HCAL for ILD

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Outline

Status of the two HCAL options

ILD HCAL optimization

-Mechanical structure

-Topological aspects

-Active layer optimization

Conclusion

The two options

Two options are proposed for the hadronic calorimeter of ILD: AHCAL and SDHCAL.

The modules of both AHCAL and SDHCAL are made of 48 active layers interleaved with 2 cm stainless steel layers.

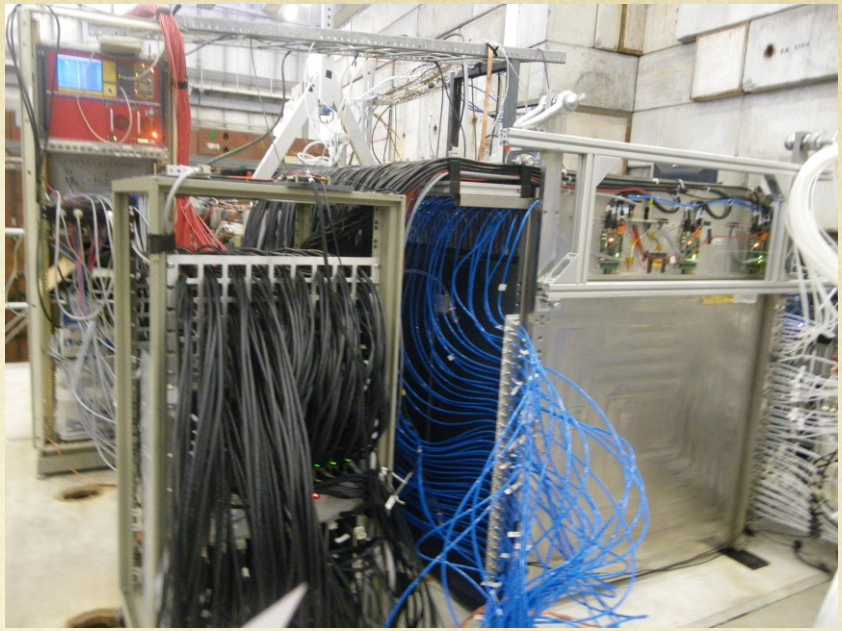
The difference is in the active layer :

AHCAL : 3x3 cm^2 scintillator+ SiPM with analogue readout

SDHCAL: 1x1 cm^2 GRPC with semi-digital read out

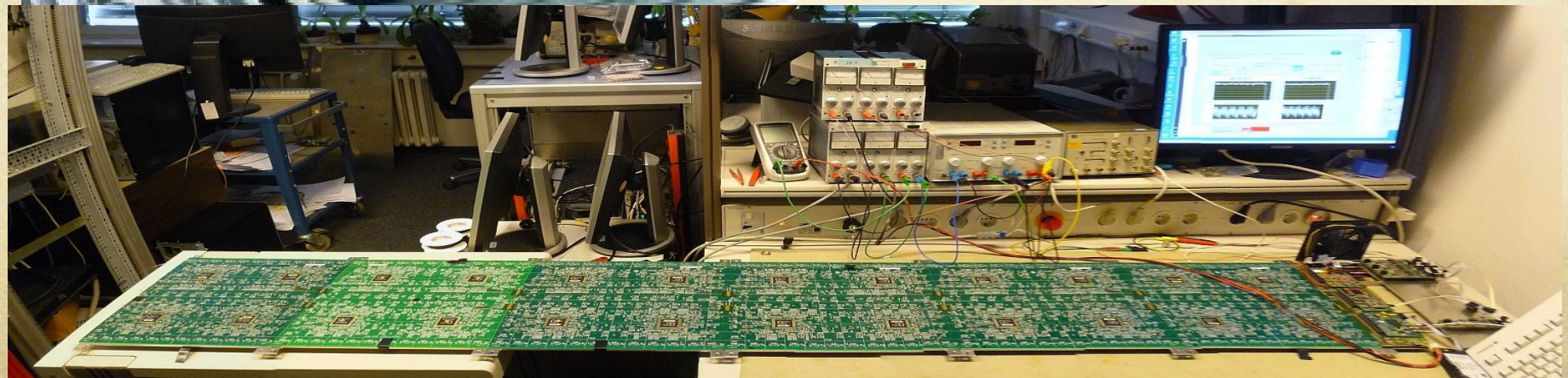
Both feature similar Jet Energy Resolution performances.

A full SDHCAL prototype (48 layers) Fulfilling the ILC requirements (cycled power, compactness,..) was built



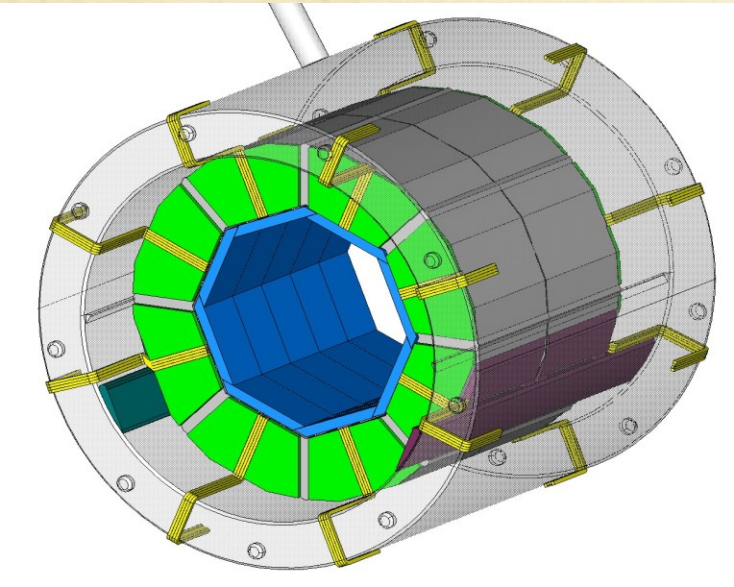
Single HBU extensively tested at DESY

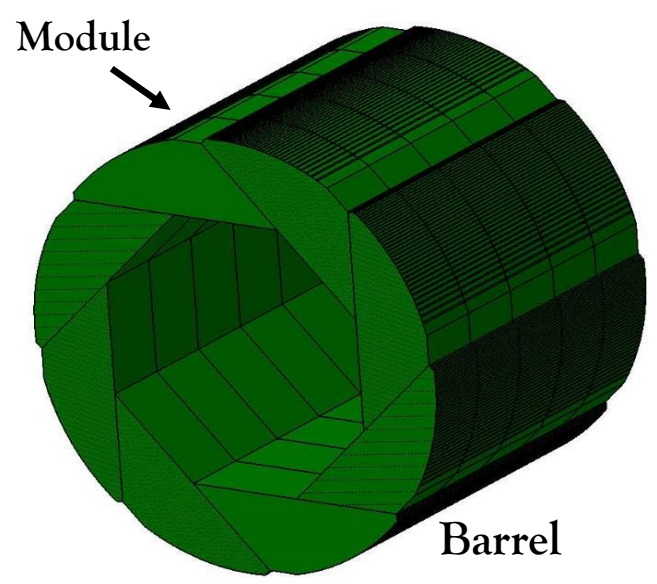
A full slab (6 HBU) is being tested with cycled-power scheme.



Mechanical structure :

Two structures are proposed :
Standard one and no-projective (Videau) one



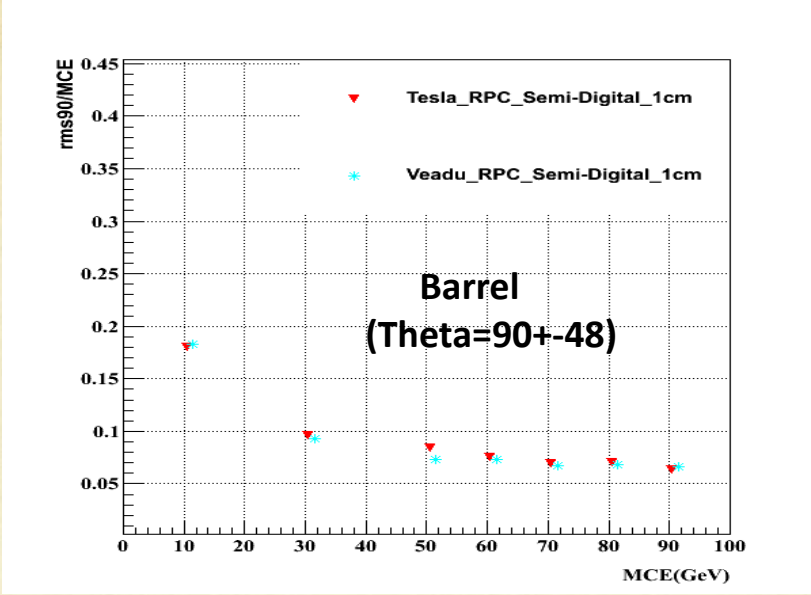


Mechanical robustness of the Videau solution is higher. However one needs to assess the difficulty to build both and more importantly what are the impacts on the physics.
In case radii are to be reduced, one should redo the study.

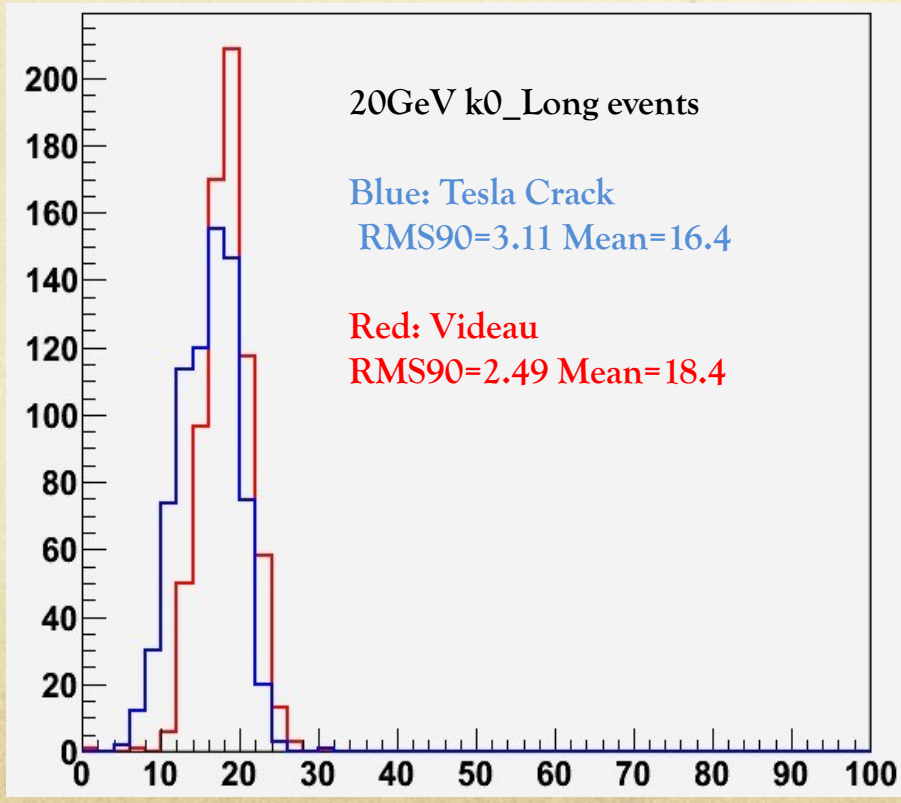
We can discuss whether one has to select one mechanical structure as a baseline (at least for the simulation).

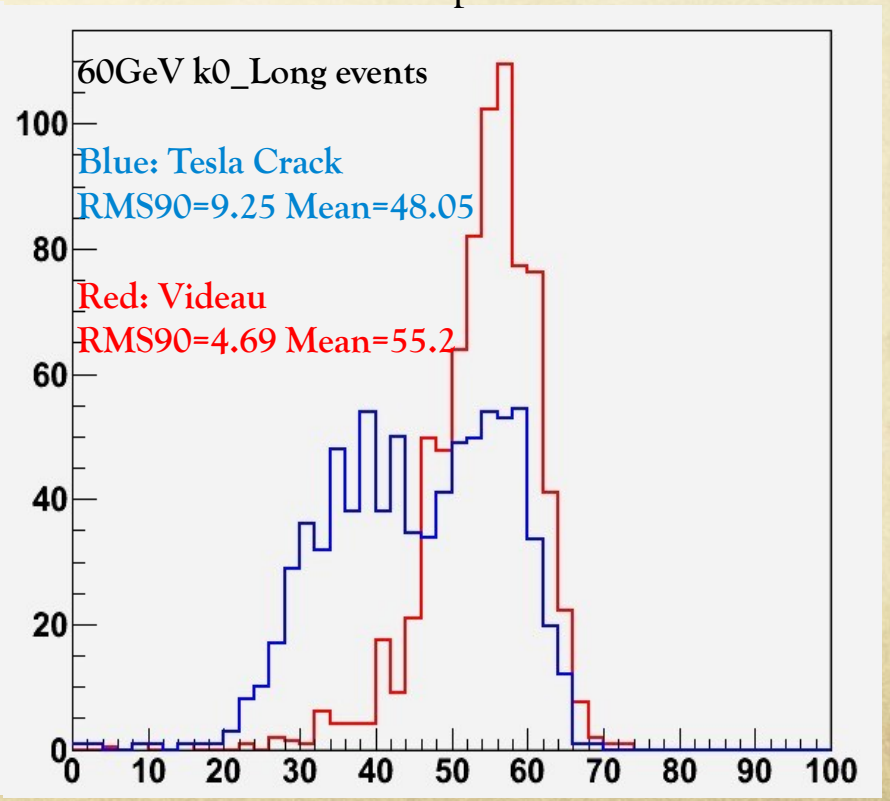
The two options were considered by the SDHCAL

The same work should be done for AHCAL



To be redone with present AHCAL model





HCAL Optimization

Role of the HCAL

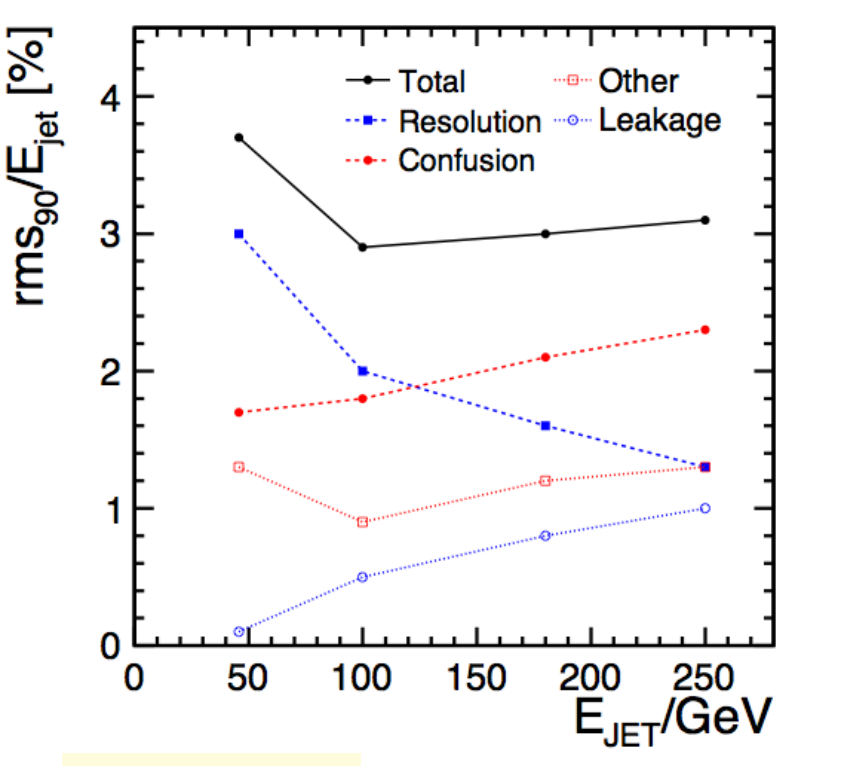
1) Measure the energy of neutral hadrons (resolution factor)

2) Charged Hadron - neutral hadron separation (confusion factor, PFA)

Important factors

- Leakage depends only on thickness
- Energy resolution depends on number of layers and for the semi-digital option on the cell size.
- Confusion depends on both radius and cell size

The smaller the HCAL radius the stronger the confusion term contribution



had energy resolution

M.Thomson

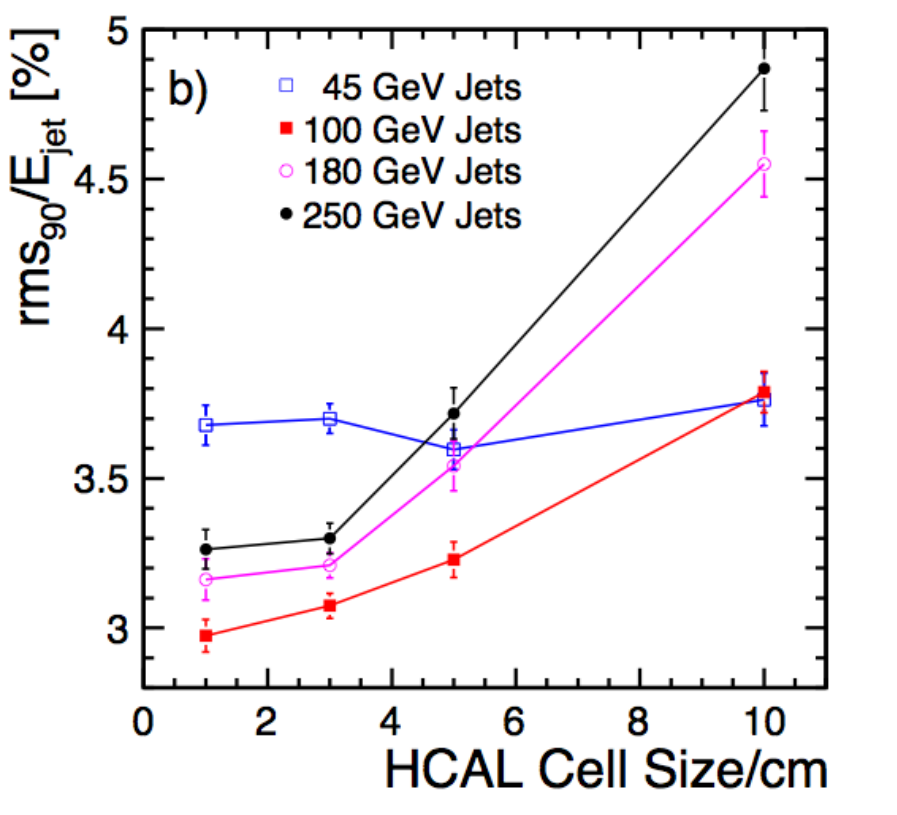
at 250 GeV:

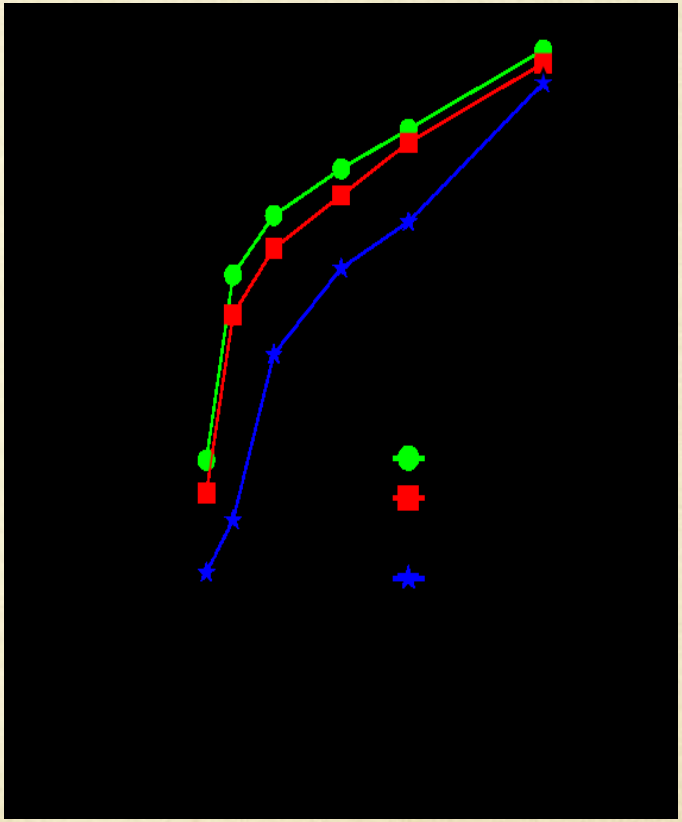
Total Resolution	3.1 %
Confusion	2.3 %
i) Photons	1.3 %
ii) Neutral hadrons	1.8 %
iii) Charged hadrons	0.2 %

Cell Size Effect

The optimization was performed using the present radius of ILD for both AHCAL and SDHCAL

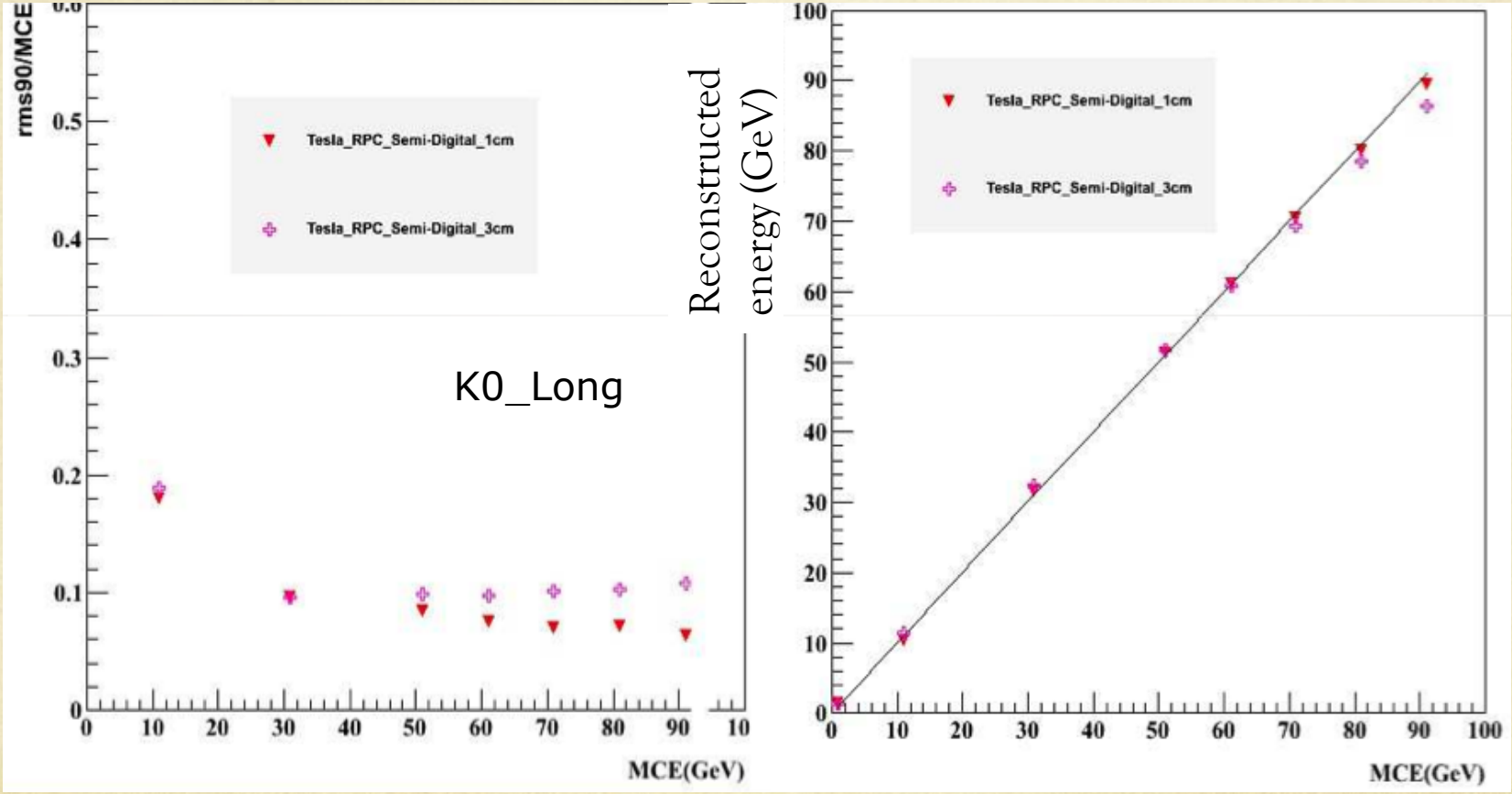
AHCAL





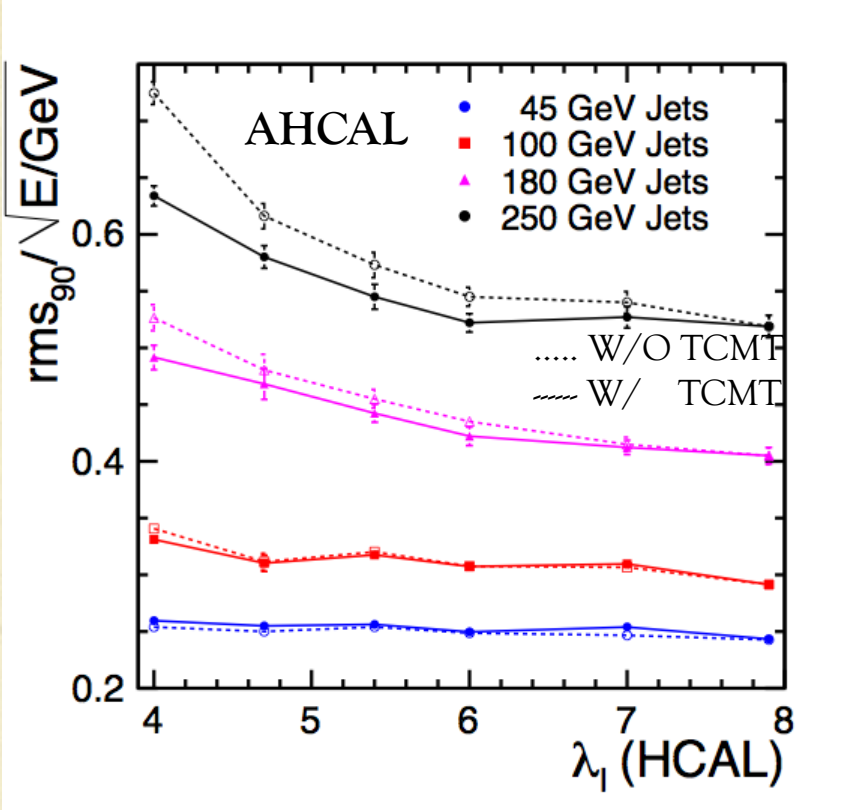
Preliminary studies of the SDHCAL concept have shown that cells of few mm present the best granularity but this means a tremendous number of electronics channels.

SDHCAL



1 cm cell seems a good compromise. Going to 0.5, 2 cm or a granularity depending on radius are still open options especially if the ECAL radius to be considered.

Thickness Effect



Thickness of the HCAL should not be reduced a priori.

Strategy

Following the study of the ECAL cost reduction study. Both HCAL options should be re-optimized. We propose the following steps:

- 1. Choose 2 or 3 radii in agreement with ECAL. Redo internal optimisation by using single particle or di-jets (no mass production)

- 2. Define detector models for 2 or 3 different radii
  (with possibly adapted internal parameters)

- 3. Redo some benchmark physics studies relevant for the new context (Higgs related study). The benchmark should include those for which the calorimeters in general and the HCAL in particular are the more relevant. For this large production will be needed.

HCAL Optimization

HCAL cost will be reduced if its inner radius is reduced. We should however try to reduce the HCAL cost without reducing its performance.

For the SDHCAL we have some ideas that we are currently following:

ASIC: 64 channels ASIC seem a good option. Future attempts with higher number of channels could be envisaged if cross-talk is kept under control

PCB: The basic option is 8-layer PCB. 6-layer option was successfully tested as well but at small scale. In the future this could be envisaged to reduce cost. New schemes replacing pads by strips are being investigated. This can reduce the ASIC costs significantly.
Also AHCAL works with Korean group on PCB cost reduction.

DAQ:
-SDHAL intends to get profit of the development pursued by CMS DAQ upgrade. GLINK protocol is an option. Consumption issues are being addressed.
-Interface Boards (DIF) are being redesigned. One for full layer rather than 3 should allow to reduce the cost and more importantly it will.

Conclusion

-We can discuss adopting the same mechanical structure for large productions.

-The impact of the ECAL study to reduce the cost on the HCAL performances should be correctly assessed.

- The HCAL optimization work should be performed in full synergy with the ECAL and the analyses groups.