CALIBRATION OF THE ECAL

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on behalf of the MPD/ECAL group

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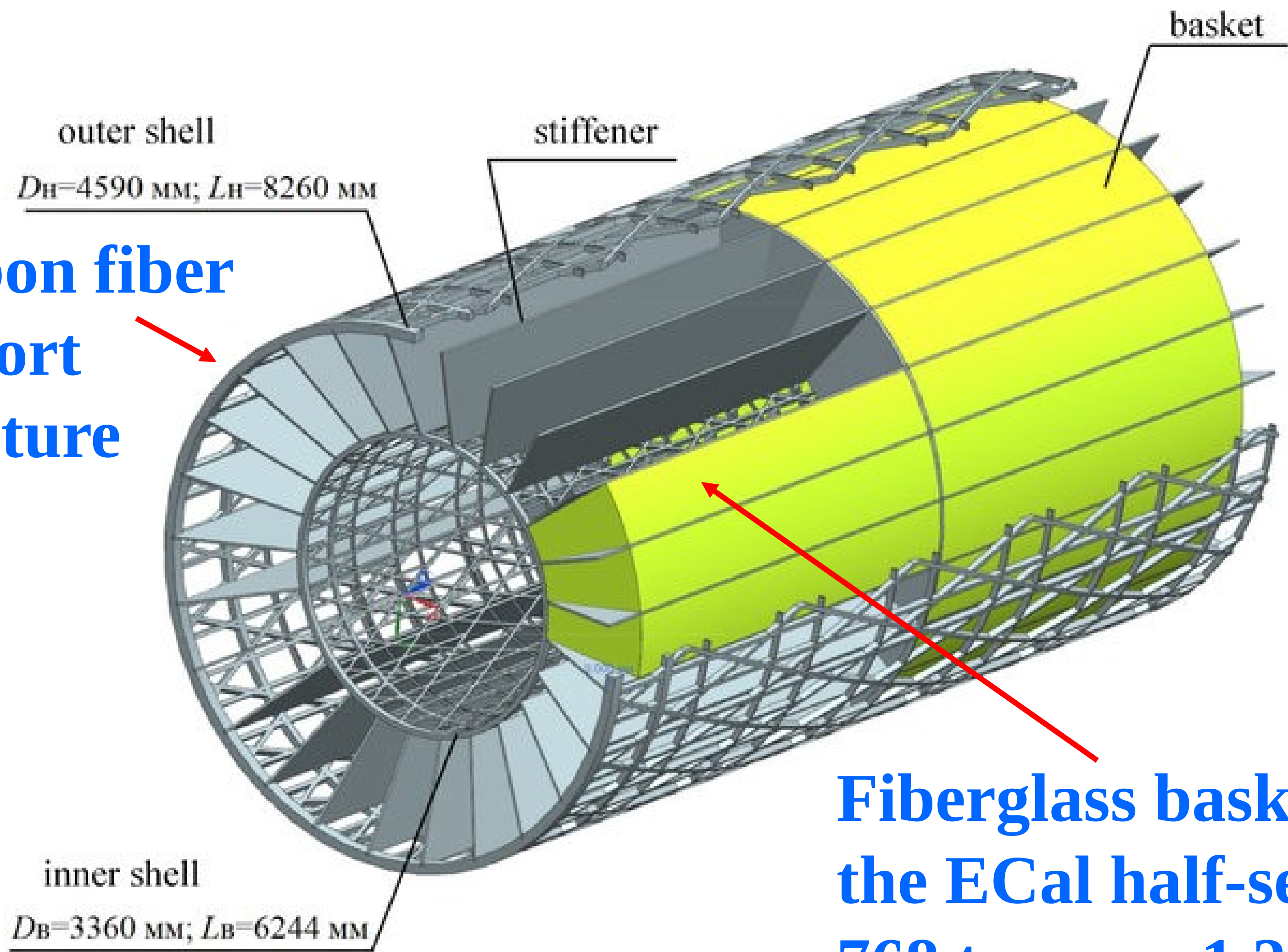
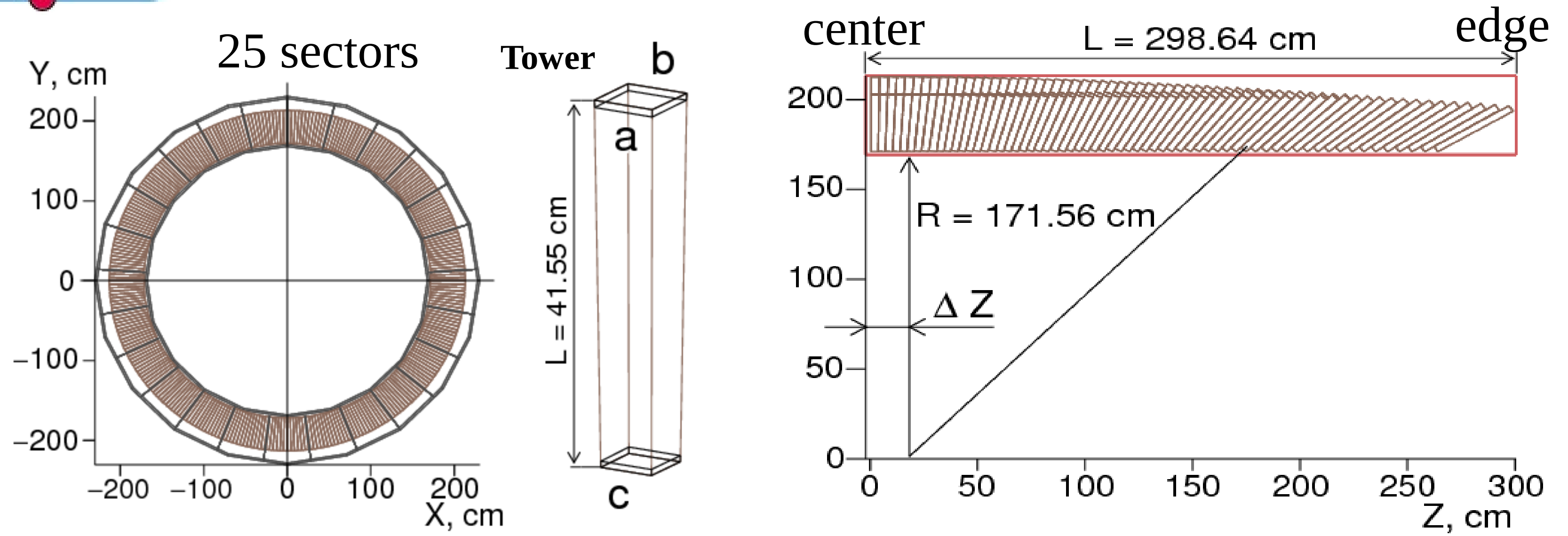
Artist's look at the ECal assembly

Carbon fiber support structure



Fiberglass basket with the ECal half-sector
768 towers, 1.2 tons

ECal half-sector structure



Approximate shape of the tower is truncated pyramid with the base of 40x40 mm^2 at center and the values of a,b,c are different for each tower. Towers are arranged in projective geometry. It needs 64 different types of towers.

The half-sector contains 768 towers, grouped in 12 rows of 64 each.

The half-sector is equipped with 12 ADC64s2 boards with self-trigger capability. Each board operates as a stand-alone devise that detects charged particles passing through the towers and transmits the data to the main computer.

ECal calibration problems with cosmic muons

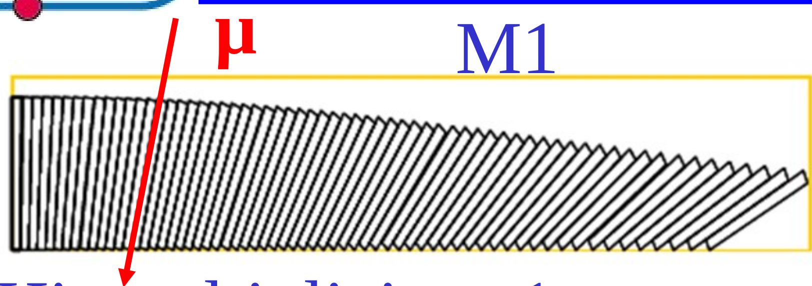
- ✓ **Calibration is needed to relate the response of the tower (in ADC units) to energy deposition in the SC in MeV.**

- ✓ **Cosmic muons are widely used for calorimeter calibrations in HEP. Problems arise when transversal sizes of the towers are small and calibration in vertical position with muons running along tower axis is extremely time consuming and technically complex. A typical way to avoid this problem is to calibrate towers in horizontal position based on tower thickness. Previously many collaborations used this way but for the box-type towers only. These are L3, ATIC, VES and others.**

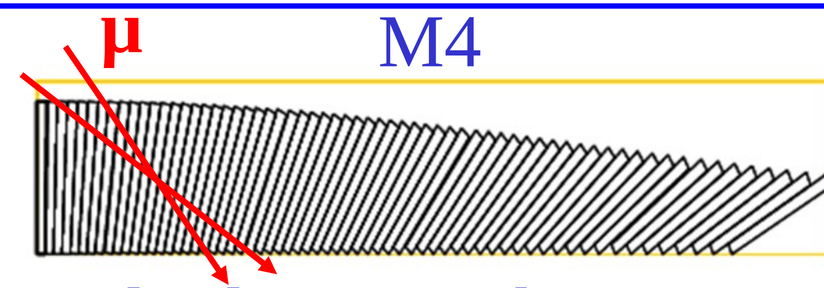
- ✓ **For ECal/MPD situation is more complicated, since we have to calibrate half-sector where towers of 64 different shapes are located and their orientation in space is different.**

- ✓ **The purpose of this report to show that calibrating ECal with cosmic muons is nevertheless possible. It will be done by MC simulation and the first half-sector test measurement.**

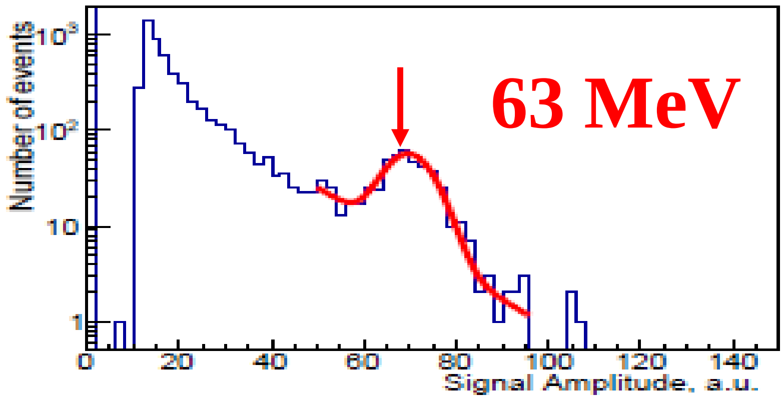
Methods of ECAL Calibration with CR muons

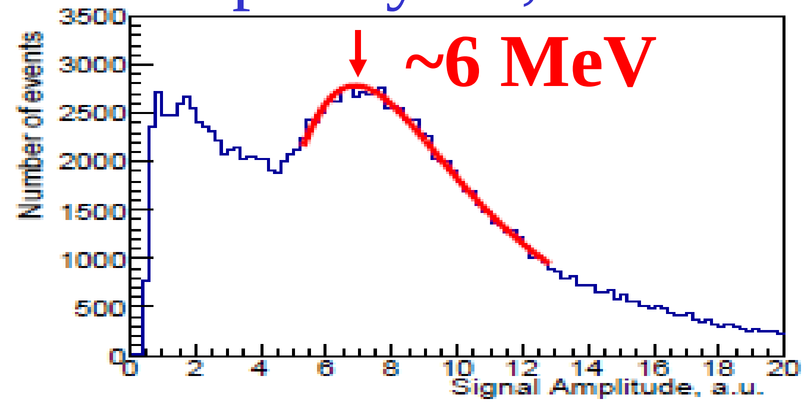


Hit multiplicity =1



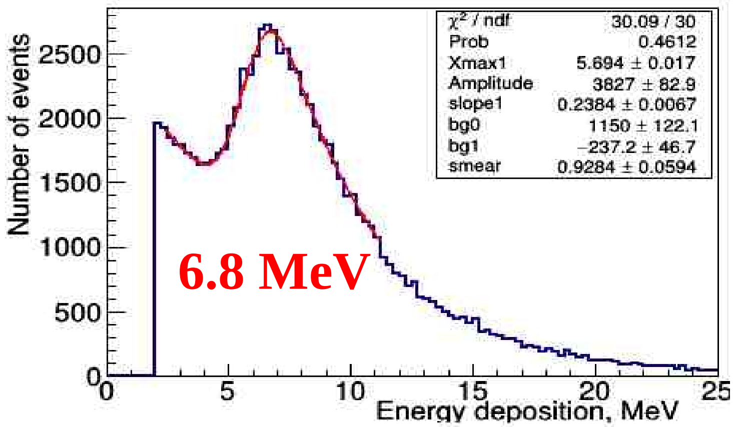
Hit multiplicity >1, here M>=4

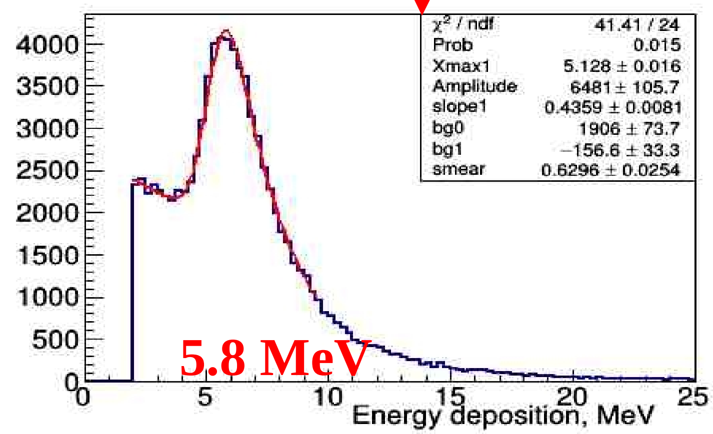


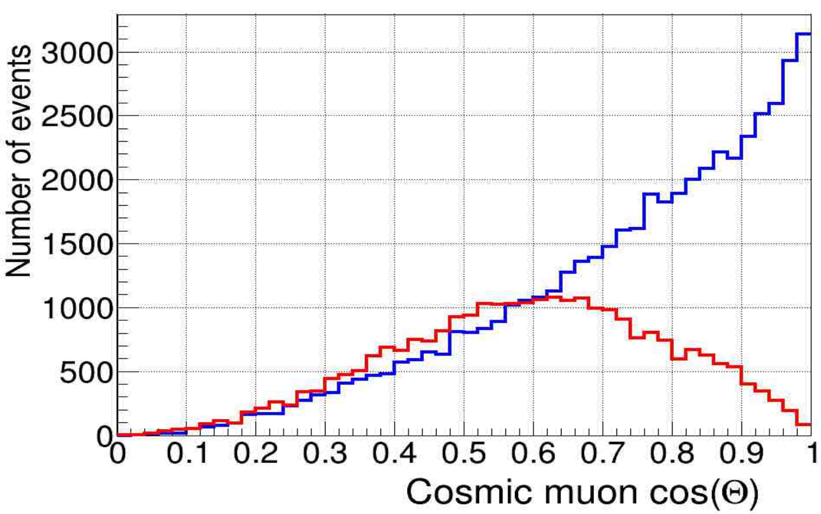


Fixed at 31.5 cm	**Track length in Sc**	**Wide range**
Fixed at 63 MeV	**Energy deposition**	**5-7 MeV(at the peak maximum)**
Close to vertical only	**Tower orientation**	**Any but needs MC corrections**
Large (few days)	**Data taking time**	**Small (few hours)**
Large as 10 MeV	**Data taking threshold**	**2-4 MeV (noise <0.3 MeV)**
High	**SiPM noise sensitivity**	**No, because of coincidences**

MC: hit multiplicity cut >= 4

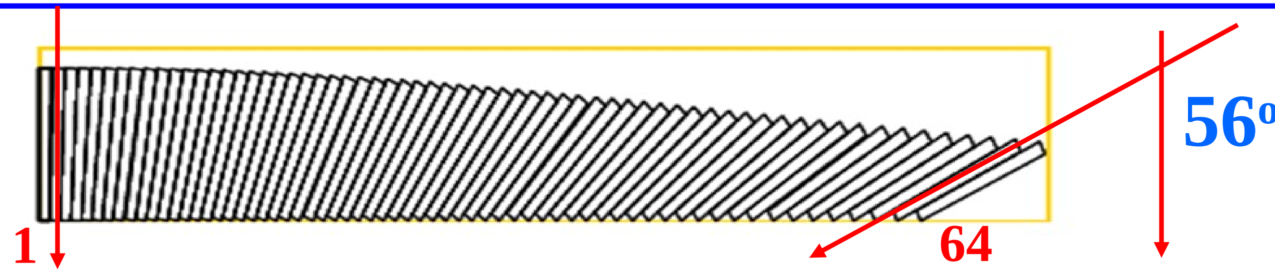


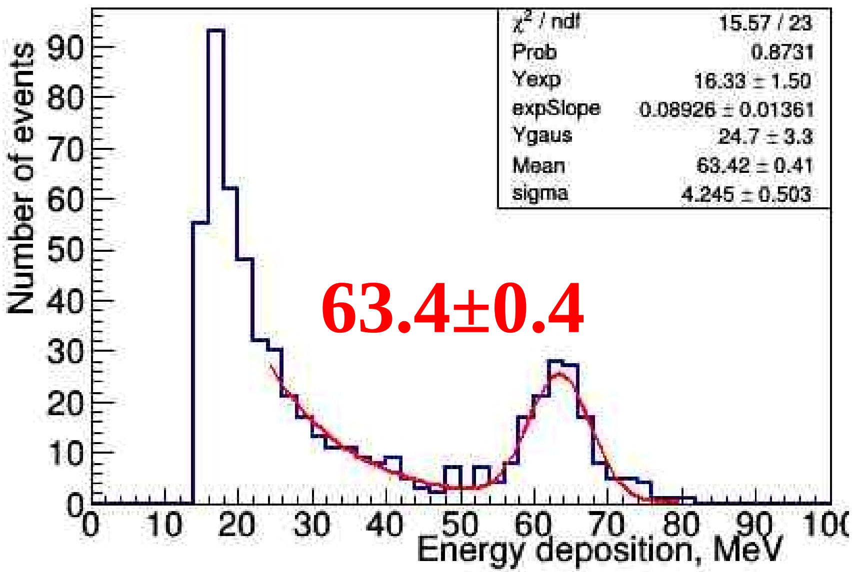


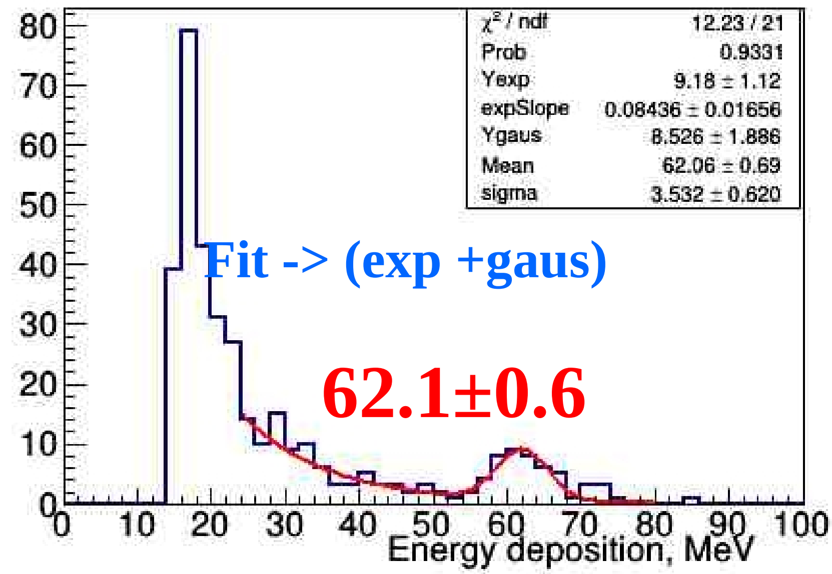


FitFunc(x) = A + B*(x-a) for x<a
FitFunc(x) = C*exp(-β*(x-a)) for x>a
smeared by gaus distribution with σ.
6 free parameters.
Advantage of M4 selection is that it can be used for any tower orientation,

MC: hit multiplicity == 1

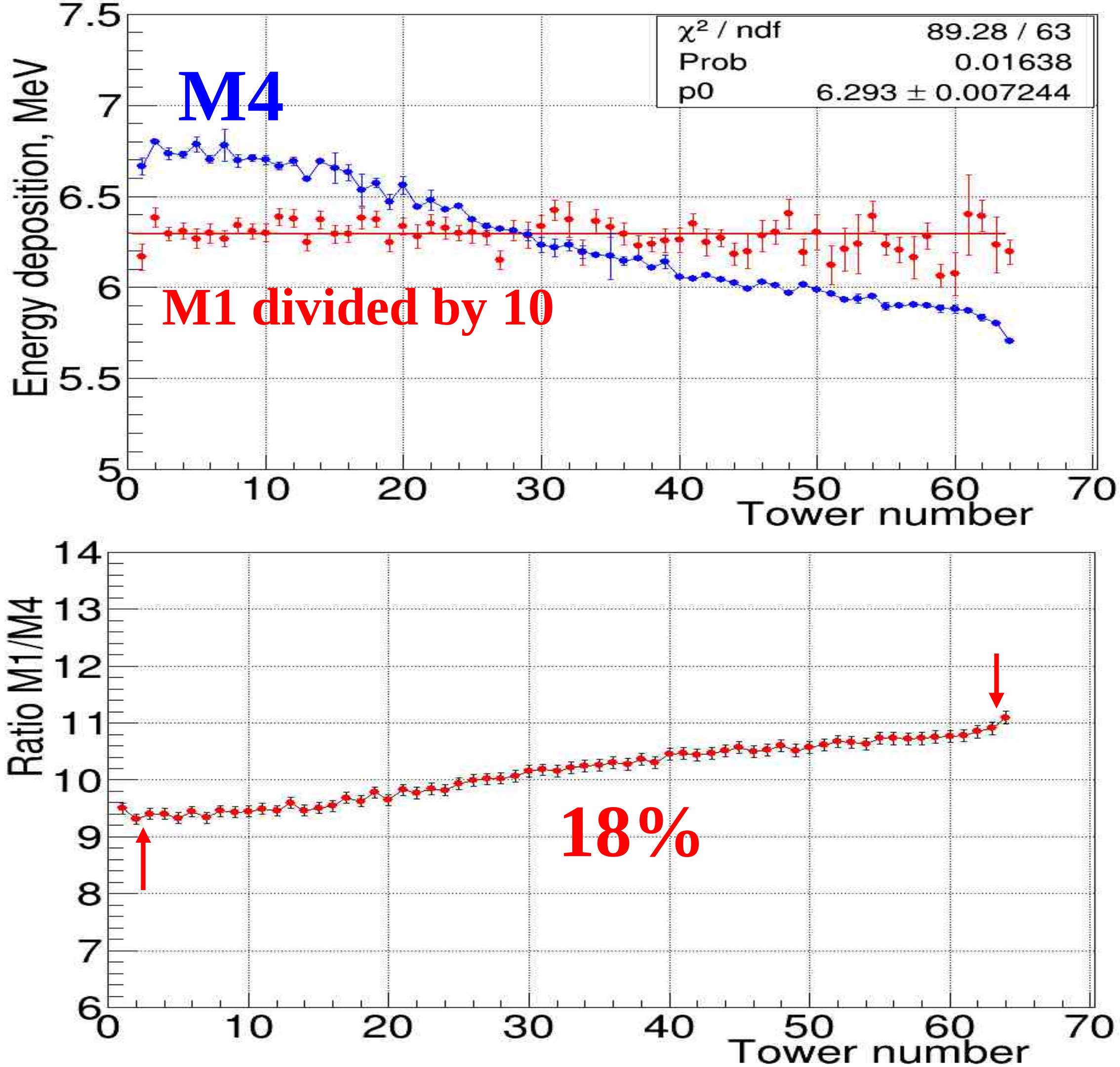






In accordance with angular dependence of CR (~cos²(θ)), the number of muons registered by towers at the edge is 3 times less than by the towers in the center. Main advantage of this calibration method is the fixed energy deposition of 63.0 MeV.

MC: comparison of M1 and M4 methods

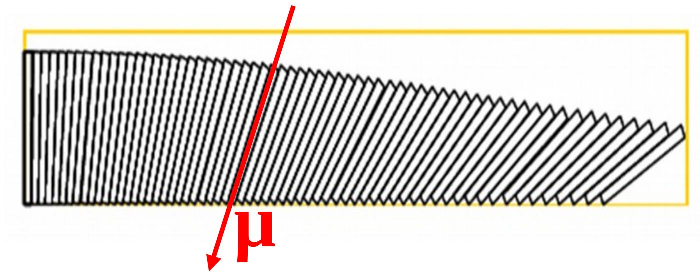


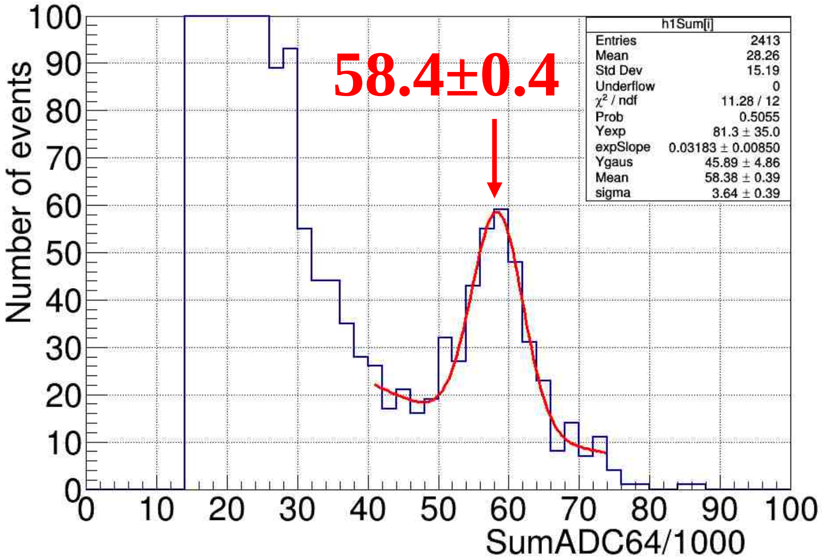
For **M1**, the averaged value of energy deposition in SC of the tower is independent of tower number and, as given by Geant4, is **62.93(7)** MeV. It is in perfect agreement with simple calculations: 210*0.15 = 31.5 cm and 1.936*1.032=1.998 MeV/cm that gives **62.93** MeV.

For M4, the position of the peak maximum depends on tower orientation. It is 6.8 MeV in central region and 5.8 MeV at the edge. This dependence can be used to normalize the calibration measurements.

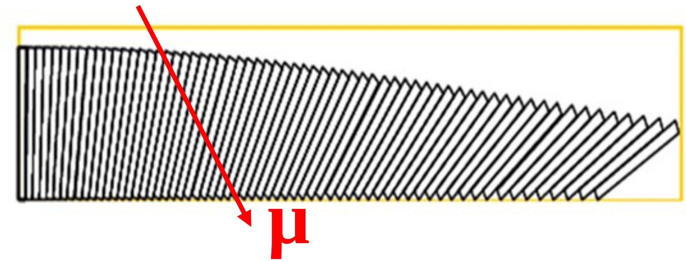
M1 and M4-8 event selections

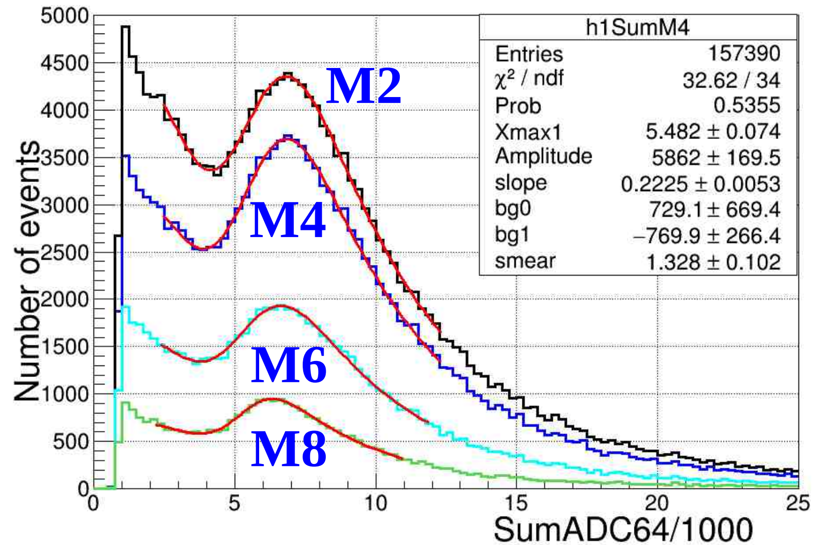
M1, 44 hours of data taking



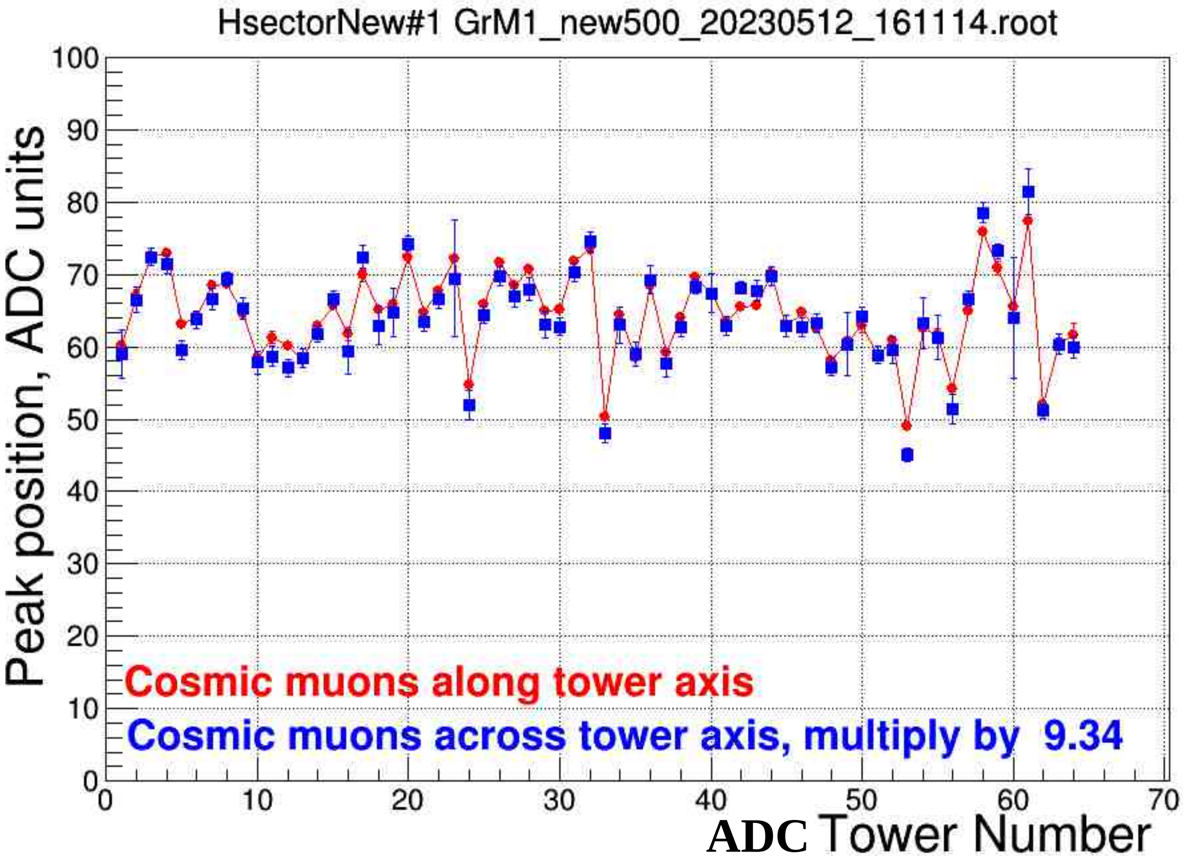


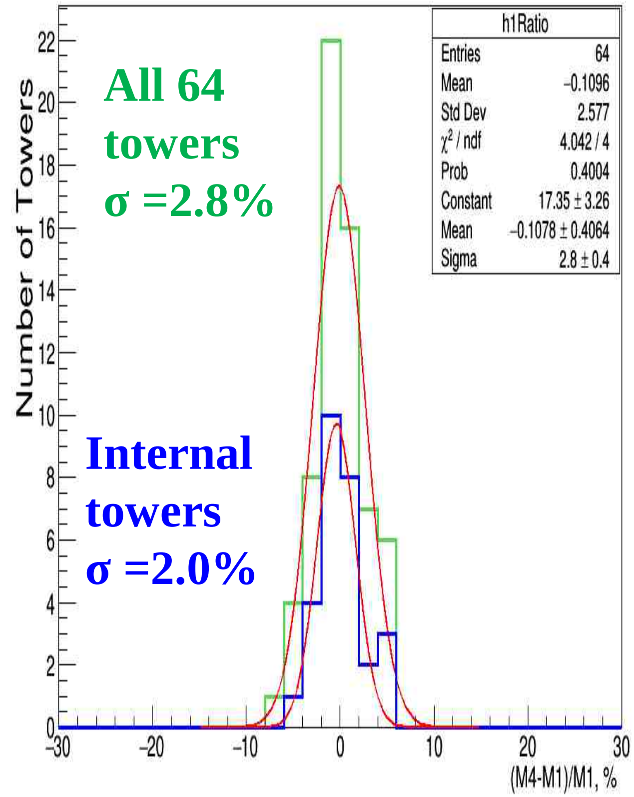
M4, 12 hours of data taking





Comparison M1 and M4 for ADC #1 (center)

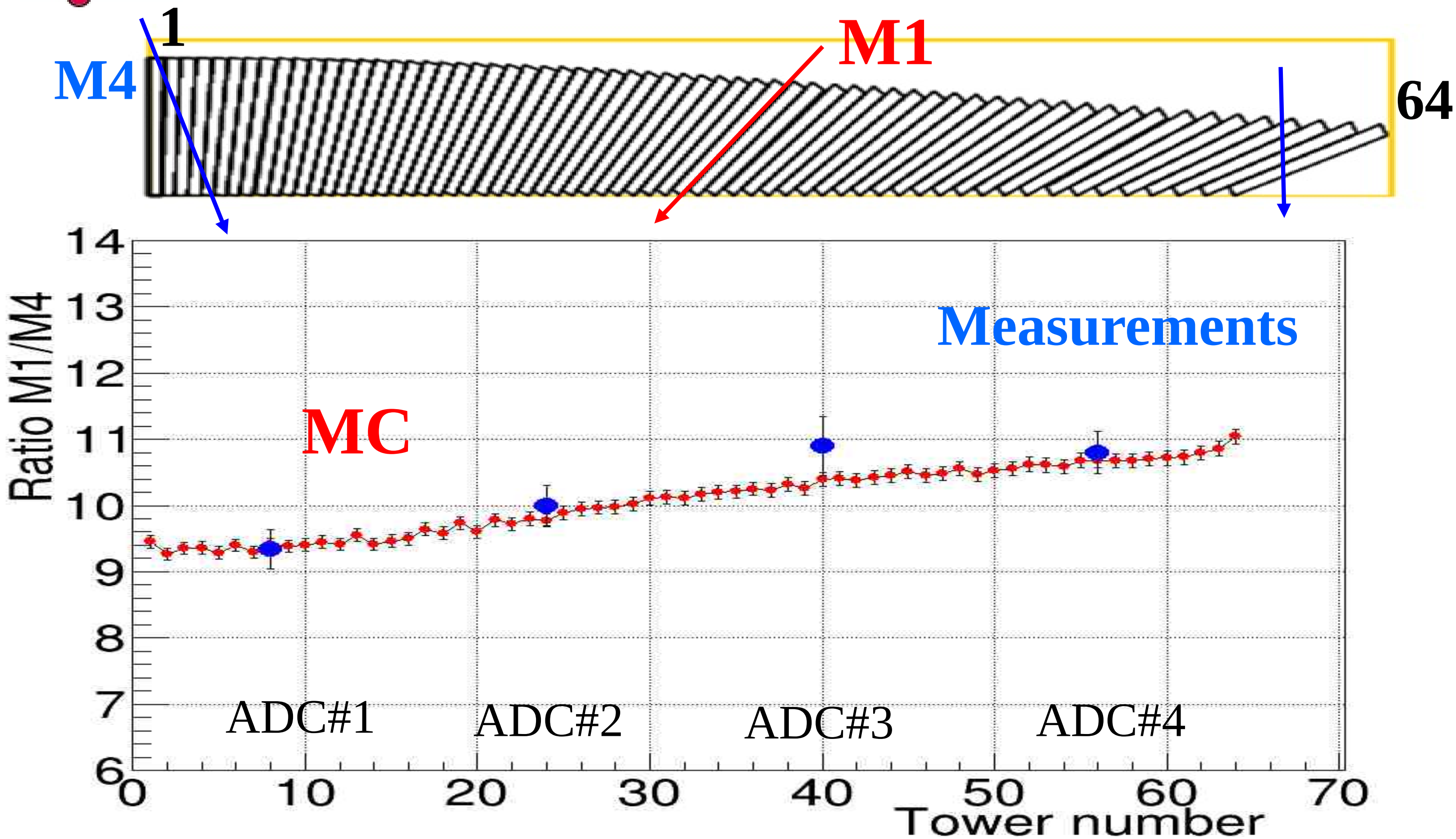




Good agreement between M1 and M4 multiplied by 9.34

Relative difference (M4-M1)/M1 in percent

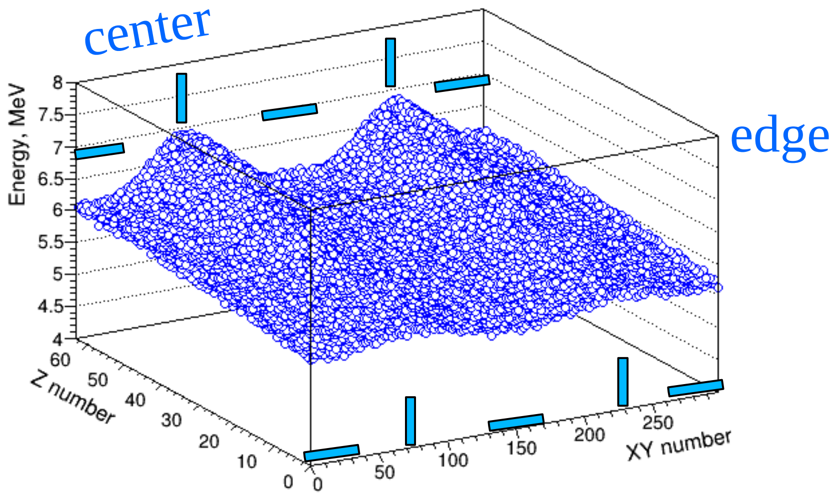
Comparison MC and measurements

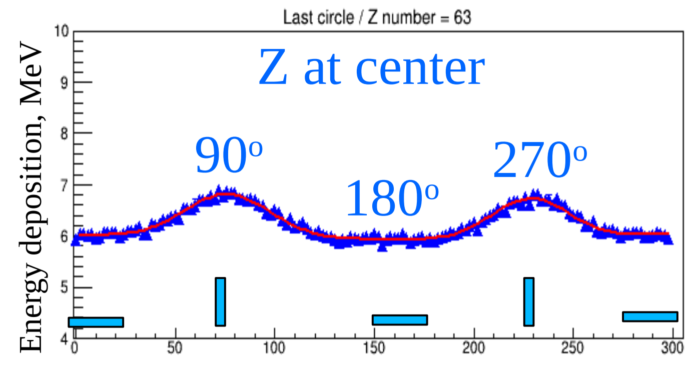


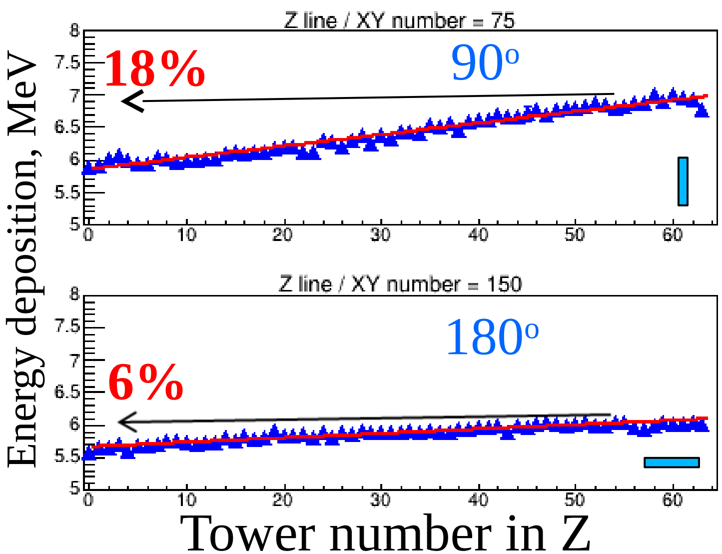
Ratio of energy deposition in a tower for muons going along tower axis to that of across for MC compared to the measurements. It demonstrate a good agreement.

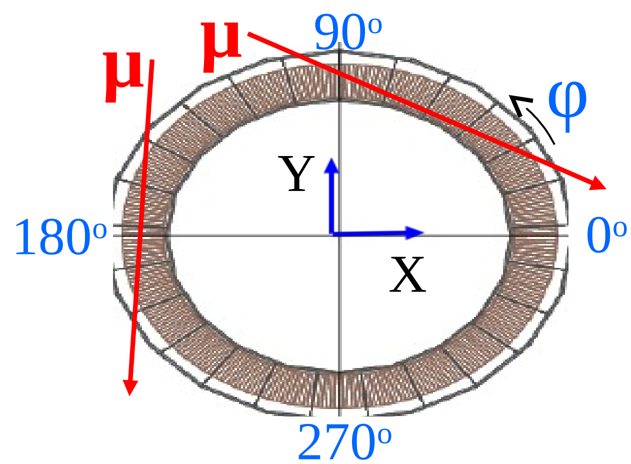
Whole ECal:MC:M4 method

Response of 19200 towers to cosmic muons









18% - due to different orientations and shapes of the tower,

6% - due to different shapes only.

Conclusions

- ✓ Two methods of ECal half-sector calibration with cosmic muons have been tested in measurements and MC.
- ✓ Both methods are based on the self-trigger mode of ECal electronics without the need for external detectors.
- ✓ The first is a traditional, with selected muons passing along the axis of the ECal tower. It takes few days of data taking to achieve acceptable accuracy.
- ✓ The second one is new. It uses muons that pass across the axes of the ECal towers and MC corrections on orientation of the towers. It is much faster than the first one. Both methods give compatible results.
- ✓ The second method is not sensitive to the orientation of the towers and can be used for the whole ECal of MPD detector.

Thank You