HELIOS Benchmark Calculation:
Radiation-Driven Shock in Aluminum

In this *HELIOS* benchmark simulation, a planar aluminum foil is irradiated by a time-dependent external radiation field. The parameters chosen are taken from a series of Al shock breakout experiments performed at the NOVA laser facility at Lawrence Livermore National Laboratory [1]. A strong shock propagates through the Al and breaks out of the rear surface. We compare the simulated shock trajectory with experimental shock breakout data.

The radiation drive is shown in Figure 1. The external drive applied to the foil is characterized by a time-dependent radiation temperature. The drive is based on DANTE radiation flux measurements from the NOVA experiments. At each point in time the external source is assumed to have a Planckian spectral distribution. The radiation field was created in a laser-heated hohlraum, with a 2 ns flat-topped laser pulse.

A *SESAME* equation of state [2] for Al (material #3717) was used in the simulation, as were *PROPACEOS* multigroup opacities. *PROPACEOS* is a code used to generate multigroup opacity and equation of state data based on *ATBASE* atomic data [3] and physics modules in the *SPECT3D* Imaging and Spectral Analysis package [4]. Radiation transport was computed using the multi-angle short-characteristics method and 100 frequency groups.

Other parameters used in this simulation are contained in the HELIOS workspace file for the "Radiation-Driven Shock" example problem.

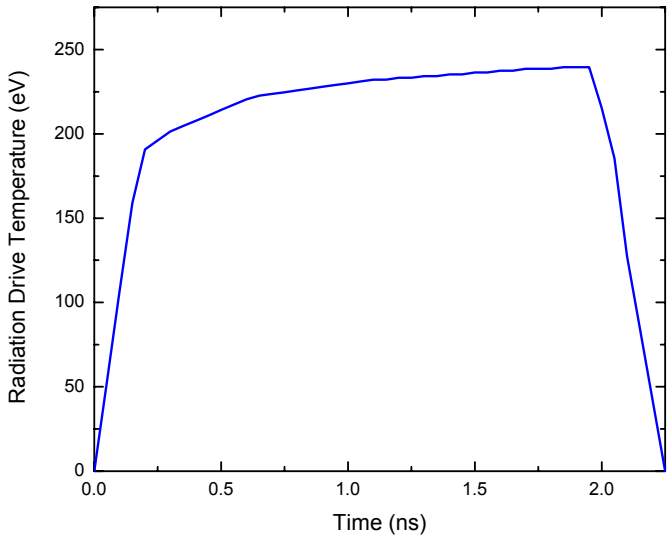

Figure 1. Time-dependent external radiation drive used for Al shock breakout benchmark simulation.

Results

Figure 2 shows the Lagrangian zone positions as a function of time (blue curves). The front of the shock in the simulation is identified by the location where the Al begins to be compressed and the Lagrangian zones begin to move. The experimental data is represented by the red triangles and circles. The agreement between the simulation and experimental shock breakout data is seen to be very good.

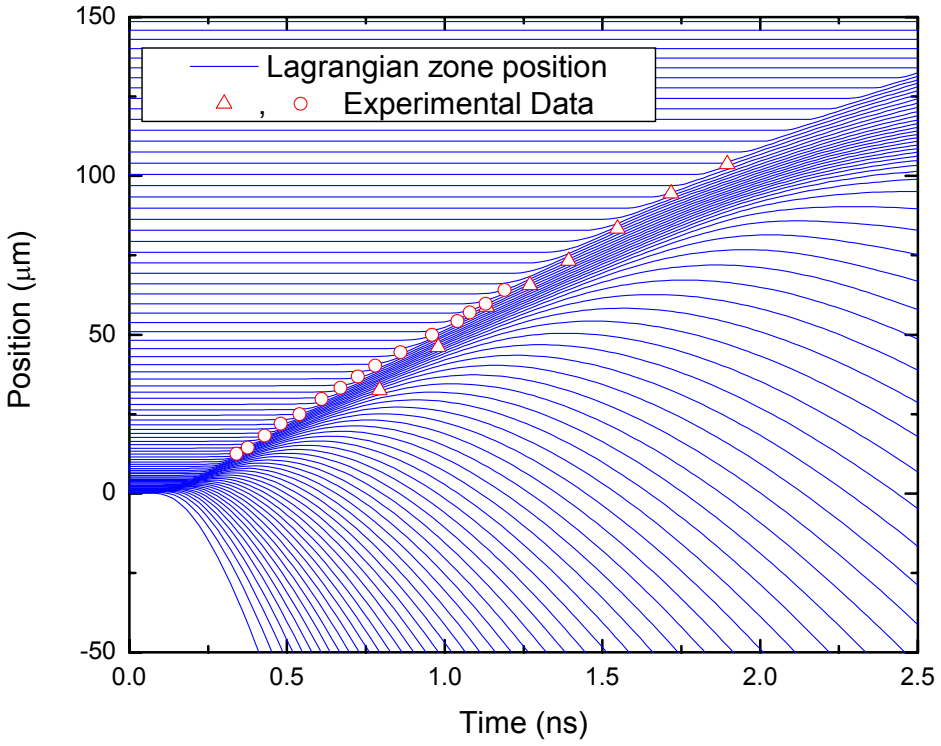

Figure 2. Comparison between Lagrangian zone positions from *HELIOS* simulation (blue curves) and experimental Al shock breakout data (red symbols).

References

[1] R. E. Olson, private communication, 1995. See also: R. E. Olson, *et al*., Phys. Plasmas **4**, 1818 (1997); R. L. Kauffmann, *et al*., Rev. Sci. Instrum. **66**, 678 (1995).

[2] "SESAME: The Los Alamos National Laboratory Equation of State Database," LANL Report No. LA-UR-92-3407, edited by S. P. Lyon and J. D. Johnson (1992).

[3] P. Wang, "*ATBASE User's Guide*," University of Wisconsin Fusion Technology Institute Report No. UWFDM-942 (1993).

[4] J. J. MacFarlane, *et al*., "*SPECT3D Imaging and Spectral Analysis Suite*," Prism Computational Sciences Report No. PCS-R-037 (2003).