Fiber Attenuation length test

Ye Tian, Mengjiao Li

Shandong University

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Fiber Attenuation length test

- Two kinds of fiber are tested: BCF98-SC(clear fiber) and BCF91A-SC(WLS fiber)
- The multi-cladding fiber should has a little worse attenuation length (some photons in MC fiber have larger angle, which means longer travel distance in fiber)
- Since the space restriction of light-tight box, the long fiber must be bent with several turns, and the bending diameter in test is always larger than 30cm(30-40cm)
- The light loss should contribute from both attenuation length and bending loss

Fiber attenuation calculation

Include the effect of both attenuation length and bending loss:

$$A' = A \cdot e^{-\frac{x}{L}} \cdot e^{-\frac{x}{R \cdot f(R)}}$$

Where

- A and A’ is the input and output signal
- x is the length of fiber
- L is the attenuation length
- R is the radius of fiber bending
- f(R) is “the light loss radian” from bending, similar as L, need to be acquired from test

Bending loss test of clear fiber

- Method one: **50cm fiber**, tested **straight and 0.5 turn** with 30cm bending diameter.

Result: No significant different is found base on our measurement accuracy.

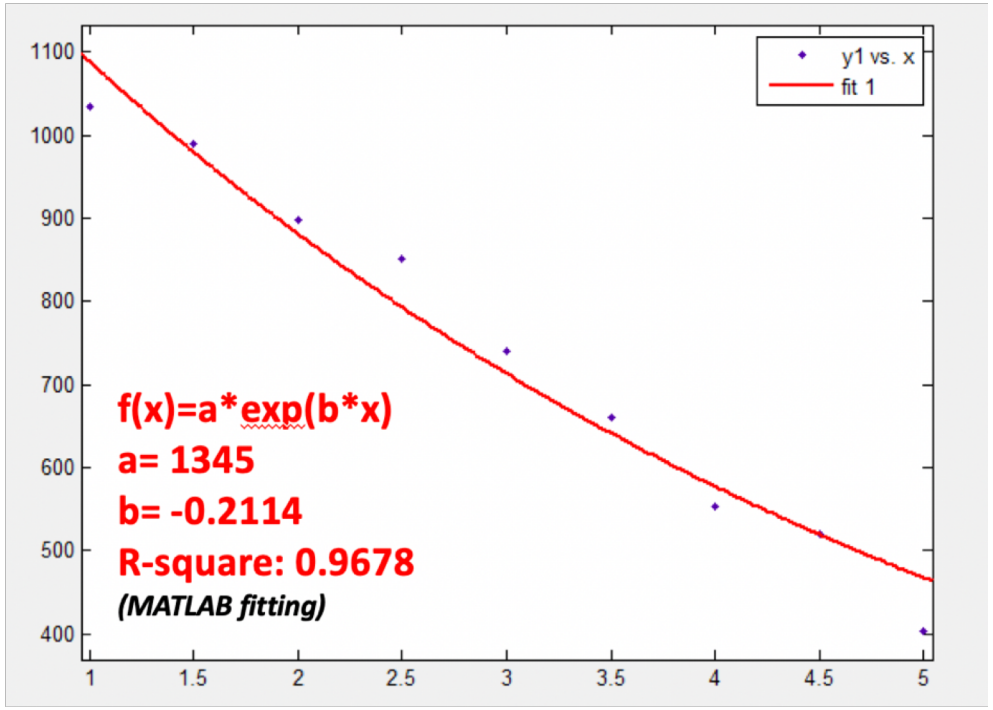
- Method two: **3m fiber**, tested with different bending diameter and turns.

Result: still no significant difference.

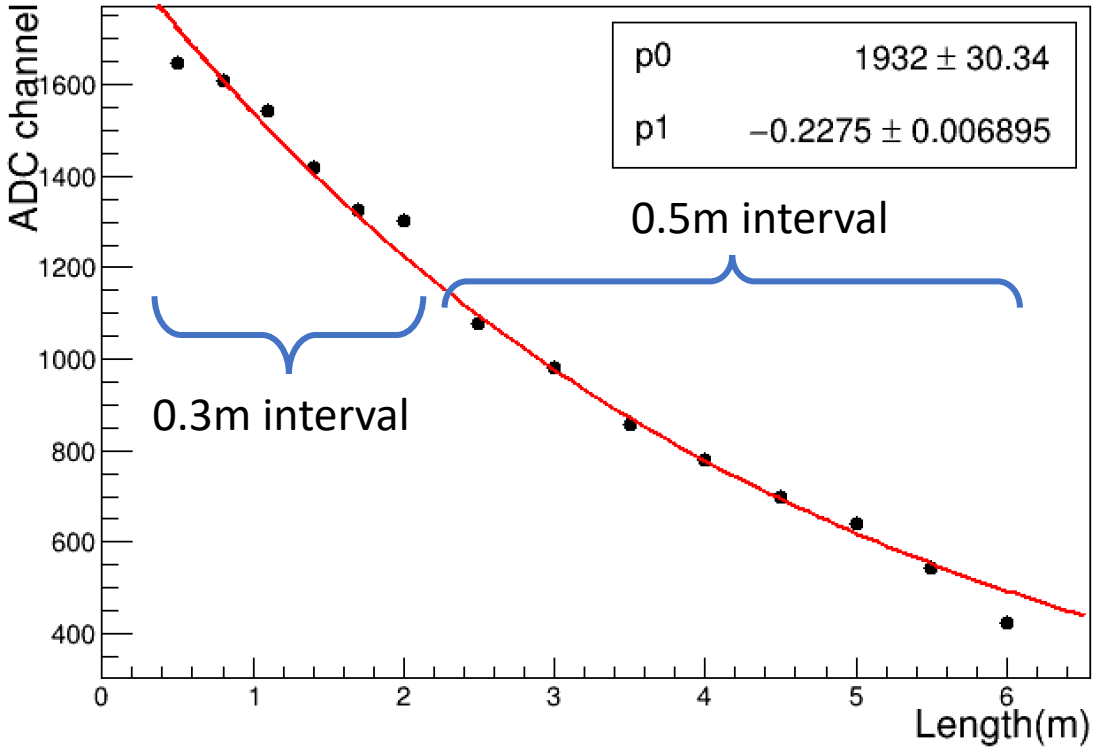
Diameter(cm)	Turns	ADC channel (repeat several times)
15	5	469, 475
22	3	468, 474
30	2.5	472, 473, 478

Attenuation length of clear fiber BCF98-SC

The result showed two weeks ago



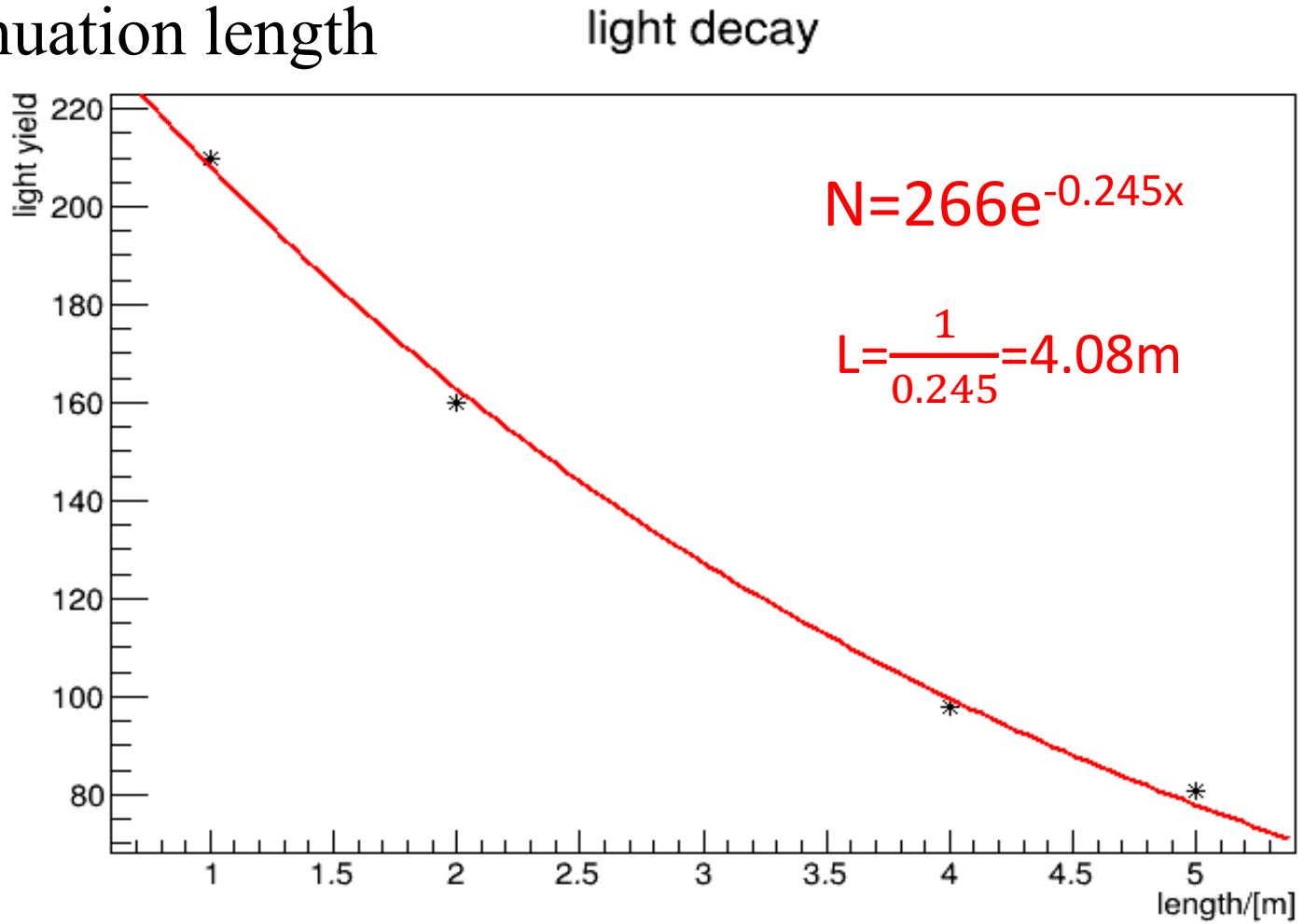
New result



Attenuation length L=1/(0.22)=**4.55m**

Previous result in presentation: “fiber light decay 6-13-2019”, using fibers with different length

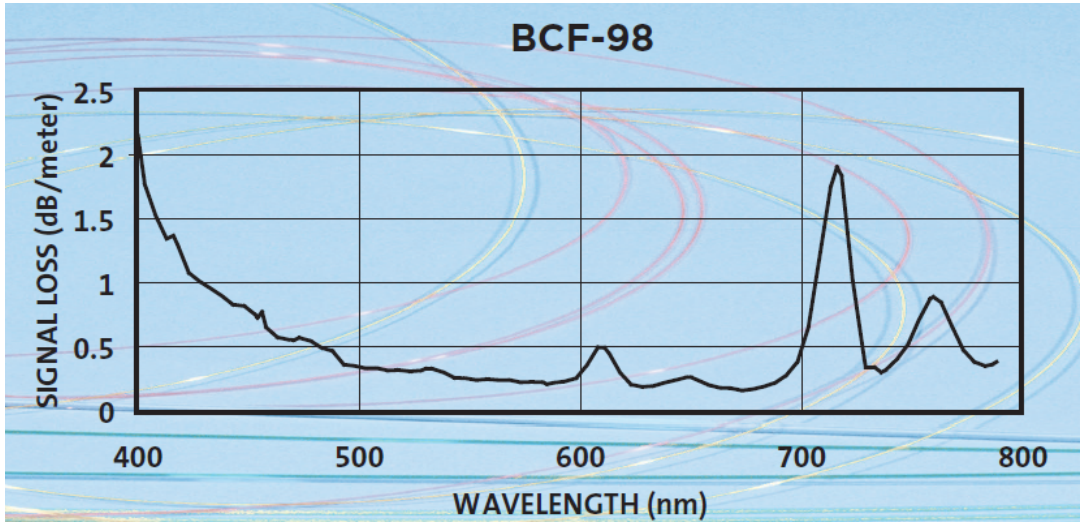
Attenuation length



By using $N=N_0 e^{lx}$ and $L=\frac{1}{l}$, we can get the clear fiber attenuation length : $N=266e^{-0.245x}$

and $L=\frac{1}{0.245}=4.08m$

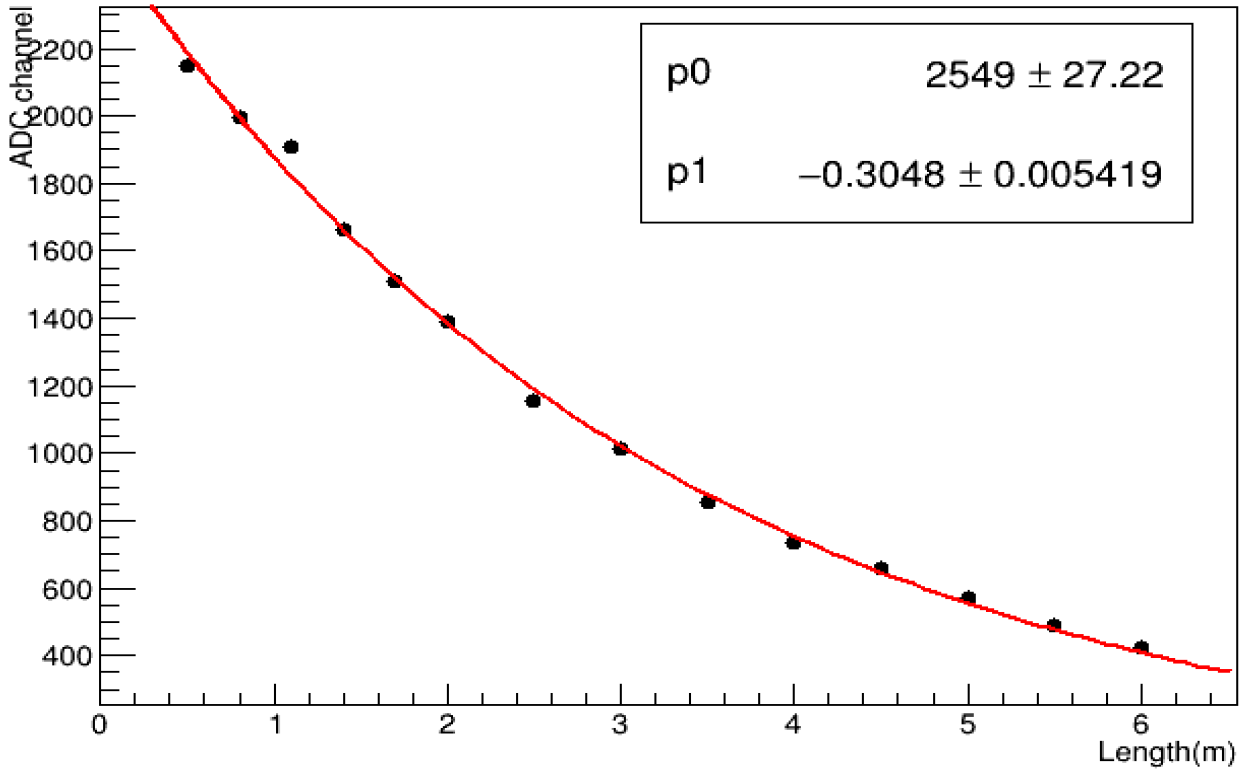
Attenuation plot from Saint Gobain Brochure



dB = 10 * log N, N is attenuation ratio.

For clear fiber with 495 nm wavelength, the dB/m is -0.5, which equal to the N = 0.89. $(0.89)^x = 1/e$, **x=8.68m**.(amplitude??)

Attenuation length of WLS fiber BCF91A-SC



Attenuation length L=1/p1=**3.28m**

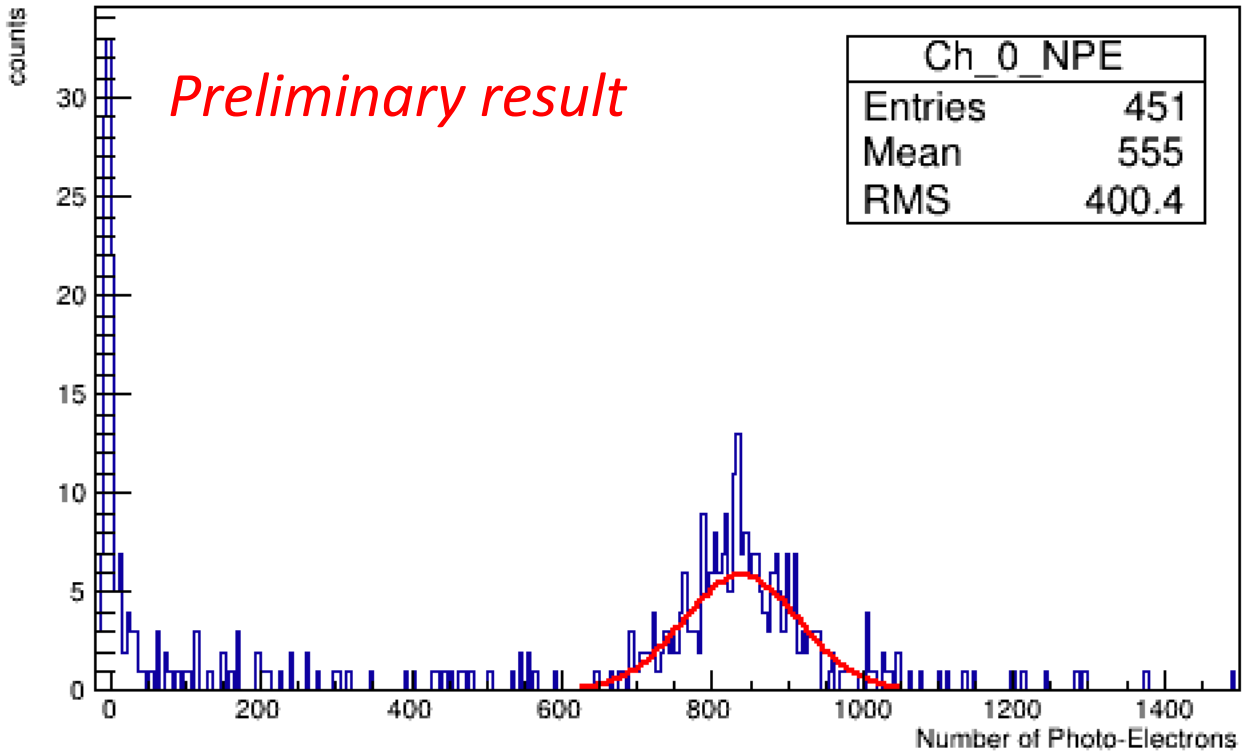
- The WLS fiber has WLS material will re-absorb the photon, short attenuation length is reasonable.
- Attenuation length on brochure: >3.5m. Similar result with brochure, why clear fiber is different?

Summary

- The bending loss for diameter larger than 15 cm could ignored(more test with short radius will be test soon)
- Attenuation length of BCF98-SC is about 4.55m
- Attenuation length of BCF91A is about 3.28m

Backup

- SDU #6 is built
- Test result will be shown next time

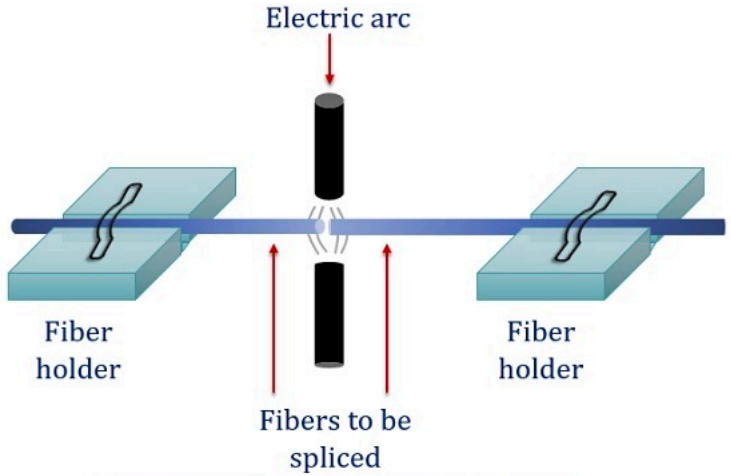


Peak is 838, this result has problem of large signal readout, the actual value will be a little larger.

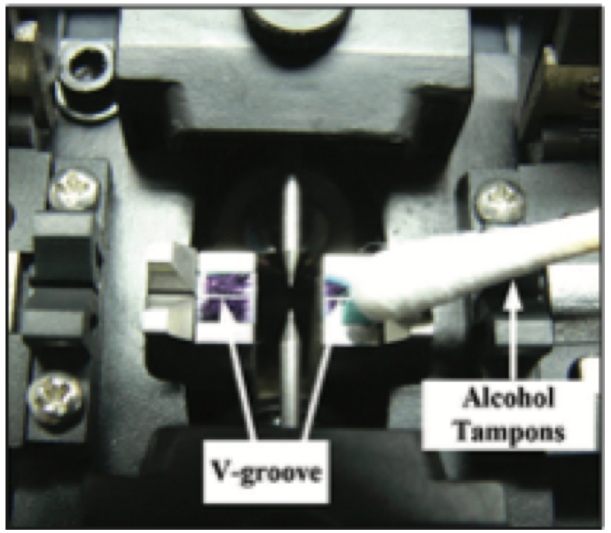
A commercial machine of fiber Fusion Splicer

- Portable commercial machine
- Vendor tell me that it works for 1mm diameter plastic fiber
- Automatic adjust the fiber position, fusing fiber and check fused fiber quality
- Less light loss <10%
- Cheap price: ¥5000

- It seems fusing is not practical and convenient for our long fiber design, but it may be a candidate choice for other purpose.



Fusion splicing of optical fiber



Two fusion article published 1991 and 1993:
https://www.sciencedirect.com/science/article/pii/0168900294908524
https://www.sciencedirect.com/science/article/pii/016890029290650S?via%3Dihub

I think connector method should be developed easier than fusion method that is more advanced and less loss. But why few detector use fusion method now?