Solenoid Studies

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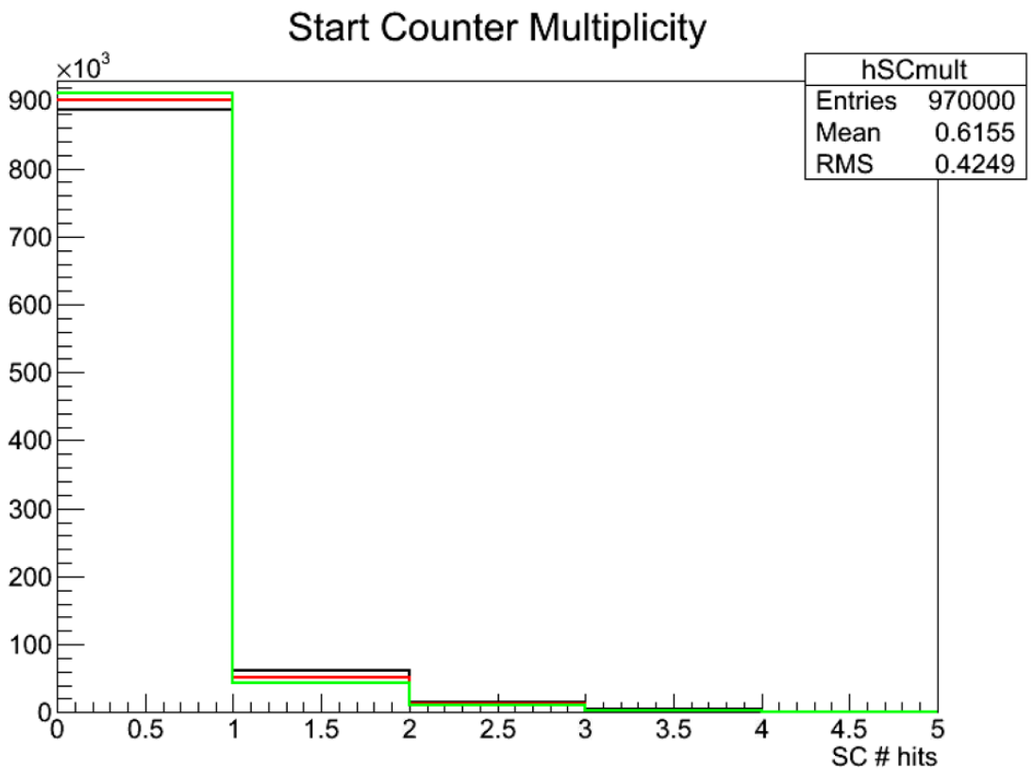
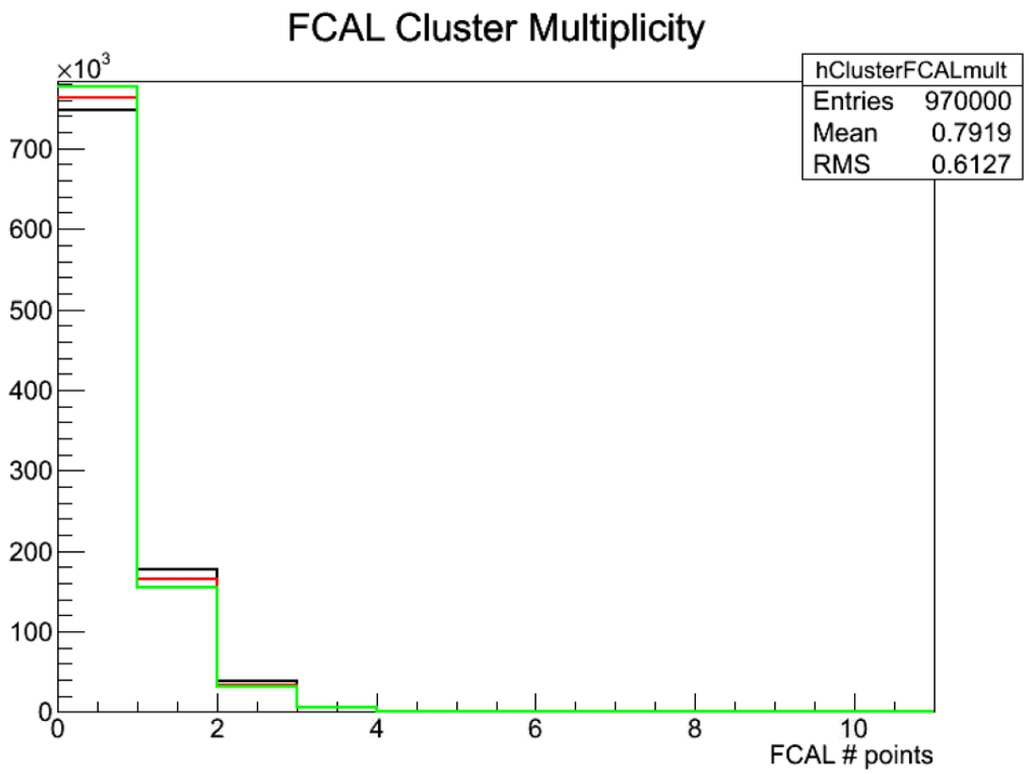
Trigger Meeting 6.10.14

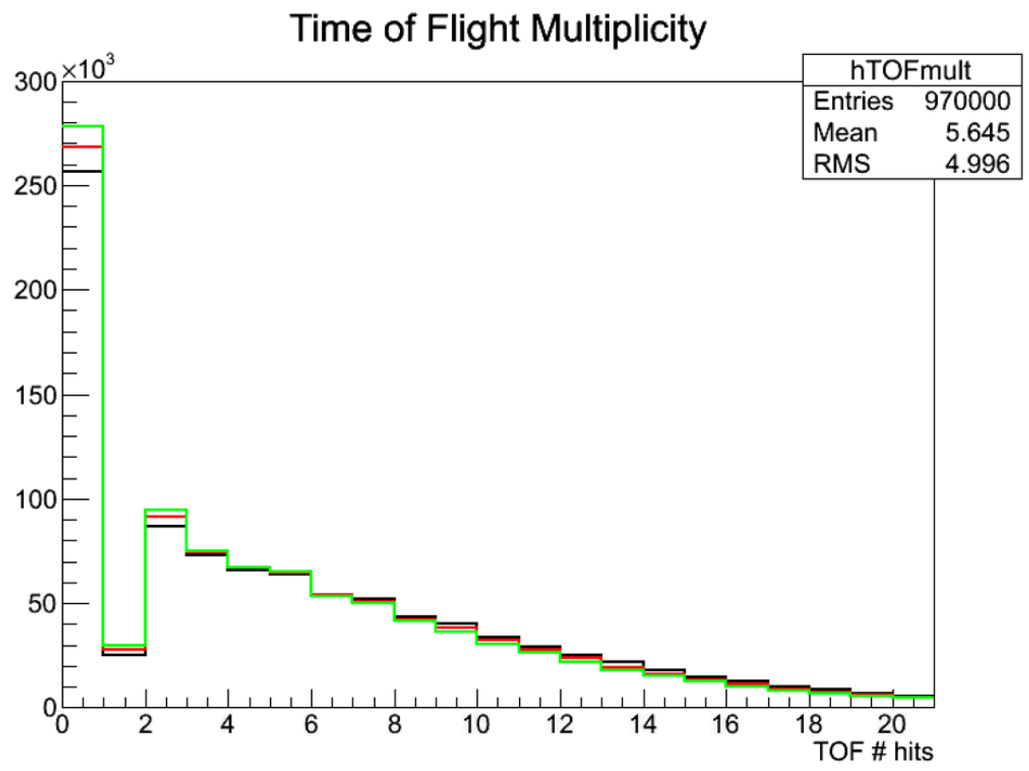
Datasets

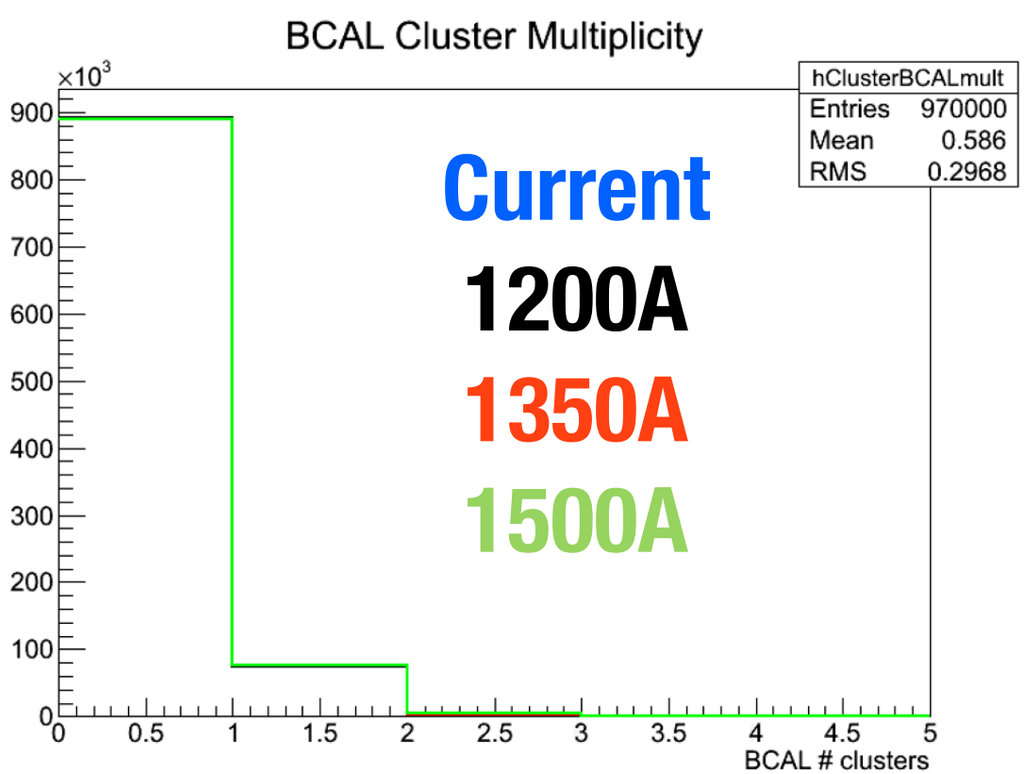
- 3 different solenoid current settings (1200, 1350, and 1500) used to generate each samples below:
- **EM background only** (5×10^7 rate with 100 ns gate)
  - No physics event generated, just the EM bkgd
- **Single particle MC** uniform in phase space
  - No EM background, used for tracking resolution
- **bggen with EM pileup** (5×10^7 rate with 100 ns gate)
  - full photon energy spectrum, for L3 evaluation

Multiplicities: EM sample

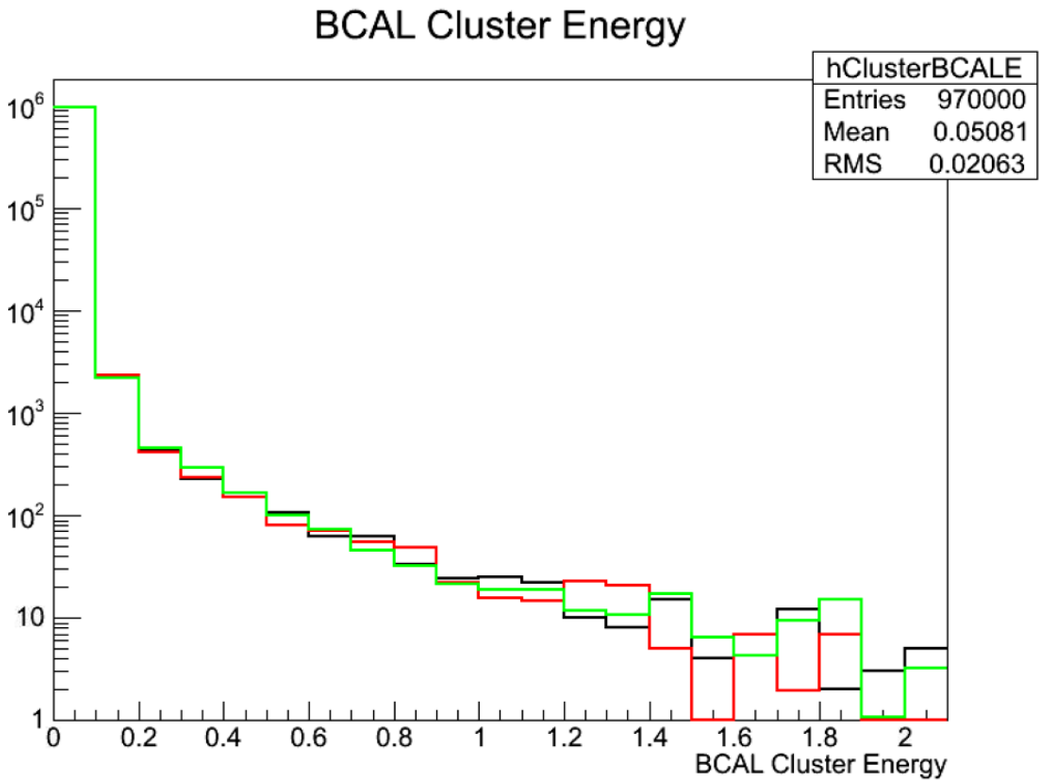


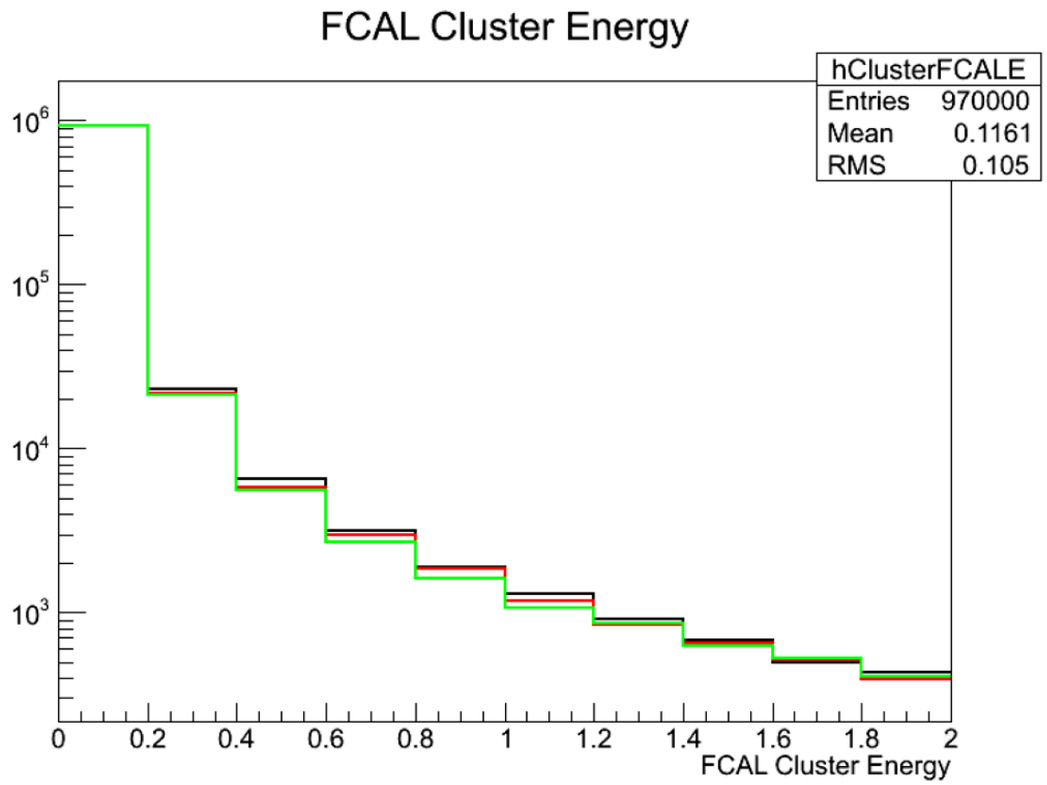






ECAL Energy sums: EM sample





- Very little change in summed cluster energy for different field settings
- L1 trigger performance should be very similar for different field settings

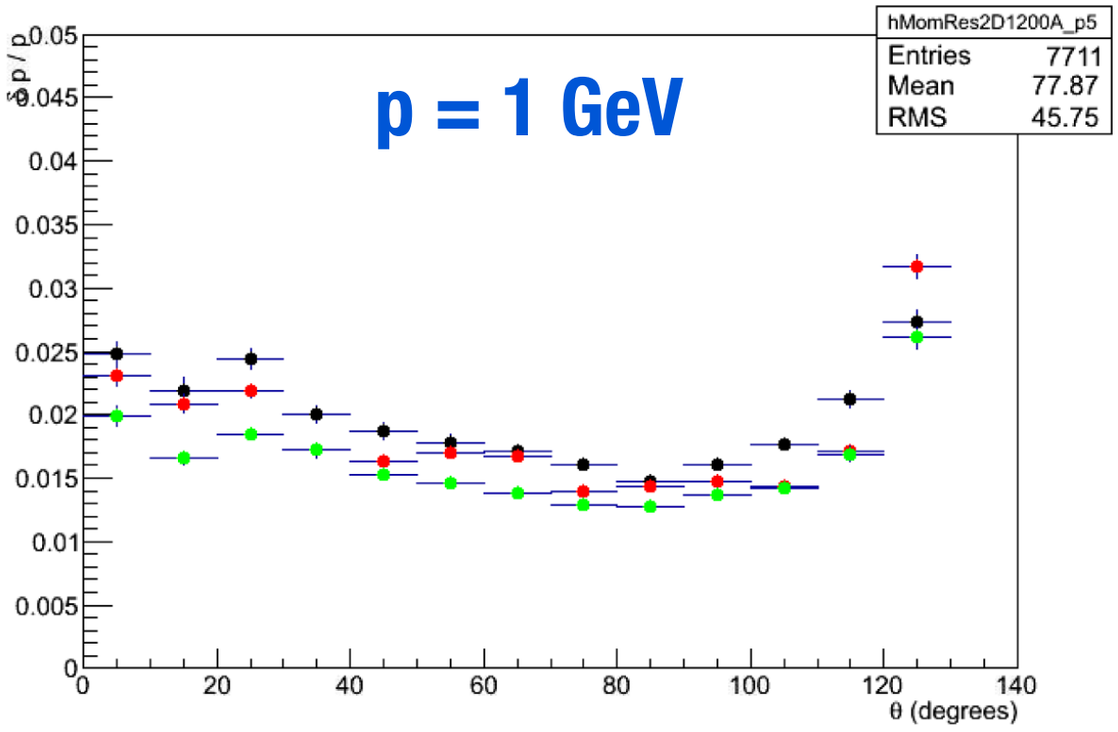
Current

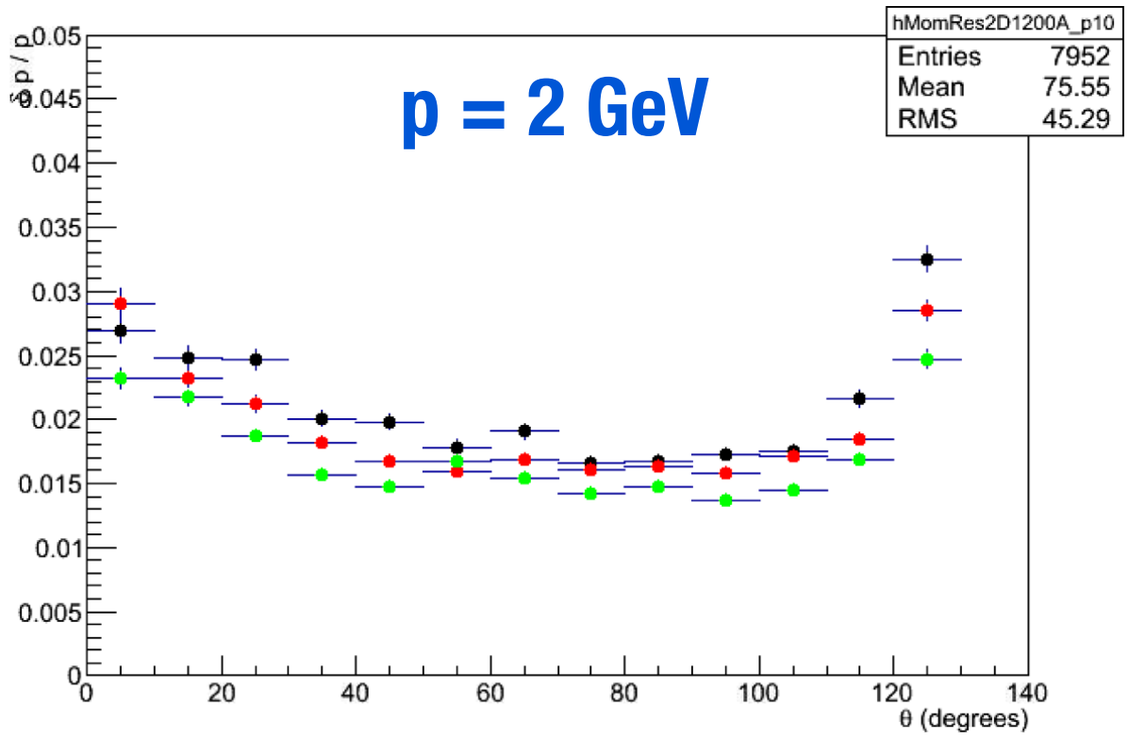
1200A

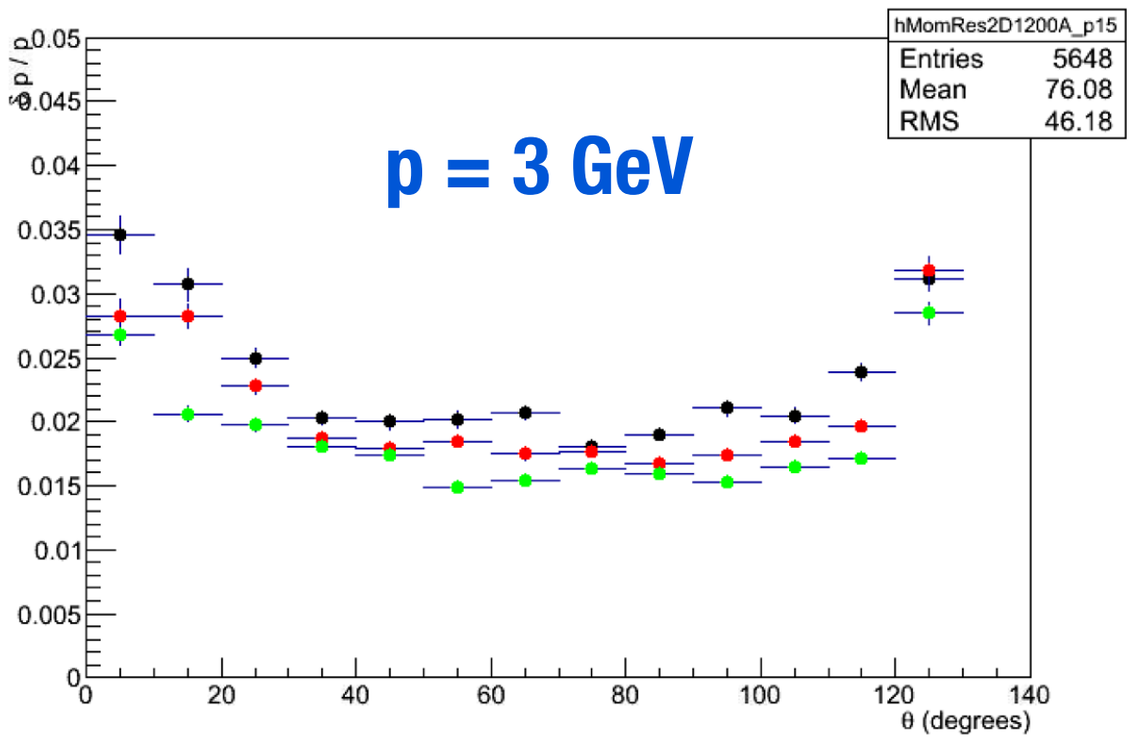
1350A

1500A

Tracking resolution: DTrackTimeBased







Single particle MC sample

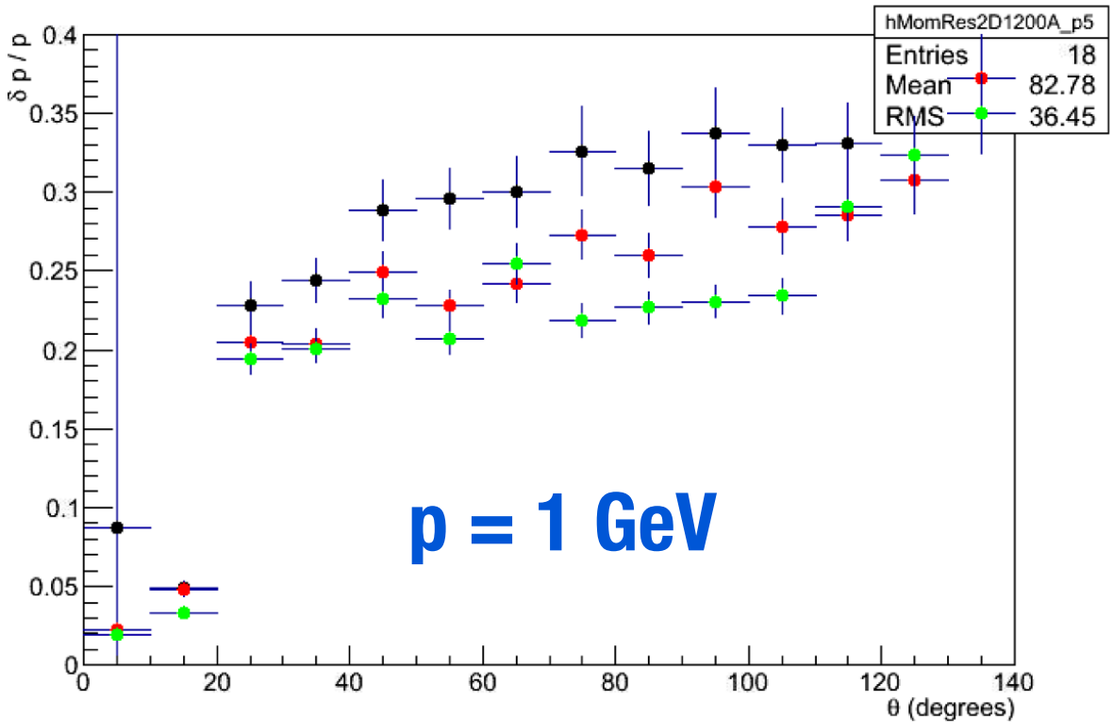
Current

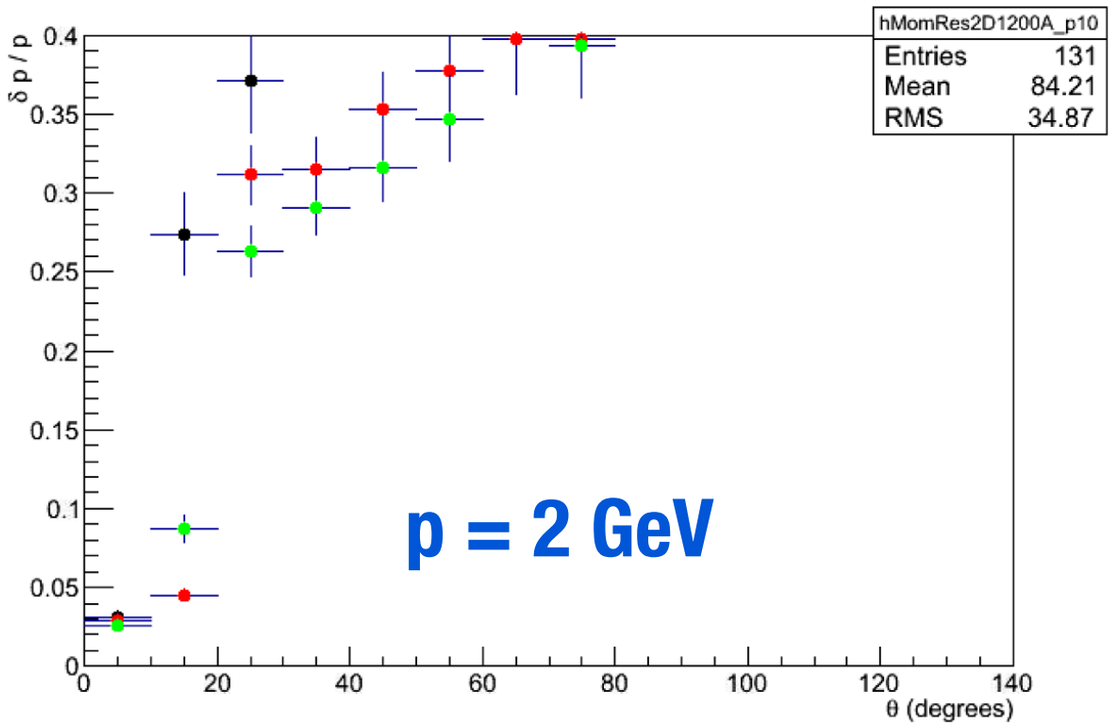
1200A

1350A

1500A

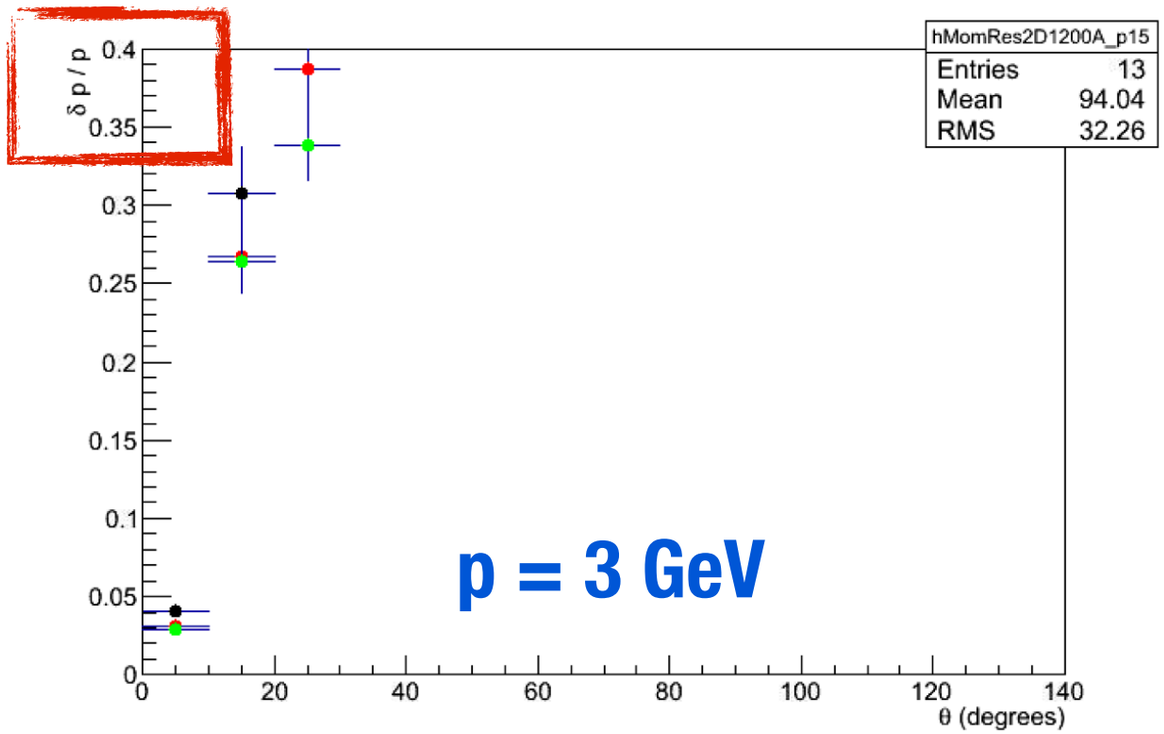
Tracking resolution: DWireTimeBased





Different y-axis scale from TimeBased

Single particle MC sample



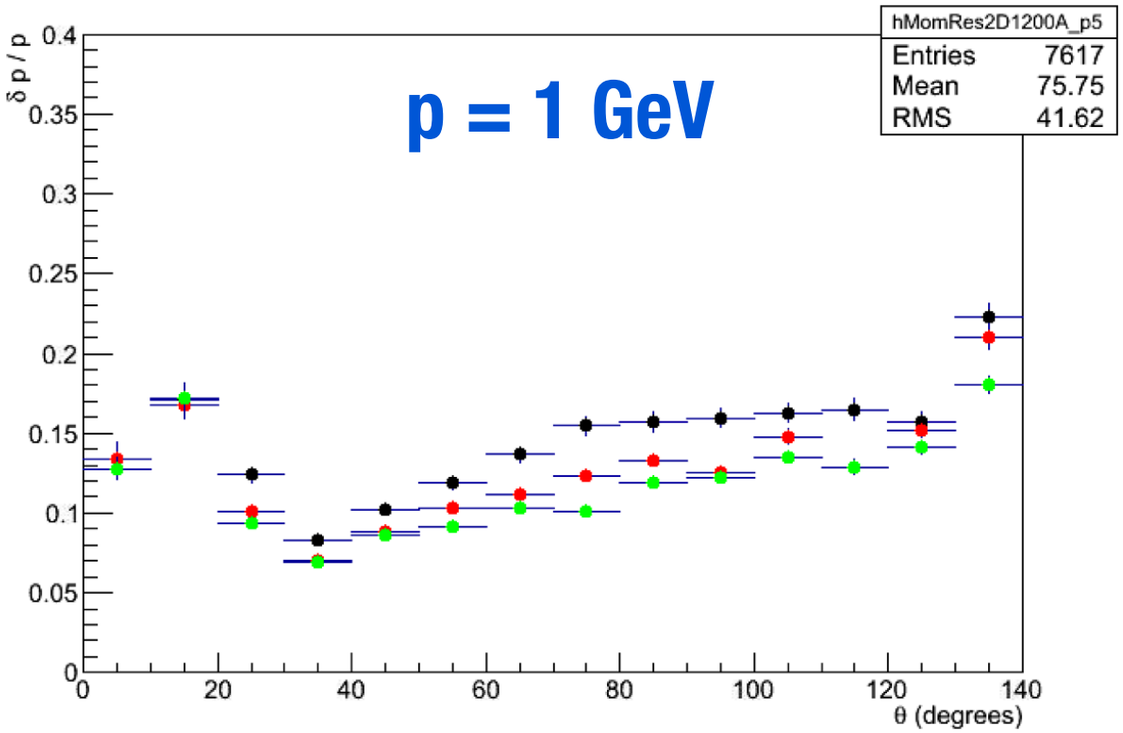
Current

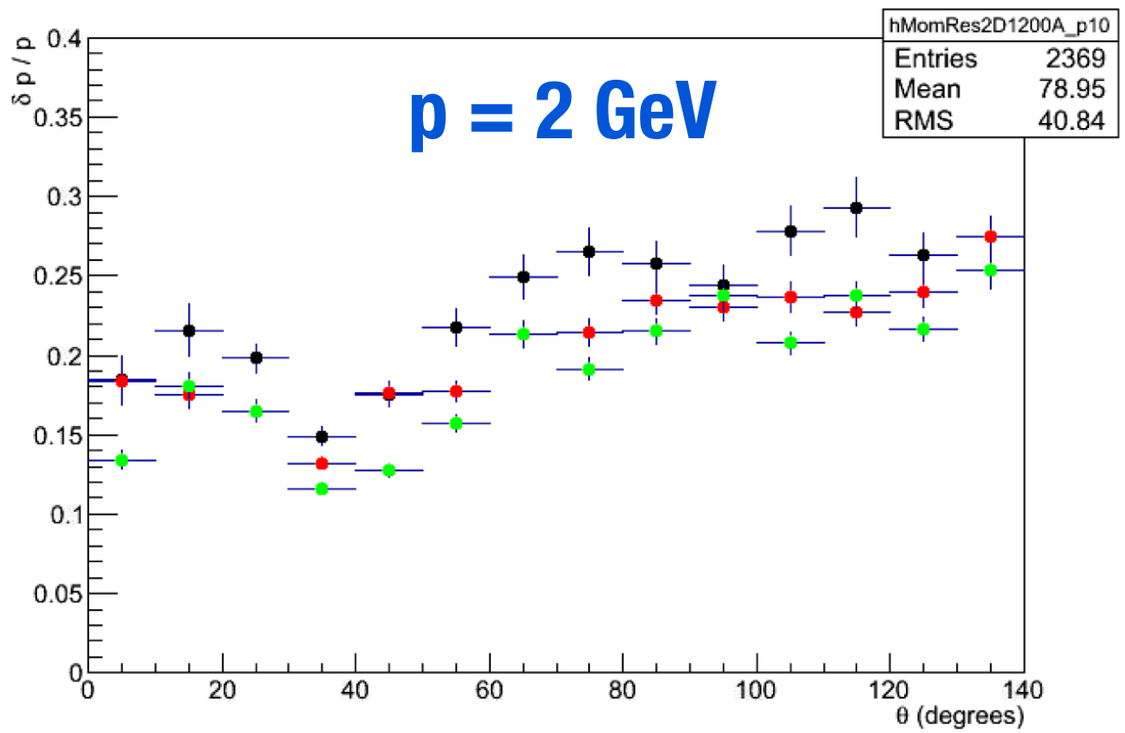
1200A

1350A

1500A

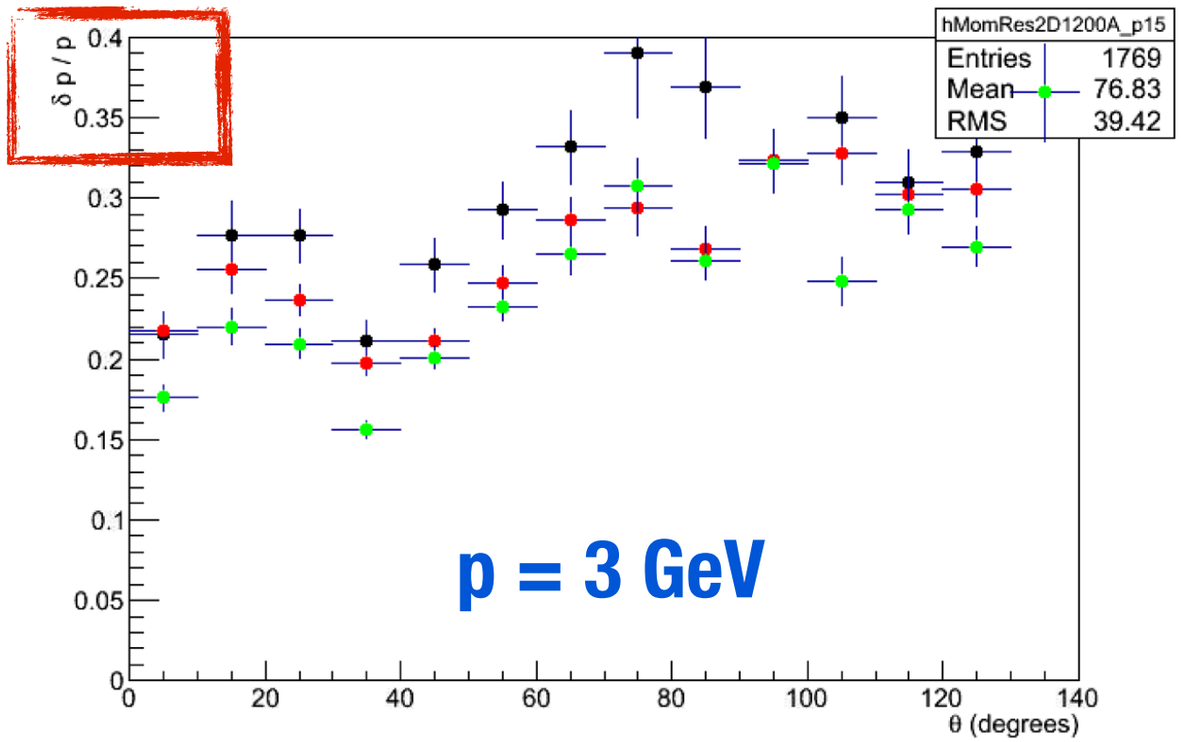
Tracking resolution: DTrackCandidate





Different y-axis scale from TimeBased

Single particle MC sample



Current

1200A

1350A

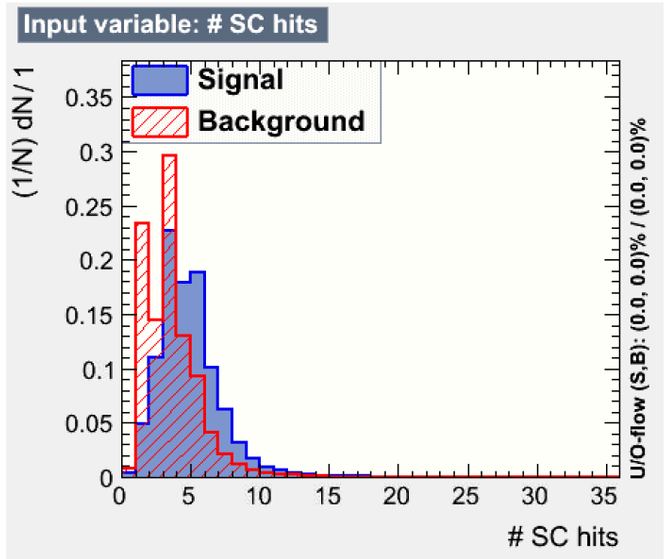
1500A

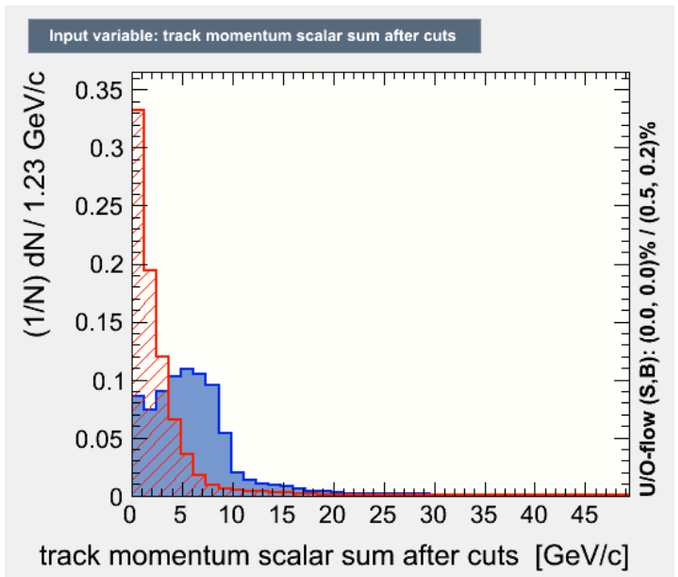
Summary of multiplicities and resolutions

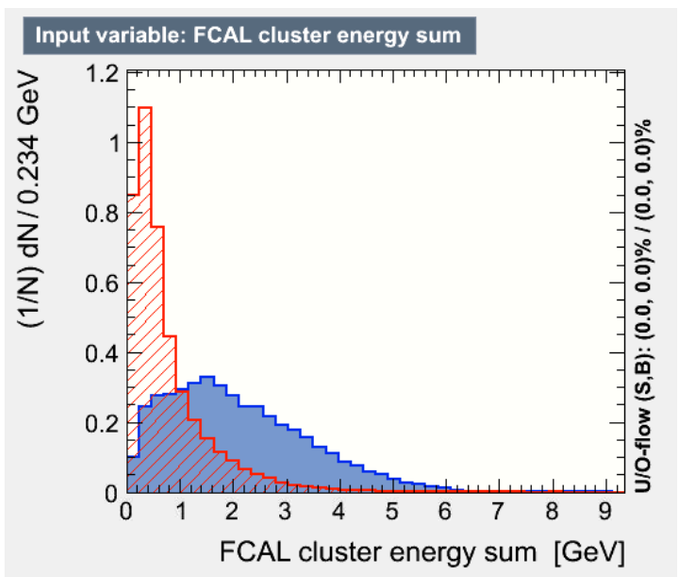
- Multiplicities and energy sums
  - Small increase in SC, TOF and FCAL multiplicities
  - ECAL energy sums are very similar for different solenoid currents, expect similar L1 performance
- Tracking resolution (non-linear)
  - Generally degraded resolution for 1200A is worse by more than a factor of x2 from 1350A
  - DTrackCandidates with $\theta>15$ used in the “hybrid” track momentum sum show the largest difference

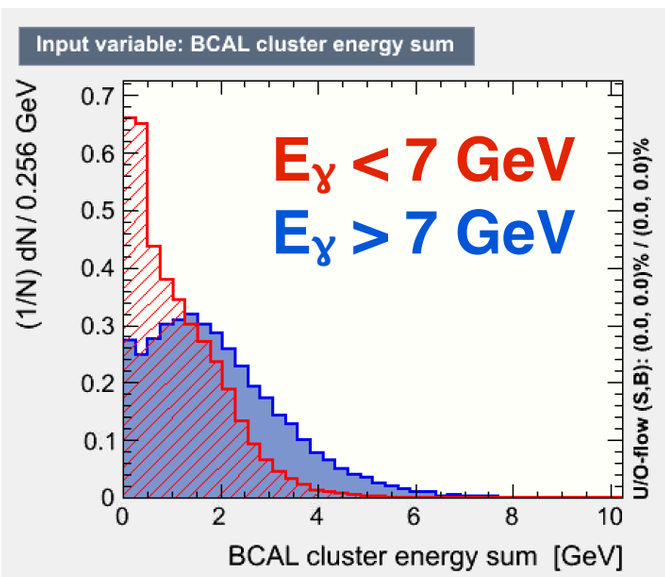
Level-3 Inputs Reminder

```
float Nstart_counter;      // Number of start counter hits
float Ntof;                // Number of TOF hits

float Nbcal_clusters;      // Number of BCAL clusters
float EbcalClusters;       // Total energy in BCAL (Clusters)

float Nfcal_clusters;      // Number of FCAL clusters
float EfcalClusters;       // Total energy in FCAL (Clusters)

float Ntrack_candidates;   // Number of track candidates
float Ptot_tracks;         // Scaler sum of total momentum from candidate tracks
```

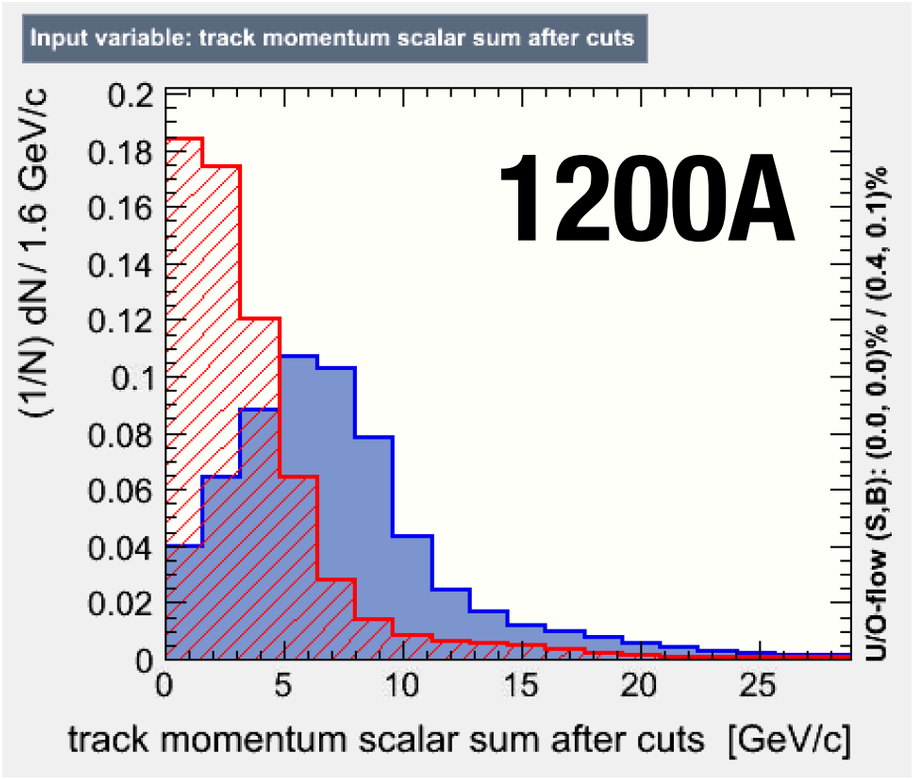


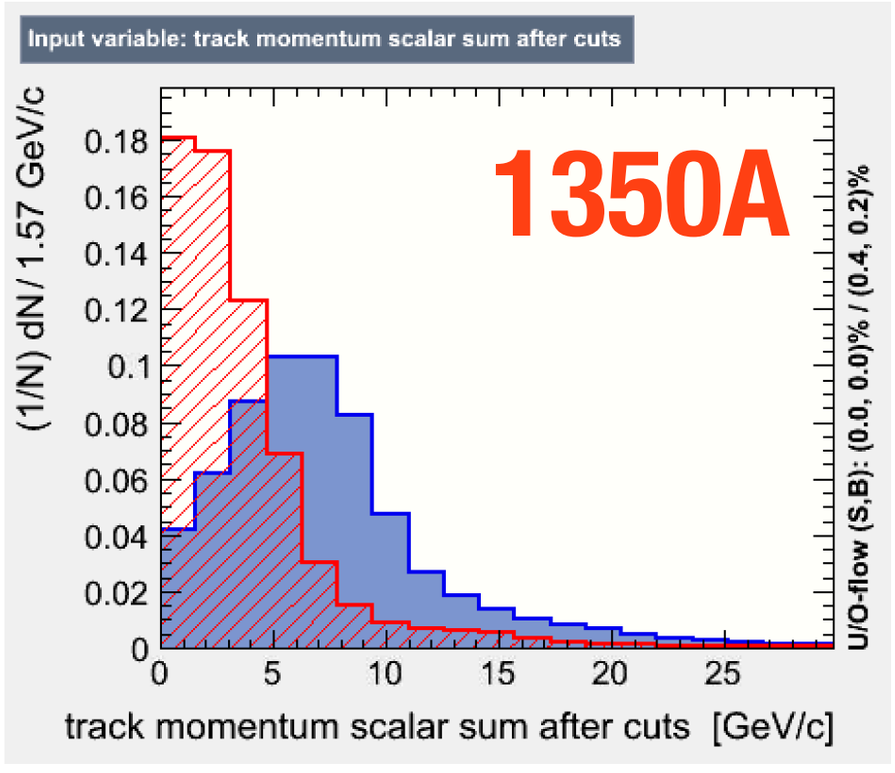


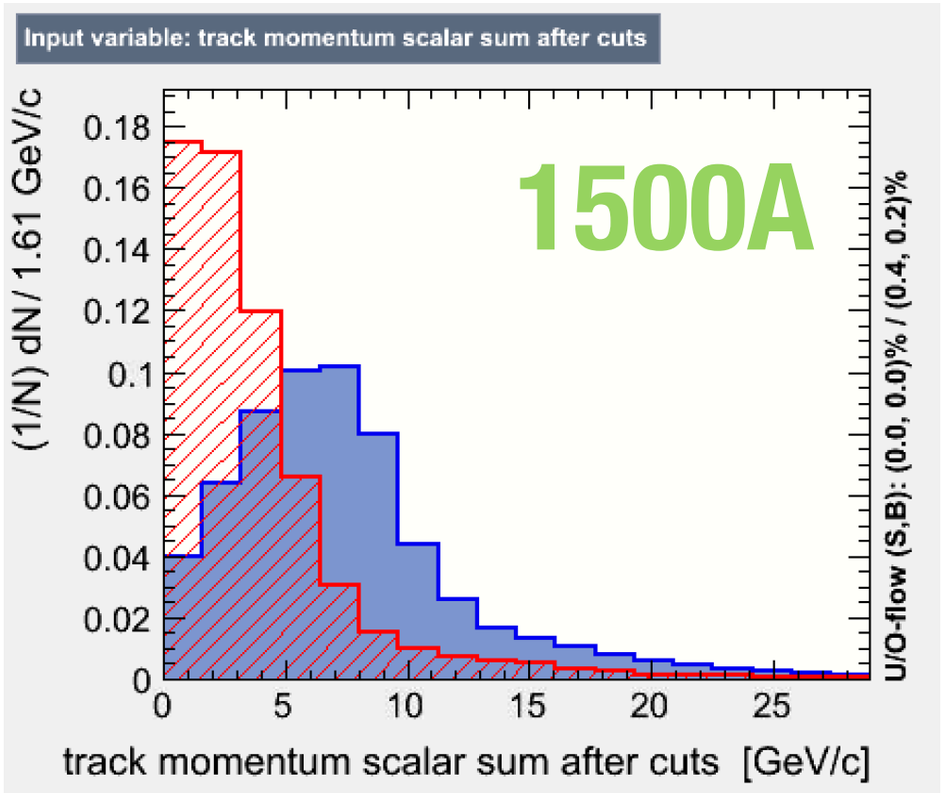




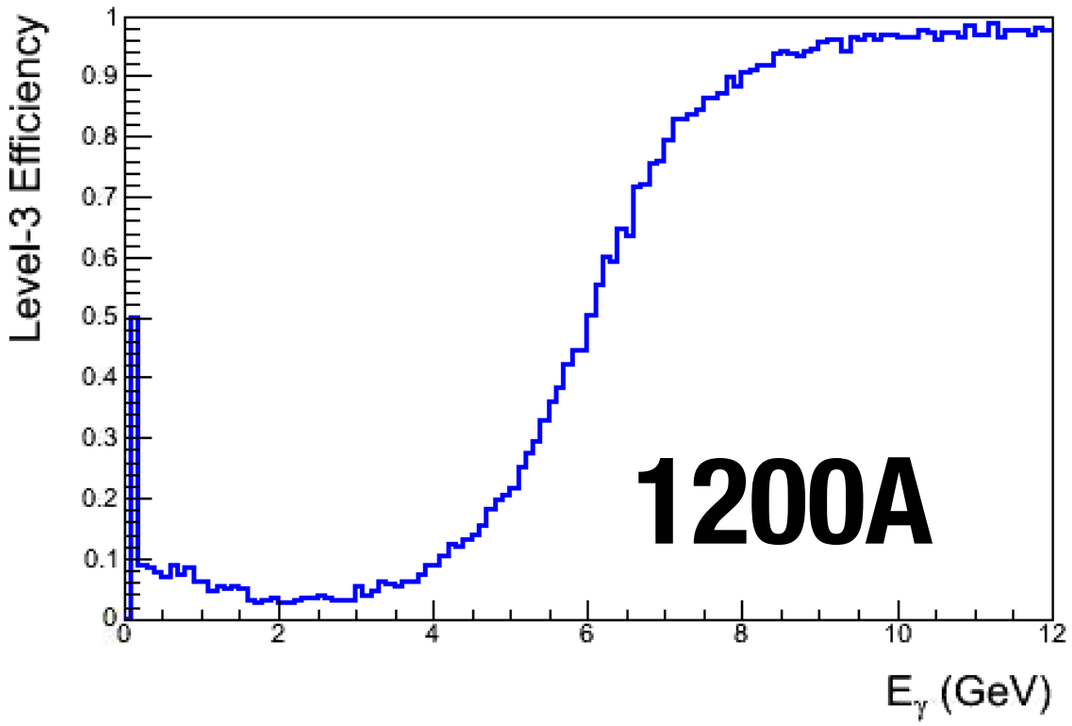
BDT input variables

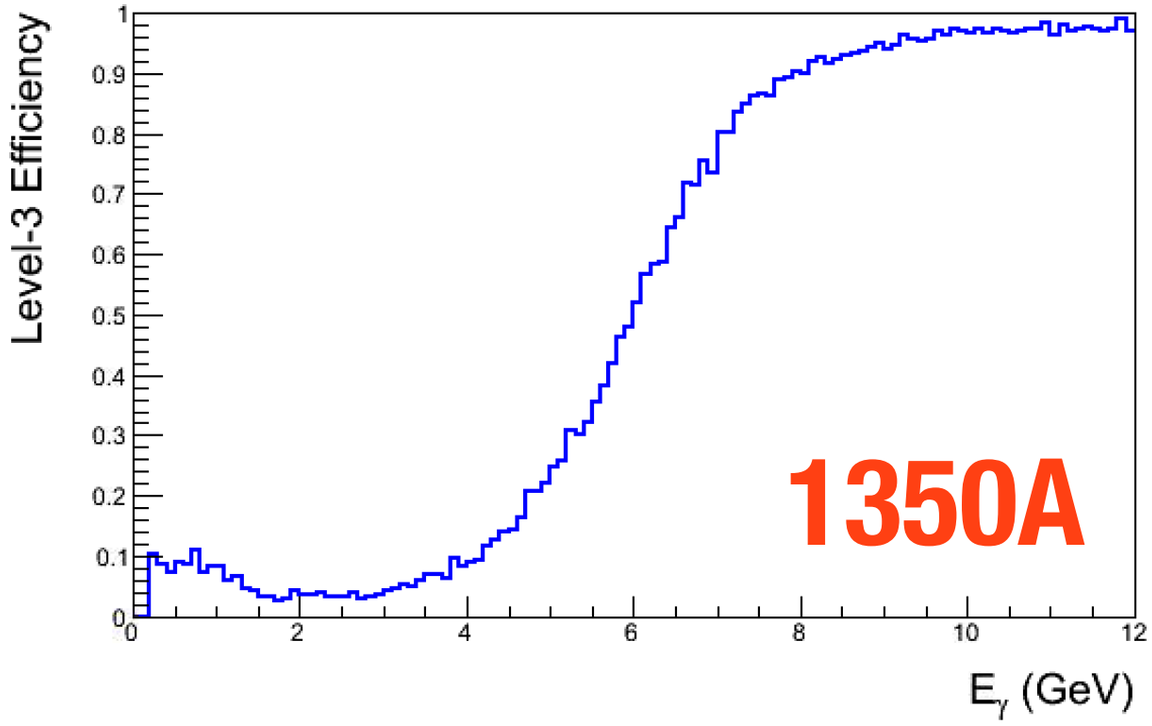


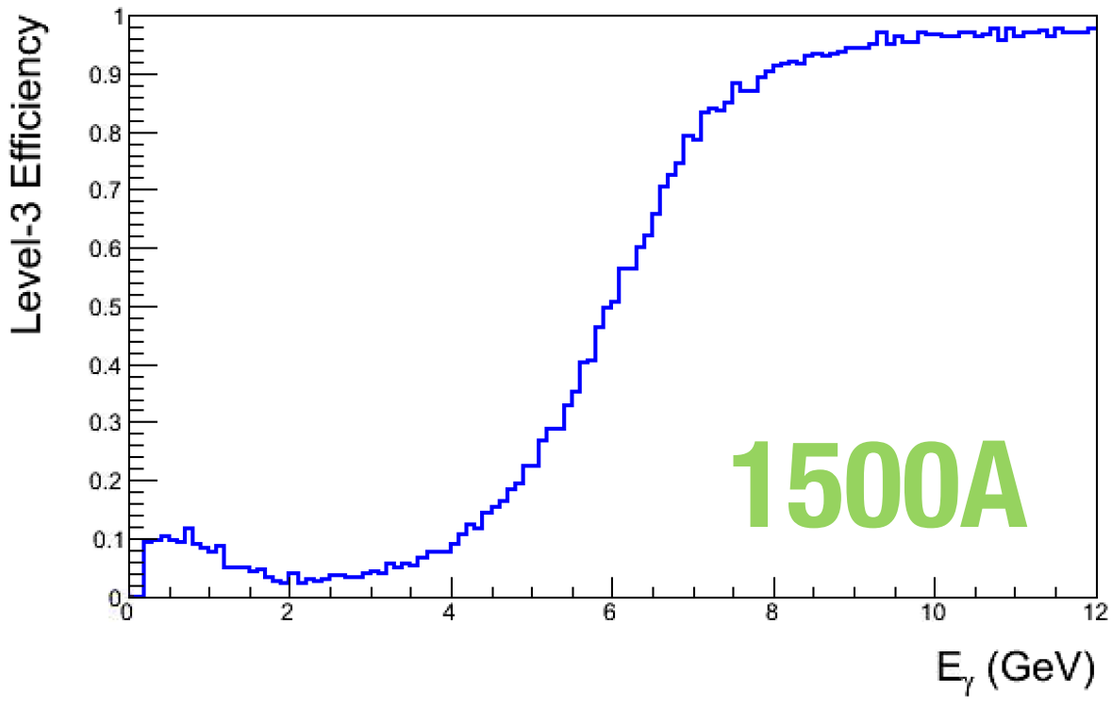




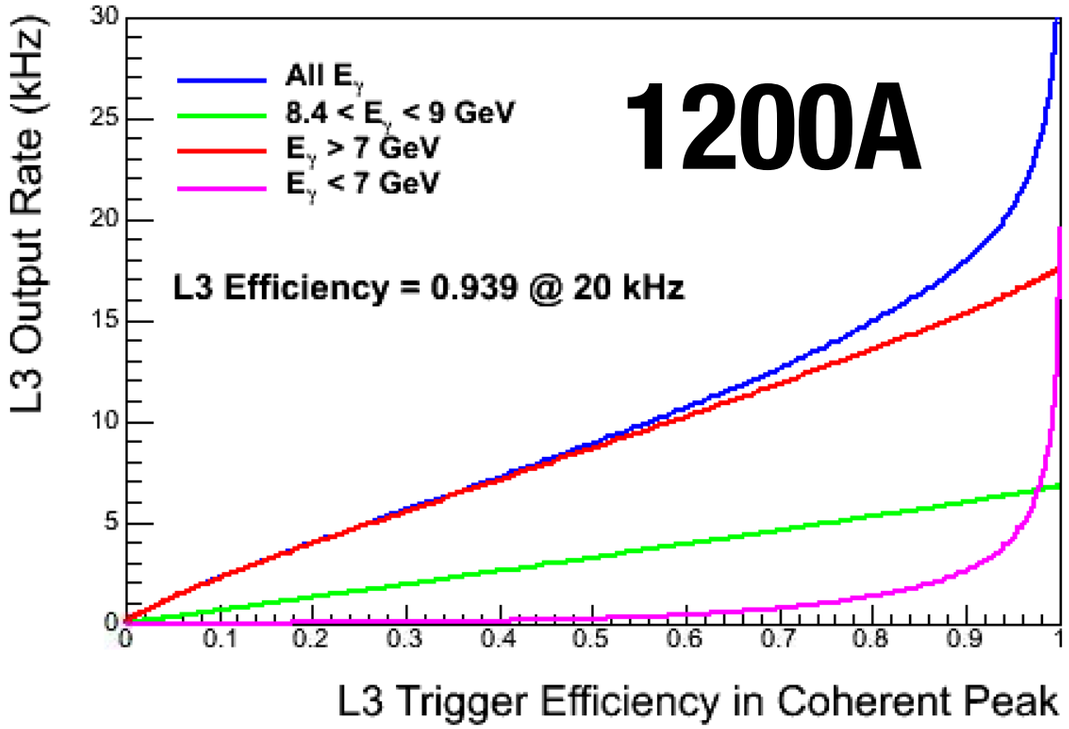
BDT evaluation

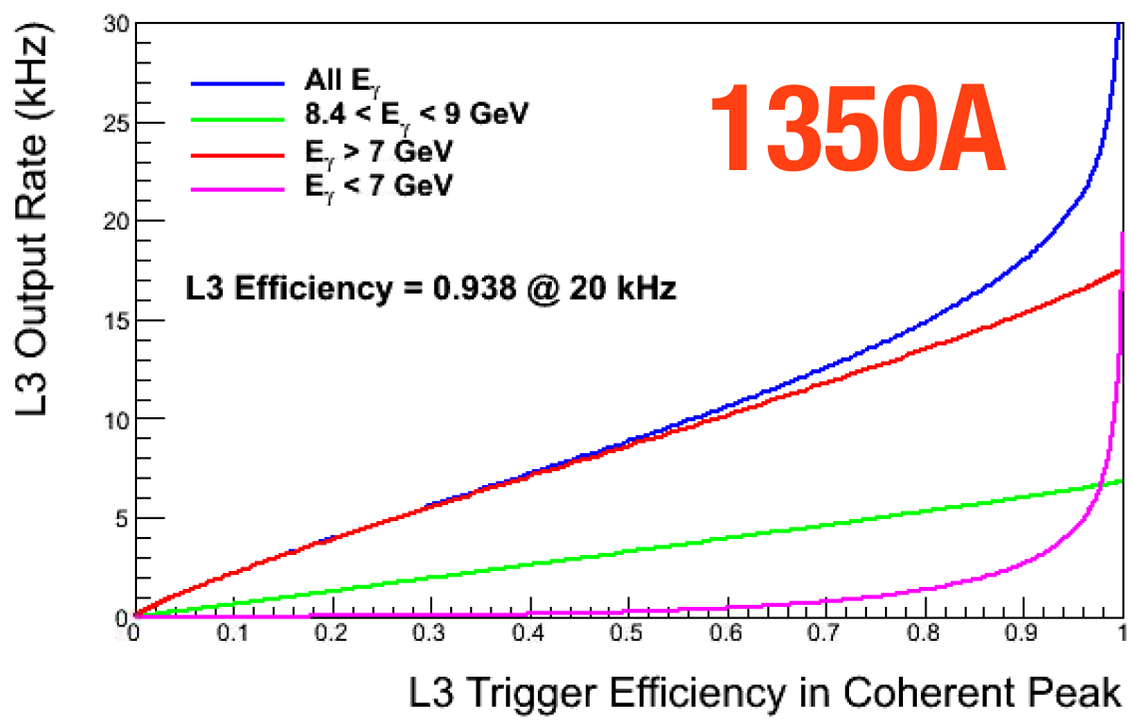


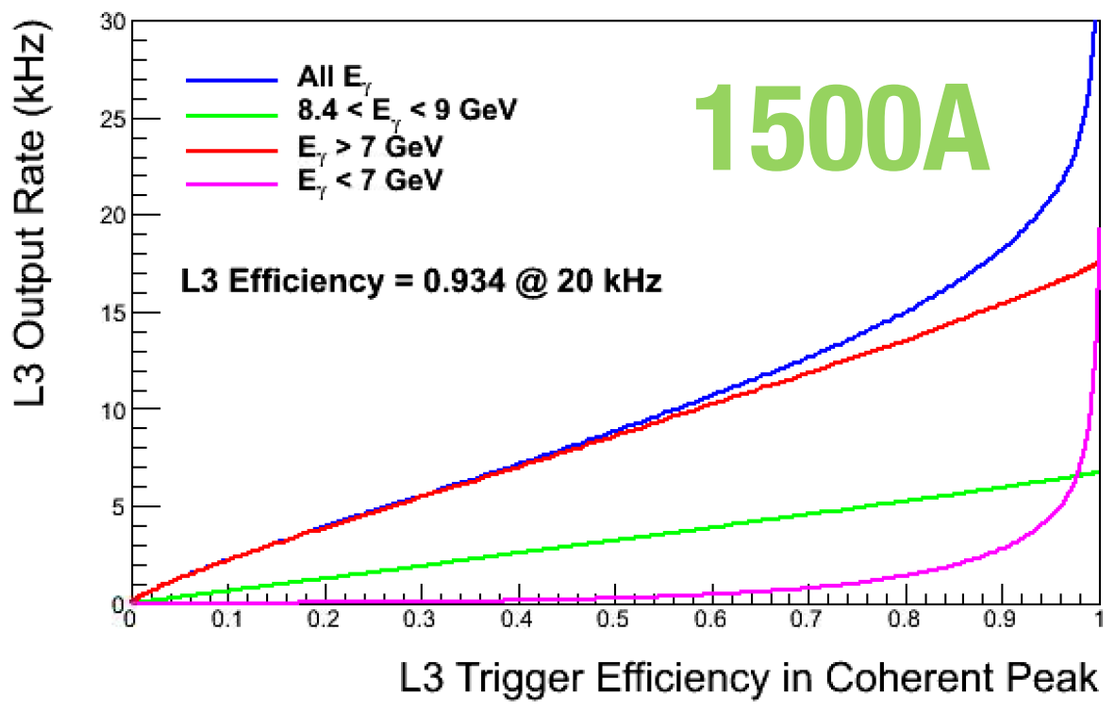




BDT evaluation







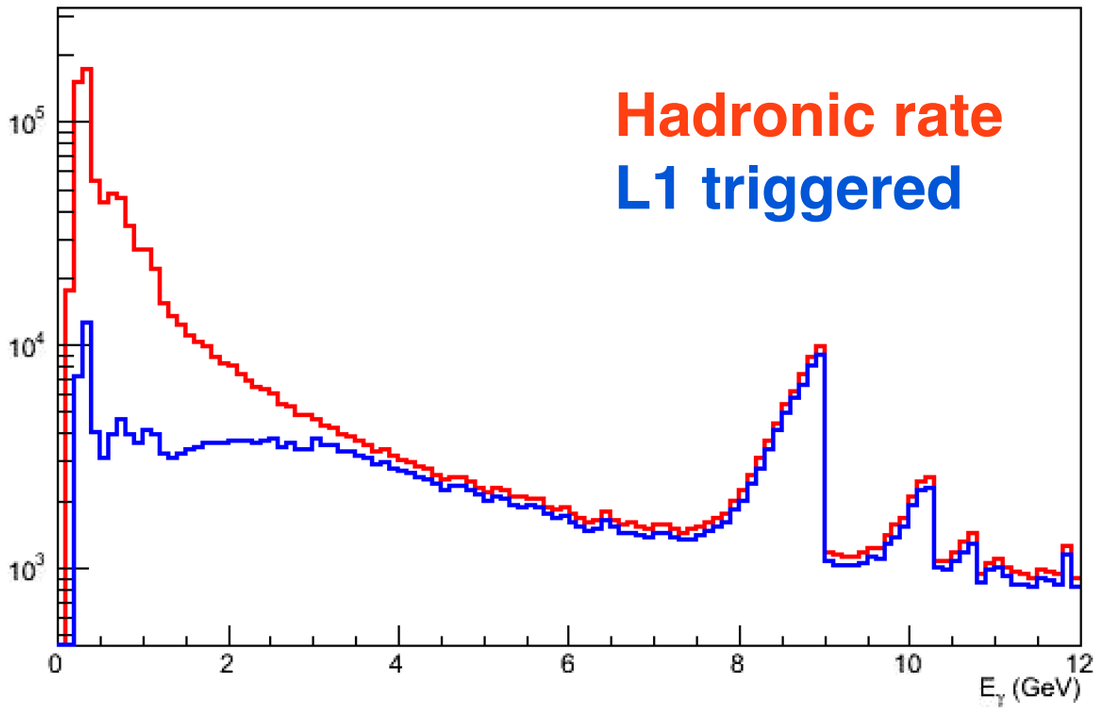
Summary

- Studied multiplicity and ECAL energy sum in EM only background events and found minor changes with solenoid current
- Momentum resolution reduced as expected with reduced magnetic field
- BDT for Level-3 trigger trained with bggen sample at the 3 different field settings
- Not much impact from magnetic field reduction observed on the variables used in L3 trigger, and therefore effect on the trigger performance is small

Backup

Level-1 Trigger

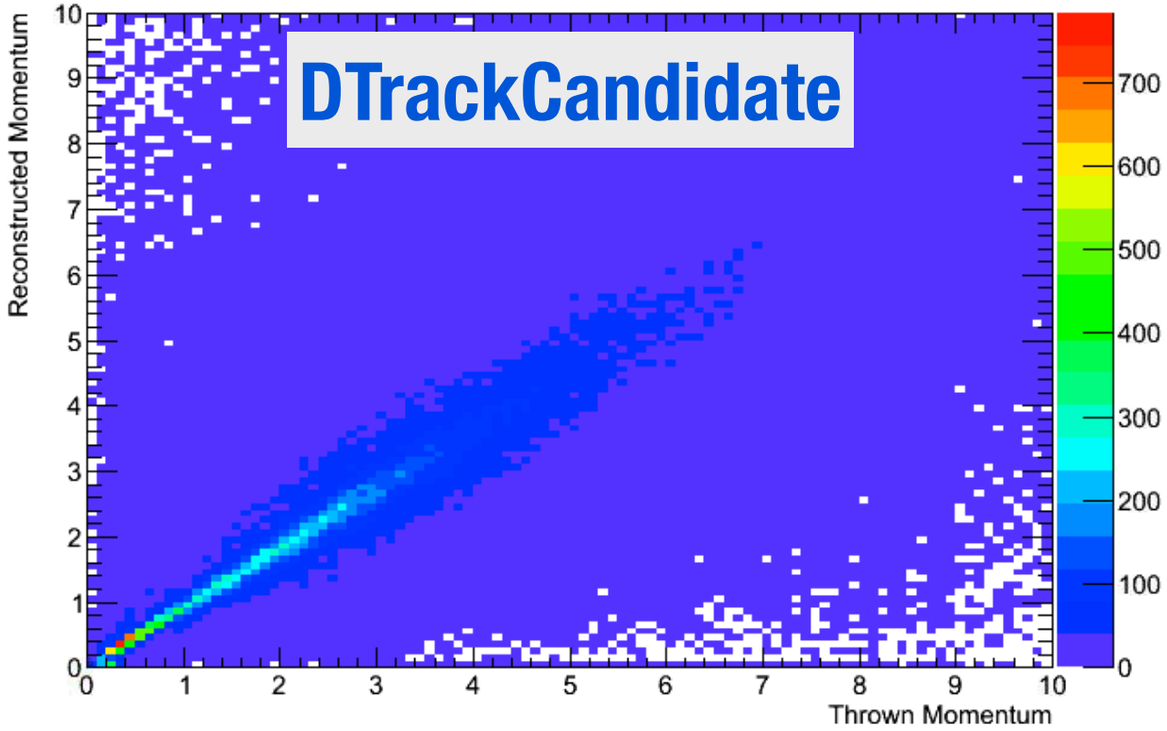
GlueX-doc-1043: Implemented in DMCTrigger

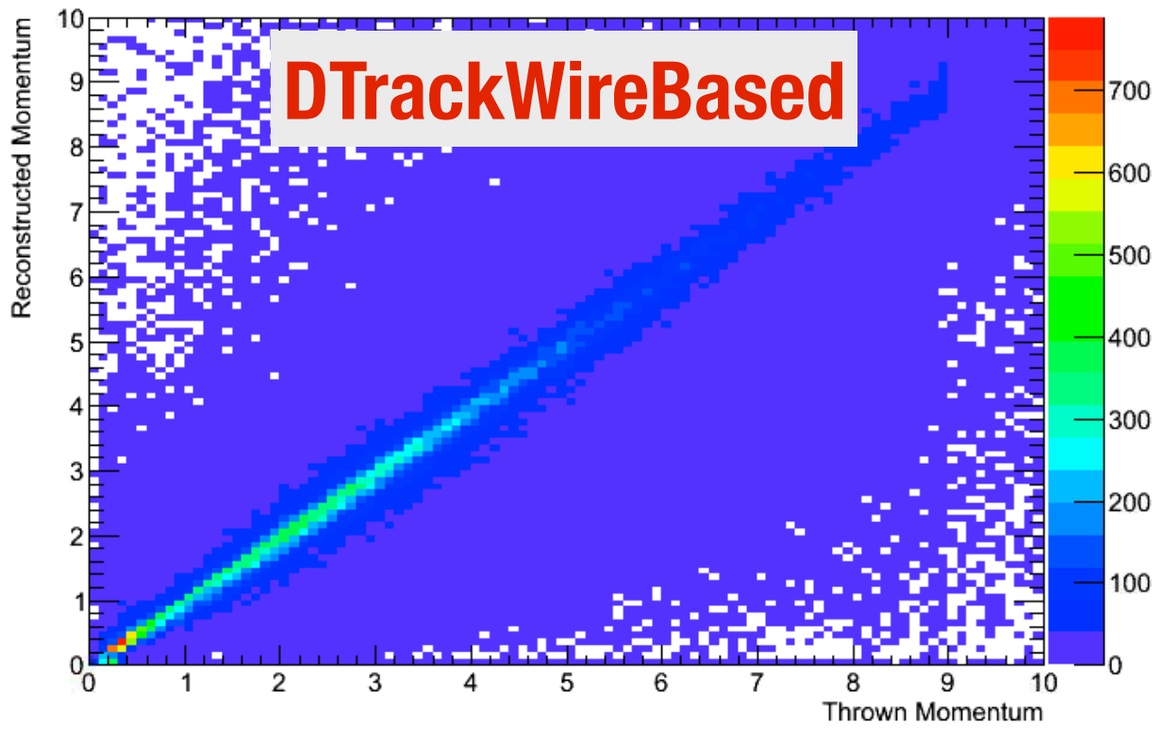


- Sample of bggen events with high-luminosity EM pileup
- Define "signal" as $E_\gamma > 7$ GeV and "background" $E_\gamma < 7$ GeV
- Accept events which fire L1a or L1b emulated trigger
- Reject ~77% of background with signal efficiency of 92%
- So far haven't considered EM only background rate

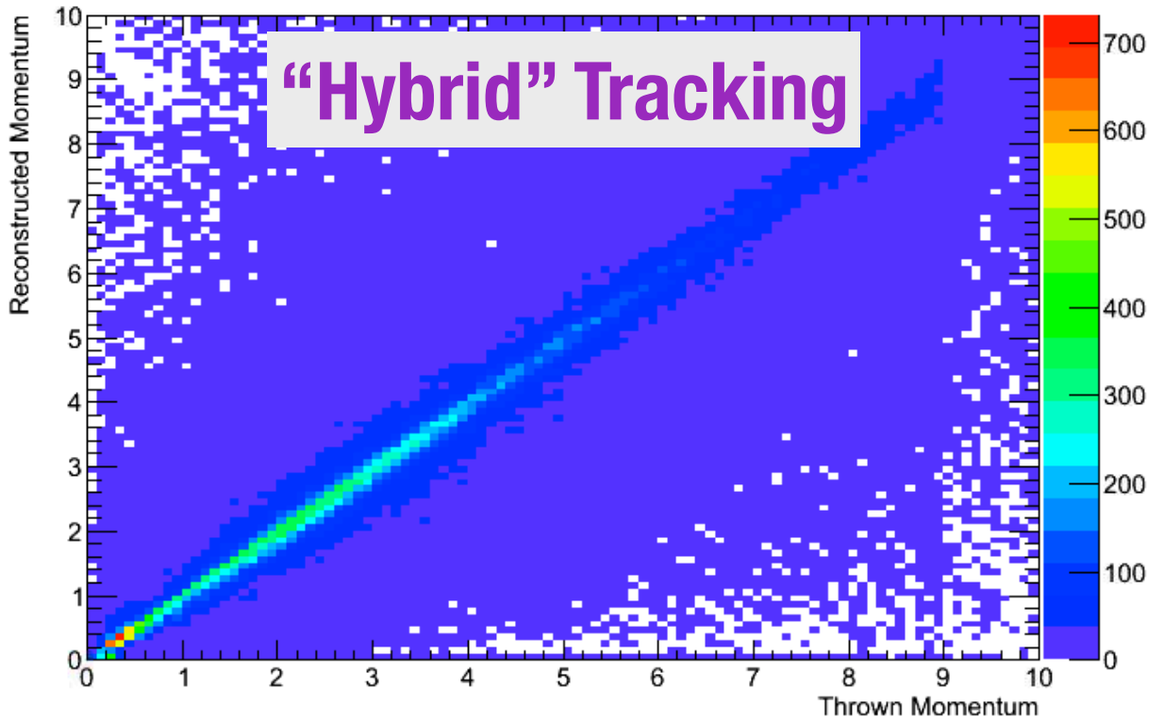
```
bool sum_cut = (Ebcal + 4.0*Efcal)>=2.0;
trig->L1a_fired = sum_cut && Ebcal>0.200 && Efcal>0.030;
trig->L1b_fired = sum_cut && Ebcal>0.030 && Efcal>0.030 && Nschits>0;
```

Track momentum sum resolution

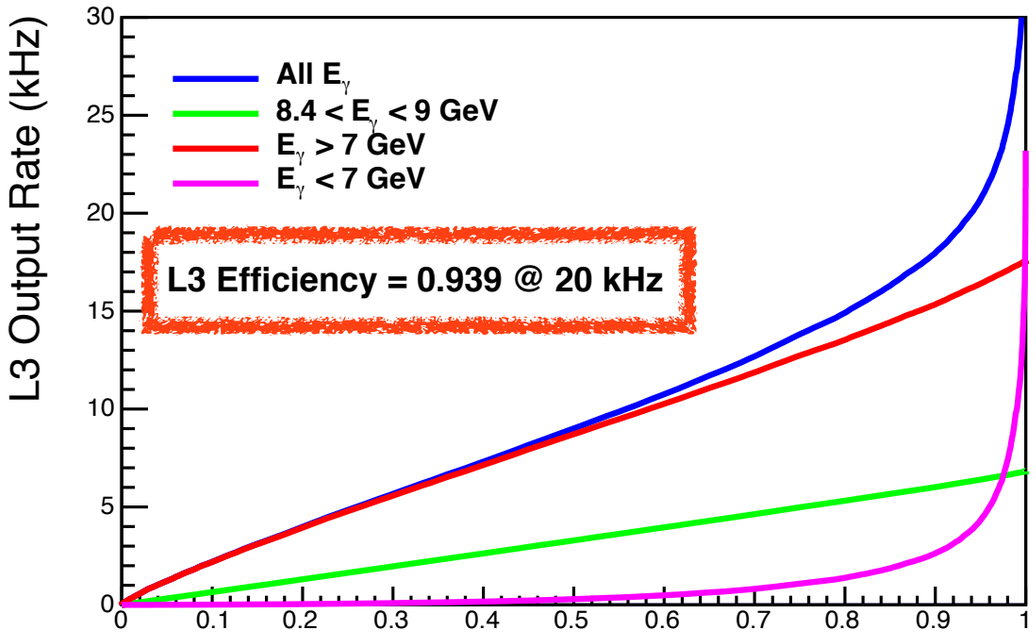


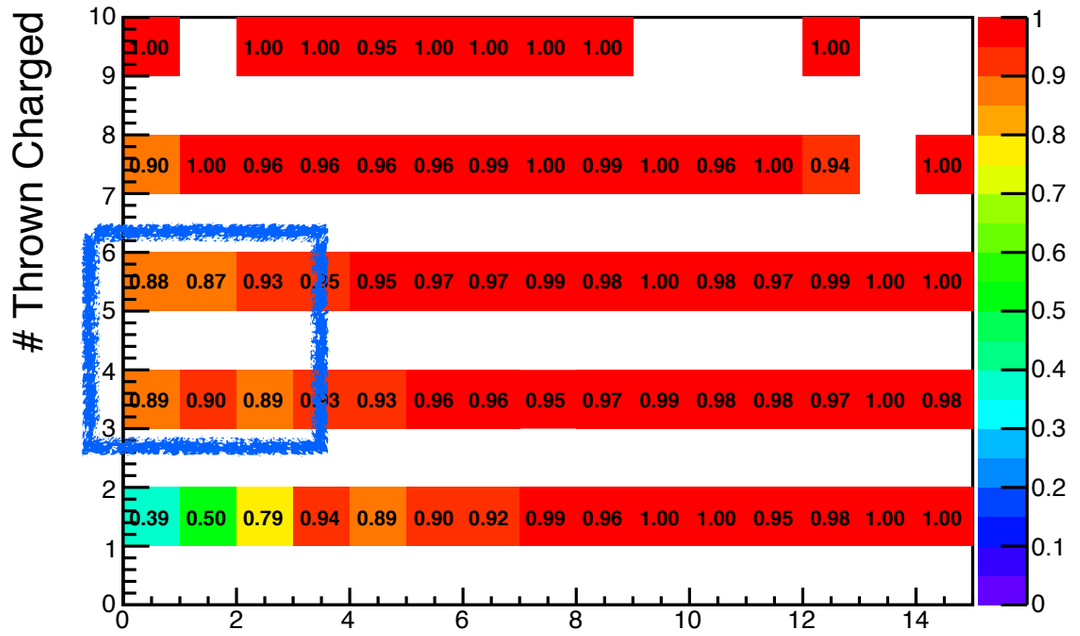


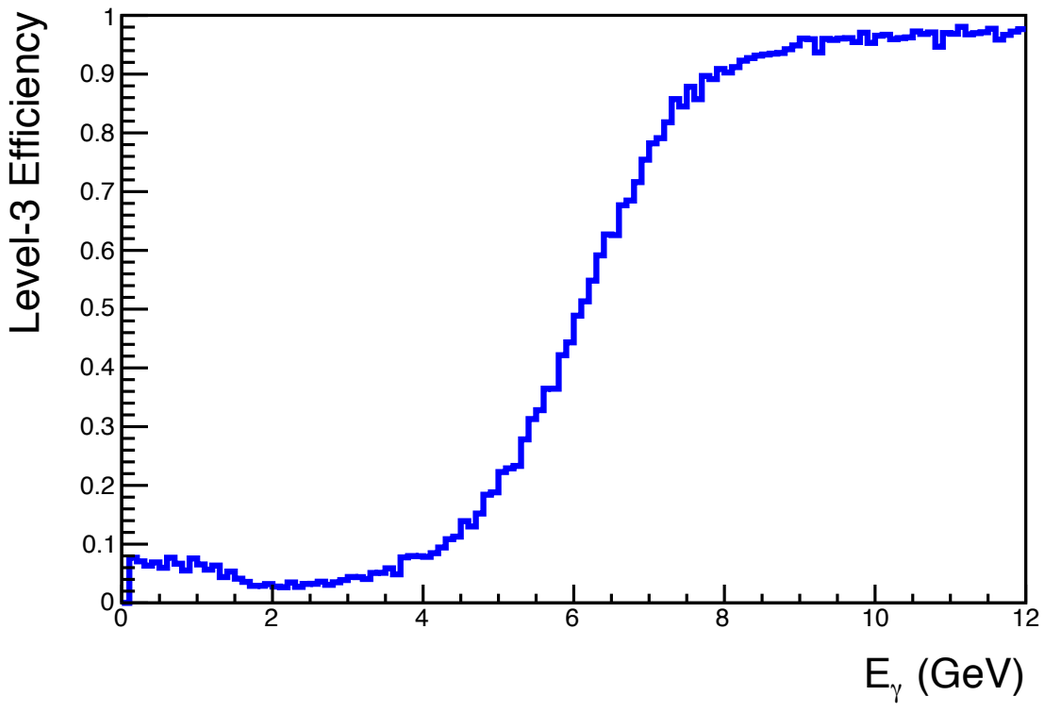
- Resolution only improved for wire-based with θ < 15
- **Take "hybrid" approach**: for DTrackCandidate's with θ < 15 (40% of candidates) and do wire-based fit and use that in track momentum sum



Hybrid tracking approach







- Now use **hybrid tracking** approach
- For a rate of 20 kHz, achieve ~94% L3 average efficiency in the coherent peak
- For # neutrons = 0, have ~96% effic
- 89% efficiency for zero photon events
- Performance is similar to doing full wire-based tracking (with less CPU)