”Update on comparison of Geant4 simulation with CMS 2006 H2 test beam data”

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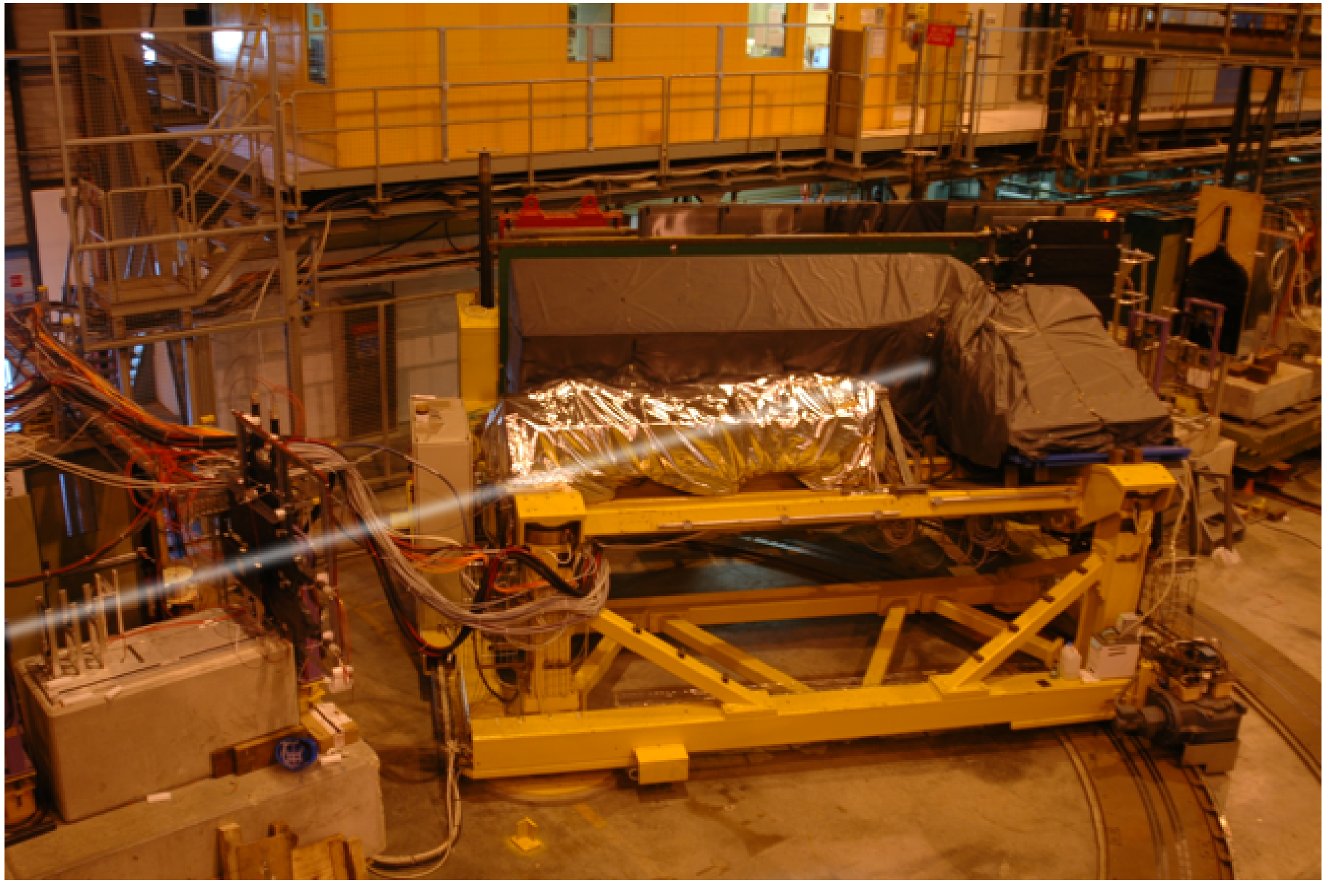
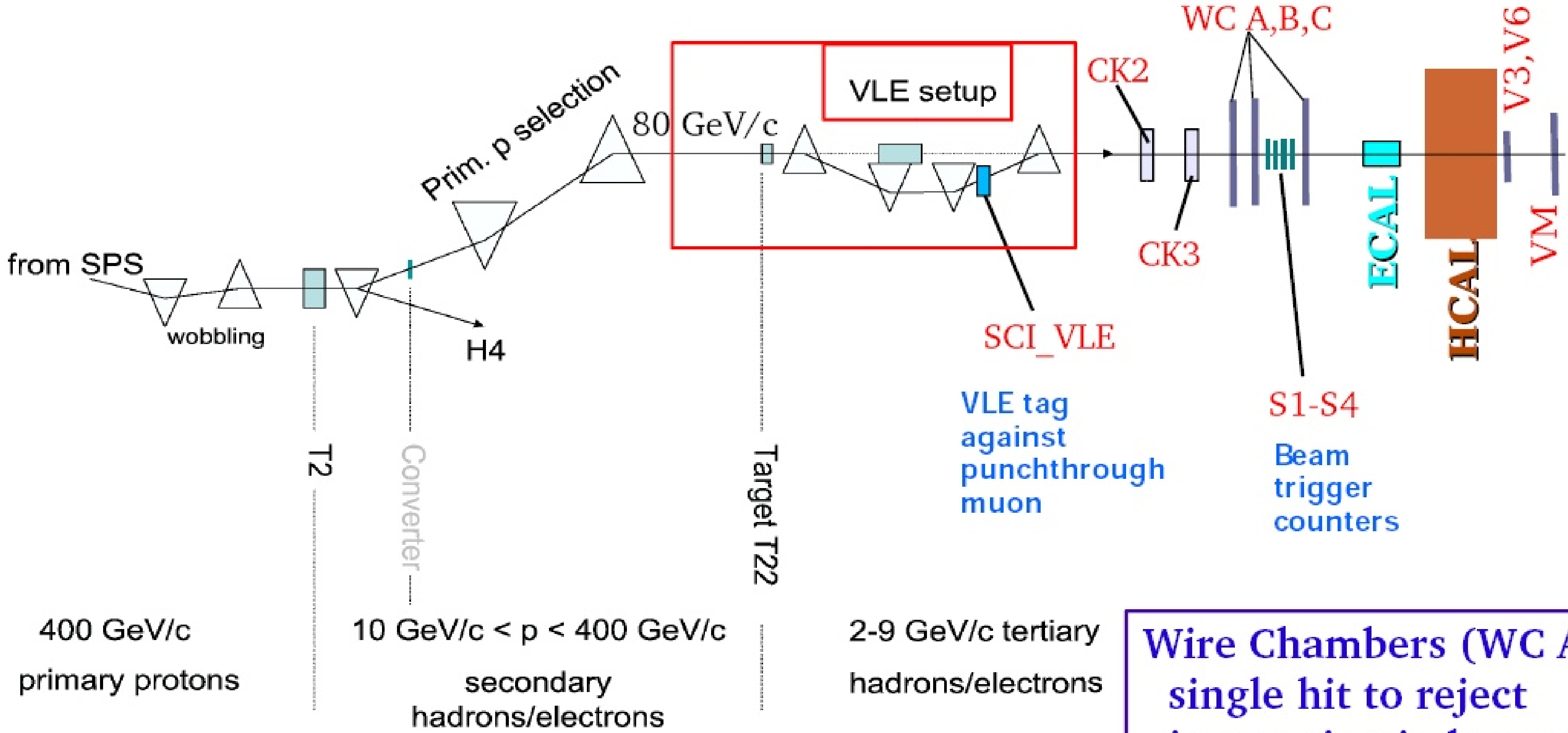
Jan 30, 2008



ECAL: $PbWO_4$ Crystals
Real Super Module

HCAL: Sampling Calorimeter
Brass - 50 mm
Scintillator - 3.7 mm



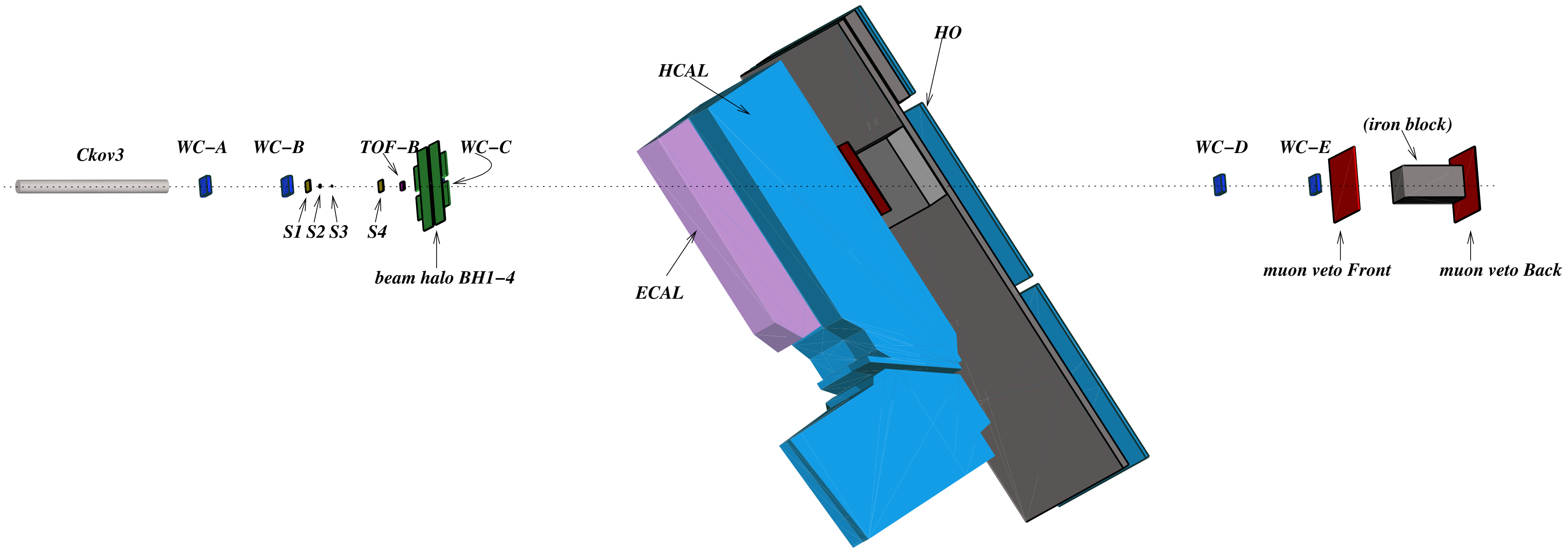
Wire Chambers (WC A,B,C):
single hit to reject
interaction in beam line

Available beam tunes:

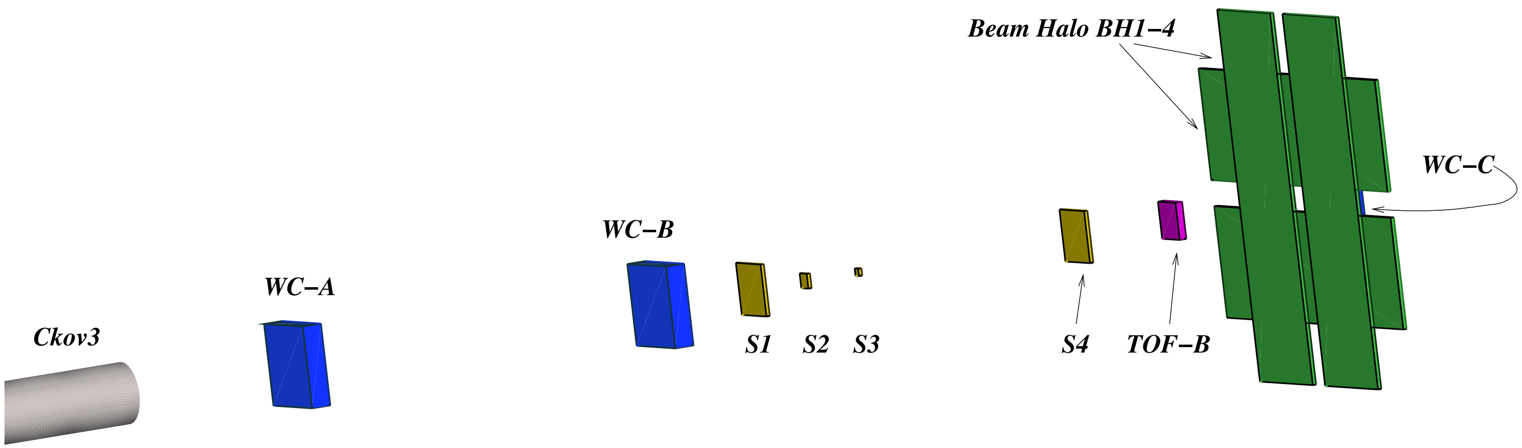
- pions 2-300 GeV
- muons 80/150 GeV
- electrons 9-100 GeV

P-ID:

- Cerenkov counter (CK2) - electron
- Cerenkov counter (CK3) - pion / kaon / proton
- Scintillators (V3, V6, VM) – muon tagging



detail:



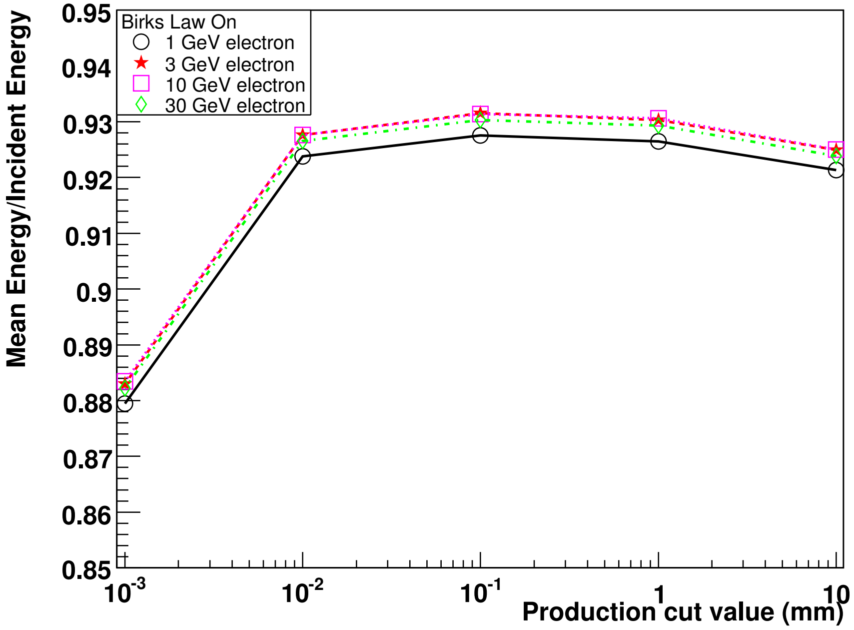
(S1...S4 + TOF-B) = 5cm plastic material in the beam

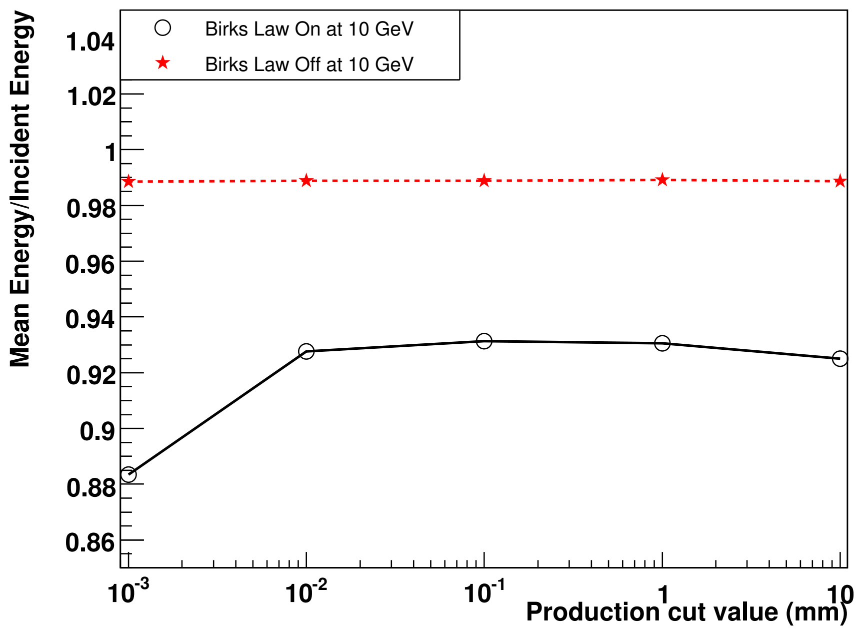
- Require hits in trigger scintillators S1, S2 and S4
- Reject events with multiple hits in S1 or S4
- Reject events with hits in the Beam Halo scintillators BH1-4
- ECAL signal calculated from 7x7 crystals around beam center
- HCAL signal calculated from 3x3 towers around beam center
- no HO signal used in both TB and MC
- timing of MC hits similar to the TB: 75ns window
- calibration of both ECAL and HCAL with 50GeV electrons

Without application of Birks' law saturation correction we find the response of our calorimeter to be too high.

We are using the default Birks' constants for the scintillators in HCAL, and the BGO crystal constants (about 3.5 times higher than the default) for the ECAL.

We've checked that our default cuts do not affect adversely the application of Birks' correction:

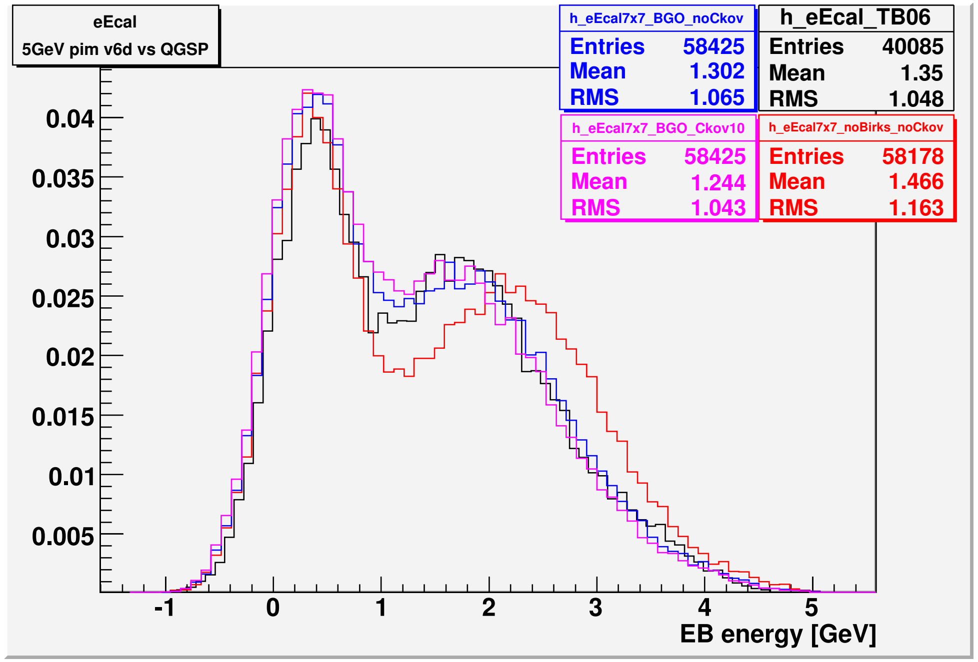


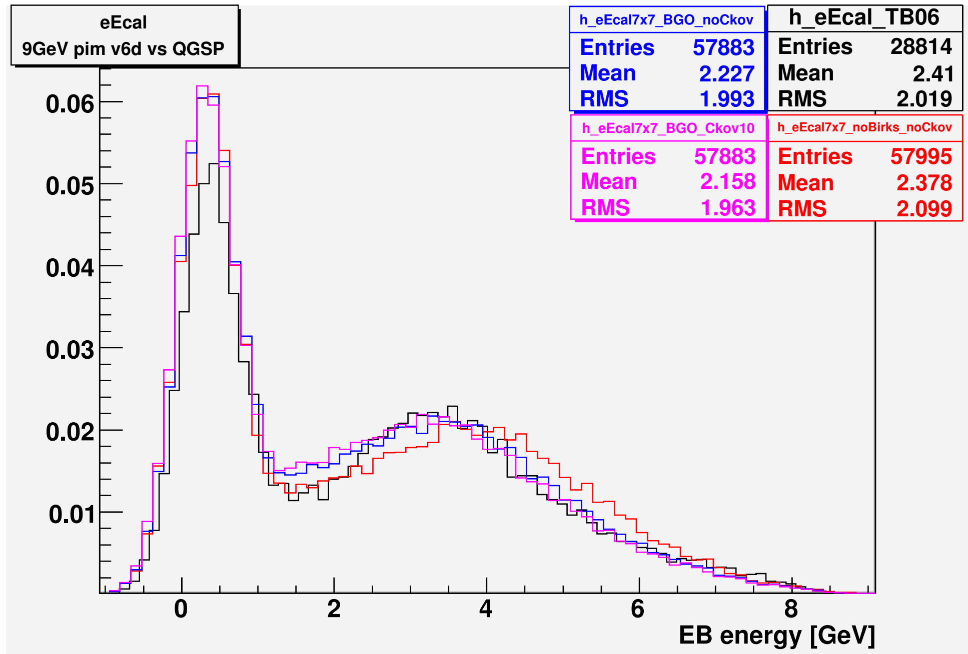


The 6.5% decrease in electron response is expected given the values of the Birks' constants for BGO.

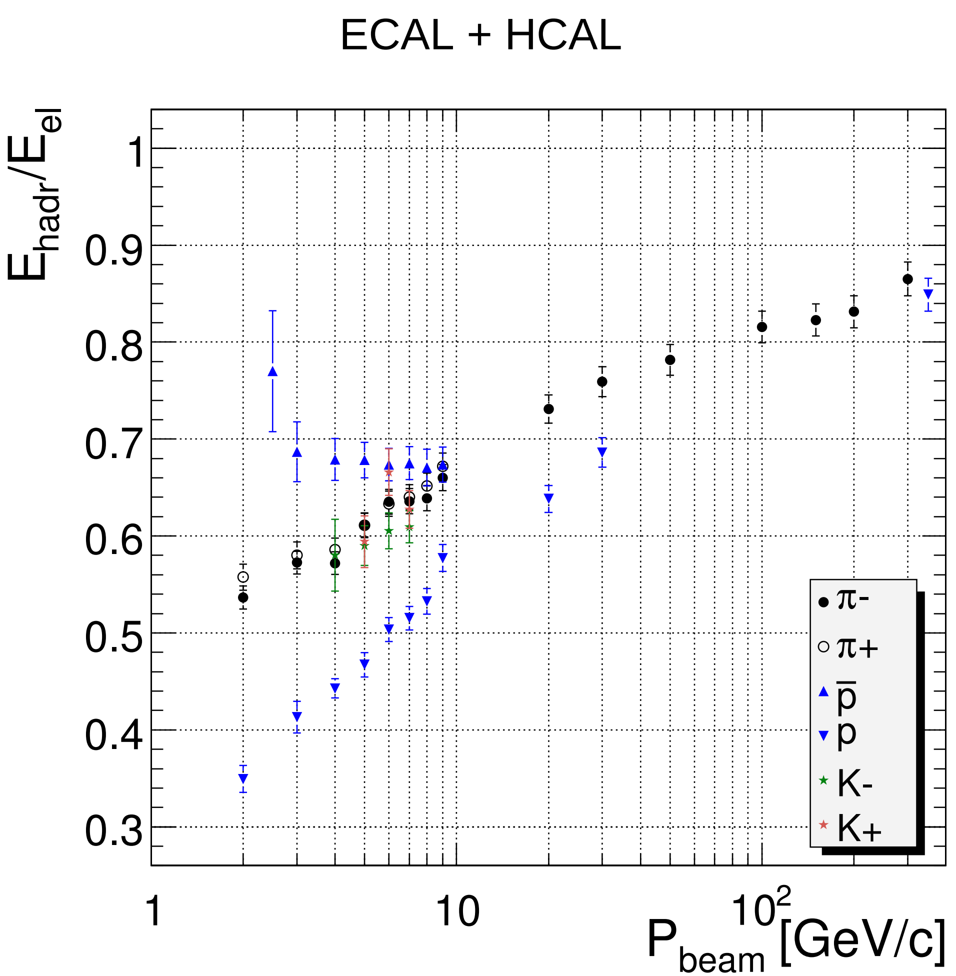
Signal in ECAL crystals is not generated only by scintillation, but also by Cherenkov light produced by the particles in the EM shower. Therefore we have to account for it in the simulation. Recent measurements show that the Cherenkov light can add between 6% and 14% to the scintillation light, depending on direction of the particle crossing the crystal.

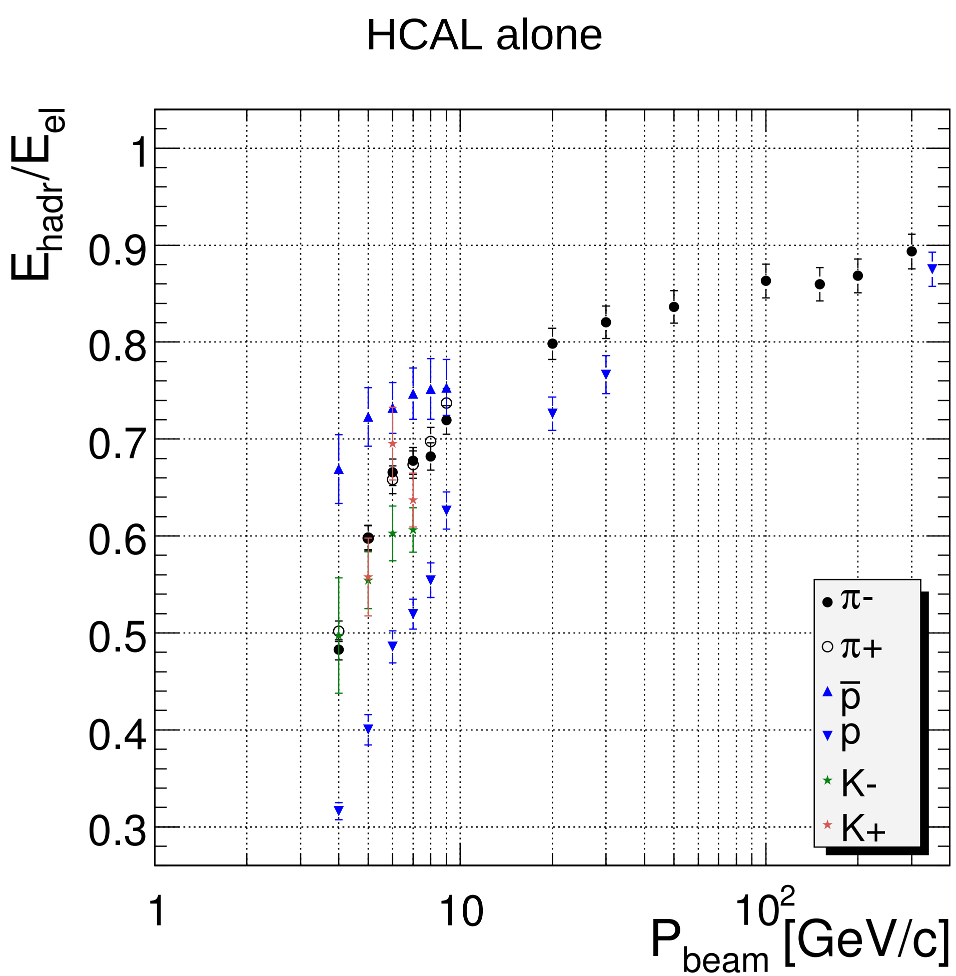
We do not simulate the Cherenkov light generation, propagation and collection. That would be pretty complicated. Instead, we scale up by 10% the EM fraction of the shower in ECAL.





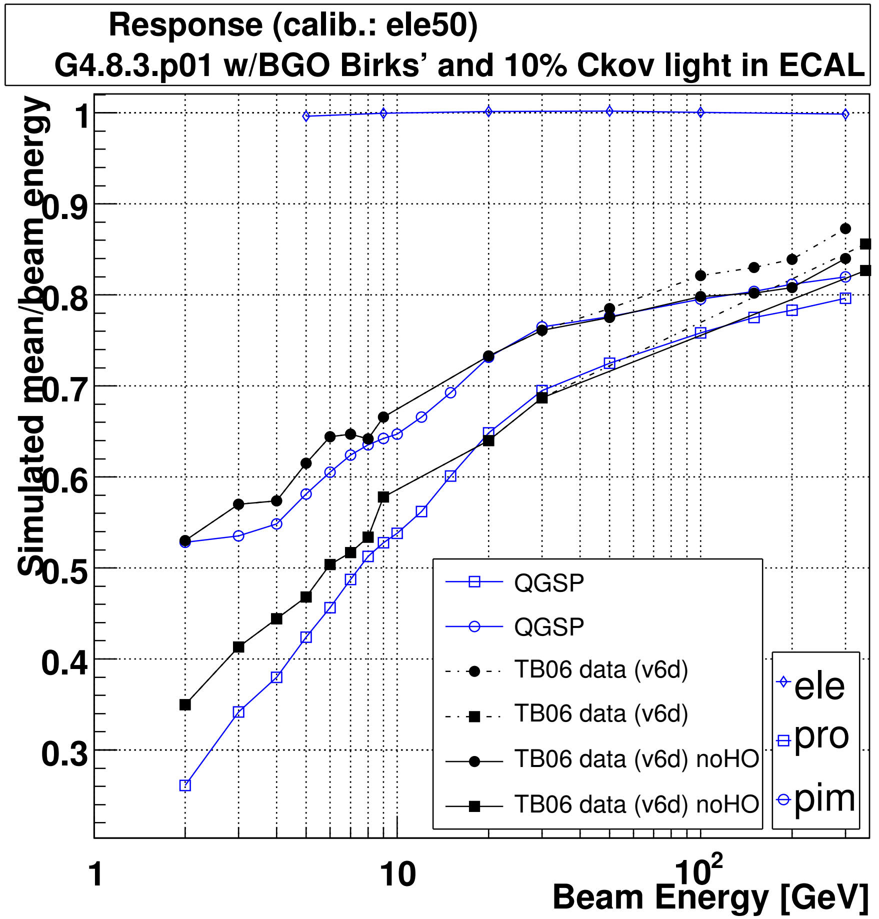
That produces even better agreement with data. However we still have no explanation for the different ammount of MIP's in simulation and TB data.



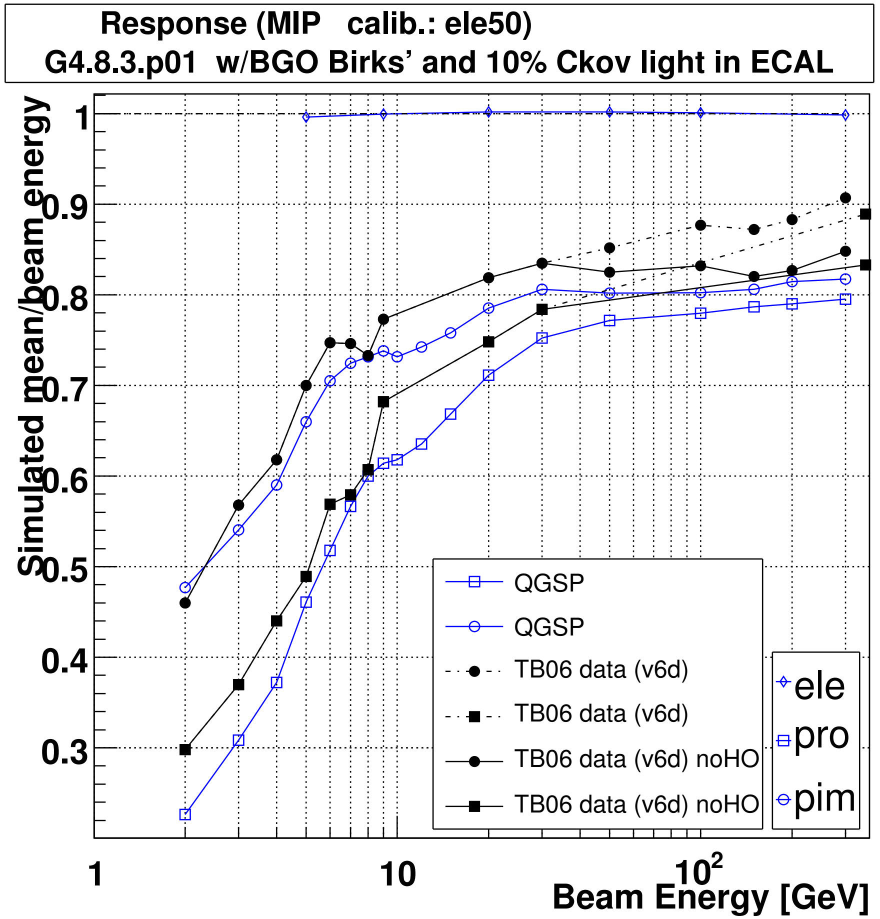


Both calorimeters calibrated with 50GeV electrons

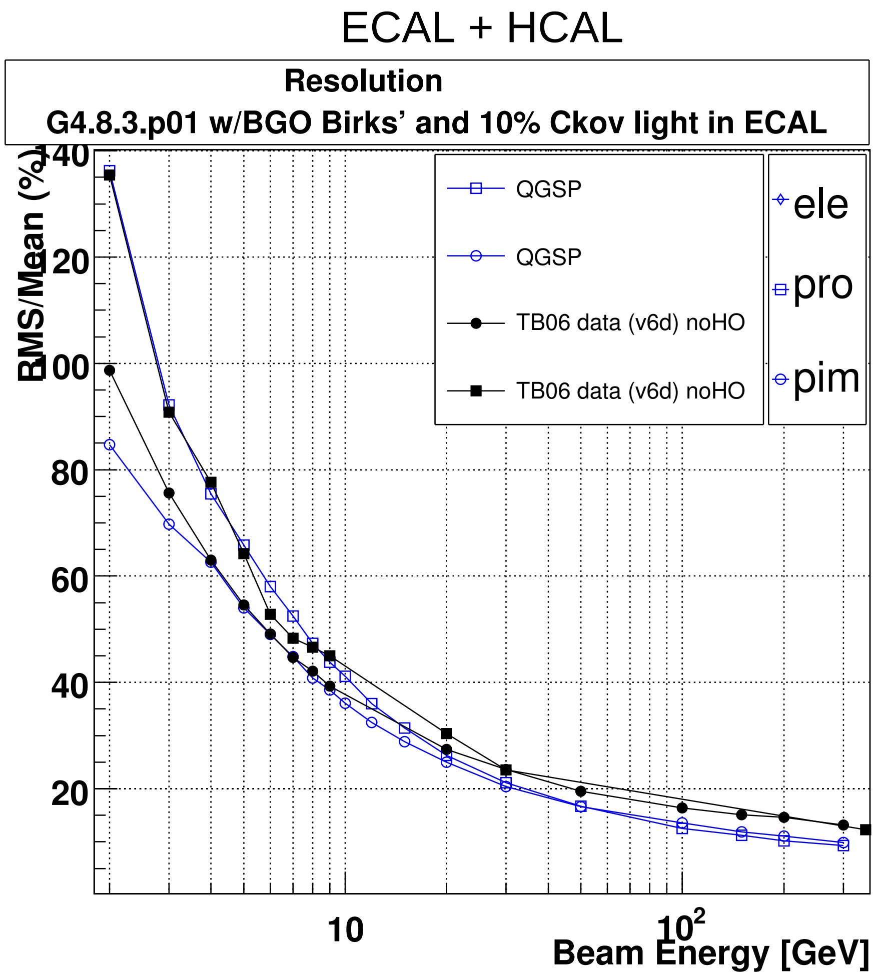
ECAL + HCAL

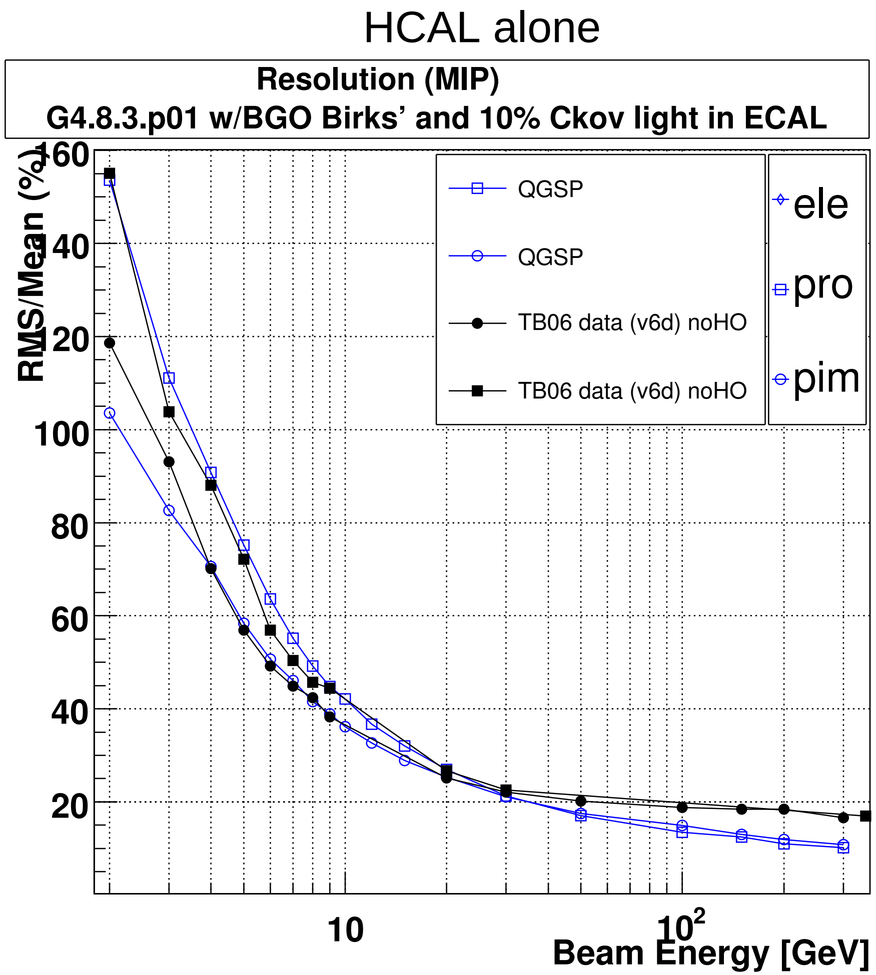


HCAL alone



Agreement for the combined system becomes more and more satisfactory. HCAL alone however still shows a deficit.





MC shows better resolution at high-momenta. (being investigated)

- Understanding of beam contamination and cleaning seems crucial for the comparison between test-beam data and MC simulation.
- Birks' law saturation correction is necessary in the simulation. We still don't have the exact constants for the ECAL crystals or HCAL scintillators, and therefore are using the closest available ones.
- We introduced Cherenkov light generation in the ECAL crystals in an ad-hoc way, which seems to work for the moment.
- With the current degree of beam-cleaning, Birks suppresion and Cherenkov generation, the combined system ECAL+HCAL starts to show linearity of response approaching the measured one. HCAL alone still does not agree very well though.
- The resolution of the simulated calorimeter is still better than the measured.

Plan: Short term (before CMSSW 2.0.0):

- Move on to Geant4.9
- Understand the beam-cleaning and try to fine-tune the Birks constants of ECAL and HCAL.

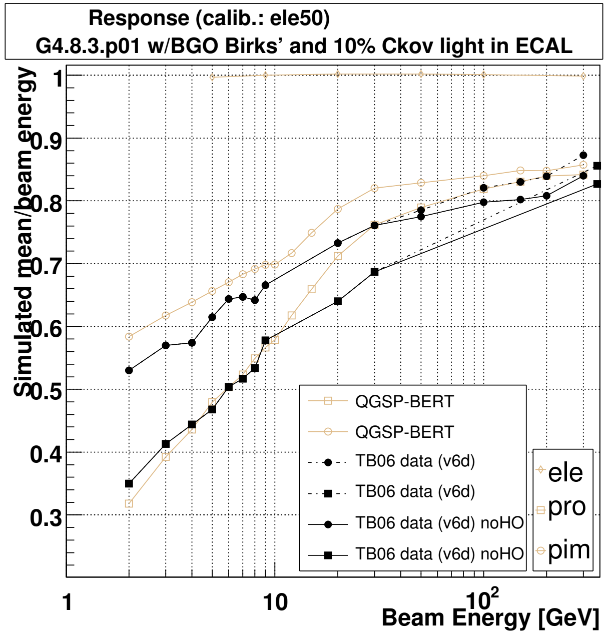
Longer term:

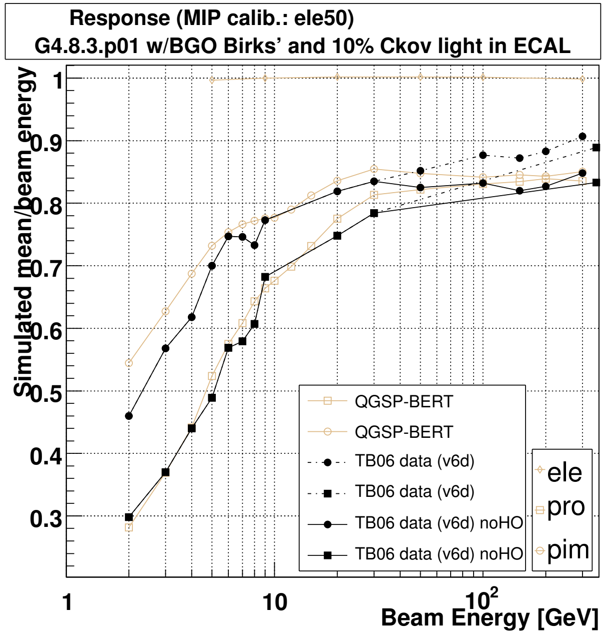
- Understand the ECAL response (pi-zero, proton, neutron distributions) and improve the simulation.

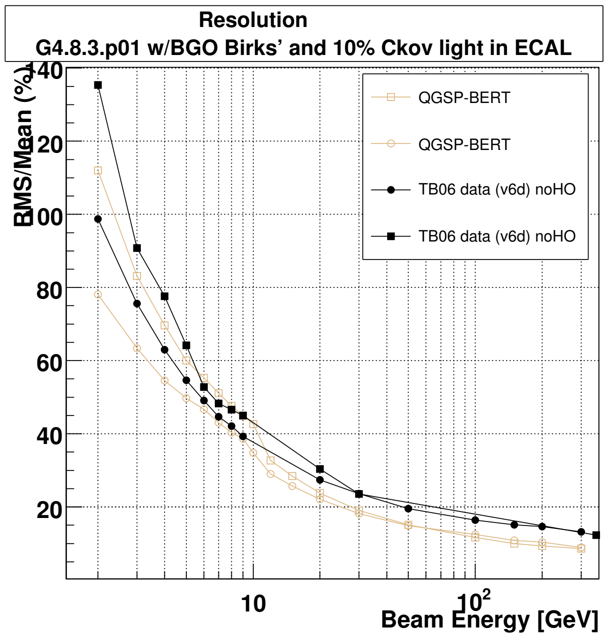
(backup slides)

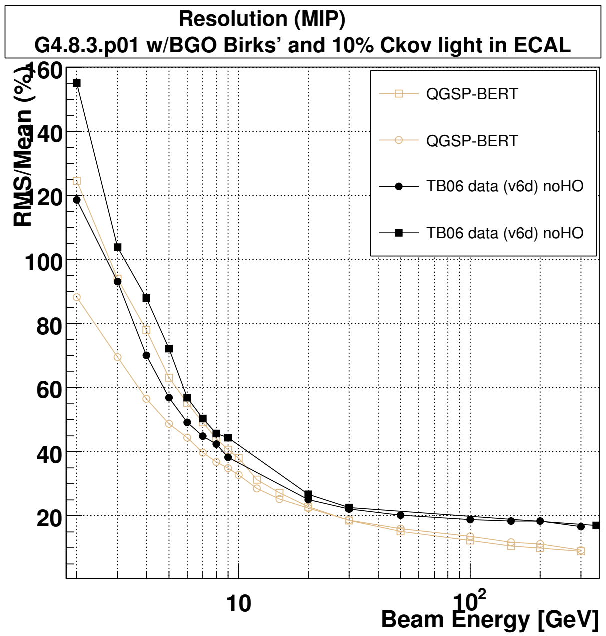
(backup slides)

Linearity and Response for QGSP-BERT

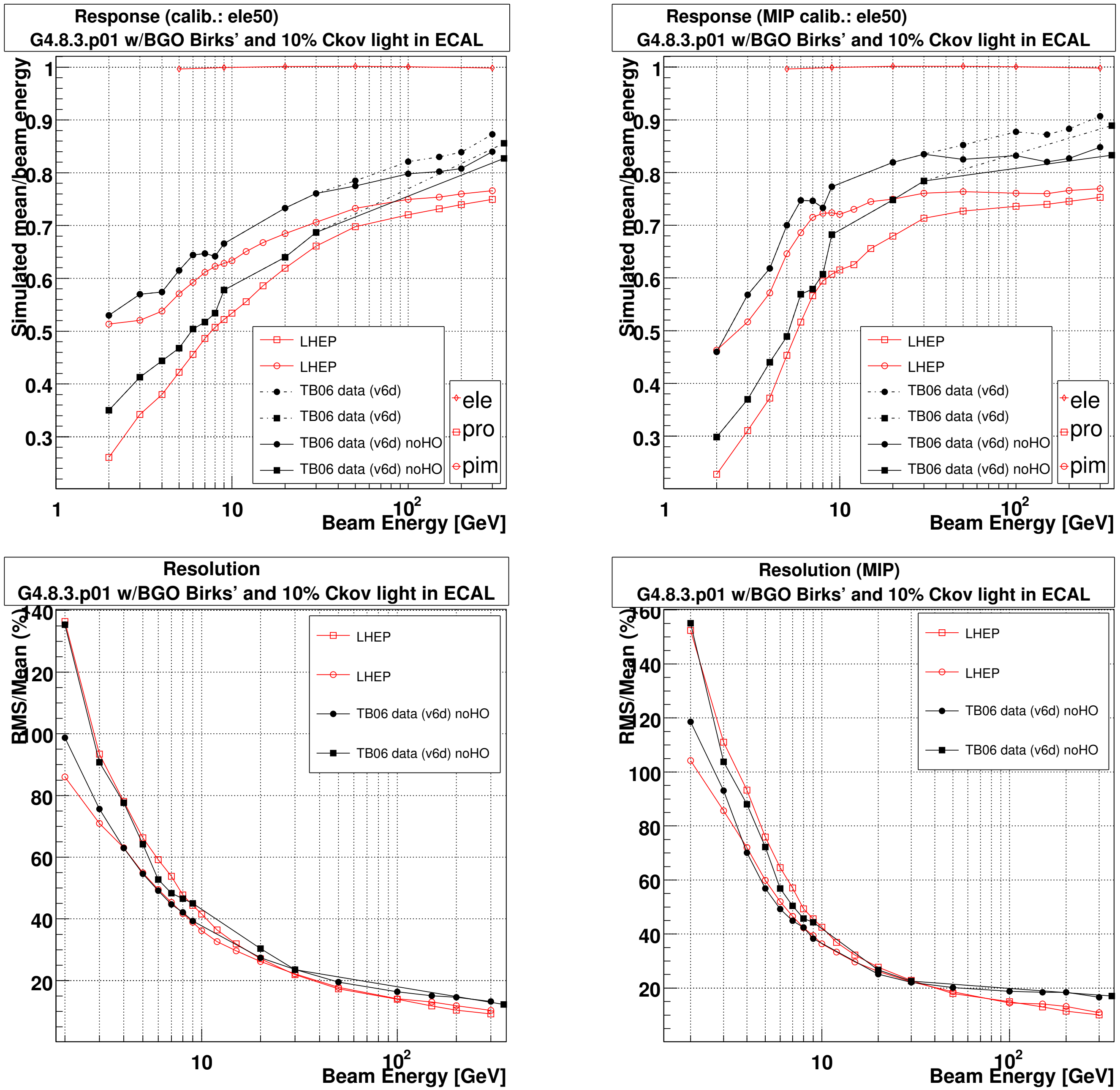








Linearity and Response for LHEP



Linearity and Response for FTFP