Comparison of two measurements of neutral pions within the PHENIX −Experiment

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Motivation for measuring π^0's

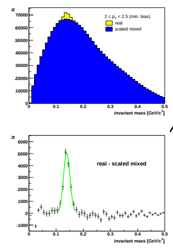
- Studying π^0 production in heavy ion collisions
- Suppression at high p_T suggested as quark gluon plasma signature („jet quenching“)
- Comparison of central and peripheral
- Comparison to expectation from pp reactions
- π^0's main source of background γ's for direct photon measurement

HOWTO measure π^0's

- Via 2γ−decay branch
- Reconstruction of π^0 invariant mass (134,98 MeV)

$$m_{inv} = \sqrt{2 E_{\gamma_1} E_{\gamma_2} (1-\cos\theta_{12})}$$

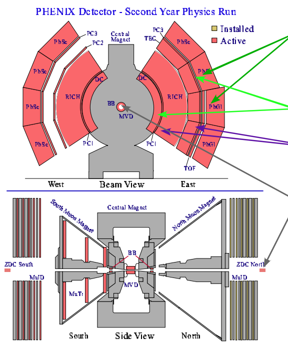
- In heavy ion collisions:
  - ✓ Yield determination on statistical basis
  - ✓ Large combinatorial background due to high multiplicities
  - ✓ Background estimated by mixing γ−candidates from different events



Needed corrections to raw π^0 yield

- Detector geometry (acceptance)
- Detector response (efficiency)
  - ✓ Intrinsic resolution
  - ✓ Overlap effects in high multiplicity events
  - ✓ Losses due to different particle identification cuts

Various sources of systematic errors



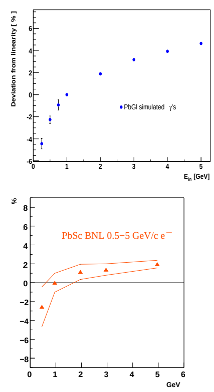
Au−Au Collisions @ RHIC:

First year: $\sqrt{s_{NN}} = 130\ A$GeV
Second year: $\sqrt{s_{NN}} = 200\ A$GeV (design value)

Lead−Scintillator−Calorimeter (PbSc)	Principle	Lead−Glass−Calorimeter (PbGl)
Sampling of electromagnetic or hadronic showers in Pb by different layers of scintillator		Detection of Cherenkov−light generated by charged particles in electromagnetic or hadronic showers
2.1 cm	Radiation length	2.8 cm
31.9 cm	Interaction length	38 cm
$5\times5\times37.5$ cm³	Single Module Size	$4\times4\times40$ cm³
$8.1\ /\sqrt{E/GeV}\oplus 2.1$	Energy resolution (%)	$5.9\ /\sqrt{E/GeV}\oplus 0.8$
$5.7\ /\sqrt{E/GeV}\oplus 1.55$	Position resolution (mm)	$8.4\ /\sqrt{E/GeV}\oplus 0.2$

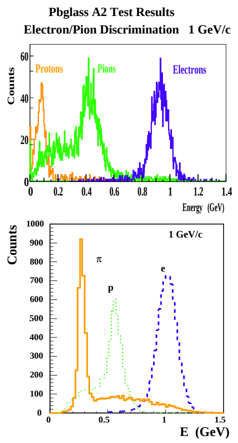
Two very different calorimeters, which offer the unique opportunity to perform essentially independent measurements of the same quantities

Energy linearity



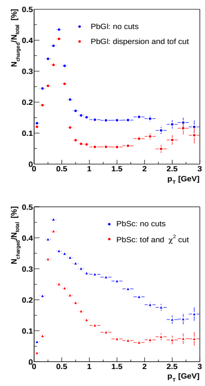
- **PbGl**
  - ✓ Absorption of Cherenkovlight
  - ✓ High energetic particles produce showers closer to PM−readout
  - ✓ Strong non−linearity
- **PbSc**
  - ✓ Scintillation light sampled over whole module
  - ✓ Non−linearity less pronounced

Hadron response



- Hadrons unwanted background for photon measurement
- Response suppressed due to large interaction length
- Most hadrons only minimum ionizing particles (MIP's)
- PbGl: response further suppressed by Cherenkov−thresholds
  - ✓ $\pi^{+/-}$: p_{min} = 106 MeV/c
  - ✓ p : p_{min} = 715 MeV/c
- PbSc: scintillation light provides more direct measure of deposited energy

PID cuts

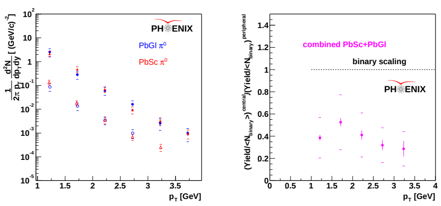


- **PbGl**
  - ✓ Dispersion (hadronic showers show larger lateral width)
  - ✓ Tof−cut
- **PbSc**
  - ✓ Tof−cut
  - ✓ χ^2 (deviation of shower profile from electromagnetic shape)

Analysis

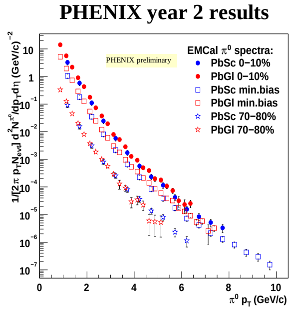
- Two independent teams
  - ✓ Different methods of yield extraction
  - ✓ Different approaches for efficiency calculation
- Year 1, two different fast Monte−Carlo simulations for efficiency
- Year 2, additional efficiency calculation via embedding of simulated particles into real events

PHENIX year 1 results



- Good agreement within systematic errors
- Combination weighted with errors
- Indication of „jet quenching“ ?
- **Phys. Rev. Lett. 88, 022301 (2002)**

PHENIX year 2 results



See also parallel talk by David D'Enterria in session 1 on Saturday