



Pion rejection in EEEMCal: E/p classifier

Dmitry Kalinkin

University of Kentucky

Pu-Kai's studies

Backward end-cap ECAL (energy & spatial resolution)

Energy resolution can be expressed:
 $\sigma_E/E = \alpha \oplus \beta/E \oplus \gamma/E$
 α : radiation length, geometry
 β : calorimeter technology
 γ : noise level

Spatial resolution can be expressed:
 $\sigma_x = \Delta \oplus \alpha'/E \oplus \beta' \sin^2\theta$
 δ and c : module size
 Δ : radiation length

The simulation setup:
 - Detector geometry: all central subsystems
 - Particle: γ
 - Energy reconstruction: island clustering
 - For energy resolution: 0.5 – 20 GeV
 - For spatial resolution, E: 1 – 20 GeV (fixed η), η : -2 – -3.2 (fixed E)

The σ_x is better
 (6.5% → 17% of crystal width) as incoming angle is smaller (η : -1.8 – -3.6)

The σ_x is better
 (15% → 10% of crystal width) as particle's energy is larger (1 – 20 GeV)

$-\sigma_x/E$ is from the width of Gaussian and Crystalball functions

The α and β from the YR requirements are: 1.5, 2.5, respectively.

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Pion rejection & 2γ separation

Simulation Setup for 2γ separation:
 - 1 – 20 GeV single particle gun
 - full geometry
 - uniformly distributed over NEMC

2γ separation efficiency:
 # of events identified as 2 clusters / Total $p\pi$

Simulation Setup for pion rejection:
 - 0.5 – 20 GeV single particle gun
 - full geometry
 - uniformly distributed over NEMC

Pion rejection:
 Total pions / # of pions pass the cut

Electron efficiency:
 # of electrons pass the cut / Total electrons

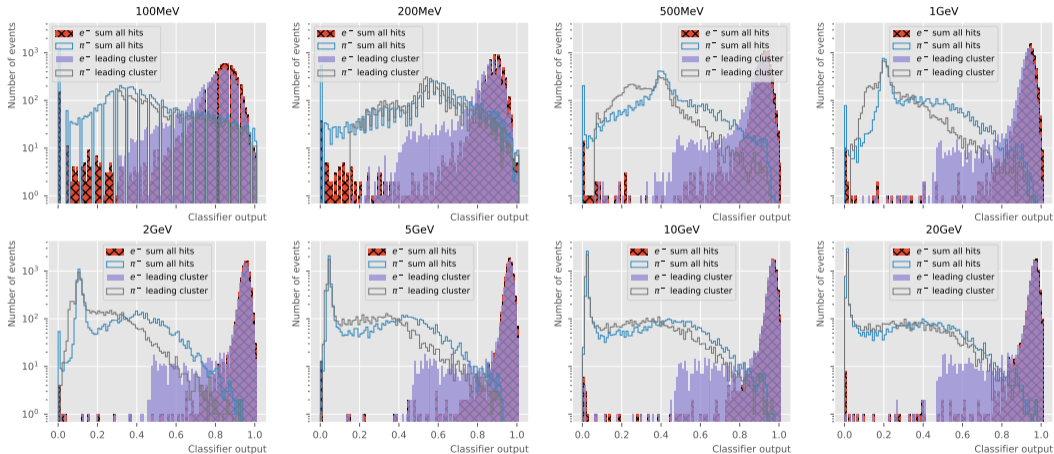
E/P distribution of e-(black) and pion(red) @ different momentum

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Peak performance at 5 GeV: $3 \cdot 10^3$

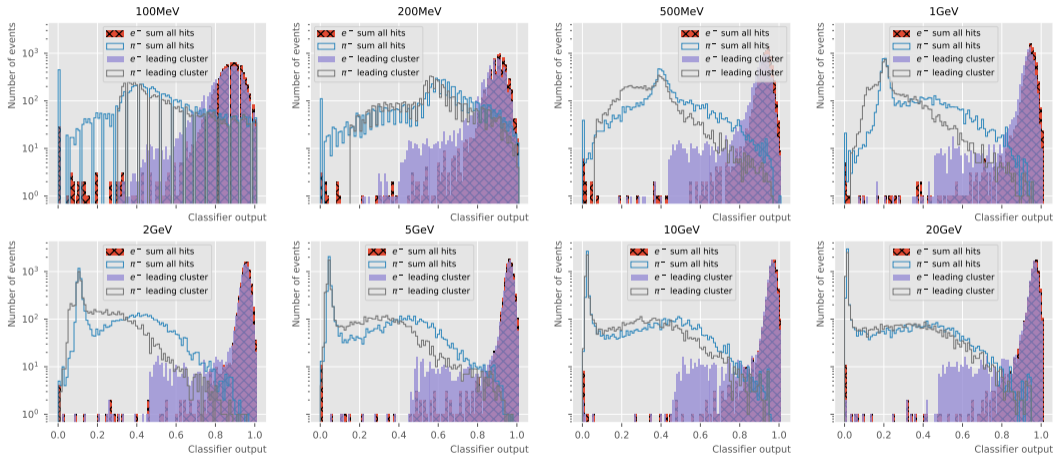
Goal for Today is to focus on E/p -based classifier for $-3.5 < \eta < -2.0$.

epic_inner_detector_24.07.0

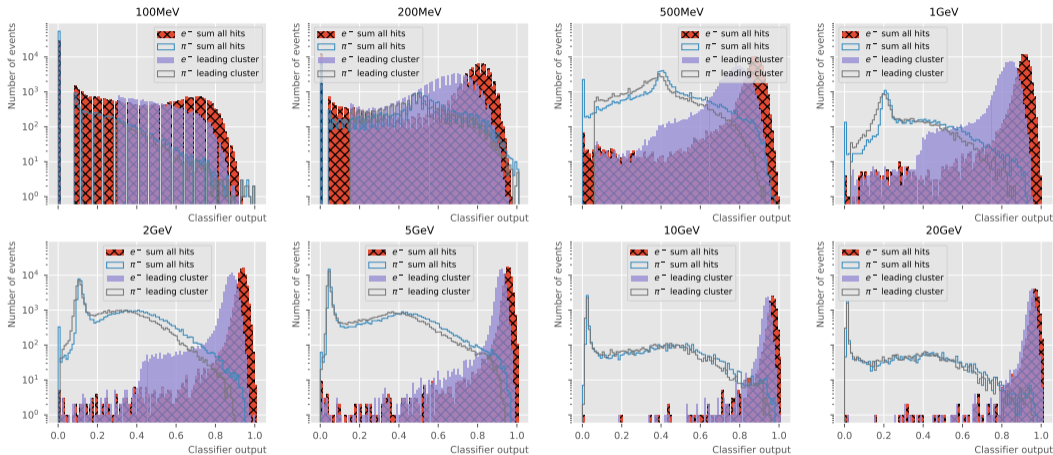


Issues with the clustering?

epic_eemcal_only_24.07.0



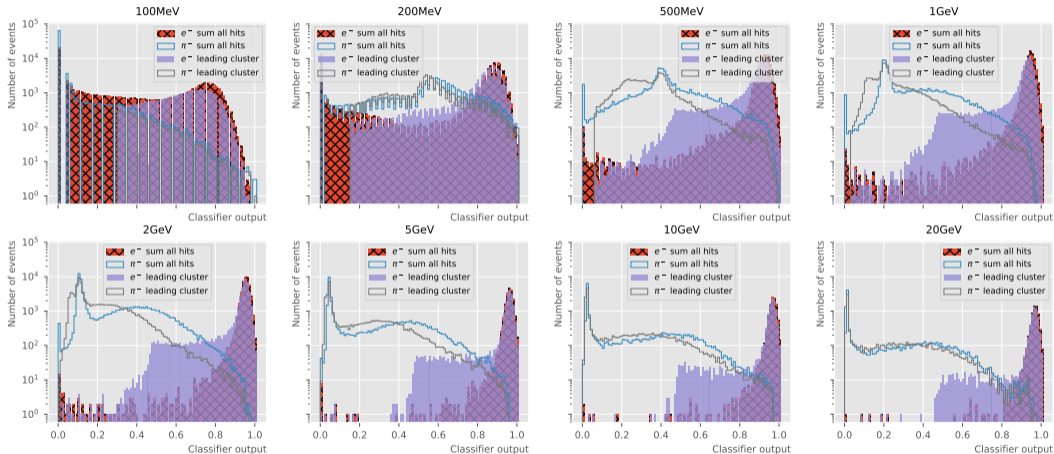
Issues with the clustering?



There was a bug with clustering in 22.10.0

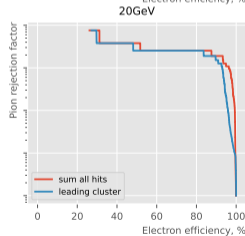
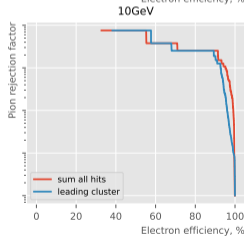
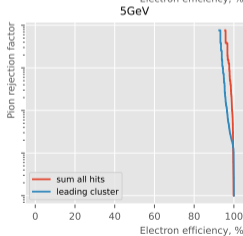
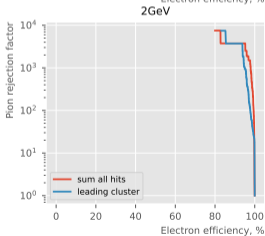
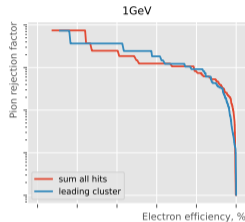
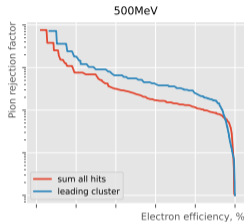
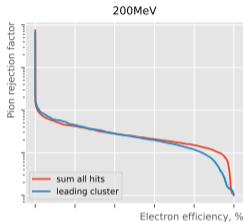
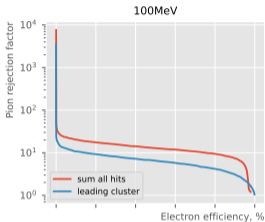
<https://github.com/eic/EICrecon/pull/610>

official_campaign_24.07.0_craterlake

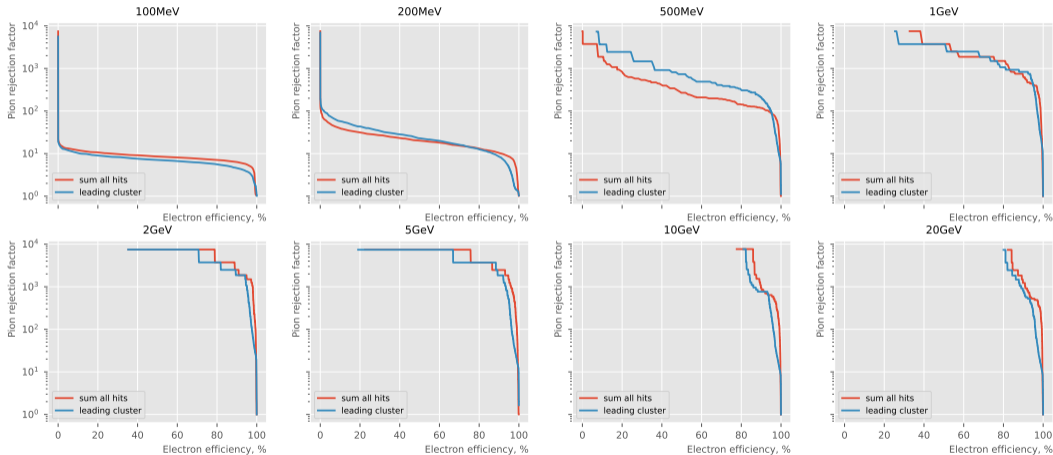


Issues with the clustering?

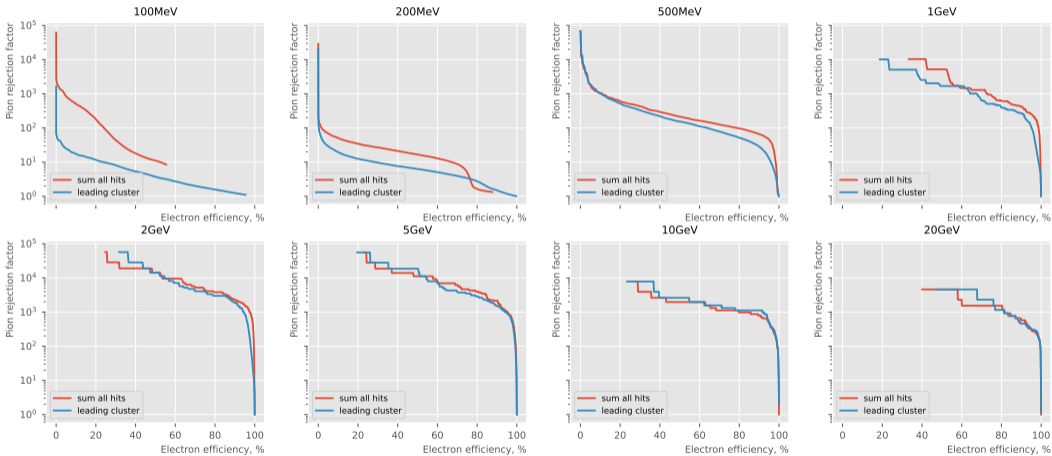
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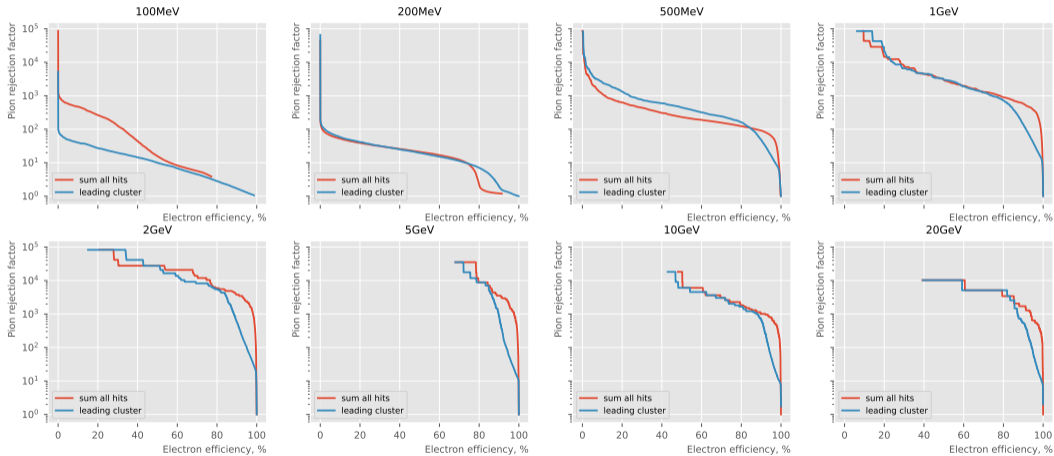
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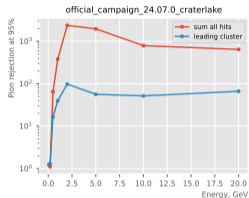
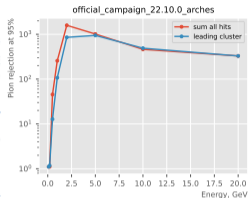
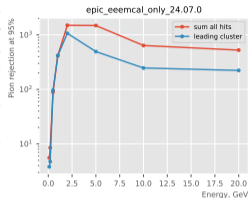
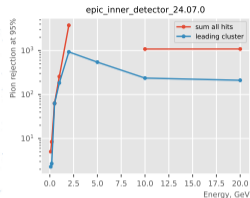
official_campaign_22.10.0_arches



official_campaign_24.07.0_craterlake



Pion rejection summary



- » Clustering underperforms (something isn't right?)
- » Geometry with beam pipe, trackers and pFRICH (epic_inner_detector¹) outperforms geometry without it (epic_eeemcal_only²). (Note: both of these geometries lack magnetic field).

¹ https://github.com/eic/epic/blob/main/configurations/inner_detector.yml

² https://github.com/eic/epic/blob/main/configurations/inner_eeemcal_only.yml