CLIC HCAL Studies

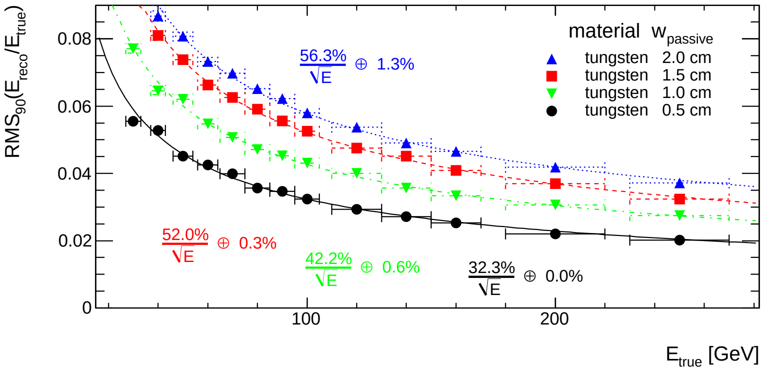
Peter Speckmayer, Christian Grefe,
Angela Lucaci-Timoce

Comparison of tungsten and steel HCAL

- Studies done by **Peter Speckmayer** and **Christian Grefe**, in the SLIC software framework
- Method published in LCD note 2010-001 (distributions to be updated)
- Detector: "infinite" HCAL stack ($\gg 20\ \lambda_I$), with $5\ \mathrm{m} \times\ 5\ \mathrm{m}$ transverse size
- HCAL sampling structure:
  absorber (variable) + 5 mm scintillator + 2.5 mm electronics (G10)
- Absorber: W or steel, from 5 mm to 30 mm thick
- Single particles (π^+), energies from 1 GeV to 300 GeV
- Results obtained wtih *neural networks (TMVA)*, with beam energy as output
- Energy resolution presented in terms of $RMS\left(\frac{E_{reco}}{E_{true}}\right) \approx RMS\left(\frac{\Delta E}{E}\right)$; valid under specific assumptions (good linearity of the reconstruction, etc)

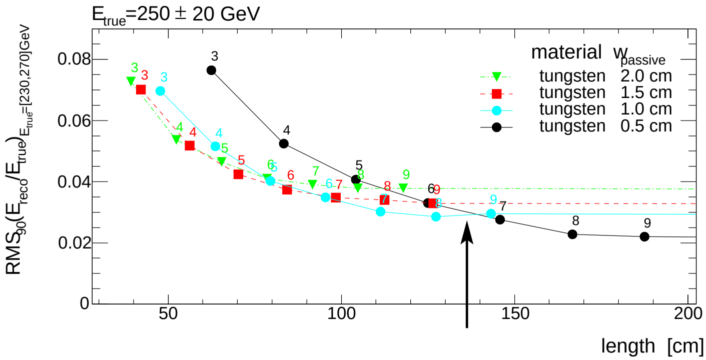
Absorber thickness: Tungsten - Resolution

- Energy resolution for an "infinite" calorimeter
- Constant term small for all cases since there is no leakage, and no detector effects (only imperfections of the reconstruction algorithm)



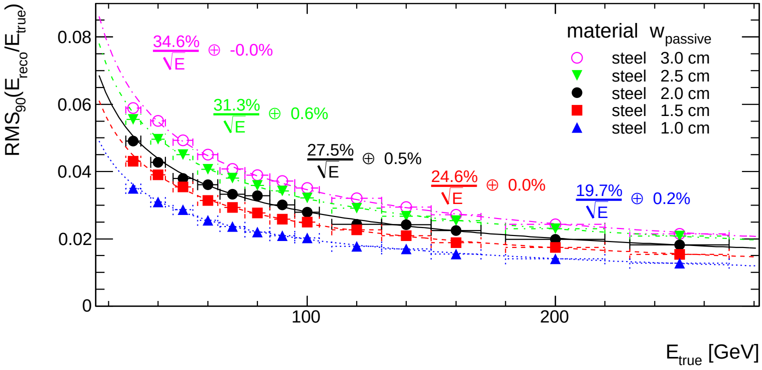
Absorber thickness: Tungsten

- In general:
  - for small calorimeters: leakage effects dominate
  - for larger ones: showers are contained, intrinsic calorimeter resolution dominating
- Numbers indicate number of λ_I, from which 1 λ_I ECAL
- For 1 λ_I ECAL + 7.5 λ_I HCAL, 1.0 cm tungsten is optimal



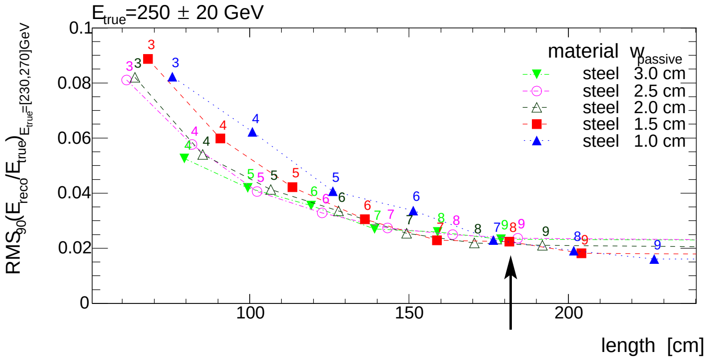
Absorber thickness: Steel - Resolution

- Energy resolution for an "infinite" calorimeter



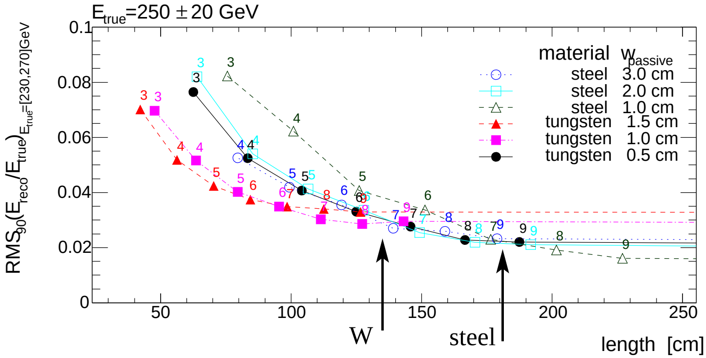
Absorber thickness: Steel

- Need more length to contain showers
- For 1 λ_I ECAL + 7.5 λ_I HCAL, 2.0 cm steel is optimal
  (while 1.0 and 1.5 cm still suffering from leakage)



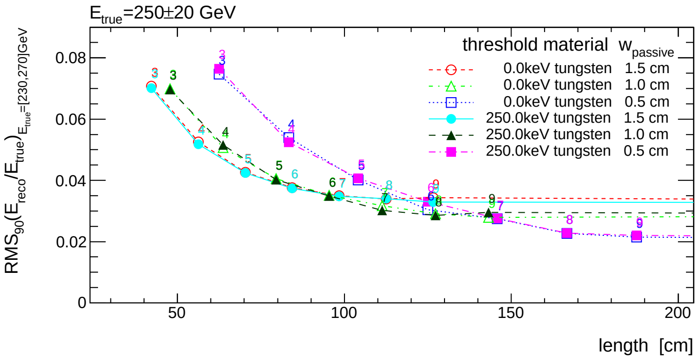
Absorber thickness: Tungsten vs. Steel

- Steel HCAL a little bit better resolution than W-HCAL, but W more compact



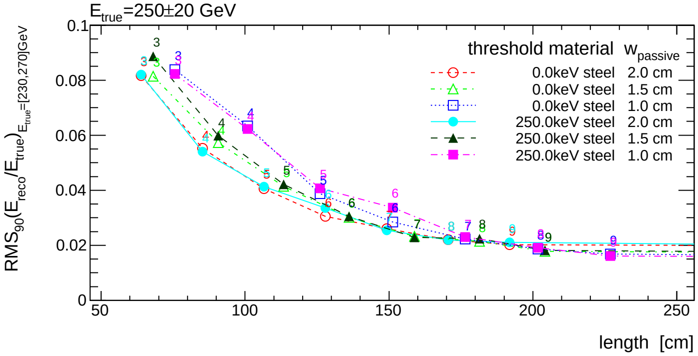
Effect of threshold cut: Tungsten

- Study effect of requiring a minimum energy deposited per cell (to reject noise)
- Marginal impact due to threshold
- Expected, since variables used to train the neural network had only small weights on individual cells ⇒ hits with small energy have limited impact on the overall shower shape



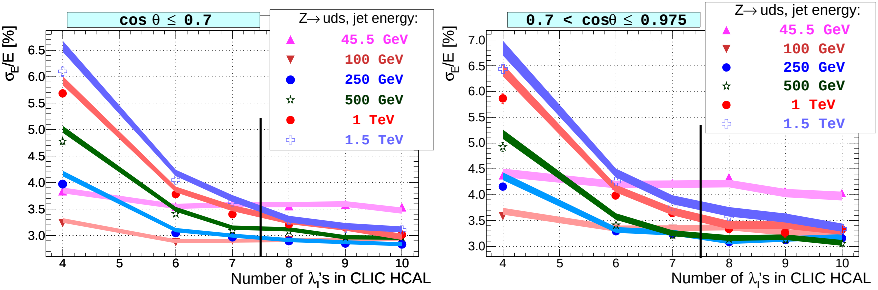
Effect of threshold cut: Steel

- Marginal impact due to threshold



Studies of CLIC HCAL depth with Pandora PFA

- Studies done with $Z \rightarrow uds$ events, based on a modified *CLIC*01*_ILD* model
- Jobs submitted to the GRID, via DIRAC
- Markers: with Tail Catcher
- Bands: WITHOUT Tail Catcher



- Small influence of the Tail Catcher
- Final decision on HCAL depth: 7.5 λ_I

Back-up slides

Linearity plots for an "infinite" calorimeter