Light Nucleus Production in p+p & d+Au

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Rice University
☆ Analysis Meeting, UCLA
June 17, 2010

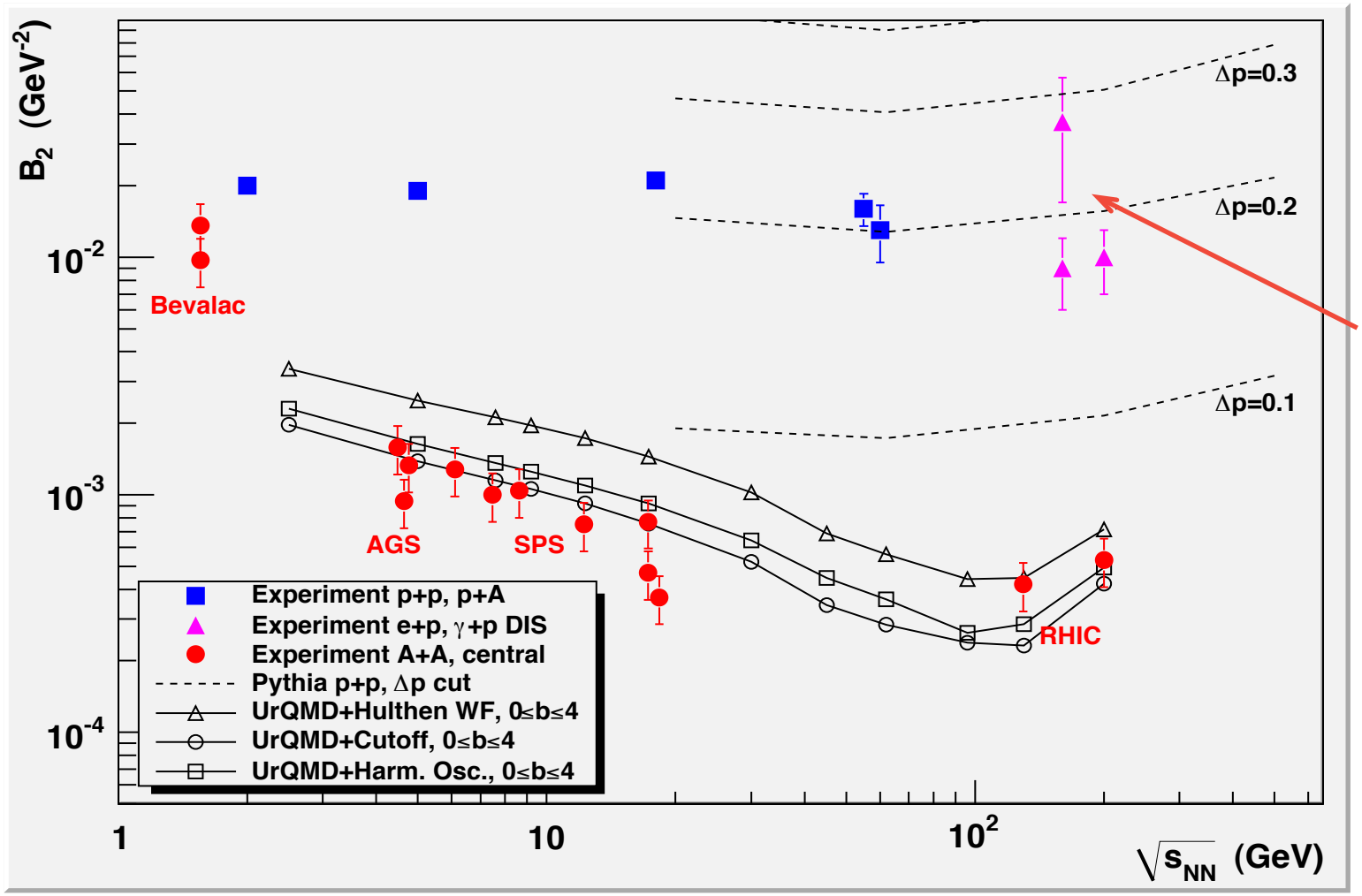
Outline:

- Results so far...
- Embedding Request...
- Run-9 200 & 500 w/ TOF
  - PID
  - Bunch ID
  - Cuts
  - Cross-sections

Existing Results on B_2

$B_A = \sigma_A / [\sigma_N]^A$ where the cross-sections are evaluated at same momentum

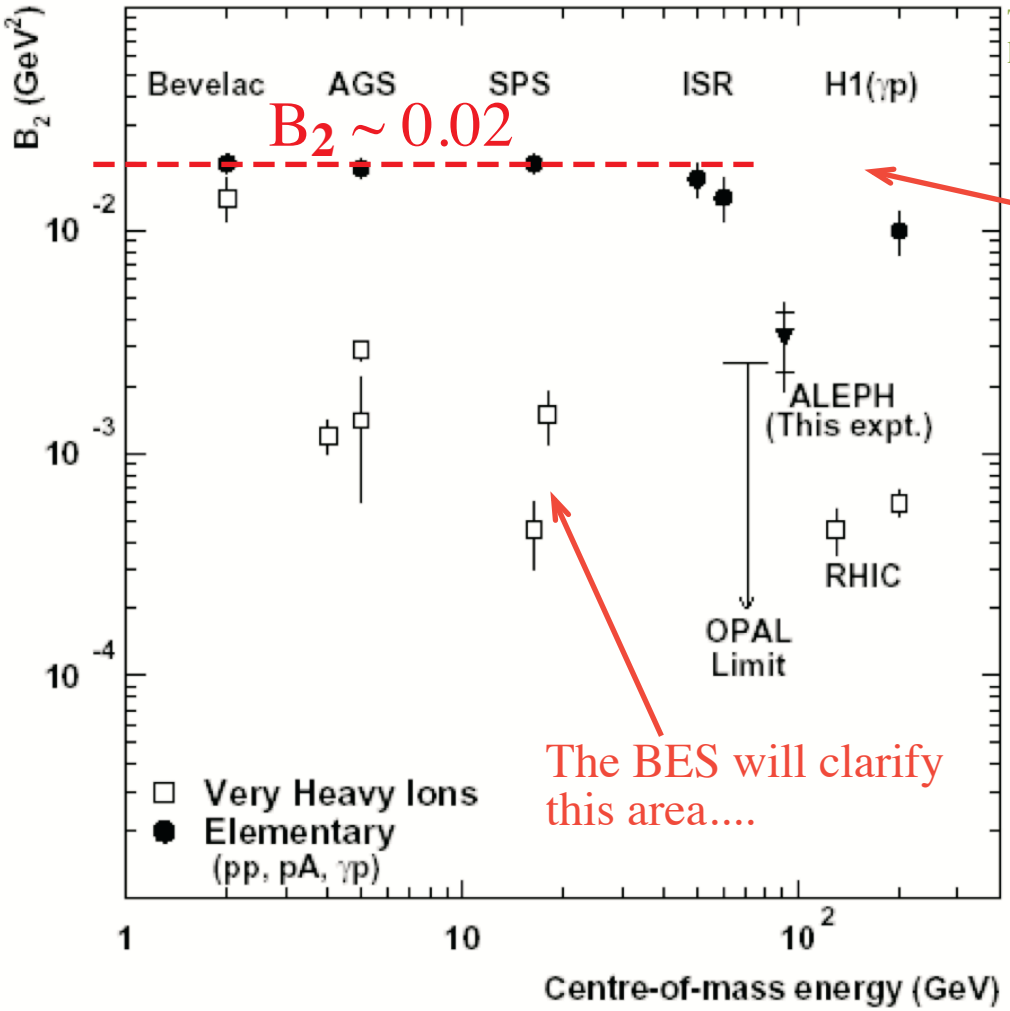
$B_A = d/p^2$ where cross-sections are formed at same P_T/A & y=0, Δy=1.0



where's the RHIC results?!?

deuterons relative to protons is largest in "elementary collisions"...

- factor of ~40 larger than in A+A according to the trend (blue squares)
- essentially independent of beam energy ... also unlike A+A



T. Sloan, GDR Meeting Paris April 2006
http://www.lpta.univ-montp2.fr/GDR/documents/reunion2_2006/sloan.ppt

where does the RHIC data fall?

...we have p+p @ 62, 200, & 500 GeV
& d+Au @ 200 GeV

The BES will clarify this area....

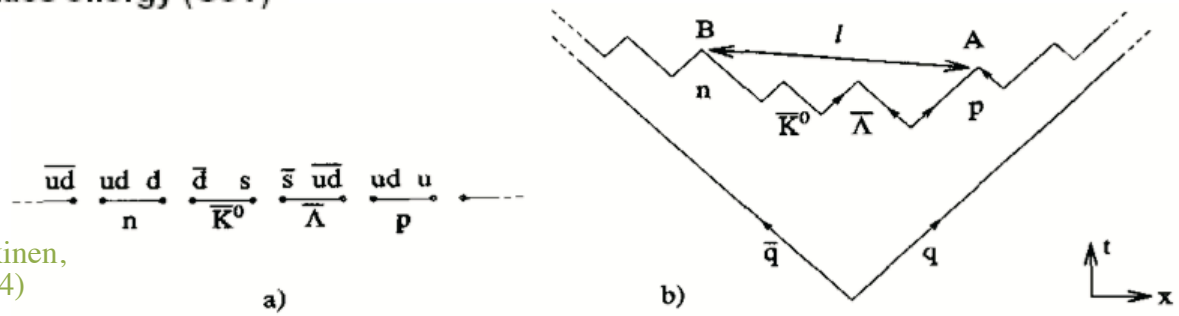
Conventional Wisdom:

p+p: several strings stretched between 2 hadrons
...B2 ~ 0.02

γ+p: fewer strings
...B2 ~ 0.01

e+e: only one string
...B2 ~ 0.003

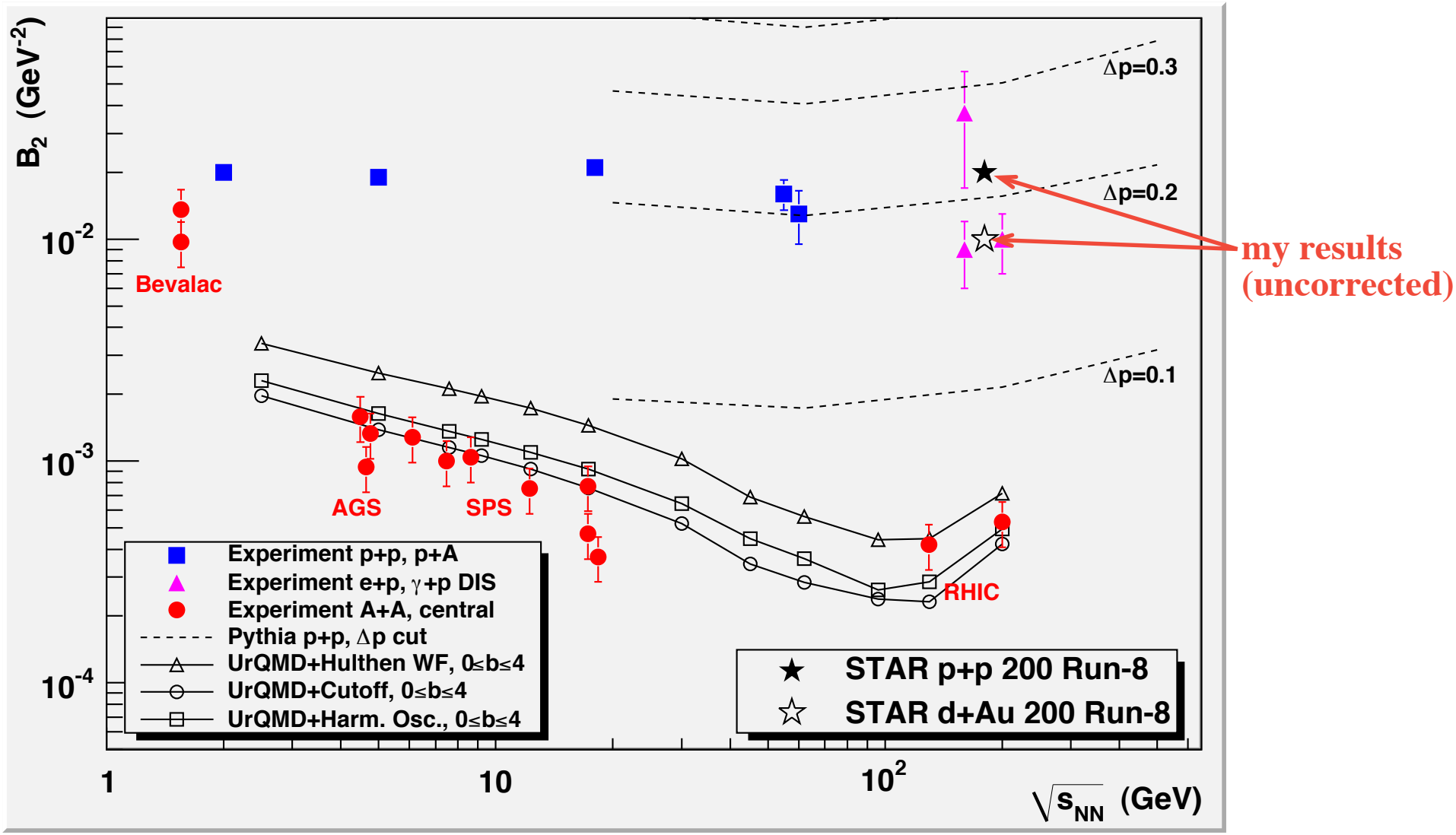
A+A: lots of strings, but strong rescattering kills all d's except those that form very late
...B2 ~ 0.0003



Gosta Gustafson, Jari Haikkinen,
Z. Phys. C 61,683-687 (1994)

Fig. 3a, b. a Possible string breakup process with a *pn* pair. **b** Space-time structure of the breakup

Comparisons to world's data.....



Summary* so far:	Experiment	Coalescence Picture:	Pythia+Δp
p+p, 200 GeV, Run-8:	$B_2 = 0.02$ GeV^2	R ~ 3.3 fm, p_o ~ 180 MeV	Δp ~ 210 MeV
d+Au, 200 GeV, Run-8:	$B_2 = 0.01$ GeV^2	R ~ 4.2 fm, p_o ~ 150 MeV	Δp ~ 180 MeV

(*) No tracking & PID efficiency, absorption, or feeddown corrections yet!

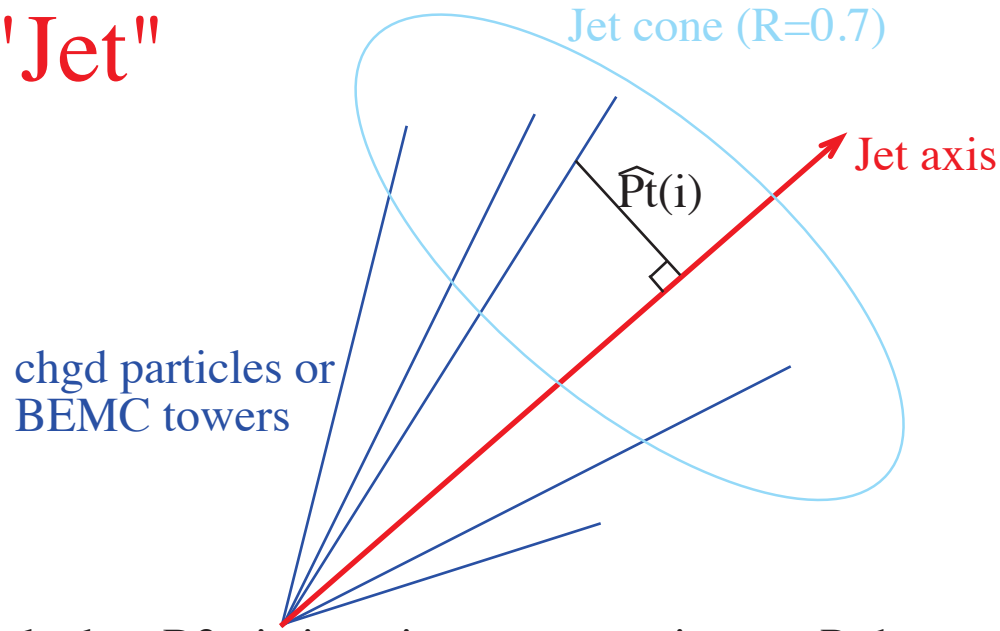
Light nucleus production & Jets in p+p and d+Au....

Plot proton & deuteron cross-sections and B_A values separately for

- events in which no jet(s) reconstructed... "UE"
- tracks not associated with a Jet...
- tracks associated with a Jet... "Jet"

Does B_A depend on UE vs Jets?

Different nucleus production mechanisms?
Are R & p_o different?



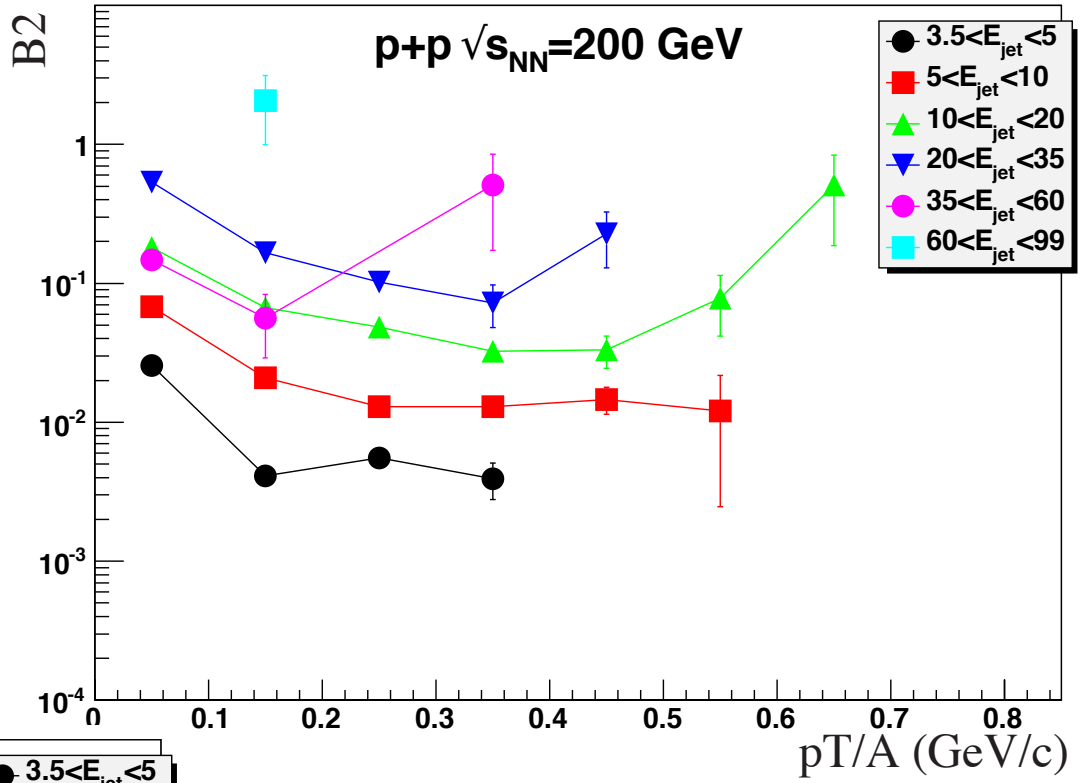
Must calculate B2 via invariant cross-sections vs Pt-hat...
the same analysis strategy is typically used when doing HBT in jets...

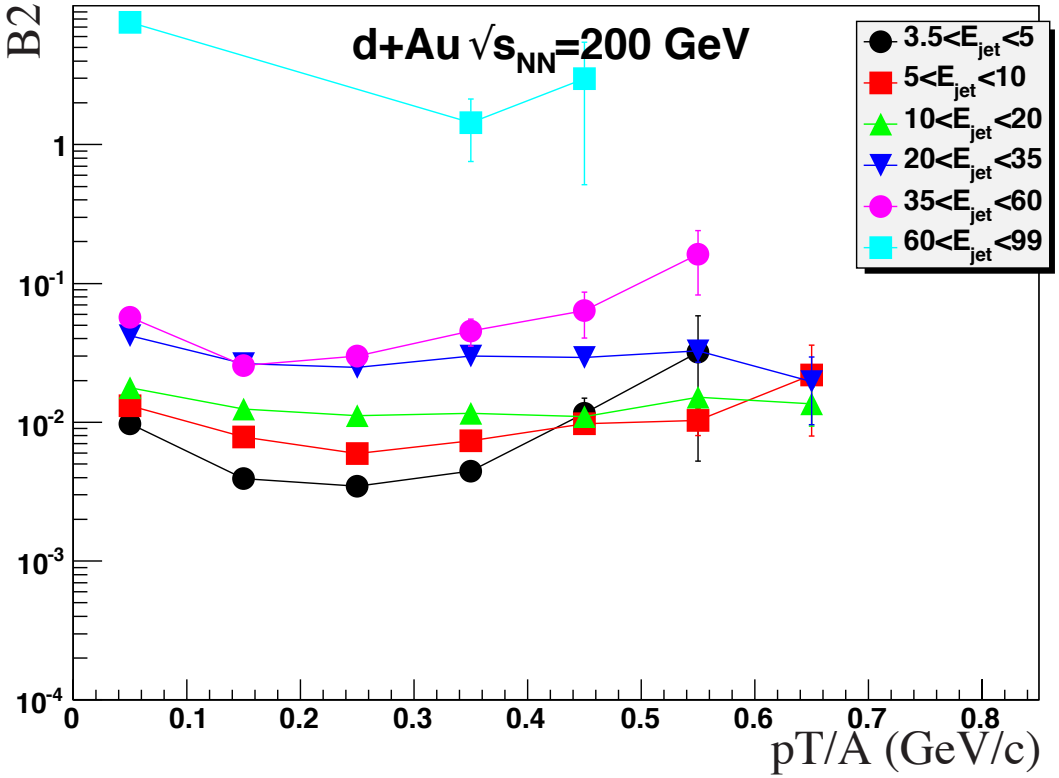
can also use $1/(Pt.N_{ev}.d\phi)dN/dPt/d\phi$ and set ϕ via jet axis

Need to respin the data: Jet Makers not set up exactly as this analysis requires...

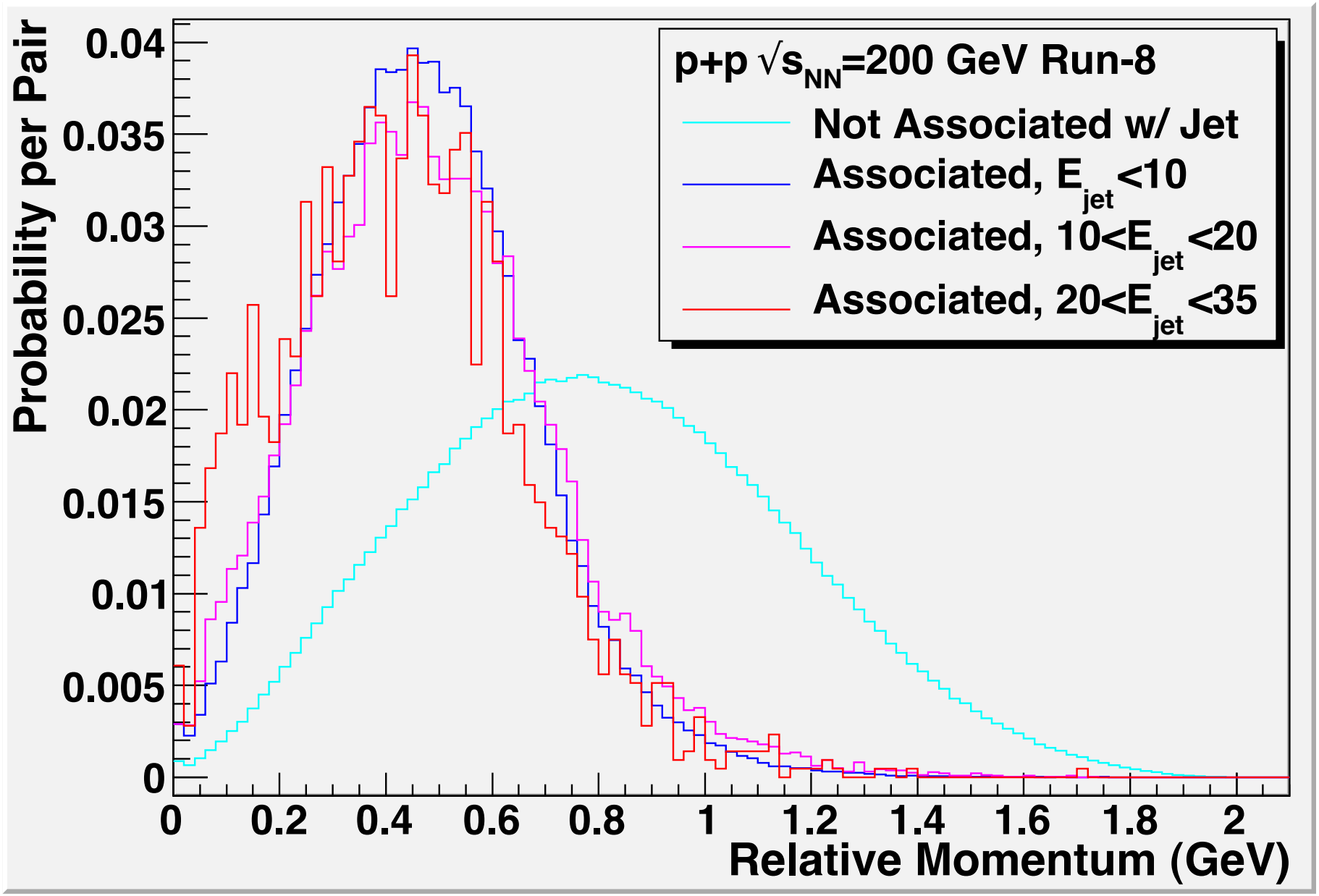
1. StVpdCalibMaker (locate vertex that VPD/TOF sees)
2. JetMakers with Modified StBET4pMaker (use consistent vertex!)
   see http://www.star.bnl.gov/HyperNews-star/protected/get/jetfinding/1003.html and replies
3. Call StBTofCalibMaker and MyAnalysisMaker to analyze Jets and Tracks

Large increase in BA with increasing Jet Energy for (anti)nucleons & nuclei in Jets remains!





Pair Normalized 2 “proton” relative momentum distributions, gated on Jet Energy



Higher-energy Jets → proton pairs more “focussed” (decreasing <Δp>)
→ Consistent with observed increasing B2 vs E_{jet}

Embedding Request

1. pbar, dbar, & tbar p+p 62 GeV, Run-6 P06ie
2. pbar, dbar, & tbar p+p 200 GeV, Run-8 P08ie
3. pbar, dbar, & tbar d+Au 200 GeV, Run-8 P08ie

1 particle per event...

Max pT: 1.5 GeV for pbar
3.0 GeV for dbar
4.5 GeV for tbar

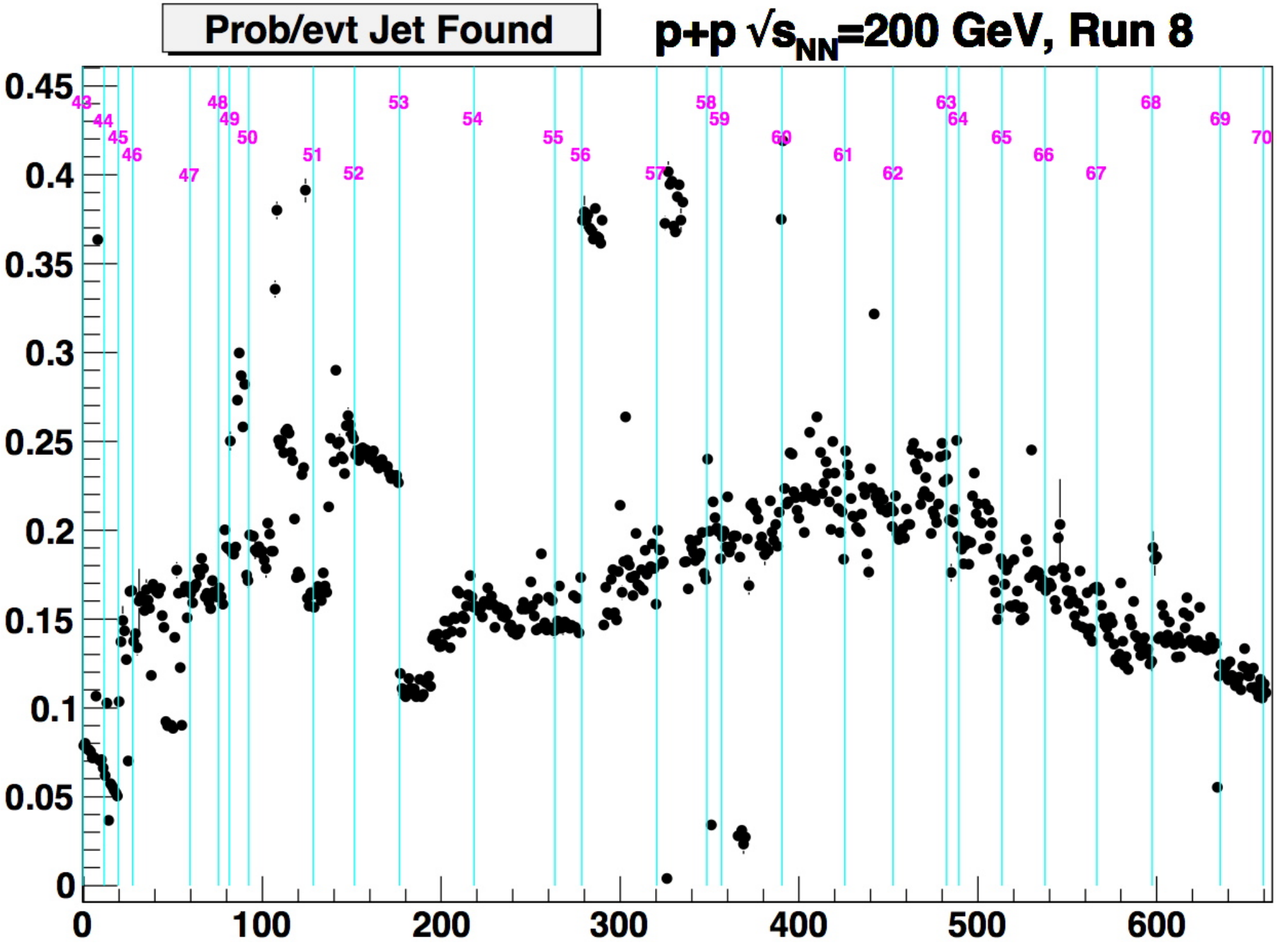
Eta range includes EEMC: $-1.5 < \eta < 2.0$

No special treatment of jets in terms of placing simulated particles in specific events....

Need to specify run numbers in specific periods of each run (see following pages)...

priority: EC	priority: pwg	req.id	req.type	pwg	created	last state change	title	status
0	High	20102101	Filt EvGen Sim.	Spin	Wed, 2010-05-26 15:28	Wed, 2010-05-26 17:09	Filtered Dijet Simulation	New
0	Normal	20101901	Standard Emb.	Heavy Flavor	Tue, 2010-05-11 05:11	Tue, 2010-05-11 05:11	Upsilon in p+p 2009	New
0	High	20101709	Standard Emb.	Light Flavor Spectra	Fri, 2010-04-30 15:12	Fri, 2010-04-30 15:12	tbar in run 6 p+p 62 GeV	New
0	High	20101708	Standard Emb.	Light Flavor Spectra	Fri, 2010-04-30 15:09	Fri, 2010-04-30 15:13	dbar in run 6 p+p 62 GeV.	New
0	High	20101707	Standard Emb.	Light Flavor Spectra	Fri, 2010-04-30 15:04	Fri, 2010-04-30 15:04	tbar in run 8 d+Au 200 GeV	New
0	High	20101706	Standard Emb.	Light Flavor Spectra	Fri, 2010-04-30 14:52	Fri, 2010-04-30 14:52	dbar in run 8 d+Au 200 GeV	New
0	High	20101705	Standard Emb.	Light Flavor Spectra	Fri, 2010-04-30 12:10	Fri, 2010-04-30 12:10	tbar in run 8 p+p 200 GeV	New
0	High	20101704	Standard Emb.	Light Flavor Spectra	Fri, 2010-04-30 12:00	Fri, 2010-04-30 12:00	dbar in run 8 p+p 200 GeV	New
0	High	20101703	Standard Emb.	Light Flavor Spectra	Fri, 2010-04-30 10:58	Fri, 2010-04-30 11:13	pbar in run-6 p+p 62GeV	New
0	High	20101702	Standard Emb.	Light Flavor Spectra	Fri, 2010-04-30 10:40	Fri, 2010-04-30 10:41	pbar in run 8 d+Au 200 GeV	New

Request submitted 4/30/2010..... Looks it's close to starting (?)


Prob/evt Jet Found
p+p √s_NN=200 GeV, Run 8
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
100
200
300
400
500
600
43
44
45
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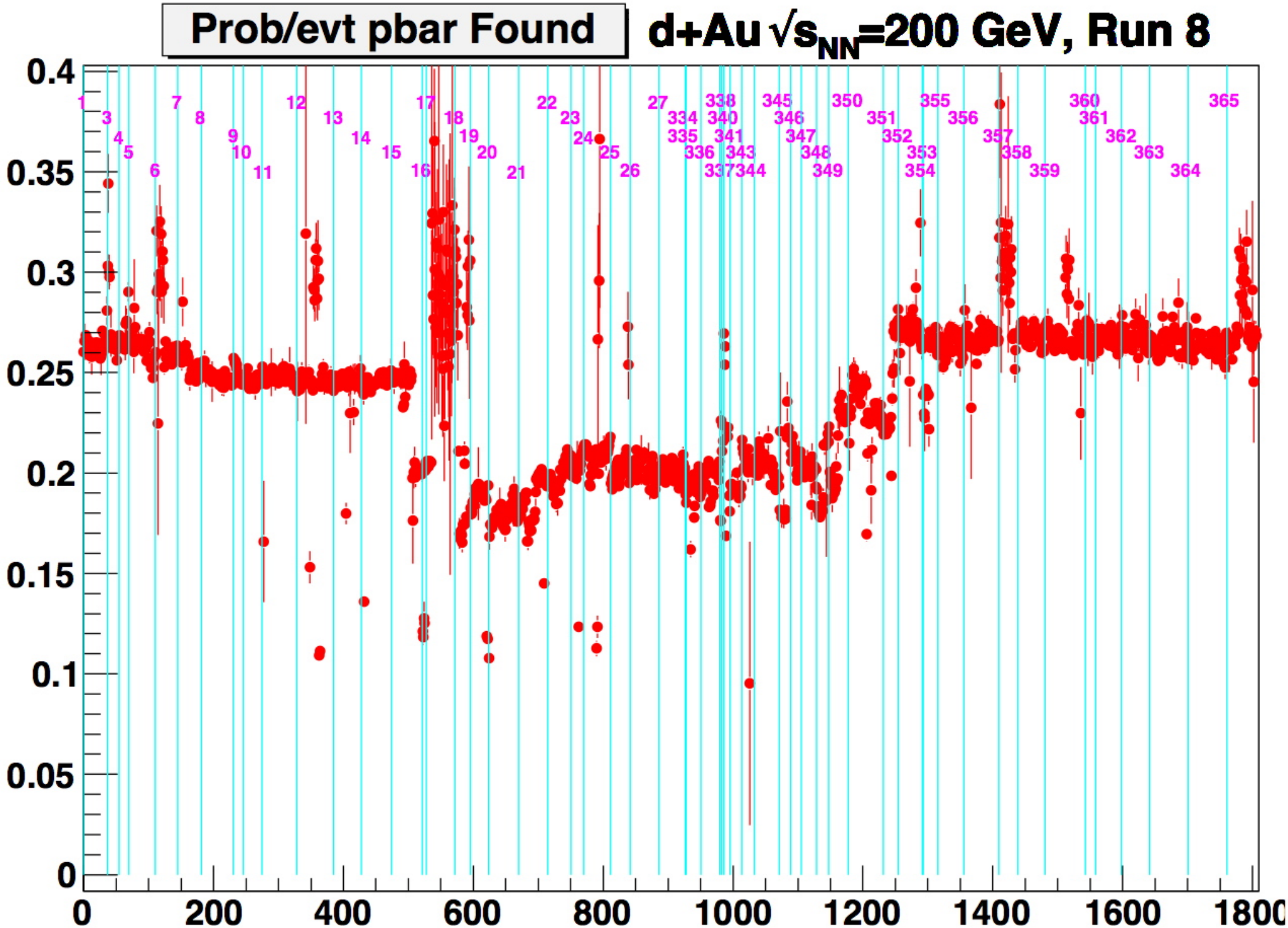
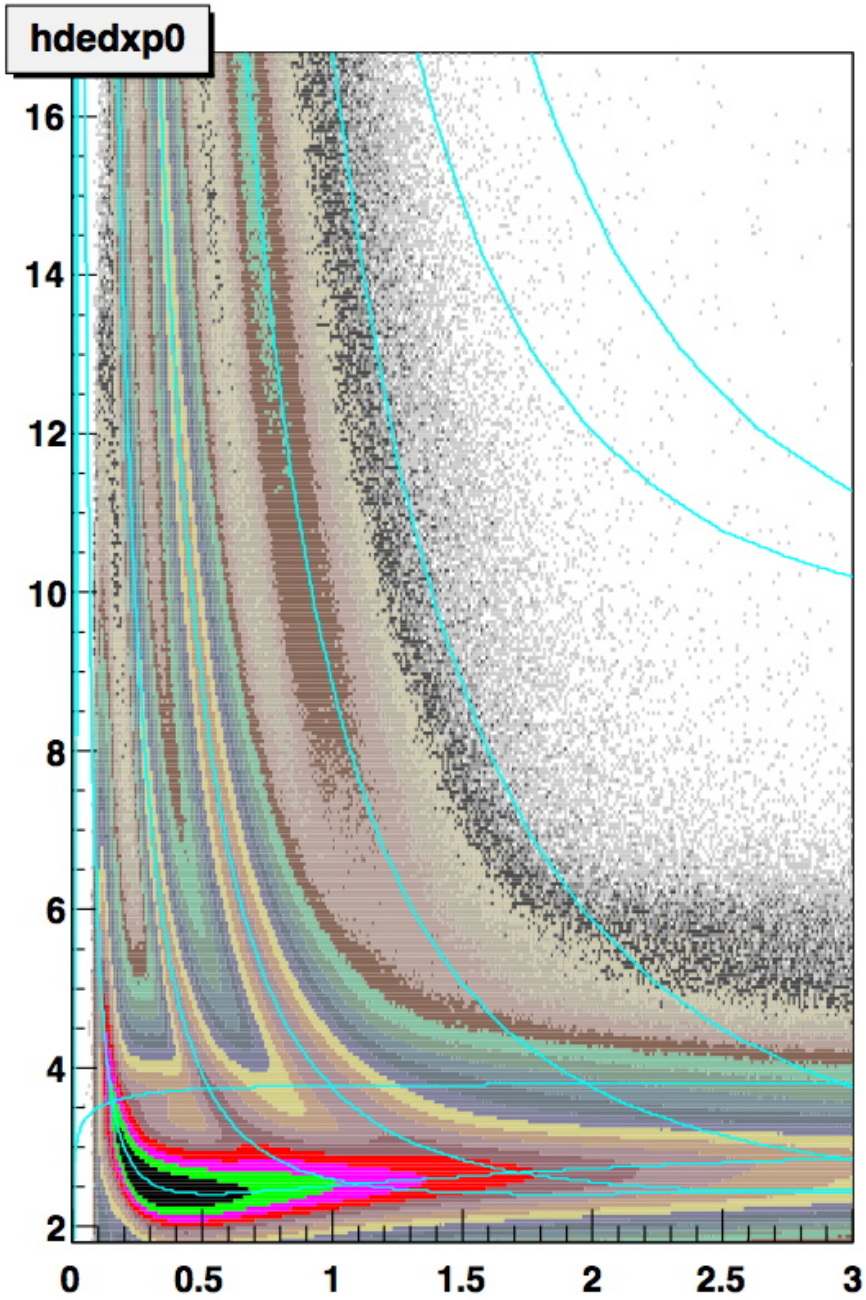
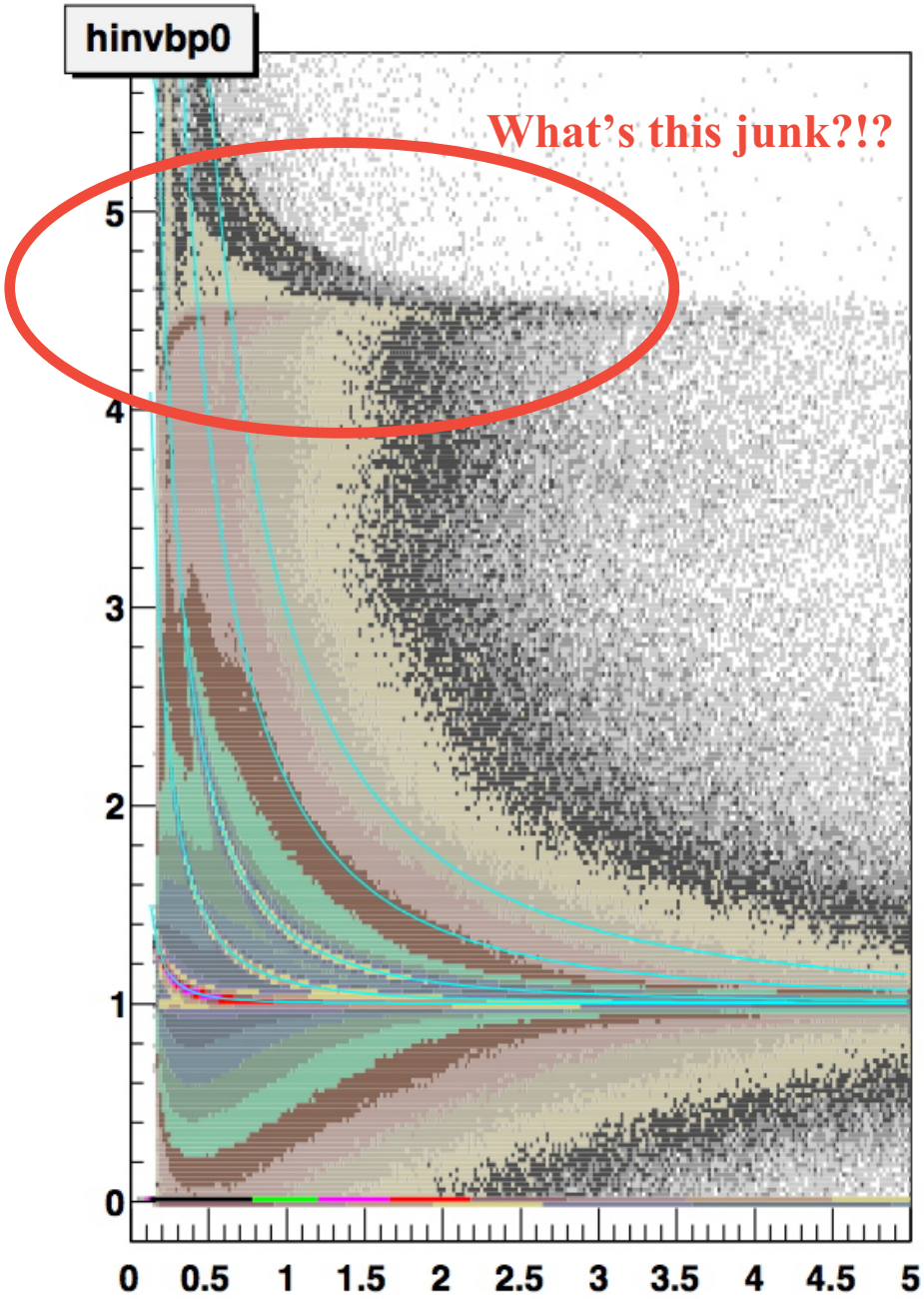

Prob/evt pbar Found
d+Au √s_NN=200 GeV, Run 8
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
200
400
600
800
1000
1200
1400
1600
1800
1 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 334 335 336 337 338 340 341 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365

Run-9 Data: p+p @ 200 & 500 GeV: big datasets, low-material, ~3/4 TOF!

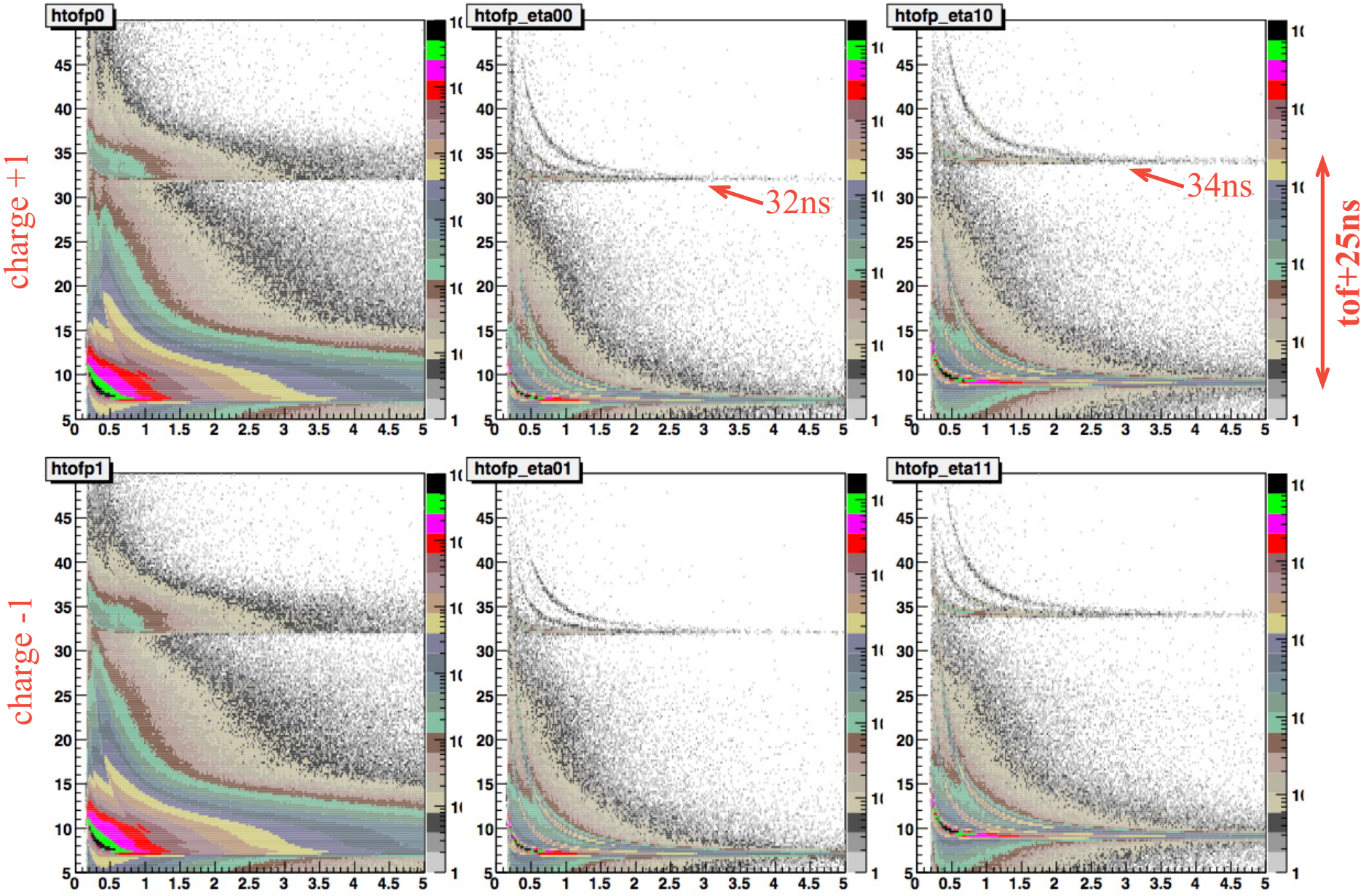


TPC dE/dx (keV/cm) vs p (GeV/c)



TOF 1/β vs p (GeV/c)

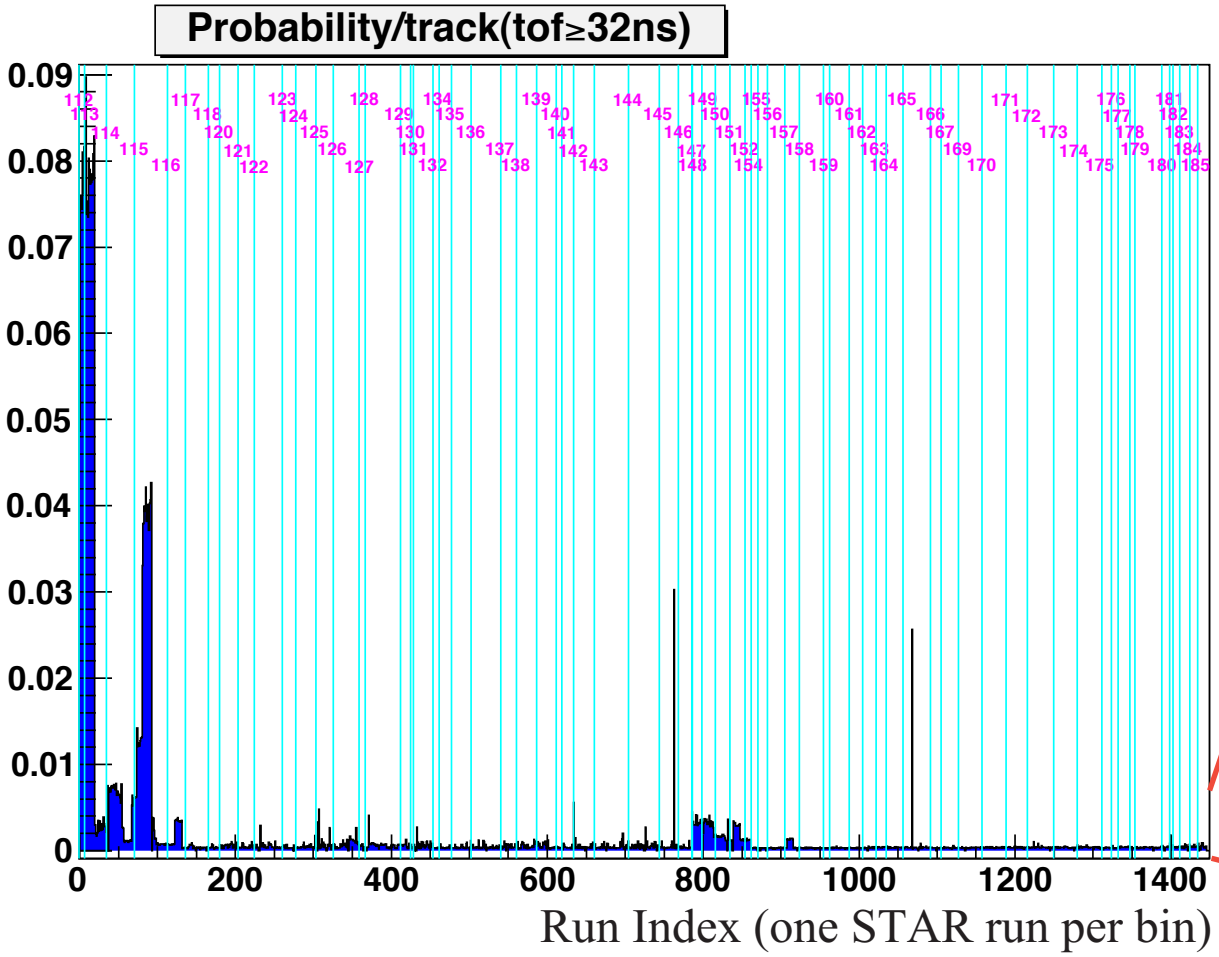
Plot TOF not 1/β....

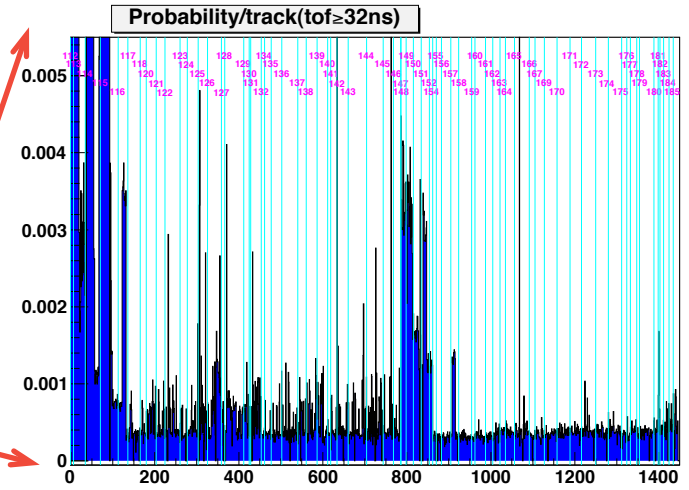


The ugly blob @ 1/β ~ 4.5 is coming from "Bunch ID shifts" (TOF electronics errors)

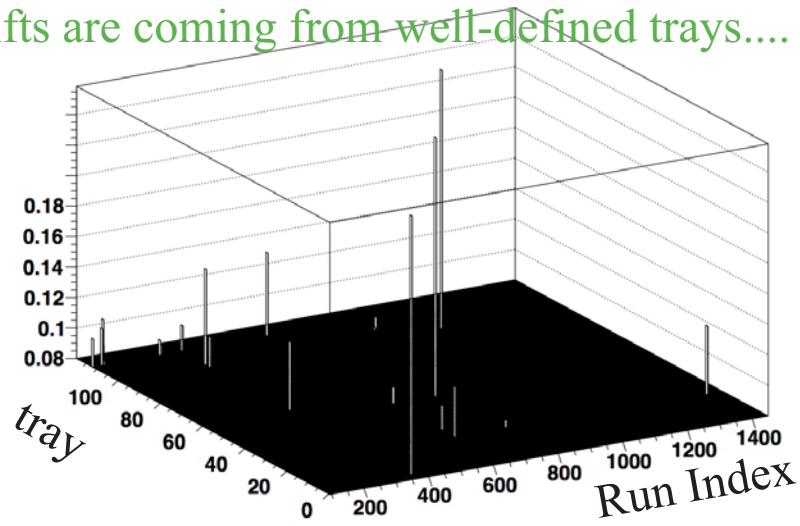
One can simply require tof<32ns (solid dE/dx PID exists for these momenta)

Better to remove the offending run numbers (see next pages)





Shifts are coming from well-defined trays....

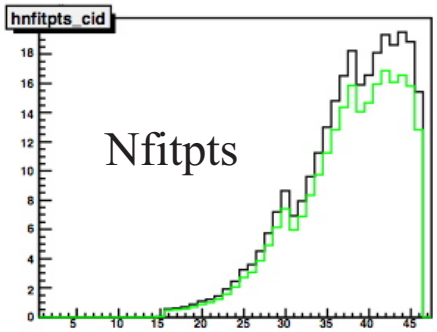


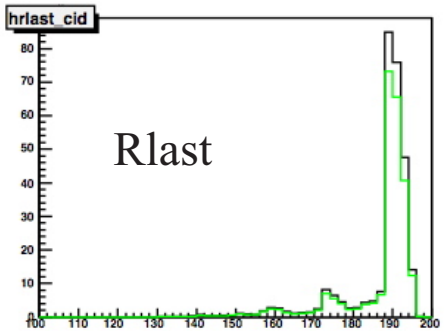
I've generated the BunchID shift Run & Tray list
for both 200 and 500 GeV

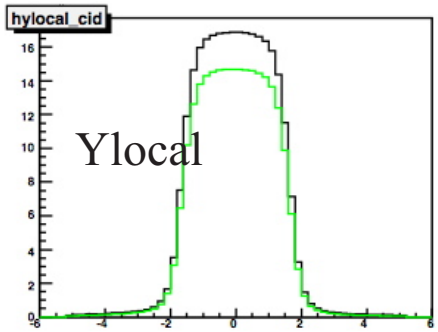
Ready to be input to the STAR dB
User chooses to skip the whole Run
...or just the shifted Tray(s)

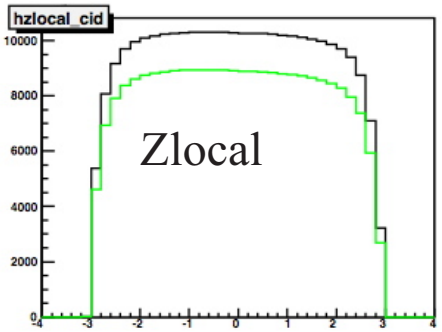
Optimizing the TOF and Track Cuts to get best TOF PID

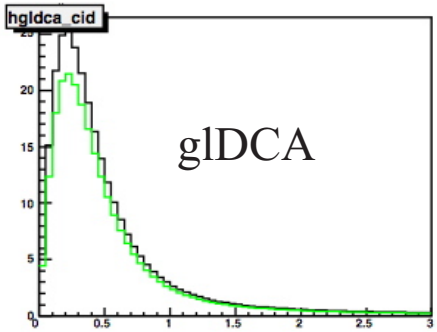
Black: all tracks with $1/\beta > 0$ Green: good π/K/p PID via simple M^2 cut

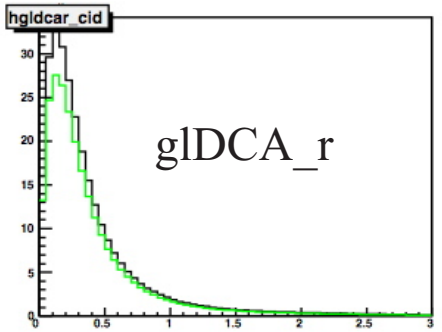


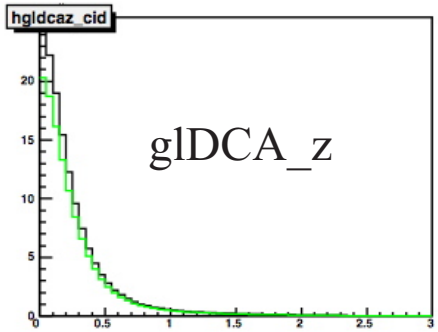


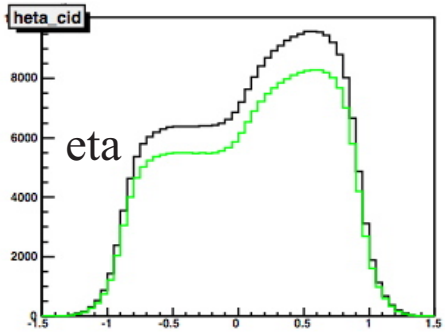


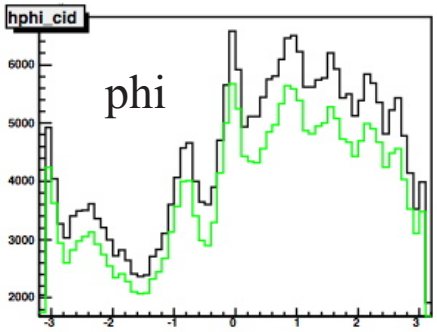


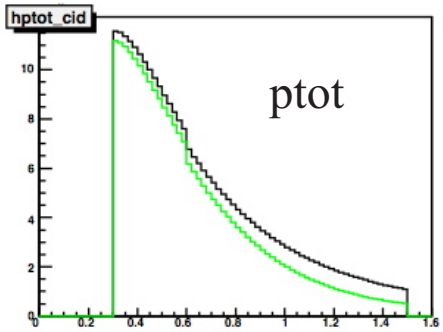


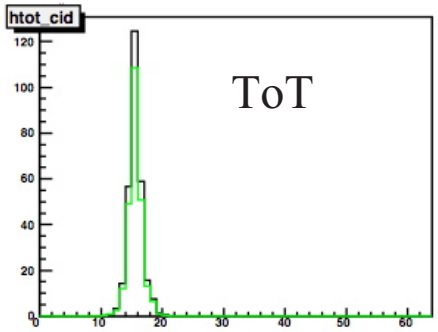


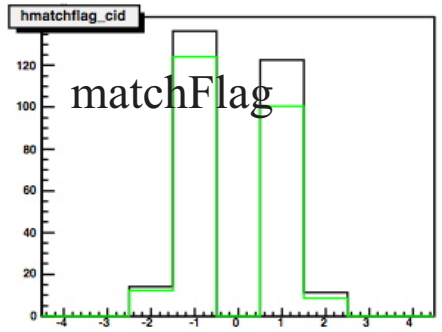


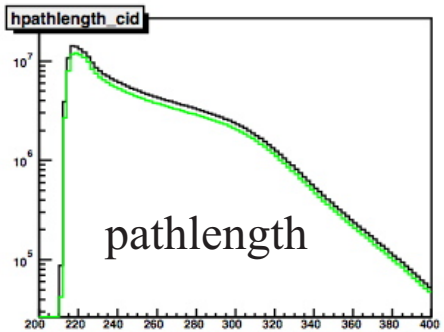


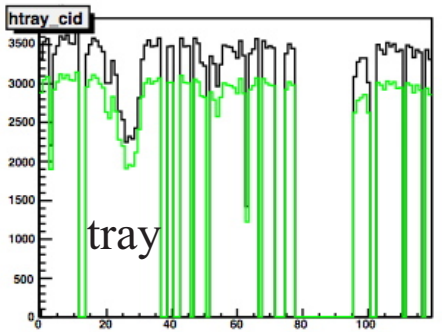


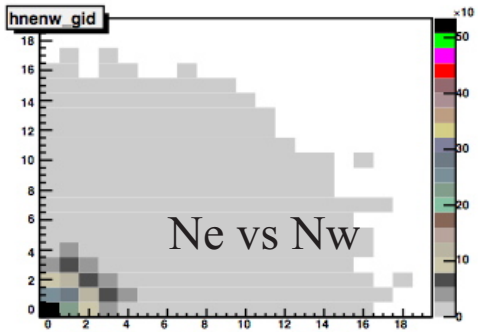




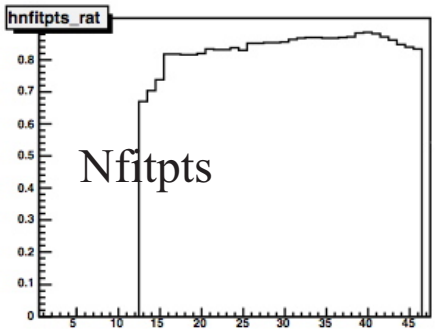


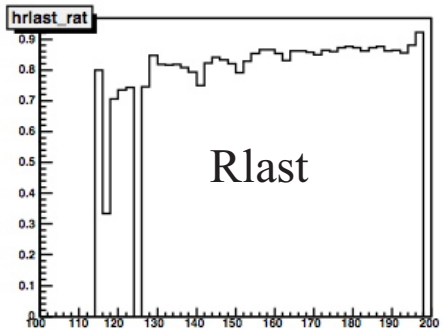


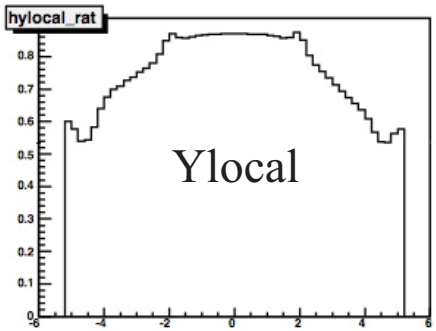


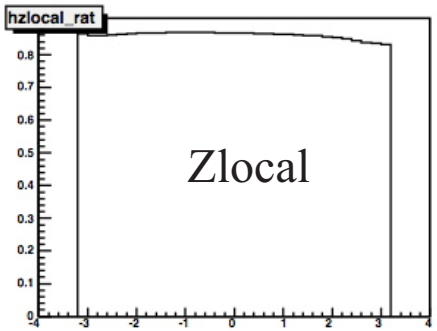


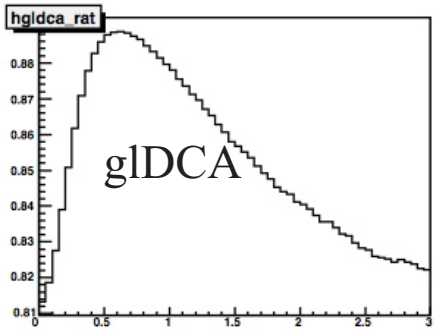
Ratios.... (”PID Efficiency per track”)

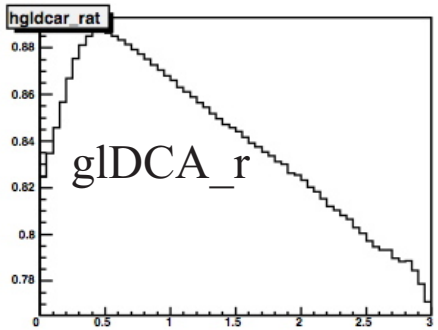


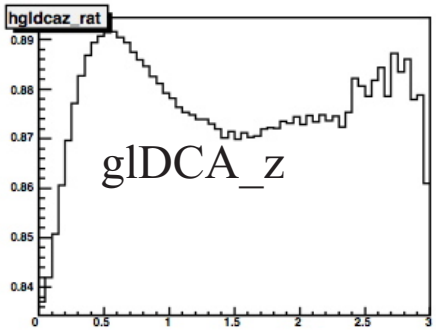


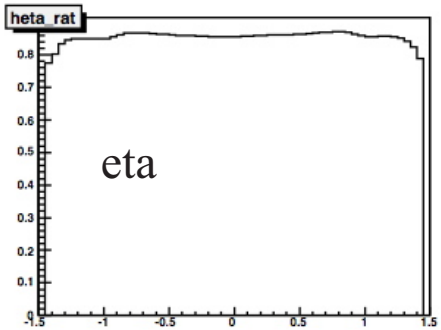


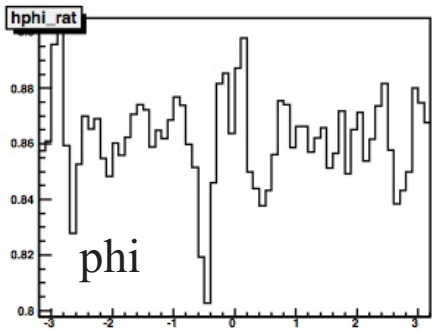


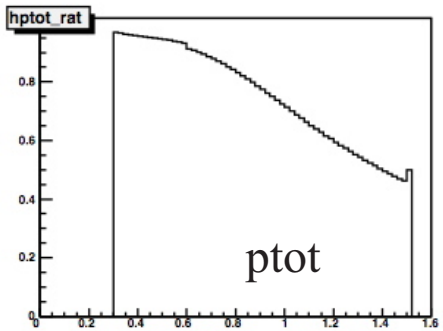


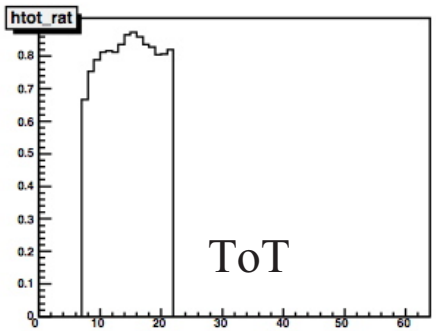


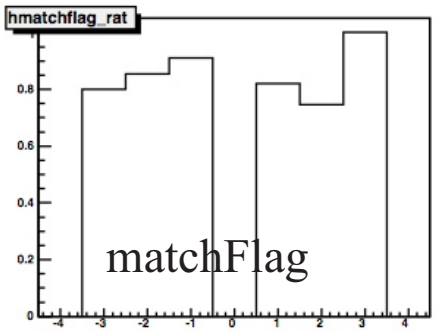


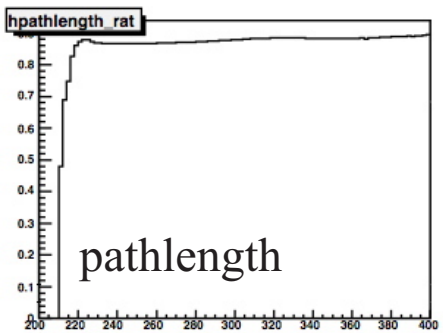


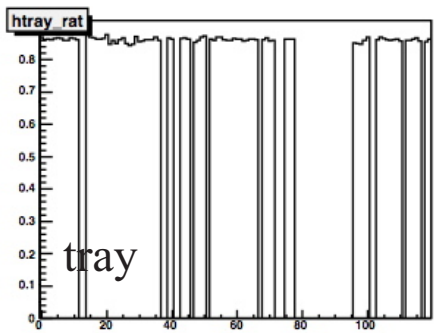


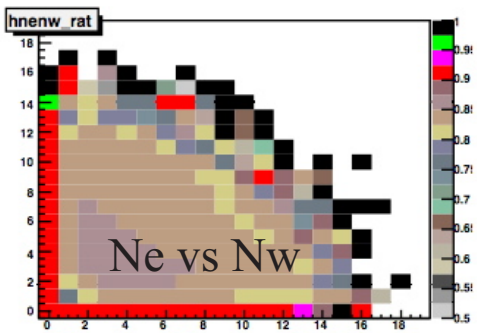




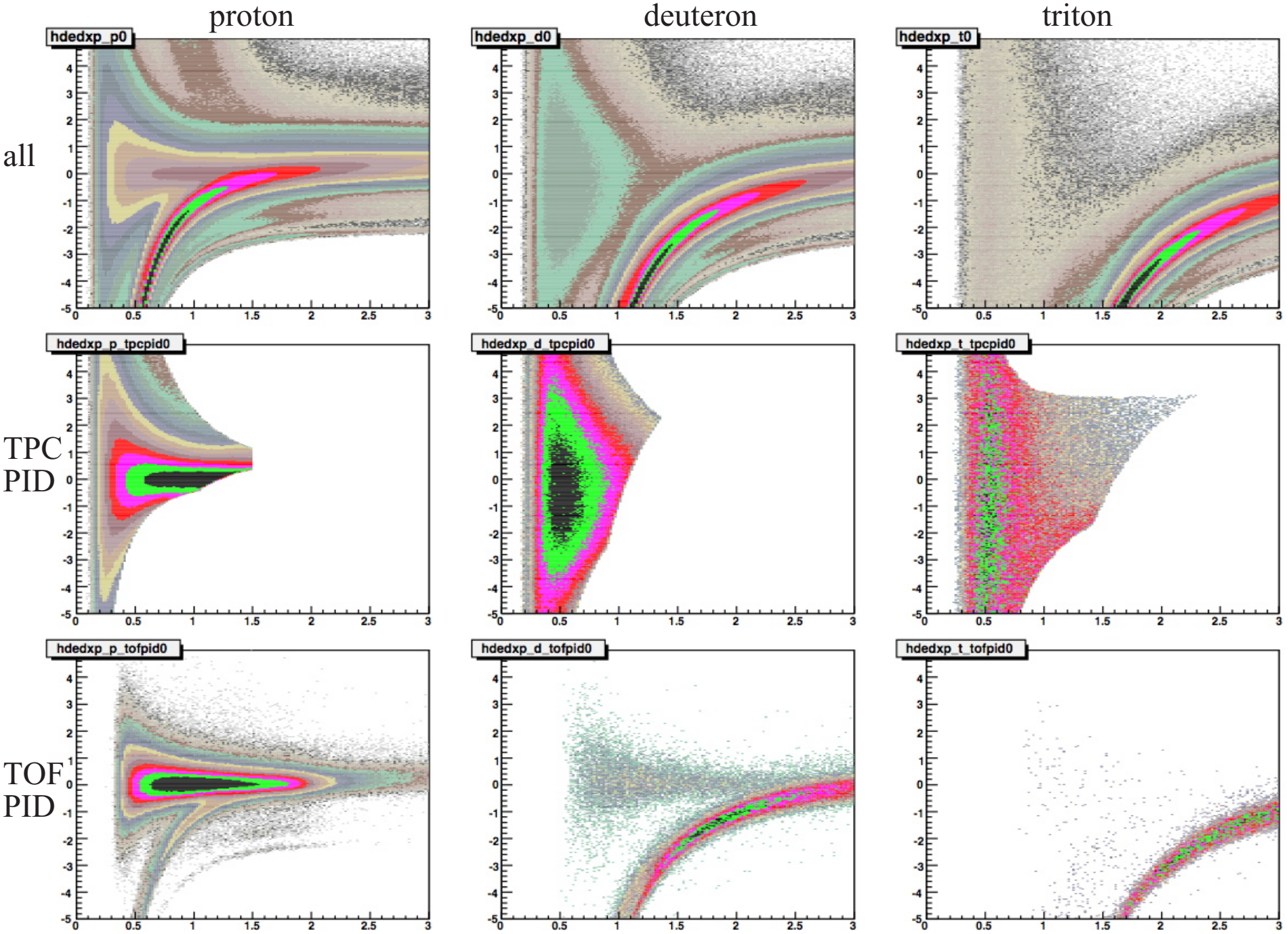




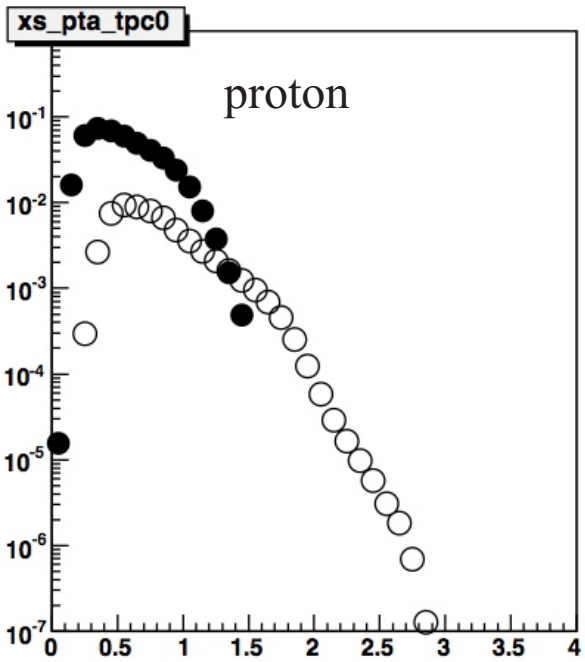


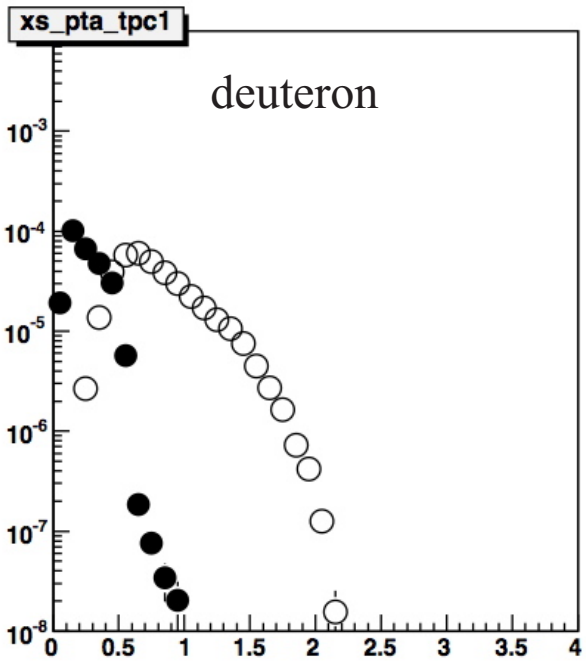


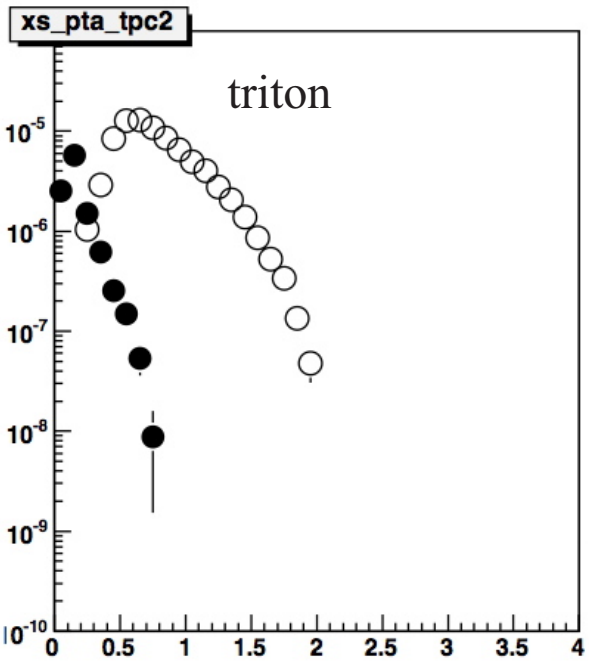
dE/dx-Bichsel vs. Momentum with various PID techniques.....

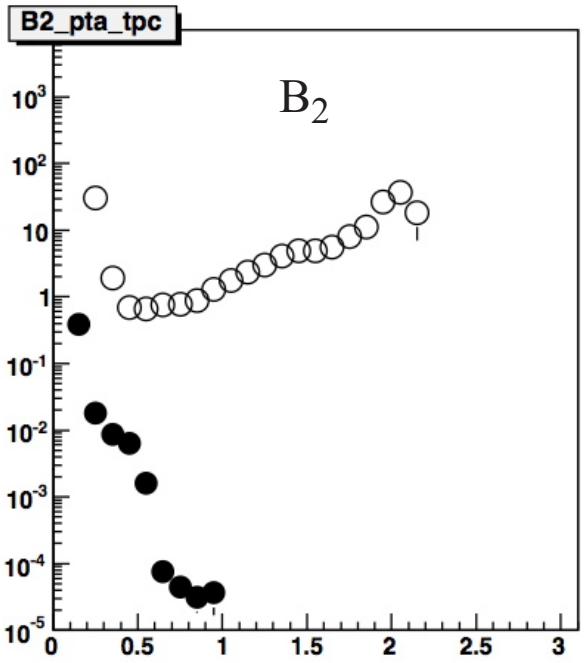


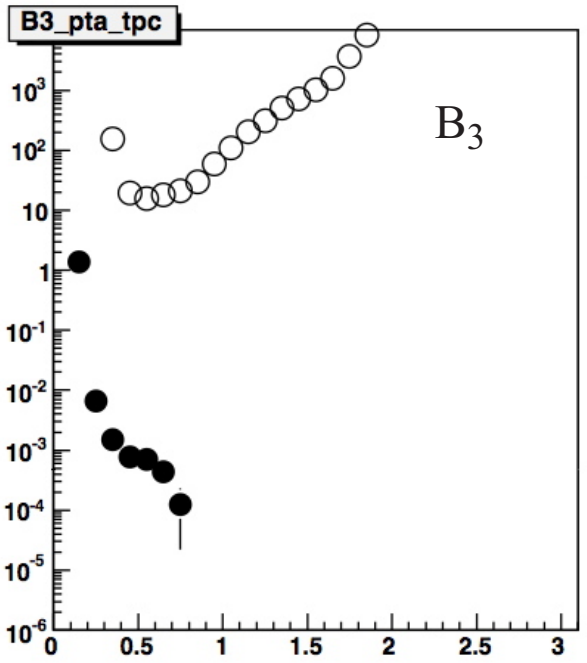
Cross-sections and B_A with TPC (solid) and TOF (open) PID.....











I still have some PID contamination issues....

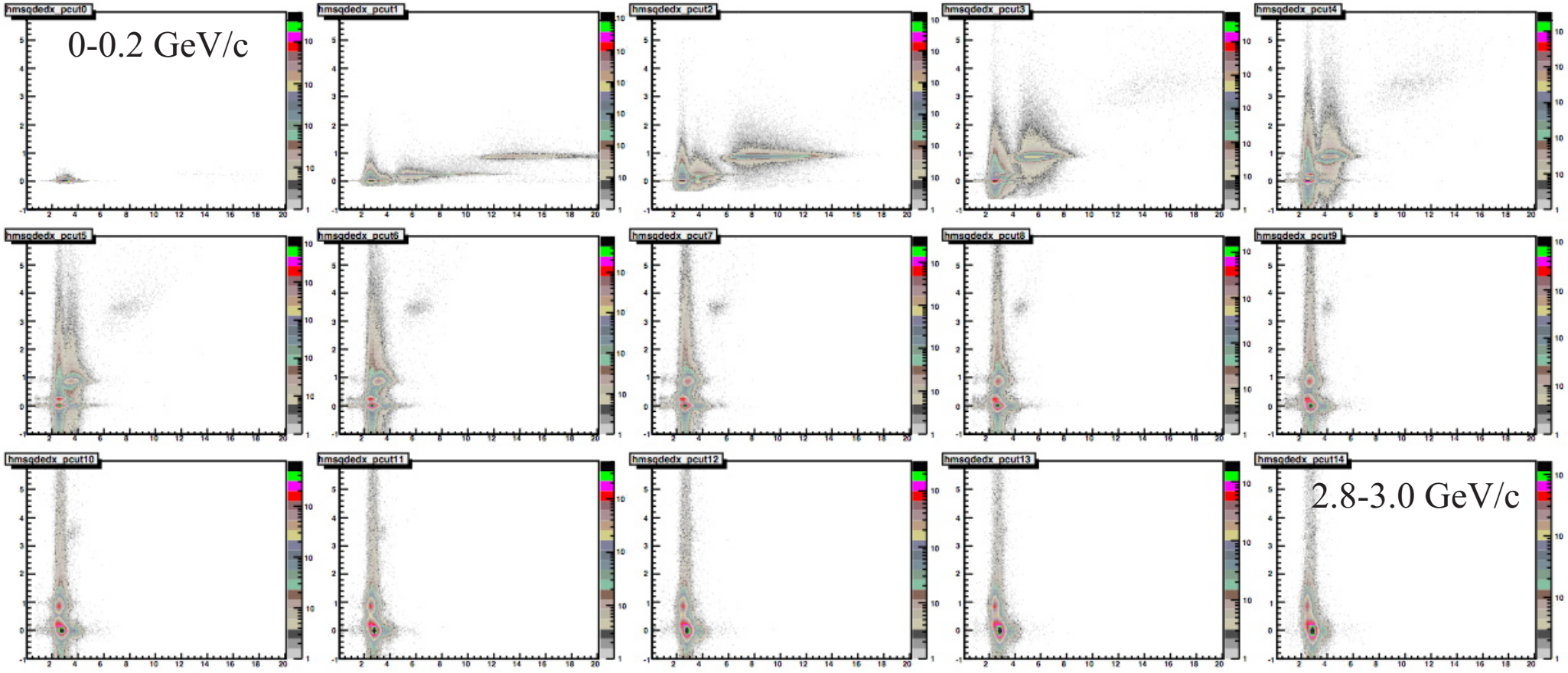
Need to
- optimize TOF cuts
- efficiency/trk from ratio

- "unified PID"

- Repeat Jet correlations

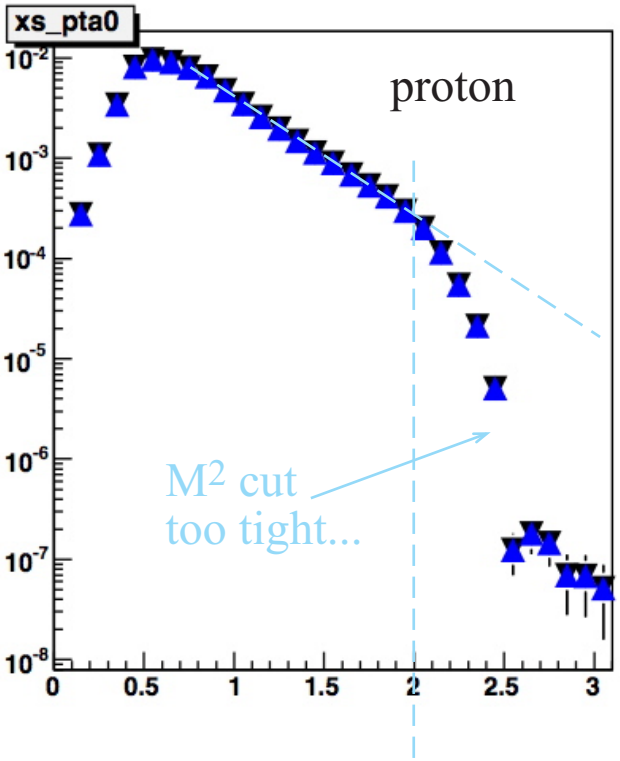
Playing with a different style of PID.....

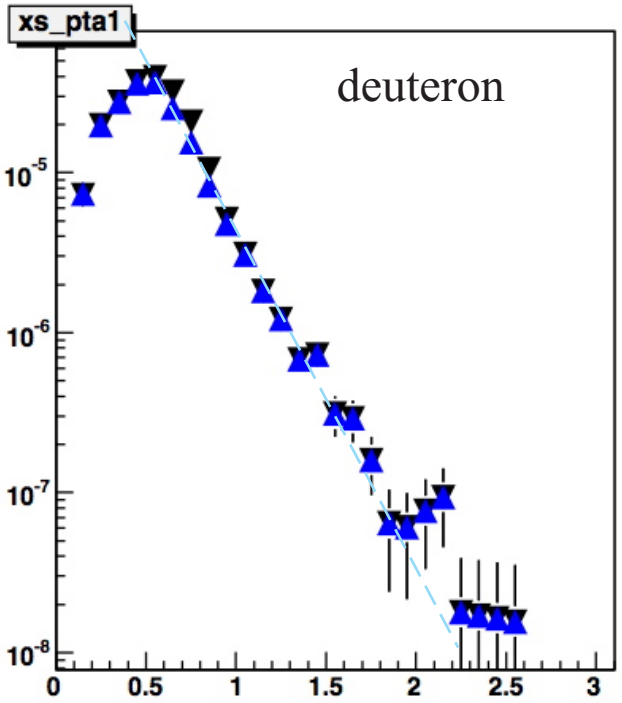
TOF M^2 vs dE/dx in separate momentum bins... (200 MeV/c wide)

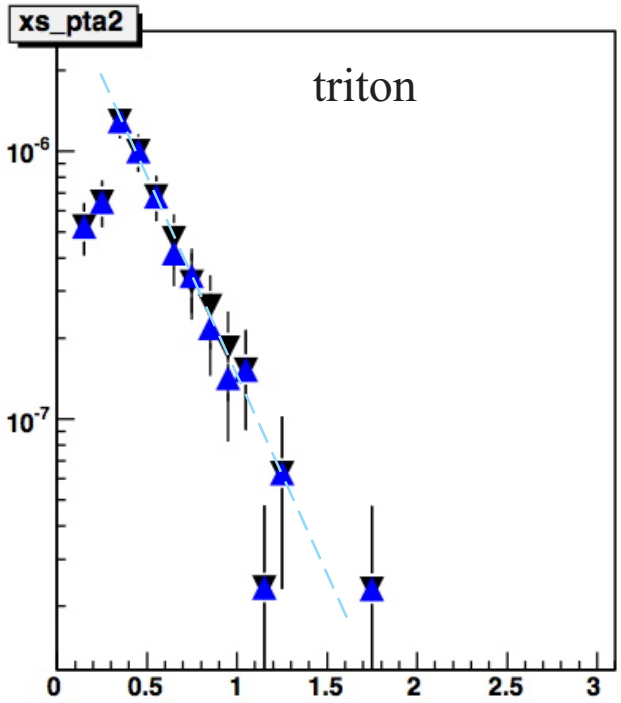


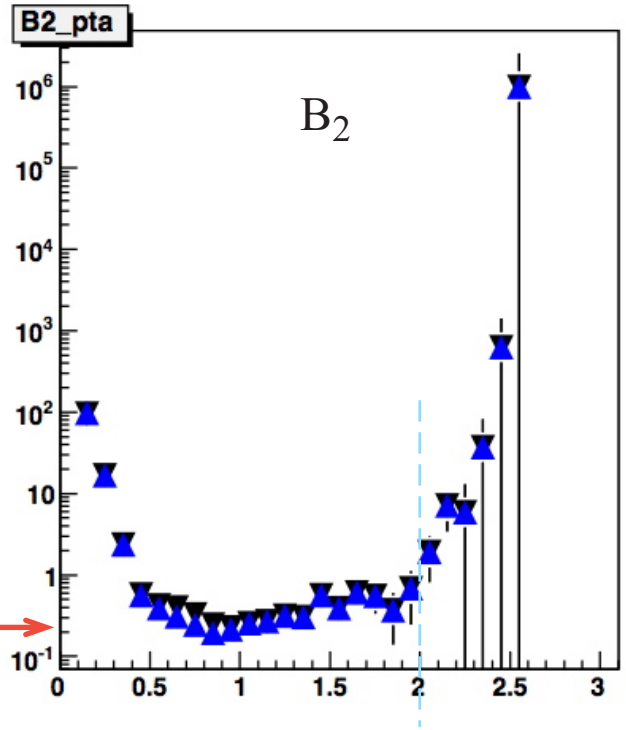
Still very crude at the moment.....
just set a M^2 window and dE/dx lower limits....

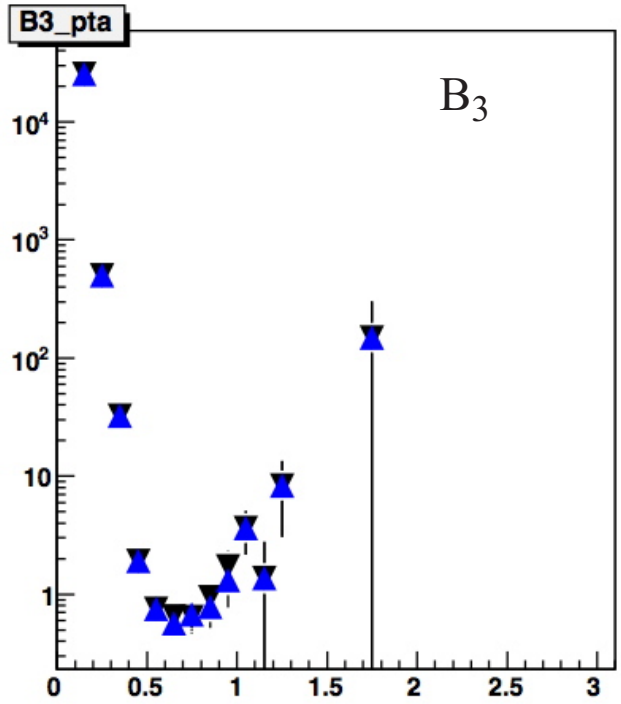
Will be improved... ...next week



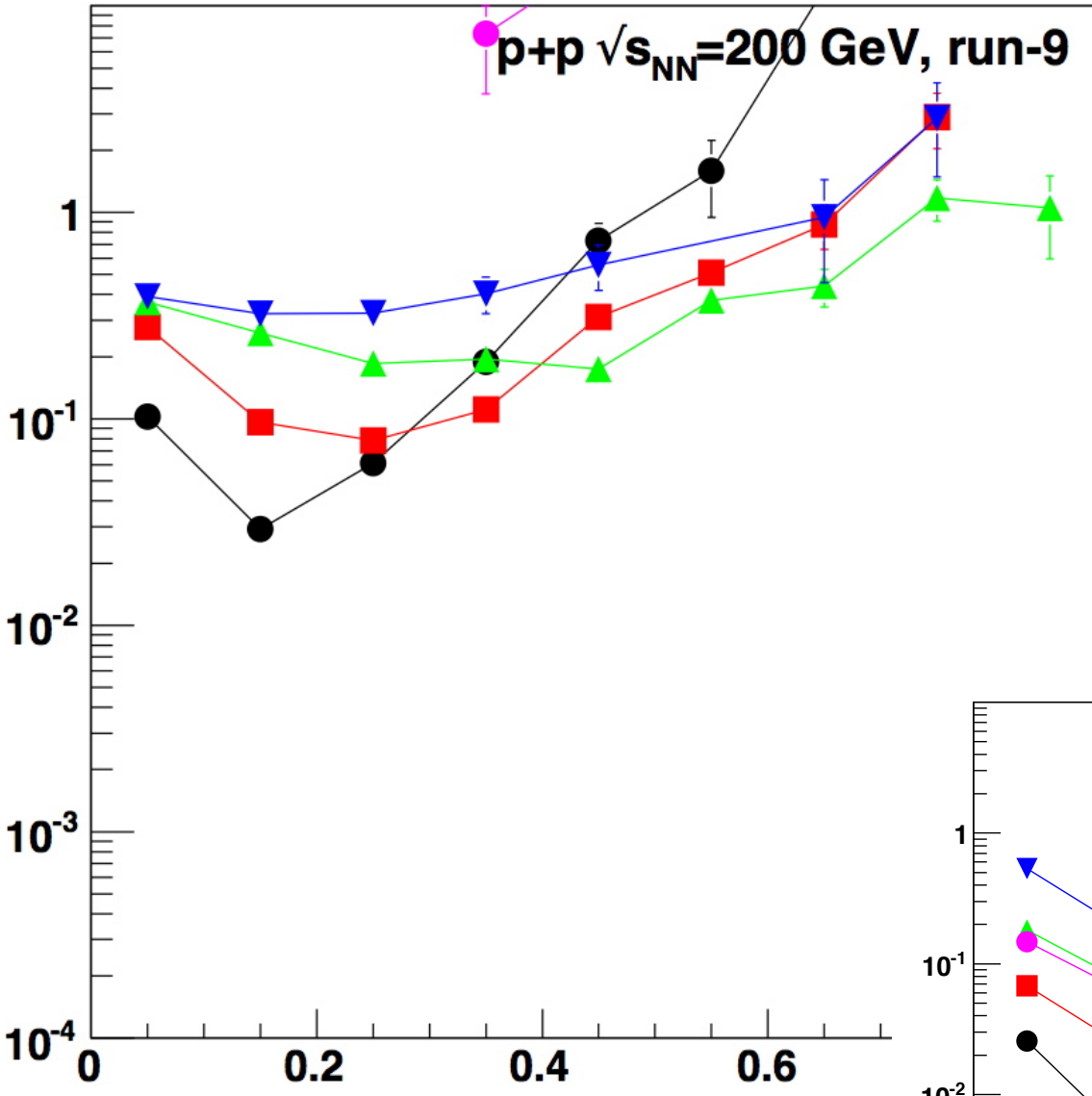




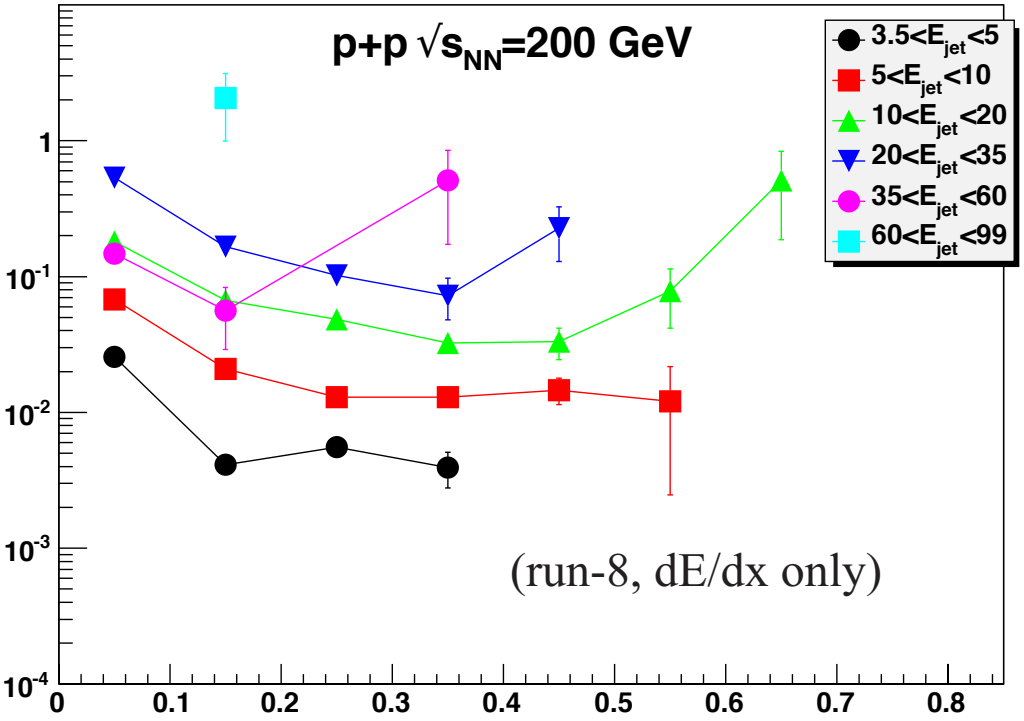




$B_2 \sim 0.02$
...trend from
lower-energy data...



Increasing B2 with Jet Energy trend still apparent....



Autocorrelation? (question from my talk @ March 2010 Collab. Mtg.....)

Plot Jet Energy spectrum....

Black Jet does not include p or d....
Red Jet contains a p but no d...
Magenta Jet contains a d but no p...