Pb/SciFi: SciFi measurements and beam tests

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Barrel ECAL DSC, ePIC Collaboration Meeting, January 11, 2024

Fiber Specifications

- **Method:** mutually acceptable between Project & Contractor
- **Specs:**
  - Light yield shall exceed 8000 photons/MeV.
  - Diameter mean and variation shall be 1.00 mm, RMS =<0.02 mm.
  - Attenuation length for blue light > 4m.
  - Batch to batch or lot to lot variation of light yield =<15%.
  - Batch to batch or lot to lot variation of attenuation length =<10%.
  - Delivery method in canes. Length of fibers 4.55 meters +/- 0.01m.

Highlights in 2023 & Plans for 2024

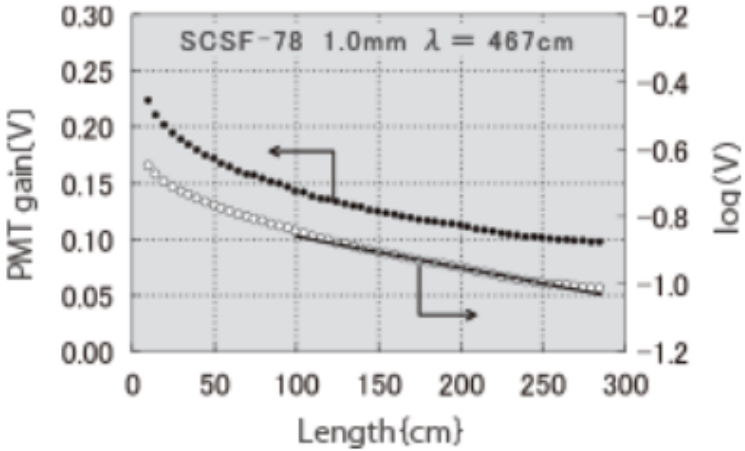
- **Fiber Testing**
  - Spectrophotometer station**:** λ; recalibration needed. Jan/Feb 2024
  - **Photodiode station:** λ; one- and two-exp analysis. Feb 2024
  - Npe station @ Regina (SiPM)**:** Npe & λ; redo setup and retest. Feb 2024
  - **Npe station @ Korea (SiPM):** λ; single- and double-clad Ongoing
- **Beam/Cosmics Tests:**
  - **Baby BCAL at JLab:** positron analysis Eres & Npe. Update in next 2 weeks
  - **Baby BCAL at ANL:** cosmics and readout. Starting soon

Attenuation Length Calculation

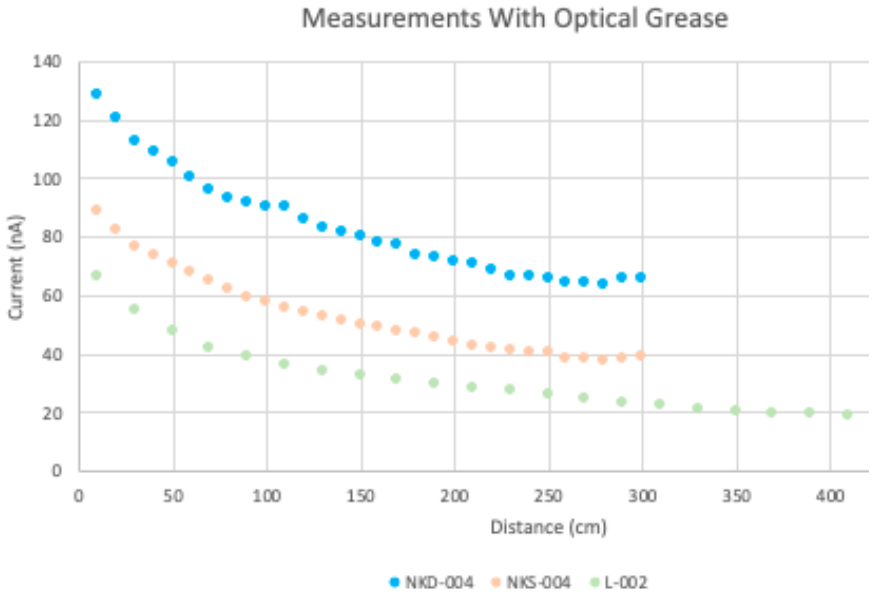
I - intensity
I_0 - initial intensity
x - distance along fiber
λ - attenuation length

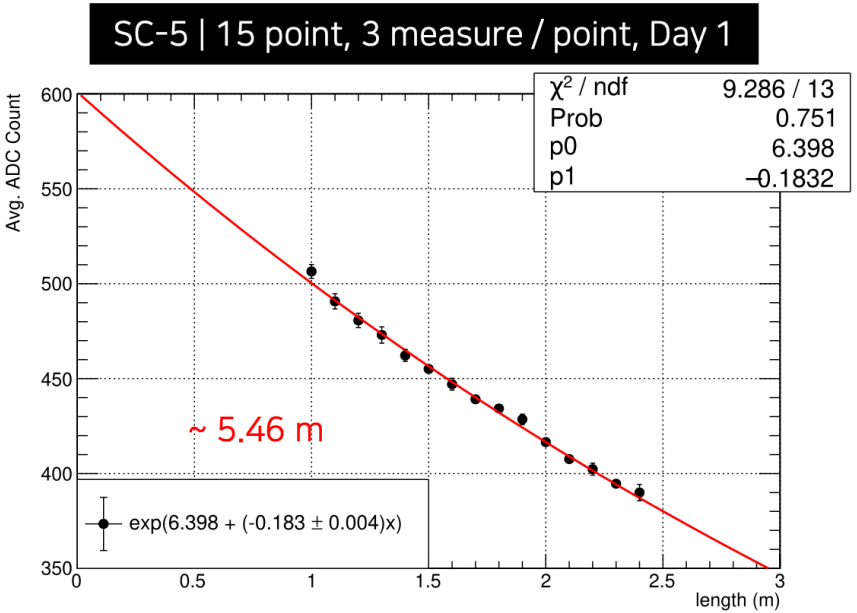
$$I = I_0 \cdot e^{\frac{-x}{\lambda}}$$

- Adjusted attenuation length calculation method to correspond with Kuraray's documentation:
- Attenuation length of single and double clad fibers should be > 400.0 cm when fit using a single exponential function between 100.0 and 300.0 cm



Photodiode Station - NKD, NKS, L fibers tested





Attenuation Length Comparison (100-300cm)

Regina

NKS-00i	λ (cm)	L-00i	λ (cm)	NKD-00i	λ (cm)
001	431±17	001	412±17	001	620±41
002	480±22	002	386±13	002	528±24
003	486±16	003	377±8	003	505±21
004	441±46	004	406±8	004	544±17
005	460±13	005	439±8		
001G	432±27	001G	425±8	001G	641±67
002G	532±42	002G	407±9	002G	529±41
004G	449±17	004G	567±66	004G	531±29

Korea

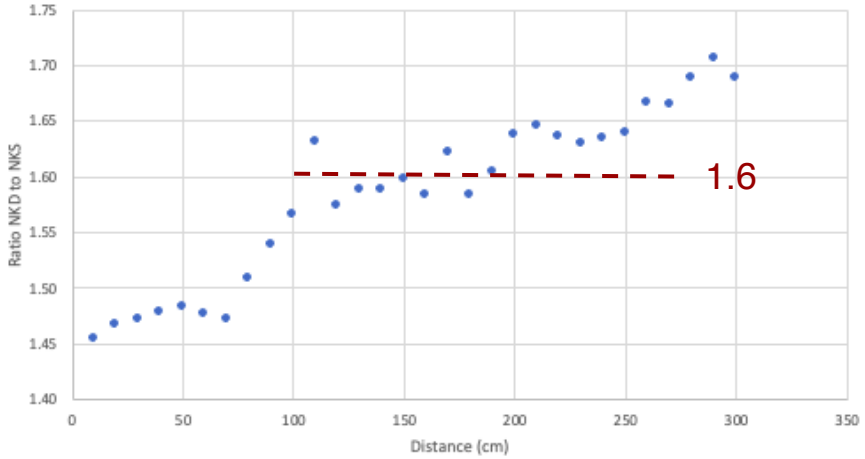
Fiber Quality Test
Summary & Plan

Fiber	Atten. Length (m)	Fiber	Atten. Length (m)	Fiber	Atten. Length (m)
SC-1	4.61	SC-5 (1)	5.46	DC-1	4.85
SC-2	5.78	SC -5 (2)	5.35	DC-2	5.13
SC-3	4.90	SC -5 (3)	5.05	DC-3	4.76
SC-4	5.35			DC-4	4.74

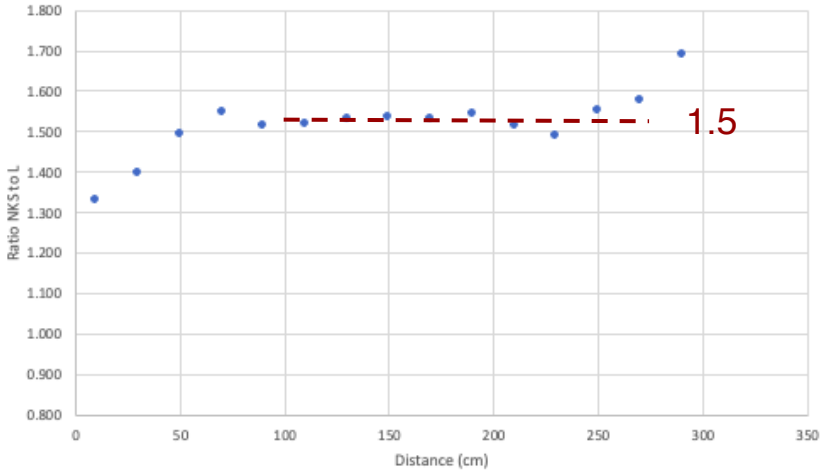
	SC	DC
Avg.	5.19 m	4.87 m
Stdev.	0.45 m (~9%)	0.18 m (~4%)

Photodiode Station - baseline used in simulations

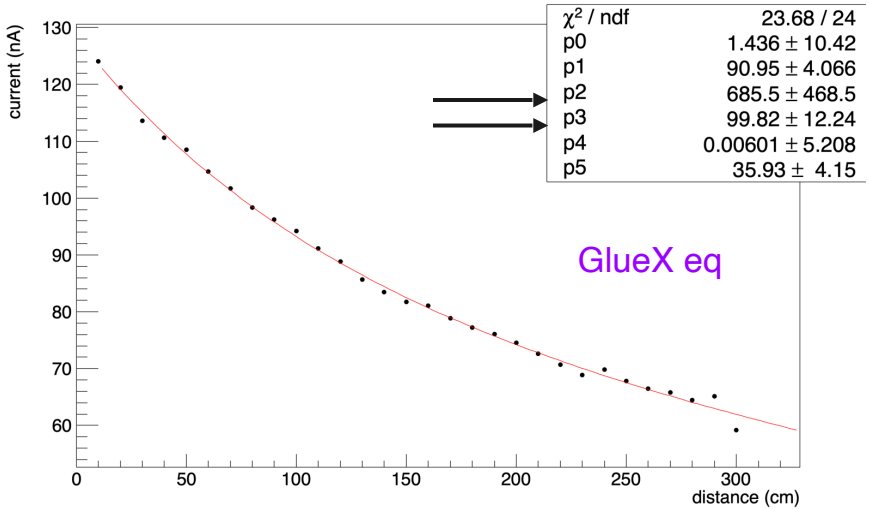
NKD/NKS



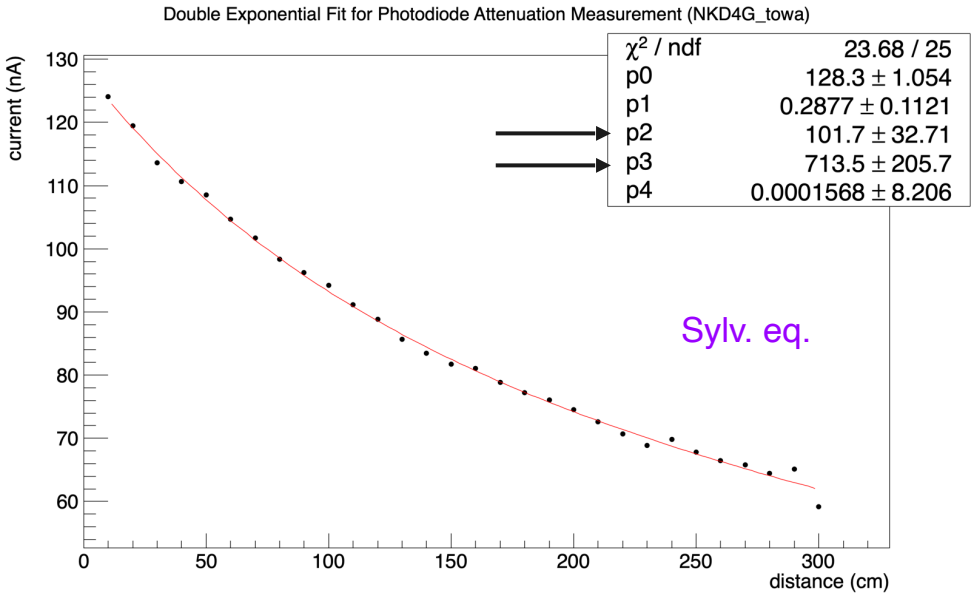
NKS/L



Photodiode Station: two-exp fit; GlueX vs Sylvester

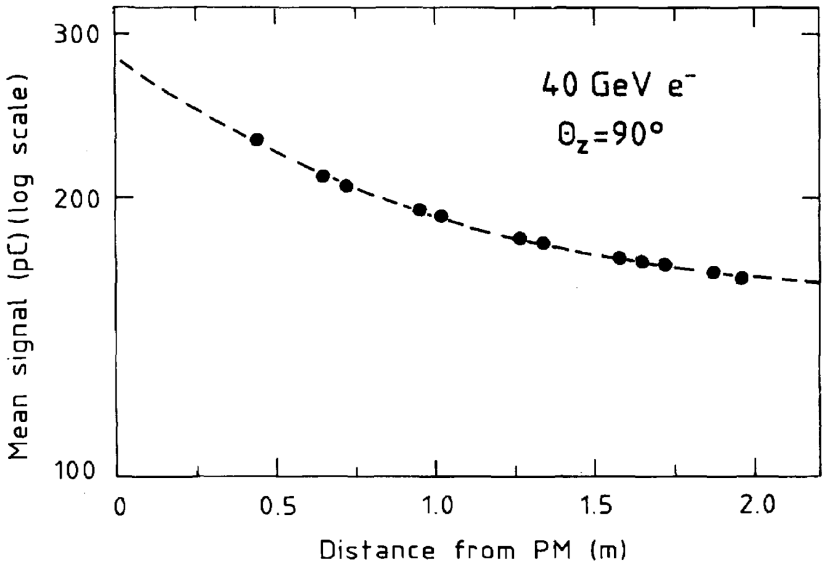


$$I(d) = I_0 + \alpha_1 \cdot e^{-(d-d_0)/\lambda_1} + \alpha_2 \cdot e^{-(d-d_0)/\lambda_2}$$



$$I(\Delta) = I_0(\alpha e^{\Delta/\lambda_1} + (1-\alpha)e^{\Delta/\lambda_2})$$

Fiber End Treatment



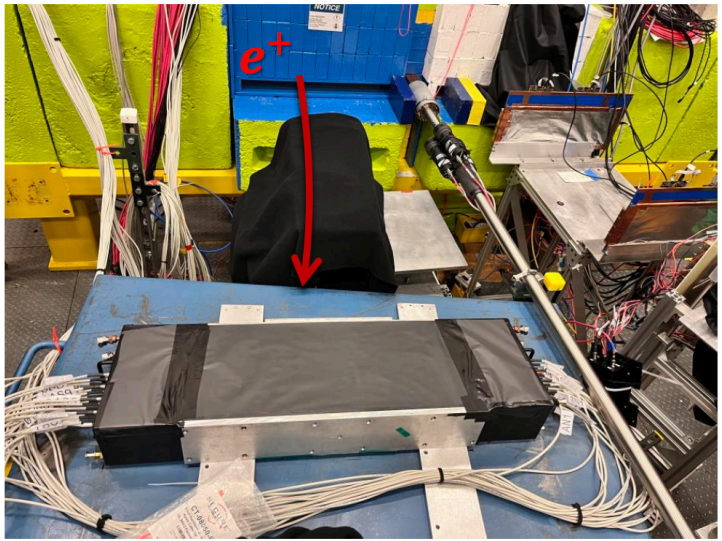
SPACAL Calorimeter

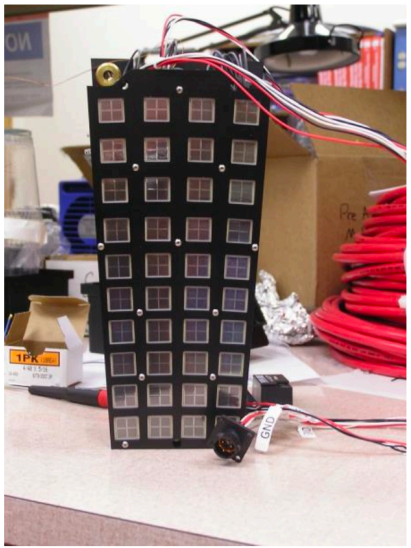
$$I(z)\,[\mathrm{pC}] = 102\,[e^{-z/11.0} + 0.85\,e^{(z-4.4)/11.0}] + 124\,e^{-z/0.77}$$

long reflection short

Baby BCAL Beam Tests & Cosmics

View from above





Hall D/GlueX

Baby BCAL Beam Tests & Cosmics

March e^+ Beam

- GlueX fADCs and DAQ
- e^+ energy 3-6 GeV

- Goal: resolution studies & $N_{p.e.}$ extraction
- Upstream hodoscope to measure e^+ energy and trigger
- Largely uncalibrated prior

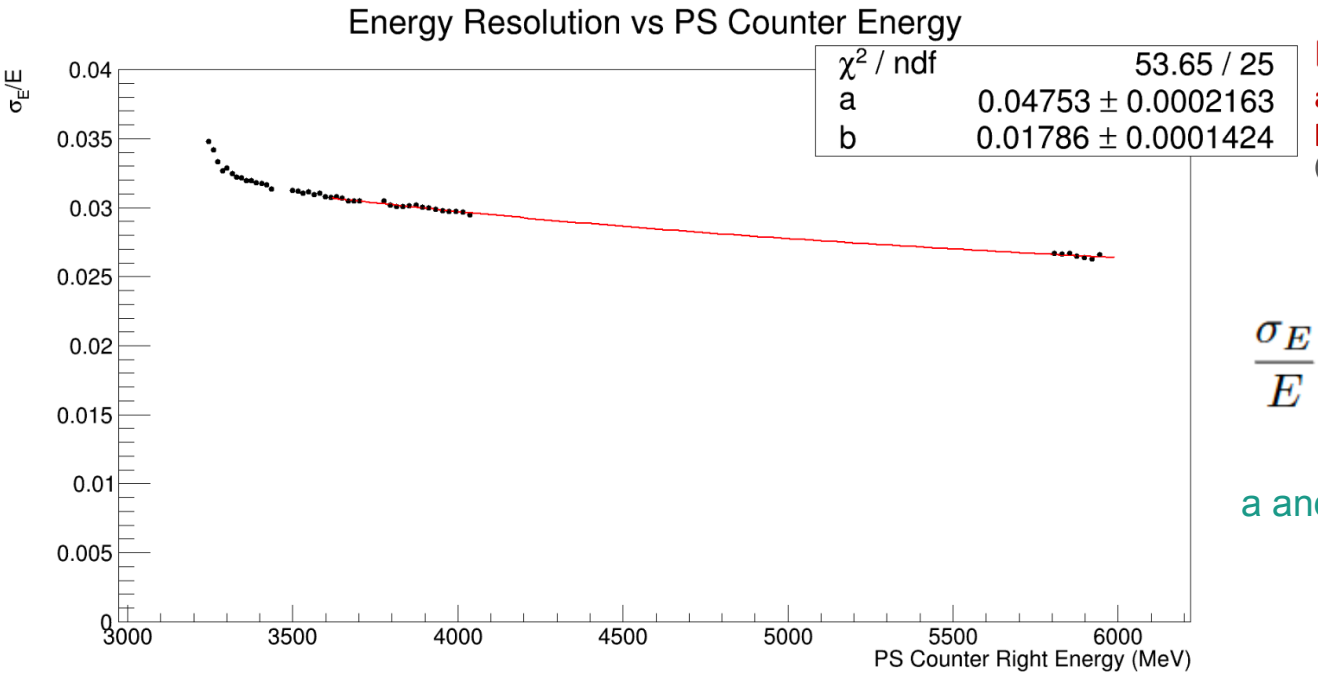
Fall Cosmics

- GlueX fADCs and DAQ
- Trigger on cosmics

- Goal: better gain determination for low occupancy channels
- Scintillator paddles above/below provide trigger
- Better geometric coverage for calibrations

Fed into ANL Simulations

Baby BCAL Beam Tests & Cosmics



BCAL NIM (2018):

a: 0.052

b: 0.036

(measured via symmetric etas in $\gamma p \to \eta\pi^+\pi^- p$)

$$\frac{\sigma_E}{E} = \frac{a}{\sqrt{E(GeV)}} \oplus b$$

a and b are fairly stable over runs

Summary

- Discussion
  - Attenuation length > 4m; Kuraray more light than Luxium single-clad
  - To be evaluated?: Luxium double-clad; Kuraray roll-habit
  - Npe absolute numbers (Regina & Korea)
- **Fibers measurements**: effort will continue in 2024
- **Baby BCAL**:
  - Beam tests Eres & Npe: final results by March
  - Cosmics and readout efforts at ANL
- GlueX-BCAL Npe & SiPM Dark Rate: summer