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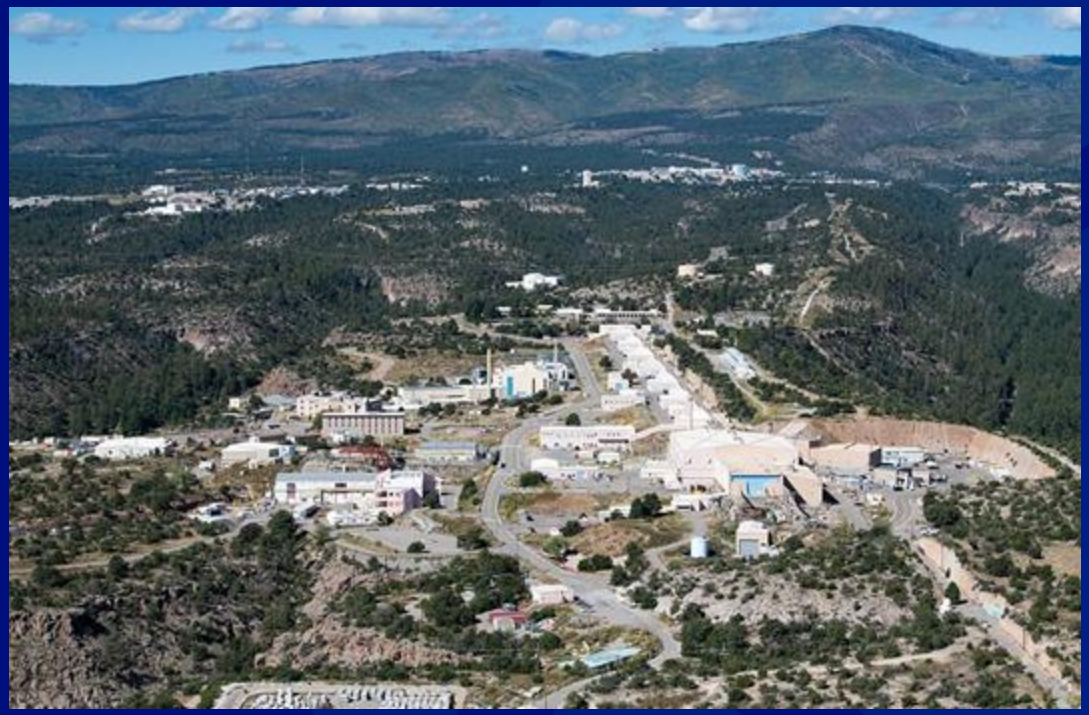
RADIATION EFFECTS FACILITIES at LANSCE



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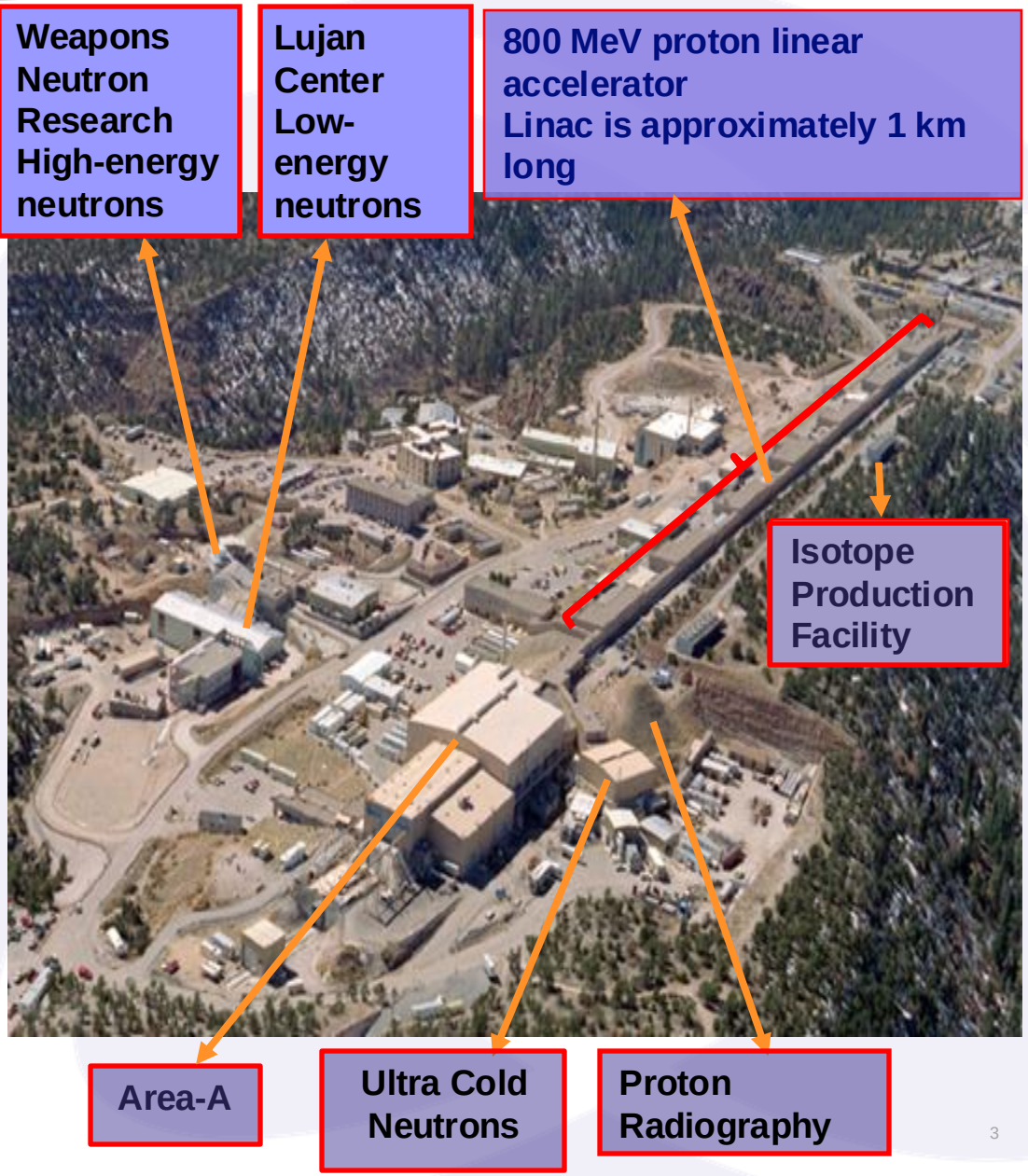
Outline

- Los Alamos Neutron Science Center (LANSCE)
  - LANSCE Accelerator
  - LANSCE Experimental User Facilities and Capabilities
- Neutron Radiation Effects Facilities at LANSCE
  - Irradiation of Chips and Electronics (ICE) Houses
- Proton Radiation Effects Facility at LANSCE
  - Target-2 (aka Blue Room)
- More information available at https://lansce.lanl.gov/facilities/Radiation%20Effects/index.php

LANSCE is a world-leading multi-beam user facility

- LANSCE accelerator came online in 1972
- From 1972 until mid-1990s LAMPF (Los Alamos Meson Physics Facility) was a major Medium Energy Nuclear Science user facility.
- Since the mid-1990s, LANSCE has been an important National Nuclear Security Administration (NNSA) facility.
- LANSCE is a multi-user, multi-beam facility that uses energetic protons to make intense sources of neutrons via spallation reactions as well as supplying proton beams for isotope production, supporting basic and applied science research.
- Typically, the LANSCE accelerator runs 6 months every year from June – December.



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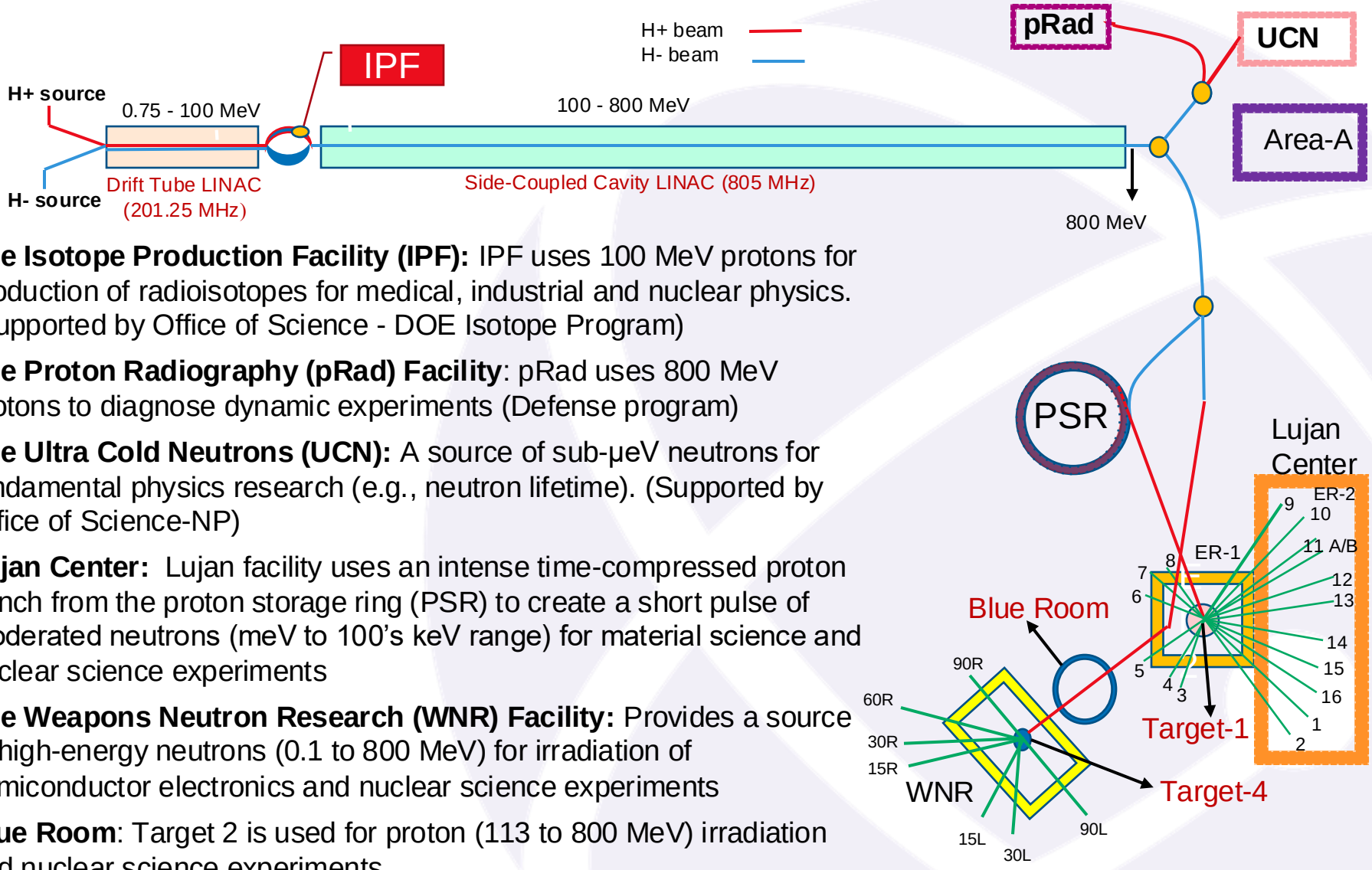
Major state-of-the-art experimental facilities at LANSCE

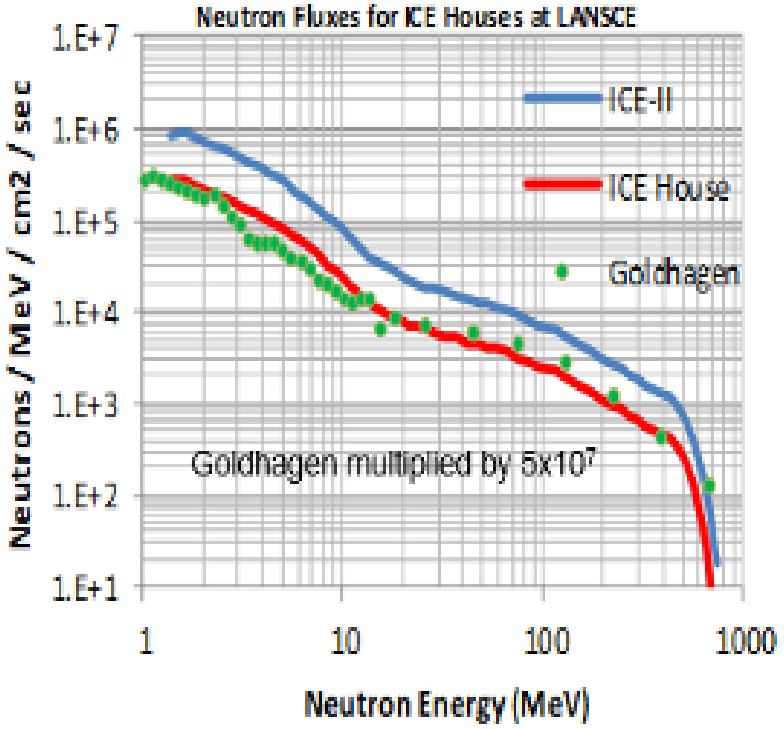


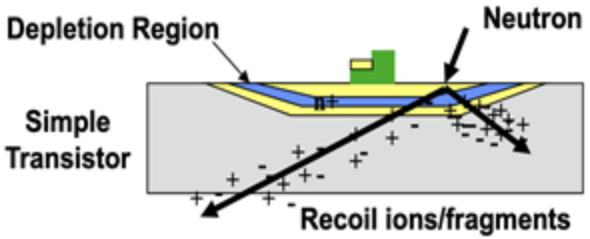
- **The Isotope Production Facility (IPF):** IPF uses 100 MeV protons for production of radioisotopes for medical, industrial and nuclear physics. (Supported by Office of Science - DOE Isotope Program)
- **The Proton Radiography (pRad) Facility**: pRad uses 800 MeV protons to diagnose dynamic experiments (Defense program)
- **The Ultra Cold Neutrons (UCN):** A source of sub-μeV neutrons for fundamental physics research (e.g., neutron lifetime). (Supported by Office of Science-NP)
- **Lujan Center:** Lujan facility uses an intense time-compressed proton bunch from the proton storage ring (PSR) to create a short pulse of moderated neutrons (meV to 100's keV range) for material science and nuclear science experiments
- **The Weapons Neutron Research (WNR) Facility:** Provides a source of high-energy neutrons (0.1 to 800 MeV) for irradiation of semiconductor electronics and nuclear science experiments
- **Blue Room**: Target 2 is used for proton (113 to 800 MeV) irradiation and nuclear science experiments

Neutron Irradiation Facilities at LANSCE

Neutron Irradiation Facilities: ICE-I and ICE-II

- The ICE (Irradiation of Chips and Electronics) Houses provide a broad-energy neutron spectrum that is very similar to the cosmic-ray induced neutron spectrum in the atmosphere.
- The ICE Houses are used by Industry, LANL/other labs, and university researchers to qualify and test semiconductor devices for single-event effects (radiation-induced errors).
- ICE Houses spectra are approximately 10^8 time more intense than the natural sea-level neutron intensity.
- This large acceleration factors allow testing of semiconductor device at a fast rate.



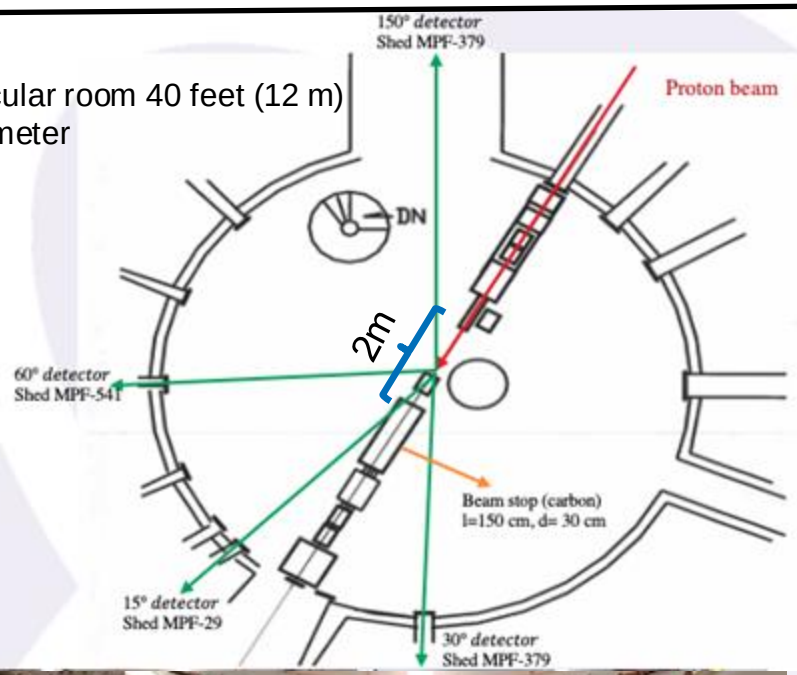


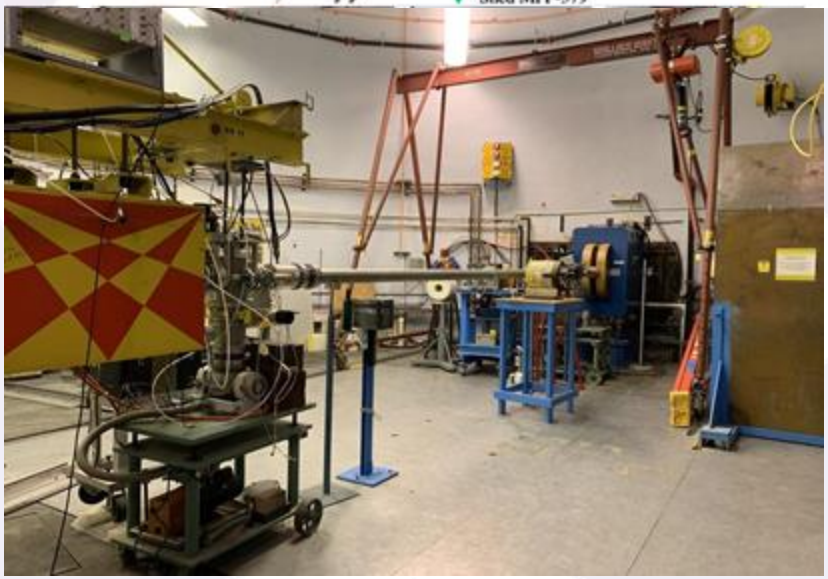
Proton Irradiation Facility at LANSCE
Target-2 / Blue Room

Blue Room provides direct access to proton beams

- Target-2 (Blue Room) is a unique facility for performing proton irradiation experiments with 113-800 MeV proton beams.
- Target-2 is a 12 m diam circular room. When Target-2 is operating, part of the beam pipe is removed and ~ 2m of space is available along the beamline to set up experiments.
- Based on experimental requirements, either the linac beam or the high-peak intensity stacked beam from the Proton Storage Ring (PSR) can be delivered
  - Linac beam provides ~10^8 protons in a ~ 250 ps wide micropulse
  - PSR beam provides 3x10^{13} protons in a pulse with a base width of 250 ns

Circular room 40 feet (12 m) diameter





Blue Room has multiple operational capabilities

- Remote sample positioning
  - Users can position their samples in and out of the beam
  - Pneumatic system- 6 available slots
  - Translational stage- continuous positioning
- Laser alignment of samples
- Three cameras:
  - To view beam spot on a phosphor at the sample location
  - To view beam spot at beam stop phosphor
  - To monitor experiment remotely
- The proton current is measured using a Bergoz Integrating Current Transformer with appropriate sensitivity
  - 5:1 for PSR beam
  - 20:1 for LINAC beam
- Freezer to store radioactive samples at low temperatures
- External Data Room for users to work

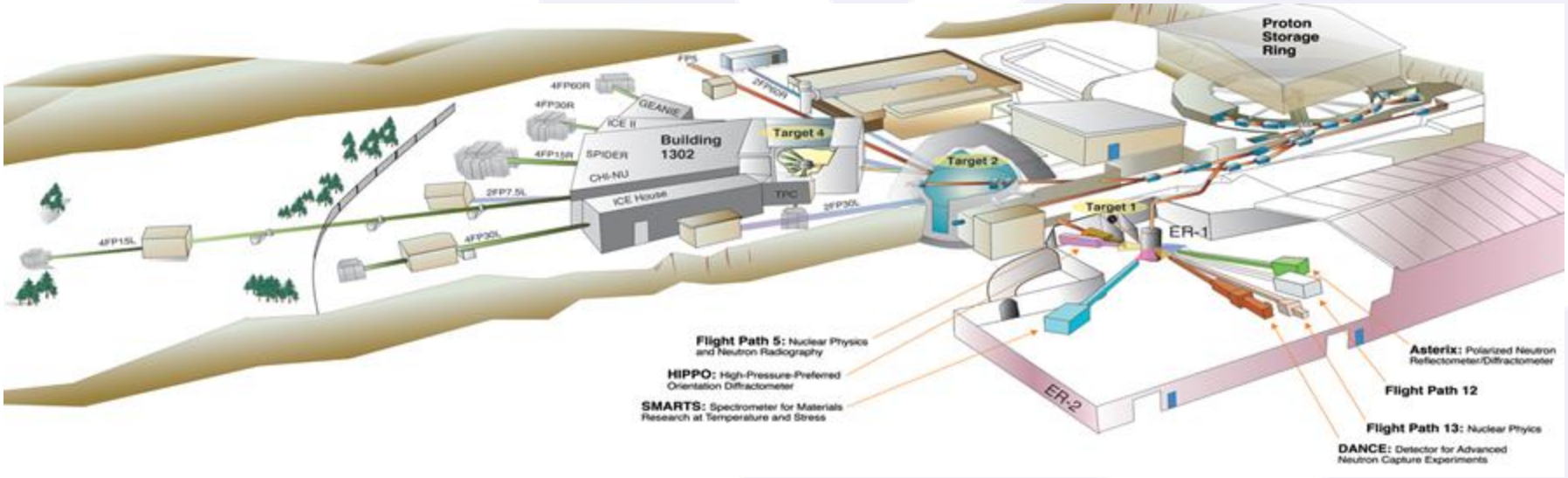
LANSCE can meet HEP Irradiation Requirements

- LHC HEP requirements are to irradiate their electronic boards/scintillators to achieve an integrated proton fluence of 10^{17} *p/cm*^{2}
- With the beam current limit of 80 nA and a beam spot diameter of 3 cm (1.1 cm FWHM), we can achieve 10^{17} *p/cm*^{2} in approximately 52.8 hr (2.2 days)
- We are in the process of increasing this beam current limit to reduce irradiation times by:
  - Adding local shielding
  - For thin samples we can remove the carbon beam stop and stop the beam at Target-4

Current (nA)	Number of protons/s	Flux (p/cm^2/s)	Time (hr)
80	5×10^{11}	5.26×10^{11}	52.8
1000	6.25×10^{12}	6.58×10^{12}	4.2

Target-2 Operational Limitations

- Due to shielding limitations the average current to Target-2 is approximately 80 nA or 5 x 10^{11} protons/sec
- The operation of Target-2 impacts the operation of other facilities
  - When the linac beam is delivered to Target-2, we cannot operate WNR neutron flight paths
  - When the PSR beam is delivered to Target-2, we cannot operate Lujan center and WNR neutron flight paths
- Because of these impacts, beam time to Target-2 is limited, and only the highest priority experiments are scheduled. In the last run cycle, only ~ 240 hours were scheduled.



Conducting radiation effects experiments at LANSCE

- LANSCE is an NNSA designated user facility that generally operates June to December each year. User facilities at LANSCE are Lujan, WNR, and pRad.
- Some typical numbers:
  - The Weapons Neutron Research (WNR) facility hosted ~160 users in a recent run cycle, including proprietary users and a variety of nuclear science focused efforts.
  - Many of those users are doing radiation effects research; of those, roughly 50% the proposals are from proprietary users, 30% from universities, and 20% from internal LANL users or other national laboratories.
- If conducting radiation effects experiments at LANSCE is of interest, contact us or look at the website mentioned earlier to learn more about the process (proposal, user agreements, visitor paperwork, and training, for example).
- Unlike Office of Science user facilities, being an NNSA designated user facility does not provide dedicated funding to support external users.
- LANSCE's operating model is being revisited to include cost recovery models for all external users.

Summary

- LANSCE is an excellent facility for conducting neutron and proton irradiation measurements
- LANSCE has extensive experience with hosting visitors and providing support for visitors
- There are several excellent capabilities at LANSCE for electronics and detector/materials irradiation testing for HEP experiments
  - High energy neutron beams (1 - 600 MeV) irradiation facilities: ICE Houses
  - Low-intensity proton beams (80 nA) irradiation facility: Target-2 (aka Blue Room)
- If these radiation effects capabilities are of value to the HEP community, they should have discussions with LANL management to understand HEP requirements and the support needed.

Thank You!