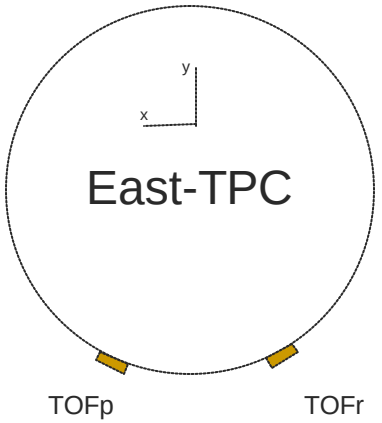
TOF PID results in Au+Au and d+Au

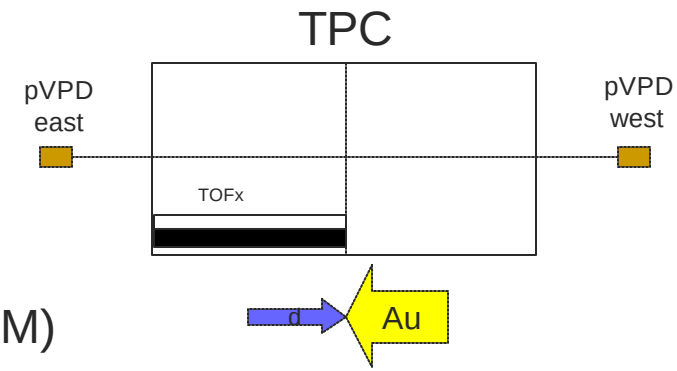
Frank Geurts for the TOF group

- Apparatus & Data sets
- Au+Au
  - calibration
  - PID results
  - particle ratios: RFF/FF problem
  - simulation & embedding status
- d+Au
  - calibration
  - PID results
  - spectra: hadron, B/Nch, single-e
- Summary & Outlook

TOF = pVPD + TOFx, x={p,r}

- Au+Au
  - detectors:
    - start: pVPD (2.and.2)
    - stop: TOFp
  - this data set: central (830k)
  - other data sets: minbias, 22GeV
- d+Au
  - detectors:
    - start: pVPD (1.and.1)
    - stop: TOFr + TOFp
  - this data set:
    - dAuTOF (2M)
    - dAuMinBias, dAuCombined (6.5M)

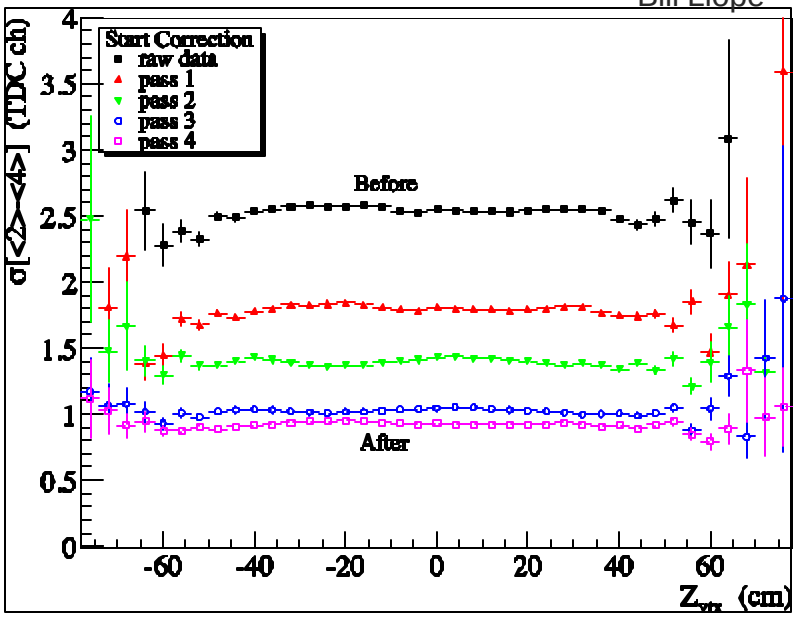




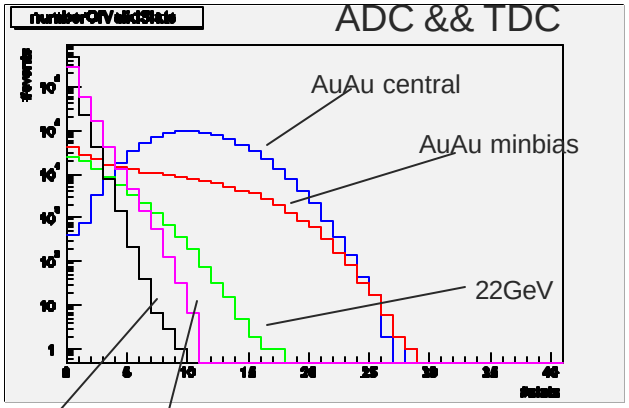
Au+Au: start time calibration

- all 6 tubes fired for every event
- slewing effect:
  - iterative techniques based on difference of averages <2>-<4>
    - <2>=<Ei+Wi>, i=1..3
    - <4>=? <Ej+Wj>, j?i
  - raw start time resolution ~70ps
  - after corrections ~24ps
- done

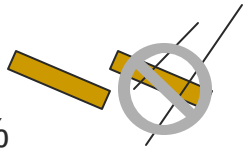
Bill Llope



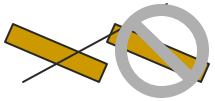
AuAu: TOFp track matching



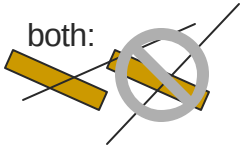
- TOFp: 41 slats, ?f =6°, ??=1
- occupancy in central evts ~40%
- 13±3 tracks/tray/evt for central data
- effective inside tray acceptance: 51%
  - 41*Aslat/Atray ~ 60%
  - 6 dead slats: 85%
- high multiplicity
  - singly-tracked slats
  - single-slat tracks
- primary track match ~2.5 per event (8%)

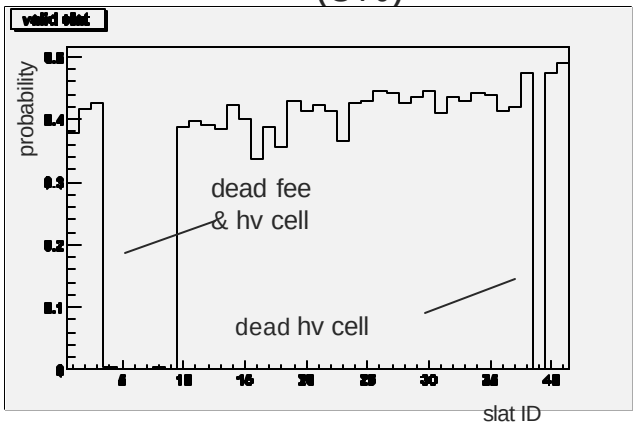


two tracks crossing one slat



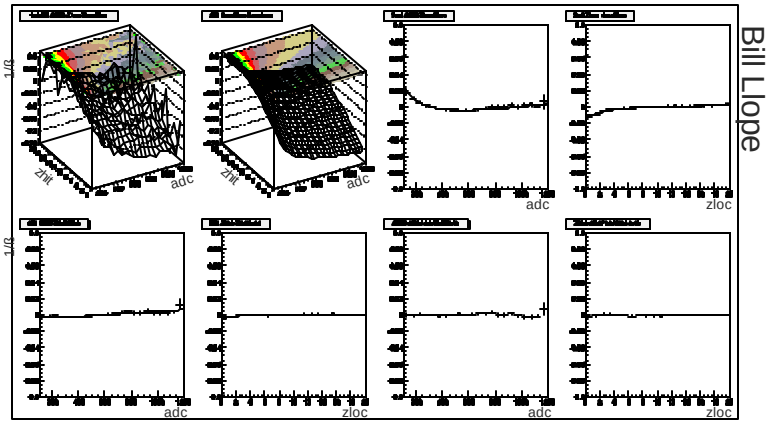
one track crossing two slats

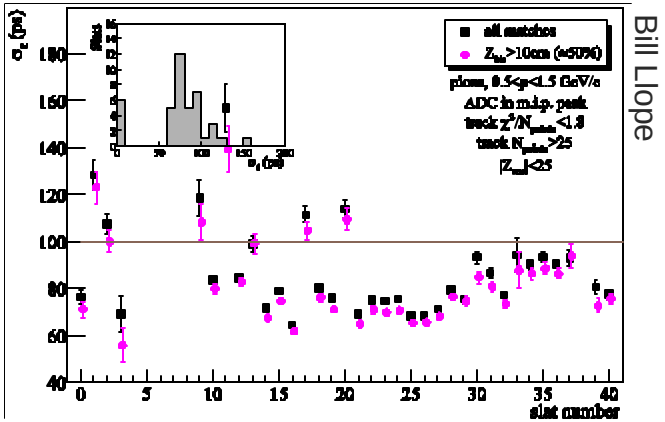




Au+Au: stop time calibration

- single-ended slats
  - light propagation ~65ps/cm
  - slat length = 20cm
  - hit position correction
- pulse-height dependence, *slewing*
  - light attenuation (position dependent!)
  - momentum dependent (Bethe-Bloch)
  - track length inside slat
- optimize iteratively in $(1/\beta)^{exp} - (1/\beta)^{p}$
  - no momentum cuts used to select calibration p s
- done.

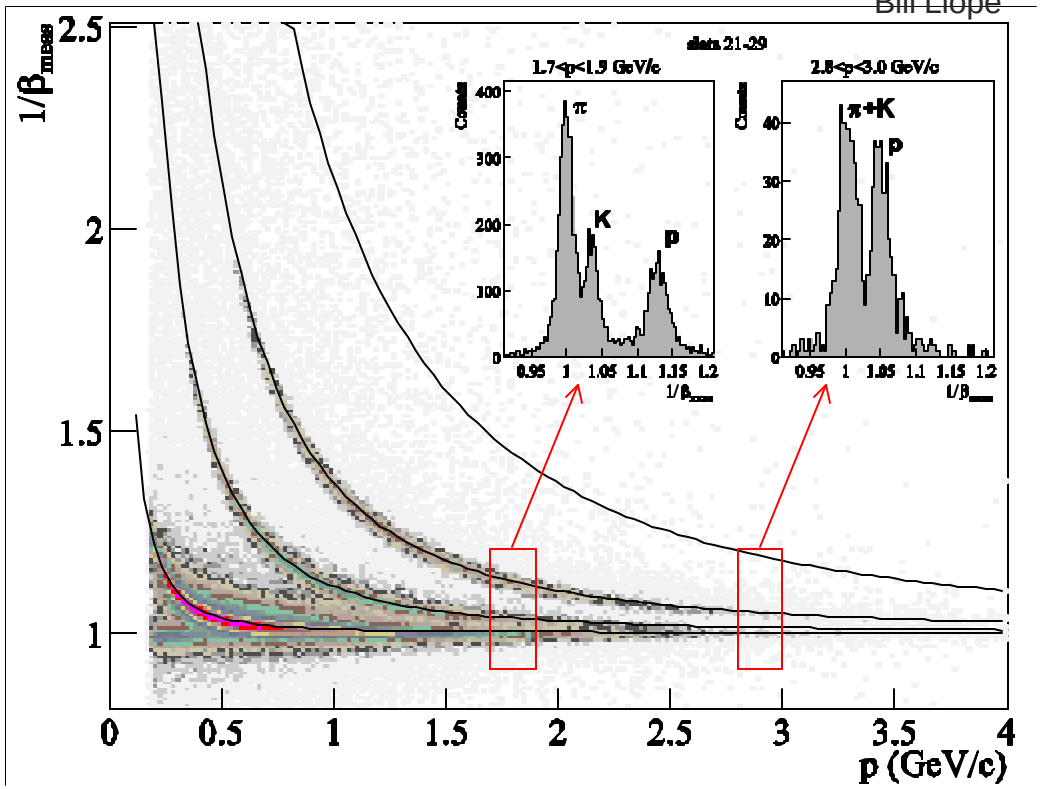




total (start+stop) time resolution in central Au+Au:

- averaged over all slats: 87ps
- averaged over the best 25 slats: 79ps

Au+Au: PID

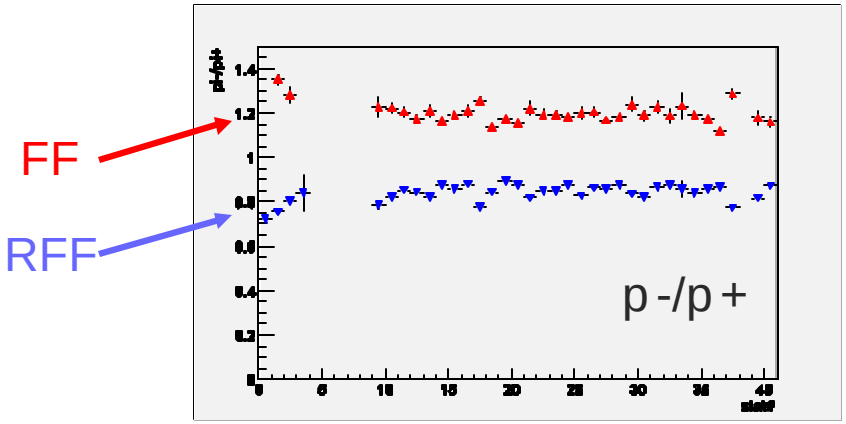


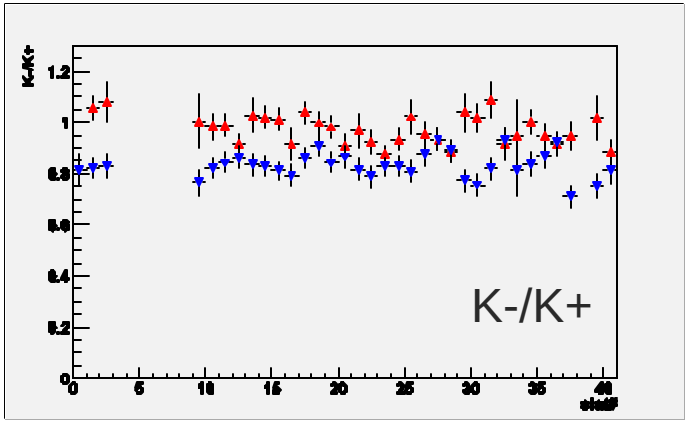
- TOFp PID[1]:
  - p /K separation up to 1.9GeV/c
  - (p+K)/p separation up to 3.1GeV/c
- more details:
  - TOFp NIM paper
  - talk by Bill Llope in spectra parallel session on Sat.

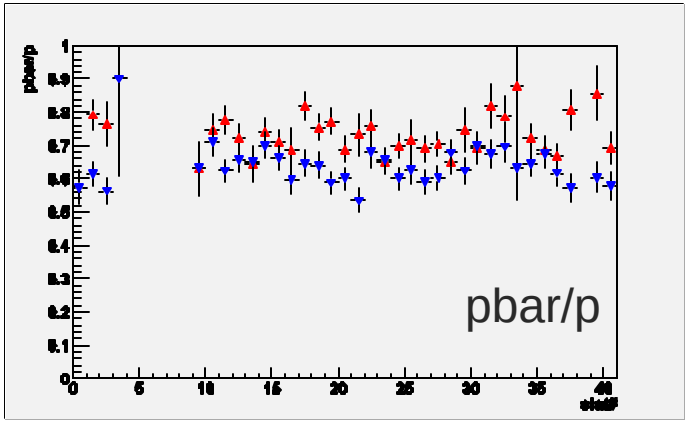
[1]) PID ranges based on (1+1) s

Au+Au: particle ratios problem

- B-field problem in h-/h+
- h-/h+ ratio per slat
- slight F -dependence

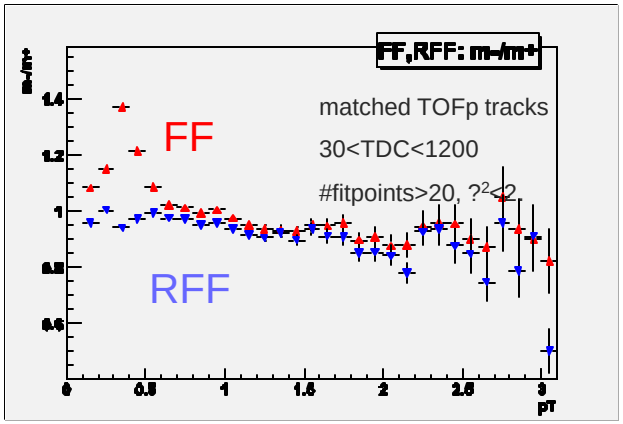


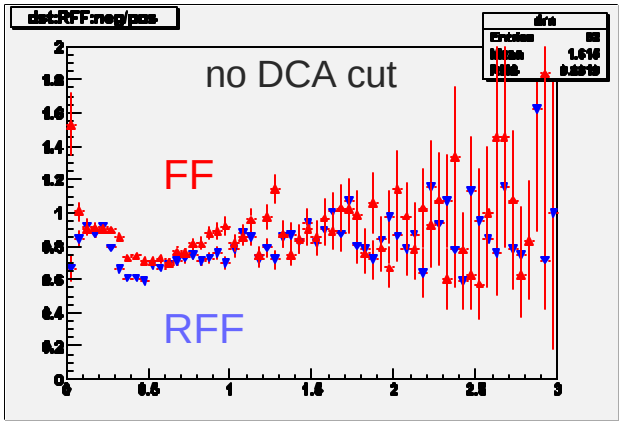




Au+Au: particle ratios, RFF/FF

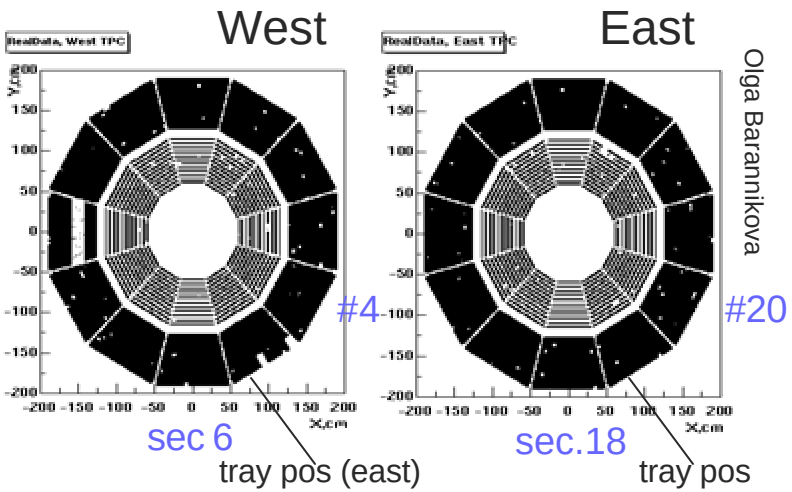
- significant enhancement in m-/m+ spectra below pT<0.5GeV/c for FullField compared to Reversed FullField.
- no B-field dependency in matching code
- bias introduced in mDST?
  - compare same run sample for mDST and event.root
  - no difference in final m-/m+ spectra
  - indication of field dependency in the track input distribution
- select on very good tracks
  - #fitpoints>35
  - even stronger effect
- vary DCA cut
  - stronger effect for smaller DCA cut
  - weaker effect for larger DCA cuts
- maximize DCA cut
  - effectively removing the primary track requirement
  - RFF/FF effect seems to have disappeared

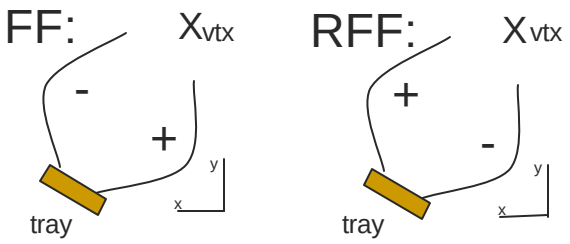




Au+Au: RFF/FF (cont'd)

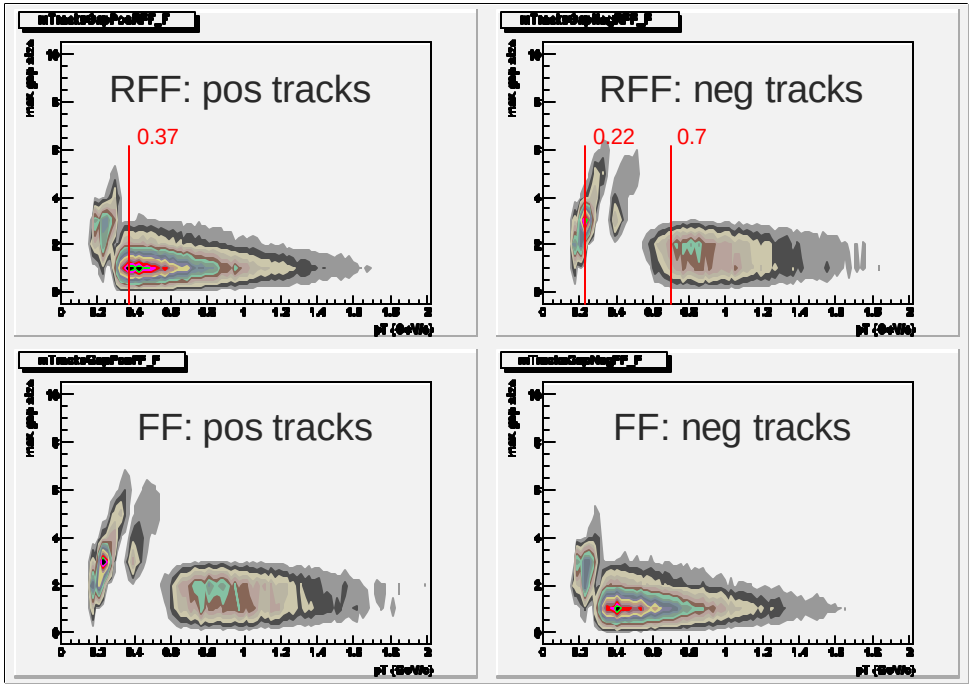
- dead pads or RDOs?
  - west TPC has dead pads close to TOFp position
  - no dead pads on East TPC side
  - no obvious differences from Zvtx<-25cm vs. Zvtx>25cm
- geometrical effect?
  - small f -acceptance detector!
  - low pT primary tracks large curvature
    - pT < 1.4GeV/c tracks can pass through sect.19 and 18 (depending on charge*B)
    - pT < 0.49GeV/c all primary tracks will pass through either sects 18,19,20





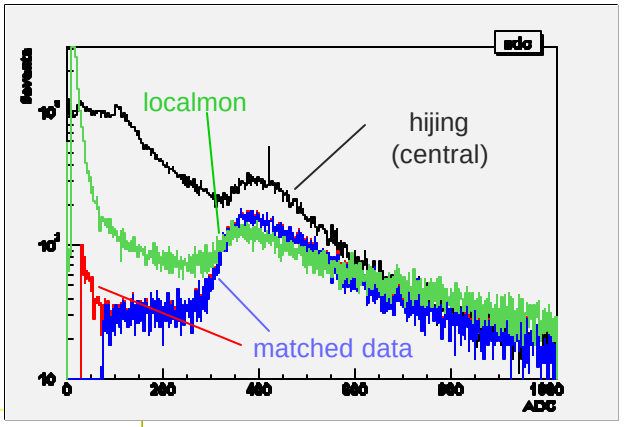
Au+Au: RFF/FF (cont'd)

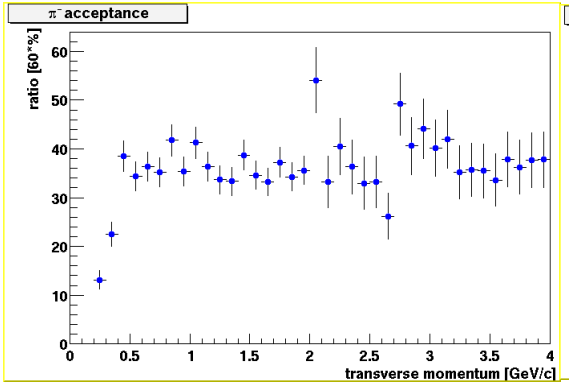
- sector boundary crossing?
  - RFF:
    - neg. tracks pT<0.7GeV/c (<0.22GeV/c)
    - pos. tracks pT<0.37GeV/c
  - FF:
    - neg. tracks pT<0.37GeV/c
    - pos. tracks pT<0.7GeV/c (<0.22GeV/c)
  - hint from max gap distributions
    - increasing max gap size as a function of pT
    - consistent with large path in between sectors for smaller curvatures, i.e. larger pT
  - energy loss for low momentum tracks
    - effective pT thresholds different then those based on a pure helix model
- TOFp tray is asymmetrically positioned in sect.19:
  - closer to sect.18 then 20
  - therefore different effect w.r.t. field setting
  - more simulations required
  - corrections from embedding
- TOFr tray is symmetrically positioned in sector 17.

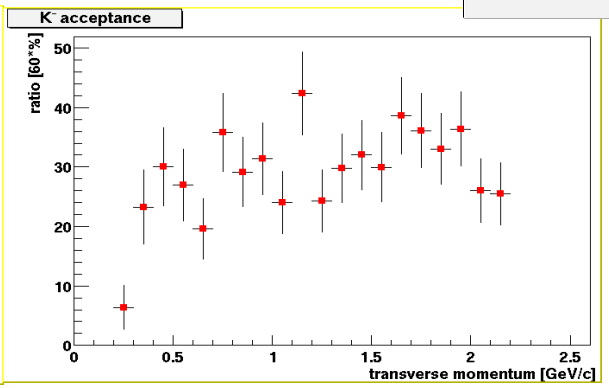


TOFp: simulation & embedding

- slat signal simulations
  - ADC distributions match
  - introduce individual slat gain factors
- embedding:
  - match efficiency
  - ADC thresholds
  - RFF/FF effect







- based on TPC track embedding
  - not enough statistics
- massive TOF embedding after analysis meeting

d+Au: TOFp + TOFr

- TOFr tray prototype for Full Barrel TOF
  - 72 digitized out of 168 available channels
  - ?f =6°, ??~0.4
- very successful and stable operation
- large data sets, dedicated TOFr trigger
  - dAuMinbias & dAuCombined: 6.6M pVPD physics events (25M STAR evts)
    - 1.6M TOFp counts (0.24 per pVPD physics evt)
    - 0.7M TOFr counts (0.10 per pVPD physics evt)
    - 45k hits/TOFp-slat, 12k hits/TOFr-cell
  - dAuTOF: 2.0M pVPD physics events (2.5M STAR events)
    - 630k TOFp counts (0.32 per pVPD phys evt)
    - 2.4M TOFr counts (1.22 per pVPD phys evt)
    - 15k-25k TOFp hits/slat; 25k-45k TOFr hits/cell
- TOFr analysis based on dAuTOF

d+Au: start time calibration

- pVPD coincidence changed to 1.AND.1
  - east pVPD “sees” Au fragments
    - ~2.4 hits per event
  - west pVPD “sees” d fragments
    - 1.3 hits per event
  - time resolution better on the east pVPD, worse on west
- single-detector equivalent time resolutions
  - east ~110ps
  - west ~170ps
  - see Bill’s talk in spectra PWG session

#pVPD west

3	0.6	0.7	1.4
2	4.1	5.2	11.2
1	14.5	18.6	43.7
	1	*2*	*3*

based 5M pVPD evts, days 24-55

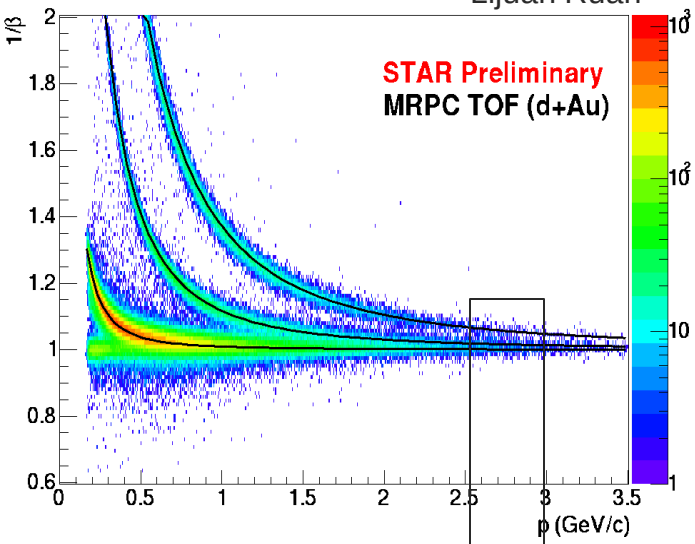
#pVPD east

fraction of pVPD phys evts for various east/west configurations

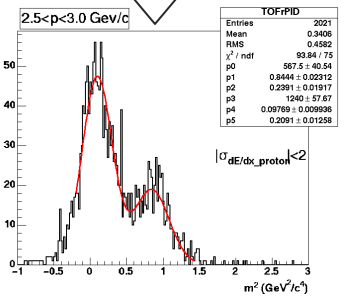
d+Au: TOFr calibration

- low multiplicity:
  - straightforward matching procedure
- small hit position correction
  - perform slewing and hit position correction in subsequent steps
- non-linear TDC range
  - in-situ calibration
  - moved the TOFr TDC common-start for p+p run
- overall TOFr resolution: ~120ps

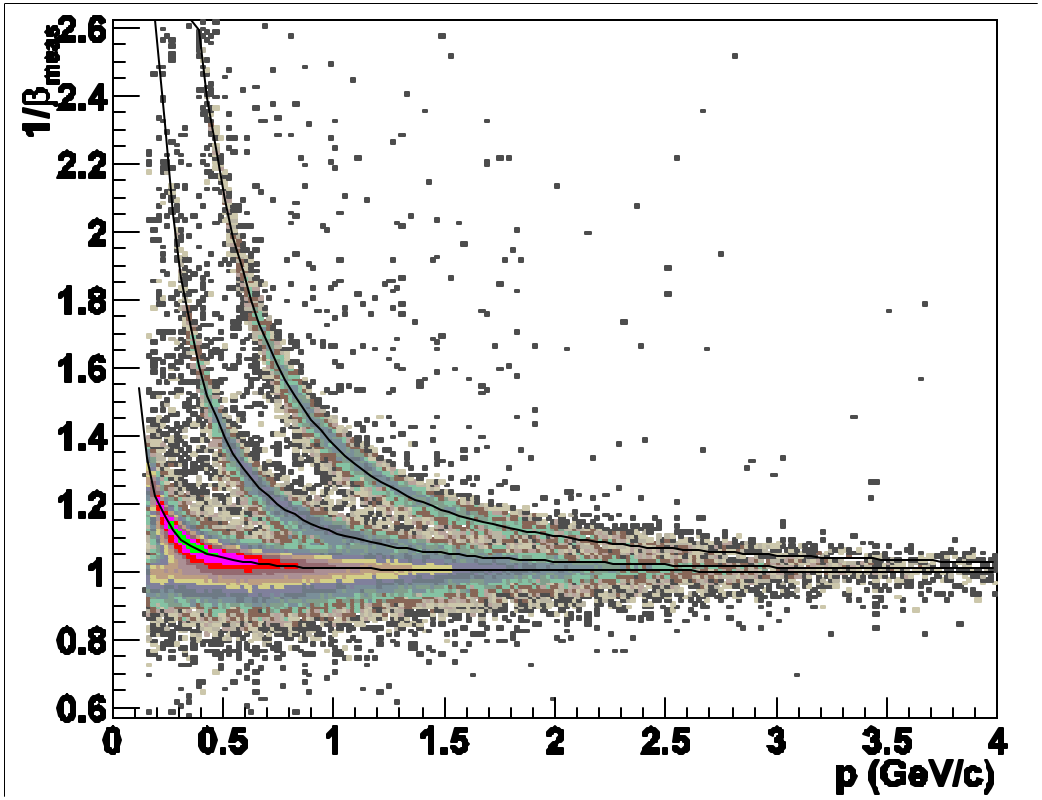
Lijuan Ruan



capable of p/(p+K) separation up to 3GeV/C

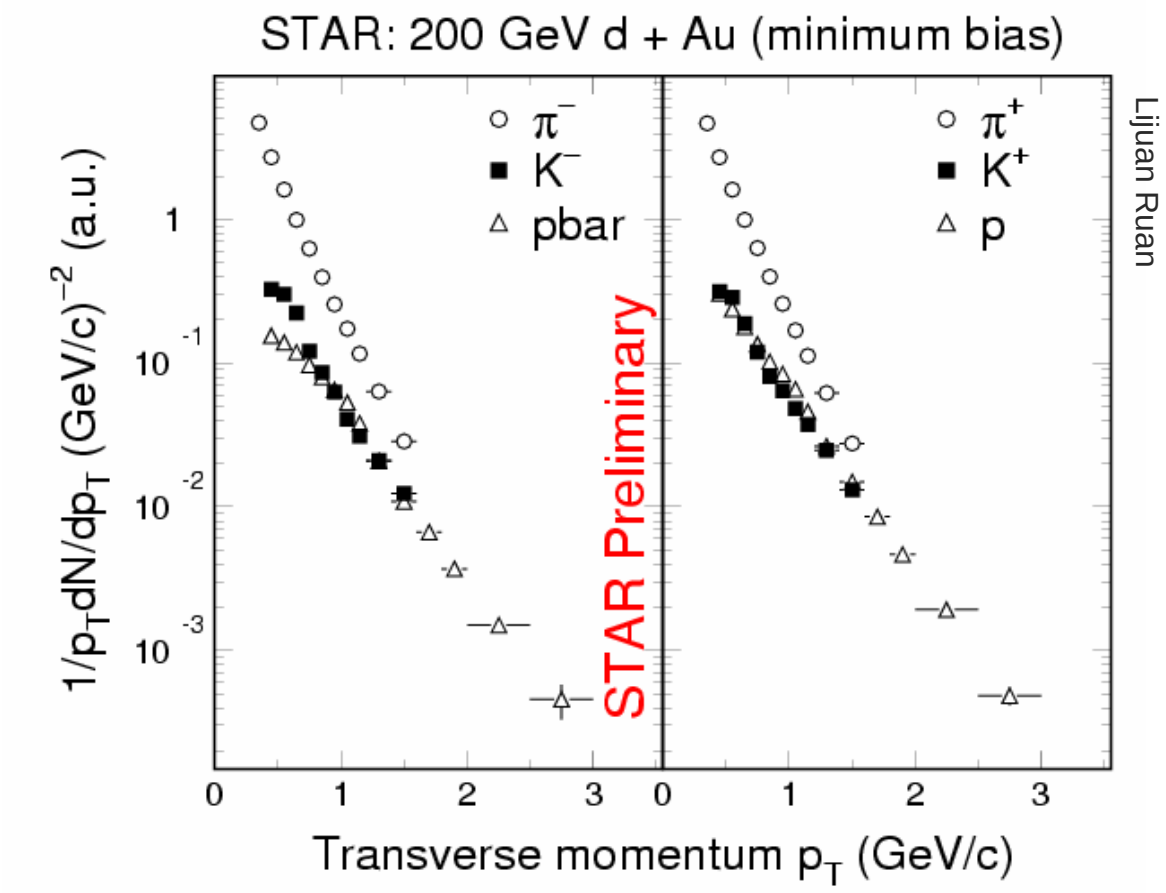


dAu: TOFp calibration



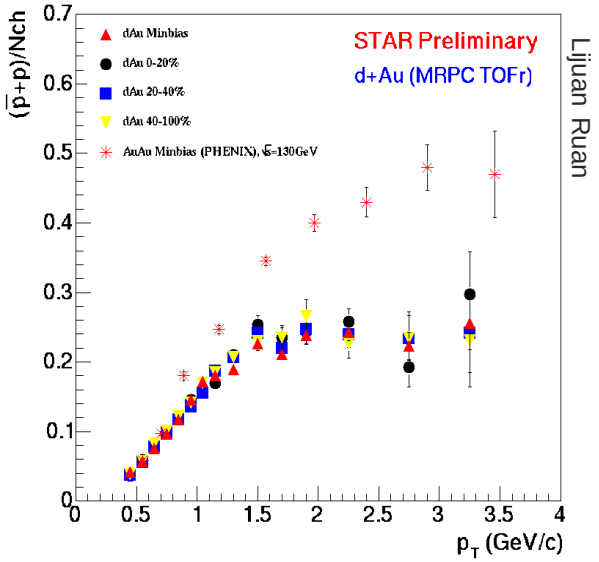
- just off the press !!!
- pVPD for full pVPD data set
- pVPD: E3 & W1 (~40%)
- preliminary separations: 1.5GeV/c and 2.5GeV/c

d+Au: hadron spectra

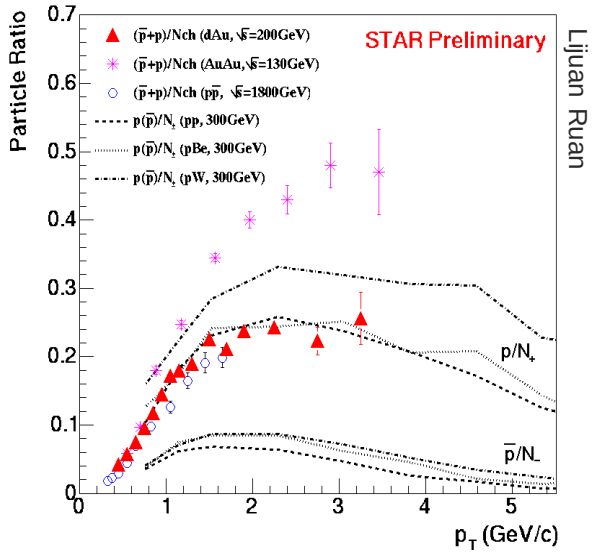


- based on TOFr data with dAuTOF trigger
- corrected for
  - absorption
  - matching efficiency

d+Au: baryon/Nch ratio



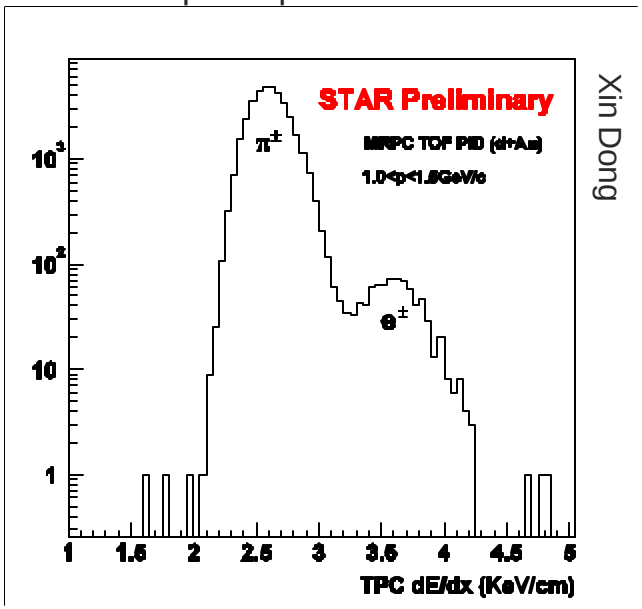
- no difference between multiplicity bins
  - small mass dependence of Cronin effect for *this* energy
- large difference from Au+Au!!
  - prominent final state interactions in AuAu
- p+p data for R(dAU)



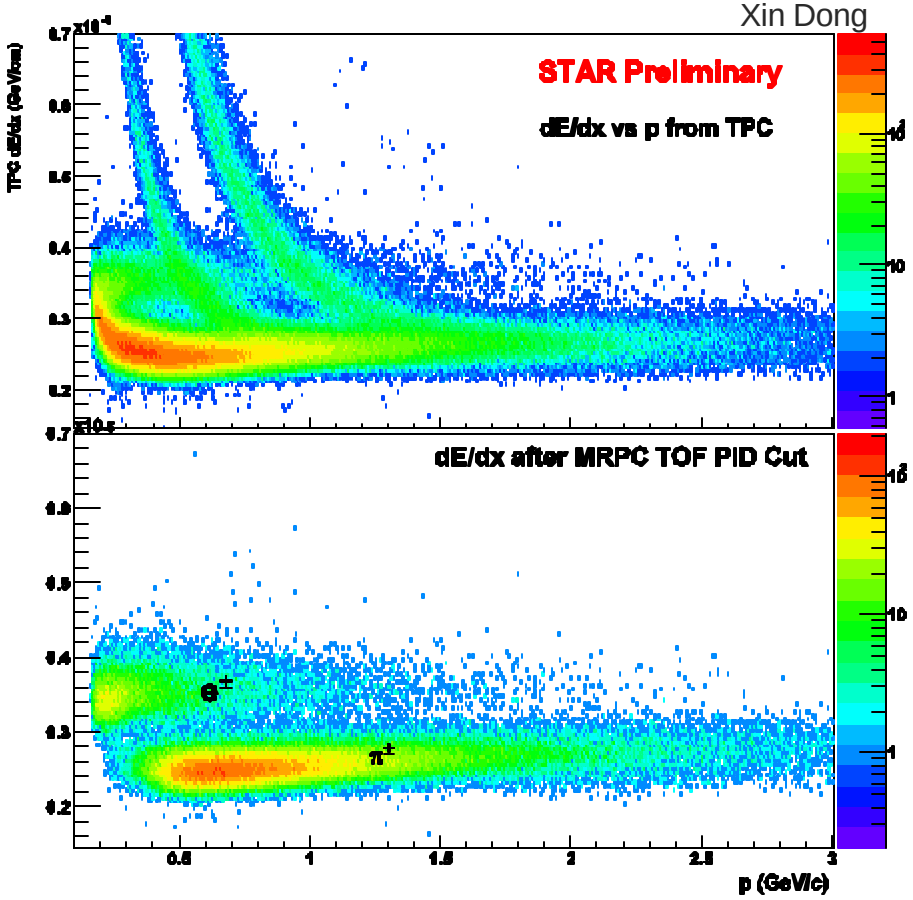
- comparison to pbar+p @1.8TeV
  - similar
- comparison to p/N+ at lower energies
  - comparable
  - clear A dependence in p+A collisions
- More details: see Lijuan's talk today

d+Au: single-electron spectra

- complicated electron ID from TPC dE/dx
  - cross-over regions
- use TOF PID cut to separate e-band
  - |1-1/ß| <0.03

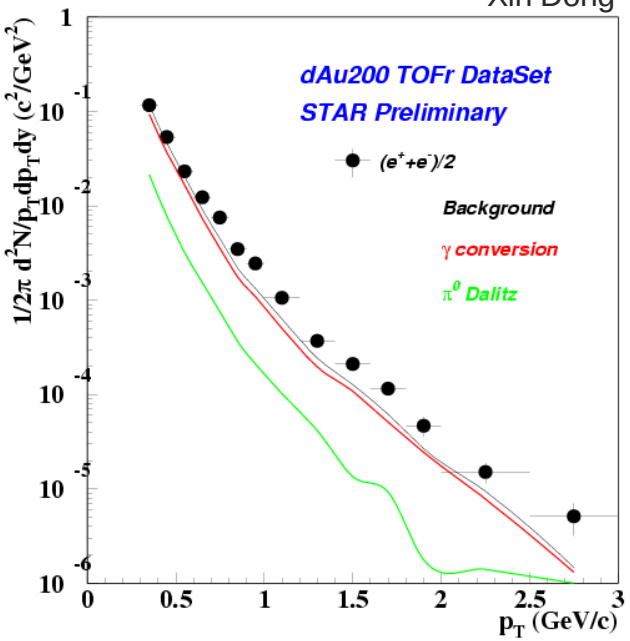


Xin Dong

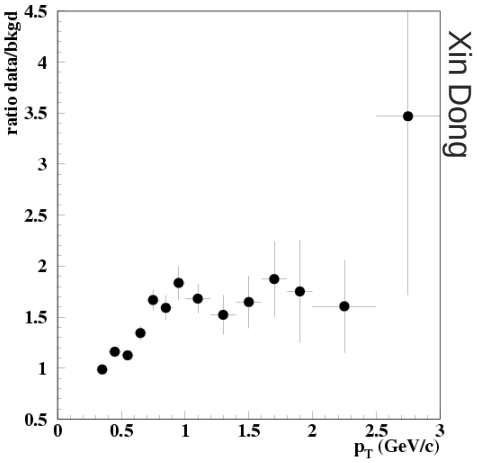


d+Au: open charm production

Xin Dong



- single electrons pT>1GeV/c from heavy-quark production
- large background
  - ? conversion
  - p°, ? Dalitz decays
  - K decays
  - ?, ?, f
- MC study on ?-conv. and p° Dalitz-decay BG
- increasing excess in data/BG ratio at high pT

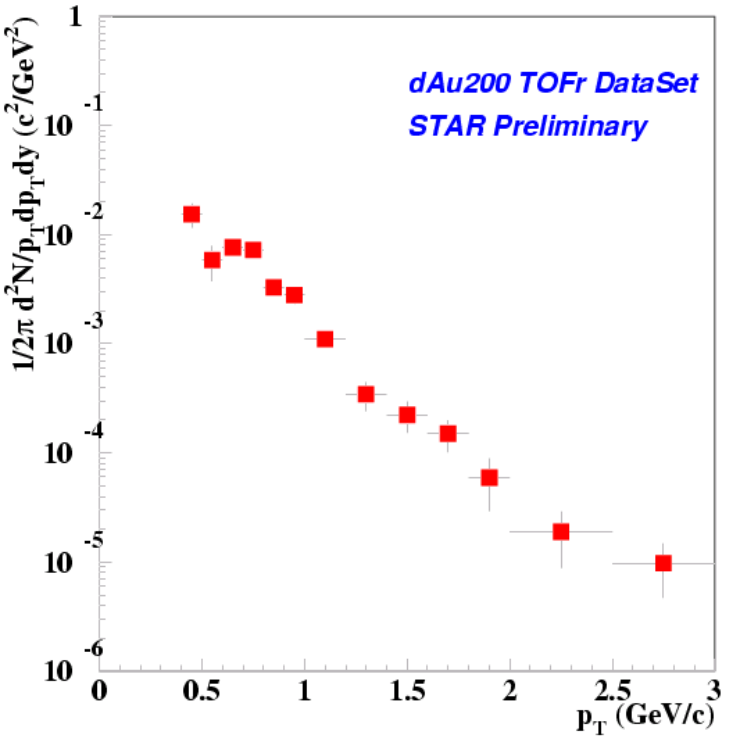


- remaining BG from ? (Dalitz) and ?, ? , f decays
- contribution from charmed decay

d+Au: open charm (cont'd)

- very preliminary acceptance and efficiency correction
- background-subtracted $(e^+ + e^-)/2$ spectrum
- more details: see Xin's talk on Saturday

Xin Dong



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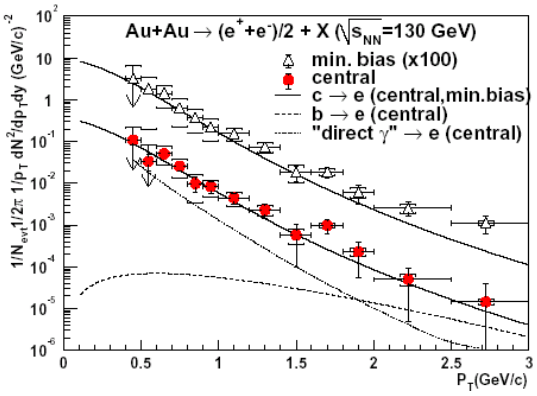
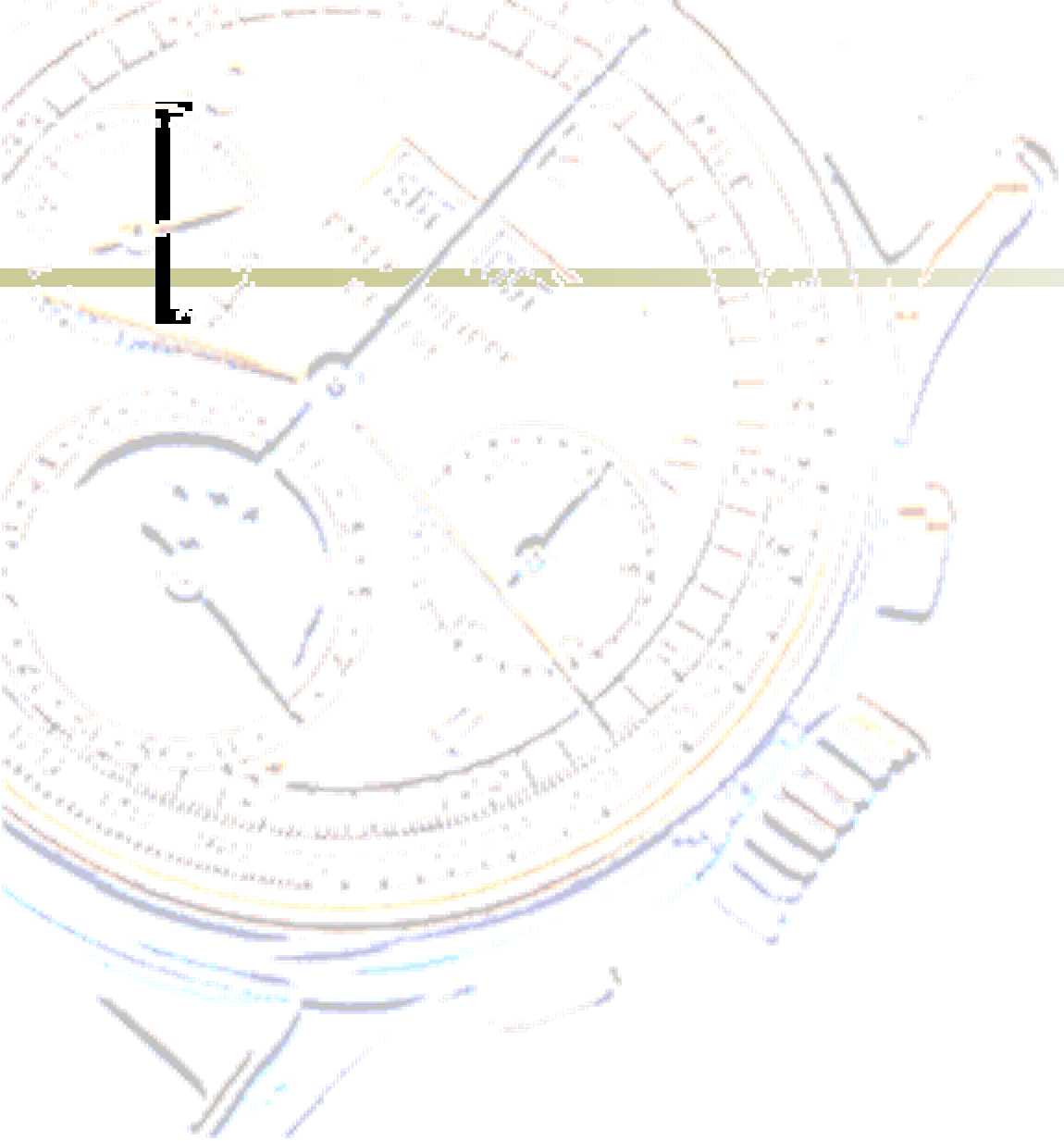


Summary & Outlook

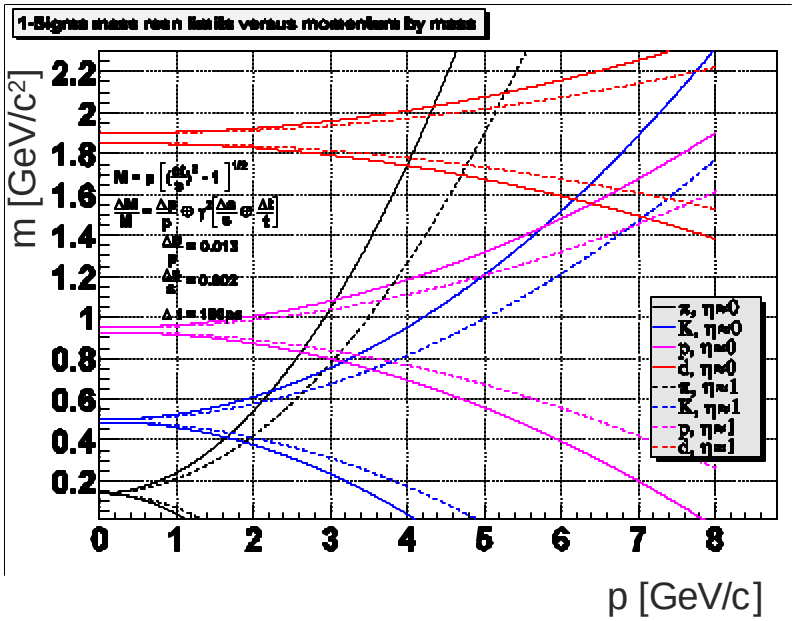
- Au+Au analysis:
  - calibration done
  - ready for spectra, however...
  - RFF/FF problem identified
- d+Au analysis:
  - TOFr worked and is producing physics!!!
  - pVPD and TOFr calibrated for dAuTOF trigger
  - exciting new results and analyses:
    - (p+pbar)/Nch up to 3GeV/c (Lijuan)
    - single-e spectra (Xin)
- Au+Au
  - embedding
- d+Au
  - final calibration of pVPD and TOFp,r for dAuMinbias and dAuCombined trigger
  - TOFx embedding
- p+p
  - calibration of pVPD and TOFp,r
  - R_dAu !!
- papers ...

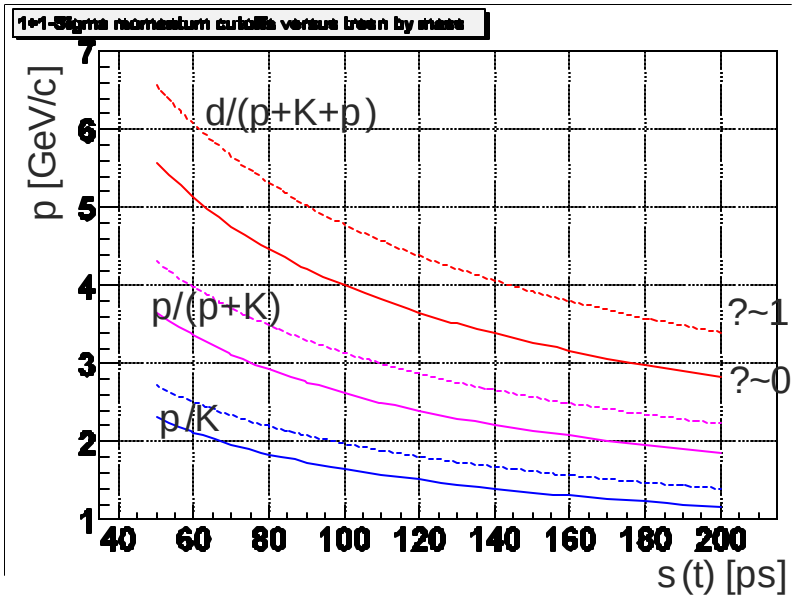
TOF talks @ Analysis Meeting

- Lijuan Ruan
  - *PID spectra from TOFr in d+Au*
  - today 17h20
- Xin Dong:
  - *Single Electron Spectra from TOFr capability, background study and open charm*
  - Sat. 9h00, Spectra PWG
- Bill Llope :
  - *TOF analysis/calibration*
  - Sat. 14h10, Spectra PWG



(1+1)s separation and s(t)





Cronin effect

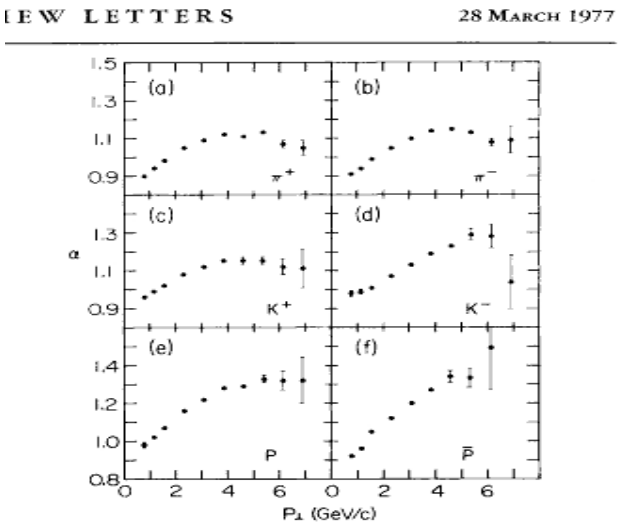


FIG. 2. The power α of the A dependence of the invariant cross section vs $p_\perp$ for the production of hadrons by 400-GeV protons; (a) π^+, (b) π^-, (c) K^+, (d) K^-, (e) p, and (f) $\bar{p}$. Unless indicated otherwise, the errors are smaller than or equal to the size of the points.

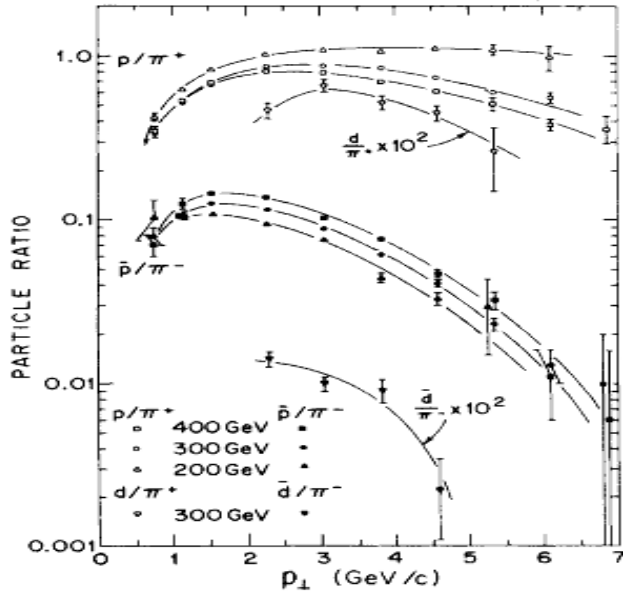


FIG. 13. Cross-section ratios p/π^+, $\bar{p}/\pi^-$, d/π^+, and $\bar{d}/\pi^-$ versus $p_\perp$ for W target.

- $s(pA) = A^a\, s(pp)$
- large effect for p compared to p and K

- p/p ratio in p+W changes for different energies
- different energy dependence of a_p and $a_{\bar{p}}$

$(e^-+e^+)/2$: PHENIX vs. STAR

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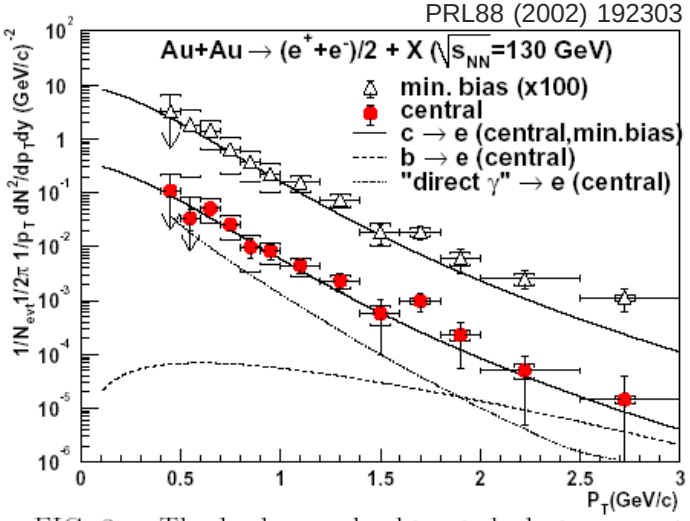

FIG. 3. The background-subtracted electron spectra for minimum bias (0-92%) and central (0-10%) collisions compared with the expected contributions from open charm decays. Also shown, for central collisions only, are the expected contribution from bottom decays (dashed) and the conversion electron spectrum from a direct photon prediction (dotted).