Sections for ScECAL in DBD

22th May 2012

@ Calice meeting (pre-ILD)

K. Kotera

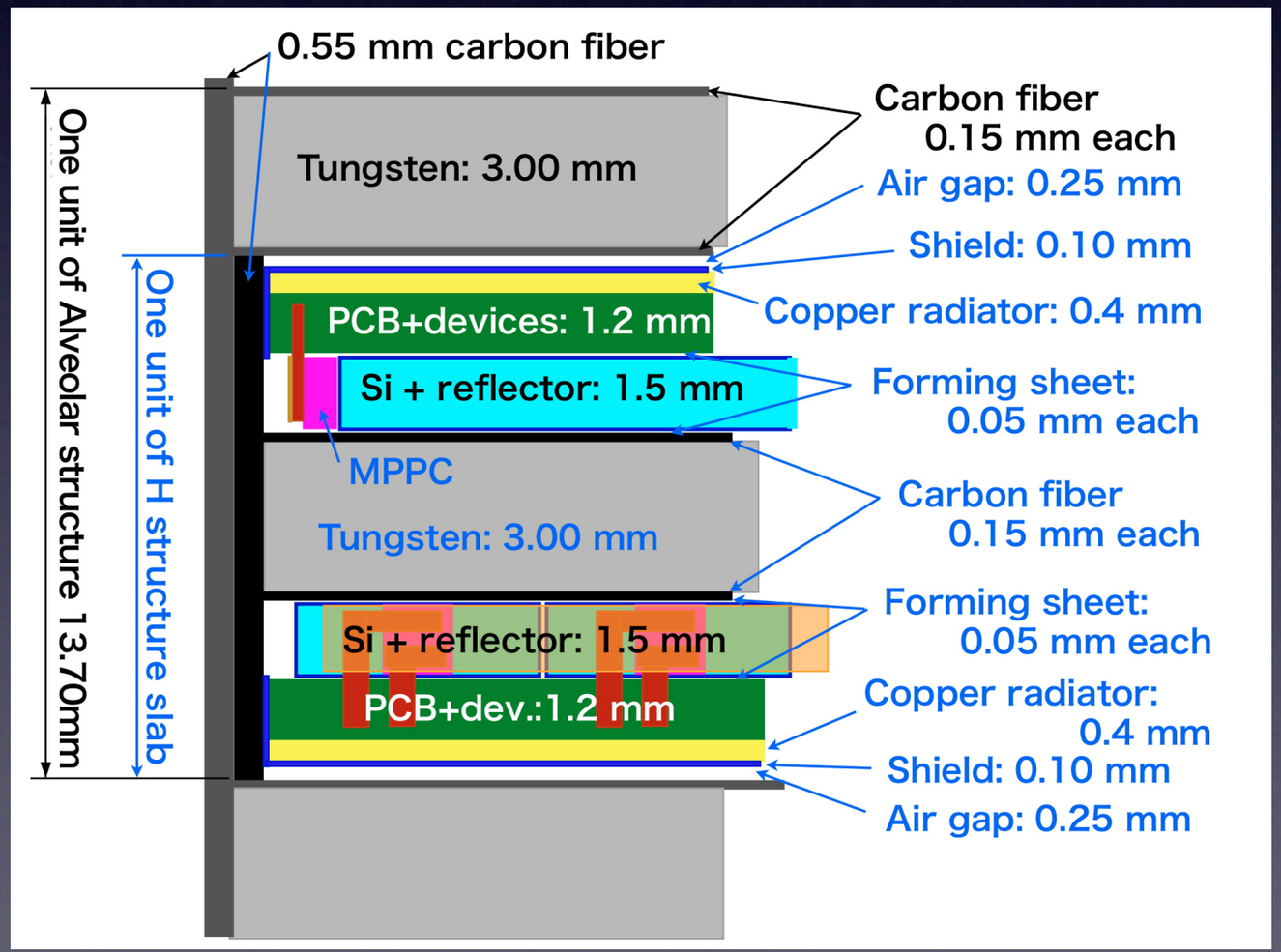
Shinshu University

Contents of the internal CALCE document for DBD for ScECAL

- Idea of Technology
- Activity
- Main conclusions (Established performance)
- Step toward a real detector
- R&D plans

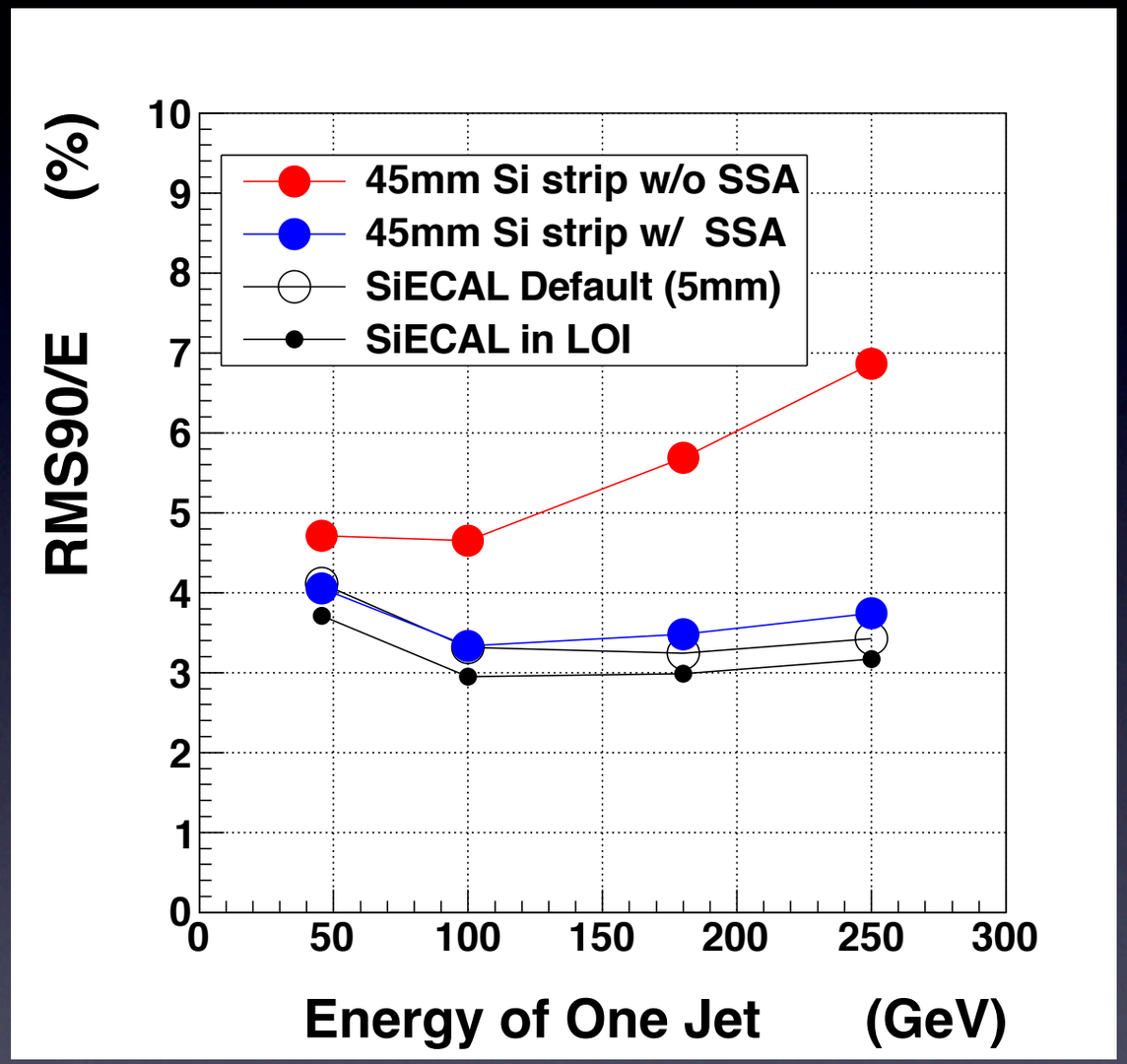
Introduction (Idea of Technology)

- Recent SiPM development allows us to make fine granular electromagnetic calorimeter using scintillator technique read out from each scintillator with a SiPM
- To reduce readout channels and dead volume from SiPM, strip scintillator technique is employed



- Scintillator strips in odd layer and even layer are put having orthogonal direction wrt each other
- Special reconstruction algorithm for the scintillator strip Ecal is also being developed.

Introduction (Idea of Technology)



- In order to minimize effects of calibration in PandoraPFA, Strip Splitting Algorithm was tested by a special ECAL model with si strip readout.
- JER improved significantly by SSA especially at H.E.

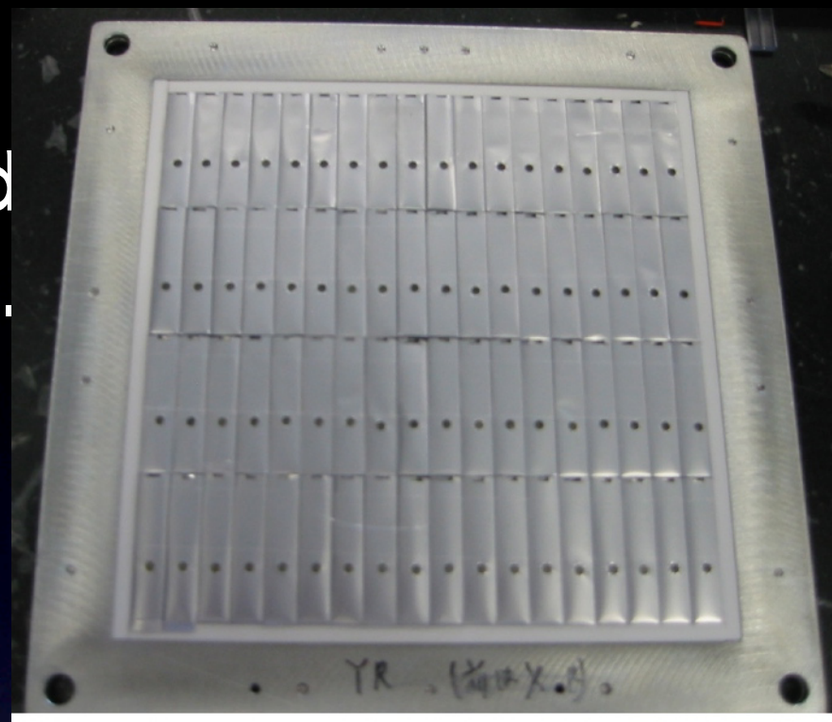
(● → ●)

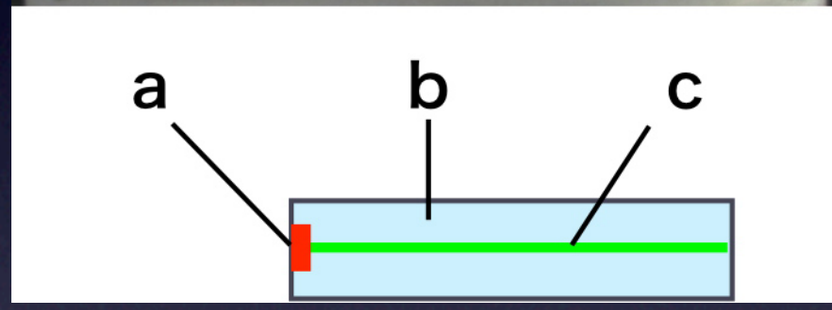
- A little bit degradation of strip ECAL is seen at H.E.

(● → ○)

  - Square cell layers between strip layers will help to improve this
  - On of the candidate ▶ Hybrid ECAL (H. Ueno)

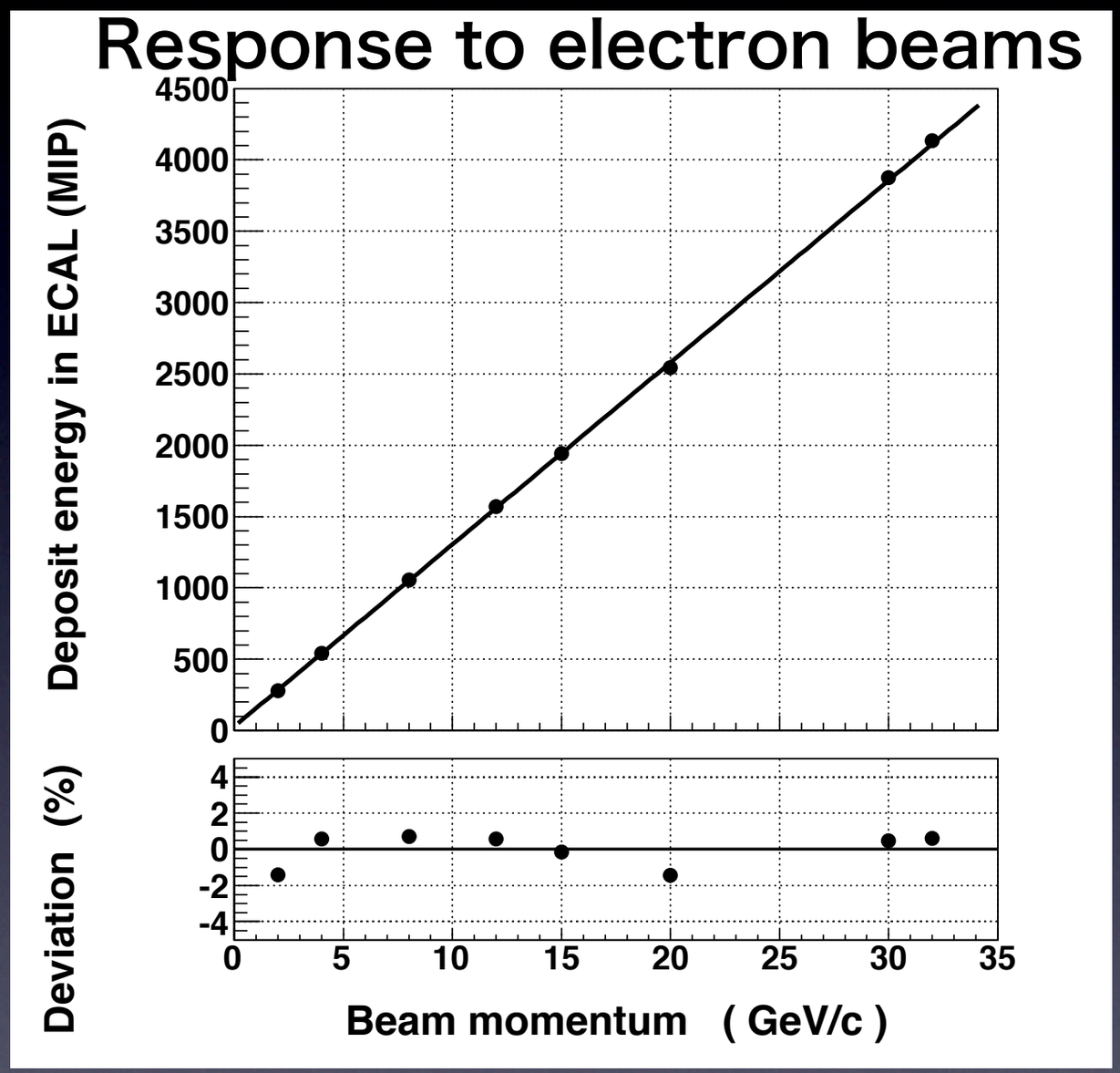
Activities





- 9 cm x 9 cm x 24 layer Prototype tested with 1 - 6 GeV positron at DESY in 2007.
- 18 cm x 18 cm x 30 layer Prototype at FNAL Sep. 2008, May 2009.
  - Sensor unit: 45 x 5 x 3 mm^3, 1600 pix MPPC, using WLS fiber, enveloped hermetically with reflector film
- 1 - 32 GeV electron, charged pion, proton, pi0, and muon (for calibration)
- An LED gain monitoring system has been established.
- Combined with AHCAL and TCMT
- Energy scan, position scan, and tilt angle scan ...

Established performance(1)



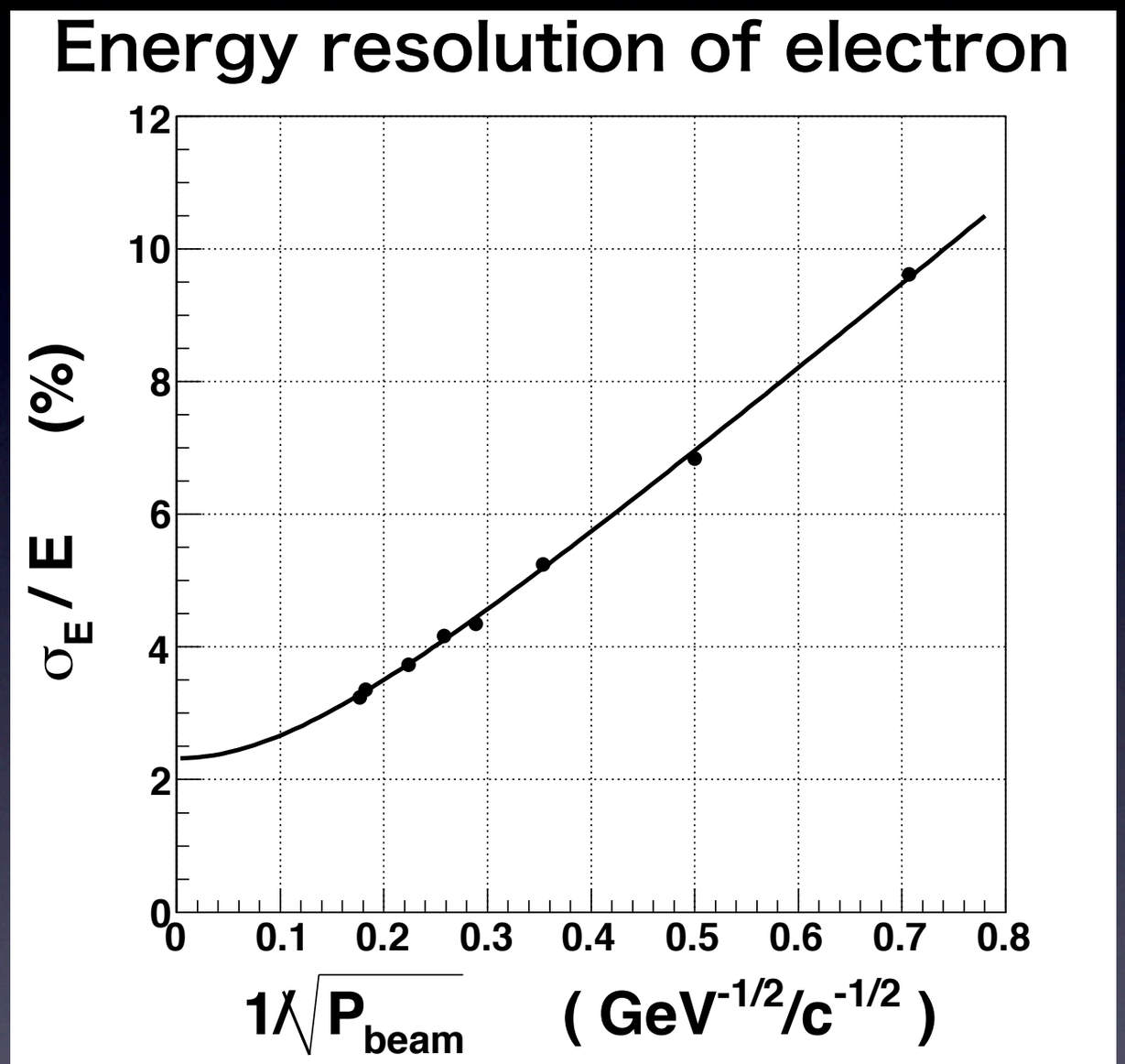
Written already:

- Deviation from linear fit:
  < ± 1.5% (2 - 32 GeV)
- MPPC saturation correction with one Npix
- Variances come from the temperature fluctuation from 19℃ to 27℃ is removed by using a temperature correction
- w/o systematic study

Toward the final version:

- systematic uncertainties

Established performance(2)



Written already:

- Stochastic term
  13.16 ± 0.05(stat)%
- Constant term including intrinsic beam mom.spread
  2.32 ± 0.02(stat)%
- subtract 2% of beam momentum spread from each data point,const.term
  1.17% ± 0.02(stat)%
- This is consistent with MC w/o beam mom.spread
- FNAL estimates 1- 3% of beam mom.spread

Established performance(3)

w/ new information from FNAL:

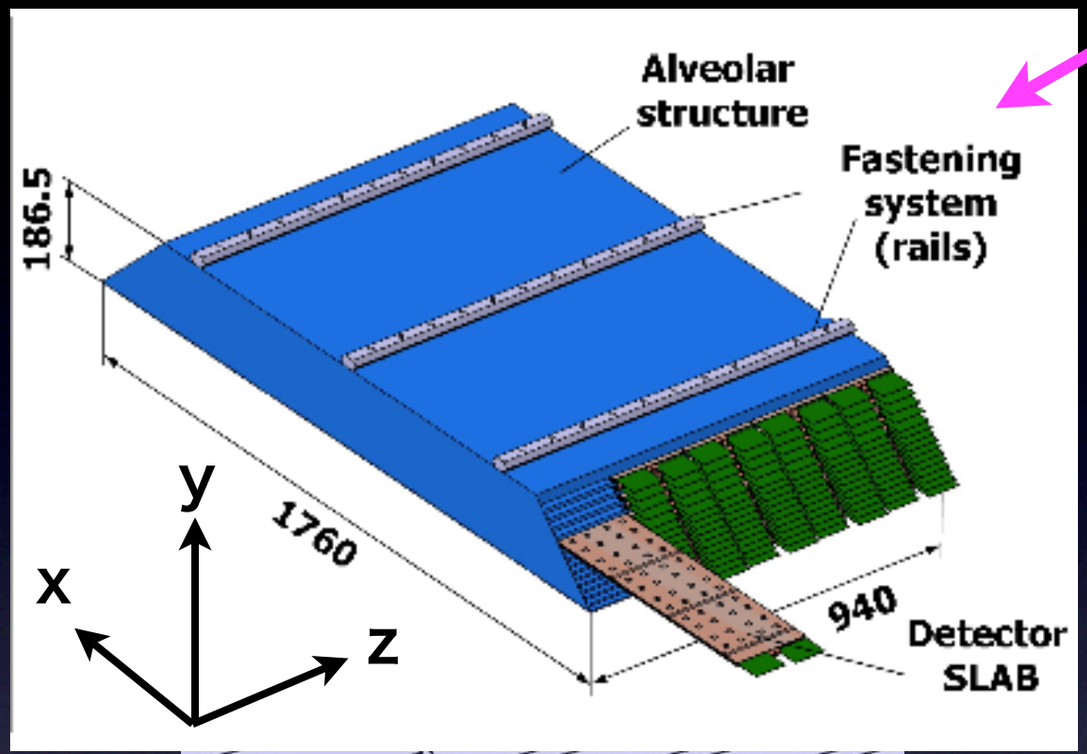
- Measured beam momentum spread at MT6-2
  - 2.7% for 1- 4 GeV elec., 2.3% for 8GeV
  - w/ linear assumption:2.3% for 8 GeV to 2% for 32 GeV
  - constant term: 1.21%, stochastic term: 12.7%
  - These constant and stochastic term are consistent with MC (const:1.27±0.09%, stochastic: 12.5±0.2%)

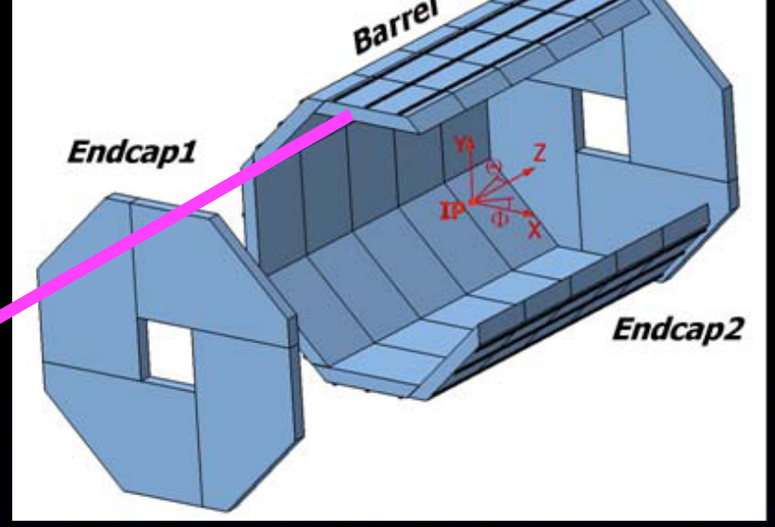
Toward the final version:

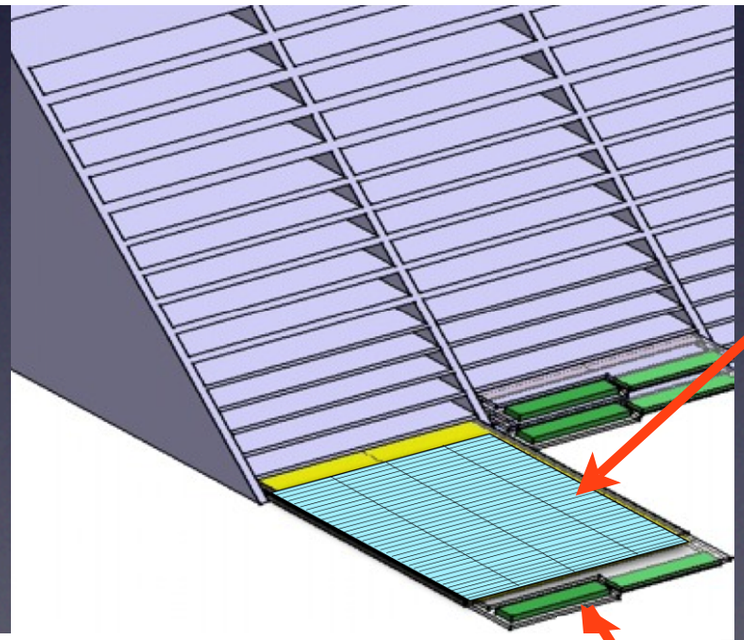
- Systematic uncertainties
- Uncertainty from the beam mom.spread should be the largest uncertainty. ▶ Only beam line MC can help us to add some more information.
- Validity by using MC (started, an example is study on the constant term in this slide)

Towaord ILD

A module in the top stave of Barrel



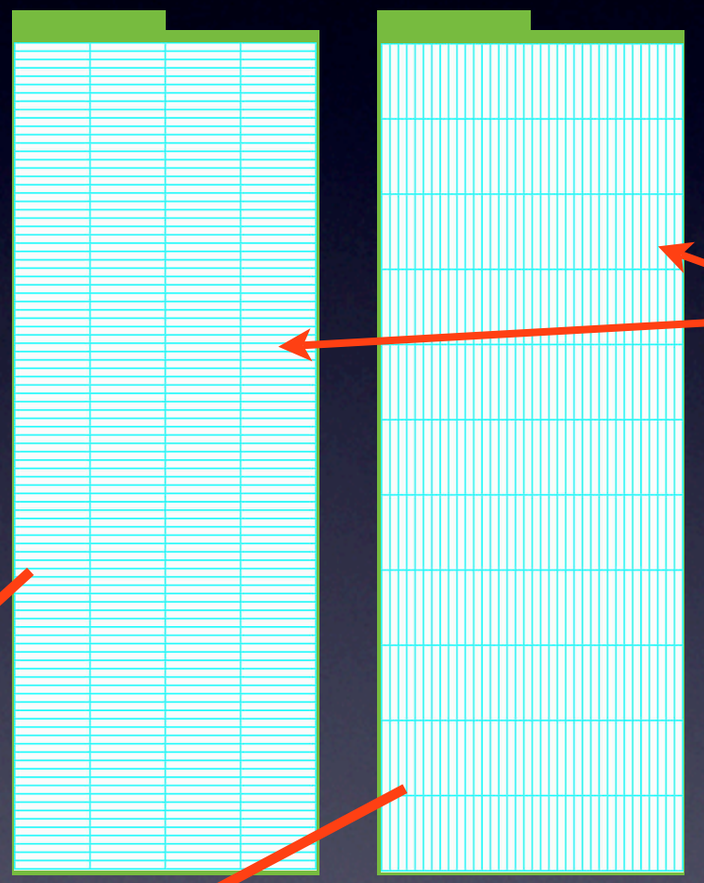


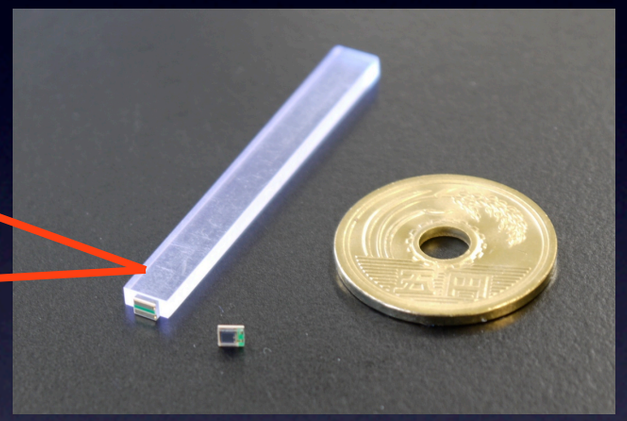


a pair of layers is inserted into the alveolar structure

fine in x

fine in z





a x layer and a z layer are put back to back on the H structure W layer

Step toward a real detector(1)

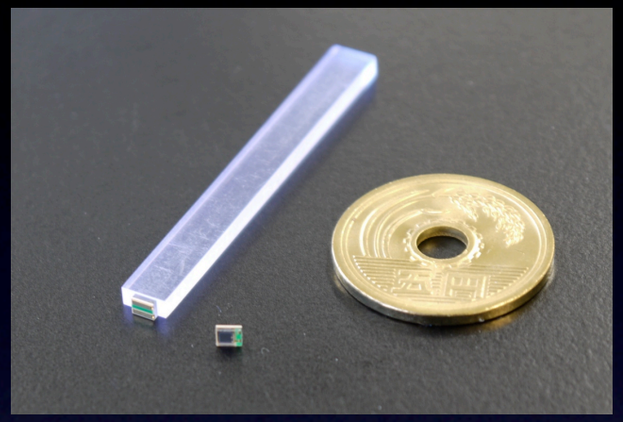
Scintillator/MPPC unit:

- Witten already:
  - To achieve 5 mm x 5 mm lateral granularity, 5 mm width scintillator is mandatory

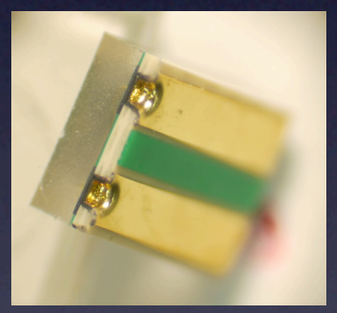
  - Need readout technique w/o WLS fiber ▶ direct readout
  - Enough p.e. (> 7.p.e.), uniformity of response ▶ almost done.
- Toward the final version:
  - Suitable method for the mass production
  - Reduce dead volume comes from MPPC

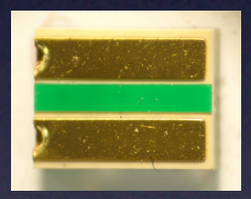
a Scintillator-MPPC unit on PCB

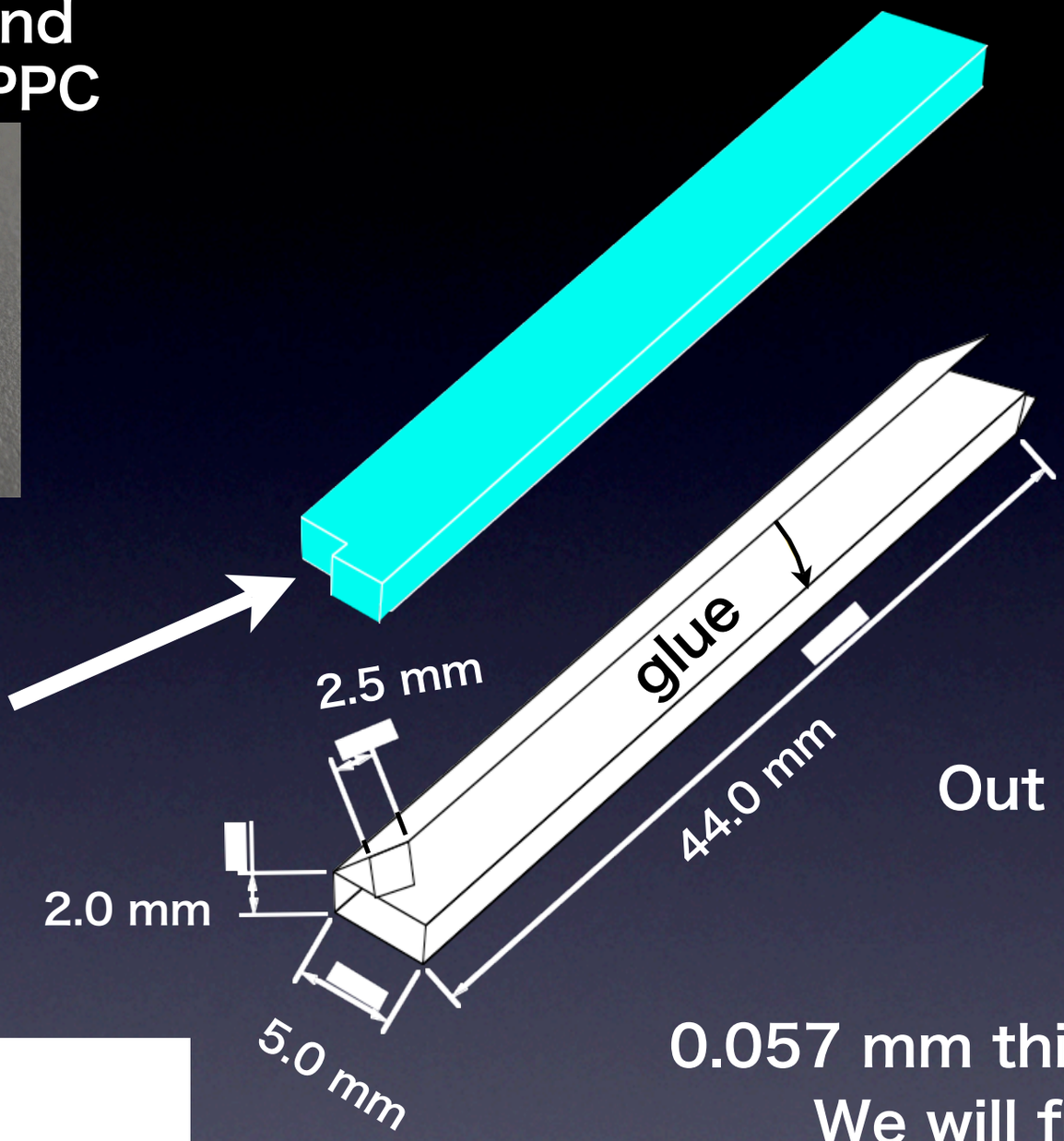
Scintillator strip and
Surface Mount MPPC



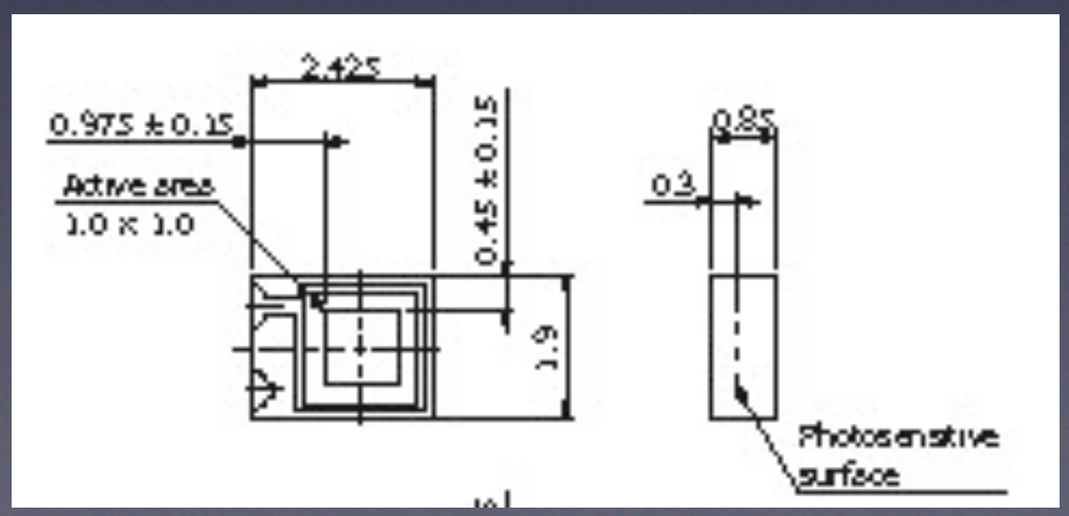
Backside of MPPC







Out side scales



0.057 mm thick reflector
We will find thinner film

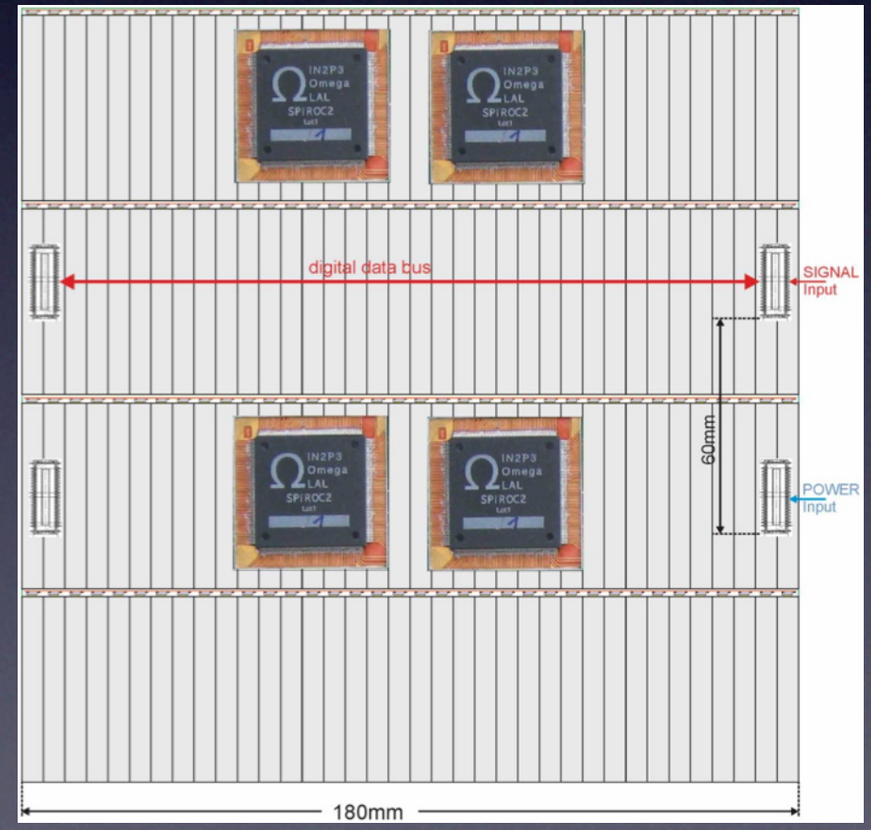
Hamamatsu developing
more small package now

→ 1.4x1.4x0.6mm³

Step toward a real detector (2)

Sensor leyers on the printed circuit boards :

- Witten already:
  - PCB for ScECAL (EBU) is being developed with the technology for AHCAL: strong support from AHCAL G.
  - 144 channel-scintillator/MPPC units are on a EBU with four SPIROC2b so far
  - more than 1.4 mm thickness, so far ▶ 0.8 mm
  - need of automatic integration of (scinti./MPPC)s on PCB.
- Toward the final version:
  - Show ideas to reduce the thickness
  - Design of Detector PCB interface

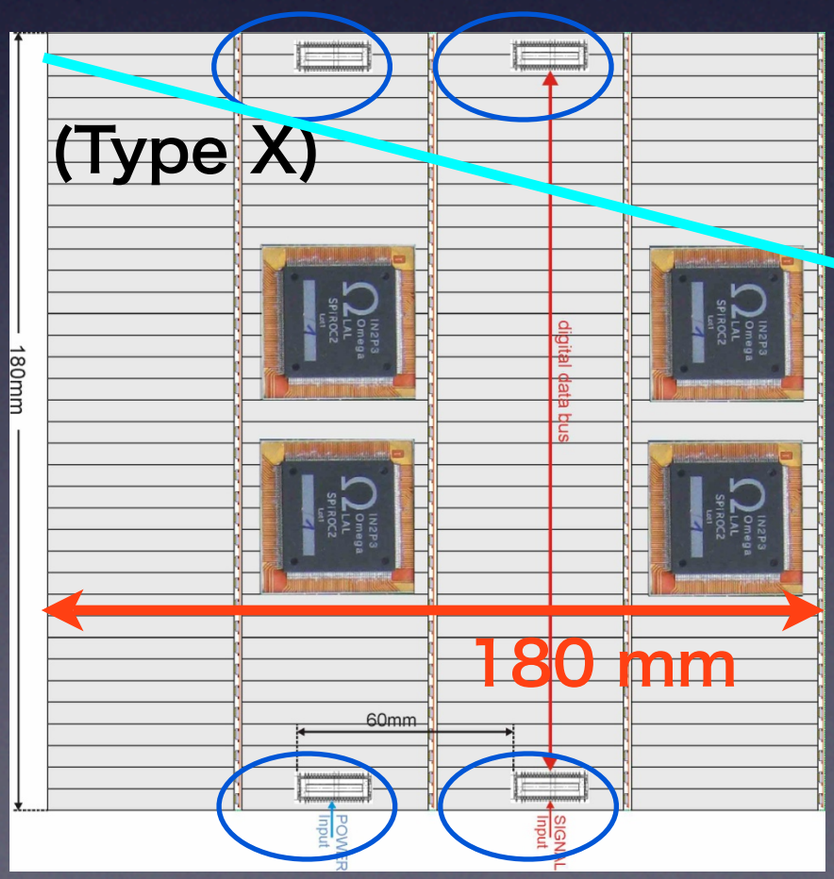


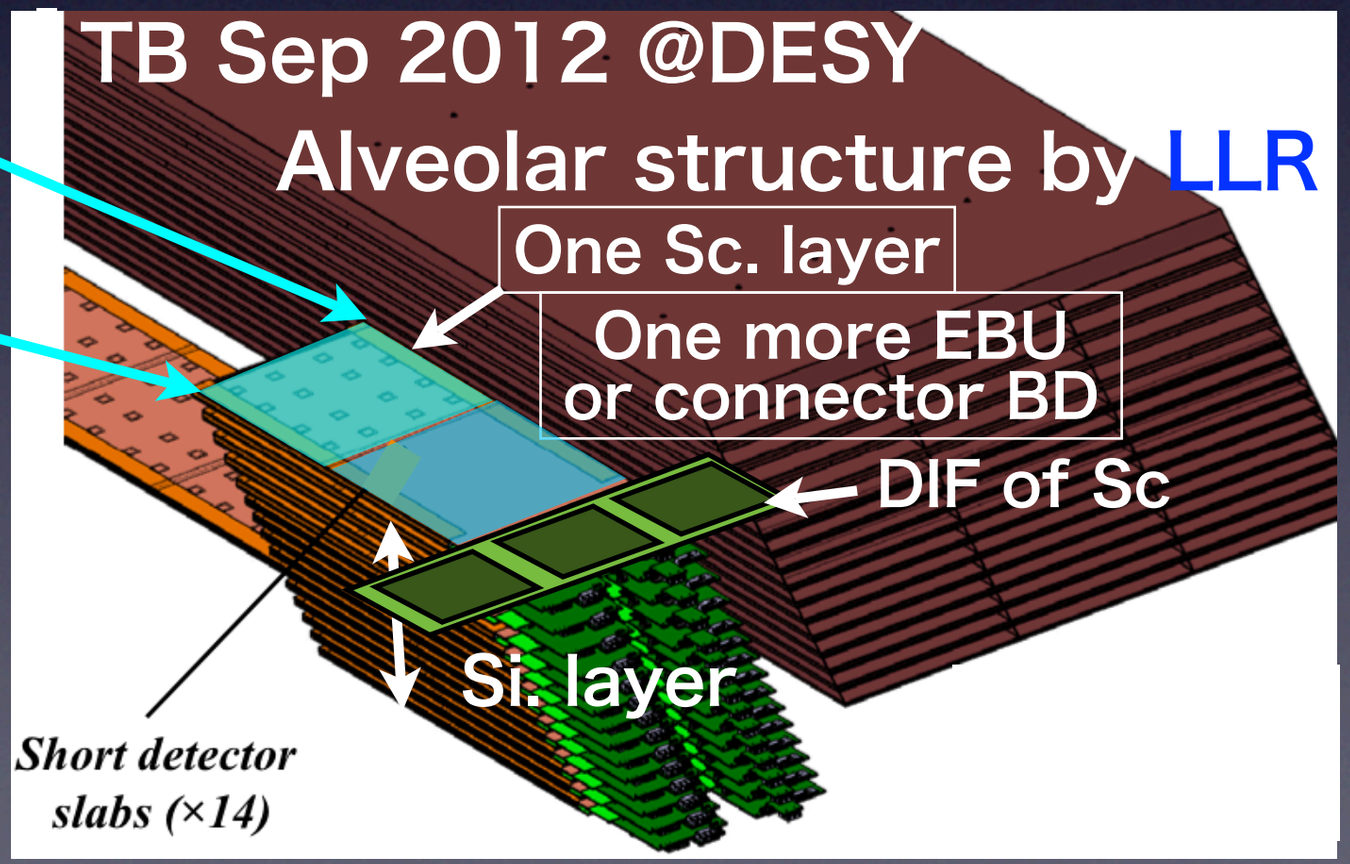
R&D plans (1)

TB with a 144 chan. technical prototype at DESY this autumn

- Witten already:
  - One layer scintillator layer on a PCB is mounted on U structure absorber plate instead of H structure, and it then is installed into an alveolus of alveolar structure constructed by SiECAL group
  - Goal: to test signal stability, noise, control ability of

corrent technology





R&D plans (2)

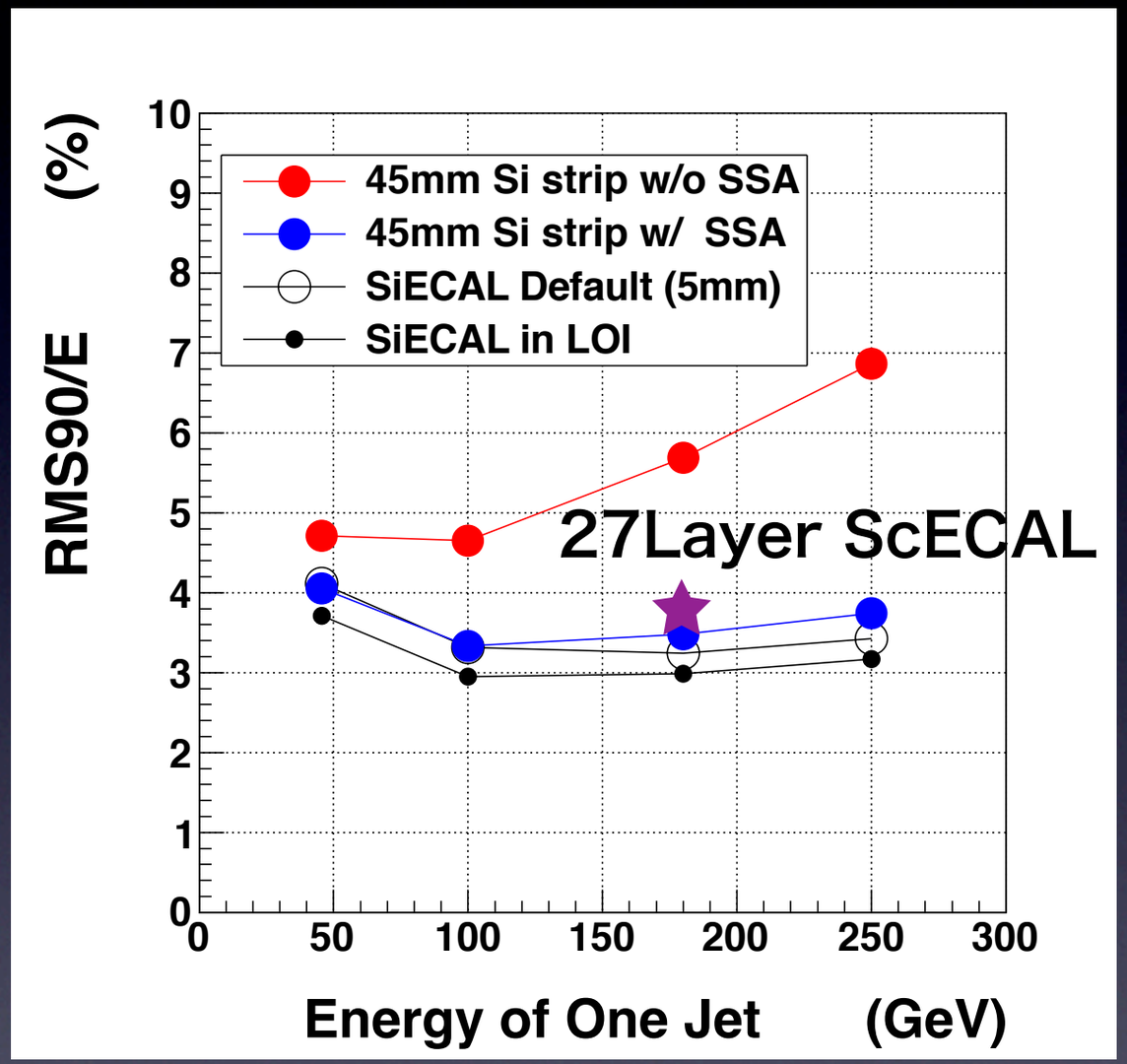
Scintillator/MPPC units

- Witten already:
  - Kongpook National University is developing technology of strip scintillator mass production by using extruding method
  - Shinshu University is testing some other ideas of readout and is developing industrial cooperation with some candidates
  - large pix-number MPPC is being developed with Hamamatsu KK,. and HPK is also developing smaller MPPC package such like 1.4 x 1.4 x 0.6 mm^3
- Toward the final version:
  - established readout technology of scintillator by using MPPC, established with industrial cooperation.

Summary

Back up

Introduction (Idea of Technology)



- In order to minimize effects of calibration in PandoraPFA, Strip Splitting Algorithm was tested by a special ECAL model with si strip readout.
- JER improved significantly by SSA especially at H.E.

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- A little bit degradation of strip ECAL is seen at H.E.

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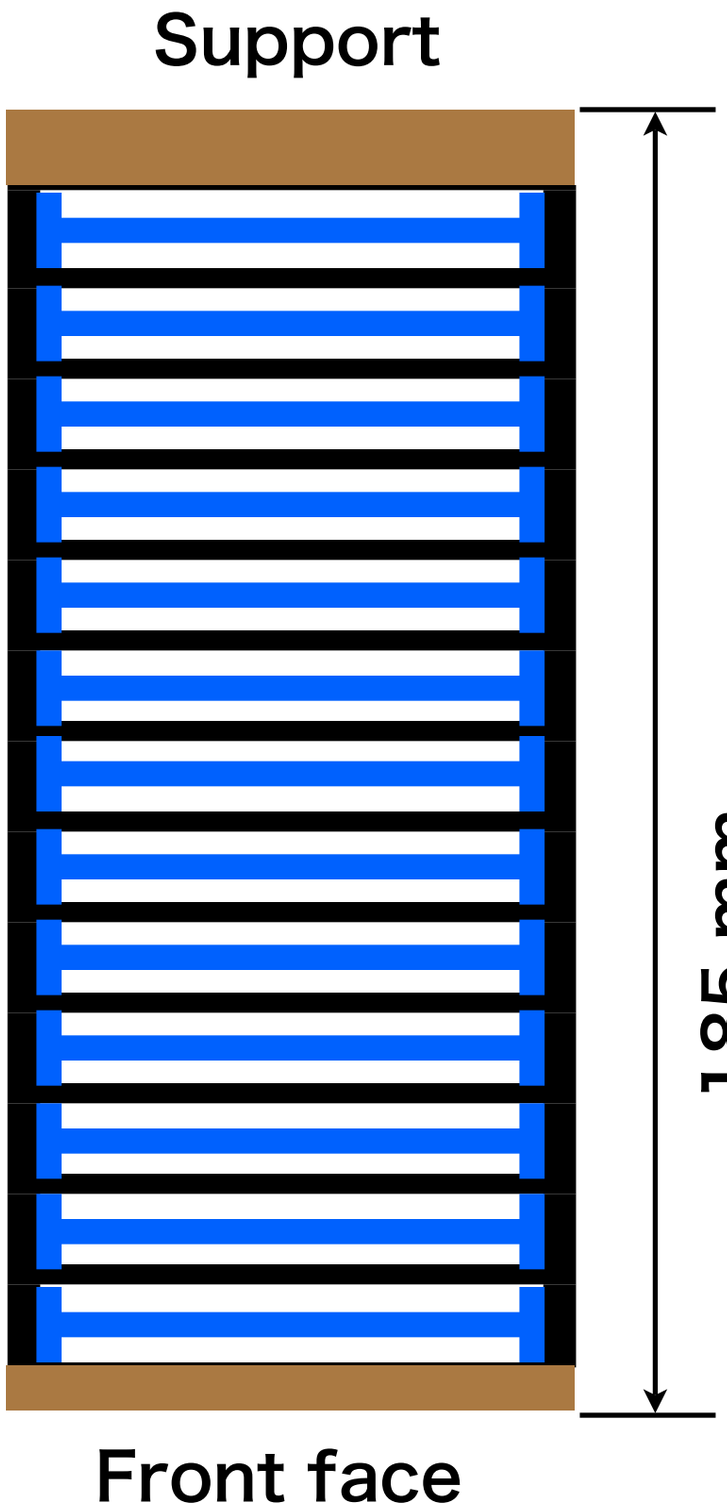
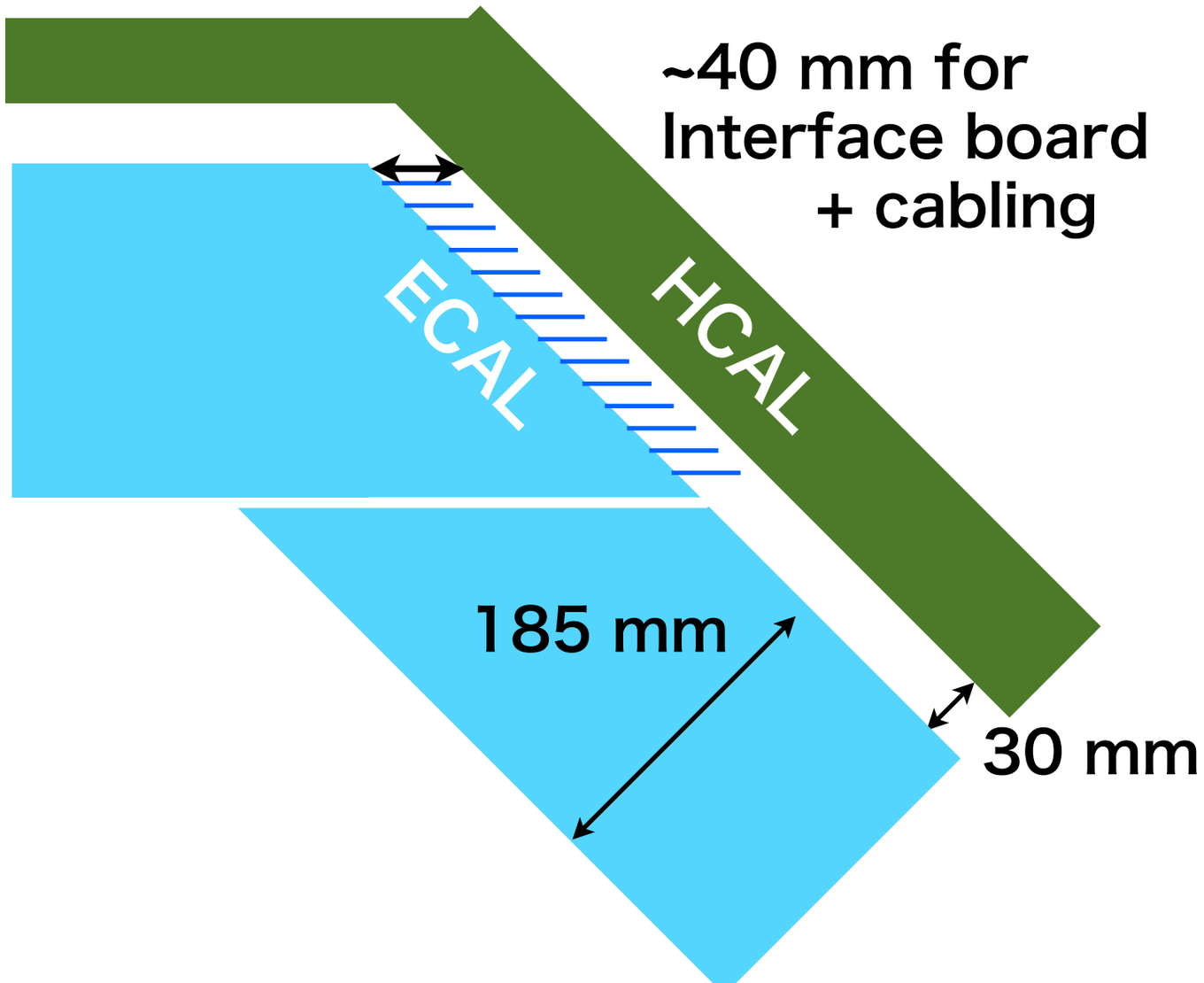
  - Square cell layers between strip layers will help to improve this
  - On of the candidate ▶ Hybrid ECAL (H. Ueno)

Module thickness and Gap in ILD

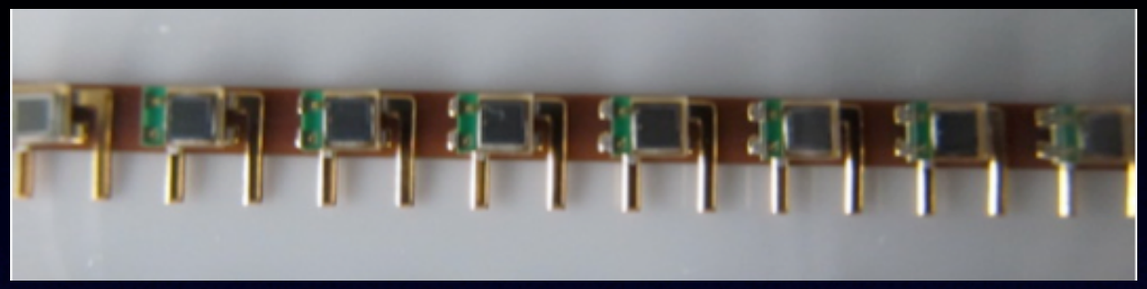


- 25 tungsten layers, 13 alveolars,
- 21.5 X_0,
- total ~185 mm Module thickness allows 30 mm between HCAL inner most surface,



Stacked channels

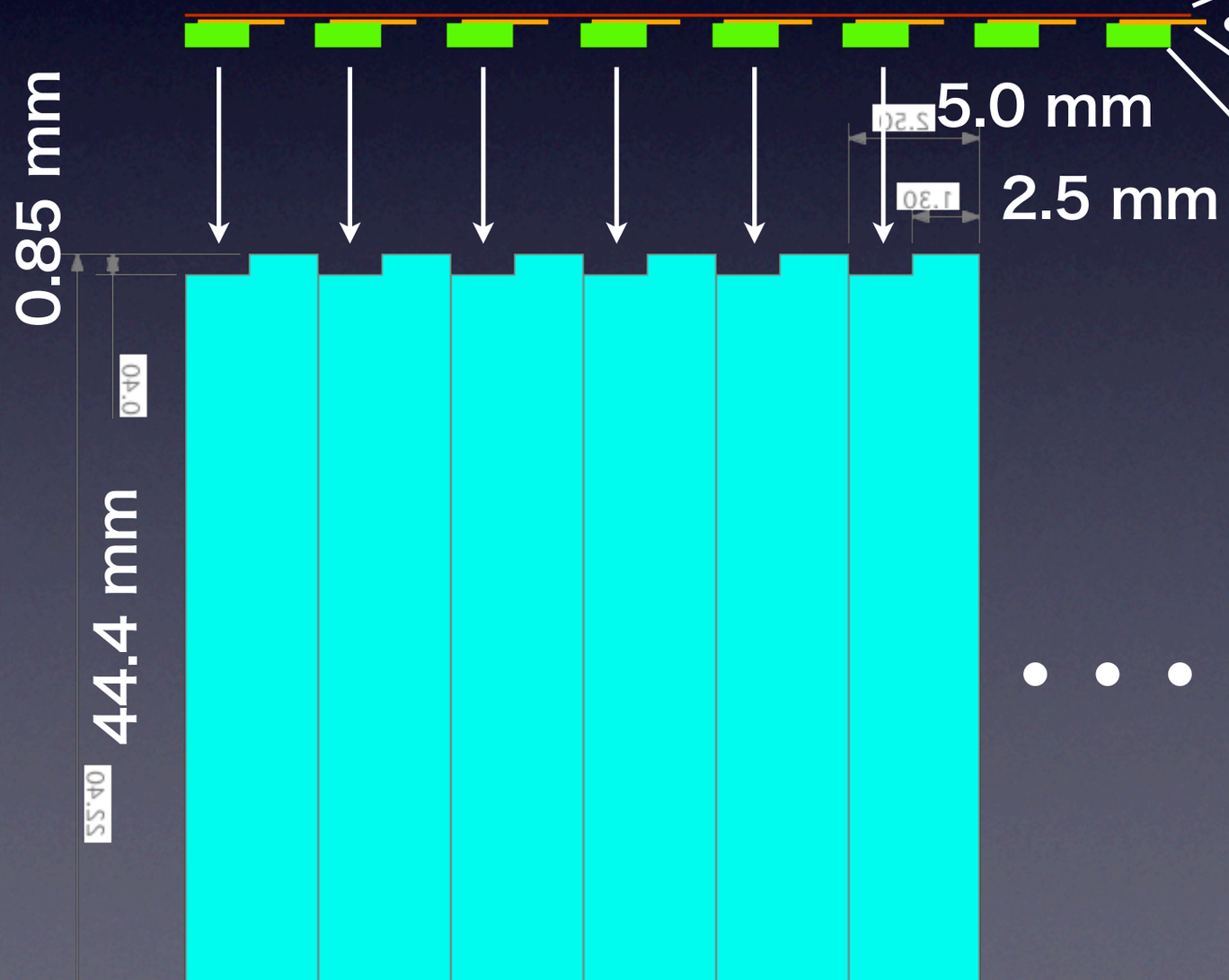
36 MPPCs soldered on electrodes
on a polyimide ribbon



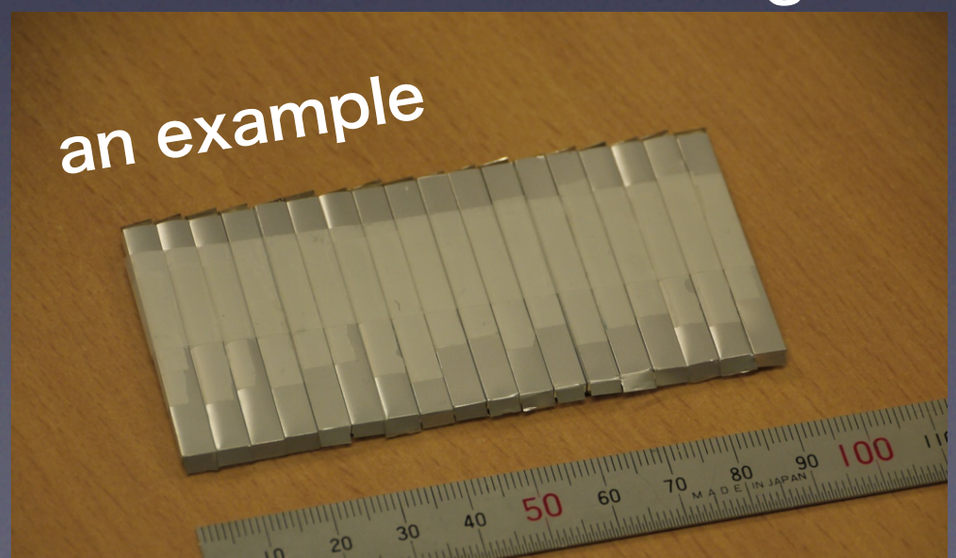
Thickness of ribbon: 0.06 mm

Thickness of electrode: 0.5 mm

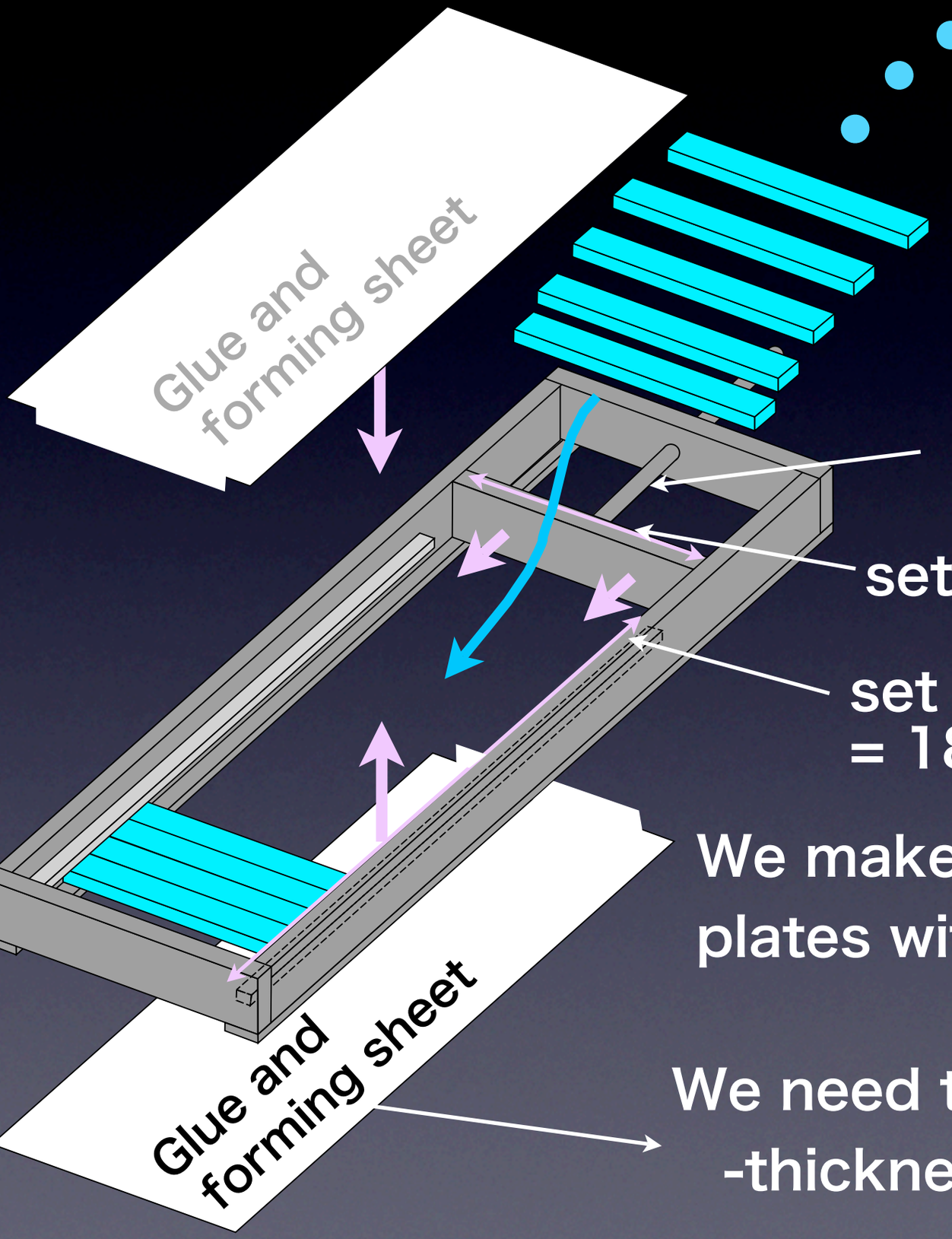
Thickness of MPPC: 0.85 mm



18 scintillator strips enveloped in
reflector film stacked together



How to make them be rigid together in a plate with precise dimension



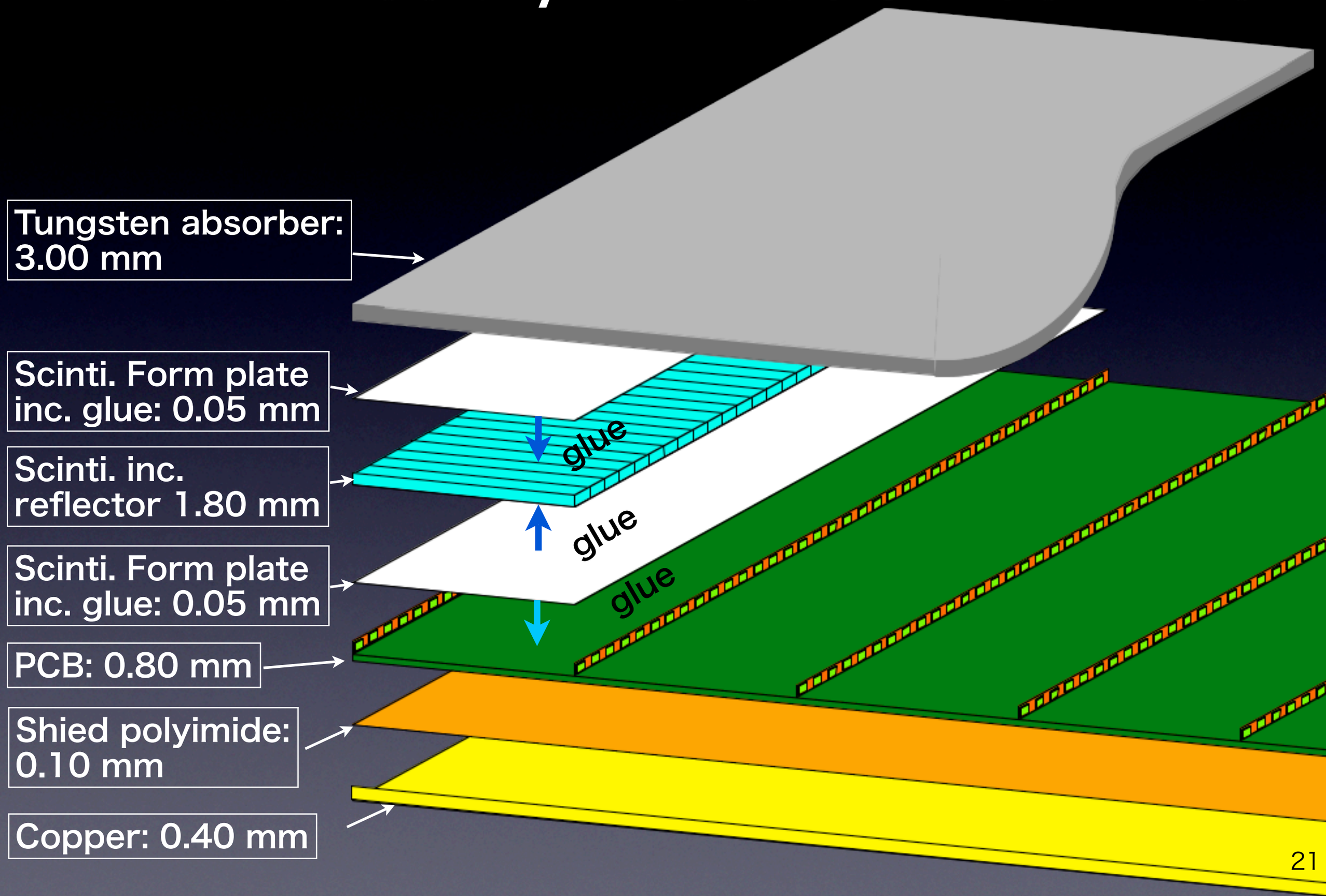
set exactly to strip length, 44 mm

set exactly to strip width x 36 = 180 mm

We make 44 mm x 180 mm scintillator plates with 36 strips in each.

We need to study the material
-thickness, tolerance, glue also ...

In a alveolar/ without Carbon fiber



Technical prototype TB July. 2012 @ DESY

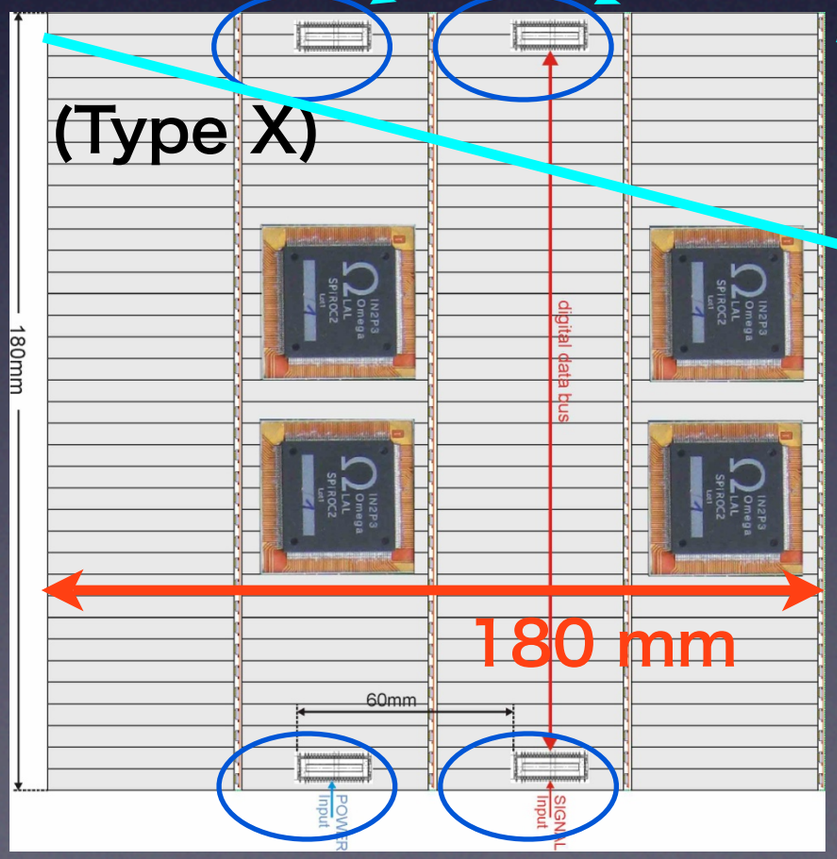
Power control

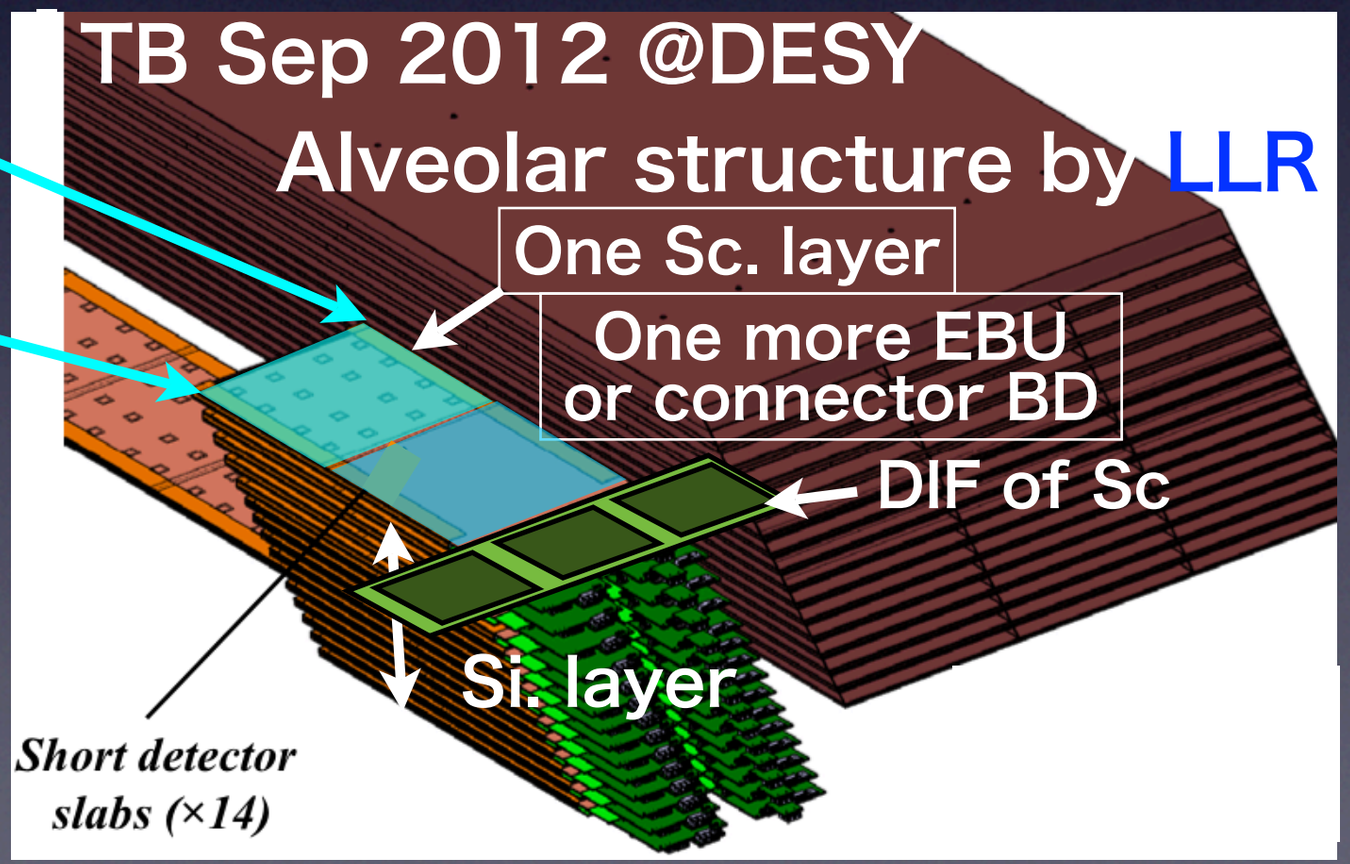
LED system

Detector-DAQ interface

Carrier board

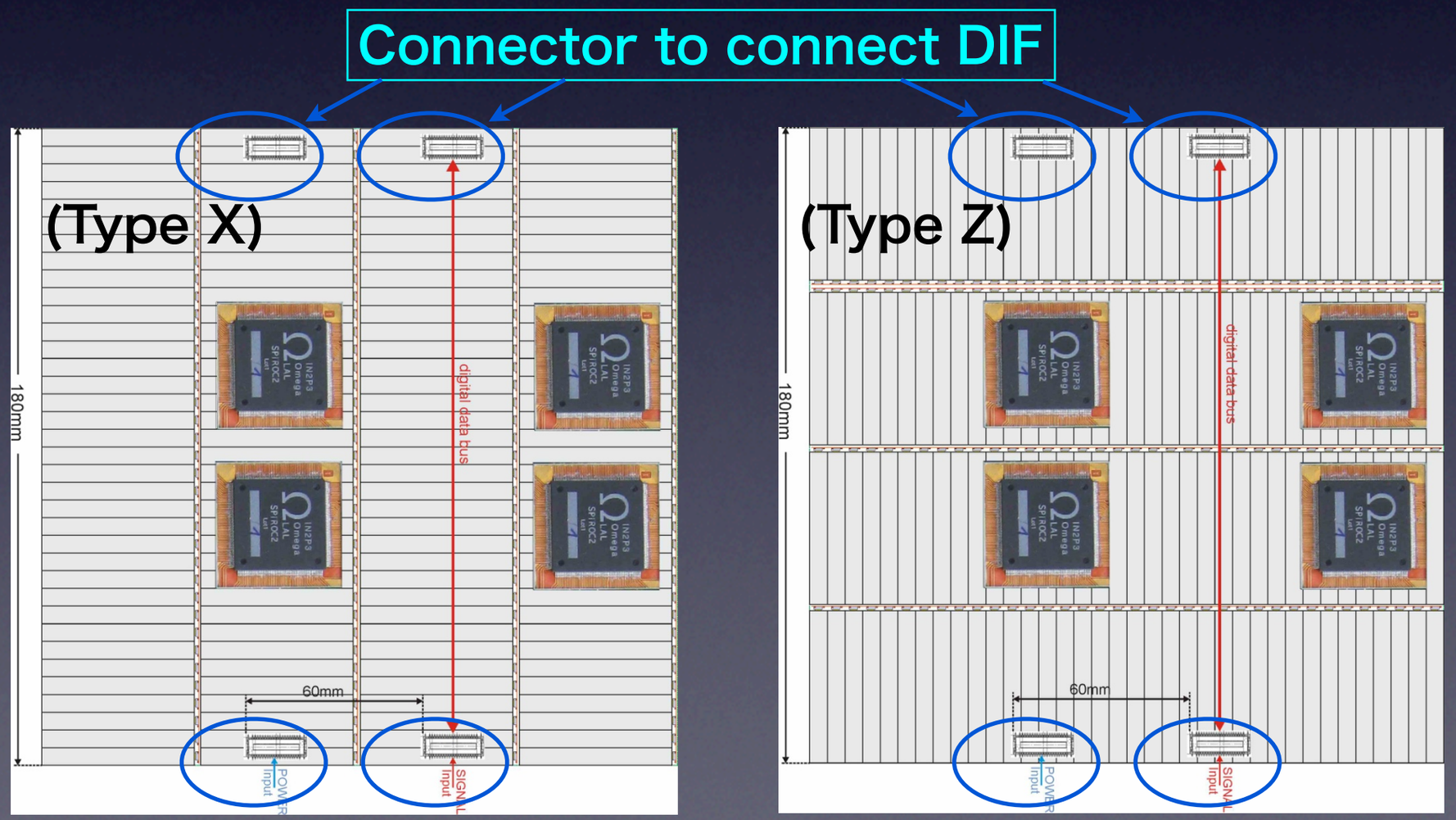
360 mm



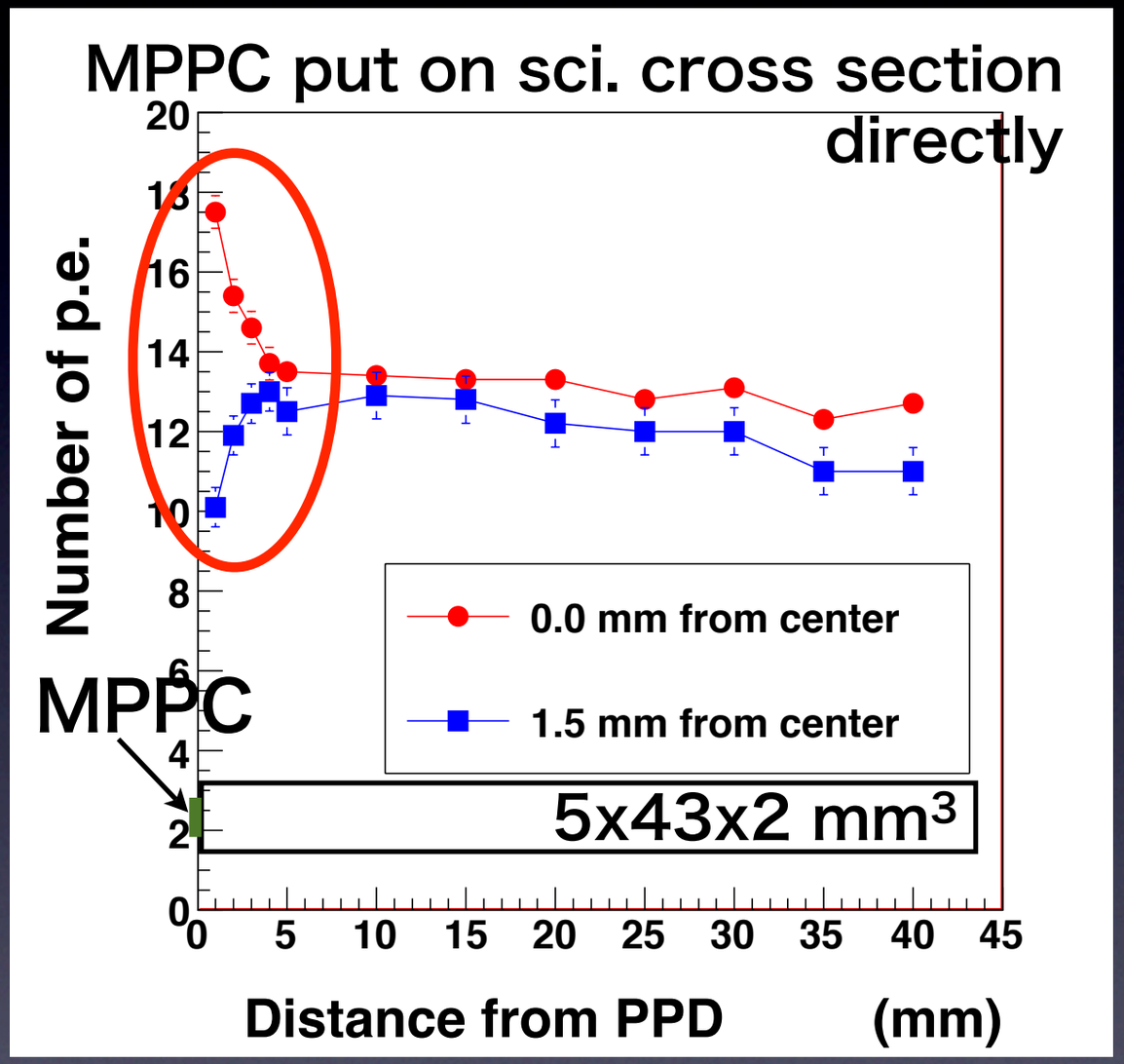


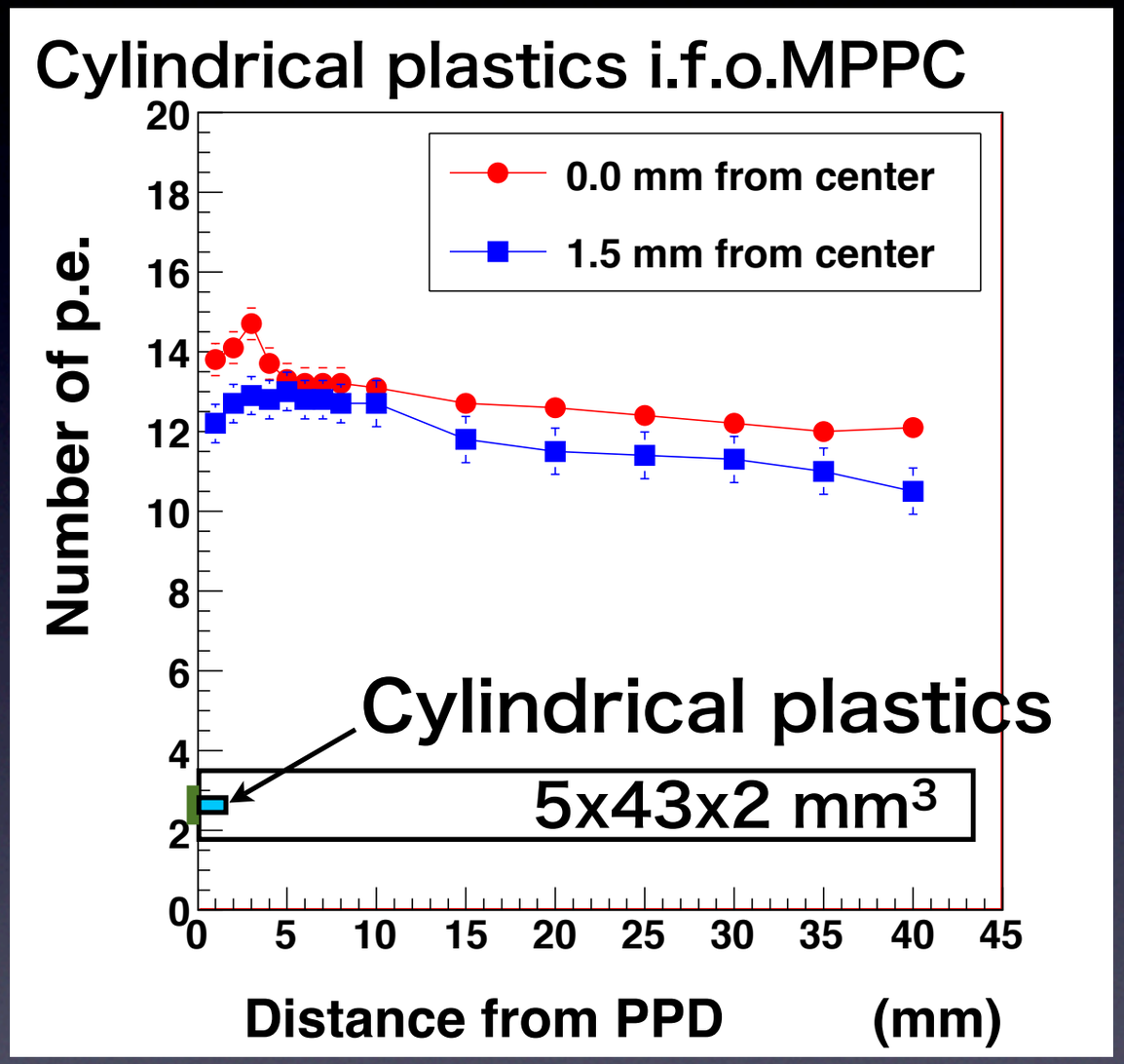
Technical prototype TB Sep. 2012 @ DESY

- U structure (LLR France) instead of H structure, since slab thickness cannot be achieved to be thin enough.
- EBU: using HBU (PCB for AHCAL) technology will be developed at DESY. An EBU has four SPIROC2.
- 36 x 5 mm strips in a row,
- 4 rows are on one unit of EBU,
  - Two types of EBU



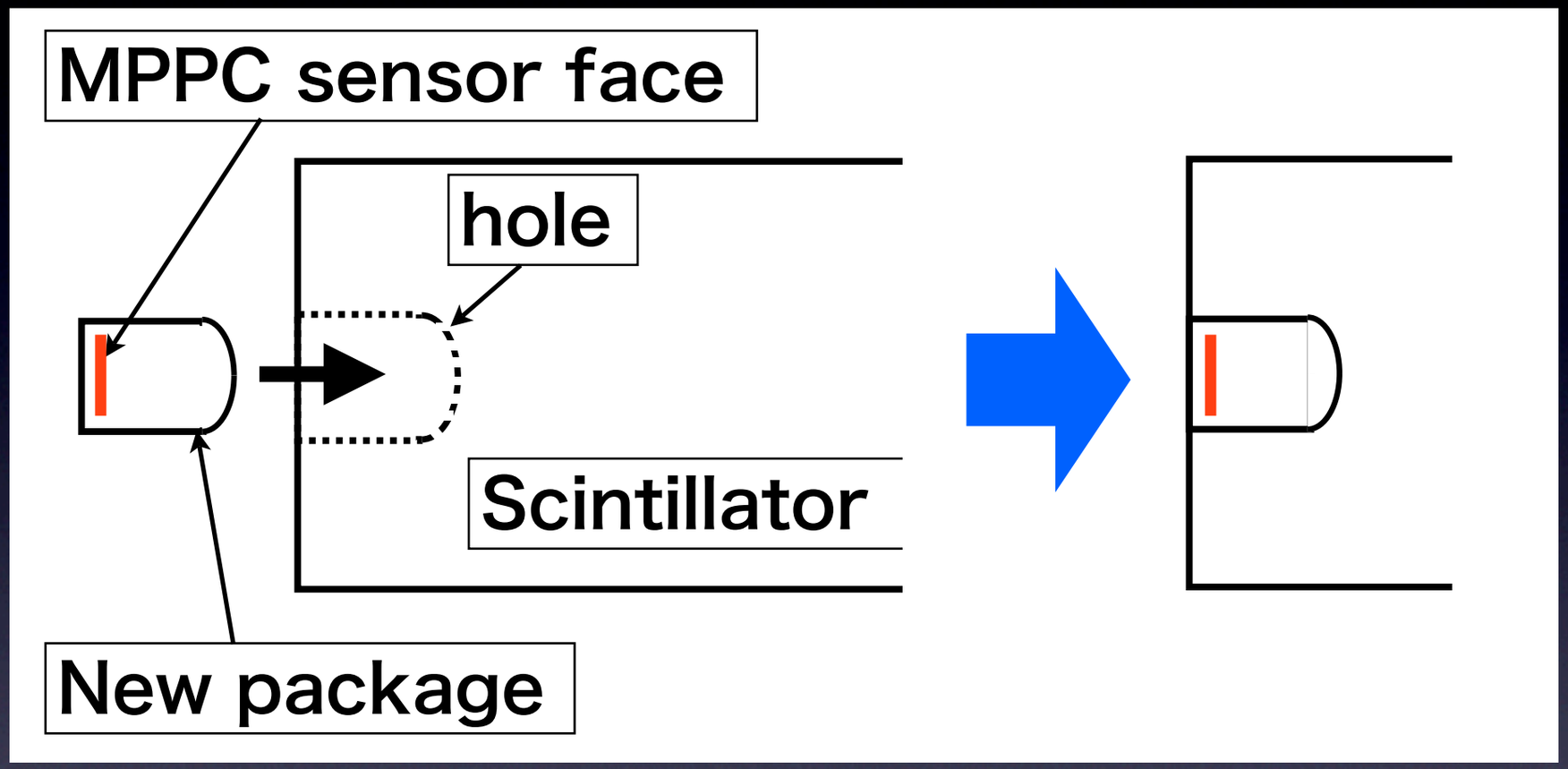
A method to keep uniformity





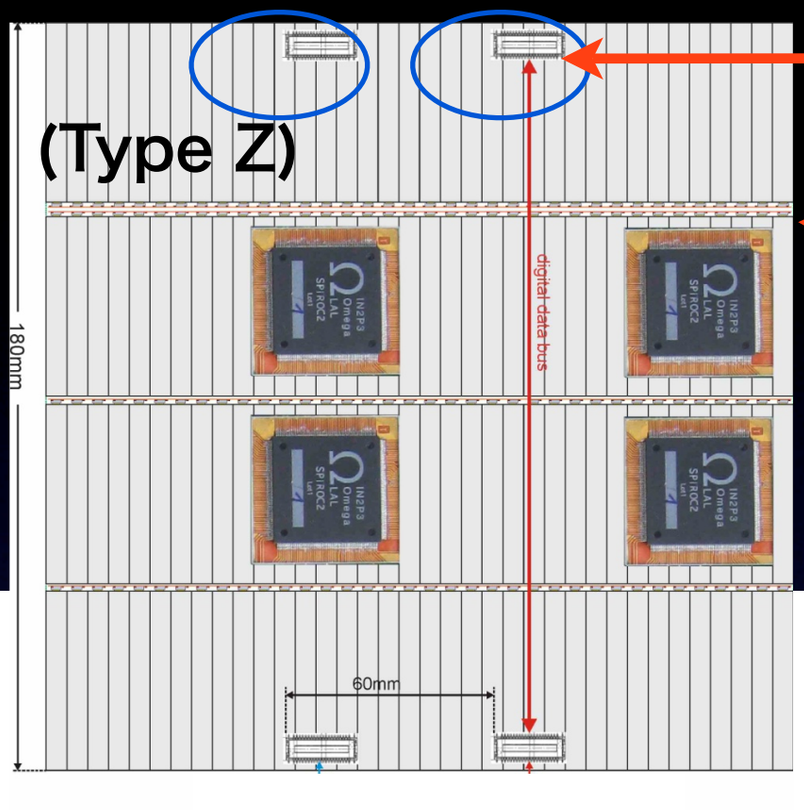
- Direct readout makes large fluctuation of response in front of MPPC
- Plastic cylinder in front of MPPC potentially improves uniformity.

Acrylic socket MPPC package

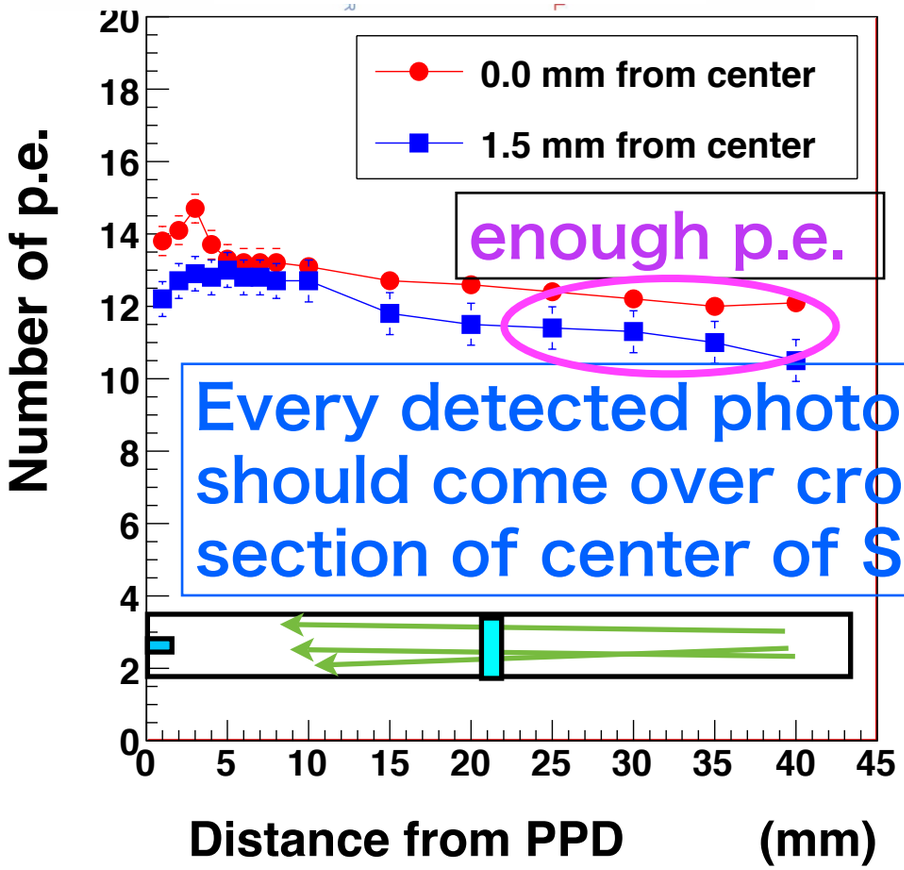


We need to optimize the shape of socket to have uniform response.

Another idea ... ‘seeing from the bottom’

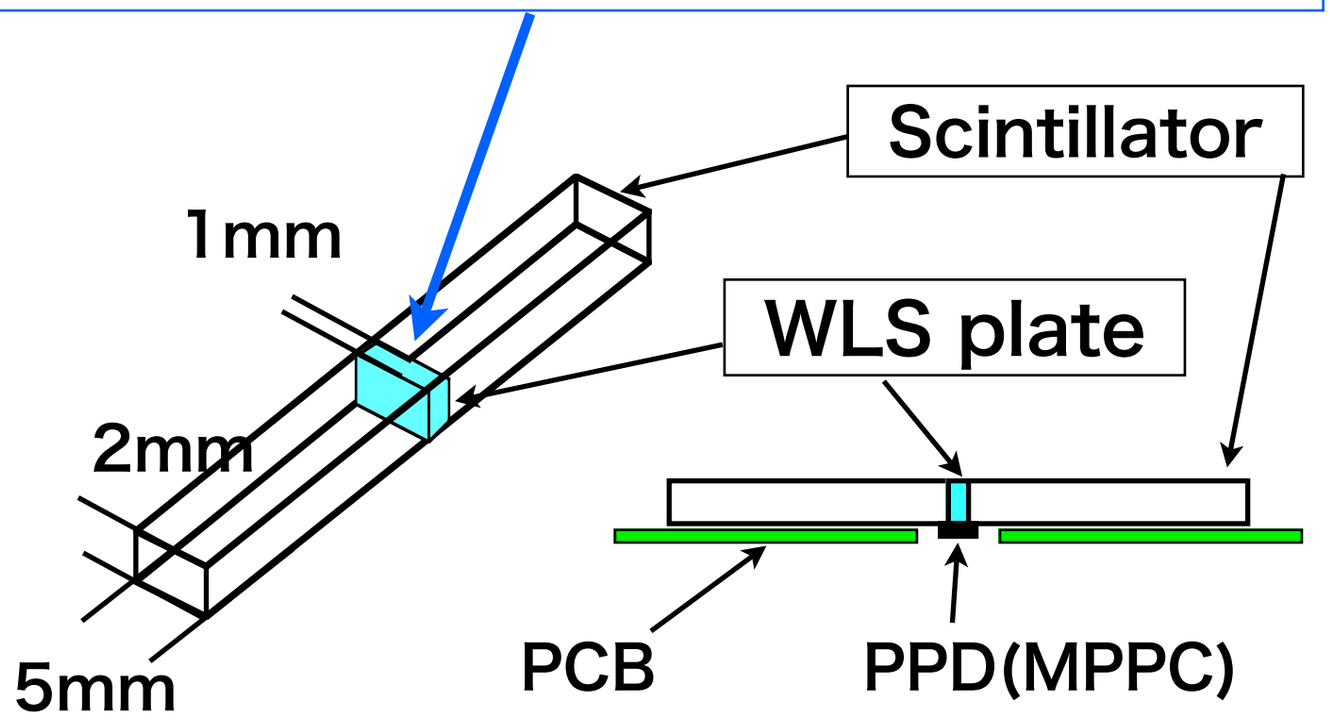


-To avoid flat cable of connectors goes over MPPC pins,
-strips only in this row are flipped so that the dead volume from MPPC becomes doubled than others
-standing MPPC is not stable on PCB



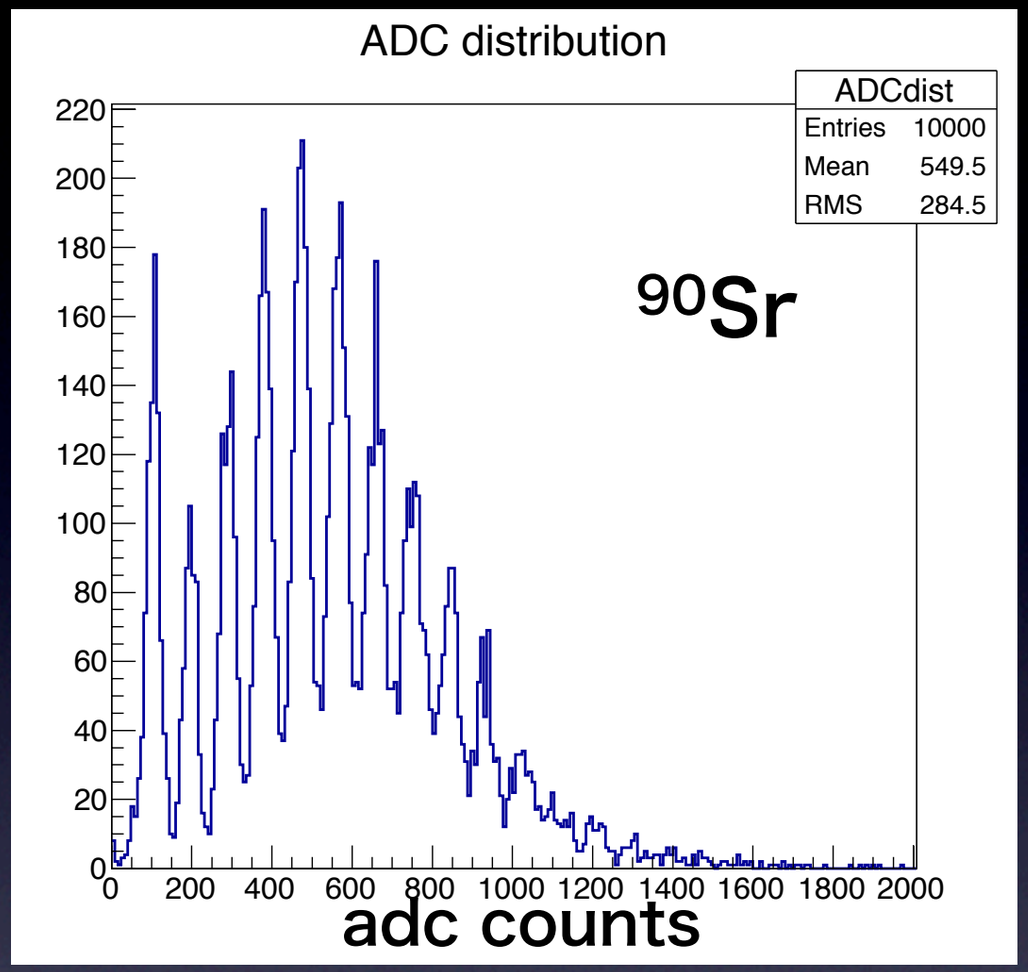
Every detected photons should come over cross section of center of Sci.

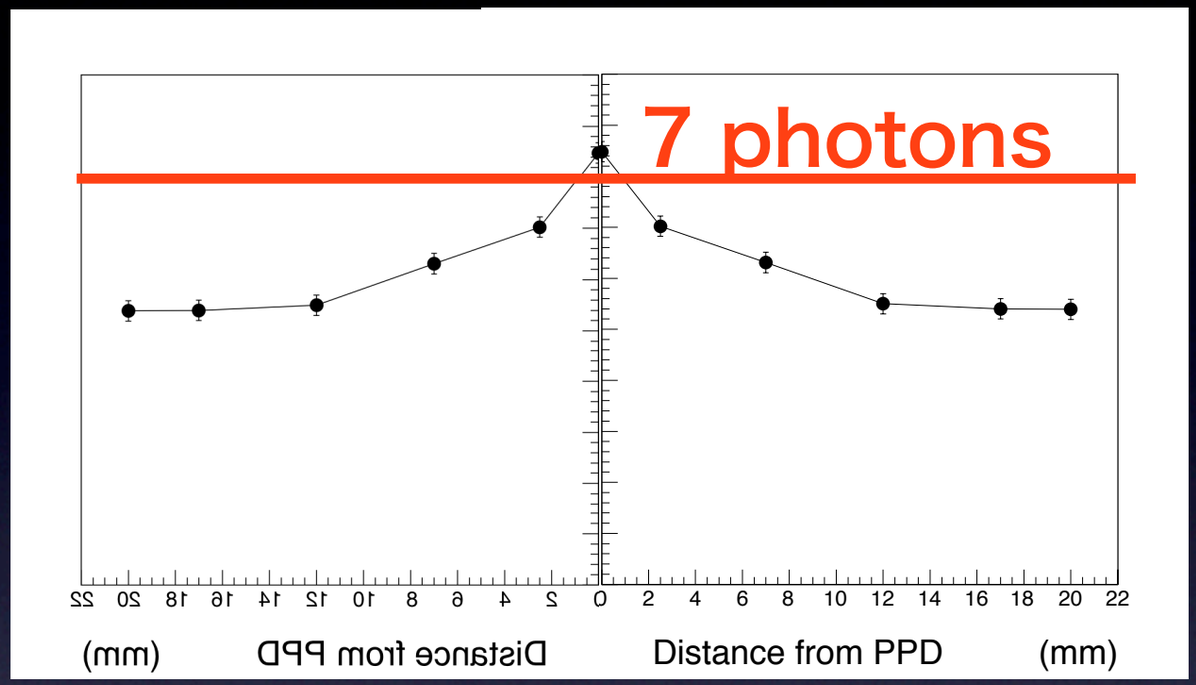
We can effectively catch the photons here by using something covering whole cross section of the scintillator.



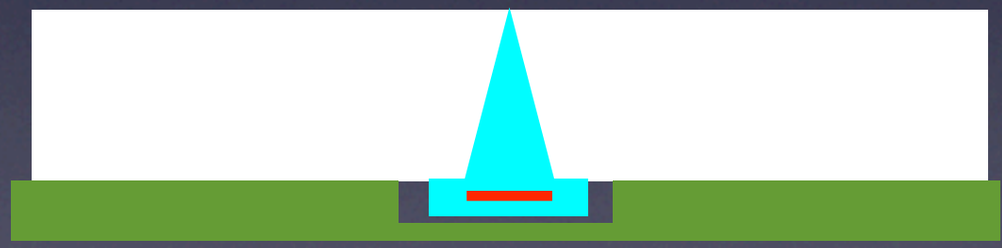
note:
this still has 1 mm width dead space

First results of “seeing from the bottom method”





From the first result of trial,
- we need more light,
- we need more flatness.



MPPC package-WLS plate unification