Photonic Adaptive Optics

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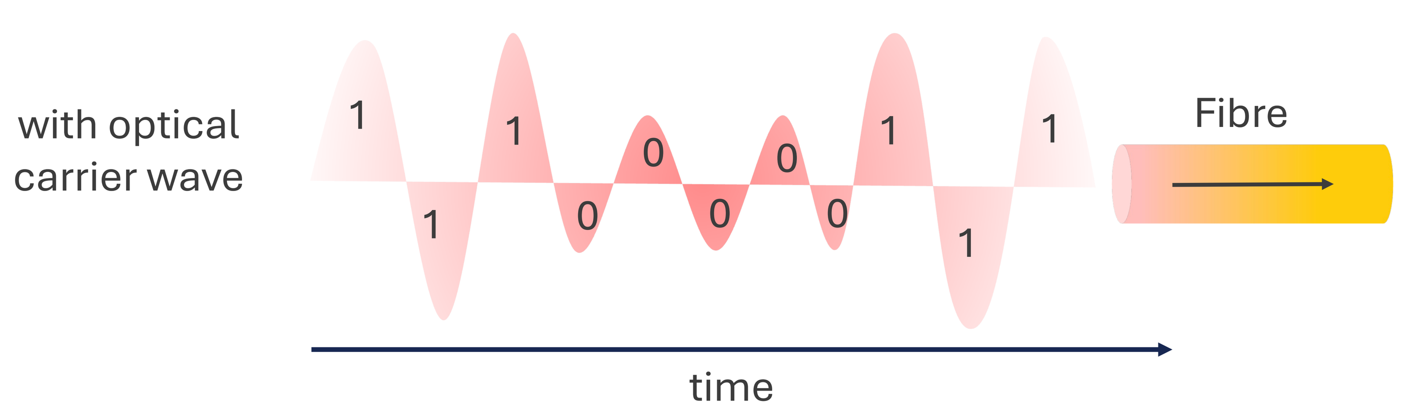
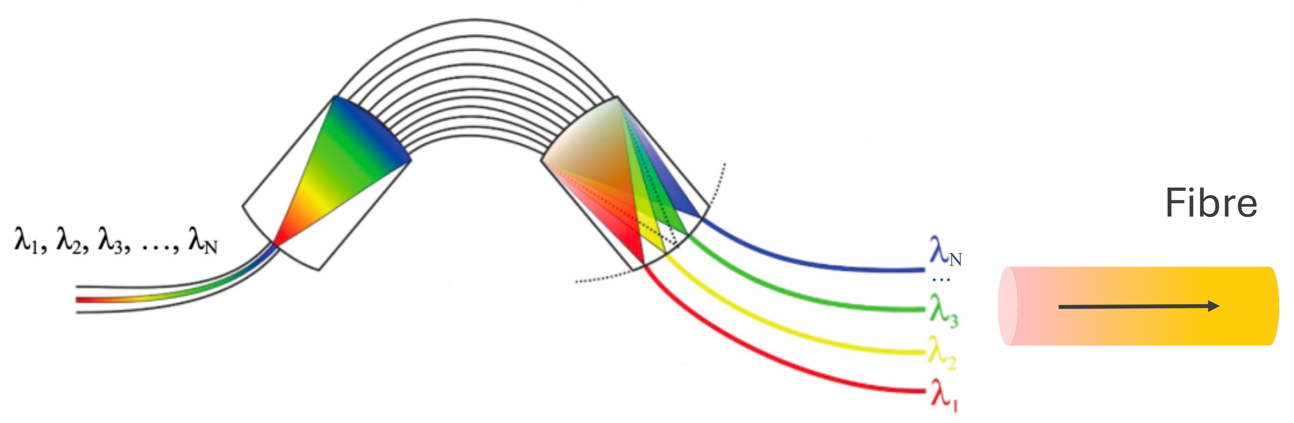
Motivation

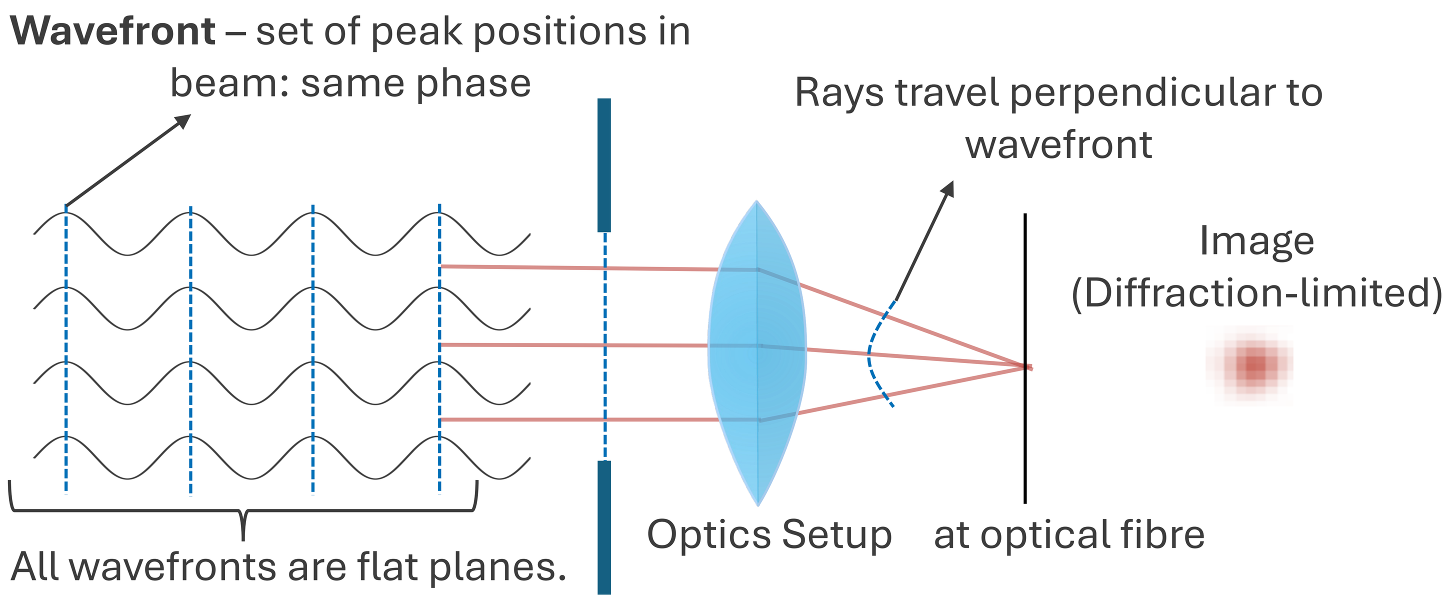
Satellite-to-ground optical links require efficient coupling of light into optical fibres. This results in 100x faster data transfer, lower power consumption, and smaller transmitters. Additionally, for astronomy applications, fibre-fed spectrographs offer robust and high-resolution spectra.

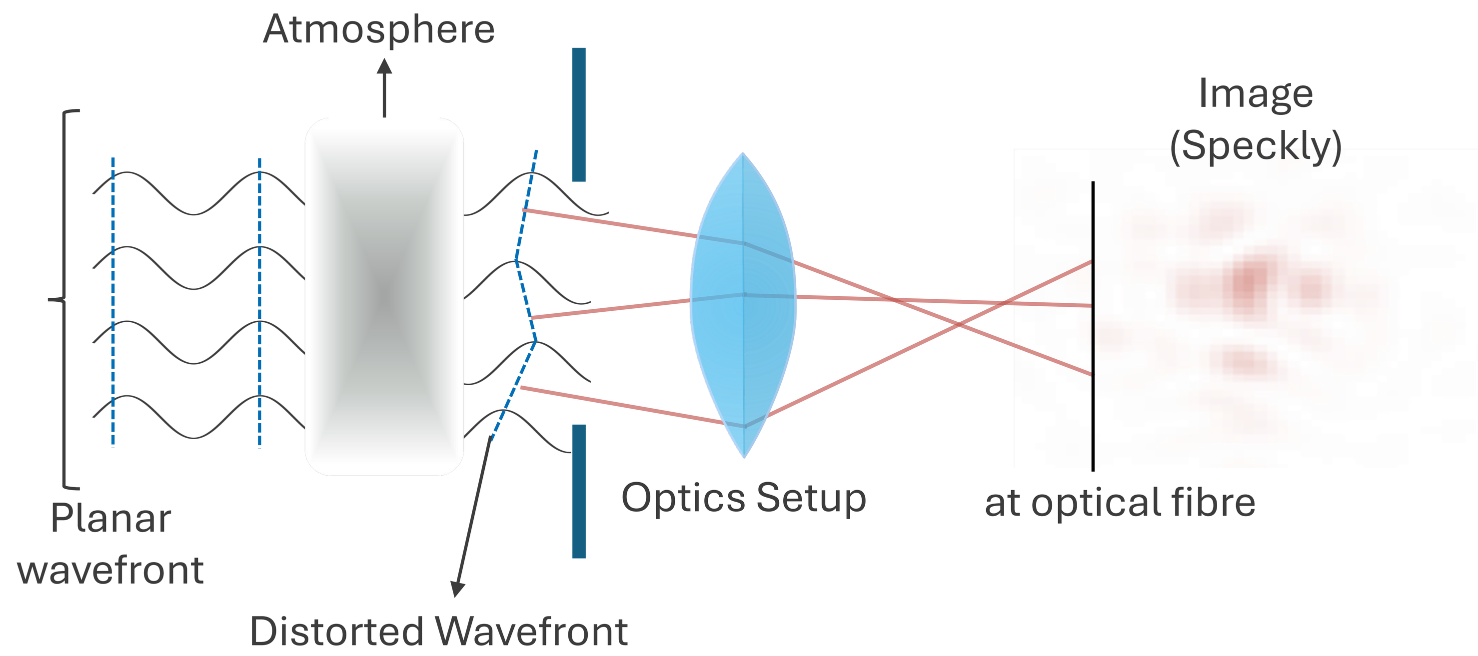




Problem

Light needs to be coupled into the optical fibers before any processing can take place. With flat wavefronts, a confined image would be formed at the receiver and coupling into the fiber could be efficient. However, the atmosphere distorts the wavefronts, resulting in a speckled image that cannot couple into the fiber.

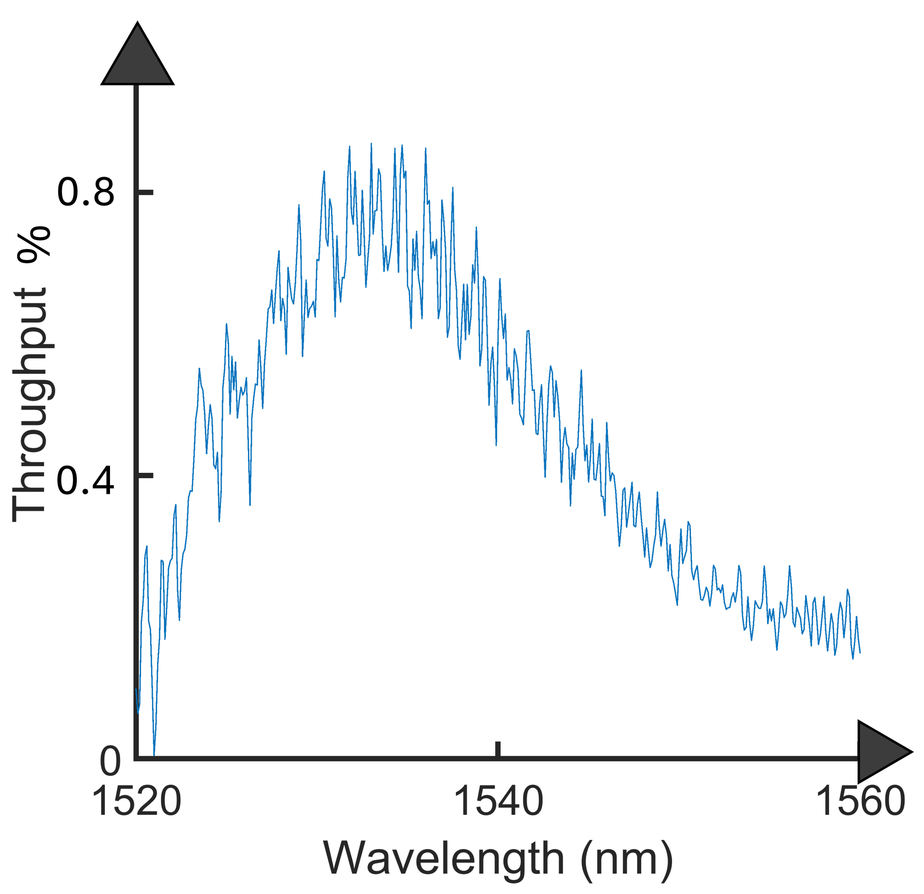


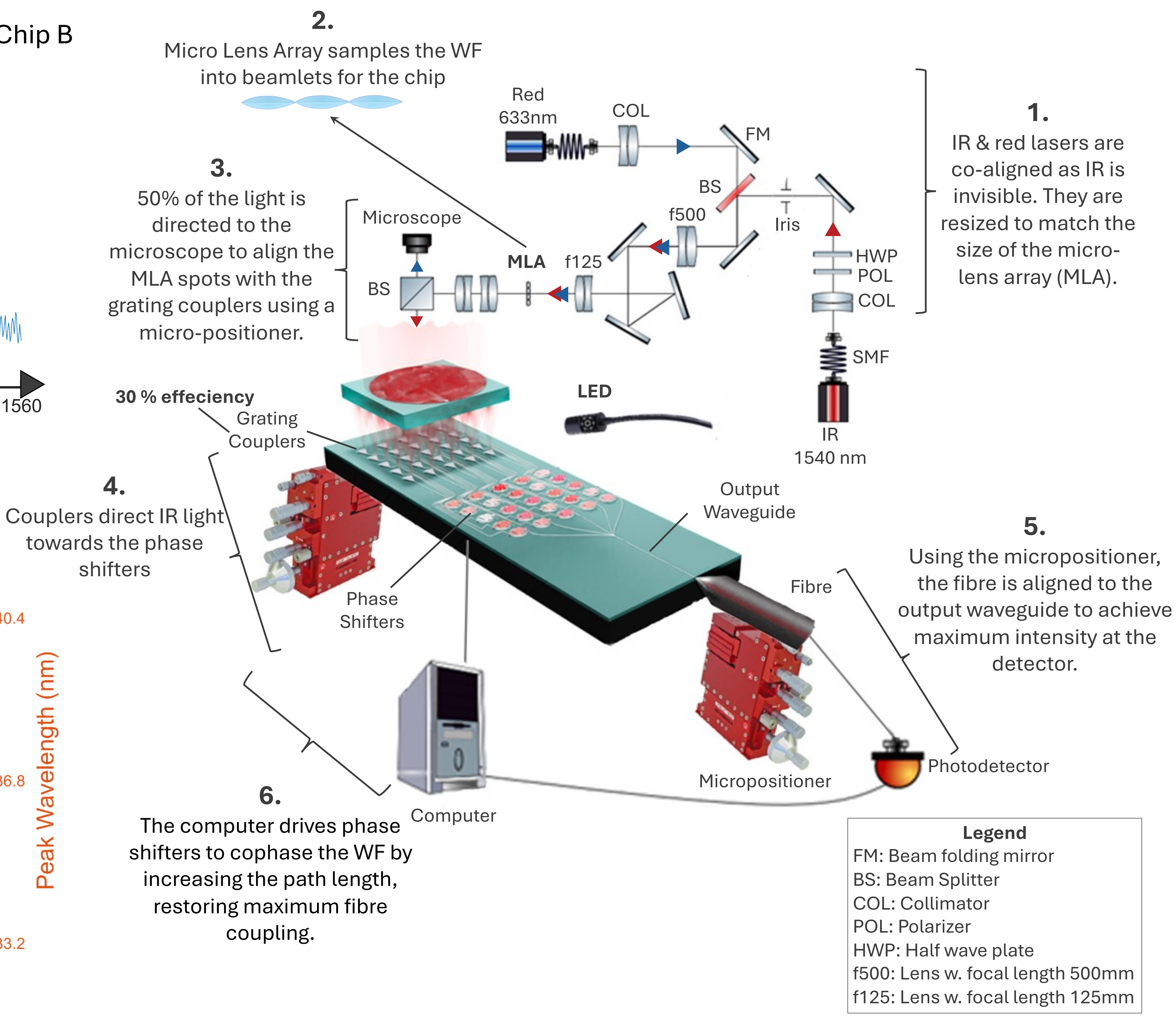


Solution & Results

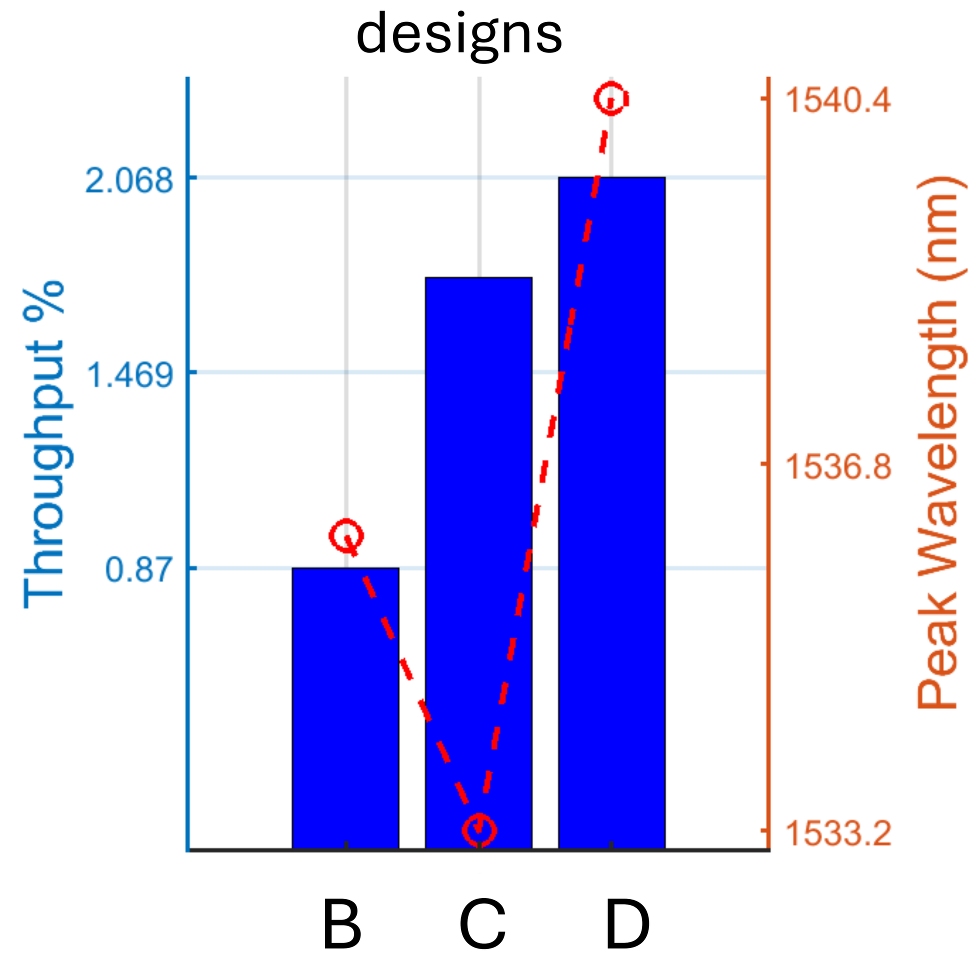
The distorted IR wavefronts (WFs) can be corrected to increase fibre coupling. Specifically, a photonic chip can slow down parts of the wavefront so that each peak lies in a flat plane (co-phasing). We measured the throughput and spectrum of the photonic chip and the grating couplers (see below), and identified systematic errors.

Throughput spectrum of Chip B





Tests of different chip designs



Findings, Limitations & Future

The chip's throughput and alignment were found to be affected by it's temperature. In the future, the chip will be temperature controlled. We tested four different chip designs and identified the best device. The next steps include adding a Shack-Hartmann wavefront sensor to measure the wavefront before correction.