Hybrid ECAL Simulation for ILD

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Motivation

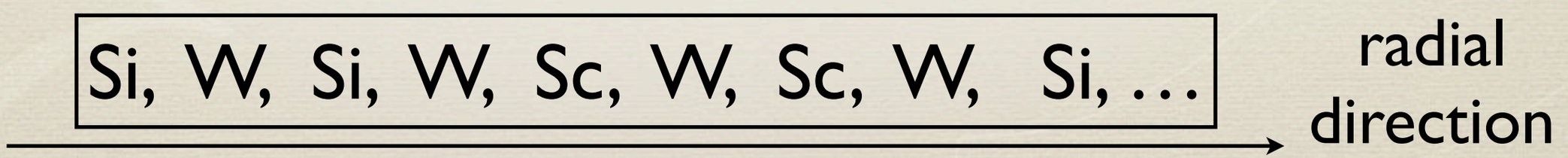
- Silicon-pad ECAL would be the best for PFA calorimetry for Linear Collider experiments, but its cost dominates whole ILD price.
- One of the solutions to reduce the cost while keeping the performance as much as possible is to replace some Si-pad layers by Scintillator strip layers.
- We have therefore started to evaluate the performance of the Hybrid ECAL (combination of Si and Sc) to optimize its configuration in terms of the cost and performance.

Simulation Tools

- We made detector simulation using *Mokka*, which is the Geant4-based simulation code, and reconstruct the simulated events using *Marlin*.

- The structure of Hybrid ECAL currently implemented in the Mokka is alternate between two Scintillator strip layers and two Silicon layers as the figure, and the thickness of each layer is 2mm and 0.5 mm, respectively.

- Absorber is tungsten whose total layers are 27, and inner 20 layers are 2.1mm and outer 7 layers are 3.5mm.

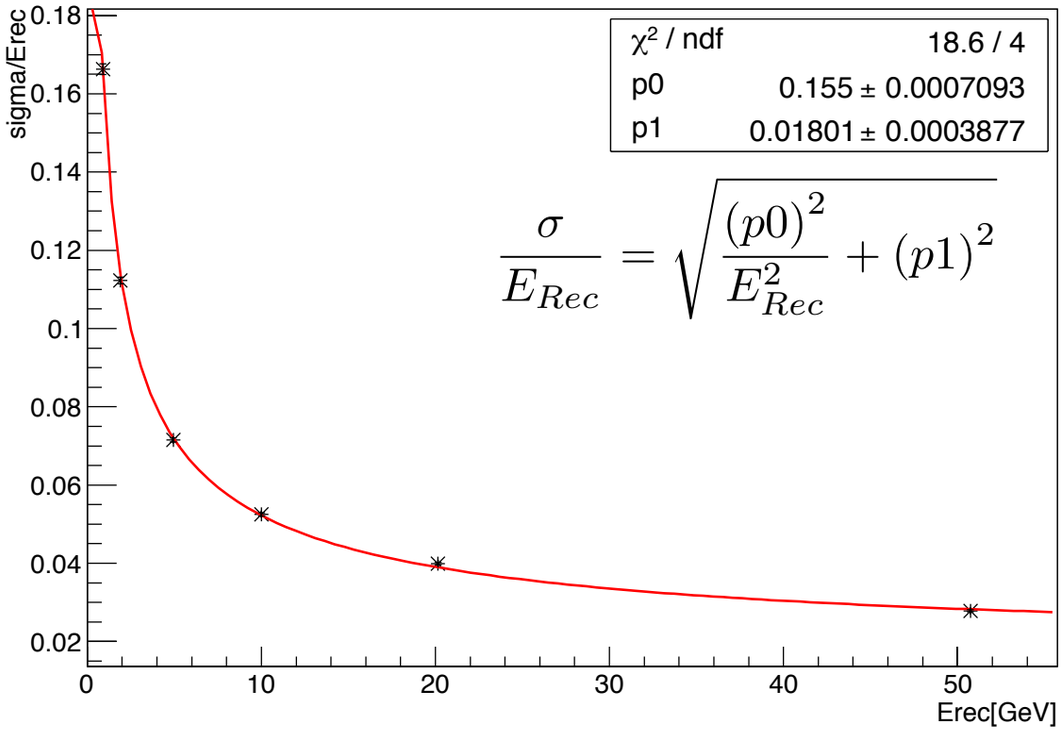


Calibration for Hybrid ECAL

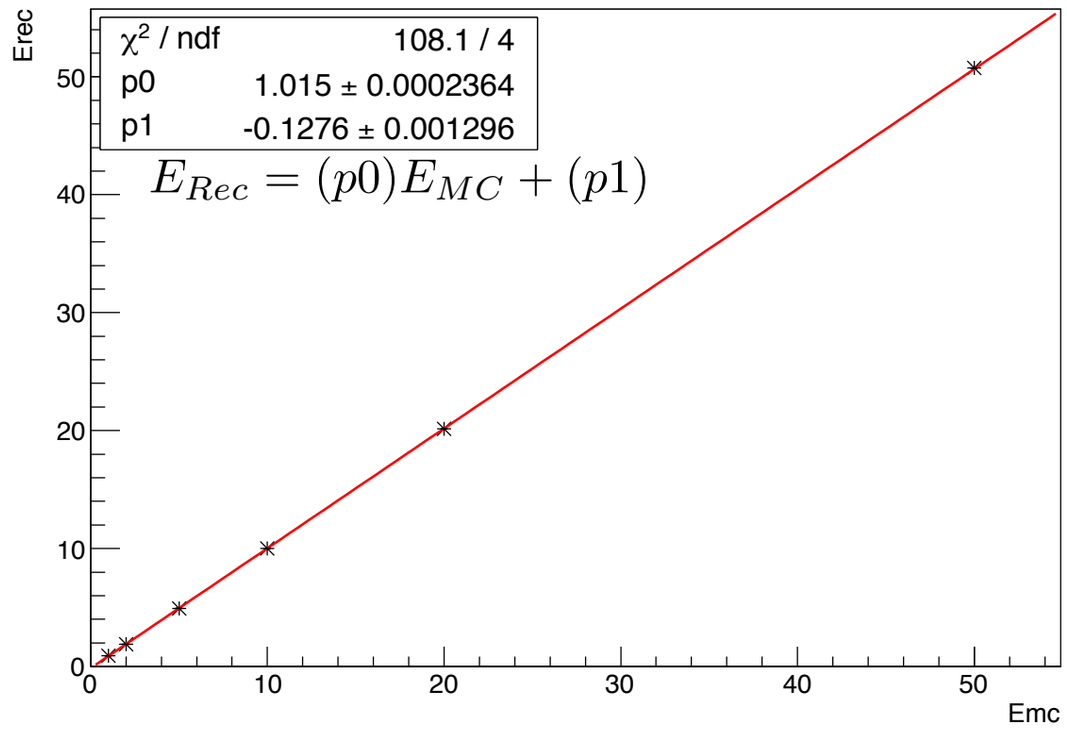
- Calibration constants for the Hybrid ECAL should be determined using single photon data.
- The performances of All Scintillator ECAL and All Silicon ECAL should be investigated in advance, in order to obtain criteria for the calibration.
- We evaluated the energy resolution and linearity of each ECAL.

Performances of All Scintillator ECAL

Resolution



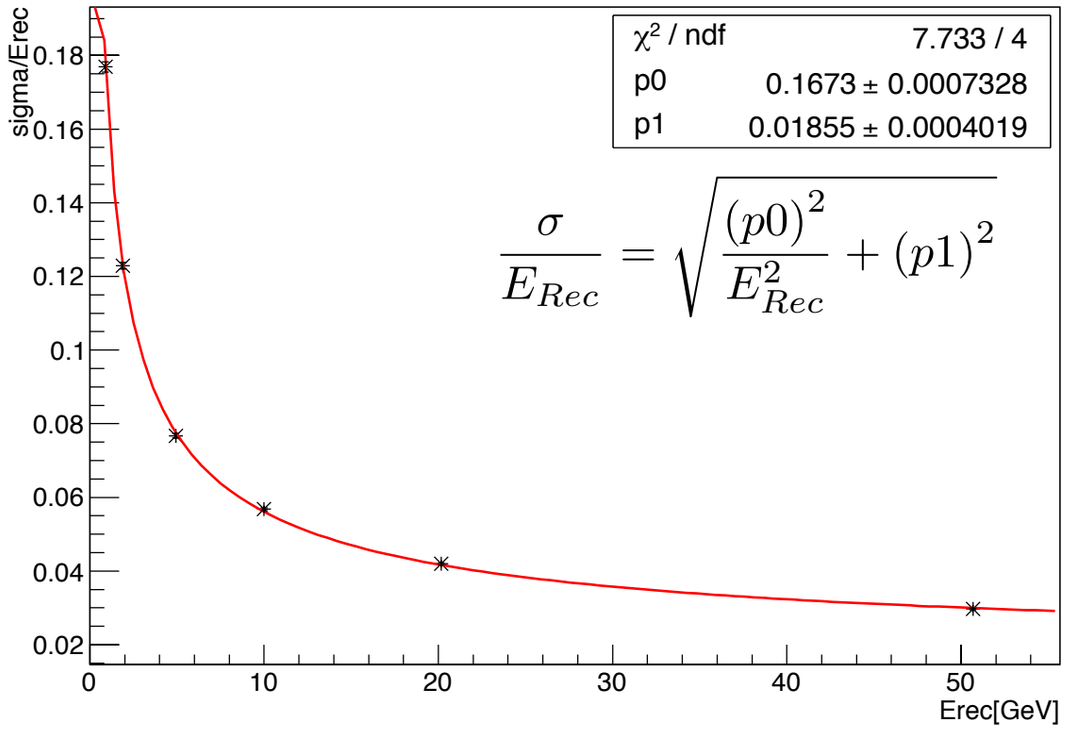
Linearity



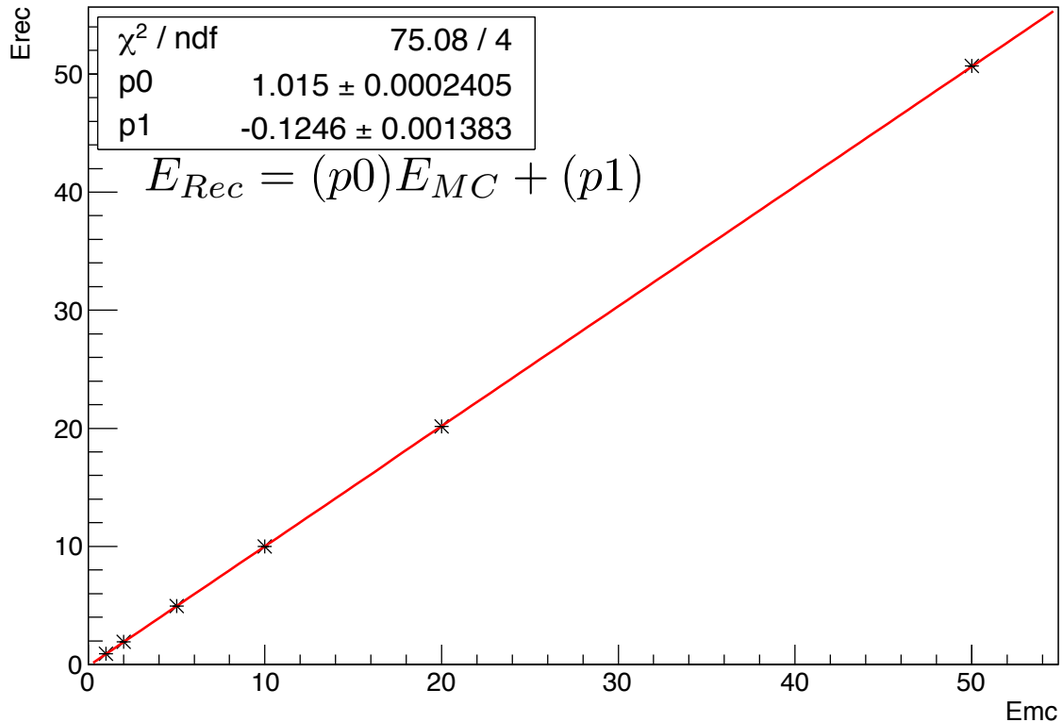
- Resolution 0.15503±0.00071
- Linearity 1.01547±0.00024

Performances of All Silicon ECAL

Resolution



Linearity



- Resolution 0.16734±0.00073
- Linearity 1.01480±0.00024

Performance Summary

	Energy Resolution	Linearity
All Scintillator	0.15503±0.00071	1.01547±0.00024
All Silicon	0.16734±0.00073	1.01480±0.00024

In each case, Energy resolution is about 16% and linearity is almost 1.

Calibration for Hybrid ECAL

$$E_{true} = a \times E_{Sc}^{inner} + b \times E_{Si}^{inner} + c \times E_{Sc}^{outer} + d \times E_{Si}^{outer}$$

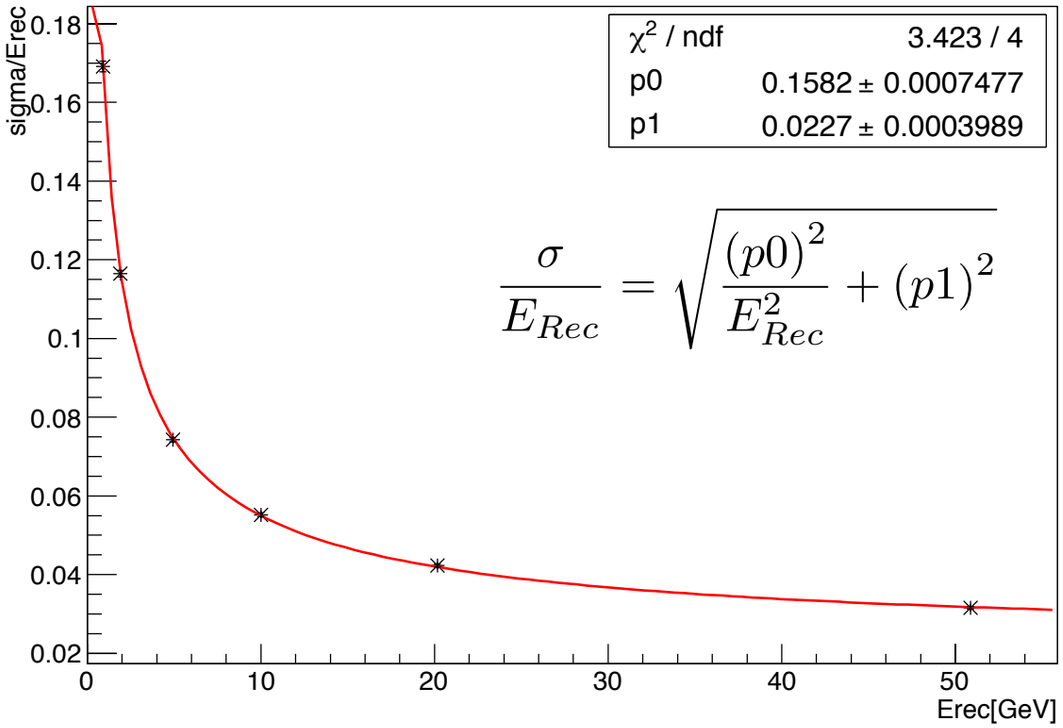
- We assumed the relation between “a” and “b” by taking into account each radiation length.
- Then “a” and “b” were adjusted so that the reconstructed energy is peaked at right position.
- “c” and “d” are determined by considering difference of absorber’s thickness.

Thickness	Sc [mm]	Si [mm]	W[mm]
All Sc	2.0	—	3.0
All Si	—	0.5	2.1/4.2
Hybrid	2.0	0.5	2.1/3.5

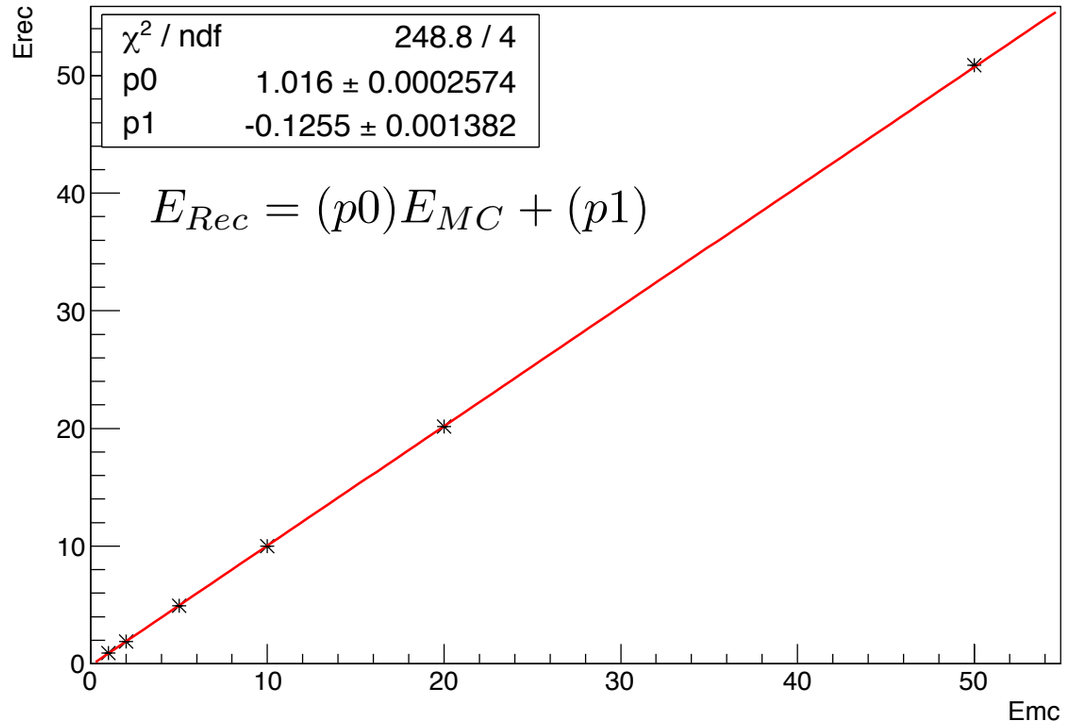
First 20 layer / After 7 layer

Performances of Hybrid ECAL

Resolution



Linearity



- Resolution 0.15824±0.00075
- Linearity 1.01646±0.00026

Performance Summary

	Energy Resolution	Linearity
All Scintillator	0.15503±0.00071	1.01547±0.00024
All Silicon	0.16734±0.00073	1.01480±0.00024
Hybrid	0.15824±0.00075	1.01646±0.00026

Reasonably good!

Summary and Prospects

- We obtained calibration constants for a proposed configuration of Hybrid ECAL, and evaluated the energy resolution and linearity.
- Our calibration for Hybrid ECAL achieved the same level as that of All Scintillator ECAL and All Silicon ECAL.
- In the next, we will confirm the other calibration constants by using K_L and muon samples.
- Then, we will analyze the jet events and compare the performance with that of All Scintillator and All Silicon.
- We will repeat the procedure with various hybrid configurations in order to optimize the cost and performance.