Diffractive EM-Jet A_N at Forward Rapidities With FMS and EEMC

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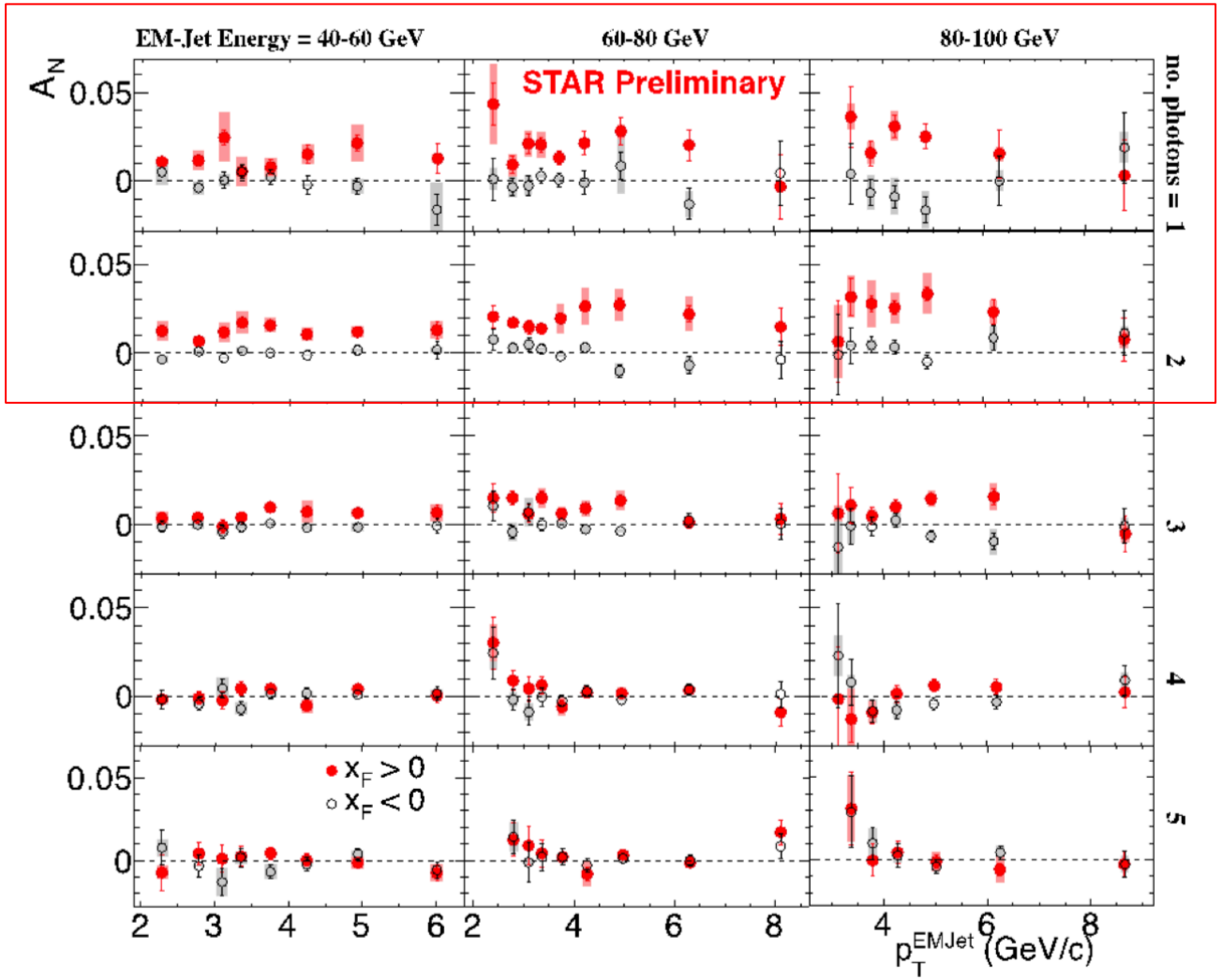
Outline

- Motivation
- EM jet with FMS (QA)
- EM jet with EEMC (QA)
- Roman Pot QA (include Afterburner)
- Event selection plan
- Further analysis plan

Motivation

- Increasing number of photons in EM jets causes A_N becomes smaller and smaller.
- 1 (2) photon events show a serious large A_N . (contain isolated π^0 , might include diffractive event)
- This indicates that the diffractive process might have some contribution for large transverse single spin asymmetries in the forward direction.
  - would open a new avenue to study the nature of pomerons in p+p collisions.

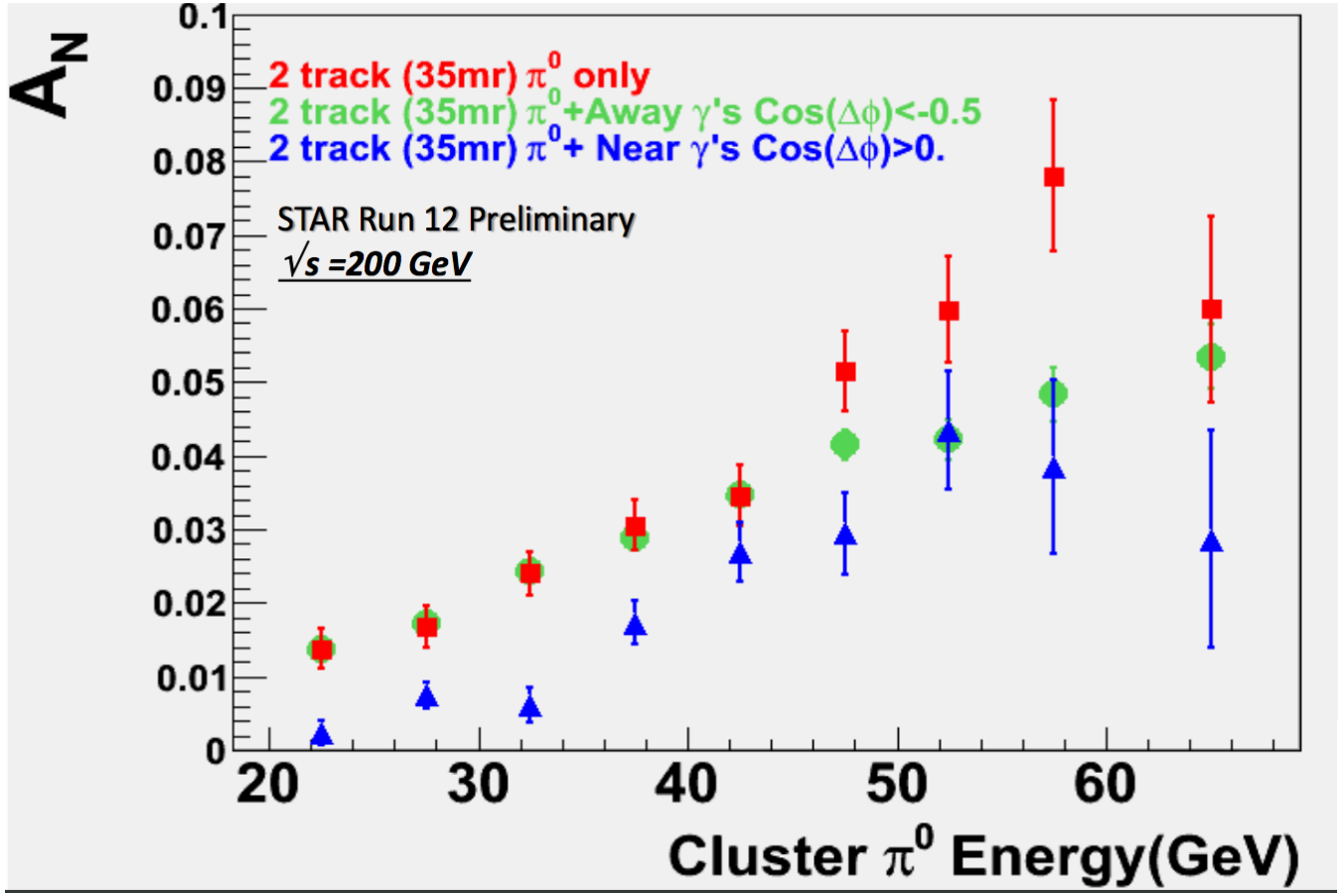
Transverse Single Spin Asymmetry : $A_N = \frac{\sigma^{\uparrow} - \sigma^{\downarrow}}{\sigma^{\uparrow} + \sigma^{\downarrow}}$

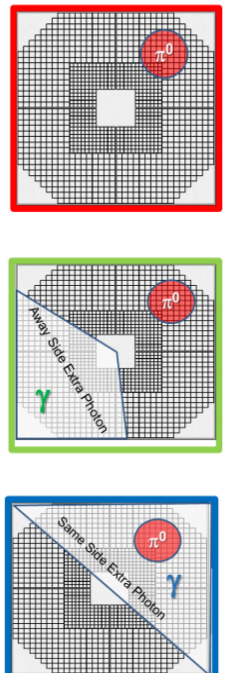


Inclusive EM Jet Results from Mriganka , with run11 pp500trans

Indication: Diffractive contribution to large A_N

- Isolated π^0 event (red point) have larger A_N.
- This indicate that the diffractive events (isolated π^0 event) might have some contribution to larger A_N.

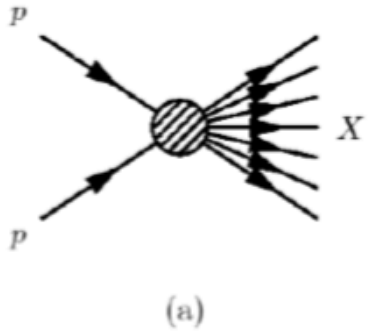




S. Heppelmann
DIS 2013
Run12 pp200

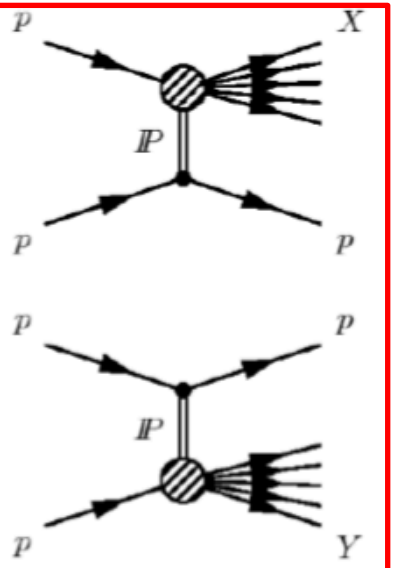
Diffractive scattering

- The process is called diffractive when there is rapidity gap.
- Roman Pot PHASE-II will allow us to make a measurement of A_N for single and double diffractive events by tagging one or both protons in the Roman Pots.
  - Start with tagging 1 east Roman Pot tracks for this analysis.



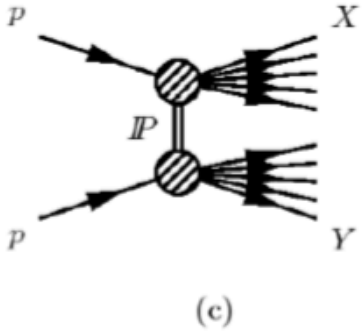
(a)

No diffractive



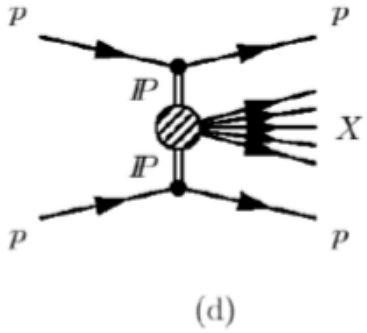
(b)

Singly diffractive



(c)

Doubly diffractive



(d)

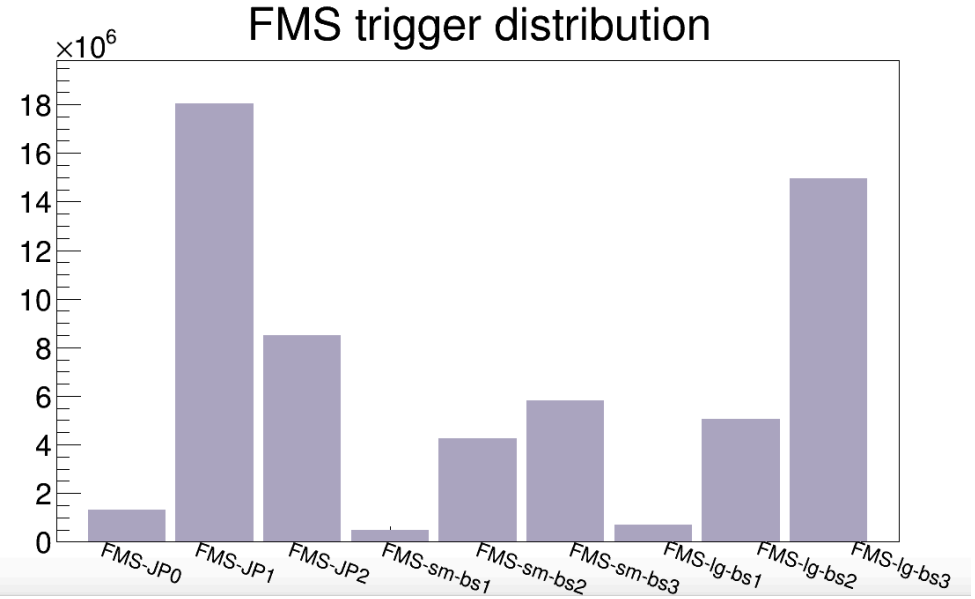
Centrally diffractive

FMS data sets and triggers

- Data sets: run15 pp transverse data , $\sqrt{s} = 200\ GeV$
  - Later on will use run17 pp transverse data
- Stream: st_fms
- Trigger for FMS : Use FMS small board sum, FMS large board sum and FMS-JP.
- Requirement: Event must also contain at least 1 Roman Pot track.
- Trigger list: FMS-JP0, FMS-JP1, FMS-JP2, FMS-sm-bs1, FMS-sm-bs2, FMS-sm-bs3, FMS-lg-bs1, FMS-lg-bs2, FMS-lg-bs3. (9 triggers)
- Trigger veto: FMS-LED

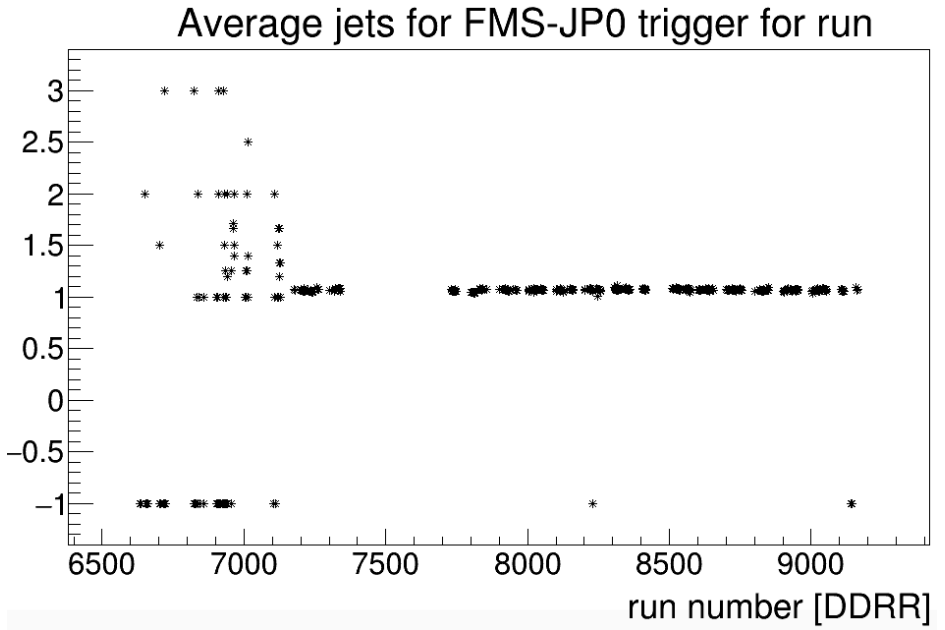
Trigger distribution

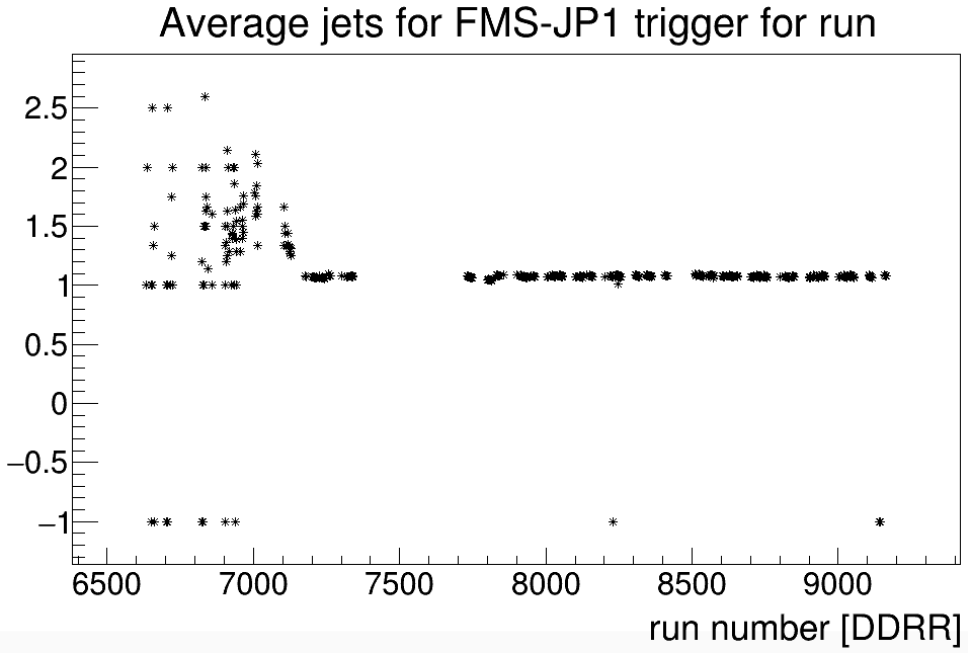
$$average\ jet: \frac{total\ number\ of\ jets\ for\ trigger}{total\ number\ of\ trigger}\ per\ run$$

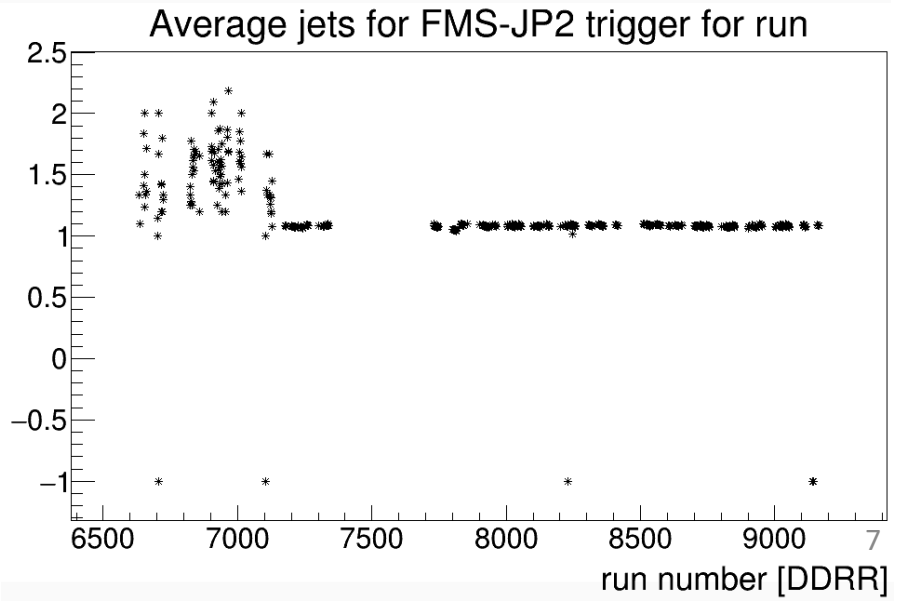


Requirement : event must contain at least 1 RP track.

- X axis: run number (choose 4 digits)
  - First 2 digits (DD): last 2 digits of run day
  - Last 2 digits (RR): last 2 digits of run number
  - run 16066001 will show as 6601
- Value -1 means this run do not have such trigger
- Before day 72, not much events sorted into st_fms stream.





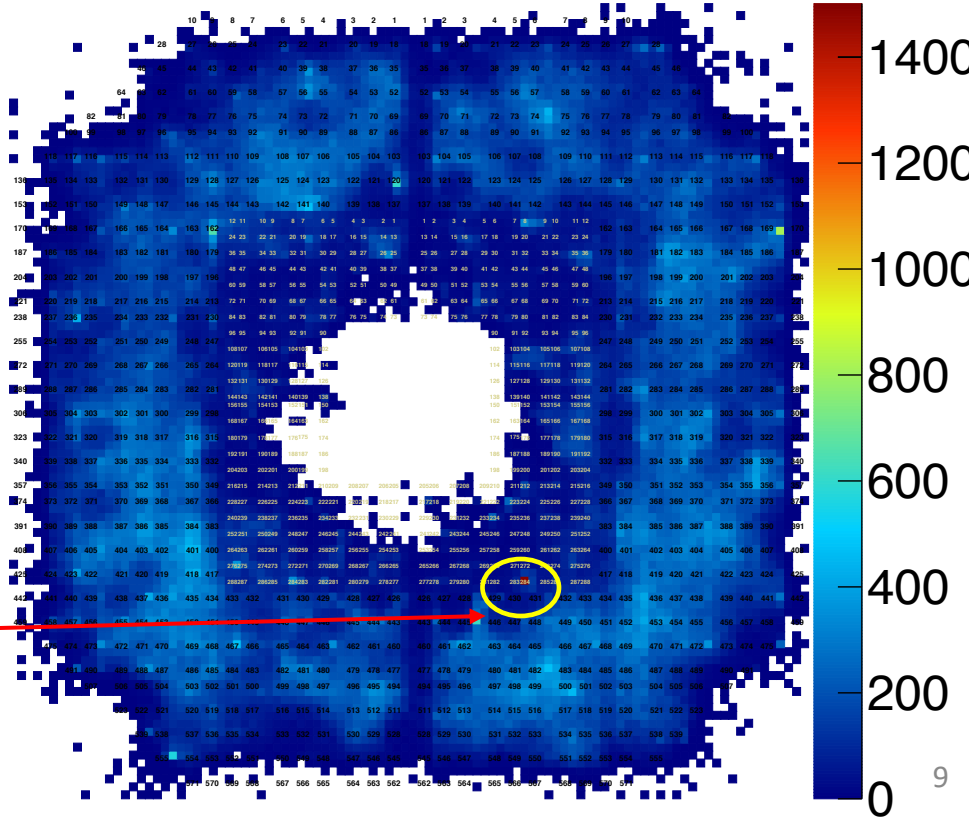


Jet reconstruction

- Jet in this study: electromagnetic jets, EM Jets (photon)
- Jet finding maker: StJetMaker2015
- Jet finding algorithm: Anti-kT
- R parameter for this analysis currently is R<0.7
- Input object for Anti-kT: FMS point (from FMS tower)
- EM Jet $p_T > 2GeV$ (current cut, might change after MC)

FMS QA

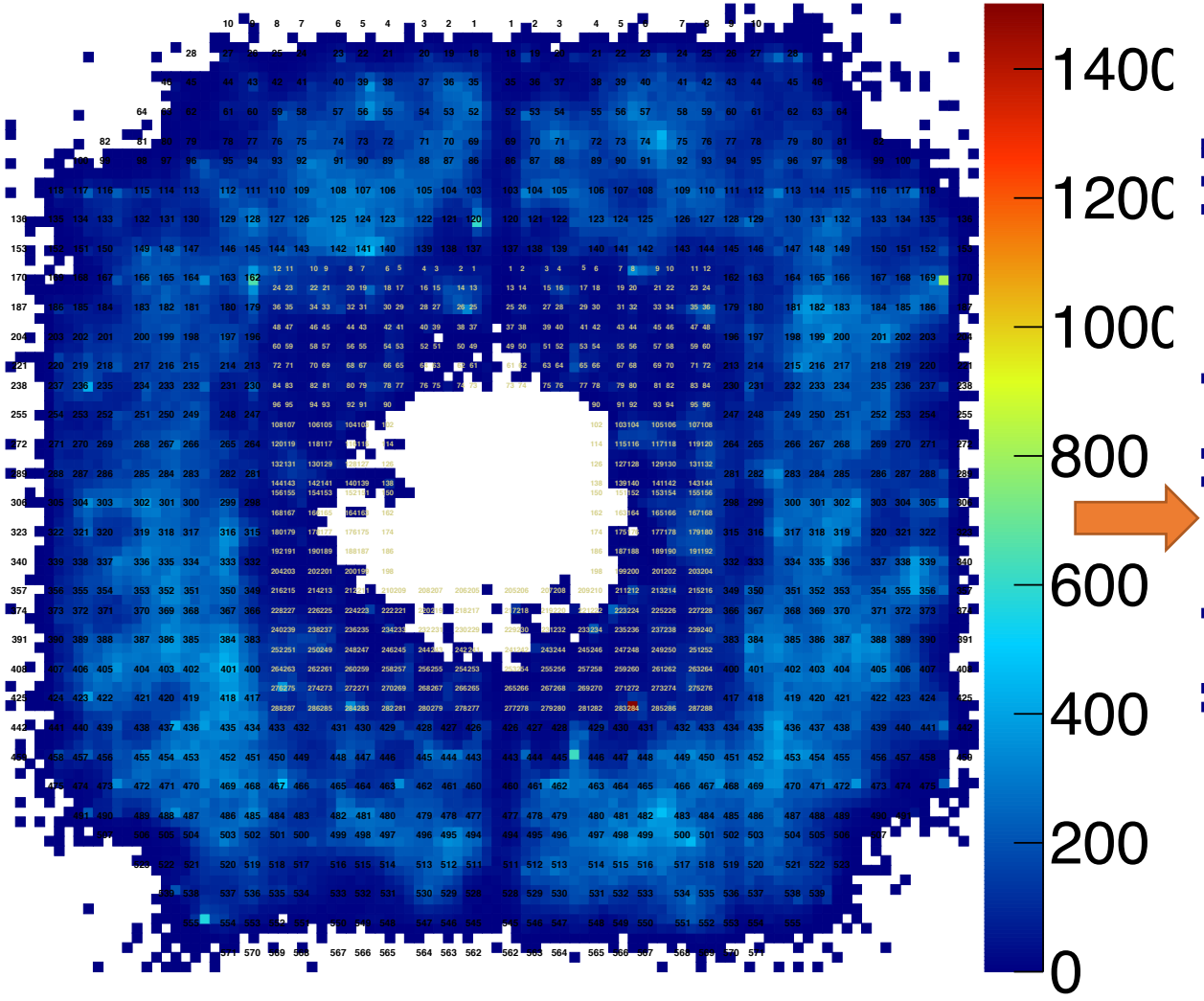
- Basic QA for run15 FMS data set: bad/dead channel QA, hot channel QA, bit shift from FMS group (already applied)
- Further QA from fill by fill EM jet position distribution:
  - Plot EM jet position distribution fill by fill.
  - Find out hot area (red) in the plot
  - Find out the channels in and around these hot area
  - Add these channels to hot channel list.



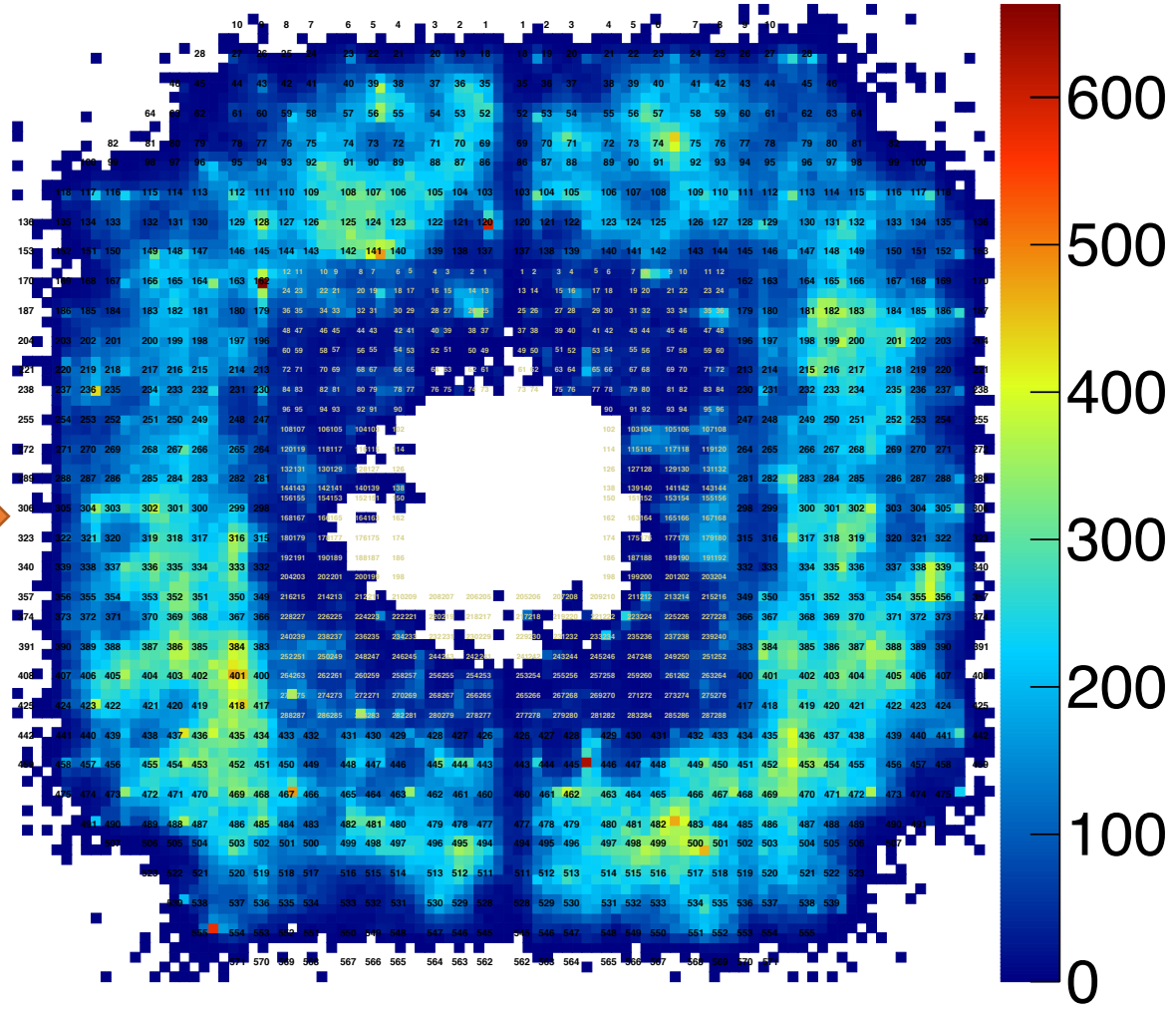
“Hot” channel

Further FMS QA result (fill 18827)

Before masking hot channel from EM jet distribution

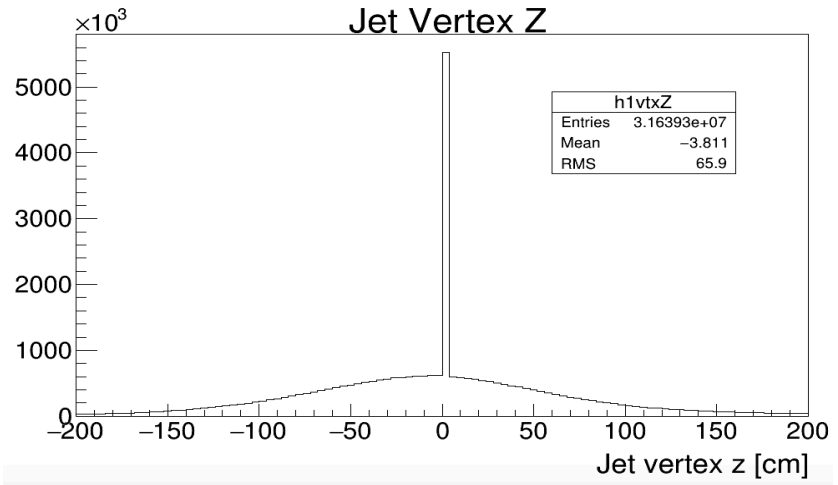


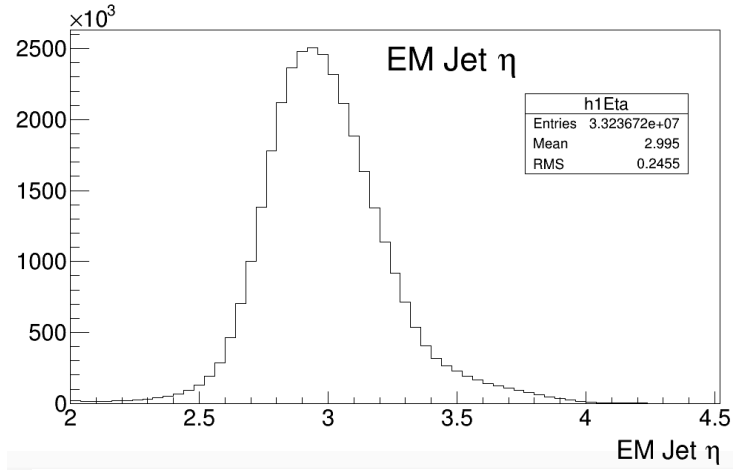
After masking hot channel from EM jet distribution

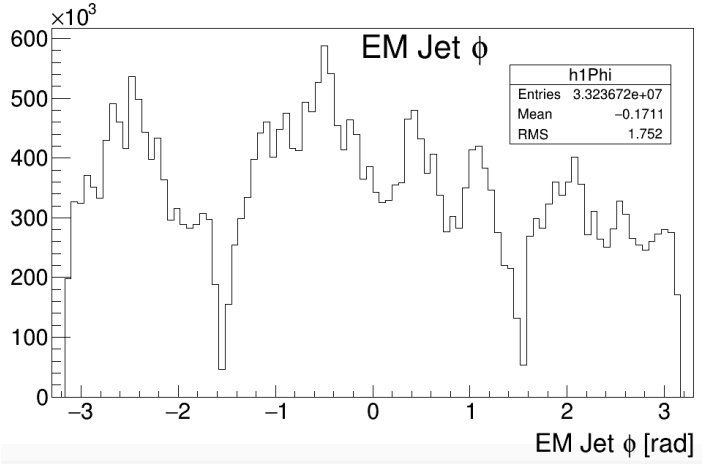


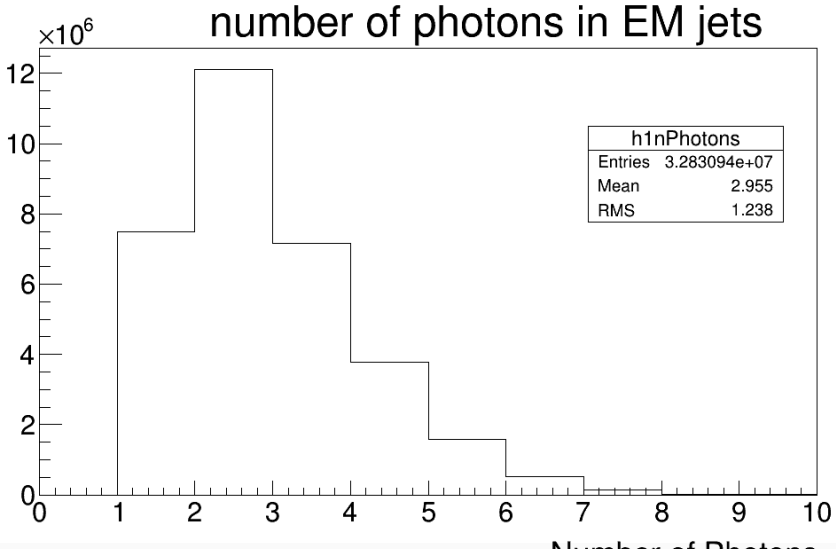
After further FMS hot channel masking

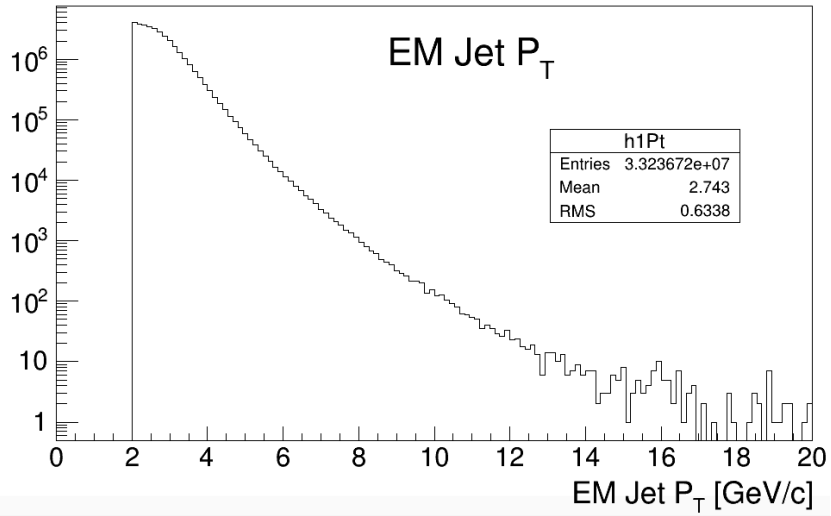
- Pseudorapidity range for FMS: $2.6 < \eta < 4$
- $p_T > 2\ GeV$
- Vertex obtain:
  1. TPC (< 1%)
  2. VPD (33%)
  3. BBC (51%)
  4. Others (16%)
- QA plots look reasonable.

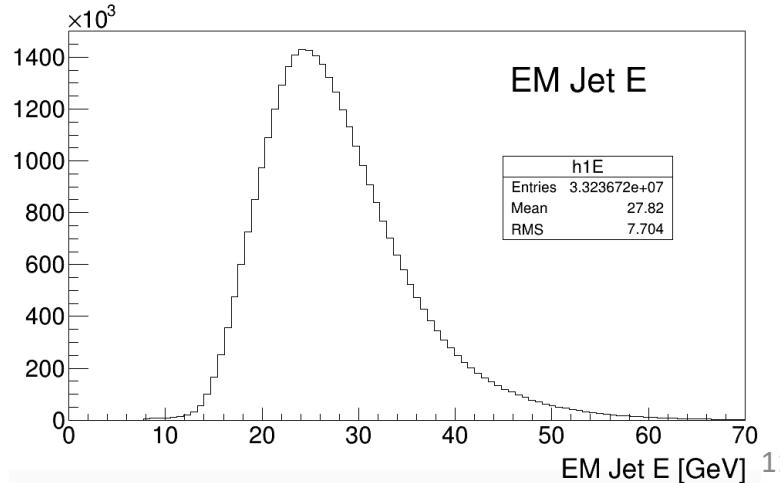










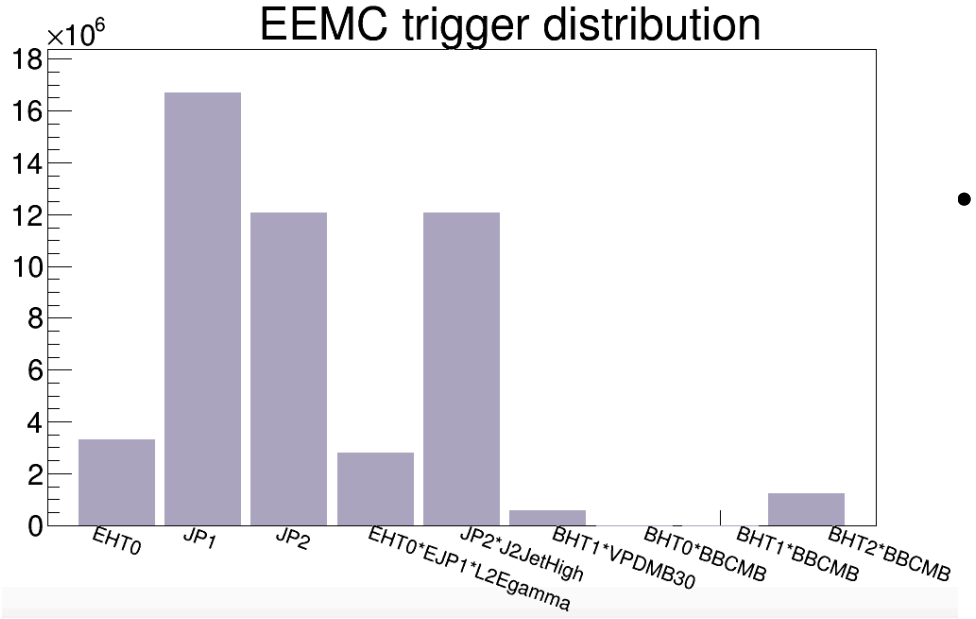


EEMC data sets and triggers

- Data sets: run15 pp transverse data , $\sqrt{s} = 200\ GeV$
  - Later on will use run17 pp transverse data
- Stream: st_physics
- Triggers:
  - Trigger list: "EHT0” "JP1” , "JP2” , "EHT0*EJP1*L2Egamma” , "JP2*L2JetHigh” , "BHT1*VPDMB-30” , "BHT0*BBCMB” , "BHT1*BBCMB” , "BHT2*BBCMB”
- Requirement: Event must also contain at least 1 Roman Pot track.
- Jet reconstruction algorithm:
  - Anti-kT, R<0.7 , $p_T > 2GeV$, photon candidate from TPC tracks and EEMC towers.

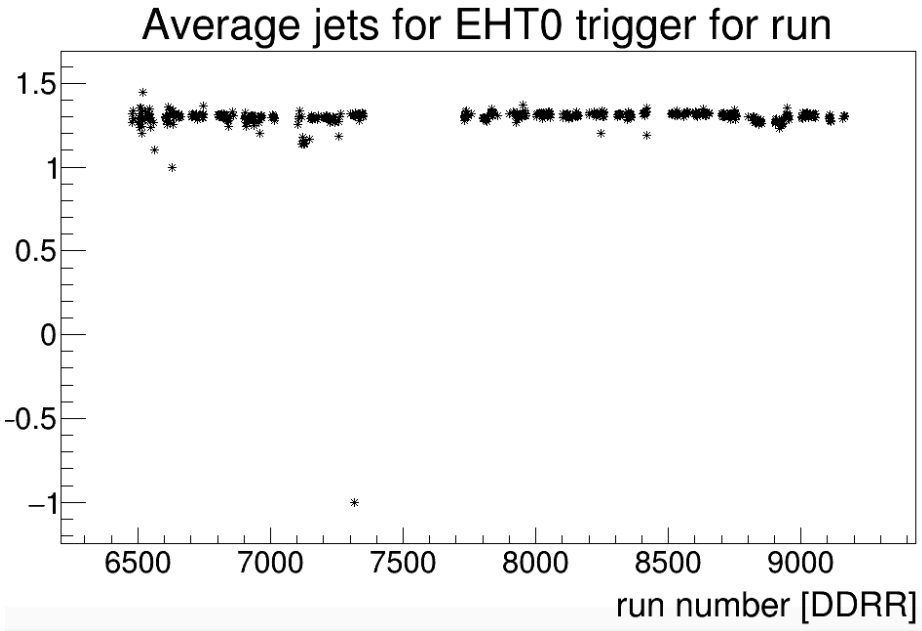
EEMC Trigger distribution

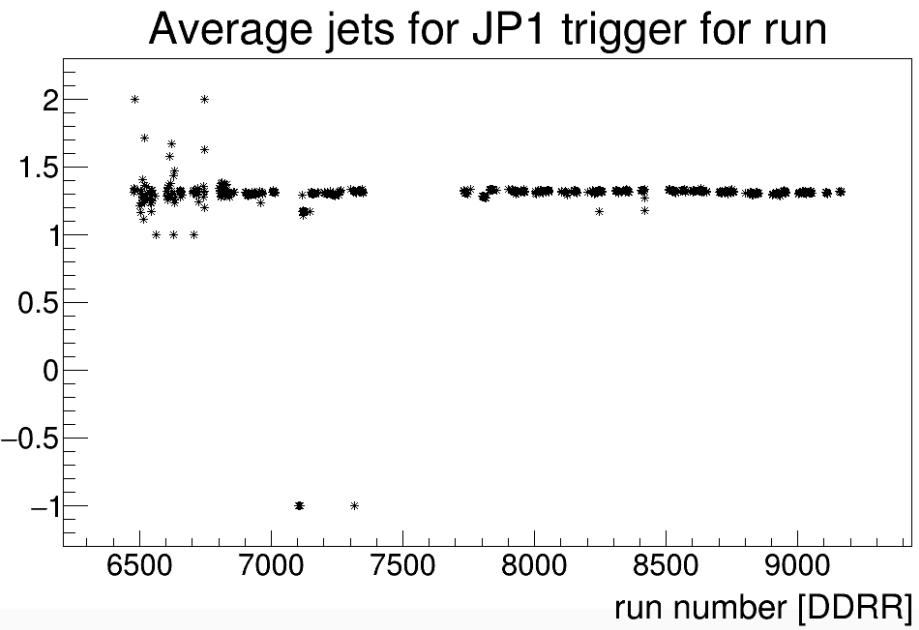
$average\ jet$: $\frac{total\ number\ of\ jets\ for\ trigger}{total\ number\ of\ trigger}$ $per\ run$

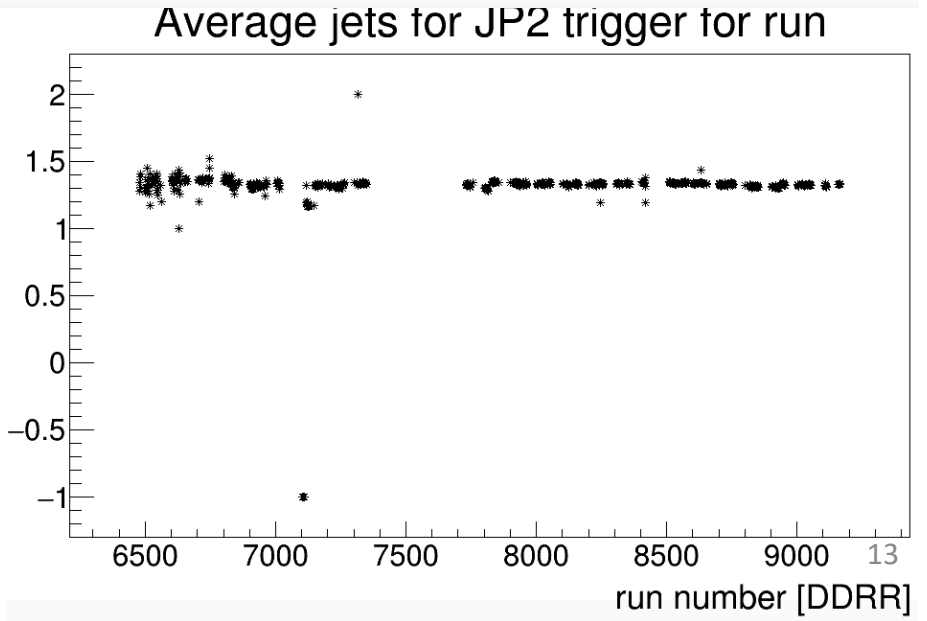


Requirement: event must contain at least 1 RP track.

- X axis: run number (choose 4 digits)
  - First 2 digits (DD): last 2 digits of run day
  - Last 2 digits (RR): last 2 digits of run number
  - run 16066001 will show as 6601
- Value -1 means this run do not have such trigger (not too many run have no such trigger)





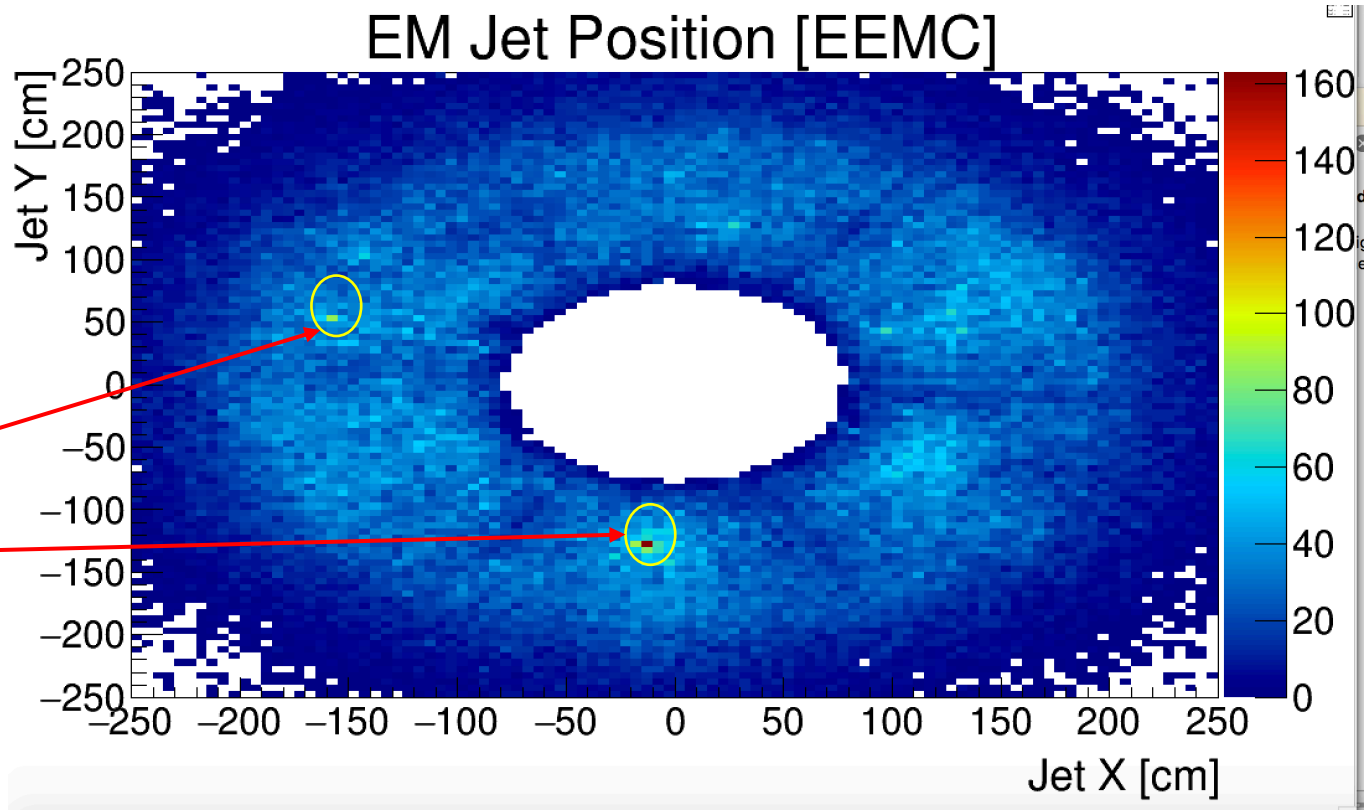


EM Jet position fill by fill

- Check all the fill result, they all have these 2 hot towers.
- Beside of these hot tower, we don’t see any other hot tower in any fills.
  - We don’t have more further action to do QA.

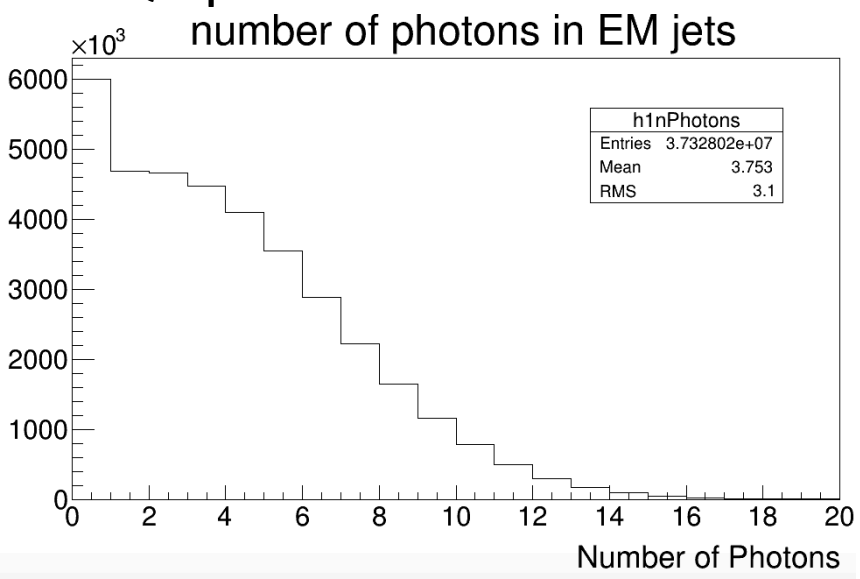
Note: EM jet x-y position based on EM jet physics η-ϕ

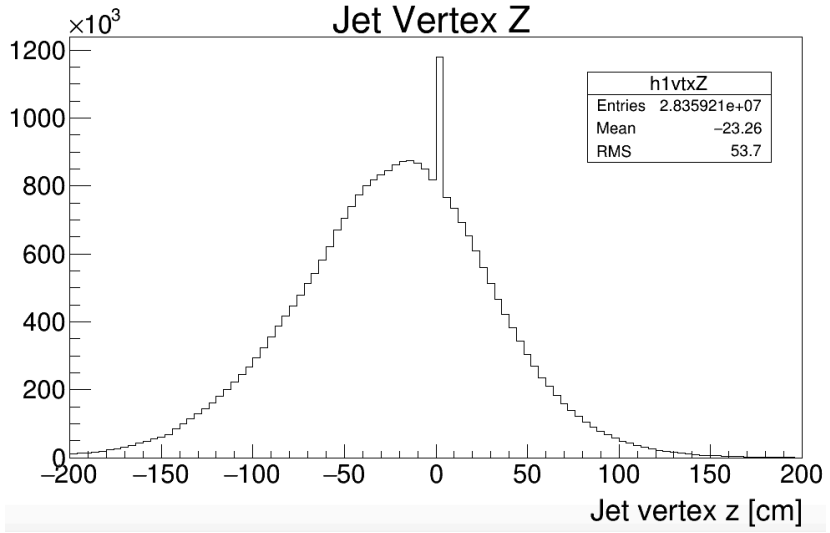
“Hot” towers

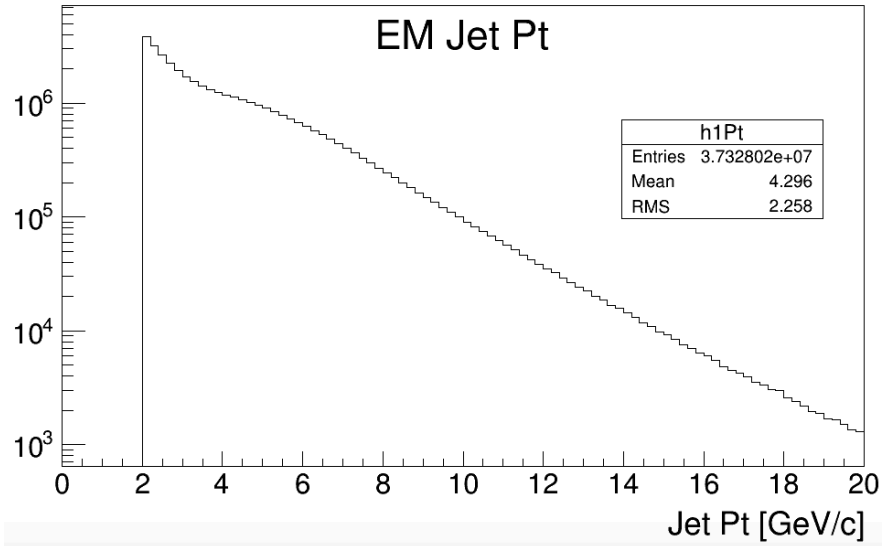


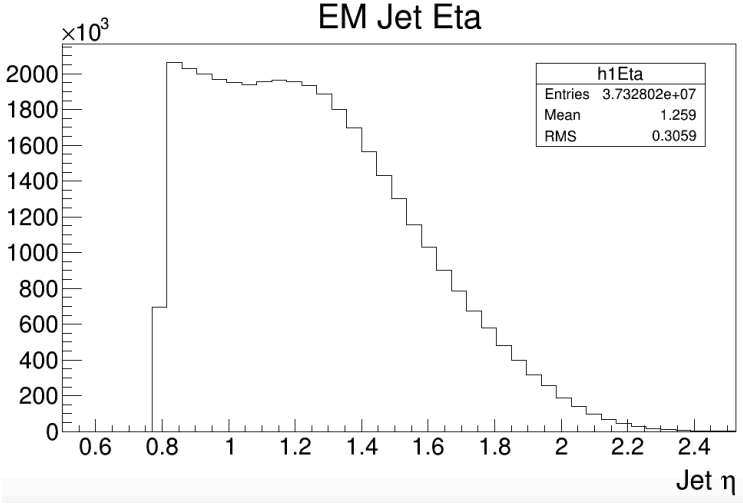
EEMC basic QA plots

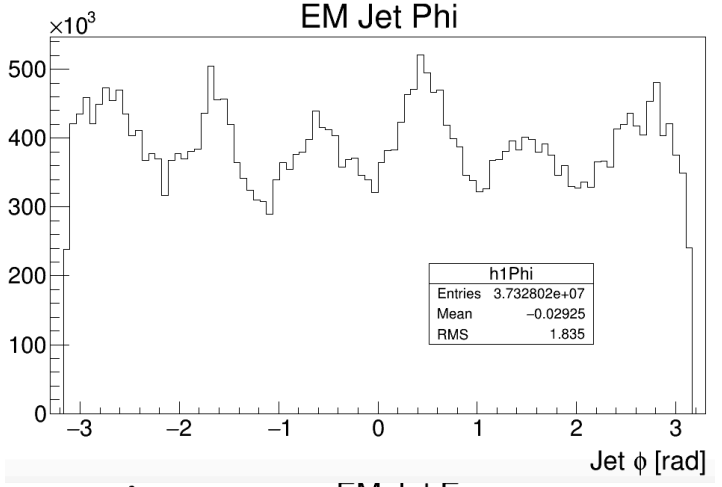
- Pseudorapidity range for EEMC: $1 < \eta < 2$
- $p_T > 2\ GeV$
- Vertex obtain:
  1. TPC (86%)
  2. VPD (4%)
  3. BBC (5%)
  4. Others (5%)
- QA plots look reasonable.

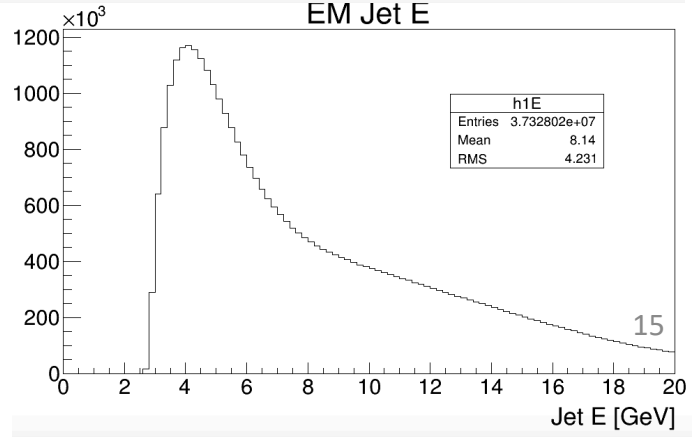






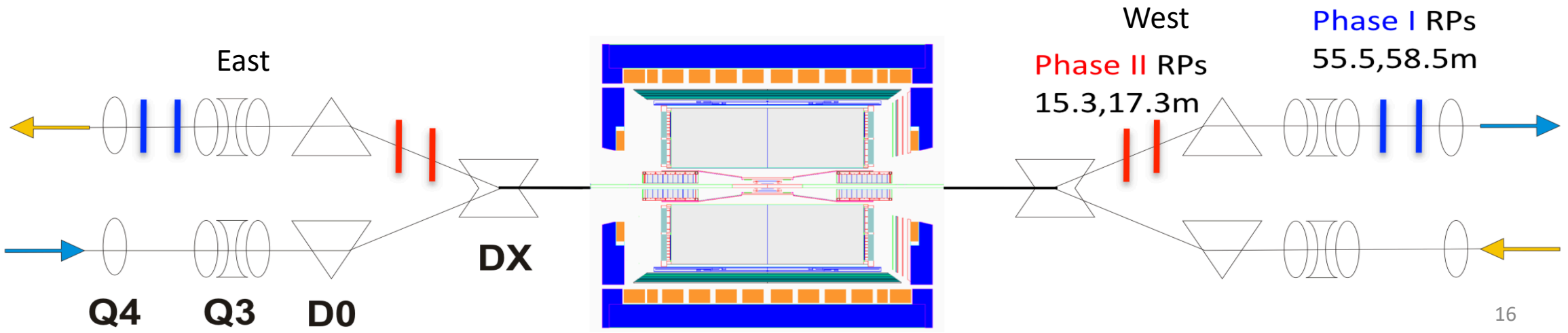






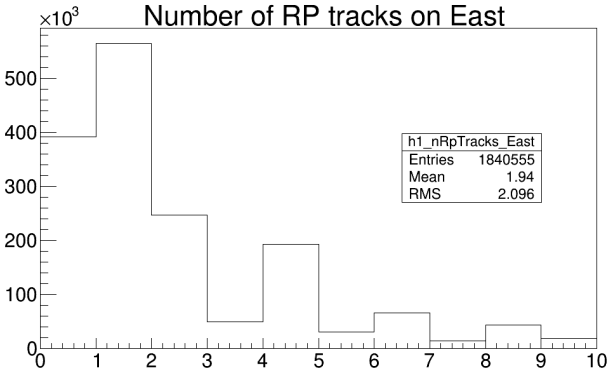
Roman Pot (RPs) QA

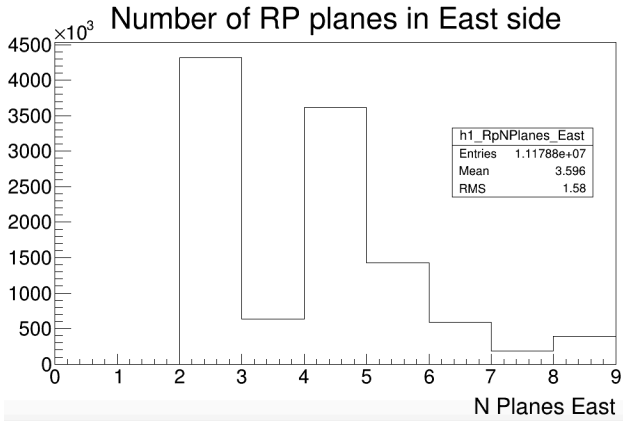
- RPs are good detectors for measuring forward protons.
- 8 planes for east and west side (2 package on each side, with 4 silicon strip planes)
  - Basic selection: require RP track to hit more than 6 planes.
- Apply RPs post-process correction (Afterburner)
  - Including masking the hot strip
  - 2% of RP track difference

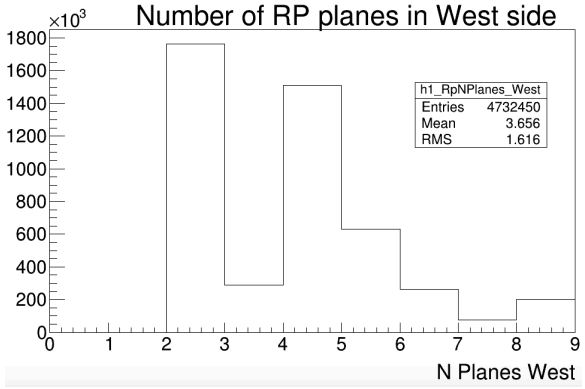


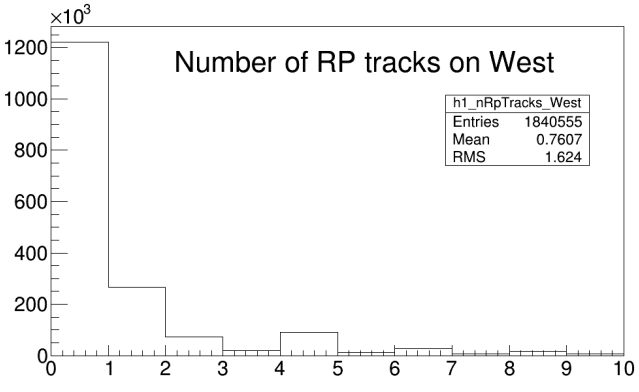
Roman Pot tracks QA for FMS (RP Afterburner applied)

Not so much different w/wo RP afterburner.

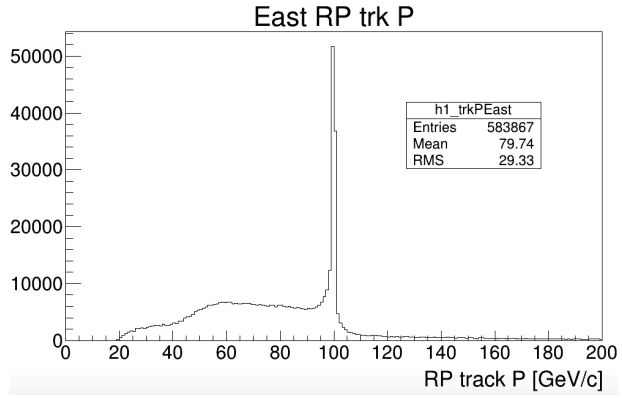


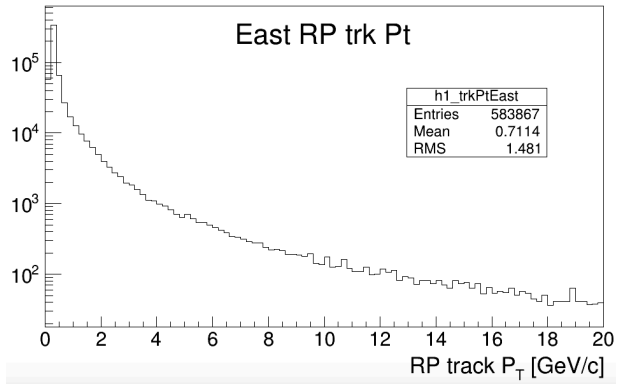


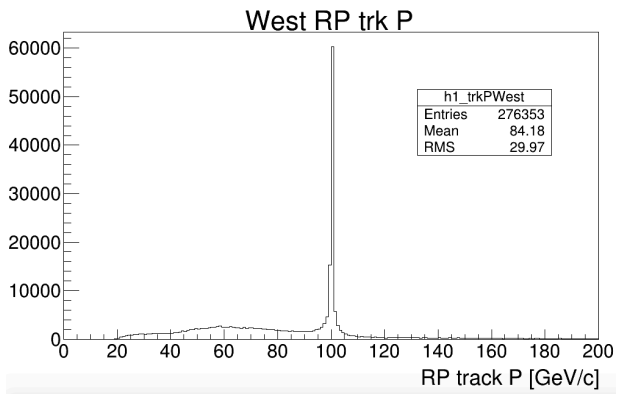


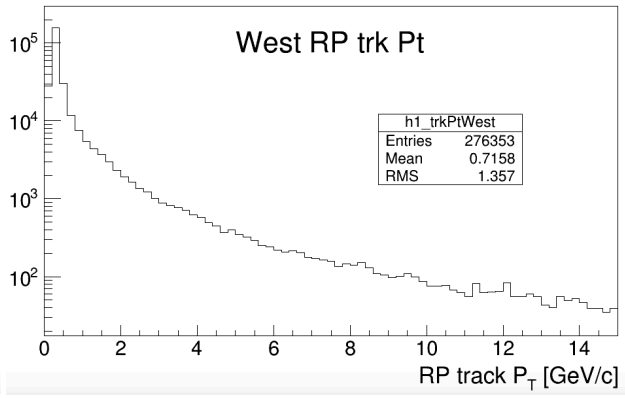


After selecting track hits 6+ planes, we can see some reasonable tracks.



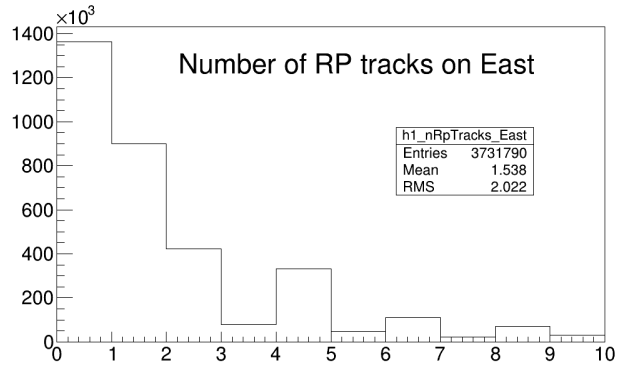


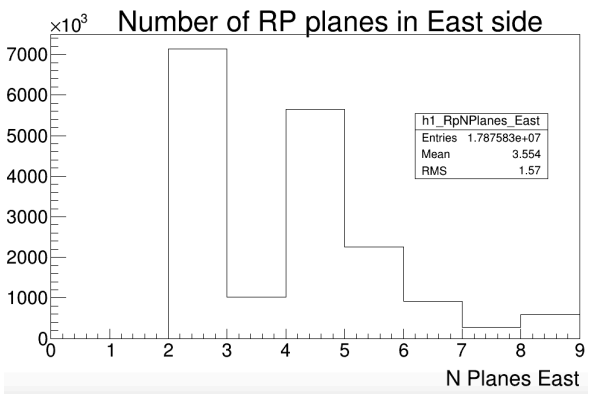


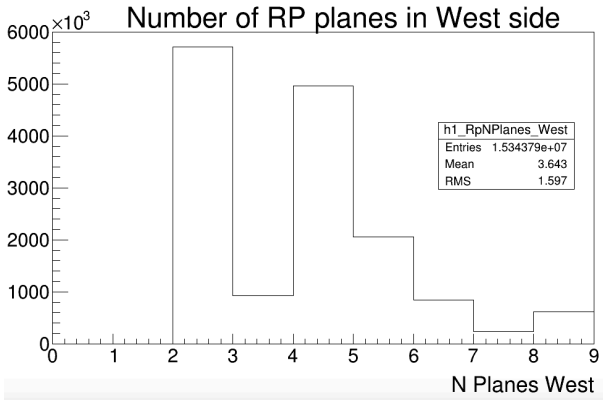


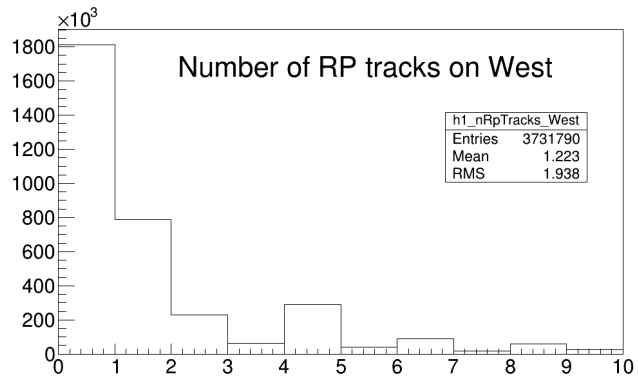
Roman Pot tracks QA for EEMC (RP Afterburner applied)

The proportion of event containing east RP track is less than that of FMS data.
Not so much different w/wo RP afterburner.

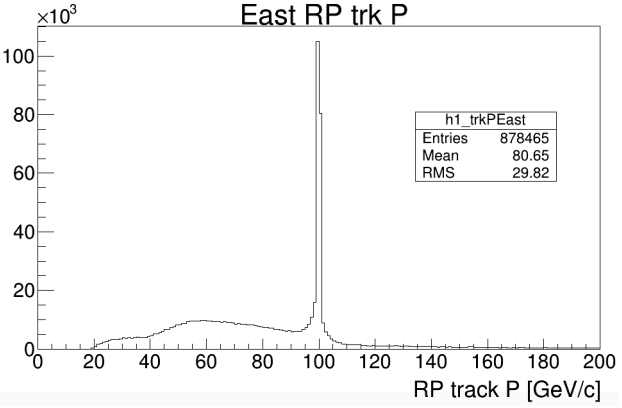


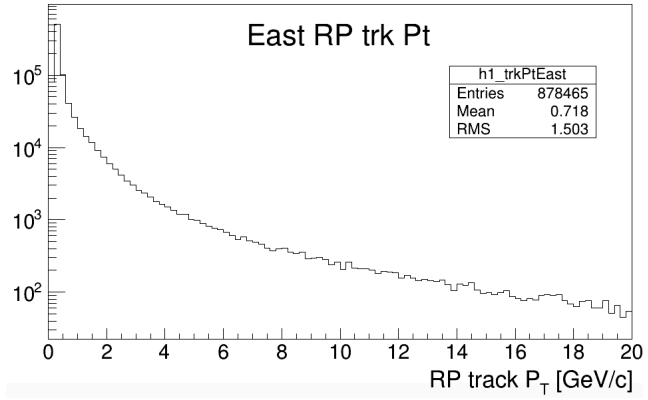


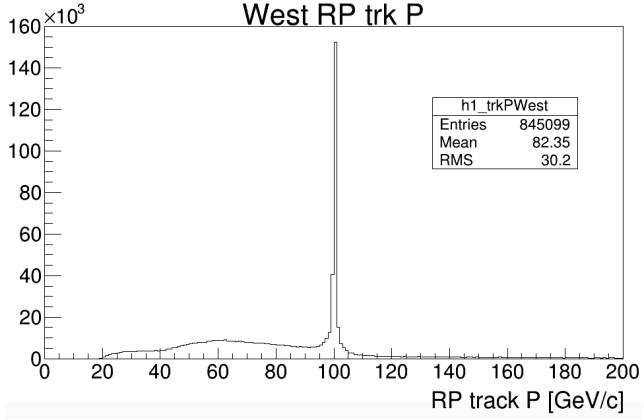


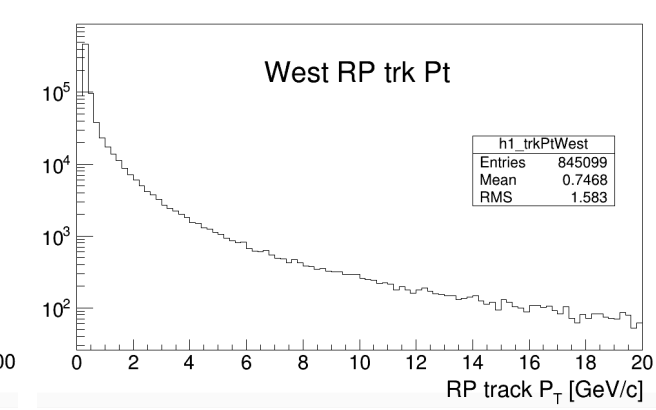


After selecting track hits 6+ planes , we can see some reasonable tracks.
Look similar to the results of RP with FMS data.





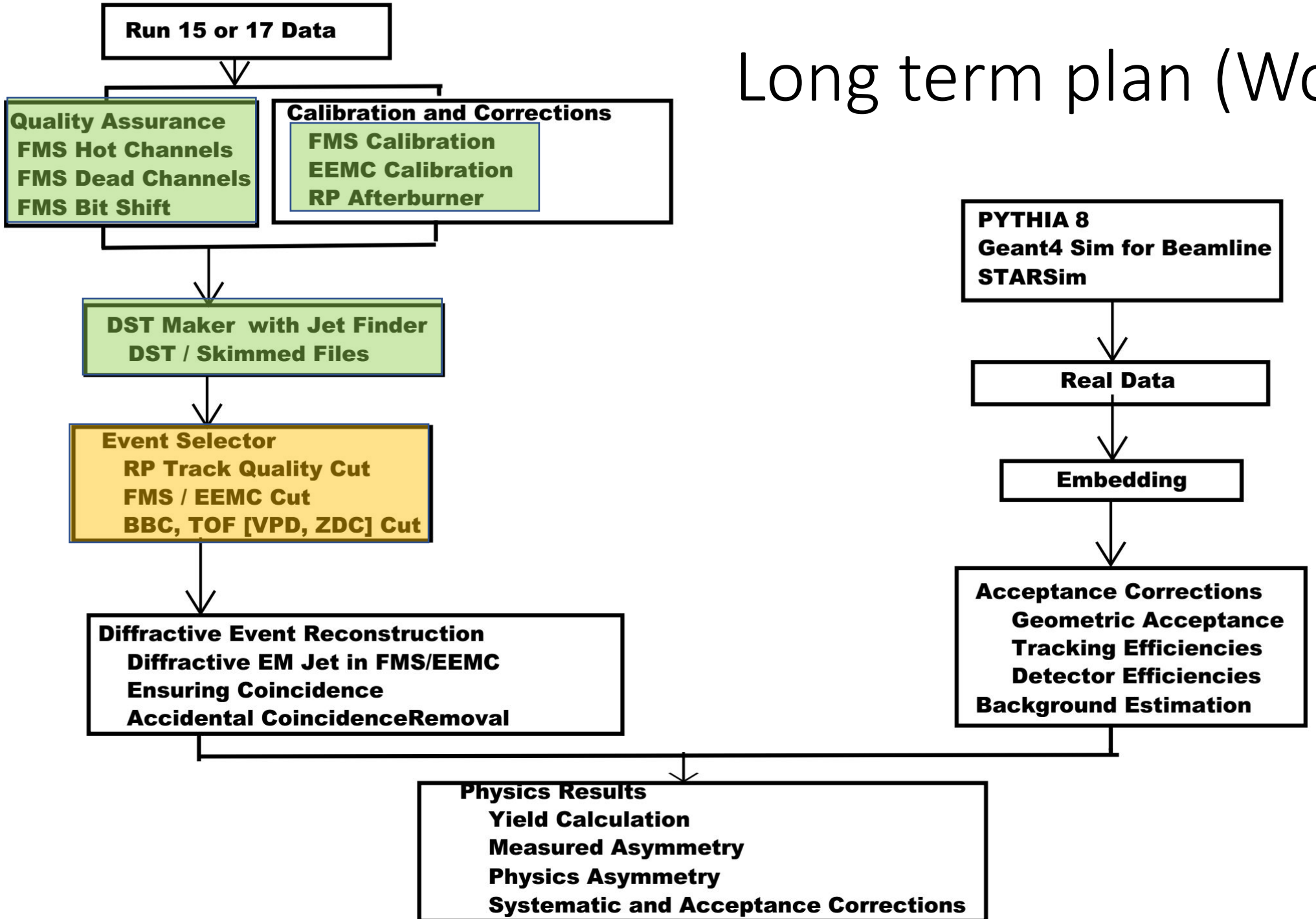




Event selection plan

- FMS
  - 9 Triggers , veto on FMS-LED , avoid ring of fire
  - bit shift, bad / dead / hot channel masking (include beam by beam hot channel masking)
  - Jet reconstruction: StJetMaker2015 , Anti-kT, R<0.7 , p_T > 2 GeV , FMS point as input
- EEMC
  - 9 triggers
  - Jet reconstruction: StJetMaker2015 , Anti-kT, R<0.7 , p_T > 2 GeV , TPC track and EEMC tower as jet finding input
- Roman Pot
  - Event must also contain at least 1 Roman Pot track.
  - Only 1 east RP track
  - Each track hits 6+ planes
  - Similar event selection based on RP group
    - Roman pot position match with expectation from IP.
    - RP tracks lie within the fiducial range.
- Vertex
  - Determine z priority according to TPC , VPD, BBC.
  - Vertex $|z| < 80\ cm$
- Others?

Long term plan (Workflow)



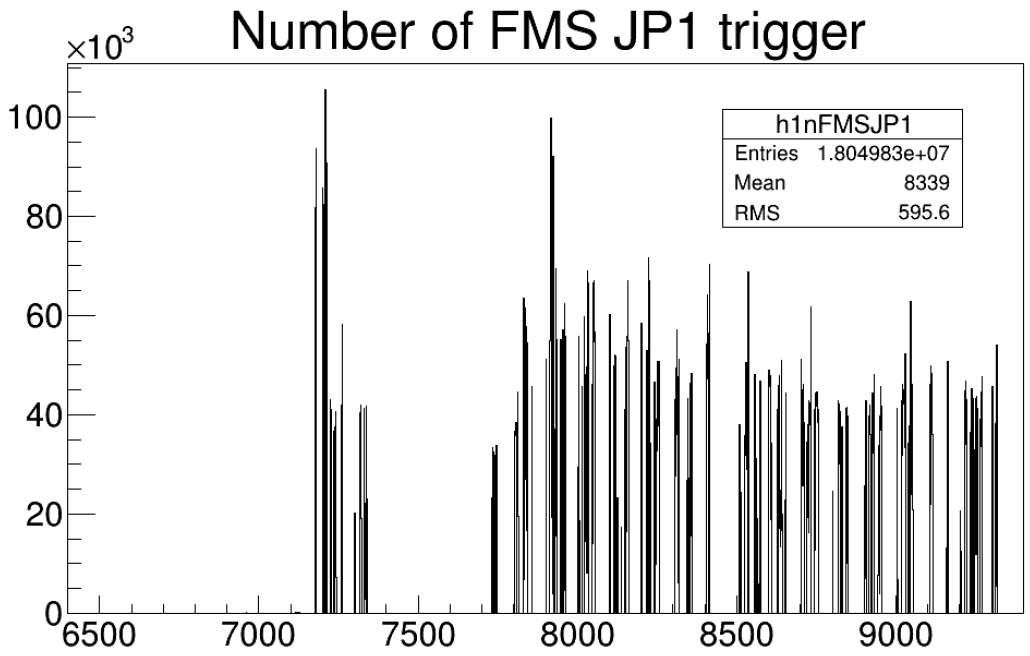
Conclusion

- Show good basic EM jets QA plots for FMS and EEMC data.
- Show basic QA for Roman Pot track applying afterburner.
- Next step: consider what should add in event selection and apply the event selection.

Back up

Number of EM jet and trigger per run

- Before day 72, there are few FMS triggers and jets per run. (use FMS JP1 as example)

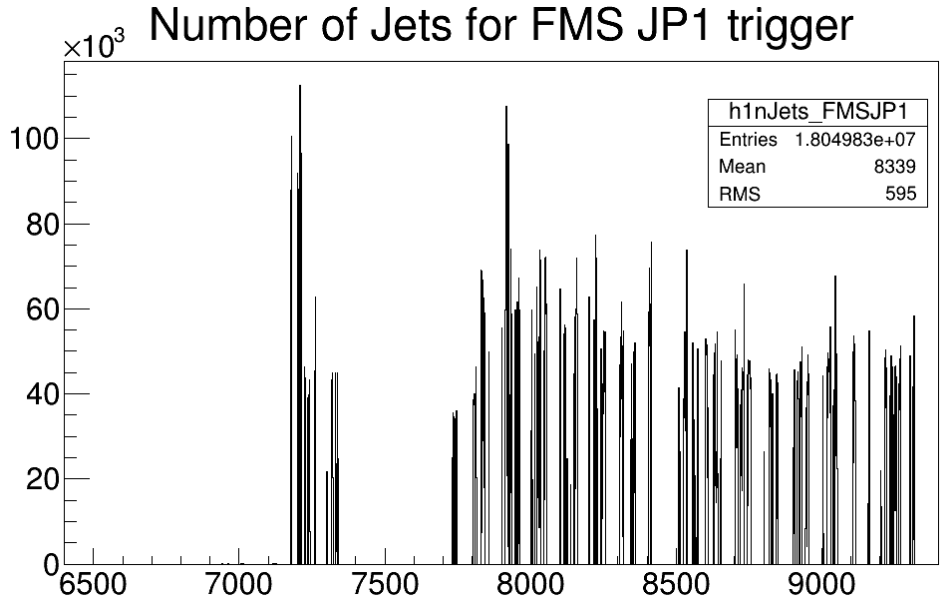


X axis: run number (choose 4 digits)

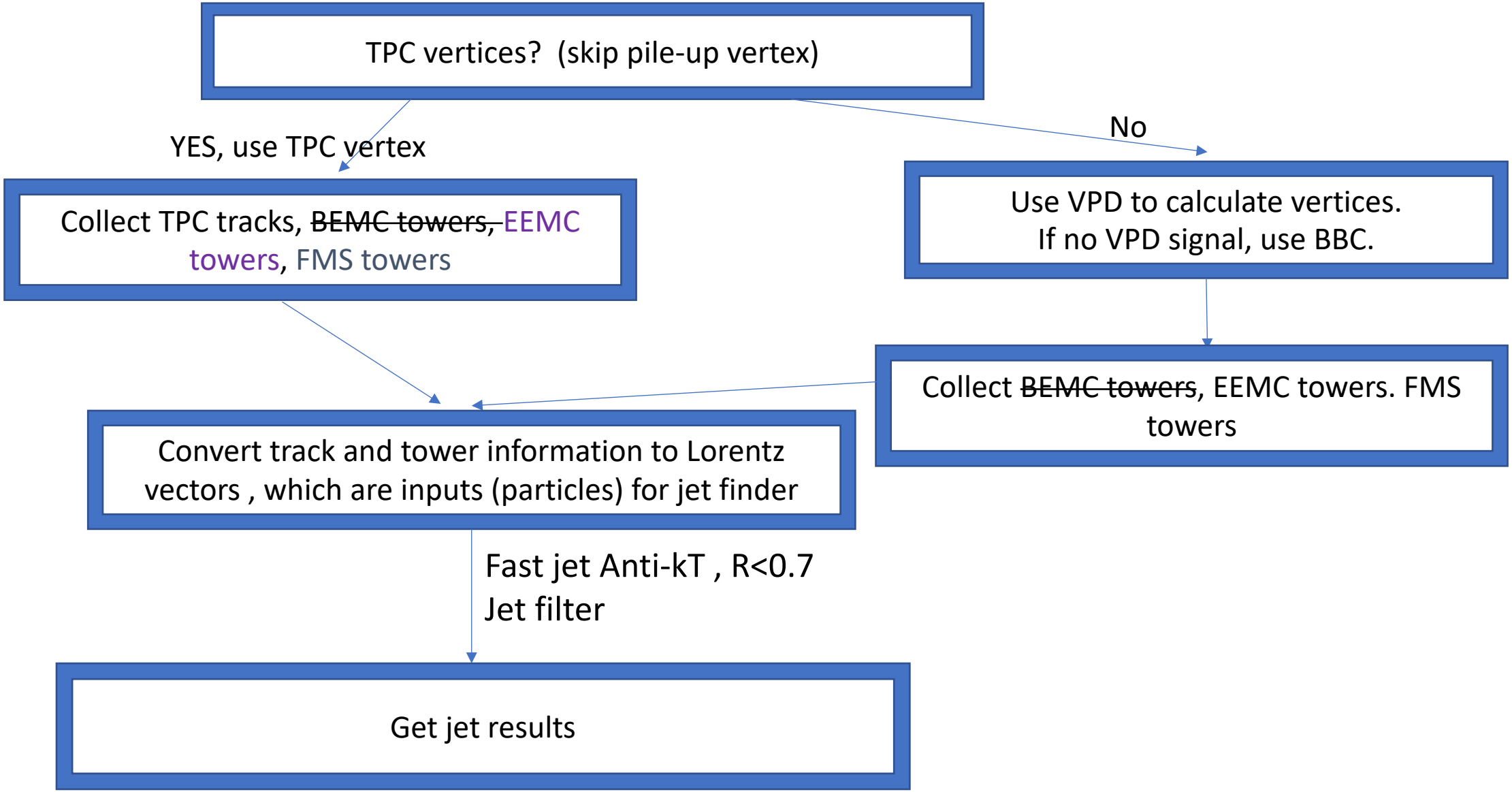
First 2 digits (DD): last 2 digits of run day

Last 2 digits (RR): last 2 digits of run number

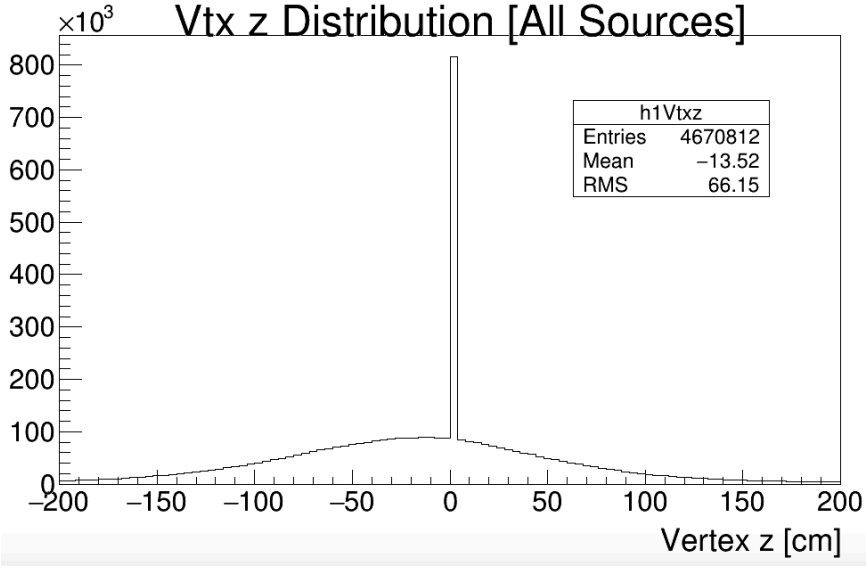
run 16066001 will show as 6601

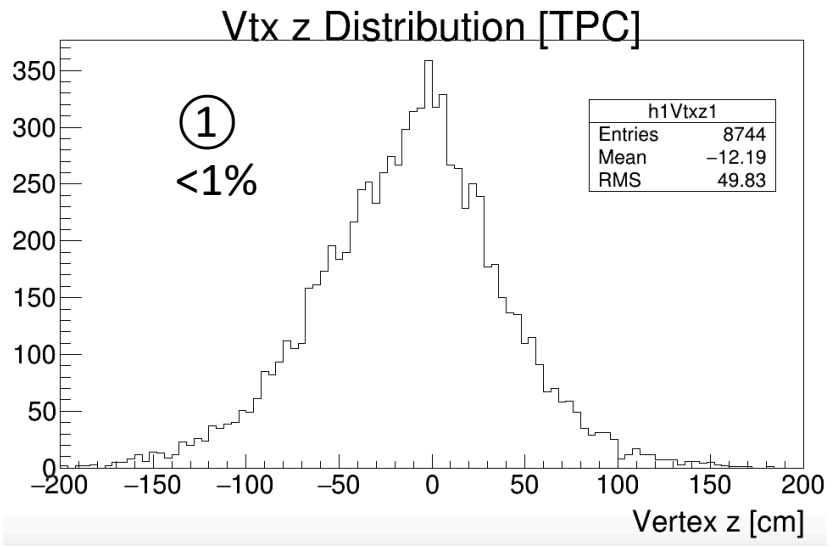


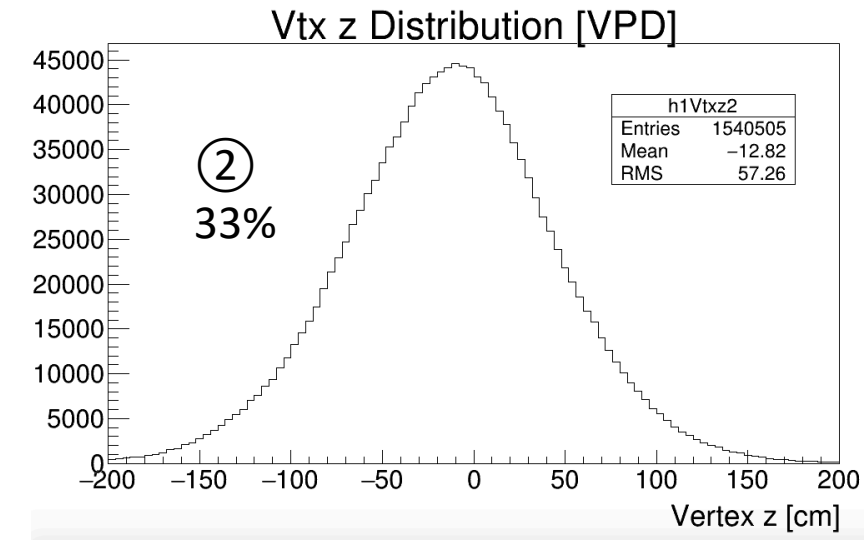
JetMaker2015

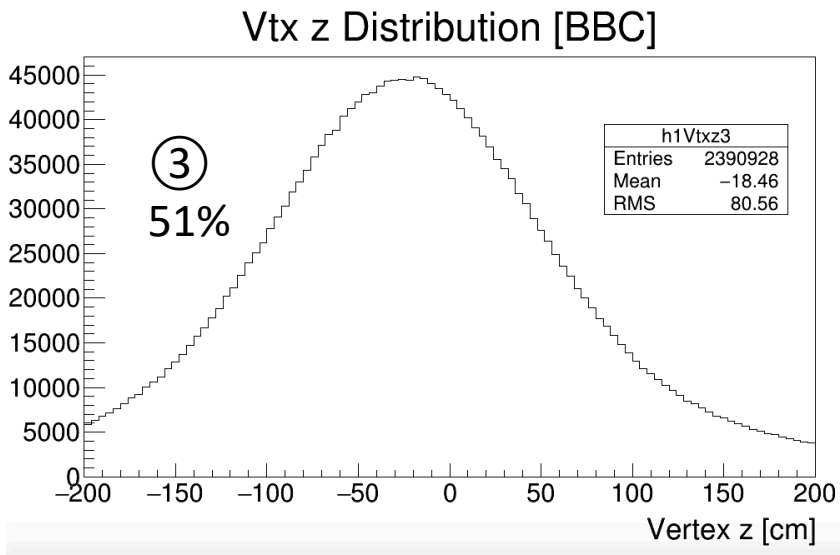


Vertex z position for FMS data





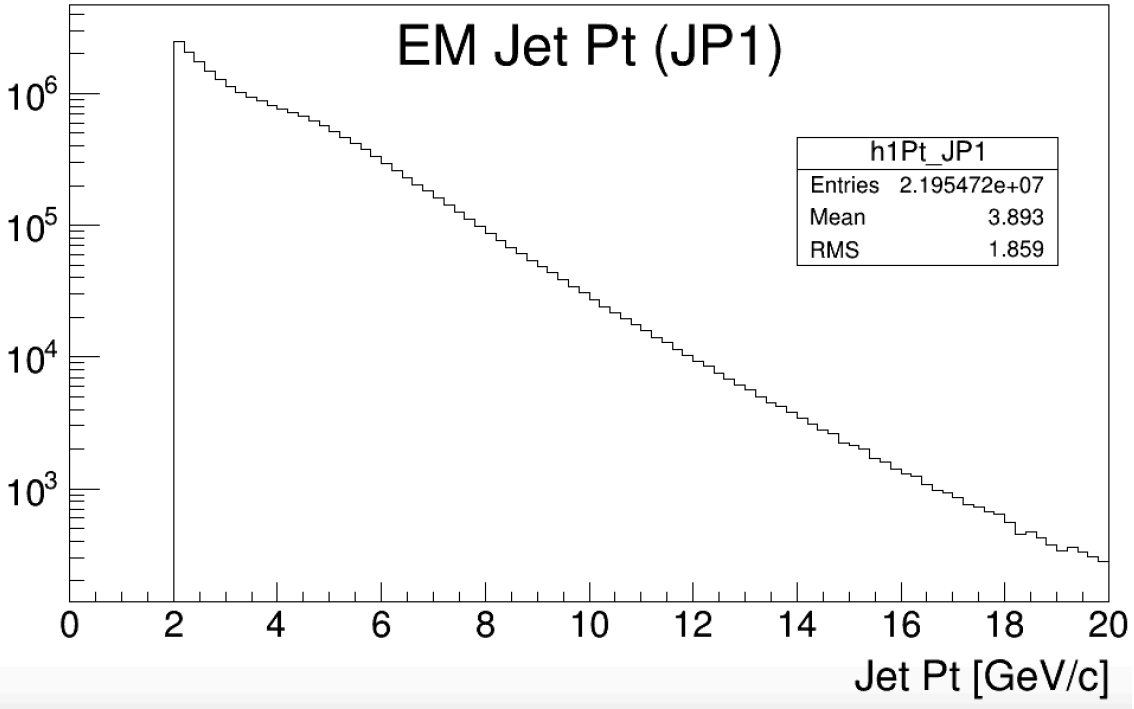


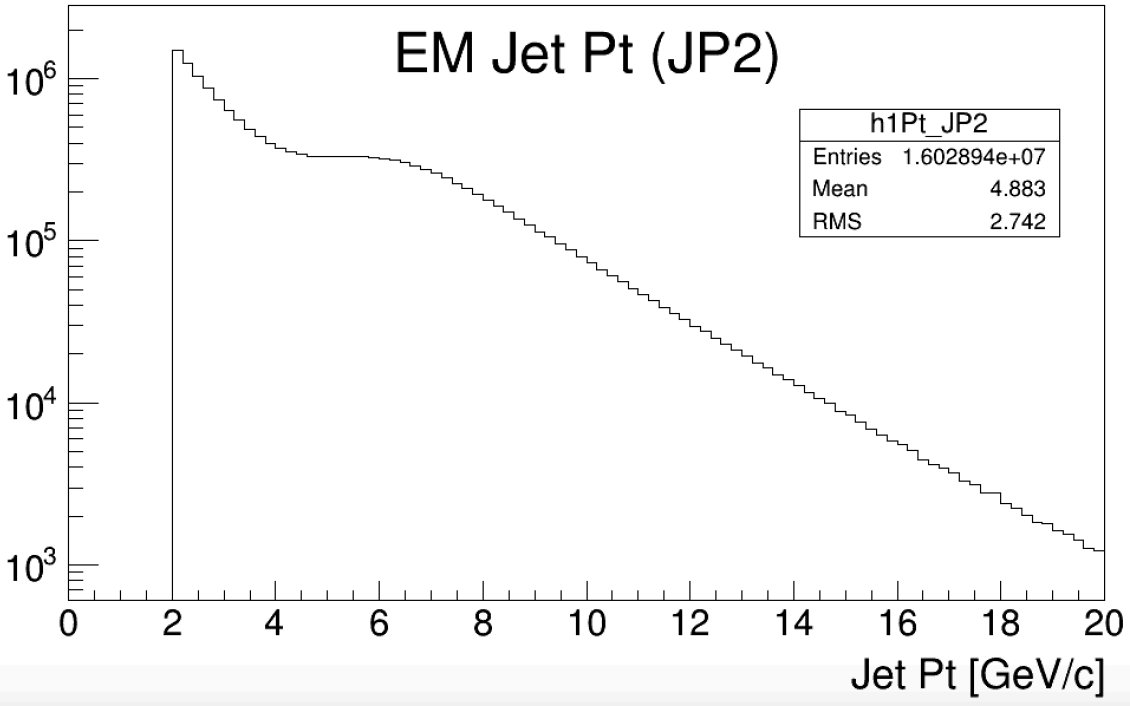


④ others type 16%
Set vertex to be at (0,0,0)

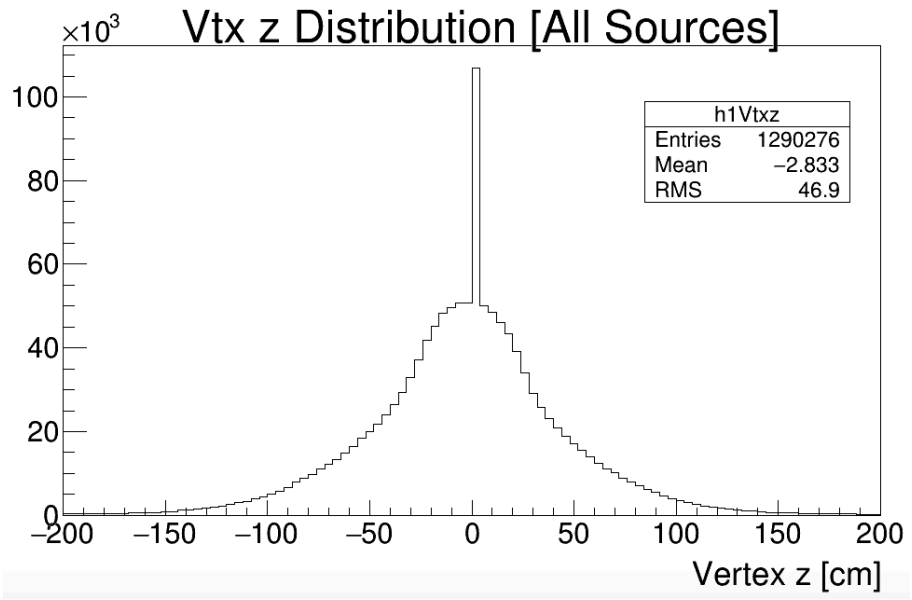
EM Jet in EEMC

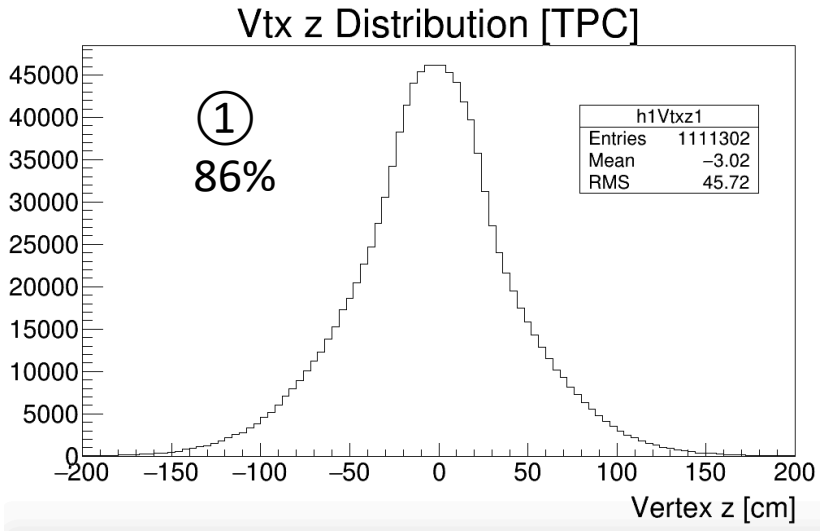
- EM Jet event with JP2 trigger have a obvious peak at Jet P_t=6 GeV

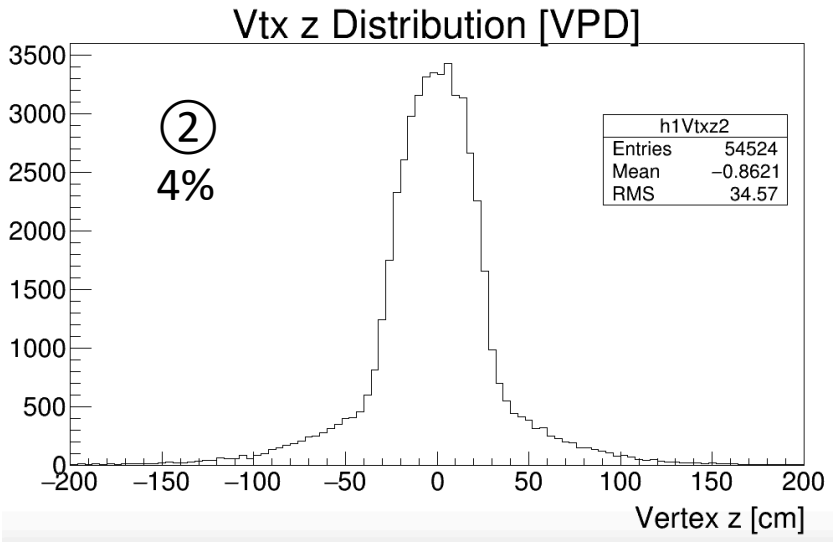


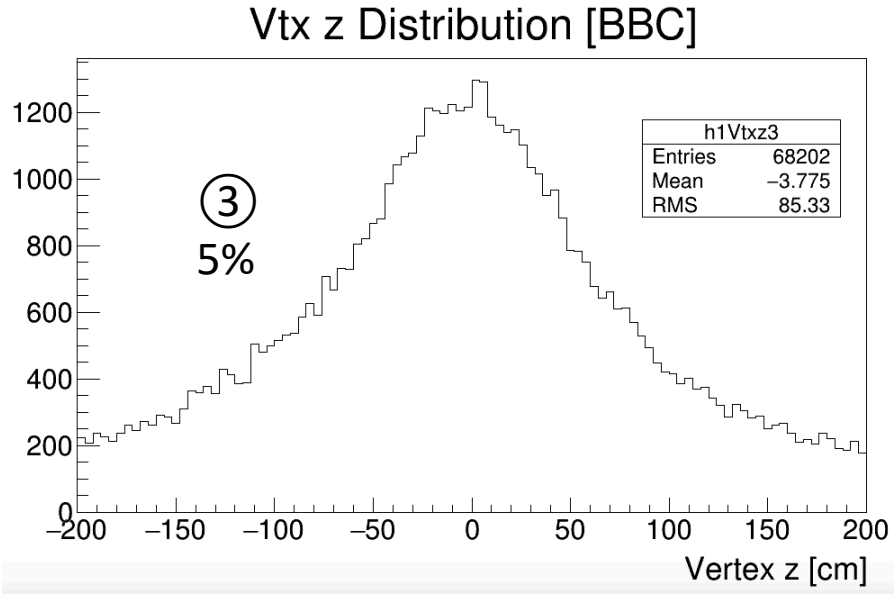


Vertex z position for EEMC data





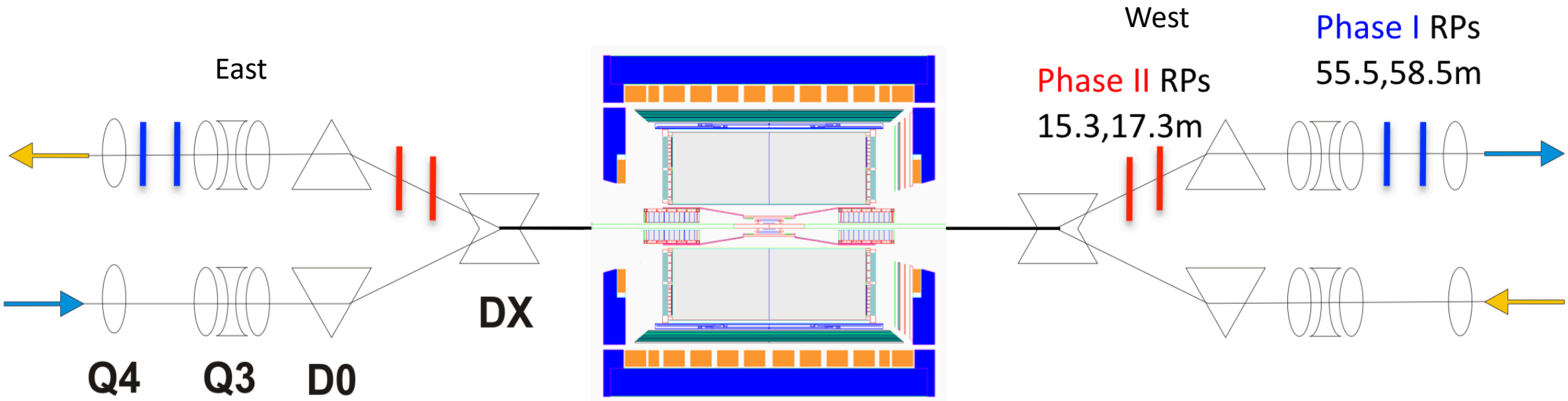




④ others type 5%
Set vertex to be at (0,0,0)

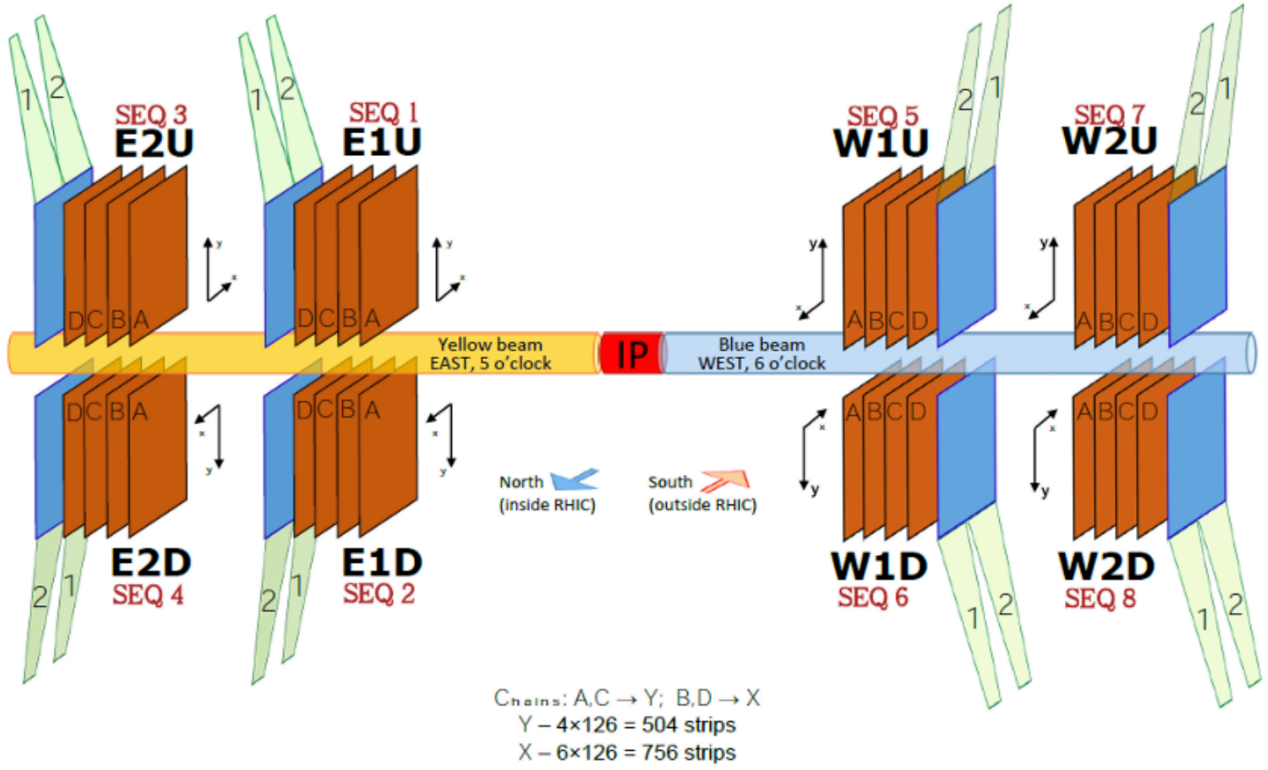
Roman Pot (RPs)

- Each Roman Pot vessel contains Si strip detector package which is consist of 4 planes. Total 8 planes for each side.
- Designed for measuring forward protons with small t and ζ $\quad \zeta = \frac{|\overrightarrow{p_0}| - |\overrightarrow{p_1}|}{|\overrightarrow{p_0}|}$



RPs layout and design

- 8 planes for east and west side.
  - 2 package on each side, with 4 silicon strip planes (brown color) in each package.



https://drupal.star.bnl.gov/STAR/subsys/romanpot/map-of-connections