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Ecal R&D at THU

9th workshop on hadron physics in China and opportunities worldwide

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清華大學

Tsinghua University

outline

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Cosmic test

3

Fiber test

4

optimized prototype

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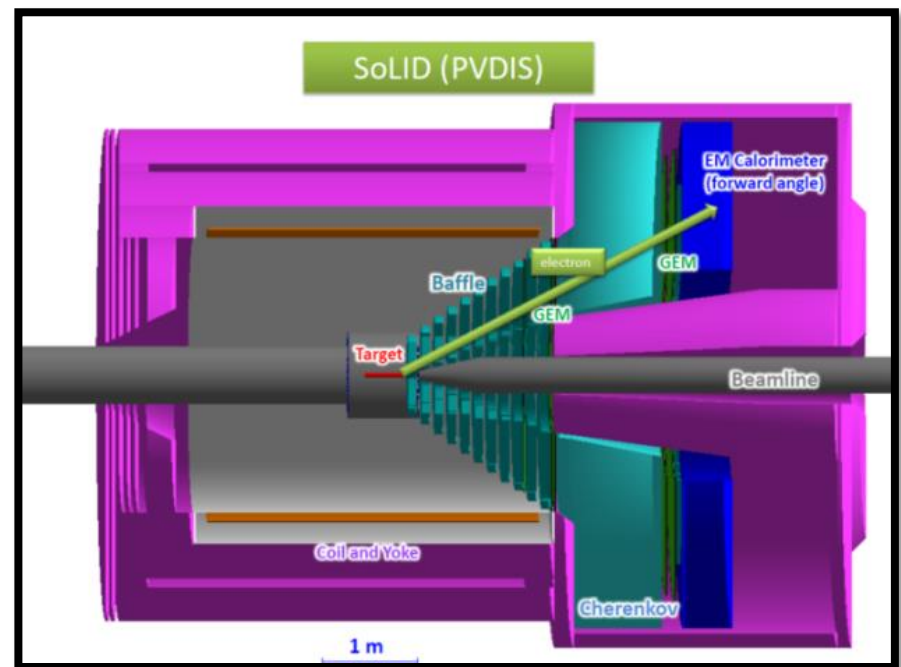
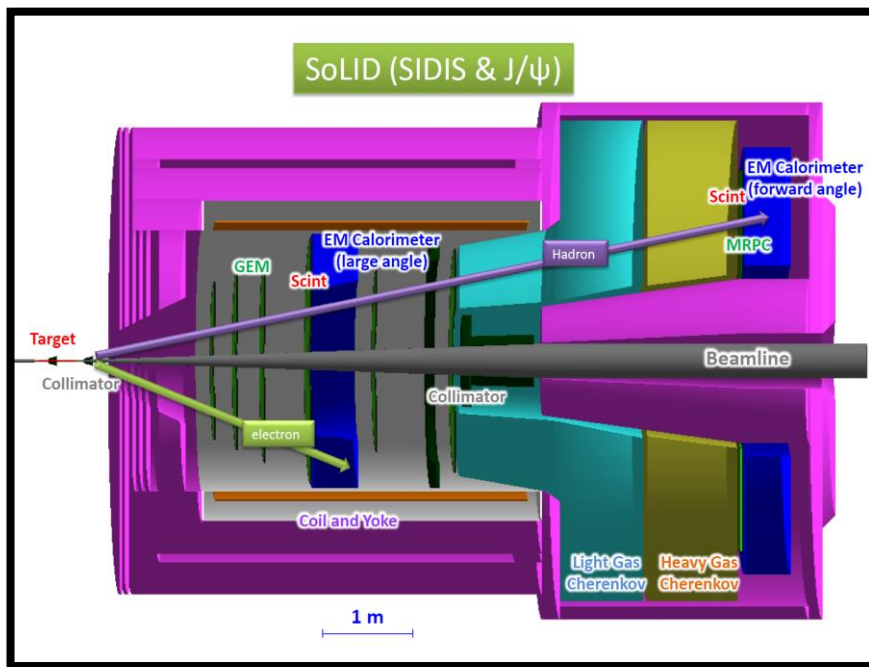
Summary



□ SoLID: Solenoidal Large Intensity Device

High Intensity ($10^{37} \sim 10^{39} \text{ cm}^{-2}\text{s}^{-1}$) and,
Large Acceptance ($8 < \theta < 24$, $0 < \Phi < 360$, $1 < p_e < 7 \text{ GeV}/c$ for SIDIS)

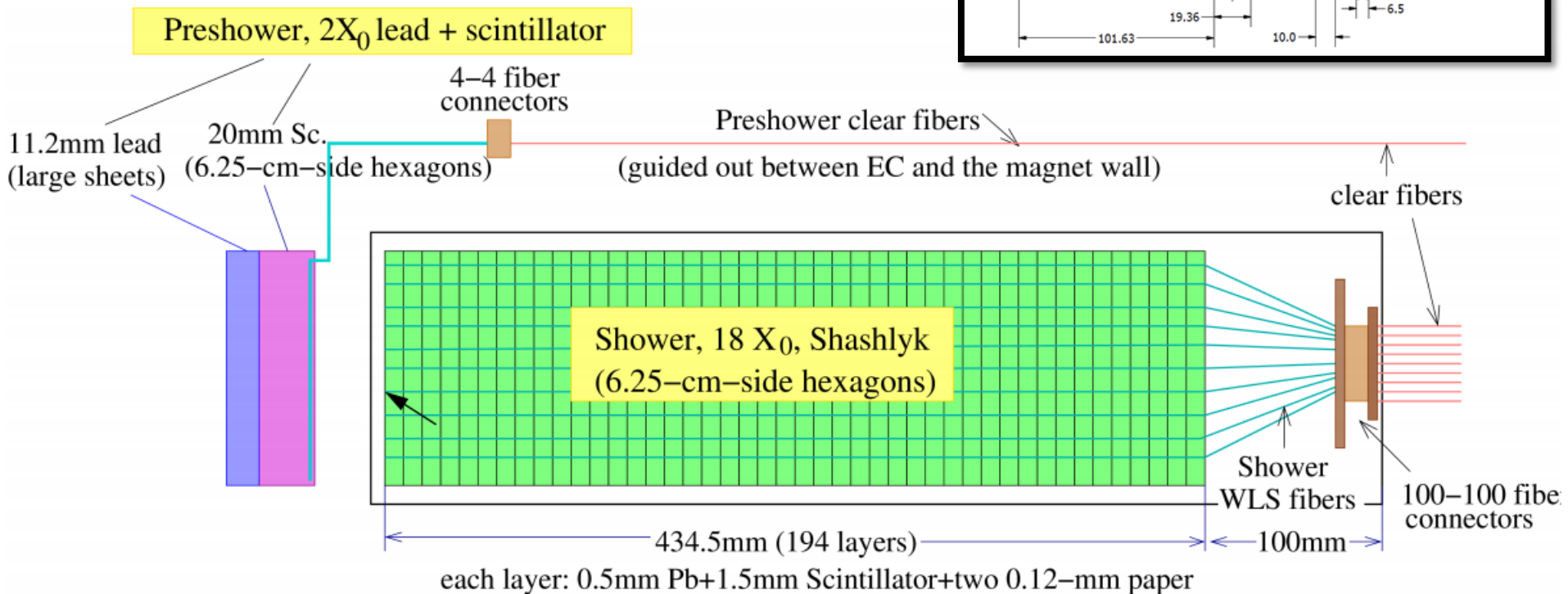
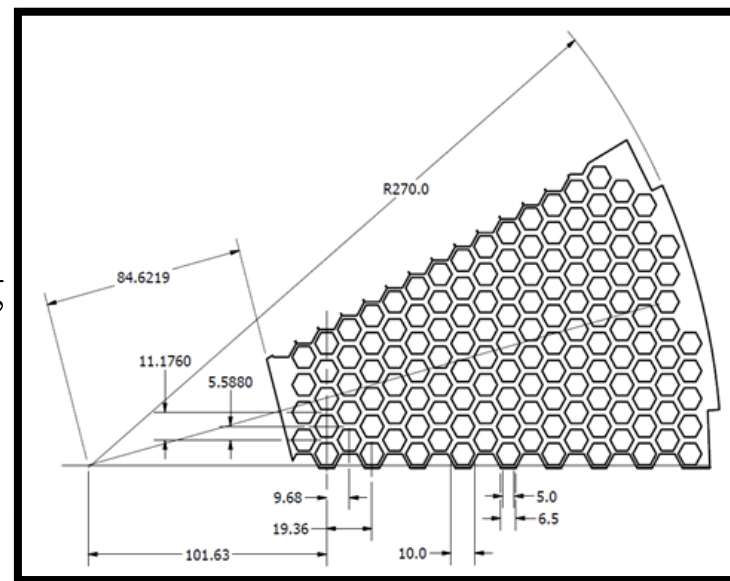
Two Configurations



1

Introduction of ECal

- Preshower: $2X_0$ lead + 20mm scintillator
- Shower: 0.5mm lead / 1.5mm scintillator sampling
- Total length: $20X_0$ ($< 2\%$ leakage)

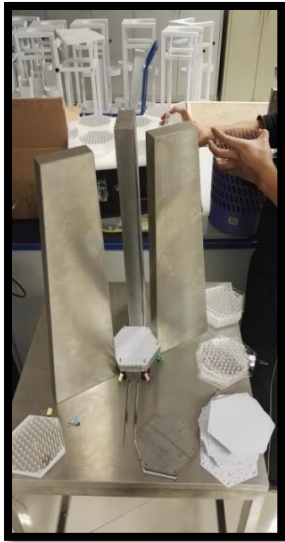


1

Introduction of ECal

This assembling steps:

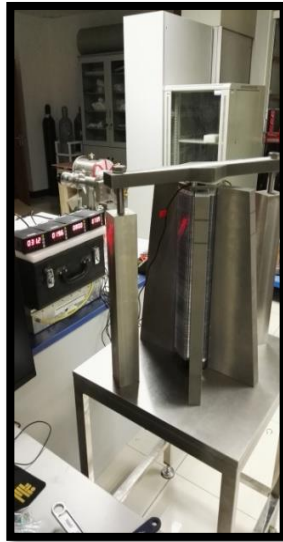
- ✓ Stack lead and scintillator accurately to ensure that every fiber can be inserted freely.
- ✓ The ECal can be pressurized by 500kg force.
- ✓ The pressure can be put under close monitor by pressure sensors.
- ✓ The pressure can be transferred from pressure bar to 6 stainless steel rods.



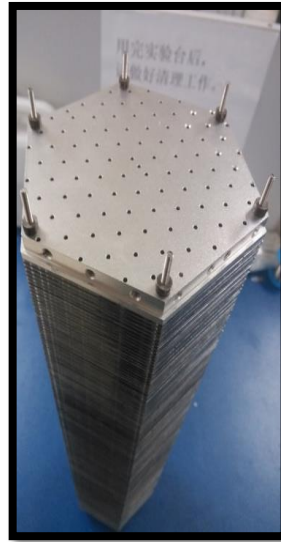
Step1



Step2



Step3



Step4

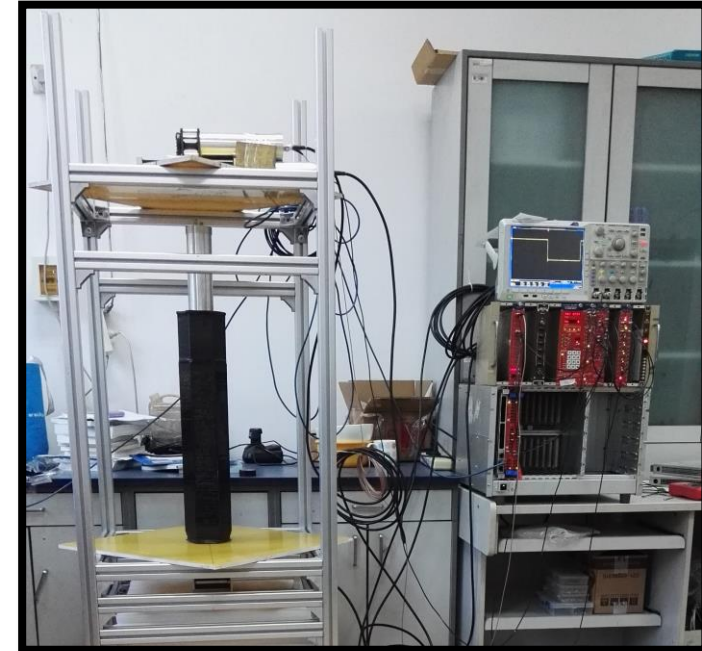
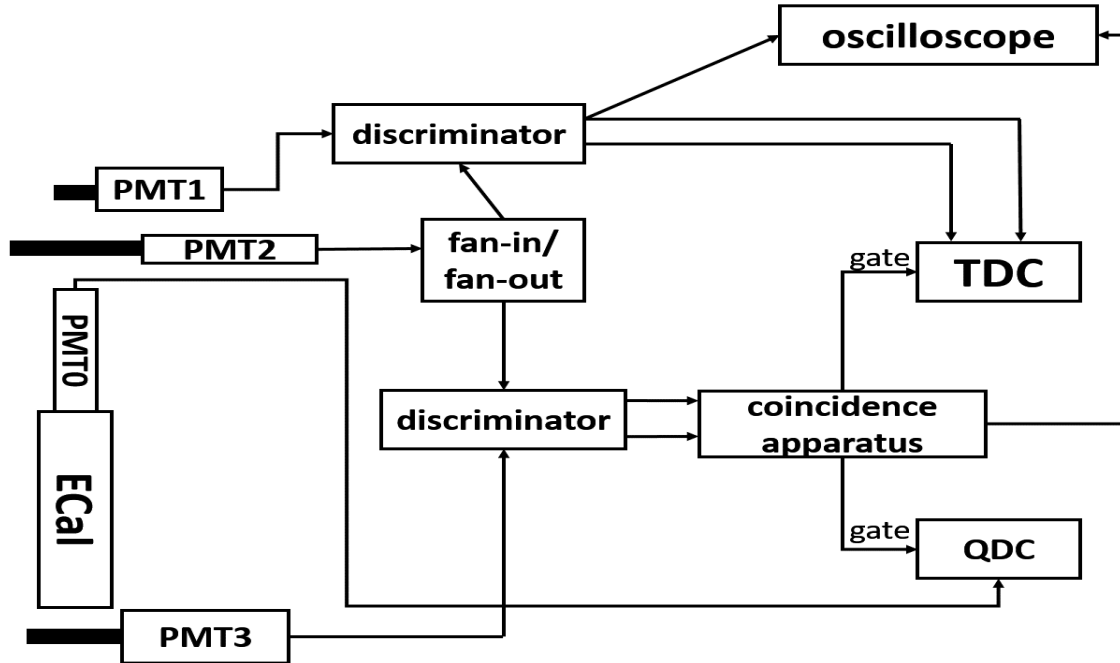


Step5



Step6





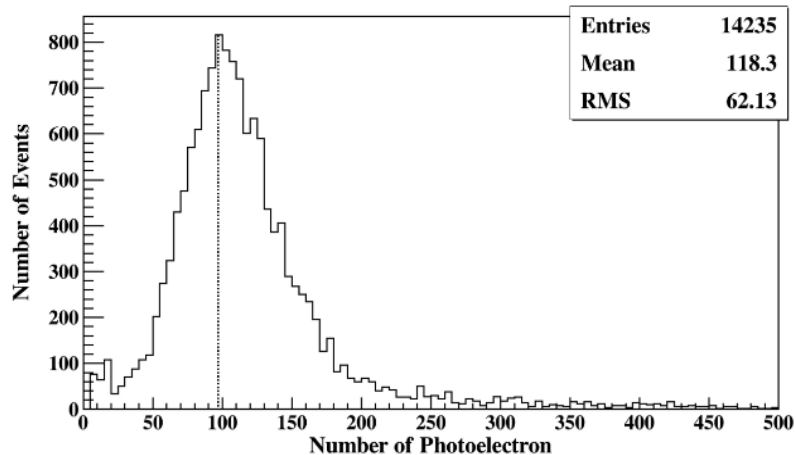
First Ecal module in THU (Sep 2016)

Schematic diagram of vertical cosmic ray experiment setup

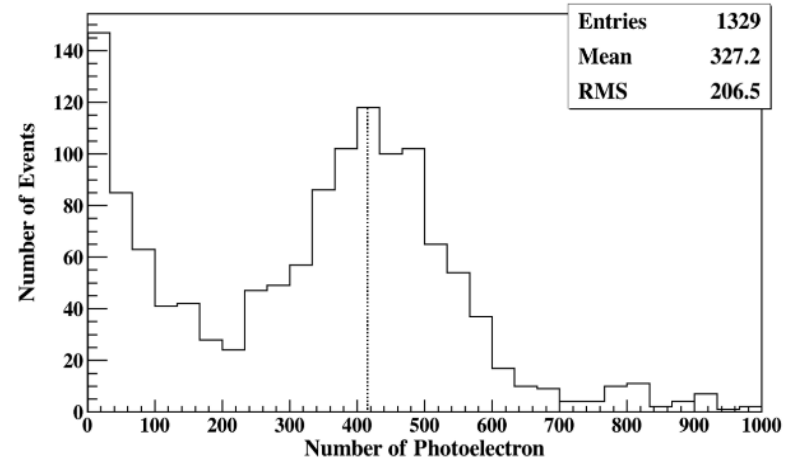


light yield test results in UVa

number of p.e. per shashlyk layer, hedgehog test	# p.e. per 1 GeV electron in shashlyk module, SoLID running condition, assuming 20% sampling fraction and light yield proportional to energy deposit in scintillator					expected # of p.e. for shashlyk module cosmic horizontal test (assuming 10cm vertical thickness, 7.5cm of which is scintillator)
	Y11, no mirror at end of fiber, light yield directly out of WLS	if using BC91A instead of Y11	after light loss of connectors and clear fibers (use 50%)	adding mirror to end of fiber (use +60%)	extra energy resolution due to photoelectron statistics	
0.500	300.000	150.000	75.000	120.000	0.091	25.000
1.000	600.000	300.000	150.000	240.000	0.065	50.000
1.500	900.000	450.000	225.000	360.000	0.053	75.000
2.000	1200.000	600.000	300.000	480.000	0.046	100.000
2.500	1500.000	750.000	375.000	600.000	0.041	125.000



Peak of Npe in horizontal test

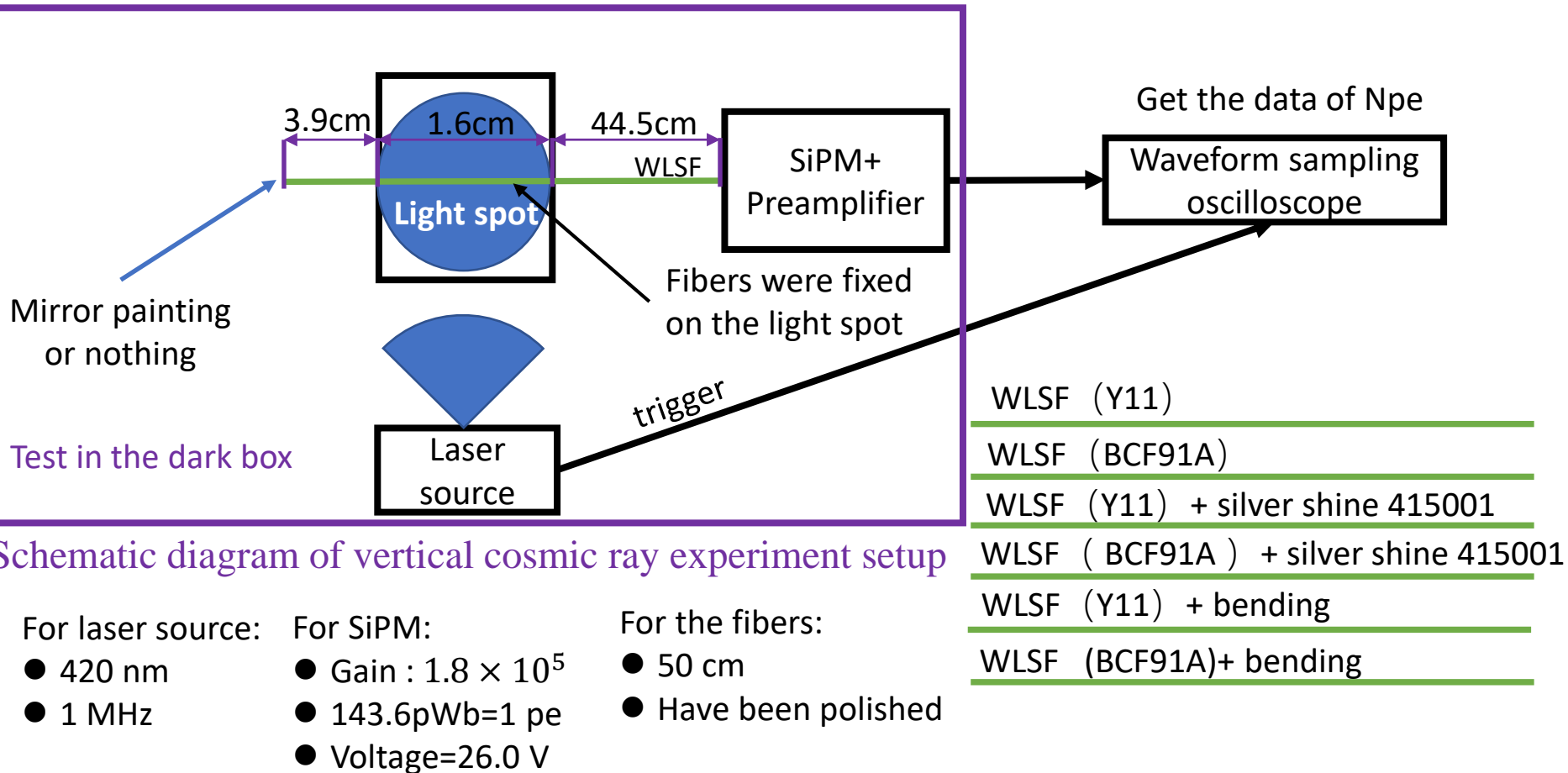


Peak of Npe in vertical test

For the result, the peak of Npe in horizontal test is 48 and the peak of Npe in vertical test is 209. Through the result of the vertical and horizontal cosmic ray test, we have obtained that the prototype need to be improved to increase the light yield.

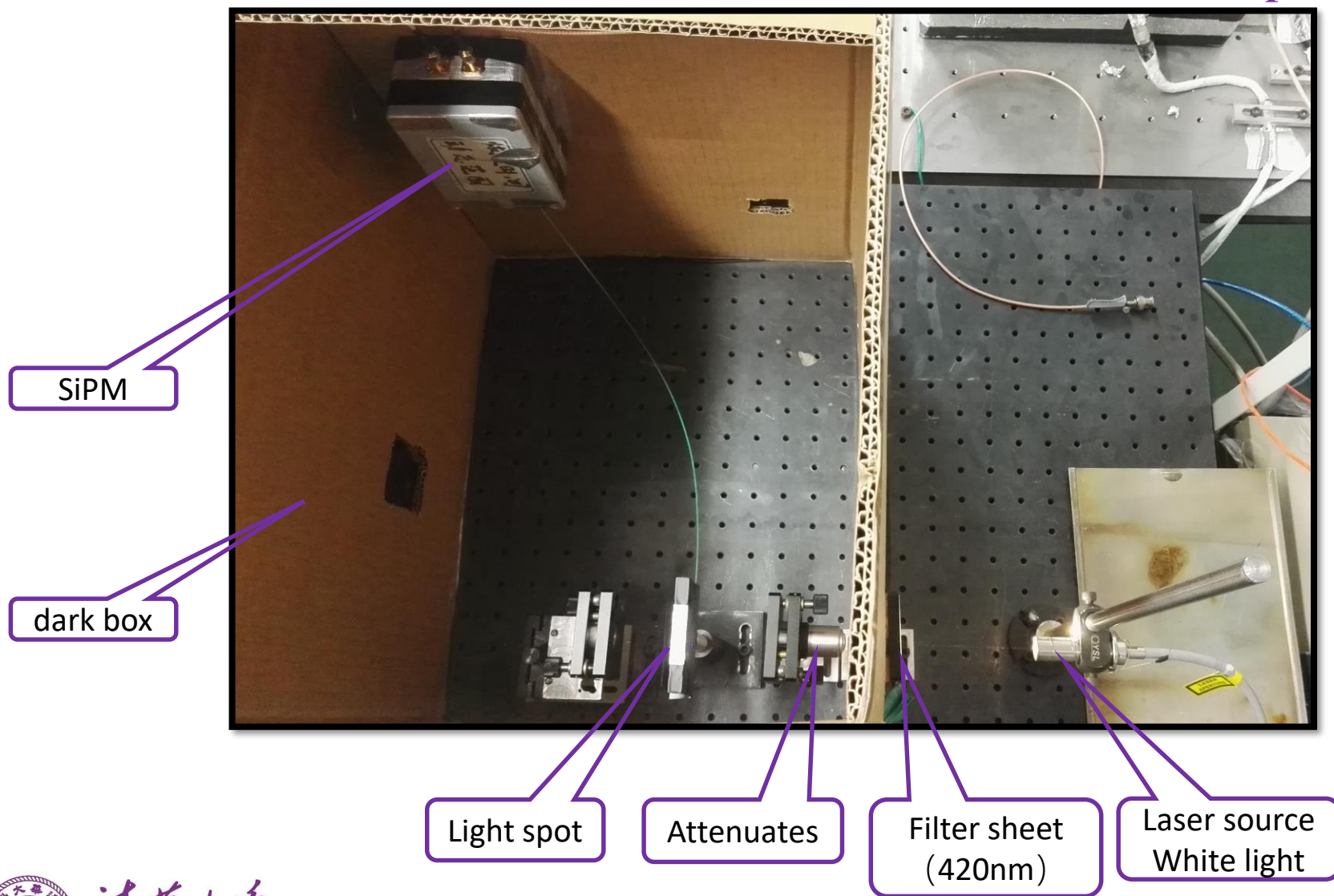


Test of two different fiber & mirror painting



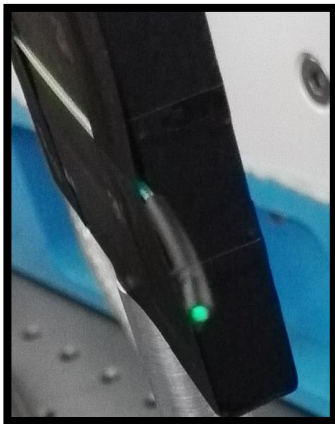
Schematic diagram of vertical cosmic ray experiment setup

WLS Fiber test Set up

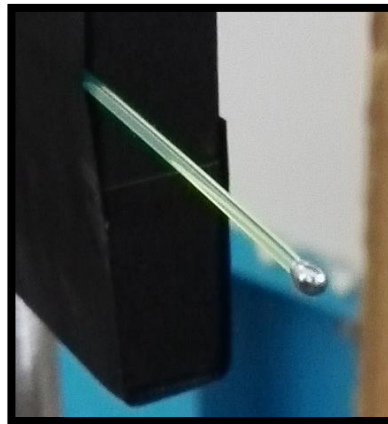


Compared results

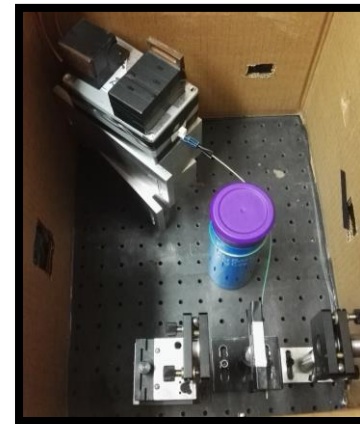
	BCF91A	Y11
No mirror painting	14	13
Mirror painting	17 (+21.4%)	17 (+30.1%)
Bending ($\phi 6$)	4 (-71%)	11 (-15%)



No mirror painting



Mirror painting

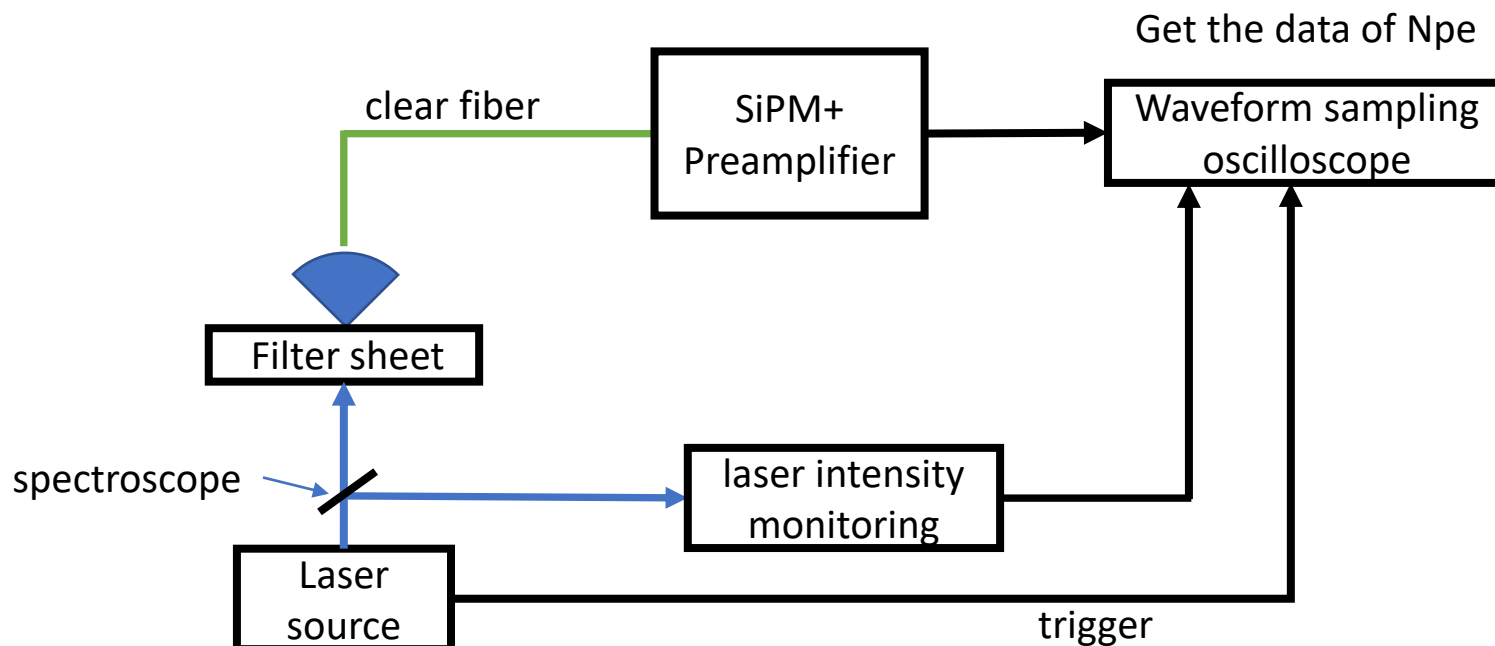


Bending

A comparison of Y11 and BCF91A multi-clad fibers has shown that Y11 double-clad S-type fiber from KURARAY and BCF91A from BICRON give about the same light yield,

but that the Y11 S-type has better mechanical properties. The BCF91A fiber has less mechanical stability against bending at small radius.





For laser source:

- 420 nm
- 1 MHz

For SiPM:

- Gain : 1.8×10^5
- $143.6 \text{ pWb} = 1 \text{ pe}$
- Voltage = 25.0 V

For the fibers:

- 1m, 2m, 3m, 4m, 5m, 7m and 9m
- Have been polished
- BCF98, single cladding



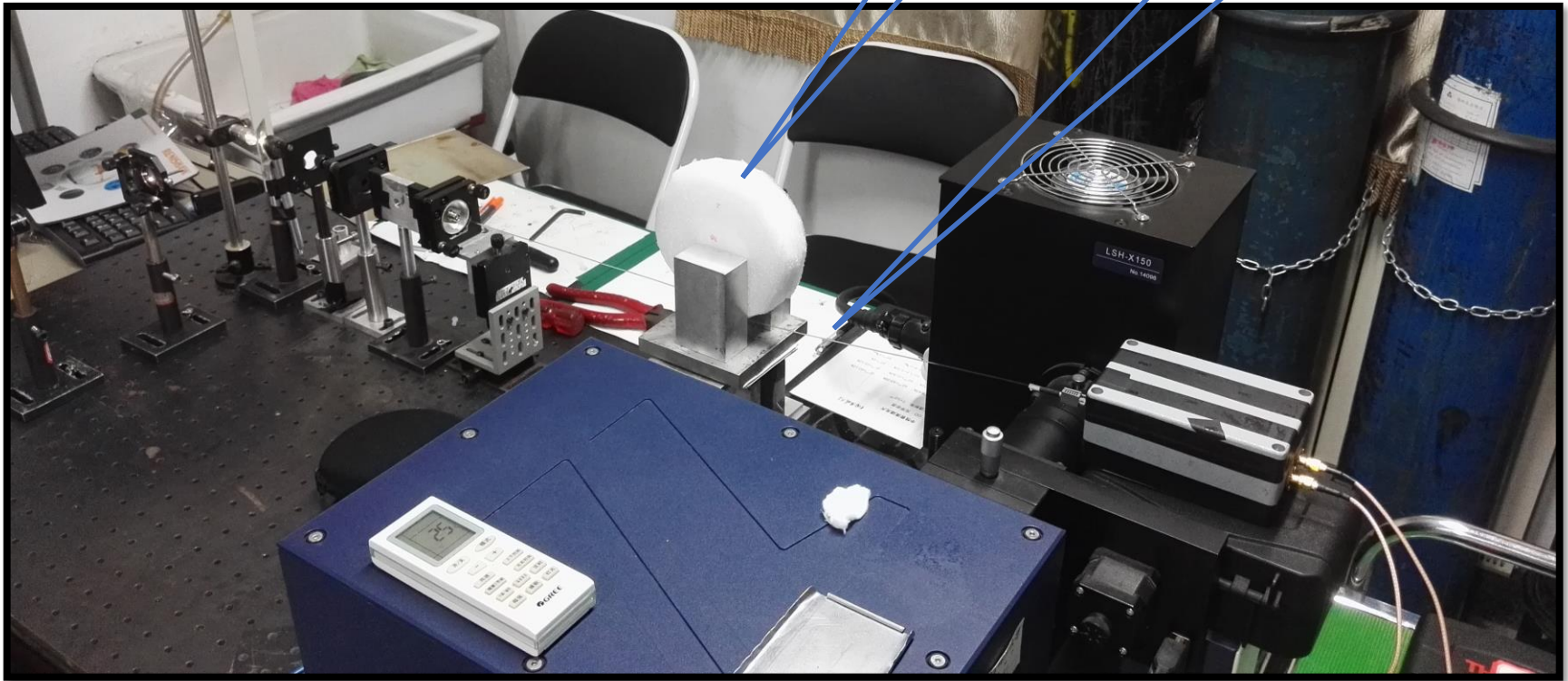
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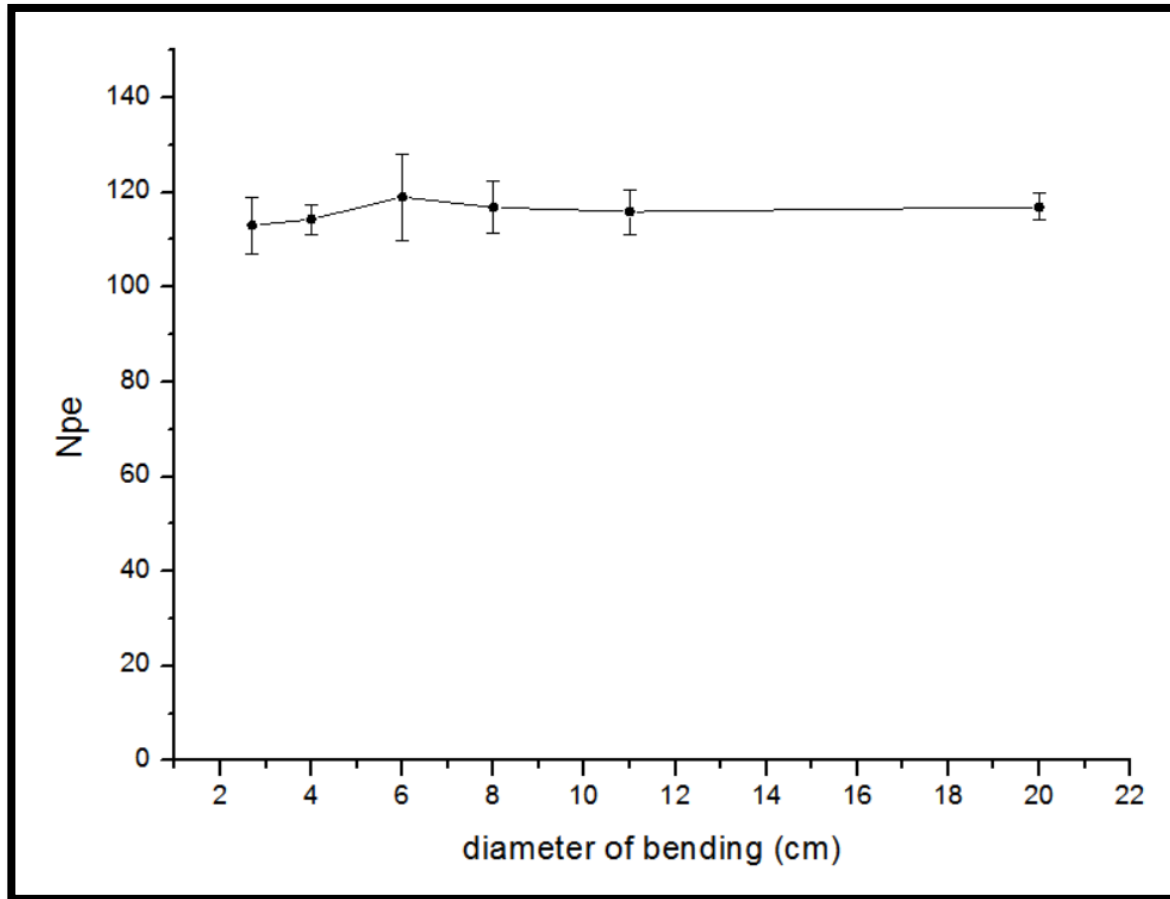
Clear Fiber test

To measure the light loss due to bending

Bending tool

1m of clear fiber





The effect of bending on the clear fiber can be ignored
no bending loss for clear PSM above a diameter of (4-5)cm

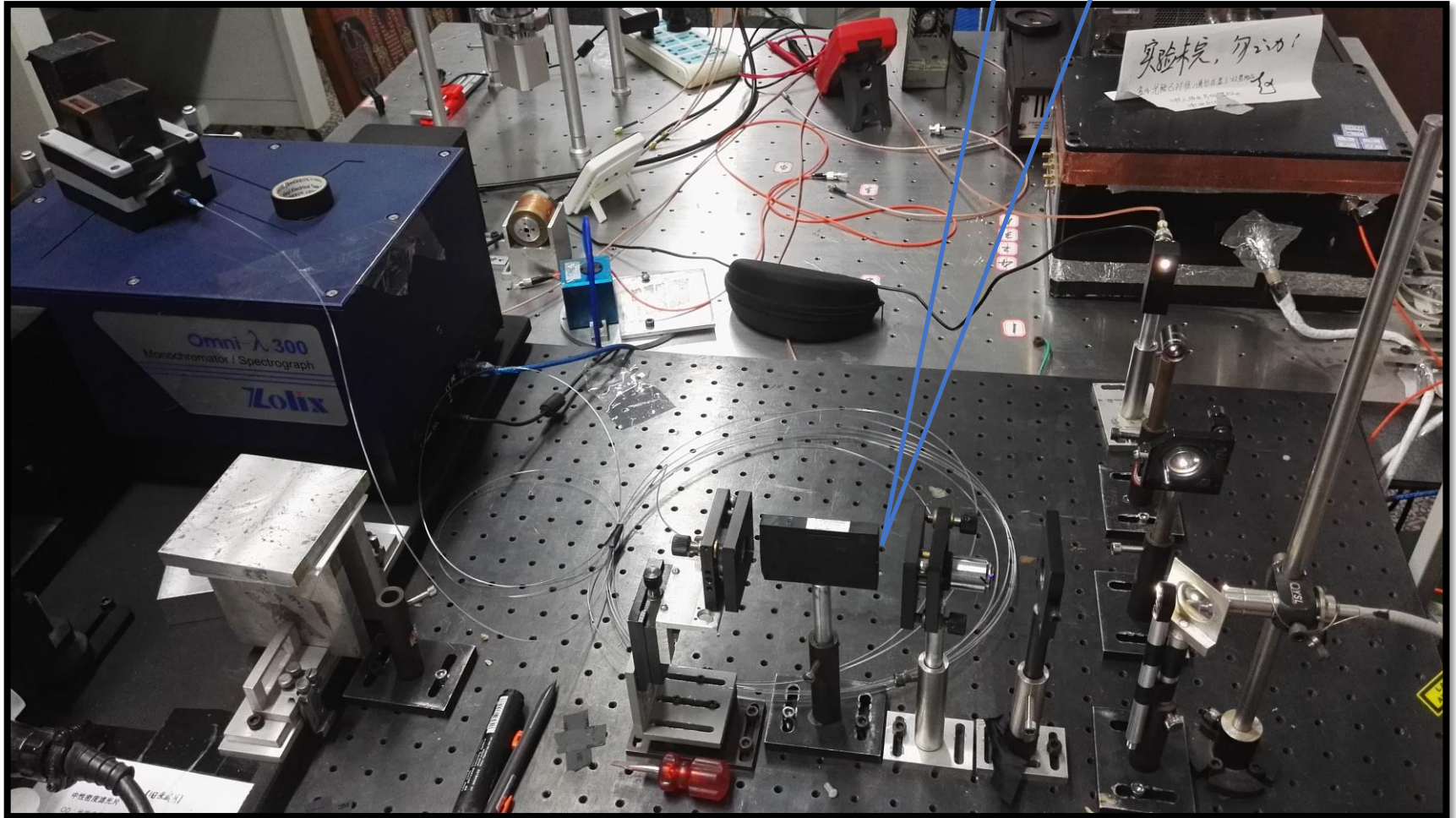


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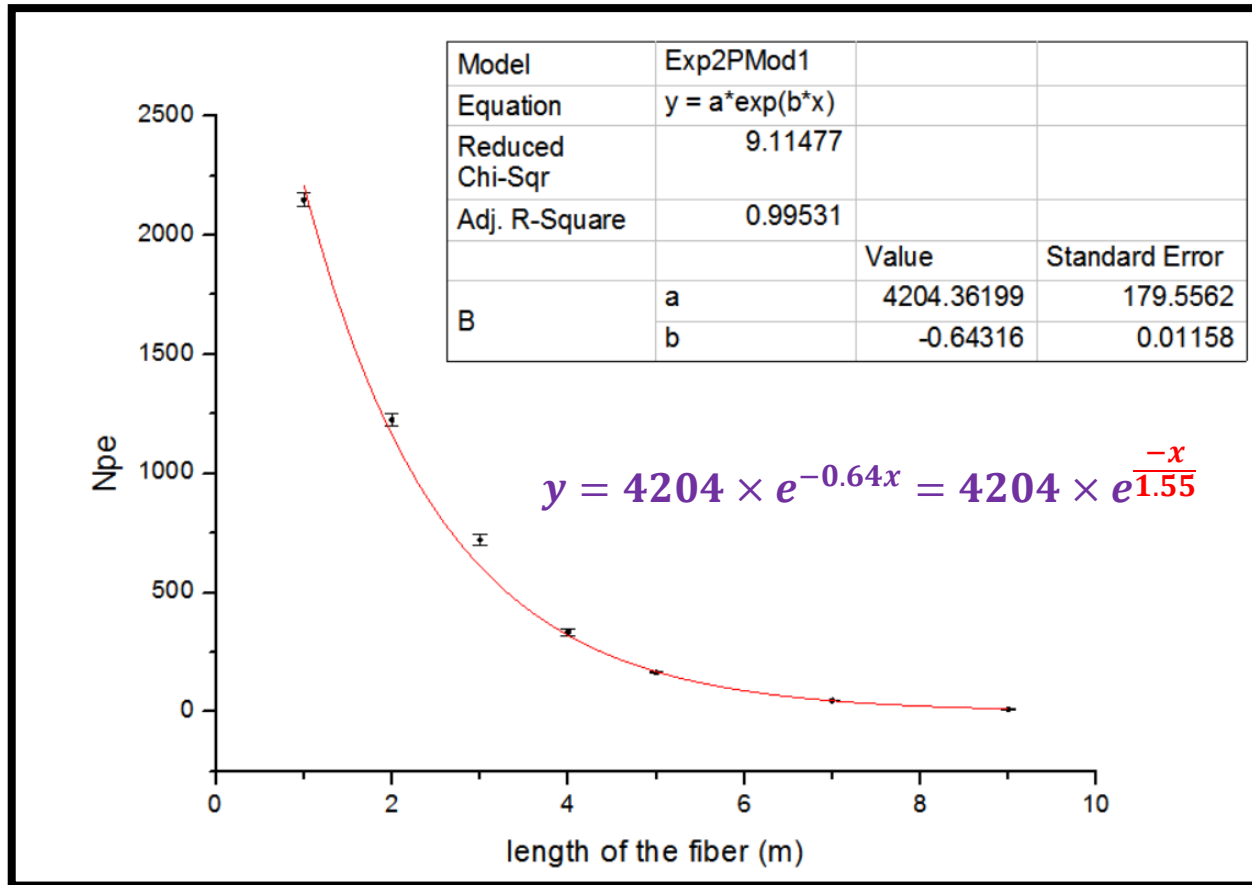
Clear Fiber test

To measure the light loss due to length

End of the fiber



measure the light loss due to length

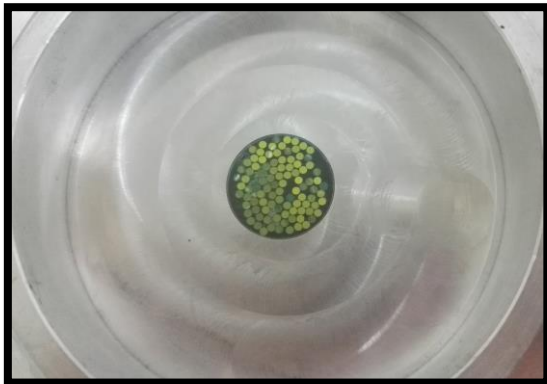


From the result, the attenuation length is 1.55m

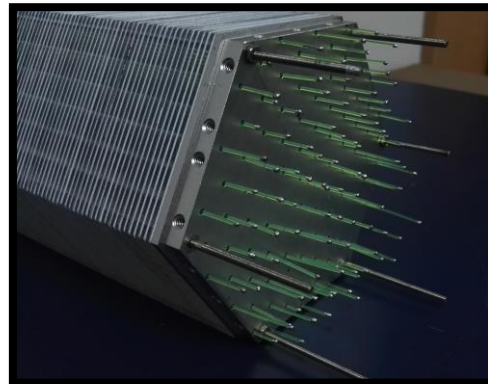


materials of THU #1 and THU #2

Material	THU #1	THU #2
Lead plate	Beijing, China	
Reflective materials (WLS fiber)	Silver ink from Italy	
Scintillator plate	Kedi #1	Kedi #2
Reflective materials (between scin and lead)	Sliver paper (Mirror reflection)	Powder painting (Diffuse reflection)
WLS fiber	Kurray Y11	Saint Gobain BCF91A



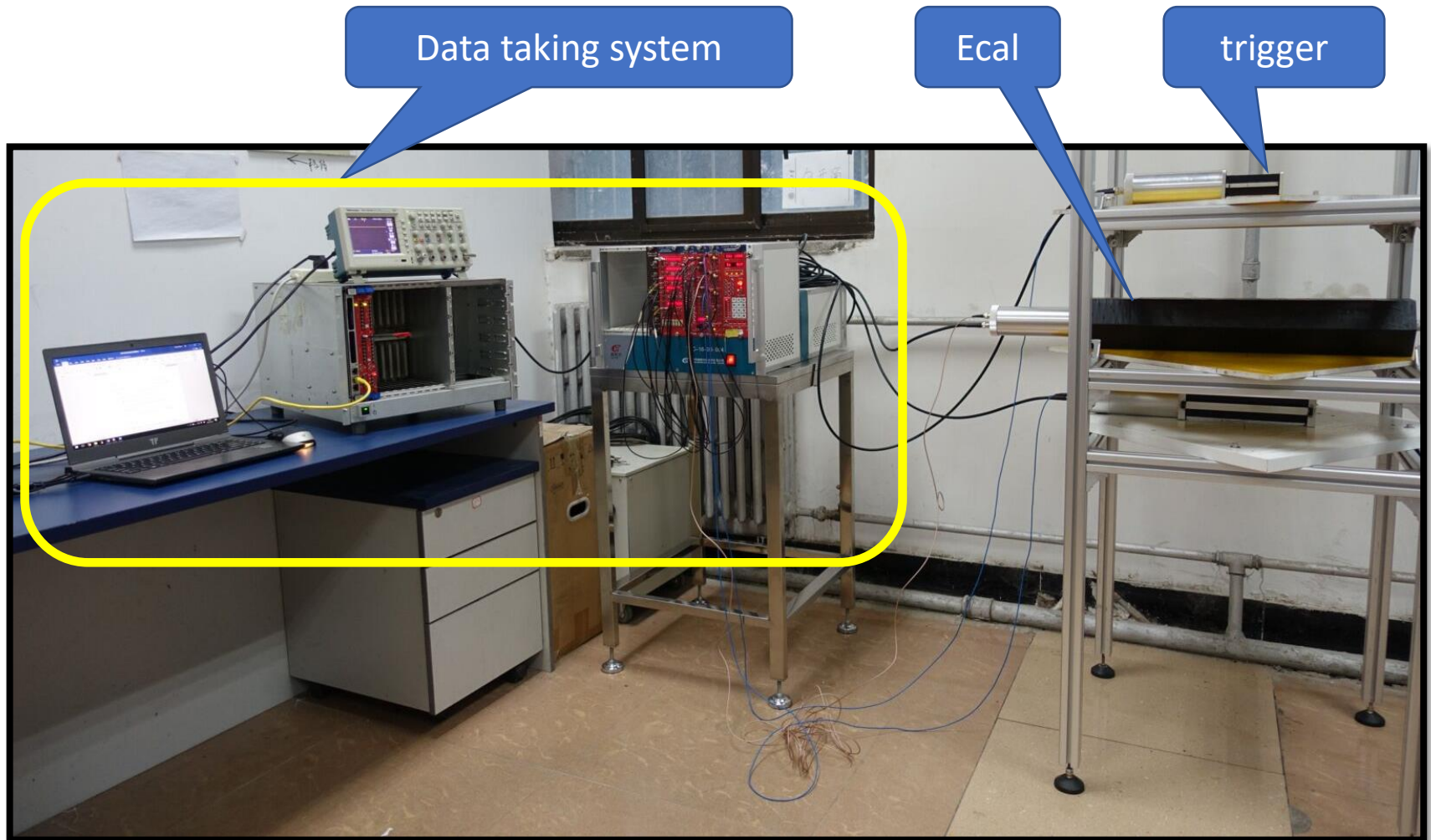
Top of the WLS fiber
(connect to the PMT)



End of the WLS fiber
(mirror painting)



THU #2



cosmic ray test setup

- Experimental device has been built
- Cosmic ray test is currently underway
- we will present the test results soon

Finished

- The cosmic test for THU #1 has been finished, JINST_103P_1216.
- Fiber R&D
 - WLS fiber (BCF91A & Y11) test has been finished, the results show that:
 - Y11 double-clad S-type fiber from KURARAY and BCF91A from BICRON give about the same light yield without bending
 - Italian silver shine: ~30%
 - Clear fiber (BCF98, single cladding) test has been finished, the results show that:
 - no bending loss for clear PSM above a diameter of (4-5)cm
 - the attenuation length is 1.55
- The optimized prototype (THU #2) has been assembled.

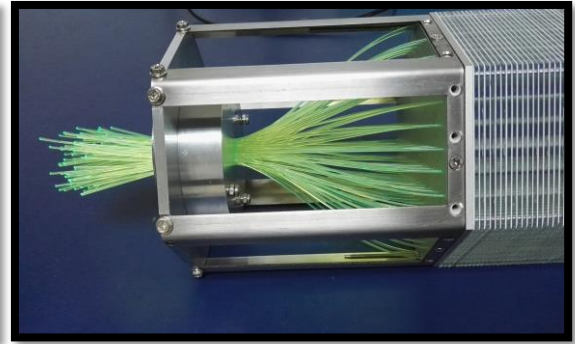
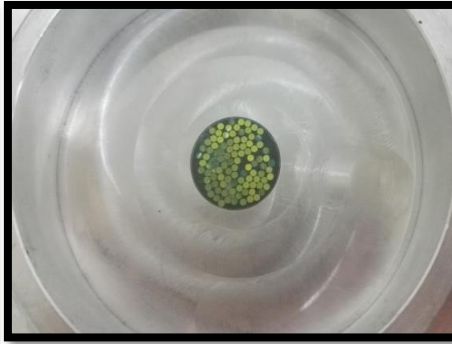
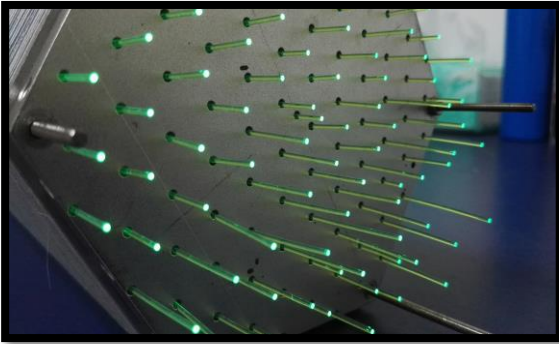
Next to do

- Re-test the BCF98 single-cladding clear fiber with 470nm lights
- Will also test BCF98 multi-cladding fiber and kurraray PSM clear fiber (bending loss, attenuation length.....)
- Will use THU #2 to do the cosmic ray test to get the basic performance of Ecal.
- Prepare for beam test in IHEP (E3 line) and compare with the results of cosmic ray test.





Thanks For your attention



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