How to use Active Optics Shack-Hartmann data to measure the seeing at the focal plane of a telescope.

The Active Optics of ESO's VLT sense aberrations thanks to a Shack-Hartmann wavefront sensor (SHWFS) with typical exposure times of 30 seconds and correct them by deforming the active primary mirror of the telescope.

The SHWFS slopes are used for this measurement, but as diagnostic the average spot size in the sub-apertures is also measured and stored since the commissioning of the VLT telescopes, while the raw images and the slopes are not.

The size of those spots is directly related to the atmospheric seeing in the line of sight, and presents the advantage that it is measured at the focal plane of the telescope, i.e. where the scientific instruments are located. Hence the spots are affected by the same aberrations as the instruments, i.e. the atmospheric turbulence but also telescope optical path, residual wavefront error and eventual dome seeing, whereas it doesn't see the lower part of the turbulence (surface layer) that can make a difference with seeing measurements from outside the dome.

The major drawback of using this method is that the VLT SHWFS is specified to measure slopes and not spot sizes, i.e. in good seeing conditions the spots are barely Nyquist sampled or not even.

In this presentation we will compare two algorithms and show that spot sizes can be accurately retrieved from the SHWFS images, thanks to images both simulated and recorded at the VLT. We will demonstrate that a bias is present in the 10 or so years of VLT data and propose a formula to correct it. Finally, we will use this formula to draw statistics on the seeing at the focal plane of one VLT measured with this method, and compare the results with the DIMM statistics.