LANSCE Facilities for High-Power Target Development

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Outline

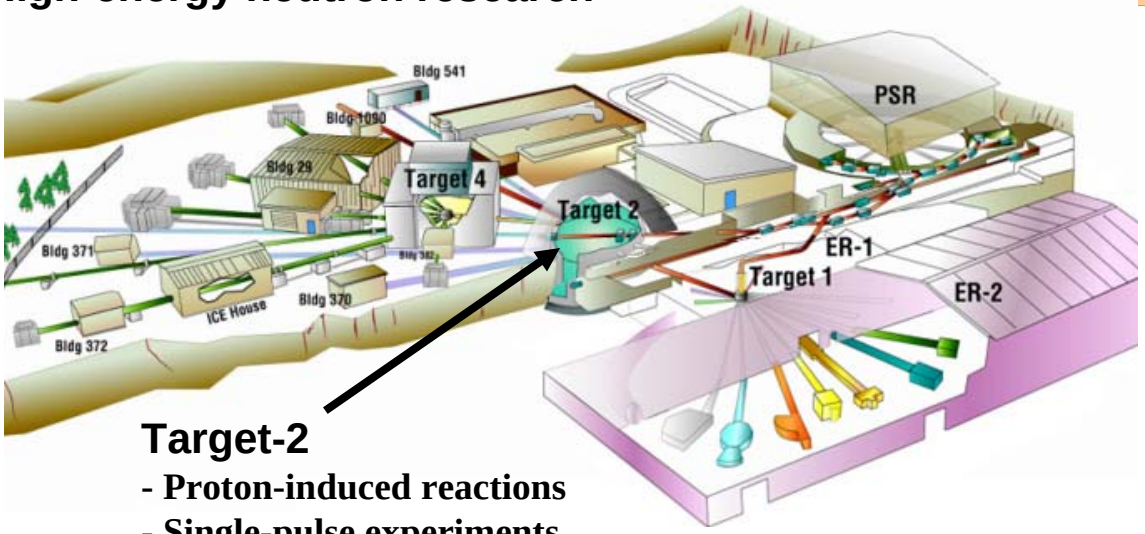
- Overview of LANSCE
- Present capabilities
- Extensions and upgrades
- Example of other applications
- Summary

LANSCE is a unique multidisciplinary national user facility for basic and applied science research

LANSCE experimental areas

Weapons Neutron Research Facility

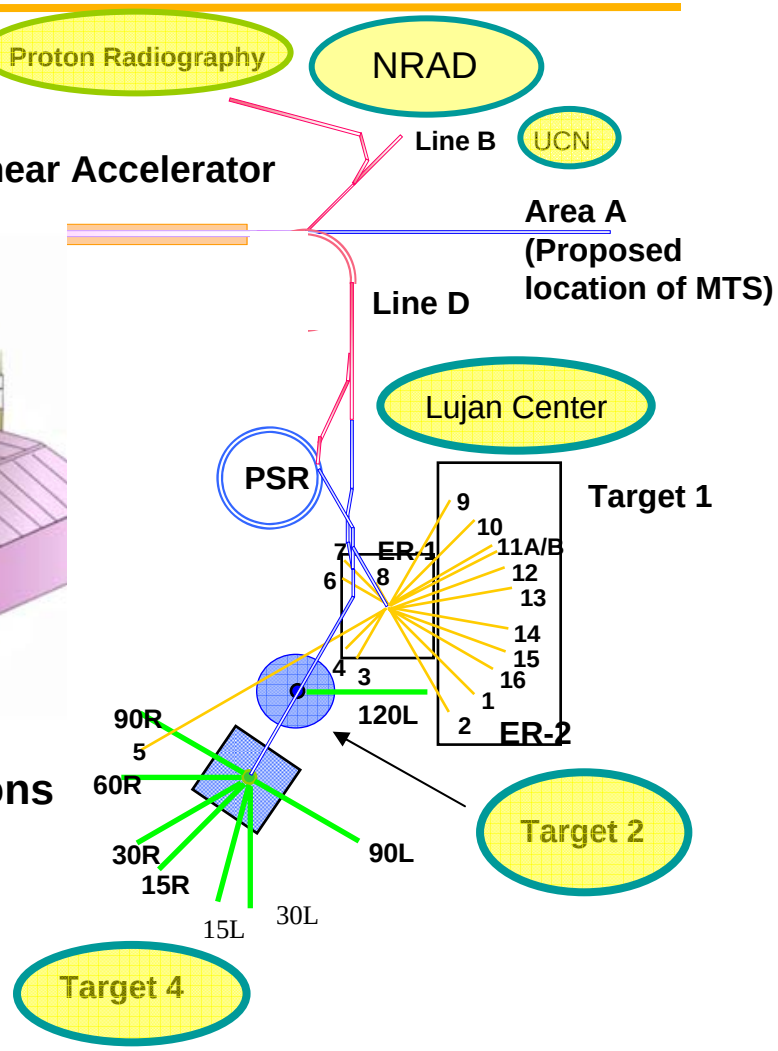
Target-4
High-energy neutron research



Target-2
- Proton-induced reactions
- Single-pulse experiments

Low-energy neutrons
- Material science
- Nuclear science

Many measurements were performed to develop and test mercury targets in Target-2 between 1997 and 2005

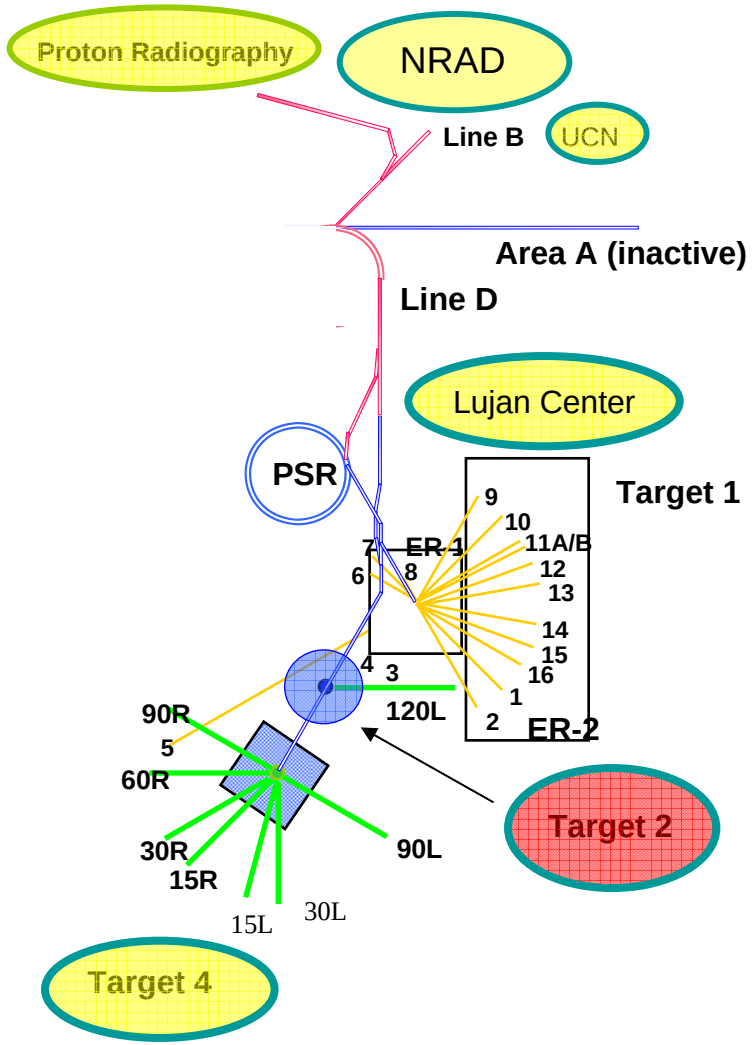


Existing capabilities can support high-power target development efforts

- **Linac**
  - 800 MeV proton beam (lower energies possible)
  - Versatile time structure, intensity 120 Hz, 800 μsec long pulse, ~ 1 mA average
  - Accelerates both H^+ and H^- beams
- **Proton Storage Ring (PSR) operation**
  - 20 (30) pulses / second
  - 4 10^{13} protons / pulse continuously to Target-1 (adjustable)
  - 5 KJ/pulse with ~1 cm radius spot size
  - Greater intensity at reduced rate
  - Pulse width is roughly triangular with a FWHM of ~135 nsec and a base width of 270 nsec
- **Target-1** (Low-energy neutron source--Lujan Center)
  - 125 μA of beam at 20 Hz is delivered to Lujan Center for the BES user program
  - Poor access to proton beam because of massive shielding around target
  - Proton beam strikes target from above

Target-2 (Blue-Room) is used for proton experiments

- 40 ft diam room
- Accepts both linac and PSR beam
- Good access to proton beam
- Limited current
- Past operation has been limited to ~1-2 PSR pulses/minute because of shielding constraints. Actual current limit depends on experimental setup typical ~100 nA average current. We have operated at 1 μA for LSDS.
- Limited access because cannot occupy room when transporting beam to Target-4
- Cannot be used with PSR while operating Lujan Center



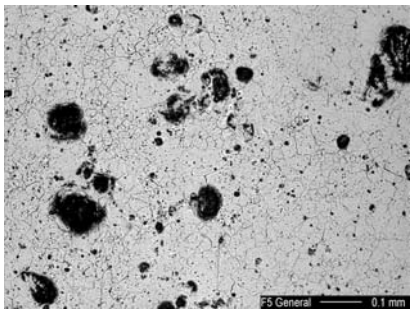
Target-2 experimental area

Target-2 with pipe in place for beam transport to Target-4

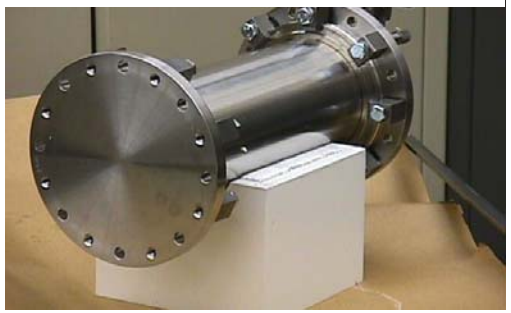
Target-2 with neutron production target and explosive containment vessel in place

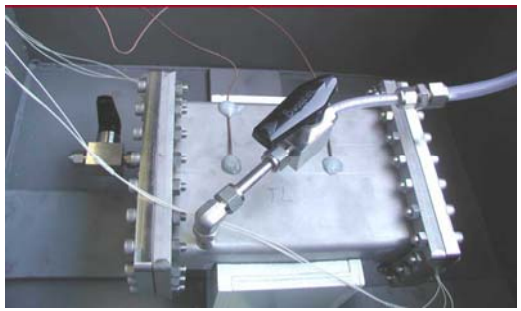
Beam pulses cause pitting in mercury target containers

- Pitting of stainless steel surfaces in contact with Hg was observed by the JAERI team in off-line tests with a split Hopkinson pressure bar apparatus
- Two Hg targets were exposed to 200 pulses each during July 23-25, 2001 tests at the LANSCE-WNR facility. The energy density is similar to SNS.
- 7 Targets tested in December 2001
- 21 Target geometries were tested in June 2002 at WNR
  - Power dependence, He bubble and gas migration, geometry, materials, total number of pulses, LBE target



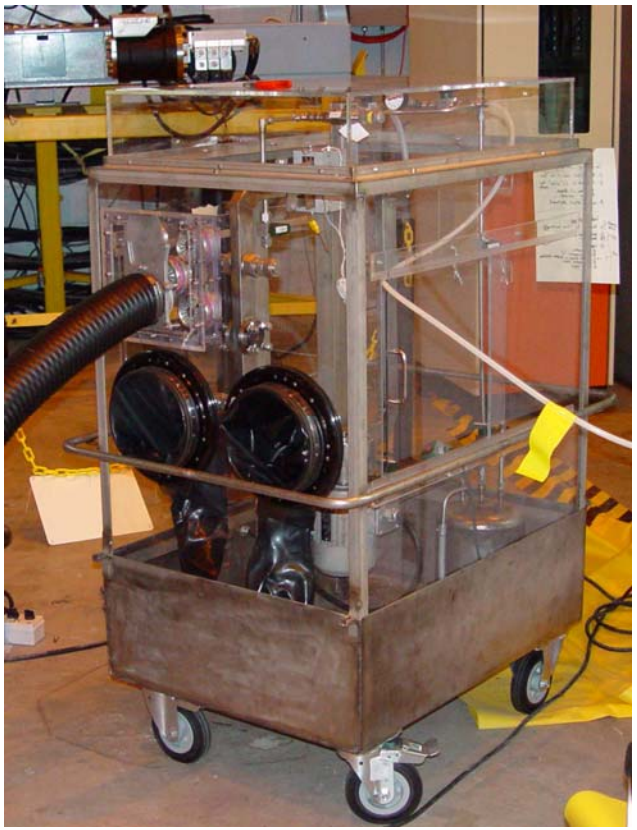
After irradiation





Typical test targets

Recent measurements at WNR (June 2005) tests effect of mercury flow and helium injection



Flowing mercury loop apparatus

Mercury test loop

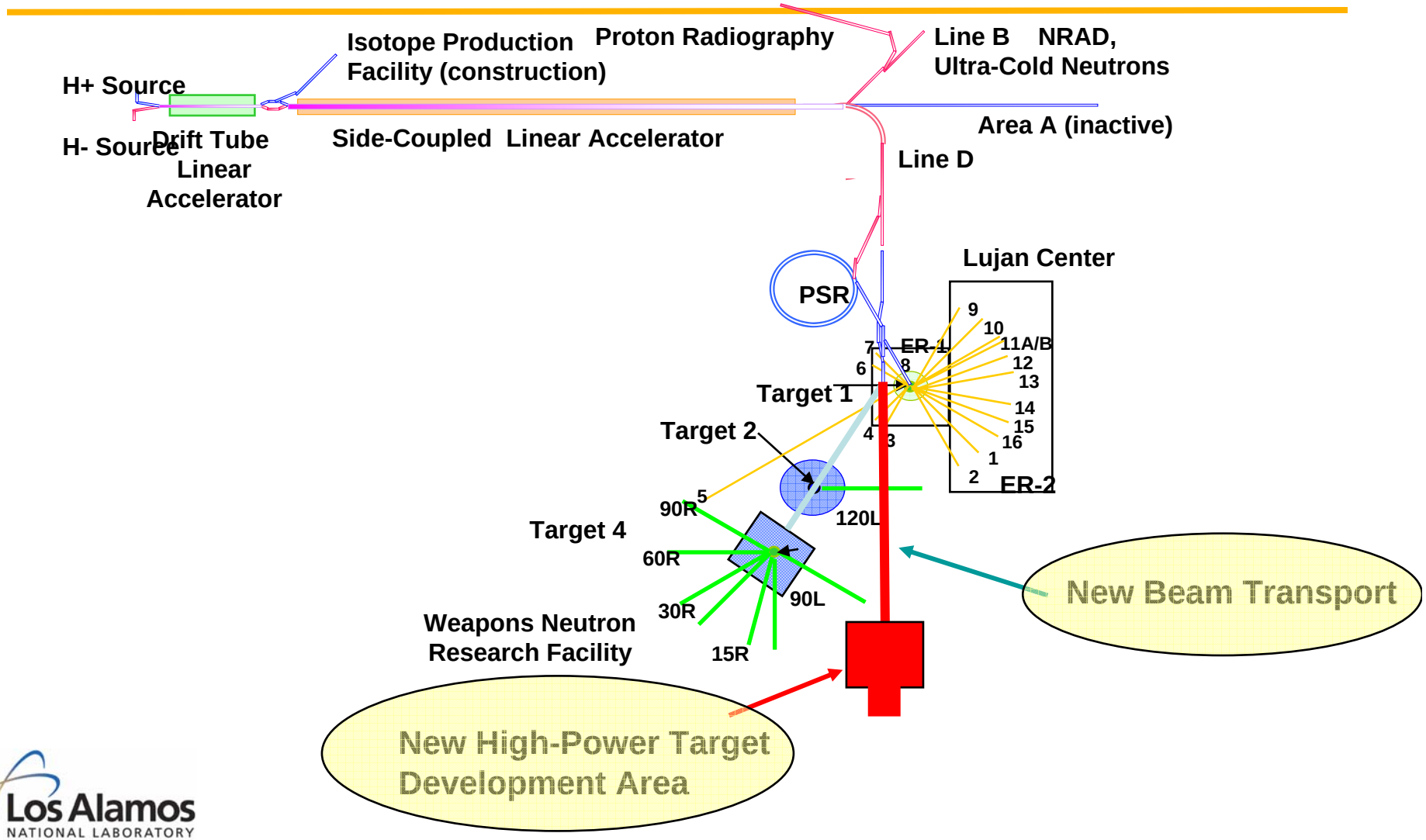
Summary of present capabilities in Target-2

- Large and flexible experimental area for hands-on work
- 4 10^{13} protons / pulse. Can get more intensity for short times
- Both linac and PSR beams possible
- Average current limited to ~100 nA but depends on experiment.
- Limited availability. Target-4 can't operate when in Target-2. Lujan Center can't operate when using PSR beam.
- Requires significant re-tuning of PSR beam. So can't easily switch between experimental areas

Possible upgrades to LANSCE for high-power target development

- Increase current with new ion source (x2).
  - Increase protons / pulse to 8 10^{13}
- Lengthen fill time of PSR (x1.3-1.5)
  - This can be done for limited amounts of time
- Increase repetition rate of PSR to 60 Hz (x3)
  - This is does not seem like a major effort
- Install switching magnet to switch beam between Target-2 and Lujan Center on a single macropulse basis and improve transport
  - This will remove the conflict between Lujan Center and Target-2 for more available time
- Develop new experimental area
  - Low power-hands on access to remove conflict with Target-4 operation
  - High power- remote handling ~1 mA average current
  - Staging, assembly, PIE tools area

New experimental area for high-power target development

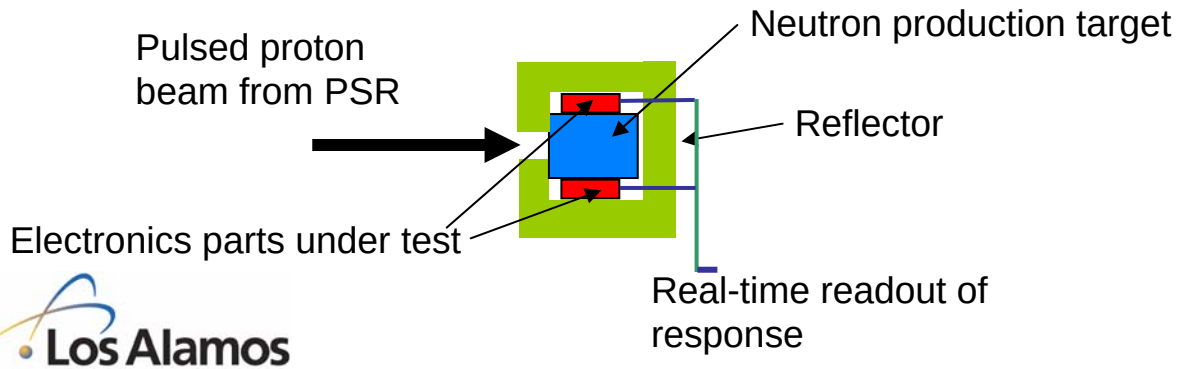


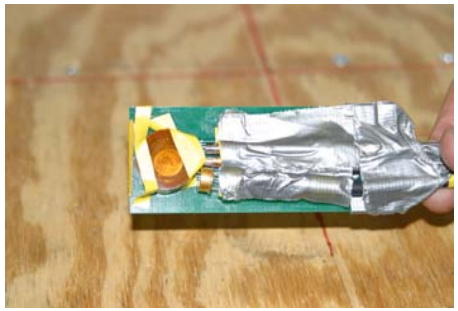
A new target area will address several programmatic requirements

- Lead slowing down spectrometer (LSDS)
- Neutron resonance spectroscopy (NRS)
- Radiation effects studies

Scientists from Sandia measure gain changes in transistors following irradiation

- Sandia is responsible for certifying the performance of electronic components in neutron fields
- Past Sandia efforts used SPR pulsed reactors to simulate intense neutron bursts
- SPR is scheduled to be shut down because of security, safety and cost concerns. Sandia needs to find alternative to the SPR.
- Pulsed beams from LANSCE/PSR provide shorter duration pulses but have less intensity / pulse than pulsed reactors
- To achieve the required integrated neutron intensity several pulses (~10) must be delivered to the neutron production target

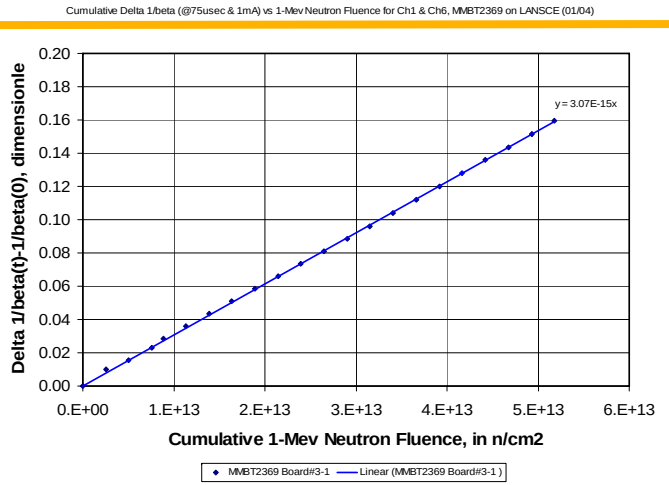


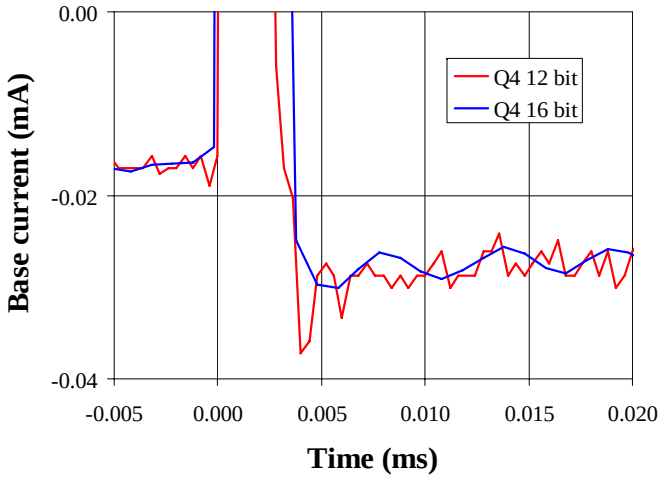


Electronics package placed near production target

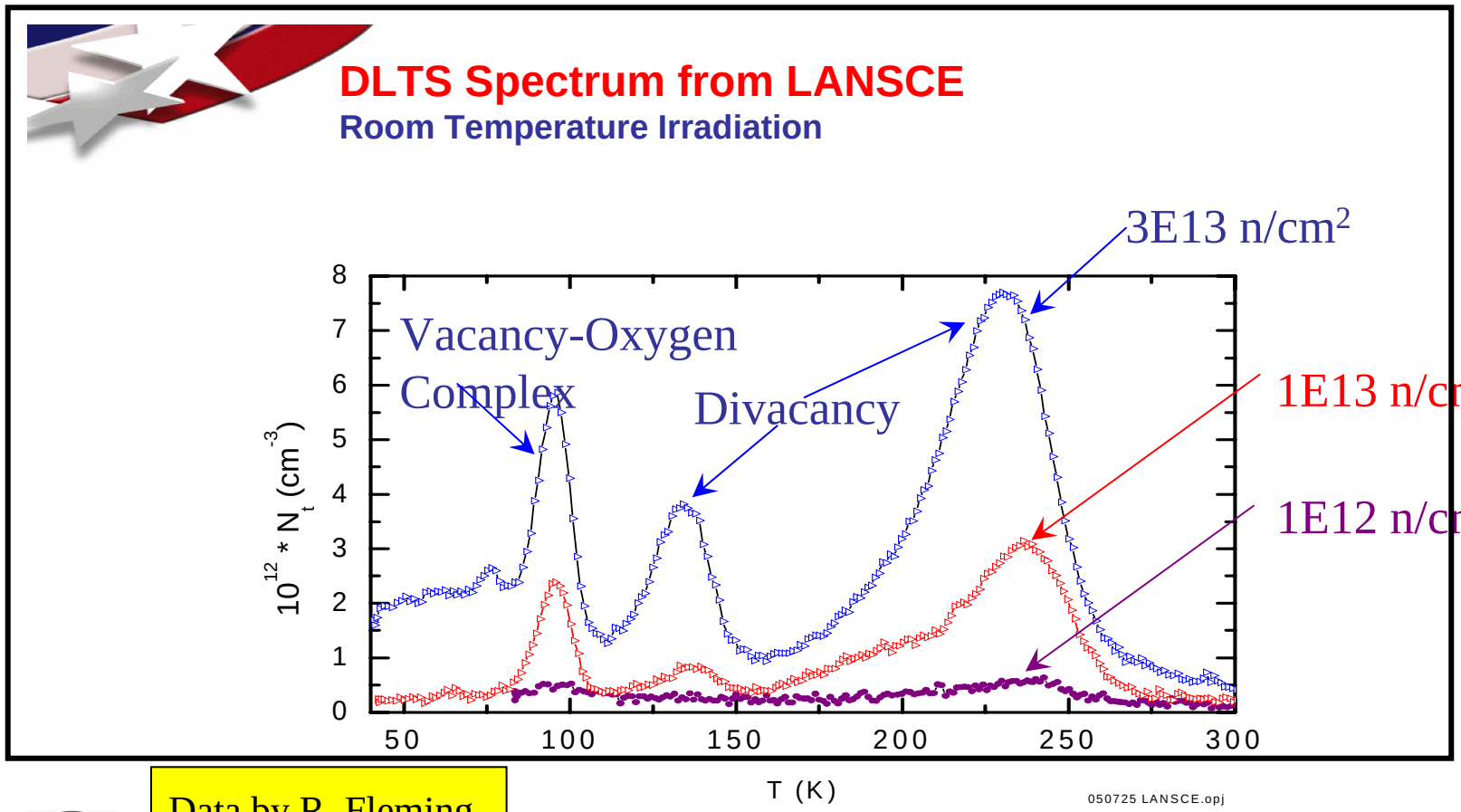
Neutron pulses at LANSCE show effect of irradiation on transistor gain

- First efforts were to characterize the neutron spectrum in terms of equivalent 1 MeV neutrons
- Straight line shows that a series of pulses is equivalent to a single large pulse
- The short pulse from the PSR allows measurements to earlier times compared to SPR
- In the latest run gain measurements were made at ~6 μsec after beam pulse
- Initial runs to characterize damage sites and compare to SPR reactor results





DLTS results show damage distribution seen at LANSCE is similar to the damage distribution seen with reactors



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Summary

- LANSCE facilities have provided important information on high-power targets and can continue to do so in the future
- Upgrades to the facility can be made to make the facility more accessible and useful for target-testing
- The costs for these upgrades depends on the scope of the upgrade and will have to be worked out in detail once the scope is established
- In addition to contributing to spallation source development, LANSCE scientists may be interested in developing such a target area for LANL programs