Performance of charged hadrons identification in the CBM experiment

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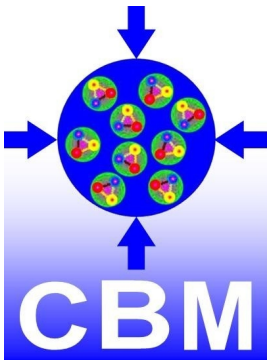
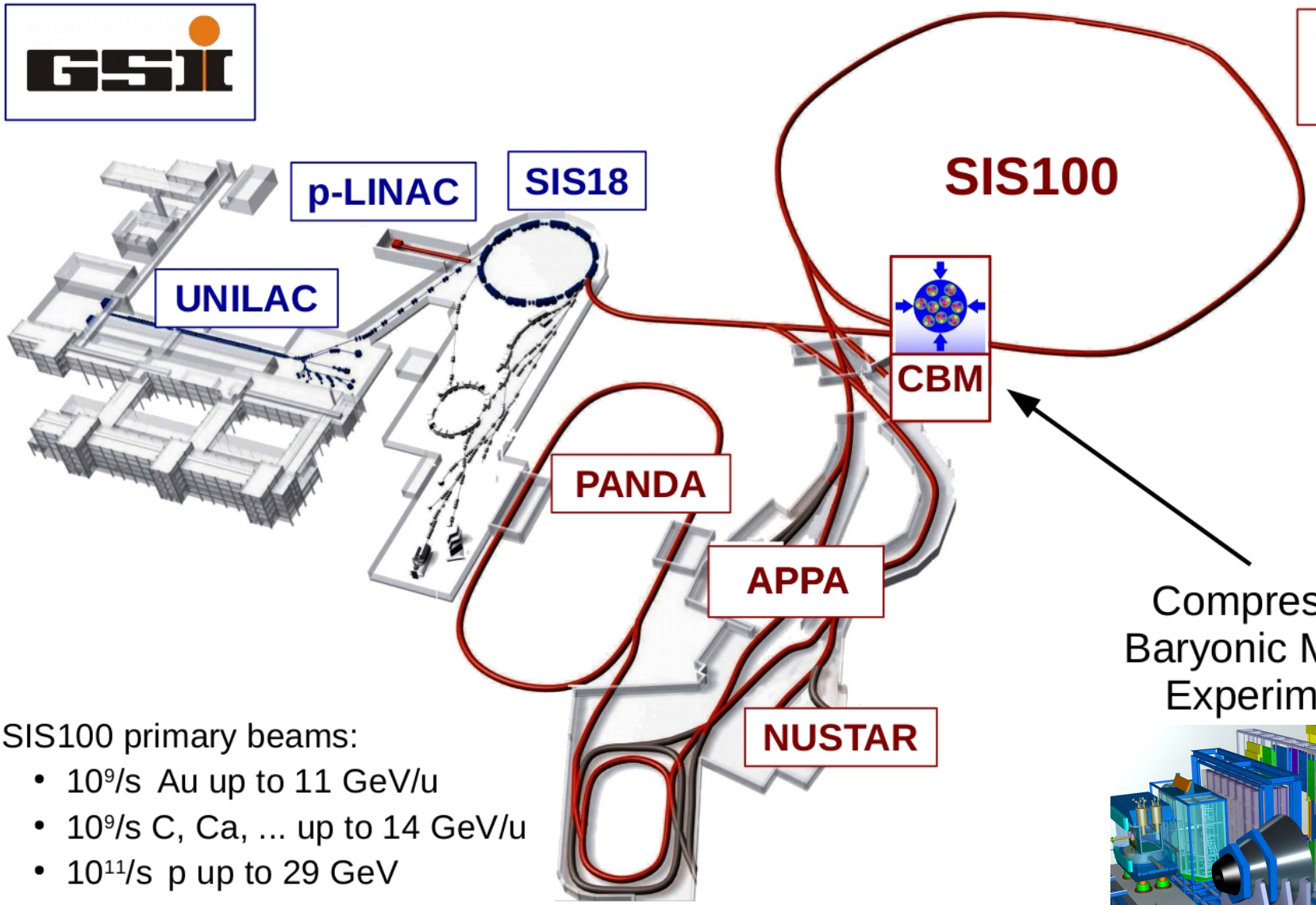


Facility for **A**ntiproton and **I**on **R**esearch (FAIR)

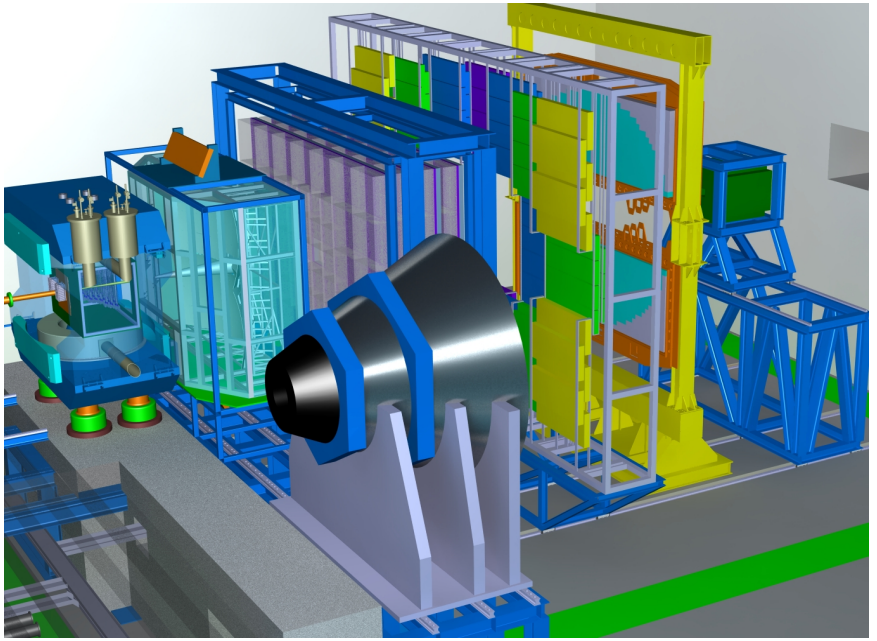


SIS100 primary beams:

- 10^9/s Au up to 11 GeV/u
- 10^9/s C, Ca, ... up to 14 GeV/u
- 10^{11}/s p up to 29 GeV

Simulation setup

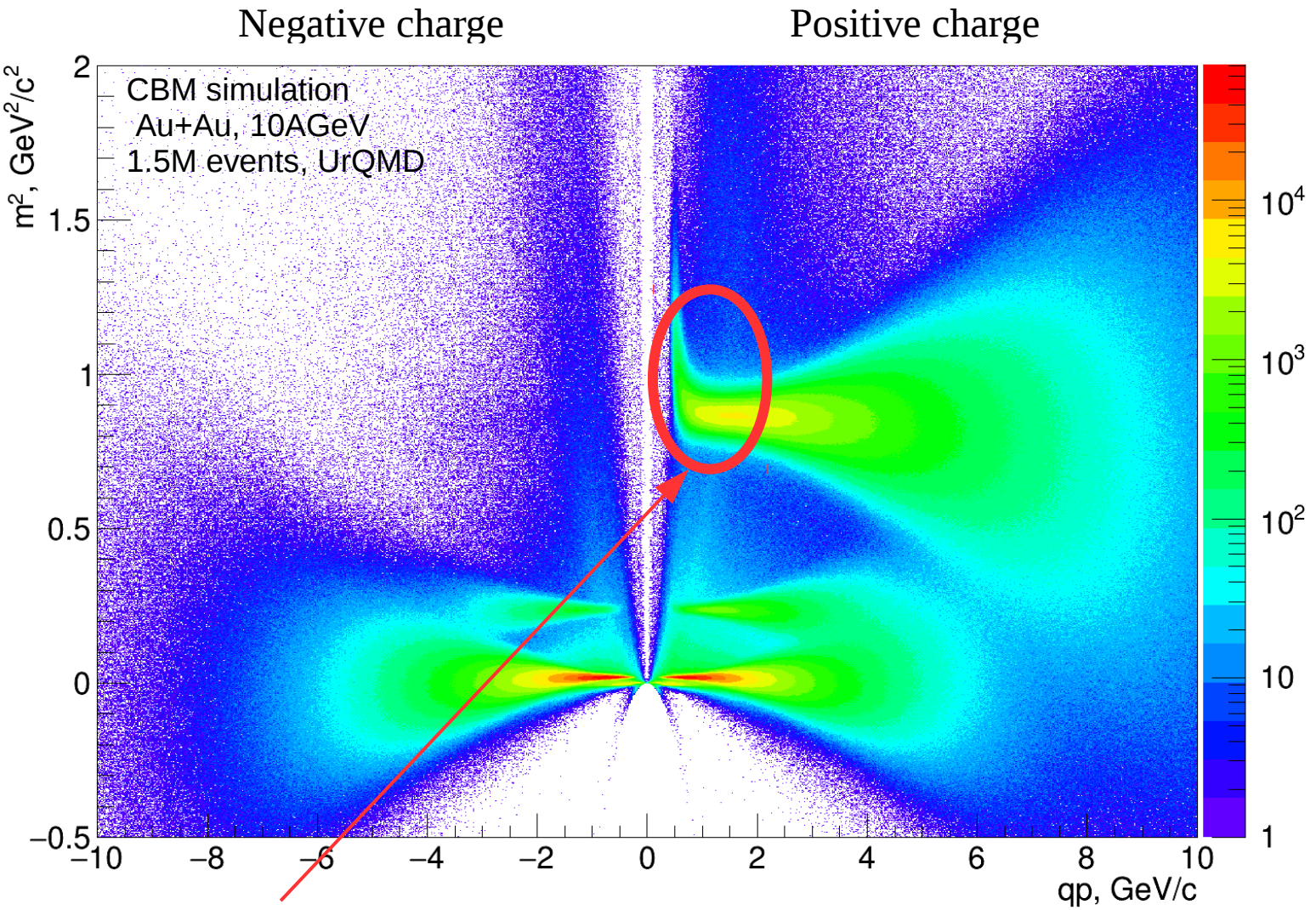
Model	UrQMD (no fragments)
System	Au-Au
Beam energy	10 AGeV
Statistics	1.5M events
CBM geometry	MVD, STS, RICH, TDR, TOF, PSD
TOF geometry	6 m from the target size ~ 12×9m^2 number of modules - 226 6 different types of modules
Transport code	GEANT3
Detector response	CBMRoot



Track cuts:

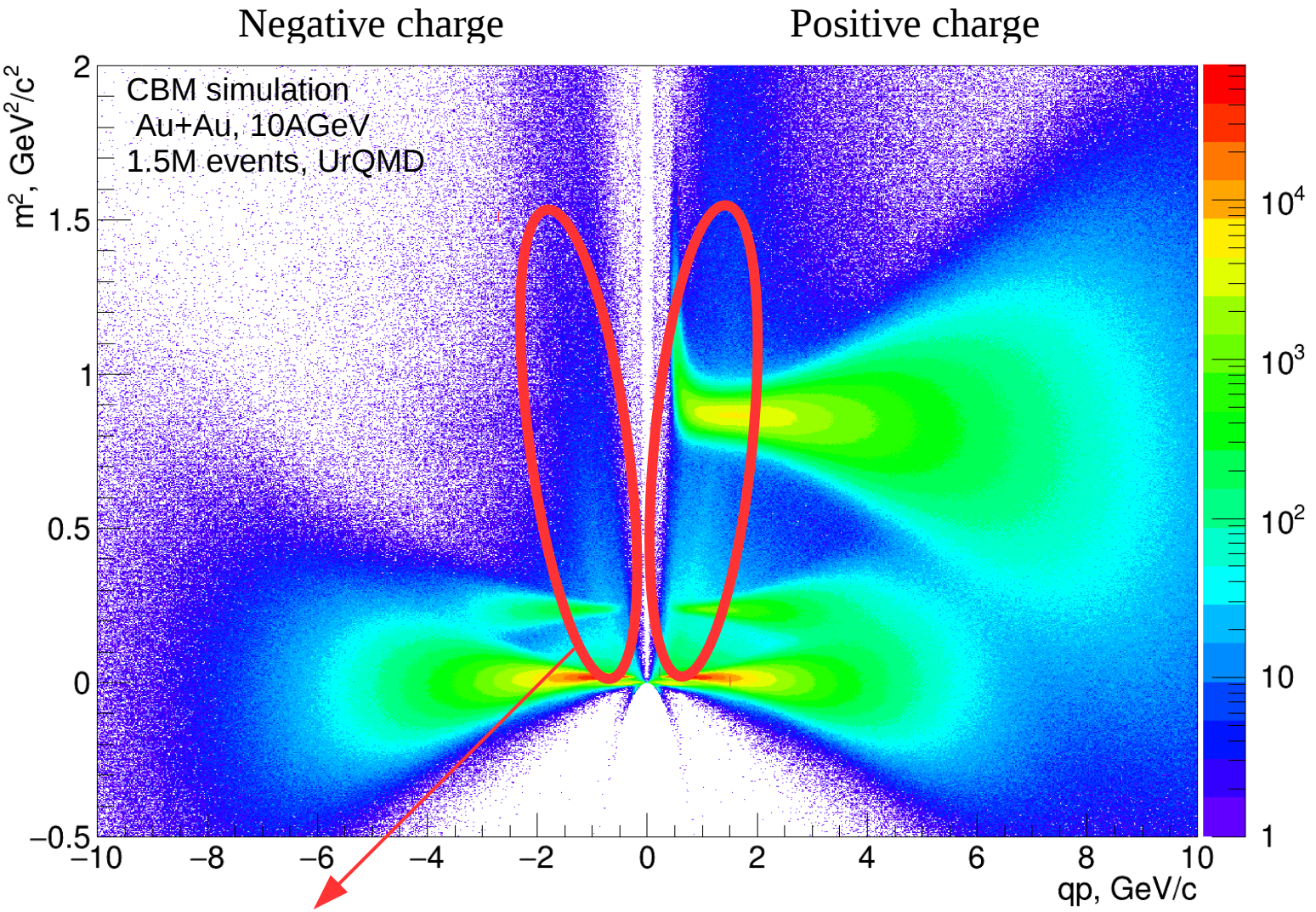
- Number of hits $N_{hits} > 3$
- Fit quality $\chi^2/NDF < 3$
- $DCA_x^2 + DCA_y^2 < (0.1\ cm)^2$
- $|DCA_z| < 0.2$ cm

Particle identification with TOF



Pion mass assumption during track reconstruction

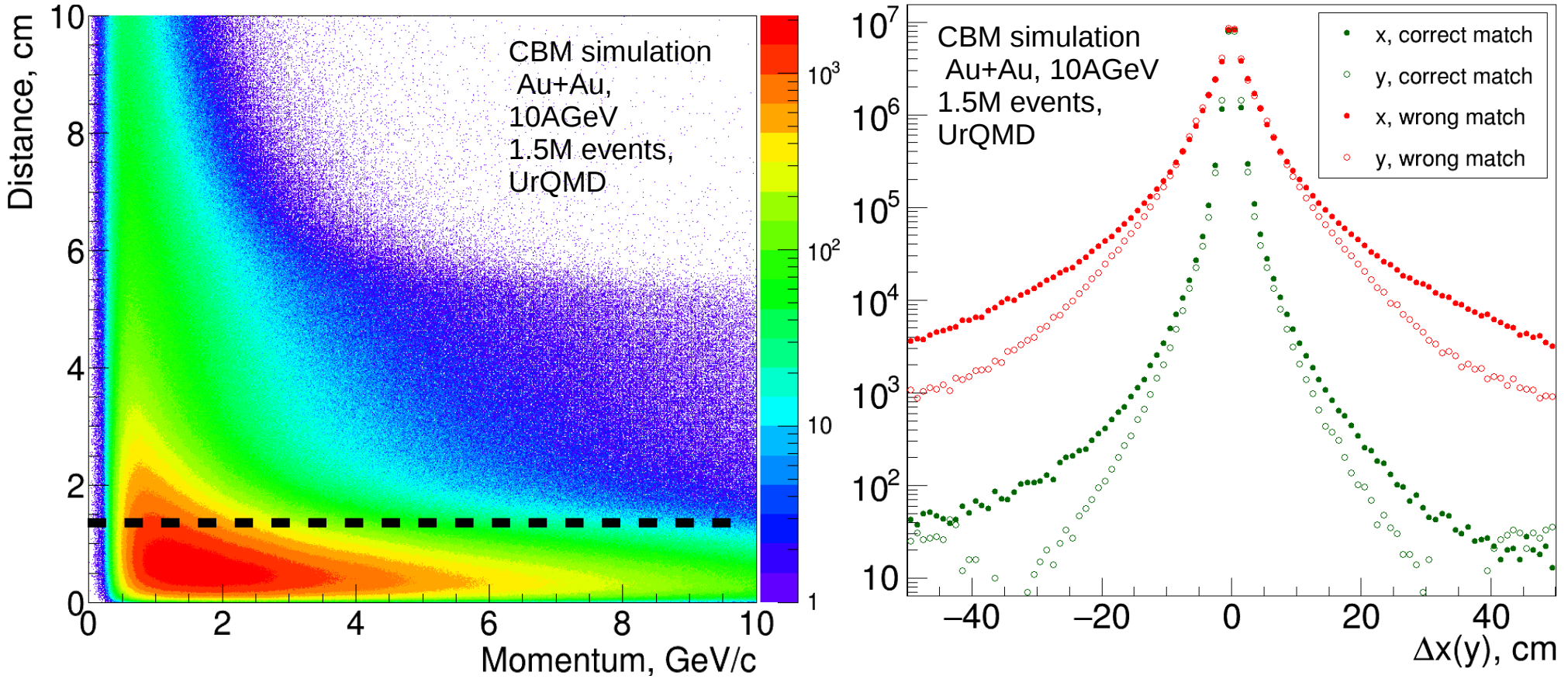
Particle identification with TOF



STS-TOF mismatch.
Additional cuts are needed to remove mismatch

Distance between TOF hits and associated track

distance vs momentum



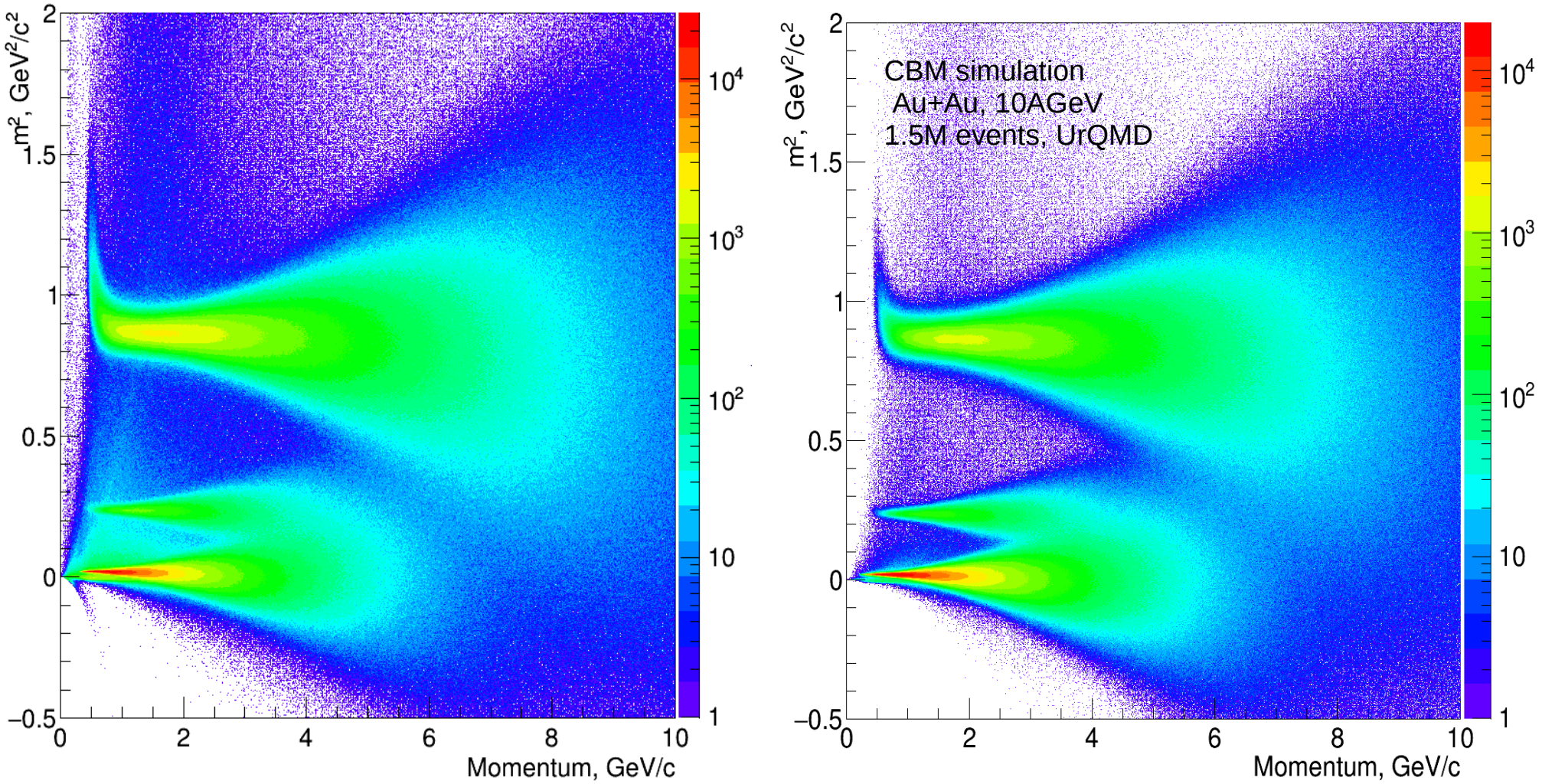
Cut on distance between TOF hit and extrapolated STS track
$dx^2+dy^2/1.5^2<1$ is applied. In future momentum dependent cut will be introduced.

m^2 vs p before and after applying the cut

before

q>0

after



Most of mismatched tracks are removed

PID algorithm

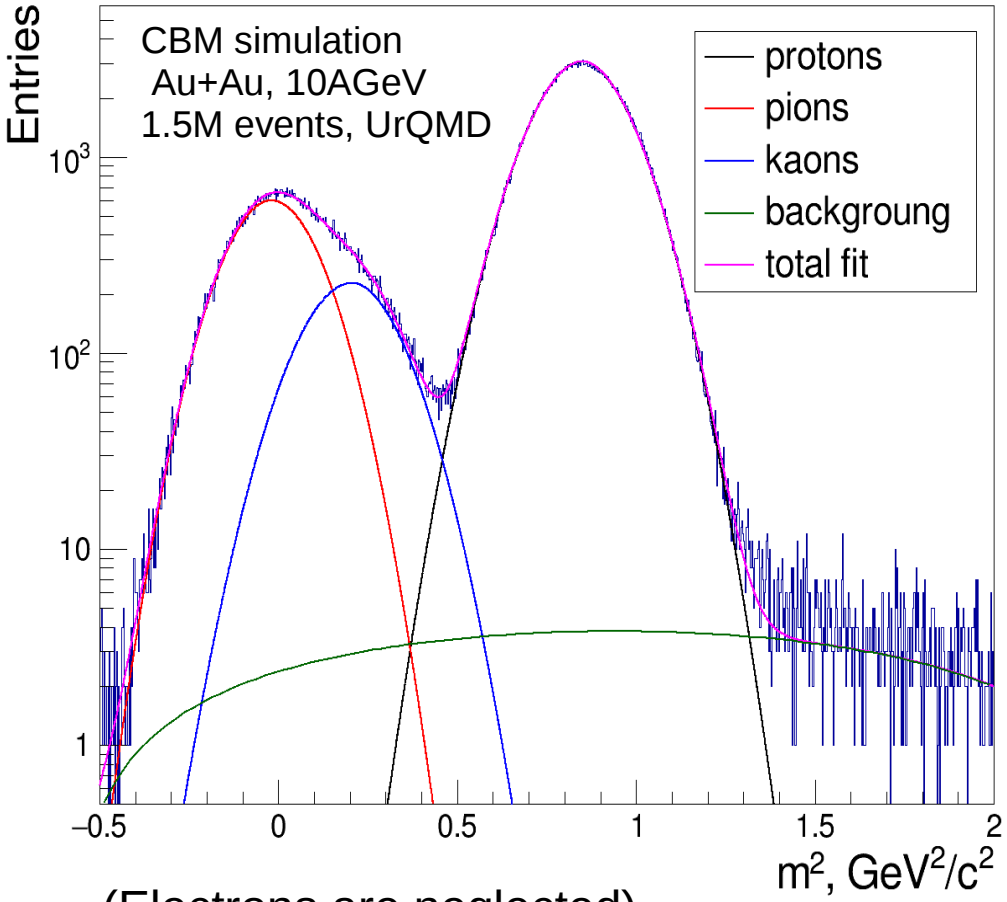
1. Fill m^2 vs p distribution for a pure sample of π, K and p and for all particles

2. Parameterize m^2 distribution in slices of momentum (Gaussians for signal, polynomial function for background)

3. Parametrize momentum dependence of the fit parameters. Repeat until parameters are stabilized

4. Save fit parameters to the ROOT file for further use in the analysis

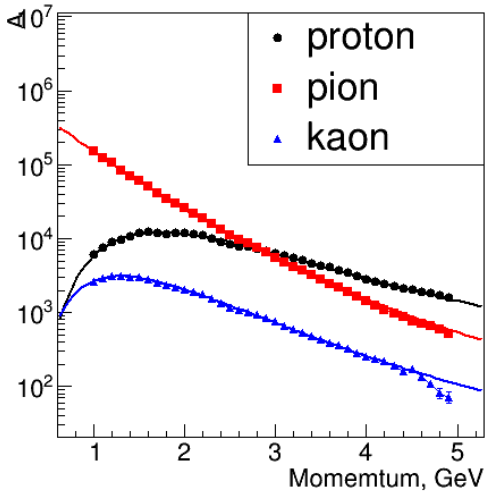
5. In the analysis apply cuts based on the Bayesian probability or distribution width

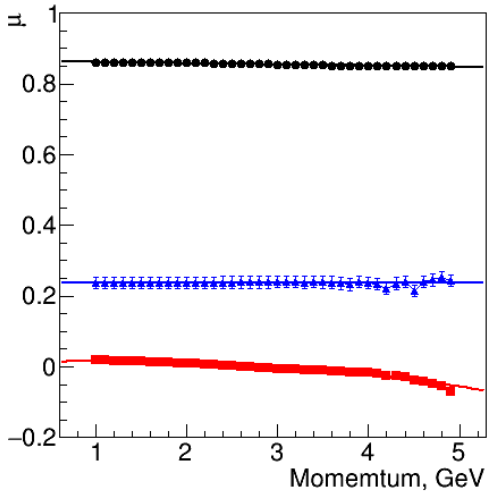


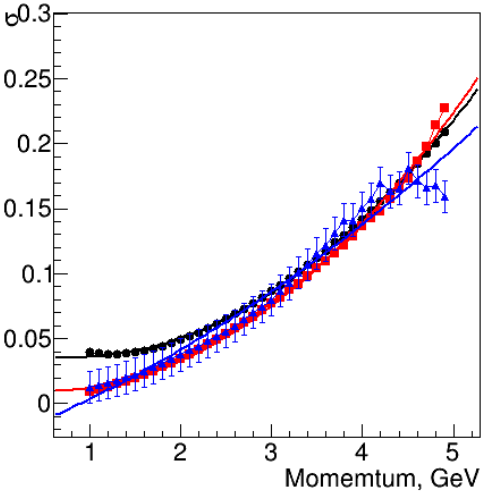
(Electrons are neglected)

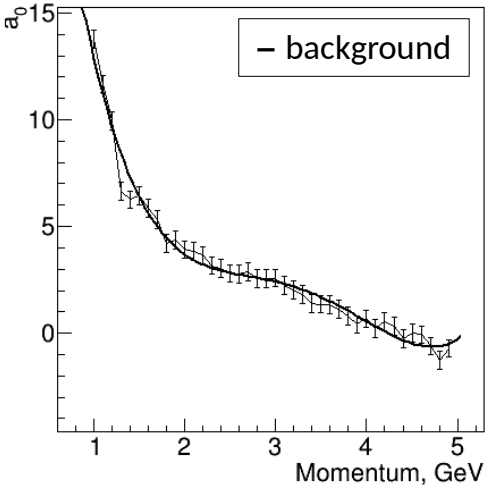
Fit parametrization in momentum bins

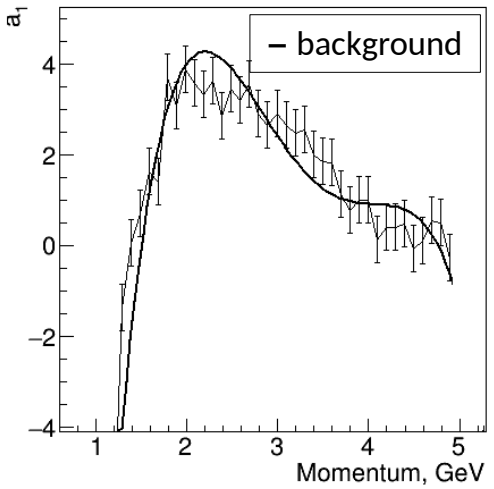
CBM simulation
Au+Au, 10AGeV
1.5M events, UrQMD

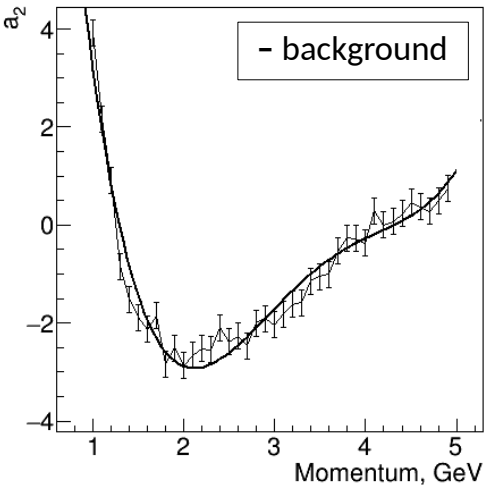












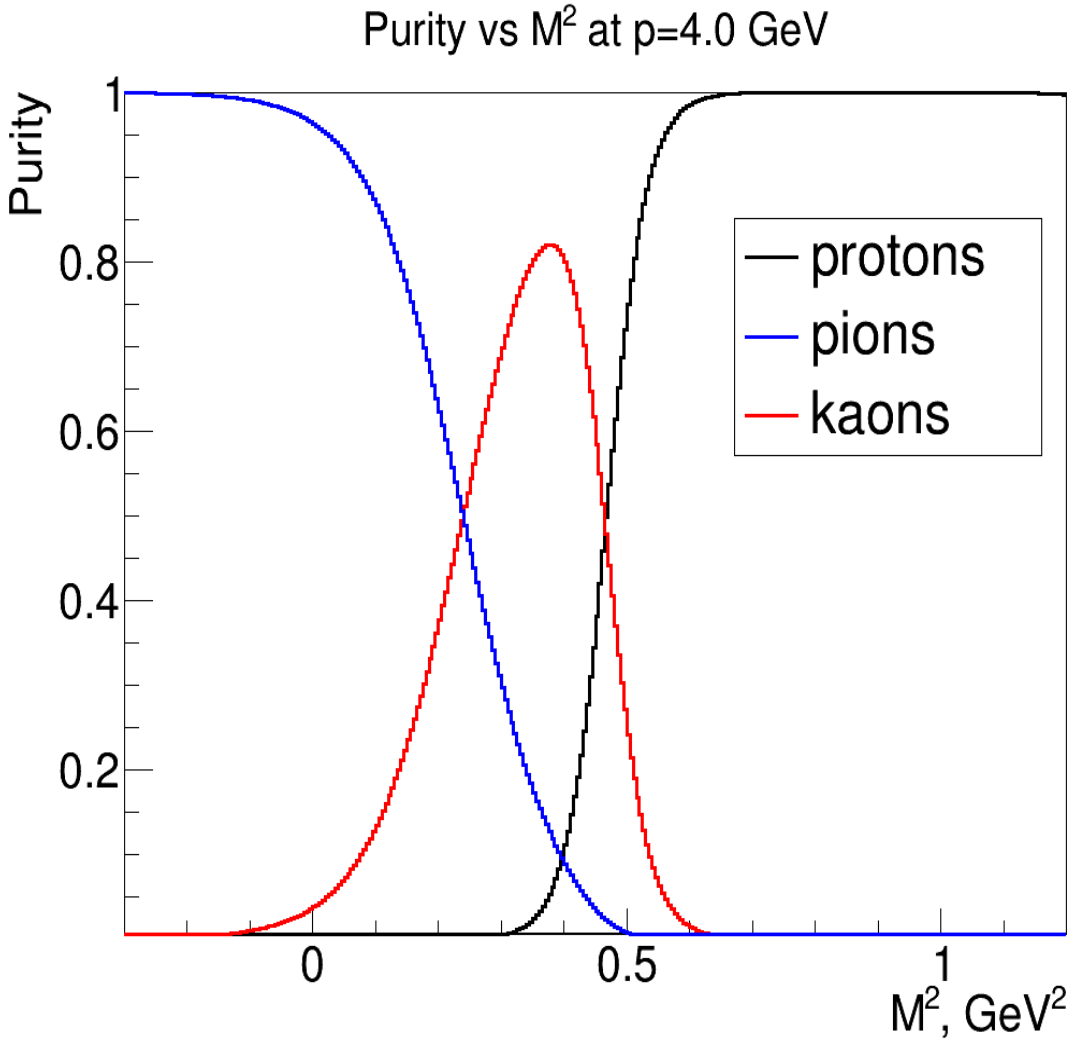
Stable fits in momentum range 1-5 GeV/c

Proton, pion and kaon purity

$$Purity_i = p_i / \left(\sum p_i + p_{bg} \right)$$

$$p_i = A_i e^{\frac{(\mu - m_i^2)^2}{2\sigma^2}}$$

Not possible to select pure sample of kaons in some kinematic regions. Bayesian probability needs to be used.

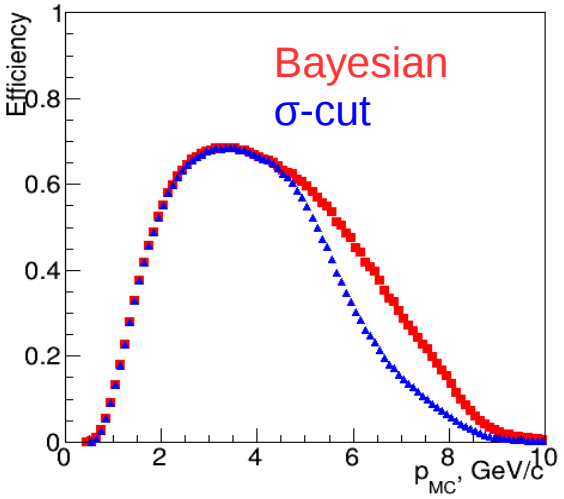


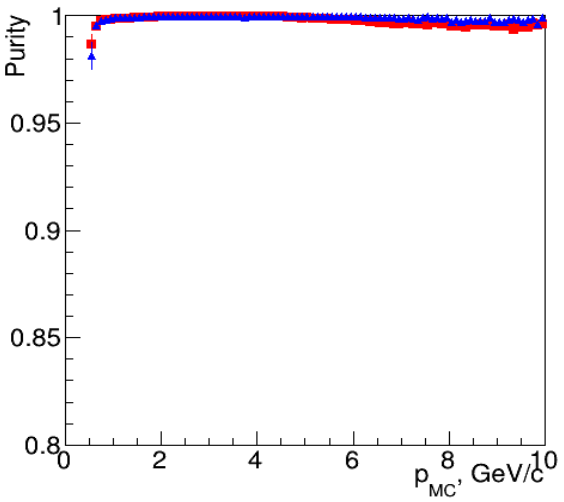
Efficiency & purity

Bayesian approach: purity > 90%
σ-cut: σ < 3 + 2σ exclusion

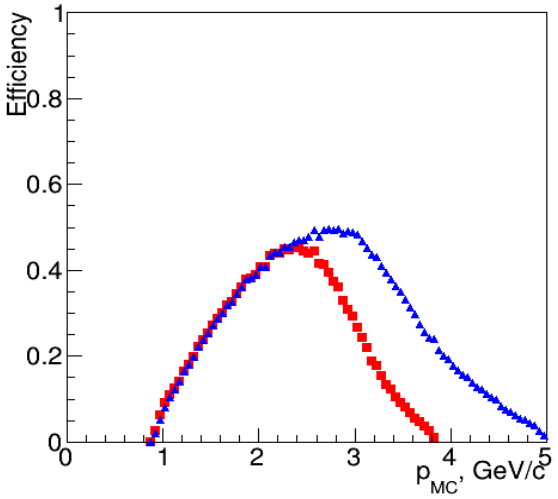
Normalization on total number of simulated particles

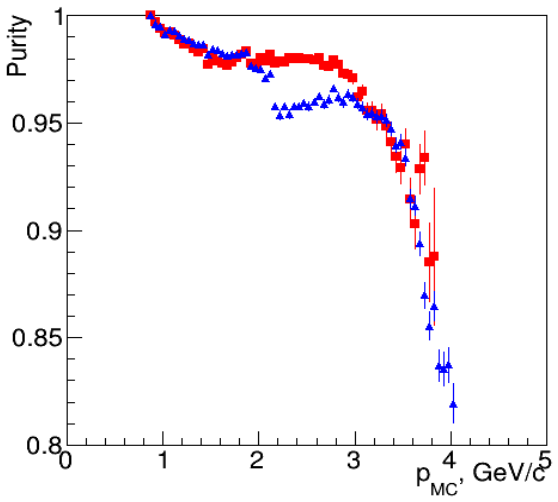
protons



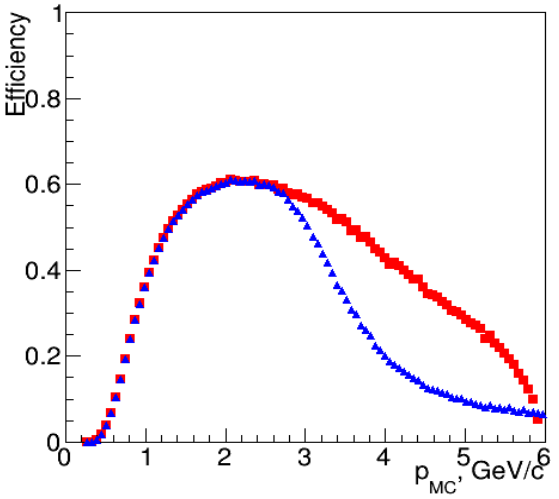


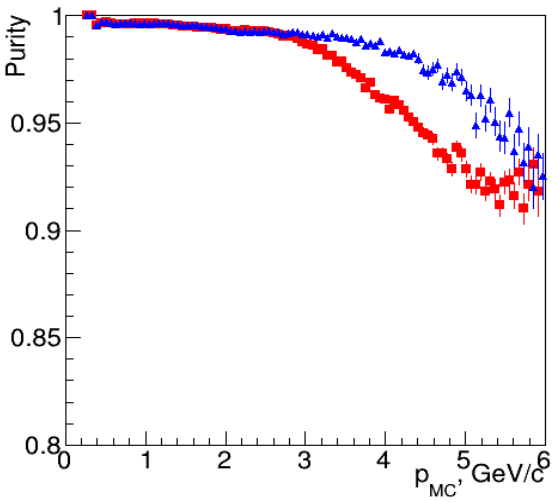
kaons





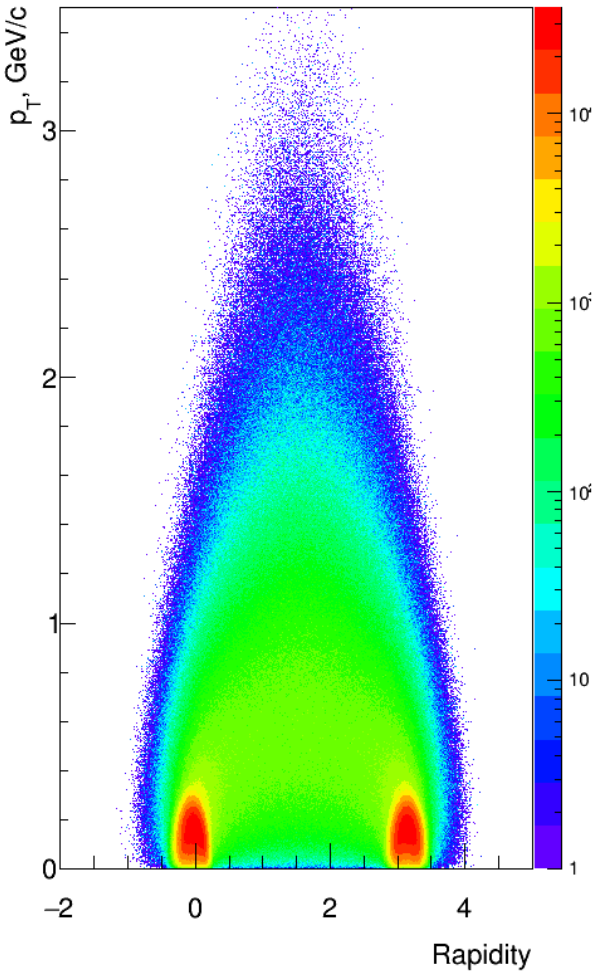
pions





MC p_T-Y distribution

protons



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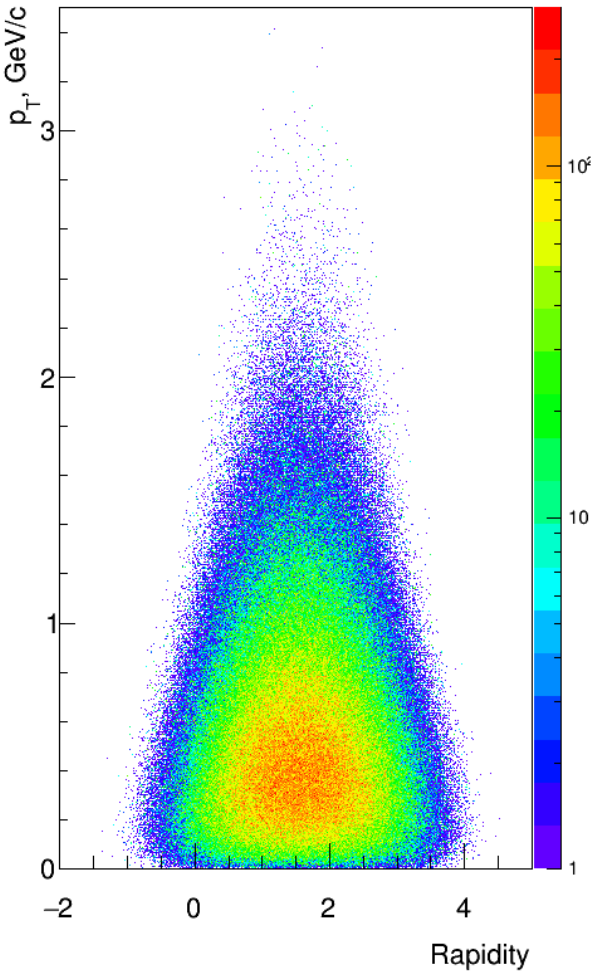

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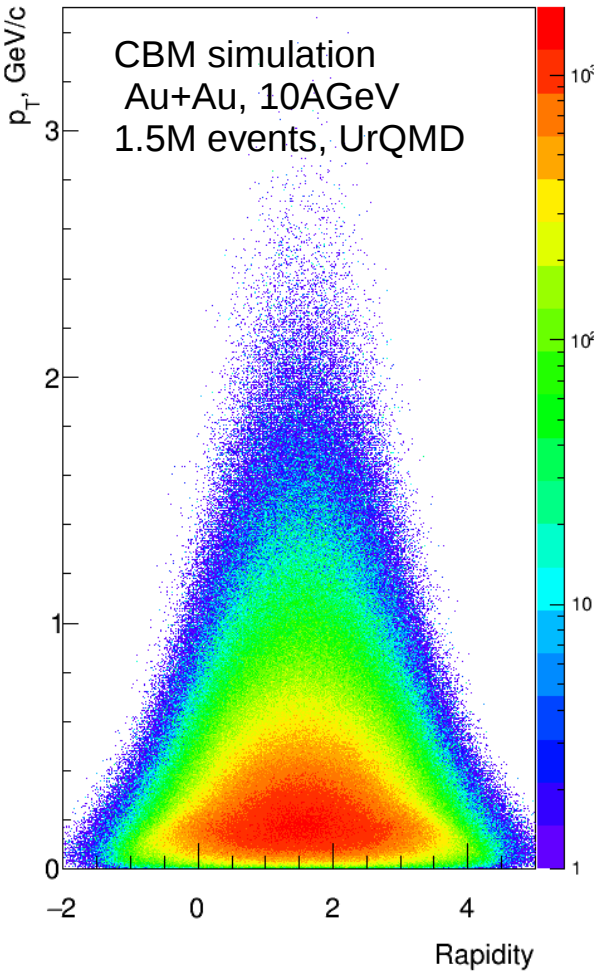
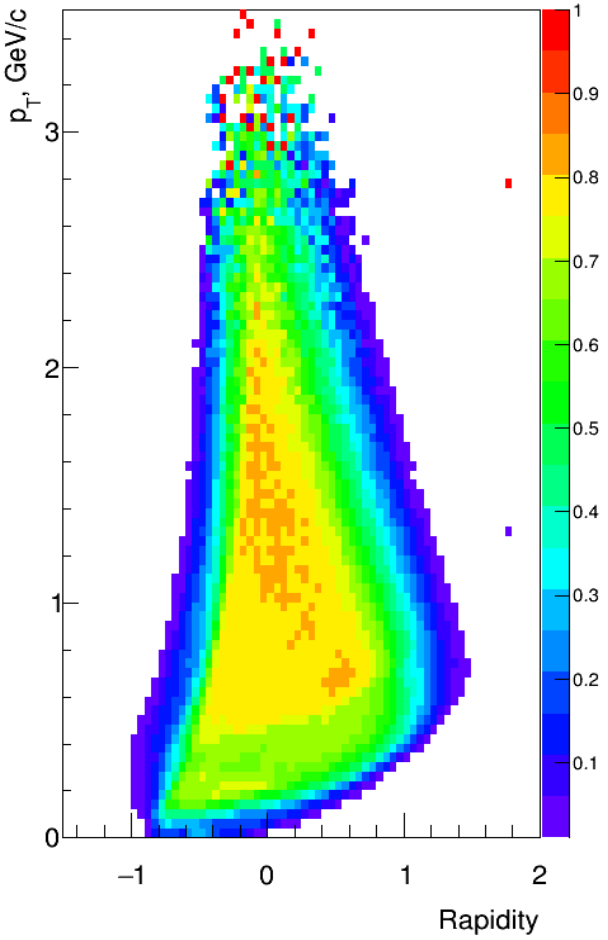


p_T-Y efficiency map

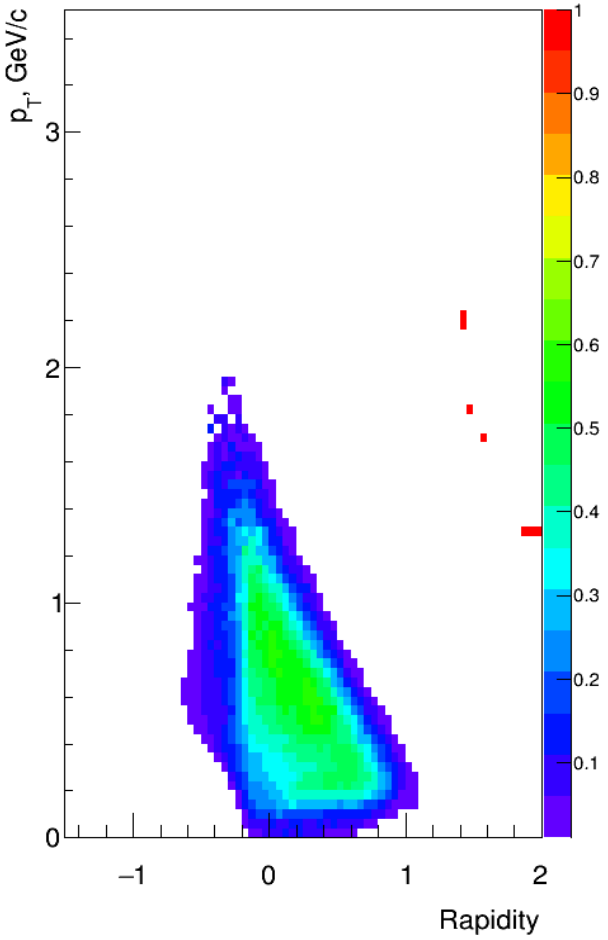
$$Efficiency = \frac{N_{selected}[p_T^{MC}, Y^{MC}]}{N_{MC}[p_T^{MC}, Y^{MC}]}$$

Bayesian cut: purity > 90%

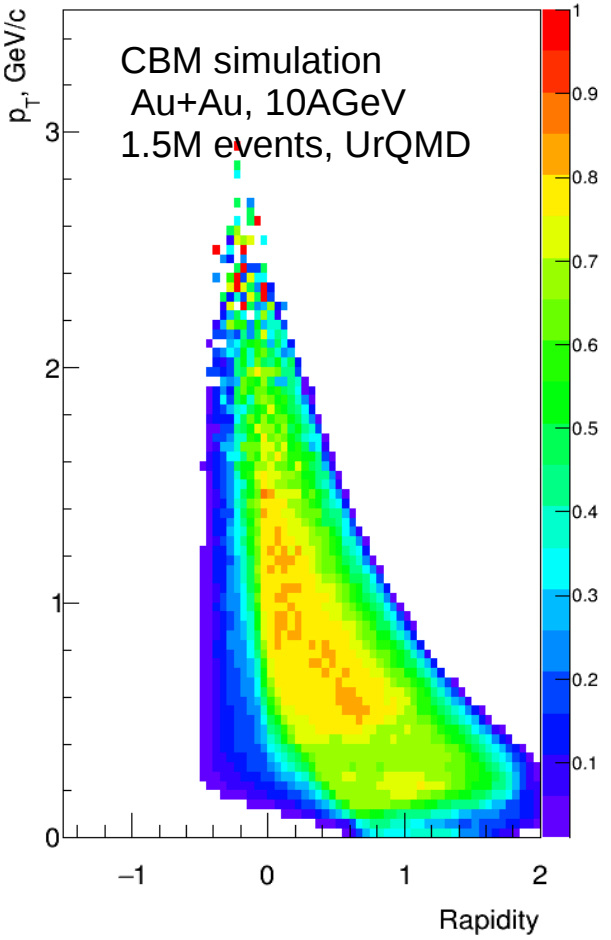
protons



kaons



pions



For protons and pions high efficiency ~80%.

Summary

- TOF detector response is parametrized to allow pion, kaon,and protons identification with high purity and efficiency
- Acceptance matrix are extracted for CBM

Next steps:

- Introduce momentum dependent cut for reducing mismatch
- Study negative particles distribution
- Establish method to obtain high purity samples of individual particles from data