



# ECAL Japan Group activity

ILC Tokusui Workshop 2012

2012/12/21

Yuji Sudo (Kyushu University)

# Members of The Univ. of Tokyo

Sachio Komamiya (professor @ dept of physics, director ICEPP)  
grant from MEXT for calorimeter development

Wataru Ootani (associate professor @ ICEPP)  
Heavily involved in MEG  
Analysis, upgrade (MPPC for ECAL)  
Interested to join ILC ECAL activities  
possibly with new student from April

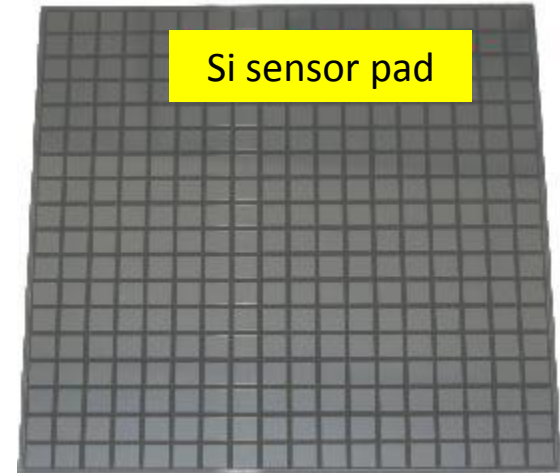
Yoshio Kamiya (assistant professor @ ICEPP)  
Interested to join ILC ECAL, on hardware side

Daniel Jeans (project researcher @ dept of physics)  
employed via MEXT grant

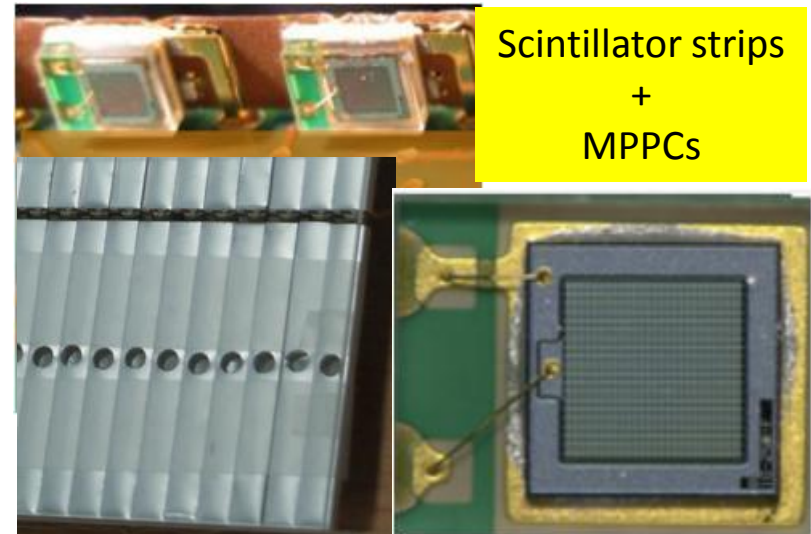
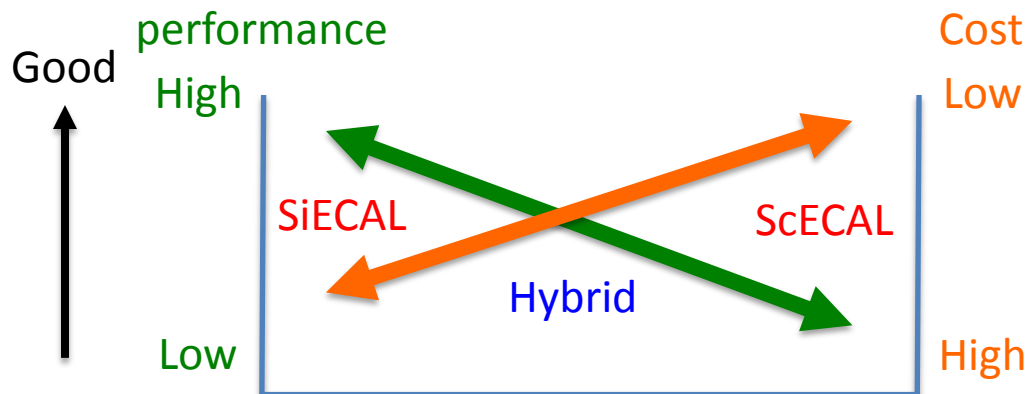
Chihiro Kozakai & Shiro Chen  
Komamiya-san's 1st year Master students

# ILD ECAL

- Particle Flow Algorithm  
→ Highly granular ECAL
- SiECAL  
Si pixel detectors, pixel size  $5 \times 5 \text{ mm}^2$
- ScECAL  
Scintillator strip + MPPC  
 $5 \times 45 \text{ mm}^2$  strip ( $5 \times 5 \text{ mm}^2$  effective cell)
- Hybrid ECAL



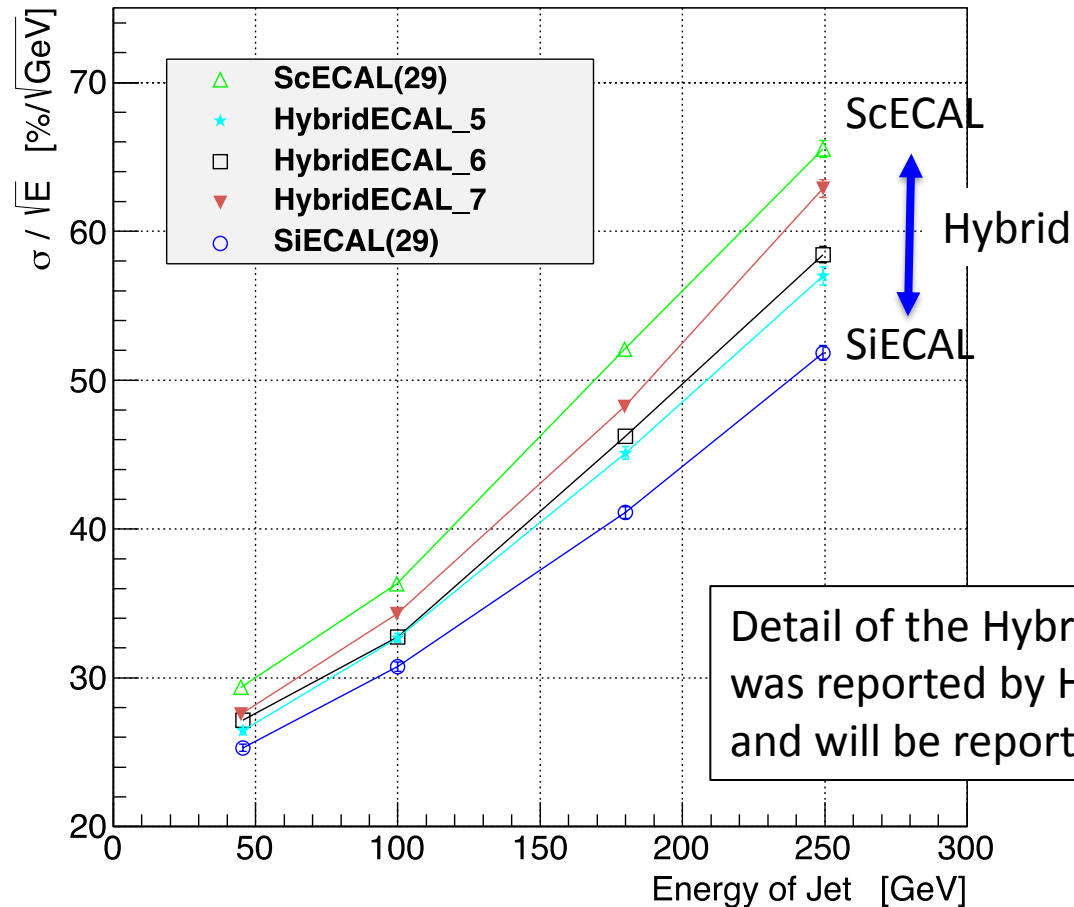
OR/AND



# Hybrid ECAL Study

We are working on the Hybrid ECAL study.

ECAL Jet energy resolution



# SiECAL

We took part in the test beam for the technological prototype  
@ DESY July 2012

4 SKIROC2b ASICs on a layer

6 layers

Total 1536 channels

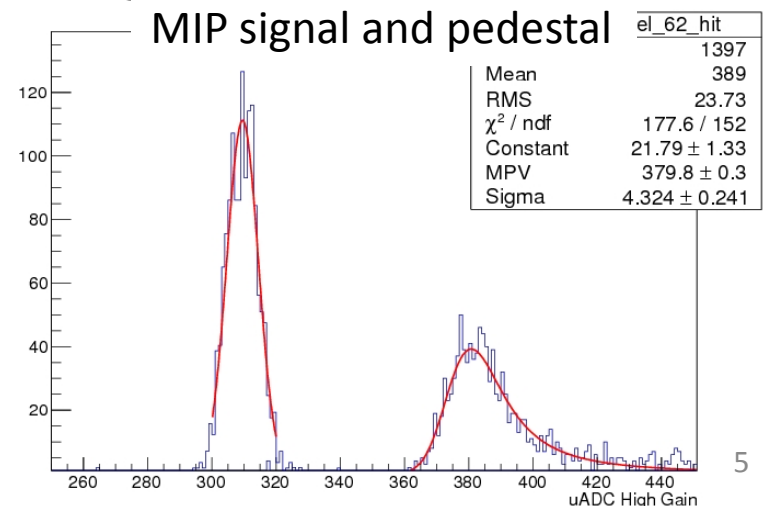
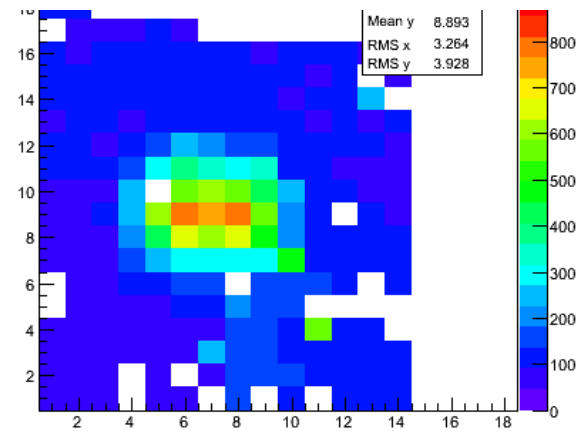
**Total active channels = 1278**

(PreAmplifiers of noisy channels are switched off)

**S/N > 10**



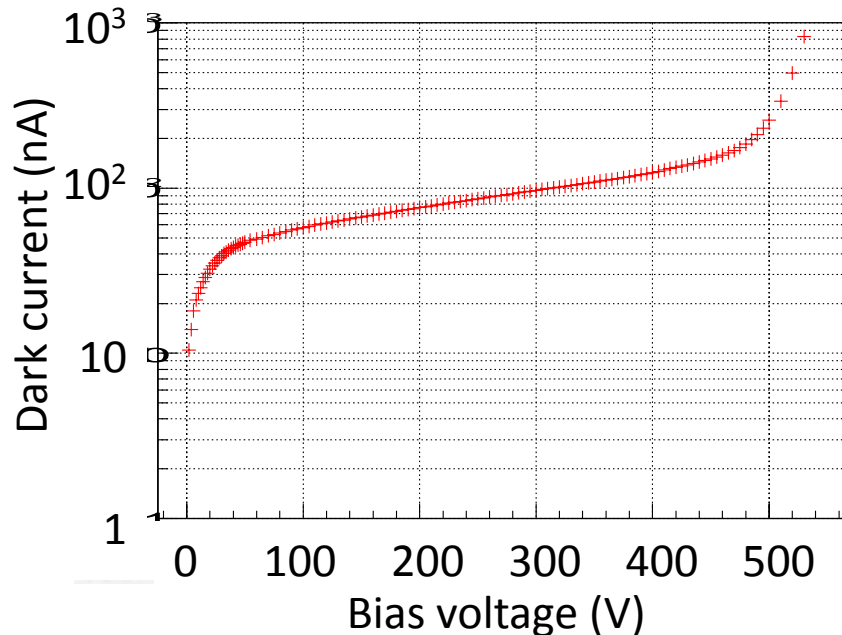
A hit map with electron beam  
Number of events in 5x5mm<sup>2</sup>



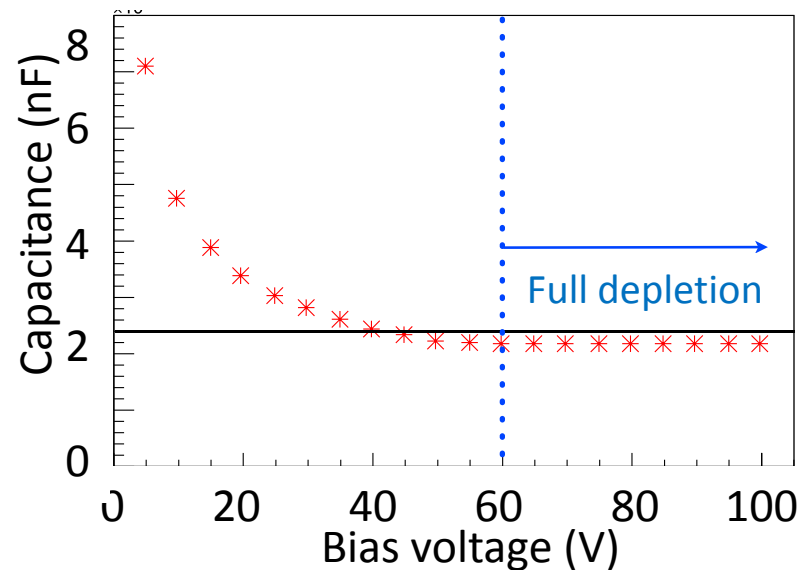
# Si Sensor Study

We measured basic properties of Si sensors manufactured by HPK  
Main chips have 16x16 pixels, pixel size 5x5mm<sup>2</sup>  
Baby chips have 3x3 pixels, pixel size 5x5mm<sup>2</sup>

I-V measurement



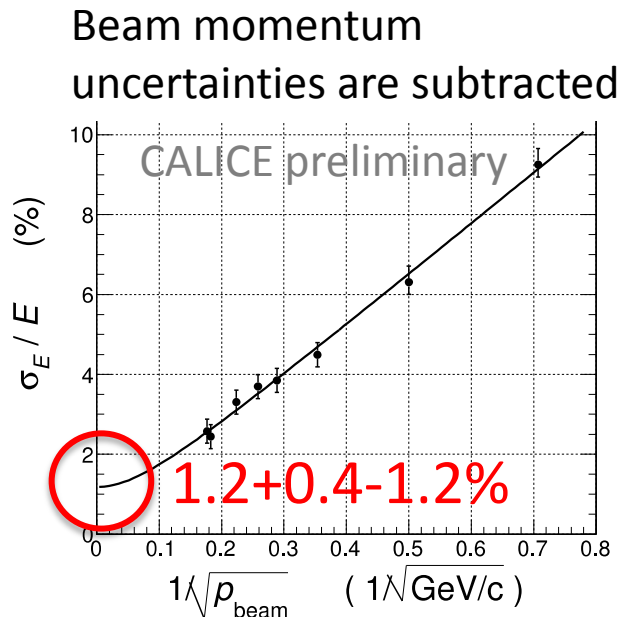
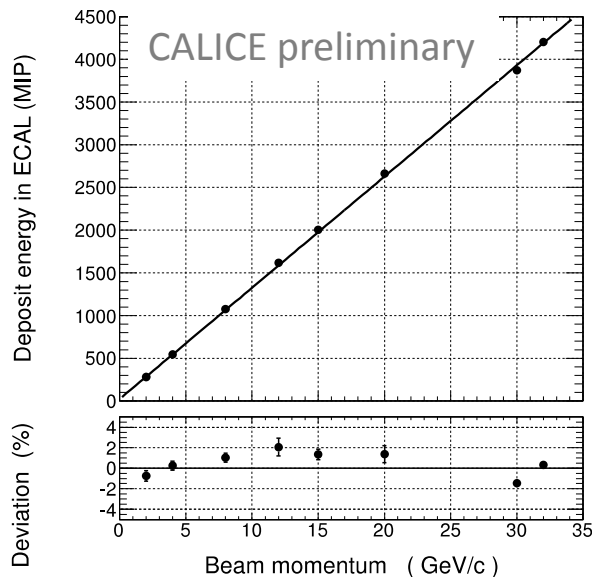
C-V measurement



Detail of the Si sensor study  
will be reported by Youhei Miyazaki

# ScECAL Studies

- 2007 first physics prototype TB @ DESY
  - Paper under review by CALICE collaboration
- 2009 second physics prototype TB @ FNAL MT6
  - Estimate systematic uncertainties
  - sources of constant term on the energy resolution
  - Measured momentum spread at MT6 :
    - $2.7 \pm 0.3 \% @ 1\sim 4 \text{ GeV}$ ,  $2.3 \pm 0.3 \% @ 8 \text{ GeV}$

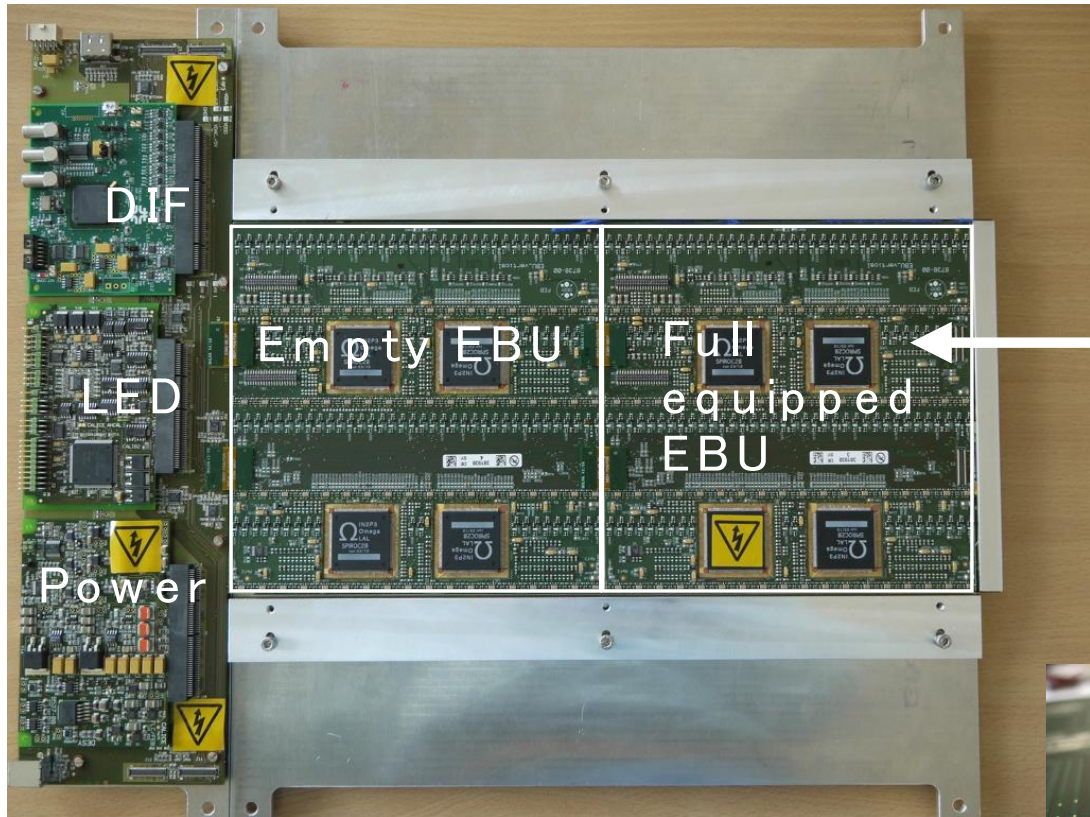


Components of constant term

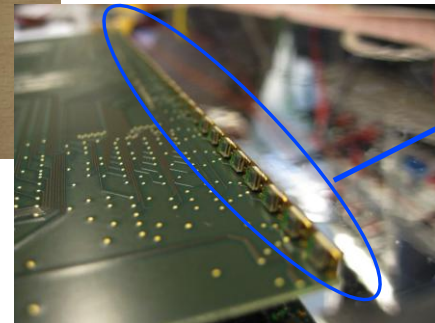
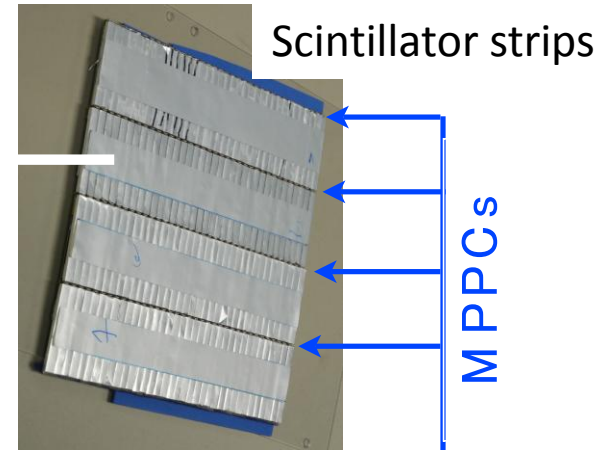
ADC to gain conversion	< 0.02 %
MPPC saturation	< 0.2 %
Run by Run	< 0.3 % @ low E
Shower leakage	< 1 %

# First ScECAL Technological prototype

- Scintillator strip + MPPC and Electronics are integrated in a layer
- Use 144 scintillator strips + MPPCs (strip size 5x45x2mm<sup>3</sup>)



The other side.

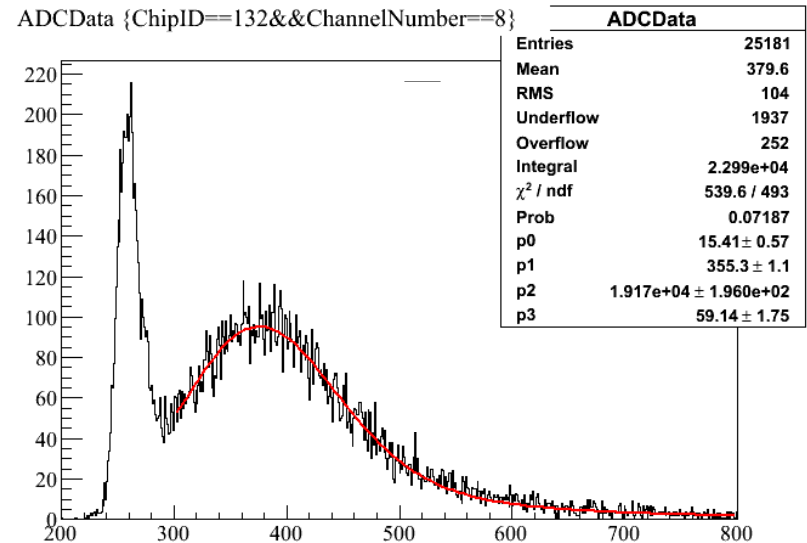
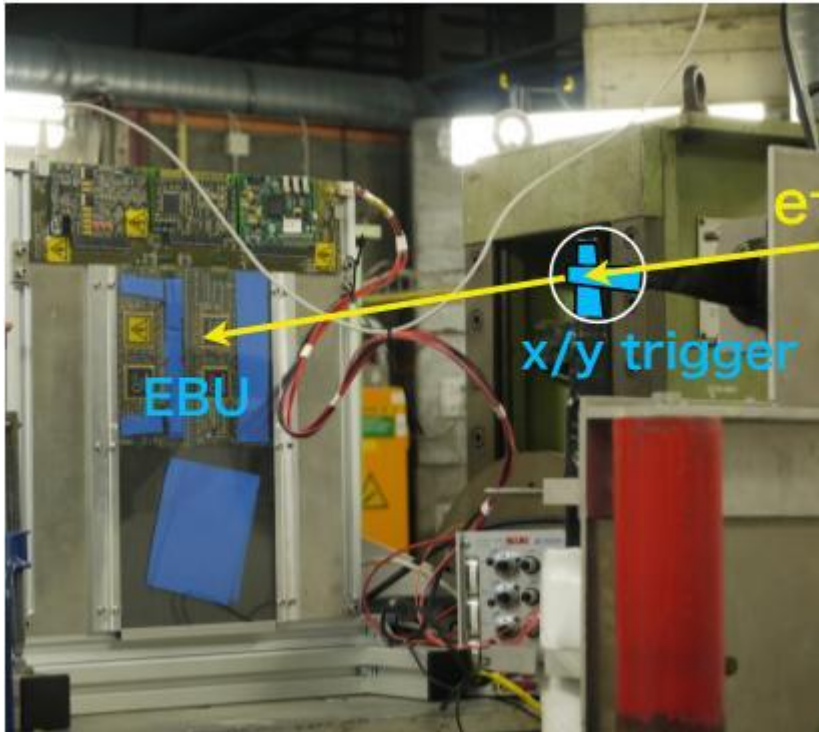


DIF, LED controller, and Power controller are the same technology as the AHCAL HBU



# ScECAL Technological prototype Test Beam @ DESY

In October, we performed a test beam for the first technological prototype with 1-6 GeV electron beam

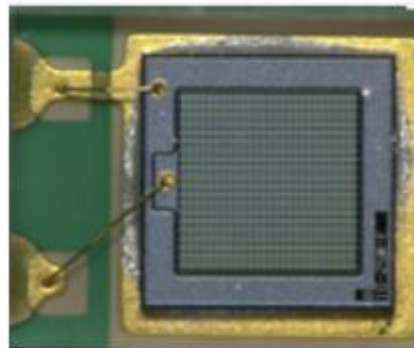


We can see MIP signal!

Detail of the TB analysis status  
will be reported by Shinji Inayoshi

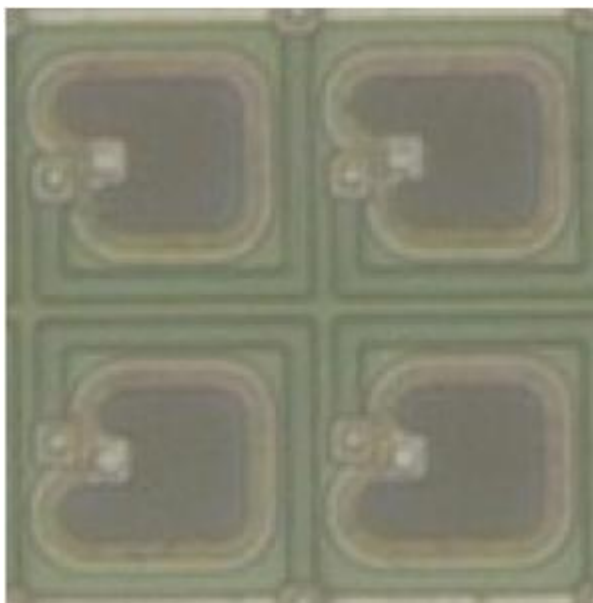
# MPPC Studies

- Response curve
- Timing resolution
- Scintillator + MPPC



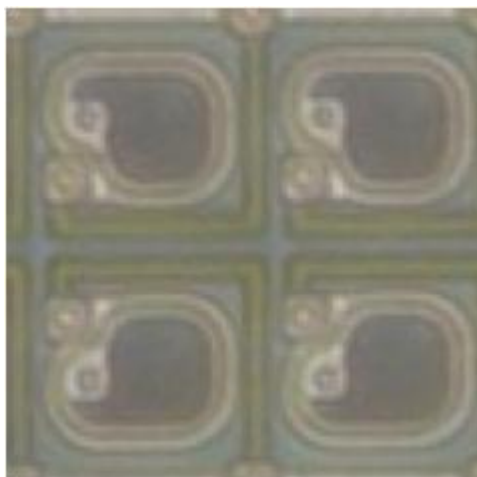
25  $\mu\text{m}$  pitch

1600 pixels in  $1 \times 1 \text{ mm}^2$



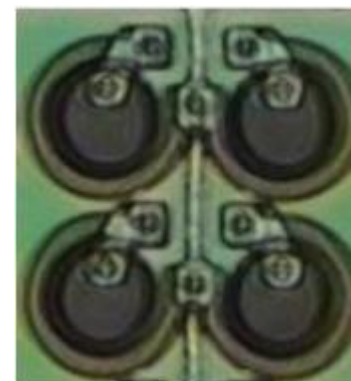
20  $\mu\text{m}$  pitch

2500 pixels in  $1 \times 1 \text{ mm}^2$

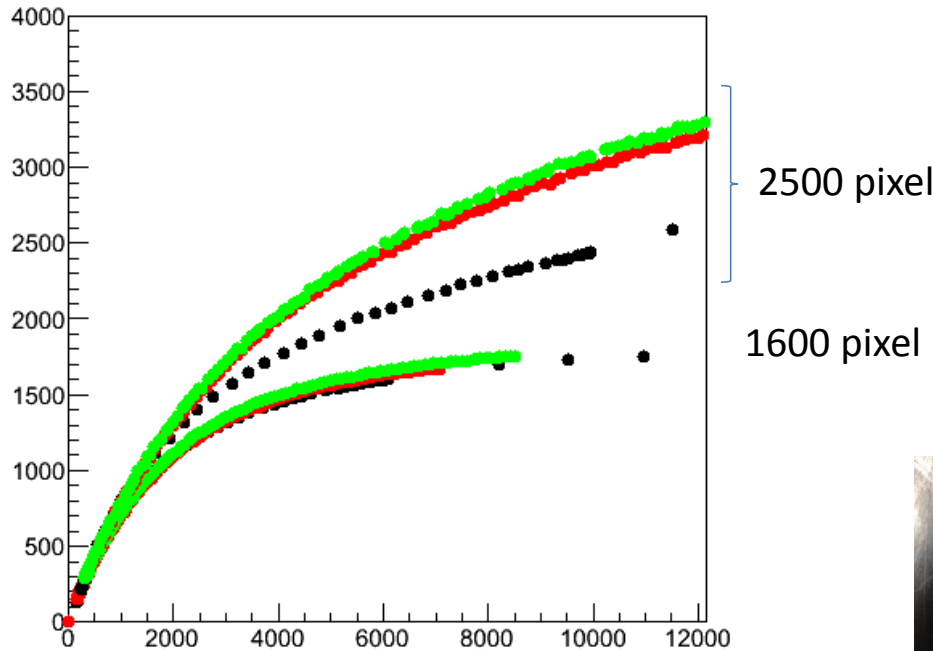


15  $\mu\text{m}$  pitch

4400 pixels in  $1 \times 1 \text{ mm}^2$



# MPPC : Response Study



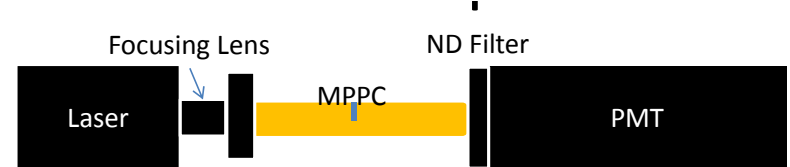
Black: MPPC Single body

Red: MPPC+Scintillator

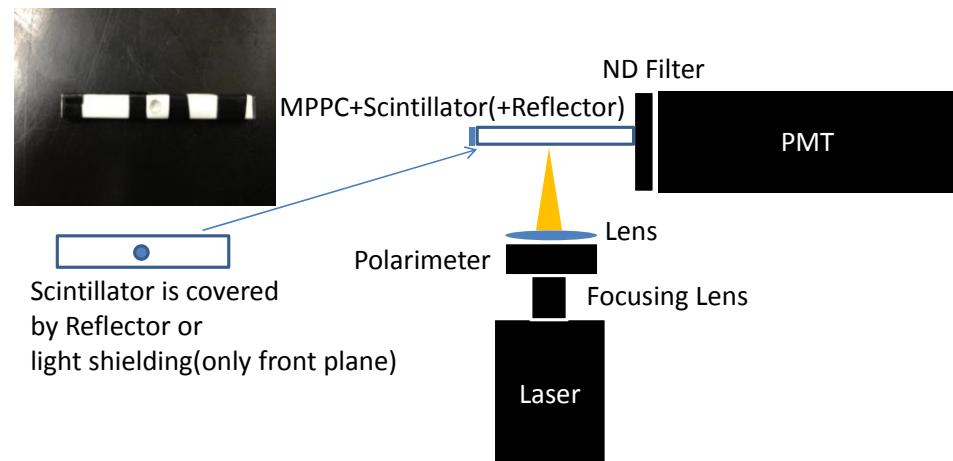
Green: MPPC+Scintillator+Reflector

Detail of the response study of MPPCs  
will be reported by Ryosuke Fuchi

MPPC only



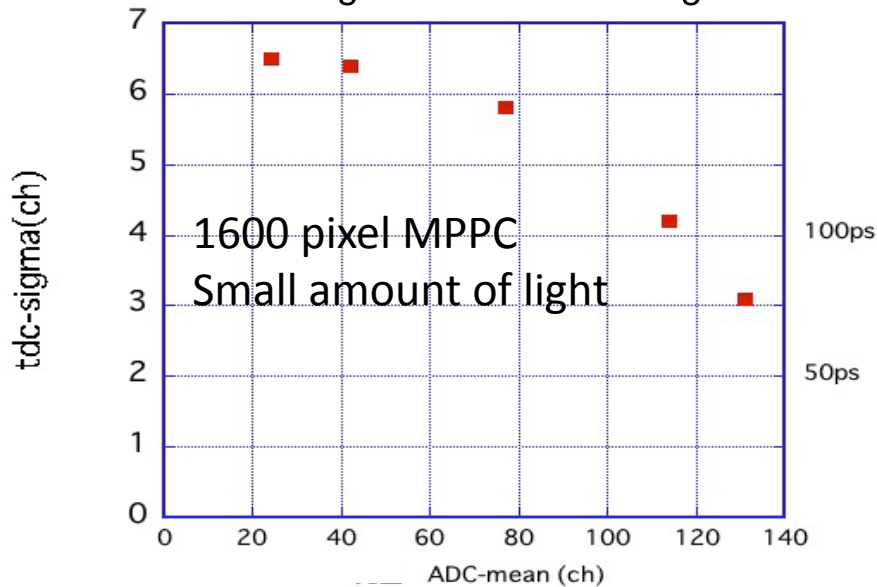
MPPC + Scintillator w/wo Reflector



# MPPC : Timing Resolution

■ tdc-sigma(ch) TDC : 25ps / ch

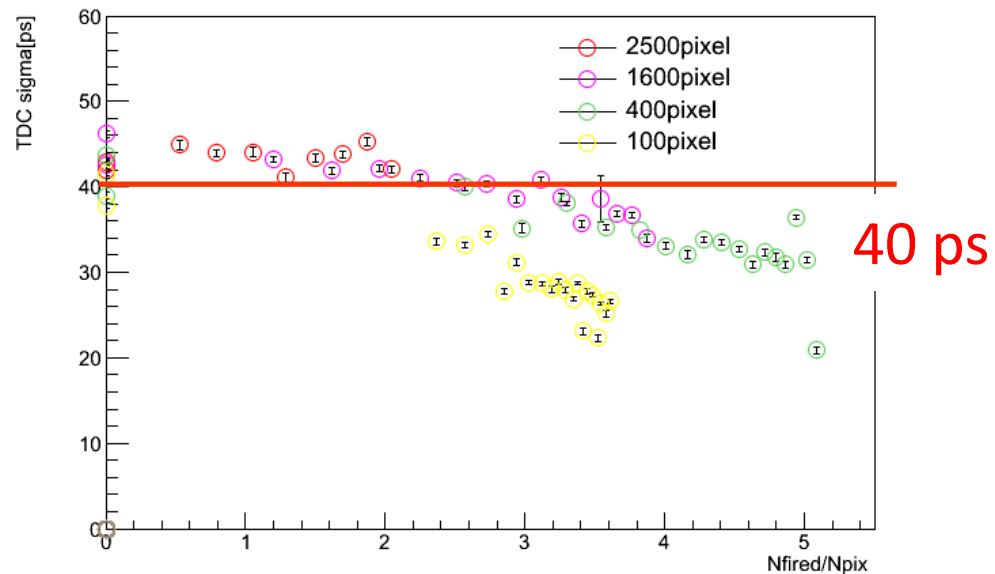
TDC-sigma vs. amount of light



Timing resolution Worsened  $\sim 170$  ps

TR with large amount of light

Nfired/Npix vs. TDC sigma



Detail of the timing resolution study will be reported by Ryutaro Hamasaki

# Scintillator Strip + MPPC study

Scintillator width 10  $\rightarrow$  5 mm

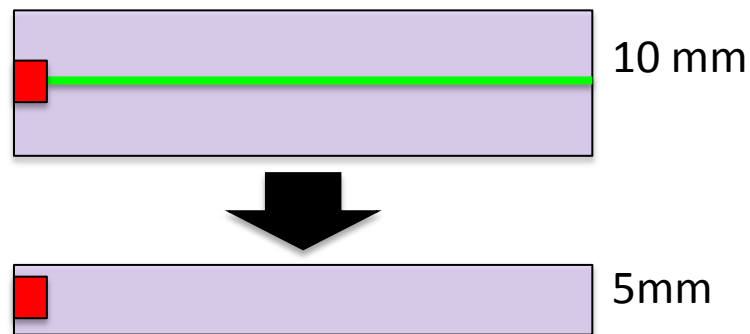
$\rightarrow$  Without WLSF

$\rightarrow$  ~~precise alignment~~

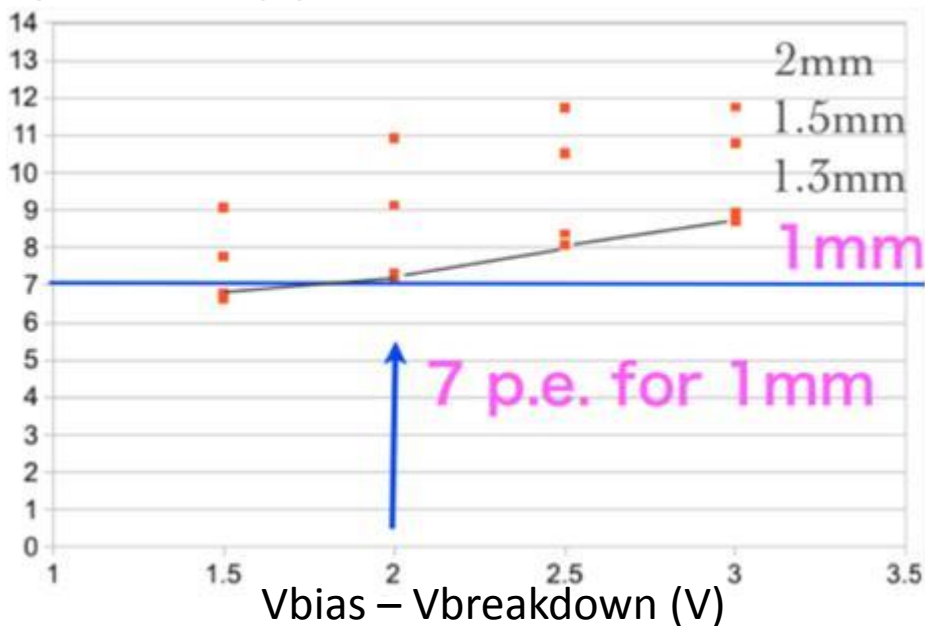
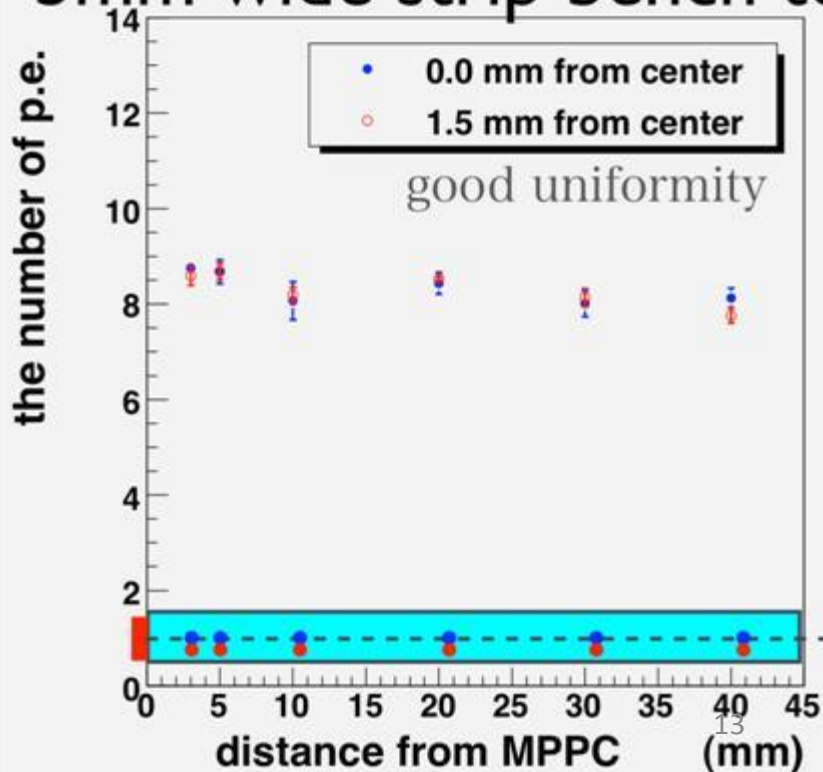
$\rightarrow$  Uniformity Studied

Scintillator thickness : 3  $\rightarrow$  2, 1 mm

5 mm wide



5mm wide strip bench test



# Summary

- The Tokyo University members joined in our ECAL group.
- The paper of the first physics prototype ScECAL is under review by CALICE collaboration.
- We are preparing the paper of the second physics prototype ScECAL.
- Test beam with a SiECAL technological prototype was successfully done @ DESY in July.
- Test beam with the first ScECAL technological prototype was successfully done @ DESY in October.
- Hybrid ECAL optimization is in progress.
- MPPC + scintillator strip study is in progress.

# Next Steps

- SiECAL next TB, main target is power pulsing mode
- ScECAL technological prototype second TB
  - with SiECAL → first Hybrid ECAL TB!
- Si sensor measurement @ Kyushu & Tokyo
- Infrared LASER system for Si sensor study @ Kyushu
- MPPC + 1mm thickness scintillator Study @ Shinshu & Tsukuba
- Hybrid ECAL Study @ Kyushu & Tokyo