Simulation Studies of Fast Waves Launchers for Current Drive in Tokamak using COMSOL Multiphysics®

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INTRODUCTION: Helicon current drive is gaining the attention of plasma community to achieve off-axis study state plasma operation for longer duration for high electron density conditions. RF launchers are used to launch the helicon waves to the desired region of the current drive inside the plasma. A combline travelling wave antenna is one such type of a launcher which is used to launch helicon fast waves onto the plasma. It is a two port launcher such that power is fed into the input port and output port is connected to the dummy load. A fraction of power is radiated from first element of the combline antenna while the remaining power is coupled to the adjacent element. This process continues throughout the antenna. Subsequently, the remaining power is deposited in a dummy load.

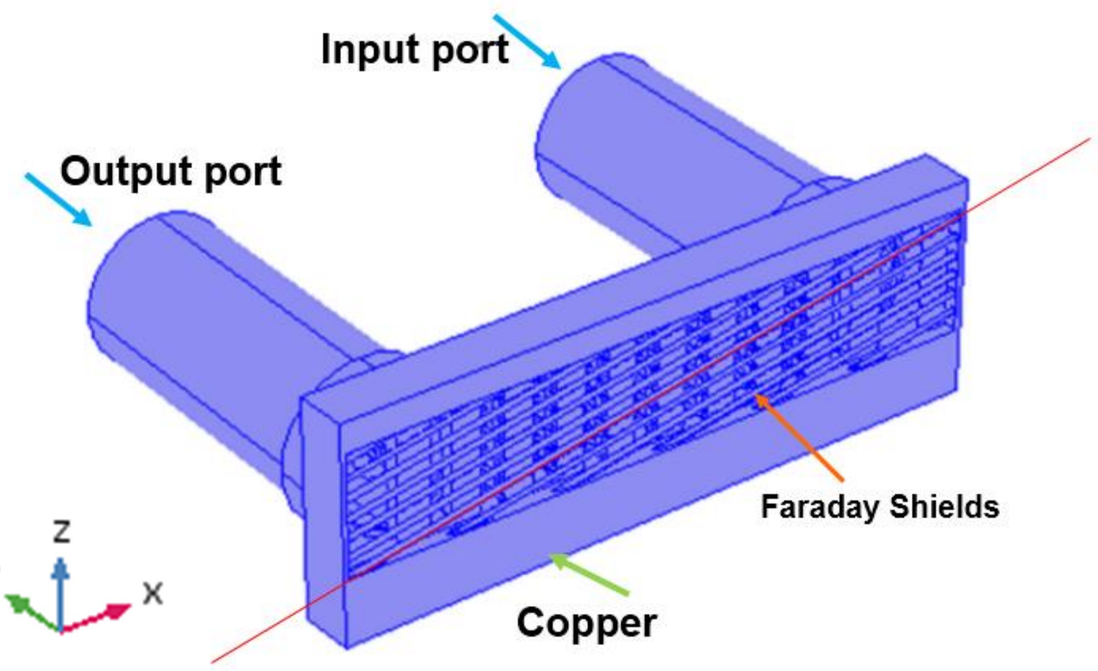
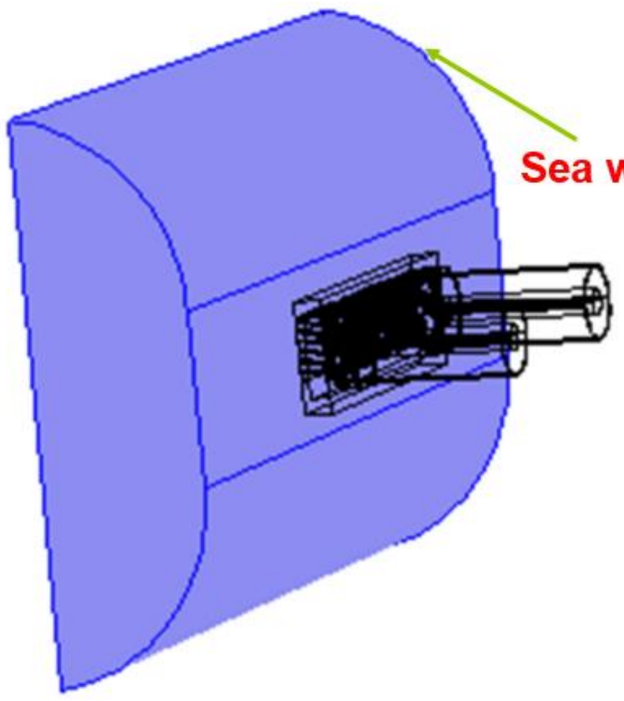


Figure 1. Combline travelling antenna [1]



sea water properties:
Relative permittivity: 74
Electrical Conductivity : 3.53 S/m

Figure 2. Combline travelling antenna with sea water loading

RESULTS:

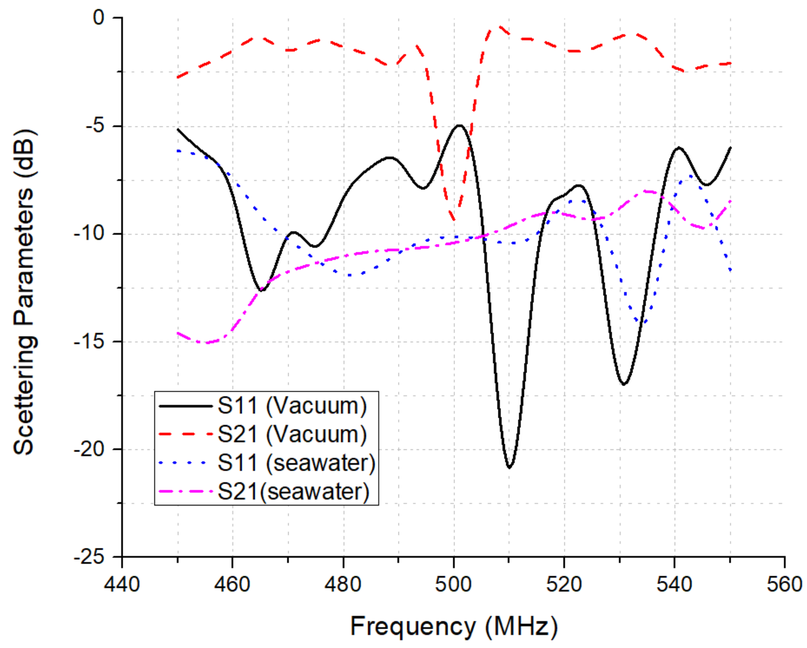


Figure 3. Scattering parameters of combline travelling wave antenna

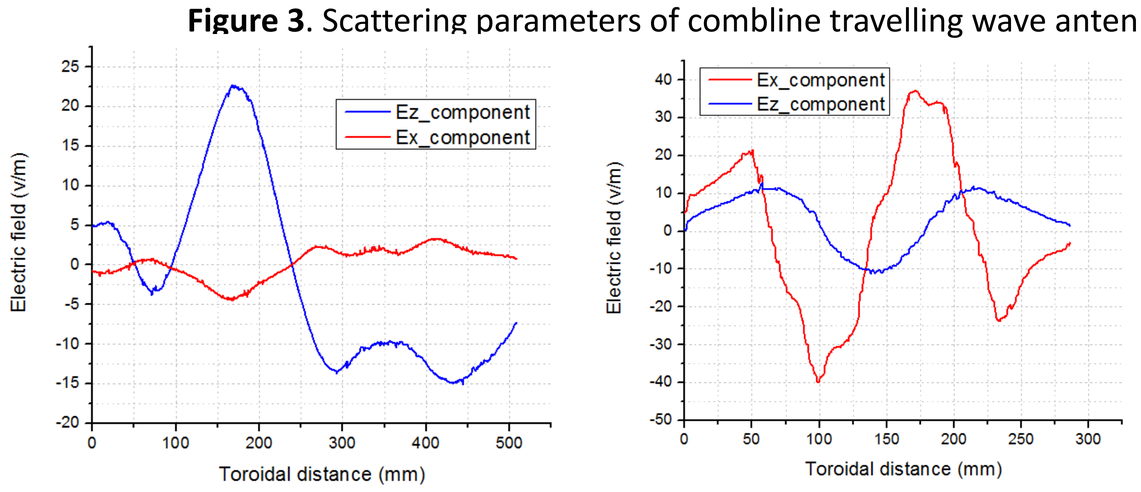


Figure 4. Fields components (a) with (b) without Faraday shields

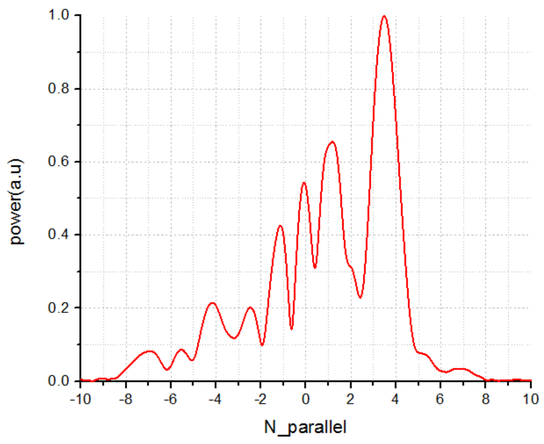


Figure 5. Calculated power spectrum

$$n_{||} = \frac{ck}{\omega}$$

$$k = wavenumber = \frac{2\pi}{\lambda}\ radians/meter$$

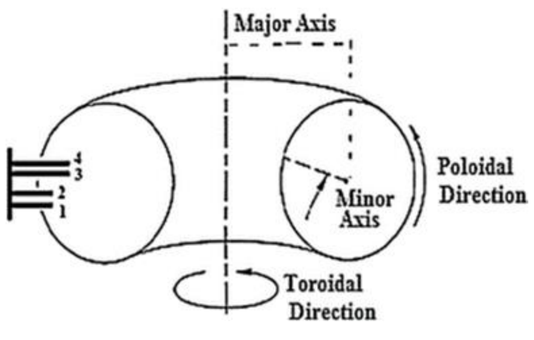


Figure 6. Cross section view of plasma

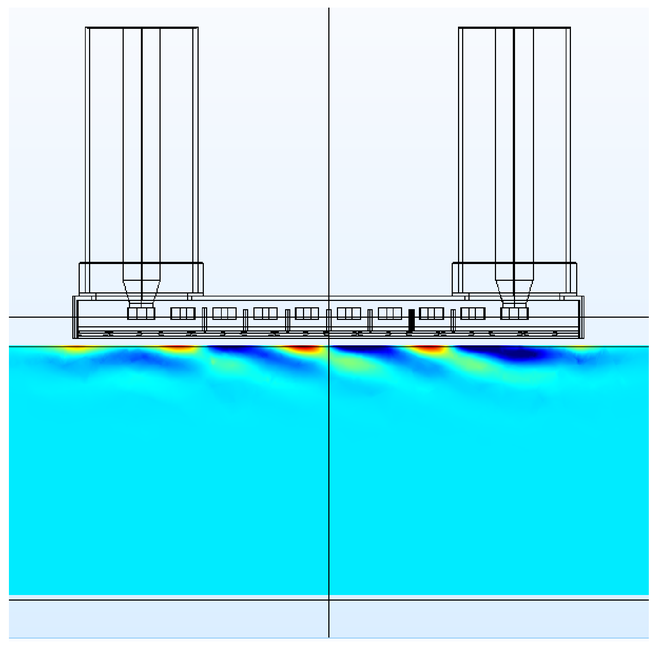


Figure 7. Wave propagation in sea water

CONCLUSIONS: Combline antenna is simulated with vacuum and sea water as a plasma. Faraday shields gives the dominant electric field component in the perpendicular direction. At particular parallel refractive index, maximum power is absorbed.

REFERENCES:
1. H. H. Wi, S. J. Wang, H. J. Kim, and J. G. Kwak, “Design and RF test of a prototype traveling wave antenna for helicon current drive in KSTAR," Fusion Engineering and Design, vol. 126, pp. 67-72, Jan.2018.