## Multiple SpatialFrequencies 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 Beam Splitter with two Smartt...

















• Position of the secondary peak on the focal plane depends upon n



### 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 10diffraction 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 & Macinthos, 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 istance)...



# Wavefront sensing classes of spatial frequencies independent one from each other





#### 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 aperturec) A fraction of the spatially filtered central diffr lim 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... 'η=1 $\lambda/d_0$ $\lambda/d_1$ λ/D Đ

Yes, a pyramid is behind...

#### A Smartt 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 unpeturbed by residuals from low modes for XAO...
- For a certain spatial frequency, r0 and D, this will be automatically assured by Kolmogorov..!

When **2-4 Oct 2017** Where **Padova (italy)** Web site:

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

