LA-UR- 11-01362

Approved for public release; distribution is unlimited.

Title:	Proton Radiography studies the strength of materials at very high strain-rates
Author(s):	B.J. Hollander (P-25), for the Proton Radiography collaboration
Intended for:	LANSCE Highlights

Los Alamos
NATIONAL LABORATORY
EST. 1943

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the Los Alamos National Security, LLC for the National Nuclear Security Administration of the U.S. Department of Energy under contract DE-AC52-06NA25396. By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

Form 836 (7/06)

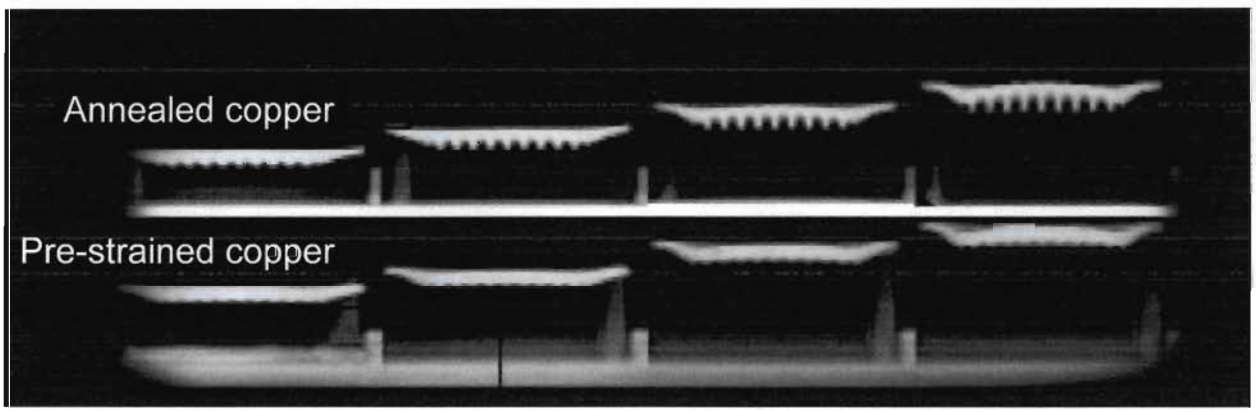
LANSCE Highlights – Feb. 2011

Colleagues,

The proton radiography facility is one of LANSCE's unique capabilities. This month we will feature a science highlight related to materials behavior under extremes utilizing the Proton Radiography Facility

Proton Radiography studies the strength of materials at very high strain-rates

A series of proton radiographs showing the evolution of instability in two copper samples manufactured with different processing techniques. The data are multiple frames from a single event taken at 1 microsecond intervals using proton radiography at LANSCE



Proton radiography provides an ideal probe to diagnose dynamic materials under extreme pressures, strains, and strain rates. The depicted experimental series, utilizes a flat metal plate with perturbations of known wavelength and amplitude machined into one side of the plate. The detonation products from high explosives (HE) rapidly accelerate the sample, generating shock-free, planar loading on the perturbed side of the plate. This sinusoid acts as a seed for the onset of Raleigh-Taylor (RT) instability growth as the sample accelerates. The perturbation growth rate is directly related to the dynamic yield strength of the metal. The growth of the RT fingers depends sensitively on the initial conditions of the material, which vary with processing. Thus, the slower-growing fingers in the pre-strained (stronger) sample reveal that it resists high strain-rate deformation more than the annealed (softer) sample. The amplitude of the RT unstable perturbations are measured from radiographs aqcuired as a function of time. These experiments provide data to validate the calculations that model such behaviors under extreme conditions. This technique has been used to investigate the high strain-rate strength of different metals manufactured under various processing techniques.