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# Development of a full scale remote steerable ECRH mm-wave launching system test set-up for ITER

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**Abstract**

FOM is developing a full-scale mock-up of the mm-wave upper-port launching system for electron cyclotron resonance heating in ITER. The test set-up foresees in most of the typical ITER operation conditions, e.g. primary vacuum and the secondary vacuum, blanket cooling and component cooling conditions. All relevant operational ITER conditions except neutron radiation can be simulated, including baking conditions. The fabrication of the launching system mock-up will be the last step in the development phase, which will be characterized by the fabrication of test samples and mm-wave tests and calculations. The parameterized modeling of mm-wave beam propagation in CATIA [D.M.S. Ronden, et al., Parameterized modeling of mm-wave beam propagation of the ITER ECRH remote steering upper port launcher in CATIA, this conference] (8th figure in this article) the test and calculation results will be used for the built to print design of the remote steering ECRH launcher for the ITER upper ports [A.G.A. Verhoeven, et al., Design of the Remote Steering ITER ECRH Upper Port Launcher, this conference].
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## 1. Introduction

A remote steering launching system for ECRH (electron cyclotron resonance heating) via the ITER upper ports is being designed (Fig. 1). 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 remote steering launcher consists of six mm-wave beam lines (Fig. 2) capable of transmitting high power into the plasma: up to 2 MW at 170 GHz. To avoid movable components at the plasma-facing end of the launcher, the concept

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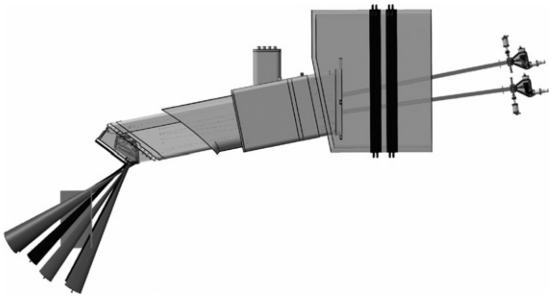

Fig. 1. Remote steerable ECRH launching system for the ITER upper ports.

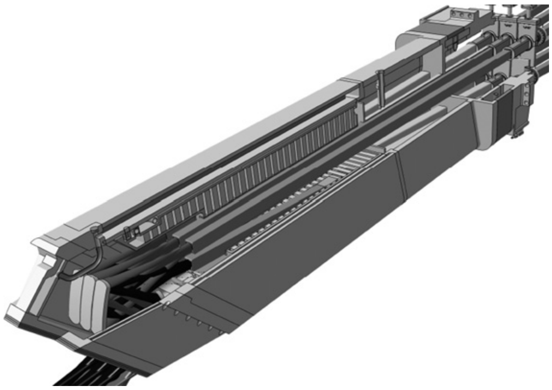

Fig. 2. Interior of the ECRH port-plug consisting of the six square waveguides and six fixed front mirrors.

of remote mm-wave beam steering (RS) is used, having six square corrugated waveguides and three sets of two fixed front mirrors located inside the port-plug, which is placed in primary (torus) vacuum. For reasons as robustness and maintenance, the launcher steering mechanisms and steering mirrors are placed outside of the first confinement boundary of the ITER vacuum vessel. The FOM Institute Rijnhuizen has taken up the challenge to develop a built to print remote steerable ECRH launcher for the ITER upper ports before the end of 2008. The complete system includes drawings, control systems, remote handling solutions and devices for in situ maintenance.

## 2. Design criteria

The general design criteria as heat loads, maximum radiation levels and maximum stresses in materials are crucial for a reliable design, but not less important are design criteria, e.g. safety regulations, reliability (effect of failures in the ECRH system on the ITER operations) and in situ maintenance. All design aspects as mentioned above must be kept in mind during the whole design process.

## 3. Reliability

There are three important factors to express reliability:

- The expected lifetime of the in-vessel components;
- The average time needed for a repair;
- And the effect on ITER operations if a sub-system fails.

The lifetime of the in-vessel components should warrant proper operation over the full ITER lifetime of 20 years. The steering mechanism (Fig. 3) is also designed for the full 20 years but has a somewhat higher probability of failure. Therefore it is placed outside the torus vacuum. Replacing a steering mechanism can be done in 1 day. The effect on ITER operations depends on the number of effected ITER main systems, e.g. torus vacuum and blanket cooling. All in-vessel mm-

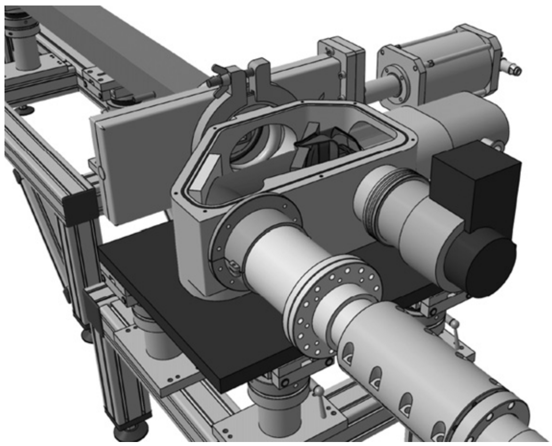

Fig. 3. This picture of the steering mechanism shows the most vulnerable parts of the ECRH system. The mode converter in yellow connected to the steering mechanism housing, and behind the housing the isolation valve which is connected to the ex-vessel square waveguide. These components are places outside the port plug, for easy maintenance.

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