Light Nucleus Production in p+p and the BES

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Outline

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Quick overview of major directions of this analysis

- Fragment spectra in p+p collisions
  - B_2 and source radii (first measurement at RHIC)
  - UE vs in-Jet differences, & dependence on Jet Energy (first measurement anywhere)
- Fragment production in BES
  - antinucleus production cross-sections and B_2 at low root-s (first measurement anywhere)
  - source radii from B_2 vs P_T & $\sqrt{s_{NN}}$ (some RHIC results at high-$\sqrt{s_{NN}}$, but not at BES/SPS energies)
    - direct comparison to HBT (existing results from SPS, but not RHIC)
  - (anti)baryon density vs $\sqrt{s_{NN}}$ (significant extension in P_T using TOF, and in $\sqrt{s_{NN}}$ in BES data)
- Direct comparison to models (urqmd 2.3/3.3p1, AMPT, Pythia)
  - millions of events (from SUG@R & davinci) + coalescence

Just need corrections now

- Absorption "done"
- Feeddown in progress (CPU intensive)
- Reconstruction Efficiency (now underway)!

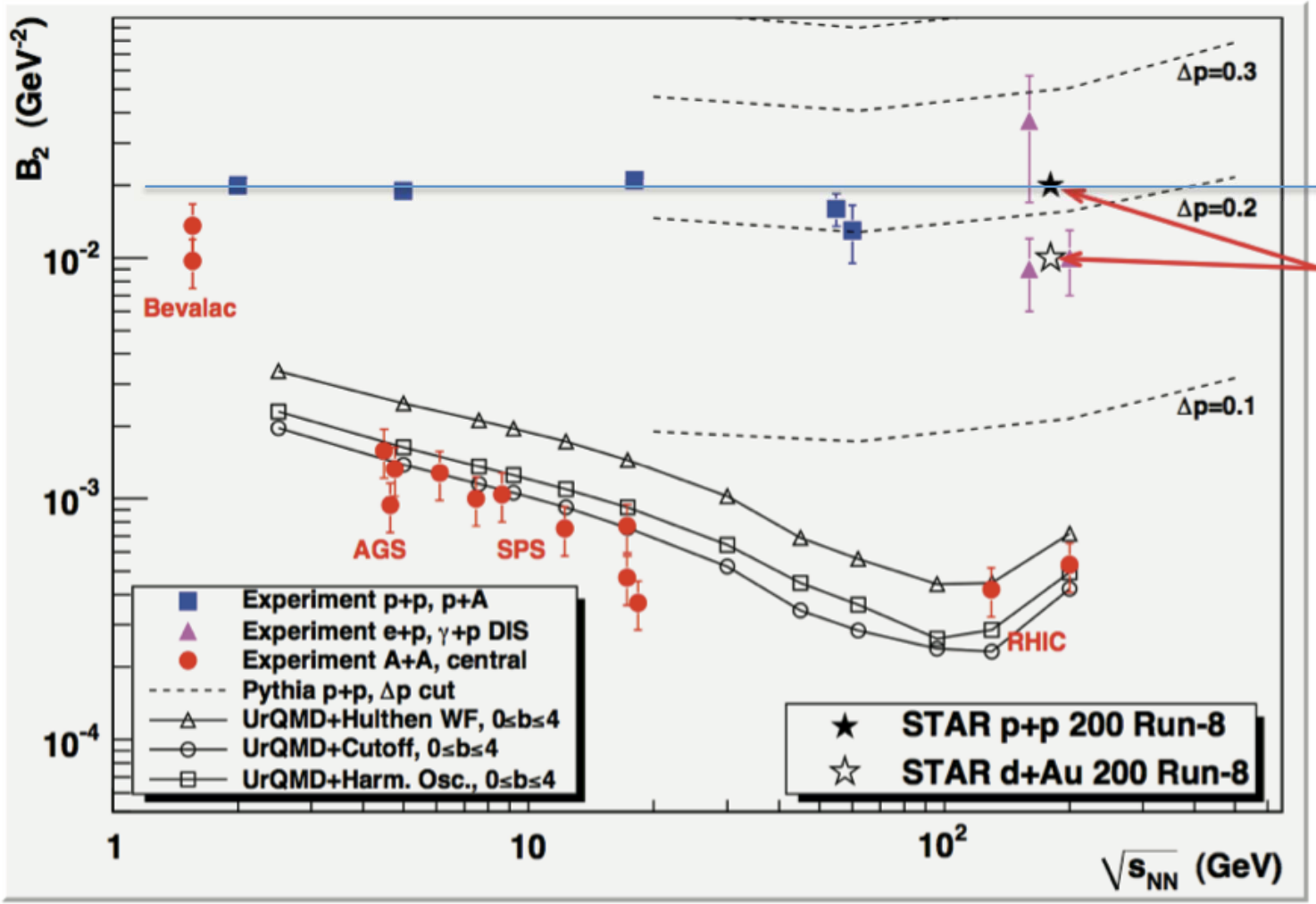
…an astoundingly rich data set from an awesome detector!

Datasets Analyzed with the same code:

11 = p+p	62GeV	run-6	no TOF
12 = d+Au,	200GeV	run-8	no TOF
13 = p+p	200 GeV	run-8	no TOF
14 = p+p	500 GeV	run-9	partial TOF
15 = p+p	200 GeV	run-9	partial TOF
16 = Au+Au	200 GeV	run-10	full TOF
17 = Au+Au	62.4 GeV	run-10	full TOF
18 = Au+Au	39 GeV	run-10	full TOF
19 = Au+Au	7.7 GeV	run-10	full TOF
20 = Au+Au	11.5 GeV	run-10	full TOF
23 = Au+Au	19.6 GeV	run-11	full TOF
25 = Au+Au	27 GeV	run-11	full TOF

World's Data on B_2 in various entrance channels

Comparisons to world's data.....



$B_2 \sim 0.02$

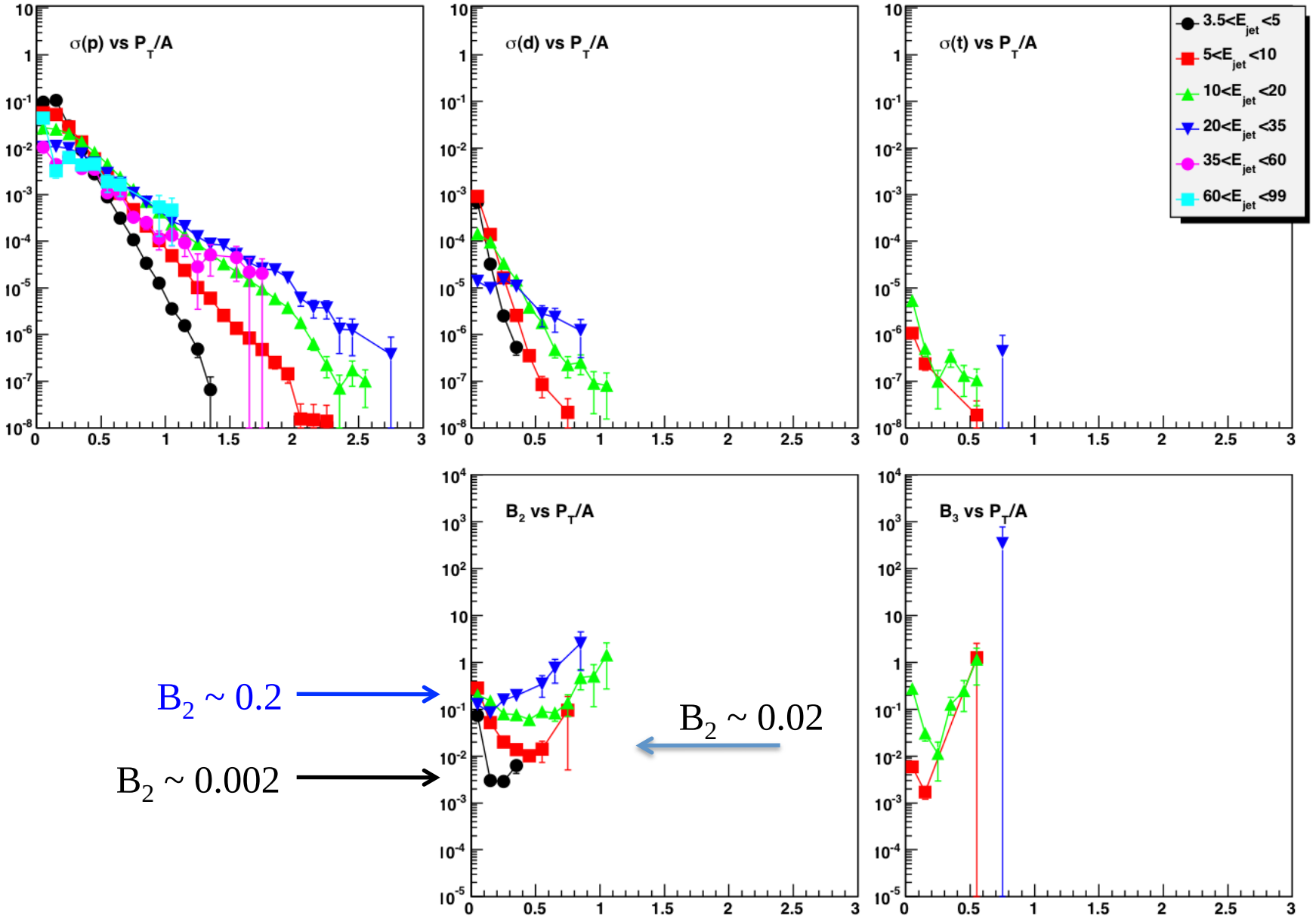
my results (uncorrected)

but PT lower limit to avoid inefficiency

These are the run-8 points, p+p will be superceded by run-9 (lots of TOF)

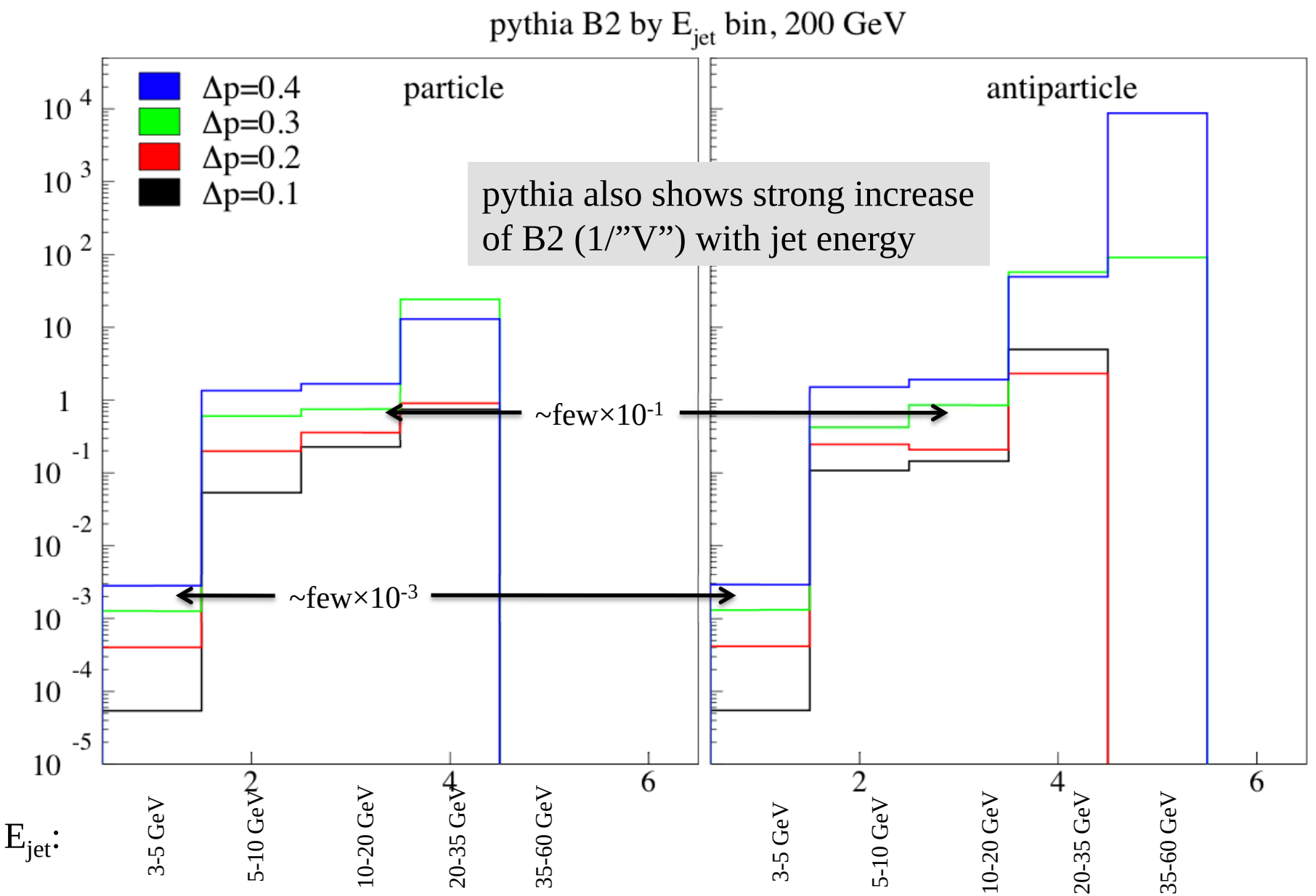
Summary* so far:	Experiment	Coalescence Picture:	Pythia+Δp
p+p, 200 GeV, Run-8:	$B_2 = 0.02$ GeV^2	R ~ 3.3 fm, $p_o \sim 180$ MeV	$\Delta p \sim 210$ MeV
d+Au, 200 GeV, Run-8:	$B_2 = 0.01$ GeV^2	R ~ 4.2 fm, $p_o \sim 150$ MeV	$\Delta p \sim 180$ MeV

Dependence of B_2 for p,d in Jets vs Jet energy

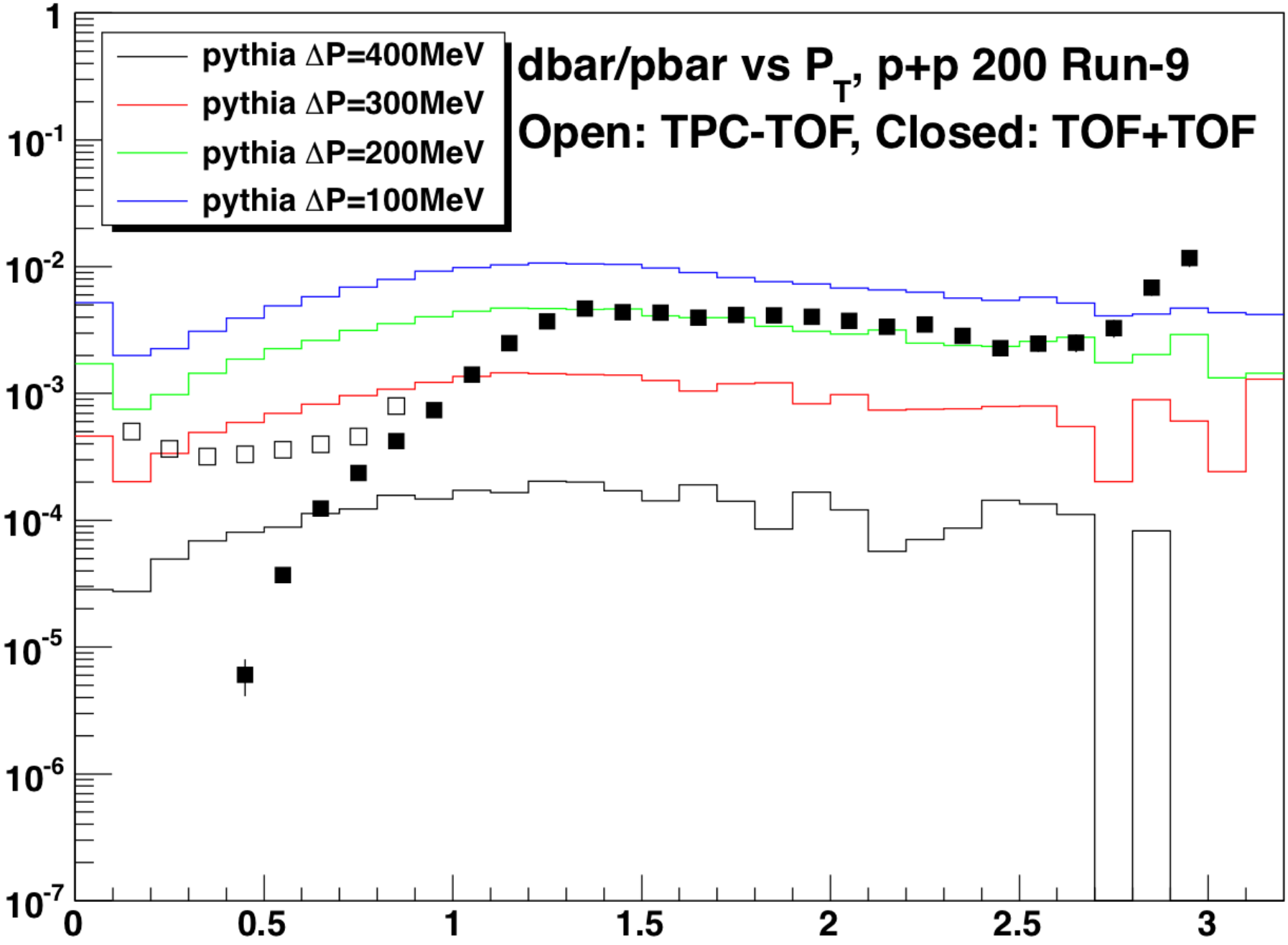


strong increase in B_2 (strong decrease in "source volume") with inc. E_{jet}

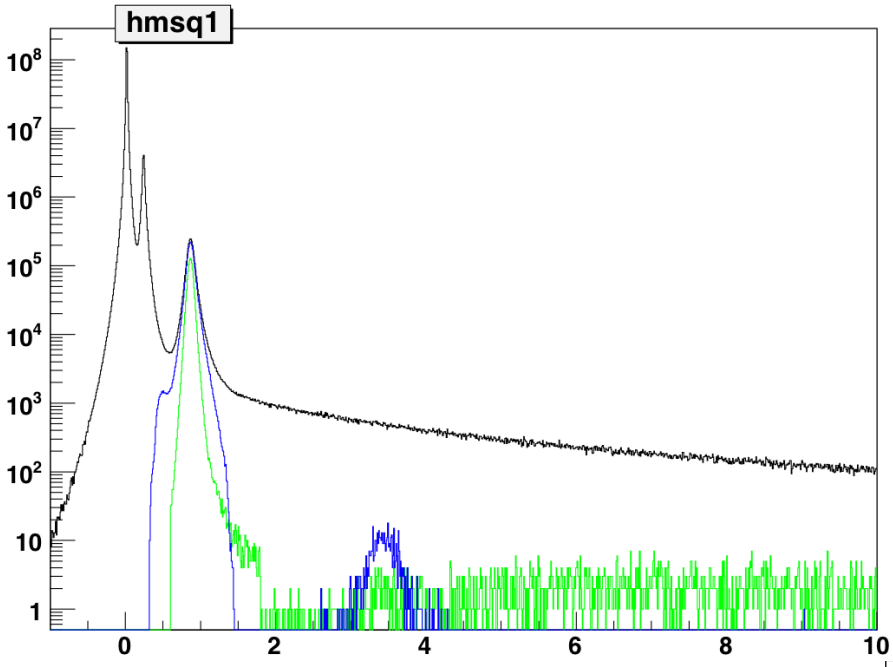
Dependence of B_2 for p,d in Jets vs Jet energy, from Pythia



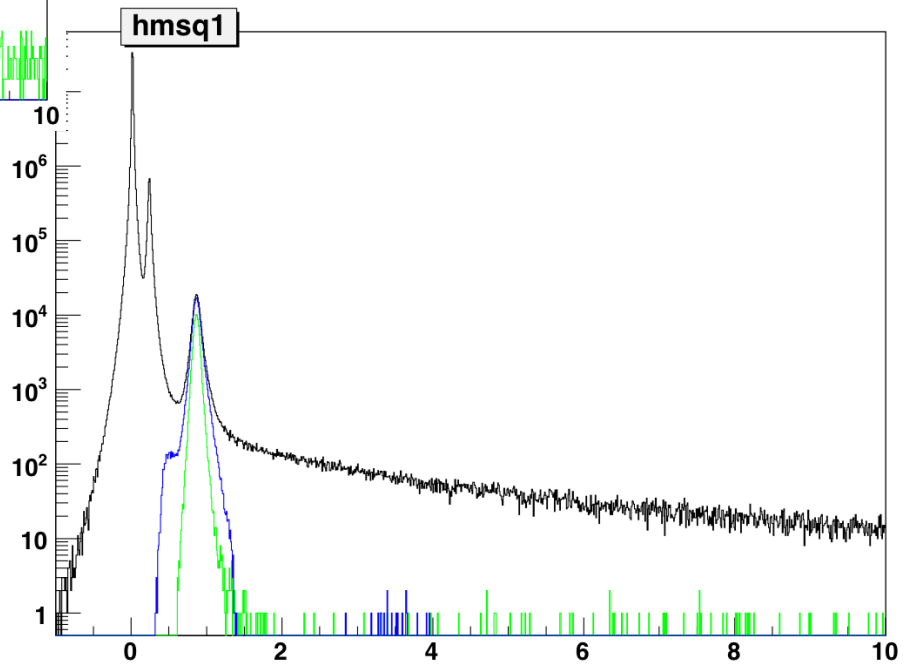
B_2 from Data and from Dynamic Coalescence on Pythia events



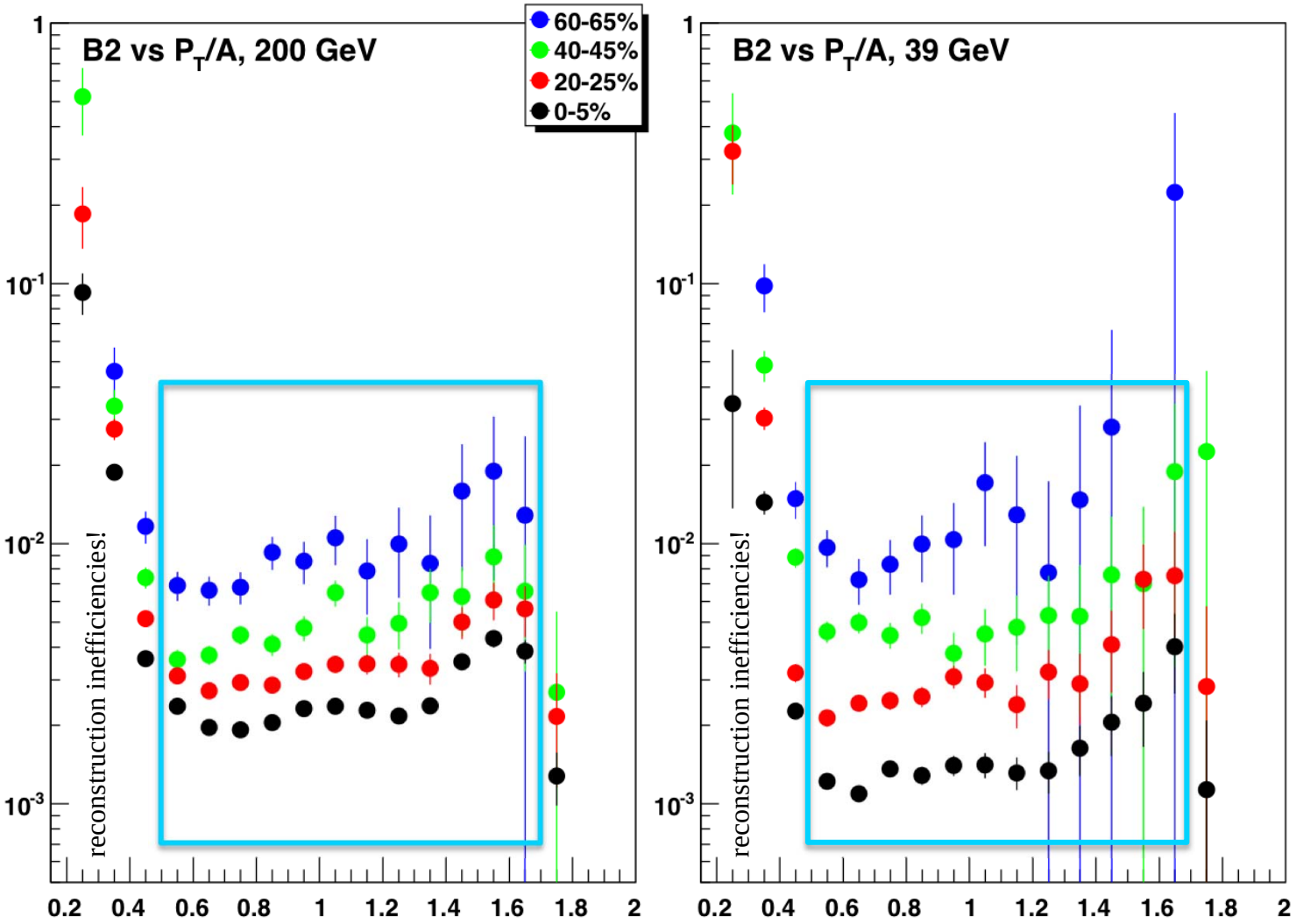
Antinucleus Production at very low (~SPS) root-s



dbar spectra, and dbar/pbar & B_2 ratios at these very low root-s values not reported by any of the SPS experiments



B_2 vs P_T/A vs centrality

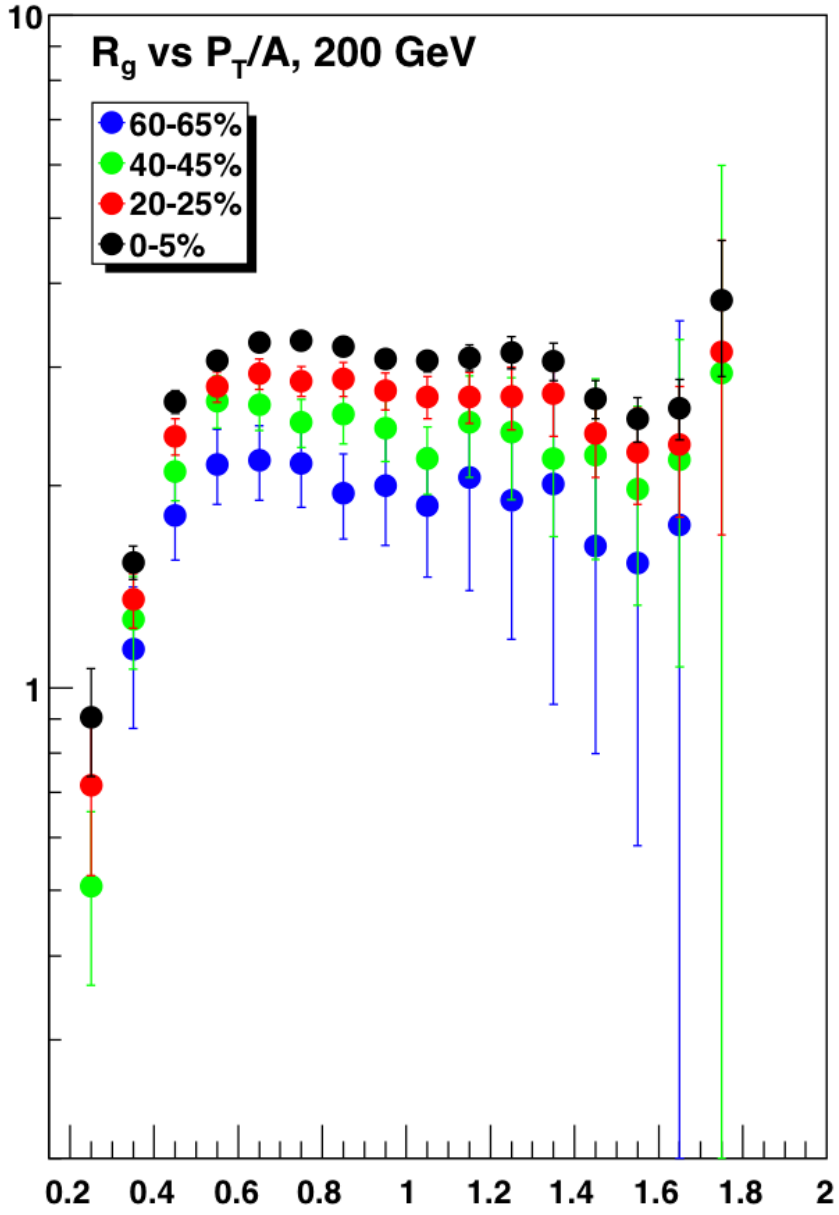


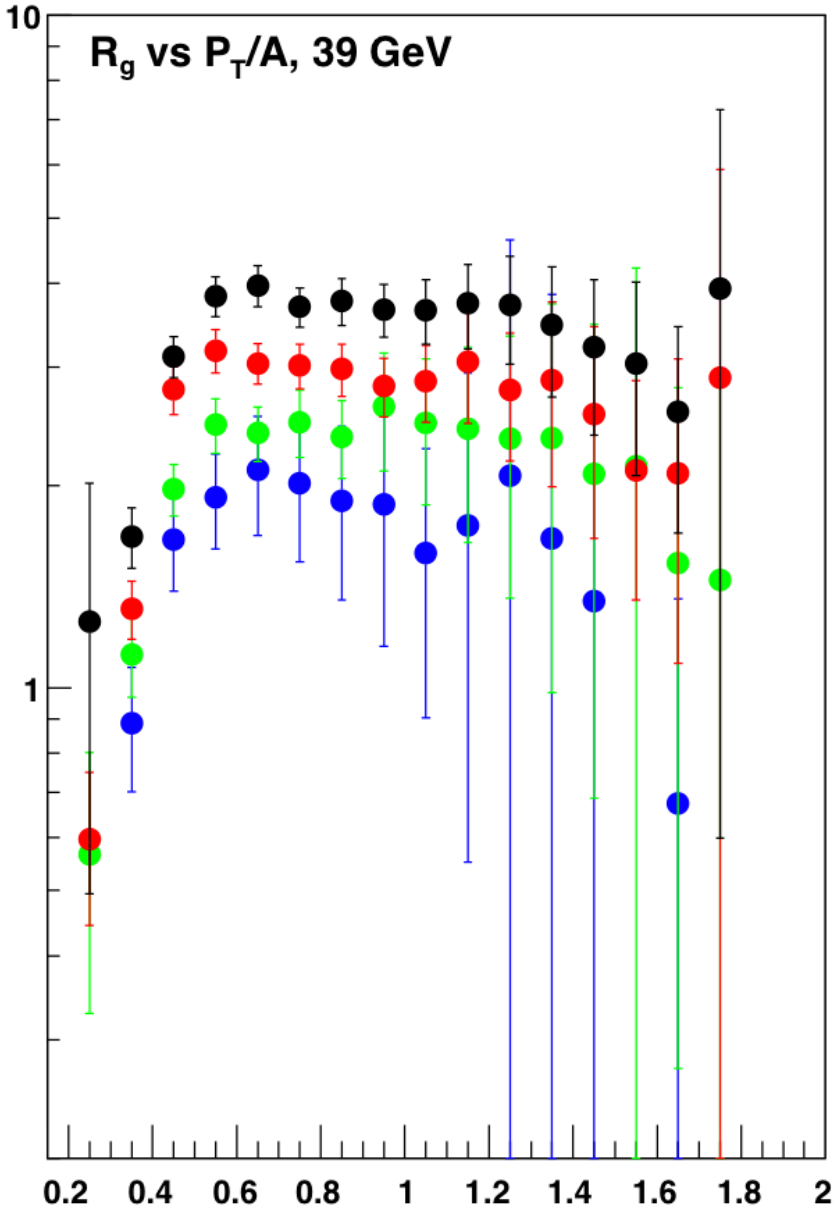
B2 increases ("V" decreases) as collisions get more peripheral

Source Radius at freezeout from B_2 values

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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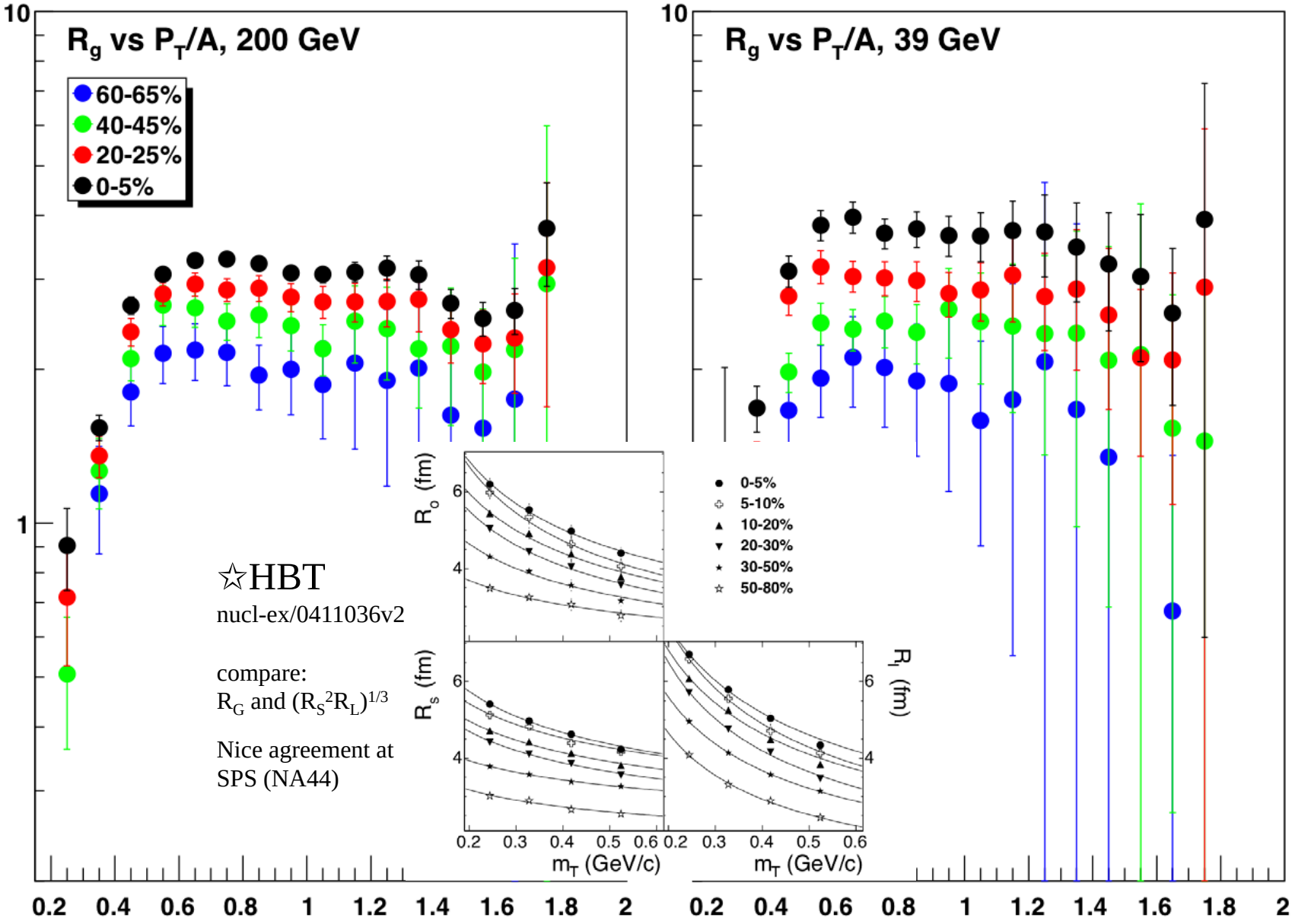
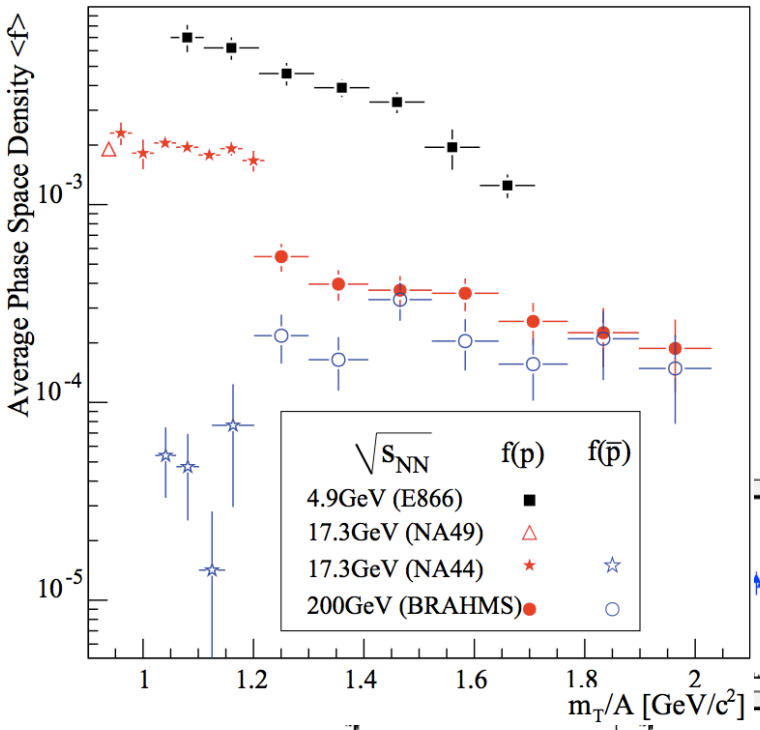
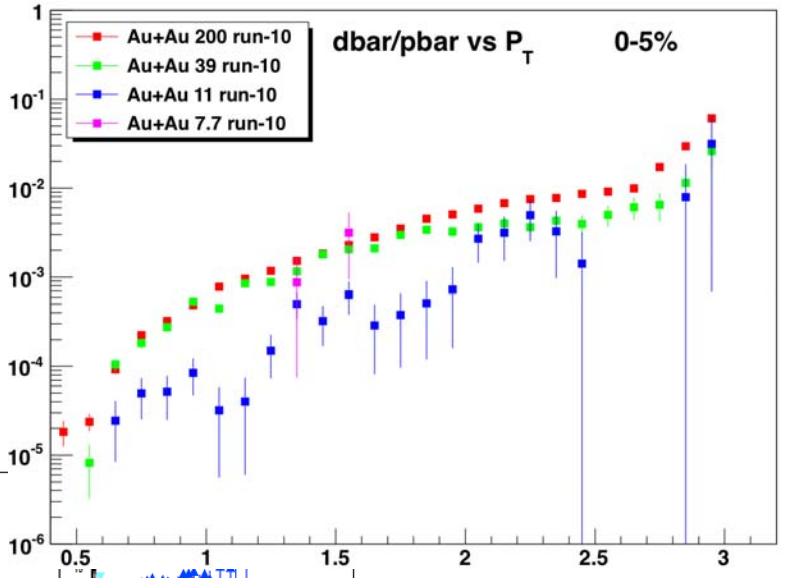
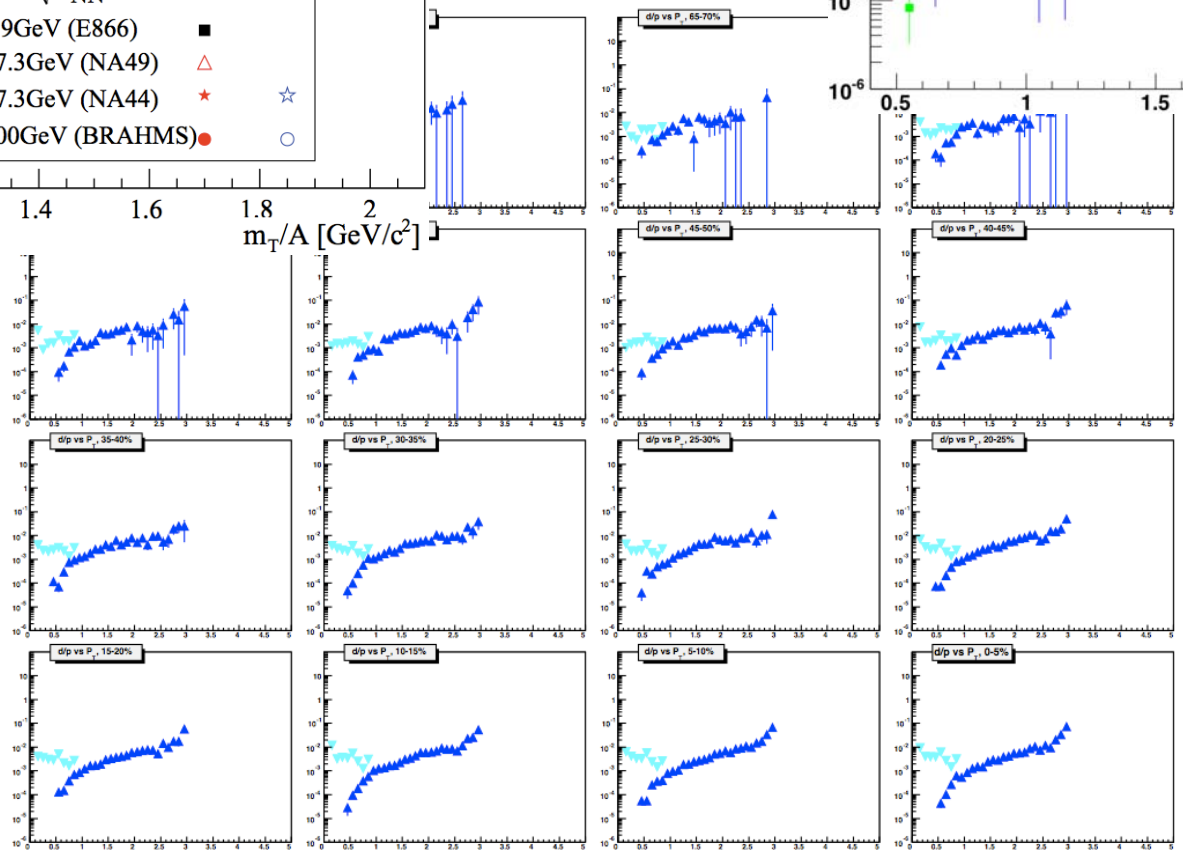


Baryonic Phase Space Density (d/p with a simple prefactor)







Corrections Introduction

absorption

- pbar handled by geant/embedding
- Abar cannot be done w/ geant, need to use an empirical approach

feeddown

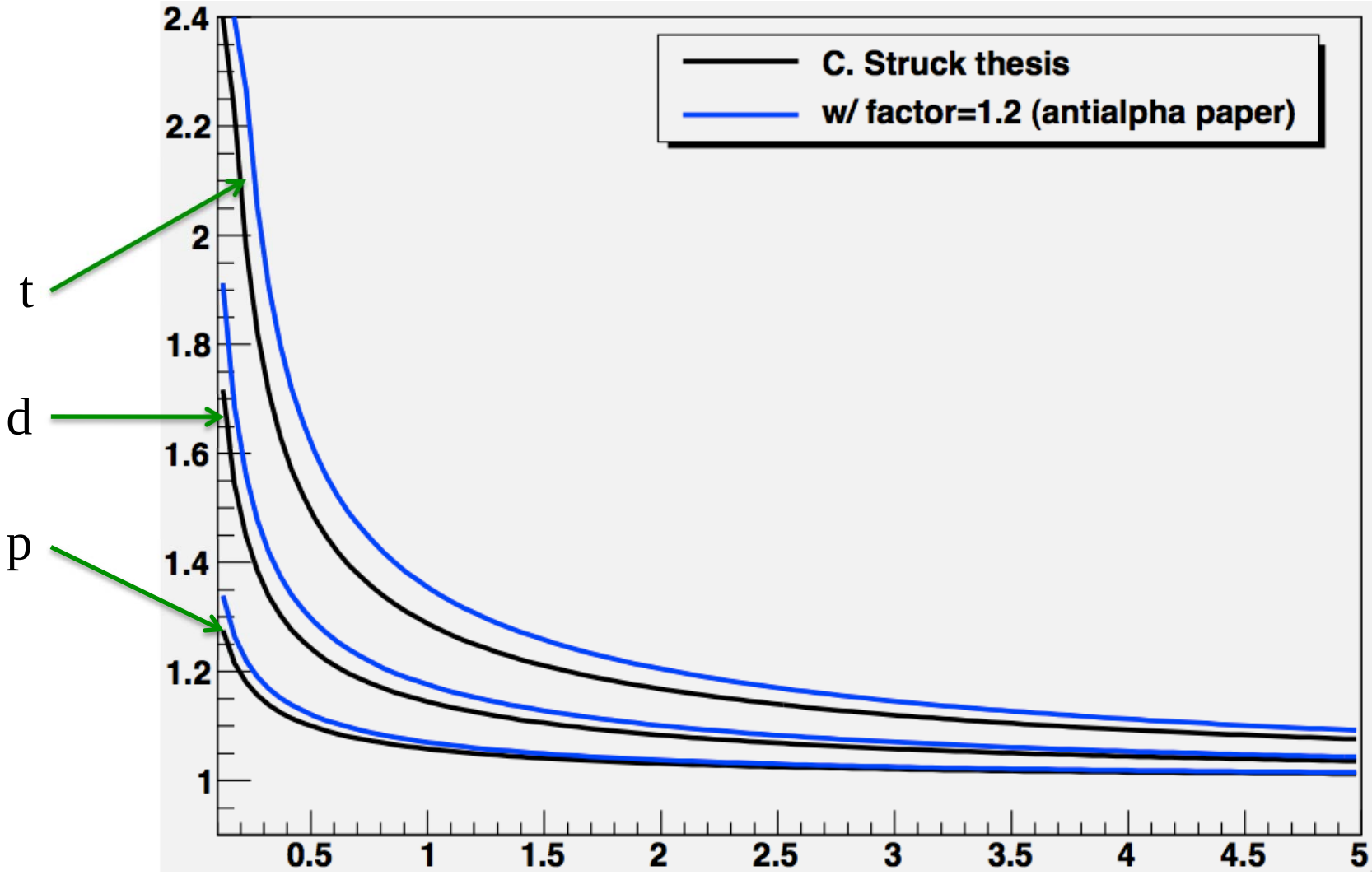
- simulation/reconstruction of full events from some model

reconstruction efficiency

- embedding

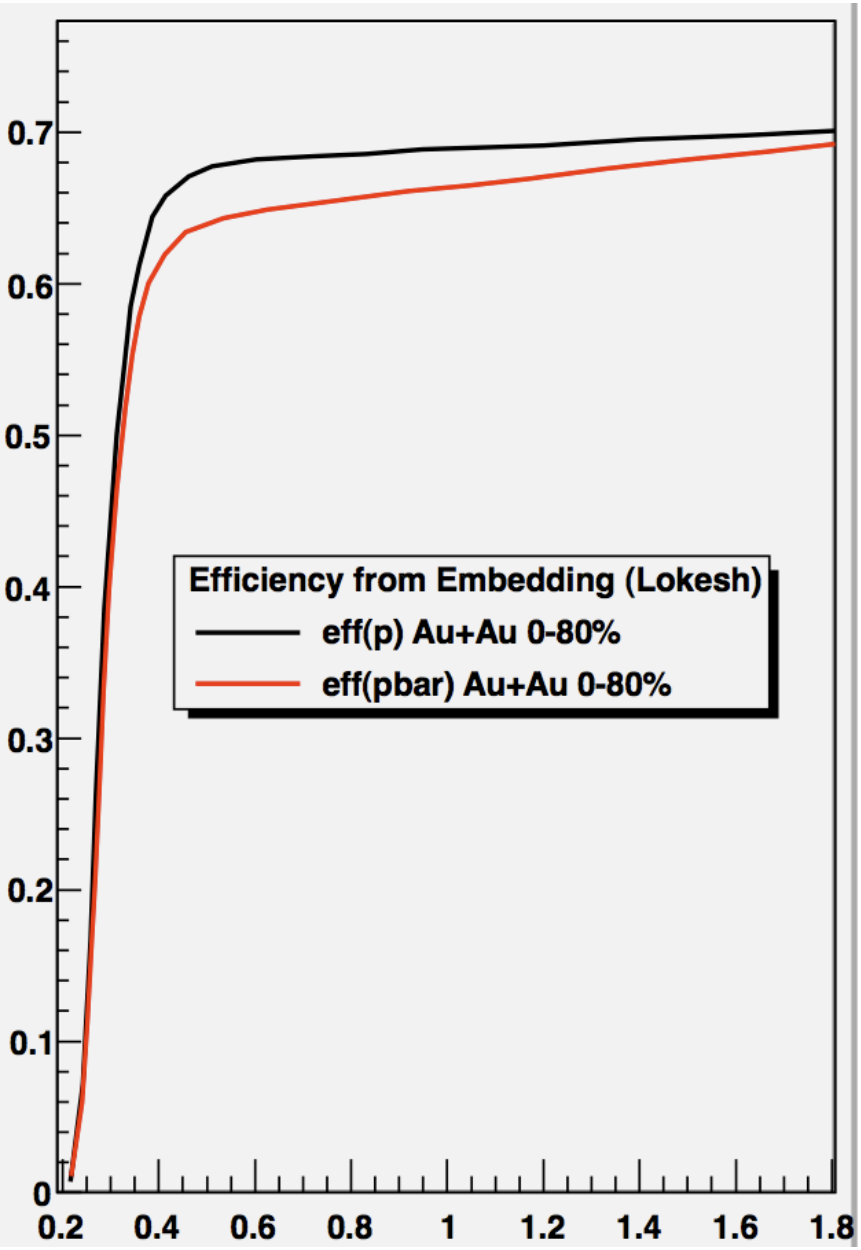
Absorption

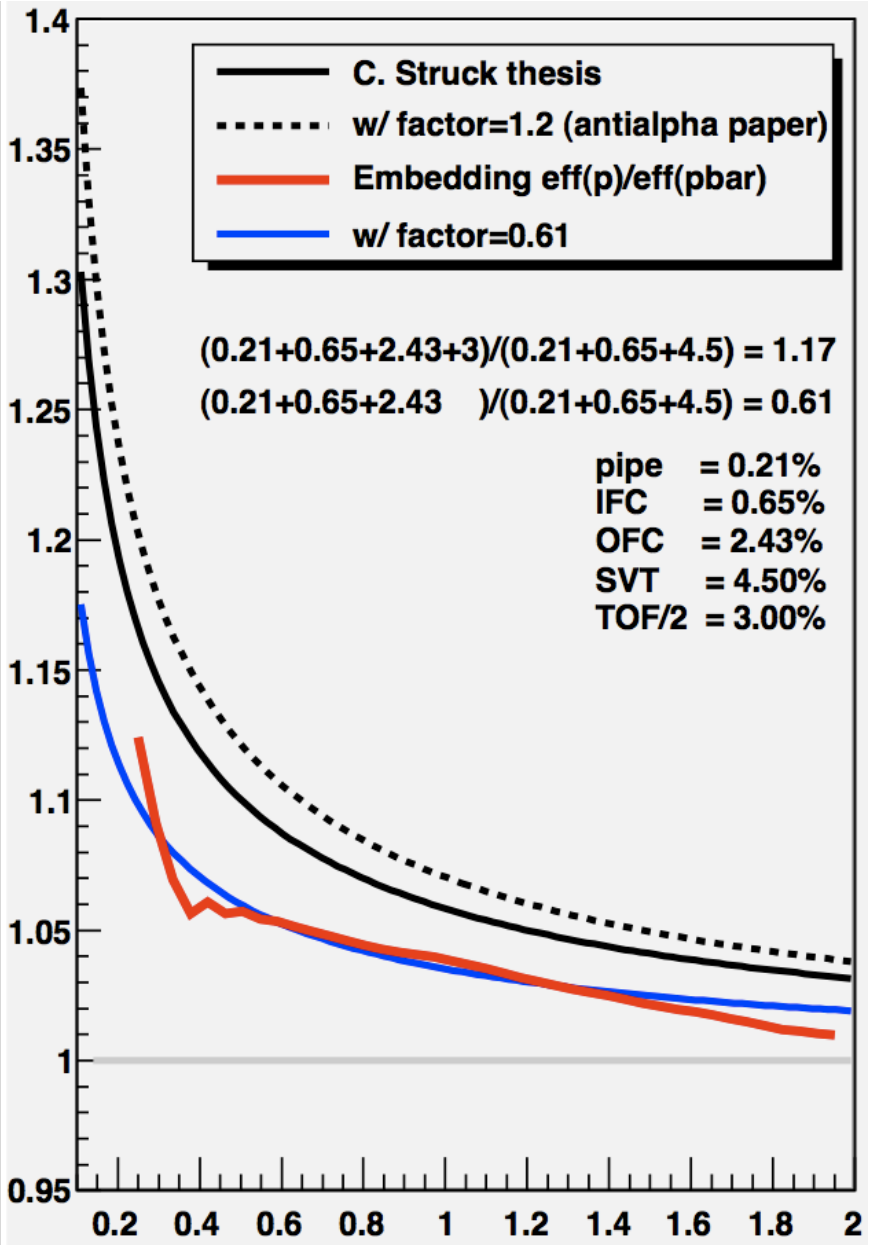
geant does not know how to interact antinuclei w/ arbitray materials
so use prescription described in Christof Struck's thesis…
same prescription used in recent antialpha paper after scaling the materials
(remove SVT, add half-depth of TOF)



Absorption

geant *does* know how to interact pbars, so one can test the absorption prescription using embedding data!



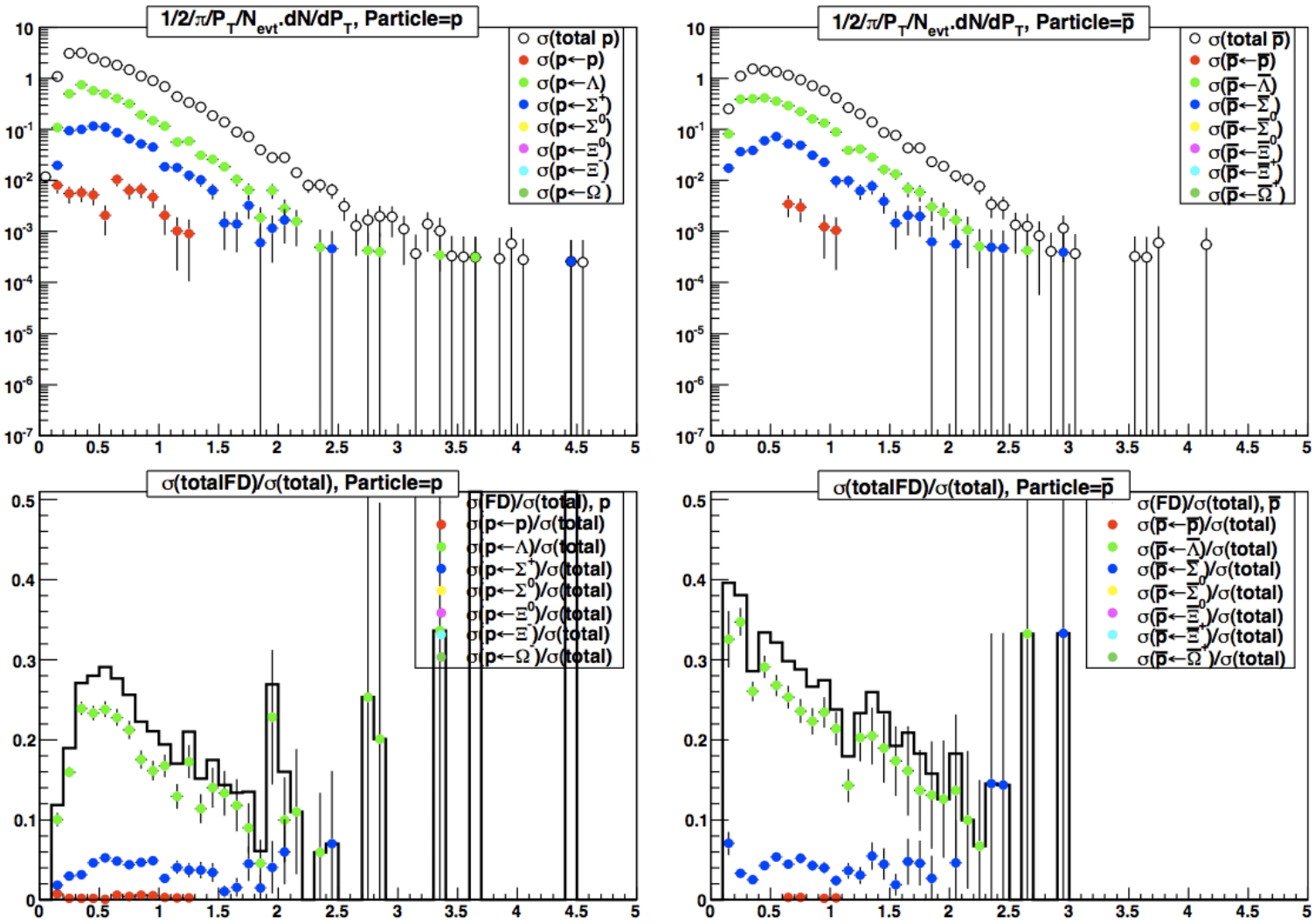


Feeddown

UrQMD 3.3p1
starsim & Y2010C
- geom repairs
- realistic σ_{Zvtx}

bfc.C
- TpcRS
- MiniMcMk

TpcRS is **slow**
but most realistic…
no dE/dx fudging!

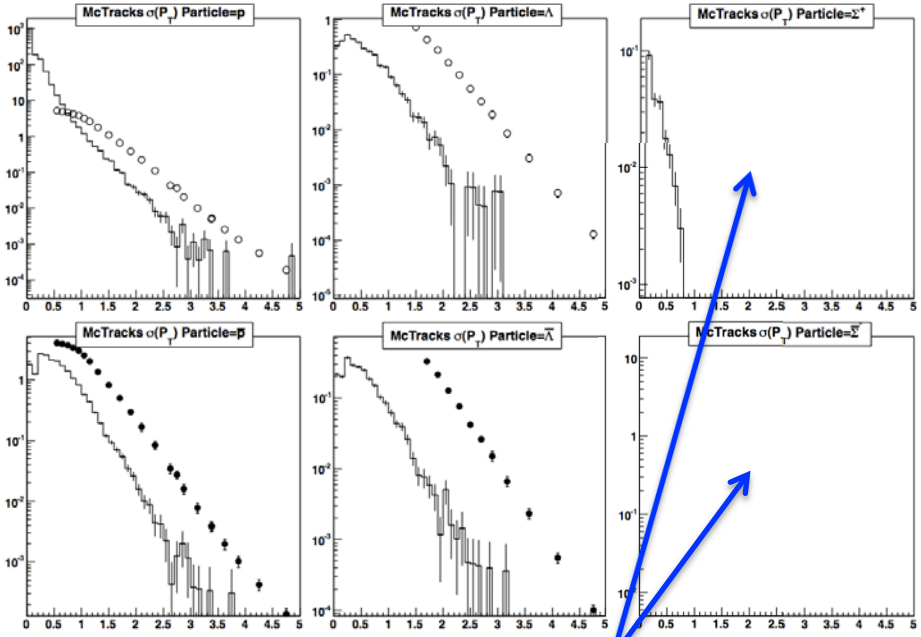


Uncovered problems in trs
- unknown species was given a geantID=0, and then no energy loss, and then no rec. tracks

Fix entailed changes to trs and StarClassLibrary to properly include light antinuclei…
- see RT Ticket #2157.

Feeddown

then scale the sim x-secs to measured x-secs

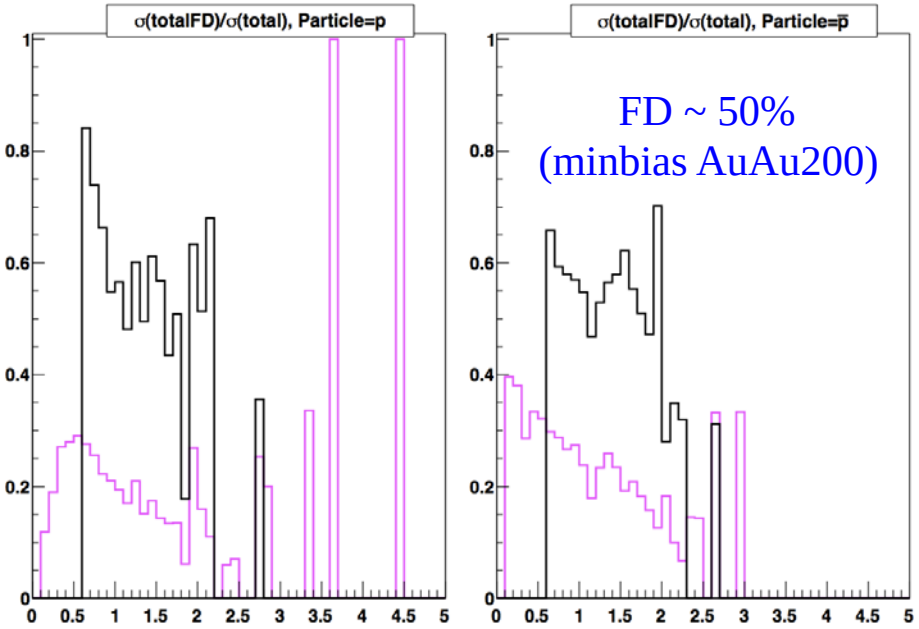


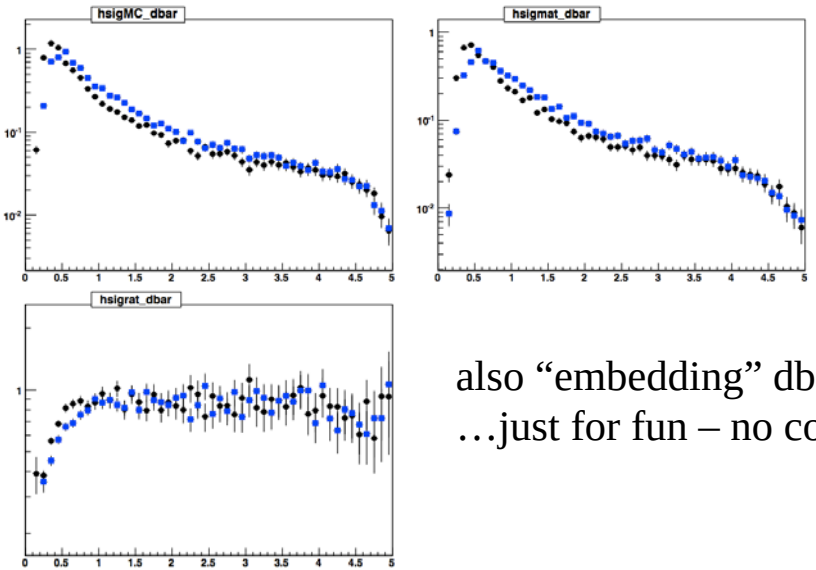
no measured Σ±
…scale by Σ/Λ…

extremely CPU intensive…

will need to pick a few root-s values and then interpolate…

then scale the sim FD ratios…





also “embedding” dbar,tbar
…just for fun – no cost…

Embedding Introduction

Lots of technical problems in many different codes….
(many thanks to Hiroshi, Xiangli, Geraldo, Xianglei, Gene, Jason, & Victor!)

Block 1:

dbar in p+p, 200 GeV, run-9	20101704	DONE
dbar in Au+Au, 200 GeV, run-10	20101706	DONE (final QA)
dbar in Au+Au, 11.5 or 39, run-10	Hope to start this very soon….	

Block 2:

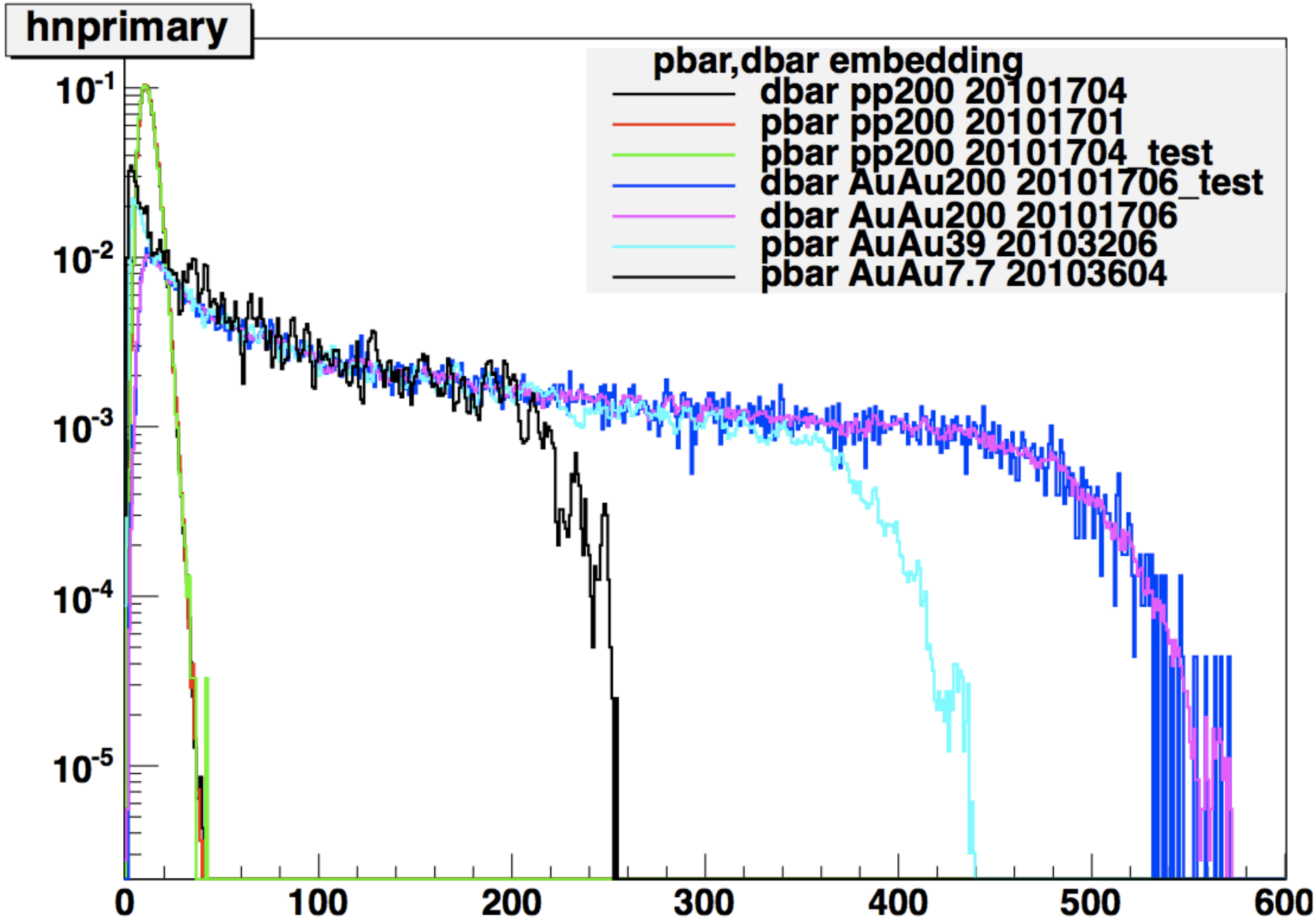
tbar in p+p, 200 GeV, run-9
dbar in Au+Au, 200 GeV, run-10
tbar in Au+Au, 11.5 or 39, run-10
pbar in p+p, 200 GeV, run-9
pbar in Au+Au, 200 GeV, run-10
pbar in Au+Au, 11.5 or 39, run-10

these will be exactly the same as the block 1 requests except simply change the GeantId in StPrepEmbedMaker…..

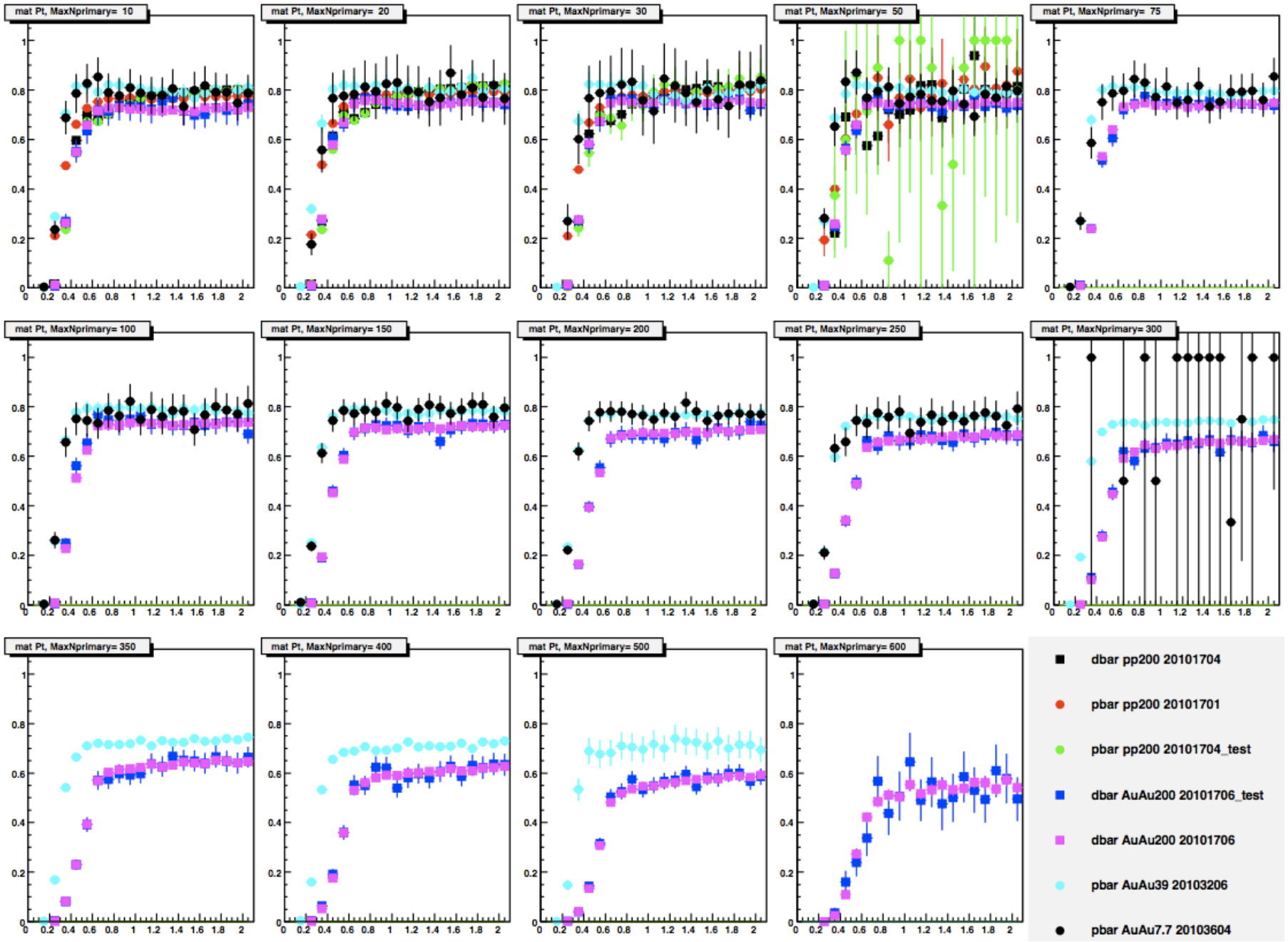
I also found some existing embedding productions laying around….

pbar	p+p	200GeV	20101701
pbar	Au+Au	39GeV	20103206
pbar	Au+Au	7.7GeV	20103604

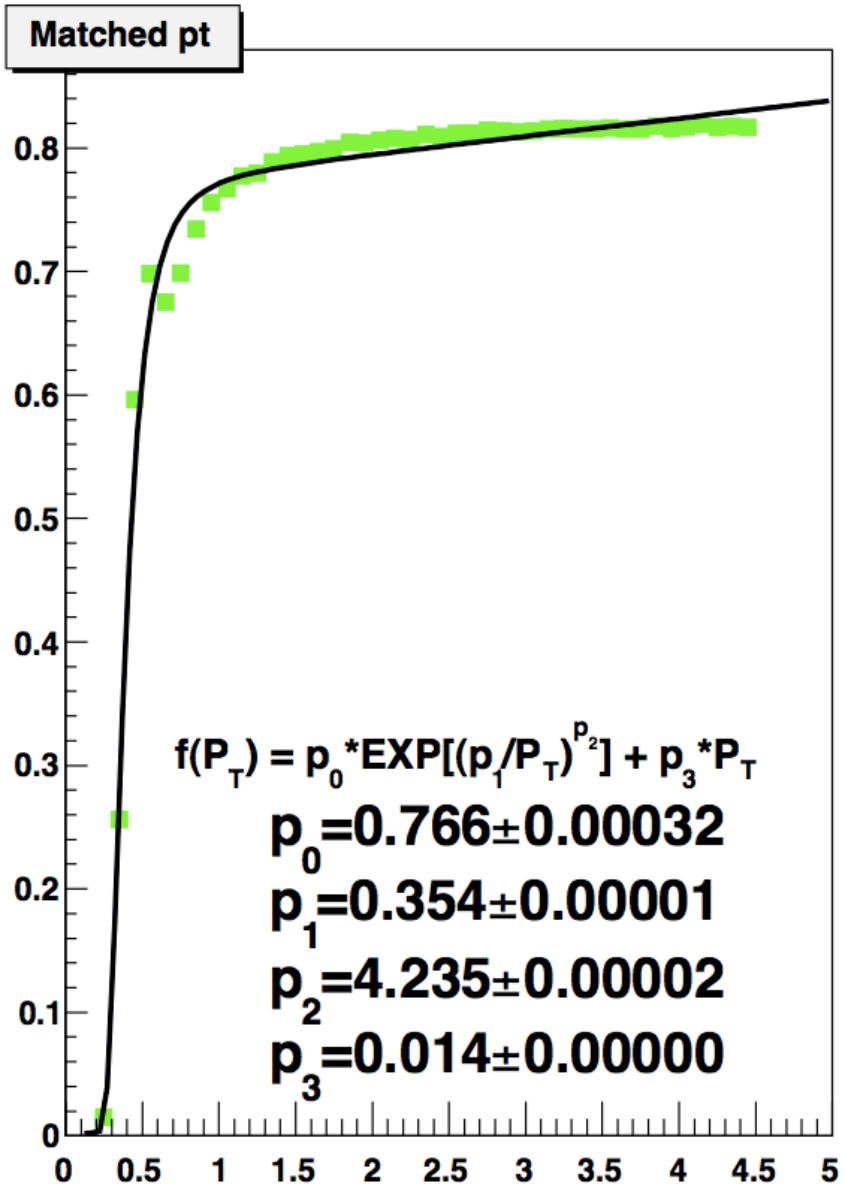
Embedding

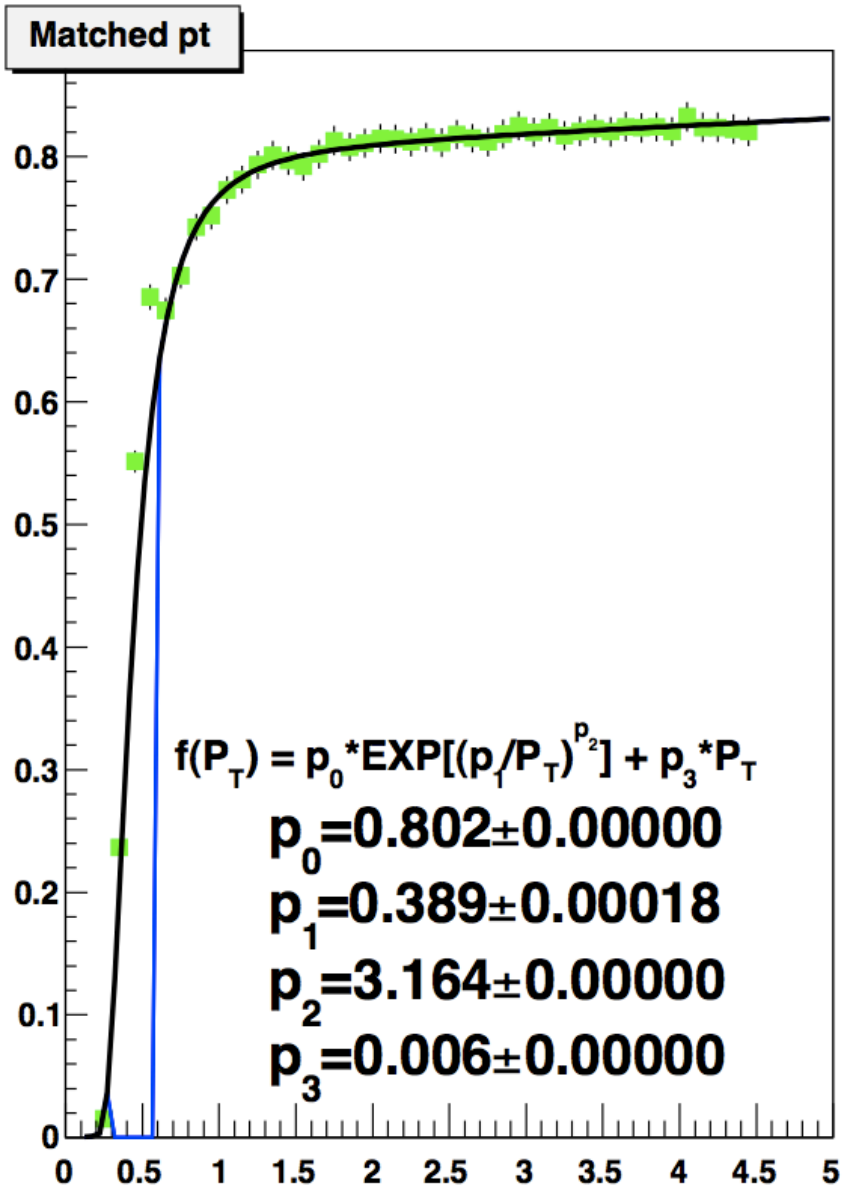

hnprimary
pbar,dbar embedding
dbar pp200 20101704
pbar pp200 20101701
pbar pp200 20101704_test
dbar AuAu200 20101706_test
dbar AuAu200 20101706
pbar AuAu39 20103206
pbar AuAu7.7 20103604
10^-1
10^-2
10^-3
10^-4
10^-5
0
100
200
300
400
500
600

Embedding

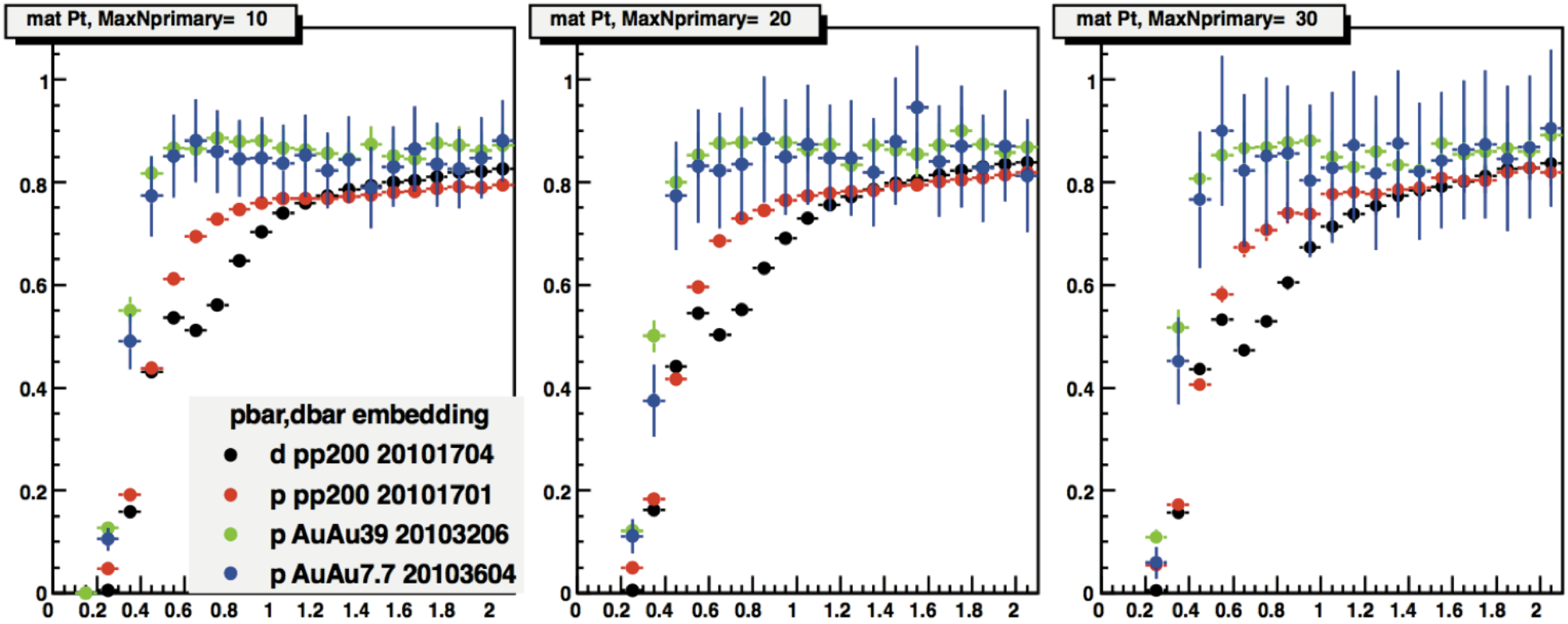

mat Pt, MaxNprimary= 10
mat Pt, MaxNprimary= 20
mat Pt, MaxNprimary= 30
mat Pt, MaxNprimary= 50
mat Pt, MaxNprimary= 75
mat Pt, MaxNprimary= 100
mat Pt, MaxNprimary= 150
mat Pt, MaxNprimary= 200
mat Pt, MaxNprimary= 250
mat Pt, MaxNprimary= 300
mat Pt, MaxNprimary= 350
mat Pt, MaxNprimary= 400
mat Pt, MaxNprimary= 500
mat Pt, MaxNprimary= 600
dbar pp200 20101704
pbar pp200 20101701
pbar pp200 20101704_test
dbar AuAu200 20101706_test
dbar AuAu200 20101706
pbar AuAu39 20103206
pbar AuAu7.7 20103604

Embedding, dbar in p+p 200GeV Run-9 20101704





Embedding (weird shape of dbar eff in p+p 200GeV Run-9 20101704)



dbar efficiency follows pbar efficiency up to ~0.5GeV/c (?!?)