Reconstruction of $\gamma\gamma$ mass spectra in AgAg collisions at 1.23 and 1.58 AGeV beam energy with ECal detector of the HADES experiment

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on behalf of ECal team of the HADES experiment

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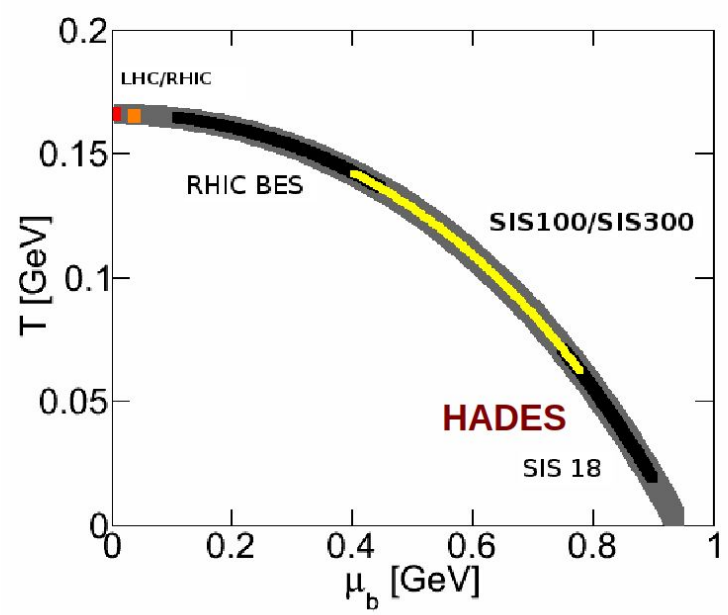
HADES

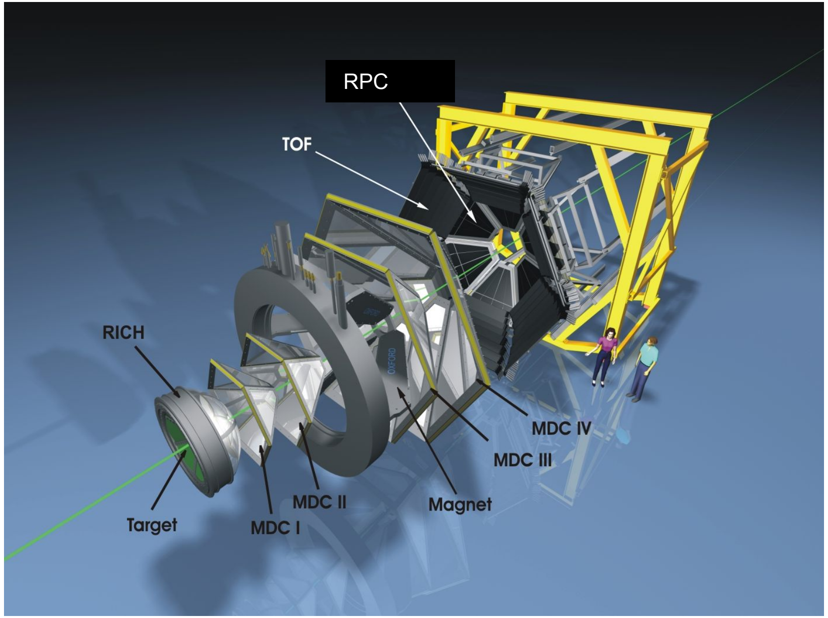
I N R
R A S

Plan

- HADES experiment
- ECal detector
  - construction
  - calibration
- Reconstruction of γγ invariant mass spectra
  - selection of γ-quants
  - reconstruction of γ-pair spectra
  - subtraction of combinatorial background

HADES


0.2
0.15
0.1
0.05
0
T [GeV]
LHC/RHIC
RHIC BES
SIS100/SIS300
HADES
SIS 18
0
0.2
0.4
0.6
0.8
1
μ_b [GeV]

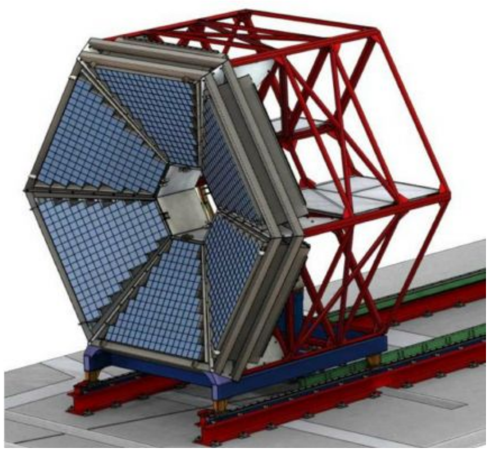

RPC
TOF
RICH
MDC IV
MDC III
MDC II
Magnet
Target
MDC I

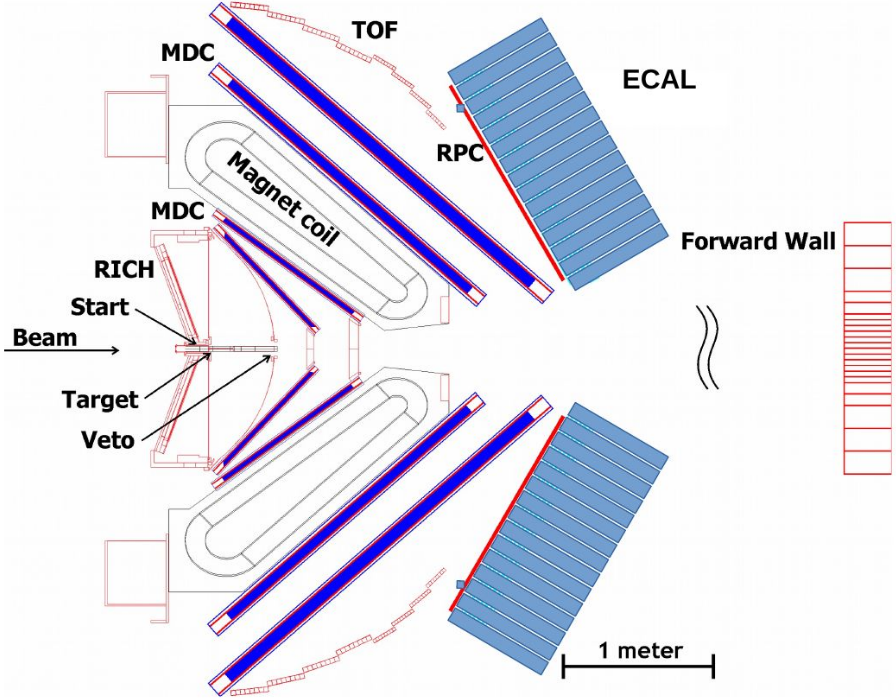
Electromagnetic calorimeter

construction

ECal detector

- 6 sectors * 163 modules each
- Goals:
  - strangeness study
  - π^0 yield
  - improve e/π separation



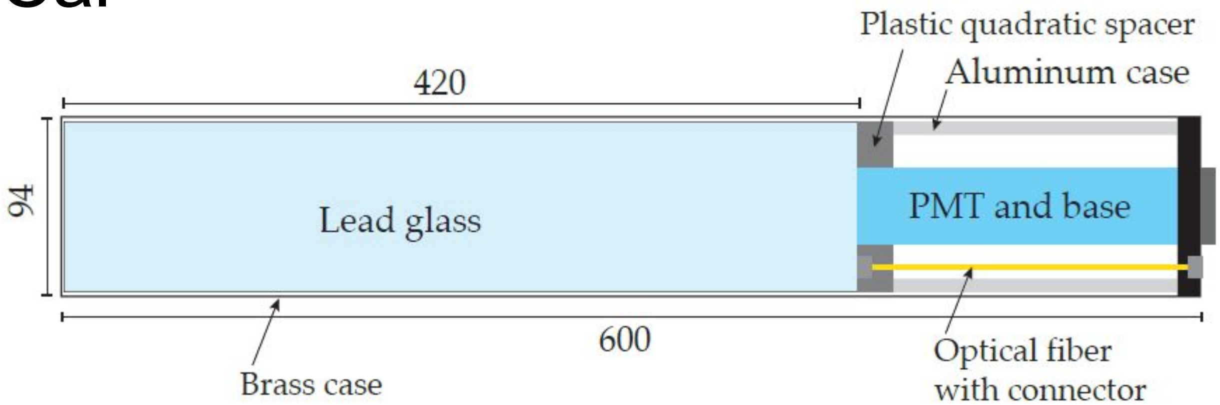


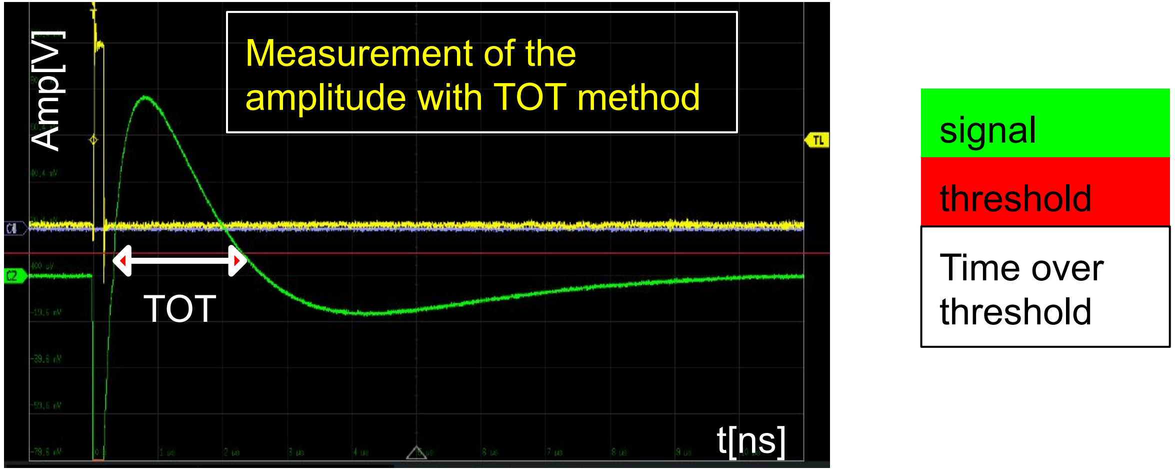
Module of the ECal

Homogeneous Cherenkov radiator is made of CEREN25 lead glass (16.7 radiation length long)

3” PMT Hamamatsu register Cherenkov light

Time Over Threshold method (TOT) is used to digitize the amplitude of signal





Electromagnetic calorimeter

calibration

Analyzed data

March 2019 runs

Ag target+Ag beam

<u>1.58 AGeV,</u>

3200 A current in solenoid (28 days)

<u>1.23 AGeV,</u>

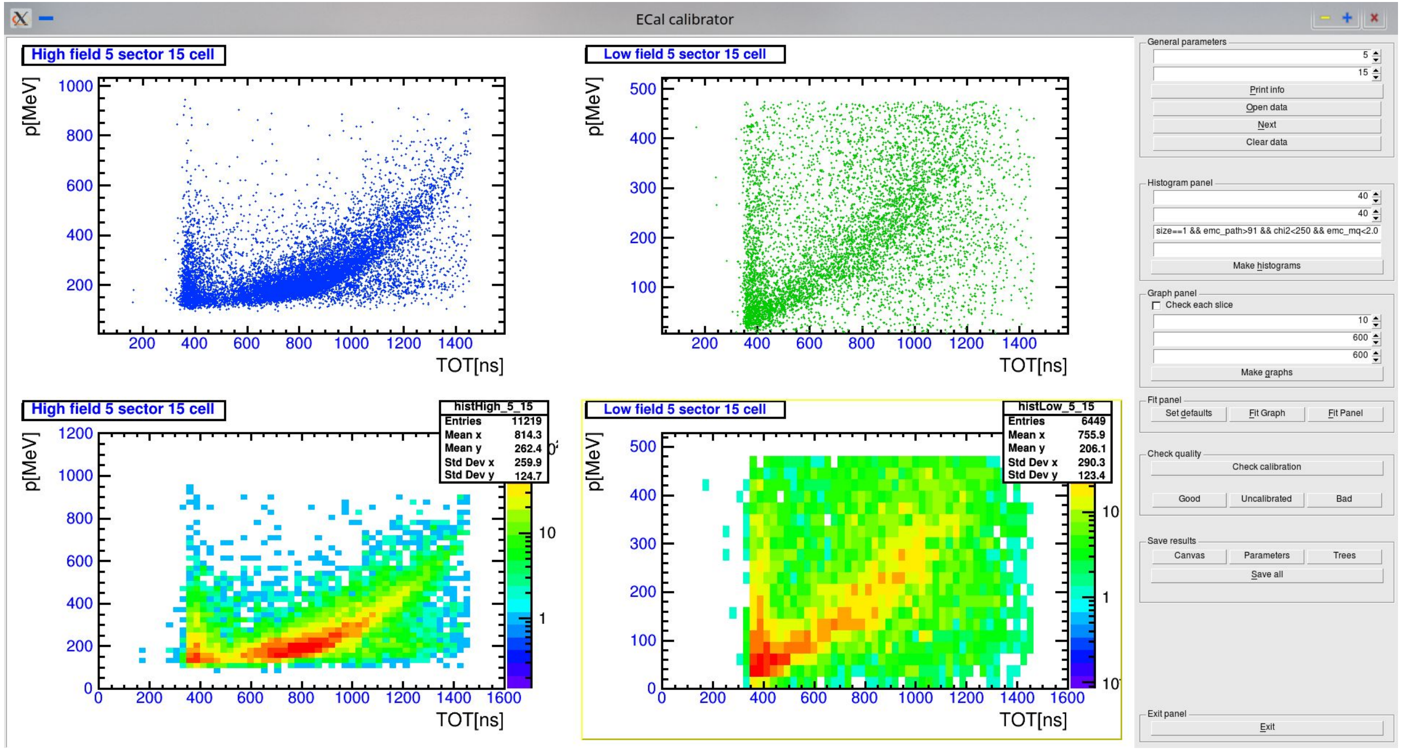
2500 A (3 days) - “High field”

200 A (2 days) - “Low field”

Calibration of the ECal detector

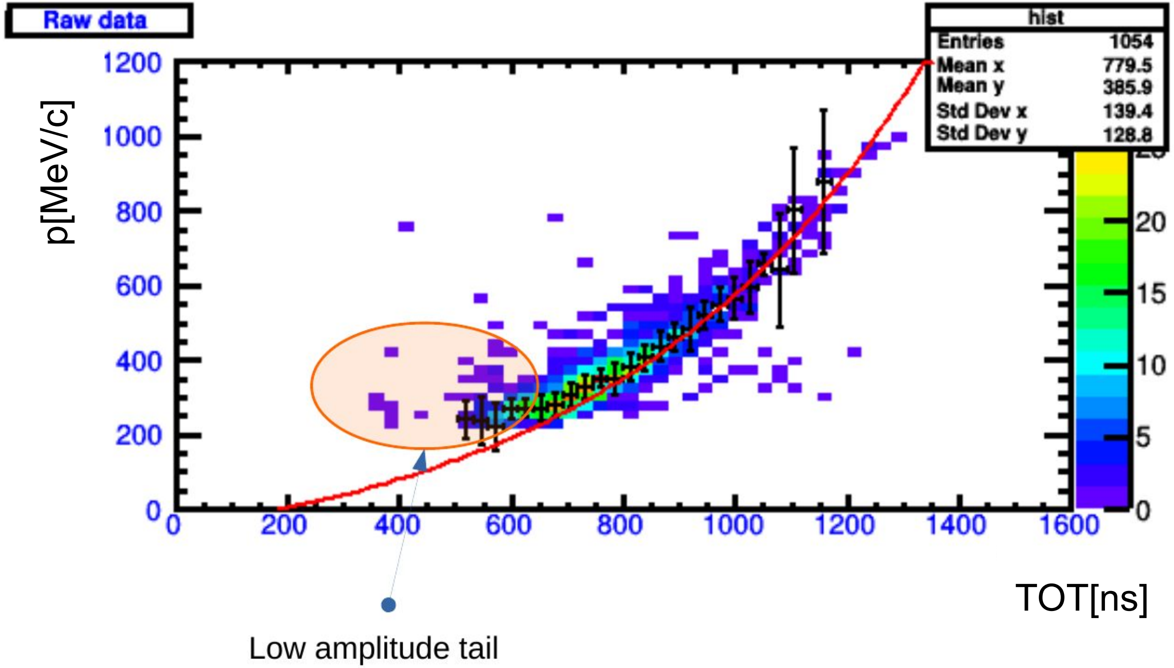
e+, e- are selected for calibration

their momentum is calculated by curvature of trajectory in magnetic field



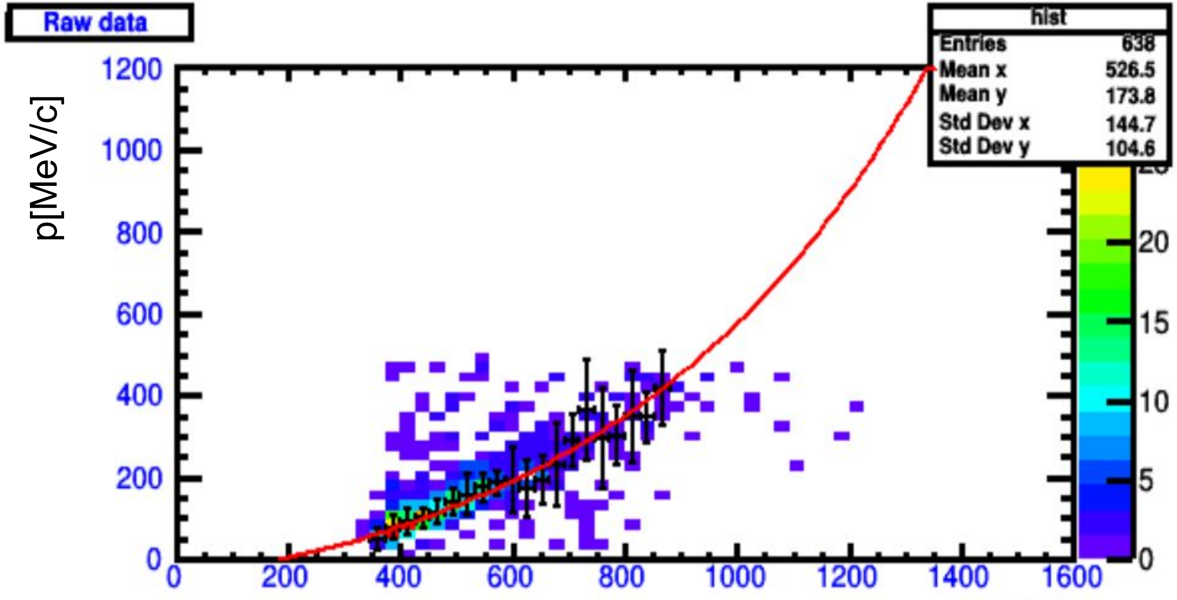
High field data

low energy **e** are unavailable because of their reverse in magnetic field



Low field data

momentum of high energy **e** is defined with poor resolution



p[MeV/c]

TOT[ns]

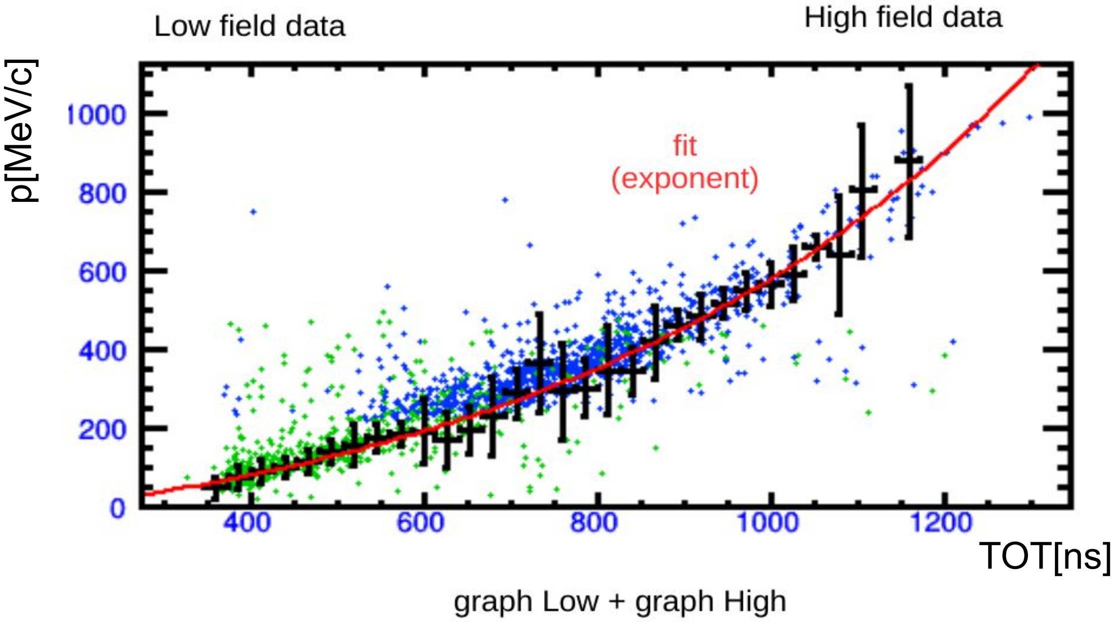
Joint distribution

$$E = p_0 + \exp\left(p_1 + p_2 \cdot TOT\right)$$

Low- and High-field data are concatenated

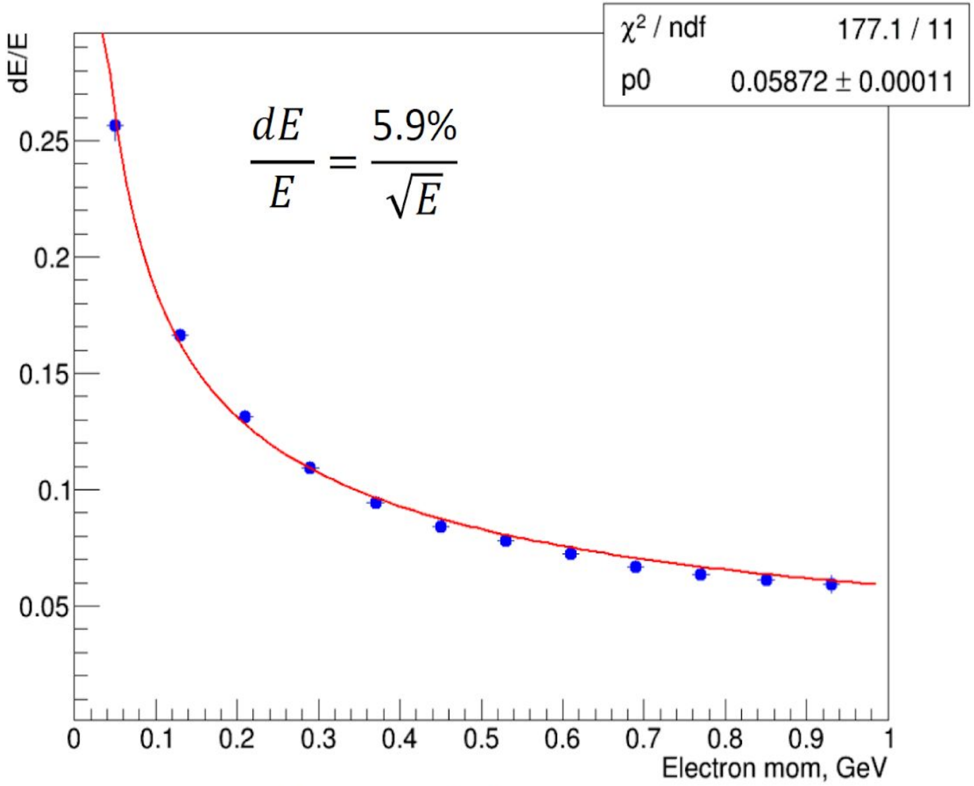
the dependence is fitted with exponent

parameters p0, p1, p2 for each module are written to the database



Resolution

Energy resolution ~6%/√E[GeV]



Reconstruction of γγ invariant mass spectrum

Selection criteria

Photon selection

- no match with any track
- $\beta > 0.95$
- $E\gamma > 300$ MeV

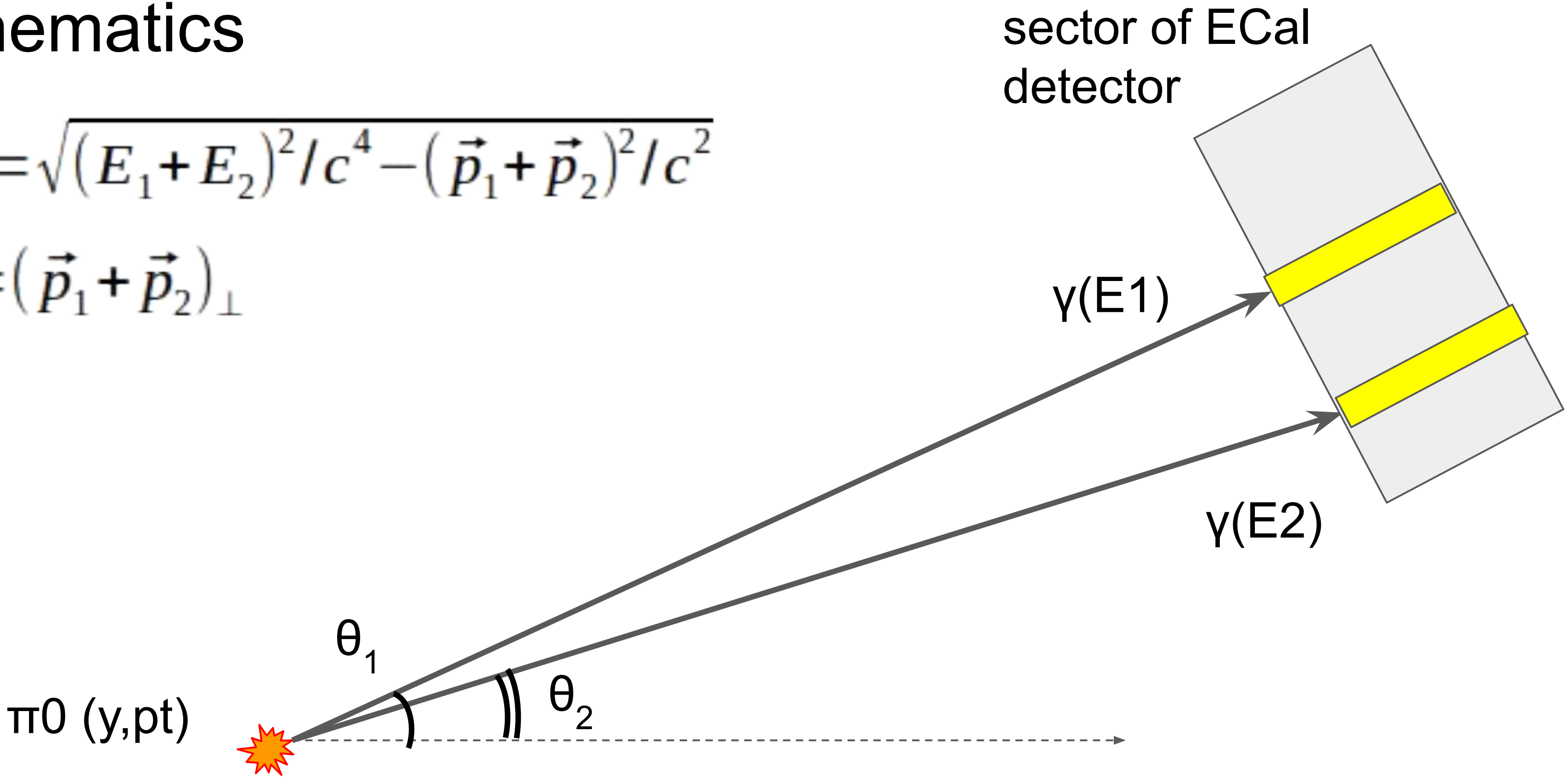
Pair selection

- opening angle > 5°
- both photons hit the same sector

Kinematics

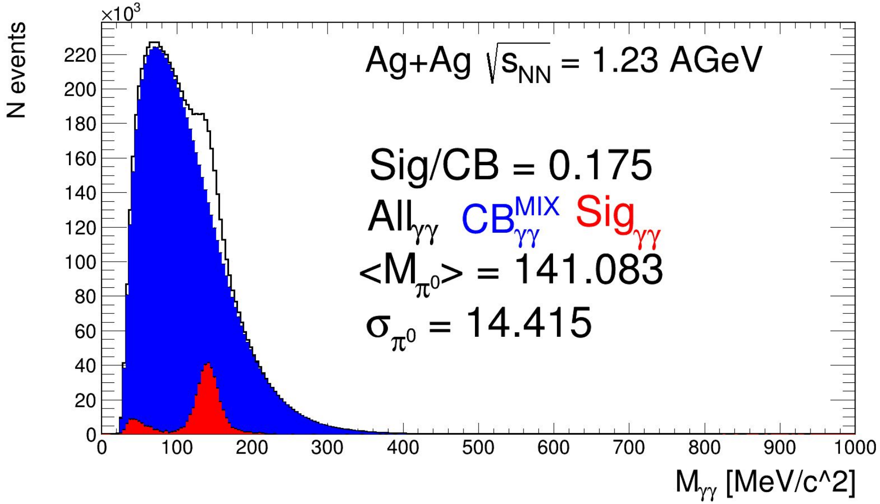
$$m_{\pi^0} = \sqrt{(E_1 + E_2)^2/c^4 - (\vec{p}_1 + \vec{p}_2)^2/c^2}$$

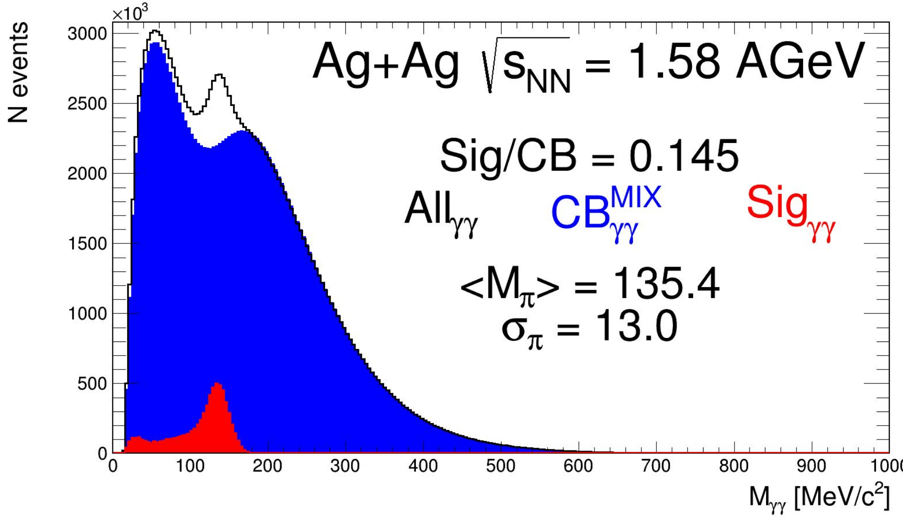
$$p_t = (\vec{p}_1 + \vec{p}_2)_\perp$$



Invariant mass spectra

For each possible combination of γ pairs the invariant mass is calculated

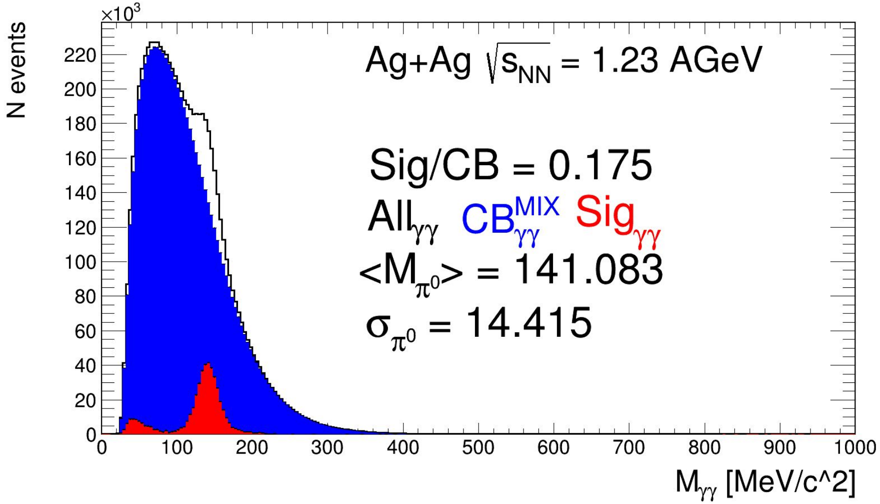


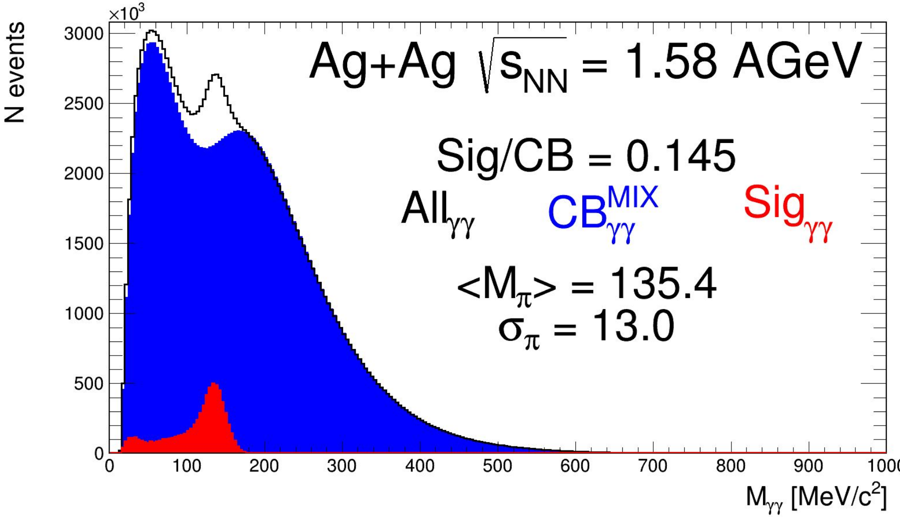


Combinatorial background

Mixed event technique is used to calculate the combinatorial background.

Photons are taken from different events to combine pairs.



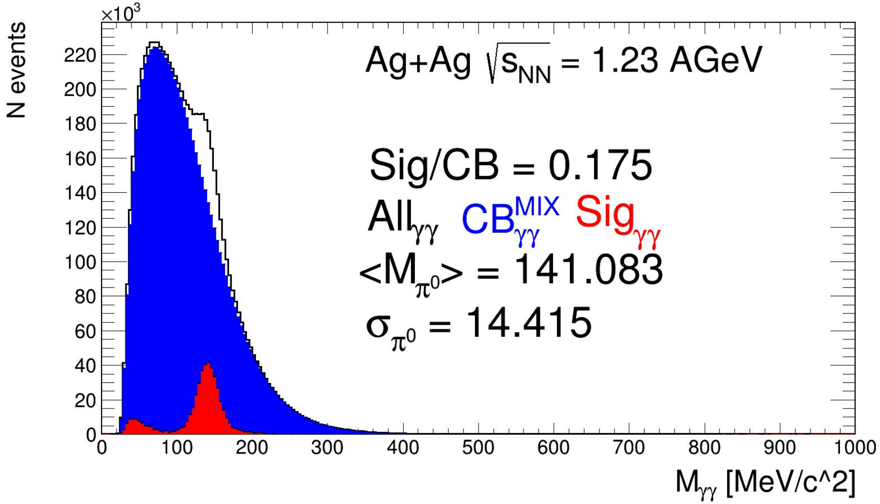


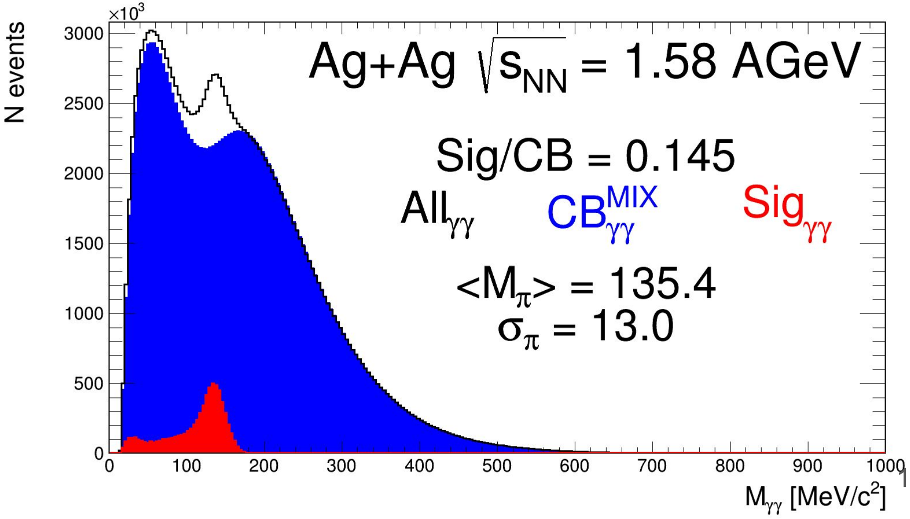
π^0 peak

Combinatorial background is subtracted from the spectra.

π^0 peak is fitted by Gaussian curve

(PDG:
$M_{\pi 0}$ = 134.97 MeV
$\sigma_{\pi 0}$ = 0,0005 MeV)

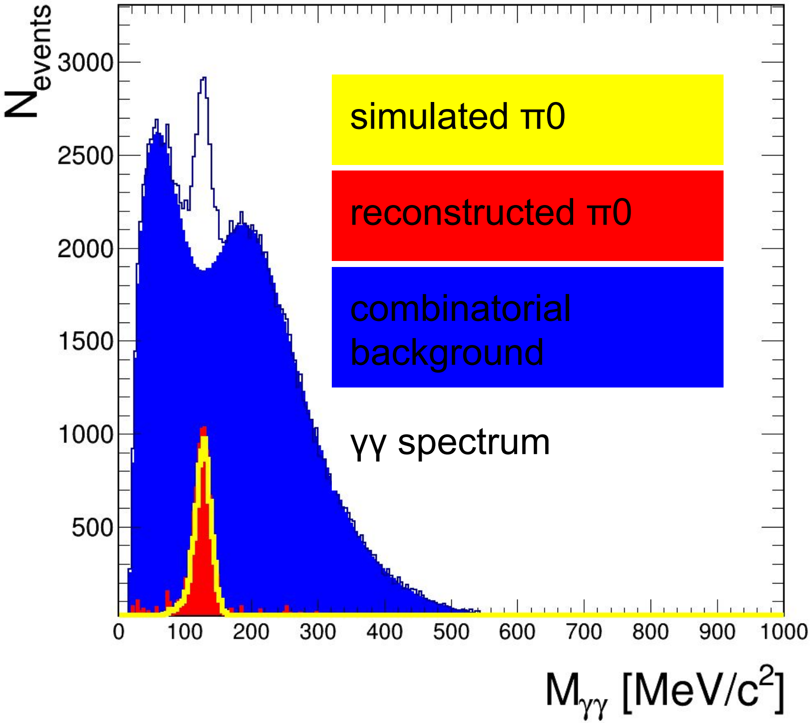




Simulation

UrQMD generator + HGeant

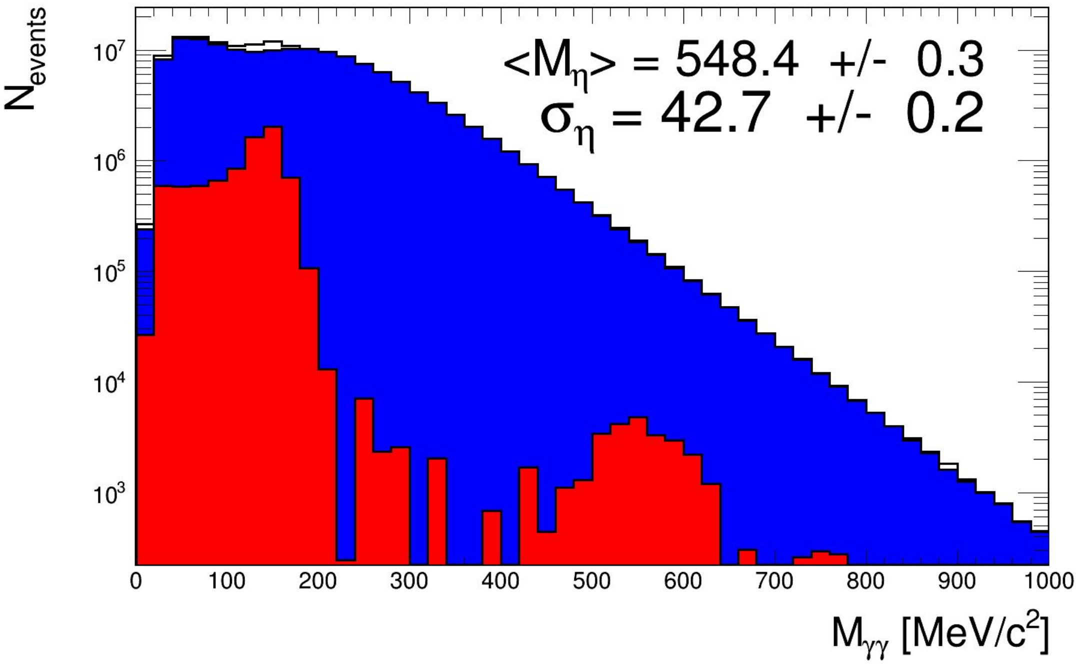
Spectrum, obtained with used technique, represents the same results as direct selection of pi0 by its PID



η-meson peak

η-meson peak is visible at 1.58 AGeV (high statistics, enough energy)

η-meson peak is not seen at 1.23 AGeV (low statistics, energy sub threshold)



Conclusions

- Resolution of ECal is $6\%/\sqrt{E}$
- $\pi 0$ peak is clearly visible at 1.23 and 1.58 AGV
- η-meson is visible at 1.58 AGeV
- Efficiency correction will be done in future

Thank you for attention!