Status of Forward Hadron Calorimeter (FHCal)

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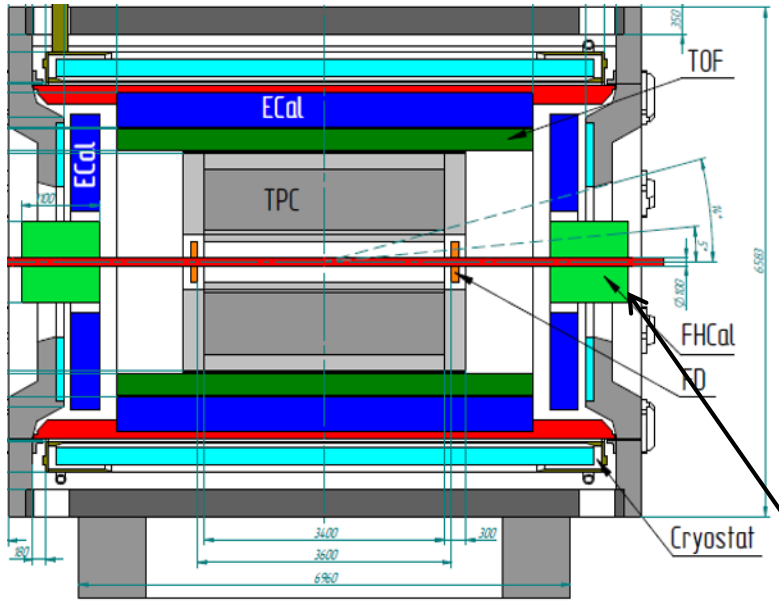
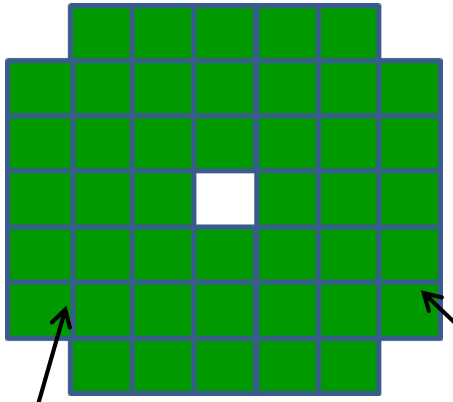
on behalf of the FHCal group

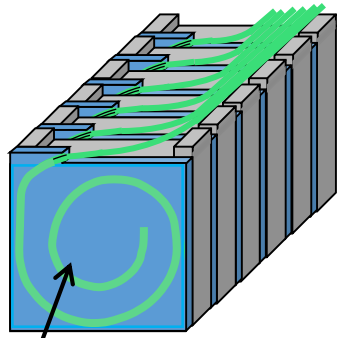
- FHCal overview;
- Status of FHCal modules;
- FHCal subsystems and activity;
- Integration to MPD

11th MPD collaboration meeting, Apr., 2023.

FHCal in MPD







FHCal

FHCal modules

- Two arms of hadron calorimeter at opposite sides in forward regions.
- At the distance 3.2 meters from the interaction point.
- Available acceptance corresponds to pseudorapidity $2.0<\eta<5.0$

- FHCAL consists of 2x44 modules.
- ~1x1 m^2 each part.
- Beam hole 15x15 cm^2.
- Lead/scintillator sampling calorimeter.
- Longitudinal segmentation;
- Light readout- WLS-fibers;
- 7 sections/photodetectors in each module.

FHCal detects spectators to measure:

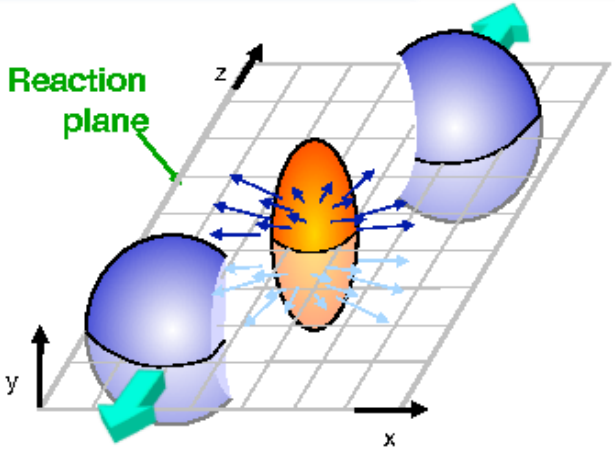
a) **The centrality of the collision;**

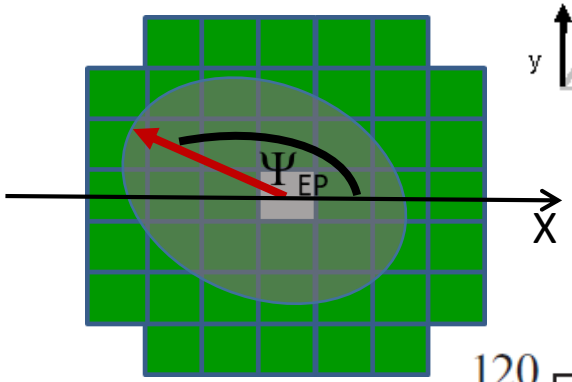
b) **The reaction plane orientation;**

c) **Minimum bias trigger;**

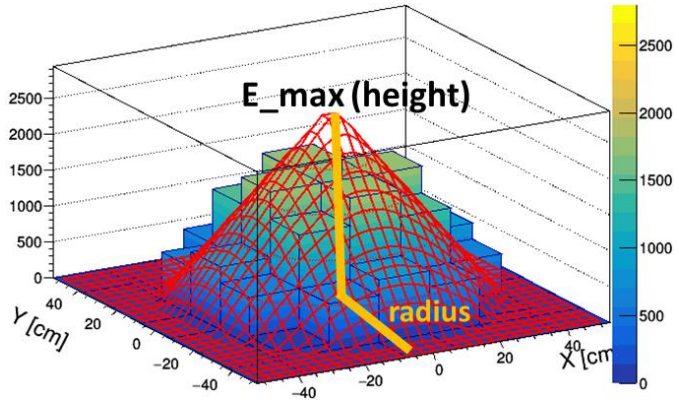
d) **Physics in forward rapidity.**

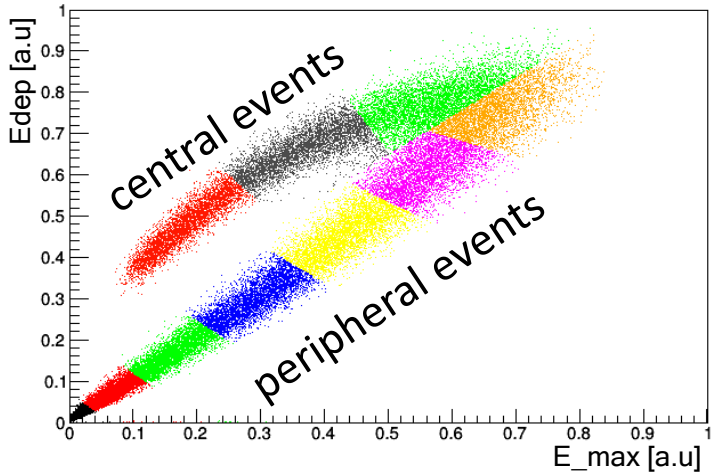
$$\Psi_{EP} = acrtg \frac{\sum E_i \sin(\varphi_i)}{\sum E_i \cos(\varphi_i)}$$

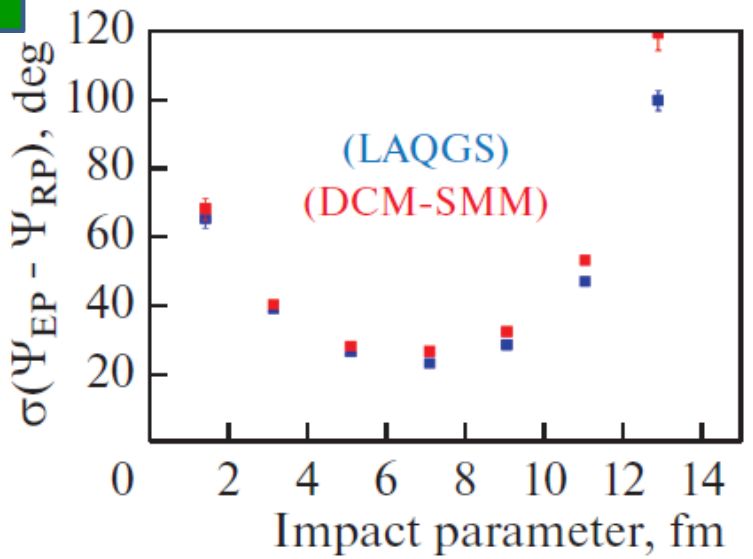




Centrality:
2D-Fit of energy distributions in FHCal modules







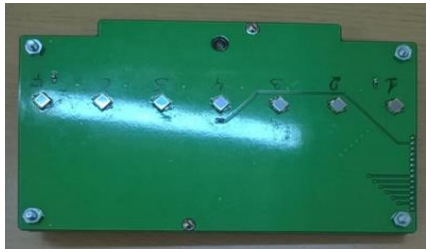
FHCal modules

- All (90+spare) FHCal modules are assembled and tested with cosmic rays.
- 100 Front-End-Electronics (FEE) boards are produced and tested.
- Modules are ready for the delivery at MPD site.

The activities with modules:

- Calibration with cosmic muons;
- Development of readout;
- Development of FHCal trigger;
- Development of Detector Control System;
- Monitoring system.

Front-End-Electronics



MPPC: new type
S14160-3010PS
size – 3x3 mm²;
pixel -10x10 µm²;
PDE~18%.

Two PCBs in each module with:

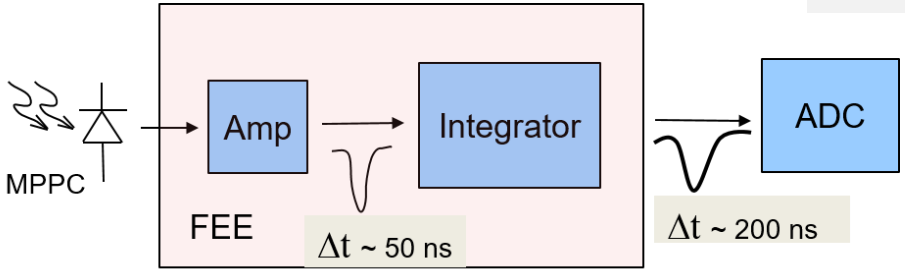
7 photodetectors ;

Photodetectors – MPPCs;

two-stage amplifiers;

HV channels;

LED calibration source.



100 units of FEE were produced and tested.

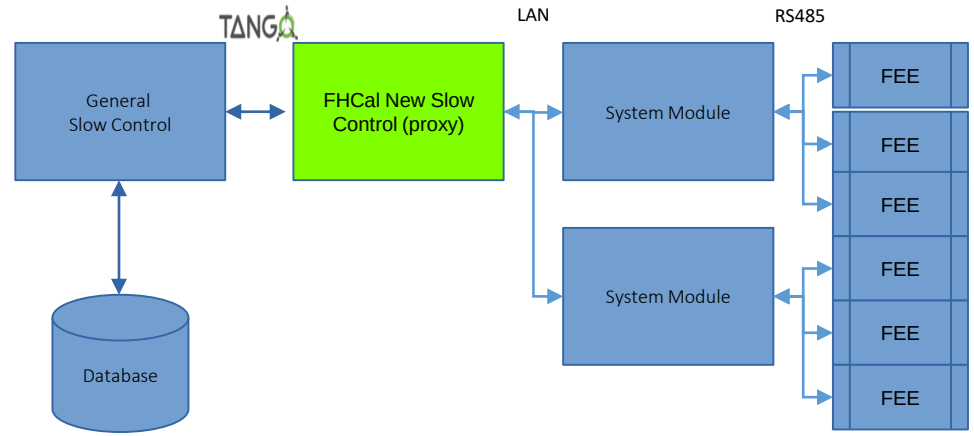
Detector Control System (DCS)

DCS Tasks:

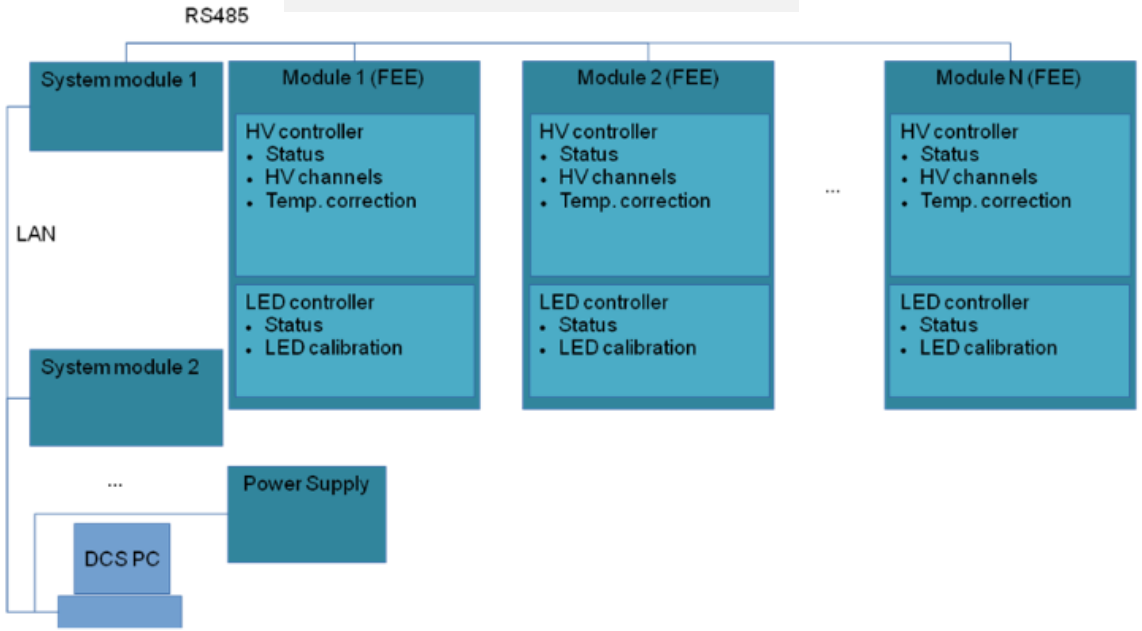
- **Control of HV at photodetectors (MPPC's);**
- **Temperature control of photodetectors;**
- **Compensation of temperature drift of MPPC gain;**
- **Monitoring of MPPC gain with stabilized light source.**

Status of DCS:

- **It is practically fully operational;**
- **Further improvements of functionality are going on.**

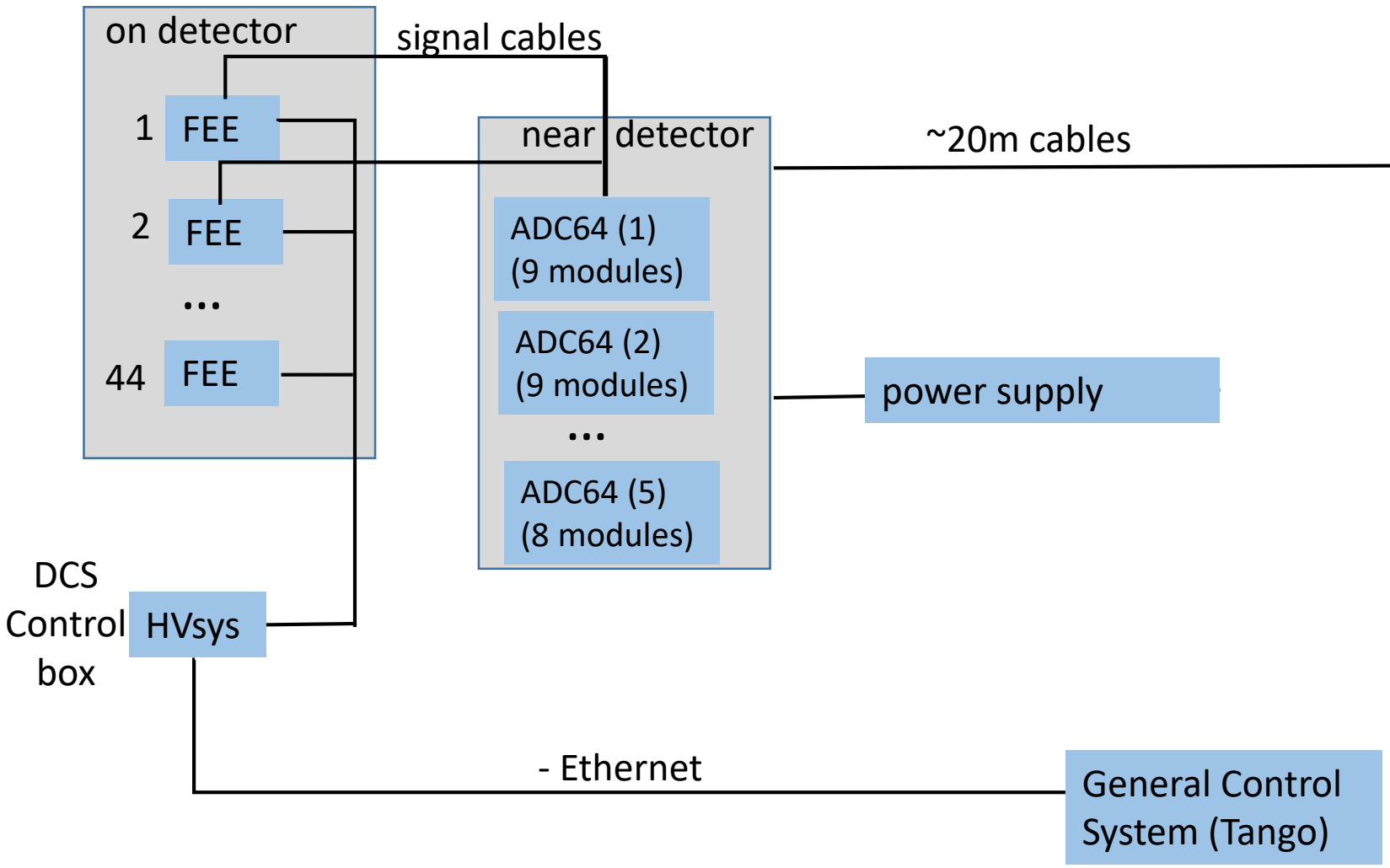


Connection diagram



FHCal readout and control

FHCal arm

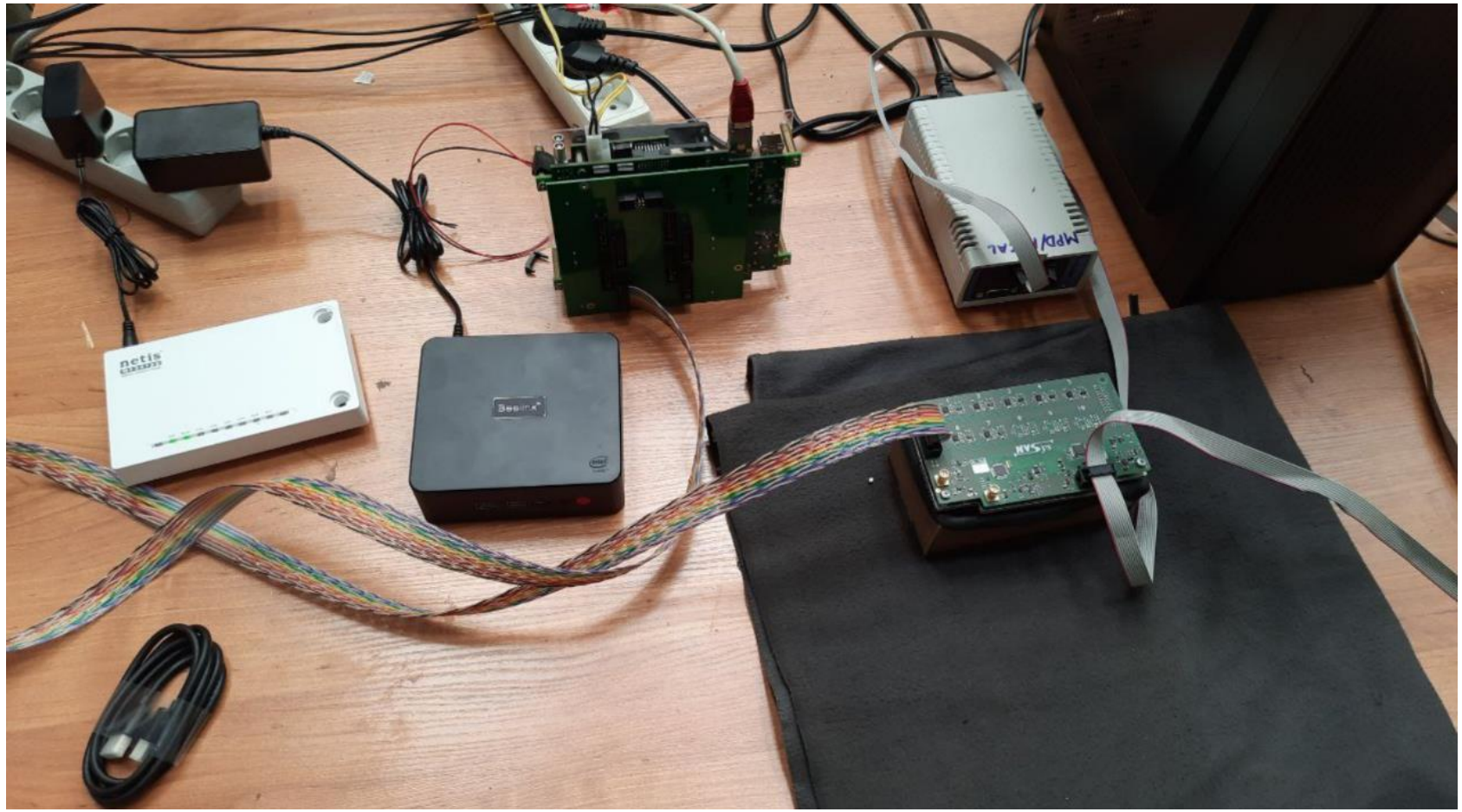


The readout electronics: FPGA based 64 channel ADC64 board, 62.5MS/s (AFI Electronics, JINR, Dubna).

Both FHCal arms have the same readout scheme.

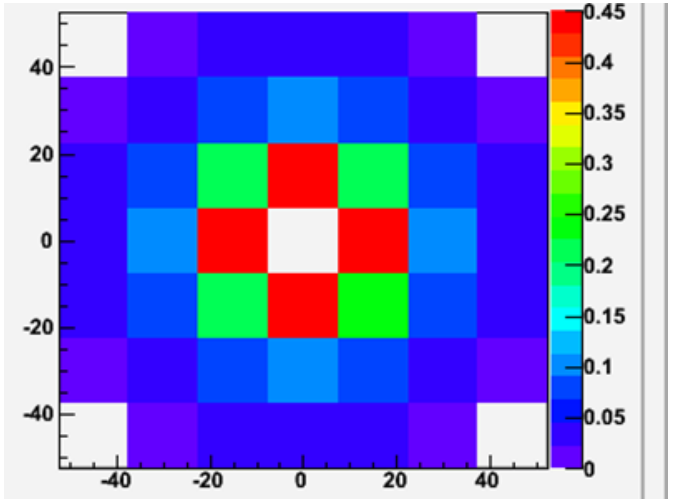
Preparation to the tests of ADCs

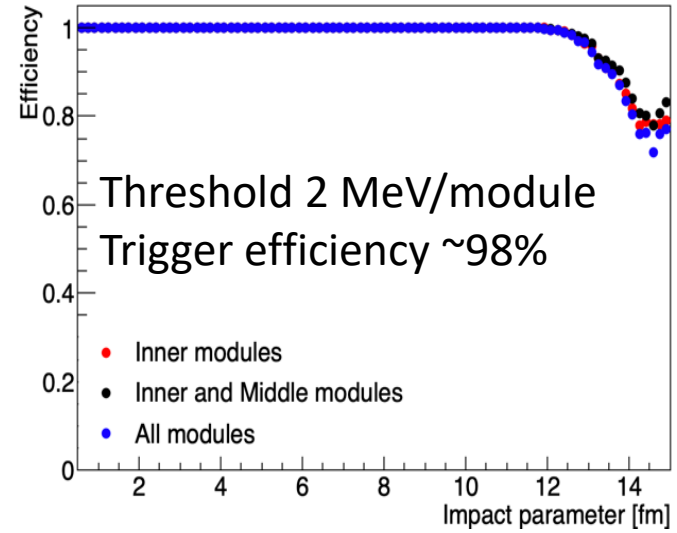
Test bench for ADC readout



FPGA based 64 channel ADC64 board, 62.5MS/s (AFI Electronics, JINR, Dubna).

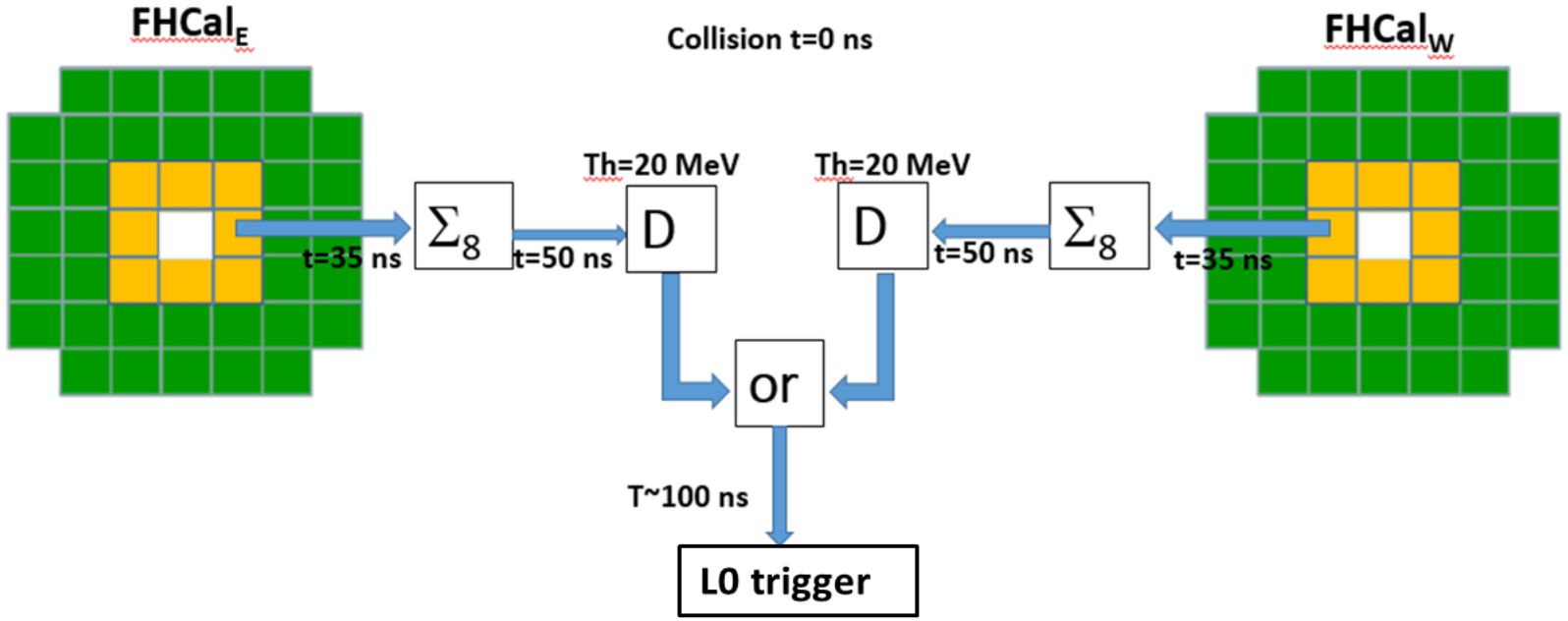
FHCal trigger





Dependence of trigger efficiency on the configuration of modules (Au-Au 11 GeV).

Scheme of FHCal trigger

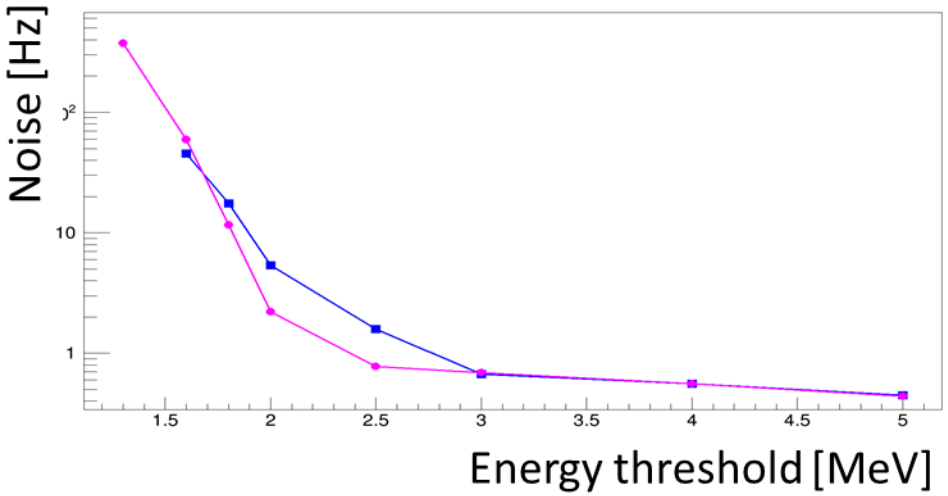


Preparations for FHCal trigger

- Adders of analog signals from individual modules were produces for full FHCal.
- The configuration of modules in trigger would depend on FEE and correlation noises. Flexible configuration is to be developed.

12-channels signal adders

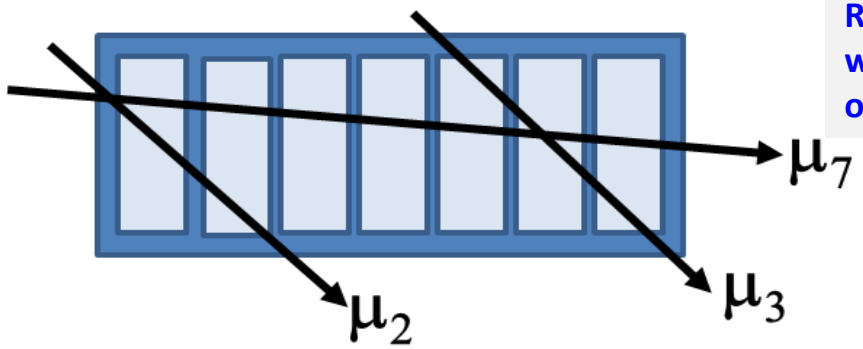
Test of trigger noise on energy threshold in one module

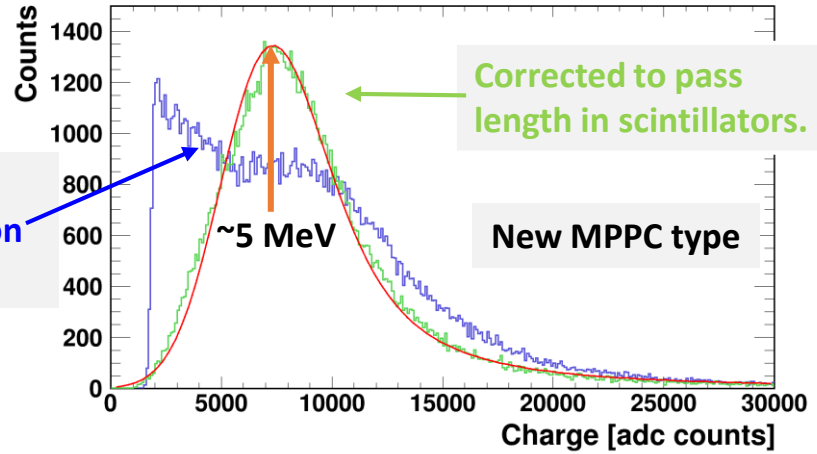


All adders are working. The noises are under tests.

Energy calibration with cosmic nuons

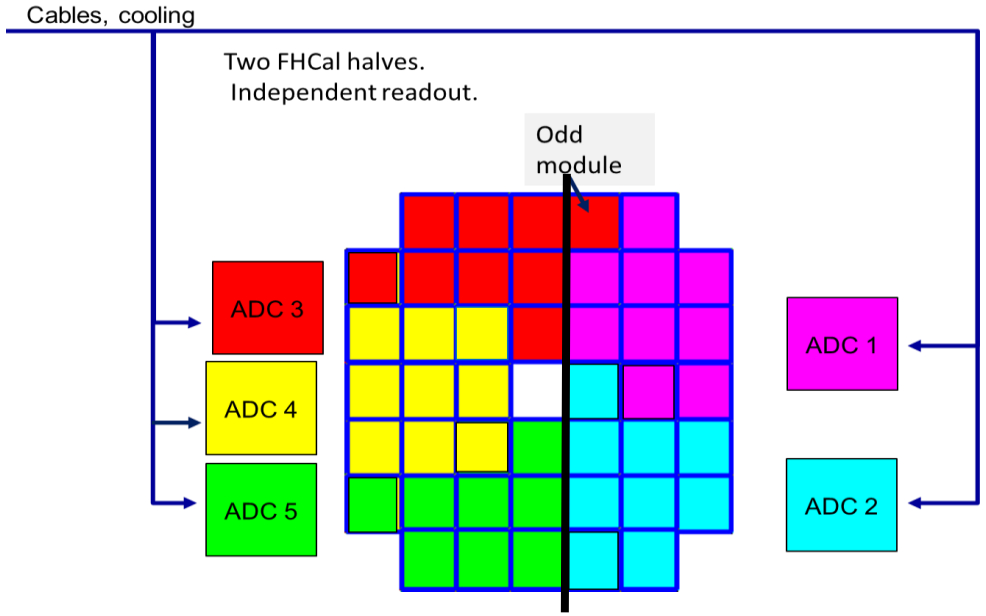
Response of FHCal modules to cosmic muons with different track geometries.





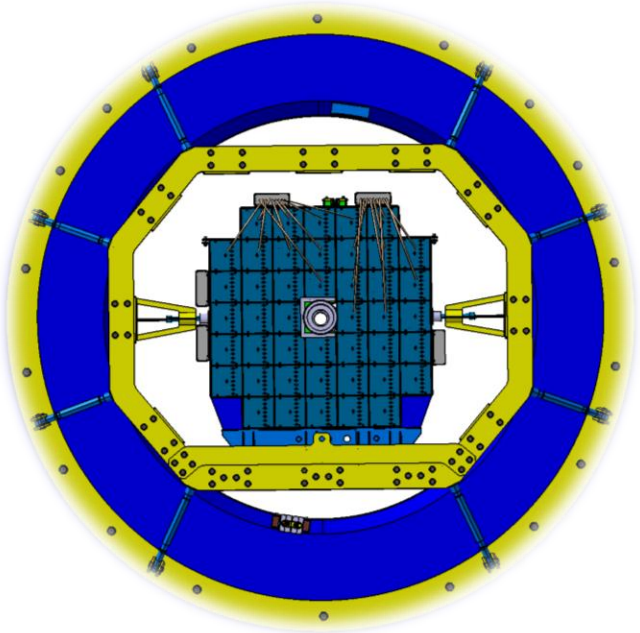
- The energy calibration is planned in self-triggering mode (without external muon trigger).
- The different geometries of muon tracks are to be considered.
- The selection of different muon tracks can be done by requiring the coincidence of muon signals in FHCal modules and longitudinal sections.
- A new simplified version of energy calibration is under development.

FHCal integration to MPD (ADC readout)



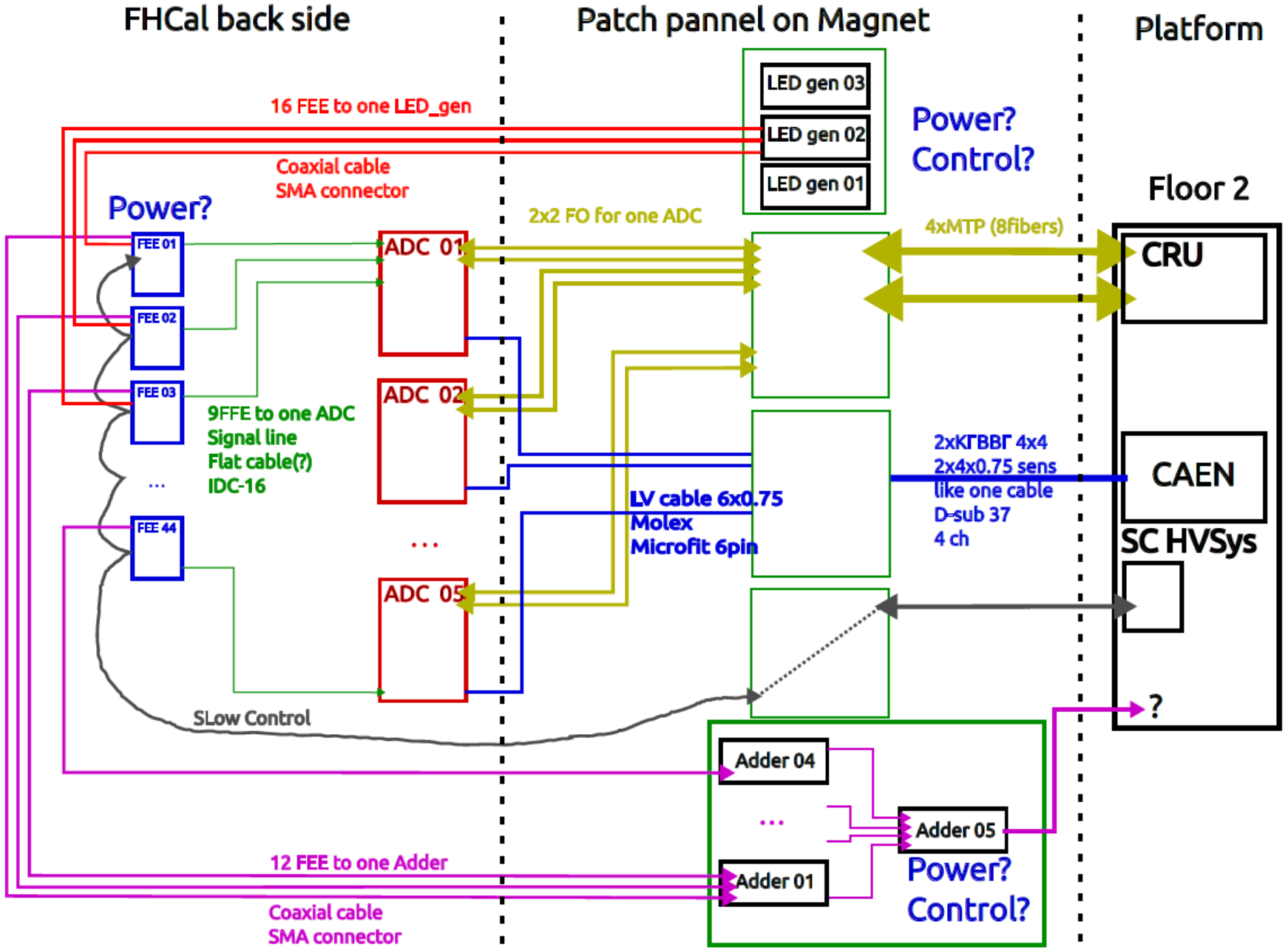
Two halves of FHCal.

ADC boxes are placed at the lateral sides of FHCal support

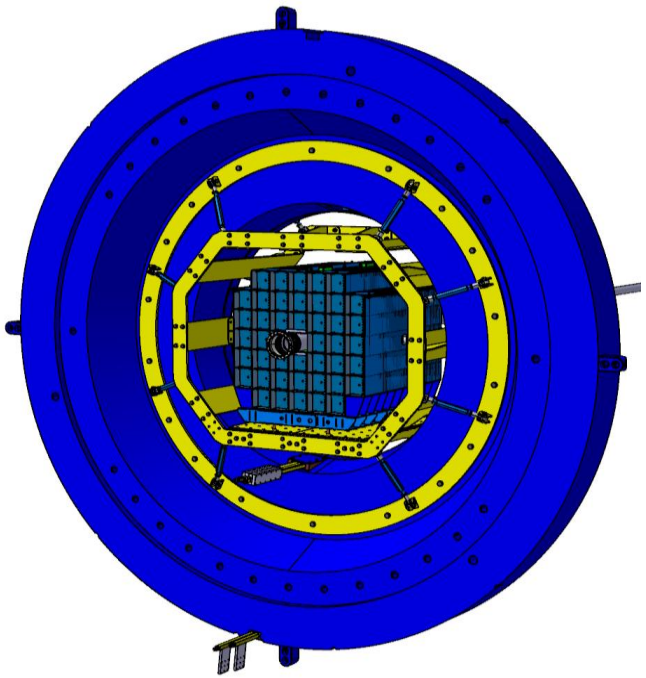


ADC cooling with compressed air is planned.
5 pipes from each side are to be available!

FHCal cabling

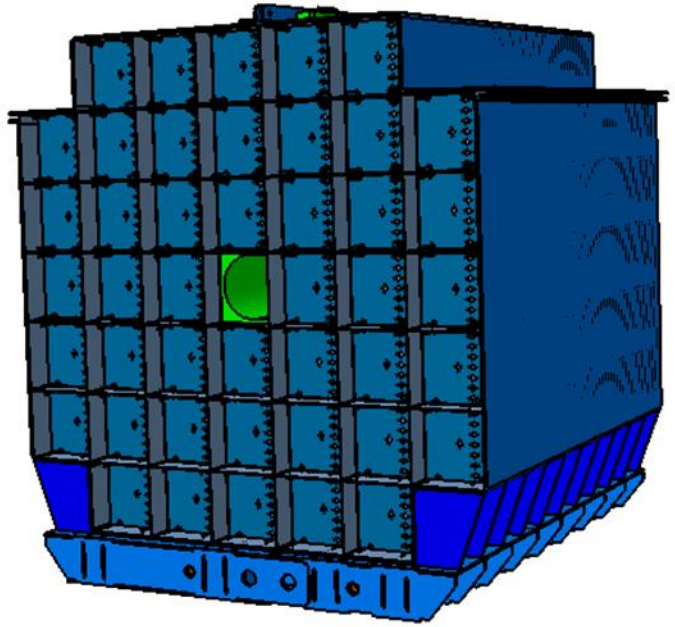


Prepared by
M. Rumyantsev

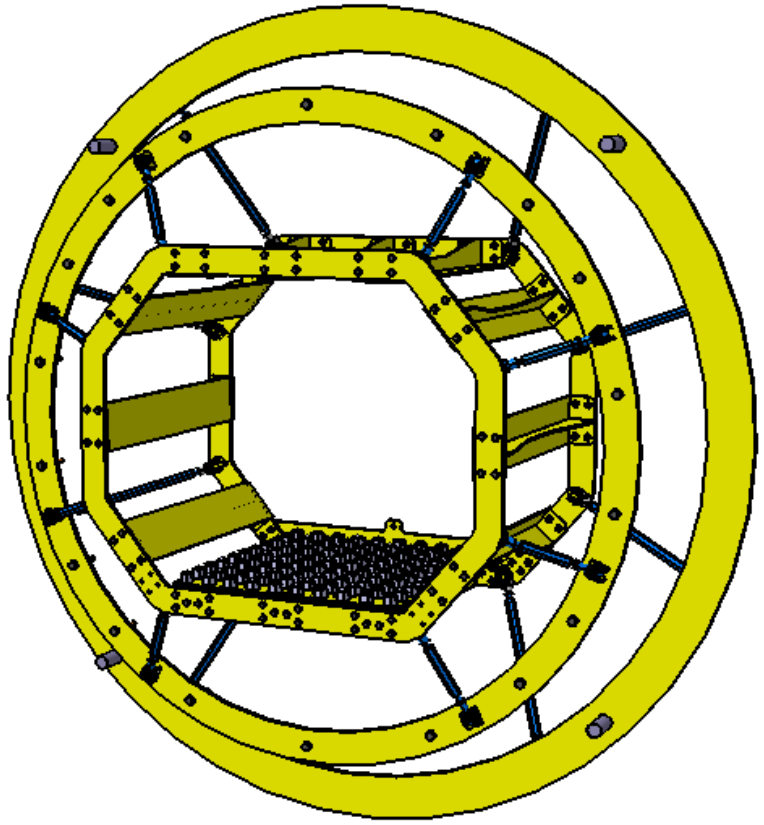


Mechanical support (main elements)

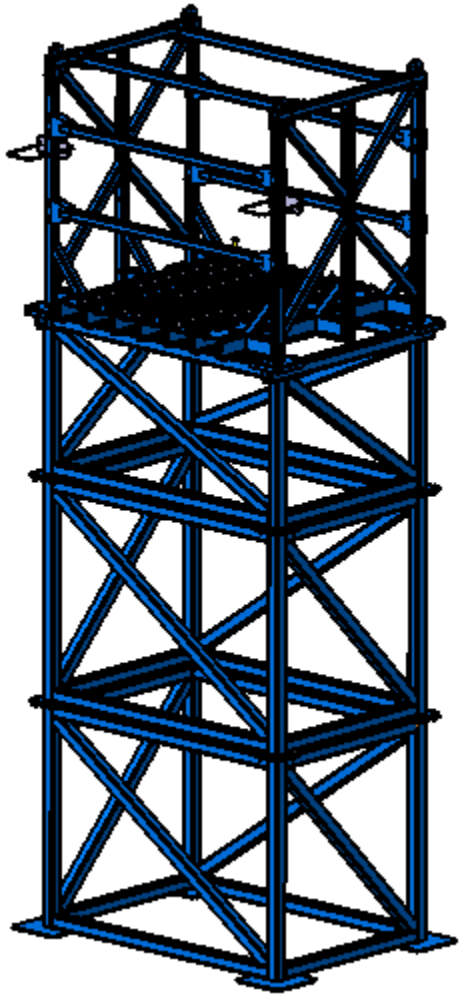
Basket of FHCal modules



Support frame in magnet pole

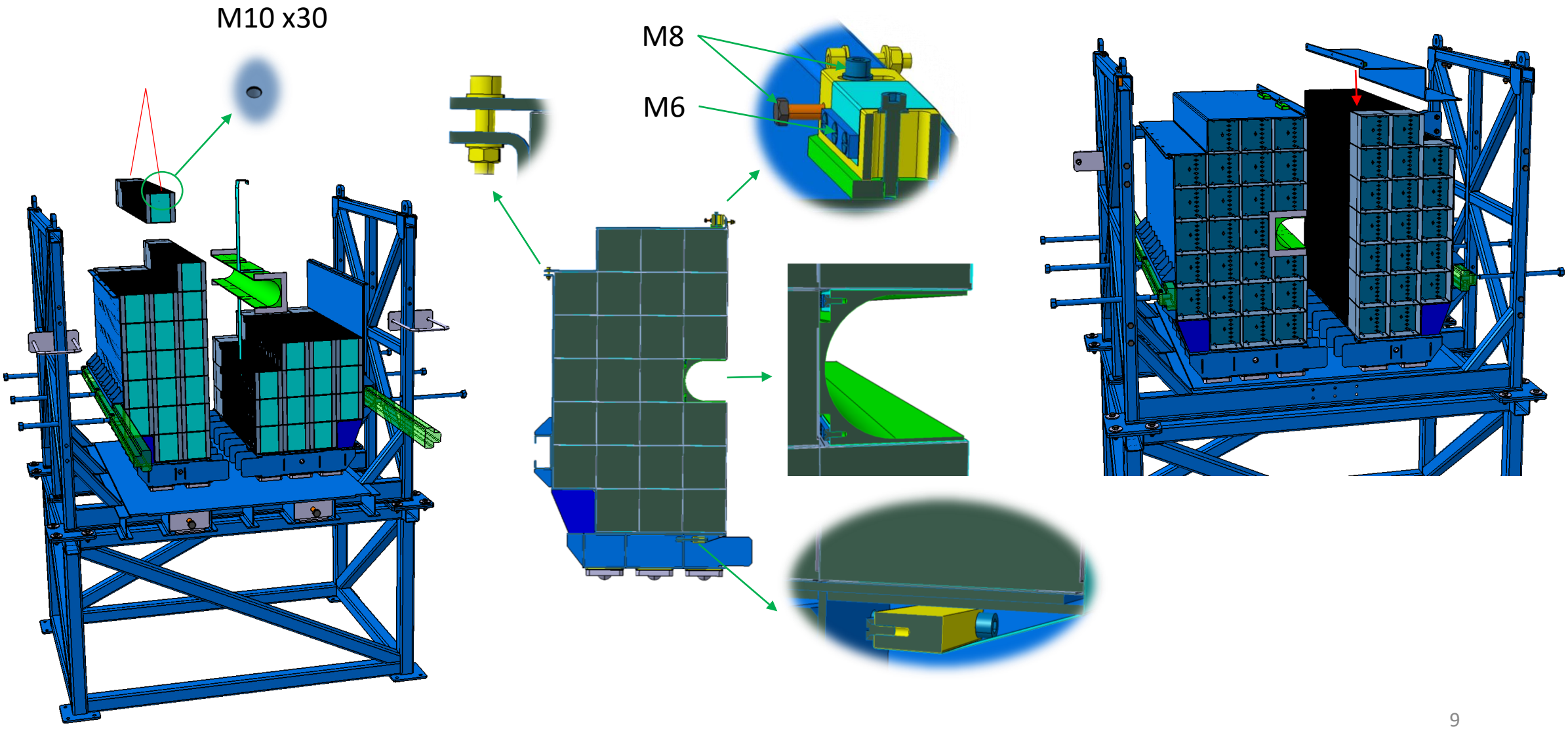


Outer table



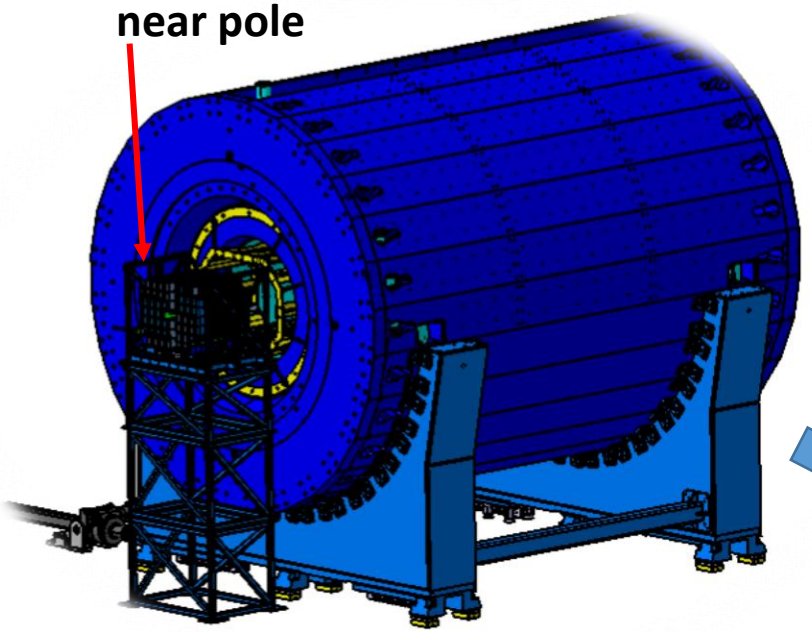
- Design of all elements was finished a month ago!
- The production starts now!

Assembling of FHCal modules in basket

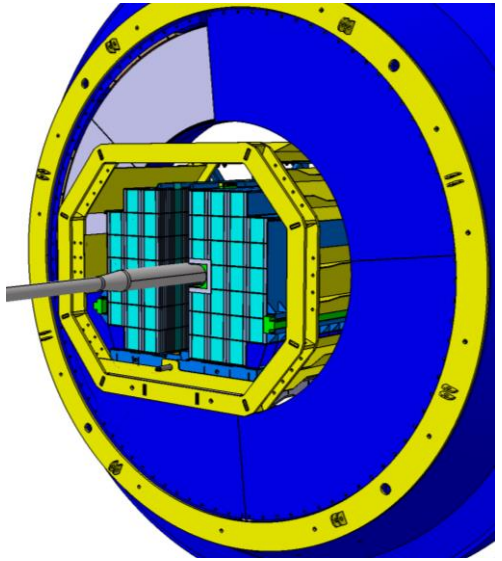


FHCal installation into magnet pole

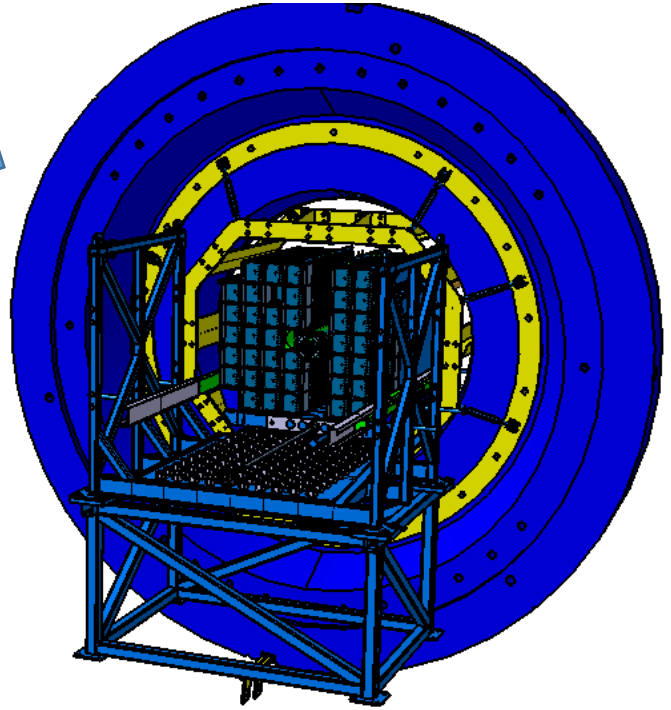
Table with FHCal near pole



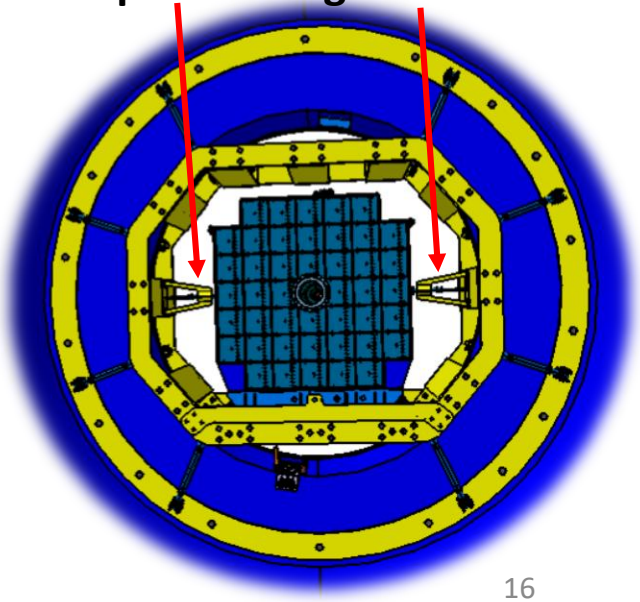
Main problem: beam pipe between two FHCal halves



FHCal inserted into pole



Two FHCal halves pressed together



Summary

- All FHCal modules were tested and are ready for delivery at MPD site.
- FEE was produced and tested.
- Detector Control System is ready and is improved permanently.
- Energy calibration procedure is under optimization.
- FHCal trigger is under development. Flexible configuration of modules is considered.
- The design of mechanical platform is finished. The production starts now!

- We plan to be ready for the calorimeter assembling at MPD site in the middle of 2023.
- The space an some infrastructure for FHCal assembling must be available!

Thank you!