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年会予稿原稿のWordサンプル[講演題目]

Design of high field side injection of X-mode for EBW conversion experiment in QUEST

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Introduction

Electron Bernstein wave (EBW) is used to overcome plasma density limit induced by wave propagation as electron cyclotron wave. Several mode conversion scenarios for achieving EBW exist, but in this literature, we focus on high field side (HFS) injection of extra-ordinary (X) mode to EBW (B) mode conversion. Ordinary (O)-mode injection from low field side (LFS) is expected to be converted to HFS X-mode, hitting the upper hybrid resonance (UHR) and converting to B-mode [1,2]. QUEST's low toroidal magnetic field and thereby low RF frequency (8.2 GHz) dictates the use of oversized mode-converting mirror for HFS injection. In this work, proposed is to extend vacuum-tight waveguide for RF power transmission from to LFS to HFS.

HFS injection system design

In the proposed system (shown in fig. 1) waveguide must traverse electron cyclotron resonance layer (ECRL) inducing waveguide breakdown. To avoid the breakdown, waveguides are filled with SF_6 gas and a window is placed past the ECR layer to prevent SF_6 from compromising the vessel vacuum condition. RF power of 25 kW per 8.2GHz klystron can be supported, however, with the window power threshold of 12.5 kW, two klystrons will be connected to two magic T's, creating 4 branches assembled in a phase array antenna format giving a theoretical total injection power of 50 kW.

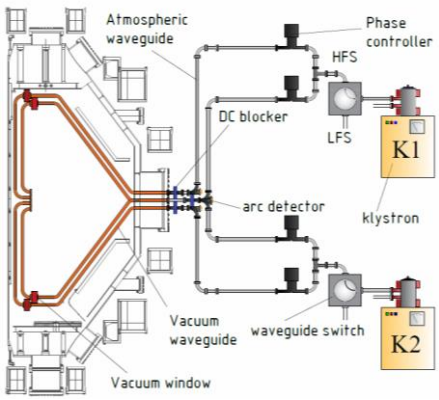

Fig. 1 HFS schematic where K1 and K2 are Klystrons 1 and 2, PC is Phase Controller

To avoid undesired ECR absorption and reach UHR for B-mode conversion requires a directive antenna (horn antenna), but an open-ended waveguide is used due to space restriction. Open-ended waveguide radiation pattern gives an ECR absorption loss of 7% for bulk electron temperature of 50 eV.

System analysis

8.2 GHz of power transmission across the ECR layer through a 0.03Mpa SF_6-filled RG-50 waveguide was conducted. An external magnet was used to emulate QUEST's 0.3 T ECR layer. Power transmission of 12 kW was successfully transmitted across the emulated ECR layer. Moreover, GENRAY ray tracing [3] was used to confirm the ability of X-B conversion and therefore breaking QUEST's density barrier of 10^{17} m^{-3}, potentially achieving up to 10^{18} m^{-3} for 8.2GHz.

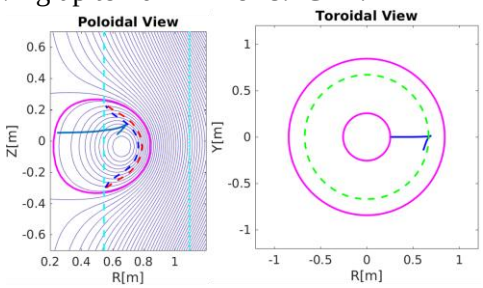

Fig. 2 GENRAY ray tracing results showing ability to reach UHR from HFS. Plasma density is $5\times10^{17}m^{-3}$.

Summary

Sufficient RF power transmission can penetrate ECR and reach HFS in the proposed scenario. HFS X-B conversion has the potential to break QUEST's density limit for 8.2GHz. ECR absorption at the fundamental resonance is acceptably low ~ 10% for perpendicular X-mode.

[1] V. F. Shevchenko, et al., Nuclear Fusion, vol. 50, no. 2, 2010.
[2] T. Maekawa, et al., Physics Review Letters. 86, 003783, 2001.
[3] A.P. Smirnov, et al., Report CompX-2000-01, Ver. 2, 2003.