Design/Construction of Scintillator ECAL for ILD

25th April 2012

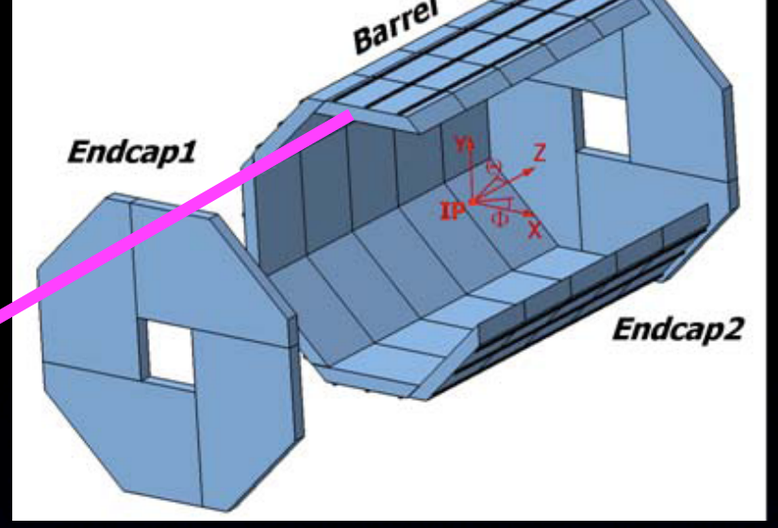
@ KILC12 Daegu Korea

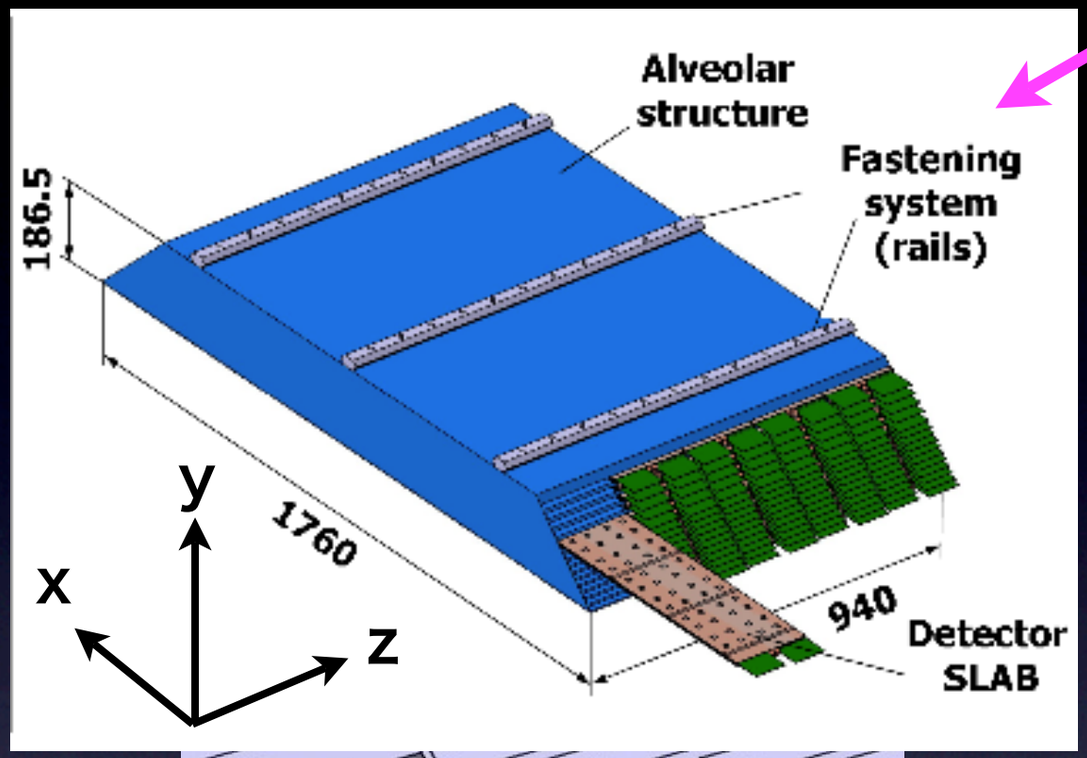
K. Kotera Shinshu University

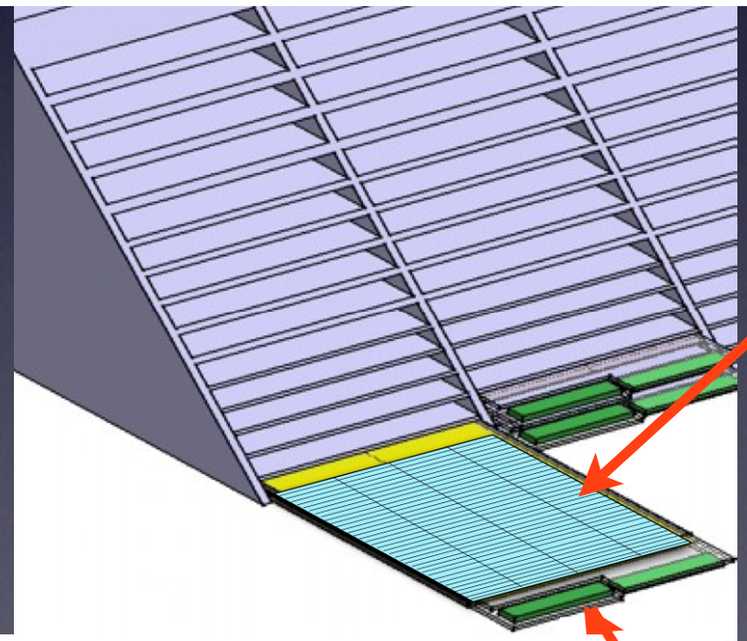
for CALICE and CALICE-ASIA

ScECAL in ILD

A module in the top stave of Barrel



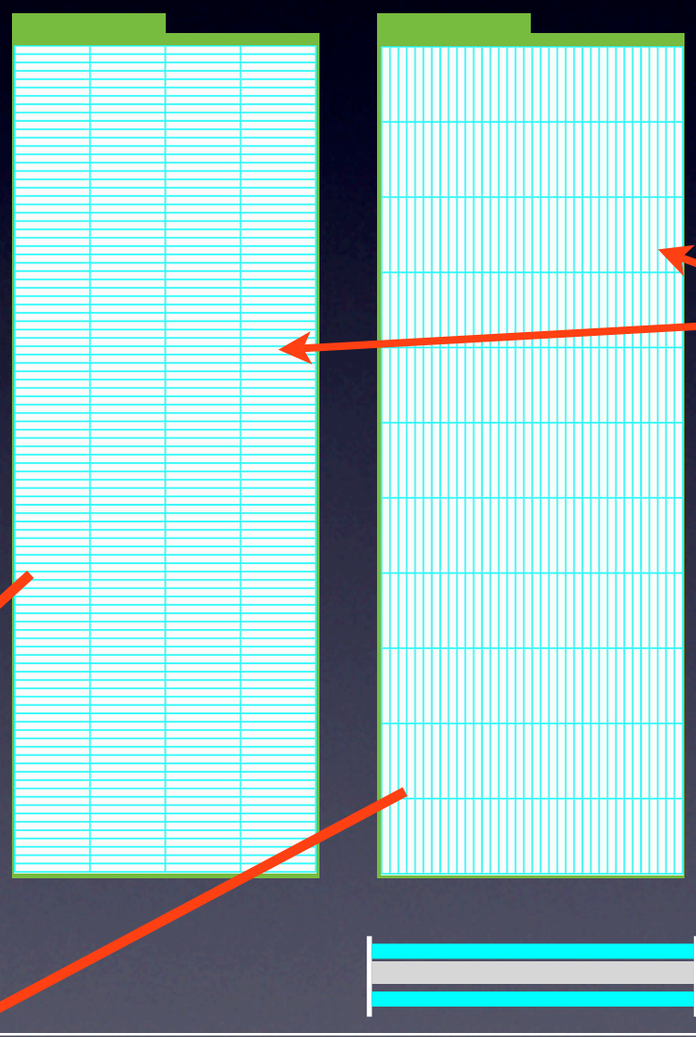


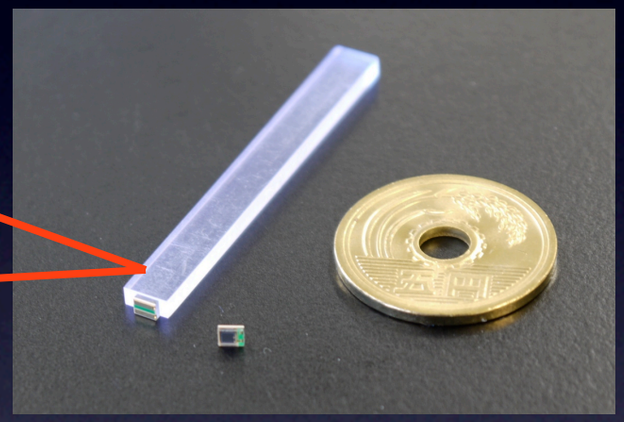


a pair of layers is inserted into the alveolar structure

fine in x

fine in z

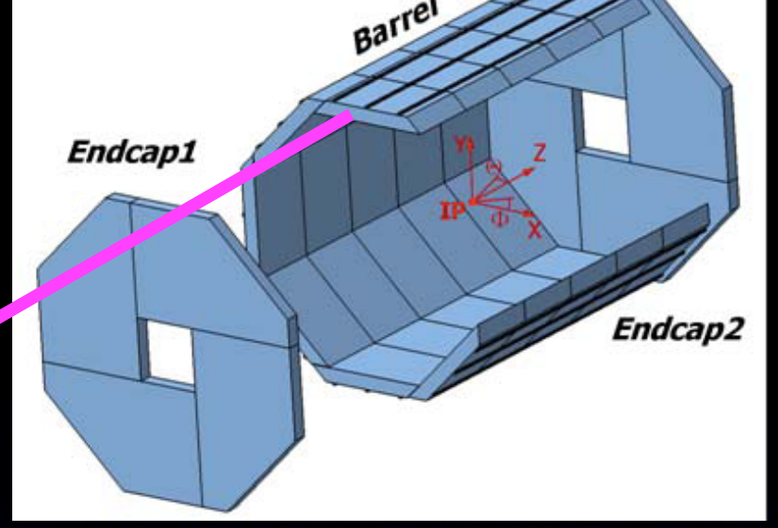


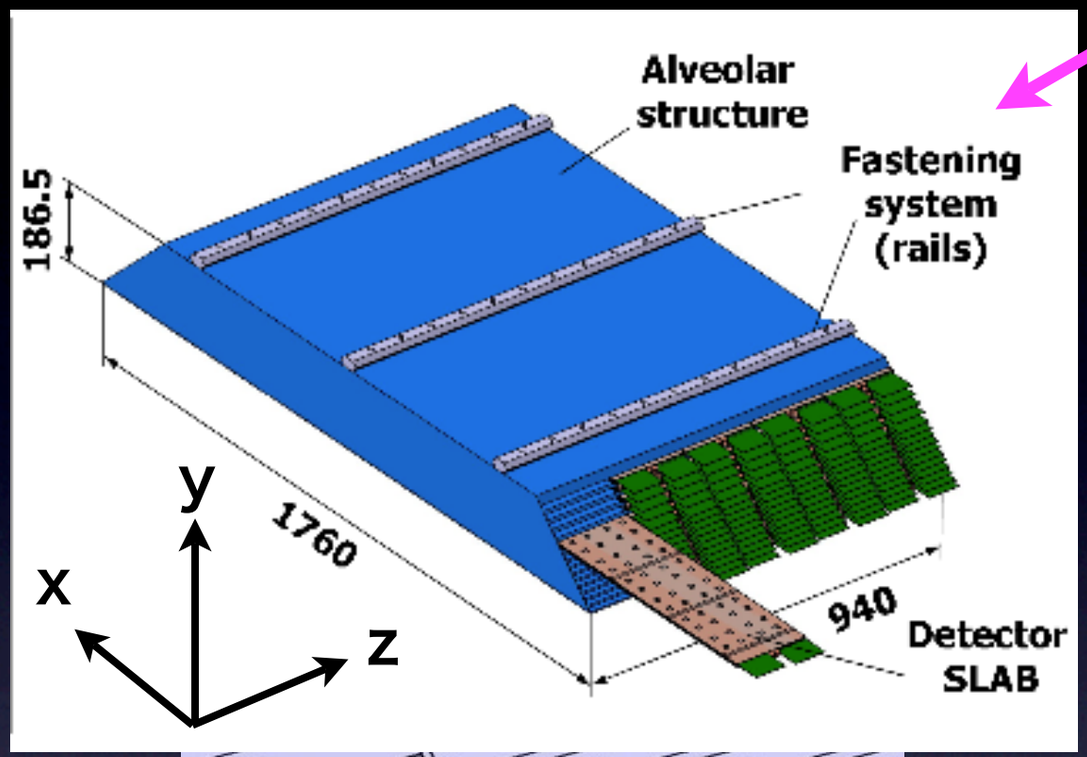


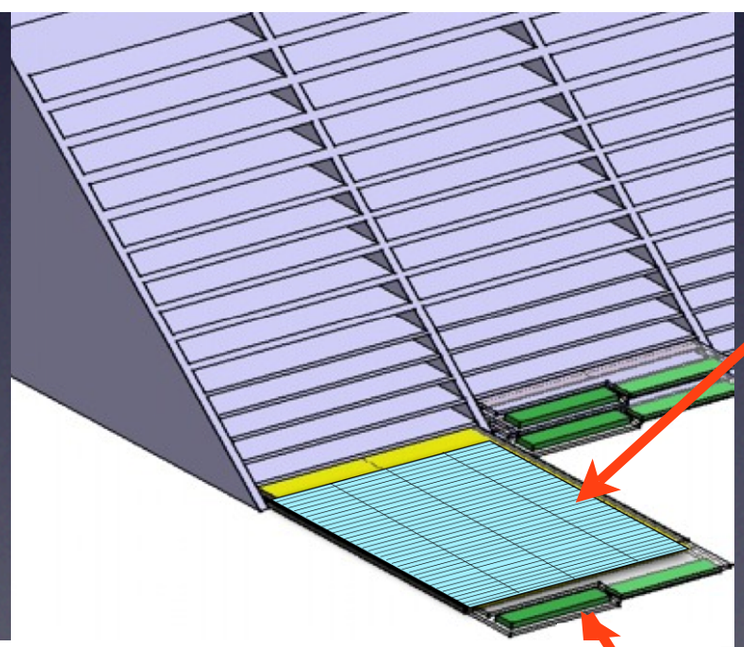
a x layer and a z layer are put back to back on the H structure W layer

ScECAL in ILD

A module in the top stave of Barrel







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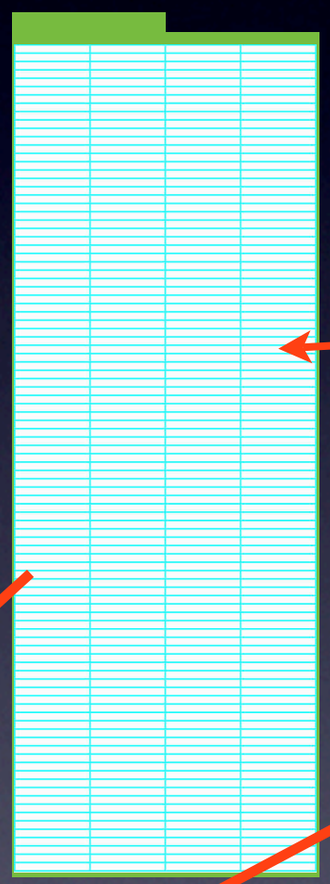
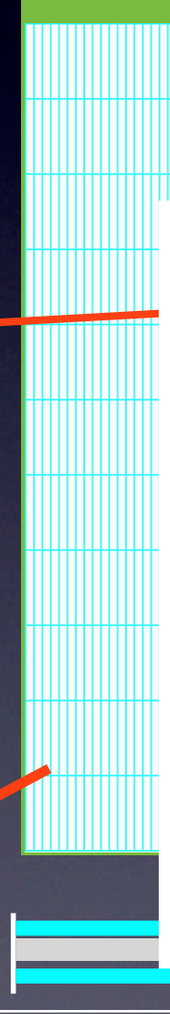
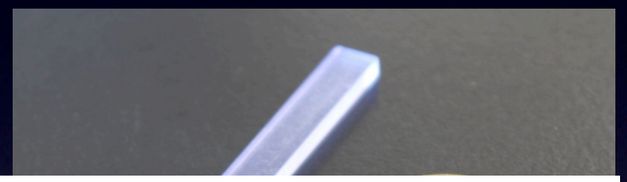
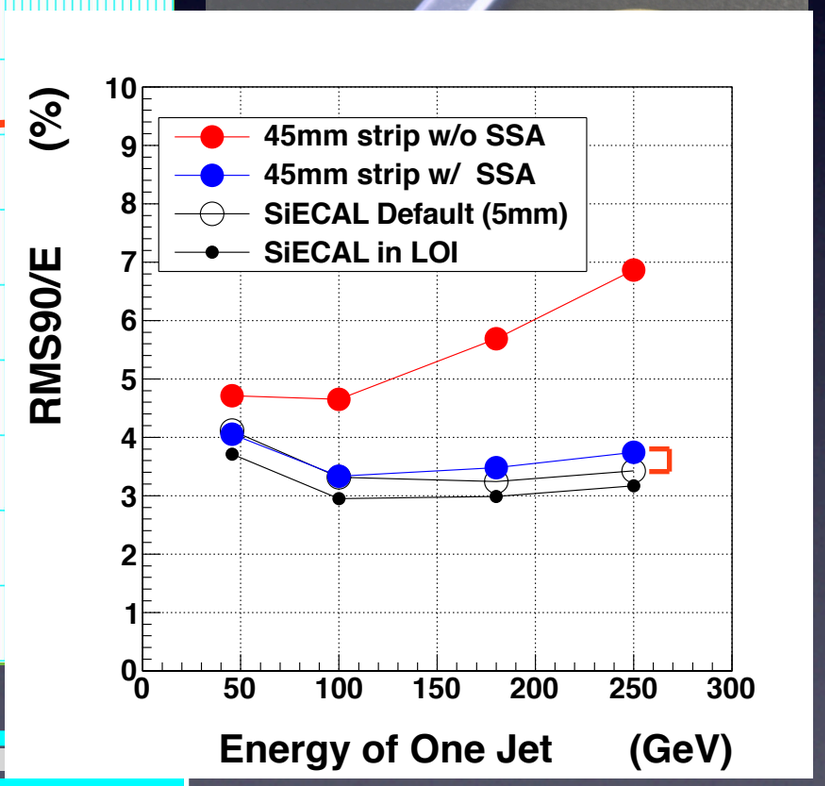


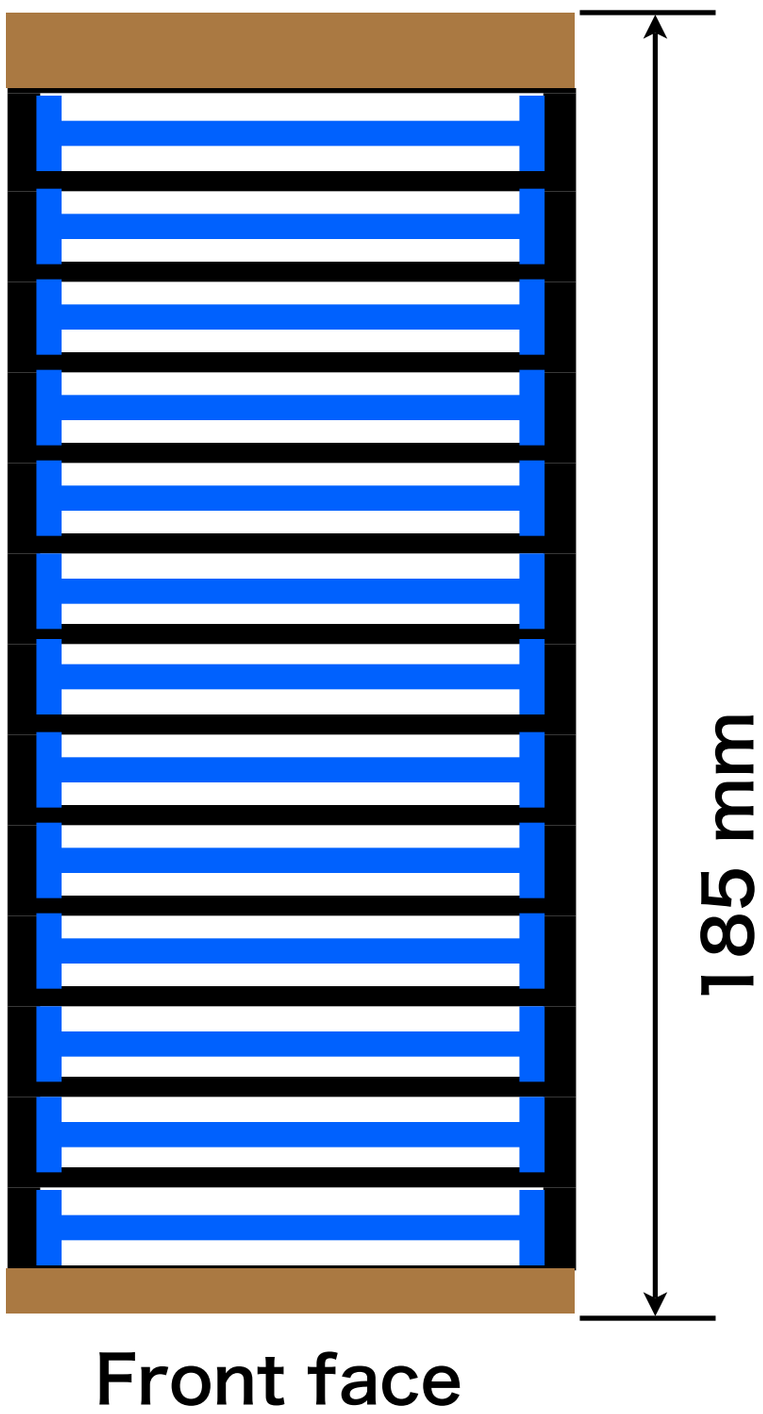




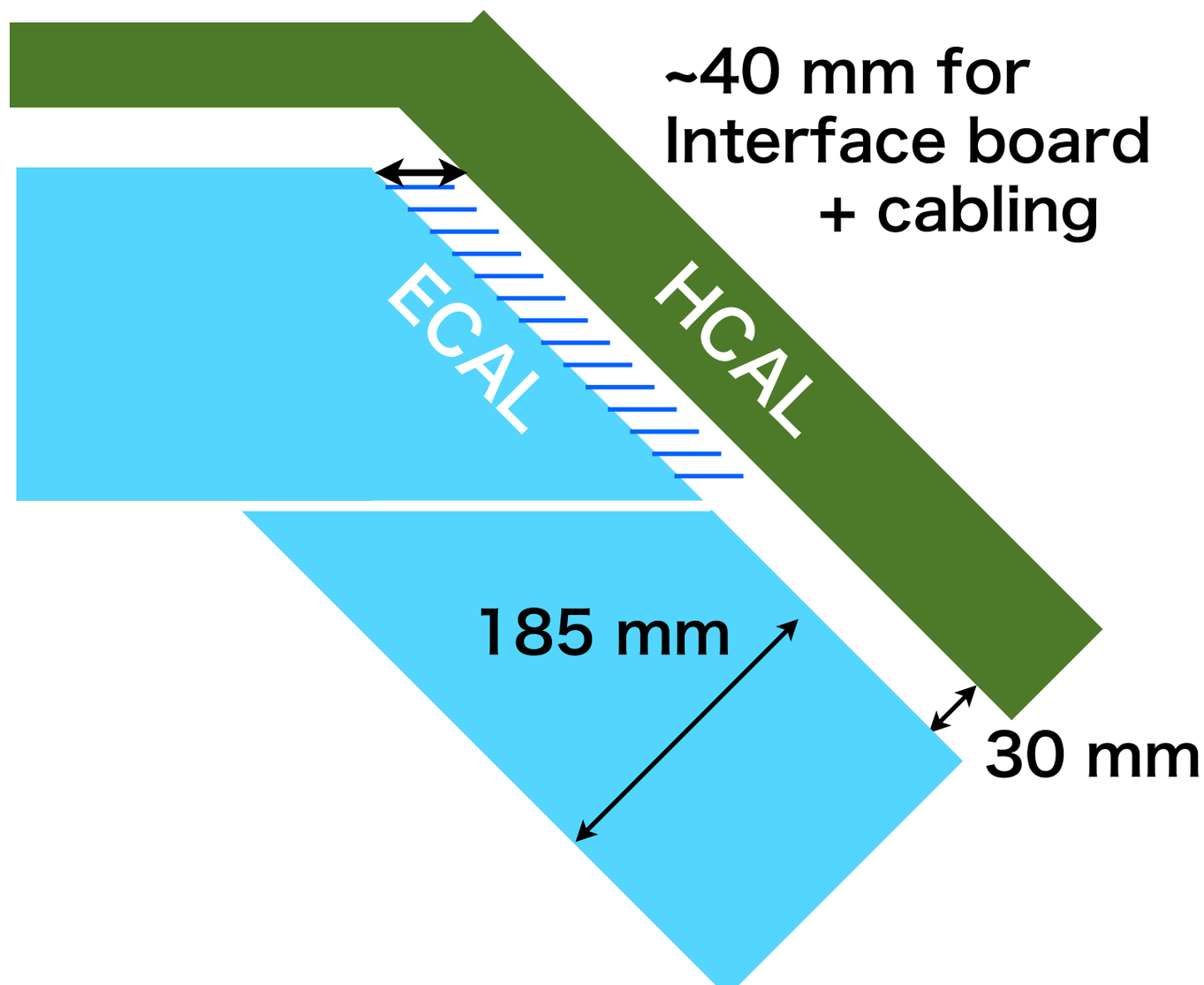


a x layer and a z layer are put back to back on the H structure W layer

Module thickness and Gap in ILD

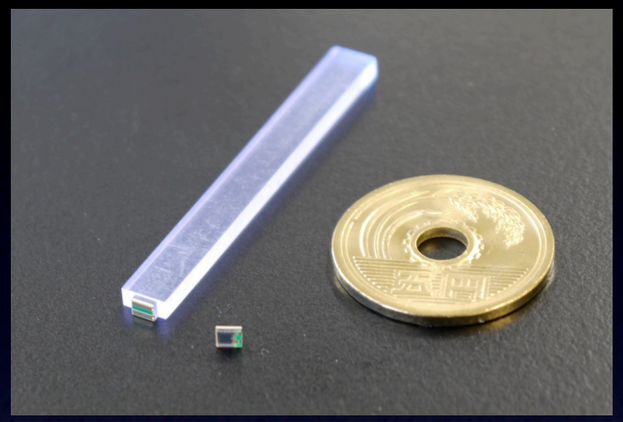


- 25 tungsten layers, 13 alveolars,
- 21.5 X_0,
- total ~185 mm Module thickness allows 30 mm between HCAL inner most surface,

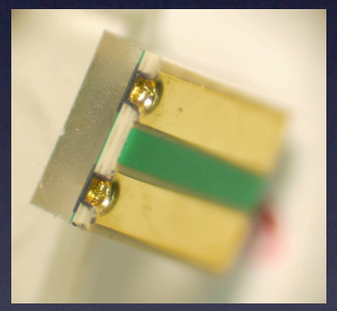


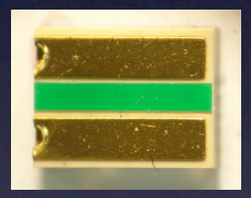
Scintillator-MPPC unit on PCB

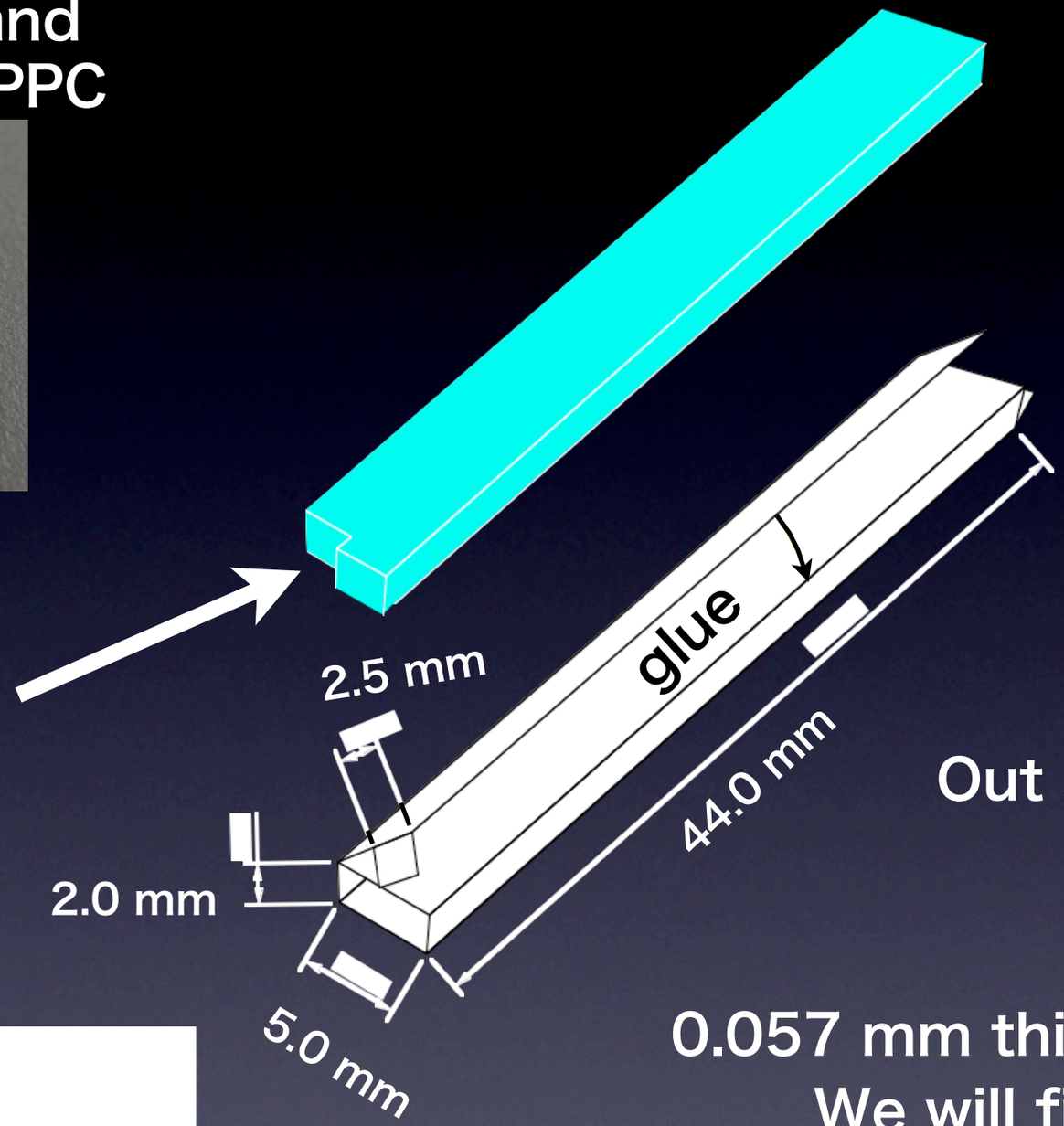
Scintillator strip and
Surface Mount MPPC



Backside of MPPC

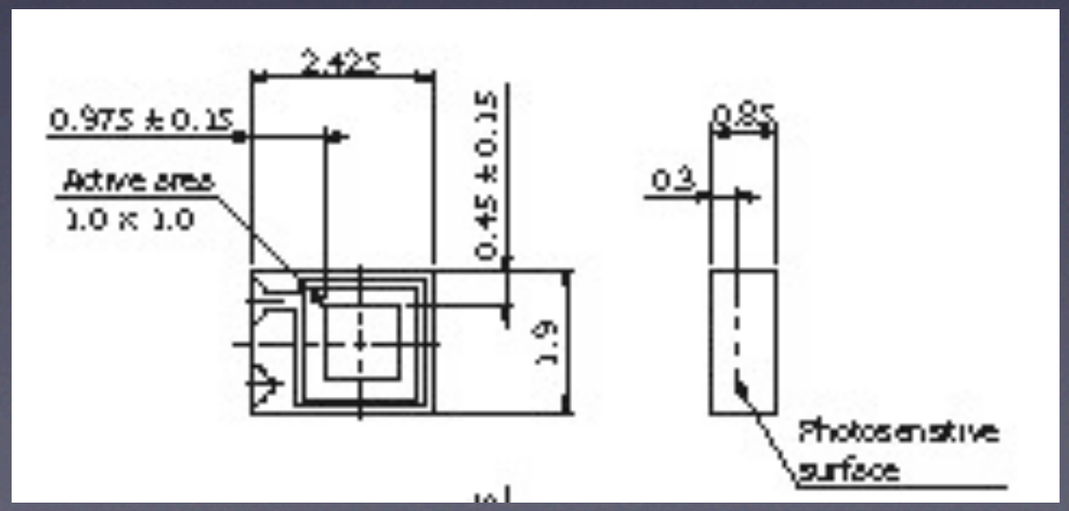






Out side scales

0.057 mm thick reflector
We will find thinner film

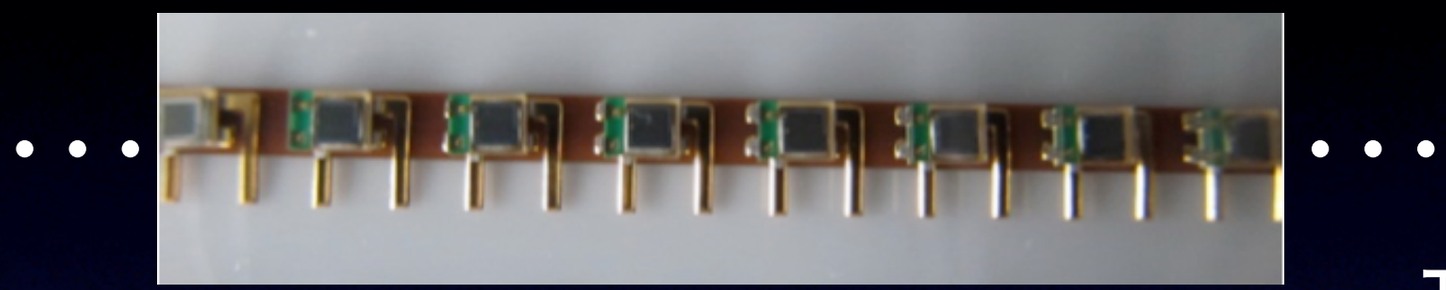


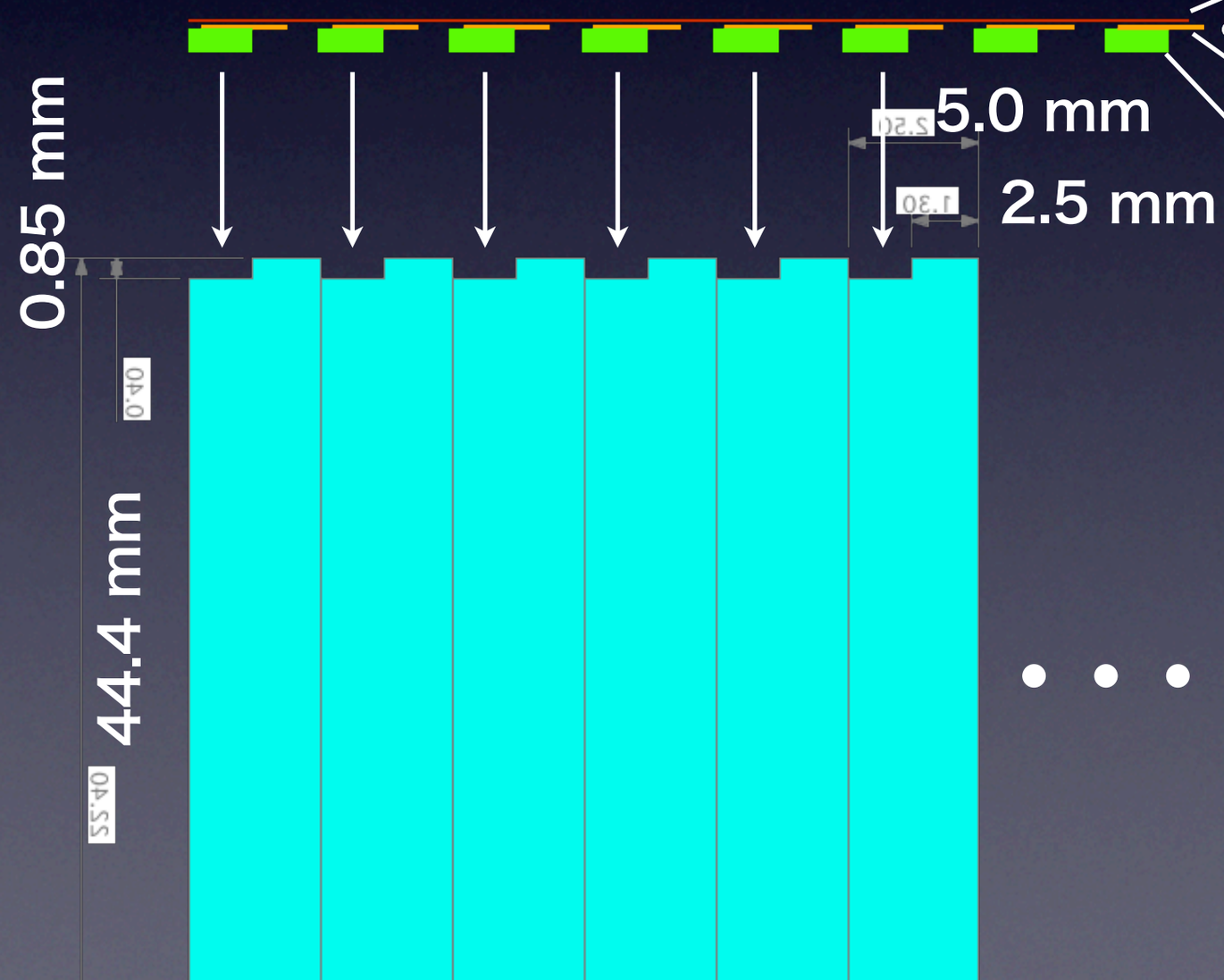
Hamamatsu developing
more small package now

→ 1.4x1.4x0.6mm³

Stacked channels

36 MPPCs soldered on electrodes
on a polyimide ribbon



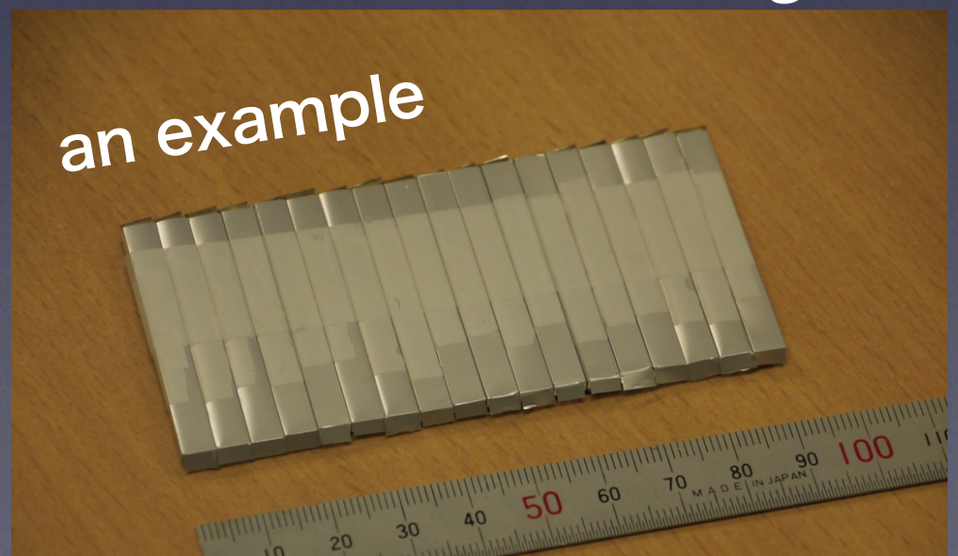


Thickness of ribbon: 0.06 mm

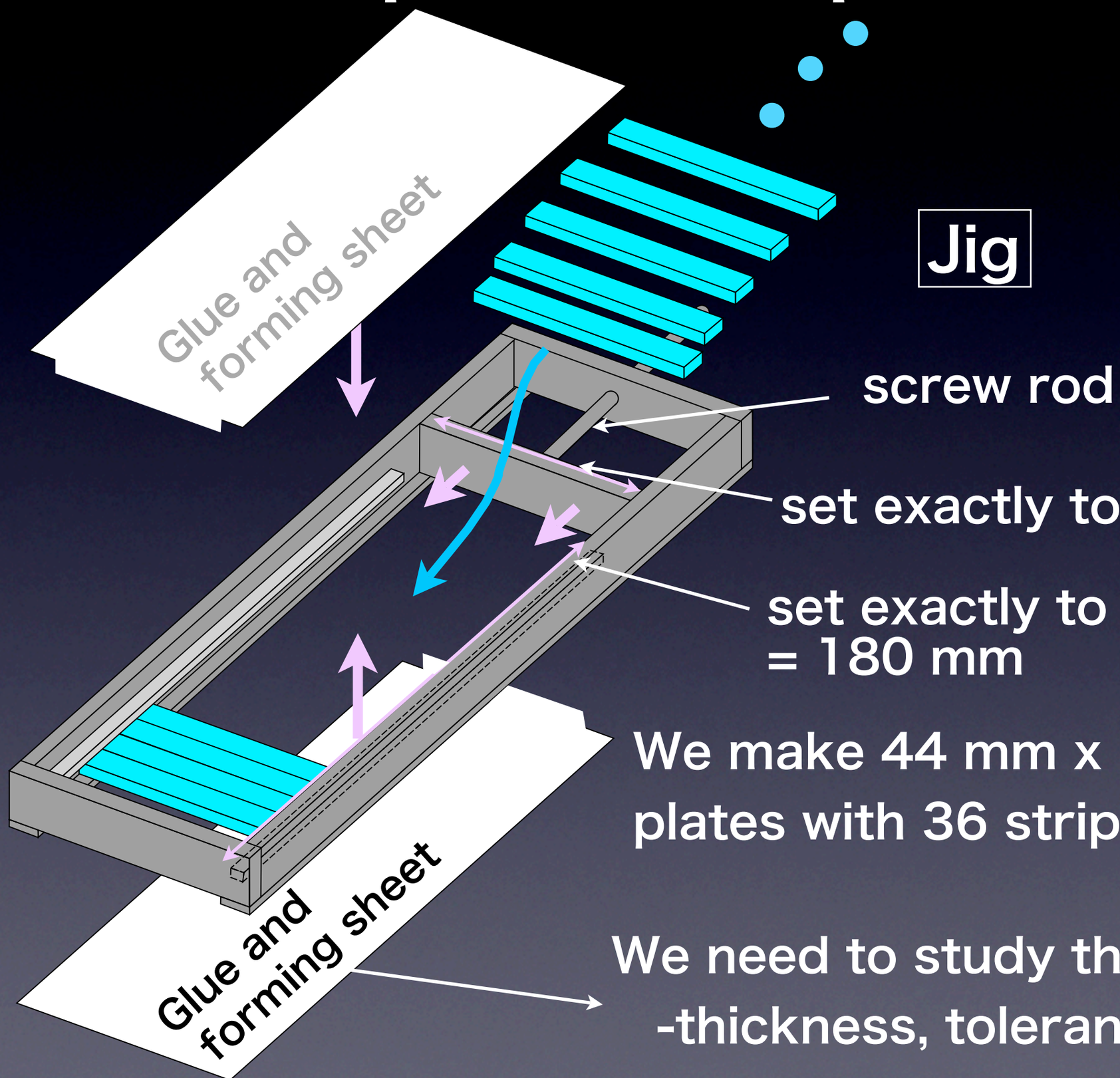
Thickness of electrode: 0.5 mm

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



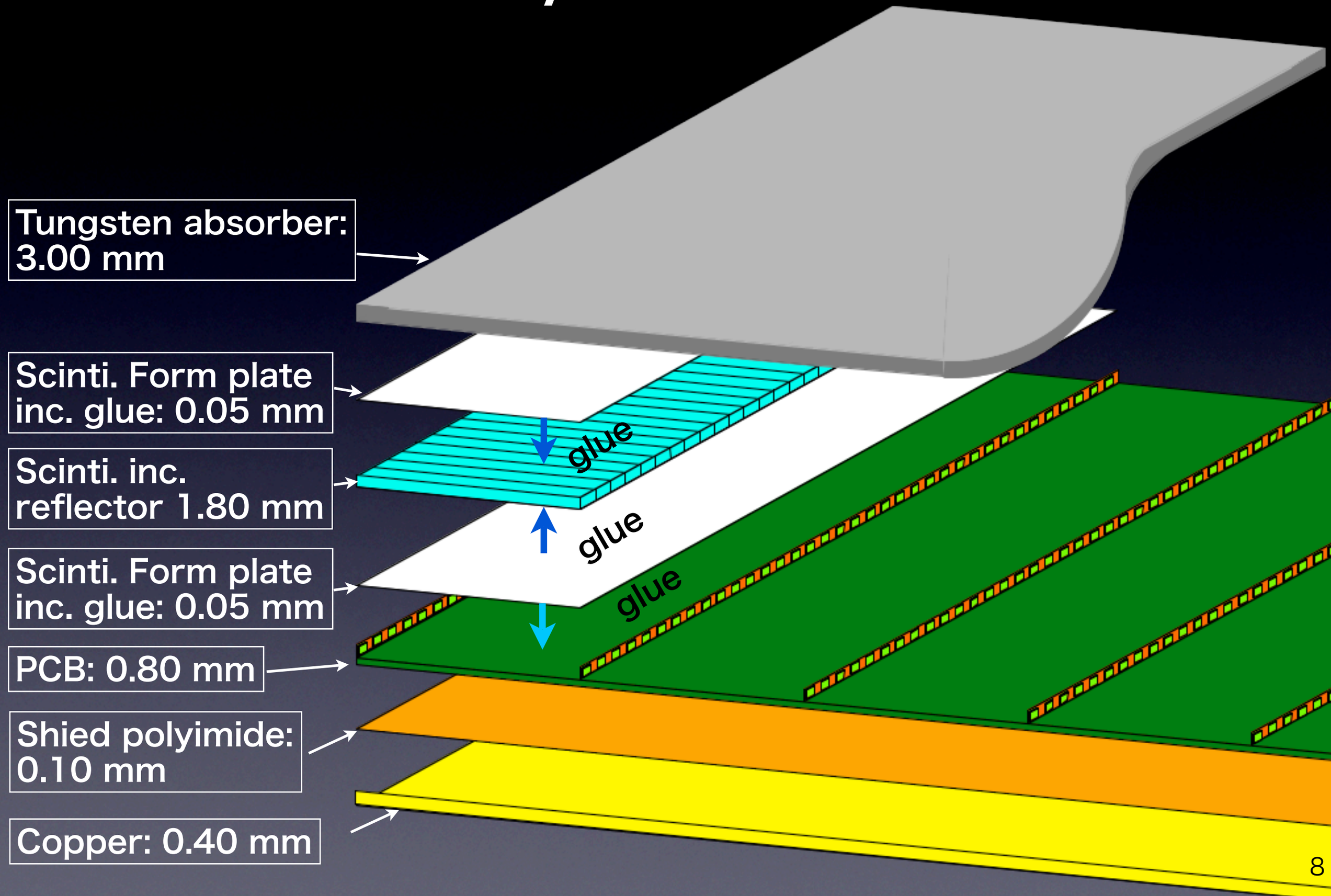
set exactly to strip length, 44 mm

set exactly to strip width x 36 = 180 mm

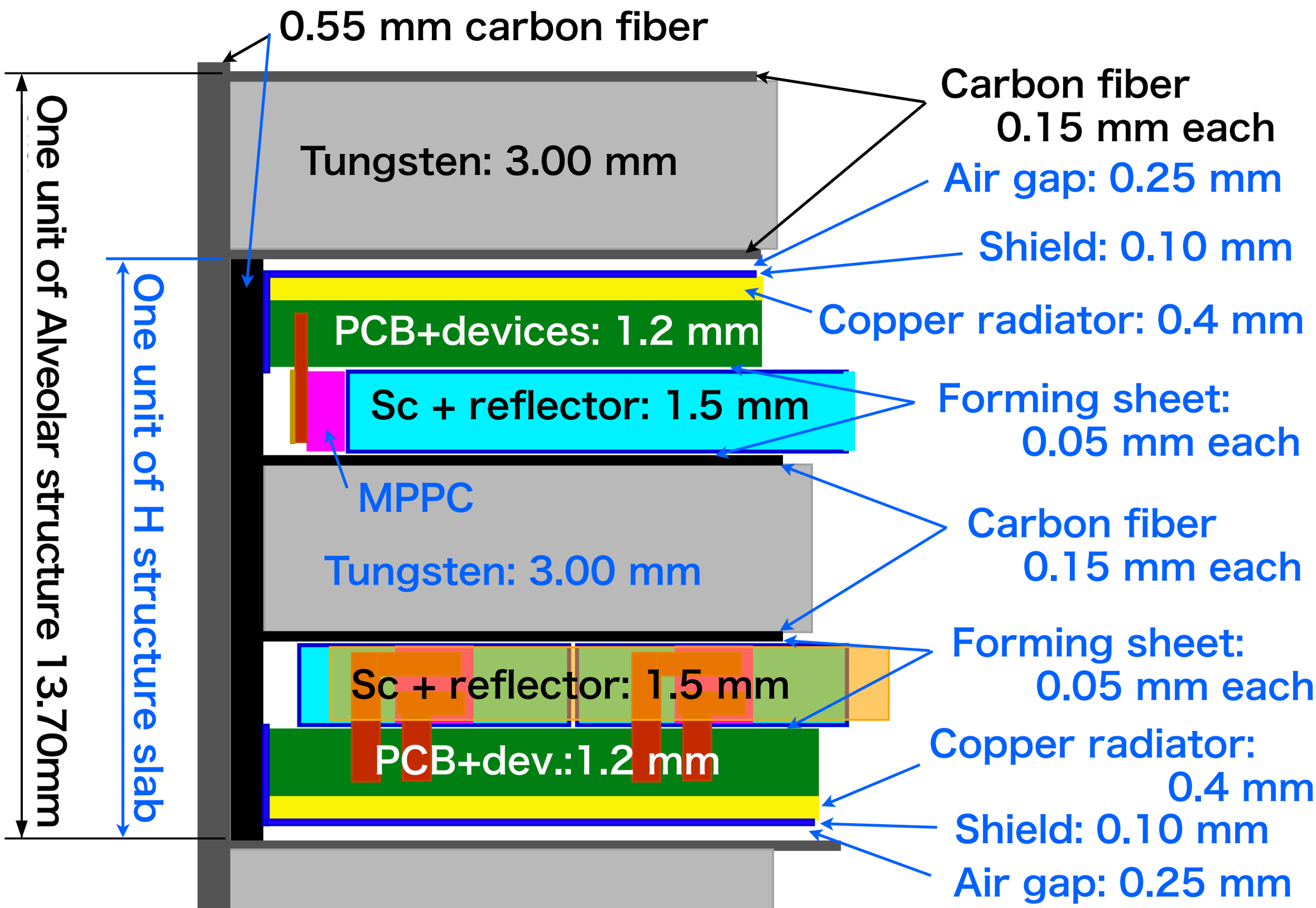
We make 44 mm x 180 mm scintillator plates with 36 strips in each.

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

In a alveolar/ without Carbon fiber

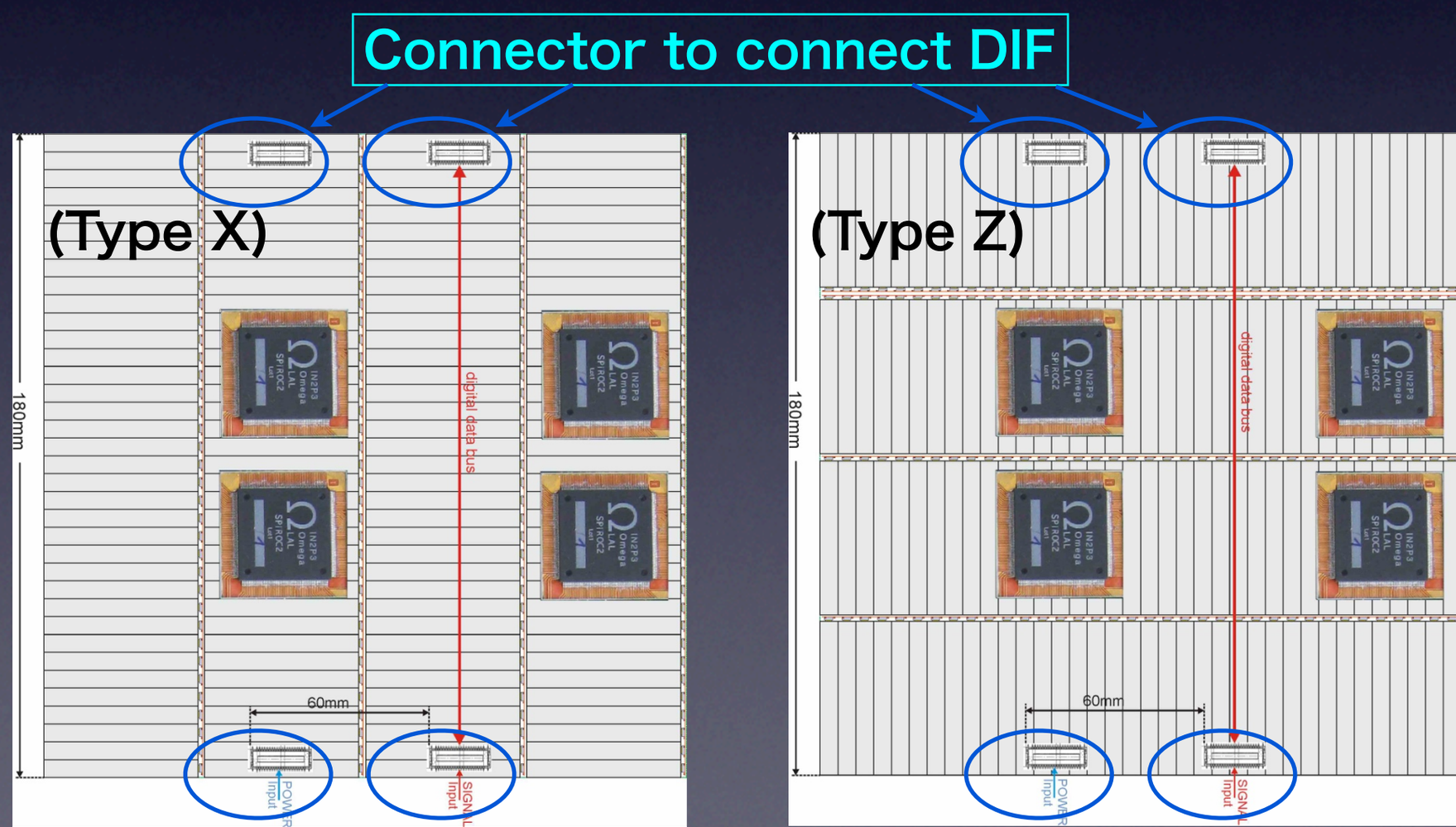


One unit of alveolar (a pair of Sc)



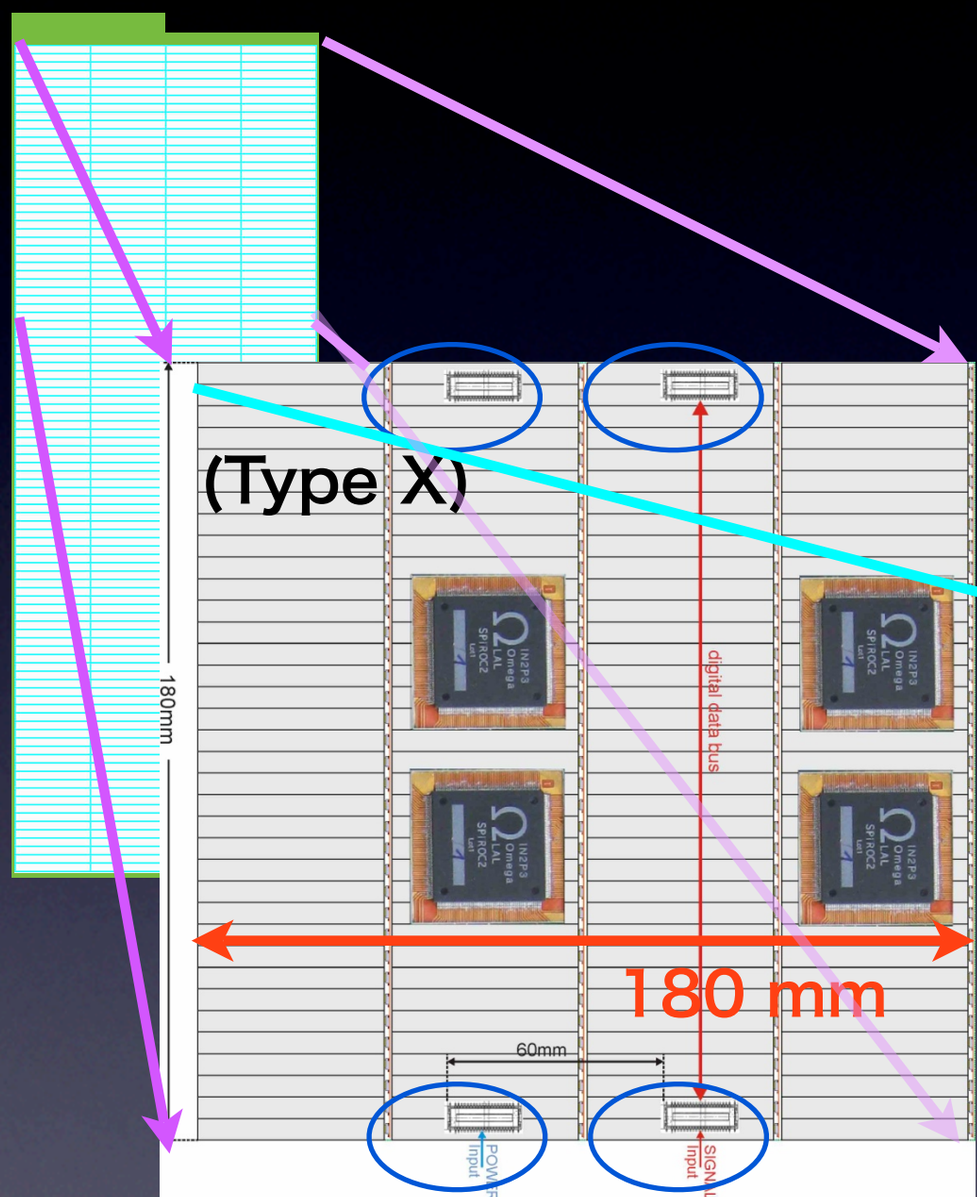
Technical prototype TB Sep. 2012 @ DESY

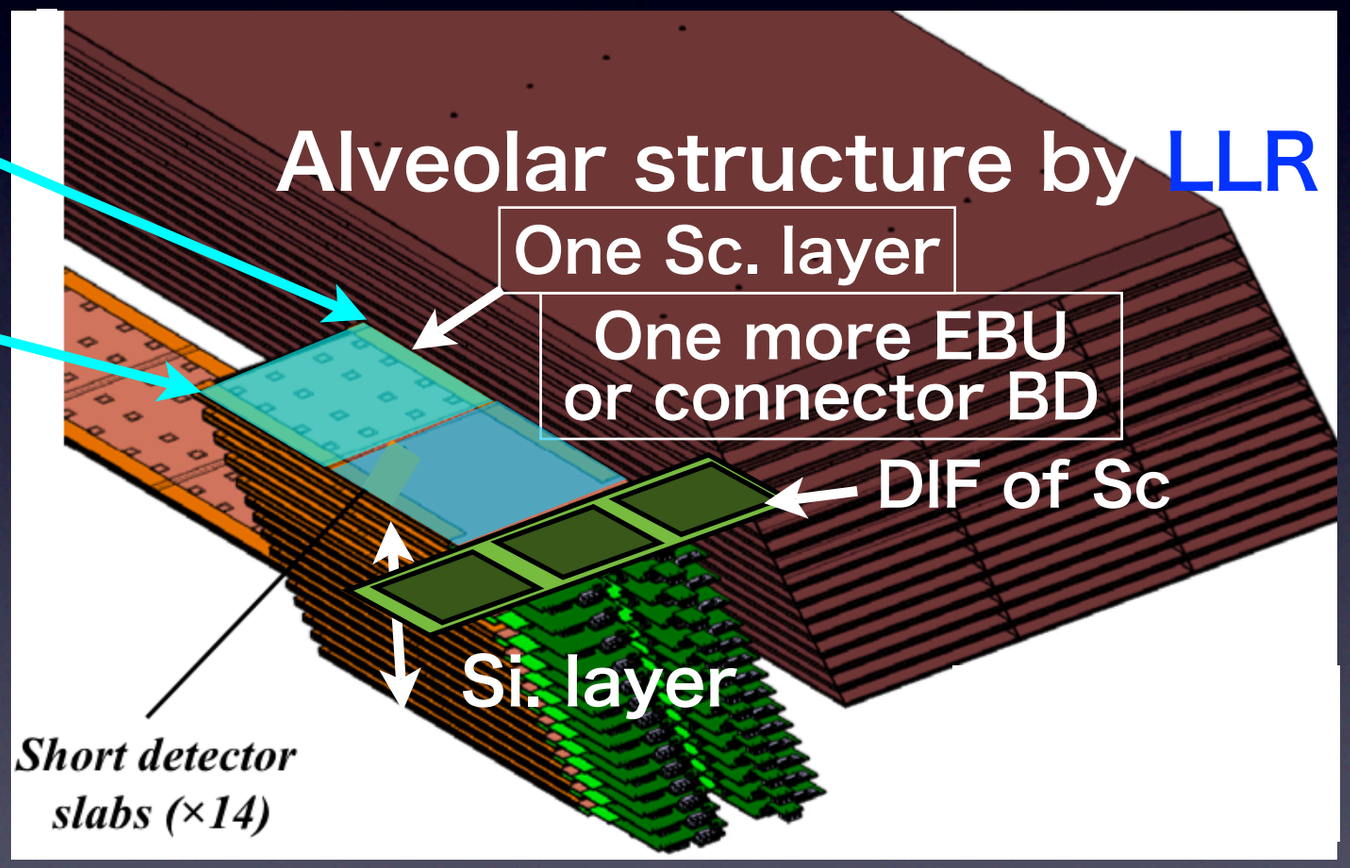
- U structure (LLR France) instead of H structure, since slab thickness cannot be achieved to be thin enough.
- EBU: using HBU (PCB for AHCAL) technology will be developed at DESY. An EBU has four SPIROC2.
- 36 x 5 mm strips in a row,
- 4 rows are on one unit of EBU,
  - Two types of EBU



Plan for Technological plototype

TB Sep 2012 @DESY



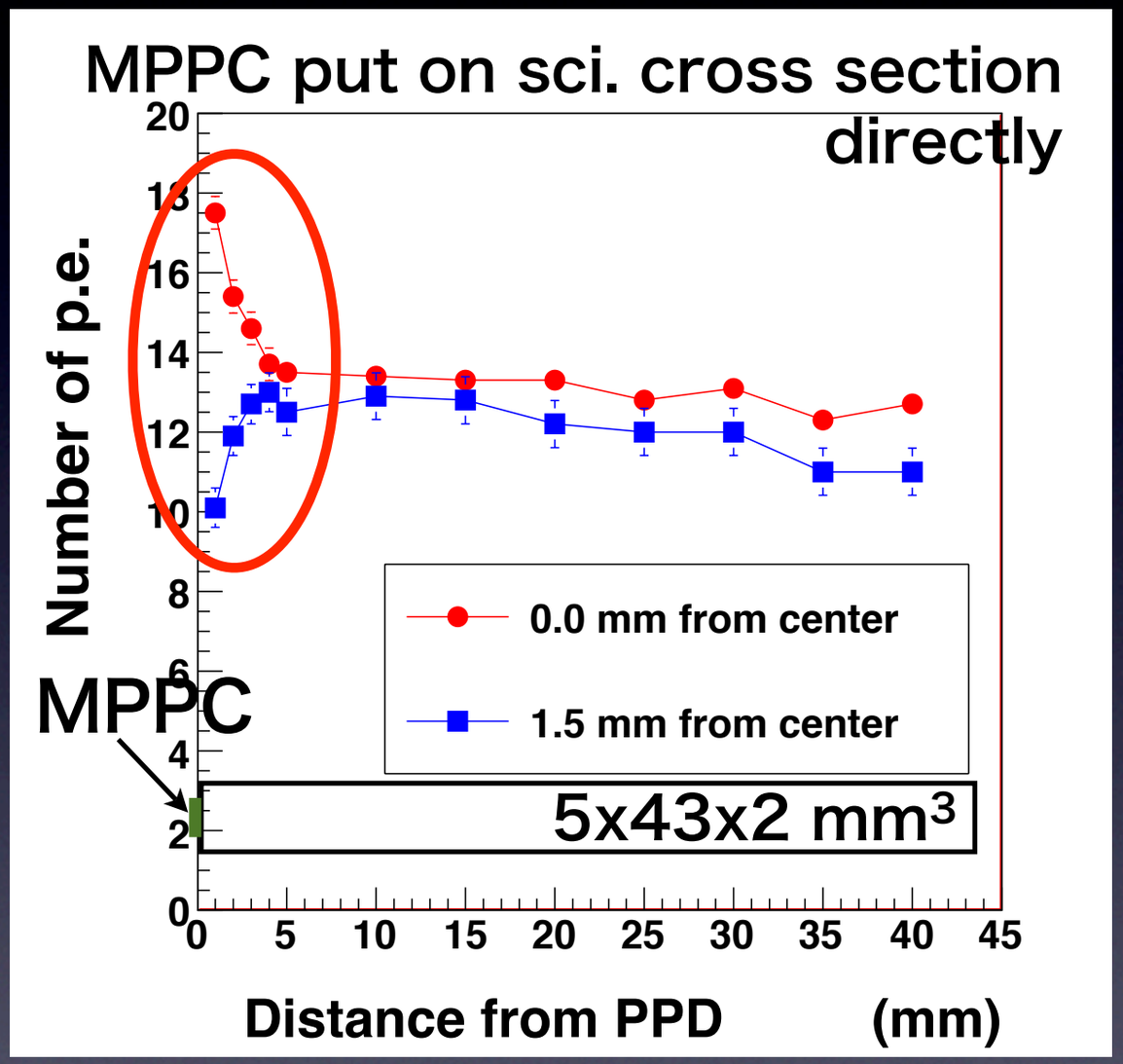


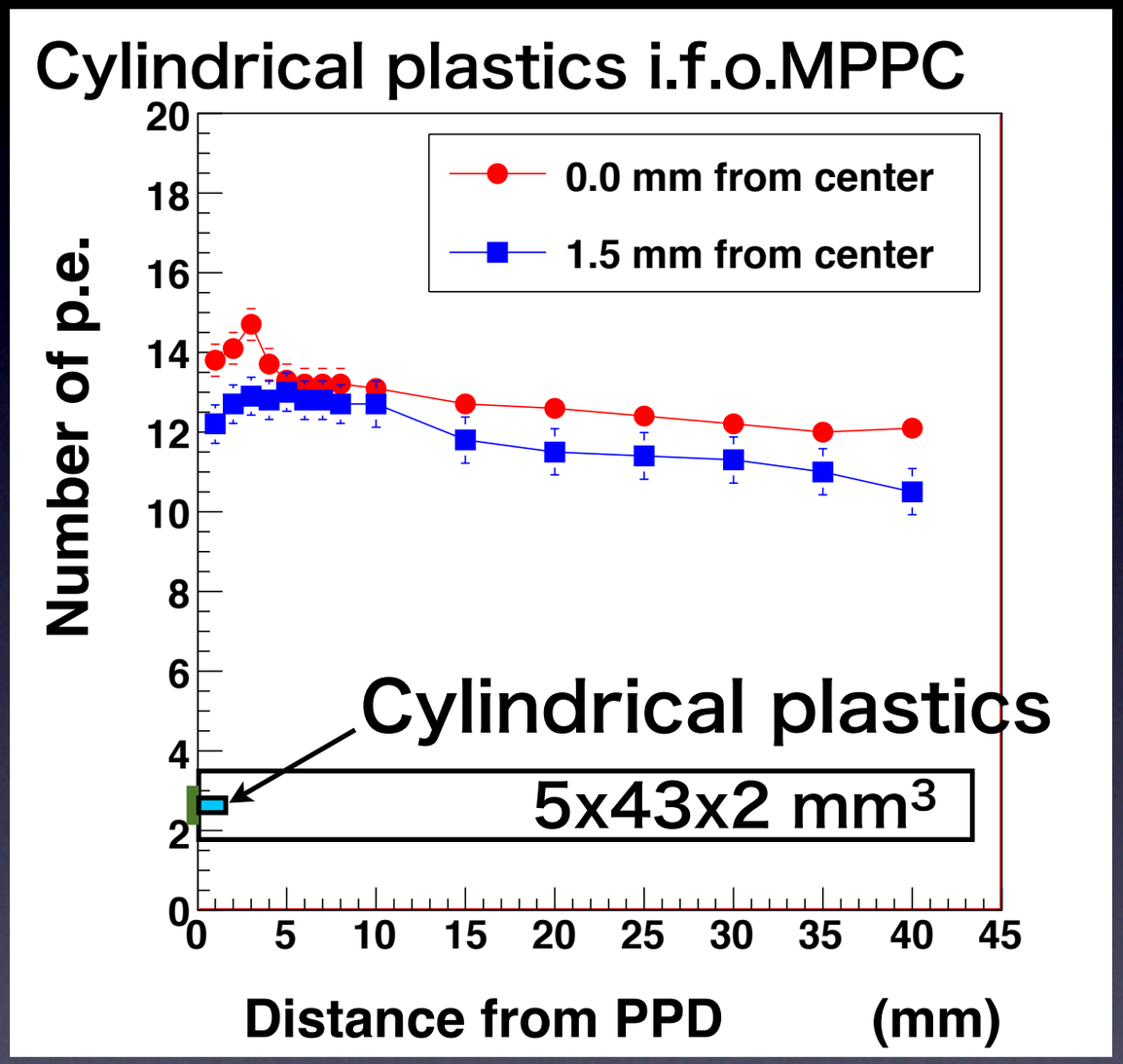
Requirements to Scintillator-MPPC

- We need to develop Scintillator-MPPC strip unit which has;
  - good uniformity of response to have good energy resolution,
  - 10 x 45 mm^2 x 3 mm ▶ 5 x 45 mm^2 x 2 mm

  - we cannot use WLS fiber for 5x2 mm^2 cross section of scintillator anymore ➡ Direct coupling of MPPC/Strip
  - at least seven p.e. at MPPC by MIP, considering noise effect from 10^7 channels.
  - reduction of dead space from MPPCs, and
  - rigidity of set of units on PCB.

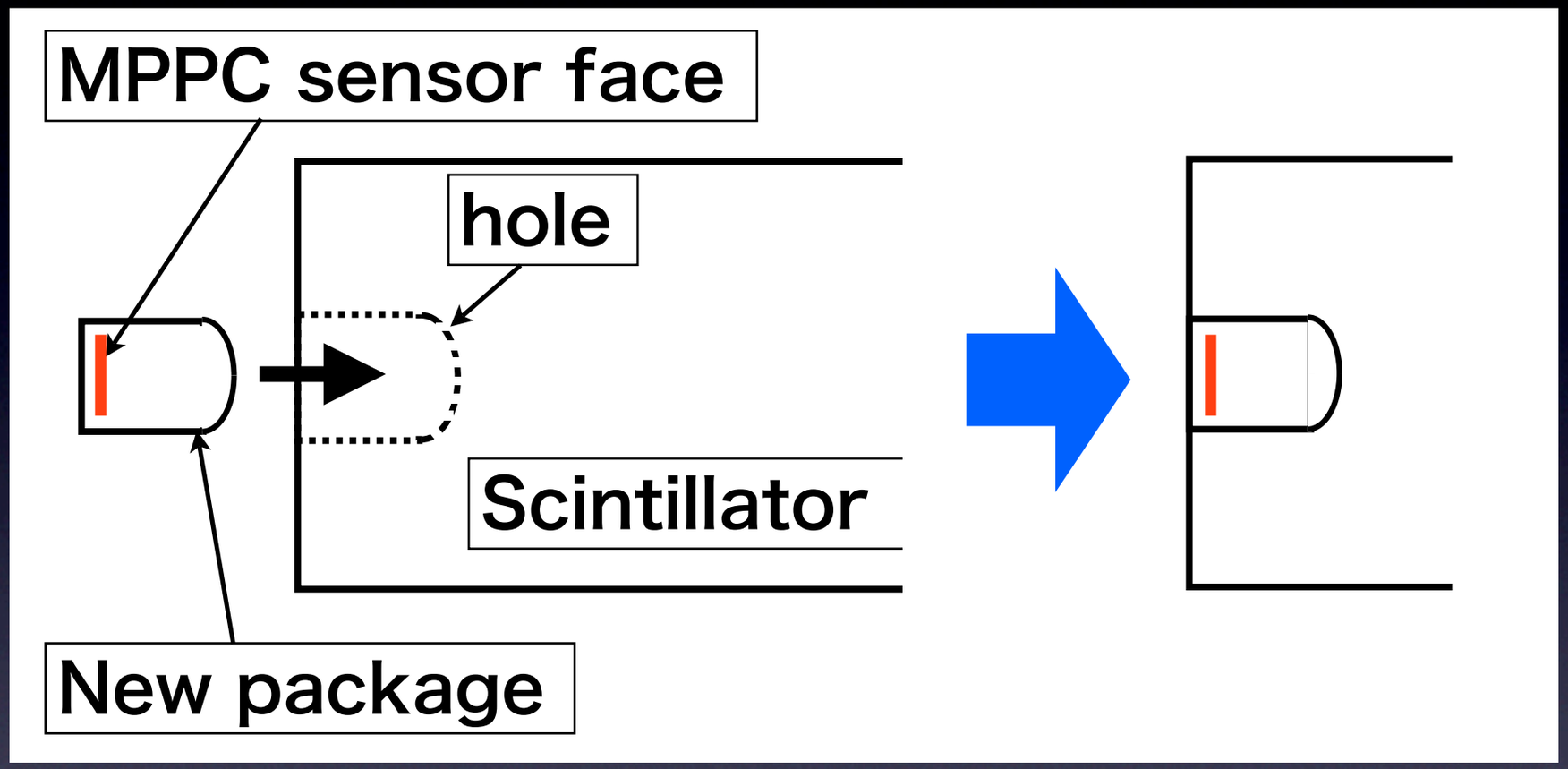
A method to keep uniformity





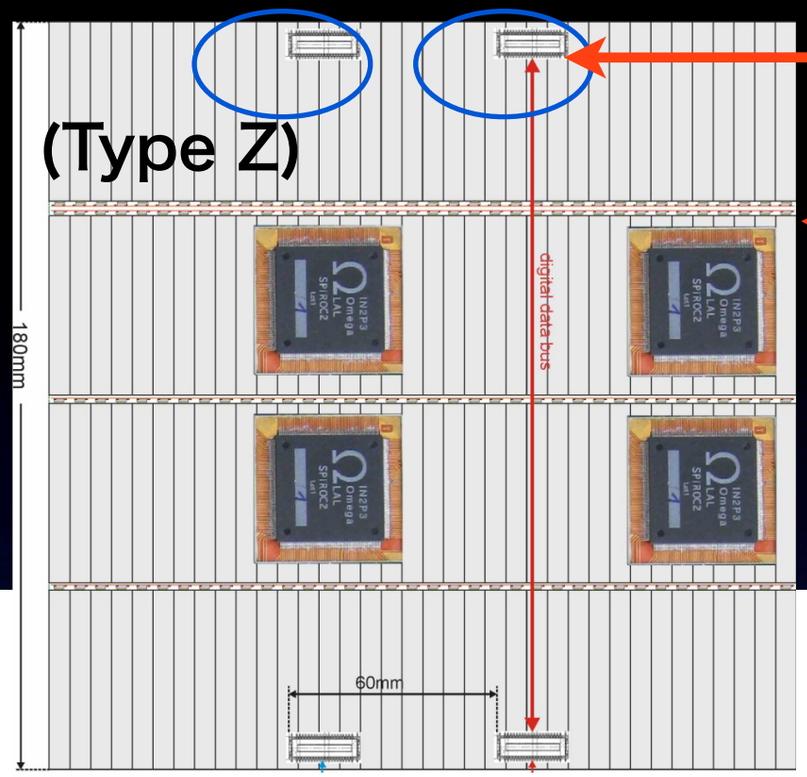
- Direct readout makes large fluctuation of response in front of MPPC
- Plastic cylinder in front of MPPC potentially improves uniformity.

Acrylic socket MPPC package

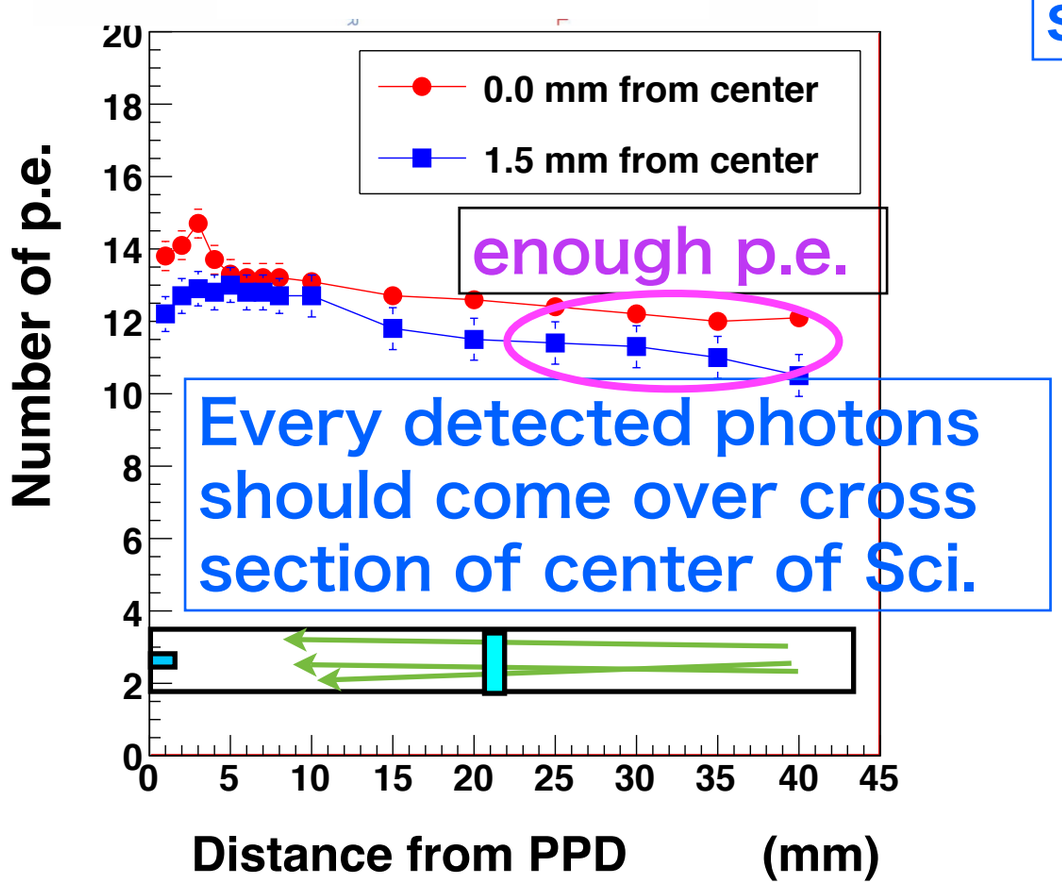


We need to optimize the shape of socket to have uniform response.

Another idea ... ‘seeing from the bottom’

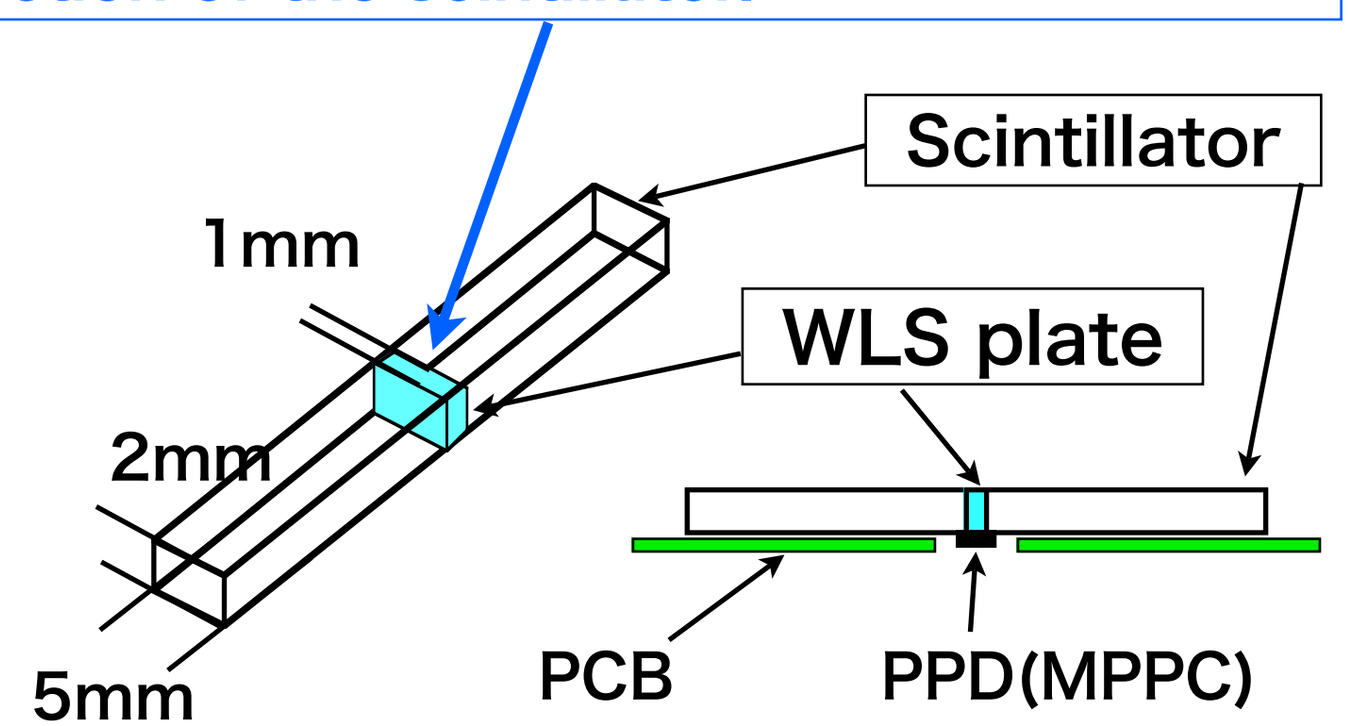


-To avoid flat cable of connectors goes over MPPC pins,
-strips only in this row are flipped so that the dead volume from MPPC becomes doubled than others
-standing MPPC is not stable on PCB



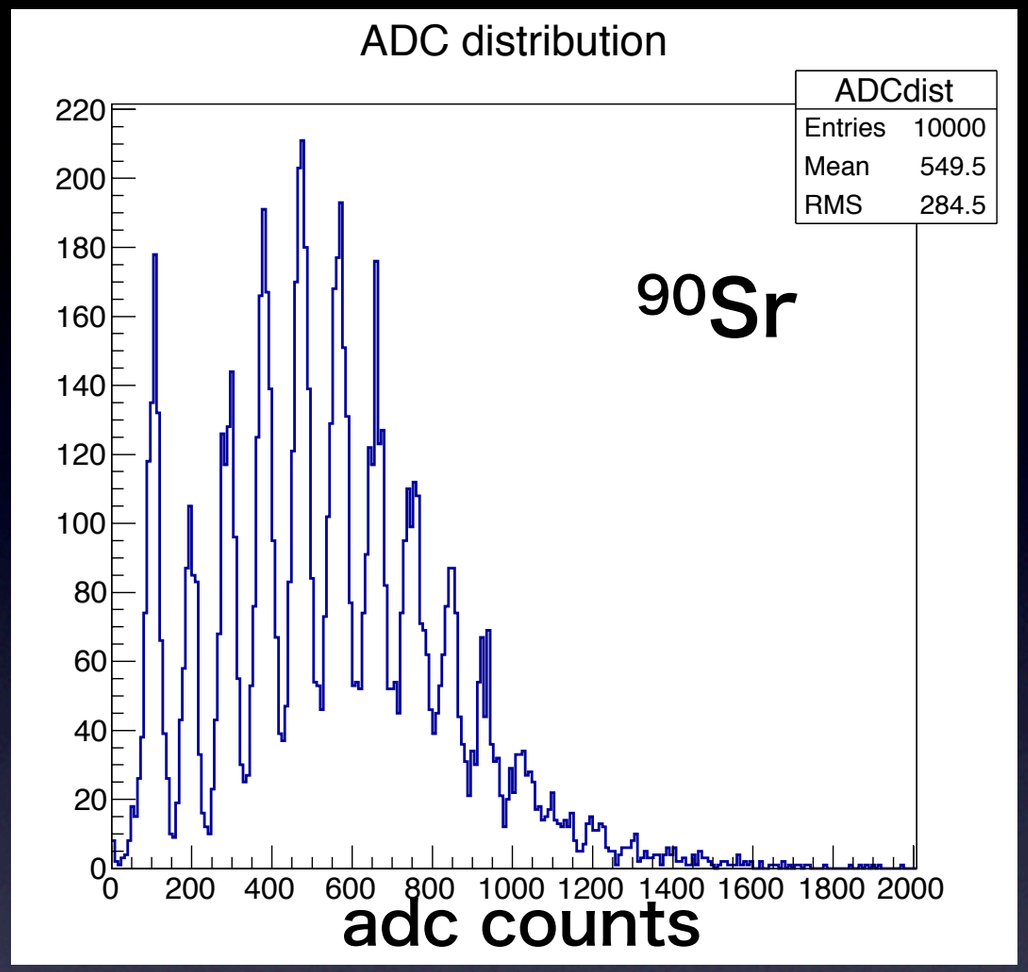
Every detected photons should come over cross section of center of Sci.

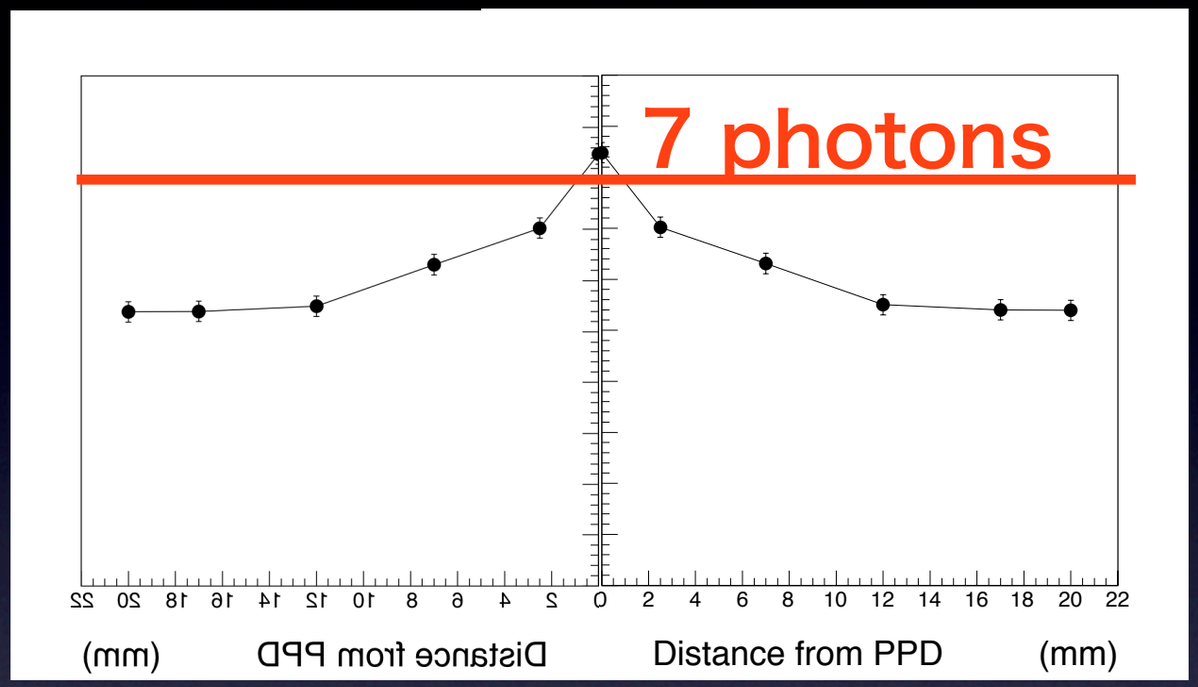
We can effectively catch the photons here by using something covering whole cross section of the scintillator.



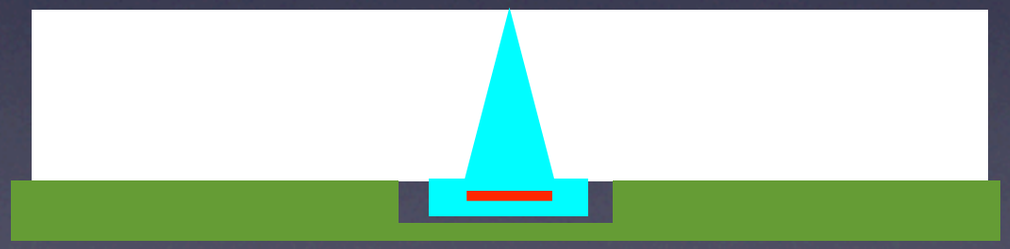
note:
this still has 1 mm width dead space

First results of “seeing from the bottom method”





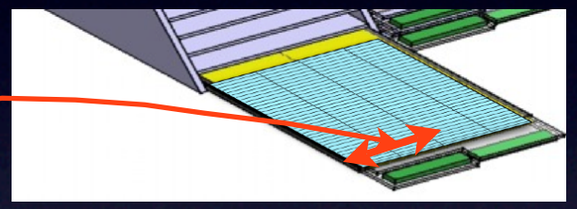
From the first result of trial,
- we need more light,
- we need more flatness.



MPPC package-WLS plate unification

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.
- What we need to overcome
  - DAQ interface of 180/2 mm x 40 mm dimension for each layer,
  - ~1 mm PCB, including ASIC and electric parts etc
  - Scintillator/MPPC unit having:
    - Good uniformity of response.
    - more than 7 p.e. for MIP
    - reduce dead volume from MPPC
    - stable on PCB



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

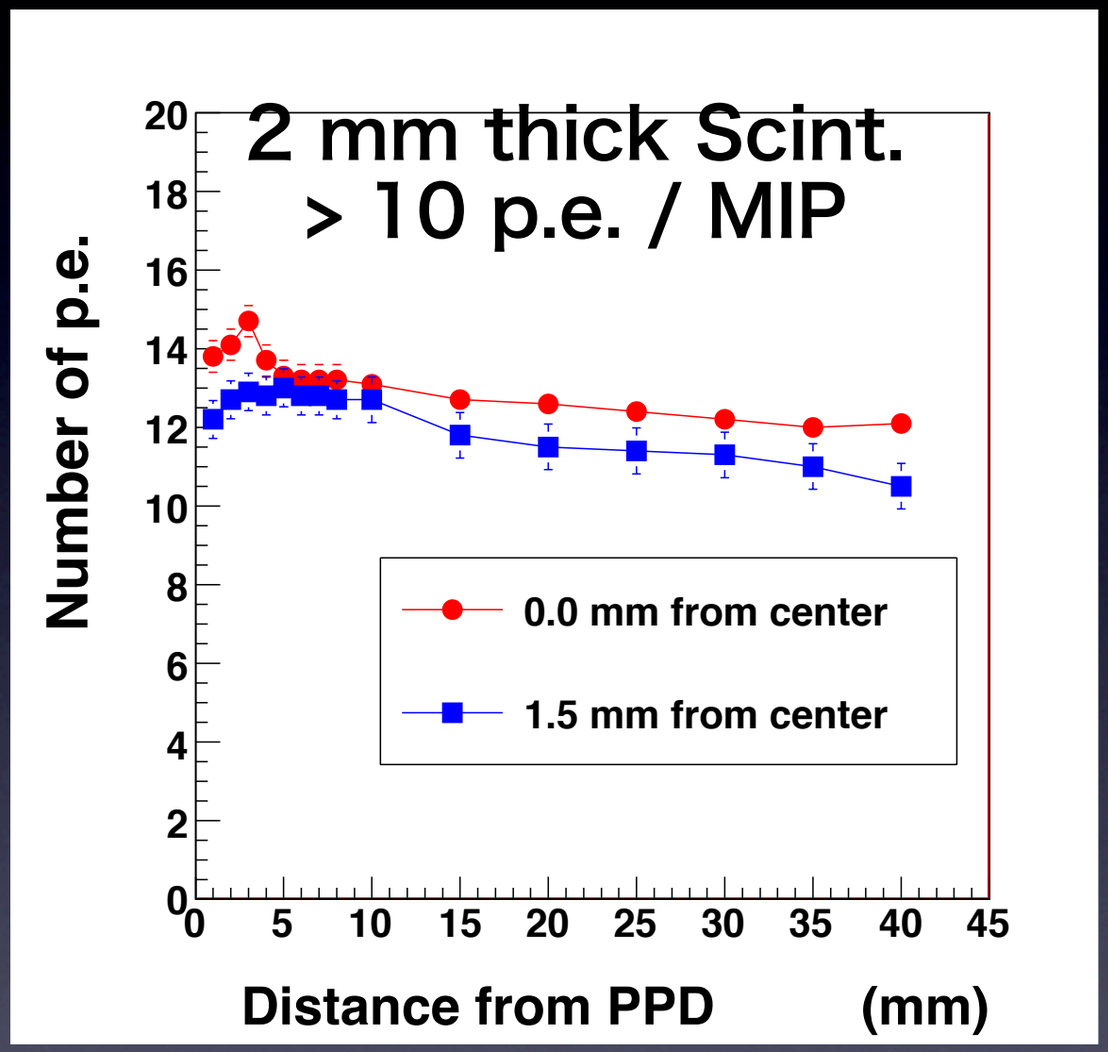
ScEcal Thickness Calculation

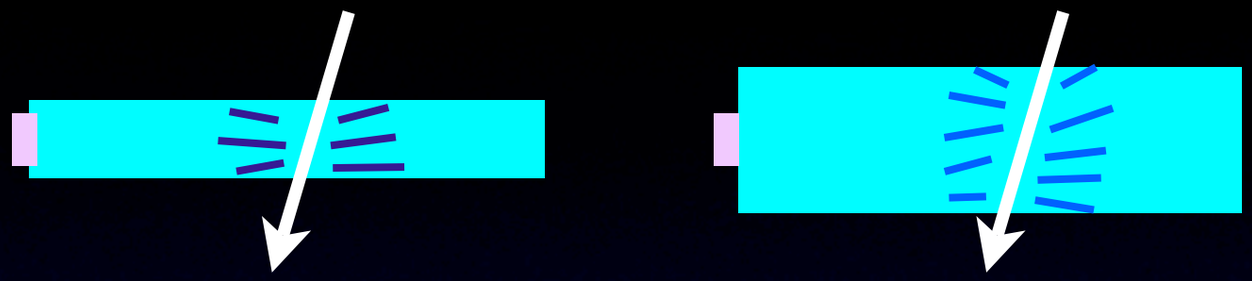
Thickness (mm)

				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

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.

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