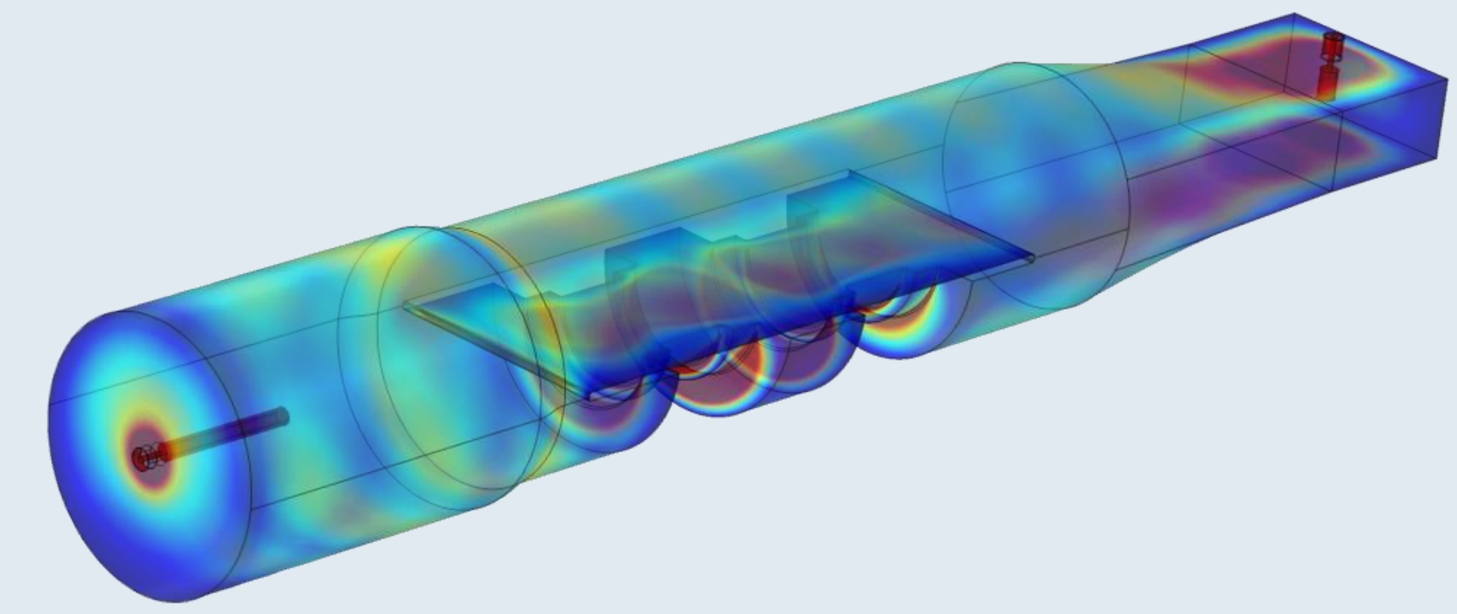

Simulation and Validation of TM_{01} to TE_{11} mode converter using COMSOL Multiphysics

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High-power microwave sources generate power in symmetric modes with boresight null which is undesirable. Mode converters are used to convert the field pattern to a boresight maxima. This poster presents a TM_{01} to TE_{11} mode converter for 3 GHz.

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Introduction

High-Power Microwave (HPM) sources like Magnetically Insulated Transmission Line Oscillator (MILO), Virtual Cathode Oscillator (VCO), and Relativistic Magnetron (RM) generate power in TM_{01} mode, characterized by a donut-shaped radiation pattern. However, it is preferable to have maximum E-field radiation at the boresight for HPM applications. The radiation pattern at the boresight is achieved by converting symmetric mode TM_{01} to asymmetric mode TE_{11}. The circular waveguide is divided into two halves section and a phase shifter is introduced in the lower half of the waveguide to provide a 180-degree phase shift to the input mode TM_{01}. The mode converter is designed for the operating frequency of 3 GHz.

A detailed analysis to determine the design parameters of the mode converter is performed and the design is constructed in COMSOL multiphysics. The mode converter present a mode conversion efficiency of 93%, return loss of 28 dB at 3 GHz and bandwidth of 217 MHz (for insertion loss less than 0.5 dB) in simulation. The simulation and measured results are compared and a detailed analysis of the performance is presented. The performance of the fabricated mode converter is verified using two ways: (1) a wideband mode launcher and detector and observing S parameter results (2) using a horn antenna and observing E-Plane and H-Plane radiation pattern.

Design Philosophy

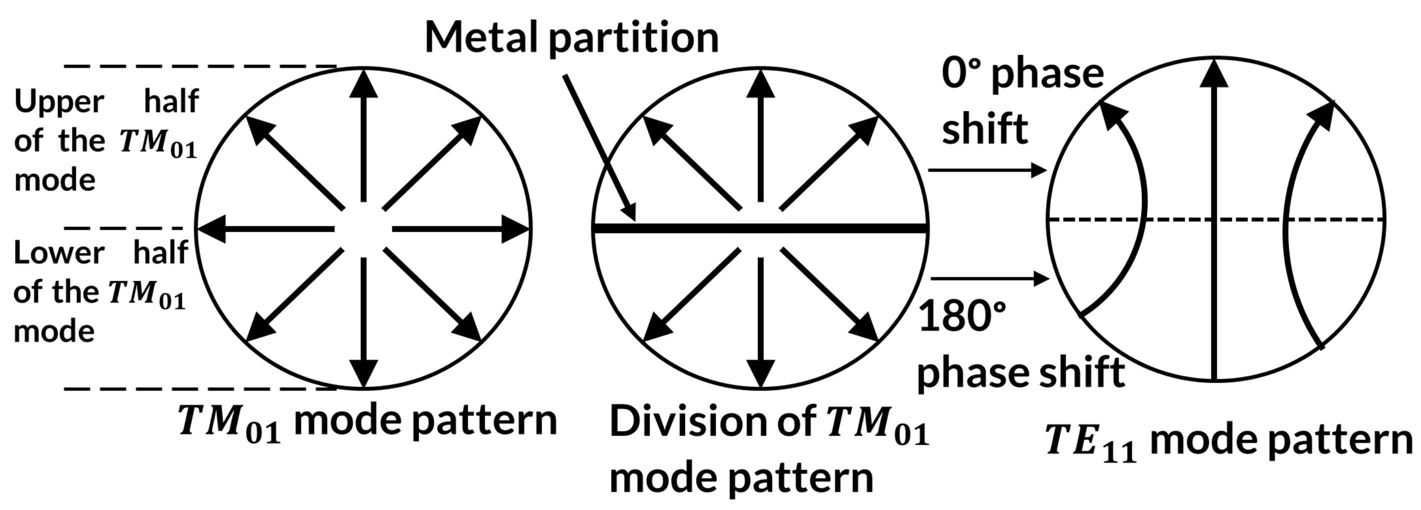

Fig. 1 The design philosophy for the mode conversion from TM_{01} to TE_{11} [1]

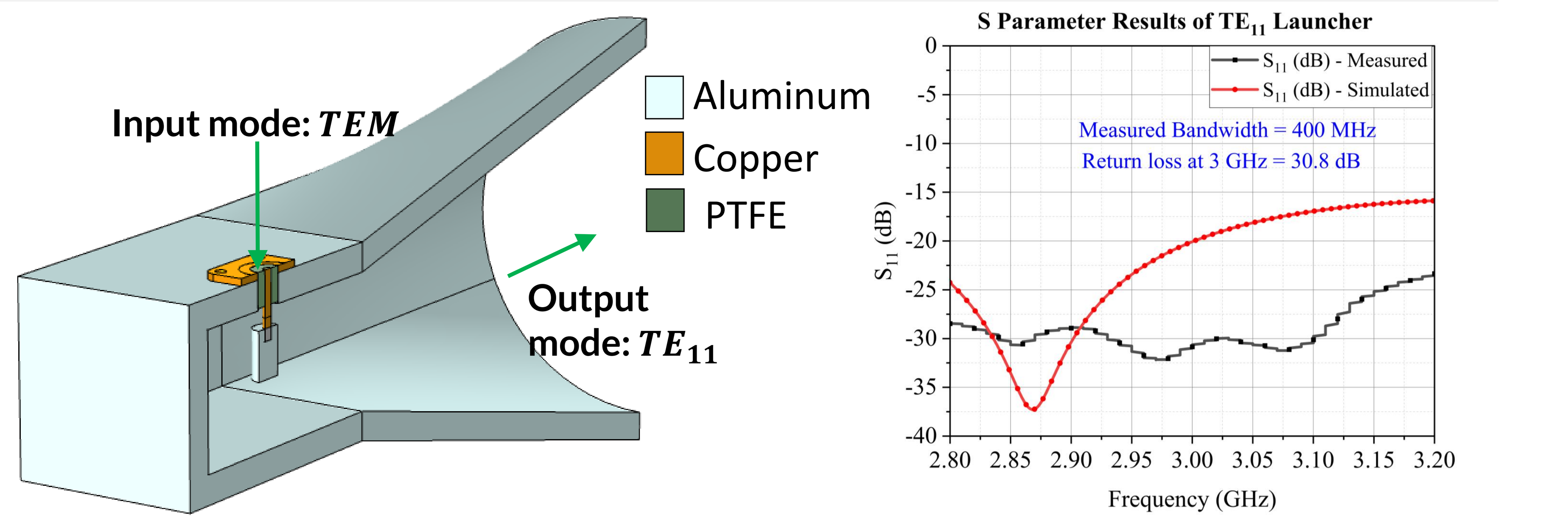

Fig. 3 Mode converter design with detector [3] and its simulated and measured results

Computational Methods

Physics used: RF Module, Electromagnetics waves, frequency domain (emw), **Boundary condition**: Impedance boundary condition used on the inner surface to resolve the skin depth of aluminum and perfect electric boundary on the outer surface of air, **Operating frequency** : 3 GHz, **Type of Port**: Coaxial with input power of 1 W, **Input port**: TM_{01} and **Output port**: TE_{11}, TE_{21}, TM_{11}, TE_{31} in two different orientation to analyze the mode formation in undesired modes.

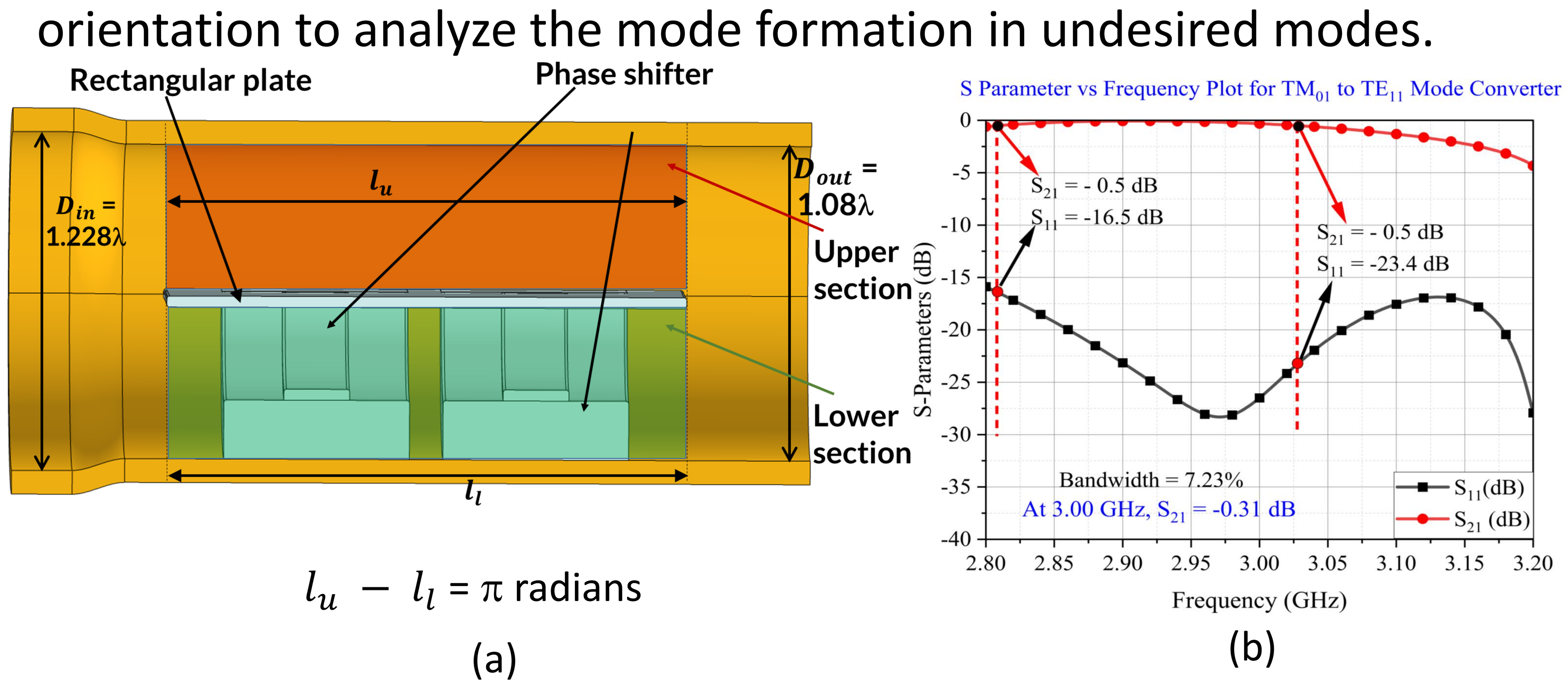

Fig. 2 (a) Mode converter design in COMSOL Multiphysics [1] (b) Simulated results of the mode converter having input of TM_{01} and output of TE_{11} mode

Simulated return loss: 28 dB, Insertion loss: 0.31 dB, Bandwidth for insertion loss of 0.5 dB: 217 MHz (7.23%)

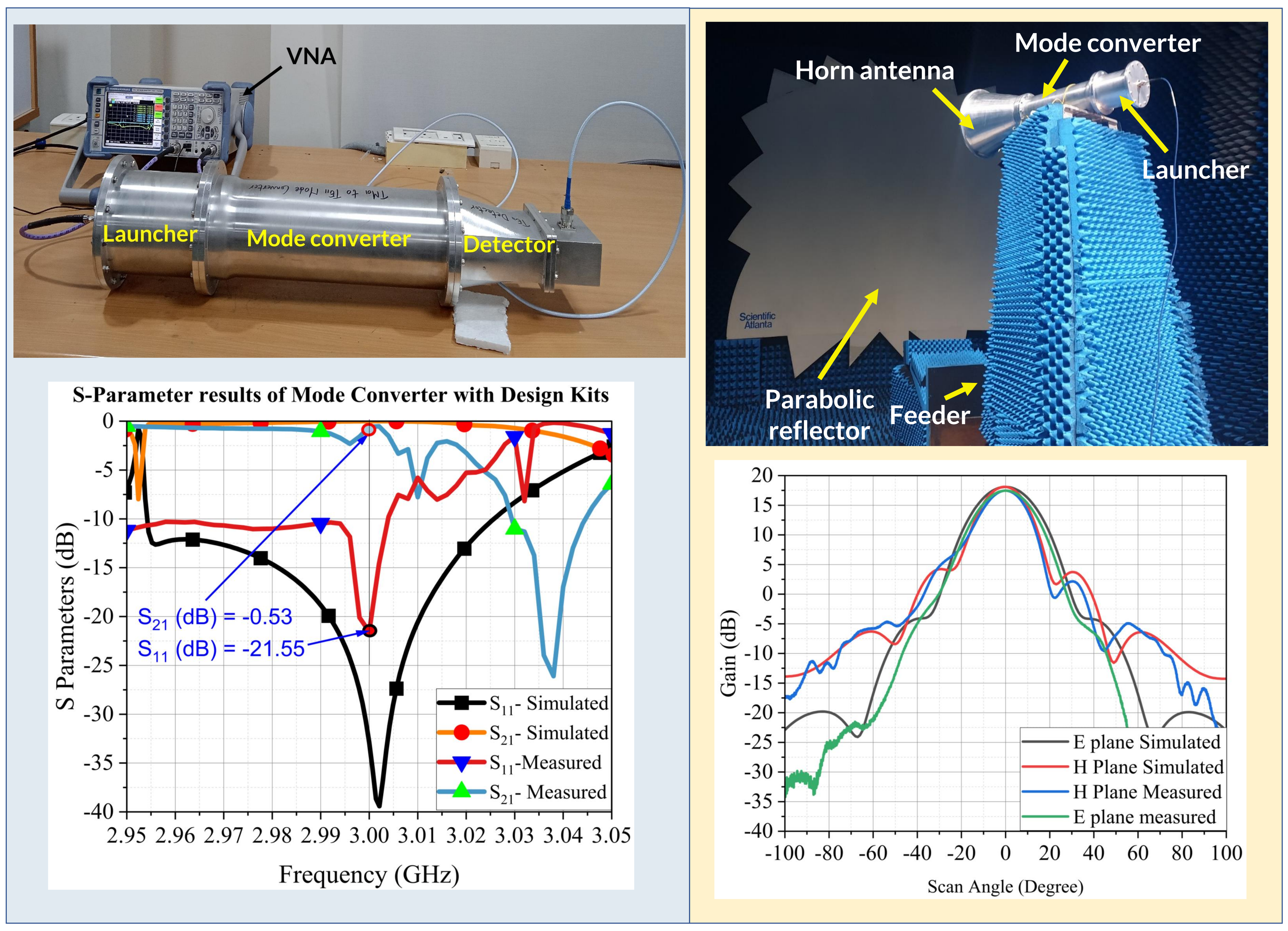

Fig. Fabricated mode converter with testing equipment and its Simulated and measured results

There is good agreement between the simulated and COMSOL results. The measured results shows that mode conversion efficiency is more than 90% (simulated ~95%) and the bandwidth obtained in 70 MHz.

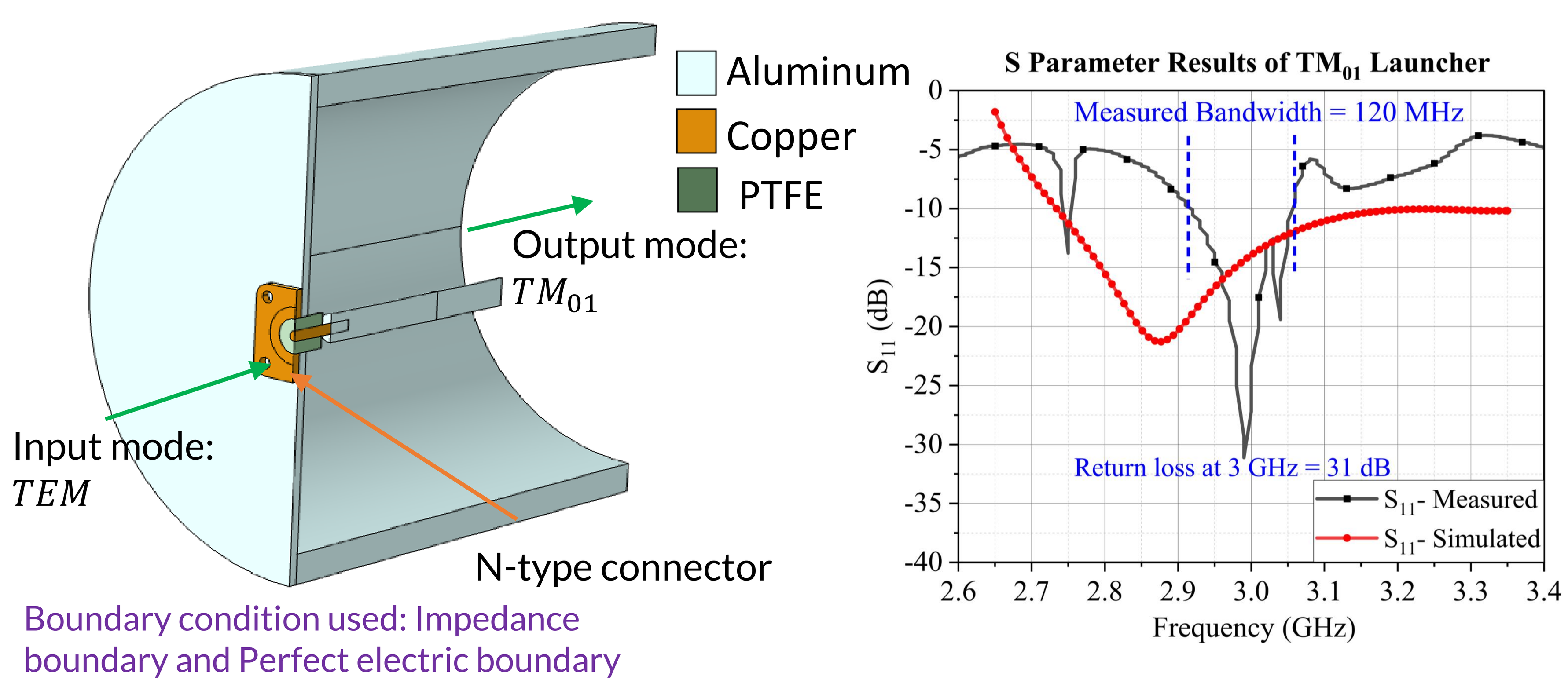

Fig. 3 Mode launcher design [2] and its simulated and measured S-Parameter result

Result extraction: Simulated S-Parameter results are obtained by adding **Global Variable Probe** in definitions and selecting expression of **emw.S11dB** (or S21dB)

Conclusion

Mode converter from TM_{01} to TE_{11} is designed for operating frequency of 3 GHz in COMSOL Multiphysics. The fabricated mode converter with was tested and measured results were found to be in good agreement with simulation results. Such mode converter is to be connected with high power microwave sources for directed energy applications.

Acknowledgment

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