Run 17 FMS diffractive EM-jet A_N

Xilin Liang

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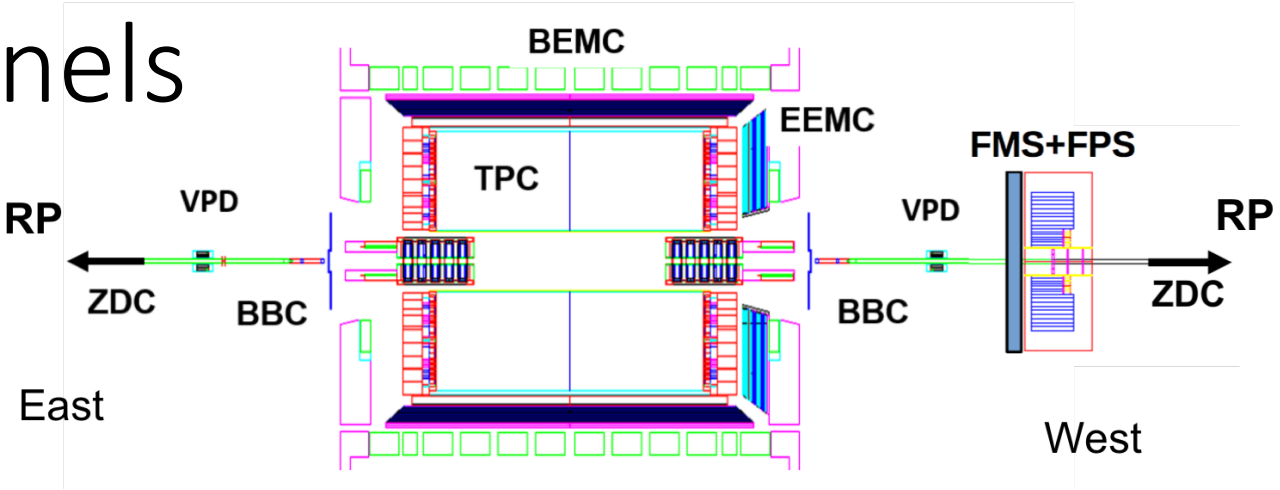
Data set

- Data set: run 17 pp transverse $\sqrt{s} = 510$ GeV ,fms stream
  - (pp500_production_2017)
- Production type: MuDst ; Production tag: P22ib
- Triggers for FMS : FMS small board sum, FMS large board sum and FMS-JP.
- Requirement: Event must contain Roman Pot (RP) information (pp2pp).
  - Already filter out events without RP response. Totally 180 fills.

Total number of events from data set sample (with FMS and RP coincidence)	**882 M**
Total number of events with FMS points	874 M
Total number of events with FMS EM-jets	860 M

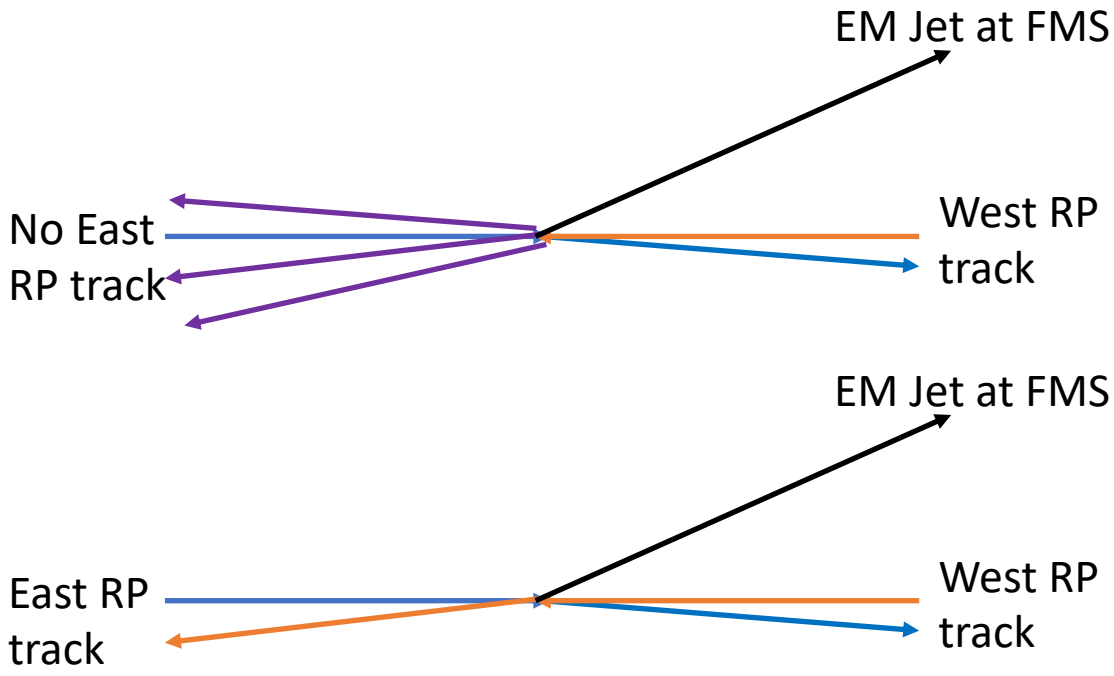
Diffractive process channels

2 diffractive channels are considered.



Require:

- Contain only 1 west RP track.
- Either no east side RP track or only 1 east side RP track.
- sum of west side tracks energy (west side proton + EM Jet) less than beam energy



Event selection and corrections

- **FMS**
  - 9 Triggers, veto on FMS-LED
  - bit shift, bad / dead / hot channel masking
  - Jet reconstruction: StJetMaker2015 , Anti-kT, R<0.7 , FMS point energy > 2 GeV, $p_T > 1$ GeV/c, FMS point as input.
  - Apply energy correction.
- **Only allow acceptable beam polarization (up/down).**
- **Vertex** (Determine vertex z priority according to TPC , VPD, BBC.)
  - Vertex $|z| < 80\ cm$
- **Roman Pot and Diffractive process:**
- Acceptable cases: (in next slide)
  1. Only 1 west RP track + no east RP track
  2. Only 1 east RP track + only 1 west RP track
  - RP track must be good track:

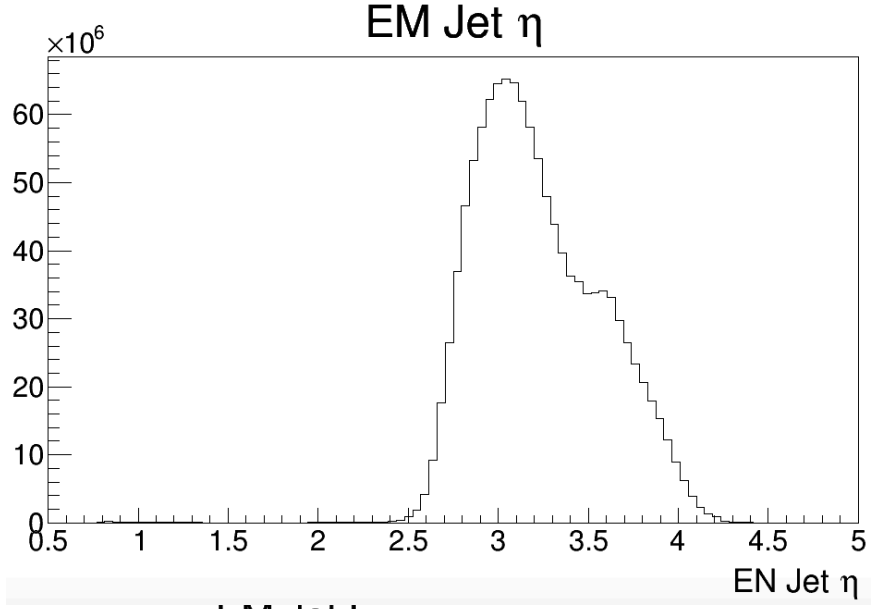
  a) Each track hits 8 planes

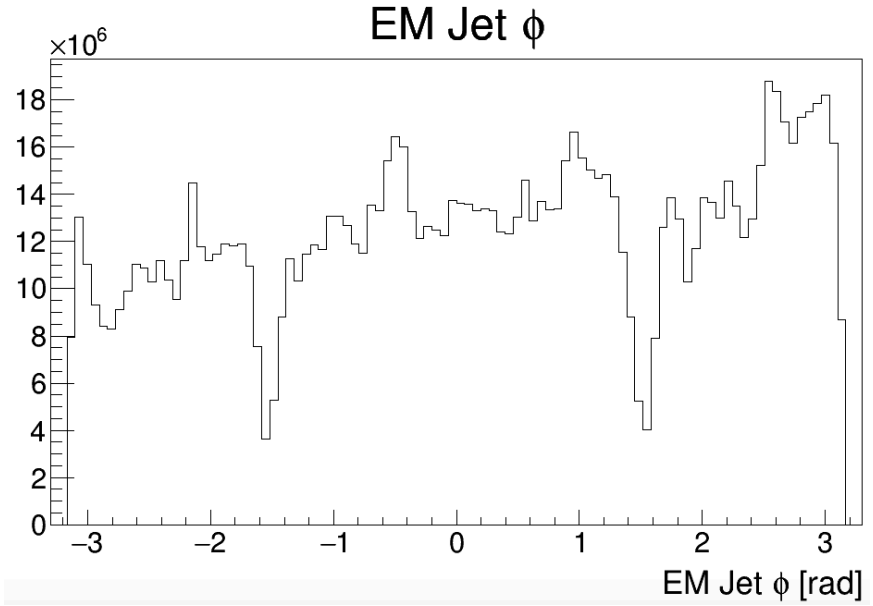
  $\boldsymbol{b)\ -0.3 < p_x < 0.5}$ **[GeV/c]** $\boldsymbol{, 0.25 < |p_y| < 0.4}$ **[GeV/c]**
  - Sum of west RP track energy and all EM Jet energy
- **BBC ADC sum cuts:**
  - West Small BBC ADC sum < 600

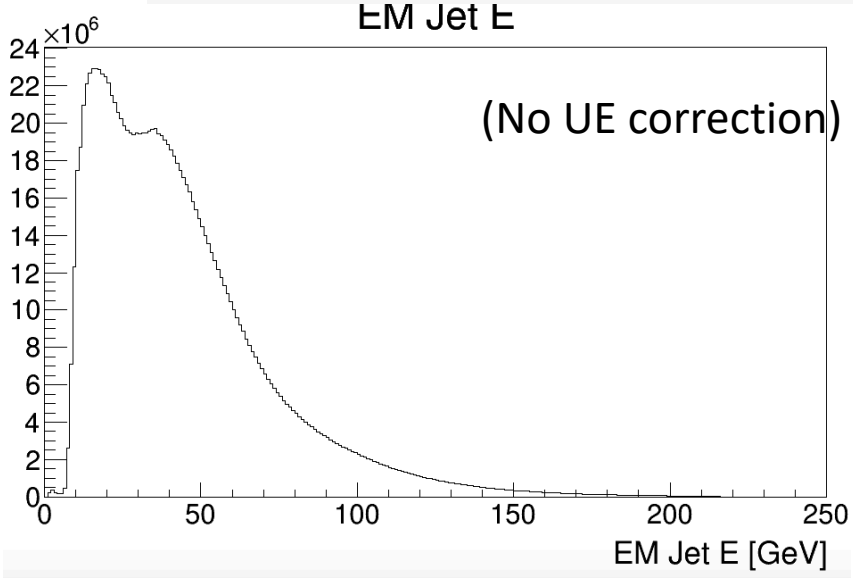
Corrections:
Energy correction and
Underlying Event correction

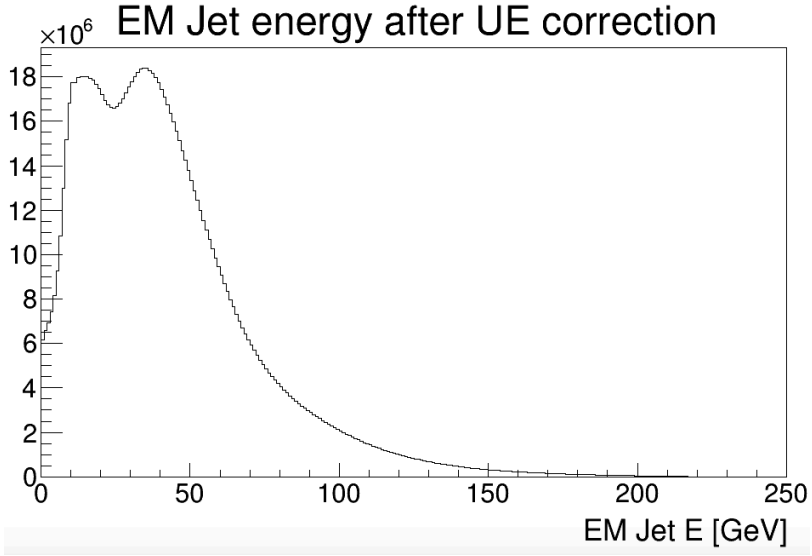
x_F	E sum Cut
0.1 - 0.15	E_{sum} < 265 GeV
0.15 - 0.2	E_{sum} < 280 GeV
0.2 - 0.25	E_{sum} < 295 GeV
0.25 - 0.3	E_{sum} < 305 GeV
0.3 - 0.35	E_{sum} < 315 GeV
0.35 - 0.4	E_{sum} < 330 GeV
0.4 – 0.45	E_{sum} < 340 GeV

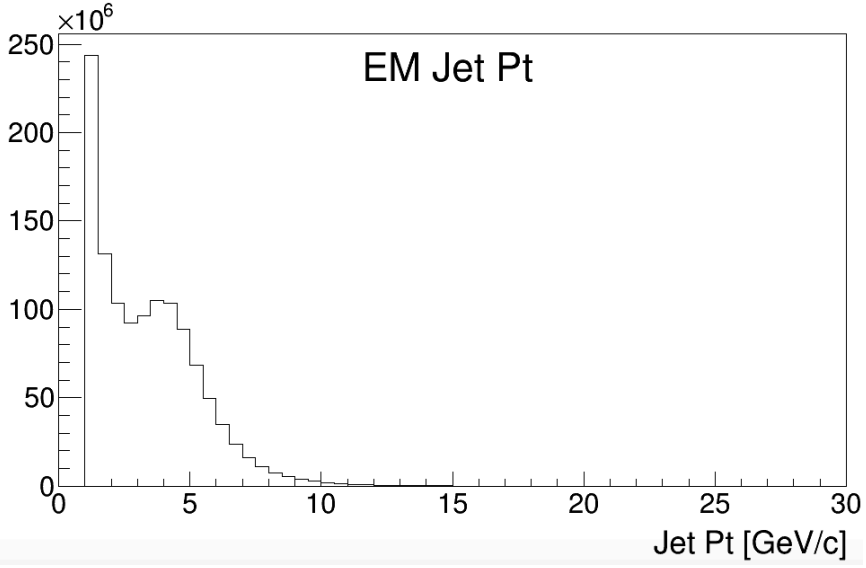
EM-jet QA (no cuts)







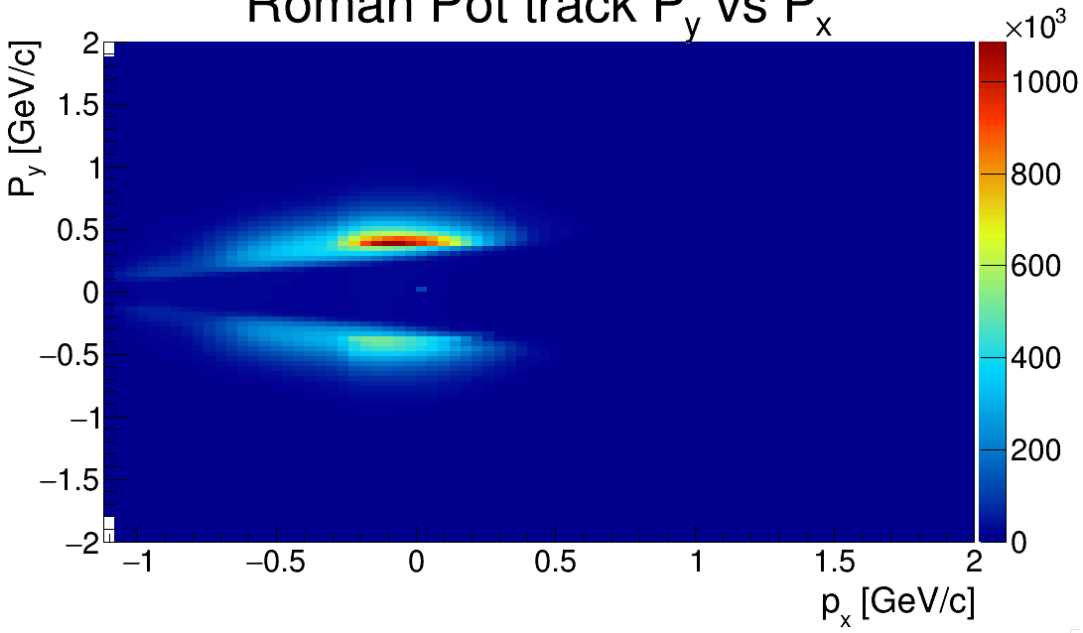




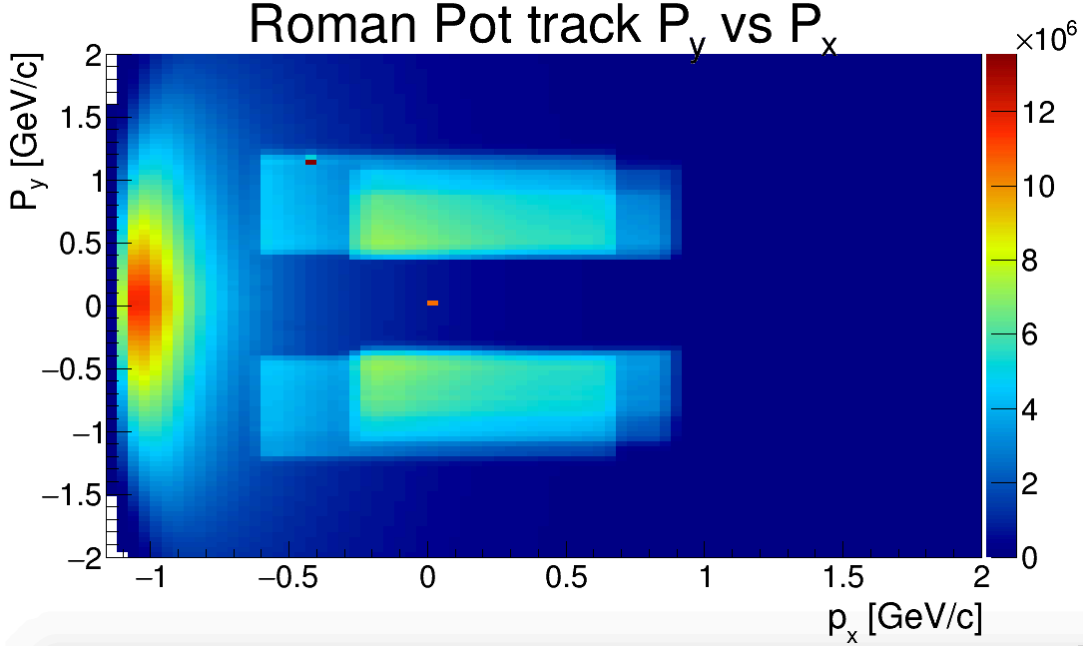
Roman Pot track p_Y vs p_x

- Plot RP track p_Y vs p_x
  - Consider cuts based on p_x and p_y distribution.
  - Plot ratio of good RP track to all RP tracks.
  - Good RP track: $N_{planes} = 8$

Good RP track (with $N_{planes} = 8$)



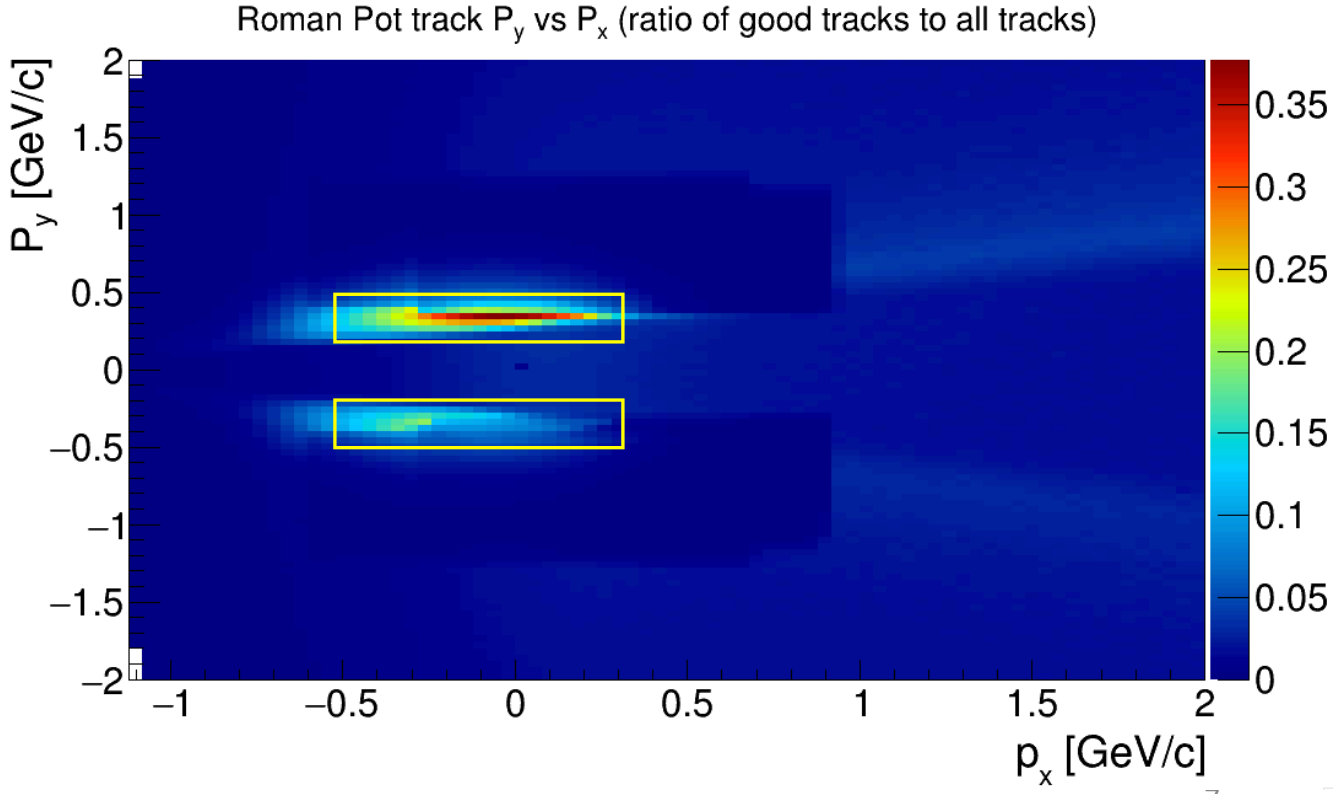
Bad RP track (with $N_{planes} < 8$)



Cut on Roman Pot track p_y and p_x

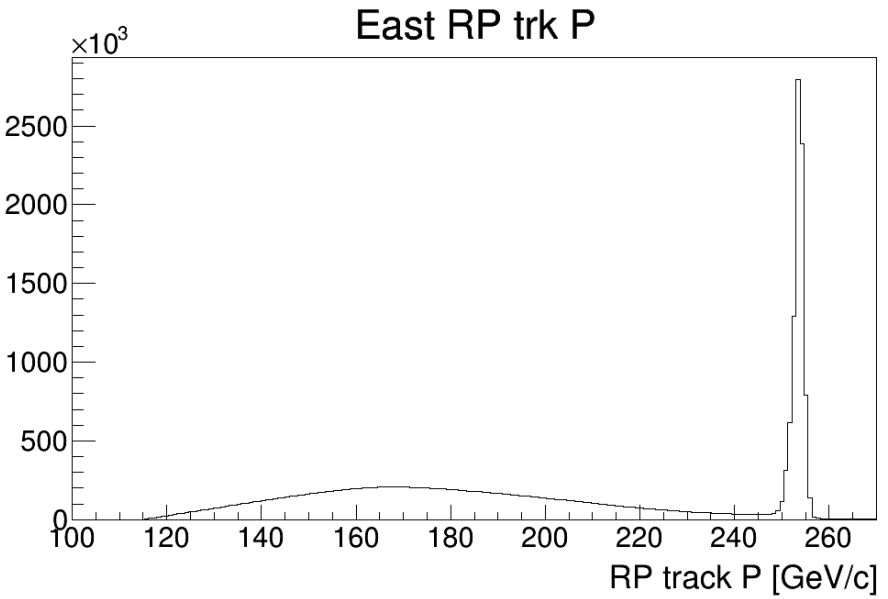
$$\frac{n_{nplane=8}}{n_{all}}$$

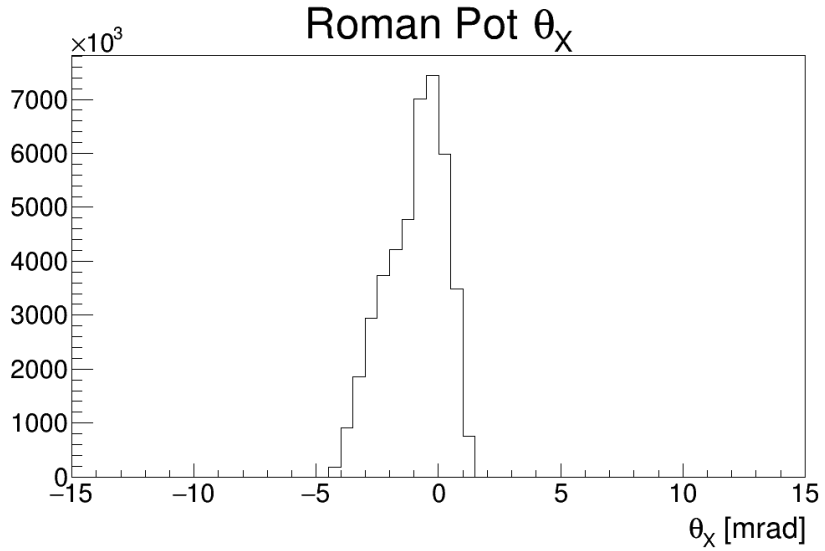
- Plot RP track p_y vs p_x
  - Consider cuts based on p_x and p_y distribution.
  - Plot ratio of good RP track to all RP tracks.
  - Good RP track: $N_{planes} = 8$
- Consider cuts:
  - $-0.3 < p_x < 0.5$ [GeV/c]
  - $0.25 < |p_y| < 0.4$ [GeV/c]

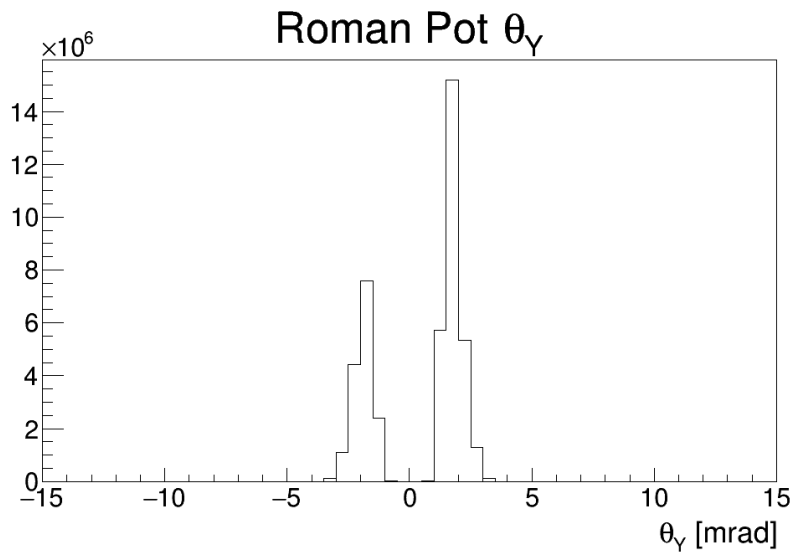


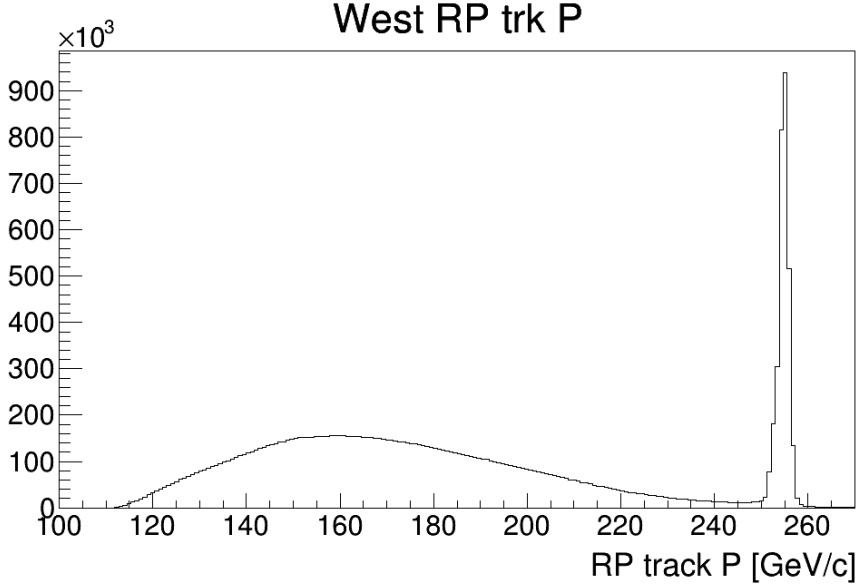
Roman Pot track QA

- After we apply the cuts on N planes that RP track hits and Roman Pot track p_x and p_y, the θ_x and θ_y distribution looks reasonable, matching with ranges of cut for θ_x and θ_y in run 15.







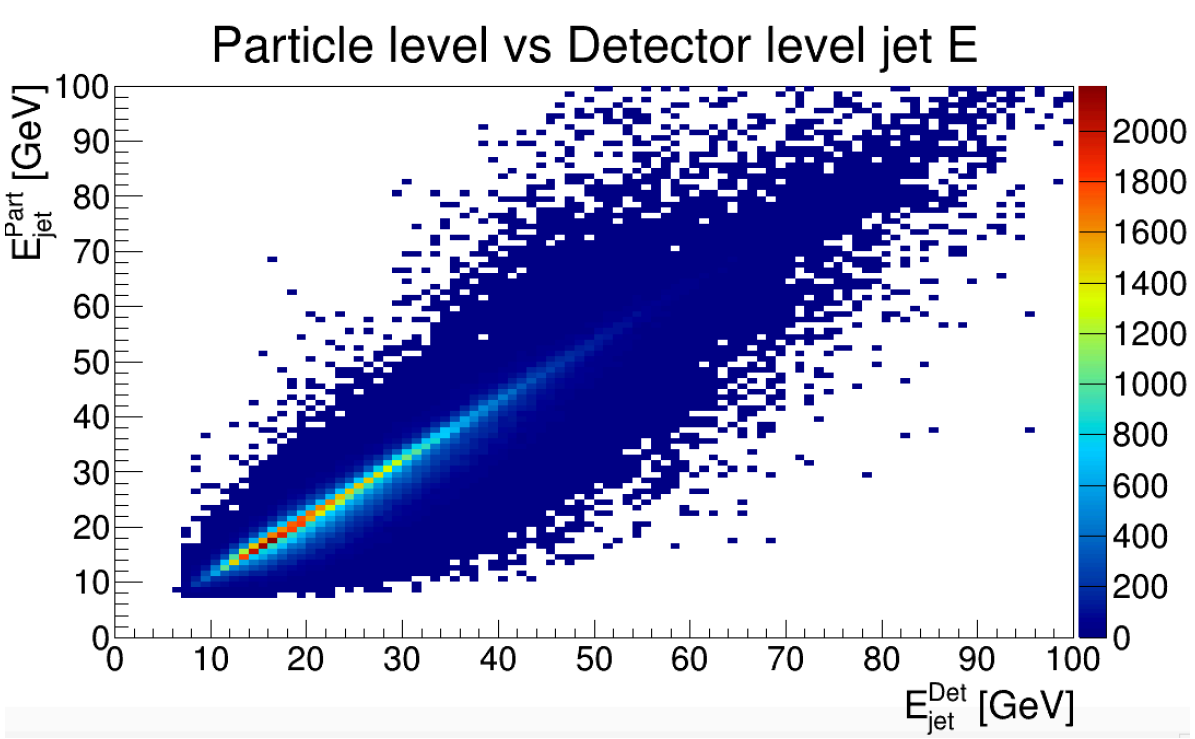


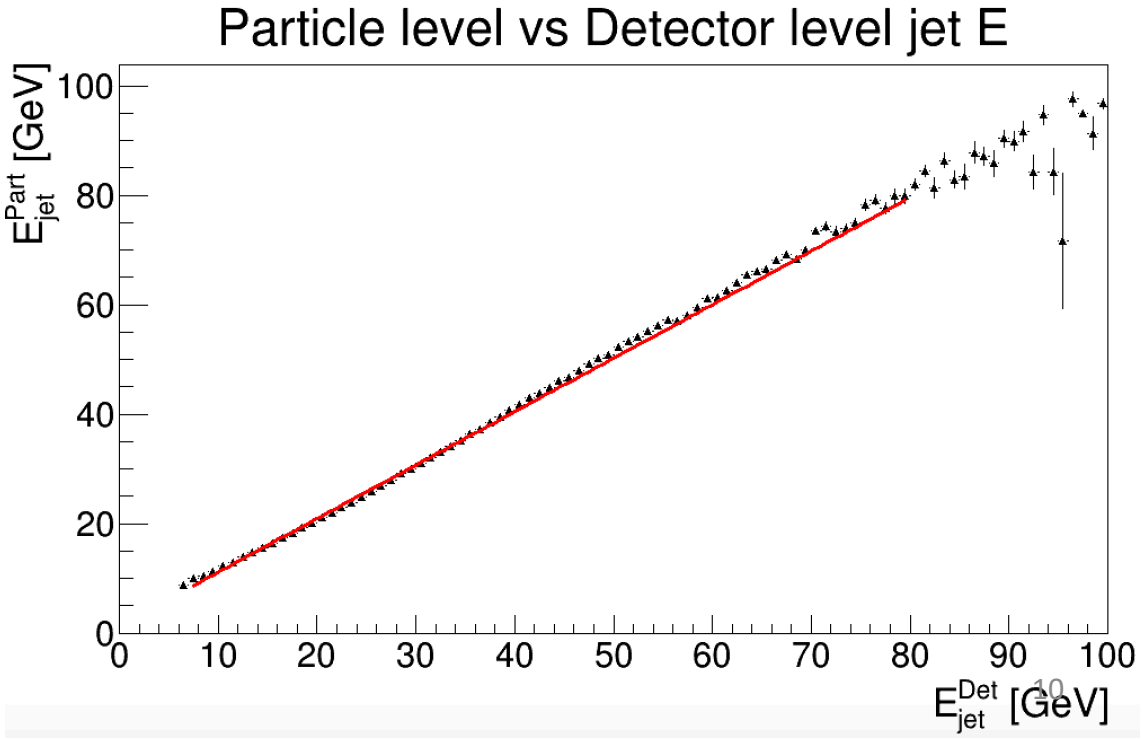
Simulation to get energy correction

- About 4 M simulation events
- Particle level simulation (Pythia 6):
  - Pythia 6, Tune Perugia6 (Tune param 370) , same as run 15 simulation
  - pp 510 GeV
- Detector level simulation (Geant 3):
  - Library version: SL20a
  - Geometry: y2017
  - Chain option: DbV20220729 y2017 MakeEvent ITTF NoSsdIt NoSvtIt Idst BAna l0 Tree logger Sti VFPPVnoCTB beamLine tpcDB TpcHitMover TpxClu fmsDb fmsSim fmspoint tags emcY2 EEfs eess evout -dstout IdTruth geantout big fzin MiniMcMk clearmem
  - Note: chain option is similar as run 15, but DB version is changed to the latest one.

Particle level vs detector level EM-jet energy

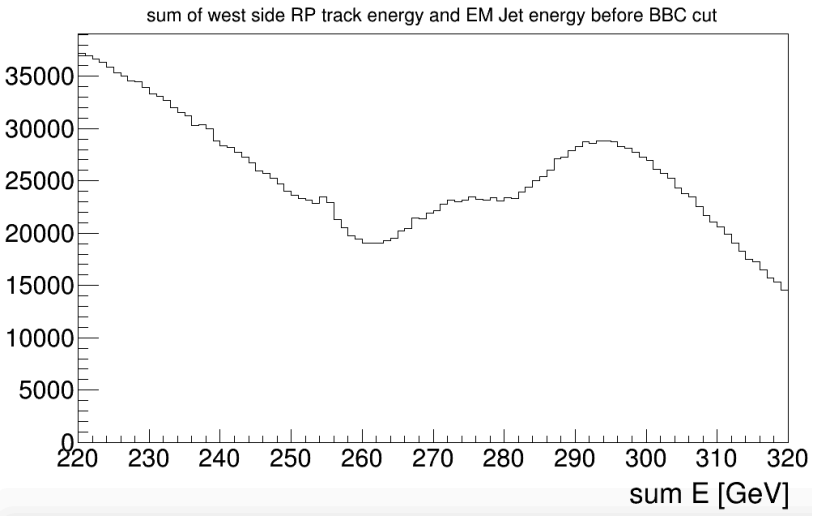
- Particle level vs detector level EM-jet energy plot
  - Apply linear function ($p_0 + p_1 \times x$) to fit for [7,80] GeV
  - p_0: 1.400 ± 0.019
  - p_1: 0.977 ± 0.001

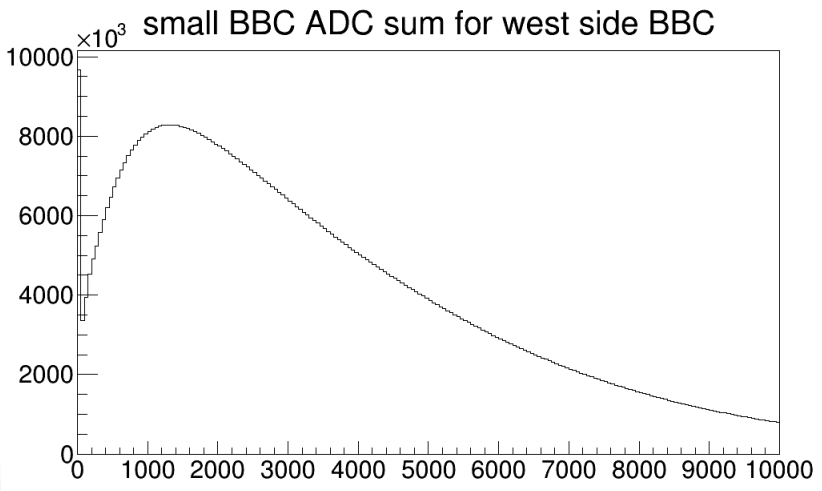


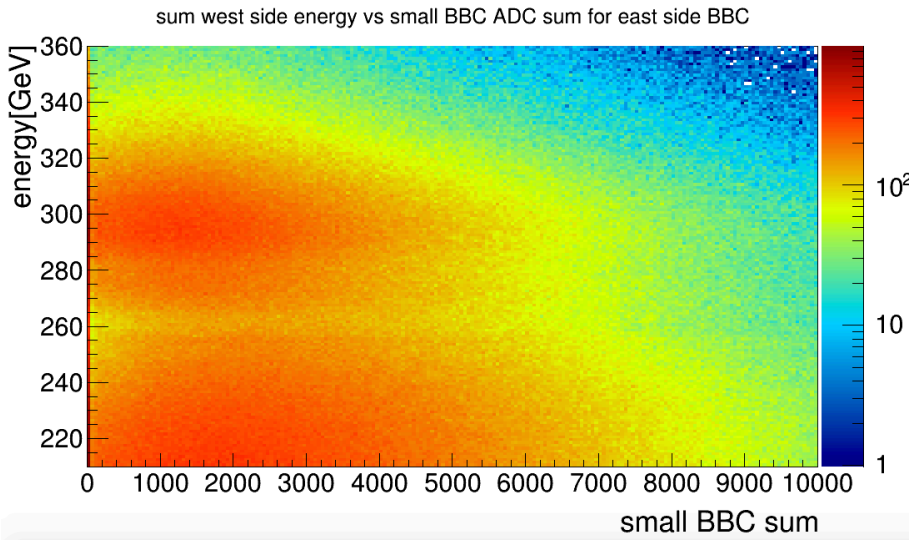


Sum energy and west BBC distribution

- Sum energy: sum of west side RP track energy and all FMS EM-jet energy.
  - Get rid of events without good FMS EM-jet.
  - Note: only consider the 2 accepted channels.
- Only small BBC ADC sum collected in the data sets.

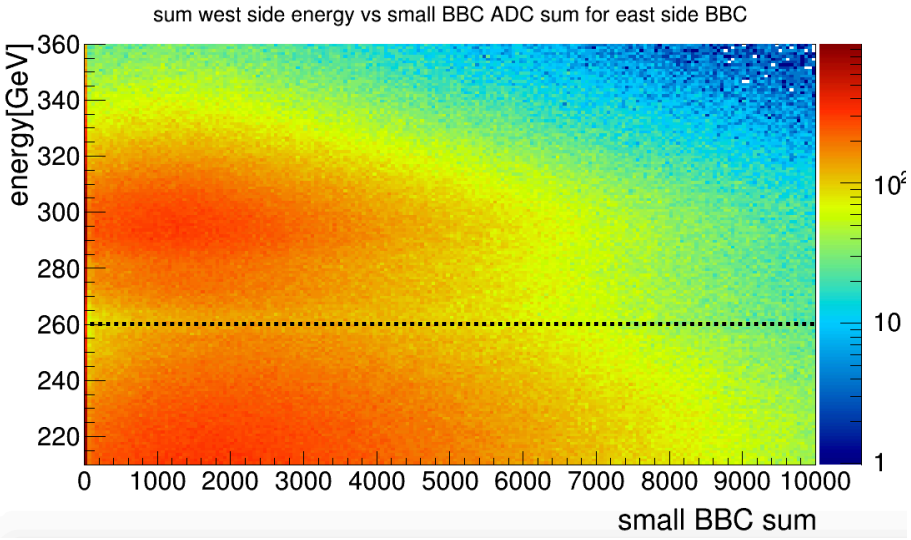


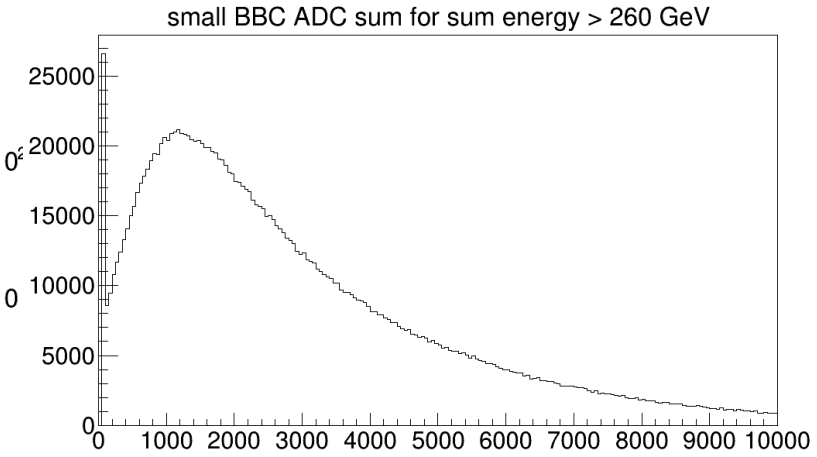


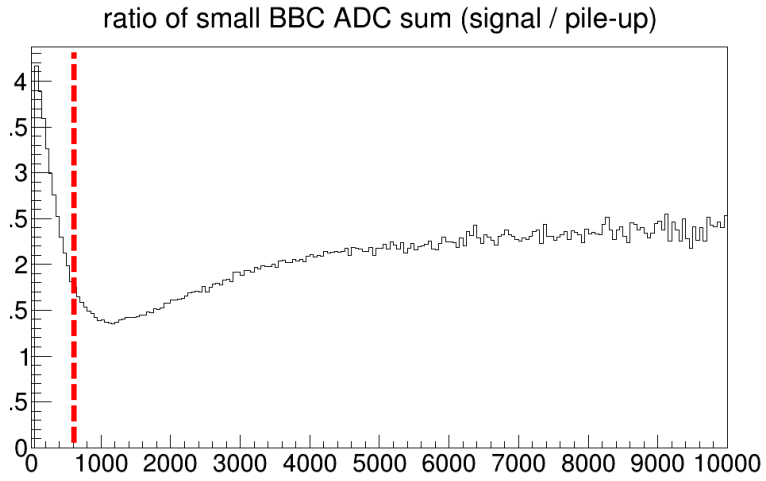


West side small BBC ADC sum cut

- Plot sum energy vs small BBC ADC sum
  - Sum energy: sum of west side RP track energy and all FMS EM-jet energy.
  - Consider $E_{sum} < 260$ GeV as signal and $E_{sum} > 260$ GeV as pile-up
- Plot ratio of signal to pile-up events as function of small BBC ADC sum
  - Apply small BBC ADC sum < 600 as cut.

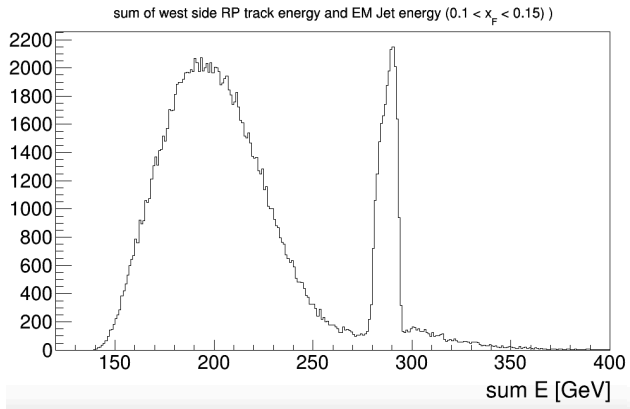


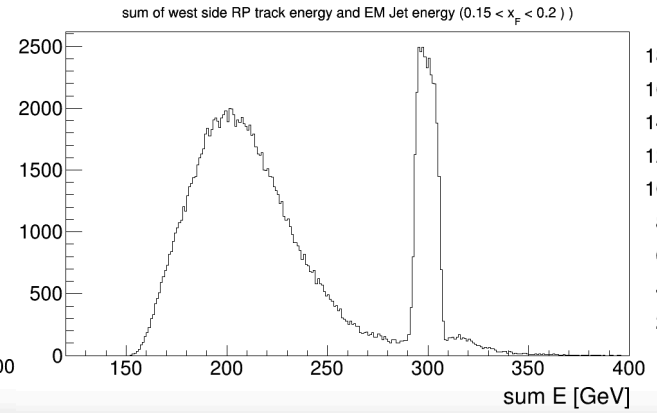


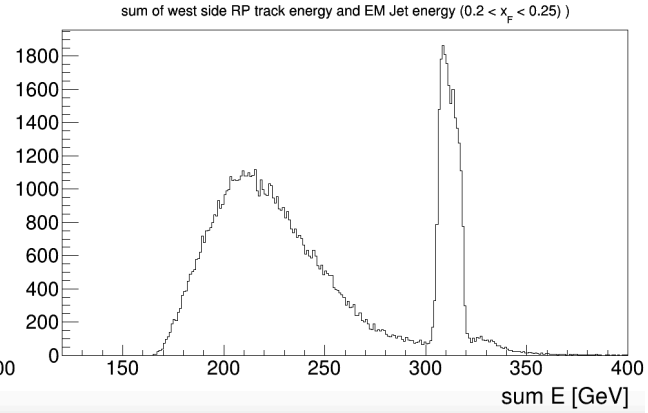


E sum cuts based on different x_F ranges

- Apply E sum cuts based on signal peak and pile-up peak splitting position.







x_F	E sum Cut
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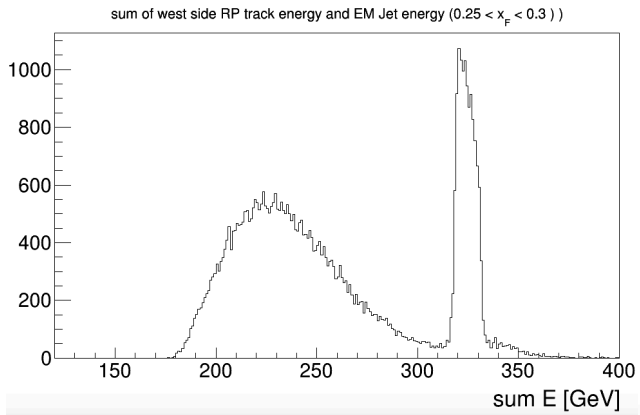
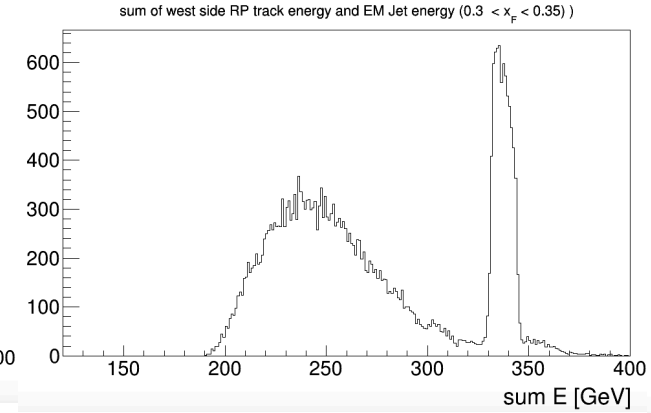
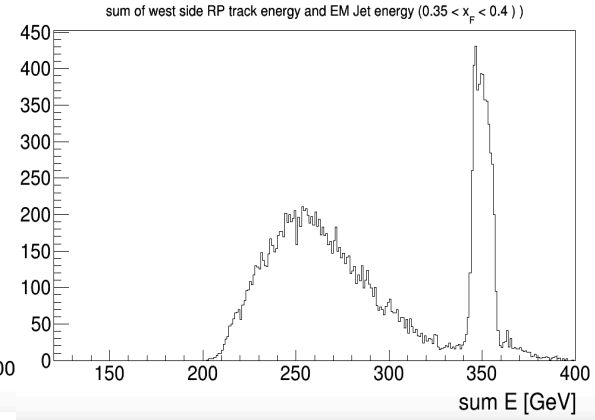
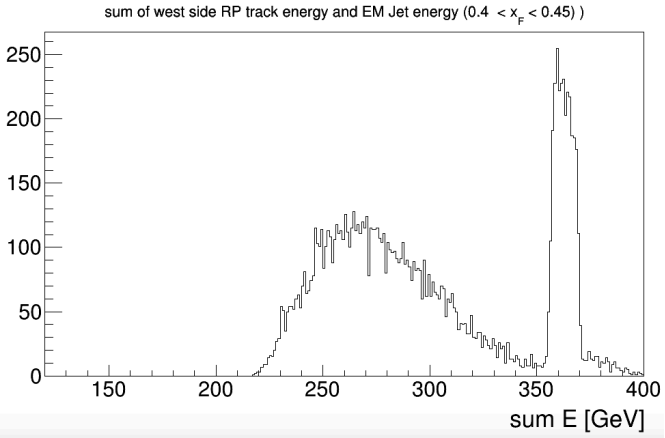


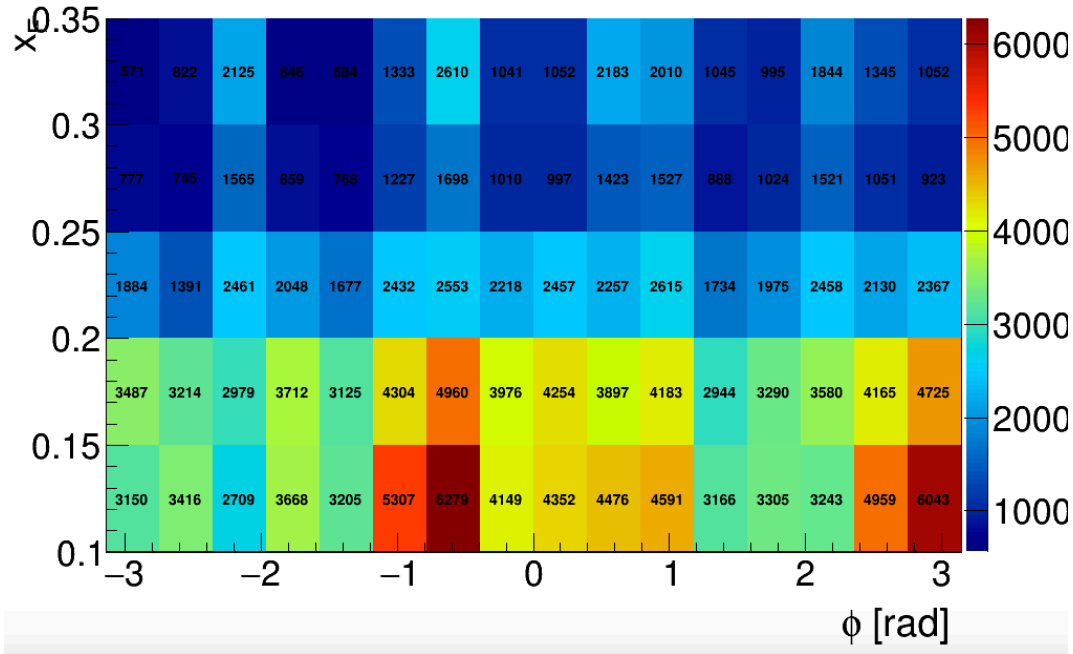


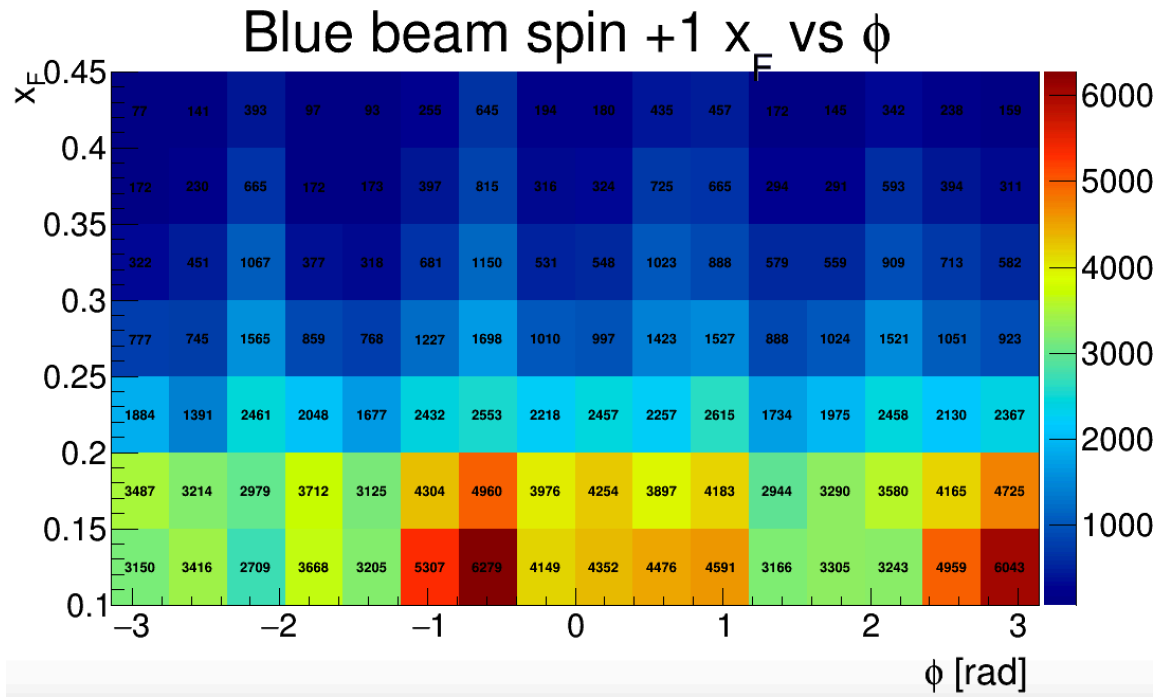




EM-jets yield counts by each x_F and ϕ

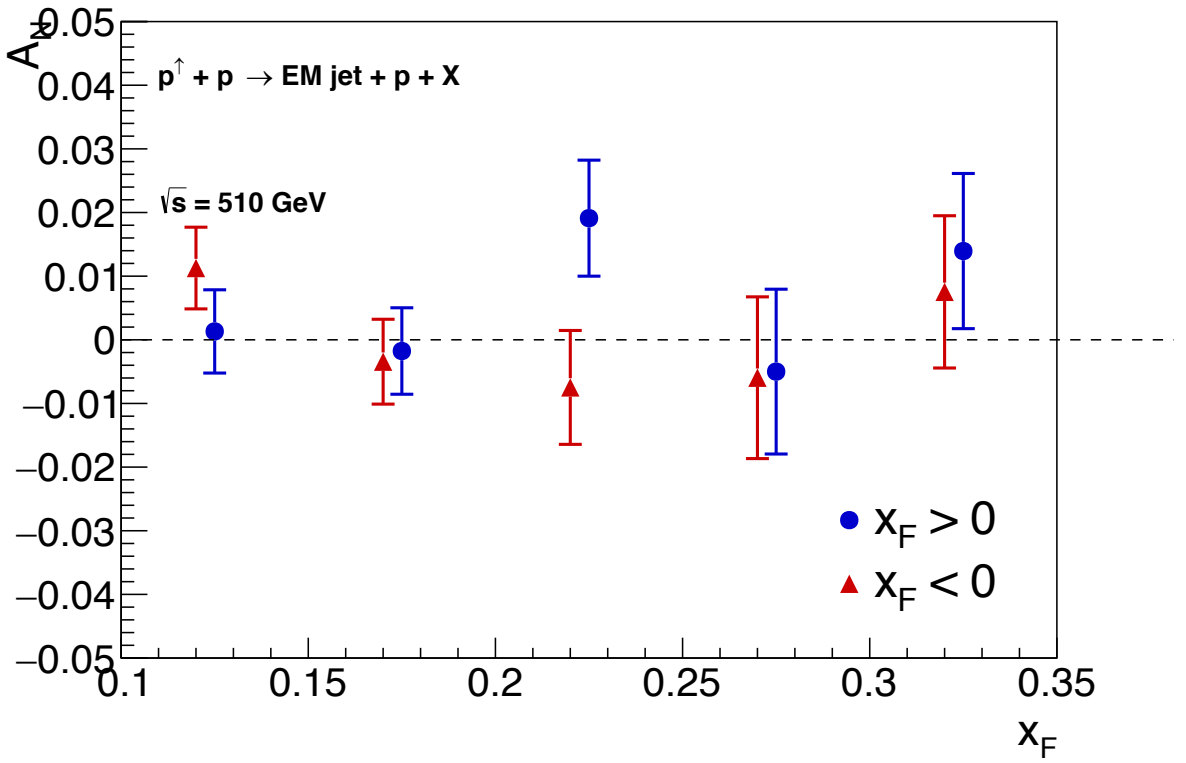
- Run 17 FMS data provides us more events than run 15 FMS data.
  - See EM-jets yield counts for same x_F regions as run 15 FMS analysis (left):
    - x_F: [0.1,0.15], [0.15, 0.2], [0.2, 0.25], [0.25, 0.3], [0.3, 0.45]
  - However, for run 17 data, we can access to A_N for higher x_F (right)
    - x_F: [0.1,0.15], [0.15, 0.2], [0.2, 0.25], [0.25, 0.3], [0.3, 0.35], [0.35, 0.4], [0.4, 0.45]





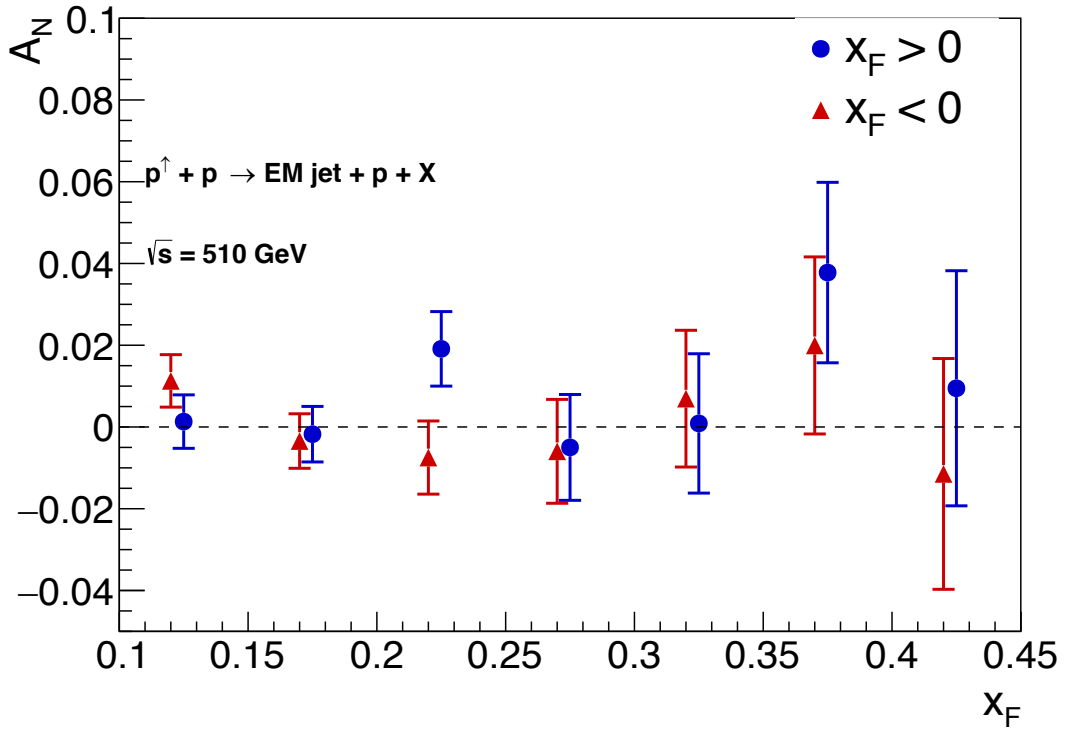
Run 17 FMS diffractive EM-jet A_N results

- Cross ratio method is applied to extract the A_N.
- Consider only **5** x_F ranges: [0.1,0.15], [0.15, 0.2], [0.2, 0.25], [0.25, 0.3], [0.3, 0.45]
- They seems to get A_N close to 0.



Run 17 FMS diffractive EM-jet A_N results

- Cross ratio method is applied to extract the A_N.
- Consider **7** x_F ranges: [0.1,0.15], [0.15, 0.2], [0.2, 0.25], [0.25, 0.3], [0.3, 0.35], [0.35, 0.4], [0.4, 0.45]
- They still seems to get A_N close to 0.



Conclusion and outlook

- First look at run 17 FMS data sets. They are well generated and good enough for the diffractive EM-jet A_N analysis.
- Follow the similar analysis procedures for run 15 diffractive EM-jet A_N analysis to run 17 diffractive EM-jet A_N.
- The run 17 diffractive EM-jet A_N is close to 0.

- Next to do:
  - Possible separate low photon multiplicity EM-jet A_N.
  - Systematic uncertainty study
  - Compare with run 15 results.
  - Compare with inclusive EM-jet A_N results.

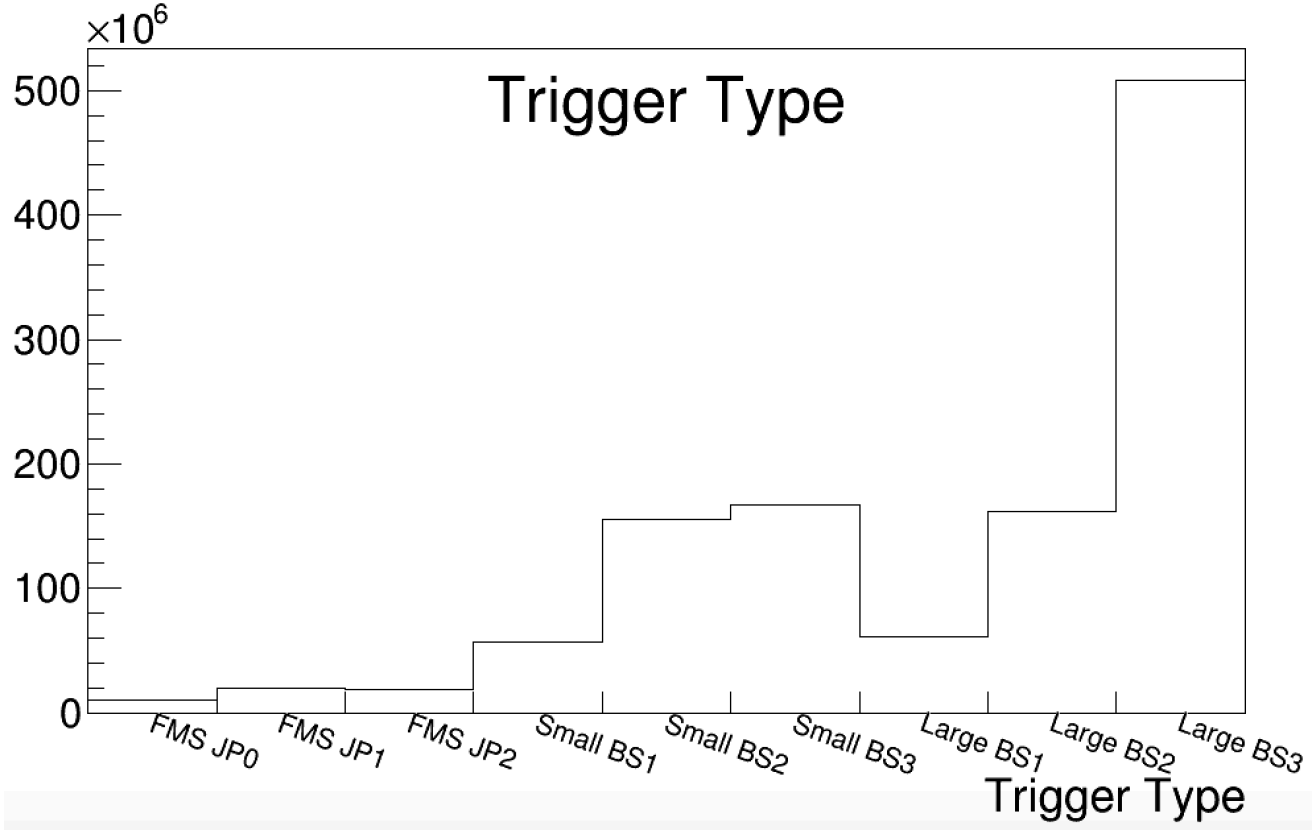
Back up

FMS EM-jet reconstruction

- EM-jet reconstruction: Anti-k_T algorithm with R=0.7 (Same as run 15 FMS analysis)
  - EM-jet: the jet reconstructed using only photons (FMS point).
  - Jet reconstruction: StJetMaker2015 , Anti-kT, R<0.7 , FMS point energy > 2 GeV, p_T > 1 GeV/c, FMS point as input.
- Calibration: already applied the final run 17 FMS calibration during generating MuDst files. No additional calibration currently applied (additional hot channel masking)

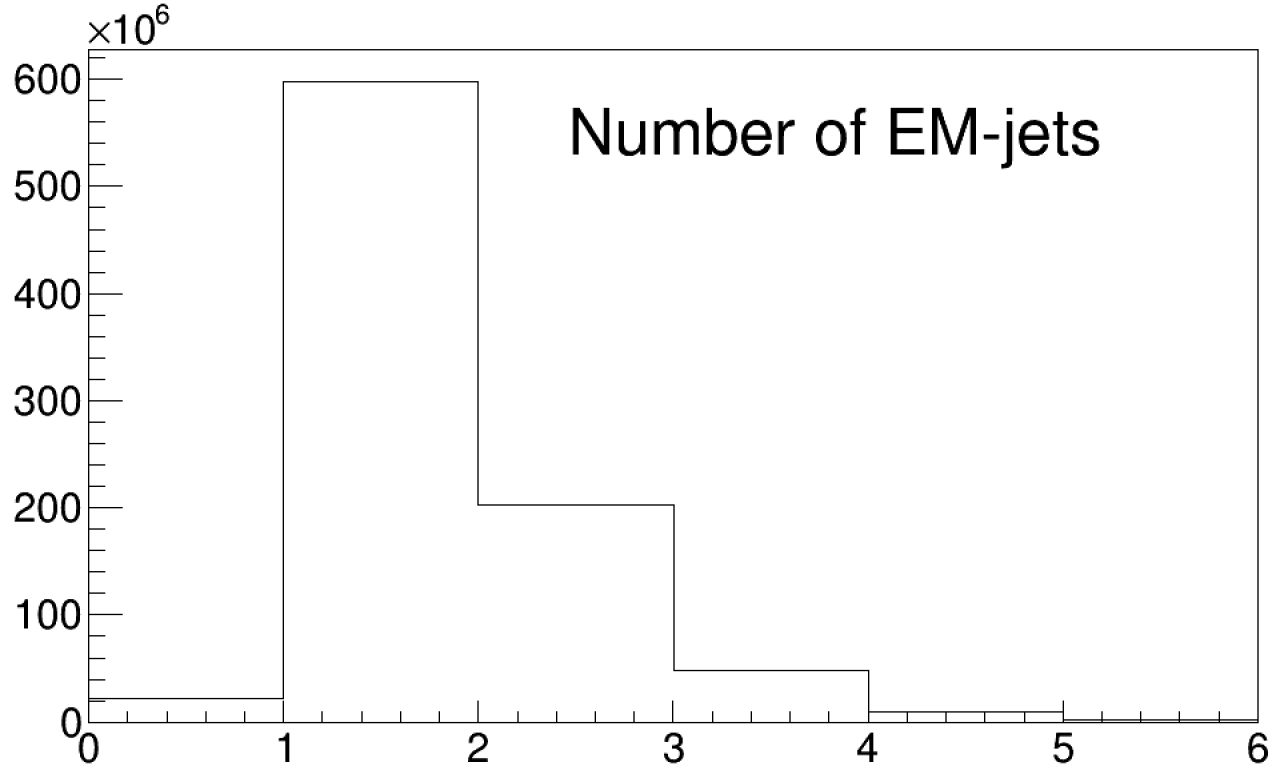
FMS trigger distribution

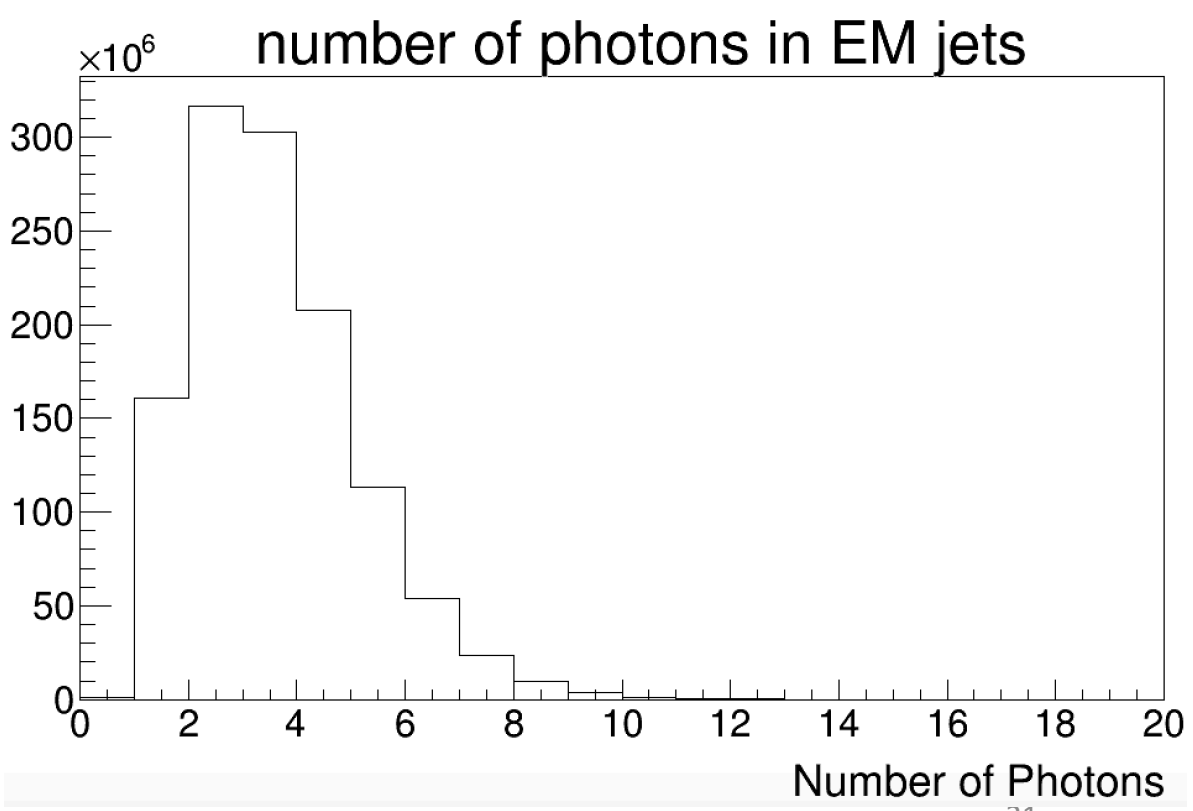
- 9 triggers are considered.
- Already filter out events without passing any FMS trigger.



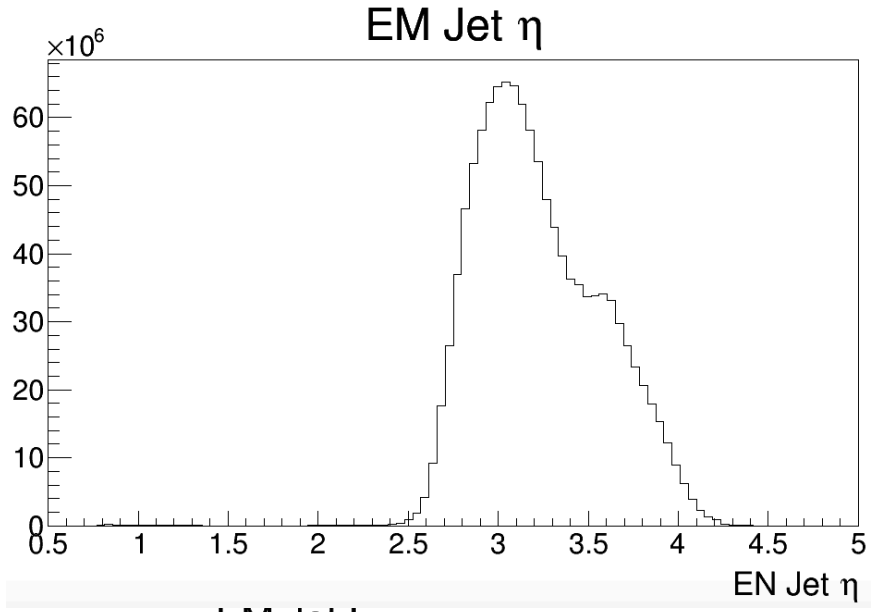
EM-jet QA

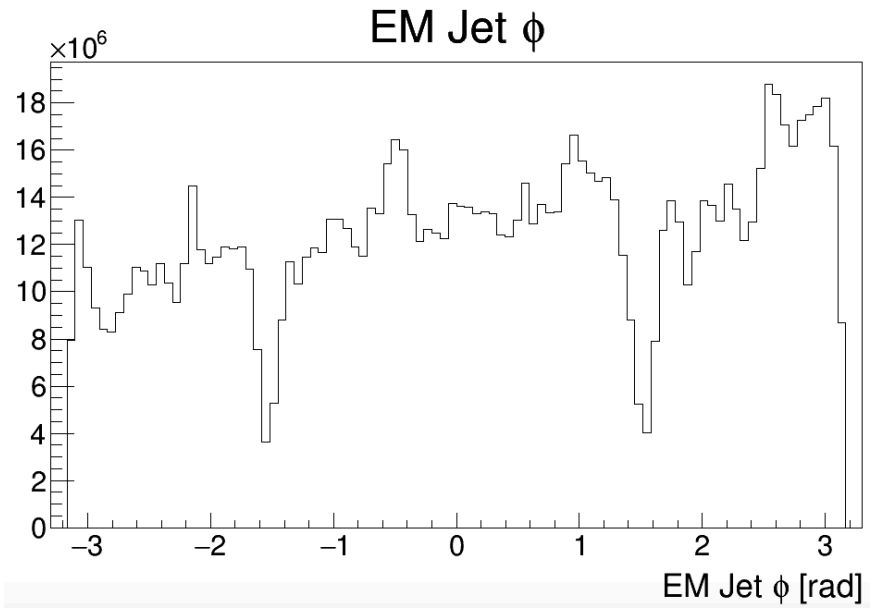
- Most of events contain 1 or 2 EM-jets.

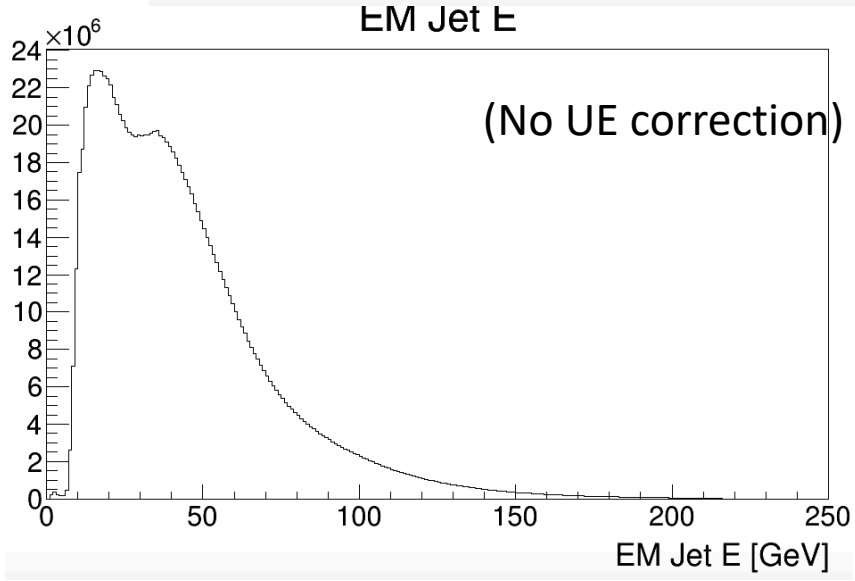


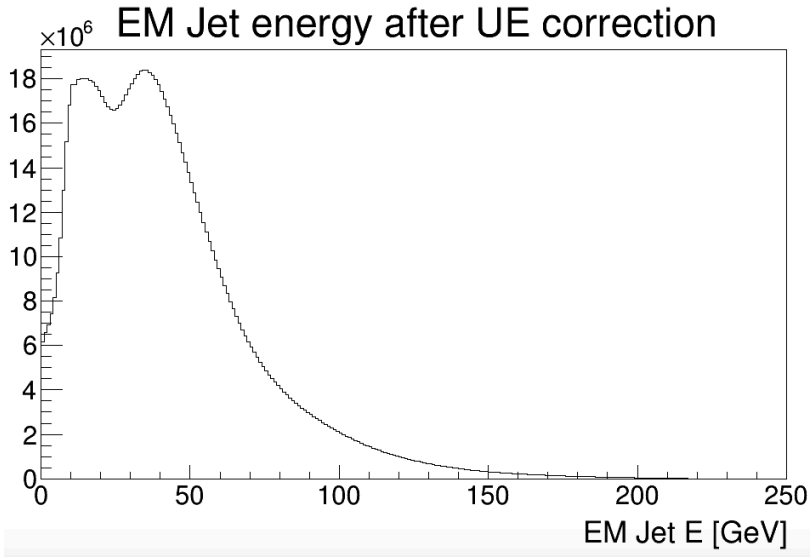


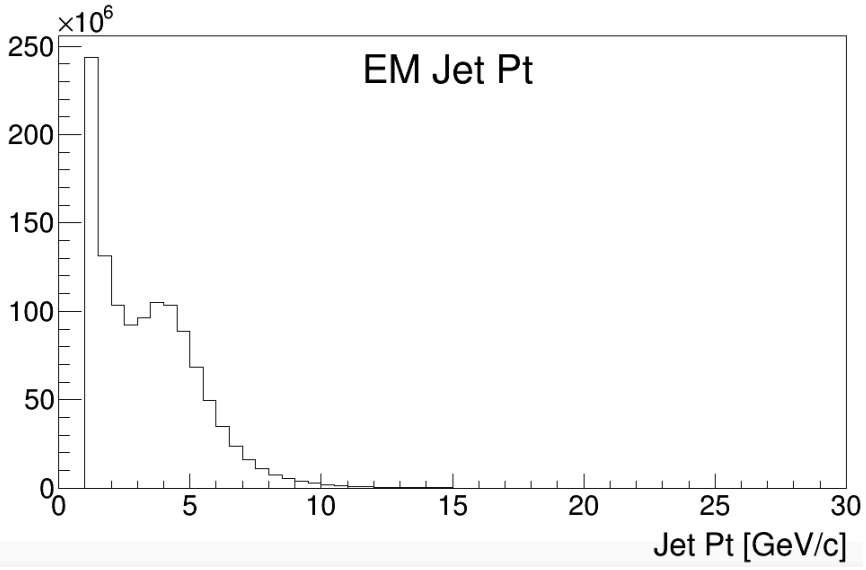
EM-jet QA


EM Jet η
×10^6
60
50
40
30
20
10
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
EN Jet η


EM Jet ϕ
×10^6
18
16
14
12
10
8
6
4
2
0
−3
−2
−1
0
1
2
3
EM Jet ϕ [rad]

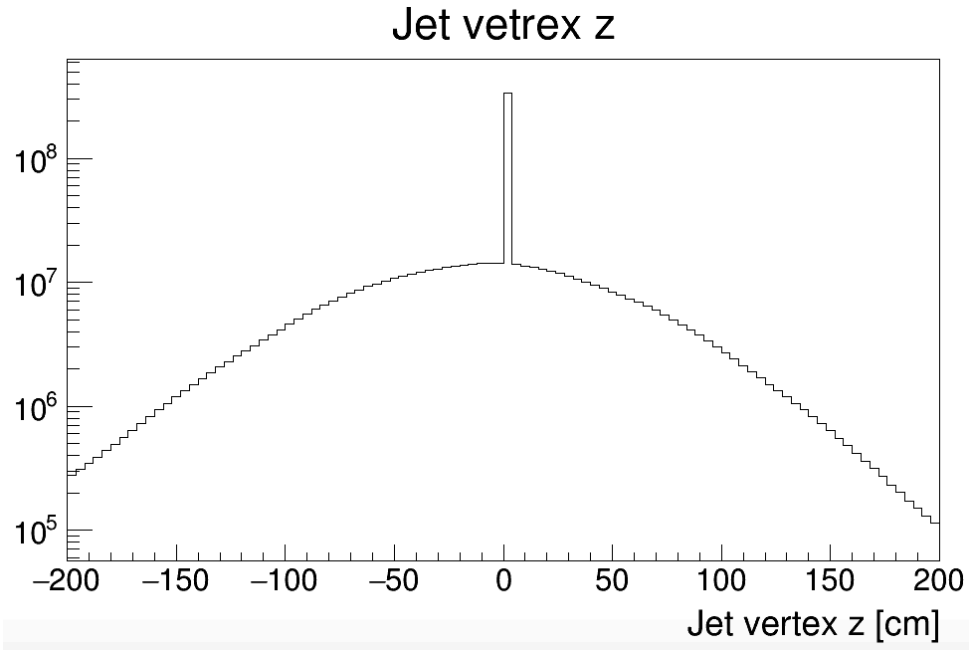

EM Jet E
(No UE correction)
×10^6
24
22
20
18
16
14
12
10
8
6
4
2
0
0
50
100
150
200
250
EM Jet E [GeV]

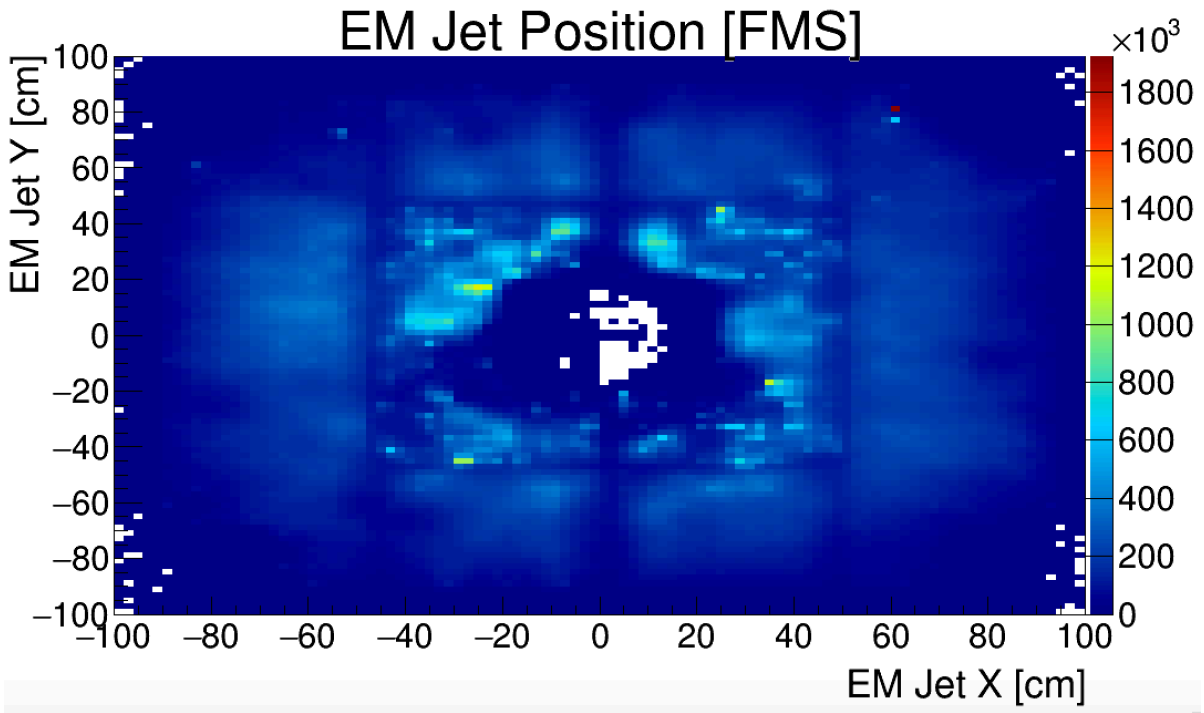

EM Jet energy after UE correction
×10^6
18
16
14
12
10
8
6
4
2
0
0
50
100
150
200
250
EM Jet E [GeV]

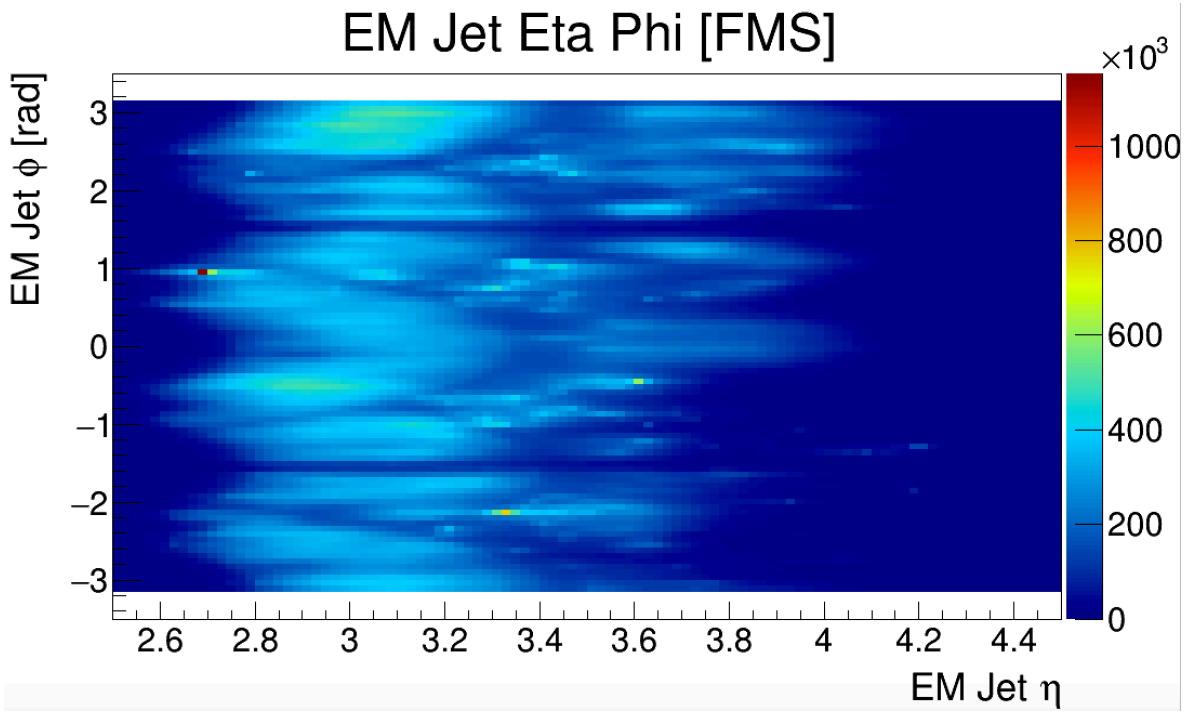

EM Jet Pt
×10^6
250
200
150
100
50
0
0
5
10
15
20
25
30
Jet Pt [GeV/c]

EM-jet position QA

- EM-jet position for all the data.
- Determine vertex z priority according to TPC , BBC, VPD. If vertex z is still not determined by these detector, set to 0.

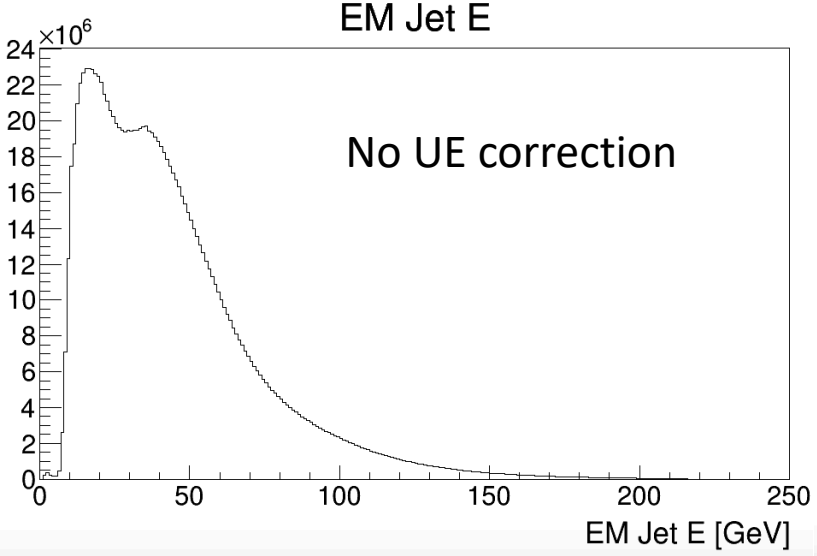


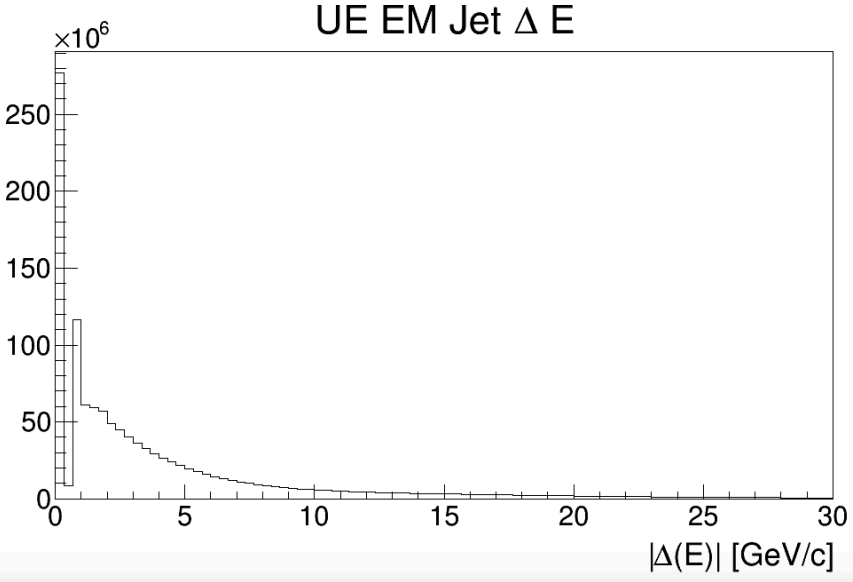


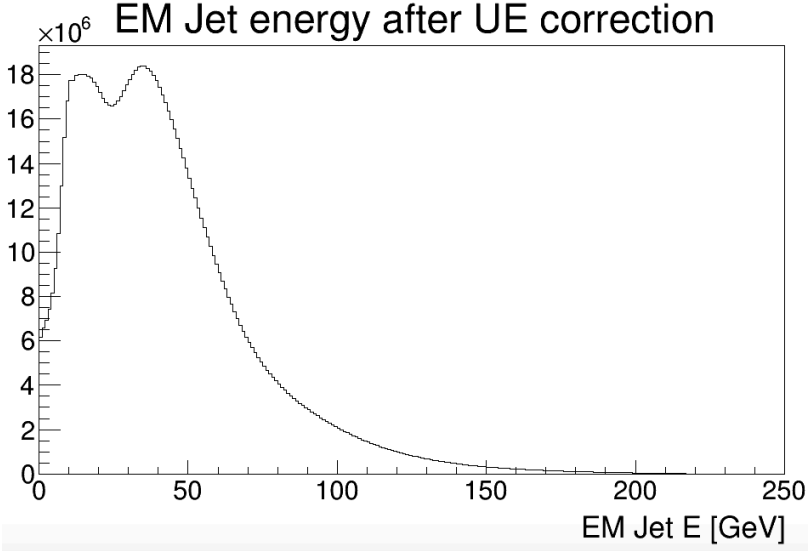


Underlying Event correction

- The set up for UE correction is same as EM-jet for run 15.
  - UE ghost area: 0.04
  - Apply UE correction only for EM-jet energy







Roman Pot track QA

- We can get Roman Pot track information in MuDst!