Centrality measurement and the centrality dependence of $dN_{ch}/d\eta$ at mid-rapidity at $\sqrt{s_{nn}} = 130$ GeV

Judith Katzy (MIT)

for the

PHOBOS collaboration

The PHOBOS Collaboration

ARGONNE NATIONAL LABORATORY

Birger Back, Nigel George, Alan Wuosmaa

BROOKHAVEN NATIONAL LABORATORY

Mark Baker, Donald Barton, Alan Carroll, Stephen Gushue, George Heintzelman, Robert Pak, Louis Remsberg, Peter Steinberg, Andrei Sukhanov

INSTITUTE OF NUCLEAR PHYSICS, KRAKOW

Andrzej Budzanowski, Roman Holynski,, Jerzy Michalowski, Andrzej Olszewski, Pawel Sawicki , Marek Stodulski, Adam Trzupek, Barbara Wosiek, Krzysztof Wozniak

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Wit Busza* , Patrick Decowski, Kristjan Gulbrandsen, Conor Henderson, Jay Kane , Judith Katzy, Piotr Kulinich, Johannes Mueimenstaedt, Heinz Pernegger, Corey Reed, Christof Roland, Gunther Roland, Leslie Rosenberg, Pradeep Sarin, Stephen Steadman, George Stephans, Gerrit van Nieuwenhuizen, Carla Vale, Robin Verdier, Bernard Wadsworth, Bolek Wyslouch

NATIONAL CENTRAL UNIVERSITY, TAIWAN

Willis Lin, JawLuen Tang

UNIVERSITY OF ROCHESTER

Josh Hamblen, Erik Johnson, Nazim Khan, Steven Manly, Inkyu Park, Wojtek Skulski, Ray Teng, Frank Wolfs

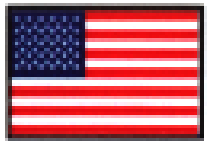
UNIVERSITY OF ILLINOIS AT CHICAGO

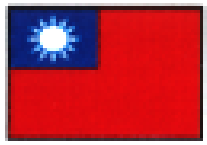
Russell Betts, Clive Halliwell, David Hofman, Burt Holzman, Wojtek Kucewicz, Don McLeod, Rachid Noulcer, Michael Reuter

UNIVERSITY OF MARYLAND

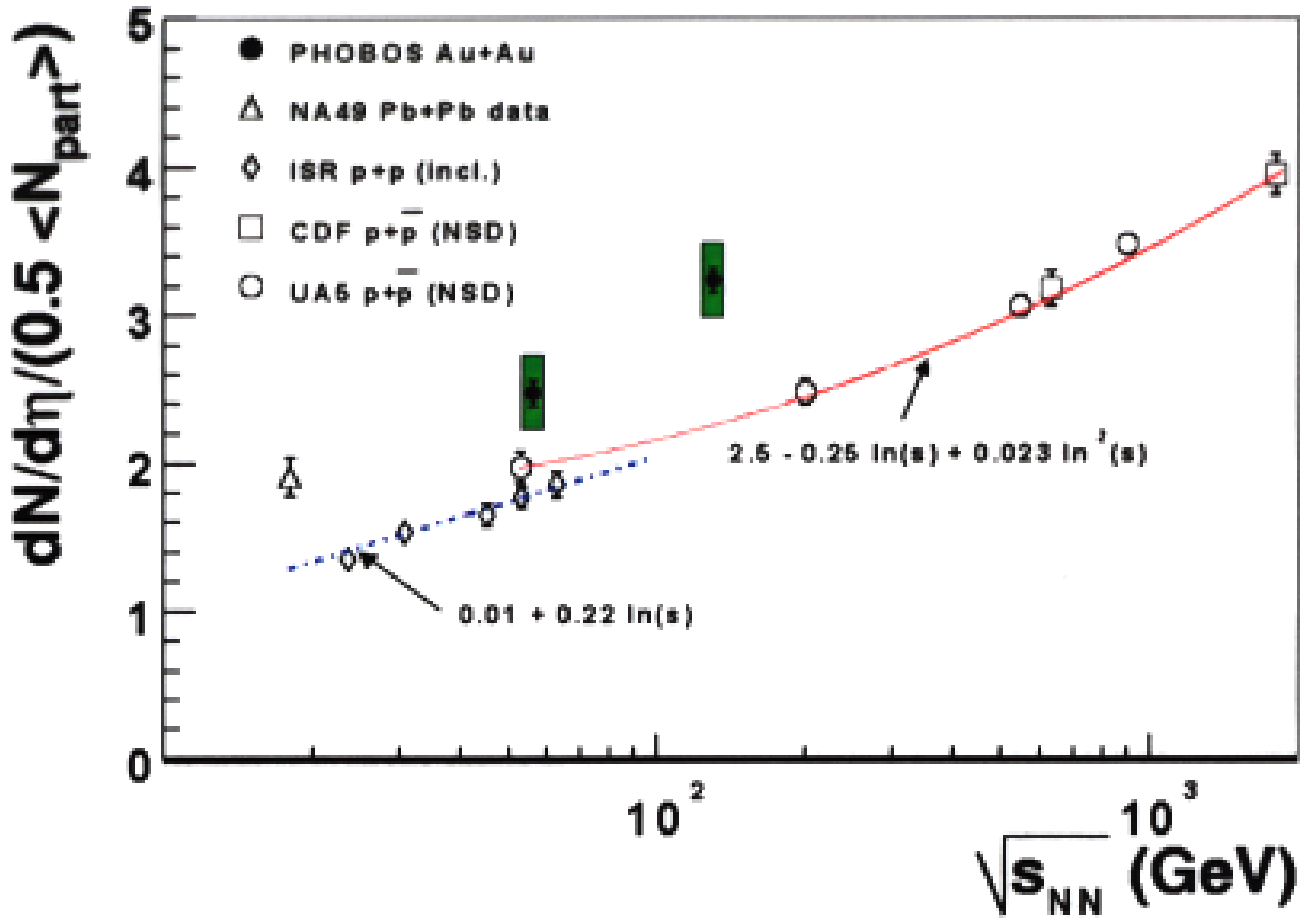
Richard Bindel, Edmundo Garcia-Solis, Alice Mignerey

* spokesperson





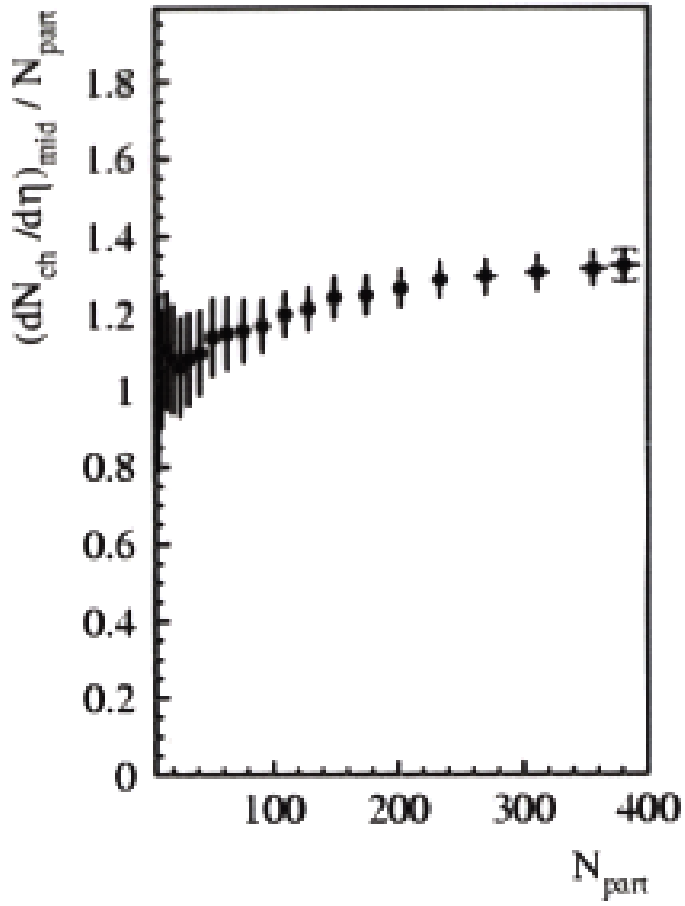
Why measure centrality dependence of $dN_{ch}/d\eta$?



Increase in charged particle density observed at central events relative to $p\bar{p}$

How does this increase evolve as a function of participants?

Measurement of $dN_{ch}/d\eta$ at SPS



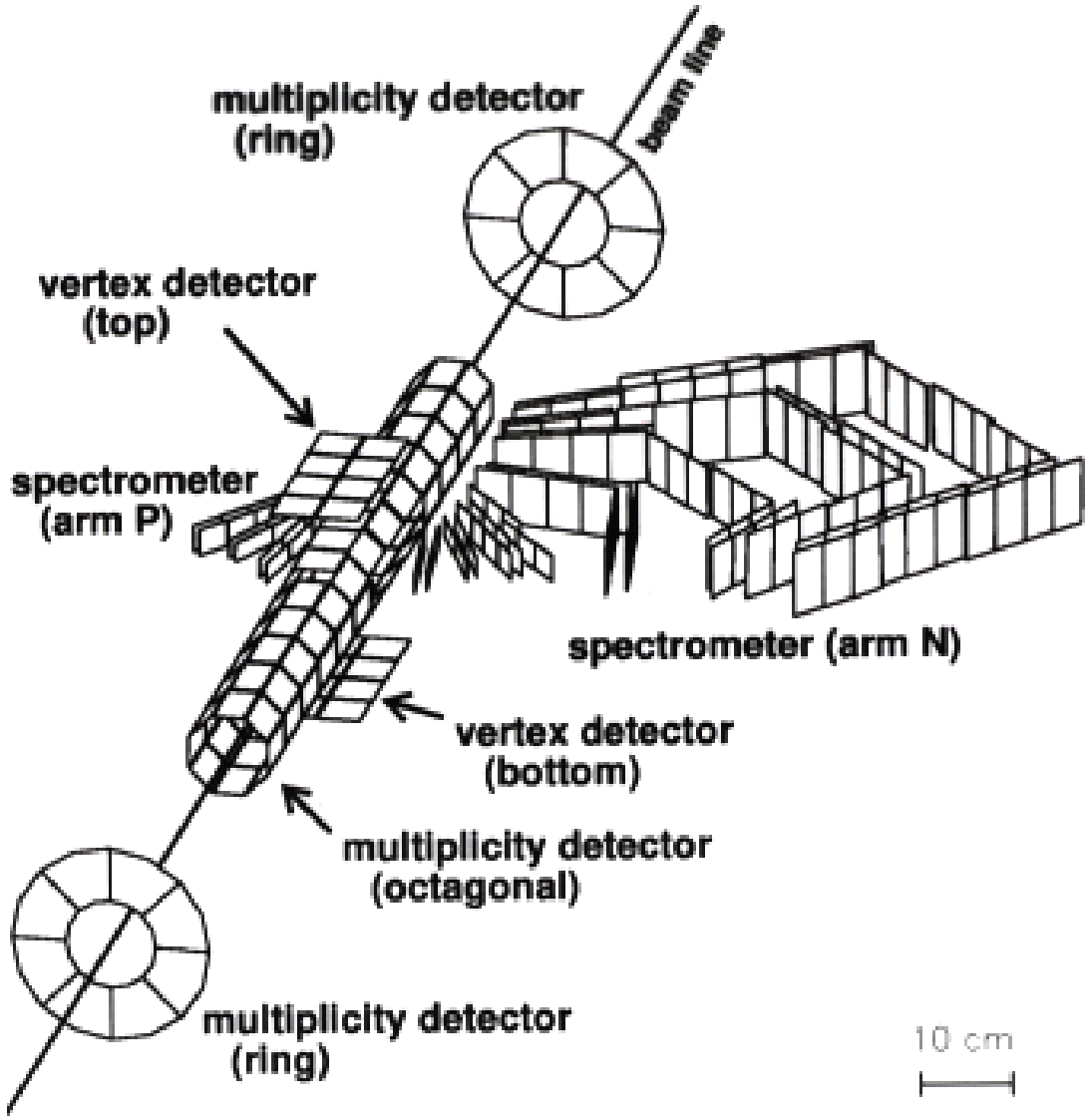
WA98 Collaboration
nucl-ex/0008004

How does it look at RHIC?

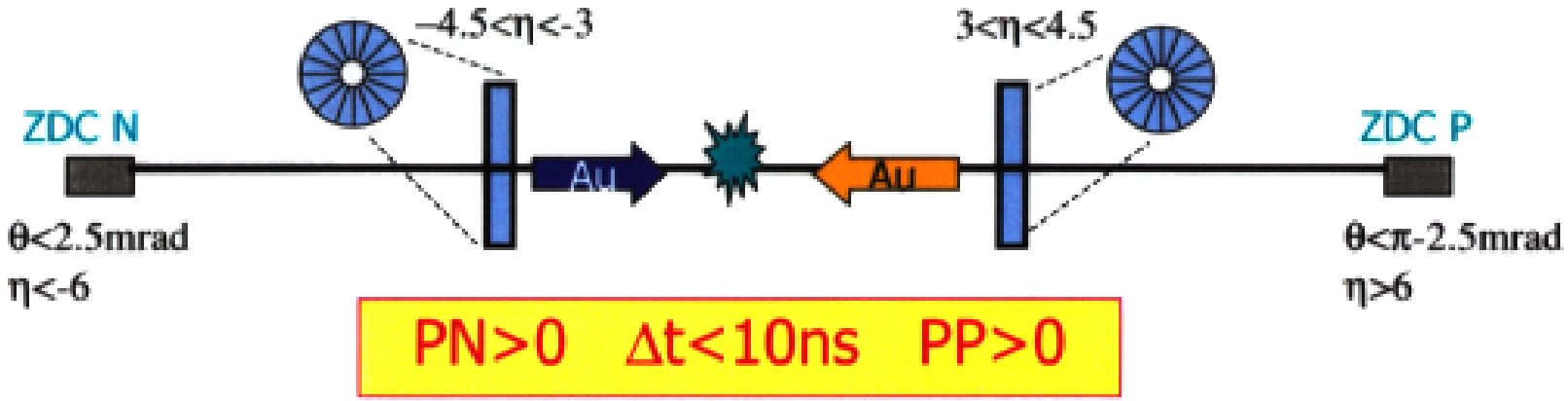
What do we have to do at RHIC?

- Determine nuclear geometry
- Reconstruct charged particle density at mid-rapidity

Silicon detectors of PHOBOS



Trigger & Event Selection



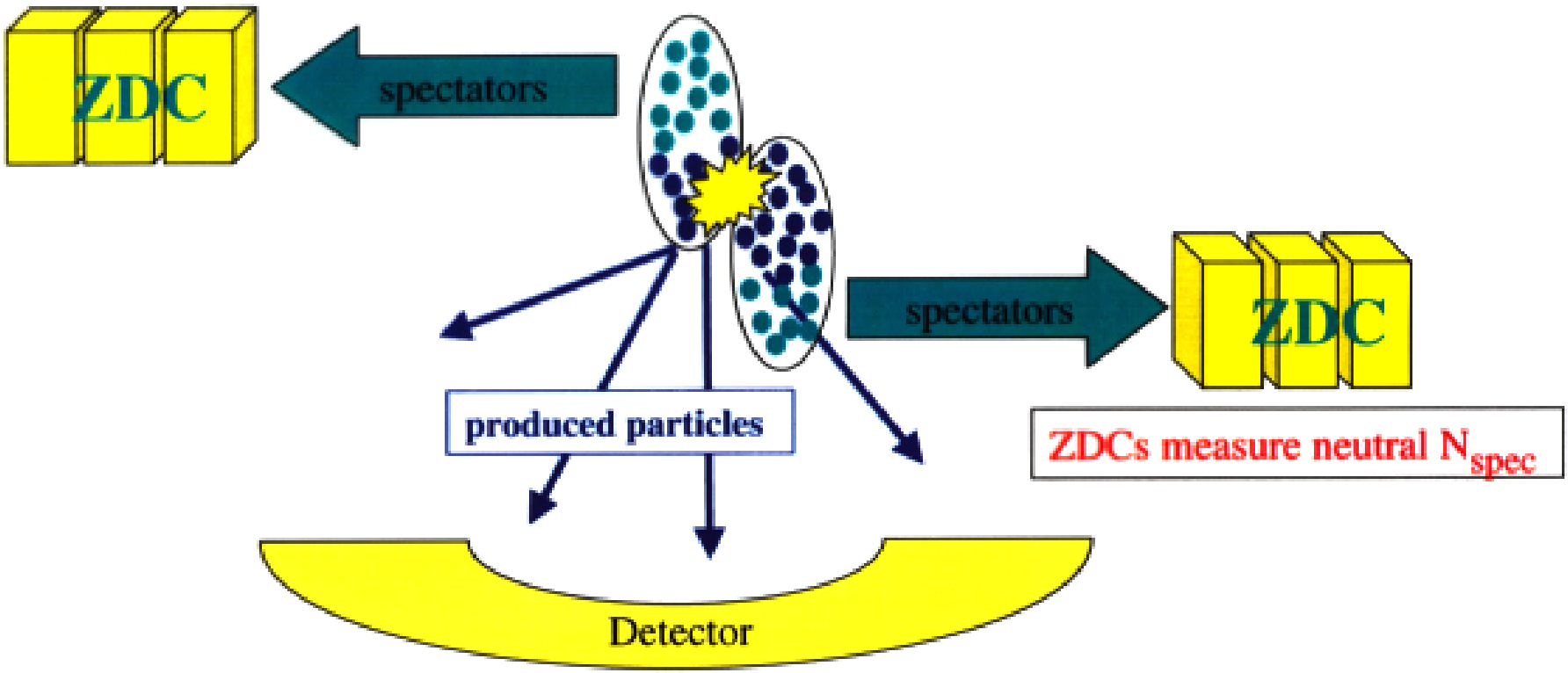
Offline analysis cuts:

ZDC timing cuts → background suppression

$\Delta t_{paddle} < 4ns$ → $-60cm < z < 60cm$

→ register ~ 97% of the inelastic cross section

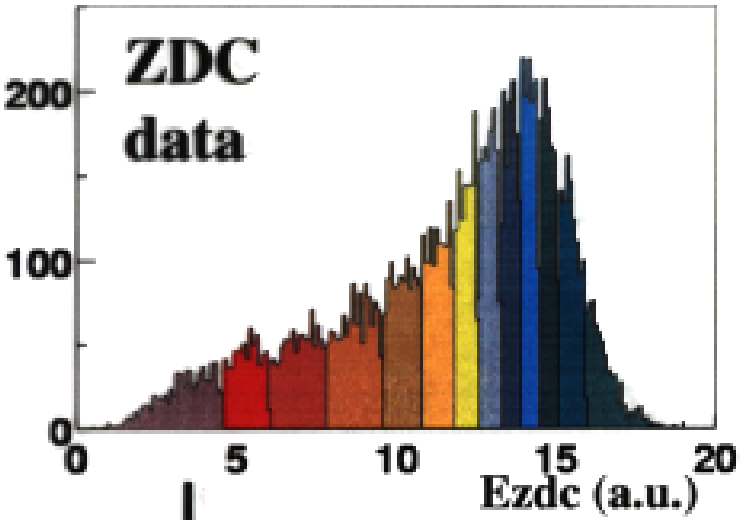
Determination of the collision geometry

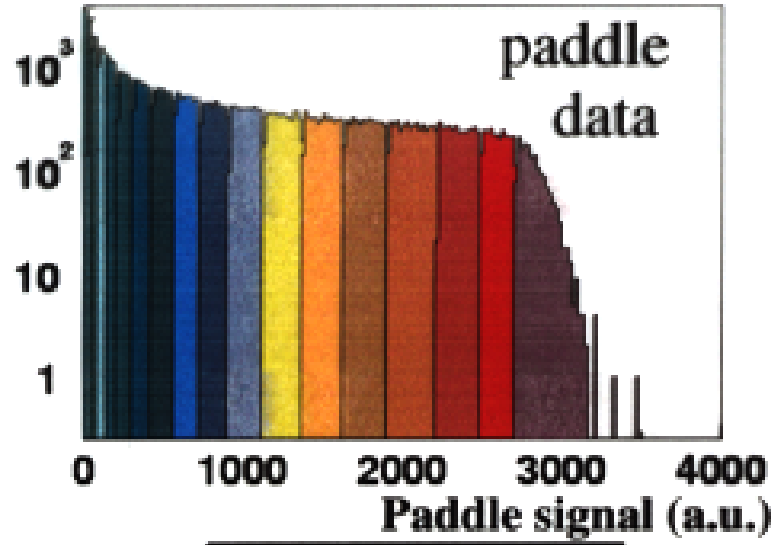


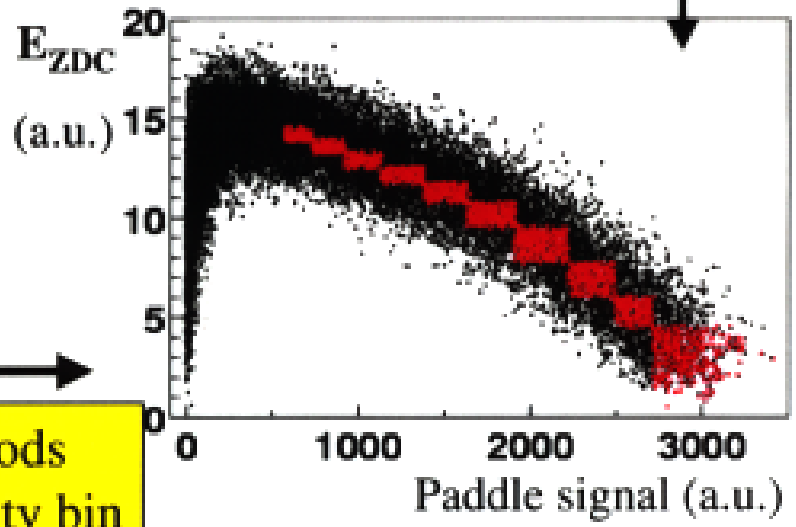
Many observables change monotonically with N_{part}

- total number of produced charged particles
- $dN_{ch}/d\eta$ at any $|d\eta|$ interval
- $dN_{ch}/d\eta$ at $3 < |\eta| < 4.5$ measured in the paddle counter used in this analysis

Determination of Centrality

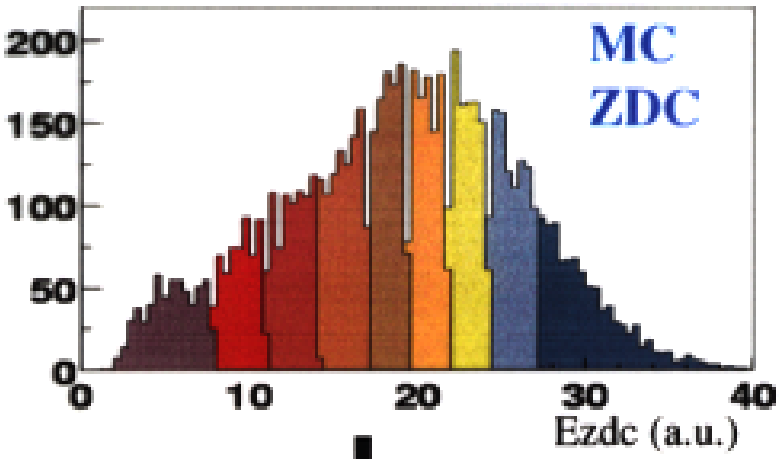


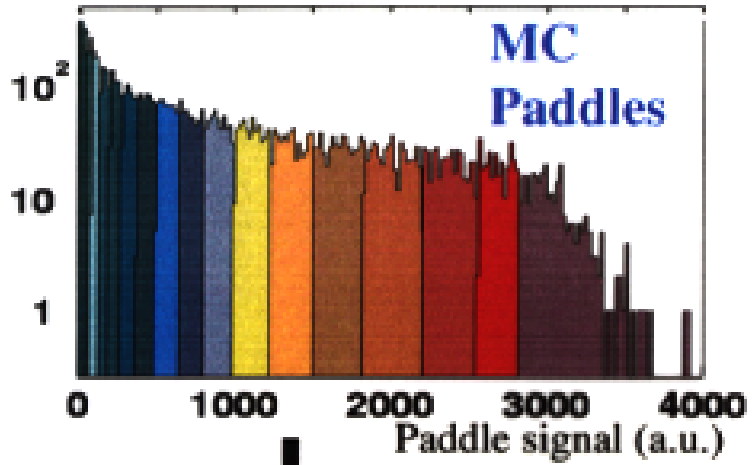




On average both methods yield the same centrality bin

Determination of N_{part}

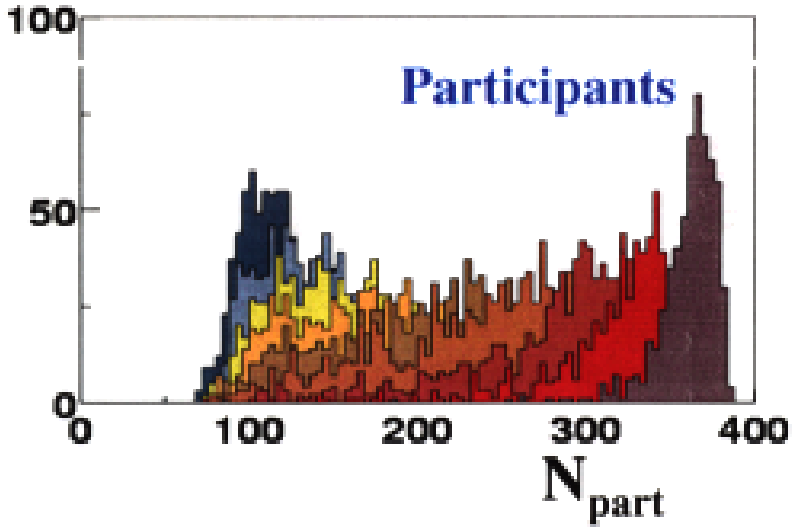


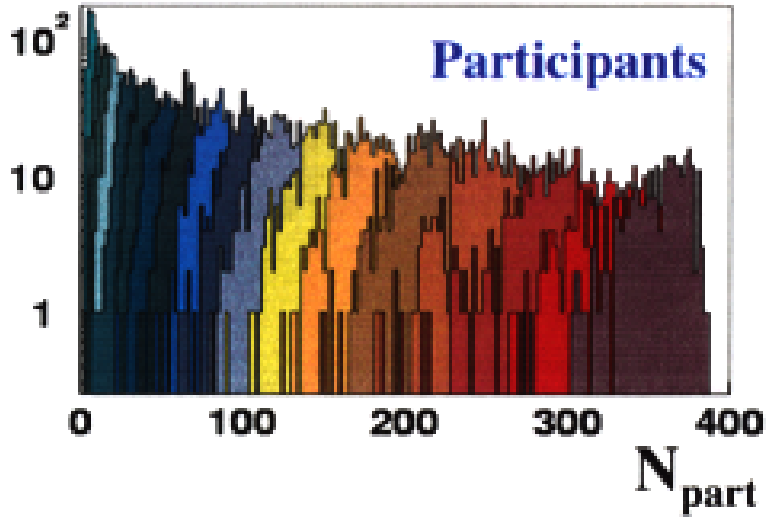


- Fragmentation
- pt broadening
- Detector response

- Glauber implementation (HIJING)
- Parametrization of nuclear density (HIJING)
- Trigger efficiency for peripheral events

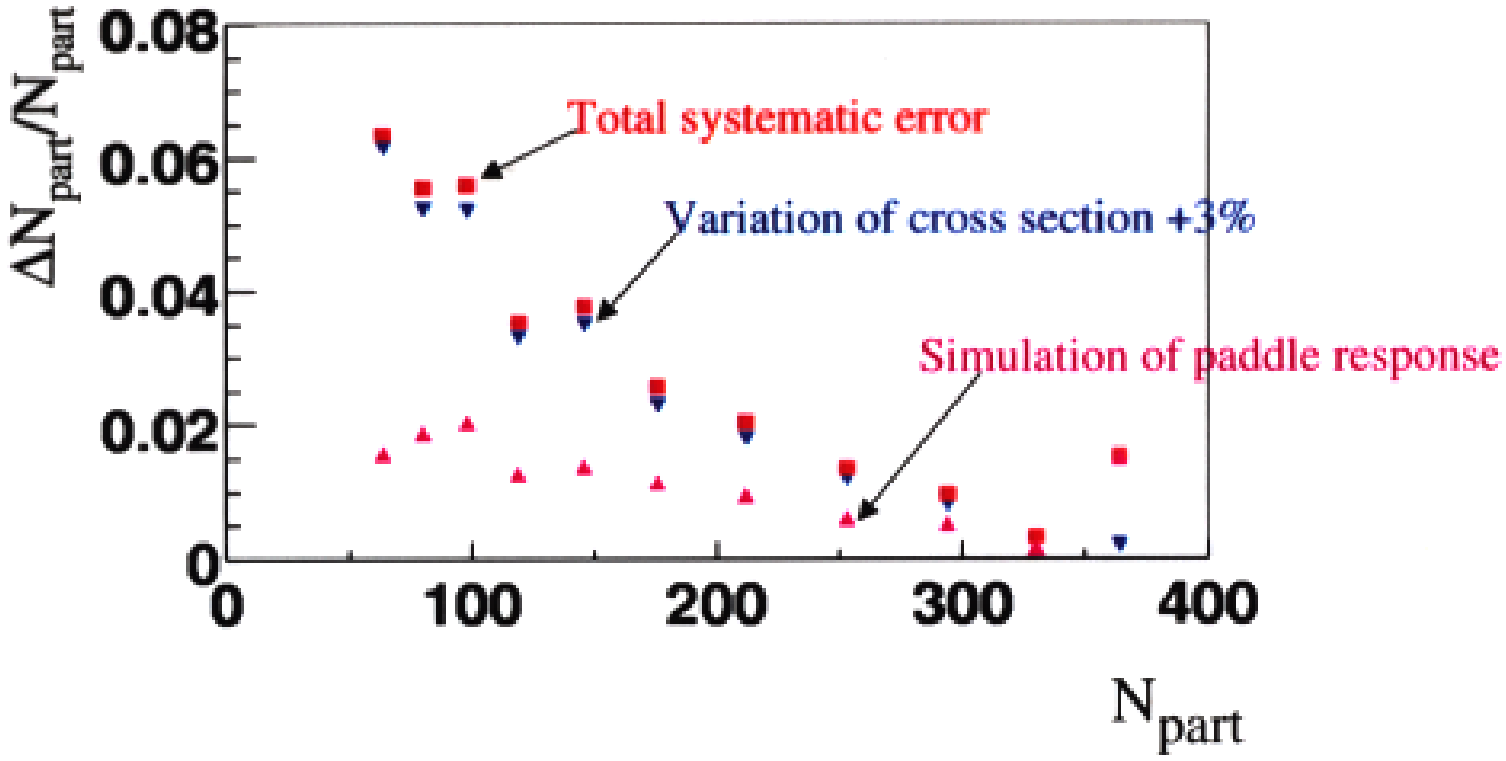
- Hadronic cross section
- Event shape
- Detector response





Systematic uncertainties of N_{part}

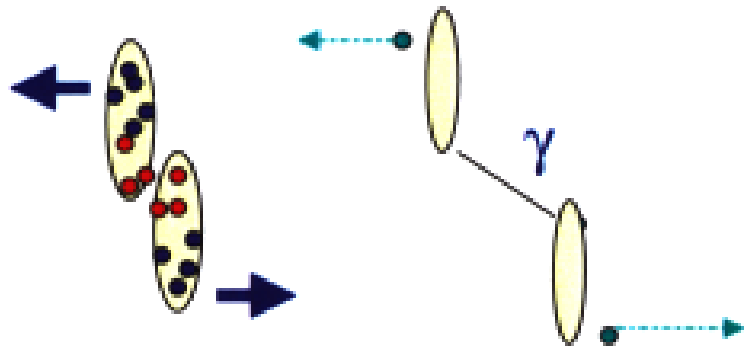
- 3% uncertainty on trigger efficiency — 0.5-7 %
- uncertainty on simulation of paddle response — <2 %



Measurement of cross section ratios

	σ_{tot}	=	σ_{hadron}	+	$\sigma_{Coulomb}$
theoretical predictions:	10.92	=	6.92	+	4.0 barn
measurement (trigger):	N_{tot}	=	N(paddles)	+	N(exclusive ZDC)

$$\sigma = N / L$$



$$\frac{\sigma_{hadron}}{\sigma_{tot}} = \frac{N_{hadron}}{N_{hadron} + N_{Coulomb}}$$

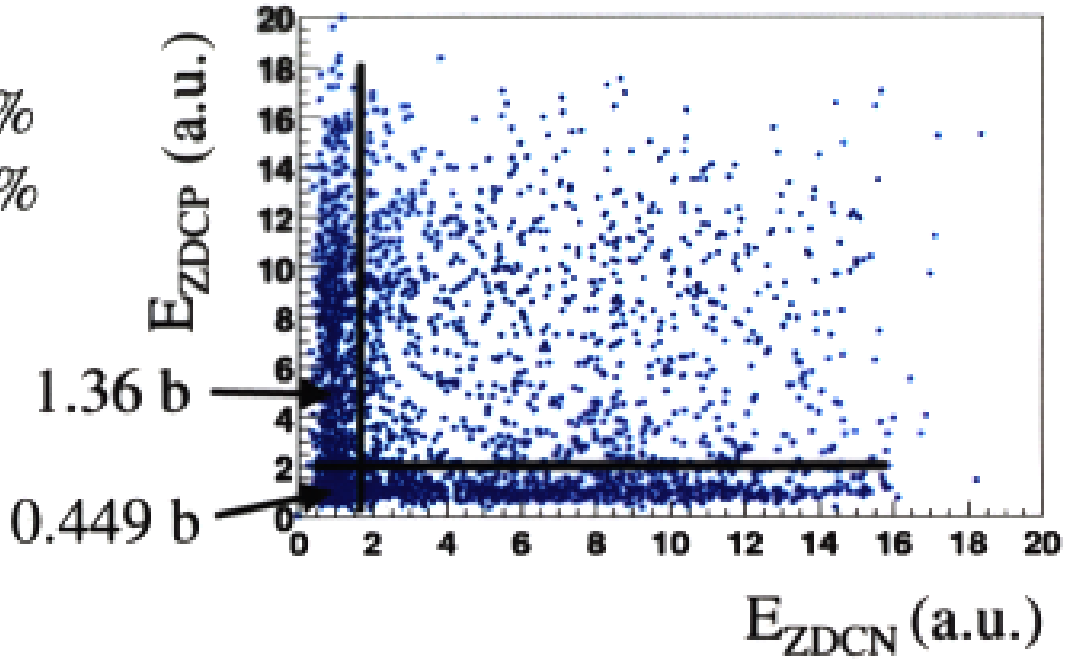
$\sigma_{hadron}/\sigma_{tot}$ theory: 0.636 +/- 0.032 **(Nucl.Instr.Meth.A 417(1998)1)**

data: 0.615 +/- 0.061 **(preliminary)**

Mutual Coulomb Dissociation Measurement

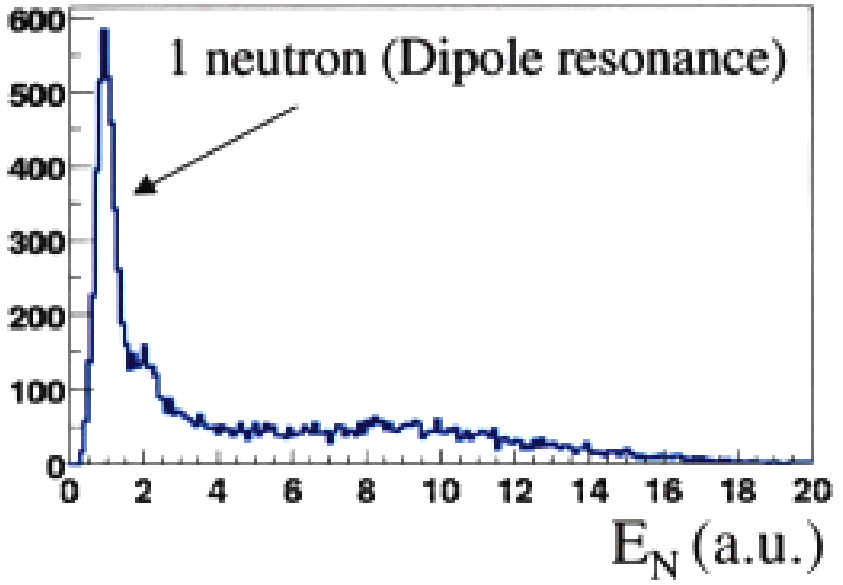
Random Coincidences: 4%
ZDC inefficiency: <1%

$$N_{coulomb} = N_{zdc} - RC * \Delta t$$



$\sigma_{1n} / \sigma_{1nX}$
theory: 0.33
data: 0.31 +/- 0.05

$\sigma_{1nX} / \sigma_{tot}$
theory: 0.12
data: 0.13 +/- 0.02

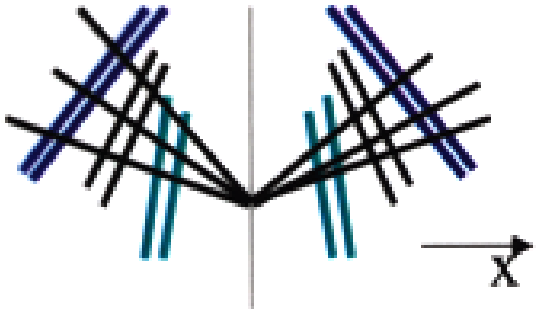


Measurement of charged particle density at mid-rapidity

Spectrometer

(M.P.Decowski Poster)

$0 < \eta < 1$

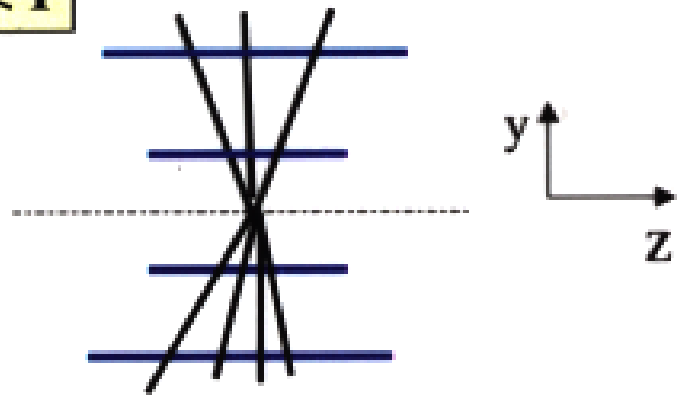


$(\Delta\eta^2 + \Delta\phi^2)^{1/2} < 0.015$

High resolution

Vertex Detector

$-1 < \eta < 1$



$\Delta\phi < 0.1$, $\Delta\eta < 0.04$

Large acceptance

Vertex and Tracklet Reconstruction

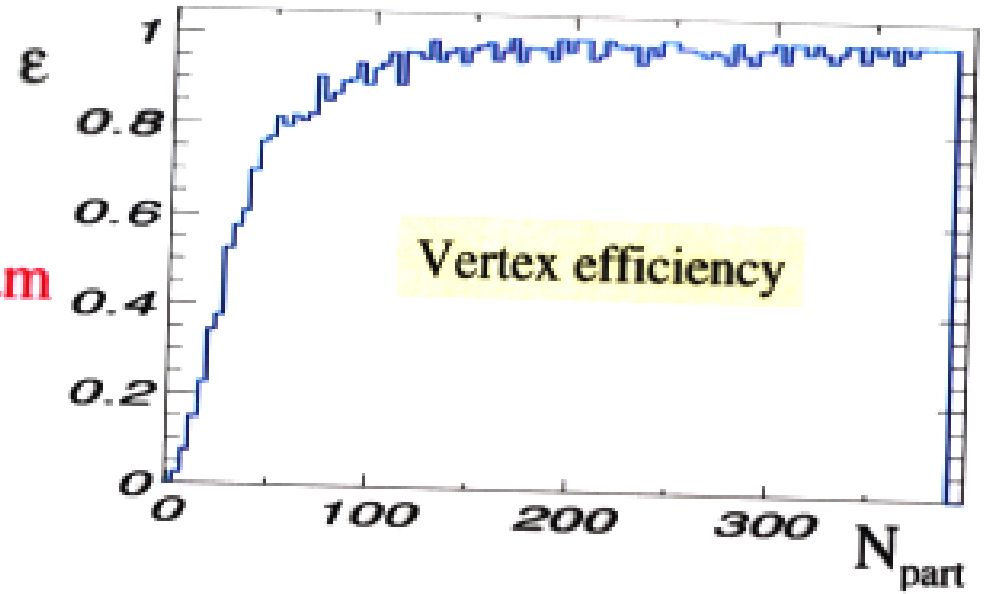
Vertex reconstruction:

Resolution $\sigma_z = \sigma_y = 200\ \mu m$

$\sigma_x = 450\ \mu m$

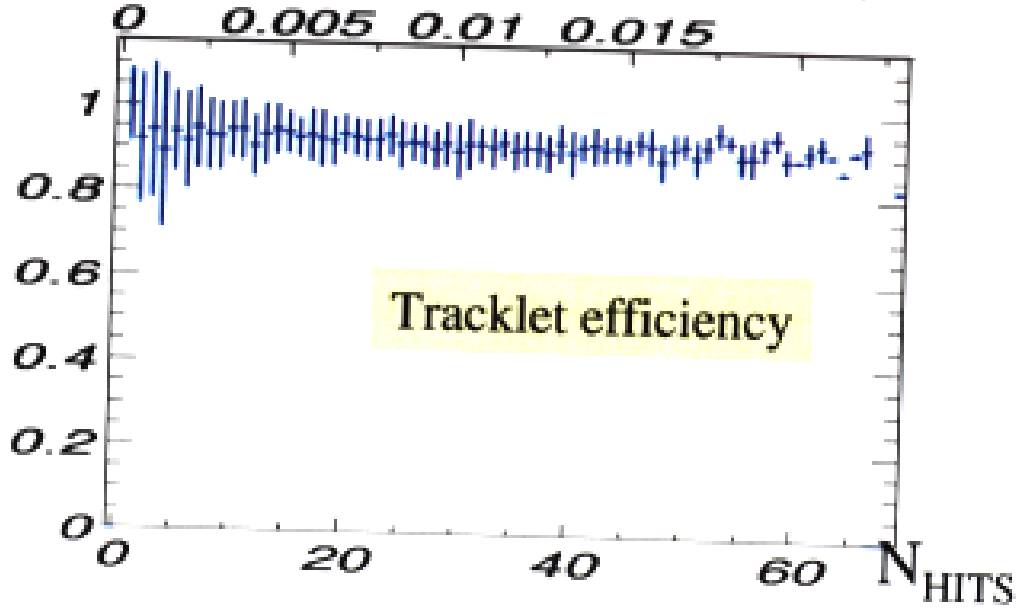
selection for this analysis:

$-4\ cm < z < 12\ cm$



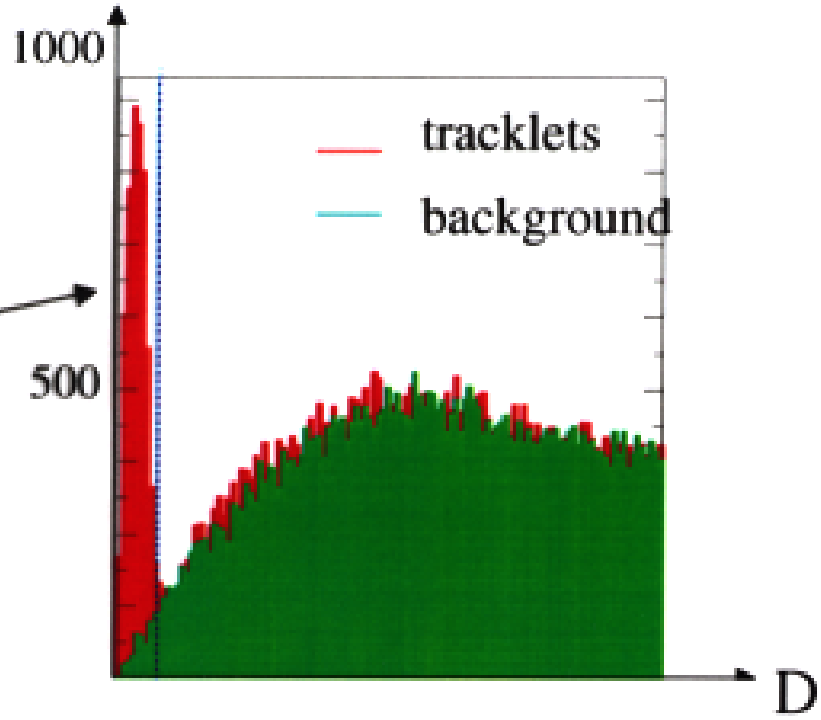
Tracklet reconstruction:

- efficiency independent of occupancy



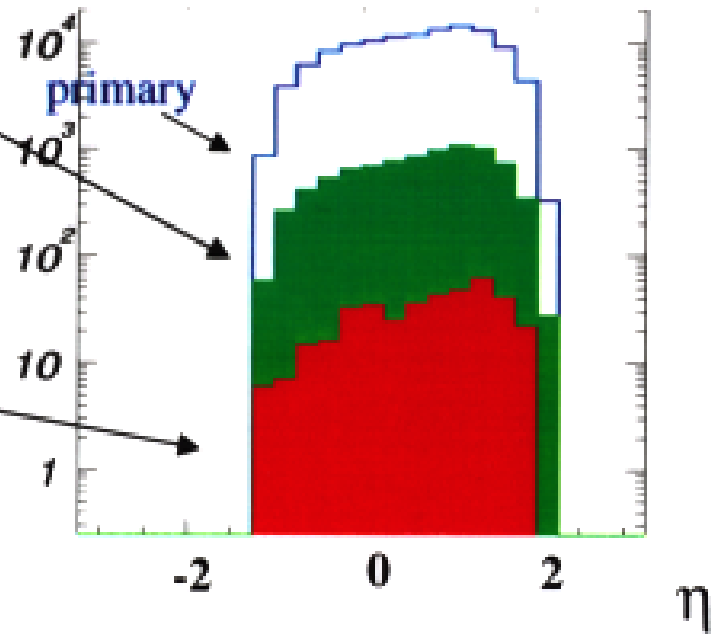
Background

1 - 15% combinatorial background
dependent on occupancy

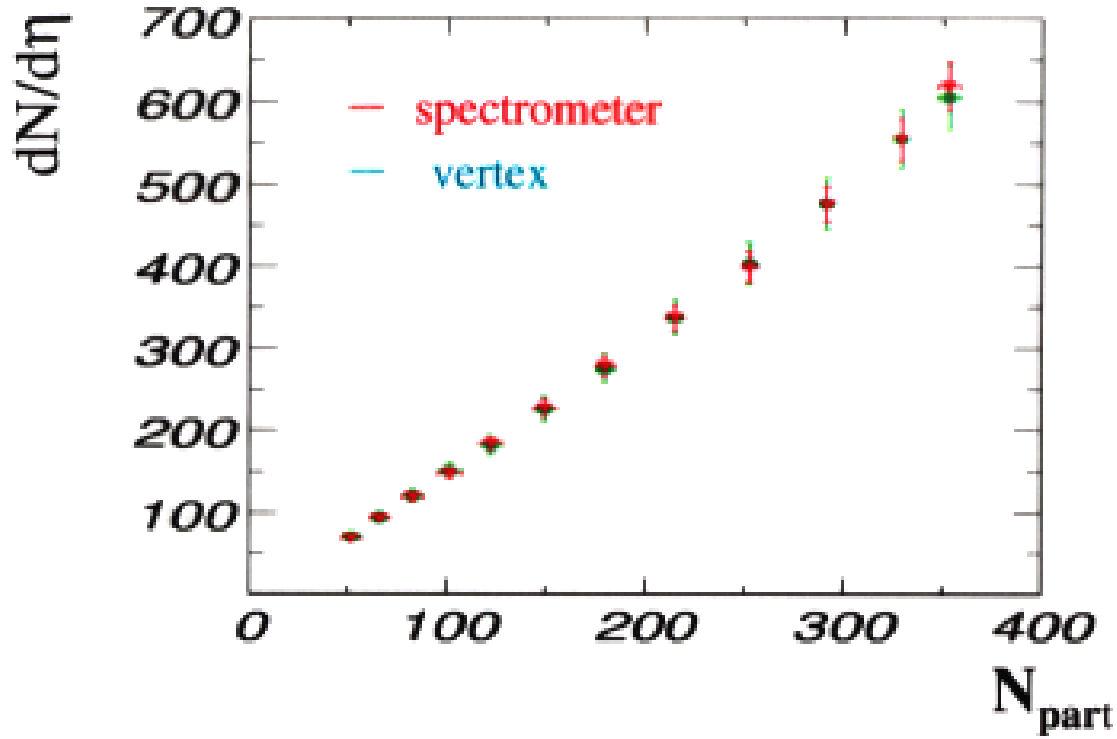


6.5 % secondaries from material
(Hijing,Geant)
little dead material in front of
sensitive detector

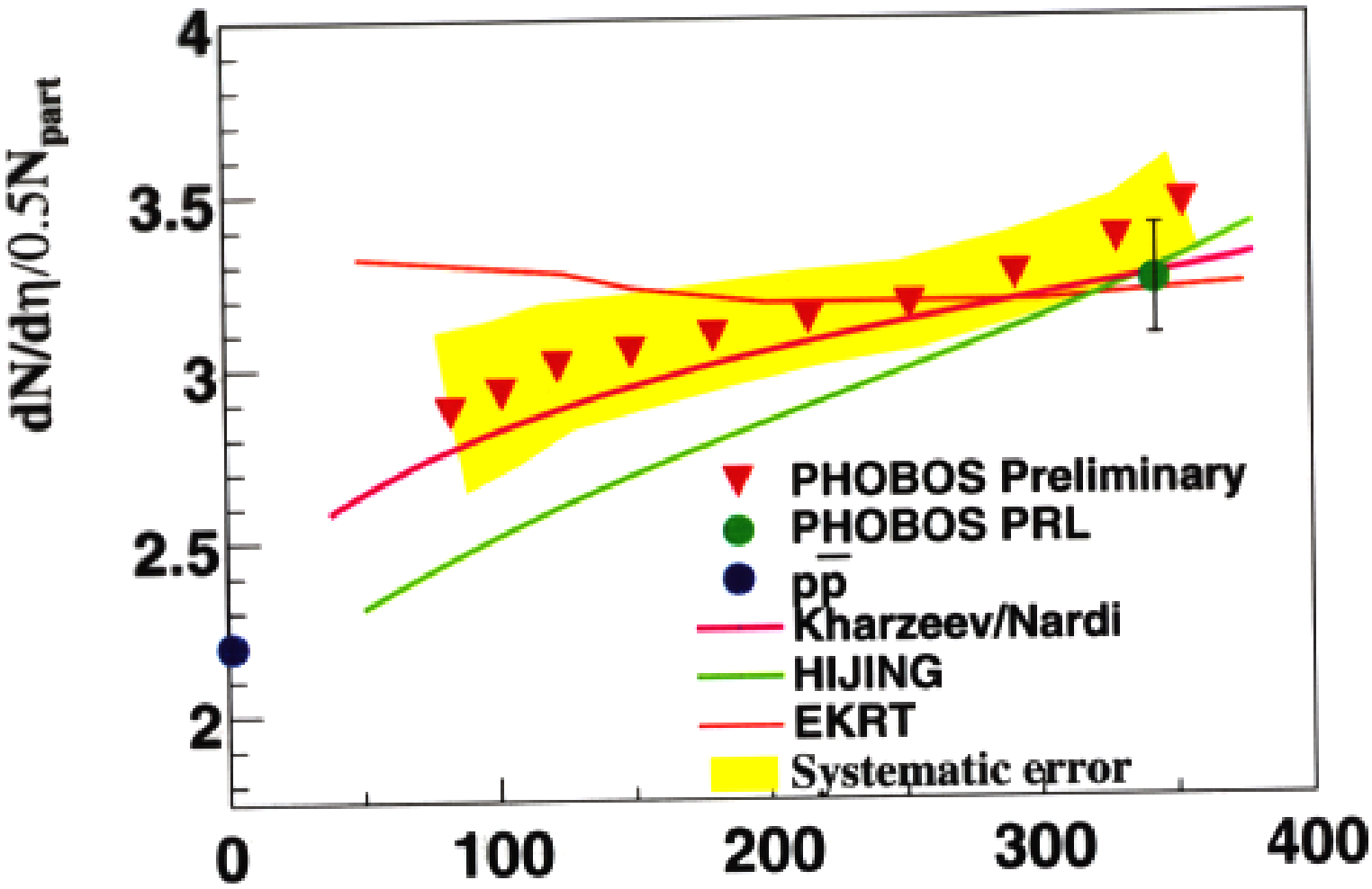
0.5 % background from decaying
particles (Hijing)
closeness to interaction point



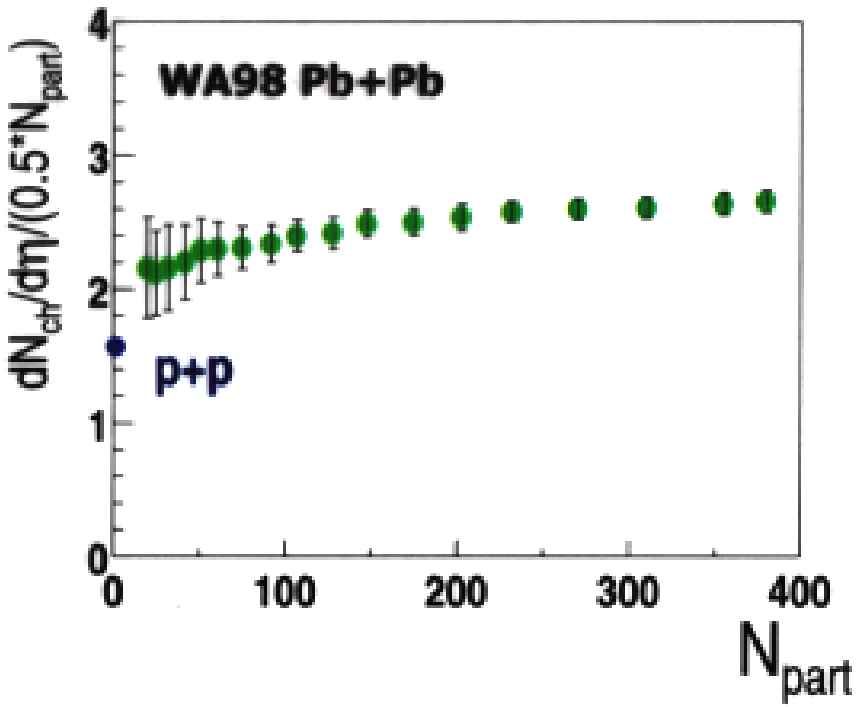
Reconstructed particle densities

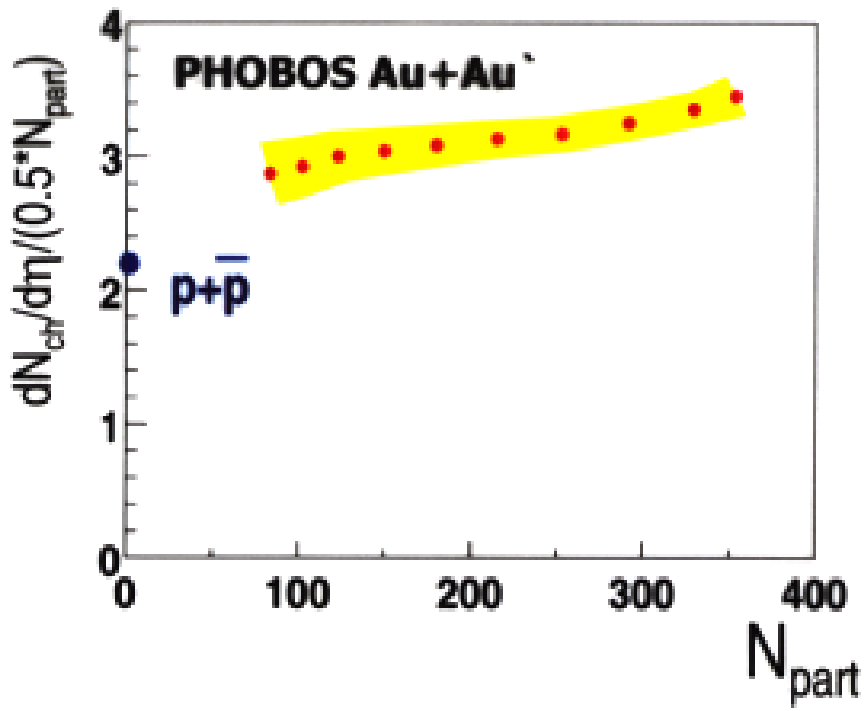


Uncertainty on dN/dη	spectrometer	vertex
• combinatorical background	1%	
• tracklet reconstruction and event selection	3%	4%
• error on decaying particles	0.5%	0.5%
• mis-estimate of secondaries		3%



Note: additional theoretical uncertainties in the comparison of N_{part} determination of Kharzeev and Nardi with HIJNG/PHOBOS





- General features (rapid rise/flat top) similar
- Note that WA98 $dN_{ch}/d\eta$ measured in lab frame

Summary

- Determination of centrality and N_{part} with 2 different detectors. The uncertainty on N_{part} is 1-7% dependent on N_{part}
- Confirmation of the ratio of hadronic to total cross section
- Measured charged particle density as function of centrality with 2 different detectors
- Charged particle density per nucleon pair rises with N_{part}. The data disfavor HIJING and EKRT.
- Change of charged particle density with Npart similar in shape as at SPS.