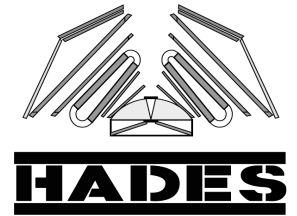


Charged Kaon- & ϕ -Reconstruction in Au+Au @ 1.23 AGeV



Heidi Schuldes
for the HADES Collaboration



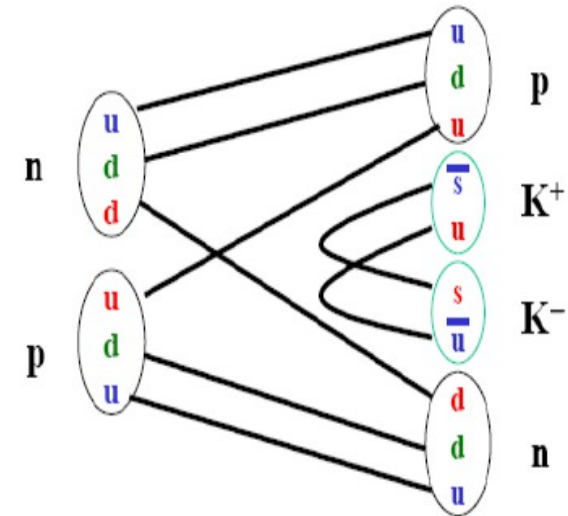
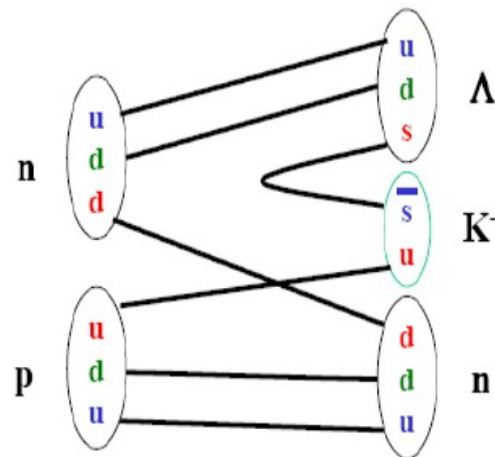
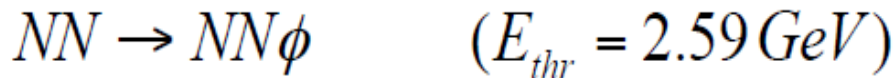
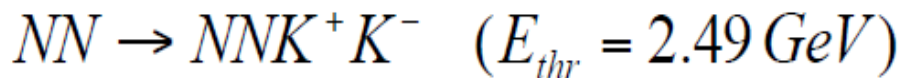
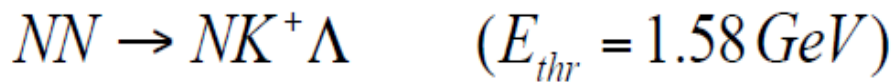
FAIRness 2014

Outline

- Introduction
 - Strangeness production at SIS18 energies
 - Statistical model
 - HADES
- Differential analysis & preliminary results of single particles in m_t - y
 - K^+
 - K^-
 - Φ -reconstruction
- Summary

Strangeness production

- Rare strangeness production at SIS18 energies (typical one $s\bar{s}$ -pair/event)
- **Elementary collisions:**
 - Different production threshold for K^+ and K^-

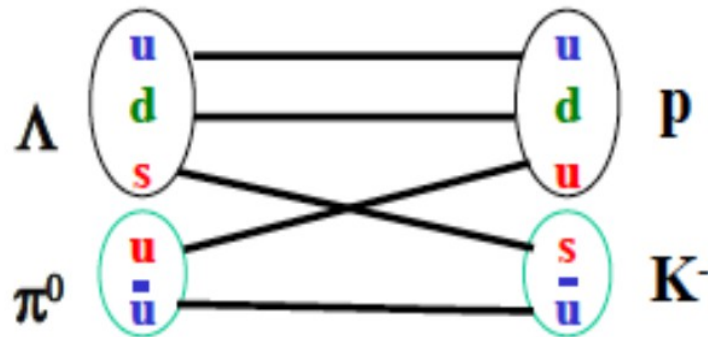
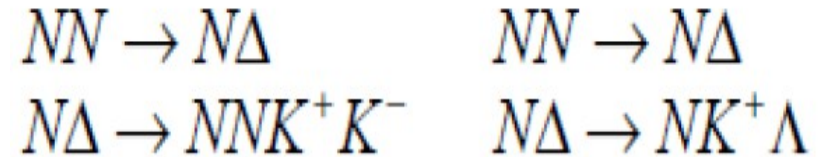


! Complete strange particle production in Au+Au collisions at 1.23 AGeV below elementary production threshold !

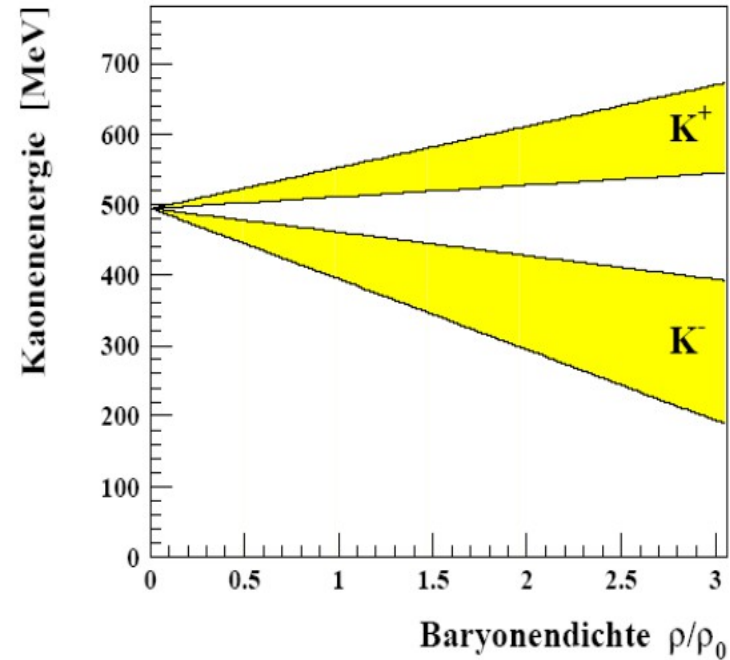
Strangeness production

- **Heavy ion collisions:**

- Accumulation of energy in multi-step processes
- Strangeness exchange reactions



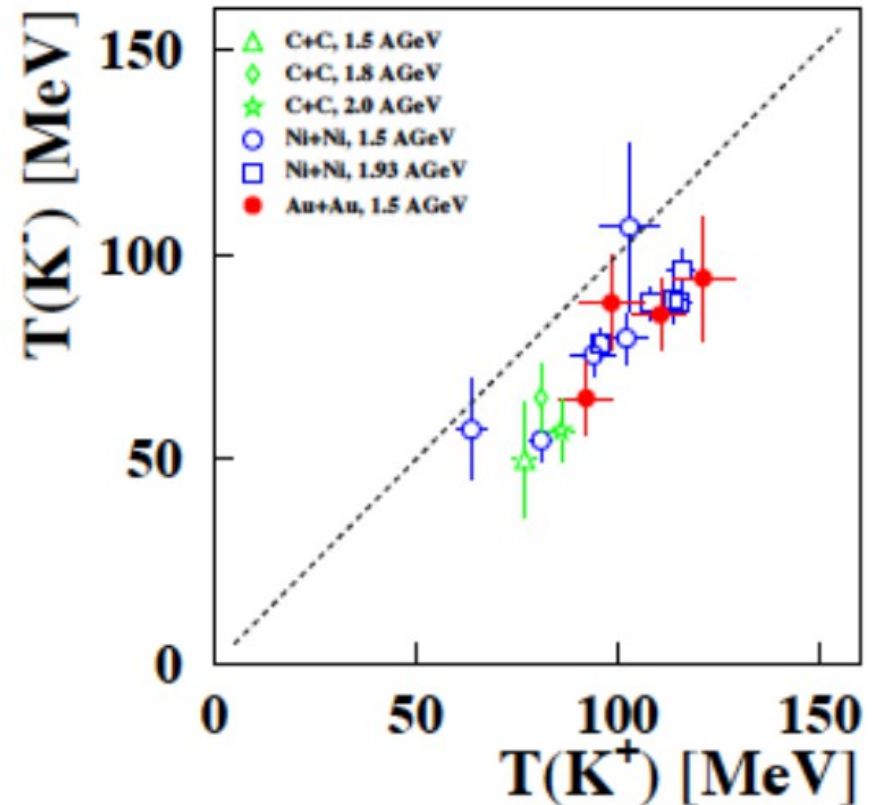
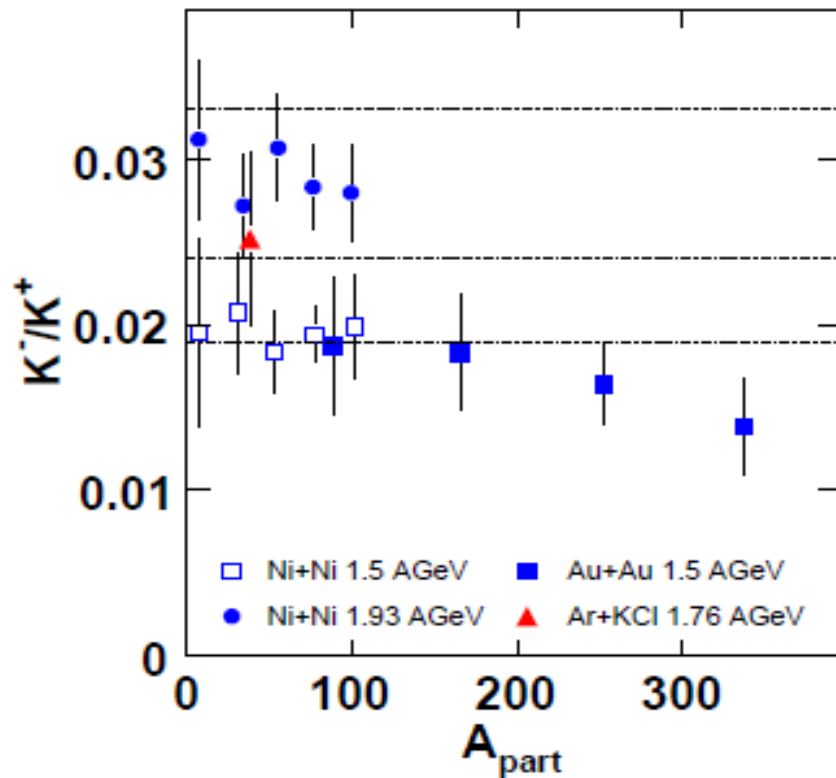
Endothermal
reaction
in vacuum



Schaffner-Bielich

Strangeness production

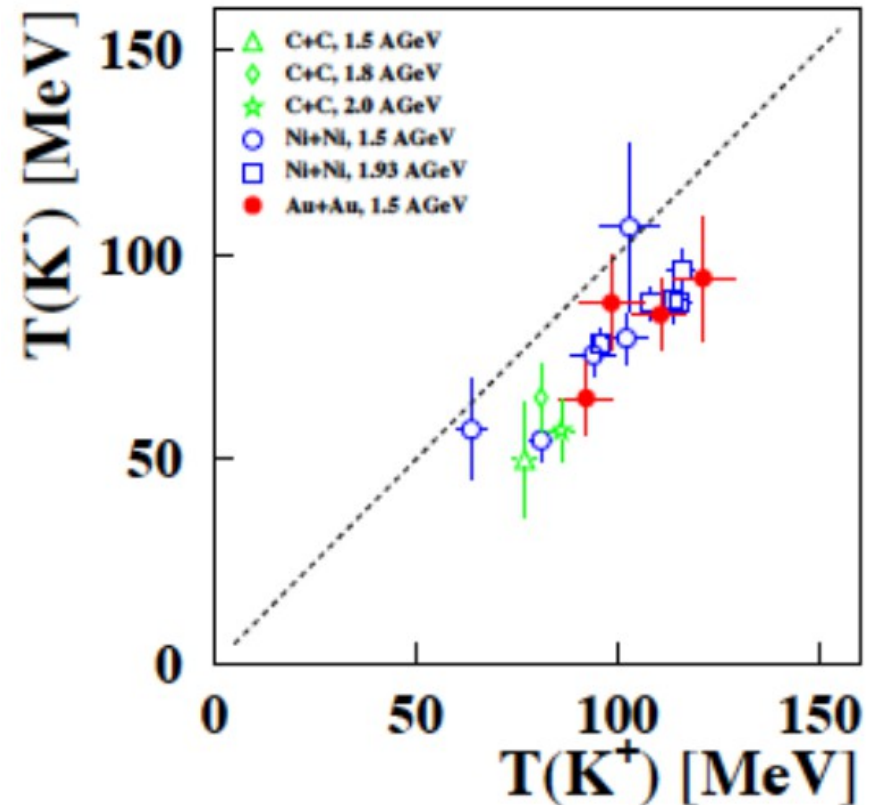
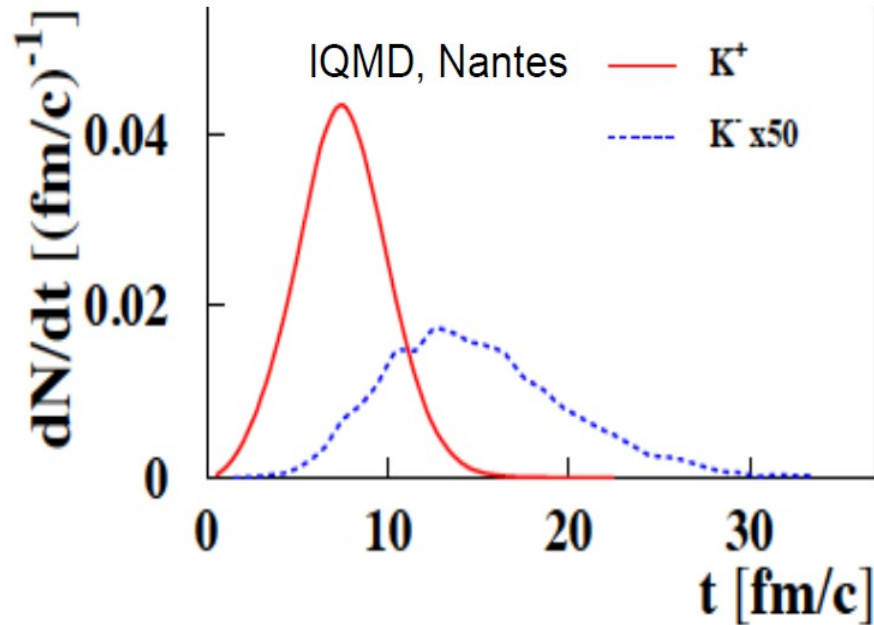
Förster et. Al (KaoS)
PHYSICAL REVIEW C 75, 024906 (2007)



- K^+ & K^- show similar A_{part} dependence but different inverse slope parameters
 - Production coupled
 - Strangeness exchange dominant for K^- production

Strangeness production

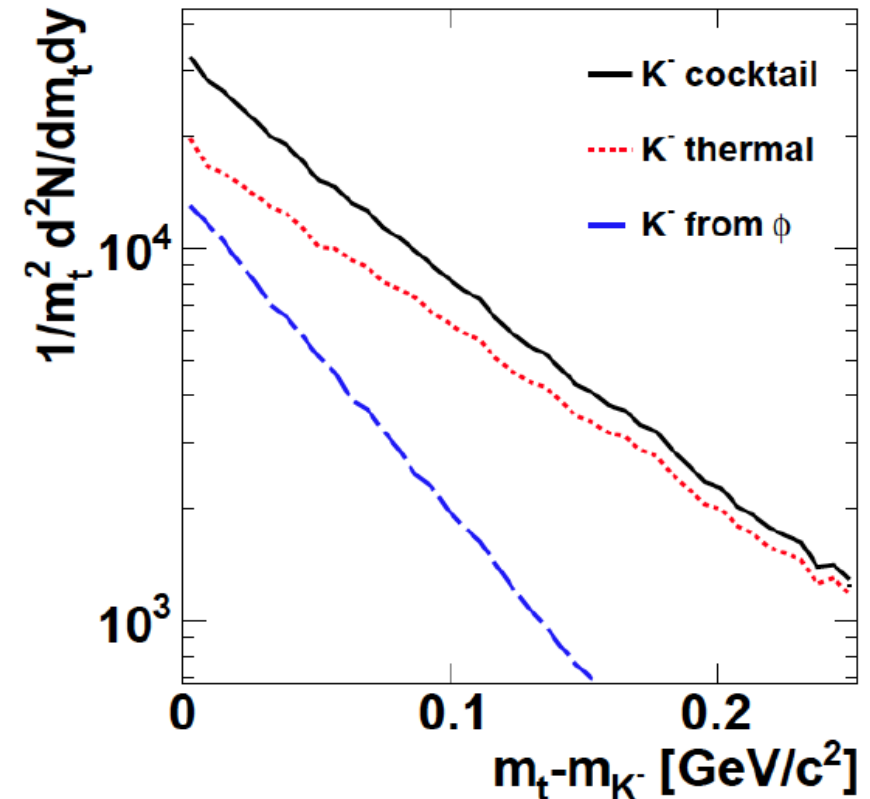
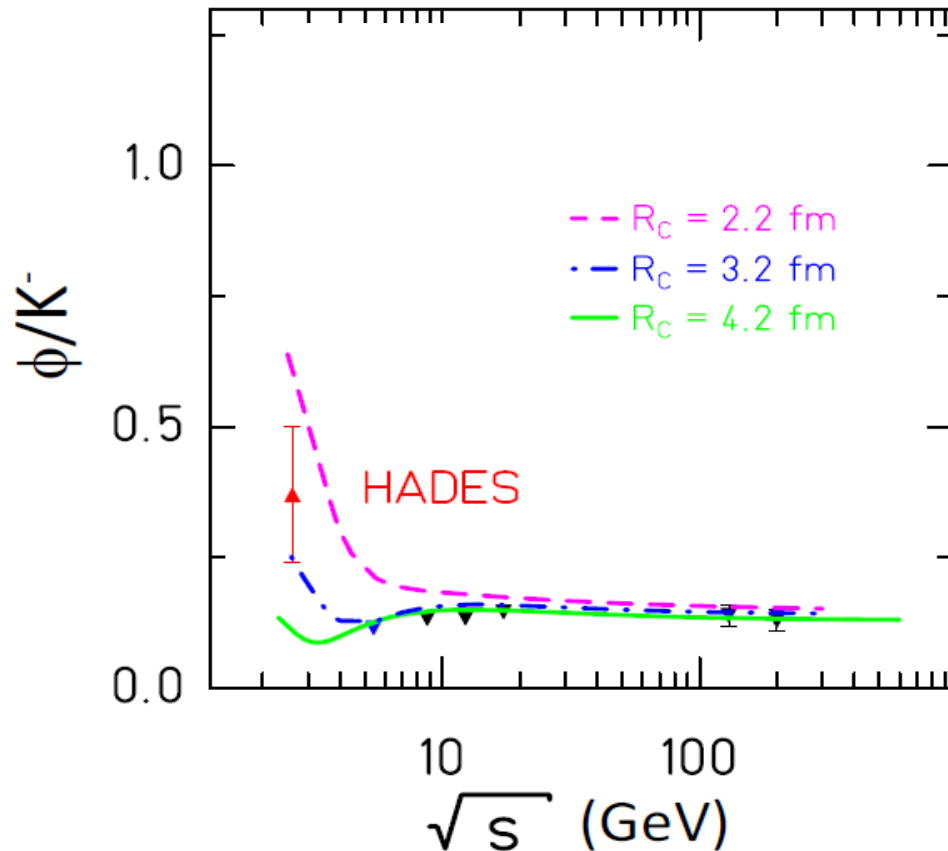
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- K^+ & K^- show similar A_{part} dependence but different inverse slope parameters
 - Production coupled
 - Strangeness exchange dominant for K^- production

Strangeness production

arXiv:0902.3487v1 [nucl-ex] 20 Feb 2009

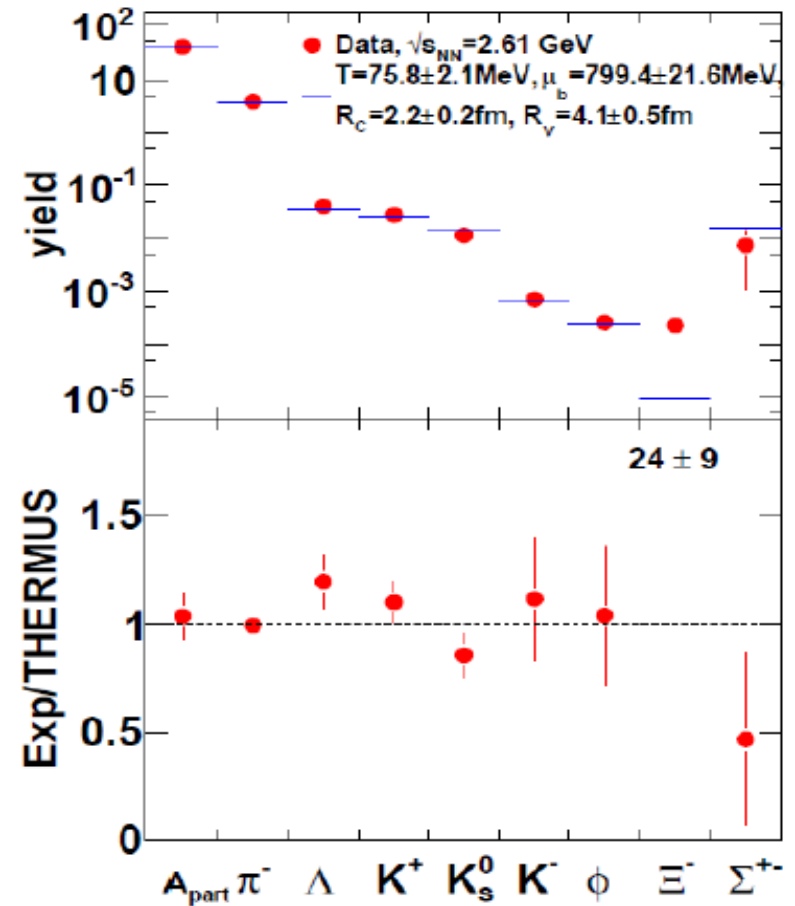
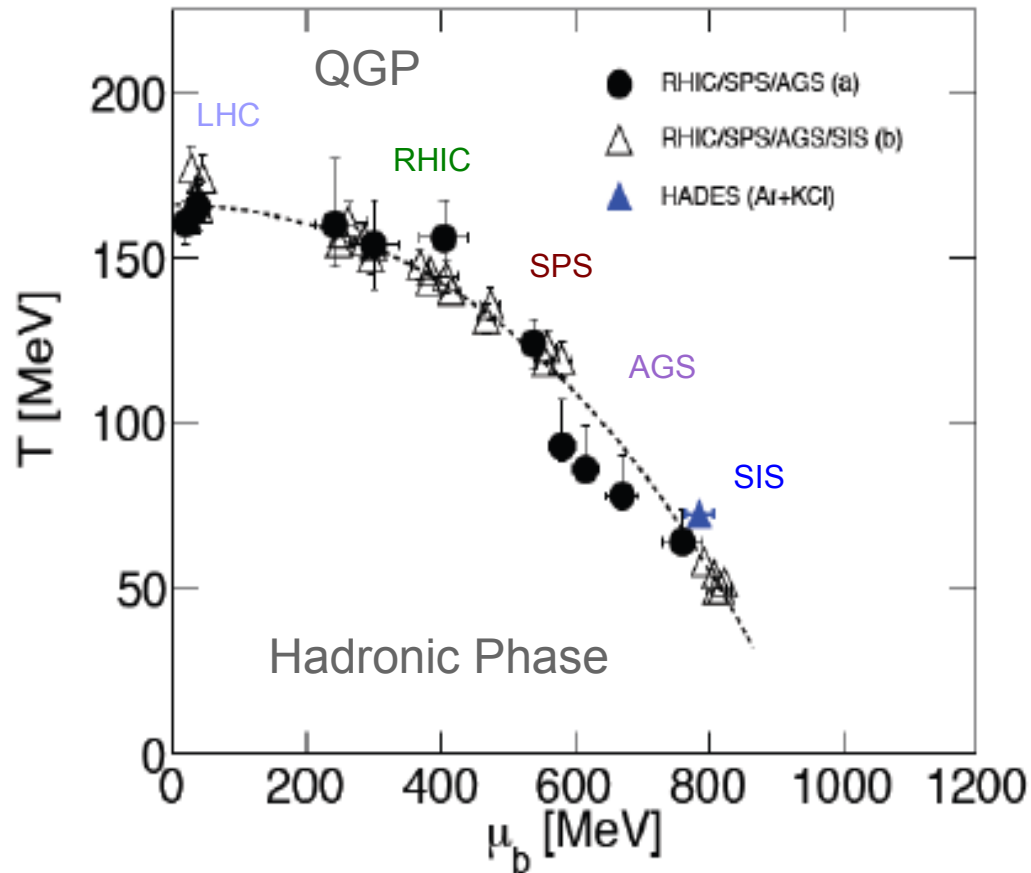


- First hints from FOPI for sizeable Φ -meson production at SIS18 energies
- Higher precision measurement by HADES
- What happens at lower energy?

- Feed-down explains lower freeze-out temperature
- Not taken into account before
- Φ -meson one of the main players for understanding of K^- -production

Statistical Model

→ see Timo's talk



Eur.Phys.J. A47 (2011) 21

- Statistical particle production from a homogeneous source
- (Grand) canonical ensemble (Parameter T, μ, V)
- Strangeness has to be conserved exactly in a volume smaller than the volume of the system (radius: $R_C < R_V$)
- Good description of particle yields at various beam energies

(a) P. Braun-Munzinger, A. Andronic and J. Stachel. Nucl. Phys., A 772(167), 2006.
 (b) K. Redlich, J. Cleymans, H. Oeschler and S. Wheaton., Phys.Rev., C 73(034905), 2007
 (FOPI) X. Lopez et al., Phys. Rev., C 76(052203), [arXiv:0710.5007[nucl-ex]] 2007

HADES

The **H**igh **A**cceptance **D**i-**E**lectron **S**pectrometer **HADES** is a fixed target detector, located at SIS18 at Gesellschaft für Schwerionenforschung in Darmstadt, Germany.

Physics program:

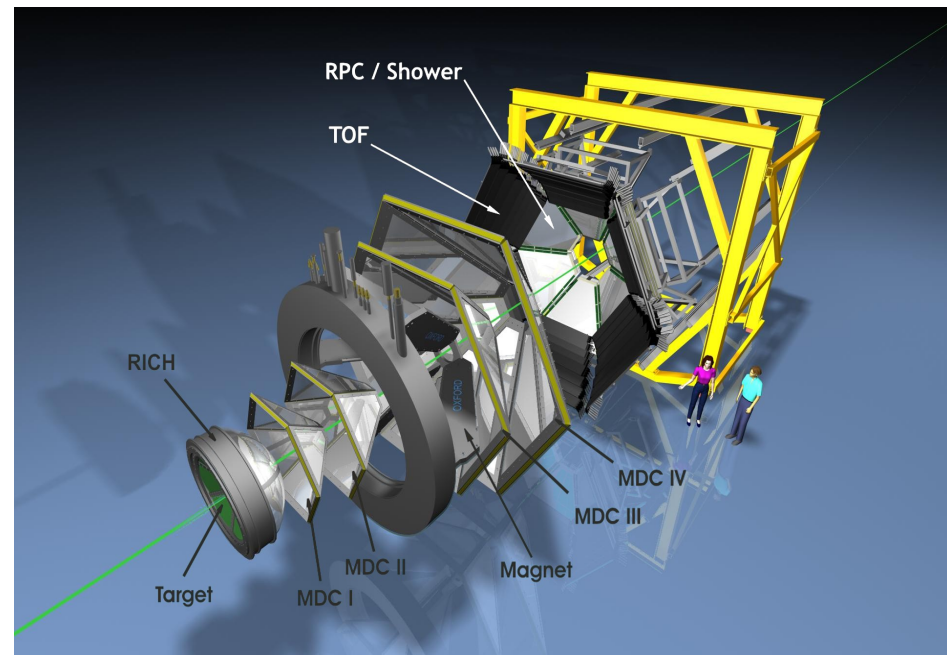
- Heavy ion collisions
- Elementary reactions
($p+p$, $d+p$, $\pi+p$, $\pi+A$)

Acceptance:

- Full azimuthal angle
- Polar angle $18^\circ - 85^\circ$

Detector components:

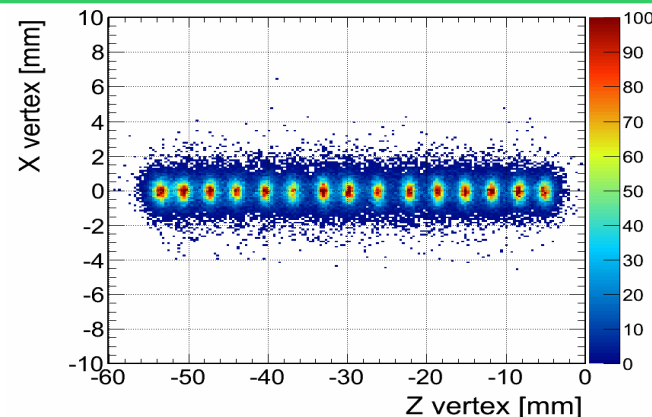
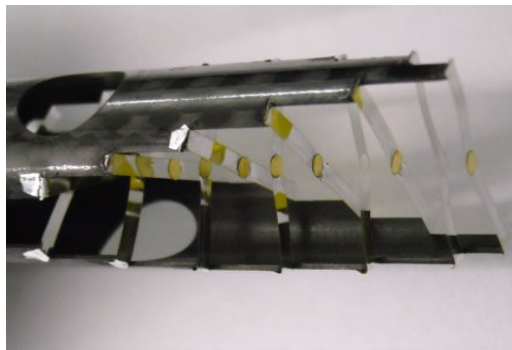
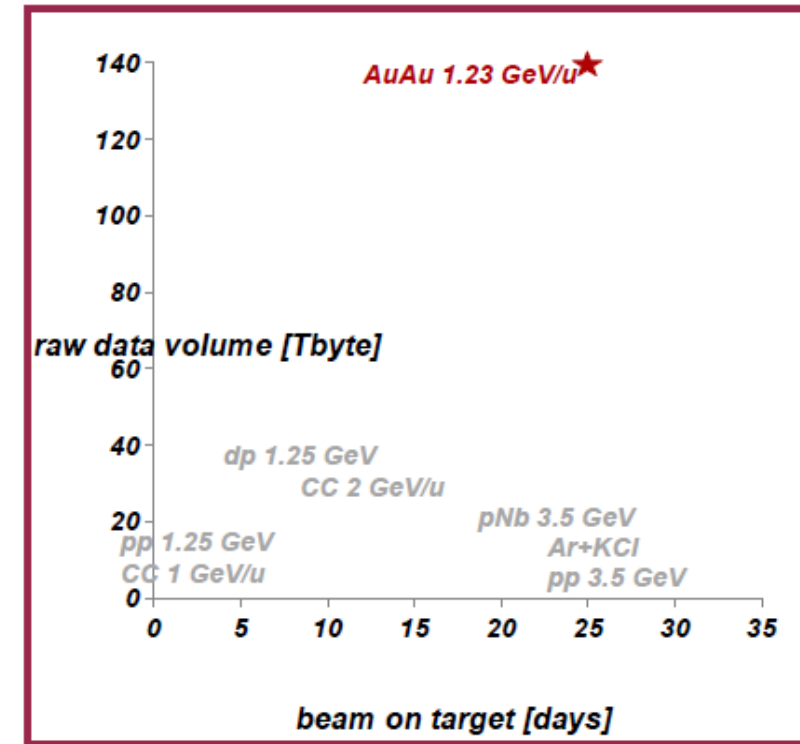
- **RICH** and **SHOWER** detector for lepton identification
- **Multi-wire drift chambers (MDC)** for tracking and energy loss information, and momentum determination (combined with a magnetic field)
- **Time of flight** detectors (TOF, RPC) for timing and energy loss information



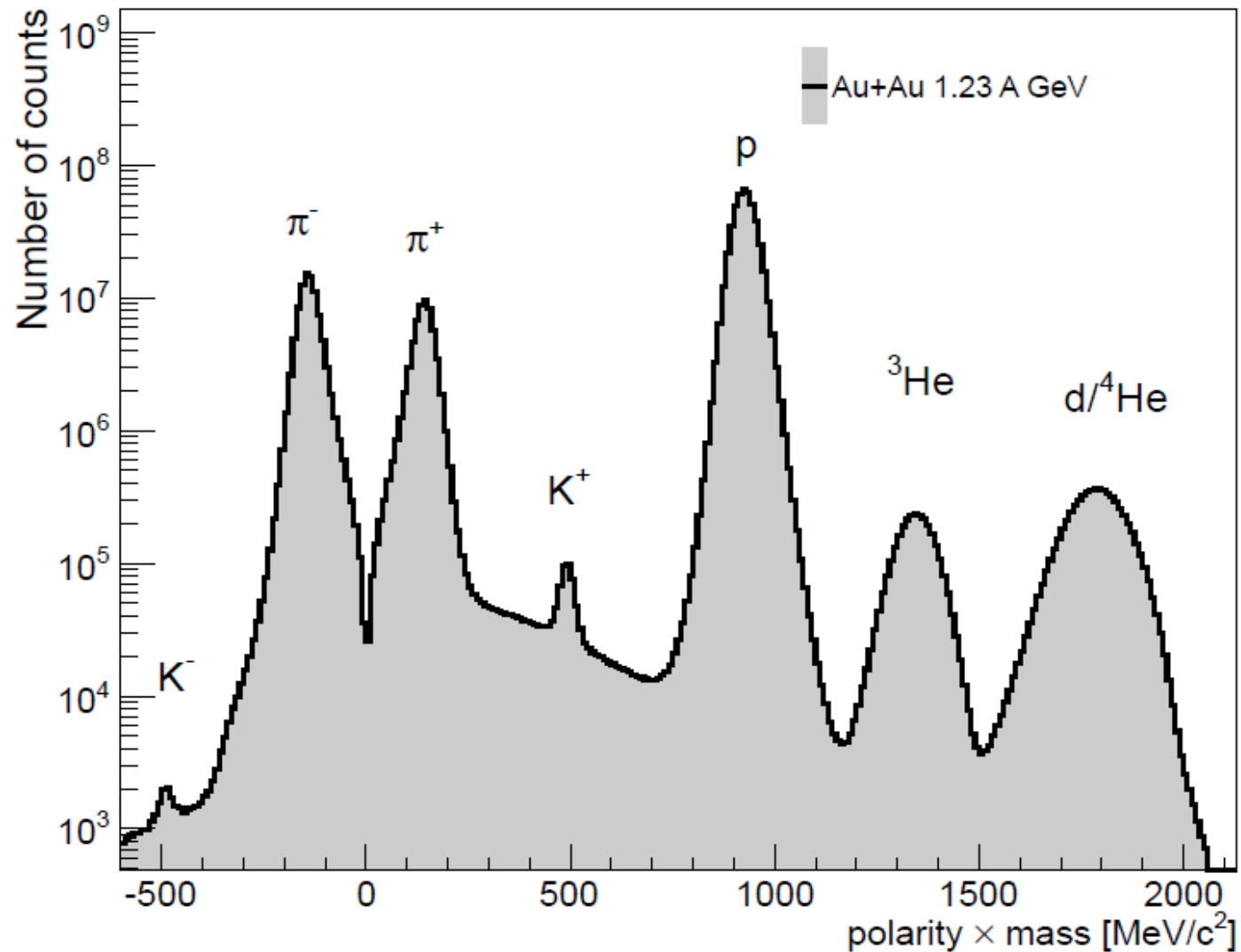
Au + Au @ 1.23 AGeV

HADES DAQ performance:

- 557 hours Au beam on Au target
- $(1.2 - 1.5) \times 10^6$ ions per second
- 8 kHz trigger rate
- 200 MByte/s data rate
- 7.3×10^9 events \Rightarrow 140 TByte of data
- Beam energy 1.23 AGeV, $\sqrt{s} = 2.4$ GeV
- Segmented Au target
- Trigger on multiplicity in TOF ≥ 20 (PT3) $\Rightarrow b_{\max} \approx 10$ fm

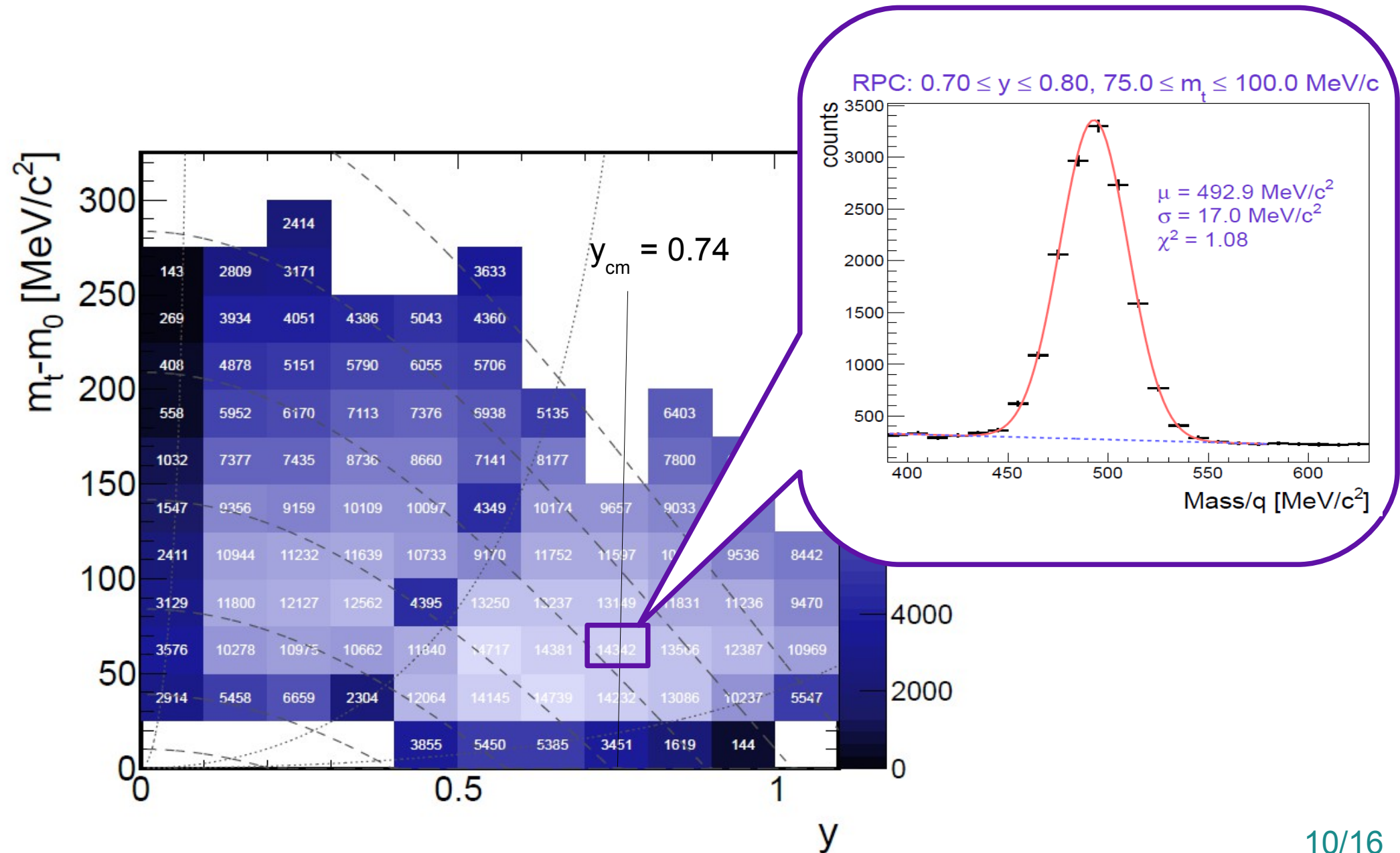


HADES

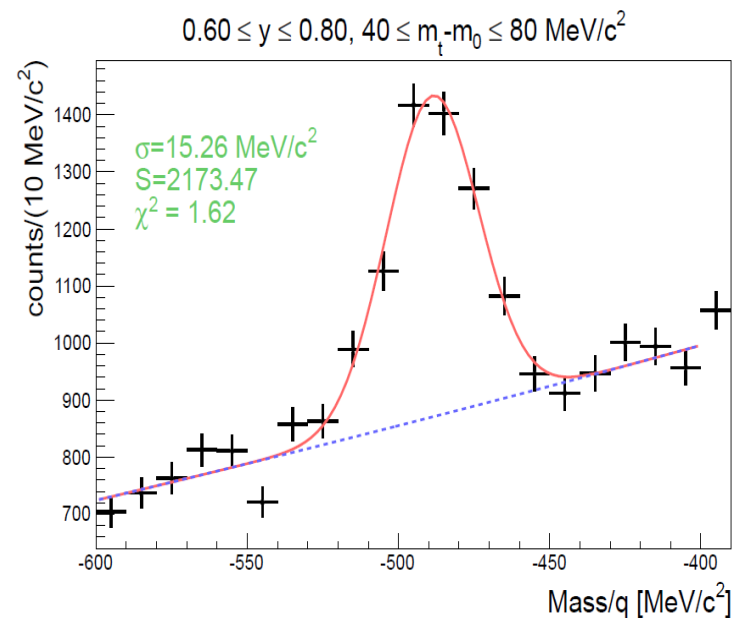
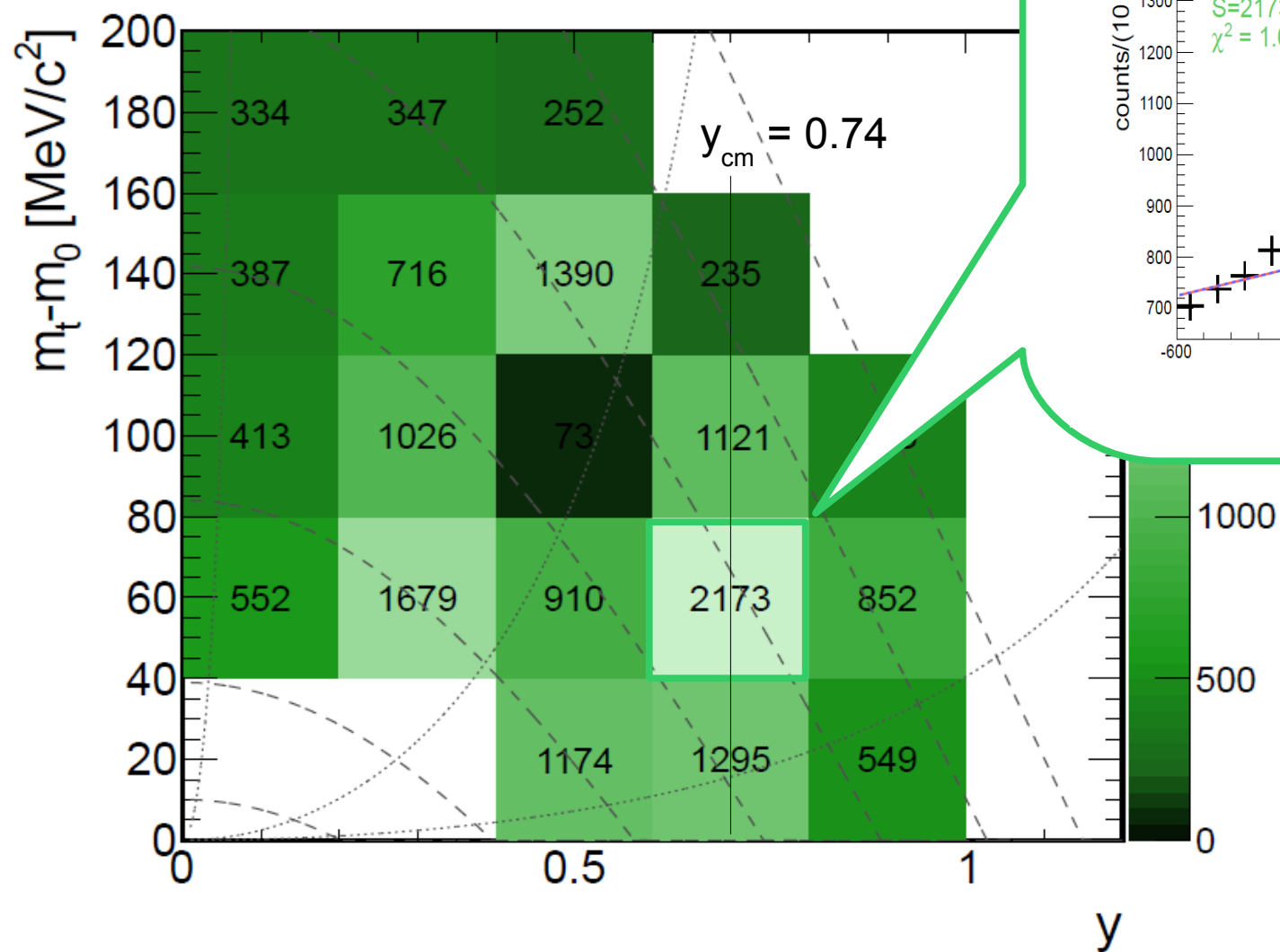


- First observation of K^- at such low energies!
- Orders of magnitude below proton and pion yield

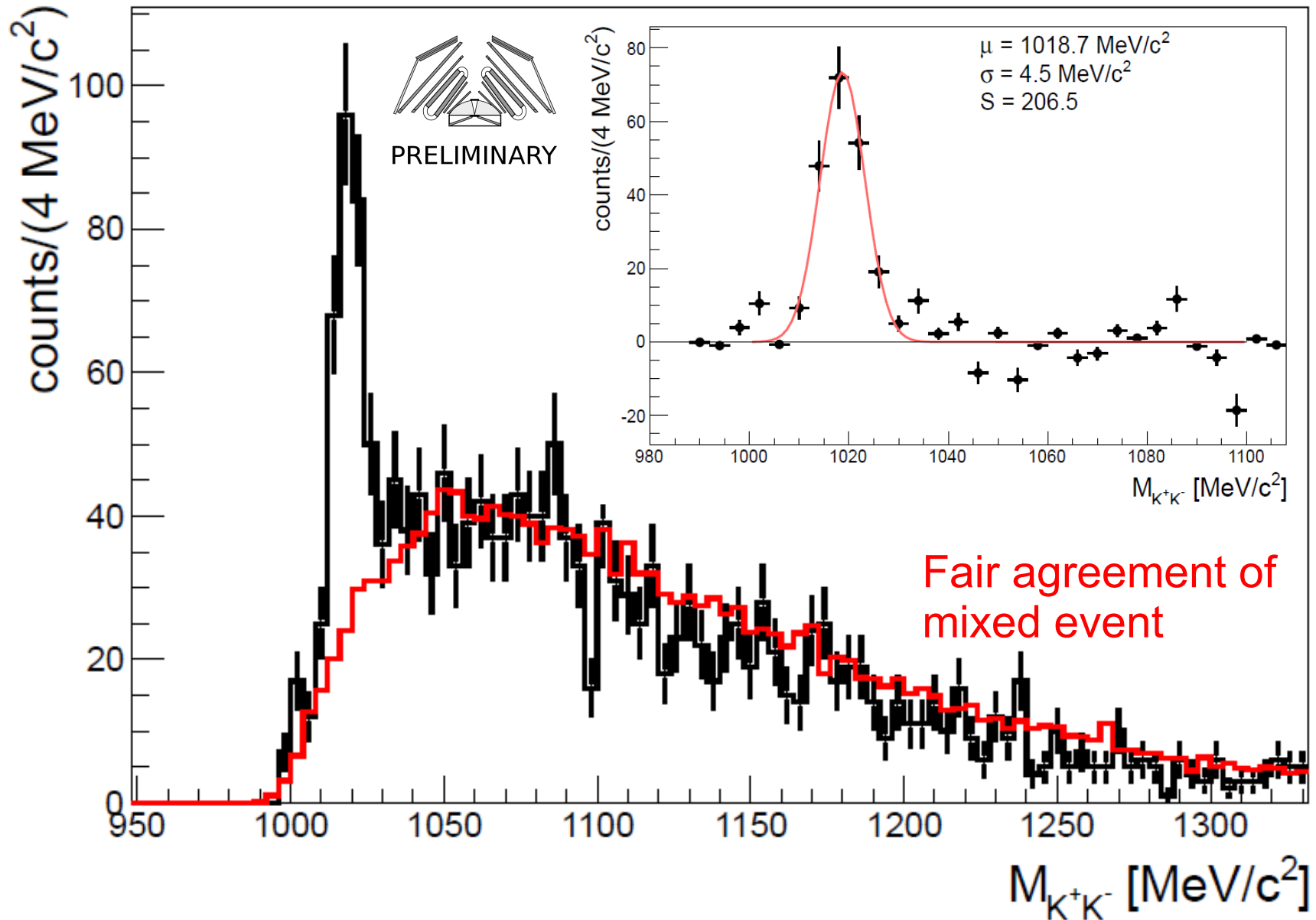
K^+ : Phase space coverage



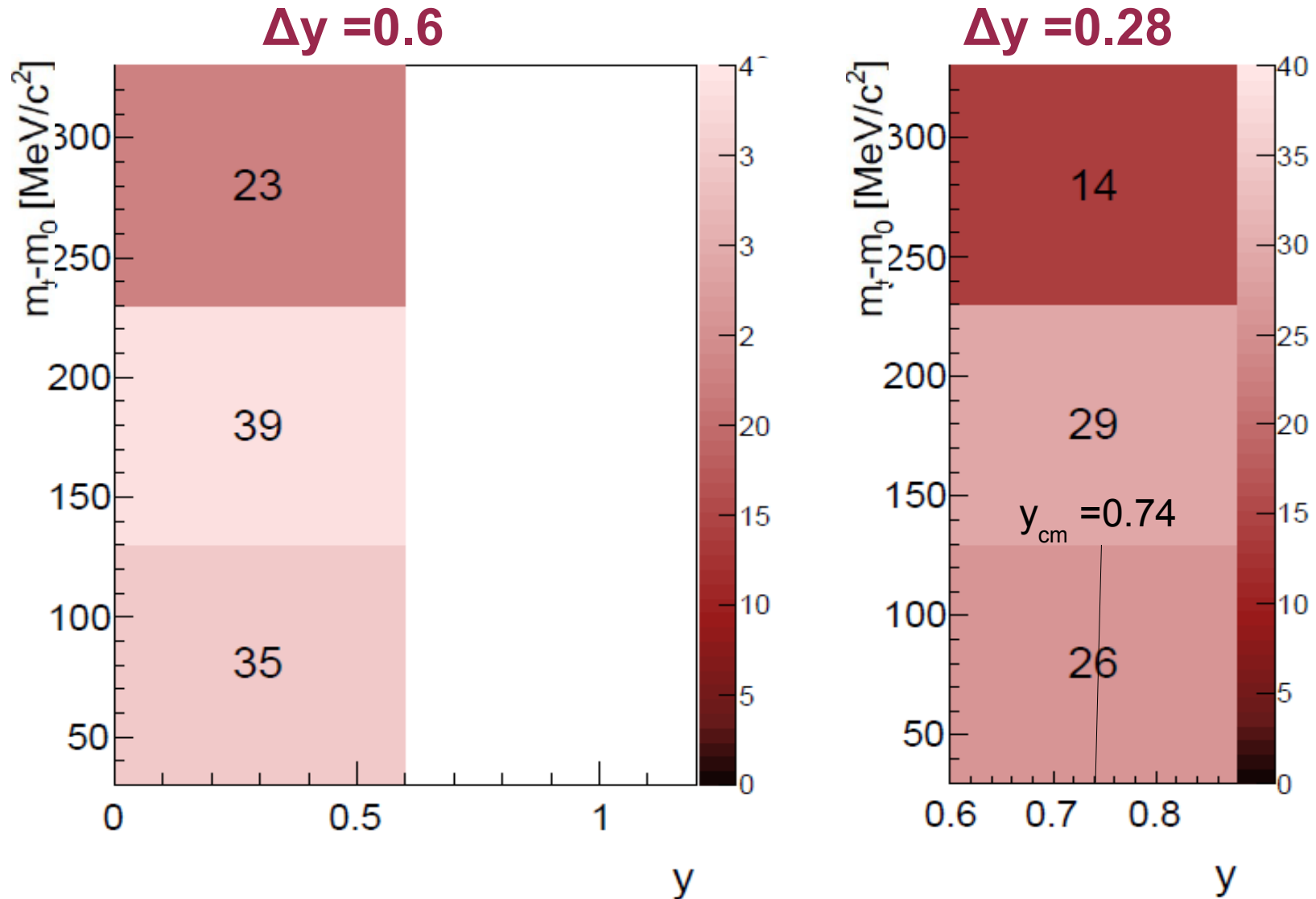
K^- : Phase space coverage



Φ : Invariant mass

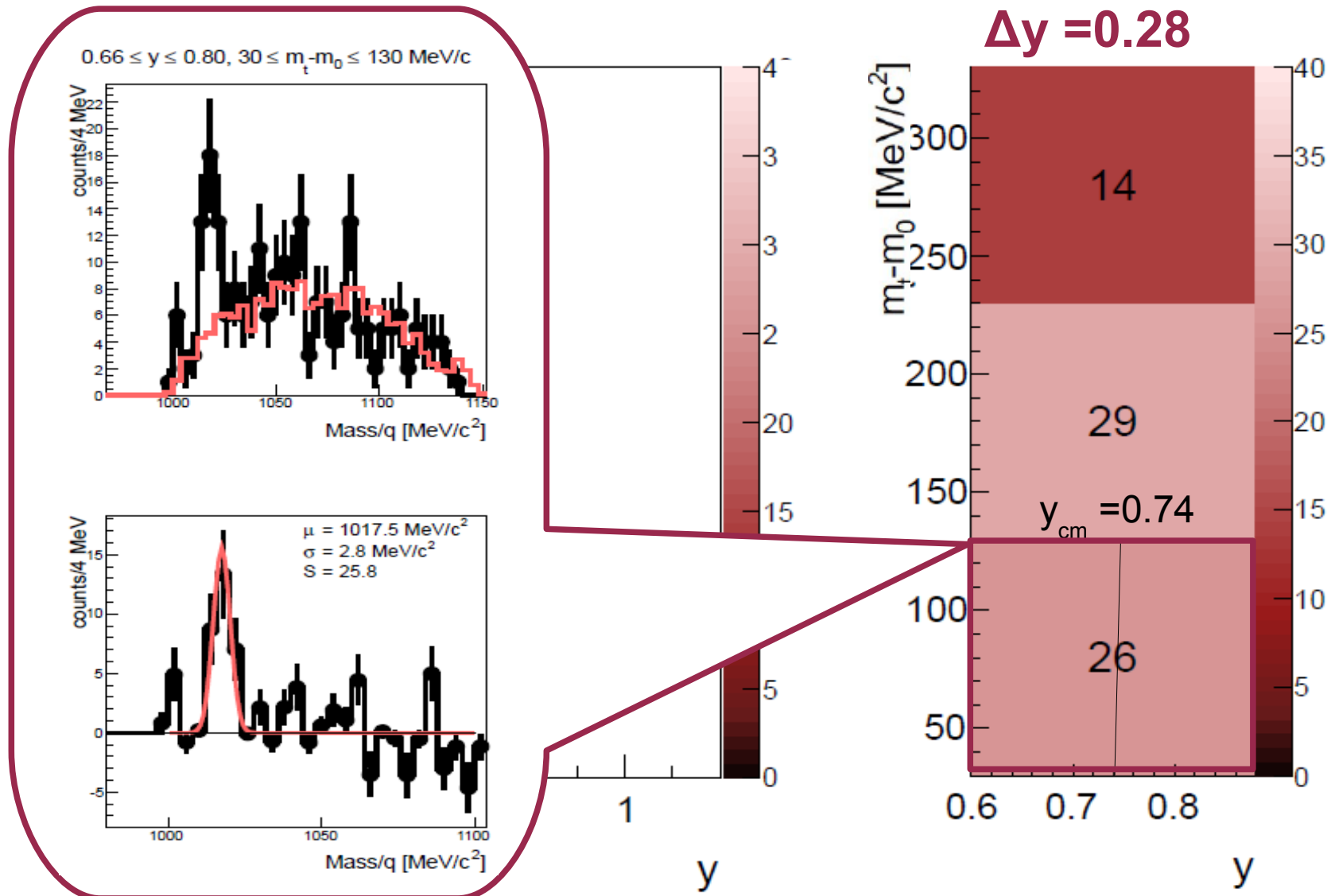


Φ : Phase space coverage



→ Optimized for rapidity distribution

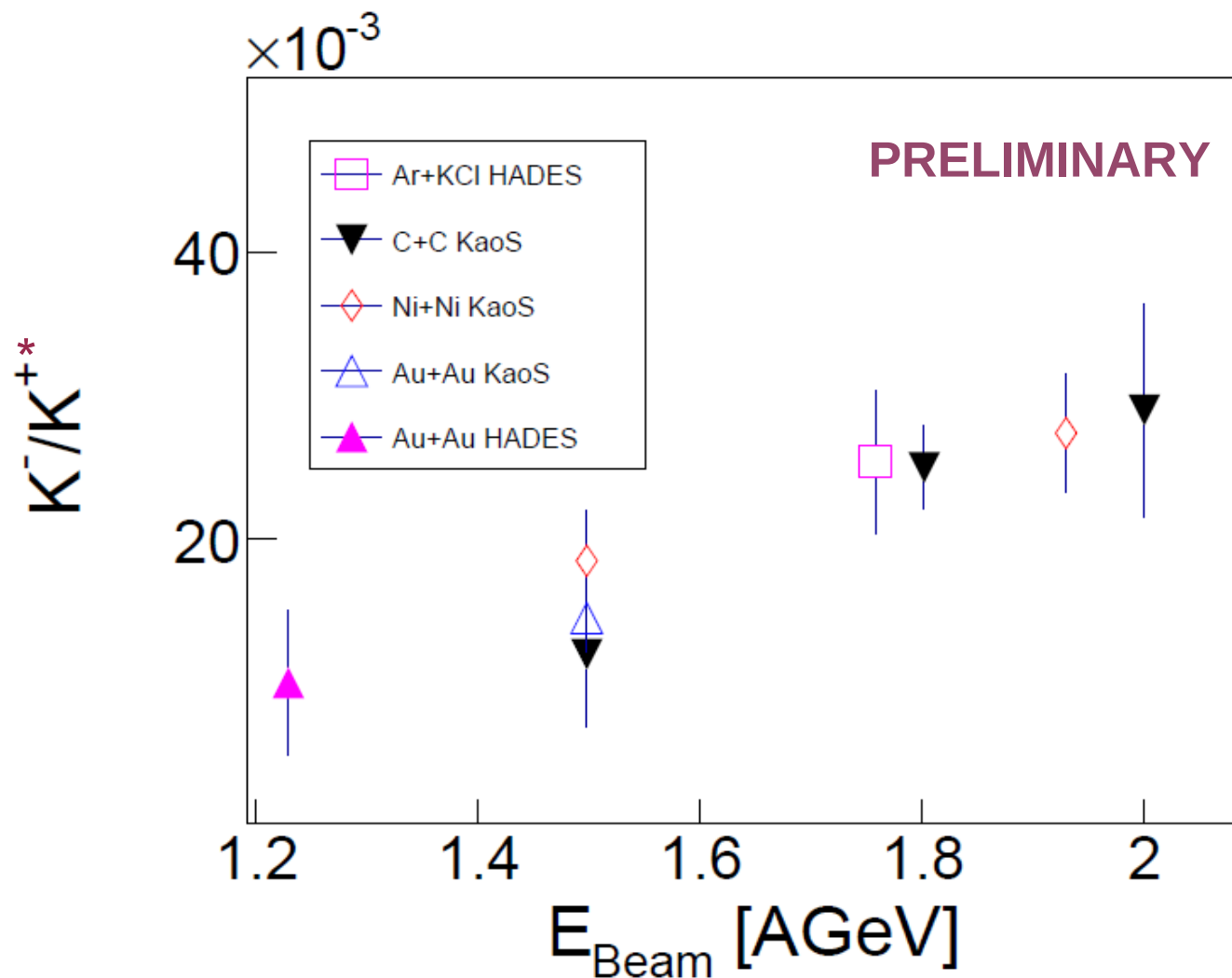
Φ : Phase space coverage



→ Optimized for rapidity distribution

Results

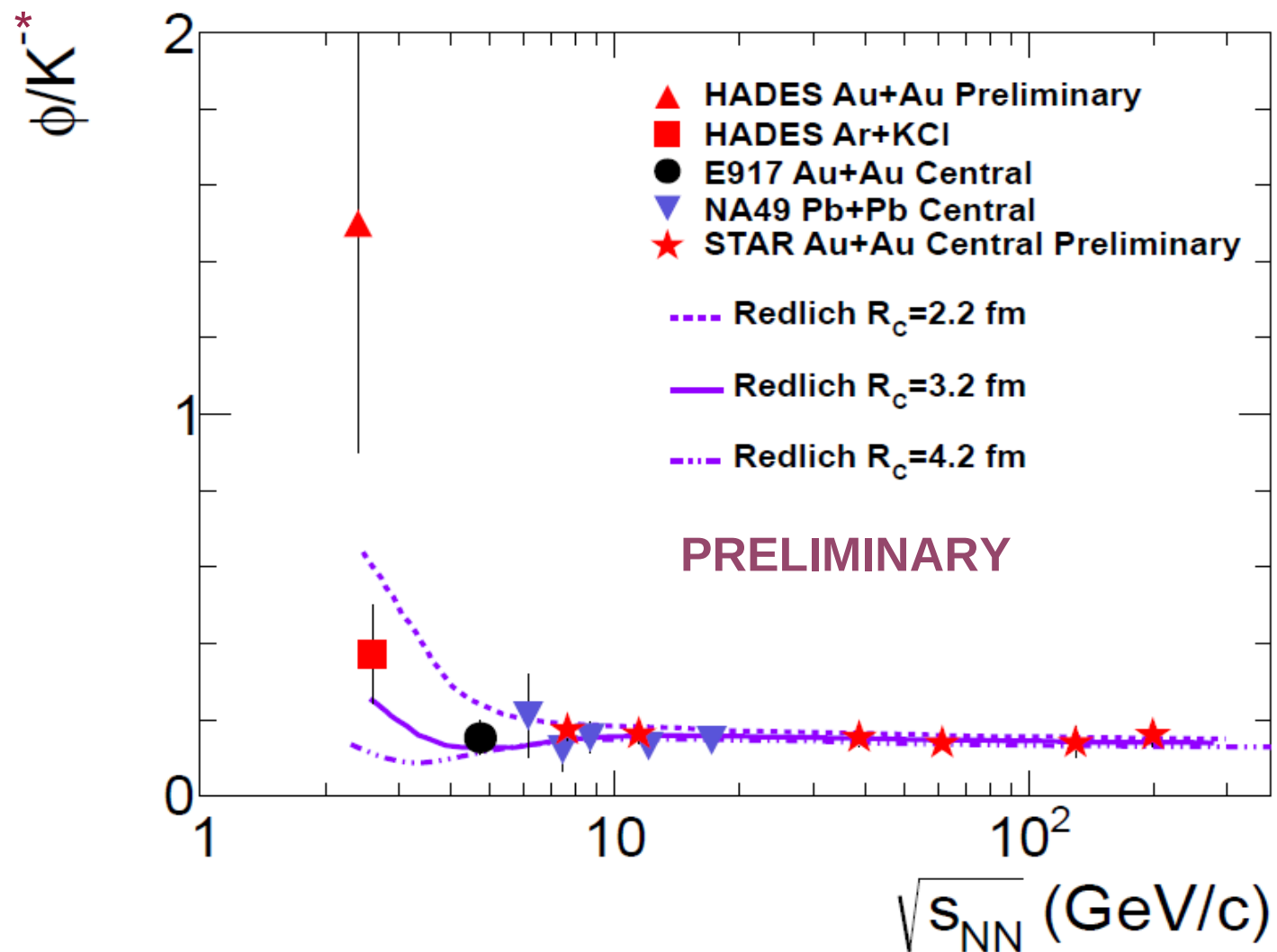
Förster et. Al (KaoS)
PHYSICAL REVIEW C 75, 024906 (2007)



- K^-/K^{+*} -ratio* fits to the trend seen by other experiments

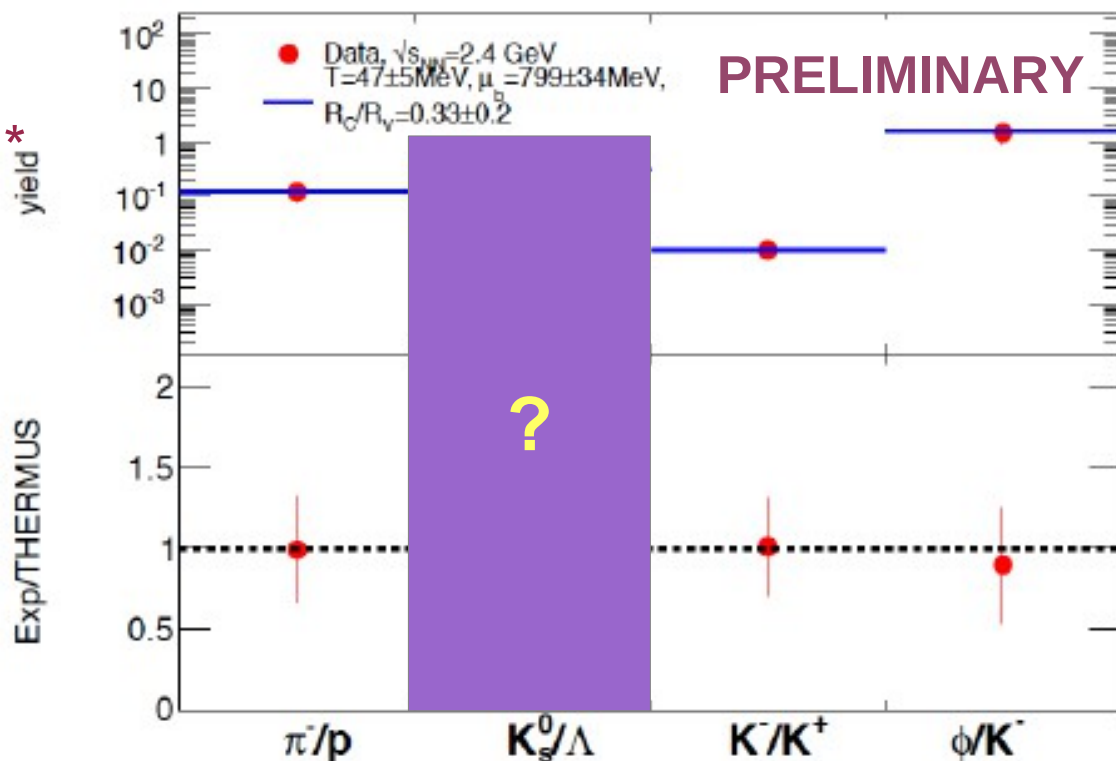
* Yields at mid-rapidity

Results

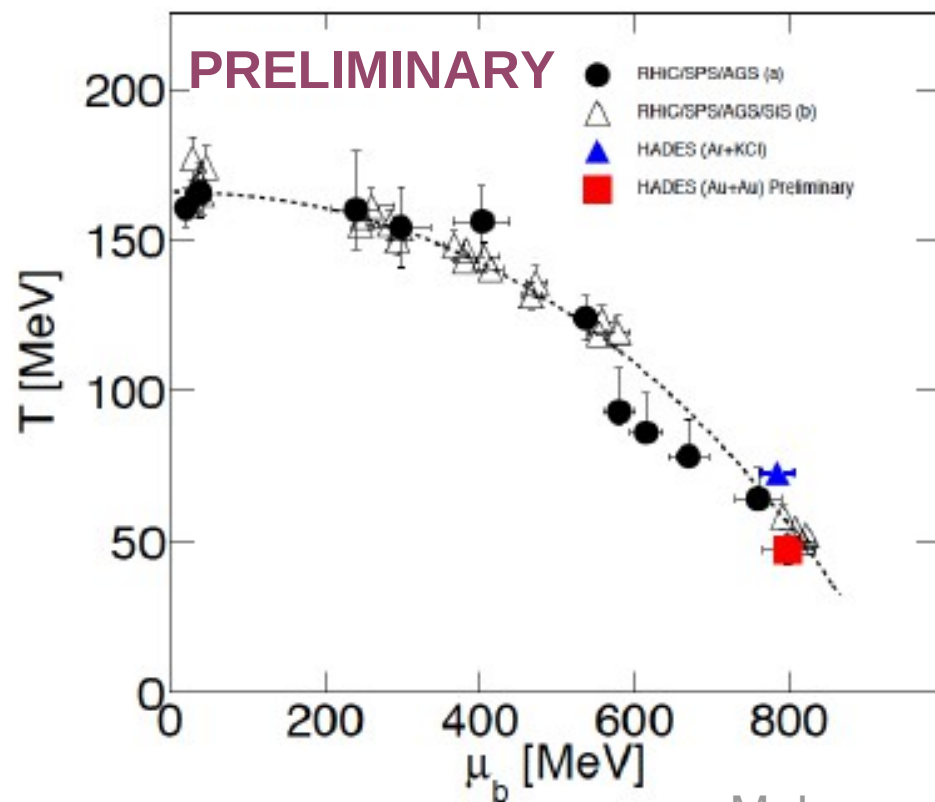


- The Φ/K^- -ratio* rises strongly with decreasing beam energy

Results



→ see Timo's talk



M. Lorenz

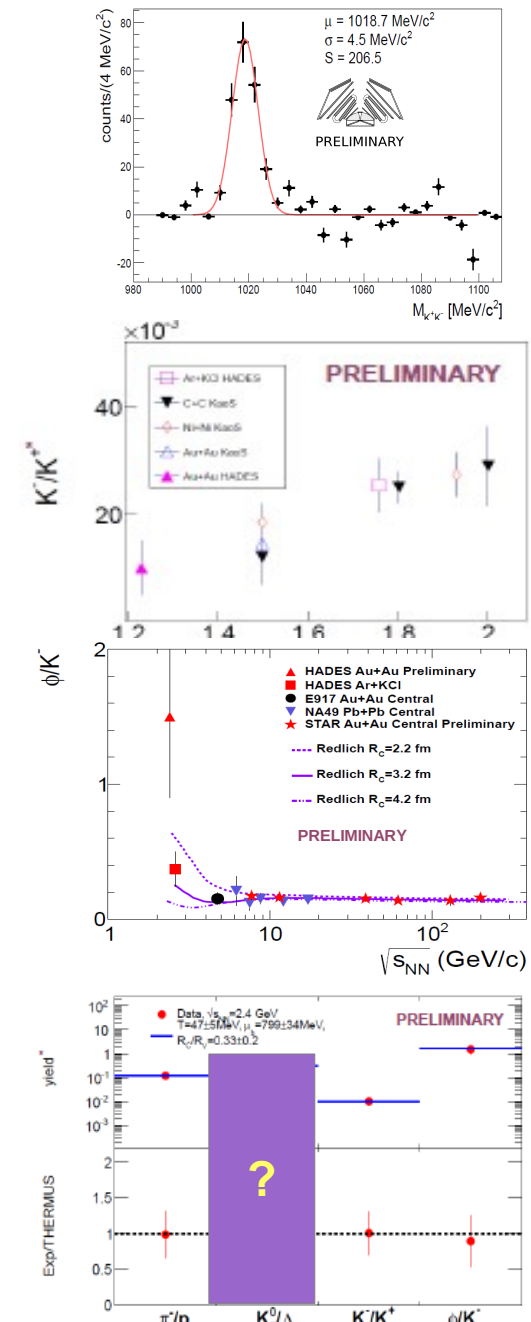
* Yields at mid-rapidity

- First results from a statistical hadronization model fit to ratios of yields at mid-rapidity show nice agreement with the data
- Estimated parameters $T=(47\pm 5)$ MeV, $\mu=(799\pm 34)$ MeV agree nicely with universal freeze-out curve

Summary

- First observation of K^- - and Φ -mesons in Au+Au-collisions at 1.23 AGeV
- Sufficient statistics for phase space analysis of charged kaons and reconstructed Φ -meson
- K^-/K^+ -ratio* fits to the trend seen by other experiments
- The Φ/K^- -ratio* rises strongly with decreasing beam energy
- First results from a statistical hadronization model fit to ratios of yields at mid-rapidity show nice agreement with the data

* Yields at mid-rapidity



The HADES-Collaboration



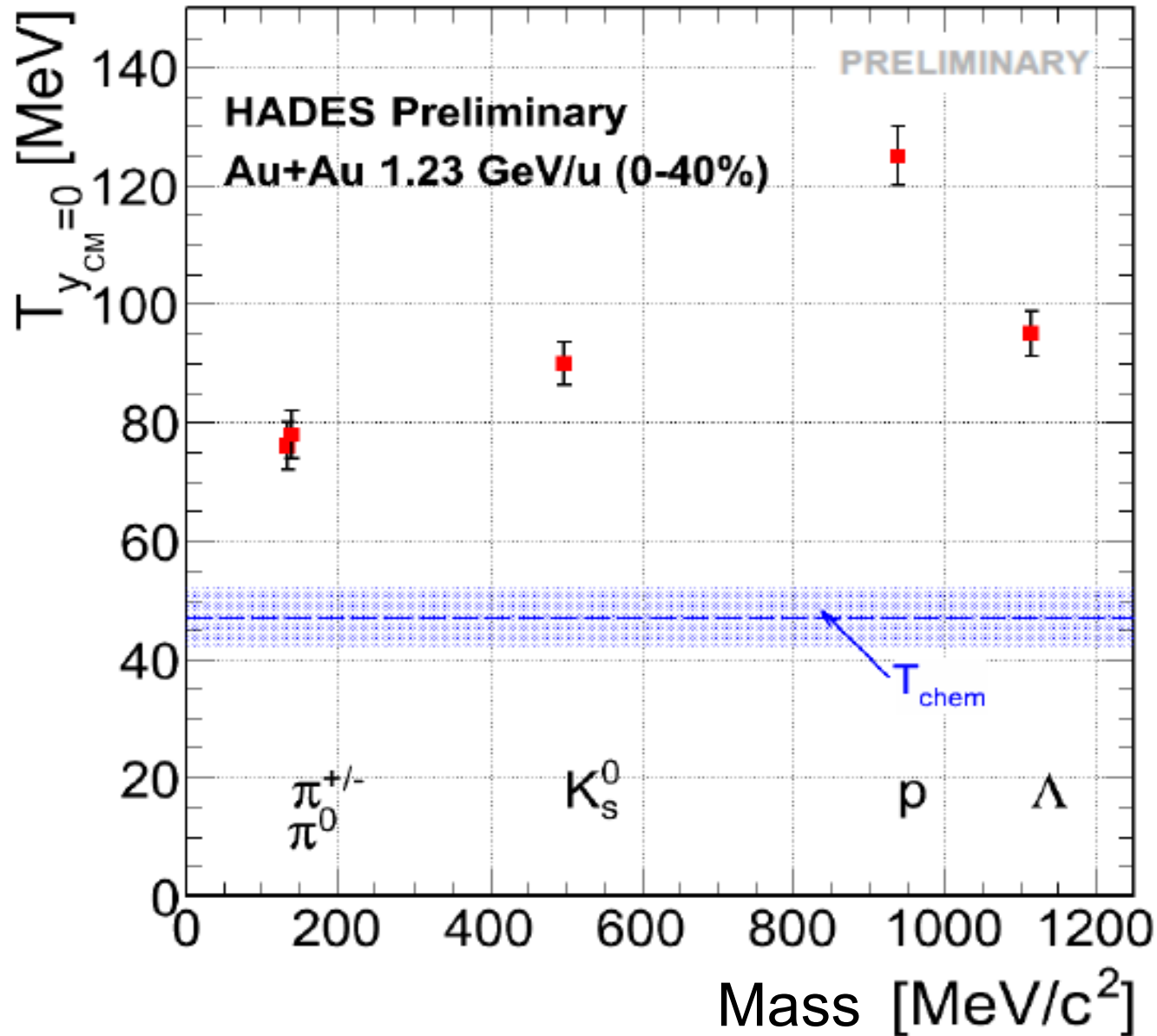
Backup

Mean Npart

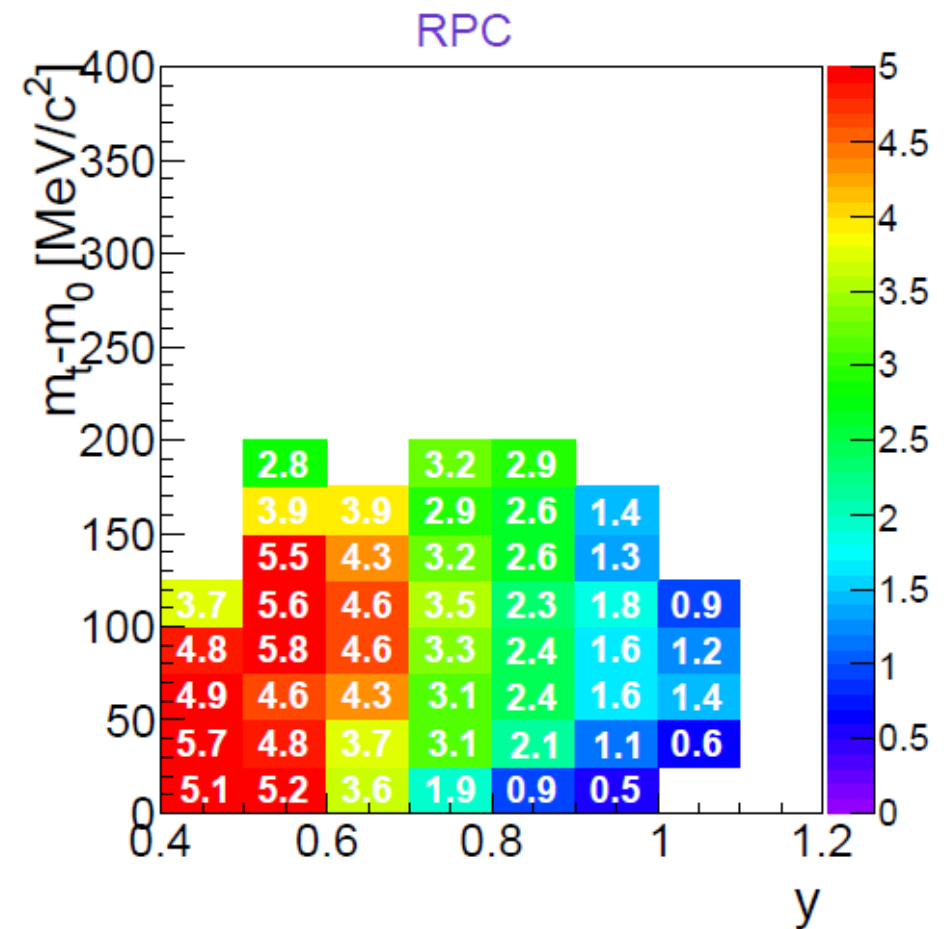
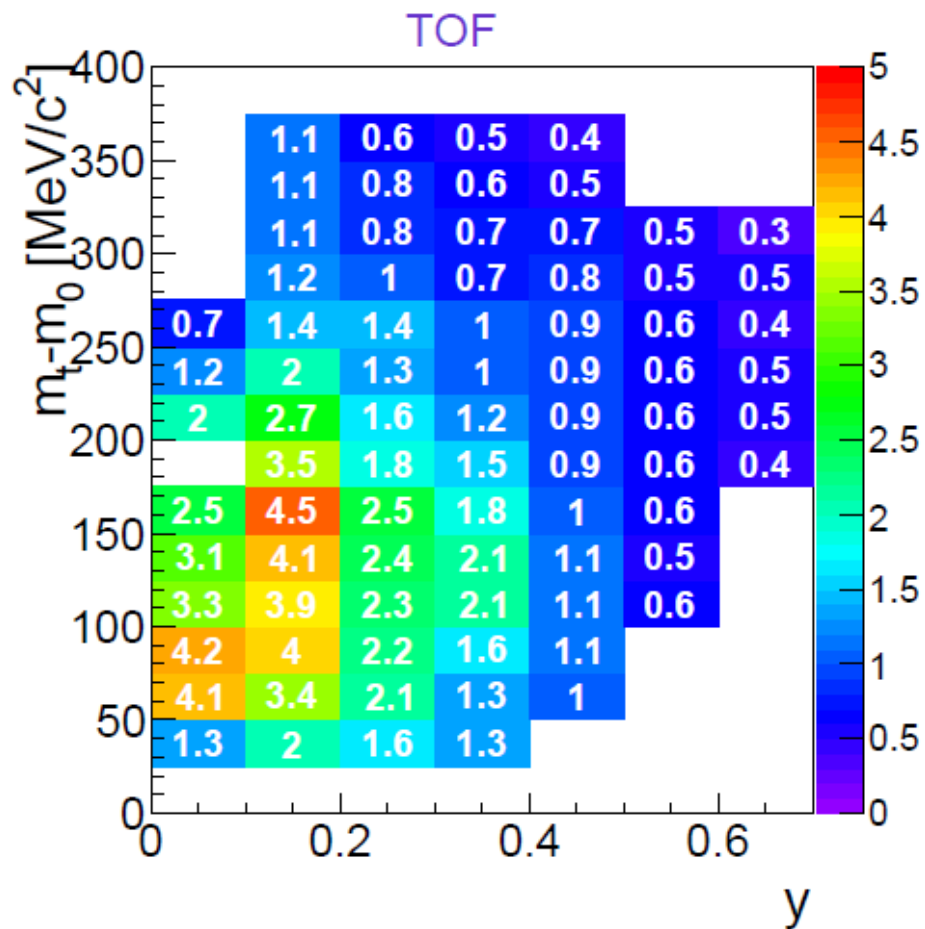
Apart Au+Au 177

ArKCl 38,5

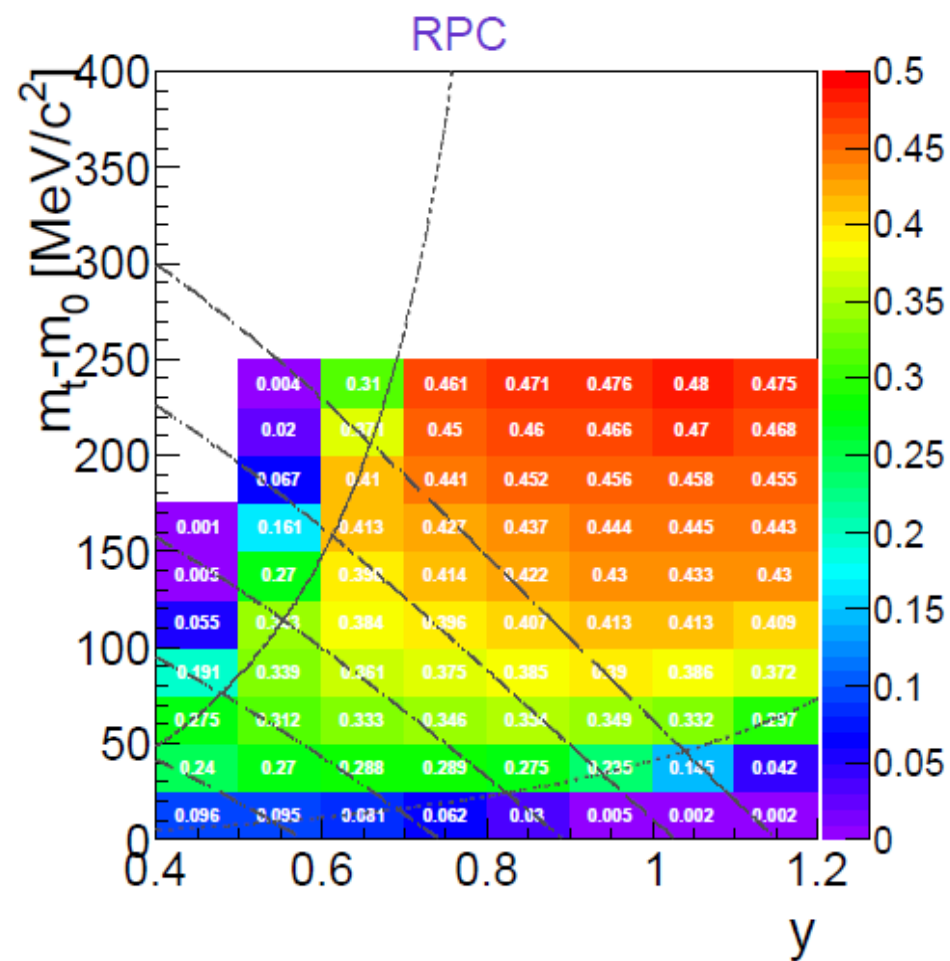
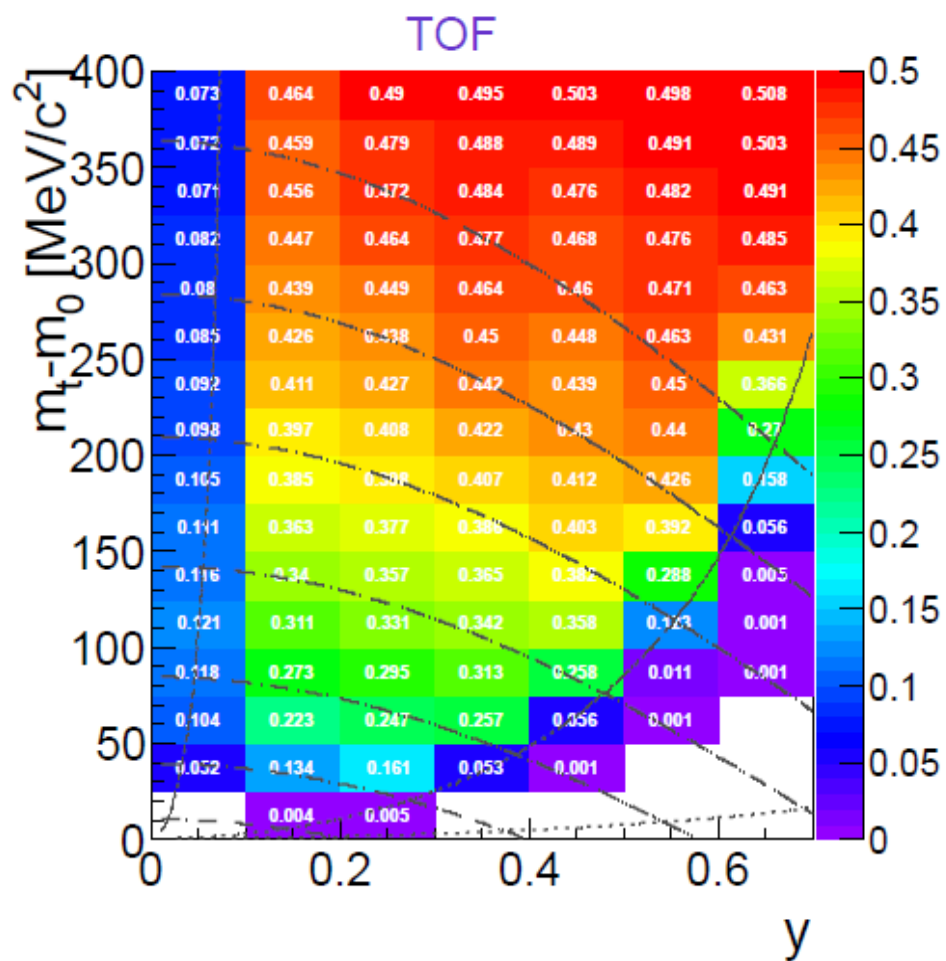
T_{chem} vs. T_{eff}



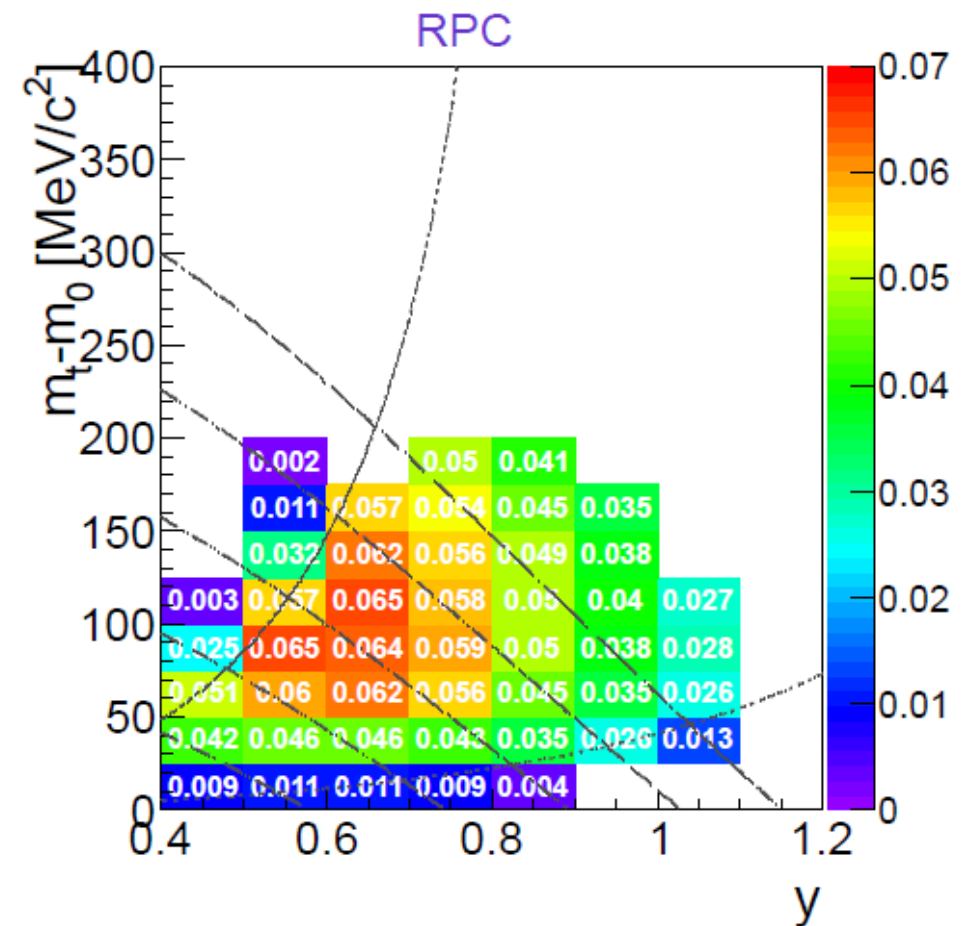
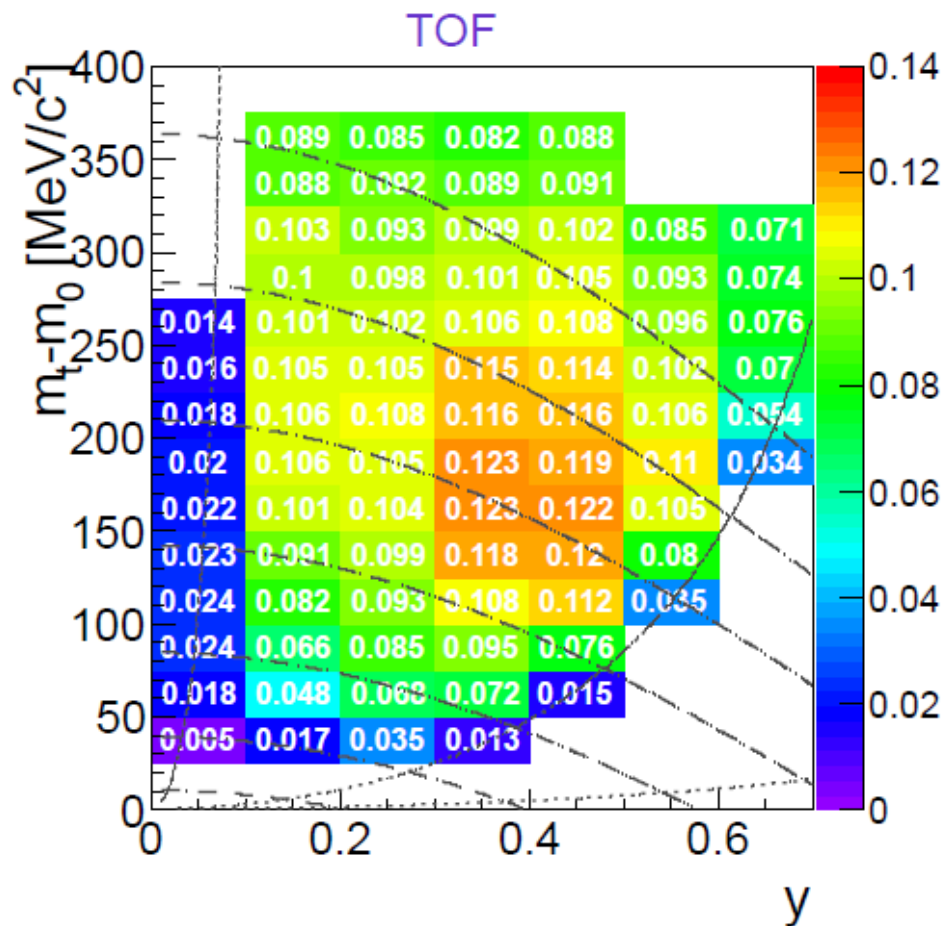
K^+ : Signal/Background for sharp cuts



K^+ : Acceptance



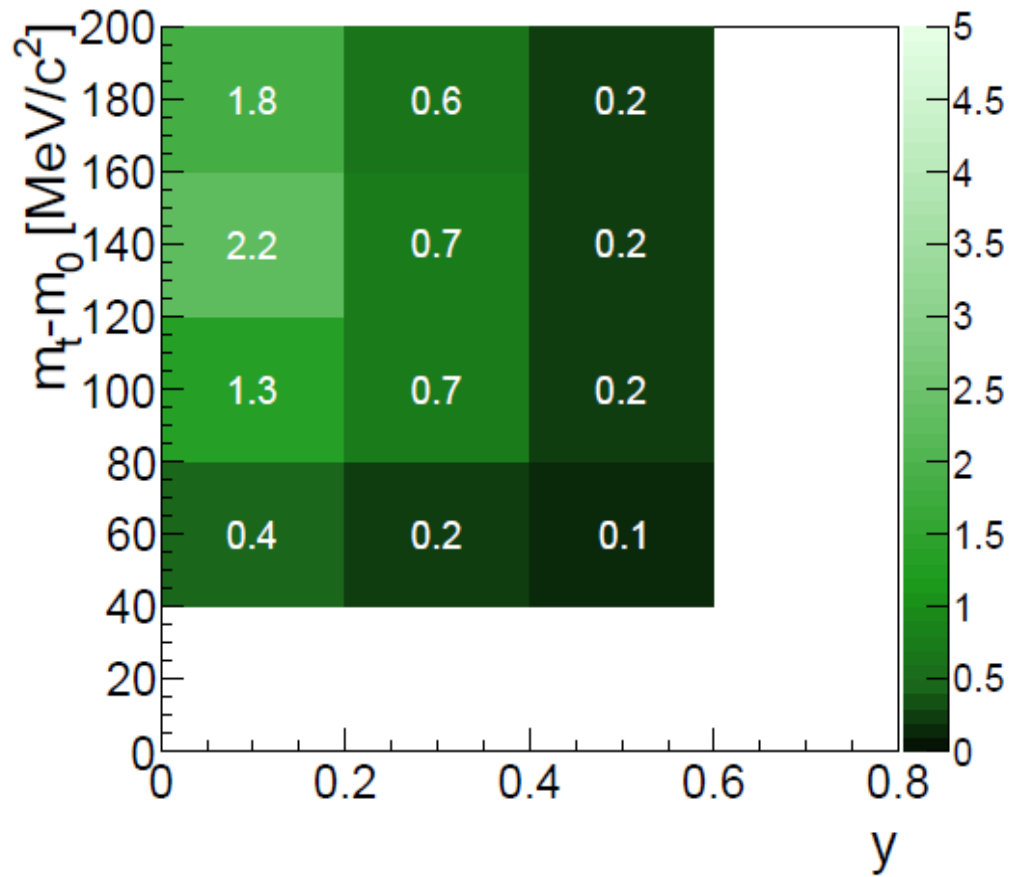
K^+ : Efficiency * Acceptance



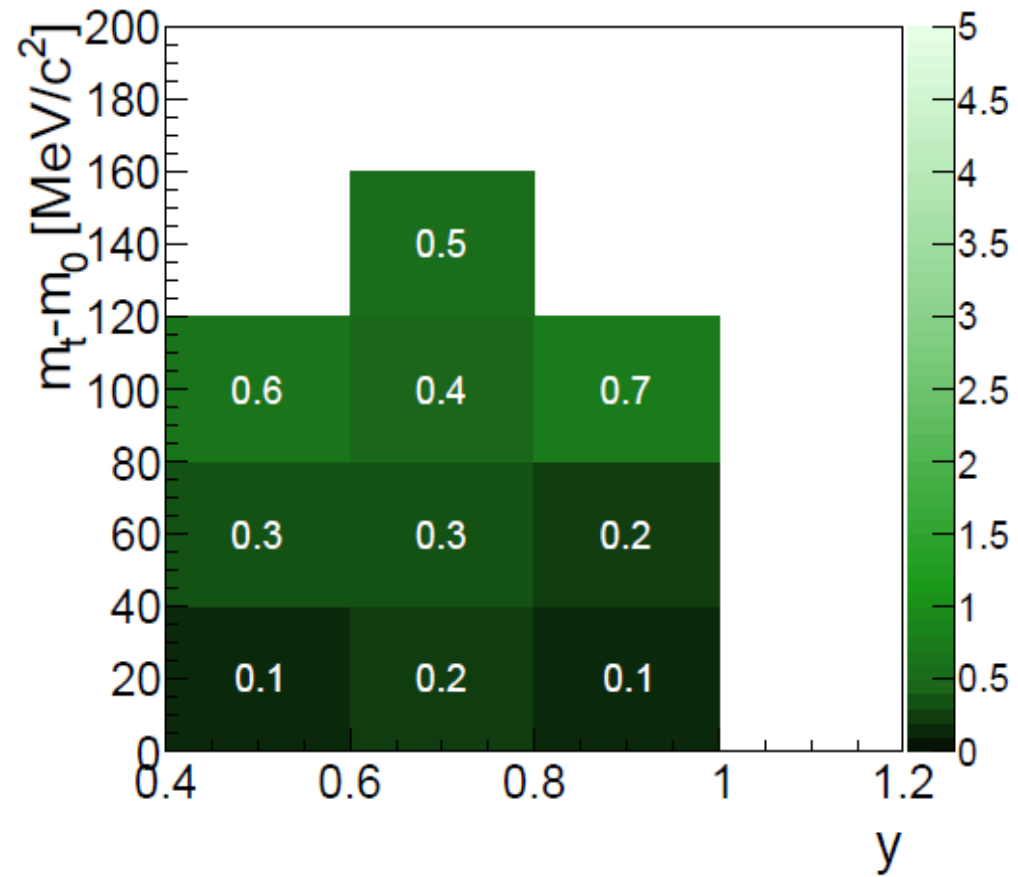
- Small (efficiency * acceptance)-factors → huge corrections
- Small uncertainties have strong effect

K^- : Signal/Background

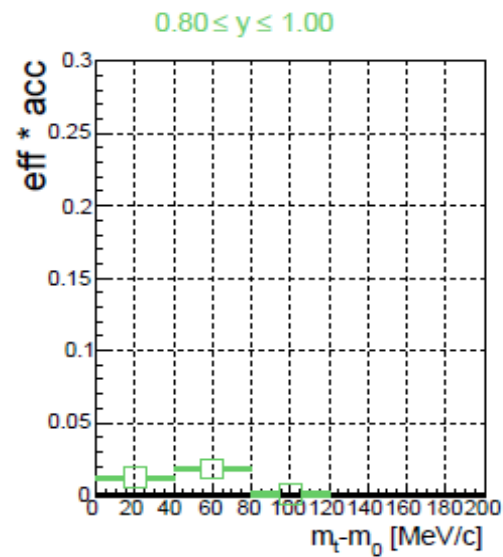
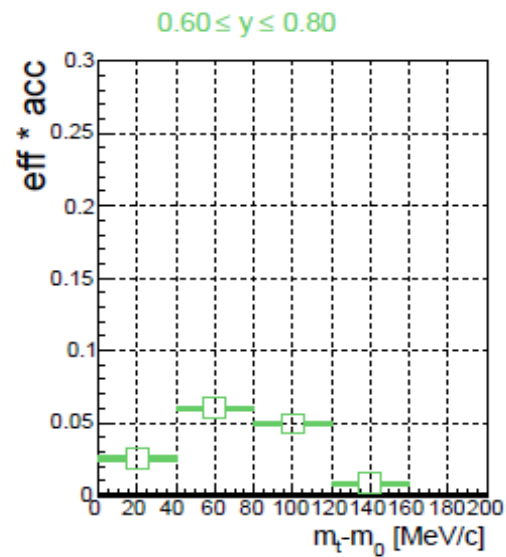
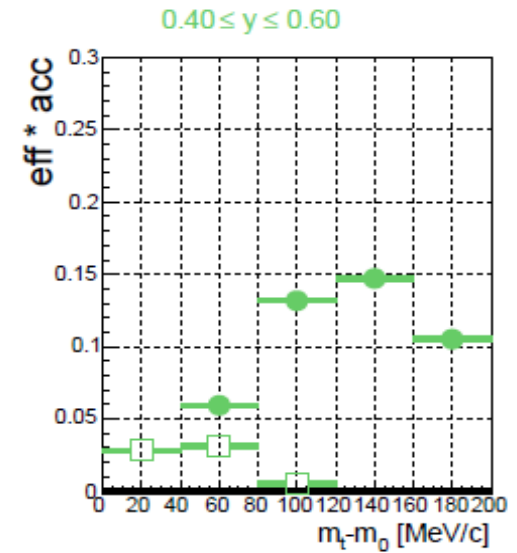
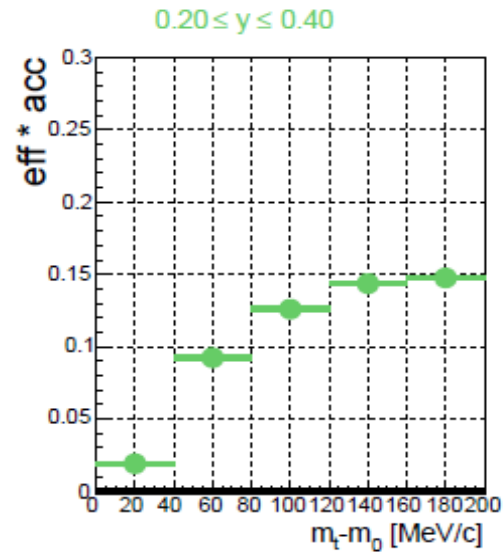
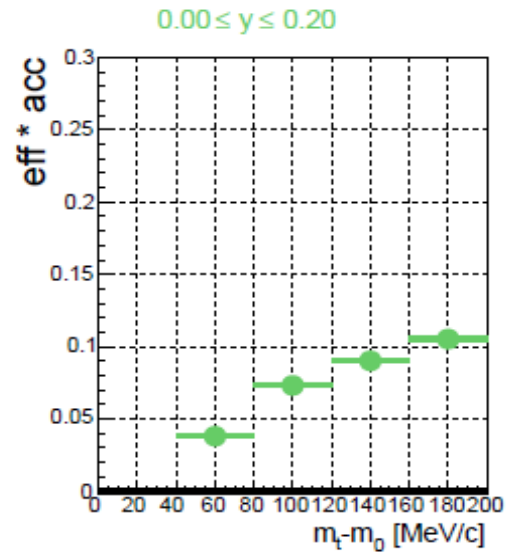
TOF



RPC



K^- : Efficiency * Acceptance

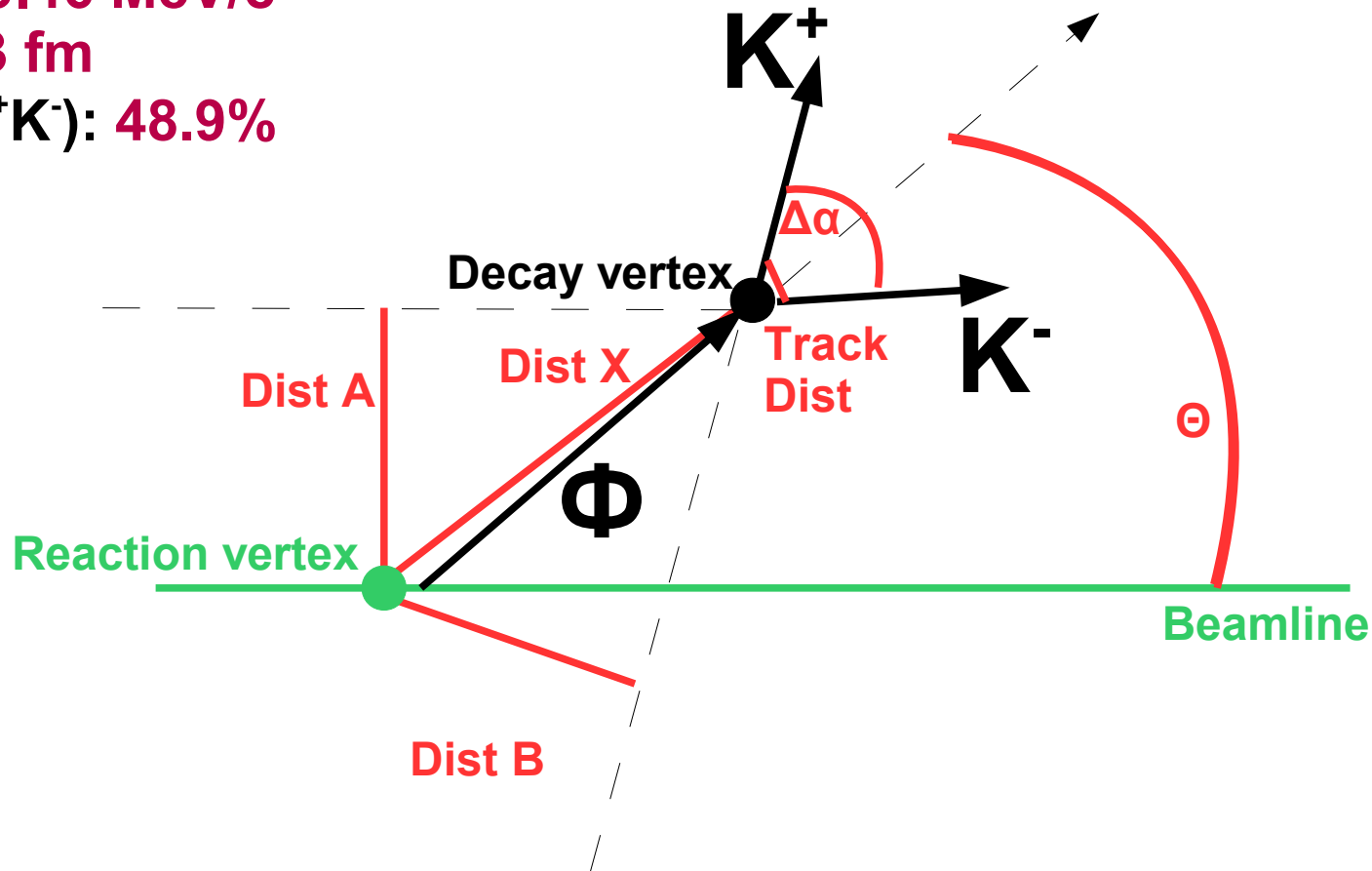


Φ Reconstruction

Mass: 1019.46 MeV/c²

CT : 46.3 fm

BR($\Phi \rightarrow K^+K^-$): 48.9%



K^+	440<m<545	mom<1000	$\chi_{Rk} < 8$	Meta<1.5	$\chi_{In/Ou} < 10$	
K^-	440<m<545	mom<800	$\chi_{rk} < 7.5$	Meta<1.25	$\chi_{In/Ou} < 10$	dE/dx
Decay topology	Dist A<10	Dist B<10	Dist X<10	Track Dist<10	$M_t > 30$	