First results of Polarimeter-Interferometer System for current density measurement on EAST*

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Abstract.
A multichannel far-infrared laser-based POLarimeter-INTerferometer (POINT) system utilizing the three-wave technique has been implemented for current density and electron density profile measurements in the EAST tokamak. Double-pass, horizontal, radially-viewing chords access the plasma via an equatorial port. The laser source consists of three CW formic acid (HCOOH) FIR lasers at nominal wavelength 432.5 µm which are optically pumped by independent infrared CO₂ lasers. Each of the three FIR lasers can generate output power of more than 30 mW per cavity. Two lasers, with slight frequency offset (~1 MHz), are made collinear with counter-rotating circular polarization in order to determine the Faraday effect by measuring their phase difference in the plasma. The third laser, frequency offset (~ 2 MHz), is used as a reference providing local oscillator (LO) power to each mixer so that one can obtain the phase shift caused by the plasma electron density. Novel molybdenum retro-reflectors are mounted in the inside wall for the double-pass optical arrangement. The retro-reflectors can withstand baking temperature up to 350°C and discharge duration more than 1000s. VDI planar-diode Integrated Conical Horn Fundamental Mixers optimized for high sensitivity, ~750 V/W, are used in the heterodyne detection system. A five-chord layout has been installed with expansion to 11 chords anticipated to fully diagnose the core region of EAST plasmas in next campaign. A Digital Phase Detector with 250 kHz bandwidth, which will provide real-time Faraday rotation angle and density phase shift output for use in plasma control, have been developed for use on the POINT system. Reliability of both polarimetric and interferometric measurement are obtained in 22s H mode discharge and 52s long pulse discharge, indicating the density gradient in H-mode discharge does not impact POINT measurements and that system works for any heating scheme on EAST so far. The electron line-integrated density resolution of POINT is less than 1×10¹⁶ m⁻² (<1%), and the Faraday rotation angle rms phase noise is <0.1°. With the high temporal (~1 µsec) and phase resolution(<0.1°), perturbations associated with the sawtooth cycle and MHD activity have been observed. The current profile, density profile and safety factor(q) profile are reconstructed by using EFIT code from the external magnetic and the validation POINT data. Realtime EFIT with Faraday angle and density phase shift constraints will be implemented in the plasma control system in the future.

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