Status of Muon detector

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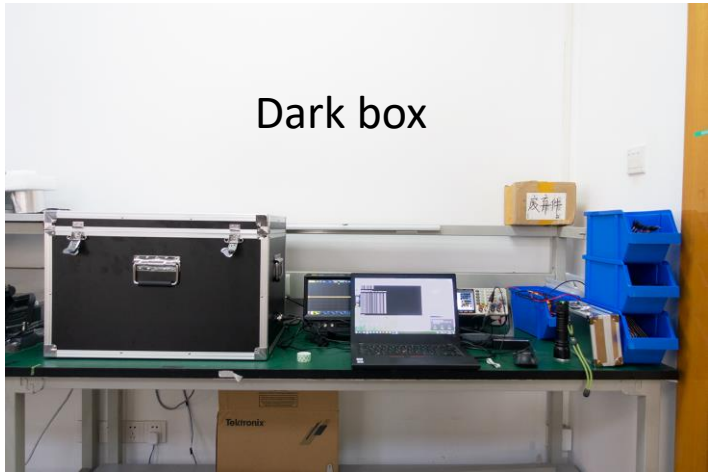
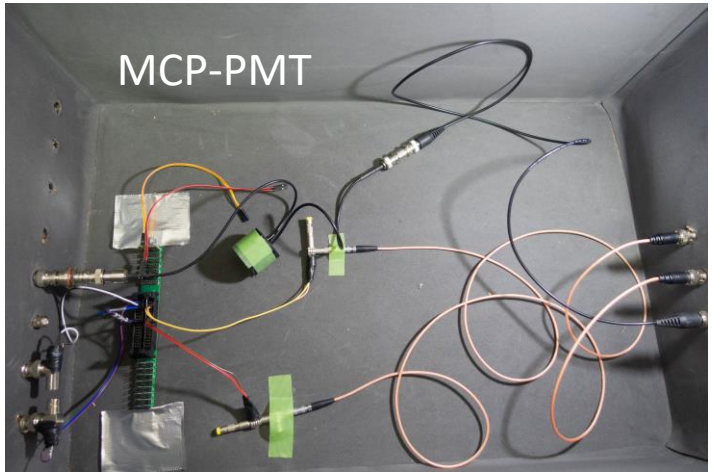
Fudan University

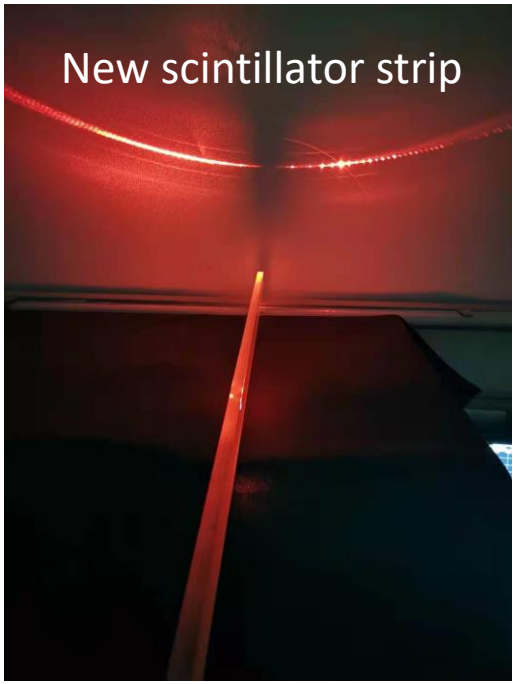
Plenary Meeting, July 7, 2021

Something new

And new MPPCs from KEK.



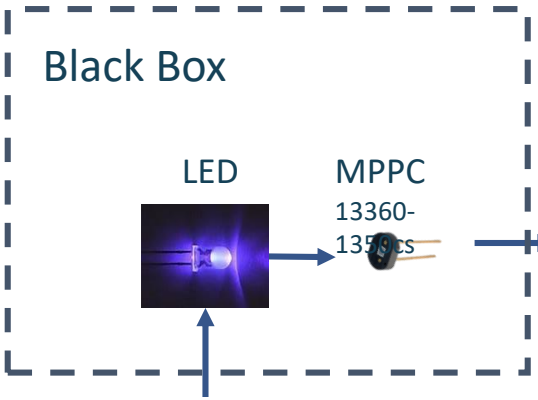


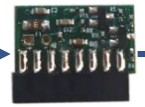


Long attenuation length!

High time resolution!

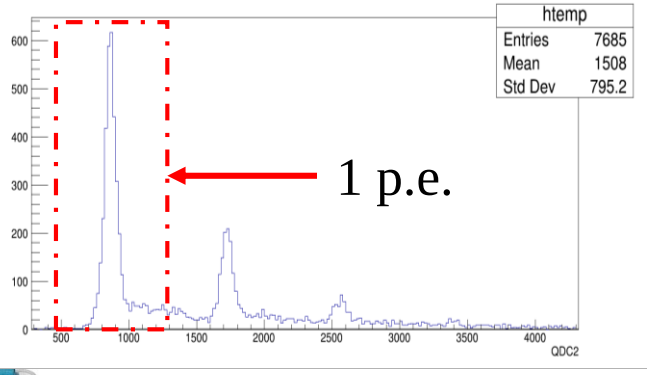
Study with MPPC only





Differential Amplifier

Signal



QDC

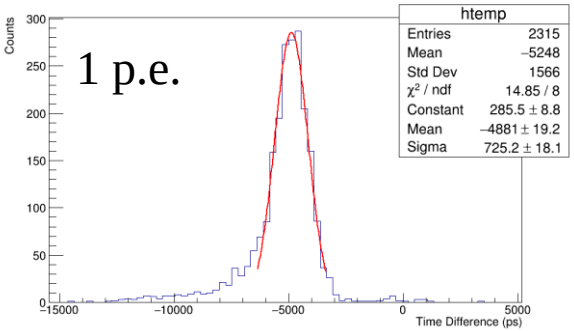
MFG-2200

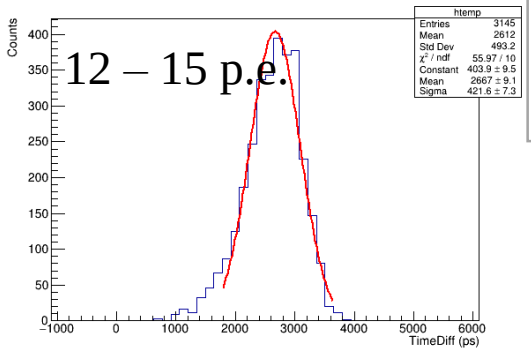
Reference

MSO 56 Oscilloscope

Oscilloscope: 6.25 GS/s

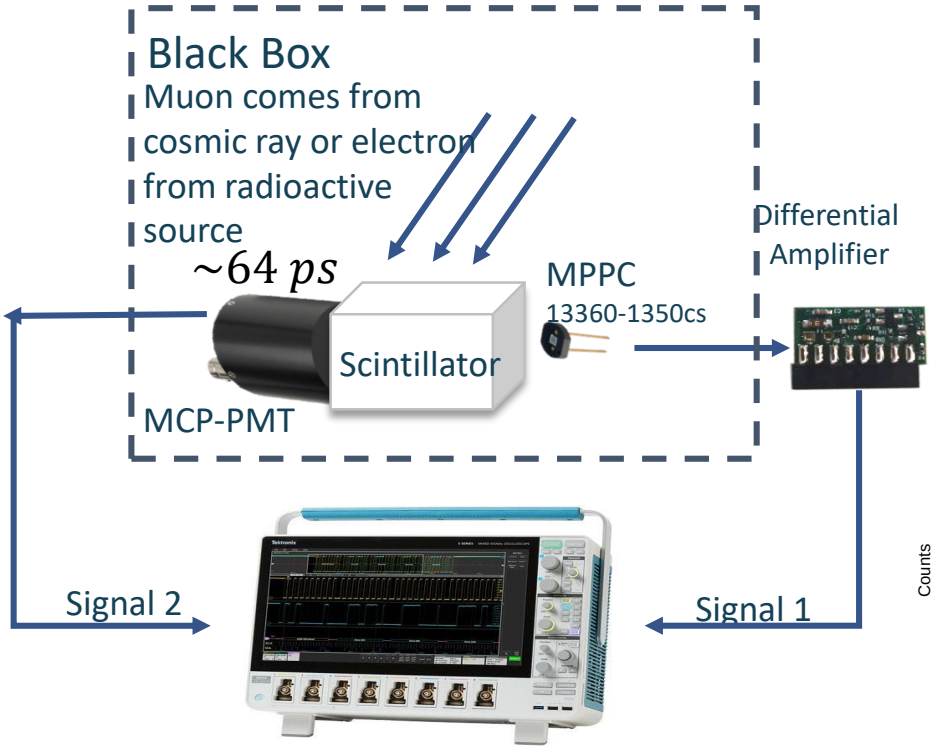
$\sigma_{acq} = 17.0\ ps$

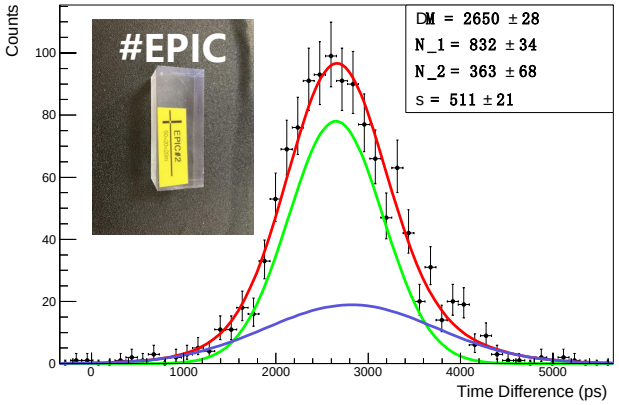


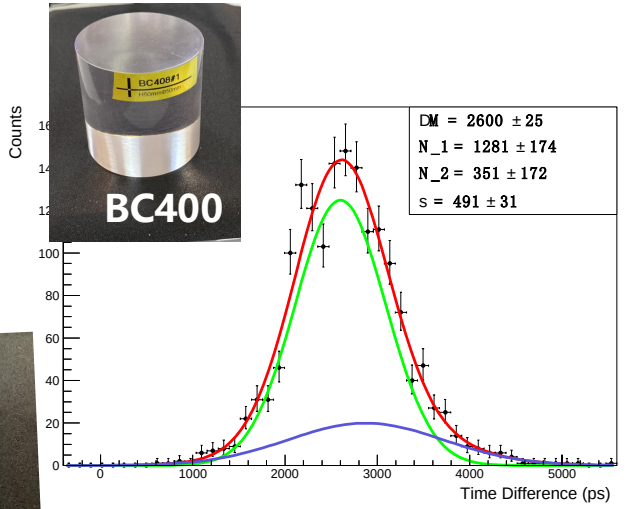


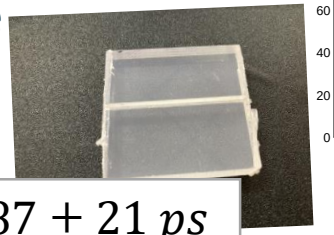
With 2 MPPCs was tested as well, we estimated $\sigma_{SiPM+pream}$~400 ps

Study with MCP-PMT









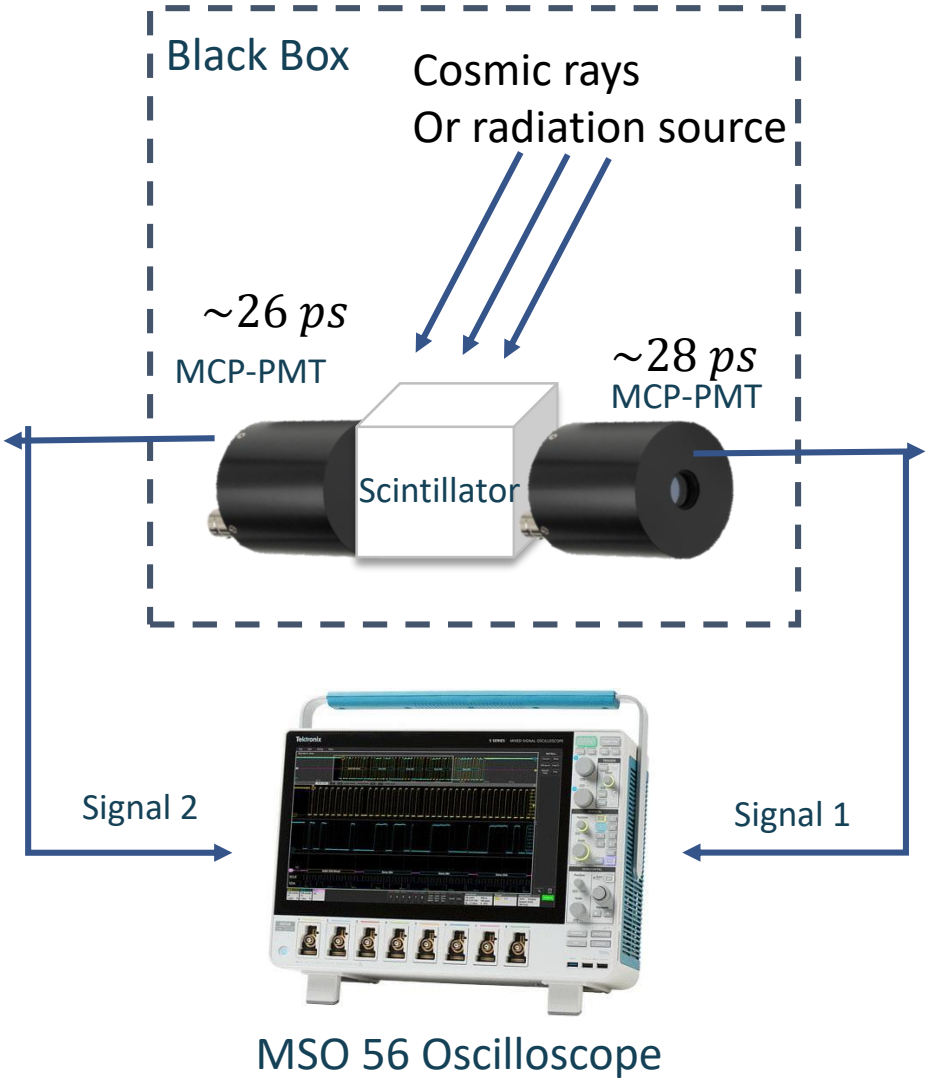
$\sigma = 487 \pm 21\ ps$

Confirm that:

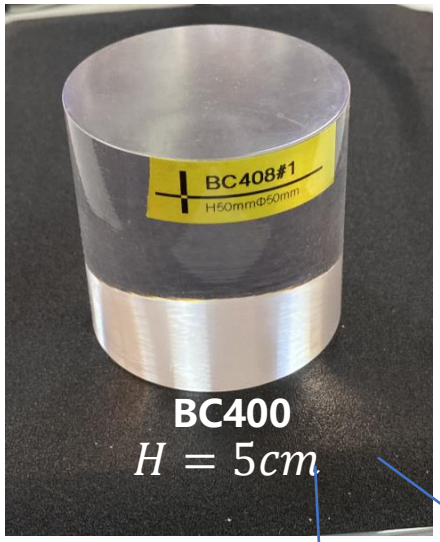
$\sigma_{SiPM+pream} \sim 400\ ps$

2 MCP+1 scint.

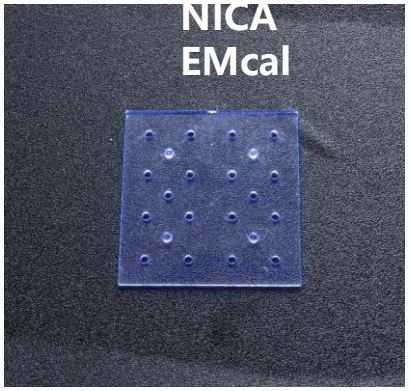
- Study with a setup of high time resolution.
- Uncertainty from geometry.

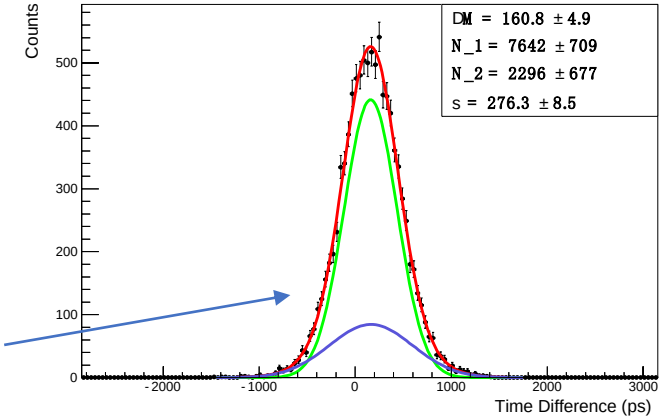


Reasonable results



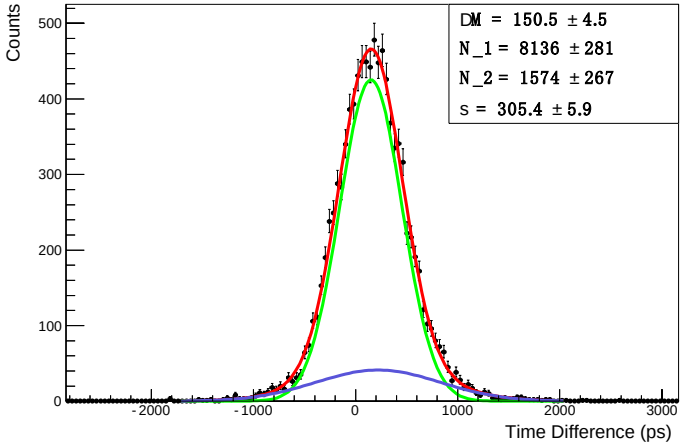
Cosmic Ray



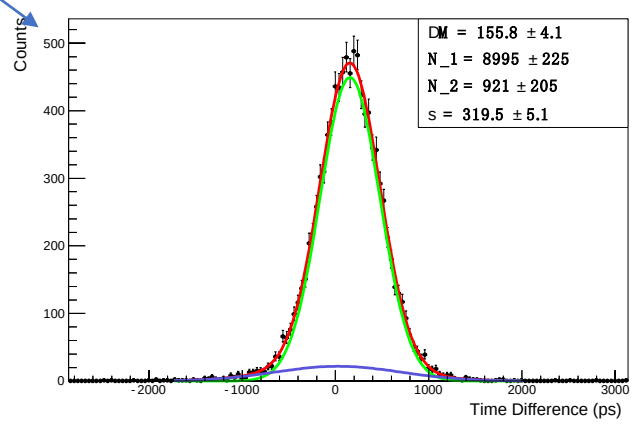


But, there could be uncertainty in photon generation

Cosmic Ray

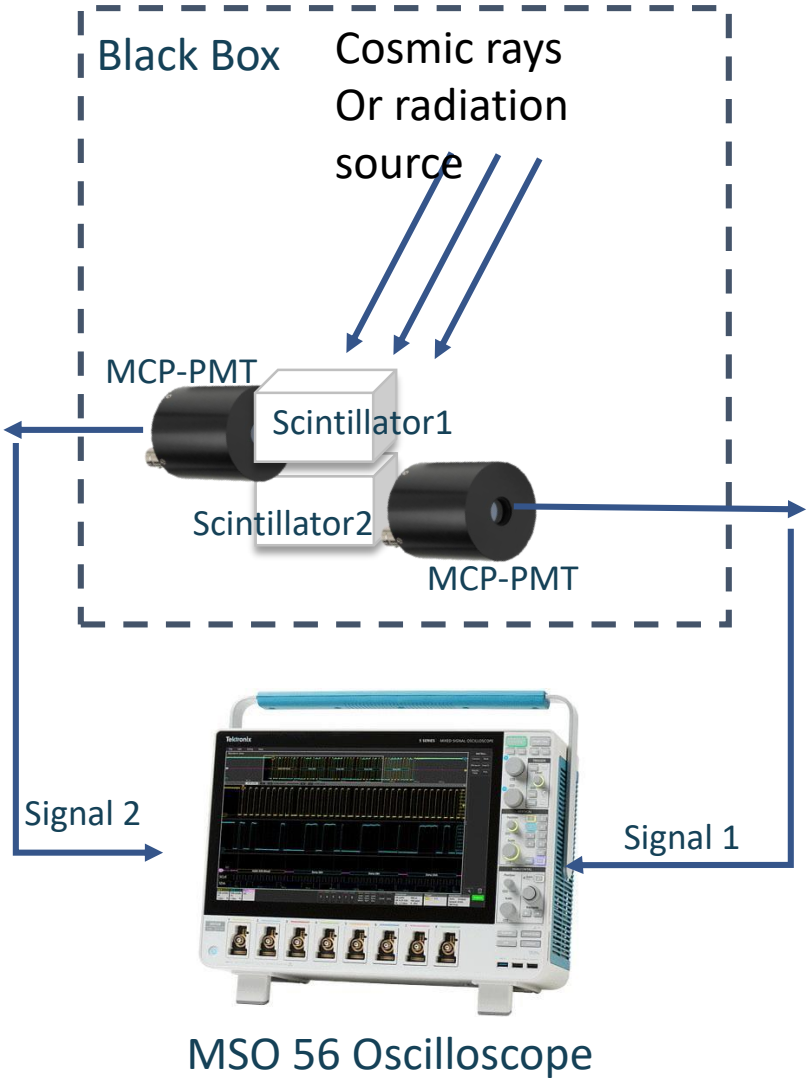


Cs^{137} in the middle



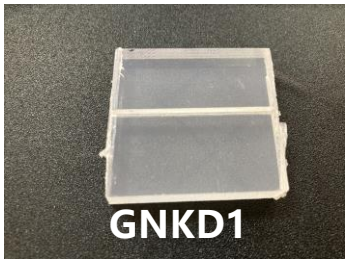
2 MCP+2 scint.

- Signals from 2 scintillators.
- Light block between scintillators.
- Measure the time difference at photon generation.
- Still have to fight against noise.



MSO 56 Oscilloscope

Only one BC400:
$305 \pm 6\ ps$



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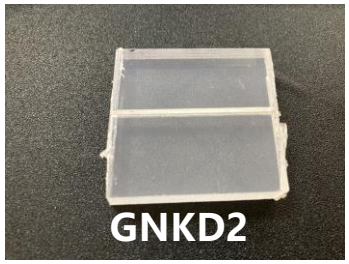
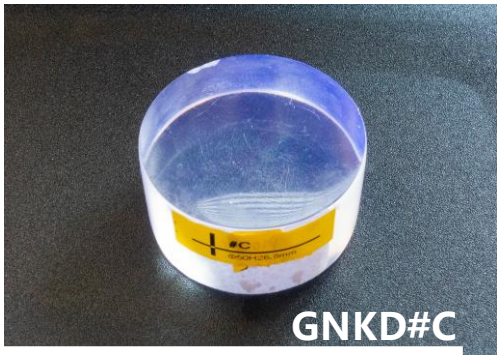
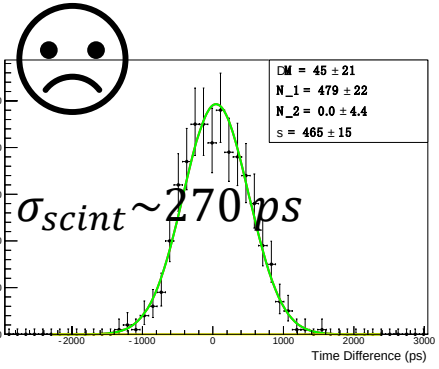
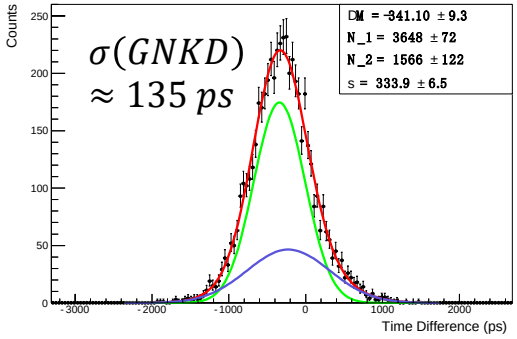
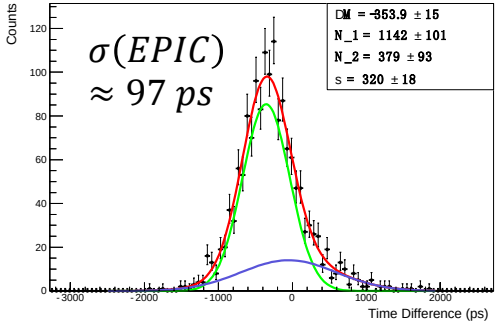






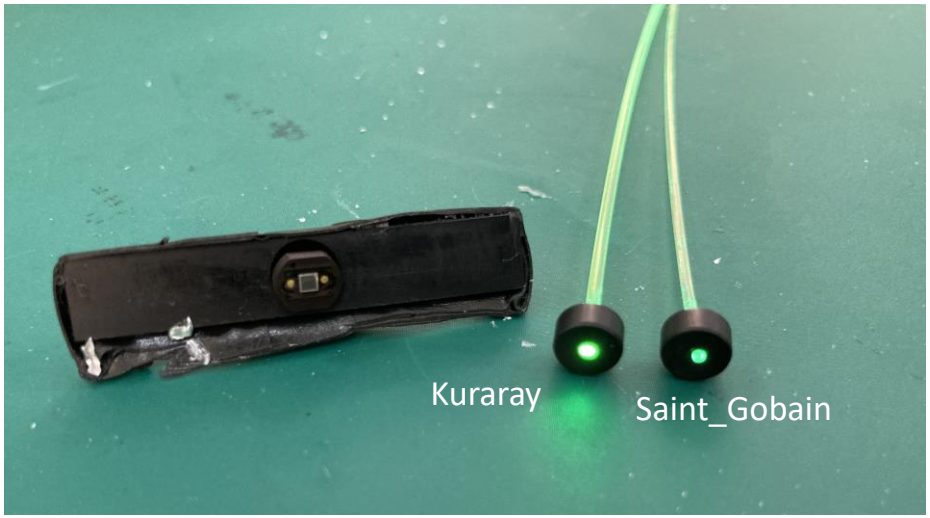


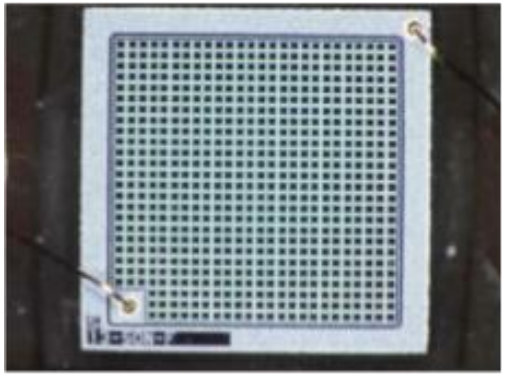


Some good samples!!!

We are asking companies to improve the quality of scintillator.

Kuraray WLS fibre





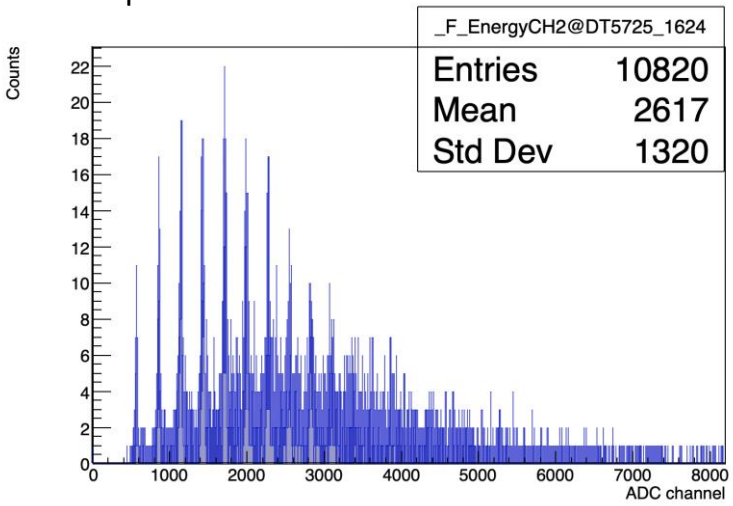
$1.3 \times 1.3\ mm^2$

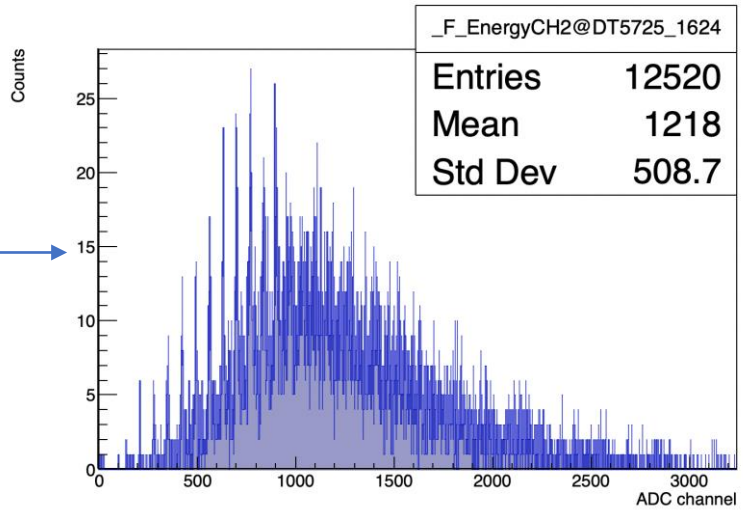
- Kuraray Y11 WLS, which is used in Belle II KLM.
- $D = 1.2\ mm$, matching the $1.3 \times 1.3\ mm^2$ MPPC surface well.
- About 200 SiPMs arrived Fudan from KEK, along with the fibre.

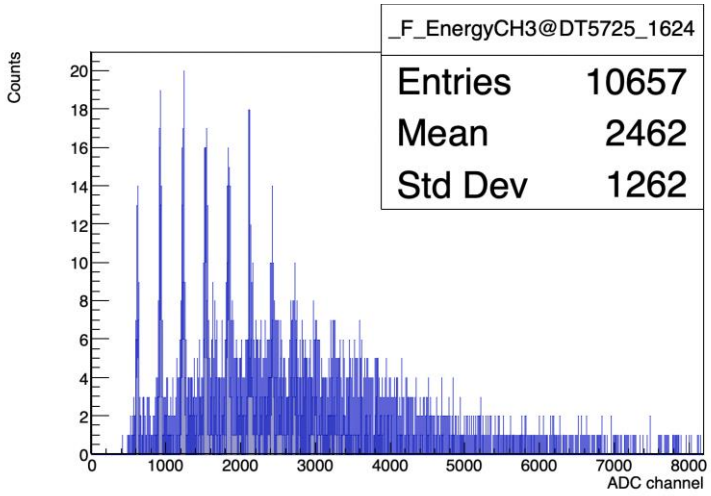
ADC measurement I

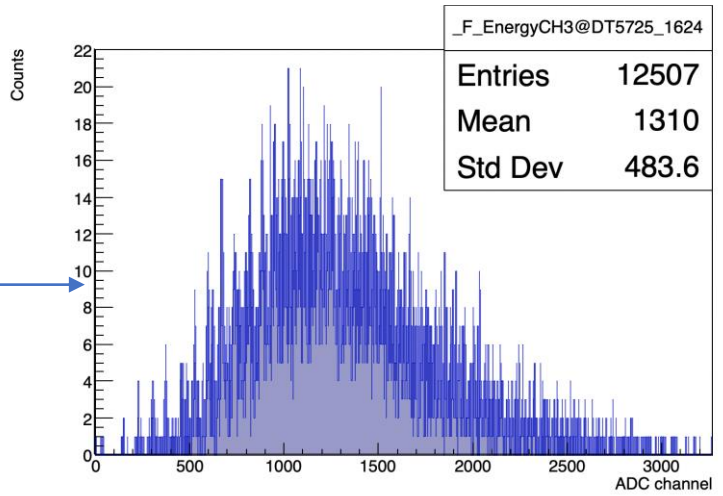
Trigger position： 0-150cm

Sample#1









Sample#2

Saint_Gobain

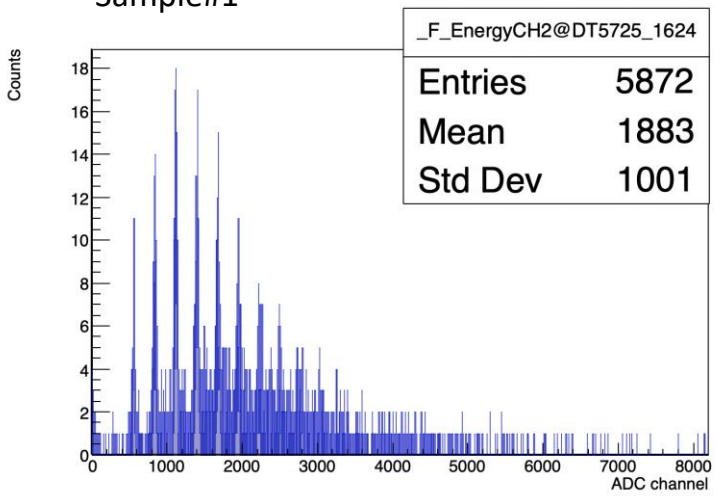
Kuraray

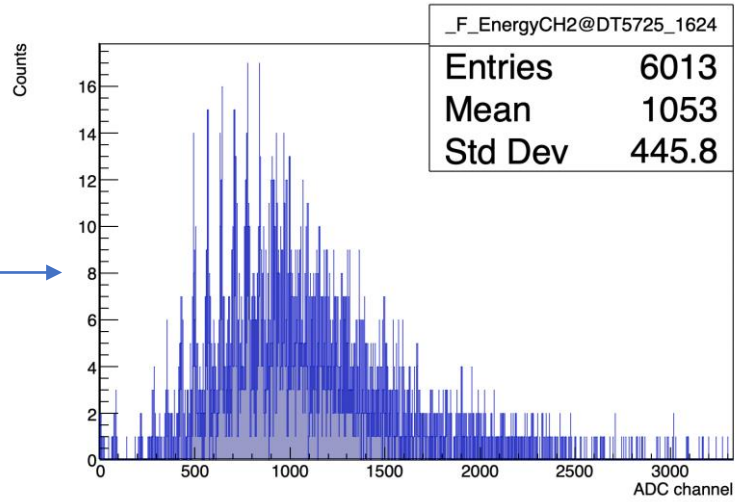
ADC/4

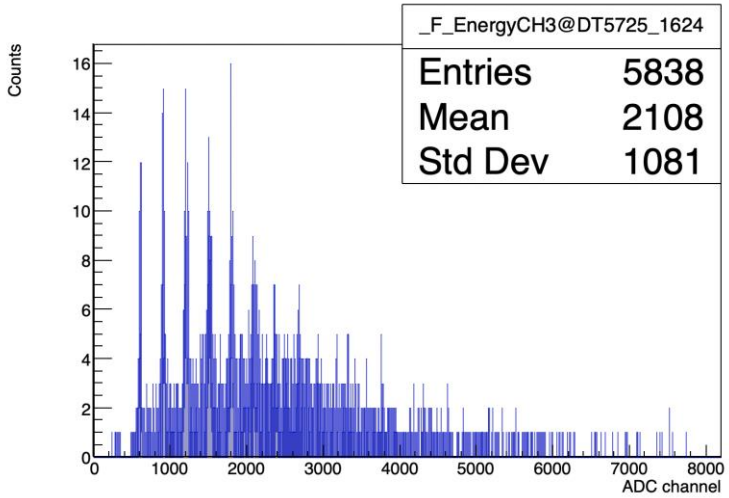
ADC measurement II

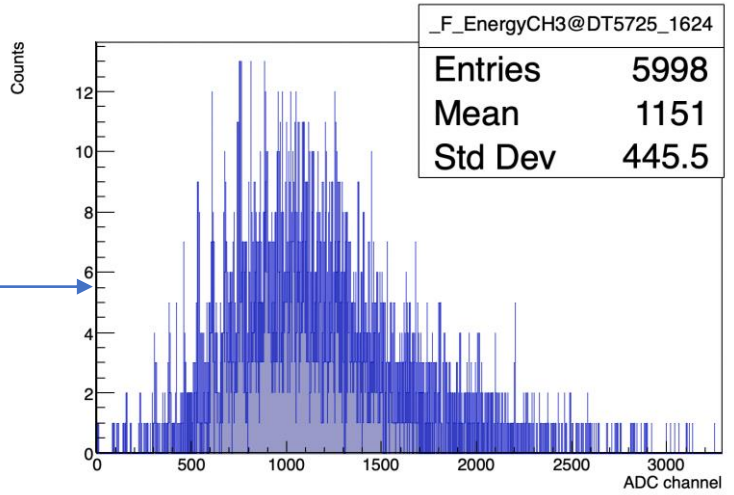
Trigger position: $70 - 80\ cm$ (middle)

Sample#1









ADC/4

Saint_Gobain

Kuraray

Sample#2

Comparison on WLS fibre

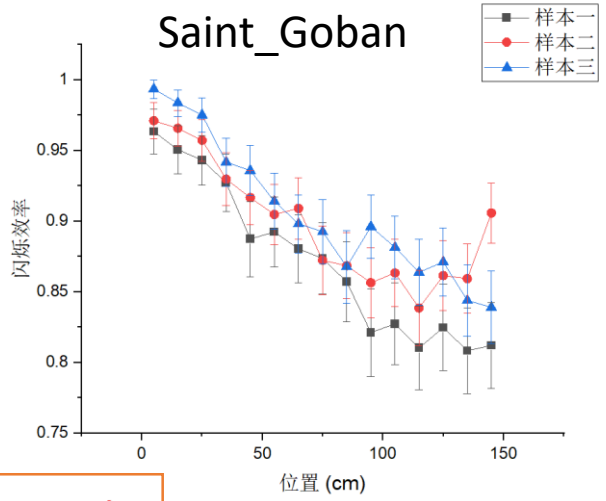
			Saint_Gobain			Kuraray			Ratio
Position	Time	Scintillation sample	Entries	Mean	Entries× Mean ($\times 10^7$)	Entries	Mean	Entries× Mean ($\times 10^7$)	Kurary/SG
$0-150\ cm$	1h	#1	10820	2617	2.83	12520	4892	6.12	2.16
		#2	10657	2462	2.62	12507	5260	6.58	2.51
$70-80\ cm$	10h	#1	5872	1883	1.10	6031	4216	2.54	2.30
		#2	5838	2108	1.23	5998	4608	2.76	2.24

Light collection:

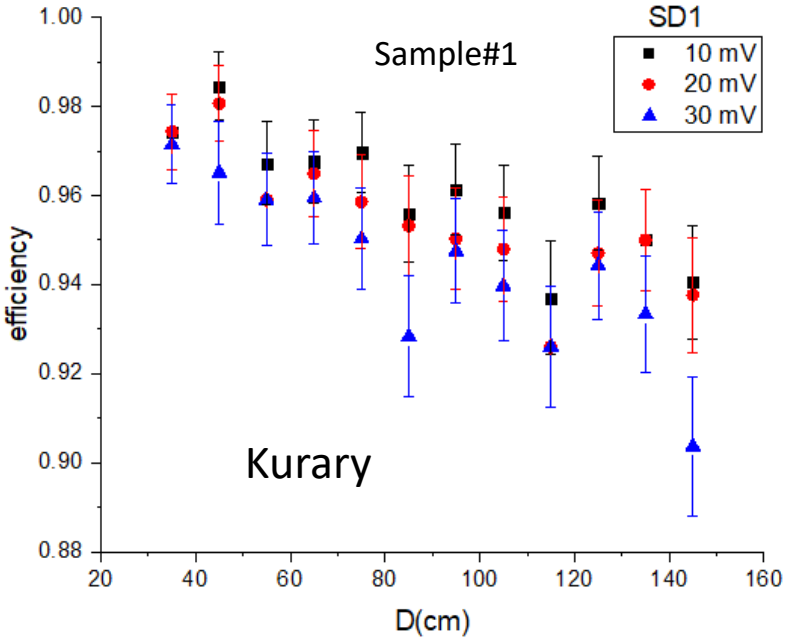
Kurary:Saint_Goban $\approx 2:1$

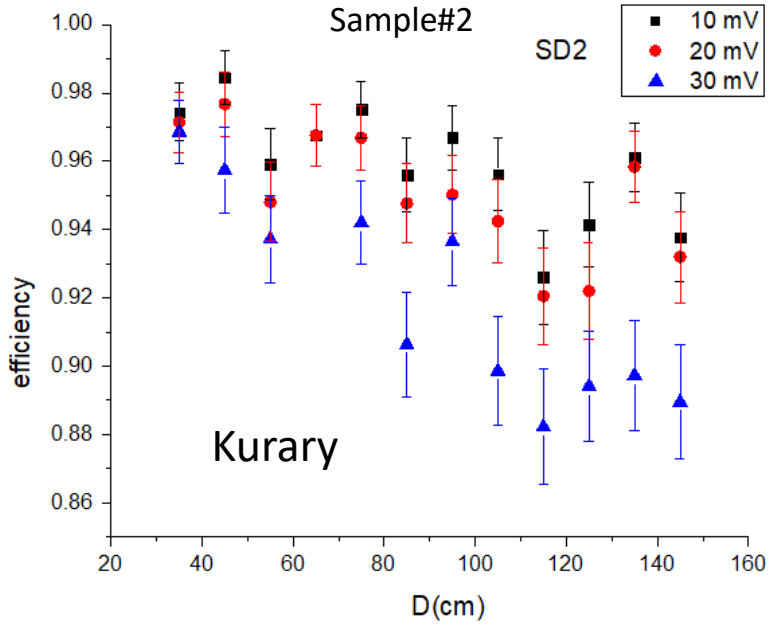
Efficiency study

Trigger Threshold： 4.5 p.e.



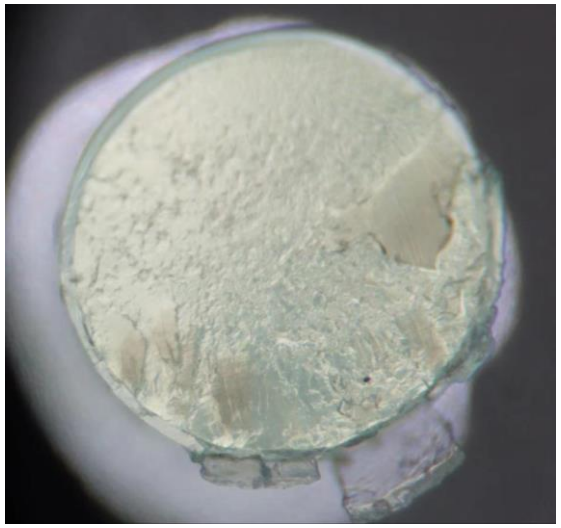
Good improvement on efficiency!

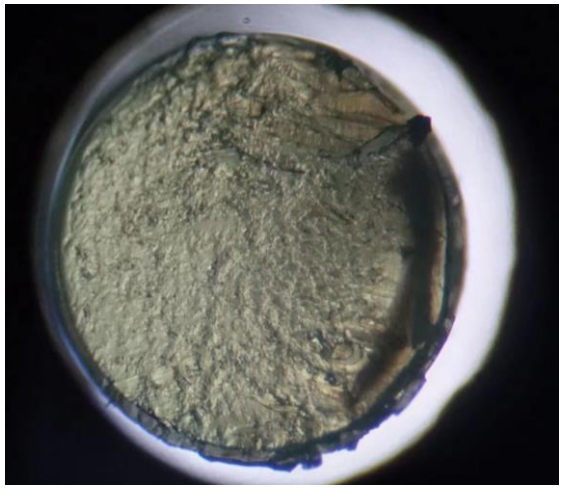




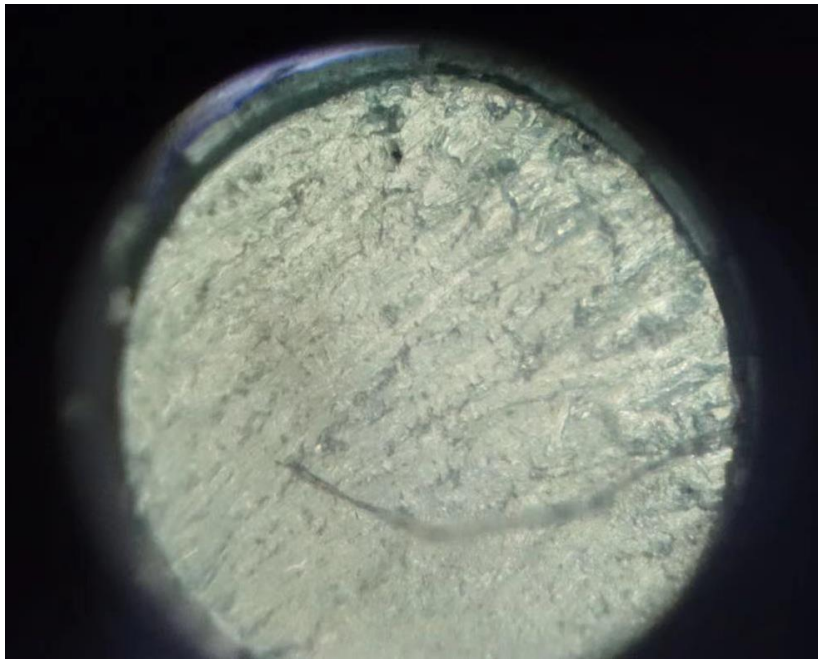
WLS fibre section

Cut with knife,
Random quality…



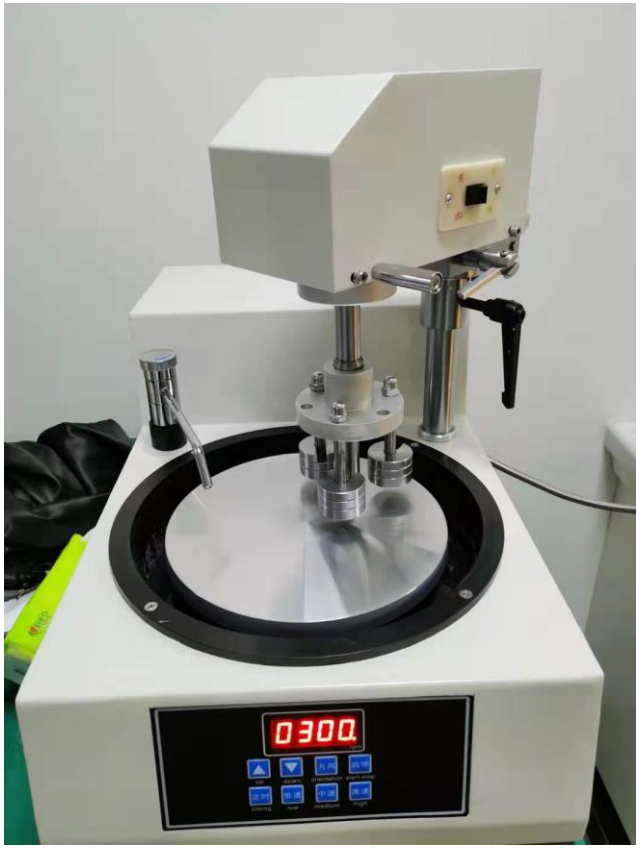


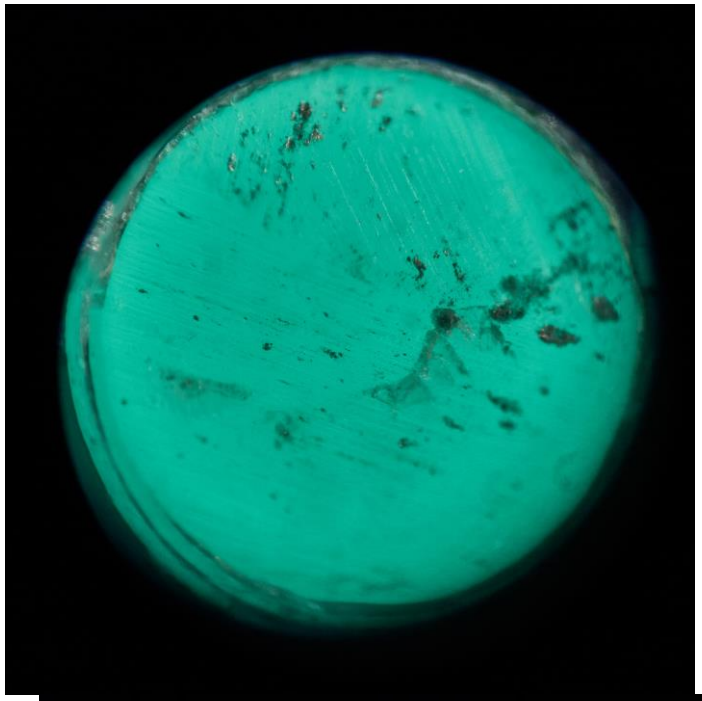
After surface grinding
With sandpaper

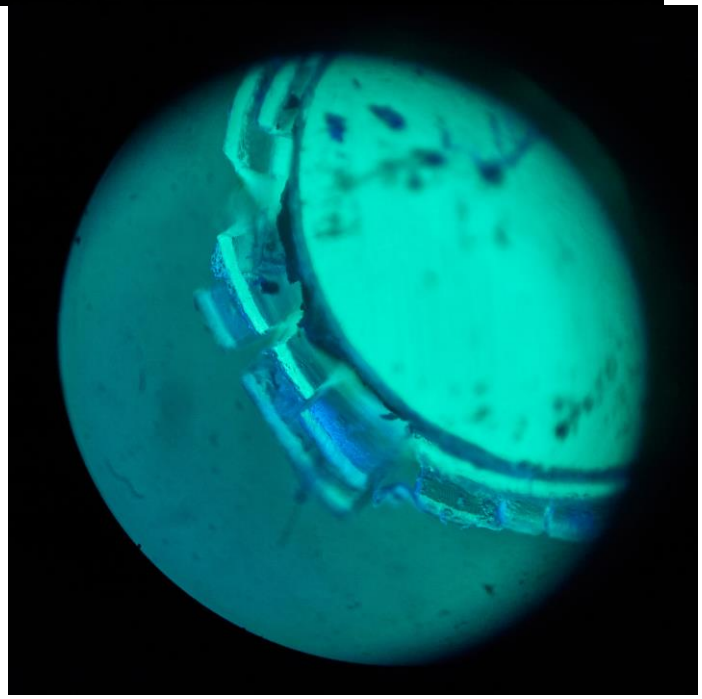


Need improvement on surface grinding for WLS fibre.

Polish for fibre







- First time to use the polish machine.
- Some improvement, but the surface is a bit dirty.
- Damage on the out cover layer.

Summary and plan

- Time resolution study performed, $\sim 400\ ps$ of the current KLM pream.
- Some good time resolutions achieved, and the one of regular scintillator should be well below $500\ ps$.
- Kuraray WLS fiber has better performance.
- The surface of the fibre section could be polished with machine.
- Plan to do more testing with new scintillator samples and the Kuraray fibre.

Thank you!