Predesign of 1mm microwave interferometer with high stability and wide dynamic range for EAST steady-state plasmas

B.L. Ling[1], H. Zhong[2]

[1]Institute of Plasma Physics, Chinese Academy of Sciences

[2]Department of Engineering Physics, Tsinghua University

e-mail(speaker) :ling@ipp.cas.cn

Microwave interferometry is an effective and reliable way to measure line integrated plasma electron density. In order to perform the predesign of a microwave interferometer for Experimental Advanced Superconducting Tokamak (EAST), an extremely low noise heterodyne interferometer has been developed for routine operation in Sino-UNIted Spherical Tokamak (SUNIST). The system has been designed with optimum frequency deduced from detailed calculation in real geometry and discharge parameters. In contrary to traditional heterodyne interferometers, the application of a single sideband modulator (SSBM) eliminates the necessity of the second millimeter wave (MMW) oscillator, which averts the intermediate frequency (IF) stability problem aroused by the two high frequency oscillators in the traditional heterodyne configuration.

The bench test data and plasma electron density measurement result have verified the interferometer's excellent phase linearity, precision and resolution. This design is very suitable for long pulse operation discharges in EAST due to its long term stability. The feasibility of such interferometer for EAST device has been confirmed despite their different probing beam frequencies (about 1mm estimated for EAST).

References

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[2] Zhong H., Ling B.L.*, Wang S.Z., et al., Design and implementation of an interferometer with high stability and wide dynamic range for steady-state plasmas. Fusion Engineering and Design, 2018.128: 143-148.

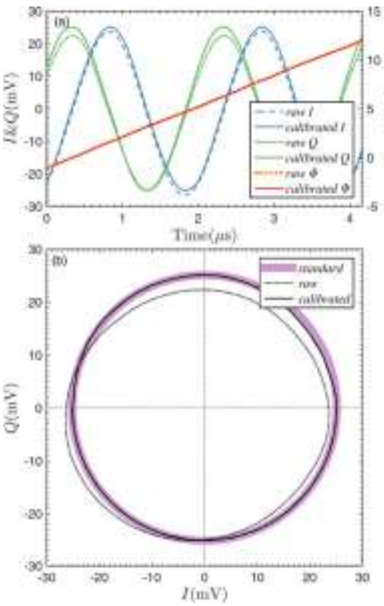

Fig. 1. The test result of the interferometer's phase response linearity. (a) shows the I&Q signal waveforms before and after the calibration algorithm, together with the calculated phase difference Φ. (b) shows the corresponding Lissajous trajectory before and after calibration.

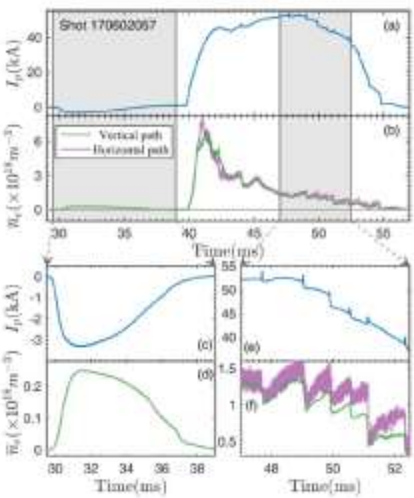

Fig. 2. (a) and (b) show the plasma current and line averaged density measured from two orthogonal paths respectively throughout the discharge. (c) and (d) shows the results during the preionization stage, with very small density value and reversed plasma current. The acquisition system for the horizontal path wasn't activated during the preionization, so the corresponding result is absent in (d). (e) and (f) are the results during the series of IRE.