Validation of CAL MIP finder algorithm with CERN / PS proton data

MF variables, data sets and cuts

- Procedure
  - Uses only CAL information !
  - selects CAL hits with energy between 2 MeV and 50 MeV (must be >3)
  - starts from a region far from the energy centroid and loop over hits
  - finds MIP track segments = sets of aligned hits with energy compatible with a MIP
  - Rev 1.17 (1.19 in BTrelease)

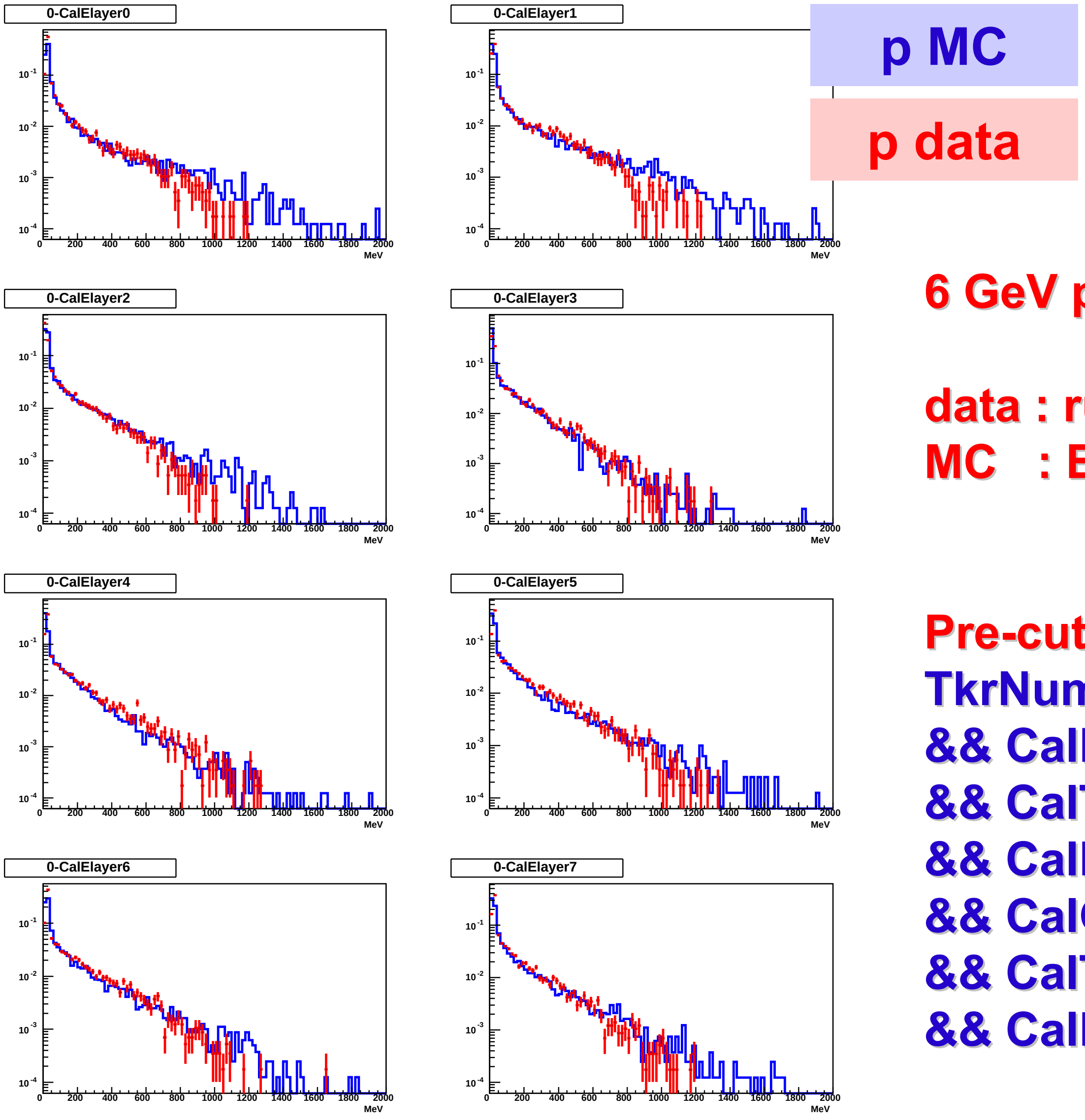
- Outputs
  - Merit: number of tracks (CalMipNum) and best track (from chi2)
  - Recon: all tracks with >3 hits

- CAL only variables
  - center point, direction, distance to closest CAL edge
  - chi2 = (chi2_xz + chi2_yz) / (Nhits-1) from a simple least square fit
  - arcLen = total arc length over all layers containing at least one hit for this track
  - ecor = mean equivalent vertical energy computed by averaging path-length corrected energies on a layer basis
  - ecorRms = corresponding RMS
  - erm = total energy contained in a cylinder of 1 Moliere radius around track

    $\Rightarrow$ ermc = erm/arcLen (not in merit!)

- CAL + TKR variables (not in merit!) – need TkrNumTracks>0
  - dErr = Acos(CalMipTrackDir*Tkr1Dir) = angle between CalMipTrack and TKR best track
  - barDist = distance between TKR best track extrapolation and CalMipTrack center point

MF variables, data sets and cuts



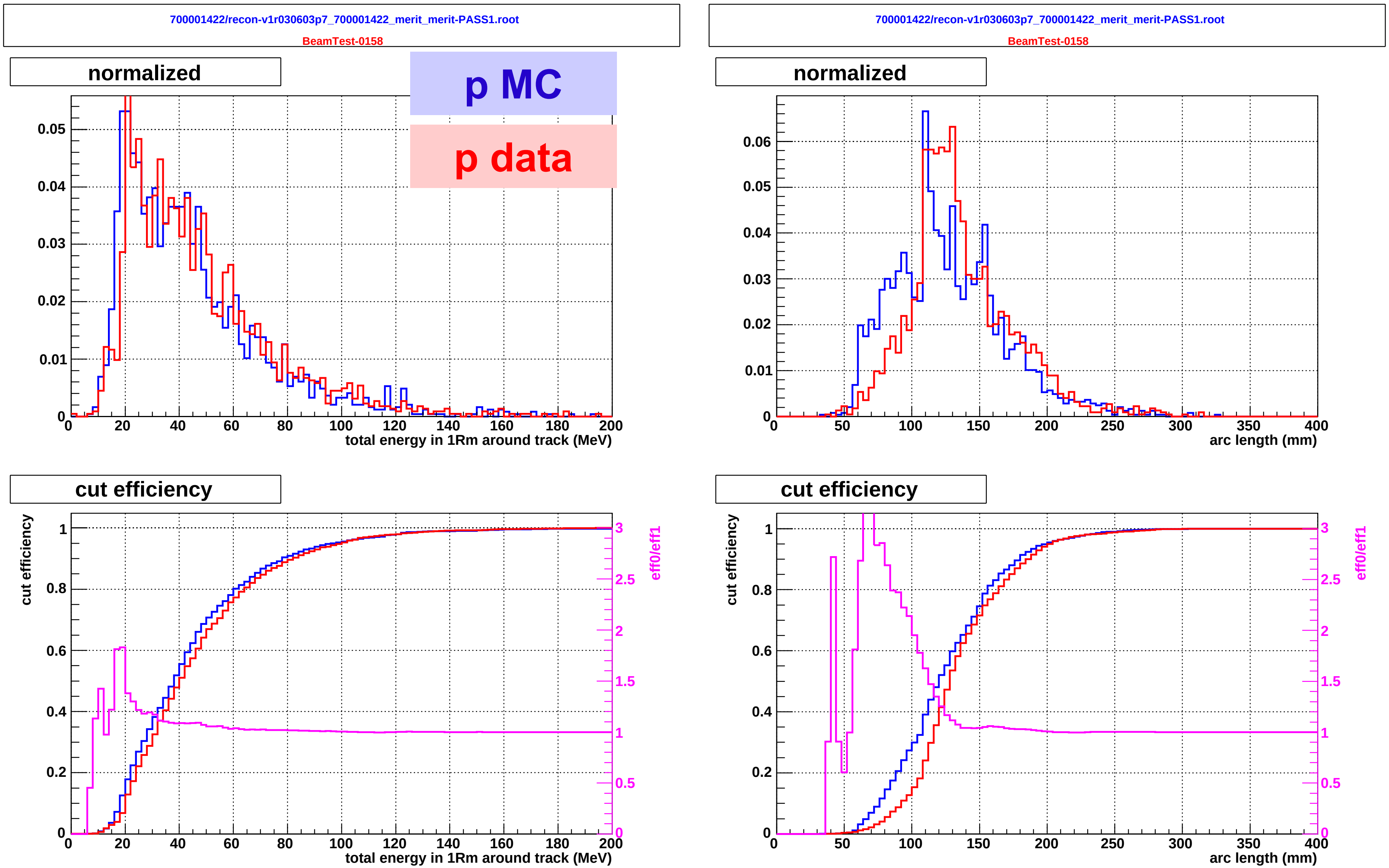
Raw energy per layer

6 GeV protons at 60 deg

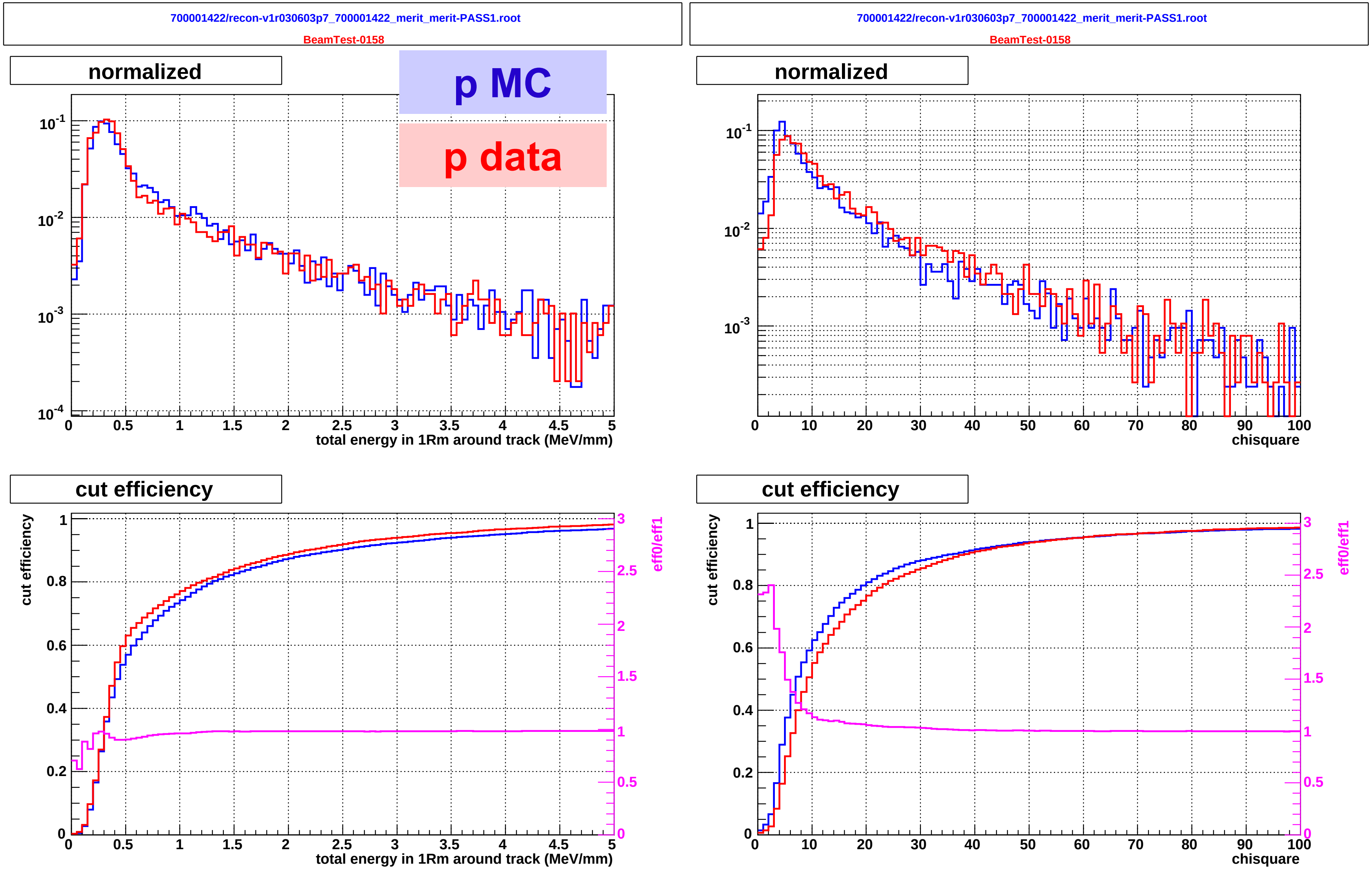
data : run 700001422
MC : BeamTest-0158

Pre-cuts:
TkrNumTracks > 0
&& CalEnergyRaw > 5
&& CalTotalCorr < 3.5
&& CalDeadTotRat < 0.15
&& CalGapFraction < 0.30
&& CalTransRms < 60
&& CalLRmsAsym > 0

p data vs MC


700001422/recon-v1r030603p7_700001422_merit_merit-PASS1.root
BeamTest-0158
normalized
p MC
p data
total energy in 1Rm around track (MeV)
arc length (mm)
cut efficiency
eff0/eff1

p data vs MC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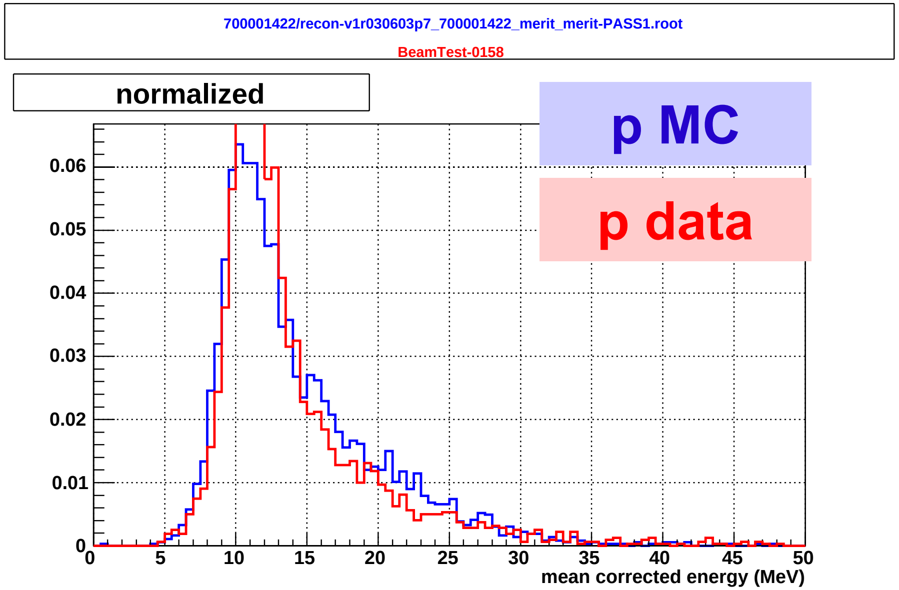
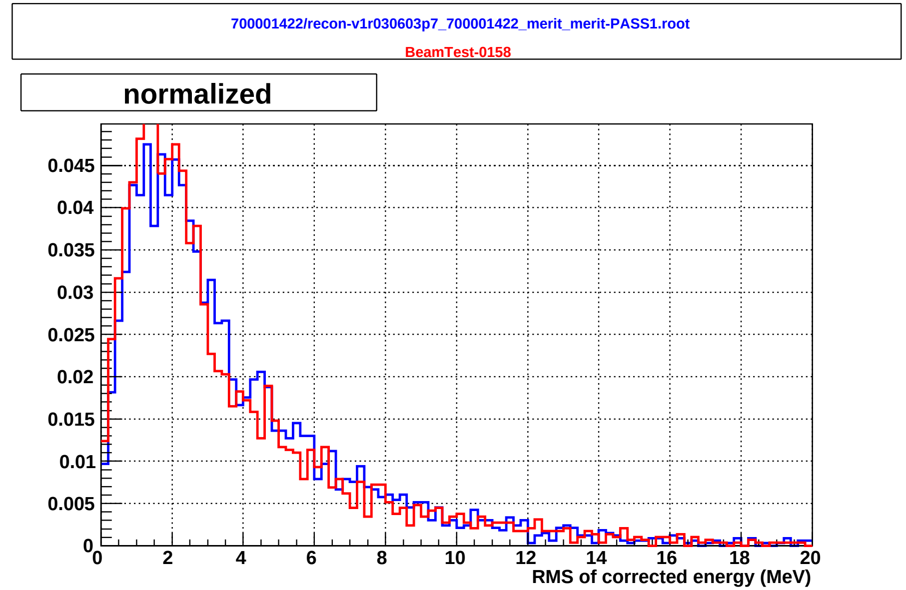
BeamTest-0158
normalized
p MC
p data
total energy in 1Rm around track (MeV/mm)
700001422/recon-v1r030603p7_700001422_merit_merit-PASS1.root
BeamTest-0158
normalized
chisquare
cut efficiency
cut efficiency
eff0/eff1
total energy in 1Rm around track (MeV/mm)
cut efficiency
cut efficiency
eff0/eff1
chisquare

p data vs MC


700001422/recon-v1r030603p7_700001422_merit_merit-PASS1.root
BeamTest-0158
normalized
p MC
p data
0
0.01
0.02
0.03
0.04
0.05
0.06
0 5 10 15 20 25 30 35 40 45 50
mean corrected energy (MeV)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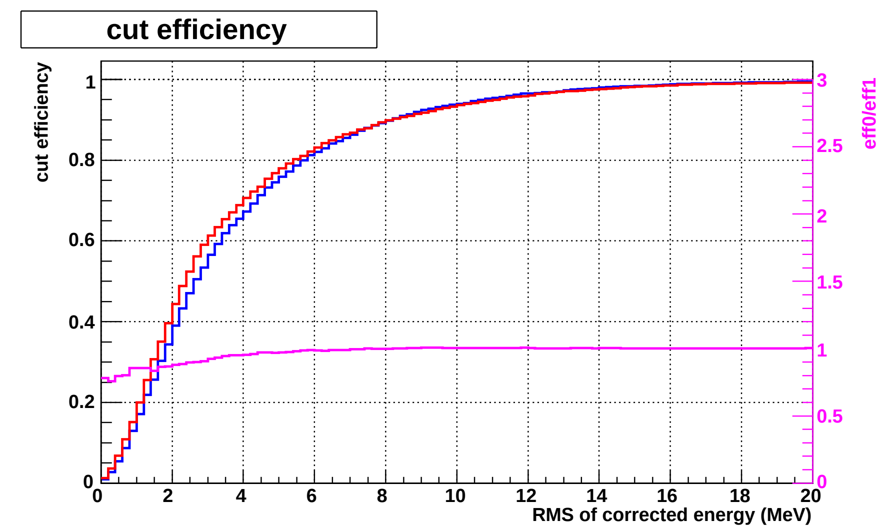
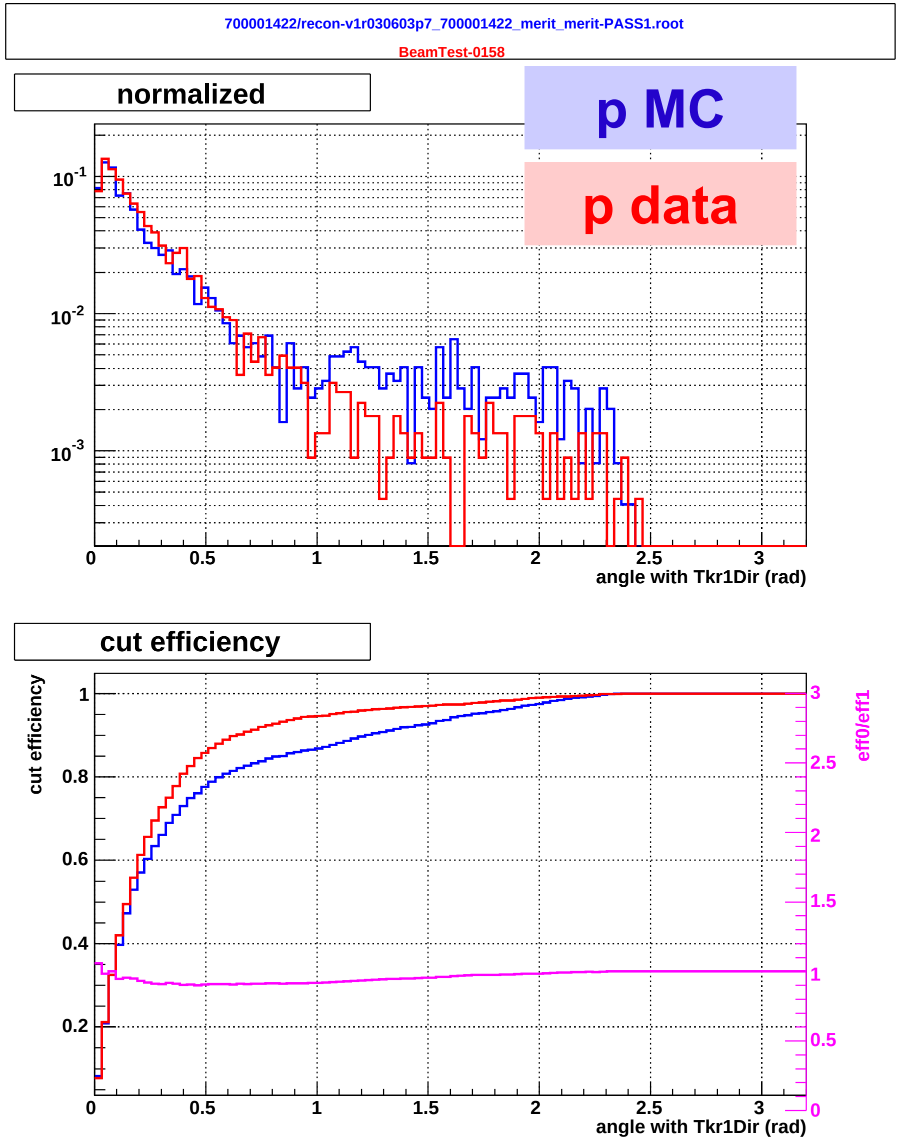
BeamTest-0158
normalized
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
0.045
0 2 4 6 8 10 12 14 16 18 20
RMS of corrected energy (MeV)


cut efficiency
cut efficiency
0
0.2
0.4
0.6
0.8
1
eff0/eff1
0
0.5
1
1.5
2
2.5
3
0 2 4 6 8 10 12 14 16 18 20
RMS of corrected energy (MeV)

p data vs MC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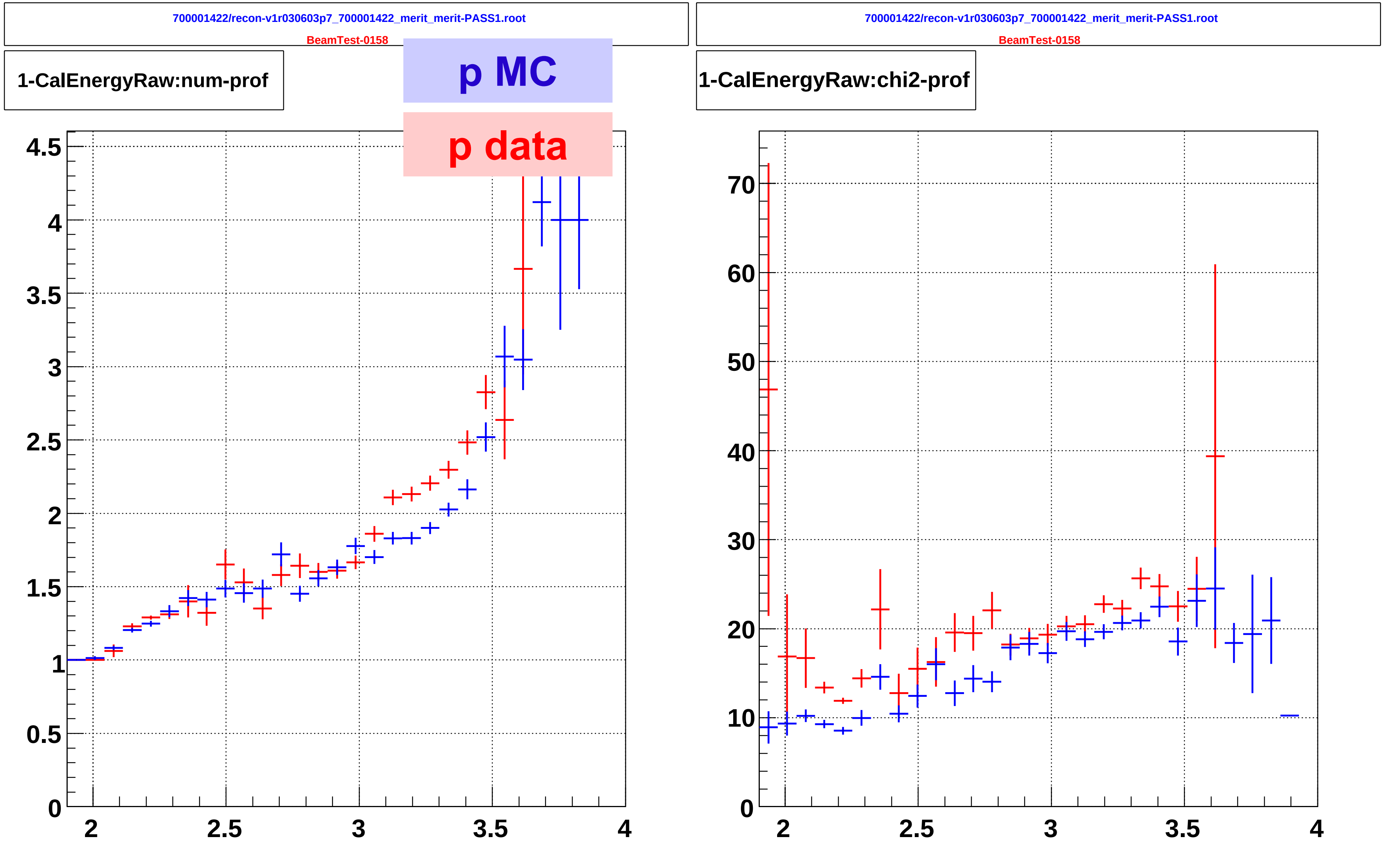
BeamTest-0158
normalized
p MC
p data
10^{-1}
10^{-2}
10^{-3}
0
0.5
1
1.5
2
2.5
3
angle with Tkr1Dir (rad)
cut efficiency
cut efficiency
1
0.8
0.6
0.4
0.2
eff0/eff1
3
2.5
2
1.5
1
0.5
0
angle with Tkr1Dir (rad)

p data vs MC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BeamTest-0158
1-CalEnergyRaw:num-prof
p MC
p data
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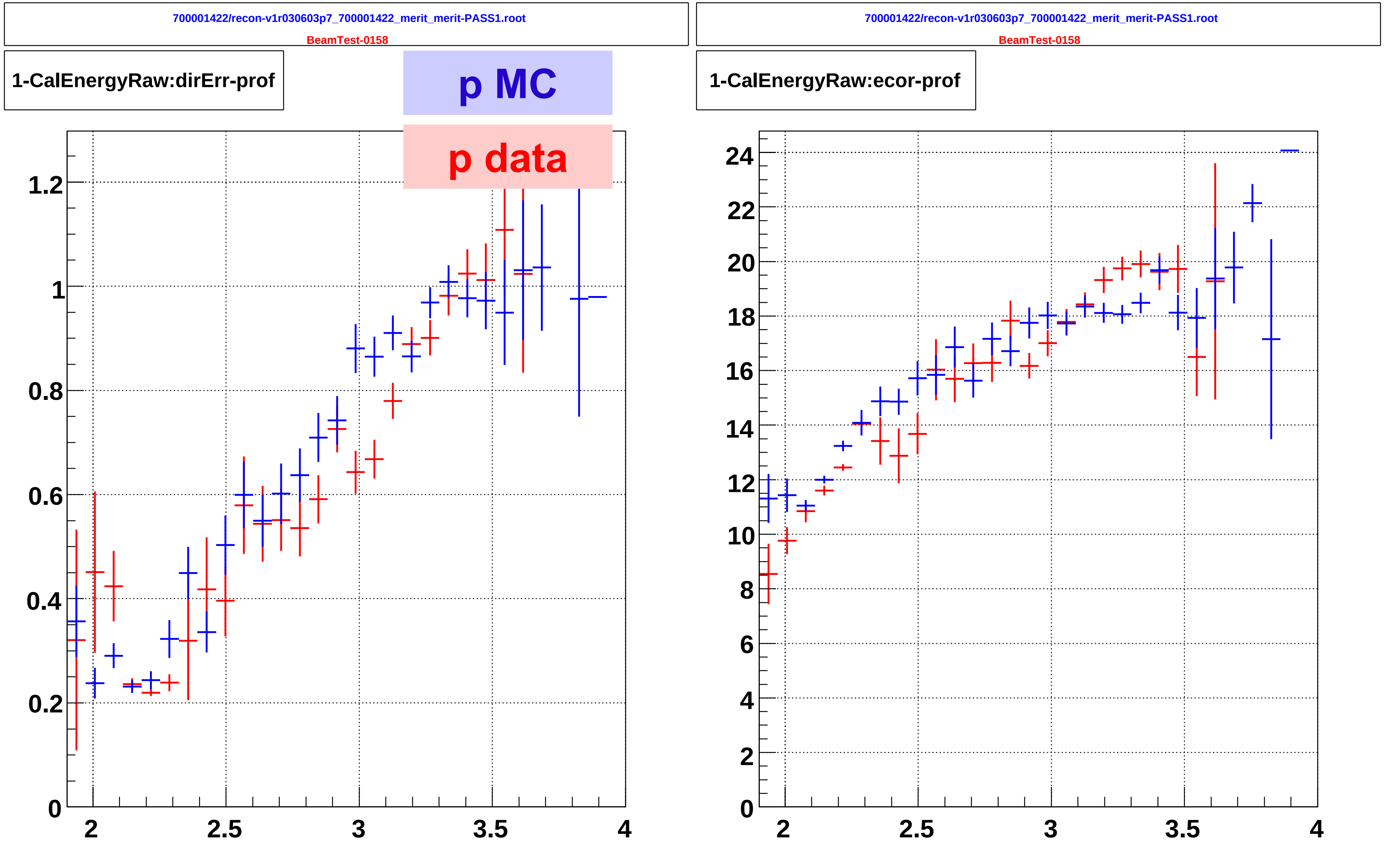
BeamTest-0158
1-CalEnergyRaw:chi2-prof

p data vs MC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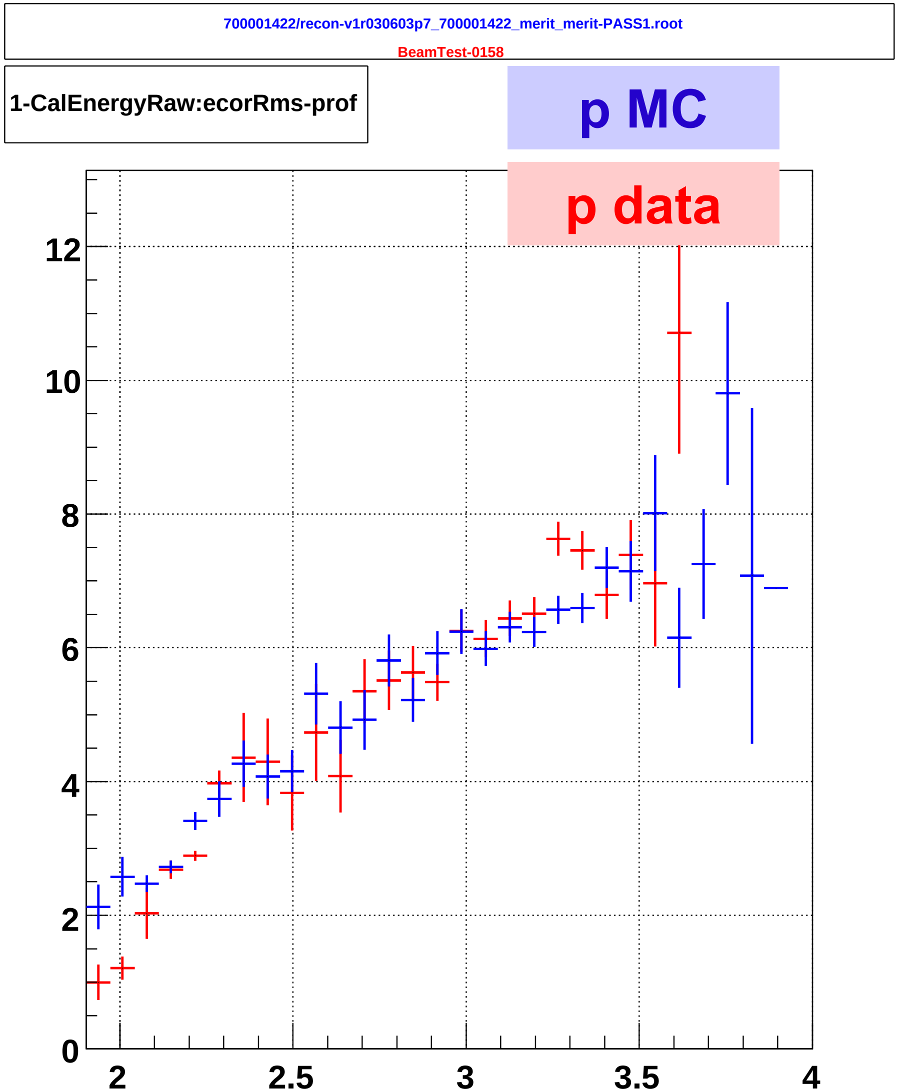
BeamTest-0158
1-CalEnergyRaw:dirErr-prof
p MC
p data
1.2
1
0.8
0.6
0.4
0.2
0
2
2.5
3
3.5
4
700001422/recon-v1r030603p7_700001422_merit_merit-PASS1.root
BeamTest-0158
1-CalEnergyRaw:ecor-prof
24
22
20
18
16
14
12
10
8
6
4
2
0
2
2.5
3
3.5
4

p data vs MC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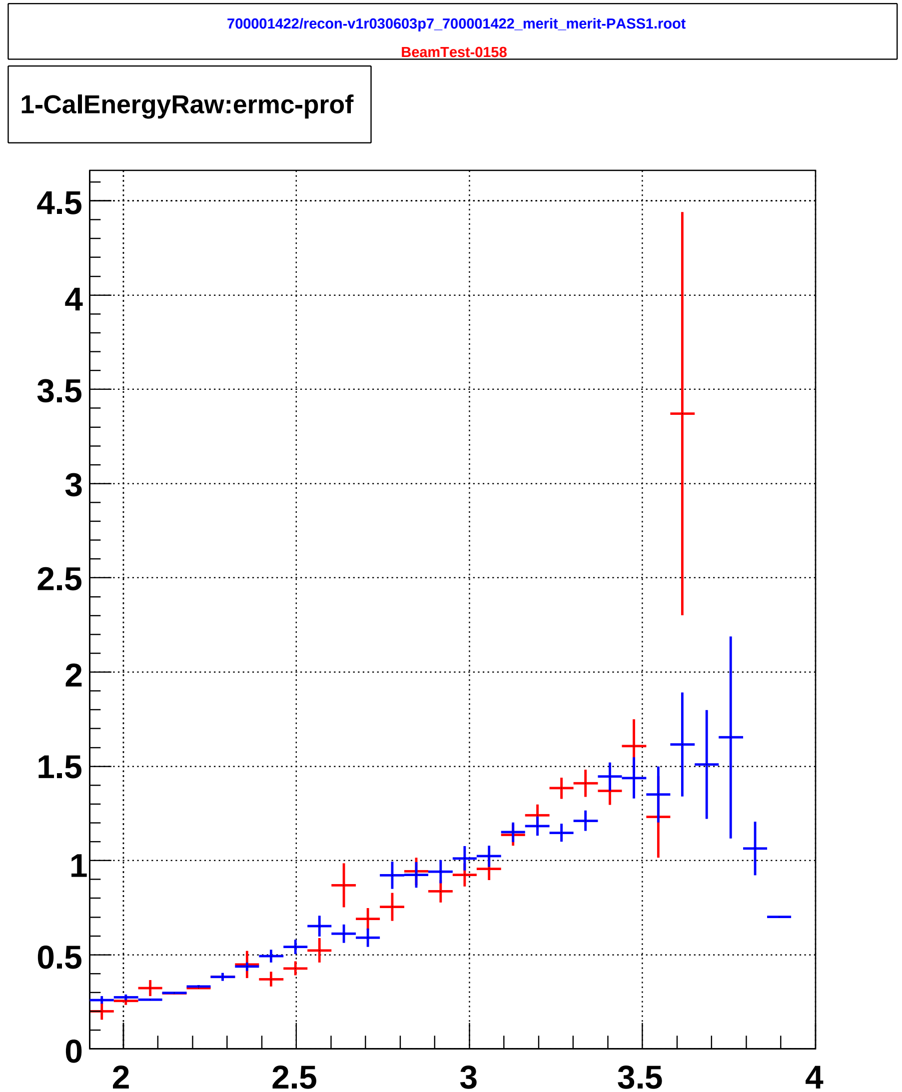
BeamTest-0158
1-CalEnergyRaw:ecorRms-prof
p MC
p data
0
2
4
6
8
10
12
2
2.5
3
3.5
4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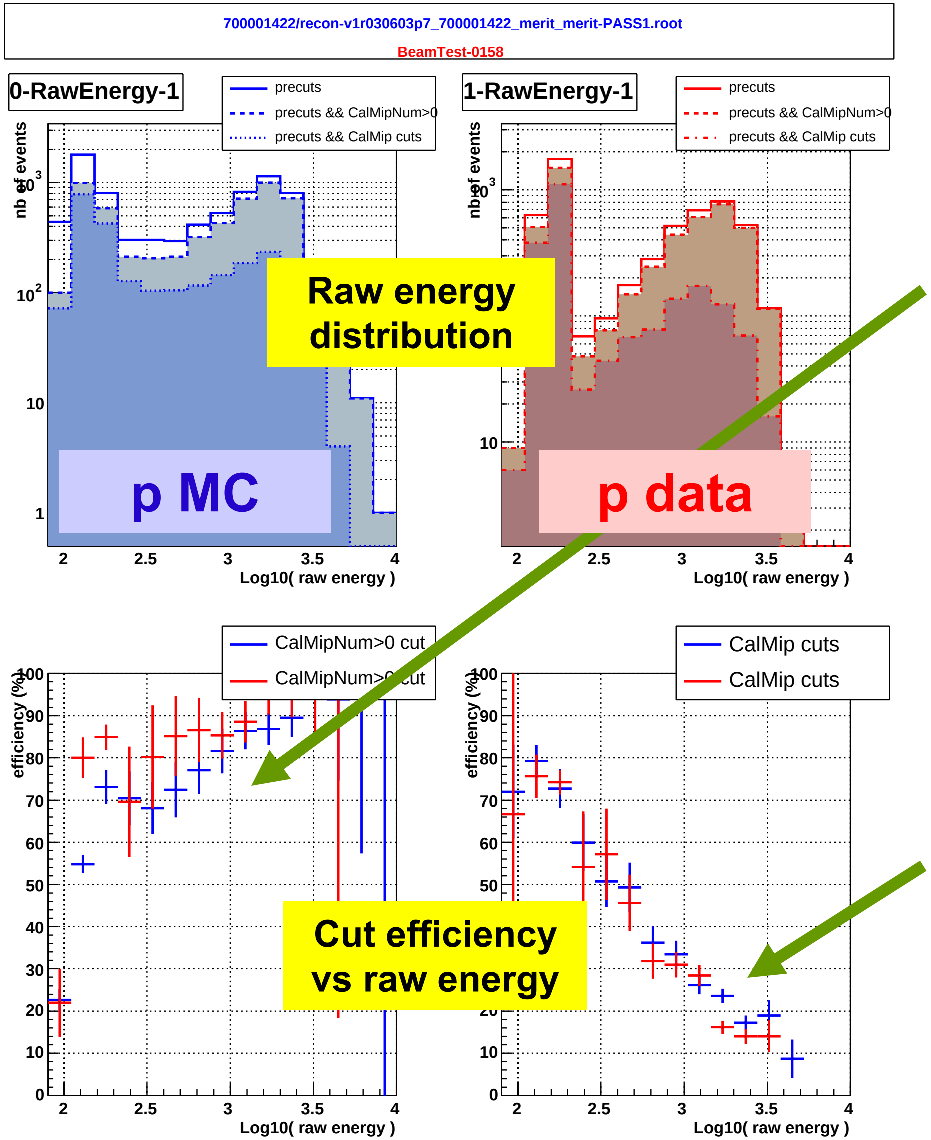
BeamTest-0158
1-CalEnergyRaw:ermc-prof
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
2
2.5
3
3.5
4

p data vs MC



After precuts, 80% of proton events have >=1 CalMipTrack

MF efficiency :

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

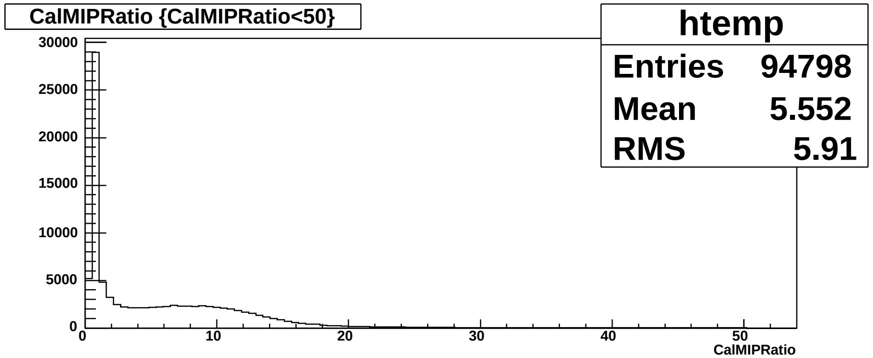
Efficiency well reproduced (not optimized here - poor at large energy deposit)

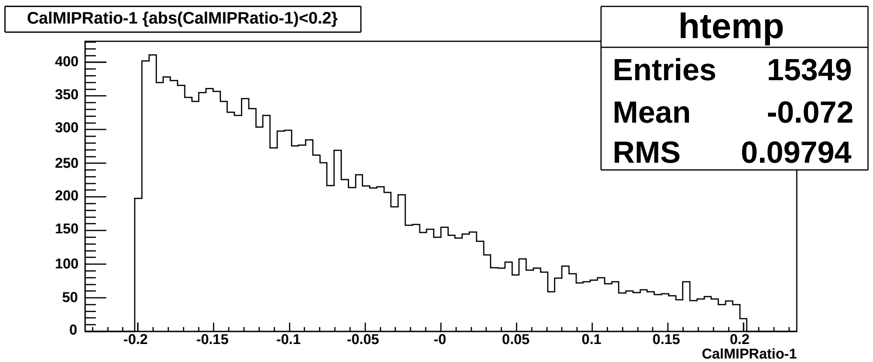
Conclusions

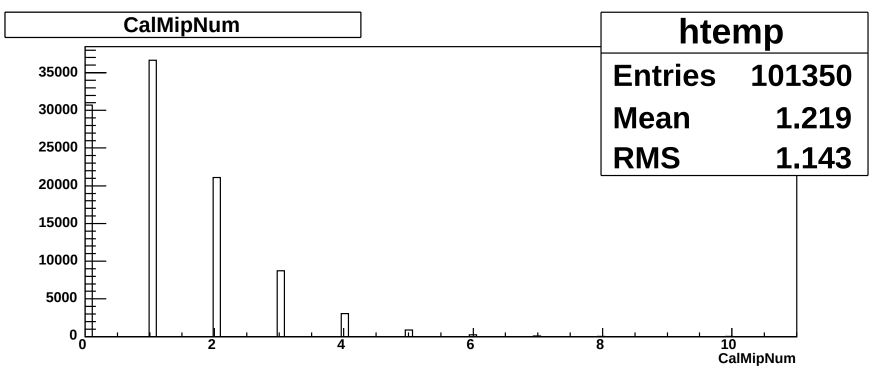
- MF validated
  - The Mip-Finder (Rev 1.17) works well and can be used in background studies:
    - with the full list of discriminating variables (including 3 variables not directly in the merit, mostly barDist – and ermc)
    - and taking account of their dependency on raw energy

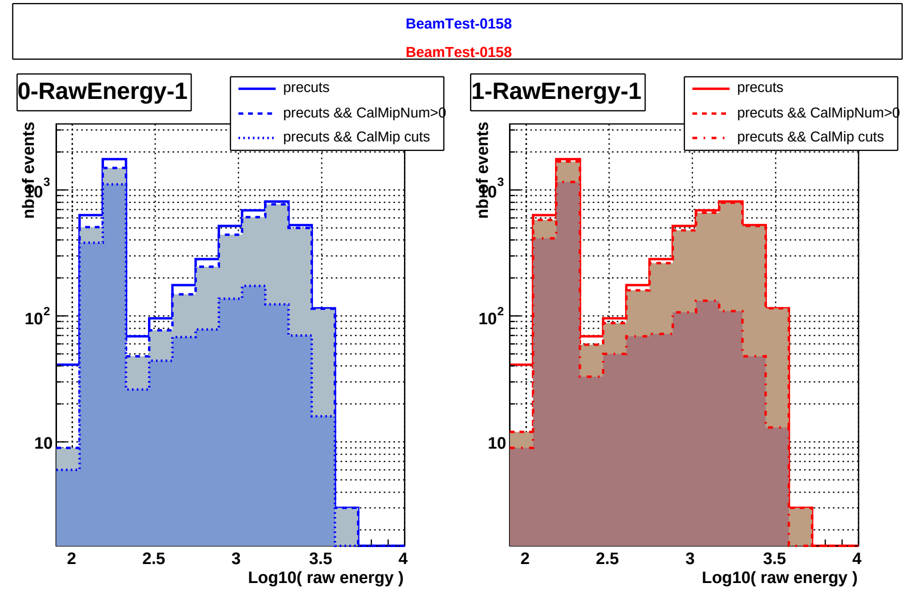
- To do
  - MF VERY slow for gammas
    - use of CAL clustering to speed up the algorithm (pending)
  - Check proton / gamma separation

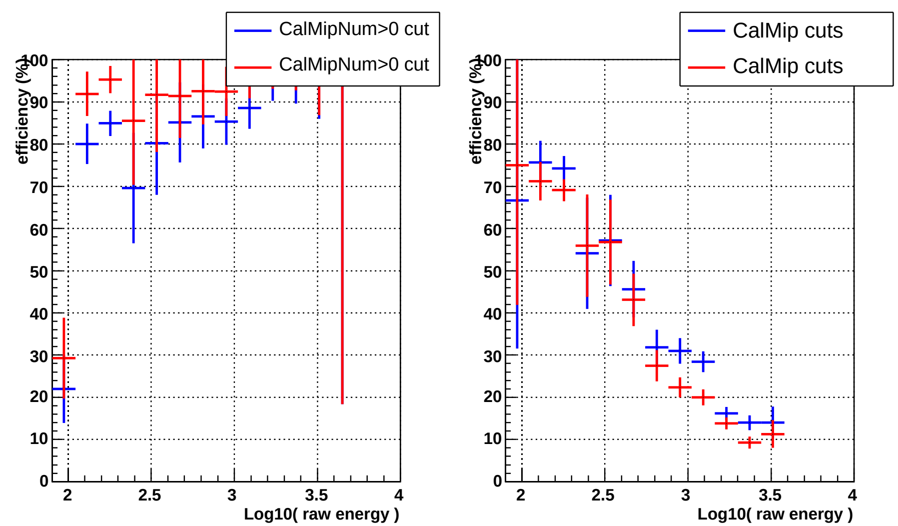
MF vs CalMIPRatio











even current MF (in BT) is better!

slightly improved MF