Elemental optical fiber-based blocks for building modular computing parallel architectures

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Introduction A lot of effort has been put on free-space interconnects as a way to alleviate the wiring congestion inherent to planar VLSI technology. However, industry is still awaiting for a reliable support, comparable in robustness to optical fibers (1D) or planar guided-wave optics (2D). We present here first steps towards a **set of robust, prealigned 3D fiber-based interconnection blocks**, usable as **elemental building modules for most parallel computing architectures**. Thanks to the guided nature of the interconnect, we can expect these to achieve **better efficiency than diffractive optics**, while the use of a third dimension will certainly **eliminate cross-talk**.

System Although technologically challenging, there is no fundamental reason excluding the use of optical fibers as a way to implement complex **interconnection patterns between plane arrays**. However, compared to free-space optics, alignment (of both inputs and outputs) may represent a real challenge. Our solution consist of using prealigned **micromachined fiber-holder arrays** (Fig.1). Also, to avoid dealing with arbitrary large or complex blocks, we look for "minimal blocks" reusable in most parallel computing/networking topologies. By definition, **separable permutations** can be **decomposed into row and column independent permutations,** which make them easily to **fold in two dimensions** and **easily to build**. Fig.2 Shows the testing of a folded 16-input/output exchange permutation. Crosstalk is negligible, as can be seen at the bottom of the figure. Fig.3 also shows the separability of the exchange permutation. **Scalability and modularity** of the blocks is another important issue being explored. As a demonstration of these principles, we are building a **Banyan multi-stage interconnection network** (Fig.3).

Further research will be conducted on **multi-permutation modules**, which are going to contain several independent-addressable permutations (all separable and having the same modular properties).

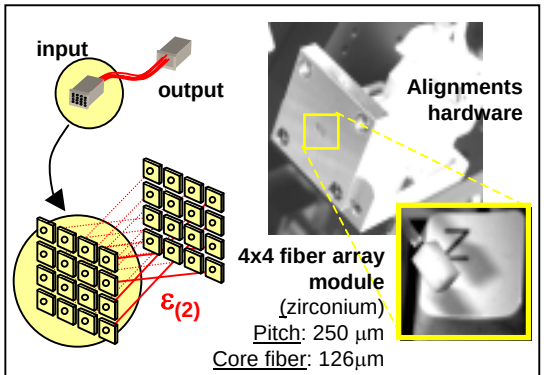

Fig.1 Prototype: ***4x4 exchange block***

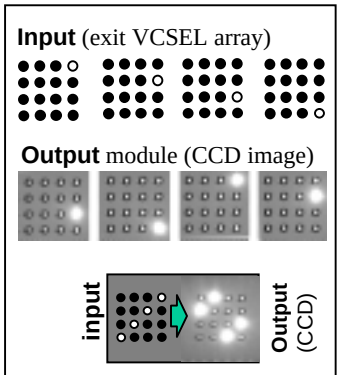

Fig.2 Module Testing

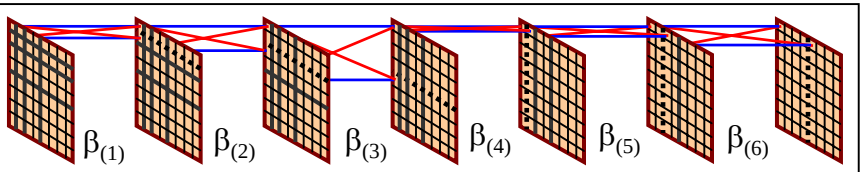

Fig.3 Example application: ***Banyan Multi Stage Interconnection Network***

Alignment of the blocks with respect to inputs/outputs is a critical issue, now being studied both **dynamically** [1] and **statically** (prealigned **plug and play** exchangeable blocks [2]).

[1] Naruse et al., JSAP spring meeting 2002. [2] Goulet et al., OJ2000, pp.247-248.