# §27. Researches on Compression and Heating of Cryogenic Target and Related Physics

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**Status of LFEX laser**

In the April, 2006, the installation of optical components into two beams of the heating laser (Laser for Fusion Experiment; LFEX), for FIREX-I (Fast Ignition Realization Experiment) was installed and the first light was successfully operated [1]. We successfully operated the laser at 4kJ at a narrow band and 3 kJ at a broad band that is required for the full power short pulse laser. Namely these results are very promising to achieve initial demands of 10 kJ/10 ps/1.06 μm. Along with construction of the laser, a huge vacuum chamber for pulse compression was installed. The present outlook of the chamber is shown in Fig.1.

**Target development**

Development of cryogenic foam targets are continued as the collaboration program between Osaka University and NIFS (National Institute for Fusion Science). Proof of principle of cryogenic foam target was demonstrated under collaboration with General Atomics in addition to above NIFS-ILE collaboration. Pictures in Fig. 2 show a dry, partially filled and fully filled foam shell with liquid hydrogen, respectively. These photographs show that foam layer can support the spherical fuel layer under existence of the cone and the gravity.

**Plasma experiment**

Good understanding and control of hydrodynamics of targets with a cone for the Fast Ignition scheme are the most critical elements for the success of the FIREX program. Employing the ultra-fast x-ray imaging technique, we have observed the non-symmetric implosion hydrodynamics of the spherical target with a gold cone by using a new ultra-fast x-ray imaging technique: McSIXS (Multi-channel multi-imaging x-ray streak camera). Structure and movement of the core as well as its temperature distribution were clearly observed with a temporal resolution of 24 ps. It was found that the core was created at the center, and then, moved towards the cone tip. The plasma flow stagnates at the cone tip to break the top of the cone.

**Integrated simulation of fast**

Two-dimensional simulations of cone-guided implosions are performed to study and design a fast ignition target, especially for FIREX-I using 2-D radiation hydrodynamic code, PINOCO. We have distinguished the effect of radiation transport on implosion dynamics. The surface of the gold cone is irradiated by the X-rays emitted from the CH shell. Coating CH on the cone surface is one approach as well as the coating shell by thin high-Z material.

About the generation of high energy electron for heating the core plasma, two-dimensional large scale Particle-in-Cell simulation of generation of high energy electron is executed to optimize the cone angle. In the result, the Sub-MeV electrons which are preferable for heating core plasma in fast ignition are mostly generated in 30-degree cone target, where surface acceleration takes place.

Concerning the heating core by hot electron beam, Fokker-Planck simulation (FIBMET) was performed to estimate the requirement of the electron beam conditions for FIREX-I.

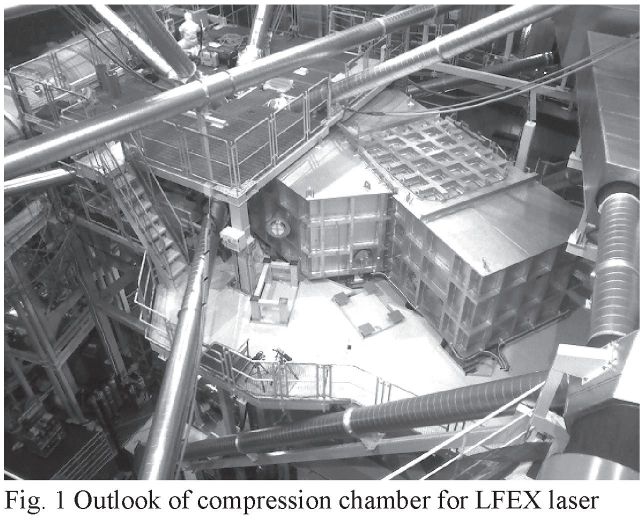

Fig. 1 Outlook of compression chamber for LFEX laser

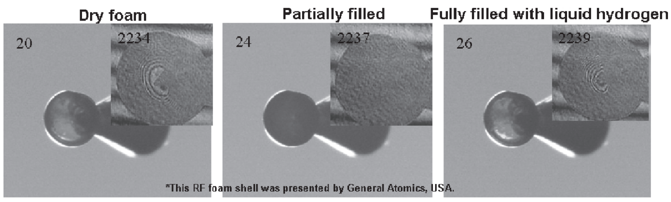


Fig. 2. Liquid $H_2$ filed in foam shell