bECAL Fiber Tests + Cosmics @Regina - Update 6

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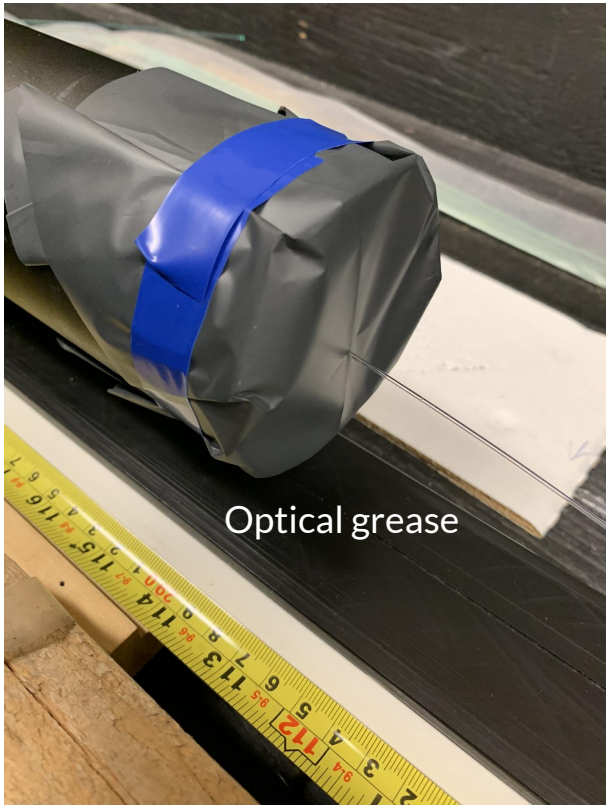
Presentation to the weekly Barrel ECAL Meeting, September 19, 2023

Timeline - September/October

- **Past Plan**
  - July & August: Spectrophotometer, Photodiode, Npe tests
  - August 29: Presentation to bECAL Group; discussion of results
  - August 30-Sept 4: organization of evidence for Sept 13 Review
- Moving Forward
  - Sep 18: **Npe station**: measure more double-clad fibers
  - Sep 25: **Spectrophotometer station**: recalibration
  - Oct 02: **Photodiode station**: measure more double-clad fibers
  - Ongoing: **Baby BCAL Hall D beam and cosmics**; shipment

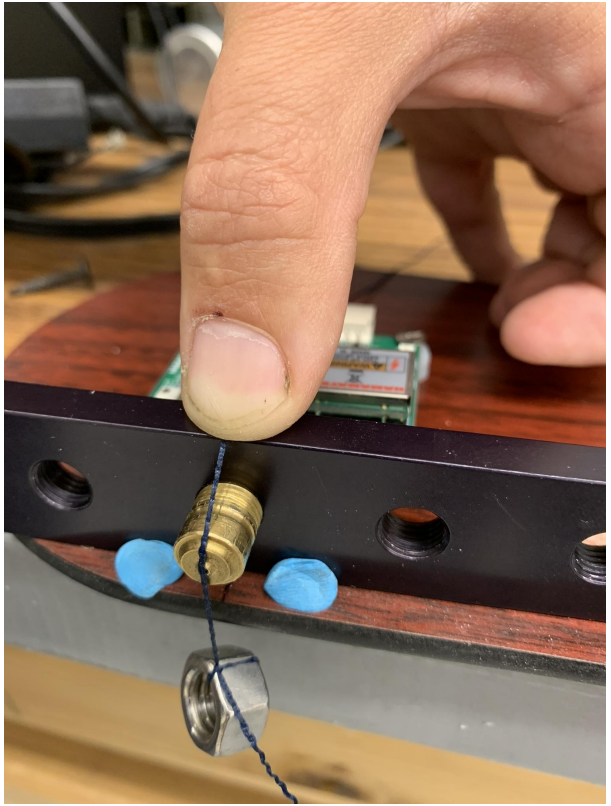
Npe Station - Setup PMT

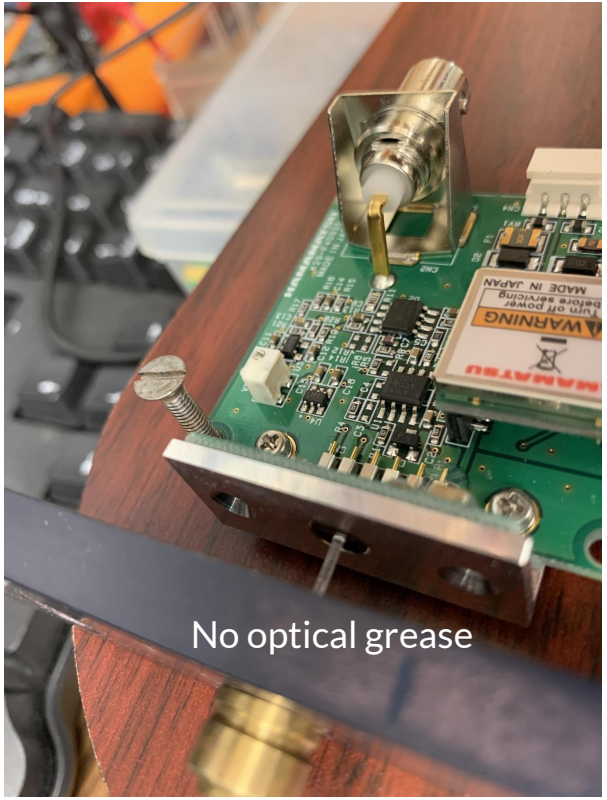
- puck board and runner
- Stronger ^{90}Sr
- Ambient light control
- Coincidence with PMT



Npe Station - Setup SiPM

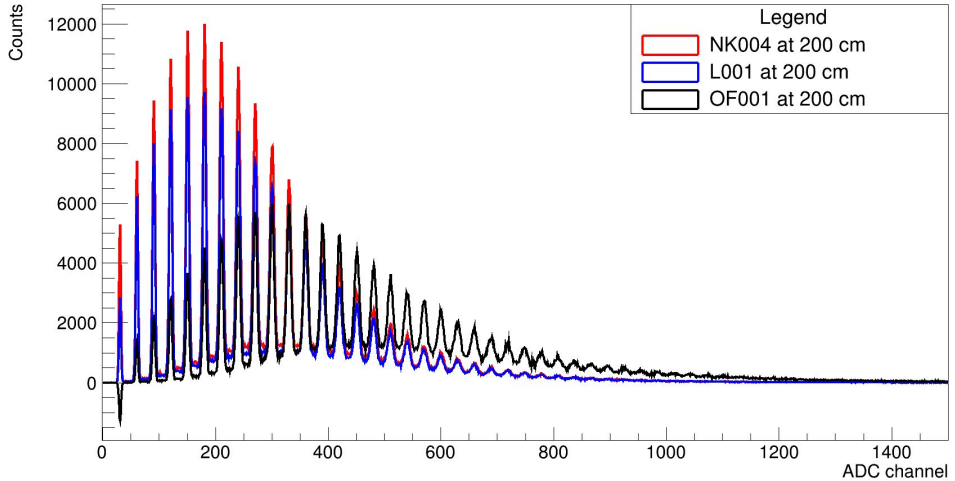
- Hamamatsu Module: high resolution, low noise, temp control
- Alignment
- Reproducible coupling





Npe spectra

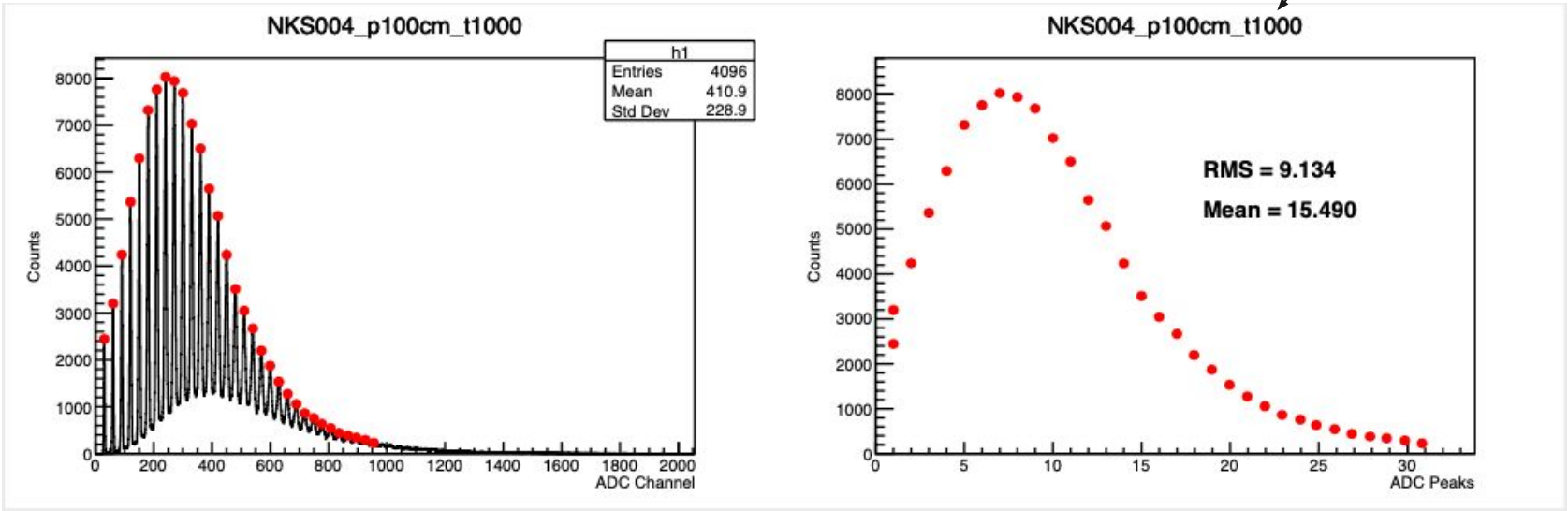
- **NKS, L and OKD** fibers measured; **coincidences**
- Noise-subtracted comparison at 5 distances (100, 140, 200, 240, 280 cm)
- Analysis scripts: multi-peak finding and light calibration



OKD > NKS > L

Npe - Peak finding & calibration

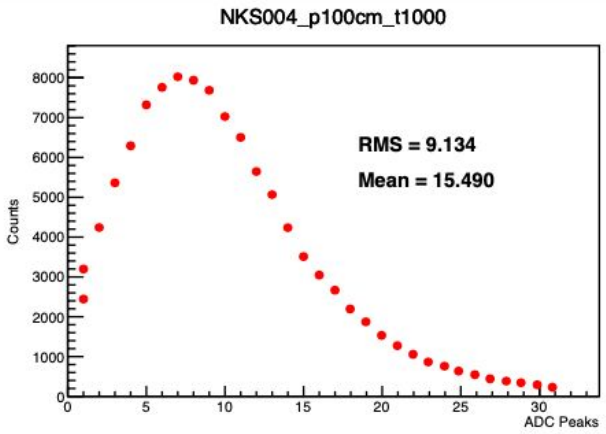
10 min running

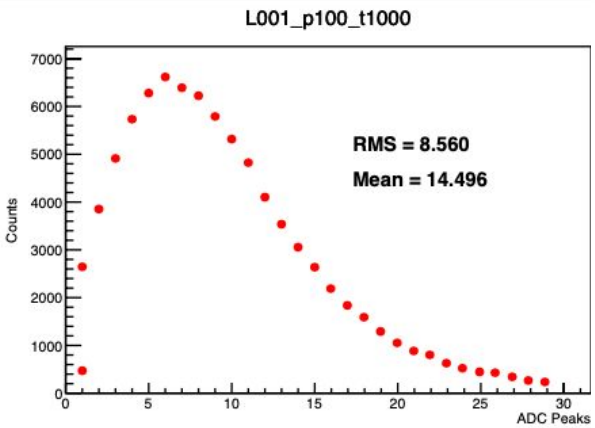


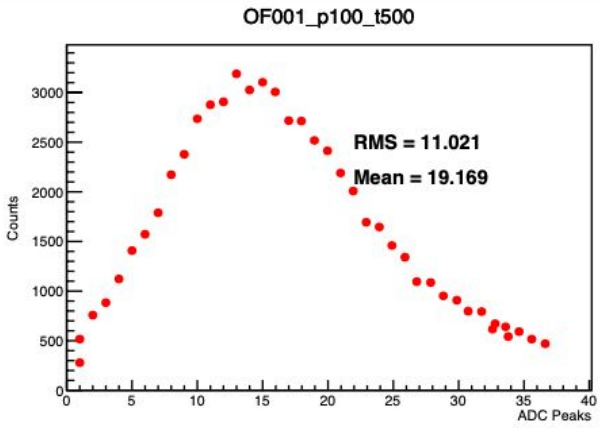
ADC units → **p.e. units**

Npe - Comparisons - 90Sr at 100 cm

5 min running



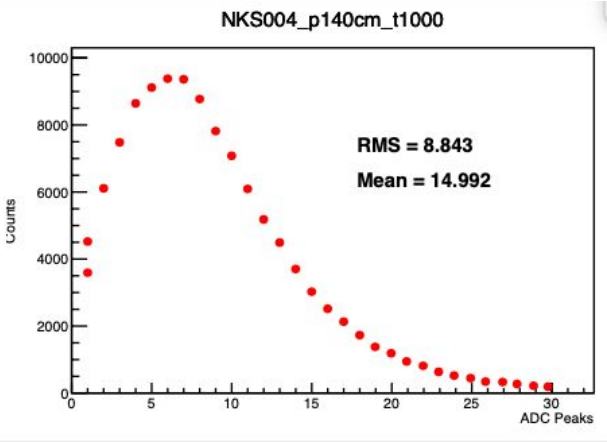


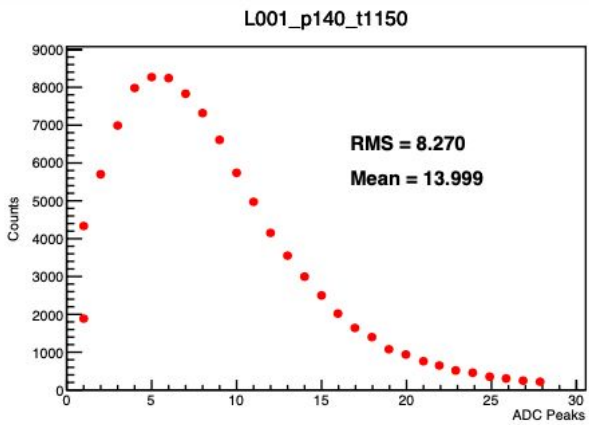


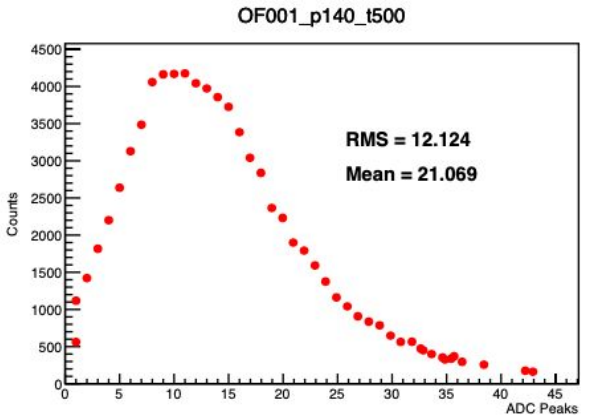
No grease!

NKS/L = 6.4%, NKD/NKS = 20%

Npe - Comparisons - 90Sr at 140 cm



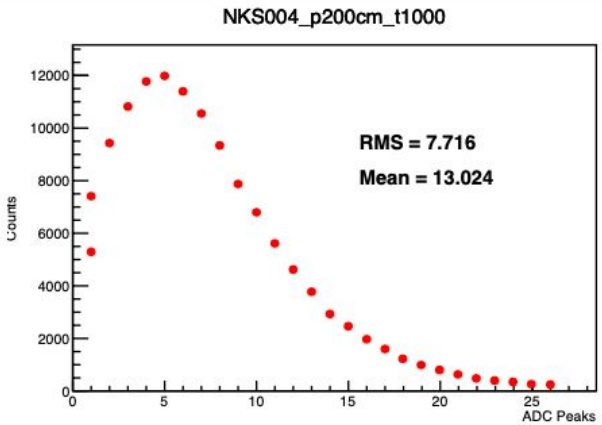


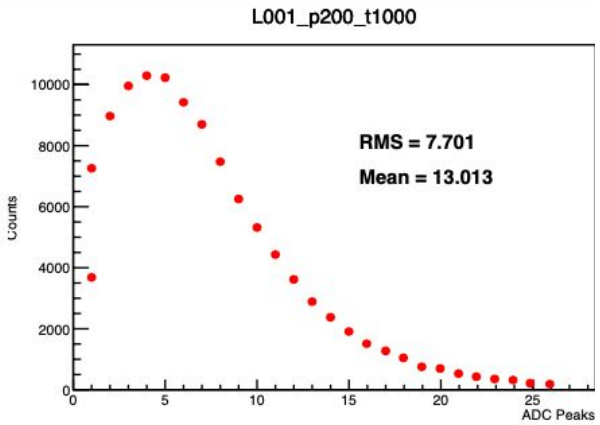


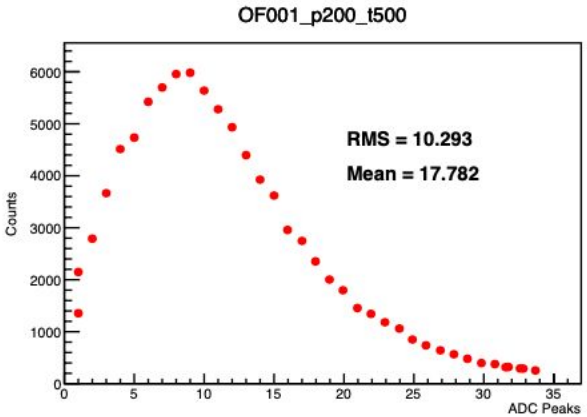
No grease!

NKS/L = 6.7%, NKD/NKS = 29%

Npe - Comparisons - 90Sr at 200 cm







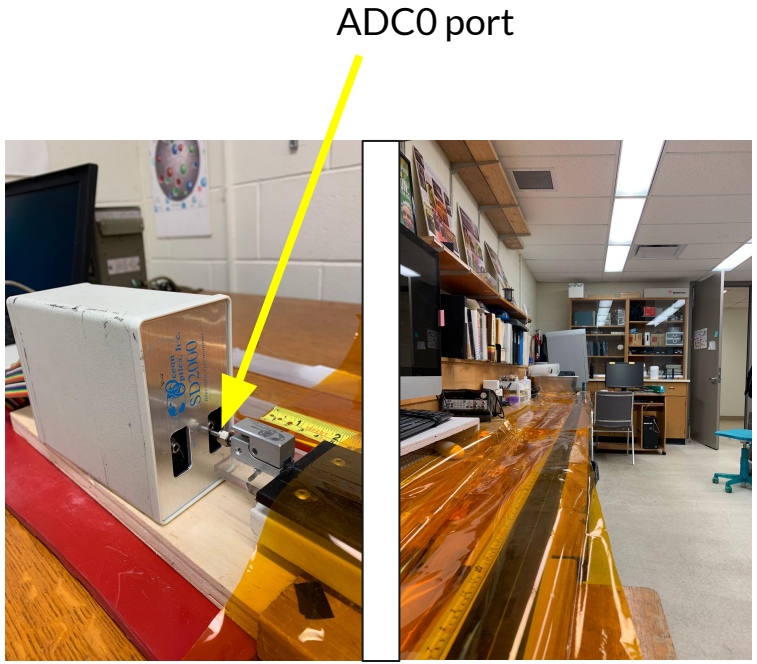
No grease! NKS/L = 0.3%, NKD/NKS = 27%

Npe Station - continue studies

- Examine fiber polish in imager. Repolish if needed.
- Retake **noise spectrum** and recheck analysis to understand results.
- Measure additional fibers, including **double-clad NKD**.
- Longer running times and normalize more accurately.
- Quantitatively compare to photodiode results for same fibers.
- At the conclusion, move puckboard to photodiode/spectrophotometer station.

Spectrophotometer Set-up

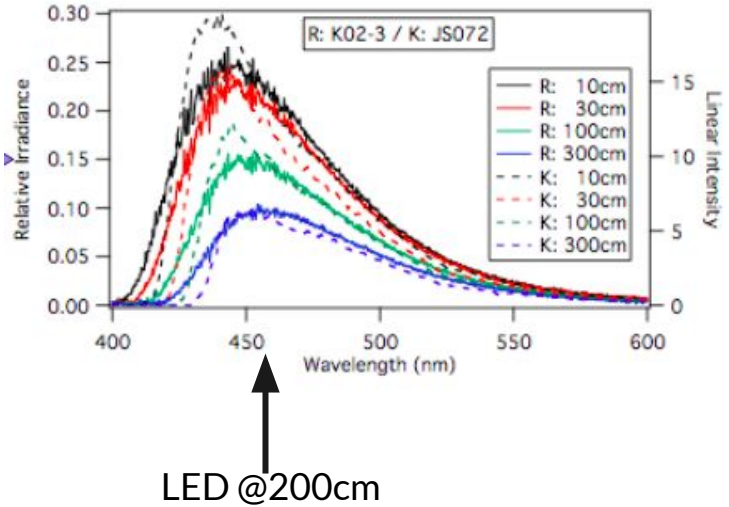
- Fiber laid in groove of polyurethane tray (puckboard).
- Fed into **ADC0** of Ocean Optics SD2000[1] spectrophotometer; clip for stability.
- SD2000 connected to ADC (Ocean Optics ADC1000-USB Serial[1]), then connected to DAQ laptop via USB.
- Measurements in darkness; double layer of UV-absorbing film covering fibers.



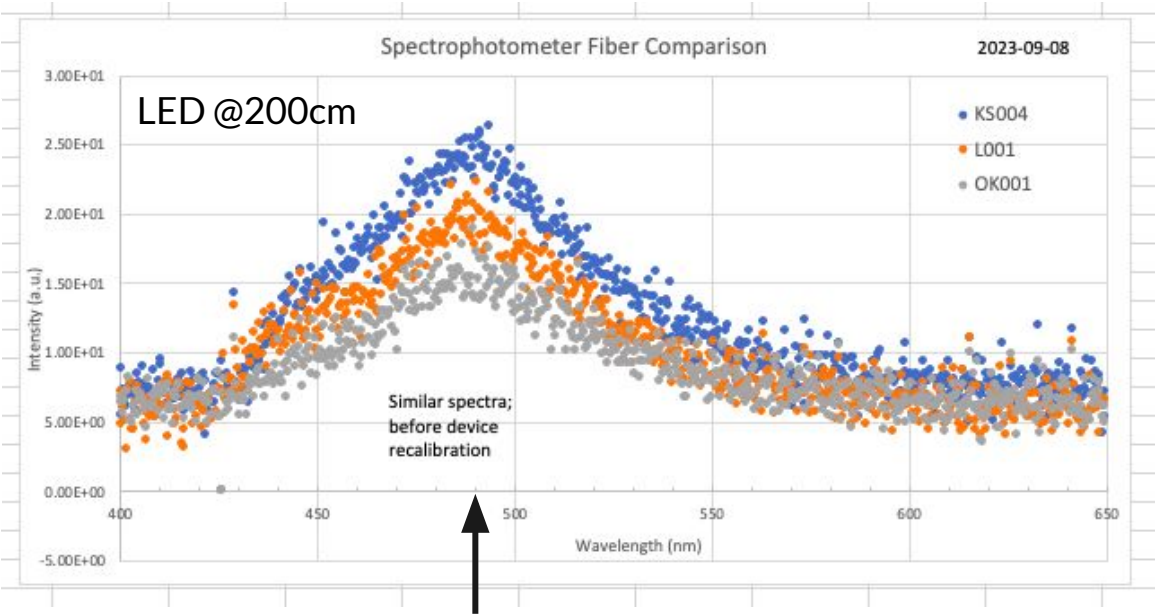
Spectrophotometer with fiber inserted (left); view down the tray holding the fibers (right)

[1]Ocean Insights, Orlando, FL, USA (www.oceaninsight.com)

Fiber wavelength spectrum



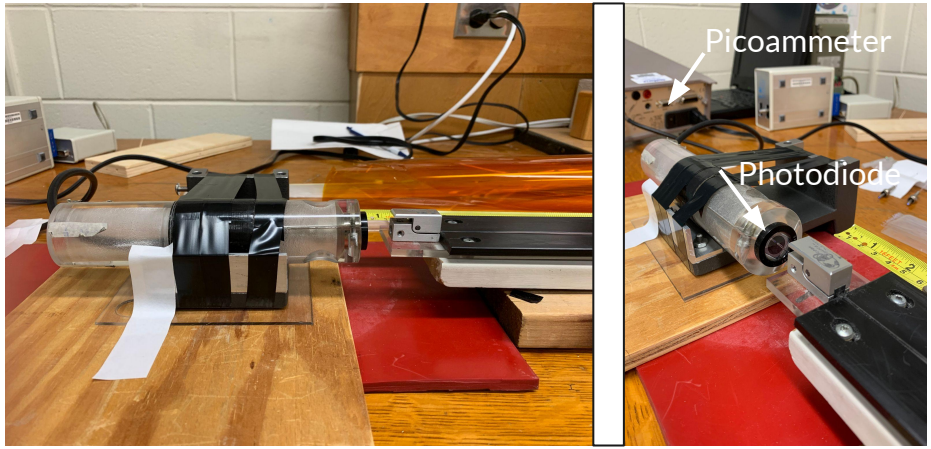
LED @200cm



Spectrophotometer Station - continue studies

- Remeasure select NKS, NKD and L fibers in **ADC0**.
- Repeat with same fibers in **ADC1**.
- Re-calibrate CCD, using the D2J1470.SPEC calibration file.
- Remeasure same fibers in ADC0 and ADC1 and compare.
- Check calibration with new LEDs: 365, 390, 400, 450, 460, 470, 520 nm.
- Use Ocean Optics clear fibers for fiber-to-fiber connection with optical grease.

Photodiode Setup



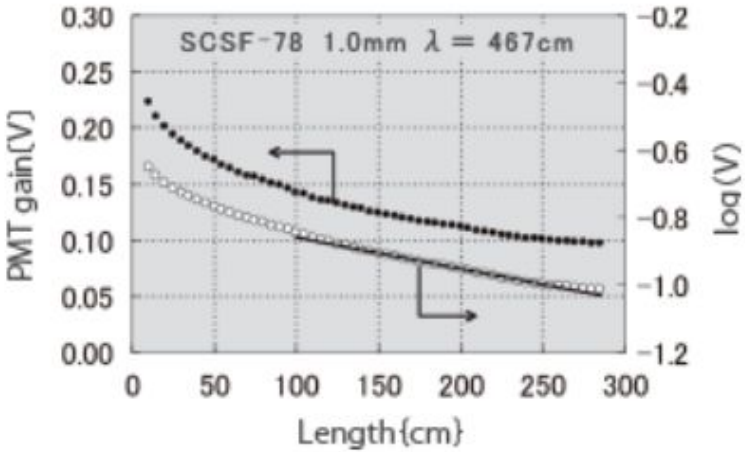
- Fiber laid in groove of polyurethane tray, polished end on photodiode.
- LED powered by power crate at 3.8 V, which corresponds to ~0.041 A.
- Picoammeter readings taken at 10.0 cm intervals, 10.0 cm to 300.0 cm.
- **Several NKS, L and NKD fibers tested.**

Attenuation Length Calculation

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

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

- **NEW**: 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



Attenuation Length Comparison (100-300cm)

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

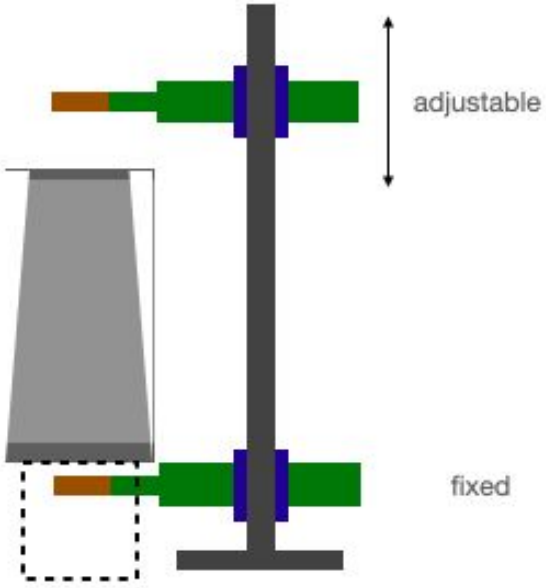
Photodiode Station - continue studies

- Fiber **elasticity memory** from coils:
  - Upwards “bump” at 300.0 cm distance on Kuraray fiber measurements;
  - Luxium numbers have smaller errors; fiber curvature?
- Inconsistent measurements closer to photodiode.
  - LED pulses? Light reflecting onto photodiode screen?
  - Recheck cover over photodiode and screen around LED.
  - Extract **short- and long-wavelength** components.
- Quantify/recheck: NKS vs L vs NKD 50% with and without grease.
- Slice wavelength spectrum and extract short- and long-components.

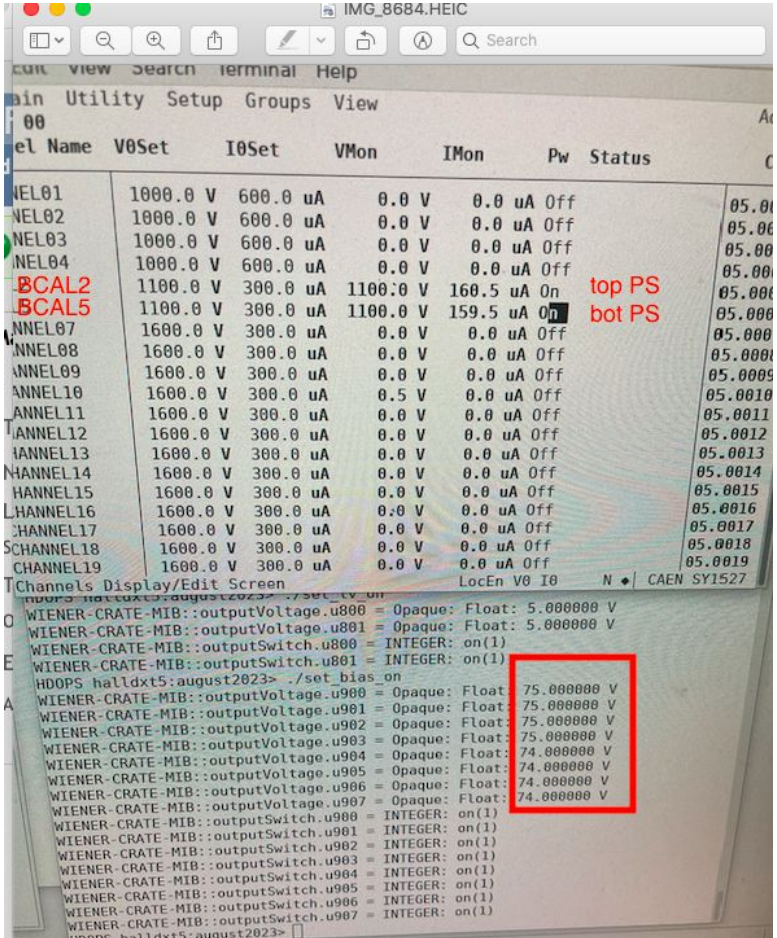
Baby BCAL - cosmics first analysis

- Tests in Hall D:
  - Paddle counters trigger; 32 SiPM channels (N and S).
  - Data collected in Mode 10 (raw+pulse) and at 3 bias sets.
- Hardware set up ok: discriminators firing as expected.
  - Waveforms look very nice; clear tracks through vertical “stacks” of cells .
- Analysis:
  - code is working as of Friday; statistics too low!
  - Some checks make sense (vertical cuts, North vs South).

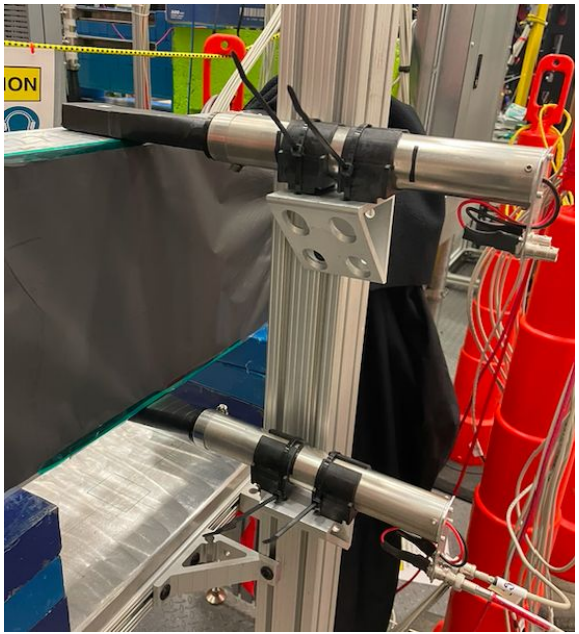
Cosmics Setup



Longitudinal View



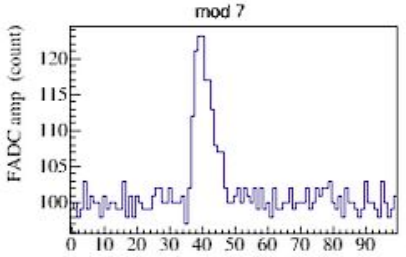
Cosmics Setup

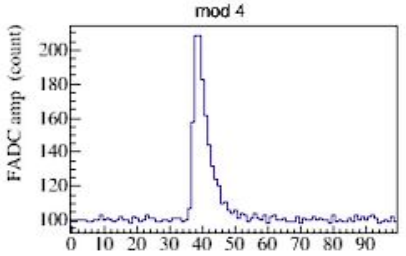


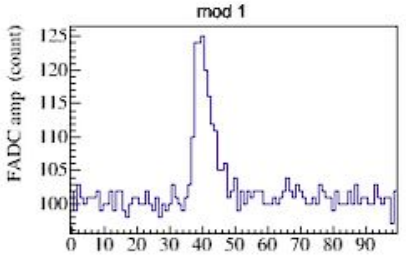
Cosmics Setup

Waveforms

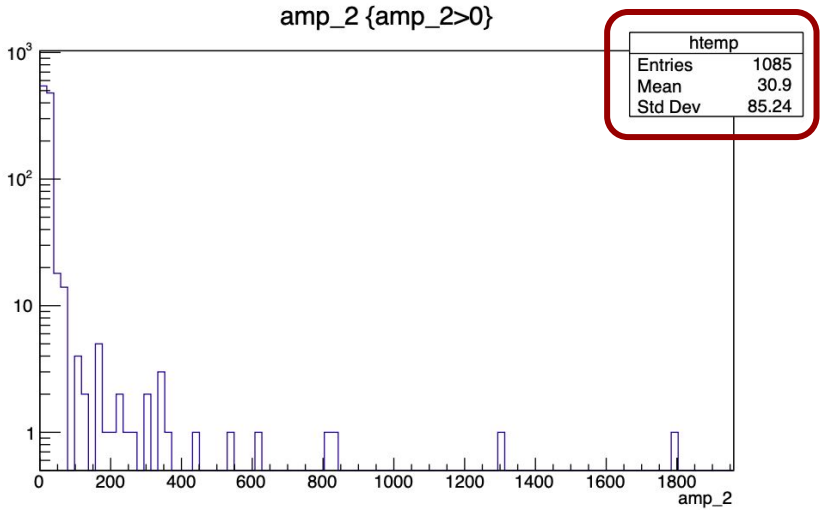
```
JANA >>
JANA >> --- Configuration Parameters --
JANA >> OUTPUT_FILENAME = bbcal.root
JANA >> PLUGINS         = glass_prototype
JANA >> THREAD_TIMEOUT  = 30 seconds
JANA >> --------------------------------
JANA >>Control event: End - Fri Sep  1 16:55:10 2023.0Hz  (avg.: 921.3Hz)
No more events
JANA >>
JANA >>No more event sources
JANA >>Thread 0x7faaaf2d4700 completed gracefully: Mon Sep 18 09:31:35 2023
JANA >>Merging thread 0 (0x7faaaf2d4700) ...

 EVIO Processing rate = 562.575 Hz
  NDISPATCHER_STALLED =     176100 (91.6%)
      NPARSER_STALLED =     340679 (88.6%)
   NEVENTBUFF_STALLED =         28 ( 0.0%)

EVIO Statistics for /gluonraid5/data4/raudata/active/RunPeriod-2023-01/raudata/Run121303/hd_rawdata_121303_000.evio :
-------------------------
    Nblocks: 12
    Nevents: 108208
    Nerrors: 0
Nbad_blocks: 0
Nbad_events: 0

JANA >>Merging event reader thread ...
JANA >> 108208 events processed  (108208 events read) Average rate: 920.9Hz

Closed ROOT file
JANA >>Closing shared object handle 0 ...
HDOPS gluon100:glass_prototype>
```



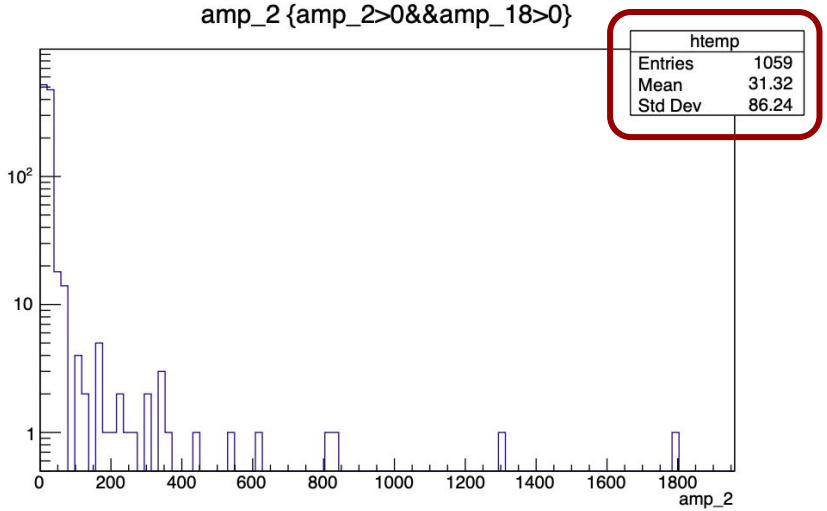




Amplitudes - Run 121308

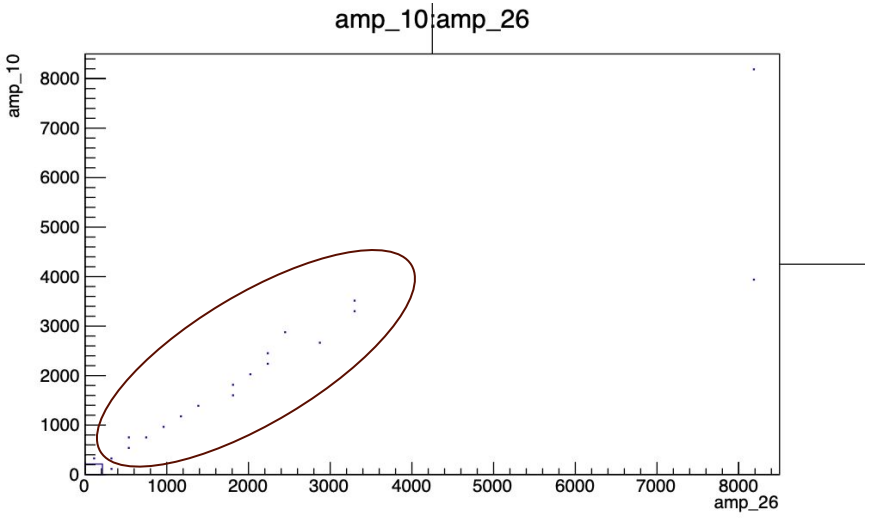


Low stats

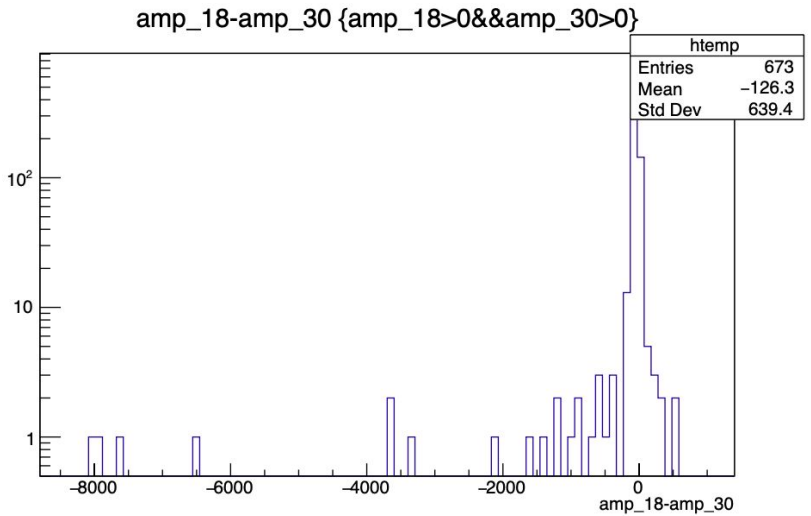


Progressive cuts

North v South - Run 121308



Gain ratio N-S



n times dE/dx

North v South - dE/dx differences of means

				n
N2-N6	**-58**	S2-S6	**-67**	2
N2-N10	**-92**	S2-S10	**-95**	3
N2-N14	**-131**	S2-S14	**-126**	4

GlueX BCAL SiPM
Summing scheme 1:2:3:4

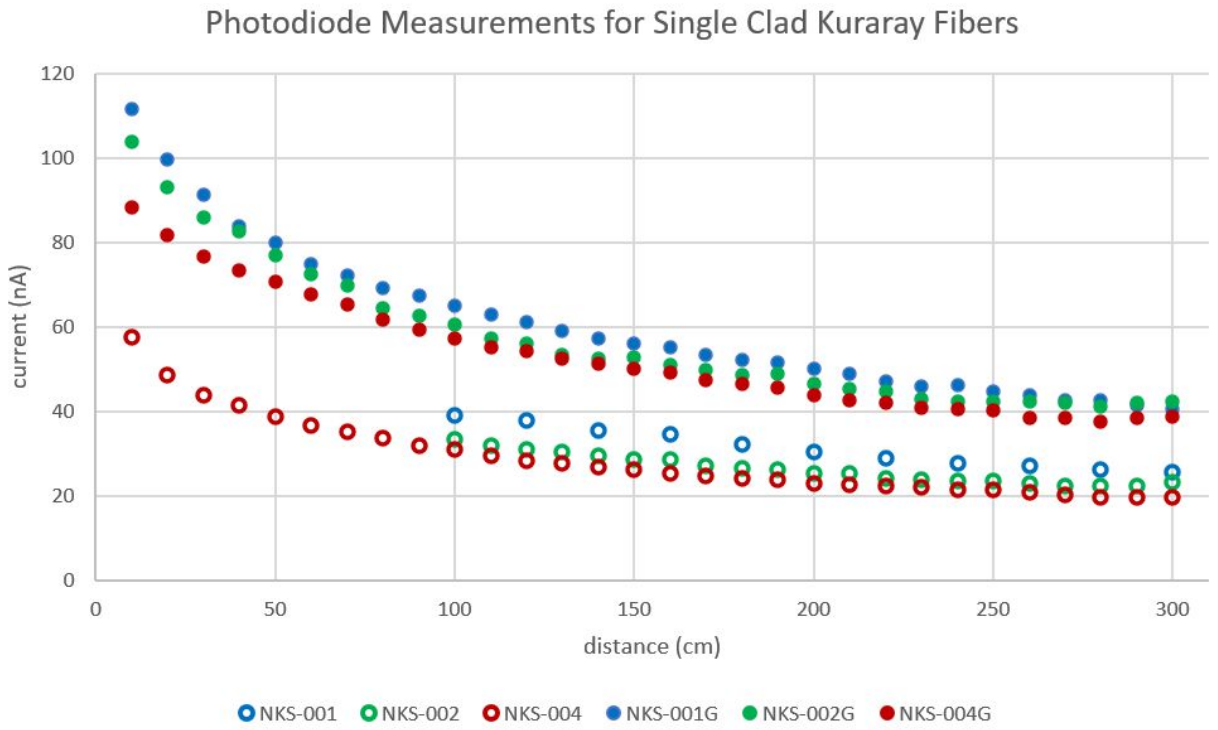
n times dE/dx

Summary

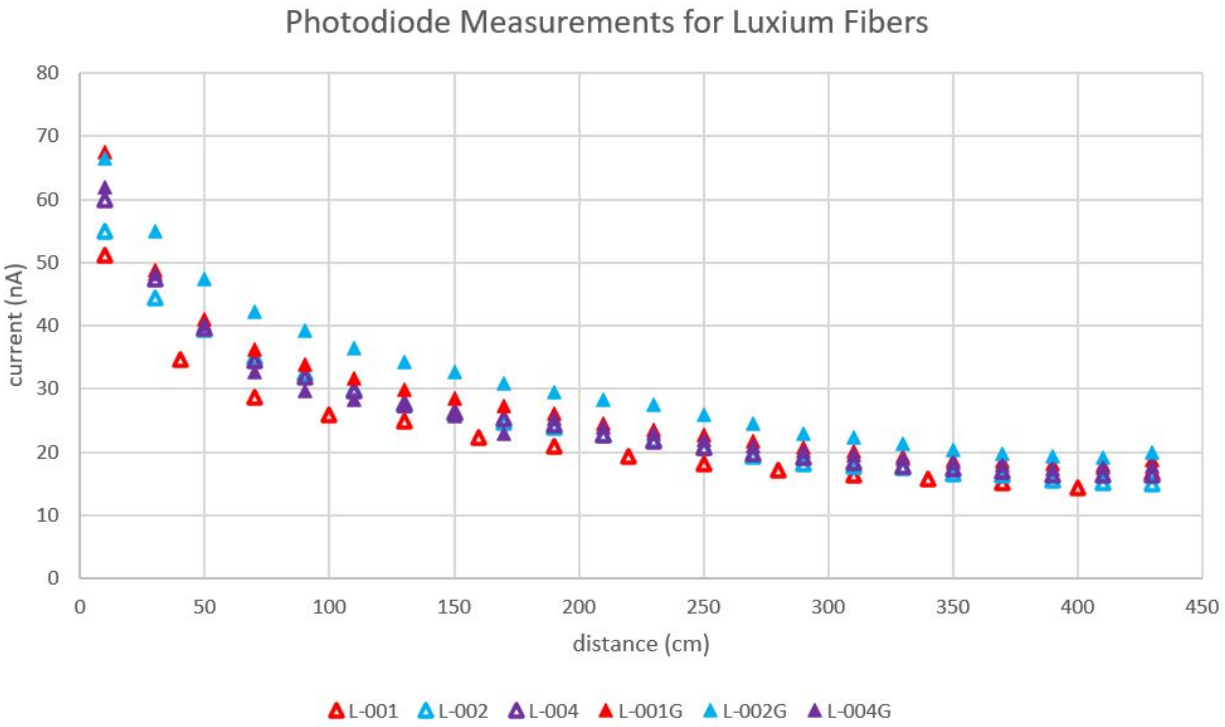
- Fibers: S. Oreśič, M. Kaban, J. Draper (seniors), I. Zhenchuk, H. Ahmed (juniors)
  - Npe measurements this week
  - Spectrophotometer, week Sep 25
  - Photodiode, week Oct 2
- Beam tests Eres & Npe: M. Kerr, J. Zarling (resume week of Sep 25)
- Cosmics gain calibrations: J. Zarling, ZP (start week Oct 2)
- Big BCAL Npe: M. Kerr, J. Zarling (start mid October)

Backup Slides

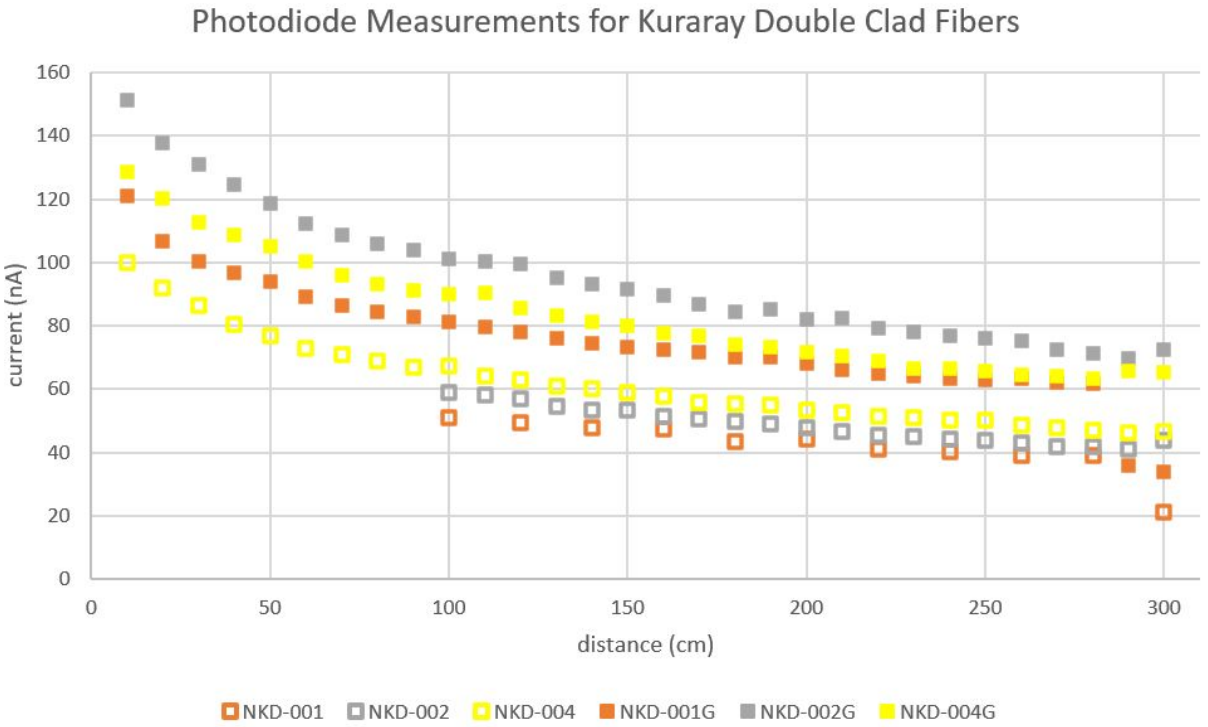
Kuraray Single Clad Results

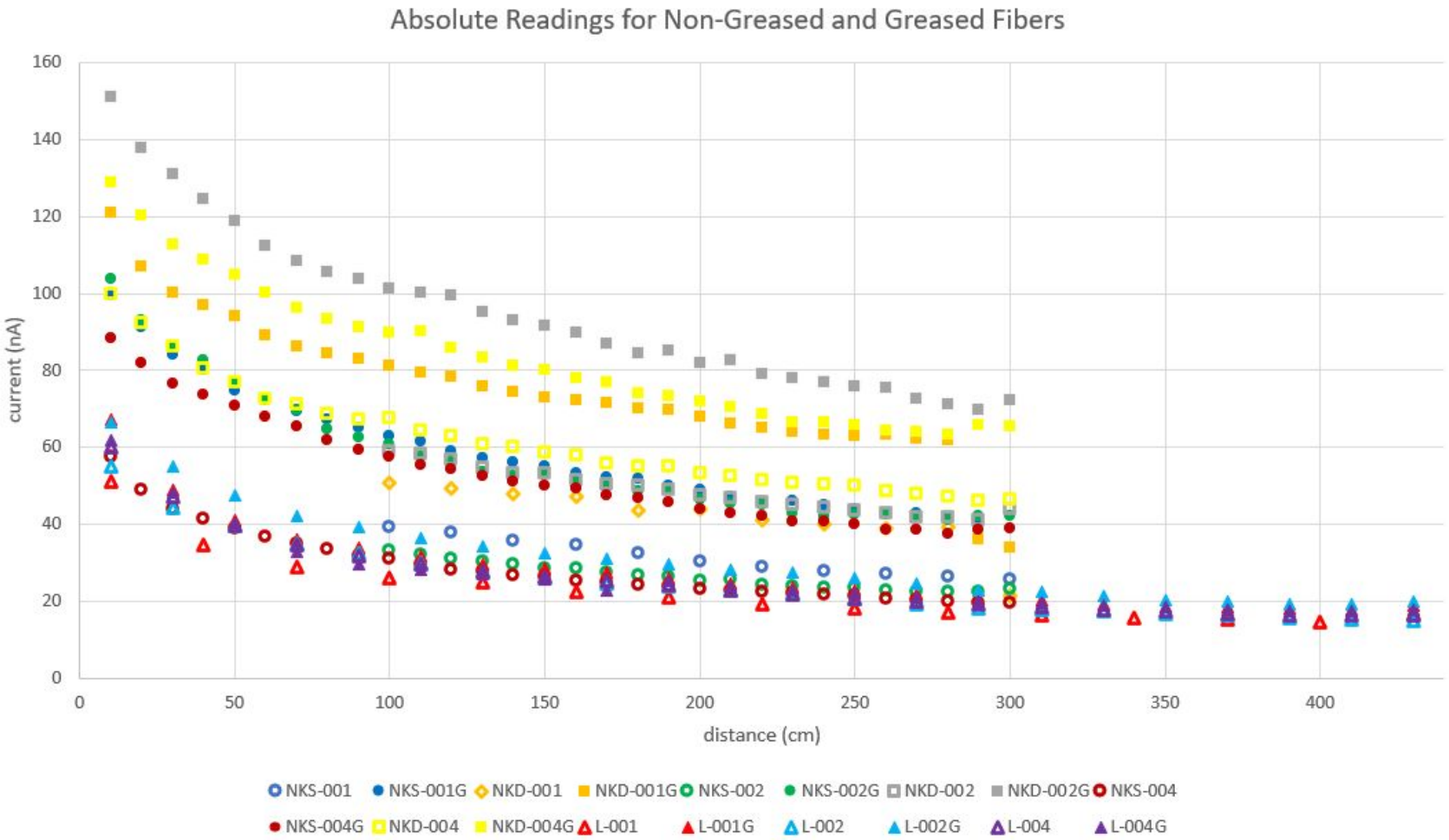


Luxium (Single Clad) Results

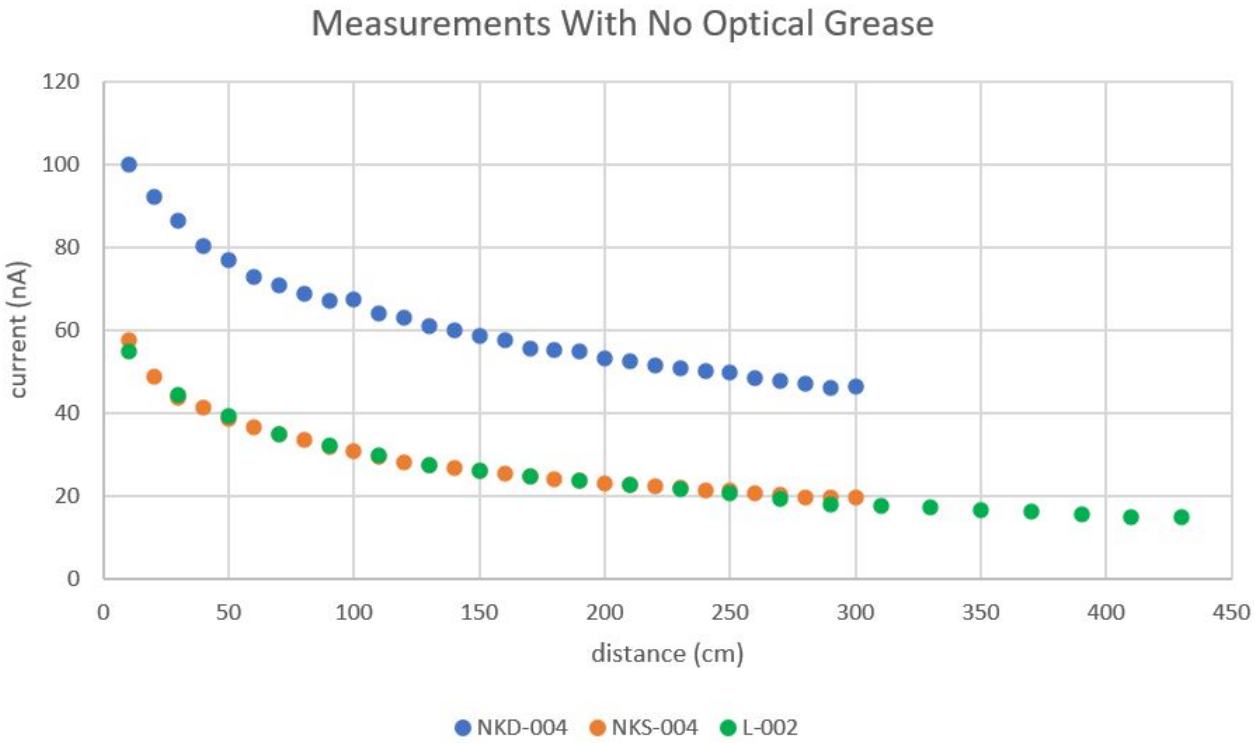


Kuraray Double Clad Results

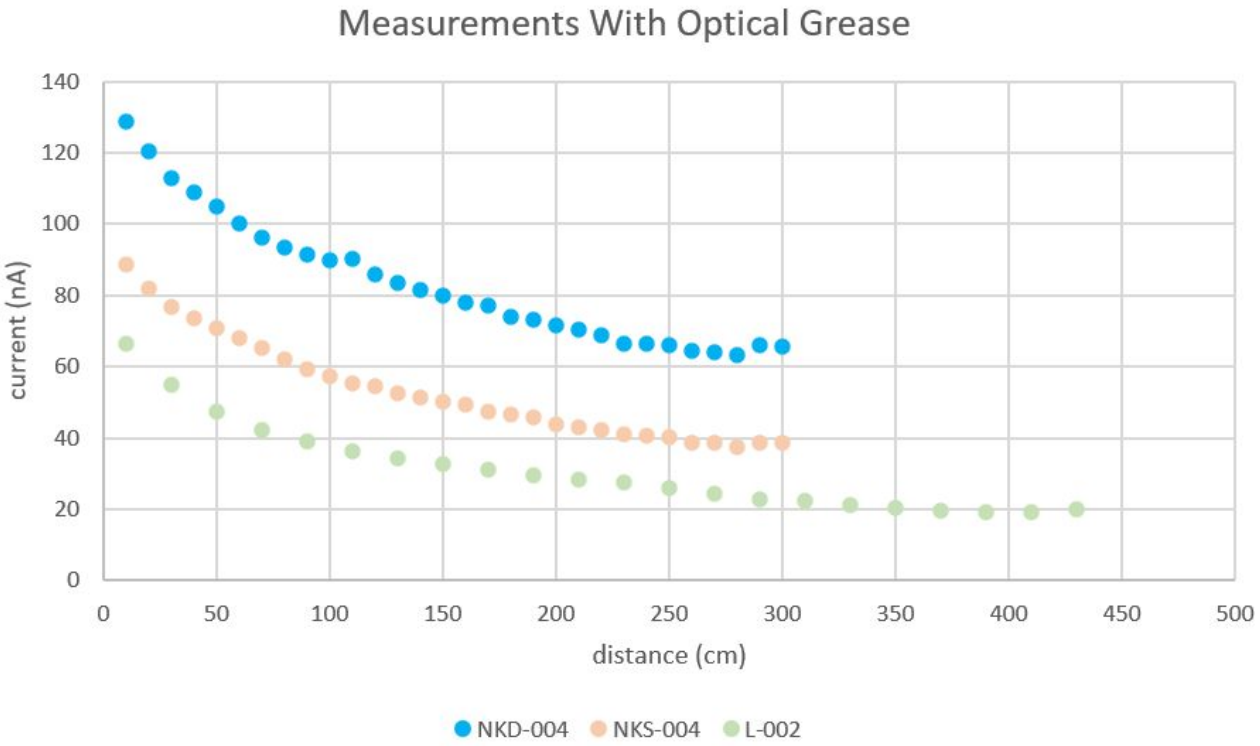



Absolute Readings for Non-Greased and Greased Fibers
current (nA)
distance (cm)
0
20
40
60
80
100
120
140
160
0
50
100
150
200
250
300
350
400
NKS-001
NKS-001G
NKD-001
NKD-001G
NKS-002
NKS-002G
NKD-002
NKD-002G
NKS-004
NKS-004G
NKD-004
NKD-004G
L-001
L-001G
L-002
L-002G
L-004
L-004G

No Optical Grease

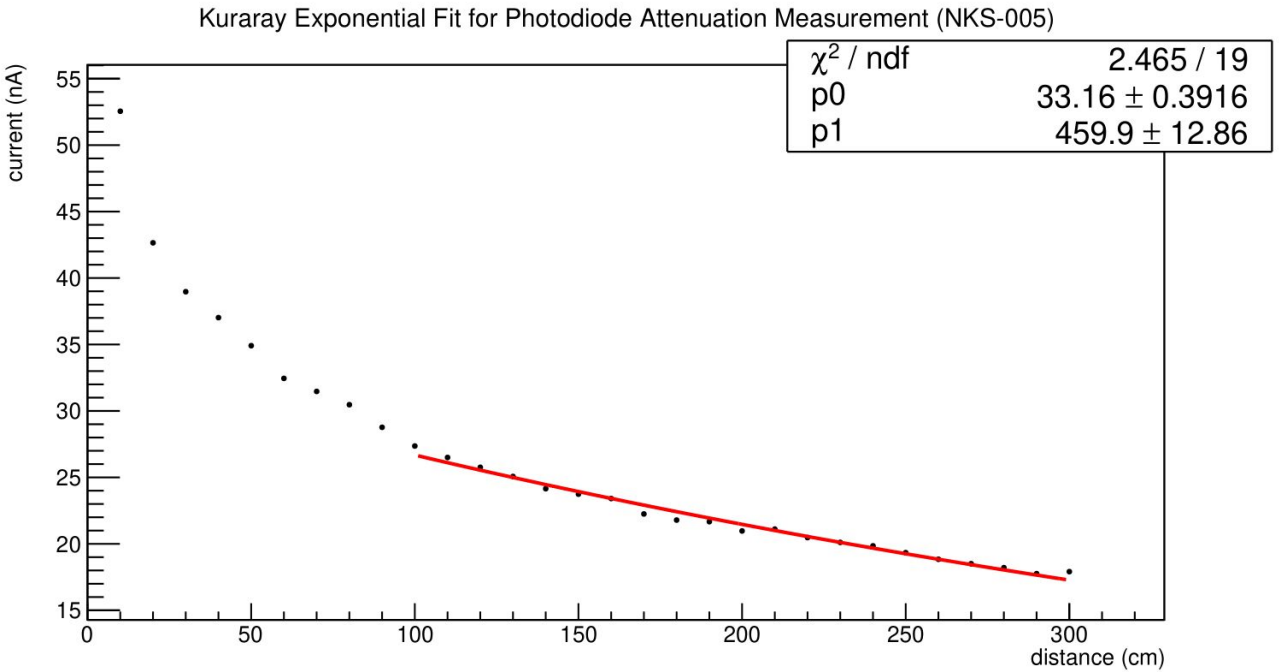


With Optical Grease

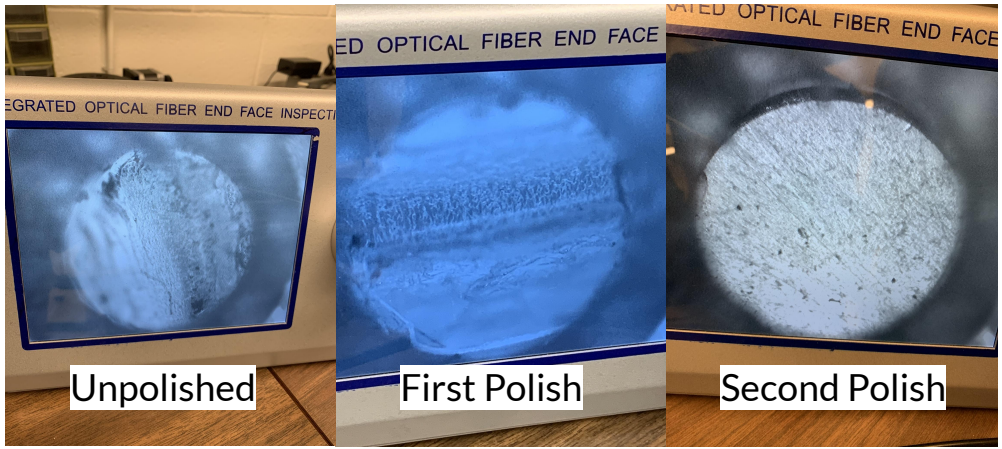


NKS-005

No measurement with optical grease taken



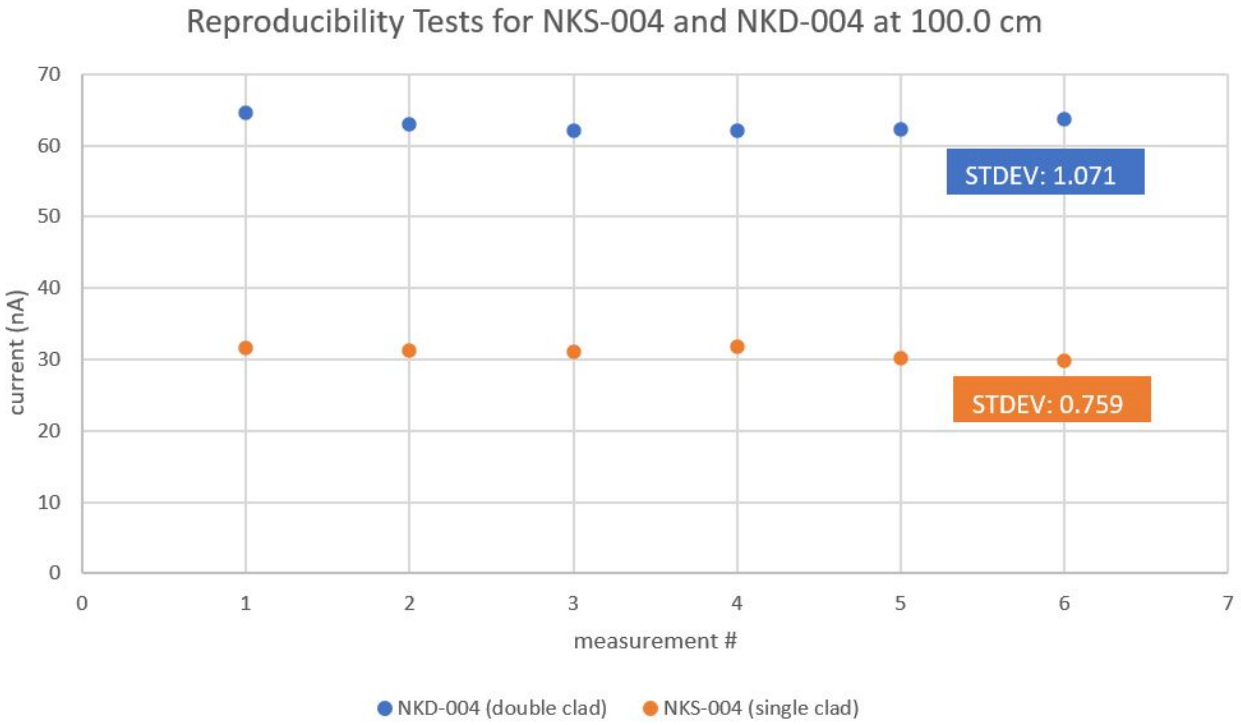
August 7 - August 11



- **Luxium fibers** arrived!
  - Received **10 fibers**
  - **Unpolished**
  - **435 cm** long
- Luxium fibers were polished (x2) using previous **Fiber Polishing Station** and measurements were carried out using **Photodiode/Picoammeter Setup**
  - Measurements every 20.0 cm from 10.0 cm to 430.0 cm
- **Five Luxium fibers have been measured**

Reproducibility Tests - 100.0 cm

- 6 measurements @ 100.0 cm on NKS-004 and NKD-004
- Photodiode moved away from fiber and repositioned



Reproducibility Tests - 10.0 cm

- 5 measurements @ 10.0 cm on NKS-005 and NKD-004
- Fiber moved away from photodiode and repositioned
- Less consistent at closer distance for both fibers