Track – Particle Associations in Jets
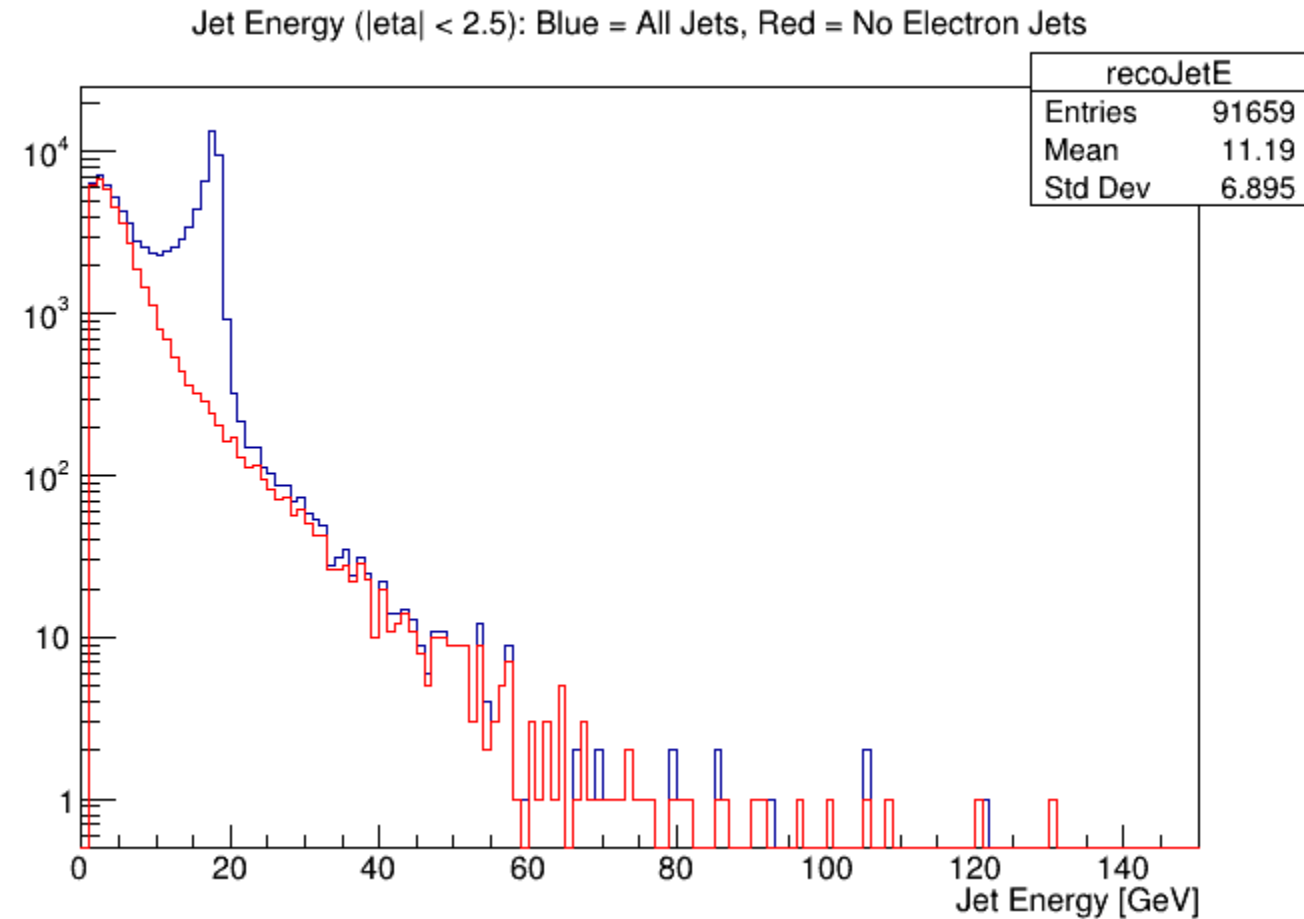
Brian Page

Tracking and Vertexing Meeting

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Identify Electron Jets

- ❑ Look at jet energy spectrum excluding jets containing an electron (track-only jets)

- ❑ For each jet constituent, find associated MC Particle and see if it is an electron

- ❑ If jet contains an electron, remove it from the spectrum

- ❑ See that the electron peak is eliminated -> Track-particle associations must be working to a high degree
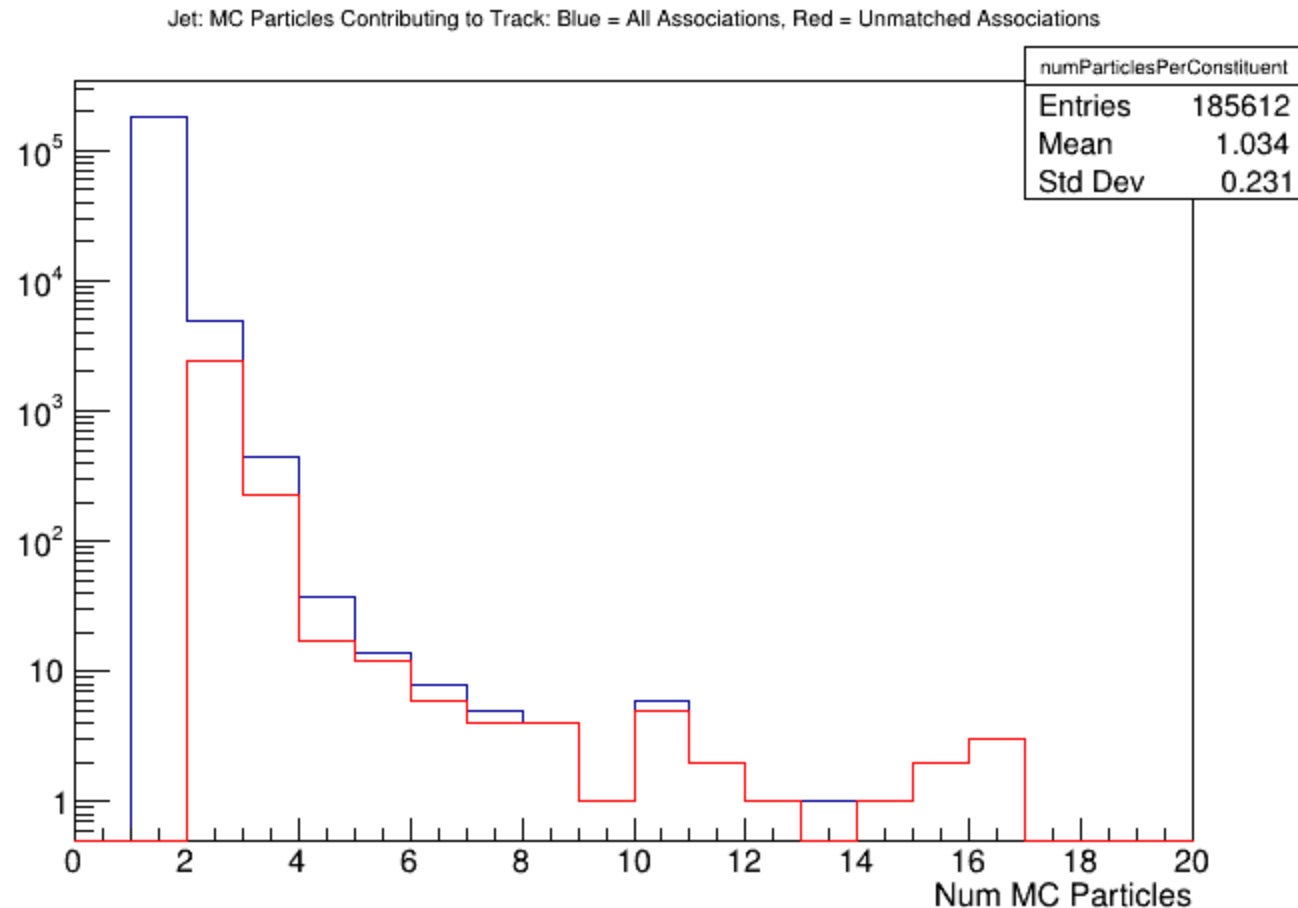

Jet Energy (|eta| < 2.5): Blue = All Jets, Red = No Electron Jets

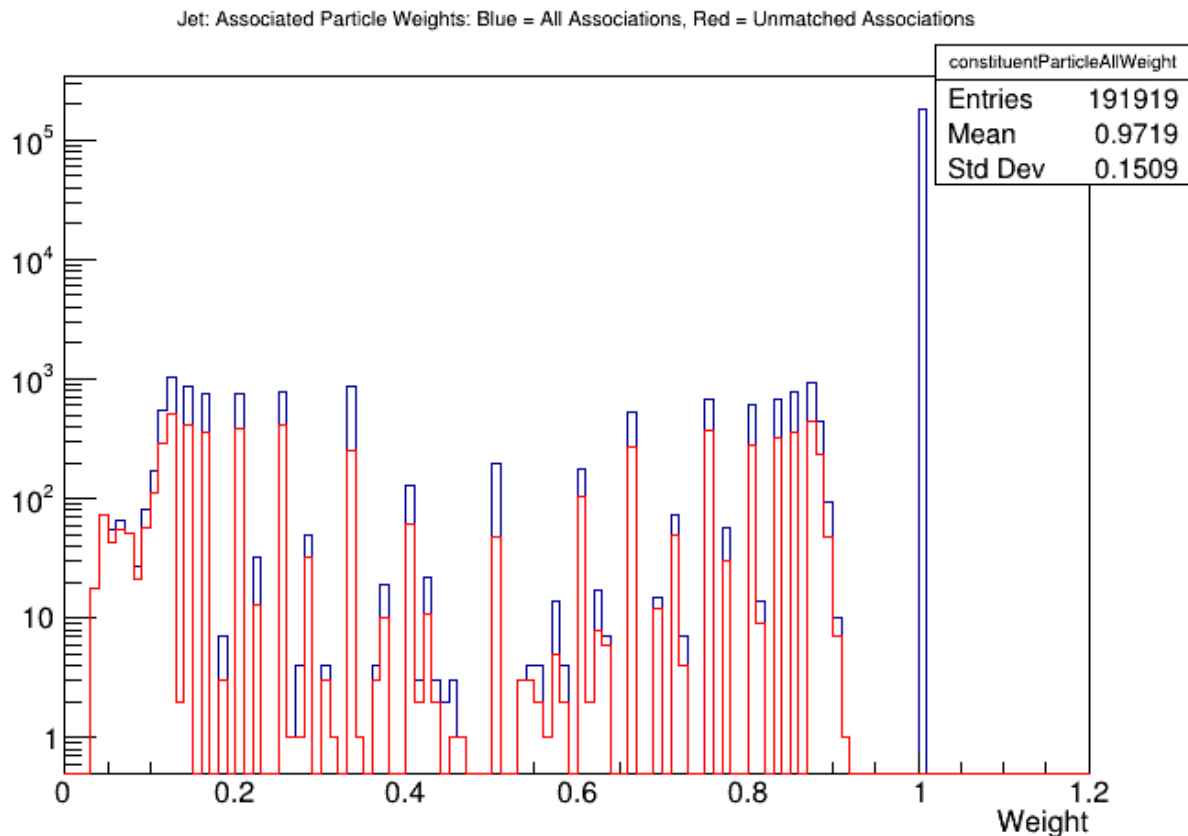| recoJetE	
Entries	91659
Mean	11.19
Std Dev	6.895

Using Associations (With ROOT Tree Reader)

❑ Access associations between ReconstructedChargedParticles and MCParticles with one of two branches:
1. ReconstructedChargedParticleAssociations
2. _ReconstructedChargedParticleAssociations_sim(rec).index

❑ Both branches relate the reco index to the matching sim index – branch 1 also contains the weight for each association

➢ Note: There can be more than one MCParticle associated to a reconstructed track

❑ Weight is the fraction of hits contributing to the reconstructed track coming from each particle

➢ MCParticle contributing the largest fraction of hits should be the matched particle for that track

❑ Using branch 1. : Loop over all associations; find associations with reco index == ReconstructedChargedParticles; find entry with largest weight; sim index for this association is the matching MCParticle

❑ Using branch 2. : Loop over all associations; find associations with reco index == ReconstructedChargedParticles; weight information not stored – choose first entry; sim index for this association is the matching MCParticle

➢ For tracks with multiple MCParticles contributing hits, the first entry is not necessarily the one with the highest weight – can get a mismatch between methods 1 and 2

Using Associations (With ROOT Tree Reader)

❑ Plot is the number of MCParticles associated with a given ReconstructedChargedParticle

❑ Blue curve is all associations and red curve are those associations that return different MCParticle indices using methods 1 and 2

❑ Mismatch only occurs when more than one MCParticle contributes hits

❑ See that 97% of ReconstructedChargedParticles get hits from only 1 MCParticle

❑ See that 1.4% of ReconstructedChargedParticles will have a mismatch (essentially 50% chance of getting the correct association for tracks with multiple MCParticles using branch/method 2)

Jet: MC Particles Contributing to Track: Blue = All Associations, Red = Unmatched Associations

numParticlesPerConstituent	
Entries	185612
Mean	1.034
Std Dev	0.231

Num MC Particles

Weights

Jet: Associated Particle Weights: Blue = All Associations, Red = Unmatched Associations

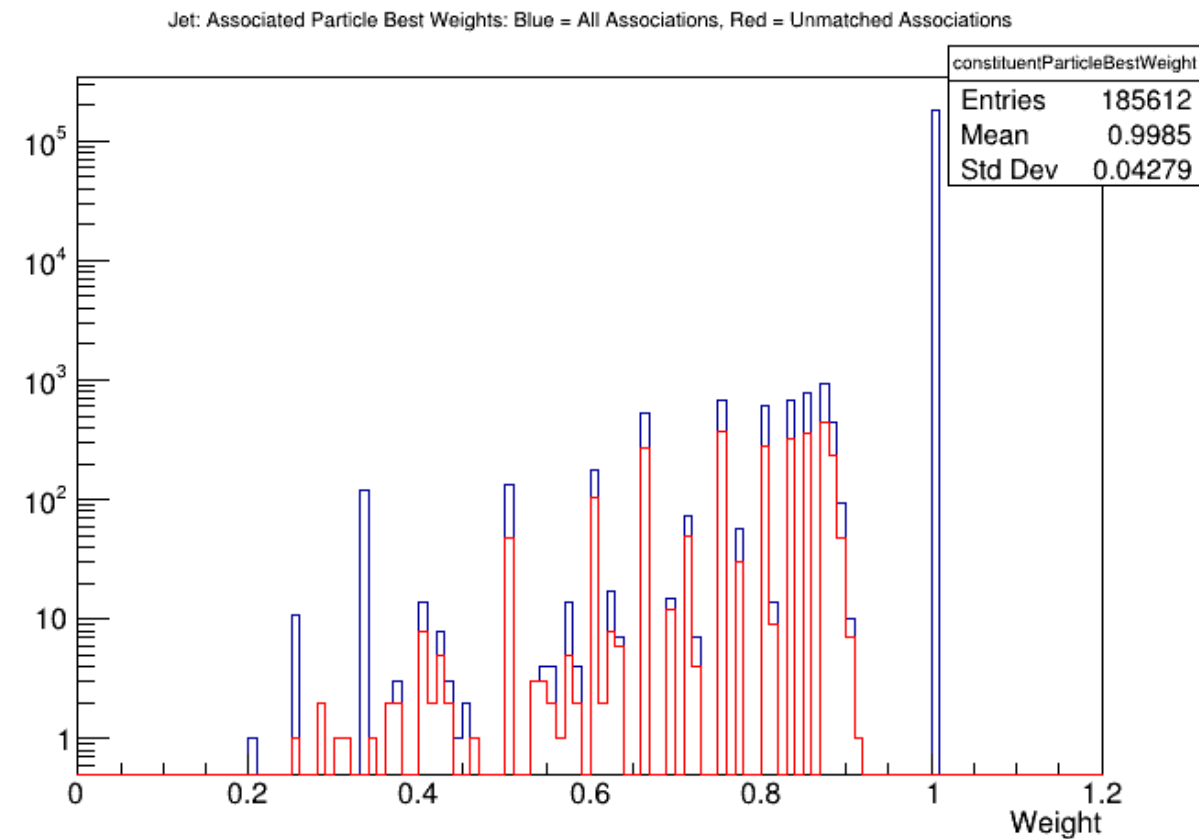| constituentParticleAllWeight	
Entries	191919
Mean	0.9719
Std Dev	0.1509

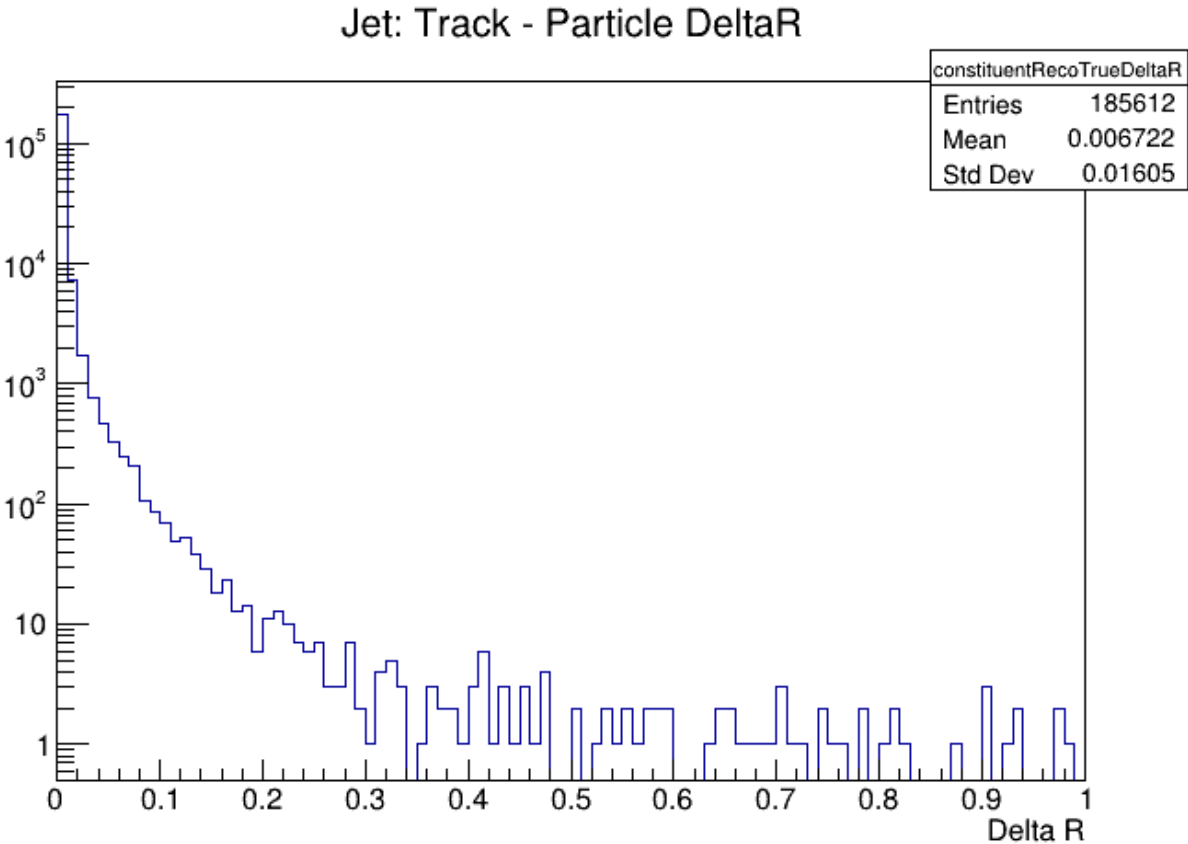❑ Red and blue distributions follow each other

❑ No systematic selection of which association is first in branch 2

❑ Look at weight distribution for every MCParticle contributing hits to a track (Left) and the highest weighted MCParticle for each track (Right)

❑ Blue is all associations and red is associations where methods 1 and 2 do not match
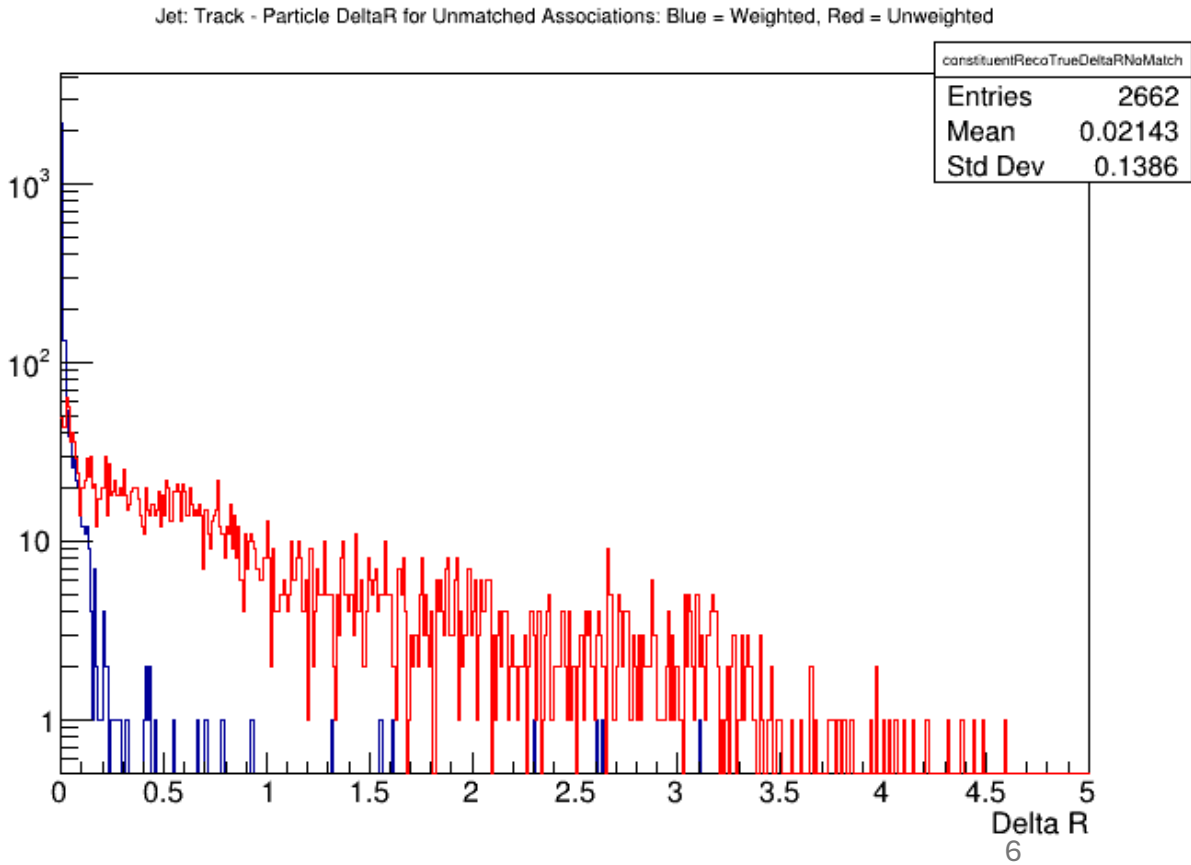

Jet: Associated Particle Best Weights: Blue = All Associations, Red = Unmatched Associations

constituentParticleBestWeight	
Entries	185612
Mean	0.9985
Std Dev	0.04279

Geometric Association

Jet: Track - Particle DeltaR

- Left plot shows eta-phi distance between ReconstructedChargedParticle and associated MCParticle (as obtained using method 1)

- Quite good matching seen

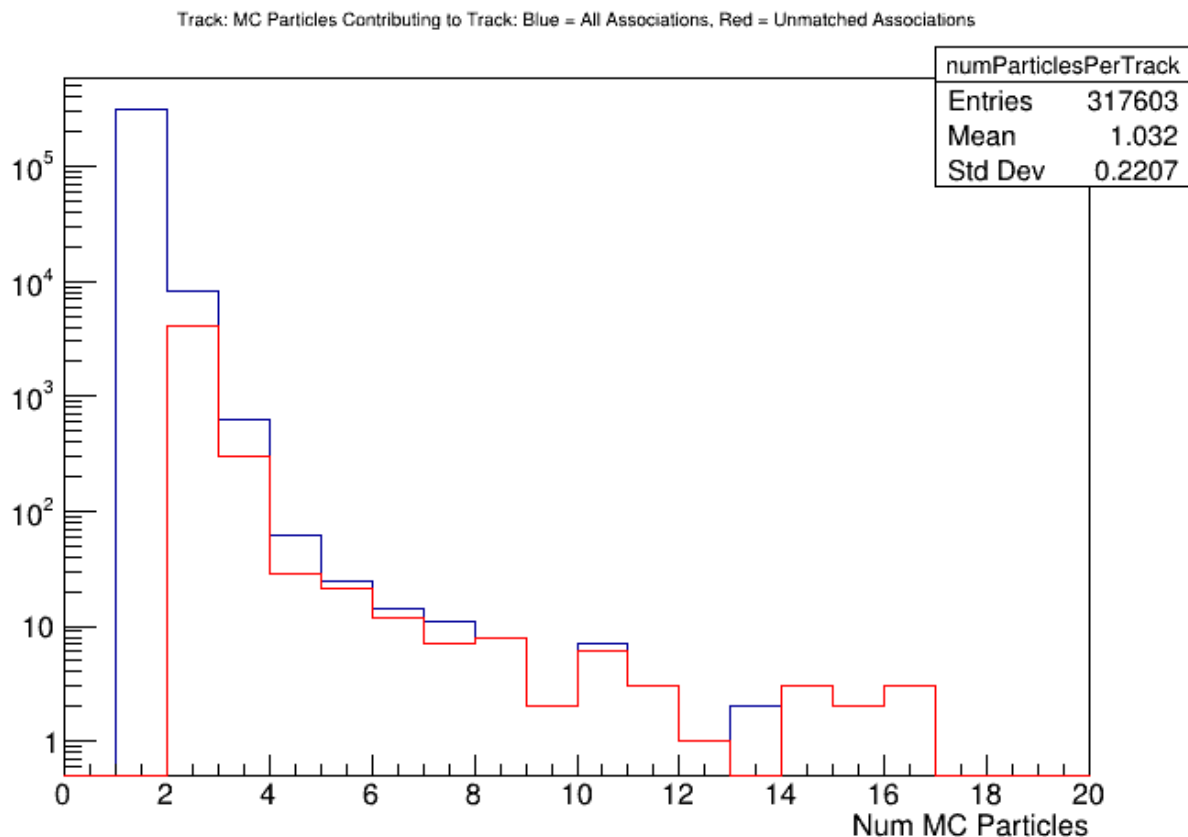Jet: Track - Particle DeltaR for Unmatched Associations: Blue = Weighted, Red = Unweighted

- Right plot shows eta-phi distance between reco and MC for tracks with a mismatch between methods 1 and 2
- Blue = association from method 1 and Red = association from method 2
- Clearly see that selecting highest weight is better

Jet Tracks Vs All Tracks

Track: MC Particles Contributing to Track: Blue = All Associations, Red = Unmatched Associations

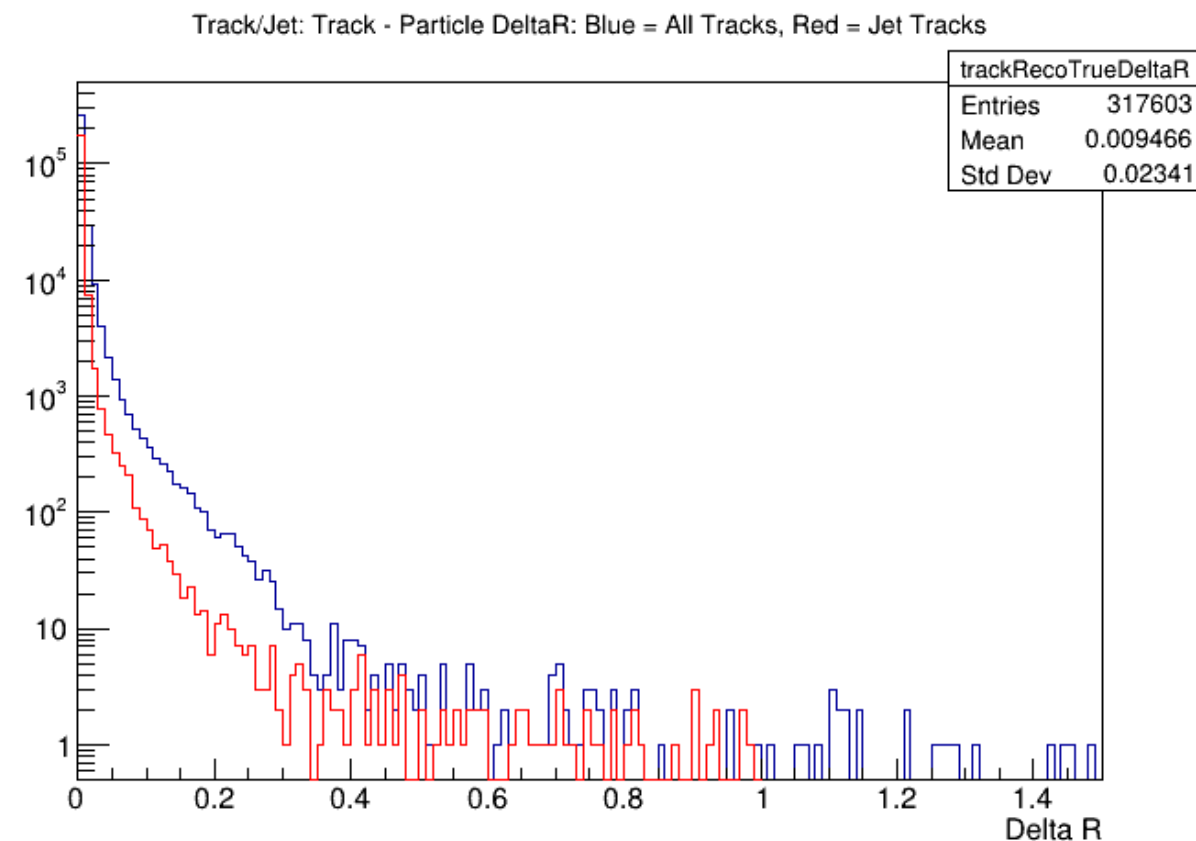| numParticlesPerTrack	
Entries	317603
Mean	1.032
Std Dev	0.2207

- ❏ Geometric distance between tracks and associated MCParticles look pretty similar for tracks in jets (red) and all tracks in event, regardless of whether they are in a jet or not (blue)

- ❏ Do tracks in jets behave any differently than general tracks?

- ❏ Left plot is again the number of MCParticle contributing hits to a track

- ❏ Same behavior as for tracks in a jet

Track/Jet: Track - Particle DeltaR: Blue = All Tracks, Red = Jet Tracks

trackRecoTrueDeltaR	
Entries	317603
Mean	0.009466
Std Dev	0.02341

Summary

❑ Appears that when associating ReconstructedChargedParticles to MCParticles using ROOT tree reader, one needs to find the association with largest weight by hand (maybe this is easier using PODIO?)

❑ If possible, would be nice to make the highest weighted association clearer so end user does not need to loop through all weights themselves

❑ Do not see any strong evidence that associations for tracks in jets are systematically different than for all tracks