SAND2011-6762C

Sandia's Ion Beam Laboratory

Startup Lessons-Learned

September 20, 2011

Theodore N. Simmons
Health Physicist

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Mission of Ion Beam Laboratory

Using ion beams to:

- **analyze the composition of solids**
- **modify solids on the atomic scale study and**
- **simulate micro-area radiation effects on systems**

Old Facility

The former IBL was housed in an aged facility with asbestos concerns, inadequate space for current operation and inadequate neutron shielding for new mission requirements. The facility ceased operations in CY09 while a new facility was built. It is now demolished.

Sandia National Laboratories

Accelerators in the IBL

- 6 MV tandem Van de Graaff accelerators for analyses requiring high energies (for example, light element profiling and high energy back scattering).
- Van de Graaff accelerator for more routine techniques such as Rutherford Backscatter Spectrometry and channeling.
- Cockroft Walton accelerator, which can operate up to 350 KV, for the Heavy Ion Backscattering analysis.
- RFQ booster for gold ions at 380 MeV.

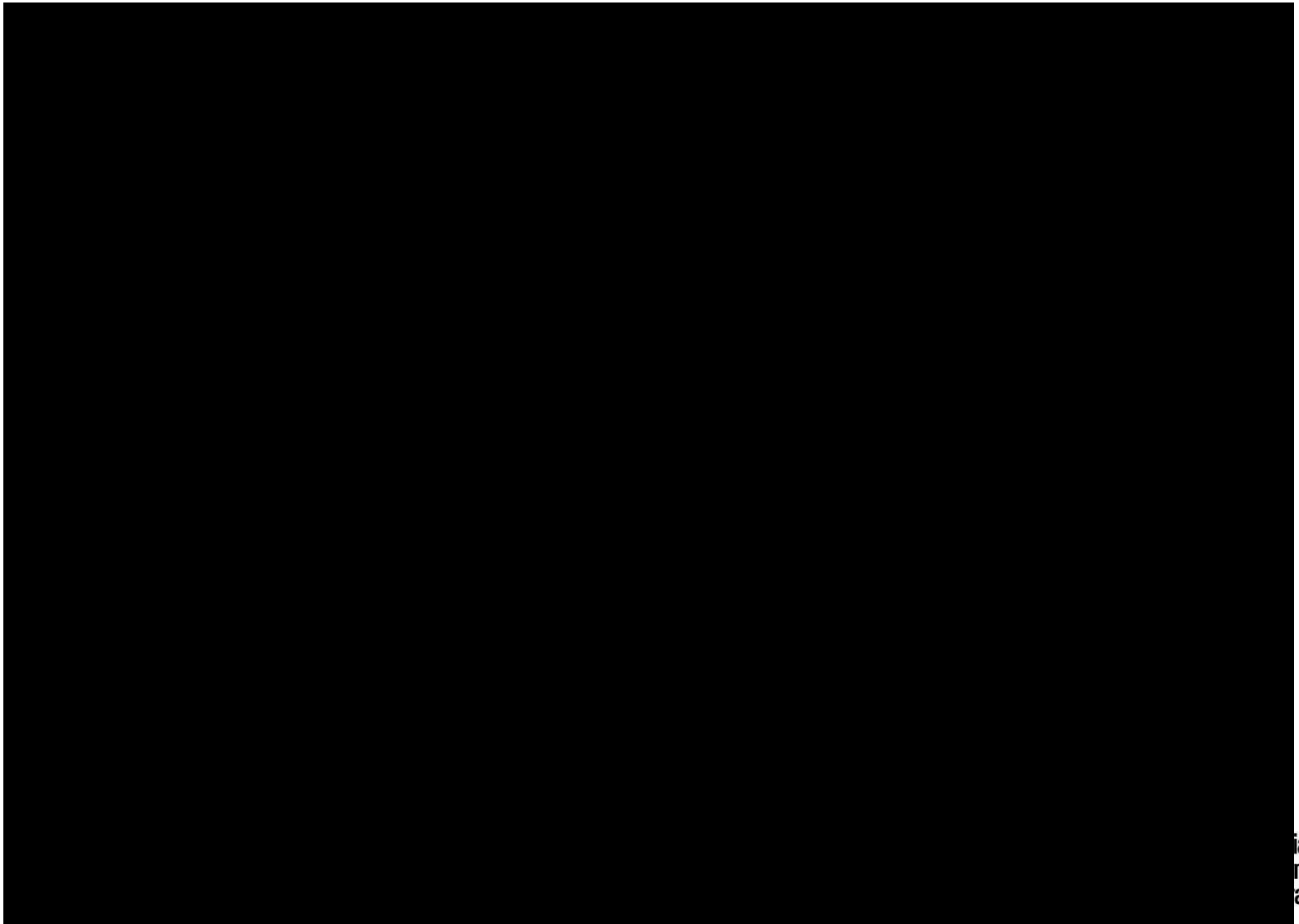
Workloads and outputs allowed for open-topped shields.

New Facility

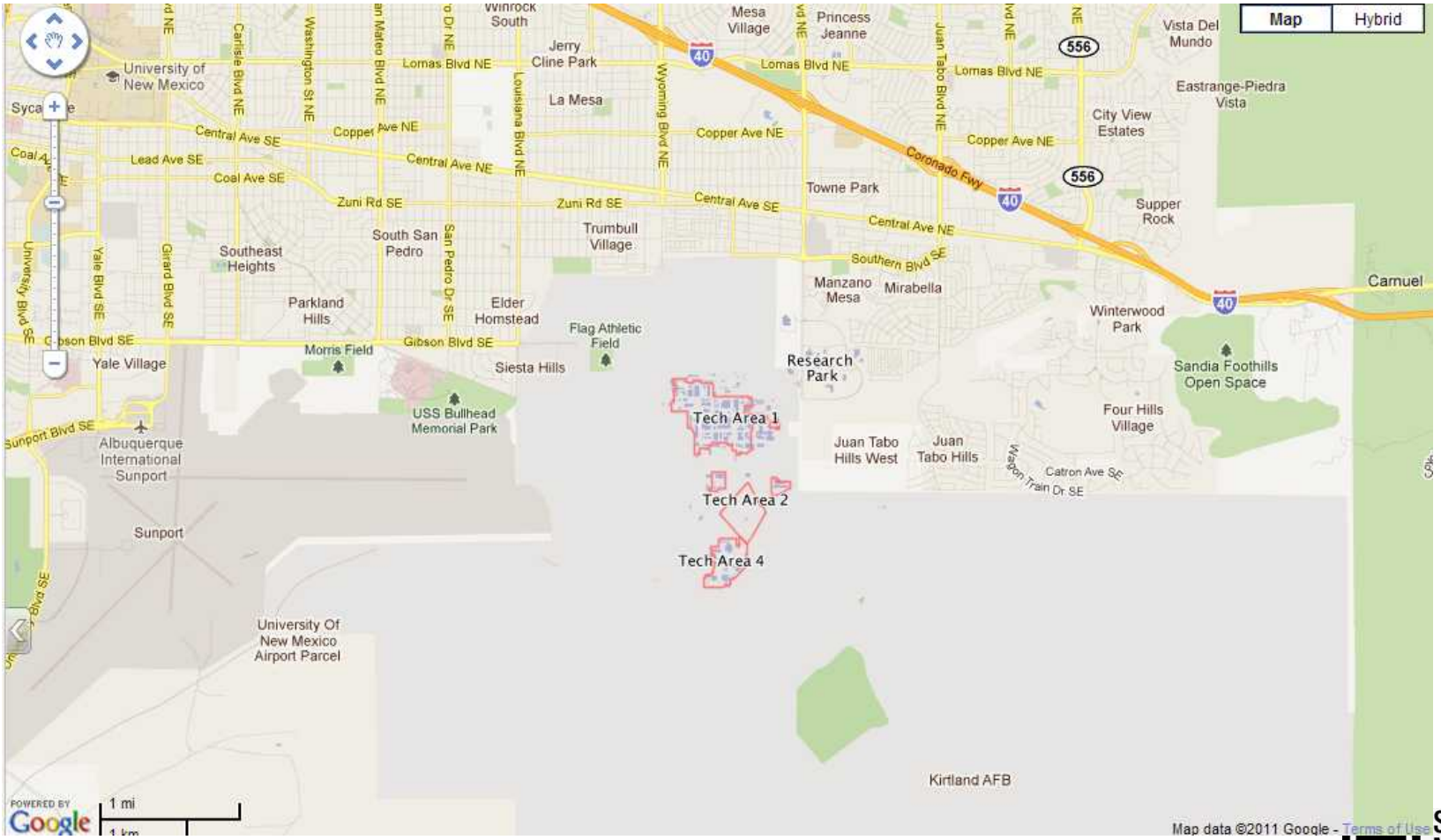
- Provided a cell for higher neutron irradiation tests to provide a new test capability.
- Sited north of Tech Area I, 800 feet from DOE property boundary.
- Designed considering the workloads of existing accelerators and anticipated workloads of new accelerators.
- DOE dose limits applied at site boundary using an occupancy factor of $1/16^{th}$.
- SCALE and MCNP used for design calculations.

Sandia National Laboratories

Video of IBL

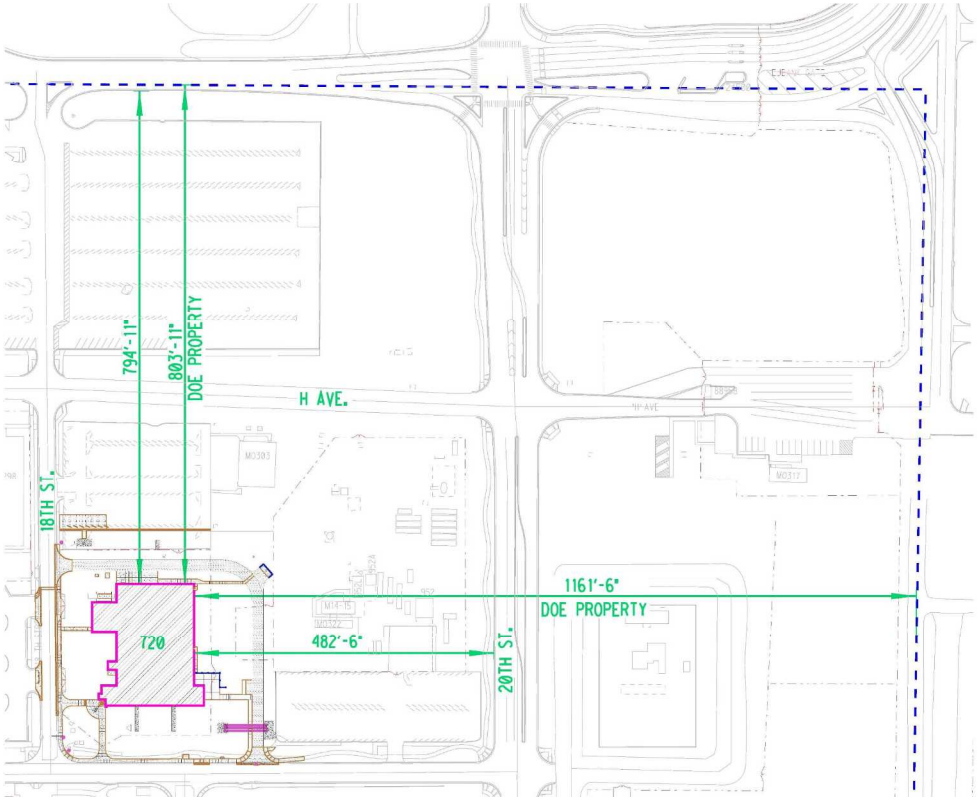


Sandia New Mexico Site



Sandia National Laboratories

Site Boundary



Sandia National Laboratories

Shielding Design Goals

- Rad workers ≤ 100 mrem per year
- Non-rad workers ≤ 10 mrem per year (inside and outside the facility)
- Collective dose goal of ≤ 1 person-rem per year

5400.5 Concerns t2

- IBL was designed with dose of building occupants as the primary concern. Due to low occupancy of space around the building dose outside the building to non-rad workers was a secondary concern due to low occupancy.
- After construction DOE environmental radiation safety officials disallowed use of occupancy factors for calculations showing compliance with Order 5400.5.

Sandia National Laboratories

Slide 10

t2 The IBL was designed and sarted up under 5400.5

tnsimmo, 9/8/2011

Design Dose Estimates

- Rad workers: 60-80 mrem per year
- Non-rad workers onsite: 3-4 mrem per year (used occupancy factor)
- Offsite public: 3-4 mrem per year (occupancy factor of 1)

Sandia National Laboratories

t1 assumed an occupancy factor of 1/16th
tnsimmo, 8/11/2011

Construction Project Completion (CD4)

- Acoustic testing during construction indicated possible voids in concrete shields – most in non-critical locations.
- DOE wanted to verify shield integrity before closing out the project.
- Operating accelerators and measuring leakage considered best method to verify shield integrity.
- DOE agreed that 14 MeV neutron production from the most important cell could be used to verify shields. The shields did not require verification for lower intensity, x-ray production.

Experimental Design

- Used HVEE Europa Accelerator producing 14 MeV neutrons
- Produced ~4.1 rem/hr @ 1 foot
- Neutron measurements made near calculated points
- Used portable instruments and TLDs for measurements

Fig 1: Bldg 720 High Radiation Room Shield Wall Verification Survey

Sandia National Laboratories

Results

- Most measurements were in locations where calculations indicated dose rates would be below detection limits for the instruments used. This was the case.
- Detectors near beam line penetrations were 10x the values calculated without penetrations (no surprise)
- The measurement at the door to the high radiation cell was ~4x calculated value (170 mrem/hr vs. 40 mrem/hr)
- The measurement at another door agreed closely with calculated values. (140 mrem/hr vs. 141 mrem/hr)
- No neutron exposure was detected at the nearby bus stops
- NSSA accepted the shields as part of approving operation in the IBL (CD4 milestone).

Accelerator Safety Order

- **Facility was designed and started-up under version 420.2B of the accelerator safety order.**
- **Was excluded under section 4.c(1) of that order.**

Unmodified commercially available units that are acceptable for industrial applications, including (but not limited to) electron microscopes, ion implant devices, and x-ray generators.

Sandia National Laboratories