Status of Forward Hadron Calorimeter (FHCal)

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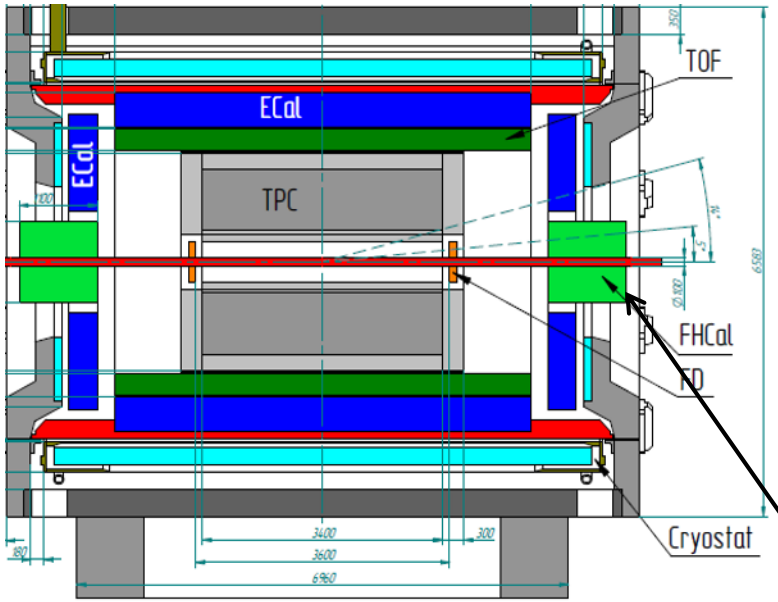
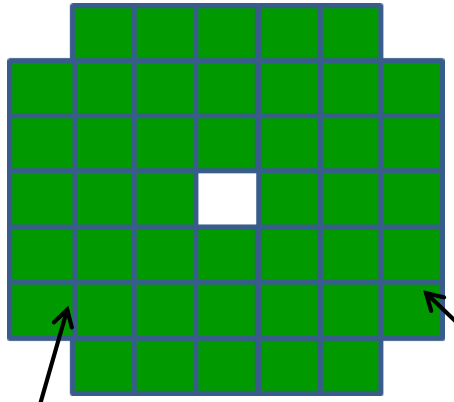
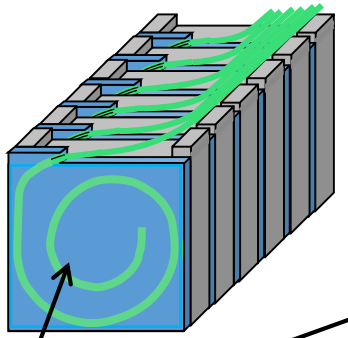
- FHCal overview;
- Installation in magnet pole;
- FHCal readout;
- FHCal in trigger;
- Integration to MPD;
- Open questions.

14th MPD collaboration meeting, Oct., 2024.

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.

Tasks of FHCal :

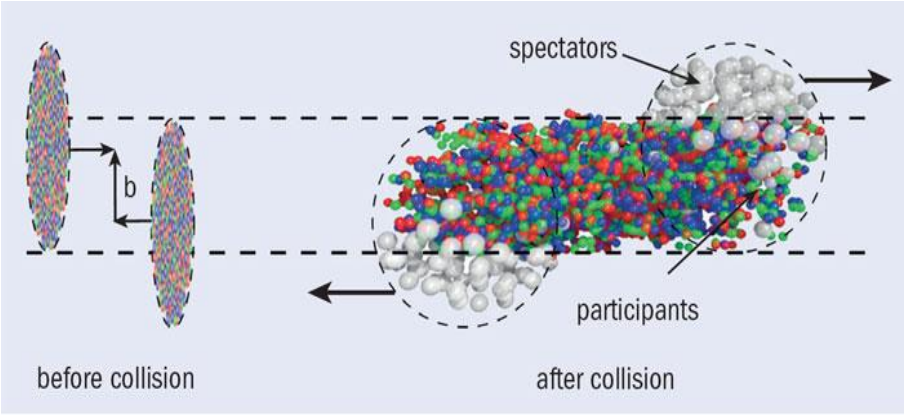
Detection of spectators:

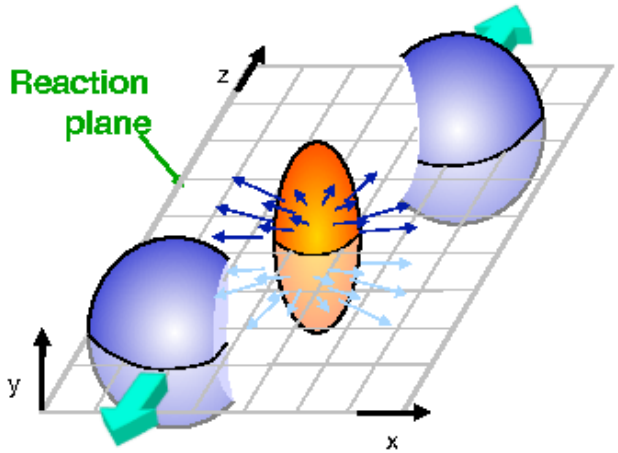
a) The centrality of the collision;

b) The reaction plane orientation;

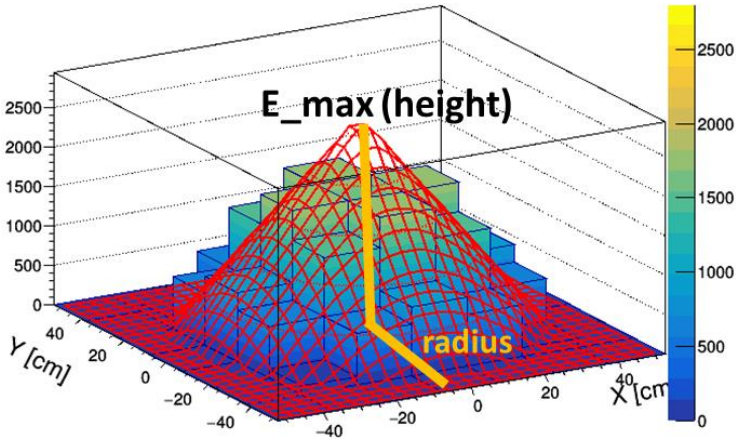
c) Minimum bias trigger;

d) Physics in forward rapidity.



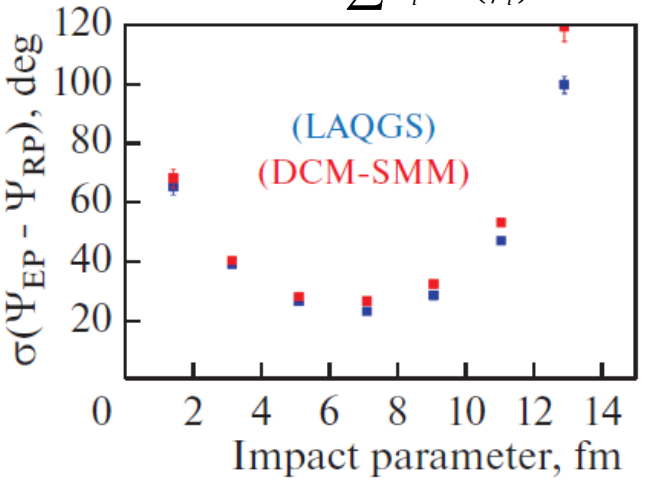


Centrality:
2D-Fit of energy distributions in FHCal modules

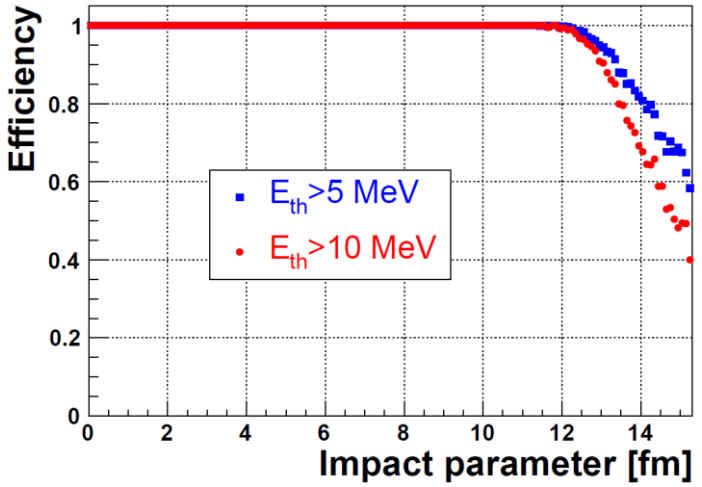


Reaction plane:

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



Trigger efficiency:

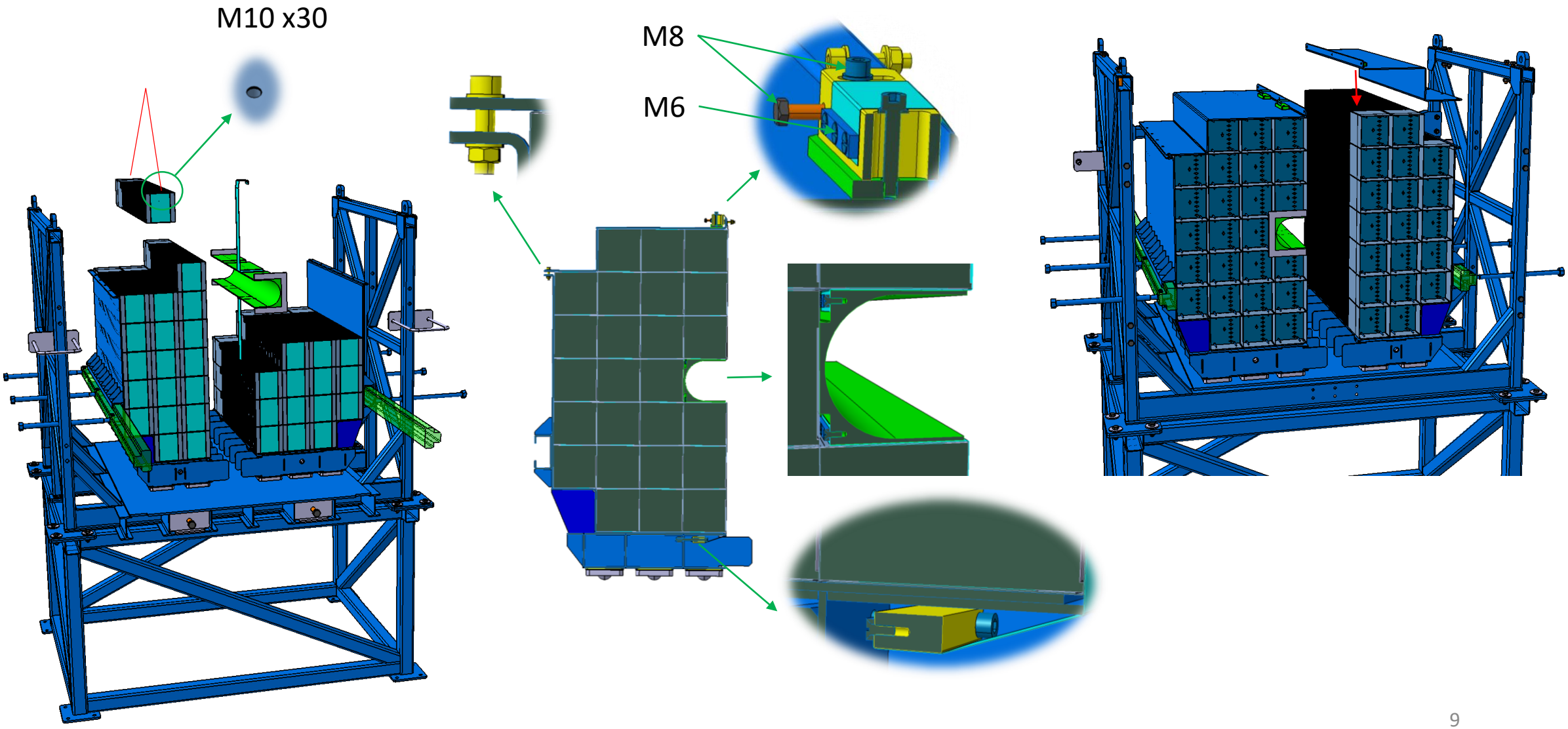


Mechanics of FHCal

- Assembling of modules;
- Installation into magnet pole;
- Mechanical manipulations.

Step 1: **Assembling of modules in basket**

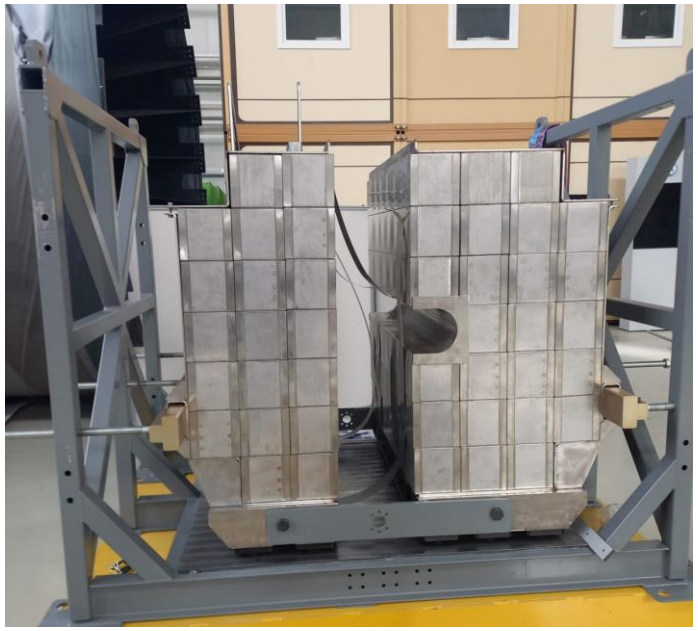
Drawings



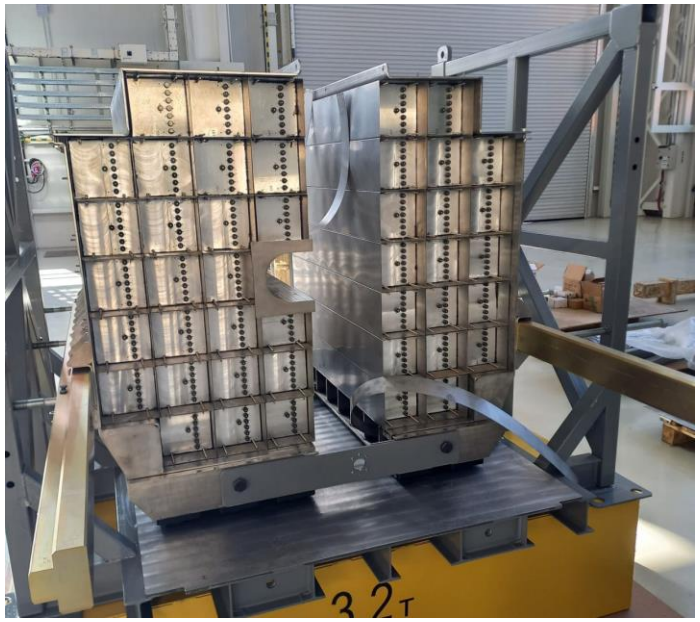
FHCal modules at MPD hall

In Nov’23
90 modules were delivered
form INR to MPD hall

Assembling of FHCal modules in basket at floor:



April’24

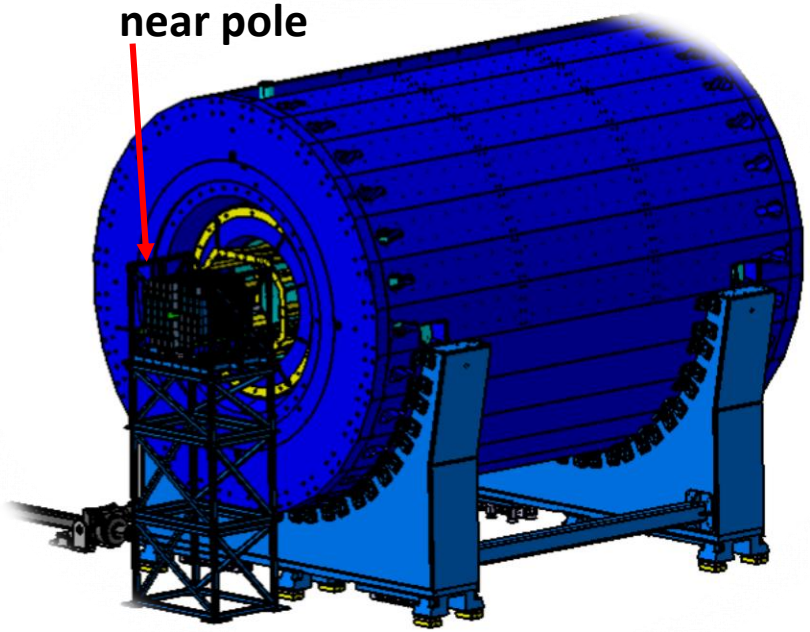


Done by S. Gerasimov and JINR technical group!

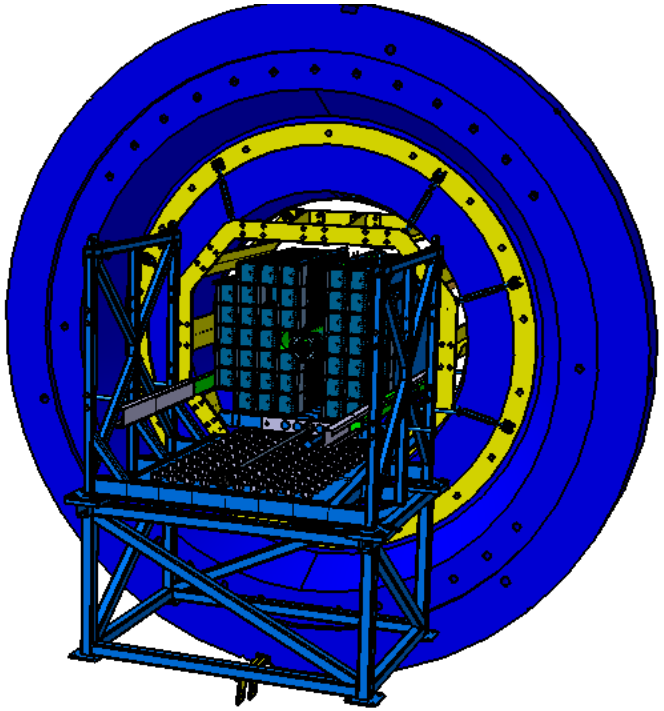
Step 2: **FHCal installation into support frame (in pole)**

Drawings

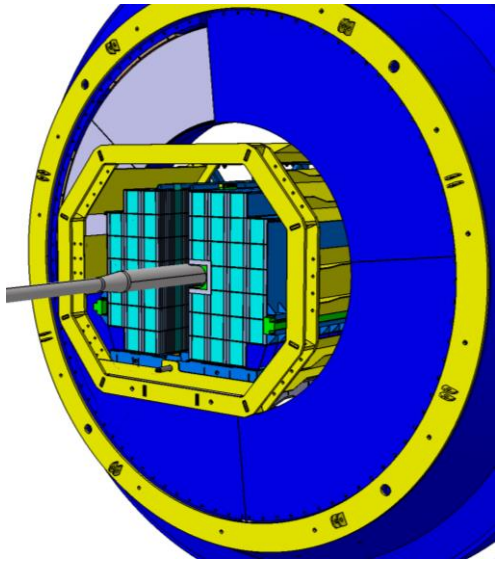
Table with FHCal near pole



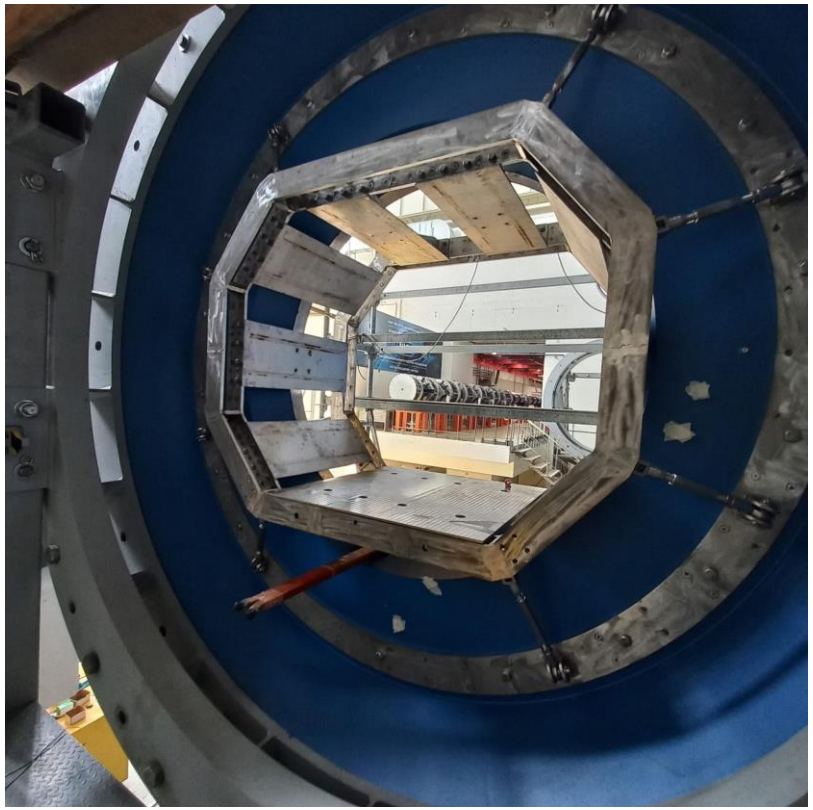
FHCal moved into pole



Main problem: beam pipe between two FHCal halves

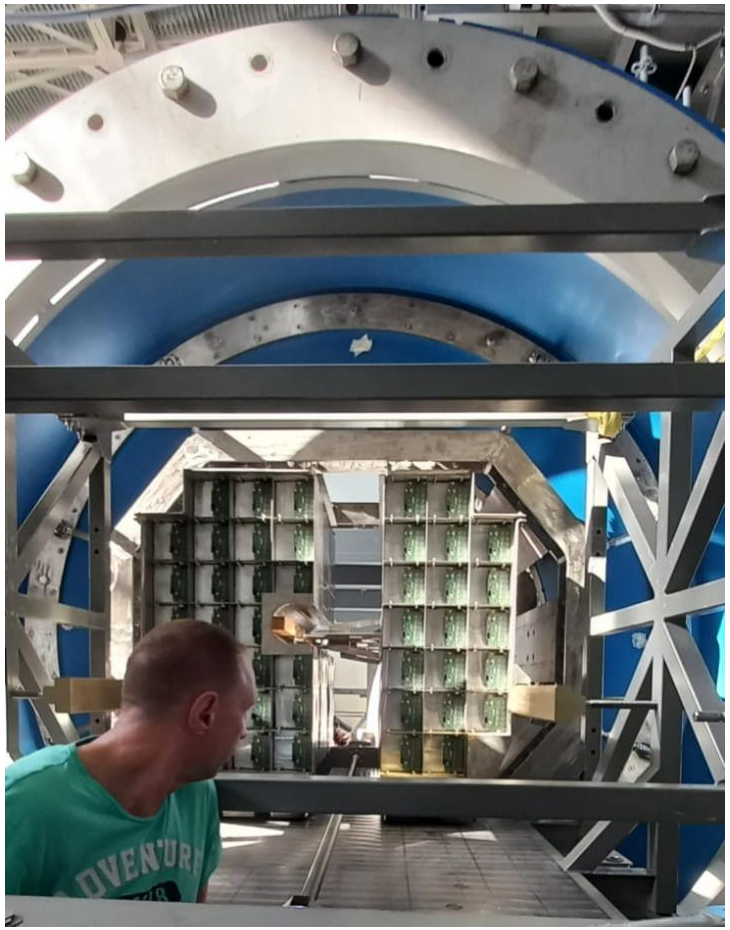


FHCal installation into magnet pole (Sept'24)

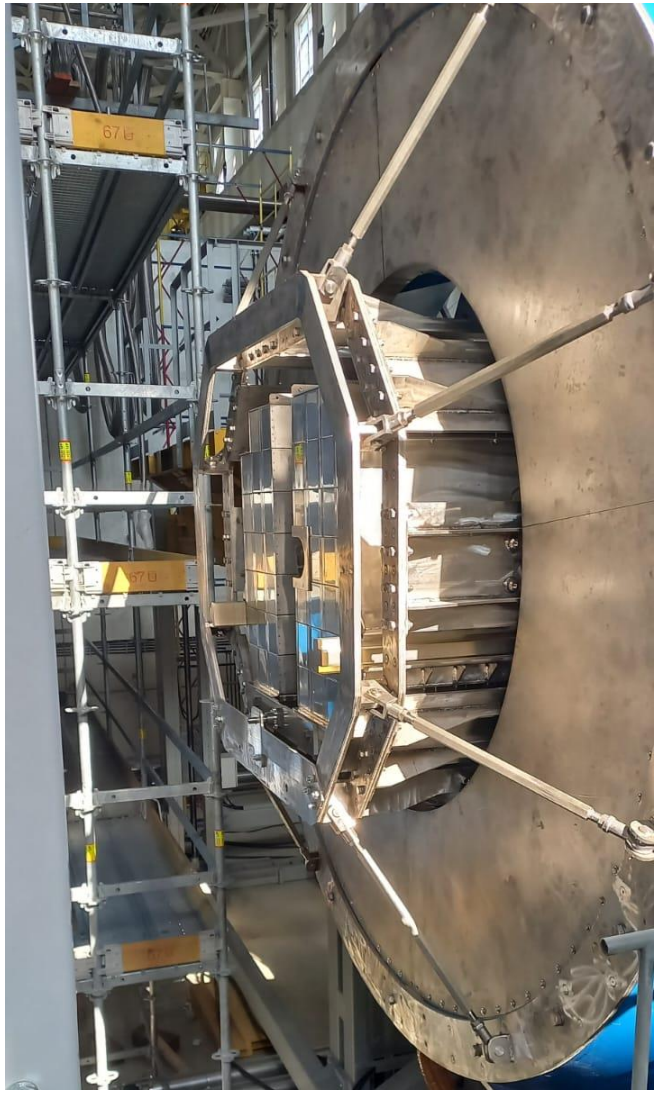


FHCal support frame in magnet pole

Outer view



Inner (front) view

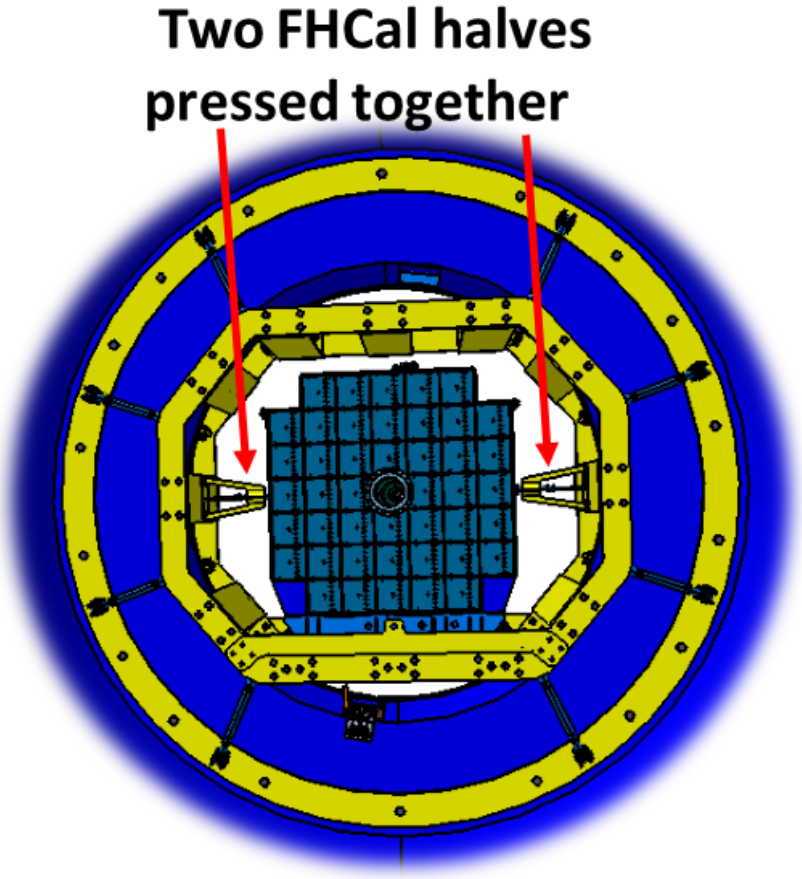


FHCal arm already moved into magnet pole!

Done by S. Gerasimov and JINR technical group!

Step 3: **Press FHCal parts together**

Drawing



FEE is installed in modules already,
but must be replaced!

FHCal parts should be pressed together!
To be done soon!

Up to now all manipulations with FHCal were performed successfully!
Many thanks to S. Gerasimov and JINR technical group!

Next steps in construction of FHCal

- Installation of Front-End-Electronics;
- Installation of Detector Control System (DCS);
- Installation of readout;
- Development of FHCal trigger.
- Calibration with cosmic muons;

Front-End-Electronics (FEE)

Two PCBs in each module with:

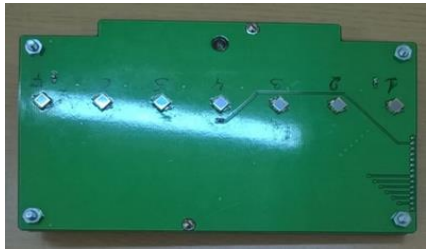
7 photodetectors ;

Photodetectors – MPPCs;

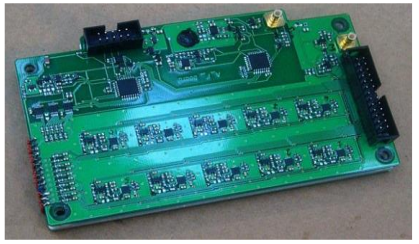
two-stage amplifiers;

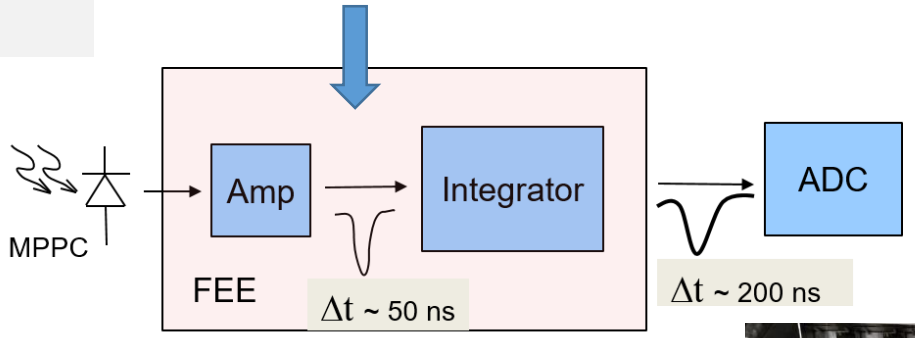
HV channels;

LED calibration source.



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





- FEE should be slightly modified to adjust the reference voltage at new (fast) ADC's.
- For second arm of FHCal it is already done.
- FEE installed in first arm must be dismounted!

Detector Control System (DCS)

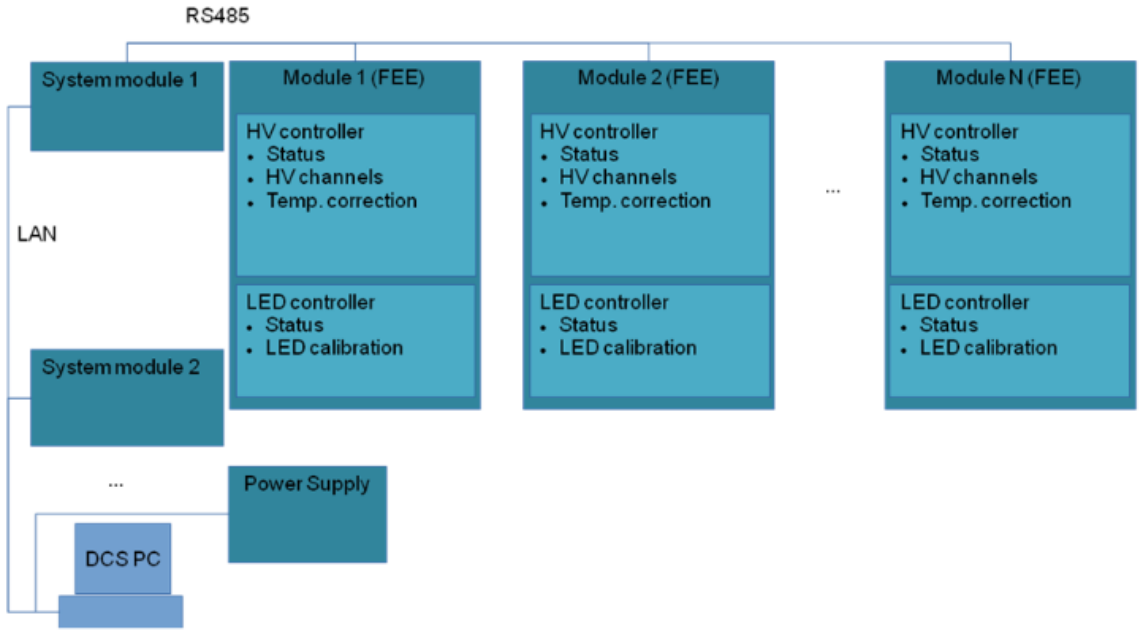
DCS Tasks:

- **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.**

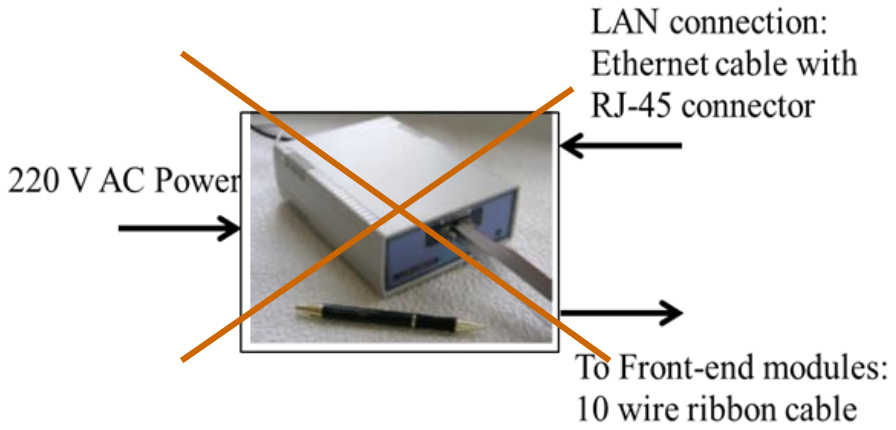
DCS open questions:

- **Cabling for RS485 bus (now flat cables)?**
- **Pick up noises in real environment ?**
- **Place for System Module: near calorimeter or in Control Room?**

Connection diagram



Hardware: System Module

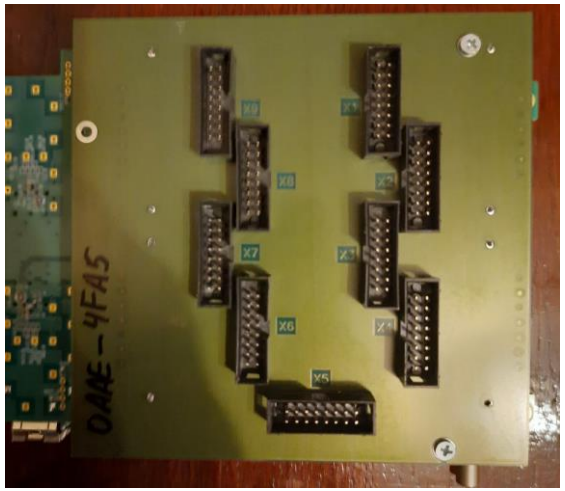


New system modules (boards) in VME crate format will be produced and installed in Control room. (The design is similar to ECal boards).

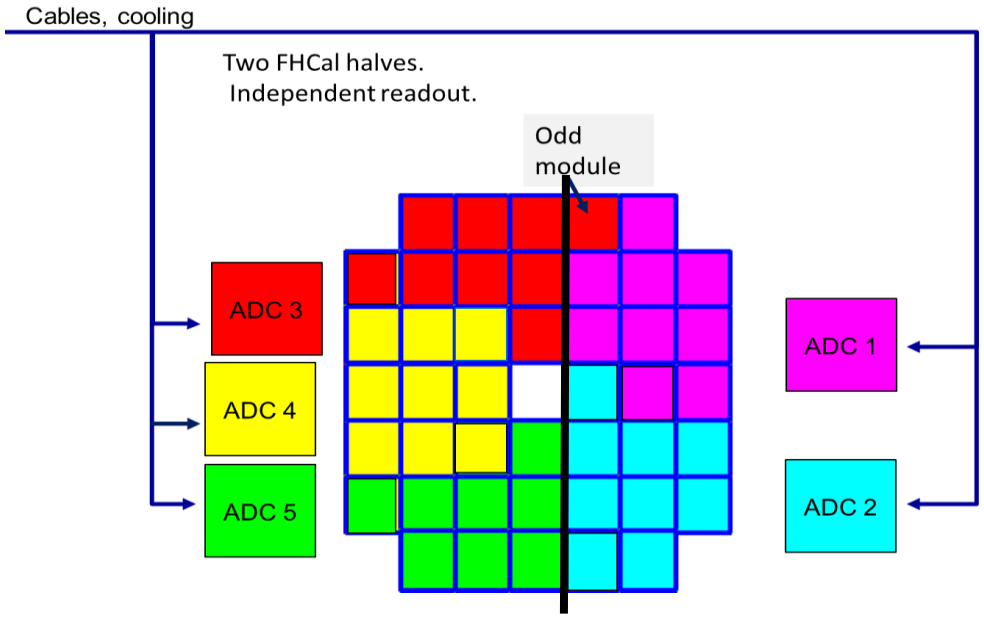
Many thanks to I.Tyapkin, V.Astakhov and M.Rumyantsev

ADC signal readout

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



5 ADCs for each arm of FHCal



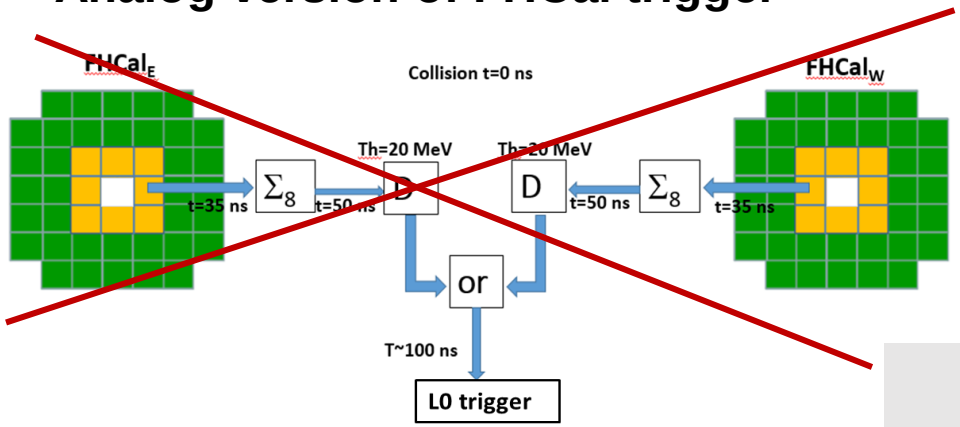
Two halves of FHCal.

- ~~All 10 ADC boxes are tested and ready for installation.~~
- **Open questions for readout:**
- **Would ADC be replaced by new ECAL-type modules? (Fast ADC for FHCal trigger)?**
- **ADC cooling? Pipes for air?**

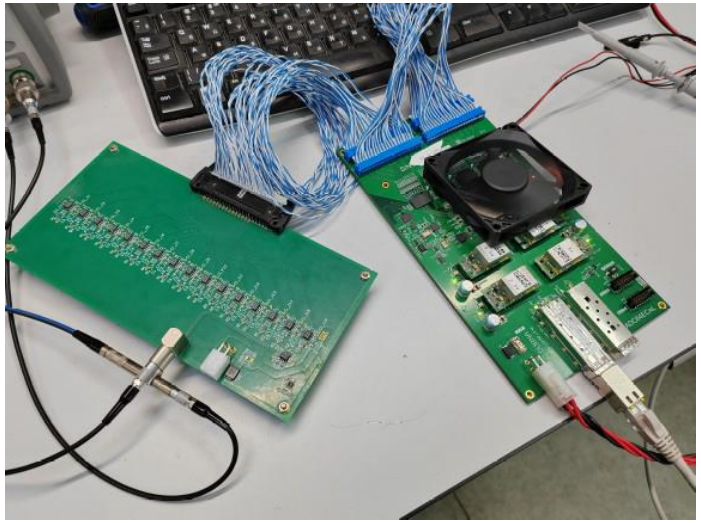
- **New fast ADCs are produced by S.Bazylev group to arrange the FHCal trigger.**
- **Tests must be done!**

FHCal trigger

Analog version of FHCal trigger

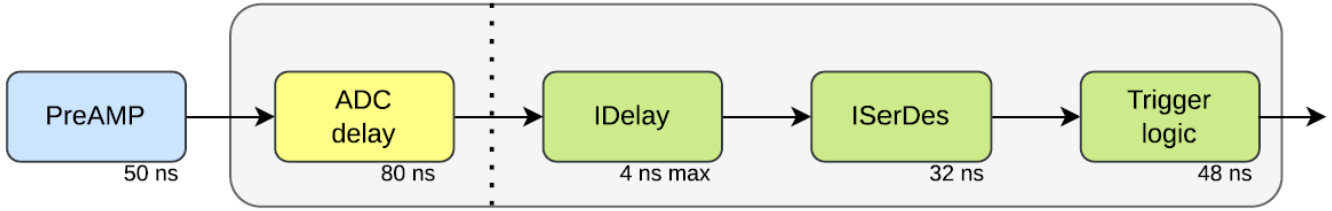


Digital trigger based on fast ADC



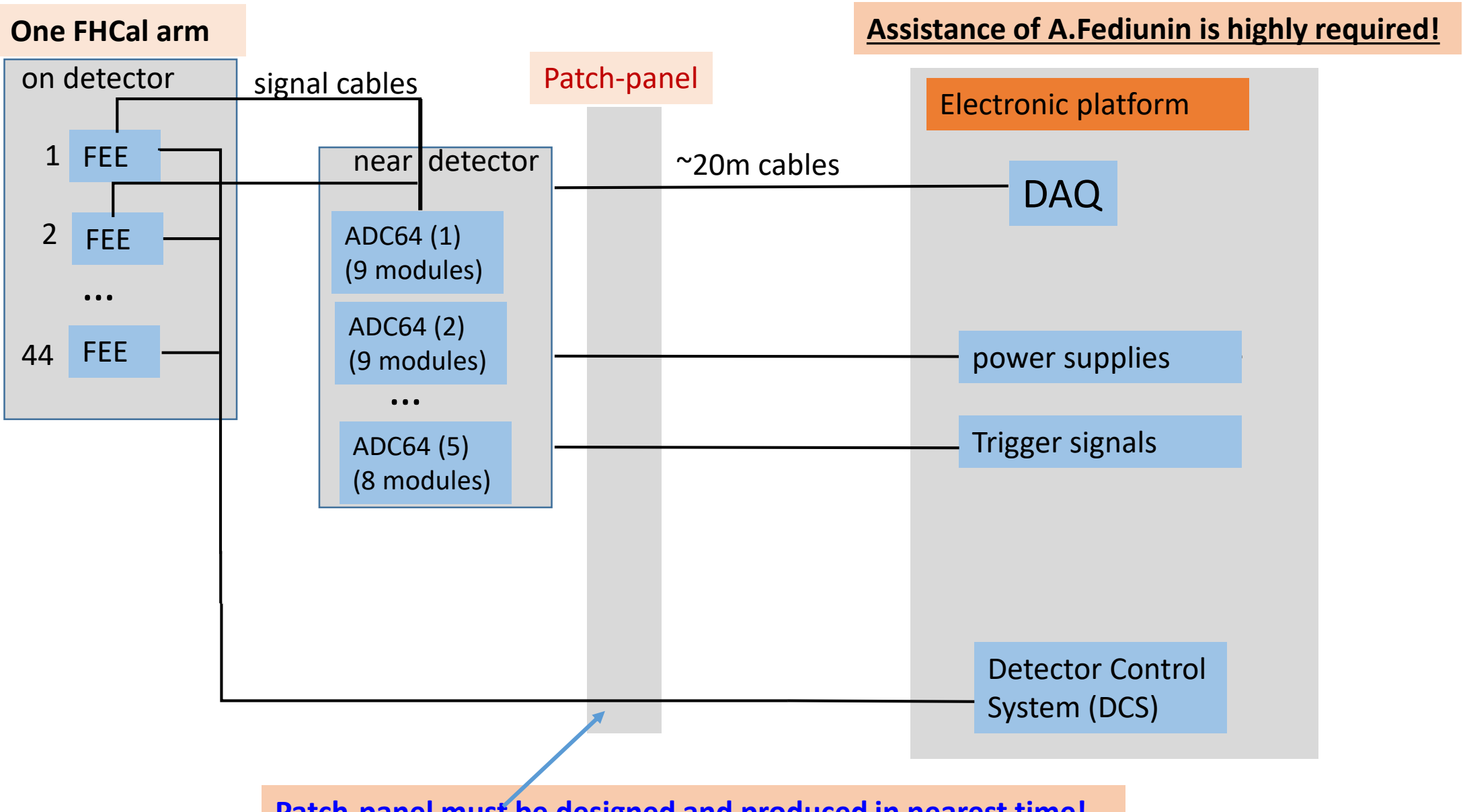
This remarkable idea was suggested and developed by S.Bazylev group

New ADC version is much faster with delay time 237 ns (150 ns shorter)

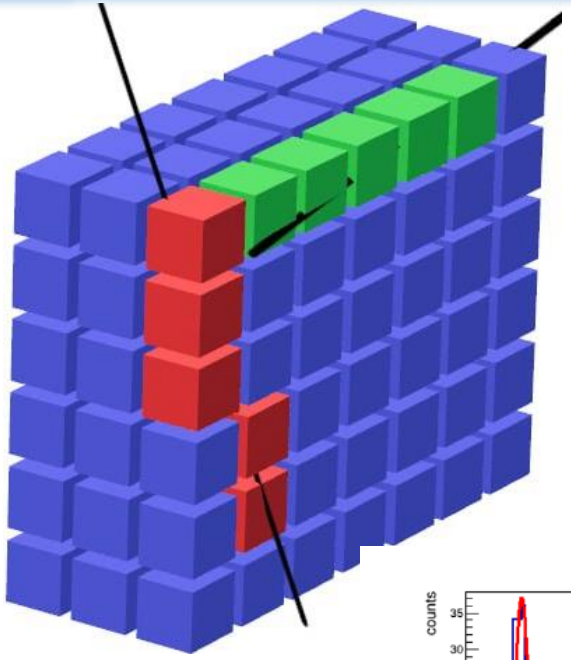


New ADC modules already produced.
Practically any configuration of energy depositions in FHCal modules can be implemented in trigger!

FHCal cabling



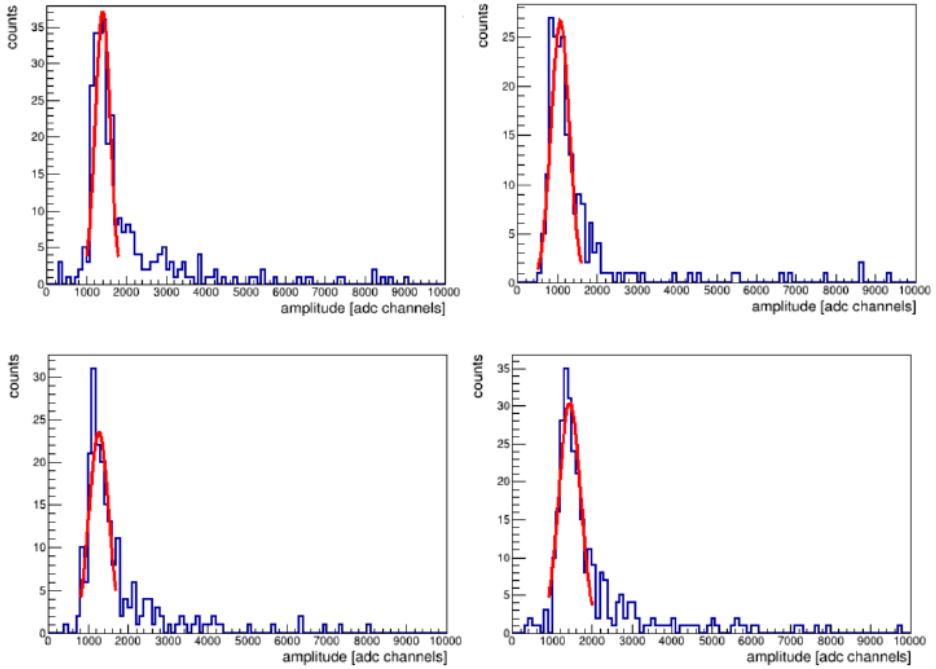
Energy calibration with cosmic nuons



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

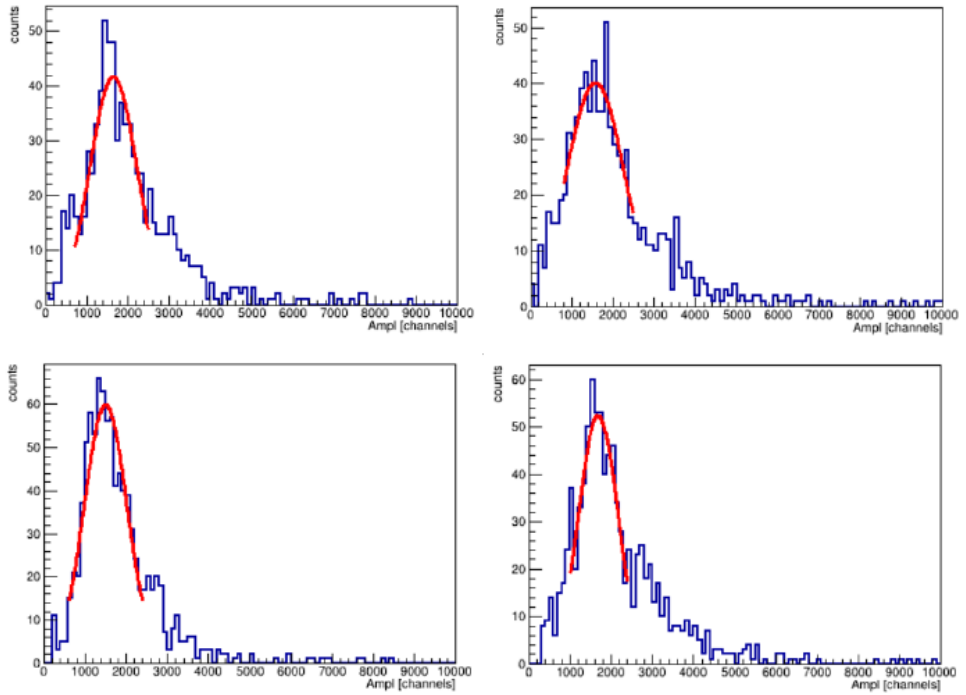
Horizontal muons

- Energy deposition 5 MeV;
- Narrow peak;
- But long time for collection; (one week data acquisition);
- Required at least one time.



Vertical muons

- Wide peaks;
- Short time for collection; (one day data acquisition);
- Energy deposition should be normalized to horizontal muons;



Tests done for FHCal prototype.
Must be done for full FHCal.

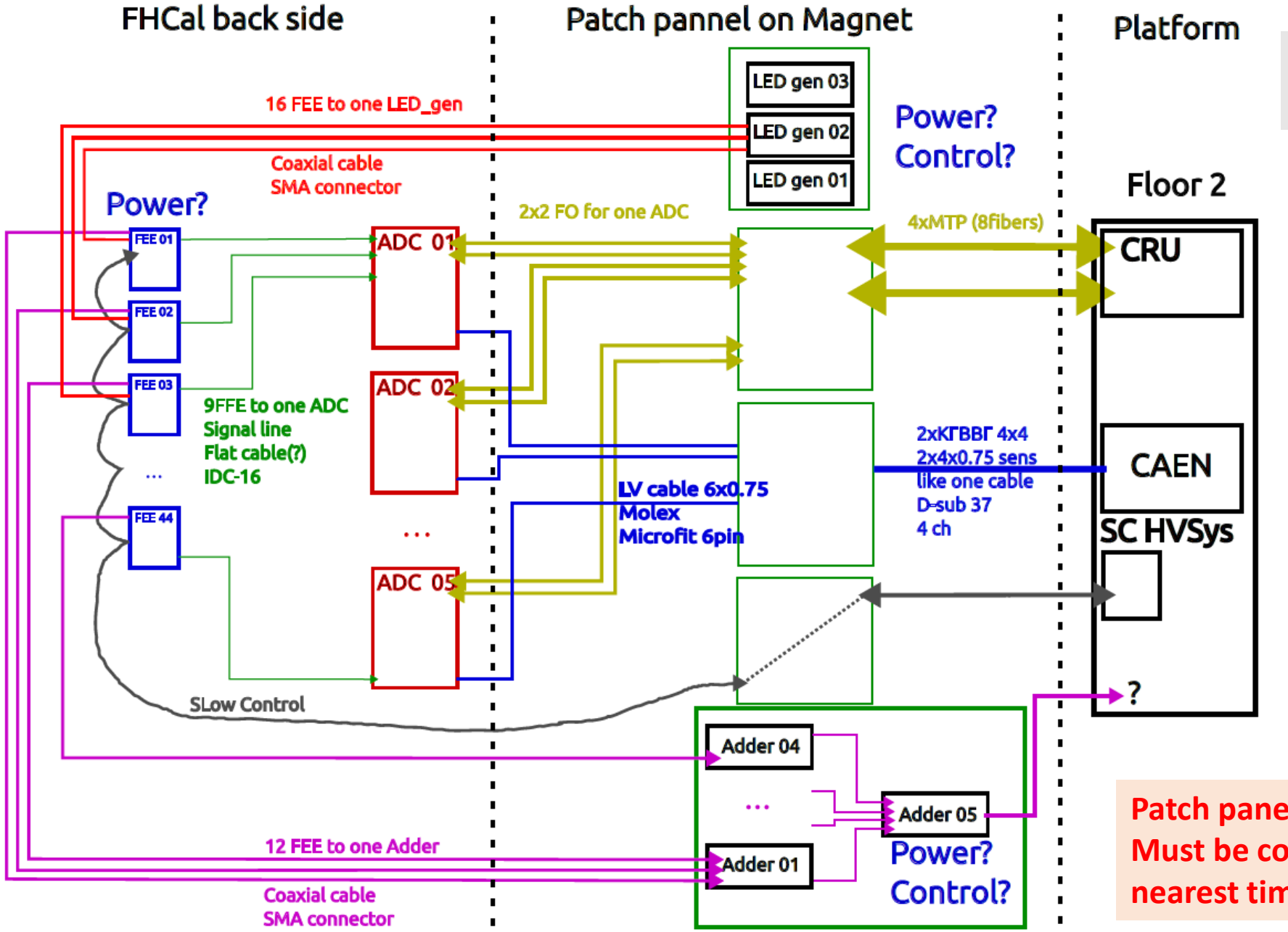
Summary (open questions)

- Timetable for FHCal installation?
  (Interference with magnet field measurements.)
- One or two FHCal arms for the fixed target option?
- Cabling?
  (Types of cables, length, path)
- Patch-panel?
  (Position, connectors)
- Configuration of energy depositions for FHCal trigger?
  (Input from simulation)
- Pipes with cooling air for ADCs?
  (Compressed air or…)
- Cosmic muon calibration of full FHCal?

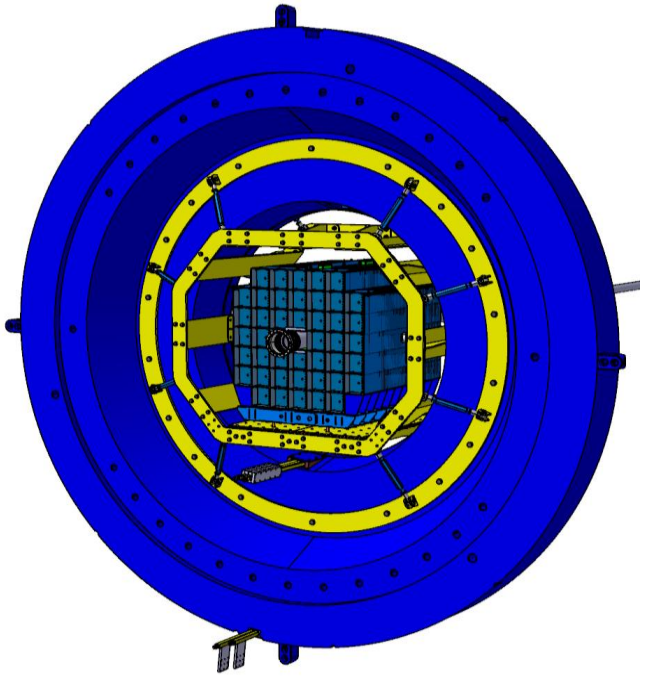
Further assistance of S.Bazylev, S.Gerasimov, M.Rumyantsev and A.Fediunin is highly requested!

Thank you!

FHCal cabling



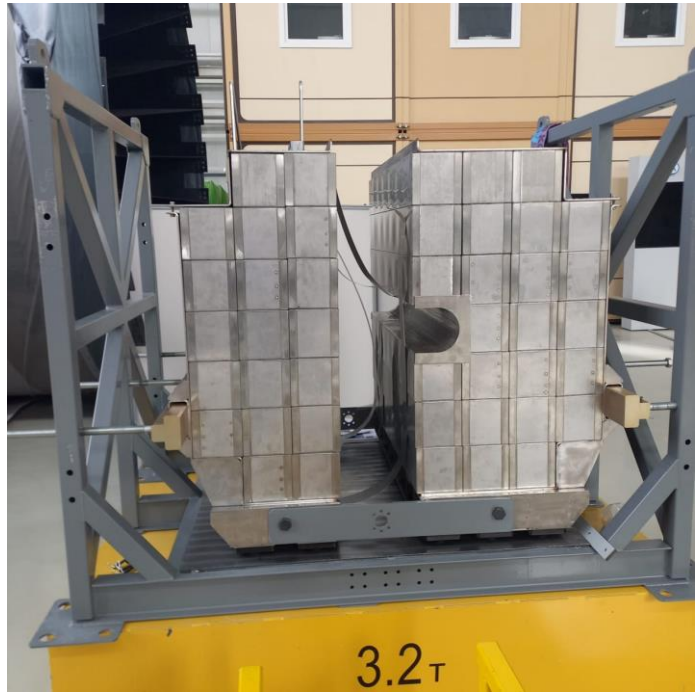
Prepared by
M. Rumyantsev

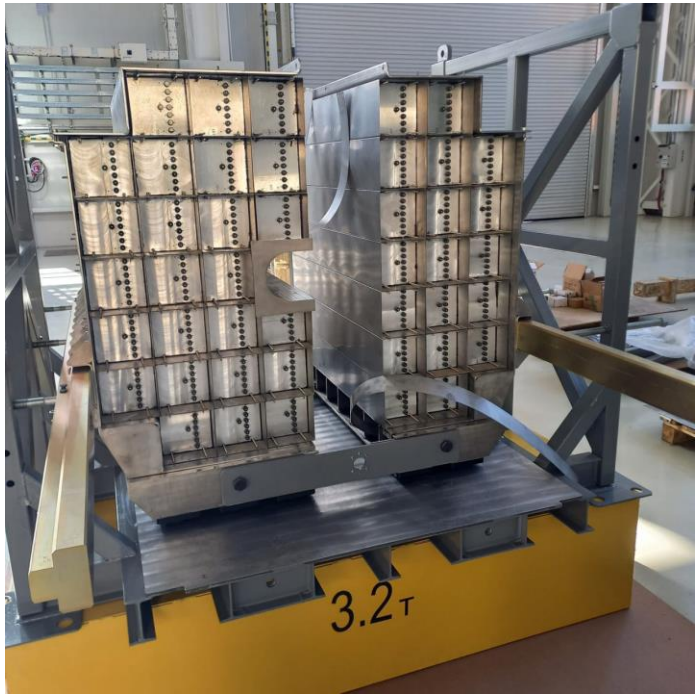


Patch panel is not ready.
Must be constructed in
nearest time

Step 1: **Assembling of FHCal modules in basket**

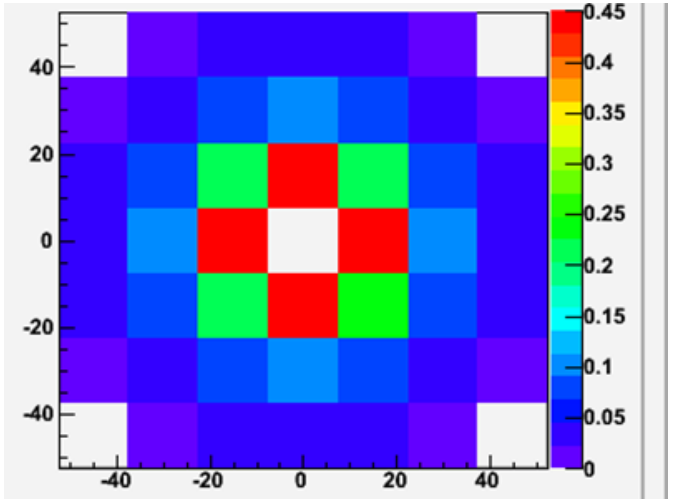
Photos from MPD hall

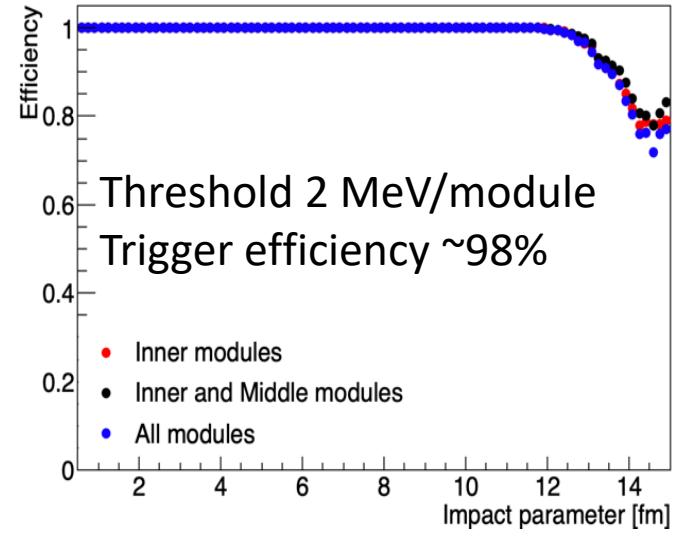




One FHCal arm already assembled in basket !

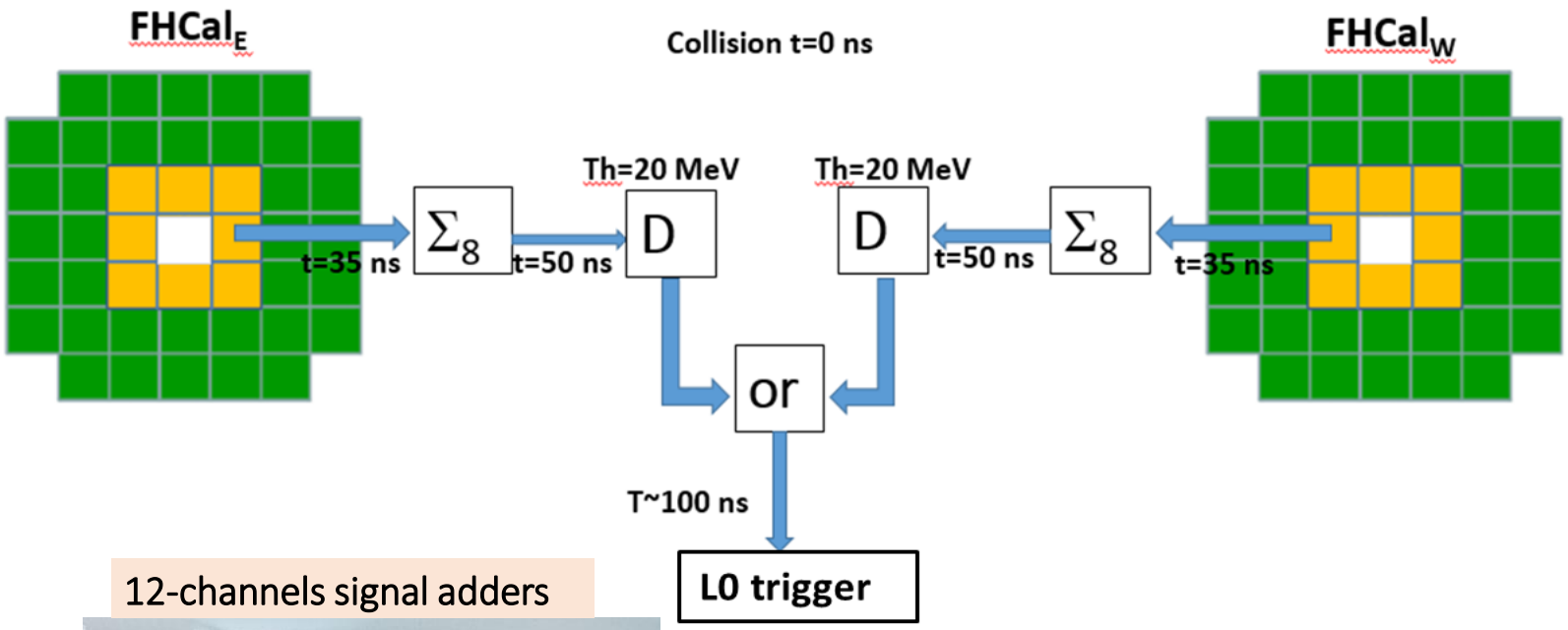
FHCal trigger (analog version)





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

Scheme of FHCal trigger



12-channels signal adders

- 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.