5P04

激光XII号レーザーで駆動した磁気圧縮を用いた非線形ゼーマン分光への挑戦

Design of Zeeman spectroscopy experiment with magnetized silicon plasma generated by GEKKO-XII

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Compressing a strong seed magnetic field by laser driven implosion makes it possible to generate a strong magnetic field of more than 10 kT on the Earth. 10 kT is close to a strength on the surface of a compact star like a white dwarf. Magnetic field strength is one of the most important parameters for understanding the structure of the compact stars. Zeeman effect is frequently used as a measure of the magnetic field in the astronomical observation. High power laser facilities provide possibility to simulate the astronomical Zeeman effect in the laboratory under controlled conditions.

We will use two capacitor coil targets to generate ~100 T seed field and compress the seed field by laser driven implosion. As Silicon is one of the abundant materials in the universe, a cylindrical polyimide shell filled with a low density SiO_2 foam (1 mg/cm^3) will be placed in the magnetic field and the cylinder surface will be irradiated by high power laser. The seed magnetic field is compressed by the plasma shell converging to the center of the shell, SiO_2 becomes a plasma having ~10^{22} cm^{-3} of electron density and ~100 eV of electron temperature at the peak compression timing. The magnetized SiO_2 plasma emits soft X-rays and the soft X-rays will be measured with a grazing incident soft-X-ray spectrometer from the direction along the cylinder axis.

According to the simulation results, at the peak compression timing, the Zeeman splitting of a Si line (96 eV) is calculated to be 3.4 eV in ~10 kT magnetic field which is measurable with the spectrometer. This splitting is measurable with the spectrometer ($\Delta\lambda/\lambda > 1/100$). Compressed magnetic field strength will be measured by using an independent proton radiography technique. This experiment will give astrophysicists valuable information to deepen the understanding of the universe.

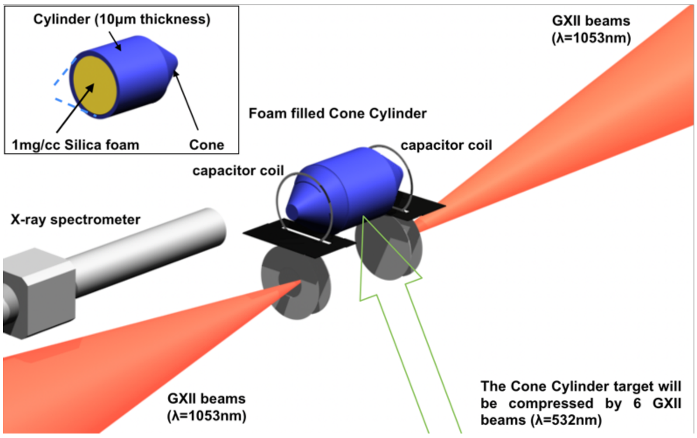

Figure 1. Experimental setup.

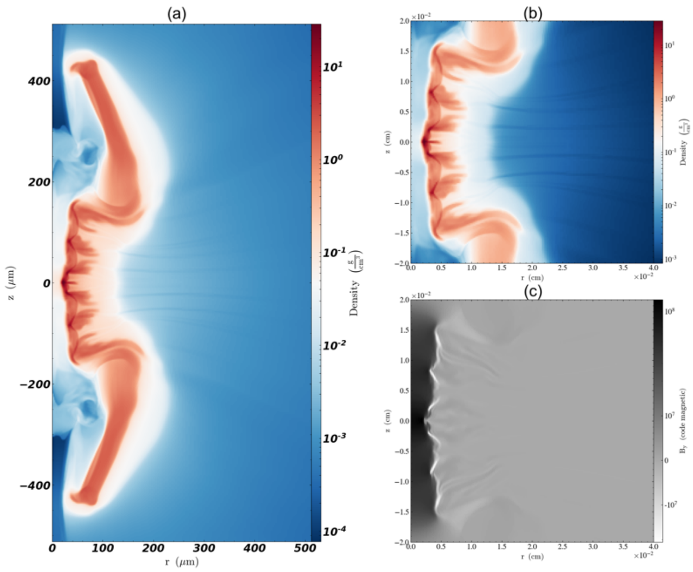

Figure 2.
(a). Hydrodynamics calculation results.
(b) The mass density distribution of the central area at the maximum compression timing.
(c). The B-field distribution of the central area at the maximum compression timing.