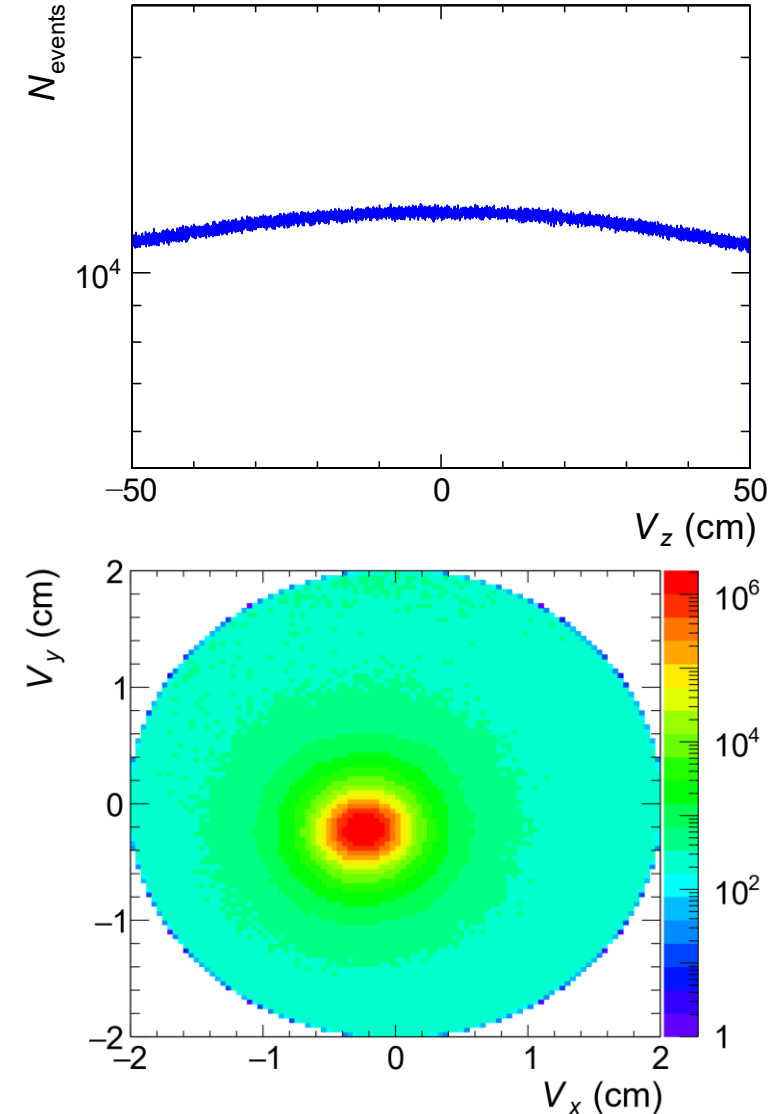


Proton fluctuation analysis at 11.5 GeV

Fan Si

Dataset

- Au+Au @ 11.5 GeV
- Trigger setup: production_11p5GeV_2020
- Stream: st_physics(_adc)
- Production: P23ia
- Library: SL23a
- Run ID: 20365001 – 21055017 (1373 runs)
- Events: 593M (accessible 45699 PicoDst files)



Run-by-run QA

- Variables

Detector	Event level	Track level
Other	BBCx, ZDCx	
TPC	V_x, V_y, V_z, V_r , RefMult3X, RefMultHalfX	gDca, gDca _{xy} , signed gDca _{xy} , gDca _{ϕ} , gDca _z , nHitsFit, nHitsFit/nHitsPoss, nHitsDedx, p_T , ϕ , η , dE/dx
bTOF	nBTofMatches, nBTofHits	bTOF $1/\beta$

- Iteratively remove empty bins and 5- σ outliers until no new bad runs
 - Averages and standard deviations weighted by # events or tracks

- Bad runs [109]

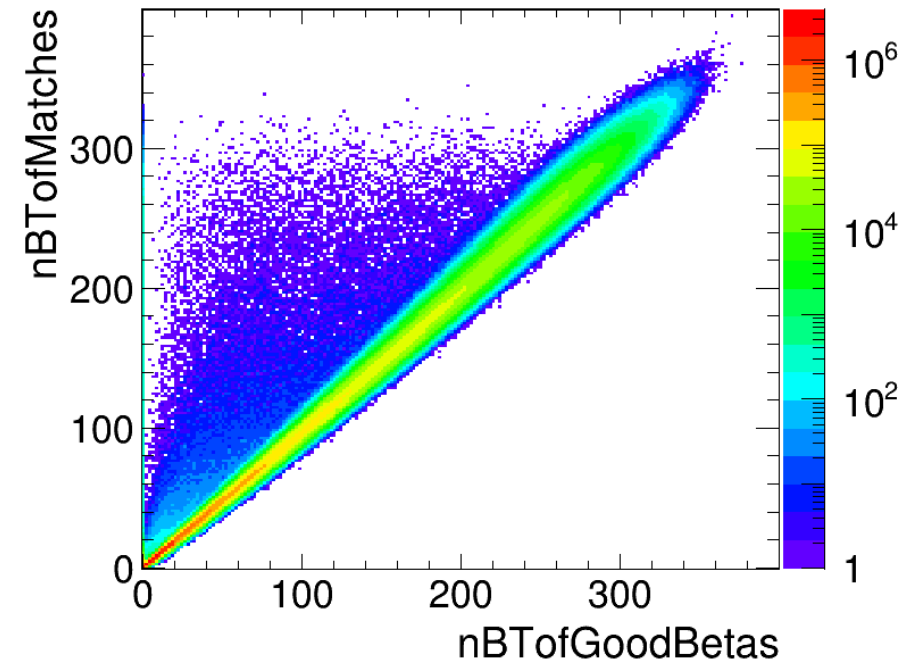
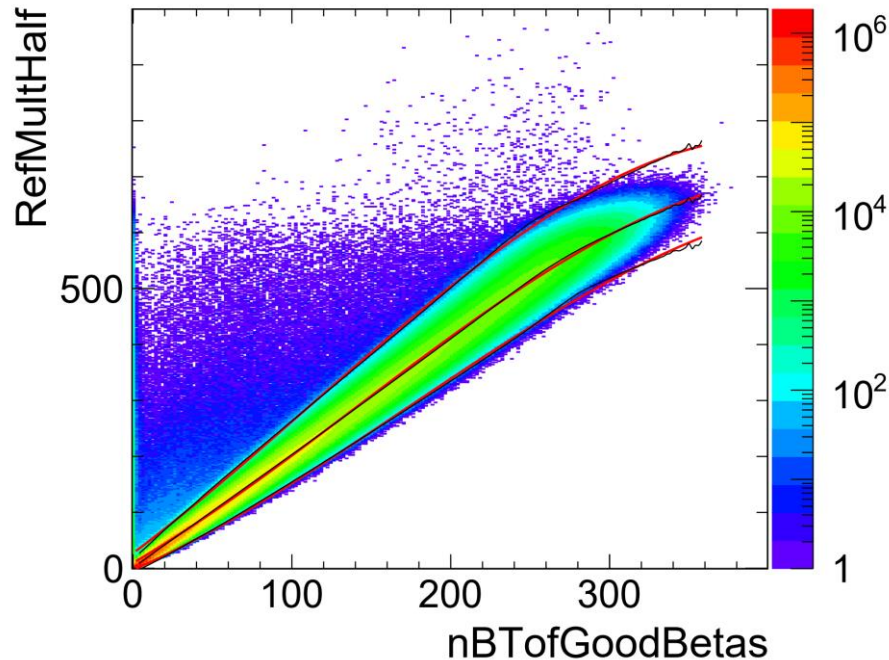
- 20365014, 20365023, 21003044, 21004033, 21004034, 21004035, 21004036, 21004037, 21005009, 21005015, 21005034, 21005039, 21005040, 21006008, 21006014, 21006015, 21006027, 21006029, 21006031, 21007034, 21008011, 21008012, 21008014, 21008015, 21008016, 21008034, 21010036, 21011001, 21011004, 21012030, 21012035, 21014027, 21015029, 21017048, 21019016, 21019020, 21019050, 21019052, 21019069, 21019072, 21019073, 21020026, 21020051, 21021009, 21021010, 21021011, 21022053, 21023026, 21024027, 21041025, 21041027, 21041028, 21041029, 21041030, 21041032, 21041033, 21041034, 21041035, 21041036, 21041037, 21041038, 21041039, 21041040, 21042001, 21042002, 21042004, 21042005, 21042006, 21042007, 21042008, 21042009, 21042010, 21042011, 21042012, 21042014, 21042015, 21042016, 21042017, 21042020, 21043022, 21045044, 21046005, 21046047, 21046048, 21050047, 21050048, 21050049, 21050050, 21050055, 21050056, 21050057, 21050058, 21050064, 21051016, 21051017, 21051024, 21052032, 21052036, 21052039, 21052043, 21053024, 21053029, 21053030, 21053044, 21053060, 21053062, 21053063, 21053064, 21054018

Multiplicity definitions

- Basic cuts: primary, $|gDca| < 3$ cm, $nHitsFit \geq 10$, $p > 0.1$ GeV/c
- RefMultHalf (official StPicoDstMaker/StPicoUtilities.h): basic cuts, $|\eta| < 1$
- RefMultHalfX: basic cuts, $|\eta| < 1.5$
- RefMult3 (official + $\langle n\sigma_{\text{proton}} \rangle$ shift)
 - Basic cuts, $|\eta| < 1$, $n\sigma_{\text{proton}} - \langle n\sigma_{\text{proton}} \rangle < -3$, bTOF $m^2 < 0.4$ GeV²/c⁴ (if available)
- RefMult3X:
 - Basic cuts, $|\eta| < 1.5$, $n\sigma_{\text{proton}} - \langle n\sigma_{\text{proton}} \rangle < -3$, bTOF $m^2 < 0.4$ GeV²/c⁴ (if available)
- NBTofMatches (official StEvent/StPrimaryVertex.cxx): all bTOF-matched tracks
- NBTofGoodBetas: basic cuts, $|\eta| < 1$, bTOF $\beta > 0.1$

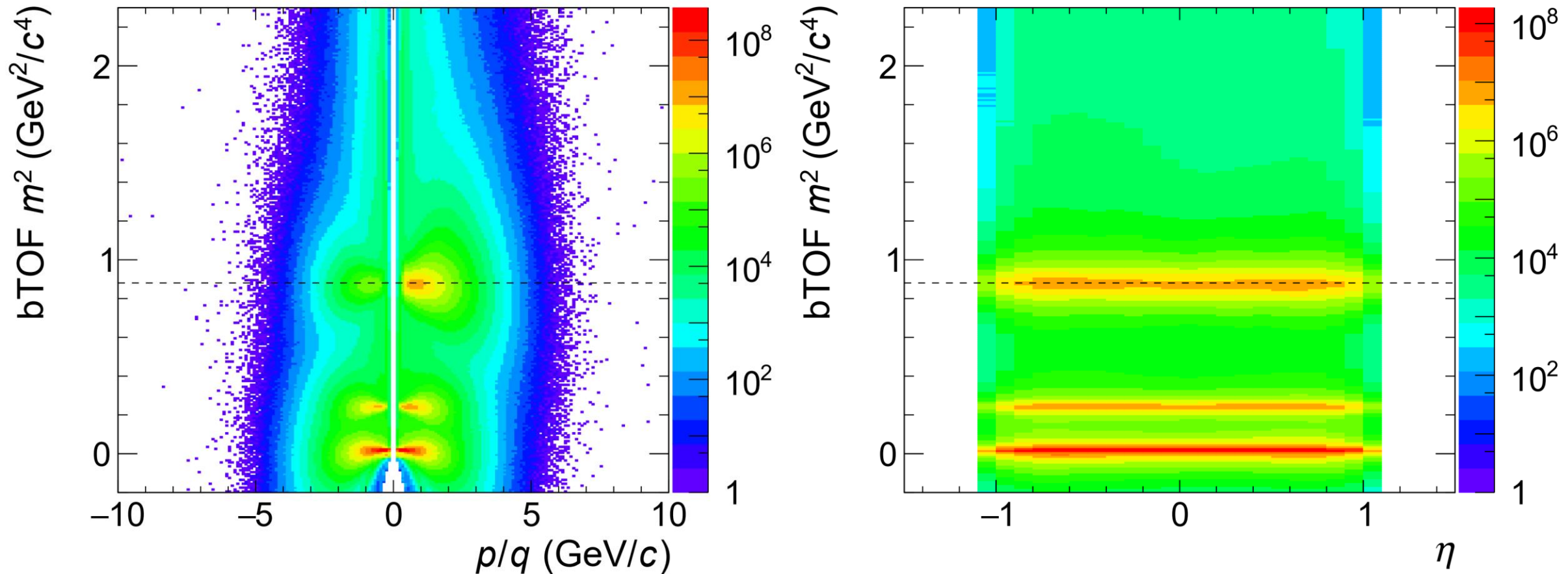
Pileup event rejection

- Using correlation between nBTofGoodBetas & RefMultHalf
 - nBTofGoodBetas: more sensitive than nBTofMatches (can show more strange bands)
 - RefMultHalf: same basic cuts and acceptance ($|\eta| < 1$) as nBTofGoodBetas
- Using procedures in [isobar analysis note v3.pdf](#)



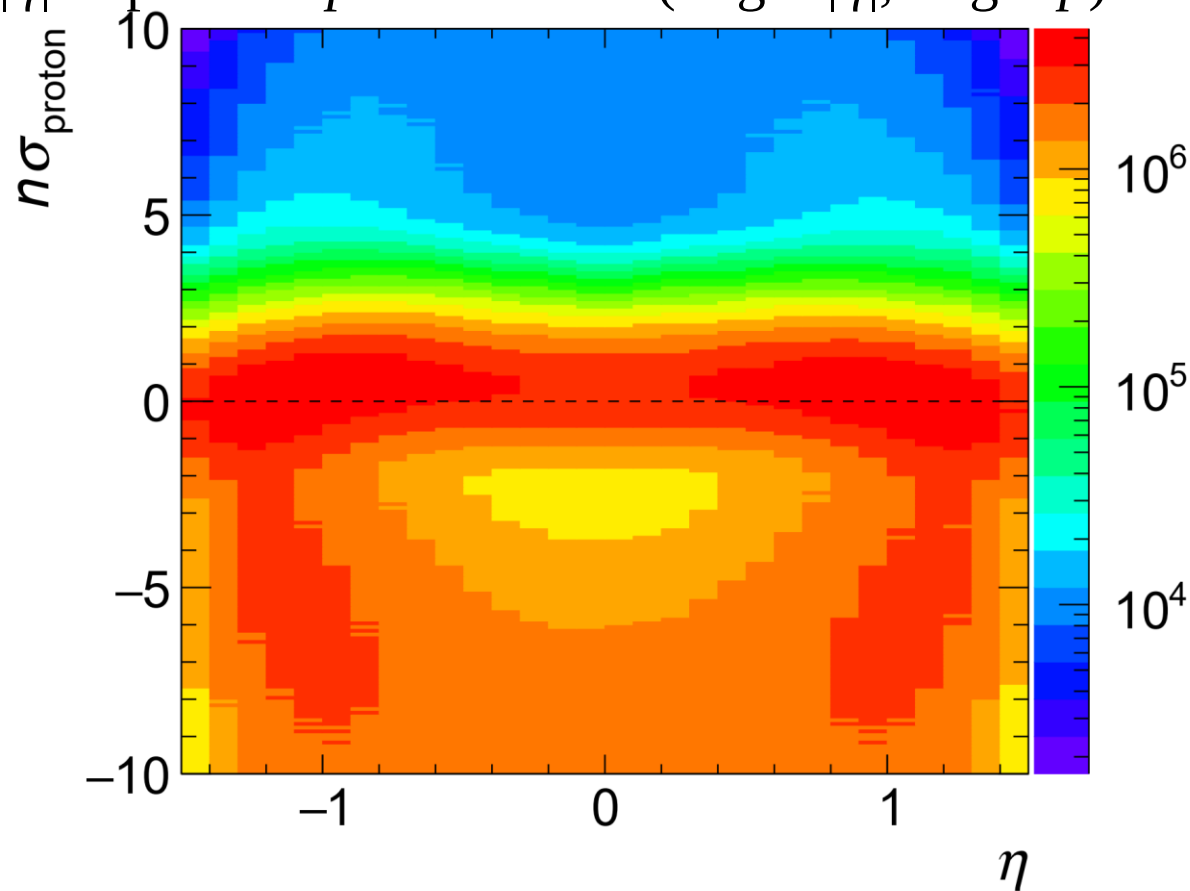
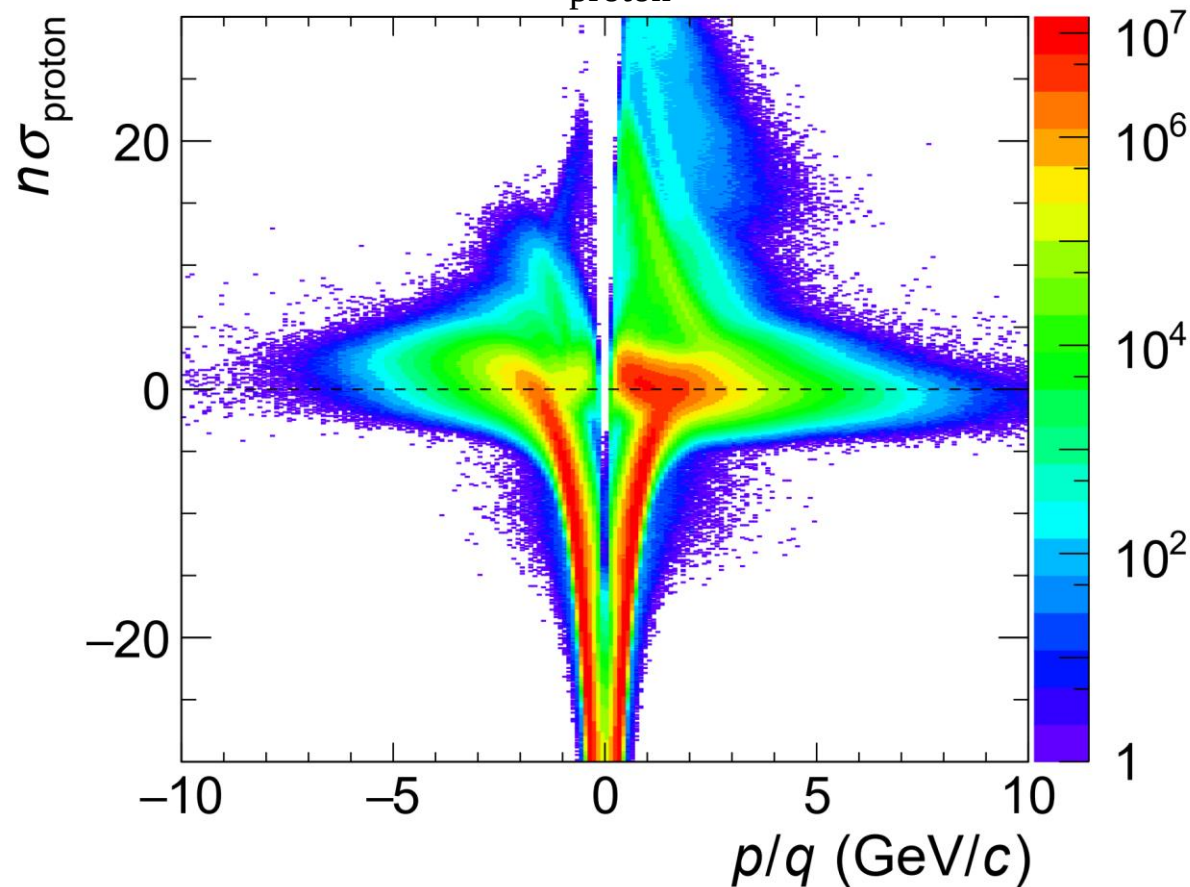
bTOF PID plots

- Excellent PID



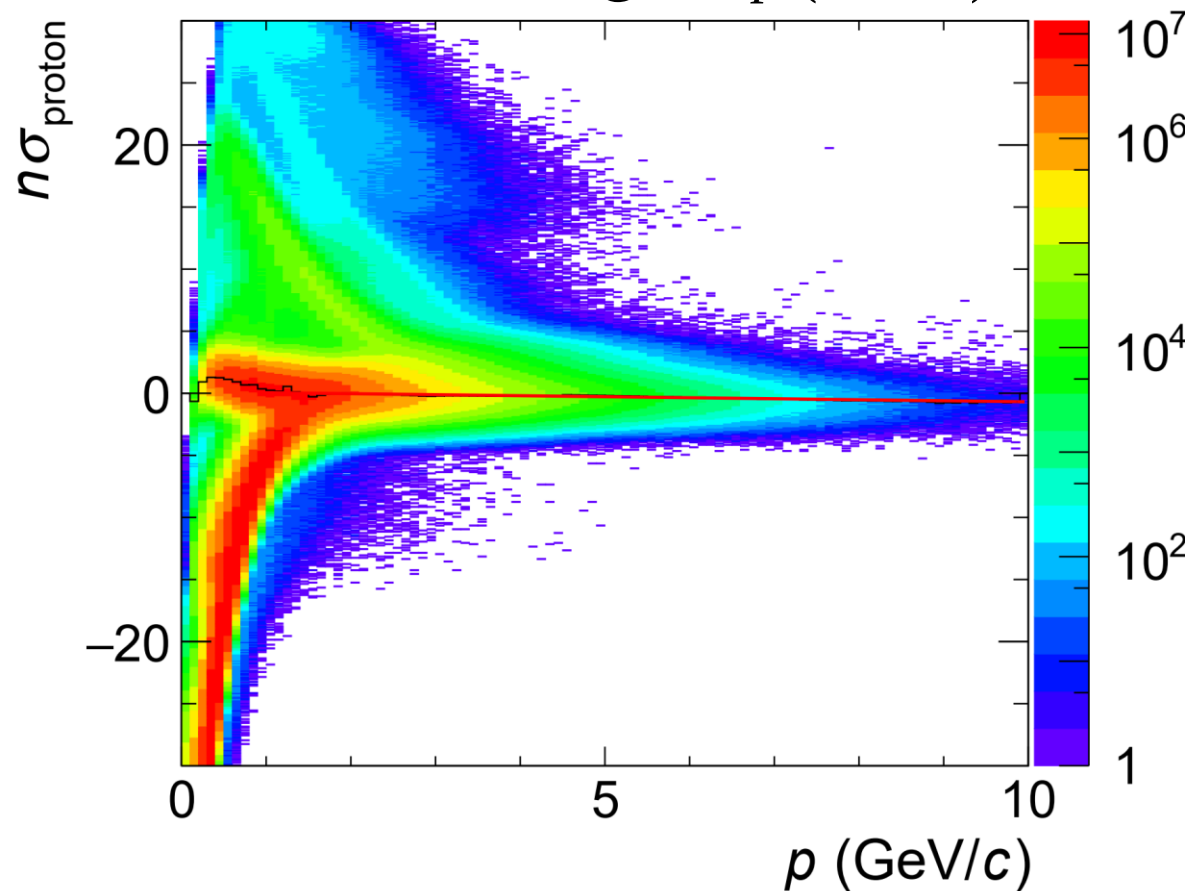
TPC PID plots

- Recalibration required
 - Only p -dependent $\langle n\sigma_{\text{proton}} \rangle$ studied temporarily
 - $|\eta|$ -dependent $\langle n\sigma_{\text{proton}} \rangle$ seems to come from $|\eta|$ -dependent p distribution (larger $|\eta|$, larger p)



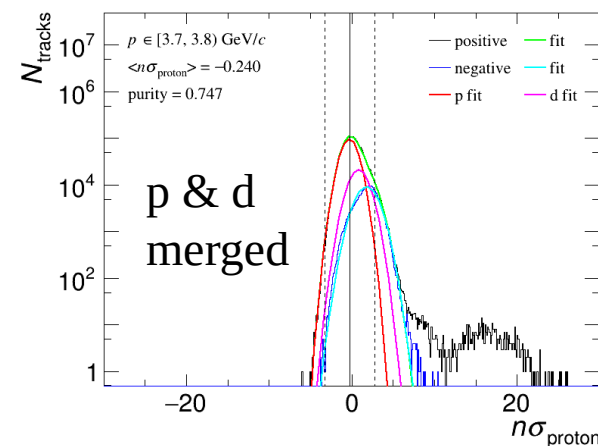
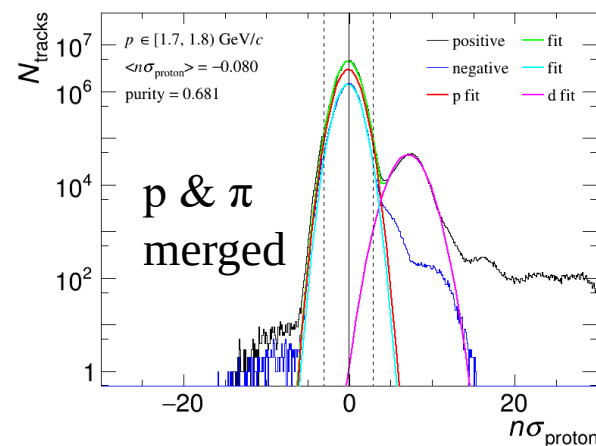
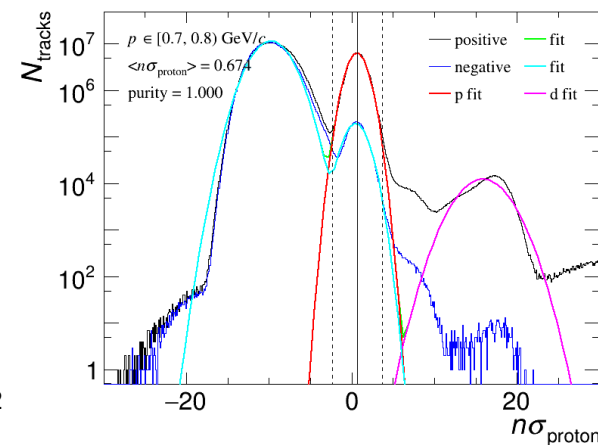
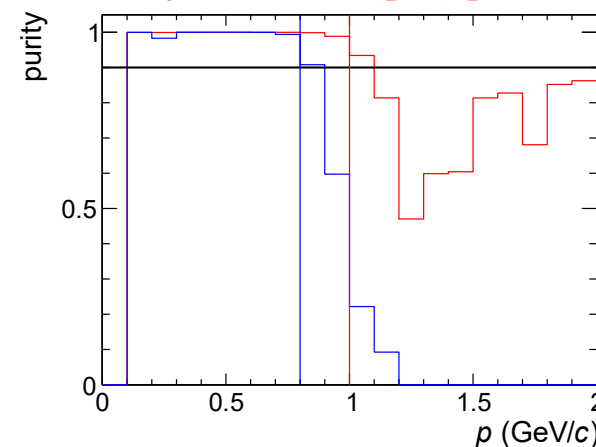
TPC recalibration

- Black curve: $\langle n\sigma_{\text{proton}} \rangle$
- Multi-Gaussian fits in p slices
- Red line: linear fit @ $1 < p \text{ (GeV/c)} < 9$



- Purity = $1 - (N_{\pi^-} + N_d)/N_{\text{pos}}$
- In range $|n\sigma_{\text{proton}} - \langle n\sigma_{\text{proton}} \rangle| < 3$

Purity > 90% @ (pos) $p < 1$ GeV/c, (neg) $p < 0.8$ GeV/c



Centrality definition

- Using RefMult3X (extended $|\eta|$ range, shifted $\langle n\sigma_{\text{proton}} \rangle$)
- Luminosity correction
 - Linear fit for $\langle \text{RefMult3X} \rangle$ as a function of ZDC coincidence rate
- V_z correction
 - $f(\text{RefMult3X}) = A * \text{Erf}(-\sigma * (\text{RefMult3X} - h)) + A$ for RefMult3X tail
 - $h(V_z) = \text{pol6}$
 - $\text{RefMult3XCorr} = p_0 / h(V_z) * \text{RefMult3X}$

Event-level $\langle \text{signed gDca}_{xy} \rangle$ & $\langle \text{gDca}_z \rangle$

- To reject abnormal structures in net-proton distributions
- Track cuts: same as RefMultHalfX (basic cuts, $|\eta| < 1.5$)

