eID with PID discussion II

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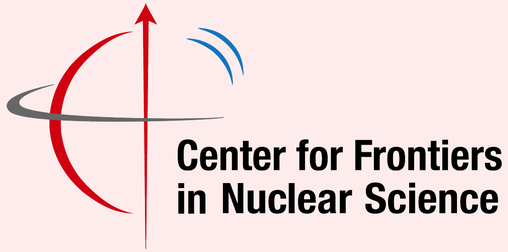
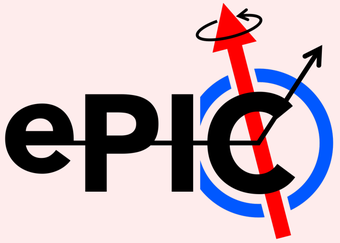
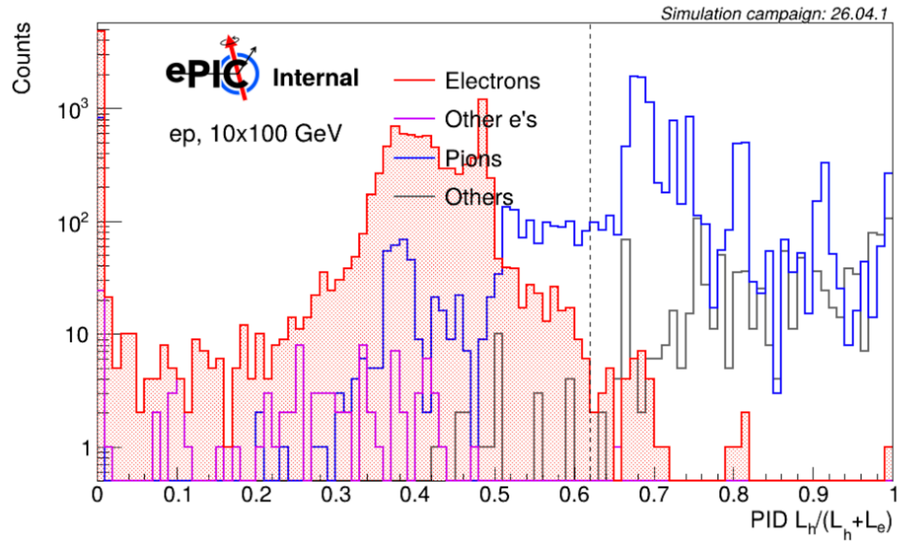




In the last discussion:

PID lookup table **Link**



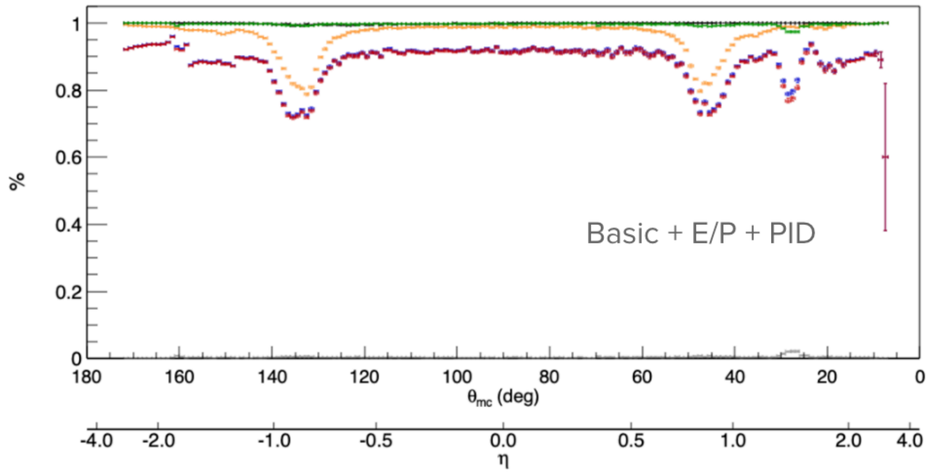
However, currently, the LUT is not returning the likelihood

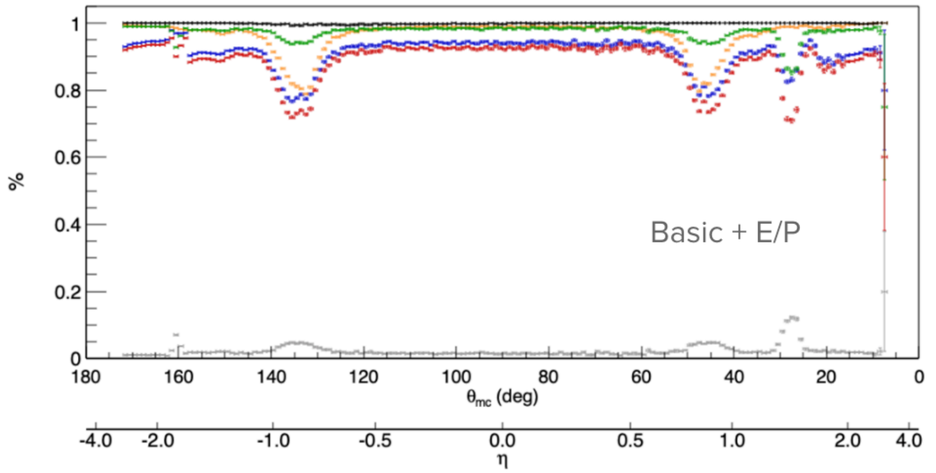
Lh: Max likelihood of being h+

Le: 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 $L_h / (L_h+L_e) > 0.62$



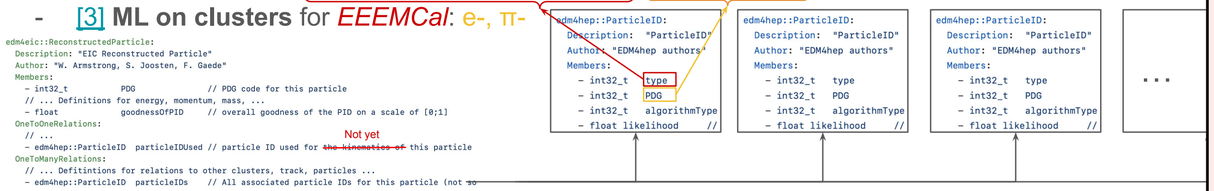


What is “getLikelihood()” in current PID LUTs?

- 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±, π±, K±, p±
  - [3] **ML on clusters** for *EEEMCal*: e-, π-



  - 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.

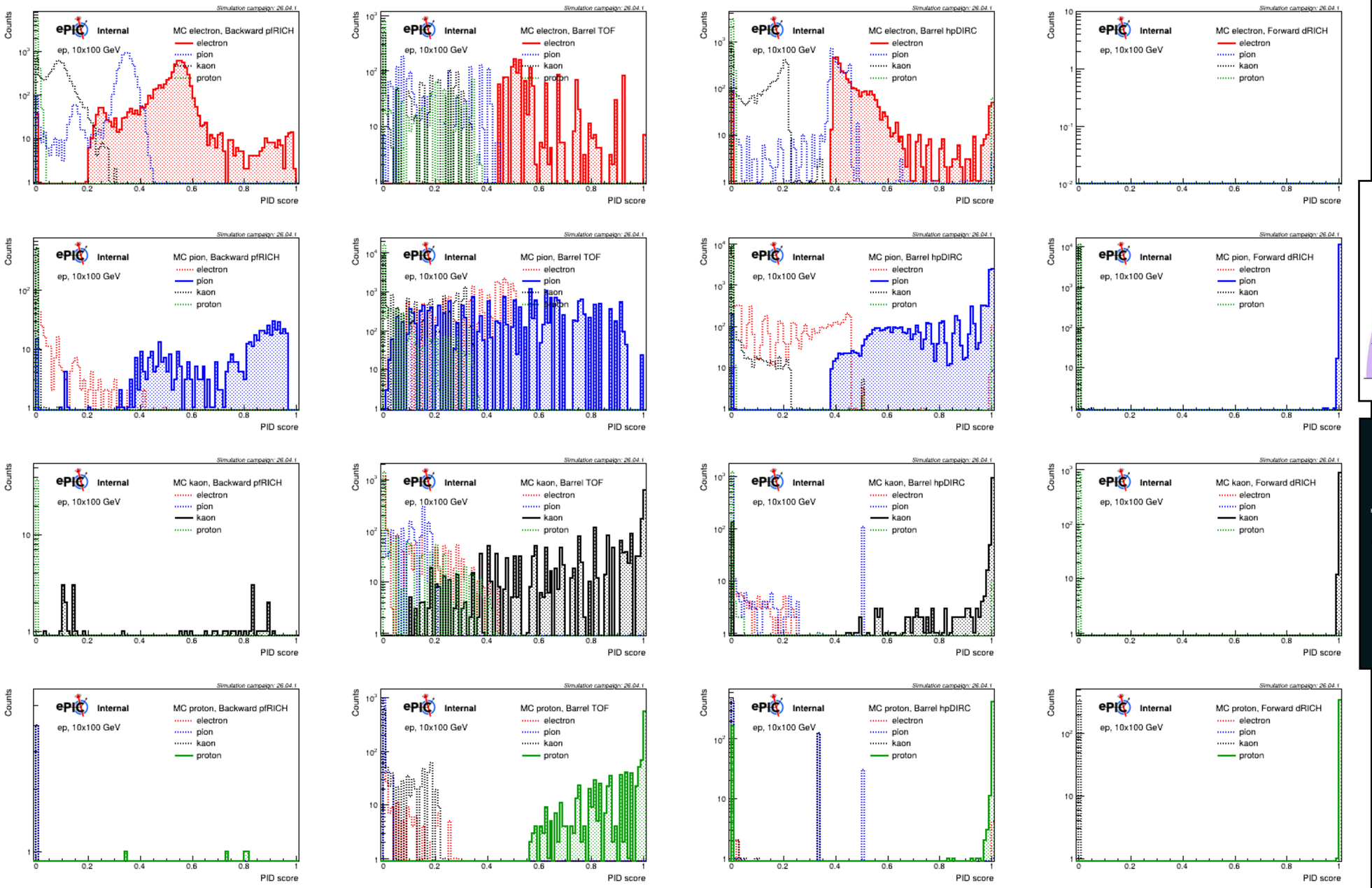
Likelihood: $L_\alpha^d = P(x_d \mid \alpha)$

- 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 $P(\alpha \mid x)$

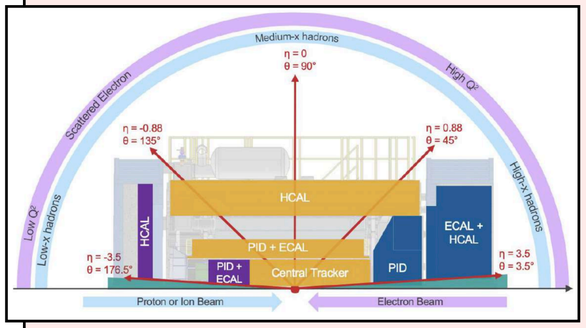
→ For particle α, how likely is the algorithm to predict it as α, β, γ …

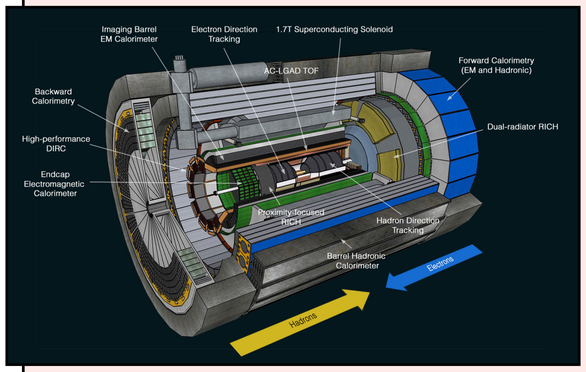
- The current $L_h/(L_e + L_h)$ fraction should be interpreted as a empirical score

Distribution in each PID detector



PID score = getLikelihood()



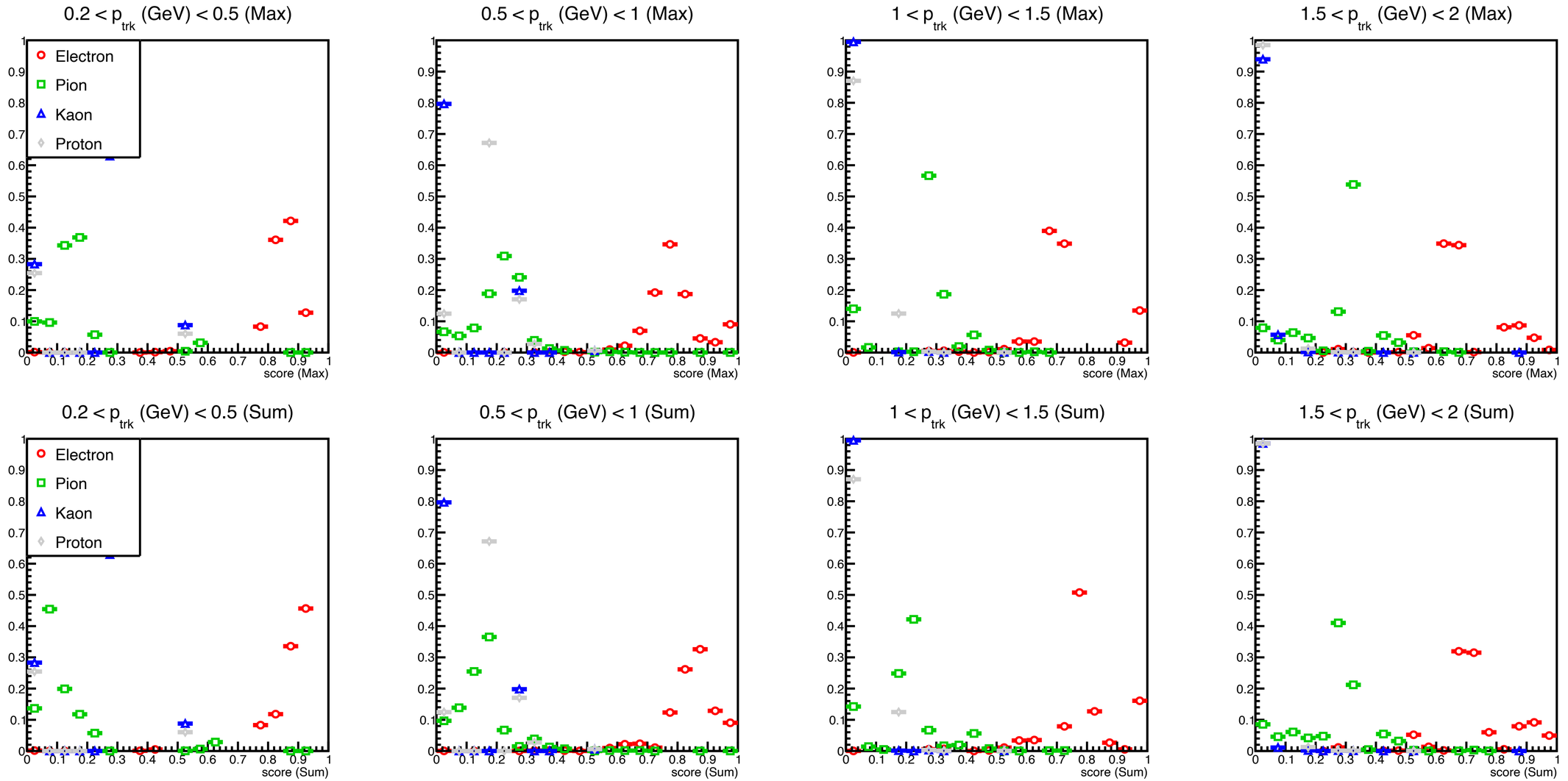


Apply individual VETO cuts for each detector?

Barrel tracks

Figure by Jae N. (BNL)

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



$$L_h = \mathrm{Max}(\mathrm{L}_\pi, \mathrm{L}_\mathrm{K}, \mathrm{L}_\mathrm{P})$$

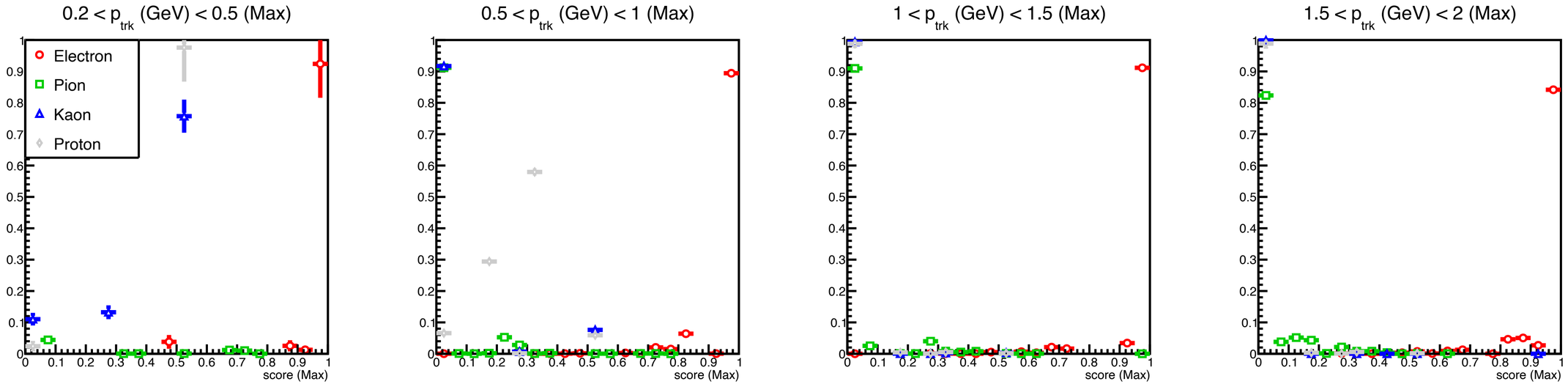
$$L_h = L_\pi + L_K + L_P$$

Apply individual VETO cuts for each detector?

N-Endcap tracks

Figure by Jae N. (BNL)

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



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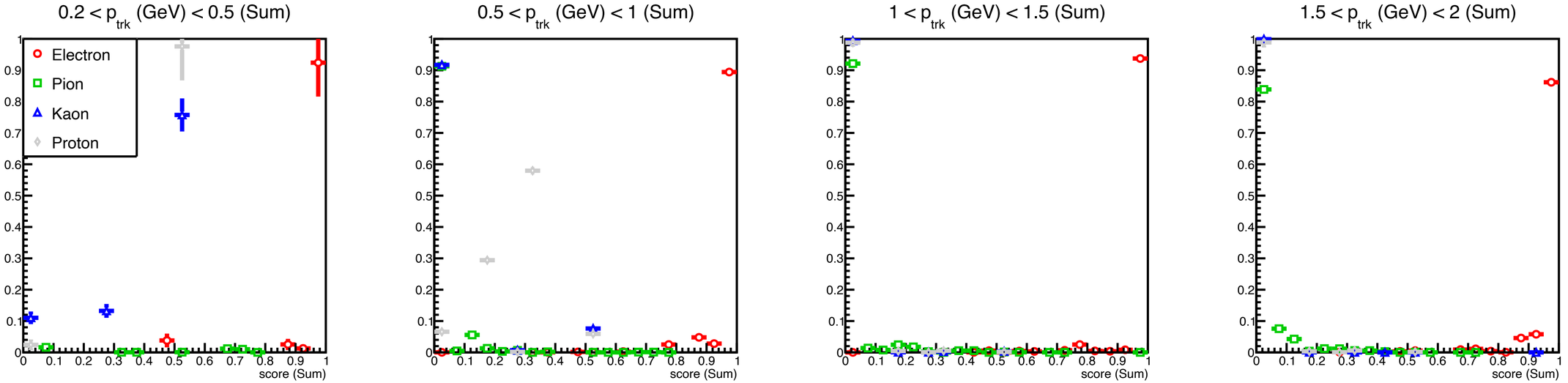


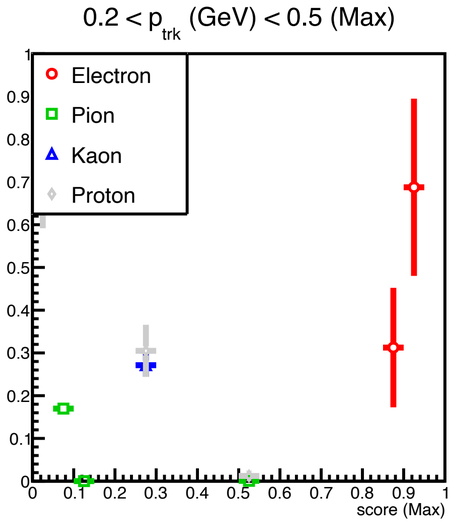
$$L_h = L_\pi + L_K + L_P$$

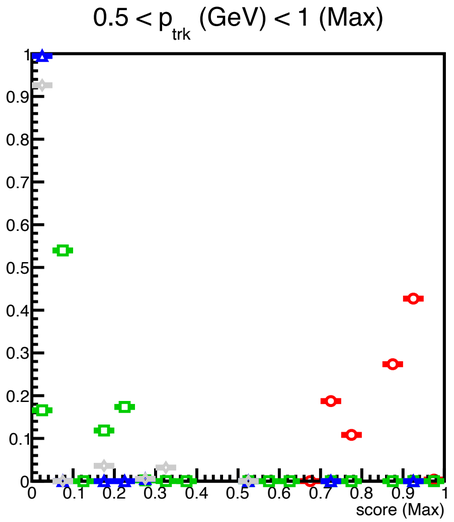
Apply individual VETO cuts for each detector?

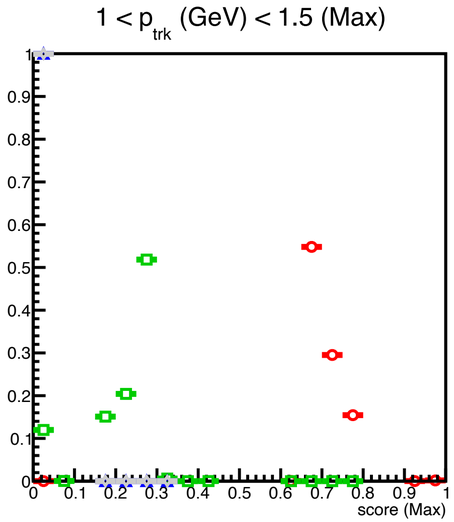
P-Endcap

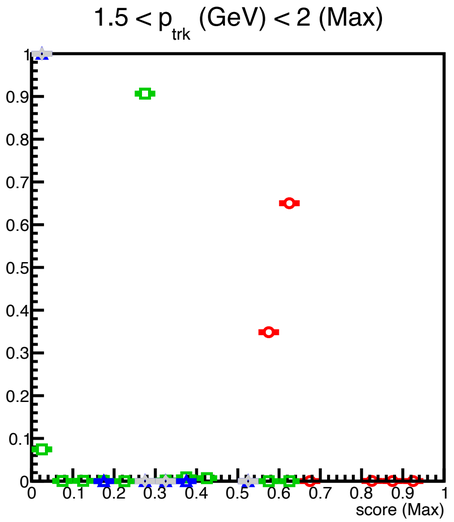
Figure by Jae N. (BNL)

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

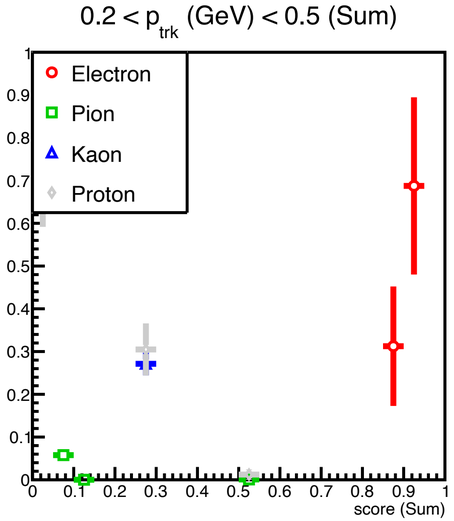


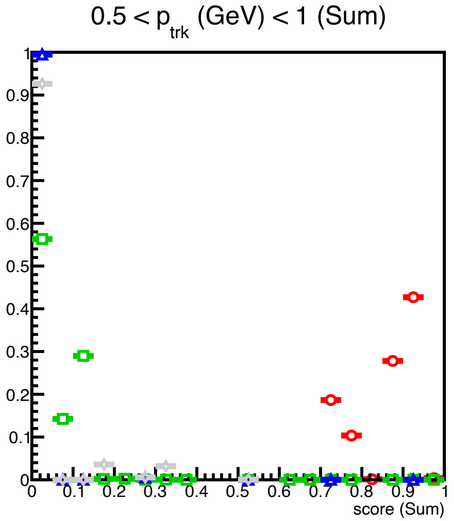


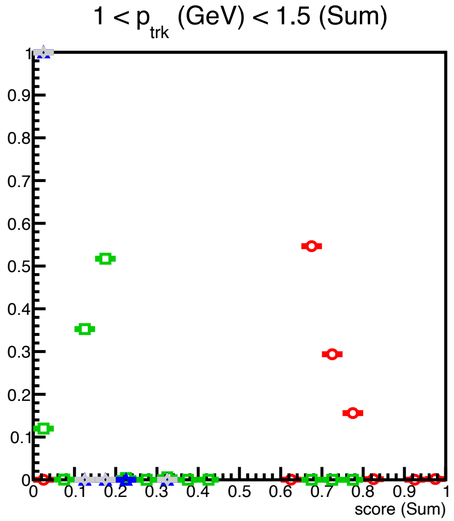


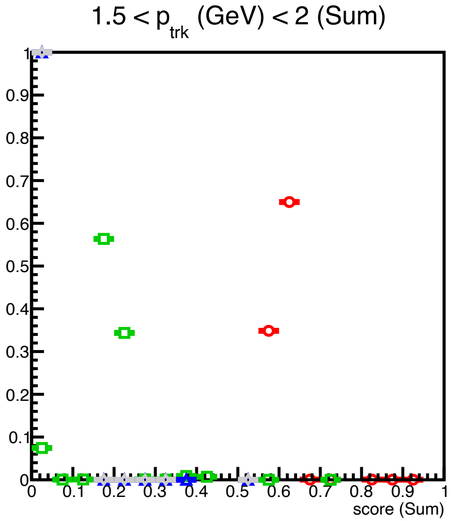


$$L_h = \mathrm{Max}(\mathrm{L}_\pi, \mathrm{L}_\mathrm{K}, \mathrm{L}_\mathrm{P})$$









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