Radiation Protection at the Spallation Neutron Source (SNS)

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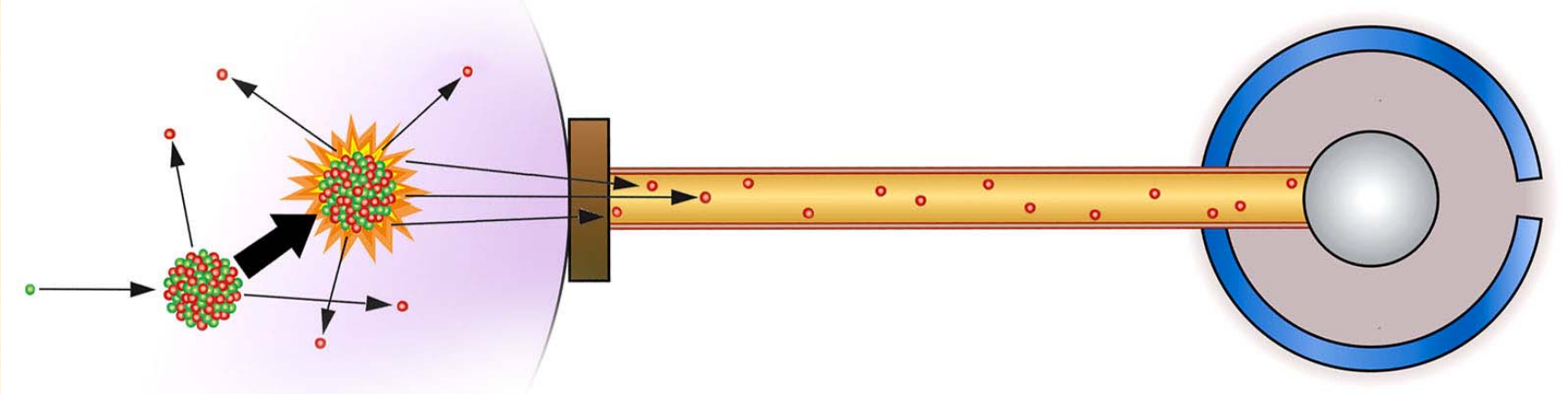
Aerial View of the SNS

Scientific Justification for SNS

- **Neutrons provide unique insight into materials at the atomic level.**
  - **'See' light atoms in biomaterials and polymers.**
  - **Study magnetic properties and atomic motion.**
  - **Measure stress in engineering components.**
- **Neutron scattering was developed in the United States, but we now have a serious shortage of facilities and they are not best in the world.**
  - **State-of-the-art neutron source has been an urgent priority for ~15 years**
- **SNS will be world-leading and will help restore United States leadership, in partnership with the High Flux Isotope Reactor.**

Spallation Neutrons for Research

First beam-on-target in April 2006!

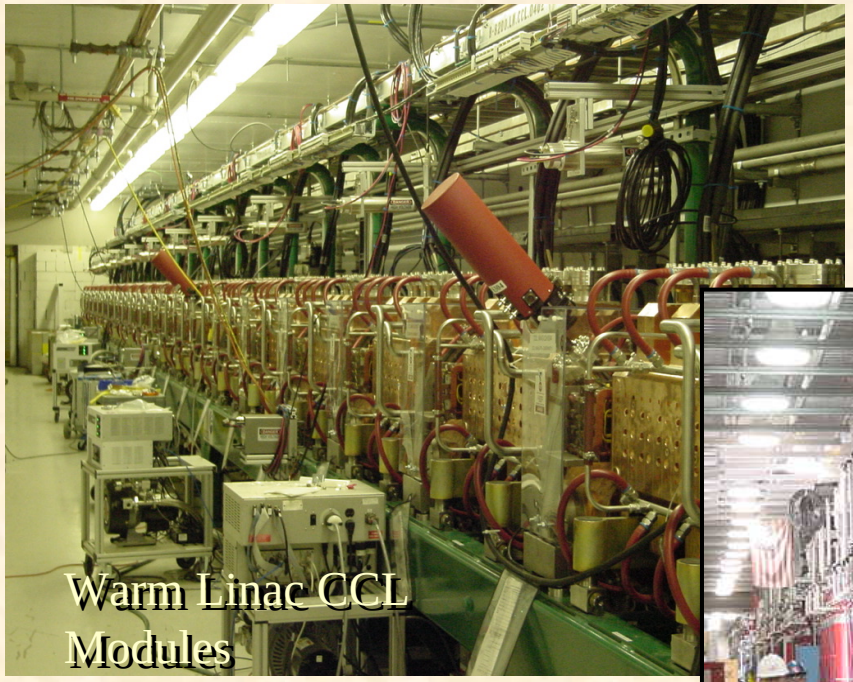


1-GeV protons incident on mercury atoms generate neutrons through “spallation” of the nucleus.

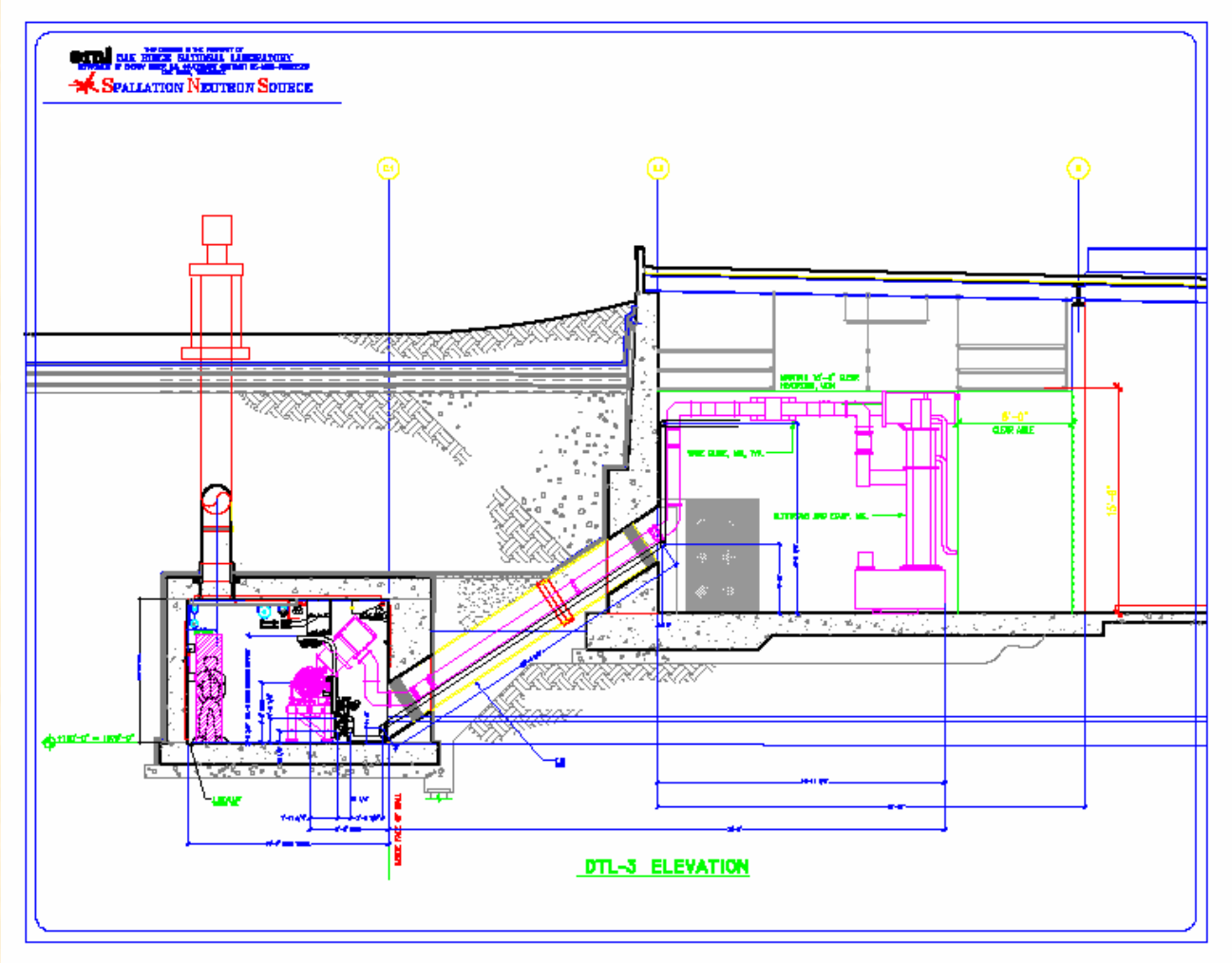
Neutrons are “moderated” (cooled) and then sent along beam lines to instruments.

SNS is a Multi-Laboratory Project Funded by DOE

Coupled Cavity Linac and Klystrons – Designed and Built by Los Alamos National Laboratory



Typical Tunnel/Klystron View



Radiation Protection Challenges at a Pulsed High-Energy Proton Accelerator Facility

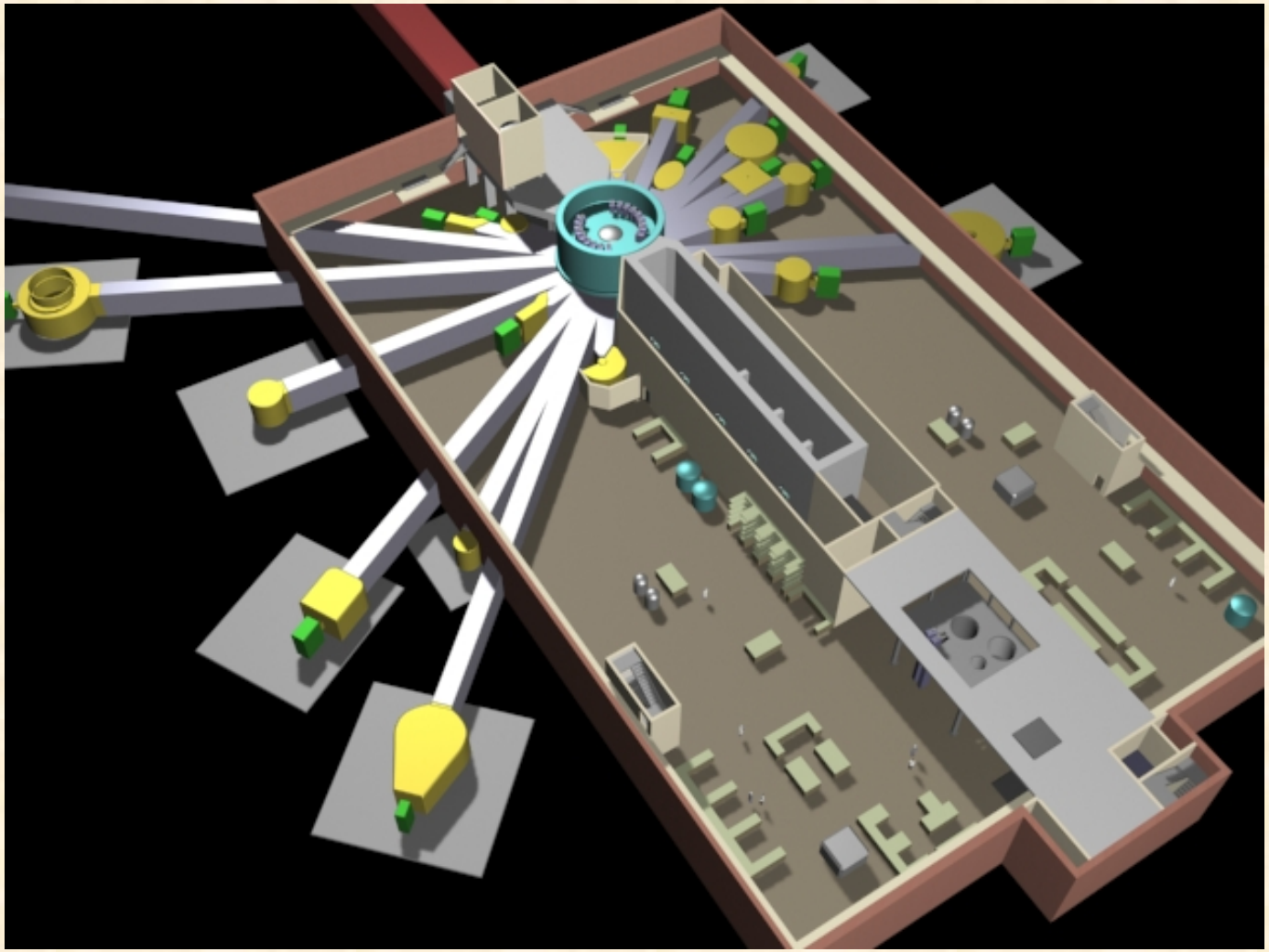
- **Standard instruments may not respond to short pulses.**
  - **A few instruments have been designed to meet this need.**
- **Standard thermoluminescent dosimetry will not detect high-energy neutrons.**
  - **Determine spectrum and/or use special (CR-39) dosimetry.**
- **Proton beams activate everything they hit!**
  - **Residual fields are 1/1000 of the average beam-on radiation levels.**
  - **Work on activated systems is the major source of worker dose.**
- **Full beam can be spilled at ANY point.**
  - **Megawatt proton beam-spill produces tens of megarad/h in tunnel.**
  - **Through 17+ ft of dirt penetrations, still tens of rad/h.**
    - **Active, highly reliable rad instruments are interlocked to beam.**

Target Inner Reflector Plug Installation

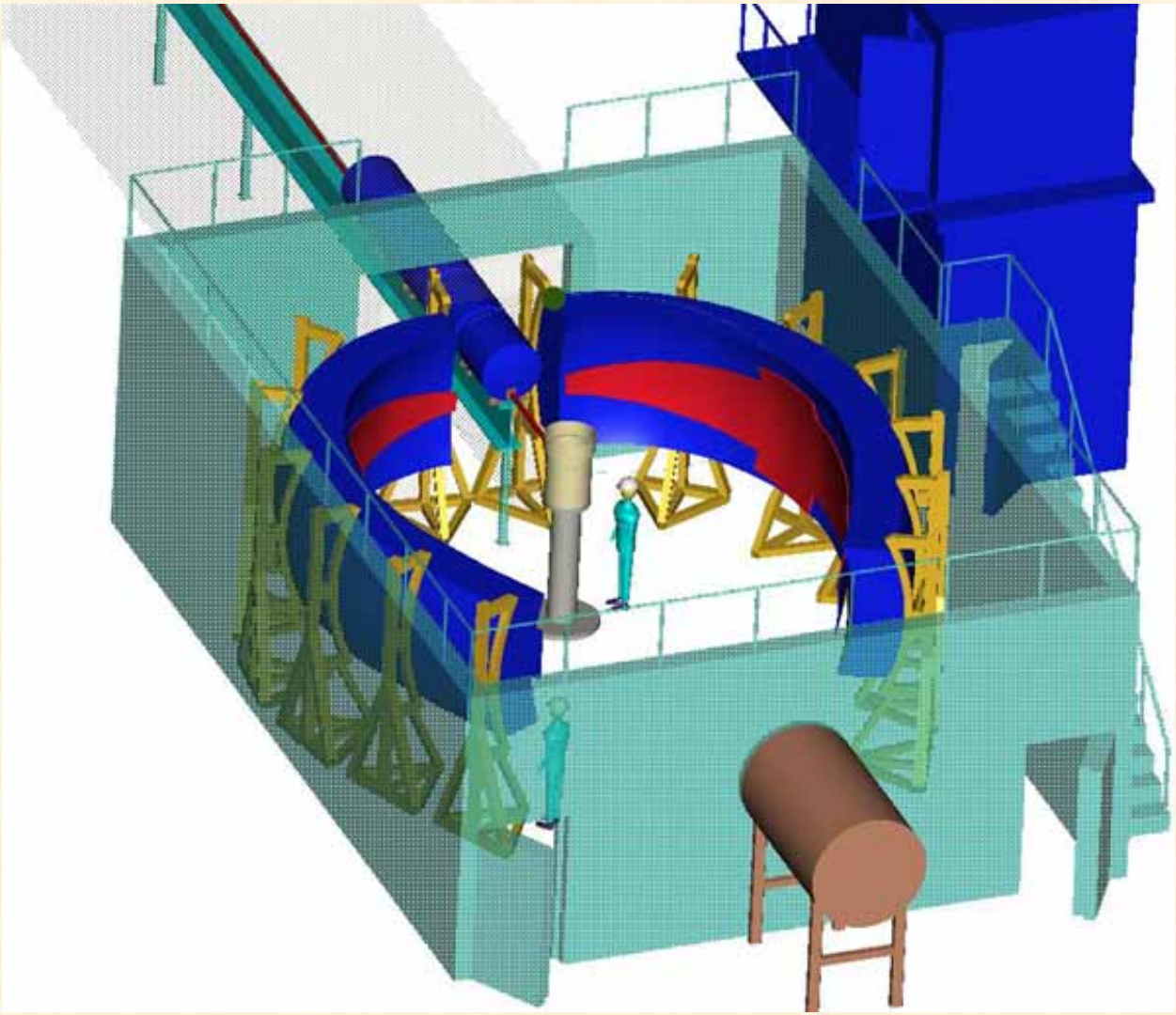
Radiation Hazards of the Mercury Target

- **Eventual radioactive inventory >0.5 MCi in mercury.**
  - **In addition to mercury, wide variety of isotopes.**
  - **1.4-m^3 mercury inventory used for life of project.**
- **6000 Ci of tritium per year produced in target.**
  - **Extracted in off-gas system with other volatiles.**
- **Cooling water has >350 Ci of ^{16}N, ^{15}O.**
  - **Short-lived, circulated through shielded hold-up tank.**
- **Radioactive mercury is very hard to contain, easy to detect.**
  - **All mercury operations take place in a "hot cell."**
- **Potential chemical and radiological hazards to people from mercury vapor are about equal.**

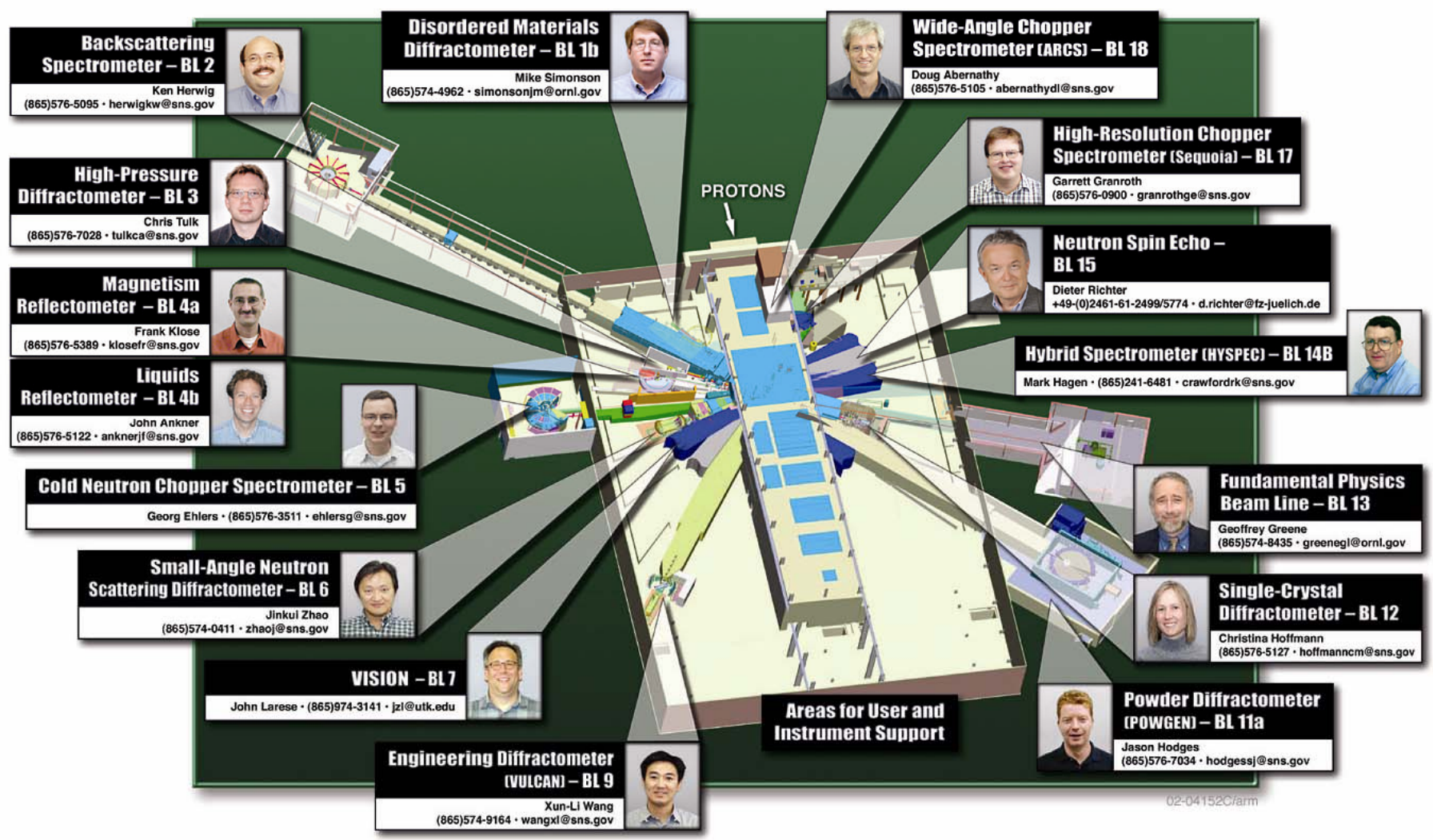
Target Building



Backscattering Spectrometer



Instrument Status



User and Instrument Safety

- **1000 to 2000 users per year expected for up to 20 instruments.**
  - **Generally accessible areas of target building <0.25 mrem/h.**
  - **Instrument huts interlocked or prox card access.**
  - **All or almost all users will be Rad Worker trained.**
- **Up to 5000 samples per year.**
  - **Experiment Review Committee evaluates sample hazards.**
  - **Samples will be bar-coded, tracked.**
  - **Disposal plan is part of application to perform experiment.**
- **Sensitive experiments require low backgrounds.**
  - **Adequate instrument design is generally safe for workers.**

Safety is Important at SNS

- **Strong emphasis on working safely.**
- **Financial incentives for contractors.**
- **Strong and effective surveillance.**
- **Examples – seatbelt use survey, and 19-mph speed limit on site.**
- **Over 4 million hours without a lost day accident – on a construction site!**

- Non-radiological hazards during operations include oxygen deficiency, exposed conductors (high-voltage and high-current), radio frequencies, magnetic fields, as well as standard Occupational Safety and Health Administration hazards.
- We intend the atmosphere of Construction Safety – including radiation safety - to carry over into operations!