

eID with PID discussion II

Jae Nam

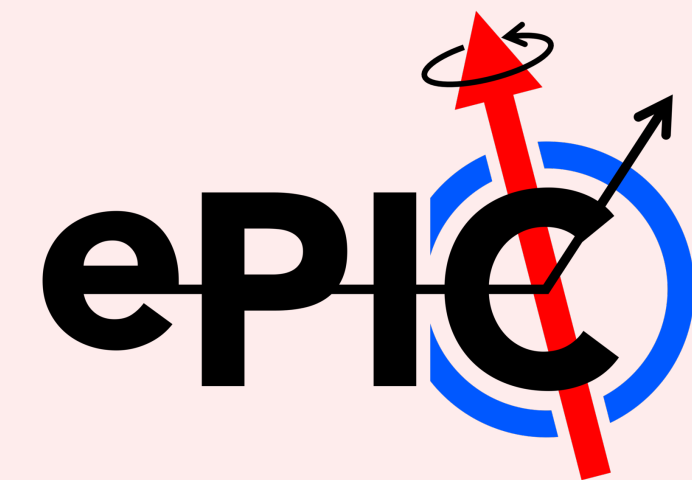
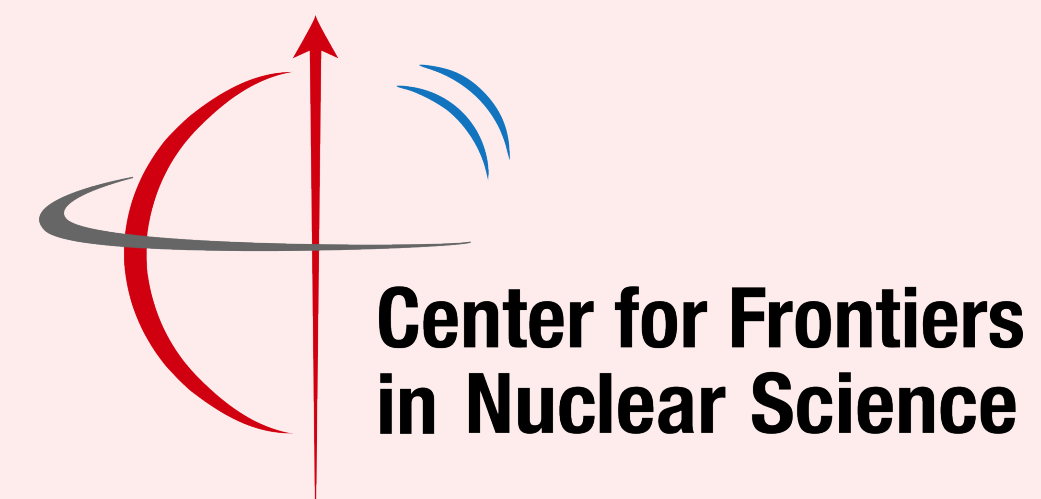
Brookhaven National Laboratory

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Stony Brook University

Joint inclusive/EW+BSM PWG Meeting

08/05/2026



PID lookup table [Link](#)



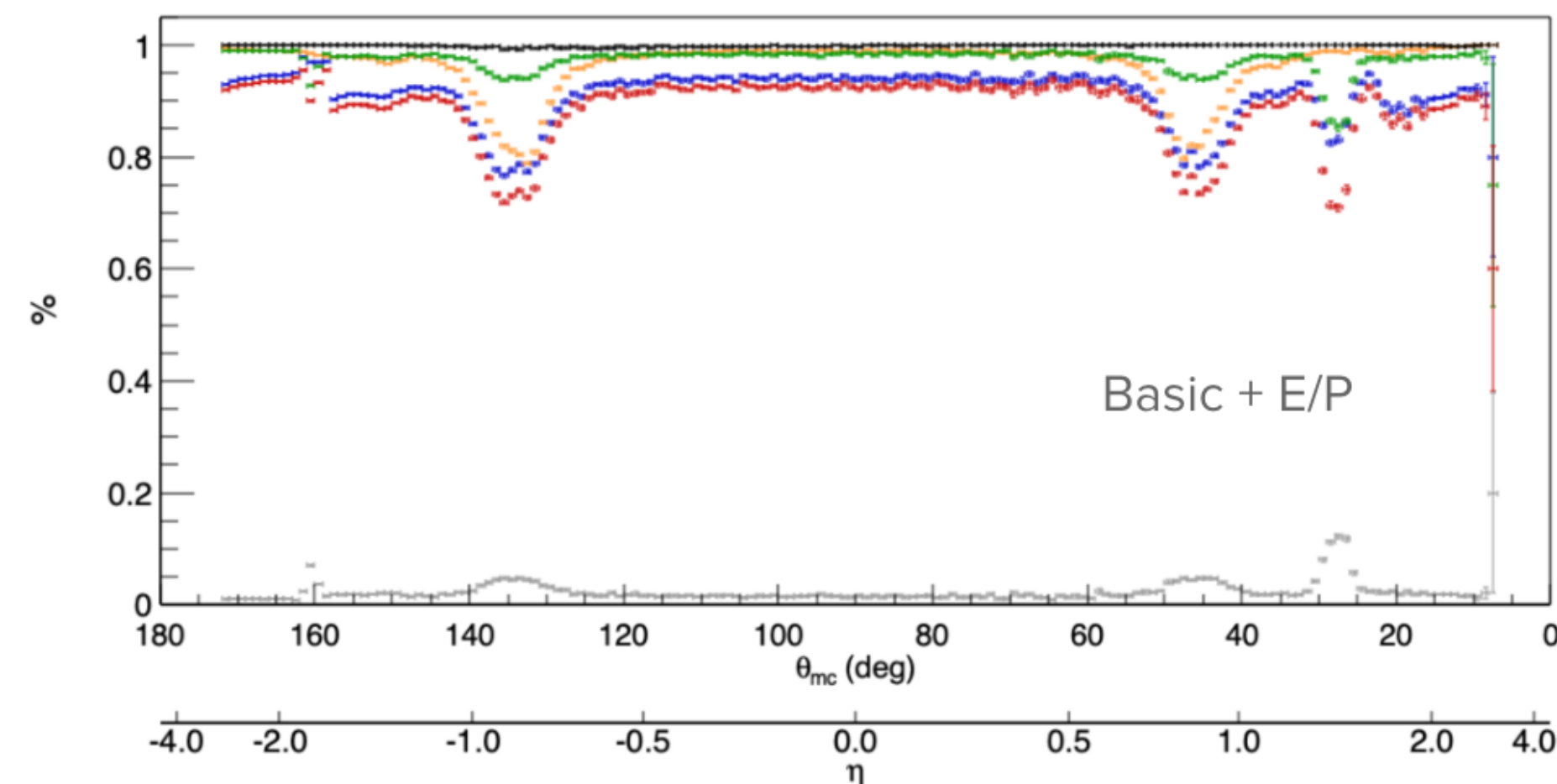
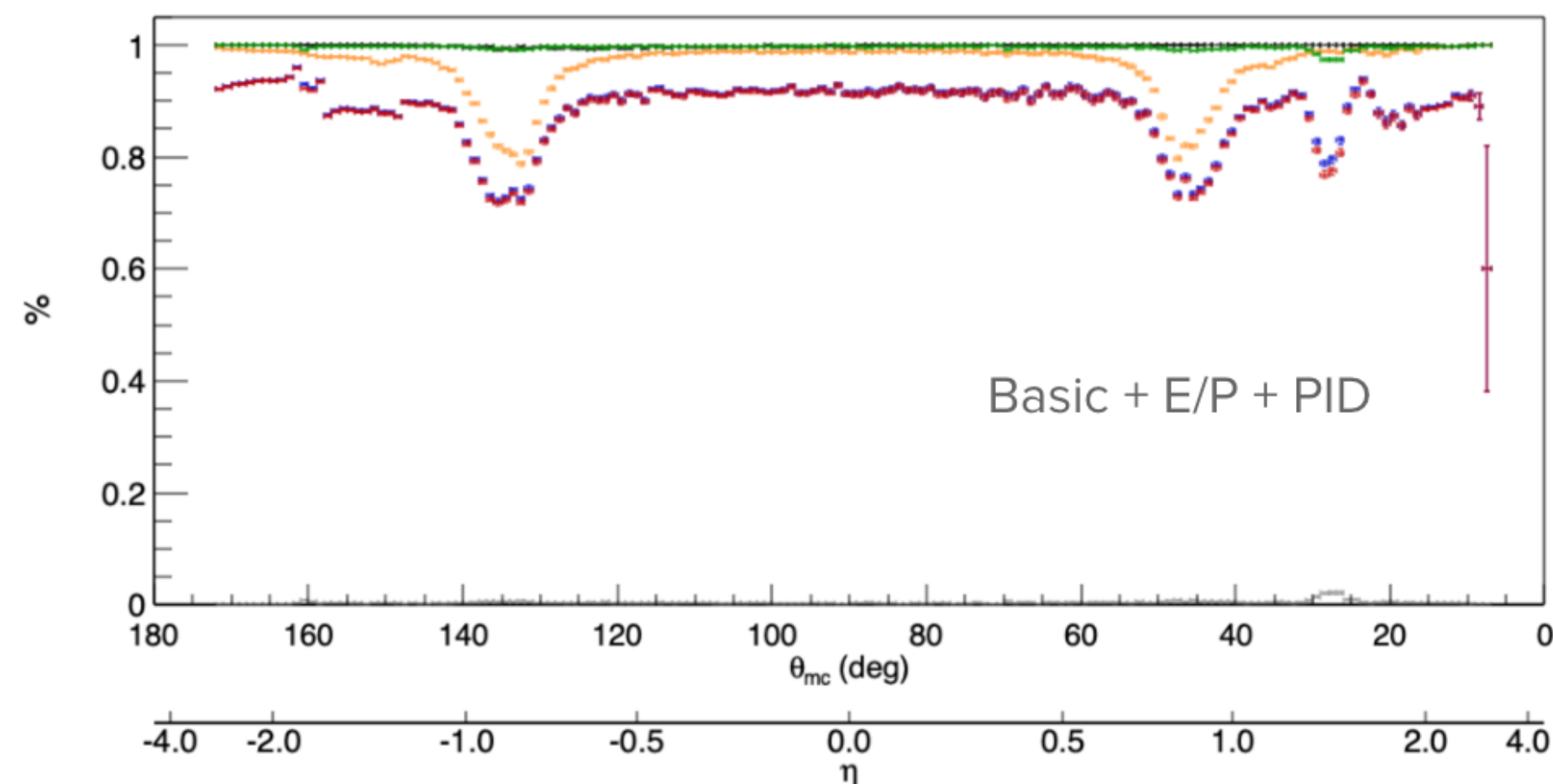
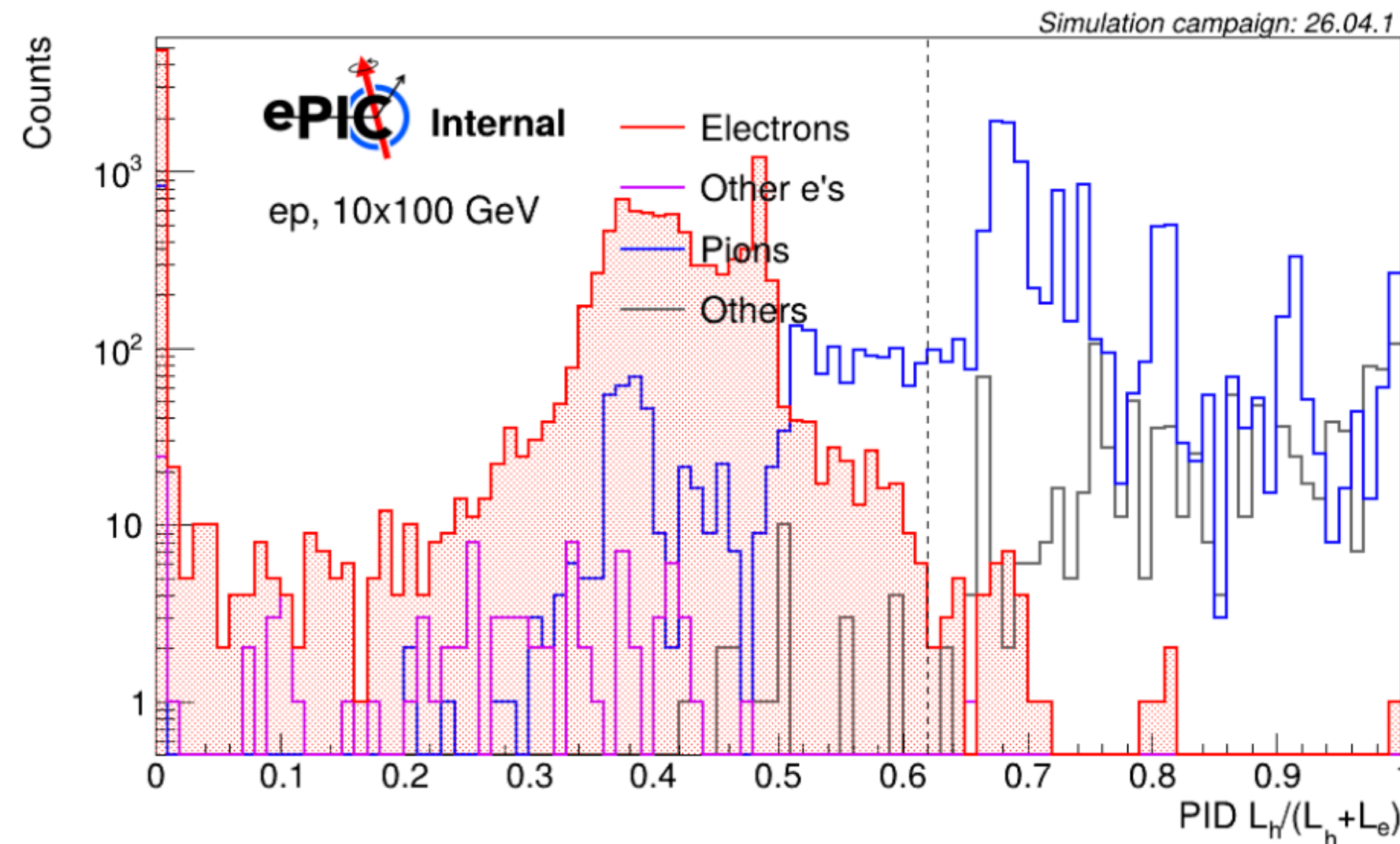
However, currently, the LUT is not returning the likelihood

L_h: Max likelihood of being h⁺

L_e: Max Likelihood of being e⁻

L = getLikelihood() from LUT

- Rate of success is low if we only consider the first prediction from PID LUT
- Calculate likelihood ratio from PID LUT accessed through “Reconstructed Particle” list
- Veto if $L_h / (L_h + L_e) > 0.62$



ePIC Work in Progress

ep, 10x100 GeV

- e track eff.
- e cluster eff.
- eID efficiency
- eID purity
- Overall eID rate
- Contamination

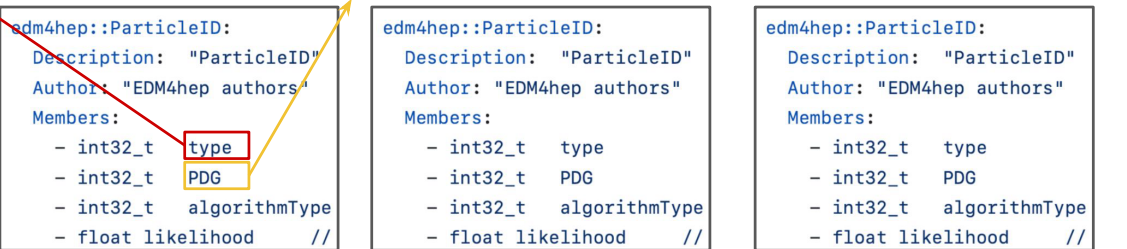
Simulation campaign: 26.04.1

- Information from PID group:

State of PID structures in our EDM

- Two implementations that rely on edm4hep::ParticleID:
 - [1] [2] PID LUTs for *pfRICH, DIRC, TOF, DRICH*: $e^\pm, \pi^\pm, K^\pm, p^\pm$
 - [3] ML on clusters for *EEEMCal*: e^-, π^-

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edm4hep::ReconstructedParticle:
  Description: "EIC Reconstructed Particle"
  Author: "W. Armstrong, S. Joosten, F. Gaede"
  Members:
    - int32_t      PDG          // PDG code for this particle
    // ... Definitions for energy, momentum, mass, ...
    - float        goodnessOfPID // overall goodness of the PID on a scale of [0;1]
  OneToOneRelations:
    // ...
    - edm4hep::ParticleID particleIDUsed // particle ID used for the kinematics of this particle
  OneToManyRelations:
    // ... Definitions for relations to other clusters, track, particles ...
    - edm4hep::ParticleID particleIDs    // All associated particle IDs for this particle (not yet
```



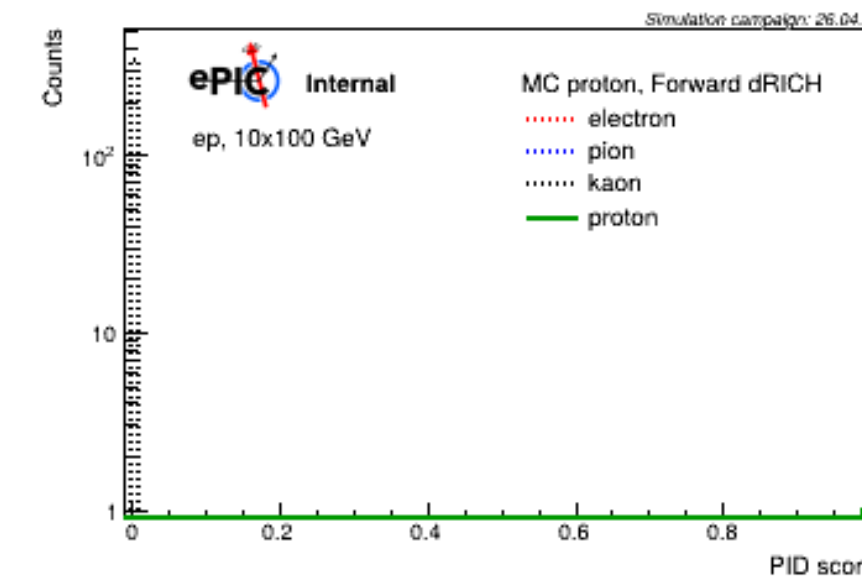
- EDM4hep insists on inverting the relation, i.e. ParticleID points to ReconstructedParticle [4] [5]
- The ML method currently “misuses” the **likelihood field** and **provide posterior P(hypot|meas)** instead of the **likelihood P(meas|hypot)**
- The LUTs also “misuse”, providing **distribution of model outputs conditioned by true class P(prediction|hypot)**. Main charge for LUTs was to fill the PDG field, reproducing a realistic misclassification distribution.

Likelihood: $L_\alpha^d = P(x_d | \alpha)$

- Assuming the particle is α , how likely is detector d to produce the observed measurement x_d
- L_α^d can be combined to global likelihood and can be used to convert to PID probabilities $P(\alpha | x)$

For particle α , how likely is the algorithm to predict it as $\alpha, \beta, \gamma \dots$

- The current $L_h / (L_e + L_h)$ fraction should be interpreted as a empirical score



A 3D cutaway diagram of the LHCb detector. The diagram shows the internal structure, including the central tracking region with the AC-LGAD TOF and Proximity-focused RICH, surrounded by calorimeters (Backward, Forward, and Endcap Electromagnetic, and Dual-radiator RICH). The detector is housed in a large, cylindrical structure. Labels point to various components: Imaging Barrel EM Calorimeter, Electron Direction Tracking, 1.7T Superconducting Solenoid, AC-LGAD TOF, Forward Calorimetry (EM and Hadronic), Dual-radiator RICH, Hadron Direction Tracking, Barrel Hadronic Calorimeter, Electrons (indicated by a blue arrow), Hadrons (indicated by a yellow arrow), Proximity-focused RICH, Endcap Electromagnetic Calorimeter, High-performance DIRC, Backward Calorimetry, and Electron Direction Tracking.

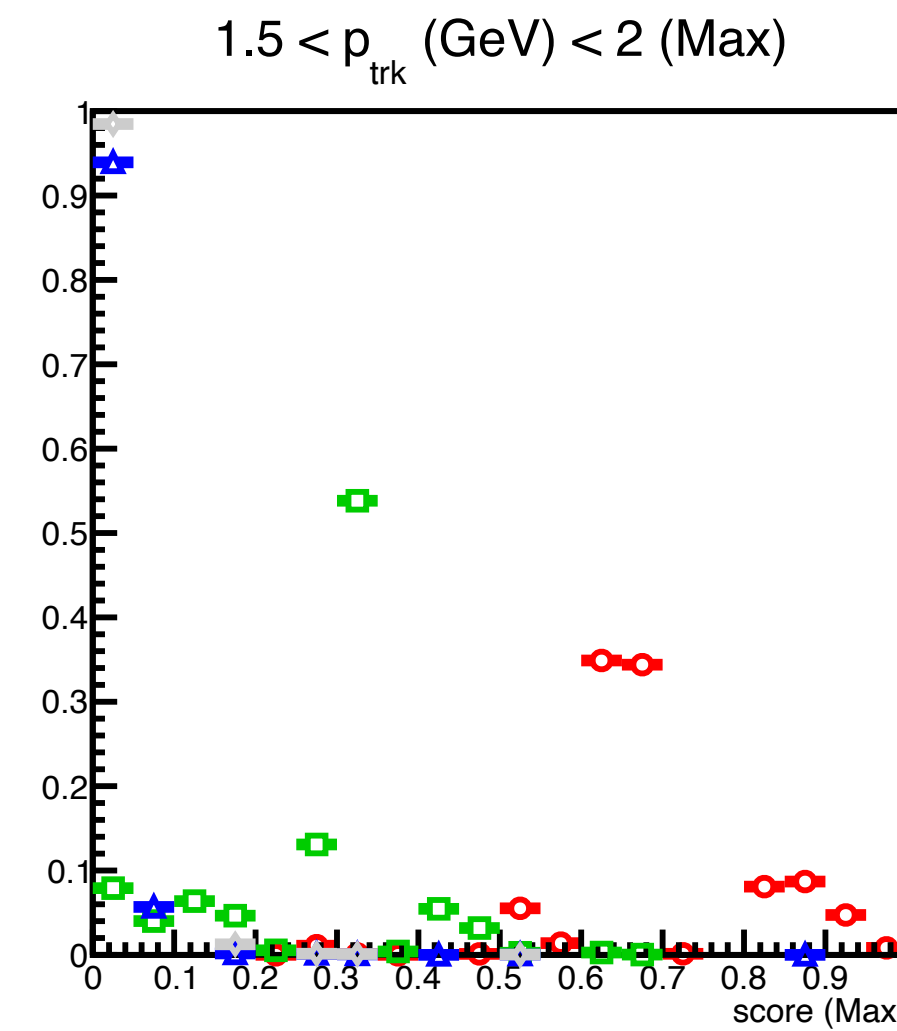
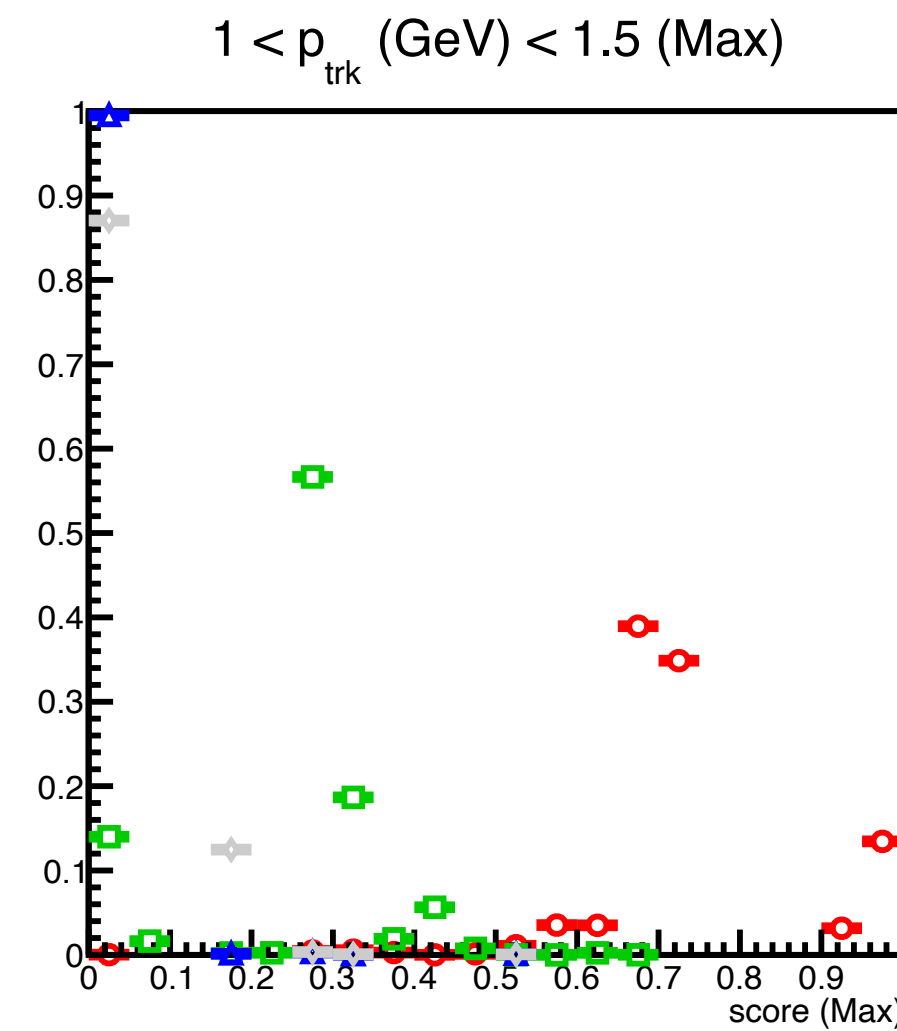
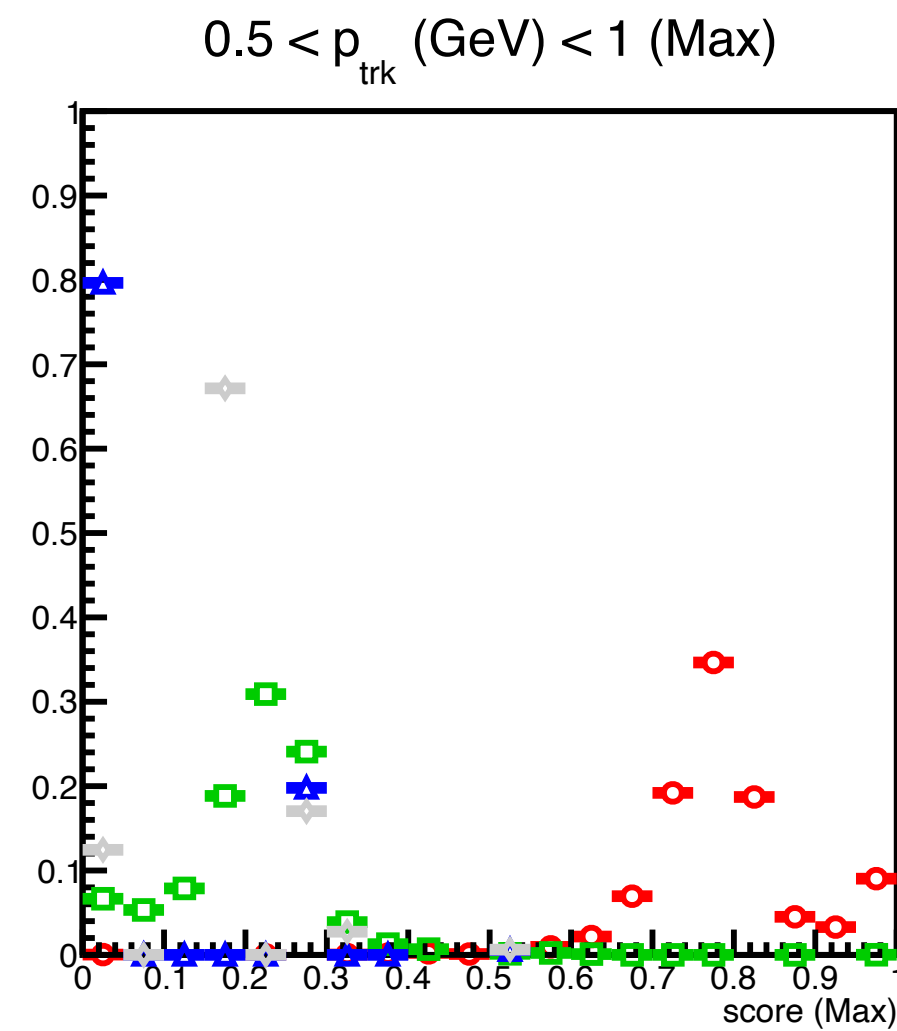
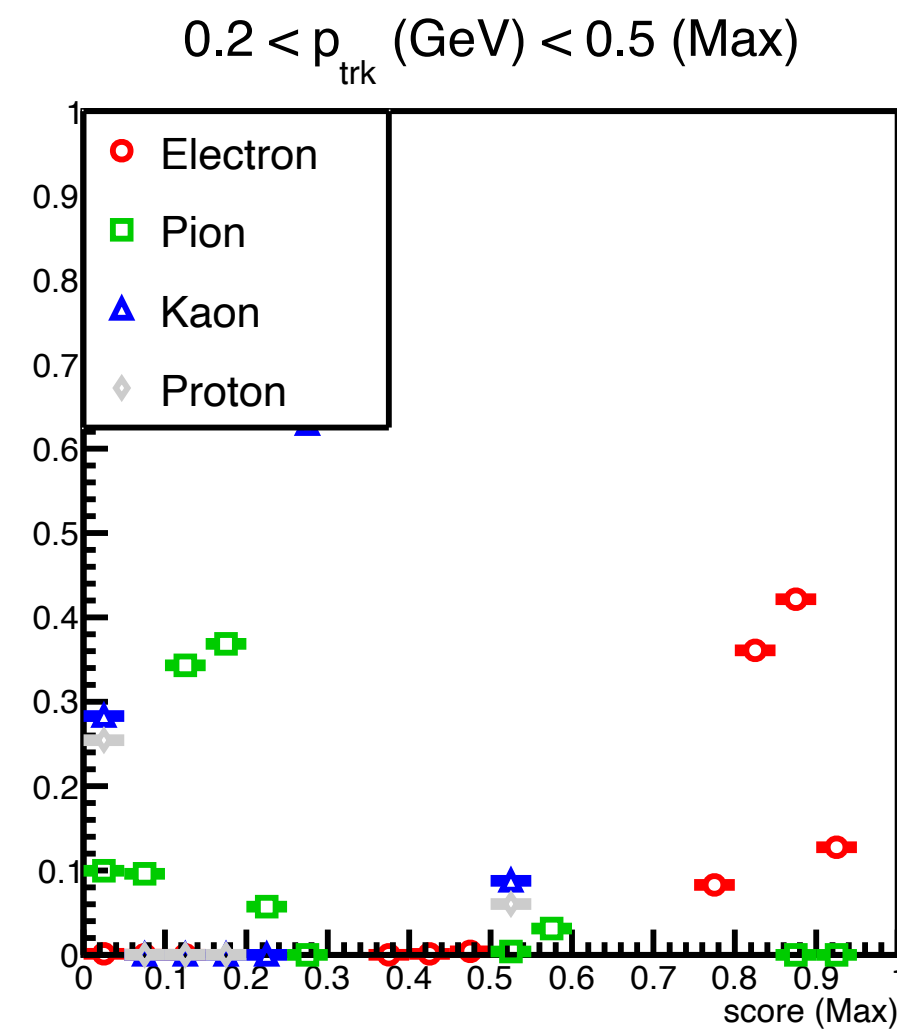
Apply individual VETO cuts for each detector?

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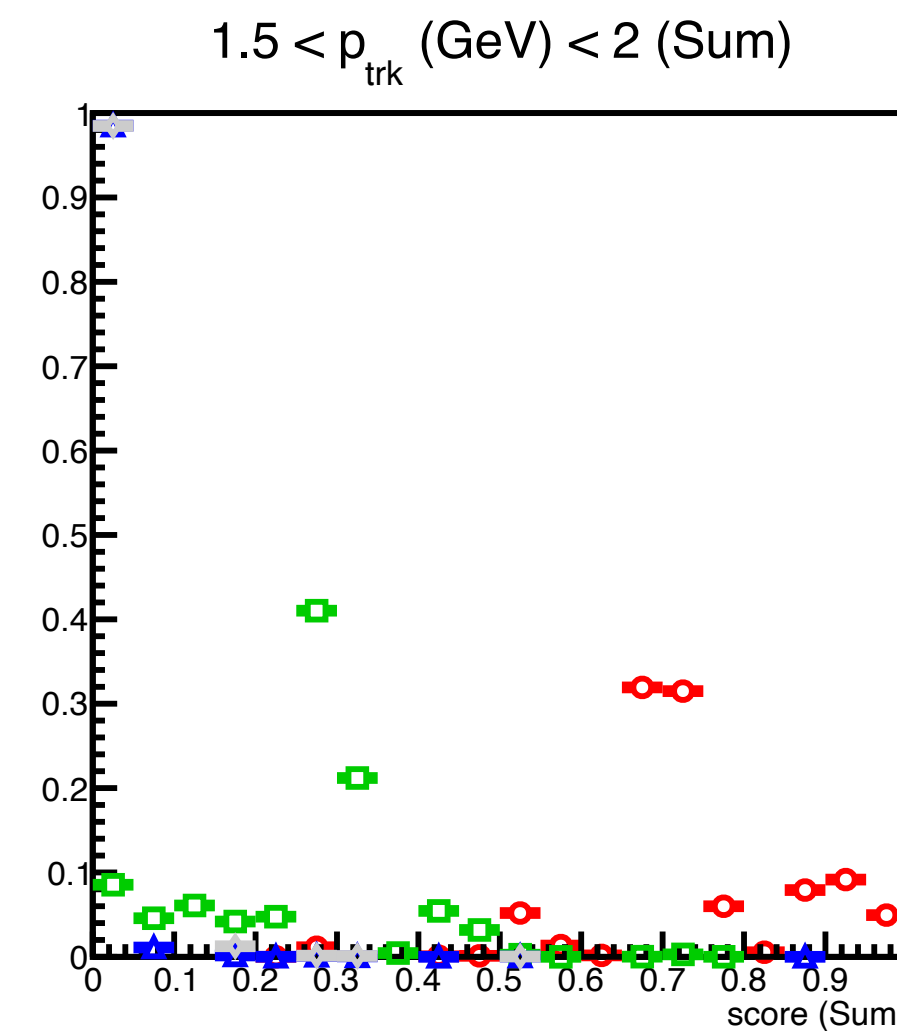
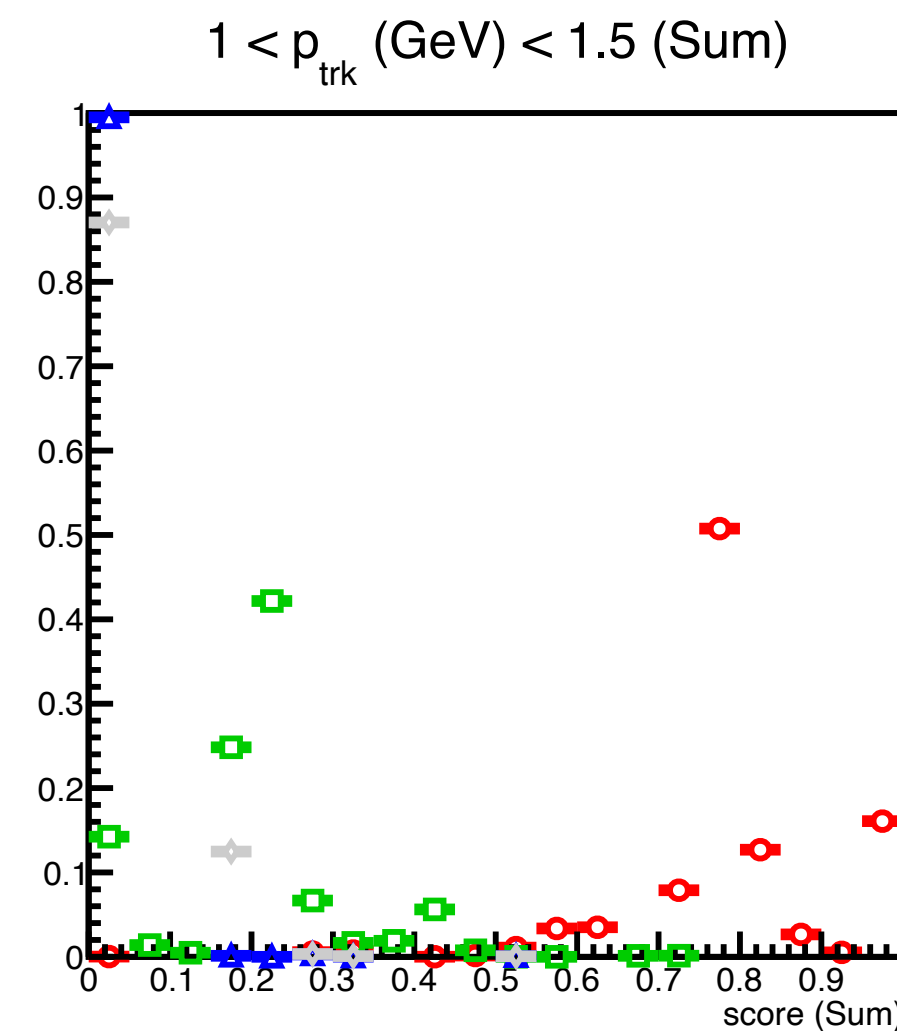
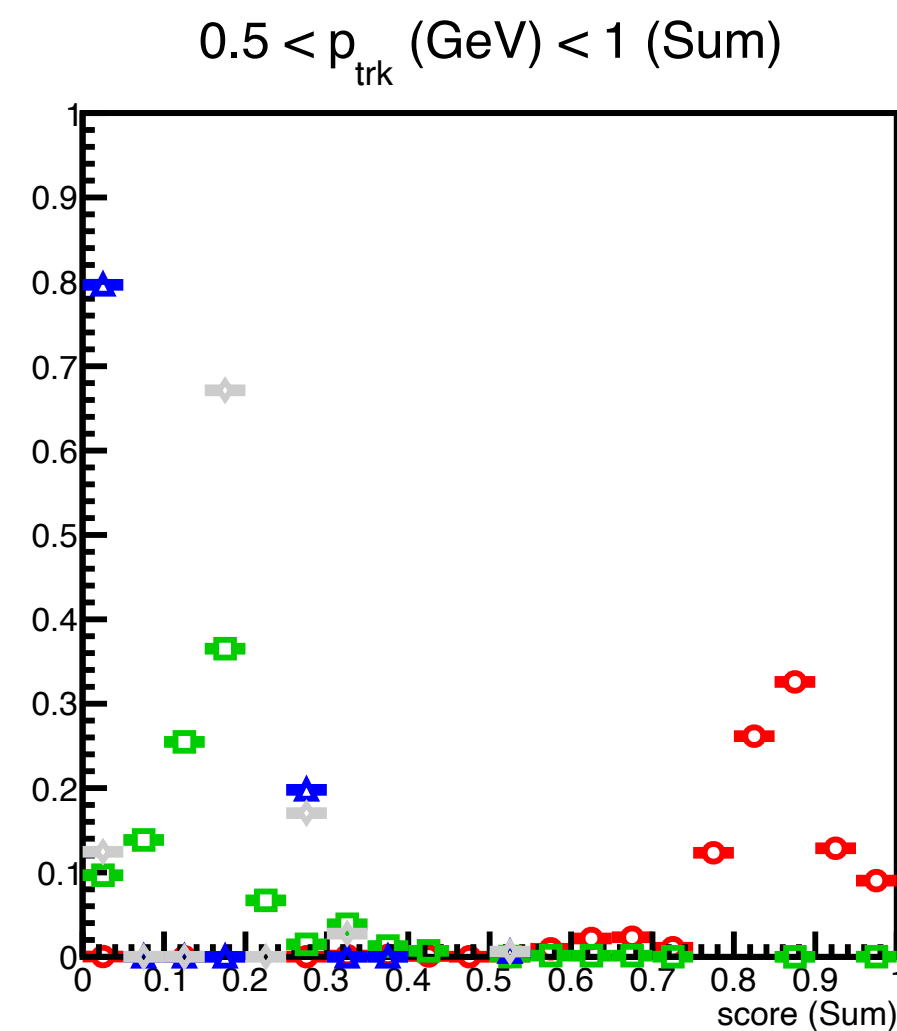
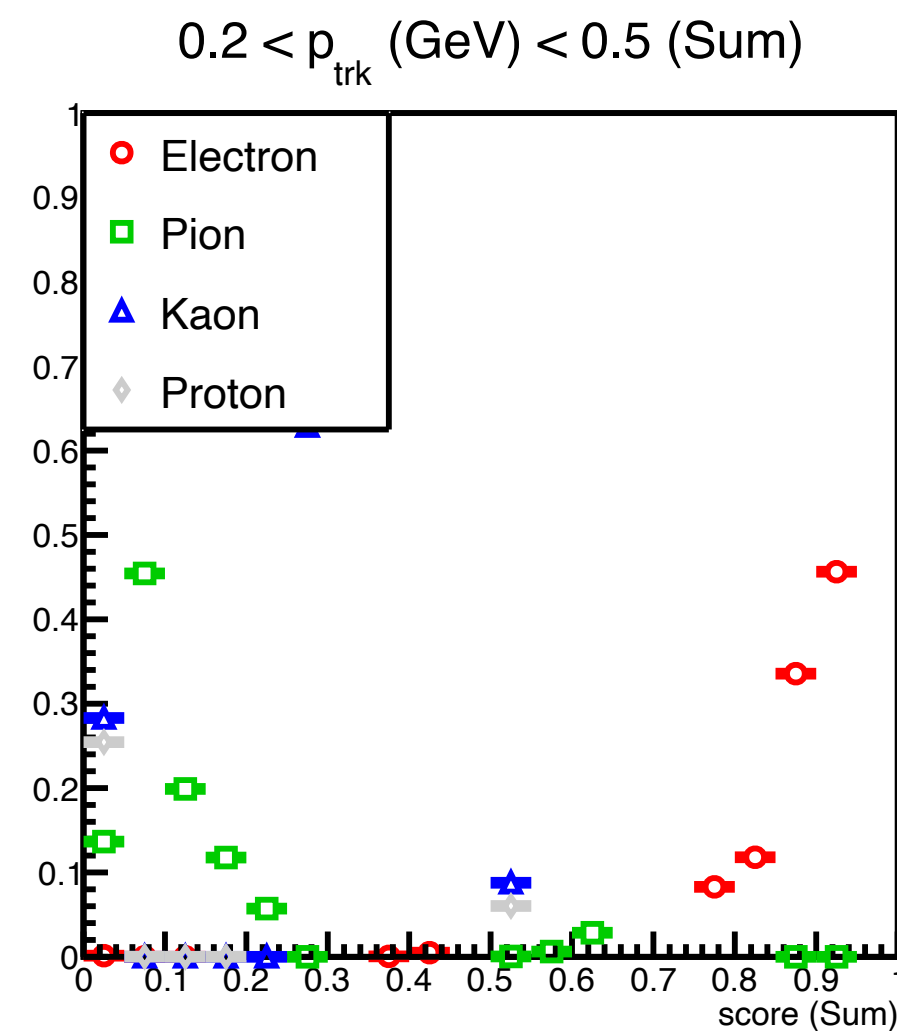
Barrel tracks

Figure by Jae N. (BNL)

$$L_e = \frac{L_e}{L_e + L_h}$$



$$L_h = \text{Max}(L_\pi, L_K, L_P)$$



$$L_h = L_\pi + L_K + L_P$$

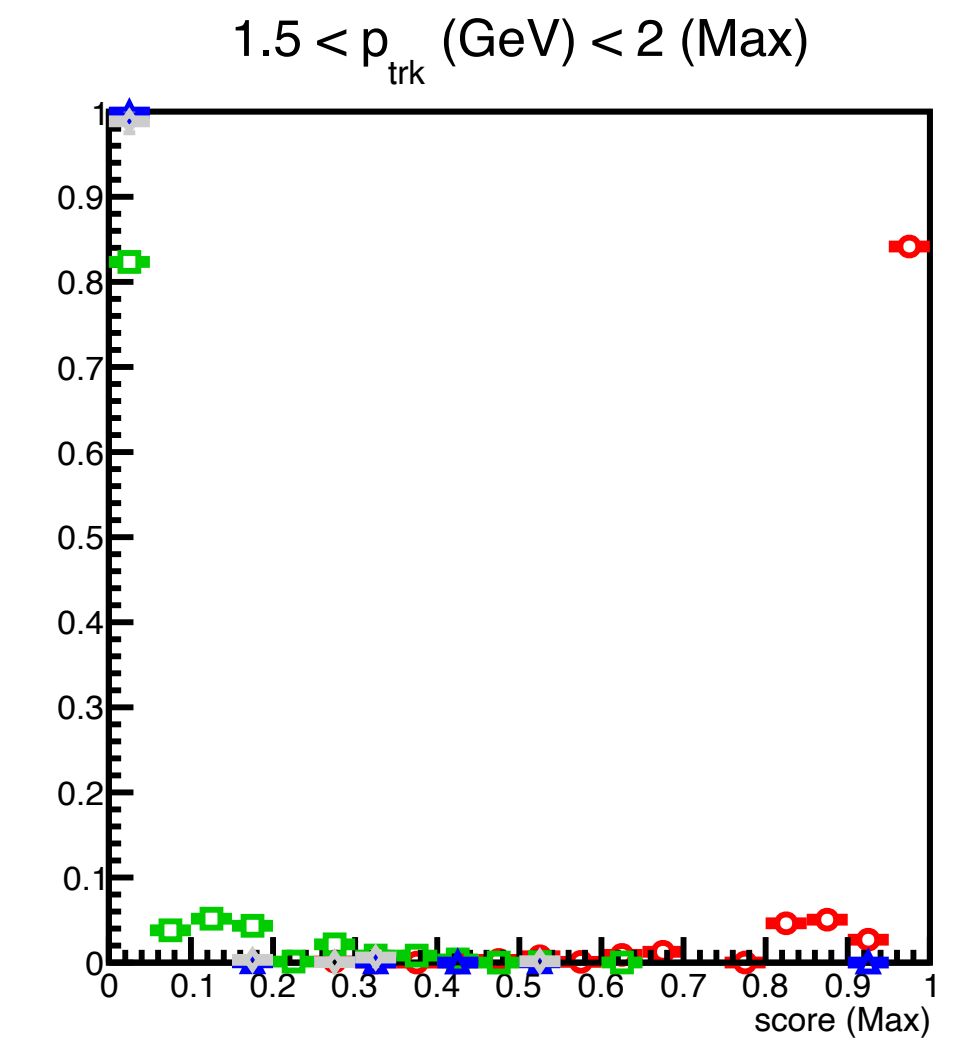
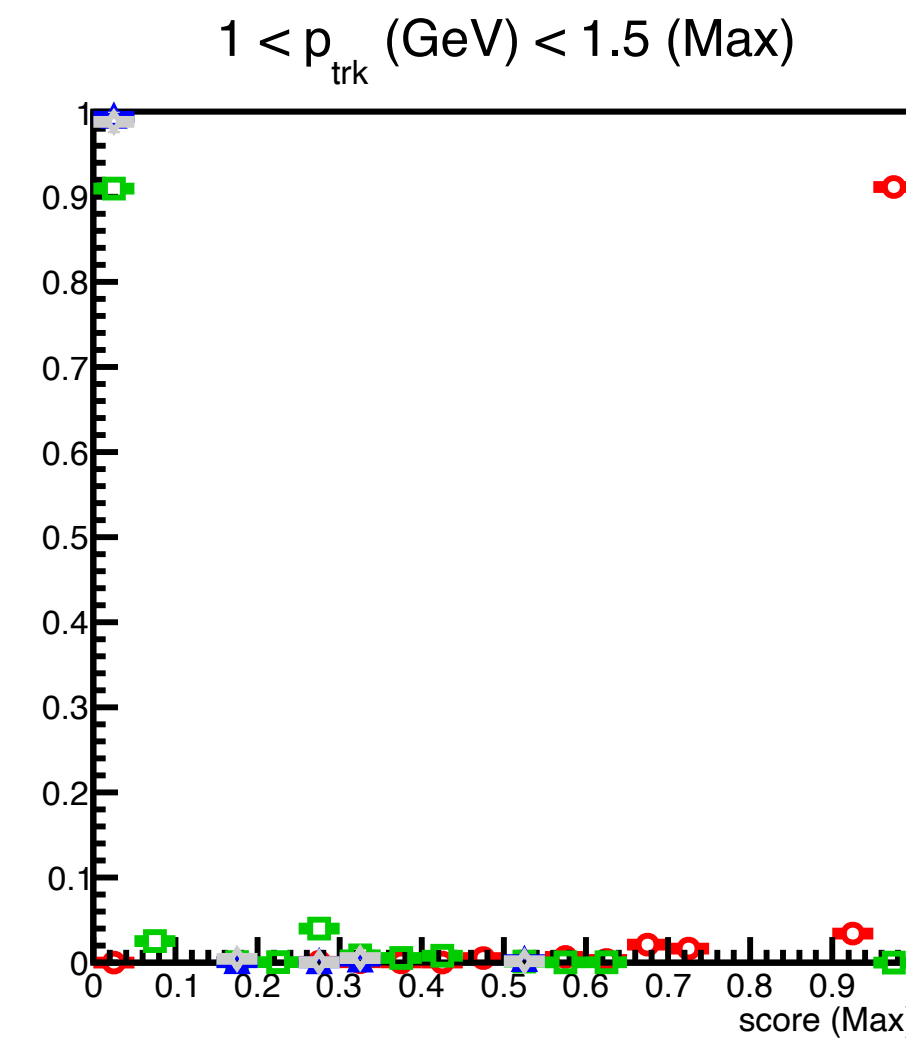
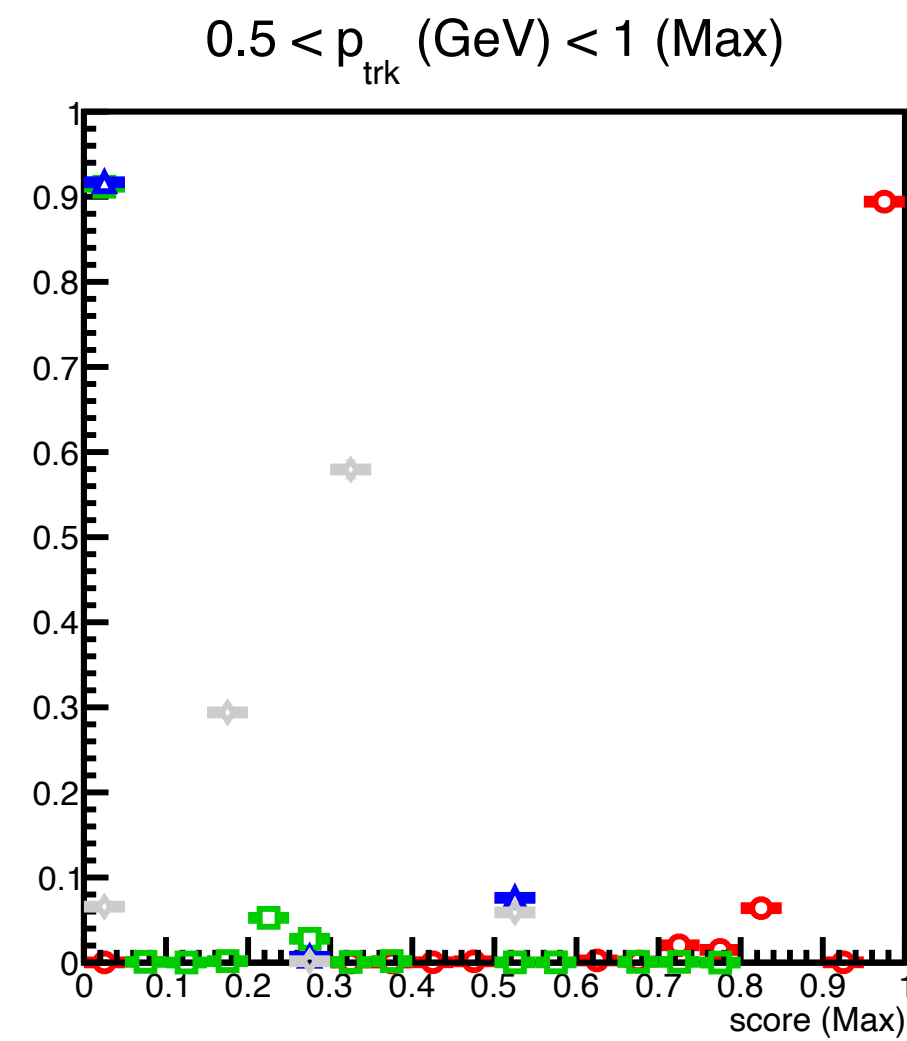
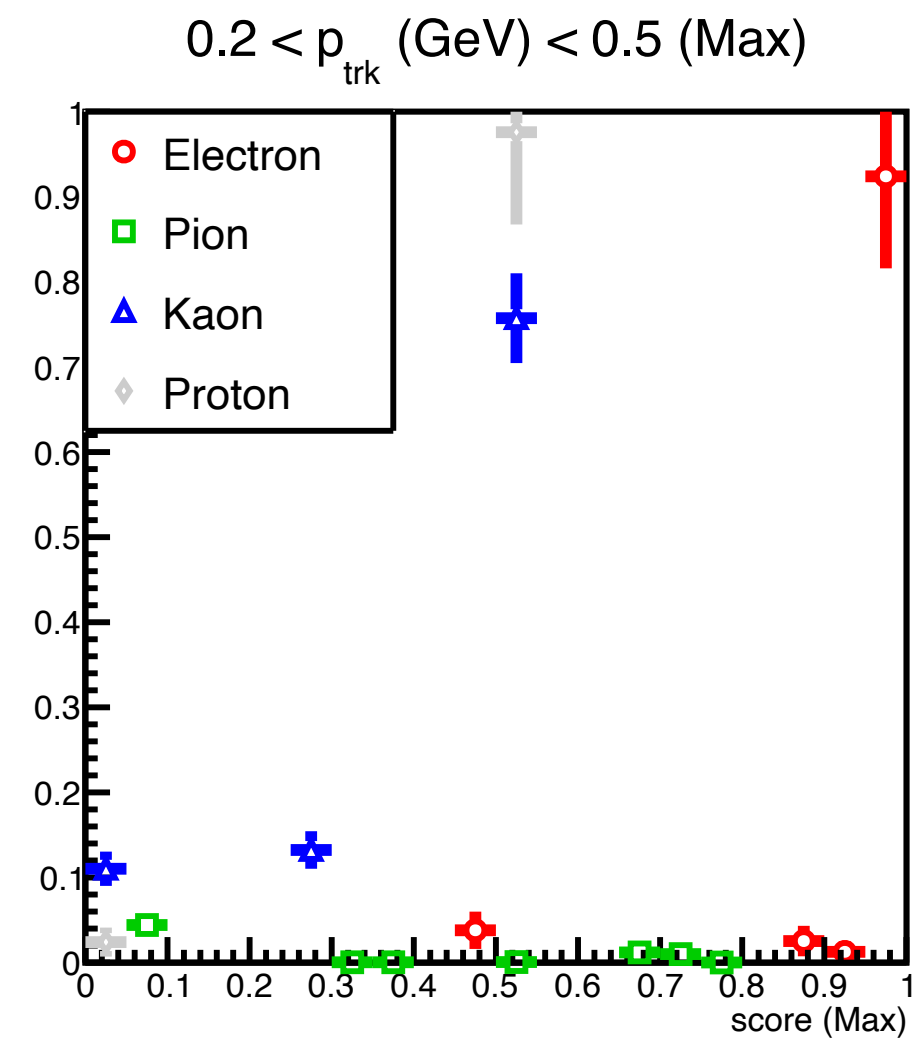
Apply individual VETO cuts for each detector?

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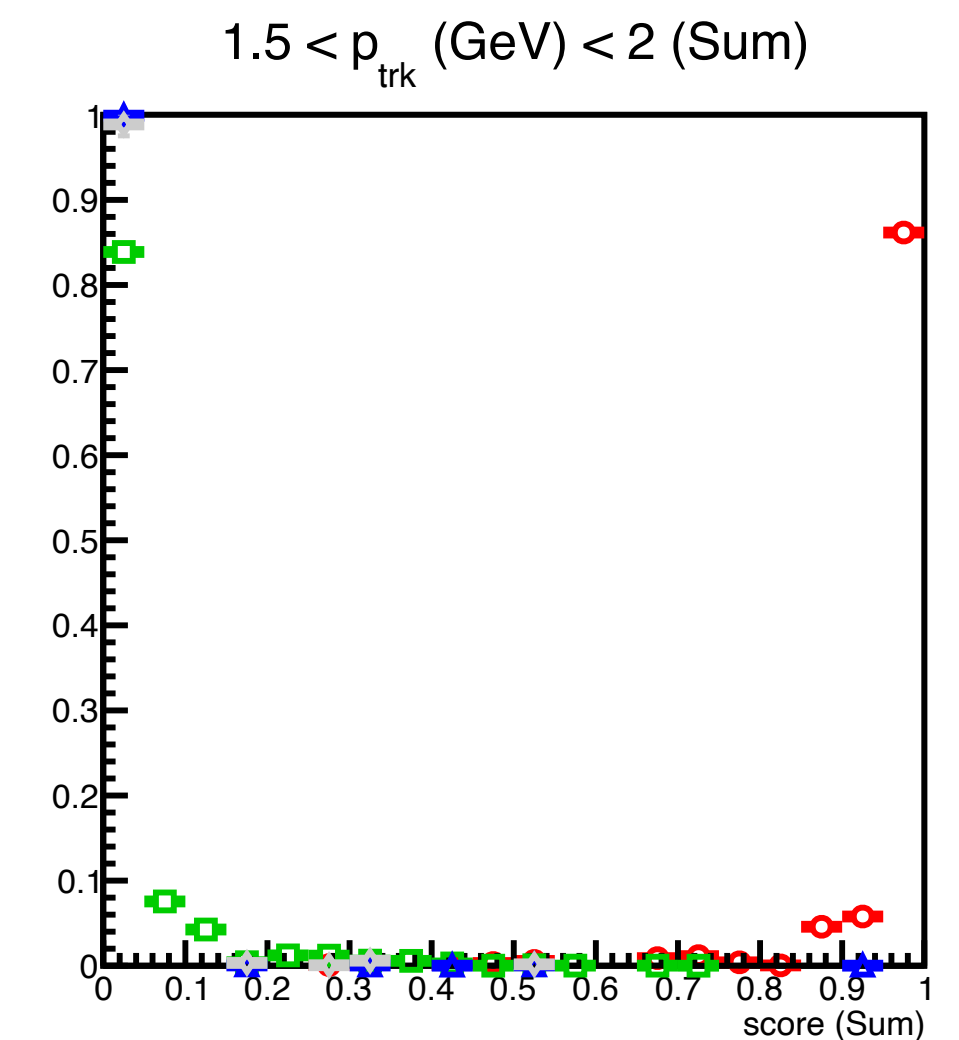
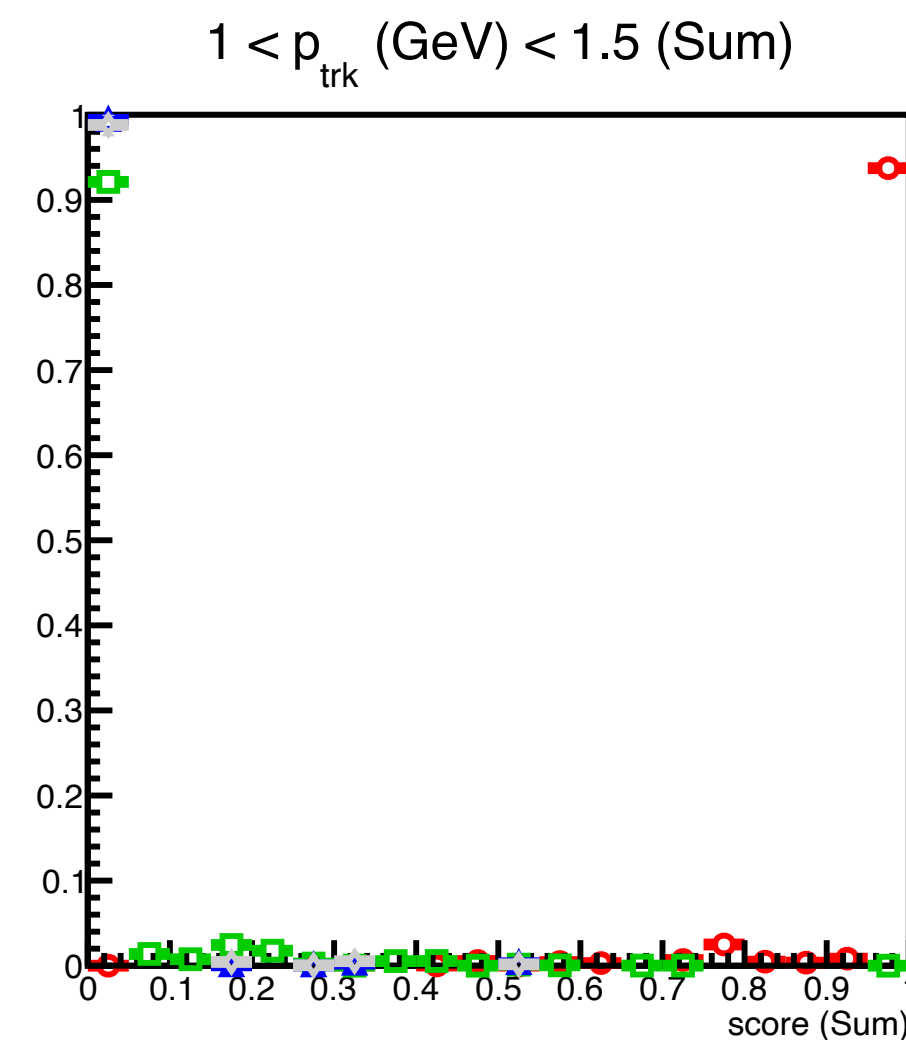
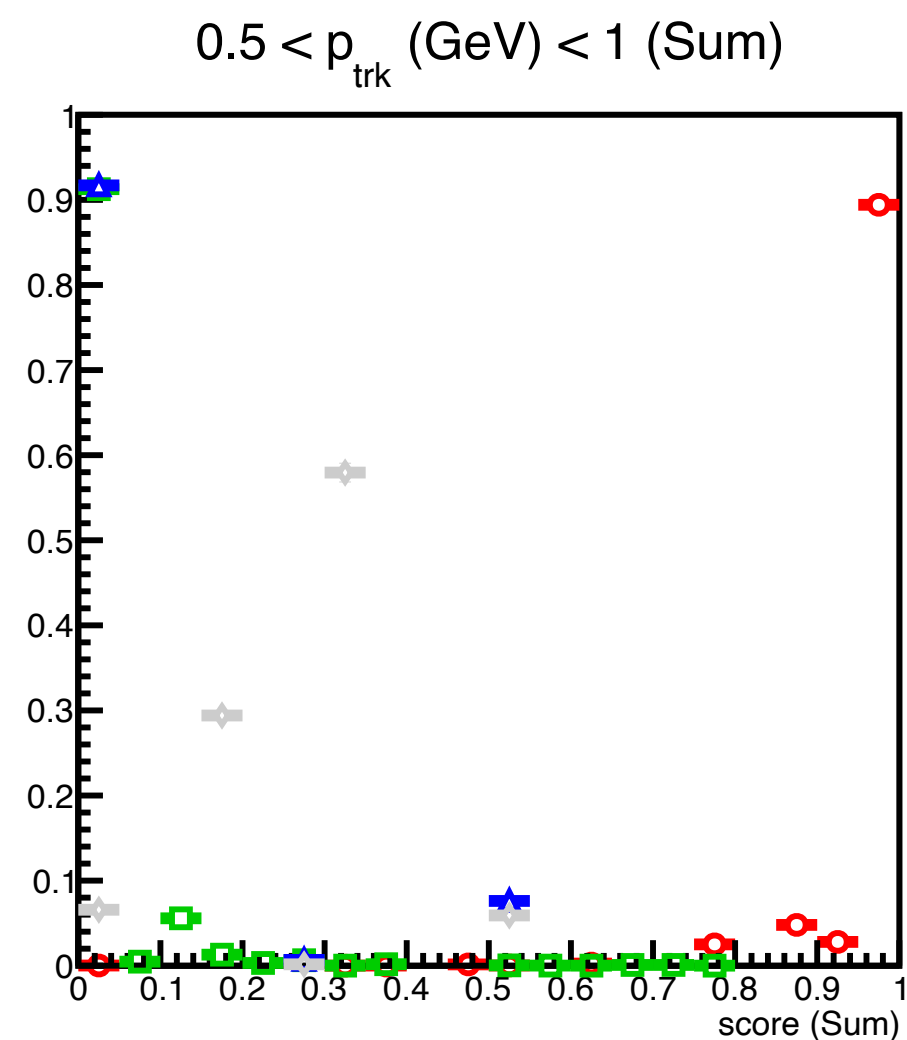
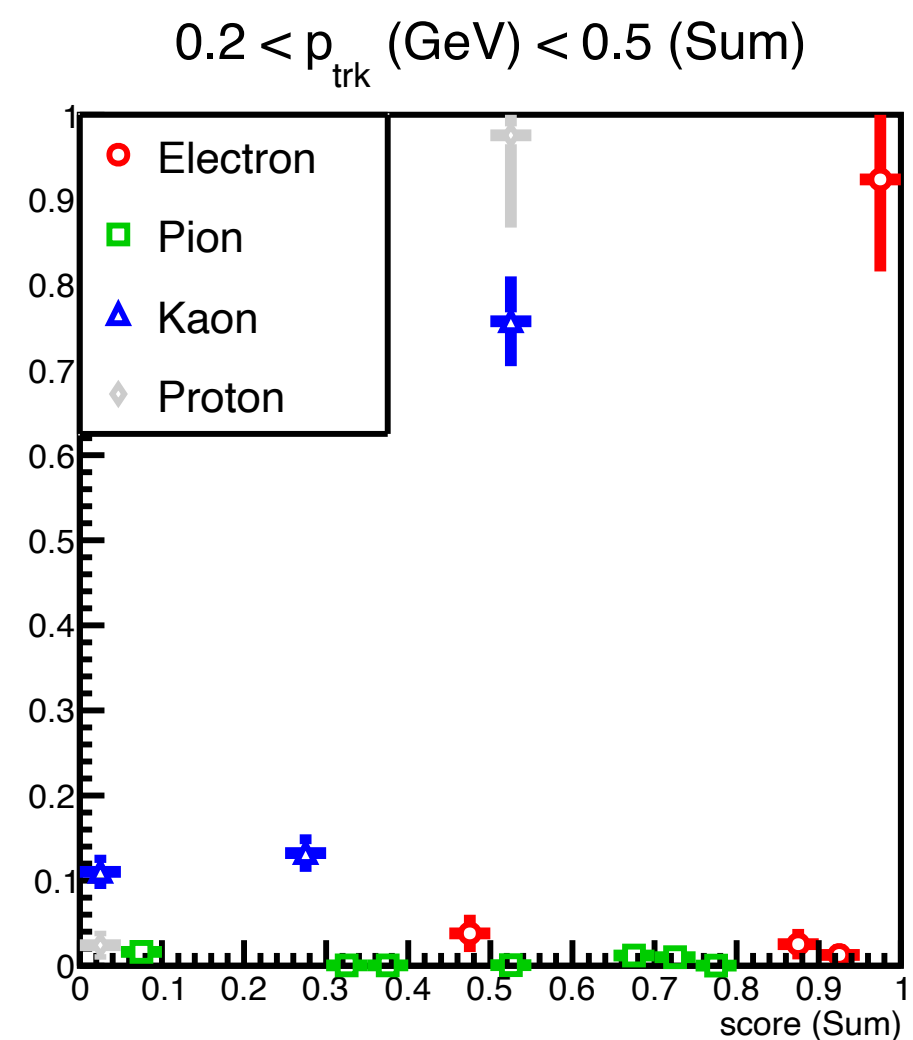
N-Endcap tracks

Figure by Jae N. (BNL)

$$L_e = \frac{L_e}{L_e + L_h}$$



$$L_h = \text{Max}(L_\pi, L_K, L_P)$$



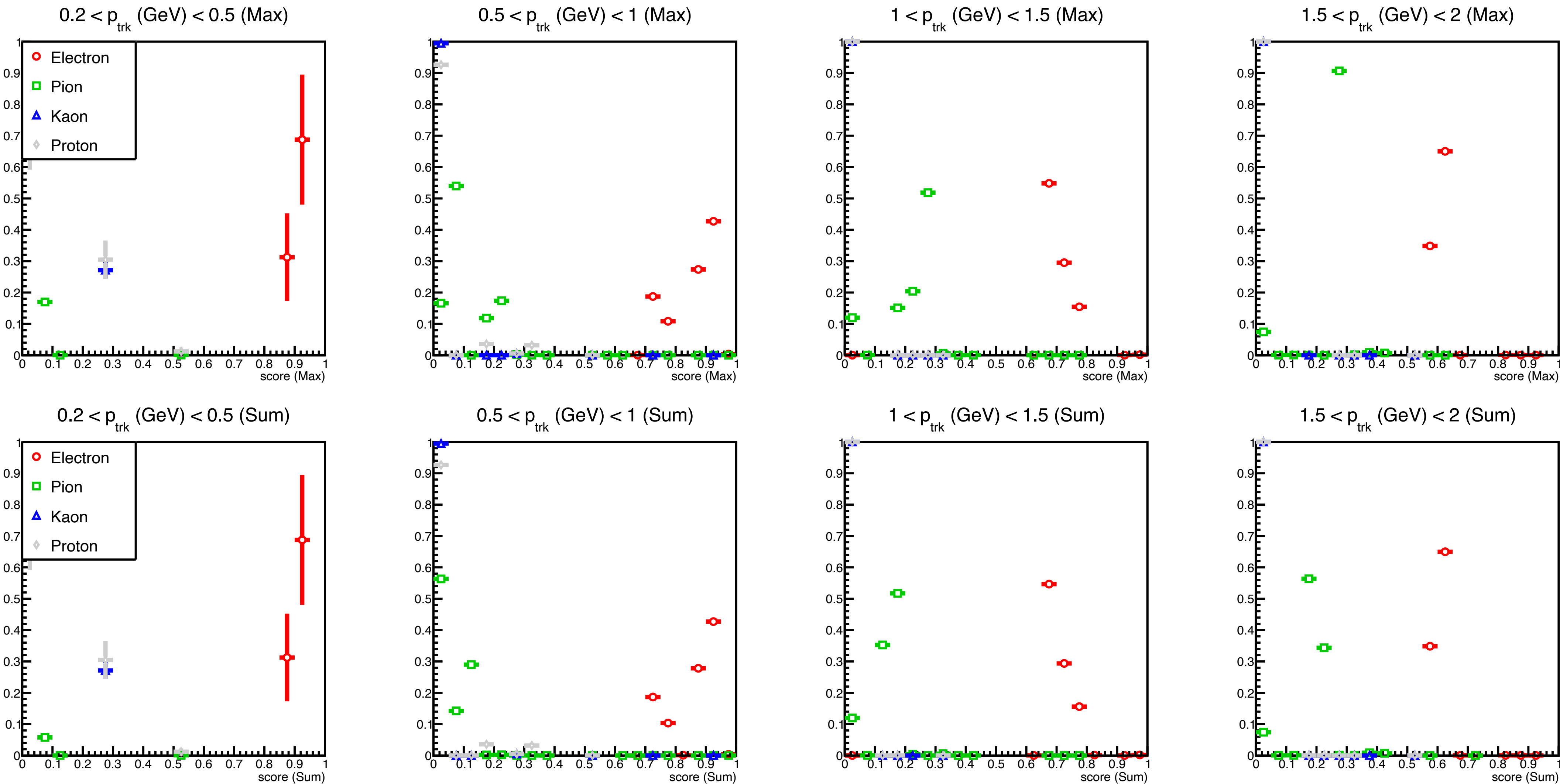
$$L_h = L_\pi + L_K + L_P$$

Apply individual VETO cuts for each detector?

P-Endcap

Figure by Jae N. (BNL)

$$L_e = \frac{L_e}{L_e + L_h}$$



$L_h = \text{Max}(L_\pi, L_K, L_P)$

$L_h = L_\pi + L_K + L_P$