EM cluster shapes for fake-electron rejection

February 26, 2008

Summary

- Why look at EM cluster shapes?
  - fake electrons and real electrons produce a reco object through very different processes
    - real high-p_T e^-
    - $\gamma \to e^+e^-$
    - $\pi^0 \to \gamma\gamma \to e^\pm X$
    - $\pi^+ + N \to \pi^0 X$
    - $\rho^+ \to \pi^+\pi^0$
  - ECAL segmentation is very fine (0.02×0.02) — can it resolve the e from the X in these $\mathcal{O}(0.1)$ processes?
- How to look at cluster shapes?
  - shape variables depend on η, p_T, f_{brem}, $\Delta\eta_{\text{in}}$, $\Delta\phi_{\text{in}}$, ... $\Rightarrow$ need to account for these
- How do we tell if it's any good?
  - better than E/p, $\Delta\eta_{\text{in}}$, $\Delta\phi_{\text{in}}$?
  - better than $\sigma_{\phi\phi}$, $\sigma_{\eta\eta}$, $E_{3\times3}$, $E_{5\times5}$?
  - not just an artifact?

Shape variables

"Shape variables" means all quantities that can be computed from the cluster — $\sigma_{\phi\phi}$, $E_{5\times5}$ etc.

(I'll call everything else — E/p, H/E, p_T, f_{brem} etc. — "track variables")

Current variables:

- $\sigma_{\phi\phi}$
- $\sigma_{\eta\eta}$
- $E_{3\times3}$
- $E_{5\times5}$
- E_{max}/E
- n(peaks) (in ϕ or η)
- $\Delta\eta$ and $\Delta\phi$ between max and 2nd crystal
- working on more . . .

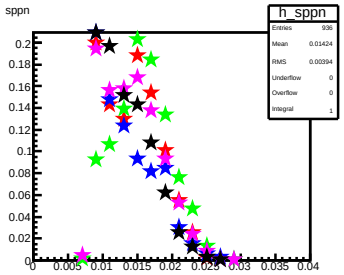
Look at shape variables for e^-, $\gamma \to e^+e^-$, π^0, π^+, ρ^+

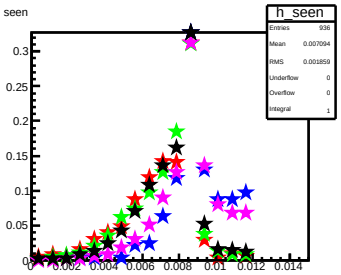
Events generated with single-particle gun: $p_T < 100$ GeV, $|\eta| < 2.5$ (but only look at barrel for now)

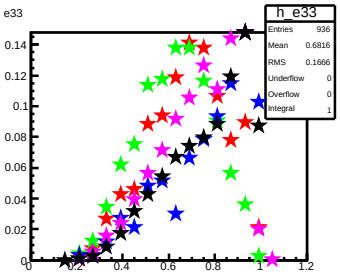
Reconstructed with "Algo B"

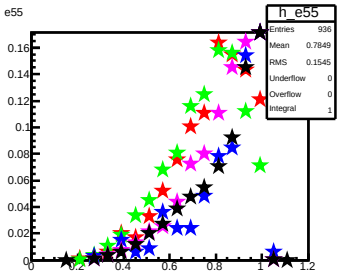
Using tight electron cuts

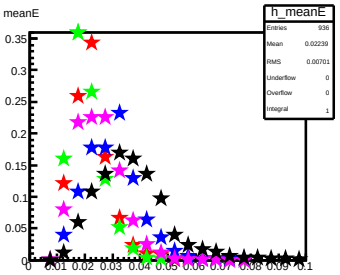
Shape variables

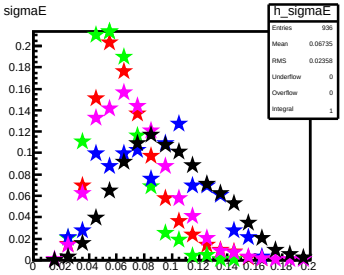


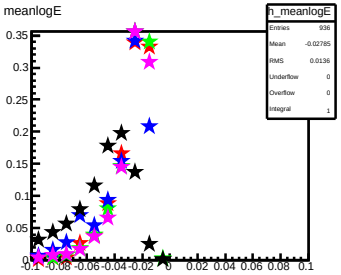


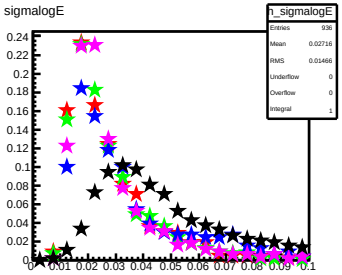


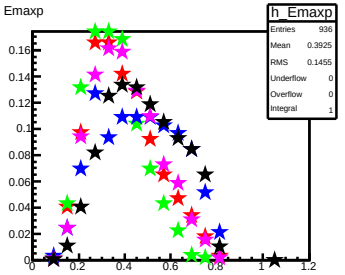


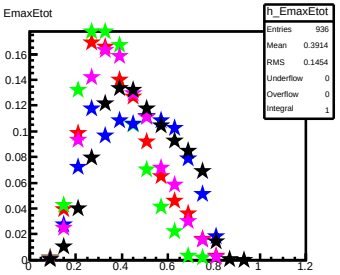


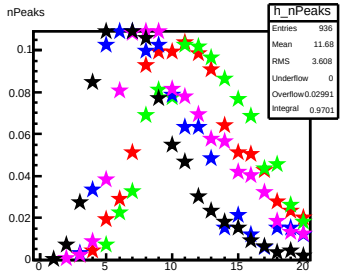


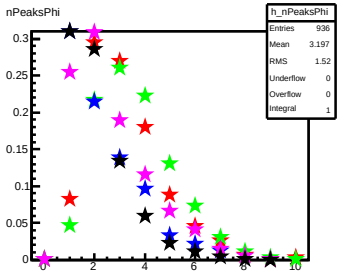


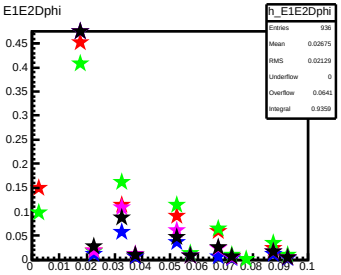


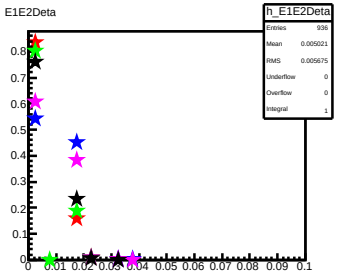


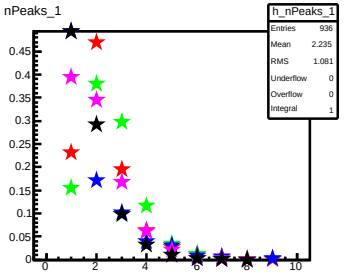


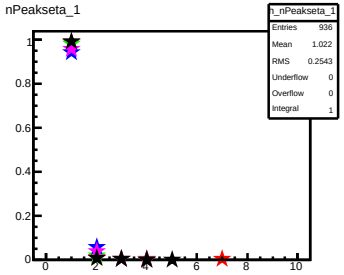


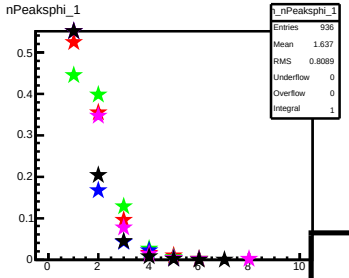






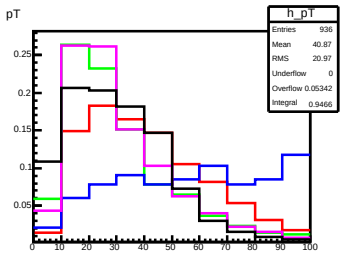


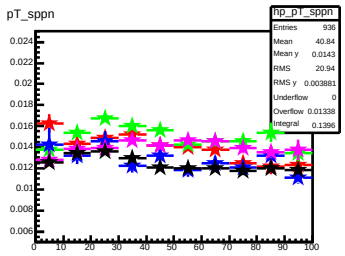


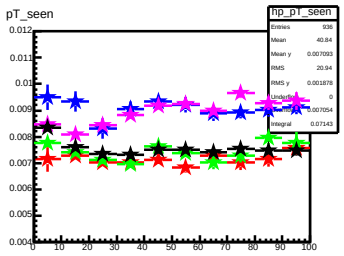


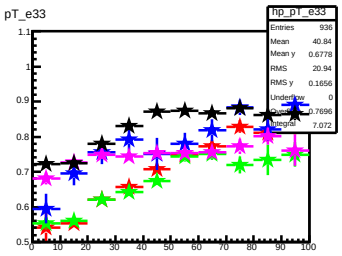
Merely statistical separation

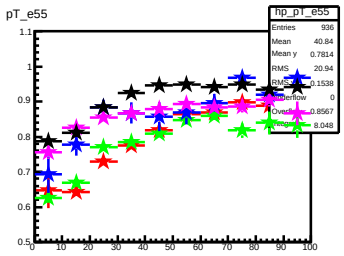
Dependence on track variables — p_T

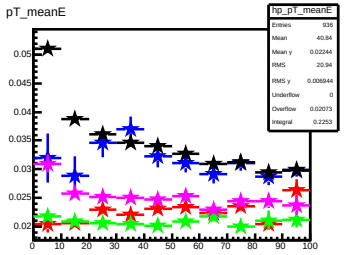


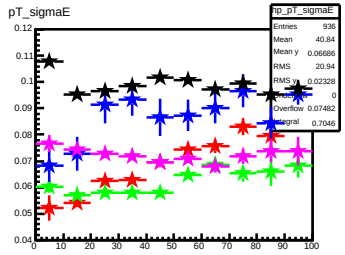


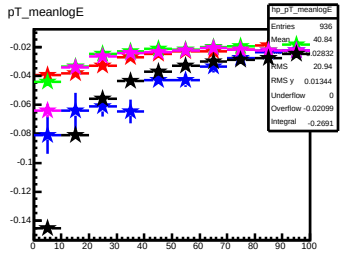


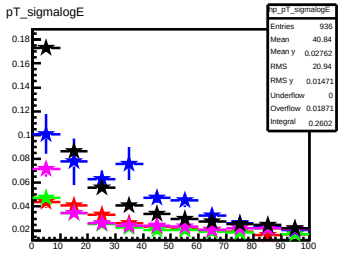


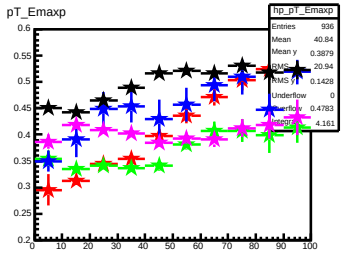


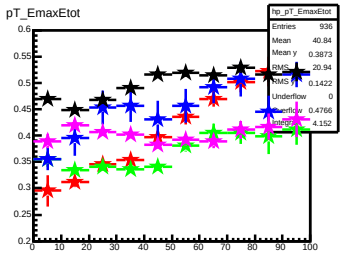


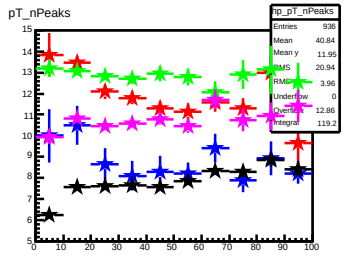


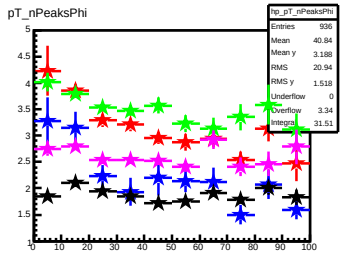


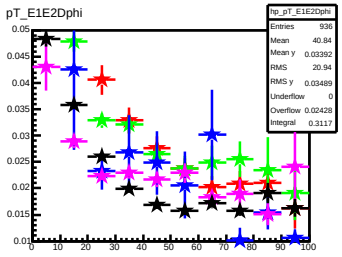


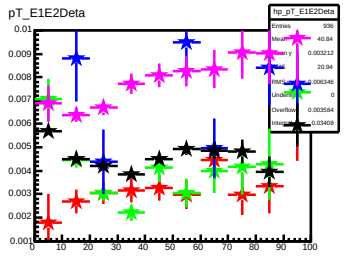


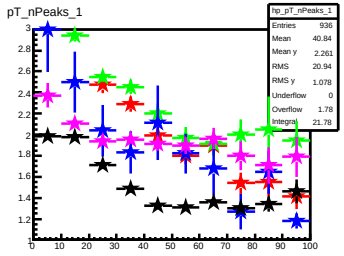


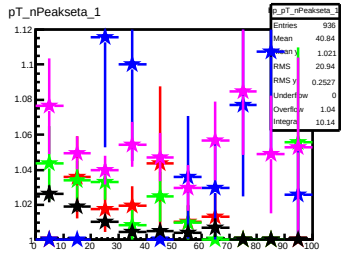


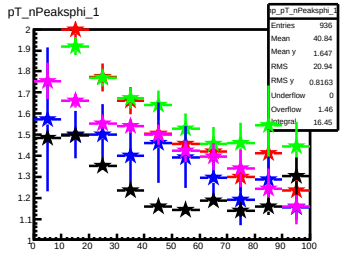




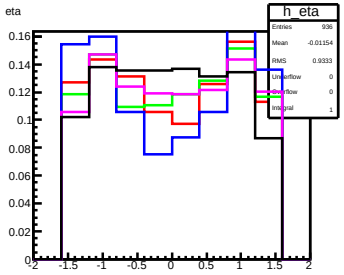


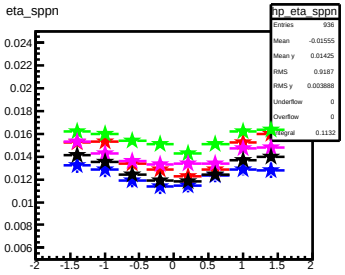


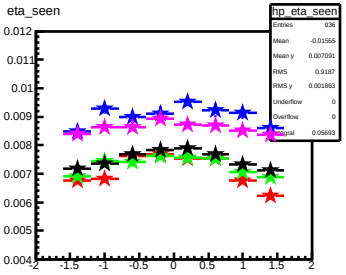


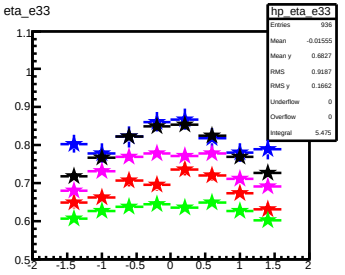


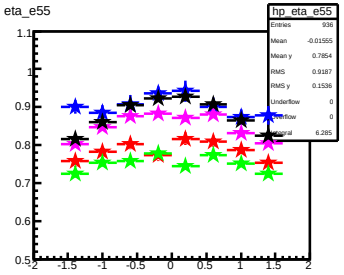
Dependence on track variables — η

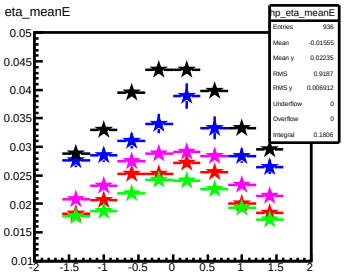


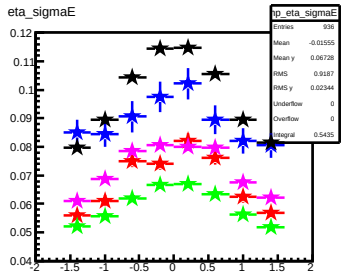


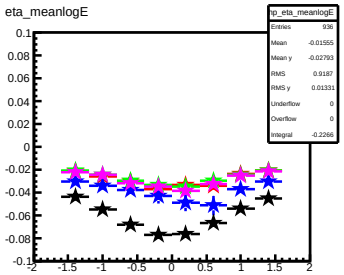


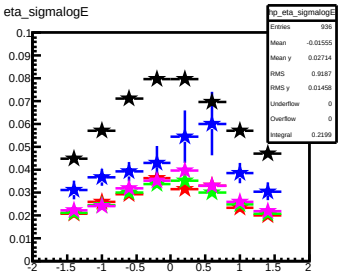


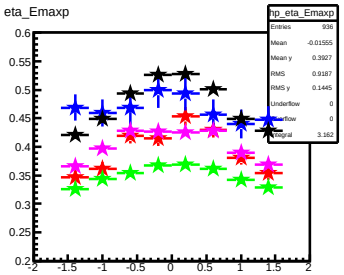


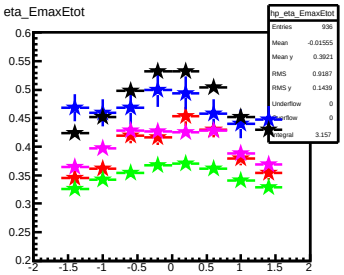


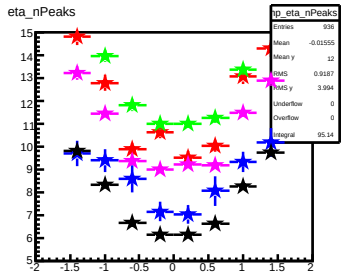


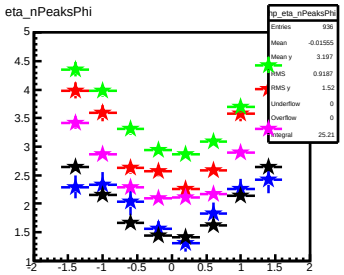


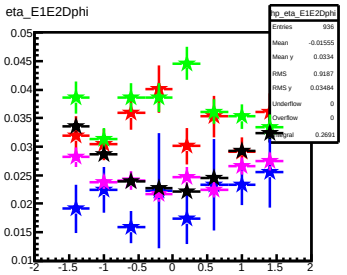


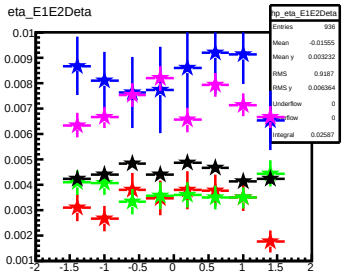


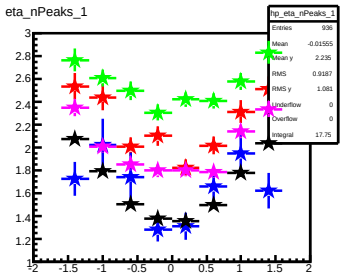


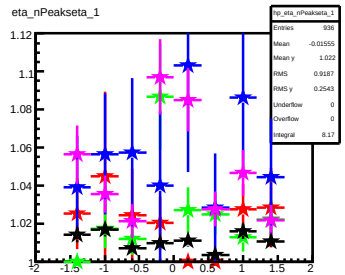


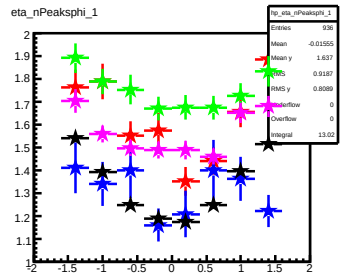




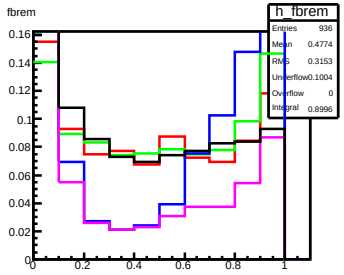


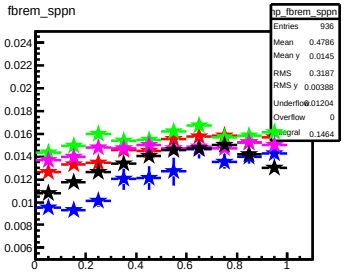


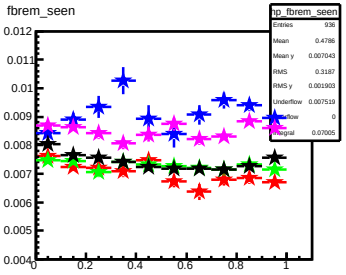


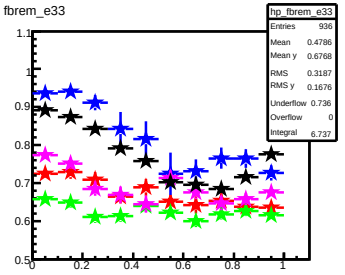


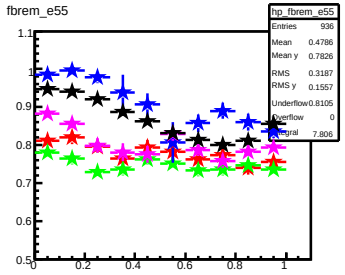
Dependence on track variables — f_{brem}

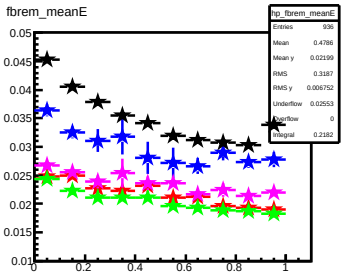


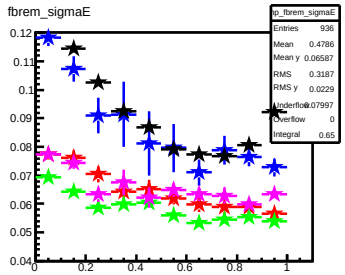


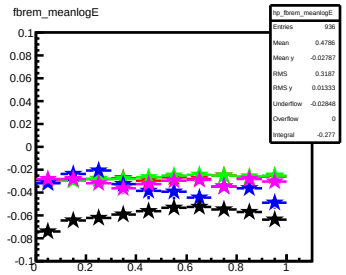


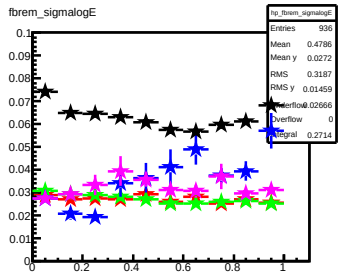


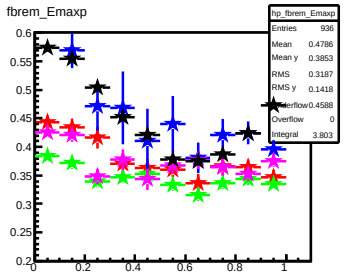


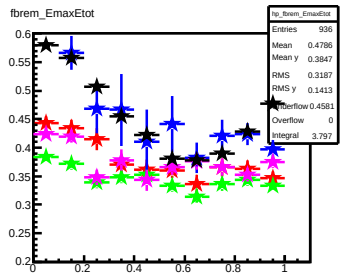


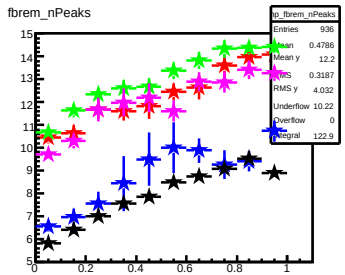


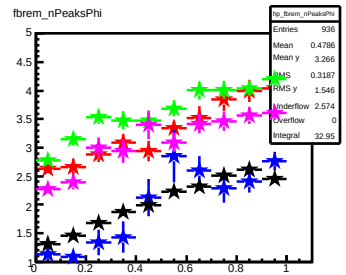


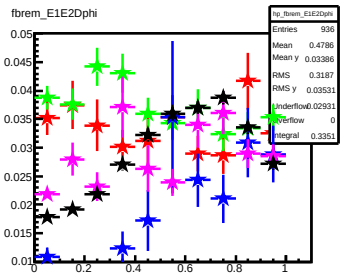


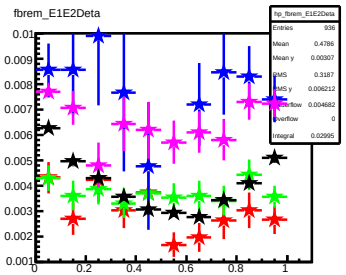


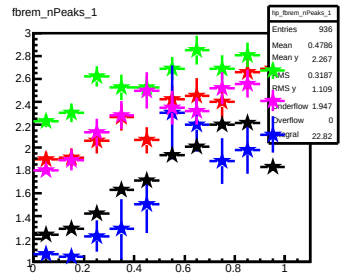


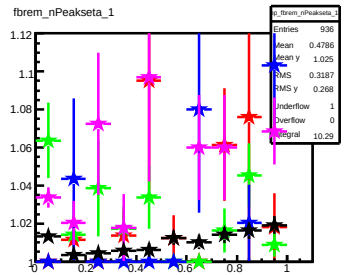


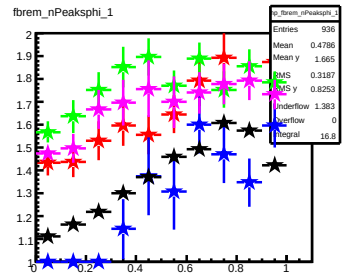












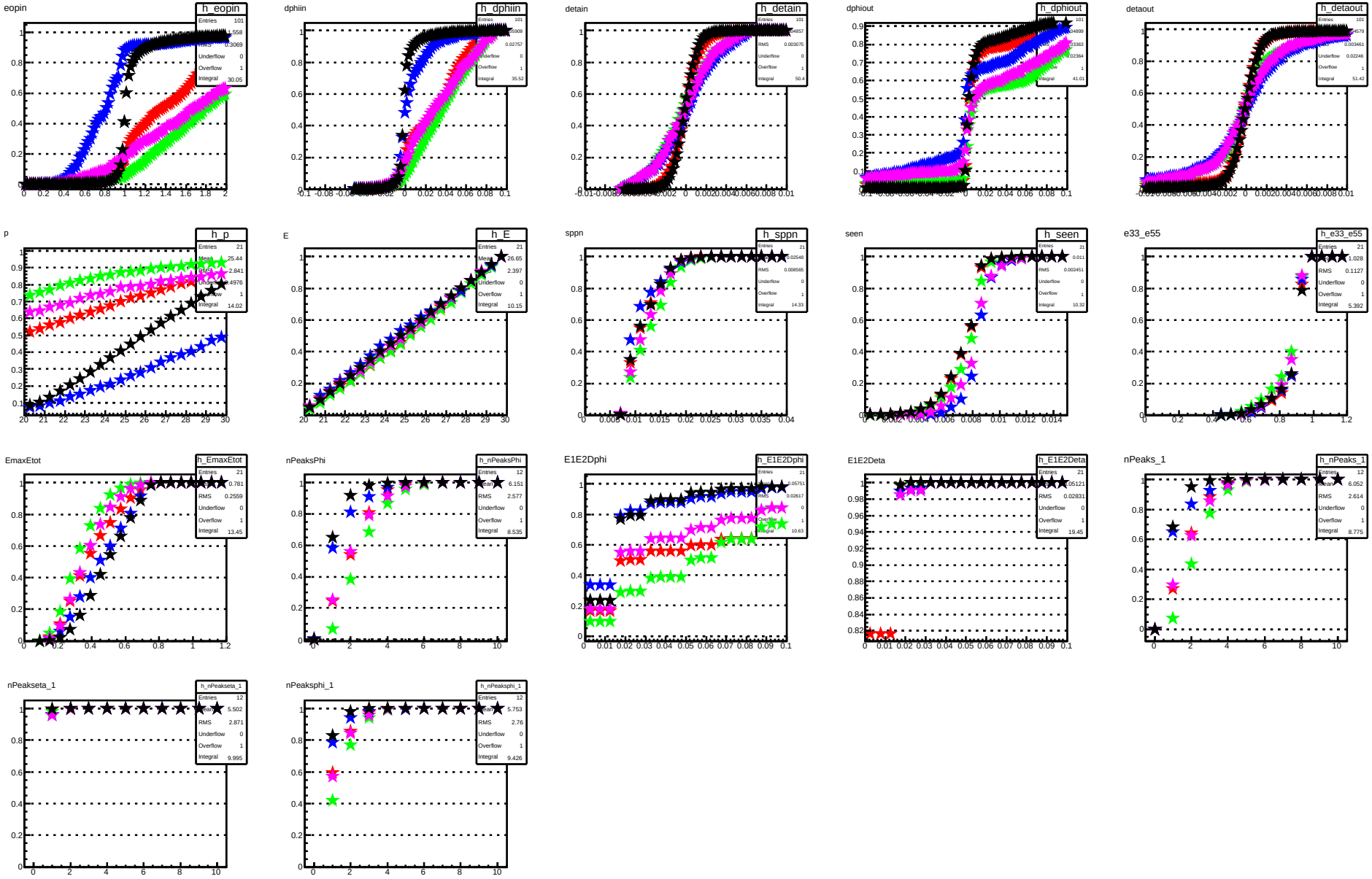
Shape variables binned in track variable

Strong dependence on track variables

- if we account for the dependence, can we get candidate-by-candidate separation?

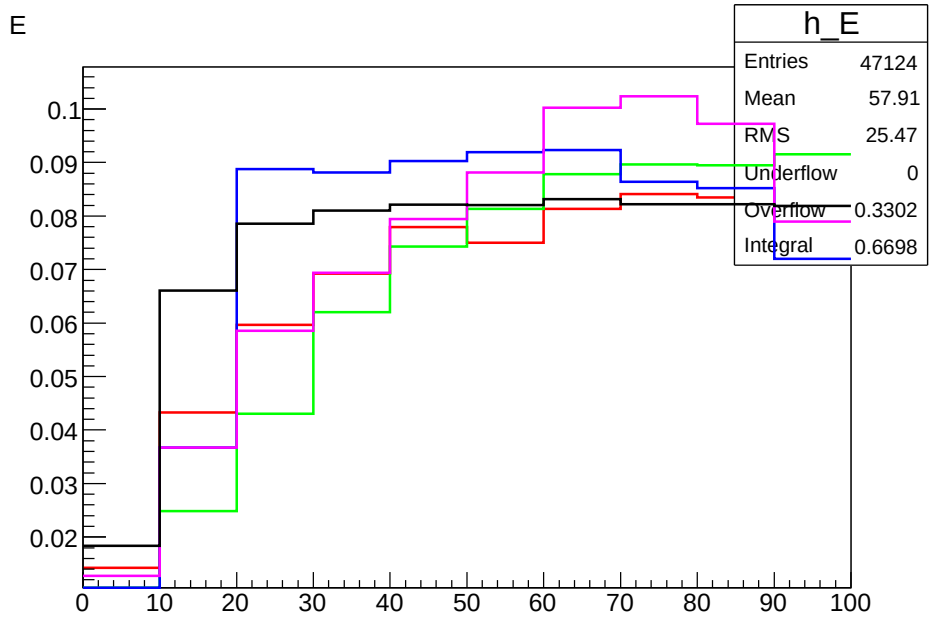
Let's look at 20 GeV $< E <$ 30 GeV, $0.1 < |\eta| < 0.5$

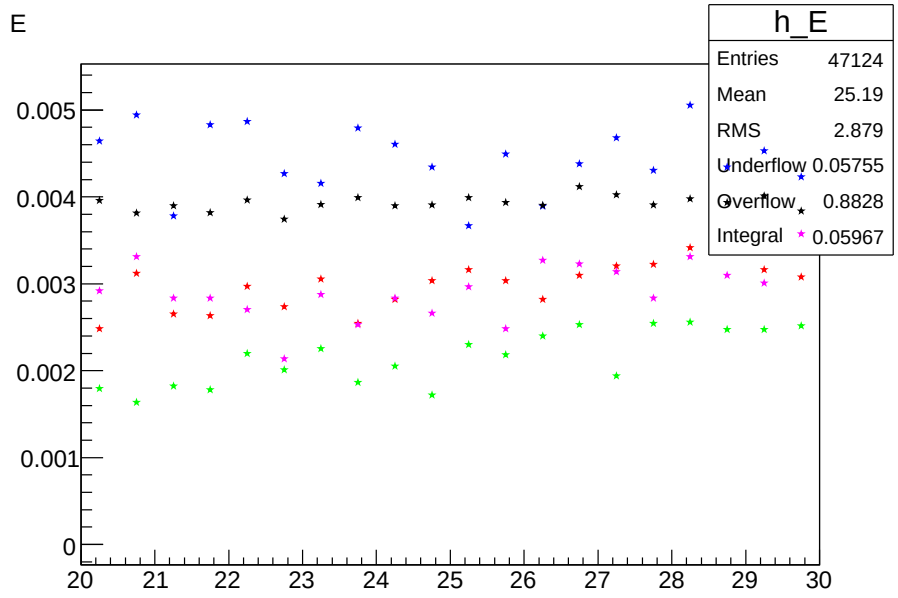
20 GeV $< E <$ 30 GeV, $0.1 < |\eta| < 0.5$, cumulative



Are we not just riding the spectrum?

Shape variables are correlated with E. Does this get us in trouble?





If bins are small enough, we should be OK

Are we better than them?

cut	γ	π^0	π^+	ρ^+	e^-
baseline	0.60	0.32	0.38	0.32	0.94
$+\sigma_{\phi\phi}$	0.55	0.27	0.37	0.29	0.93
$+\sigma_{\eta\eta}$	0.57	0.28	0.24	0.21	0.89
$+E_{\text{max}}/E$	0.59	0.30	0.37	0.31	0.93
$+n(\text{peaks})_\phi$	0.53	0.25	0.37	0.28	0.92
$+\Delta\phi(1,2)$	0.47	0.25	0.37	0.27	0.92

We're slightly better in γ and π^0 rejection

But overall, shape variables are disappointing

Need better variables!