bECAL Fiber Tests @Regina - Update 5

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Presentation to the weekly Barrel ECAL Meeting, August 29, 2023

Timeline - August/September

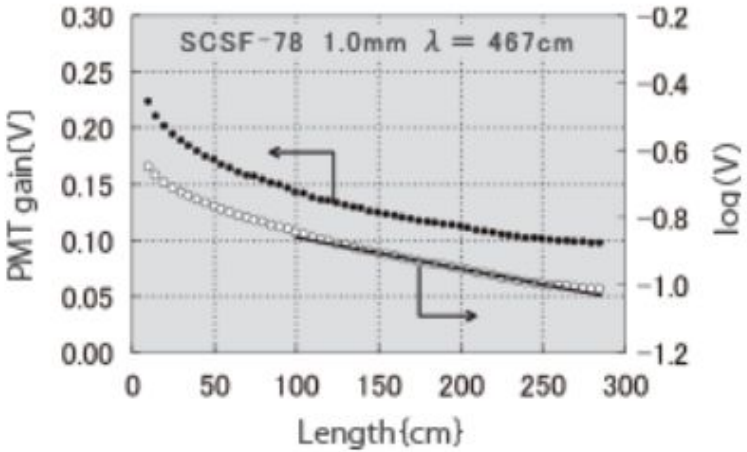
- Original plan:
  - August 14-18: **Kuraray** and **Luxium** fiber testing at **Photodiode Station**; Npe testing at **Npe station**
  - August 21-25: Further measurements as needed
  - August 28-September 1: Finalize results for **September Review**
- **Updated Plan:**
  - August 21- 28: Npe measurements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

Attenuation Length Calculation

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

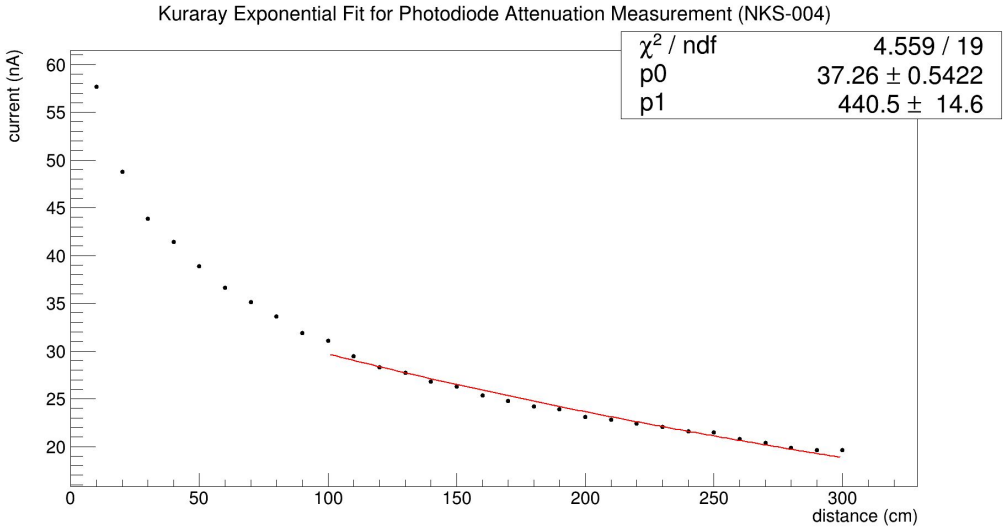
$$I = I_0 \cdot e^{\frac{-x}{\lambda}}$$

- **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

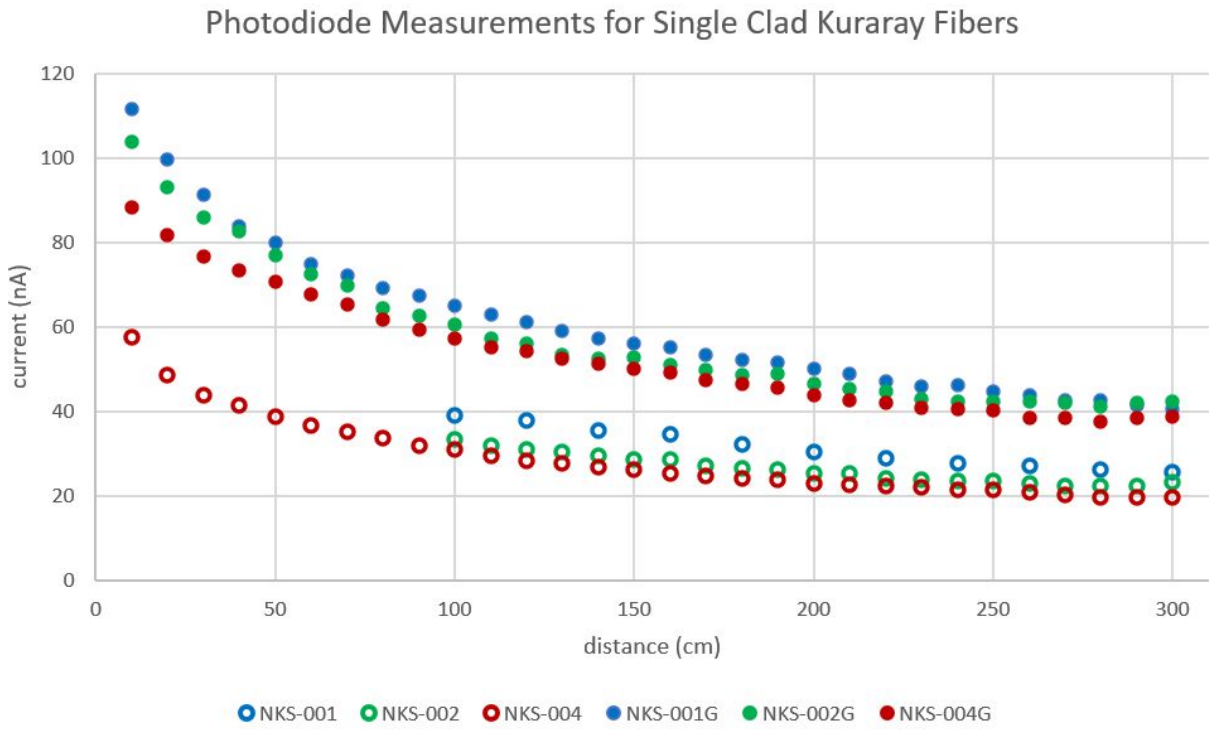


Attenuation Length Results - Kuraray Single Clad Fibers

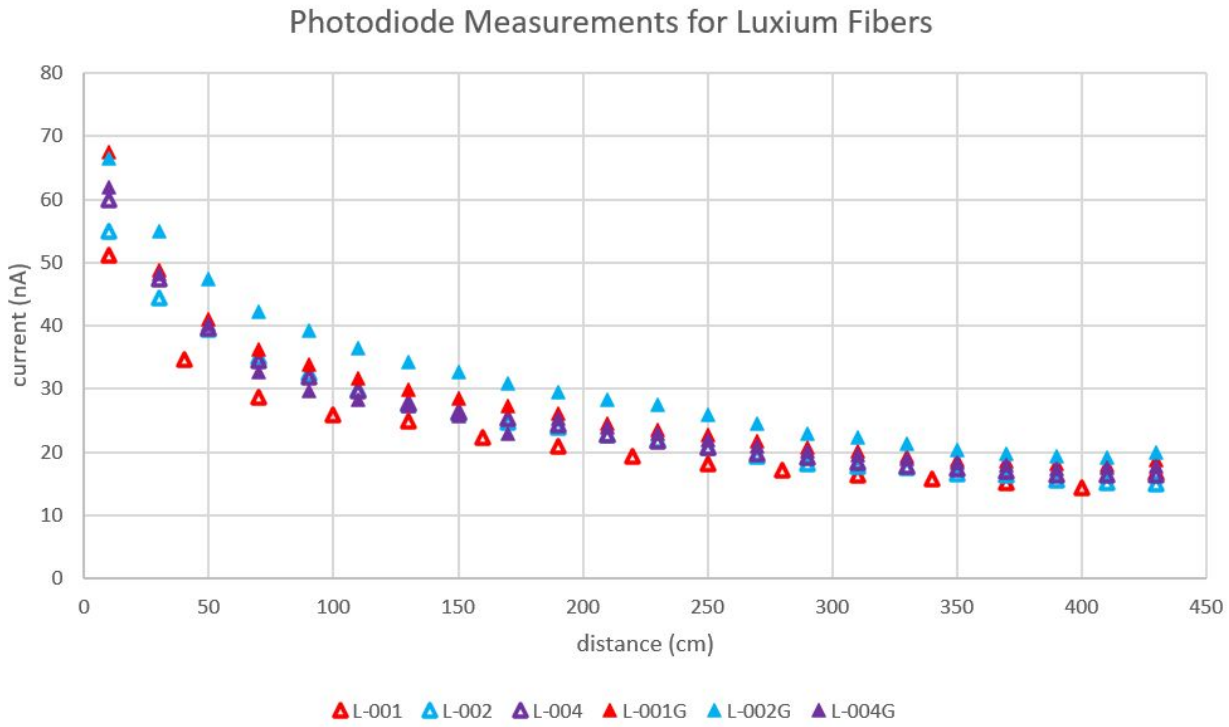
- NKS-004
- **N**ew **K**uraray **S**ingle clad fiber **-004**
- Single clad attenuation lengths ranged from 430 - 490 cm
- ~3.0% error (LED fluctuations dominate)



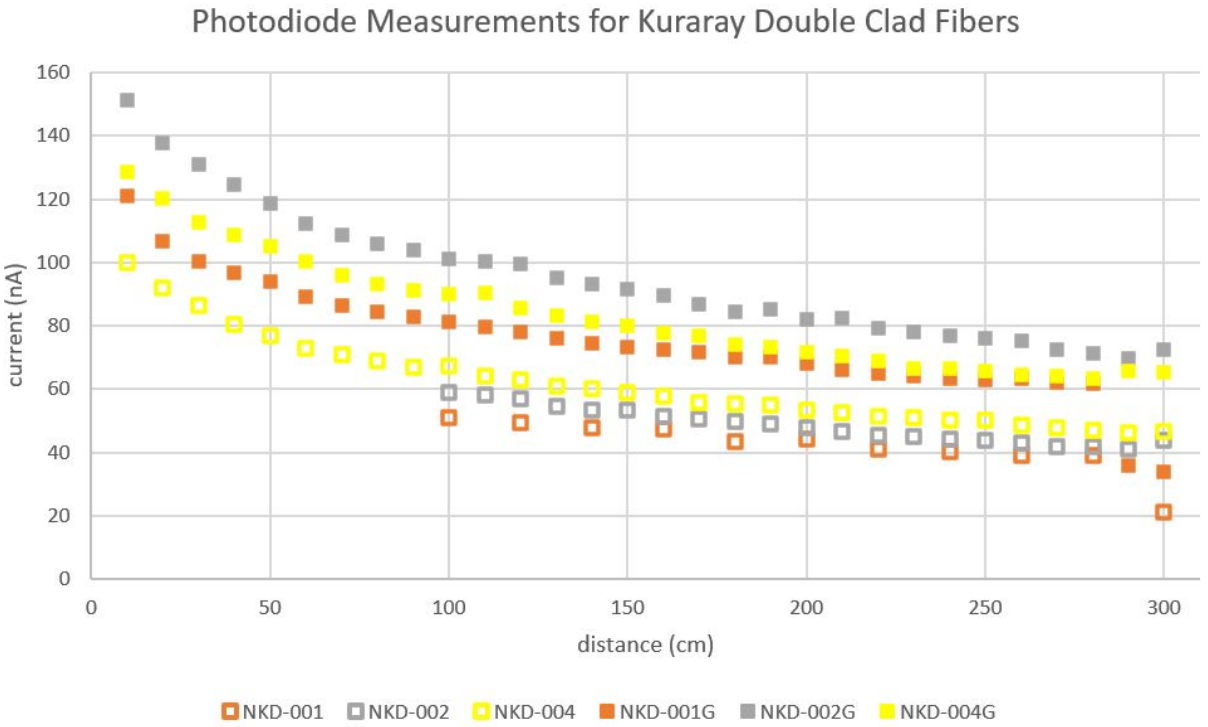
Kuraray Single Clad Results



Luxium (Single Clad) Results



Kuraray Double Clad Results



Attenuation Length Comparison (100-300cm)

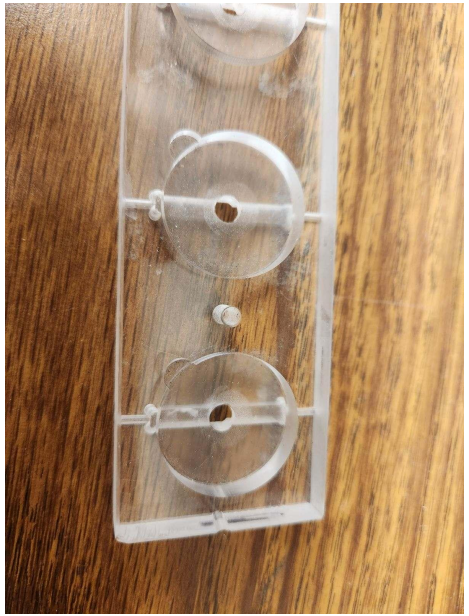
NKS-00i	λ (cm)	L-00i	λ (cm)	NKD-00i	λ (cm)
001	431±17	001	412±17	001	620±41
002	480±22	002	386±13	002	528±24
003	486±16	003	377±8	003	505±21
004	441±46	004	406±8	004	544±17
005	460±13	005	439±8		
001G	432±27	001G	425±8	001G	641±67
002G	532±42	002G	407±9	002G	529±41
004G	449±17	004G	567±66	004G	531±29

Issues/Observations

- Upwards “bump” at 300.0 cm distance on all Kuraray fiber measurements
  - Fiber coming loose in grove - “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

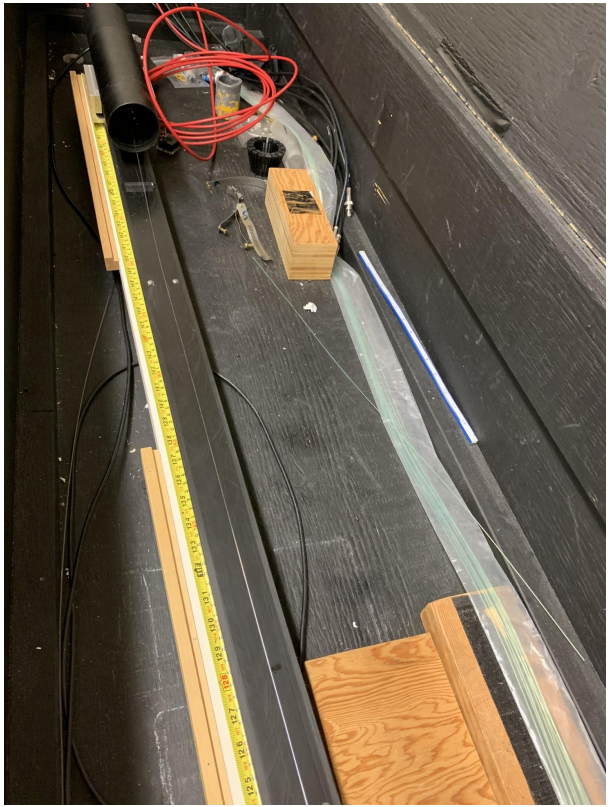
Npe Station

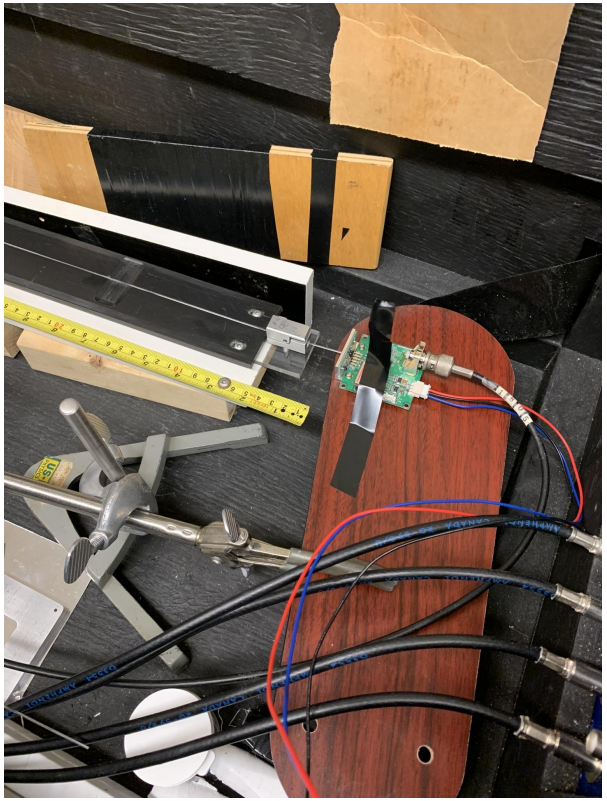
- Use photodiode puck board and runner in coffin, with modifications
- Fiber radius of curvature
- Easy positioning and moving ^{90}Sr
- Machined ^{90}Sr holder to be mounted on **new** runner
- Coincidence with PMT
- Measurements started yesterday



Npe Station - Mechanical 1

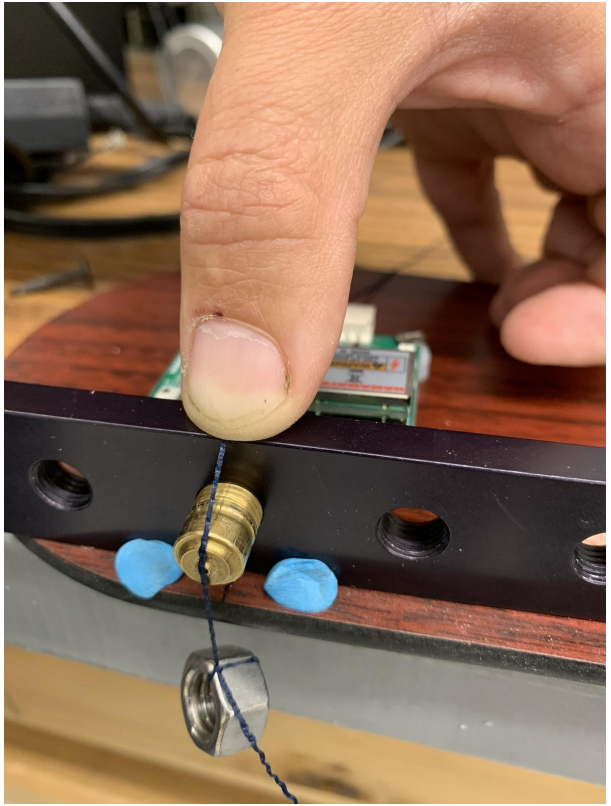
- Last week’s setup
- Level fiber to devices
- PMT open
- SiPM clamp wobbly
- Ambient light issue





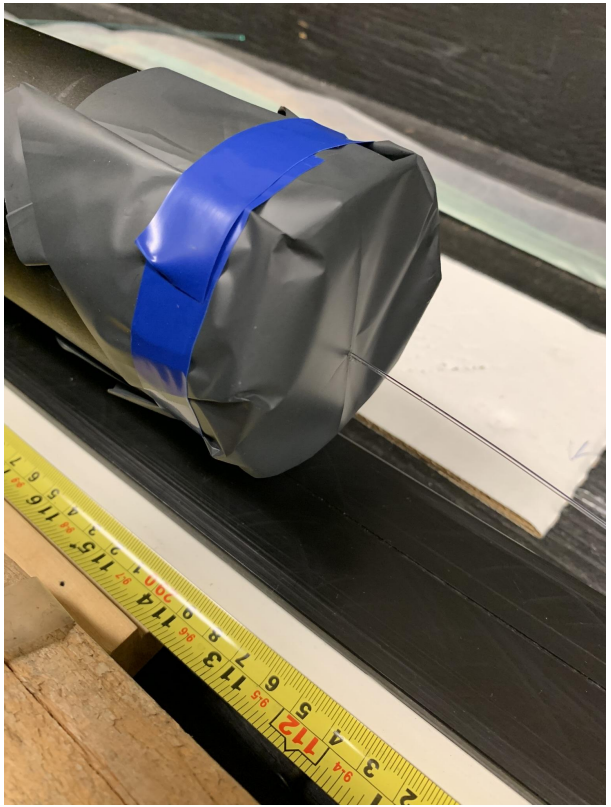
Npe Station - Mechanical 2

- Friday's setup
- Fiber alignment
- SiPM clamp better



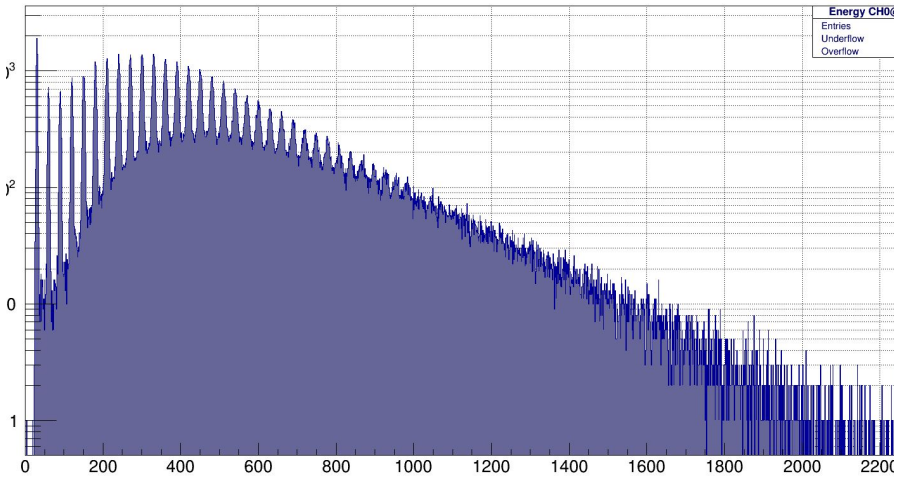
Npe Station - Mechanical 3

- Friday's setup
- PMT opening covered
- Ambient light control
- Stronger ^{90}Sr
- Reproducible coupling

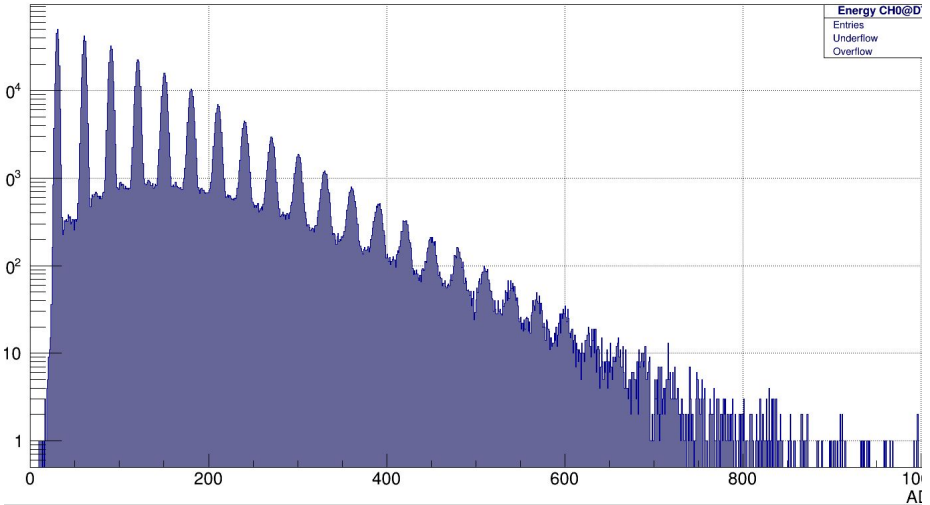


Npe Station ^{90}Sr @ 240cm

Friday: Mechanical alignment improved!
x-axes are not the same



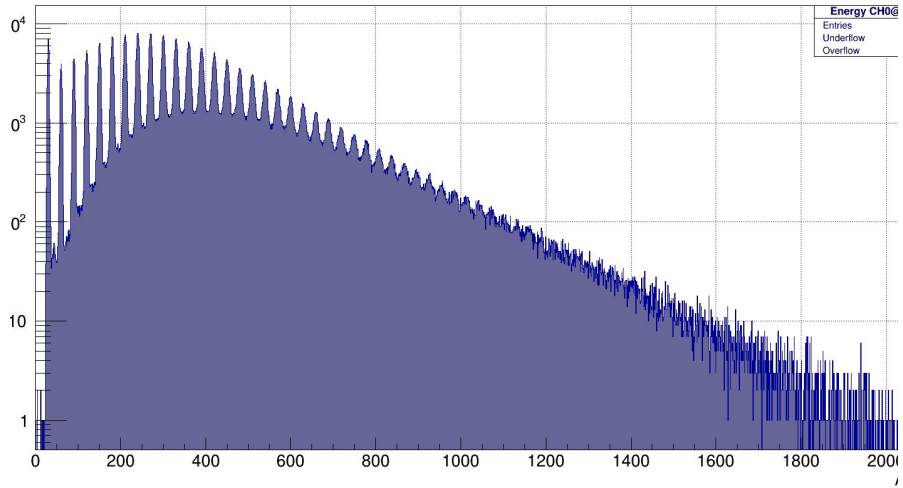
Fluke: 30 peaks



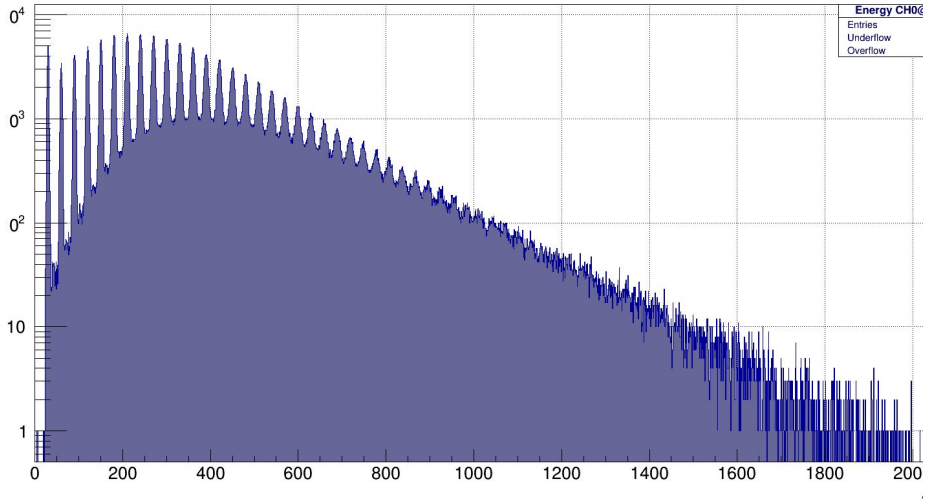
Reproducible: 20 peaks

Npe Station ^{90}Sr @ 100cm

Monday: 10 min run



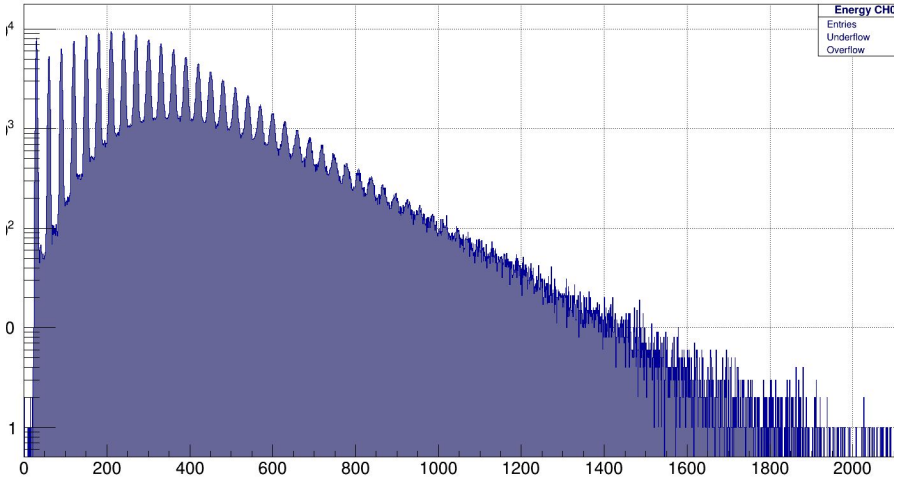
NKuraray004



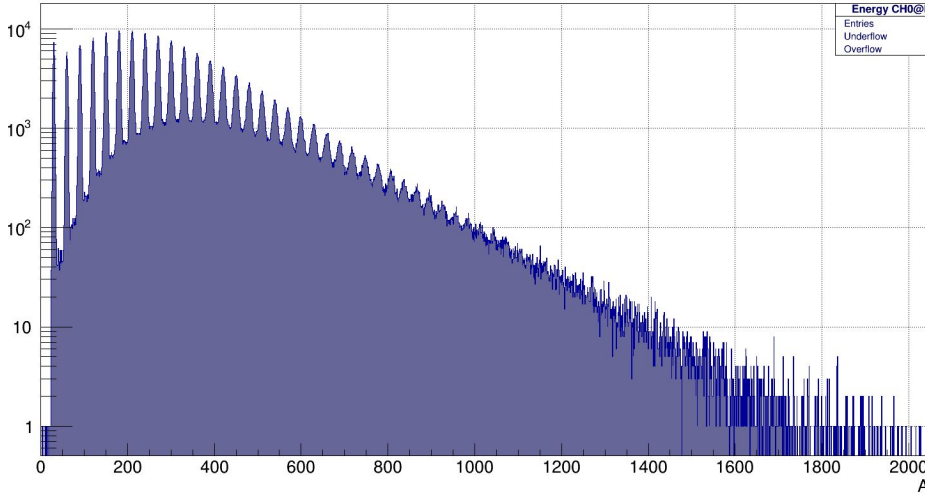
Luxium001

Npe Station ^{90}Sr @ 140cm

Monday: 10 min run



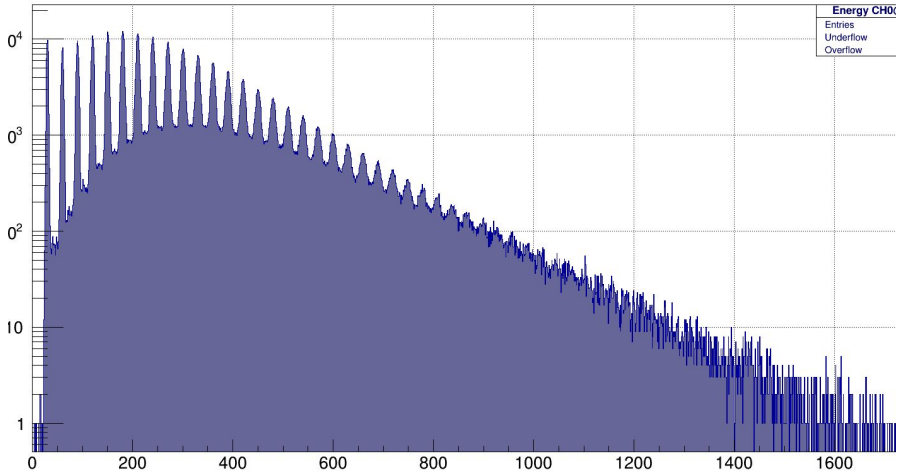
NKuraray004



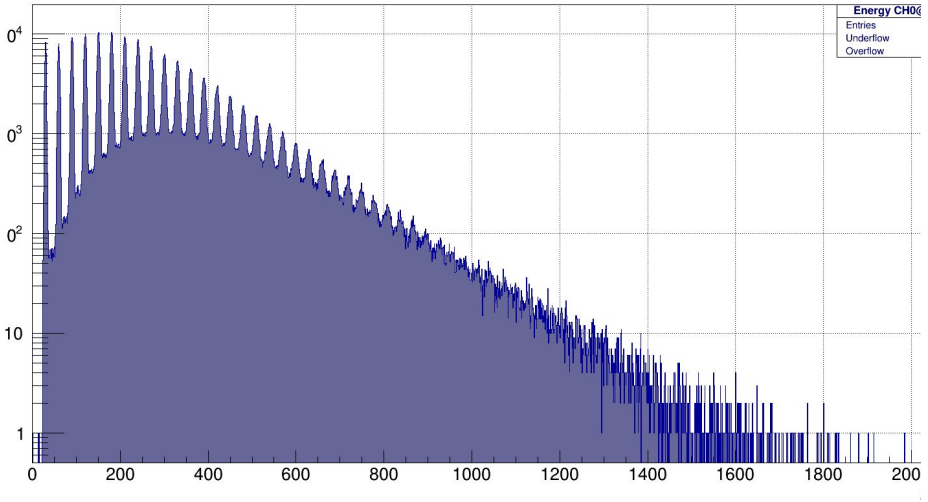
Luxium001

Npe Station ^{90}Sr @ 200cm

Monday: 10 min run



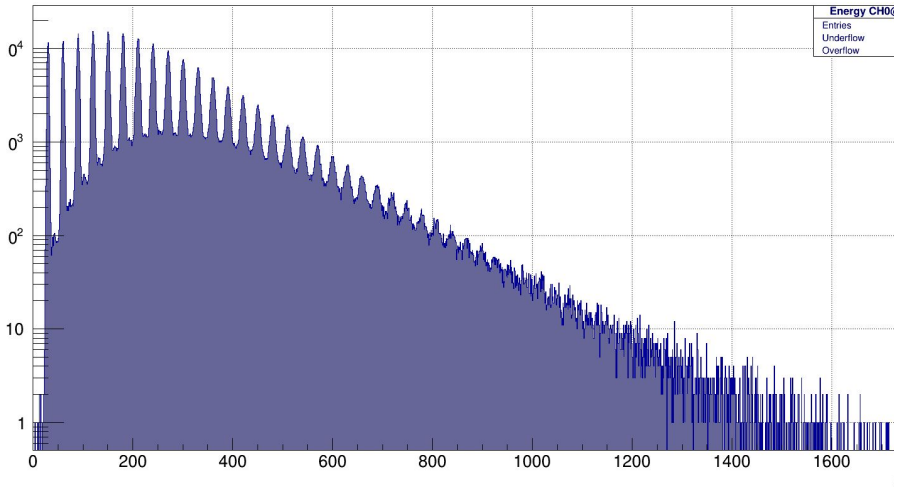
NKuraray004



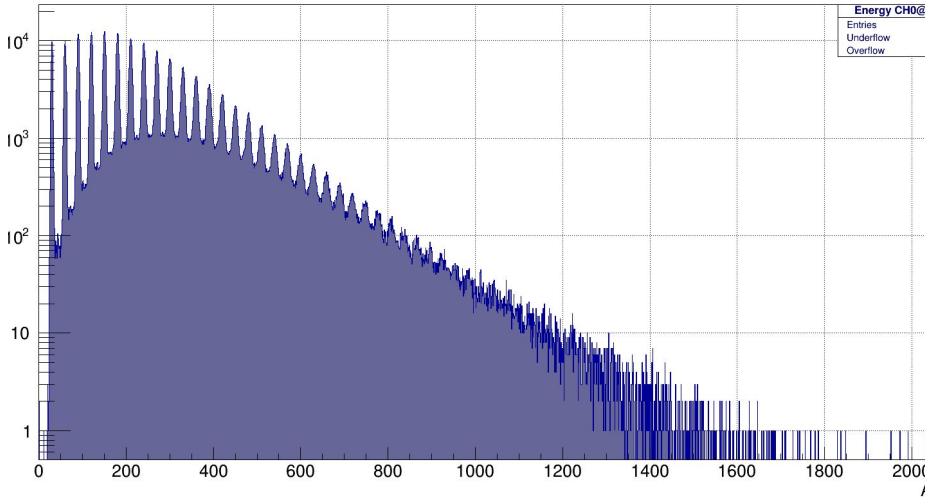
Luxium001

Npe Station ^{90}Sr @ 240cm

Monday: 10 min run



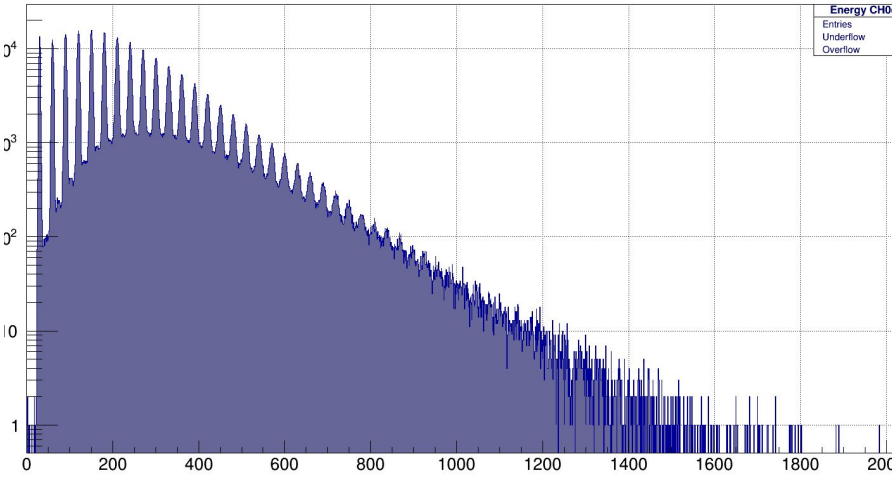
NKuraray004



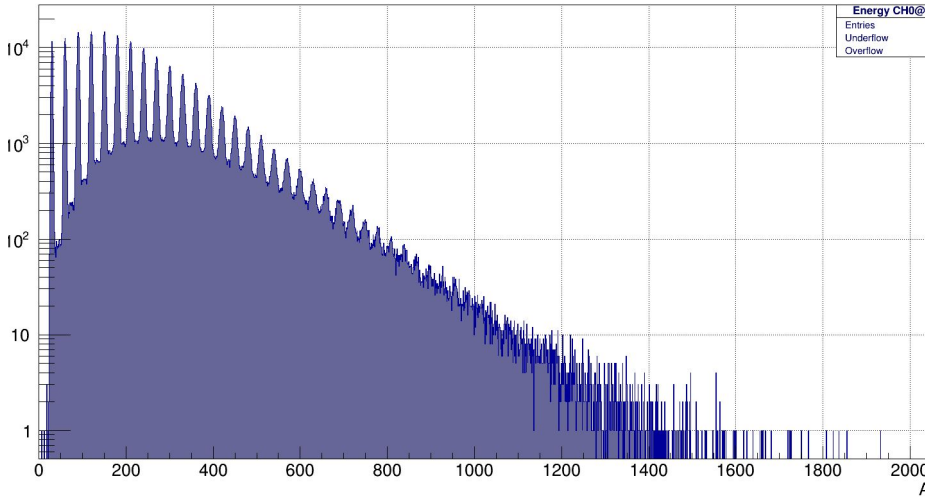
Luxium001

Npe Station ^{90}Sr @ 280cm

Monday: 1000 second run



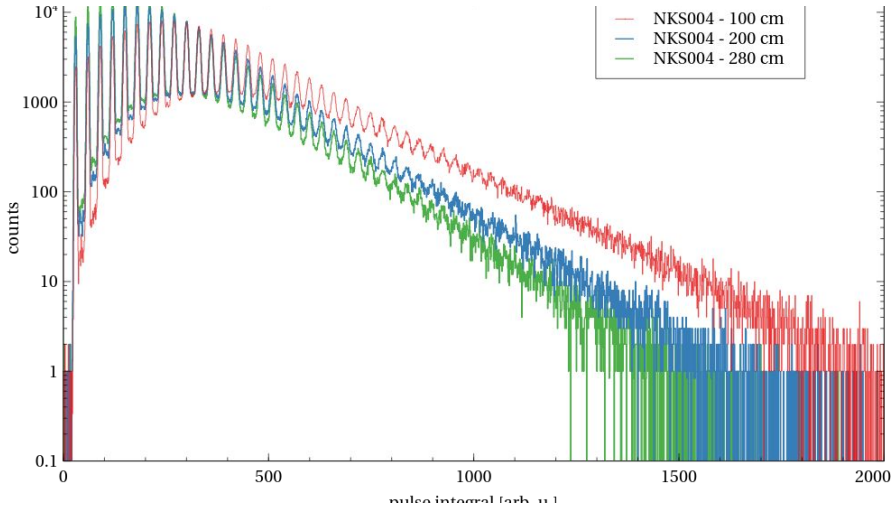
NKuraray004



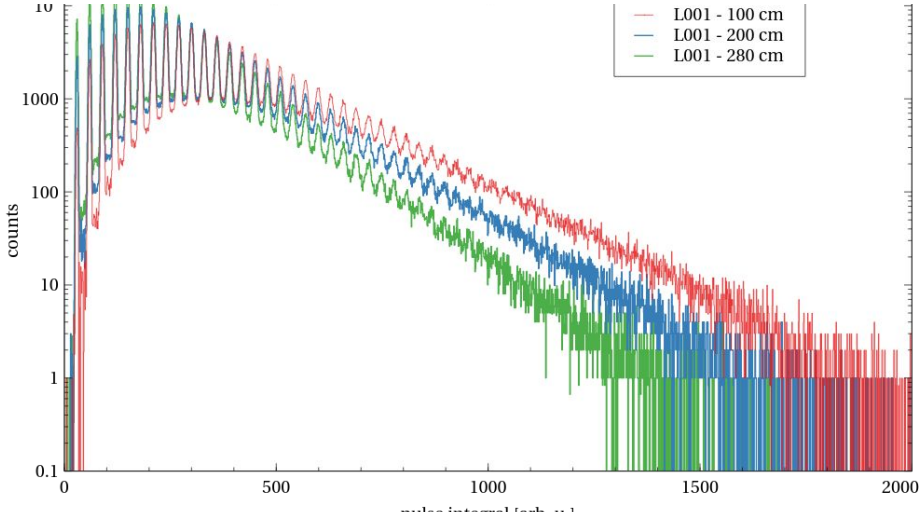
Luxium001

Npe Station ^{90}Sr Atten Len

Evolution with distance



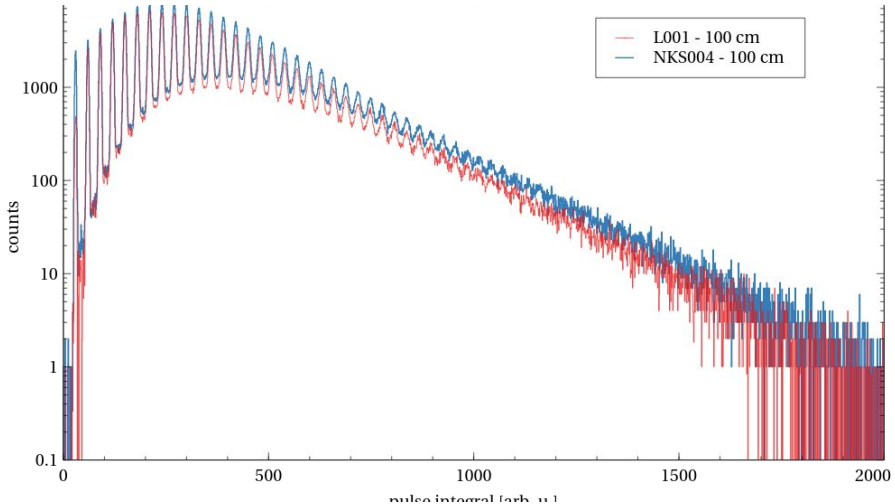
NKuraray004



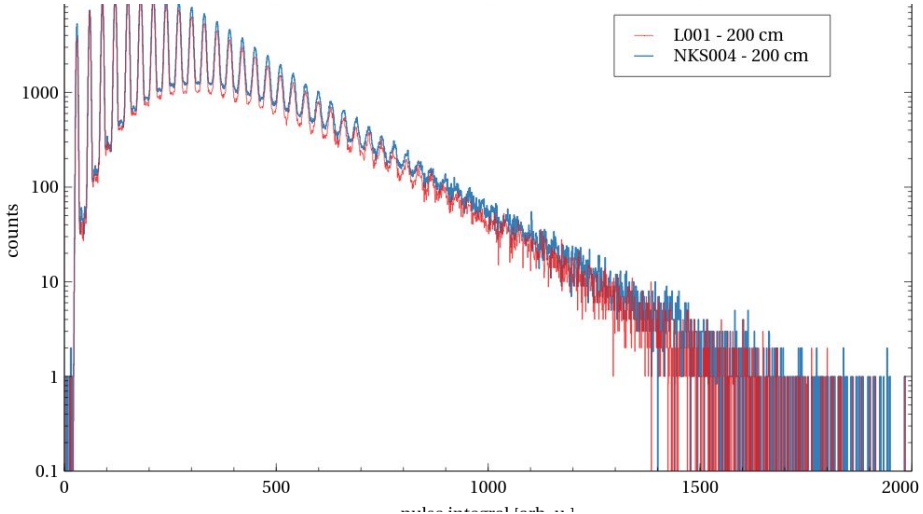
Luxium001

Npe Station ^{90}Sr @ 280cm

Comparisons of vendors

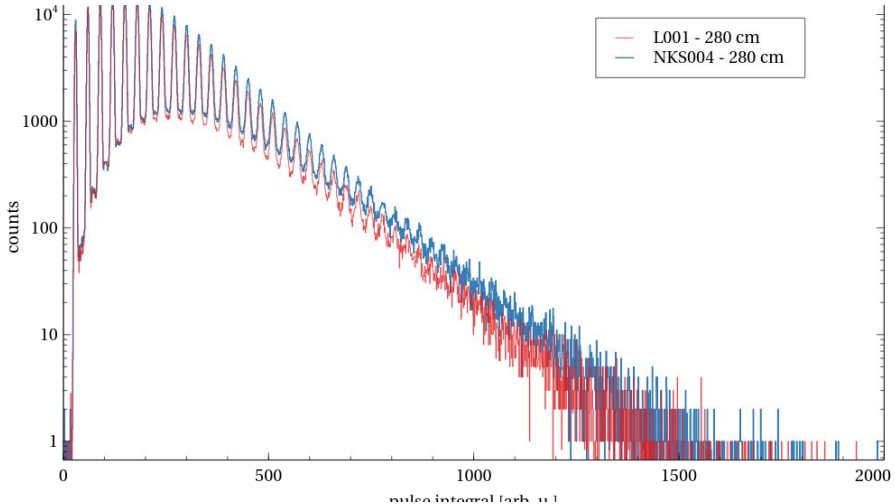


NKuraray004 vs Luxium001

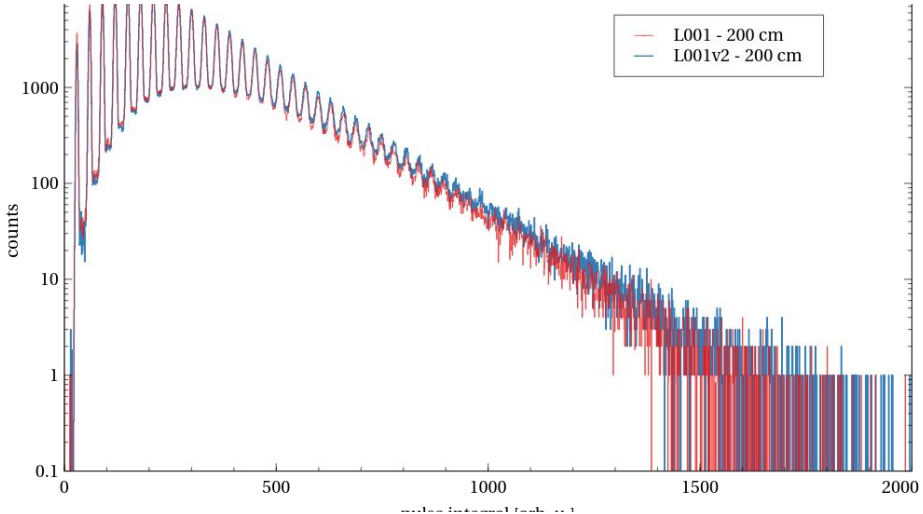


NKuraray004 vs Luxium001

Npe Station ^{90}Sr @ 280cm



NKuraray004 vs Luxium001



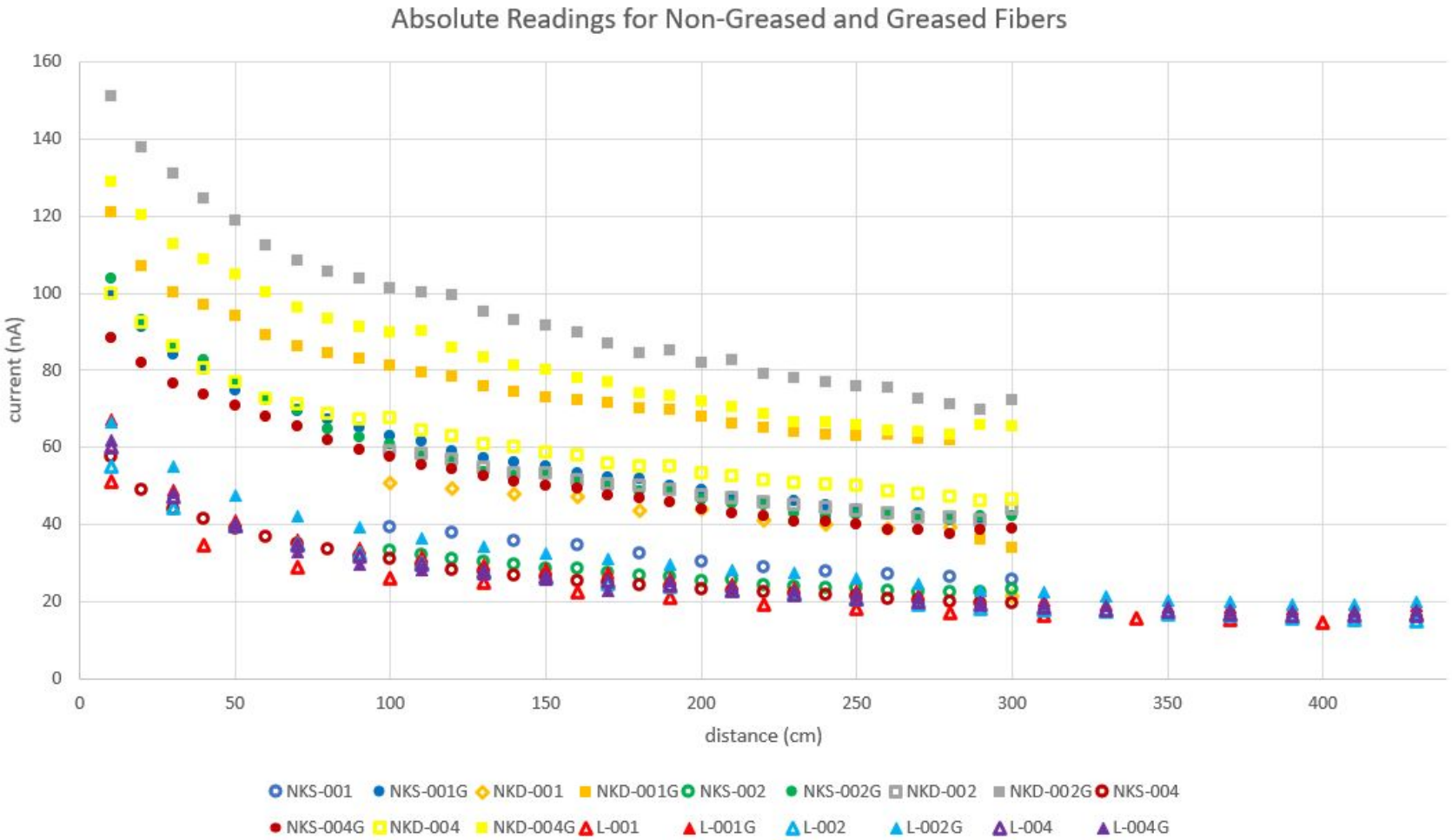
Luxium001 - reproducibility

Comparisons of vendors

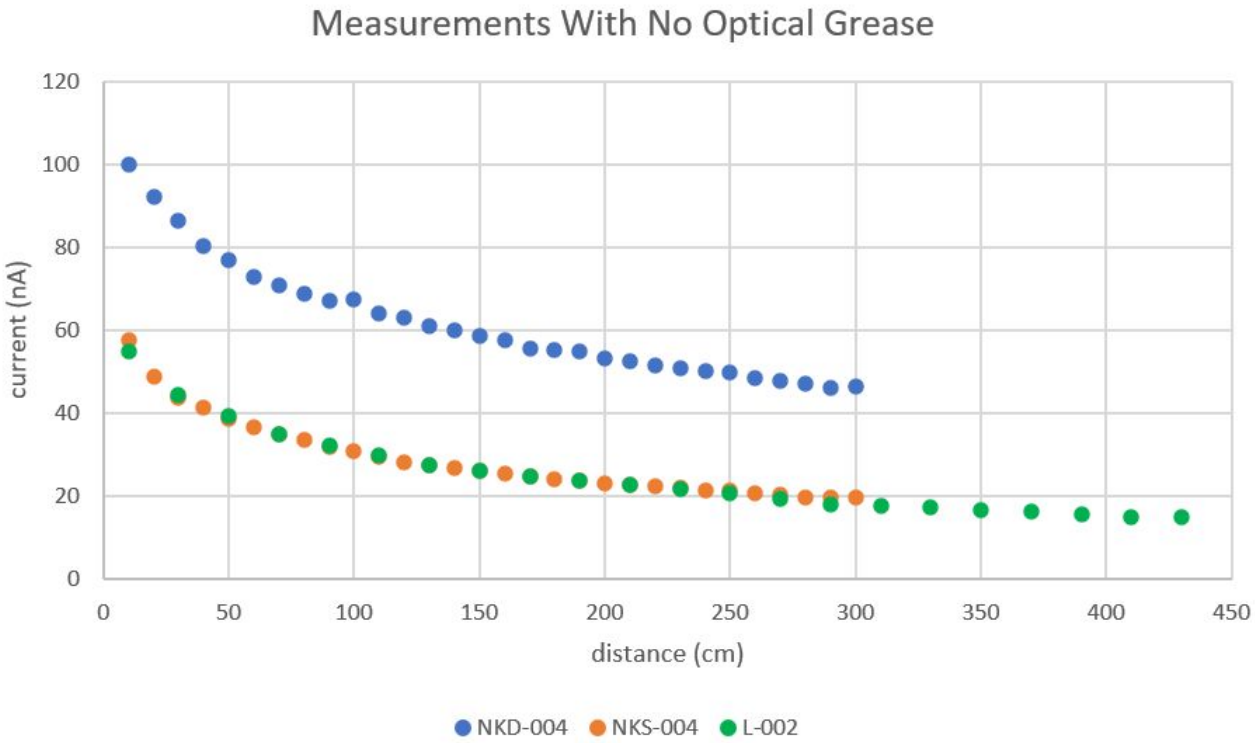
Summary

- Discuss and digest **photodiode**/**Npe** results: both vendors meet λ specs
- Npe measurements (SiPM-PMT coinc) with **stable** SiPM setup
  - Develop fitting method; ^{90}Sr dE/dx modelled (GlueX)
  - Extract attenuation length from Npe station
  - Attempt absolute light output/Npe extraction
- Technical report draft ready by August 28; mostly ready
- LEDs ordered to scan spectrophotometer (370-520 nm); September
- Love Preet completed his work; Madelyn Kaban (senior ugrad) joining

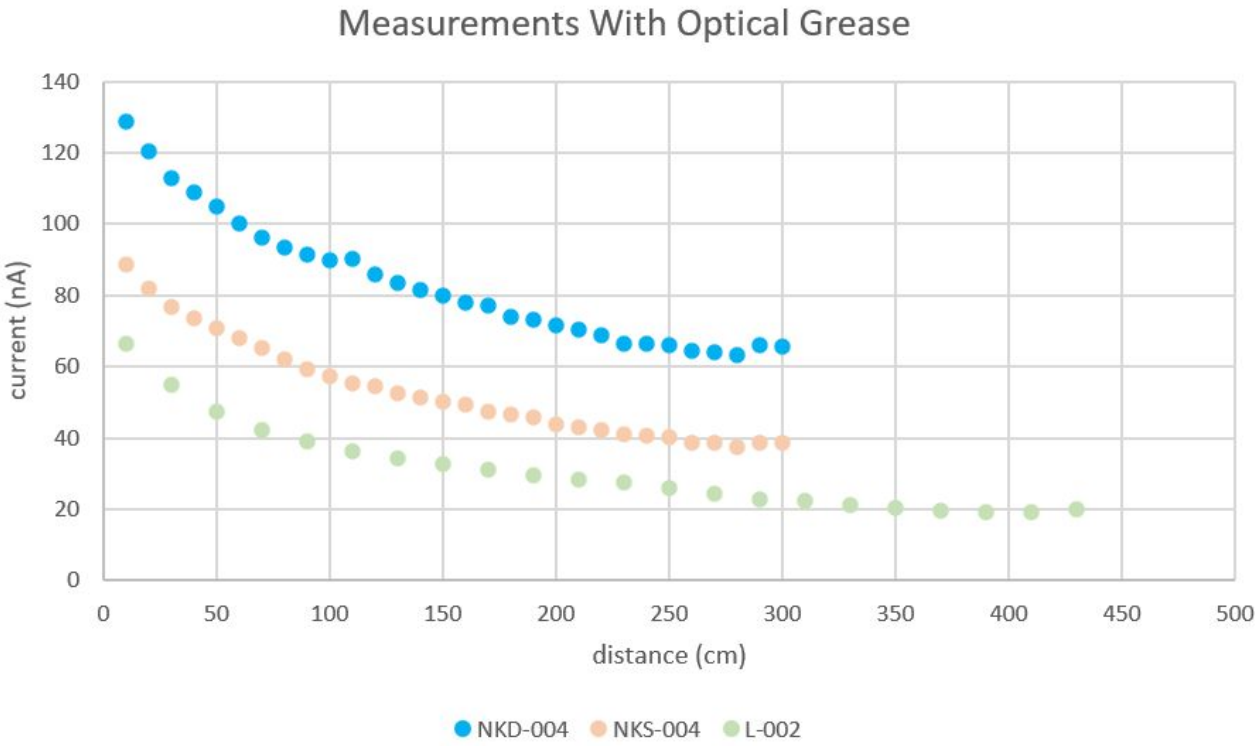
Backup Slides


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



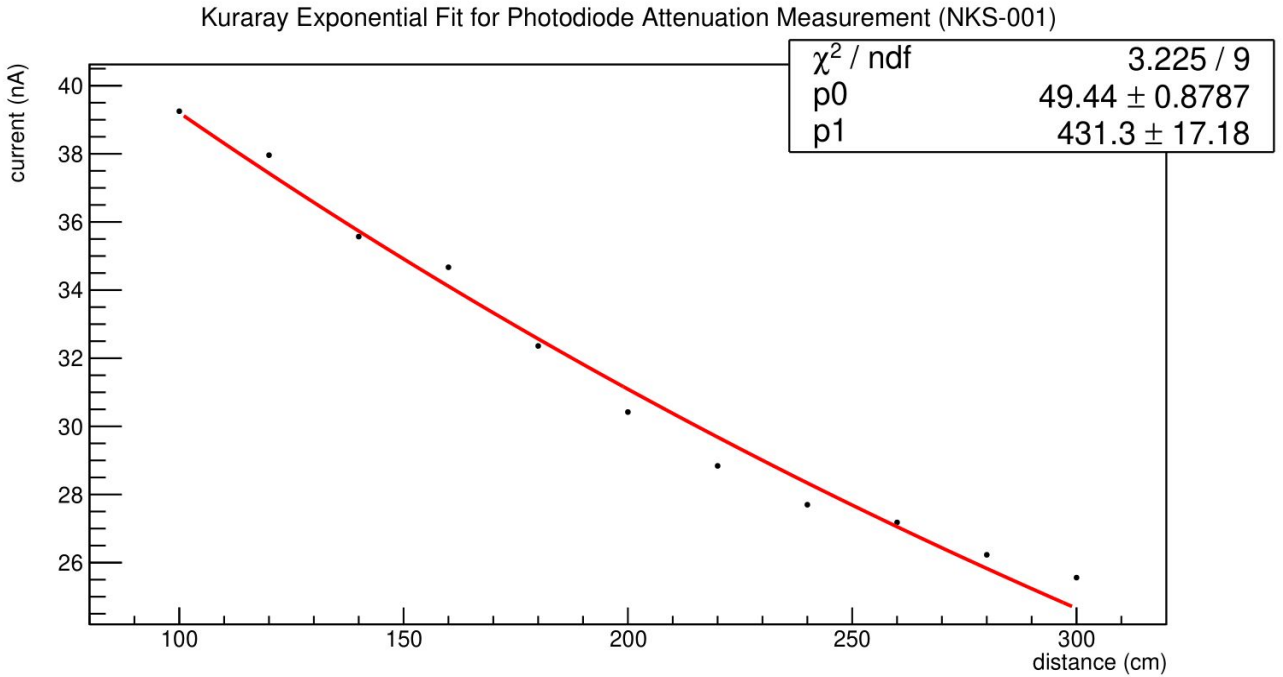
With Optical Grease



NKS-001

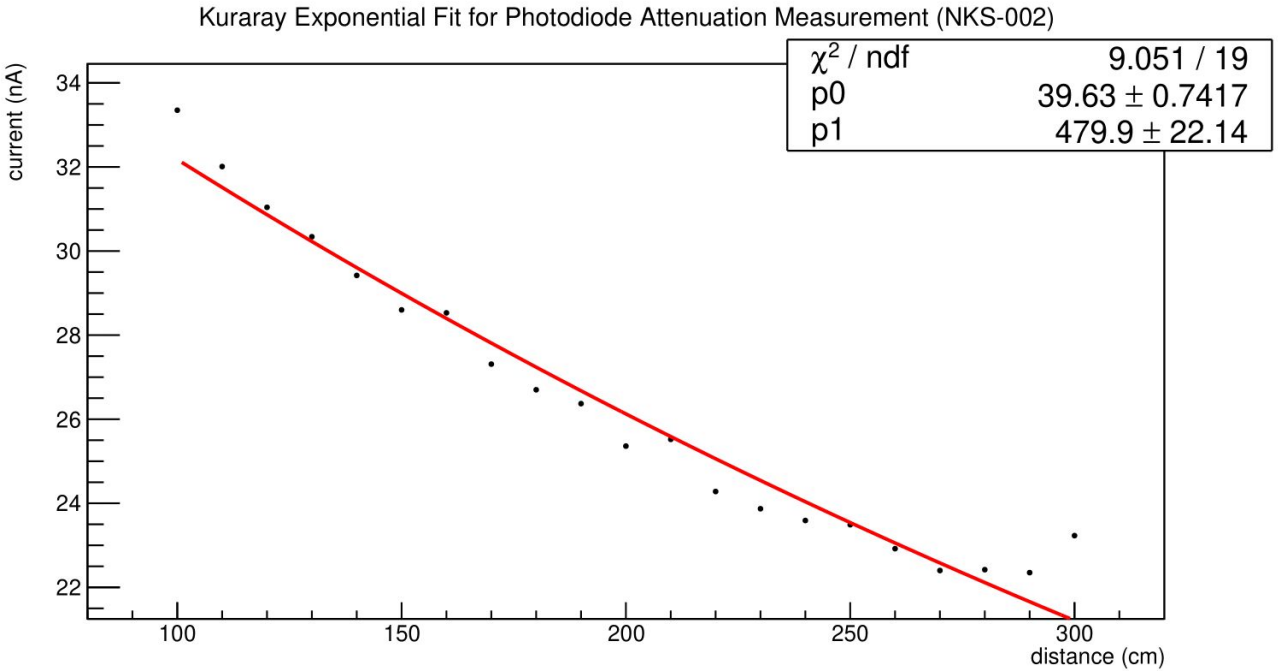
**Different measuring increments used for initial measurements (NKS-001 and NKD-001)

No measurement with optical grease taken



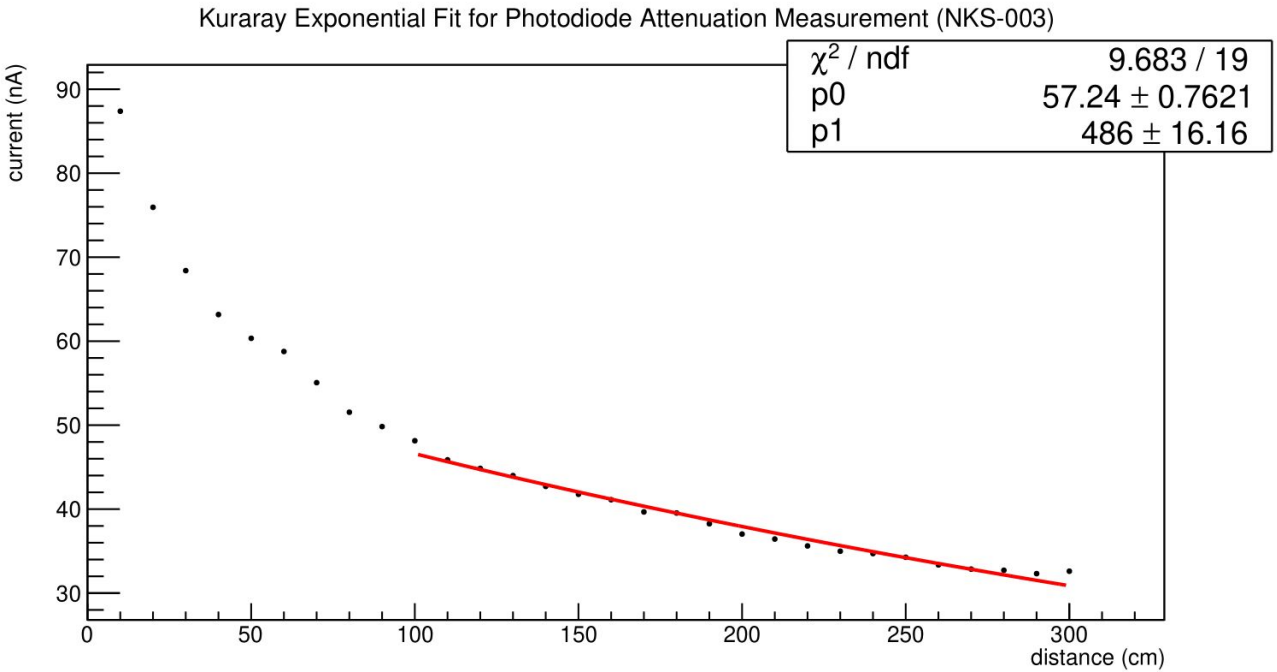
NKS-002

No measurement with optical grease taken



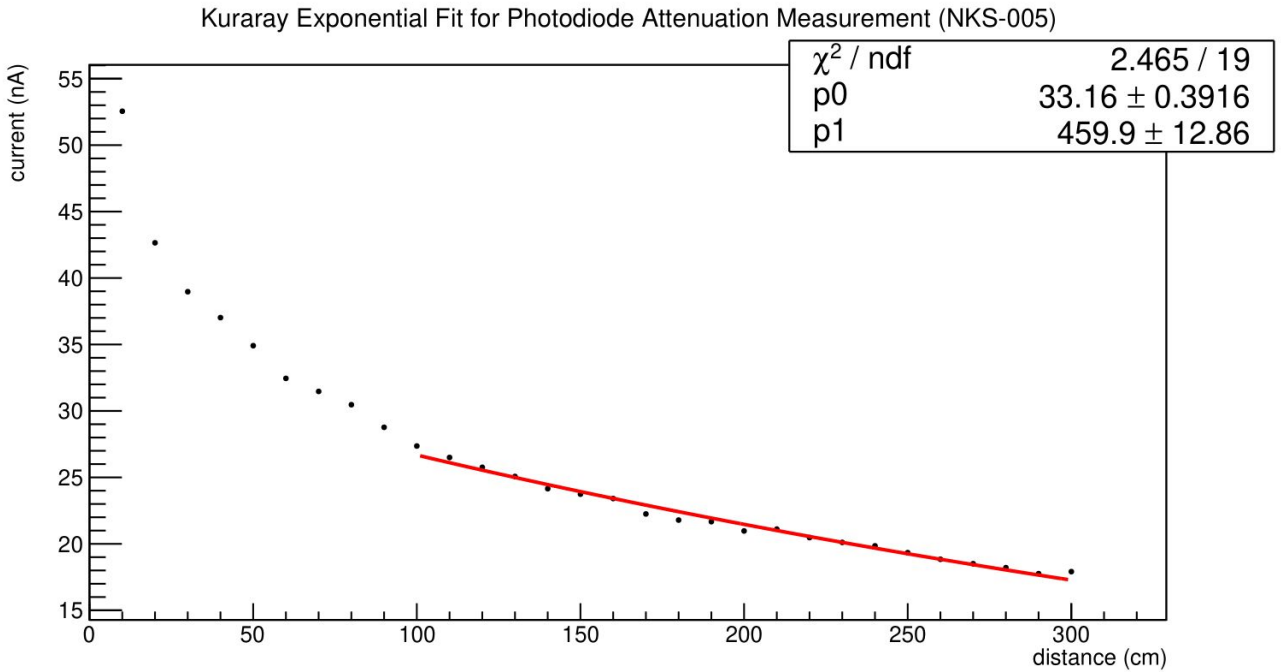
NKS-003

No measurement with optical grease taken



NKS-005

No measurement with optical grease taken

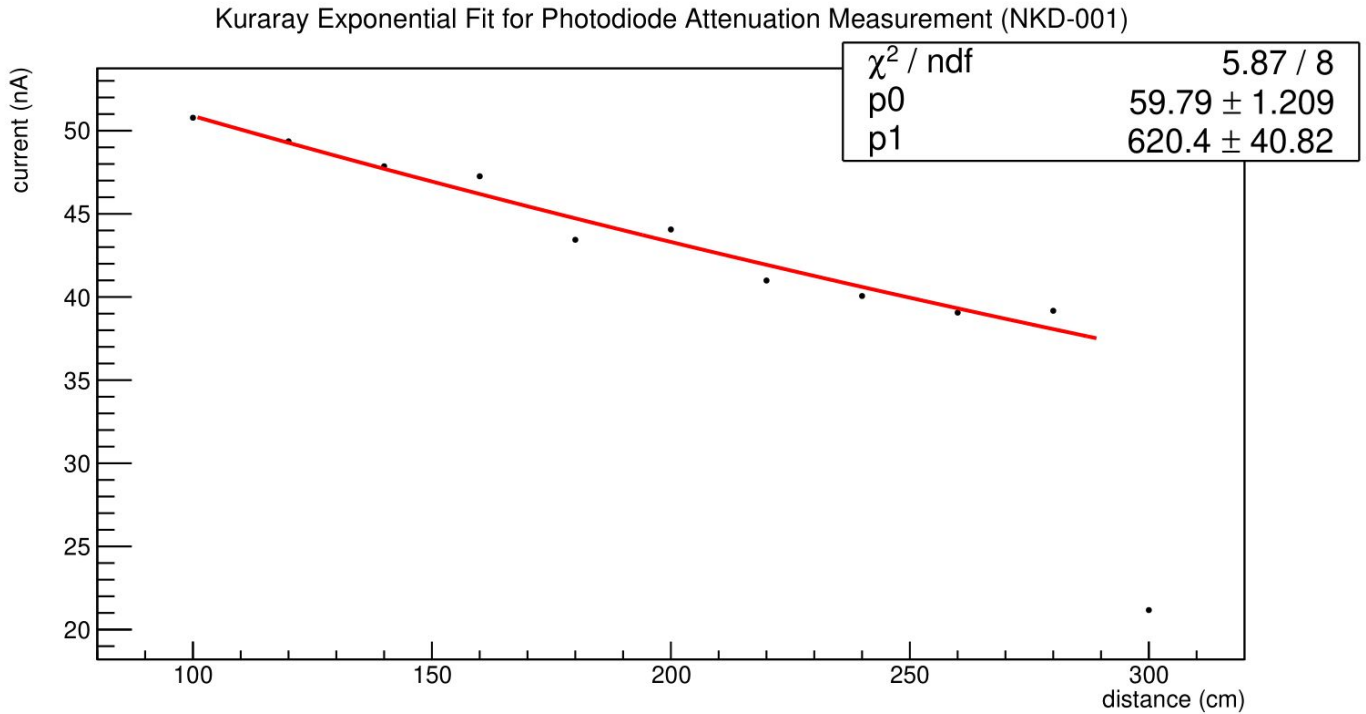


NKD-001

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

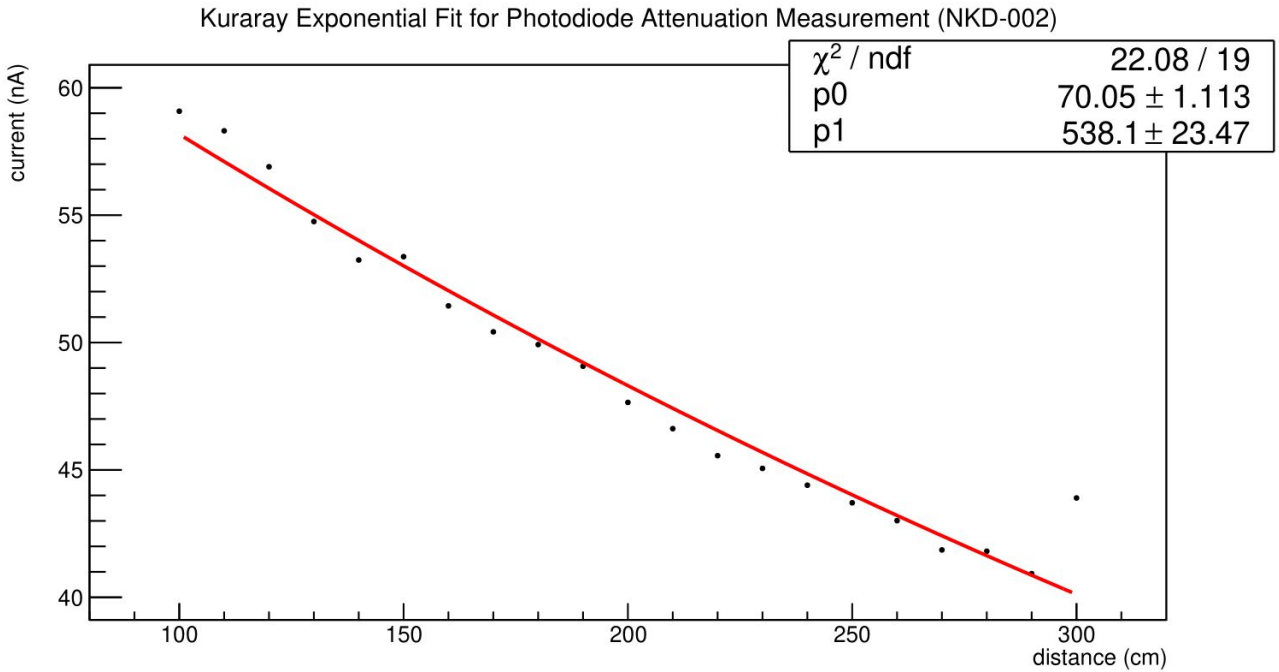
No measurement with optical grease taken

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



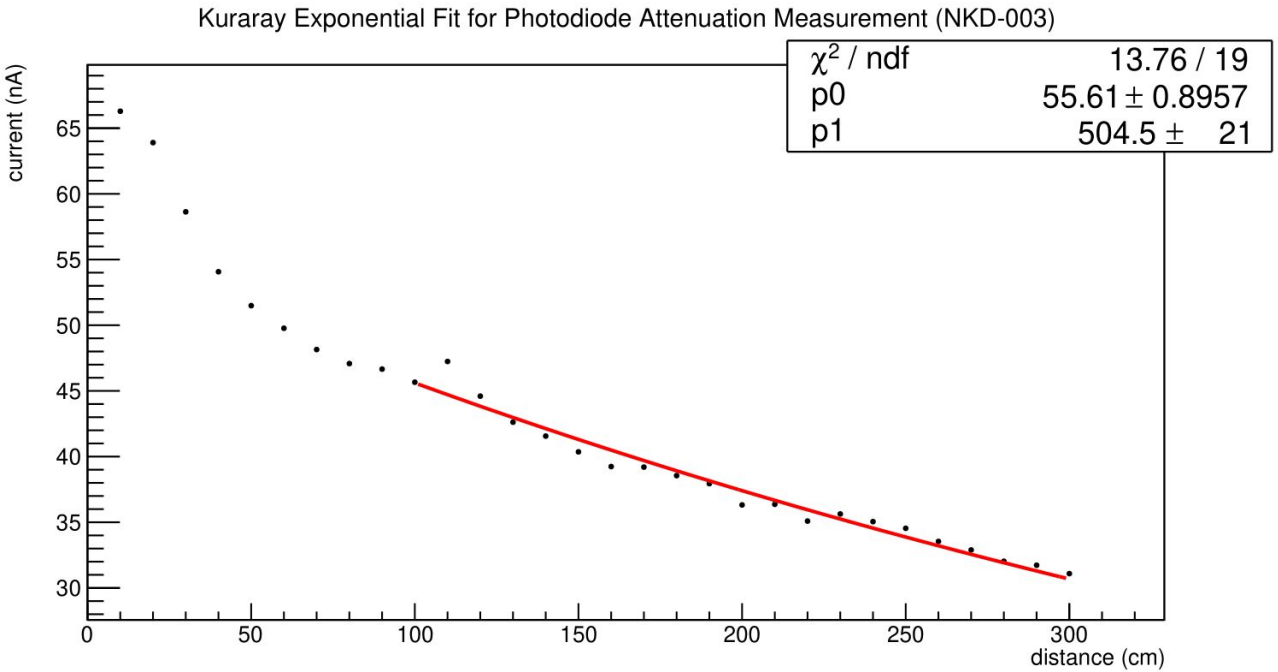
NKD-002

No measurement with optical grease taken



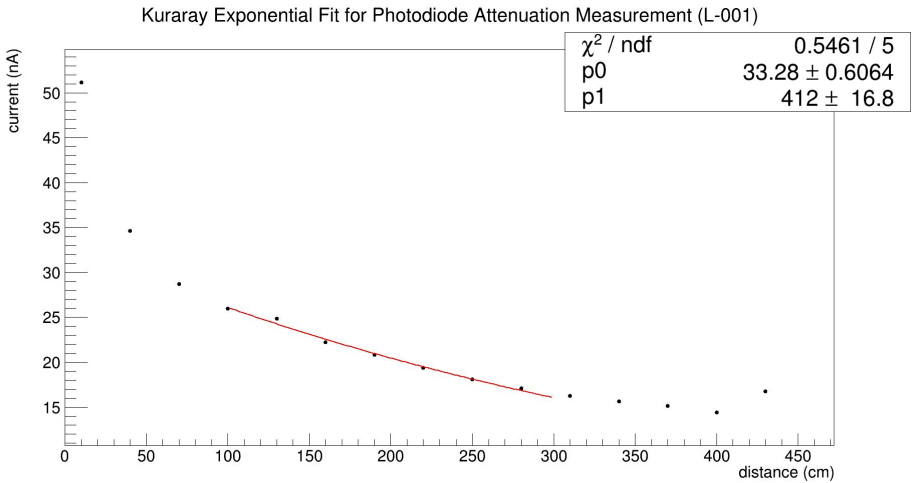
NKD-003

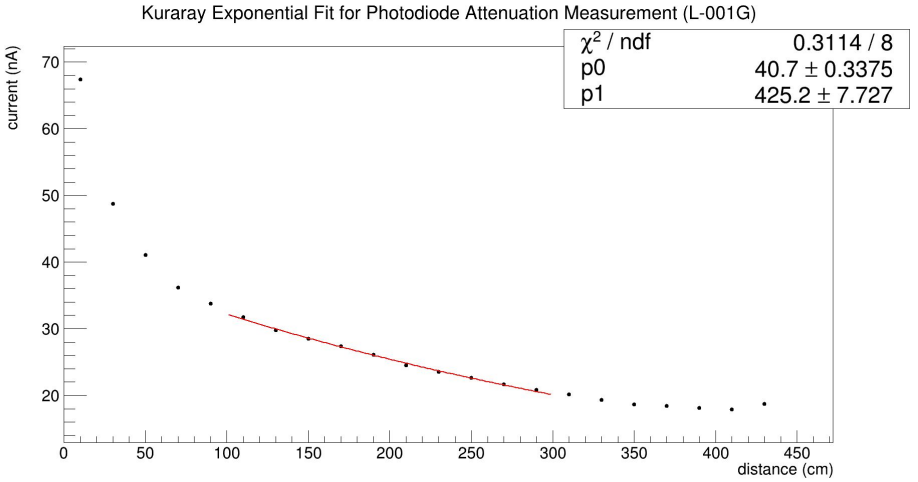
No measurement with optical grease taken



L-001

Without optical grease

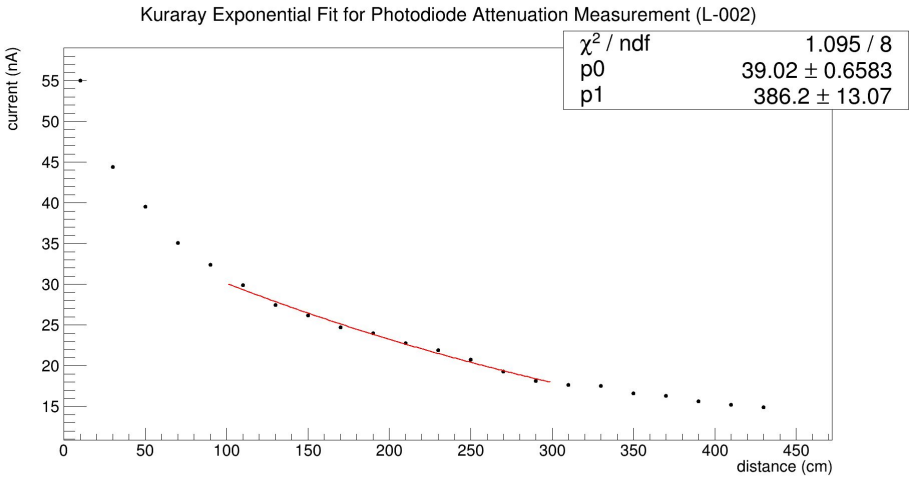


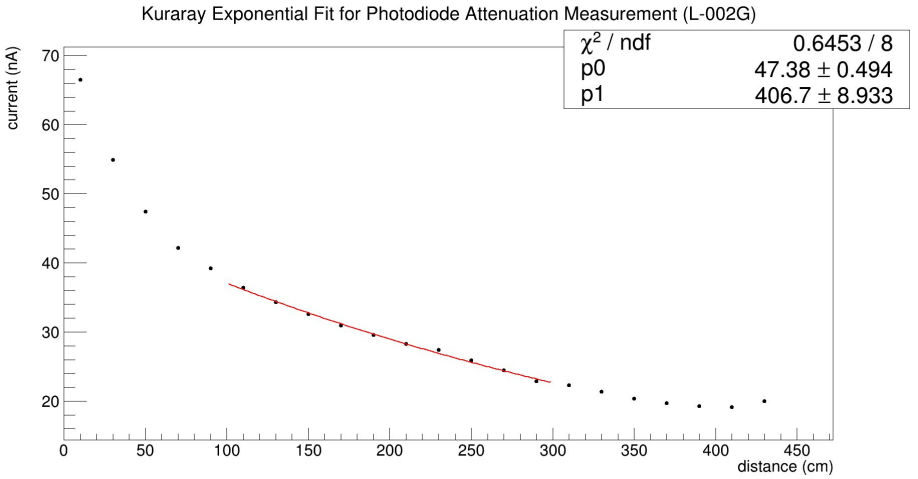


With optical grease

L-002

Without optical grease

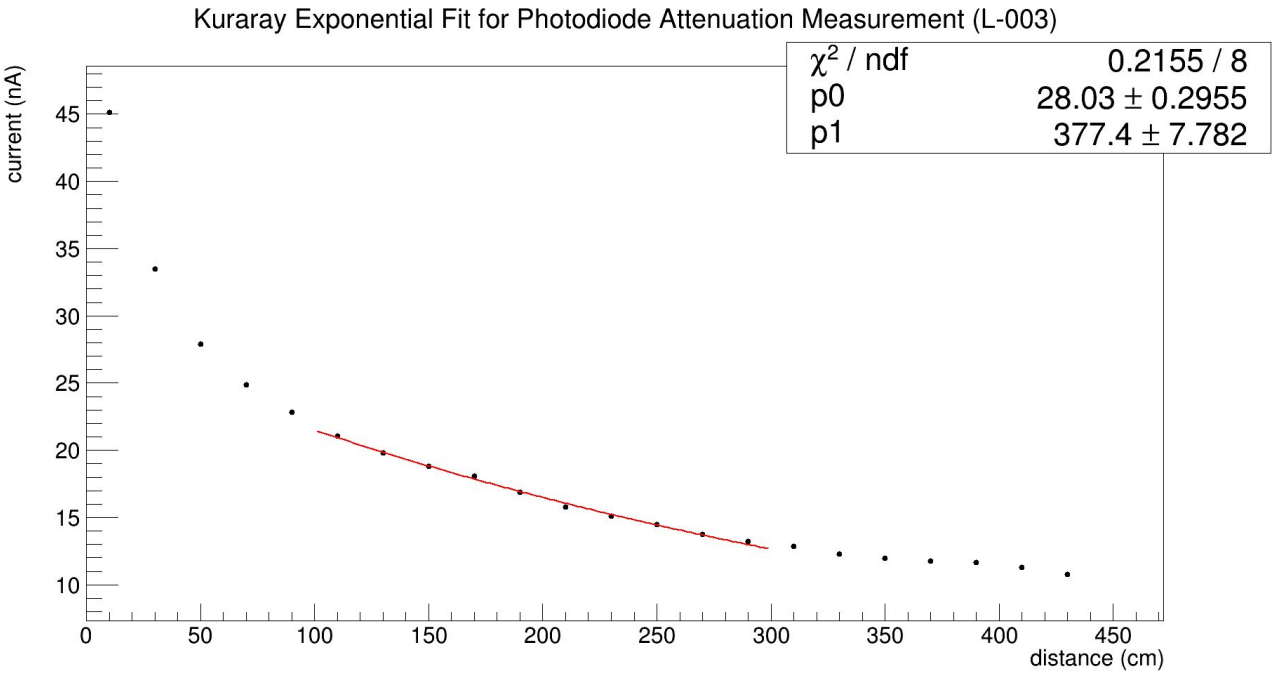




With optical grease

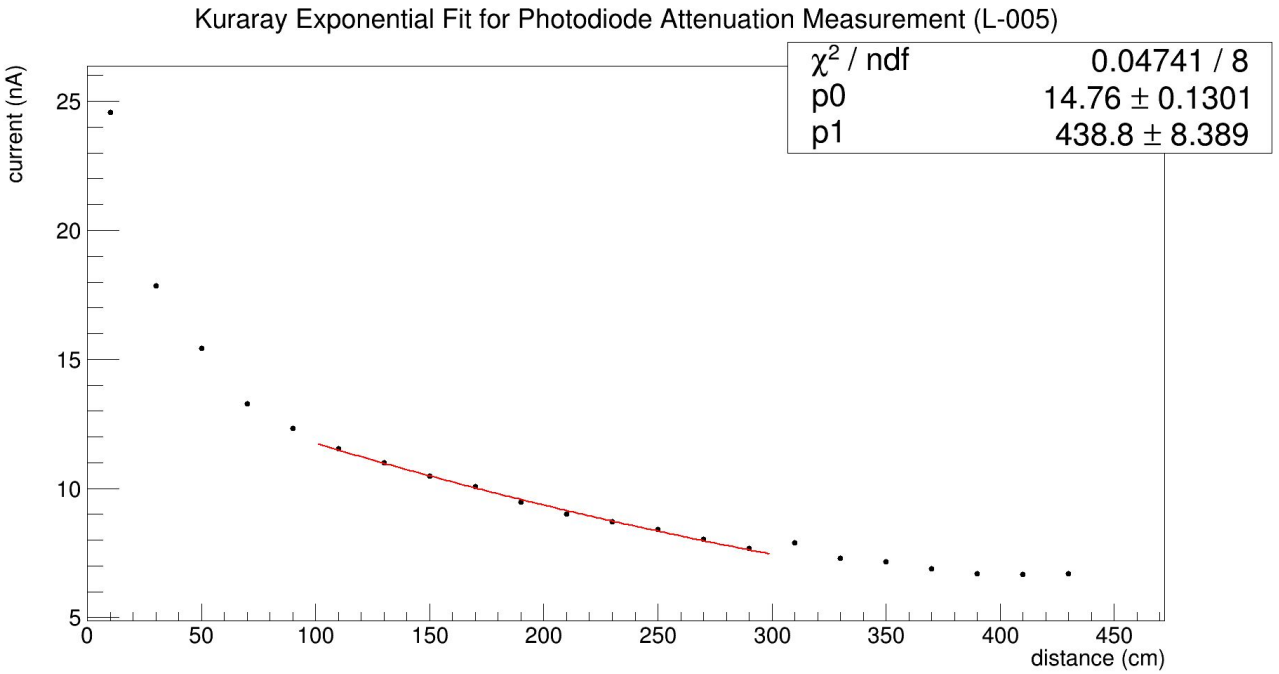
L-003

No measurement with optical grease taken

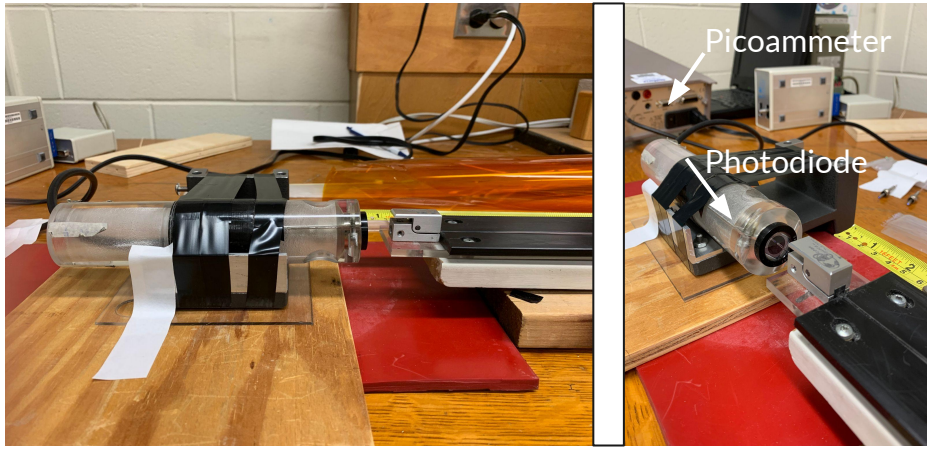


L-005

No measurement with optical grease taken

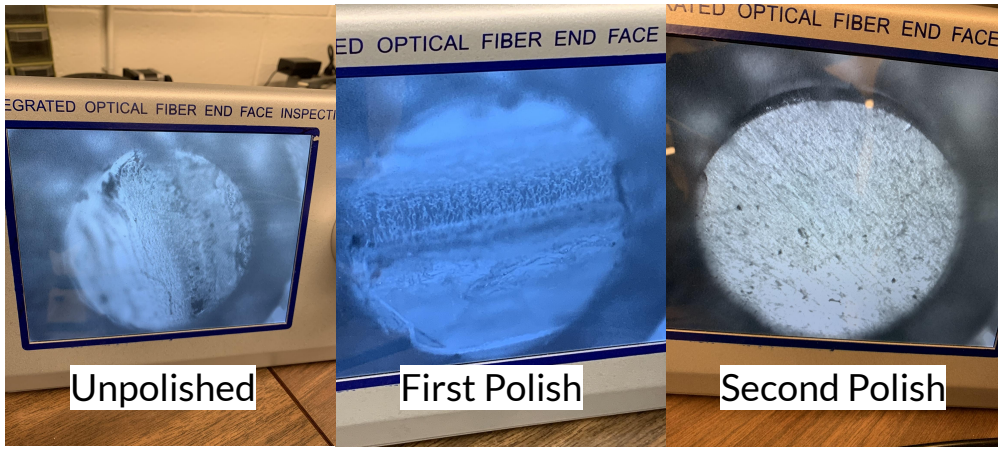


July 31 - August 4



- 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

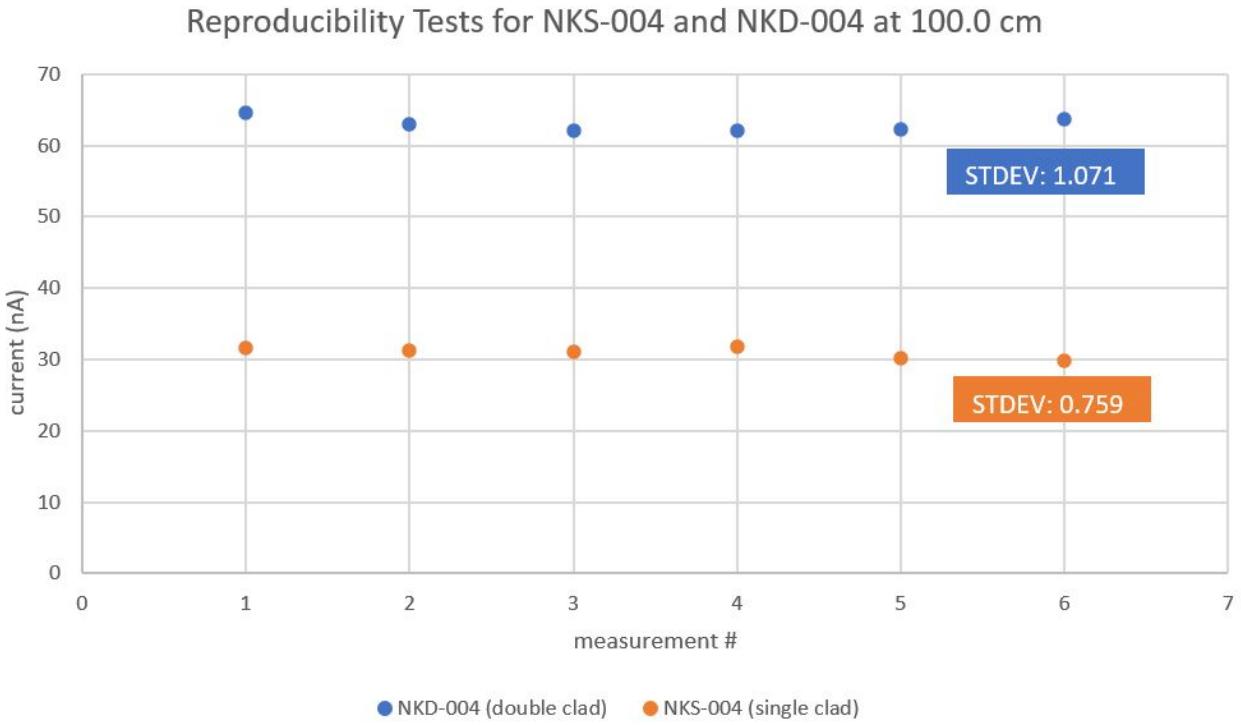
August 7 - August 11



- **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