Jet Reconstruction and Global Particle Flow in the ATLAS Experiment for Run 3 of the LHC

Anubhav Gupta

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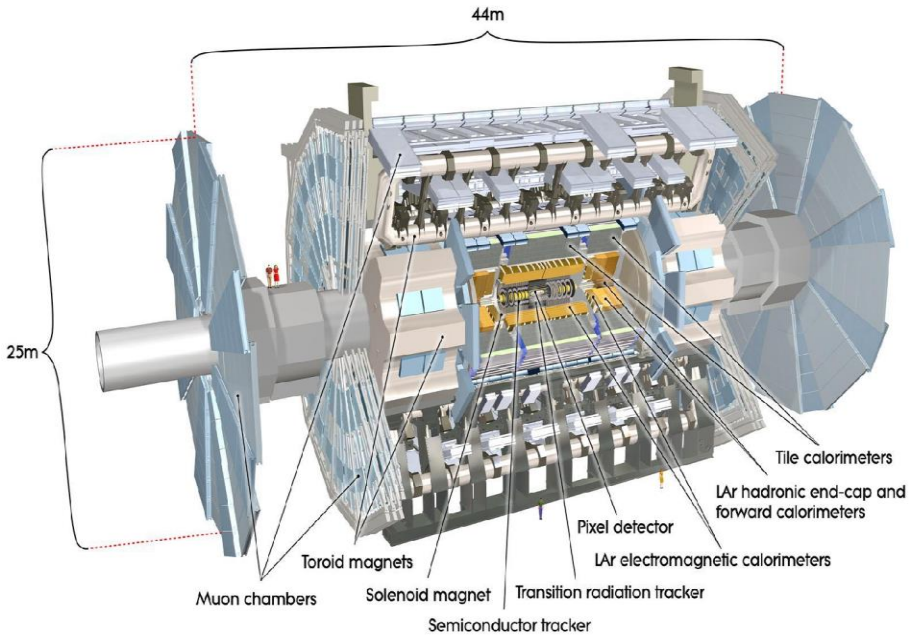
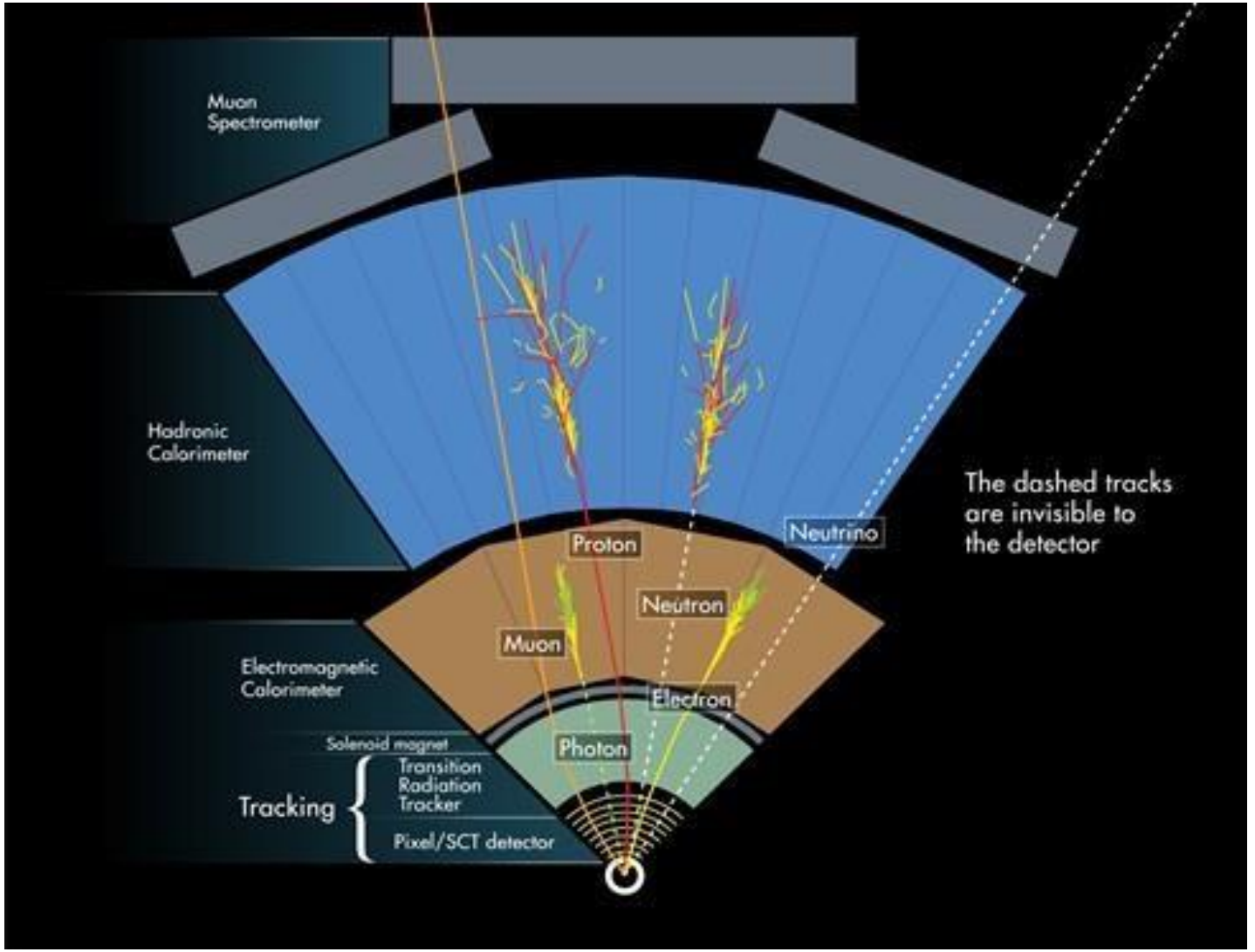
8th BCD ISHEP Cargèse School

The ATLAS Detector : Transverse Plane

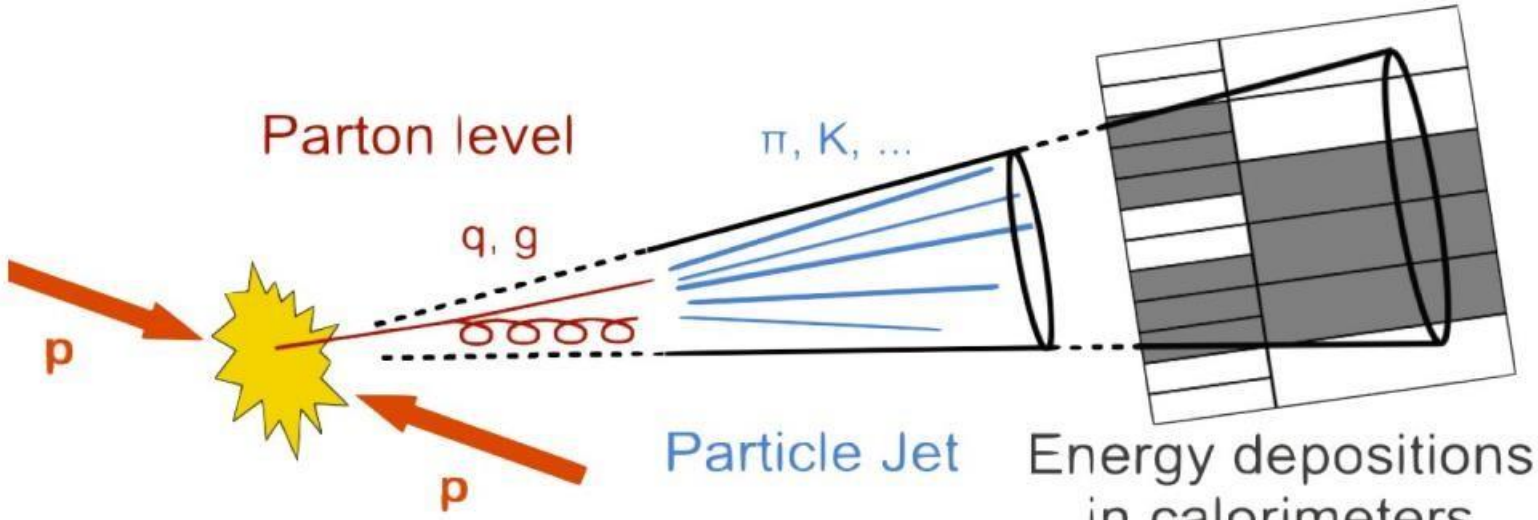


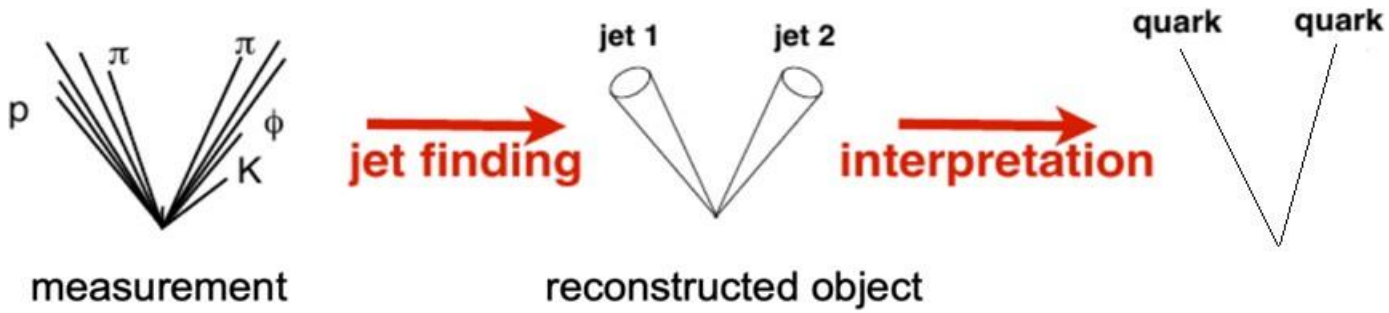
http://cds.cern.ch/record/1095924



https://cds.cern.ch/record/1505342

Jets


Parton level
π, K, ...
q, g
p
p
Particle Jet
Energy depositions
in calorimeters


p
π
π
ϕ
K
jet finding
jet 1
jet 2
interpretation
quark
quark
measurement
reconstructed object

Topo-clusters

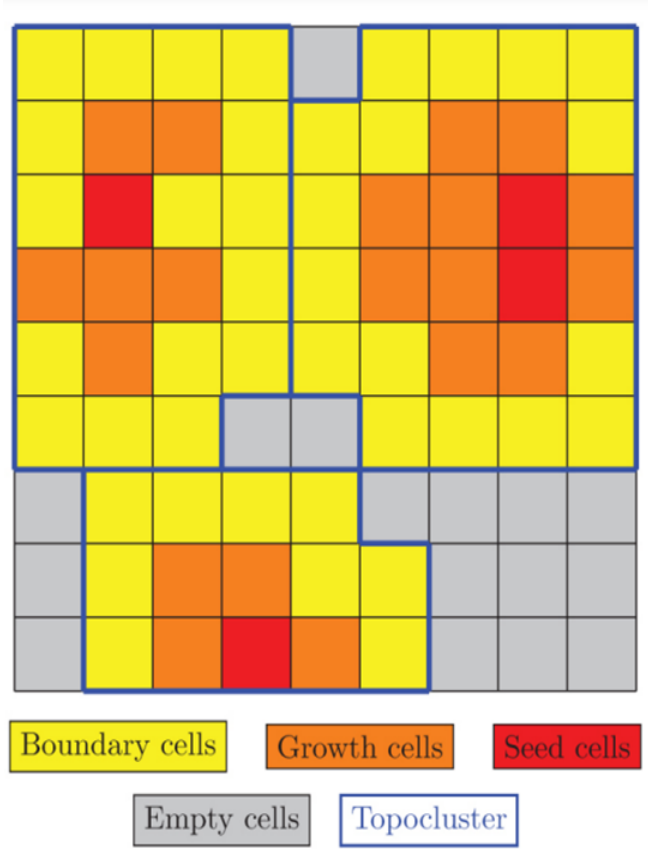
Clusters of topologically connected calorimeter cells

cell significance:

$$\xi = \frac{\text{cell signal}}{\text{average noise}}$$

Topo-clustering Algorithm:

- Cells with $\xi > 4\sigma_{\text{noise}}$ seed the topo-cluster
- Neighbouring cells with $\xi > 2\sigma_{\text{noise}}$ are included iteratively until all adjacent cells have $\xi < 2\sigma_{\text{noise}}$
- Cells with $\xi \geq 0$ are added to the cluster
- A cluster with two or more local energy maxima is split into two or more clusters

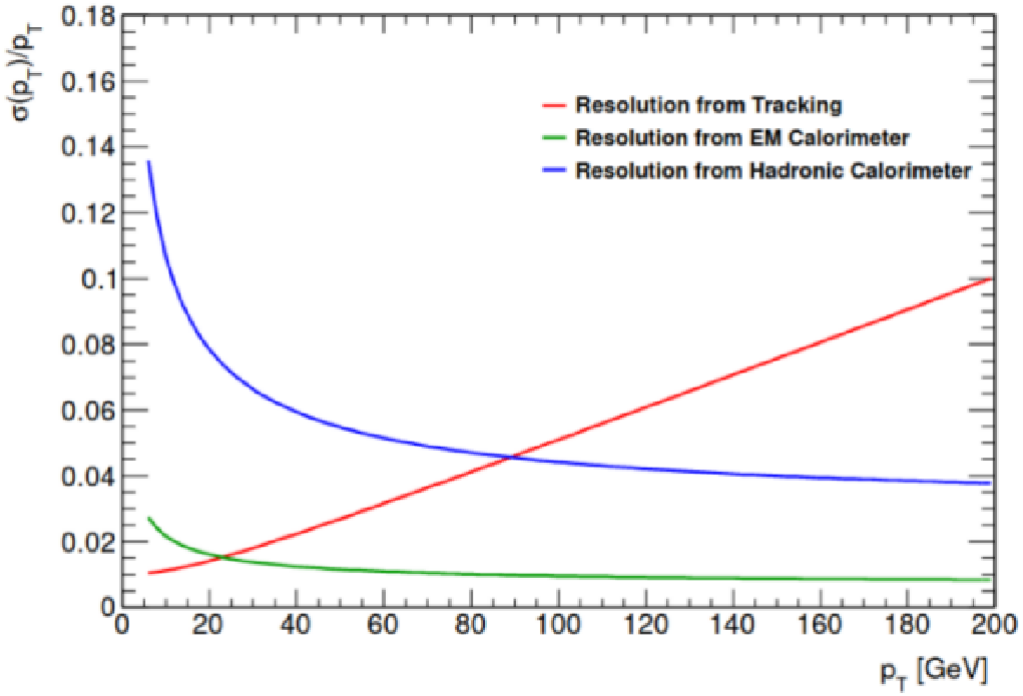


D. Kar, Experimental Particle Physics, 2019

Particle Flow (PFlow)

Tracking system:
- ❑ Better p_{T} resolution for charged low p_{T} particles
- ❑ Better angular resolution
- ❑ Traces particles to hard-scatter interaction: suppresses pile up

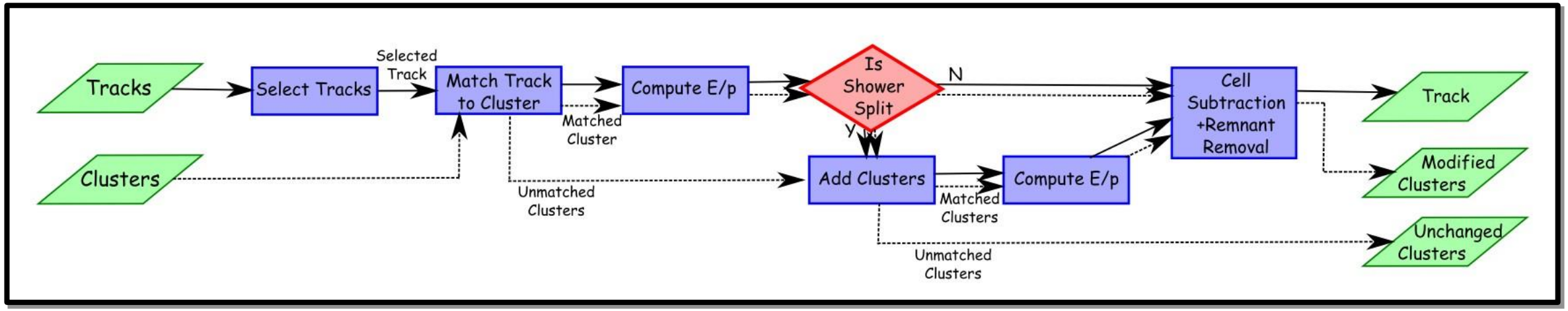
Calorimeter:
- ❑ Better resolution for high p_T particles
- ❑ Reconstruct neutral particles



DOI:10.1088/1748-0221/3/08/S08003

PFlow:
- ❑ Combines information from tracking system and calorimeters
- ❑ Improves energy and angular resolution
- ❑ Reduces pile-up

Particle Flow (PFlow) Algorithm

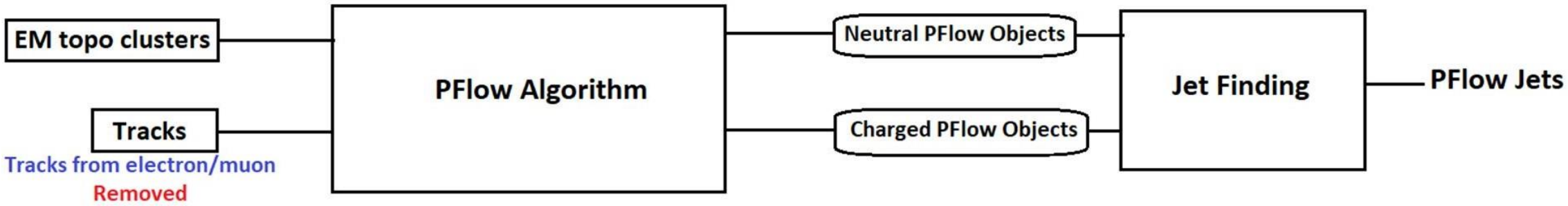


arXiv:1703.10485

Expected energy $\mathrm{E} = \left(\frac{\mathrm{E}}{\mathrm{p}}\right)_{\mathrm{ref}} \cdot p_{\mathrm{track}}$

- Tracks form charged PFlow objects
- Modified and unchanged clusters form neutral PFlow objects
- These objects are passed for jet finding

Run 2 PFLow Jet Reconstruction

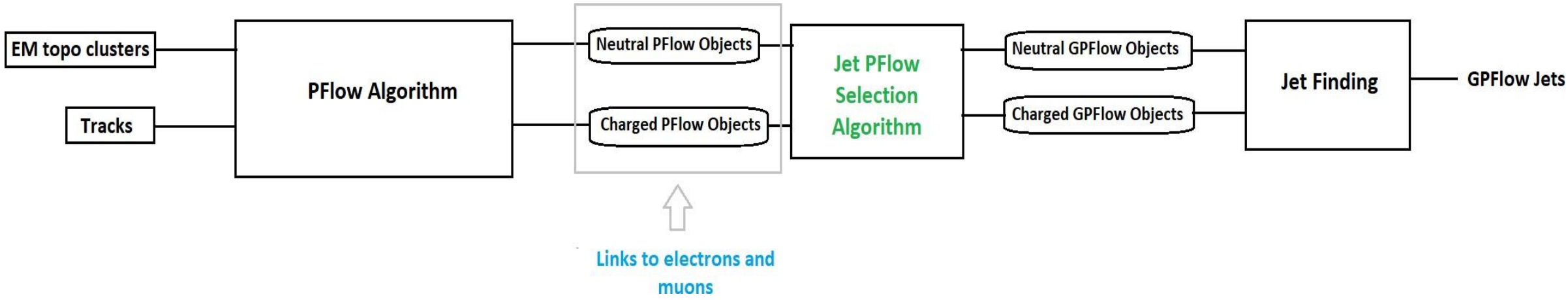


- Tracks of electrons and muons removed before PFlow algorithm

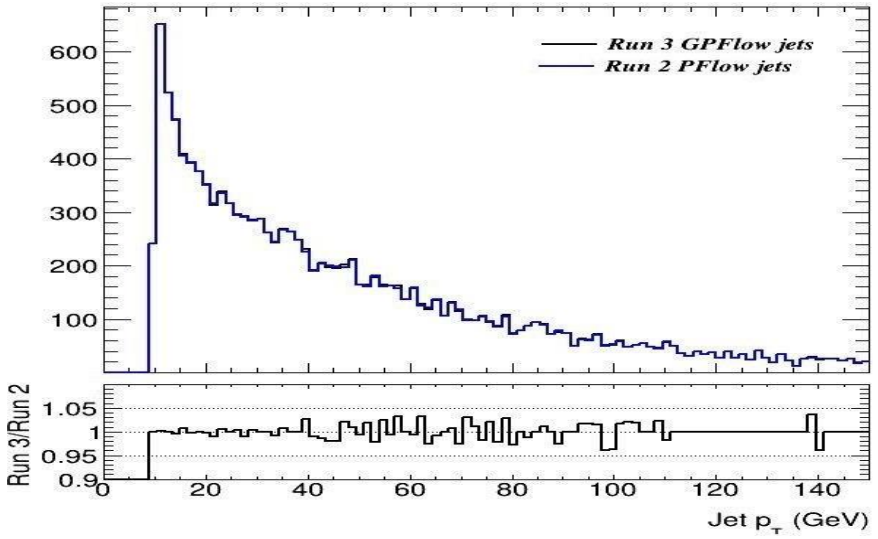
Global PFlow and Run 3 Jet Reconstruction

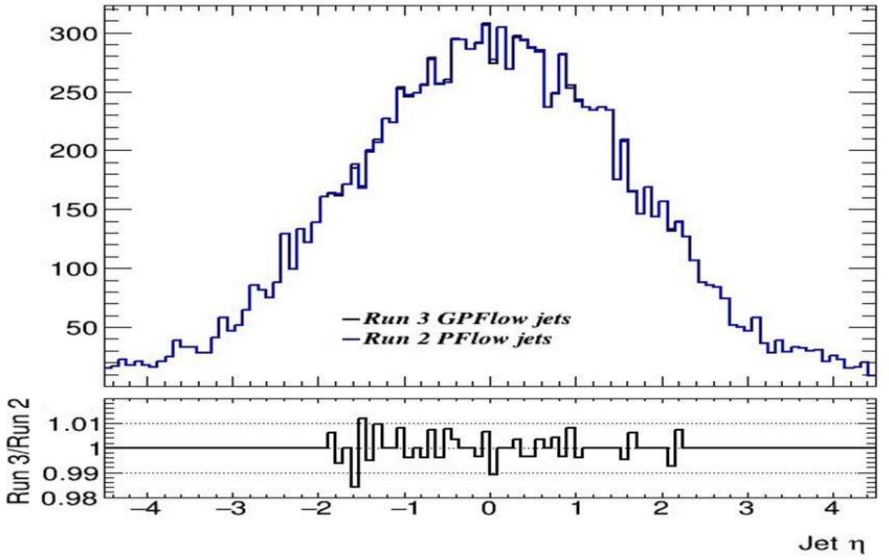
Global PFlow (GPFlow)

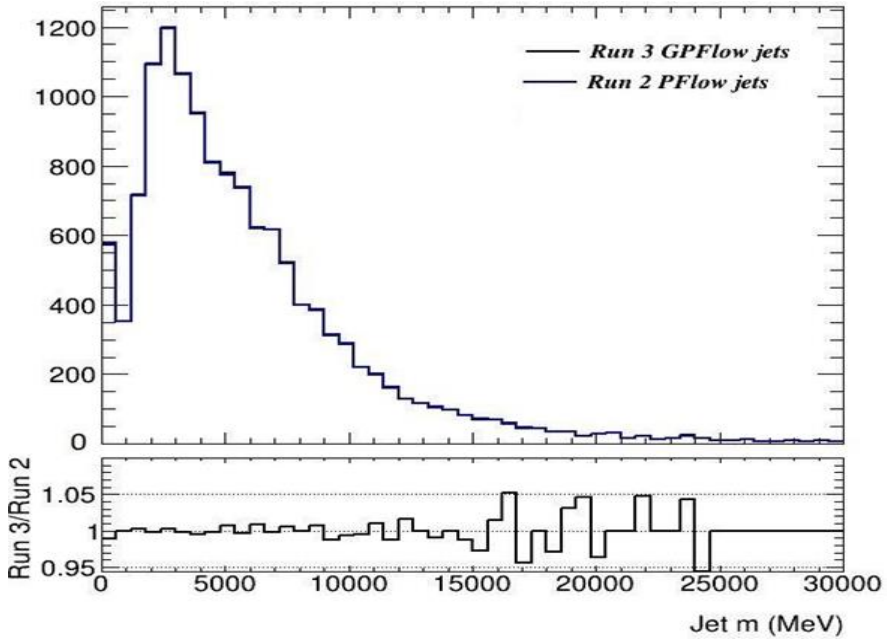
- ❑ Extending PFlow to take into account other physical objects (leptons and photons)
- ❑ Linking of electrons and muons with PFlow objects in an event

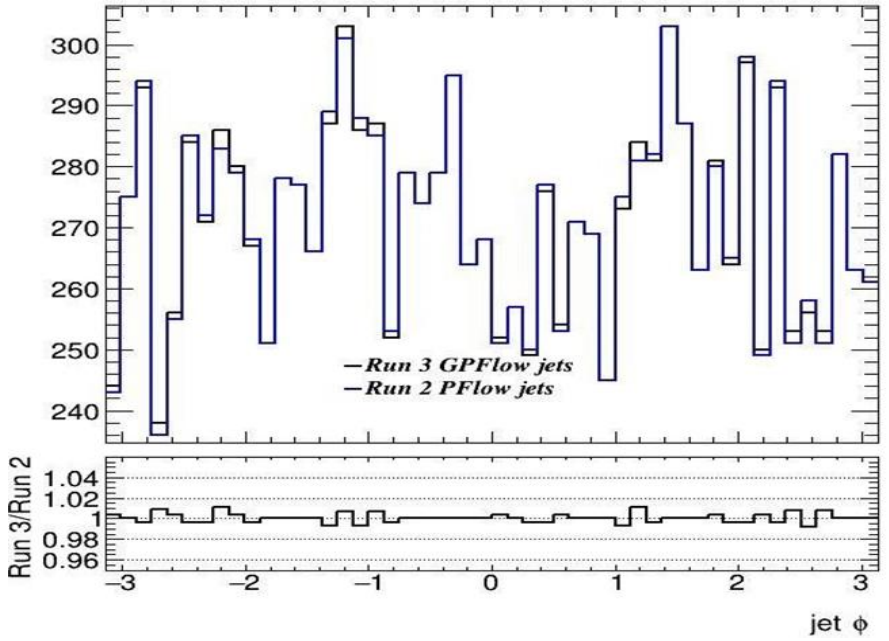


Validation of Run 3 GPFlow Jets





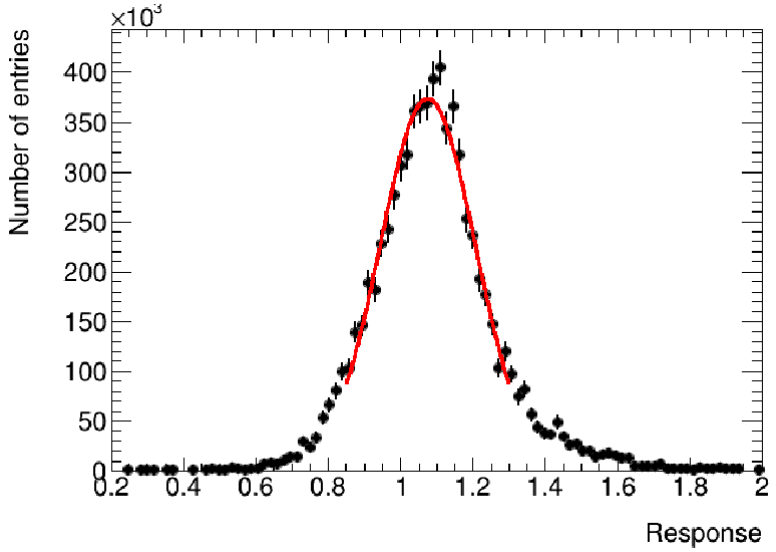




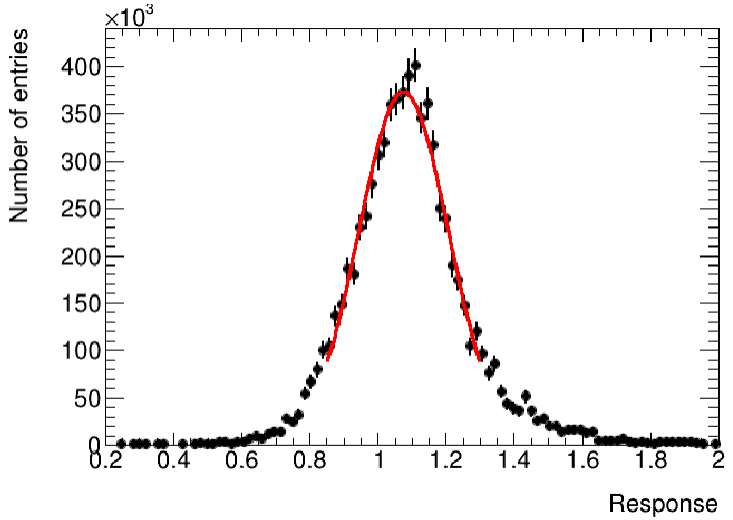
Conclusion

- ❑ Implemented and validated the jet PFlow selection in Run 3
- ❑ Compared Run 2 and Run 3, and saw no significant drop in jet energy resolution in Run 3

Jet Energy Scale (JES) and Jet Energy Resolution (JER)



Run 2 PFlow jets



Run 3 GPFlow jets

Parameters	PFlow jets without removing lepton tracks	Run 2 PFlow jets	Run 3 GPFlow jets
JES	1.078±0.002	1.075±0.002	1.075±0.002
JER	0.139±0.002	0.132±0.002	0.132±0.002