Multiple Spatial Frequencies Wavefront Sensing

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No, I did not gave up on *Dark WF Sensing*...

Removing all the photons that do not contribute to the actual sensing, ideally making a WFS where no photons means the incoming wavefront is flat...!!
Typical reaction of friends...
A four quadrant detector...

This light is removed from here...

This light is added up here...

This light remains where it was...
A Beam Splitter with two Smartt...
Geometrical description

Diffraction description
Geometrical description

Diffraction description
- Position of the secondary peak on the focal plane depends upon $n$
- Amplitude of peaks depends upon $w$
Wavefront perturbation

Low Frequency (LF) Wavenumber n=6

High Frequency (HF) Wavenumber n=26
The spatial filtered pyramid
The state-of-the-art in performance:

Diffraction limit resolution LBT FLAO PSF in H band. Composition of two 10s integration images. It is possible to count 10 diffraction rings. The measured H band SR was at least 80%. The guide star has a mag of R = 6.5, H = 2.5 with a seeing of 0.9 arcsec V band correcting 400 KL modes

Thanks Simone...!!!
This light goes mostly to the edges of the pupils.

This light goes in the pupils (and does not contribute to the AO Compensation).
Assuming is the dominant source of noise in faint end (e.g. no RON)
Pyramid version of the SH-spatially filtered (Poyneer & Macintosh, JOSA-A 21, 810 (2004))
Some remarks...

- The diagphram should change accordingly to the amount of modes corrected...
- Some oversizing to balance wrt attenuation of highest corrected modes...
- The edges of the diagphram are not necessarily “sharp”...
- The diagphram is not necessarily fully black (to make acquisition simpler, for instance)
Wavefront sensing classes of spatial frequencies independent one from each other
Pupil plane for high spatial freq

Pupil plane for low spatial freq
Generalizing to more than 2 classes..
Recall the two sources model...

a) A fraction of the inner quadrant...
b) A fraction of the whole inner aperture
c) A fraction of the spatially filtered central diffraction spot
A lot of parameters...

- Basically the residual from one class of spatial frequencies does not perturb with their Poissonian photon noise the others...
- The spatial frequencies domain (and how much sharp they are)...
- The fraction of light from the central spot splitted into the various channels...
- The actual degree of compensation in each spatial frequency domain....
Are we unveiling a class of WFSs that are “spectroscopist-friendly”...???
Various kind of PSFs....

- The eXtreme AO, exoPlanets friendly one...
- The low Strehl *I am happy anyway* one...
- The spectroscopist (and cosmological) friendly one....
A Pyramid version...

Yes, a pyramid is behind...
A Smartttt version...
A spatially filtered Smart(t) WFS

- Smartt gives directly the WF if perturbations are not larger than a radian...
- Very fine high spatial frequencies correction unperturbed by residuals from low modes for XAO...
- For a certain spatial frequency, r0 and D, this will be automatically assured by Kolmogorov..!
WaveFront Sensing in the VLT/ELT era II

When
2-4 Oct 2017

Where
Padova (Italy)

Web site:
https://www.ict.inaf.it/indico/event/521/
(or just Google the title...)