§4. Applications of Phase Conjugate Mirror to Thomson Scattering Diagnostics

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We have proposed a multi pass Thomson scattering method employing phase conjugate mirrors based on stimulated Brillouin scattering (SBS-PCM). [1] The multi pass method has a possibility of high repetitive measurement. The advantage is that only one laser is enough for high repetitive measurement. In the multi pass method with SBS-PCMs, SBS-PCMs are installed facing each other through the plasma. A pulsed laser beam is confined between a pair of SBS-PCMs by controlling the polarization state of the laser beam. Therefore the pulsed laser beam is shuttled between SBS-PCMs, the scattered light is generated whenever the laser beam passes through the plasma. A reflected beam by the SBS-PCM returns on the same path as the incident beam by means of the phase conjugation of the optically nonlinear stimulated Brillouin scattering process. Consequently alignment free operation is available except for initial adjustment, and this is another advantage of this method.

To demonstrate the multi pass Thomson scattering method, we are considering the proof-of-principle tests in LHD as shown in Fig.1. Since a Brillouin gain coefficient is inverse proportional to line width of the laser, single longitudinal mode is necessary to obtain the high reflectivity of the SBS-PCM. We have developed a high power YAG laser system with single longitudinal mode applying two existing commercial lasers. The first laser (Continuum 8050) is a single longitudinal mode laser, but low output energy (0.55 J, 50 Hz). The second laser (Continuum 9010) is a multi mode laser, but high output energy (2 J, 10 Hz). In this modification, the first laser and the second laser are utilized as a master oscillator and a power amplifier, respectively. An SBS-PCM is employed to compensate the thermo-optical effect of laser rod. The effective amplification is also expected by double pass amplification by the SBS-PCM. The optical layout is shown in Fig.2. Target performance of the laser system is more than 1 J at 50 Hz. An extra power supply for power amplifier was added for 50-Hz operation. Therefore each power amplifier has the power supply independently. After modification, we have successfully obtained 1.15 J of output energy at the maximum pumping in the 50-Hz operation. Since the beam profile has a peak, we will optimize the beam profile to prevent from laser damage. The thermal induced depolarization will be also improved by adding an amplifier in the Continuum 8050 laser. For the next step, we are planning to carry out the double pass Thomson scattering measurement using the SBS-PCM in LHD for the feasibility check. To install the SBS-PCM, laser output port with glass window is necessary. It is consider that laser output window is most serious part for the laser damage. We will conduct the laser damage test before the double pass measurement.

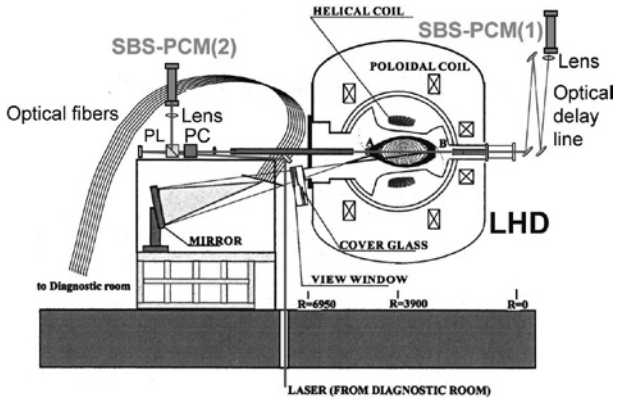

Fig. 1. Optical layout for the multi pass Thomson scattering method in LHD

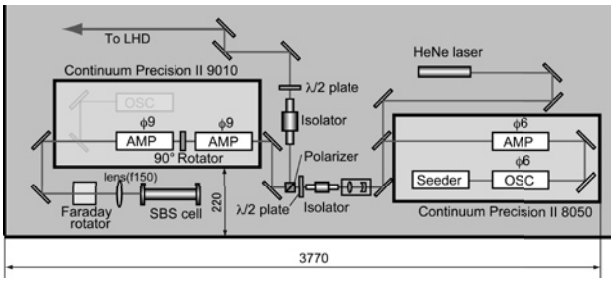

Fig. 2. Optical layout of YAG laser system

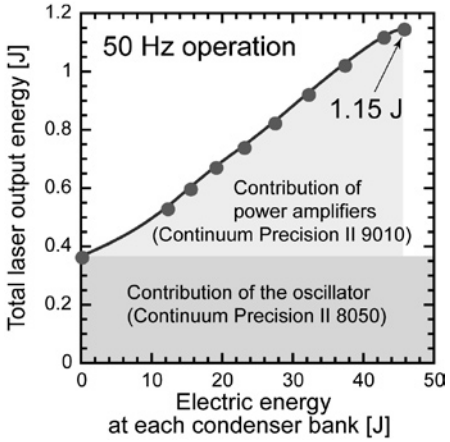

Fig.3. Laser performance at 50-Hz operation

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