Los Alamos
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High Strain/High Strain Rate (HSR) Experiments

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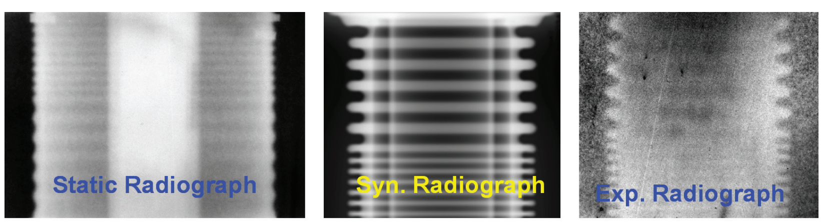
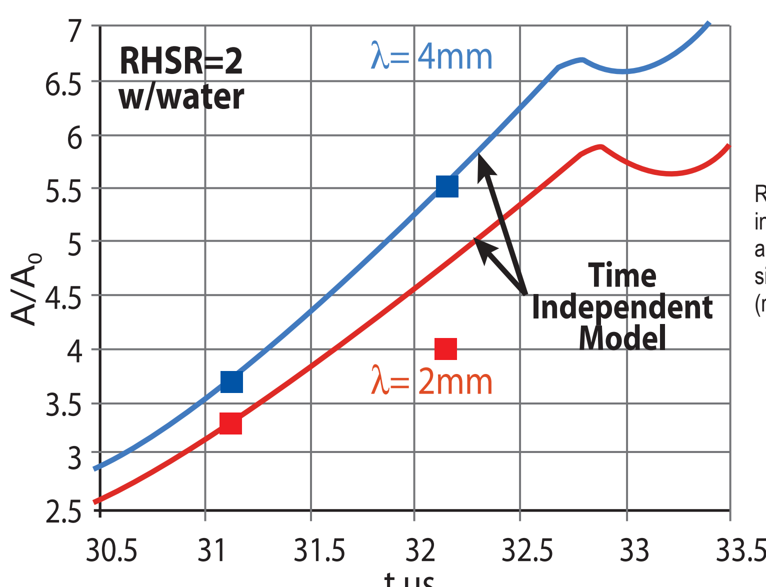
Project Description

Applying liner technology developed in previous LANL/VNIIEF technical efforts, the objective of this project is to obtain experimental data to validate existing models of the behavior of the strength of metals and polymers at high rates-of-strain in multi-dimensional strain fields and to motivate the development of new, extended strength models for use in integrated codes. A series of experiments, performed on laboratory capacitor bank facilities and on VNIIEF explosive pulsed power facilities, apply perturbation growth techniques to explore strength effects in reference metals (and possibly polymers) at conditions of high total strain and high rate of strain in converging geometry. This effort provides for the conceptual and engineering design, and for the fabrication, execution, and analysis of a series of experiments that will extend techniques first used in FY02 experiments on Atlas and demonstrated during a series of three joint LANL/VNIIEF DEMG experiments, designated R-HSR, conducted in FY03 and 04 at VNIIEF. The results of the new experiments will further expand the initial data set with the objective of quantitatively comparing Steinberg/Guinen (SG); Preston/Tonks/Wallace (PTW), MTS, and Gulschak models for strain-rate dependencies of material strength.

Conceptual design for the new series of experiments was completed in early FY03. Detailed engineering design was conducted and experiments begun in FY-04. Final analysis, completed in late FY-04 for the highly successful R-HSR-1,2 experiments reported two surprising results. The first result was a very substantial, and very unexpected, strengthening of a polymer (polyethylene) at high strain rates; and second, a similarly unexpected strengthening of M-1 copper at high strain rates. These results suggested



Static and dynamic radiographs of experimental system compared to predicted (synthetic) radiograph from simulation codes.



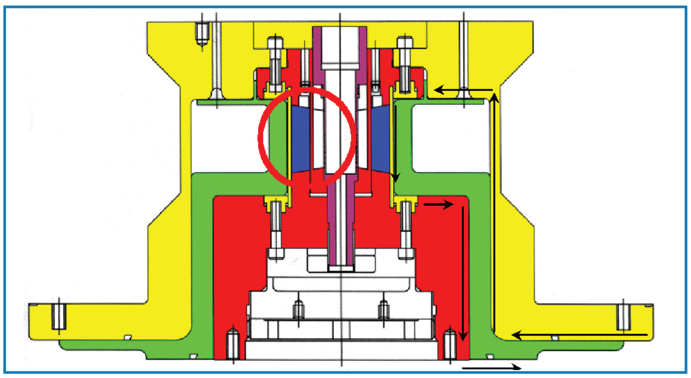
Results of FY03-04 experiments indicating good agreement between experiment and model at low strain rate (blue) but significant deviation at higher strain rates (red).

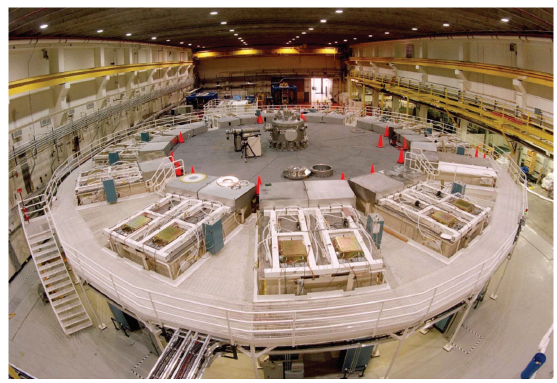
several changes to the technical approach for the new series, and a redesign of the experiments was completed in FY05 and 06 to, among other things, emphasize the effects of multidimensional strain fields that are present in the converging geometry but absent in earlier (separate) planar experiments. The new designs were technically reviewed in September 2005 and the final design report completed in FY06.

Uncertainties in the availability of the US Atlas platform in FY07 and beyond made it prudent to plan this task order to accommodate the possibility of executing the new series on Atlas or on an alternate experimental facility such as the Shiva Star system in Albuquerque or (again) using VNIIEF explosive pulsed power drive (as was demonstrated in FY03 and 04) . The additional complexity of creating final designs for two different experimental drivers has extended the time for the dual-design to late FY06 and tentatively means that the first experiments cannot be scheduled before early FY08.

Technical Purpose and Benefits

Validating material strength models under conditions of high-strain, imposed at high rates of strain, is important for accurately simulating the operation of dynamic systems. Furthermore, full-scale simulation of complex implosion experiments tests the capability of ASC codes, aids in the motivation of new and improved models, and similarly aids in code validation. Improved predictive capability is vital to the NNSA mission to achieve advanced predictive capability for sophisticated systems.





Configuration of “three layer liner” used in HSR experiments and the Atlas experimental platform at the Nevada Test Site.

ВНИИ VNIIEF

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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