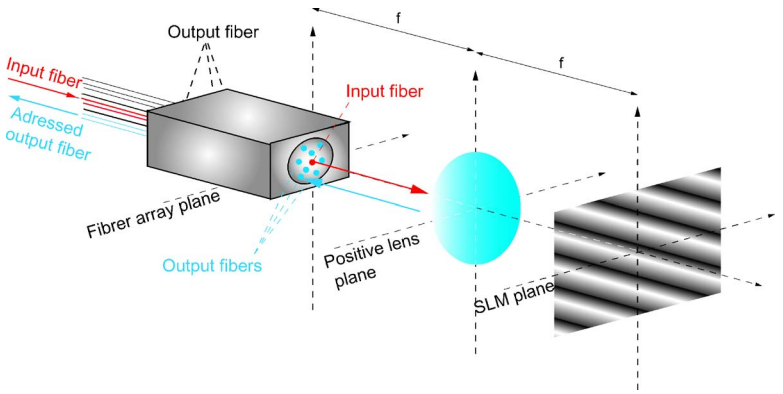

Fig. 1 Reflective holographic space-switch architecture.

(or holograms), which, since the input and output fibers are located in the same fiber array holder, permits us to limit the switch length while improving the opto-mechanical alignment procedure. The angular deviation resulting from the beam passing through the hologram is transformed into a spatial offset at the output (replay) plane. Overall, this system can be considered a fiber spatial correlator. Compared to MEMS reflective techniques, diffractive beam-steering provides motionless and high-capacity space switching with wavelength-band selection capabilities.[7] Both techniques have their own advantages: Micro-mirror arrays have low loss and are intrinsically independent of the polarization and wavelength of the input light. On the other hand, LC holographic modules operate with no moving parts and can be used not only to steer optical beams but also to address several output fibers simultaneously, providing natural channel-bridging capabilities, as well as to shift the spectral response of the selected optical output.[7] These two points represent a decisive advantage over MEMS technology in terms of system flexibility.

Using liquid crystal technology, various phase modulations can be achieved depending on the LC material choice. An almost continuous-phase profile can be obtained with a nematic LC, but the phase modulation depth is polarization-dependent. In contrast, a Smectic C liquid crystal—often referred to as ferroelectric liquid crystal (FLC)—makes the device purely polarization-insensitive, with a switching time of a few hundreds of microseconds,[6–8] but to the detriment of diffraction efficiency. The recent introduction of 2D-LCOS (Liquid Crystal on Silicon) SLM devices operating in the 1.55-μm telecommunication window for both WSSs[5] and holographic switches[8] makes the design of large-capacity (i.e., output port count >100) devices possible.

In that framework, a key step is the design of an optimized 2D single-mode fiber array that takes advantage of the high-output port count addressing capabilities of holographic deflectors.

2.2 *Holographic Beam-Steering Model*

A detailed analysis of the optical reconstruction generated by pixellated and phase-quantized LC-SLMSs can be found in the literature.[9] We shall briefly present the reconstruction model for binary and pixellated hologram patterns with the purpose of determining the relevant steering parameters,

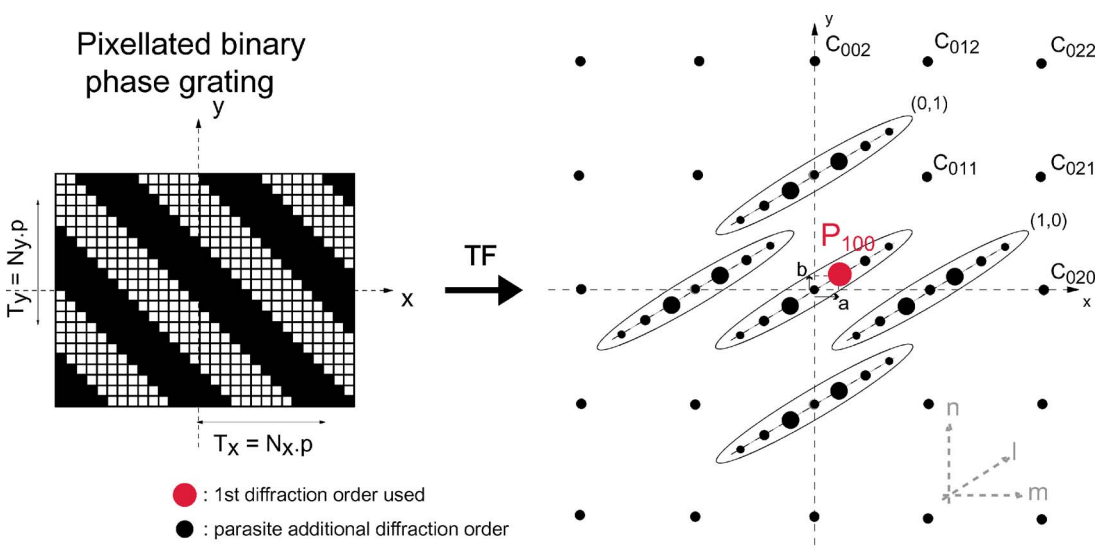

Fig. 2 Three-dimensional higher diffraction order distribution generated by a binary-phase 2D grating.