DESIGN OF THE MM-WAVE SYSTEM OF THE ITER ECRH UPPER LAUNCHER

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Introduction

The coordination of the design of the mm-wave system to be installed in the ITER Upper Ports is carried out at the FOM institute. The aim of the system is to inject Electron Cyclotron Waves (ECW) in the ITER plasma in order to stabilize neoclassical tearing modes (NTM). Each upper-port launcher consists of eight mm-wave lines capable of transmitting high power up to 2 MW at 170 GHz.

In order to exploit the capability of ECW for localized heating and current drive over a range of plasma radii in ITER, the ECH&CD upper port launcher must have a beam steering capability. The steerable optic is considered a critical component for the ECH&CD system since it is subject to nuclear, radiative, particle, and Ohmic thermal loads and hence must be cooled during plasma operation. To avoid movable mirrors at the plasma-facing end of the launcher, the concept of remote mm-wave beam steering (RS) is used, having a corrugated square waveguide within the launcher and the steerable optic is then placed outside of the first confinement boundary of the vacuum vessel.

System lay-out

Starting from the gyrotrons mm-wave power will be transmitted towards the tokamak by circular evacuated waveguides with an aperture of 63.5 mm. Steering of the beam over a range of +/- 12° will be achieved by a mirror system consisting of a combination of curved and remote steerable mirrors. Via the mirror system the beam will be directed into a square corrugated waveguide of approximately 44x44 mm with a length of 4.4 m. This follows from: L = $4a^2/l$, L being the length and *a* the diameter of the square remote-steering waveguide. A single diamond-disk window and an isolation valve will provide the tritium boundary between the primary and secondary vacuum. At the end of the square waveguide, mm-wave beams will be guided through penetrations in the front-shield blanket module by a fixed-mirror system towards the ITER plasma [4]. This mirror will have focusing properties in both directions. The resulting, effective steering range in the plasma is still under study but will be around +/- 8°.

Outlook

Conceptual designs for all of the key issues related to remote steering will be presented. The design analysis has demonstrated the feasibility of the remote-steering approach in the ITER environment. Therefore, the next step will be devoted to the detailed design of the mm-wave layout of the remote-steering concept for the upper-port launcher and to come to a consistent integration into the ITER environment. Furthermore, a full-scale mock-up line will be designed and build at the appropriate ITER frequency, 170 GHz. Testing at the appropriate power level will start early 2005 at the 1.5 to 2 MW coaxial, short pulse gyrotron at FZK, Karlsruhe.

Demonstration of CATIA models

For the mechanical modelling and finite-element calculations the CATIA 3-D design package is used. B.S.Q. Elzendoorn will demonstrate some of the models during the presentation.

More information can be found on: http://www.rijnh.nl/ITERECRH