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Liner Physics (LP) Experiments for Pulse Power Hydrodynamics

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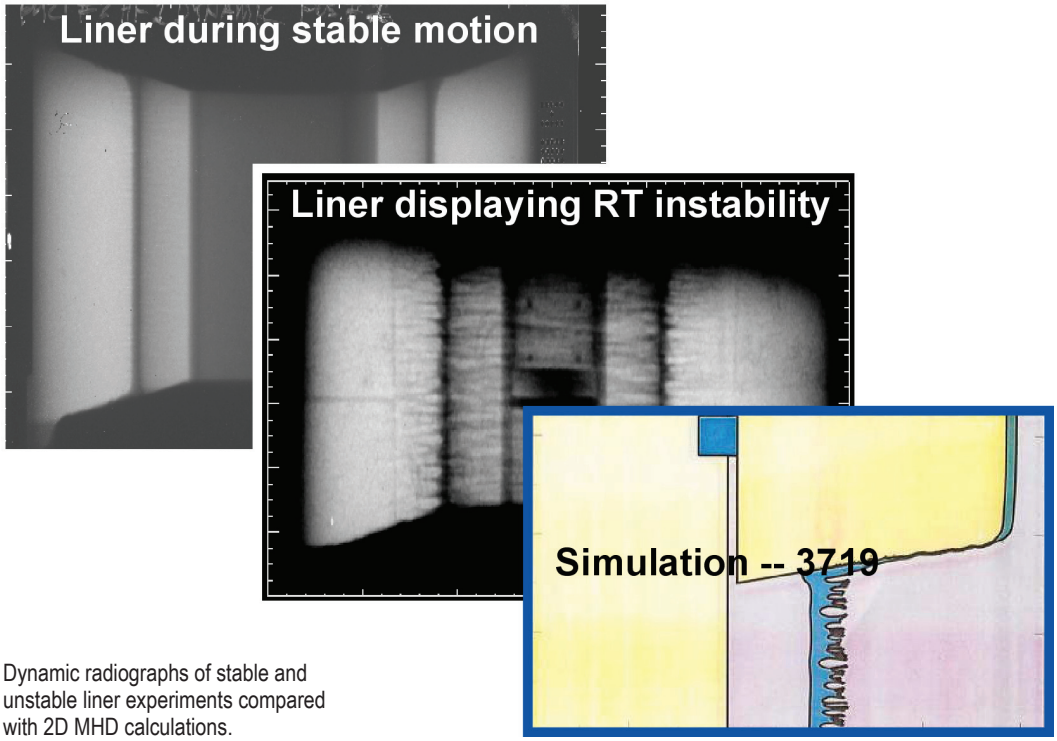
Project Description

The objective of this project is to test and improve MHD simulation capability in legacy codes and ultimately in ASC integrated codes by modeling magnetically driven, near-solid density, high precision, cylindrical imploding liner experimental data under a variety of initial conditions. These codes and models can extend the performance of magnetically imploded liners to higher drive energies and potentially higher implosion velocities, validating both hydrodynamics and materials models in the integrated codes for application to sophisticated dynamic systems. In the 1990s, an extended experimental series was conducted on the LANL Pegasus facility to study the "Liner Stability" (LS) problem (field/fluid/solid interfaces at the outer surface of cylindrical liner carrying very large electrical currents). Legacy US simulation codes with MHD capability, and Russian codes, were used, with some success, to simulate both bulk behavior of the implosion and to explore the details of interfacial behavior. In the late 1990s, the results from the LANL designed LS experiments were extended through a series of five VNIIEF-designed experiments (Russ 1-5) also exploring liner stability, but designed with both US and Russian simulation tools. Early in the series, the MHD stability of the field/metal interface was the focus of attention, and in later experiments, the behavior of liners after collision with a target was explored as well. In preparation for higher current experiments on Atlas, two experiments were conducted by VNIIEF (ALT 1,2) using a Russian pulse power system that duplicated the Atlas current waveform and provided insight into the problems to be expected at higher drive (Project: Atlas Liner Technology for Pulsed Power Hydrodynamics). By combining data from experiments and simulations, a model of liner behavior was held in fair confidence as Atlas operations began in Los Alamos in FY02. Of four "liner physics



Dynamic radiographs of stable and unstable liner experiments compared with 2D MHD calculations.

experiments" conducted in FY02, the results of the first two departed significantly from that predicted by the simulations, requiring short term modifications to both model and experiment to support the immediately following weapon physics experiments. These observations significantly challenged both the physics in the numerical models, especially the EOS models, and the ability of the integrated codes to describe a well defined, relatively simple implosion situation. Over the long-term, one or two Liner Physics (LP) experiments per year are planned to continue this investigation, and this task provides for VNIIEF participation in both simulation and experiment.

Technical Purpose and Benefits

The ability to accurately predict the dynamics of implosion systems is central to the NNSA mission to predict the behavior of complex systems. Highly detailed data from carefully controlled, magnetically driven liner experiments diagnosed with modern high precision, high resolution diagnostics, challenge current simulation capability, validating some hydrodynamic and some materials models, motivating improvements in others, and testing the ability of the integrated codes to model integrated problems.

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Collaboration between Los Alamos National Laboratory (LANL), Los Alamos, NM, USA, and the Russian Federal Nuclear Center – All Russian Research Institute of Experimental Physics (RFNC-VNIIEF), Sarov, Russia

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