Executive Summary

The goal of this work is to increase the size of the High Energy Density Laboratory Plasma (HEDLP) community by facilitating the access of University and Industry Users to the Omega Laser Facility at the University of Rochester's Laboratory for Laser Energetics (LLE). LLE operates Omega as a national User Facility for the National Nuclear Security Administration (NNSA) with approximately 30% of shot time available for peer-reviewed Basic HEDLP Science. One of the difficulties of developing the HEDLP community is the high "barrier of entry" for new University and Industry Investigators to design and propose experiments on NNSA's large HEDLP facilities. Inexperienced Users have a significant disadvantage in the review process and even experienced Users often lack the full set of design tools to develop new platforms that can elucidate the field's exciting physics. It was for this reason that OLUG strongly recommended to the LLE management the need for this design/simulation capability to support the OMEGA/OLUG external users. This proposal will facilitate the access of Users to Omega and help new Investigators develop the ability to propose and carry out experiments on the Facility in the future.

The concept for this Community Development Proposal stems directly from the two recent National Academy of Science reports that emphasize the need to pursue frontier high energy density plasma science, see Figure I.A-1. This project will help solidify the high energy density community by providing a foundation for frontier HEDLP science and a mechanism for interested new scientists to become engaged with HEDLP community. This foundation will facilitate access for principal

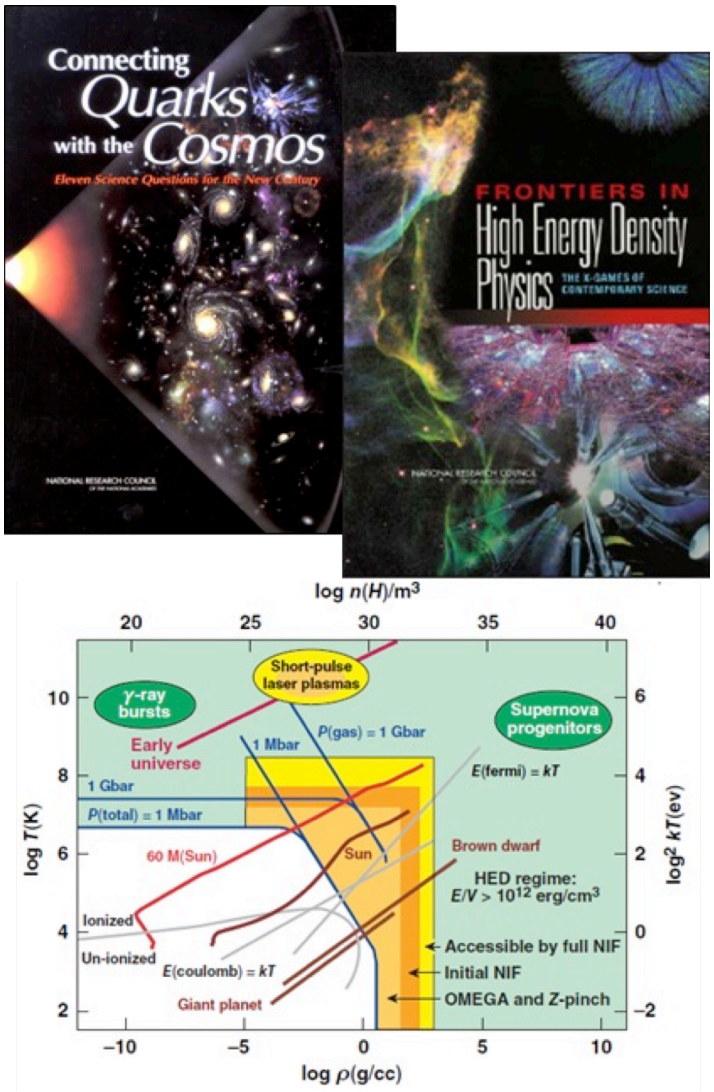

Figure I.A-1 (top) The two recent National Academy of Science reports highlight the need to pursue frontier high energy density plasma science through the development of User Facilities that have an infrastructure to support basics science research. (bottom) These reports point out the ability of HEDLP facilities to access novel regimes of matter within the laboratory which will allow the community to understand the fundamental behavior of our universe [2,3].

investigators interested in entering the field to pursue novel research at the Omega Laser Facility by providing an infrastructure that can support the development, implementation, facility access, experiments, and analysis that will bring the science of the universe to the laboratory. This is a unique opportunity to endorse HEDLP science outside of the DOE/NNSA and fuel the development of the HEDLP science community.

Two "beamline scientists" will be added to LLE's staff (one experimentalist, one theorist). In the model used at the Office of Science's User Facilities, their primary responsibility will be to provide the design- and implementation-support for current and future Users to develop, propose, and perform experiments on Omega. LLE's Coordinator for External Users will match User needs with the "beamline scientists." The addition of "beamline scientists" was a strong recommendation of both the Omega Laser Users Group [4] and the 2009 ReNeW [3] report.

This activity will grow the HEDLP community by developing experiments with groups that have no experience on large HEDLP facilities, but are interested in developing that capability. LLE has identified three co-investigators who will be teamed with an LLE Principal Investigator to develop novel experimental platforms. The co-Investigators will participate in the design, proposals in the future. The three developmental basic science experiments are:

Viscous plastic flow at extreme pressures and strain rates, co-PI: G. Ravichandran, California Institute of Technology

This team will investigate the dynamic strength properties of tantalum and iron that exhibit markedly different strength and deformation characteristics. The experiments will supply a wealth of quantitative data for model and code validation in the Mbar range. The research will execution, and analysis of the experiments, giving them the experience to make their own focus on coarse-grained molecular-dynamics schemes developed under the auspices of Caltech's ASC/PSAAP Center for the Predictive Modeling and Simulation of High Energy Density Dynamic Response of Materials.

Improved x-ray based diagnostics of warm dense matter, co-PI: Gerald Seidler, University of Washington

The ability to determine the state variables and structure of high atomic density, high temperature phases is a continuing challenge in the HEDP community. Prof. Seidler's team will develop new dispersive-mode x-ray spectrometers based on coupling a polycapillary collimator to a curved Bragg dispersing element. These instruments will have extremely high net collection efficiencies and numerous applications in warm dense matter (WDM) research. Newly-enabled LLE-based experiments on the thermometry of WDM and the structure of two-component WDM will be performed.

Particle acceleration from magnetic reconnection, co-PI: Hantao Ji, Princeton University

Magnetic reconnection is a ubiquitous astrophysical phenomenon in which magnetic energy is converted into kinetic energy. The unique high energy Petawatt OMEGA EP beams will generate collisionless magnetized plasma plumes that will reconnect as they expand. The spectrum of energetic particles as a function of local parameters (e.g. collisionality) and global parameters (e.g. driving energy) will characterize the particle acceleration due to reconnection. The information on the particle energy spectrum is new, and essential for understanding how

collisionless reconnection proceeds in such contexts as solar flares and Poynting flux driven astrophysical jets.

In summary, this proposal will develop the HEDLP community by lowering the "barriers to entry" for University/Industry Users to develop, propose, and carry out experiments on the Omega Laser Facility. This will be carried out in two parts; the addition of "beamline scientists" to LLE's staff to aid both new and current Users, and bringing new scientists into the HEDLP community by developing experiments for the Omega Laser Facility in collaboration with LLE scientists.

This proposal will deliver:

- New opportunities for University/Industry Users to develop advance HEDLP platforms and experiments,
- New Users for the nation's large-scale HEDLP User Facilities,
- Novel scientific results and publication in major journals.

The requested funding will support the "beamline scientists," the Investigators performing novel basic science experiments and provide the Omega Laser Facility time to carry them out.