Los Alamos
NATIONAL LABORATORY
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Accelerating particles to revolutionize science and medicine

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Director
Los Alamos National Laboratory
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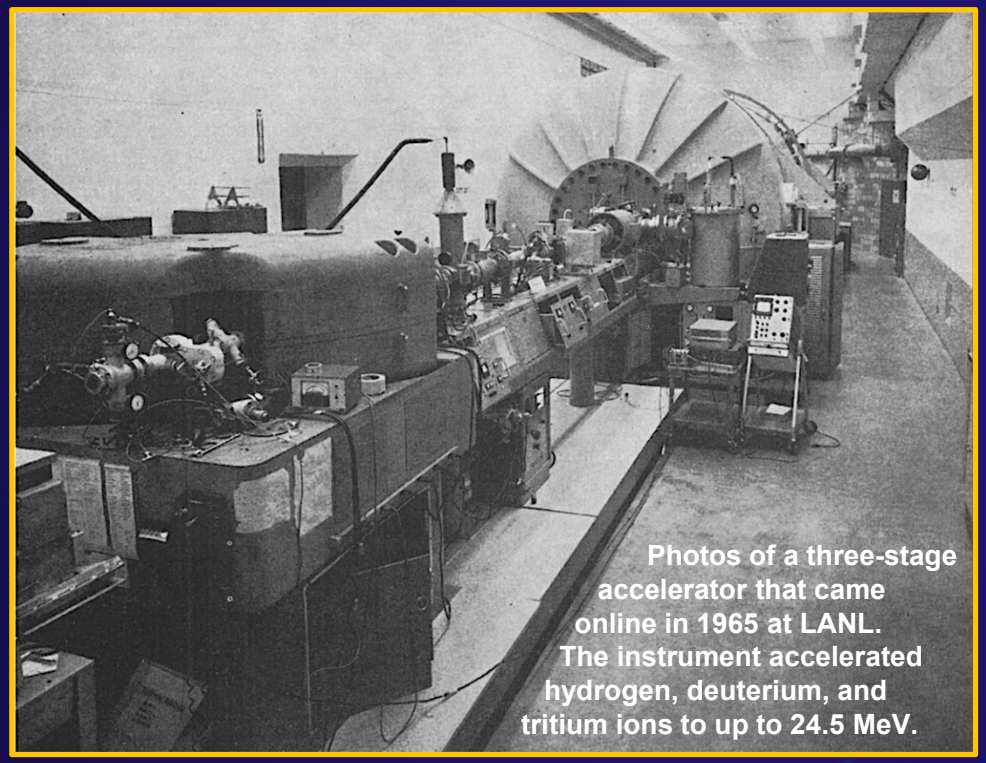
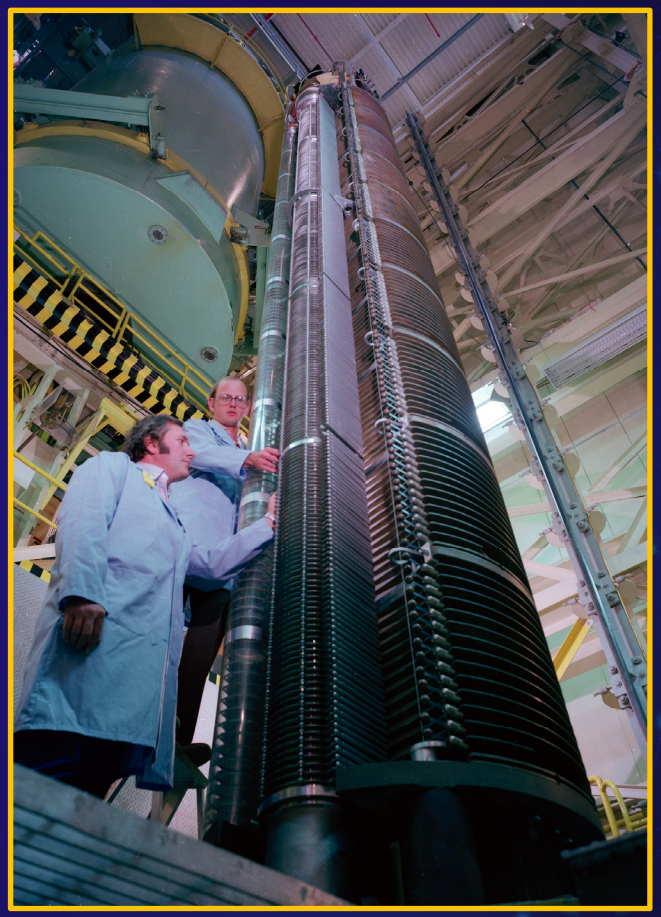
Accelerators propel tiny particles to high speeds & energies

- **The beams of particles that result are useful for research, radiation therapy, and technology**



Photos of a three-stage accelerator that came online in 1965 at LANL. The instrument accelerated hydrogen, deuterium, and tritium ions to up to 24.5 MeV.



Stephen Hawking posited that a large enough particle accelerator could enable human time travel.

SNS: DOE's largest scientific construction project

SNS groundbreaking ceremony, December 1999

2000 2005 2010

BESAC Report (Russell Subpanel Report), 1996

First neutrons produced at SNS, April 28, 2006

Accelerators have discovered particles like the Higgs boson.

Construction costs for SNS were $1 million per day

Total cost: $1.41B

Completed: May 2006

Ahead of schedule

Under budget

With greater technical scope than originally specified

More than 4M hours of construction without a lost workday

Before it came online, some were afraid the Large Hadron Collider would create a black hole every second.

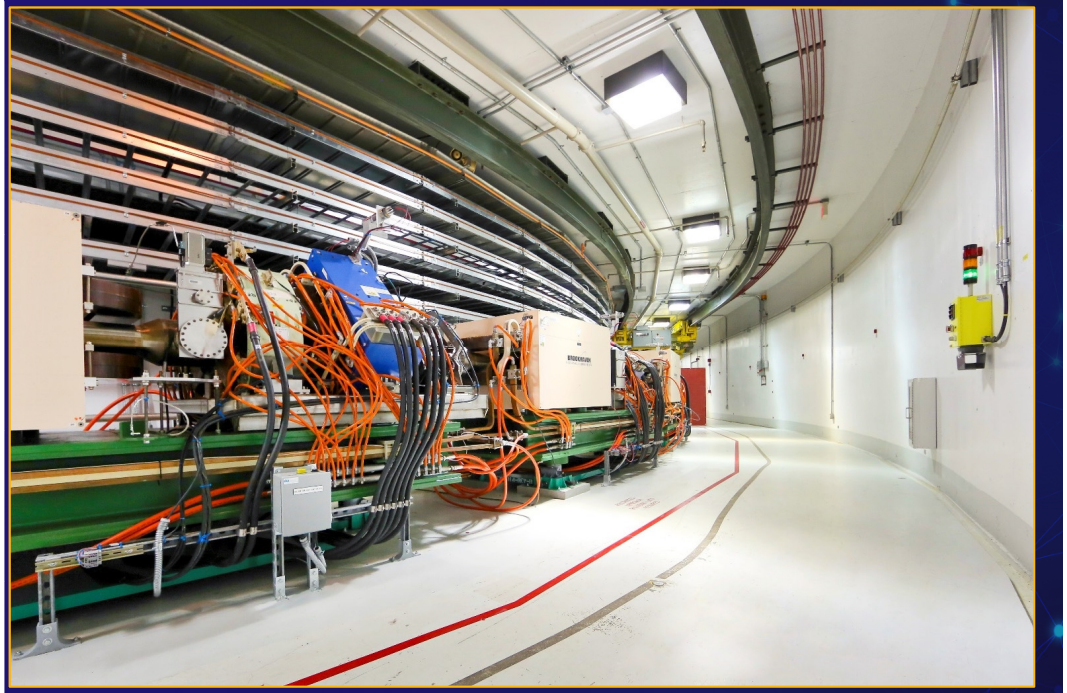
SNS has realized a number of technological firsts and is the world's most powerful pulsed neutron source

First (and only) megawatt-class pulsed superconducting proton linear accelerator and proton accumulator ring

First use of a liquid mercury target to produce high-intensity pulsed spallation neutrons at a user facility

High-voltage current modulators (HVCMs) incorporating insulated gate bipolar transistors (IGBTs)

Individual neutron event-based data acquisition



Nature's accelerators: cosmic rays can be vastly faster than manmade accelerators (think 300 million trillion electronvolts) part of the reason not to fear artificial black holes

SNS drew on expertise from six national labs; LANL designed and built the linear accelerator and RF system

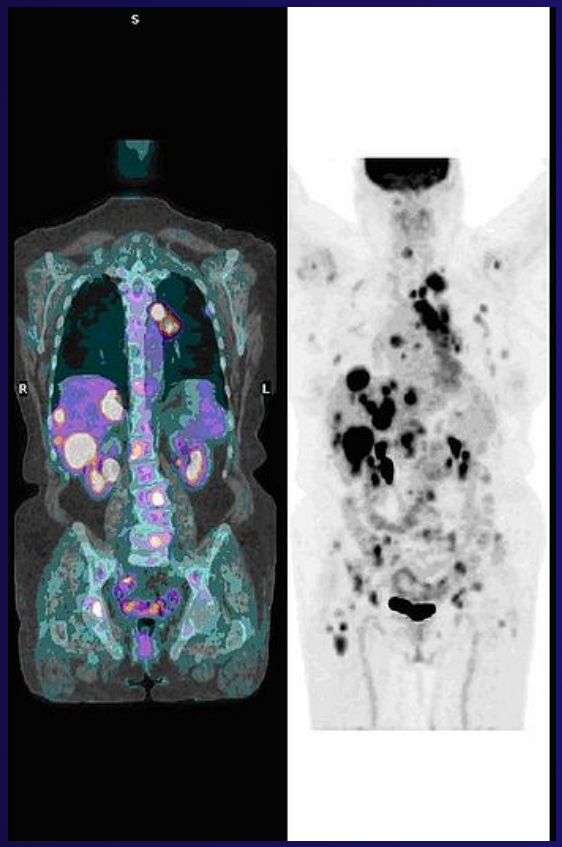
Modern machines can accelerate particles to almost lightspeed (~186,000 miles per second).

LANSCE is one of the world's most versatile accelerator facilities

- The Los Alamos Neutron Science Center (LANSCE) delivers protons & neutrons to five nearby facilities, all with different capabilities
- This linear accelerator accelerates protons to about 84% lightspeed (800 MeV), providing particles for national security

Ernest Lawrence named the first hadron accelerator the Cyclotron.

Isotopes from LANL help medical patients around the world



The Isotope Production Facility is one of the five facilities that accepts beam from the LANSCE accelerator

IPF uses protons to generate radioactive isotopes that:

- Show where diseases like cancer have taken root in the body
- Maximize damage to tumors while reducing impact to surrounding tissue
- Diagnose cardiac disease

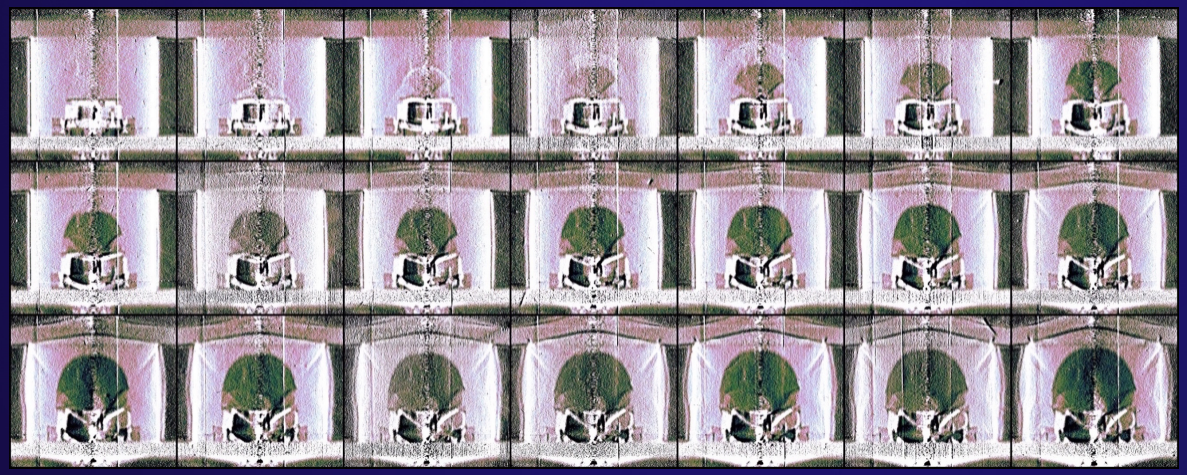
The Lab is a major supplier of diagnostic isotopes Sr-82 and Ge-68

Researchers are scaling up production of Ac-225, an alpha-emitting isotope in FDA trials for treating cancer

Modern Phineas Gage: a Russian scientist was accidentally zapped in the head by the U-70 Synchrotron. Shockingly, he survived.

LANSCE particles can film materials at extremes

- In the 90s, nuclear physicists at LANL created lens-focused charged particle radiography, a technique that takes fast radiographs of dynamic systems, like x-rays of explosions and implosions
- Users at the Lab's Proton Radiography (pRad) facility now use elementary particles called protons to understand how material behaves in extreme conditions



Radiographs from a recent shot studying the initiation of insensitive high explosives with a booster system.

Accelerators have produced a quark-gluon plasma, a state of matter that may have existed in the universe's first moments.

What's in store for LANSCE:

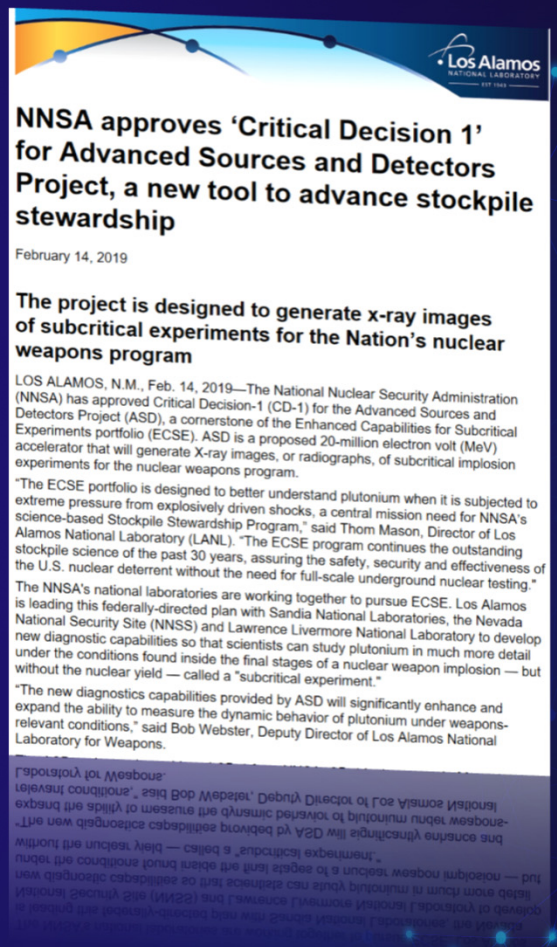
- 2019 Run Cycle to start June 19
- New spallation target at the Lujan Center in 2020
- Pu@pRad being re-established to fill a gap in NNSA missions

A technician catalogs one of the hundreds of magnet power supplies that keep the LANSCE accelerator operating efficiently.

SLAC's main accelerator runs right underneath I-280 in California.

What's next? ECSE

- **ECSE is a portfolio of projects designed to see what happens to plutonium hit with extreme pressure from explosively driven shocks**
- **ECSE is planned for Nevada National Security Site's U1a Complex**
- **President's proposed budget for the coming year fully supports the ECSE budget plan**



Los Alamos NATIONAL LABORATORY

NNSA approves 'Critical Decision 1' for Advanced Sources and Detectors Project, a new tool to advance stockpile stewardship

February 14, 2019

The project is designed to generate x-ray images of subcritical experiments for the Nation's nuclear weapons program

LOS ALAMOS, N.M., Feb. 14, 2019—The National Nuclear Security Administration (NNSA) has approved Critical Decision-1 (CD-1) for the Advanced Sources and Detectors Project (ASD), a cornerstone of the Enhanced Capabilities for Subcritical Experiments portfolio (ECSE). ASD is a proposed 20-million electron volt (MeV) accelerator that will generate X-ray images, or radiographs, of subcritical implosion experiments for the nuclear weapons program.

"The ECSE portfolio is designed to better understand plutonium when it is subjected to extreme pressure from explosively driven shocks, a central mission need for NNSA's science-based Stockpile Stewardship Program," said Thom Mason, Director of Los Alamos National Laboratory (LANL). "The ECSE program continues the outstanding stockpile science of the past 30 years, assuring the safety, security and effectiveness of the U.S. nuclear deterrent without the need for full-scale underground nuclear testing."

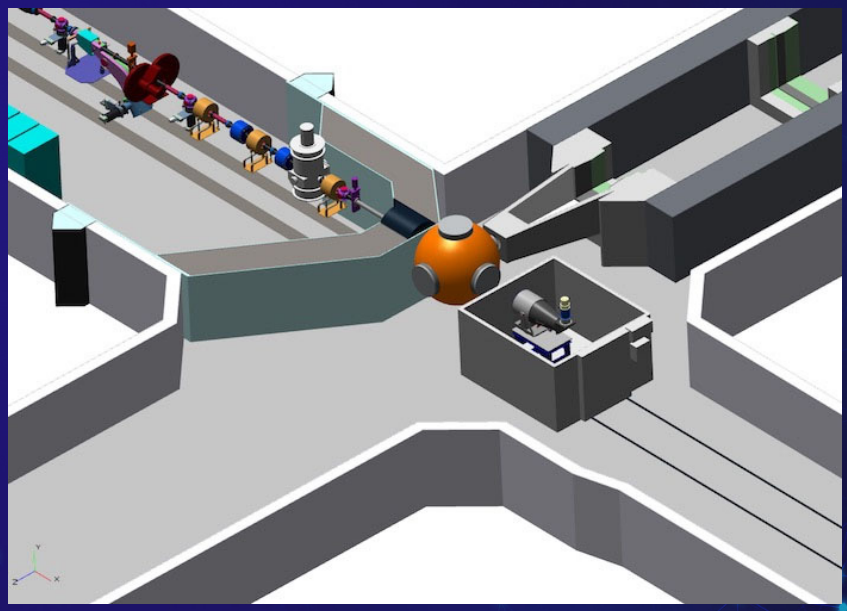
The NNSA's national laboratories are working together to pursue ECSE. Los Alamos is leading this federally-directed plan with Sandia National Laboratories, the Nevada National Security Site (NNSS) and Lawrence Livermore National Laboratory to develop new diagnostic capabilities so that scientists can study plutonium in much more detail under the conditions found inside the final stages of a nuclear weapon implosion — but without the nuclear yield — called a "subcritical experiment."

"The new diagnostics capabilities provided by ASD will significantly enhance and expand the ability to measure the dynamic behavior of plutonium under weapons-relevant conditions," said Bob Webster, Deputy Director of Los Alamos National Laboratory for Weapons.

Fermilab once used a ferret named Felicia to clean miles of underground beam line. She was eventually replaced by a robot. *Bye, Felicia.*

ECSE's 'Scorpius' project will help steward the stockpile

- One of the ECSE's 10 projects, nicknamed Scorpius, is a proposed 20-MeV accelerator for x-raying subcritical implosions
- Experimental campaigns using Scorpius will radiograph subcritical implosion experiments using real plutonium



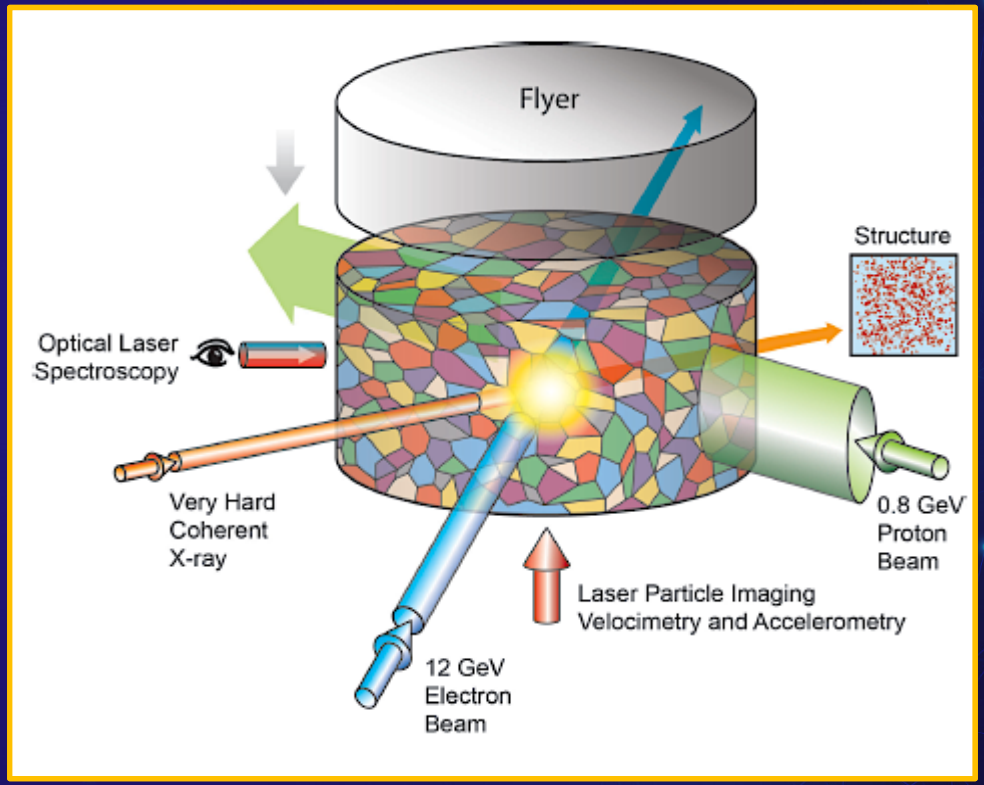
SLAC's linear accelerator is the longest in the world.

Anticipating national & energy security needs with DMMSC

What is DMMSC?

- **Dynamic Mesoscale Materials Science Capability is a proposed R&D capability that would benefit modern national security and energy security**
- **Would show how materials age, behave, and interact under dynamic conditions**

DMMSC will use experiments combined with high-performance computing to validate future high-fidelity models

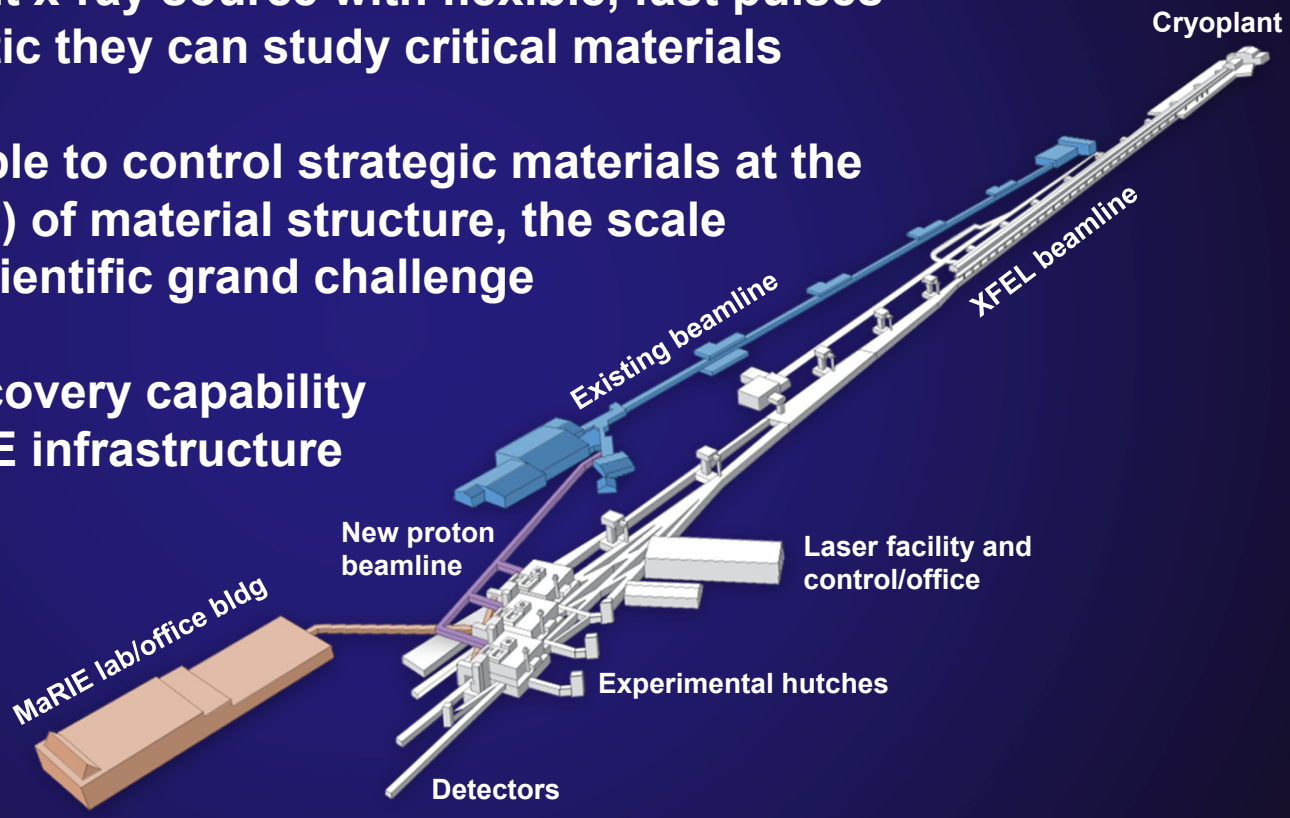


Above, a potential experimental setup for predicting dynamic microstructure and damage evolution.

An accelerator produced the world's hottest manmade temperature—7.2 trillion ºF, or 250,000x hotter than the Sun's core.

MaRIE is LANL's high-tech architecture that could fill the DMMSC need

- **Matter-Radiation Interactions in Extremes (MaRIE) would be a laser-like, brilliant x-ray source with flexible, fast pulses that are so energetic they can study critical materials**
- **MaRIE would be able to control strategic materials at the middle (mesoscale) of material structure, the scale recognized as a scientific grand challenge**
- **This materials discovery capability would use LANSCE infrastructure**



CERN's Large Hadron Collider is 5 miles in diameter. The first circular particle accelerator? Fewer than 5 inches across.

Questions?

Two people filed a lawsuit to stop the Large Hadron Collider from operating & producing a black hole powerful enough to "destroy the world."