Detector optimisation

(When including cost in the optimization)

ECAL pixel size versus radius versus cost

- Studies at Tokyo and Kyushu show that 30 layers of Silicon, with $5x5mm^2$ at R=1843 mm is questionable
  The studies made with ECAL scintillator strips or Hybrid ECAL ,
  while insufficient for real optimization due to lack of realism of the simulation,
  show that performances could be approached by a cheaper detector,
- The cost estimation of the SiW ECAL,
  while very complete… , will represent a large fraction of the overall cost

Forgetting the cost, The DBD ILD-model is the best possible detector

But is it the best compromise between cost and performances ??

A first approach is to relax on the technical process by accepting to dilute the density and the quality

Hardware optimisation

- relaxing the quality constraints (leakage current, fraction of dead pixels, fraction of unusable wafers, etc.)
- relaxing the guardring size, the PCB thickness, … (better industrial yield … cost reduction)

Industrial optimization

- VFE chip in package (ASICS burning, industrial cost of the PCB, etc…) (much easier QC)
- simplified PCB (outside of silicon, it is an important part of the ECAL cost) (factor 2 on cost with packaged chip)

Geometry optimization

the overall size is a very important scale factor for the cost : **internal ECAL radius and Zbarrel length**

Keeping the ratio R/Z, and trying to optimize the cost/performances , we are wondering about the following question

« What will the jet PFA performances degradation be, for a cost reduction of a large factor ”
(reduction of the OVERALL ILD cost, not only the ECAL)

We see in the LoI that it is possible to gain about a factor 2 on the Ecal by going to a radius of 1400 and reducing the layer number to 25.

Performances ?

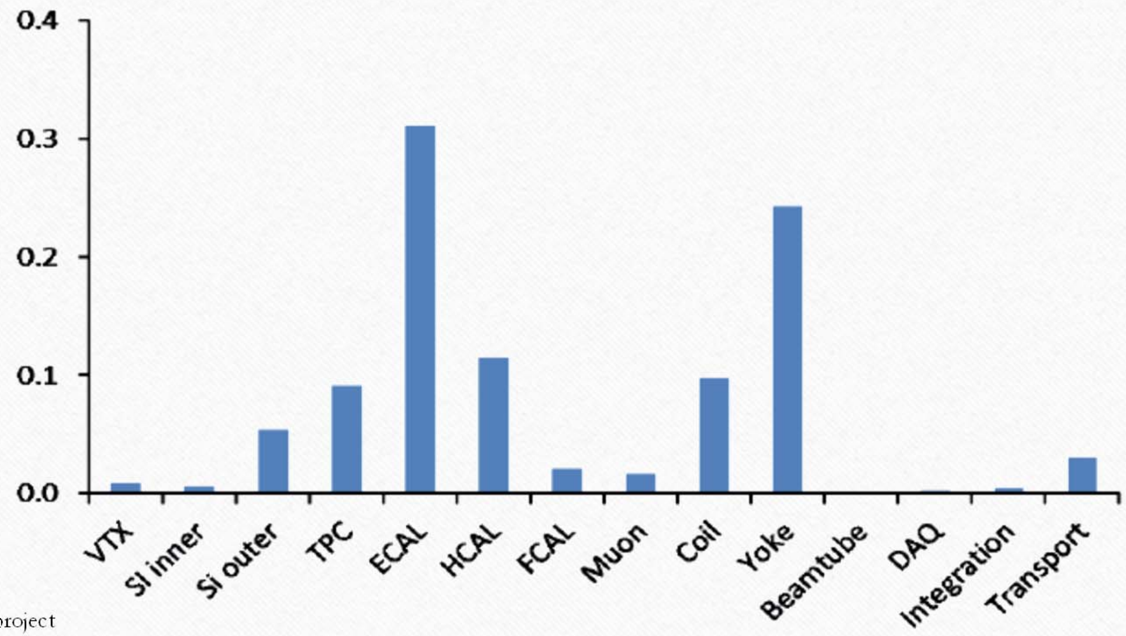
Remark from **Henri Videau**

It is not only on the ECAL, but also on the **cost of the return yoke**:

The simple reduction of 40cm does not bring much, but the problem is to return the flux which varies as the square of the coil radius. That makes a reduction by 0.8.

But reducing the tolerance to the stray field from 50G at 15m to 200G provides much more, 6m outer radius instead of 7. Both together bring a factor about 0.5

in other words



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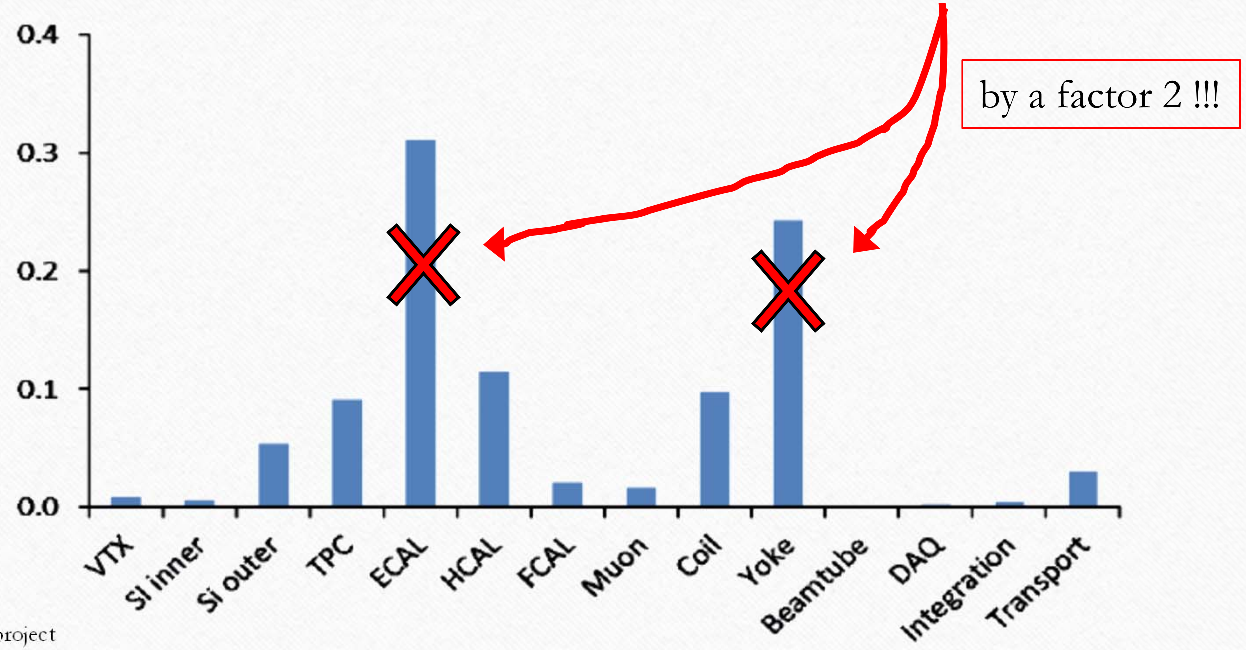
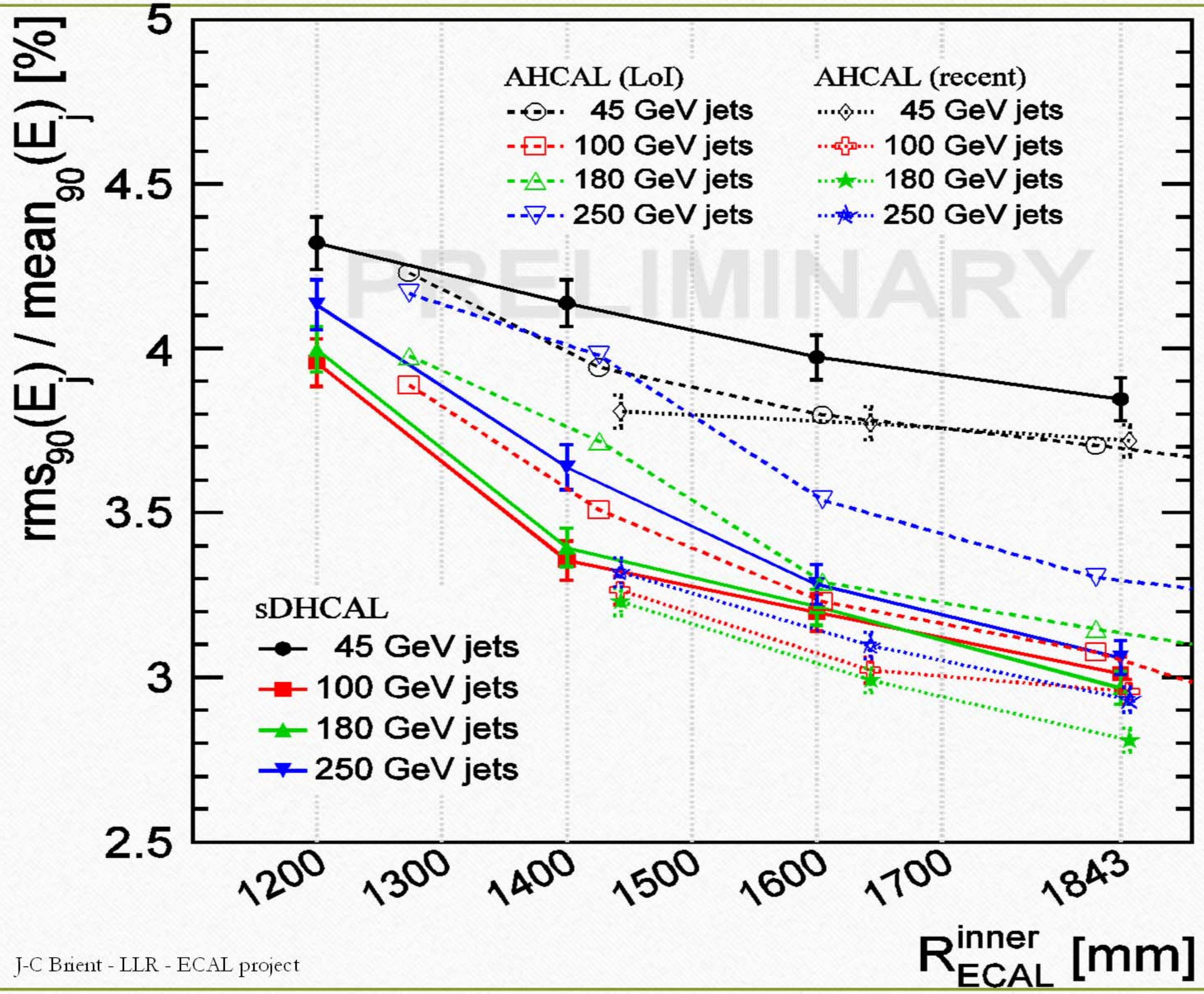


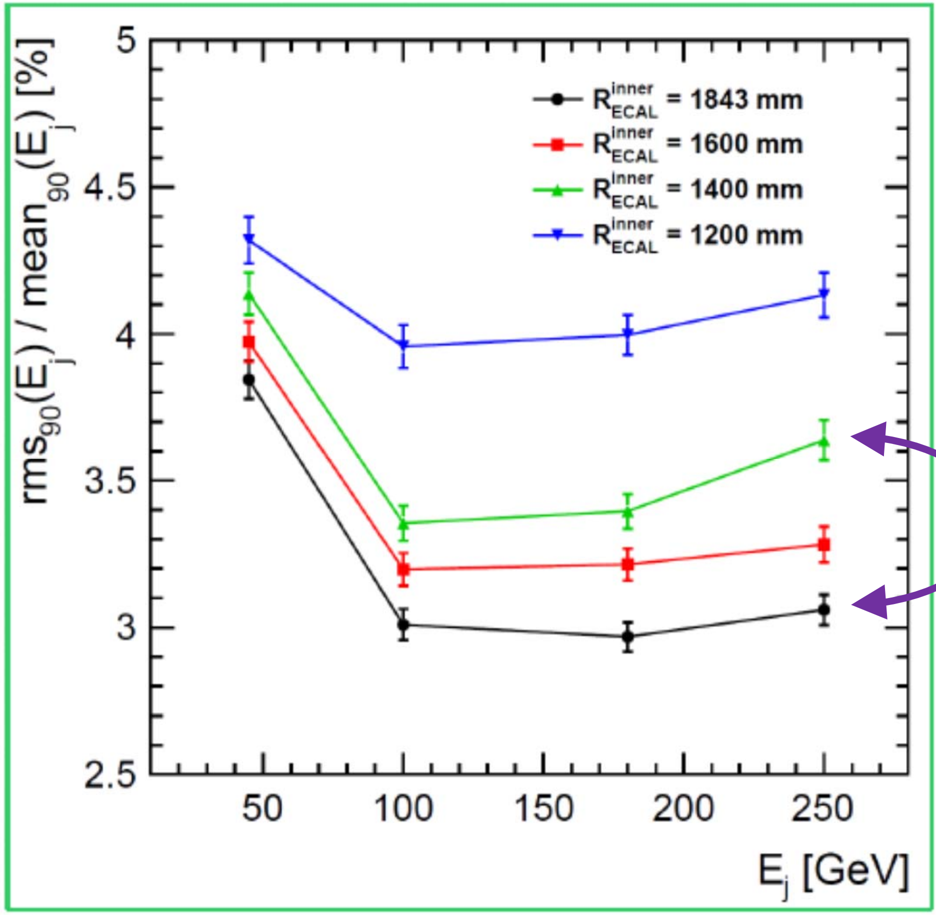


Study done by
Trong-Hieu Tran (LLR)
See presentation at LCWS13

And for the ideal scintillators Detector Study,
work of J.Marshal (Cambridge)

WARNING :
In the study of THT, the ratio R/Z is kept constant

In the study of JM, only R is reduced (R/Z not constant)



+10% up to 180 GeV !!!

JER is downgraded by

+7% at 45 GeV

+14% at 180 GeV

At this stage, the conclusion is very clear …. The radius at 1843 mm is an overshot of Spixel/R and at a modest degradation of **about +10% on JER** gives a **large cost reduction** (a factor 2 for the ECAL)

Physics case related to tracker device performances ($\delta p/p^2$ at few 10^{-5})

- ZH, with Z decaying into $\mu^+\mu^-$

Strong impact …. But it must be quantified (beamstr. versus resolution)

and in addition

Tracking code is, up to now, not using the primary vertex, what does it bring?

Proposed model

ECAL with $\mathbf{R_{ECAL\ entrance} = 1450}$ **, Nlayers = 25**

A priori, the cost of such an ECAL device is about 50% of the DBD detector cost (160MILCU)
An ECAL cost ≤ 75 MILCU (cheaper than CMS ECAL)

and a large reduction is foreseen for the overall detector cost

The proposed strategy is therefore

1 – reduce the internal radius corresponding to about a large reduction of overall ILD cost (**DBD-2 model**)

2 – re-do the optimization versus the number of layers and "hardware" limitation (pixels size, dead wafers, etc..)

3 – re-do the mechanical model (CAD) and all the construction and insertion model of the ECAL (tooling…)

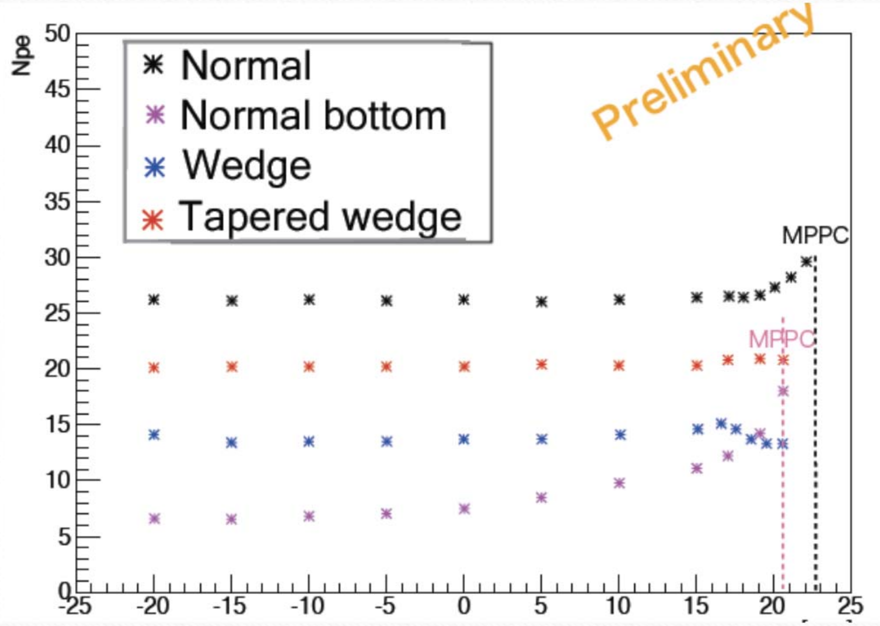
4 – re-do some physics cases and compare with DBD model

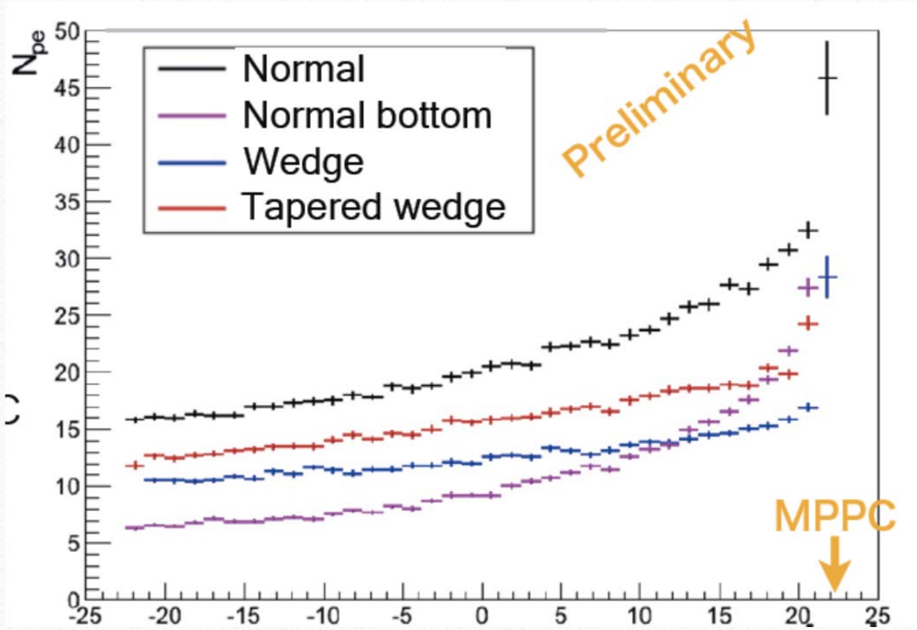
5 – In parallel, work on cost to optimize the ECAL cost in DBD-2 model (PCB, Chip in Package, MPPC for strips, etc..)

6 – In parallel, re-do optimization of scintillator and Hybrid ECAL, with REALISTIC simulation as defined by ECAL experts (V.Balagura and D.Jeans) …..

7 – In parallel, the tracking code must include primary vertex and quantified the case of ZH with Z in $\mu^-\mu^+$

Example of input for simulation in the strips ECAL detector





The natural goal would be to finish the study within the next 2-3 years (end of 2015-2016)

It will depend strongly on the manpower available for the project