Centrality definition on Run21 3GeV dataset

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Dataset

Official badrun list:
https://drupal.star.bnl.gov/STAR/pwg/common/bes-ii-run-qa/FXT-datasets
https://drupal.star.bnl.gov/STAR/system/files/dsli_Run21_3GeV_total_list_240926_v1.pdf
After the reproduction, the QA will be repeated

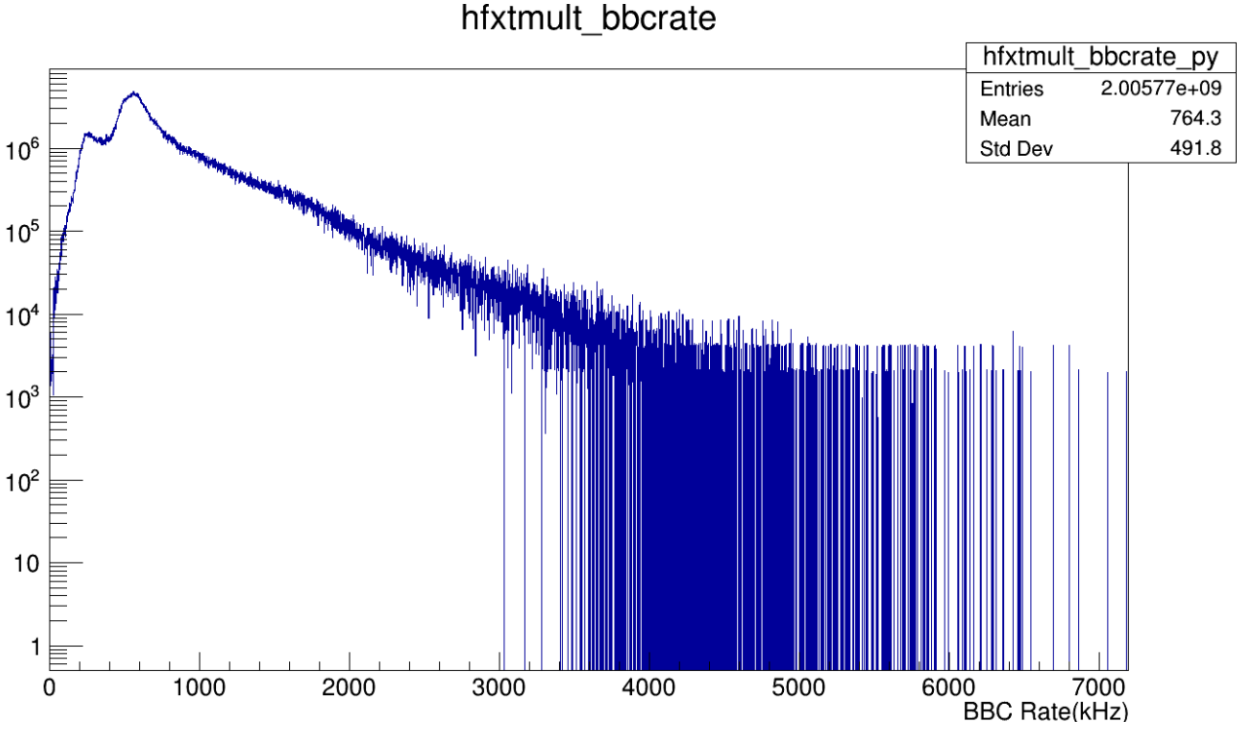
Triggers:
820030,820020,820010
(EPDEorBBCEorVPDEorZDCE-tof1)

Event level cuts:
|Vr| < 2 cm (it's centered at (0,-2) (cm))
198 cm < Vz < 202 cm

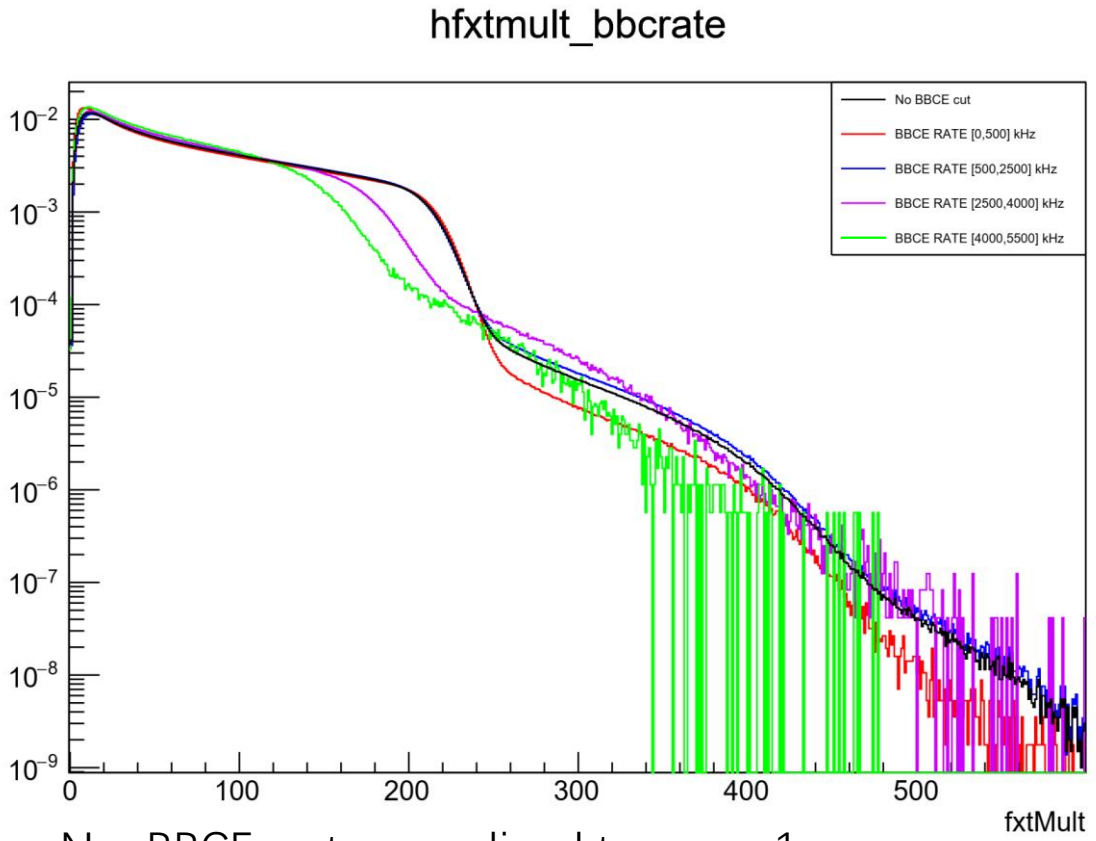
Related Variables:
fxtmult = fPicoDst->event()->fxtMult() (ALL PRIMARY TRACKS)
ntofmatch = fPicoDst->event()->nBTOFMatch()
bbcrate = fPicoDst->event()->bbcEastRate()

Luminosity correction

- **High luminosity may cause TPC occupancy problem**



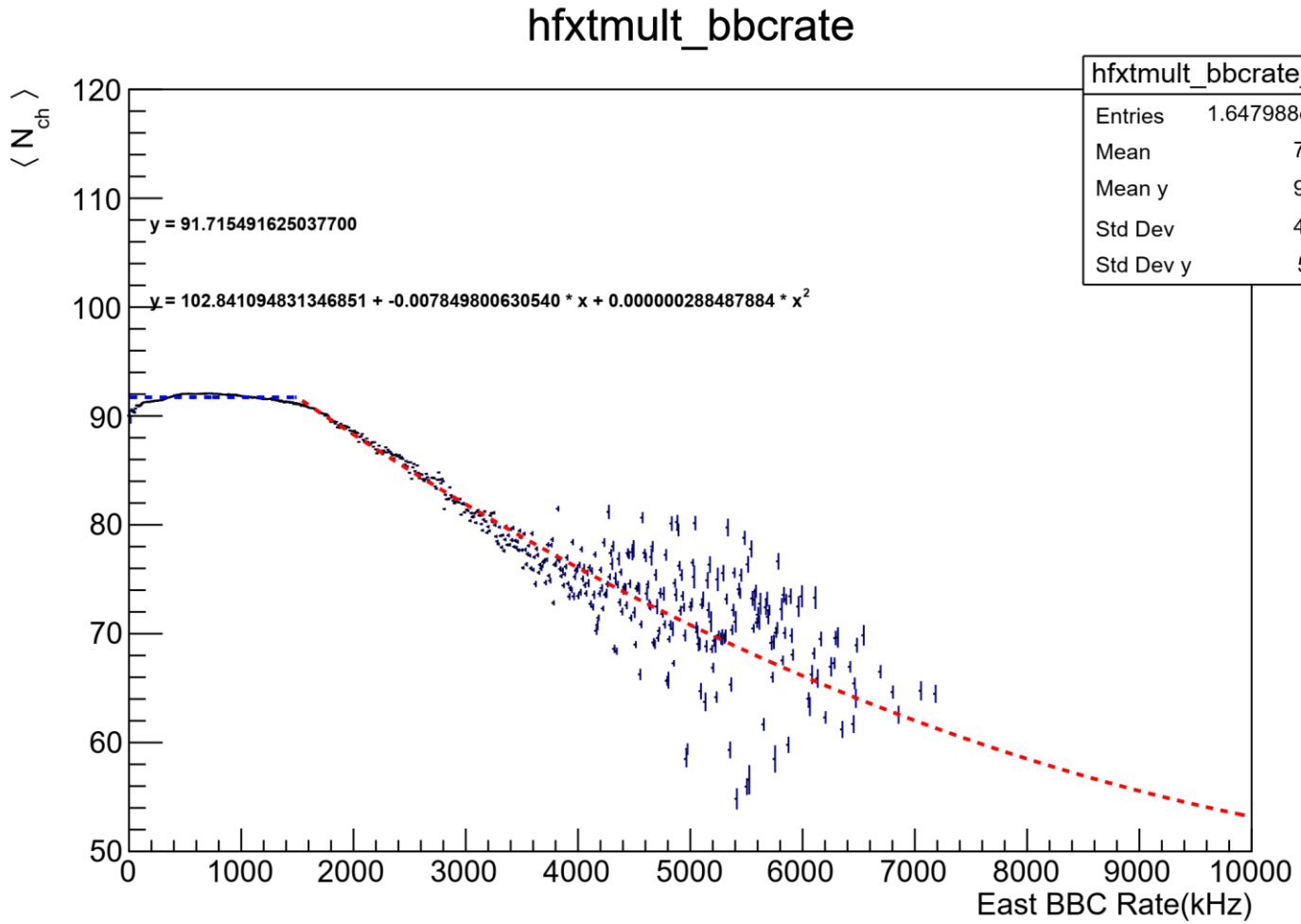
Most events have BBC rate < 2500 (99%)



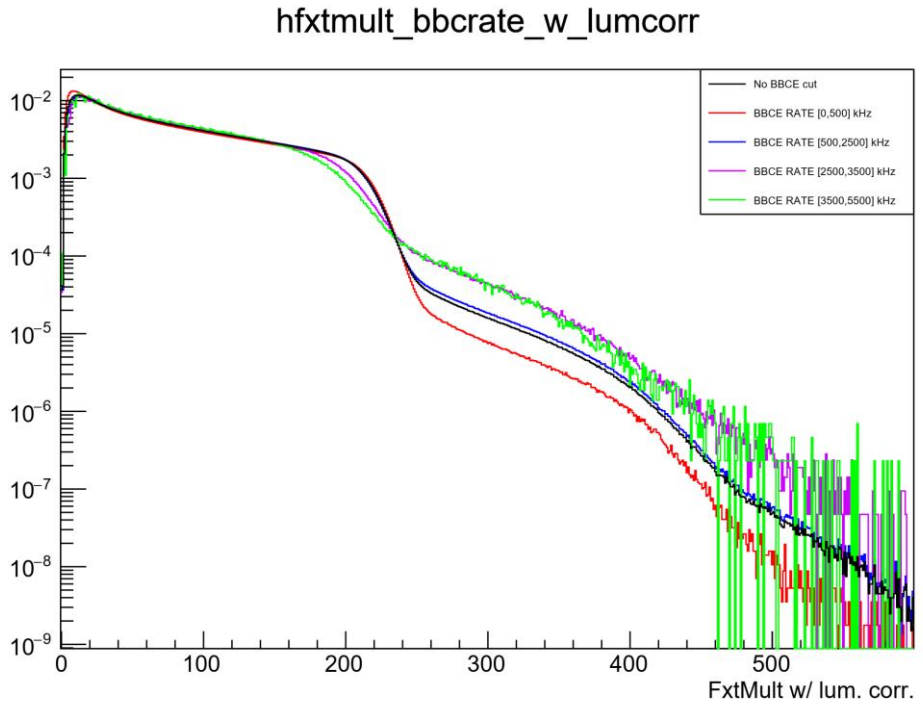
No-BBCE-cut normalized to area=1
Others normalized to No-BBCE-cut at fxtmult <200
Shape changes at BBC rate > 2500

Luminosity correction

- **Corrected N_ch with the correlation of N_ch and bbcrate**

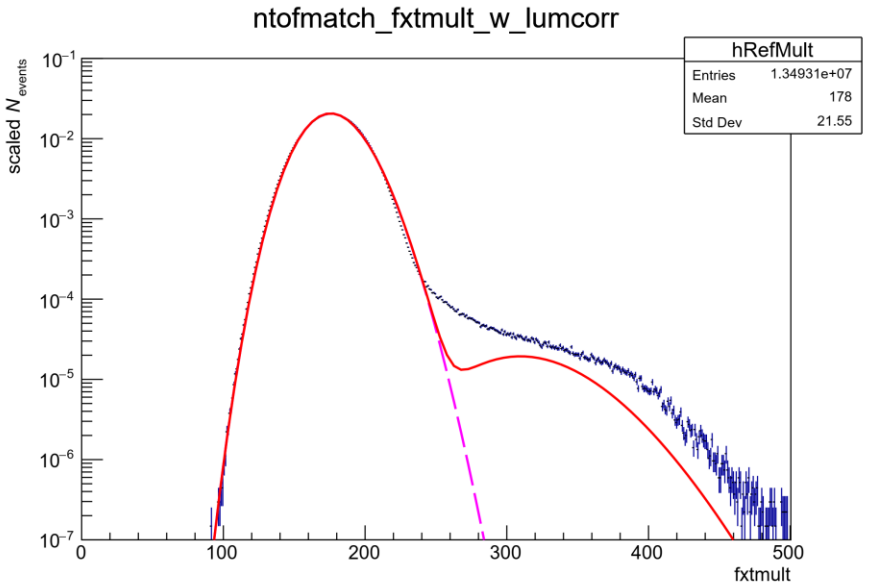


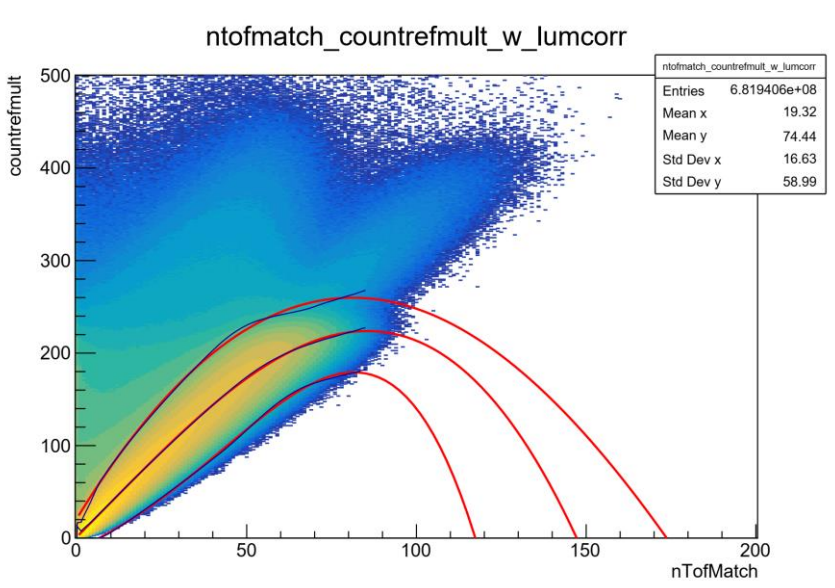
BBC rate < 1500, use constant value
BBC rate > 1500, use pol2

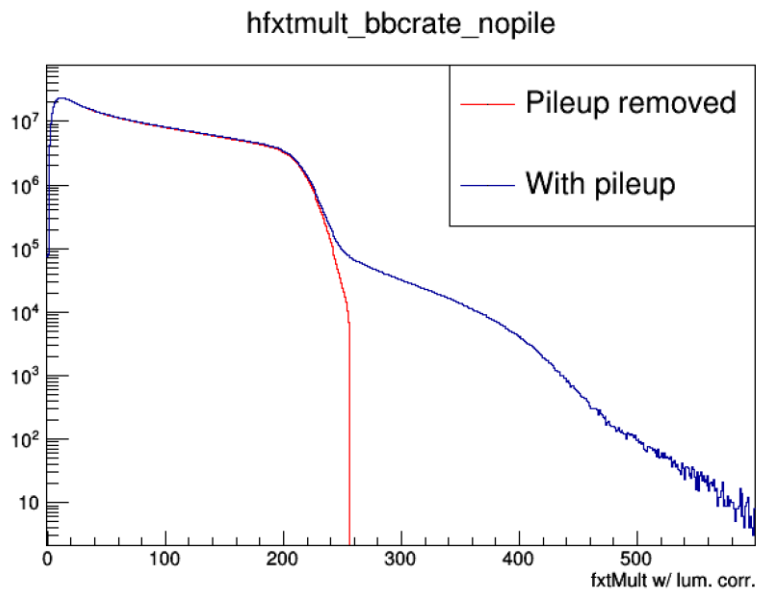


Pileup removal

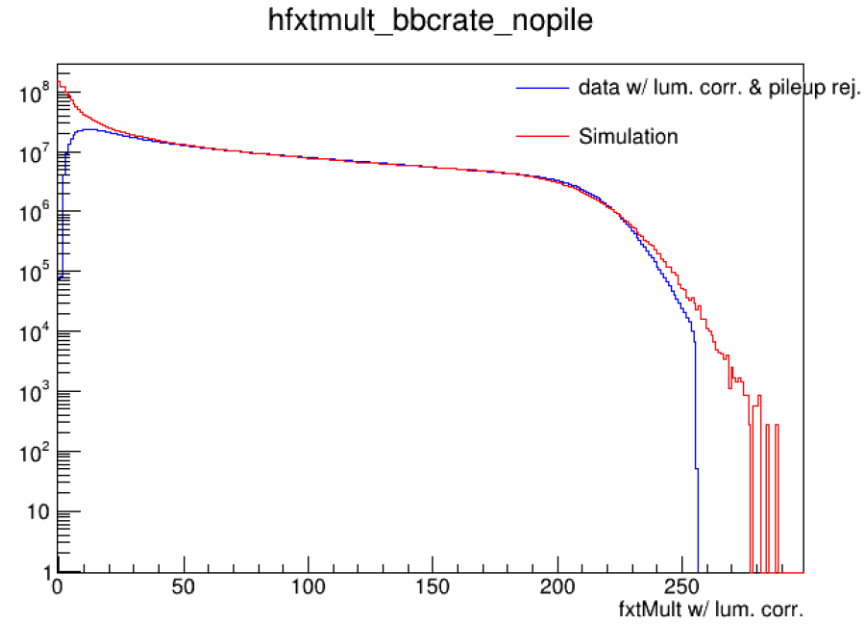
- **Use the correlation of ntofmatch and fxtmult**
  - Project each ntofmatch slices to the fxtmult axis
  - Fit the slice with a double-NBD distribution (mean, sigma and skewness parameters from the first peak)
    - Lower bound: 3*sigma
    - Higher bound: 2.5*(1+skewness)*sigma
  - Fit the black lines with pol4 functions
    - Lower bound::y = -11.496453205466938 + 1.648141784930263 * x + 0.020516240879845 * x^2 + 0.000151718561470 * x^3 + -0.000003610955234 * x^4
    - Higher bound: y = 20.309872998310297 + 6.035054106025867 * x + -0.038155611357729 * x^2 + 0.000000100000000 * x^3 + 0.000000100000000 * x^4

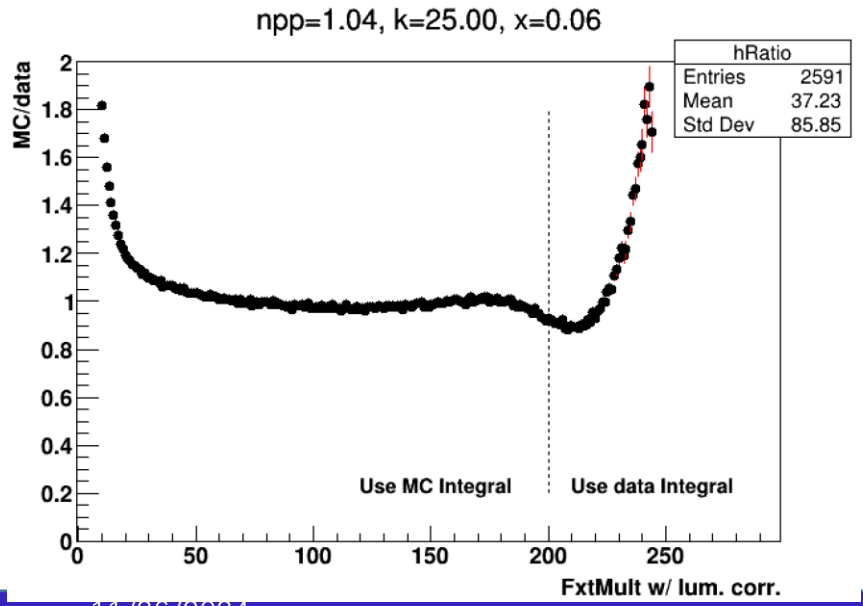






Glauber fit

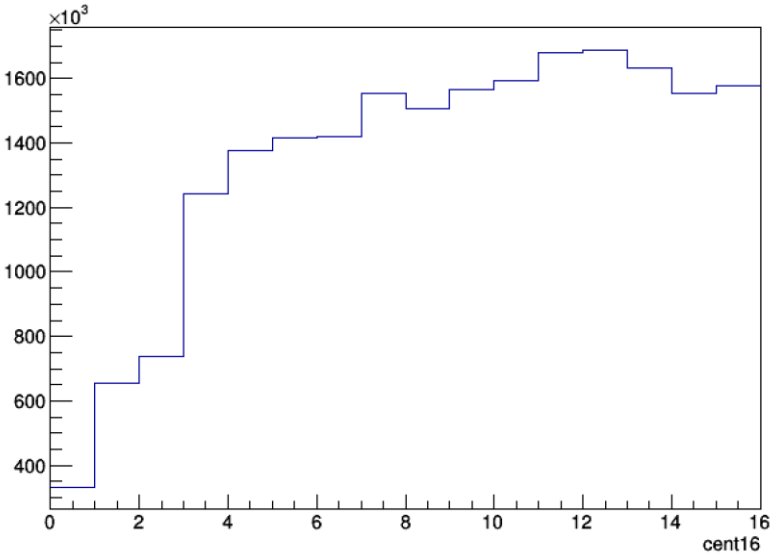





```
if(xx<5)
cent16 = -1;
else if(xx<7)
cent16 = 0;
else if(xx<10)
cent16 = 1;
else if(xx<13)
cent16 = 2;
else if(xx<18)
cent16 = 3;
else if(xx<24)
cent16 = 4;
else if(xx<30)
cent16 = 5;
else if(xx<39)
cent16 = 6;
else if(xx<48)
cent16 = 7;
else if(xx<60)
cent16 = 8;
else if(xx<73)
cent16 = 9;
else if(xx<88)
cent16 = 10;
else if(xx<106)
cent16 = 11;
else if(xx<126)
cent16 = 12;
else if(xx<150)
cent16 = 13;
else if(xx<179)
cent16 = 14;
else
cent16 = 15;
```

Centrality definition according to MC distribution at low mult + data distribution at high mult

- **Parameter scan**
  - Npp: 1-1.4 (21 points)
  - K: 10-30 (5 points)
  - X: 0.06-0.1 (5 points)
  - Eff: 0.10-0.15 (6 points)
- **Fit range: 50-260**
- **Chi2: 27.744/210**
- **The high mult tail is not well described by current Glauber simulation setup**



Summary

- We studied the centrality definition of Run21 3GeV
  - Luminosity correction and pileup rejection have been performed
  - Glauber fit is done and we defined centrality
    - However the fit maybe look not so good, maybe try to scan a larger parameter space in the next step

BACKUP: Badrun list in Run21 Au+Au 3 GeV

Total badrun list:
22121045 22122003 22122020 22125011 22158032 22158033 22158036 22159001 22159008 22159009 22159011 22159013 22160002 22161015 22162009 22162023 22163002 22163003 22164033 22163004 22166029 22167003 22169008 22171022 22174003 22174004 22174005 22174007 22174010 22174011 22174012 22176006 22178013 22171028 (run-by-run QA only, 34 badrun)

22122024, 22124003, 22124008, 22160003, 22160005, 22160006, 22160018, 22160020, 22160022, 22161006, 22162008, 22163007, 22165019, 22165033, 22165035, 22166006, 22166018, 22166023, 22166026, 22166031, 22167016, 22168004, 22168005, 22168008, 22169022, 22173035, 22174046, 22170016 (AI diagonosis only, 28 badrun)

22163005, 22166024, 22174006, 22174013 (their overlap, 4 badrun)

34+28+4 = 66 badruns in total