UrQMD+Thermus

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& data+Thermus NEW!

Data from D. McDonald

Motivation:

-- Transport model view of lfspectra centrality dependent ($<\mu_B>$,$<T>$)…

-- Explore bulkcorr assumption that centrality selection alone tightly constrains (μ_B,T)…

-- Explore possibility of constraining (μ_B,T) event-by-event with suitable cuts…

e.g. net and total pion moments products gated on pbar/p…

This is a follow-up to last week's presentation:

http://wjllope.rice.edu/fluct/protected/urqmdthermus_20120905.pdf

Here:

…in UrQMD+Thermus (E-by-E and in 1fm/c steps), constrain μ_S and γ_S, 2 par fit, GCE

…on the Number of degrees of freedom (with Evan Sangaline)

…data+Thermus (with Daniel McDonald)

…STAR acceptance- & efficiency-filtered UrQMD+Thermus (eff from Evan Sangaline)

Approach and codes

UrQMD 3.3p1

- Default parameters, only set impact parameter range and `ecm` only
  - centrality set on impact parameter in "standard" percentages assuming b_{max}=14fm
- output in 1 fm/c timesteps in each event
  - 500-800 timesteps total depending on root-s
- in each timestep, ignore spectators
  - and count multiplicity of 20 different particles (light hadrons and hyperons)

Thermus

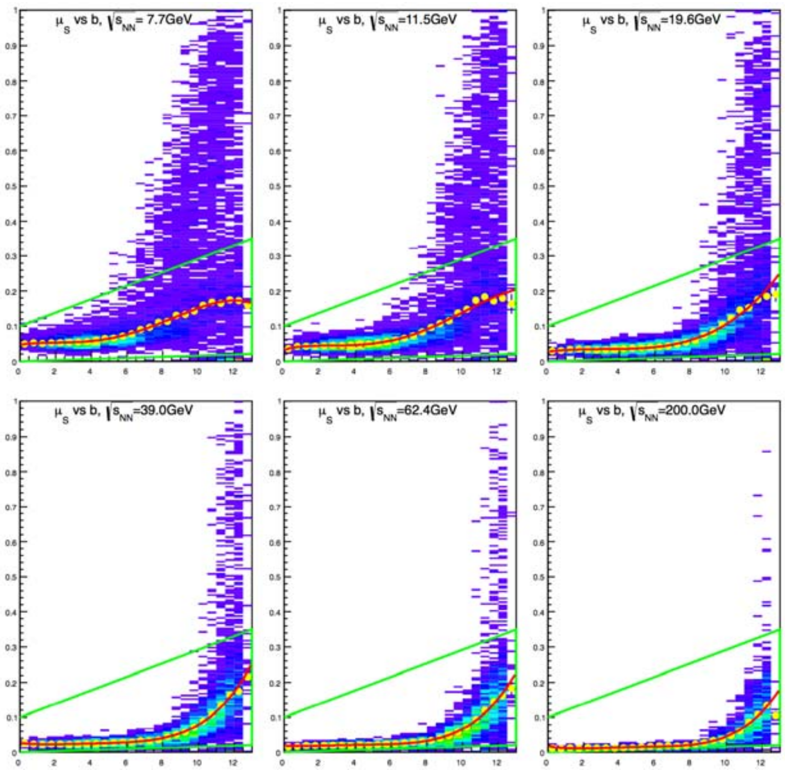
- Standalone application that reads the UrQMD files and
  - fits the multiplicity ratios in every timestep in every event
- Grand Canonical Ensemble, fit parameters: $(T, \mu_B, \mu_S, \gamma_S)$
- 12 ratios considered ($\pi\pm$, K$\pm$, p$\pm$, $\Lambda\pm$)
- Mult errors in each time step & evt taken as Poisson ($\sim\sqrt{N}$) – but not that important
- Also fit "averaged events" (in a given centrality bin) in each time step

Can thus

- plot the trajectories of individual events in (μ_B,T) space
- plot the trajectories of averaged events in (μ_B,T) space
- plot the distributions of $(T, \mu_B, \mu_S, \gamma_S)$ in centrality-selected events

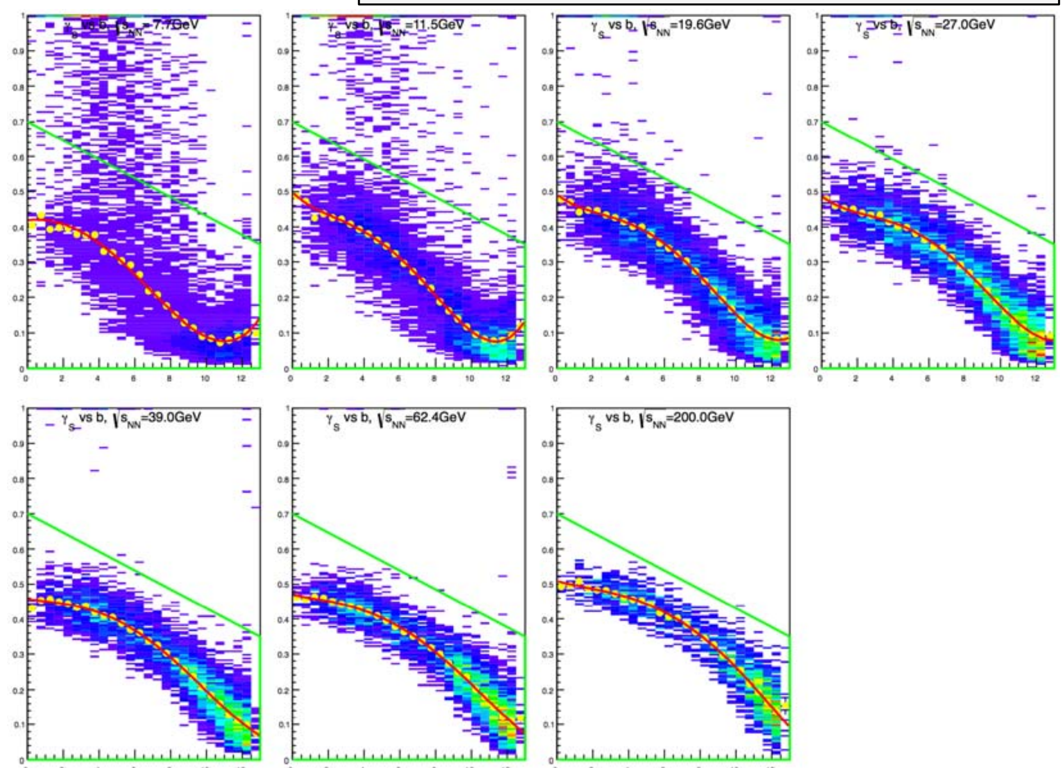
Constrain μ_S and γ_S and Fit (T, μ_B), GCE

In previously presented slides, (T, $\mu_{S,}$ $\mu_{B,}$ γ_S) were allowed to vary freely…
Resulted in some events with γ_S pegged at 1, and others w/ low values
and two peaks in μ_B for non-peripheral collisions at low root-s



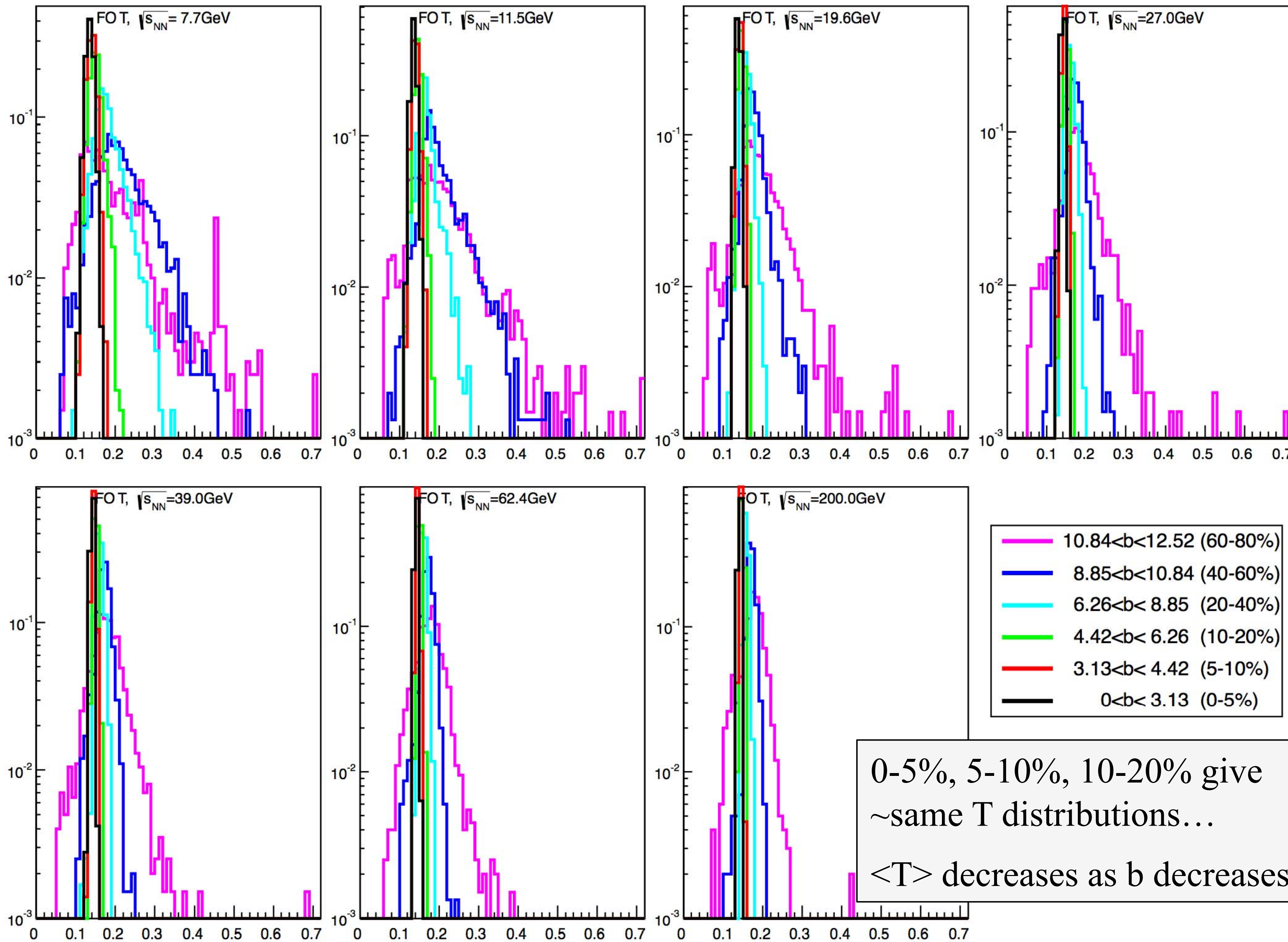
μ_S *vs* b and root-s from 4 par fits

γ_S *vs* b and root-s from 4 par fits



now constrain ($\mu_{S,}$ γ_S) values to the red curves and fit only (T, μ_B)….

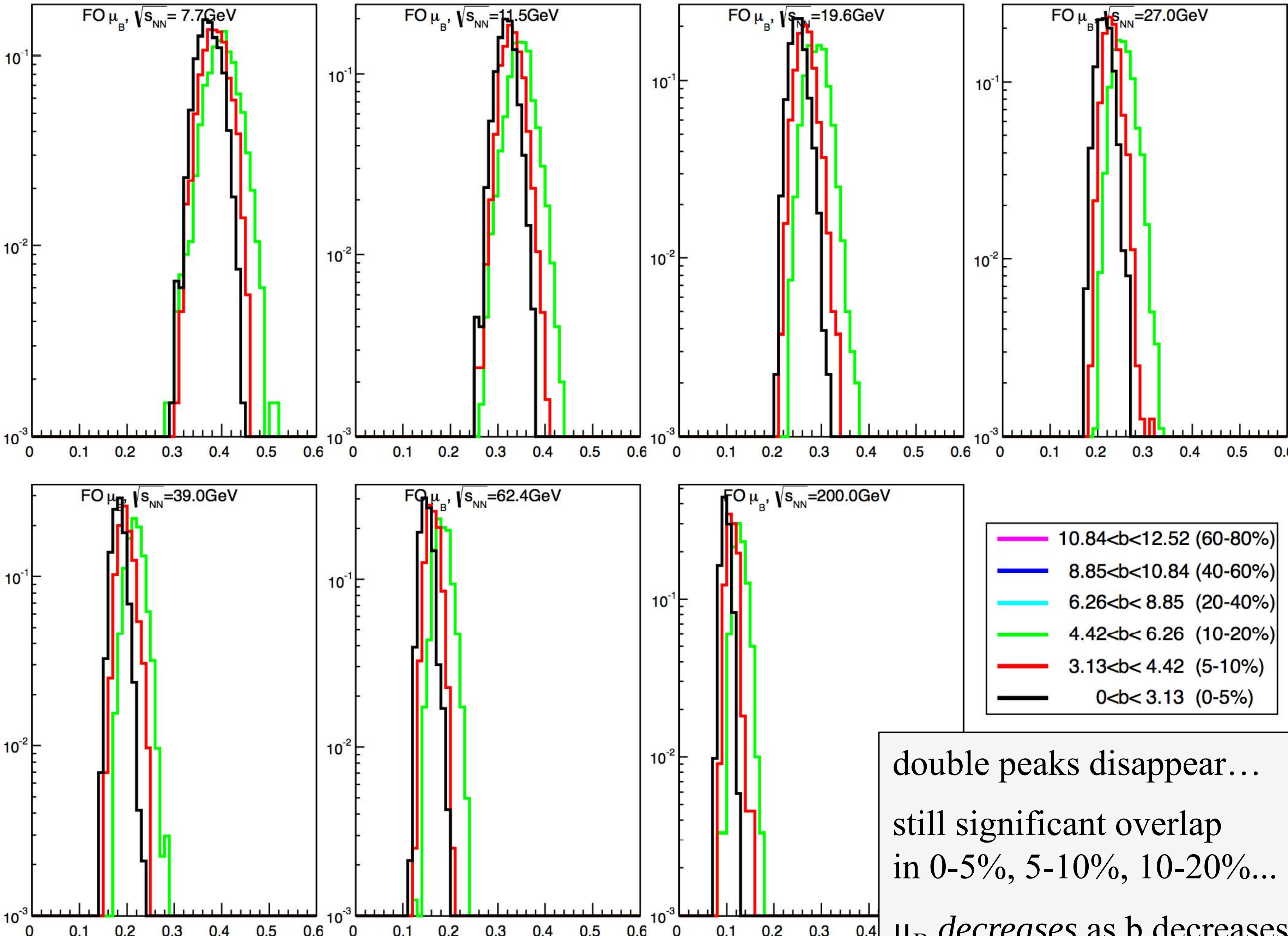
Constrain μ_S and γ_S and Fit (T, μ_B), GCE



0-5%, 5-10%, 10-20% give ~same T distributions…

<T> decreases as b decreases…

Constrain μ_S and γ_S and Fit (T, μ_B), GCE

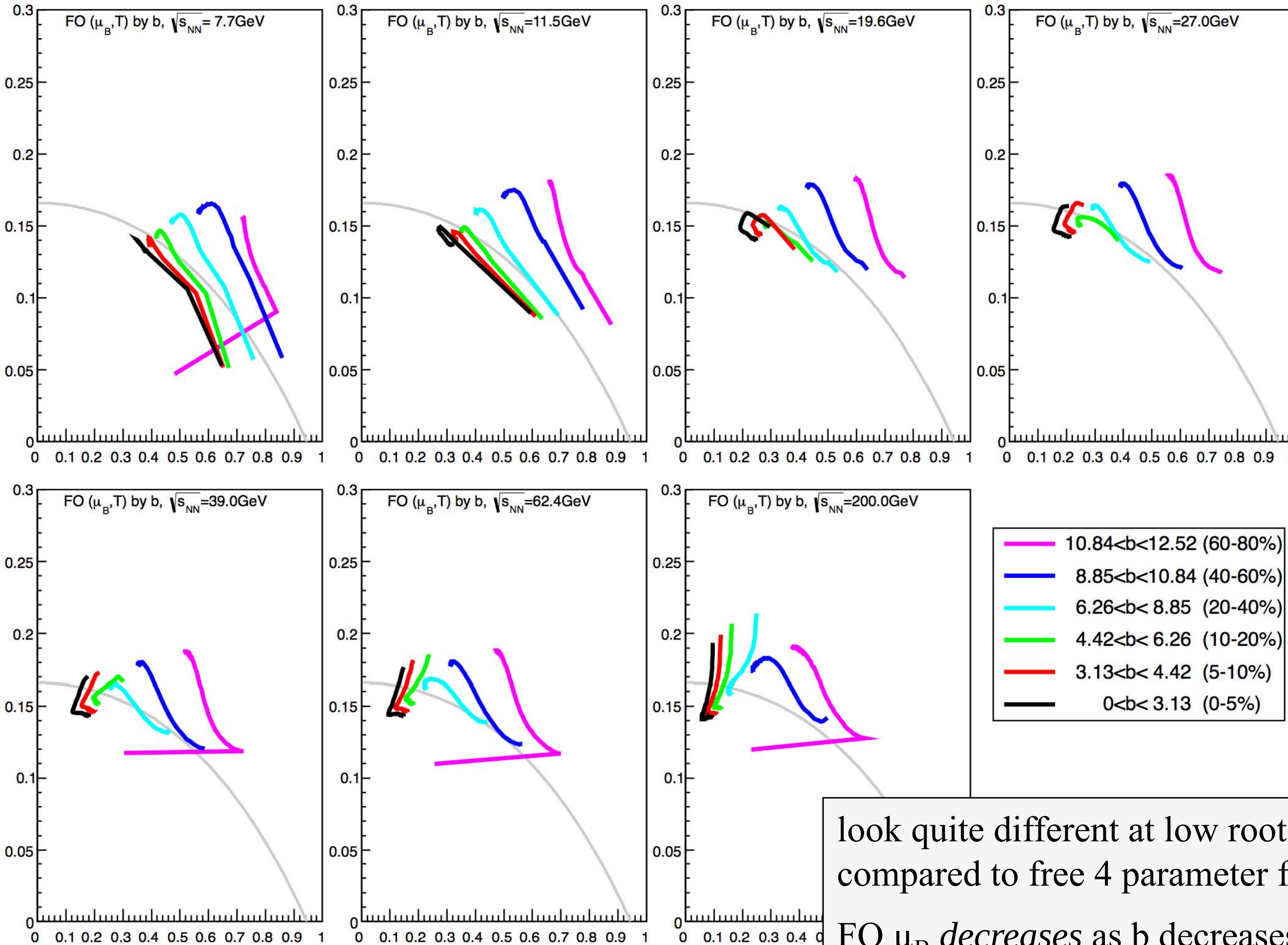


double peaks disappear…

still significant overlap
in 0-5%, 5-10%, 10-20%...

μ_B *decreases* as b decreases…

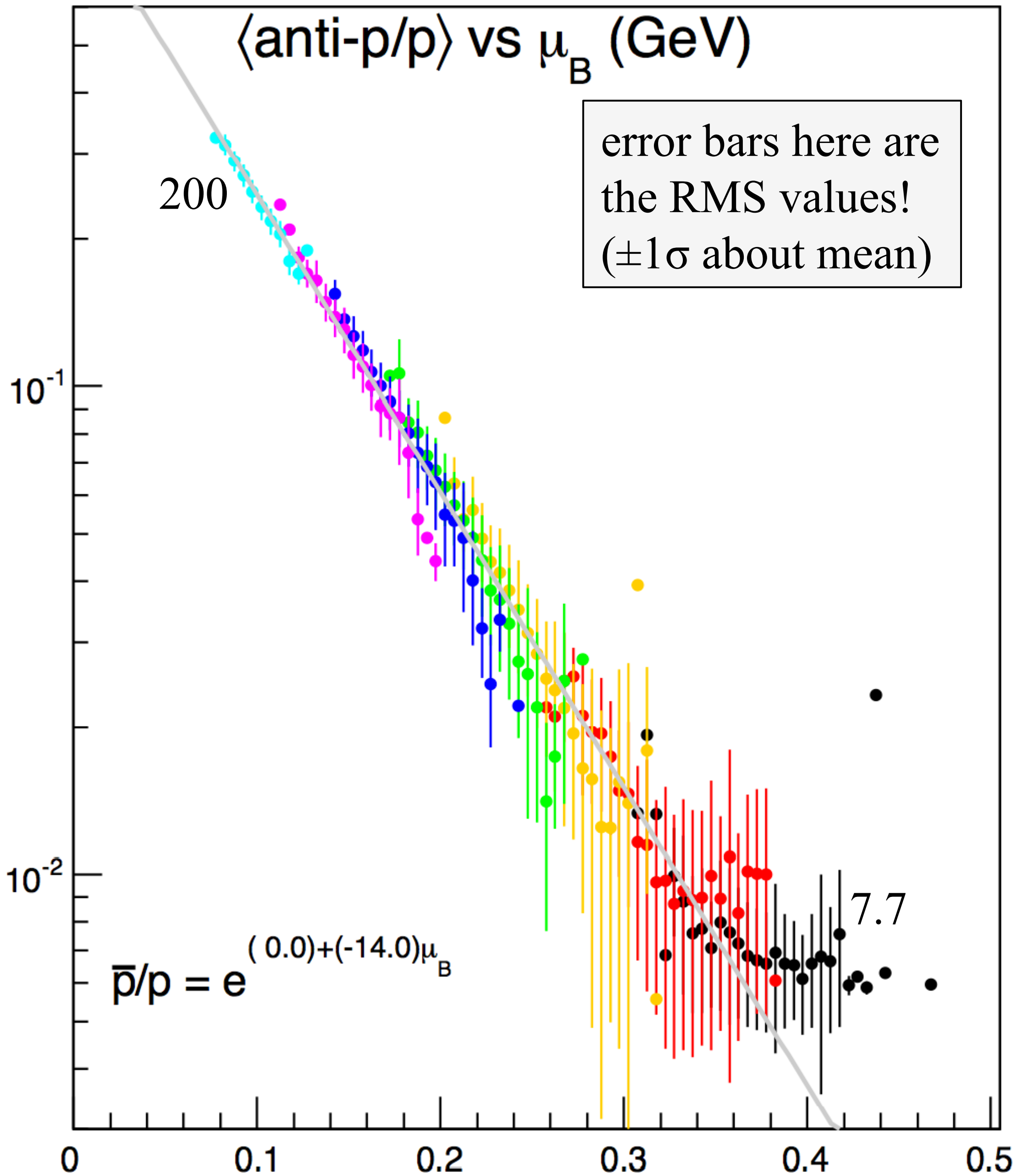
Constrain μ_S and γ_S and Fit (T, μ_B), GCE, Event-Avg Trajectories



look quite different at low root-s compared to free 4 parameter fits…

FO μ_B *decreases* as b decreases…

Constrain μ_S and γ_S and Fit (T, μ_B), GCE



Here: 0-5% central

trend holds for less central events
w/ non-zero pbar and p multiplicities

pbar/p = exp(-14μ_B)

This is the same trend as seen
in the 4 parameter fit…

N_{DOF}

For N non-zero yields, one can form $\sum_{i=1}^{i<N} i$ ratios…

i.e. for $\pi^{\pm}$,$K^{\pm}$,$p^{\pm}$ –> up to N=6 non-zero yields –> 15 non-zero ratios possible

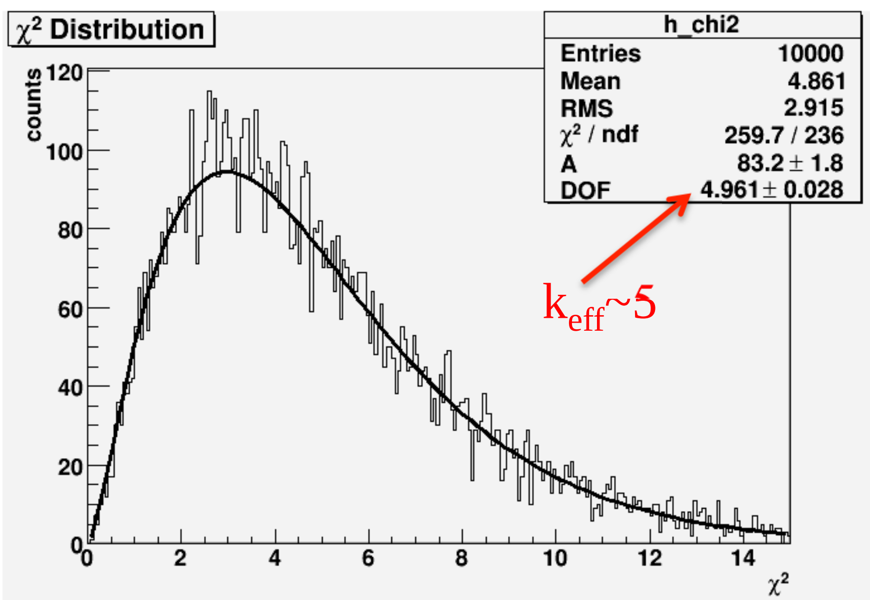
Of these 15 non-zero ratios from N non-zero yields, N-1 are independent…
Now, I am only fitting events if $N-1 \geq N_{par}$

Evan's simulation:

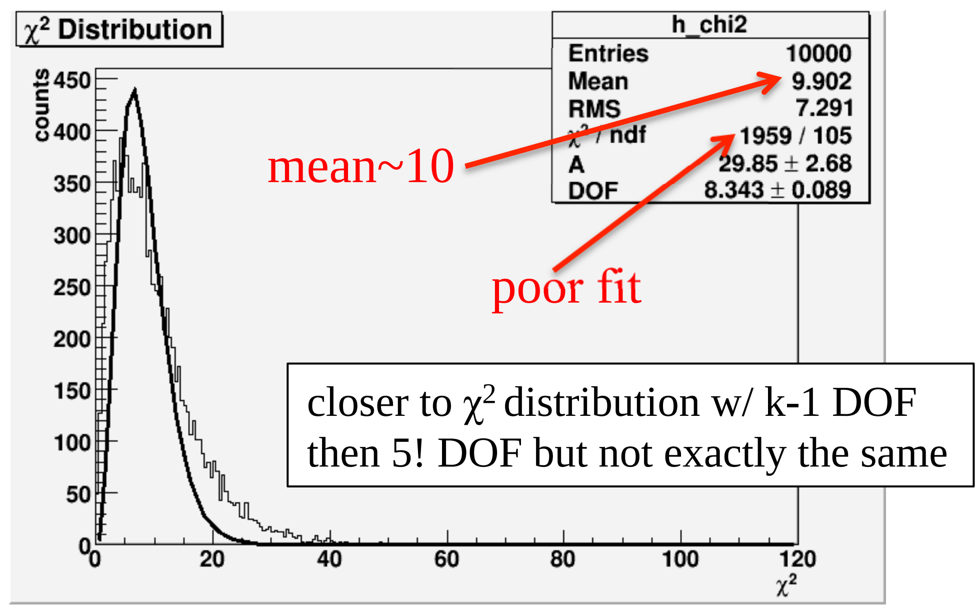
how probable is it to measure **b** if normal distributed with means **m** and covariance C.
$(\mathbf{b}-\mathbf{m})^T C^{-1}(\mathbf{b}-\mathbf{m})$ is χ^2 distributed with k DOF

m = meas (vector with k values)
b = model (vector with k values)
C = meas covariance (k×k matrix)
v = meas variances (diagonal of C)

only yields….
k=5 measurements are independent
plot diagonal-only χ^2 sum



all ratios….
plot diagonal-only χ^2 sum for 5! ratios
…mean~10, k-1<mean<5!



Used same Thermus code to fit experimental $\pi^{\pm}$,$K^{\pm}$,$p^{\pm}$ yield ratios event-by-event

Yields from Daniel McDonald

Detailed bad-run and bad-event rejection
Same event and track cuts as he uses in his moments analyses
Centrality from refmult2corr
dE/dx+TOF plus spallation P_T cut for p
N=6 $\pi^{\pm}$,$K^{\pm}$,$p^{\pm}$ yields calculated for all directly identified tracks with $|\eta|<0.5$

But, BTW, there is a problem re: feeddown contributions to the observed yields….
Thermus can be run in two modes.

- No Decays: *i.e.* Input yields do not include any feeddown contributions
  (this is how I appropriately run the UrQMD+Thermus simulations)
- Allow Decays: *i.e.* Input yields include 100% of the possible feeddown
  from all particles known to Thermus (fit or not) with known branching fractions

AFAIK, our data is not consistent with either case

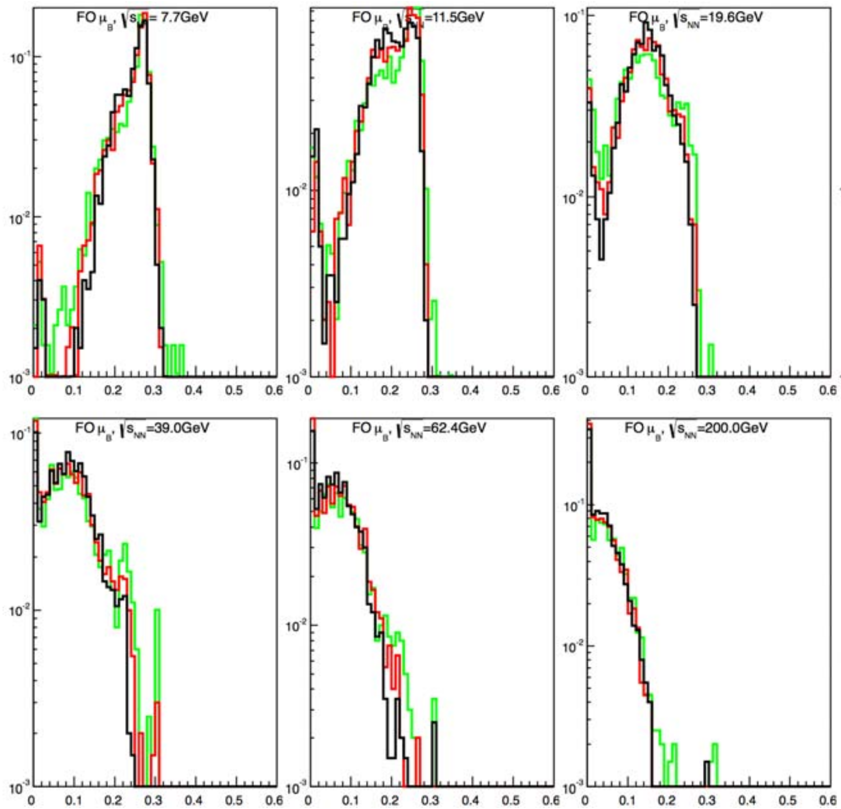
we can estimate feeddown but we don't generally measure all the necessary parent yields
or we can completely ignore feeddown, but there is typically a 1-3fm dca cut applied

…I'll just run Thermus in both modes and will provide both sets of results…

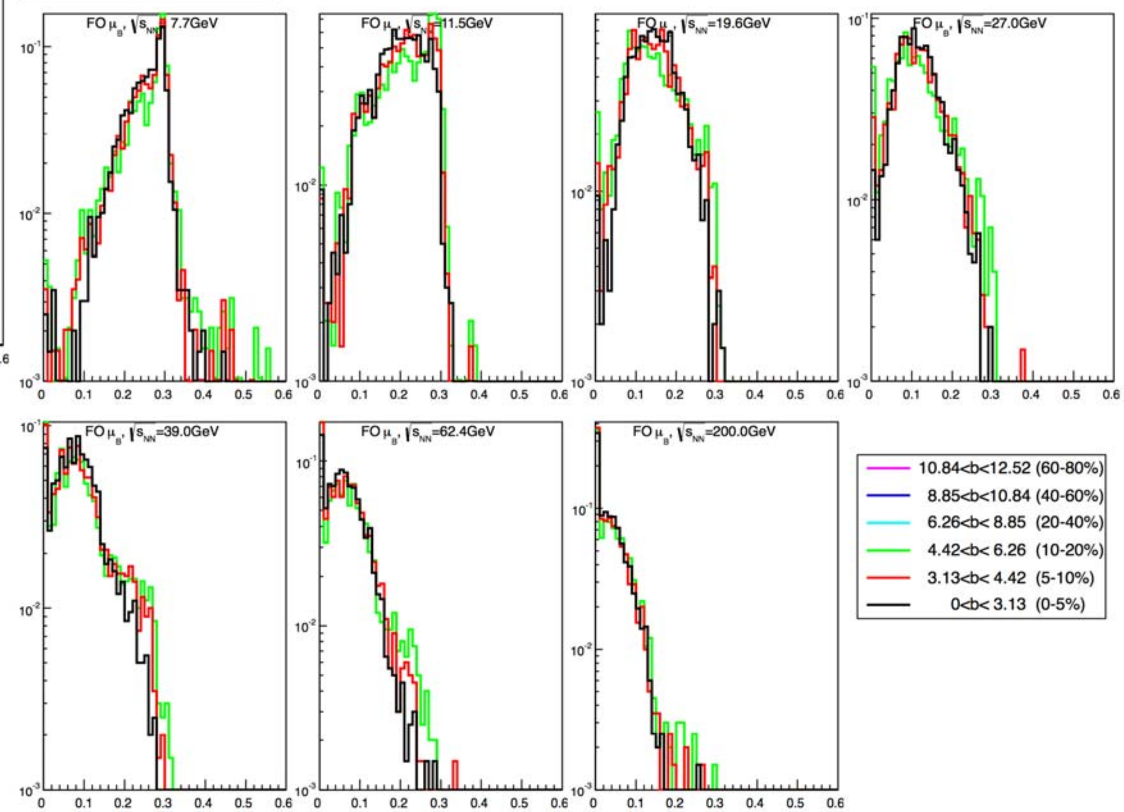
μ_B from data+Thermus fits: 0-5%, 5-10%, and 10-20% centrality only

Here, using 4 parameter fits – which look fine in general – non-zero ratios are reproduced…

DK off (zero feeddown)



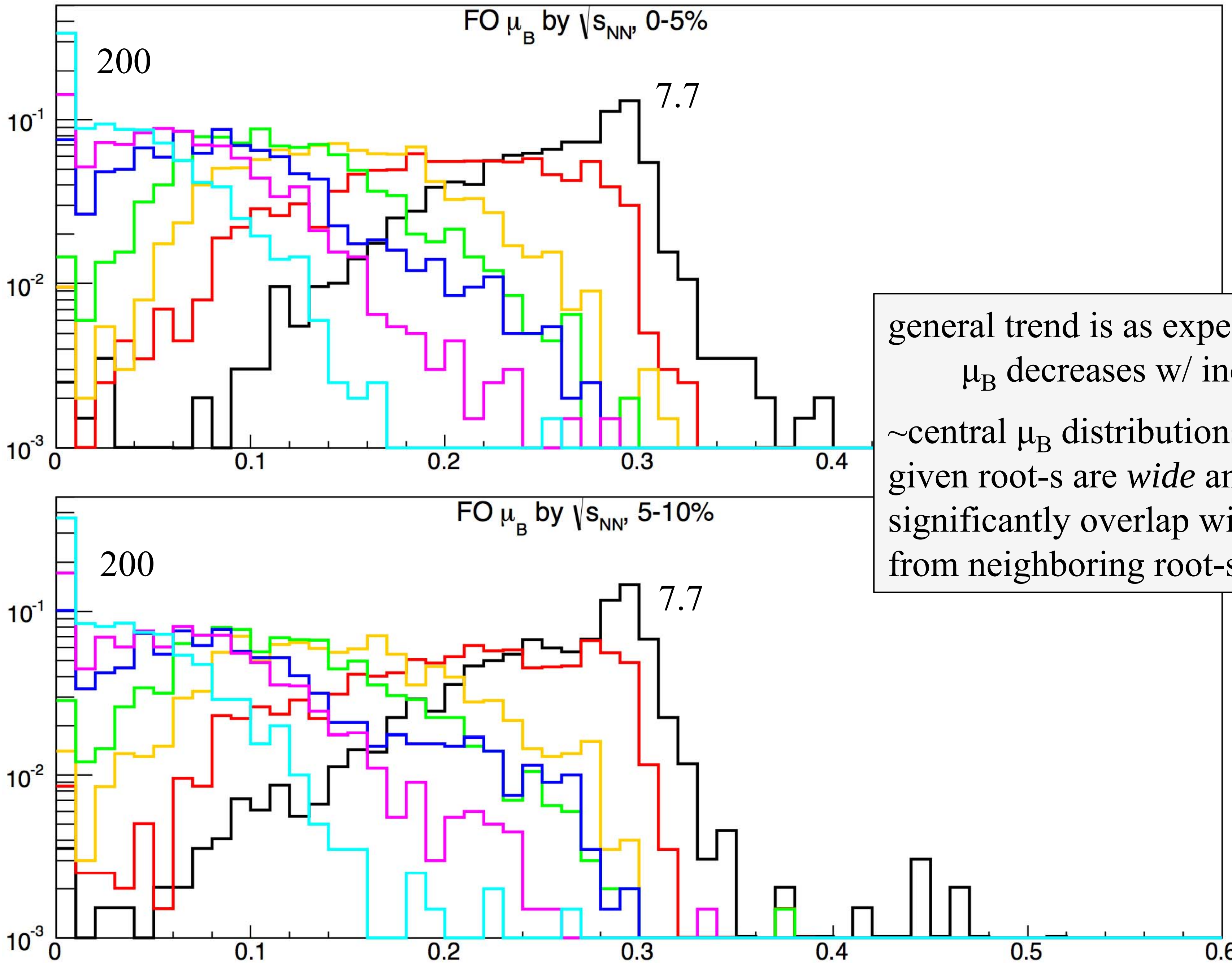
DK on (complete feeddown)



general trend is as expected
- μ_B decreases w/ increasing root-s

essentially no difference between
- 0-5%, 5-10%, and 10-20%

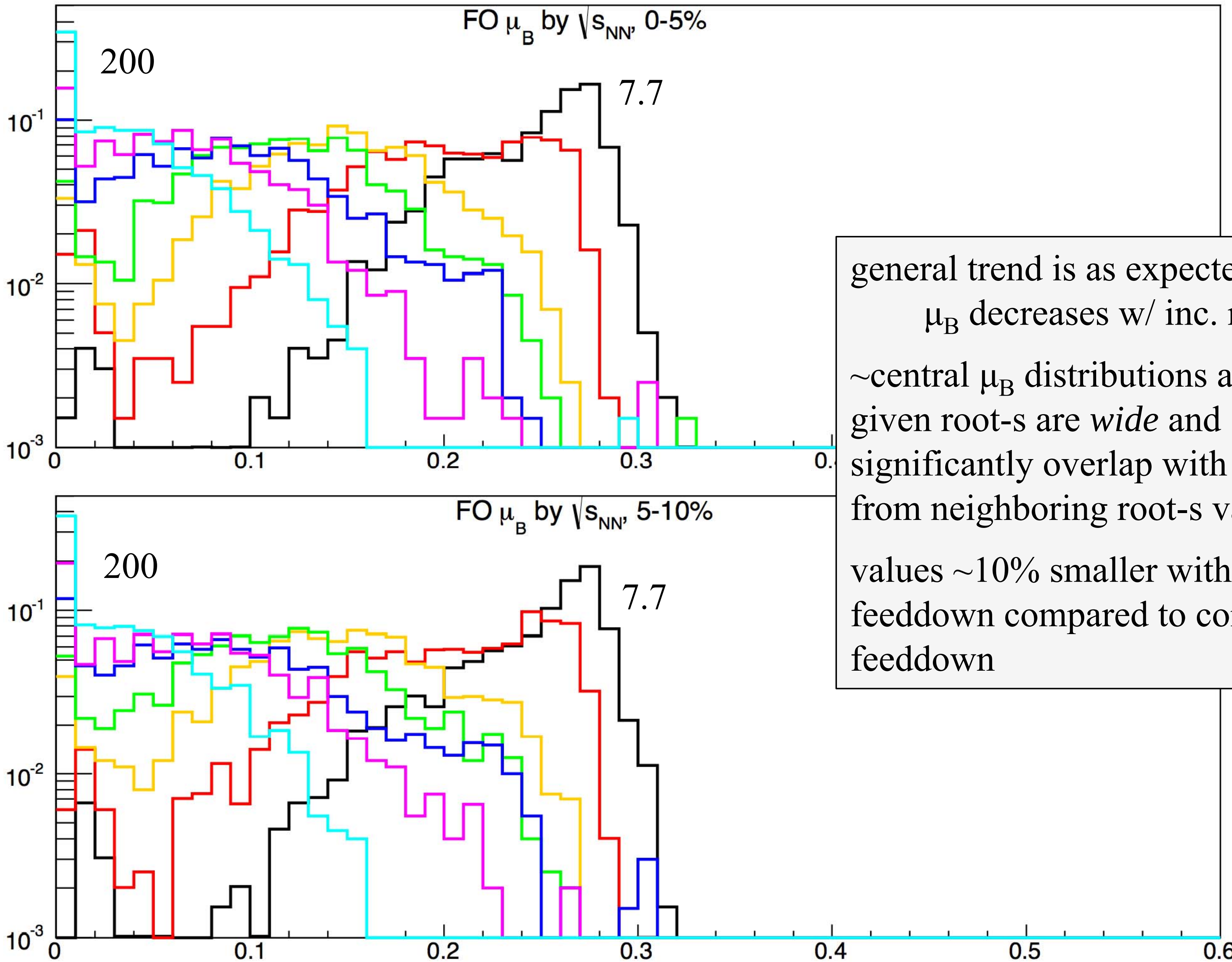
μ_B from data+Thermus fits, Complete feeddown



general trend is as expected
μ_B decreases w/ inc. root-s

~central μ_B distributions at a given root-s are *wide* and significantly overlap with data from neighboring root-s values

μ_B from data+Thermus fits, Zero feeddown



general trend is as expected

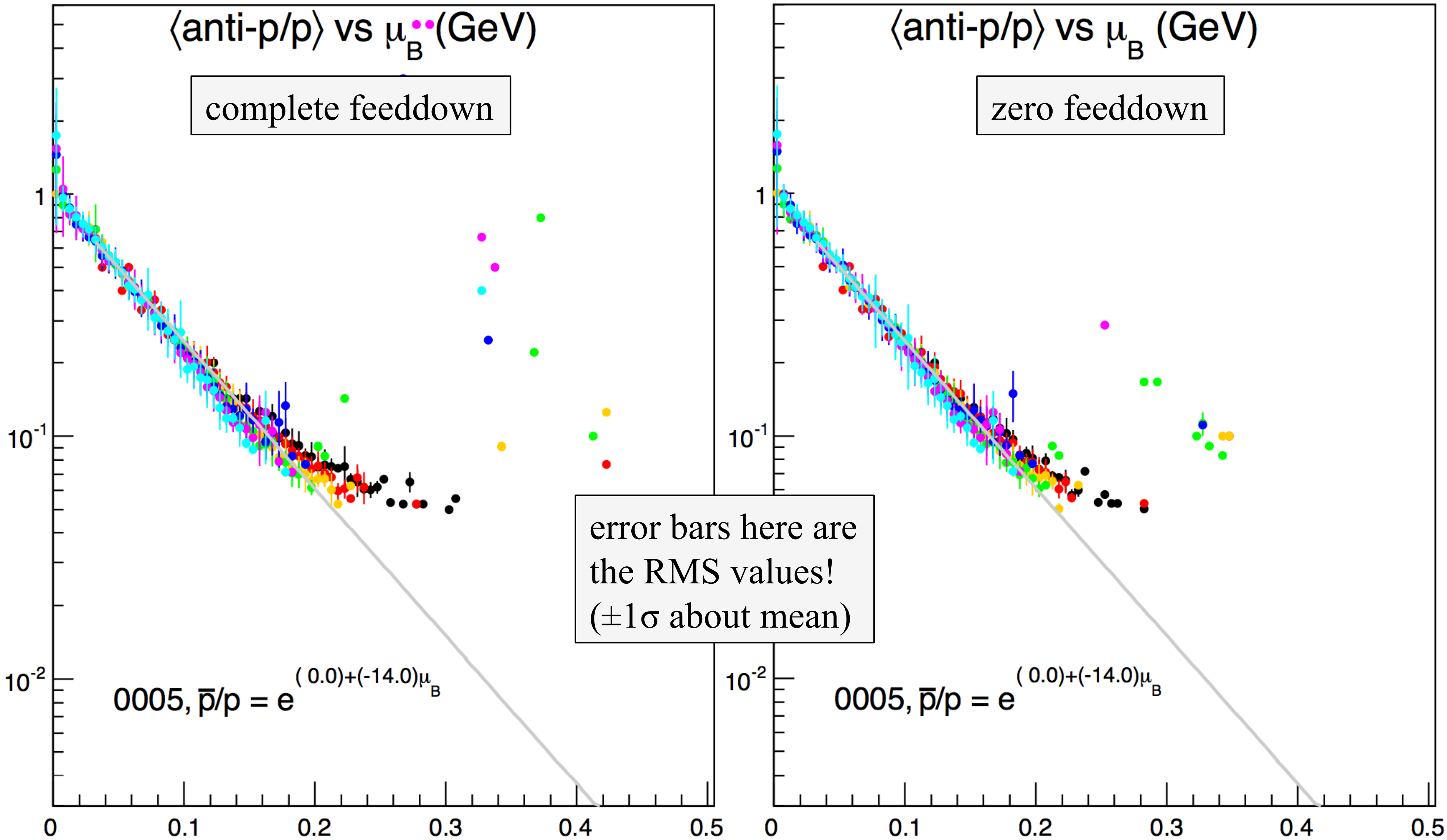
μ_B decreases w/ inc. root-s

~central μ_B distributions at a given root-s are *wide* and significantly overlap with data from neighboring root-s values

values ~10% smaller with zero feeddown compared to complete feeddown

UrQMD+Thermus

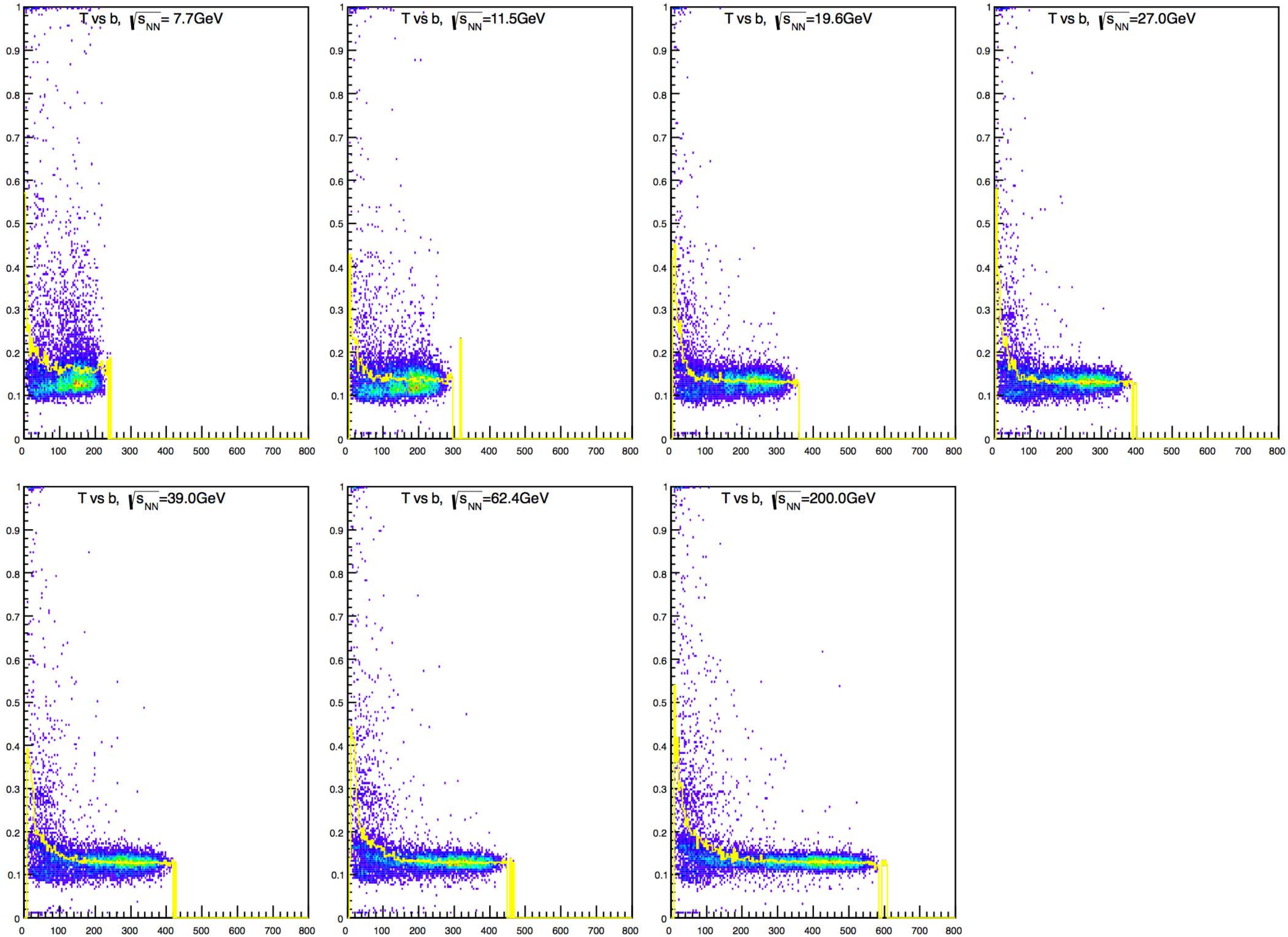
data+Thermus fits, 0-5% central



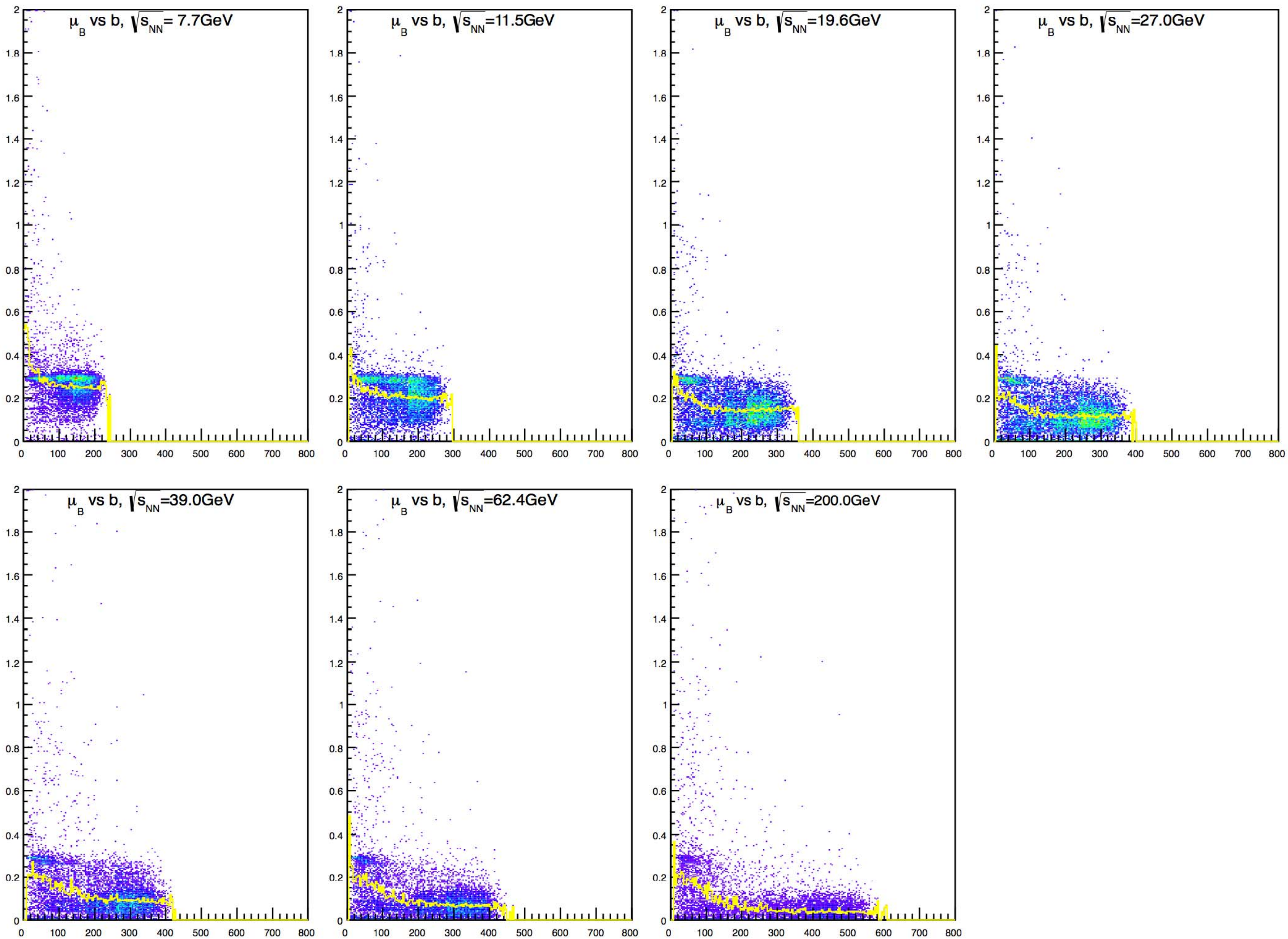
error bars here are the RMS values! (±1σ about mean)

…same pbar/p=exp(-14μ_B) trend is seen when fitting the yields from the experimental data…

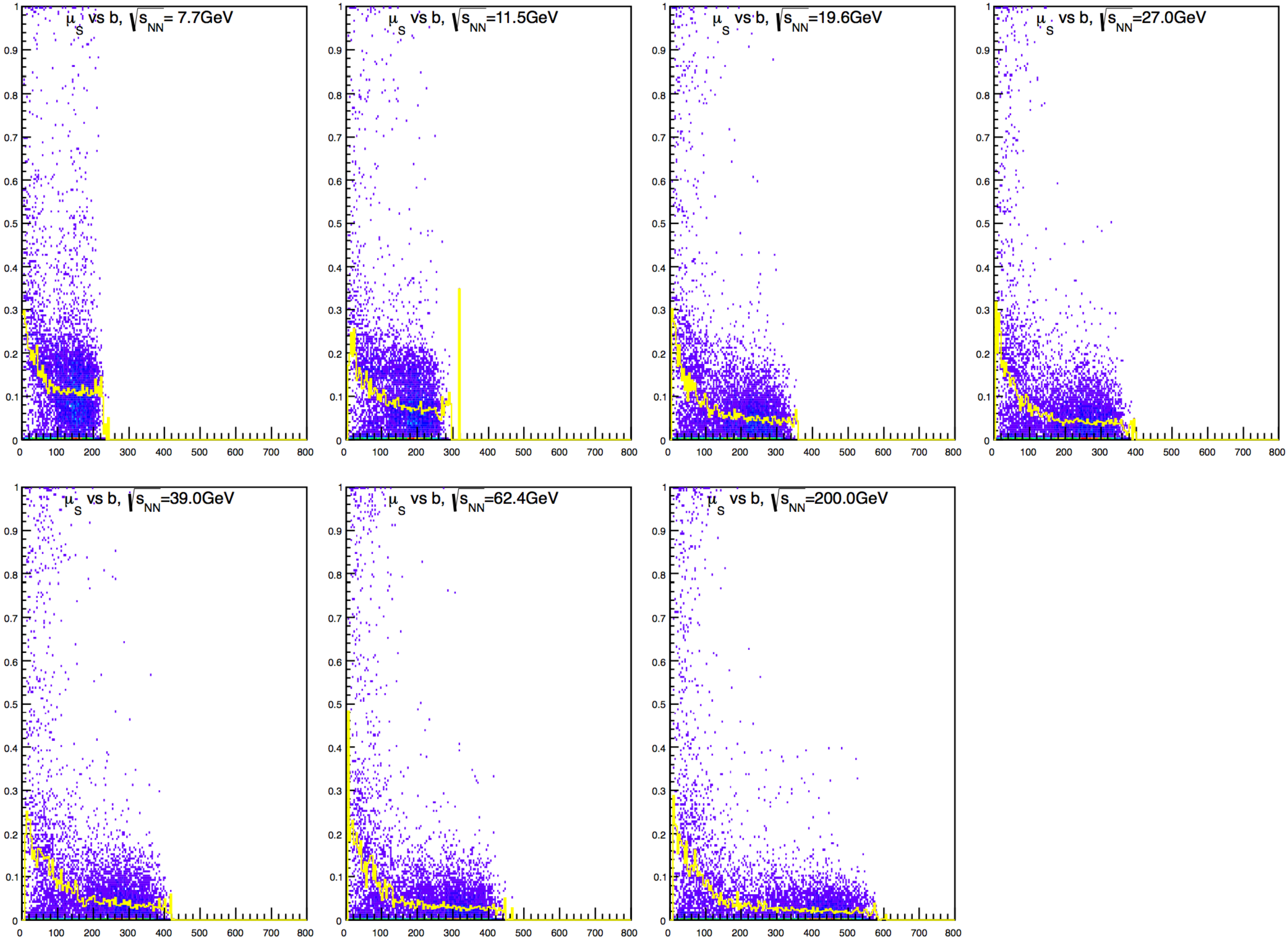
data+Thermus fits, complete feeddown, T *vs.* refmult2corr



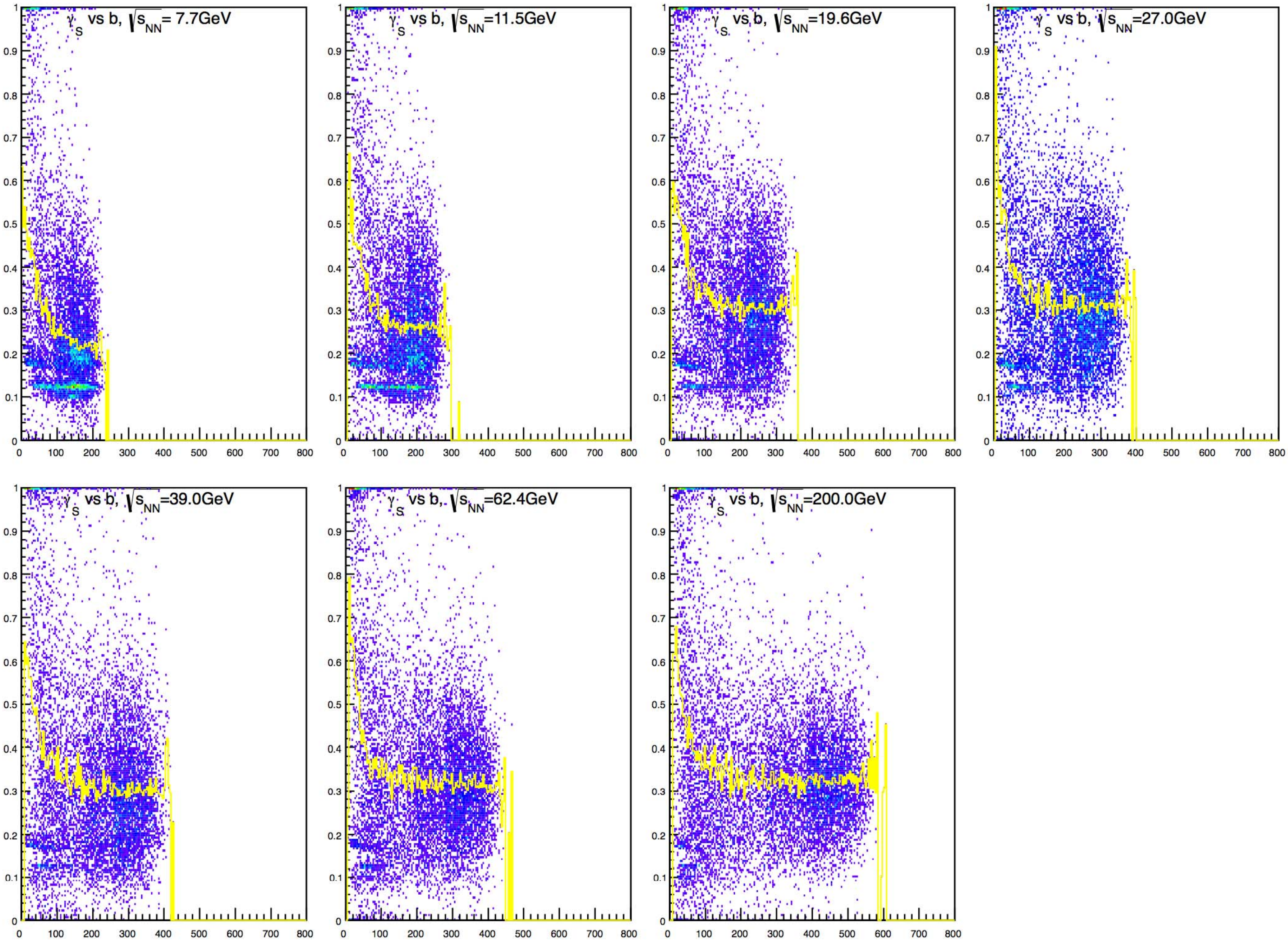
data+Thermus fits, complete feeddown, μ_B *vs.* refmult2corr



data+Thermus fits, complete feeddown, μ_S *vs.* refmult2corr



data+Thermus fits, complete feeddown, γ_S *vs*. refmult2corr



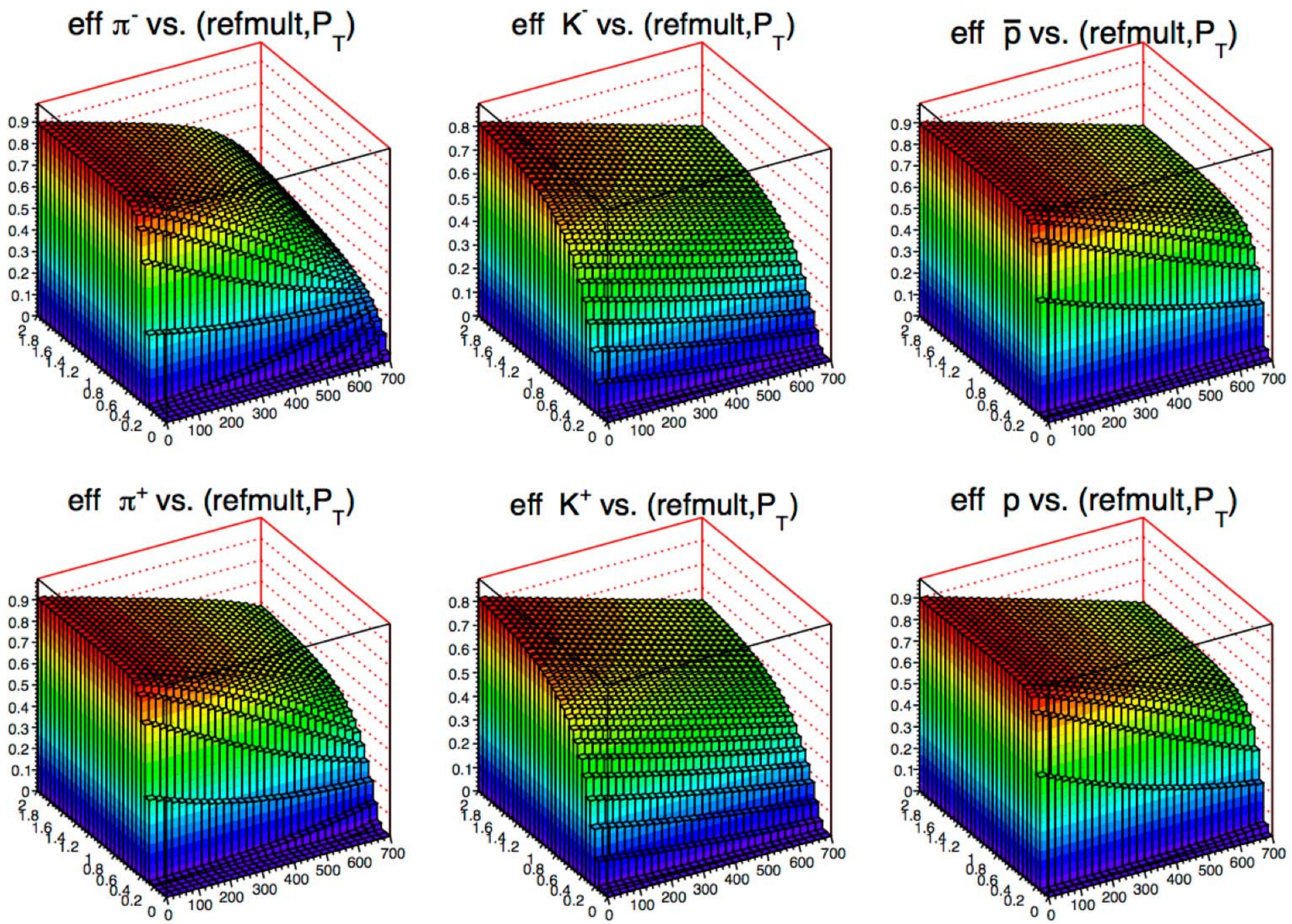
Towards filtered UrQMD+Thermus simulations…

In progress now: Apply “STAR” acceptance & efficiency filter to UrQMD

Compare perfect, 4π, participant-only simulation results to those we might measure E-by-E…

- refmult, refmult2 and refmult3 *vs.* impact parameter with and without the filter
- yields in |η|<0.5, P_T>0.2 GeV, and including a parameterized tracking efficiency

(parameterized tracking efficiencies from Evan Sangaline)



jobs running now…

plot $X^{perfect}$ vs X^{meas} where X=T, μ_B, μ_S, γ_S

Summary

Perfect 4π participant-only UrQMD+Thermus simulations:

- Constraining ($\mu_{S,}$ γ_S) values and fitting only (T, μ_B) makes the fits more stable…
- Significant overlap in TD pars for ~3 most central bins remains
- ~central selection alone does not tightly constrain (T, μ_B)...
- pbar/p = exp(-14μ_B)

Changed how N_{DOF} is calculated for each fit

Require sufficient number of non-zero yields: $N-1 \geq N_{par}$

Began to fit the experimental yields E-by-E

- TD parameter distributions are very wide, ~central bins are very similar…
- ~central selection alone does not tightly constrain (T, μ_B)...
- pbar/p = exp(-14μ_B)

To-do

Plots from application of STAR acceptance & efficiency filter and direct comparison of the TD pars event-by-event

GCE vs SCE in perfect detector and STAR detector simulations

How to handle the feeddown question?

Implement pbar/p gating in net- and total-pion moments analyses