

EC and SPD Updates

The SoLID EC Working Group

SoLID Collaboration Meeting

January 10-11, 2019



- 1. Progress in material tests fiber end and lead plate reflective material
- 2. Progress in support structure
- 3. Progress in prototype shashlyk module construction

(Simulation focused on reducing the cost and won't be reported here)

Shashlyk prototype and light yield overview

Proto- type	scintill ator	lead	reflective layer	WLS fiber	WLS fiber end	module side	cosmic vertical test Npe	cosmic horizontal test Npe	PMT gain method
SDU1	Kedi original	US	printer paper	BCF91A	none	Tyvek → TiO2	224 → 254	$\begin{array}{c} 48 \rightarrow N \\ A^{**} \end{array}$	SPE/SDU
SDU2	Kedi new	Chn	printer paper	BCF91A	Chn silver- plating	Tyvek → TiO2*	427 → 383*	$\begin{array}{c} 83 \rightarrow N \\ A^{**} \end{array}$	SPE/SDU
SDU3	Kedi new	US	printer paper	Y11	Chn silver- plating	TiO2+glu e (1/1)	491	107	SPE/SDU
THU1	Kedi original	Chn	mirror mylar (reflective)	Y11	Italian silver shine	TiO2 (Kedi)	430-470	96	not measured
THU2	Kedi new	Chn	powder paint (喷 塑) (diffusive)	BCF91A	Italian silver shine	Tyvek wrapping (now)	680	90-103	SPE/ IHEP

* TiO2 side-paint was not as good as SDU1 ** could not finish before shipping to JLab Vields 500/200 layers for MIP \rightarrow 1666 p.e./GeV electron, factor 2-3 lower than LHCb or ALICE \rightarrow 833 p.e./GeV if using clear fibers \rightarrow 3.5% in δ E/E due to photoelectron statistics

The main difference between THU and SDU modules appears to be the reflective material SoLID Collaboration Meeting, January 10-11, 2019 3

Reflective Layer Material

Previous/LHC experiments used Tyvek, printer paper, "bond" paper, etc.

We used printer paper, "mirror mylar", and now are focusing on different "powder painting" on lead plates – work mostly done at Tsinghua U.







SoLID Collaboration Meeting, January 10-11, 2019

标准源

KSYB

1848053

β

9000Bg

2.9382E+5粒子数/2π·分

2018 年 05 月 22 日

Sr-90/Y-90 **半表期**_____

放射源名称

规格型号

放射源标号

国家编码

射线类型

名义活度

发射率

标定日期

核

Photo of the setup with different materials (THU)





Nuclear Instruments and Methods in Physics Research A 584 (2008) 291-303

Material	VoltageU1 (V)	Backgroun d voltage U2 (V)	U1-U2(V)	Reflectiv ity	Thicknes s (µm)	Total thickness (mm)	
Thick TYVEK	0.54	0.045	0.495	0.870	544.5	1 389	SDU5
Thin TYVEK	0.5	0.045	0.455	0.800	181	0.662 Re	ference
New Wrinkled	0.49	0.035	0.455	0.800	104	0.508 Thi	ckness×
Smooth	0.5	0.055	0.445	0.782	62	0.424 Pri	ce×
New smooth	0.45	0.035	0.415	0.730	62.5	0.425	THU3
Print paper	0.44	0.035	0.405	0.712	124	0.548 <mark>S</mark> D	U1/2/3
Old smooth	0.45	0.045	0.405	0.712	61.5	0.423	THU2/
Currently used	0.45	0.045	0.405	0.712	81.5	0.463	SDU4
Thin wrinkled	0.43	0.035	0.395	0.695	70.5	0.441	
Thin waterborne	0.44	0.045	0.395	0.695	61	0.422	
Thick waterborne	0.43	0.035	0.395	0.695	116	0.532	
Silver plated	0.43	0.035	0.395	0.695	145	0.59	THU1
Only lead	0.42	0.035	0.385	0.677	0	0.35	
Black reflective	0.42	0.045	0.375	0.659	137	0.574	

THU3 and SDU4 will use "new smooth" and THU2 used "old smooth", but this company in Beijing may close soon. Plan to use a company in Nanjing. The samples labeled "Nanjing thin" and "thick" gave results as good as "new smooth" and "old smooth".

Also using oscilloscope, not multimeter

Thickness still under study

For comparison:

- Old smooth surface (36.5mm)
- New smooth surface (37.5mm)
- Thick TYVEK (62.5mm)



	Multimeter/ mV	Digital Oscilloscope /mV	Previous Test/V
Old smooth	41 (39~43)	3.924	0.45 (0.44~0.49)
Nanjing thin	40 (38~42)	4.127	
Nanjing thick	40 (37~43)	3.749	
New smooth	36 (33~39)	3.463	0.45 (0.43~0.49)
Thick TYVEK	47 (44~50)	4.177	0.54 (0.52~0.56)
no resource	3 (2~4)	0.918	0.04 (0.03~0.05)

Fiber Reflective End Material

Previous/LHC experiments used dedicated polishing/plating equipment. Fermilab may have similar resources but we need to develop one that works for SoLID.



Ja **Figure 2.7:** Comparison of light transmission efficiency versus distance of propagation for Kuraray Y-11 fibres with and without aluminized mirrored ends.

SoLID Collaboration Meeting, Ja

Factory-based processing (tested at SDU)





varies, (40-80)%

+90%

Shanghai's silver painting has been retested and results good, but cost ~50RMB/fiber, prohibitive.

Yantai's cost (600-700)RMB/50 fibers, too high! And results are not uniform among samples: batch 1 (48-62)%, batch 2A (63-78)%, batch 2B NG, batch 3 NG

Overall, we concluded we should not pursue factory-processing of the fiber end: either the cost is prohibitive (shanghai), or is lower but results are not good.

As a comparison, Chinese SDU quote includes only 100 CNY per module for silver plating.

Setup and Results from THU





Silver ink: Silver Shine 415001 6 scintillator



+(20-40)%

TiO₂ + Epoxy Resin 6 scintillator



+(40)%

Silver tape (3M from Amazon) 6 scintillator + 1 powder lead



+64% if all 16 fibers are taped

Setup and Results from SDU

led

light

tape

added to

fiber end

source



3M™ Enhanced Specular Reflector (3M ESR)



Results show (70-80)% improvement in signal.

Reflective tape is the best option so far, can be glued to fiber ends;

However, must compress module first, then insert fibers. This means the module front plate must have all holes.

New Modules

- Goal: construct 7 modules for the test at IHEP, incorporating best material
- We already have: SDU1, SDU2, SDU3, THU1(defective), THU2
- SDU4, SDU5, THU3 in progress.



New Prototypes in Construction

Proto- type	scintilla tor	lead	reflective layer	WLS fiber	WLS fiber end	module side	cosmic vertical test Npe	cosmic horizontal test Npe	PMT gain method
SDU1	Kedi original	US	printer paper	BCF91A	none	Tyvek → TiO2	224 254	48 → N/A**	SPE/SDU
SDU2	Kedi new	Chn	printer paper	BCF91A	Chn silver- plating	Tyvek → TiO2*	427 → 383*	83 → N/A**	SPE/SDU
SDU3	Kedi new	US	printer paper	Y11	Chn silver- plating	TiO2+glue (1/1)	491	107	SPE/SDU
SDU4	Kedi new	Chn	powder paint	BCF91A	nothing yet	none (yet)	261		SPE/SDU
SDU5	Kedi new	US	Tyvek (0.145mm)	BCF91A	nothing yet	(nothing →) loose tyvek	(217 →) 270		SPE/SDU
THU1	Kedi original	Chn	mirror mylar (reflective)	Y11	Italian silver shine	TiO2 (Kedi)	430-470	96	not measured
THU2	Kedi new	Chn	powder paint	BCF91A	Italian silver shine	Tyvek wrapping	680	90-103	SPE/IHEP
THU 3	Kedi new	Chn	powder paint						



- ANL's engineer (Vic G.) has been working on module support structure, to be integrated with the main support (JLab/eng).
- Designed a 7-module support for the beam test, which SDU made and test out, but there are many problems.
- Has been working on EC layout for 3 configurations, but latest layout is still incorrect

ECal Support



Problem with the current support design:

Rigid box, must mount all modules on the front plate in the module-vertical position, rotate it, then mount the back plate. Not that practical → should use adjustable rods/spacers to allow horizontal mounting of individual modules.

ECal Layout



From Vic, ~August 2018 (SIDIS FAEC)



ECal Layout

However, in July 2018 also received from Vic the support plate design with quote. Coverage doesn't seem correct, not sure where this one comes from.



To do:

- Lots of uncertainties in how to mount modules. In-person discussion is necessary.
- Continue to PVDIS and SIDIS/LAEC layout.
- Figure out where the layout for the July 31st support plate design comes from, and proceed from there.