First plasma on the Plasma Liner Experiment (PLX)

After about a year-and-a-half of facility construction, first plasma was achieved on Sept. 13, 2011 on the Plasma Liner Experiment (PLX) [Fig. 1], a project funded by the DOE Office of Fusion Energy Sciences under the NNSA/SC Joint Program in High Energy Density Laboratory Plasmas (HEDLP). The project's goal is to explore and demonstrate the feasibility of forming imploding spherical plasma liners that can reach 1 Mbar of peak pressure using modest pulsed power plasma railgun drivers. Such imploding plasma liners may be useful as a unique and cost-effective method for generating cm- and μs-scale plasmas for fundamental HEDLP scientific studies, as well as a non-destructive "standoff driver" for compressing magnetized plasma to fusion conditions (i.e., magneto-inertial fusion). A modeling paper was recently published describing the physics and scaling of imploding plasma liners [T. J. Awe et al., Phys. Plasmas 18, 072705 (2011)].

In addition to basic plasma gun diagnostics, three initial physics diagnostics were online for the first few shots including a fast framing CCD camera, a survey spectroscopy system, and a photodiode array. Both camera images [Fig. 2] and argon spectra [Fig. 3] showed that plasma was indeed achieved. Experimental physics campaigns on single jet propagation will commence after further plasma gun performance optimization is completed over several more days. An eight-chord interferometer is also ready for operation.

The physical evolution of a single plasma jet will be studied for a few months before proceeding to studies of two merging jets, and then finally to studies of 30 jets to form spherically convergent plasma liners to reach 1 Mbar.

The PLX project is a multi-institutional collaboration led by LANL and includes HyperV Technologies Corp., the University of New Mexico, and the University of Alabama in Huntsville. Independently funded collaborators who also support the PLX project include Far-Tech, Prism Computational Sciences, Tech-X Corp., and Voss Scientific. The local project team in P-24 includes Scott Hsu (project PI), Tom Awe (postdoc), John Dunn (technologist), Elizabeth Merritt (UNM Ph.D. student), Colin Adams (UNM Ph.D. student), Josh Davis (post-BS student), and Jacob Schwartz (2011 summer student from UCLA). Sam Brockington of HyperV was at LANL during the first shots, advising on the operation of the plasma gun which was supplied by HyperV.

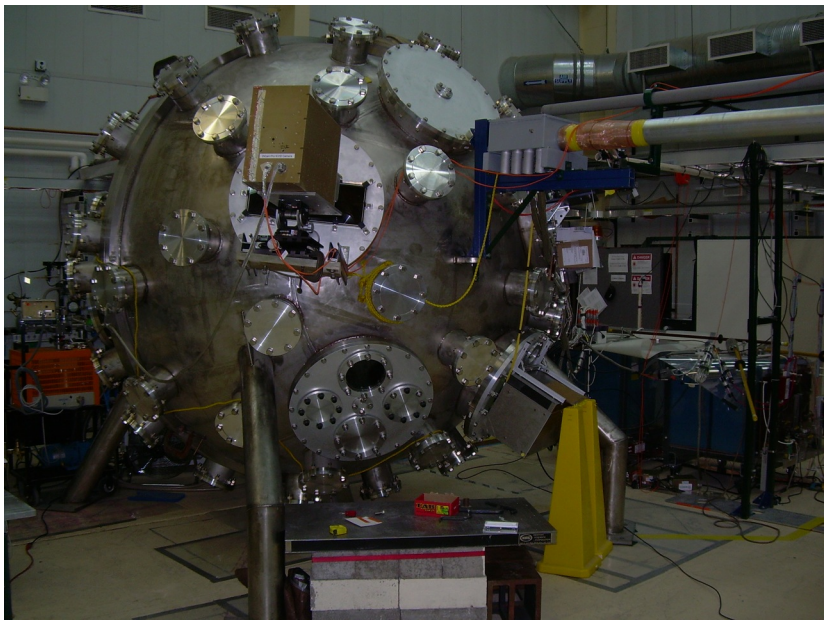

Figure 1. A photograph (taken 9/14/11) of the PLX facility, the centerpiece of which is a 9' diameter spherical vacuum chamber. The facility is located at TA-35.

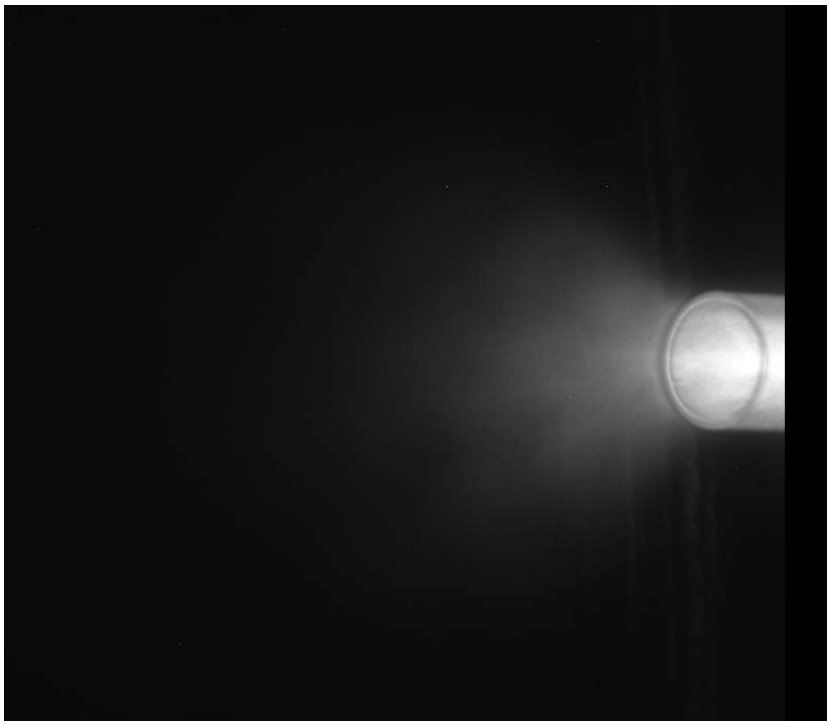

Figure 2. A visible and near IR CCD camera image (shot 6, taken 9/13/11) of argon plasma emerging from the nozzle of a plasma railgun. The plan for PLX is to use 30 such railguns to form an imploding spherical plasma liner.

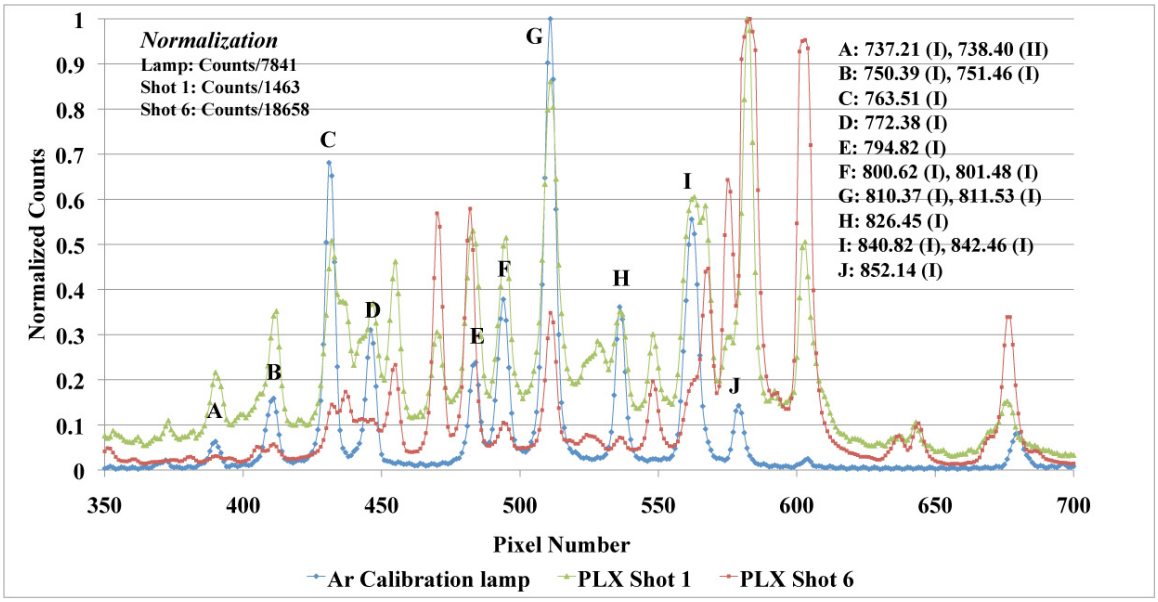

Figure 3. Argon line spectra (recorded 9/13/11) from a visible and near IR survey spectrometer system looking near the exit of the plasma gun nozzle. Plot courtesy of Tom Awe.