CAL MIP finder

- Algorithm update
- Bug correction (Rev 1.16)
- Selection efficiencies

The algorithm – Rev1.16 (1/4)

- Source code in CalRecon/src/MipFinding/StdMipFindingTool.cxx
- Uses only CAL information !
- Defines map of "good" hits = digi's from CalXtalRecData with energy between 2 MeV and 50 MeV
  - Remark: in the following, a "good" hit is "free" when it does not belong already to another track
- Requires >3 "good" hits in CAL
- Finds MIP tracks (see next slides): each track will be a set of "good" hits {C0, C1, Cn (n=2,…N)}
- Stores CalMipTrack's properties in the TDS
- Stores best track in merit (AnalysisNtuple/src/CalMipValsTool.cxx) and all tracks in recon file

The algorithm – Rev1.16 (2/4)

- Finds C0: farthest "free" "good" hit from the CAL single cluster centroid, with energy between 8 MeV and 25 MeV (for a good start)
- Finds C1:
  - Loop over all remaining "free" "good" hits Hi in other layers (don't want an horizontal direction at the beginning)
  - For each hit Hi, propagate (G4Propagator) from C0 to Hi, identify crossed volumes and proceed as follows each time a CAL crystal Xij is found (propagation step #j):
    - If Xij in same layer as C0: continue propagation (no horizontal direction)
    - Stop (Hi will not be a C1 candidate) in the following cases:
      - Xij is not in same layer as Hi
      - Xij is a "bad" hit (either log not in CalXtalRecData or too low / high energy)
      - Xij is a "good" hit, but not "free"
    - If Xij is a "free" "good" hit in same layer as Hi:
      - If Xij != Hi, continue propagation
      - Otherwise stop, determine the exact path lengths through C0 and Hi, and require corrected energies ec_0 = e_0 * CsIHeight / arclen_0 and ec_i = e_i * CsIHeight / arclen_i (vertical equivalent energies) to lie between 9 MeV and 16 MeV. If ok, then we have a C1 candidate!
  - C1 is the closest hit to C0 among the candidates (if any)
- If no C1 found, start with another C0

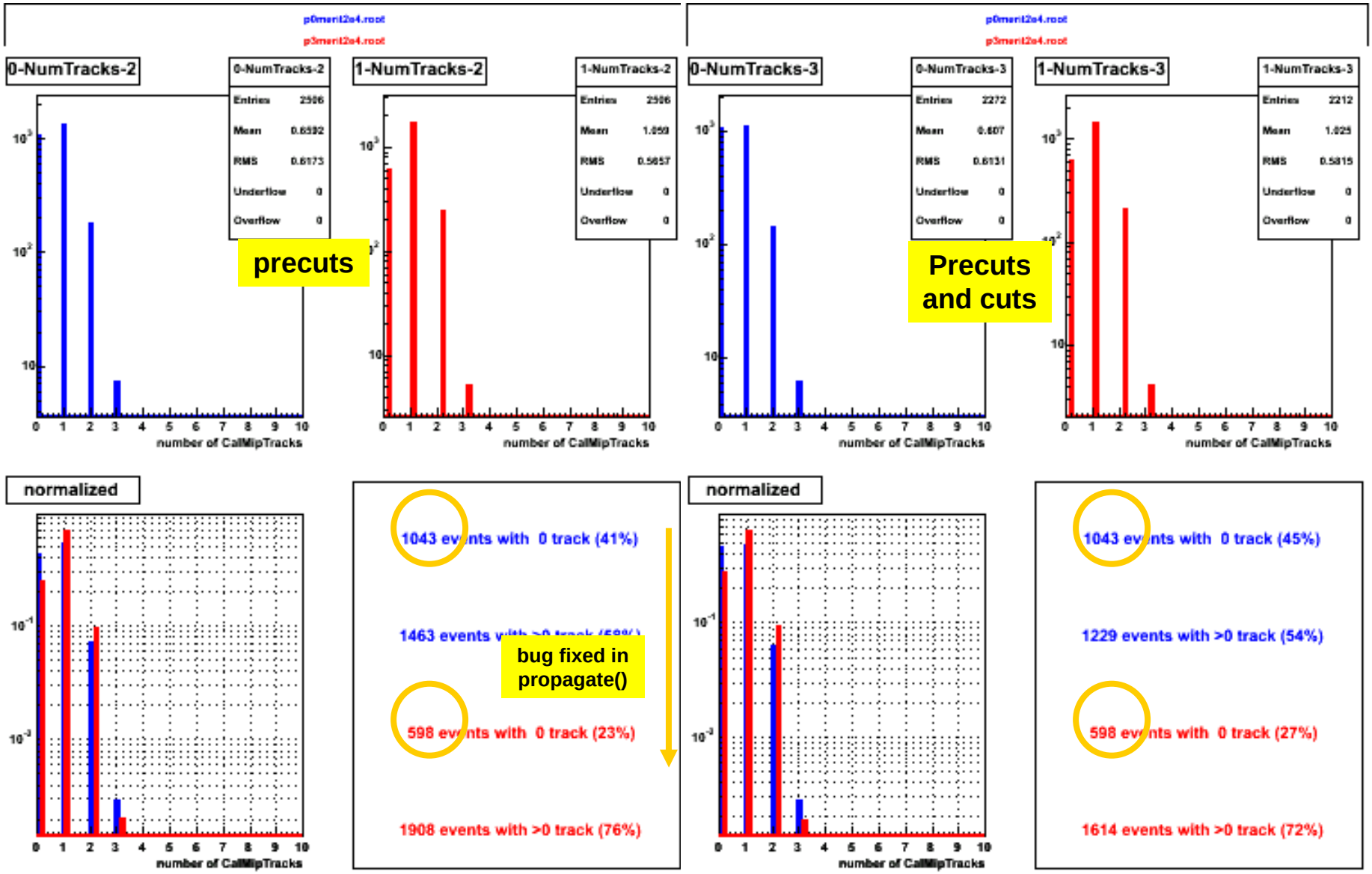
The algorithm – Rev1.16 (3/4)

- Finds Cn (n=2,…):
  - Start with direction Δ = either C0C1 (n=2) or the last fitted direction (n>2, see below)
  - Propagate along Δ (forwards and backwards) till CAL edge, identify crossed volume and proceed as follows each time a CAL crystal Xj is found (propagation step #j):
    - If Xj is a "good" hit, but not "free", continue propagation (we can have crossing tracks)
    - Otherwise stop the propagation:
      - if Xj is a bad hit, try with another direction: to avoid missing hits by stopping the propagation too soon (because of the CAL segmentation and/or error on Δ direction), propagate also along several lines parallel to Δ (and tangent to 5 cylinders of radius between 4 and 20 mm)
      - if Xj is a "free" "good" hit, compute its vertical equivalent energy ec_j and store it as a Cn candidate if ec_j between 9 MeV and 16 MeV
  - Cn is the closest hit to Δ among the candidates (if any)
- If a new Cn has been found:
  - Add Cn to the track and fit the new direction Δ through a least square method in both XZ and YZ planes (crystal lateral and longitudinal position errors set to CsIWidth/√12 mm and 10 mm, resp.; to be improved later…)
  - Go find another Cn
- If no more Cn found, go search for another track among the remaining "free" "good" hits

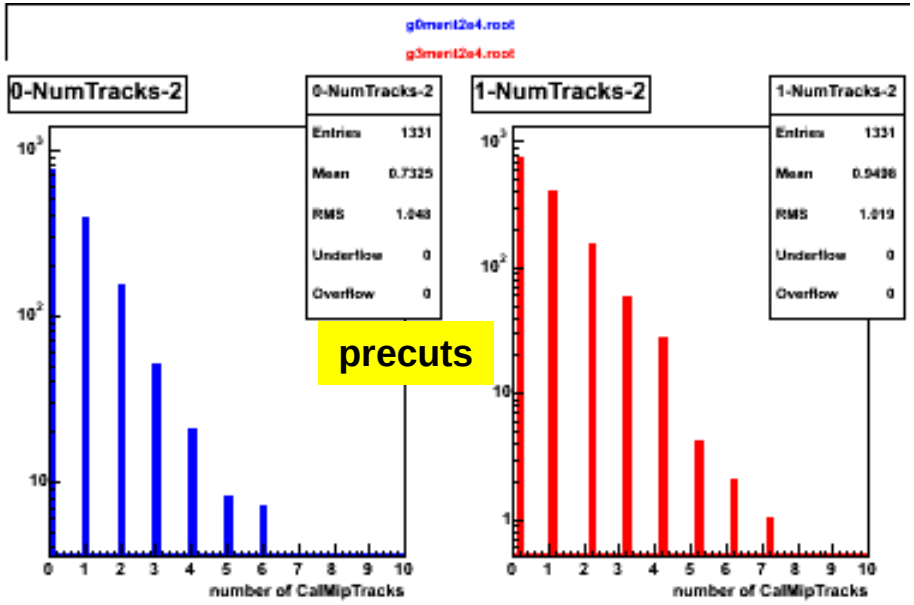
The algorithm – Rev1.16 (4/4)

- For each event, only store tracks {C0, C1, Cn (n=2,…N)} with N>3 in recon file
- CalMipTrack properties:
  - point, direction, distance to closest CAL edge
  - chi2 = (chi2_xz + chi2_yz) / (Nhits-1) from least square method
  - arcLen = summed over all layers containing at least one hit for this track
  - ecor = mean equivalent vertical energy computed by summing and correcting energies on a layer basis (to avoid the situation where the final track does not cross some of its hits!)
  - ecorRms = RMS over the different layers
  - erm = total energy (from CalXtalRecData) contained in a cylinder of 1 Moliere radius around track
- In the merit tuple: number of tracks and best track (i.e. best chi2) properties
- In the following: plot also dirErr = Acos(CalMipTrackDir*Tkr1Dir)

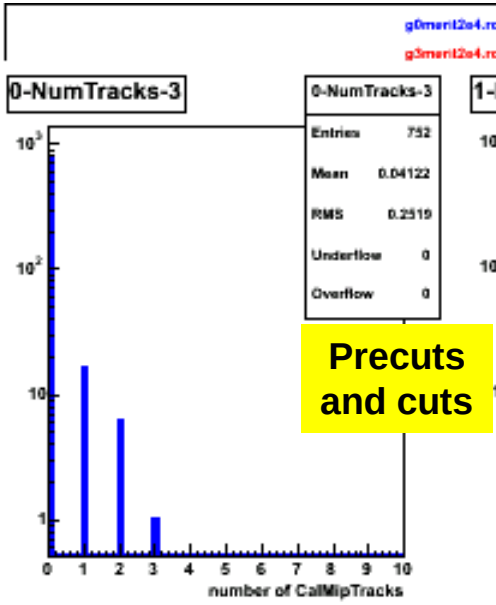
My simulations (1 GeV protons from a surface below the CAL)

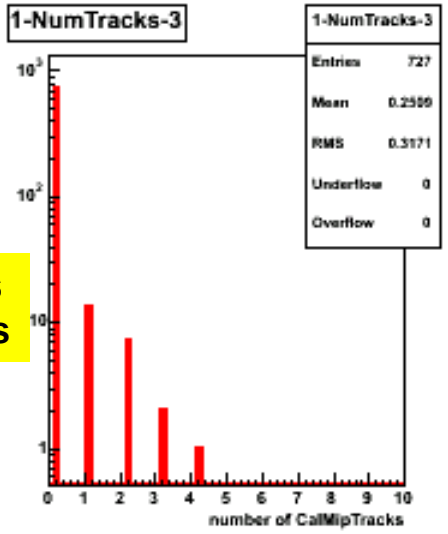


My simulations (all gamma's)

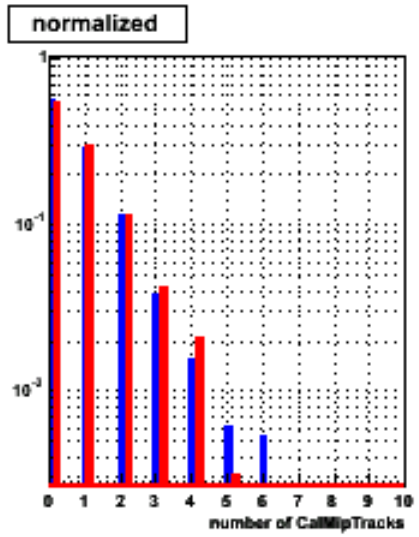


precuts





Precuts and cuts

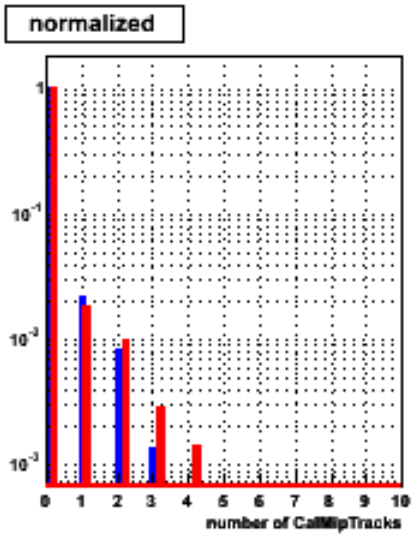


729 events with 0 track (54%)

602 events with >0 track (45%)

704 events with 0 track (52%)

627 events with >0 track (47%)



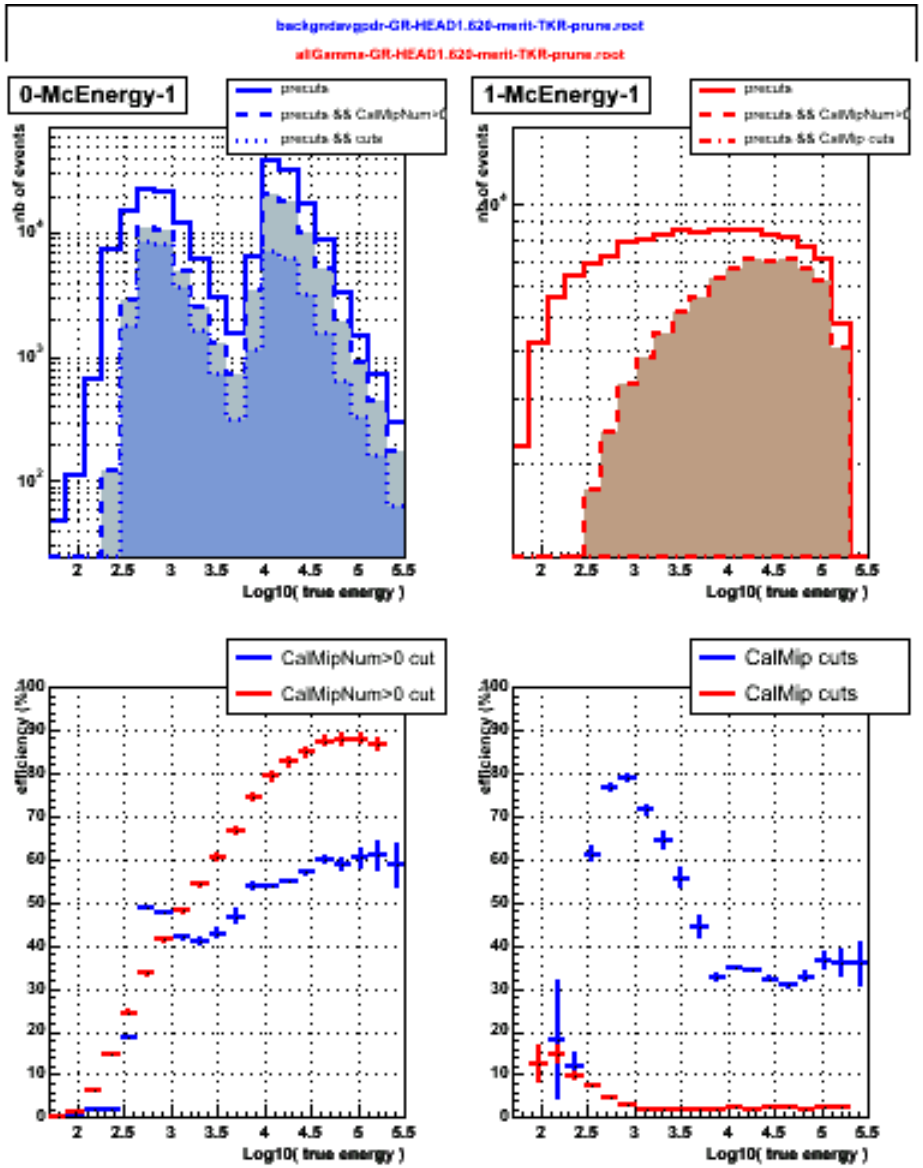
729 events with 0 track (96%)

23 events with >0 track (3%)

704 events with 0 track (96%)

23 events with >0 track (3%)

GR-HEAD1.620 simulations



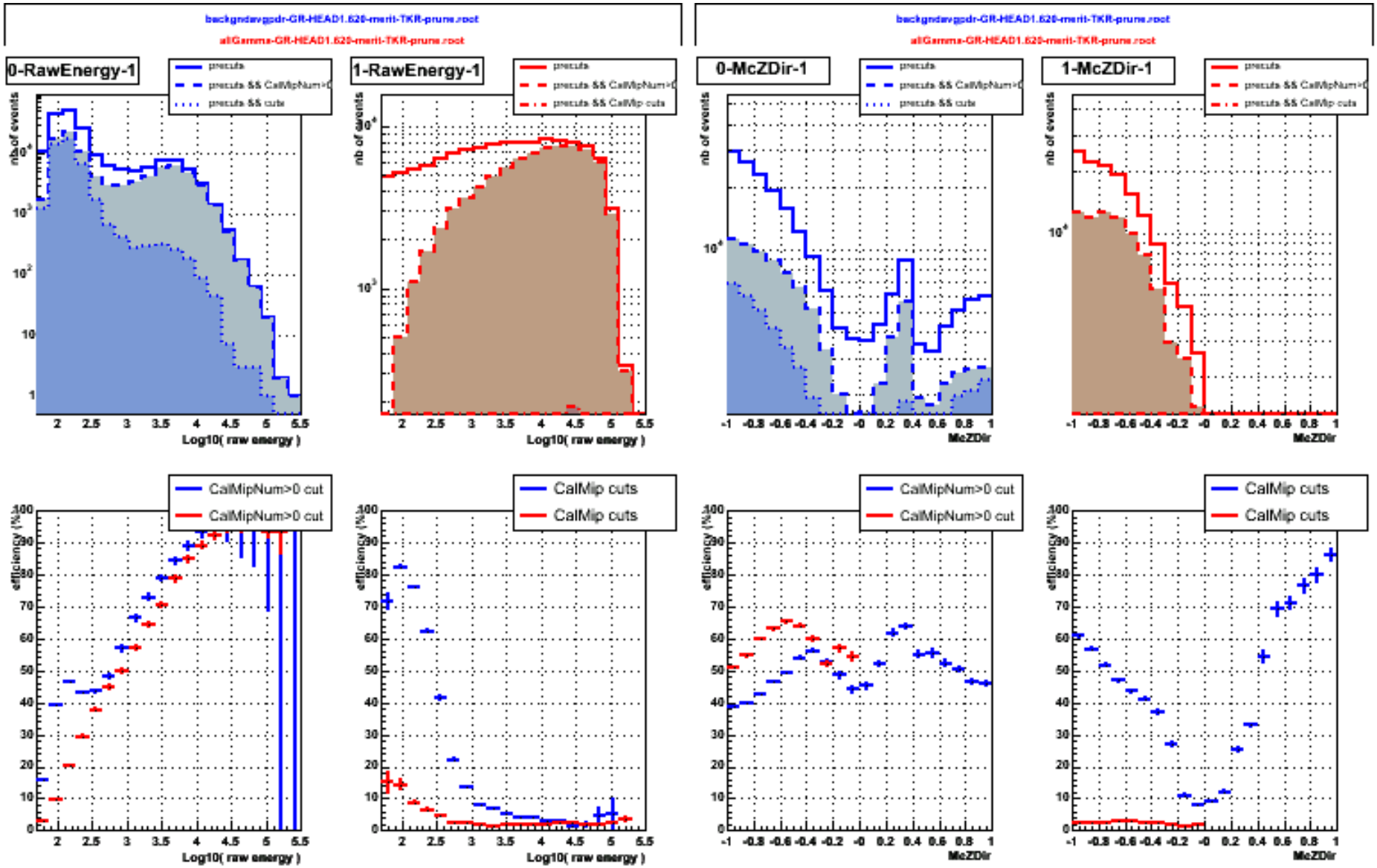
Pre-cuts :

TkrNumTracks > 0
&& CalCsIRLn > 4
&& CalEnergyRaw > 5
&& CalTotalCorr < 3.5
&& CalDeadTotRat < 0.15
&& CalGapFraction < 0.30
&& CalTransRms < 60
&& CalLRmsAsym > 0

Cuts :

CalMipErm / CalMipArcLen < 1
&& CalMipChi2 < 30
&& CalMipEcor between 8 and 25 MeV
&& CalMipEcorRms < 5
&& dirErr < 0.7

GR-HEAD1.620 simulations



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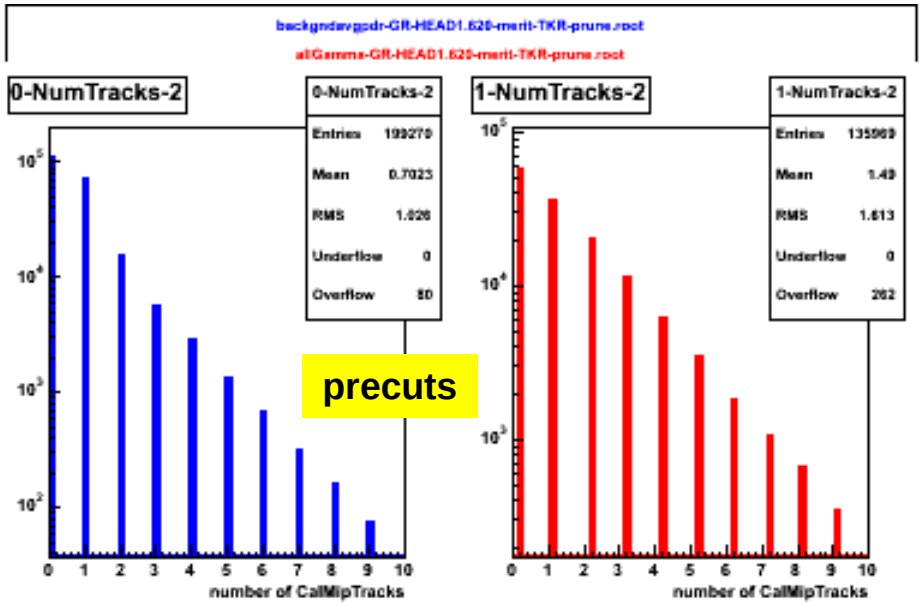
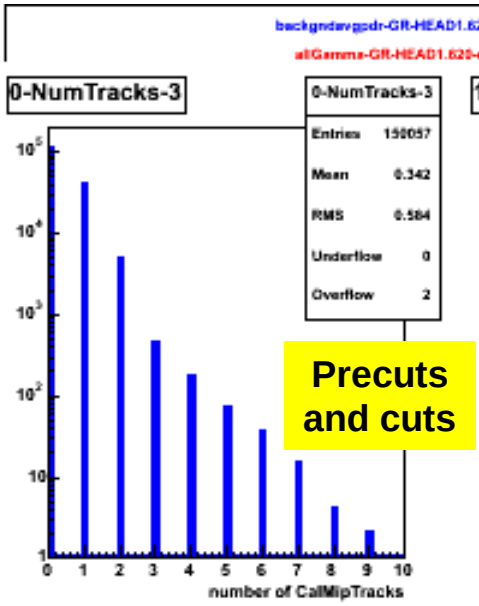
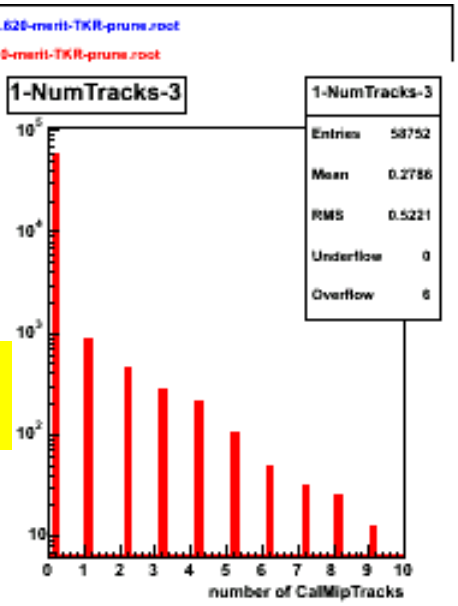


precuts





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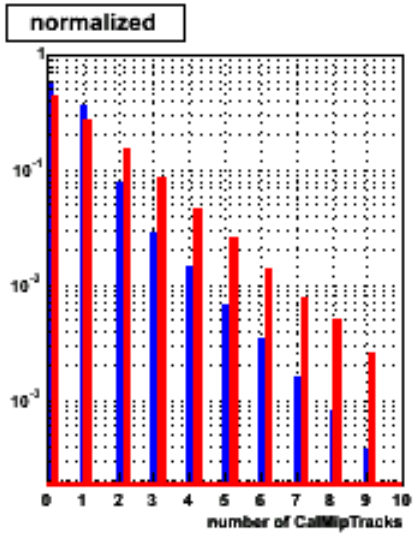
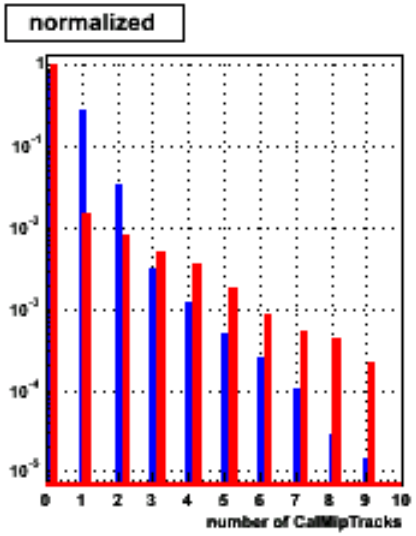


105349 events with 0 track (52%)

93921 events with >0 track (47%)

56788 events with 0 track (41%)

79181 events with >0 track (58%)



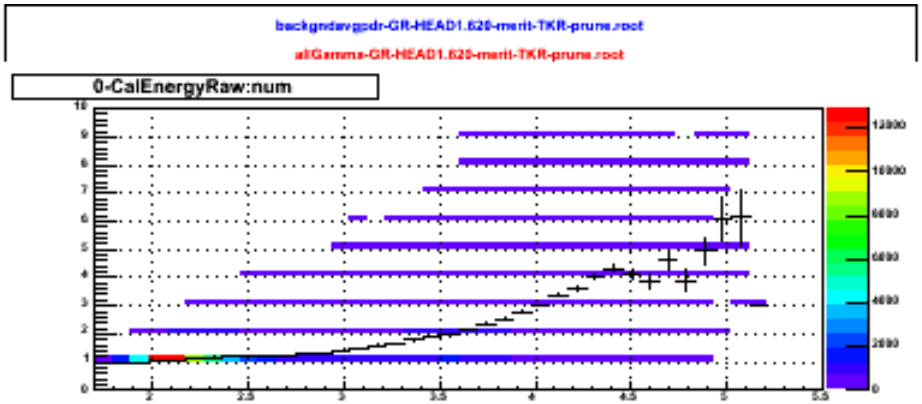
105349 events with 0 track (70%)

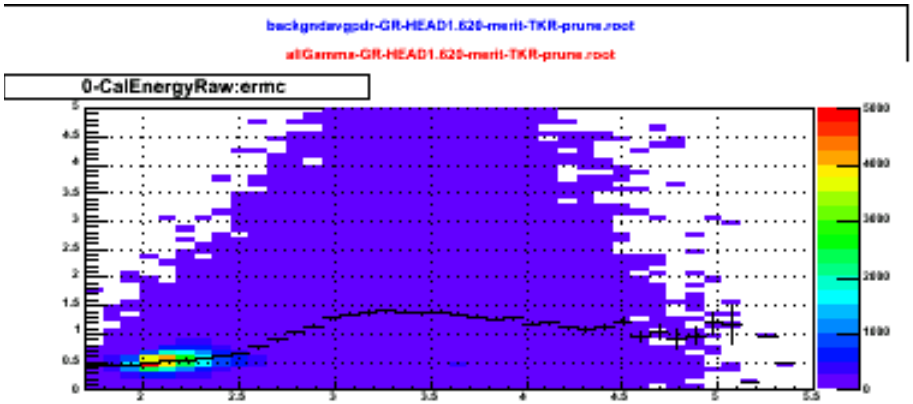
44708 events with >0 track (29%)

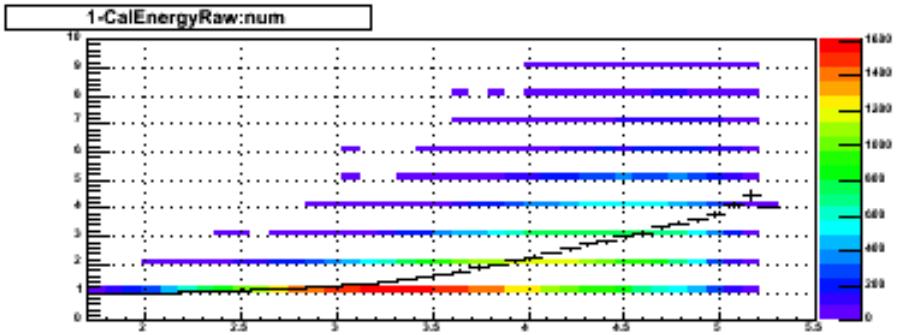
56788 events with 0 track (96%)

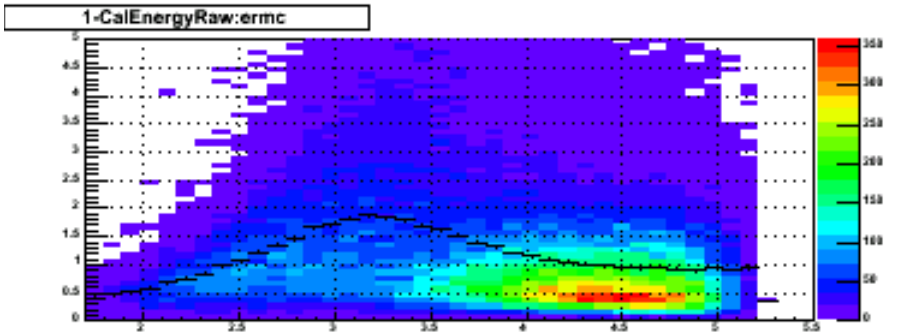
1964 events with >0 track (3%)

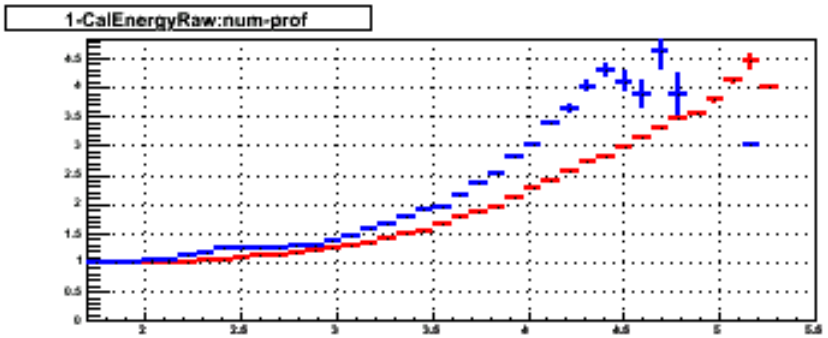
GR-HEAD1.620 simulations

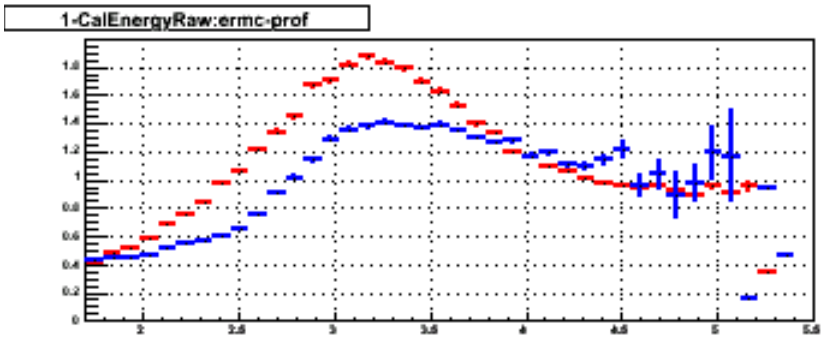












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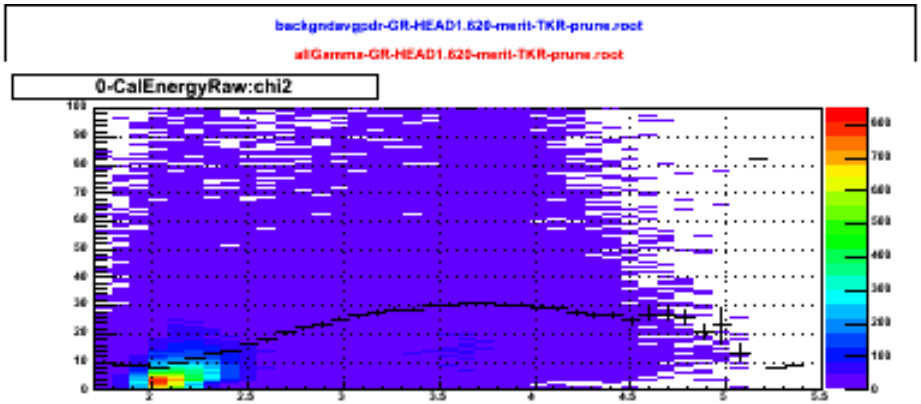
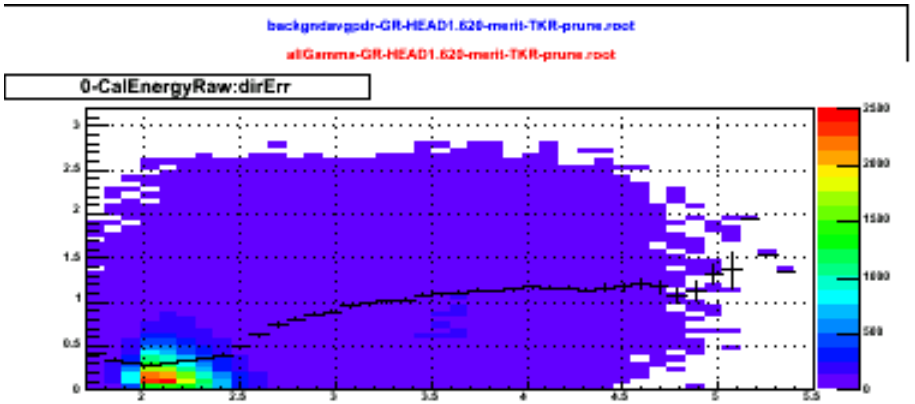
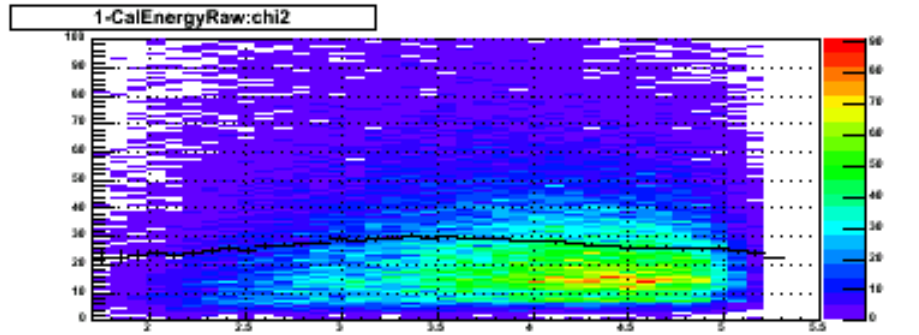
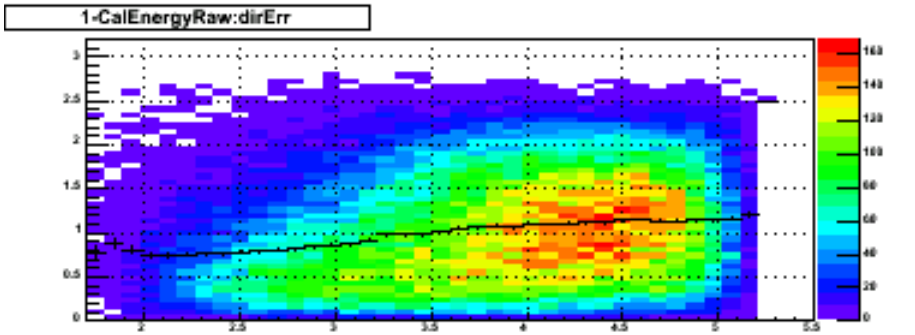
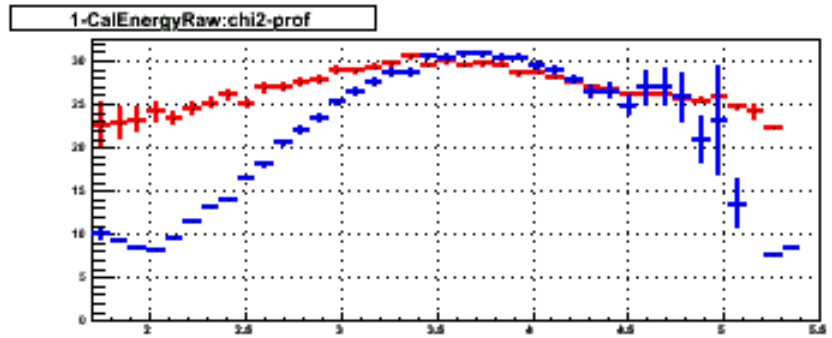
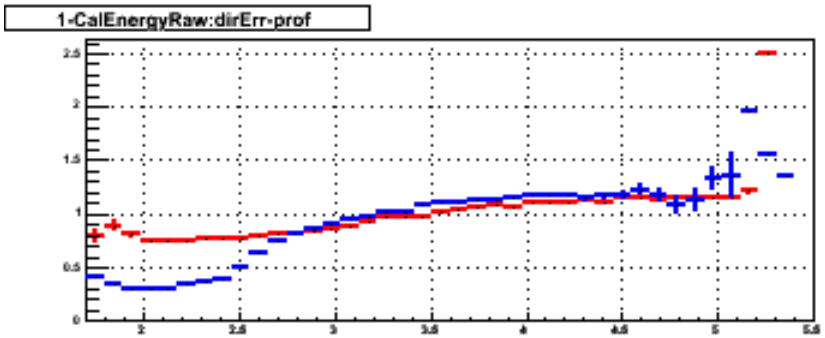




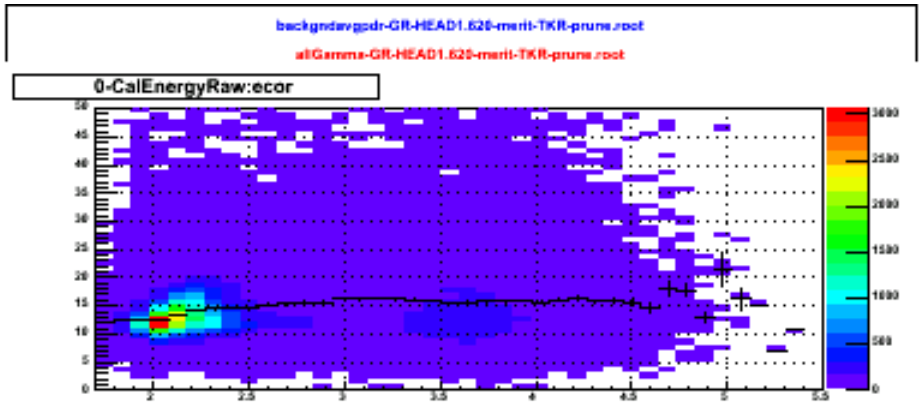


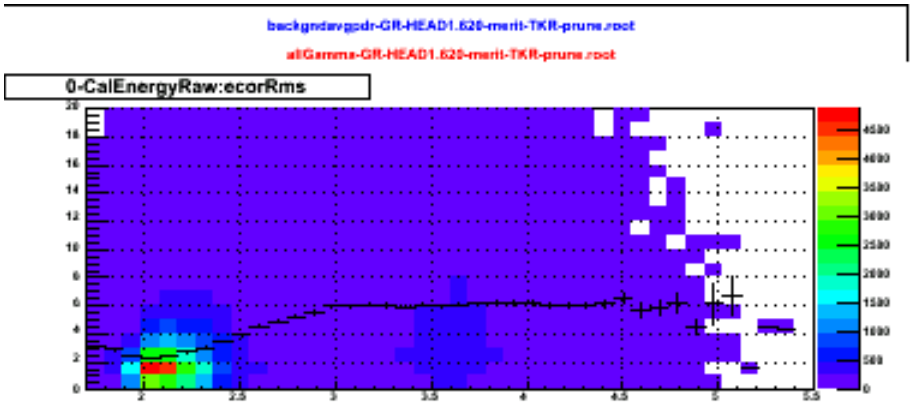


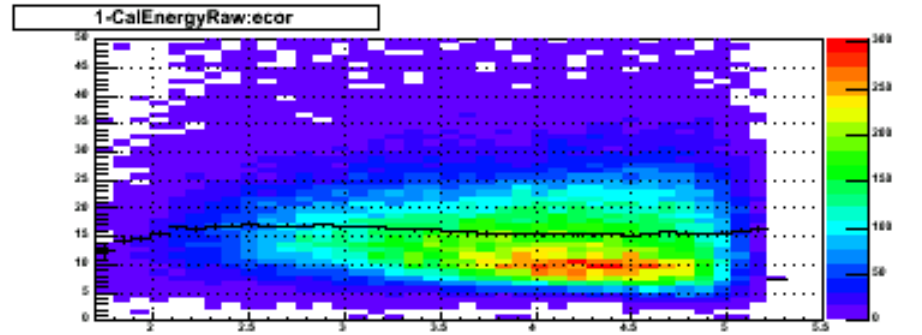


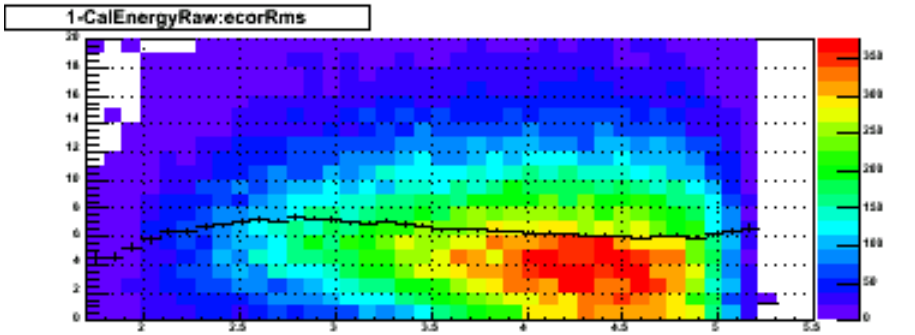


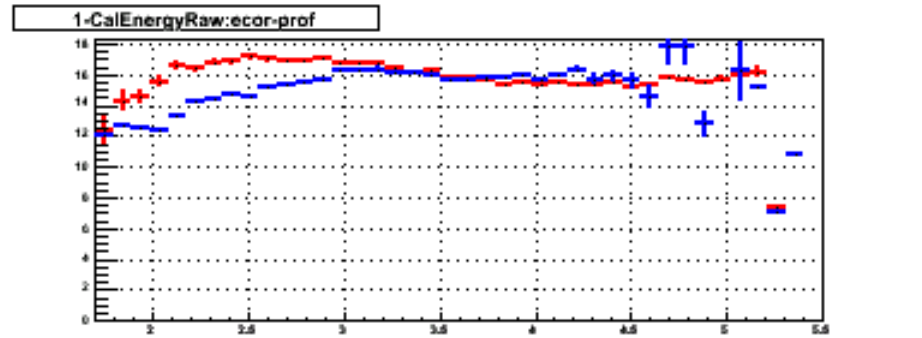
GR-HEAD1.620 simulations

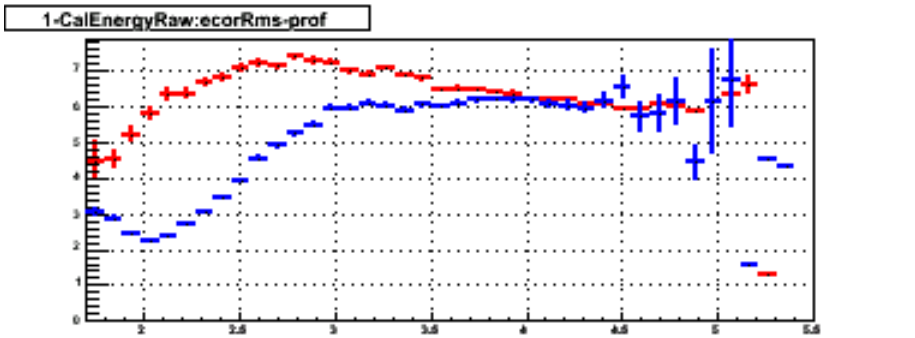












GR-HEAD1.620 simulations