Simulation Study of the Hybrid ECAL

17th-19th December, 2012

Hiraku Ueno

Kyushu University

Contents

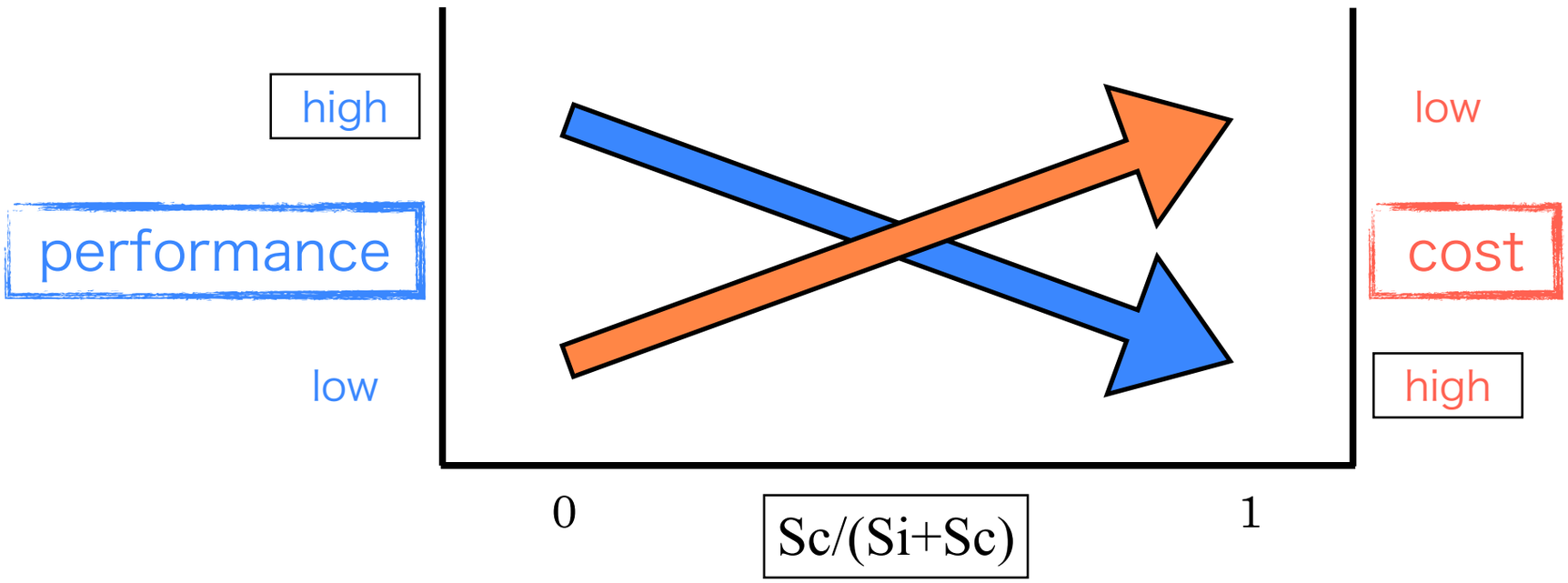
- Motivation for the Hybrid ECAL
- Calibration
- The Performances
  - same absorber thickness and number of layers
  - same module thickness
- Summary and Prospects

Hybrid ECAL

- A solution to make the ECAL with a reasonable cost while keeping the performance as much as possible would be mixture of the Silicon layers and Scintillator-strip layers.

  → ***Hybrid ECAL***

- We’re studying the performance of Hybrid ECAL.



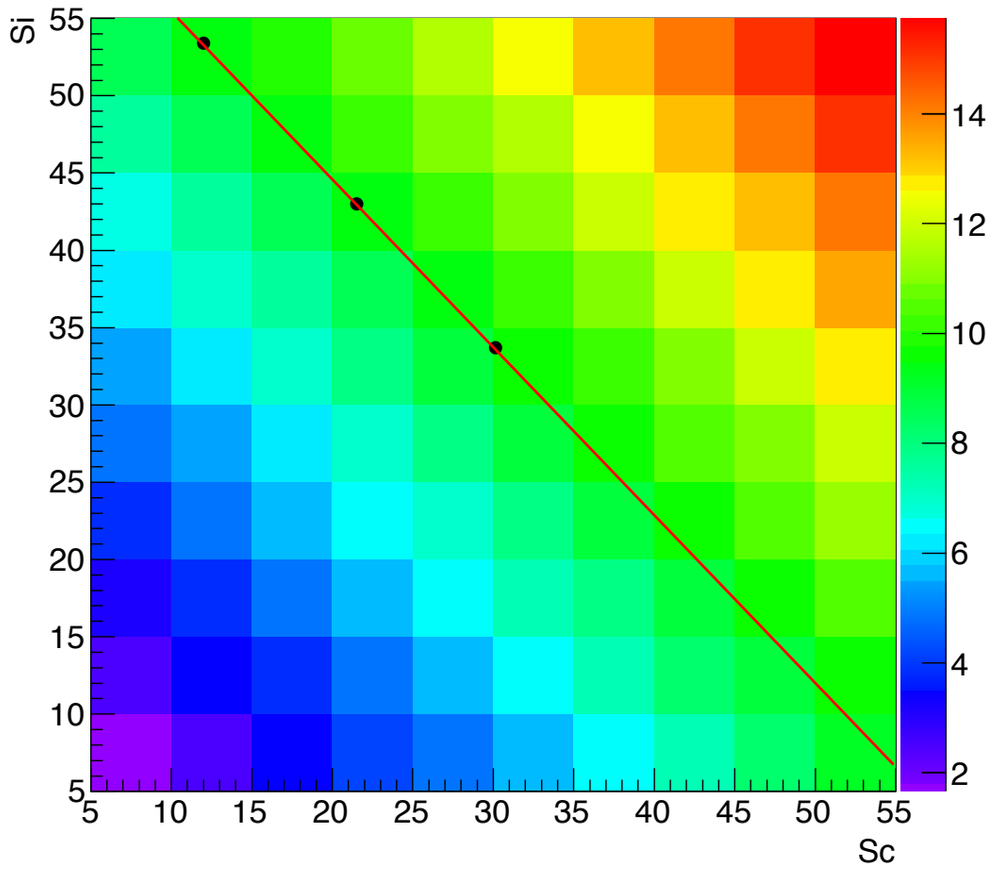
Calibration

Calibration constants for Silicon layers and Scintillator layers should be determined separately.

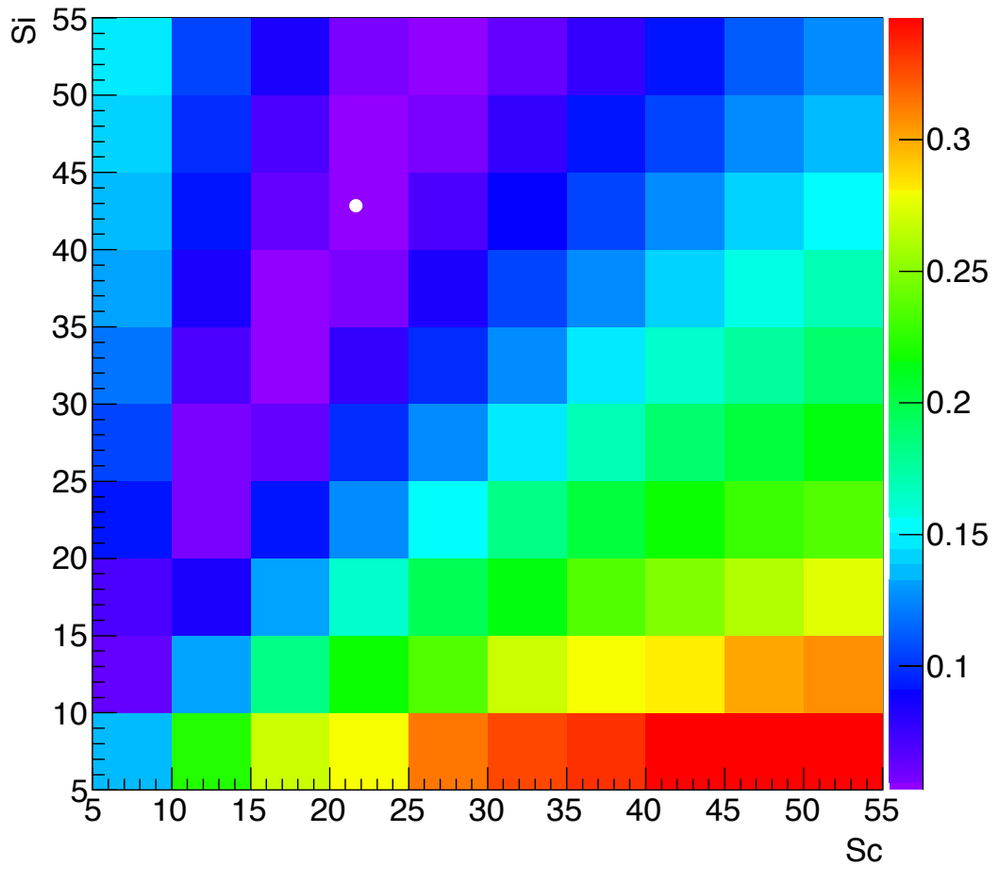
Calibration constants are determined by using 10GeV photon.

HybridECAL (Thickness - Sc 2.0mm, Si 0.5mm)

mean



sigma/mean



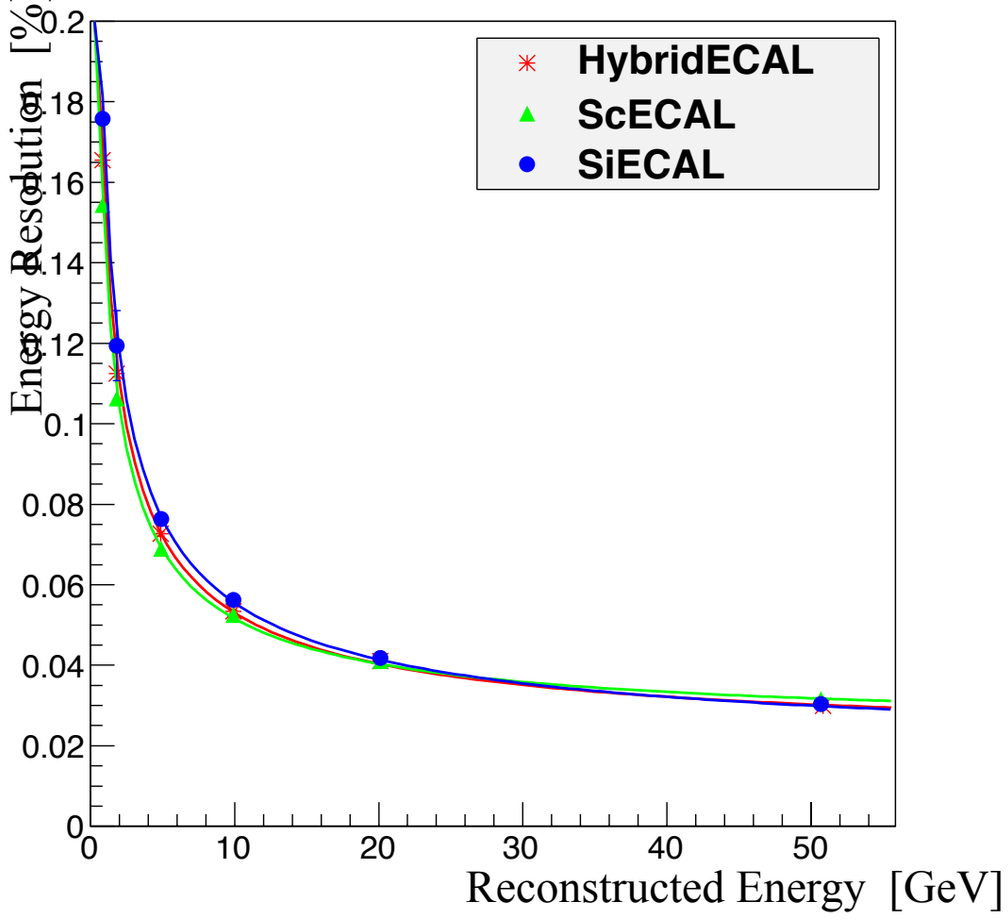
ECAL Performance

In order to check the calibration constants, we have evaluated the energy resolution and linearity of the ECALs by using 1~50GeV photons.

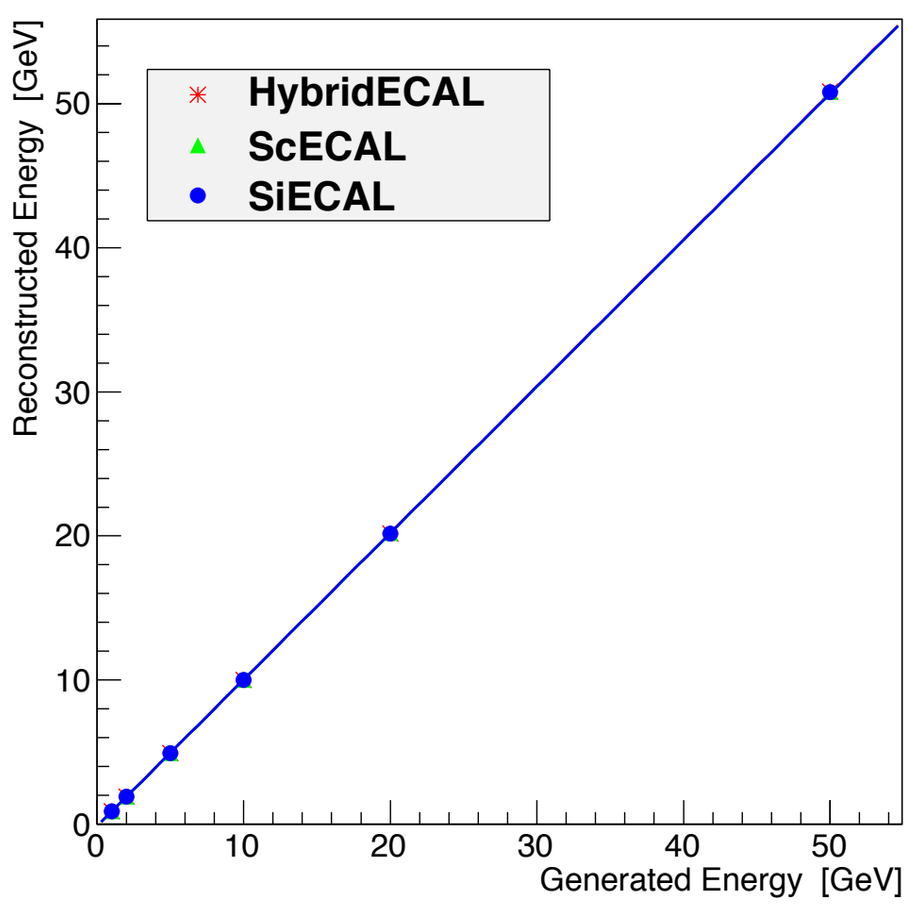
→The calibration method works well.

HybridECAL (Thickness - Sc 2.0mm, Si 0.5mm)

Energy Resolution

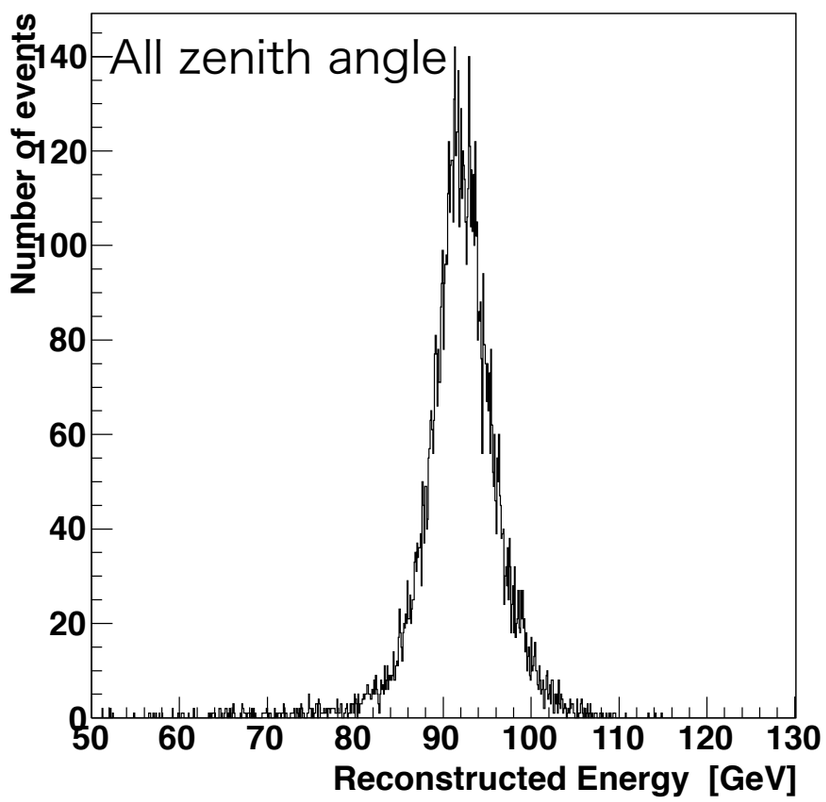


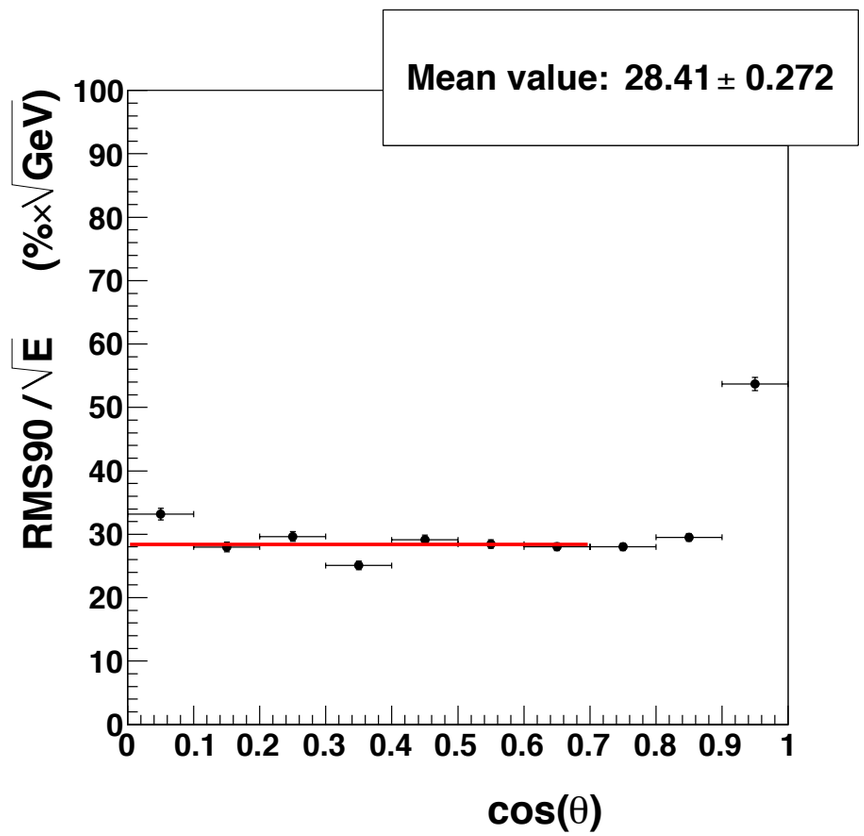
Linearity



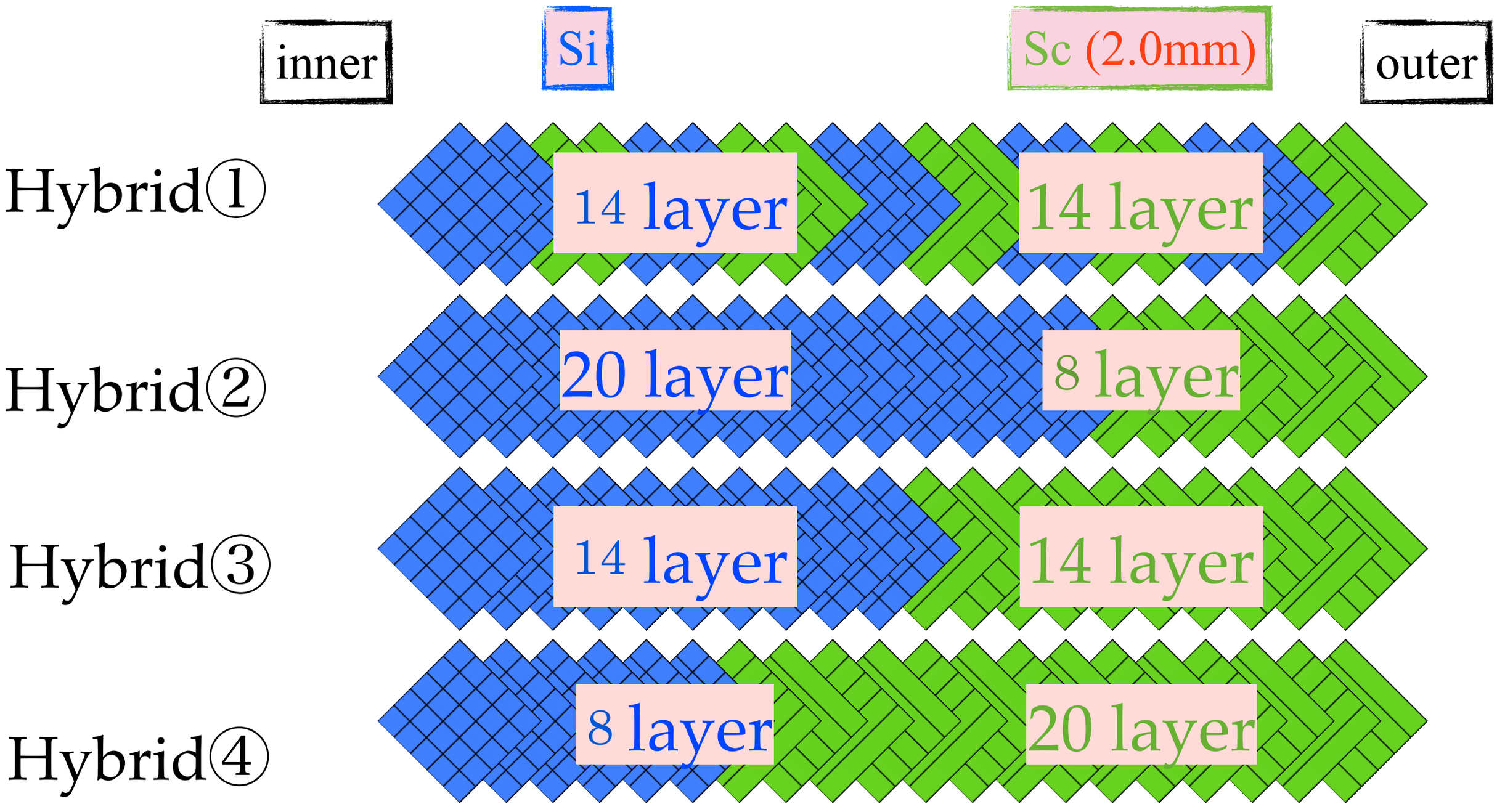
Study of Hybrid ECAL

- We simulated the performances of Hybrid ECAL with iLCSoft v01-09-02.
- We evaluated energy dependence and Sc:Si ratio dependence.
- Used events are $e^+e^- \rightarrow q\bar{q}$ (√s=91, 200, 360, 500GeV)
- Evaluated area is only barrel part (cos(thrust angle)<0.7) because energy resolution of endcap part is quite worse than barrel part.





Hybrid Configurations① ~same absorber thickness~



pure ScECAL and pure SiECAL were also simulated for comparison.

Hybrid Configurations①

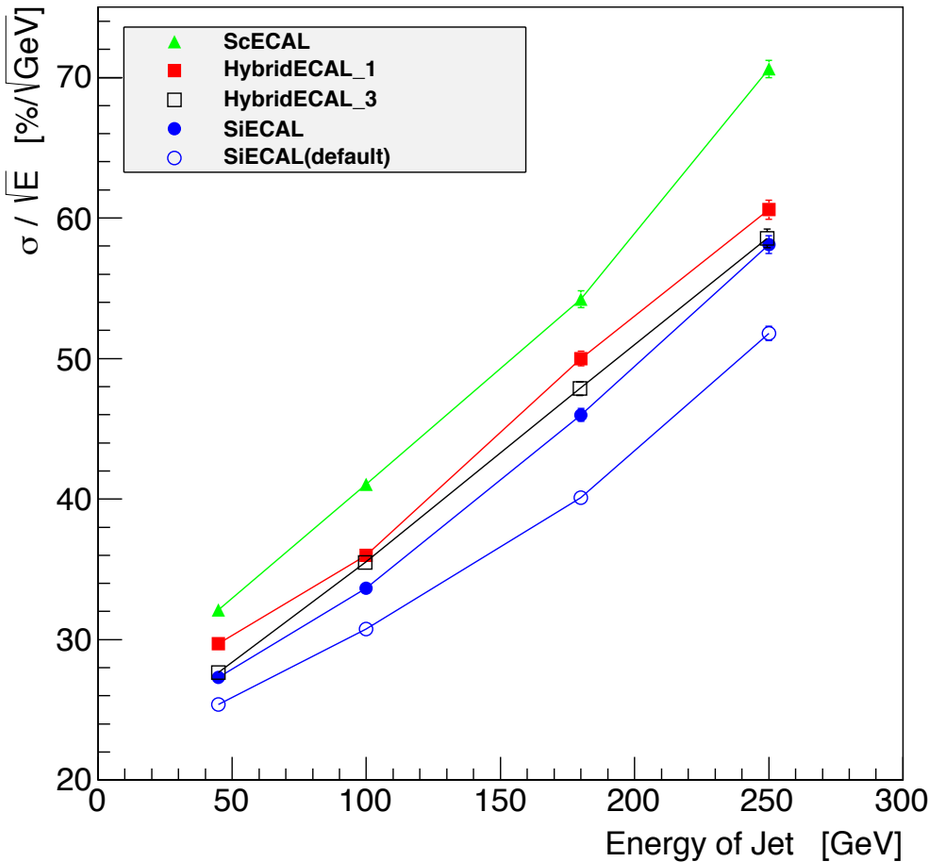
~same absorber thickness~

Sc thickness = 2.0mm
Si thickness = 0.5mm

	number of Si layer(inner)	number of Sc layer(outer)	W thickness (in20,out7)	Module thickness	Radiation Length
SiECAL(28)	28	0	2.1/3.5	165.400	$19.144X_0$
Hybrid①	14	14	2.1/3.5	185.196	$19.136X_0$
Hybrid②	20	8	2.1/3.5	176.712	$19.729X_0$
Hybrid③	14	14	2.1/3.5	185.196	$19.136X_0$
Hybrid④	8	20	2.1/3.5	193.680	$19.981X_0$
ScECAL(28)	0	28	2.1/3.5	204.992	$20.274X_0$

Energy Dependence

~ same absorber thickness ~

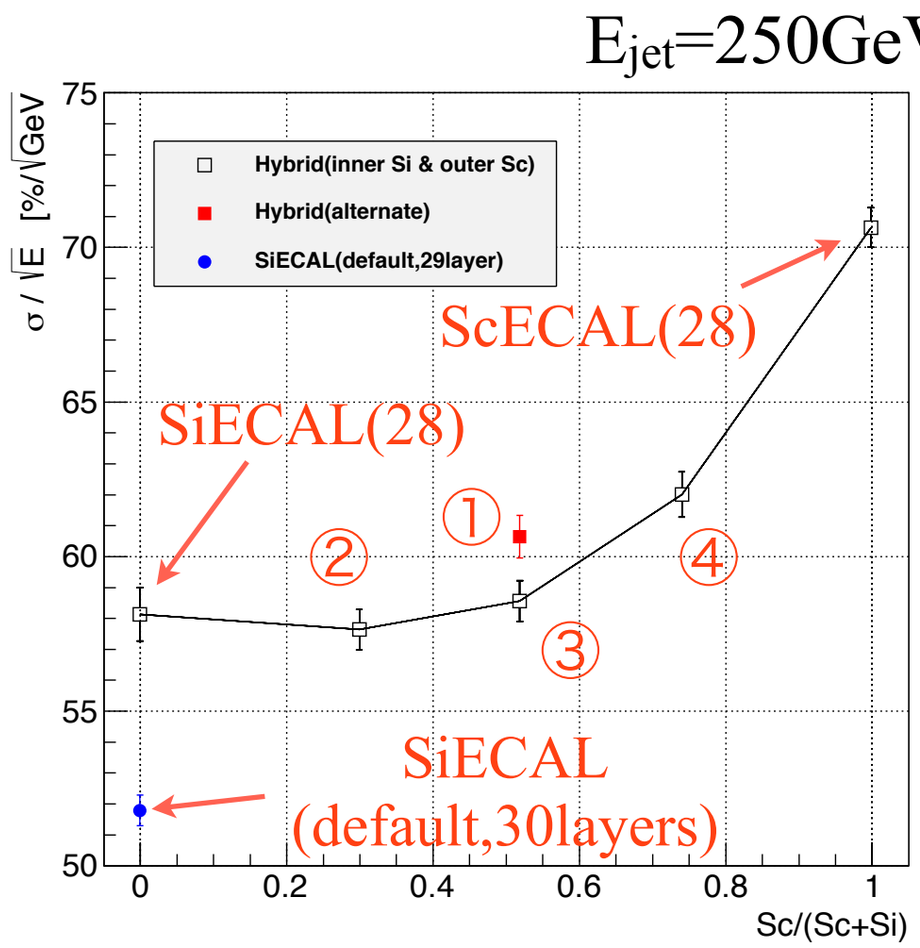


- ▲ : ScECAL (28 layers)
- ■ : alternate structure
- □ : 14 Si layers, 14 Sc layers
- ● :SiECAL (28layers)
- ○ : default SiW ECAL (30 layers)

- Default SiW ECAL is much better than SiW ECAL due to the difference of absorber thickness and number of layers.
- The performances of Hybrid① (alternate structure) are midway between SiECAL(27) and ScECAL(27).

Sc:Si Ratio Dependence

~ same absorber thickness ~



- ① : alternate structure
- ② : 20 Si layers, 8 Sc layers
- ③ : 14 Si layers, 14 Sc layers
- ④ : 8 Si layers, 20 Sc layers

Energy Resolution doesn't degrade so much up to 50% of Scintillator layers.

Hybrid Configurations②

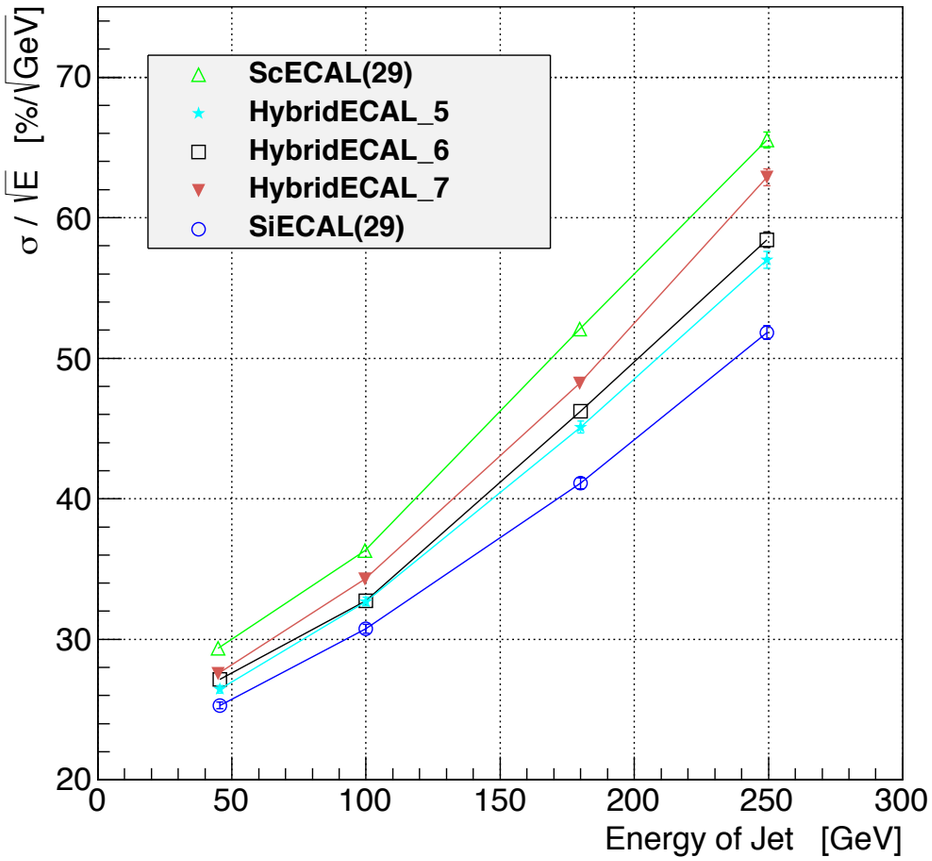
~same module thickness~

Sc thickness = 1.0mm
Si thickness = 0.5mm

	number of Si layer(inner)	number of Sc layer(outer)	W thickness (in20,out9)	Module thickness	Radiation Length
SiECAL(30)	30	0	2.1/4.2	185.000	$22.96X_0$
Hybrid⑤	22	8	2.1/3.9	185.612	$22.33X_0$
Hybrid⑥	16	14	2.1/3.6	185.396	$21.67X_0$
Hybrid⑦	10	20	2.1/3.3	185.180	$21.00X_0$
ScECAL(30)	0	30	2.1/2.9	185.720	$20.14X_0$

Energy Dependence

~ same module thickness ~

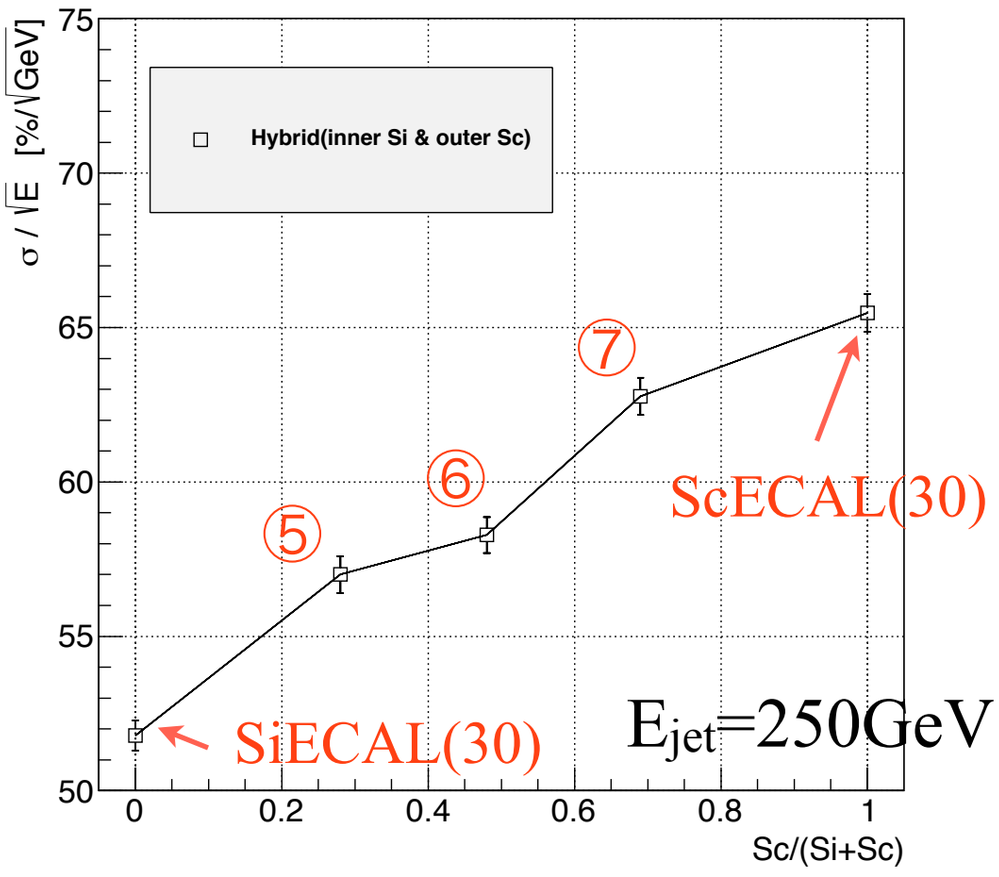


- △ : ScECAL (30layers)
- ★ : 22 Si layers, 8 Sc layers
- □ : 16 Si layers, 14 Sc layers
- ▼ : 10 Si layers, 20 Sc layers
- ○ : SiECAL (30 layers)

The performance of the Hybrid ECAL is reasonable compared with ScECAL and SiECAL.

Sc:Si Ratio Dependence

~ same module thickness ~



- ⑤ : 22 Si layers, 8 Sc layers
- ⑥ : 16 Si layers, 14 Sc layers
- ⑦ : 10 Si layers, 20 Sc layers

The performance of Hybrid ECAL become worse almost linearly as Sc ratio increases.

Summary and Prospects

- We evaluated Sc:Si ratio dependence and energy dependence for 2 cases, same absorber thickness and keeping module thickness.
  - In same absorber thickness, the performance of the Hybrid ECAL is almost same as that of SiECAL.
  - In the case of keeping module thickness, the performance of the Hybrid ECAL is about middle of that of SiECAL and ScECAL.

- We’re reevaluating their performances with iLCSoft v01-15.