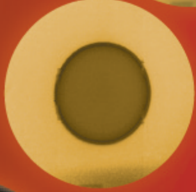
LANSCE

Los Alamos Neutron Science Center

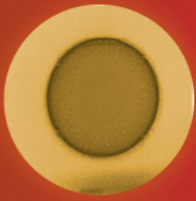
Proton Radiography (pRad)

The pRad Facility at LANSCE

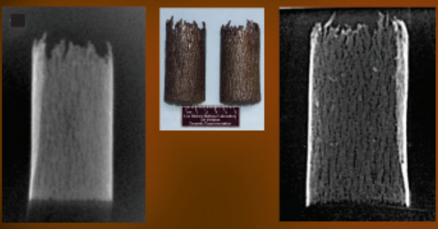
Understanding how materials react dynamically is essential to Los Alamos National Laboratory's work in conventional and nuclear explosives—but how does one "see" into explosively driven materials?



The proton radiography (pRad) facility at LANSCE provides a unique way to study the properties of energetic materials and the effects of explosively driven shocks. Proton radiography can provide a motion picture of an explosion.

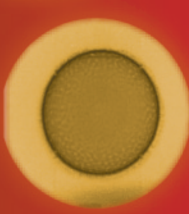


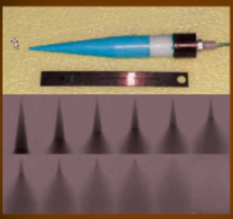
These pRad images show (top to bottom) the time sequence of a fragmentation experiment performed on a strategically interesting material, uranium alloyed with 6 percent niobium.



Three Views: The photograph at center above shows the two halves of a cylinder that were recovered after the cylinder underwent dynamic experimentation. The cylinder was expanded and then stopped at about 65 percent overall strain. The image at left is a static x-ray of a piece of the cylinder (the piece at left in the center photograph). Pictured at right is a static proton radiograph of the half cylinder shown on the right in the center photograph.

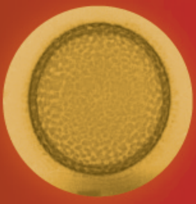
In fiscal year 2002—a record year—the pRad team, a collaboration of the Physics, Dynamic Experimentation, Applied Physics, and LANSCE Divisions at Los Alamos, carried out 42 dynamic pRad experiments. These experiments were done in support of weapons-physics efforts at Los Alamos, Sandia, and Lawrence Livermore National Laboratories in the United States, and the Atomic Weapons Establishment in the United Kingdom. The experiments provided information on such phenomena as burn characteristics of high explosives and failure mechanisms in metals. The 42 shots brought to 156 the total number of dynamic pRad experiments performed at LANSCE, and for all these shots, LANSCE provided protons with 100 percent reliability.

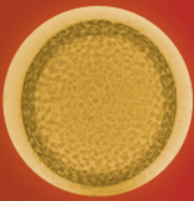




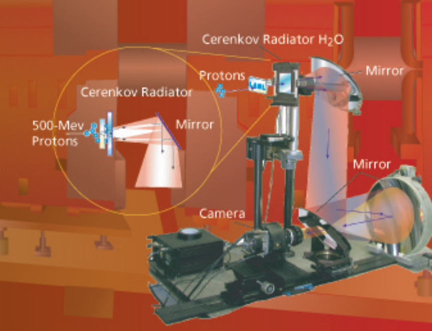
In the illustration above, the object at top is a "failure cone" designed to study the detonation characteristics of the explosive PBX-9502. The center and bottom bands in the illustration show proton radiographs taken during detonation of the failure cone.

In the pRad process, the LANSCE linear accelerator provides 800-million-electron-volt protons that penetrate the dynamic system. The protons are delivered in a series of 50- to 100-nanosecond pulses. They interact with the material of the dynamic system inside a containment vessel and undergo scattering that is proportional to the thickness of the material.





Recently, the pRad team has designed, built, and successfully tested a new proton radiography microscope. The team has also successfully imaged very thin systems by using Cerenkov light to measure the energy loss of protons in the object, a technique that improved contrast by a factor of approximately 40.



The photo above shows a new radiographic imaging system that was installed to study the use of Cerenkov light rather than scintillation light to image proton distribution in pRad experiments.

Proton Radiography

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