Special course – Autumn/Winter 2019

Measurement of 60 GHz calibration system designed for the fusion energy experiment ITER

The plasma physics and fusion energy (PPFE) section at DTU Physics is developing a diagnostic system for the World’s largest fusion energy experiment that is currently being constructed in the south of France.

The diagnostic system uses a 60 GHz millimeter-wave beam to probe the plasma inside a “tokamak” vacuum chamber. Part of this beam is scattered off fluctuations in the plasma and is collected by a set of receiver mirrors and waveguides and subsequently used as an indicator of the ion dynamics of the plasma as well as other parameters.

An important part of the 60 GHz probing system is a calibrating source that is used to periodically check that all receiver transmission lines are correctly aligned.

The goal of this project is to characterize the beam pattern of the 60 GHz calibration source antenna and verify that the receiver waveguides collects sufficient power for a robust calibration of the system.

The radiation pattern of the calibration source has been designed and simulated under the assumption that any part of the beam that is not absorbed by the receiver waveguides will simply propagate away from the system and disappear. However, in the real application this is not the case because everything is enclosed in conducting walls. An important part of the characterization is therefore to investigate how the presence of these walls will affect the power collected by the receivers, i.e. does reflected signals arrive in phase or out of phase with the direct signal and thus increase or decrease the received power.
The prototype components have already been produced and are to be mounted on an optical table in the PPFE lab, together with a 60 GHz source, horn antennas and the necessary electronics for detecting the radiated power.

![CAD drawing of components to be tested, mounted on an optical table. M2 is the source of the calibrating signal. The green parts are millimeter-wave beams that reflect off focusing mirrors and enters horn antennas (only two shown) where the power will be measured.]

A LabVIEW control interface is expected to be developed to perform automated measurements.

**Topics:**
- antenna measurements
- Gaussian beam propagation and quasi-optical systems
- microwave/millimeter-wave techniques
- LabVIEW programming

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