

# Design space exploration of functional blocks for on-chip mode division multiplexing

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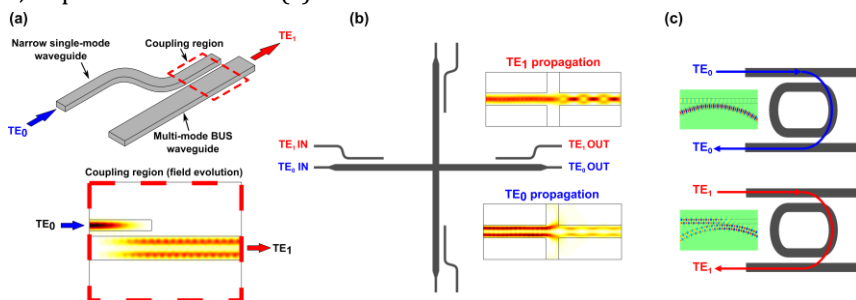
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Most of the optical networks-on-chip (ONOCs) architectures proposed so far in the literature rely for their operation on wavelength division multiplexing (WDM) [1]. A limitation to the WDM approach for on-chip communications stems from the difficulty of integrating light sources on a silicon CMOS compatible platform. Therefore, to optimise the use of the available lasers, a further dimension inherent to optical communications can be leveraged to implement on-chip networking, namely the spatial (modal) one. In mode-division multiplexing (MDM) techniques [2], distinct communication channels are allocated, on the same common wavelength, to the various modes of a multi-mode waveguide.

While for on-chip WDM networks the awareness on the requirements of functional building blocks is well established, for on-chip MDM systems, on the contrary, the design constraints at both device and system levels are still an open issue of investigation. The aim of this contribution is to explore, by means of analytical (scattering matrix formalism) and numerical (FDTD) tools, the design space of different MDM building blocks. A selection of MDM devices is depicted in Figure 1. Panel (a) shows an asymmetric directional couplers implementing  $TE_0$  to  $TE_1$  multiplexing via a phase matching condition. Panel (b) shows an orthogonal crossing between two bi-mode waveguides; here, the optical response must be assessed in both  $TE_0$  and  $TE_1$  operating modes. Microrings can also be exploited for routing in the multimode domain, as presented in Panel (c).



**Fig. 1. Building blocks for on-chip MDM. (a) Asymmetric coupler for  $TE_0$  to  $TE_1$  multiplexing. (b) Multimode orthogonal crossing. (c) Multimode ring resonator.**

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## References

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- [2] C. Peucheret et al., *Signal Processing for On-Chip Space Division Multiplexing*, Advanced Photonics OSA Technical Digest, SpT2E.3, 2015