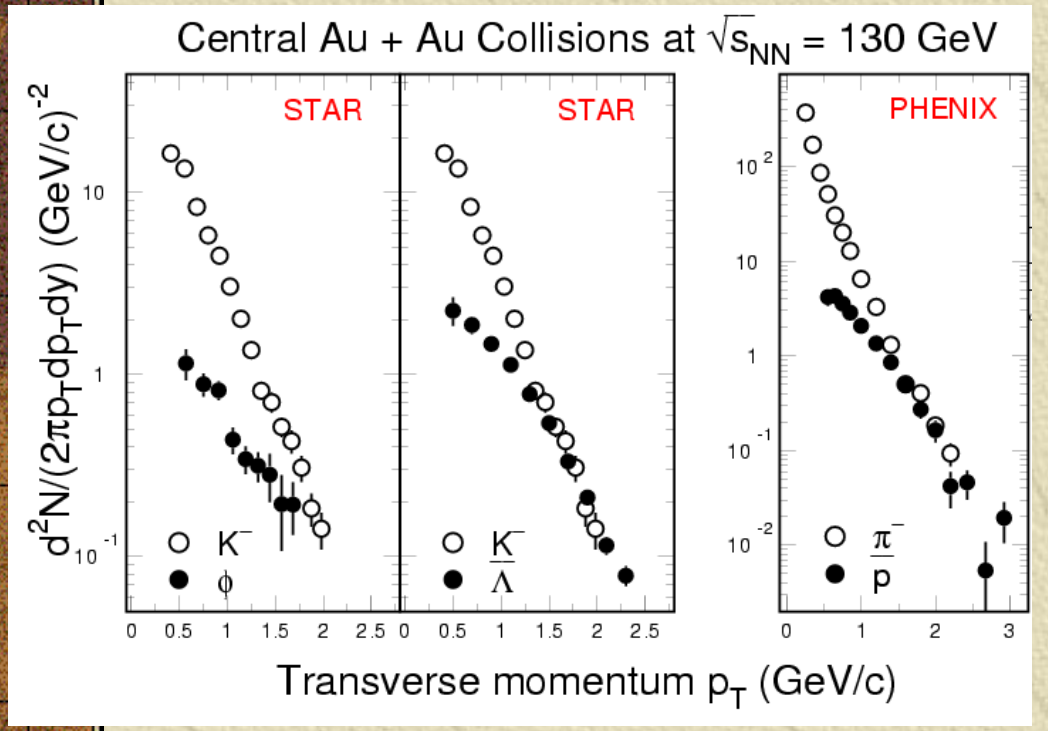
πKp Spectra in pp & dAu Collisions and Cronin Effect at $\sqrt{s}$=200GeV

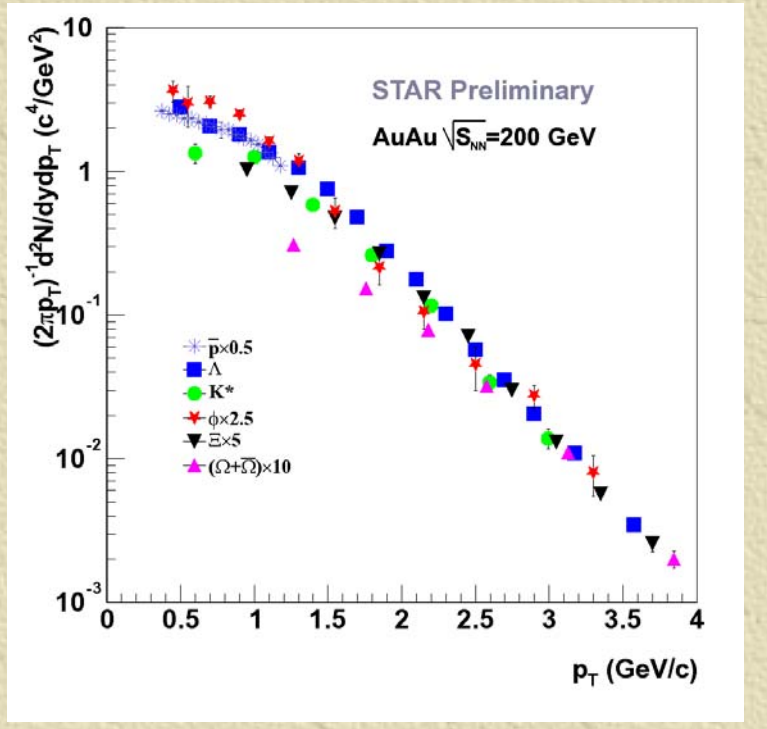
Zhangbu Xu

for the STAR Collaboration

- **Motivation:** Particle Production at Intermediate pT
- **Techonology**: Multi-gap Resistive Plate Chamber (MRPC) TOF
- **Analysis**: Identified πKp Spectra in pp and dAu
- **Conclusions**: Dependence of Cronin Effect on Beam Energy, System Size; Interpretation of AuAu data

Particle Production at Intermediate pT in AuAu Collisions at RHIC

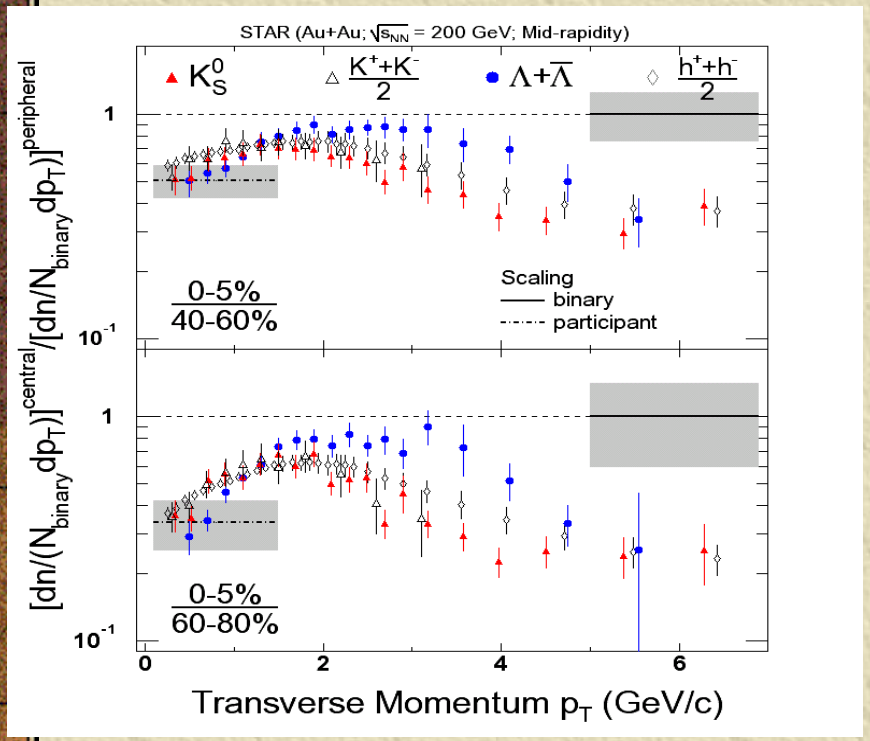


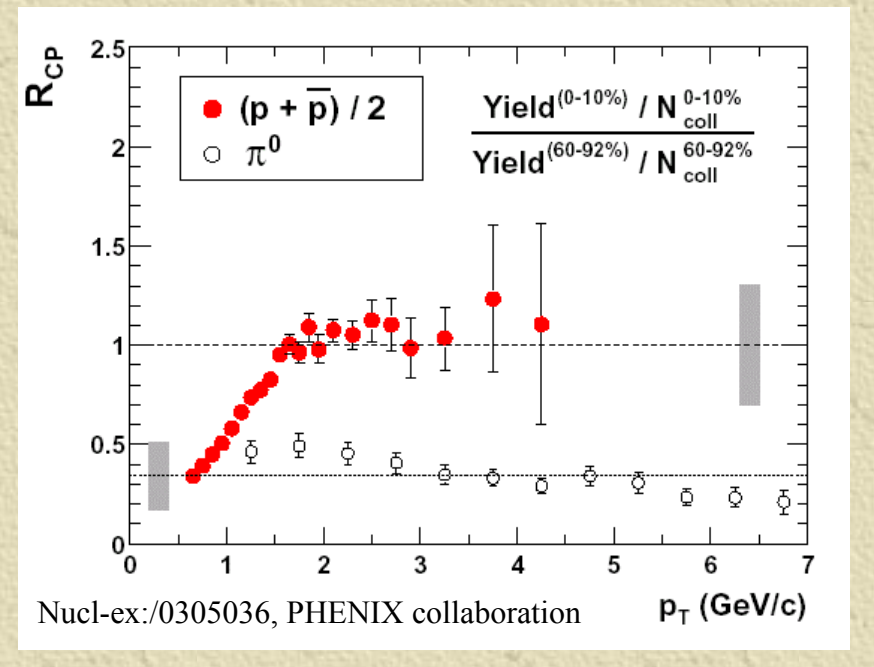


Particle Yield in Central AuAu Collisions (Gross Anatomy):

- Orders of magnitude difference at low pT
- Similar yield and slope at intermediate pT (2—5GeV/c)

Centrality Dependence: R_{CP}





- Baryons (p,Λ) increase faster than mesons (π,K) from peripheral to central
- Baryons: ~N_{bin} Scaling

Cronin Data

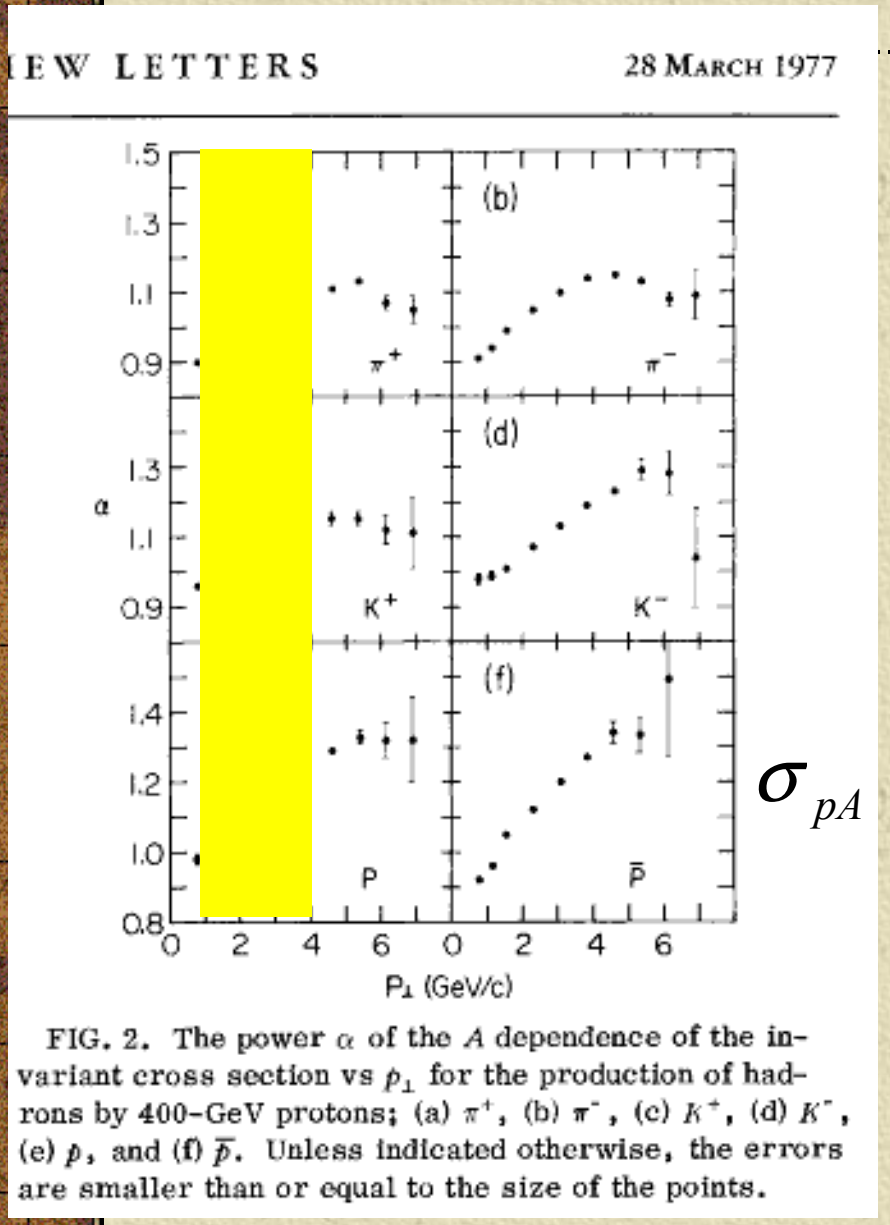


FIG. 2. The power α of the A dependence of the invariant cross section vs $p_\perp$ for the production of hadrons by 400-GeV protons; (a) π^+, (b) π^-, (c) K^+, (d) K^-, (e) p, and (f) $\bar{p}$. Unless indicated otherwise, the errors are smaller than or equal to the size of the points.

$$\sigma_{pA} = A^{\alpha}\sigma_{pp}$$

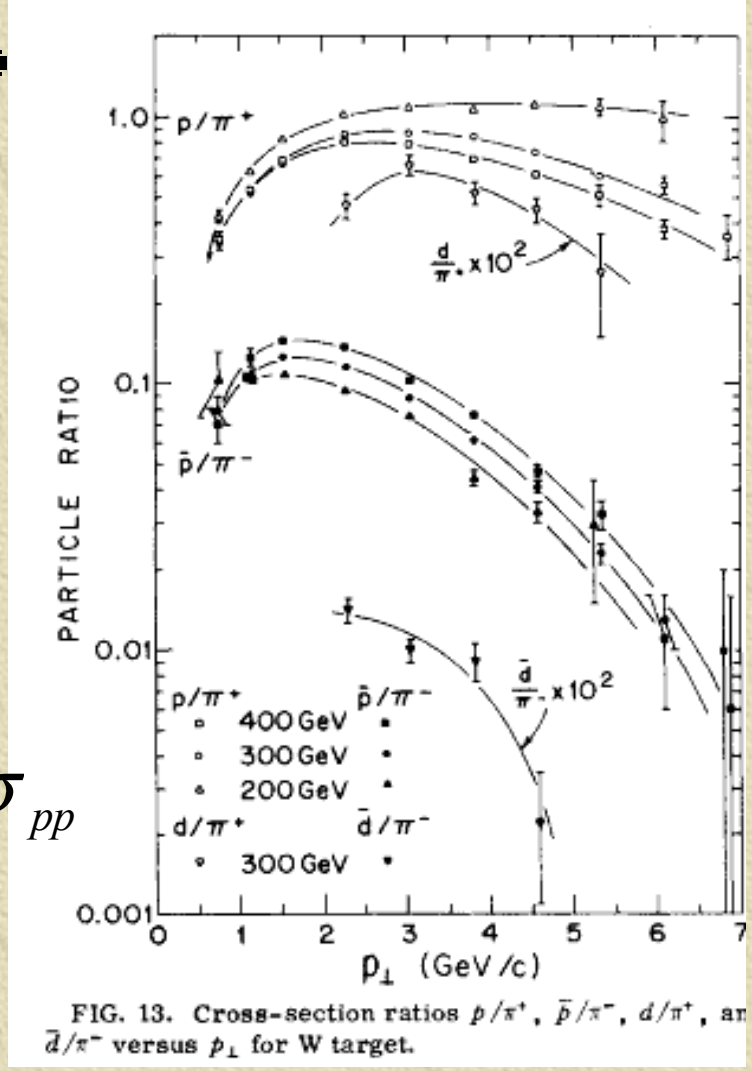
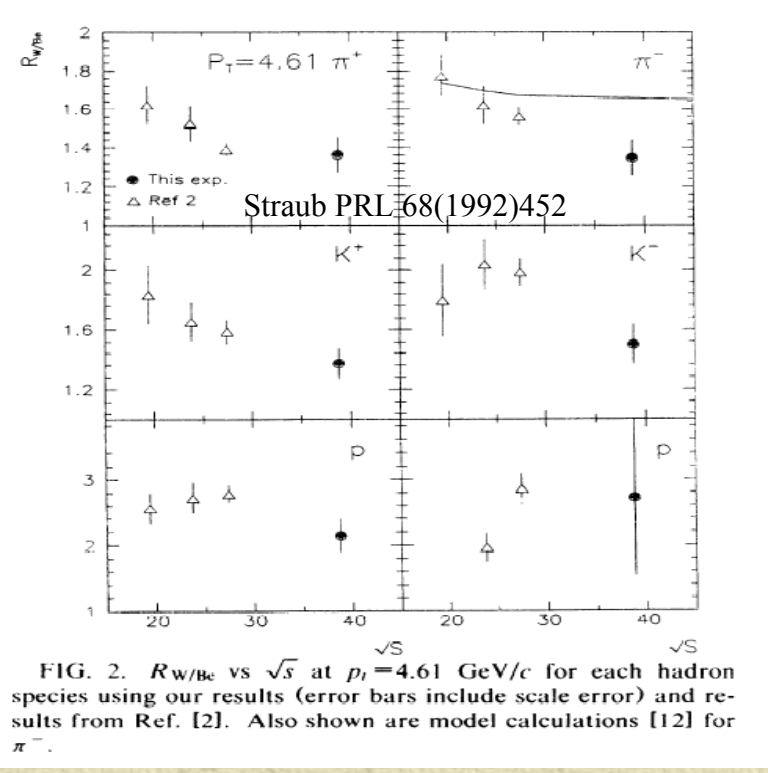


FIG. 13. Cross-section ratios p/π^+, $\bar{p}/\pi^-$, d/π^+, ar $\bar{d}/\pi^-$ versus $p_\perp$ for W target.

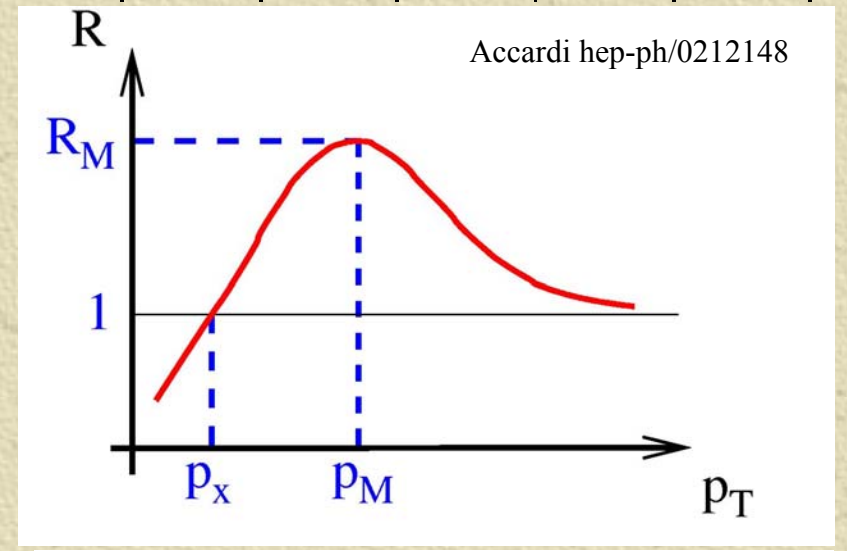
Cronin effect larger for protons compared to pions

Extrapolation & Predictions at RHIC

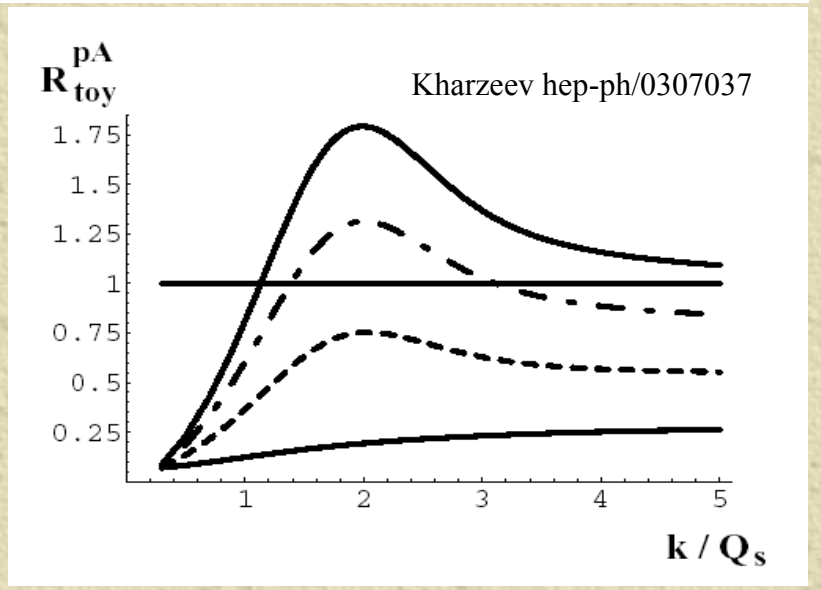


Straub PRL 68(1992)452

FIG. 2. $R_{W/Be}$ vs $\sqrt{s}$ at p_l=4.61 GeV/c for each hadron species using our results (error bars include scale error) and results from Ref. [2]. Also shown are model calculations [12] for π^-.



Accardi hep-ph/0212148



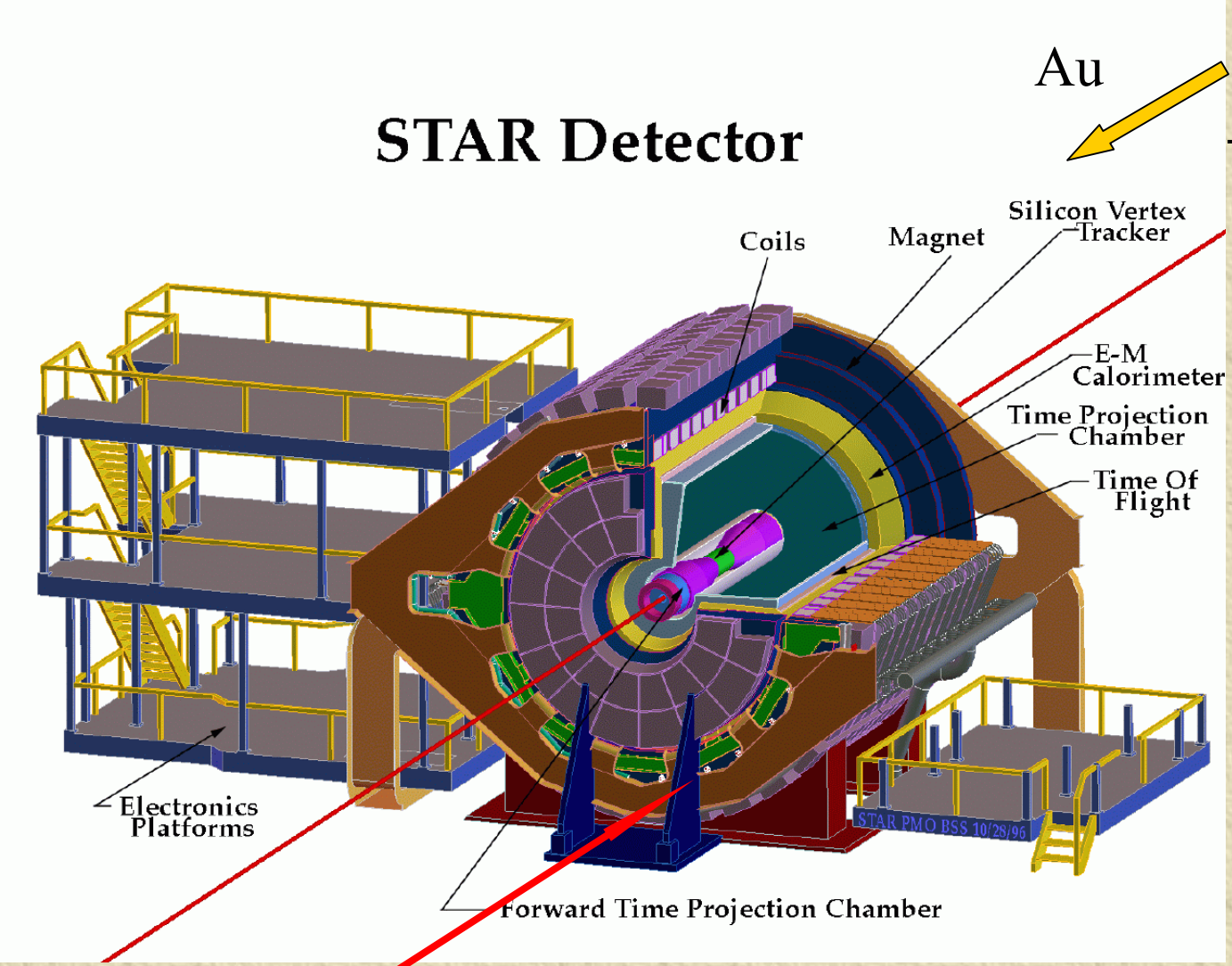
Kharzeev hep-ph/0307037

R_{pA}<1, pT<~1GeV/c

R_{pA}>1, pT>~1GeV/c

1<R_M<2, 2.5<P_M<4.5

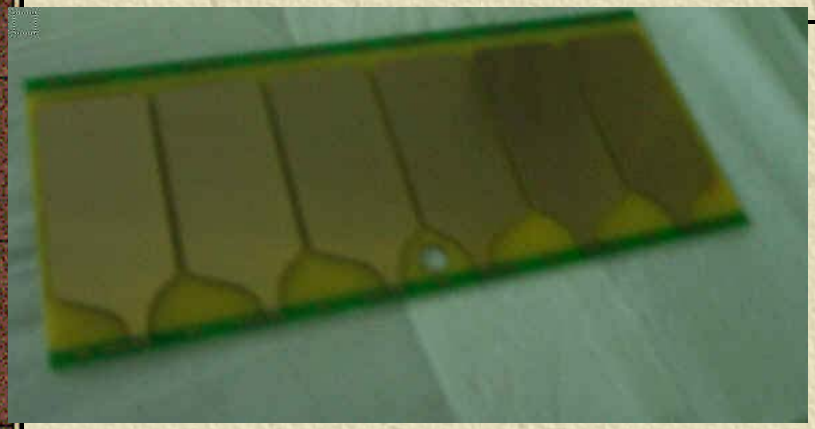
Decrease vs beam Energy

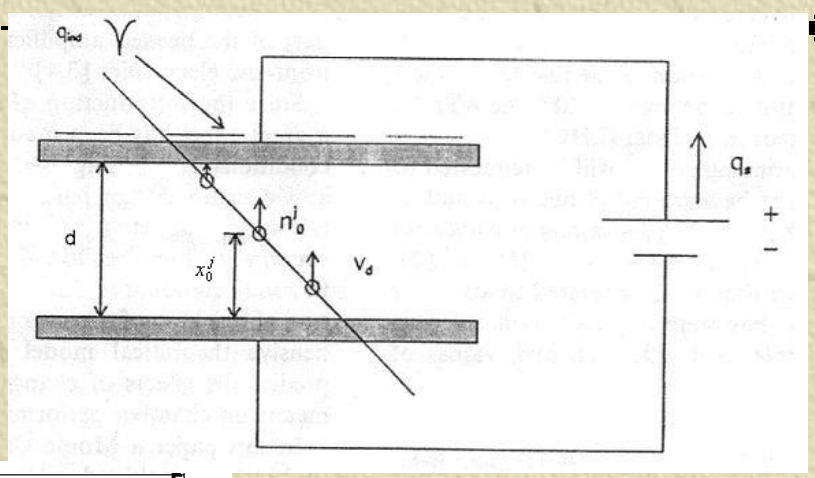


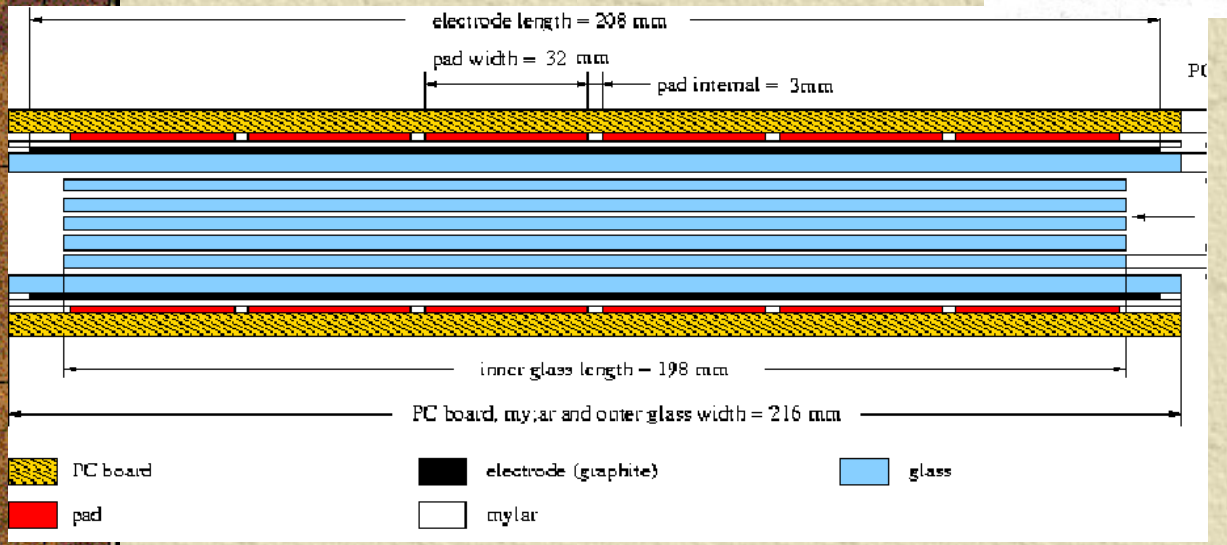
TOFr 1 of 120 trays, Au side

Pseudo Vertex Position Detector (pVPD) ±5.4m

Structure of MRPC Module





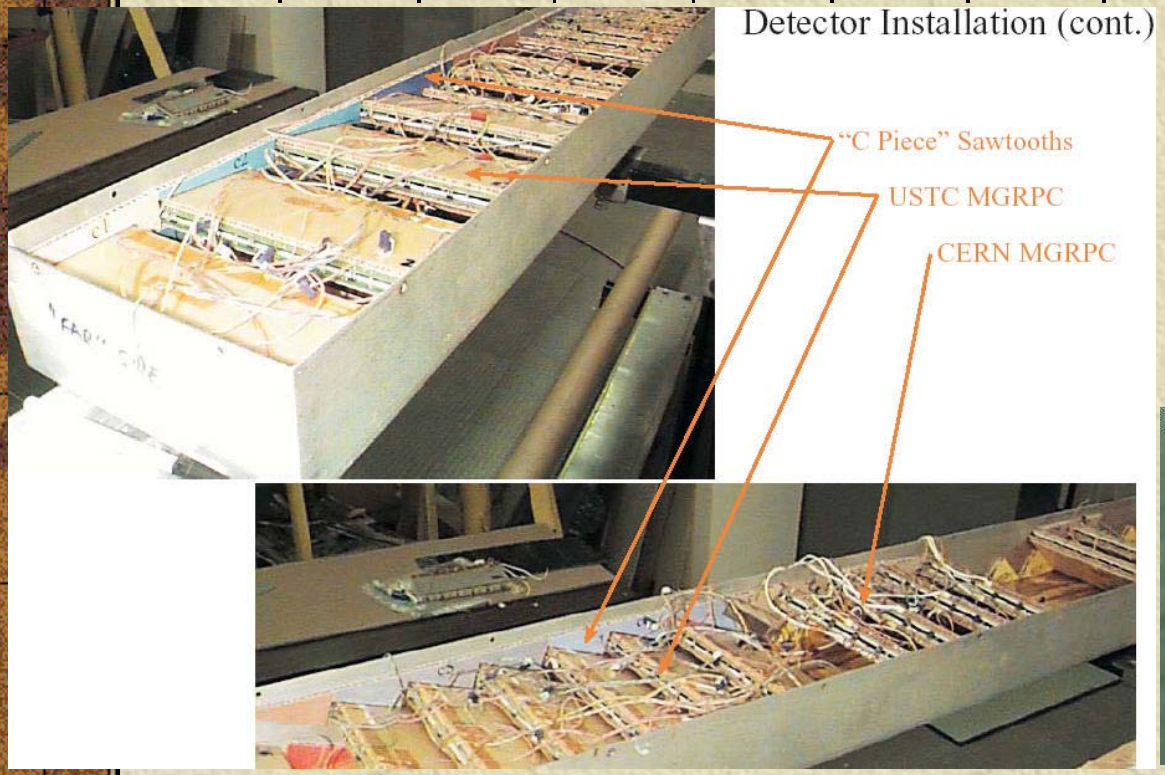


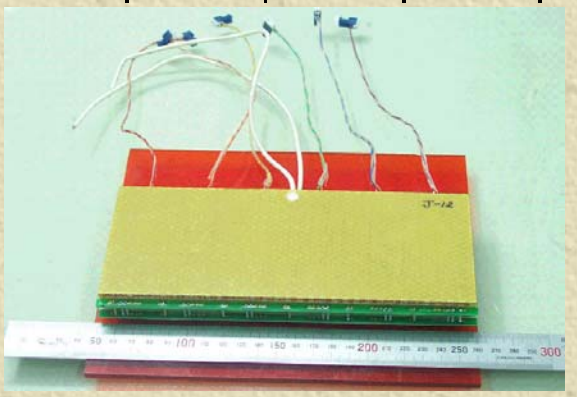
Read out pad size: 3.15cm×6.3cm, gap: 6×0.22mm

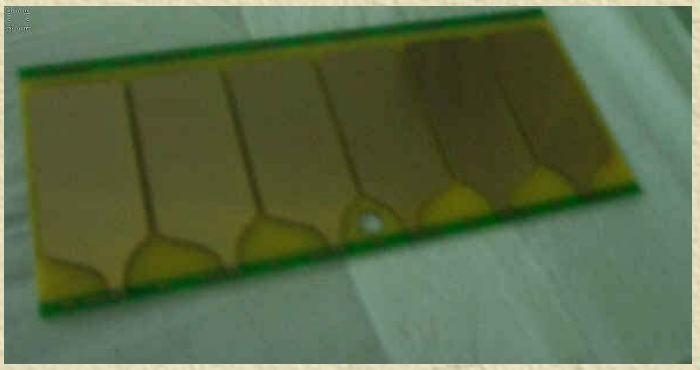
Thanks the R&D by LAA project for Alice

Multigap Resistive Plate Chamber
New Technology, Low Cost, High Resolution (<100ps)

MRPC TOFr 2003

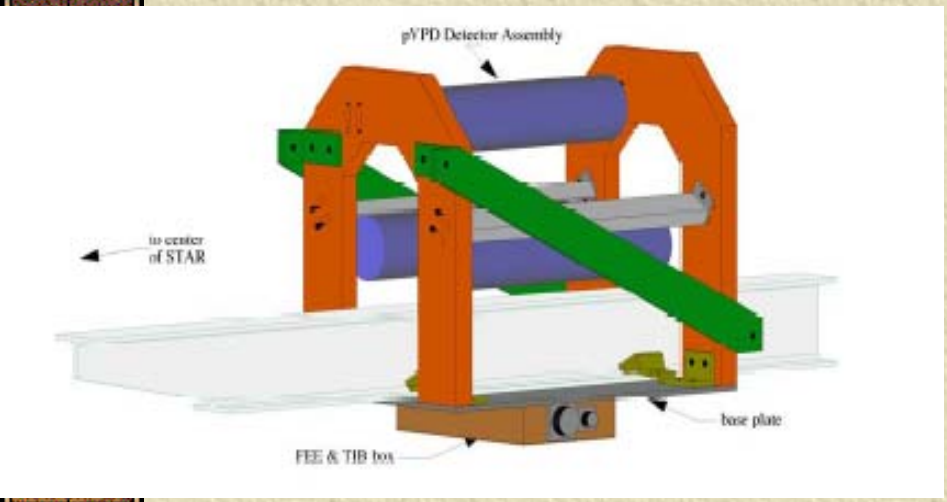


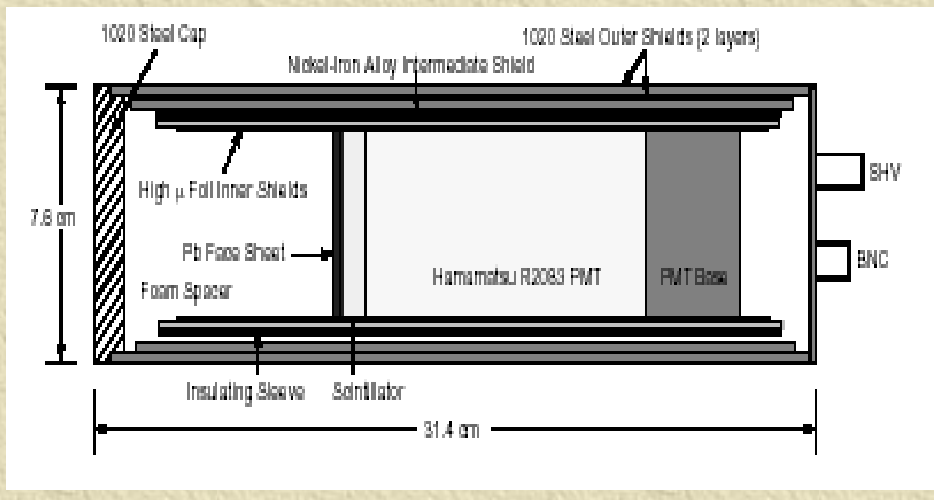




- **Just one tray: ~0.25% of TPC Coverage**
- **From dAu data: ~0.7% per event has hits matched with TPC primary tracks**

Pseudo Vertex Position Detector



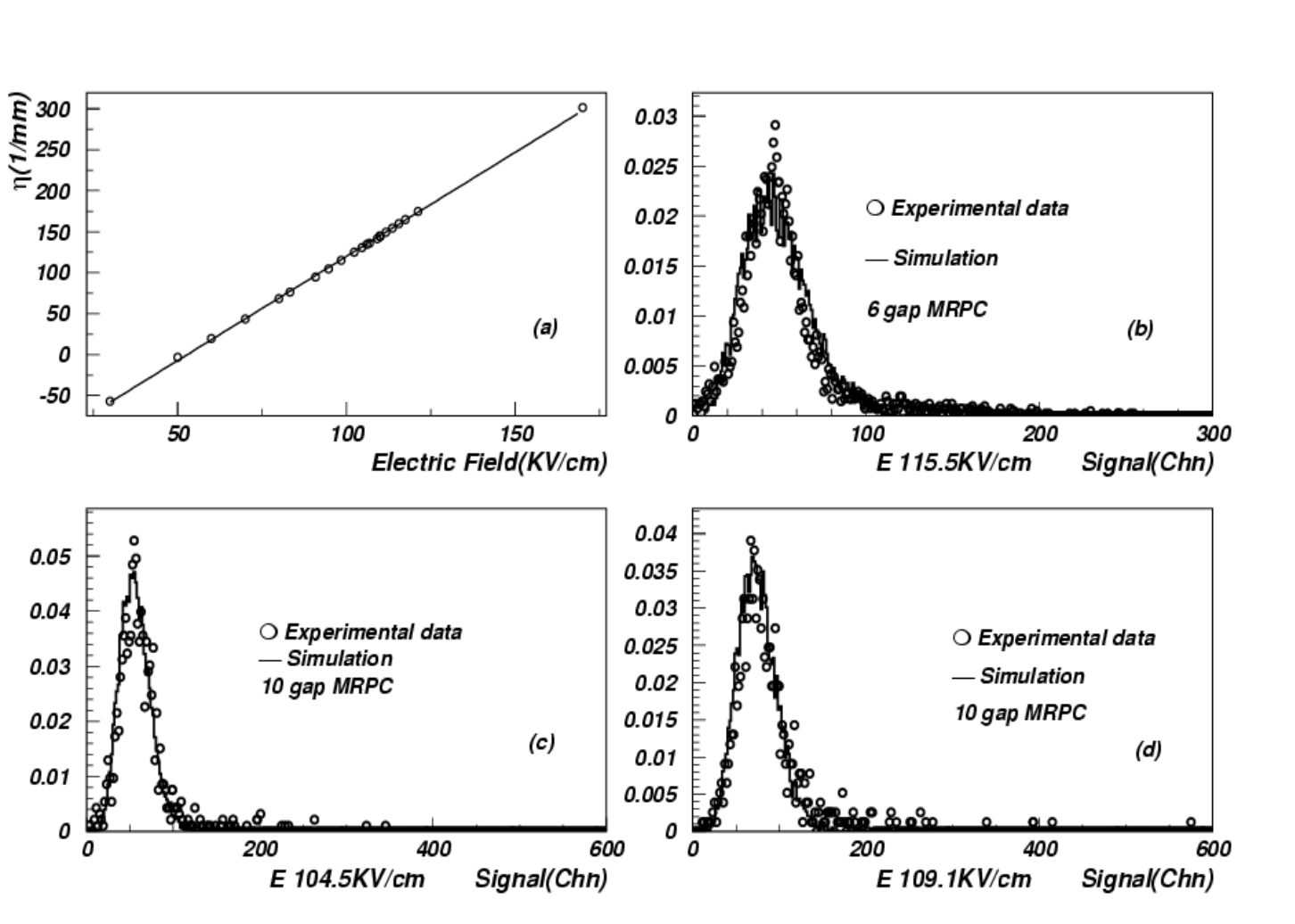


- (pVPD) ±5.4m
- $4.43<\eta<4.94$, $\Delta\phi\sim20\%$
- Trigger Efficiency: 100%, 30%, 10% in AuAu, dAu, pp
- σt=25, 85, 140ps in AuAu, dAu, pp

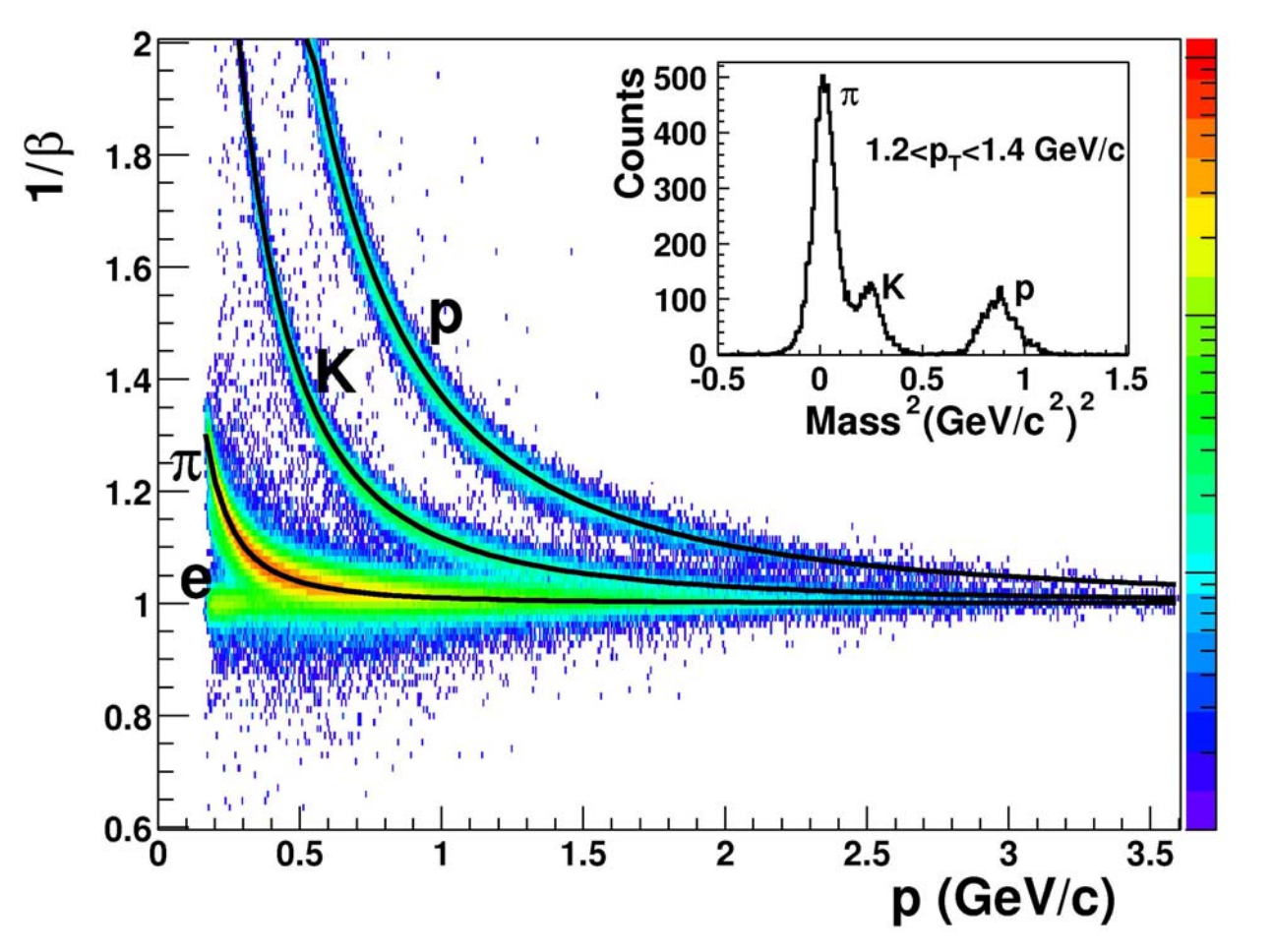
TOFr Calibration

- Trigger Enhancement: ~40 dAu, 400 pp
  dAu: ZDC-Au&pVPD&TOFr
  pp: BBCs&pVPD&TOFr
- Dataset:
  610K matched TOFr signal from 1.9M events in dAu
  300K out of 1.08M events in pp
- Calibration Procedure
  - Selecting pion sample (TPC dE/dx)
  - slewing correction cell by cell
  - z position correction
- total time resolution is about 120 ps (Overall)
  (pVPD start time resolution 85 ps,
  TOFr timing resolution 85ps)

Simulation:Charge distribution

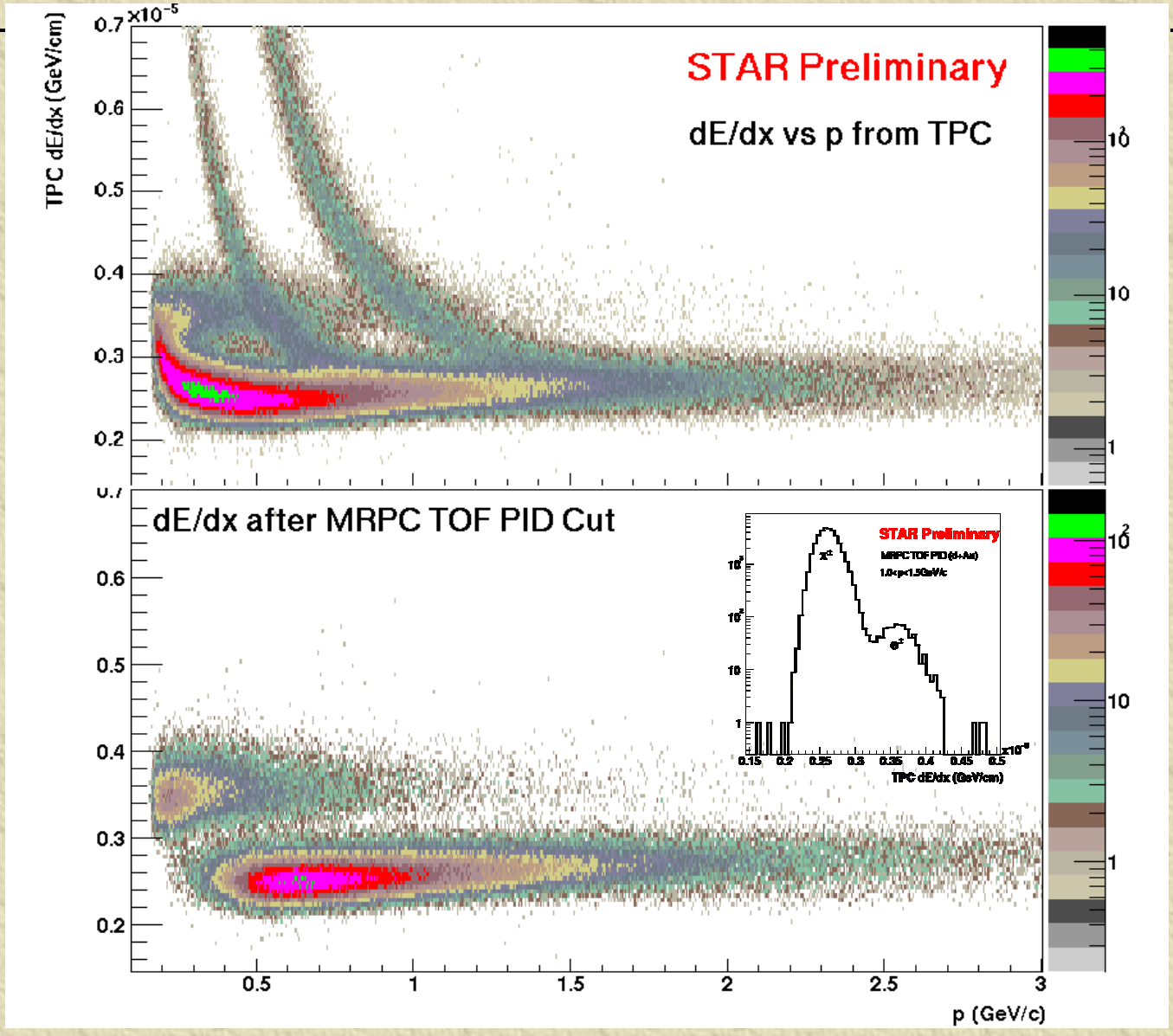


MRPC PID plot



πK seperation p=1.6GeV/c, pK p=3GeV/c

Electron Identification



欲穷千里目，更上一层楼 ——王之焕

If (you) have a vision of a thousand miles and want to widen your view, please climb one more flight of stairs.
– The Heron Lodge by Wang Zhihuan, Tang Dynasty

Proposal for a Large Area Time-of-Flight System for STAR

- Identified Particle Correlation & Fluctuation
- Improve Multistrange Particle Detecting Efficiency: Partonic Collectivity & Exotica Particle Search
- Particle Composition of Jet Fragmentation
- Antinuclei
- Extensive Resonance Spectra
- Open Charm Hadronic Decay
- Open Charm Leptonic Decay
- Dilepton
- Vector Meson Leptonic Decay

Proposal for a Large Area Time of Flight System for STAR

STAR-TOF

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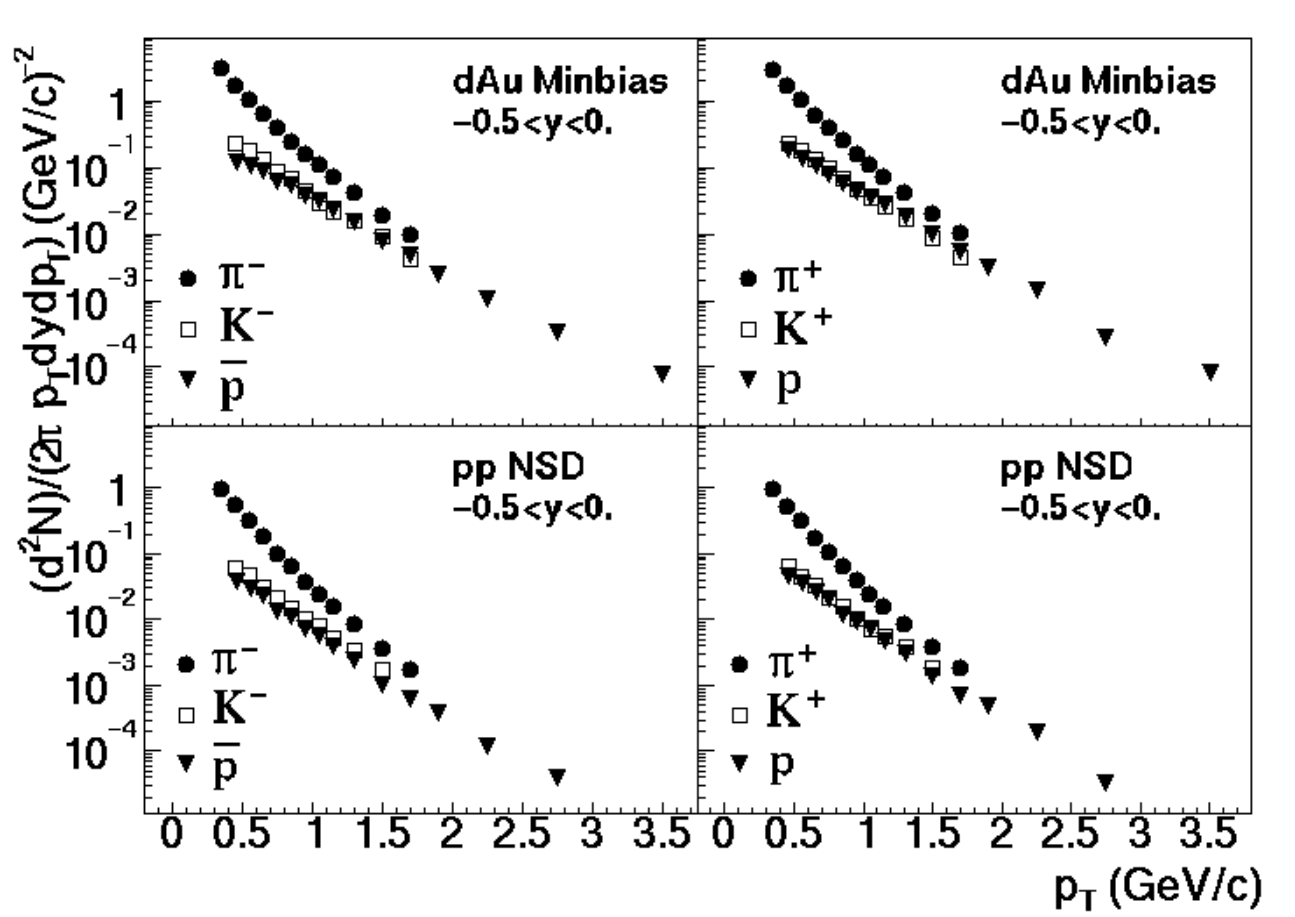
We are preparing the stairs!!!

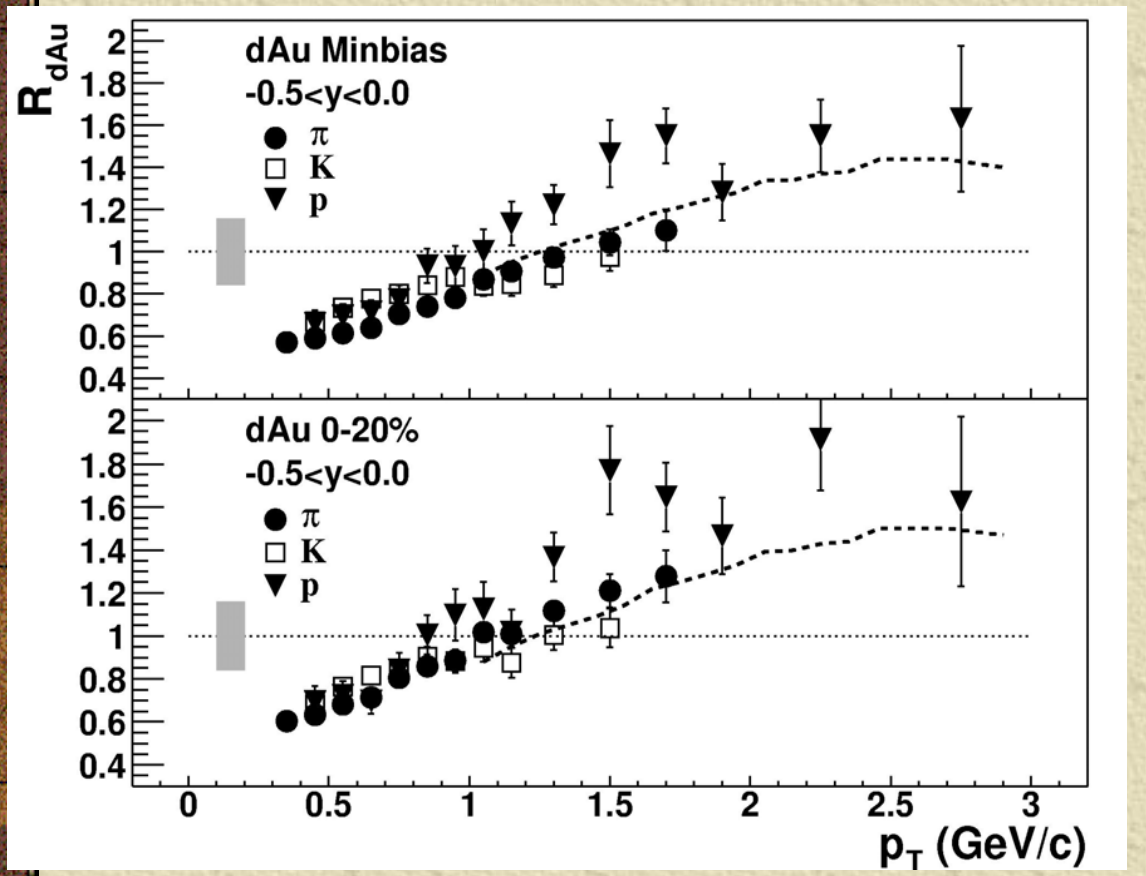
Spectra in pp, dAu



dAu Minbias: 95±3% of Total Nuclear Cross Section

pp NSD: 30.0±3.5mb, spectra correction <5% to inelastic

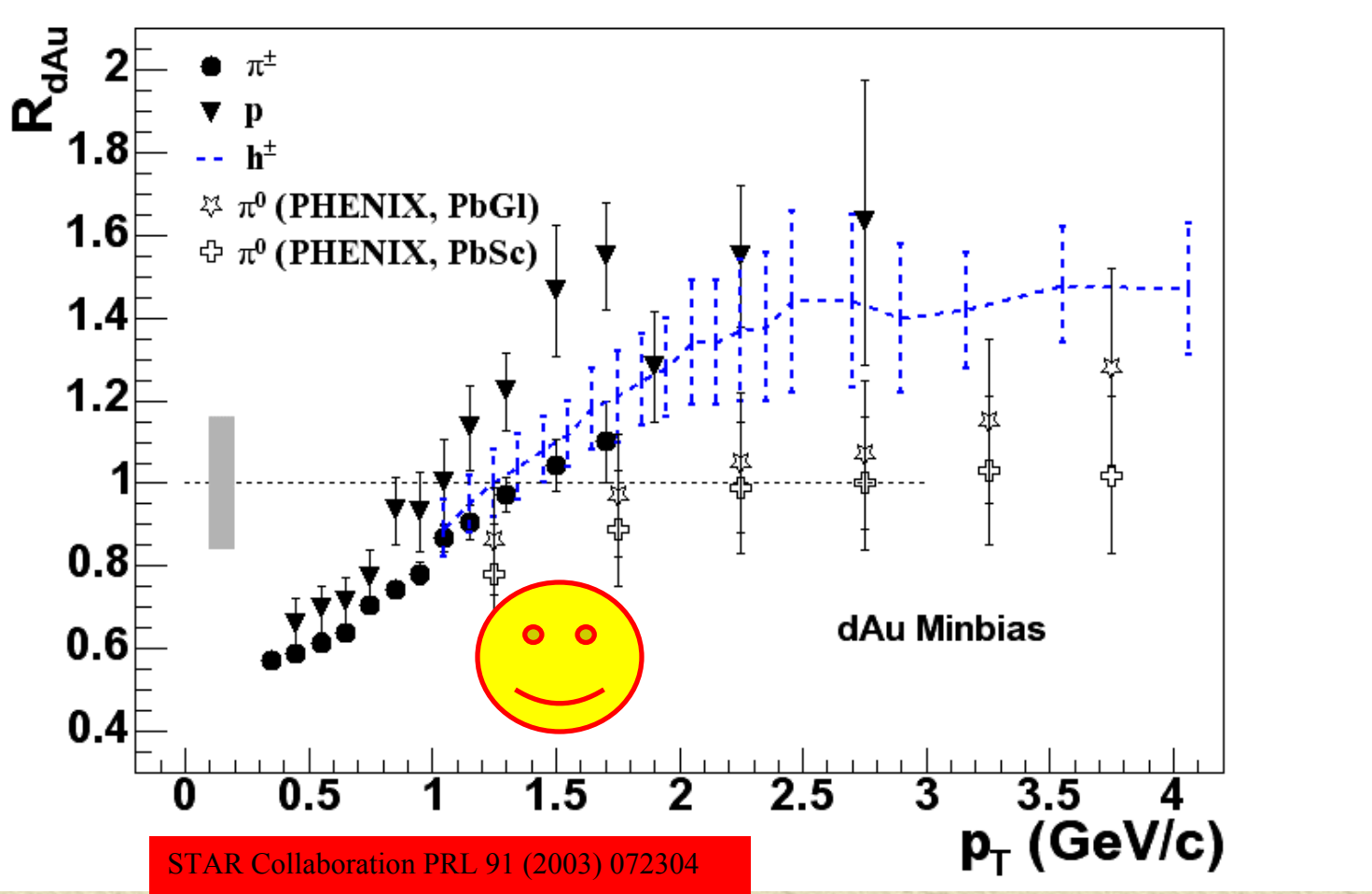
π K p R_{dAu}



- Non-Flatness
  Low pT <1
  High pT >1
  Px ~=1 GeV/c
- R_{dAu}: p>π,K
- Proton Spectra at Intermediate pT:
  No Binary Scaling
- α_p-α_π=0.041±0.01 ± 0.006
  $\sqrt{s}$≈30 GeV: (1<pT<3)
  α_p-α_π= 0.095 ±0.004

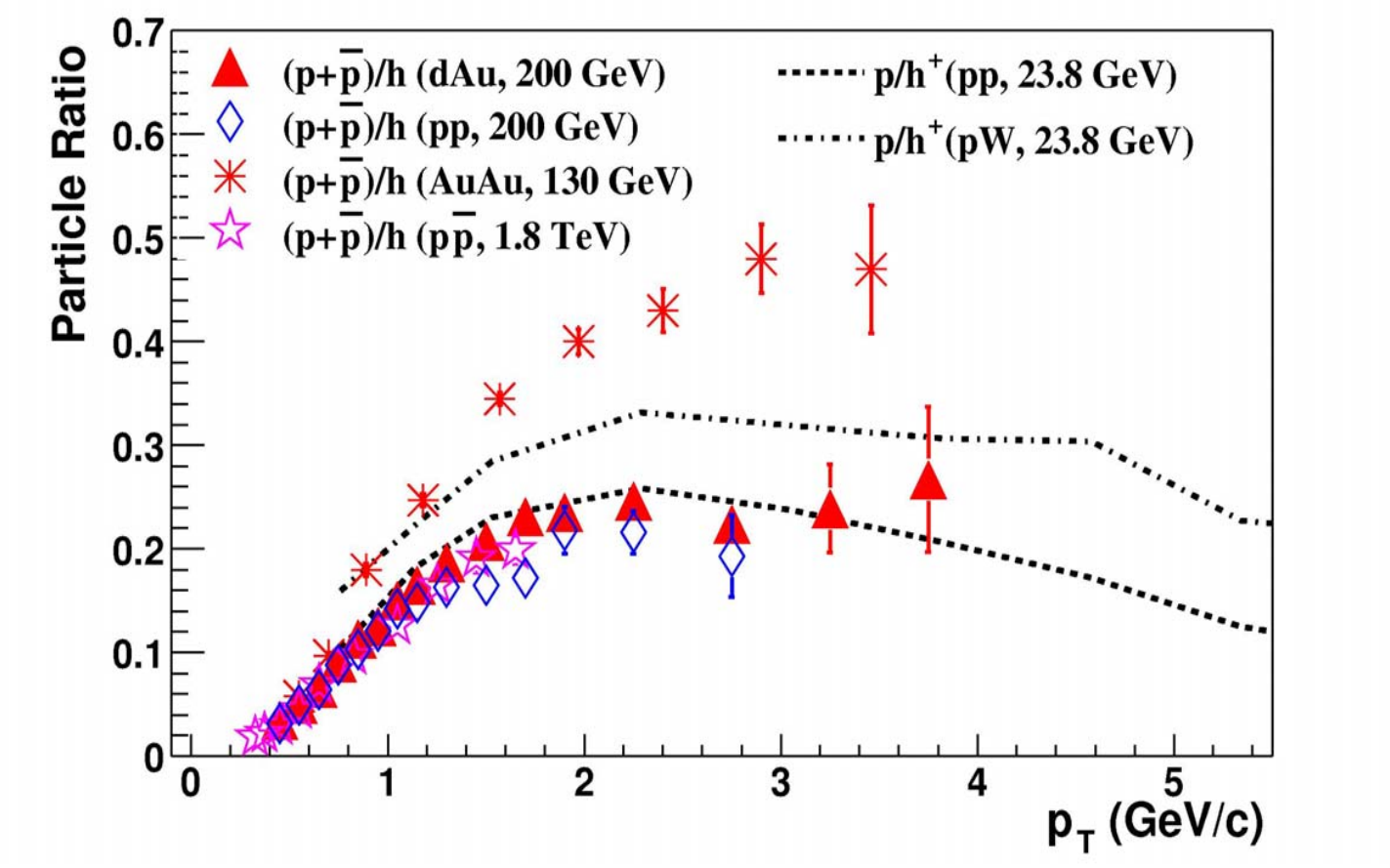
Very Characteristic Cronin Effect

Consistency Check



Within Errors, R_{dAu} STAR $\pi^{\pm}$ consistent with PHENIX π^0

Final State Effect

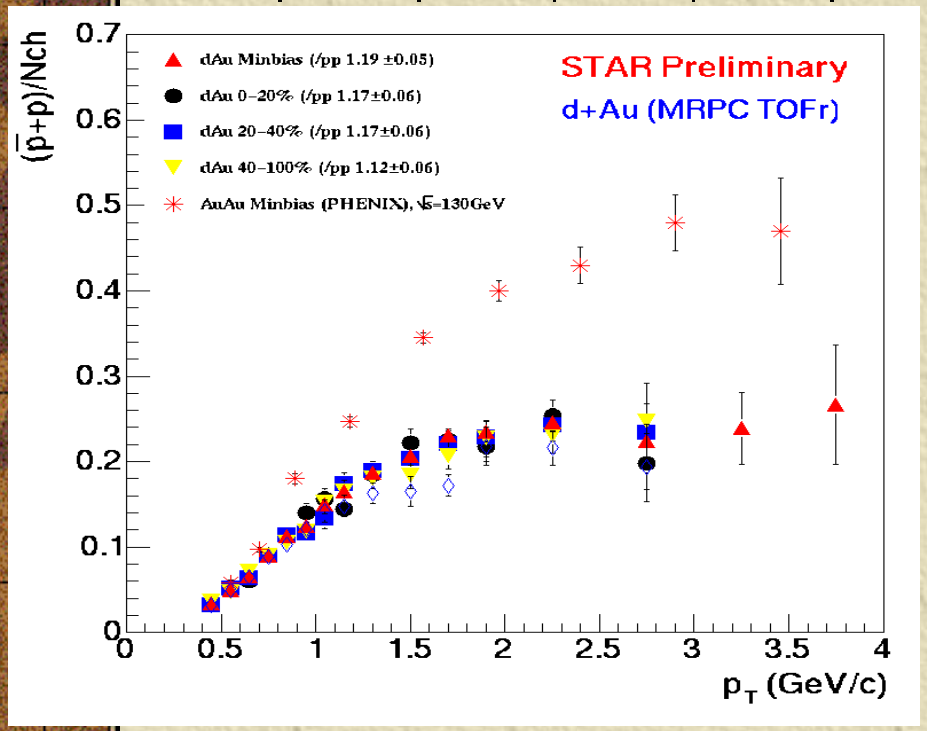


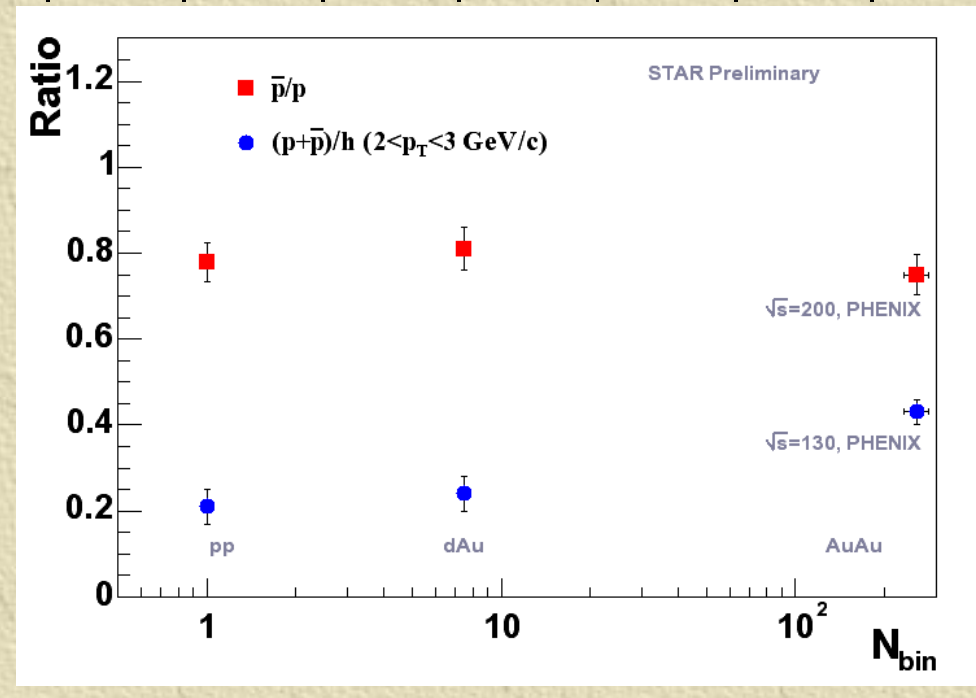
dAu: (p+ $\bar{p}$)/h = 0.24±0.01±0.03 (2<pT<3 GeV/c)

dAu: (p+ $\bar{p}$)/h = 0.21±0.02±0.03 (2<pT<3 GeV/c)

×2 smaller than that in AuAu

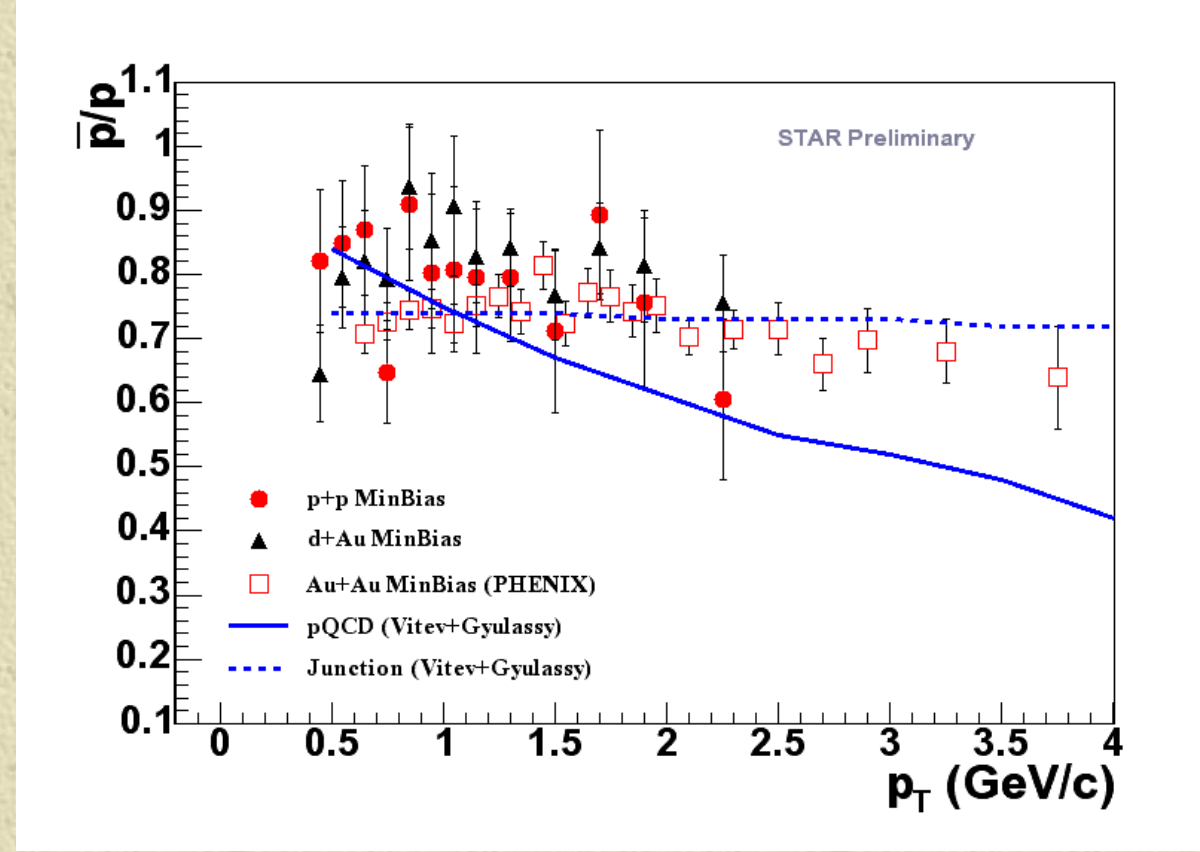
Centrality Dependence p/h





- Very Little Centrality Dependence
  Consistent with inclusive $h^{\pm}$ results!
- Due to different stopping between dAu and AuAu??
  $\bar{p}/p$ **constant** from pp, dAu to AuAu

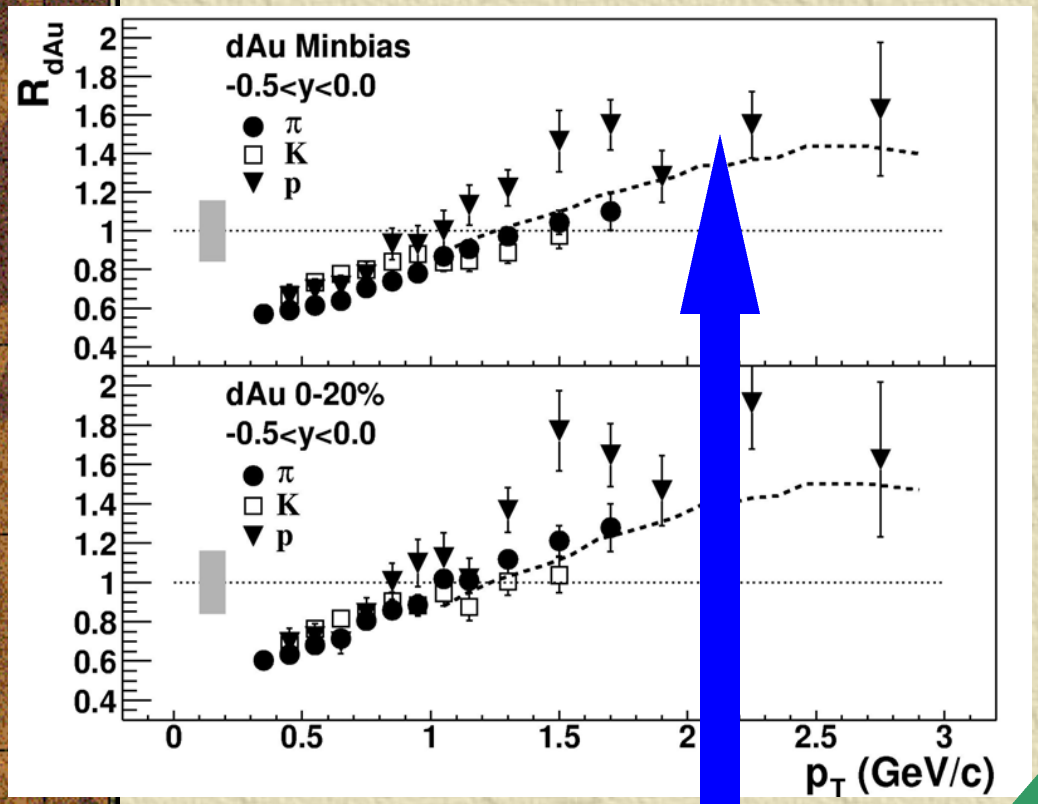
pT Dependence of $\bar{p}/p$ Ratio

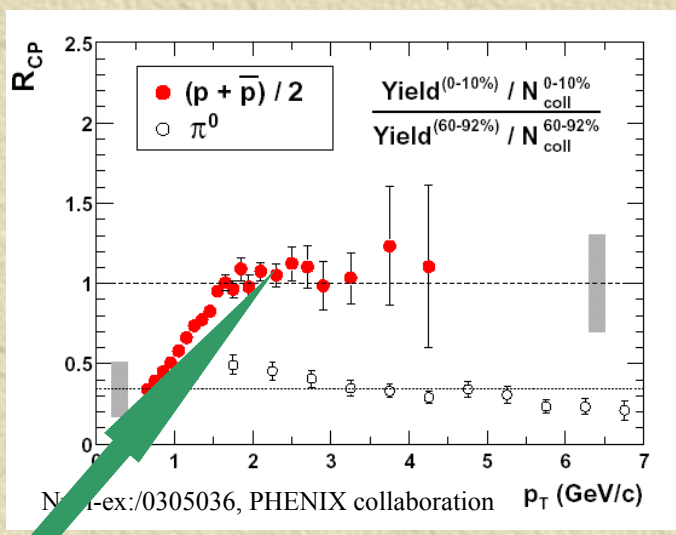


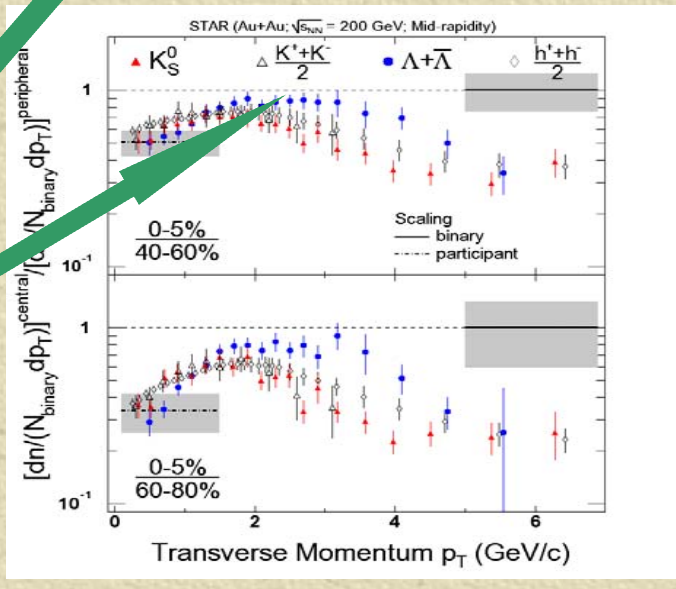
- Flat vs pT (stat. shown only, syst: 4-6%)
- No Convincing Evidence of $\bar{p}/p$ Decrease as pQCD prediction (hep-ph/0208108)

dAu:
STAR: $0.81 \pm 0.02 \pm 0.04$
PHOBOS: $\sim 0.83 \pm 0.02 \pm 0.03$
nucl-ex/0309013

Binary Scaling: A Final State Effect?

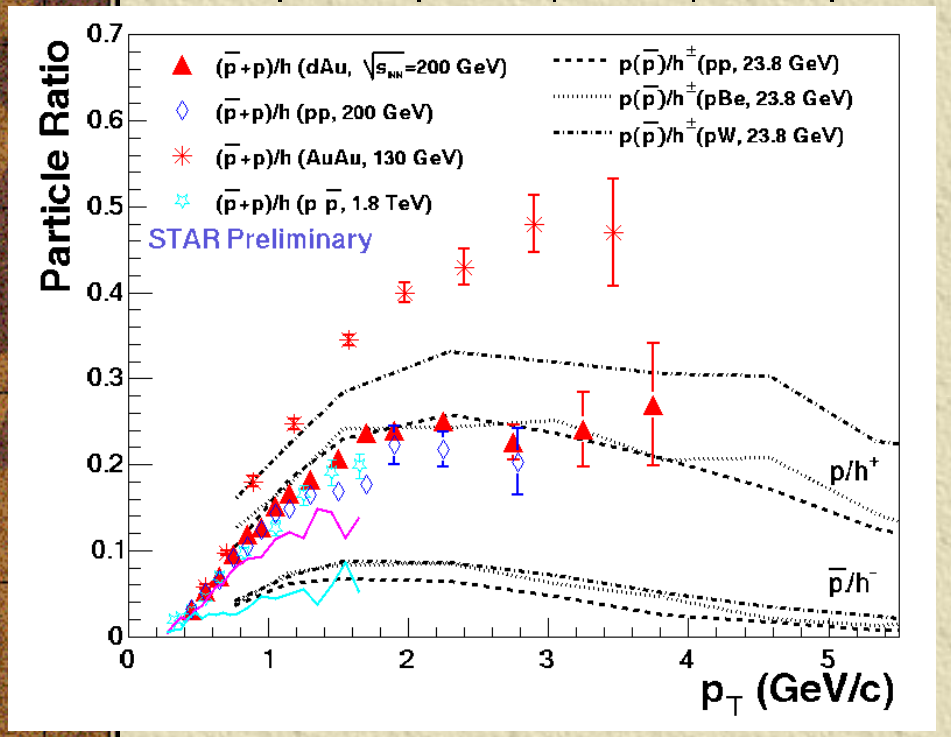


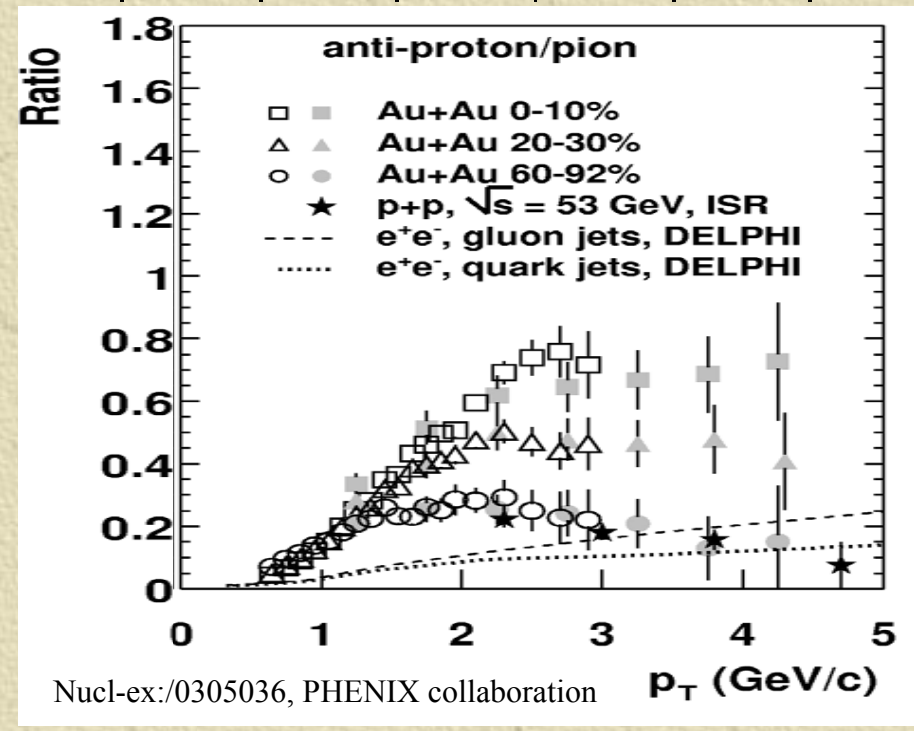




- dAu: Great than Binary Scaling
- AuAu: ~Binary Scaling

Compared to Fragmentation In e^+e^-





Nucl-ex:/0305036, PHENIX collaboration

- Baryon Production:
  - g>q (high momentum jet, DELPHI)
  - **ggg >> q $\bar{q}$** (~×3@ 10 GeV, ARGUS)
  - How about many gluons/quarks? Coalescence? Hwa, Fries , Greco *et al.*

Conclusions

dAu	AuAu
1) Characteristic Cronin Effect	1) Suppression
2) Baryon Enhanced p/h (dAu/pp)=1.19±0.05±0.03	2) Relative Baryon Enhanced p/h(AuAu/pp)=~2
3) Baryon Great than Binary Scaling	3) Baryon Binary Scaling
4) Composition weak centrality dependence	4) Composition strong centrality dependence
5) $\bar{p}$/p no pT dependence Improve precision	5) $\bar{p}$ /p no pT dependence
6) p/h>>quark/gluon fragmentation	6) p/h>>quark/gluon fragmentation
7) p/h close to ggg fragmentation	7) p/h >> ggg fragmentation

MRPC TOF is a cost-effective solution for large area time-of-flight system and it works