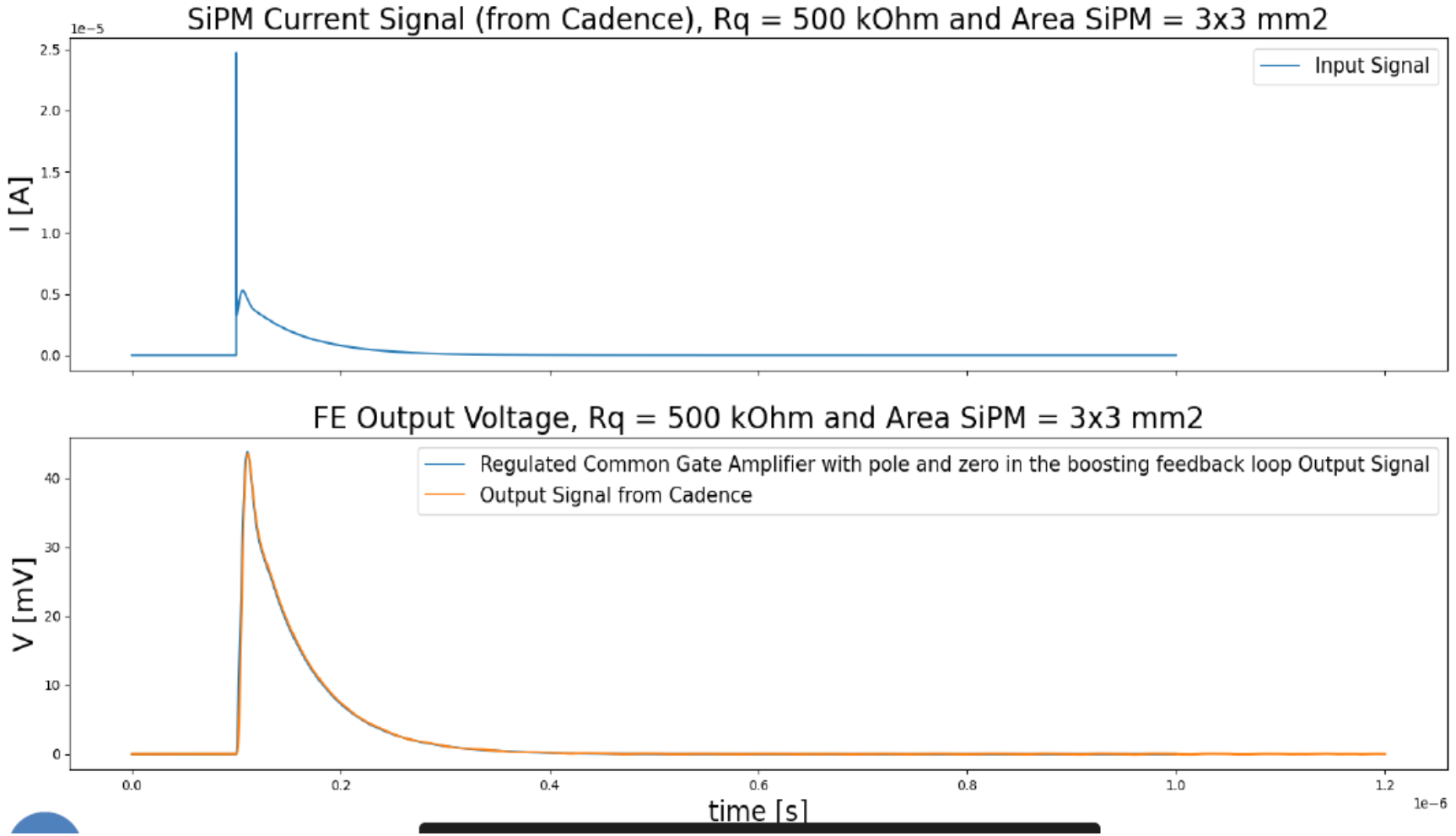
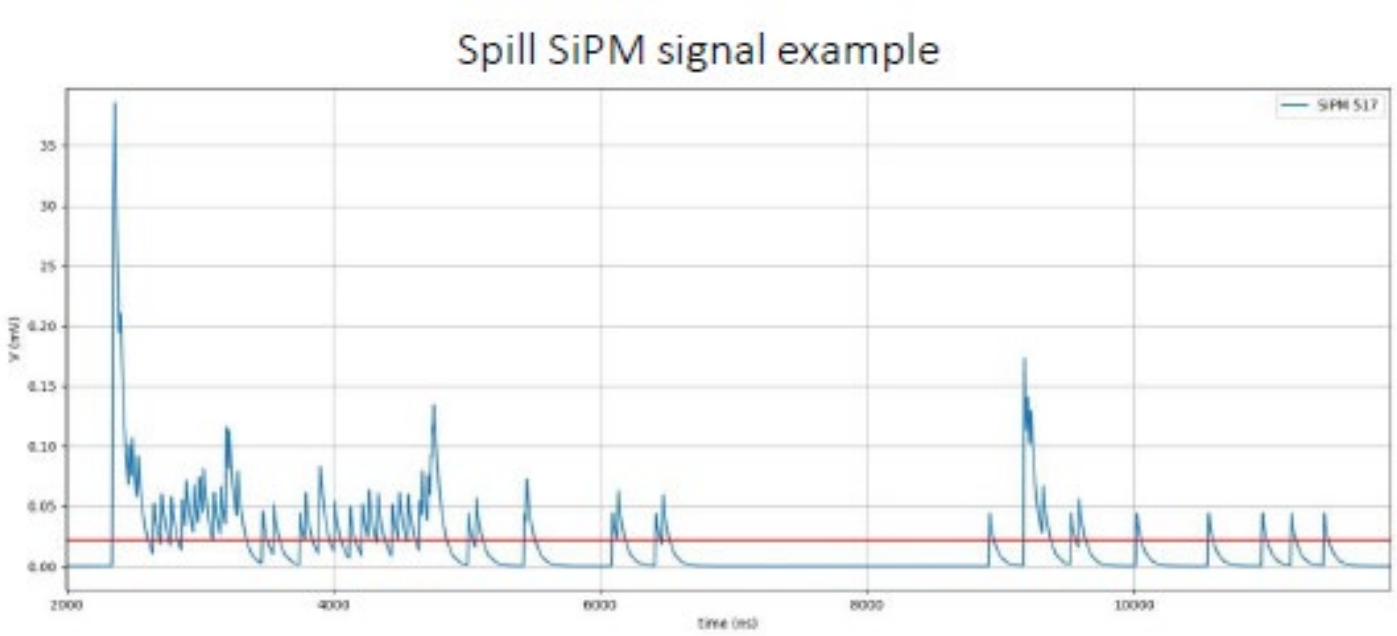
New ASIC

- FE simulation (using Alcor Transfer Function)

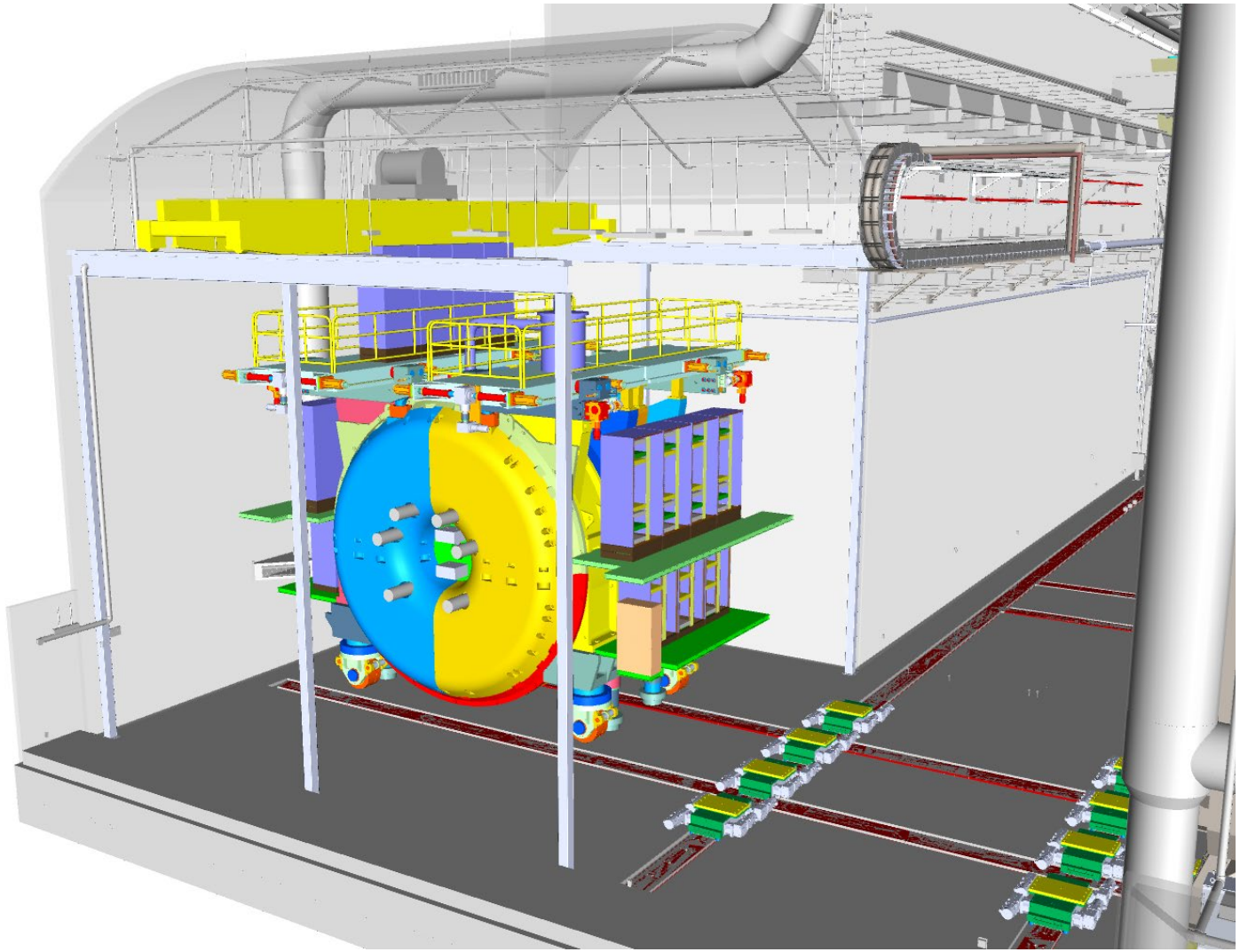


New ASIC

- Bologna and Genova are simulating the interactions in LAr, the scintillation light emission and the propagation of the photons up to the sensors. The result is the time of arrival of the photons on each SiPM (1 channel) in one spill.
- We will be able to test different architectures: anyway it seams clear that we willl have to integrate the signal.



First Thoughts about Installation



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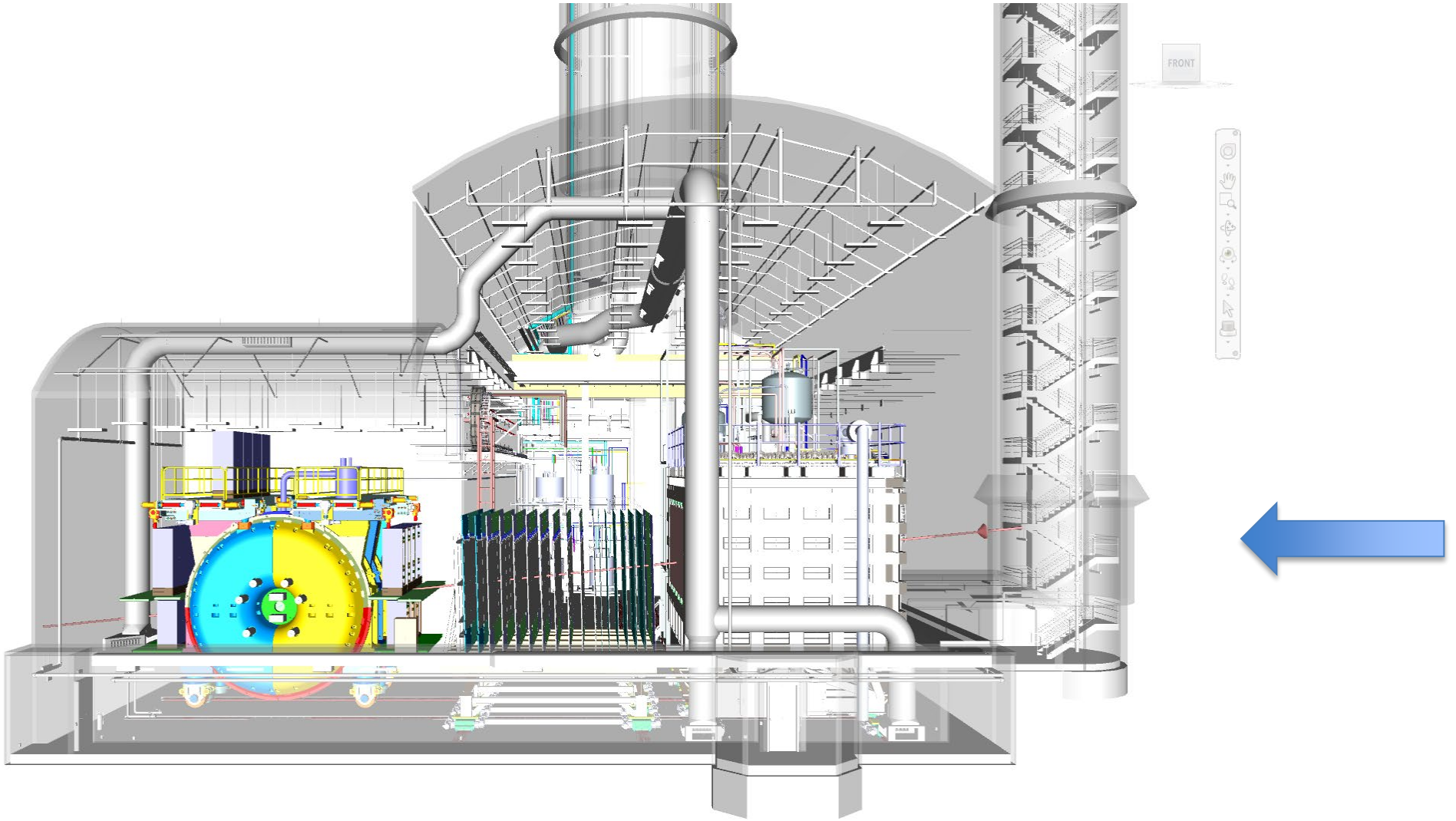

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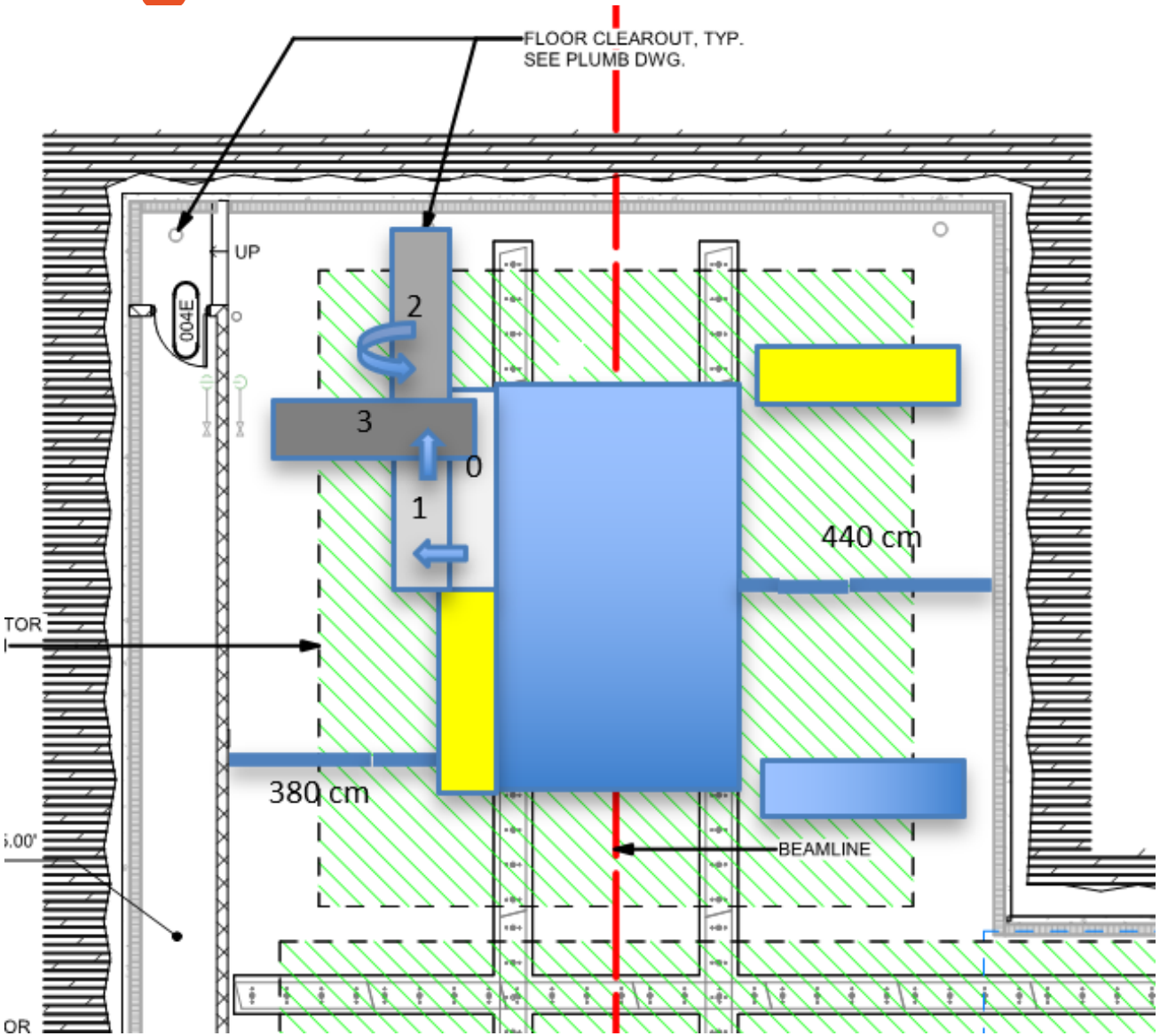

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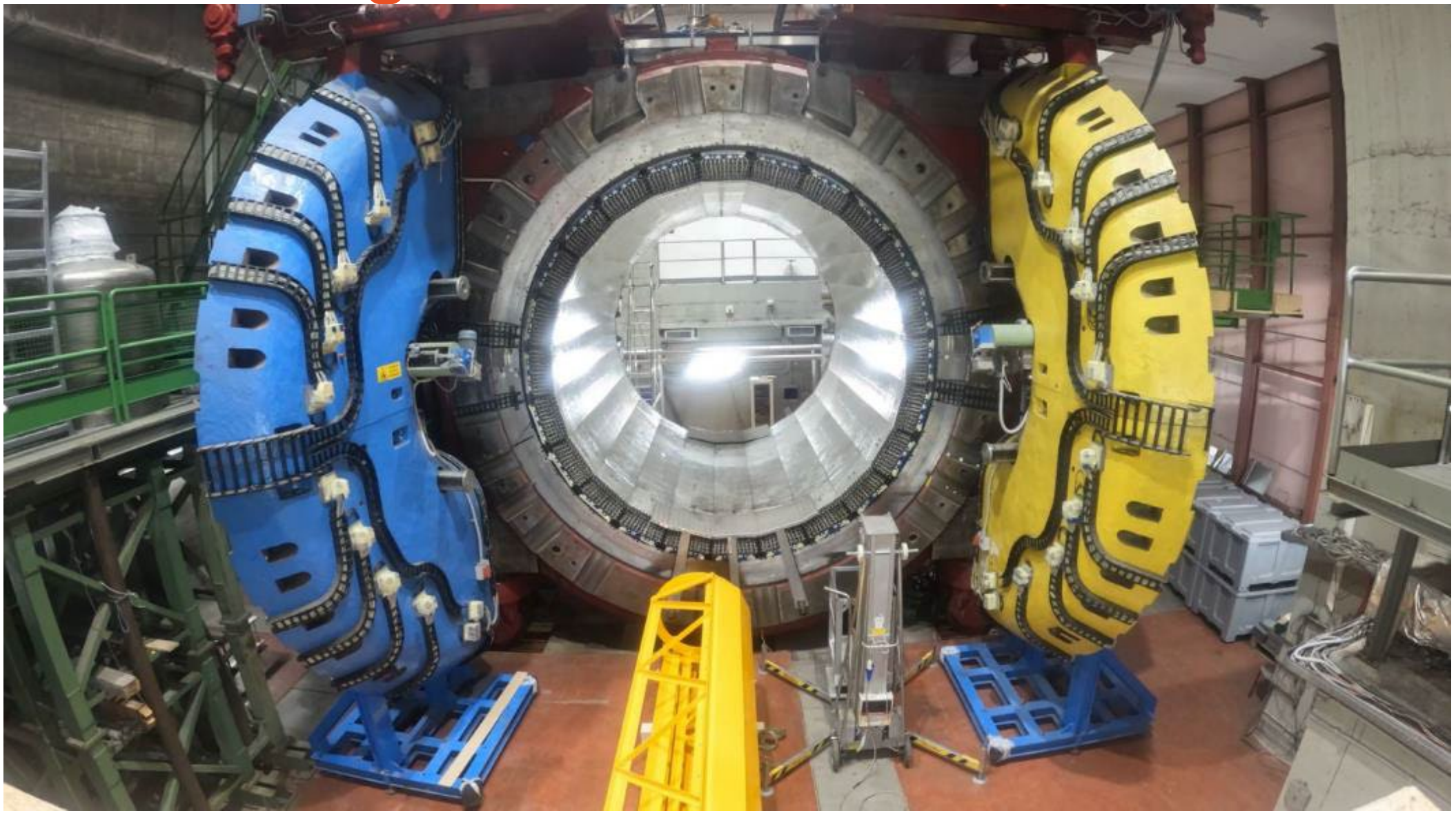

Timeline

ASIC development, test and production is on the critical path !!