

IER 538: International Dosimetry Intercomparison Exercise with Godiva-IV

NCSP Technical Program Review

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DOE Requirements

- 10 CFR §835.1304

- “an individual SHALL be issued a personal NAD if there is a possibility for a nuclear accident to occur resulting in excessive exposure of radiation to the individual”

- DOE-STD-1098-2017 part 515

particle	absorbed dose in or on a phantom (Gy)	required accuracy (%)
neutron	0.1 — 10	30
photon	0.1 — 10	20

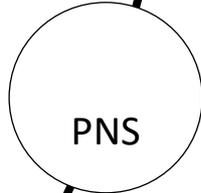
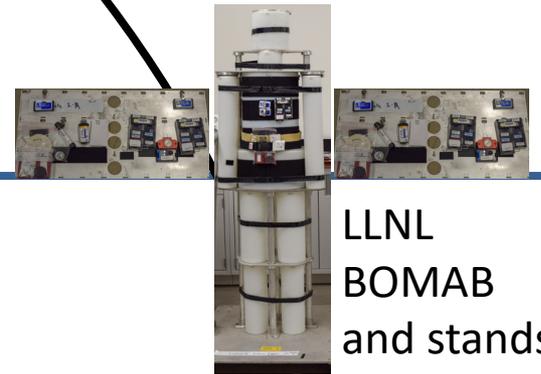
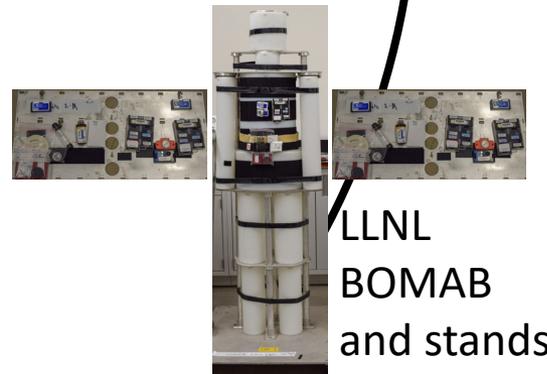
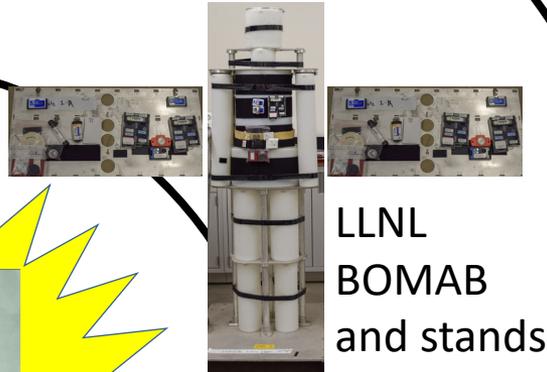
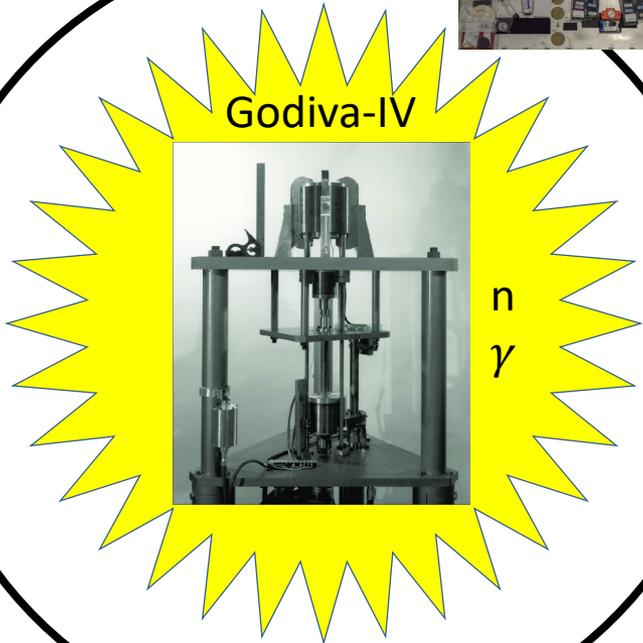
- ANSI/HPS N13.3 2013 (R2019)

total dose (Gy)	required accuracy (%)
0.1 — 1	50
1 — 10	25
>10	positive indication

DOE NCSP

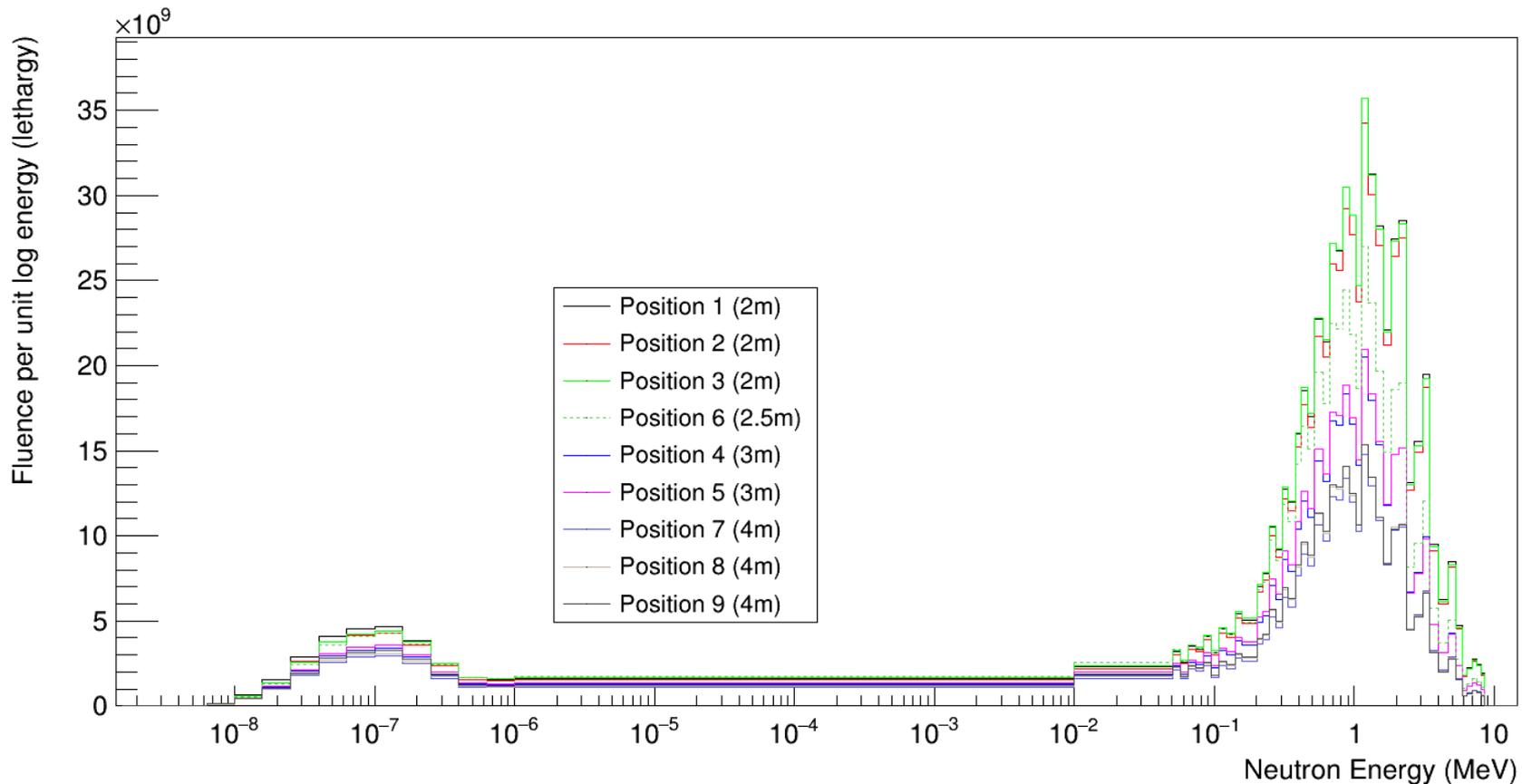
- DOE NCSP series of dose characterization and dosimetry exercises
 - IER-147 (Godiva-IV dose characterization, 2014)
 - IER-148 (Godiva-IV intercomparison exercise, 2016)
 - IER-252 (Flattop dose characterization, 2017)
 - IER-253 (Flattop intercomparison exercise, 2018)
 - **IER-538 (Godiva-IV intercomparison exercise, 2022)**
- Participating institutions:
 - LLNL, LANL, SNL, SRS, Hanford, MSTs, Y-12, NDC, AWE, and IRSN
 - 7 DOE labs
 - 1 from U.S. Navy
 - 1 from U.K.
 - 1 from France

Irradiation



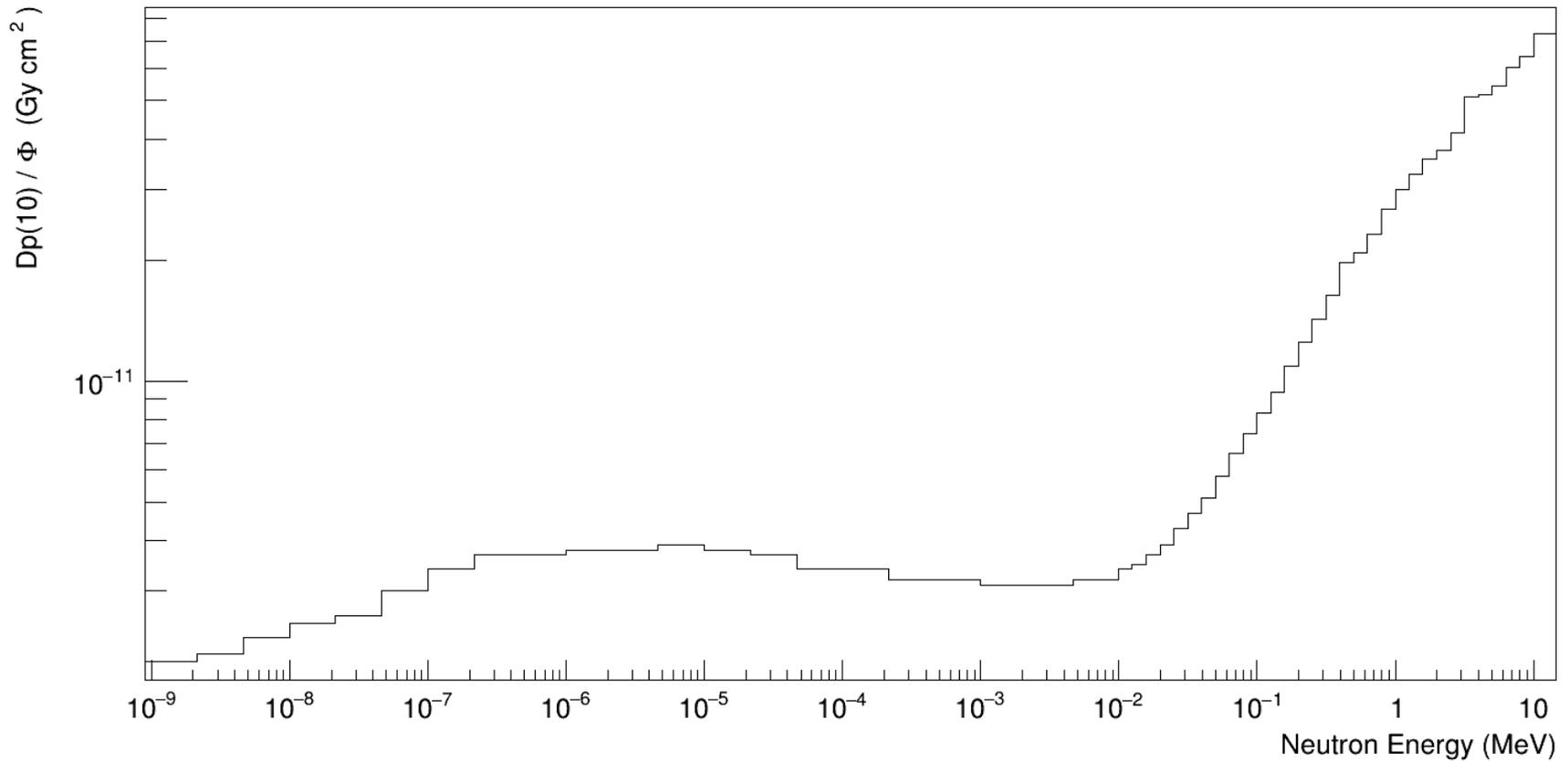
Neutron Fluence

Neutron spectra at different distances measured by AWE for a burst change in temperature = 68.6°C (from Godiva dose characterization)



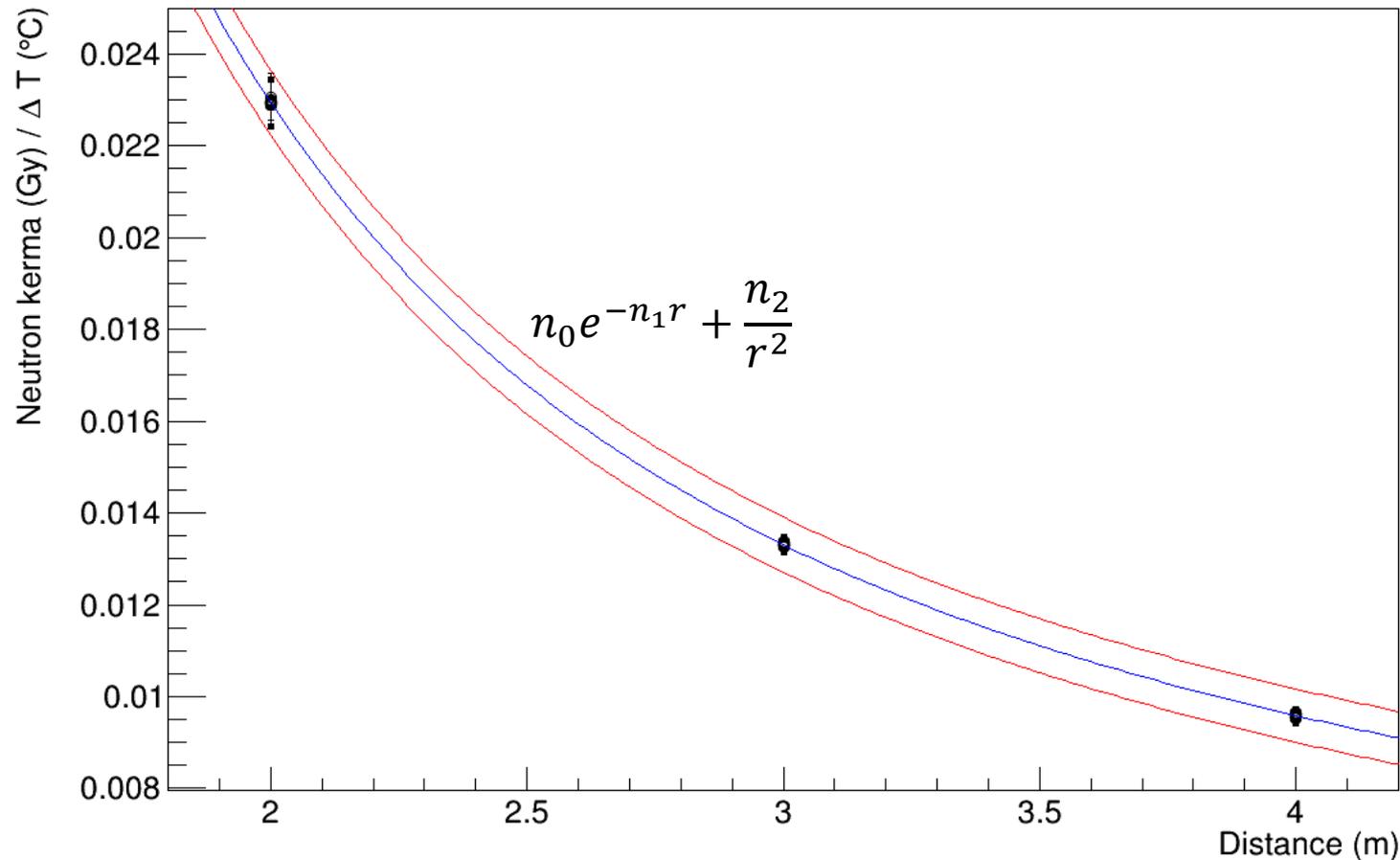
Neutron Dose Conversion Factors

Provided in the ANSI/HPS N13.3-2013 (R2019)



Neutron dose characterization

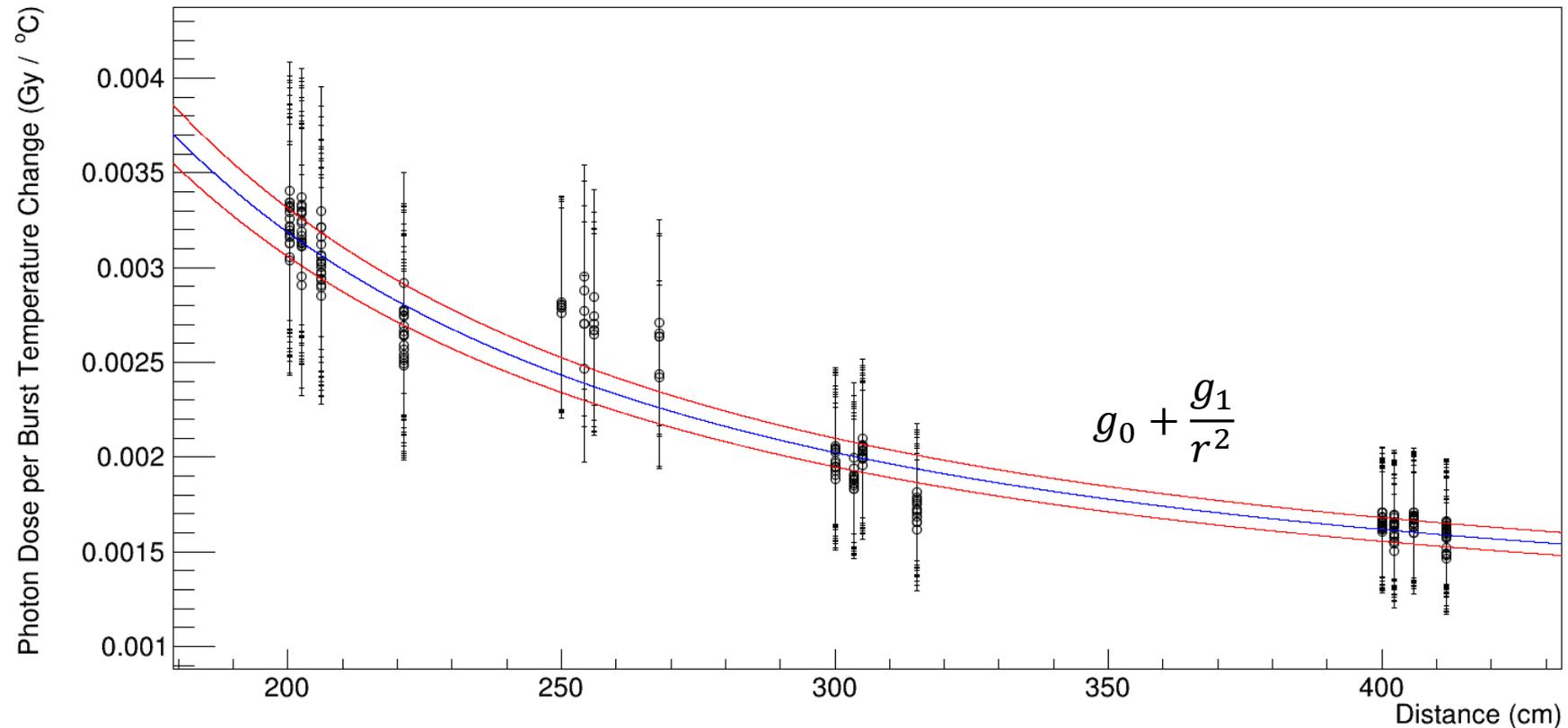
Data points are from IER-443 measurements (a more recent measurement)



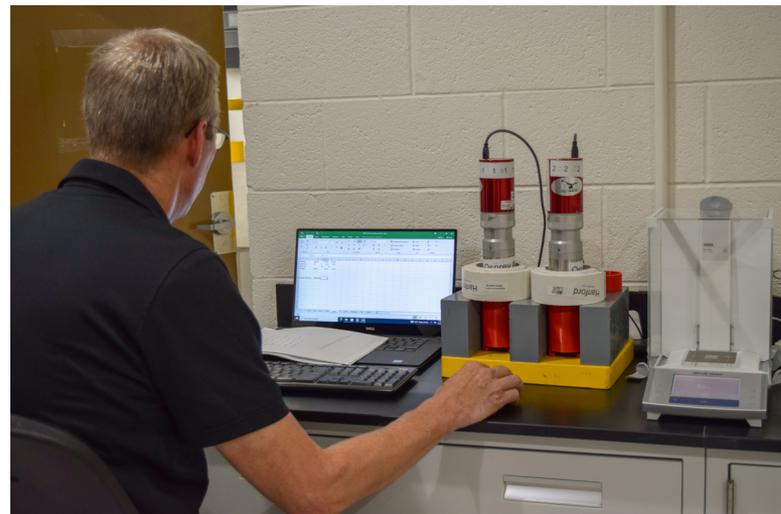
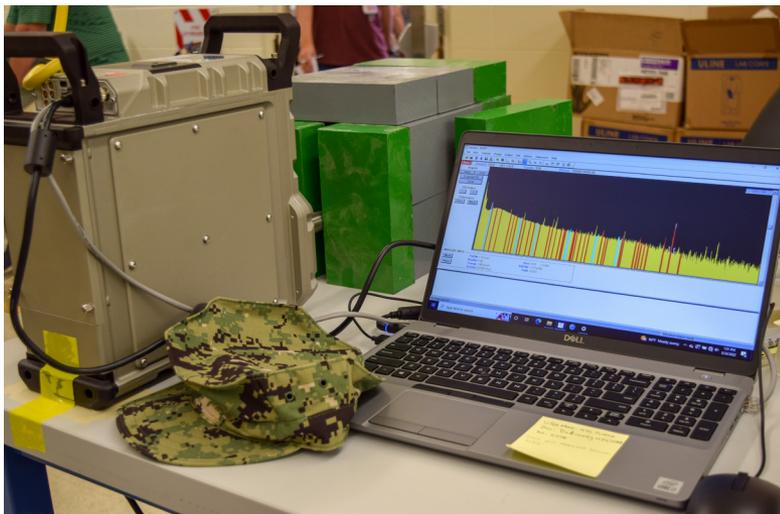
This is rescaled to the reference measurement at 68.6°C to get neutron dose.

Photon Dose Characterization

Compilation of multiple photon dose measurements for multiple bursts

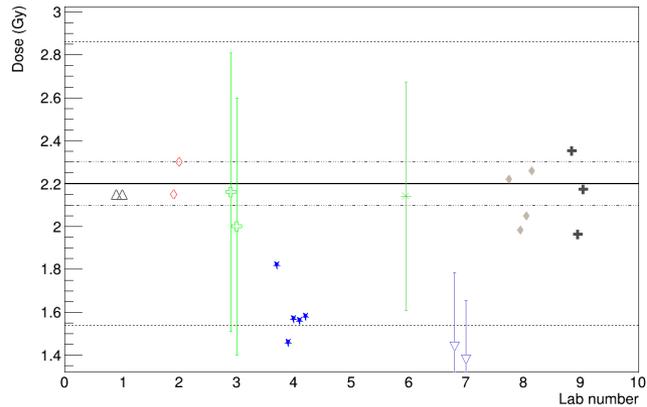


Measurement

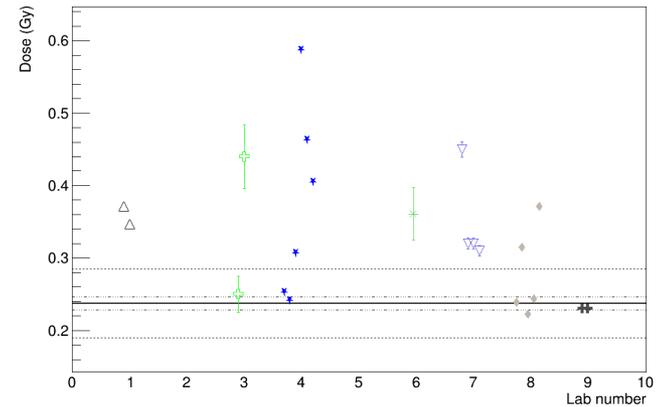


Final Results at 2m compared to DOE standards

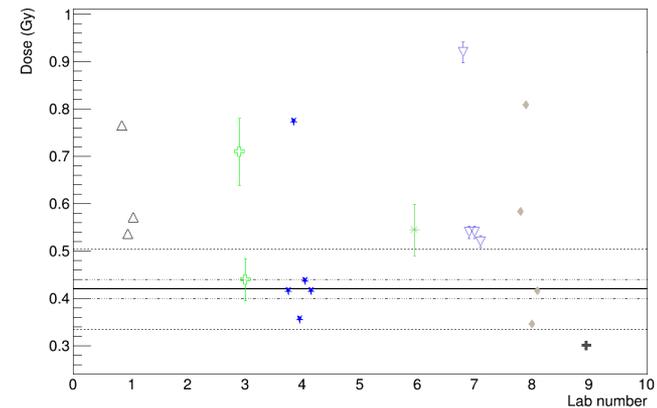
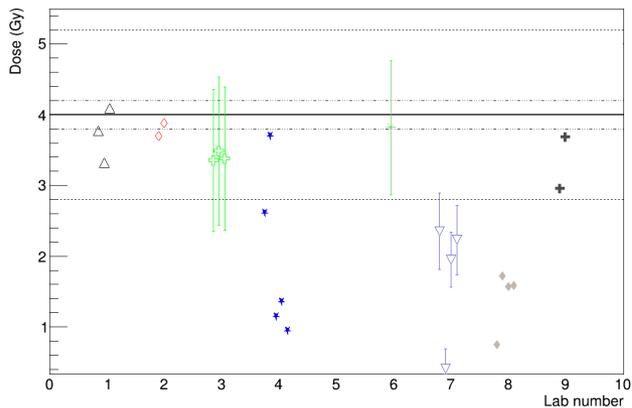
■ Neutron



■ Photon

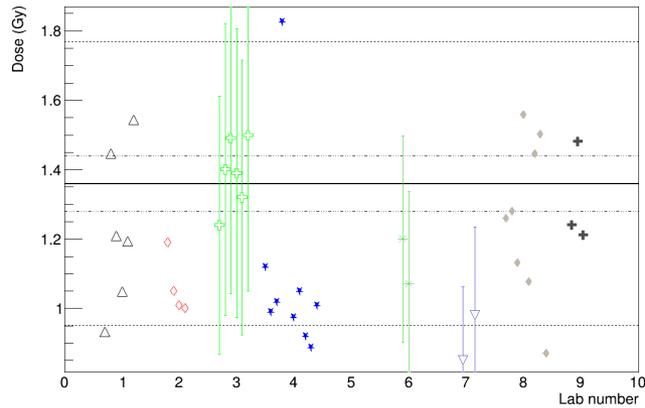


Day 2

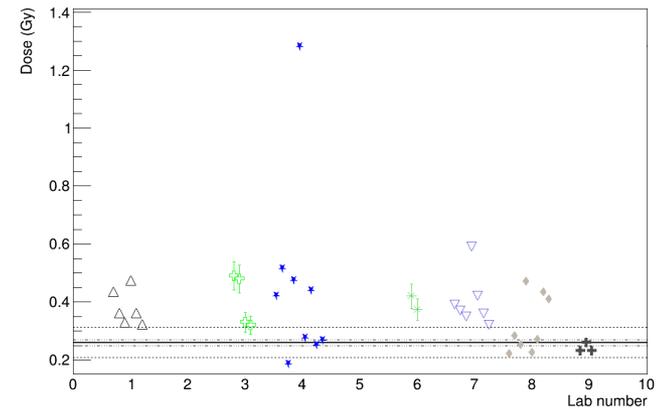
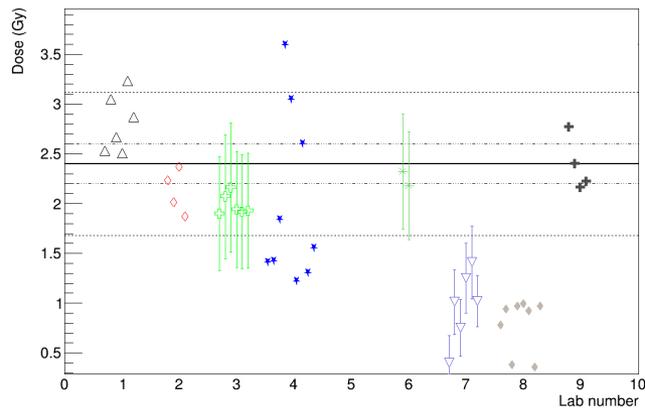
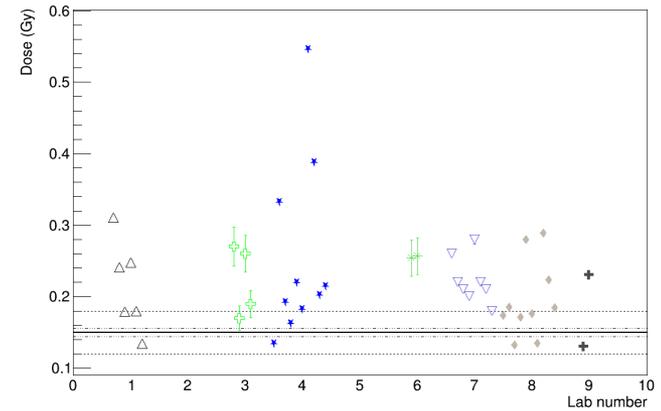


Final Results at 3m compared to DOE standards

■ Neutron

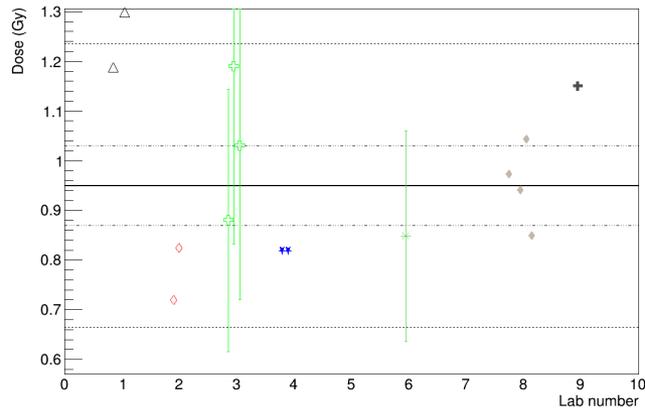


■ Photon

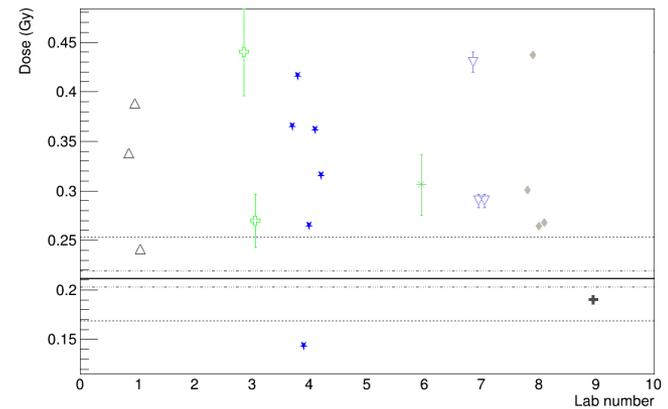
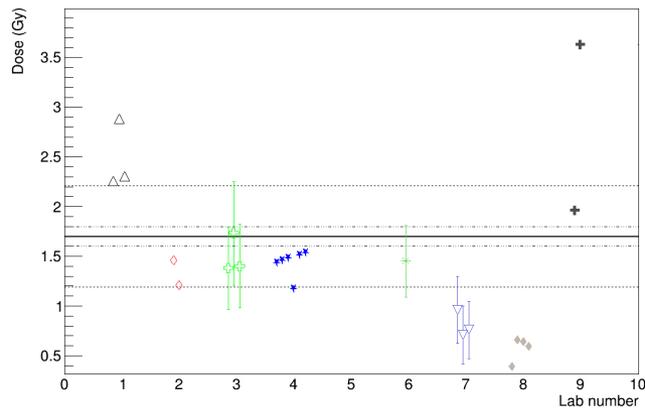
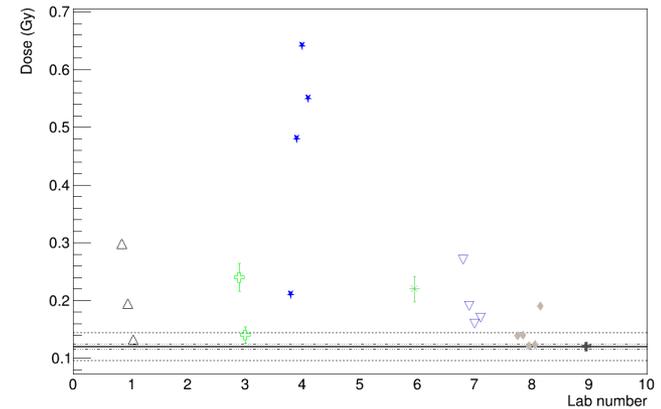


Final Results at 4m compared to DOE standards

■ Neutron

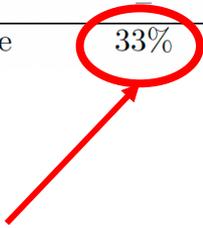


■ Photon



Summary

Lab	Provided Uncertainties	Below Neutron Dose Standard (%)	Above Neutron Dose Standard (%)	Outside Neutron Dose Standard (%)	Below photon Dose Standard (%)	Above photon Dose Standard (%)	Outside photon Dose Standard (%)
1	–	8	25	33	4	75	79
2	–	11	0	11	100	0	100
3	✓	0	0	0	30	52	83
4	–	43	5	48	5	68	73
5	–	–	–	–	–	–	–
6	✓	0	0	0	0	100	100
7	✓	0	96	96	0	97	97
8	–	58	0	58	0	47	47
9	–	0	7	7	40	7	47
Average	33%	27	5	32	22	56	78



Bias for lower neutron dose

Bias for higher photon dose

Not a criteria to provide uncertainty, but 1/3 of the labs provided

This is may be due to prolonged exposure of activated photons from the BOMABs (dosimeters retrieved 4 hours after irradiation)

Conclusion

- Photon dose measurements were limited by instrumentation not available (hard to ship TLD readers)
- There has been a turnover of staff in dosimetry
 - Knowledge gaps
- DOE NSR&D is funding development of a universal nuclear accident dosimeter (U-NAD)
- Characterization of the AFRRI radiation field is scheduled for August 2023 with an exercise to follow in 2024

Auspice

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