# How to Build a High Performance MPLC: From Simulation to Fabrication

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A multi-plane light converter (MPLC) is a wavefront shaping device that can perform lossless unitary transformation by cascading light through a series of spatially patterned phase elements called phase masks. Since the MPLC can perform lossless unitary transformations, it can be used in a variety of applications and field. These include it being used as a programable high dimensional quantum gate operator for quantum information and computing [1], a spatial mode sorter for mode division multiplexing in telecommunications [2], and even as a single shot wavefront and coherence sensor [3].

For most of the above applications a spatial light modulator (SLM) is used to generate the phase masks needed to perform some desired output. While SLM gives an enormous amount of freedom in their programmability they are inherently lossy and are not ideal for complex low loss transformations. In this work we present a 55 Hermite Gaussian (HG) mode sorter, which uses a gold plated etched fused silica material to act as the required phase masks. The basic operation of the device converts an individual Gaussian spots in a triangular array to the first 55 HG modes. As illustrated in Fig 1 the MPLC device is glued onto a glass block so that it can be housed in server mounted fibre switch box for compact and robust use for mode multiplexing. The use of the etched masks has allowed us to achieve a measured cross talk of 15dB which matches the theoretical cross talk of the device. However, one of the major drawbacks of using these etched based phase masks is the alignment and gluing process. We have developed a repeatable method for this process that has never been describe in the literature before. This device and the methodology that we have developed is a significant step forward for utilizing an MPLC in not only a research-based environment but also a major leap forward for utilizing the MPLC in an industry-based telecommunication context.

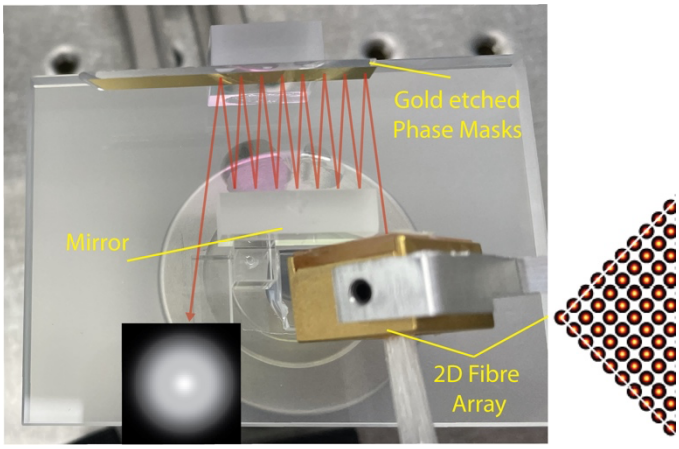


Fig 1: Illustration of a gold plated etched fused silica MPLC. The illustration shows the shape of the spot array and intensity of the first 55 HG modes as the output of the MPLC

[1] N.K.Fontaine, *et al*, *Nat.Commun.*, **10**, 1865 (2019)

[2] Florian Brandt, et al Optica **7,** 98-107(2020)

[3] D. S. Dahl, et al in *Frontiers in Optics + Laser Science 2021*, paper FTu6C.2.