

# Status of new FHCaI for BM@N experiment

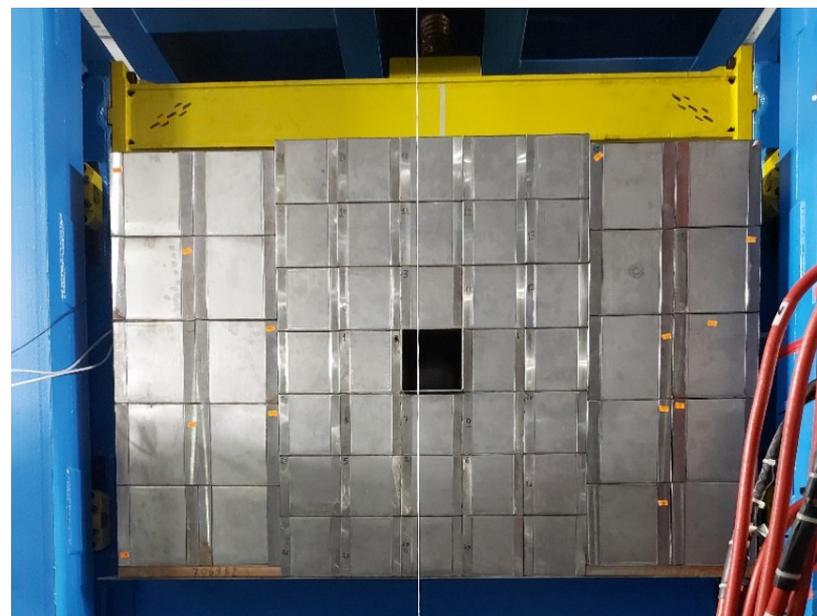
Sergey Morozov  
on behalf of INR RAS, Moscow



Forward hadron calorimeter for BM@N:

- 1) status of FHCAL assembling
- 2) front-end electronics and read-out electronics installation
- 3) DCS (slowControl) development
- 4) first results from calibration on cosmic muons
- 5) beam quartz/scintillator hodoscope development
- 6) new scintillation hodoscope for future BM@N
- 7) plans for the future

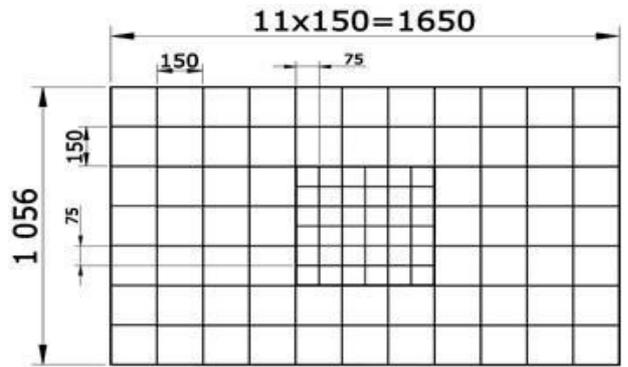
FHCAL assembled and installed in the BM@N area



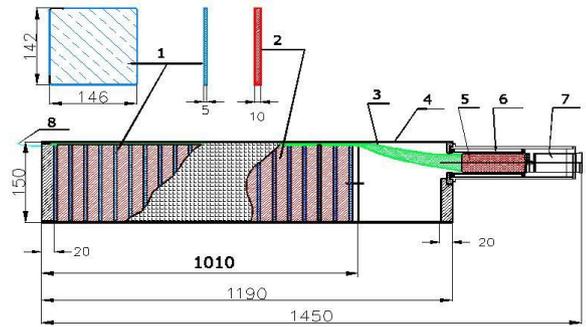
- 34 central small modules of 15cmx15cm (constructed for MPD experiment)
- 20 side large modules of 20cmx20cm (constructed for CMB experiment)
- longitudinal segmentation with 7 sections (small modules) and 10 sections (large modules), each section has an individual read-out with one MPPC (Hamamatsu)



old ZDC



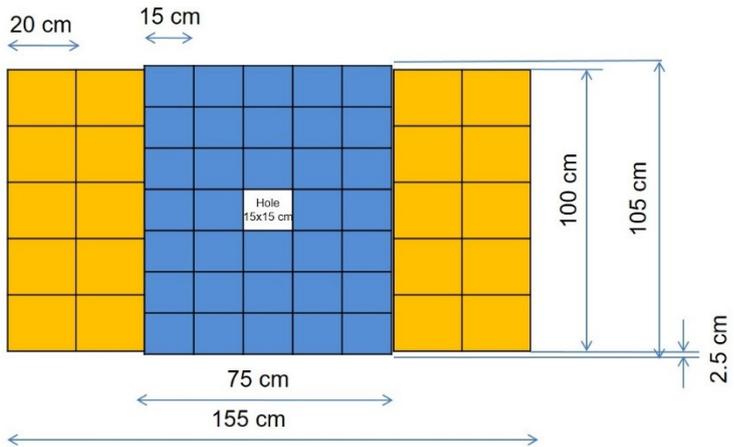
Central part: 36 modules (7.5x7.5cm<sup>2</sup>)  
 Outer part: 68 modules (15x15cm<sup>2</sup>)



64 layers (5mm (scint.)  
 + 10mm (Pb))

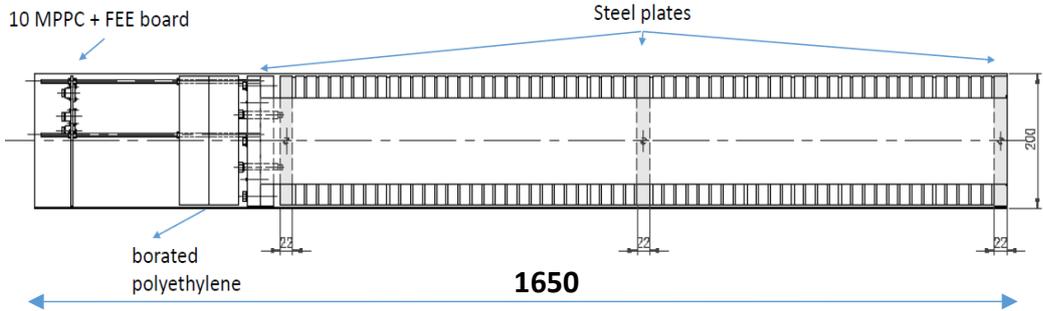
Au+Au high rate beam in future:

- high radiation doses in ZDC central modules with heavy ion beams → degradation of ZDC performance
- hole in the calorimeter center is needed
- hadron shower leakage in ZDC (small modules in the ZDC center, WLS plates for the light collection)



20 PSD CBM modules (20 cm x 20 cm)  
 34 FHCAL MPD modules (15 cm x 15 cm)

current FHCAL



PSD CBM module - 60 Pb (16mm)/scint(4mm) layers  
 Light readout - with 10 MPPCs from 10 longitudinal sections

FHCAL MPD module - 42 Pb (16mm)/scint(4mm) layers  
 Light readout - with 7 MPPCs from 7 longitudinal sections.

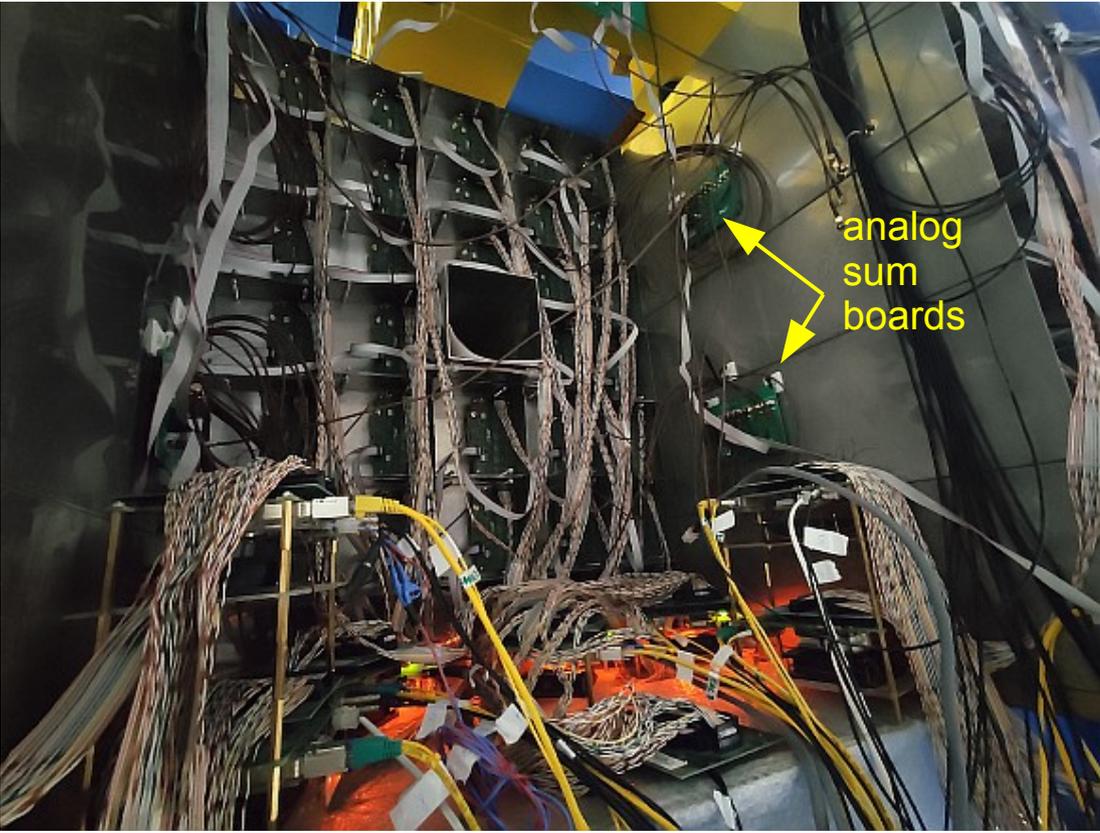
# Status of new FHCAL for BM@N



FHCAL has been assembled and installed in the BM@N area

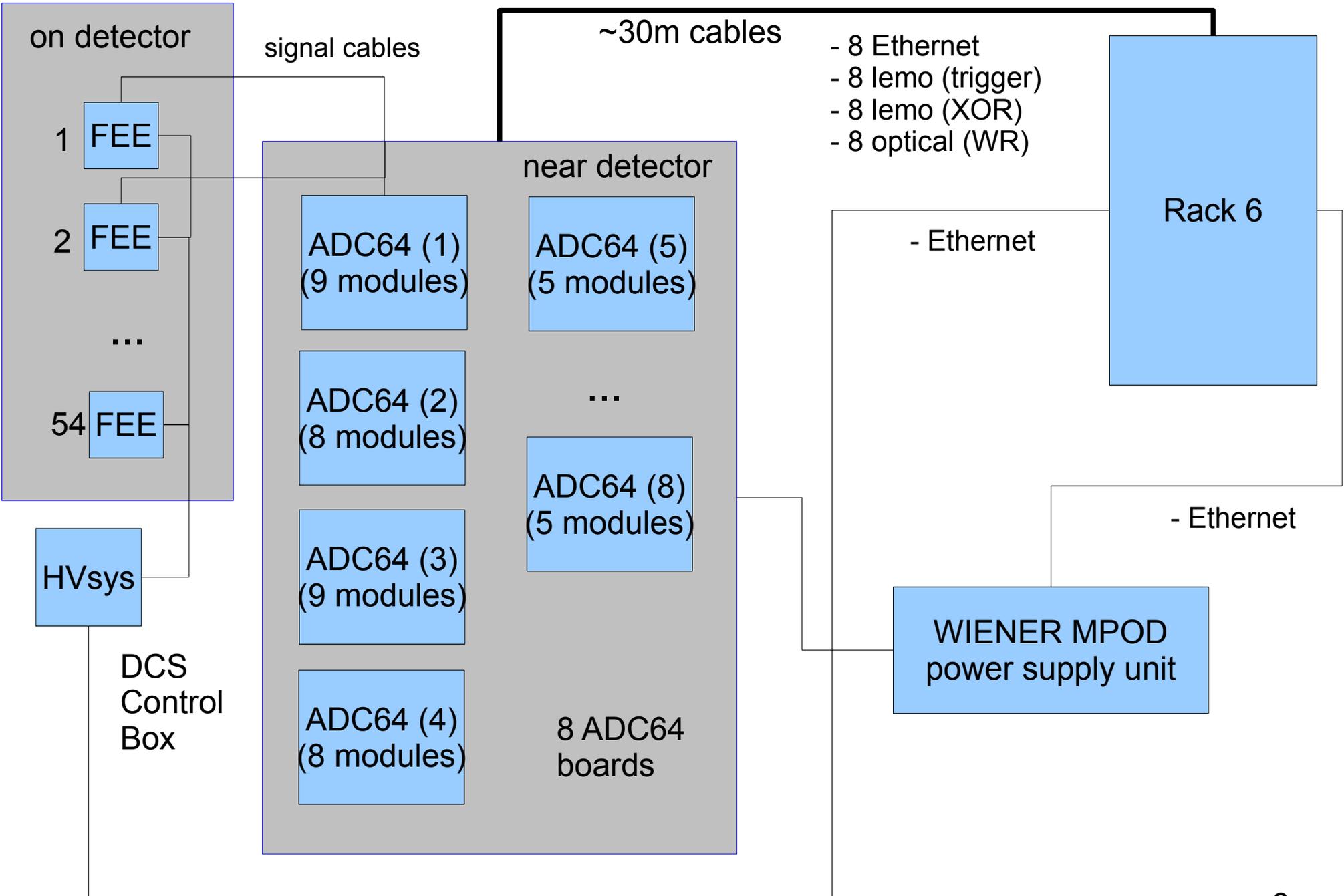


New WIENER MPOD power supply unit has been installed



- 54 FEE boards have been connected and tested
- 8 ADC64s2 board are in places, tested, connected with new cables (yellow on foto) to Rack 6 + WR optical fibers
- 6 analog sum boards are connected to FEEs
- new power supply (WIENER MPOD) has been tested

### Schematic view of connections at FHCAL



DCS for FHCAL (Java version):

- control HV on MPPCs and correct it with temperature changing to maintain the gain

**FHCAL NICA Slow Control**

Module 1

	Set voltage	Corr voltage	Meas voltage	Error
1	70.32	70.23	71.56	
2	70.32	70.23	71.56	
3	70.32	70.23	71.56	
4	70.32	70.23	71.56	
5	70.32	70.23	71.56	
6	70.32	70.23	71.56	
7	70.32	70.23	71.56	
8	70.32	70.23	71.56	
9	70.32	70.23	71.56	
10	70.32	70.23	71.56	
Pedestal	70.32	70.23	70.23	

Ref. temper... 25 25  
dV/dT 60 mV/deg

Global control  
Global LED frequency 0 0

Global HV ON  
Global HV OFF

XML Config LOAD  
XML Config SAVE

Last update has been done at: 27/12/2020 19:09:15

bash: lt: command not found (getMeasVoltages) supply.CHAN CALIB = 325

- the new version on python is under development

# Tests of 8 ADC64 read-out system (on fhcal-bmn virtual mashine at BM@N computing node)

The screenshot displays the ADC64System control interface. At the top, a table lists the system components:

Type	Serial	Slot	IP Address	t, °C	Event	Trig
ADC64WR	080C-0679	0	10.18.97.42	ADC:34 PS:32	2589	0

The main interface is divided into several sections:

- ADC64-View:** A waveform plot showing a sharp peak at approximately 55 ns. The y-axis ranges from -22,000 to -27,000. The x-axis is labeled 'Ev:2589'.
- RunControl:** A control panel with 'Start Run' and 'Stop Run' buttons. It shows 'Run #fhcal\_35 started'.
- Trigger Configuration:** A table for configuring triggers for 13 channels.
- Run Statistics:** A summary of the current run.
- Spill Phases:** A table for configuring the timing of different spill phases.
- External TTL 3:** A plot showing the busy time and trigger intervals for channel 3.

**Run Statistics:**

- Run: fhcal\_35
- Spill: 6309
- Event: 2,589
- Missed: 0.00 %
- Dead Time: 0.00 %

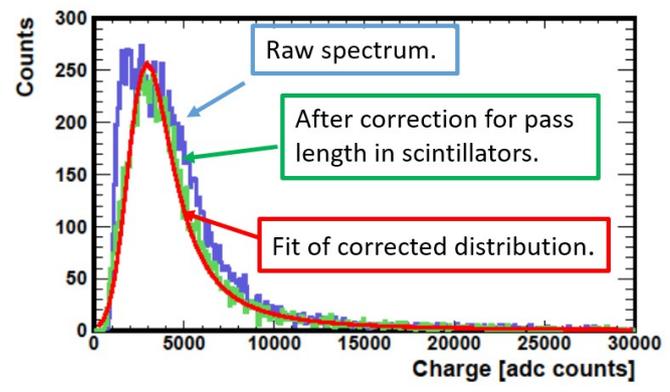
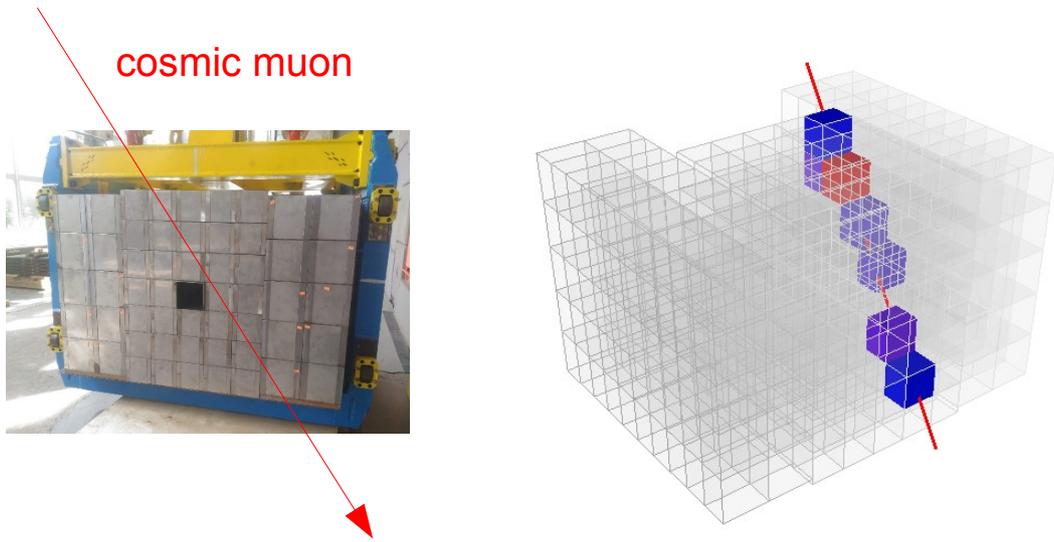
**External TTL 3:**

- Spill time, ms: 0 to 5,000
- Busy time and Trigger intervals,  $\mu$ s: 0.1 to 1

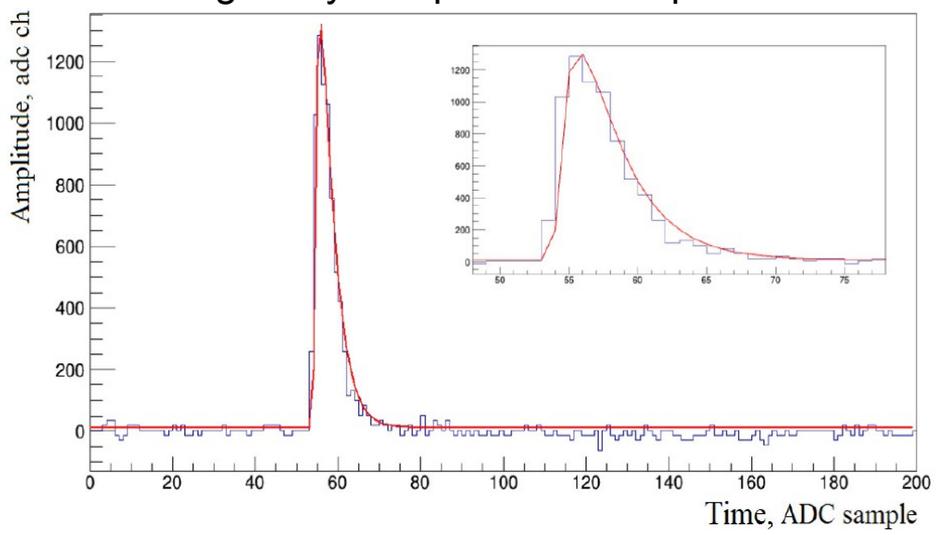
At the bottom right, the status is 'Online' and 'SC: disabled UT24VE 046F-292C, no IP 32.0°C f/w:1.1.0'.

# Status of new FHCAL for BM@N

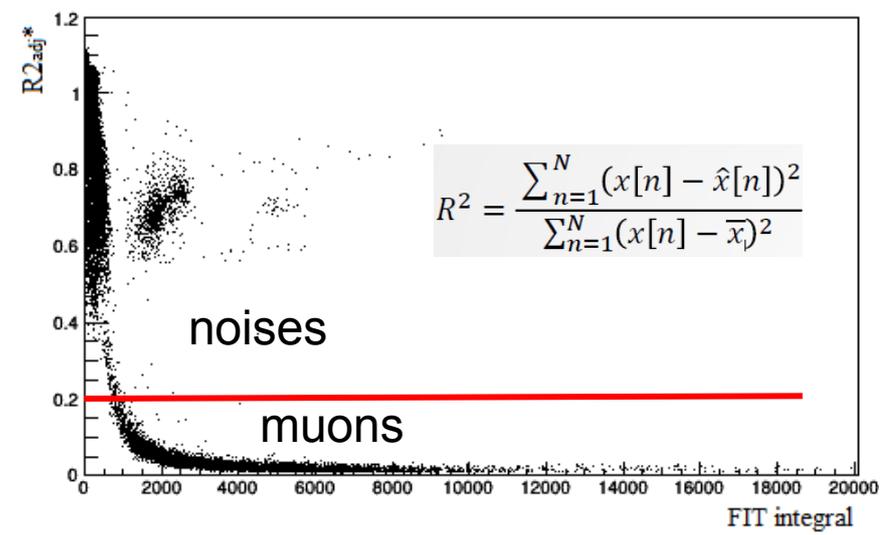
New cosmic muon calibration procedure based on 3D tracking with transverse and longitudinal granulation of FHCAL has been developed and is under testing on cosmics with FHCAL (remotely from INR)



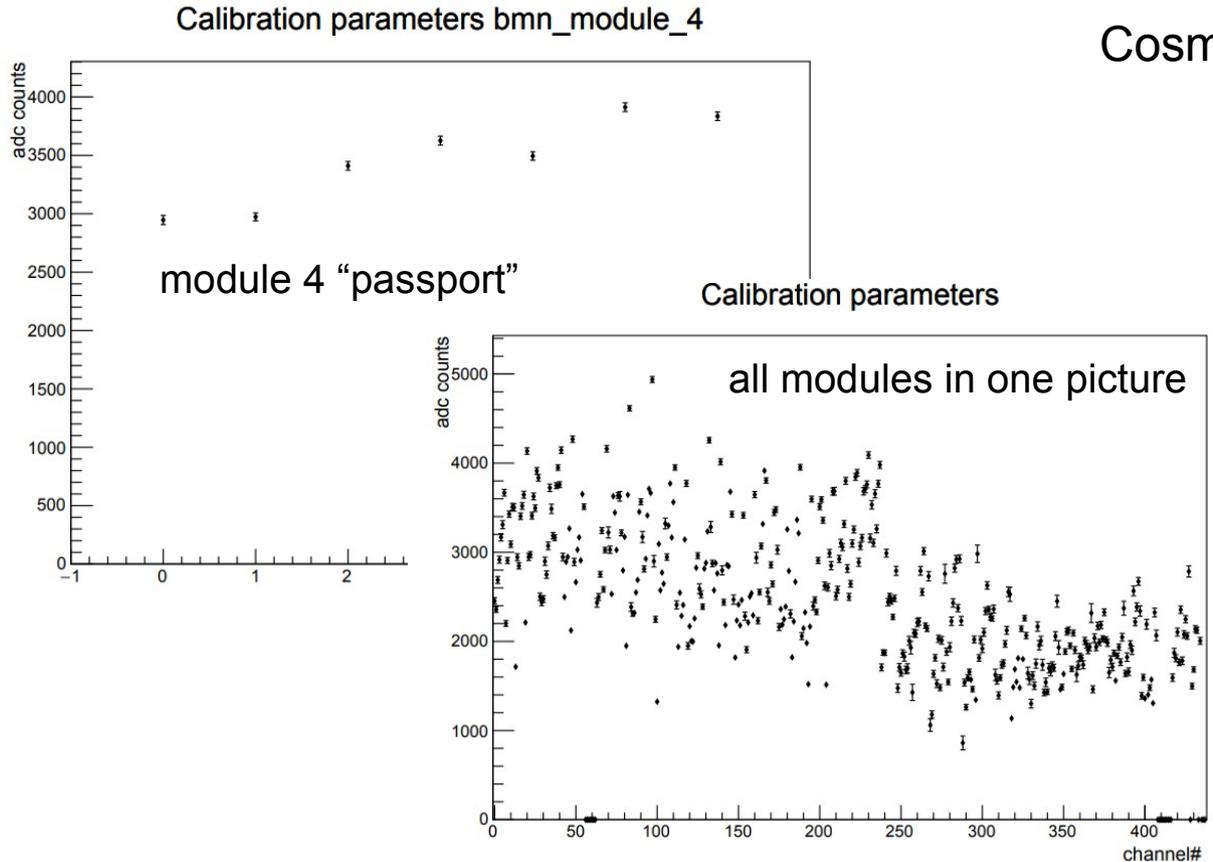
Fit signal by composition of exponents



Rejection of noises with fit quality par.

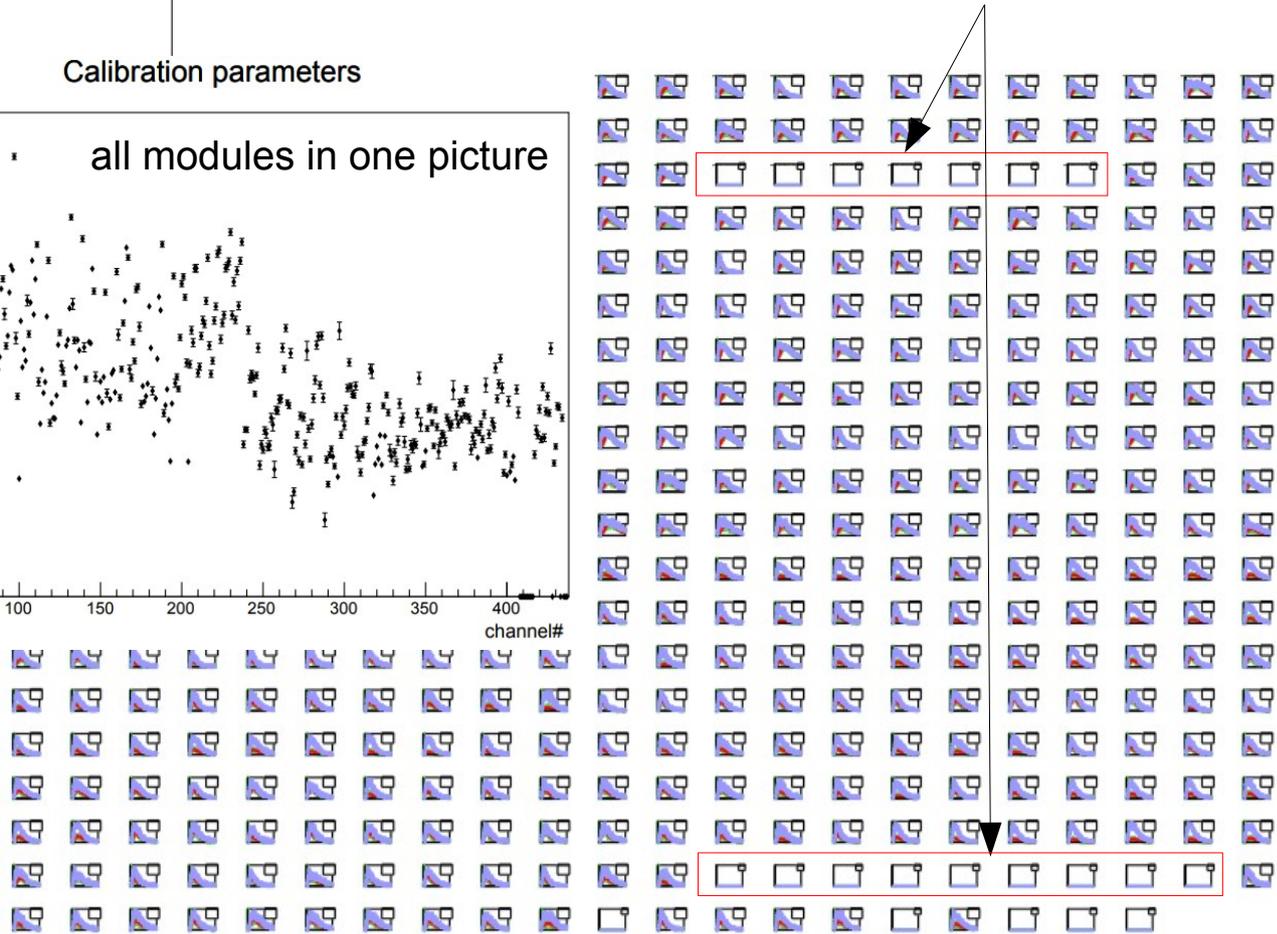


# Tests of 8 ADC64 read-out system (on fhcal-bmn virtual mashine at BM@N computing node)



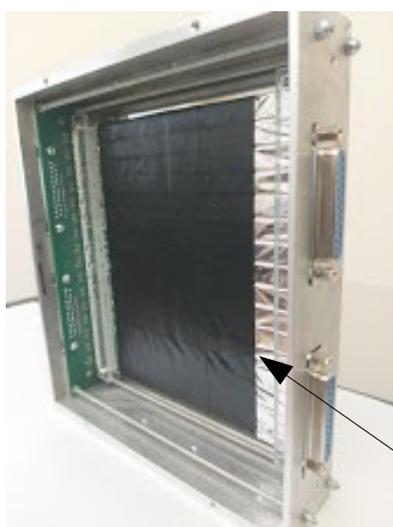
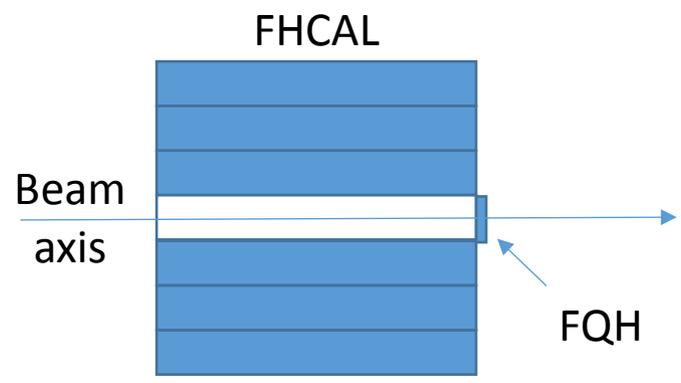
## Cosmic muon calibration results

some problems?



- the final goal: prepare "the quality passport" for each module of FHCAL

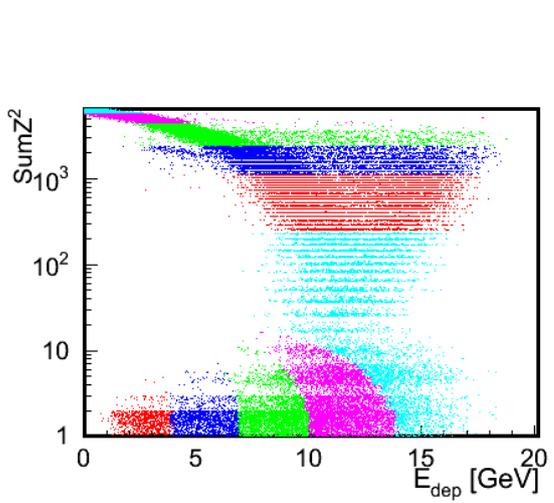
The use of the Forward Quartz Hodoscope (FQH) to measure fragments charges in the FHCAL beam hole.



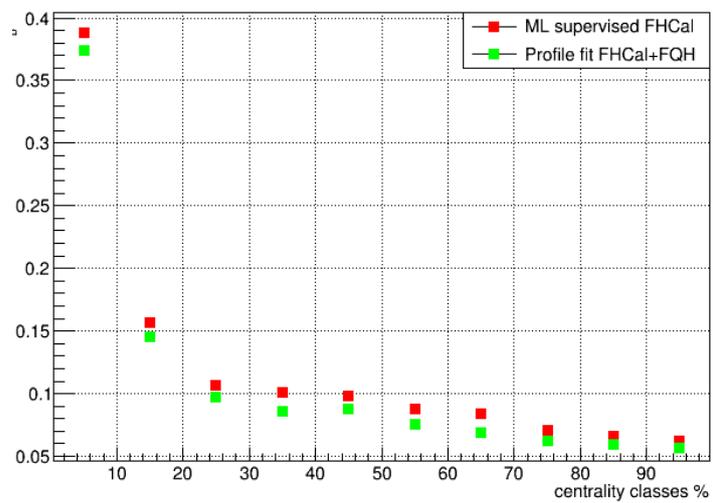
- Forward Quartz Hodoscope (FQH) is ready (2 variations – with scintillator and with quartz plates)
- TQDC board planned to use for read-out is under testing now with new FEE (at INR)

- fragments charge measurements in the FHCAL beam hole.
- alignment of the FHCAL
- MB and centrality triggers

16 strips (160 x 10 x 4 mm<sup>3</sup>) with 2-side MPPC read-out



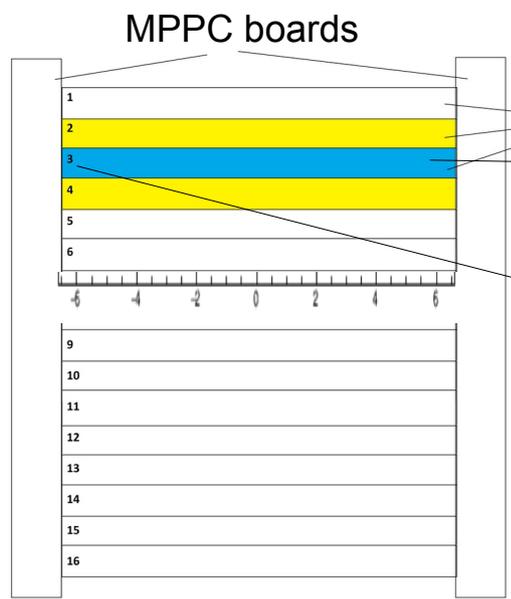
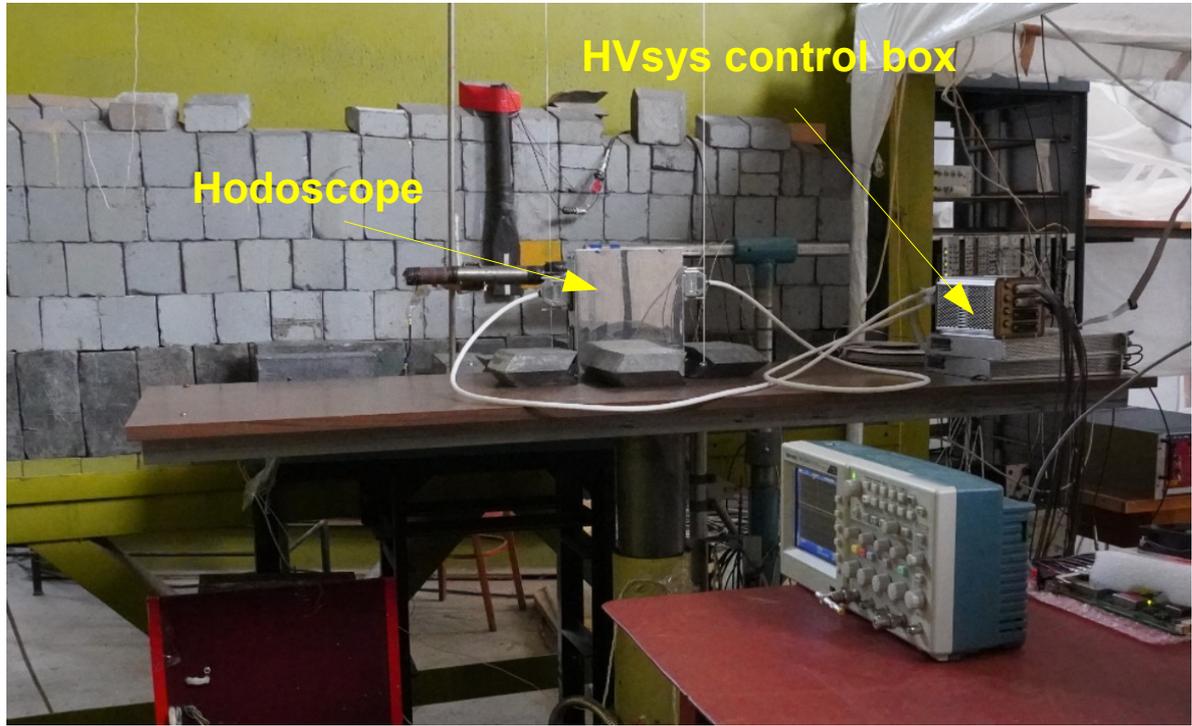
Impact parameter resolution



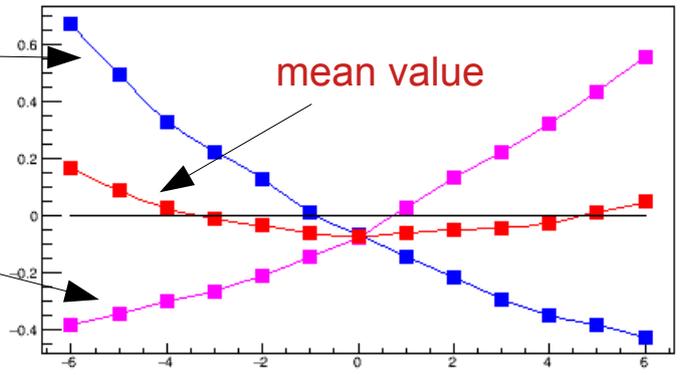
- the impact parameter resolution is slightly better when FQH+FHCAL are used
- FQH will allow to measure charge fragments in the FHCAL beam hole:
  - can be useful to tune fragments models in event generators

# Status of new FHCaI for BM@N

Hodoscope's tests has been performed on "PAKHRA" synchrotron at LPI (Troitsk)

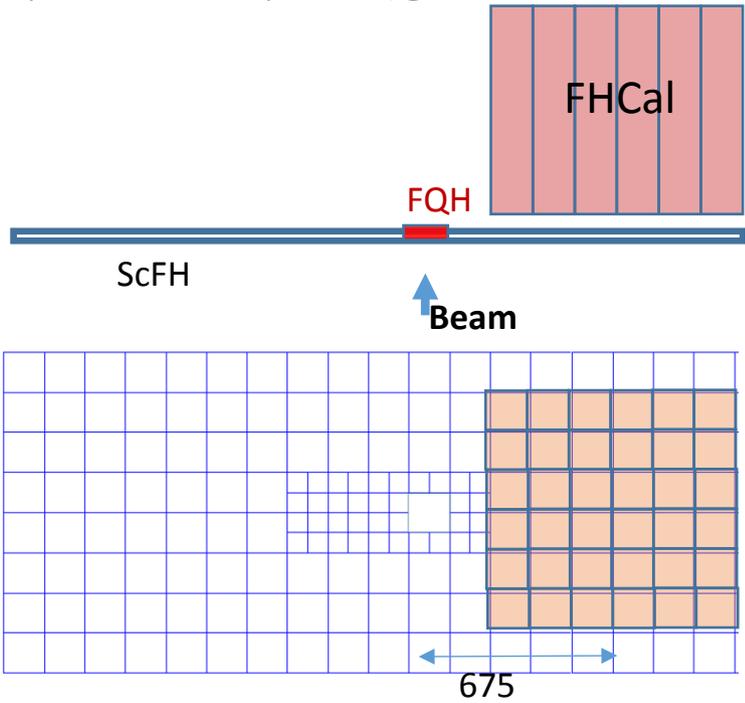


### non-uniformity of response



- difference is not more then ~20% with dual side read-out

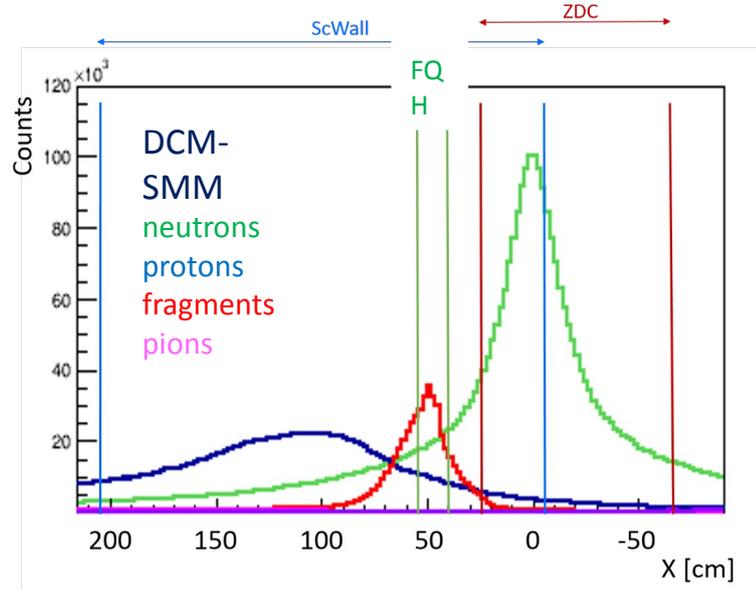
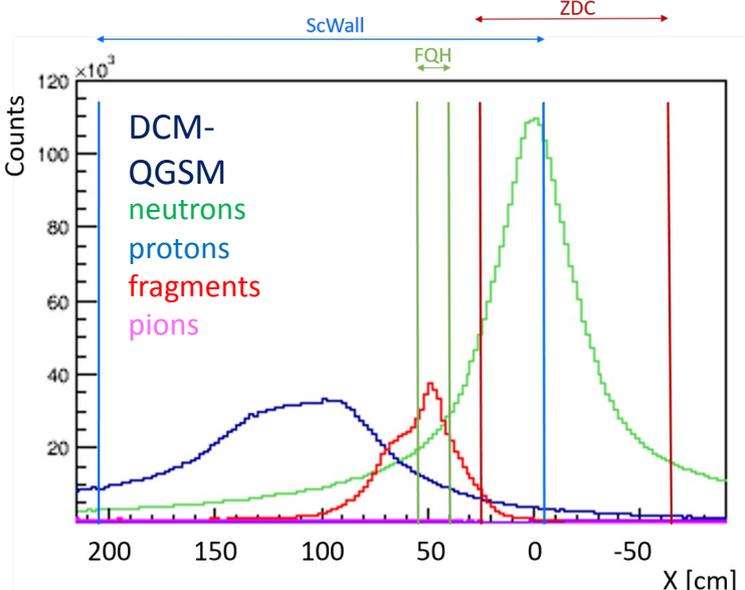
Status of new FHCaI for BM@N



Additional segmented scintillation wall is planned:

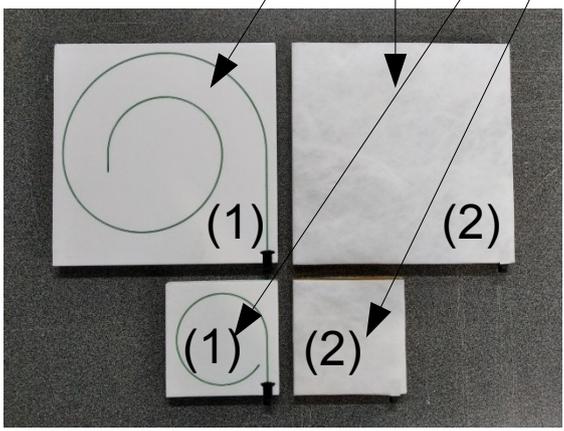
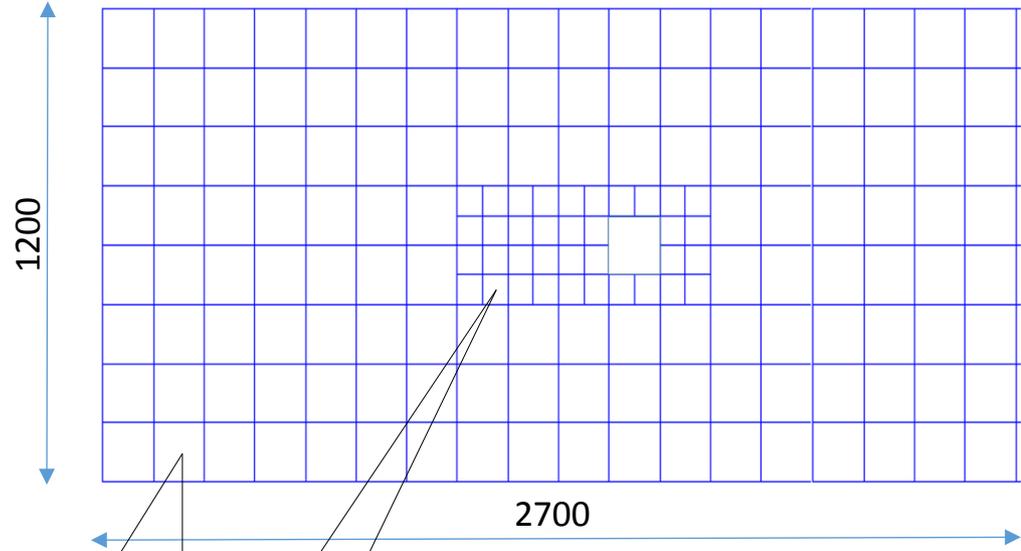
- FHCaI (36 MPD modules  $15 \times 15 \text{cm}^2$ ) to measure neutron spectators
- Scint. Wall: 36 cells ( $75 \times 75 \times 10 \text{mm}^3$ ) + 134 cells ( $150 \times 150 \times 10 \text{mm}^3$ )
- FQH (16 quartz strips  $160 \times 10 \times 4 \text{mm}^3$ ) to measure heavy fragments

Separate measurements of the neutron, proton and fragments could be possible with this detector system.



- large spatial separation between the proton and neutron spectators on the plane located at 9m from the target for Au+Au @4.5 AGeV with different event generators.

Schematic view of new BN@N Forward Scintillator Hodoscope (FSch)



Already constructed samples of scintillator cells for tests.

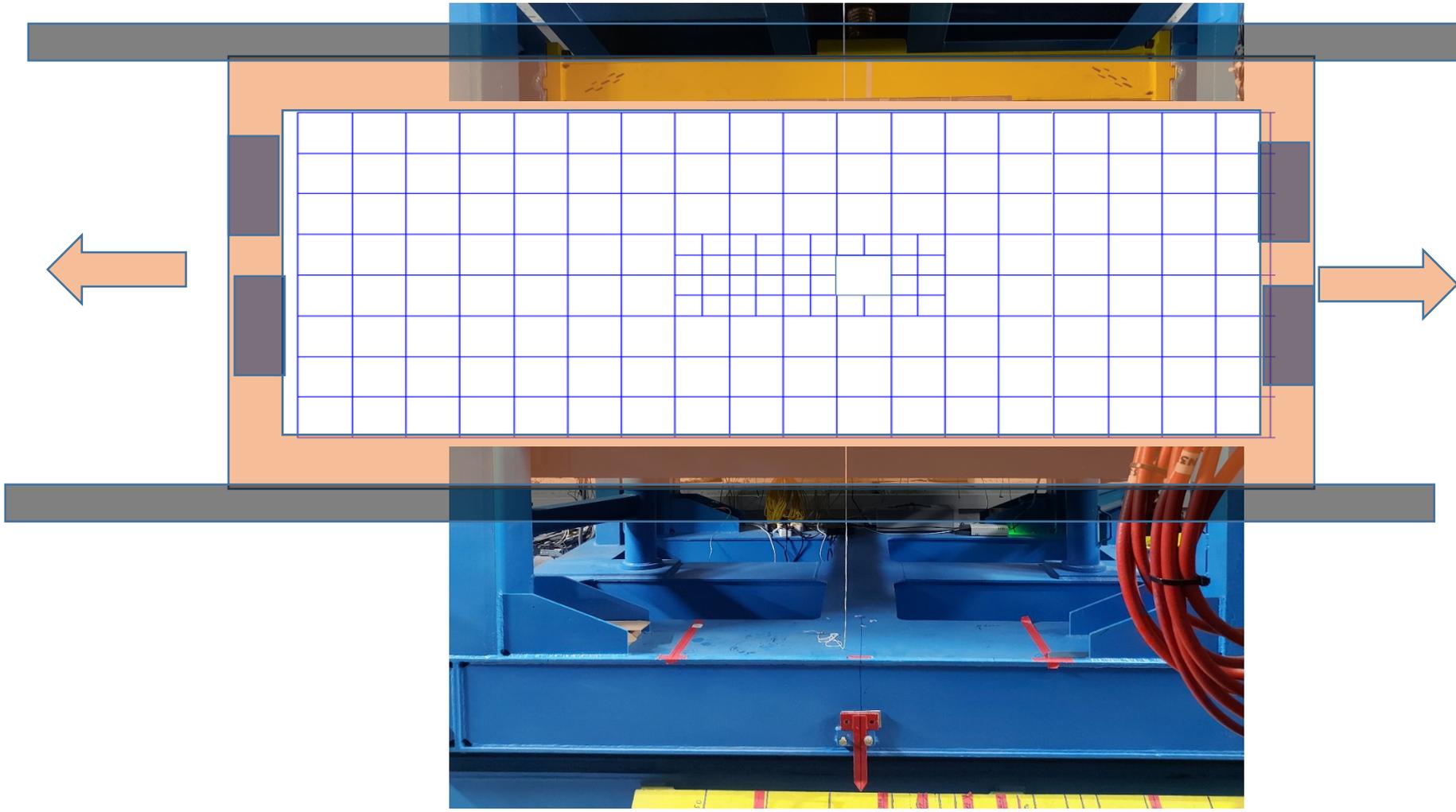
Tests have been done at “PAKHRA” synchrotron, LPI (Troitsk)

- uniformity of light collection w.r.t. beam spot

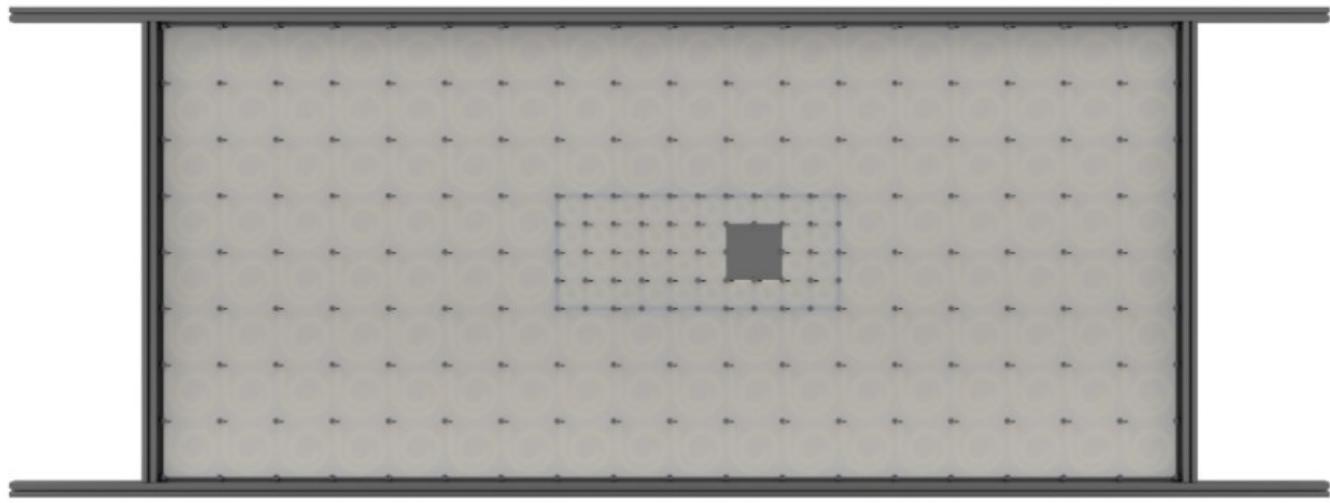
- 1) chemical prepared “foam” type reflection coating
- 2) tyvek’s coated plates

(results show tyvek coated plates to be better..)

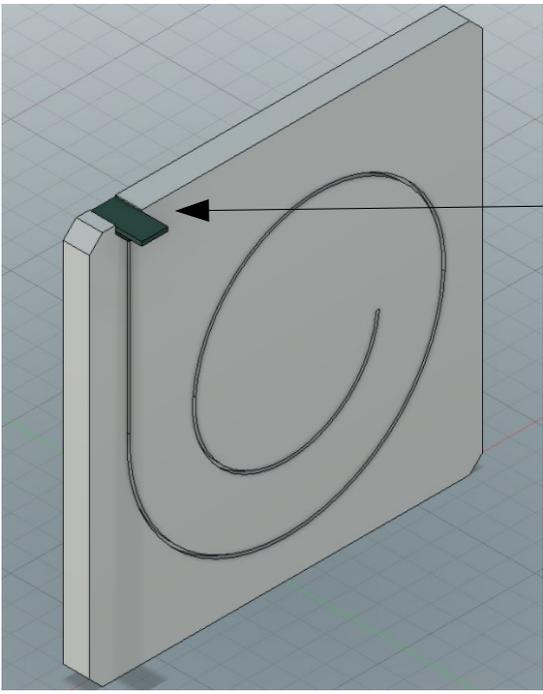
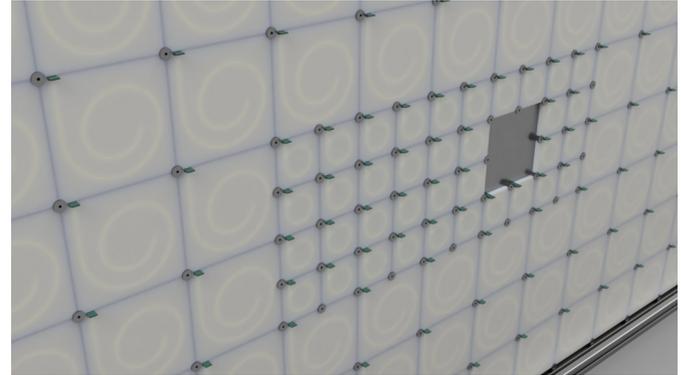
Another possible solution: the hodoscope frame will be fixed to the platform frame



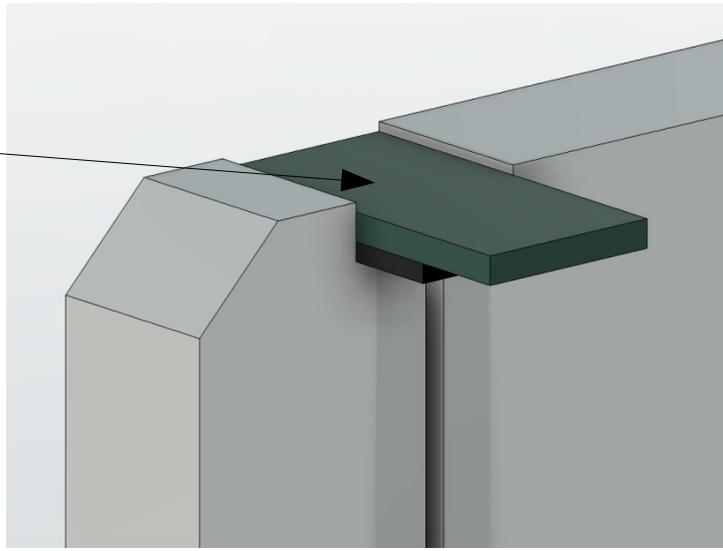
Schematic view of scint. wall design



assembling of scint. wall



MPPC  
mounting  
PCB



Plans for the future:

- check all problems with FEE boards and fix them – January 2021
- module calibration and “module passport” - February 2021
- mounting the beam quartz/scint hodoscope (FQH) on the FHCAL back side – March 2021
- desing and construct new scintillation hodoscope wall – September 2021 (optimistic)