

SPD ECAL status 2022

- 1. ECAL position inside of Cryostat
- 2. ECAL Support inside of Cryostat
- 3. End-Cap Module design cell sizes $55x55 \text{ mm}^2$ and $40x40 \text{ mm}^2$
- 4. Test results with SiPm **S14160-6015** and **EQR15-60**

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ECAL position (green) in the Cryostat (yellow), PID (magenta) and RS (red) EC-support (blue)

ECAL **Barrel** is located inside of **Cryostat** and Range System **(RS)**, as shown by green hatched boxes.

ECAL **End Cups** are located inside of RS

The calorimeter sizes determine by :

- Thickness itself;
- Criostat diameter;
- Outer size of PID.

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ECAL Barrel 3D View



ECAL Barrel composition



Concept:

- 1. Barrel consist from 9 Rings
- 2. One Ring divided on 24 sectors
- 3. Sector connected to One ADC_64
- 4. Air cooling assumed
- 5. Cables can fixed along the sector
- 6. Ring : 1536 cells, ~4.0 t
- 7. 9 Rings: 13824 cells, ~44 t

FrontEnd Numbers:

Channels:	13824
ADCs :	216
Frontend cards :	864
HV units:	10
wer (kW):	
ADC :	4.8
Frontend cards :	1.0
HV:	1.1
Total:	~7.0
	Channels: ADCs : Frontend cards : HV units: wer (kW): ADC : Frontend cards : HV: Total:

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Barrel ECAL mounting inside of the cryostat



Concept:

- 1. Rails welded to Cryostat inner side
- 2. Roller fixed on the ECALs ring
- 3. ECAL ring is rolled into the cryostat

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ECAL End Cup composition



ECAL 3D view

End Cup mounted in Supported Frame.

The Frame is installed in Range System, as supported base.

Central hole is equal 320x320 mm².

This hole size is equal of 16 modules of $80x80 \text{ mm}^2$ (matrix 4x4).



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25 ECAL modules with cell size 55x55 mm² were manufactured in 2021-2022



ECAL composition:

- Modules consist from 4 cells 55x55 mm²
- 36 WLS fiber 1 mm in dimeter Kuraray Y11(200) used for each cell
- 200 layers: 1.5 mm and 0.5 mm Scintillators an Lead correspondently, $\sim 17X_0$
- Moliere Radius is about 58 mm
- Energy resolution at 1 GeV electron is about 5% accoding to MC for E=50 MeV-10 GeV

Back module view: 4 WLS bundles of 36 fibers (1 mm diam) fitted to 4 SiPm of 6x6 mm²



Front module view: 36 WLS fiber with U-shape End



ECAL Energy resolution depended from Sampling Fraction value as: 180 layers: 1.5 mm and 0.5 mm Scintillators an Lead correspondently, ~17X₀, **B~ 5%**. 180 layers: 1.5 mm and 0.8 mm Scintillators an Lead correspondently, ~25X₀, **B~ 6%**.



ECAL Moliere Radius depended from absorber and scintillator thickness. For 1.5 mm Polystyrene Scintillator + 0.5 mm Lead Absorber – X=0.25, Rm~58 mm For 1.5 mm Polystyrene Scintillator + 0.8 mm Lead Absorber – X=0.34, Rm~45 mm Simulation studies of the Moliere radius for em calorimeter materials O.P. Gavrishchuk (1), V.E. Kovtun (2), T.V. Malykhina (2) ((1) Joint Institute for Nuclear Research, Dubna, Moscow Region, Russia (2) V.N. Karazin Kharkiv National University, Kharkiv, Ukraine)

https://arxiv.org/abs/2112.07215



ECAL Energy resolution for electrons detail described in:

https://doi.org/10.26565/2312-4334-2020-3-09

SIMULATION STUDY OF ENERGY RESOLUTION OF THE ELECTROMAGNETIC SHASHLYK CALORIMETER FOR DIFFERENT OF LAYERS AND ABSORBER COMBINATIONS

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$$\frac{\sigma_E}{E} = \frac{(2.74 \pm 0.05)\%}{\sqrt{E}} \oplus (1.96 \pm 0.1)\%$$

In ideality E resolutin can be reached as:

The energy leak for such calorimeters type is detail described in : <u>https://doi.org/10.46813/2021-133-076</u> EFFECT OF ENERGY LEAKAGE ON THE ENERGY RESOLUTION OF E.M. SAMPLING CALORIMETERS

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The Energy resolution (1 GeV electron) estimated as 5% for SPD ECAL with: 200 layers: 1.5 mm and 0.5 mm Scintillator and Lead correspondently, $\sim 17X_{0 \text{ and}}$ Moliere Radius is about 58 mm

ECAL module test in cosmic

- New SiPm S14160-6015 (Hamamatsu) and EQR15-60 (China)
- Pitch size 15 microns
- Sensitive area 6x6 mm²
- Pixels Number 160.000
- PDE ~ 30 %
- Operation Overvoltage ~ dU=3-4 V:
 - Darc Curent ~ 400 nA
 - Temperature Sensitivity (dA/dT) ~1.5%

S14160-6015 Dark Current

EQR15-60 Dark Current



S14160-6015 and **EQR15-60** Break Point vs Temperature



S14160-6015 Temperature Stability vs Overvoltage







ECAL setup for cosmic tests:

- New SiPm S14160-6015 emd EQR15-60
- Performed the matrix of 2x2 modules
- Module consist from 4 of 55x55 mm² cells
- 16 Cells matrix setup used for this test
- Sampling :
- - 190 layers;
- 1.5 mm Sc + 0.5 mm Pb.
- ECAL properties:
- X₀=17,6 rad. length;
- $-\mathbf{R}_{M}^{'} = 58 \text{ mm};$
 - L =500 mm total module length

MIP peak for ECAL's 16 cells with S14160-6015 SiPm Green color corresponded to central cells.



MIP peak for ECAL's 16 cells with EQR15-60 SiPm Green color corresponded to central cells.



a) MIP peak for 16 cells - E resolution equal to 9% for S14160-5015
b) MIP peak for 16 cells - E resolution equal to 9.51% for EQR15-60



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ECAL Front END Units

ECAL channels Numbers for:

- Barrel = 16,896 ch
- 2 EndCup = 5,760 ch
- Totally = 22,656 ch

For this channels Numbers should be supplied of:

- 1. SiPm board -1416 pc.
- 2. 16 ch Amplifier Card -1416 pc.
- 3. Power unit for Amp. Cards -32 pc.
- 4. ADCE-64 Digitizer 264+90 354 pc.
 - for Barrel +2 EndCups



Thanks everybody for attention !

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