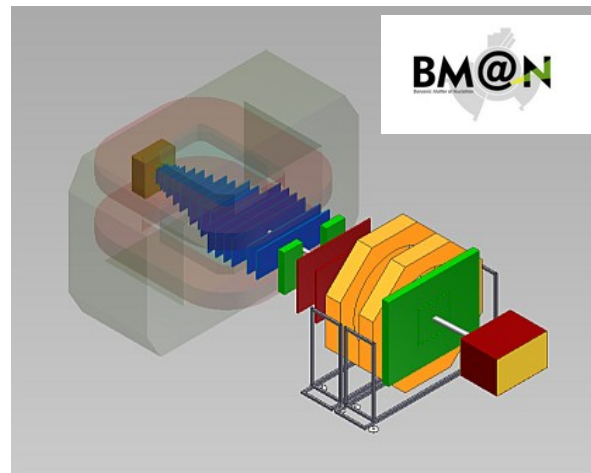


# The status of the centrality classes determination with the ZDC for CC@4AGeV (Run 6) experimental data

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on behalf of Institute for Nuclear Research RAS, Moscow



**Joint Institute for Nuclear  
Research**

SCIENCE BRINGING NATIONS  
TOGETHER

The 5<sup>th</sup> Collaboration Meeting of the BM@N experiment at the NICA Facility  
VBLHEP, JINR, Dubna, 20 – 21 April 2020

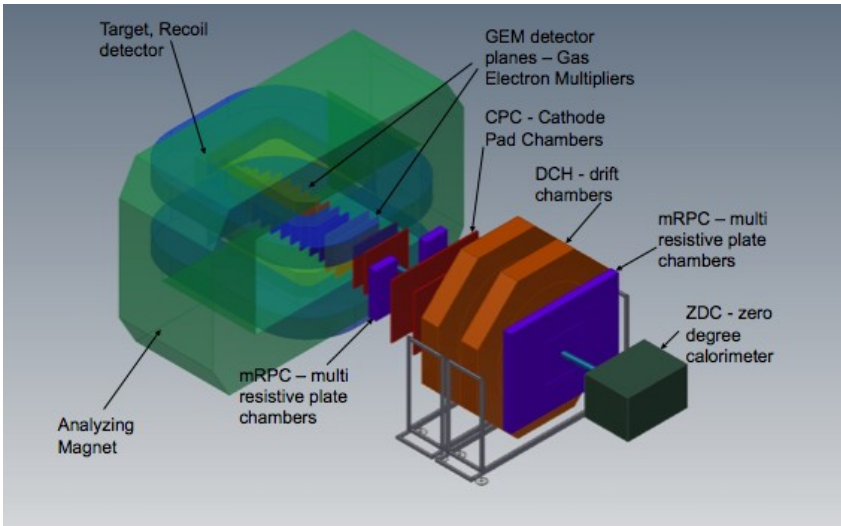
# Centrality with ZDC in C+C data

March 2017: "run6" period

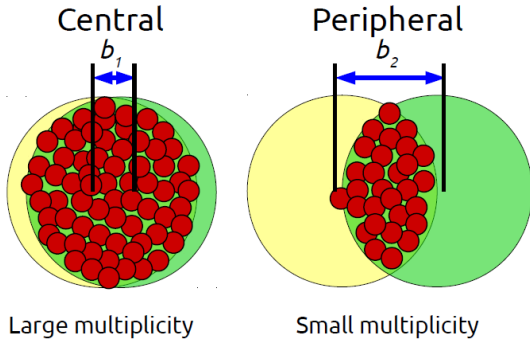
- C+C, C+Al, C+Cu @ 4AGeV
- analysis of lambda production:

- 1) experimental data reconstruction
- 2) simulation + reconstruction

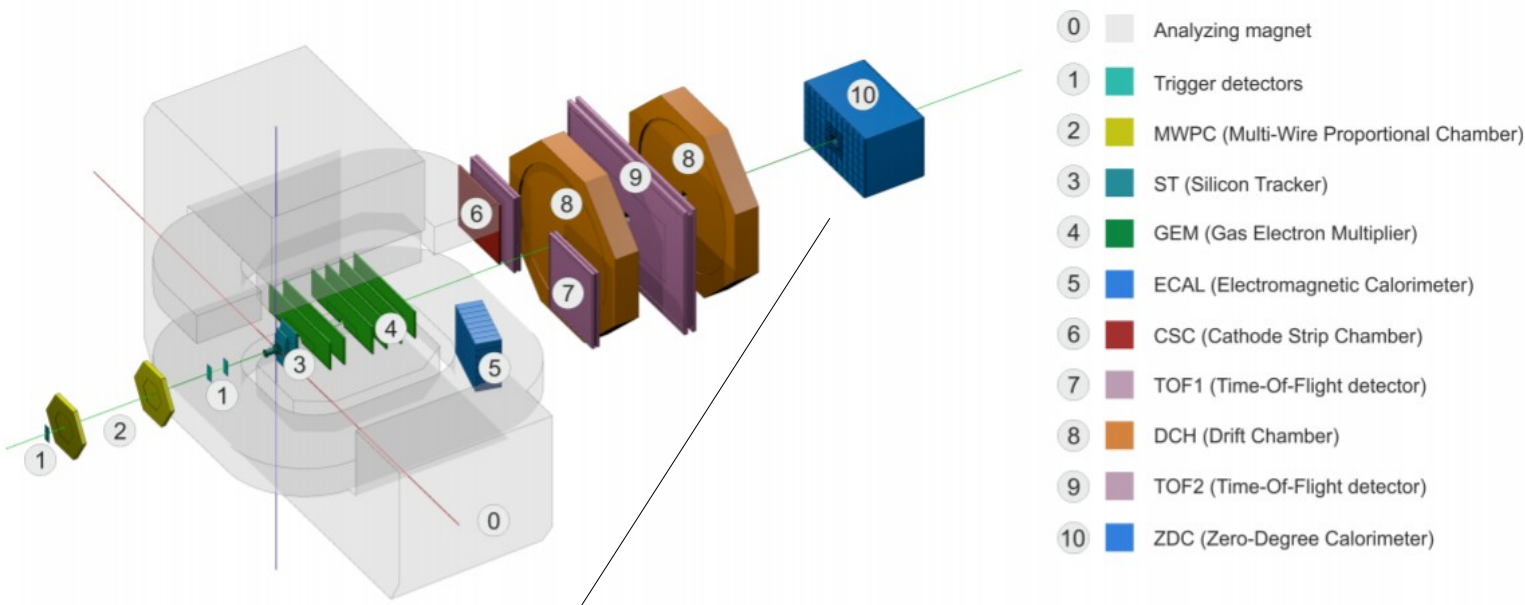
Main goal: determination of collision centrality classes with ZDC for lambda analysis



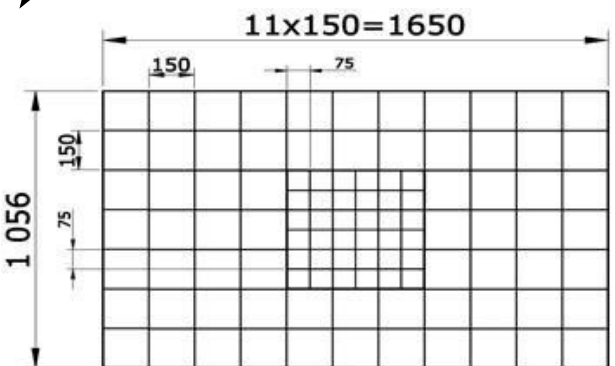
Year	2016	2017 spring	2018 spring
Beam	d(↑)	C	Ar, Kr, C(SRC)
Max.intensity, Hz	0.5M	0.5M	0.5M
Trigger rate, Hz	5k	5k	10k



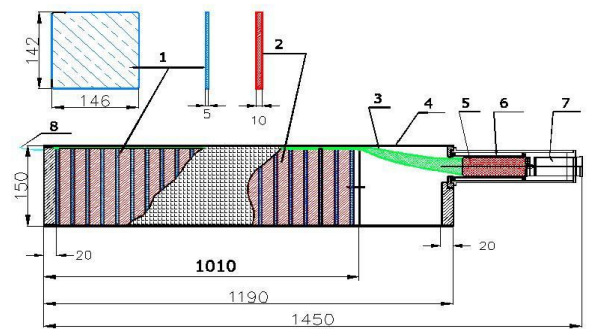
# Centrality with ZDC in C+C data



## 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))

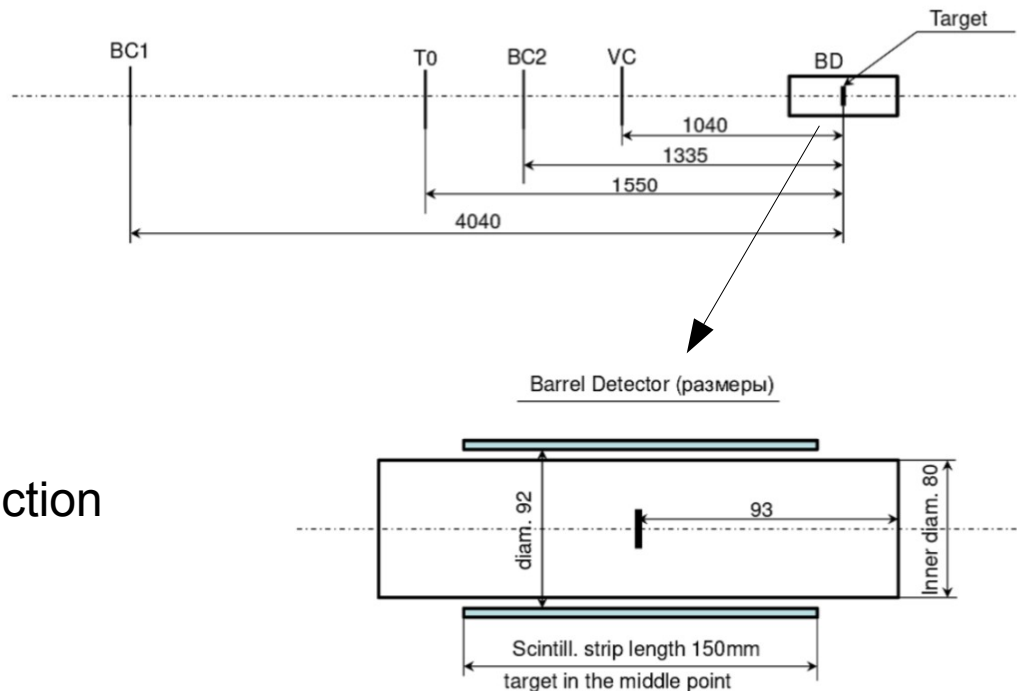
# Centrality with ZDC in C+C data

## Experimental data:

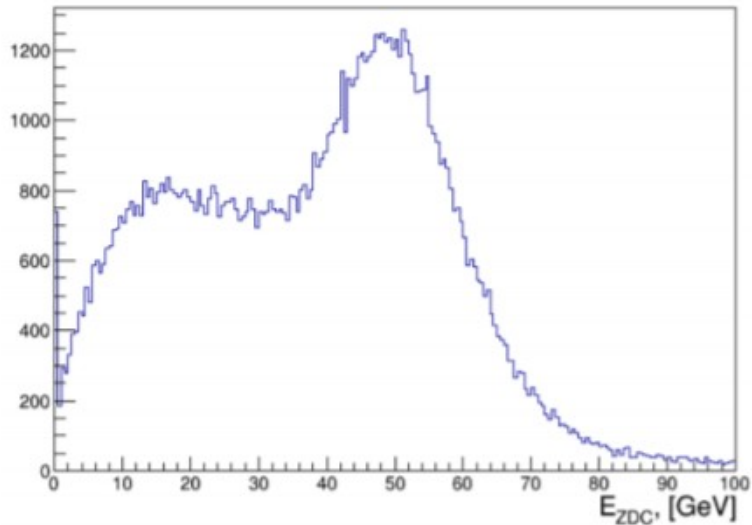
- single ion selection:
  - 1)  $nHitsBC2 = 1, nHitsT0 = 1$
  - 2) no fake trigger:  $nHitsVETO = 0$

## Simulation in GEANT4:

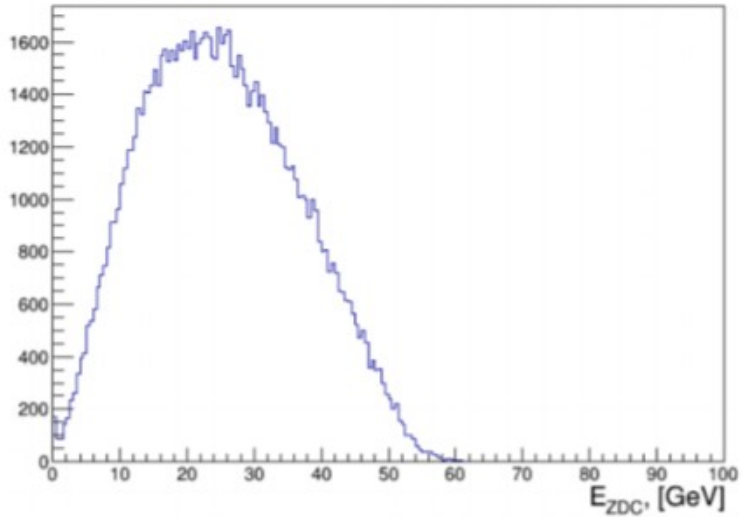
- all detectors in place (TOF + DCH)
- DCM-QGSM model, C+C@4 AGeV reaction
- event selection with BD detector ( $nHitsBD \geq 2$ )



experimental data

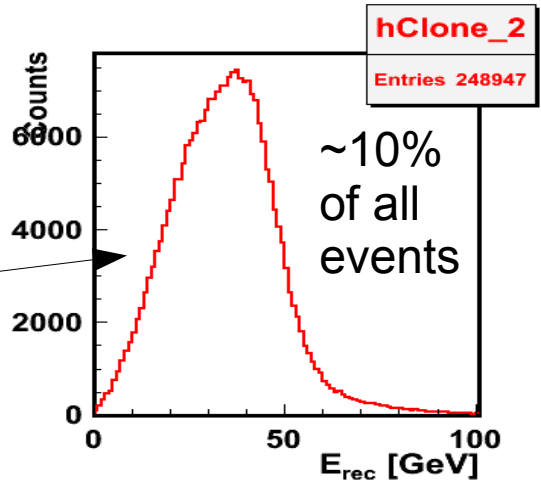
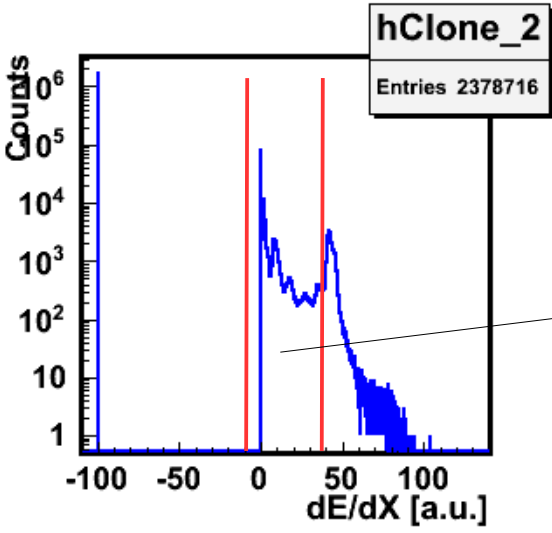
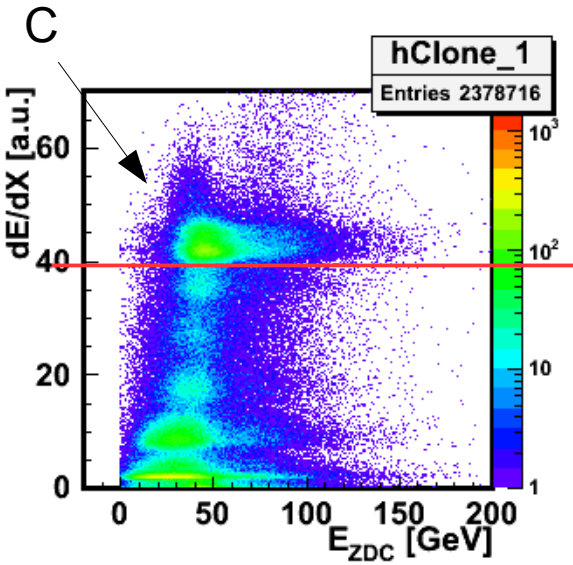
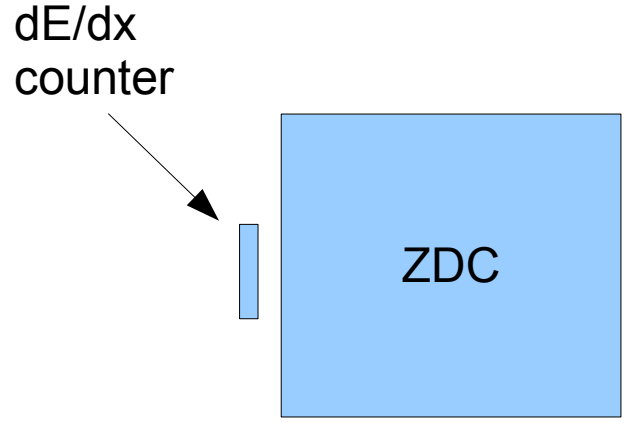
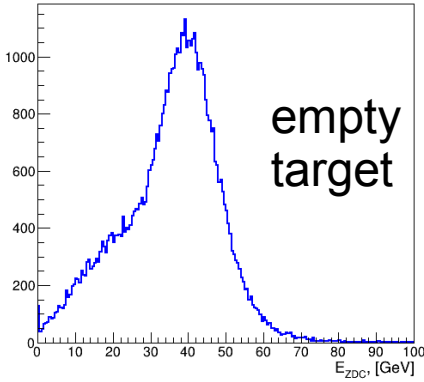
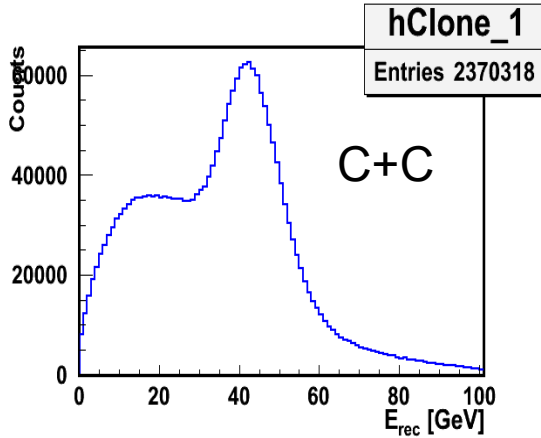


simulation



Carbon peak rejection with dE/dx counter before ZDC

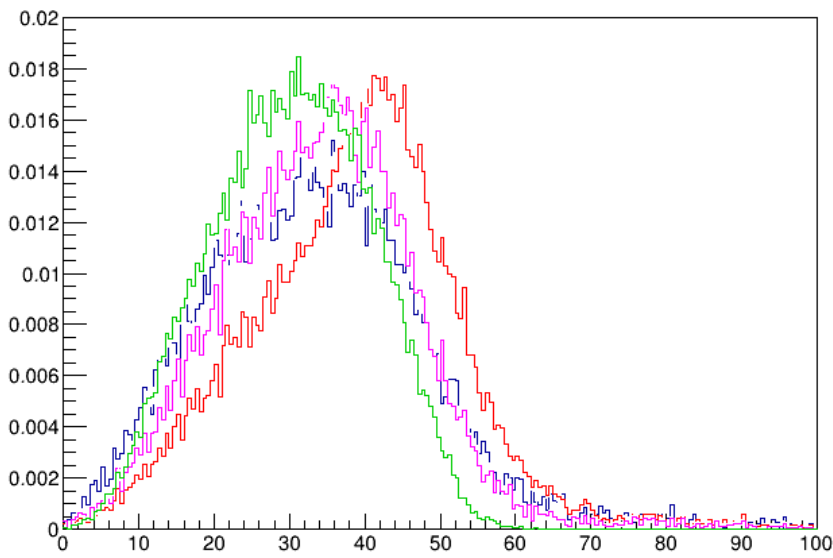
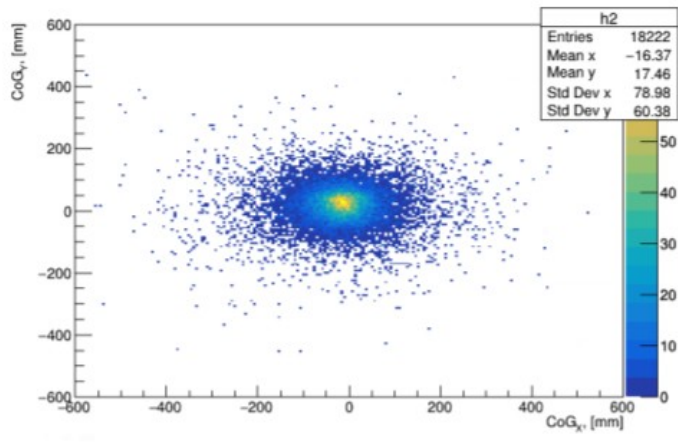
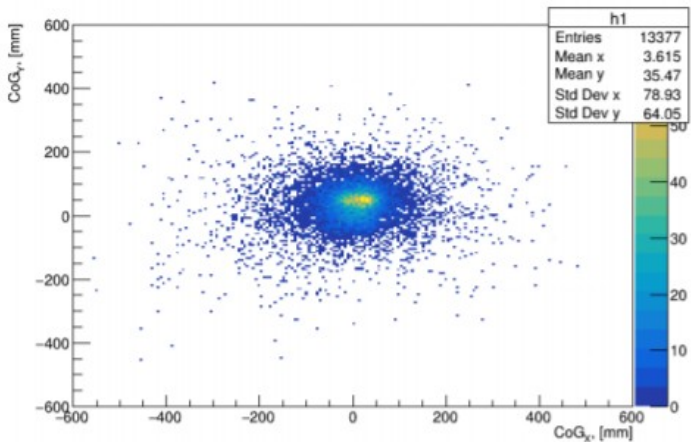
Total energy in ZDC



# Centrality with ZDC in C+C data

run group 1  
1408 – 1422 (~1.6M events)

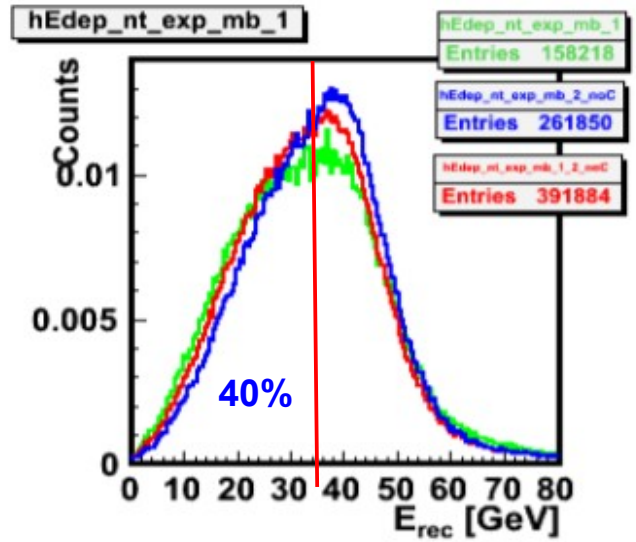
run group 2  
1539 – 1598 (~1.8M events)



group 1 ( $dE/dx > 0$ )  
 group 2 ( $dE/dx > 0$ )  
 group 2 ( $0 < dE/dx < \text{“C”}$ )  
 simulation ( $0 < dE/dx < \text{“C”}$ )  
 + BD cut



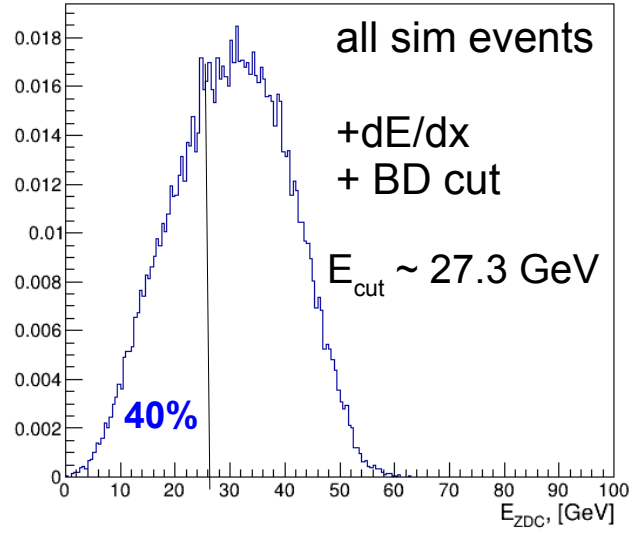
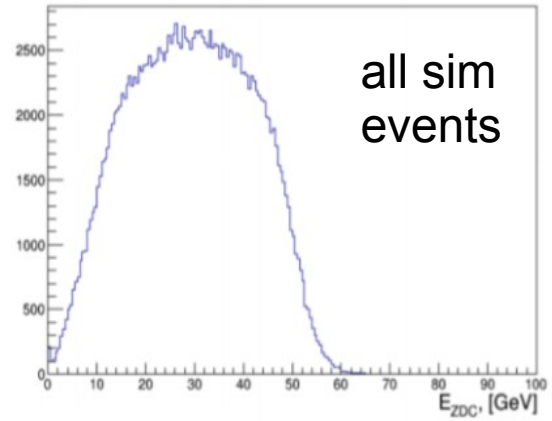
1) Exp. data (events selected with dE/dx counter)



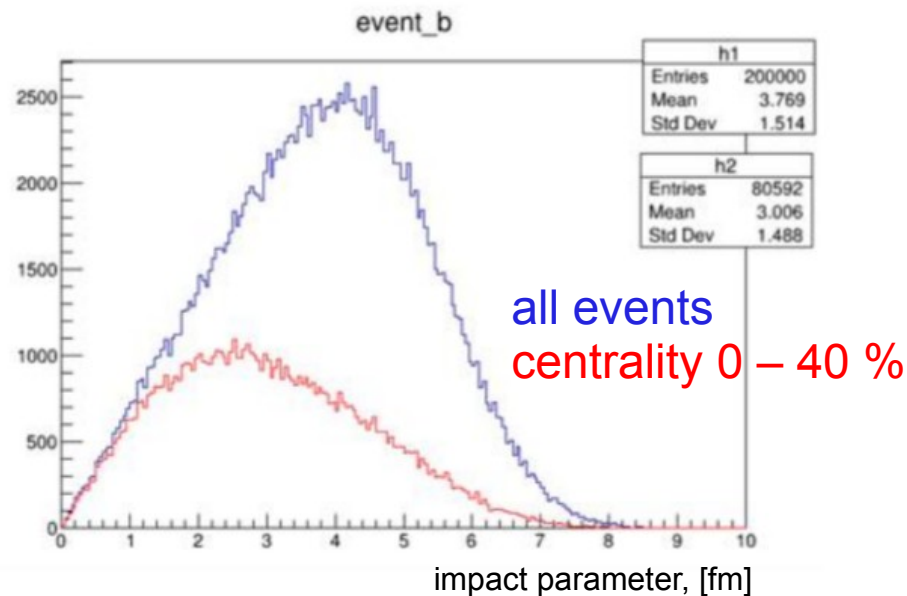
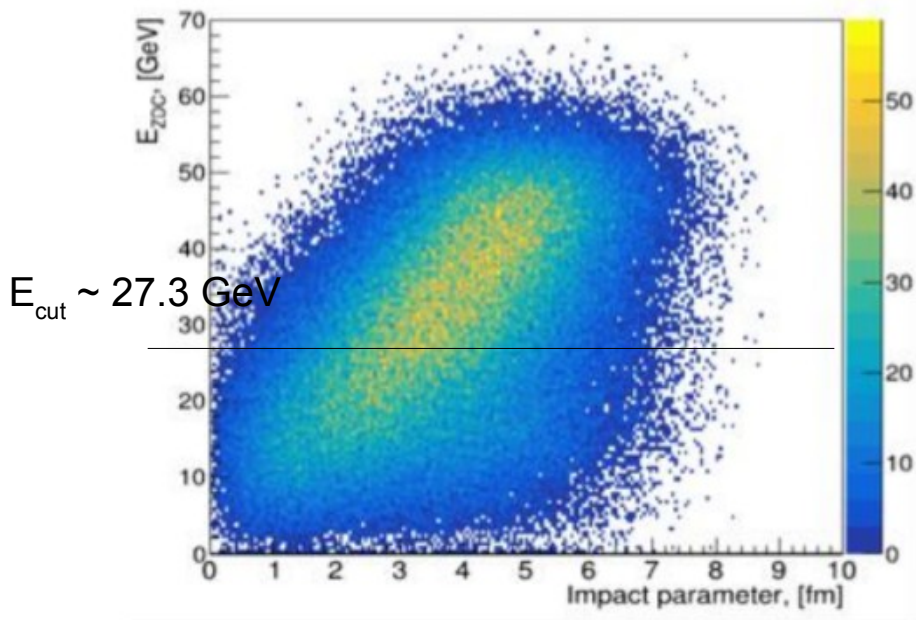
group 1  
group 2  
group 1+2

Centrality 0 - 40%  $\rightarrow E_{cut} \sim 35$  GeV

2) Comparison with simulation



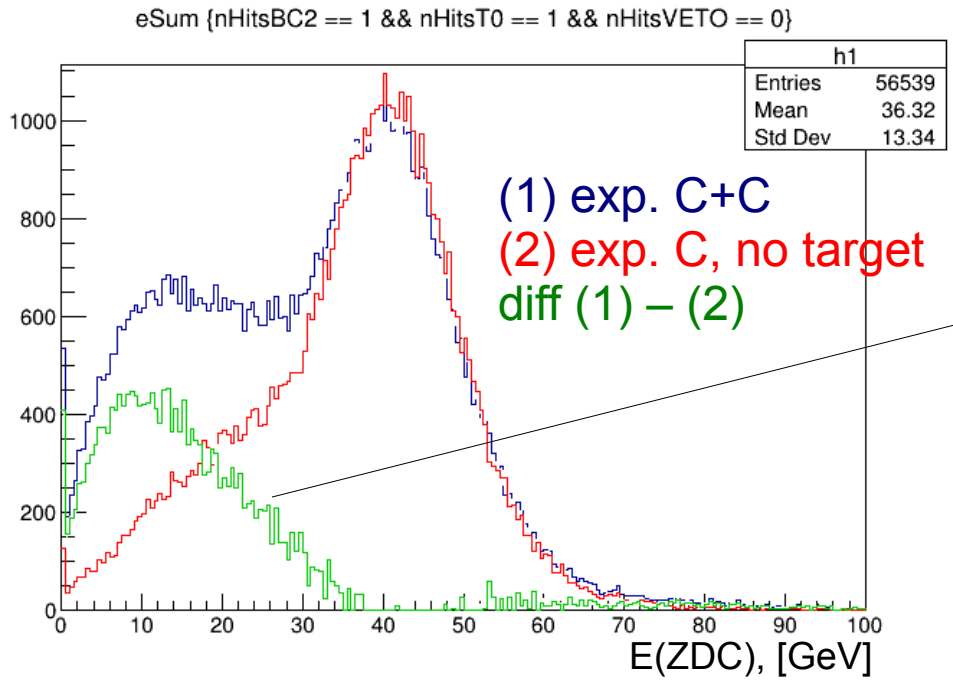
Centrality in simulation



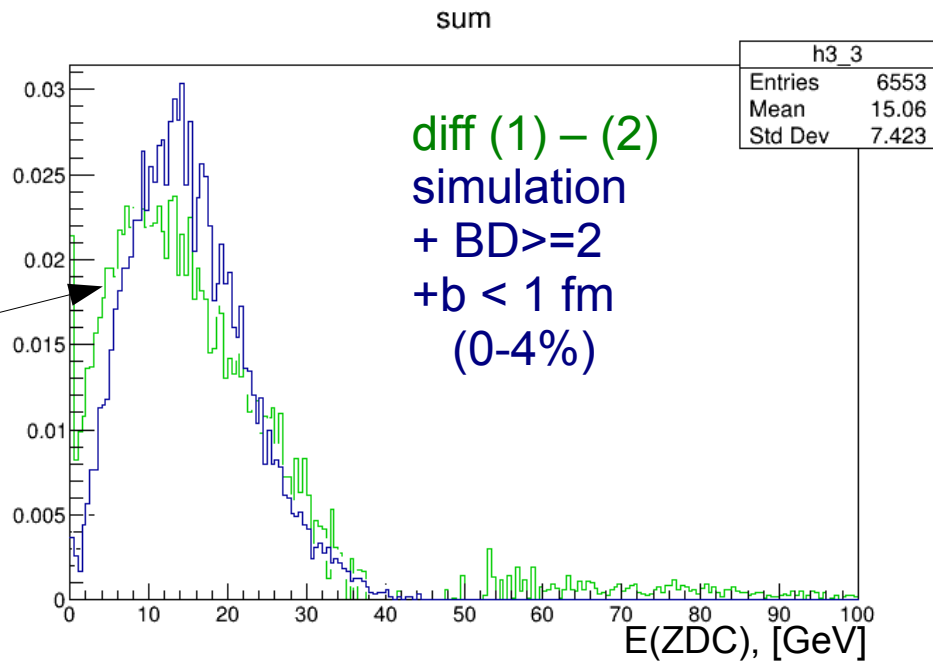
- low energy + small number of nucleons → wide b distribution after the cut



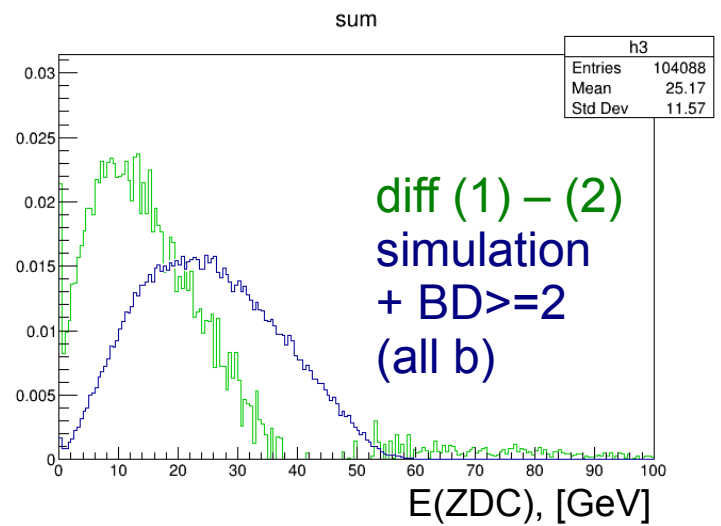
# Centrality with ZDC in C+C data

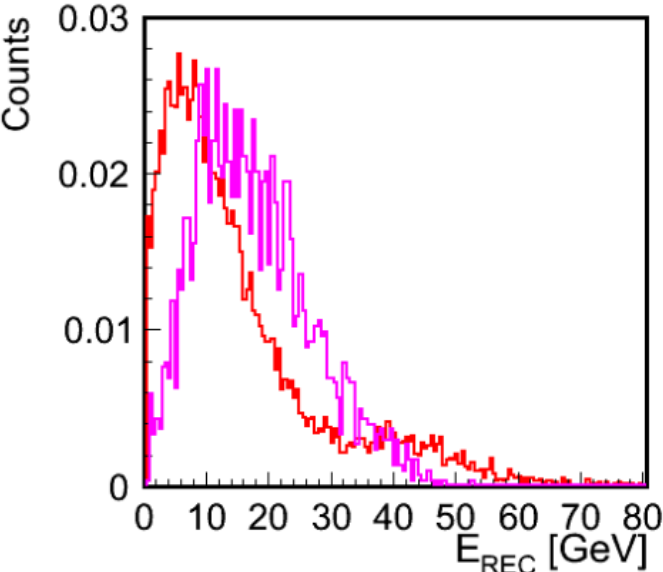


# Centrality with full energy in ZDC



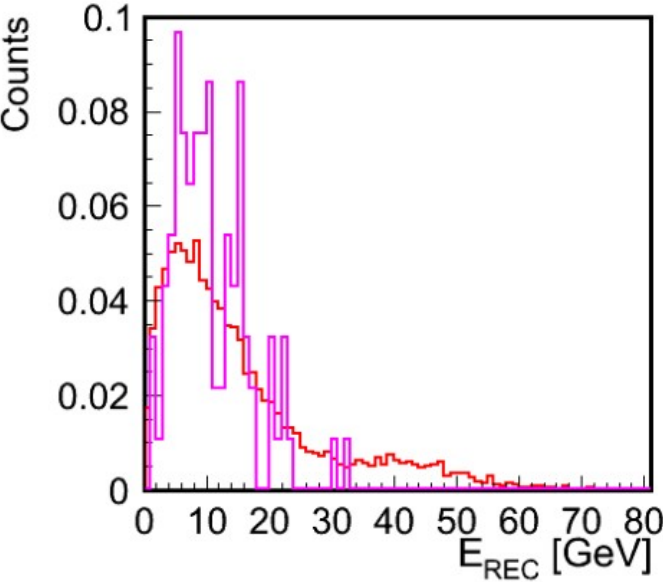
- due to events with pure carbon the event selection is biased for exp. data
- it's difficult to compare MB simulation with exp. selected with trigger





Data:  
lambda events (mass cut + kinematic cuts)

Simulation:  
lambda events (mass cut + kinematic cuts)



Data:  
events with reconstructed lambda

Simulation:  
events with reconstructed lambda  
+ cut on impact parameter  $b < 1$  fm (0-4%)

### Conclusions:

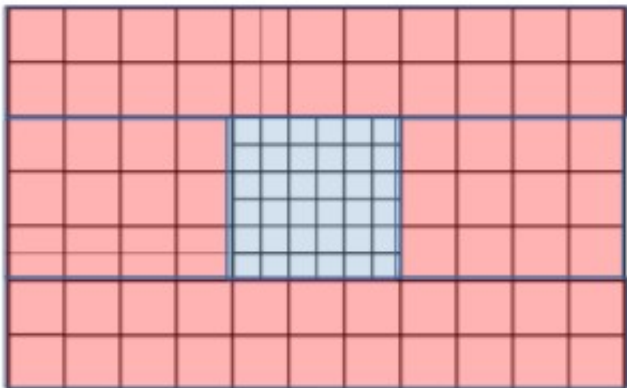
- there is a bias in MB event selections in experimental data:
  - 1) beam ion contamination in “run6” carbon run is observed
  - 2) beam ions interact with matter after the target → no possible way to reject them
  - 3) trigger with BD has some bias for targeting the MB
- comparing the MC with exp. data shows that probably only ~5% the most central events which has interactions in the target has been observed
- lambda ZDC spectra (comparing data and MC) → has the same level of ~5% the most central events from the target

### Outlook:

- other methods for centrality selection are under development (energy asymmetry, 2<sup>nd</sup> momentum of transverse energy distribution)
- analysis of C+Al, C+Cu is ongoing

Thank you for your attention!

## Backup slides



Energy asymmetry:

$$\frac{E_{ZDC\_inner} - E_{ZDC\_outer}}{E_{ZDC\_inner} + E_{ZDC\_outer}}$$

