New Results from CERES

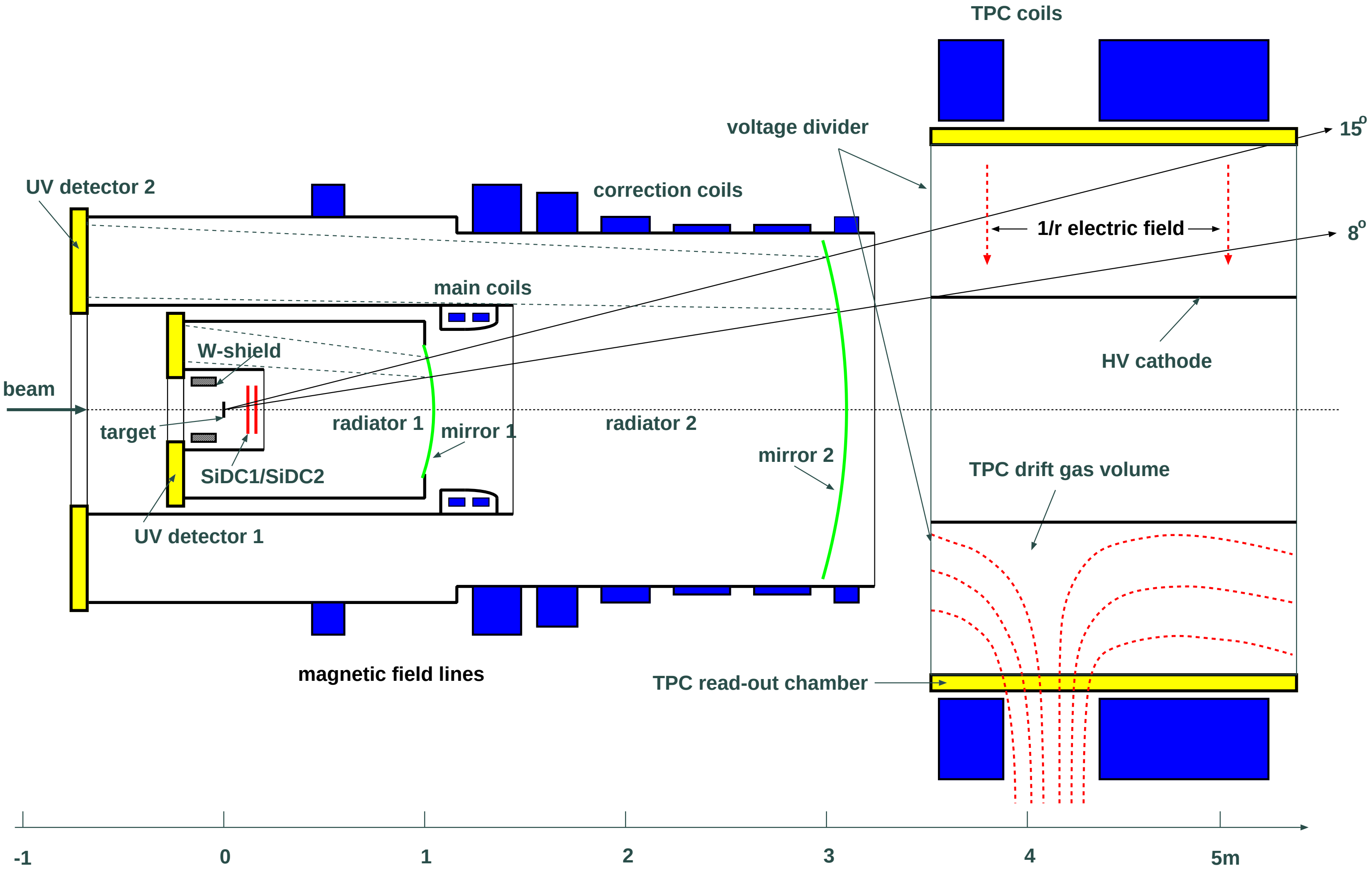
Harry Appelshäuser

Universität Heidelberg, Germany

for the CERES collaboration

- Experimental Setup
- Hadronic Observables
  - Spectra, Azimuthal Correlations and HBT
  - Event-by-Event Mean p_t Fluctuations
- Leptonic Observables
  - 40 AGeV Pb+Au e^+e^- Pair Analysis
- High p_t Pion Correlations
- Summary and Outlook

CERES/NA45 Experimental Setup



- SiDC1+2: Vertex reconstruction and angle measurement
- RICH1+2: Electron ID and angle measurement

- New cylindrical Time Projection Chamber with radial drift field, length 2 m, outer diameter 2.6 m
- New magnet system

  1999→: Azimuthal deflection inside TPC, no more B-field between RICHes

CERES-TPC

- Radial drift field (-30 kV)
- Gas mixture Ne(80%)CO_2(20%)
- 20 space points per track
- 15360 readout channels (typical: 200 kByte at 5% occupancy)

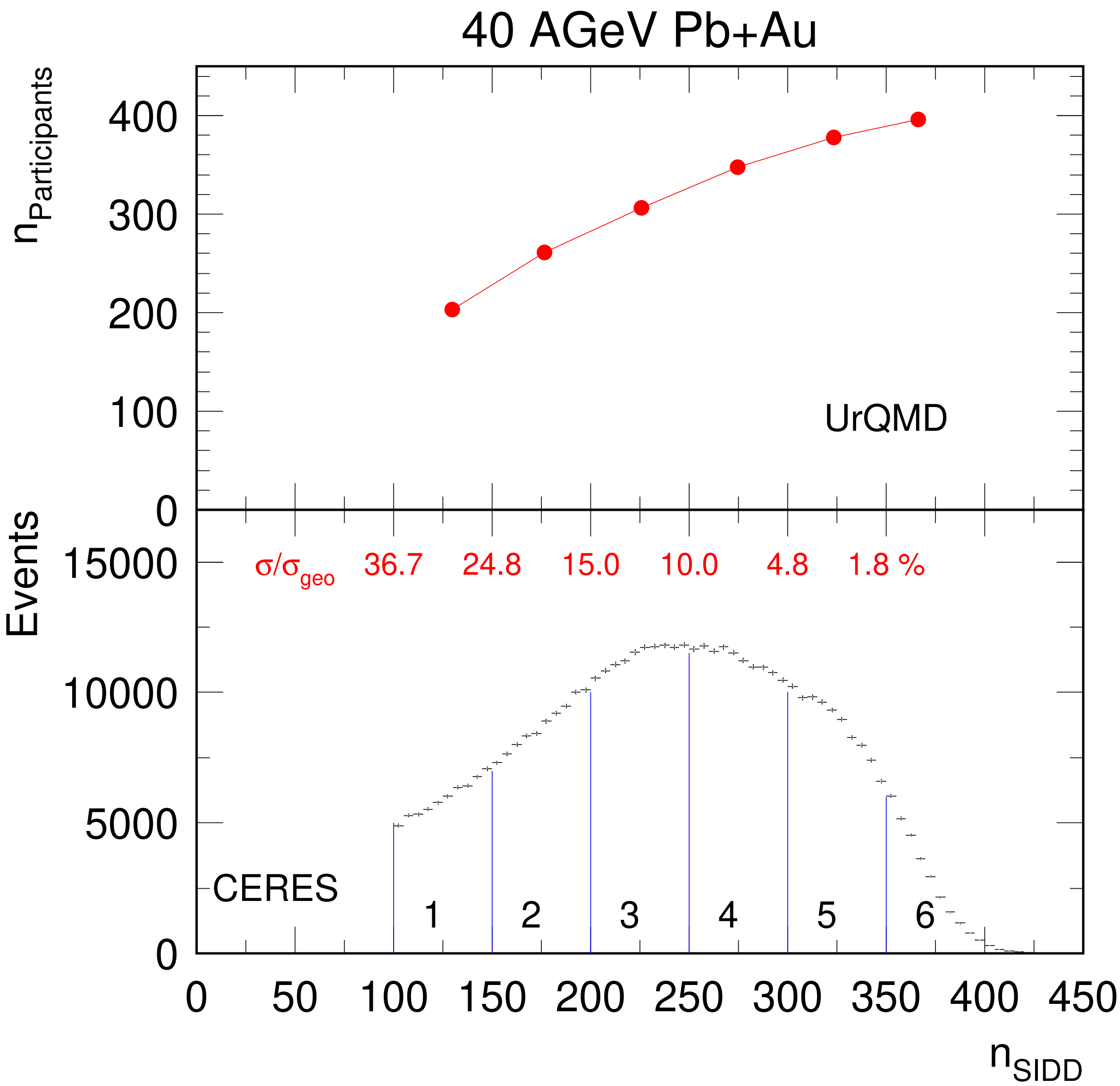
Data Set

Year	E_{beam}		Events
2000	80	AGeV Pb+Au	0.5 M
	158	AGeV Pb+Au	33 M
1999	40	AGeV Pb+Au	8 M
1996	158	AGeV Pb+Au	43 M

Centrality

Centrality determination:

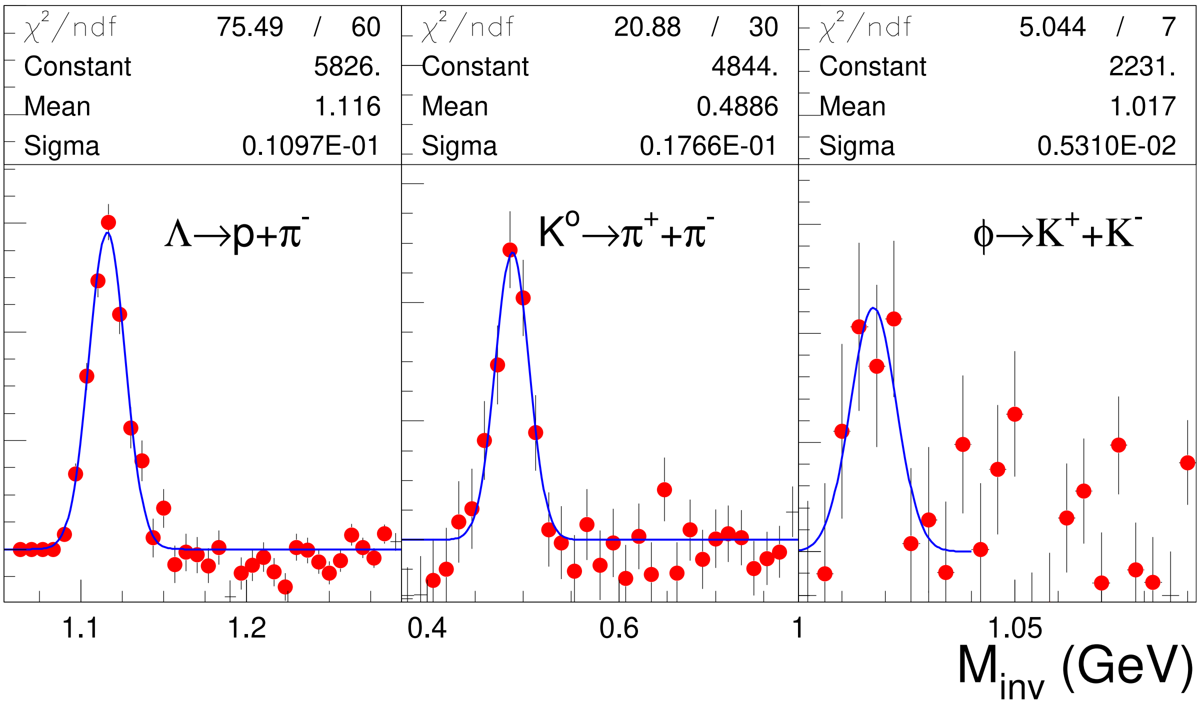
- Charged particle multiplicity in SiDD
- $n_{\text{participants}}$ from model



Hadron Analysis

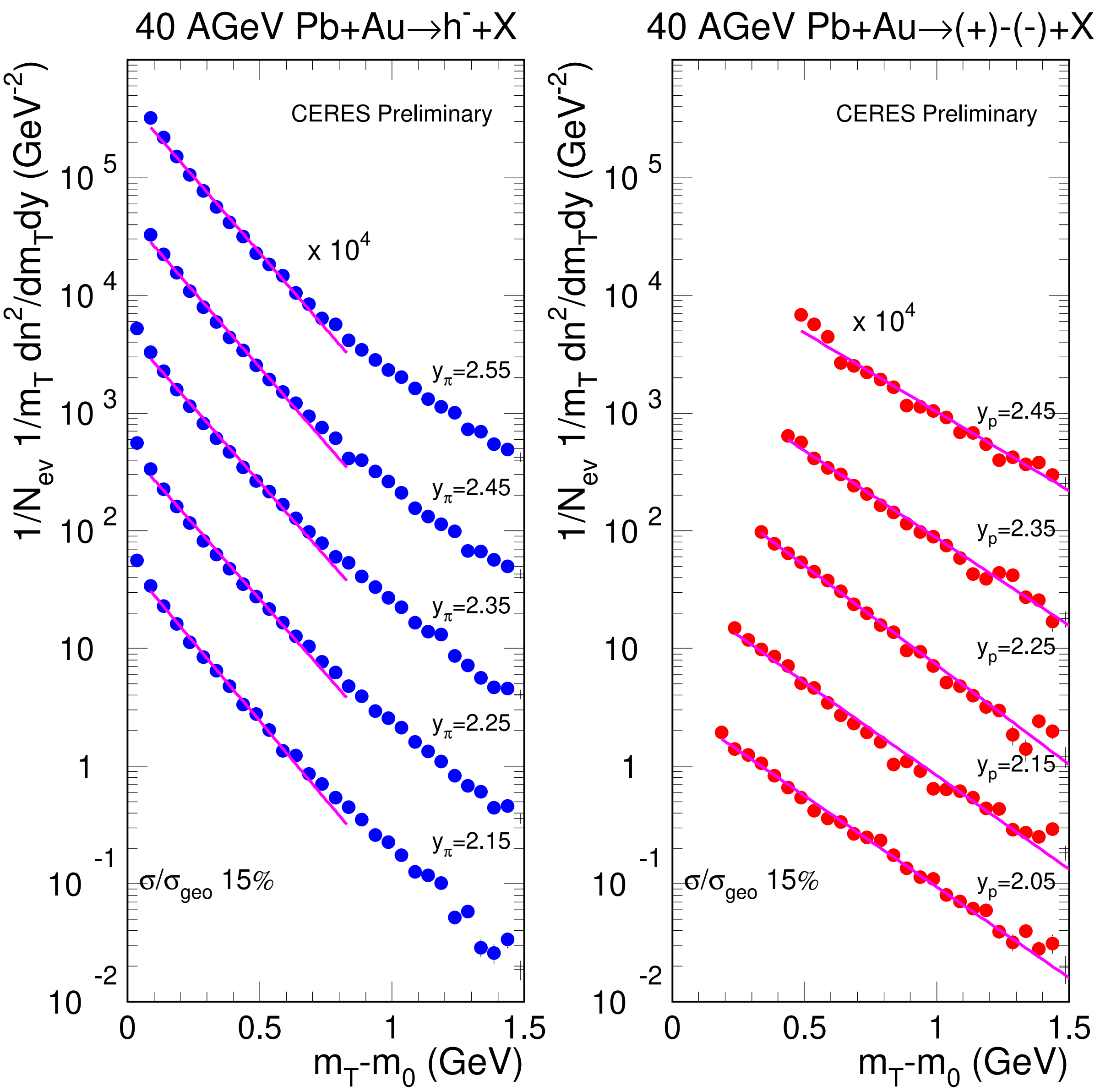
Momentum determination:

- curvature in TPC
- angles in SIDC



Present status of '99 analysis: $\mathrm{d}p/p \approx 4\%$

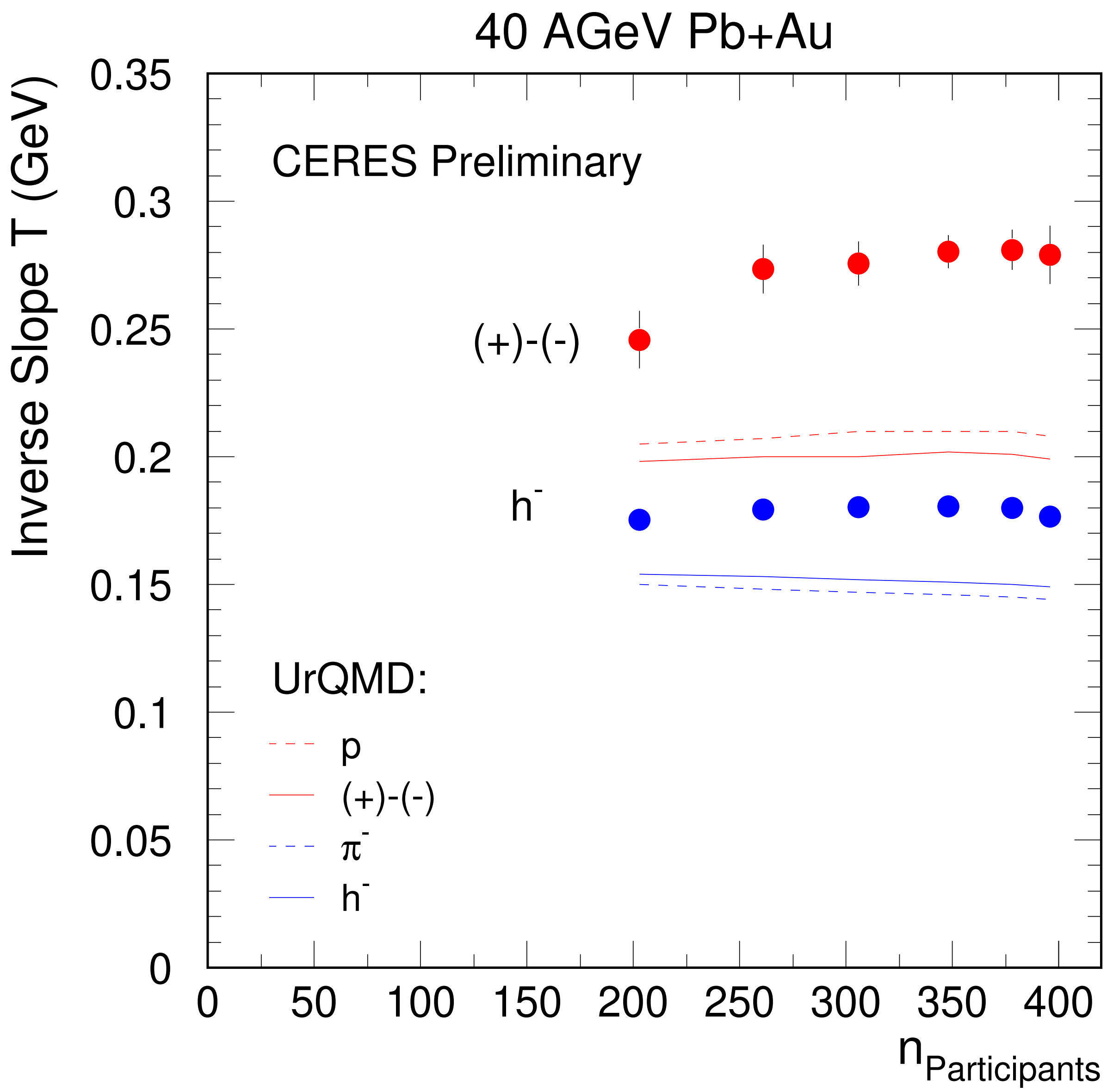
Transverse Mass Spectra



Fit:

$$\frac{1}{m_{\mathrm{T}}}\frac{\mathrm{d}n}{\mathrm{d}m_{\mathrm{T}}} = \exp\left(-\frac{m_{\mathrm{T}}}{T}\right)$$

Inverse Slopes



Fit:

$$\frac{1}{m_{\mathrm{T}}}\frac{\mathrm{d}n}{\mathrm{d}m_{\mathrm{T}}} \sim \exp\left(\frac{-m_{\mathrm{T}}}{T}\right)$$

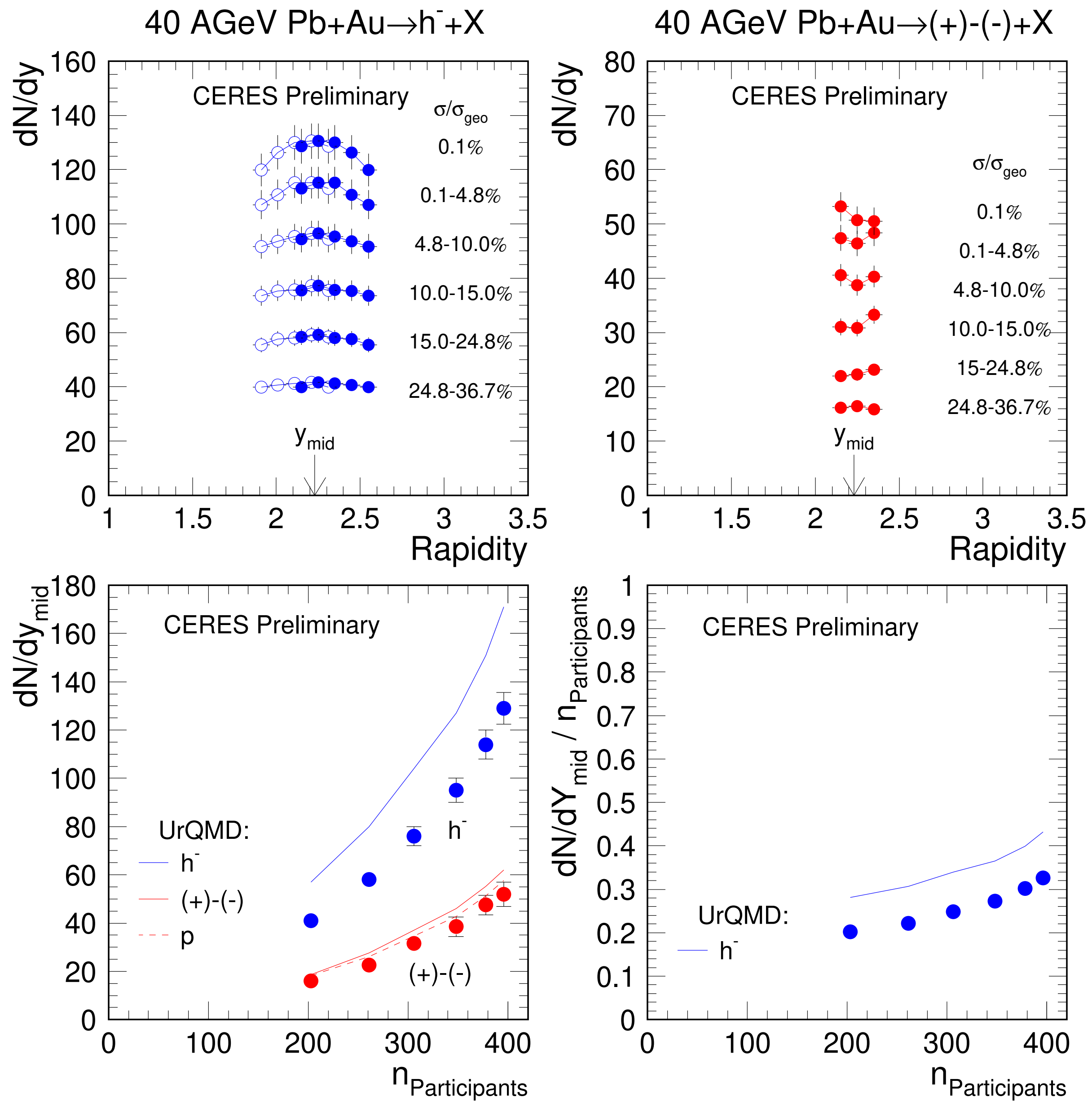
Range:

$0.3 < m_{\mathrm{T}} < 1.0$ GeV $\quad h^{-}$

$1.35 < m_{\mathrm{T}} < 2.5$ GeV $\quad (+)-(-)$

Hadron Yields

⇒ Extrapolation to $p_{\mathrm{T}} = 0$

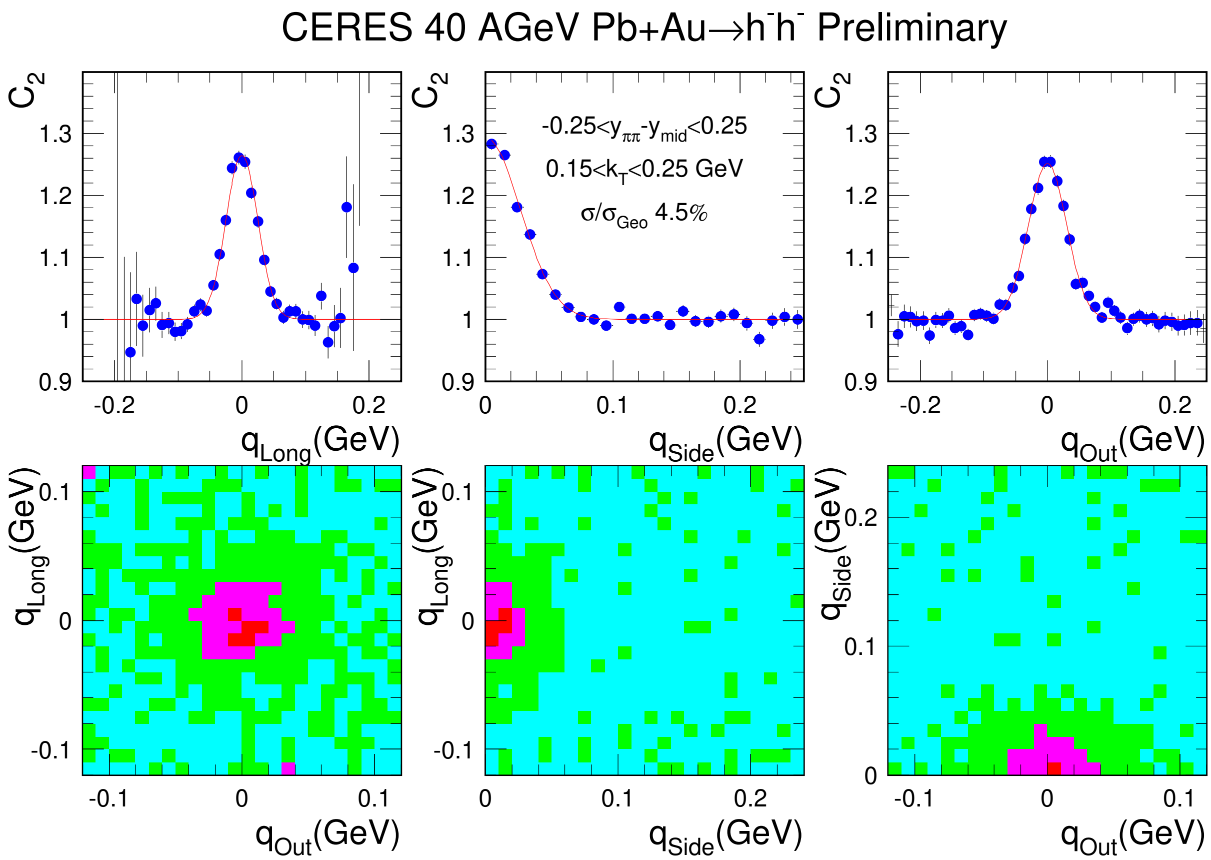


Pion HBT Analysis

h^-h^- and h^+h^+:

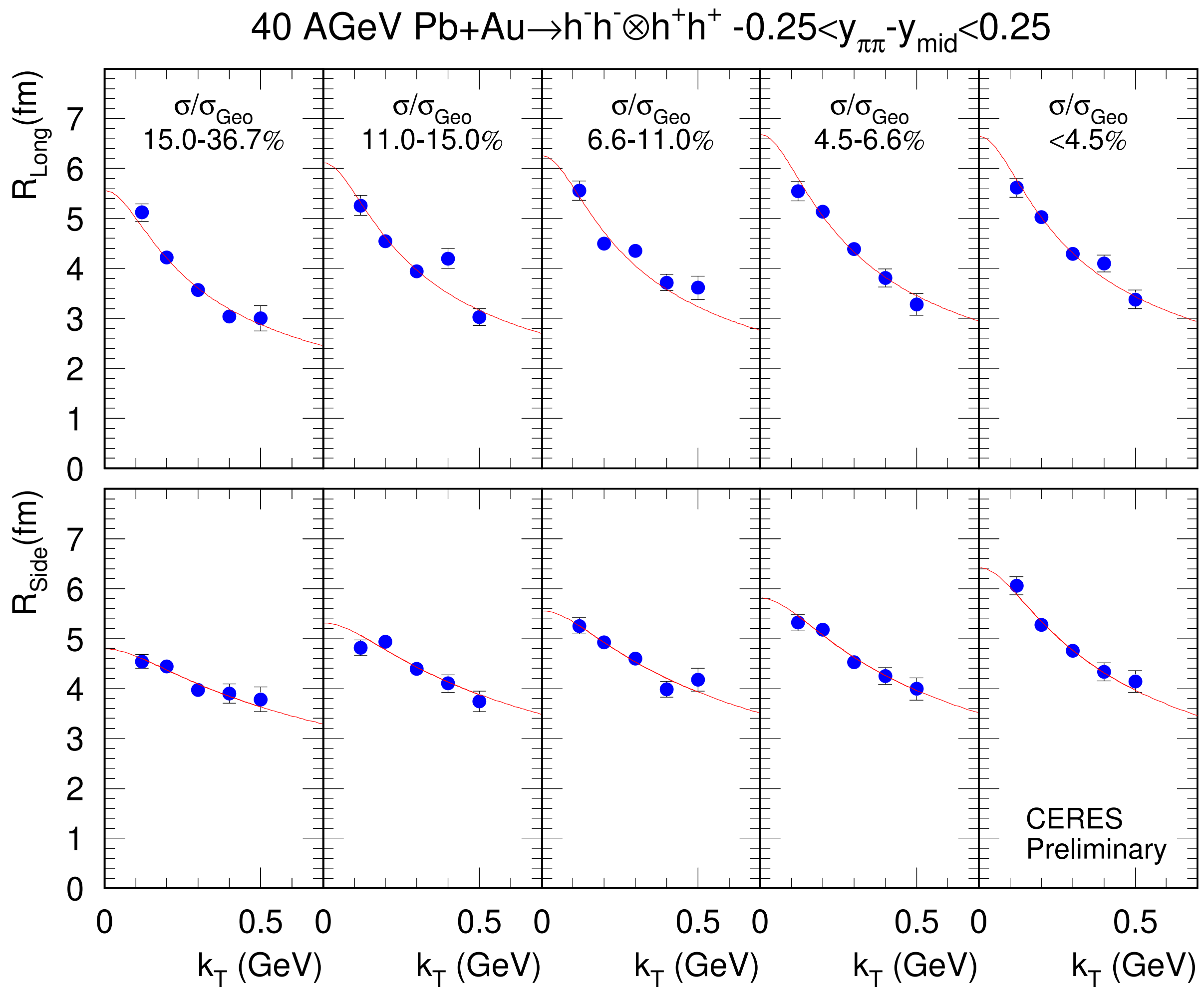
$$C_2 = \lambda \cdot \exp(-q^2_{\rm Long}R^2_{\rm Long} - q^2_{\rm Side}R^2_{\rm Side} - q^2_{\rm Out}R^2_{\rm Out} - 2q_{\rm Out}q_{\rm Long}R^2_{\rm OutLong})$$

- -0.25 $< y_{\pi\pi} - y_{\rm mid} <$ 0.25
  in bins of centrality and pair transverse momentum $k_{\rm T}$
- Finite source size Coloumb correction
- Pair opening angle cut: 10 mrad



Transverse Momentum Dependence

$$k_{\rm T} = \frac{1}{2}(\vec{p}_{\rm T,1} + \vec{p}_{\rm T,2})$$



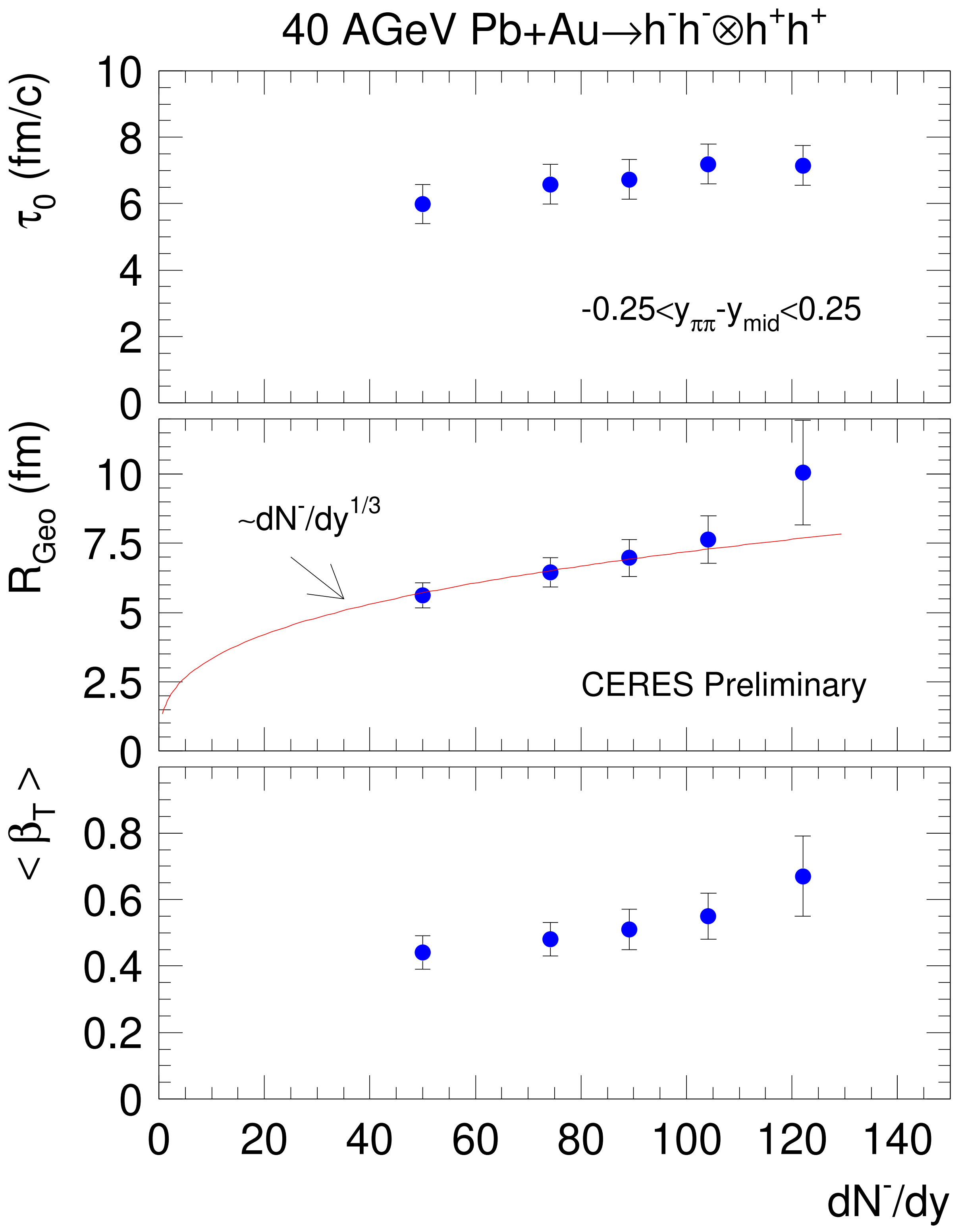
Longitudinal boost-invariant expansion:

$$R_{\rm Long} = \tau_0 \sqrt{\frac{T}{m_{\rm T}}} \qquad \text{Sinyukov}$$

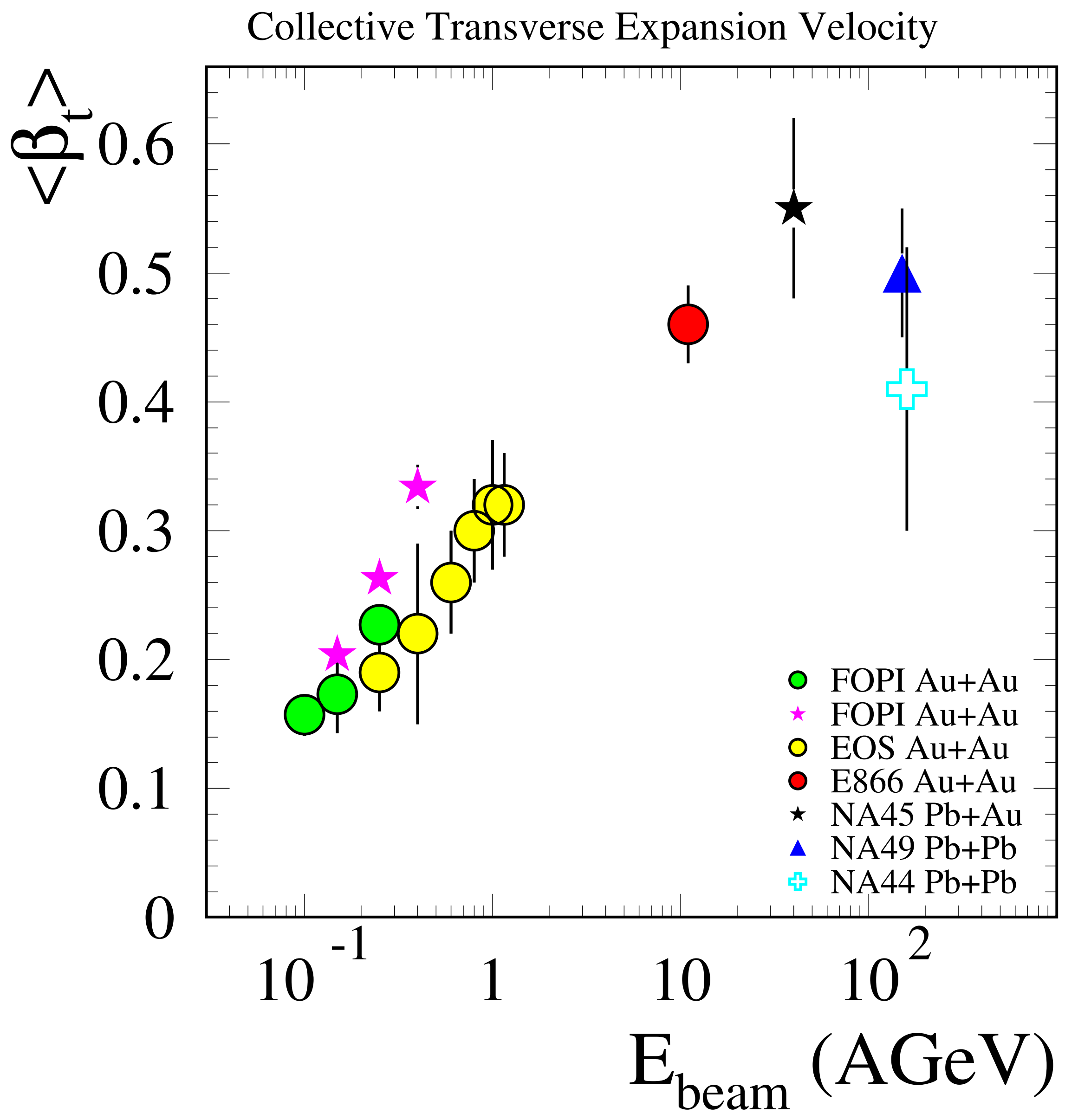
Radial flow:

$$R_{\rm Side}^2 = \frac{R_{\rm Geo}^2}{1 + \frac{\eta_{\rm f}^2}{T} m_{\rm T}} \qquad \text{Heinz, Tomasik, Wiedemann}$$

Freezeout Parameters



$<\beta_t>$ vs Beam Energy



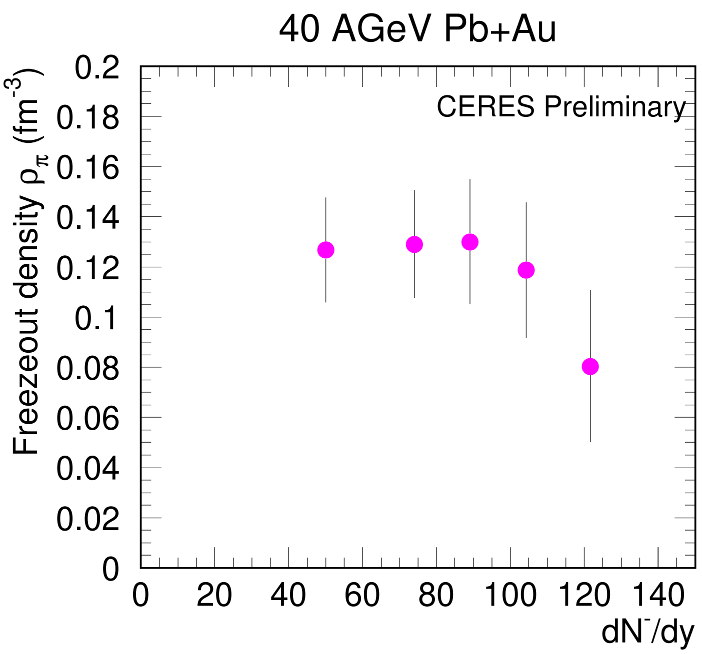
Pion Freeze-out

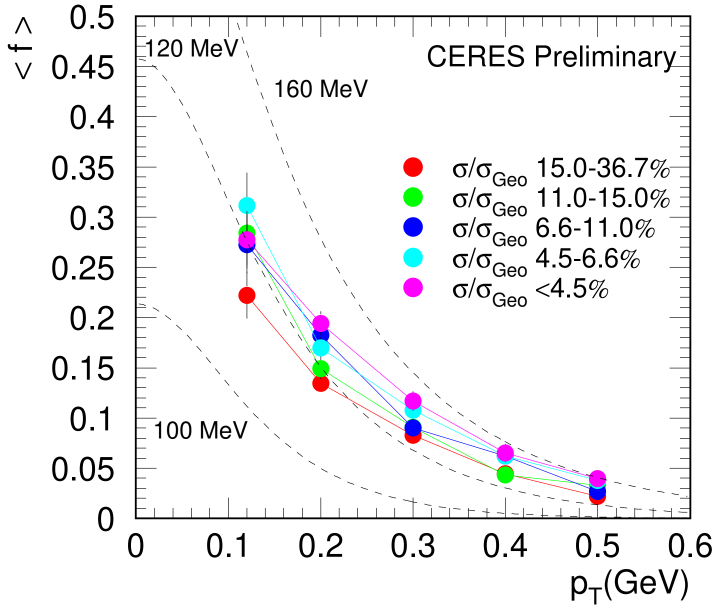
Freeze-out density:

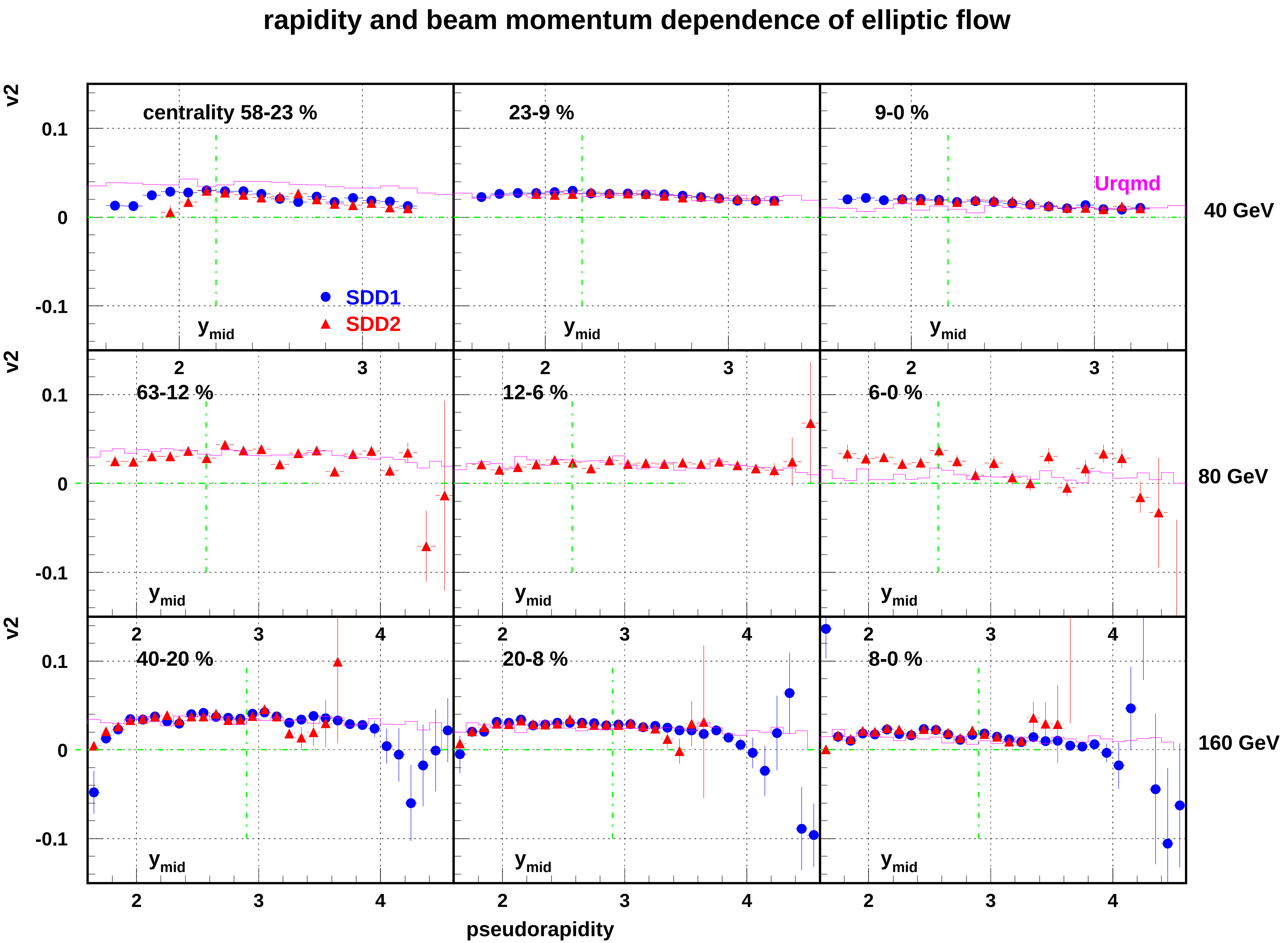
$$\rho_\pi = \frac{\mathrm{d}n/\mathrm{d}y}{2\pi \cdot R^2_{\mathrm{Geo}} \cdot \tau_0}$$

Phase-space density (Bertsch):

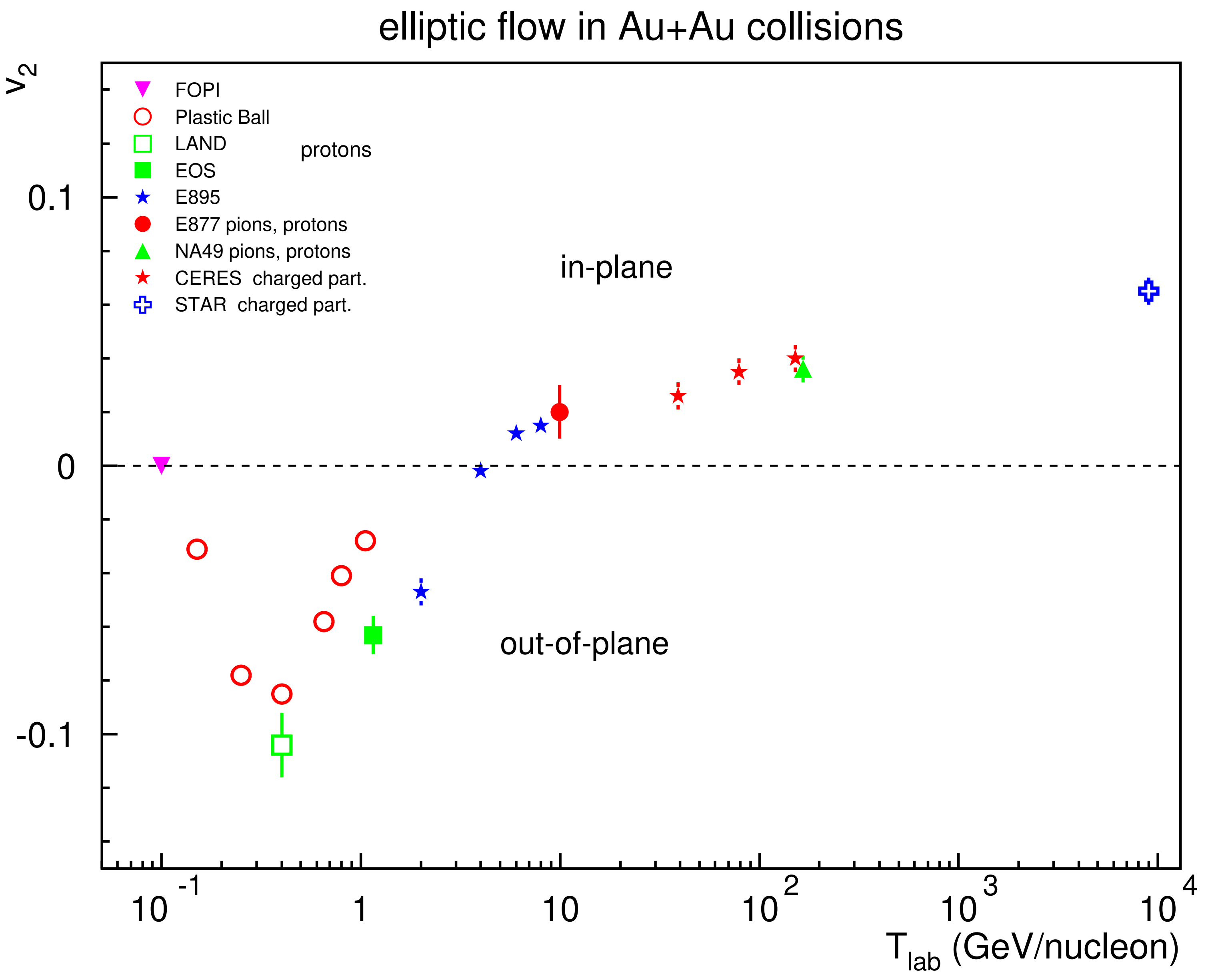
$$< f > (p_T, y) = \sqrt{\lambda(p_T, y)} \frac{\frac{\mathrm{d}n^-}{\mathrm{d}y} \frac{1}{2\pi T^2_{\mathrm{eff}}(y)} e^{-p_T/T_{\mathrm{eff}}(y)}}{\pi^{-3/2} m_T \cosh y \cdot R^2_{\mathrm{Side}}(p_T, y) \cdot R_{\mathrm{Long}}(p_T, y)}$$






rapidity and beam momentum dependence of elliptic flow
v2
0.1
0
-0.1
centrality 58-23 %
23-9 %
9-0 %
Urqmd
40 GeV
SDD1
SDD2
y_{mid}
63-12 %
12-6 %
6-0 %
80 GeV
40-20 %
20-8 %
8-0 %
160 GeV
2
3
4
pseudorapidity

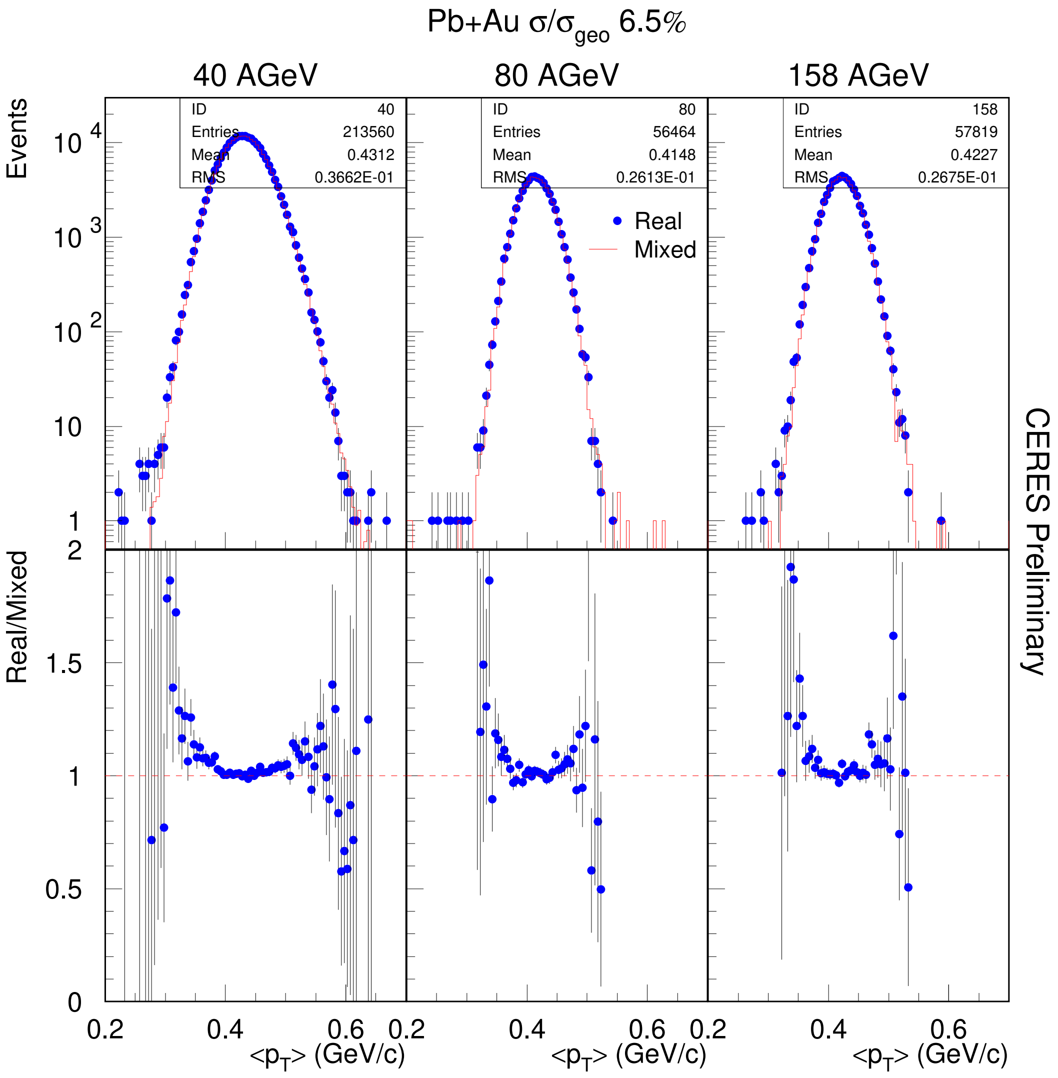
v_2 vs Beam Energy



Event-by-Event $< p_{\mathrm{T}} >$ Fluctuations

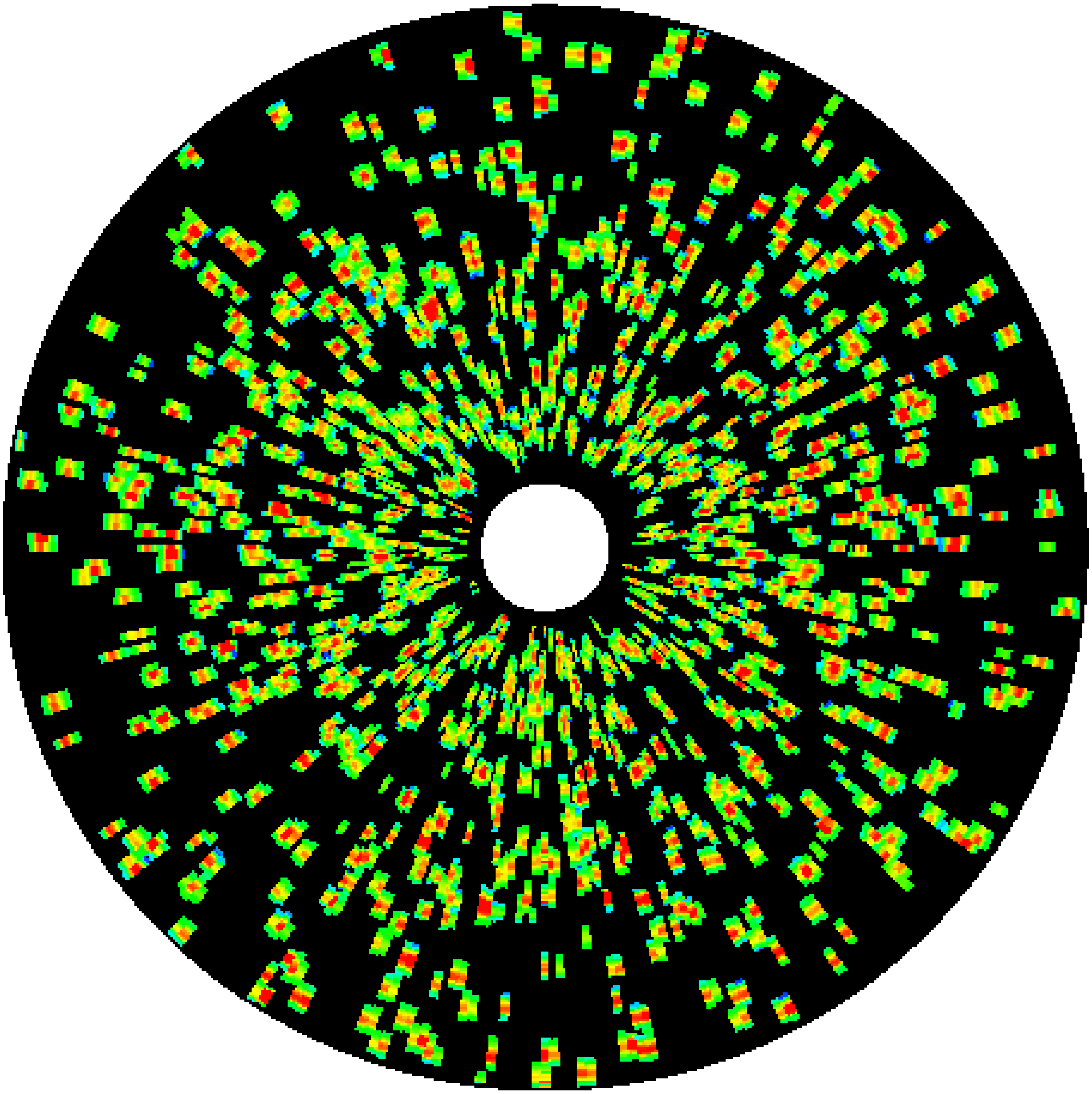
	$\mathrm{N_{events}}$	$< \mathrm{N_{tracks}} >$	$\Phi_{p_{\mathrm{T}}\mathrm{real}}$ (MeV)	$\Phi_{p_{\mathrm{T}}\mathrm{mix}}$ (MeV)
40 AGeV	216881	77.8	5.5 ± 0.7	0.0 ± 0.2
80 AGeV	56464	128.7	3.7 ± 0.9	-0.5 ± 0.8
158 AGeV	57819	129.4	7.8 ± 0.9	1.0 ± 0.9

$$0.05 < p_{\mathrm{T}} < 1.5 \text{ GeV}$$



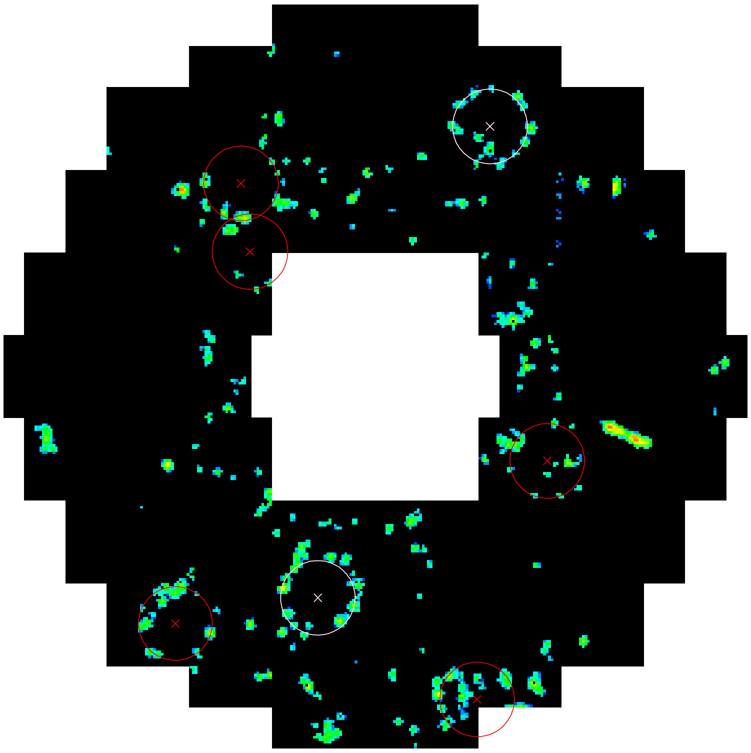
⇒ Upper limit for dynamical fluctuations: $\frac{\sigma_{dyn}}{<p_{\mathrm{T}}>} < 3\%$

SiDD Event Display

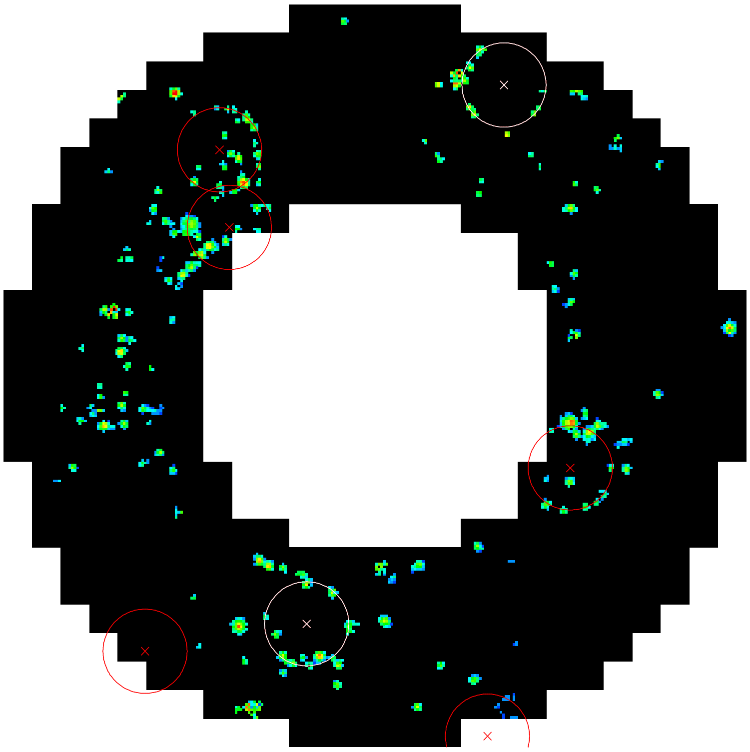


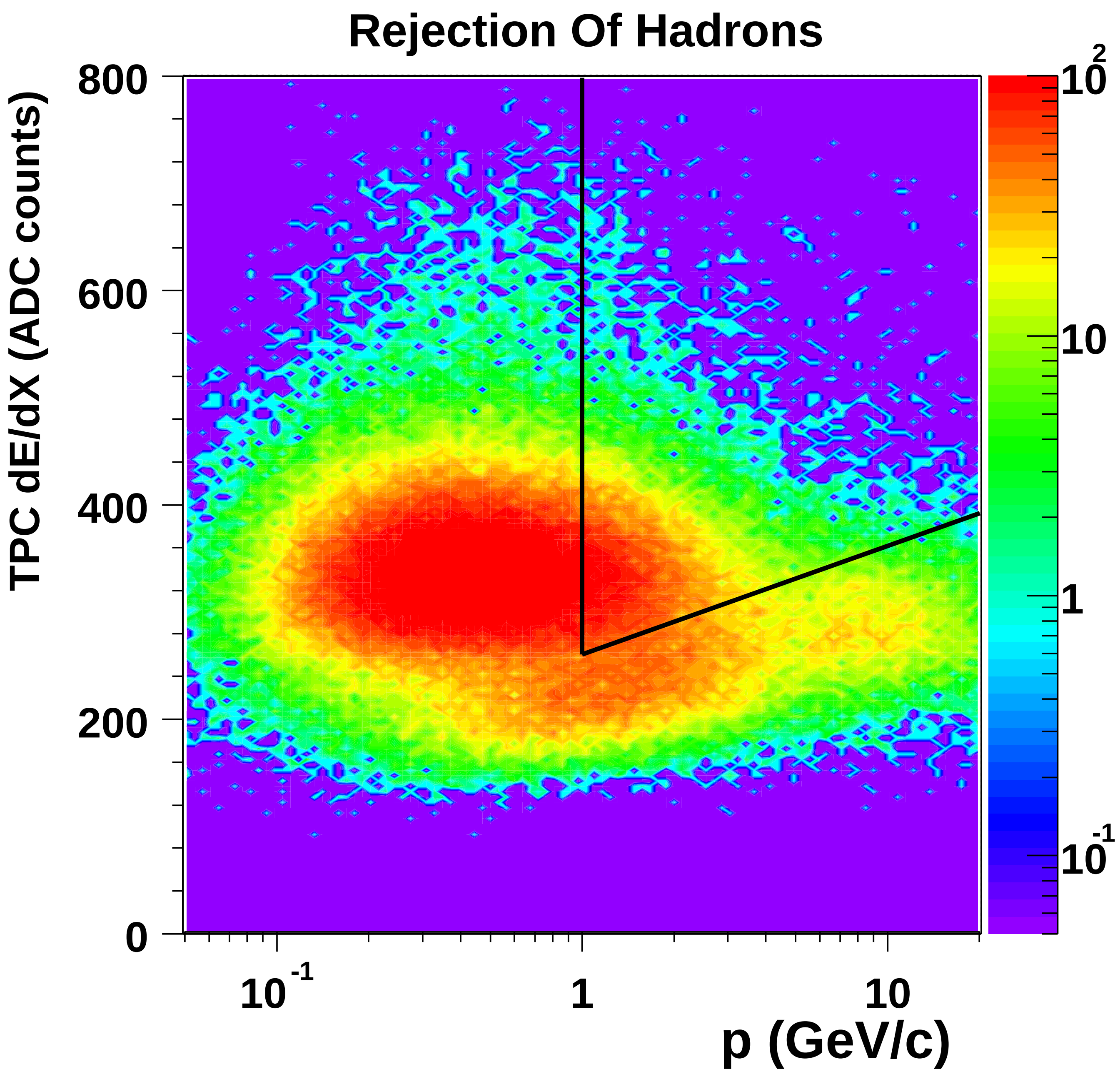
RICH Event Display

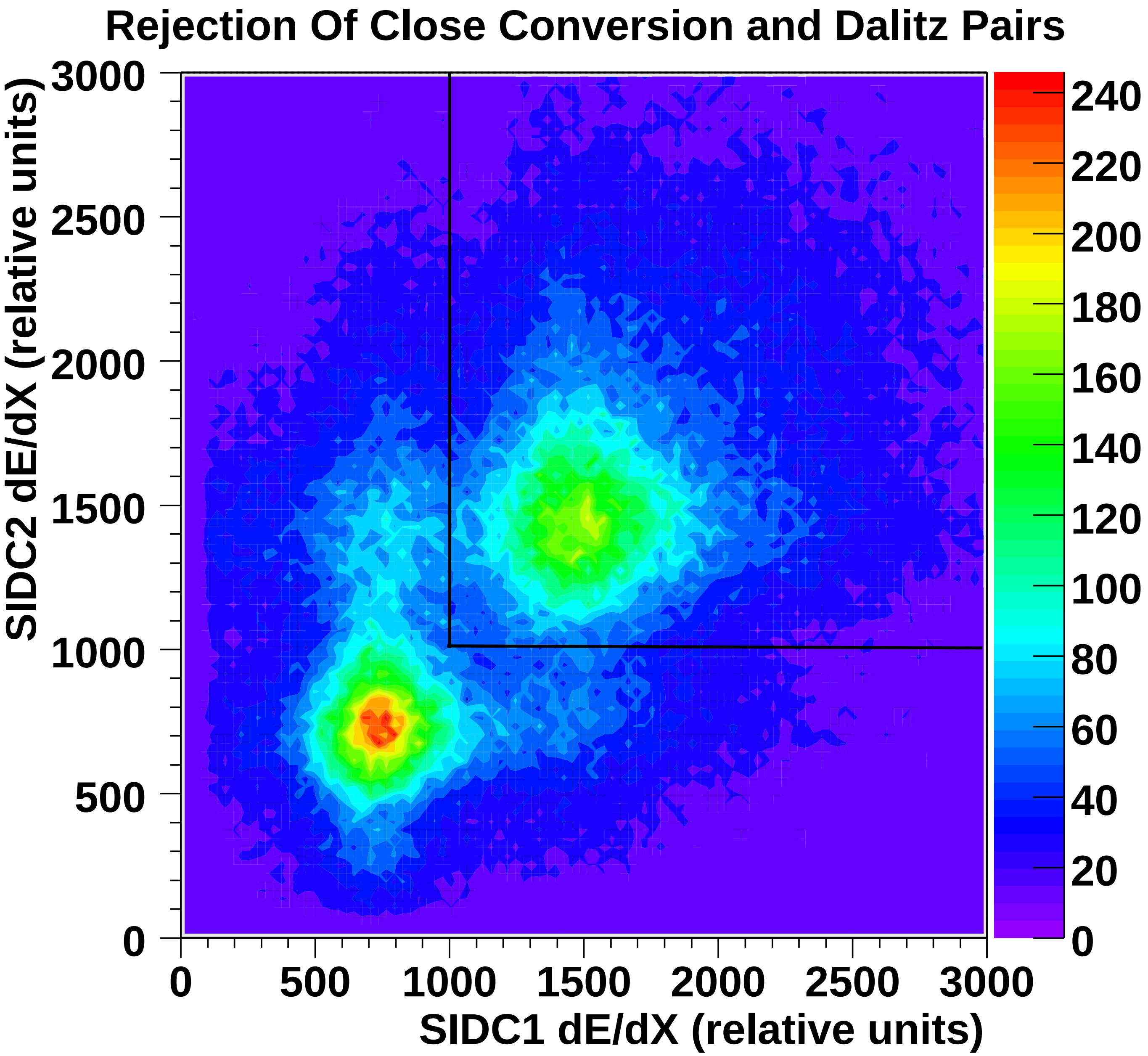
RICH 1:



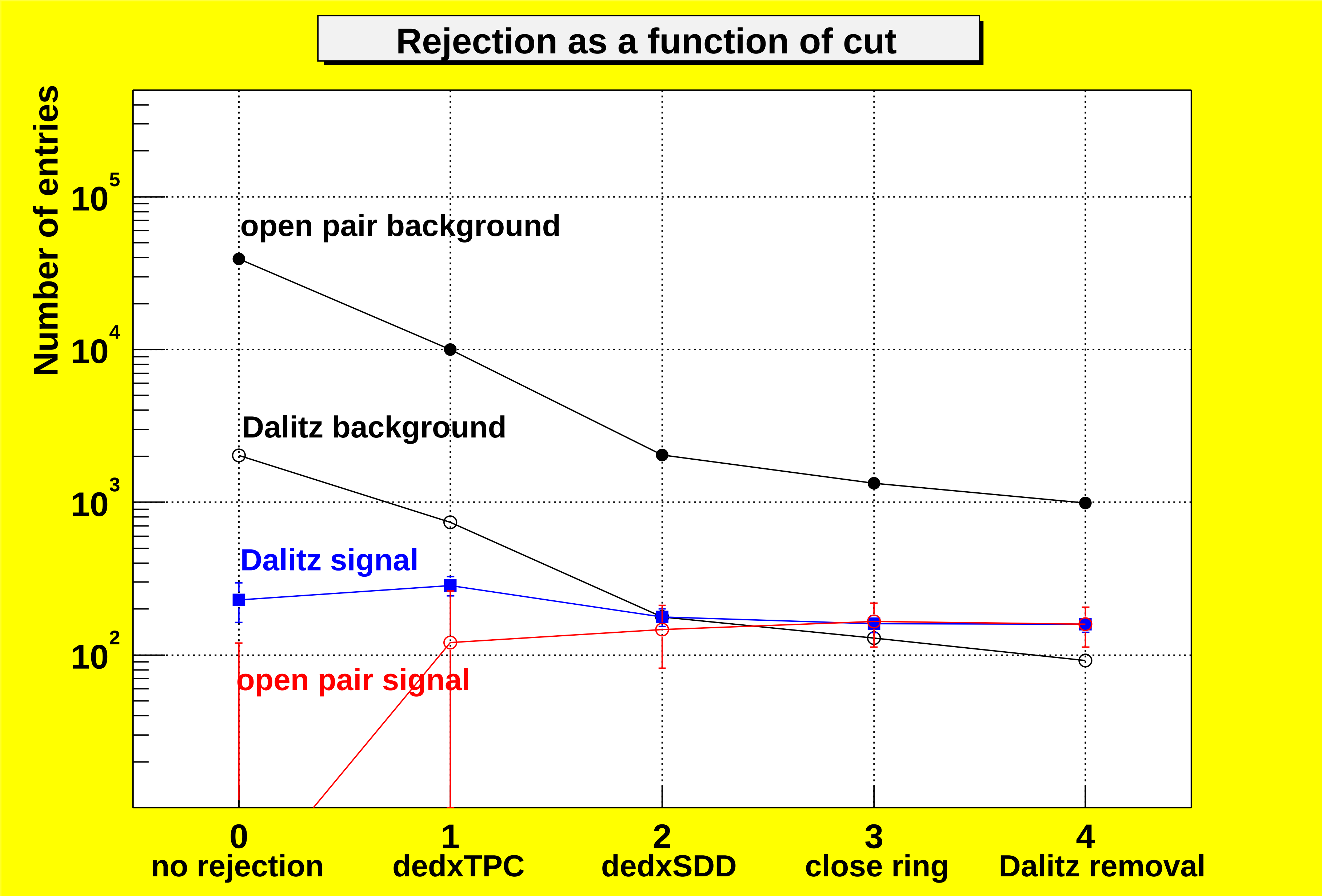
RICH 2:



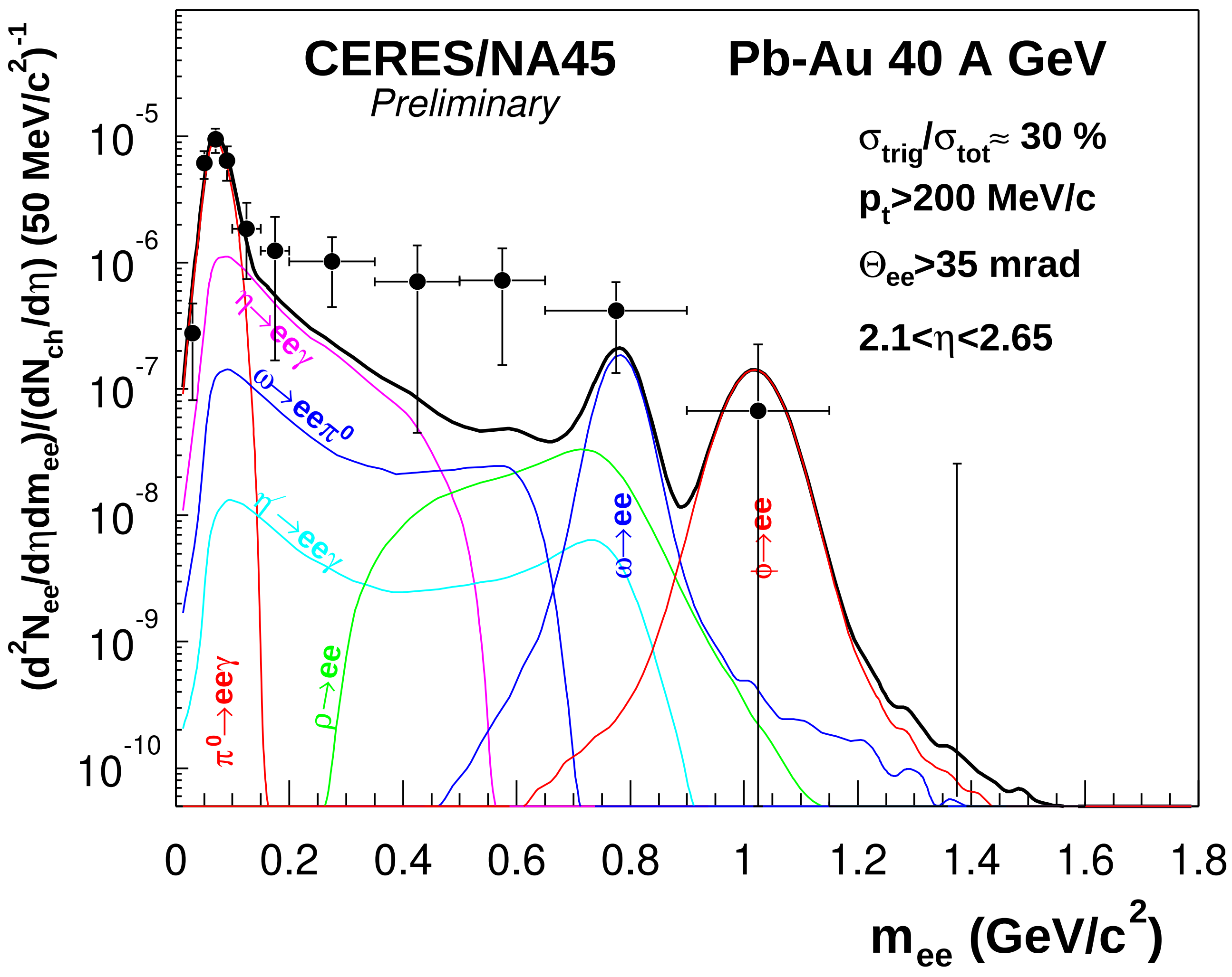

Rejection Of Hadrons
TPC dE/dX (ADC counts)
800
600
400
200
0
10^{-1}
1
10
p (GeV/c)
10^{2}
10
1
10^{-1}



Rejection Of Close Conversion and Dalitz Pairs
SIDC2 dE/dX (relative units)
SIDC1 dE/dX (relative units)
0
500
1000
1500
2000
2500
3000
0
20
40
60
80
100
120
140
160
180
200
220
240


Rejection as a function of cut
Number of entries
open pair background
Dalitz background
Dalitz signal
open pair signal
0
no rejection
1
dedxTPC
2
dedxSDD
3
close ring
4
Dalitz removal

Invariant Mass Spectrum



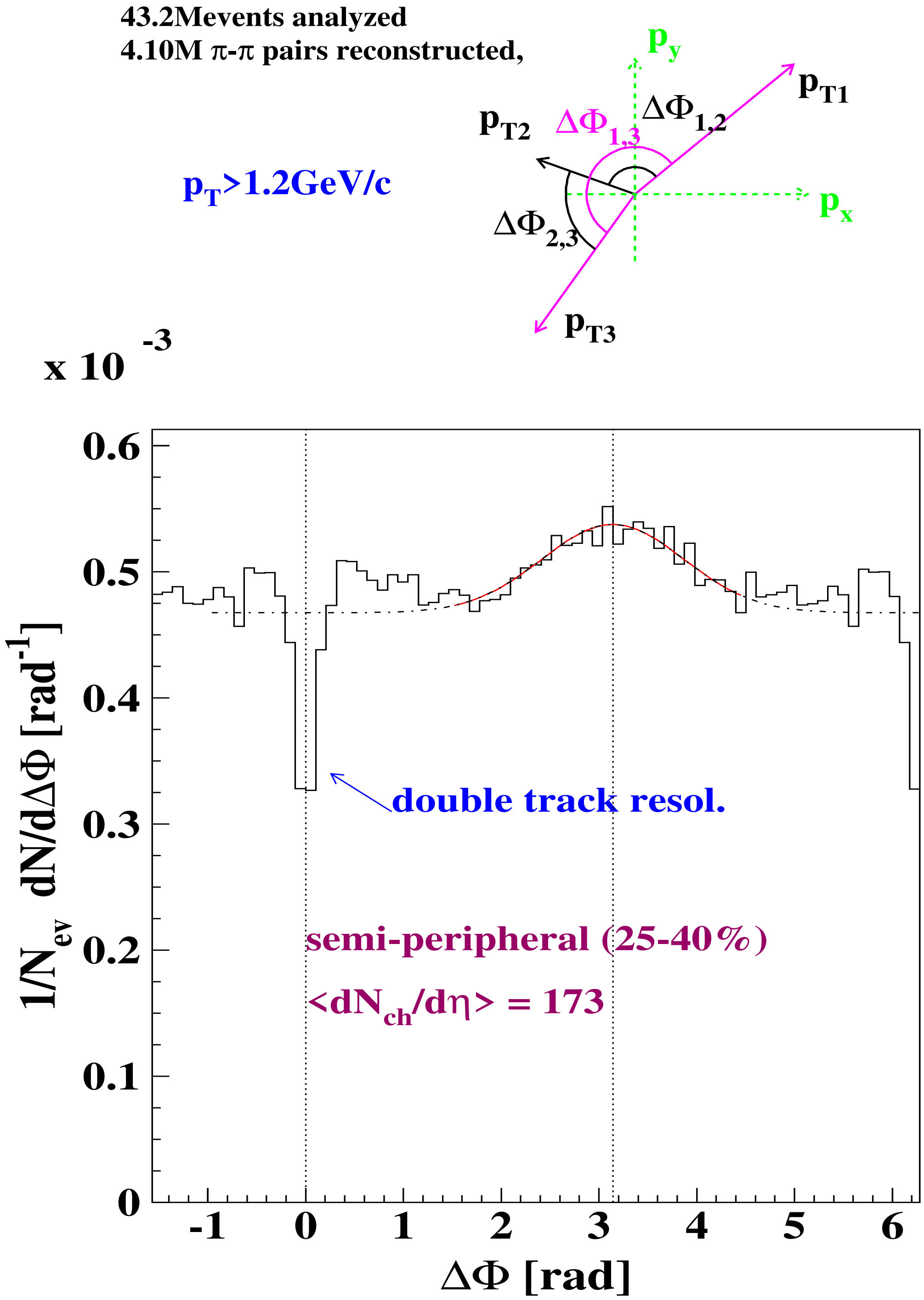
Total number of pairs for m > 0.2 GeV/c ^{2}

S=159 +- 46

Ratio Signal/Background

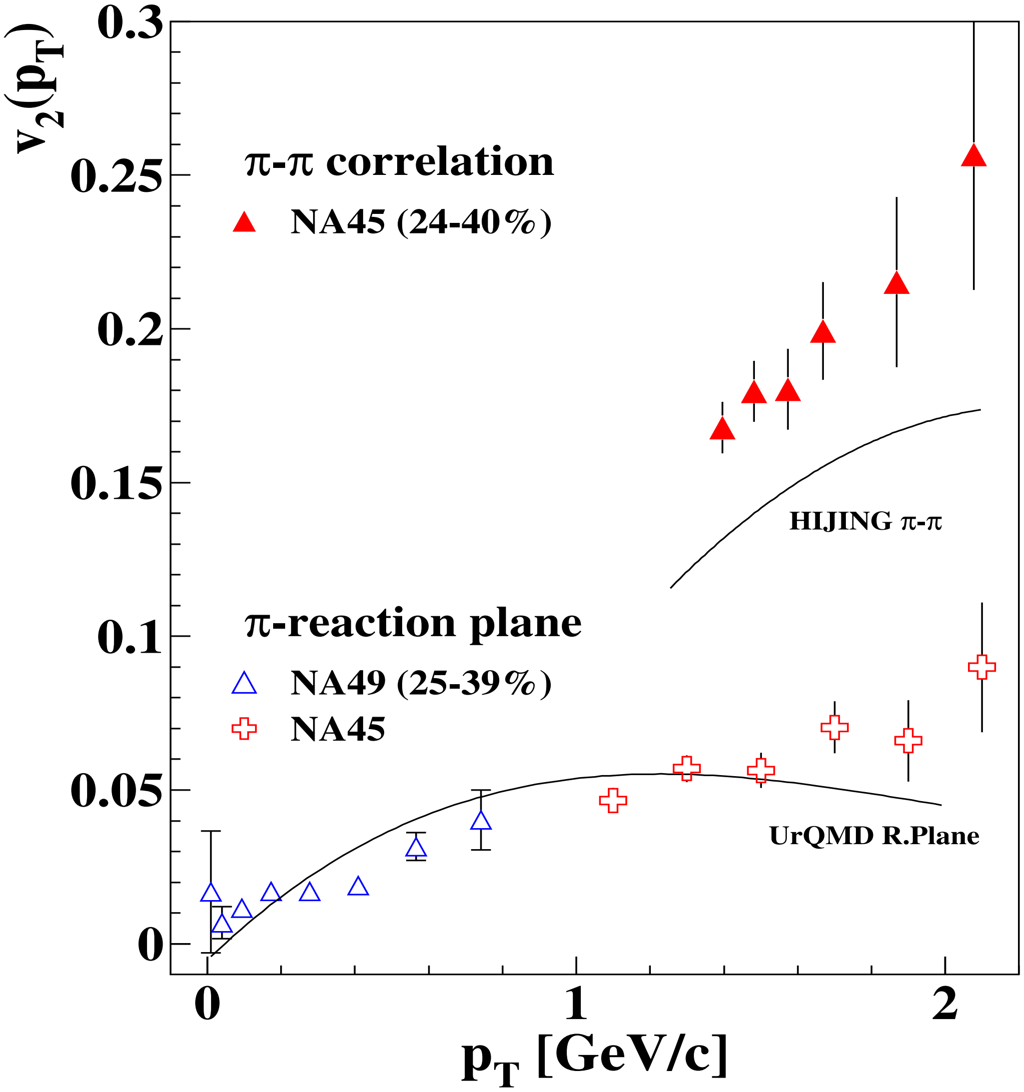
S/B=1/6

$\pi\pi$ azimuthal correlations
Pb-Au 160 A.GeV/c



parallel session Friday 19, Jan Rak : *"Observation of dijet-like azimuthal .."*

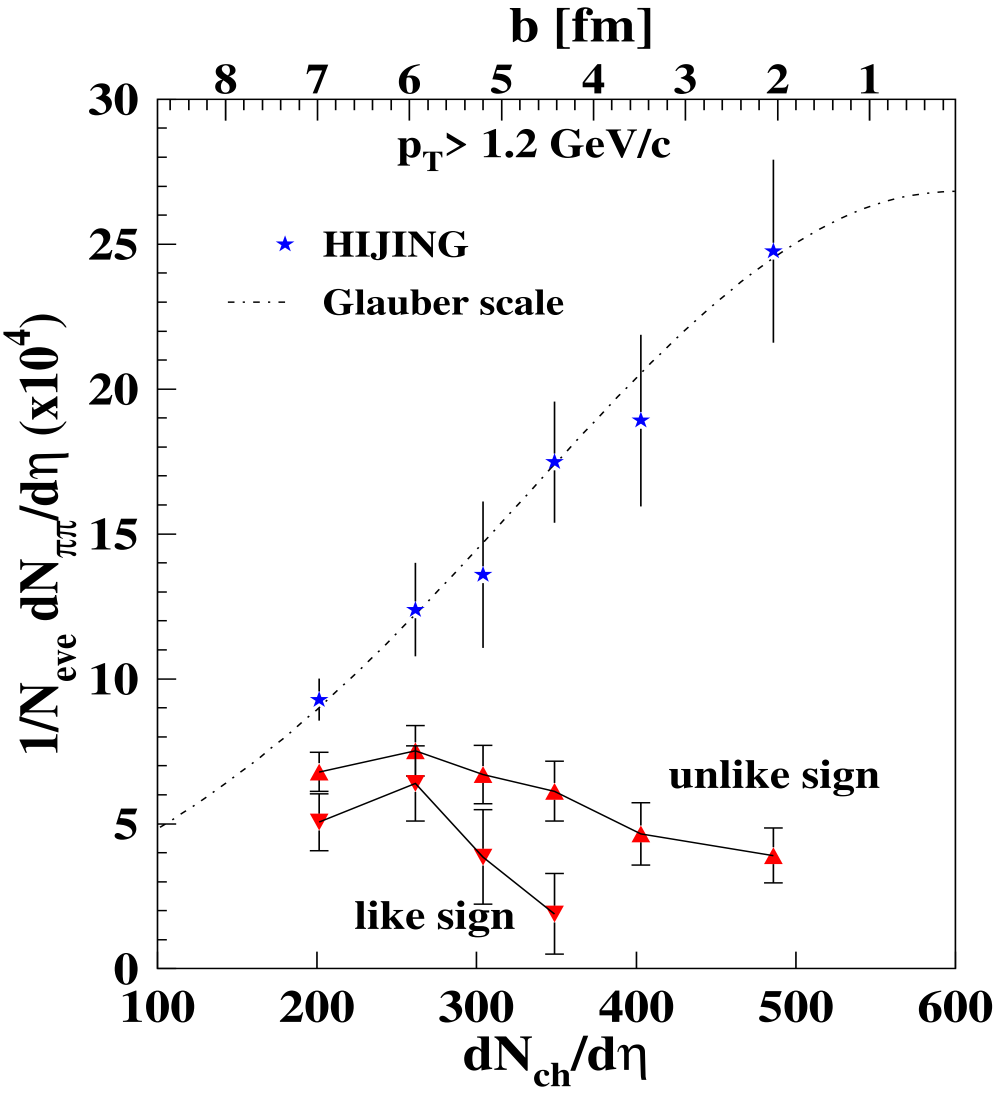
v_2 at SPS



- v_2 from $\pi\pi$ correlations exceeds v_2 values derived from standard flow analysis.
- NA45 standard-flow v_2 values follow a linear extrapolation of NA49 data to larger $p_\perp$.

Yield vs centrality

Yield is number of $\pi - \pi$ pairs in peak at $\Delta\Phi = \pi$



Do we observe jet quenching?

Summary

The TPC era has begun!!

- Hadron spectra and HBT provide useful information about the space-time evolution and freeze-out conditions of 40 AGeV Pb+Au collisions
- v_2 at 40, 80 and 158 AGeV fit into the overall E_{Beam} systematics
- Small but significant event by event $< p_{\mathrm{T}} >$ fluctuations are observed
- First preliminary measurement of e^+e^- production in 40 AGeV Pb+Au
- Indications of dijet-like azimuthal correlations of high p_{T} pions in 158 AGeV Pb+Au
  $\Rightarrow$ Talk by Jan Rak this afternoon

Outlook

- Continuation of 40 AGeV hadron and electron analysis

- 2000 data: 33 M events on tape
  $\Rightarrow$ Spectroscopy of ρ/ω and ϕ

CERES/NA45 Collaboration

P. Rehak
Brookhaven National Laboratory, Upton, USA

B. Lenkeit, A. Pfeiffer, J. Schukraft
CERN, Geneva, Switzerland

G. Agakichiev, P. Braun-Munzinger, C. Garabatos, G. Hering, J. Holeczek, A. Maas, A. Marin, D. Miskowiec, J. Rak, H. Sako, S. Sedykh
GSI, Darmstadt, Germany

V. Belaga, K. Fomenko, Y. Panebrattsev, O. Petchenova, S. Shimansky, V. Yurevich
JINR, Dubna, Russia

J. P. Wurm
Max-Planck-Institut für Kernphysik, Heidelberg, Germany

H. Appelshäuser, S. Damjanovic, L. Dietrich, S. I. Esumi, K. Filimonov, P. Glässel, J. Milosevic, V. Petracek, W. Schmitz, W. Seipp, J. Slivova, H.J. Specht, J. Stachel, H. Tilsner, J. P. Wessels, T. Wienold, B. Windelband, S. Yurevich
Universität Heidelberg, Germany

D. Adamova, V. Kushpil, M. Sumbera
NPI/ASCR, Rez, Czech Republic

A. Drees, F. Ceretto
Department for Physics and Astronomy, SUNY Stony Brook, USA

A. Cherlin, Z. Fraenkel, A. Gnaenski, A. Milov, I. Ravinovich, I. Tserruya, W. Xie

Weizmann Institute, Rehovot, Israel