LLNL-TR-840954

Lawrence Livermore National Laboratory

International Intercomparison for Nuclear Accident Dosimetry Using Godiva-IV

IER-538 CED-3B Report

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Auspices

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1 Introduction

During the week of August 22, 2022, Integral Experiment Request (IER) 538, an international blind intercomparison for nuclear accident dosimetry (NAD) exercise, was completed using the Godiva-IV critical assembly at the National Criticality Experiments Research Center (NCERC) located in the Device Assembly Facility (DAF) at the Nevada National Security Site (NNSS). This exercise builds upon a series of experiments that include the characterization the radiation fields around Godiva (IER-147) and Flattop (IER-252) and follow up intercomparisons of dosimetry around both Godiva IV and Flattop (IER-148 and IER-253, respectively).

The participants consisted of seven Department of Energy laboratories and one laboratory each from the US Navy, United Kingdom, and France. The participants of the exercise were Lawrence Livermore National Laboratory (LLNL); Los Alamos National Laboratory (LANL); Sandia National Laboratory (SNL); Savannah River Site (SRS); Hanford Site, Missions Support and Test Services (MSTS); Y-12 National Security Complex (Y-12); Naval Dosimetry Center (NDC); Atomic Weapons Establishment (AWE); and Institut de Radioprotection et de Sûreté Nucléaire (IRSN). MSTS dosimeters were included in the irradiations but not reported for evaluation.

This report primarily discusses the performance of the 24 hour results submitted by participants, though available final results are briefly discussed. Information for each irradiation performed is provided for participating laboratories to produce their own final report which will be incorporated into the CED-4a report.

2 Excecution of IER-538

The LLNL Nuclear Accident Dosimetry Laboratory (NAD Lab) hosted the participating laboratories. Each laboratory was allowed to set up their equipment and workspace in the NAD lab the week prior to the exercise. The participants submitted their dosimeters to the exercise coordinators by Monday, August 22. The dosimetry consisted of a variety of activation-based dosimeters, thermoluminescent and optically stimulated dosimetry, and biological materials such as alanine. The dosimeters were placed on BOMAB phantoms or aluminum plates on stands, with the coordinators recording their locations to be deployed around Godiva. Four BOMABs were deployed for each burst, where two were filled with Ringer's Lactate and two were filled with saline. These materials were used to simulate concentrations of sodium in blood and the human body, respectively. The BOMABs were placed at perpendicular (0°) or 45° orientations around Godiva with two plates paired with each phantom. All plates were placed perpendicular (0°) to the reactor. LLNL and AWE both deployed their versions of passive neutron spectrometers (PNS), and Y-12 deployed their passive fixed accident dosimeter. All dosimeters were shipped from the NAD laboratory to NCERC on Monday, August 22, 2022.

Two Godiva bursts were performed on August 24 and August 25, 2022. The first burst targeted a 70 degree temperature rise in the core and the second a 150 degree temperature rise. The actual

temperatures reported by NCERC are provided in Table 1. For the first burst, one location was known to participants, with the exercise coordinator providing the distance, orientation, and dose. The remaining locations for the first burst and all locations for the second burst were unknown to the participants. Following each irradiation, the BOMABs and plates were retrieved from around Godiva, packed into drums and shipped from NCERC to the NAD lab at noon. At the NAD Lab, the exercise coordinators distributed the dosimeters back to participants. The exercise coordinator also provided sample containers of Ringer's Lactate and hair samples to participants. Additionally, BOMABs filled with saline were placed in a common space in the laboratory for participants to perform in vivo measurements.

Table 1. Reported times and temperature rises for both irradiations.

Irradiation	Date	Time	Target ΔT (°C)	Actual ΔT (°C)
1	8/24/2022	10:10 AM	70	74.3
2	8/25/2022	9:48 AM	150	130.5

For each burst, participants were required to report dose results to the coordinator within 24 hours after the burst. Upon the conclusion of the exercise, participants were given the location, orientation, and distance information of their dosimeters. Participants were asked to provide revised results within 3 weeks of the conclusion of the exercise.

The purpose of this intercomparison was to evaluate the performance of participants' dosimetry in a blind scenario in a characterized radiation field. Phantoms and plates were placed at characterized locations around Godiva where known doses were determined based on IER-147, Dosimetry Characterization of the Godiva Reactor Under Burst Conditions. The delivered, "known", doses were derived using the characterization data from IER-147 based on the reported rise in temperature by NCERC. The known doses and placement of dosimeters around Godiva are presented in Table 2, above. Participants were asked to report doses using dose conversion factors from ANSI/HPS N13.3 Dosimetry for Criticality Accidents. Figures 1 and 2 show the phantom and plate placement around Godiva for both irradiations, respectively.

Table 2. Placement of dosimeters and known doses around Godiva.

Irradiation	Distance (m)	Orientation	Placement	Blood Simulation	Neutron Dose (Gy)	Gamma Dose (Gy)	Total Dose (Gy)
1	2	0/180	BOMAB + PLATES	Ringer's	2.28	0.23	2.52
1	2	-	Y12 sphere	-	2.28	0.23	2.52
1	3	0/180	BOMAB + PLATES	Ringer's	1.35	0.15	1.50
1	3	45/225	BOMAB + PLATES	Saline	1.35	0.15	1.50
1	4		PNS LLNL	-	0.99	0.12	1.11
1	4	0/180	BOMAB + PLATES	Saline	0.99	0.12	1.11
1	4		PNS AWE	-	0.99	0.12	1.11
2	2	45/225	BOMAB + PLATES	Ringer's	4.01	0.42	4.43
2	2	-	Y12 sphere	-	4.01	0.42	4.43
2	3	0/180	BOMAB + PLATES	Ringer's	2.37	0.26	2.63
2	3	45/225	BOMAB + PLATES	Saline	2.37	0.26	2.63
2	4		PNS LLNL	-	1.74	0.21	1.95
2	4	0/180	BOMAB + PLATES	Saline	1.74	0.21	1.95
2	4		PNS AWE	-	1.74	0.21	1.95

Figure 1. Location of phantoms and plates for irradiation 1.

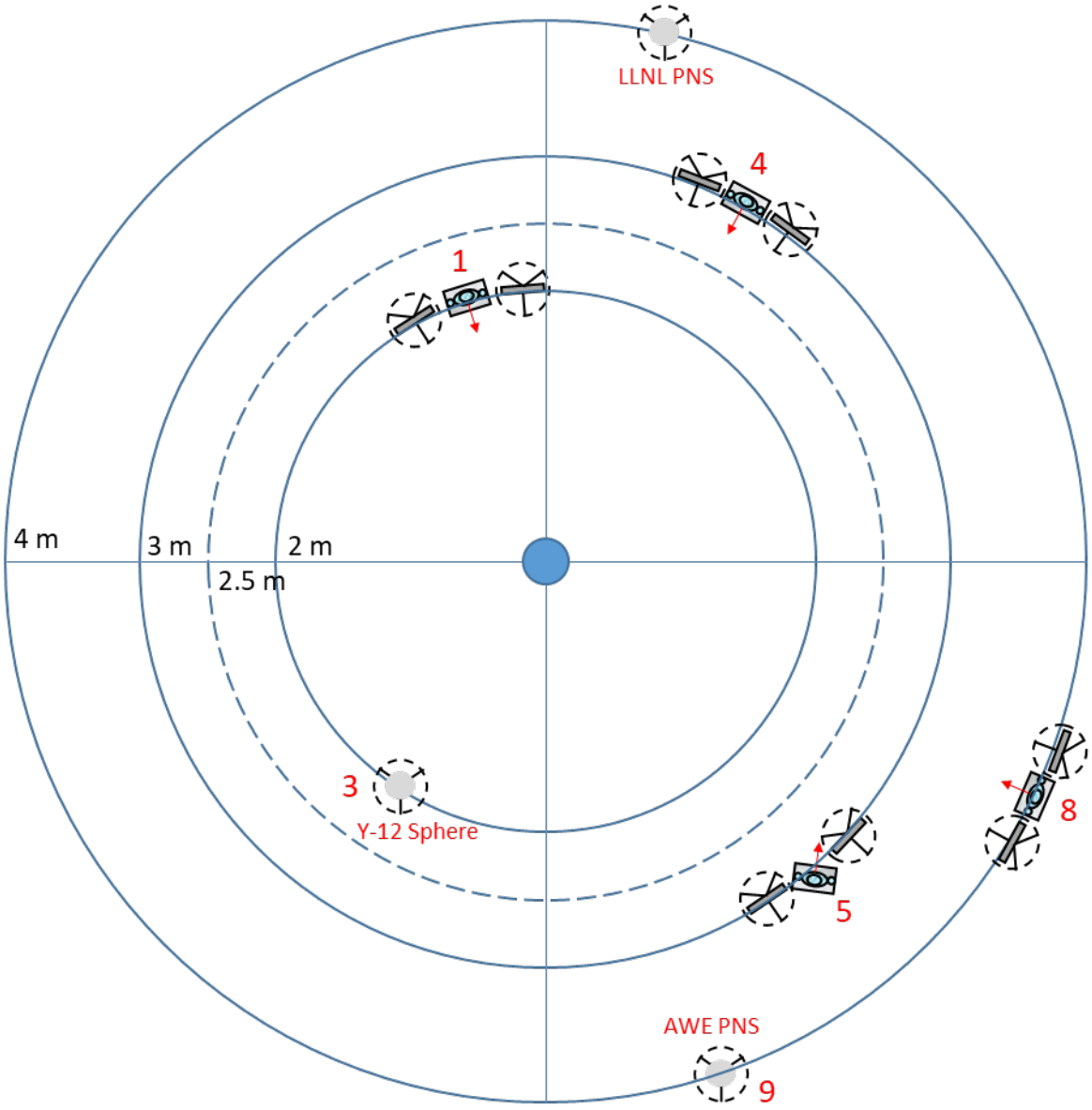
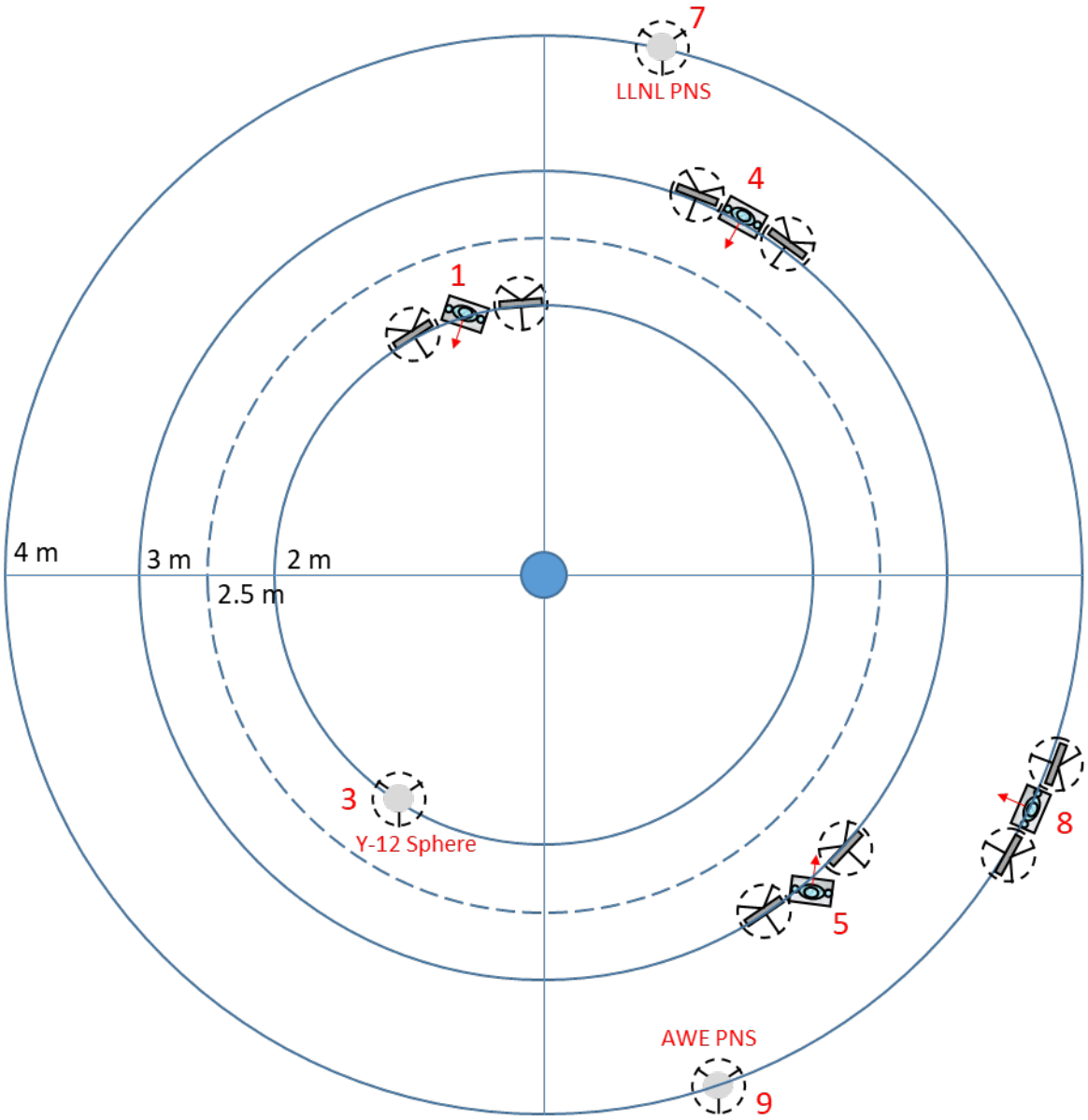


Figure 2. Location of phantoms and plates for irradiation 2.



3 Experiment Results

3.1 24 Hour Results

The 24-hour results were submitted to the exercise coordinators and evaluated based on the performance statistics and criteria for the total neutron + gamma dose defined by ANSI/HPS N13.3, where:

$$Bias = \frac{Measured\ Dose - Delivered\ Dose}{Delivered\ Dose} \times 100$$

Table 3. ANSI/HPS N13.3-2013 Performance Criteria.

Total absorbed dose range (Gy)	Test Statistic (B)
0.1 to 1	±50%
1 to 10	±25%

Specifically for DOE laboratories, the DOE Standard on Radiological Control (DOE-STD-1098-2017) provides additional requirements for performance of NADs. Article 515 states: "Personnel nuclear accident dosimeters should be capable of measuring an absorbed dose in or on a phantom from 10 rads to approximately 1,000 rads with an accuracy of ± 20% for gamma radiation and ± 30% from neutron radiation."

3.1.1 Irradiation 1 Results

For the first irradiation, 6 of the 9 participating laboratories submitted neutron dose results within the first 24 hours post irradiation. Only 4 laboratories reported gamma doses and 4 reported total doses. The remaining three laboratories submitted results shortly after the 24-hour deadline. The average bias for each laboratory ranged between approximately –61% to +15% for the reported neutron doses. Table 4 presents the average bias for each laboratory and the standard deviation of their reported results. Table 5 presents the known dose for each location and the average reported dose by each lab for each location. Neutron dose results for each distance are summarized in Figures 3. Gamma doses and total doses are summarized in Figures 4 and 5, respectively.

Table 4. Average Percent Difference for Laboratory Results for Irradiation 1.

LAB ID	Percent Difference Average Neutron Dose		Percent Difference Average Gamma Dose		Percent Difference Average Total Dose	
	Average	±1σ	Average	±1σ	Average	±1σ
1*	3.4%	34%	4.0%	48%	17%	28%
2	-19%	12%	-	-	-	-
3	-10%	23%	-10%	17%	-13%	13%
4*	-30%	45%	40%	51%	-27%	30%
5*	***6.6%***	***112%***	-	-	-	-
6	-16%	7.6%	-	-	-	-
7*	***-61%***	***13%***	-	-	-	-
8*	***-35%***	***24%***	-	-	-	-
9*	15%	65%	1.6%	51%	13%	64%

*DOE Laboratories

Results not reported within 24 hours

Table 5. Known doses and average reported doses for Irradiation 1.

Lab	Distance (m)	Neutron Dose (Gy)			Gamma Dose (Gy)			Total Dose (Gy)		
		Known	Average	Bias	Known	Average	Bias	Known	Average	Bias
1	2	2.28	1.76	-23%	0.24	0.21	-11%	2.52	2.35	-7%
2	2	2.28	2.19	-4%	0.24	--	--	2.52	--	--
3	2	2.28	1.83	-20%	0.24	0.22	-7%	2.52	2.37	-6%
4	2	2.28	1.33	-42%	0.24	0.35	47%	2.52	1.62	-36%
5	2	2.28	2.53	11%	0.24	--	--	2.52	--	--
6	2	2.28	2.09	-8%	0.24	--	--	2.52	--	--
7	2	2.28	0.91	-60%	0.24	--	--	2.52	--	--
8	2	2.28	1.28	-44%	0.24	--	--	2.52	--	--
9	2	2.28	2.01	-12%	0.24	0.20	-15%	2.52	2.21	-12%
1	3	1.35	1.40	4%	0.15	0.13	-14%	1.50	1.38	-8%
2	3	1.35	1.12	-18%	0.15	--	--	1.50	--	--
3	3	1.35	1.26	-7%	0.15	0.14	-7%	1.50	1.27	-15%
4	3	1.35	0.85	-37%	0.15	0.21	37%	1.50	1.08	-28%
5	3	1.35	1.57	16%	0.15	--	--	1.50	--	--
6	3	1.35	1.13	-16%	0.15	--	--	1.50	--	--
7	3	1.35	0.62	-54%	0.15	--	--	1.50	--	--
8	3	1.35	0.84	-38%	0.15	--	--	1.50	--	--
9	3	1.35	1.23	-9%	0.15	0.12	-20%	1.50	1.35	-10%
1	3*	1.35	1.15	-15%	0.15	--	--	1.50	--	--
2	3*	1.35	0.92	-32%	0.15	--	--	1.50	--	--
3	3*	1.35	1.34	-1%	0.15	0.16	6%	1.50	1.49	-1%
4	3*	1.35	1.44	7%	0.15	0.20	35%	1.50	1.23	-18%
5	3*	1.35	0.73	-46%	0.15	--	--	1.50	--	--
6	3*	1.35	1.03	-24%	0.15	--	--	1.50	--	--
7	3*	1.35	0.44	-67%	0.15	--	--	1.50	--	--
8	3*	1.35	0.83	-38%	0.15	--	--	1.50	--	--
9	3*	1.35	1.42	5%	0.15	0.14	-7%	1.50	1.56	4%
1	4	0.99	1.25	26%	0.12	0.15	20%	1.11	1.57	41%
2	4	0.99	0.75	-24%	0.12	--	--	1.11	--	--
3	4	0.99	0.87	-12%	0.12	0.08	-34%	1.11	0.77	-31%
4	4	0.99	0.52	-47%	0.12	--	--	1.11	--	--
6	4	0.99	0.84	-15%	0.12	--	--	1.11	--	--
7	4	0.99	0.33	-67%	0.12	--	--	1.11	--	--
8	4	0.99	0.77	-22%	0.12	--	--	1.11	--	--
9	4	0.99	1.95	97%	0.12	0.20	62%	1.11	2.14	93%

* Two locations at 3 meters

Figure 3. Neutron dose 24-hour results for irradiation 1.

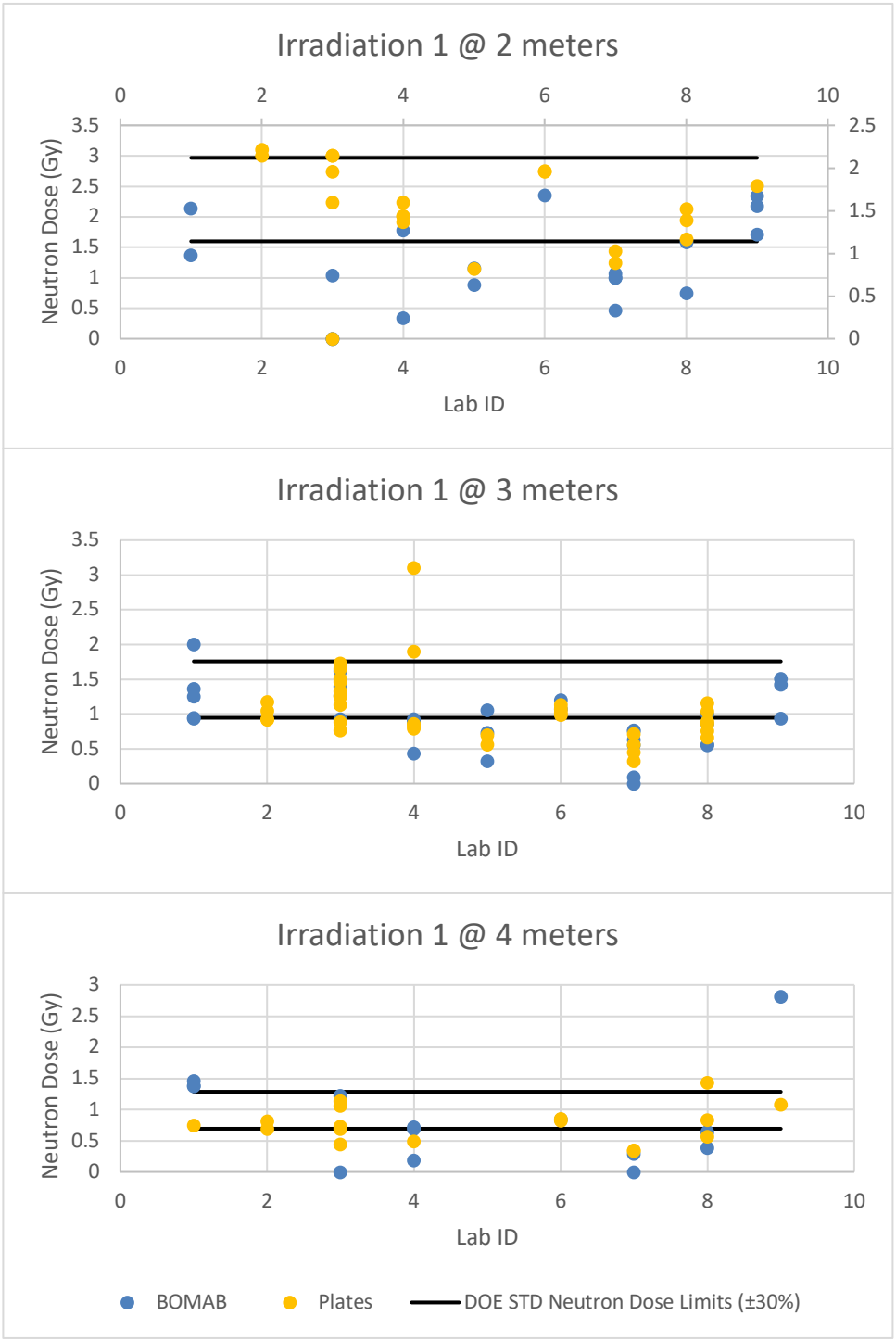


Figure 4. Gamma dose 24-hour results for irradiation 1.

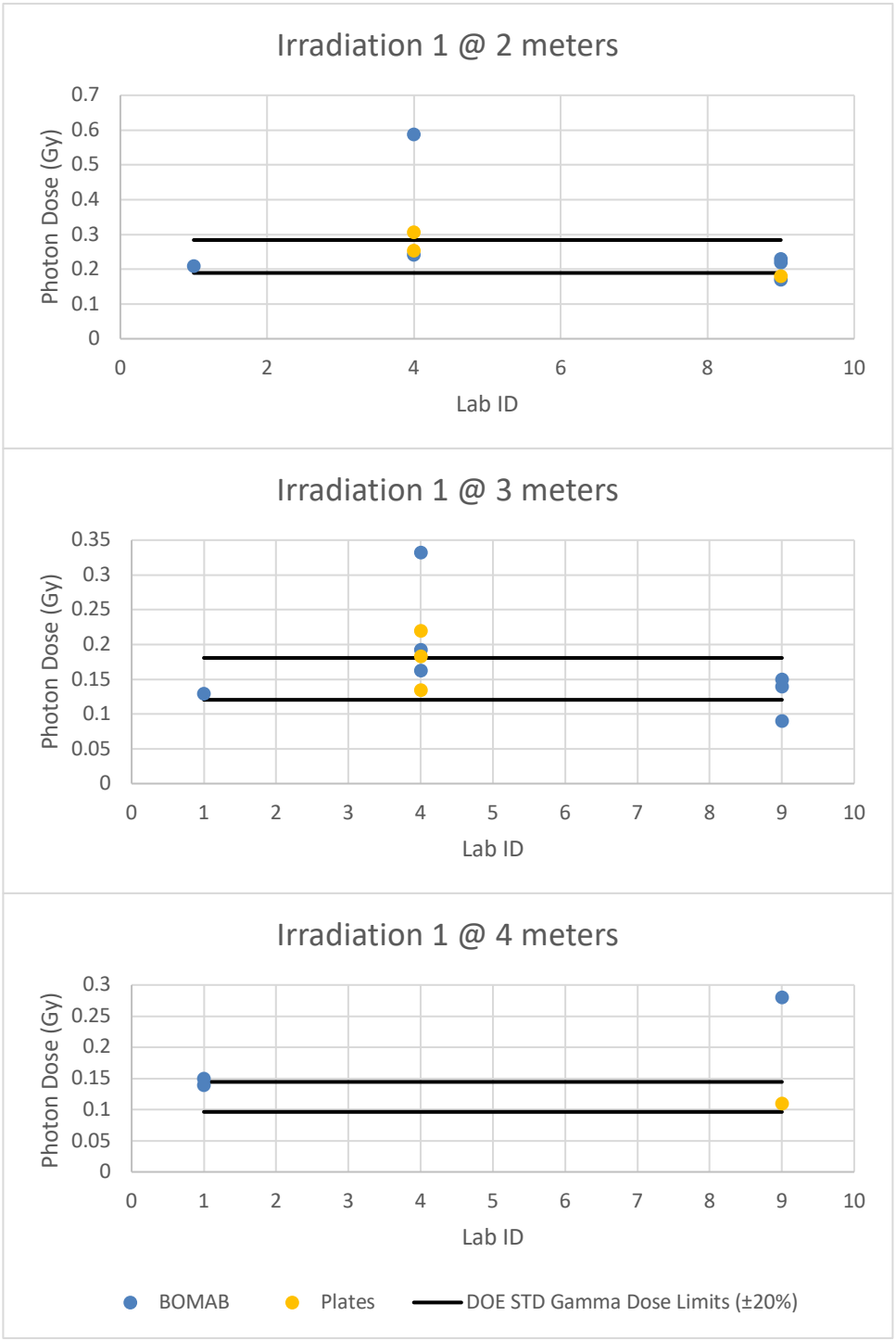
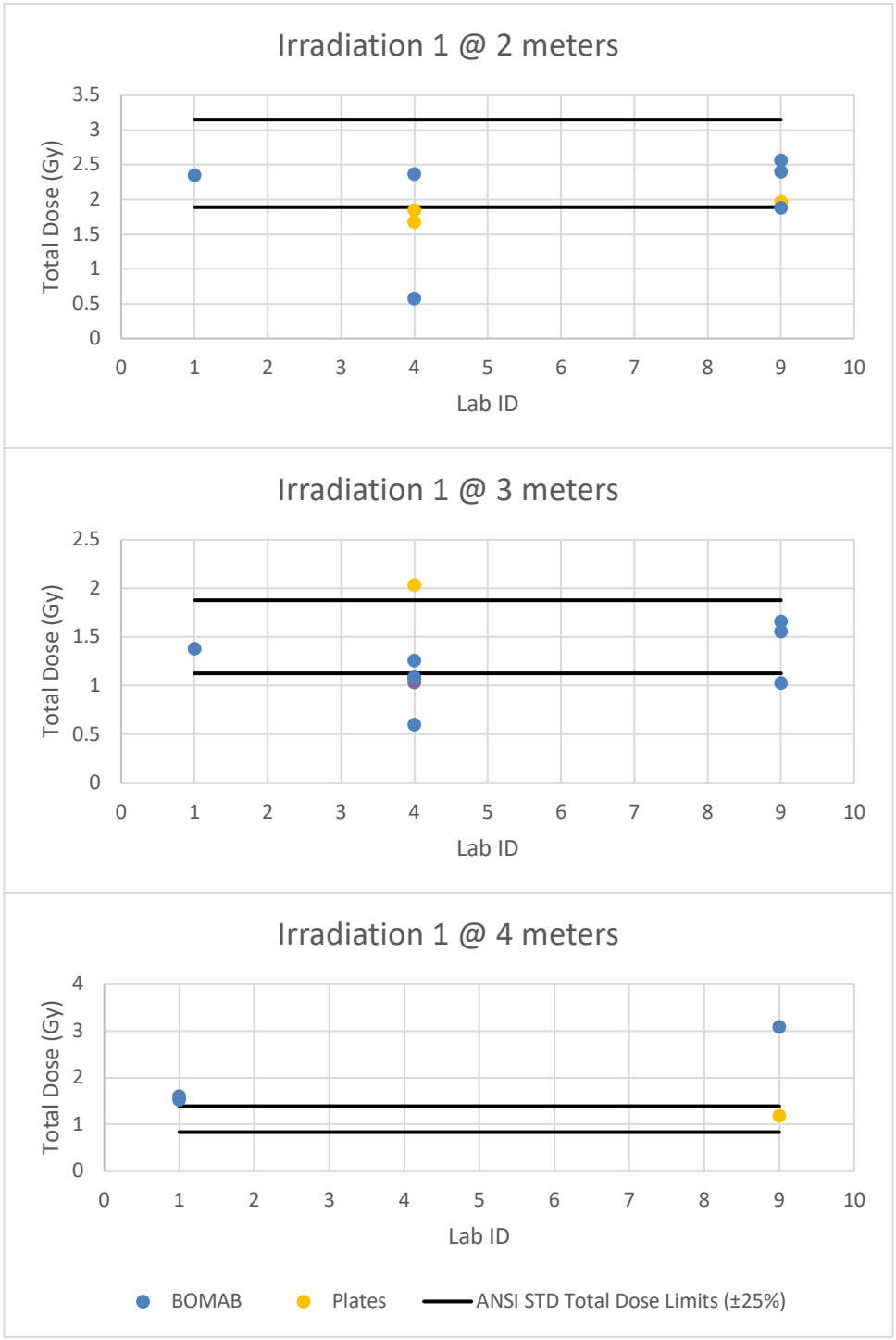


Figure 5. Total Dose 24-hour results for irradiation 1.



3.1.2 Irradiation 2 Results

For the second irradiation, 8 of the 9 laboratories submitted neutron doses within the first 24 hours post irradiation. Three laboratories provided gamma and total doses. The remaining lab did not provide a dose. The average bias for each laboratory ranged between approximately –67% to +10% for the reported neutron doses. Table 6 presents the average bias for each laboratory and the standard deviation of their reported results. Table 7 presents the known dose for each location and the average reported dose by each lab for each location. Neutron dose results for each distance are summarized in Figures 6. Gamma doses and total doses are summarized in Figures 7 and 8, respectively.

Table 6. Average percent difference for laboratory results for irradiation 2.

LAB ID	Percent Difference Average Neutron Dose		Percent Difference Average Gamma Dose		Percent Difference Average Total Dose	
	Average	±1σ	Average	±1σ	Average	±1σ
1*	10%	20%	-0.8%	5.5%	9.1%	19%
2	-15%	9.5%	-	-	-	-
3	-19%	30%	-	-	-	-
4*	-40%	6.4%	54%	46%	-29%	6.9%
5*	-	-	-	-	-	-
6	-19%	16%	-	-	-	-
7*	-67%	39%	-	-	-	-
8*	-40%	17%	-	-	-	-
9*	-14%	33%	-17%	50%	-9.1%	17%

*DOE Laboratories

Results not reported within 24 hours

Table 7. Known doses and average reported doses for Irradiation 2.

Lab	Distance (m)	Neutron Dose (Gy)			Gamma Dose (Gy)			Total Dose (Gy)		
		Reference	Average	Bias	Reference	Average	Bias	Reference	Average	Bias
1	2	4.01	3.48	-13%	0.42	0.35	-17%	4.43	3.83	-14%
2	2	4.01	3.78	-6%	0.42	--	--	4.43	--	--
3	2	4.01	3.23	-19%	0.42	--	--	4.43	--	--
4	2	4.01	2.69	-33%	0.42	0.53	26%	4.43	3.22	-27%
6	2	4.01	3.47	-13%	0.42	--	--	4.43	--	--
7	2	4.01	1.39	-65%	0.42	--	--	4.43	--	--
8	2	4.01	2.35	-41%	0.42	--	--	4.43	--	--
9	2	4.01	3.00	-25%	0.42	0.29	-32%	4.43	3.18	-28%
1	3	2.37	2.90	22%	0.26	0.29	12%	2.63	3.19	21%
2	3	2.37	2.07	-13%	0.26	--	--	2.63	--	--
3	3	2.37	1.99	-16%	0.26	--	--	2.63	--	--
4	3	2.37	1.31	-45%	0.26	--	--	2.63	--	--
6	3	2.37	1.91	-19%	0.26	--	--	2.63	--	--
7	3	2.37	0.54	-77%	0.26	--	--	2.63	--	--
8	3	2.37	1.33	-44%	0.26	--	--	2.63	--	--
9	3	2.37	2.45	3%	0.26	0.29	12%	2.63	3.24	23%
1	3	2.37	2.40	1%	0.26	0.24	-8%	2.63	2.64	0%
2	3	2.37	2.00	-16%	0.26	--	--	2.63	--	--
3	3	2.37	1.73	-27%	0.26	--	--	2.63	--	--
4	3	2.37	1.36	-42%	0.26	0.52	100%	2.63	1.77	-33%
6	3	2.37	2.12	-11%	0.26	--	--	2.63	--	--
7	3	2.37	0.90	-62%	0.26	--	--	2.63	--	--
8	3	2.37	1.32	-44%	0.26	--	--	2.63	--	--
9	3	2.37	2.06	-13%	0.26	0.21	-21%	2.63	2.27	-14%
1	4	1.74	2.27	30%	0.21	0.23	10%	1.95	2.50	28%
2	4	1.74	1.30	-25%	0.21	--	--	1.95	--	--
3	4	1.74	1.49	-14%	0.21	--	--	1.95	--	--
4	4	1.74	1.02	-41%	0.21	0.35	67%	1.95	1.37	-30%
6	4	1.74	1.15	-34%	0.21	--	--	1.95	--	--
7	4	1.74	0.60	-66%	0.21	--	--	1.95	--	--
8	4	1.74	1.24	-29%	0.21	--	--	1.95	--	--
9	4	1.74	1.48	-15%	0.21	0.20	-5%	1.95	2.16	11%

Figure 6. Neutron dose 24-hour resutls for irradiation 2.

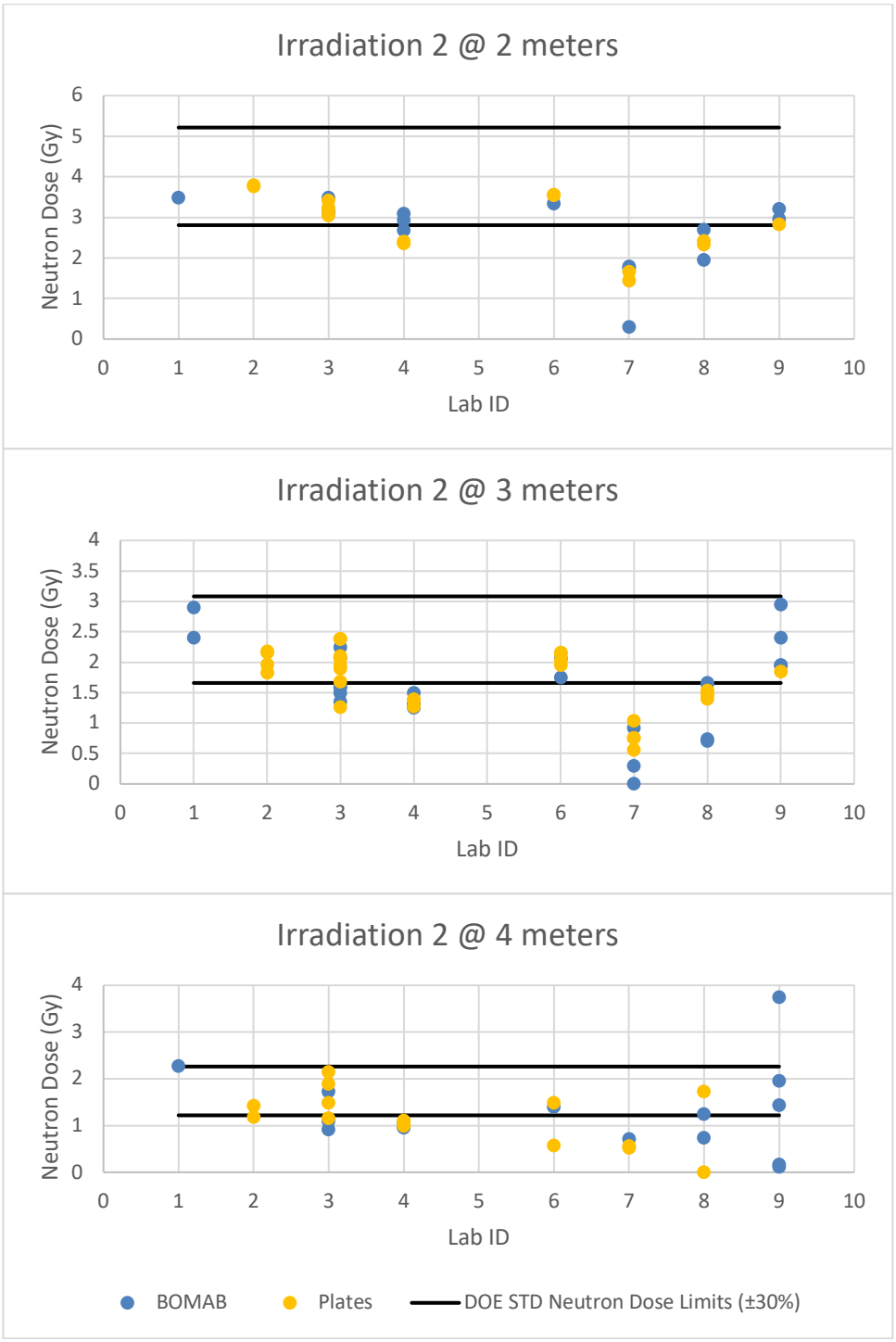


Figure 7. Gamma dose 24-hour results for irradiation 2.

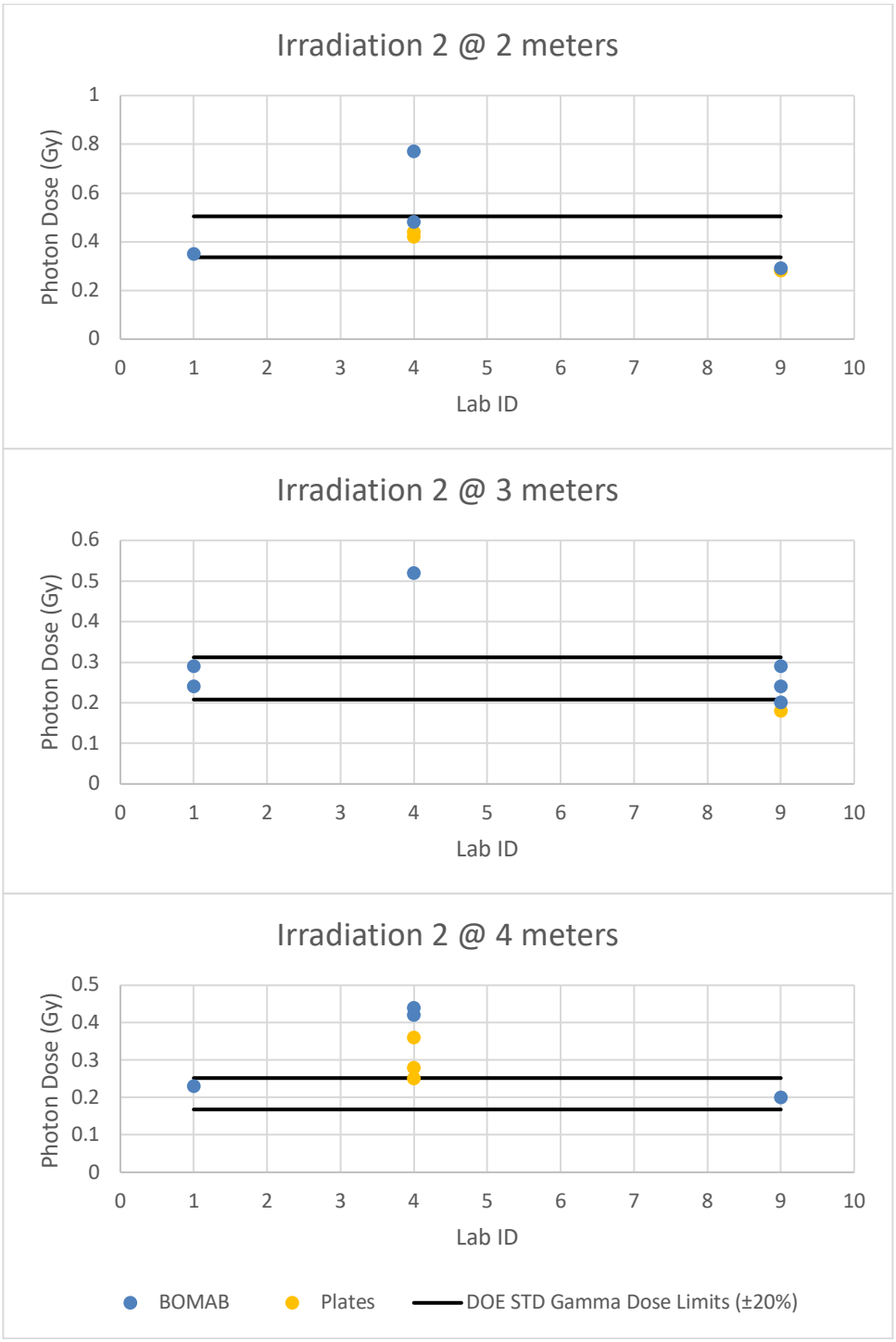
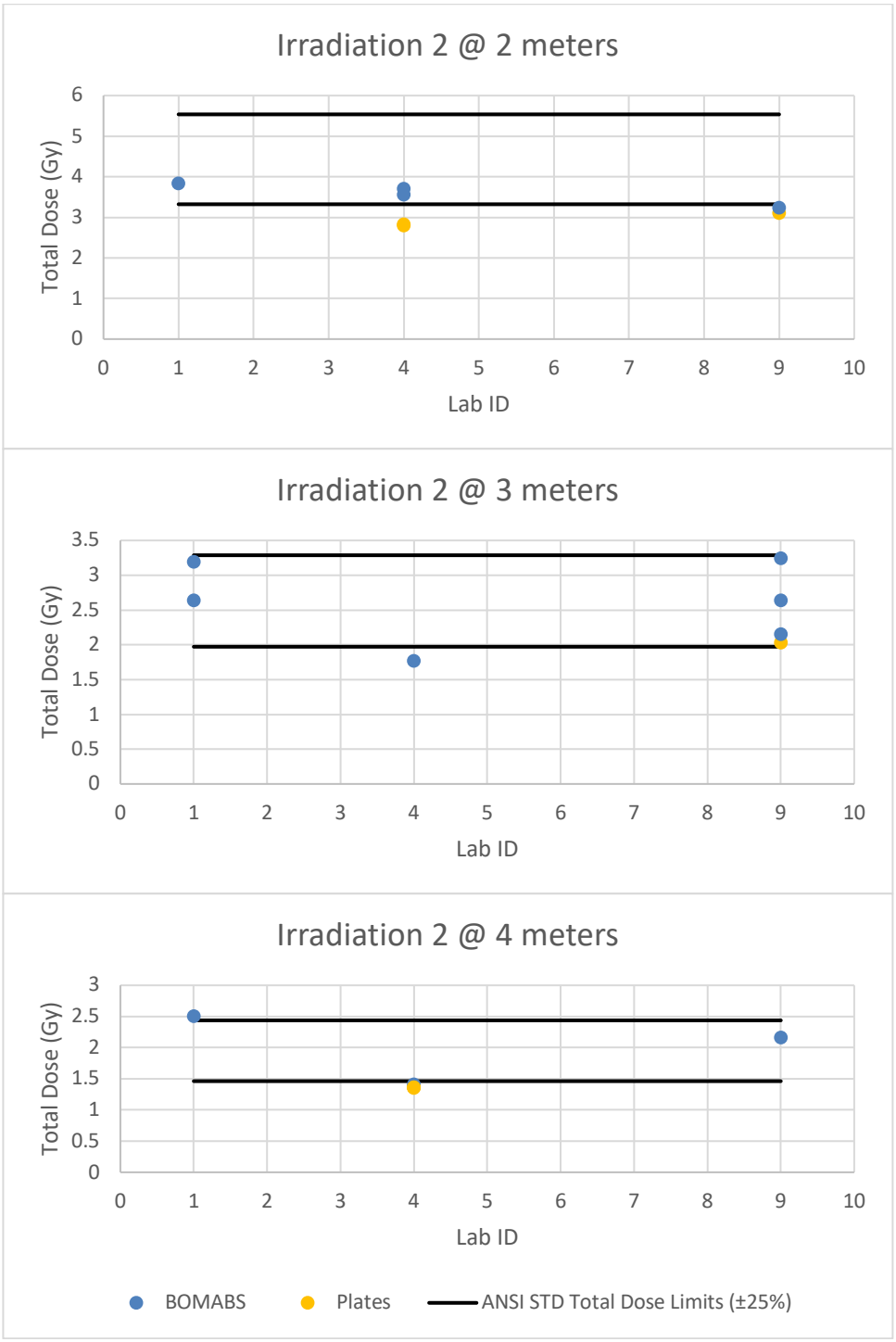


Figure 8. Total dose 24-hour results for irradiation 2.



3.2 Final Results

At the conclusion of the exercise, the participants were given the location and orientation information for their dosimetry but not the doses delivered. They were asked to provide revised,

finalized results within three weeks. At the end of the three weeks, five out of the nine laboratories submitted their final results. The following week, two more laboratories provided final results.

For the first irradiation, most laboratories saw an improvement with their final dose result or saw minimal to no change from their 24-hour result. Of the results submitted, 19% of the final results fell outside the ANSI standard limits compared to 58% for the 24-hour results. Compared to the DOE standard, 36% of the final results fell outside of the criteria verses 56% for the 24-hour results. For irradiation two, the final results for five of the seven laboratories showed improvement from their initial 24-hour result. Compared to the ANSI and DOE standard limits, 47% and 51% fell outside of the criteria, respectively. Table 8 shows the percentage of results that fall out of the limit criteria at each dose level for both irradiations.

Table 8. Percentage of final dosimeter results that fall out of limit criteria.

	Irradiation 1			Irradiation 2		
Distance (m)	2	3	4	2	3	4
Known Total Dose (Gy)	2.52	1.50	1.11	4.43	2.63	1.95
% Outside ANSI Limits	19%	18%	20%	53%	47%	44%
% Outside DOE STD Limits	38%	37%	33%	46%	50%	58%

This report provides the participants the known doses for irradiation. With this, each laboratory will be responsible for completing their own Final Report of their own results. The collection of these reports will go into the CED-4a report.

4 Acknowledgements

This international intercomparison of nuclear accident dosimetry and its associated reports would not be possible without the support of the Nuclear Criticality Safety Program Manager, Angela Chambers, and the IER-538 NCSP review team: Doug Bowen, Joetta Goda and John Miller.

I would like to acknowledge the work of members of the Advanced Nuclear Technology (NEN-2) group at LANL: Joetta Goda, Travis Grove, Theresa Cutler, Nick Thompson, Rob Weldon, Lauren Overbay and Trevor Omoto; and the NCERC Facility Operations group for conducting and ensuring successful operations of Godiva-IV, support of the facility and providing the irradiations.

I would also like to thank Scarlet Mitchell and Paul Yap-chiongco for ensuring the NAD lab had all the supplies and support needed for the participants and coordination for the exercise be successful. The work of Scarlet; LLNL Joint Laboratory Operations Manager, Andy Ashbaugh; and Building 23-703 Facility Manager, Aaron Senegal was crucial to having a new A/C unit installed in the NAD lab in time for the exercise.

Additionally, thanks to each laboratory for participation in this exercise:

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- Hanford: Heather Healy, Sean Murphy, Robert Ludwigsen

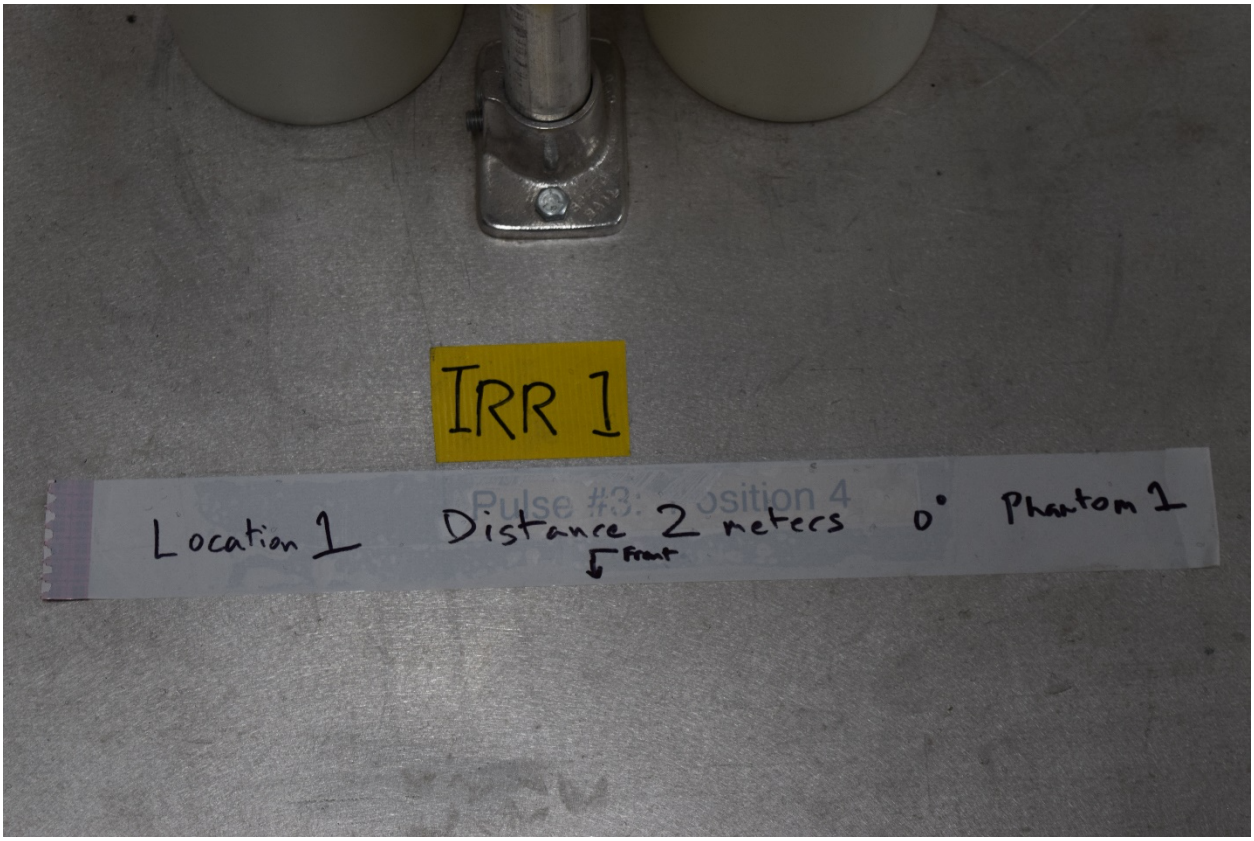
- IRSN: Francois Trompier, Yoann Ristic, Johann Herth, Sophie Pignet
- LANL: Milan Gadd, Elizabeth Hillmer, Laurel Sharisky
- LLNL: Brian Champine, Mike Firpo, Sophia Uchiyama, Logan Anspach, Aaron Tamashiro, Paige Witter
- NDC: Alexander Romanyukha, David Boozer, Keith Consani
- SNL: Dann Ward, John Kilbane
- SRS: David Roberts, Russell Abbott, Joy Epps, Dillon Vogt
- Y-12: Ken Veinot, Kieran Mcmahon, Alexandra Detweiler

Lastly, I'd like to thank Dave Heinrichs and Catherine Percher for allowing me the opportunity to complete the exercise; my ORNL management: Kevin Reaves, Rob Jones, Govind Rao and Kim Isbell for allowing me to lead and complete this exercise; and the ORNL NSCP Task Manager, Doug Bowen for the support to participate and complete IER-538.

5 Photo Notebook

IRRADIATION 1

BOMBAB 1 – STAND LABEL – FRONT – BACK

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Minigrip
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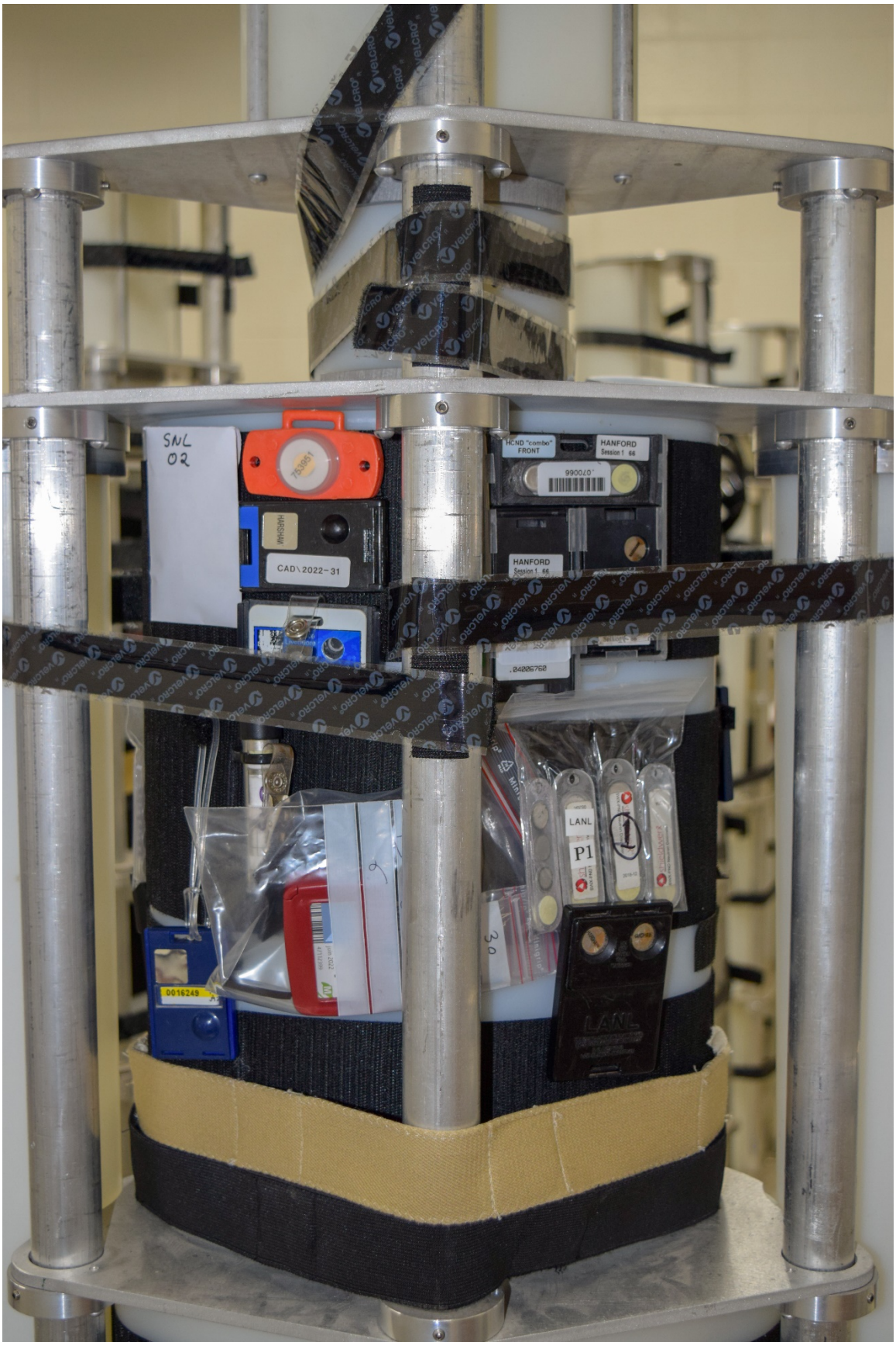
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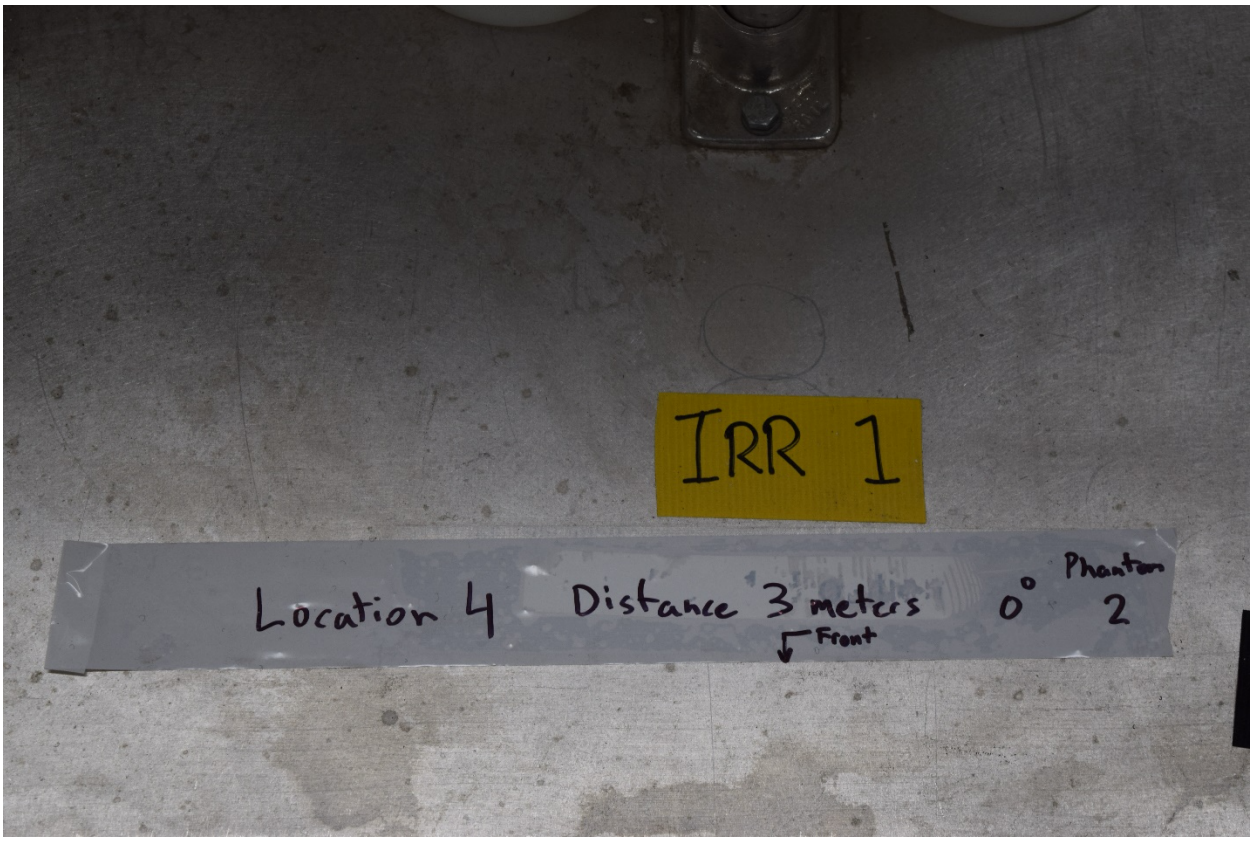
BOMBAB 2 – STAND LABEL – FRONT – BACK

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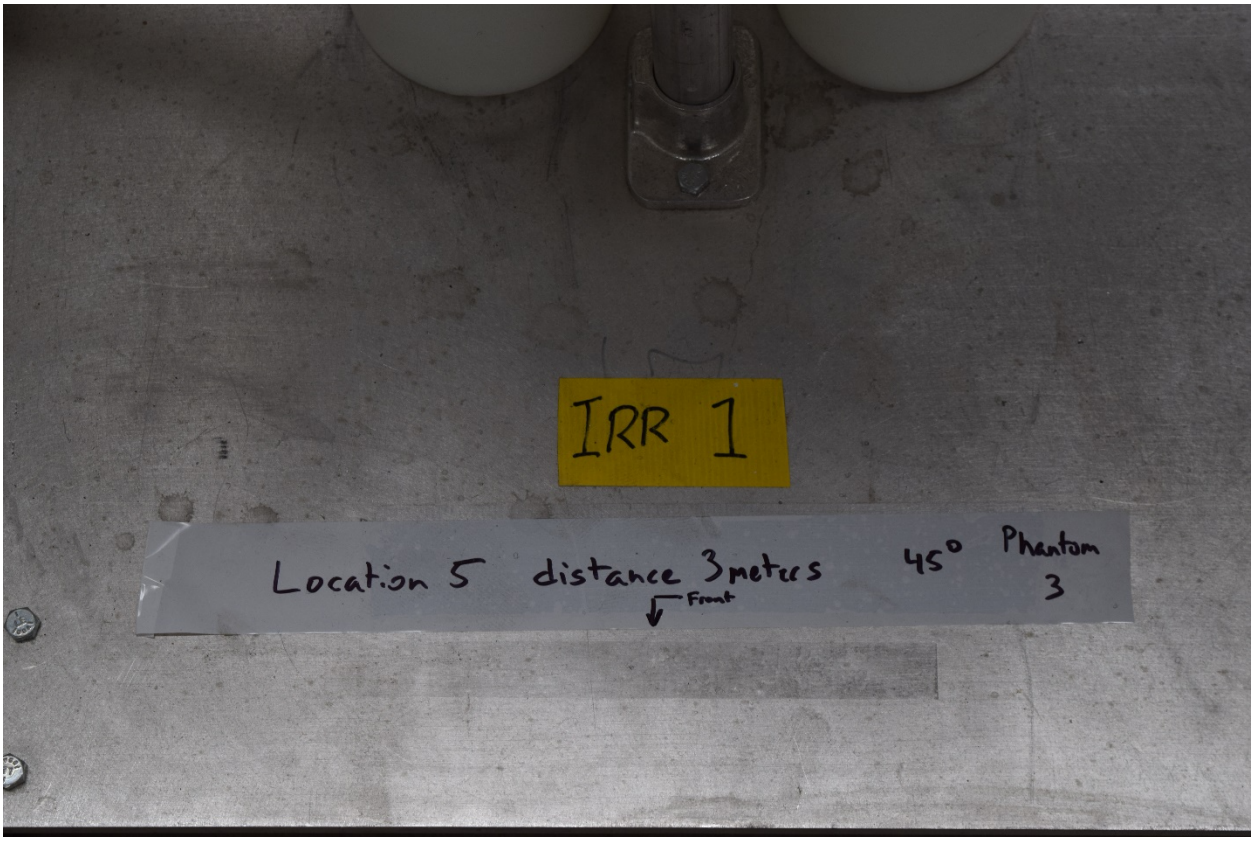
3-4-15-17
HANFORD
HCND "combo" FRONT
CAD\2022-32
RECEPT


HCND "combo"
FRONT
HANFORD
Session 1 63
.070063
HCND "combo"
FRONT
HCND "combo"
FRONT
HANFORD
Session 1 63
.04006312
F 142
SNL
06
CAD\2022-34

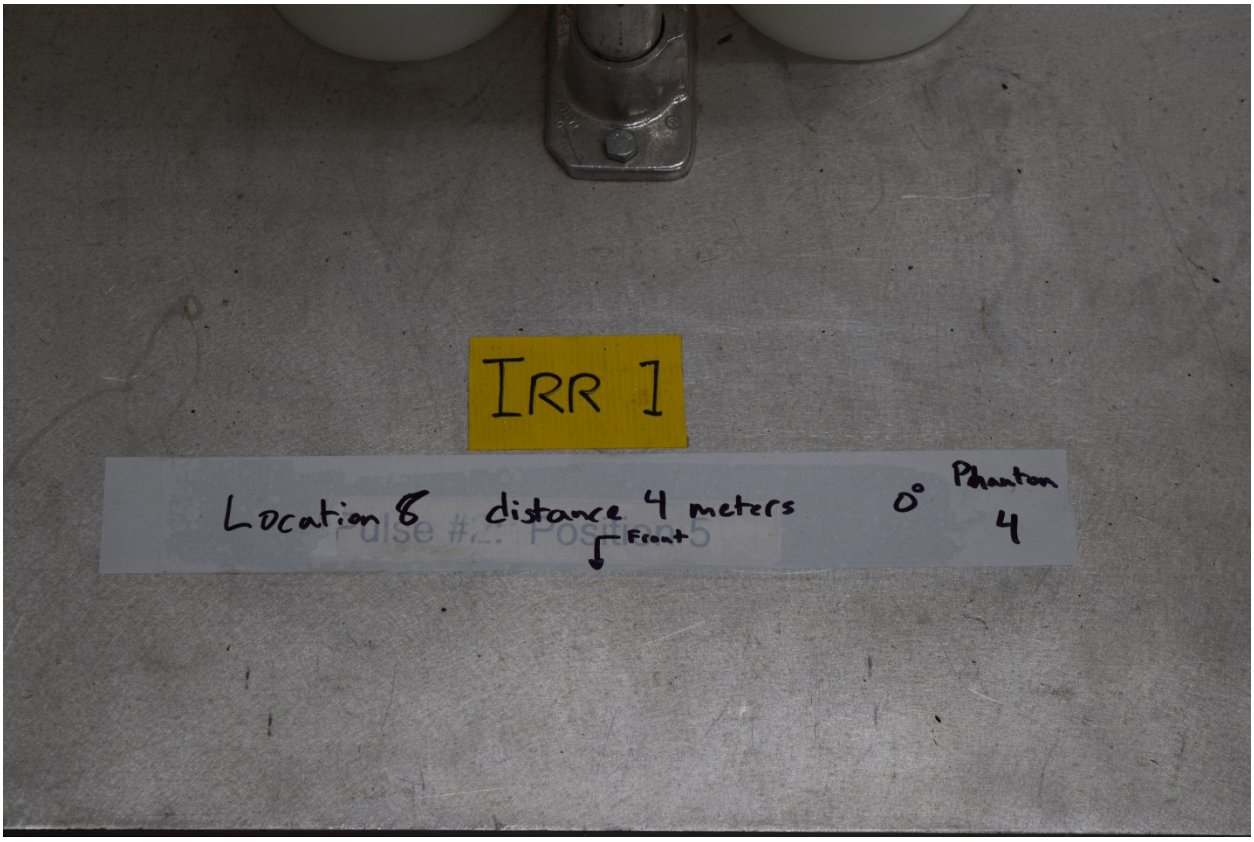
BOMBAB 3 – STAND LABEL – FRONT – BACK




SNL
09
HCND "combo" FRONT
HANFORD Session 1 72
.070072
753985
HANFORD Session 1 72
HCND "combo" FRONT
CAD\2022-51
HANFORD Session 1 72
HCND "combo" FRONT
Right
5
UP
T2
Run 1
T2
Run 1
D
3
0023334


SNL
10
HANFORD
Session 1
Minigrip
749287
HARSHAW
0017736
CAD\2022-54

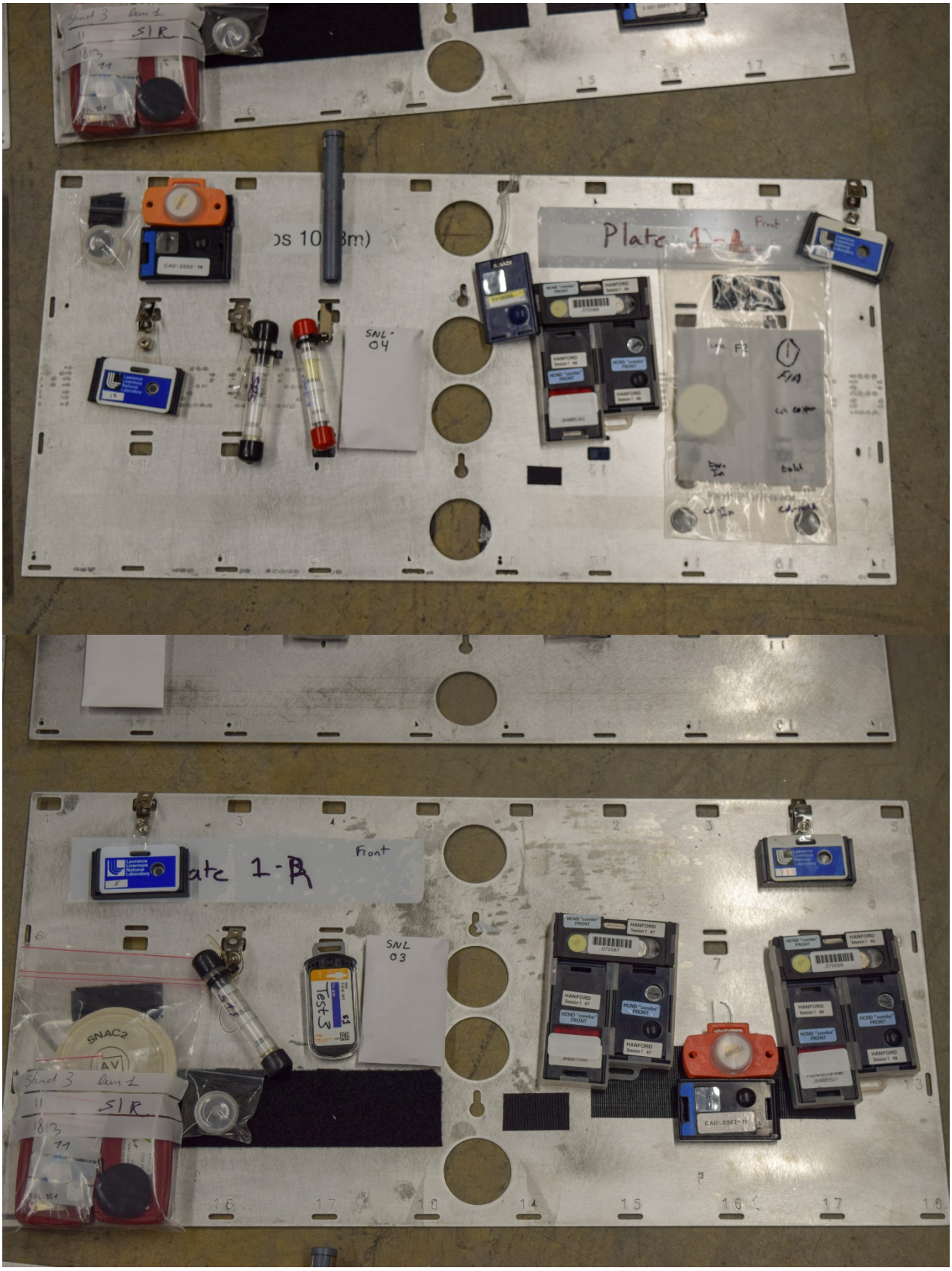
BOMBAB 4 – STAND LABEL – FRONT – BACK




SNL
13
LANL
HCND "combo"
FRONT
HANFORD
Session 1 62
.070062
HANFORD
Session 1 62
HCND "combo"
FRONT
HCND "combo"
FRONT
HANFORD
Session 1 62
.04006103
CAD\2022-52
Right
22
Run 1
Y-12
NDA 1
51K
SNS

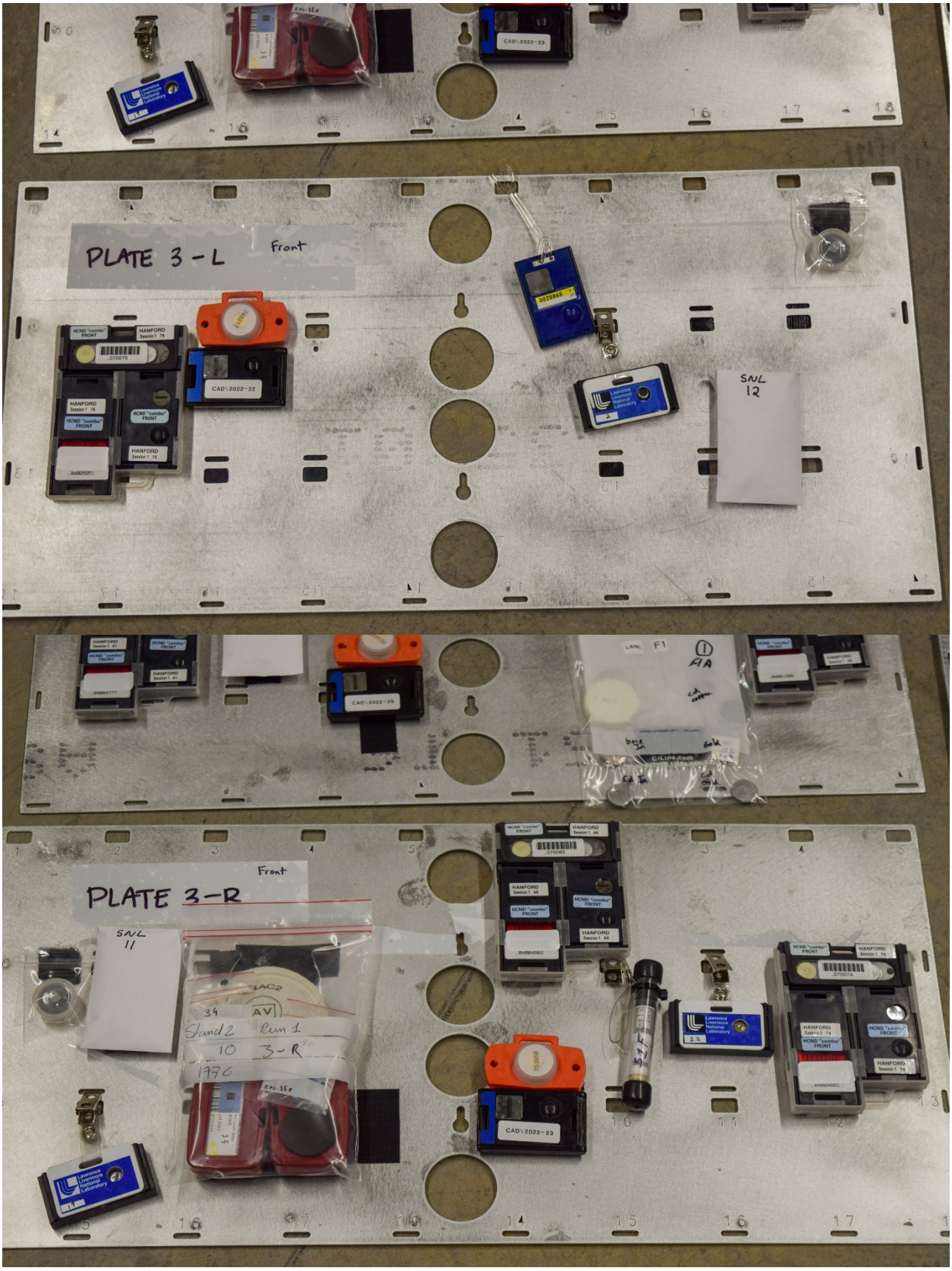

HCND "combo" FRONT
HANFORD Session 1 59
.070059
HANFORD Session 1 59
HCND "combo" FRONT
HCND "combo" FRONT
.04004619
HANFORD Session 1 59
CAD\2022-53
Z7
.0022849
32
back

ALUMINUM STANDS 1-L and 1-R

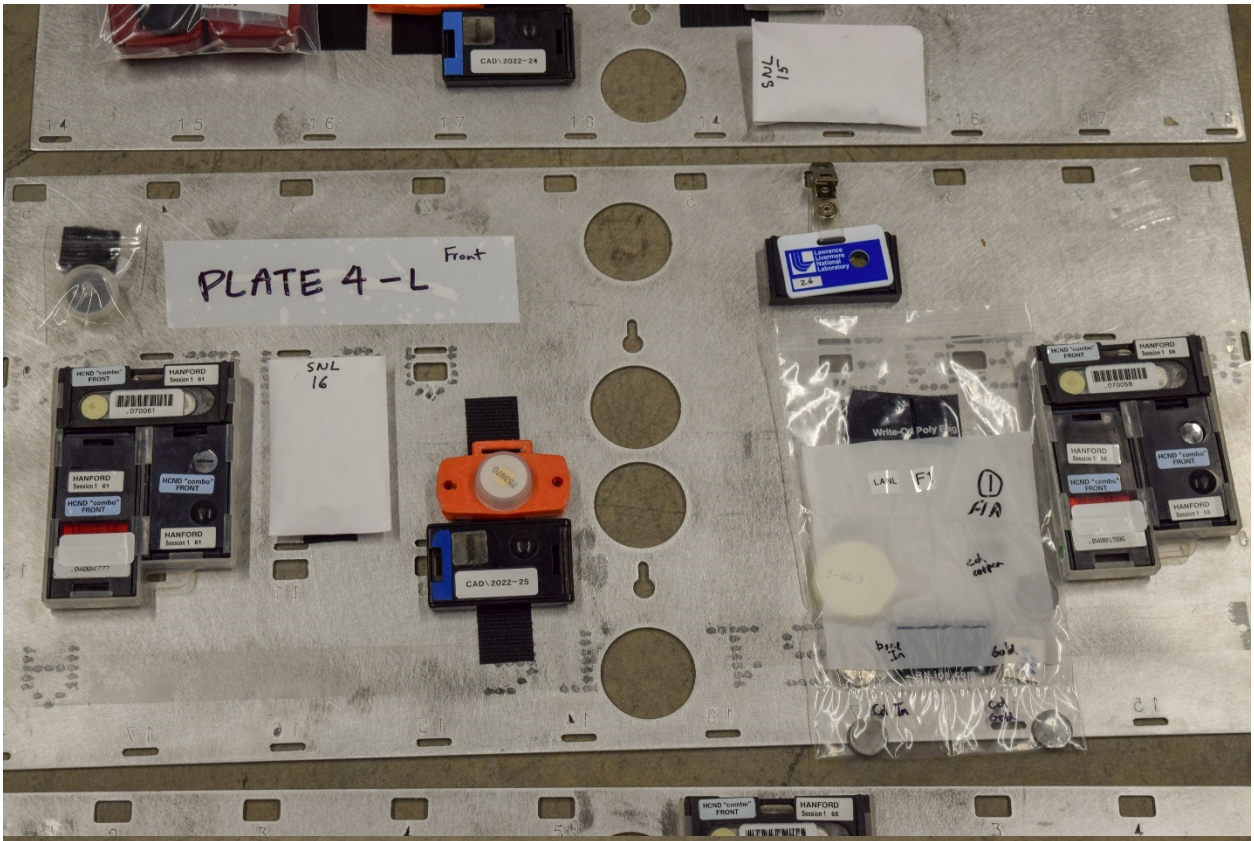


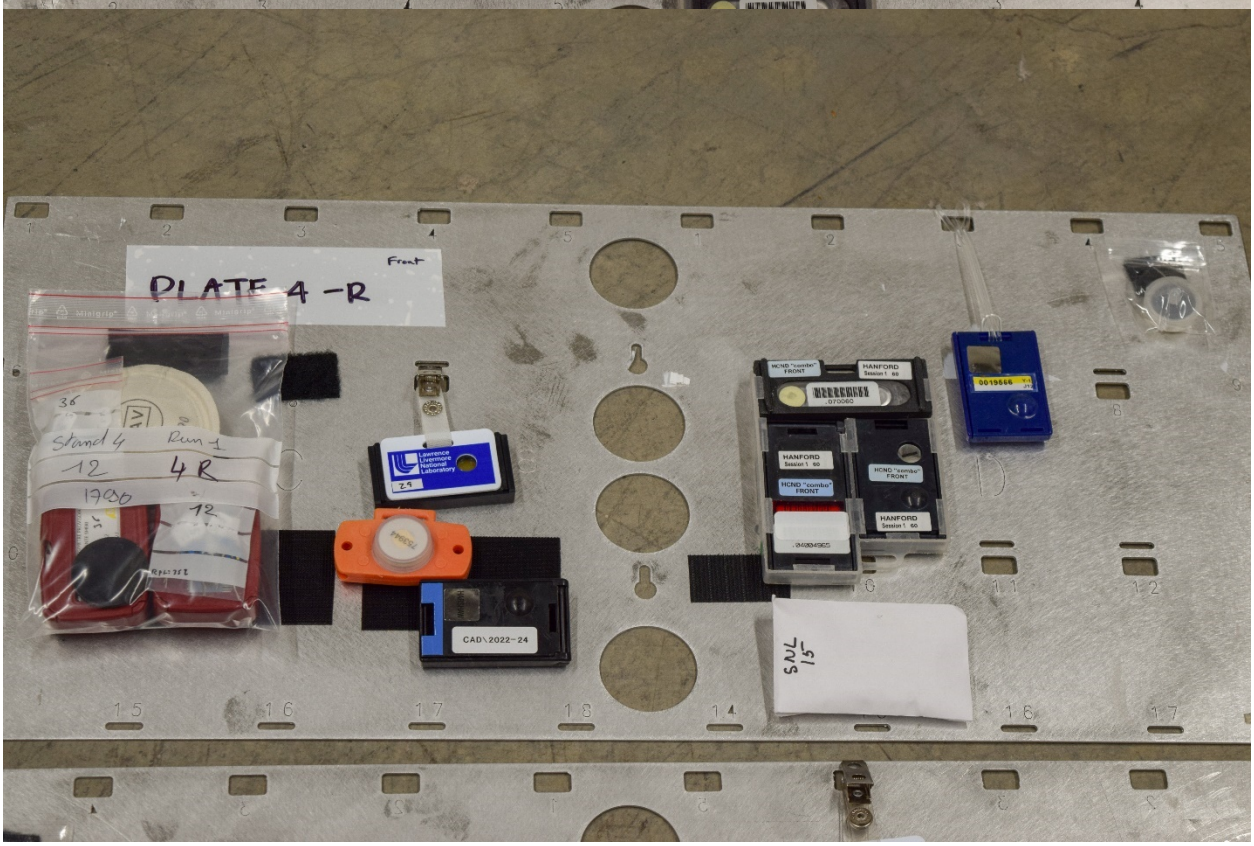
ALUMINUM STANDS 2-L and 2-R

ALUMINUM STANDS 3-L and 3-R



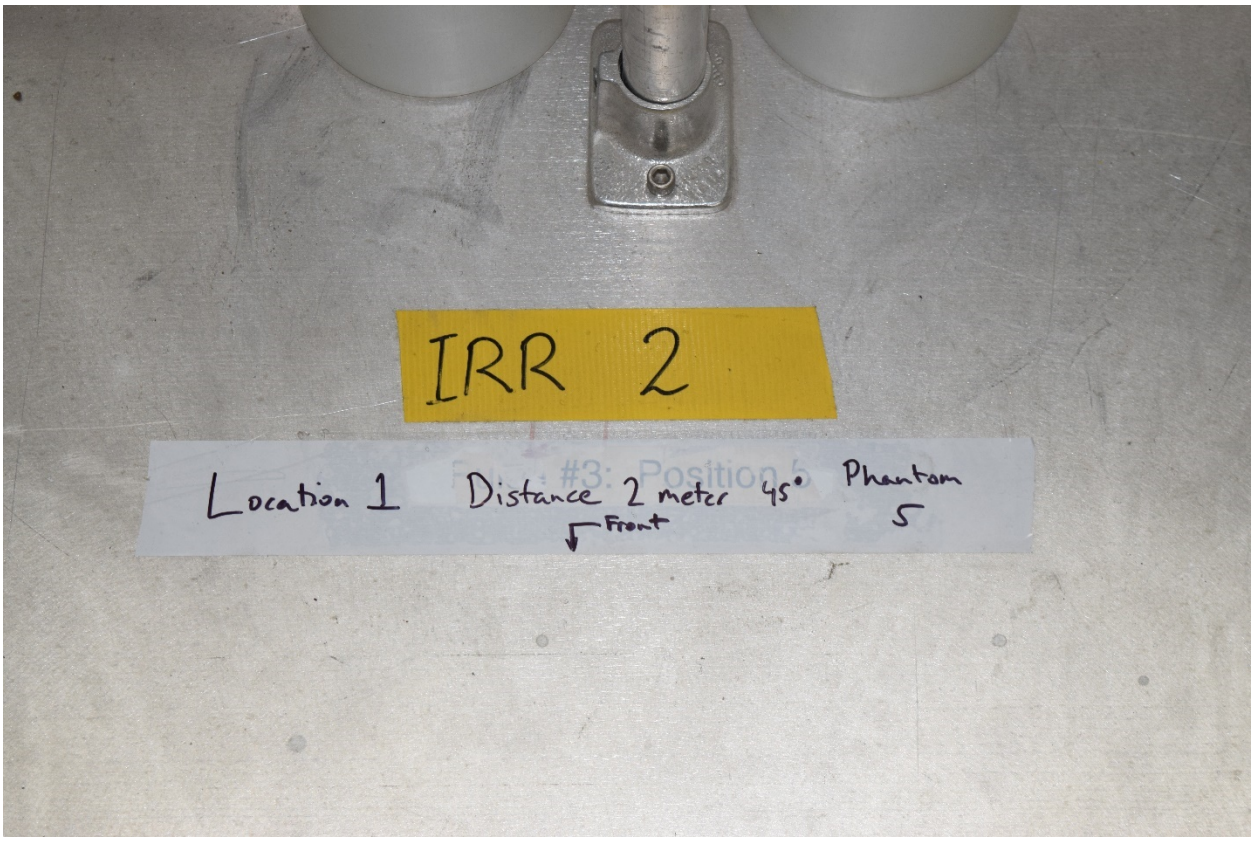
ALUMINUM STANDS 4-L and 4-R



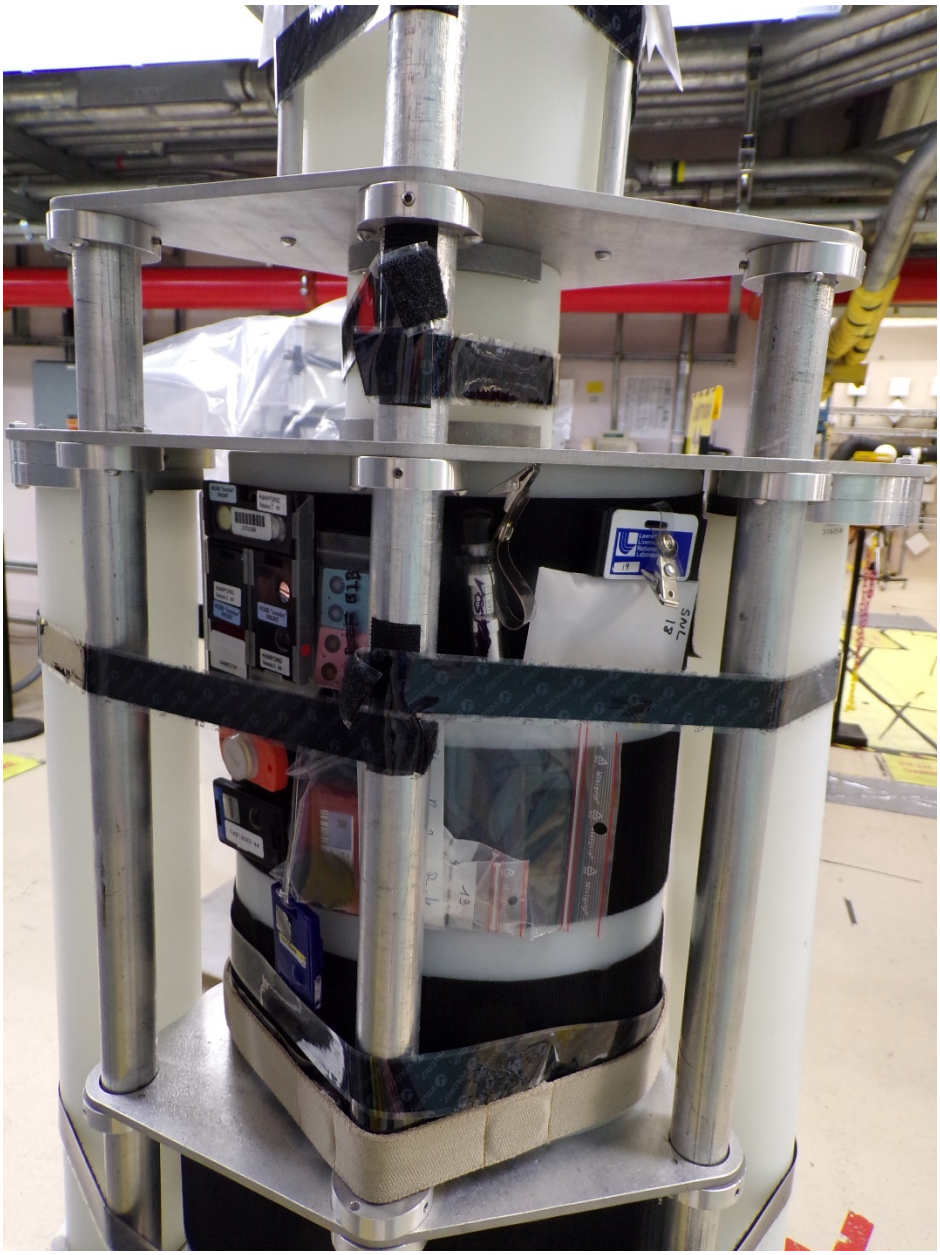


IRRADIATION 2

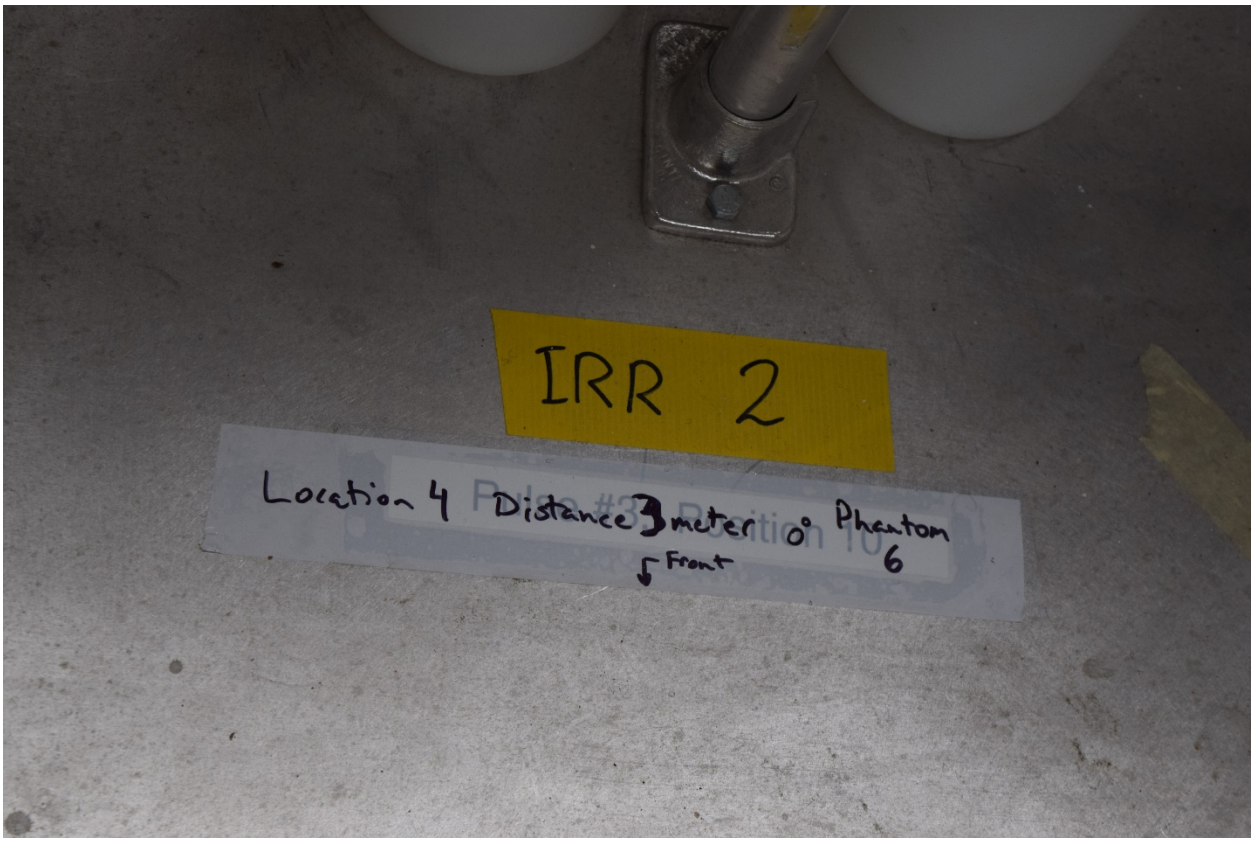
BOMBAB 5 – STAND LABEL – FRONT – BACK




UPPER TORSO
ORNL3
CAD\2022-13
Test 5
S2
HCND "combo" FRONT
HANFORD Session 2 92
.070092
LANL
P10
SNL
6.
Run 2



BOMBAB 6 – STAND LABEL – FRONT – BACK




NECK
2-17-15-7
HANFORD
Session 2 85
HCNO "combo"
FRONT
CAD\2022-42
Test 4
LANL
P9
Run 2
UPPER LEG B
2-17-15-7


HCND "combo"
FRONT
HANFORD
Session 2 84
.070084
HANFORD
Session 2 84
HCND "combo"
FRONT
HCND "combo"
FRONT
HANFORD
Session 2 84
Minigrip

BOMBAB 7 – STAND LABEL – FRONT – BACK


NECK
2-18-15-11
UPPER TORSO
2-18-15-11
753942
CAD\2022-12
HCND "combo" FRONT
HANFORD Session 2 130
.070130
0014096
HANFORD Session 2 130
HCND "combo" FRONT
HCND "combo" FRONT
HANFORD Session 2 130
LANL
P7
anneal Date: 7-13-22
Anneal Vales: 0
Set 2
10 nanodots
SNL
24
P3
Run 2
P3
Run2

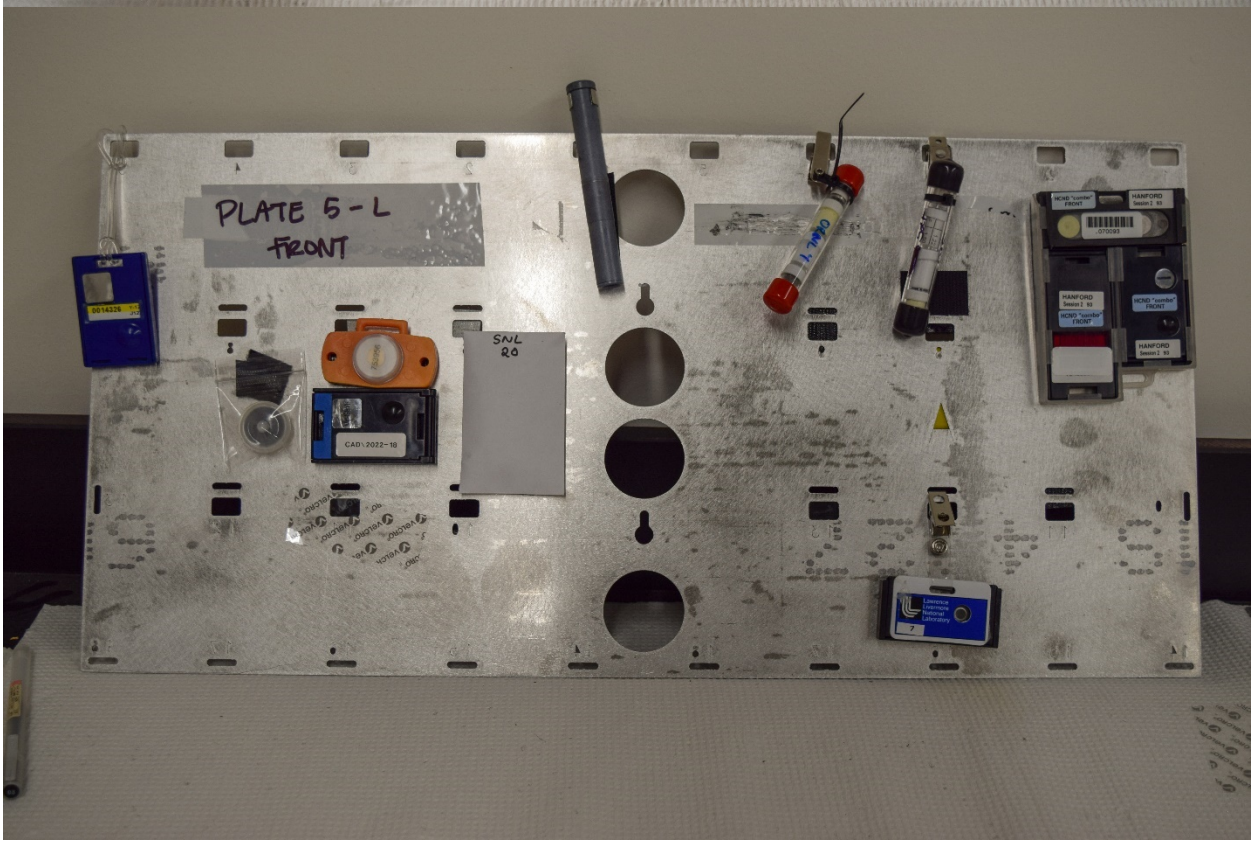

HANFORD
Session 2 129
HANFORD
Session 2 129
0020598
Minigrip
Minigrip
Minigrip

BOMBAB 8 – STAND LABEL – FRONT – BACK

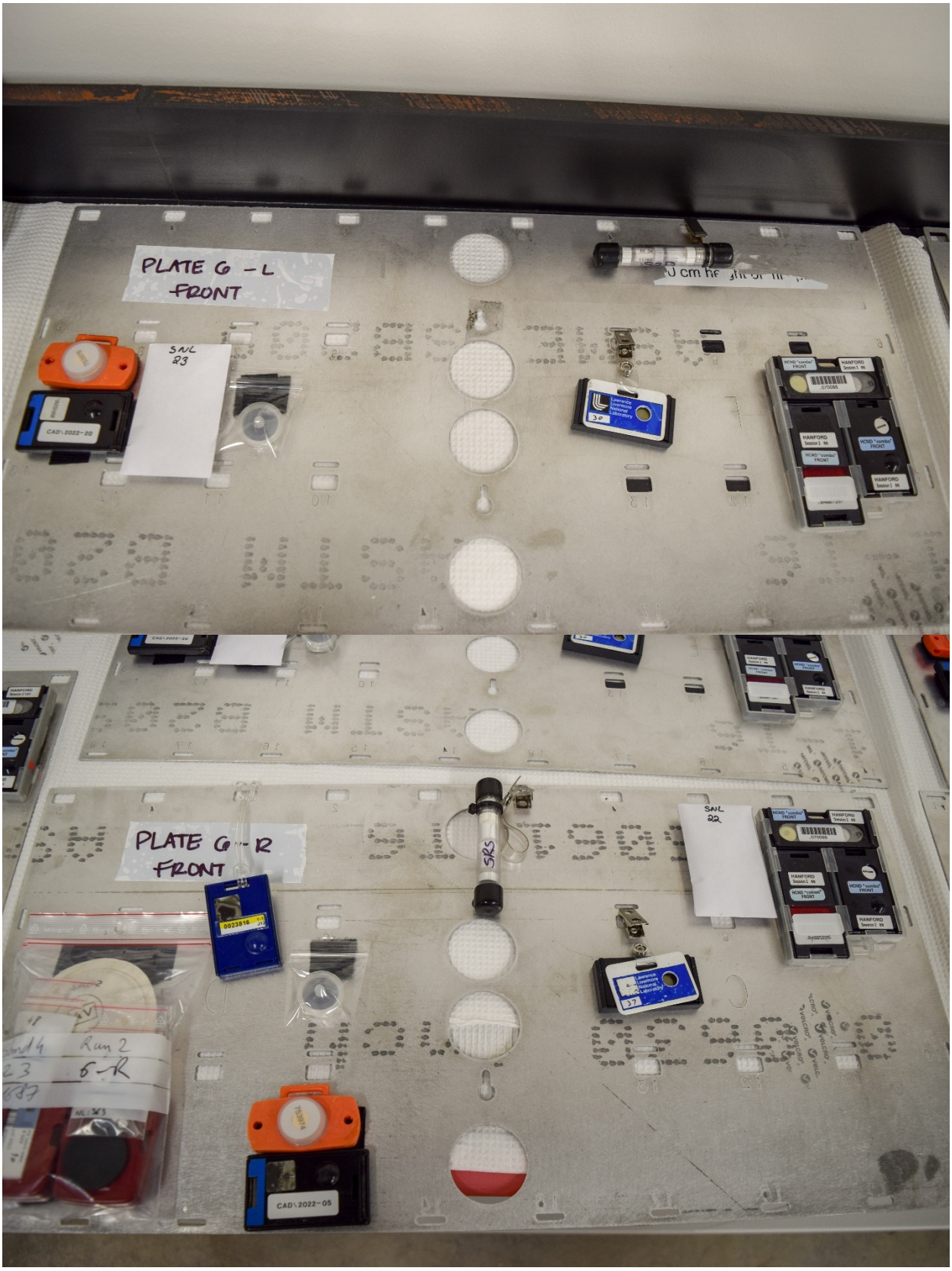

SNL
28
HCND "combo" FRONT
HANFORD Session 2 126
.070126
CAD\2022-16
Lawrence Livermore National Laboratory
7
Run 2
Front
Y-12
9-13-22


HCND "combo"
FRONT
HANFORD
Session 2 98
.070098
HANFORD
Session 2 98
HCND "combo"
FRONT
HCND "combo"
FRONT
HANFORD
Session 2 98
.24020115
HARSHAW
CAD\2022-17
Test 6

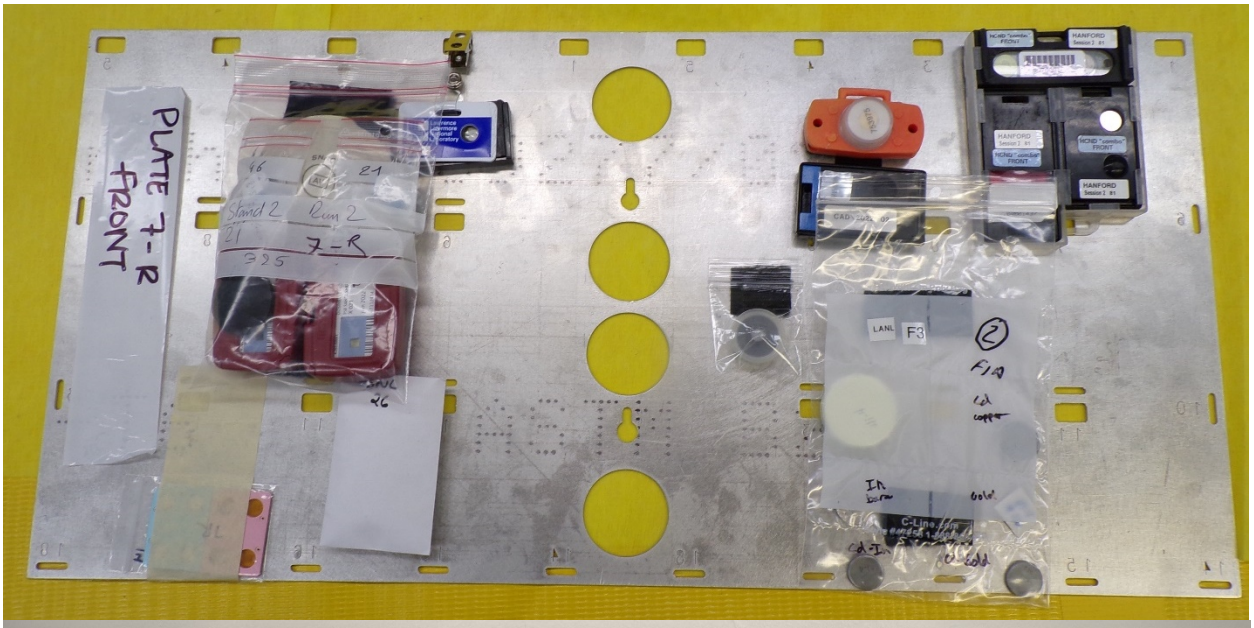
ALUMINUM STANDS 5-L and 5-R

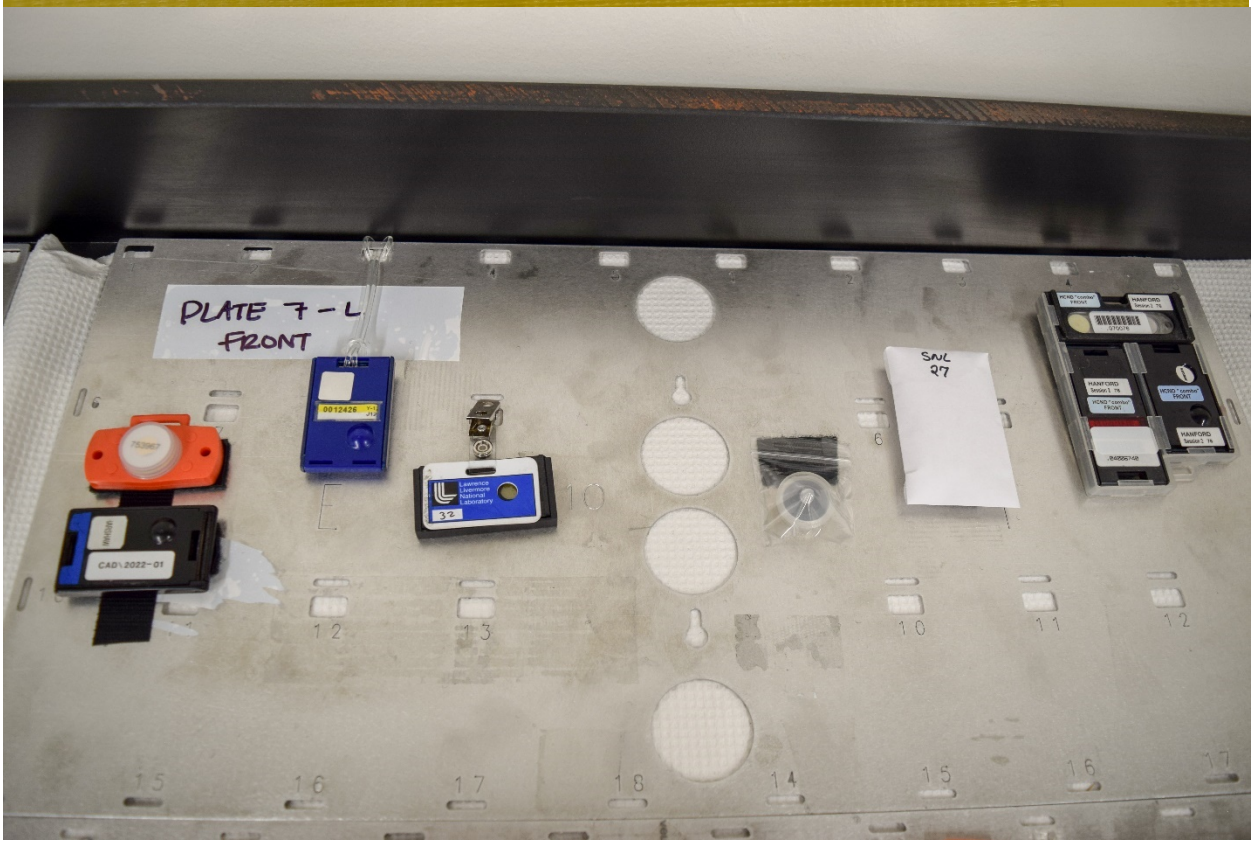


ALUMINUM STANDS 6-L and 6-R

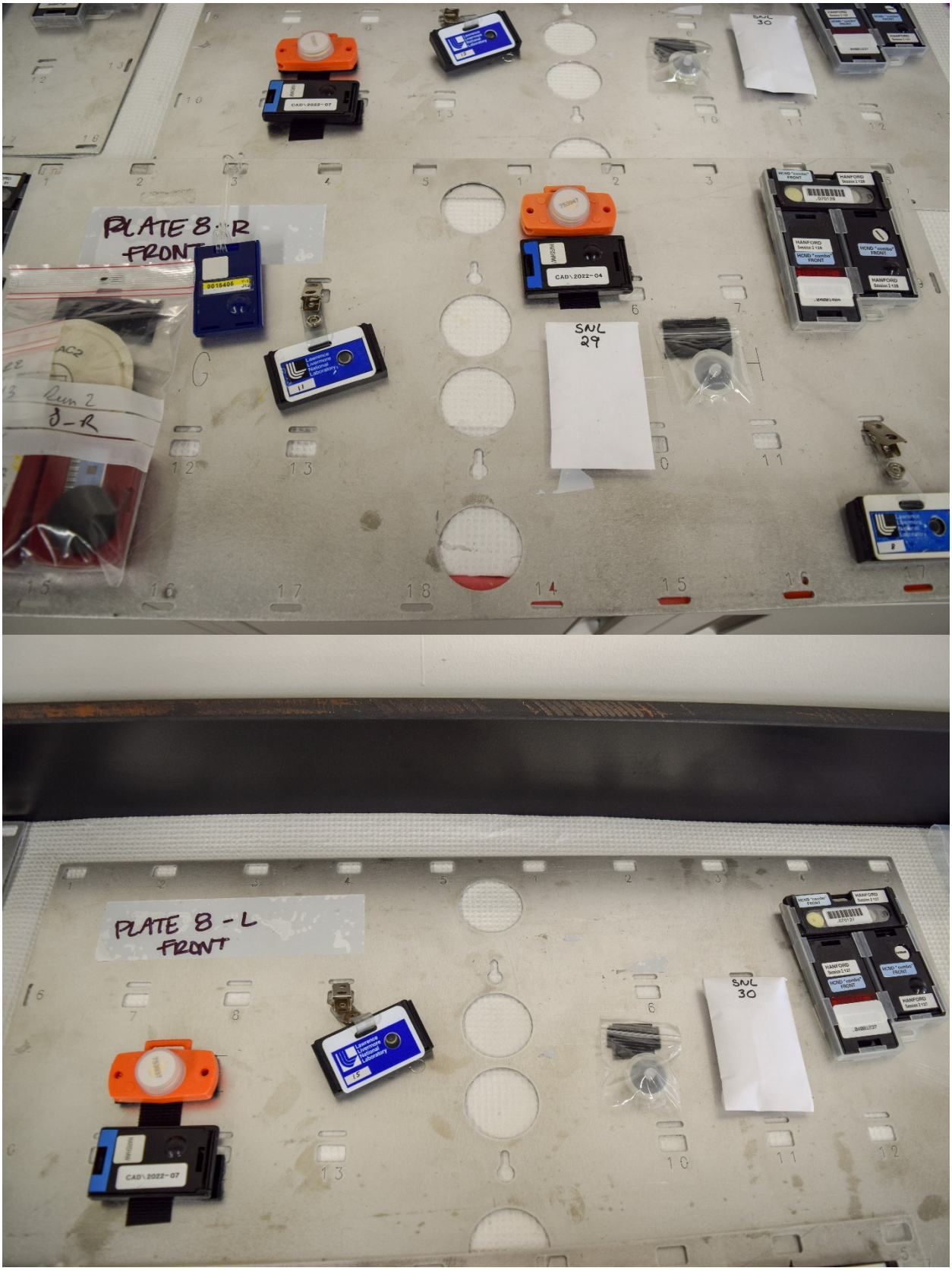


ALUMINUM STANDS 7-L and 7-R

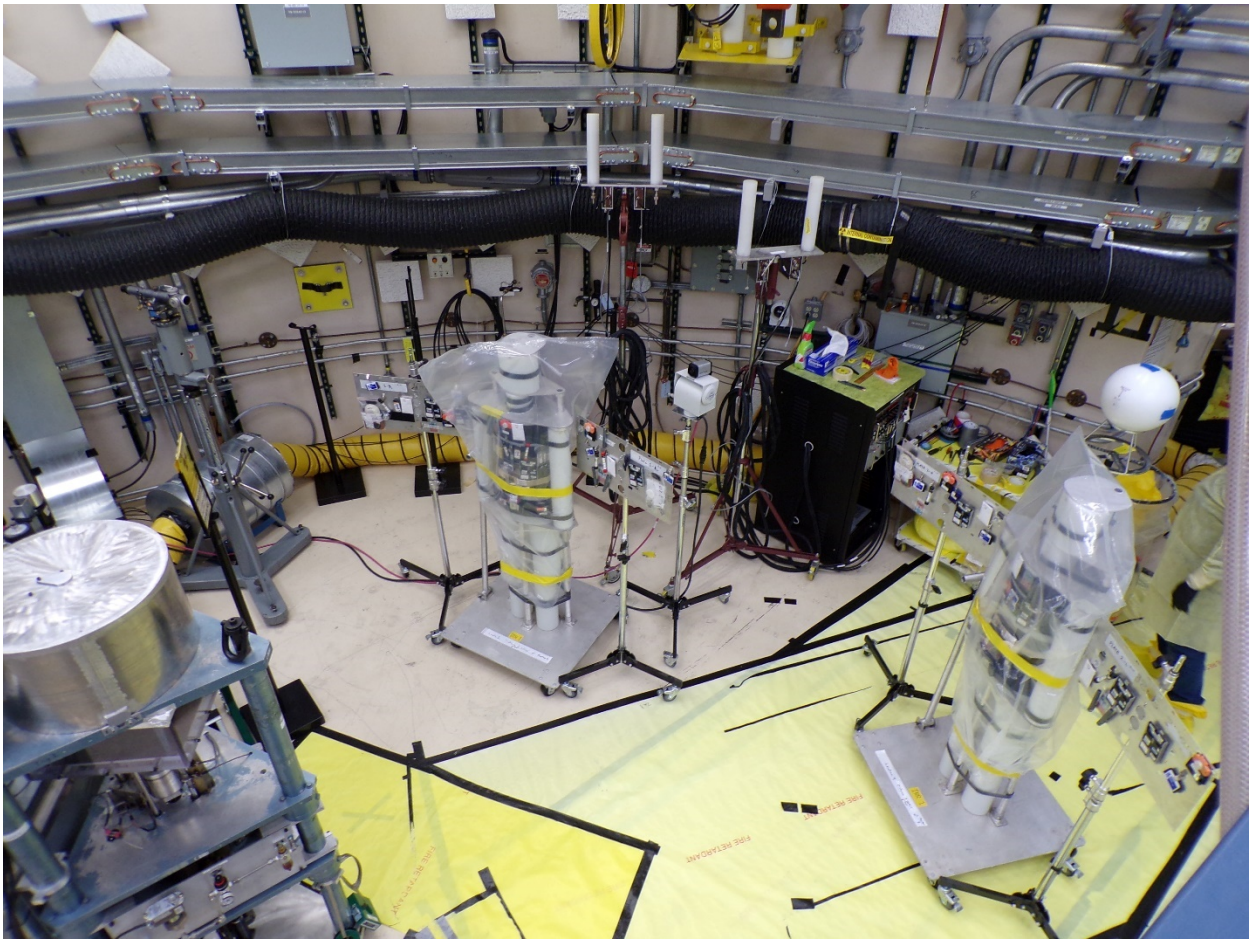




ALUMINUM STANDS 8-L and 8-R

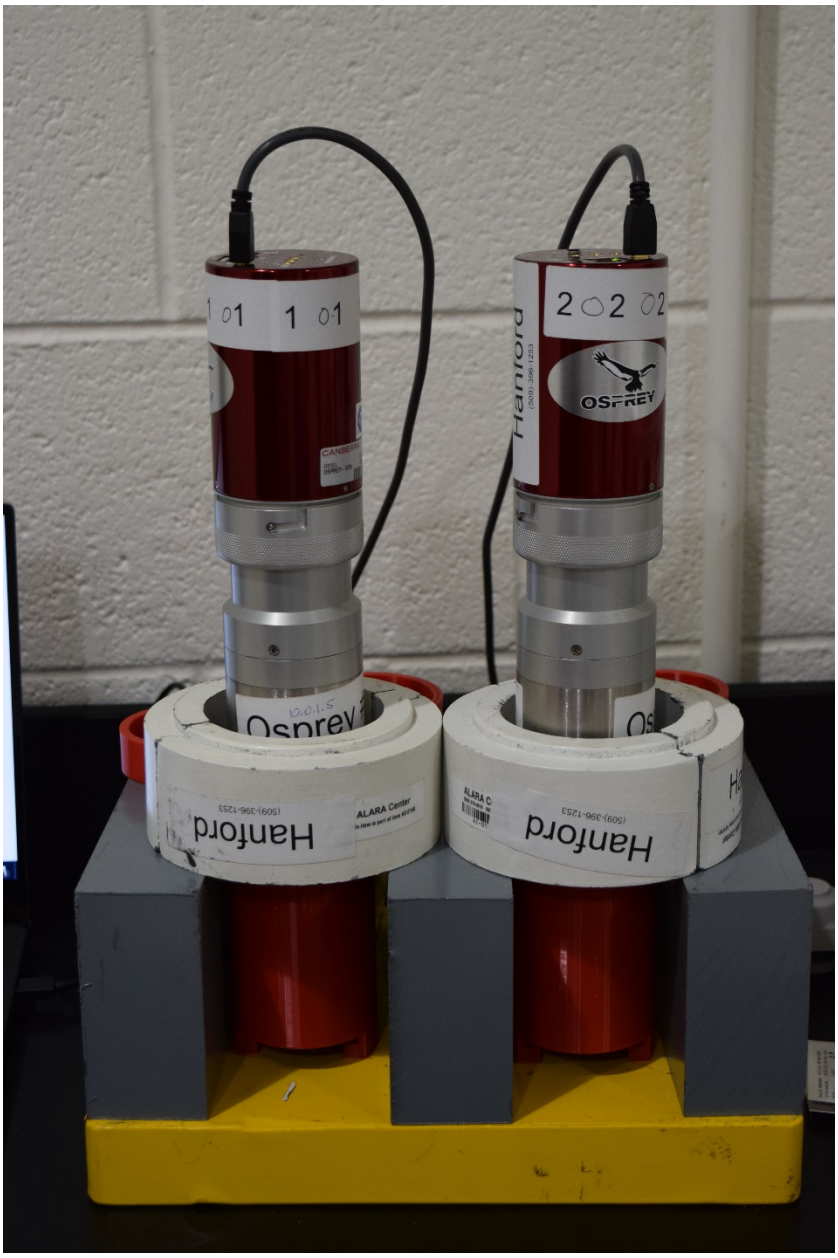


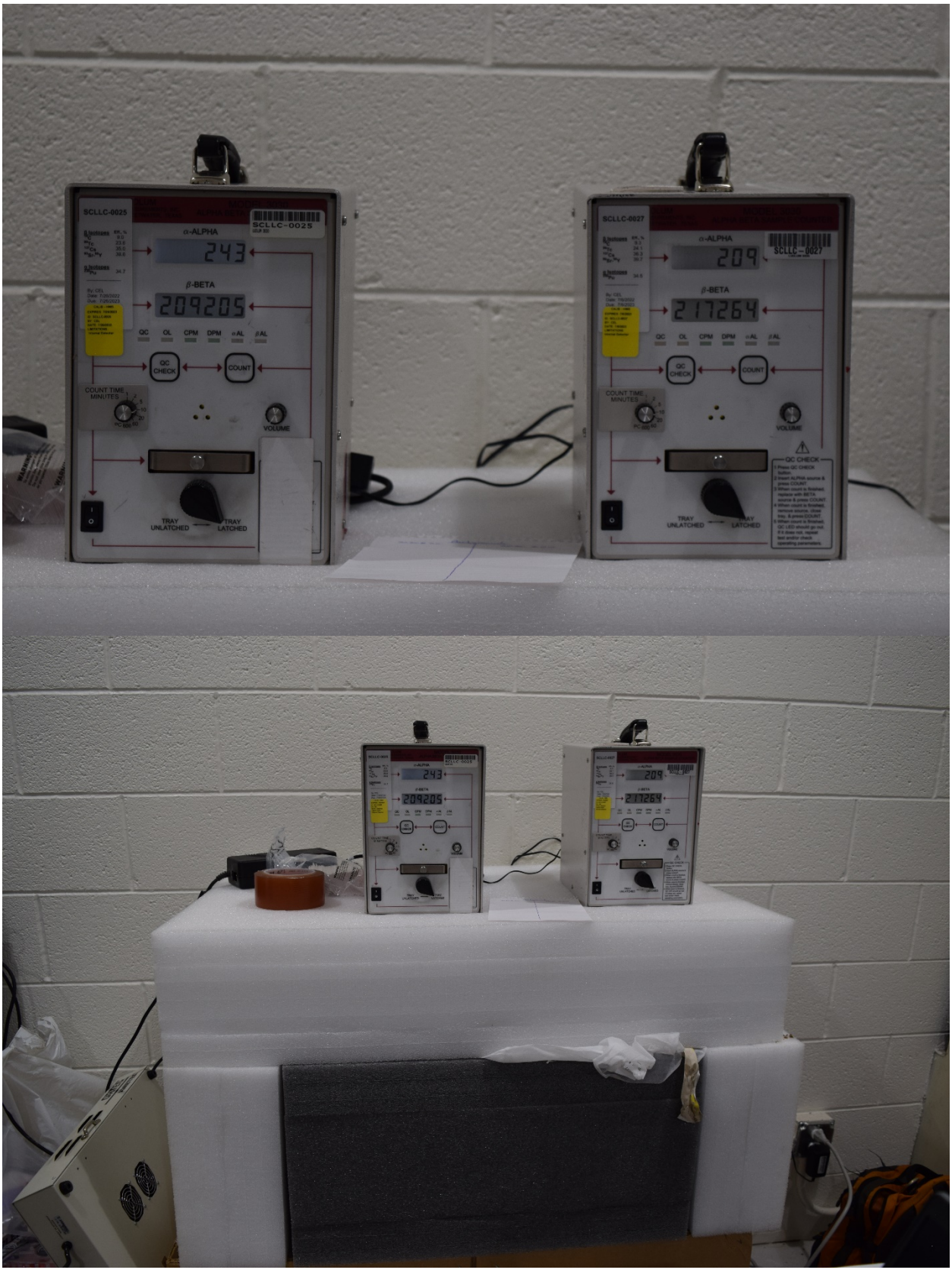
DOSIMETRY PLACED AROUND GODIVA



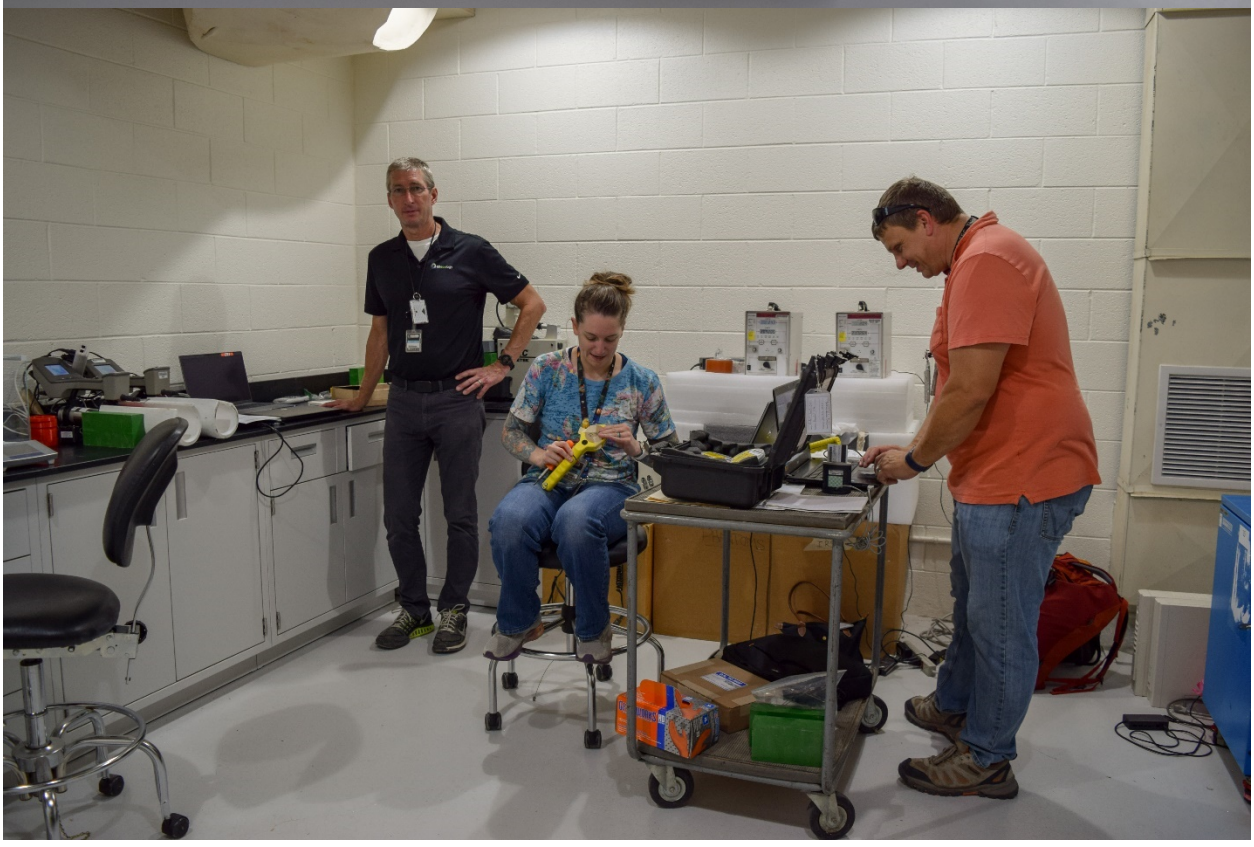
EQUIPMENT SETUP

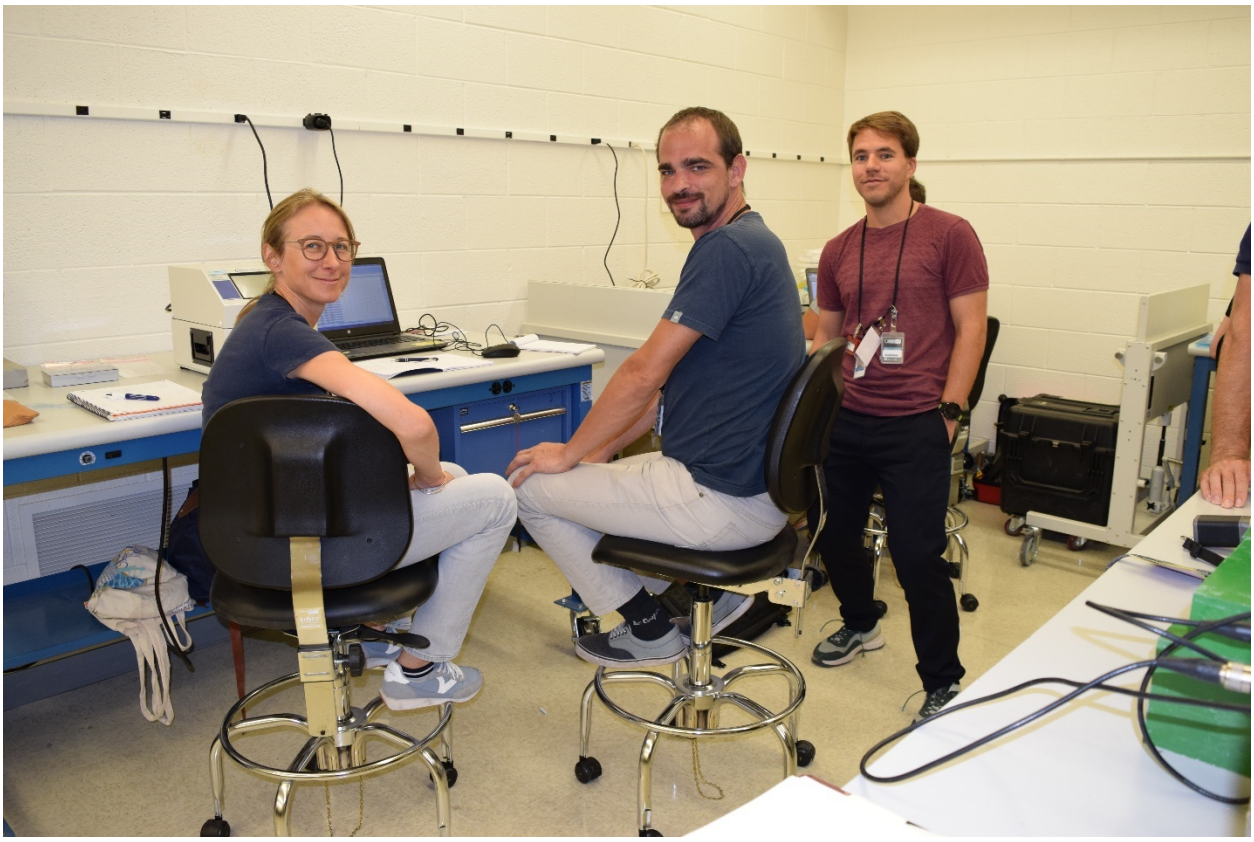

Sandia
National
Laboratories


Hanford
OSPREY
Hanford
Hanford

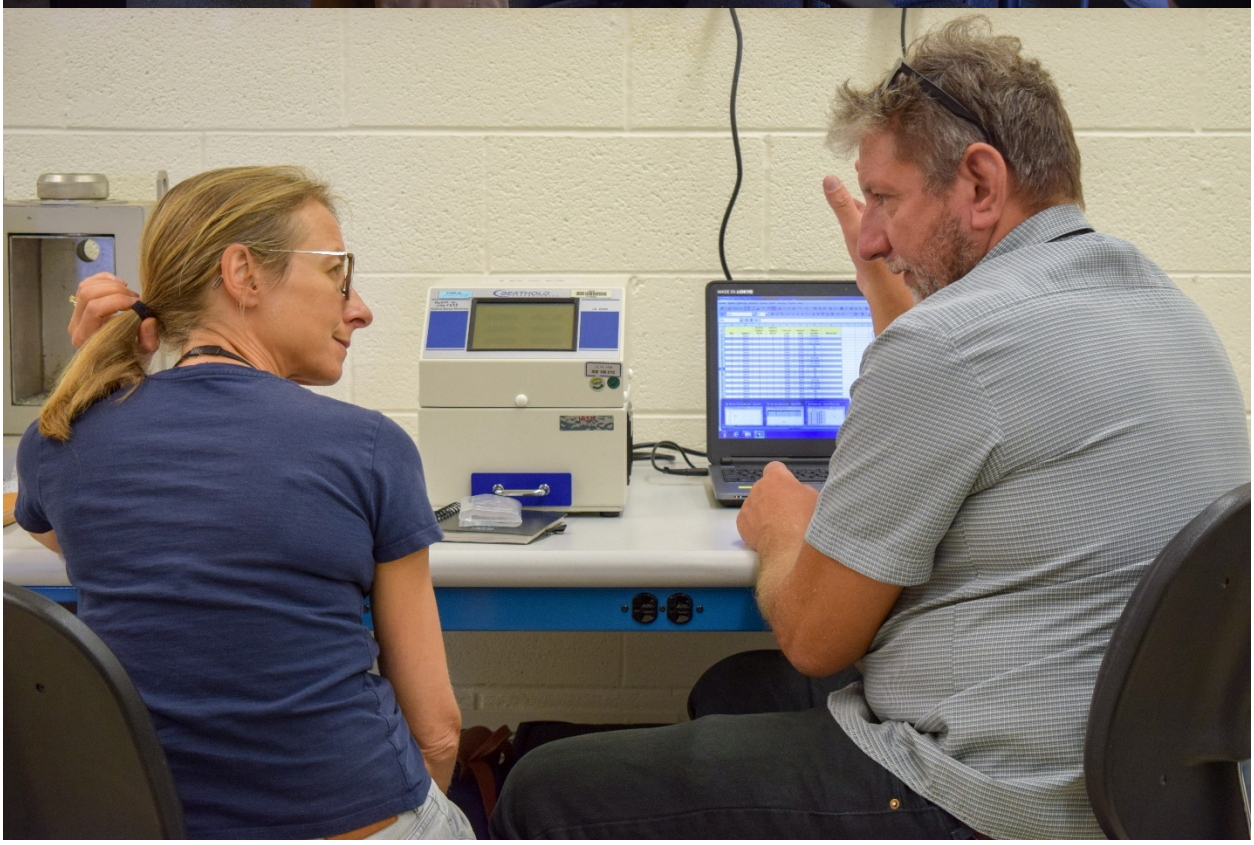

SCLLC-0025
α-ALPHA
243
β-BETA
209205
QC
OL
CPM
DPM
αAL
βAL
QC CHECK
COUNT
COUNT TIME MINUTES
VOLUME
TRAY UNLATCHED
TRAY LATCHED
SCLLC-0027
α-ALPHA
209
β-BETA
217264
QC
OL
CPM
DPM
αAL
βAL
QC CHECK
COUNT
COUNT TIME MINUTES
VOLUME
TRAY UNLATCHED
TRAY LATCHED
QC CHECK

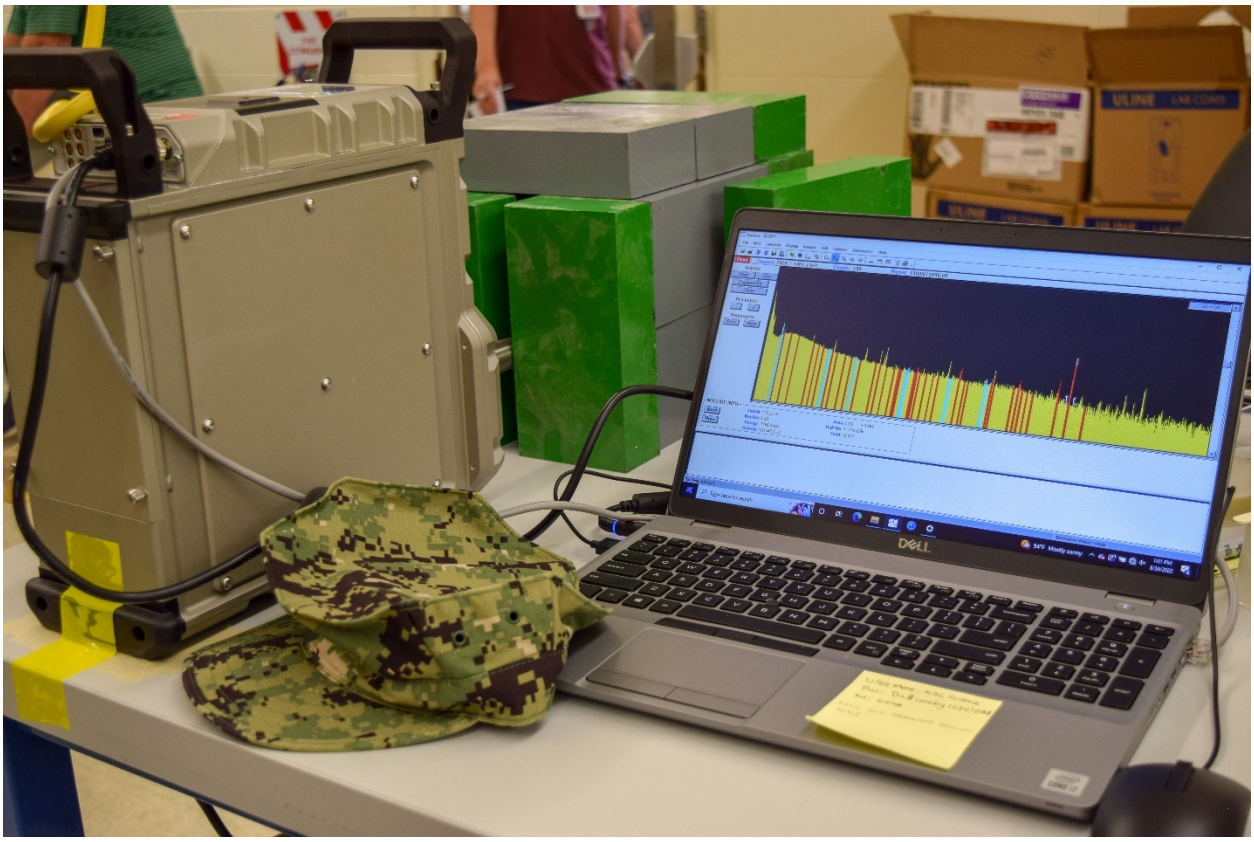

RI8,C CAL
SCINT TE
8

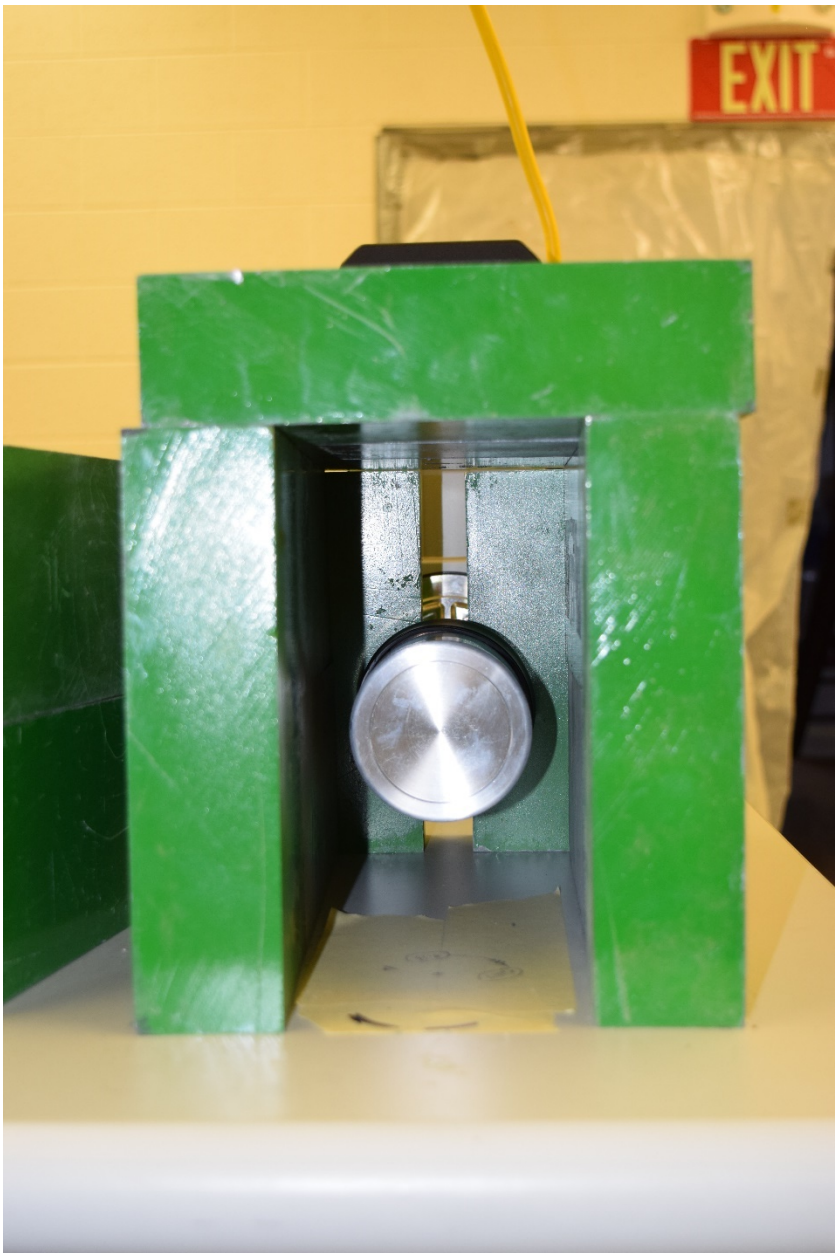


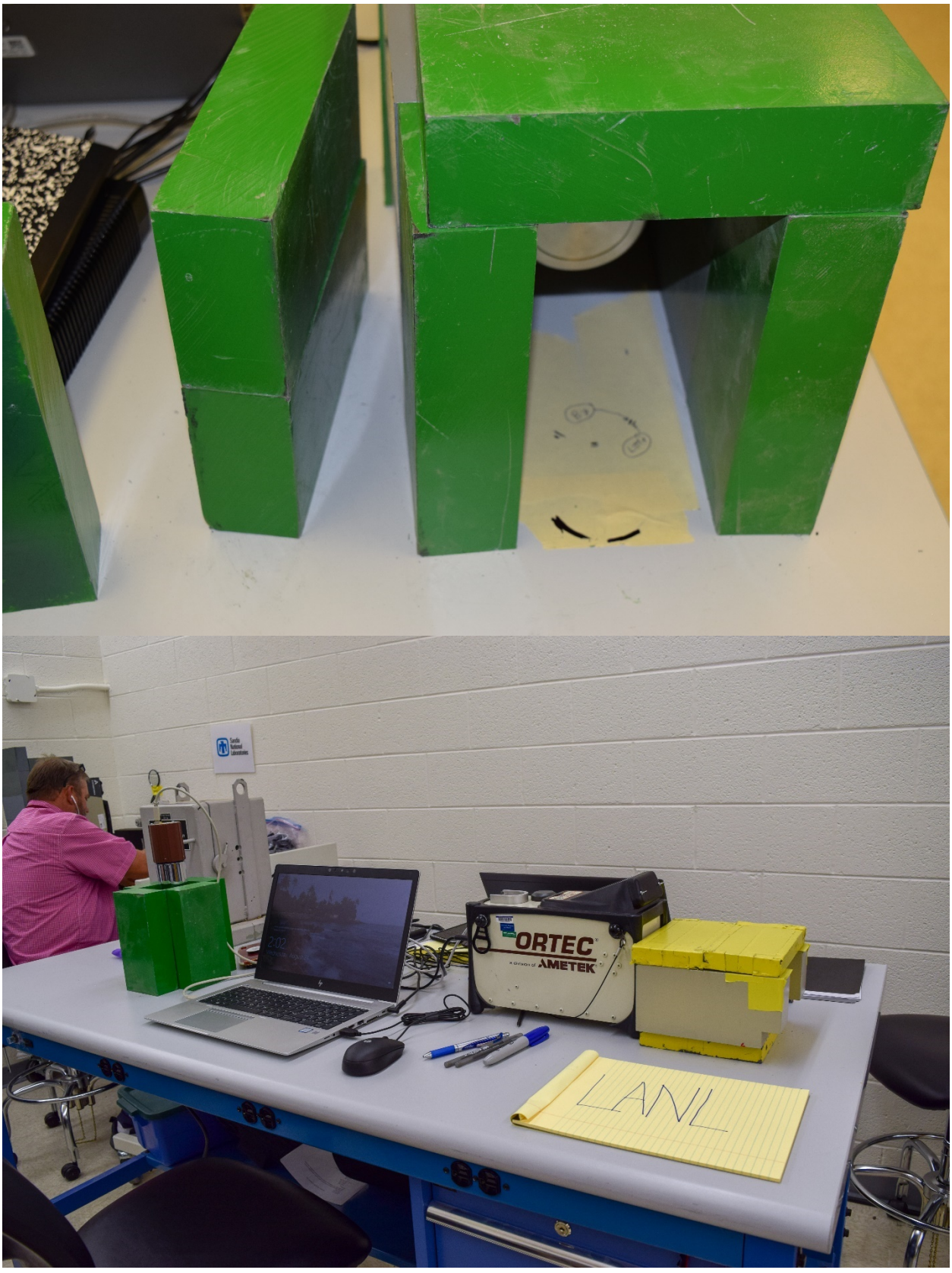


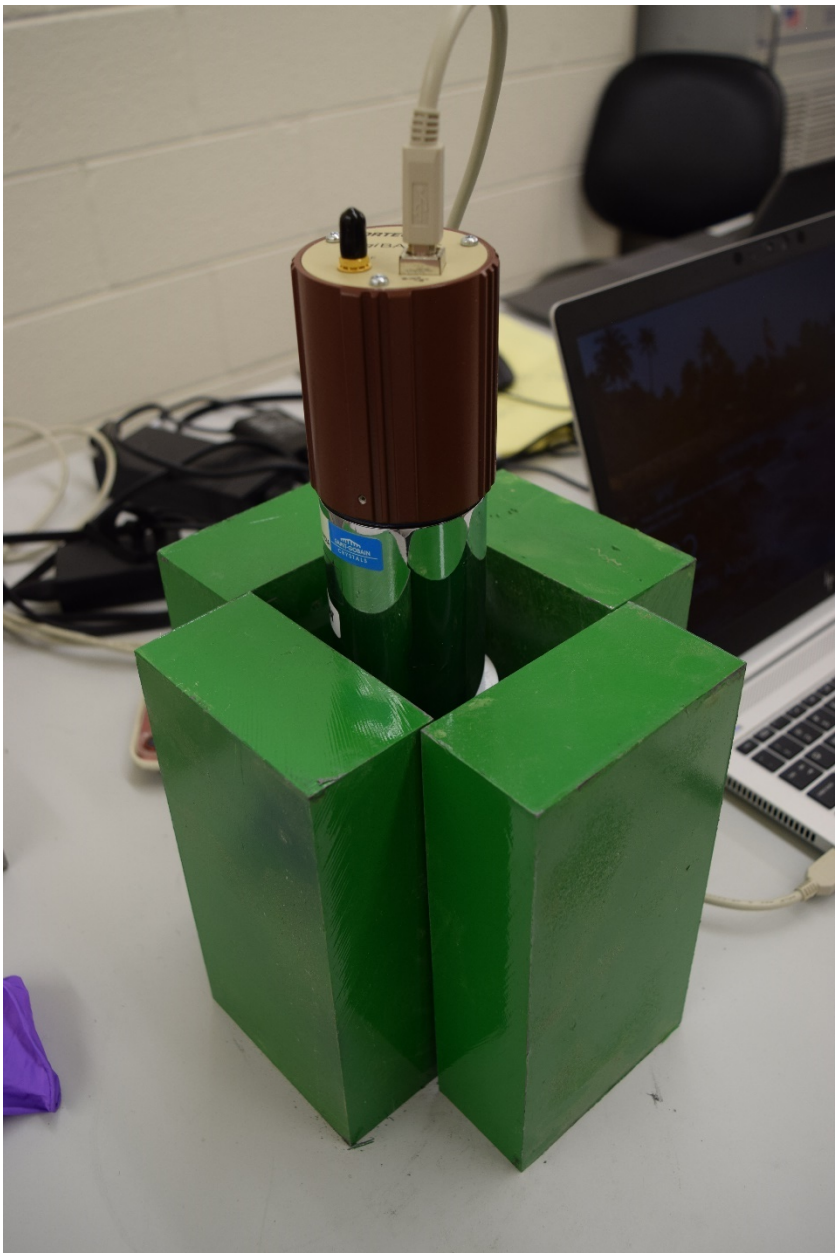

SERVICE DOG
DO NOT PET

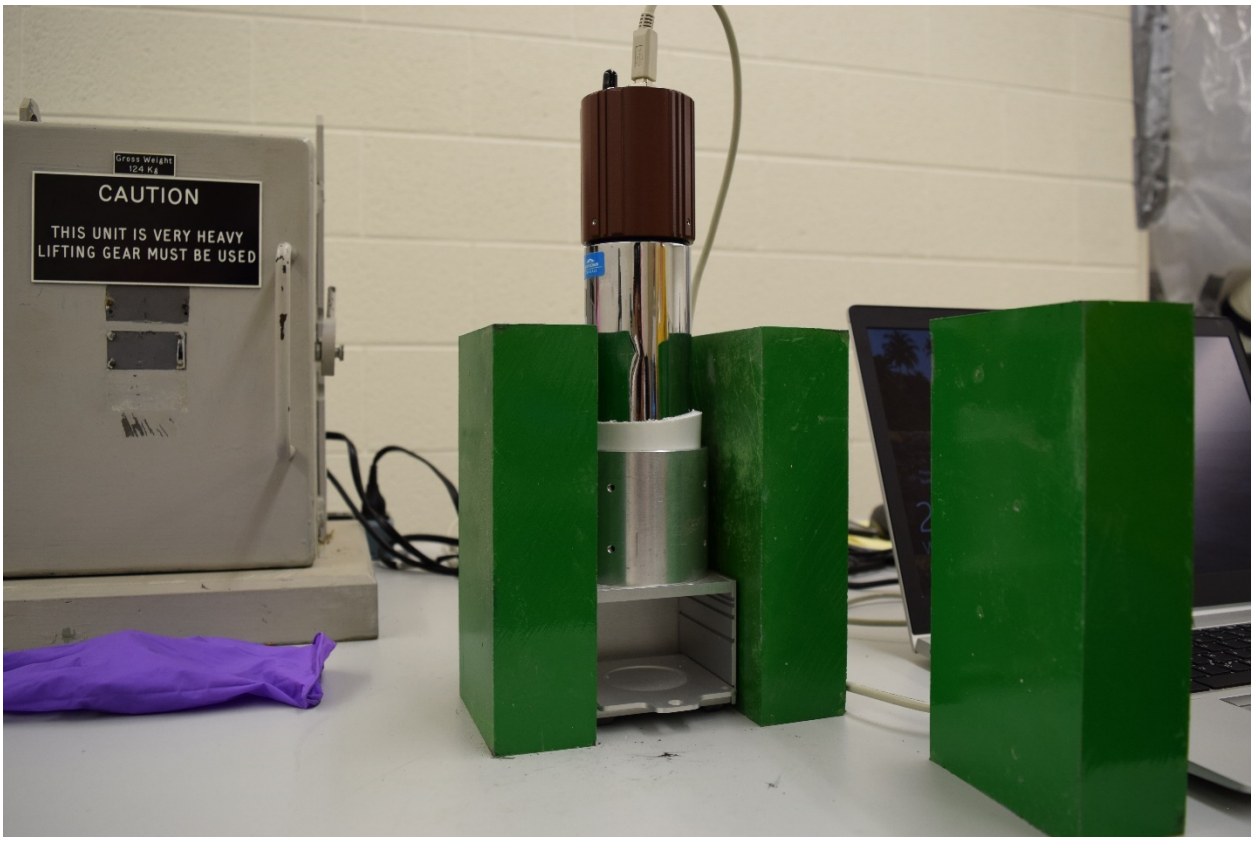


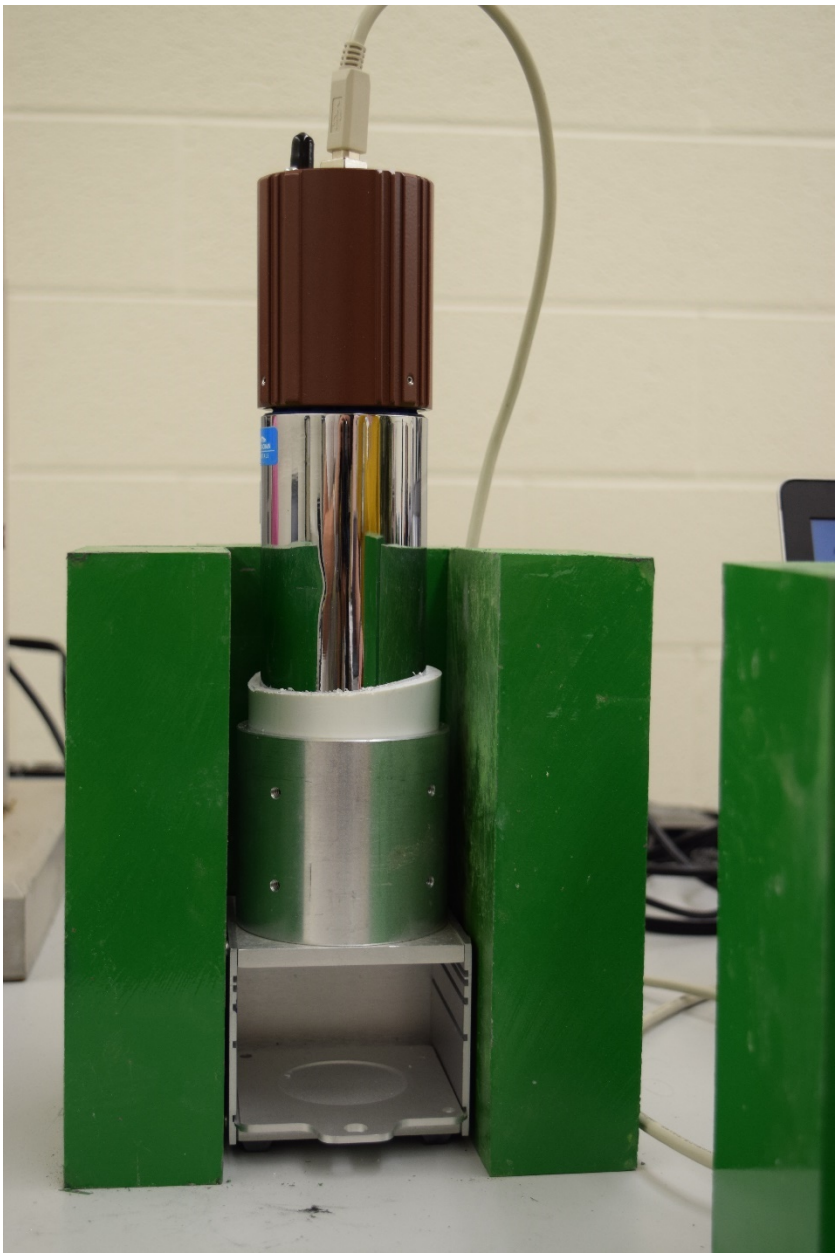

ULINE
DELL

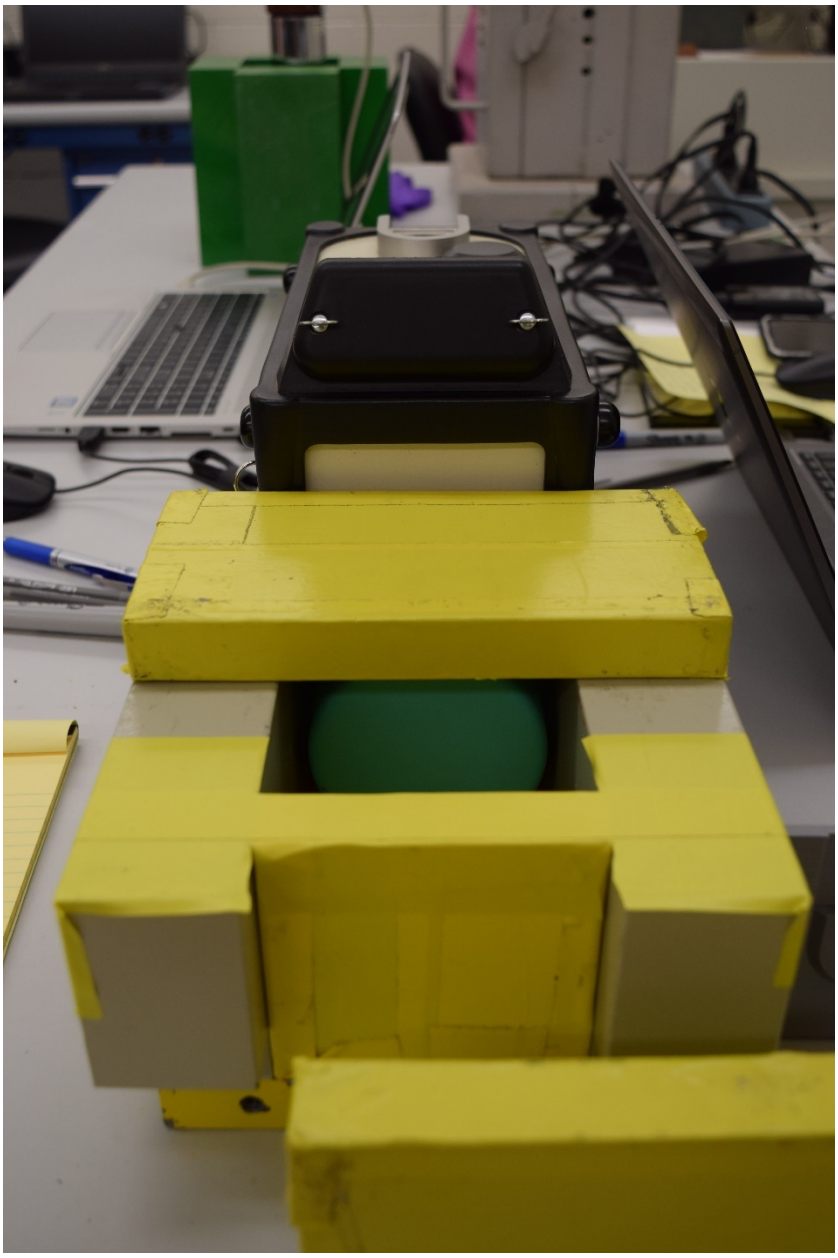

EXIT

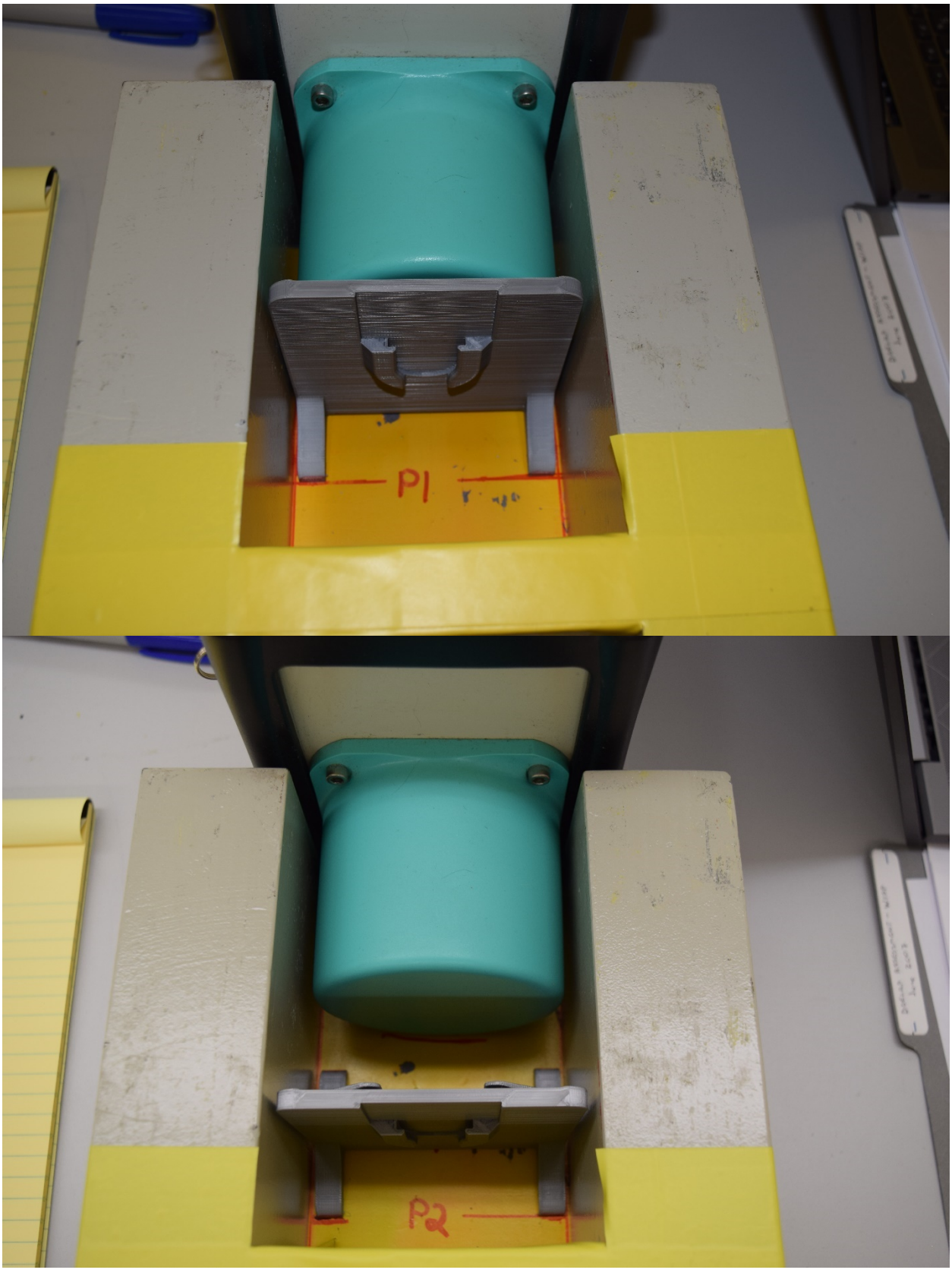

ORTEC
AMETEK
LANL



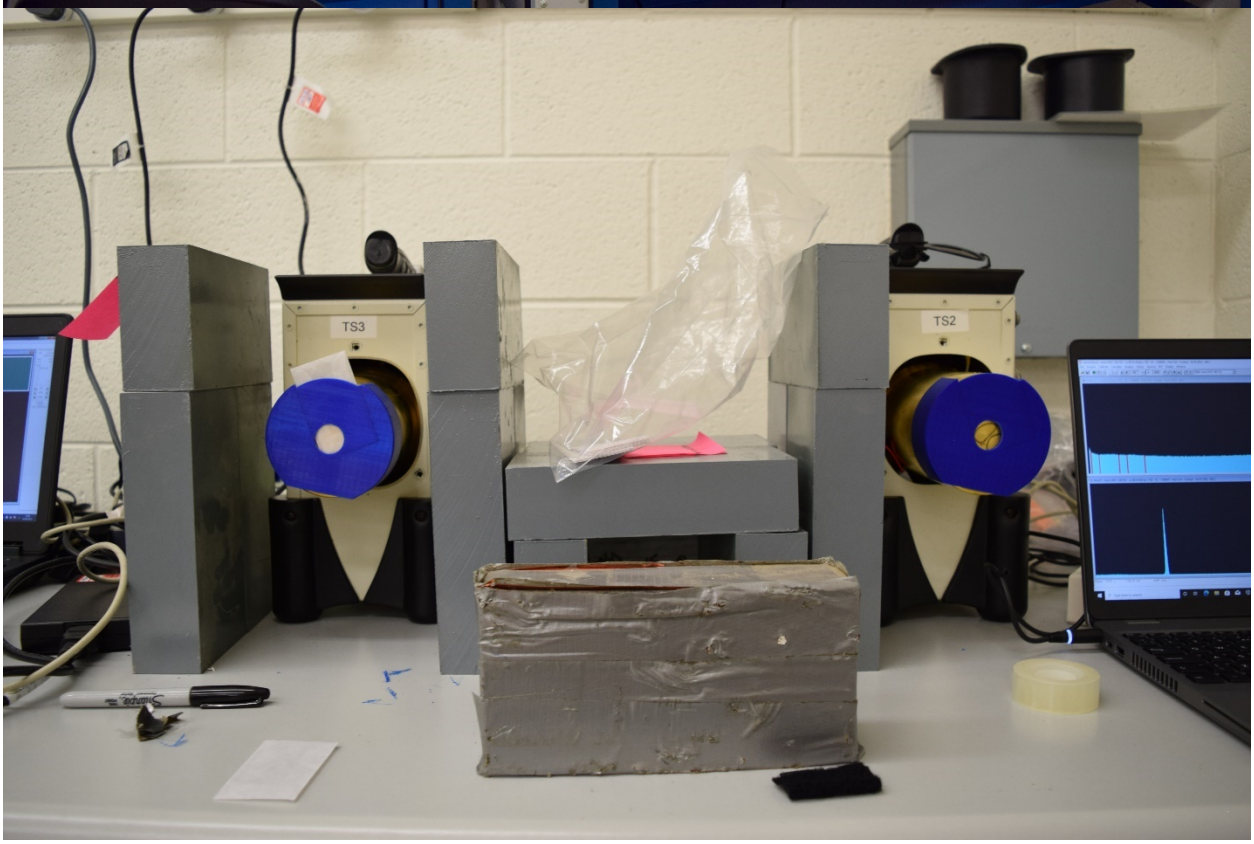

Gross Weight
124 Kg
CAUTION
THIS UNIT IS VERY HEAVY
LIFTING GEAR MUST BE USED

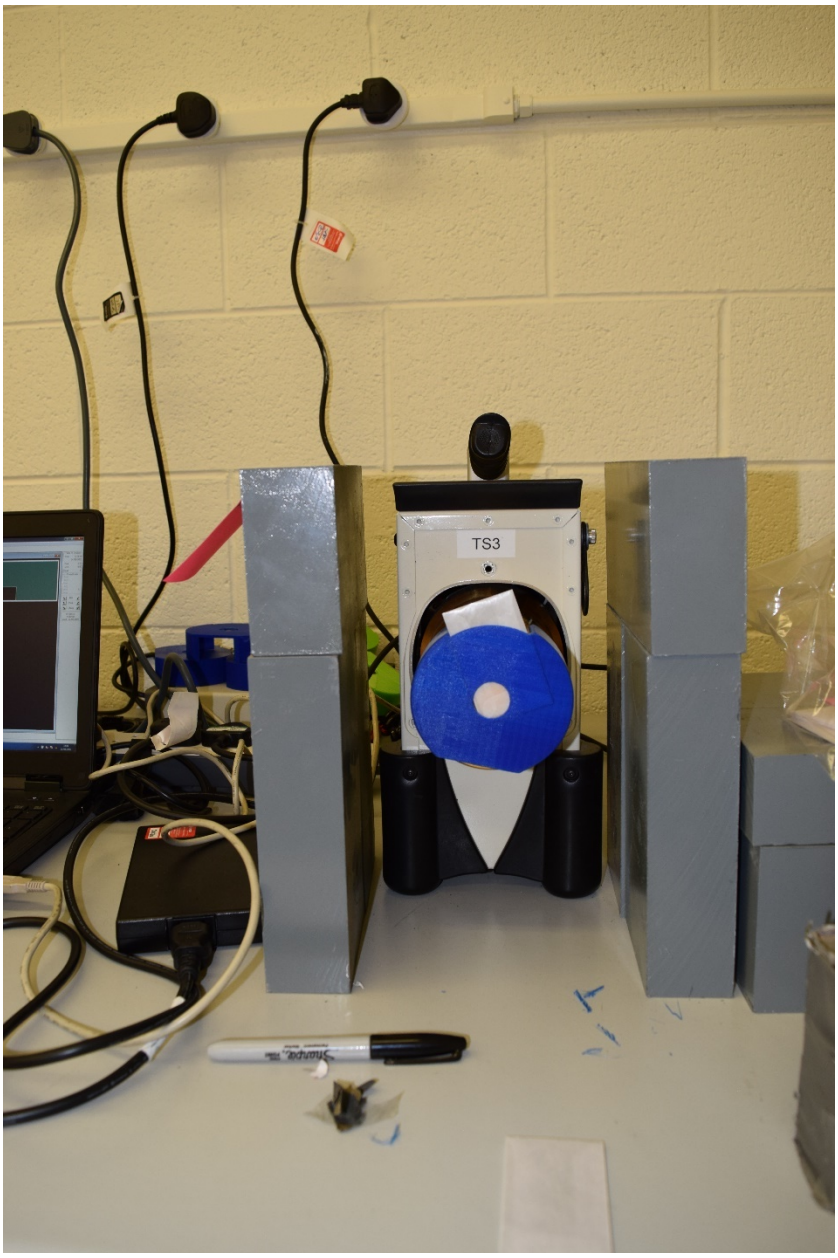


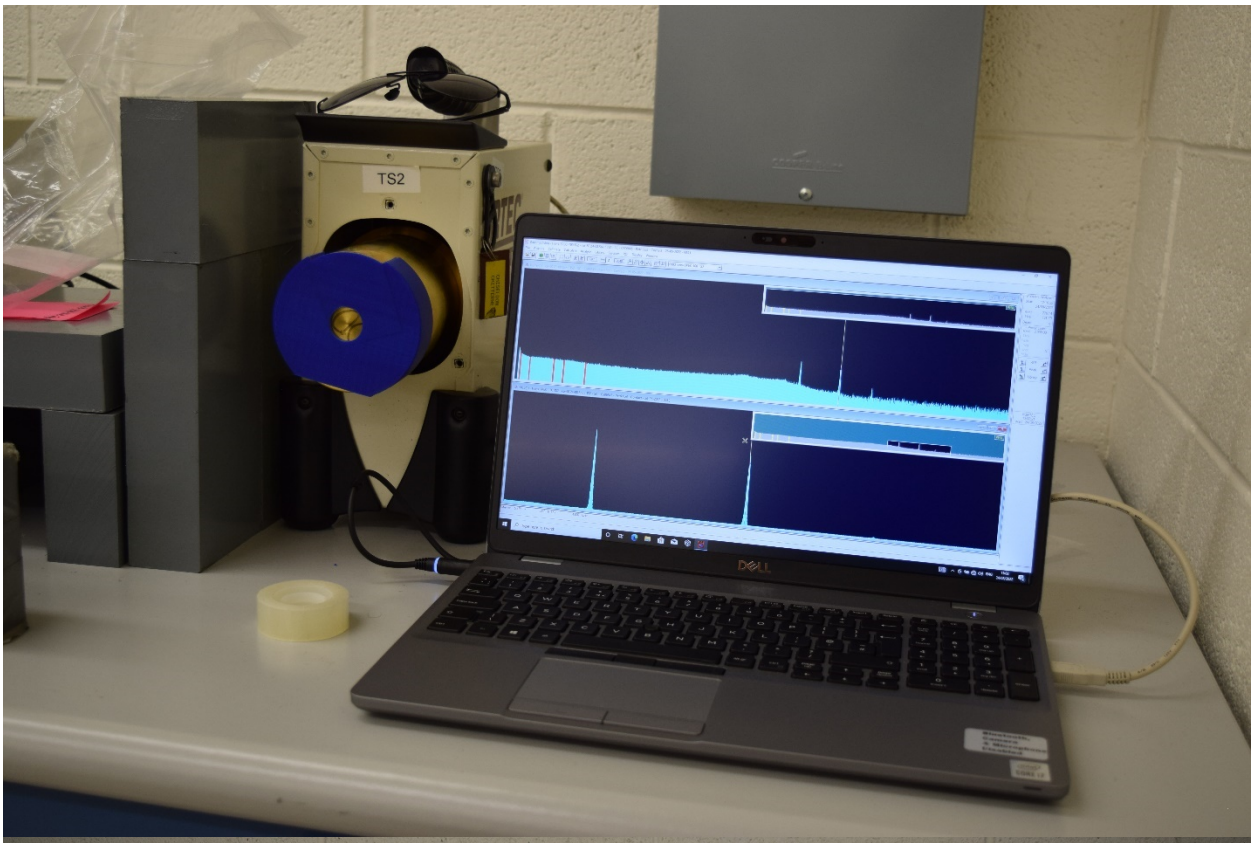



P1
P2


AWE


TS3
TS2

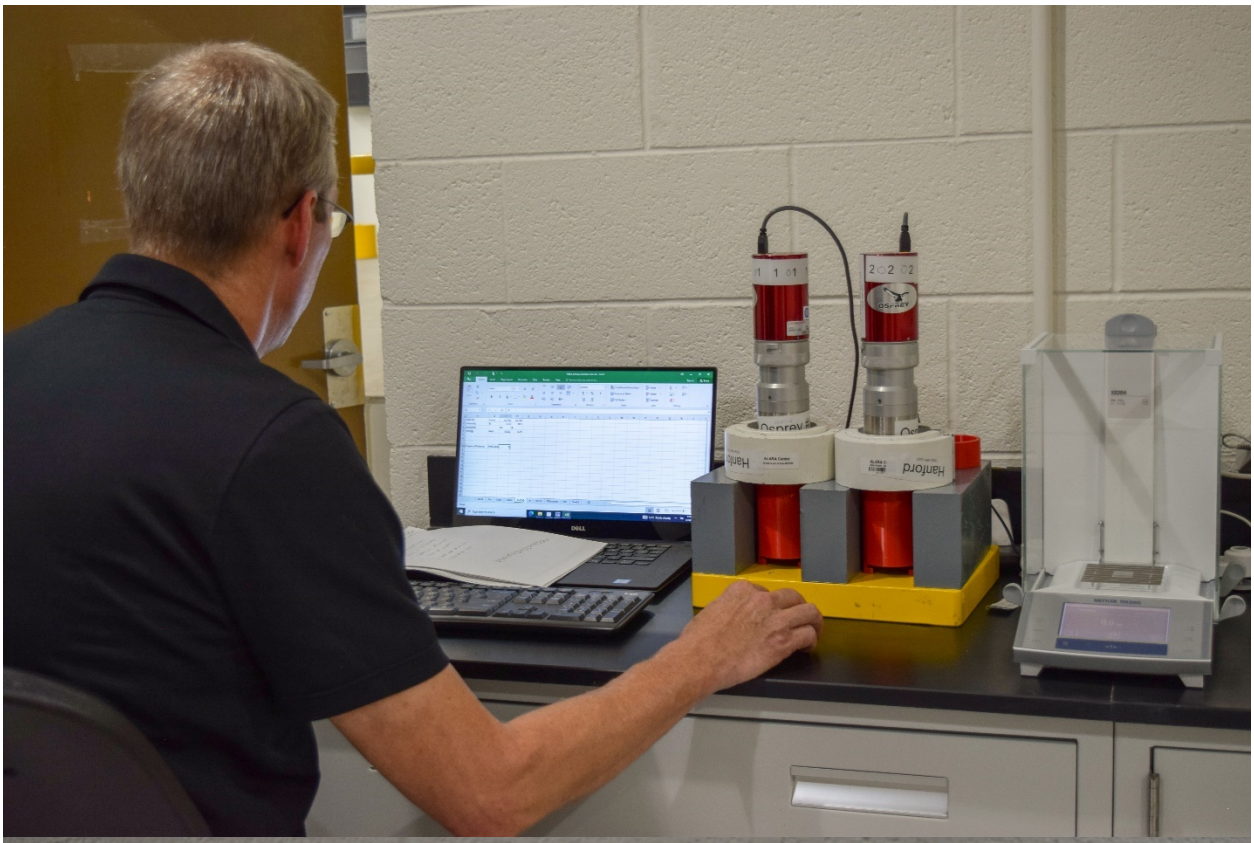

TS3


TS2

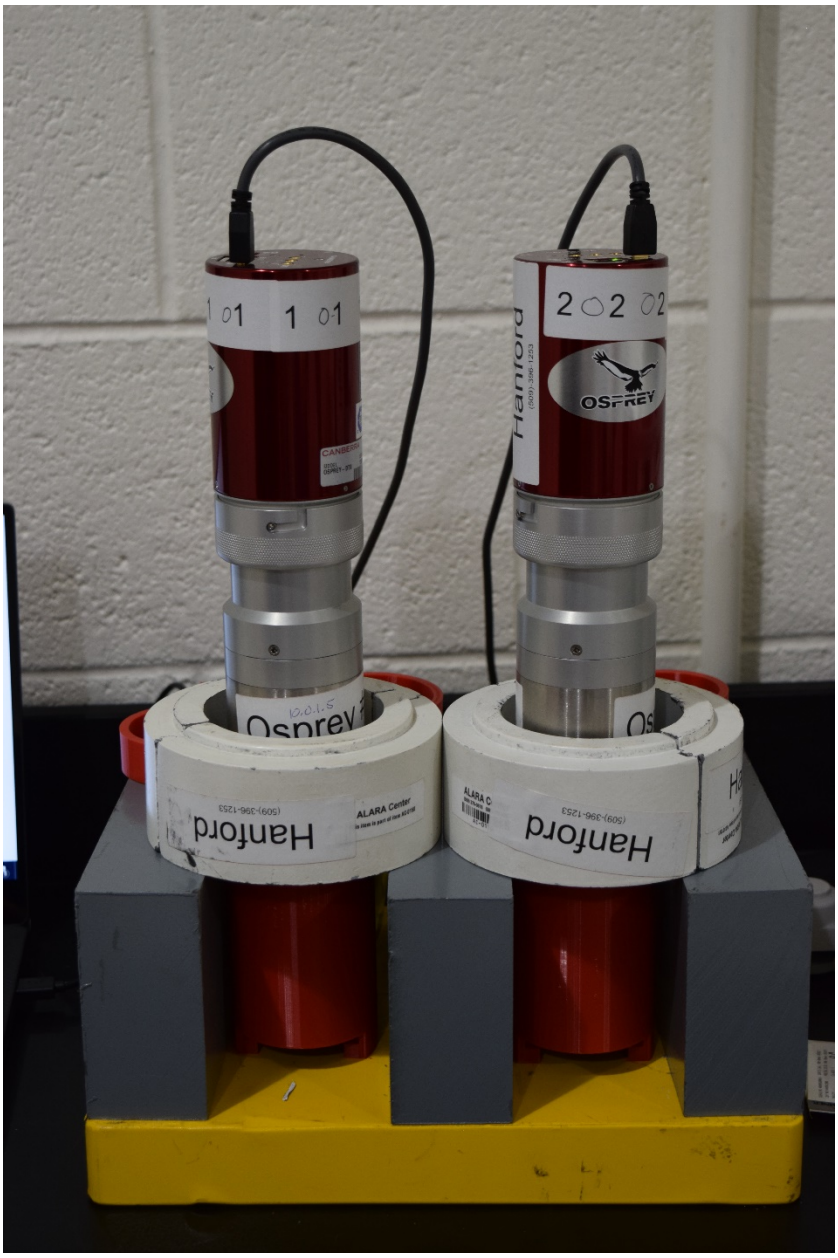

CANBERRA
CANBERRA
RECORD

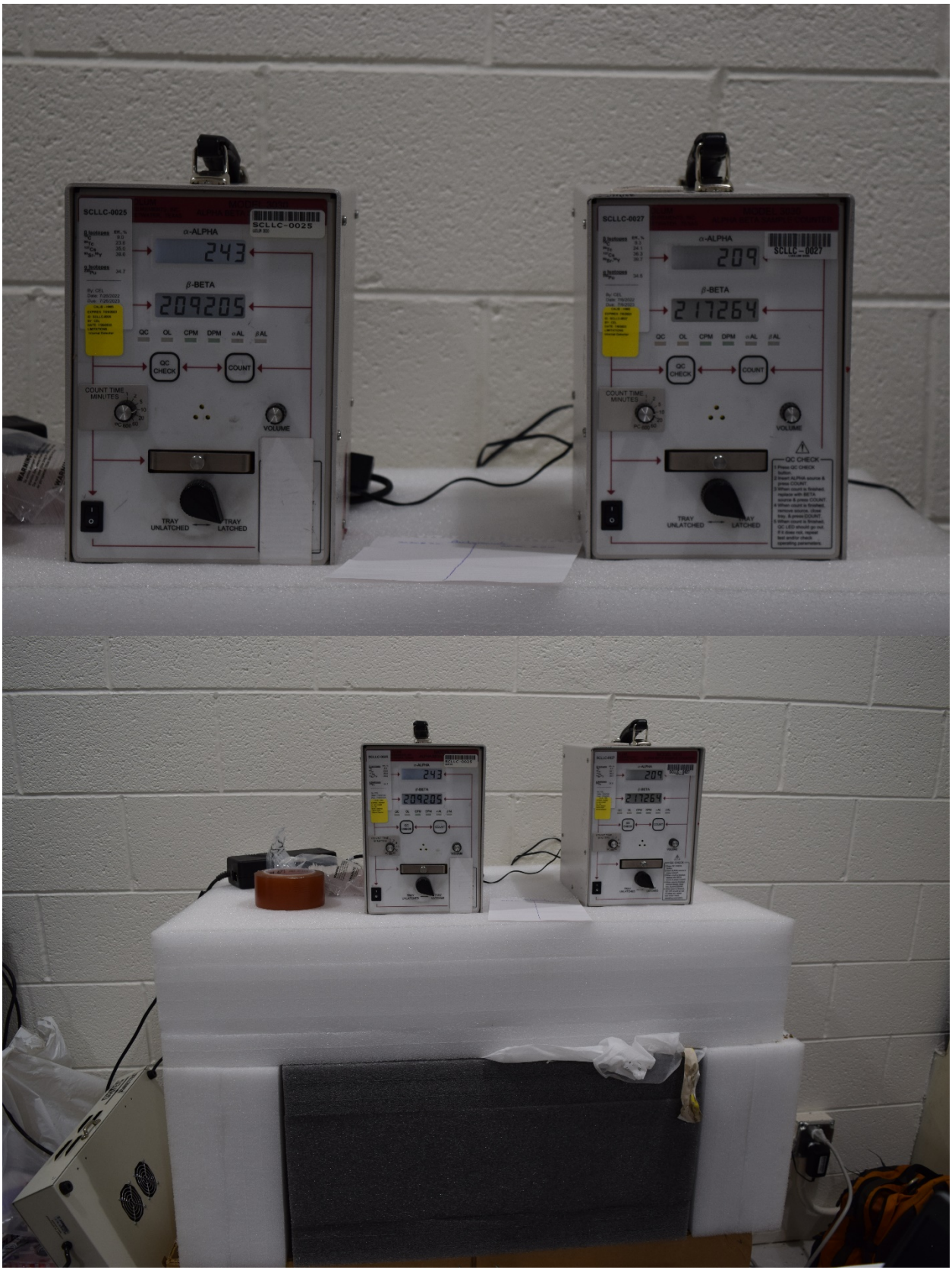

iSolo 20340
iSolo
CANBERRA
Remove Batteries
Prior to Transport
Am-241 AB8981
Sr/Y-90 AB8984


Protean Instrument
www.ProteanInstrument.Com
cpm
dpm
Alpha: 3.38
0.000
Beta: 1857.14
3698.066
Guard: 741.76
PCE: 0.80
Elapsed: 0.91 min
Remaining: 9.09 min Bias: 1140 V
Busy
01-693 LACD 10
EXIT




SCINT
8


Hanford
OSPREY
Hanford
Hanford


SCLLC-0025
α-ALPHA
243
β-BETA
209205
QC
OL
CPM
DPM
αAL
βAL
QC CHECK
COUNT
COUNT TIME MINUTES
VOLUME
TRAY UNLATCHED
TRAY LATCHED
SCLLC-0027
α-ALPHA
209
β-BETA
217264
QC CHECK
COUNT
COUNT TIME MINUTES
VOLUME
TRAY UNLATCHED
TRAY LATCHED

BOMAB PREPARATION


VERSI-DRY


UPPER TORSO
2-18-15-8
VELCRO
Minigrip


f3
Run1
f3
Run1

RECEIPT OF DOSIMETRY FROM THE DAF


XIT


SMC
RADIOACTIVE
UN2915

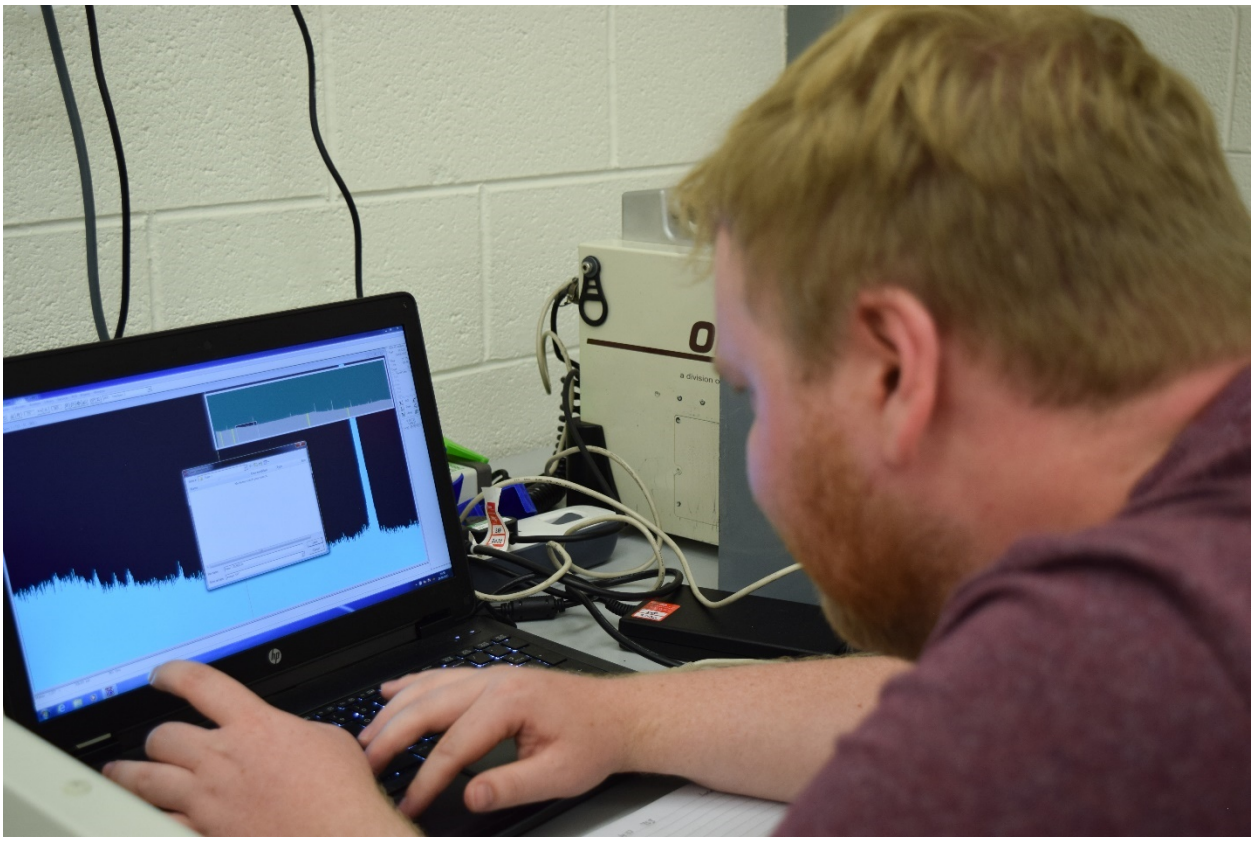

DOT 7A TYPE A
RADIOACTIVE MATERIAL
CAUTION
RADIOACTIVE
UN2915

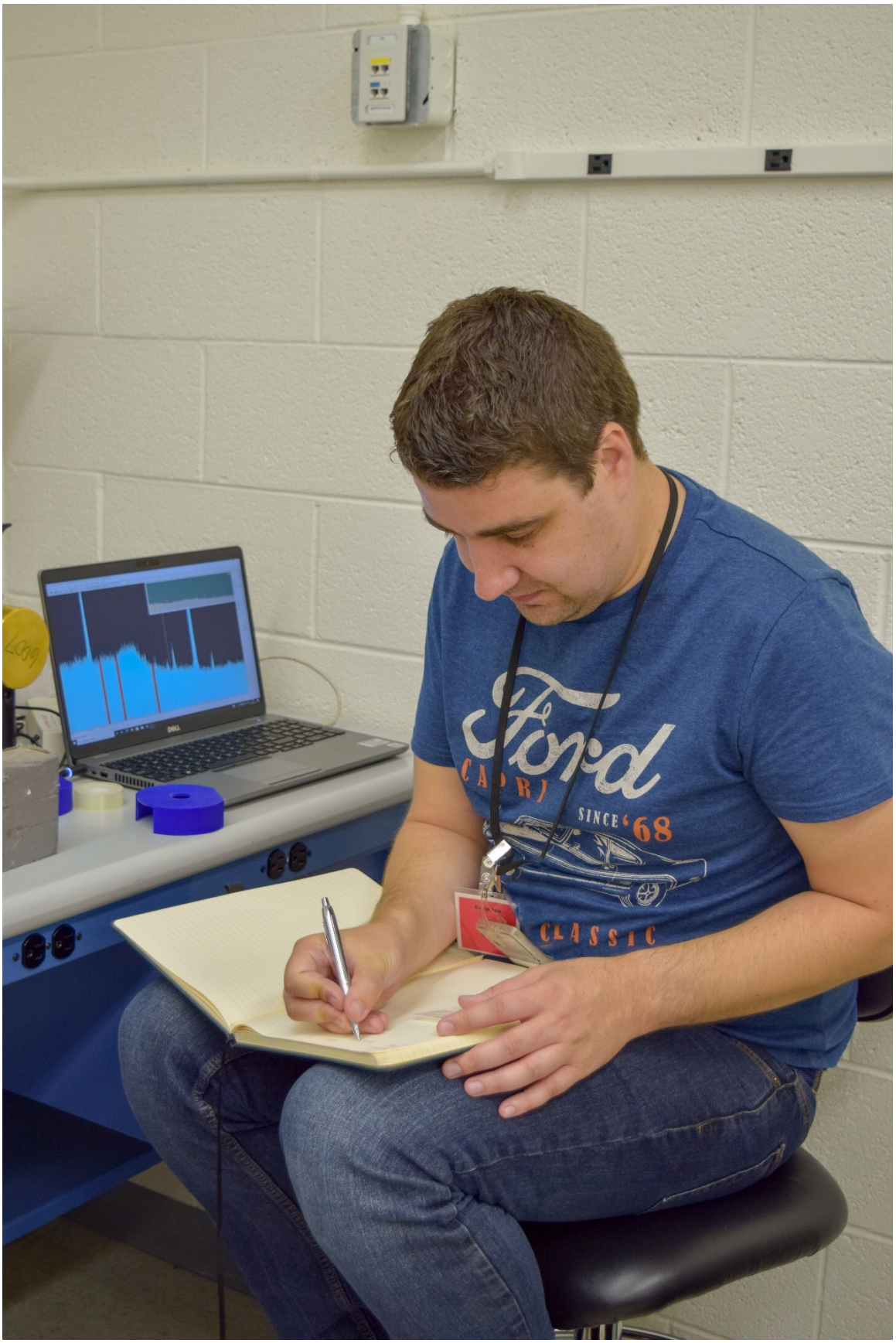

CAUTION
RADIOACTIVE
DOT 7A TYPE A

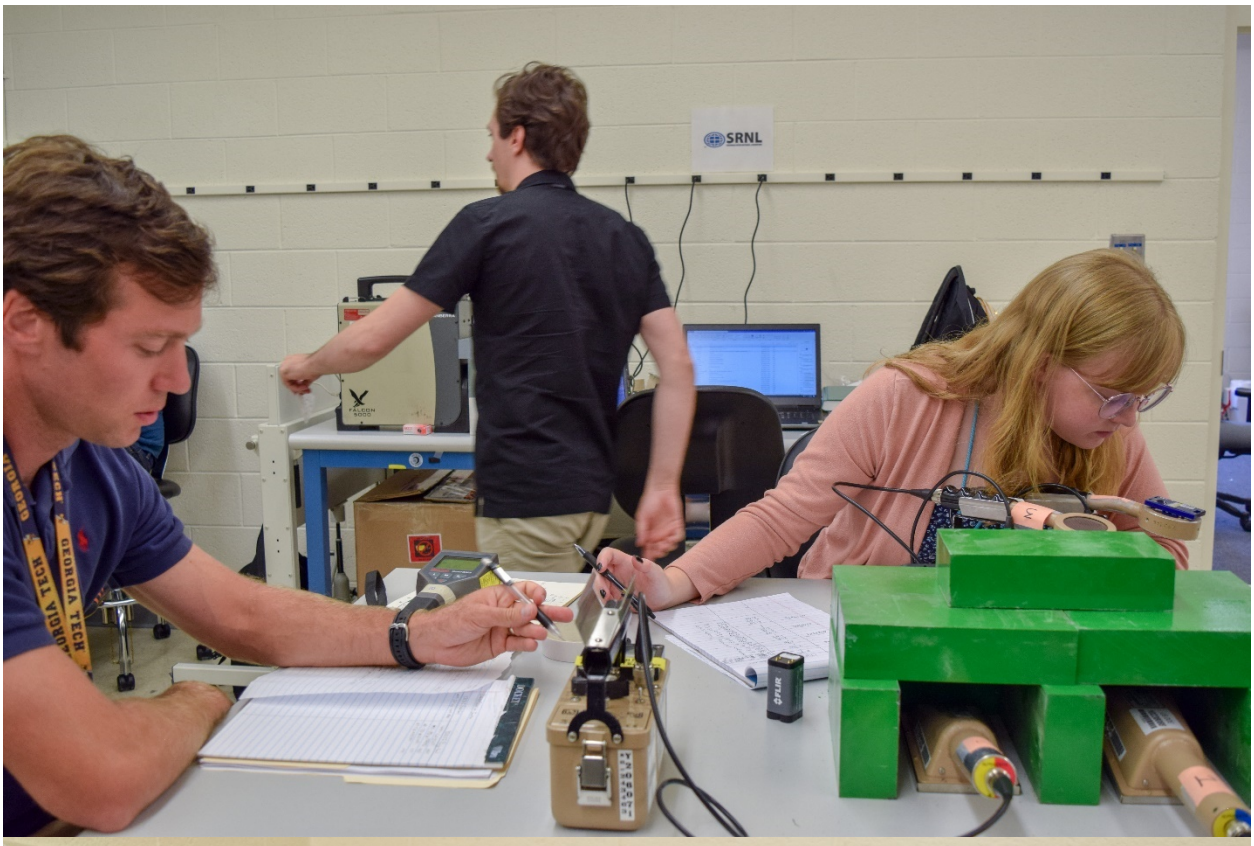

CAUTION
RADIOACTIVE MATERIAL

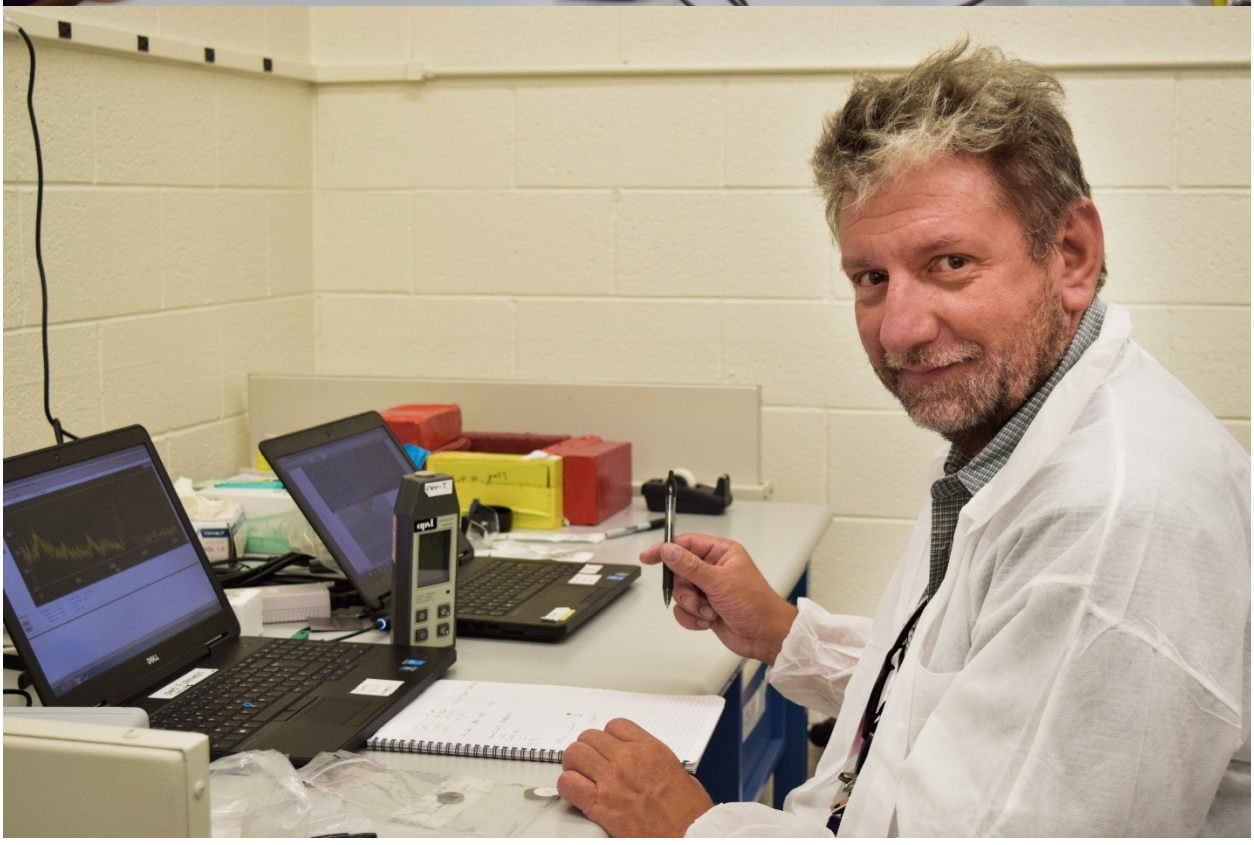

CAUTION
RADIOACTIVE MATERIAL

DOSIMETRY ANALYSIS BEGINS

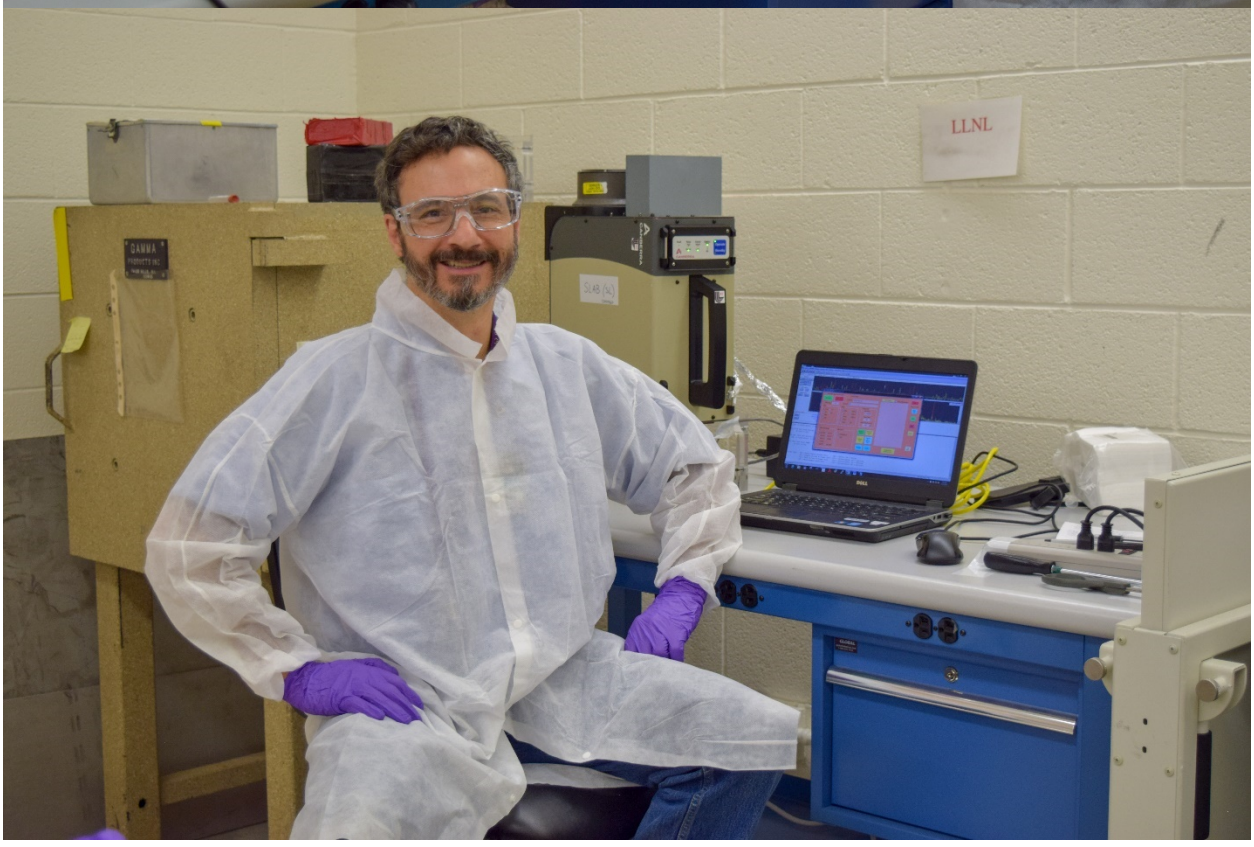


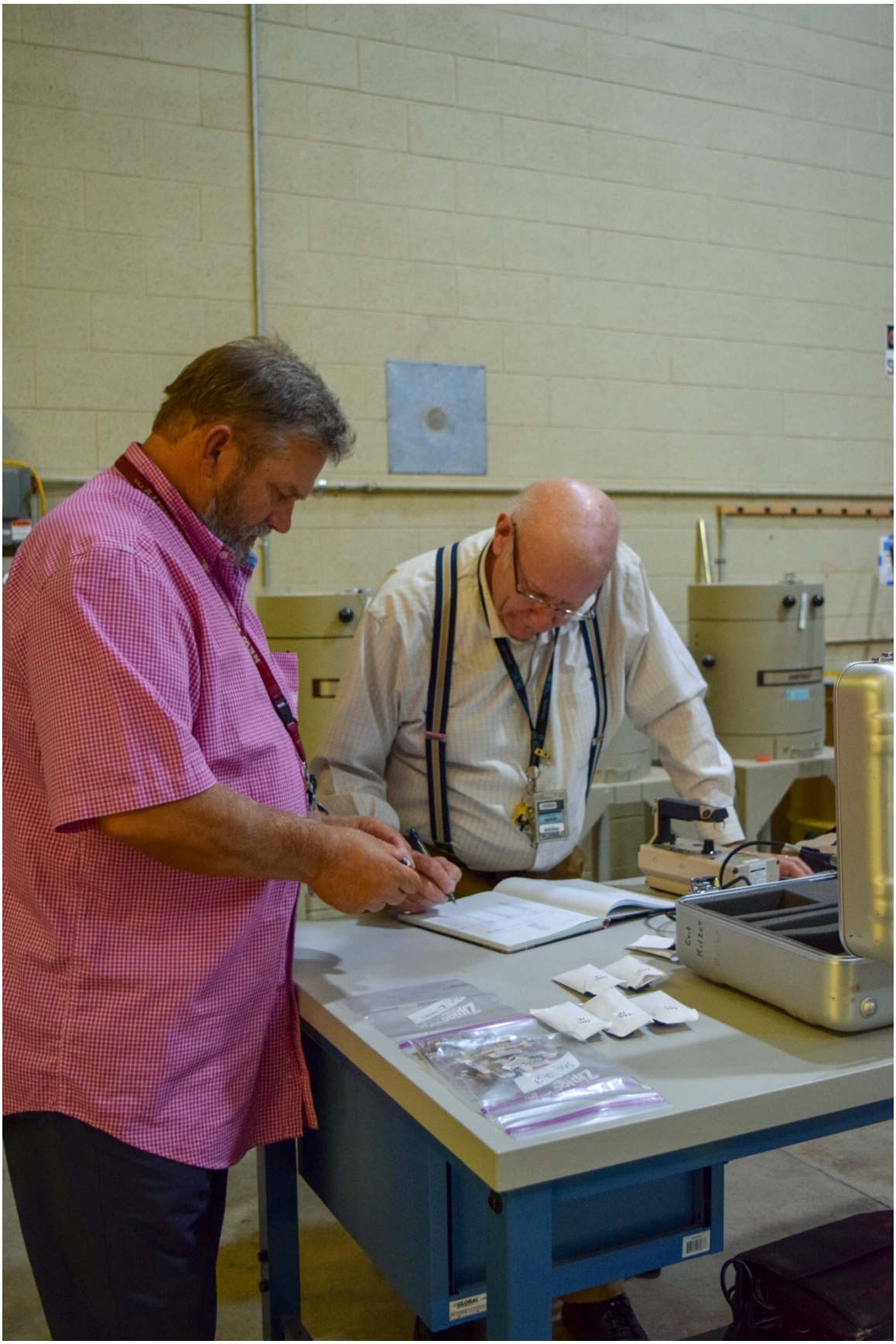

Ford
SINCE '68
CLASSIC


SRNL
GEORGIA TECH




EXIT


LLNL

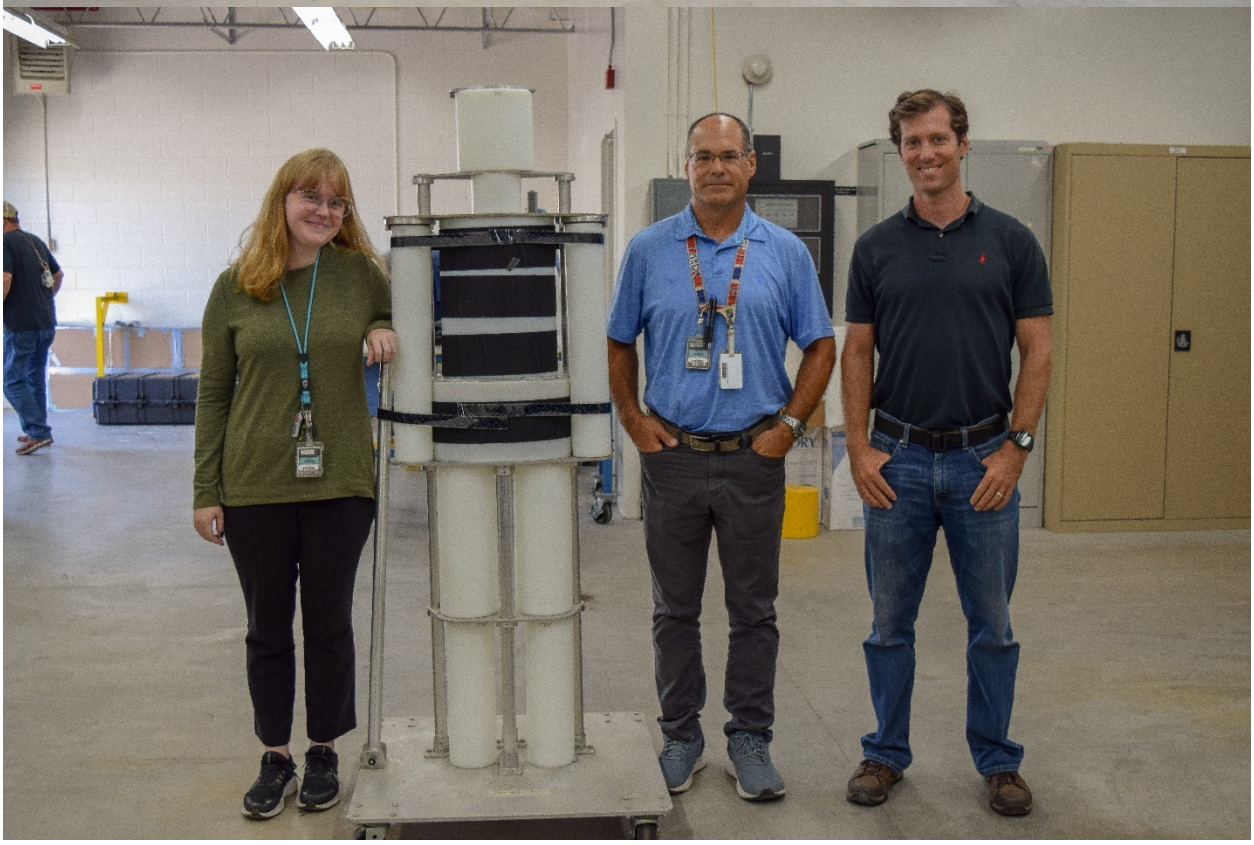



HANFORD


EXIT


X-ACTO

GROUP PHOTOS

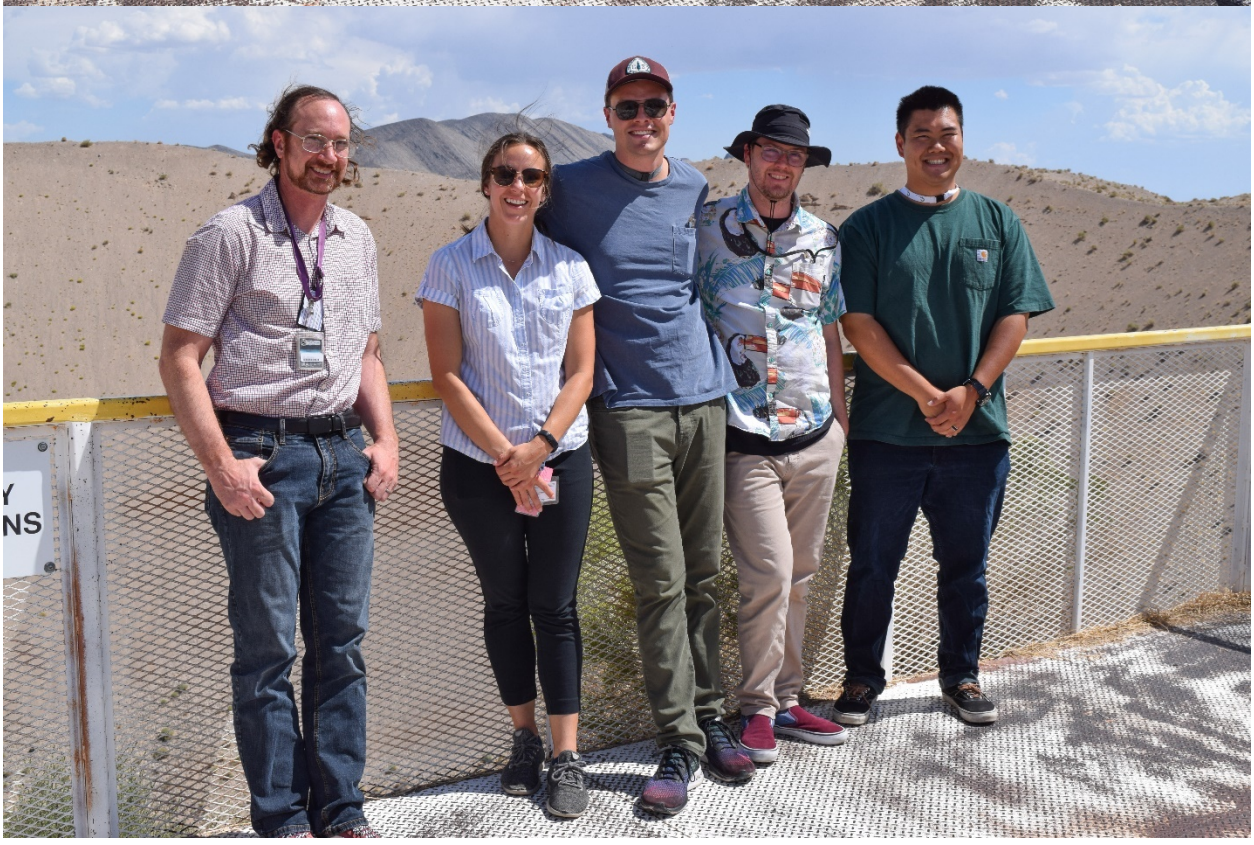



EXIT
DO NOT PET


EXIT

FIELD TRIP TO SEDAN CRATER AND GUN TURRET


LOAD
CAPACITY
50 PERSONS
MAX.
LOAD
CAPACITY
50 PERSONS
MAX.




LOAD
CAPACITY
50 PERSONS
MAX.


LOAD
CAPACITY
50 PERSONS
MAX.
LOAD
CAPACITY
50 PERSONS
MAX.


LOAD
CAPACITY
50 PERSONS
MAX.


RADIOACTIVITY LEVELS
1990
2010
THE SEDAN STORY
NNSS