CyMBaL:
Cylindrical Micromegas Barrel Layer

Status

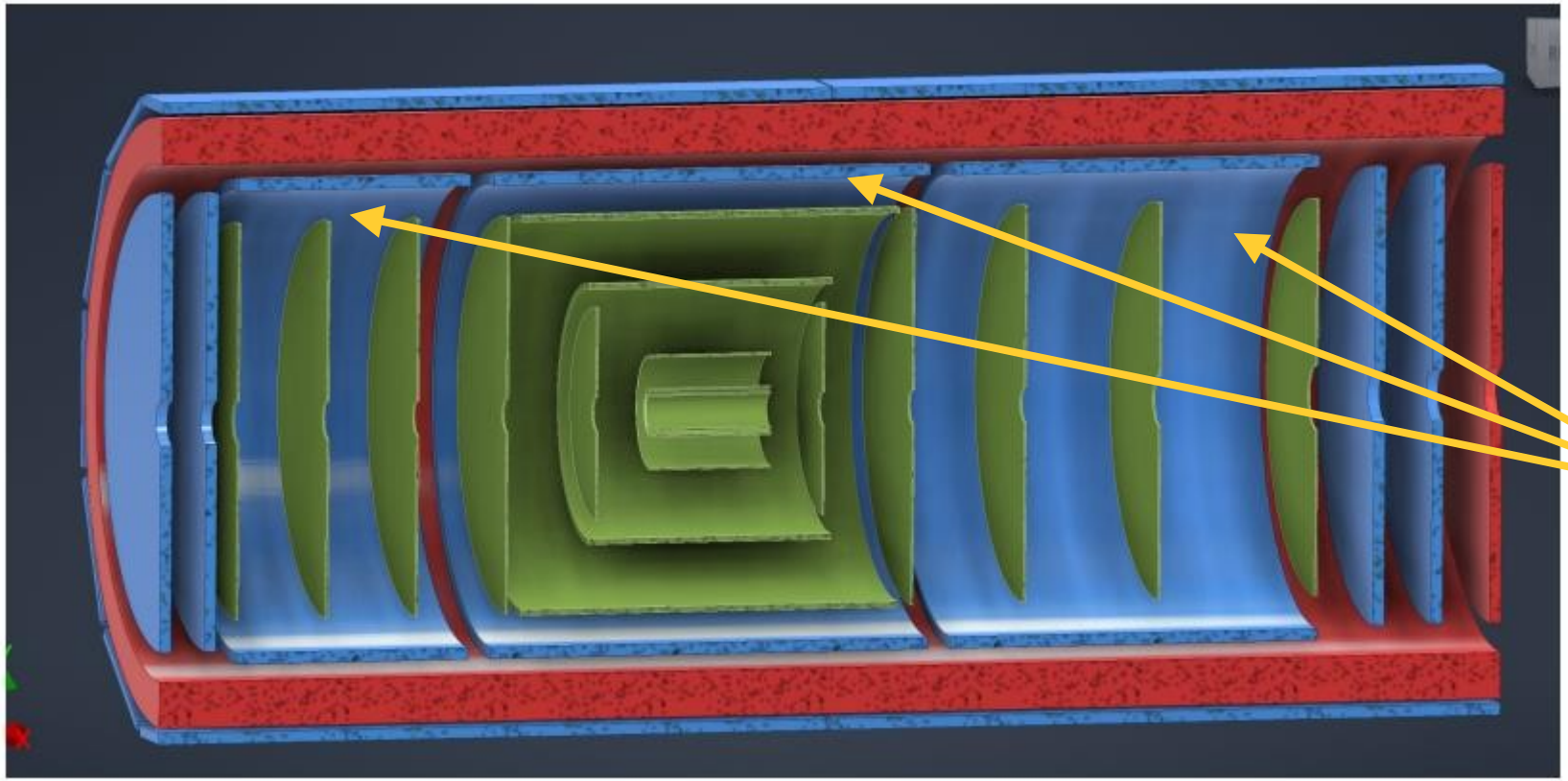
F.Bossù

As every year, the week of Aug 15th CEA is closed.

We are on holidays, therefore not able to attend the meeting.

Aug 14th 2023 – TIC meeting

The new MPGD layout in ePIC



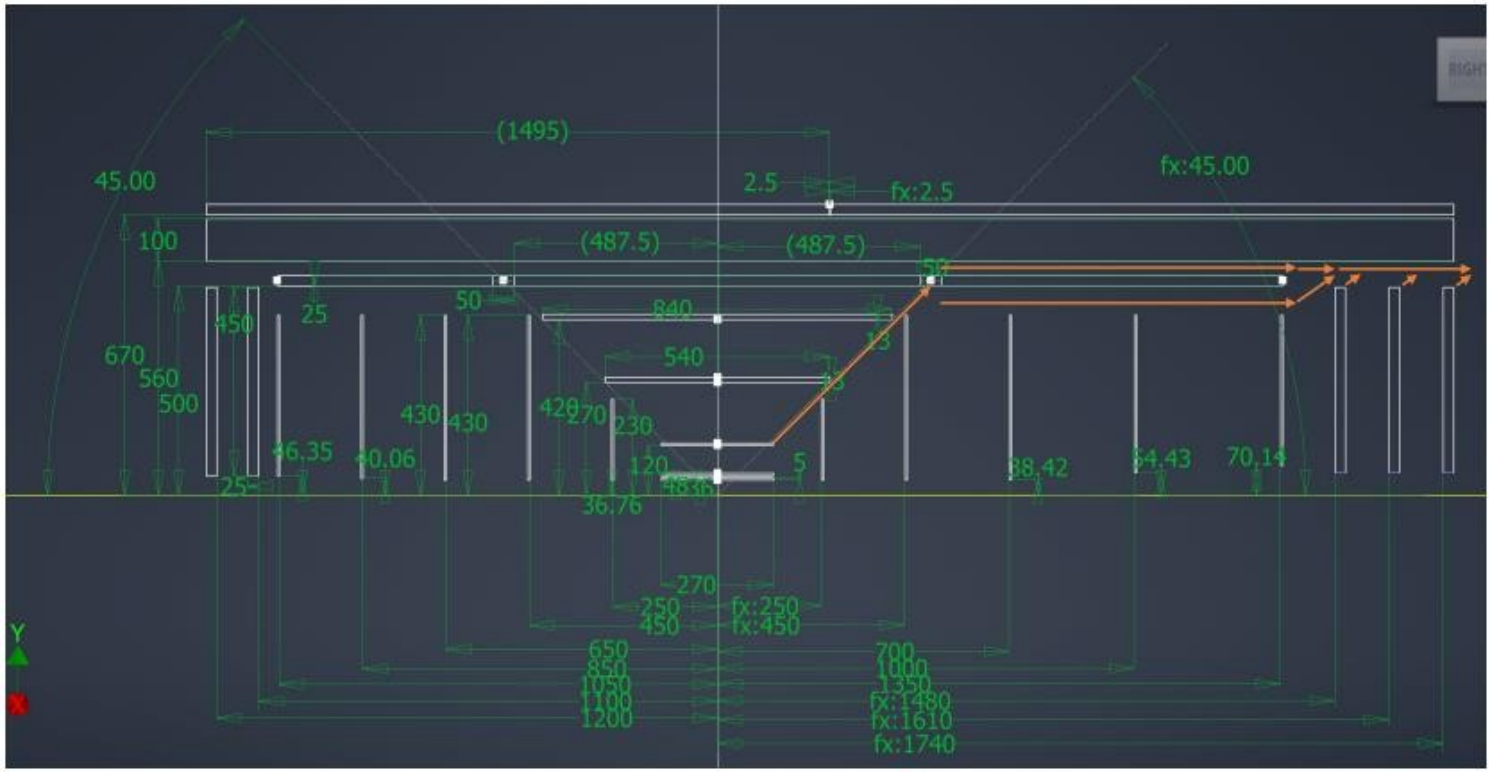
CyMBaL

Three cylinders for different lengths at R=50cm

Keeping zones

- Three cylinders for different lengths at R=50cm
- Vertical keeping zone: 25mm
- Additional space
  - 60mm to TOF
  - 70mm to the SVT
  - Can some of it be used? TBD
- Assumptions :
  - Hermetic in phi and z.
    - Is it needed? TBD

	z min	max	length
backward	-105	-53.75	51.25
central	-48.75	48.75	97.5
forward	53.75	135	81.25

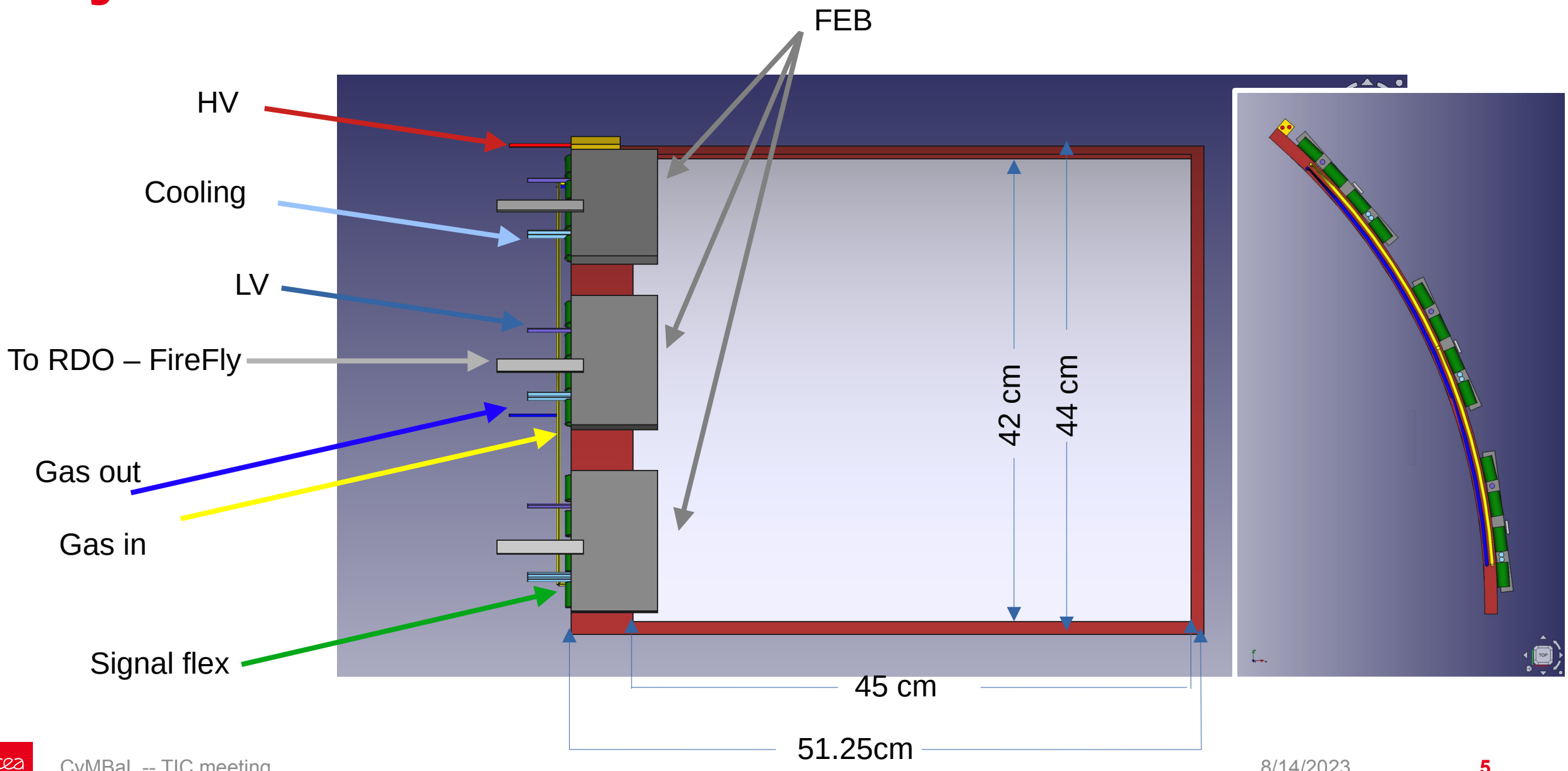


Working hypotheses

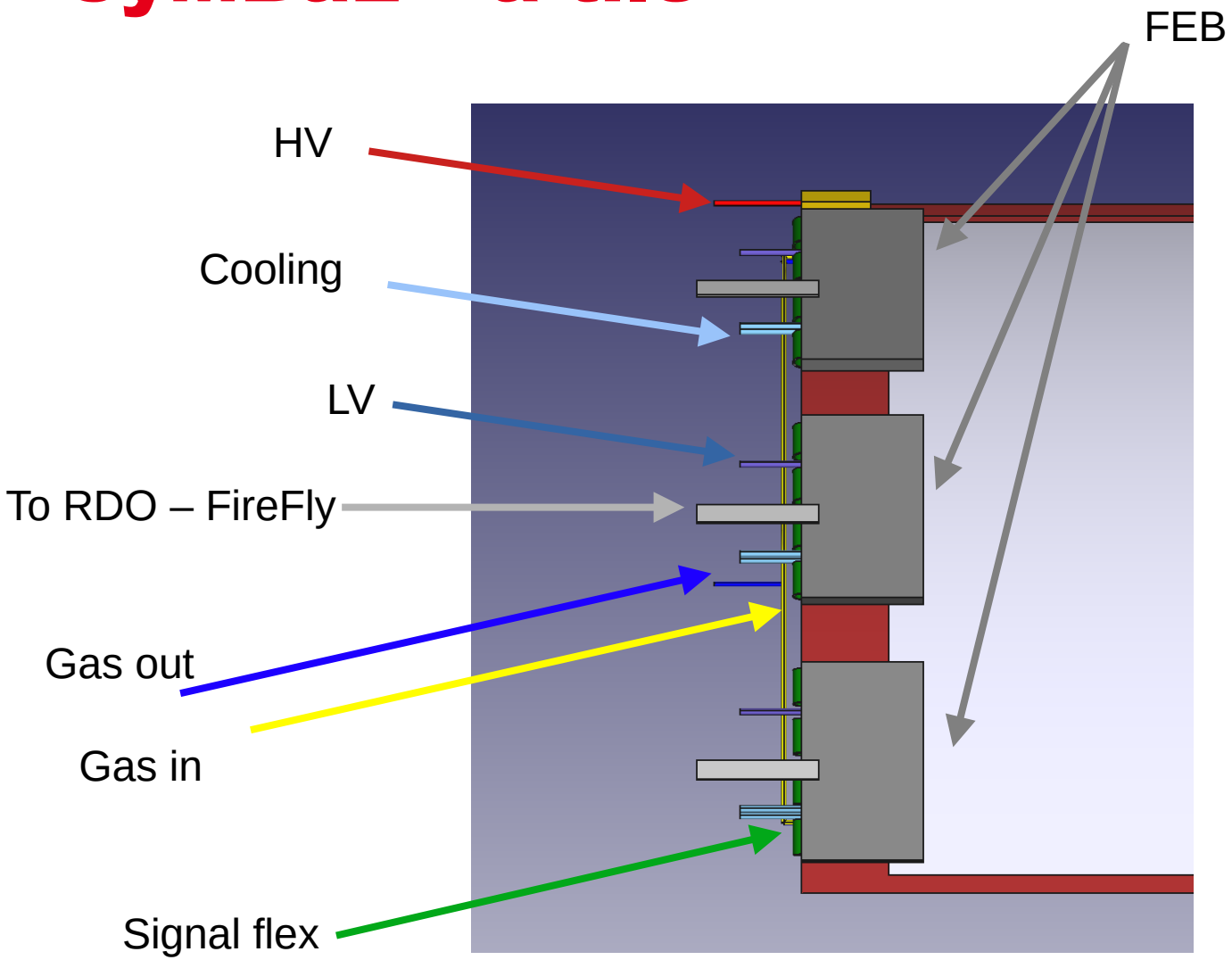
- Making small modules is simpler and the production line more robust, than long detectors
- Making few (maybe just one) module types simplify enormously the production line
- Segmenting the system in module makes it more robust to local failures during data taking
- Hermetic system both in φ and in z

What follows is a VERY PRELIMINARY set of ideas put together in a simple CAD model. None of the numbers/dimensions are cast in stone yet. It is the starting point for further evolutions

CyMBaL – a tile



CyMBaL – a tile



Assumptions:

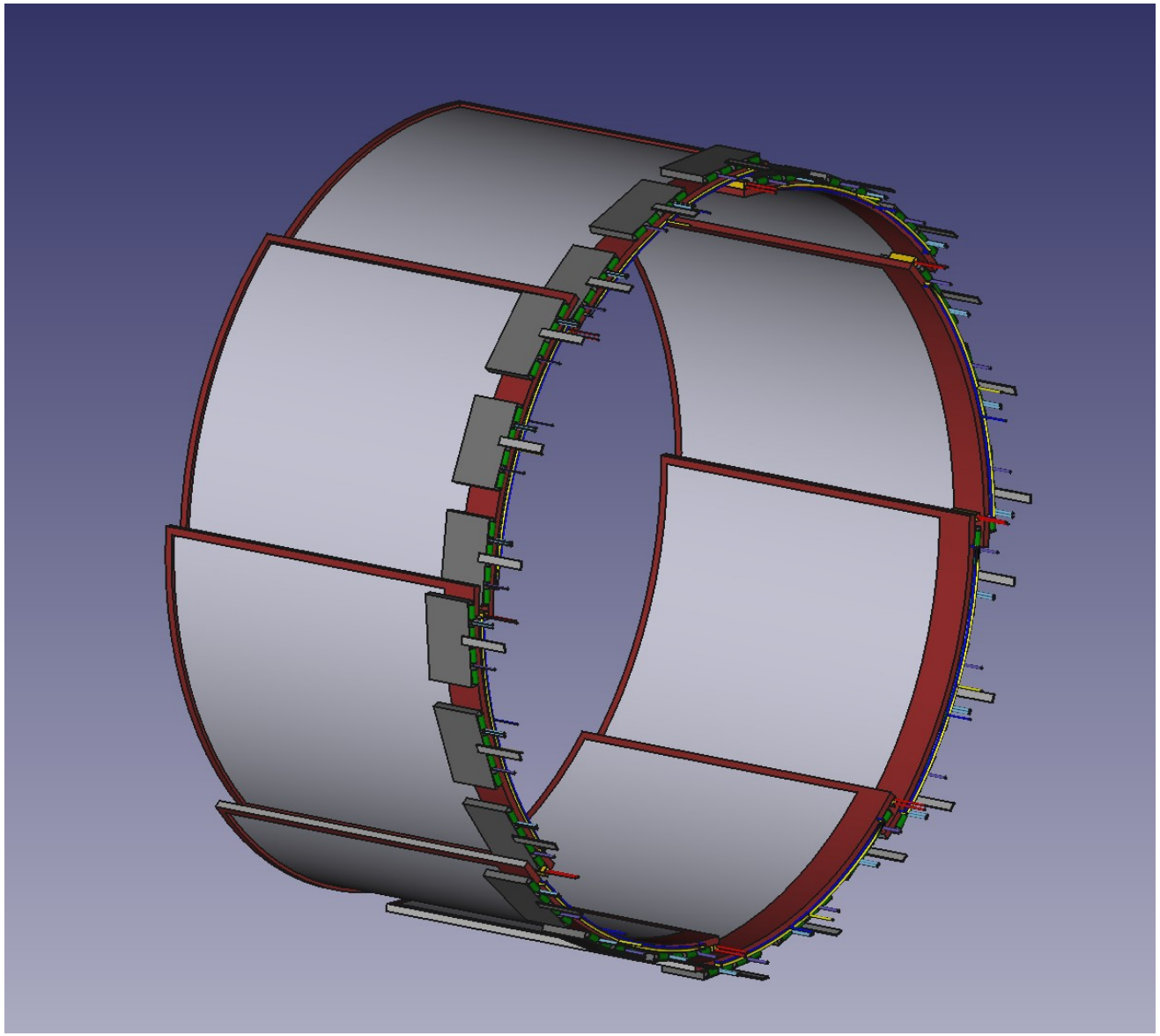
- Size: 51.25 x 44 cm^2
- Active area: 45x42 cm^2
- ~1 mm pitch in both directions
- 768 strips per tile
- 32 channels per connector, 24 connectors

Services:

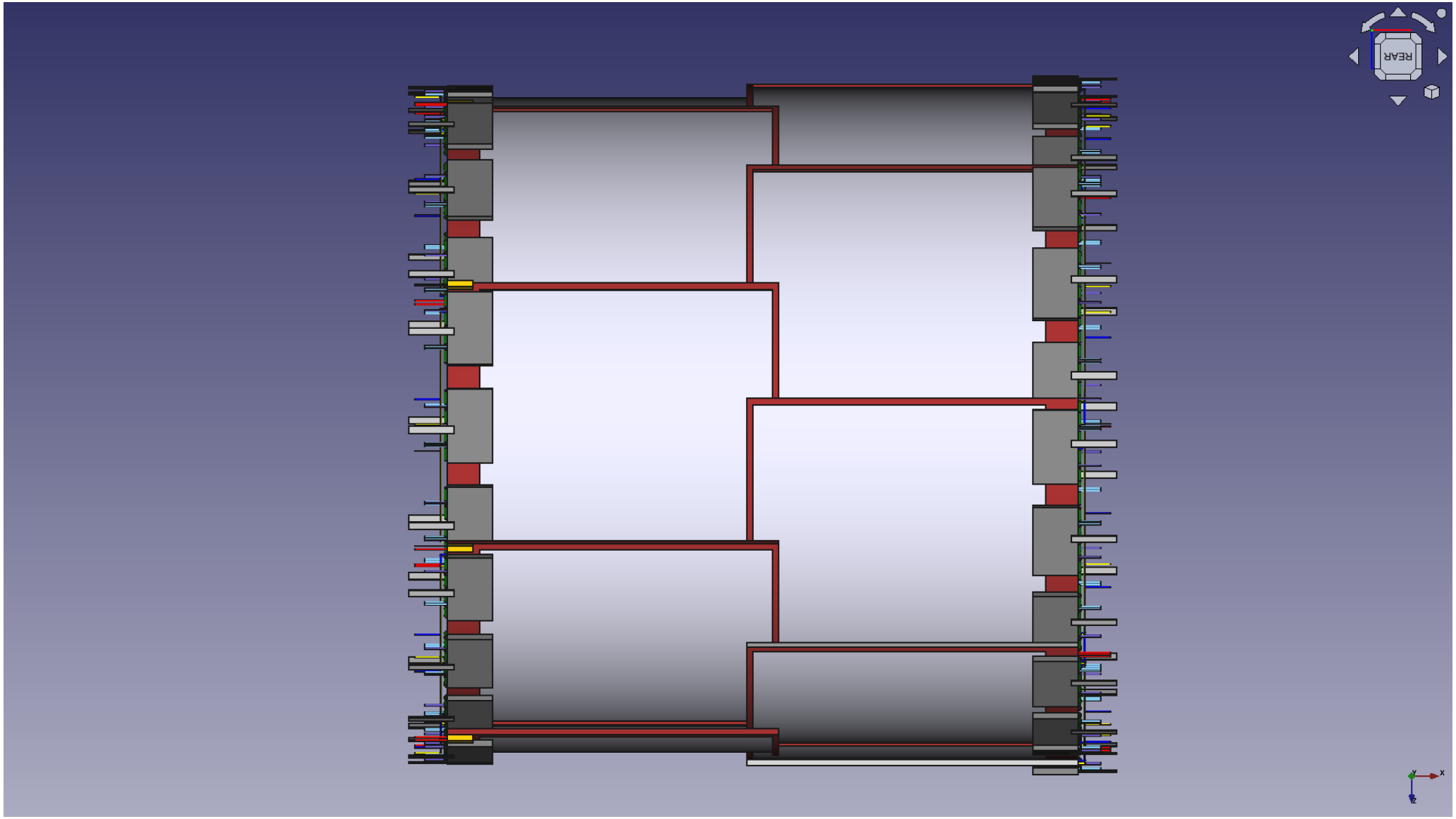
- HV: 2 channels (drift and resistive layer)
- Gas: 2 tubes (in and out)
  - Two or three tiles can be in series
- If 4 ASICs per FEB:
  - 1 8ch FireFly per FEB to the RDO
  - 2 short flex cables per ASIC, 24 flexes 10cm max
  - 1 LV
    - DCDC on the FEB?
  - Cooling in and out
    - TBD: FEB in series ?

CyMBaL – a sector

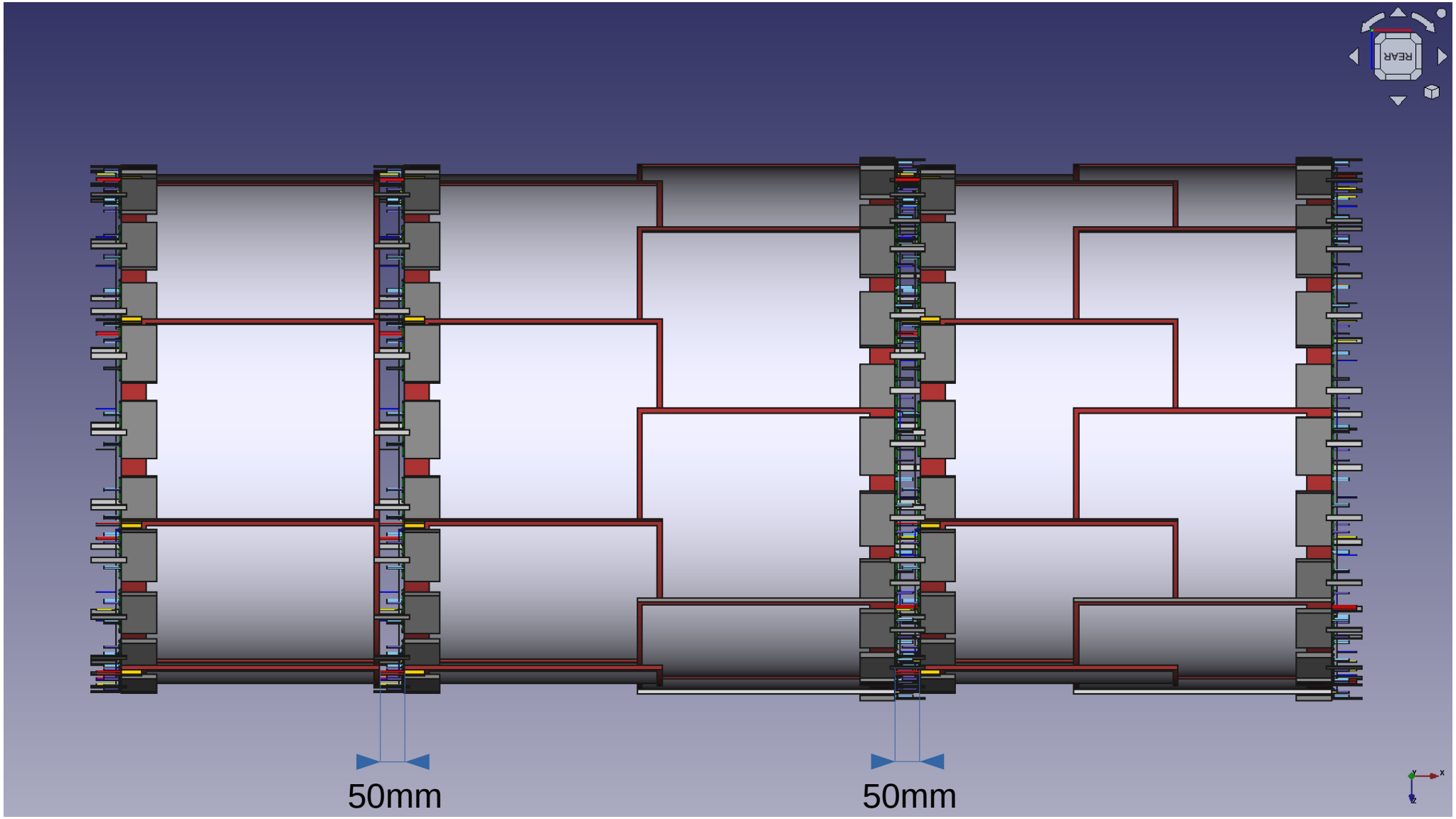
- Preliminary layout of 8 tiles to cover the circumference. It is possible to cover with 7 slightly larger tiles. It depends also on the installation procedure
- Questions:
  - Mounting procedure : will it be in two halves or a barrel that slides on the SVT?
  - With this preliminary layout the radial envelop is about 4 cm. Is this acceptable?
    - Adjusting the FEB position we can gain ~1cm
  - Support structure to be studied:
    - It depends on the installation strategy, on the connections and anchors with the other systems
    - What part of the support has to be part of the CyMBaL system and what is provided by the Project is TBD



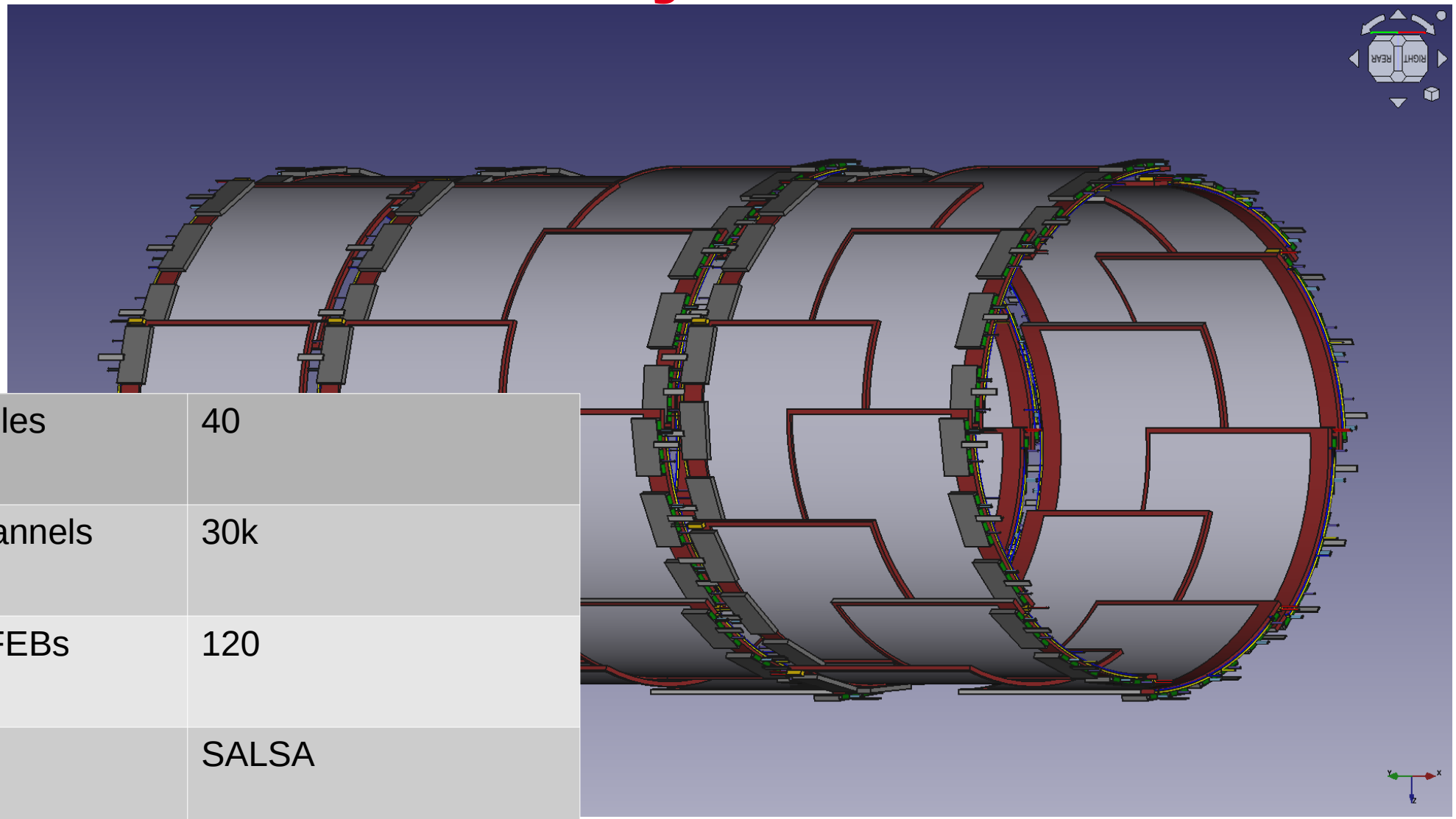
CyMBaL – the central region



CyMBaL – the whole system



CyMBaL – the whole system



Number of tiles	40
Readout channels	30k
Number of FEBs	120
ASIC	SALSA

CyMBaL

- This very preliminary sketch
- Based on a module 51.2x44 $cm^{2,}$
- A version with three different module sizes to cover the the three regions is also under consideration
- FEB on modules,
  - Because basically no space available within ~2m distance from the tiles
  - This allows us to route only ~120 FireFly data cables instead of 120x2x4=960 micro-coaxial flat cables
- Some open questions:
  - In the forward and backward regions, particles will be crossing with $|\vartheta| > 45^{\circ}$. It will be challenging to keep the 150µm spatial resolution promise. Unless counter measures, such as thin-gap detectors, are considered.
    - What is the acceptable spatial resolution for these regions?
    - Should the MPGD focus on timing resolution rather than the spatial one ?
  - Patch panels :
    - Use of patch panels for HV and LV distribution should be considered
  - FEB cooling : is there a ePIC common initiative ?
  - Efficient DCDCs for LV distribution. A common effort is welcome

Technology for CyMBaL

Motivation

- Build a full (no acceptance gaps) light-weight modular Micromegas barrel layer to complement the silicon vertex detector

CLAS12 MM Technology

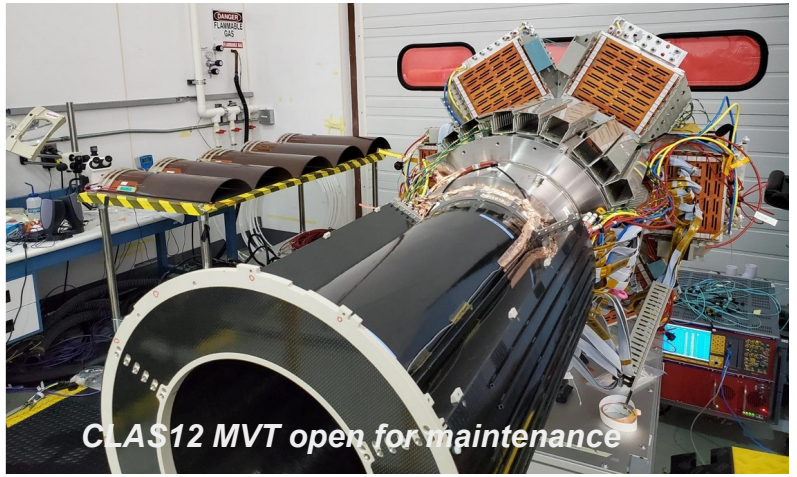
- Compact cylindrical tracker in a **B=5T solenoid**, total active area ~4m^2
- Light cylindrical tiles (**~0.4% X0 per layer**)
- 1D readout per tile (either phi or z coordinates)
- **Taking data since 2017**

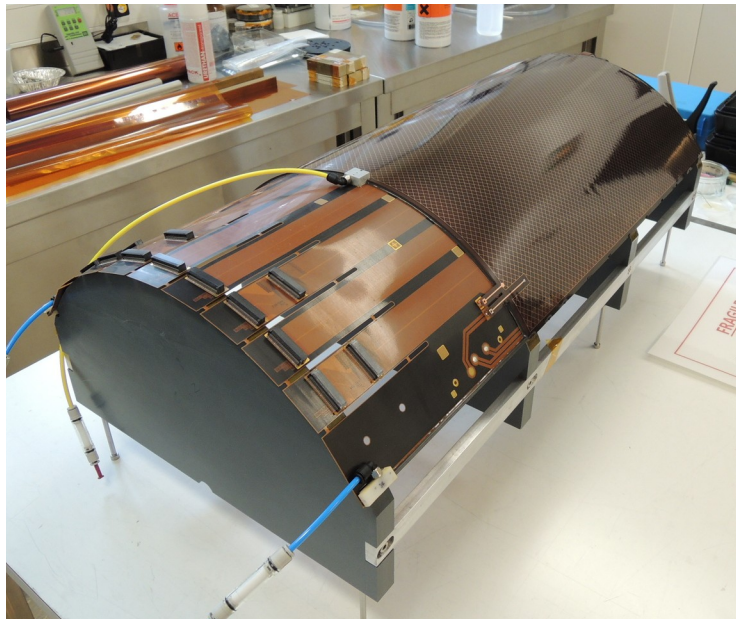
Upgrades to fit the EIC needs:

- **Simpler construction:**
  - about one module size bent at different radii,
  - overlap tiles for no acceptance gaps
- **2D readout**
  - Resolutions ~150µm, on both directions
  - Keeping the channel count as low as possible

R&D

- FY22:
  - Optimization of the 2D readout for low number of channels on small prototypes
- FY23:
  - Build a full scale prototype of a Micromegas tile (~50x50cm^2) with the chosen 2D readout

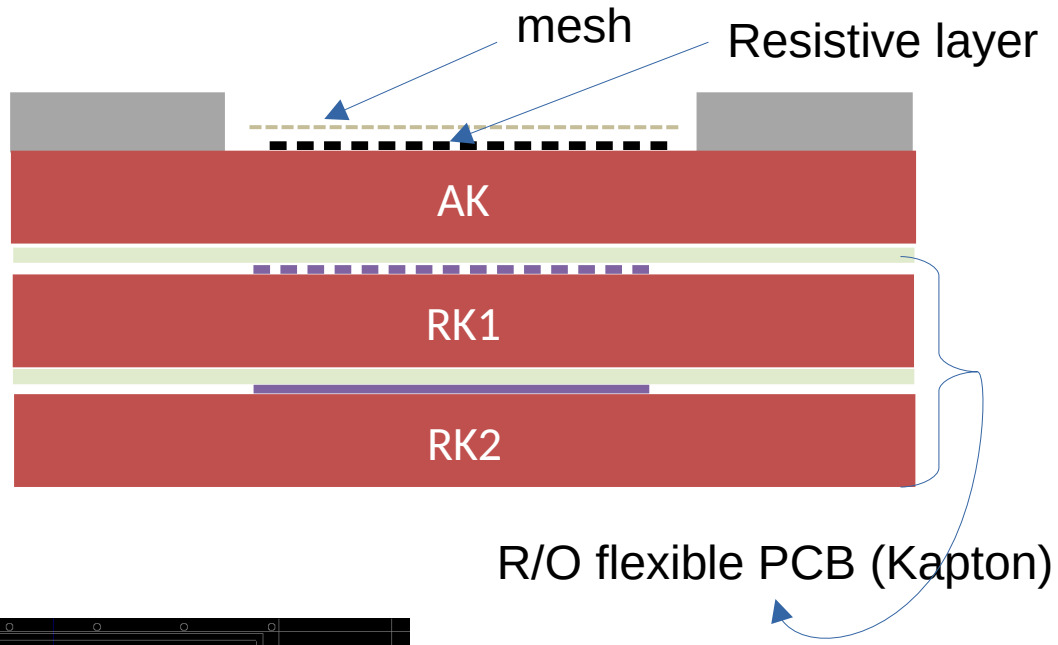


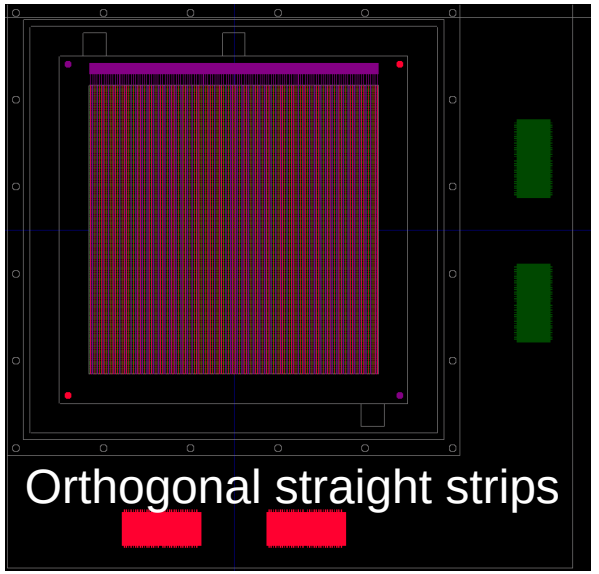


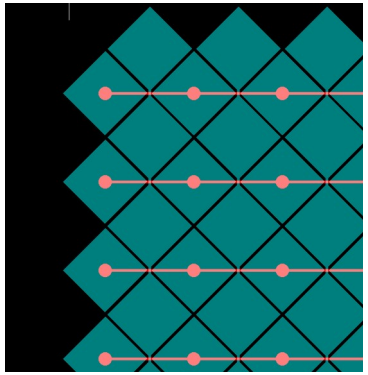
R&D for a cylindrical Micromegas tracker

R&D 2D readout

- Several small prototypes ~12x12 cm^2
- Multi stack for easy combination of different options:
  - AK: Amplification Kapton
    - Vary the resistivity, the shape, ...
  - RK: Readout Kapton
    - Different strip pitch (1, 1.5, 2 mm)
    - Vary strip type (straight, zigzag, pixel,..)
- Assembly in house
  - Pressing
  - 3D printed mechanics

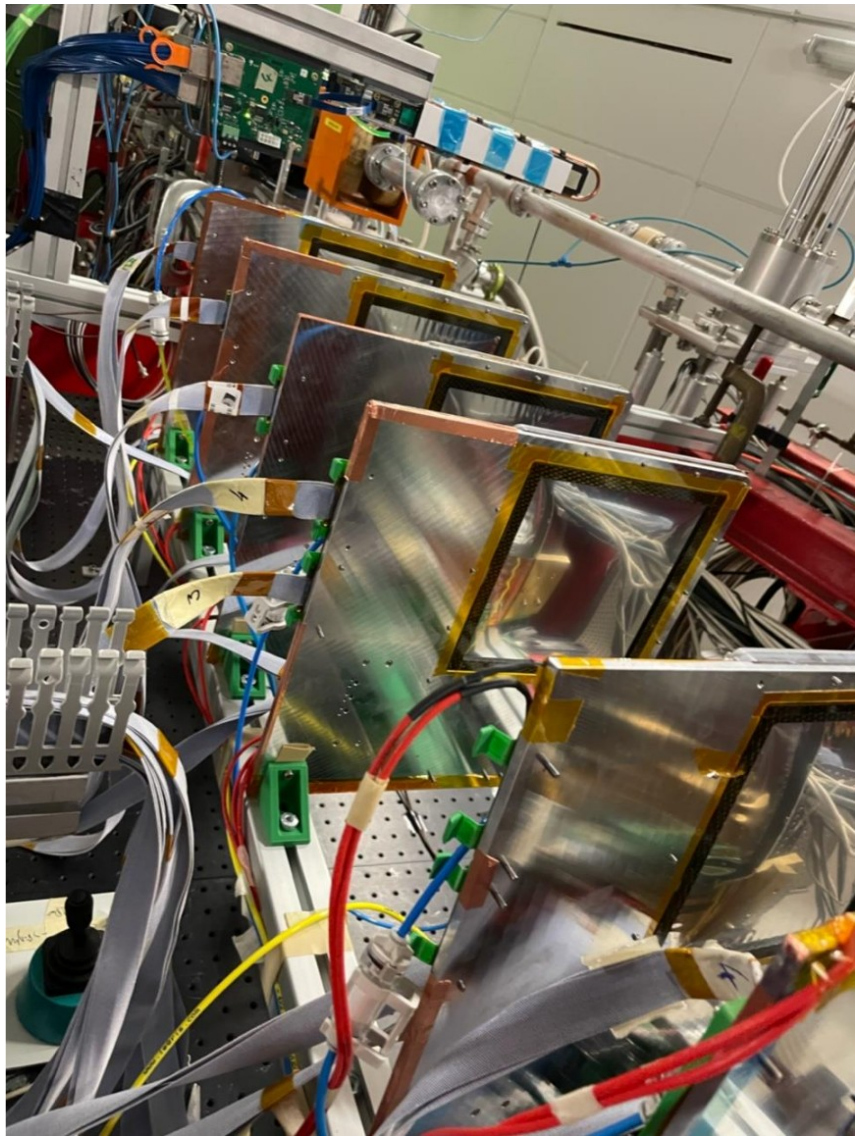




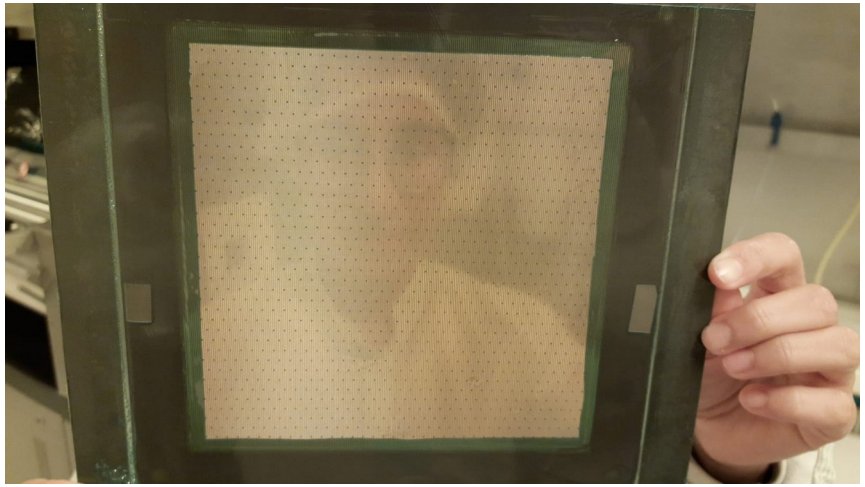


2D ASACUSA-like

Beam test 2023



- Beam test of about one week in June ‘23 in Mainz at MAMI
- In synergy with the R&D for the P2 experiment
- Tested several small Micromegas and µRWELL prototypes
- Low material budget: ~0.2%X0 in the active region



CyMBaL – Technology

- The cylindrical Micromegas technology for ePIC is an evolution of the CLAS12 Barrel Micromegas Tracker [1] [2] from 1D to 2D readout.
- Design and production will be done largely at CEA Saclay
- R&D is ongoing, plans for a large size prototype by mid-2024
- Open question about spatial resolution needs in backward and forward sections. What is required by tracking needs? Should time resolution be the focus?
  - Tests of different gas with thin-gap detectors in FY2024 will try to overcome the spatial resolution degradation
- Integration with SALSA:
  - SALSA engineering happening at Saclay (together with Sao Paolo U)
  - Close contact with engineers. See Irakli's presentations at the DAQ meetings.
- If questions, please write to Francesco, Maxence and Irakli

Backup – long tile version