# Pileup event rejection for FXT datasets

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# Datasets

| $\sqrt{s_{NN}}$ (GeV) | Trigger setup | Stream | Production | Library | Run ID | Events |
|---|---|---|---|---|---|---|
| 3.2 | production_4p59GeV _fixedTarget_2019 | st_physics(_adc) | P21id | SL21d | 20179040 − 20183025 (90 runs) | $2.76\times10^8$ |
| 3.5 | production_5p75GeV _fixedTarget_2020 | st_physics(_adc) | P21id | SL21d | 20355020 − 21045011 (31 runs) | $1.51\times10^8$ |
| 3.9 | production_7.3GeV _fixedTarget_2019 | st_physics(_adc) | P21id | SL21d | 20107029 − 20169055 (32 runs) | $0.82\times10^8$ |
| 3.9 | production_7p3GeV _fixedTarget_2020 | st_physics(_adc) | P21id | SL21d | 21035003 − 21036013 (32 runs) | $1.56\times10^8$ |
| 4.5 | production_9p8GeV _fixedTarget_2020 | st_physics(_adc) | P21id | SL21d | 21029051 − 21032016 (40 runs) | $1.81\times10^8$ |

# Data cuts

- Triggers: epde-or-bbce-or-vpde-tof1
  - 680001 for 3.2 GeV
  - 720000 for 3.5 GeV
  - 1 for 3.9 GeV (2019)
    - epde-or-bbce-tof1 for some runs
  - 730000 for 3.9 GeV (2020)
  - 740000, 740010 for 4.5 GeV

- Event cuts:
  - 198 cm < $V_z$ < 202 cm
  - $|V_r|$ < 2 cm, with center (0, −2) cm

- Track cuts
  - Primary
  - |gDca| < 3 cm
  - nHitsFit > 10
  - nHitsFit/nHitsPoss > 0.52
  - nHitsDedx > 5

# Bad run rejection

- Quantities (averaged values)

| Detector | Event level | Track level |
|---|---|---|
| TPC | $V_x$, $V_y$, $V_z$, $V_r$, FxtMult,<br>FxtMult3 (w/o $\langle n\sigma_p \rangle$ shift), $N_+$, $N_-$ | Dca, $\mathrm{Dca}_{xy}$, $\mathrm{Dca}_{\varphi}$, $\mathrm{Dca}_z$, signed $\mathrm{Dca}_{xy}$, nHitsFit,<br>nHitsFit/nHitsPoss, nHitsDedx, $p_T$, $\varphi$, $\eta$, d$E$/d$x$ |
| bTOF | bTofMatchMult, bTofTrayMult, | bTOF $1/\beta$, bTofYLocal, bTofZLocal |
| EPD | nEpdHitsEast, nEpdHitsWest, ∑nMIP, ∑TnMIP | |

- Remove empty bins and 3-$\sigma$ outliers until no new bad runs
  - Empty bins are not taken into account in $\sigma$ calculation

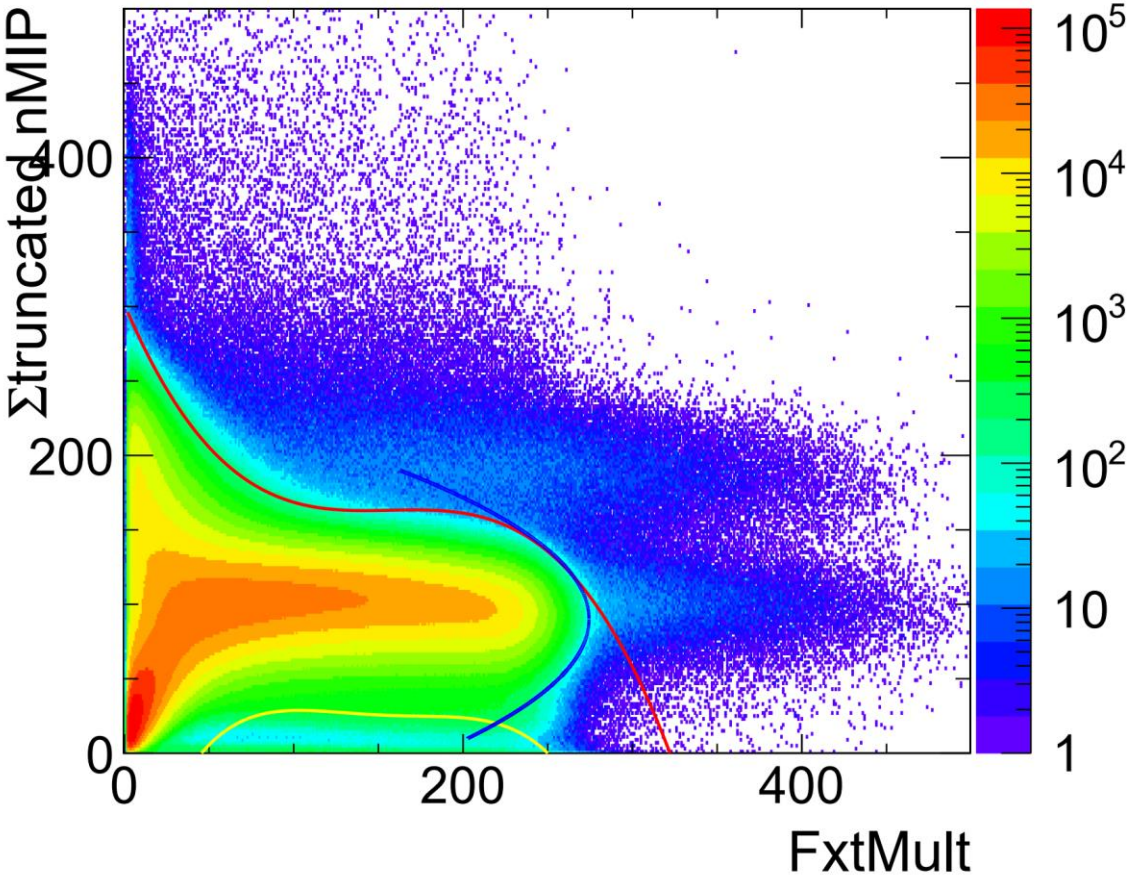
- FxtMult3 definition (according to RefMult3 in StPicoDstMaker/StPicoUtilities.h)
  - Basic cuts: primary, $p > 0.1$ GeV/$c$, Dca < 3 cm, nHitsFit ≥ 10
  - Proton exclusion: $n\sigma_p < -3$, bTOF $m^2 < 0.4$ GeV$^2/c^4$ ($m^2$ set at −999 for unavailable bTOF)

# Pileup event rejection

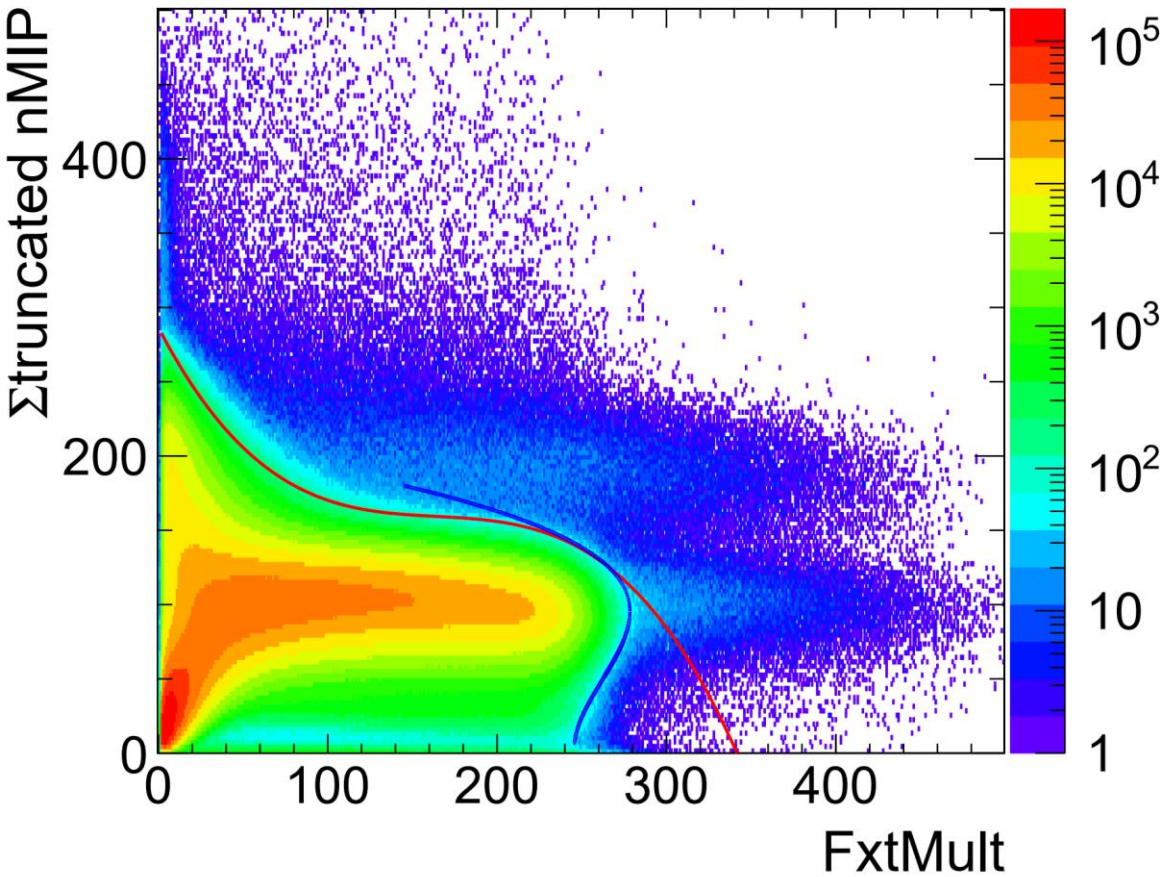
- Remove abnormal bands in 2D distributions of TPC FxtMult and EPD ∑TnMIP
- FxtMult: number of primary tracks
- nMIP: number of minimally ionizing particles (calibrated ADC)
- Truncated nMIP = StPicoEpdHit−>TnMIP(2, 0.3) = $\begin{cases} 0, & \text{nMIP} < 0.3 \\ \text{nMIP}, & 0.3 \leq \text{nMIP} < 2 \\ 2, & \text{nMIP} \geq 2 \end{cases}$

# Pileup event rejection @ 3.2 GeV

- New

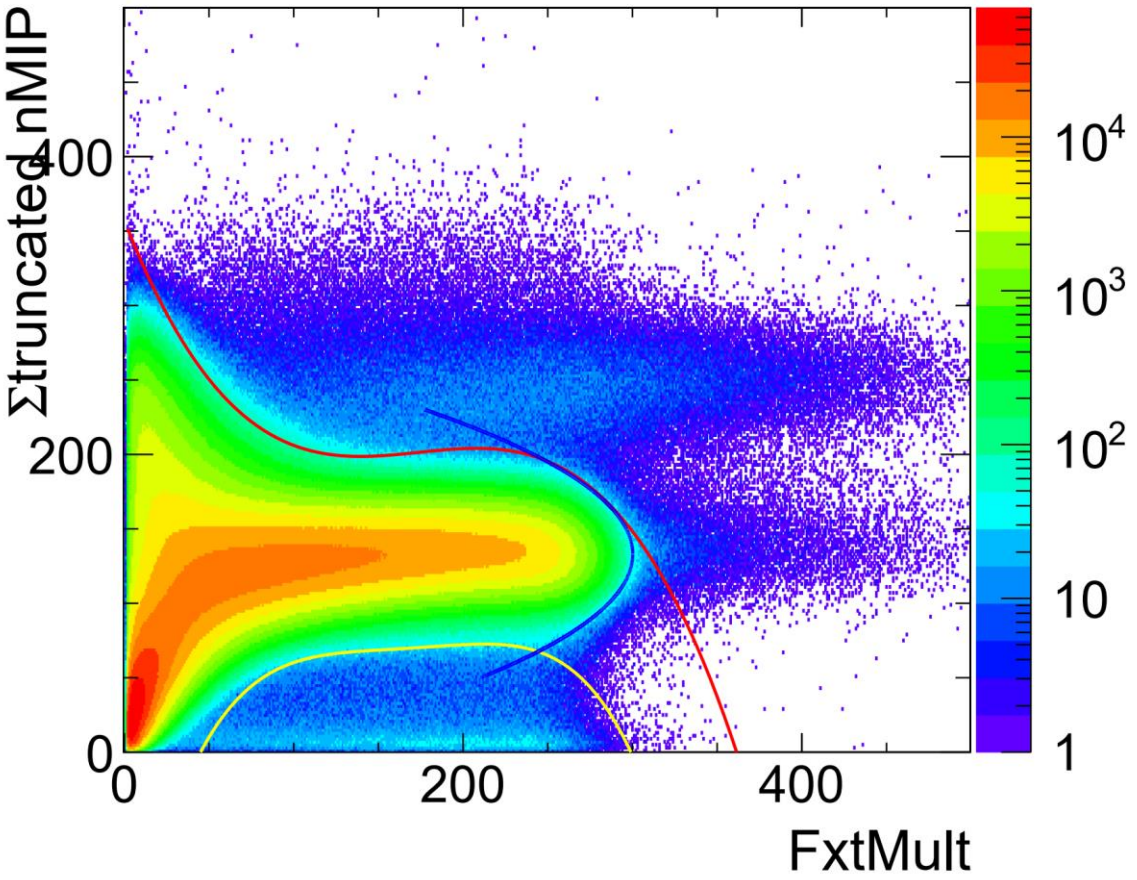



- Old

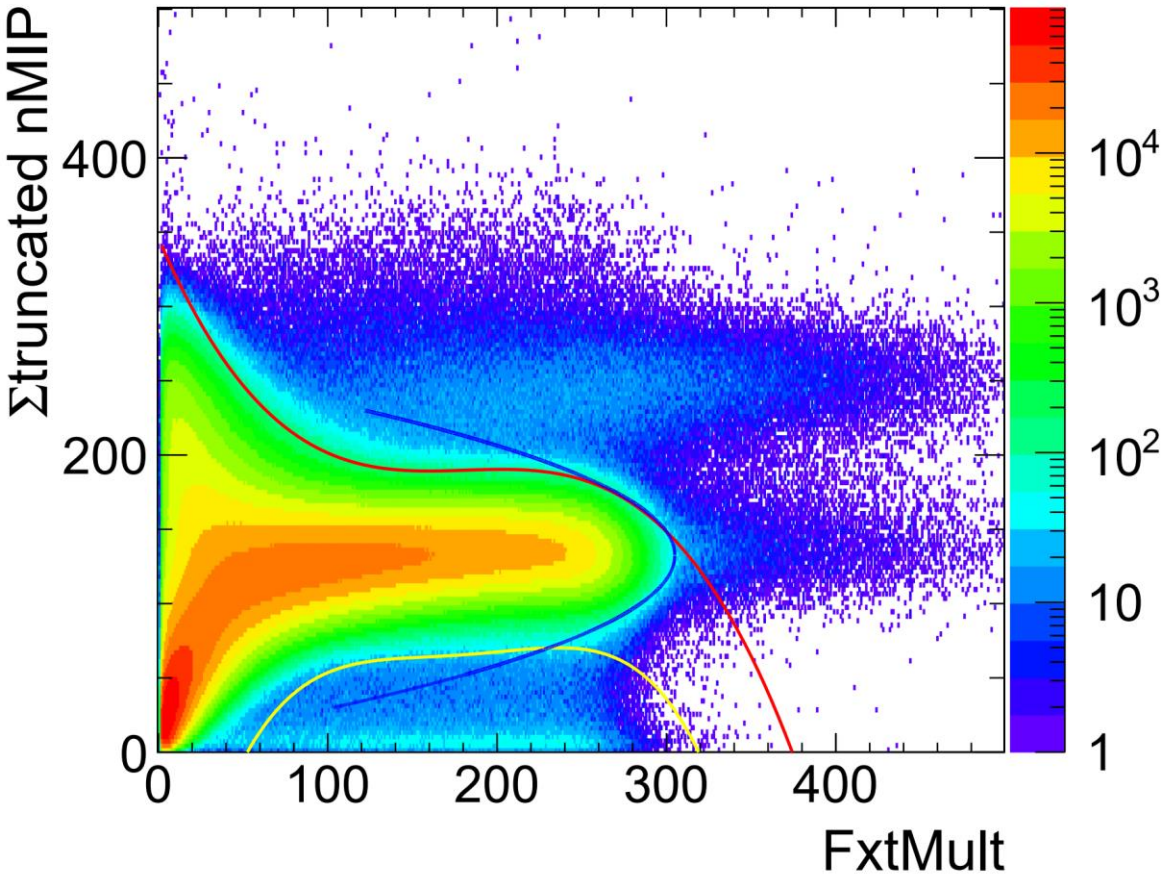


# Pileup event rejection @ 3.5 GeV

- New

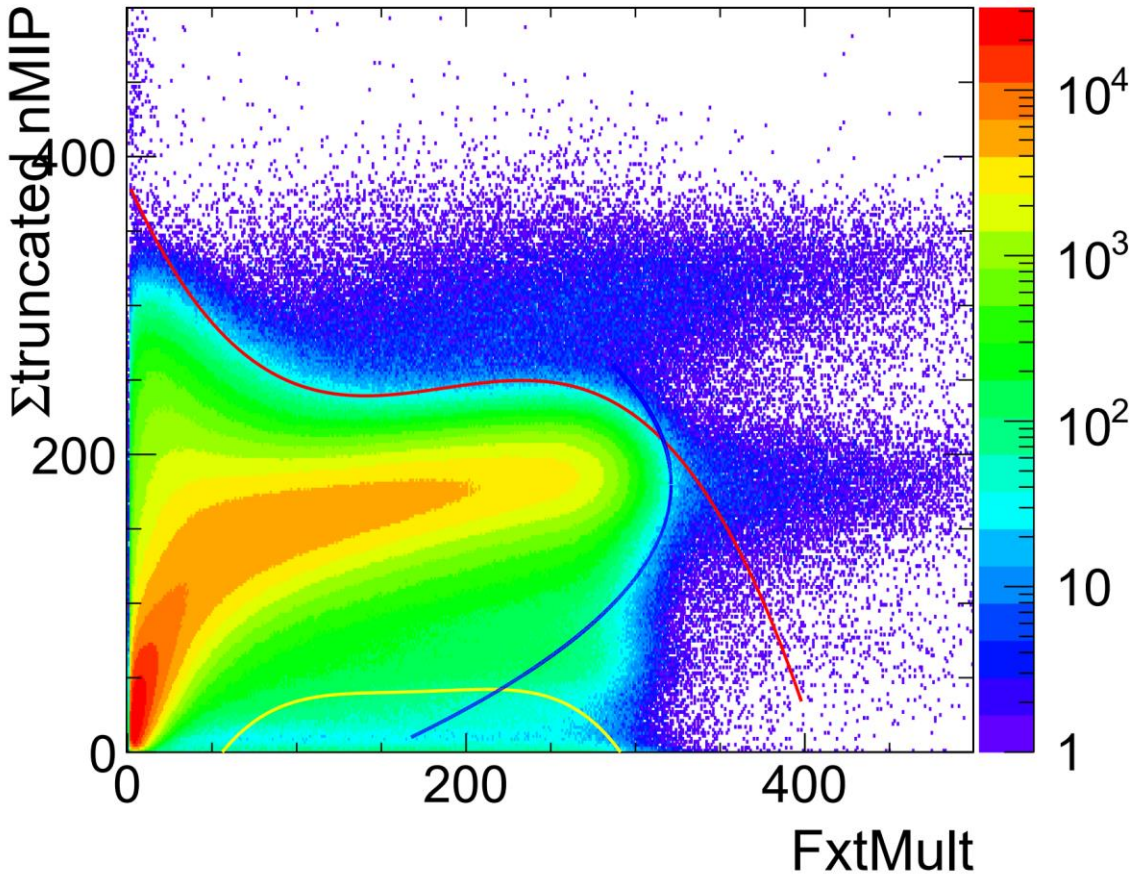



- Old

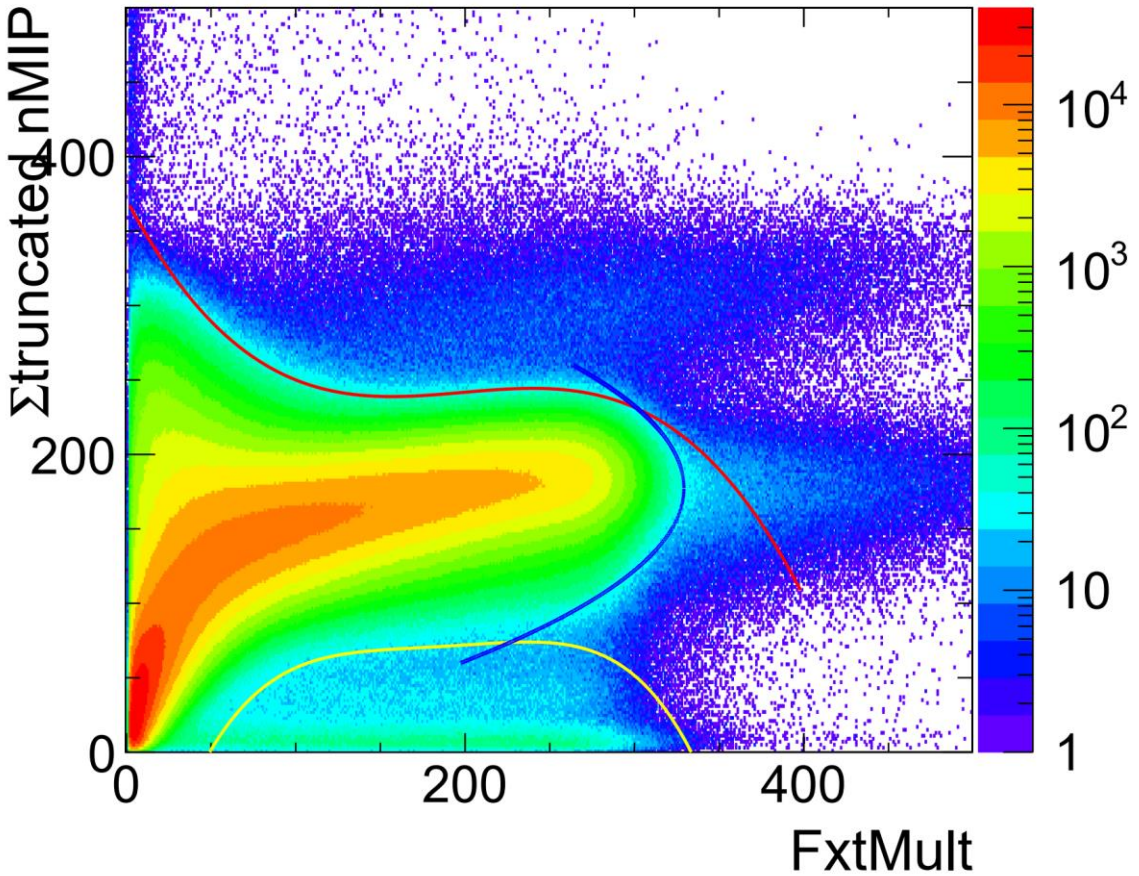


# Pileup event rejection @ 3.9 GeV

- 2019

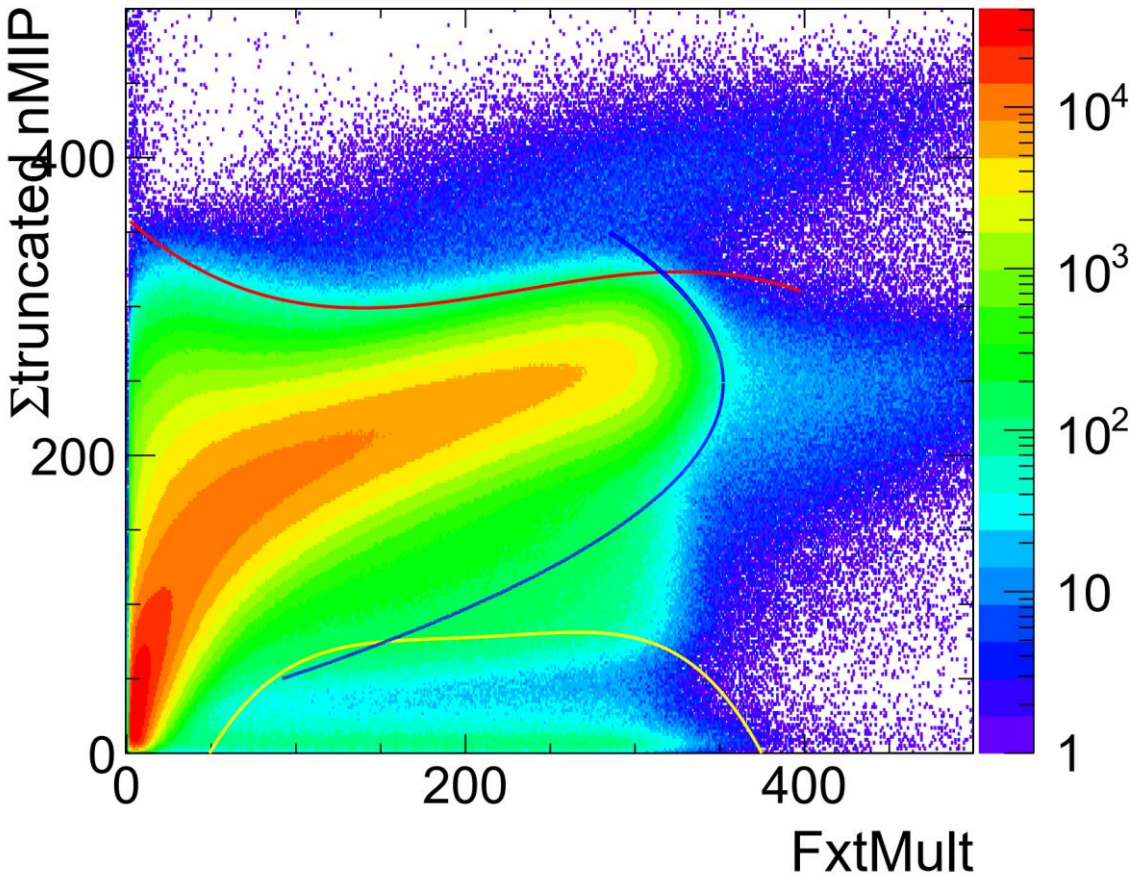



- 2020



# Pileup event rejection @ 4.5 GeV

- Remove area out of 3 colored curves



# A preliminary standard method

- 1. For 1D distribution of ∑TnMIP in each FxtMult slice
  - 1.1 Calculate bottom = mean−(3.5−0.2*skewness)*sigma and top = mean+(3.5+0.8*skewness)*sigma for ∑TnMIP
  - 1.2 Remove ∑TnMIP out of bottom to top and recalculate bottom and top
- 2. Fit bottom values as a quartic polynomial (pol4) function of FxtMult (yellow curve), and fit top values as a cubic polynomial (pol3) function of FxtMult (red curve)
- 3. For 2D distribution ($x$ = ∑TnMIP, $y$ = FxtMult)
  - 3.1 Remove bins with value/integral out of 3.8e−7 to 4.2e−7
  - 3.2 Fit rest distribution with a "[0]*TMath::Gaus(x[0], [1], [2])+[3]" function of ∑TnMIP (blue curve)
- Fitting range should be determined for each dataset