
TIPTOP: cone effect for single laser adaptive optics systems

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Abstract

TIPTOP is a python library that is able to quickly compute Point Spread Functions (PSF) of any kind of Adaptive Optics systems. This library has multiple objectives: support the exposure time calculators of future VLT and ELT instruments, support adaptive optics systems design activities, be part of PSF reconstruction pipelines and support the selection of the best asterism of natural guide stars for observation preparation. Here we report one of the last improvements of TIPTOP: the introduction of the error given by a single conjugated laser, commonly known as the cone effect. The Cone effect was not introduced before because it is challenging due to the non-stationarity of the phase.

Laser guide stars are at a finite distance with respect to the telescope and probe beam accepted by the wavefront sensor has the shape of a cone. Given a single spatial frequency in an atmospheric layer, the cone effect arises from the apparent magnification or stretching of this frequency when it reaches the wavefront sensor. The magnification effect leads to an incorrect estimation of the spatial frequency. Therefore, we estimate the residual power by calculating the difference between two sinusoids with different periods: the nominal one and the magnified one. Replicating this for each spatial frequency we obtain the power spectrum associated with the cone effect. We compare this estimation with the one given by end-to-end simulation and we present how we plan to validate this with on-sky data.

Keywords: simulation, single conjugate adaptive optics, laser, cone effect

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