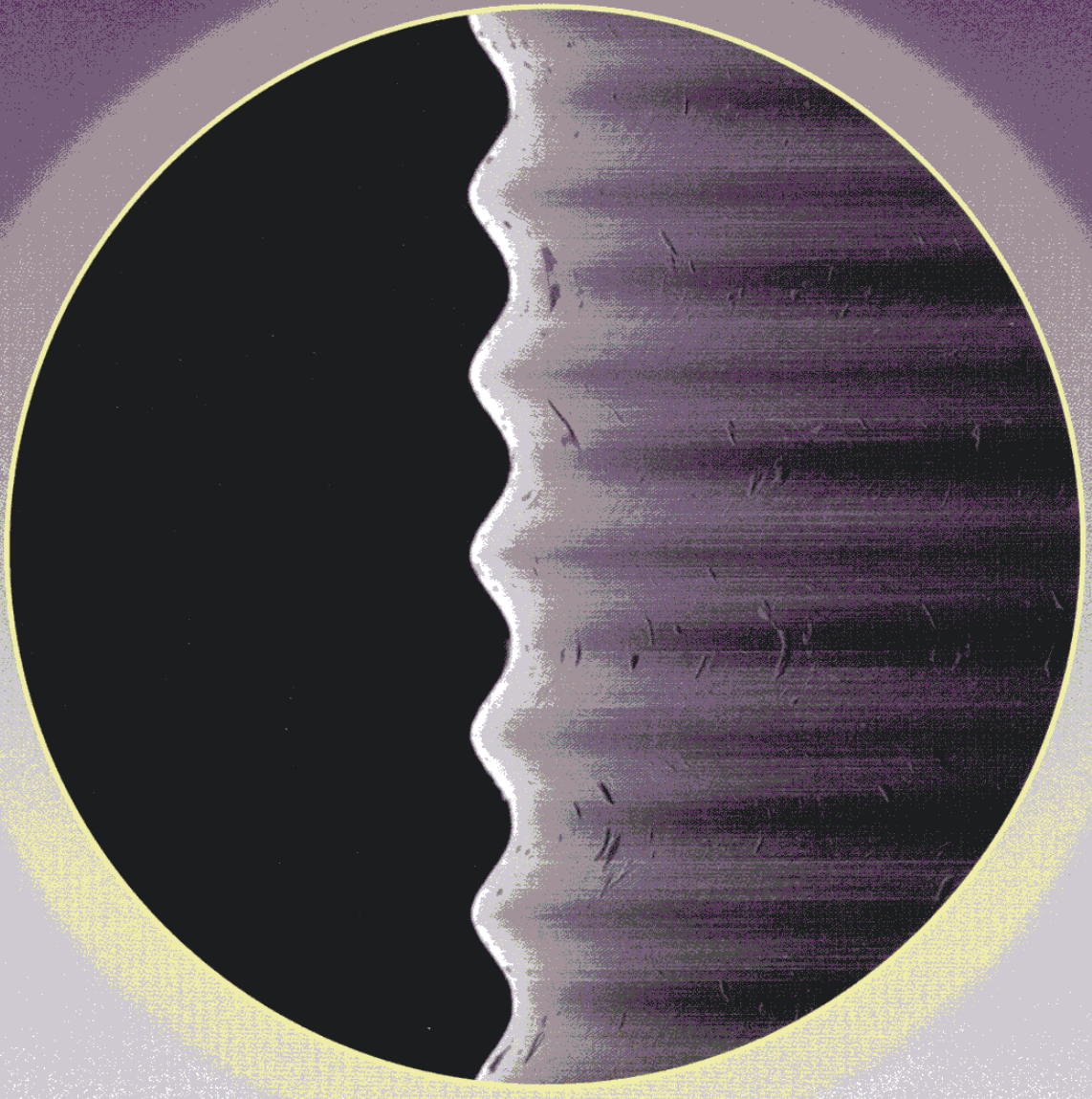
nuclear weapons journal



Winter 2004

- Validation Experiments
- Atlas
- Shock-Driven Instability
- Ion Beam Analysis
- Monitoring HE Aging
- Teflon Impact Response

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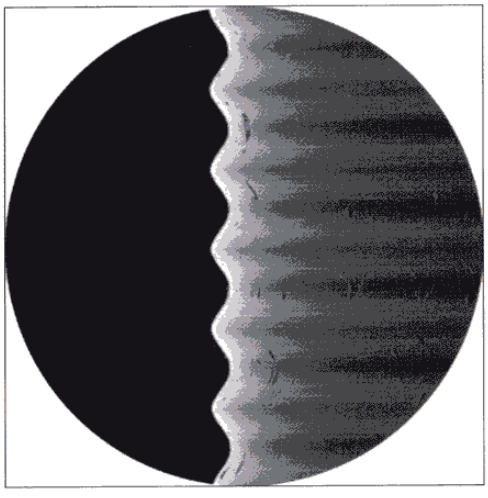

About the cover: Scanning electron micrograph (SEM) of the unstable interface in a Richtmyer-Meshkov hydrodynamic experiment performed using the OMEGA laser, showing a portion of the cylindrical target before the experiment. The laser strikes a layer of epoxy left of the figure and drives a strong shock into the cylinder, causing an implosion and initiating instability at this interface.The sinusoidal perturbations, machined into a thin aluminum layer, have a wavelength of 9 μm and peak-to-peak amplitude of 2 μm. *SEM courtesy of Norm Elliott, MST-7.*

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Correction: The "Backward Glance" in the September/October 2003 issue stated that George Gamov remained a Russian citizen after he fled the Soviet Union in 1933. In fact, he and his wife Rho (Luybov Vokhminzeva) became naturalized American citizens as soon as possible. They were proud of their American citizenship and traveled widely with their American passports. Only under Soviet law and in that territory did they remain Russian citizens. (We thank George's son, Igor, and his wife Elfriede for this information.)

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National Nuclear Security Administration

Sustaining Our Credibility: Balancing Experiments and Calculations

The quest to do science-based prediction in support of nuclear weapons stockpile stewardship is an enormous challenge for two reasons: the complexity of the physics in the weapons and the current prohibition against testing full systems. A major issue in nuclear stockpile stewardship is the need to develop computer codes that accurately simulate weapons behavior. Developing predictive capability in these codes requires validation science, which is a combination of experiments, theoretical physics models, and computer simulations that improve our understanding of weapons physics phenomena. Validation science examines one or several phenomena at a time to improve physics models or computational algorithms; in contrast, an integrated test examines many weapons phenomena simultaneously to adjust code parameters.

Credible Predictions

The credibility of our predictions depends on how well we do our science and interpret our calculations. Computer calculations designed to simulate weapons physics have limitations that must be determined accurately by science. As we all know, the scientific method is the *sine qua non* of increased understanding, and this methodology continues to be the essential tool we use to ensure our credibility about nuclear weapons computer codes. Well-designed scientific experiments—the cornerstone of the scientific method—produce data that stringently test a hypothesis based on a physics model. Such experiments not only enable us to test whether the model explains physical reality, but also help determine the limits of applicability of particular models and computational methods.

Computer Simulations

To effectively use computer simulations for stewardship, we balance baselining and code upgrading. Modern simulation codes are baselined (calibrated) primarily against nuclear test data and largely are used to calculate intermediate states of a system, up to and beyond criticality. Large-scale experiments to test precritical states are costly, integrated, explosive tests such as hydrodynamic tests (hydrotests). In addition to nuclear tests and nonnuclear integrated tests, we can perform less costly experiments that directly explore relevant weapons physics in the context of validation science. We design these experiments to upgrade codes and assess limitations. Because these smaller-scale nonnuclear experiments vigorously support science-based prediction by improving individual models and algorithms in the codes, they are essential to stewardship. A validation experiment frequently provides a definitive evaluation of a hypothesis and consequently becomes part of the bedrock of predictive science. In contrast, integrated tests usually are engineering tests that provide data used to adjust code parameters to fit those tests. However, they say little about the validity of individual physics models or computational methods. To ensure the physical reality of the final simulation, we must supplement baselining with an aggressive validation program specifically targeted at individual physical effects, such as fluid instability. Only in this way can we ensure credible science-based predictions that support our statutory responsibility for current and future stockpile stewardship.

Supporting Stockpile Stewardship

In summary, the validation experiments must underpin science-based predictions that support the Laboratory's nuclear stockpile stewardship mission. The health of such experiments is essential for invigorating the science within the Laboratory weapons program and for fostering a culture of collaborative and cross-disciplinary research that is the heart and soul of Los Alamos.

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