# Inner MPGD layer: CyMBaL

## Cylindrical Micromegas Barrel Layer

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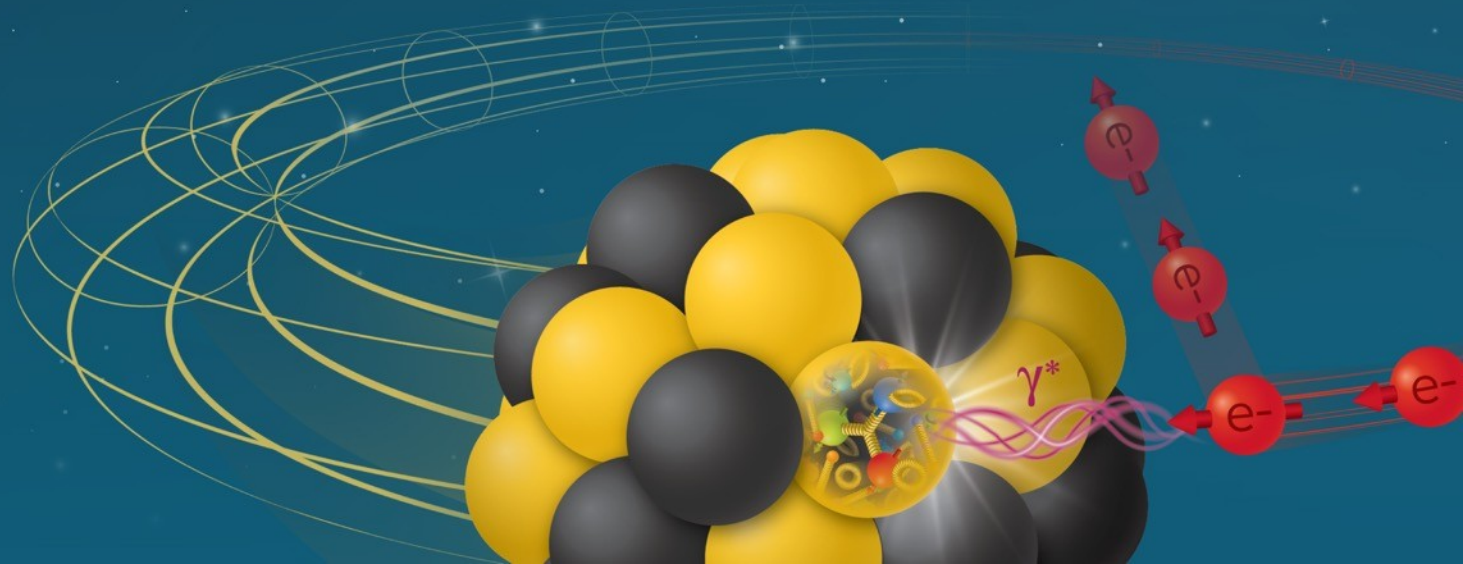
For CEA Saclay team

Incremental Design and Safety Review
of the EIC Tracking Detectors
March 20-21, 2024

Electron-Ion Collider



# Charge Questions Addressed

Grey out charge text not being addressed.
GRY RGB HEX CODE: #BFBFBF

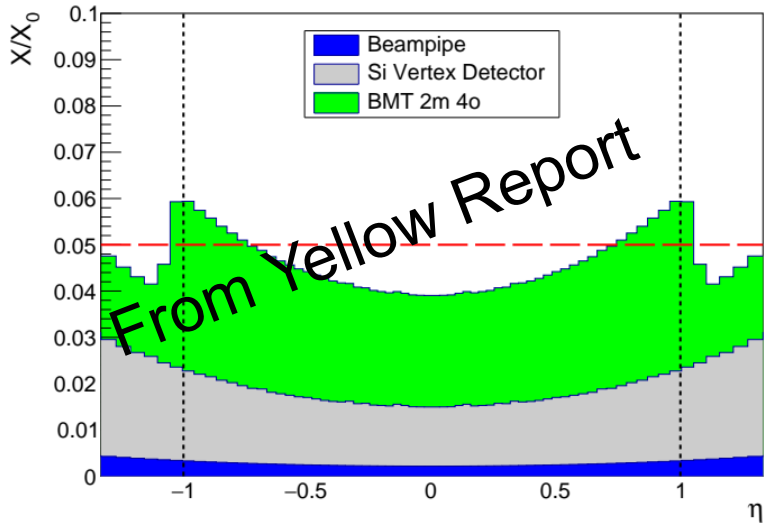
1. Are the technical performance requirements appropriately defined and complete for this stage of the project?
2. Are the plans for achieving detector performance and construction sufficiently developed and documented for the present phase of the project?
3. Are the current designs and plans for detector, electronics readout, and services sufficiently developed to achieve the performance requirements?
4. Are plans in place to mitigate risk of cost increases, schedule delays, and technical problems?
5. Are the fabrication and assembly plans for the various tracking detector systems consistent with the overall project and detector schedule?
6. Are the plans for detector integration in the EIC detector appropriately developed for the present phase of the project?
7. Have ES&H and QA considerations been adequately incorporated into the designs at their present stage?

# CyMBaL – Requirements

Charge 1

**External constraints:**

- Total material budget for the tracking system ~5%X0
- Inner MPGD layer should be ~0.5%X0 in the active area
- Tight space: about 5cm radial keeping zone
- Magnetic field ~2T
- Hermetic

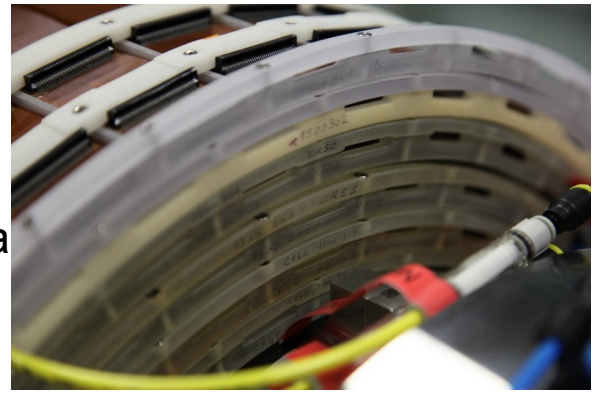



**Solutions:**

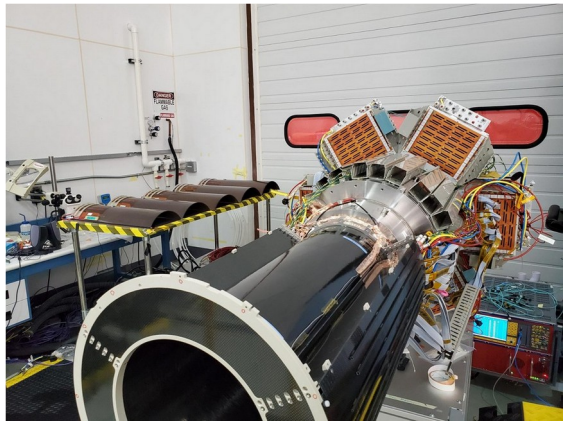
- Cylindrical Micromegas technology developed for CLAS12 BMT:
  - Material budget ~0.4%
  - Working in high radiation environment and in B=5T
- Modular solution
  - Possibly, just one single readout to tile the whole surfa

**Ongoing R&D:**

- 2D readout with small number of channels



*Close up of the BMT: fits in a tight space*



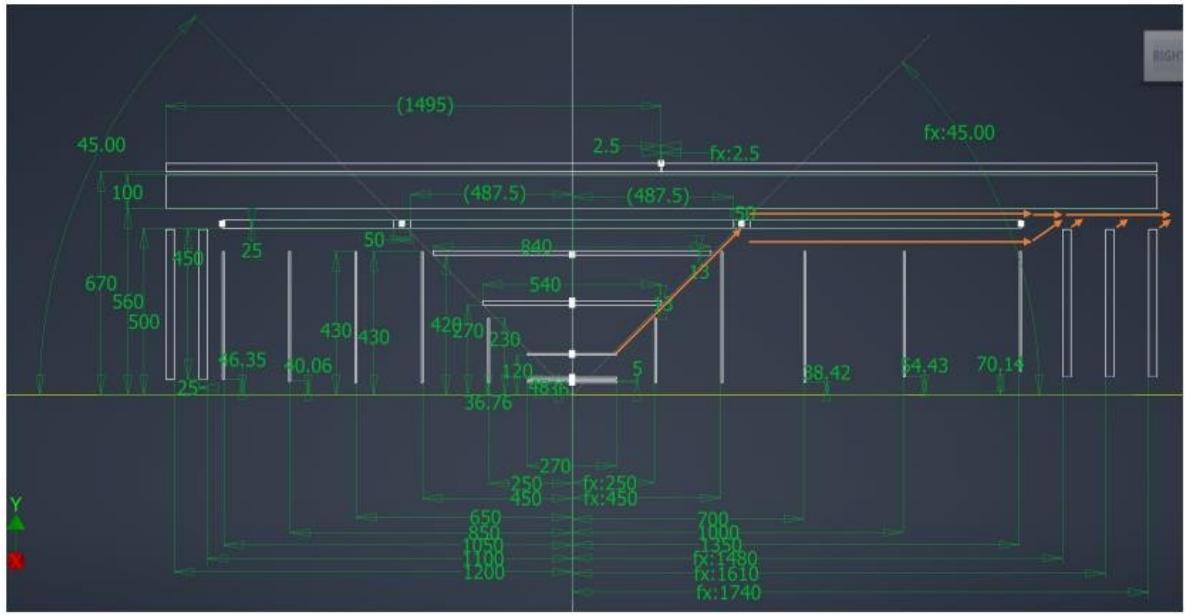
*BMT open for maintenance*

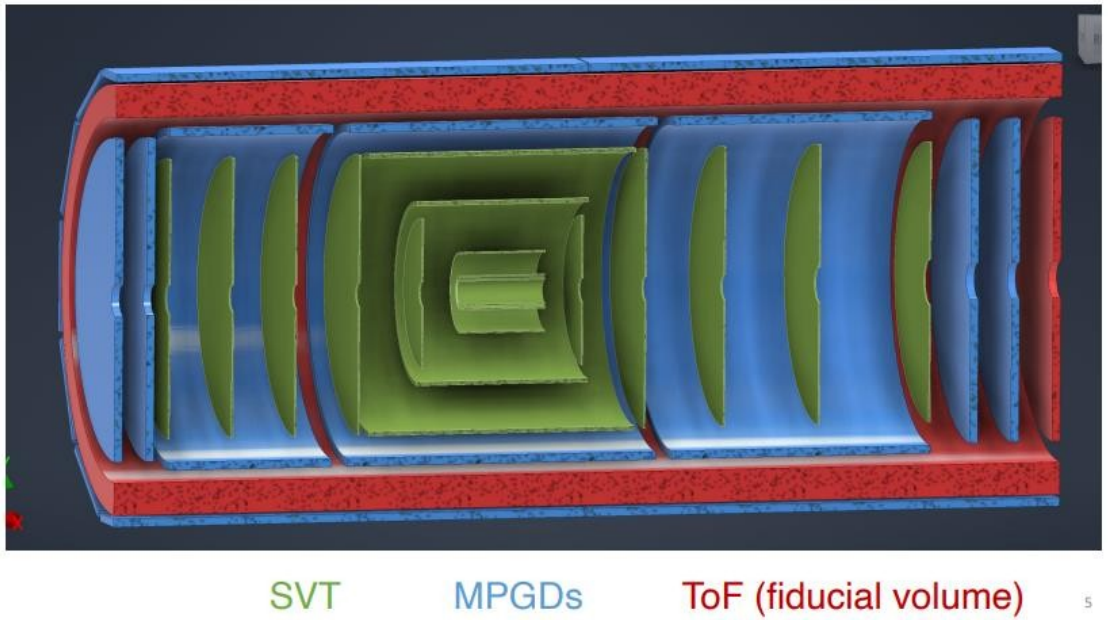
# CyMBaL – In the tracking system

Charge 1

- The inner MPGD layer wraps around the SVT
- Provides additional hit points for pattern recognition

- Keeping zones:
  - Z = [-105, 135.5] cm
  - R = [50, 55]cm



# CyMBaL – Layout

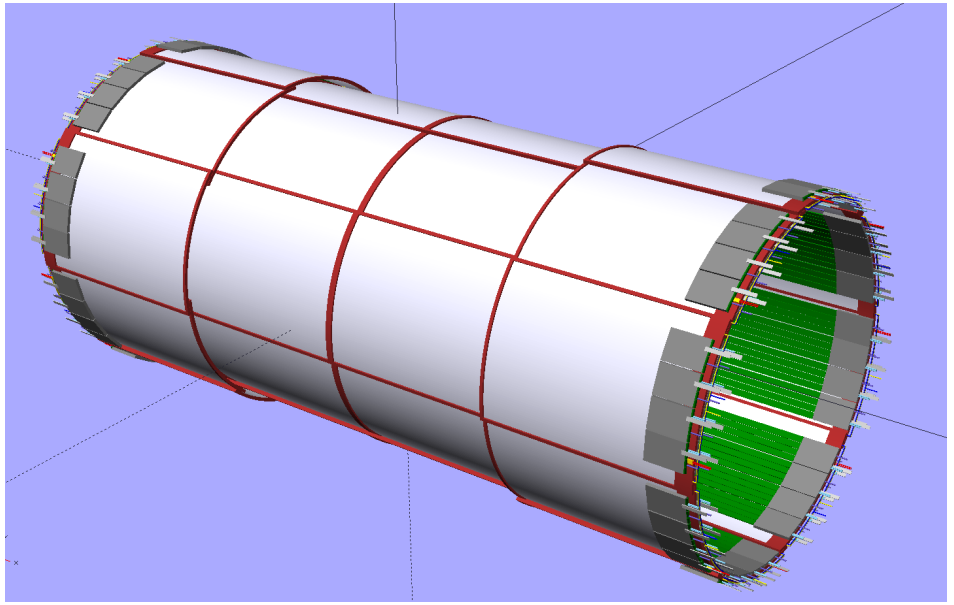
Charge 3, 4

CyMBaL: Cylindrical Micromegas Barrel Layer

- A **single module readout design**, with two curvature radii
  - **Simplify production, reduce costs**
  - **Industrial PCB production**
  - **Micromegas bulking possible at several sites, example Saclay, Elvia, CERN, ...**
- Overlaps in phi and z allow for hermeticity
- Front end boards (FEBs) on system edges to reduce material budget
- FEB based on SALSA ASIC

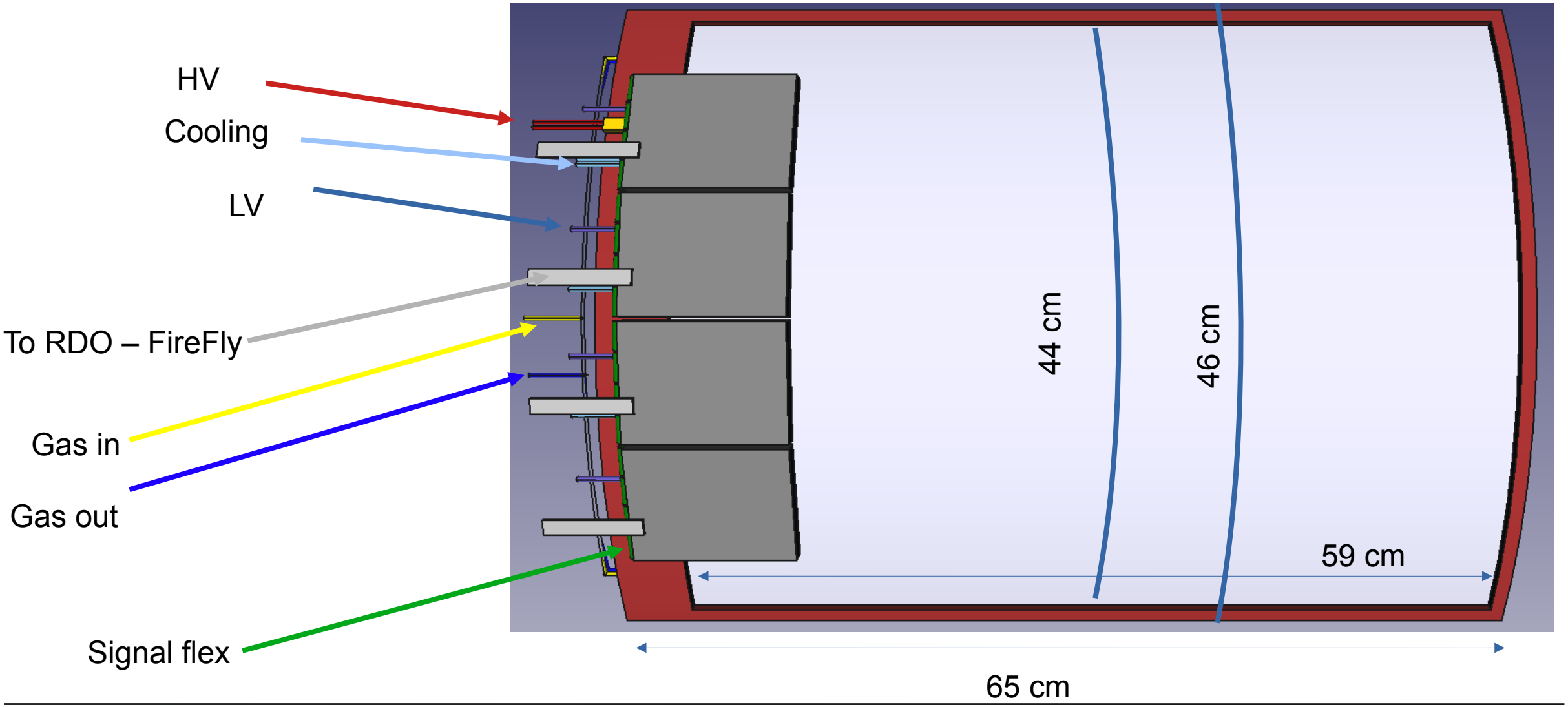
Some numbers:

- 32 moduels organized like: 8 modules in phi times 4 modules in z
- 1024 readout channels/module
- 32k readout channels



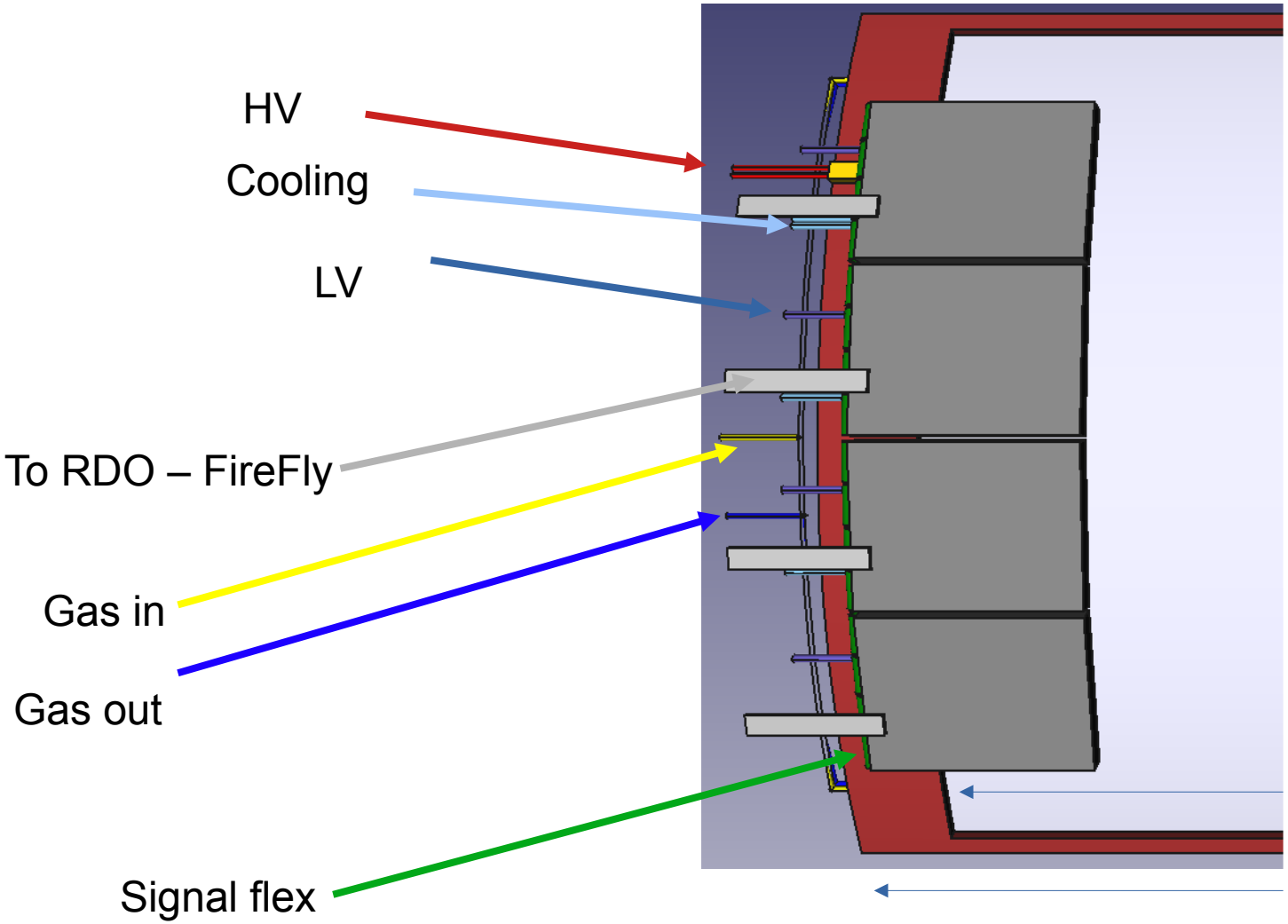
# CyMBaL – Module

Charge 3



# CyMBaL – Module

Charge 3




**Dimensions**:

- Size: 65 x 46 $cm^2$
- Active area: 59x44 $cm^2$
- r/o strips: ~1 mm pitch in both directions
- Readout strips per module: 1024
- 32 channels per connector → 32 connectors

**Services**:

- HV: 2 channels (drift and resistive layer)
- Gas: 2 tubes (in and out)
  - Two tiles can be in series
- 4 FEBs per module
- 4 ASICs per FEB:
  - 1x8ch FireFly per FEB to the RDO or optical fiber FreFly
  - 2 short flex cables per ASIC
  - Low voltages: 2 voltages and 2 grounds
  - Cooling in and out, possibly in series

# CyMBaL – Module readout scheme

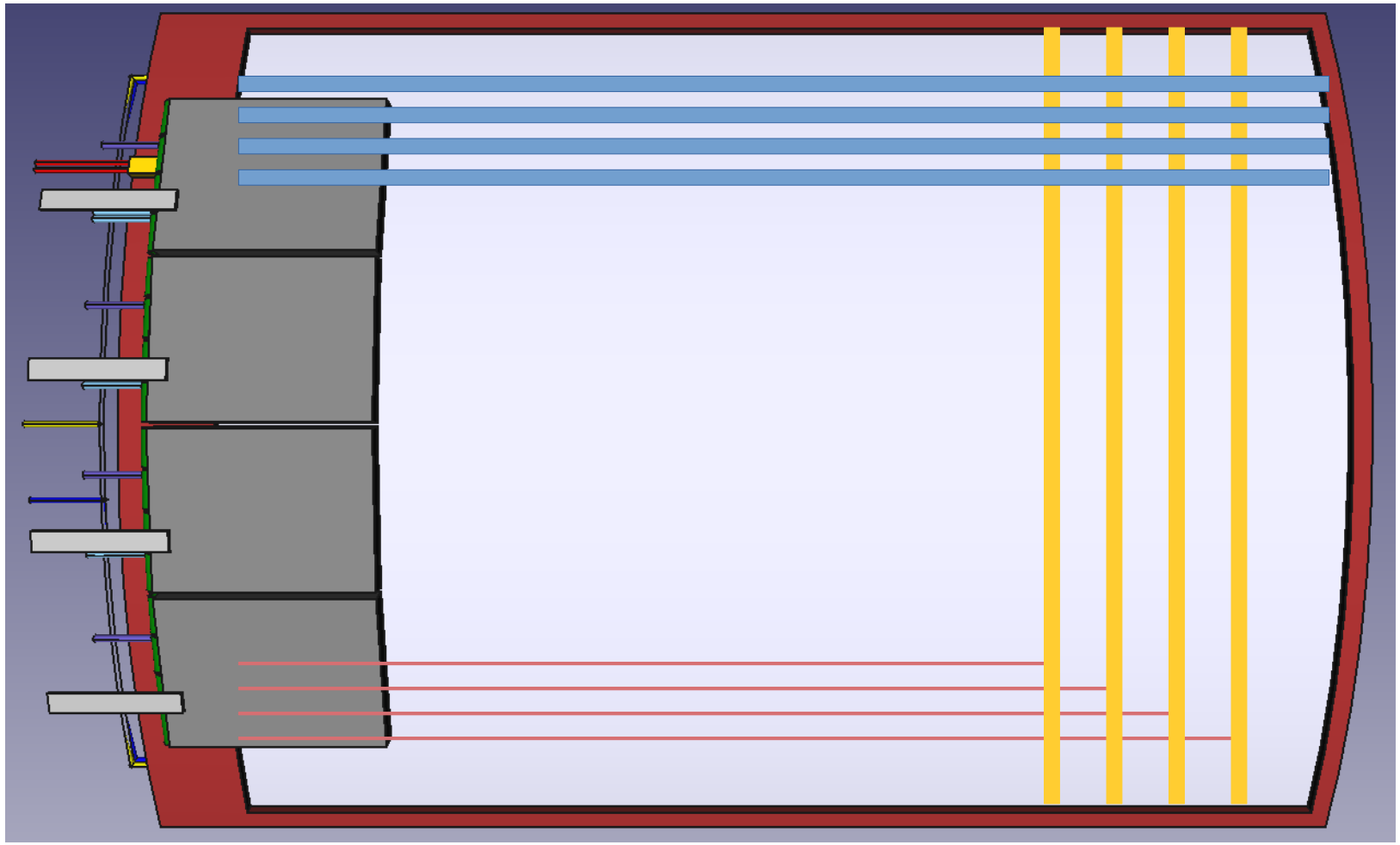
Charge 3

Z; (r phi)

C; (z)

return trail for C strips

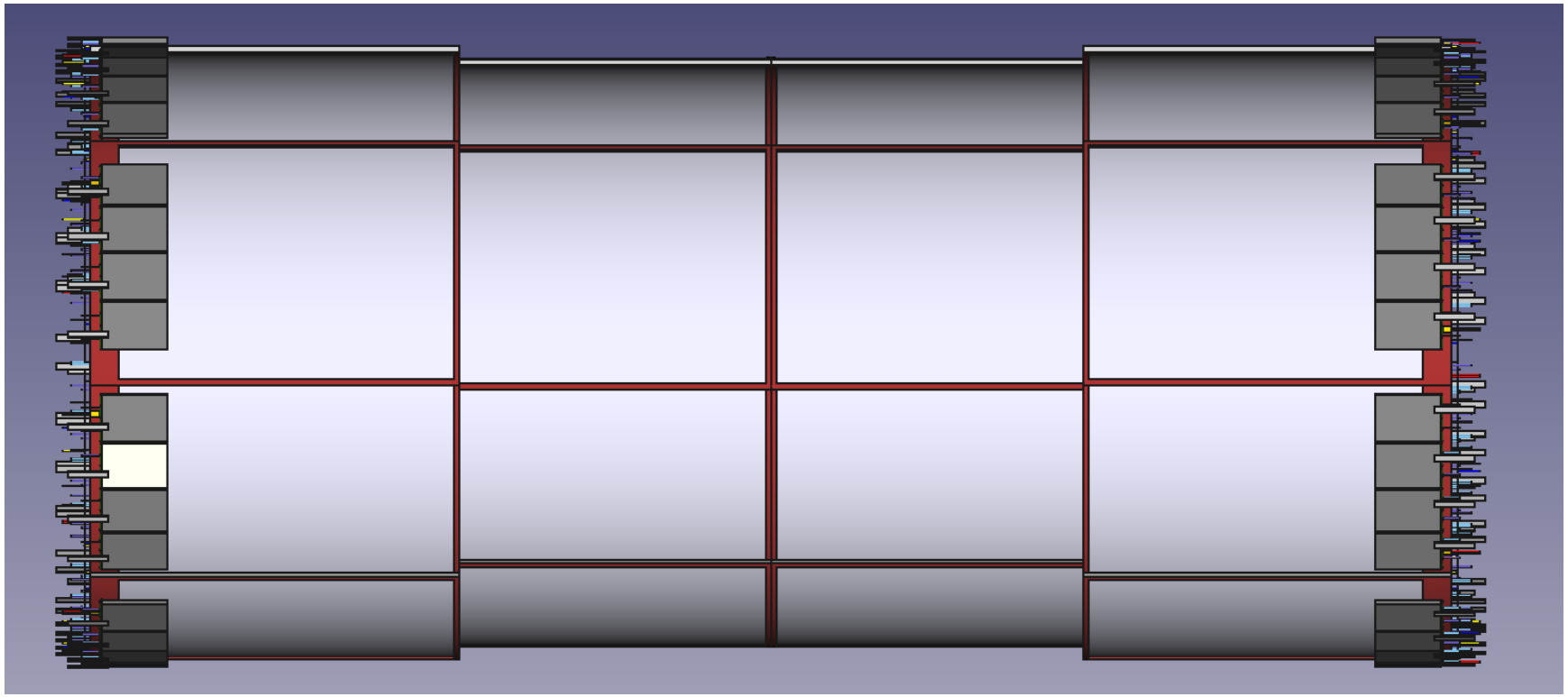
The final decision on the readout pattern design is pending the completion of the R&D



# CyMBaL – Layout

Charge 3

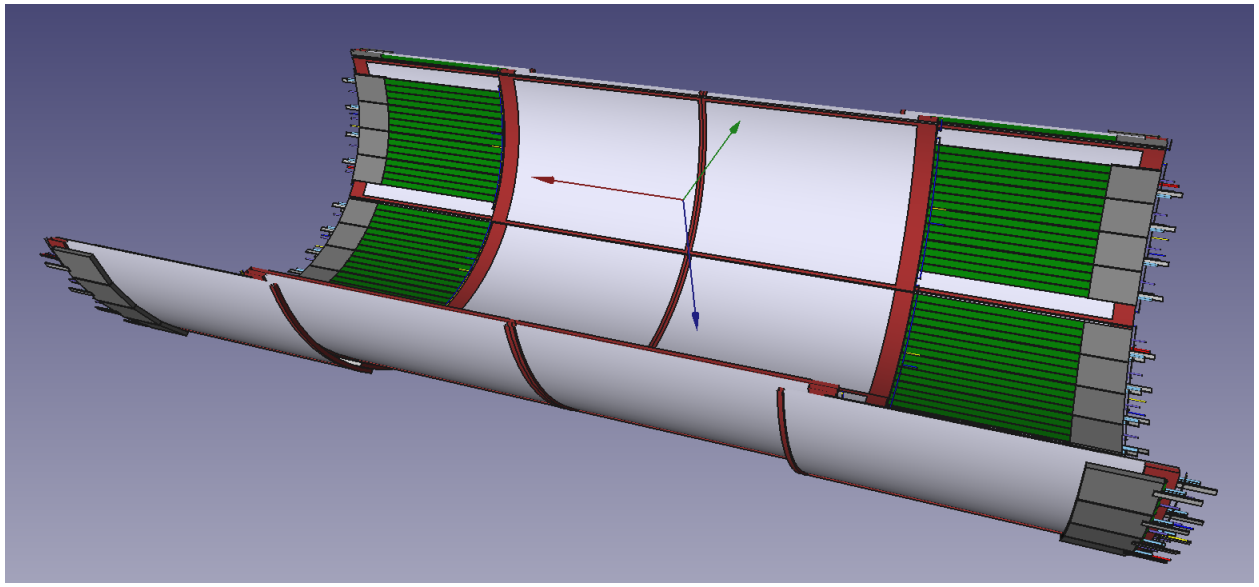
- Length covered by four modules
- Same readout PCB, two different radii
- No overlap in the middle, as there will be already support structures

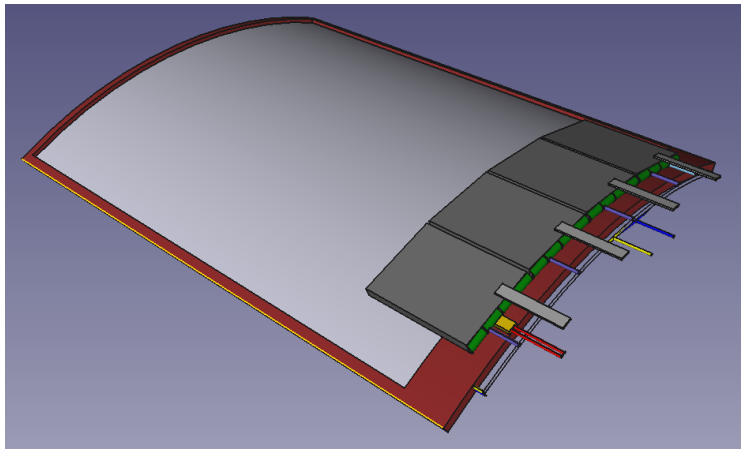


# CyMBaL – Layout

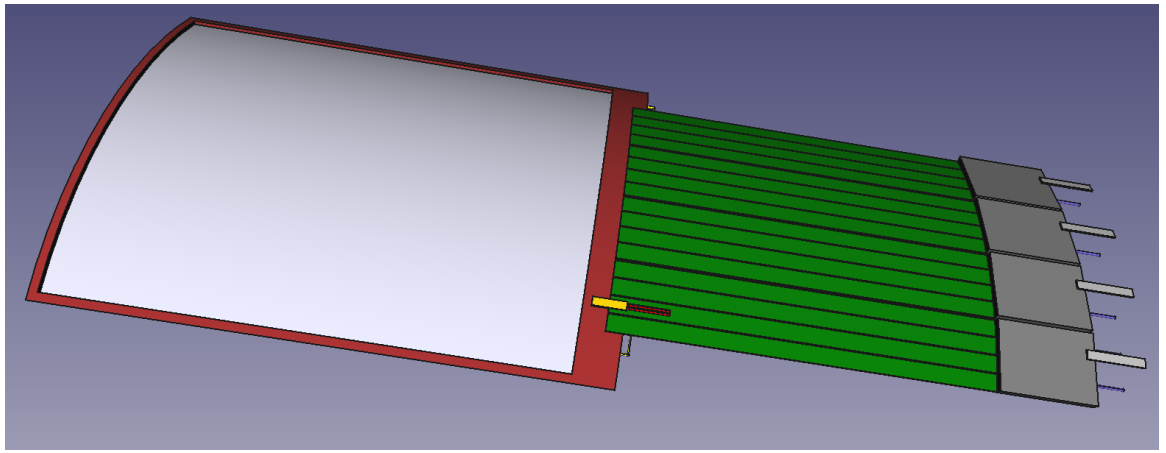
Charge 3

- Front end boards will be placed at the edges of the system
- Inner modules will be connected to the FEBs through ~50 cm of micro-coaxial cables





Outer module

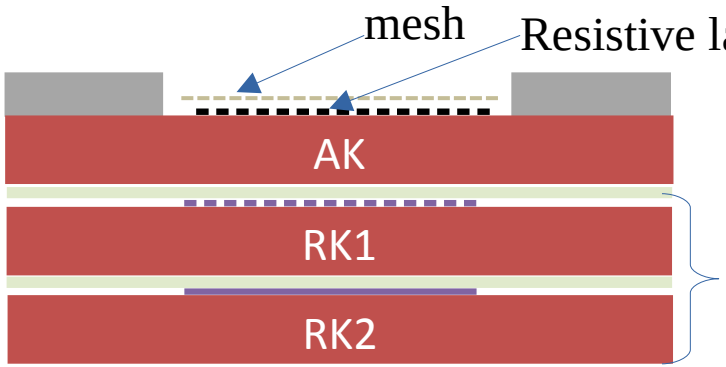


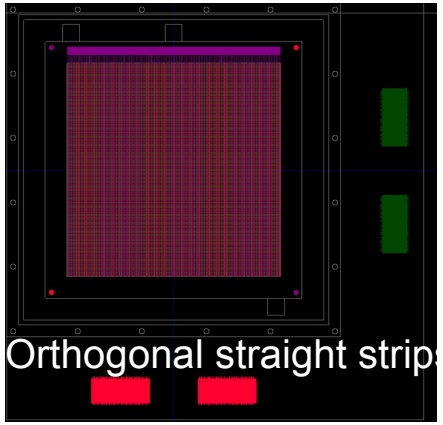
Inner module

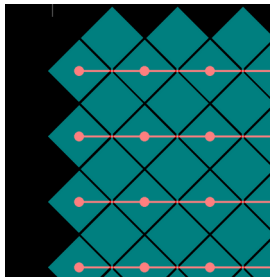
# CyMBaL – R&D

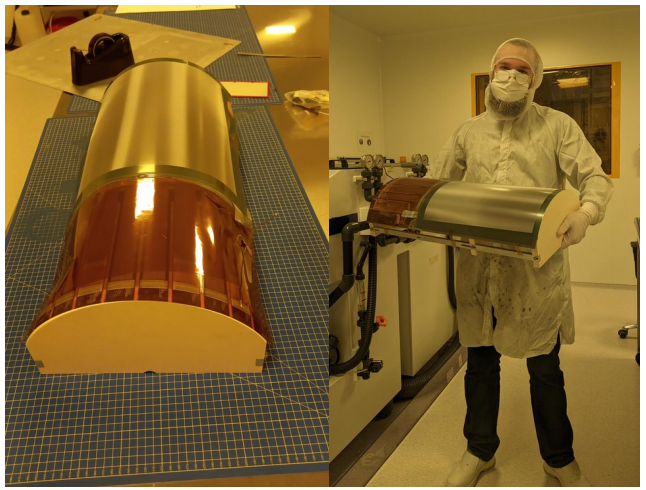
Charge 2

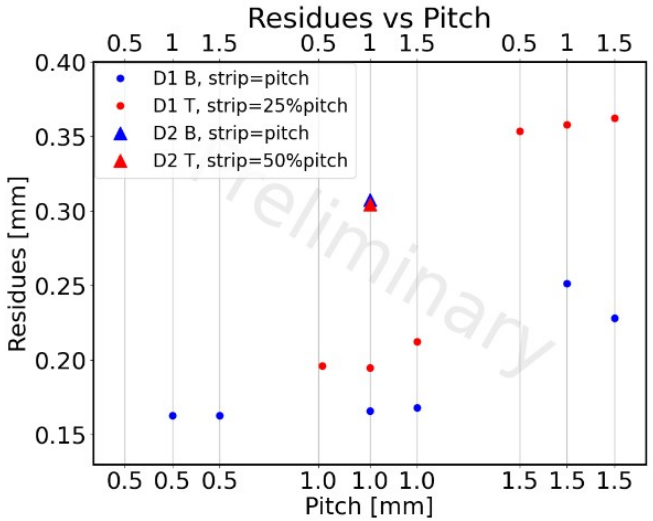
- Upgrade CLAS12 Micromegas technology from 1D → 2D readout
- Goal of the R&D: find the 2D readout pattern that will provide better than 150μm resolution with small number of readout channels
- Developed within eRD6 and eRD108
- Tests of different patterns in beam test in 2023
- FY24 goal: build and test a large scale prototype





Orthogonal straight strip


2D ASACUSA-like





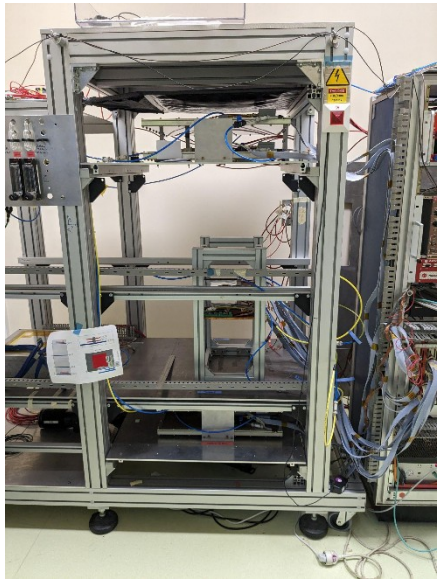
# CyMBaL – HE&S and QA

Charge 7

- Saclay MPGD Lab and clean rooms
- Experience of quality assurance in production with large projects: CLAS12 BMT, ATLAS NSW, T2K TPC
- A list of standard test per module:
  - Validation PCB (metrology and electric tests)
  - Resistive serigraphy metrology and resistivity checks
  - HV tests after Micromegas bulking
  - Gas leakage tests after assembly
  - Electric and capacitance tests after connector soldering
  - Efficiency measurements with cosmics test bench
  - Gain uniformity with Fe55

- QA engineer hired end 2023 at MPGD lab

Standard gas mixture (Ar-Isobutane 95:5) potential flammability risks. Different gas mixtures can be investigated.



# CyMBaL – Schedule

Charge 5

R&D/E&D: 2025
Pre-prod 2025 – 2027
Prod 2027 – 2029  ~2ans

Zoom for a module?

# Summary

# CyMBaL – Summary

- The design of the inner MPGD layer, i.e. CyMBaL, is advanced. A modular design to reduce design and costs.
- The technology choice is an upgrade of the current technology used for the CLAS12 BMT
- Finalization of the R&D for the final choice of the readout pattern