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# Los Alamos Neutron Science Center (LANSCE) Nuclear Science Facilities

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General Description: US DOE NNSA National Laboratory, NNSA User Facilities, proton and neutron beams for basic and applied research in nuclear science, materials research, and fundamental science.
Proposals submitted online are rated for scientific/applied merit by PAC. Proprietary proposals at Target 4 cost-recovery rates: \$11k/1$^{st}$ day, \$9k/day after 1$^{st}$ day.

Accelerator:
Proton Linear Accelerator (100 MeV (IPF) and 211-800 MeV) dual $H^+$ and $H^-$ beams.

Beams: *Neutrons*: Target 4 - bare tungsten neutron production target, 6 flight paths 8 to 90 m, proton $\Delta t < 1$ ns
*Neutrons:* Target 1 flux-trap water and $LH_2$ moderated – 3+ flight paths, 8 to 20 m
*Neutrons*: Target 4 East Port – neutron irradiations – moderated or un-moderated, $10^{11}$ n/cm$^2$-s @ 0.7 m
*Neutrons*: Target 4 60R pre-collimator neutron irradiations – $10^9$ n/cm$^2$-s @ 10 m
*Protons*: Target 2 Blue Room – (low neutron return) 12 m dia. room, 211 – 800 MeV protons, 80 nA average, higher for LSDS or shielded target.
*Protons*: Planned high current irradiations in Area A.

Experimental focus: neutron-induced nuclear reactions, fission studies, prompt reactions, activation and decay studies, isotope production cross sections, proton-induced nuclear reactions.
Neutron imaging/CT Target 1 & Target 4, energy-selective imaging.
Proton flash radiography.
Ultra-cold neutrons/fundamental physics.

Detector arrays: High-energy neutron PSD 54-detector array, Low-energy neutron 22-Li-glass array, fission time projection chamber, DANCE – 160 BaF2 array for (n,$\gamma$)

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The Los Alamos Neutron Science Center (LANSCE) facilities for Nuclear Science consist of a high-energy "white" neutron source (Target 4) with 6 flight paths, three low-energy nuclear science flight paths at the Lujan Center (Target-1), and a proton reaction area (Target-2). The neutron beams produced at the WNR Target 4 complement those produced at the Lujan Center because they are of much higher energy and have shorter pulse widths. The neutron sources are driven by the 800 MeV proton beam of the LANSCE linear accelerator or linac. Proposals for beam time at the neutron production targets, Blue Room, and proton radiography facilities may be submitted for open research or proprietary work. See http://lansce.lanl.gov "Facilities" and "User

Resources" tabs for details on the facilities and proposal submission.

Neutron beams with energies ranging from approximately 0.1 MeV to greater than 600 MeV are produced in Target-4. The Target-4 neutron production target is a bare unmoderated tungsten cylinder that is bombarded by the 800 MeV pulsed proton beam from the LANSCE linear accelerator and produces neutrons via spallation reactions. Because the proton beam is pulsed, the energy of the neutrons can be determined by time-of-flight (TOF) techniques. The time structure of the proton beam can be easily changed to optimize a particular experiment. Presently, Target-4 operates with a proton beam current of approximately 4 μA, 1.8 μs between pulses and approximately 35,000 pulses/sec. Target-4 is the most intense high-energy neutron source in the world and has 6 flight paths instrumented for a variety of measurements.

In the Target-2 area (Blue Room), samples can be exposed to the 800 MeV proton beam directly from the linac, or with more peak intensity with a beam that has been accumulated in the Proton Storage Ring (PSR). Although the total beam current is limited by the shielding in Target-2, the PSR beam provides significantly greater peak intensity than the direct beam from the accelerator. Target-2 is used for proton irradiations and hosts the Lead Slowing-Down Spectrometer (LSDS). Proton beams with energies as low as 211 MeV can be transported to Target-2.

At present there are three flight paths at the Lujan Center that are devoted to Nuclear Science research. Other flight paths are devoted to Materials Science research. These flight paths view a moderated target with both water and liquid hydrogen moderators, and have useful neutron fluxes that range from sub-thermal to approximately 500 keV.

With these facilities, LANSCE is able to deliver neutrons with energies ranging from a milli-electron volt to several hundreds of MeV, as well as proton beams with a wide range of energy, time and intensity characteristics. The facilities, instruments and research programs are described briefly below.

## Overview of the Flight Paths

Each Flight Path name identifies the target and the direction of the flight path (FP) with respect to the proton beam. For example, 4FP15R is a FP (flight path) that starts at Target 4 and is 15 degrees to the right (15R) of the incoming proton beam. Figures 1 and 2 show the layout of the flight paths.

The neutron fluxes available are shown in Figure 3.

### Target-4 Flight Paths (FP)

For the Target-4 flight paths, the neutron spectrum depends on the angle of the flight path with respect to the proton beam with the higher-energy neutron flux greater at the more forward angles. Below we list the main activities that are presently being performed

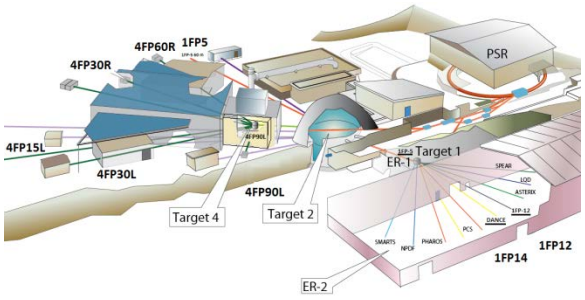


Figure 1. Layout of the Target-1, 2, and 4 flight paths at the LANSCE neutron sources.

on each flight path.

- **4FP90L** is the location of the Time-Projection Chamber (TPC) that is used to measure fission cross sections to high precision.
- **4FP30L** The ICE House is ~20 m from the production target and is used by industry, universities, and national laboratories for semiconductor electronics testing (SET) to measure neutron-induced failures in devices.
- **4FP15L** has two experimental locations available at distances of 22 and 90 meters from the spallation target. Primarily used for the Chi-Nu experiments at 22 meters. Chi-Nu is measuring the fission neutron output spectrum. A low-neutron-return room is below the 22 m station. The 90 m flight path is used mostly for neutron detector development and calibration

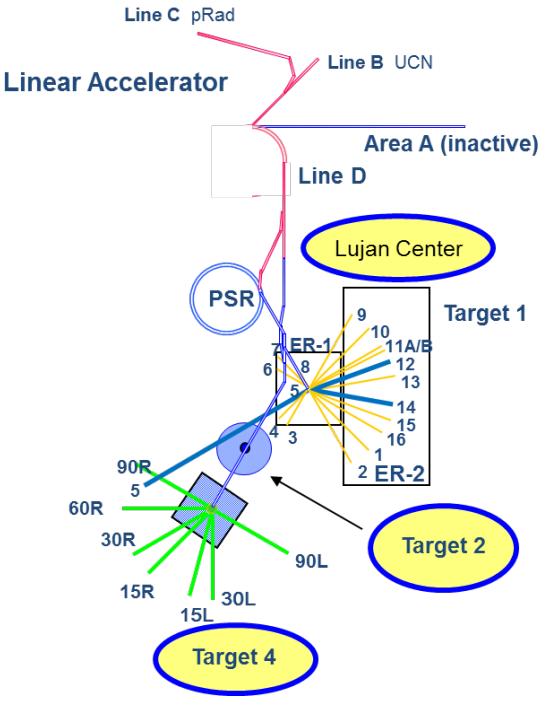


Figure 2. A plan view of the flight paths at LANSCE Targets 1, 2, and 4.

- **4FP15R** is a general purpose flight path that is now being used for neutron radiography, the SPIDER detector (fission product yields) and the low-energy (n,z) (LENZ) experiment.
- **4FP30R** or ICE II station at 15 m is primarily used by industry, universities, and national laboratories for SET.
- **4FP60R** The 20 m station is used for gamma-ray spectroscopy and other experiments. An irradiation station using peripheral beam is available at 10 m.

**Target 2 (Blue Room)**

- Target 2 is used for proton beam irradiation experiments. Beam is available directly from the linac or from the proton storage ring (PSR). Present and past experiments include:
- A lead slowing-down spectrometer (LSDS) provides very large effective neutron fluxes in the energy range from ~1 eV to ~10 keV with low neutron energy resolution for measuring cross sections with ultra-small samples.
- Pulsed beam experiments to simulate intense neutron environments for semiconductor certification.
- Proton irradiation of detectors and radiation-hardness testing of components for the Large Hadron Collider at CERN.
- Measurement of radio-isotope production cross sections for the Isotope Production Facility (IPF) at LANSCE (see the IPF contribution to this report).

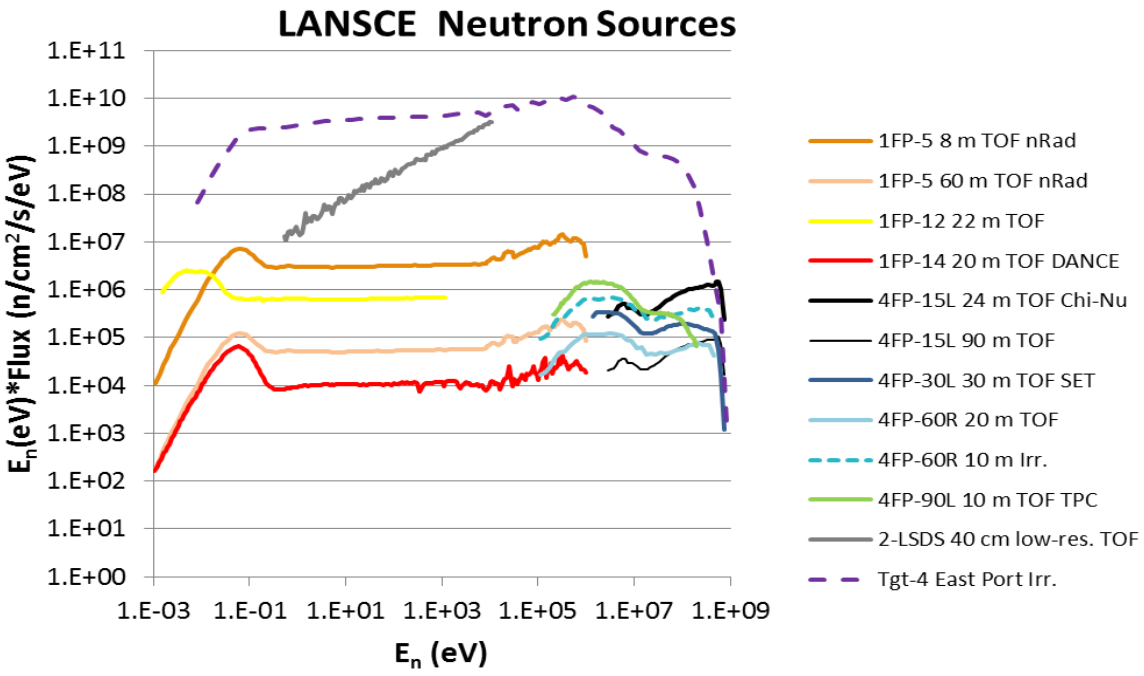


Figure 3. Graphs of the neutron flux times energy (also known as the flux/unit lethargy) for a representative sample of the neutron time-of-flight (TOF) and irradiation (Irr.) stations at LANSCE. The data are from measurements or calculations vetted against measurements

**Target 1 Lujan Center Flight Paths**

- **FP5** is a water-moderated general purpose flight path that is currently being used for neutron radiography. It has two detector areas: one at approximately 10m in ER-1 and the second at a distance of 60 m that is reached from the Target-4 yard. The 60 m station has a large field of view.
- **FP14** is the location of the Detector for Advanced Neutron Capture Experiments (DANCE). It consists of a 4-π array of $BaF_2$ scintillators designed for neutron capture measurements on sub-milligram and radioactive samples. These measurements support radiochemical detector cross section measurements for Defense Programs, and experiments for nuclear astrophysics.
- **FP12** is a cold-moderator flight path currently used by the SPIDER spectrometer to measure fission fragment yields. FP12 has a neutron guide.

**Target-4 East Port** provides a mechanism for irradiating samples in the intense broad spectrum neutron field at 0.7 m from the Target-4 neutron production target. Samples can be moved from the irradiation position to a storage position by remote control.

**Proton Radiography Facility** The pRad facility provides fast imaging of static and dynamic systems. See http://lansce.lanl.gov/pRad/index.shtml for more information.

**Ultra-Cold Neutron (UCN) Facility** State-of-the-art UCN Facility See http://lansce.lanl.gov/UCN/index.shtml