Neutron Generators

Advanced Sensors and Instrumentation (ASI)

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Boise State University (MSE) and Idaho National Laboratory

April 13, 2023

Project Overview

Through the DOE-NE University Infrastructure program, Boise State University has access to two Thermo-Scientific P385 neutron generators.

- Valued at $230k
- Deuterium-Deuterium (D-D) head with 2.5 MeV neutrons
- Deuterium-Tritium (D-T) head with 14.1 MeV neutrons

End Goal: Operate neutron generators at BSU

Intermediate Goals:

- ✓ Understand the facility, licensing, and safety requirements for operating neutron generators on campus
- ✓ Amend BSU's current NRC license to include neutron generators
- ✓ Identify space on campus and funding for a neutron science lab
- ✓ Design shielding and safety framework to operate neutron generators
- Build a neutron science laboratory
- Add analytical equipment
- Do neutron science!

Technology Impact

- Support programs such as ASI and AMMT by providing neutron irradiation to screen nuclear-relevant materials, sensors and equipment.
  - Rapid, low-cost testing allows for design iteration before reactor studies
  - Flexible experimental set up for in-situ testing and post-testing characterization

- Grow the next generation of nuclear scientists by providing hands-on experiences with neutron physics, health physics, radiological materials handling, etc.
  - Enhance coursework across multiple disciplines
  - Enhance research for students across Idaho and the NSUF network

- Stakeholders: DOE, INL, NEUP, NSUF, BSU

Project Timeline

2018

- Neutron generators are available to BSU through the DOE-NE University Infrastructure program
- Neutron Detectors is written into the Nuclear Instrumentation work package of I2

2019

- BSU researchers travel to University of Michigan's Neutron Science Lab to discuss facility design
- Campus leadership identifies a potential location for a Neutron Sciences Lab at BSU
- Initial shielding modeling via MCNP
- BSU submits initial NRC license amendment request for storing neutron generators

2020

- Continued efforts to identify a lab location on campus and model effective shielding
- BSU submits NEUP CINR GSI proposal to build shielding for neutron lab – not awarded

2021

- NRC approves license amendment for storing neutron generators
- BSU agrees to fund lab build out and shielding in Micron Center for Materials Research

2022 -

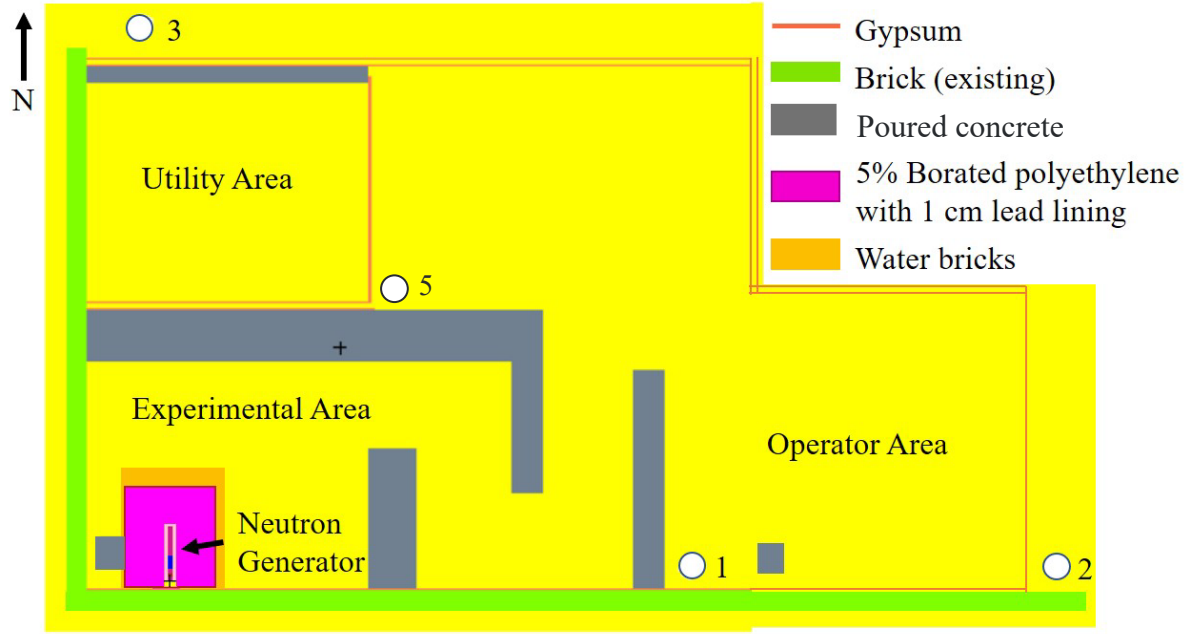
- Construction on Neutron Sciences Laboratory begins
- BSU submitted NEUP CINR GSI proposal to equip the Neutron Sciences Laboratory

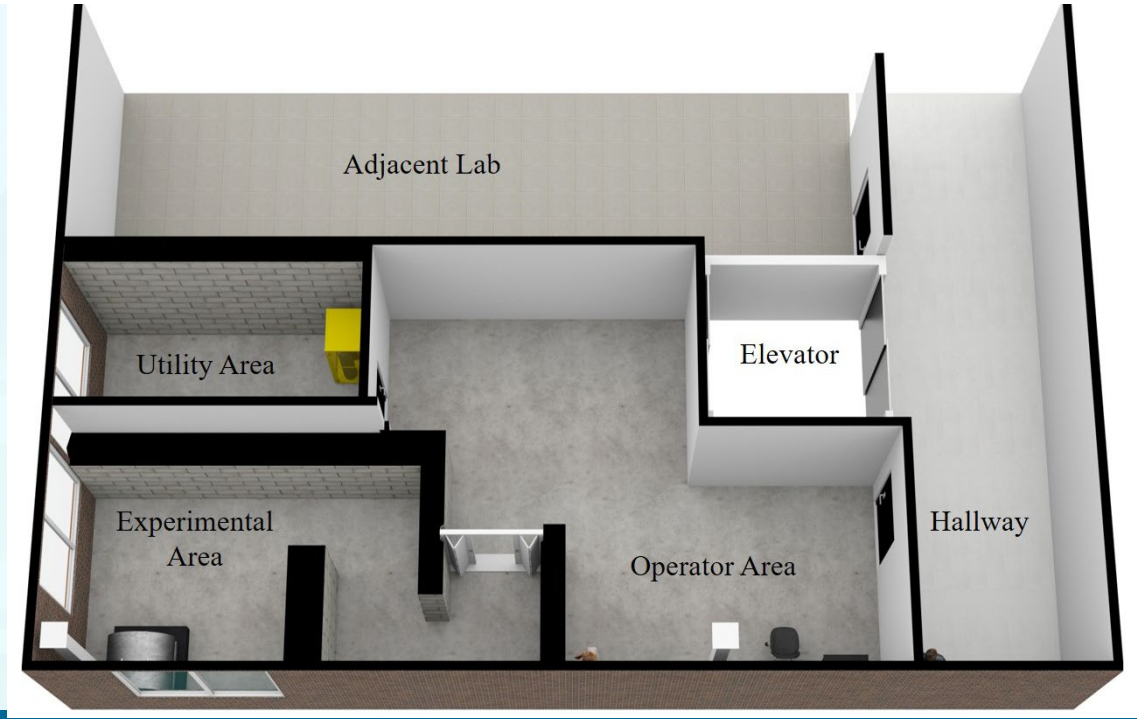
Results and Accomplishments

In FY22:

- Boise State designated a lab space on the 3rd floor of the Micron Center for Materials Research for a Neutron Sciences Lab, committing $879k to finish the lab space and build shielding.
- Iterated shielding designs with architecture and construction teams
- Currently in final stages of pre-construction

Tally location	Dosage rate (mrem/hr)	NRC limit (mrem)	Allowable operator time (hrs/year)
1. Operator 1	5.792	5000	863
2. Non-worker hallway	0.234	100	427
3. Non-worker adjacent	1.068	100	94
4. Non-worker below	0.794	100	126
5. Operator 2	34.979	5000	143





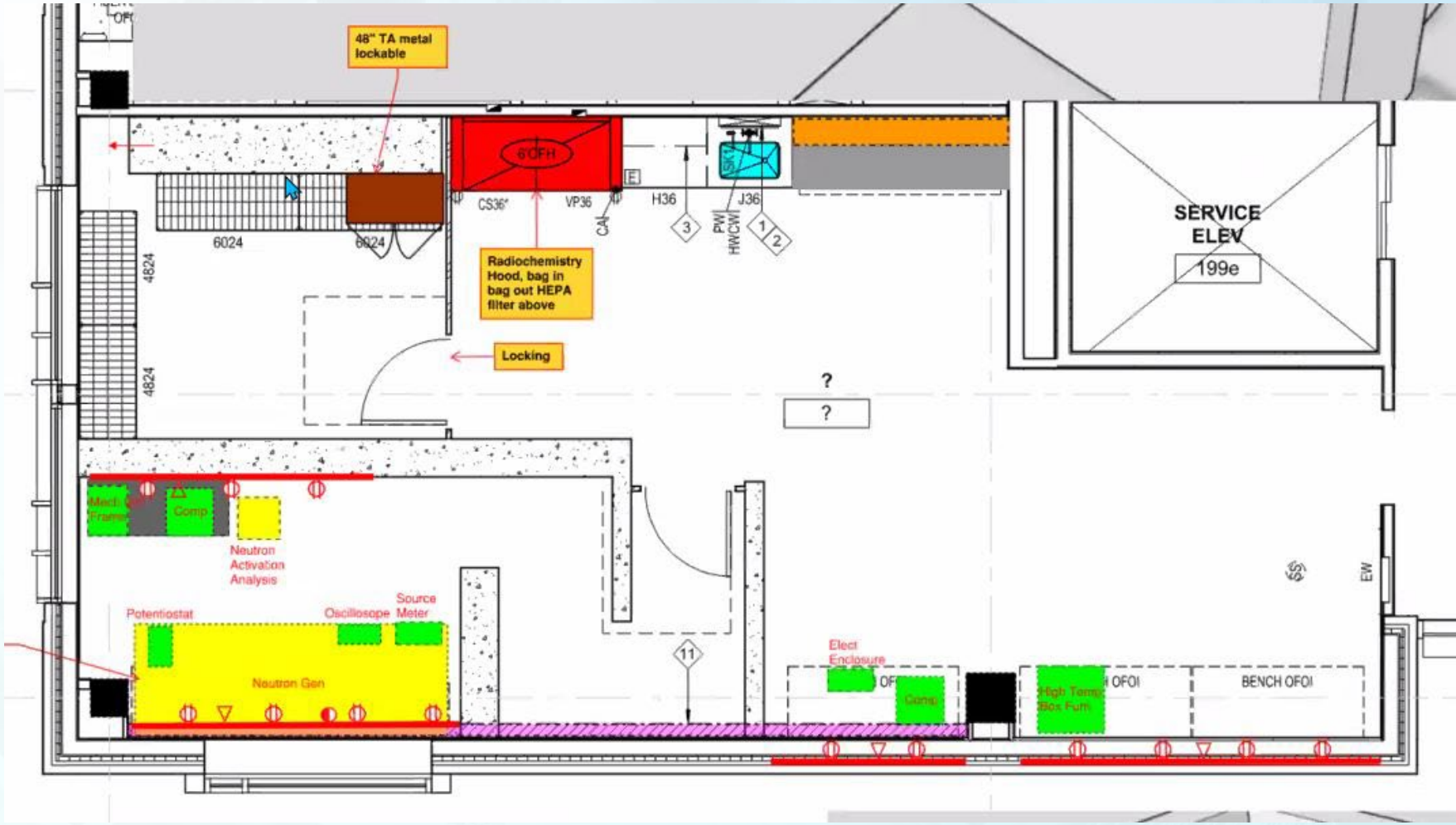
Results and Accomplishments

Final construction drawings

- Expected construction completion: Summer 2024

Included equipment:

- Secure storage and “cooling” area for neutron generators and activated samples
- Radiological fume hood
- Security equipment including locks and cameras



Results and Accomplishments

Ongoing & Pending Accomplishments:

Submitted NEUP CINR GSI for $248k in analytical equipment:

- Neutron activation analysis
- Mechanical test frame
- High temperature box furnace
- Oscilliscope
- Potentiostat
- Source & LCR meters

Submitted October 2022

Working with INL to transfer neutron generators to Boise State

- NRC license is approved
- Kort Bowman on INL side
- Brenden Heidrich on DOE-NE/NSUF side
- Confirmation on April 7, 2023 that transfer is “very close”

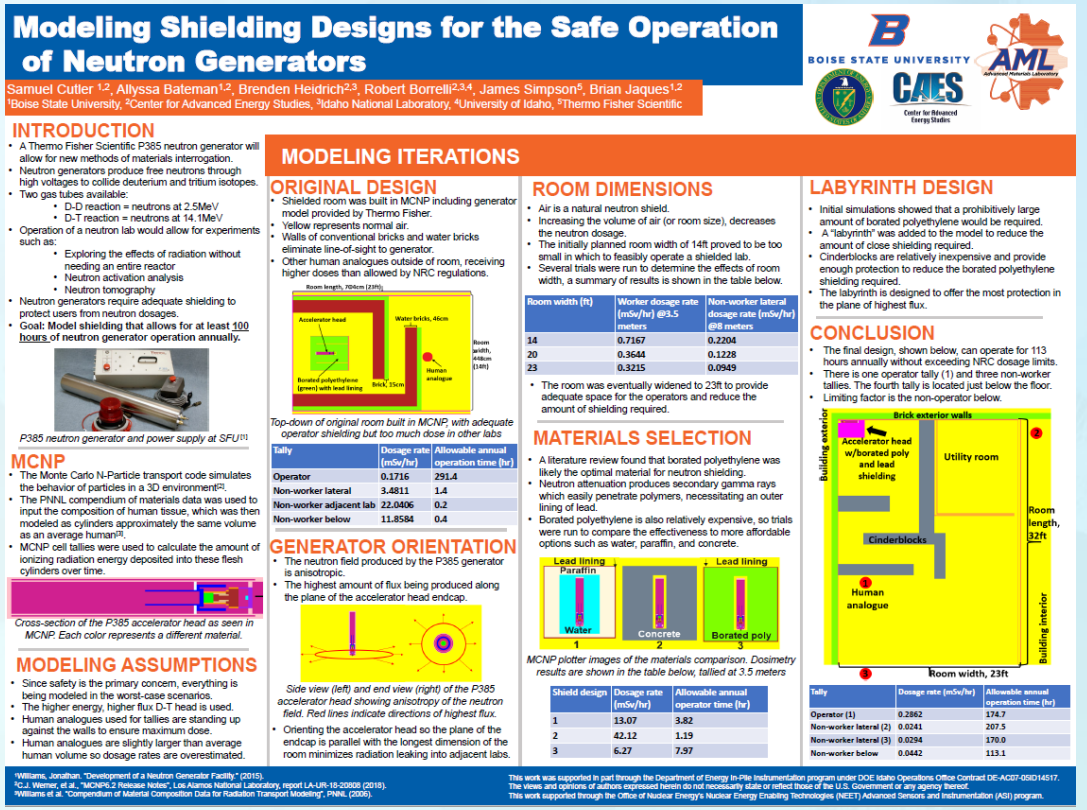
Results and Accomplishments

Training

- Samuel Cutler (undergraduate researcher) completed 1 week of MCNP training with Dr. Robert Borelli (2019)
- Allyssa Bateman completed the course “Introduction to MCNP6” through Los Alamos National Laboratory (2021)
- Allyssa Bateman attended MCNP User Symposium in 2021 and 2022.

Presentations:

- “MCNP Shielding Design for a University Neutron Science Laboratory.” A. Bateman, S. Cutler, B.J. Jaques. Presented at Monte Carlo N Particle (MCNP) User Symposium, July 2021.
- “Modeling shielding designs for the safe operation of neutron generators.” S. Cutler, A. Bateman, B. Heidrich, R. Borelli, J. Simpsons, B.J. Jaques. Poster at Idaho Conference on Undergraduate Research. July 2020.



Concluding Remarks

- DOE-NE has donated a neutron generator with both D-D and D-T heads (valued at $230k) to Boise State.
- Boise State University has committed $879k toward a neutron science laboratory, with construction completion in summer 2024.
- A NSUF CINR General Scientific Infrastructure proposal is pending for $249k in analytical equipment.

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Thank You

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