MILENE: Development of the interferometric test bench for mid infrared photonic integrated circuits characterisation

Louis Gemmerlé, Manon Lallement, Jean-Philippe Berger, Guillermo Martin, Pierre Labeye, Laurence Gluck, Stéphane Curaba

Nulling interferometry allows us to benefit from the high angular resolution provided by current ground-based (or future space-based) interferometric facilities, as well as the capability to observe exoplanets with higher planet-to-star flux ratio through coherent cancellation of the flux from the star. The LIFE space mission is an instrument aiming to perform this method within a wavelength range of 4 µm to 18 µm, and no detector has for now been demonstrated for its specifications. This space mission has a ground-based precursor, NOTT for the VLTI, working in the L' band. Using photonic integrated circuits (PIC) for the aperture recombination function has the potential to considerably simplify the instrument and enhance its performances: it allows the instrument to gain in compactness and thermo-mechanical stability compared to bulk optics and provides intrinsic self-alignment, enhancing the nulling performance.

To explore the ability of the different PIC technologies to provide strong performances in this context, with the support of LabEx FOCUS we have built a dedicated four-beam interferometric bench called MILENE (Mid Infrared Lab Equipment for Nulling Experimentations). This bench can also be used to test detector technologies in a precision interferometry context and evaluate their suitability for nulling in broadband light conditions. The chosen design of this characterisation device is composed of an association of Michelson's interferometers, dividing the flux of a unique source into four beams. The architecture of the bench permits the consideration of an upgrade to eight interferometric channels, opening the way to the characterisation of up-to-eight-telescope recombination PICs in the context of an extended VLTI facility or at the CHARA array. The coaxial aspect of this architecture provides identical pupils for all the beams, so a more uniform injection efficiency among the inputs of the nulling PIC. The uniformity of the injection is also heightened by the development of a telecentric injection system. Moreover, in order to achieve deep null values (10^-3 goal null value across the L-band), a stringent precision in controlling the phase, intensity and polarisation of each individual beam is required. We present the error budget established to evaluate these constraints, the characterisation of various control elements used on the bench and preliminary results obtained with a nulling PIC developed at CEA-Leti using the SiGe platform.