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PROGRESS ON INTEGRATED DESIGN OF ITER POLOIDAL POLARIMETER FOR CURRENT PROFILE MEASUREMENT

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PoPola measures both orientation angle (θ) and ellipticity angle (ε) of polarization state of multiple probing far-infrared (FIR) laser beams (wavelength is 119 μm). The change of θ and ε are mainly associated with the Faraday and the Cotton-Mouton effects, respectively, and provide information of electron density, electron temperature and magnetic field. Equilibrium reconstruction of PoPola measurement data together with other diagnostics data provides the current profile (or, equivalently, q profile). ITER organization and Japan domestic agency signed the procurement arrangement in 2013 and this paper provides the summary of the development activity during 2014-2015, which made an integrated design for the first time. The design study provides important knowledge for designing diagnostics of future reactors such as DEMO because long wavelength used by PoPola has potential for applicability to the reactors. All in-vessel components of PoPola are rigidly fixed, and laser beam alignment will be carried out by using ex-vessel mirrors. The alignment system can move the beam position at RR by 3-mm resolution and with a vertical range of approximately +/-3 cm even when the port plug moves by 40 mm in the vertical direction and rotates by 1 degree in the poloidal direction owing to thermal expansion. The authors developed a new analysis method for a rotating waveplate Stokes polarimeter, which is applicable to real-time calculation of FPGA. Experiments using a He-Ne laser showed that the achieved precision of θ and ε were 0.33° and 0.096°, respectively. Since the experimental condition using the He-Ne laser was worse than what is expected in ITER, the measurement error will be reduced by a factor of nine. As a result of the optical design, the measurement error of θ and ε were evaluated as 0.45° and 0.73°, respectively. A main error source is polarization change due to the optical transmission line of the zero-offset configuration. Error assessment of q profile measurement was carried out by using operation scenarios of both inductive and steady-state operations. The results suggest that a target accuracy of 10 % is achievable.

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Author: Dr IMAZAWA, Ryota (National Institutes for Quantun and Radiological Science and Technology)

Co-authors: Dr ITAMI, Kiyoshi (Japan Atomic Energy Agency); Dr KAWANO, Yasunori (Japan Atomic Energy Agency)

Presenter: Dr IMAZAWA, Ryota (Japan Atomic Energy Agency)

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