Update on
Light Nucleus Production in p+p and the BES

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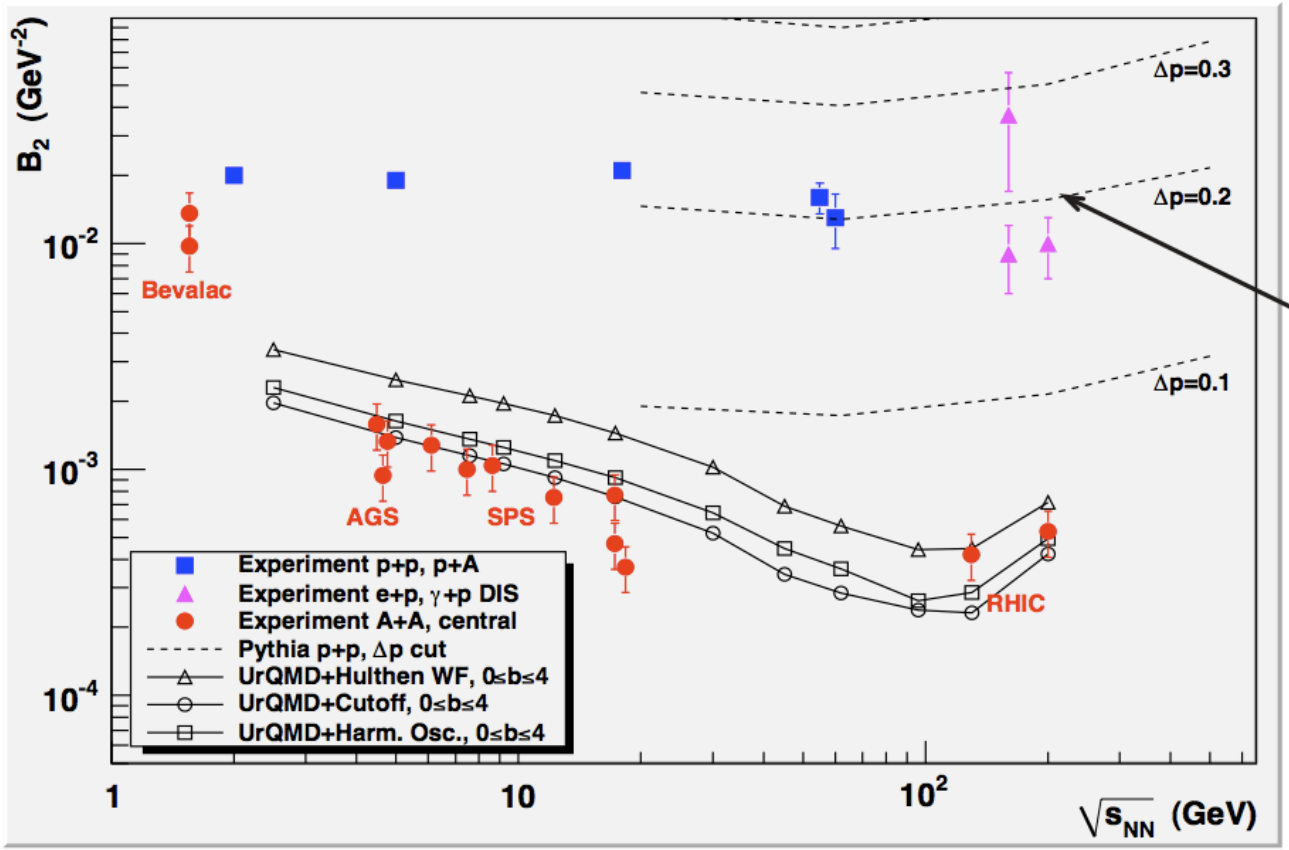
Introduction (1)

Existing Results on B_2

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

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



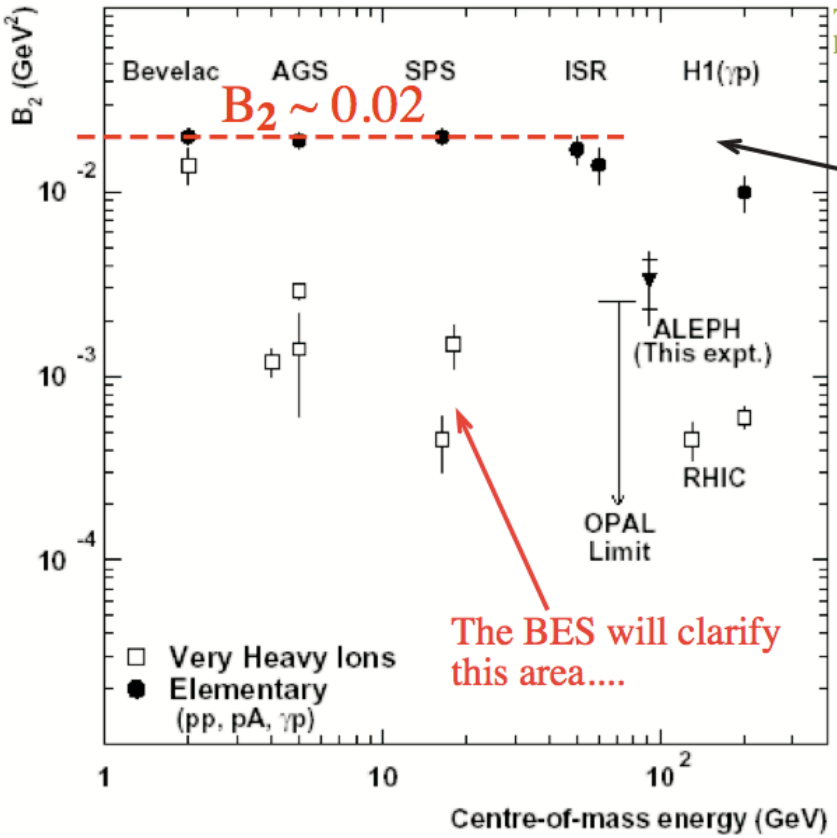
where's the RHIC results?

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 $\sqrt{s_{NN}}$ ... also unlike A+A

Introduction (2)



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

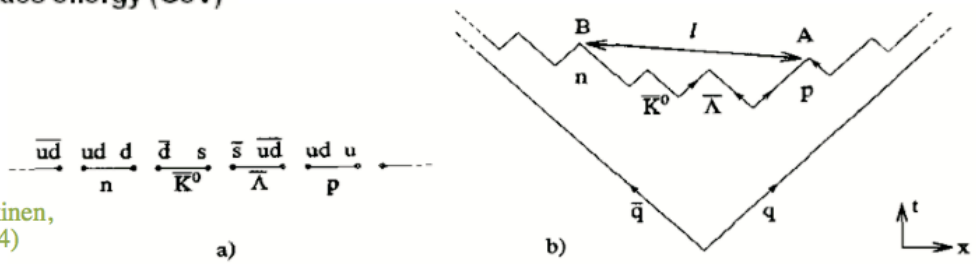
Conventional Wisdom:

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)

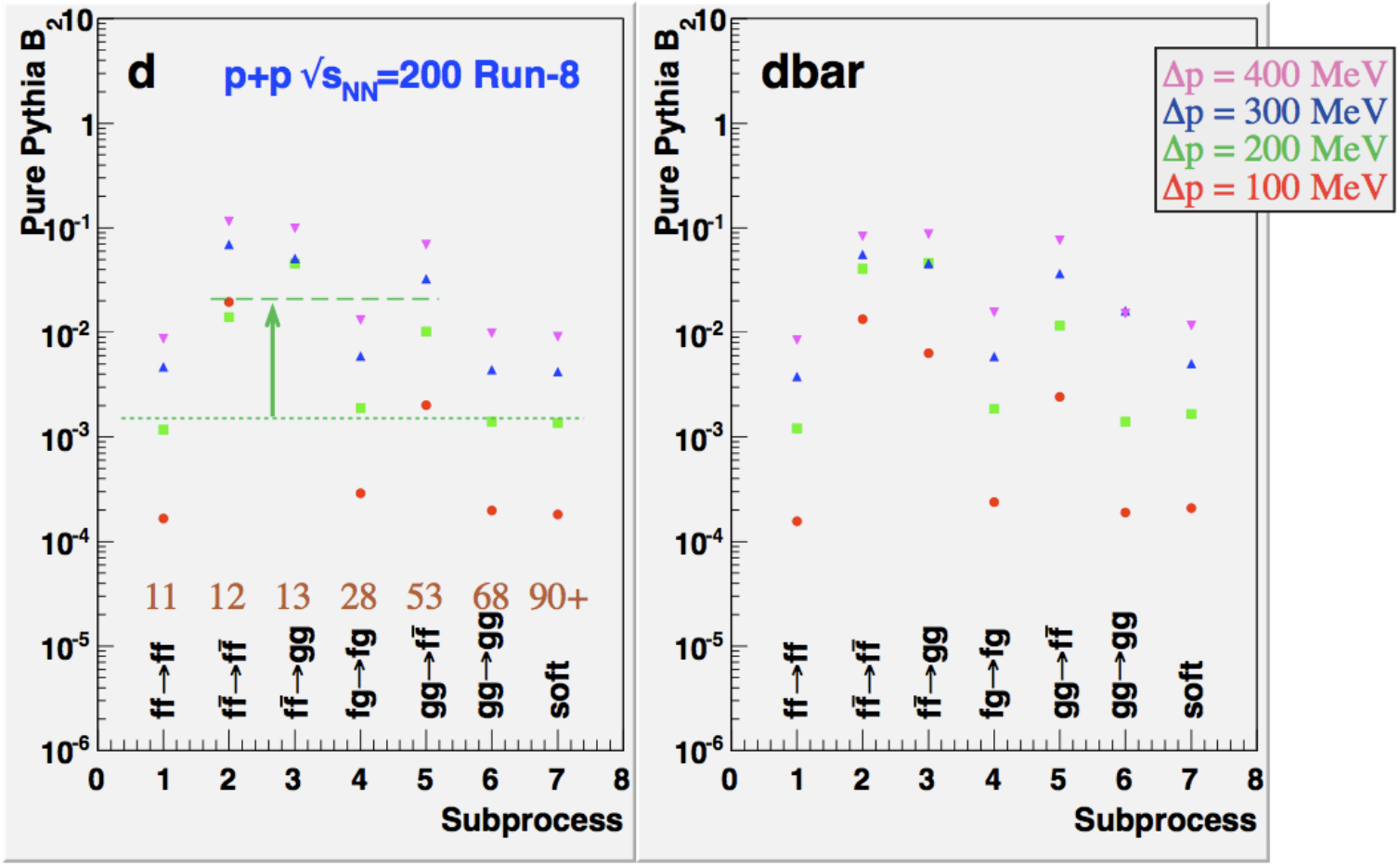
Fig. 3a, b. a Possible string breakup process with a *pn* pair. **b** Space-time structure of the breakup

Introduction (3)

Coalescence Afterburner + pure Pythia events.....

define Δp - the relative momentum cutoff for p+n pair forming a deuteron ($k = \Delta p/2$)

Δp ~ 120-140 MeV implied by earliest Bevalac A+A results...
(somewhat larger value required to match existing p+p data - see previous pages)



Factor ~10 differences in d/p^2 depending on Pythia subprocess.....

Details

Data	Nev	pythia	ampt	ampt(SM)	urqmd
pp 200 Run9	423M	653M			
AuAu 200 Run 10	23.6M		59k	40k	403k
AuAu 62.4 Run 10			180k	118k	355k
AuAu 39 Run 10	13.1M		262k	148k	230k
AuAu 11 Run 10	16.8M		770k	355k	1.8M
AuAu 7.7 Run 10	5.5M		945k	350k	1.8M

Experimental:

Cross-sections for p, d, t (^{3}He, α) versus P_T and P_T/A

in p+p, cross-referencing of tracks in jets to jet energy, angles, etc

Coalescence ratios: B_A vs P_T/A

interpretable in terms of source volumes

Spectra ratios: d/p & t/p vs P_T

Significant improvements to PID (simpler and better)

Embedding request for p+p 200 Run-9 in progress (No corrections applied yet)

http://www.star.bnl.gov/rt2/Ticket/Display.html?id=2097

Theory:

6-D Dynamic Coalescence using various models.... Pythia, AMPT, UrQMD

Source radii directly from B_A vs P_T/A.... several prescriptions available

PID

Present PID approach

(considerably simplified w.r.t. previous lfspectra talks)

“TPC-TOF”....

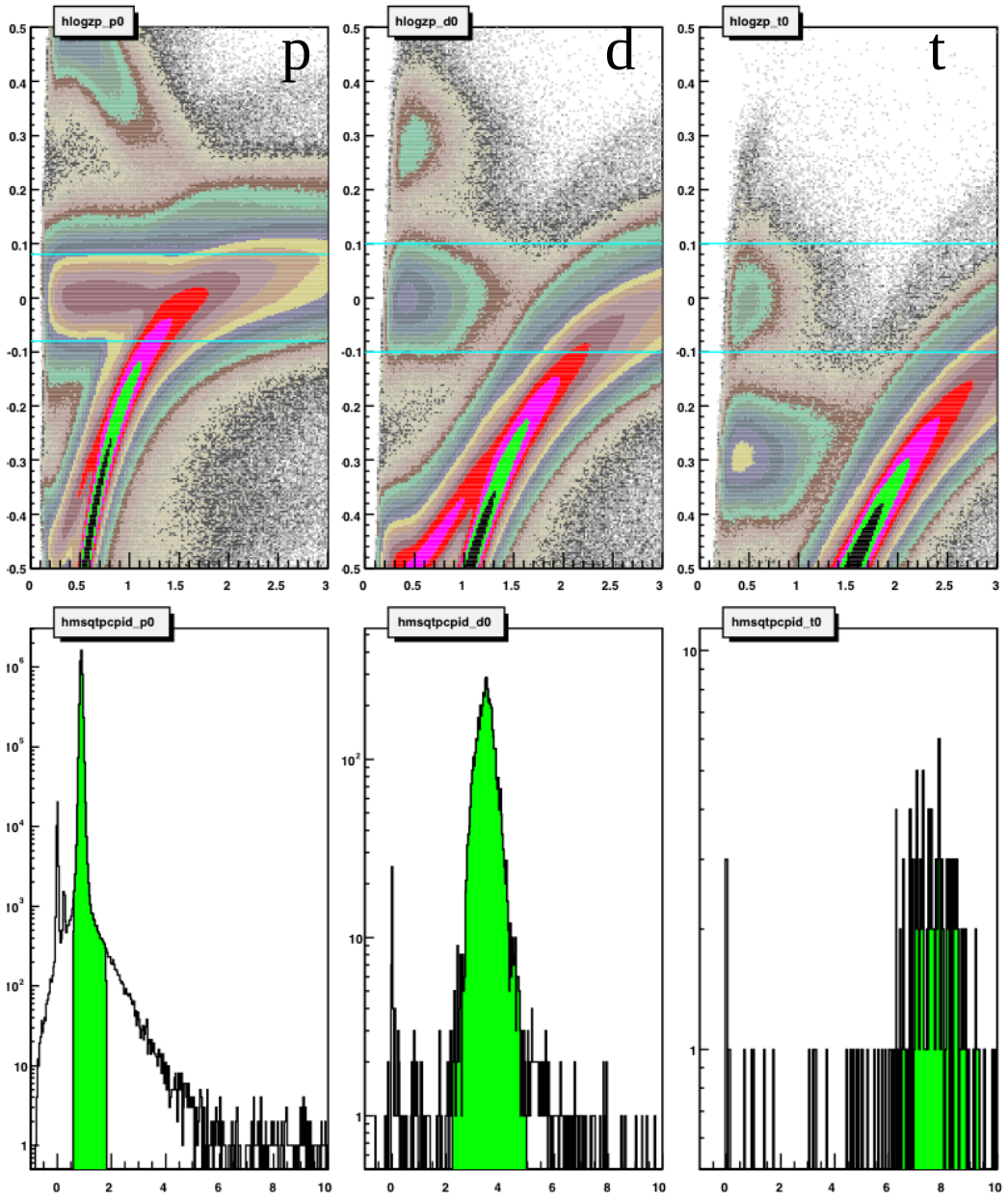
log(Z) cut with mom’n upper limits
if TOF info exists, reject incorrect assignments

...best acceptance, but only “low” momenta

“TPC+TOF”....

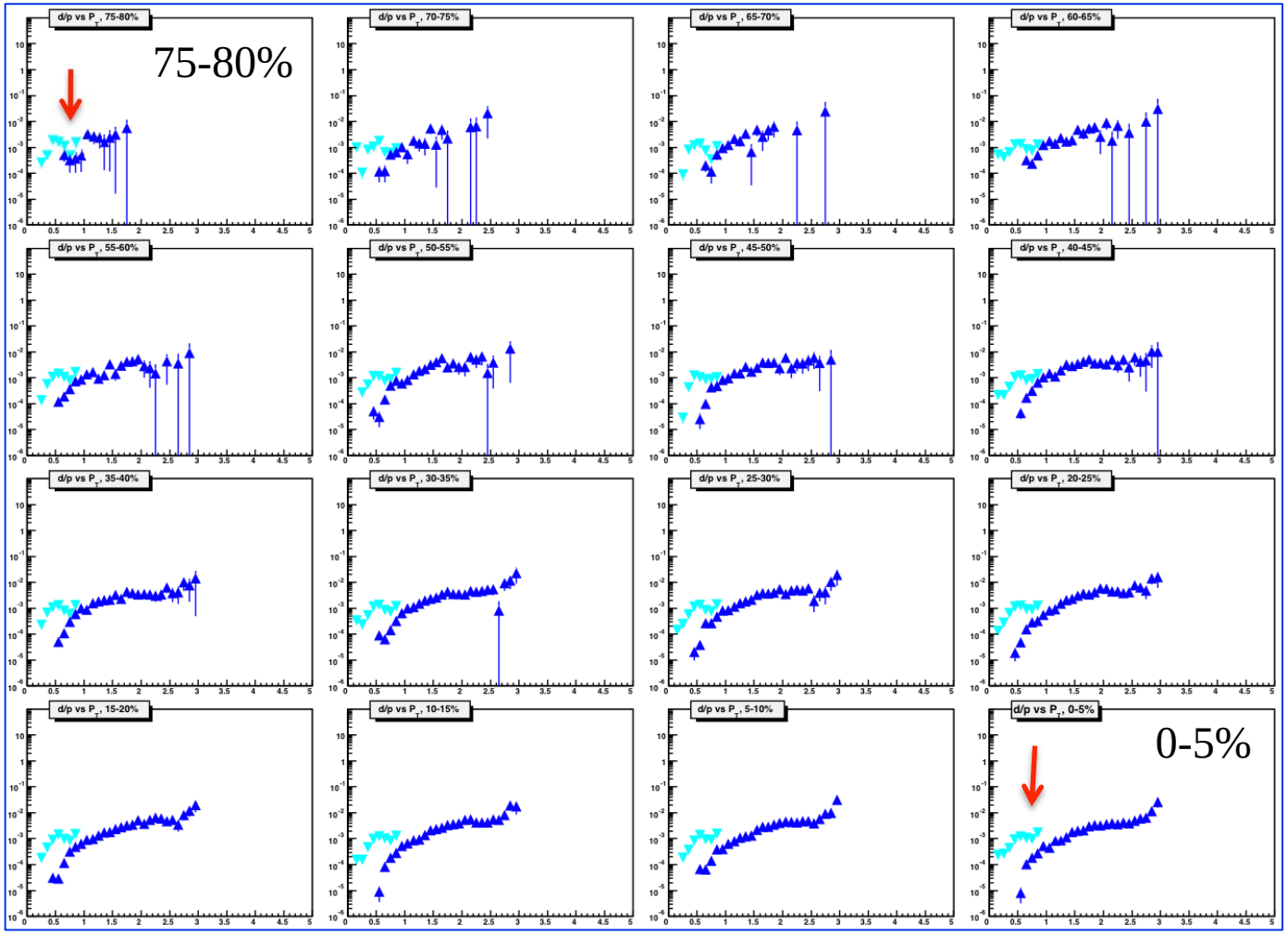
log(Z) cut without mom’n upper limits
require TOF info & correct mass

...reduced acceptance, but to higher momenta



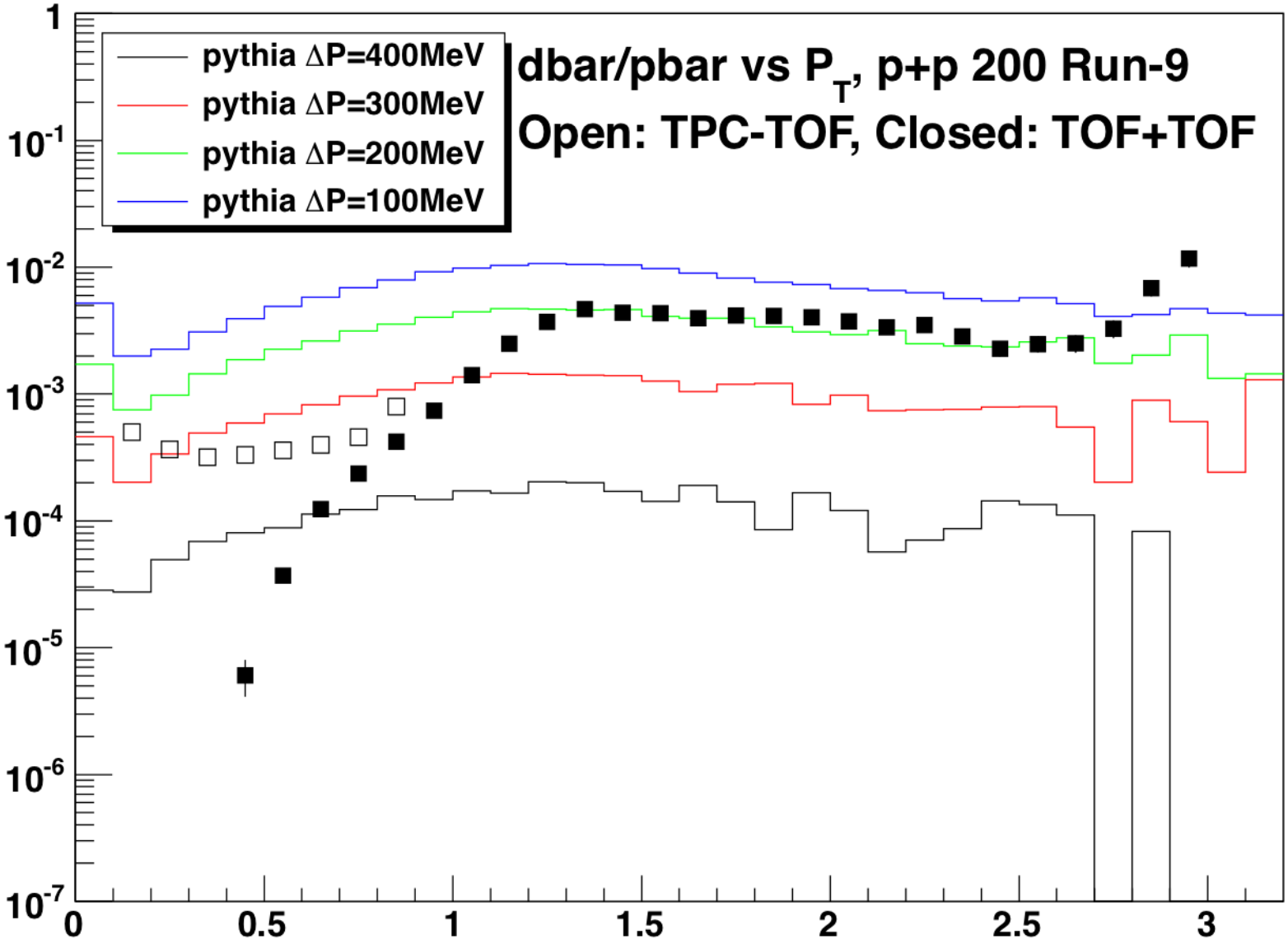
dbar/pbar vs P_T in different centality bins, Au+Au 39 GeV Run-10

TPC-TOF TPC+TOF

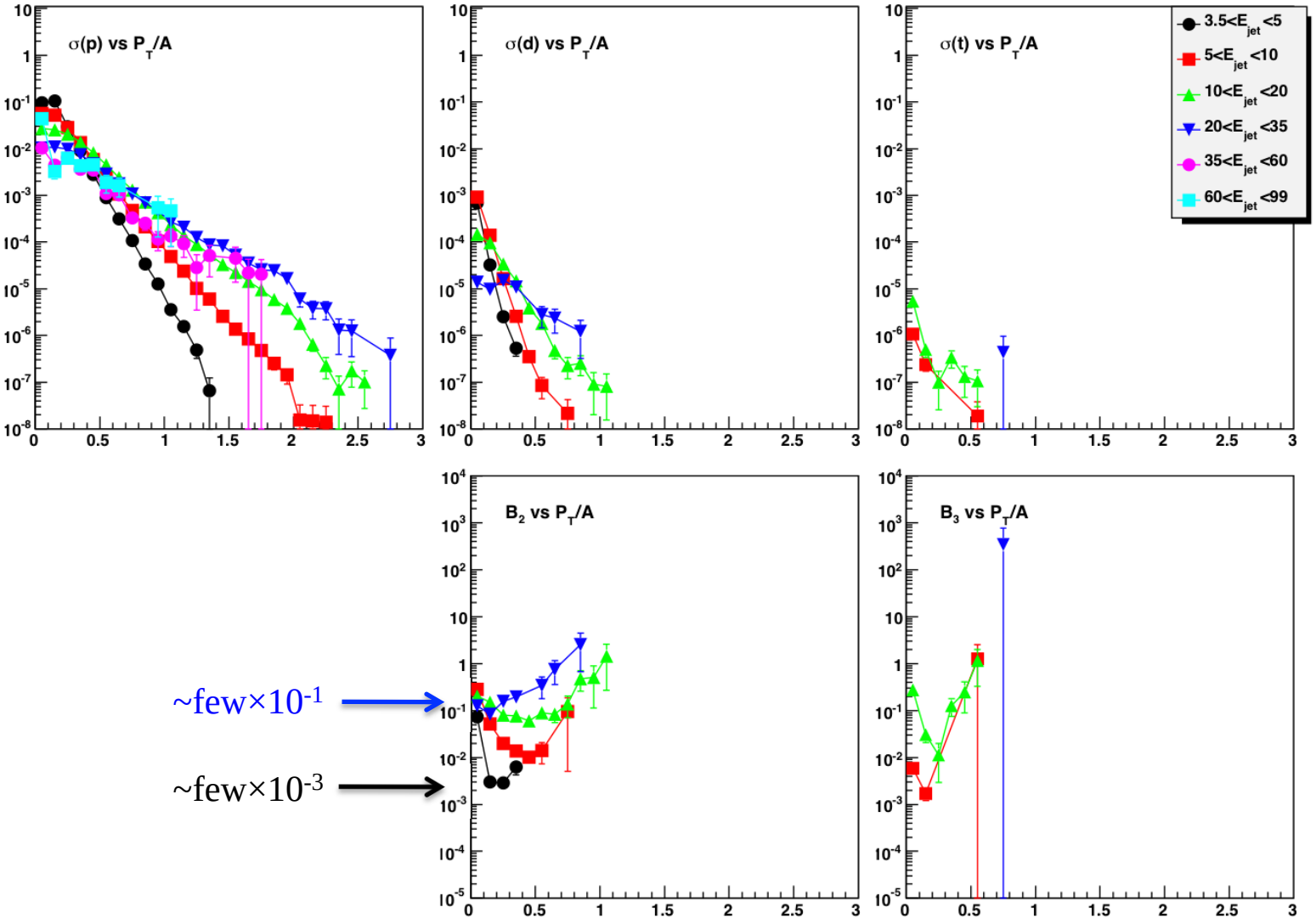


peripheral: d/p from two PID methods at the same P_T "agree"
central: additional d inefficiency (or p excess) in TOF PID (matching?)

dbar/pbar vs P_T, p+p collisions with Pythia coalescence calculations

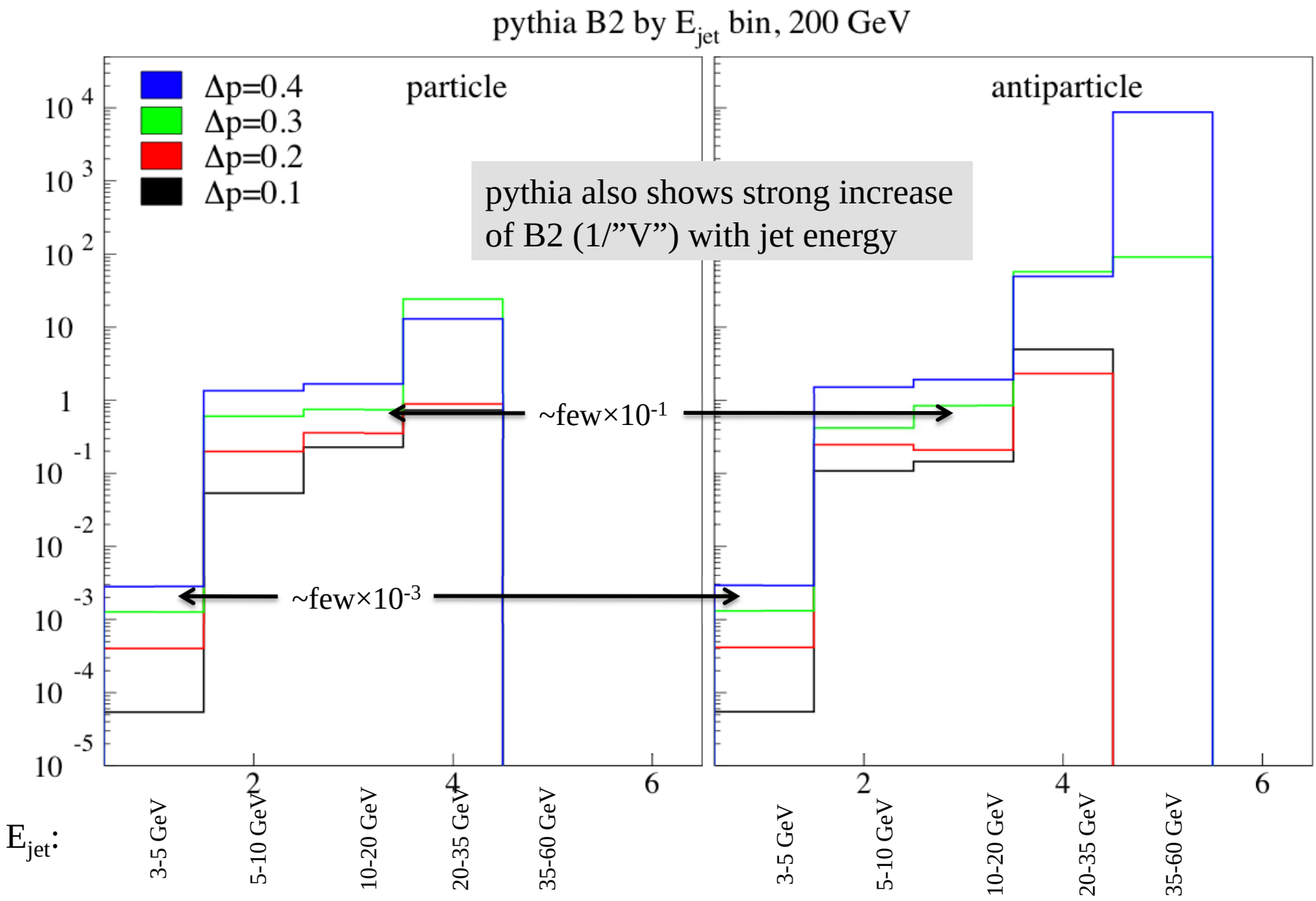


B2 vs P_T/A gated on Jet Energy, p+p 200 GeV Run-9

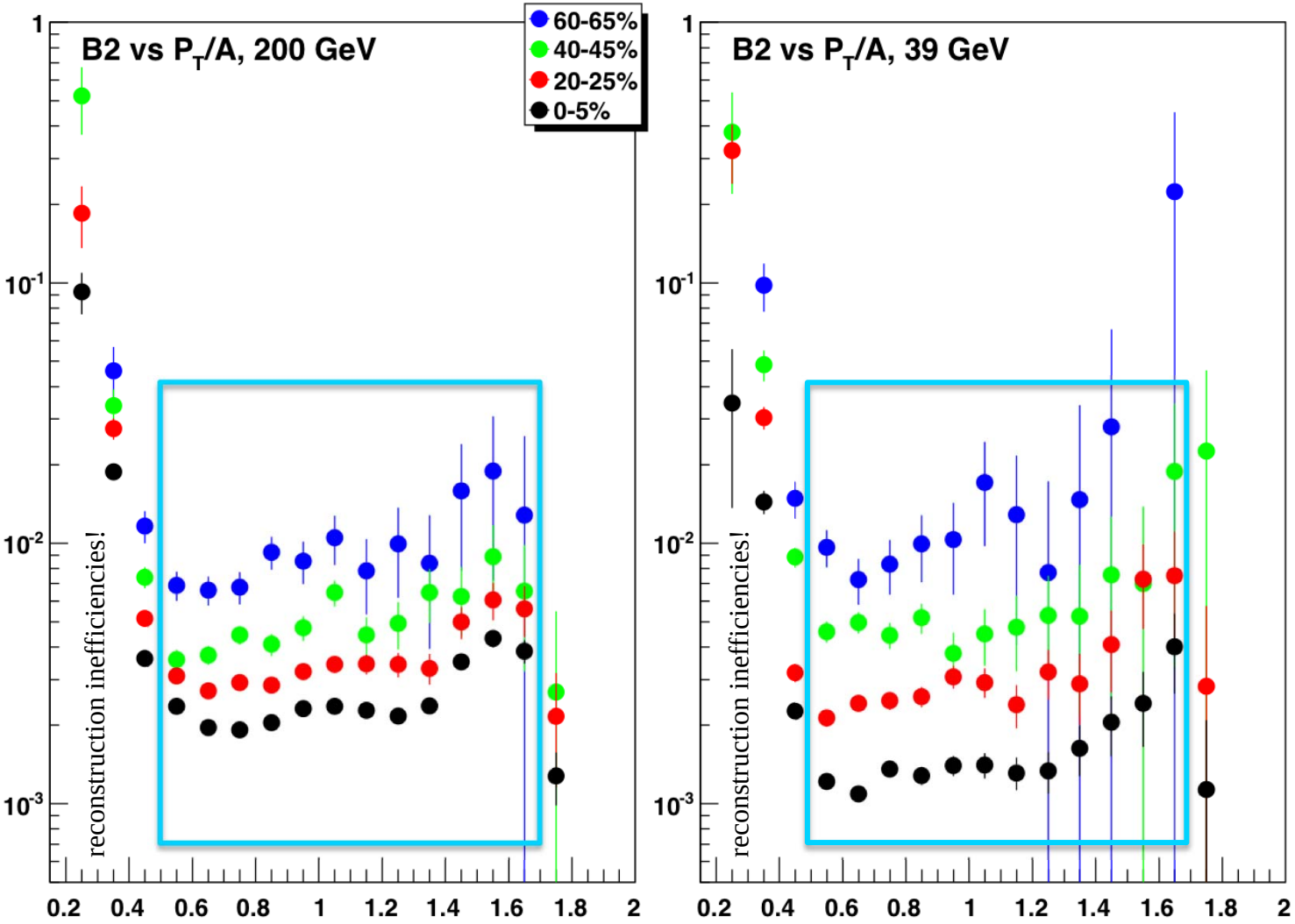


strong increase in B2 (strong decrease in "source volume") with inc. E_{jet}

<B2> by E_{jet} bin, Pythia



Antinucleus B2 in Au+Au at 200 and 39 GeV, Run-10

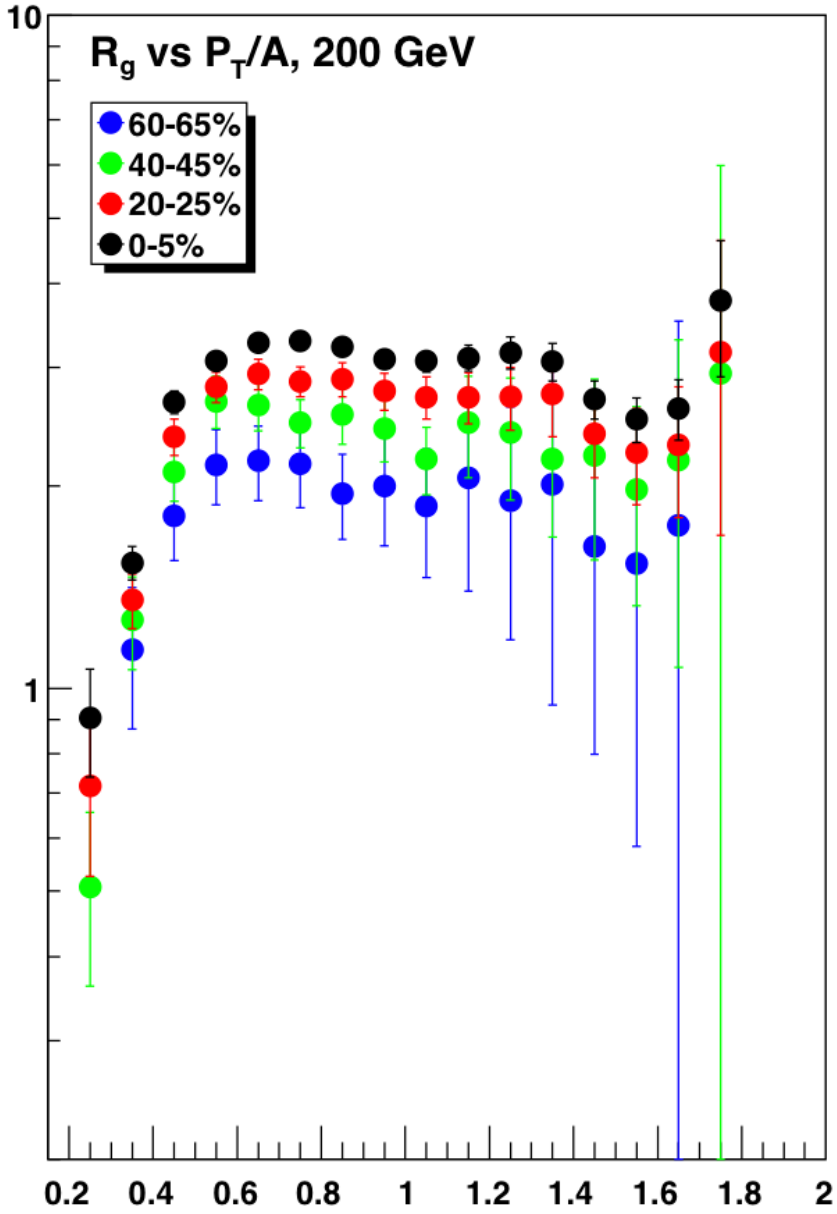


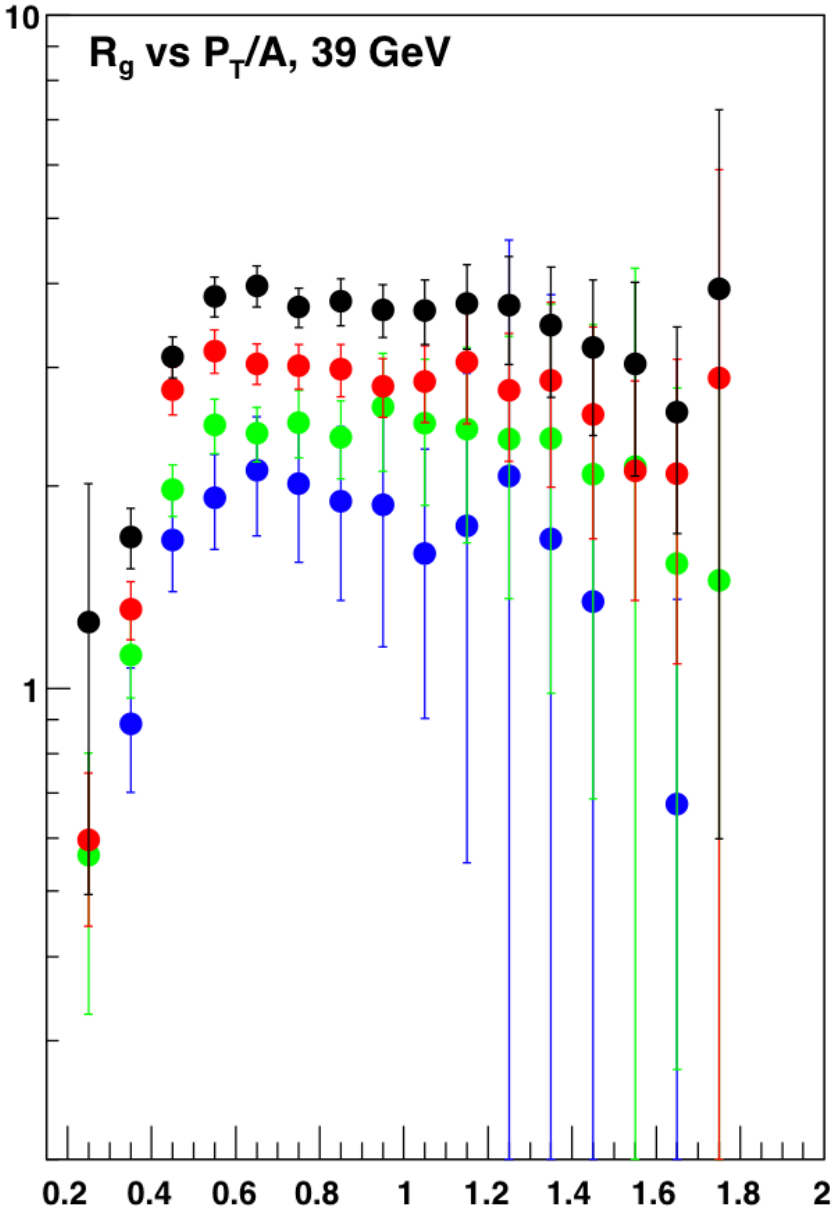
B2 increases (“V” decreases) as collisions get more peripheral

"Gaussian Source Radius" R_G (fm) vs P_T/A, Au+Au, Run-10

hard-sphere R = $2.2R_G$

conversion of B_A into R_G done via WJL *et al.*, PRC **52**, 2004 (1995).





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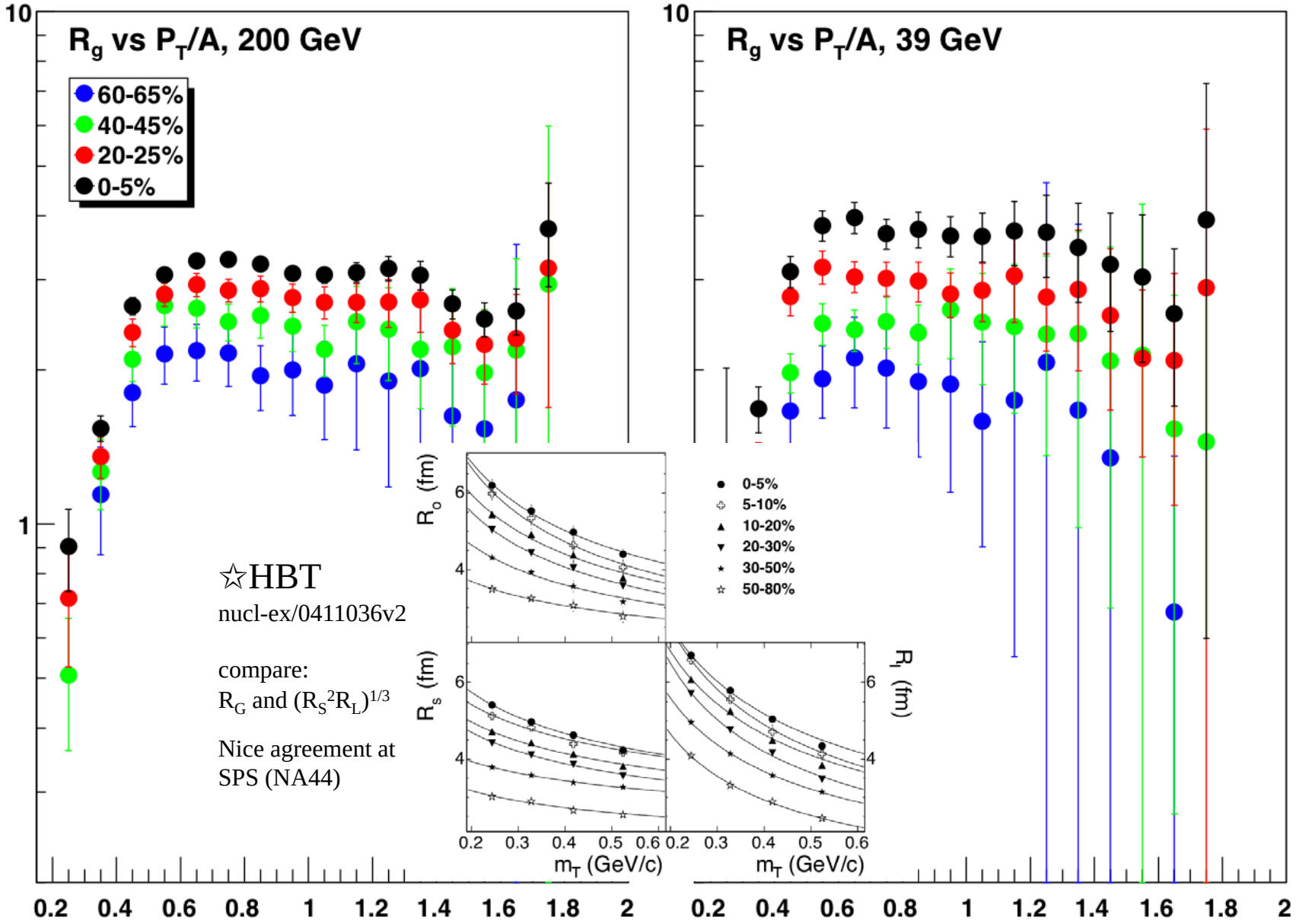
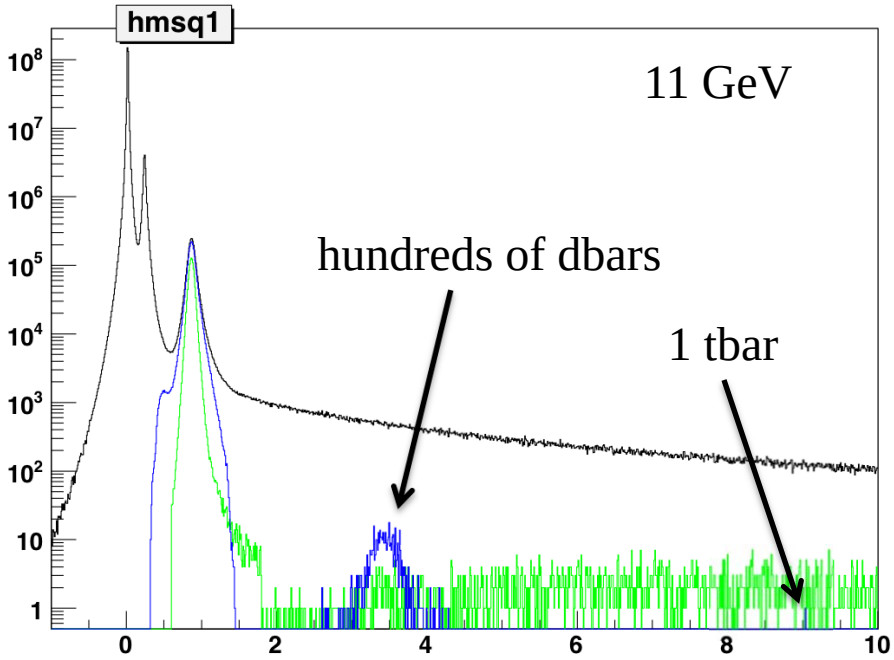
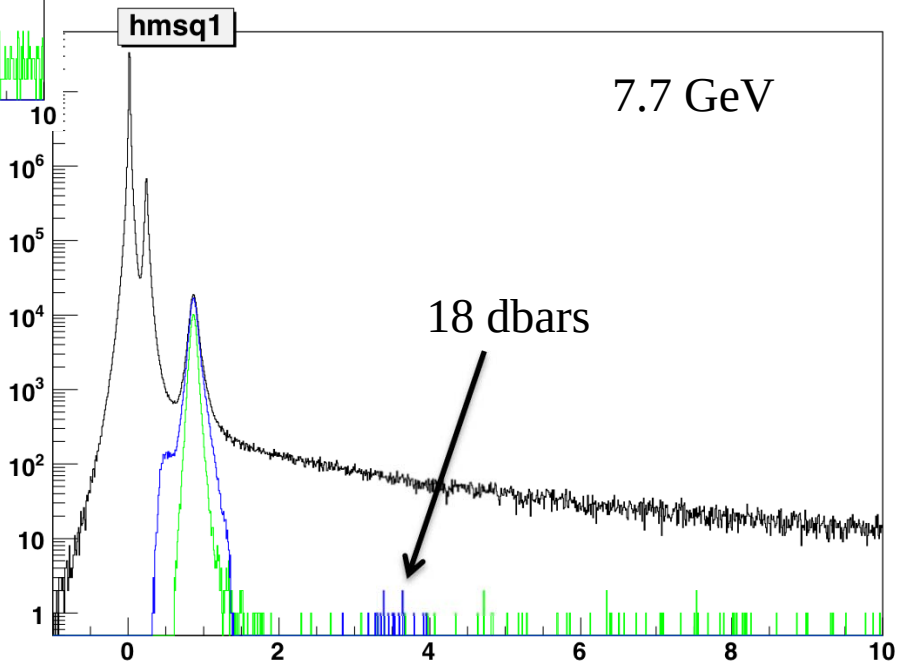


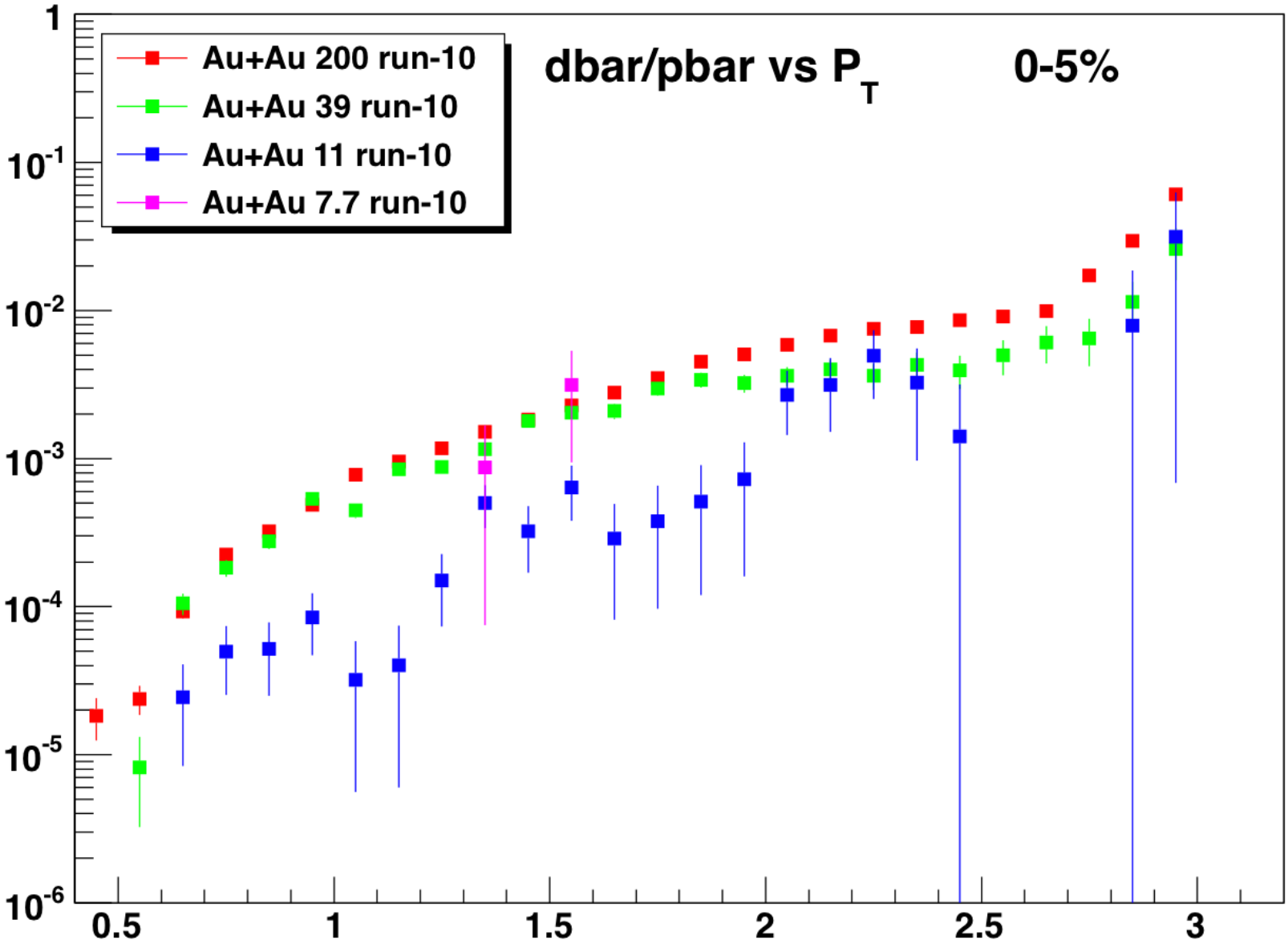
Antinuclei at 7.7 and 11 GeV, Run-10



dbar spectra, and dbar/pbar & B2 ratios
at these very low root-s values not reported
by any of the SPS experiments

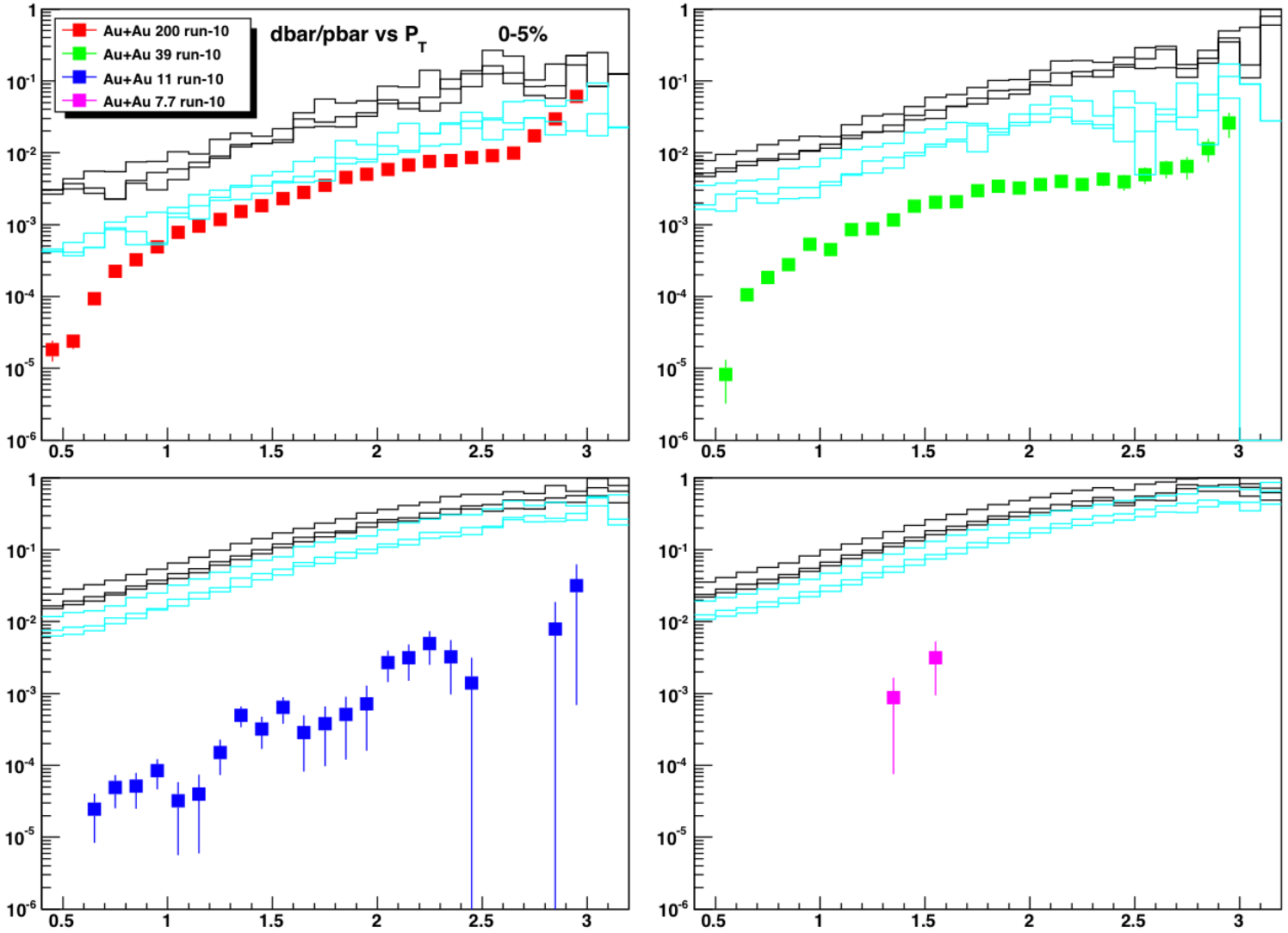


dbar/pbar vs P_T, Run-10 BES

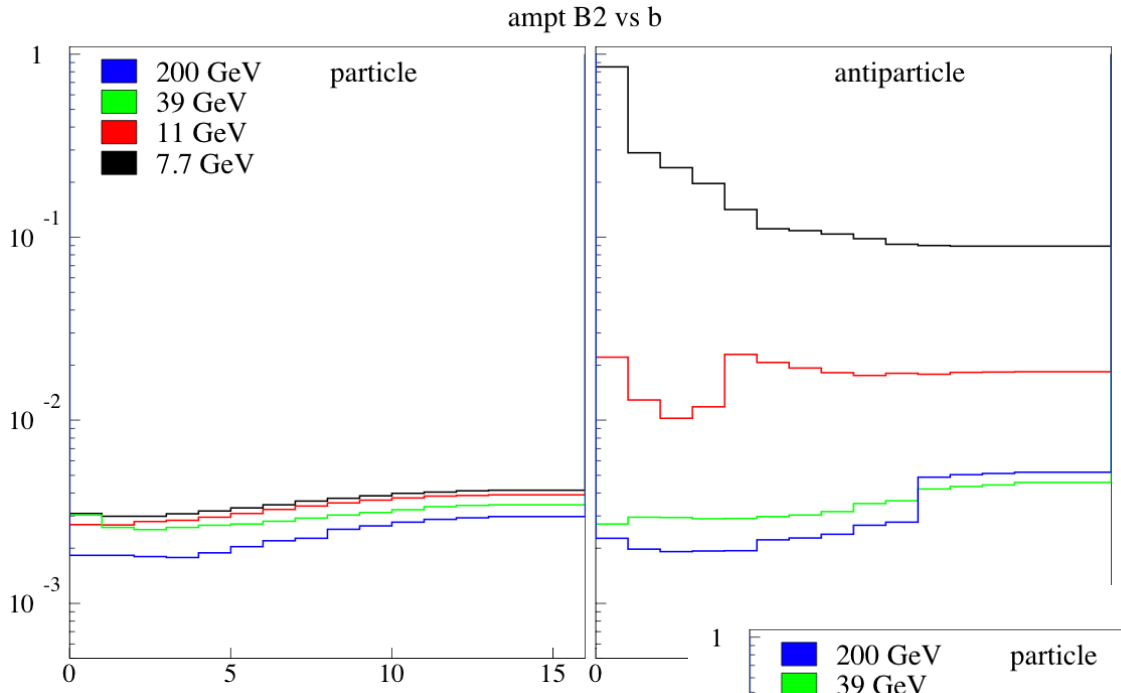


dbar/pbar vs P_T, Run-10 BES, comparison to AMPT and UrQMD

AMPT UrQMD



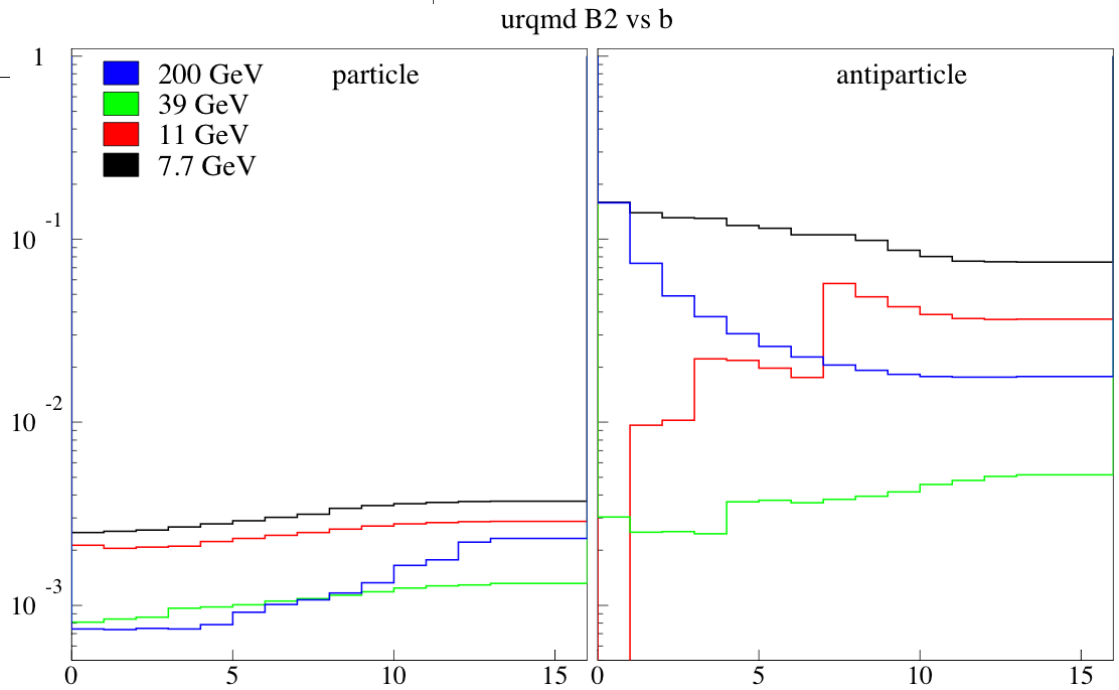
Antiparticle B2 versus impact parameter from AMPT and UrQMD



significant differences between
- the two models
- particles and antiparticles

still generating events....

I also need to run UrQMD with longer cutoff times to check sensitivity of the results to this parameter



Summary

Cleaner & simpler PID implemented

- TPC-TOF (most efficient but only at low momenta)
- TPC+TOF (less efficient but wider P_T reach)

methods "match" in overlap P_T region and in peripheral collisions

dbar & tbar spectra in p+p 200 Run-9

- never reported by any RHIC experiment
- significant dependence of B2 for particles in Jets & on Jet energy

same spectra and ratios for Au+Au 7.7, 11, 39, and 200 GeV in Run-10

- factors 2-3 variation in B2 amongst SPS experiments at highest energies
- "new" results on dbar production at lowest BES energies

Need corrections now...

- absorption correction is "easy"
- feed-down is straightforward and can be obtained from starsim
- reconstruction via embedding is broken – need expert help...