

SPD ECAL (End Cup part)

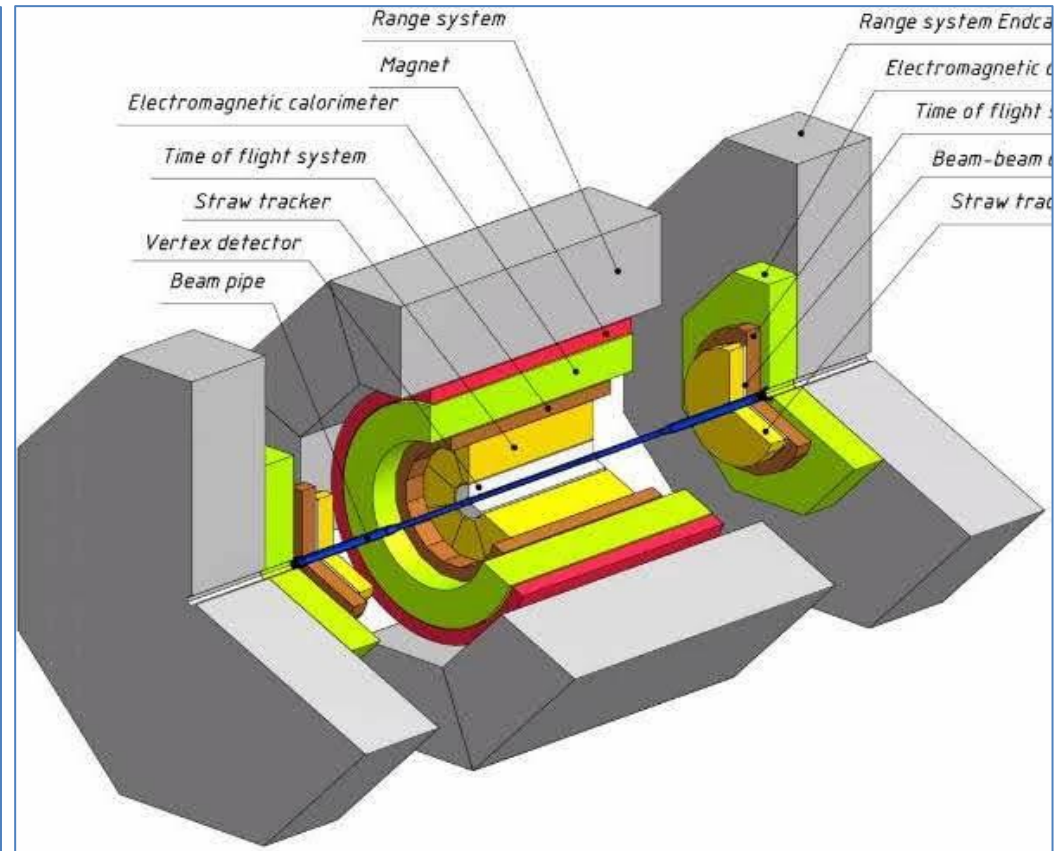
Particle physics at medium and high energies

Protvino, June 5 , 2026

Oleg Gavrishuk, Laboratory of High Energy Physics, Dubna

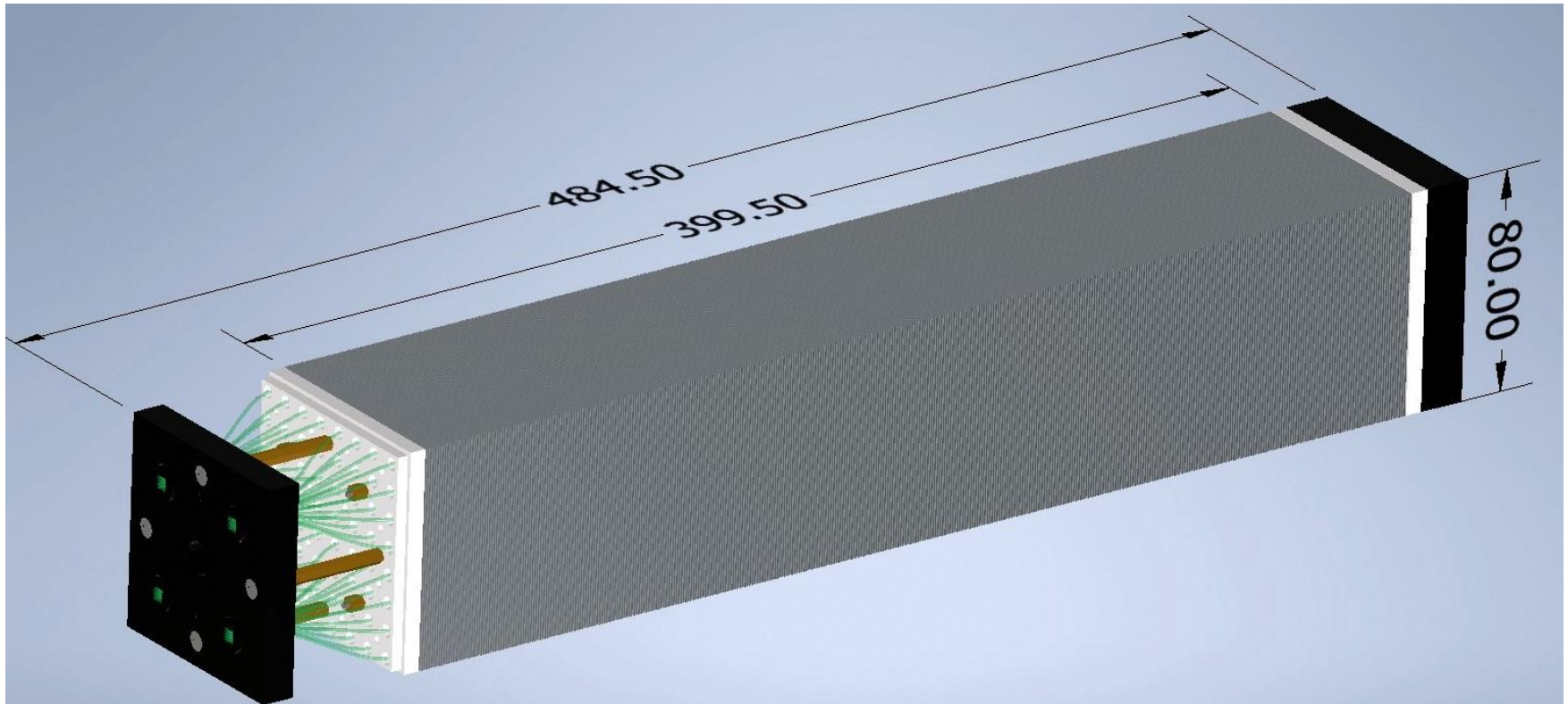
SPD ECAL inside of Criostat

1. The calorimeter (**Green**) placed inside of the Cryostat (**Red**).
2. The calorimeter designed for efficient registration of electrons and gamma in the energy range up to 10 GeV.
3. Transverse cell size should be on the order to Moliere radius of the calorimeter medium: ~58 mm.
4. The End-Cup cells have a rectangular shape 40x40 mm².
5. The Barrel cells has a trapezoidal shape in the azimuthal direction with vertex angle equal 1.87° and 40 mm in beam direction.



Calorimeters Module and cells composition

1. Calorimeter has **shashlik** sampling structure of 200 layers of 1.5-mm polystyrene scintillator and 0.5-mm lead.
2. Active part length is ~400 mm, which corresponds to ~17X0.
3. The Cells size in the End-Cup is equal to 40x40 mm².
4. The Module size composed from 4 Cells is equal to 80x80 mm².
5. 64 WLS fibers collect light onto the SiPm of 6x6 mm².
6. SiPm EQR15 11-6060D-S - it is a novel China design of NDL technology



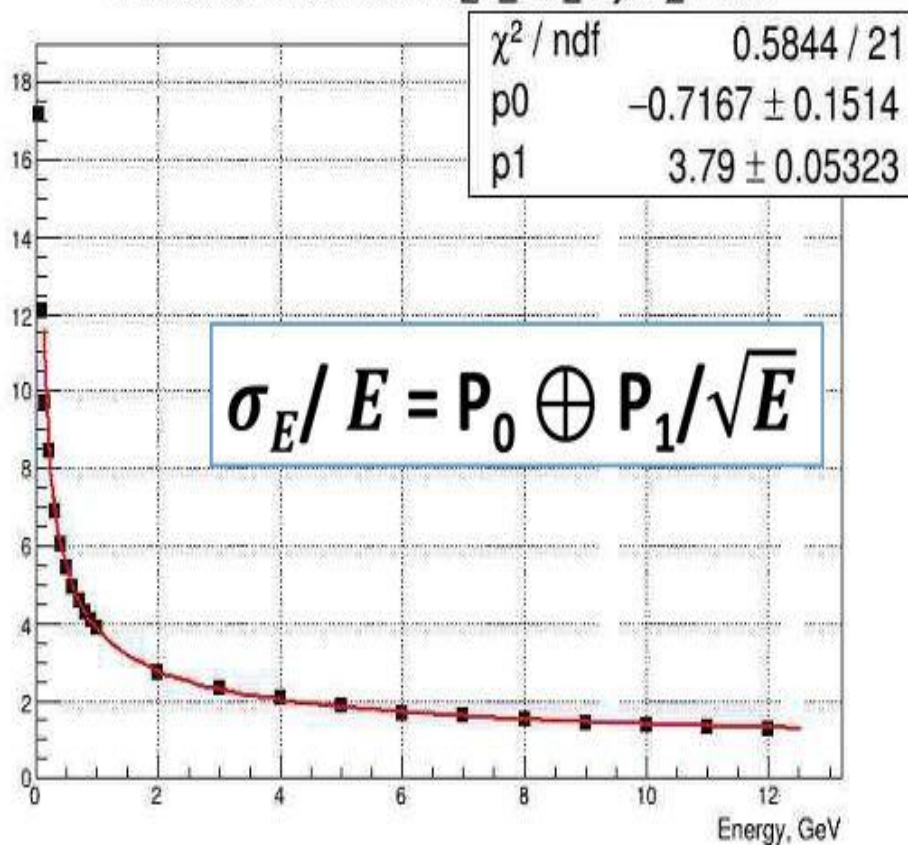
E-resolution without take in account
the NPE per GeV

3.8% - Stoh/ part

~0% - const term at WLS $L_{att} > 10m$

0.5 mm Pb + 1.5 mm Sc, 200 layers, e-
(Result of O.Gavrishchuk)

E-resolution Quadrature Fit_in_200_Layers_Pb500



E-resolution vs NPE per GeV

1- >10k - 3.9% - Stohast. part

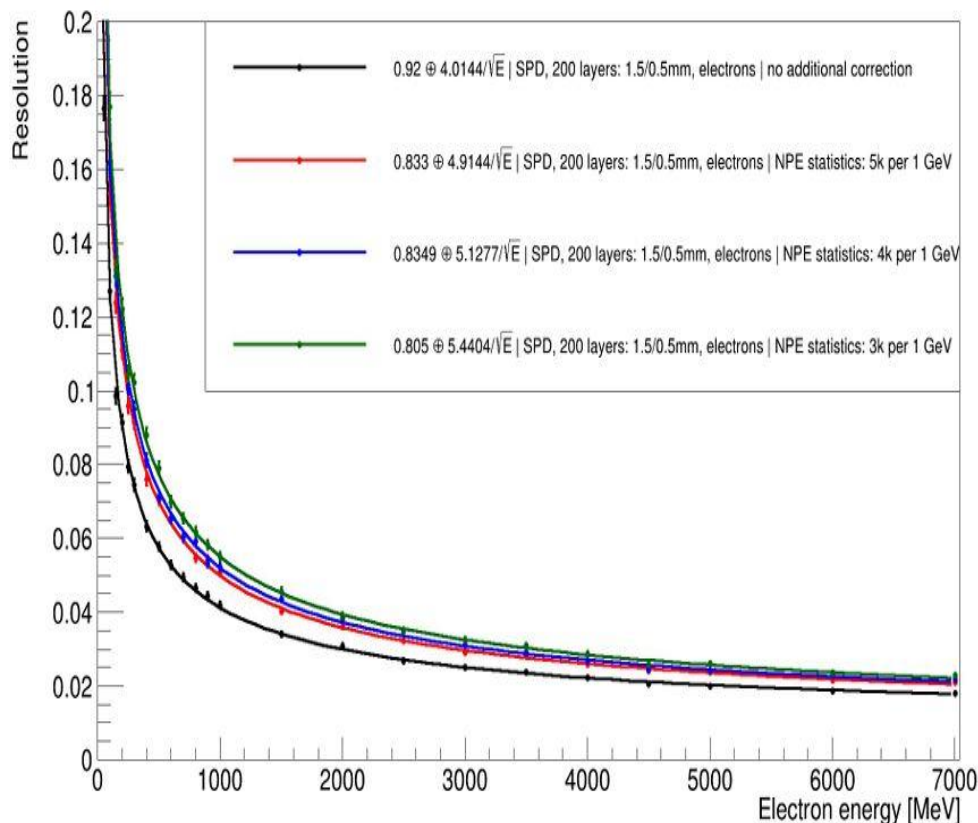
2 - 3k NPE/GeV - 5.4%

2 - 4k - 5.1%

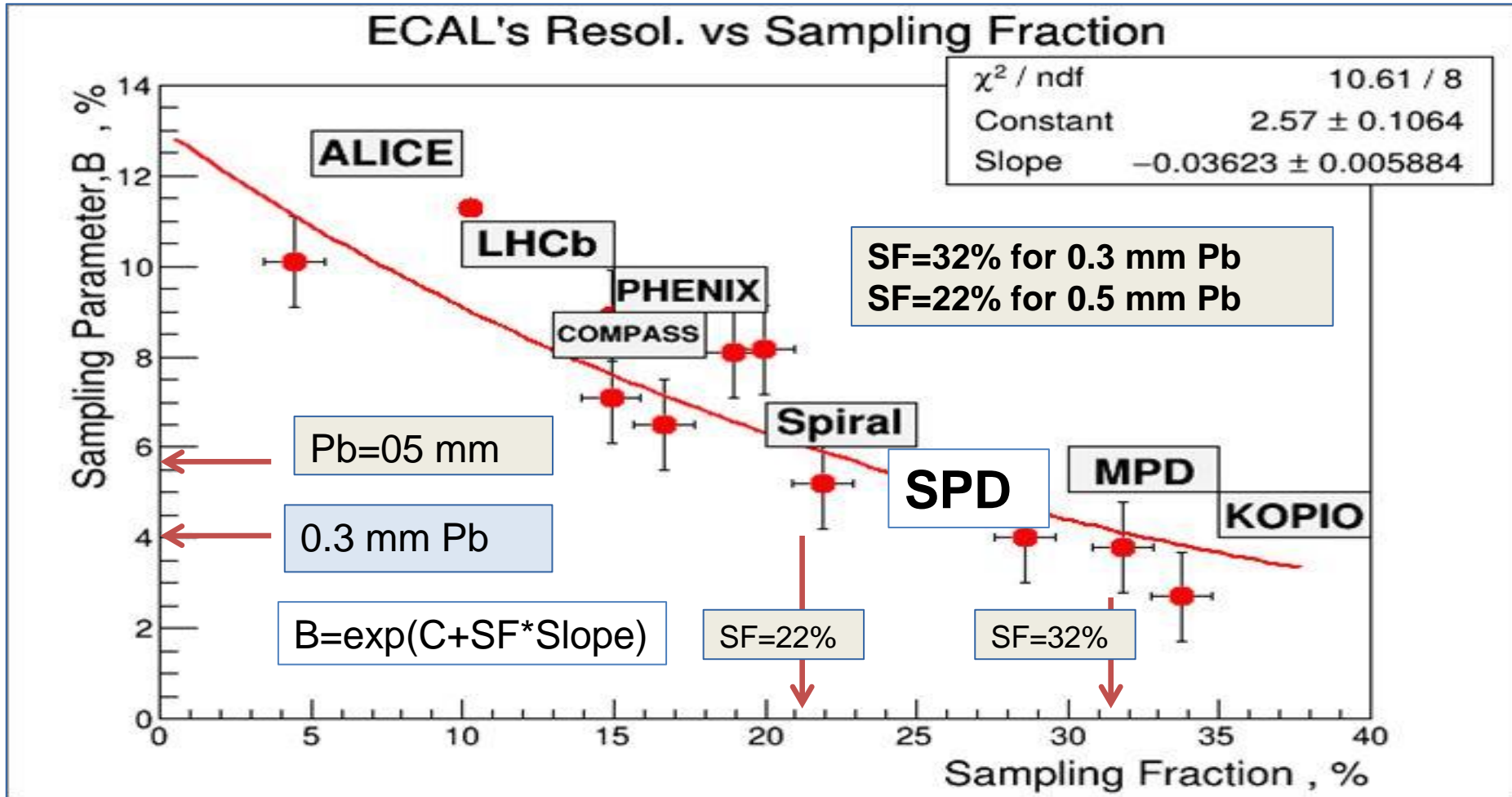
4 - 5 k - 4.3 %

Const/ Frf ~ 0.9% < WLS $L_{att} > 10m$

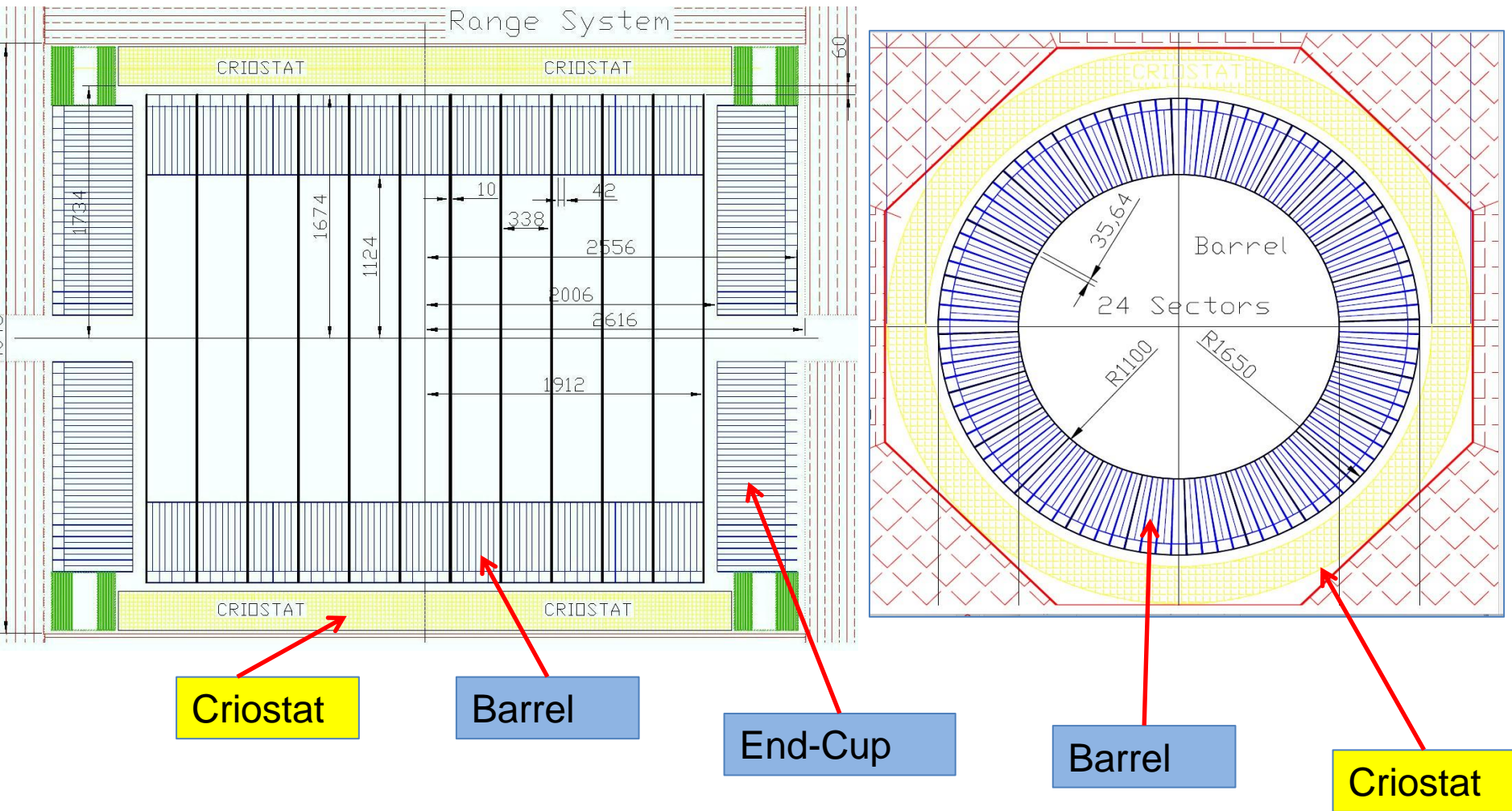
SPD ECAL resolution



ECAL energy resolution vs sampling fraction.



ECAL Barrel & End Cup geometry



Criostat

Barrel

End-Cup

Barrel

Criostat

EndCap-17

Лист: прорек.

Склад: №

A

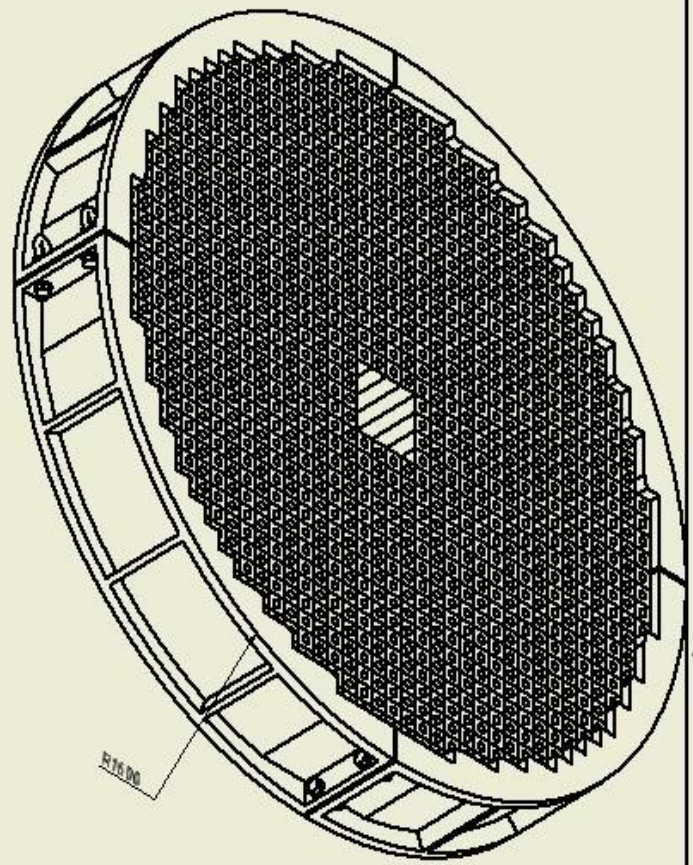
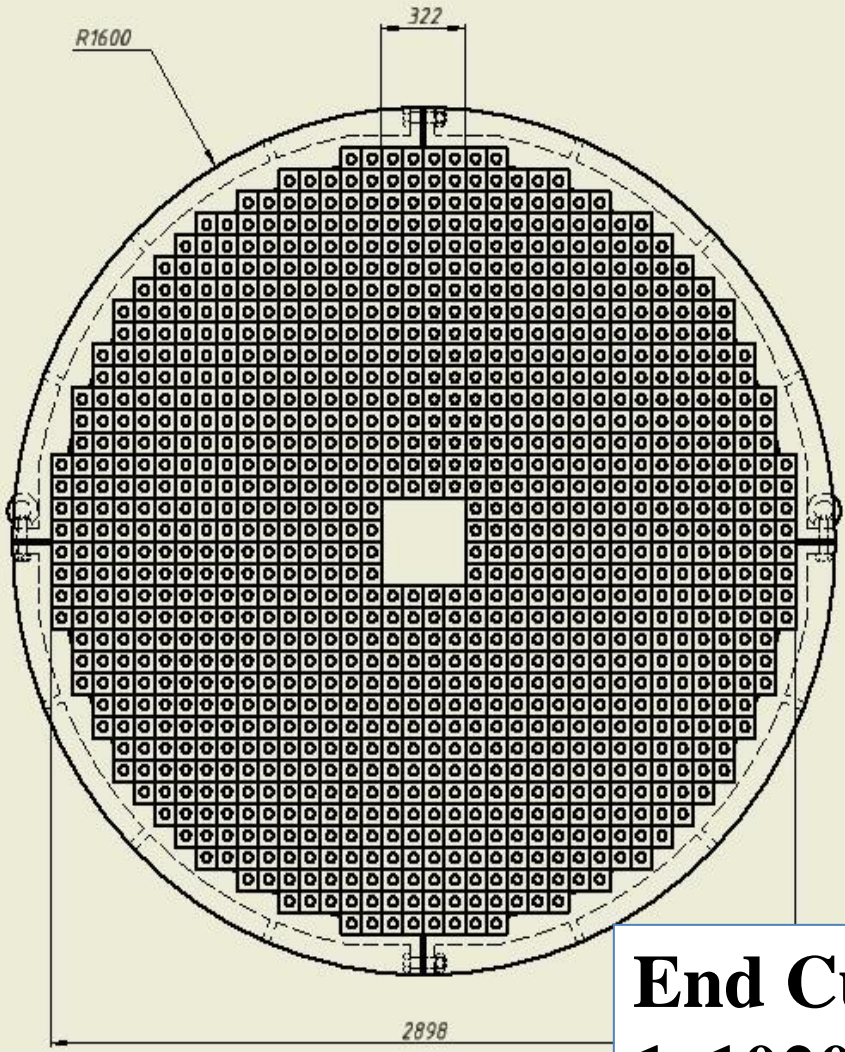
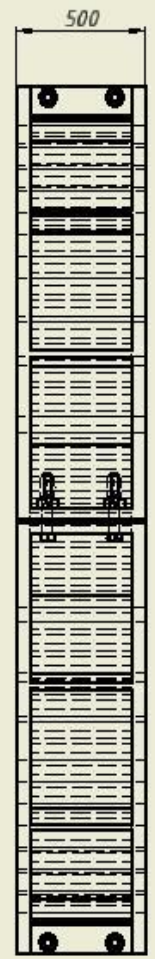
Площ. и форма

Инд. № модуля

Взам. инв. №

Площ. и форма

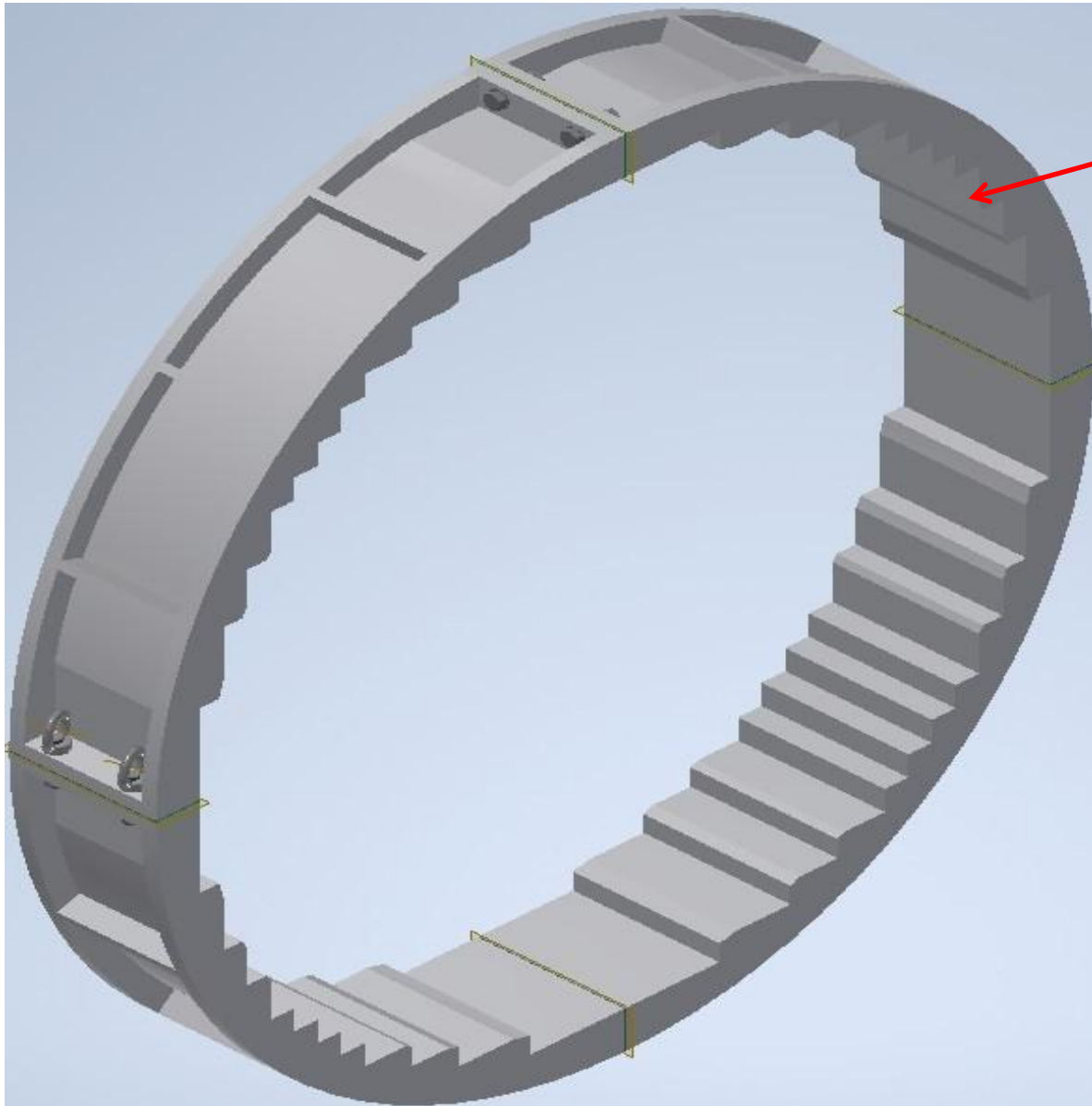
Инд. № подл.



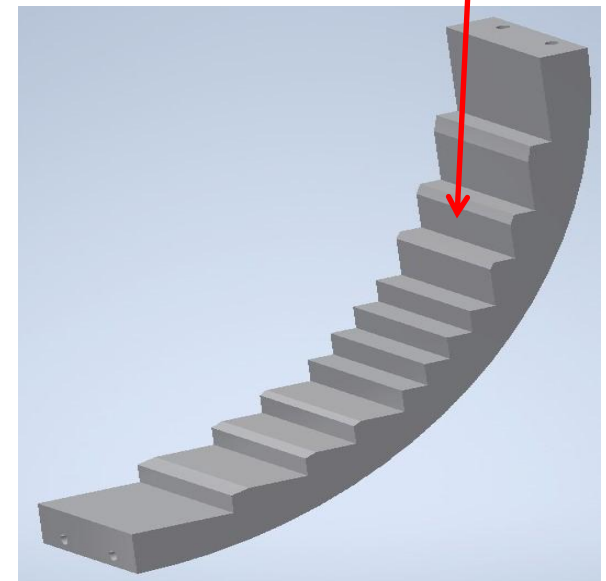
End Cup drawing:

- 1. 1020 modules 80x80 mm²**
- 2. 4080 cells 40x40 mm²**

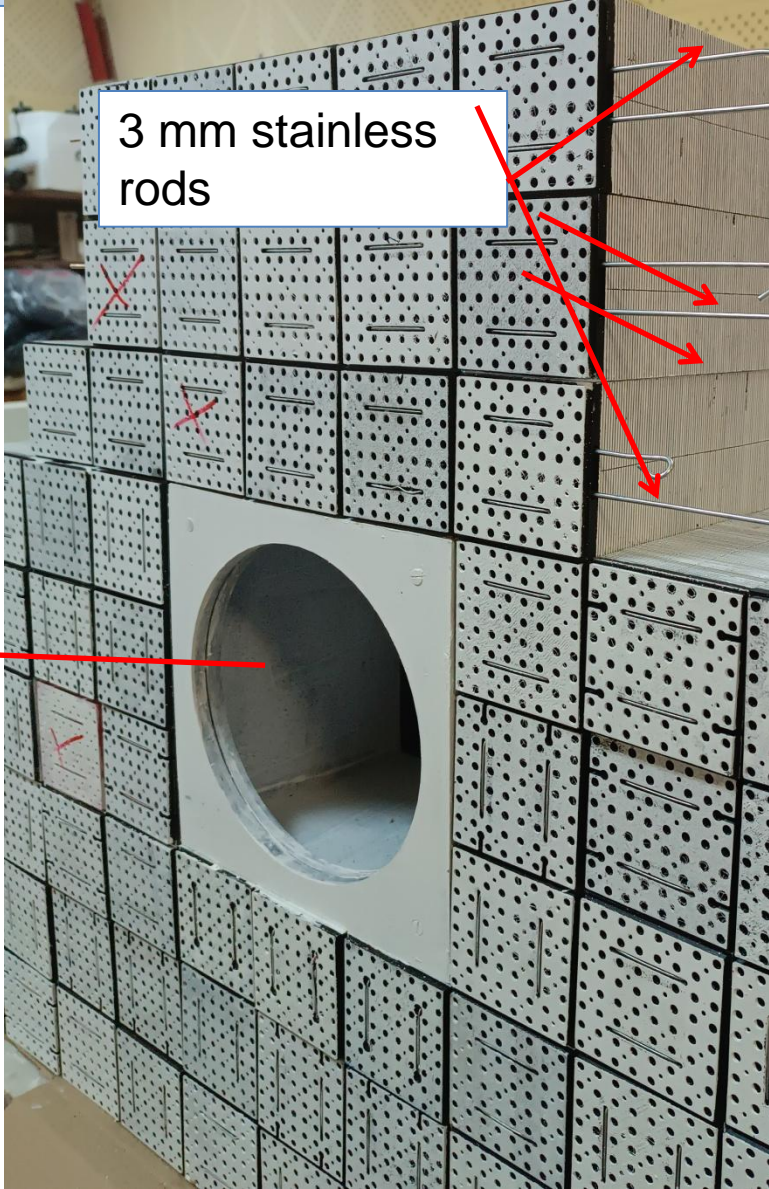
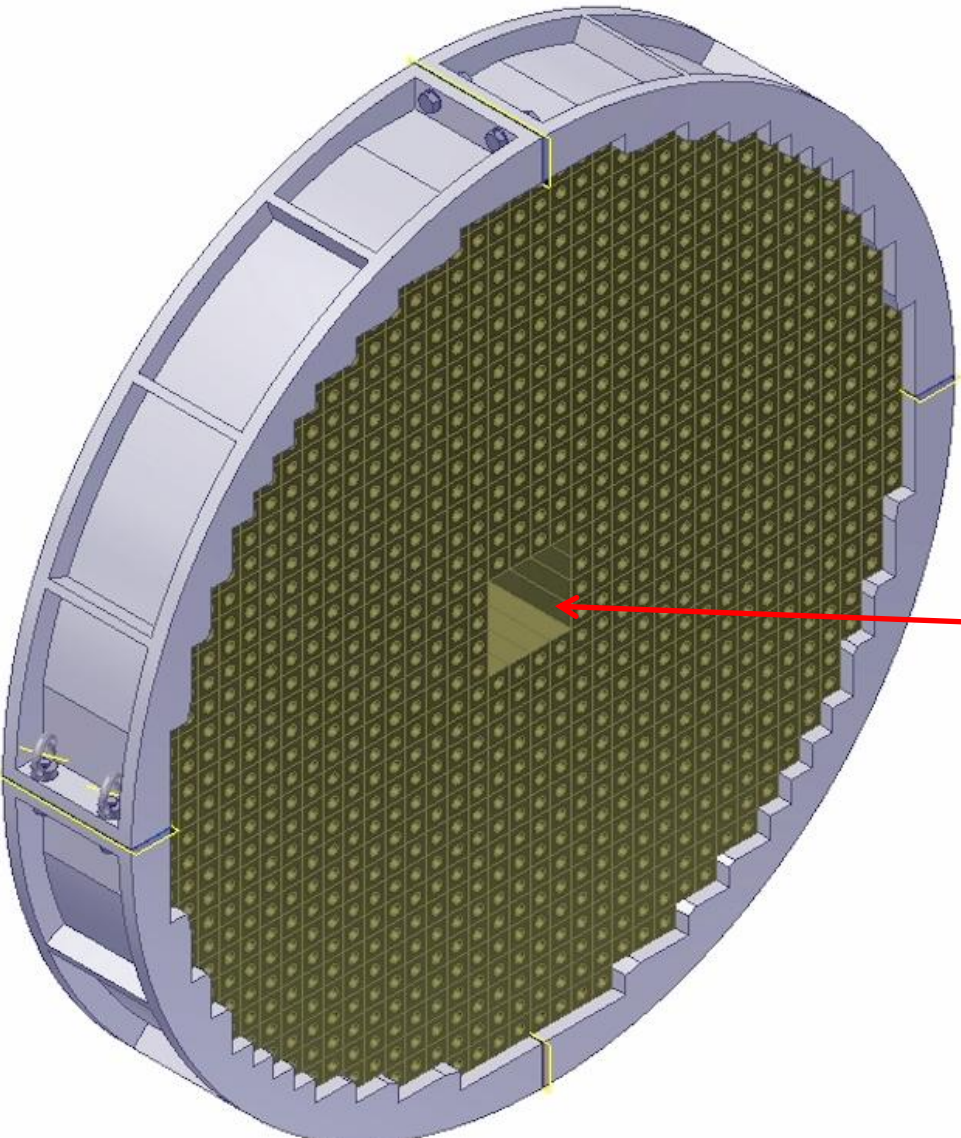
End-Cup calorimeter support:



**Aluminum frame
composed from 4
details made by
casting into a mold**



End-Cup and central windows.



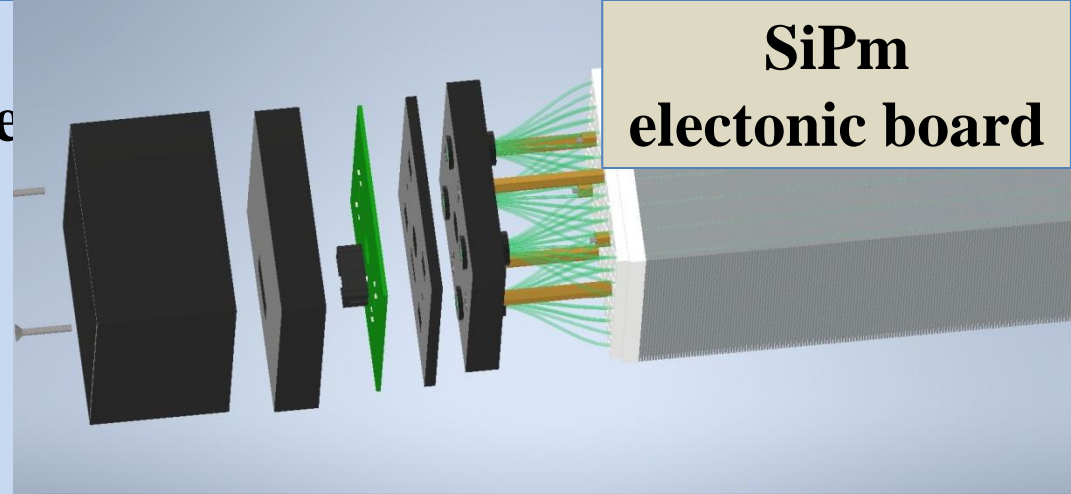
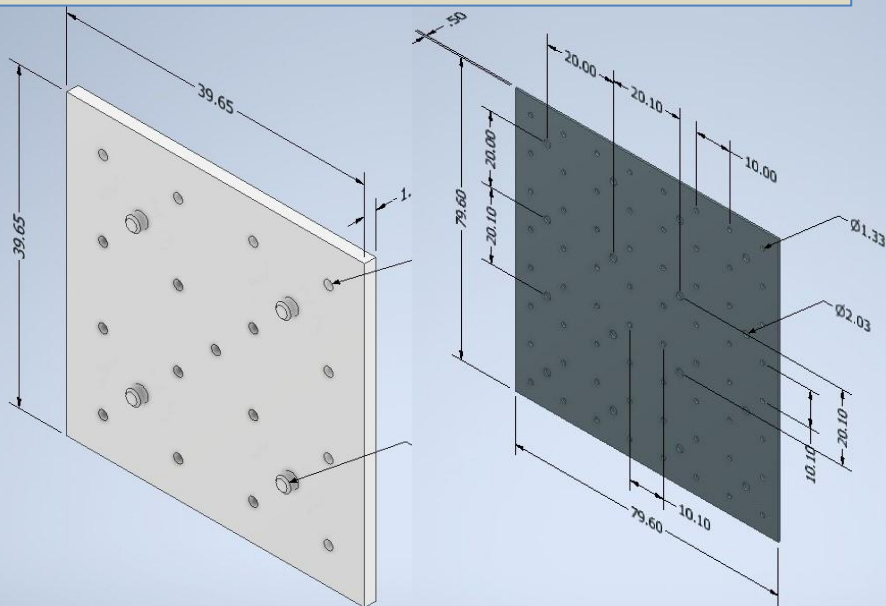
3-D Model

ECAL SPD END CUP module

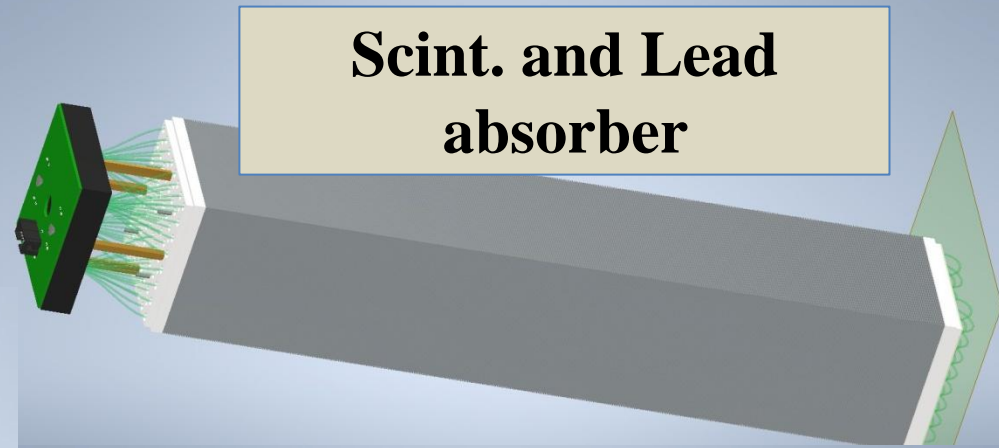
3-D Design

3-D ECAL model should be implemented in SPD Data base by help of Valery Shvetsov

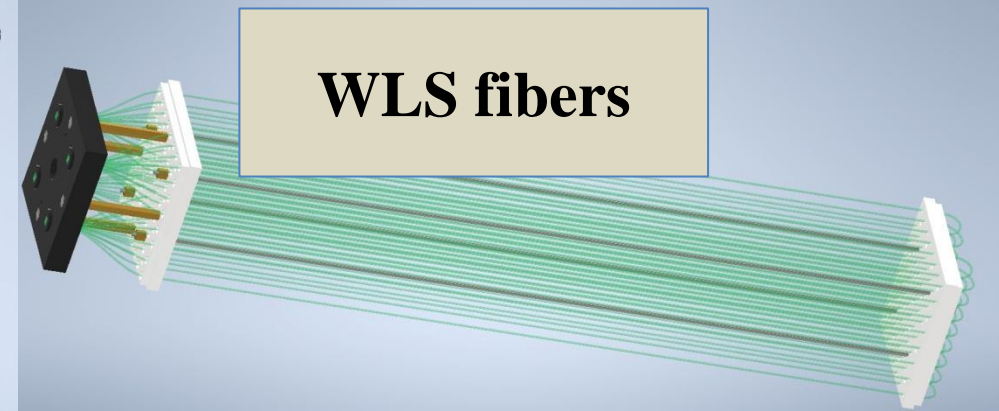
Scintillator and Led Plates



SiPm
electronic board

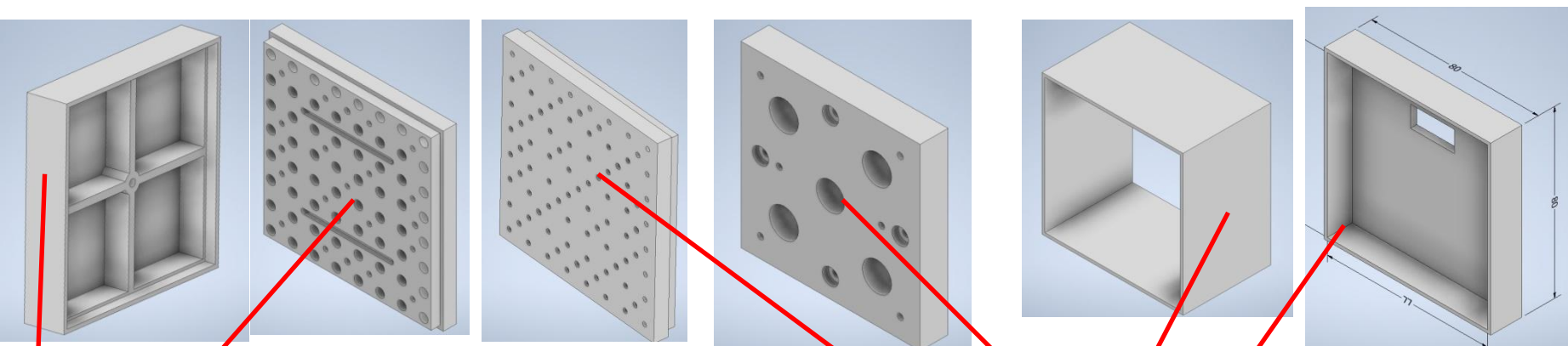


Scint. and Lead
absorber



WLS fibers

Assembling details: ABS, 3-D Printer, density=0.6 gr/cm³

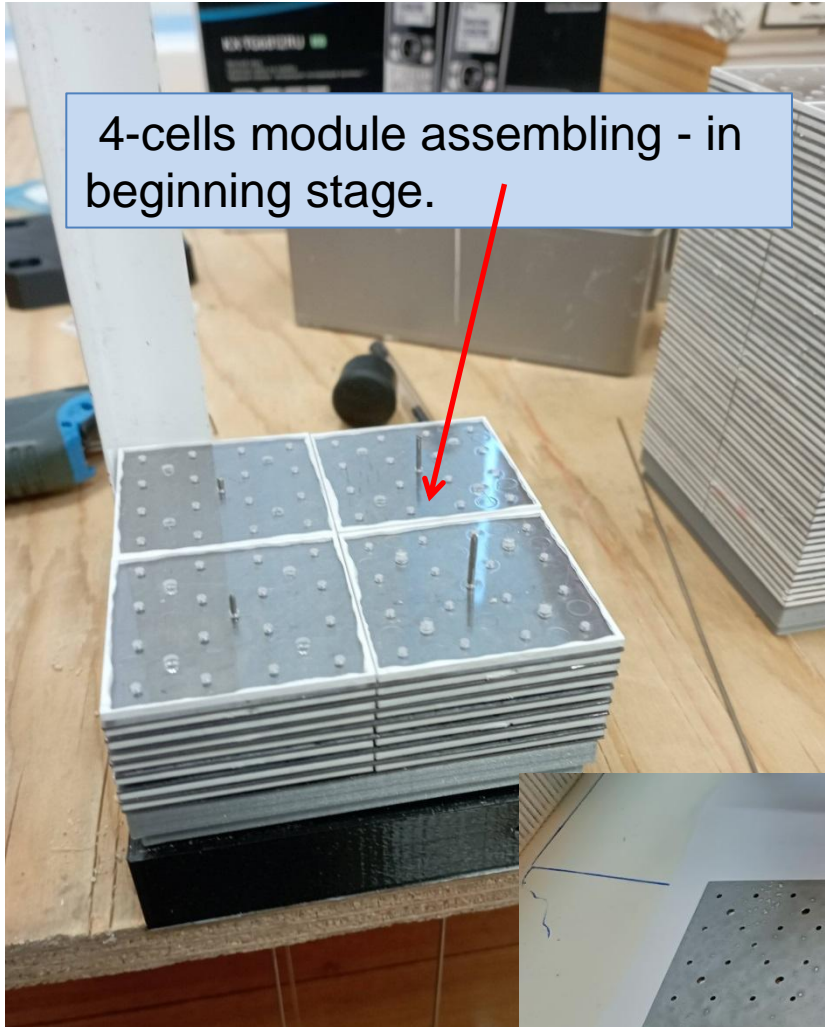


ECAL Front side:
WLS loop

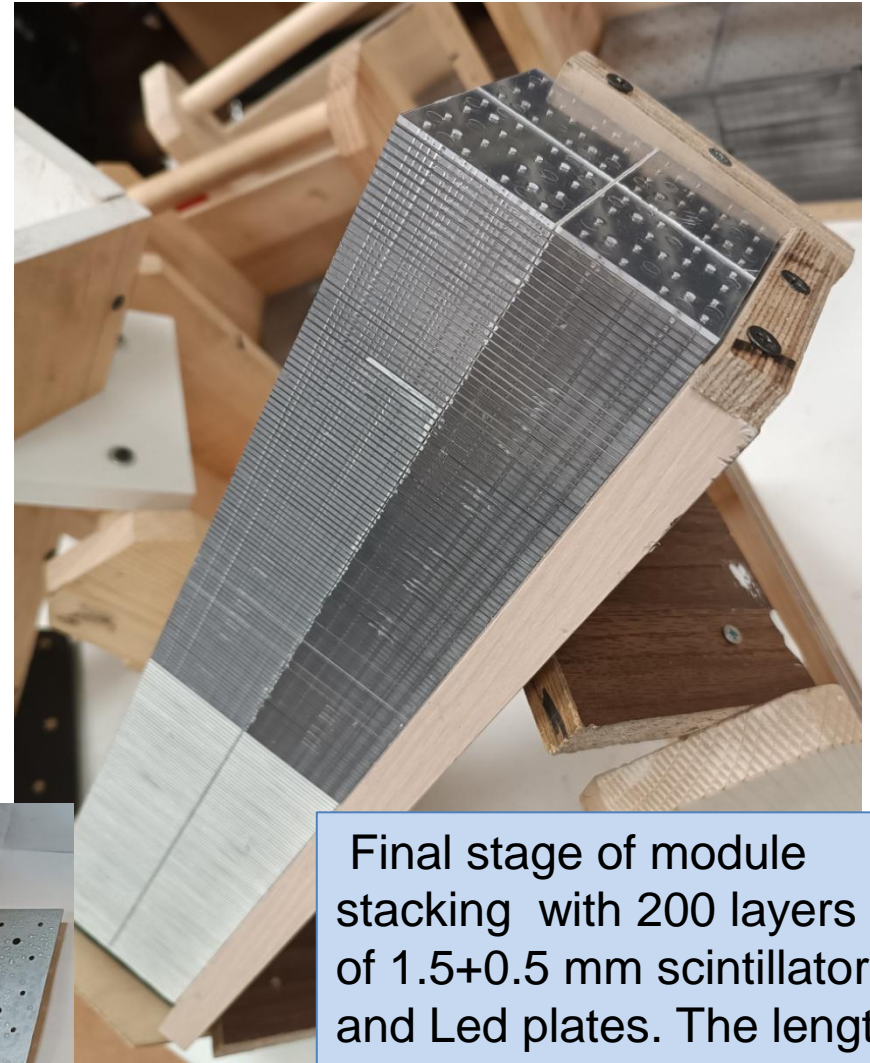


Modules assembling procedure

4-cells module assembling - in beginning stage.



Led plate $80 \times 80 \text{ mm}^2$ to joint 4 Scintillator plates $40 \times 40 \text{ mm}^2$.



Final stage of module stacking with 200 layers of $1.5 + 0.5 \text{ mm}$ scintillators and Led plates. The length of Active volume is equal 403 mm, that corresponded to the estimated period 2.02 mm



ECAL model compressed with load about 100 kg to obtain the necessary size of 403 mm for active part. Controlled by tens sensor.

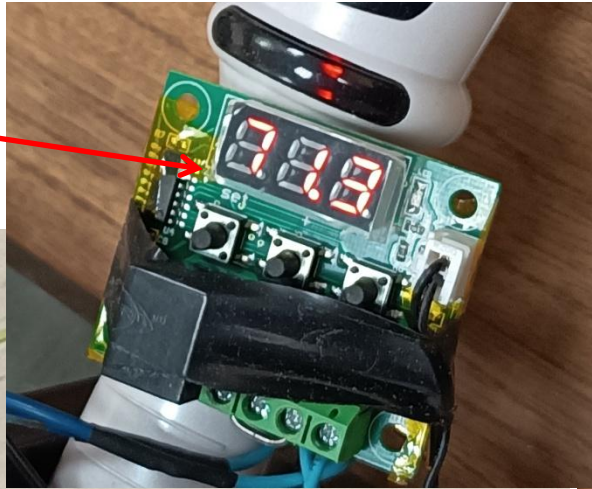
Modules Assembling in JINR LHEP.

500 modules was assembled in 2025 .

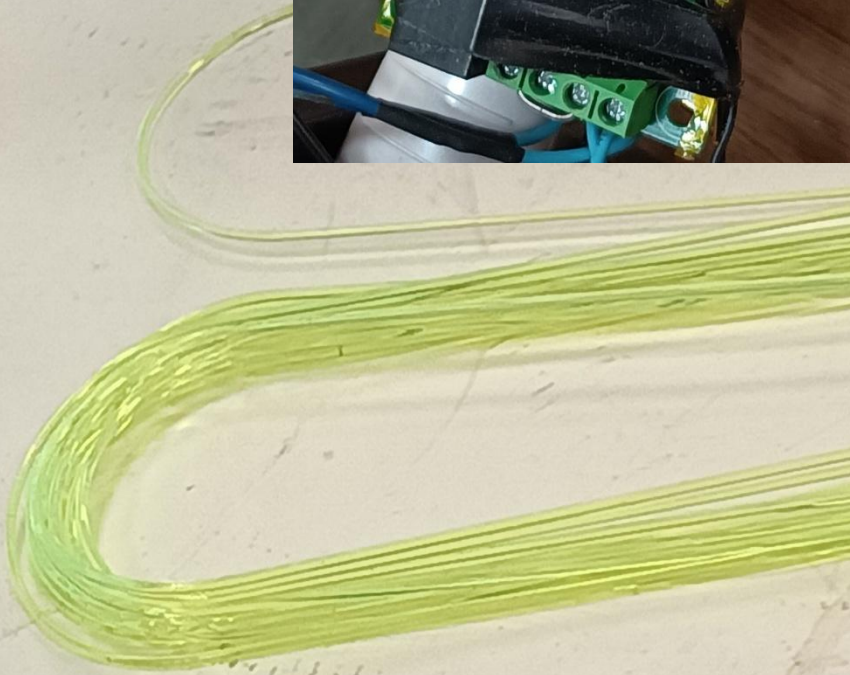
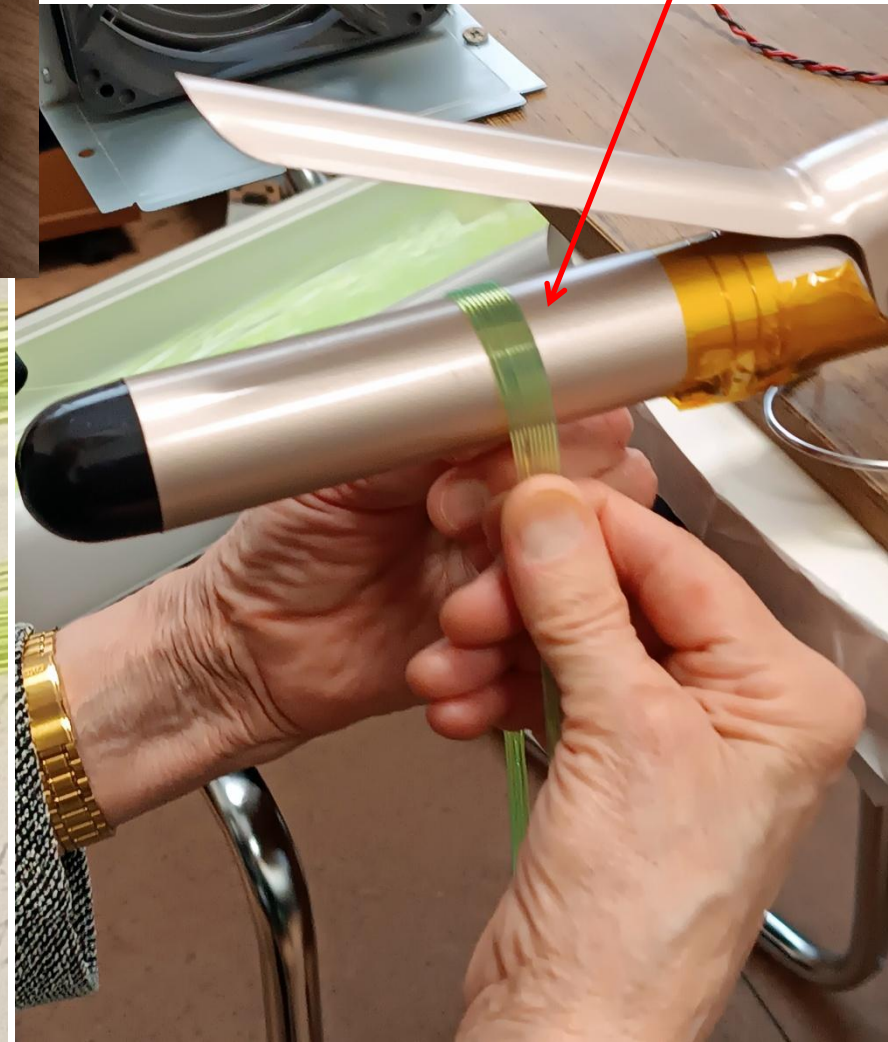


The preparation of fibers in the form of U-shaped loops is done by heating to 70-75 °C.

Thermo-sensor +
Relay



30 mm Diameter



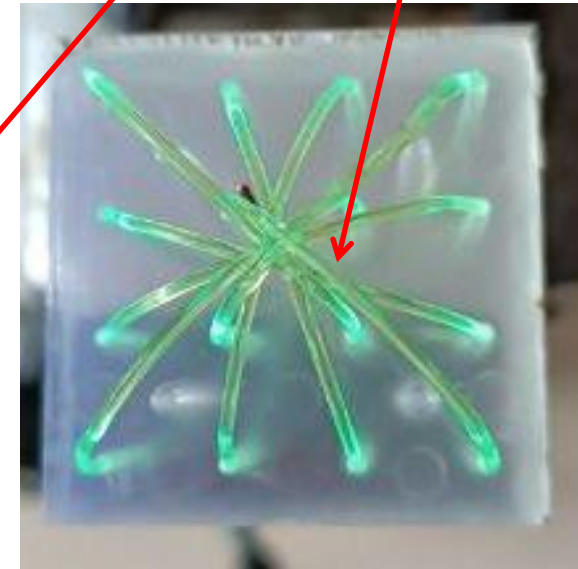
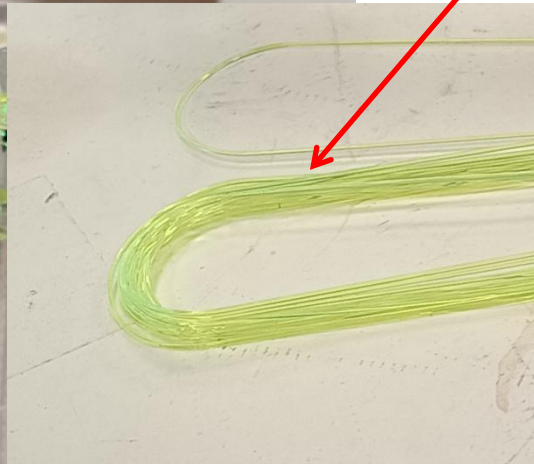
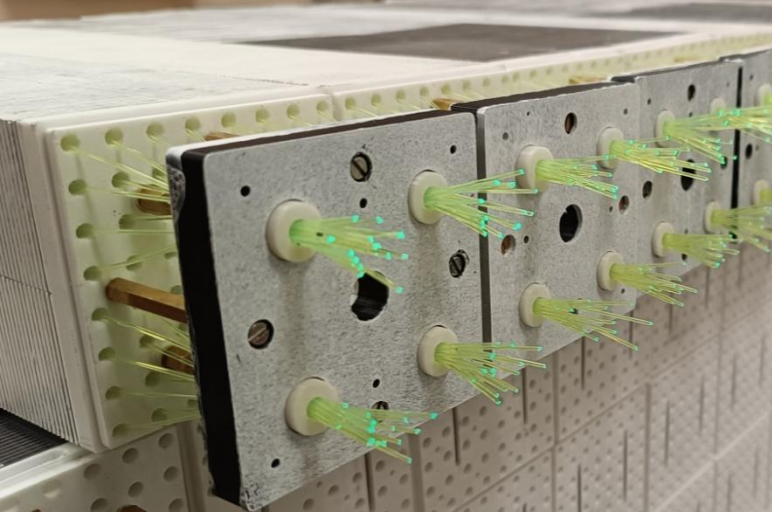
WLS fiber installation in LHEP JINR.

250 modules was assembled with WLS Y11 in 2026.



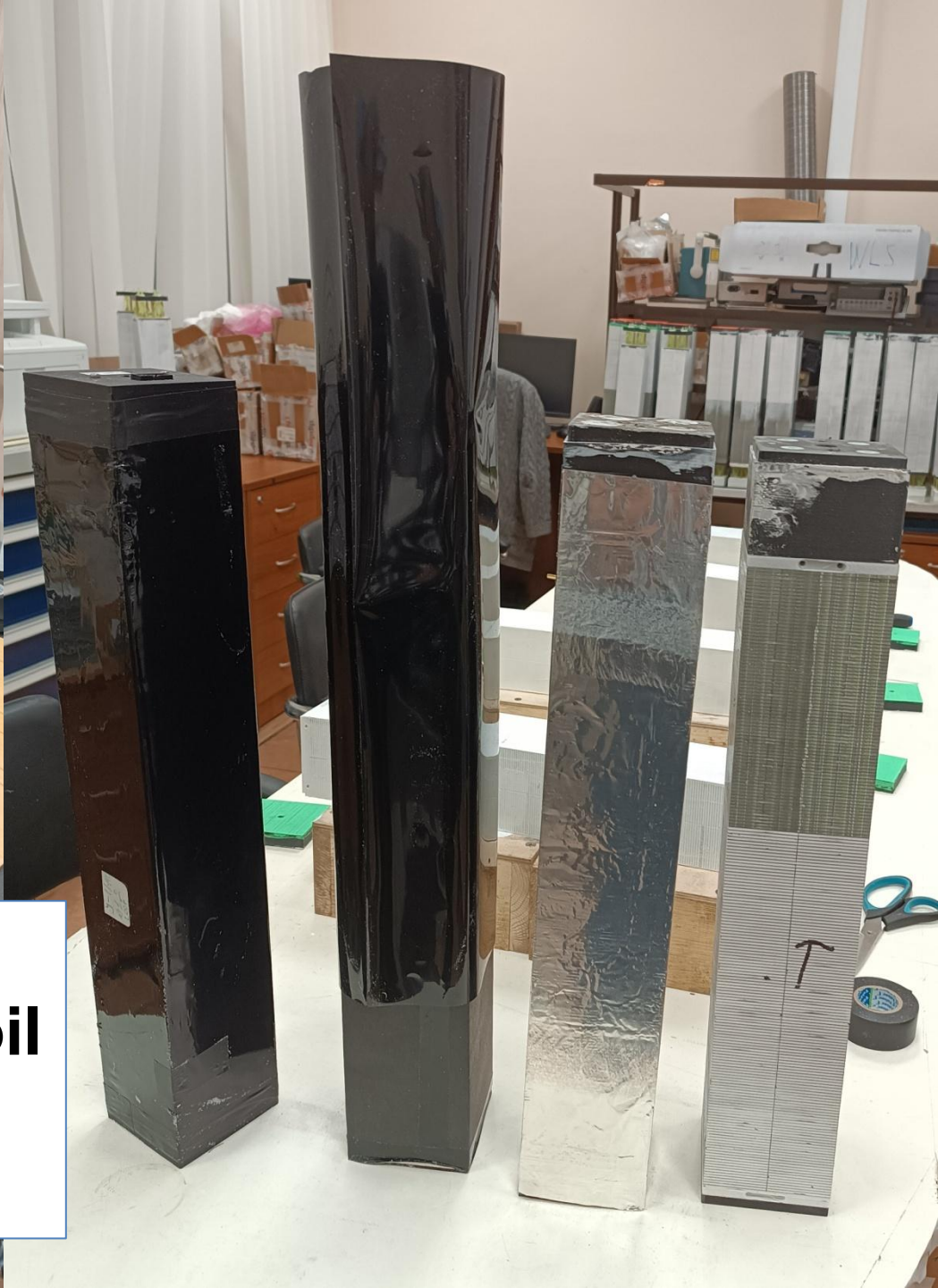
Each module contains 64 fibers. The WLS have U-shape installed in 32 U-shaped loops.

The fiber installation pattern provides a curvature diameter of approximately 30 mm





Finally, the modules are wrapped in aluminum foil and covered with heat-shrinkable black film.





WLS bundles are glued into modules in this modules position,

WLS Ends cutting was done on a milling machine.

Its take time ~1 min/mod.

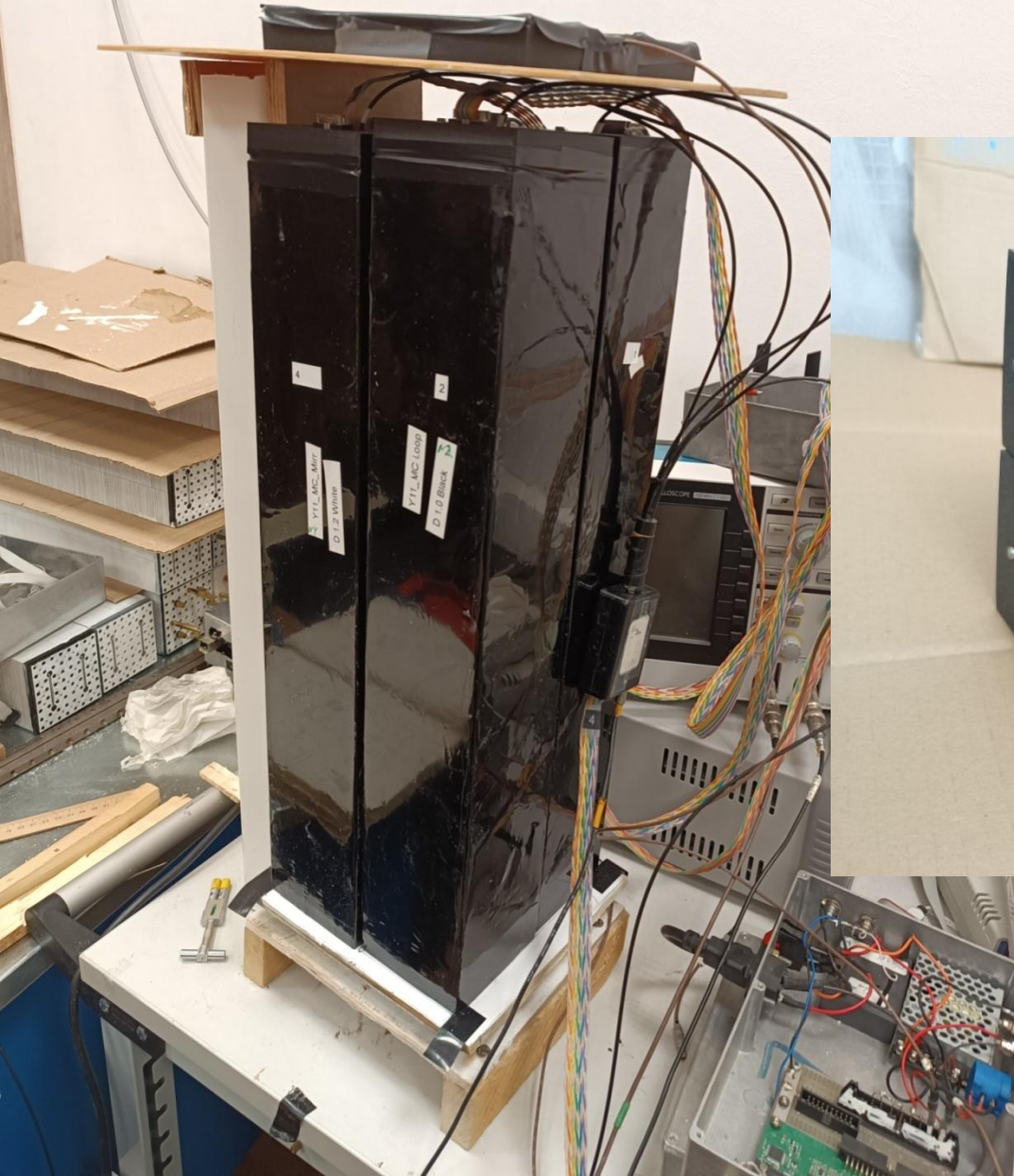
After assembly, the modules are transported to storage.



**NICA SPD clean room in Hall 17.
To store ECAL modules.**

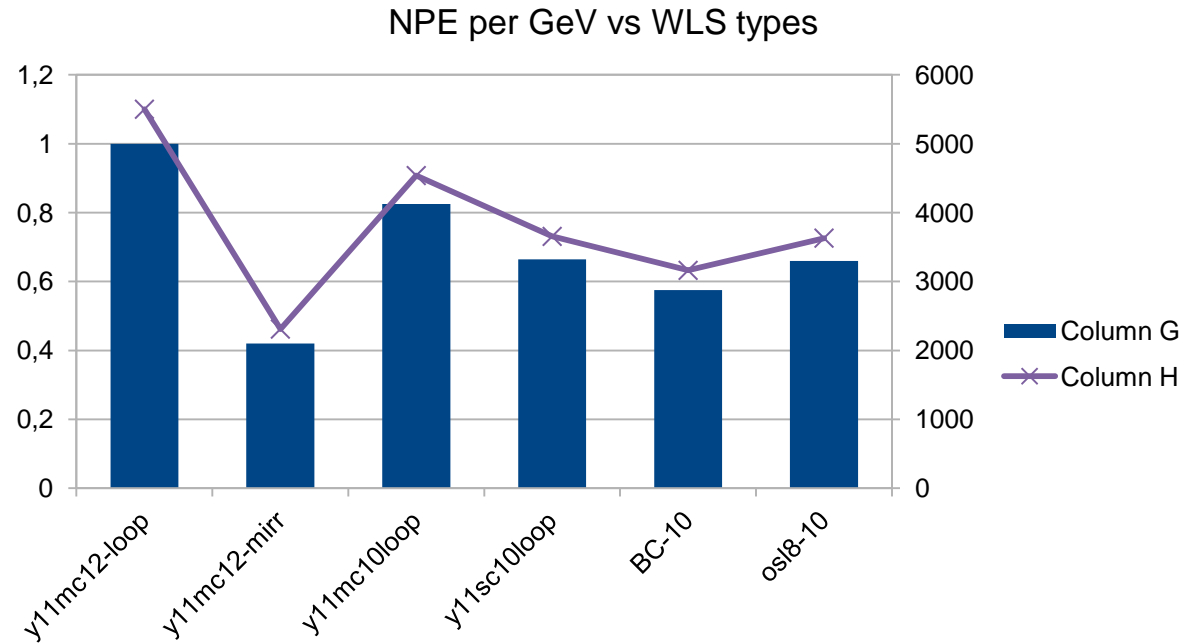


1. Test in Cosmic beam
2. MIP – position in cells
3. NPE per MIP
4. NPE per GeV



**4 Modules setup
16 cell 40x40 mm².**

1. Test in Cosmic beam
2. MIP – position in cel
3. NPE per MIP
4. NPE per GeV



NPE per GeV vs WLS Types, normalized to Y11-MC-1.2 mm

1. Y11-MC-1.2 mm – Loop SPD
2. Y11-MC-1.2 mm – Mirror, Silver Shine – COMPASS (20 Year old)
3. Y11-MC-1.0 mm – Loop SPD
4. Y11-SC-1.0 mm – Loop SPD
5. BC-MC-1.0 mm – Loop SPD
6. OSL8-SC-1.0 – Loop SPD

- 1. Scintillated tiles production in Vladimir, UNIPLAST:**
- 2. Lead absorber plates production in Vladimir , MARAL:**
- 3. Modules assembling in LHEP JINR:**
 - 1. 500 – JINR VBLHE – 2025 – assembled as Lead-Scintillator stacks.**
 - 2. ~250 Modules arranged with WLS .**
 - 3. Assembly last 500 modules will be completed in 2026-2027**

End of Report

Thanks for attention to *All*