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Initial result of the new 320 GHz interferometer system on Heliotron J

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Understanding the physics of high-density plasma transport is a critical issue in fusion plasma research. Interferometer measurement is a standard technique for measuring the electron density of magnetically confined plasmas.[1] To understand the physics of high-density plasma in Heliotron J, a single-channel 320 GHz heterodyne interferometer is developed and operated as commissioning before upgrading the system to the multi-channel interferometer system.[2] The initial results with the new interferometer are achieved in high-density plasma experiments using a pellet injection and a short-pulsed high-intensity gas puffing (HIGP).[3]

This new interferometer is a heterodyne Michelson type with a quasi-optical technique for beam propagation.[4] The schematic of the interferometer is shown in figure 1. In the optical bench A, new 320-GHz solid-state sources and mirrors are placed about 3 m away from the vertical field coils to avoid the influence of the magnetic field on the operation of sources. The submillimeter wave is transmitted to the optical bench B through dielectric oversized waveguides, and it is injected into the plasma. The injected submillimeter wave into plasma is reflected at the retroreflector array on the vacuum chamber wall, and is detected with a mixer on the optical bench B.

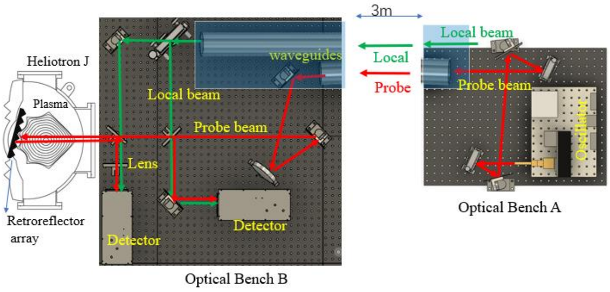

Figure.1 Schematic of single-channel interferometer The source is located on the optical bench A. Microwave is transmitted through the oversized dielectric waveguide to the optical bench B.

The first measurement with interferometer has been successfully achieved in Heliotron J. An example of time traces of the plasma discharge is shown in figure 2.

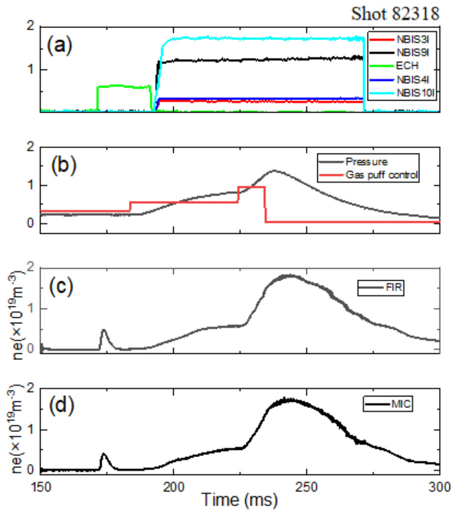

Figure 2. Time trace of (a) heating (b)gas puff (c) new interferometer (d) microwave interferometer in NBI only plasma

The line-averaged electron density from the new submillimeter interferometer agrees well with that from the conventional microwave interferometer (135 GHz) that has been operated as a routine density diagnostic system in Heliotron J. This demonstrates that the new system can be used as a routine diagnostic as well in Heliotron J.

The new interferometer also can measure density fluctuation because the IF frequency is set ~ 1 MHz. Energetic-particle-driven MHD instabilities were observed with the new system during a HIGP experiment.

[1] A.J.H. Donne et al., Review of Scientific Instruments 66, 3407 (1995).
[2] S. Ohshima et al., Review of Scientific Instruments 92, 053519 (2021).
[3] P. Zhang et al., High-Temperature Plasma Diagnostics Conference 15 -19,May (2022), PB-03.
[4] D. Veron, *Infrared and Millimeter Wave* (Academic Press, New York, 1979),Vol. 2.