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Development of a 160GHz Interferometer for Density Measurement in Taiwan Spherical Tokamak Project

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Taiwan is set to develop its first Spherical Tokamak (ST) device in coming a few years as an all-Taiwan project. The ST experiment requires precise measurement of the plasma density. We adopt an interferometry for the purpose. A frequency of 160 GHz is chosen as the frequency of the probe wave, from the designed plasma density of in our ST plasma. We have been developing and calibrating this interferometer in the magnetized plasma of our NCKU laboratory, where plasma density ranges from 10^{16} m^{-3}. Despite significant phase changes, our measurements are confirmed by a 35 GHz interferometer and a Langmuir probe.

Our setup, illustrated below, includes a frequency down converter circuit. A 0.1 GHz signal passes through a synthesizer to produce a 160 GHz microwave signal. After traversing the plasma (in o-mode), the frequency is reduced using a 159.9 GHz microwave, then compared with a reference 0.1 GHz signal to determine the phase difference. The synthesizer's frequency deviation (~0.4 Hz) necessitates using $(I + iQ)/e^{i2\pi ft}$ to determine the phase difference, simplifying phase correction. Where I and Q are the outputs of the IQ mixer, representing $\sin\Delta\emptyset$ and $\cos\Delta\emptyset$, respectively, where $\Delta\emptyset$ is the phase difference between the microwave passing through the plasma and the reference phase.

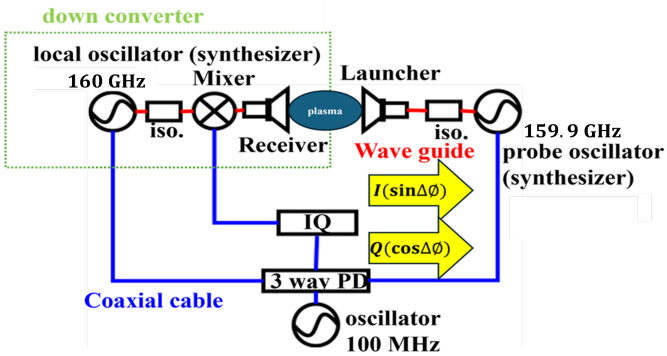

Figure 1 Circuit diagram of 160 GHz interferometer

With adding a lens to focus IF power on a small plasma region for localized measurements. Plasma scattering observed in this setup reveals real-space electron density oscillations, indicating electron turbulence.

This poster presents 160 GHz interferometer measurements in both standard and microwave-heated plasma states, along with scattering measurements observing electron turbulence.