

EC AND SPD UPDATES

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SoLID Collaboration Meeting



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Outline

- Introduction
- Progress
- Measurement & Assembly
- First Pre-prototype
- Outlook

INTRODUCTION

SoLID Coverage

• Electromagnetic Calorimeters (EC) are used in PVDIS, SIDIS and J/ψ .

	PVDIS FAEC	SIDIS FAEC	SIDIS LAEC
z (cm)	(320, 380)	(415, 475)	(-65, -5)
Polar angle (degree)	(22,35)	(7.5,14.85)	(16.3, 24)
Azimuthal angle		Full coverage	
Radius (cm)	(110, 265)	(98, 230)	(83, 140)
Coverage area (m ²)	18.3	13.6	4.0



Layout Of EC Modules

- The view of PVDIS FAEC (portion) along the beam direction
- 147 modules/30-degree wedge of the FAEC for the PVDIS configuration.
- The cross section of module is hexagon-shaped/ area is 100 cm²/ side length is 6.25 cm
- Modules from PVDIS FAEC will be split and rearranged into SIDIS FAEC and LAEC



Stucture Of EC

- Preshower: 2 X₀ lead + 20 mm plastic scintillator, WLS fiber embedded in scintillator
- Shower: shashlyk module (0.5 mm lead + 1.5 mm scintillator + 0.1 mm paper sheet ×2) ×194, WLS fiber ×96 penetrating layers longitudinally
- Overall: 20 X_{0} , energy leakage is less than 2%



PROGRESS

Members From SDU & THU

More members from SDU and THU groups contribute to the EC research.
SDU group: involved in SoLID EC since 2014 Members: Cunfeng Feng (Prof.), Jianbin Jiao (Assoc. Prof.), Ye Tian (Grad.)
THU group: involved in SoLID EC since 2015 Members: Yi Wang (Prof.), Chendi Shen (Grad.), Xiwei Wang (Grad.)

Progress Of Universities

Both SDU and THU groups made great progress in prototyping Shashlyk modules. Currently plan is to build 4 modules each.

- Ordered lead and scintillator plates
- Measured hole positions using optical grating
- SDU assembly tested using regular plastic + lead; compression up to 500kg
- In close contact with Huazhong Normal Univ. (ALICE) group on learning their assembling experience.

Work in UVa.:

- FMPMT high field test using FROST magnet (July) done, paper submitted
- Tests requiring beam \rightarrow spring 2016
 - FASPD uniformity test awaiting GEM
 - LASPD timing test
 - Preshower prototype radiation resistance
- We do have the complete drawing of the ALICE modules from Wayne State University but dissecting it and design our own requires serious engineering effort.
- Continue working on the Module design/drawings (added side-plates)
- Resumed working with ANL/Chicago engineer on the Ecal support

MEASUREMENT & ASSEMBLY

Measurement Tools

THU: Video measuring instrument

SDU: Granting Scale

Resolution: $5 \mu m$





Resolution: 1-3 μ m



Lead Plate

- US Kolgashield
 - Ordered for 5 modules
 - NOT received yet (placed an order in summer)
 - \$13/piece
- In-Tech? (英泰克)
 - 600 pieces received
 - ¥13/piece
- CNNC (中国核工业集团)
 - 400 pieces received
 - ~¥10/piece
- Jiateng Machinery Manufacturing Co. (北京佳腾机械科技发展有限公司)

Provided By THU

- 200 pieces received
- ¥7/piece
- The geometry size of lead plates are all fine

Measurement Results Of Sampling

Provided By THU 11 12 Lead plate 1.462 **Diameter Of holes** 21 22 23 24 25 Hole spacing 1.49 1.486 1.454 32 31 33 34 35 36 37 38 12to23 23 - 241.475 1.454 1.462 1.439 12to24 43 41 42 44 10.819 10.829 45 46 47 48 49 10.816 1.494 1.475 1.468 1.464 1.488 1.476 1.459 1.481 1.475 51 52 53 54 55 56 57 58 59 510 99-910 99-109 910-109 1.473 1.487 1.468 1.467 1.458 1.501 1.438 1.484 1.444 1.466 10.841 10.825 10.842 61 62 63 64 65 66 67 68 69 1.486 1.445 1.475 1.48 1.478 1.456 1.467 1.451 1.435 71 72 73 74 76 79 710 711 75 77 78 1.468 1.462 1.46 1.478 1.481 1.444 41 - 4241 - 5242-52 81 82 83 84 88 89 85 86 87 10.837 10.825 10.815 1.466 0.947 1.449 91 92 93 94 95 96 97 98 99 910 1.45 1.455 1.472 1.473 1.469 1.472 1.462 103 - 1121.466 1.481 1.442 102 - 103102 - 112108 101 102 103 104 105 106 107 109 10.815 10.843 10.831 1.463 1.466 1.47 1.449 1.456 1.451 1.477 112 116 111 113 114 115 117 118 1.478 122 124 125 121 123 Average value Variance Average value Variance 1.443 0.00053

10.822

131 132 1.43 1.459

1.465 0.00023

Scintillator Tile

- Casting with special mold
- >200 tiles received from Kedi
 Company
- The geometry size of scintillator tiles are fine
- Need to check the light yield (plan to measure light yield in UVa)



Measurement Results Of Sampling

Scintillator Tile

Provided By THU

Diameter Of holes

12	24	25	35	36	37	38	45	48	49	52			
2.312	2.35	2.275	2.383	2.326	2.272	2.256	2.403	2.232	2.254	2.387		888888	
1.364	1.428	1.339	1.372	1.377	1.313	1.362	1.339	1.378	1.338	1.374	Average	valuo	Variance
				••••••							nverage	varue	variance
56	61	62	65	76	88	89	99	102	111	112		2.325	0.0025
2.39	2.276	2.34	2.399	2.368	2.332	2.289	2.308	2.321	2.321	2.361		1.37	0.00081
1.374	1.343	1.389	1.407	1.404	1.345	1.343	1.415	1.361	1.391	1.39		000000	

Hole spacing

		61-62	52-62	52-61	48-49	38-49	38-48
rage value Variance	Average val	10.831	10.843	10.851	10.809	10.828	10.817
10.837 0.00022	10.8						
		-112 111-112	-111 102-1	102-1	89-99	88-99	88-89
		. 83 10. 861	843 10.	10.8	10.834	10.858	10.843

Paper Sheet

- Change the friction between lead and scintillator
- Increase the light collection by reflection?

NUCL. INSTRUM. METH. A 584: 291-303, 2008

- Choice:
 - Print paper
 - Tyvek
 - others
- SDU Machining Center produced 400 sheets



	Reflection	Friction (lead)	Friction (scintillator)
Print paper	Worse?	0.3	0.2
Tyvek	>90%	0.1	0.1

WLS Fiber

- Tens of meters of Saint Gobain fiber in our lab
 - Cut and polish
 - Silver plated on one end to increase photon collection
 - Placed an Order for 4 km more (awaiting delivery)
- Investigation of Kuraray fiber

Ligh	t guide	ED		PMT	4: no 1,2,3:	plating silver p	olating
No).	FWHM(full width at half maximum)(ns)	Amplitude(mV)	Charge(pC)	Comp 4	pared to No.	
4		20.2	56	12.7			
		20.3	54	12.6			and the second second
1		20.5	104	24.2	1.92		and the second
2		20.7	92	21.5	1.706		Section Section
3		20.6	96	22.5	1.786		August



rbe

Assembly Tools

SDU Design





Concept Design

Assembly Tools

Provided By THU



Concept Design

Assembly Tools

New Design of EC



"LEGO"-type lock

Provided By THU

- These locks, four per tile, maintain the position of the scintillators and the gaps, providing sufficient room for the lead tiles without optical contacts between lead and scintillator.
- ✓ This mechanical structure enables removal of the paper tiles that were in earlier modules.
- Allows removal of the compressing steel tapes at the sides of the module
- \checkmark The module is 5cm shorter.



- The complete stack of all plates is held in compression by four 1-mm stainless steel wires.
- We are designing a new scintillator layer which has four LEGO locks
 We are also optimizing our assembly stand which has four stainless steel wires.

Nucl. Instrum. Meth .A 584: 291-303, 2008

FIRST PRE-PROTOTYPE

First Pre-prototype Module at SDU

The first pre-prototype module assembled by SDU assembly tools was released in several days ago (Jan. 07, 2016)



Hanging Test

- The module was hung at the end side, and the nut and brass bar can stand the module weight.
- However, did not test to failure and do not know what safety factor we have.



OUTLOOK

Pre R&D Need

- At least 1/2 postdoc to "develop an end-to-end realistic simulation and reconstruction to further optimize cost and physics reach and derive clear performance requirements for the individual subdetectors."
- Shashlyk module prototyping well underway. Still need manpower for in-beam testing (but less of an issue).
 - Need serious engineering support on module + assembly design
 - testing: partial postdoc, 1/2 grad student
- Items underway and covered by UVa
 - FASPD uniformity test
 - LASPD timing test with GEM
 - Radiation resistance test
 - Continue working with ANL engineers on module & support
 - Continue working with JLab detector group on PMT base design & testing
 - Misc: fiber, fiber connector,

What To Do Next?

- Determine the final design of module
 - Side sheets / Rods / Steel cable?
 - > Use paper sheets or not, what kind of paper / Lego Lock ?
- Most materials are ready (awaiting WLS fiber), more modules can be assembled soon
 - Add real-time pressure and compression monitoring
 - How to let fibers go through module
 - > Measure mechanical property of the scintillator
- Cosmic test → Beam test
- Resumed working with ANL/Chicago engineer on the Ecal support
- Learn from other experiments
- Funding application



BACKUP

Layout Of Pre-shower

- Kedi scintillator, thickness: 2cm,
 - Ф9ст, 6mm deep groove.
- WLS fiber: 3m*Ф1mm
- packaged by Tyvek paper
- 6 turn fiber in groove, no grease used.

Pre-shower Light Yield

- R11102 PMTs used for • candidate scintillators
- Both ends of the fiber coupled • to Cathode center w/o grease.

MIP: ~70PE

of the scit.



Photon Collection with one silver plated end



Schematic Diagram

Different voltage of LED

No.	FWHM(full width at half maximum)(ns)	Amplitude(mV)	Charge(pC)	Compared to No. 4
4	22	113	27.8	
	22	112	27.6	
1	22	214	52.6	1.900
2	22	193	47.5	1.715
3	22	200	49.2	1.776