Virtual National Laboratory for Heavy Ion Fusion

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HIF News

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Review of Workshop on Accelerator Driven High Energy Density Physics

On October 26-29, 2004, the HIF VNL hosted a workshop at Lawrence Berkeley National Laboratory on "Accelerator-Driven High Energy Density Physics (HEDP)." The workshop was attended by sixty five researchers, from the VNL (the HIF/HEDP groups of LBNL, LLNL, and PPPL) as well as LBNLs Center for Beam Physics, and LLNLs X-and V-Divisions, Sandia National Laboratory, University of Maryland, Fermilab, Argonne National Laboratory, SLAC, MRC, Tech X Corp, University of Nevada, Reno, and the University of Electrocommunication, Tokyo, who, together, gave representation to accelerator-, laser-, high energy density-, and computational- physics.

The first day of the workshop consisted primarily of talks, reporting on what had previously been learned about the possibilities for using heavy ion beams to heat matter to "Warm Dense Matter (WDM)" conditions. WDM studies would be relevant, for example, to both the interiors of planets and the early stages of capsule implosion for inertial fusion energy. Talks were presented on the WDM science to be obtained, the experiments needed to figure out the science, and the requirements needed to carry out the experiments. Talks were also given on the status of injector and drift compression/final focus.

Prior to the workshop, four working groups were established: 1. science, experiments and diagnostics; 2. rf-accelerator concepts, 3. Pulsed-power accelerator concepts, and 4. drift compression and final focus. On the first day representatives from the working groups gave summaries and status reports of previous work and gave goals for the workshop. The working groups met separately for the next two days to explore concepts and estimate parameters for different architectures. Although, the groups nominally met separately, there was a great deal of communication between groups, as some meetings were held jointly, and some members "floated" between groups. The final half-day consisted of plenary summary sessions.

Group 1 held wide-ranging discussions, including the impact of HEDP diagnostics on the final focus and chamber design (and whether to incorporate multiple chambers in the design of the accelerator); repetition rate requirements; ion stopping and equation of state tutorials; recent warm dense matter experiments in Japan using lasers, capabilities of short pulse lasers for diagnosing accelerator-driven WDM experiments, and accelerator flexibility. Discussions also occurred on the current state of uncertainty in the equation of state (see figure 1), and the implications for this uncertainty in designing WDM experiments.

Group 2 examined several options for the rf-accelerator approach including a multiple-beam 50 MHz linac that incorporated interdigital H-mode cavities with drift tubes, and 15 T superconducting solenoids for focusing. Multiple-beam options (16 beams) with different beamline geometries and single beam options with storage rings were considered.

Group 3 looked at both single gap and multiple gap architectures using pulsed power to provide the acceleration voltage. The single gap architectures would rely on existing diodes, at Sandia, NRL, or elsewhere. A unique "ionization front accelerator" using the potential of an electron beam to accelerate ions along an ionization path created by a laser (and previous experiments of this concept) were described. Multiple gap accelerators that were considered included the novel Broad Band Traveling Wave Accelerator, and a multiple beam, electrostatic-quadrupole focused, drift tube linac.

Group 4 examined the drift compression and final focus sections, including issues of switchyards, focusing, and interface. Finding a background, which strips ions to the desired state while providing sufficient electrons for neutralization, is a key issue for drift compression. There were discussions on various "tools" in the toolbox including neutralized drift compression, large solenoids for final focus, dipoles to stop electrons (among other purposes), solenoids to suppress instabilities, pulsed lenses to compensate tilt-induced chromatic problems, and adiabatic funnels close to the experiments.

A more detailed look at the results of the workshop will be found in the workshop proceedings that are in the process of being compiled.

(– submitted by John Barnard, Ed Lee, and Christine Celata, for the HEDP brainstorming group)

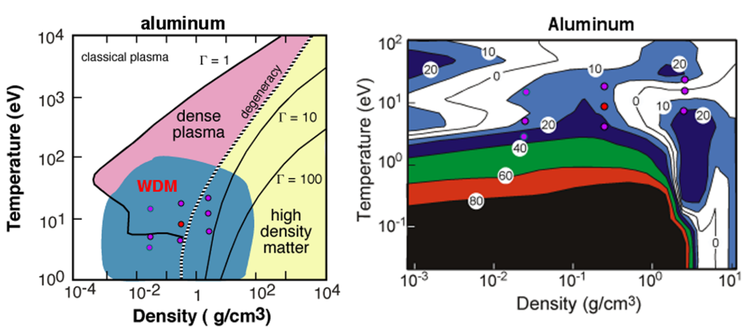

Figure 1. Temperature-Density diagrams for Aluminum. Left: Contours of the coupling parameter Γ (the ratio of the inter-ion potential energy to the temperature) over the entire High Energy Density Physic regime. Right: Contours of the percent difference in pressure, for two widely used equations of state, showing large uncertainties in the warm dense matter (WDM) regime. (Points indicate potential accelerator based WDM user facilities). (Figures courtesy, Richard Lee, LLNL).

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