Numerical Analysis and Optimization of a Multi-Mode Interference Based Polarization Beam Splitter

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The demand for smaller and faster devices in telecommunication architecture has motivated a Silicon Photonics (SiP) platform that facilitates the development of micro-opto-electronic circuits. It leverages CMOS technology, allowing for mass-manufacturable, inexpensive devices. A high index contrast allows for compactness but the inherent tradeoff is polarization sensitivity. This introduces a need for devices such as polarization beam splitters (PBS) that enable polarization diversity within SiP circuits.

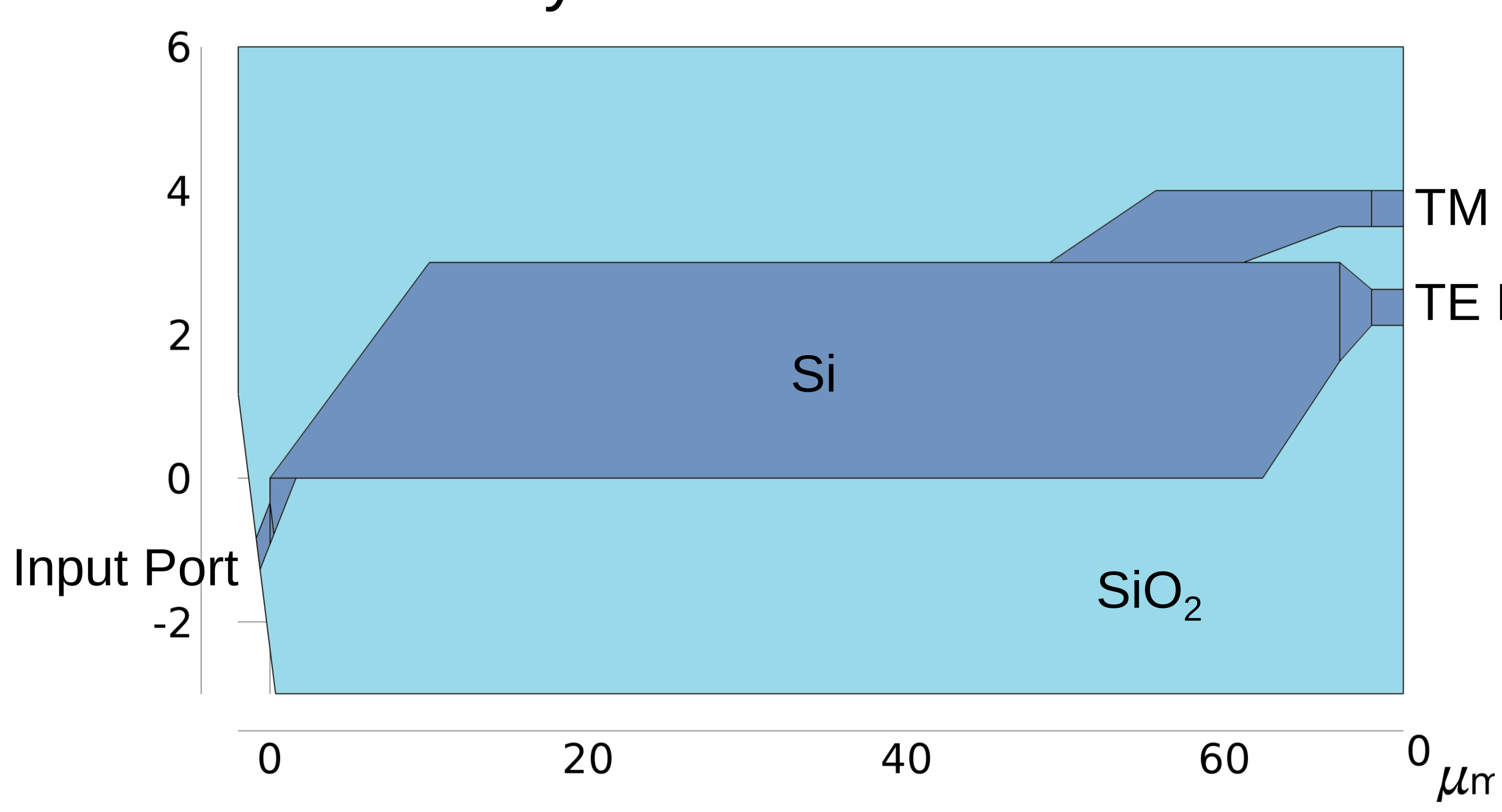

Figure 1. PBS geometry

The device proposed is a multi-mode interferometer (MMI) based PBS that utilizes the differential in effective refractive indices experienced by the two fundamental modes confined in the waveguide. This work is extensively simulated using the COMSOL Multiphysics® Wave Optics module and optimized by sweeping key parameters.

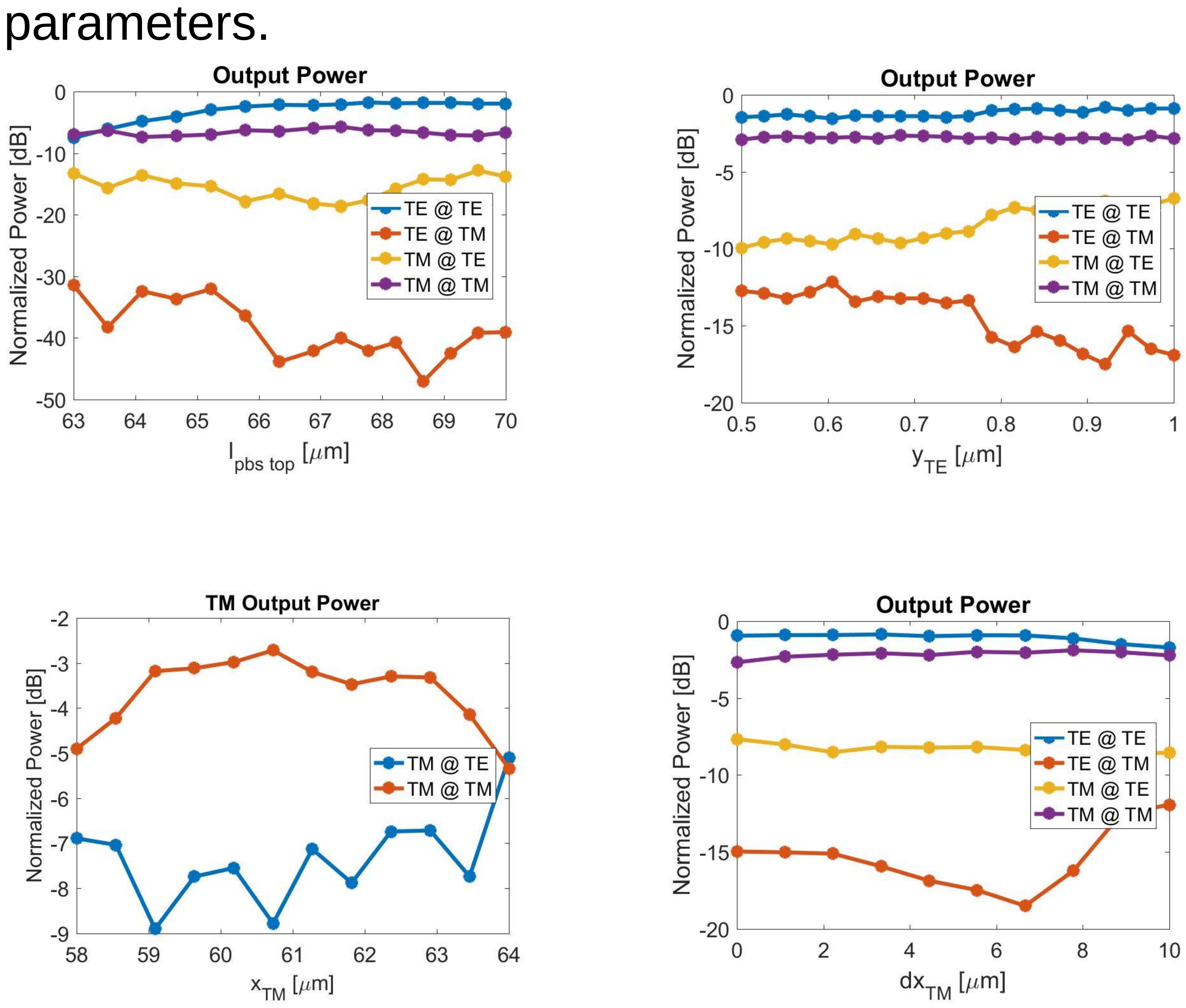

Figure 2. Effect on polarization-based isolation for varying parameter dimensions

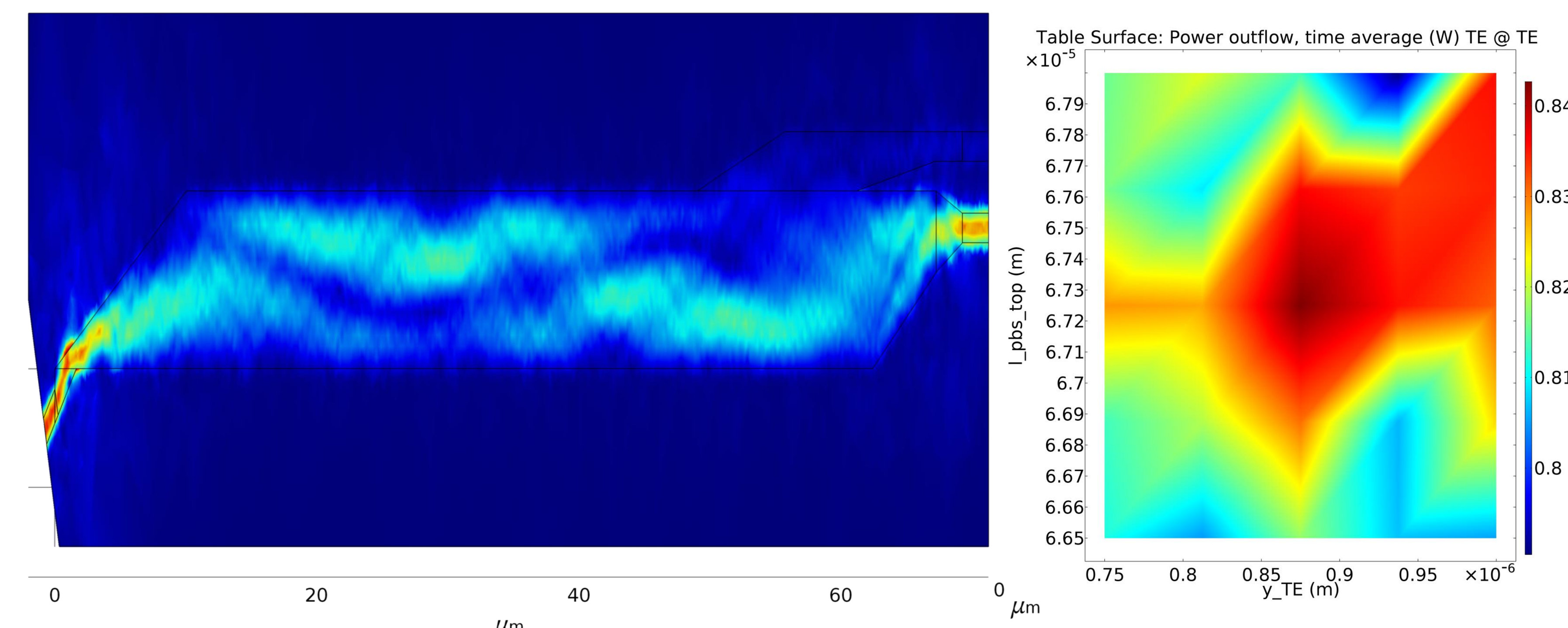

Figure 3. TE normalized E-field and port optimization map

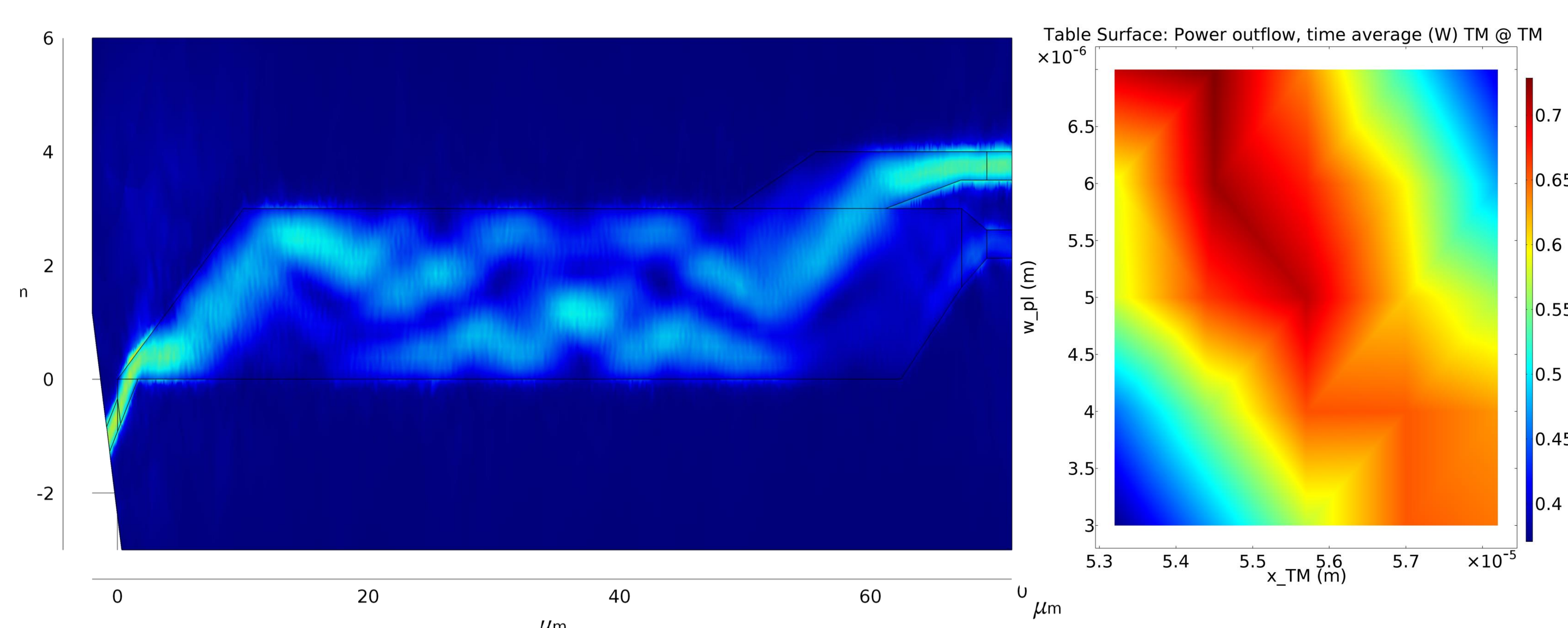

Figure 4. TM normalized E-field and port optimization map

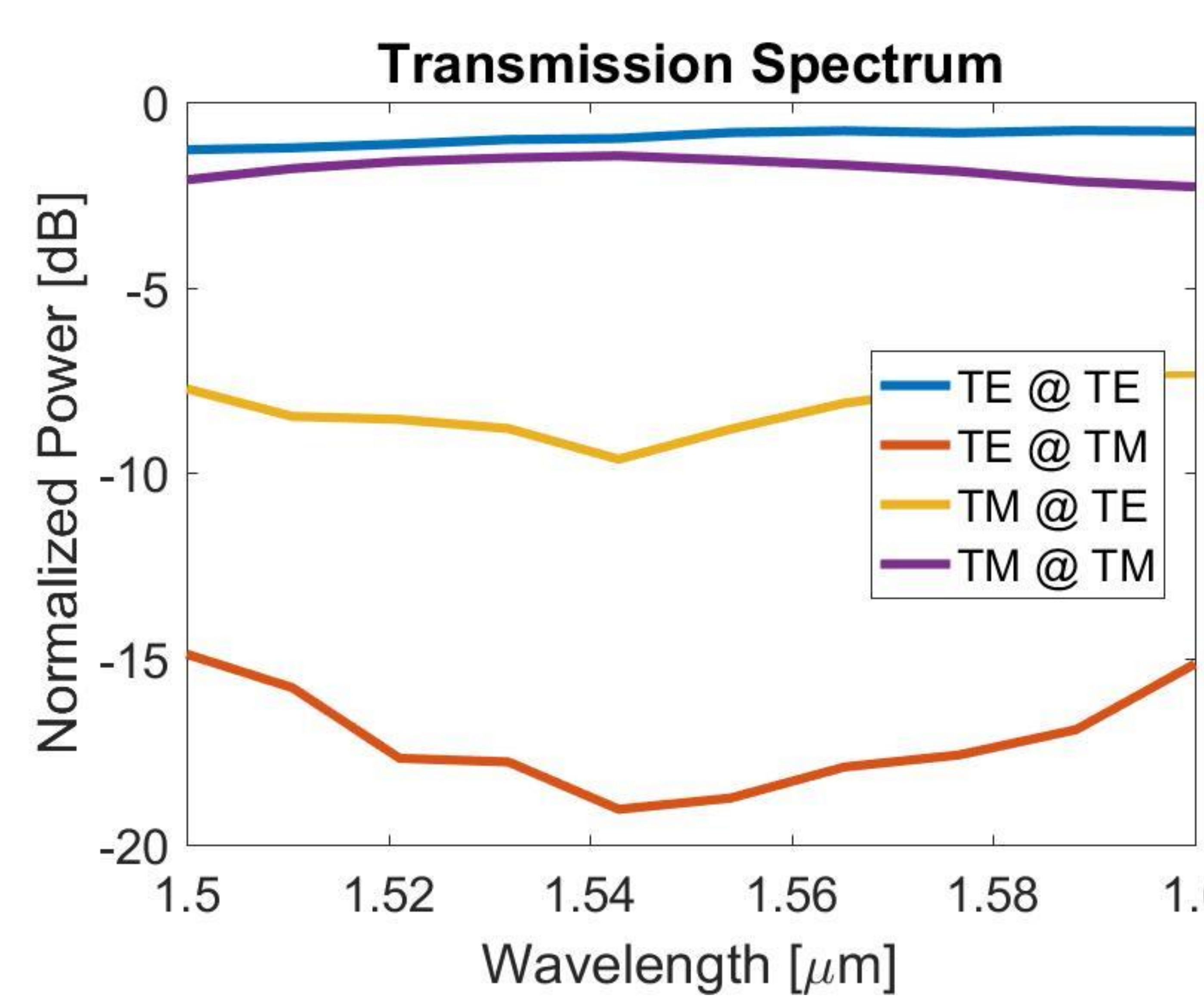

Figure 5. Transmission spectrum

The resultant PBS structure is one of the smallest fabrication tolerant devices of its kind. It is constrained by simplistic geometries within a length of 67 microns and width of 4 microns.

Mode @ Output Port	Insertion Loss (dB)
TE @ TE	0.82
TE @ TM	18.75
TM @ TM	1.56
TM @ TE *	8.81

Table 1. Insertion loss at 1550nm
*TM @ TE can be reduced further by adding a waveguide bend.

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