CREMLIN PLUS

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for Large-scale Research Infrastructures

Centrality determination at MPD with FHCal

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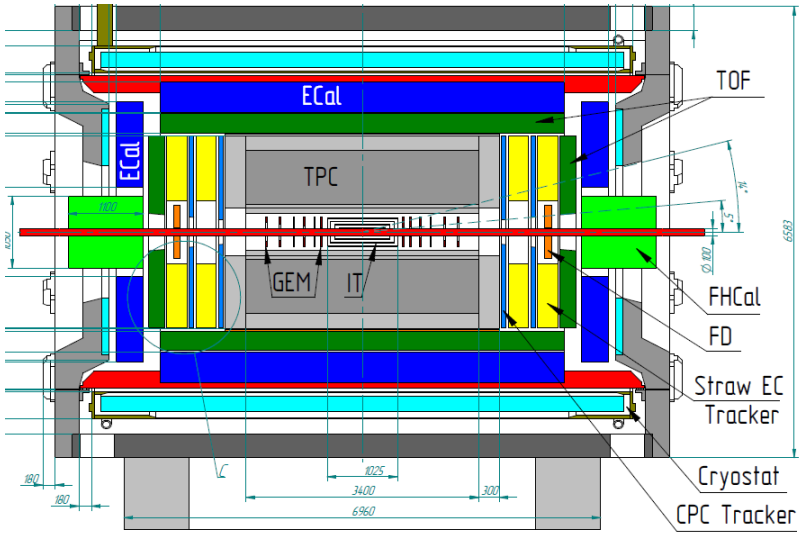
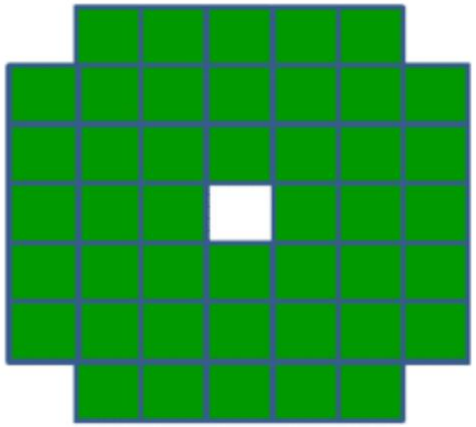
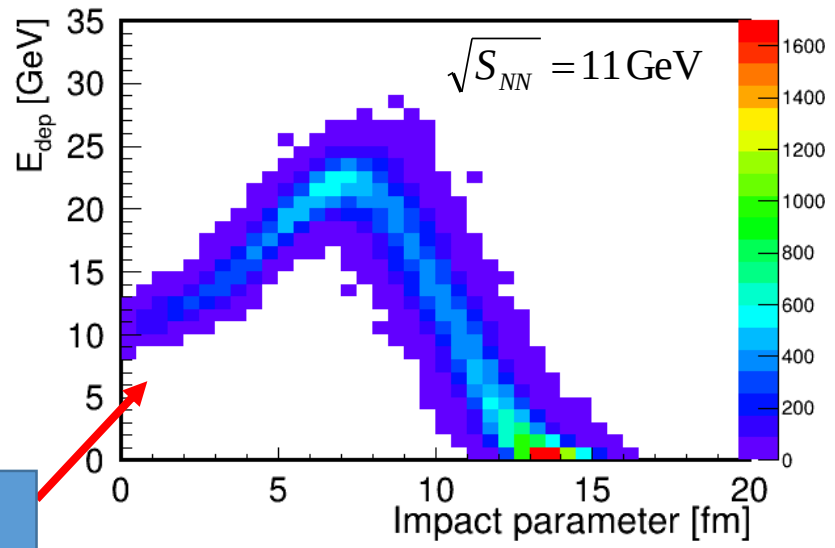
FHCal@MPD





- The main purpose of the FHCal is to provide an experimental measurement of a heavy-ion collision centrality (impact parameter) and orientation of its reaction plane.
- The main task is to resolve the ambiguity in the centrality determination

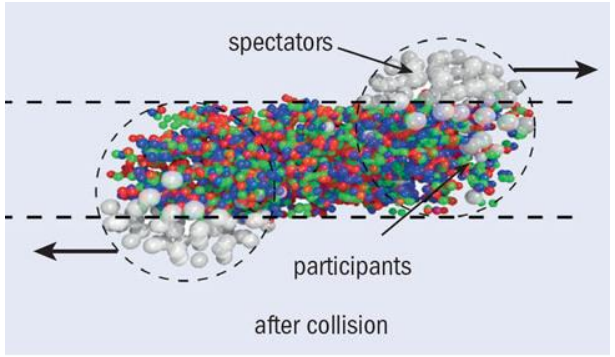


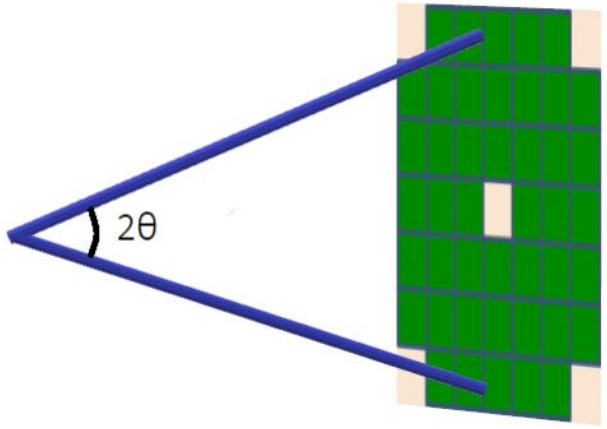
Non-spectator's contributions

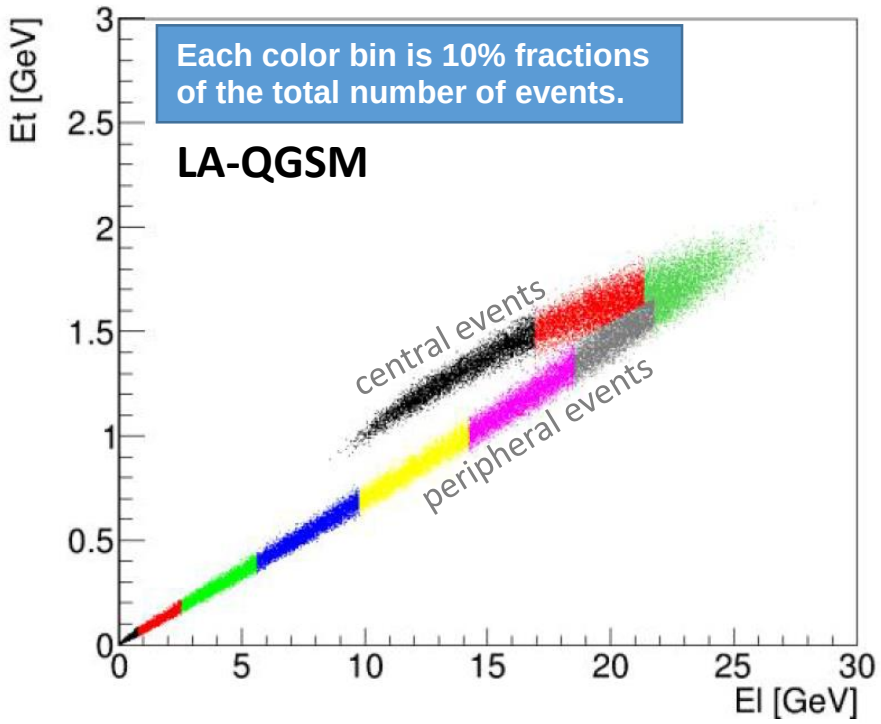
Correlation between transverse and longitudinal energies in FHCal

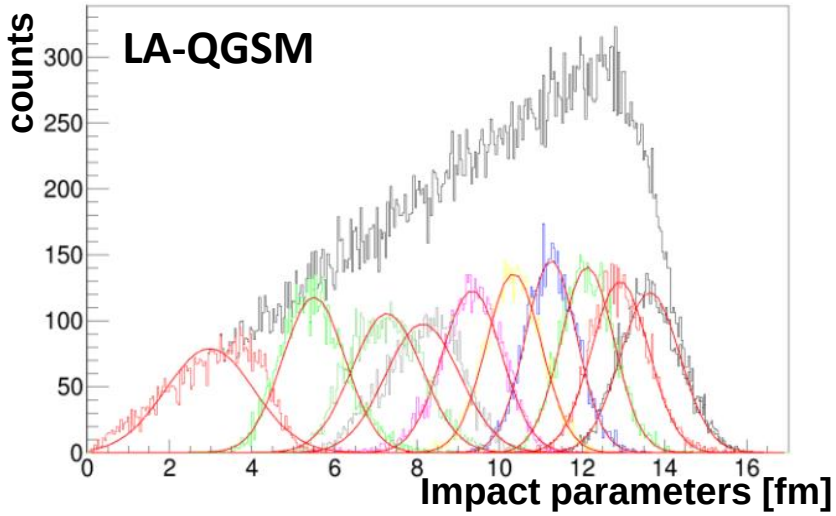
- LA-QGSM model for 11 GeV is used
- The **Et** and **El** energies are transverse and longitudinal energies respectively

$$\mathbf{E}_T = \sum E_i \, sin\theta_i, \; E_L = \sum E_i \, cos\theta_i$$

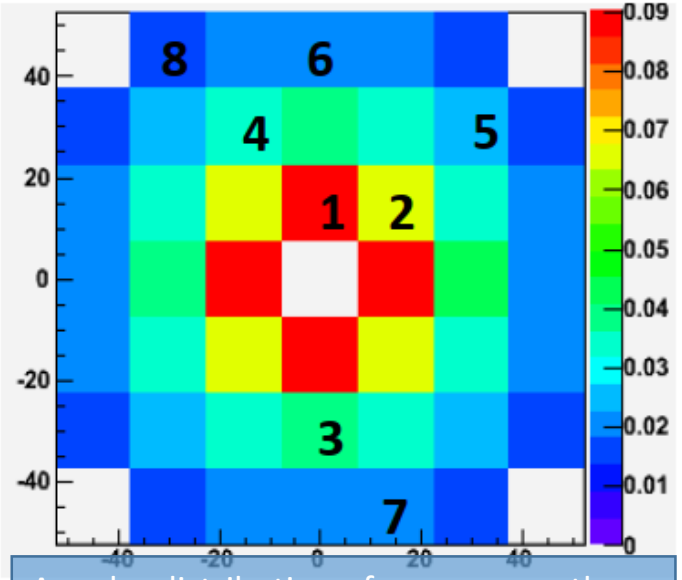




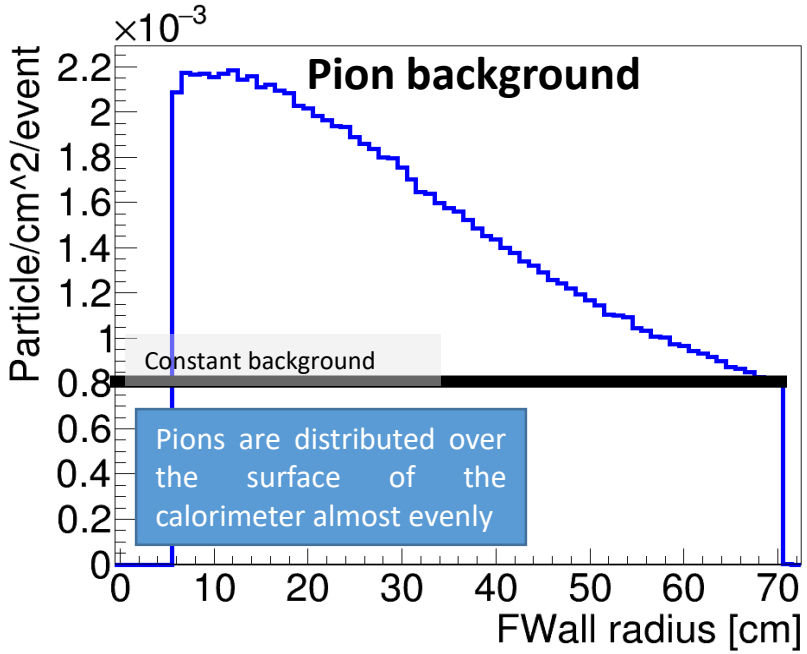


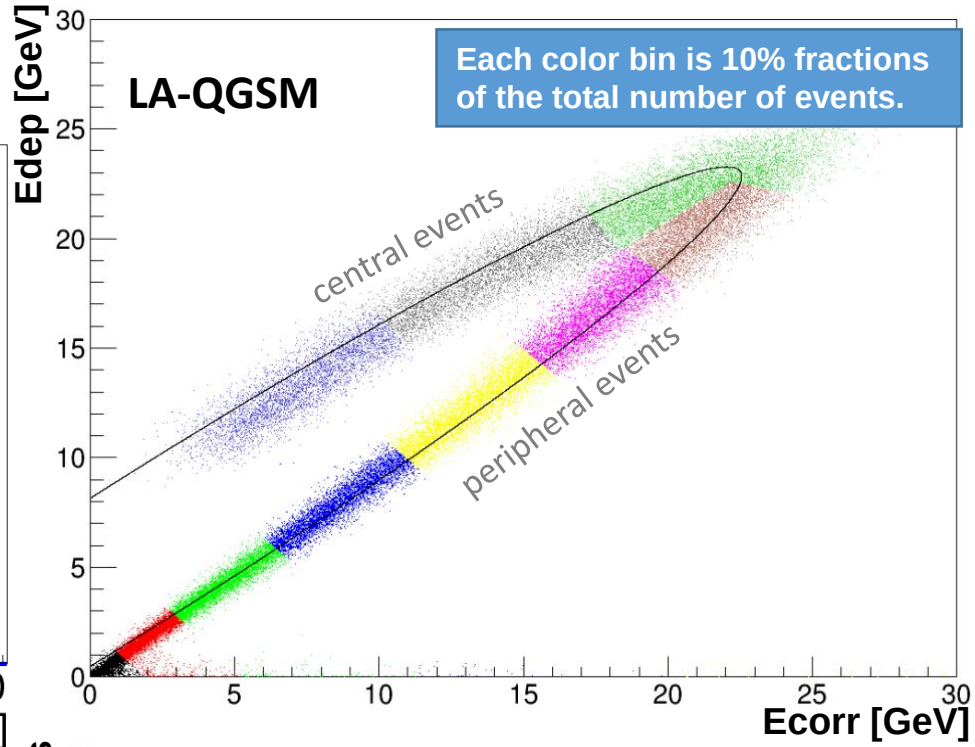


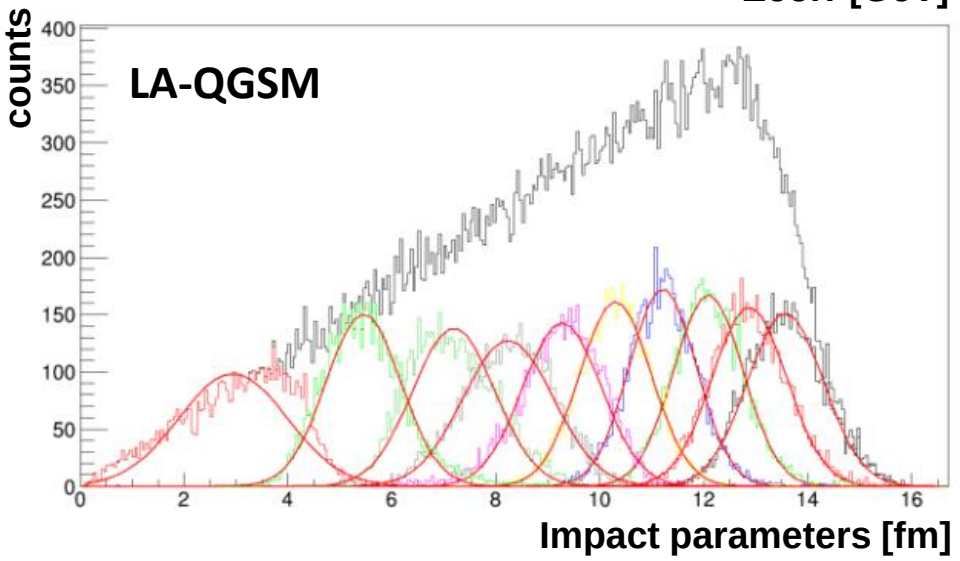
Correlation between deposited and background corrected energies



Angular distribution of energy over the transverse surface of the calorimeter

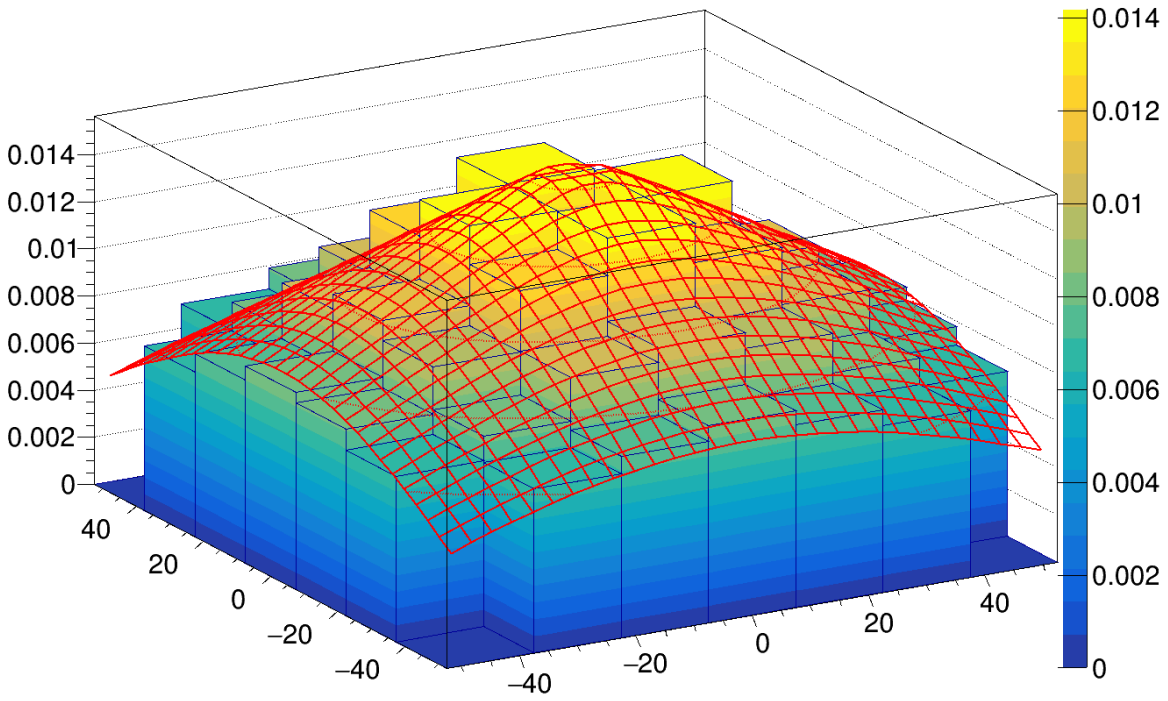






- To construct **Ecorr** (Ecalc), we use the assumption that the energy in the eighth group belongs to the pions
- The pion background is subtracted from the energy
- After pion background subtraction the exact number of spectators can be estimated

Correlation between deposited and background corrected energies – 2D fit



Average pion background fitted with cone

- It is possible to construct two-dimensional distribution of the pion background to subtract it from the initial data more accurate.
- Event by event pion background subtraction using 2D fit

This new method will be developed for MPD FHCal under the Cremlinplus grant.

Thank you for your attention!

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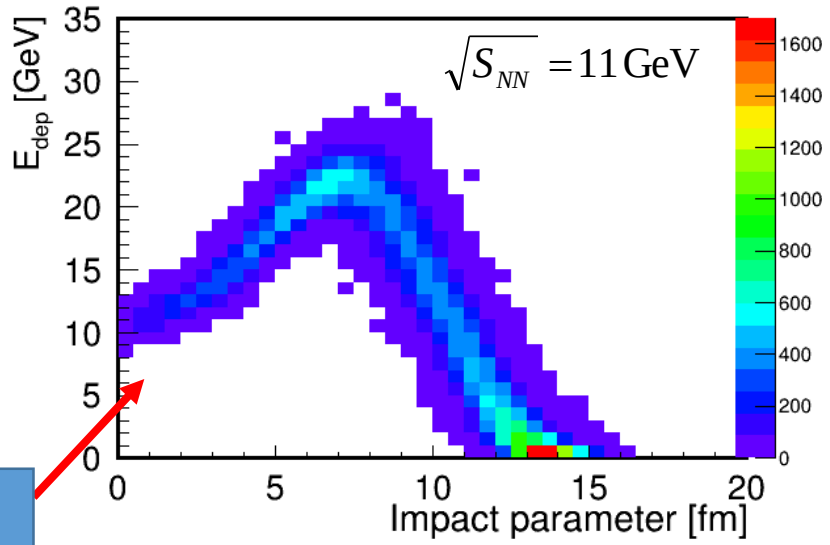
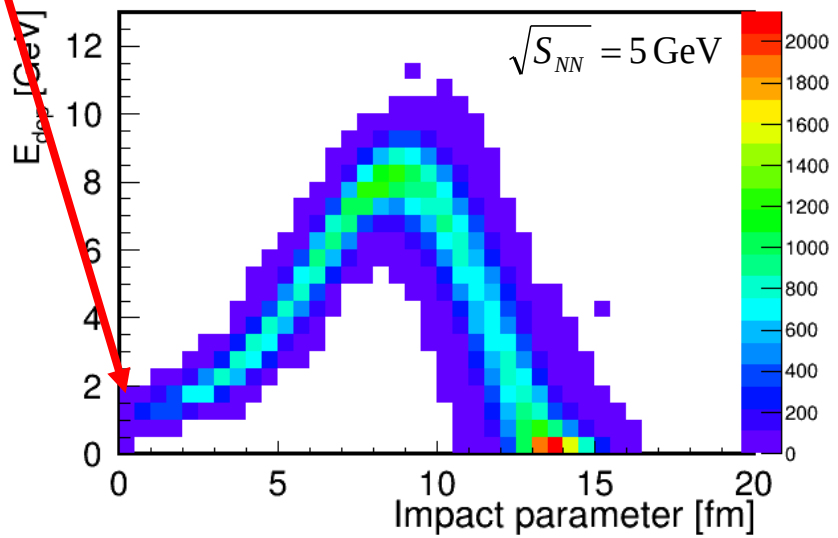
Energy depositions in FHCal



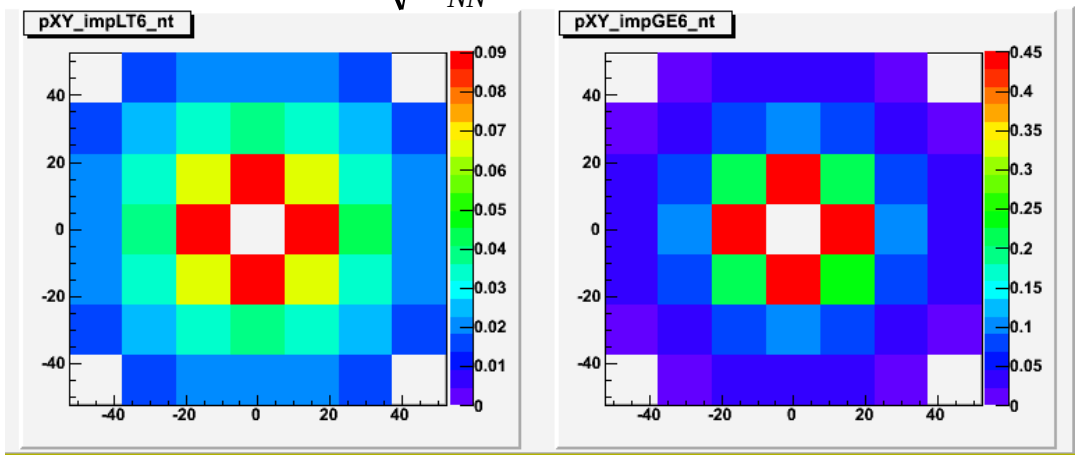
Non-spectator's contributions



- FHCal detects not only the spectators but also the produced particles and wounded nucleons from participant region.
- There is an ambiguity in FHCal energy deposition for central/peripheral events due to the fragments (bound spectators) leak into beam hole.

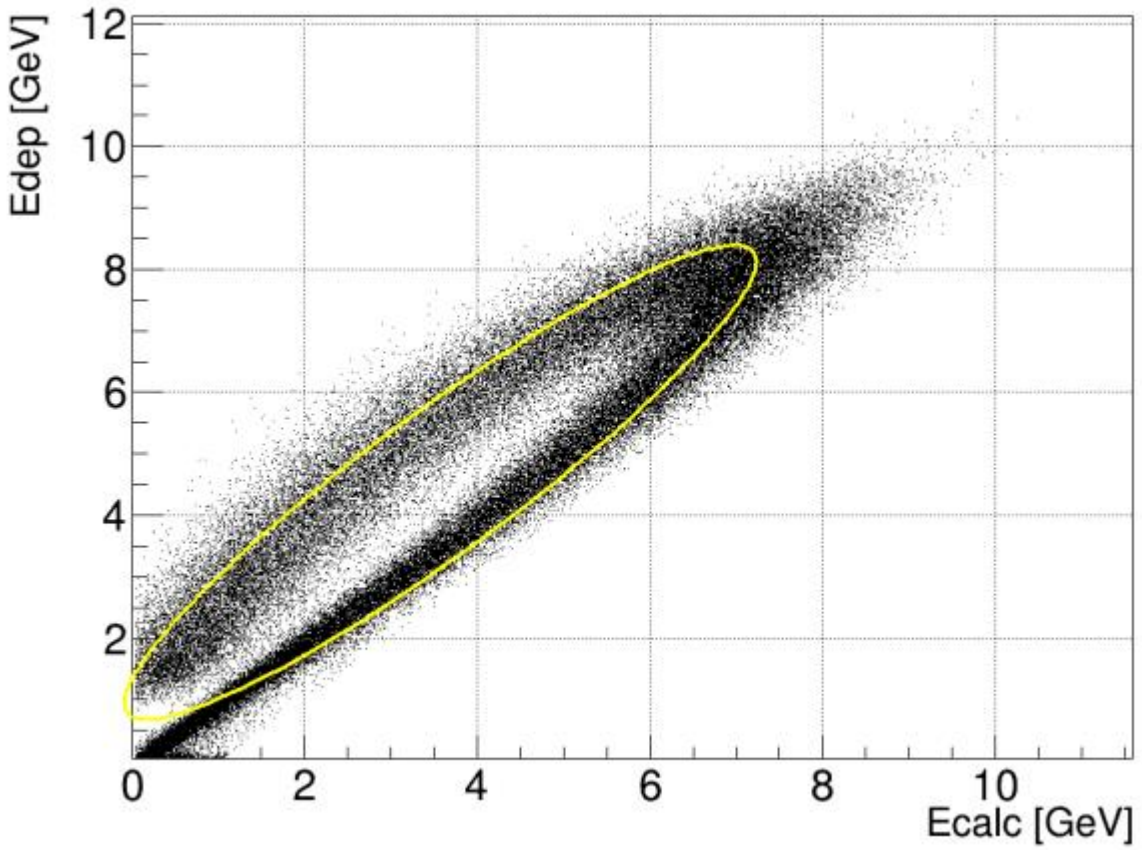
- Transverse energy distributions are wider for central events and narrower for the peripheral collisions.

$\sqrt{S_{NN}} = 11\,\mathrm{GeV}$



Impact parameter b< 6 Impact parameter b>6

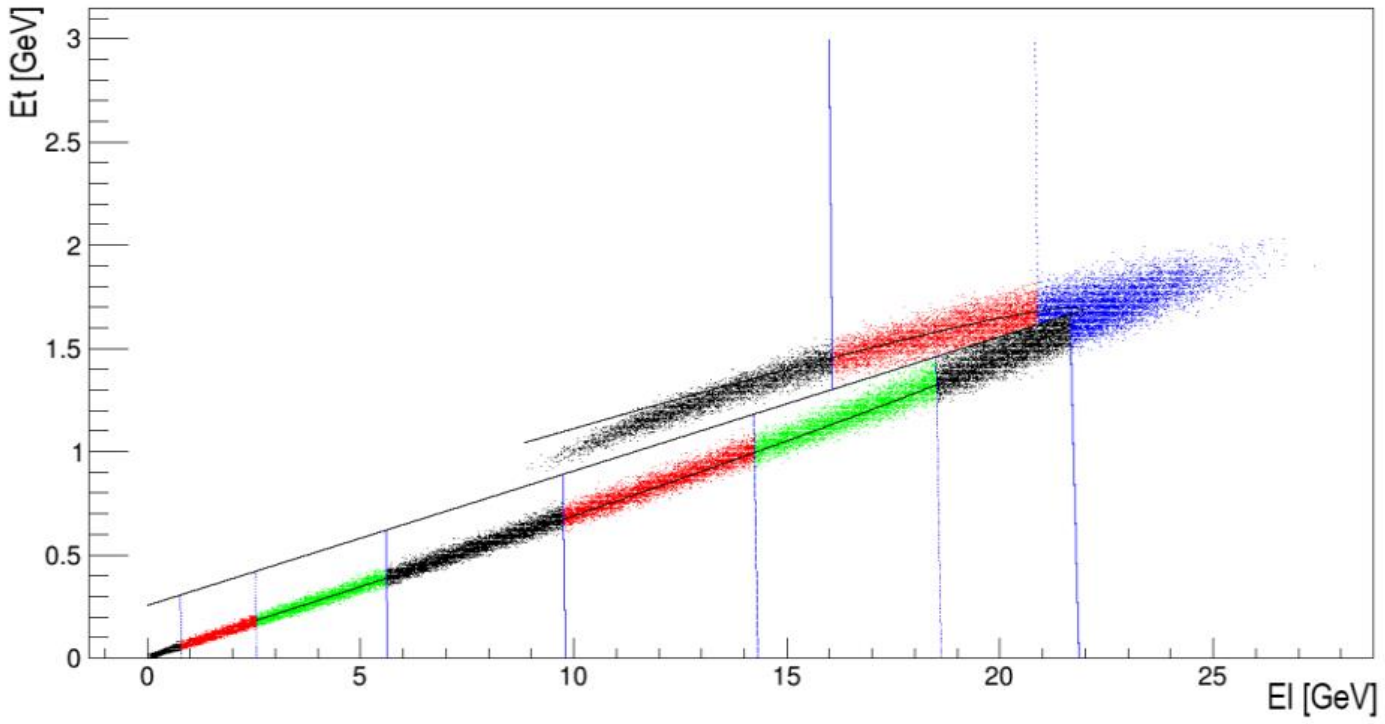
Ellipse fitting procedure (backup)



The ellipse was chosen as a fitting function. The procedure of searching for an ellipse that would describe our distribution is as follows:

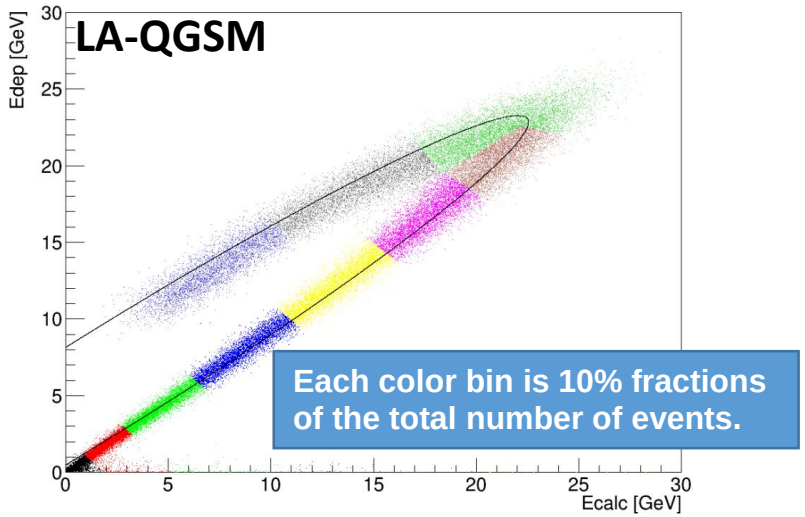
1. Initial estimation of ellipse parameters (coordinates of ellipse centre, half axis, and ellipse inclination angle) is performed. The procedure is initially based on the general parameters of the distribution (width, height of the histogram data).
2. Variables that are minimized are set.
3. Minimization limits are set.
4. These data are processed into a minimizer ("Minuit", "Combined").

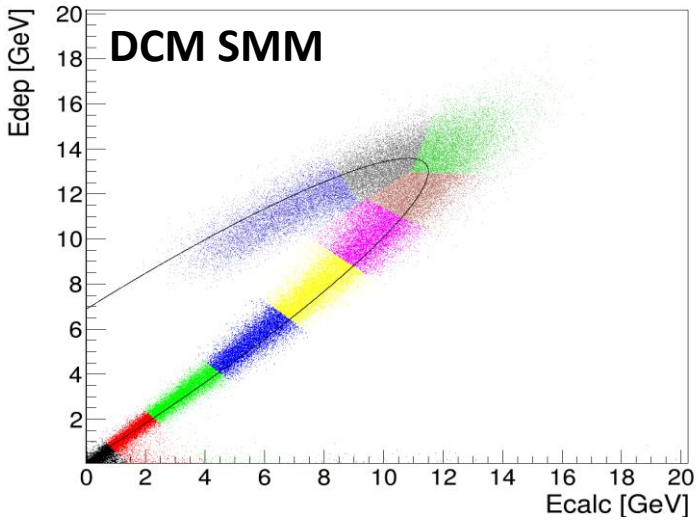
Data splitting procedure (backup)



- There is a movement along the ellipse trajectory with a certain step. At each step (x-axis) perpendicular to the ellipse is calculated, and all the bins it intersects are checked (limits of movement along the x-axis and the perpendicular are set according to the data). All bins that have passed are marked to avoid being counted again. The area in which events along the perpendicular are counted is limited on the one hand by the size of the histogram (axes), and on the other hand by the ellipse half-axis, the equation of the half-axis is obtained from the focus and centre coordinates of the ellipse.

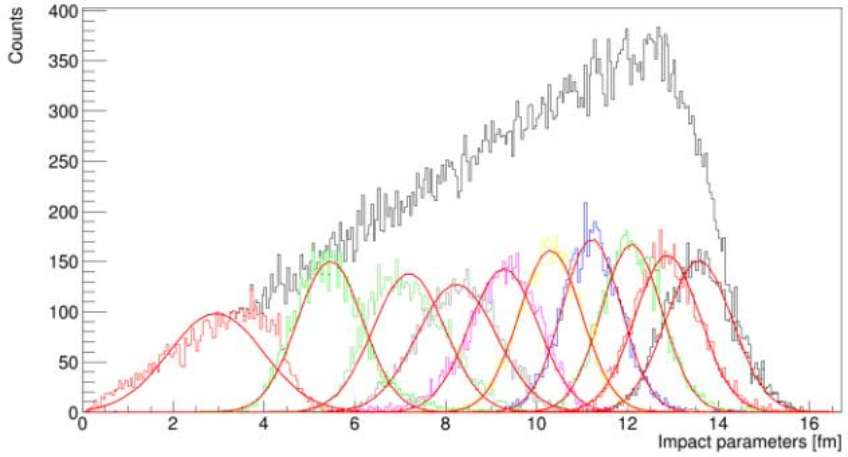
5 GeV example for LA-QGSM and DCM SMM models (backup)

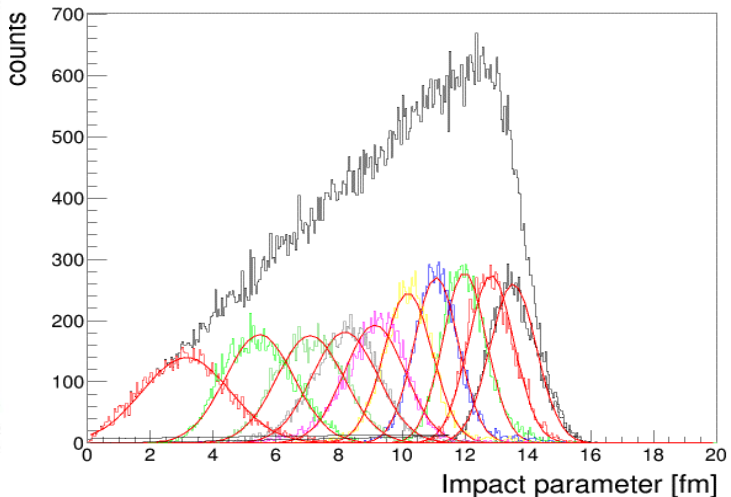




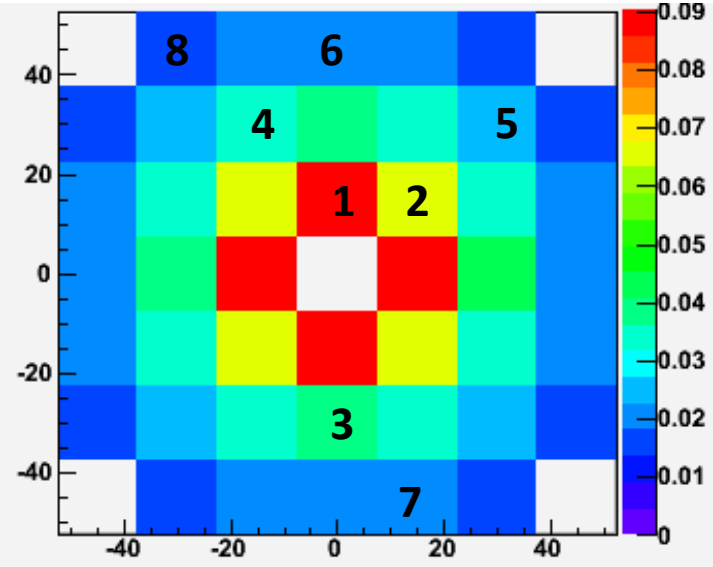
- One of the main problems in this case is the division of the branches by some parameter. It is necessary to separate the central events from the peripheral ones.

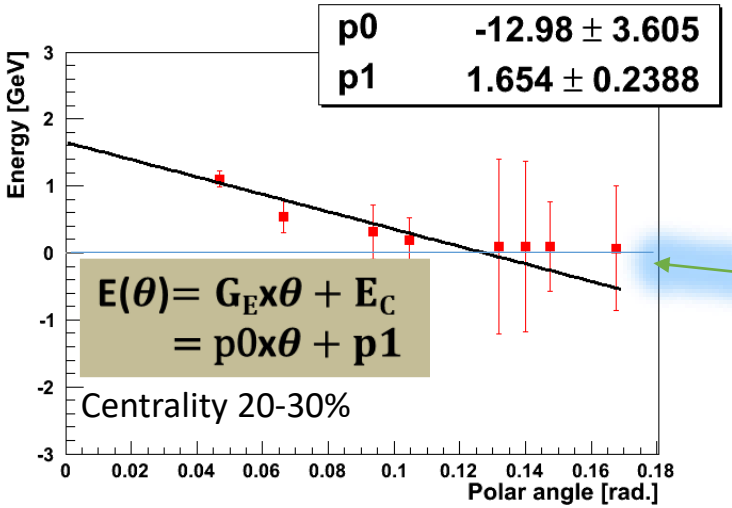
- The corrected energy is calculated as an integral of function $E(\theta) = GEx\theta + Ec$ by the calorimeter surface. The volume of the cone is calculated, the calorimeter lighting area is taken as the base area, and the Z value is taken as the energy output, which is normalized by the module square itself.

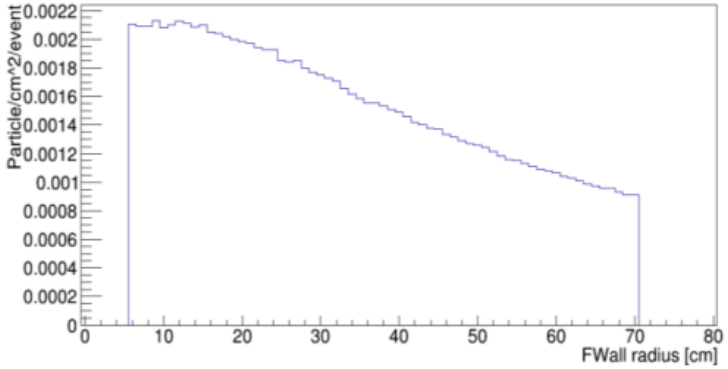




Pion background subtraction (backup)





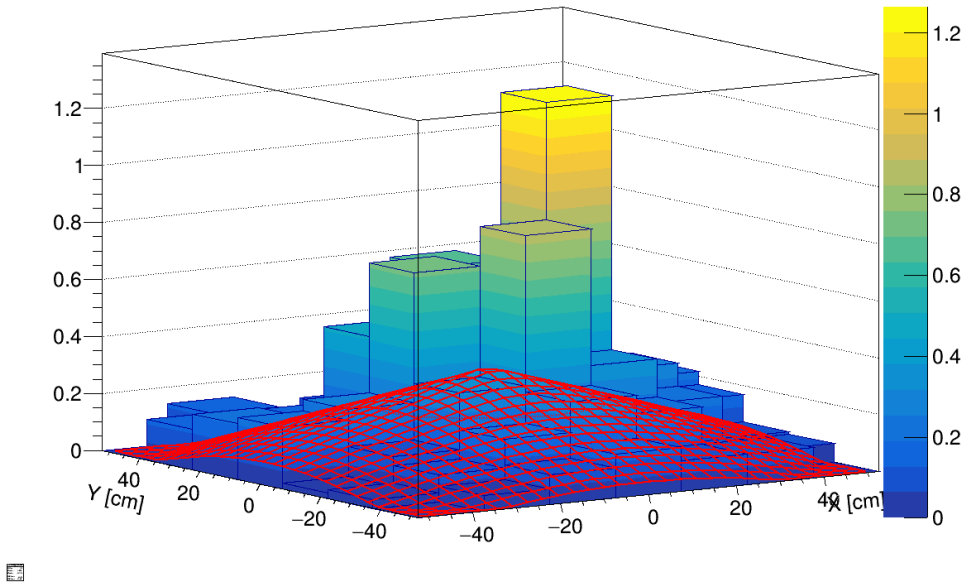


Pion distribution b<6

The last point

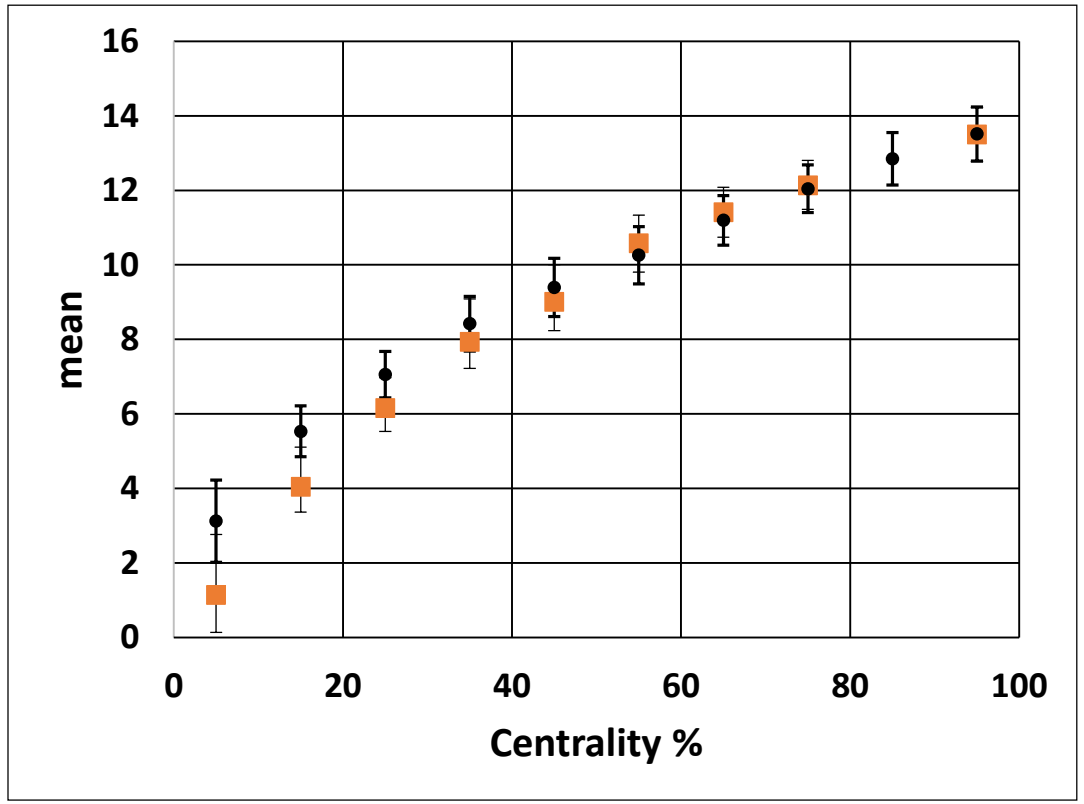
- The last point on the plot always lies above the fitting line. The possible explanation is the energy in the last "ring" does not apply to spectators. To construct Ecalc, we use the assumption that the energy in the eighth group belongs to the pions.
- The shapes of proton and neutron spots are just as easily distinguishable for central and peripheral events. Based on the obtained result, the pion background is subtracted from the energy.

Pion background subtraction (backup)

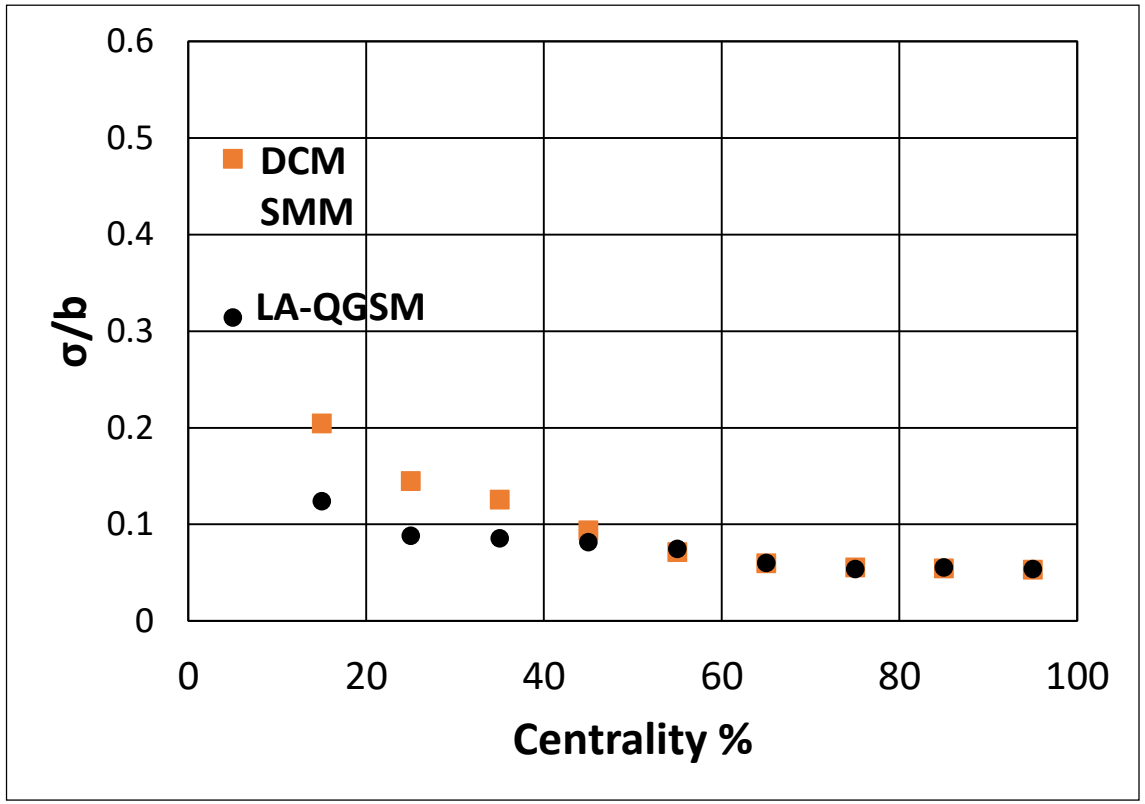


- The alternative method is a modified and advanced previous one. It is possible to construct two-dimensional distributions of the pion background to subtract it from the events. Since the angle of the fitting line of the pion background is always the same within the permissible range.

LA-QGSM and DCM SMM models for 5 GeV Ecorr Edep (backup)



Dependence of impact parameter on centrality



Dependence of resolution of impact parameter on centrality

Edep Ecorr sensitivity to centrality measurement