Final figures update:

Event activity correlations and jet measurements in *p*+Au collisions at $\sqrt{s_{NN}} = 200$ GeV at STAR

Veronica Verkest & David Stewart

HP PWG meeting

April 20, 2023

Previously in *p*+Au…

- Relevant analysis details presented by Dave on Jan 19, 2023 (https://drupal.star.bnl.gov/STAR/system/files/HP-pwg_2022_01_19.pdf)
    - Please note that all details, cuts, etc. are the same as in Dave's presentation unless noted otherwise
- Corrections: JES, tracking efficiency, and PU-subtraction
- All figures are quantitatively the same as the preliminaries; physics conclusions remain the same

What happened intermediary months:

- GPC Convenors meeting asked about pile-up (PU) correction and ZDCx dependencies

  Consequently we:
  - Found that there is non-insignificant PU, even at the track cut of DCA at 1 cm
  - Have adjusted our calculations to properly account for PU corrections
  - Updated final plots

This is what I will show!

- The physics conclusions of the final plots have not changed. Pending some work on the UE(lead jet pT) (not shown in this presentation), we will request to proceed with already authorized GPC formation

From Dave's update

- ZDCx: [5-20]kHz range; reweight embedding by ratio link to backup slide
- After tracking efficiency correction, charged PU is dependent on ZDCx, η, independent of EA link
- Pileup: subtracted as a function of ZDCx for each bin in η after tracking efficiency correction is performed link

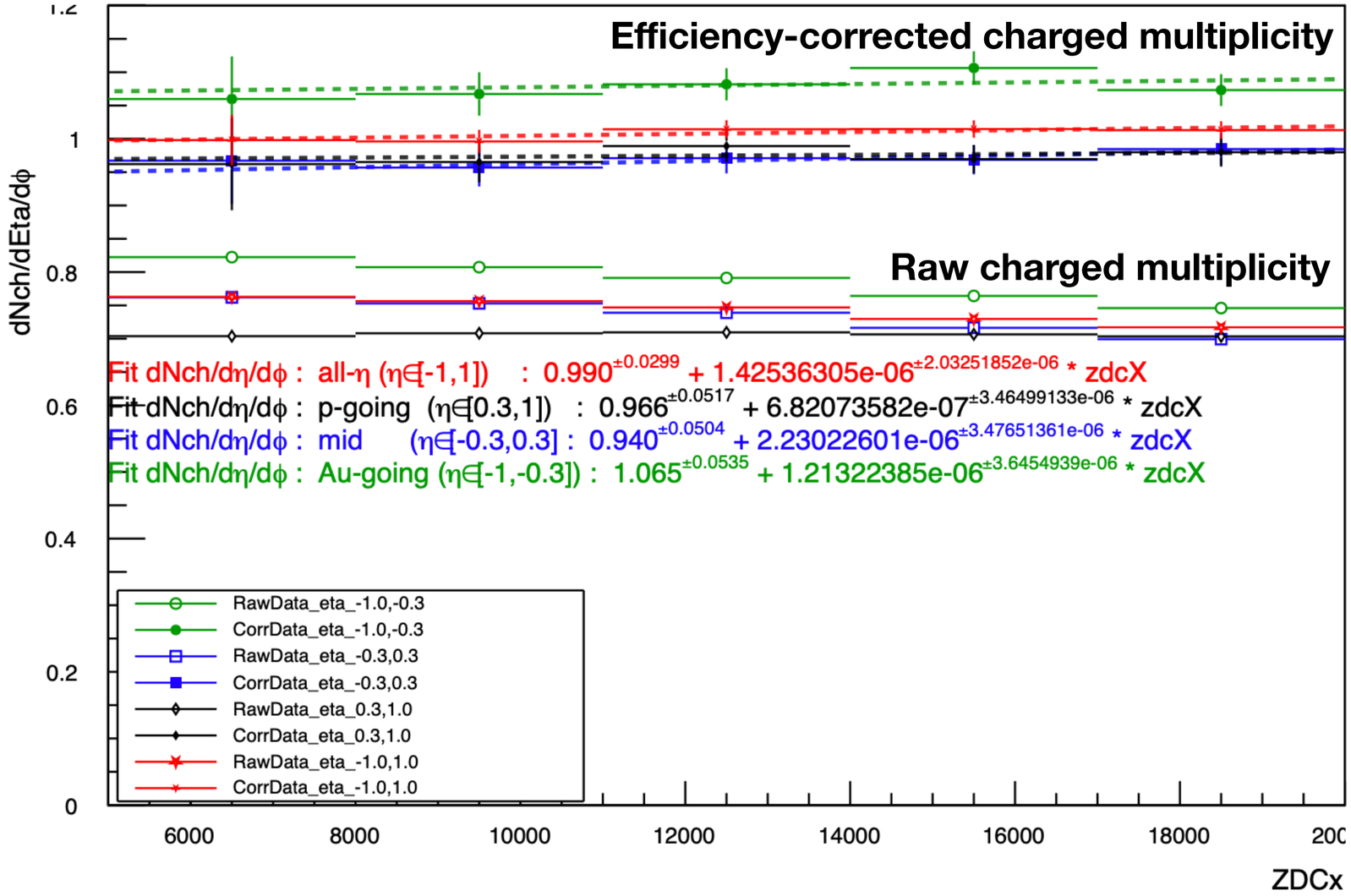
Changes and corrections

- ZDCx cut, tracking efficiency dependence, and PU-subtraction detailed in slide 4
- For consistency with Dave: now using the 500206 trigger with $E_{\mathrm{T}} \geq 4\ \mathrm{GeV}$
- The charged UE region is now defined in |η|<0.9 (removes some tracking efficiency eta-dependence)

- **JES correction**: same process, but now using the 500004 trigger for the embedding
- **Tracking efficiency**: same process, but now differential in ZDCx and η
- **PU subtraction**: now, decrease the efficiency-corrected charged UE multiplicity as a function of ZDCx and η

NEW!

PU subtraction



- Charged track density measured for *p*-going, mid, and Au-going regions and efficiency-corrected as a function of luminosity
- The PU density for an event is the difference in eff-corrected multiplicity at that event's ZDCx and at ZDCx = 2kHz

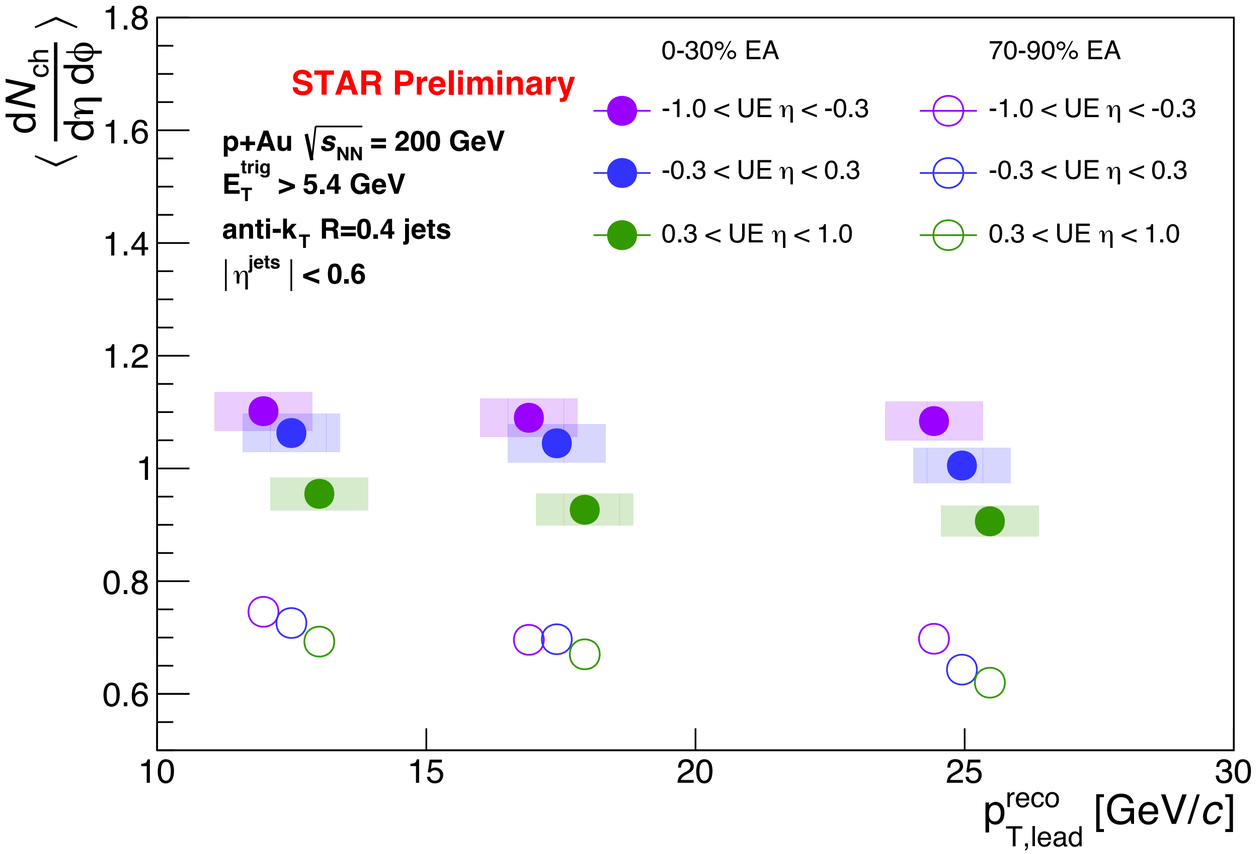
General Information

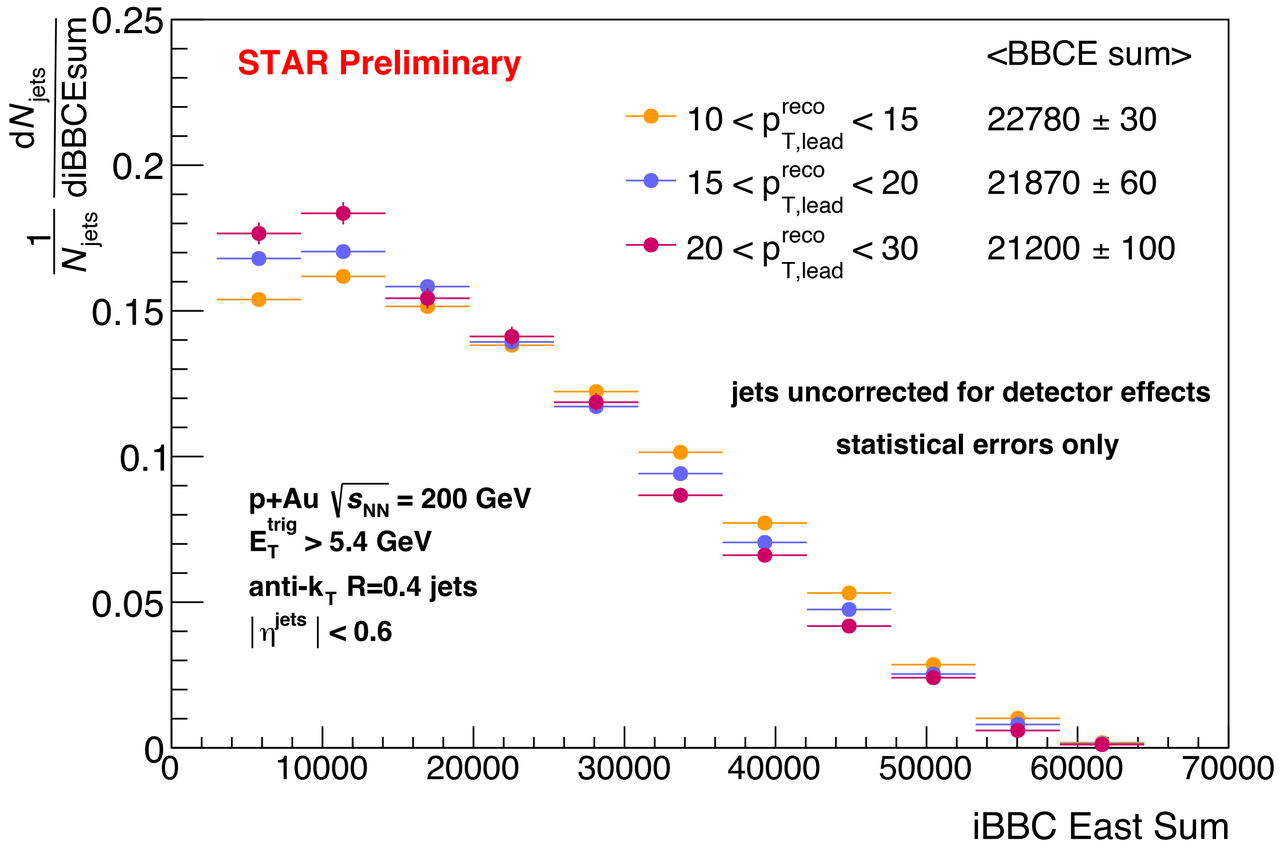
- Paper title: Event activity correlations and jet measurements in p+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV at STAR
- PAs: Helen Caines, Joern Putschke, David Stewart, Veronica Verkest
- Targeted Journal: Physics Review C
- Webpage: https://drupal.star.bnl.gov/STAR/blog/djs232/Paper-EA-and-UE-Corrs-High-Q2-Events-pAu-sNN200-GeV-Collisions-STAR
- Analysis Note:
  - Work in progress

Abstract

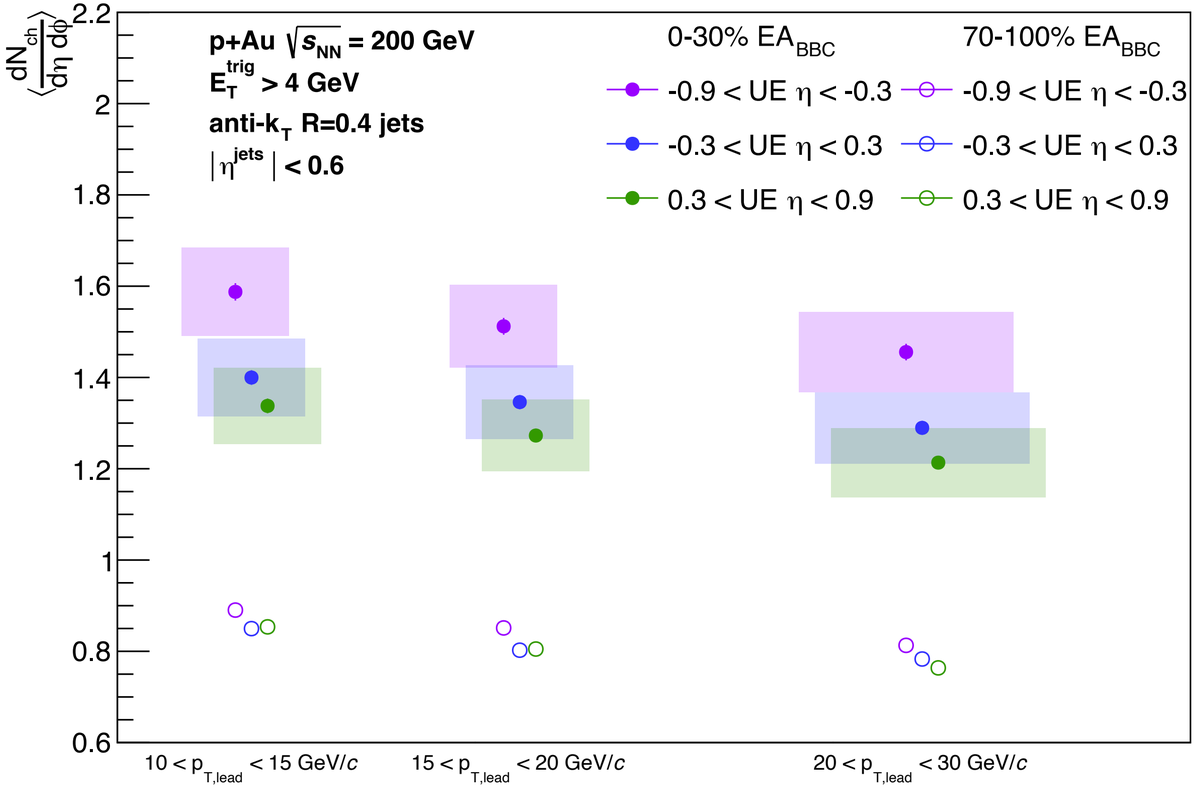
We report measurements of high transverse momentum (high p_{T}) clusters of collimated particles (jets) measured at mid-rapidity ($|\eta| < 0.6$), event activity (EA) measured at $\eta \in [-5, -3.4]$, and underlying event (UE) measured azimuthally transverse to the jets and at $|\eta| < 0.9$. We also report distributions of dijet azimuthal recoil angles ($\Delta\phi$) and dijet p_{T} balance (A_{J}) in high- and low-EA events. The jet p_{T} spectra and EA are anti-correlated, but the $\Delta\phi$ and A_{J} distributions are EA independent. This indicates that the anti-correlation is not caused by jet quenching in high-EA events, but rather results from constraints in either the configuration of the colliding ions or the earliest stages of the collisions themselves.

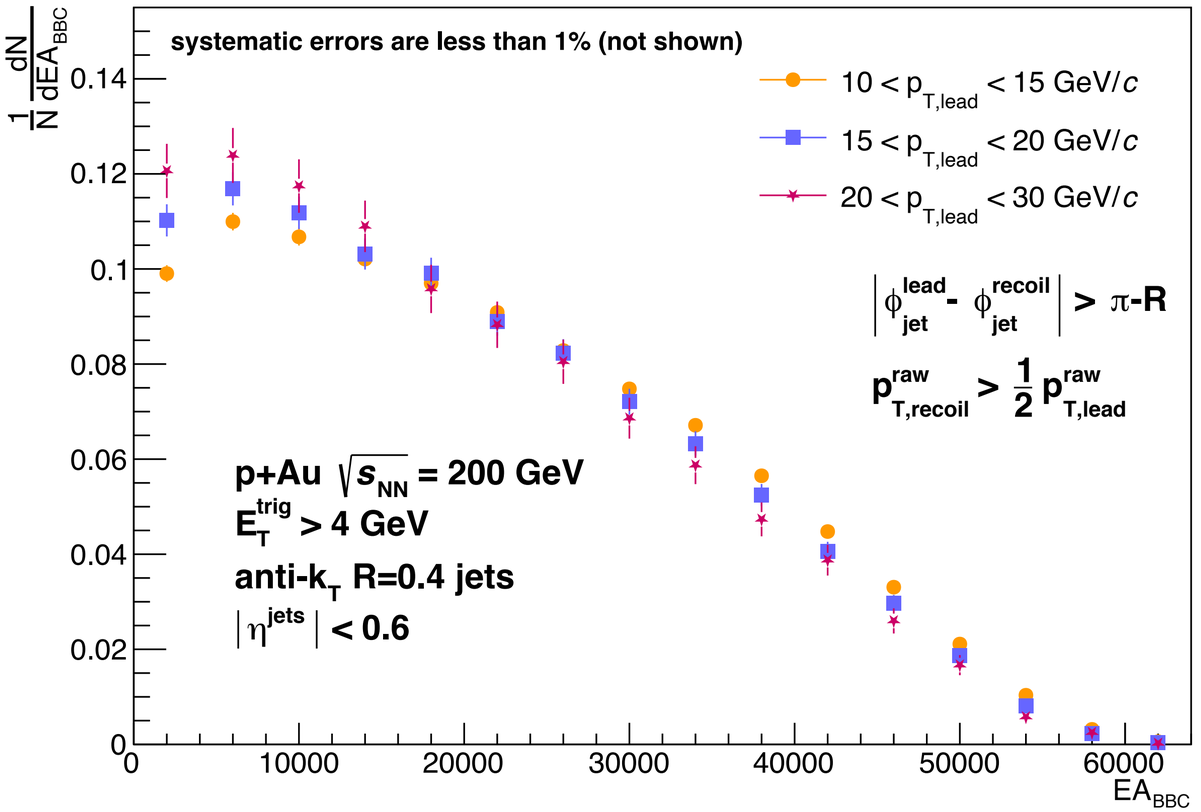
Preliminary figures





Final figures



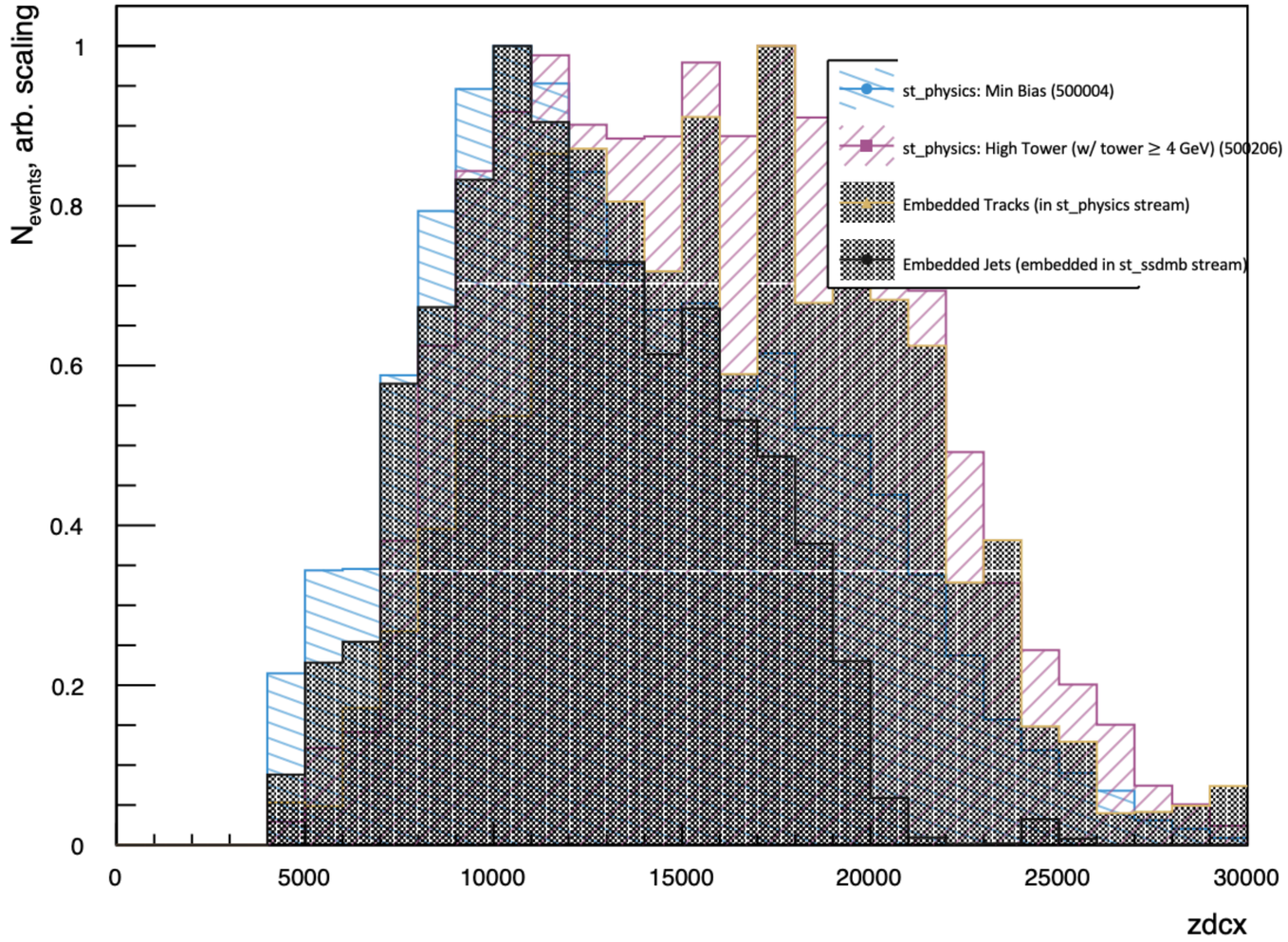


Next steps…

- **Final figures are finalized; paper draft is completed; ready for GPC formation!**
- **Paper webpage:** https://drupal.star.bnl.gov/STAR/blog/djs232/Paper-EA-and-UE-Corrs-High-Q2-Events-pAu-sNN200-GeV-Collisions-STAR
- **Paper draft:** https://drupal.star.bnl.gov/STAR/system/files/p_Au_Jets_and_UE__v0.pdf
- **Analysis notes:**
  - **EA, triggers, and jets:** https://drupal.star.bnl.gov/STAR/system/files/AN_ds_v0.pdf
  - **Jets, UE, and EA:** https://drupal.star.bnl.gov/STAR/system/files/AN_vv_v0.pdf

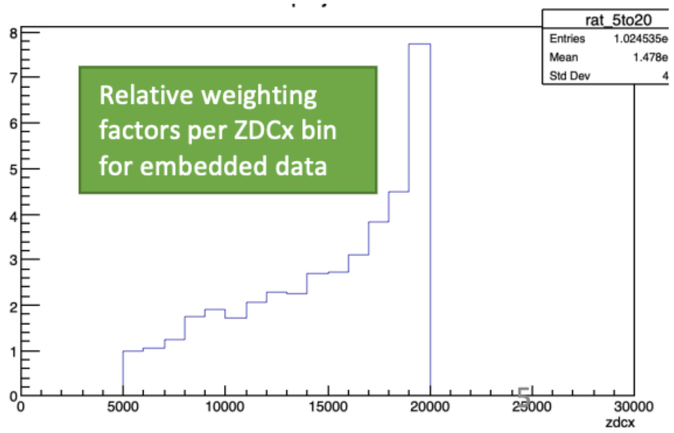
Backup

Embedding ZDCx range limited to 500001 triggers



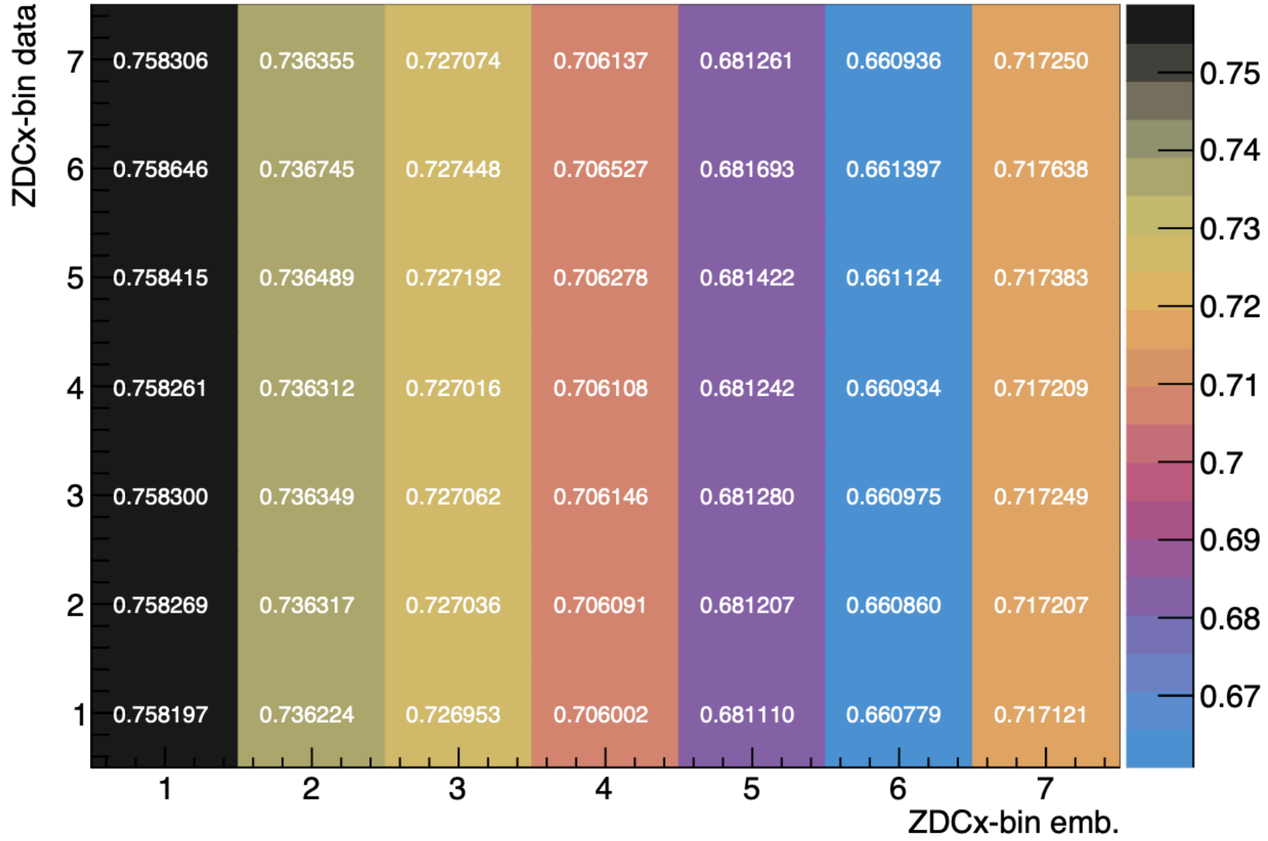
Tue Dec 6 13:20:54 EST 2022 /Users/stewart/tracks/./ztemp.cc

- The track embedding (make into 50004 triggered, st_physics stream events) goes out to about ZDCx=30 kHz
- The jet embedding (make into the st_ssdmb stream) effectively goes out to ZDCx=20 kHz
- As such, we limit our analysis to the currently available ZDCx embedding range of ZDCx≤ 20 kHz. This cuts off the top 20% of ZDCx in the data, but we can show all our physics results with this limitation.
  - Therefore we are proceeding with our GPC process, but would like to have the jet embedding made into st_physics (trigger=500004) events
- When using the embedded jets, the events are re-weighted to match the data ZDCx distribution.

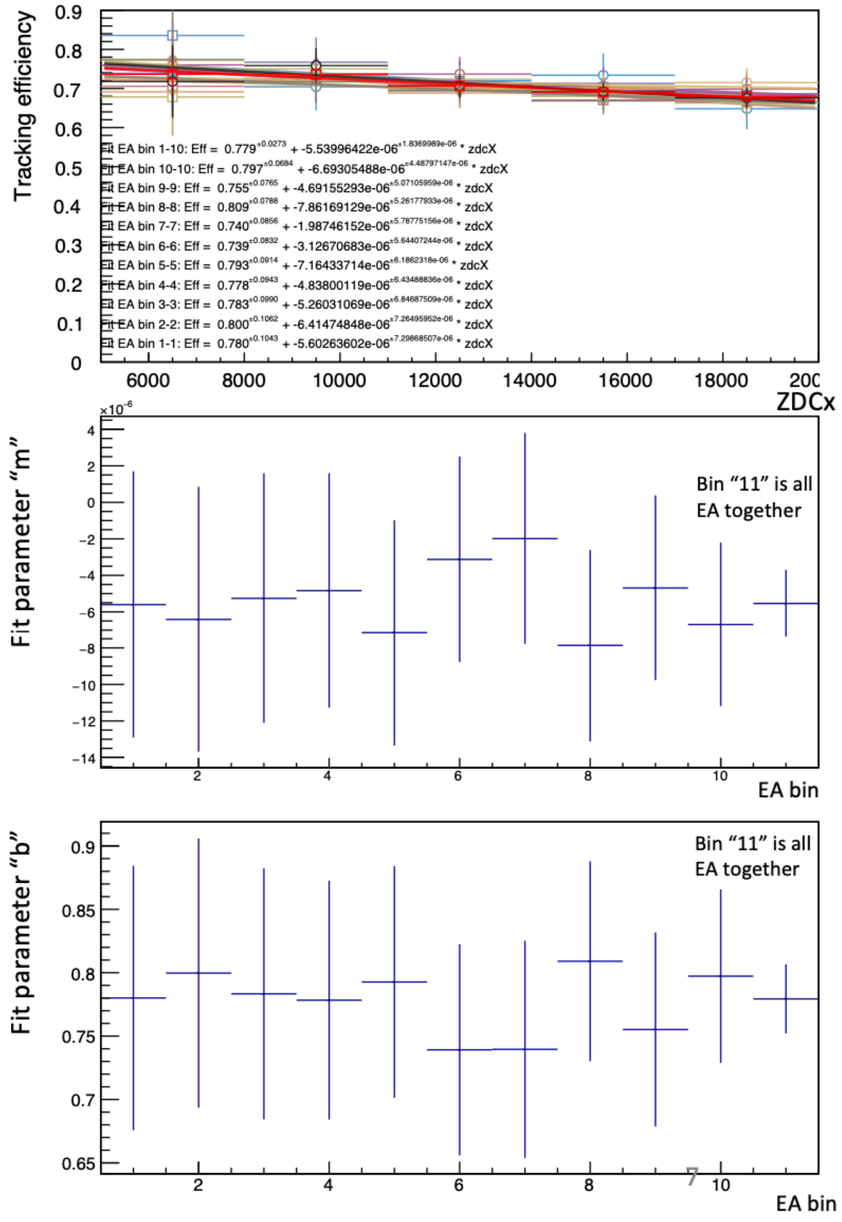


TO SLIDE 4

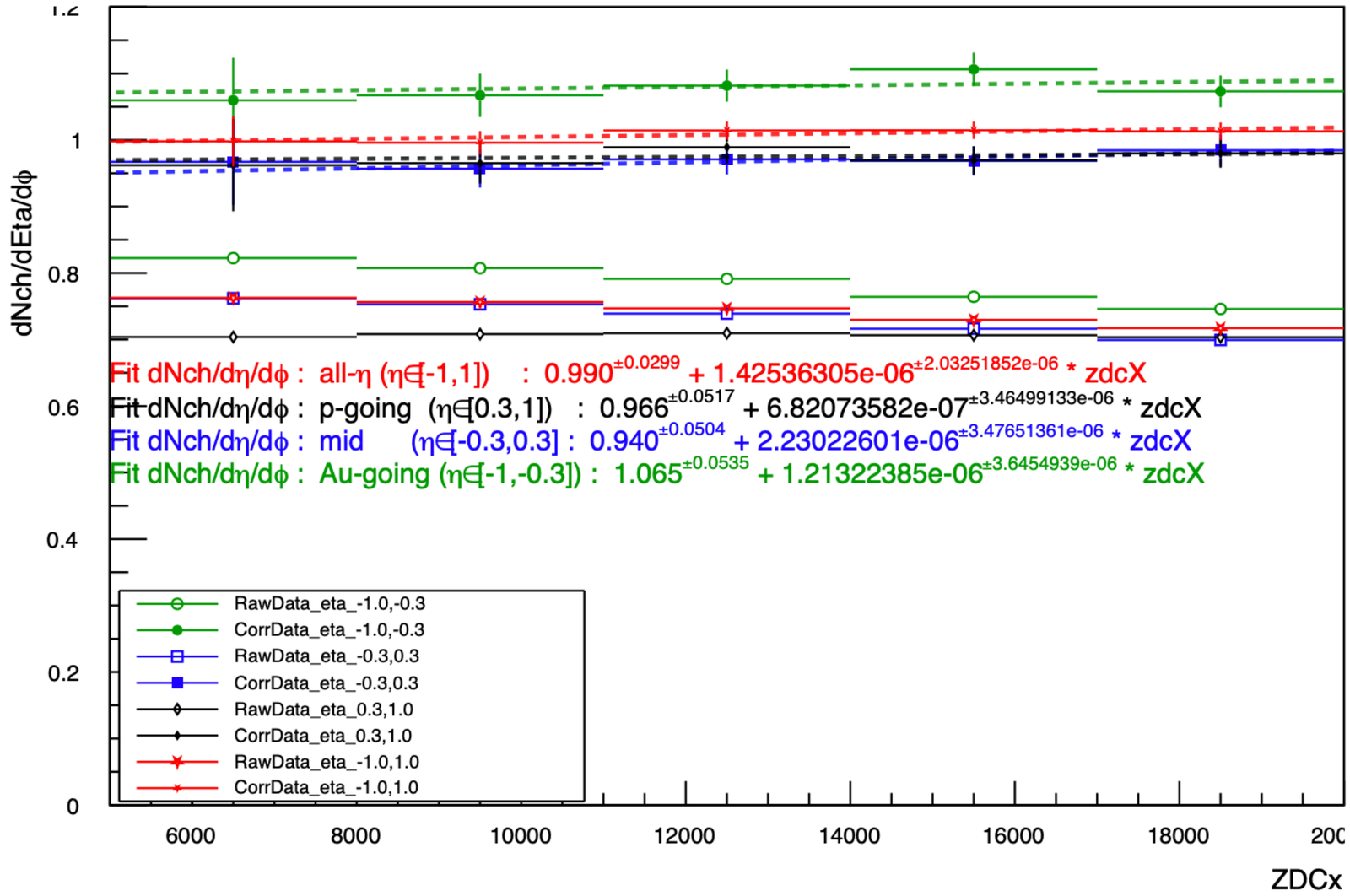
- Track reconstruction efficiency is dependent on ZDCx
- Tracks lost from decreasing efficiency are offset by the presence of increasing pile-up (PU) tracks
- Overall MB tracking efficiencies in correction as calculated using different ZDCx of data (y-axis) and ZDCx of embedding (x-axis).
- ZDCx bins are 4-6kHz, 6-9kHZ … 22-24 kHz
- Only the ZDCx of the embedding matters; this is indicative that the pT distribution of PU closely parallels the pT distribution of primary events



Fit parameters for PU density are independent of EA bin



PU(ZDCx) parameterization has eta dependence



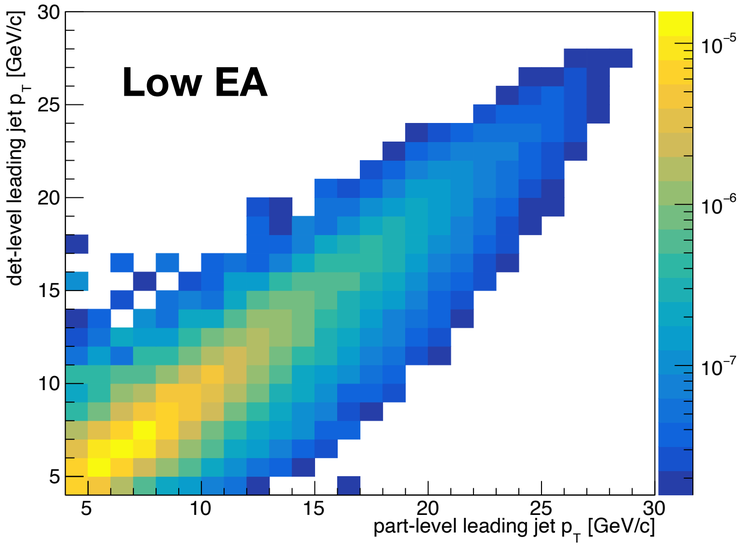
- Calculate the fit

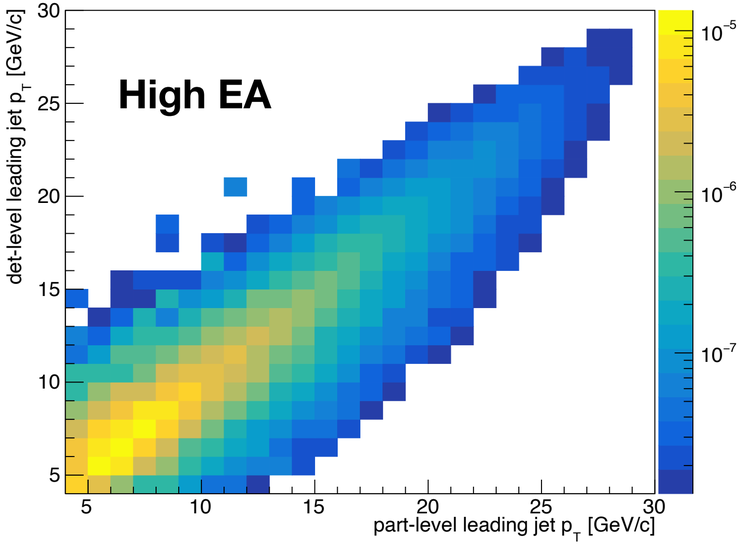
$$\rho_{\mathrm{PU}} = m\ \mathrm{ZDCx}$$

using efficiency corrected tracks (which are a mix of primaries and PU tracks)

Errors on m end up being a principal uncertainty on overall track density measurement

TO SLIDE 4





Matched jet response matrices

$$M\left(p_{\mathrm{T,lead}}^{\mathrm{part}}, p_{\mathrm{T,lead}}^{\mathrm{det}}\right)$$

JES correction

- Done separately for high- and low-EA to correct the UE multiplicity plot; inclusive in EA for the BBC distribution
- When filling the response matrices, the embedding is reweighed to have the same ZDCx distribution as the data
- The projections of $M\left(p_{\mathrm{T,lead}}^{\mathrm{part}}, p_{\mathrm{T,lead}}^{\mathrm{det}}\right)$ give the det-level and part-level matched jet spectra
- **Fake jet correction**: observables are multiplied by the true-jet probability

$$\mathrm{P}_{\mathrm{true}}(p_{\mathrm{T,lead}}^{\mathrm{det}}) = \mathrm{N}_{\mathrm{jets}}(p_{\mathrm{T,lead}}^{\mathrm{det}}) / \left(\mathrm{N}_{\mathrm{jets}}(p_{\mathrm{T,lead}}^{\mathrm{det}}) + \mathrm{N}_{\mathrm{fake}}(p_{\mathrm{T,lead}}^{\mathrm{det}})\right)$$

- **Missed jet correction**: to account for missed jets, the part-level prior is the sum of the matched part-level jets and the missed part-level jets