Brief overview of particle flow in sPHENIX

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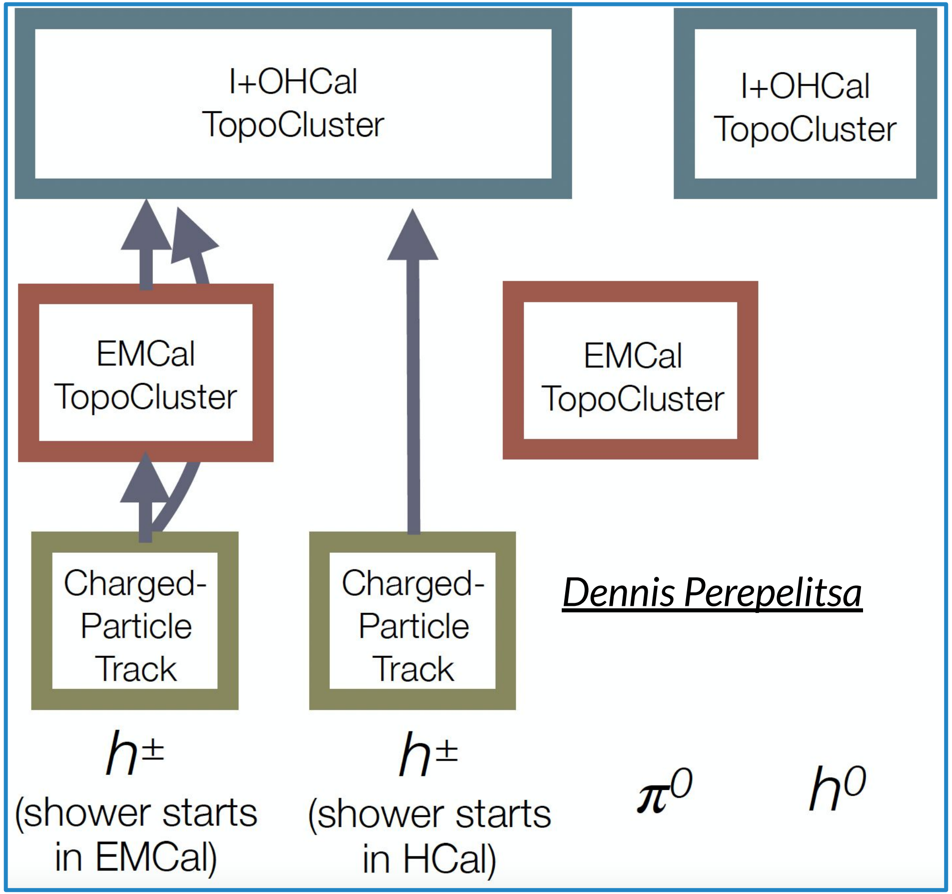
Particle flow - sPHENIX



Particle flow combines the different sPHENIX detectors to reconstruct particles

- Removes double counting between different detectors
- Takes advantage of the precision provided by tracking for charged particles, but also includes EM particles and neutral hadrons
- Ideal particle input for jets

More on particle flow

JINST 12 (2017) P10003 - arXiv:1706.04965
CMS Experiment

Particle flow - topo-clusters

Topo-clusters: 3D topological clusters

- Algorithm looks for neighbours in ***η***, ***ϕ***, and ***r***

- sPHENIX
  - EMCal topo-clusters (1 layer) - 2D clusters
  - HCal topo-clusters (2 layers) - 3D clusters
    - Inner HCal + Outer HCal

- Algorithm - key parameters
  - Seed minimum energy → Seed energy = S*Layer Noise
  - Growth parameter → Growth min energy = G*Layer Noise

Usually S > G

- Towers must to have energy significantly above noise thresholds

More on topo-clusters

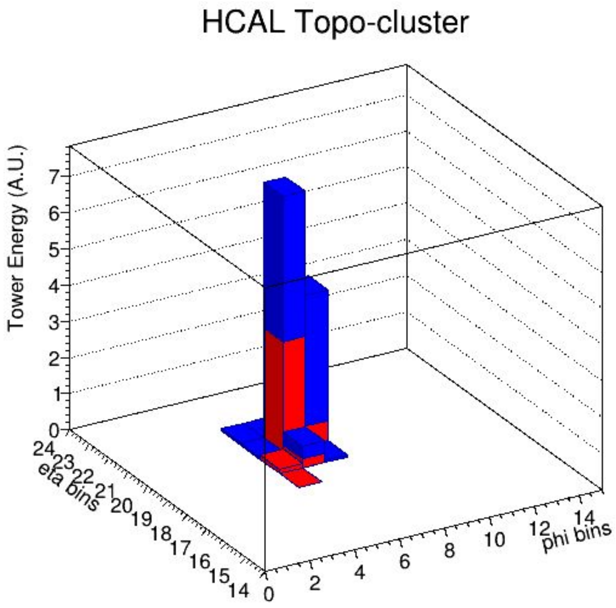
Eur. Phys. J. C 77 (2017) 490 - arXiv:1603.02934

ATLAS Experiment

Particle flow - topo-clusters

Topological clusters

- HCal topo-cluster example
  - Towers passing seed criterion are selected as seeds
    - Seeds are organized by energy in descending order
  - Adjacent towers passing growth criterion are merged
    - Even if it's also a seed



Some additional topo-cluster info

- In pp simulations at 200 GeV, the default ATLAS parameters are being used at this moment
- We are testing a centrality dependent set of topo-cluster parameters
- Probably not a issue for EIC, but could be useful to deal with possible background

Particle flow - topo-clusters

Topological clusters

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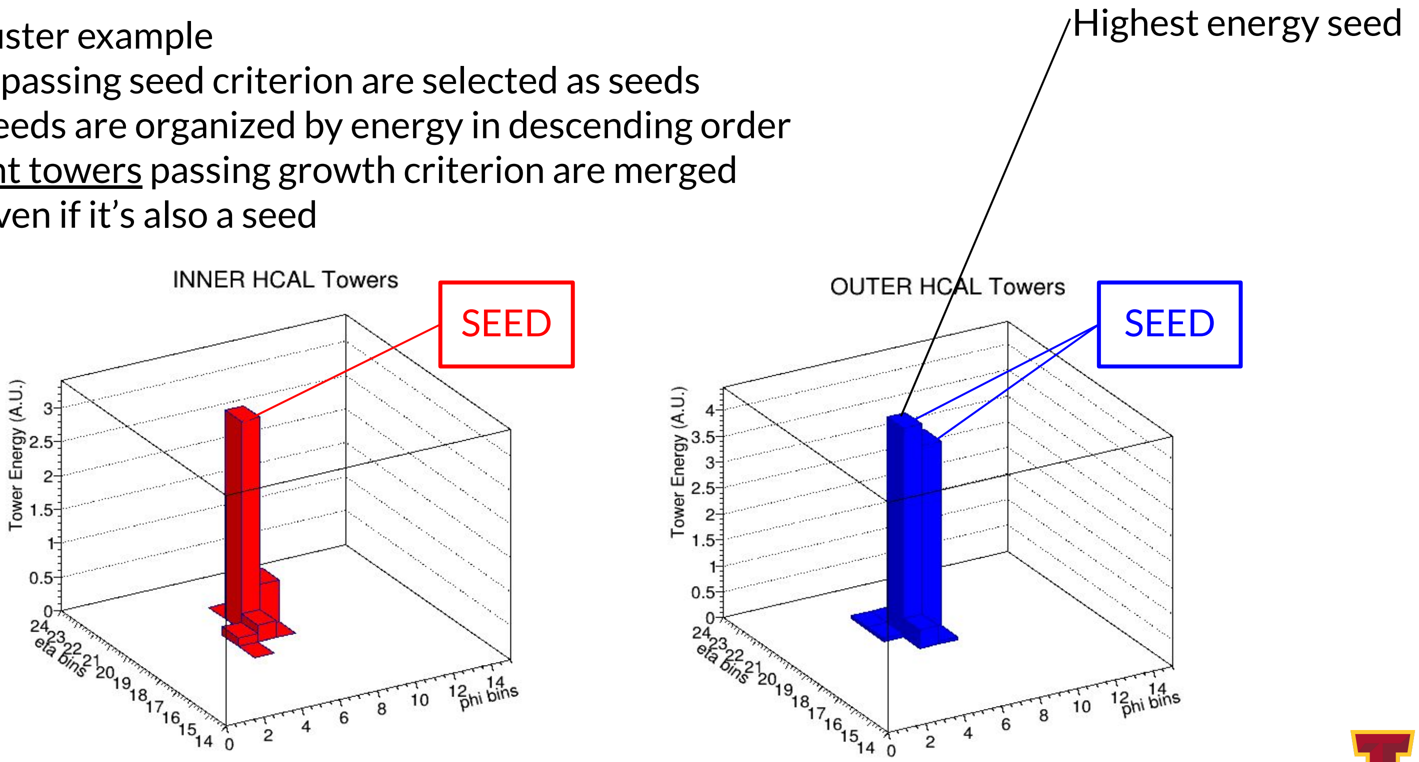
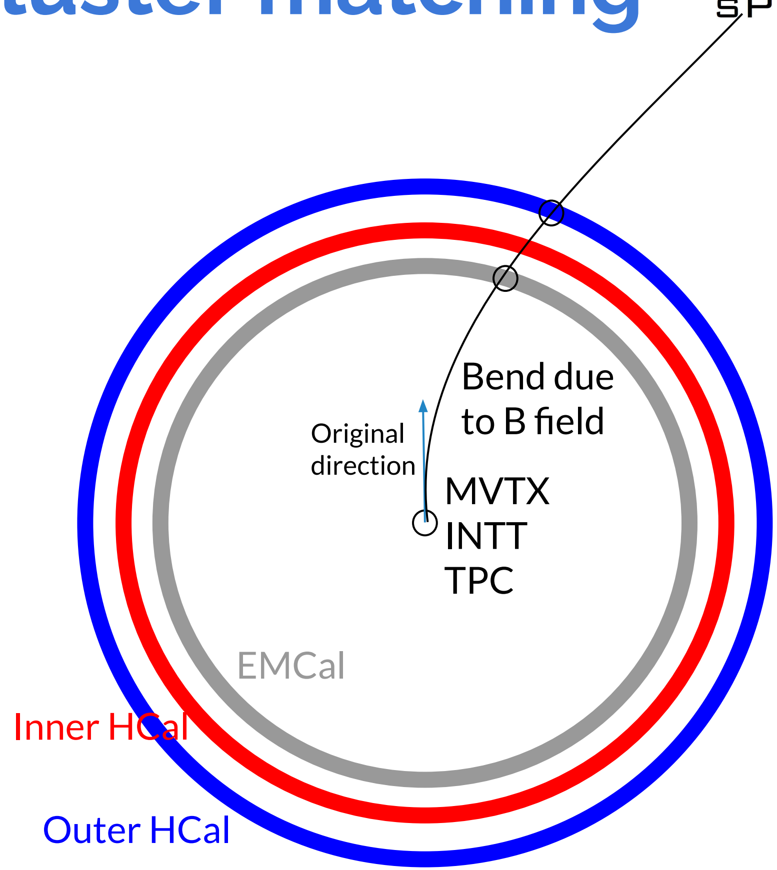


Particle flow - Track/cluster matching

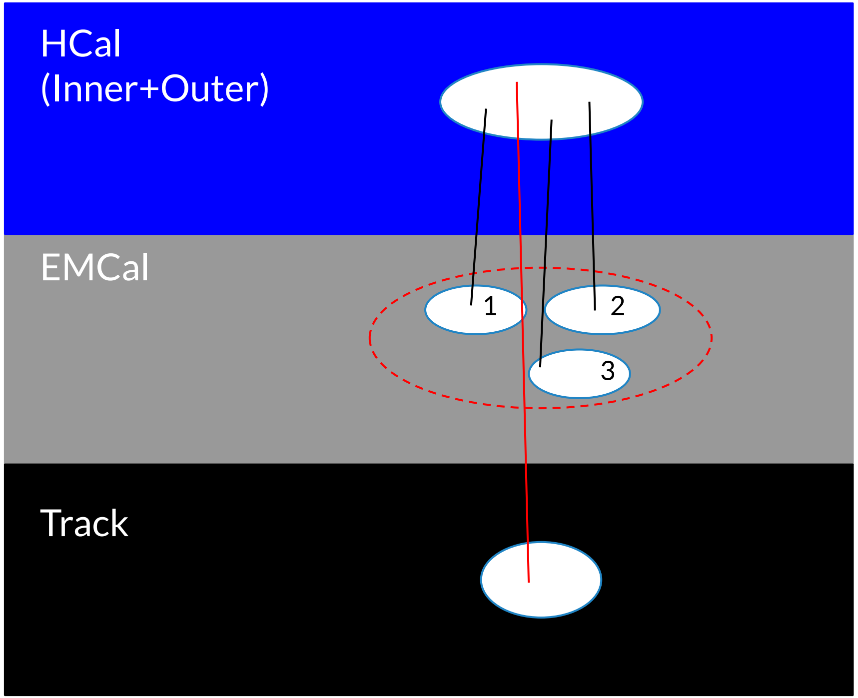
Track to topo-cluster matching

- Tracks are projected to the EMCal and Outer HCal
- Distance $\Delta R(\eta, \phi)$ between track projection and topo-clusters are calculated
- Links are created
  - Track $\rightarrow$ EM
  - Track $\rightarrow$ HAD
  - EM $\rightarrow$ HAD
  - Track $\rightarrow$ (EM) $\rightarrow$ HAD
- Links are ordered from smaller to larger ΔR

HAD = HCal topo-clusters
EM = EMCal topo-clusters



Particle flow - Track/cluster matching



HAD cluster loop

- HAD1 has at least 1 matched track
- Loop over EM clusters associated to HAD1
  - EM cluster with matched track
  - Compute Total_calo_E = EM+HAD energy
- Loop over tracks associated to HAD1
  - Compute Total_expected_energy = parametrization()*
  - A Particle Flow element is created using the track kinematics and the pion mass
- If [Total_expected_energy]> [Total_calo_E]
  - Look for additional EM clusters associated to tracks matched to the HAD
  - Then if [Total_calo_E] > [Total_expected_energy]
    - Additional Particle Flow element is created using residual energy

*Expected energy deposition of a charged hadron in the calorimeters

Particle flow - Particle sequence

Order that particles are resolved

1. HAD clusters with matched tracks (and possibly matched EM clusters)
2. EM clusters with matched tracks (and no matched HAD clusters)
3. EM cluster without matched tracks
4. HAD clusters without matched tracks
5. Tracks without HAD or EM clusters

Final considerations

- Particle flow exploits the full capabilities of different sub-systems
  - And avoid double counting
- Tests using fully reconstructed pp simulations presented good results for jet reconstruction
  - Minimizes fragmentation bias
- sPHENIX is currently focusing on particle flow in Au+Au collisions and background subtraction