

Development of the far-infrared laser polarimetry for current profile measurement on ITER

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The authors are demonstrating the key technology necessary for the ITER poloidal polarimeter (PoPola) in order to measure the plasma current profile in ITER. The entire optical train of a prototype channel was made to evaluate the performance of the laser alignment system and the stability of the polarization measurement. The PoPola system injects multiple far-infrared (FIR) laser beams into the plasmas (wavelength is 119 μm) and those probing beams are reflected by retro-reflectors (RRs). The polarization state of the FIR laser beams returning to the diagnostic room are measured by means of the rotating waveplate Stokes polarimeter (RWS polarimeter). The RWS polarimeter technique measures both orientation angle (θ) and ellipticity angle (ε) of the polarization state. Changes in θ and ε , which are mainly associated with the Faraday and the Cotton-Mouton effects, provide information of electron density, electron temperature and magnetic field. Equilibrium reconstruction of PoPola measurement data together with other ITER diagnostics data provides the current profile. Since the RWS polarimeter technique does not use interference signal of a probing and a reference beam, it does not need to take care about wave front distortion of laser beams and change of path length difference between the probing and the reference beam. However, the RWS polarimeter technique needs higher power ($\sim 10 \mu\text{W}$) of the laser beam returning to a detector than other polarimeter based on interferometer. Key technologies for getting high power of the returning laser beam are a retro-reflector and a laser beam alignment system. Prototypes of the tungsten RR was made of a tungsten mono-block by machining and the angle between orthogonal mirrors was 89.9167° . Taking into account the thermal expansion during the plasma operation, the achieved manufacturing tolerance is promising. We developed the laser beam alignment method in order to minimize the loss due to shading at the vacuum window and RR. When the laser beam is tilted within ± 1 mrad for the sake of searching the RR center, the beam position displacement at the vacuum window was 2.0 mm or less. The alignment error above leads to the laser power loss of 4 % owing to shading and acceptable.

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