Application of the 3-Fluid Hydrodynamic Event Generator THESEUS to CBM

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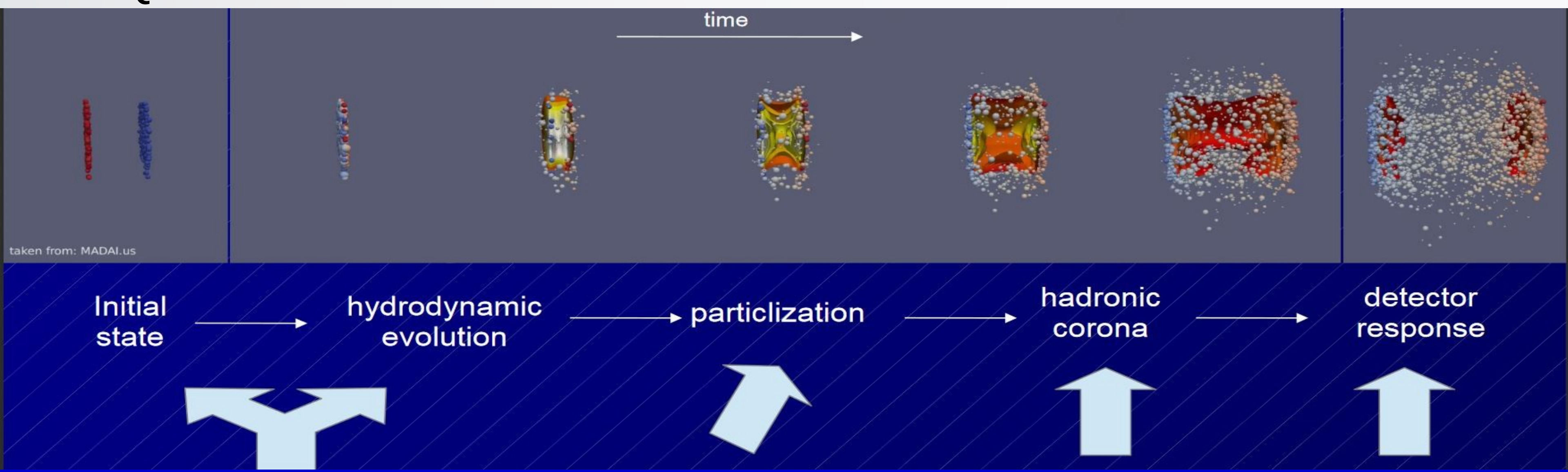
for the CBM collaboration

THESEUS

- Three-fluid hydrodynamics (3FH) was developed to simulate heavy-ion collisions at moderately relativistic energies.
- 3 ideals fluids: projectile, target and fireball nucleons
- Particlization is the process of changing from a fluid to a particle description. It allows to apply experimental cuts to particle distributions
- Final state hadronic rescattering processes are simulated using the UrQMD code.



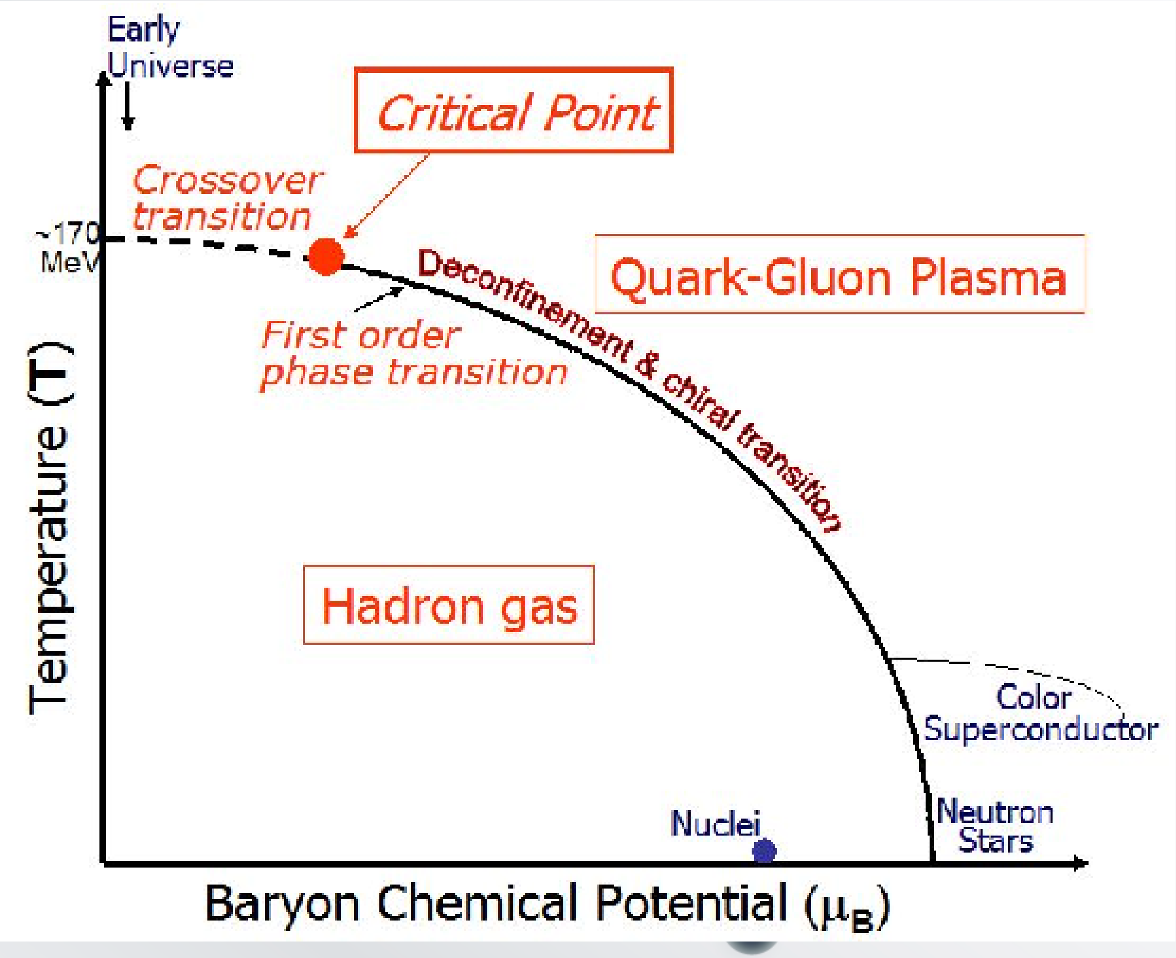
3-fluid hydro with 3 EoS

Adapt the procedure from existing hybrid model

UrQMD cascade

GEANT CBM, MPD, BM@N

Exploring QCD phase diagram



Where is critical point?

Is there phase transition between Hadron gas and QGP?

If yes, which type?

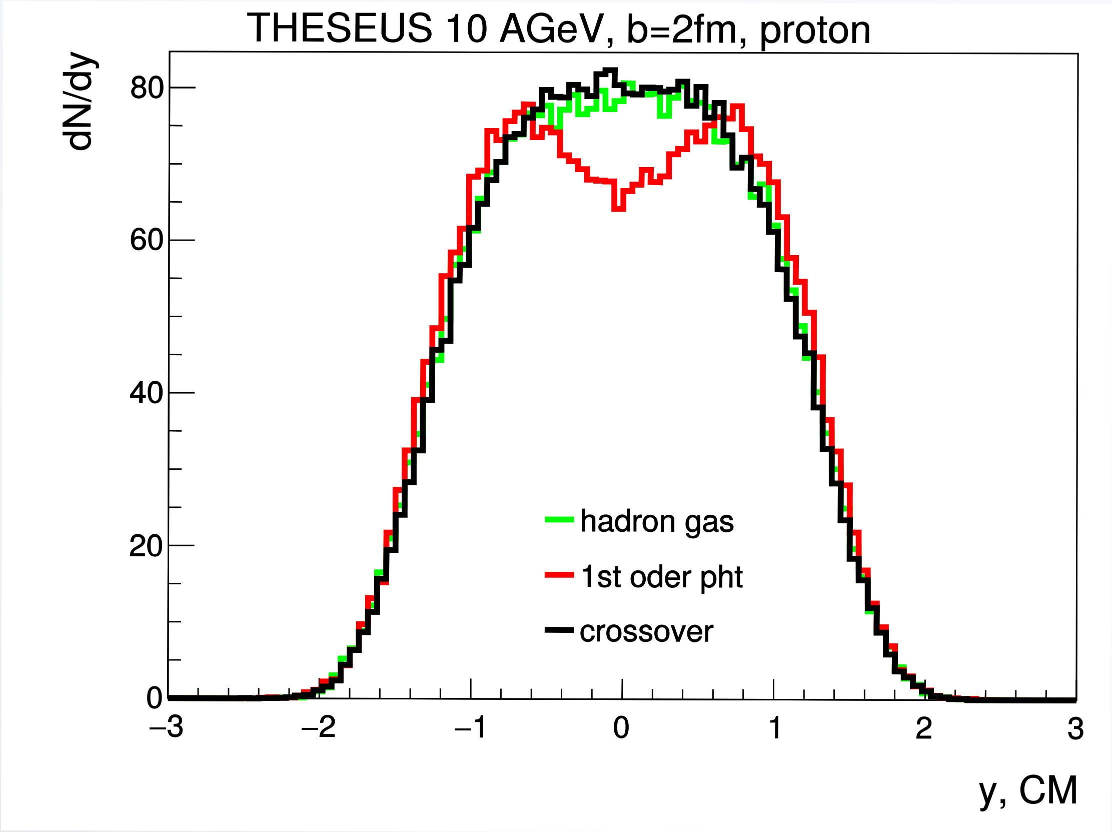
THESEUS EoS and rapidity distributions

3 different equations of state:

purely hadronic, 1st order phase transition (2-phase) EoS with deconfinement and crossover EoS with deconfinement

Will we see the difference after CBM acceptance cuts?

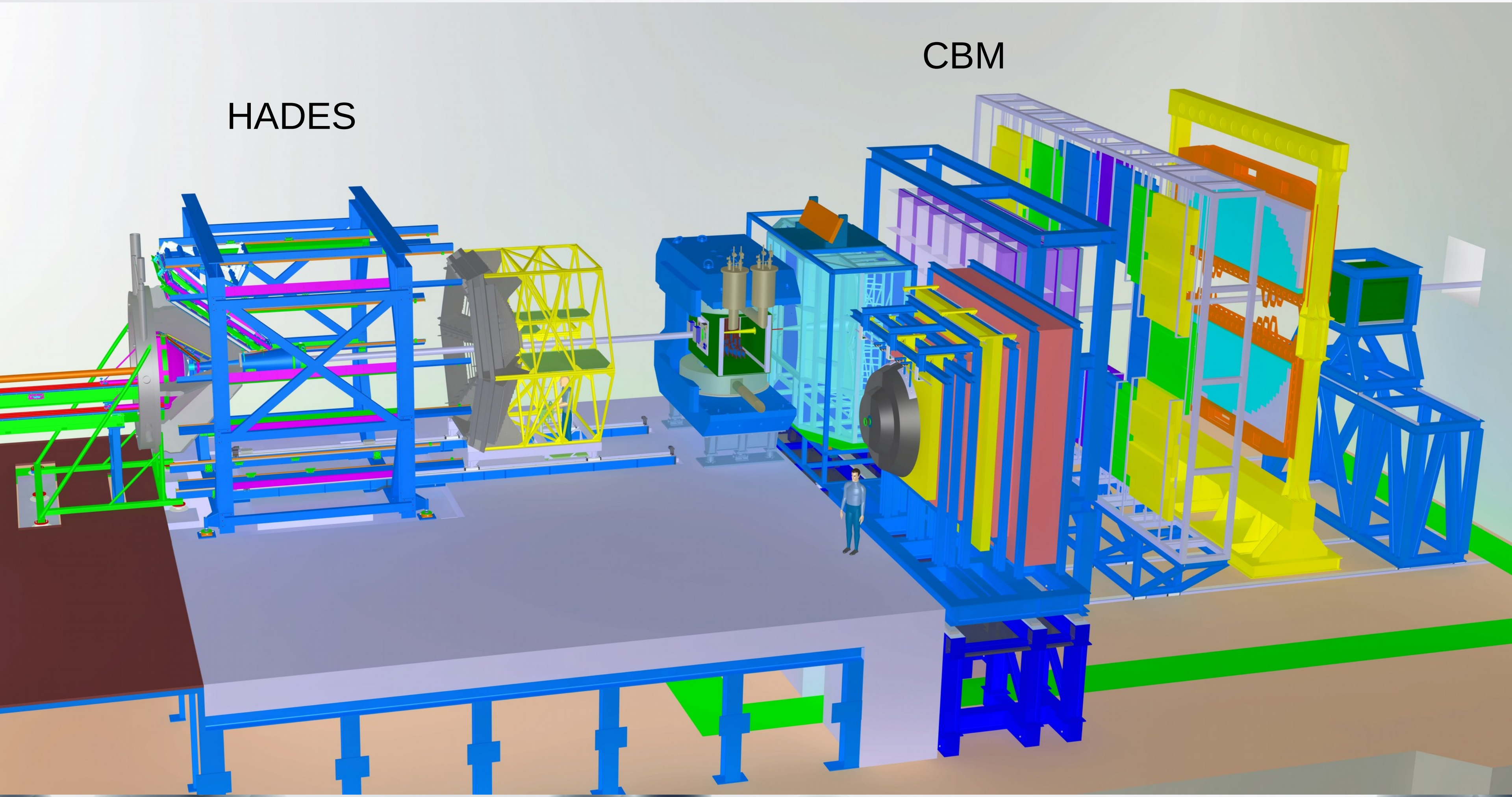
Rapidity distribution of THESEUS output



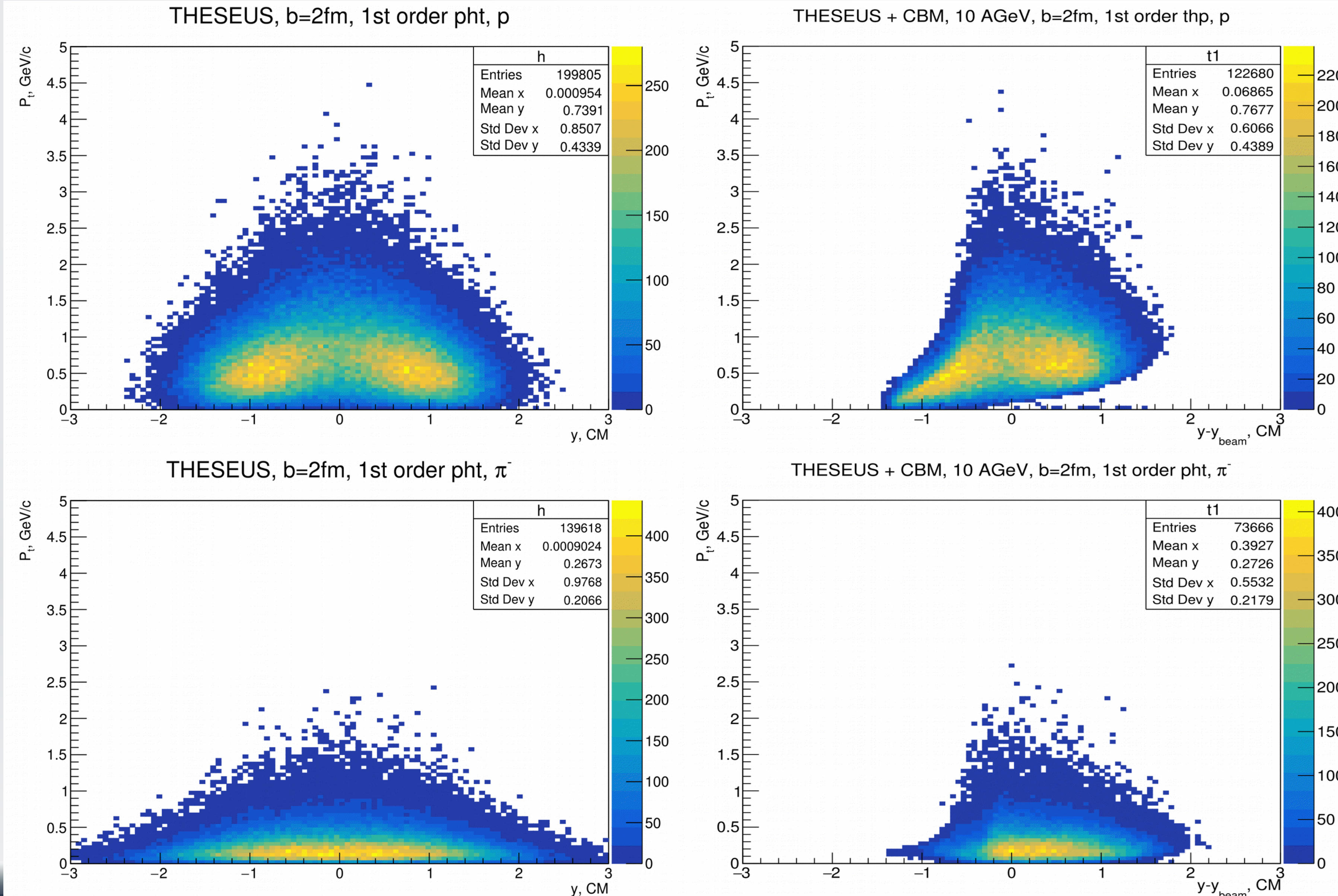
CBM setup

CBM is fixed target experiment with a polar angle acceptance between 2.5^{o} — 25^{o}

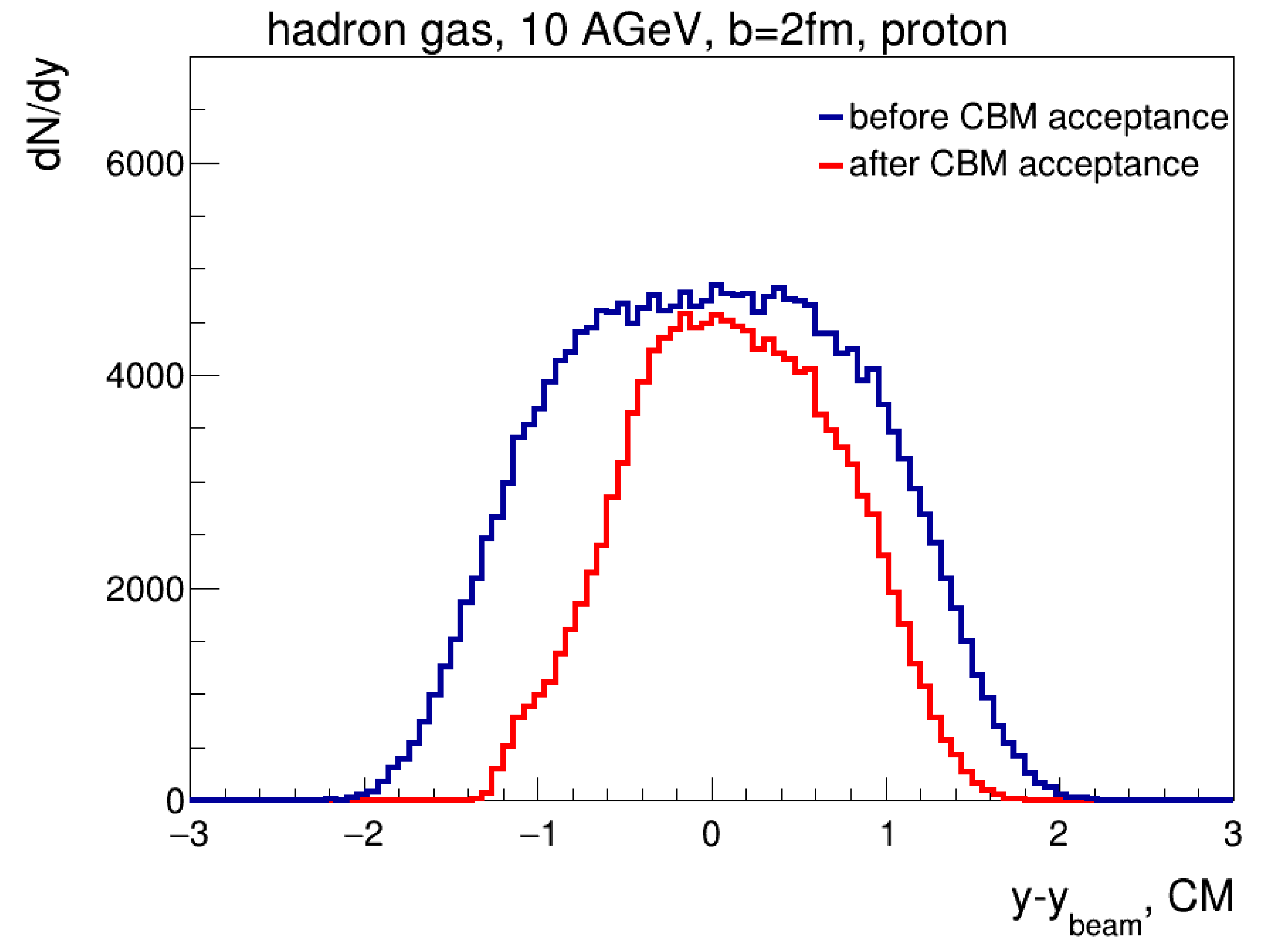
Energy range: 2-10 AgeV at SIS100 for AuAu collisions



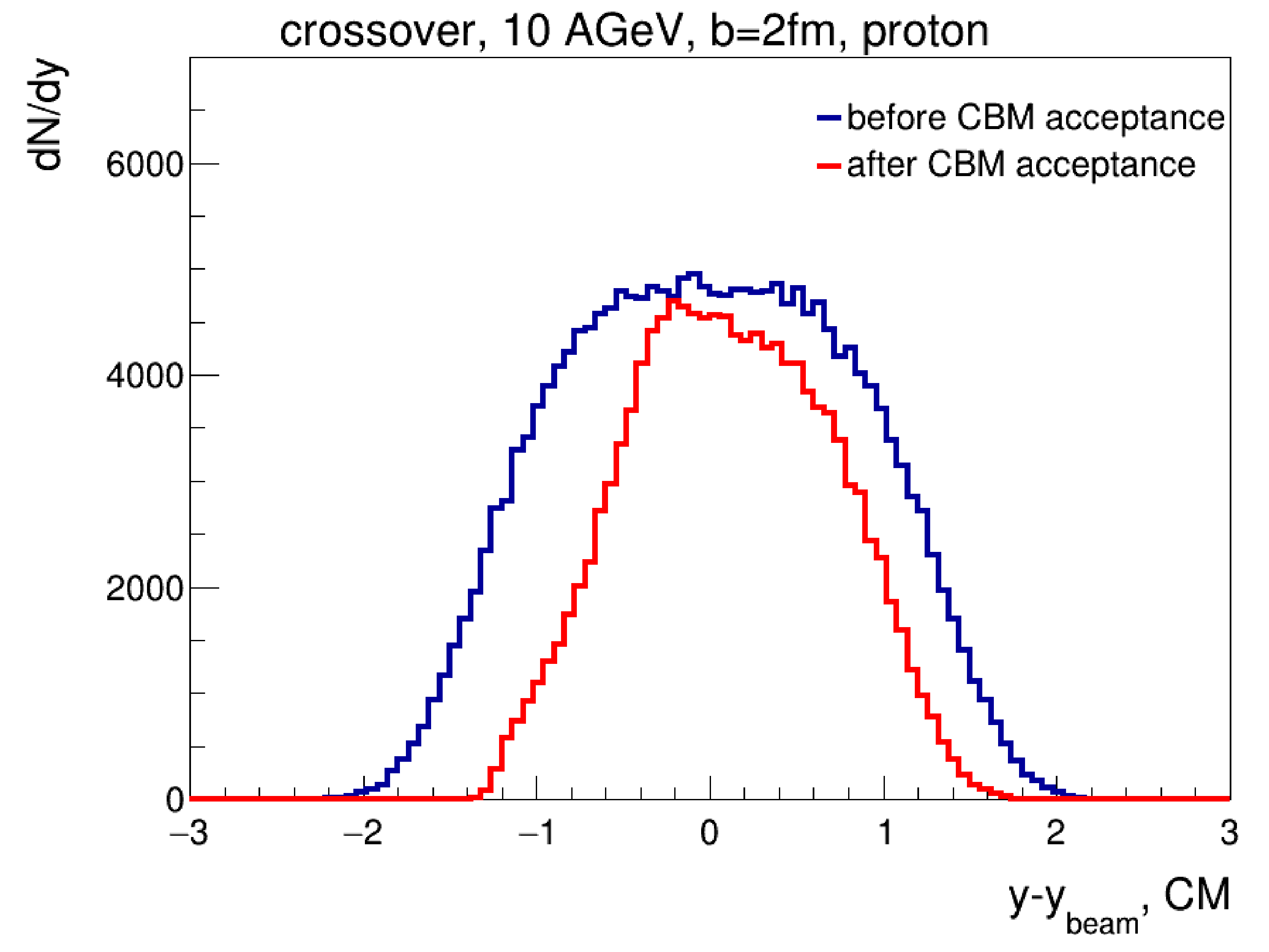
Effect of CBM acceptance cuts



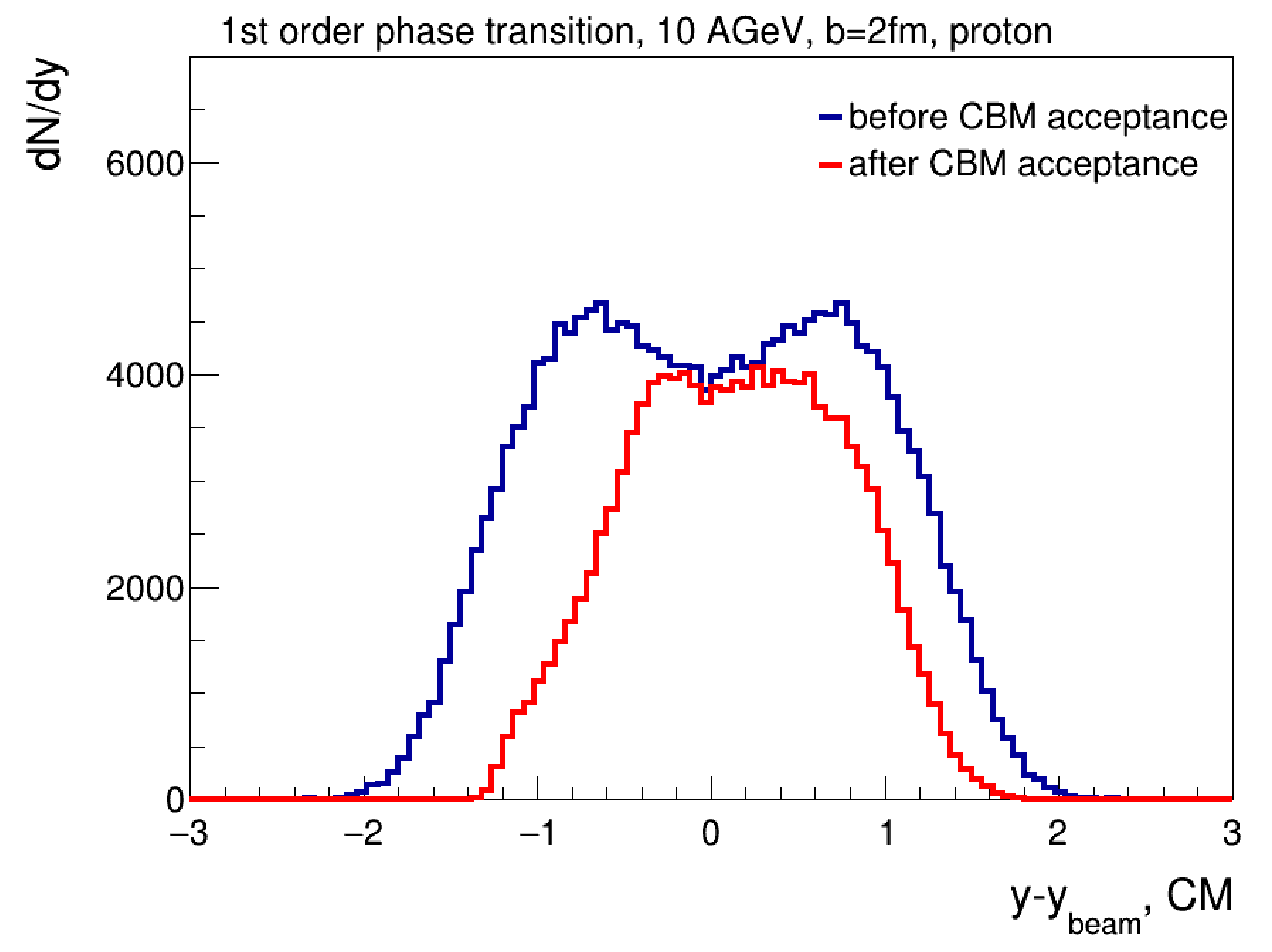
Rapidity distribution for hadron gas before and after CBM



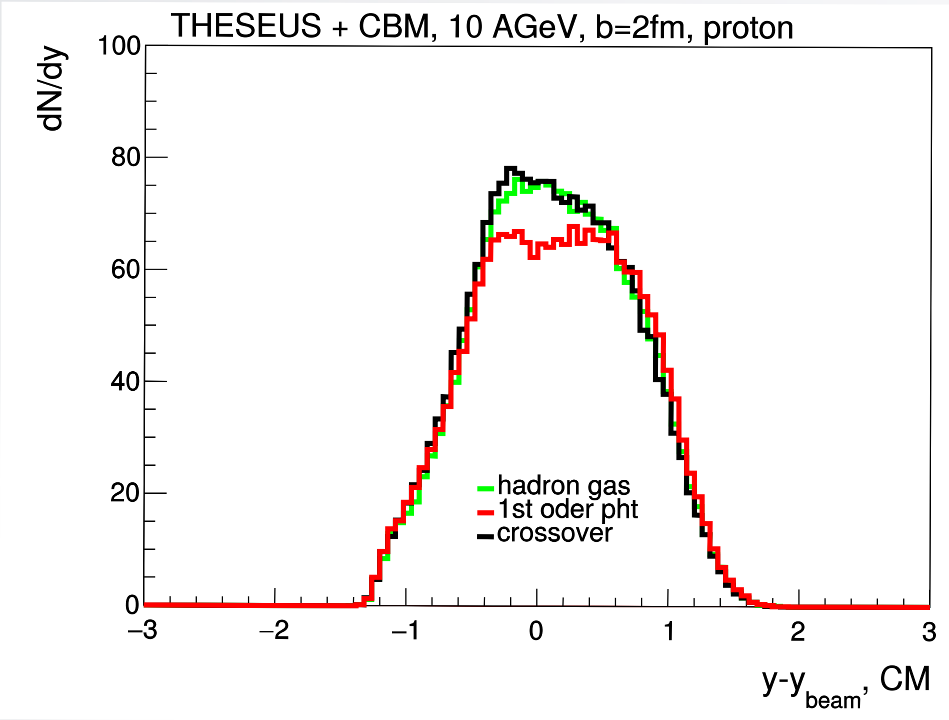
Rapidity distribution for crossover before and after CBM

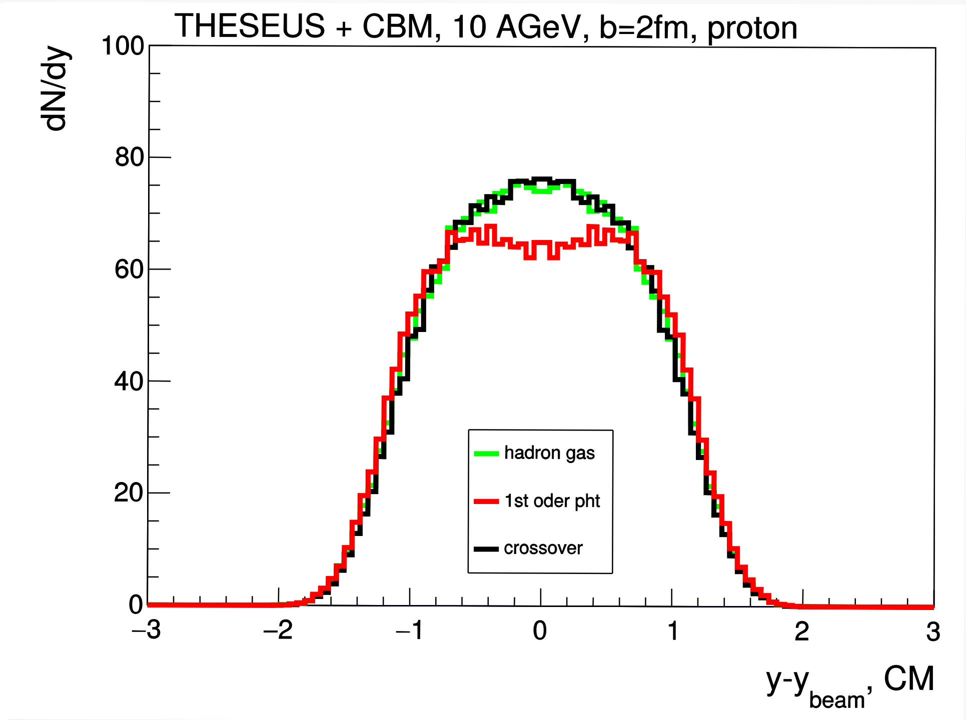


Rapidity distribution for 1st order pht before and after CBM

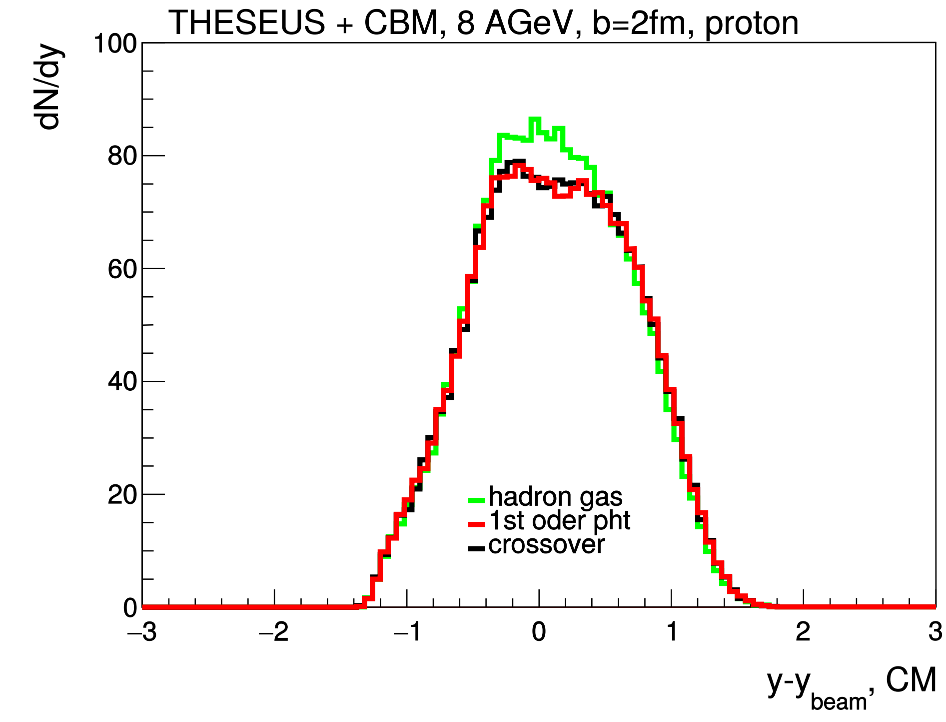


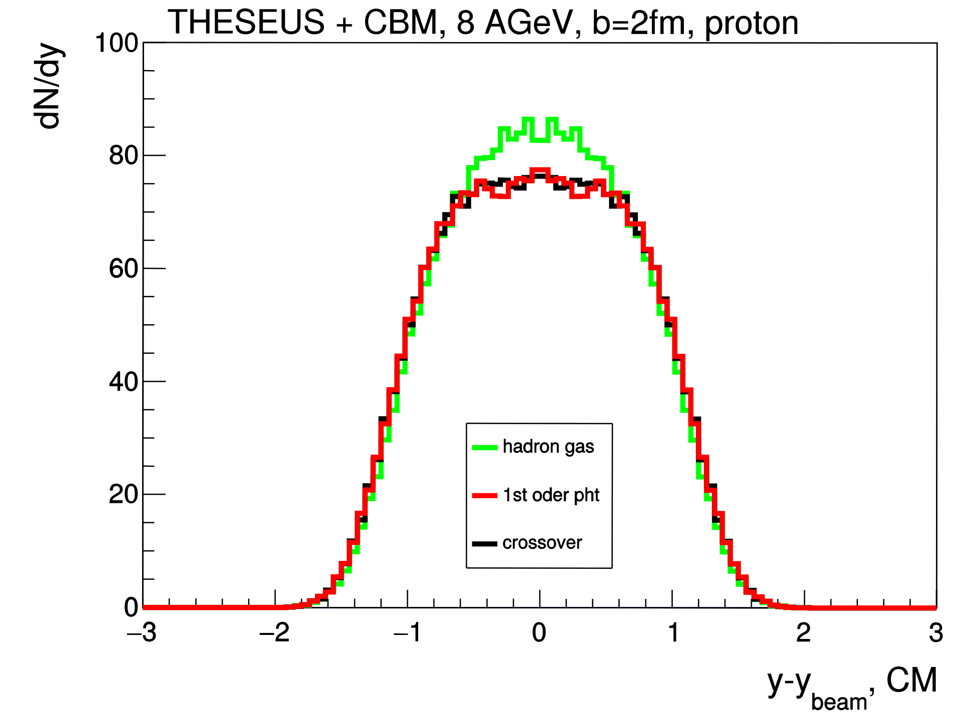
Rapidity distribution for different EoS at 10 AGeV after CBM



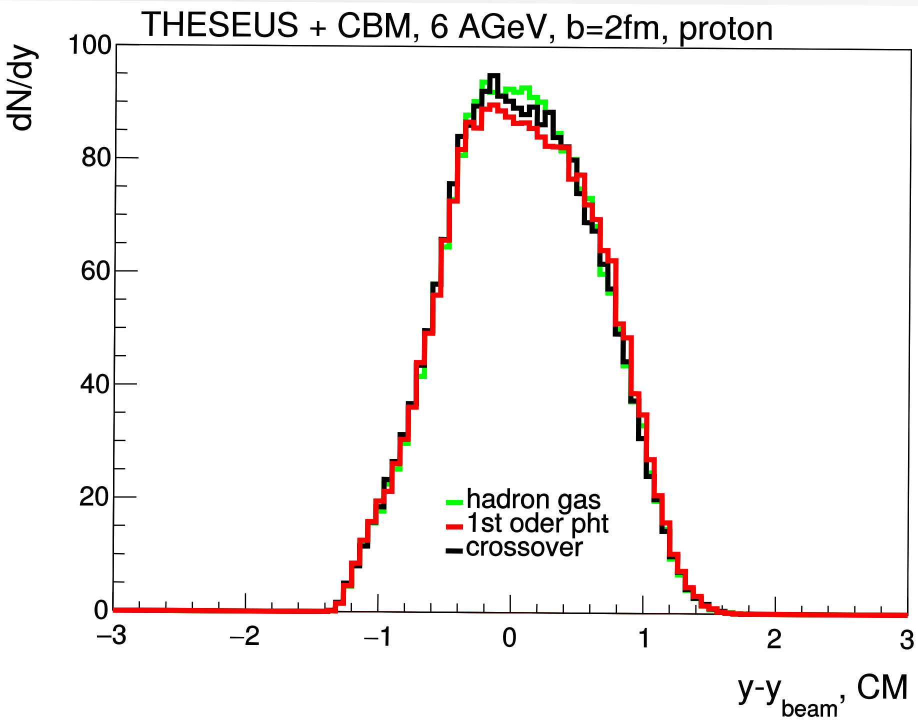


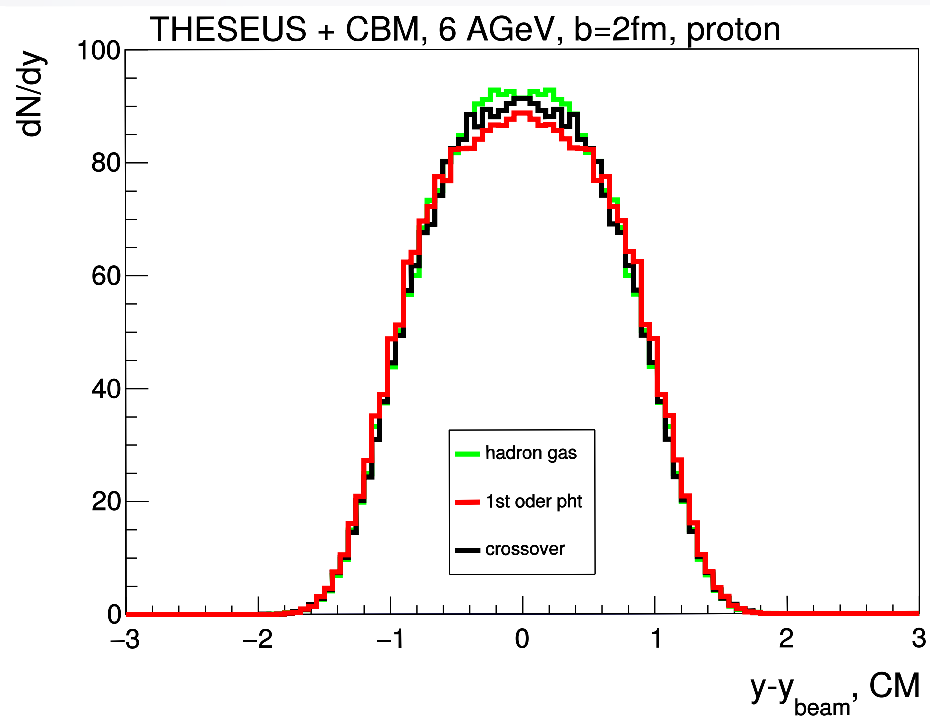
Rapidity distribution for different EoS at 8 AGeV after CBM





Rapidity distribution for different EoS at 6 AGeV after CBM

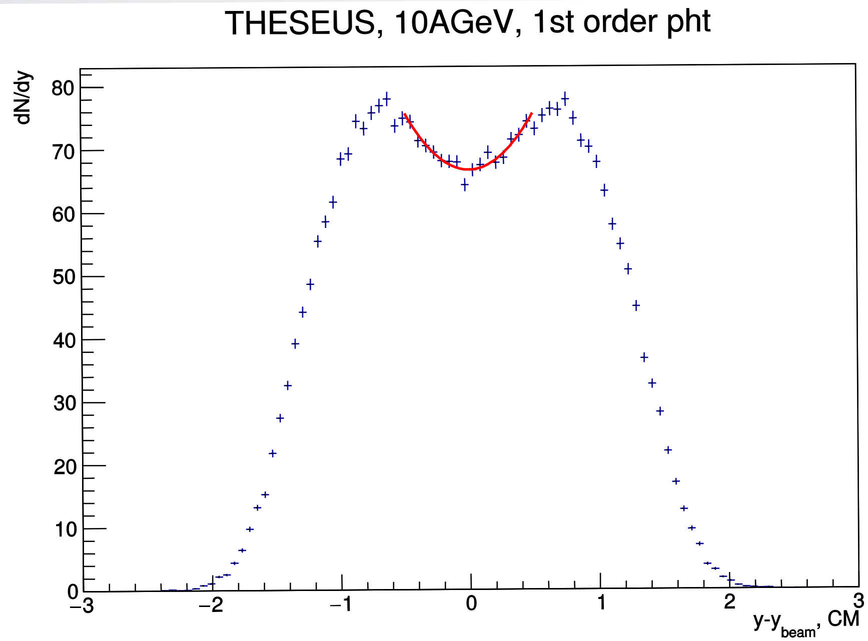


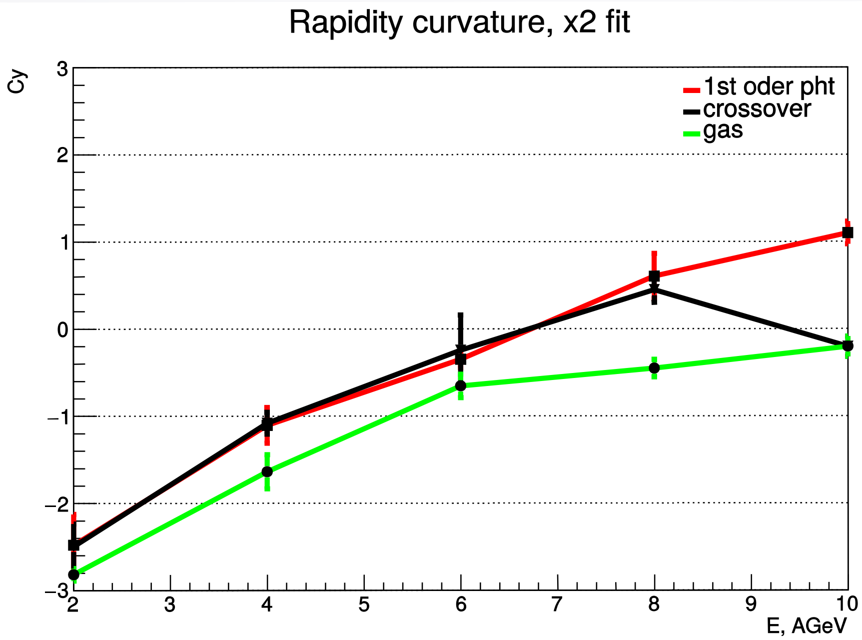


Quantitative analysis of rapidity distributions

Rapidity distribution can be analyzed quantitatively by looking at the curvature at mid-rapidity for different energies.

$$C_y \equiv \left(y_{cm}^3 \frac{d^3N}{dy^3} \right)_{y=y_{cm}} \Big/ \left(y_{cm} \frac{dN}{dy} \right)_{y=y_{cm}}$$



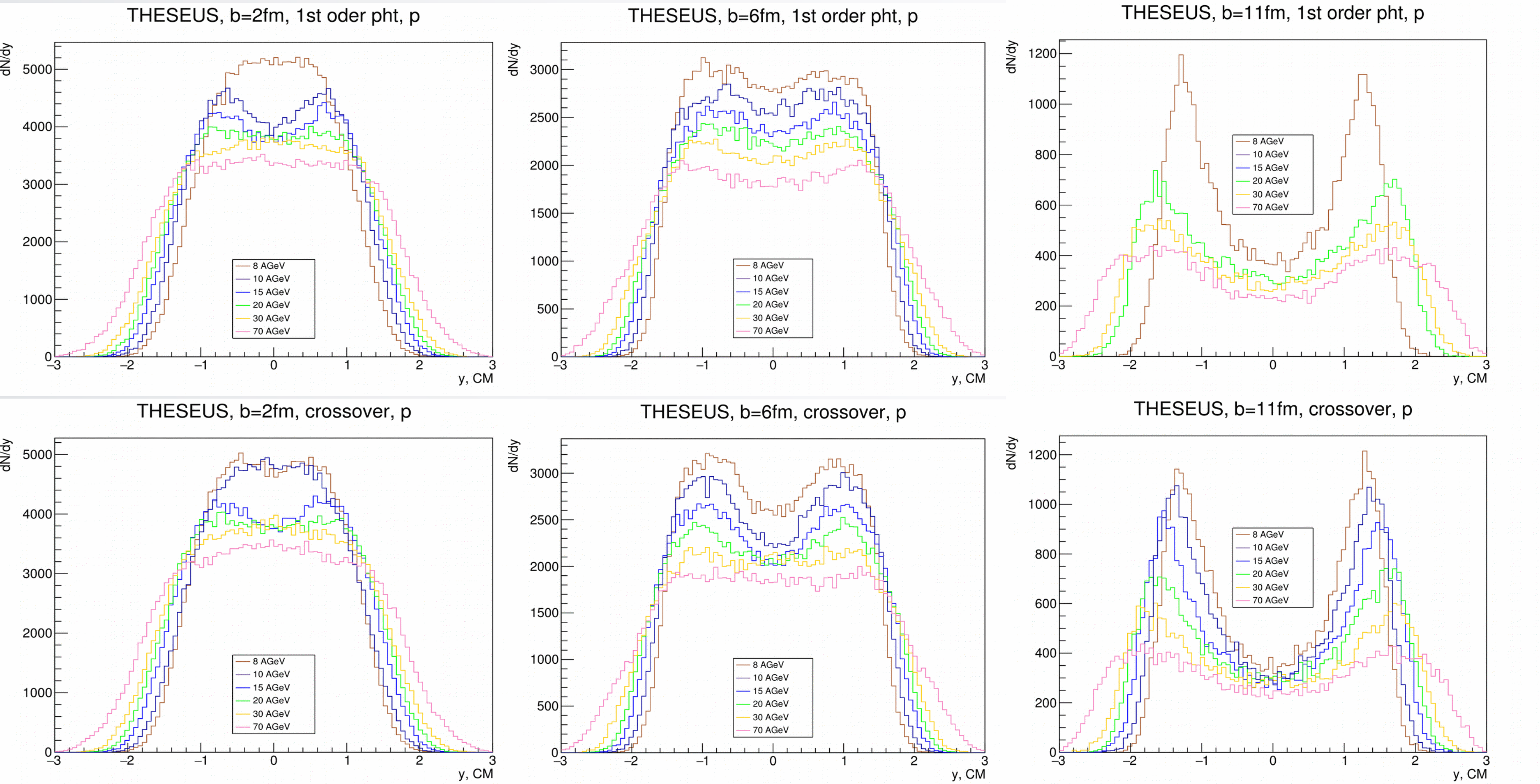


Conclusions

- Features of different EoS are (partly) presented in this talk;
- Rapidity distributions allows in principle to distinguish 1st order phase transition EoS and crossover with gas EoS;
- This features are preserved to some extent also with CBM acceptance cuts.
- The midrapidity shape can be measured by its «curvature»;
- Energy scan for the curvature C_y of the net proton rapidity distribution is observable for differentiation EoS. («Event simulation based on three-fluid hydrodynamics for collisions at energies available at the NICA and at the FAIR» P.Batyuk, D.Blaschke,Yu. B.Ivanov, Iu.Karpenko)

Backup

Rapidity evolution with energy

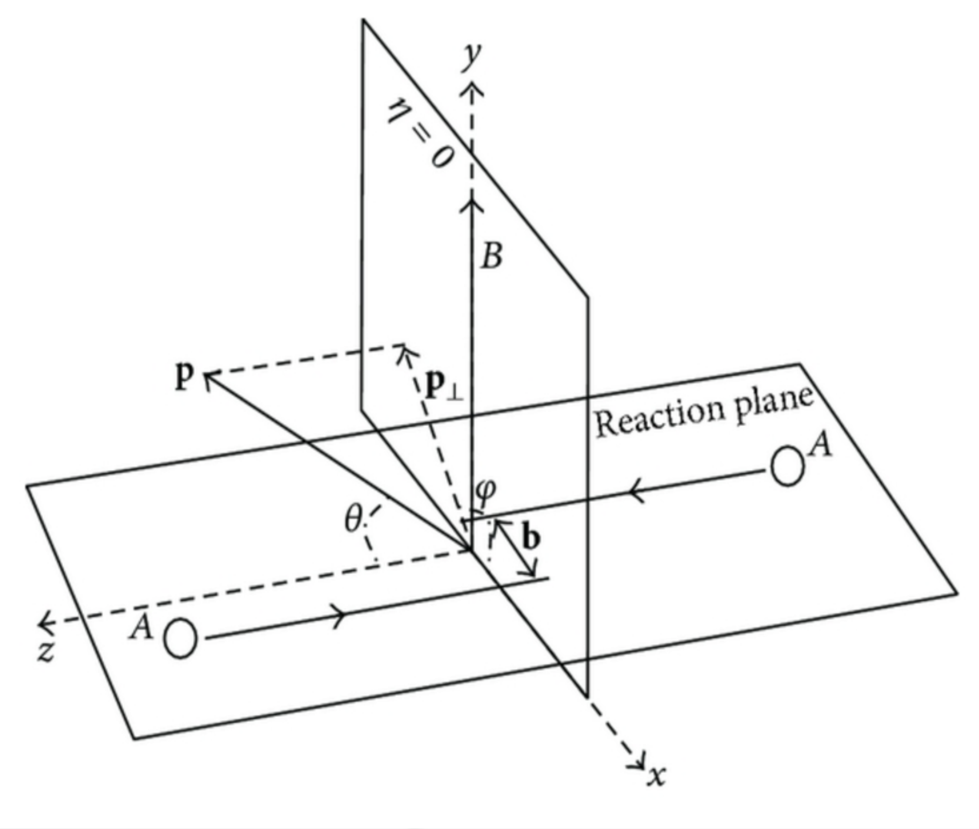


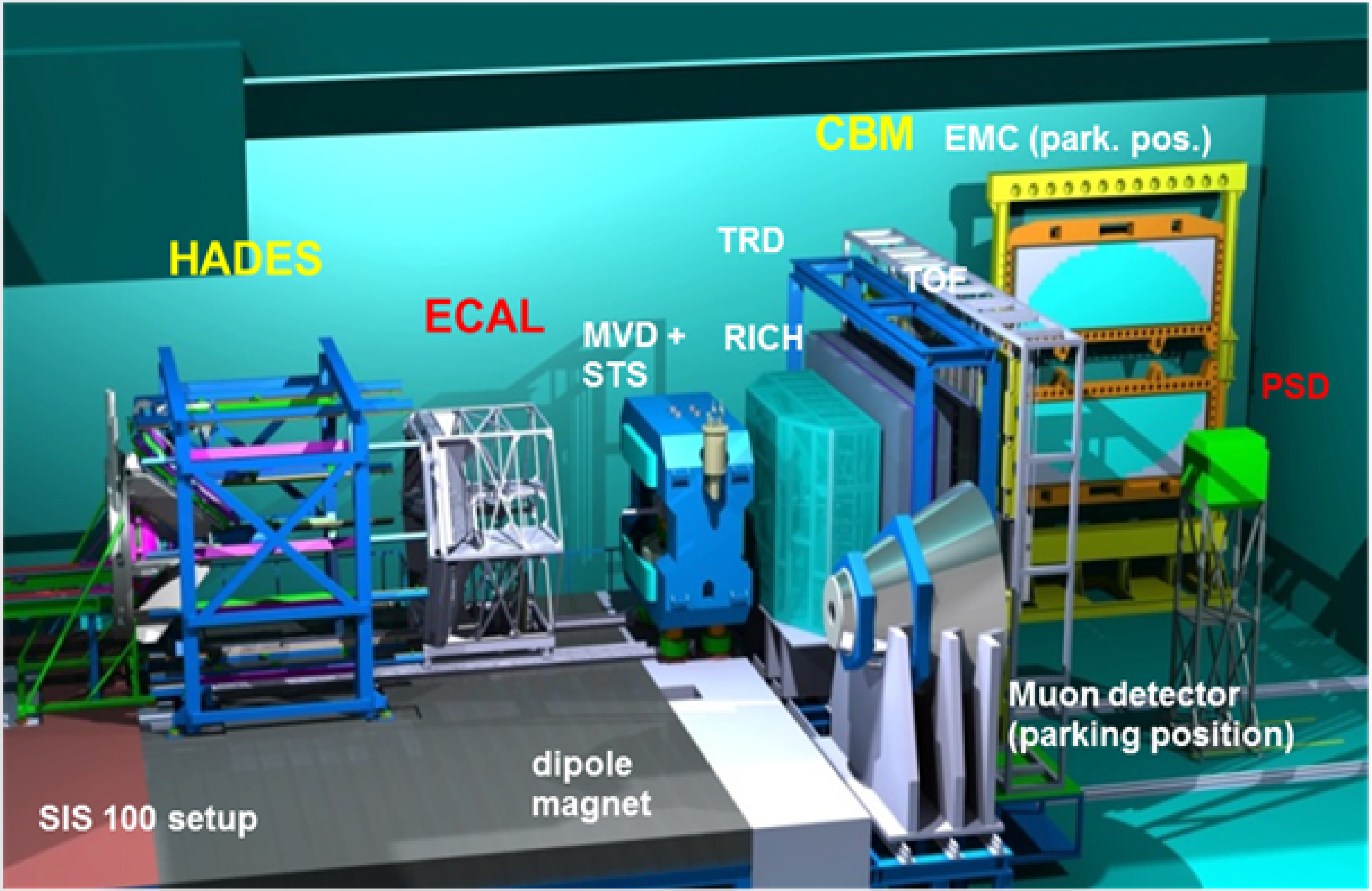
Particalization

- With density decrease the fluid approximation loses its applicability and individual particles get relevant degrees of freedom.
- Particalization is not Freez-out! Its only resonance decay after Freez-out.
- Output is set of droplets (or surface elements) with proper volume, temperature, baryon and strange chemical potentials and collective flow velocity parameters.
- The thermodynamic parameters of droples correspond to a free hadron resonance gas.

Y = ½ ln(E+pz/E-pz)

$$C_y \equiv \left(y_{cm}^3 \frac{d^3 N}{dy^3} \right)_{y=y_{cm}} \Big/ \left(y_{cm} \frac{dN}{dy} \right)_{y=y_{cm}}$$




CBM
EMC (park. pos.)
HADES
TRD
TOF
ECAL
MVD +
STS
RICH
PSD
Muon detector
(parking position)
dipole
magnet
SIS 100 setup