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Flattened pyramid & oscillating sensitivity

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By decreasing the apex angle of the Pyramid Wave Front Sensor (PWFS), the four pupil images on the detector are getting closer and closer. Below a certain angle, these images even overlap. Although this optical configuration is an obstacle to understand the PWFS output as the slopes of the phase, the so-called Flattened PWFS turns out to be an high-performance sensor. Its benefits are indeed manifold: as the PWFS, it is tolerant regarding to the spectrum of the source. Morever, it requires far less pixels than the large angle Pyramid to measure the wave front; making this sensor very efficient in terms of photon use. Last but not least, the FPWFS exhibits enhanced sensitivy on some spatial frequencies ranges. The location of these ones intimately depend on the apex angle of the pyramid and seems to be periodic wrt to the spatial frequencies. Although this peculiar behavior is observed in numerical simulations and on exprimental setup, this phenomenon still suffers from a lack of theoretical understanding. In this talk, we introduce a simple analytical model which decribes the pyramid sensitivity depending on the modulation radius and the apex angle. This approach explains the oscillations observed in the sensitivity shape as well as the high-performance of the FPWFS. It also allows to elucidate the significant difference in terms of sensitivity of the classical and the flattened pyramids. Finally, we show that this model allows to predict the behavior of a sensor combining small angle and tip/tilt modulation.

Author: Mr FAUVARQUE, Olivier (Laboratoire d'Astrophysique de Marseille)

Co-authors: NEICHEL, Benoit (ONERA); CORREIA, Carlos; SAUVAGE, J.-F.; Dr JANIN-POTIRON, Pierre (ONERA / LAM); FUSCO, Thierry (ONERA); CHAMBOULEYRON, V.

Presenter: Mr FAUVARQUE, Olivier (Laboratoire d'Astrophysique de Marseille)