

# Tunable Kernel-Nulling interferometry for direct exoplanet detection

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## Abstract

Nulling interferometry is a promising technique for direct detection of exoplanets. However, the performance of current devices is limited by the sensitivity to phase aberrations. This project attempts to improve this technique by using an active photonic technology with no moving parts instead of classic bulk optics. The studied component allows to build tunable Kernel-Nulls with 14 electro-optic phase shifters, used to compensate optical path differences that would be induced by manufacturing defects. The first part of the study consists in the development of an algorithm providing the delays to be injected into the component to optimize the performance of that device. This technique is first evaluated via numerical simulations, then in lab. It is then envisaged to leverage the Nuller mode, soon to be installed on the VLTI as part of the ASGARD project, to test this architecture under real conditions of observation. The next step of this study deals with the analysis of the intensity distributions produced at the output of the Kernel-Nuller through a series of observations, against which statistical tests and machine learning techniques will be applied to detect the presence of exoplanets. The preliminary results of this study are presented in this presentation.

**Keywords:** Interferometry, Exoplanet, Kernel-Nulling, VLTI, ASGARD

## References

- [1] Bracewell R.N., MacPhie R.H., "Searching for nonsolar planets". *Icarus* **38** (1979): 136–147. [https://doi.org/10.1016/0019-1035\(79\)90093-9](https://doi.org/10.1016/0019-1035(79)90093-9)
- [2] Martinache F. and Ireland M., "Kernel-Nulling for a Robust Direct Interferometric Detection of Extrasolar Planets". *Astronomy & Astrophysics* **619** (2018): A87. <https://doi.org/10.1051/0004-6361/201832847>.
- [3] Cvetojevic N. et al. 3-beam self-calibrated Kernel nulling photonic interferometer (2022). Preprint at <http://arxiv.org/abs/2206.04977>.