Design of ScECAL for ILD and Technical Prototype

7th March 2012
CALICE meeting in Shinshu

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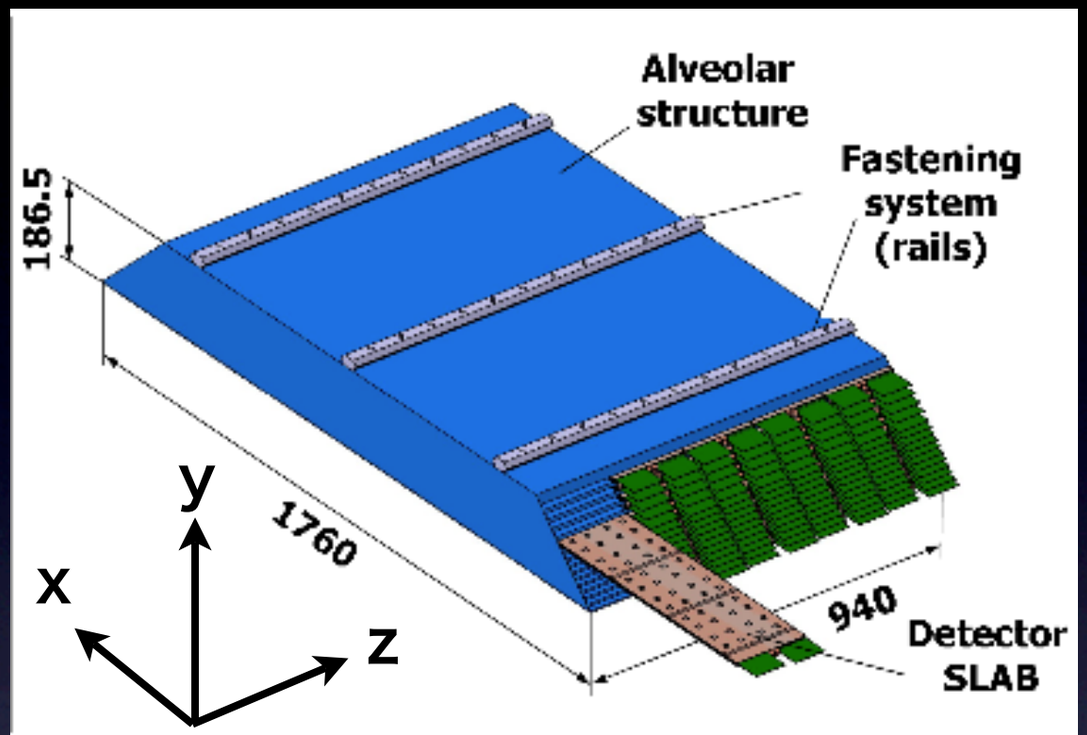
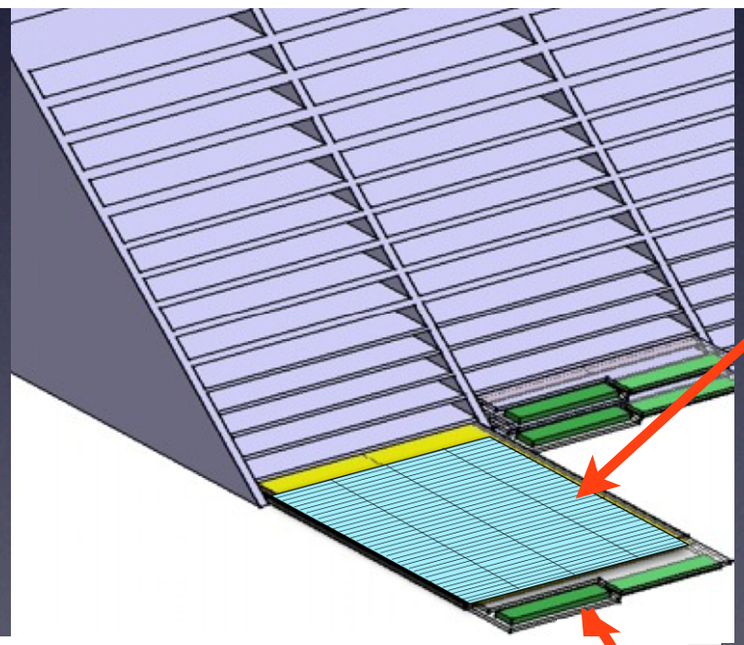
Situation

- One layer of ScECAL technical prototype will be tested together with SiECAL layers at DESY TB July 2012.
- We need to discuss ScECAL geometry separately;
  - to design the technical prototype which will test with DESY test beam, and
  - to implement it in Mokka-ILD to show detector performance,
- Current design;
  - total thickness of ScECAL will be ~185 mm to compare with SiECAL performance,
  - 25 x 3 mm thick tungsten absorbers,
  - 1.3 - 2.0 mm thick scintillator including reflector,
  - 0.8 mm PCB (in Mokka), but current; 1.5 - 1.9 mm.
- Readout board (EBU) is being developed at DESY.

ScECAL in ILD

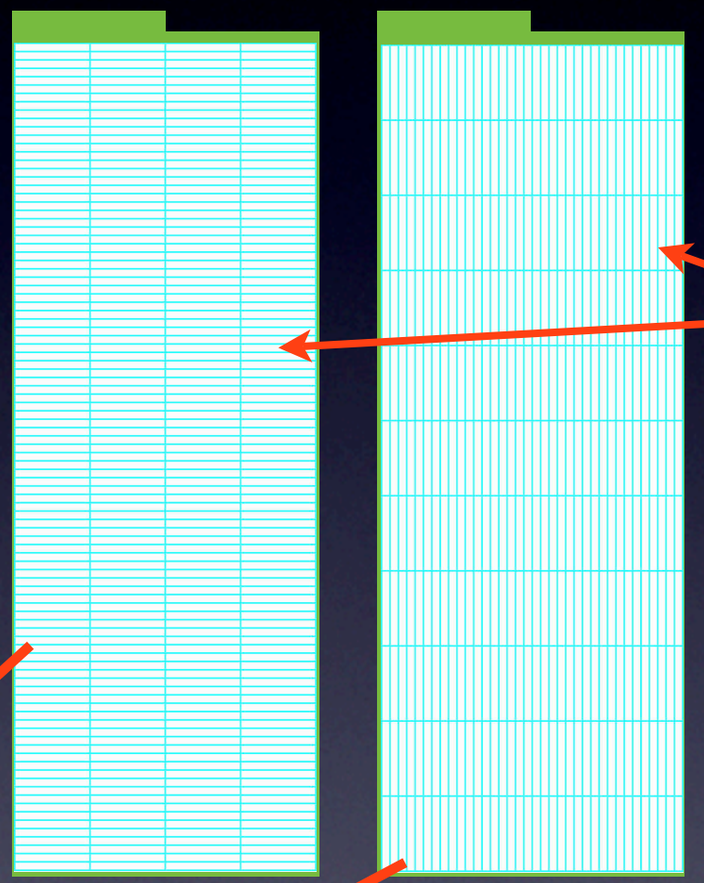
A module in the top stave of Barrel

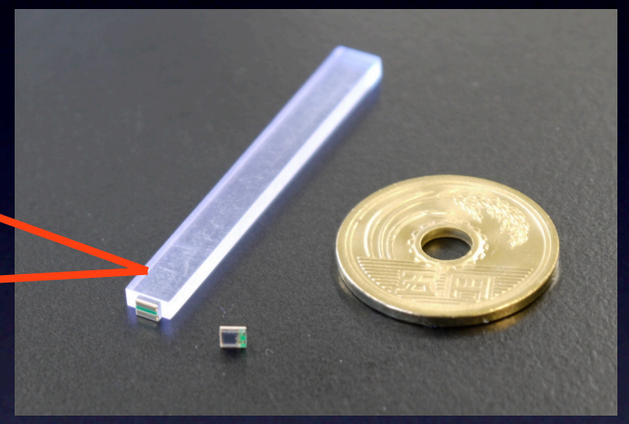




a pair of layers is inserted into the alveolar structure

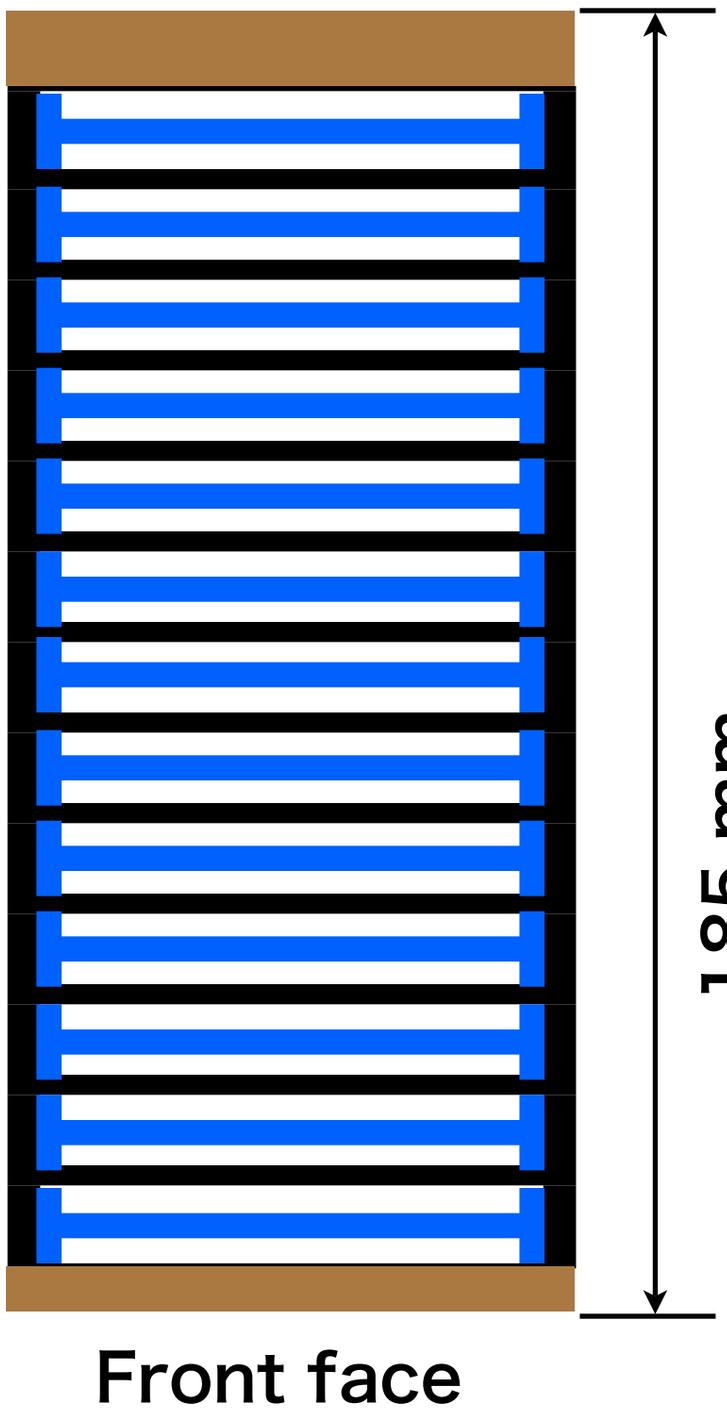
fine in x　　fine in z



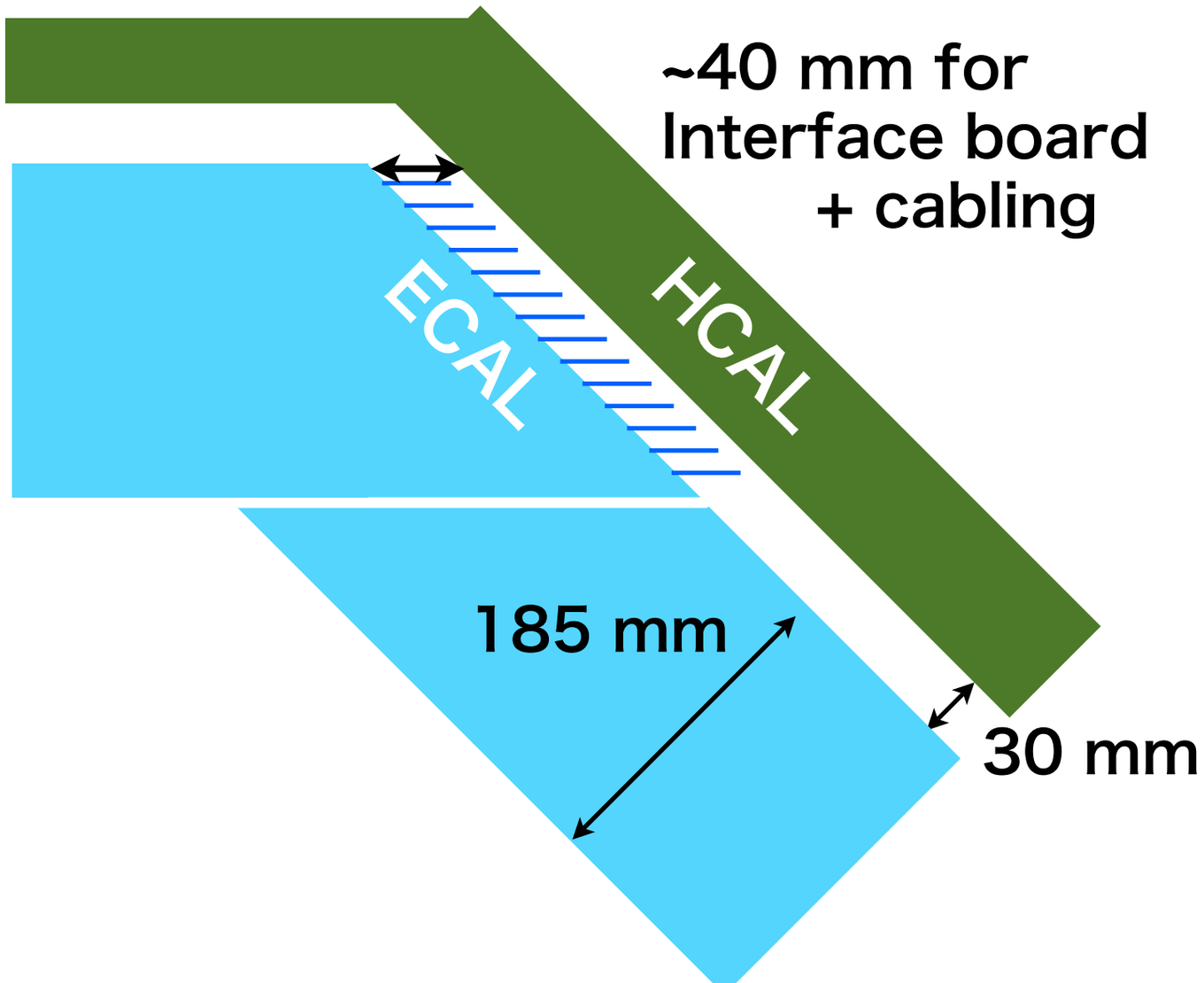


a x layer and a z layer are put back to back on the H structure W layer

Module thickness and Gap in ILD

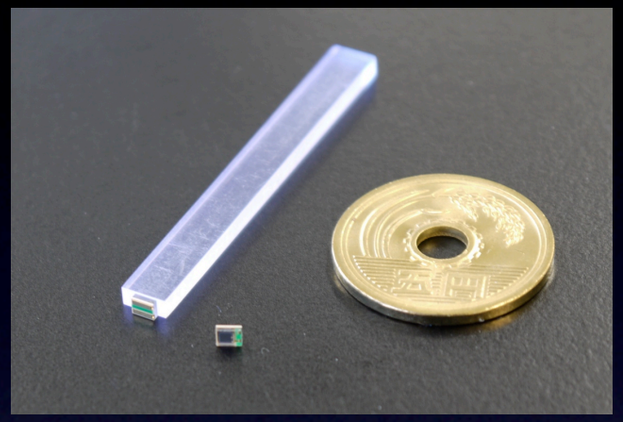


- 25 tungsten layers, 13 alveolars,
- 21.5 X_0,
- total ~185 mm Module thickness allows 30 mm between HCAL inner most surface,

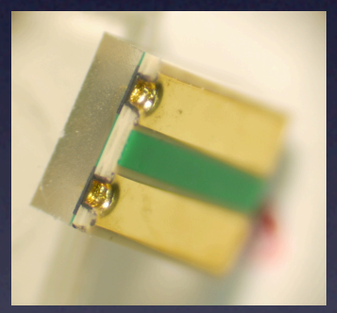


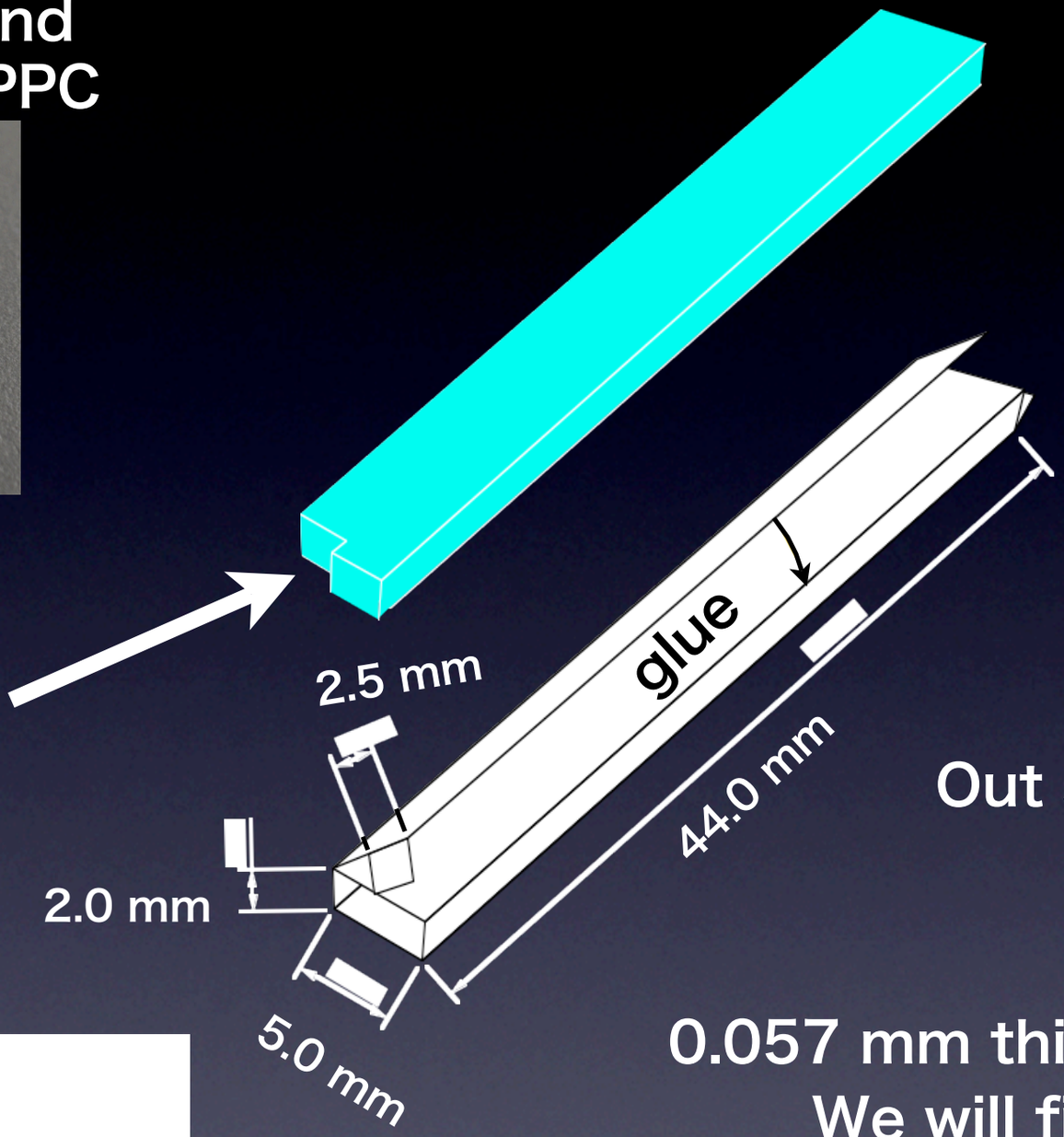
Scintillator-MPPC unit on PCB

Scintillator strip and
Surface Mount MPPC



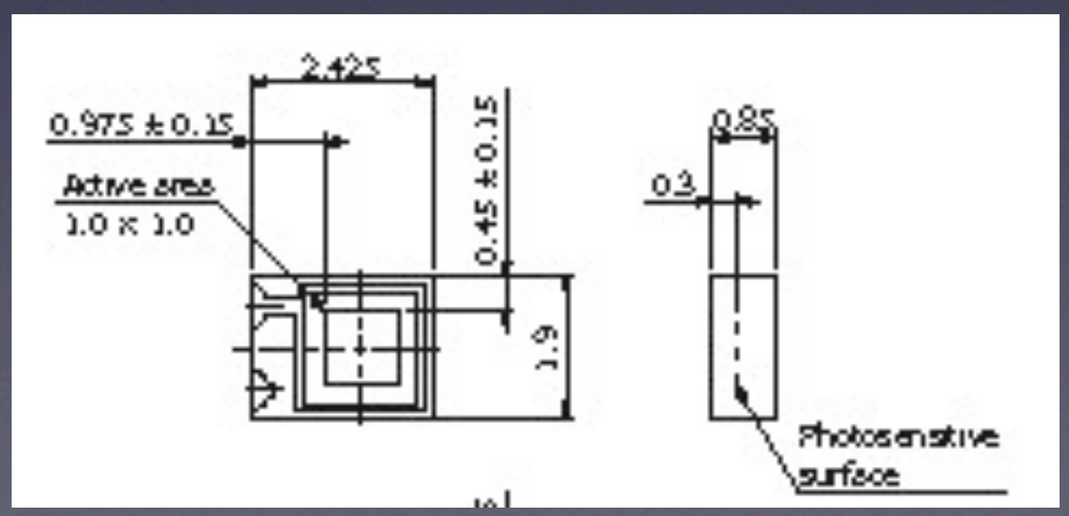
Backside of MPPC





Out side scales

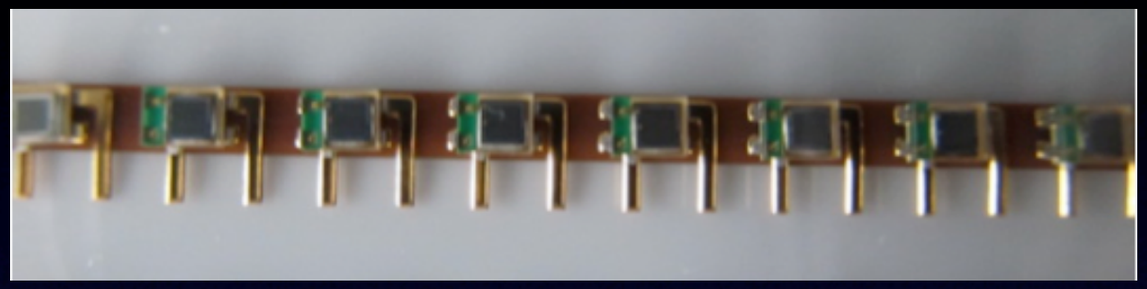
0.057 mm thick reflector
We will find thinner film



Hamamatsu developing
more small package now → discussion with
an engineer

Stacked channels

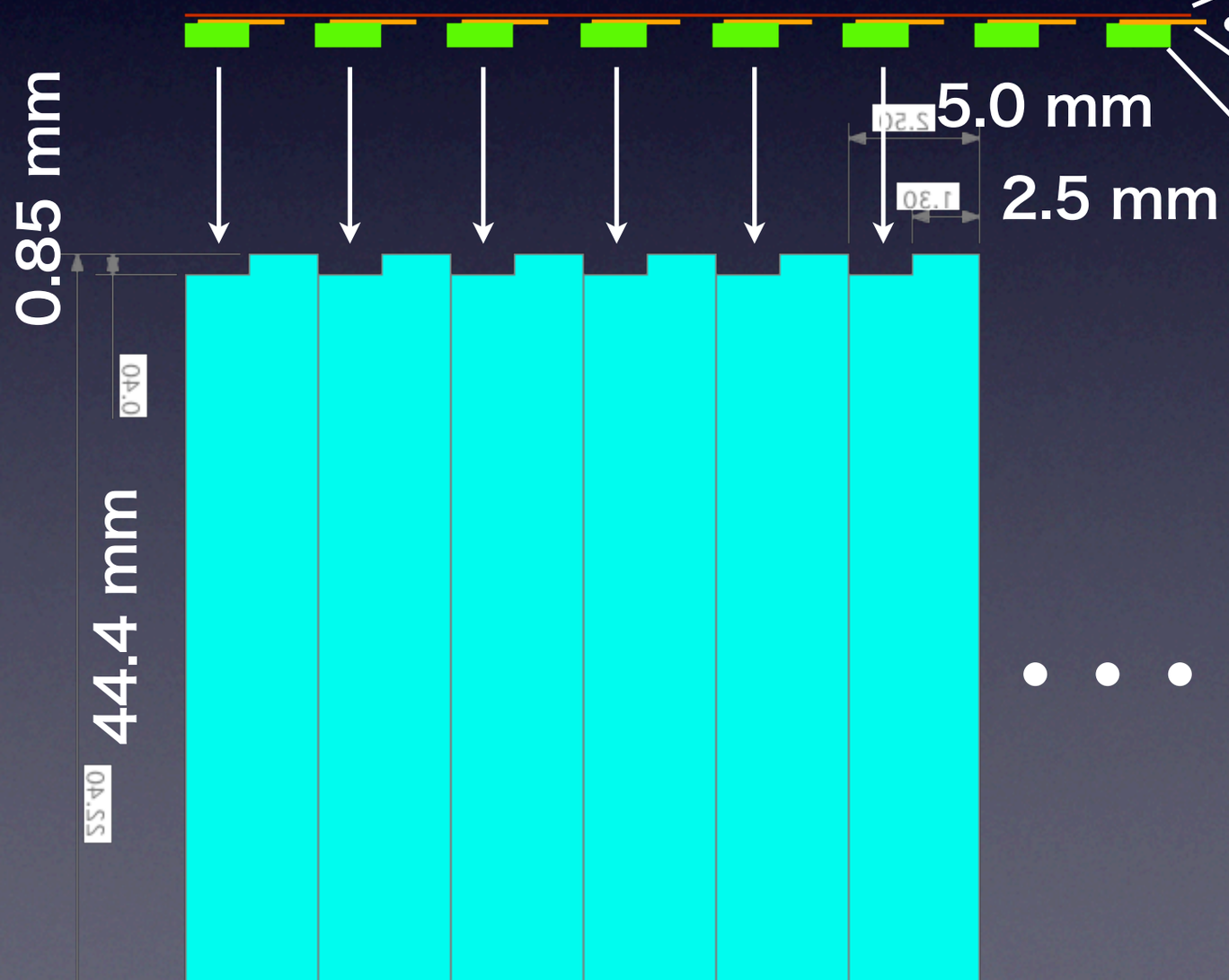
36 MPPCs soldered on electrodes
on a polyimide ribbon



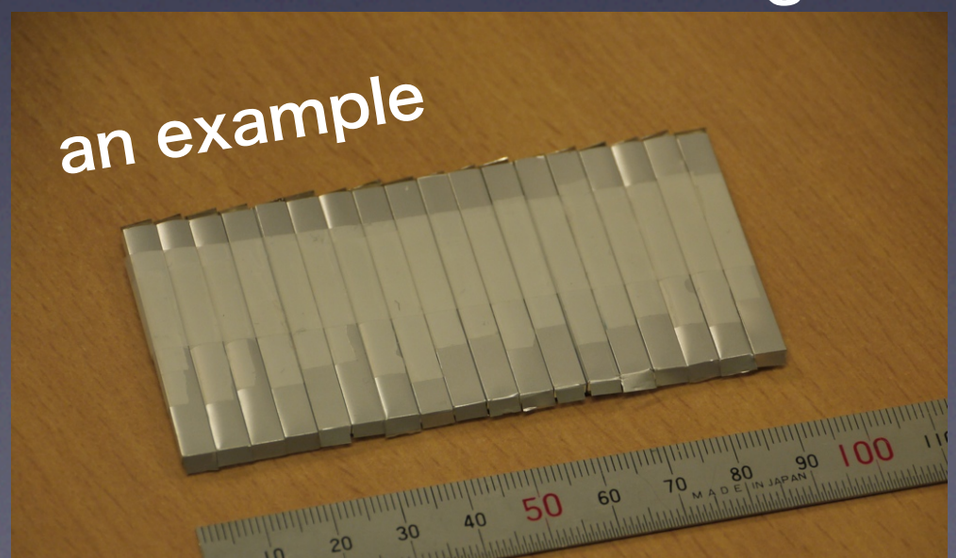
Thickness of ribbon: 0.06 mm

Thickness of electrode: 0.5 mm

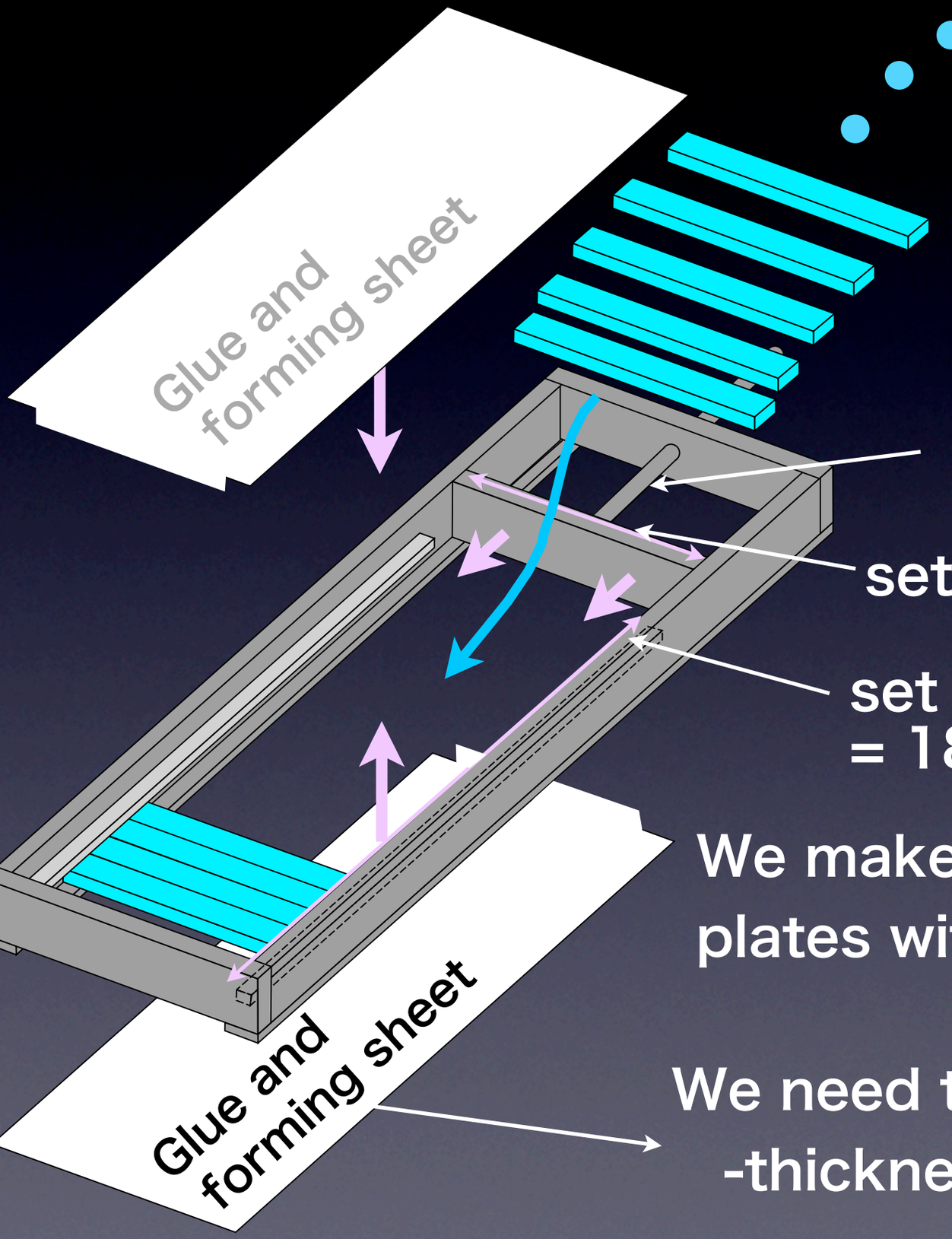
Thickness of MPPC: 0.85 mm



18 scintillator strips enveloped in
reflector film stacked together



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



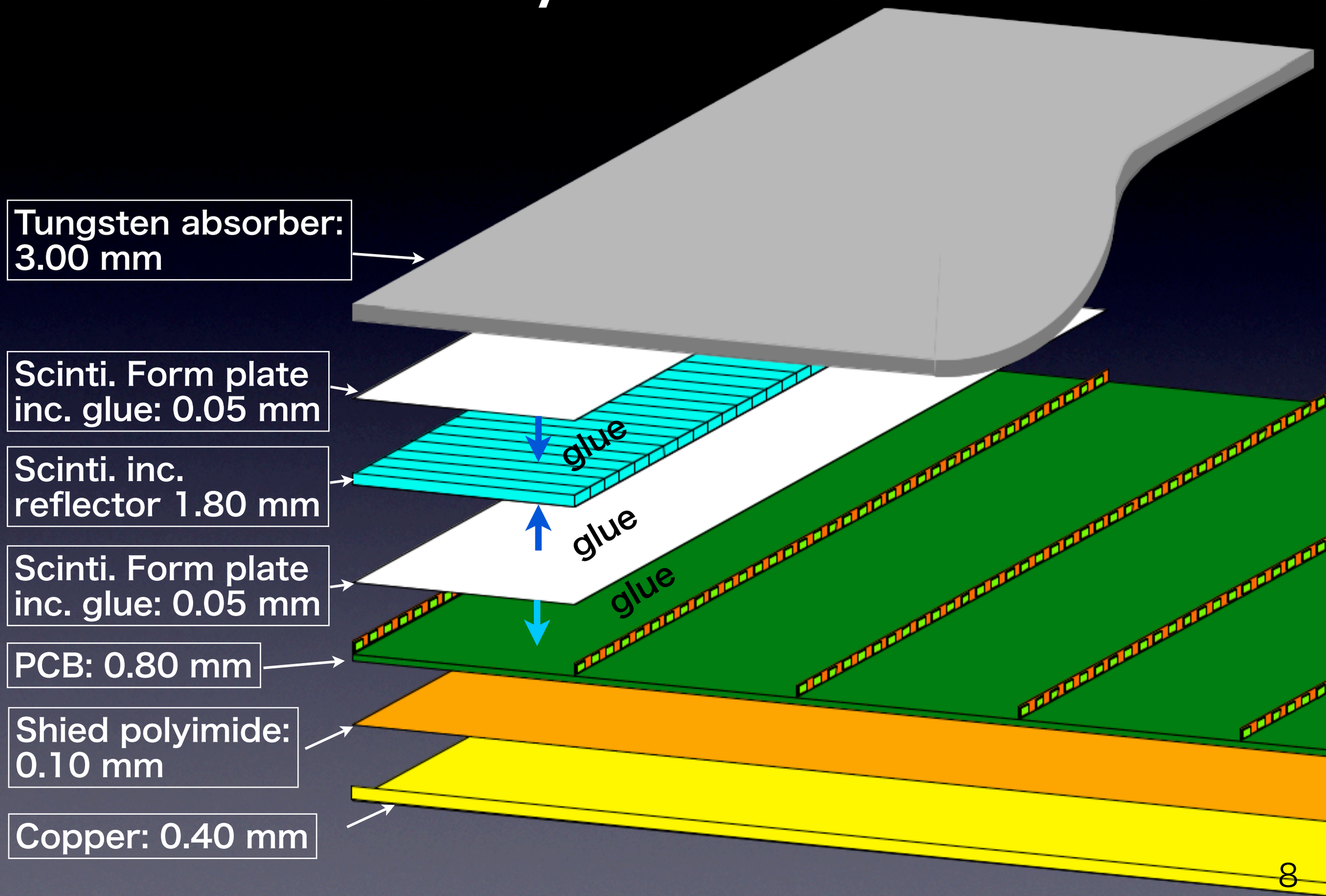
set exactly to strip length, 44 mm

set exactly to strip width x 36 = 180 mm

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

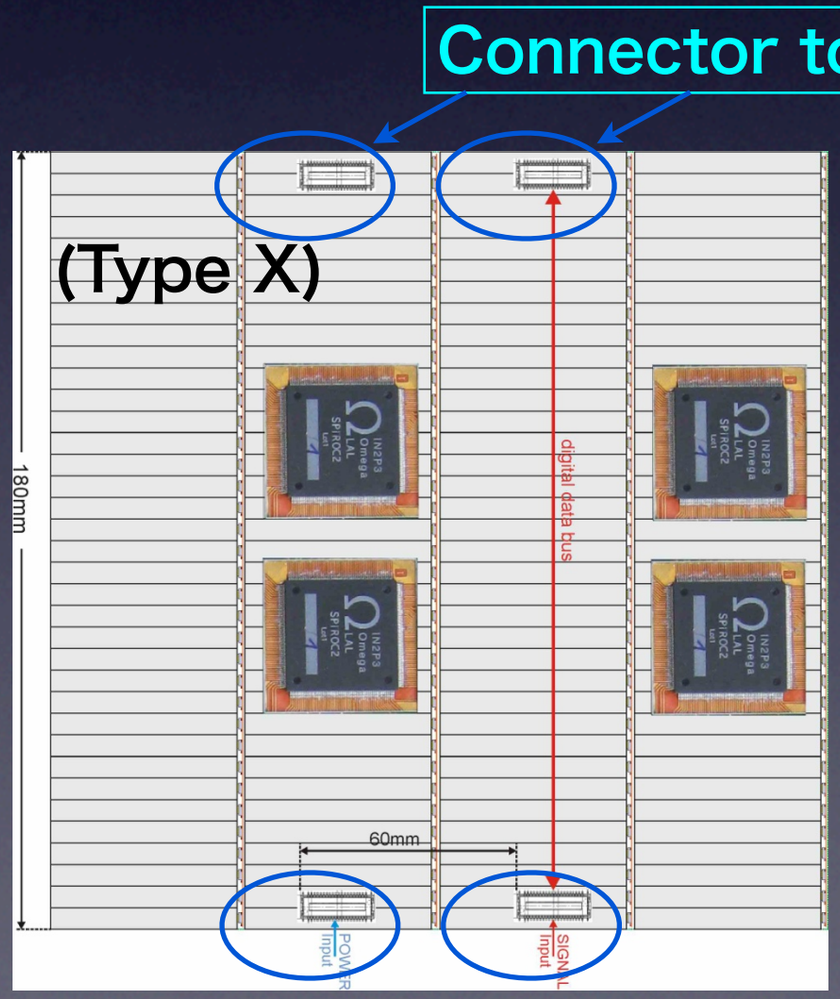
We need to study the material
-thickness, tolerance, glue also ...

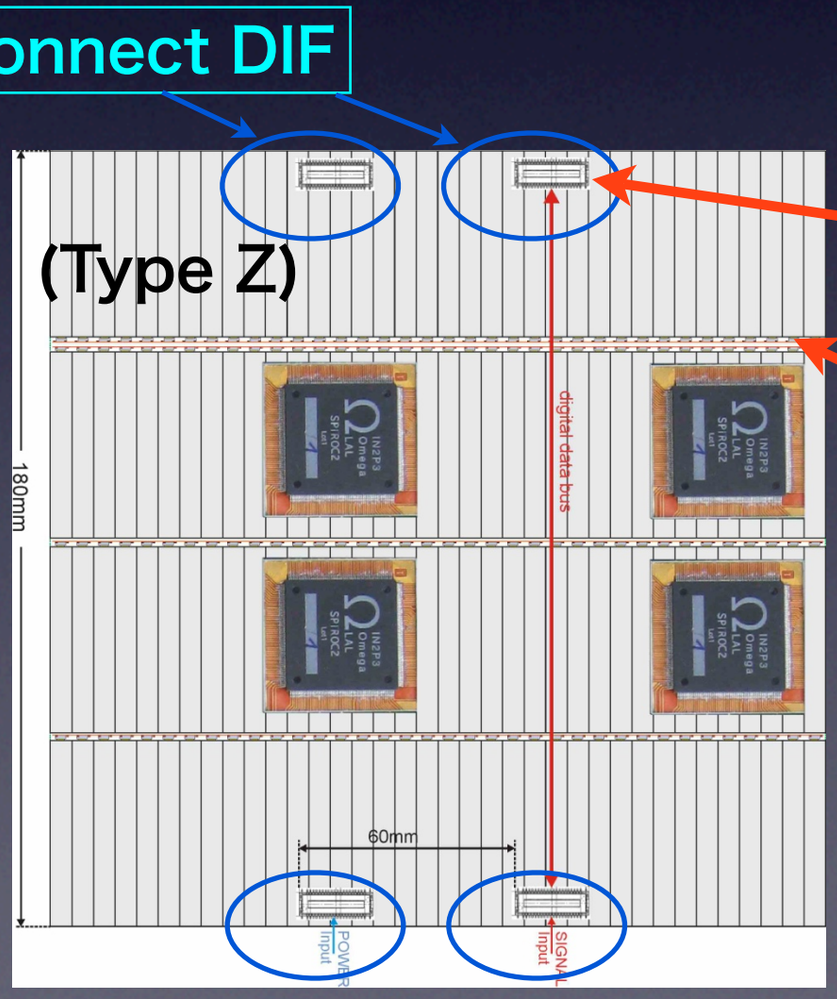
In a alveolar/ without Carbon fiber



Technical prototype TB July. 2012 @ DESY

- U structure instead of H structure, since slab thickness cannot be achieved to be thin enough.
- EBU: using HBU (BB 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





-To avoid flat cable goes over MPPC pins,
-strips only this row are flipped. We have other ideas.
  - shift connectors a bit
  - another design of strip->next tallk

Technical prototype TB July. 2012 @ DESY

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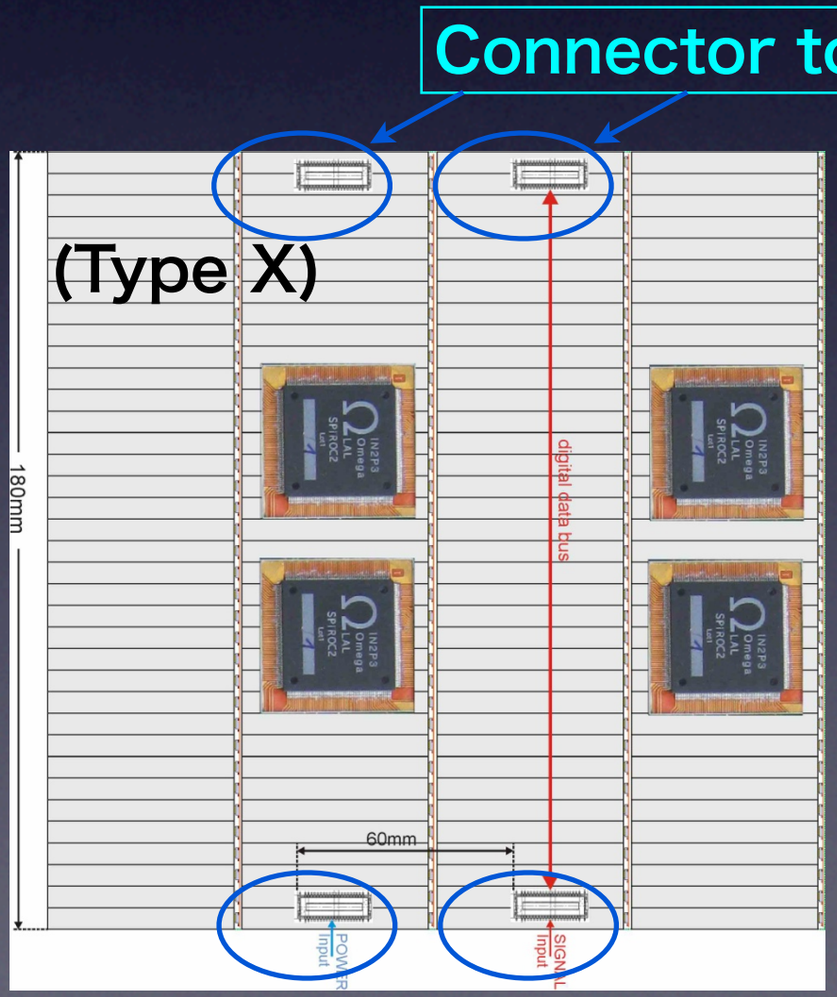


We will make only Type X for the next TB

Technical prototype TB July. 2012 @ DESY

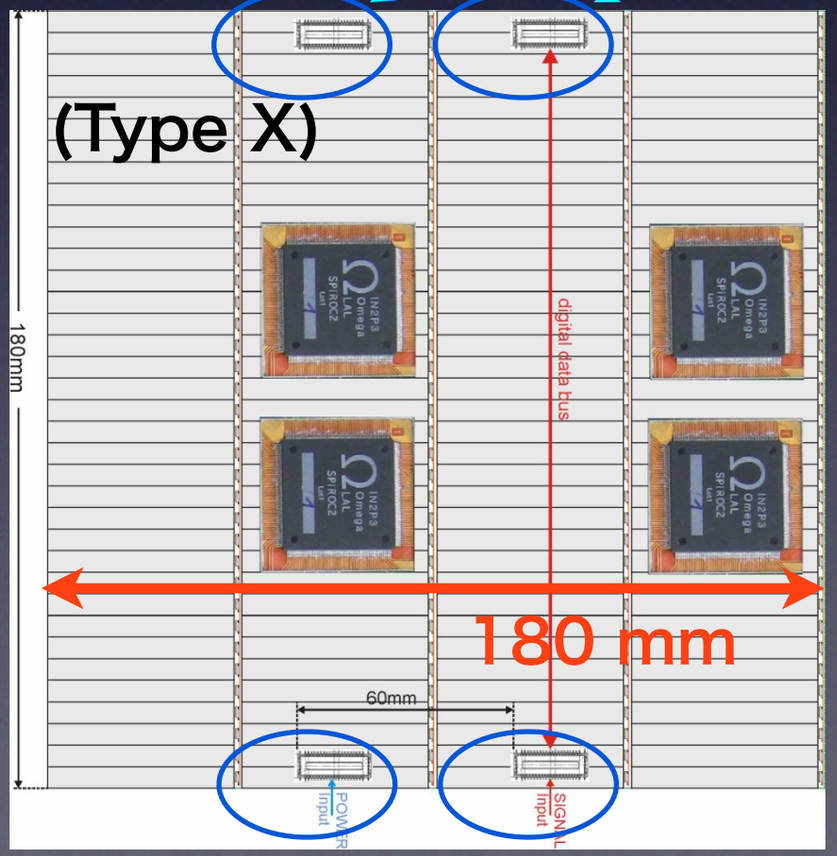
Power control

LED system

Detector-DAQ interface

Carrier board

360 mm



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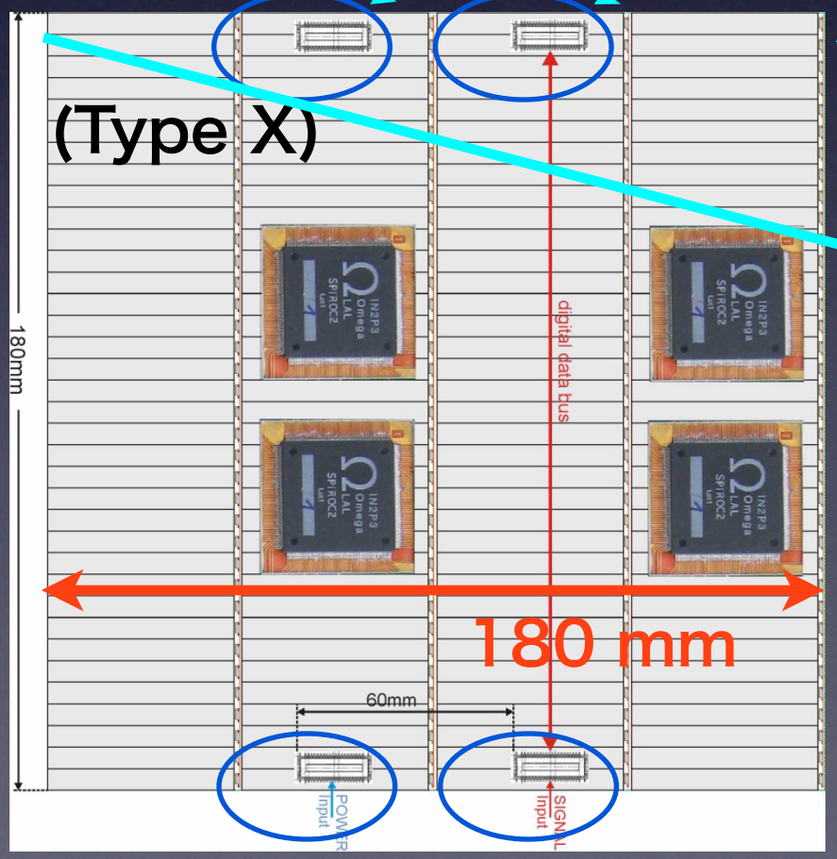
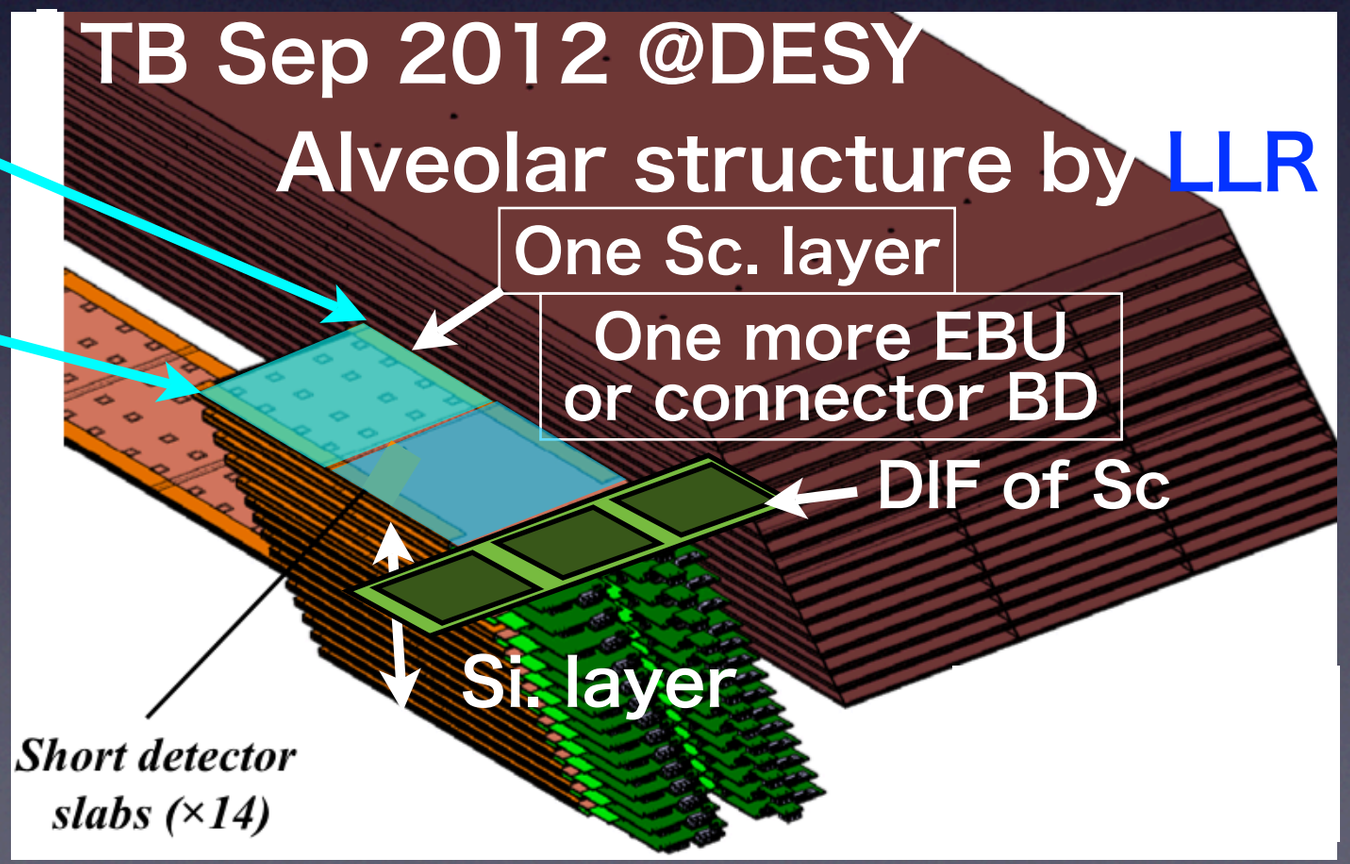
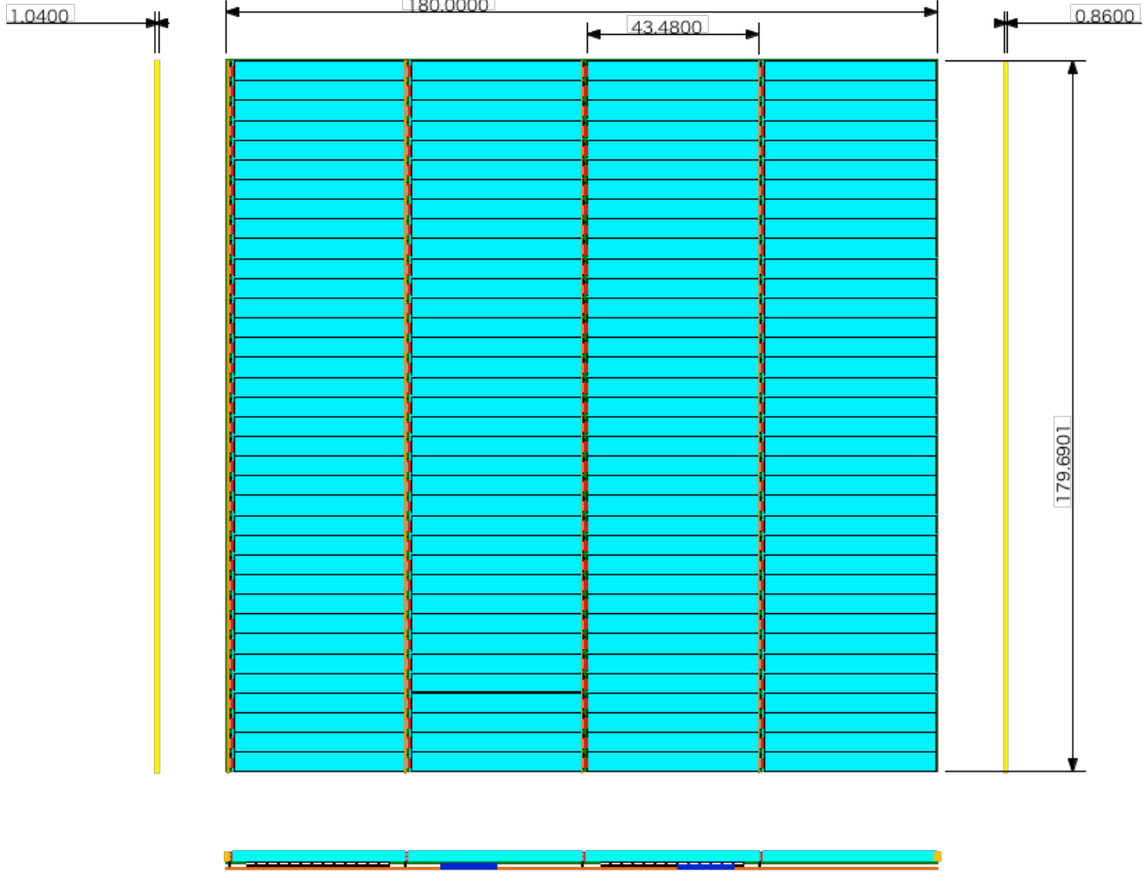
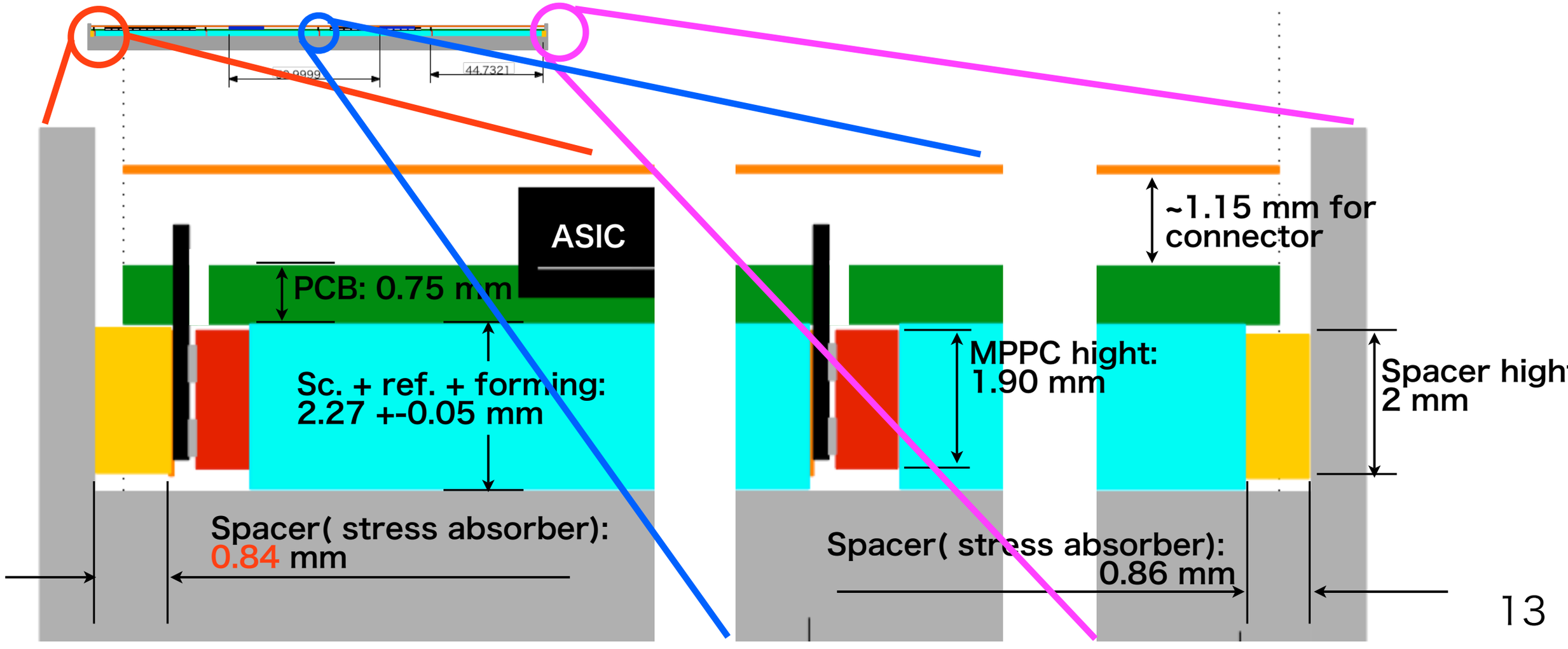






PCB and sensors are fixed on U-stracter using plastic spacers



Summary

- Design of ScECAL in ILD and technical prototype have been discussed with current available or/and future technologies.
- We have already started to make detail design of prototype with DESY and LLR.
- We need to recognize what we need to develop for real ILD
  - DAQ interface of 180/2 mm x 40 mm dimension for a layer,
  - 0.8 mm PCB, including ASIC and electric parts etc
  - 1.3 mm width scintillator strips
  - ....

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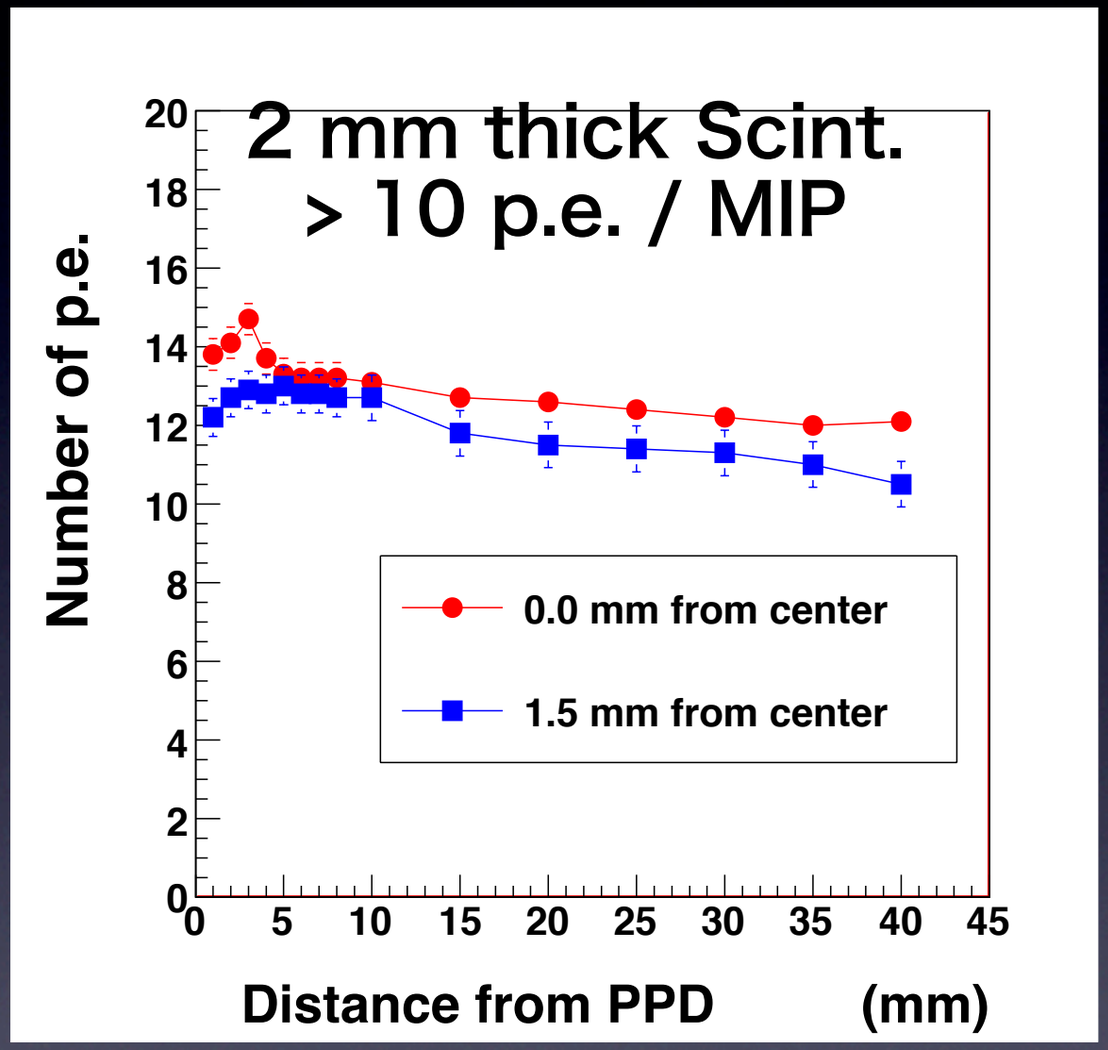
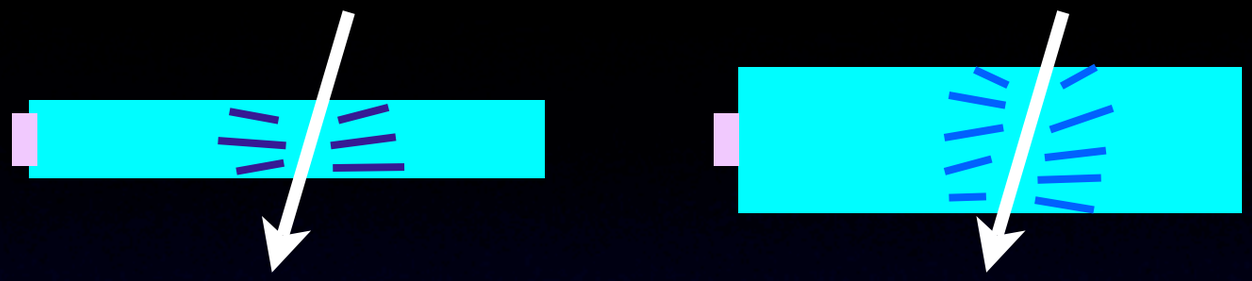
  - ....

Scintillator thickness

Position dependence of #p.e.





Scintillation is proportional
to thickness of scintillator

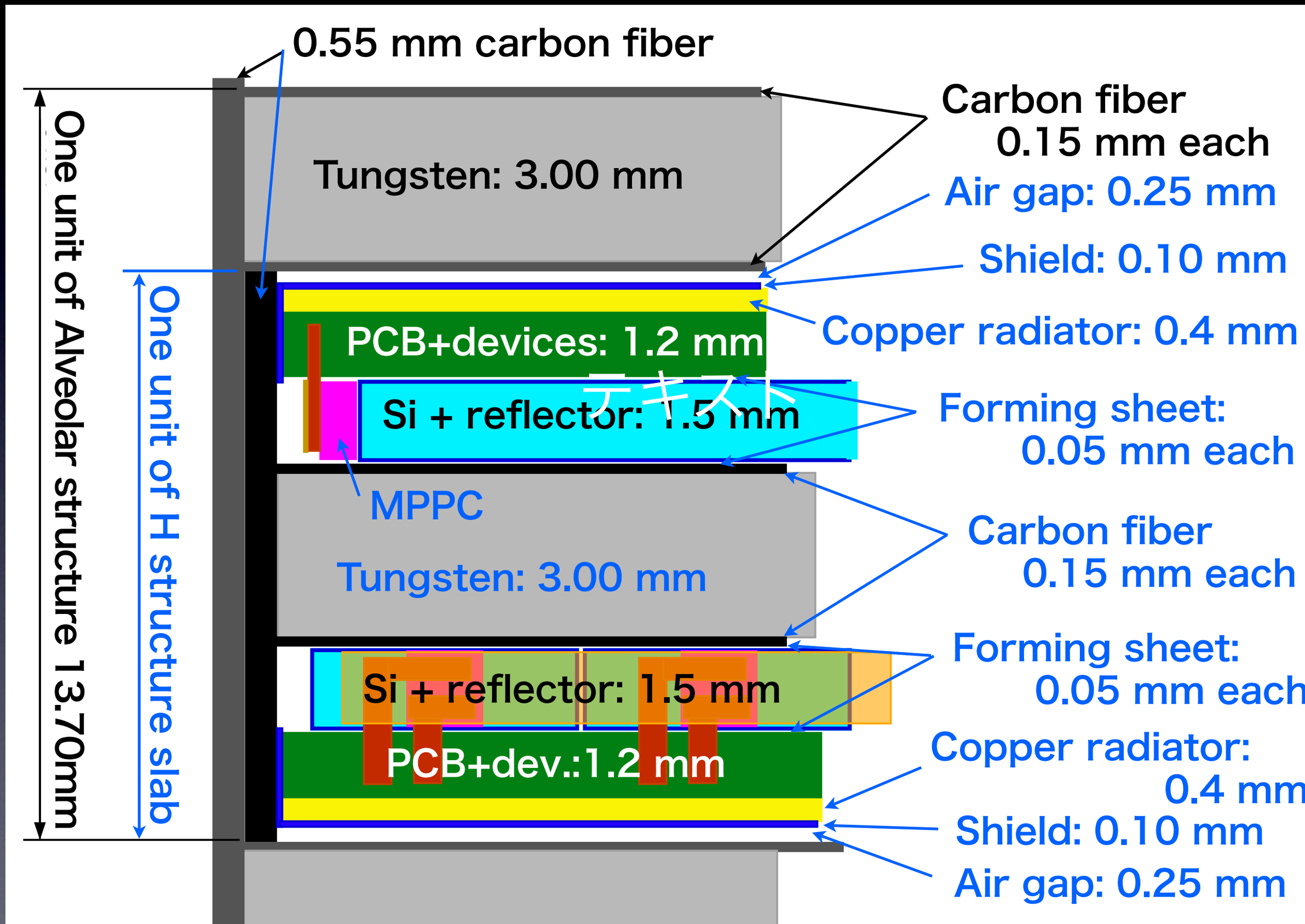
but acceptance is proportional
to the ratio MPPC hight/scinti.
hight(thickness)

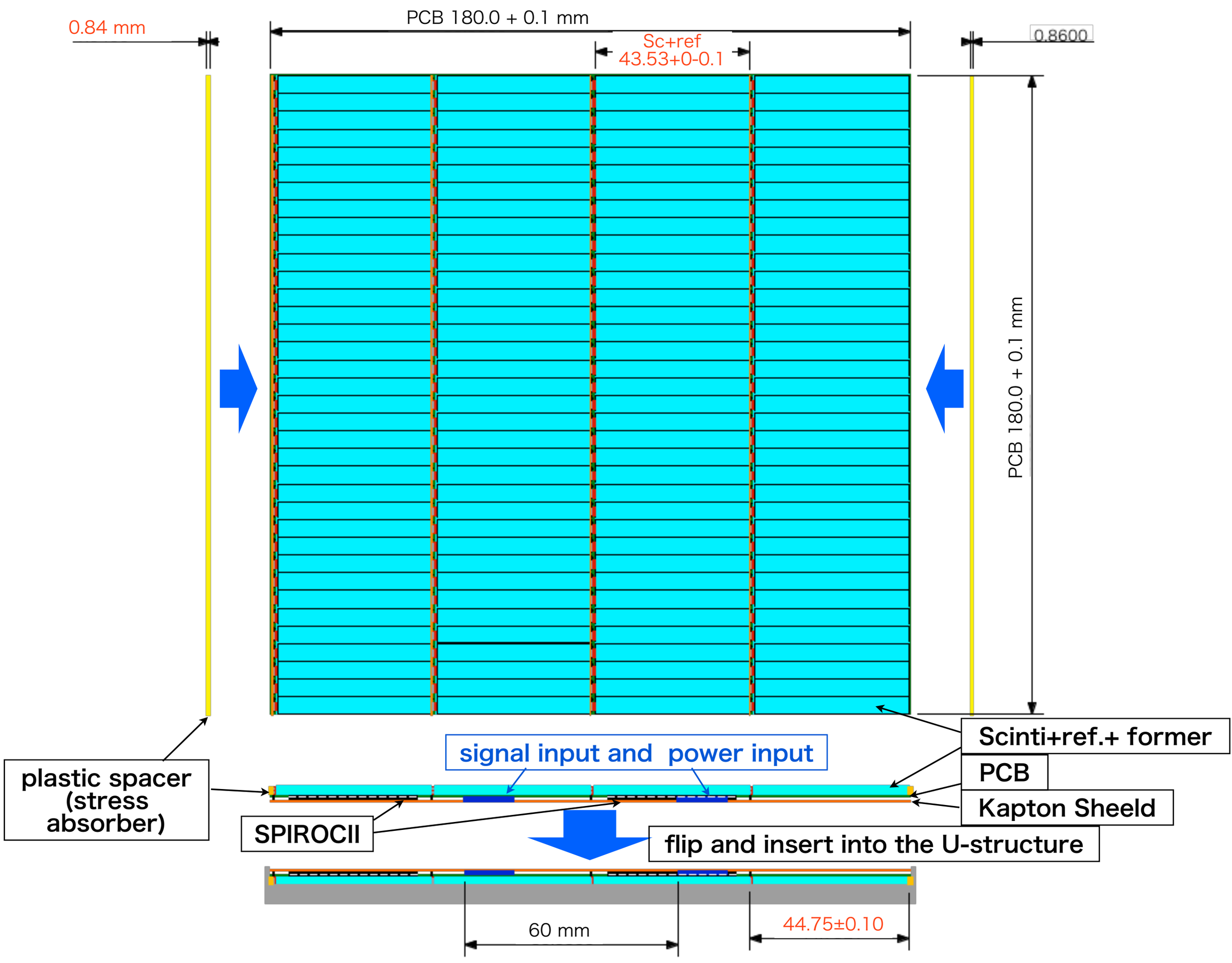
We expect that also 1.3 mm thick scintillator
can make enough photon yield.

➡ we will make confirmation in the near future.

A

One unit of alveolar (a pair of Sc)




0.84 mm
PCB 180.0 + 0.1 mm
Sc+ref
43.53+0-0.1
0.8600
PCB 180.0 + 0.1 mm
plastic spacer
(stress
absorber)
signal input and power input
SPIROCII
Scinti+ref.+ former
PCB
Kapton Sheeld
flip and insert into the U-structure
60 mm
44.75±0.10

MPPC thickness: 0.85 mm

Soldering thickness: 0.10 m

Electrode thickness: 0.21 mm

Flat cable thickness: 0.06 mm

PCB edge to flat cable: 0.44+(0.19-0.00)mm

tolerance of solder of MPPC pins in the holes

PCB edge to hole edge: 0.5 mm

Hole to hole (next MPPC): 5.00 mm

HV pin to readout pin: 25.40 mm

PCB edge to hole edge: 0.5 mm

MPPC width 2.425 mm

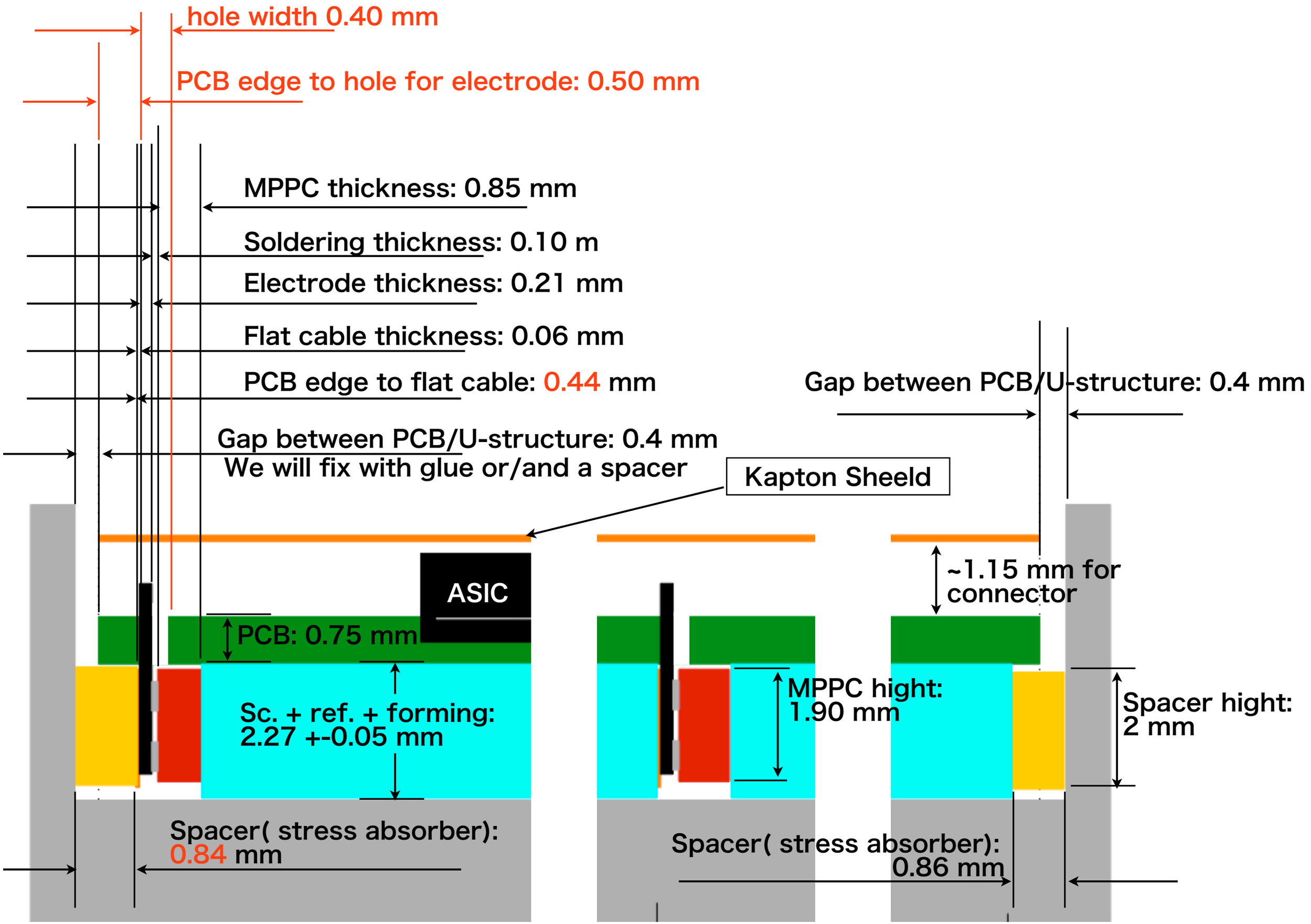
Sc.+ref: 5.00±0.1mm

**Total, 36 x 5.00 mm tolerance also±0.1mm

Distance between hole center and the hole center of the next column is 44.75 ± 0.05 mm

Readout electrode

HV electrode


hole width 0.40 mm
PCB edge to hole for electrode: 0.50 mm
MPPC thickness: 0.85 mm
Soldering thickness: 0.10 m
Electrode thickness: 0.21 mm
Flat cable thickness: 0.06 mm
PCB edge to flat cable: 0.44 mm
Gap between PCB/U-structure: 0.4 mm
We will fix with glue or/and a spacer
Kapton Sheeld
ASIC
PCB: 0.75 mm
Sc. + ref. + forming:
2.27 +-0.05 mm
Spacer(stress absorber):
0.84 mm
Gap between PCB/U-structure: 0.4 mm
~1.15 mm for
connector
MPPC hight:
1.90 mm
Spacer hight:
2 mm
Spacer(stress absorber):
0.86 mm

Summary

- Detail design of ScECAL in ILD has been discussed with current and future technologies.
- Current available layer structures are:

in 185 mm	# W layers	# X0	PCB thick	Scinti. thick
A	25	21.5	0.80 mm	1.3 mm
B	23	19.8	1.2 mm	1.5 mm

- We need to clarify the following:
  - is PCB 0.8 thickness OK? ScECAL
  - is 40 mm space for DAQ interface OK?
  - is performance OK with 3 mm x 23 W layers, 19.8 X_0?
  - does 1.3 mm thick scintillator have enough photon yields?
  - What design of structure support by using carbon fiber can we choose?

ScEcal Thickness Calculation

Thickness (mm)

				Default (Mokka) SiECAL				ScECAL 25 W, PCB: 1.2 mm				SeECAL 25 W, PCB:1.4 mm			
	The number of alveolar:			15				13				13			
		X0/Unit	Dens.												
				#	Unit	Total	#X0	#	Unit	Total	#X0	#	Unit	Total	#X0
for Alveolar structure	Front surface (G10)			1	2.00	2.00		1	2.00	2.00		1	2.00	2.00	
	Tungsten absorber (structure-1)	6.76	19.3	10	2.10	21.00	6.00	12	3.00	36.00	10.28	12	3.00	36.00	10.28
	Tungsten absorber (structure-2)	6.76	19.3	4	4.20	16.80	4.80								
	Support (G10)			1	9.30	9.30		1	9.30	9.30		1	9.30	9.30	
	Carbon fiber frame layer			56	0.15	8.40		24	0.15	3.60		24	0.15	3.60	
for H structure	Tungsten absorber(in alveolar-1)	6.76	19.3	10	2.10	21.00	6.00	13	3.00	39.00	11.13	13	3.00	39.00	11.13
	Tungsten absorber(in alveolar-2)	6.76	19.3	5	4.20	21.00	6.00								
	Carbon fiber frame layer			120	0.15	18.00		26	0.15	3.90		26	0.15	3.90	
	glue gap			30	0.10	3.00									
	Scintillator forming film + glue							52	0.05	2.60		52	0.05	2.60	
	Silicon Sensor	21.82	2.329	30	0.50	15.00	0.16								
	Scintillator + reflector	43.79	1.06					26	1.50	39.00	0.09	26	1.30	33.80	0.08
	ground			30	0.10	3.00		26	0.00	0.00		26	0.00	0.00	
	PCB			30	0.80	24.00		26	1.20	31.20		26	1.40	36.40	
	Copper radiator			30	0.40	12.00		26	0.40	10.40		26	0.40	10.40	
	Shielding film			30	0.10	3.00		26	0.10	2.60		26	0.10	2.60	
	Alveolar air gap			30	0.25	7.50		26	0.25	6.50		26	0.25	6.50	
Module Total thickness						185.00				186.10				186.10	
Total number of tungsten absorber 1				20				25				25			
Total number of tungsten absorber 2				9											
ECAL-HCAL gap						30.00				28.90				28.90	
ECAL inner surface - HCAL inner surface						215				215.00				215.00	
Total number of X0							22.94				21.507				21.49

G

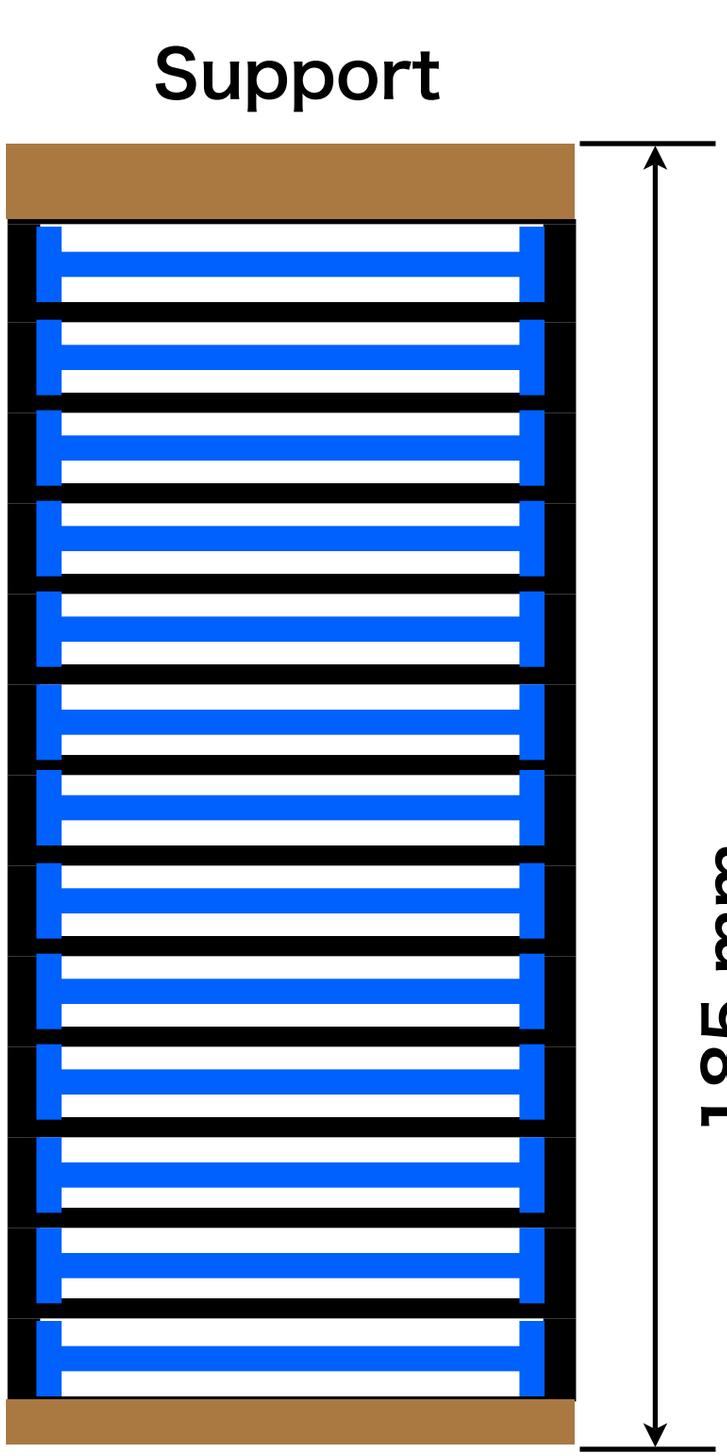
ScEcal Thickness Calculation

Thickness (mm)

				Default (Mokka) SiECAL				ScECAL 25 W, PCB: 0.8 mm				SeECAL 23 W, PCB: 1.2 mm			
	The number of alveolar:			15				13				12			
		X0/Unit	Dens.												
				#	Unit	Total	#X0	#	Unit	Total	#X0	#	Unit	Total	#X0
for Alveolar structure	Front surface (G10)			1	2.00	2.00		1	2.00	2.00		1	2.00	2.00	
	Tungsten absorber (structure-1)	6.76	19.3	10	2.10	21.00	6.00	12	3.00	36.00	10.28	11	3.00	33.00	9.42
	Tungsten absorber (structure-2)	6.76	19.3	4	4.20	16.80	4.80								
	Support (G10)			1	9.30	9.30		1	9.30	9.30		1	9.30	9.30	
	Carbon fiber frame layer			56	0.15	8.40		48	0.15	7.20		44	0.15	6.60	
for H structure	Tungsten absorber(in alveolar-1)	6.76	19.3	10	2.10	21.00	6.00	13	3.00	39.00	11.13	12	3.00	36.00	10.28
	Tungsten absorber(in alveolar-2)	6.76	19.3	5	4.20	21.00	6.00								
	Carbon fiber frame layer			120	0.15	18.00		104	0.15	15.60		96	0.15	14.40	
	glue gap			30	0.10	3.00									
	Scintillator forming film + glue							52	0.05	2.60		48	0.05	2.40	
	Silicon Sensor	21.82	2.329	30	0.50	15.00	0.16								
	Scintillator + reflector	43.79	1.06					26	1.30	33.80	0.08	24	1.50	36.00	0.09
	ground			30	0.10	3.00		26	0.00	0.00		24	0.00	0.00	
	PCB			30	0.80	24.00		26	0.80	20.80		24	1.20	28.80	
	Copper radiator			30	0.40	12.00		26	0.40	10.40		24	0.40	9.60	
	Shielding film			30	0.10	3.00		26	0.10	2.60		24	0.10	2.40	
	Alveolar air gap			30	0.25	7.50		26	0.25	6.50		24	0.25	6.00	
Module Total thickness						185.00				185.80				186.50	
Total number of tungsten absorber 1				20				25				23			
Total number of tungsten absorber 2				9											
ECAL-HCAL gap						30.00				29.20				28.50	
ECAL inner surface - HCAL inner surface						215				215.00				215.00	
Total number of X0							22.94				21.495				✓19.79

H

Module thickness and Gap in ILD



- 13 alveolars, 25 tungsten layers,
- 21.5 X_0,
- total ~185 mm Module thickness allows 30 mm between HCAL inner most surface,
- 0.8 mm PCB and/or 1.3 - 2.0 mm Sc. thickness is expected in the Model.