



bECAL Fiber Tests @Regina - Update 4

Maggie Kerr, Stjepan Oresic, Love Preet, Aram Teymurazyan, Zisis Papandreou

Presentation to the weekly Barrel ECAL Meeting, August 22, 2023



Timeline - August/September

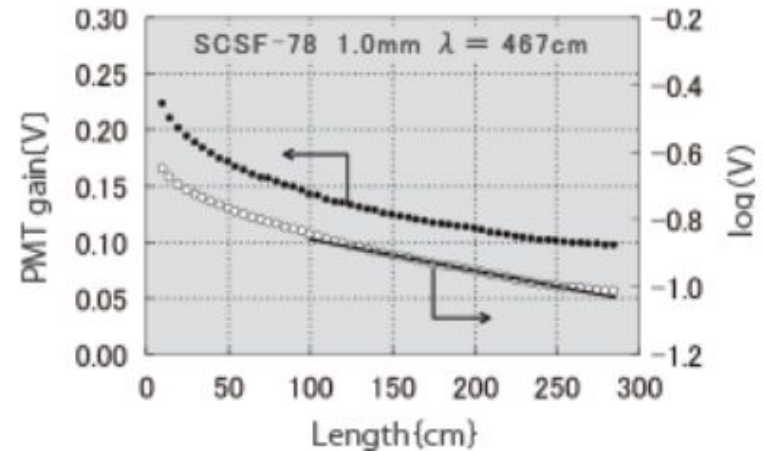
- Original plan:
 - August 14-18: **Kuraray** and **Luxium** fiber testing at **Photodiode Station**; Npe testing at **Npe station**
 - August 21-25: Further measurements as needed
 - August 28-September 1: Finalize results for **September Review**
- **Updated Plan:**
 - August 21- 25: Npe measurements
 - August 28: Technical report
 - August 29: Presentation to bECAL Group; discussion of results
 - August 30-Sept 4: organization of evidence for Sept 13 Review

Attenuation Length Calculation

- **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

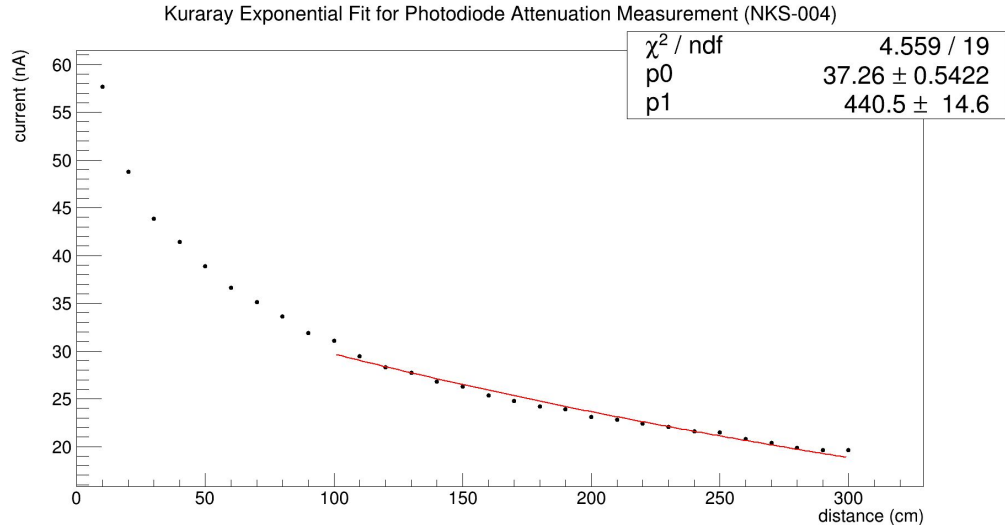
I - intensity
 I_0 - initial intensity
 x - distance along fiber
 λ - attenuation length

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

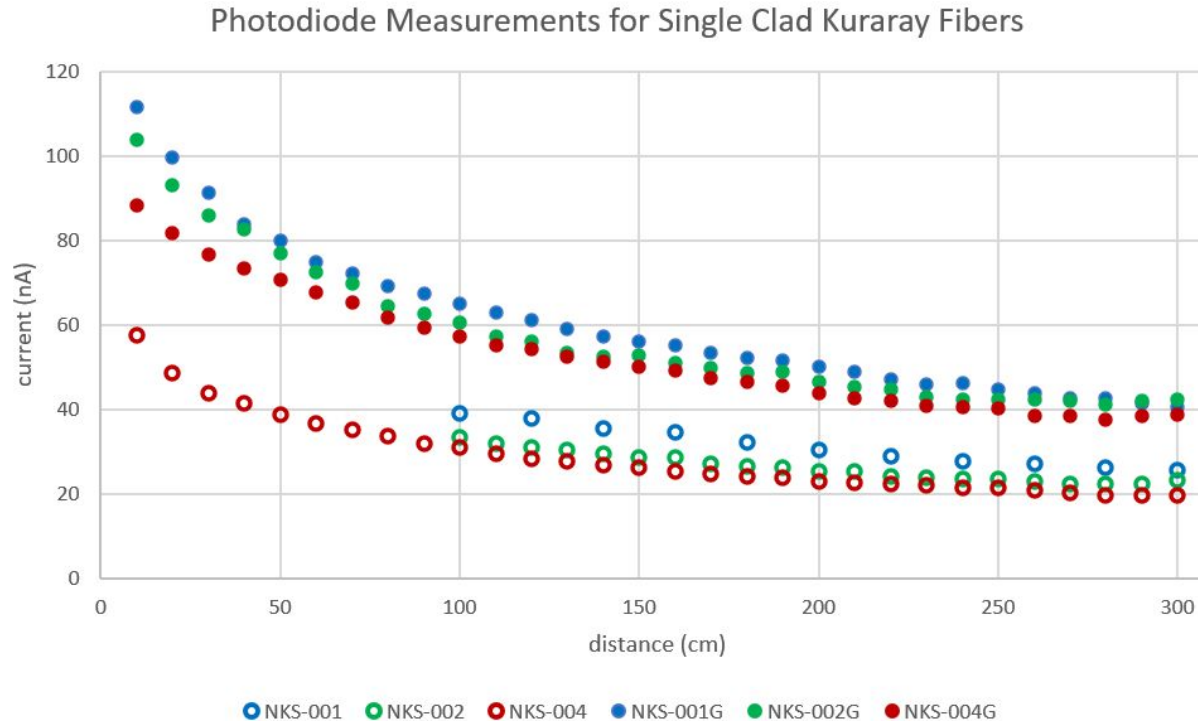


Attenuation Length Results - Kuraray Single Clad Fibers

- NKS-004
- New Kuraray Single clad fiber -004
- Single clad attenuation lengths ranged from 430 - 490 cm
- ~3.0% error (LED fluctuations dominate)



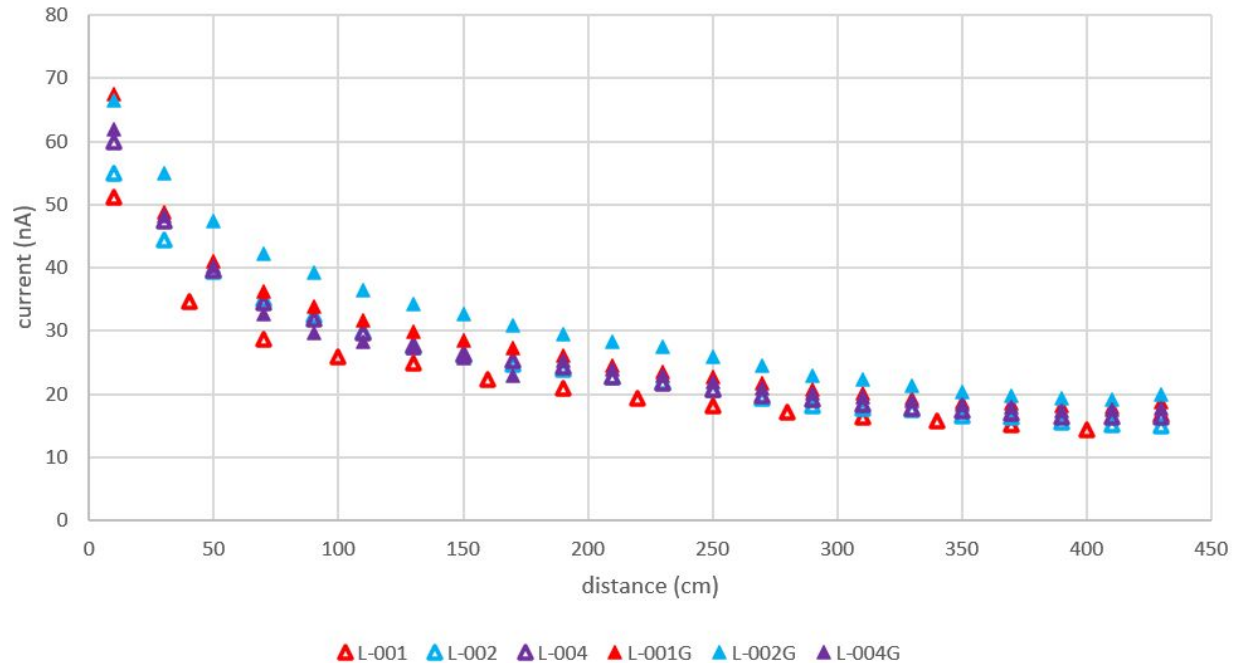
Kuraray Single Clad Results



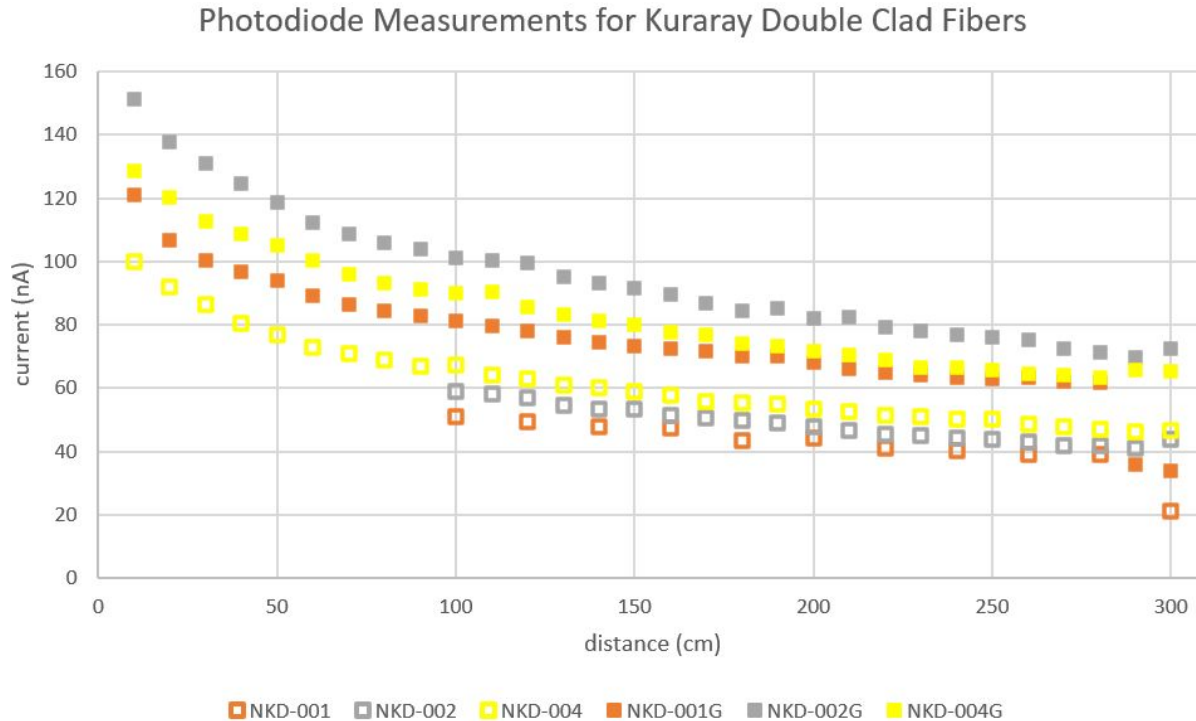
Luxium (Single Clad) Results




Photodiode Measurements for Luxium Fibers



Kuraray Double Clad Results



Attenuation Length Comparison (100-300cm)



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



Issues/Observations

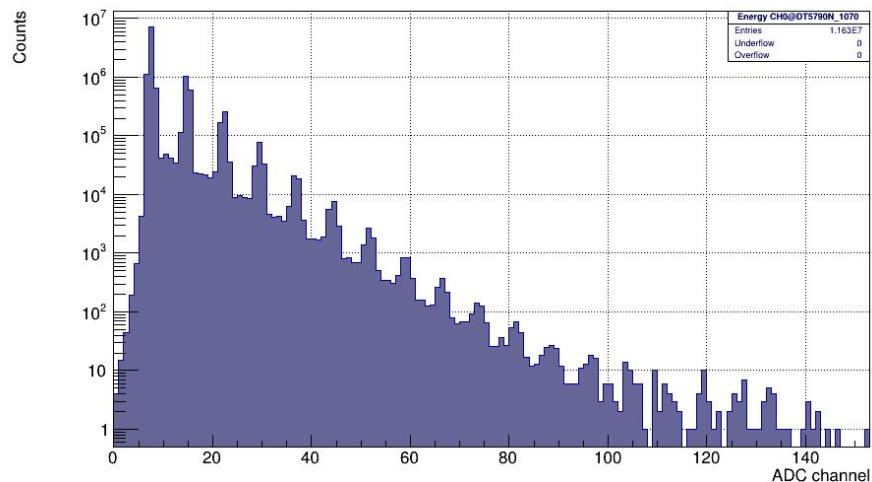
- Upwards “bump” at 300.0 cm distance on all Kuraray fiber measurements
 - Fiber coming loose in groove - “elasticity memory” from coil
- Inconsistent measurements closer to photodiode
 - LED pulses?; Light reflecting from photodiode screen, LED
 - Covered photodiode, and constructed screen around LED
 - Future measurement: recoupling near photodiode with optical grease
- Kuraray single 50% more light than Luxium with grease; 25-30% without
- Kuraray double 50% more light than Kuraray single with grease
- Luxium numbers have smaller errors; fiber curvature?
- Future: effect of grease & polish can be studied with spectrophotometer

Npe Station

- Use photodiode puck board and runner in coffin, with modifications
- Fiber radius of curvature
- Easy positioning and moving ^{90}Sr
- Machined ^{90}Sr holder to be mounted on **new** runner
- Coincidence with PMT
- Measurements started yesterday

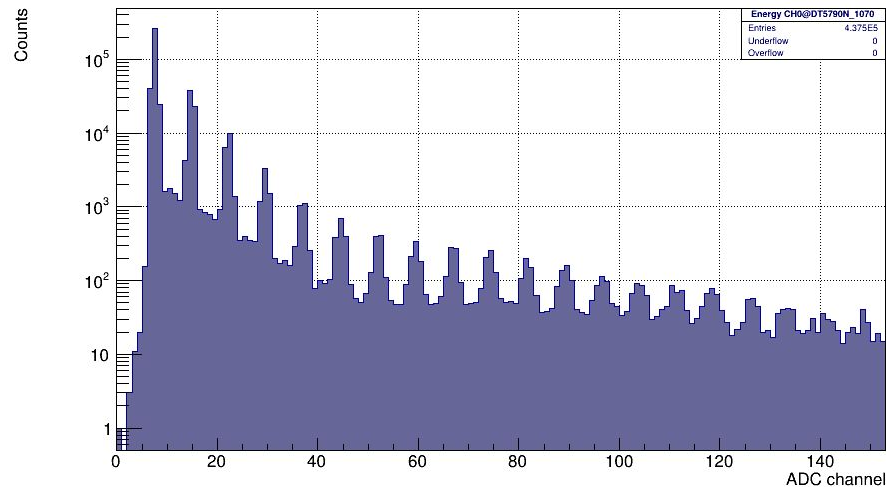


Npe Station ^{90}Sr @ 240cm



SiPM singles

Mechanical setup not perfected; difficult



SiPM -PMT coincidences

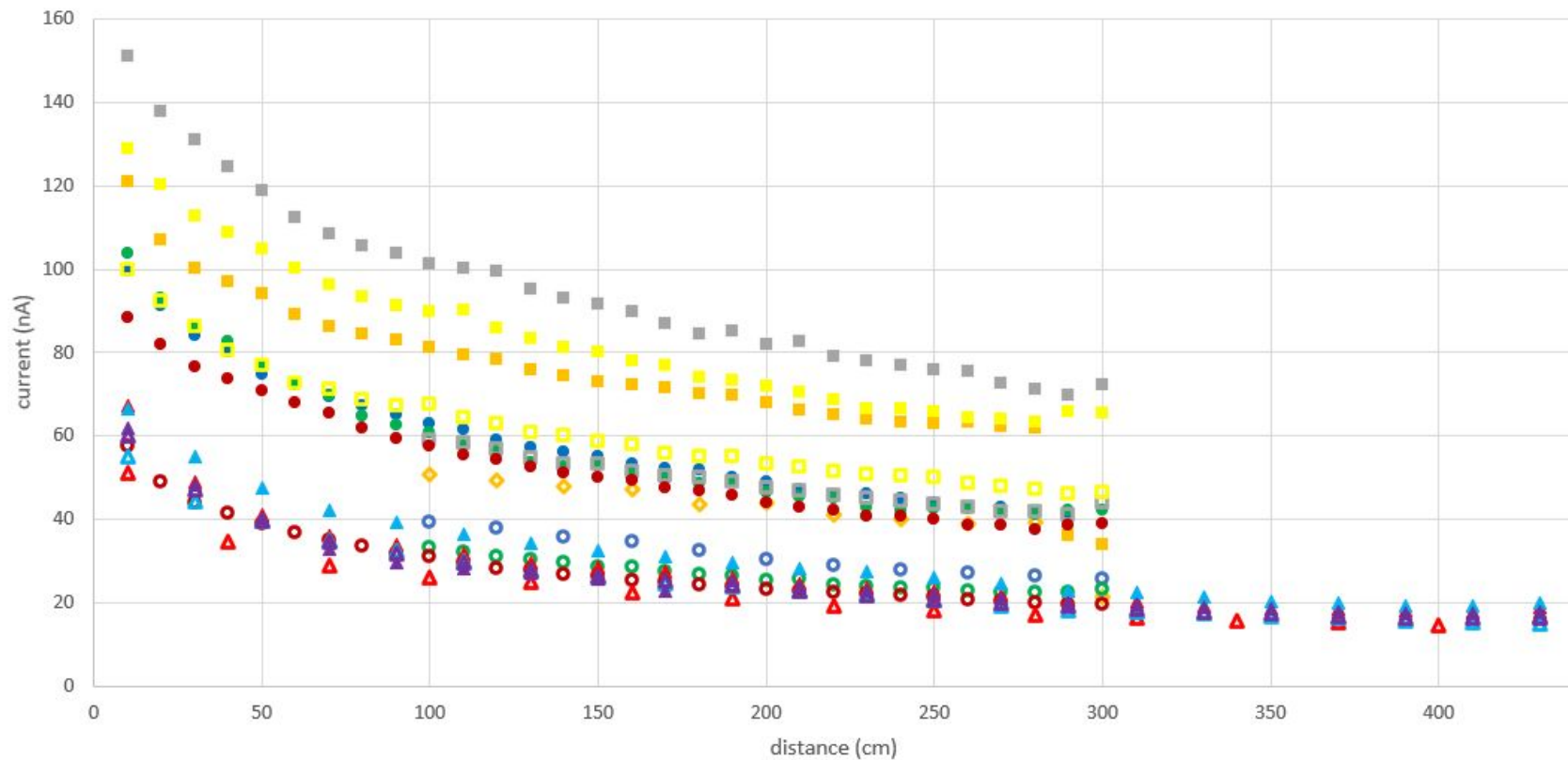


Next Steps

- Discuss and digest photodiode results: both vendors meet λ specs
- Start Npe measurements (SiPM-PMT coinc) this week with SiPM setup
 - Develop fitting method; ^{90}Sr dE/dx modelled
 - Extract attenuation length from Npe station
 - Attempt absolute light output extraction (Npe)
- Technical report draft ready by August 28 (all photodiode and some Npe)
- New LEDs ordered to scan spectrophotometer calibration (370-520 nm)

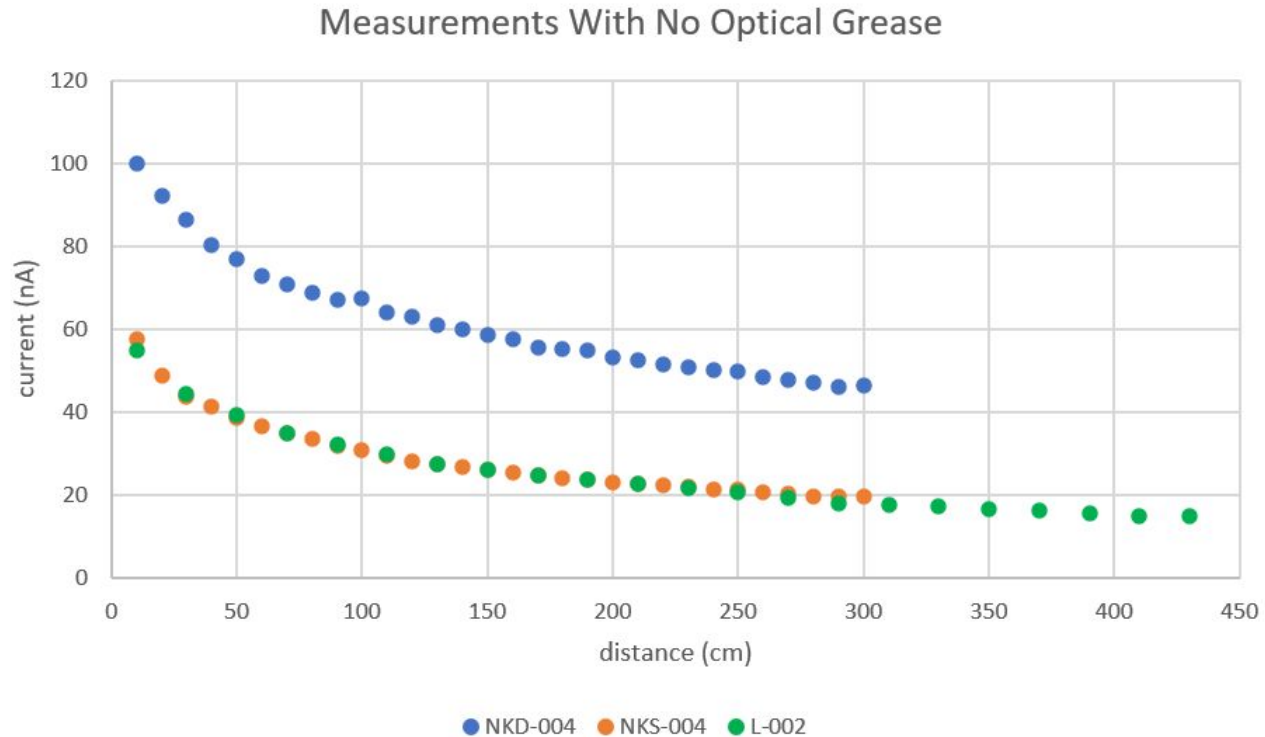
Backup Slides

Absolute Readings for Non-Greased and Greased Fibers

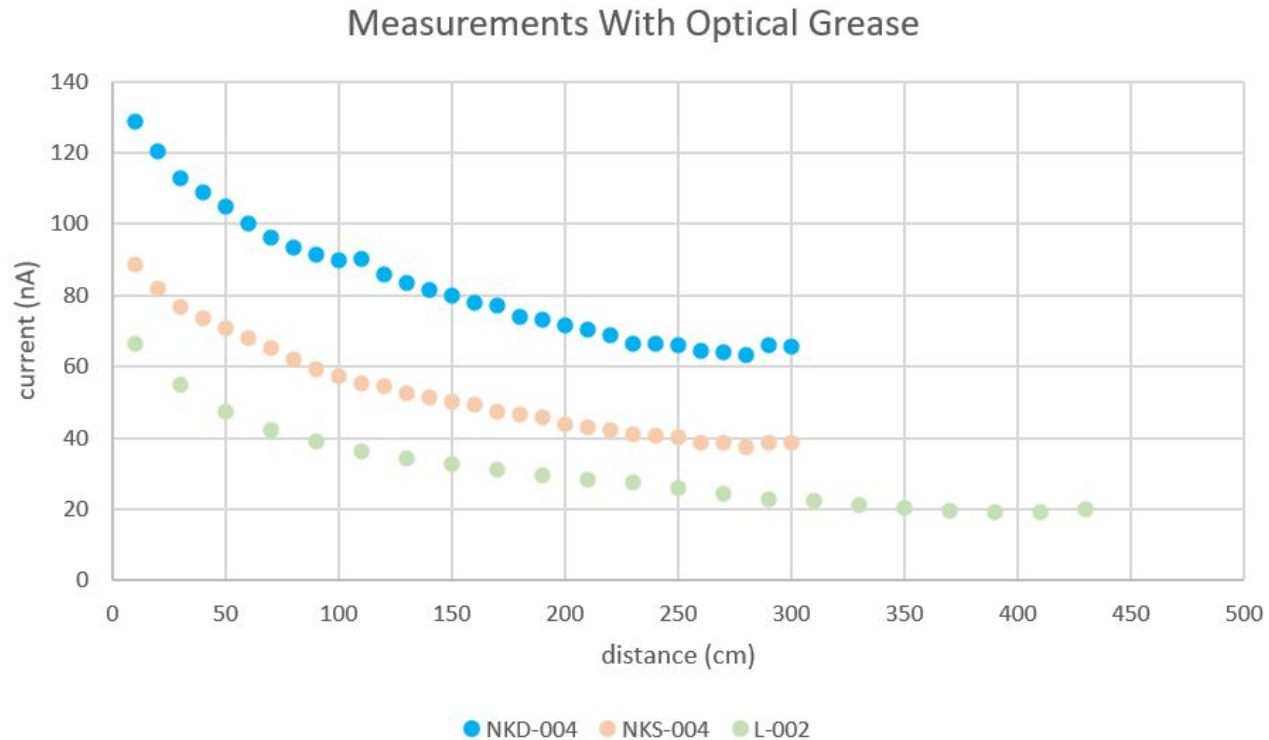


○ NKS-001 ● NKS-001G ◇ NKD-001 ■ NKD-001G ● NKS-002 ● NKS-002G ■ NKD-002 ■ NKD-002G ● NKS-004
 ● NKS-004G ■ NKD-004 ■ NKD-004G ▲ L-001 ▲ L-001G ▲ L-002 ▲ L-002G ▲ L-004 ▲ L-004G

No Optical Grease



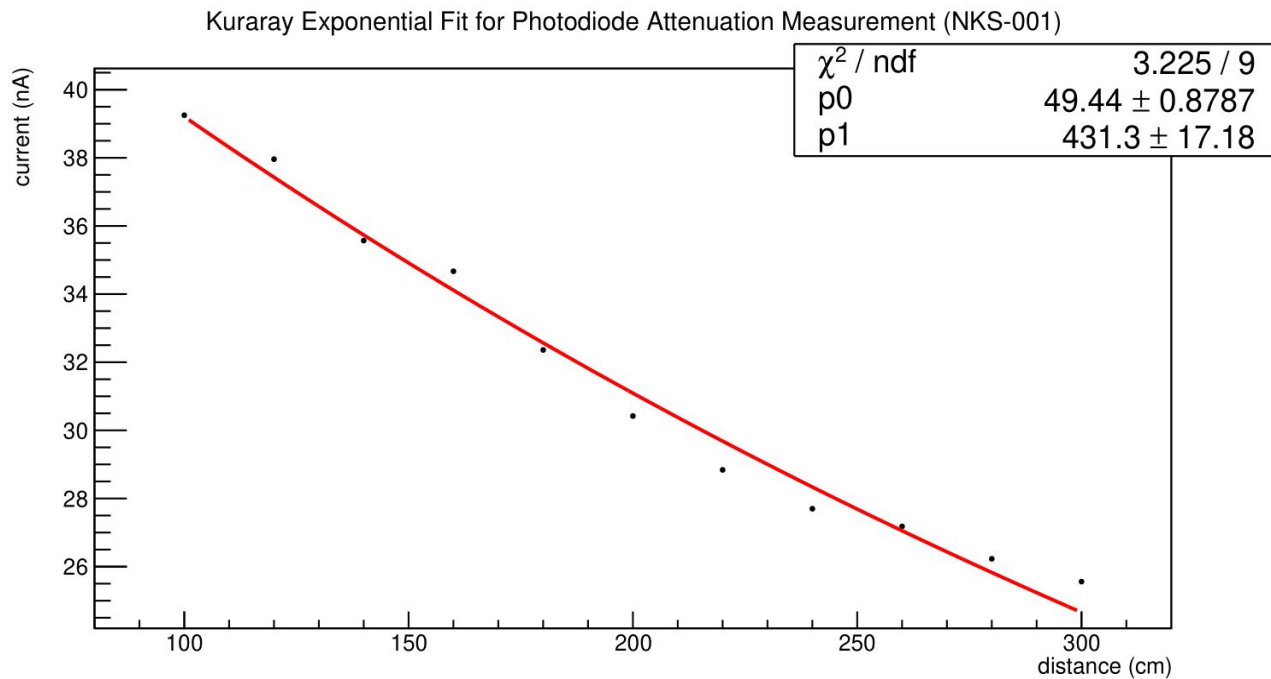
With Optical Grease



NKS-001

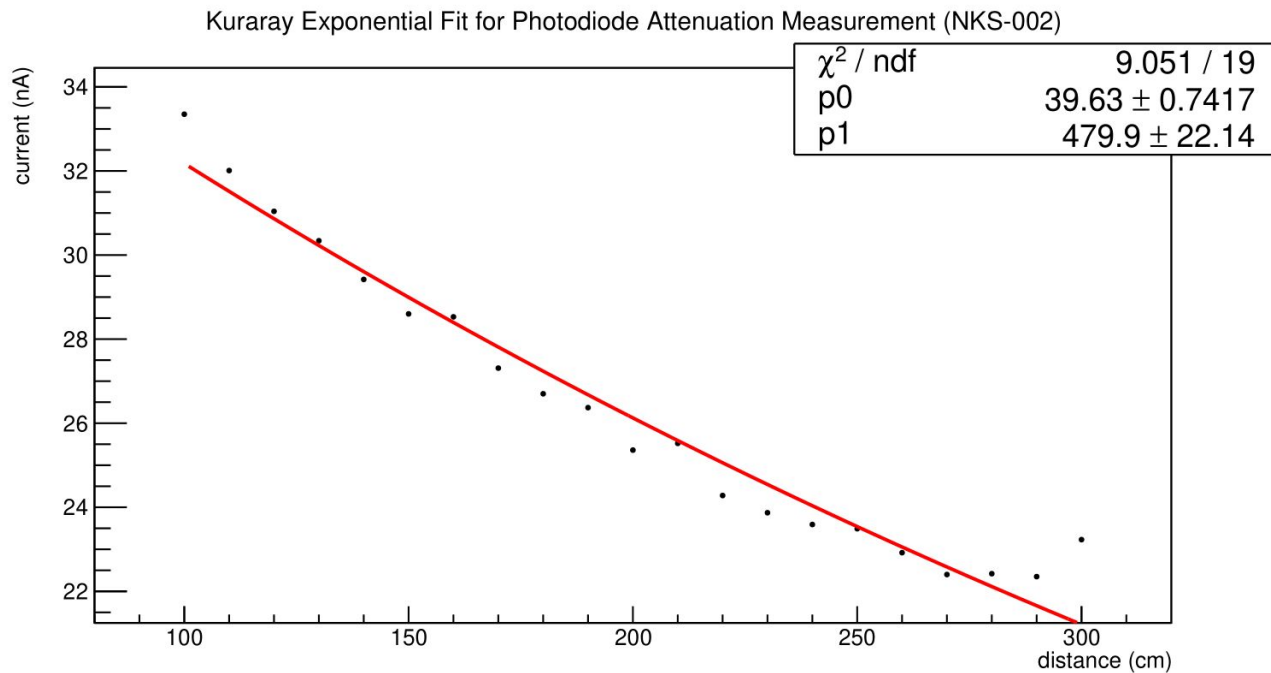
**Different measuring increments used for initial measurements (NKS-001 and NKD-001)

No measurement with optical grease taken



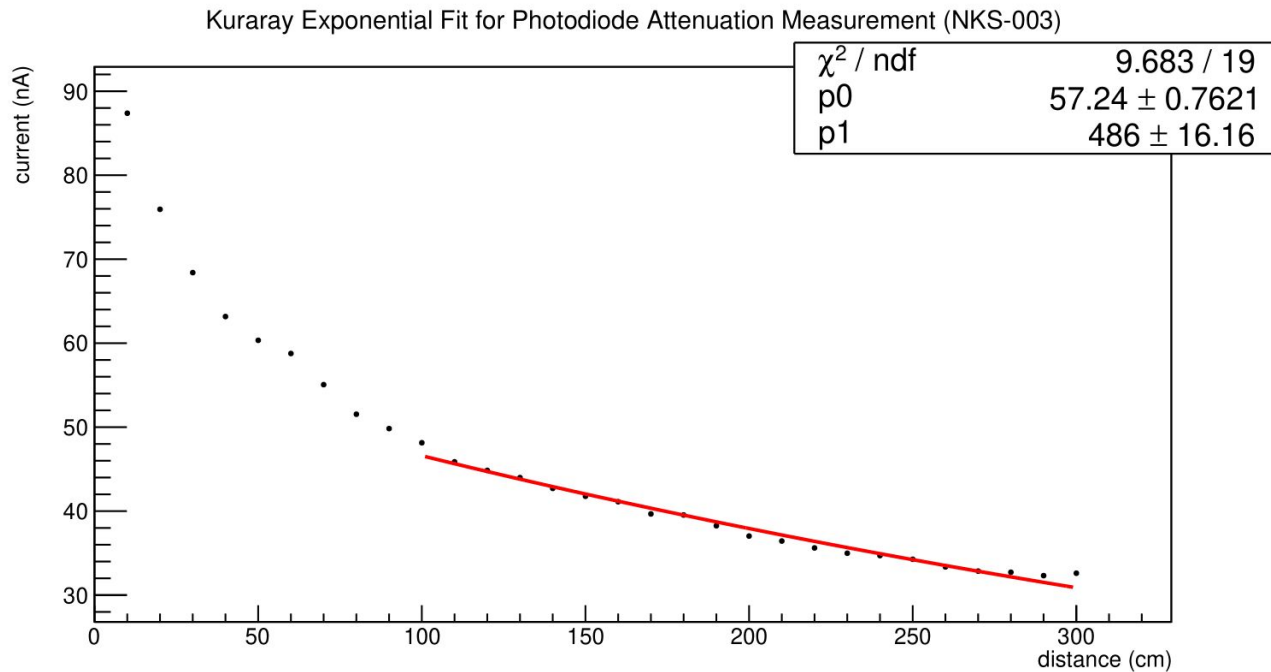
NKS-002

No measurement with optical grease taken



NKS-003

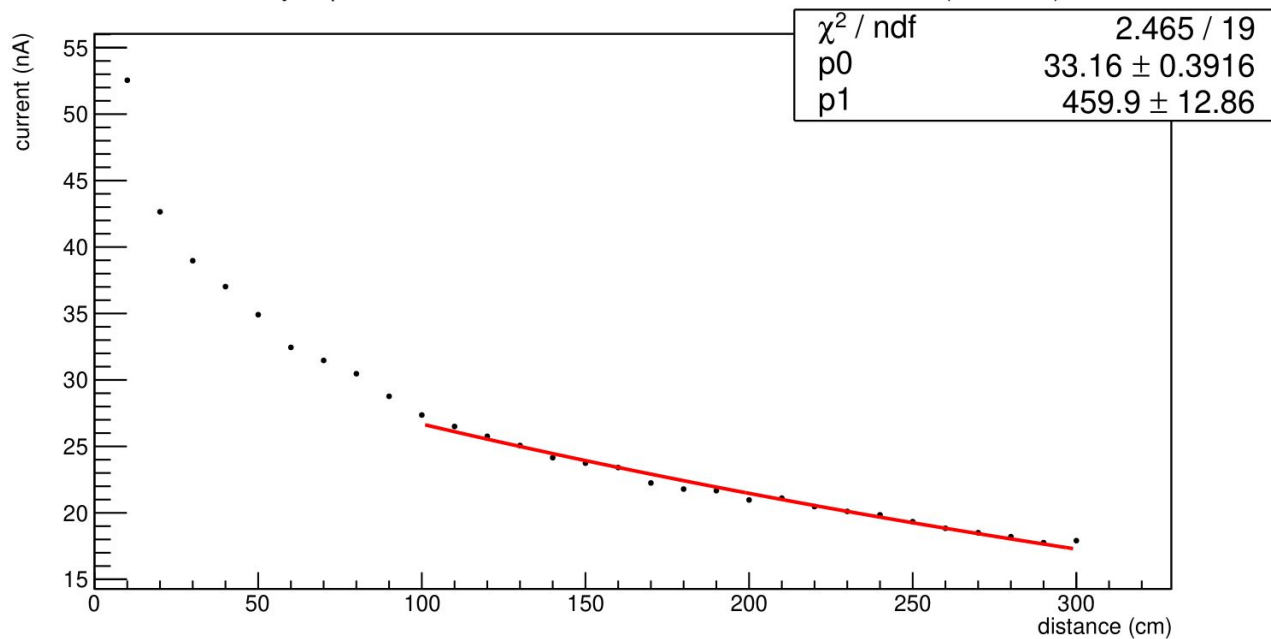
No measurement with optical grease taken



NKS-005

No measurement with optical grease taken

Kuraray Exponential Fit for Photodiode Attenuation Measurement (NKS-005)

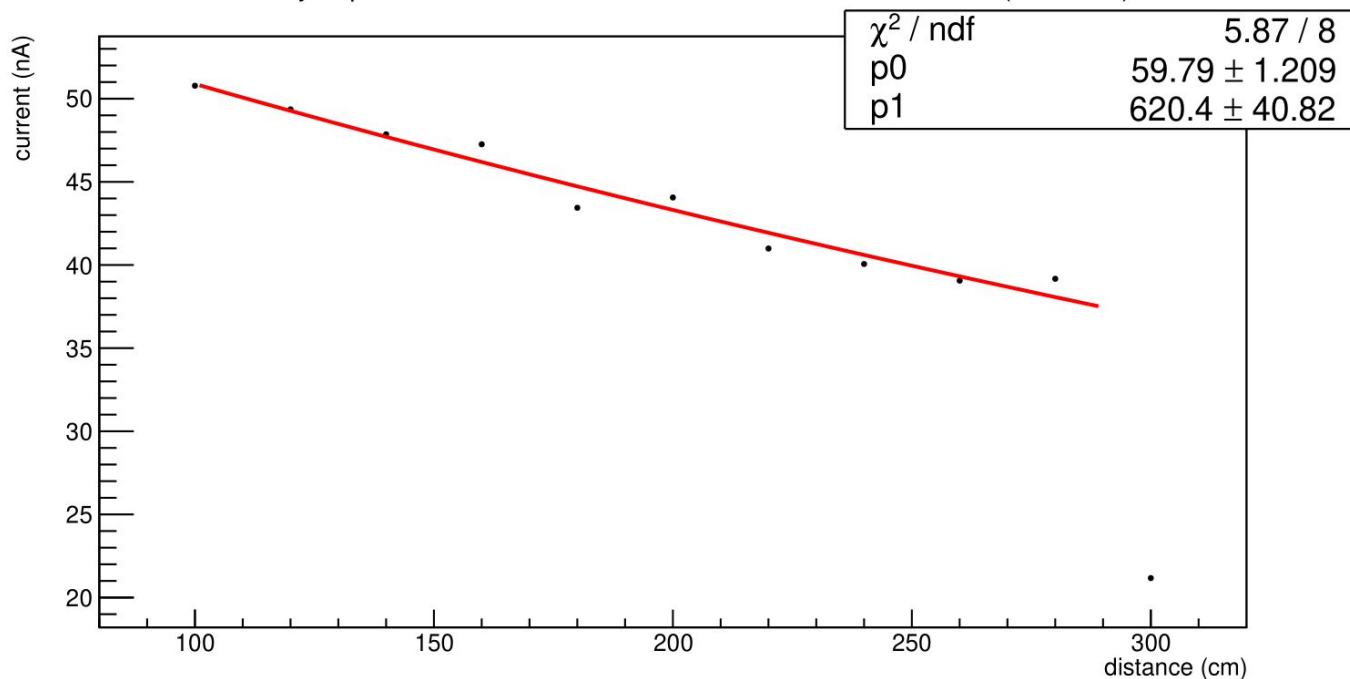


NKD-001

**Different measuring increments used for initial measurements (NKS-001 and NKD-001)

No measurement with optical grease taken

Kuraray Exponential Fit for Photodiode Attenuation Measurement (NKD-001)



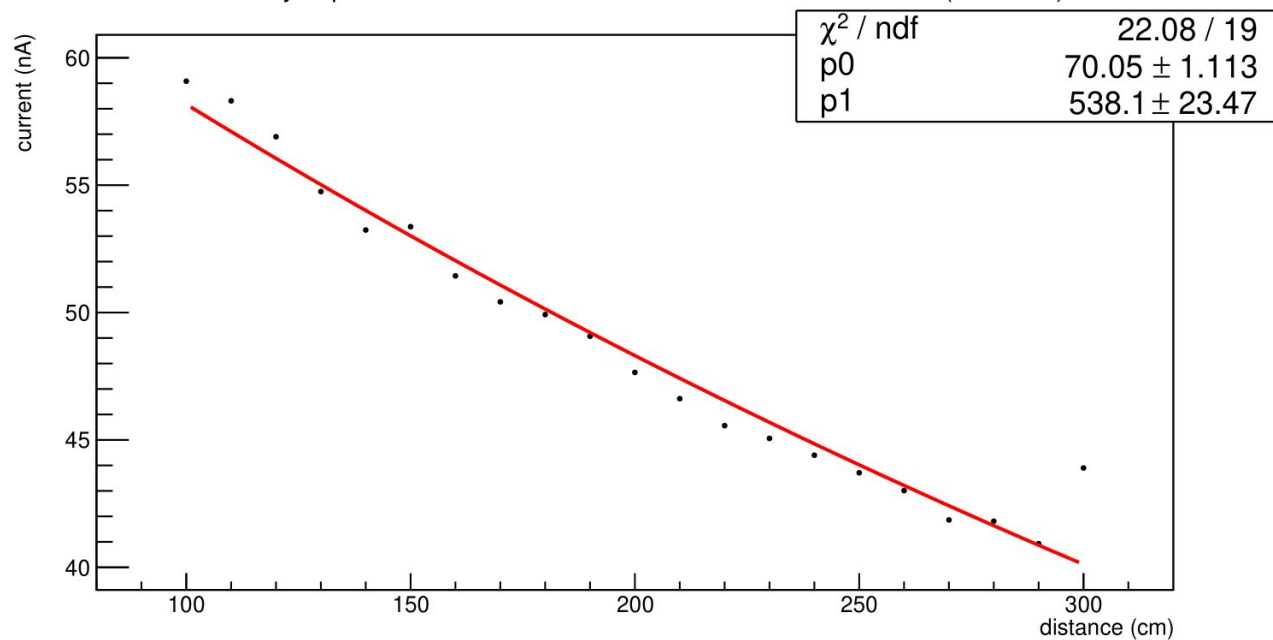
(The results for this measurement were poor; added for completeness)

NKD-002



No measurement with optical grease taken

Kuraray Exponential Fit for Photodiode Attenuation Measurement (NKD-002)

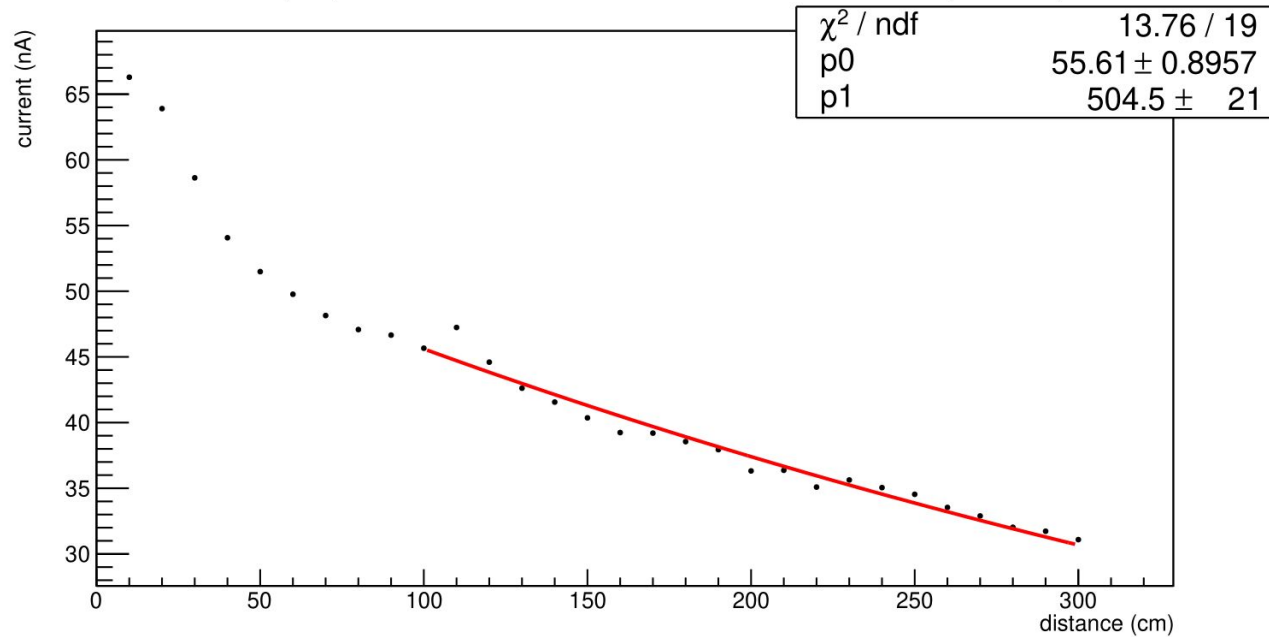


NKD-003



No measurement with optical grease taken

Kuraray Exponential Fit for Photodiode Attenuation Measurement (NKD-003)

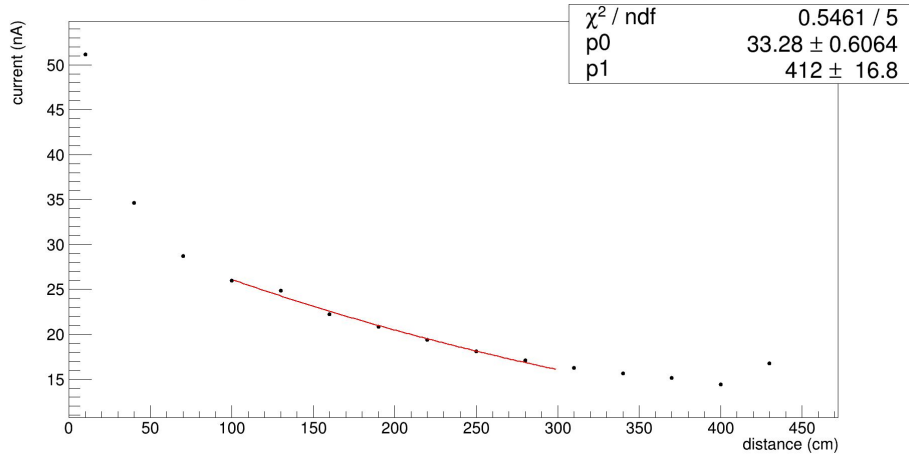


L-001

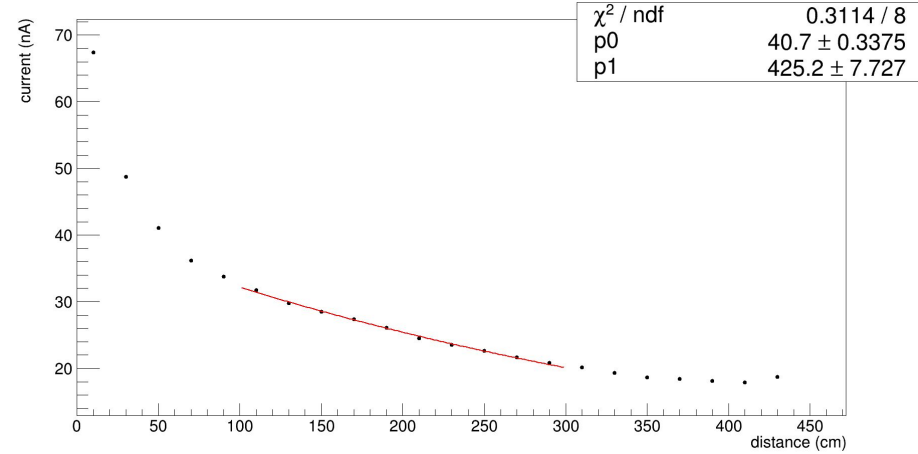


Without optical grease

Kuraray Exponential Fit for Photodiode Attenuation Measurement (L-001)



Kuraray Exponential Fit for Photodiode Attenuation Measurement (L-001G)

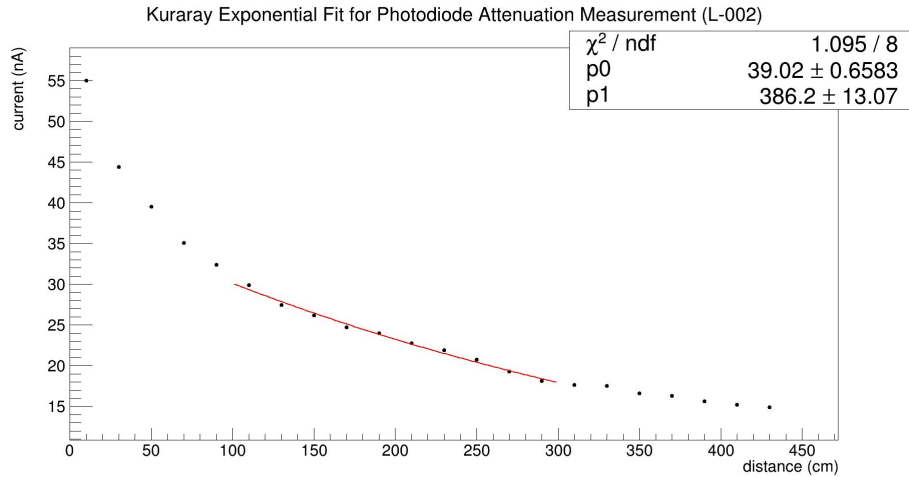


With optical grease

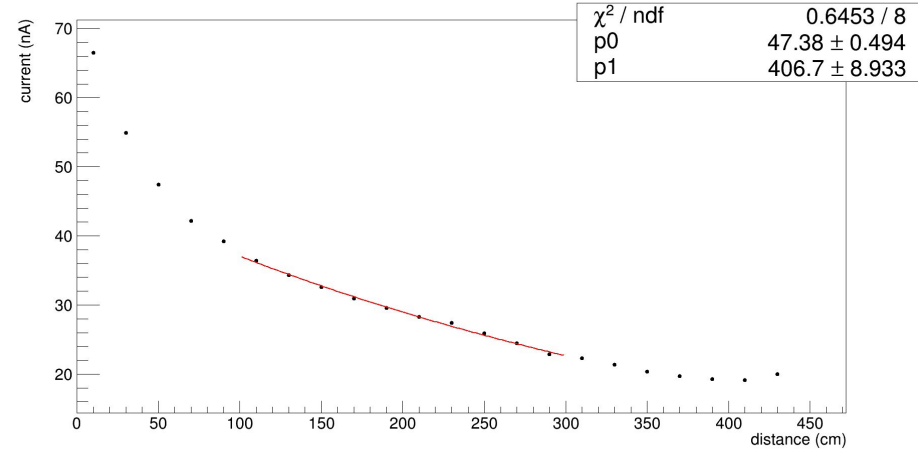
L-002



Without optical grease



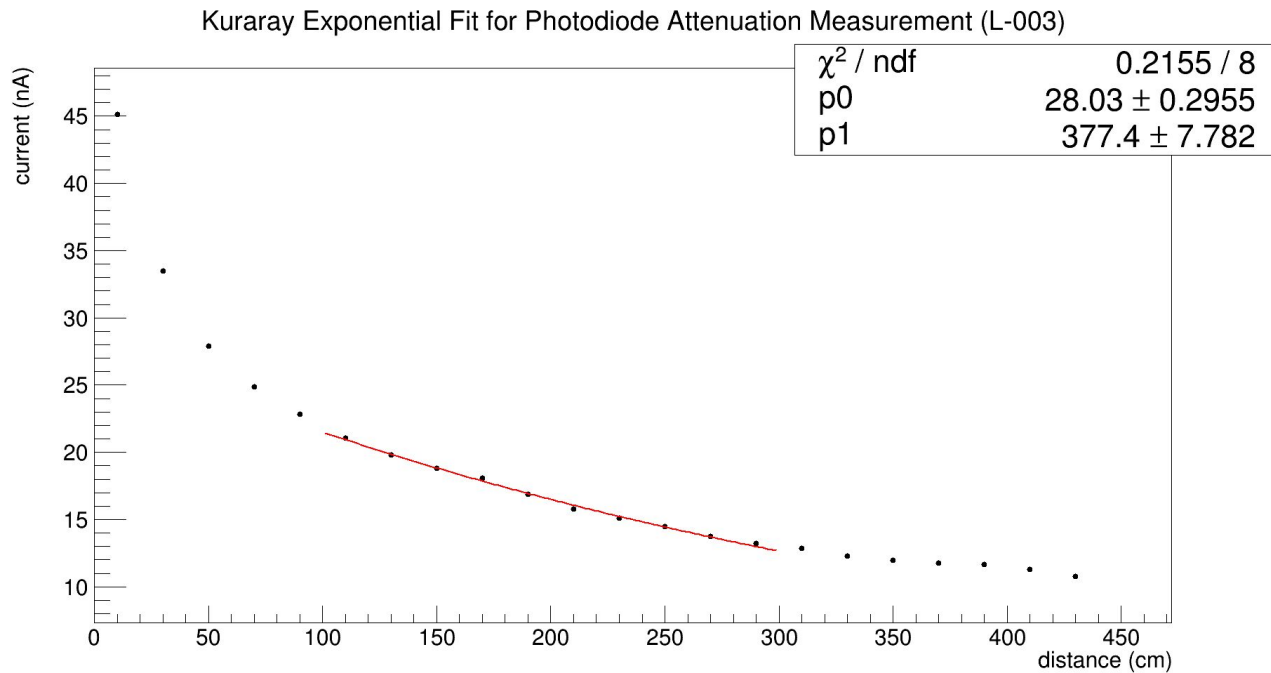
Kuraray Exponential Fit for Photodiode Attenuation Measurement (L-002G)



With optical grease

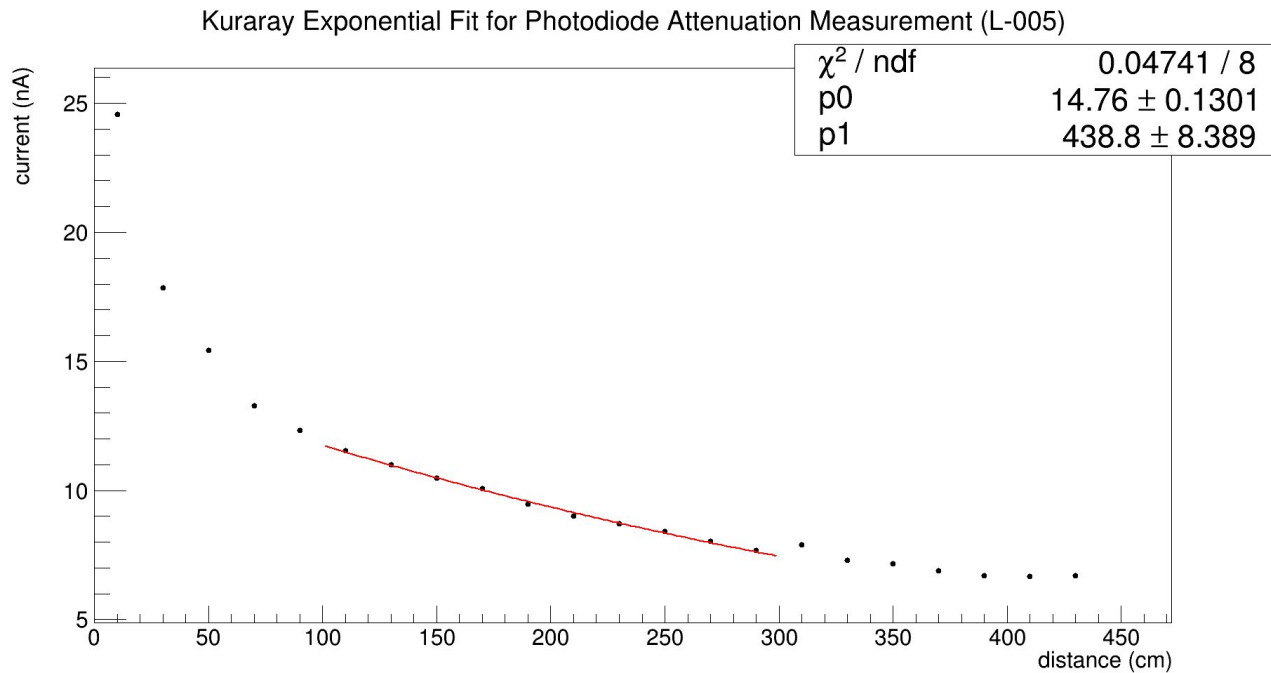
L-003

No measurement with optical grease taken

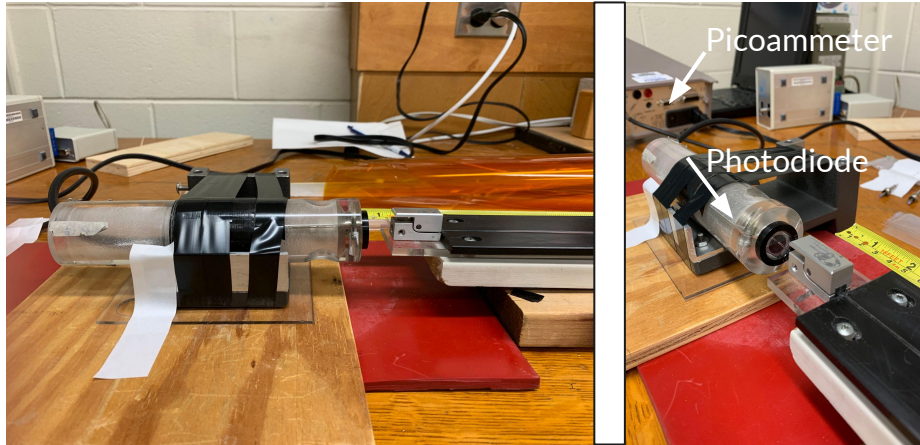


L-005

No measurement with optical grease taken

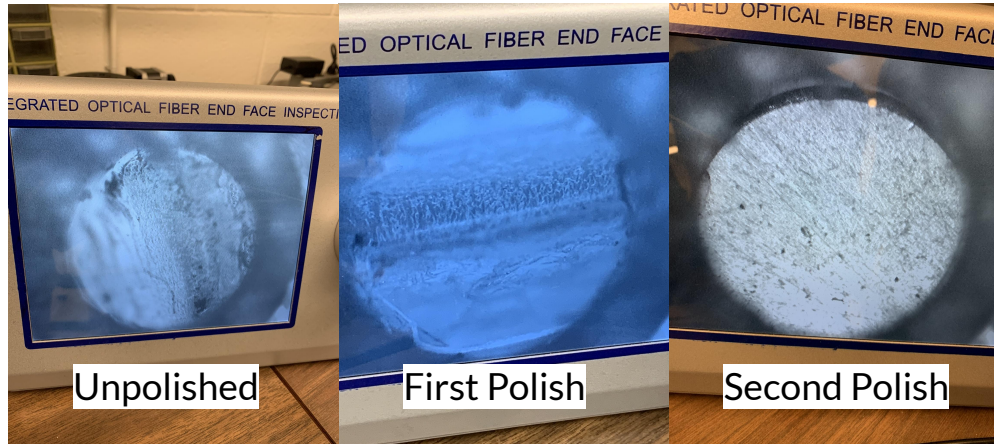


July 31 - August 4



- Continued measurements with **Photodiode/Picoammeter Setup**
 - Fiber laid in groove of polyethylene tray, polished end touching face of photodiode
 - LED powered by power crate at 3.8 V, which corresponds to ~ 0.041 A
 - Picoammeter readings taken at 10.0 cm intervals from 10.0 cm to 300.0 cm
- **A complete pouch of single and double clad fibers have now been polished and measured**
 - One pouch corresponds to five fibers

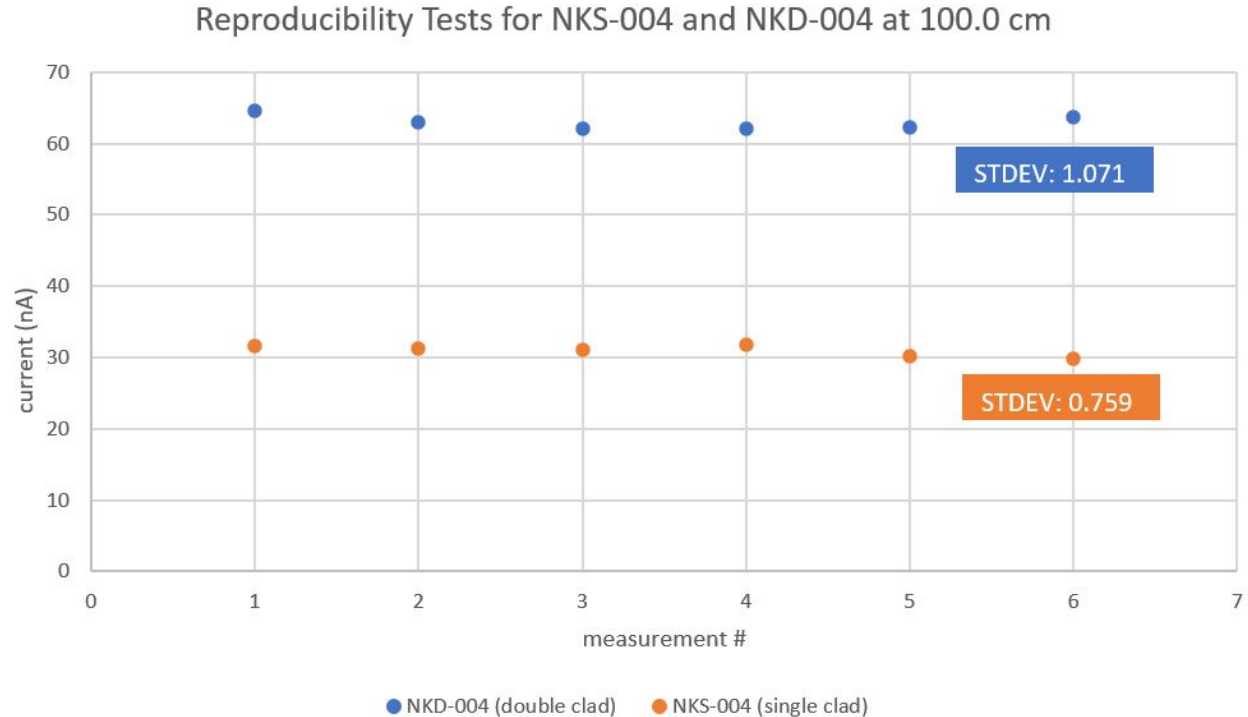
August 7 - August 11



- **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

