

Preparation and performance study of a new short slab for ILD SiW-ECAL

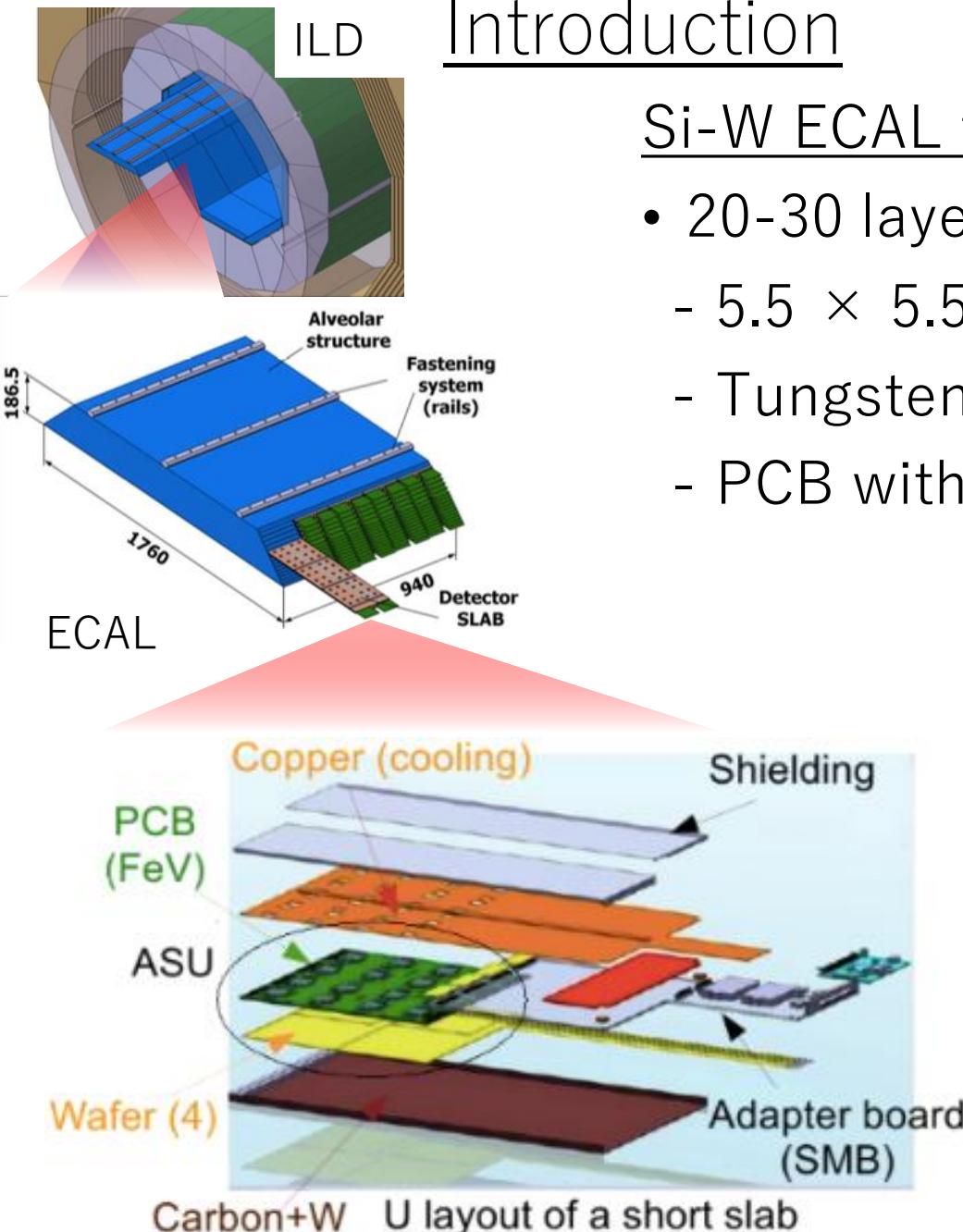
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Introduction

Si-W ECAL for ILD

- 20-30 layers of sandwich calorimeter
 - $5.5 \times 5.5 \text{ mm}^2$ segmented silicon sensors
 - Tungsten absorbers
 - PCB with ASICs (FEV)

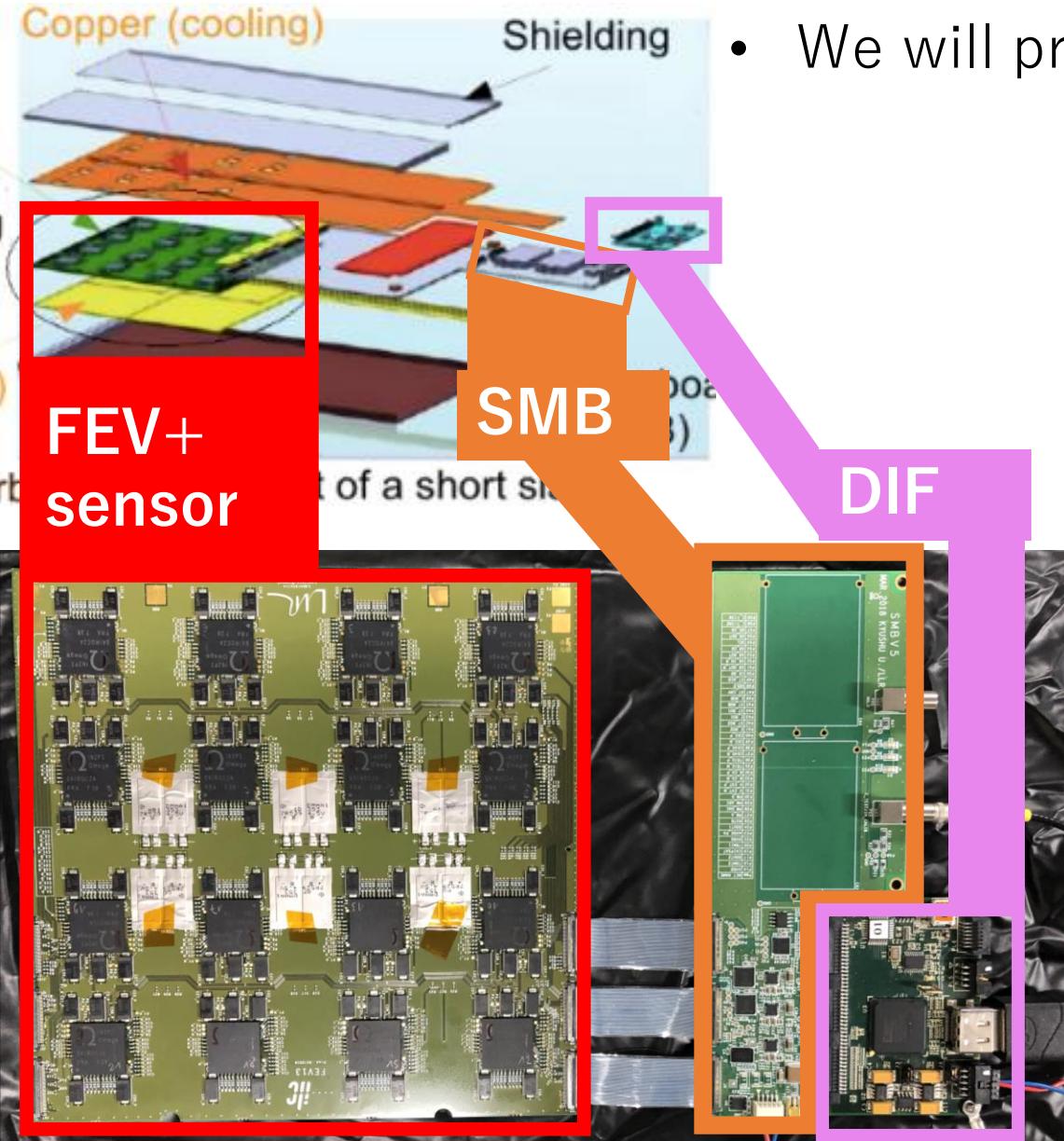
size	$89.7 \times 89.7 \text{ cm}^2$
cell size	$5.5 \times 5.5 \text{ mm}^2$
# of cell	$16 \times 16 = 256$

Slab (left picture)

- A part of ILD ECAL
- Prototype was developed in France and tested

We will prepare & check the performance of new short slab

Introduction



- We will prepare a new short slab of ILD ECAL
 - Si sensors
 - FEV13
 - SMB
 - DIF

<Procedure>

- Design jigs to assemble the FEV
- Select SKIROC2A chips
- Check the performance of the FEV without sensors
- Glue 4 Si sensors onto the FEV (training)
- Check the performance of the FEV before testbeam

A new short slab

The diagram illustrates the architecture of the FEV13 detector system. It consists of two main components:

- SMB v5 designed by Kyushu**: This is the front-end readout board. It features:
 - DIF**: Write settings in FPGAs.
 - Collect signals**: Readout data from FPGAs.
- SKIROC2A chips**: These are integrated circuit packages mounted on the SMB v5 board. They are labeled "FEV13" and "Omega".
- FEV13 from LLR**: A red box at the bottom indicates that the SKIROC2A chips read signals from sensors with ASICs.
- Back side of FEV**: This is the back-side illuminated silicon photomultiplier array. It is shown with a blue pen for scale. Key specifications are listed below:

size	$89.7 \times 89.7 \text{ mm}^2$
cell size	$5.5 \times 5.5 \text{ mm}^2$
# of cell	$16 \times 16 = 256$

Modification of new short slab

- **Silicon sensors are thicker** : $320\text{ }\mu\text{m} \rightarrow 650\text{ }\mu\text{m}$ thickness
 - It gives better separation of signal and noise
 - Full depletion voltage : around 120 V
- **ASICs are modified** : SKIROC2 \rightarrow SKIROC2A
 - better trigger threshold control
 - a fix on the improper treatment of trigger on the edge of the clock
 - an improvement on the timing measurement
- **Better routing on FEV** : two power planes (analog, digital)
 \rightarrow three power planes (analog, digital, preamplifier)
 - That plane reduces large noise from preamplifier
- **Power pulsing capacitors on FEV** : two 400 mF supercapacitors on SMB
 \rightarrow very thin 40 mF supercapacitors on FEV
 - It meets the spatial requirement of the detector

Modification of new short slab (2)

- **Smaller footprint of SMB (lower figure)**

- It meets the spatial requirement of the detector

- **Interconnection with flexible cables**

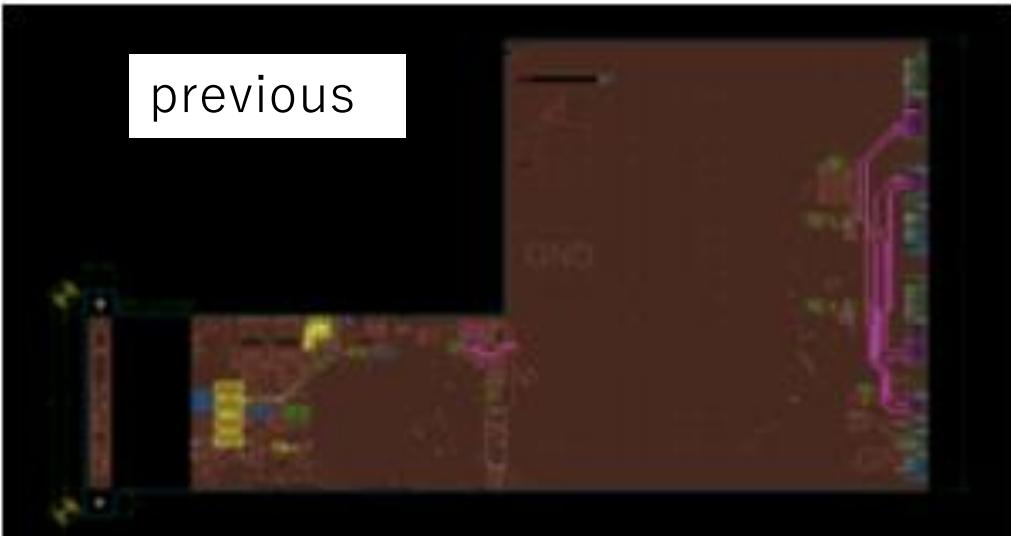
- : 1.0 mm pitch flexible circuit (FPC)

- 0.4 mm pitch thin connectors

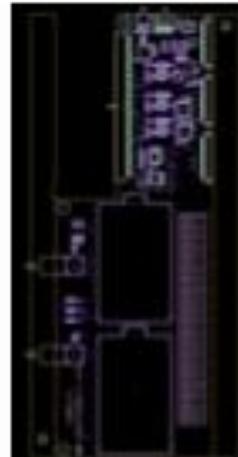
- with either a FPC cable or a micro-coaxial flat cables

- easier assembly

previous



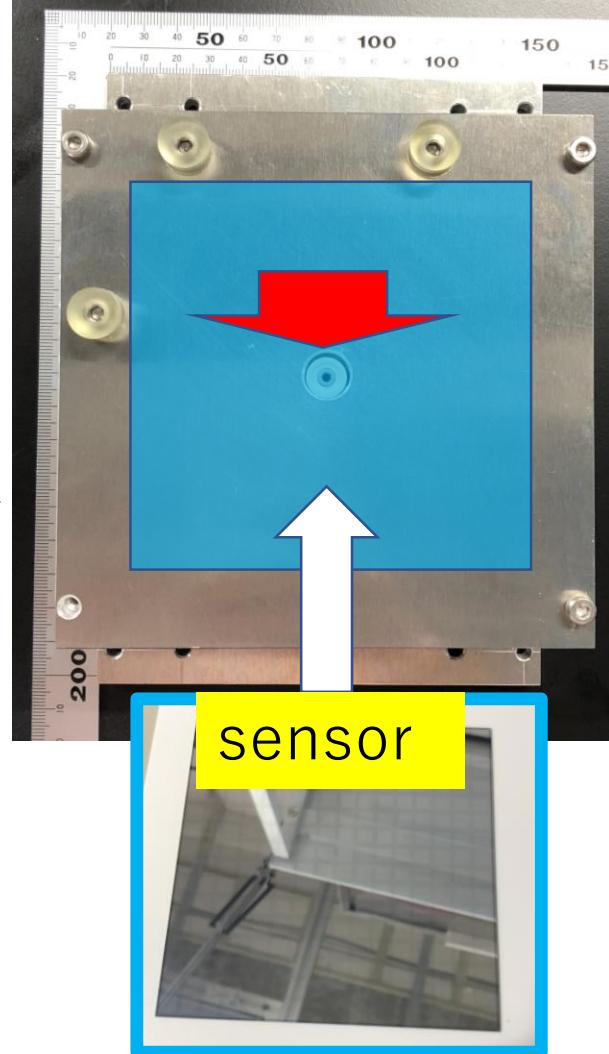
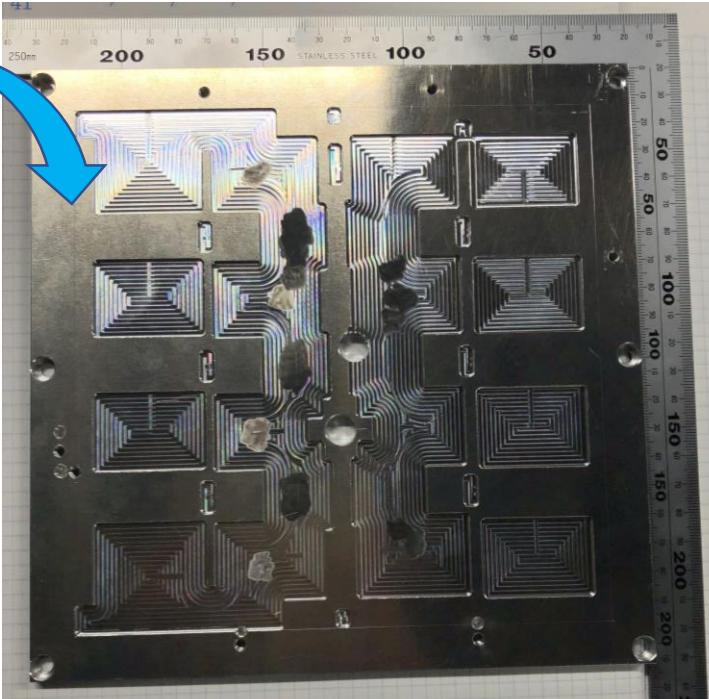
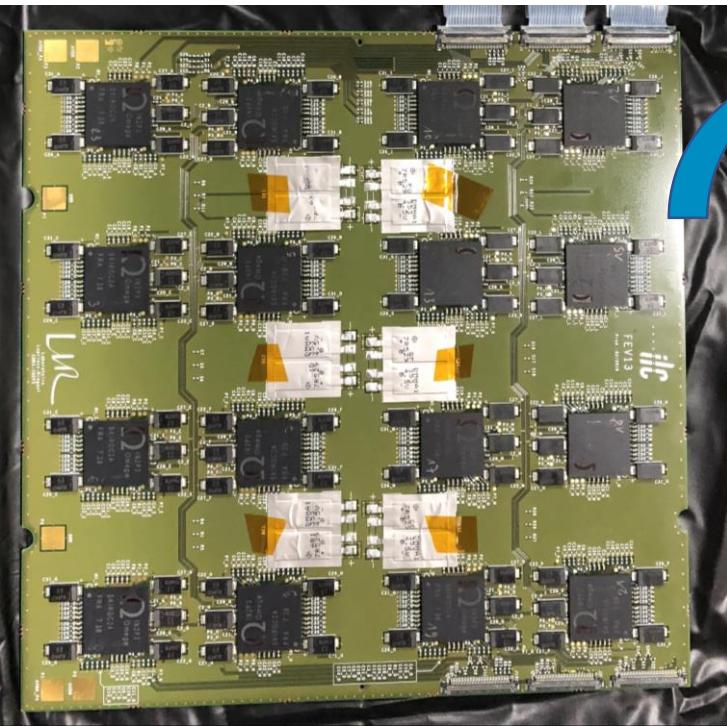
new



Layout of previous (left) and new SMB with similar scale

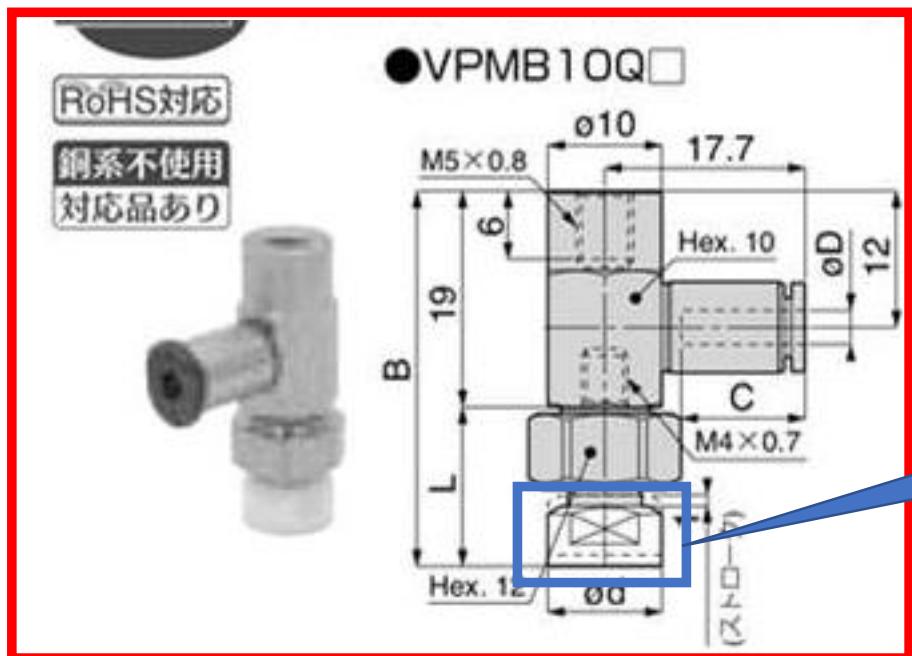
Preparation of jigs for Si sensors & FEV

- 2 jigs for Si sensors & FEV
 - Fit these edges to the **rubber cushions**
→ Fix these on the jigs **by vacuum**
- <FEV jig> ASIC chips & capacitors are mounted on the FEV
→ Dig 1.5 mm of depth for these components



Vacuum system

- We use the vacuum
 - to fix the sensor & the FEV on jigs
 - to move the sensor onto the FEV by robot arm (automatic)
- We use **pads** not to damage the sensor
 - 3 pads on robot arm
 - 1 pad on each jig



There is a spring inside the pad
→ It can touch the sensor softly

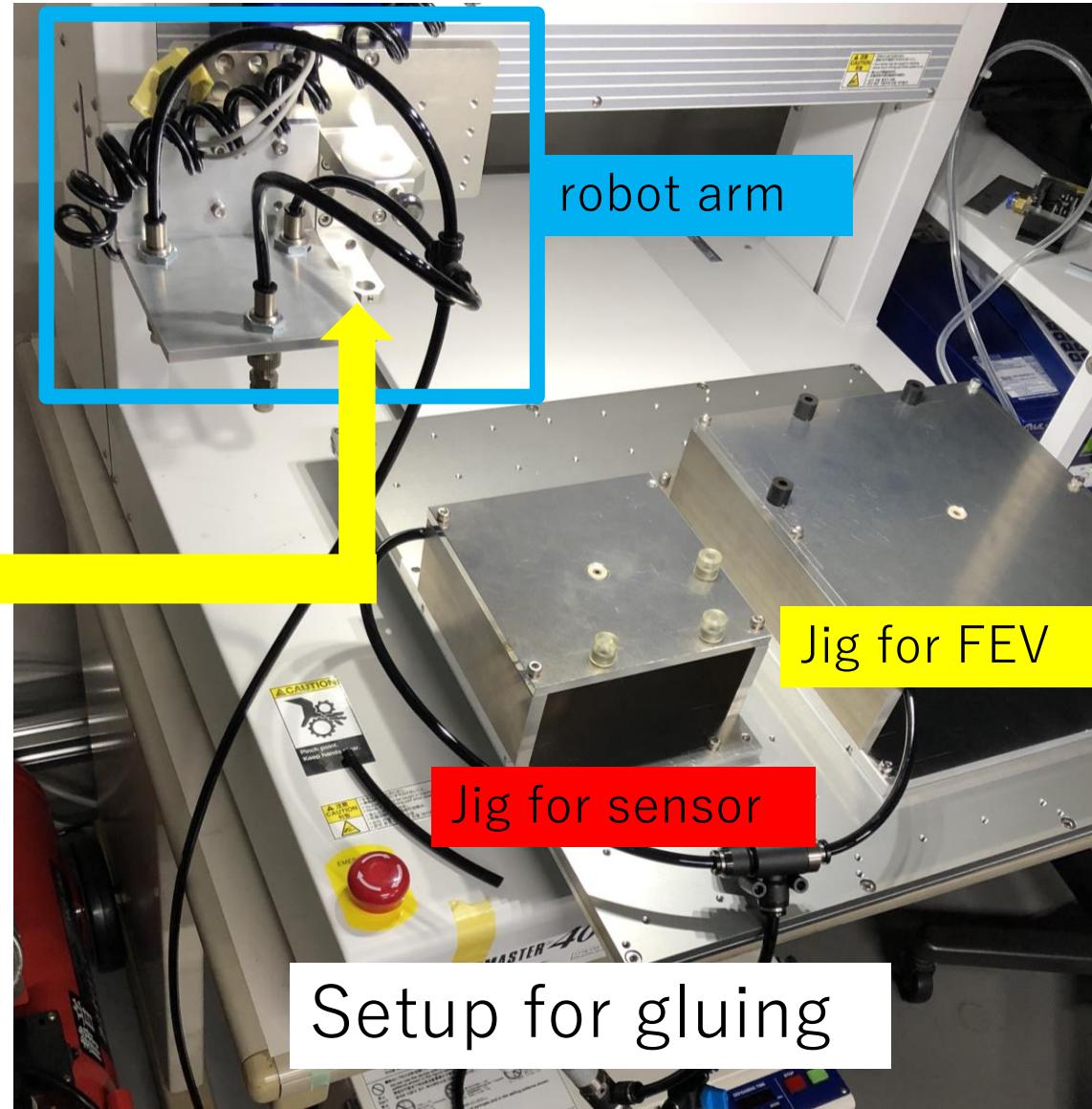
Gluing sensors onto FEV

Glue : E4110-LV (Part A & Part B)

- Conductive glue
- Mix ratio by weight ... A:B = 10:1
- Viscosity (23°C): 350-850 cPs
(as same as oil)
- Cure : 23°C/3 days



Set the syringe
to the robot arm



Setup for gluing

Preparation of jigs for FEV

Procedure of gluing

1. Set a FEV on the jig & fix by vacuum
2. Set a sensor on the smaller jig
3. Fix the sensor by vacuum
4. Put the glue on FEV cells (on 256 points) by giving high pressure
5. Lift & transport the sensor with the robot arm by vacuum
6. Glue the sensor on the FEV
7. Repeat 2~6

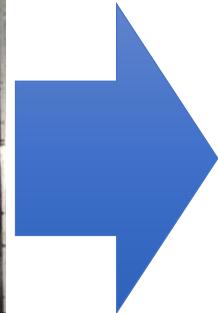
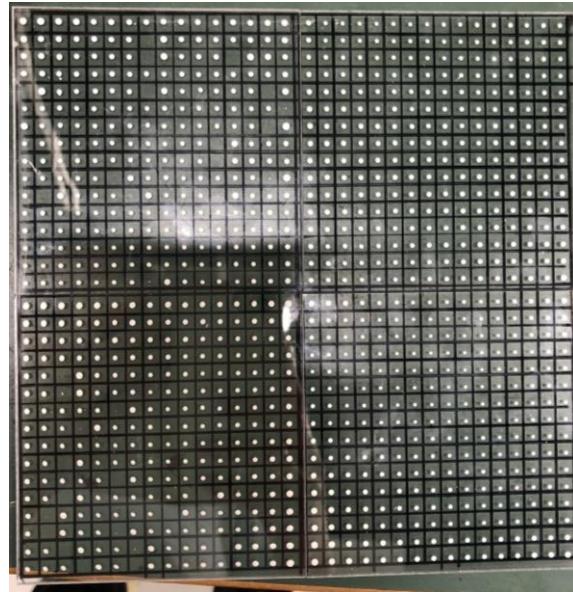
Gluing time: about 6 minutes for 1 sensor



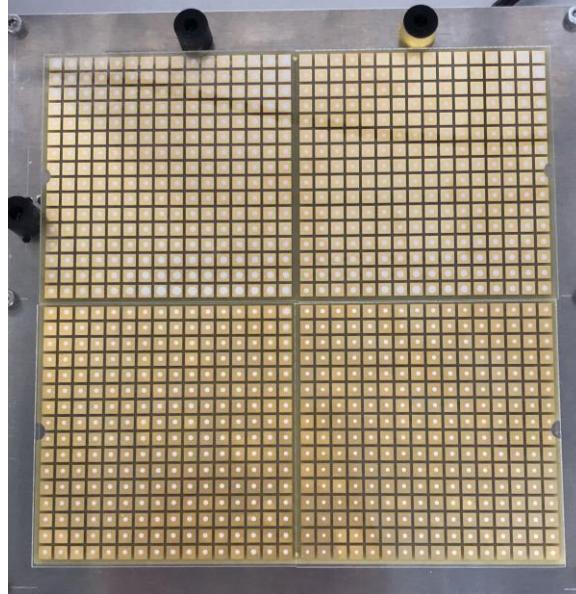
optimizing of gluing

- We optimized gluing (dummy) sensors on to a (dummy) FEV

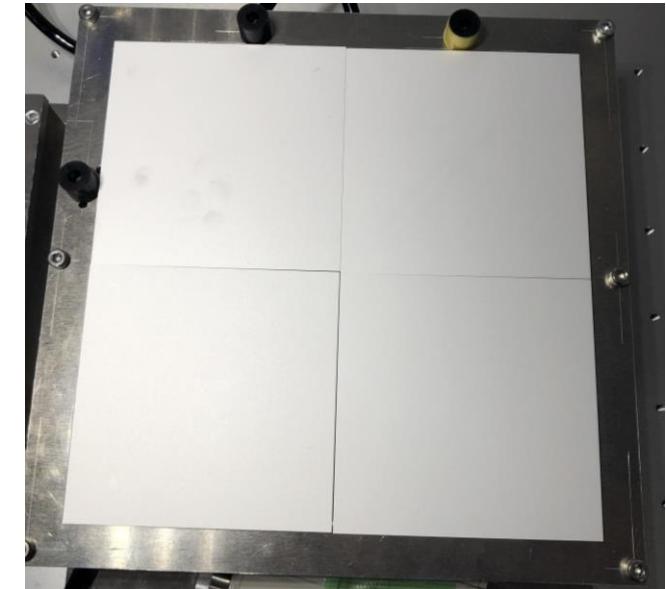
1. Small acrylic plates
onto an acrylic plate



2. Small acrylic plates
onto a dummy FEV



3. dummy sensors
onto a dummy FEV



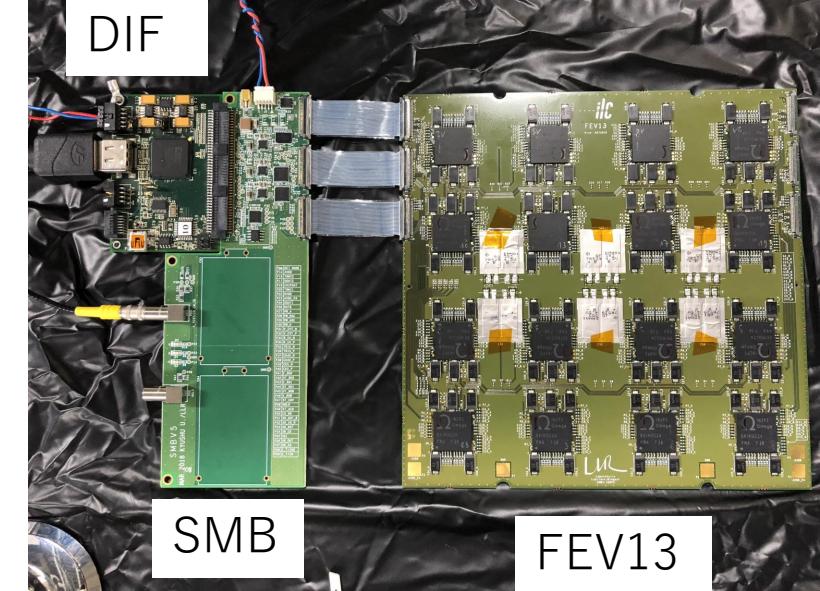
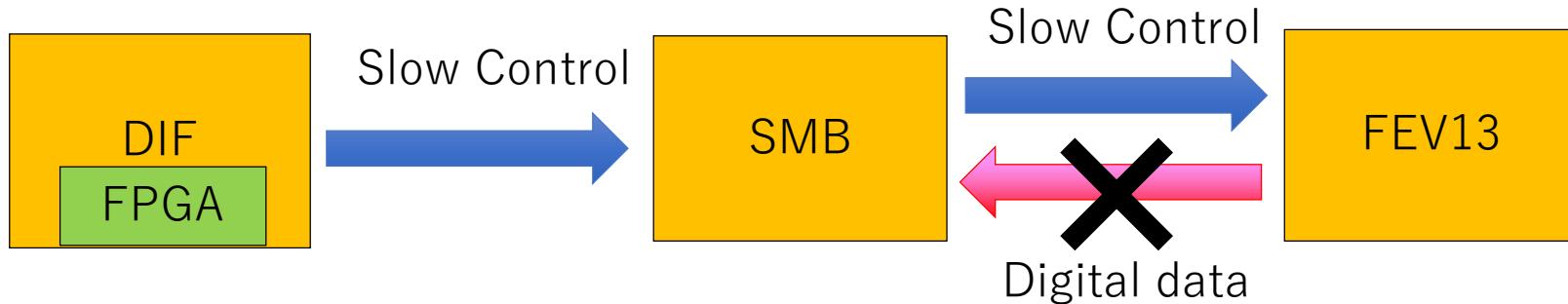
Checking amount of glue
Adjusting shot time & air
pressure

Checking positions of glue
& height of sensor from the
FEV

Checking positions of sensor
Testing of connecting
connection is OK

Checking performance of FEV w/o sensors

- We checked the FEV before mounting the sensors



- Slow control : succeeded in loading
(Trigger threshold is changed in response to slow control)
- Digital data from SKIROC2A : cannot readout
 - No triggers
 - No Dout1,2 (data serial output)
 - No TransmitOn (active data readout)

Plans

- We will check the performance of the new slab at DESY testbeam in early July
- We have to ...
 - check the FEV without sensors
 - glue 4 sensors onto FEV(Cure time is about 3 days)
 - check the FEV with sensors
- in three weeks
- At first, we have to complete validation of the FEV.
 - check around the trigger lines in detail
 - enable analog probe to check trigger/slow shaper

Summary

- We will prepare **a short slab** of ILD ECAL for DESY testbeam
- We designed & prepared jigs for Si sensors & FEV
- We optimized the gluing method
- About FEV, slow control is succeeded in loading, but data output can not be seen

Under investigation

- We have to complete validation of the FEV, glue the sensors onto the FEV, and check the performance of it before DESY beamtest.

backup

Checking performance of FEV w/o sensors

- We checked the FEV before mounting the sensors
- Slow control : succeeded in loading
(Trigger threshold is changed in response to slow control)
- Digital data from SKIROC2A : cannot readout

