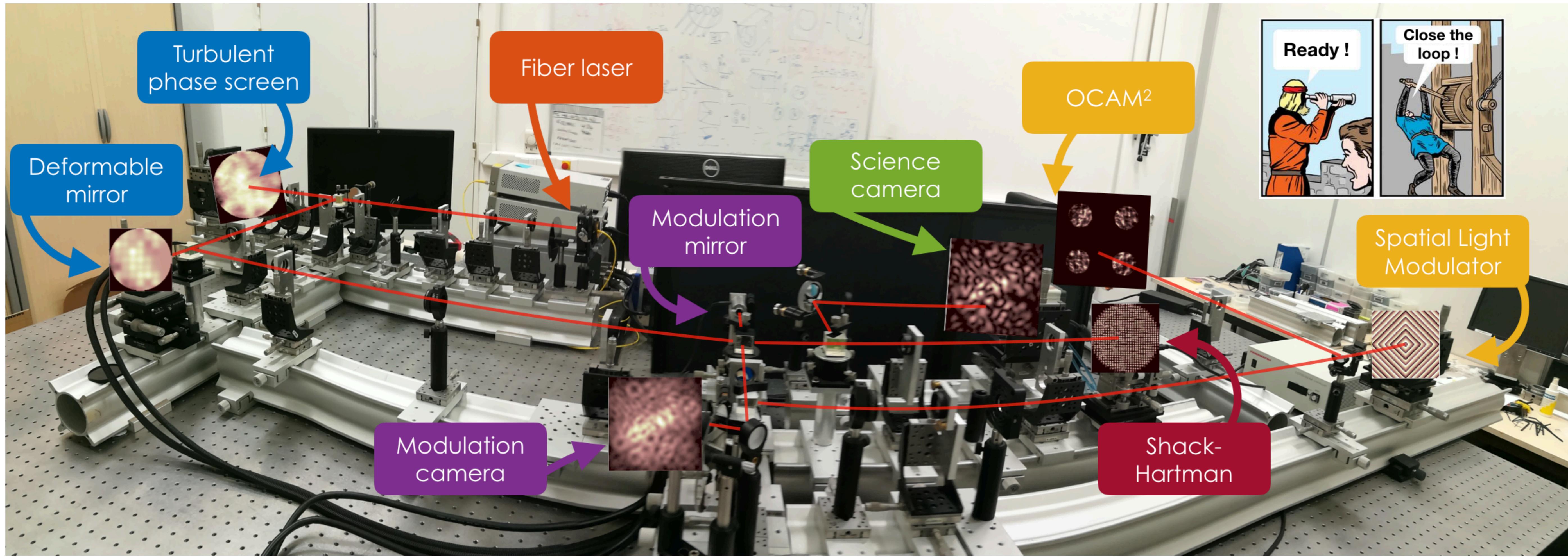
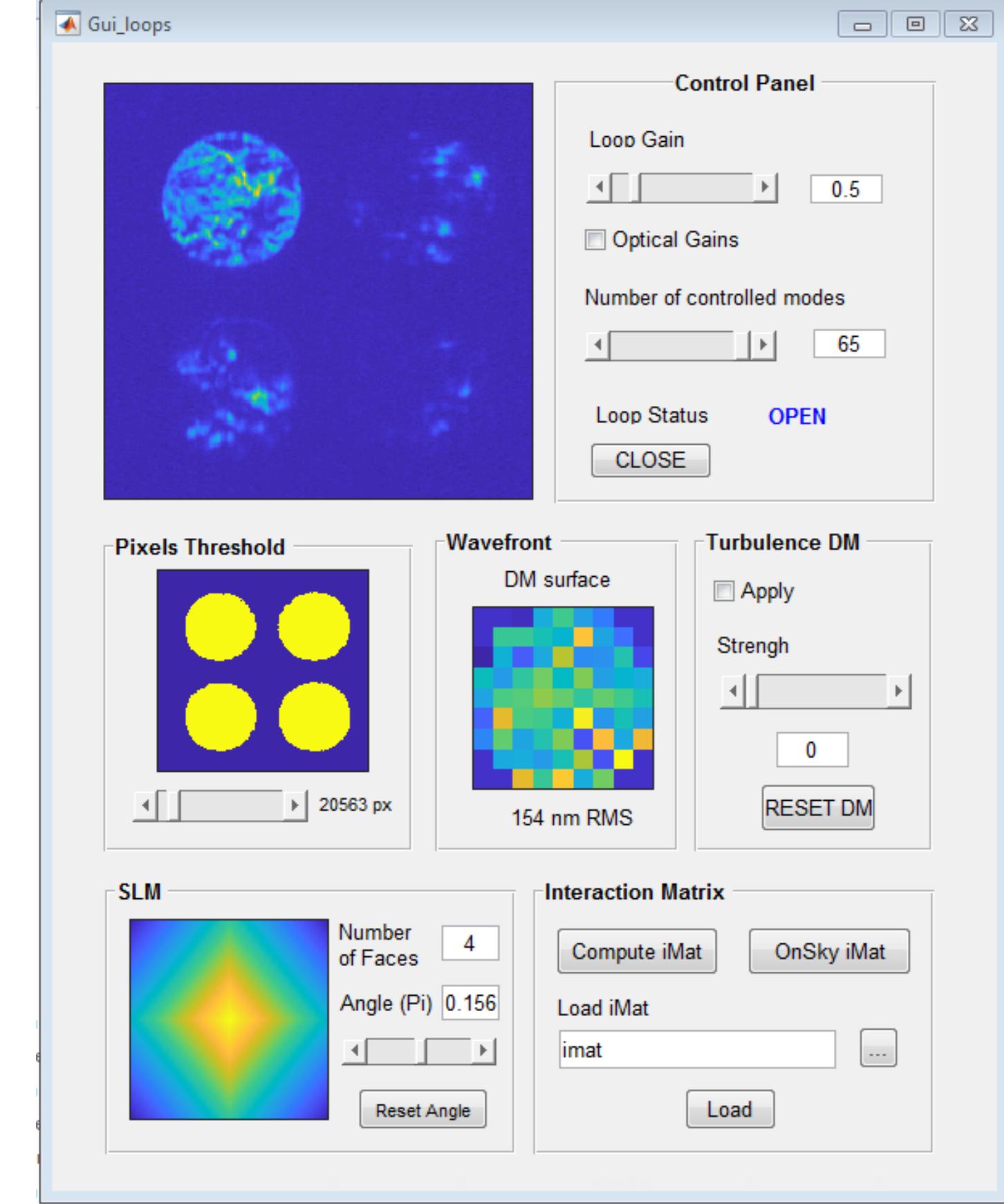


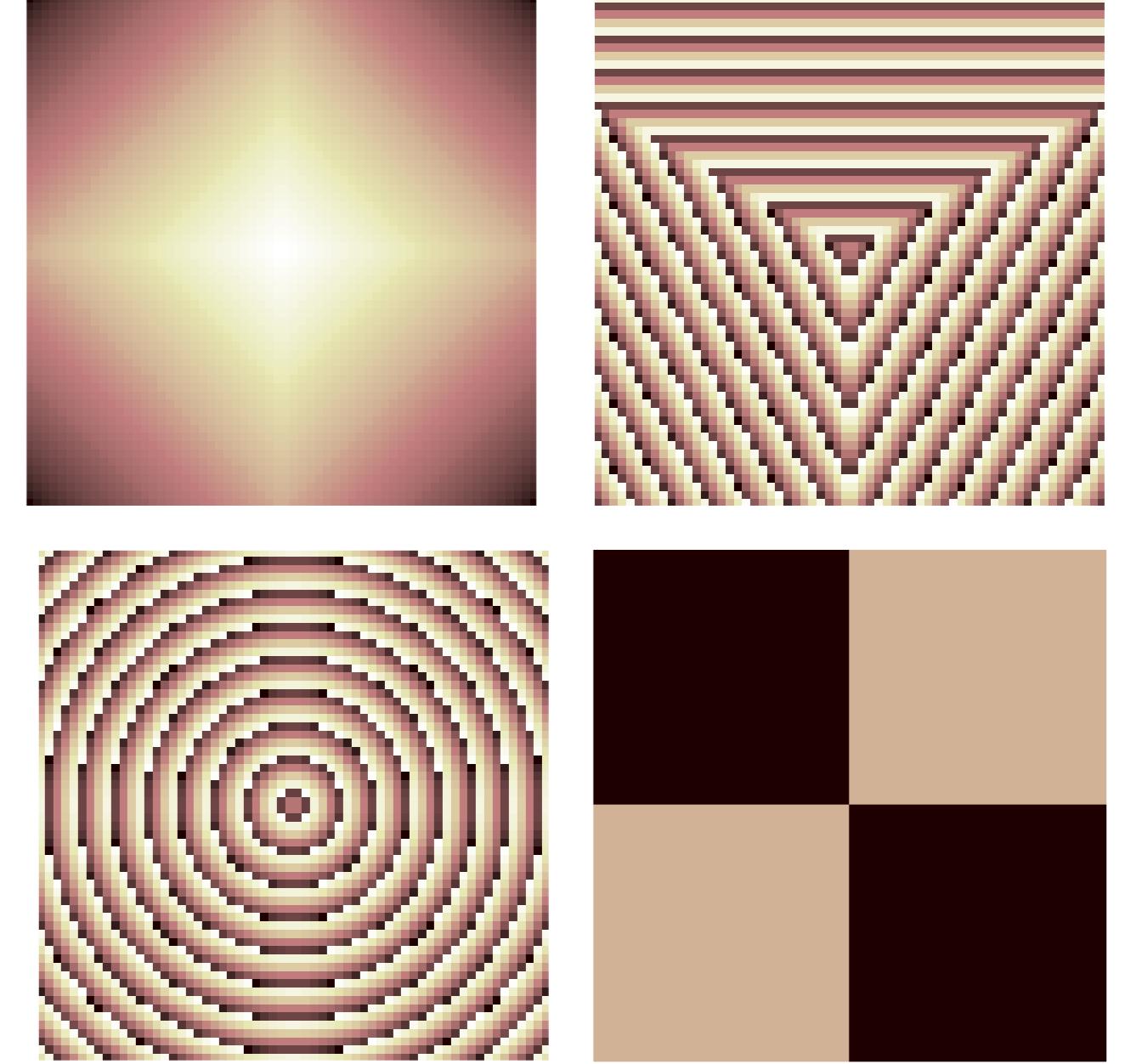
# Analysis of Fourier-based wavefront sensors with the adaptive optics testbed LOOPS

P. Janin-Potiron <sup>a, b</sup>, V. Chambouleyron <sup>a, b</sup>, L. Schatz <sup>c, b</sup>, O. Fauvarque <sup>b</sup>, C. Z. Bond <sup>d</sup>, Y. Abautret <sup>c</sup>, E. Muslimov <sup>b</sup>, K. El-Hadi <sup>b</sup>, J.-F. Sauvage <sup>a, b</sup>, K. Dohlen <sup>b</sup>, B. Neichel <sup>b</sup>, C. M. Correia <sup>b</sup>, T. Fusco <sup>a, b</sup>  
<sup>a</sup>ONERA The French Aerospace Laboratory, <sup>b</sup>Aix Marseille Univ, CNRS, CNES, LAM, <sup>c</sup>The University of Arizona, <sup>d</sup>Institute for Astronomy

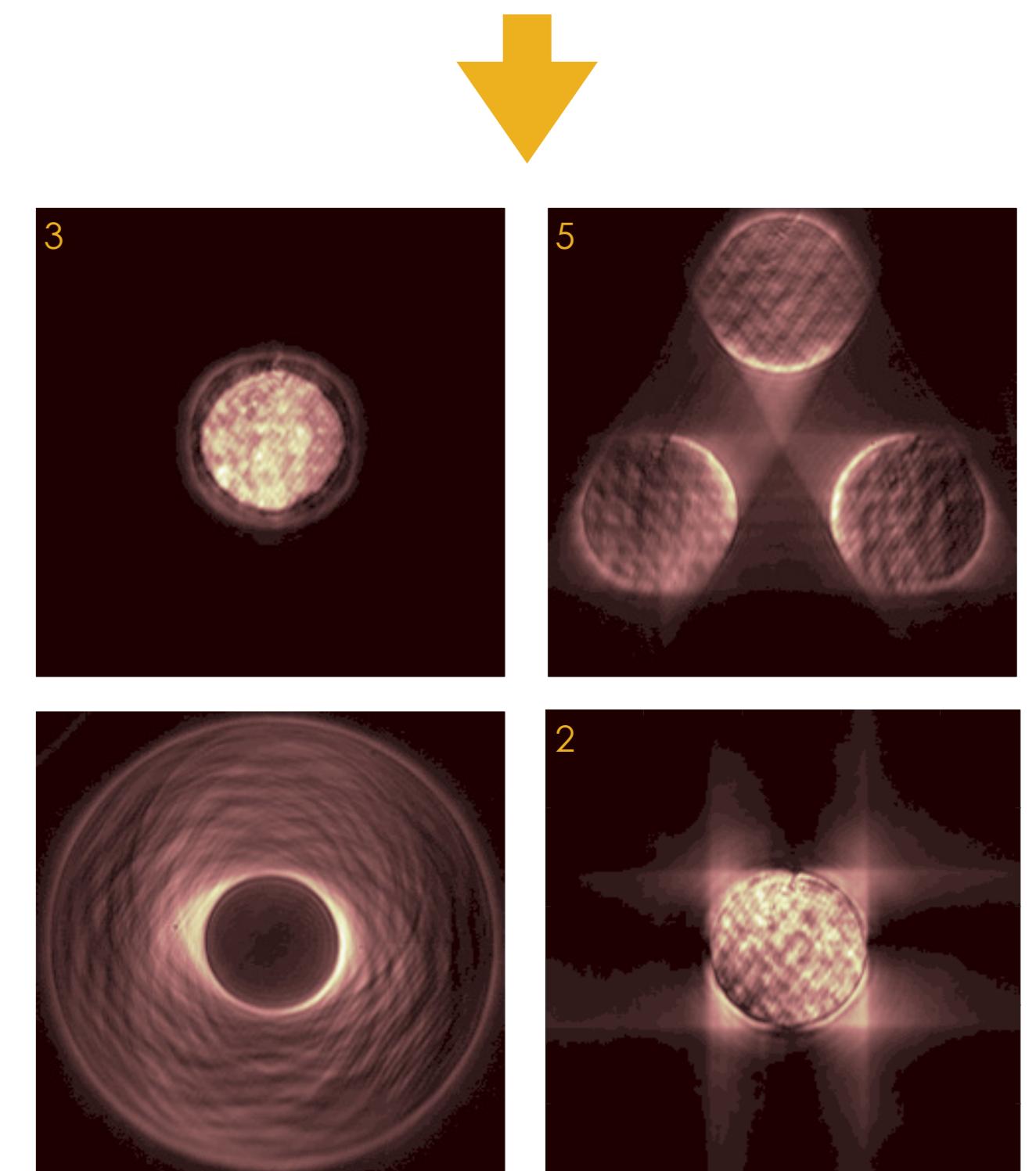
## GUI live control



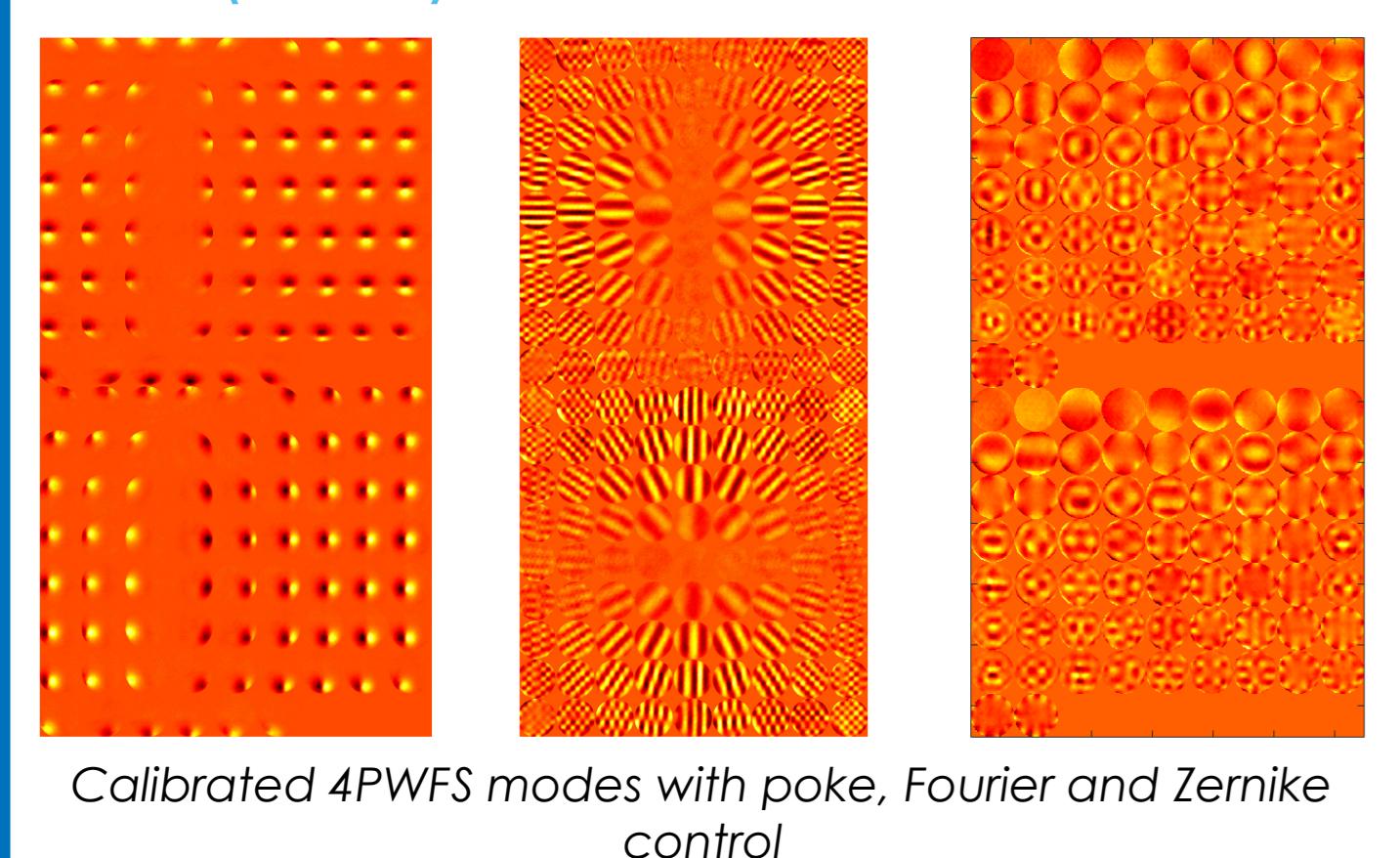
The Spatial Light Modulator (SLM) is a device that uses liquid crystal pixels to create reconfigurable phase maps ...



... to produce numerous flavor of Fourier-based WFS !



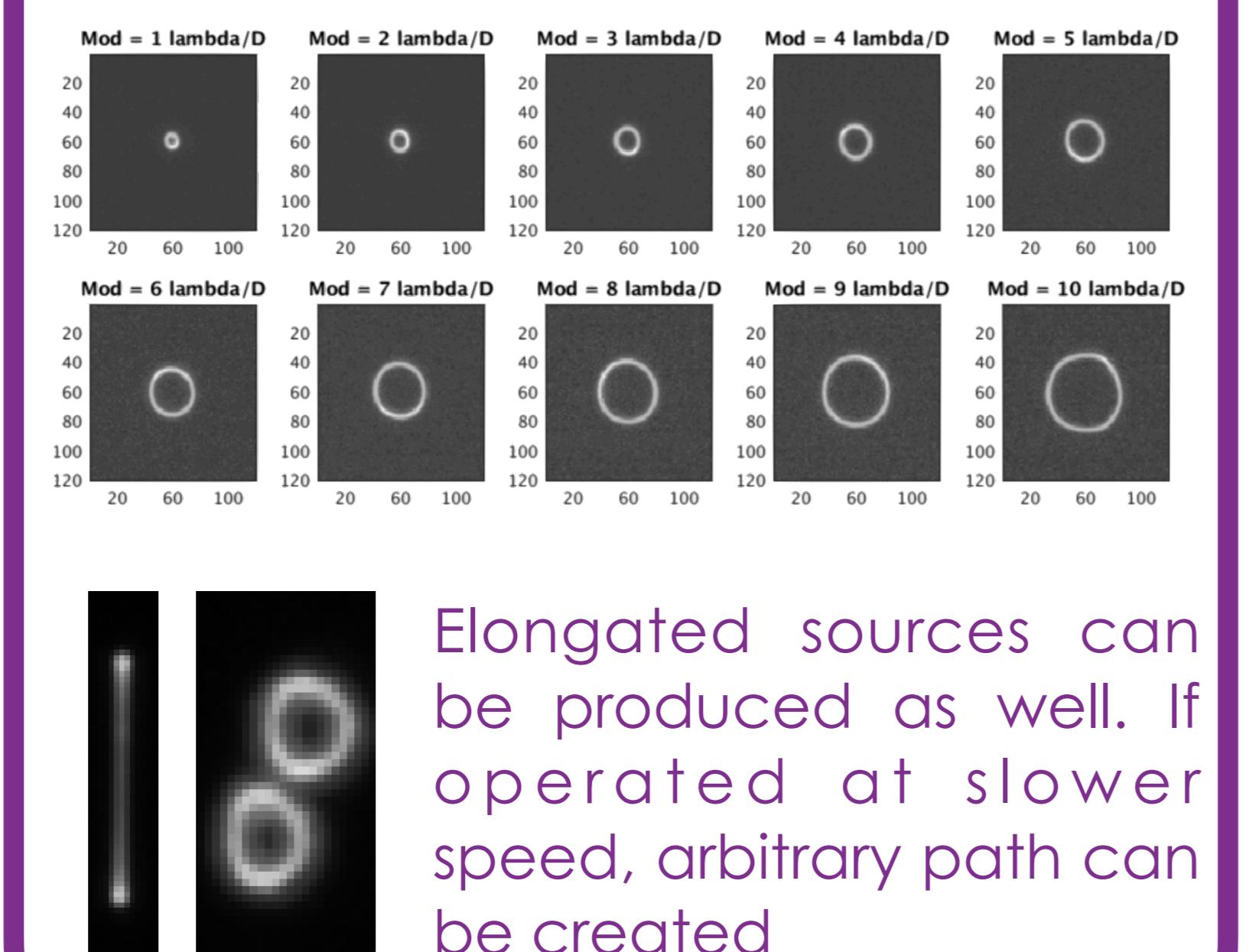
Von Karman turbulent phase screen with fixed  $r_0$  (30cm) and  $V_{wind}$  (8m/s) for a 8m tel.



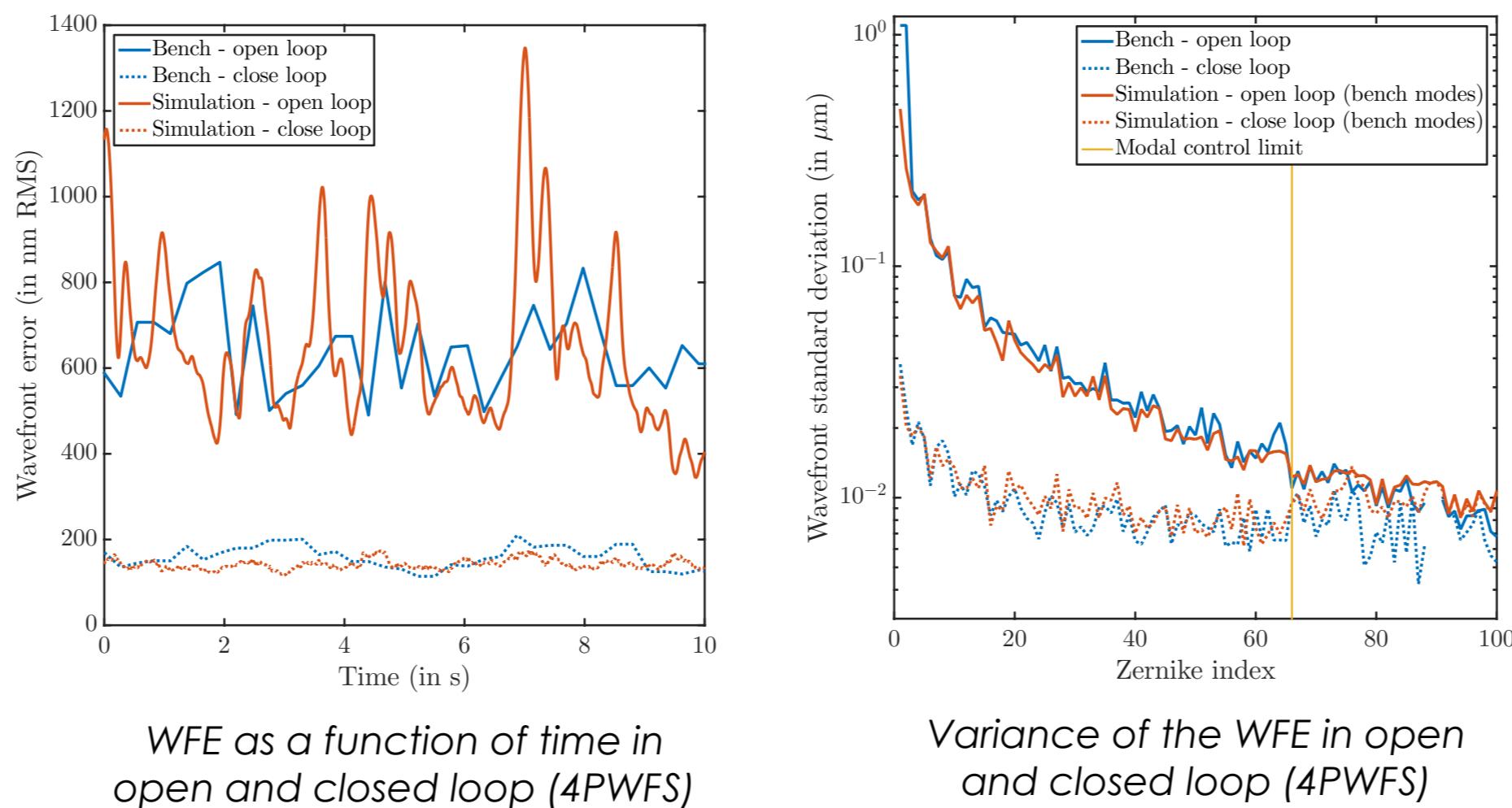
Calibrated 4PWFS modes with poke, Fourier and Zernike control

ALPAO DM - 69 actuators inside the pupil. Zonal (pokes) or modal (Zernike, Fourier, KL) control.

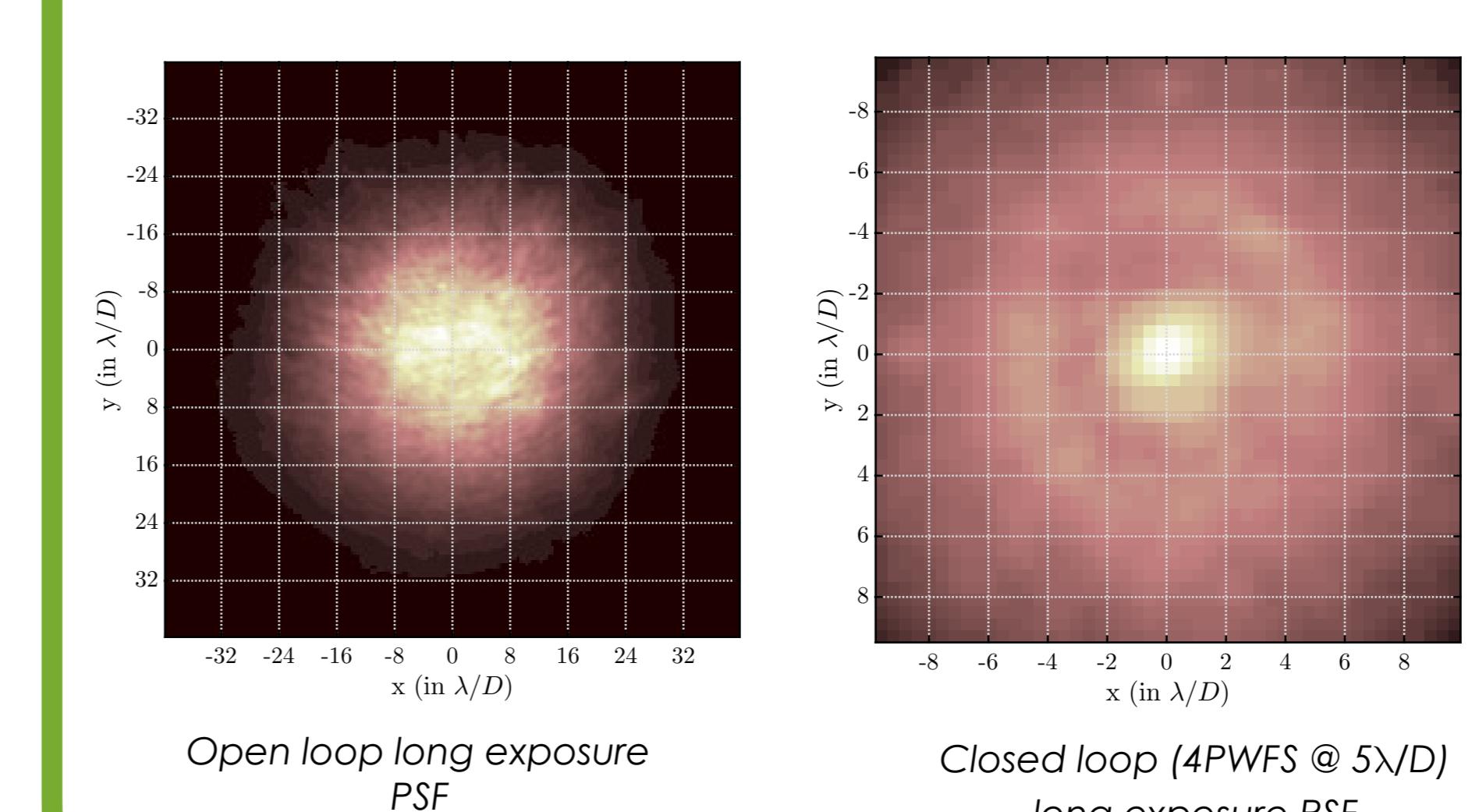
Allow to produce circular modulation up to  $10\lambda/D$  at 500 Hz



Shack-Hartman WFS to serve as a reference phase measurement

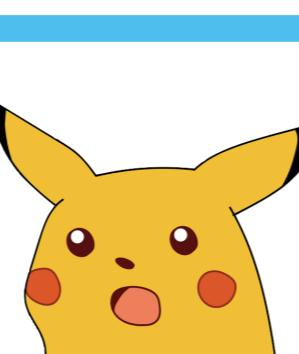


Hamamatsu detector to assess the correction provided by the LOOPS bench. Strehl ratio in the diffraction limited regime is ~75%

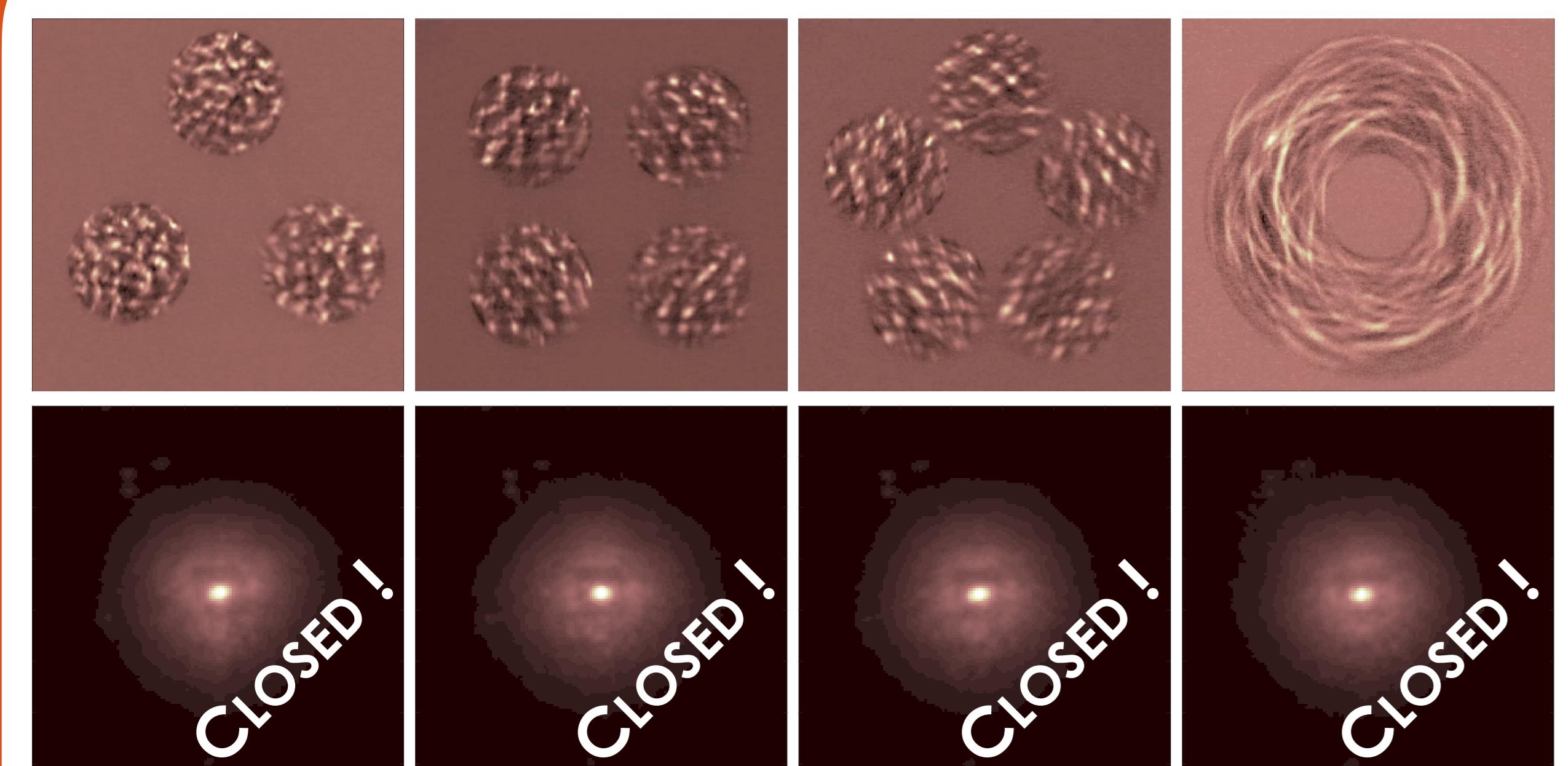


## The LOOPS bench<sup>1</sup>

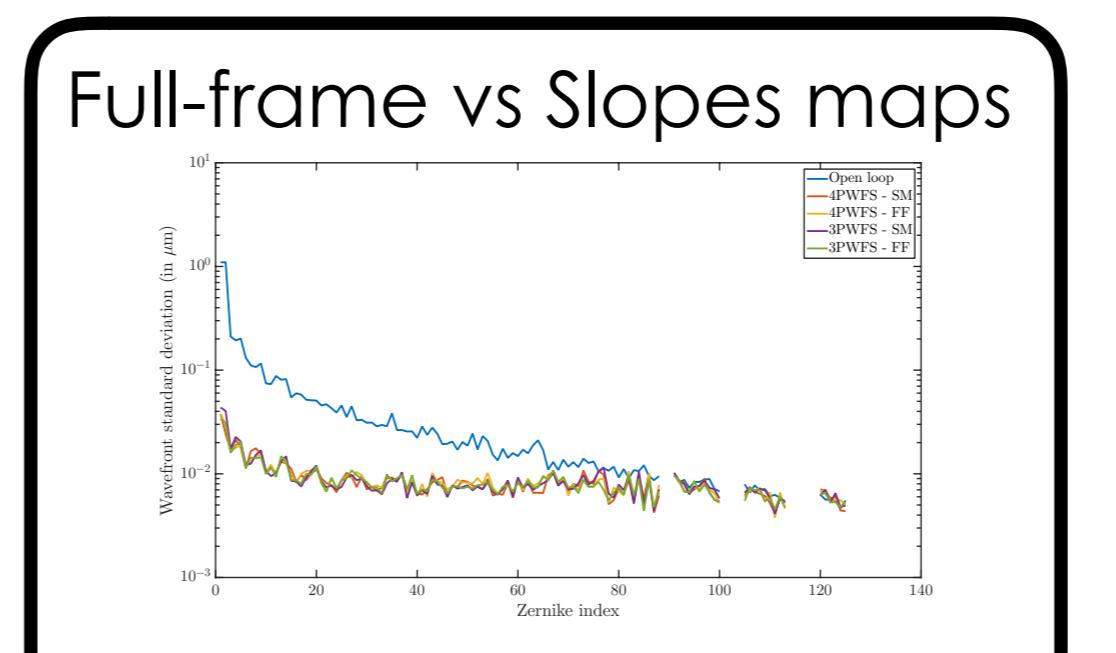
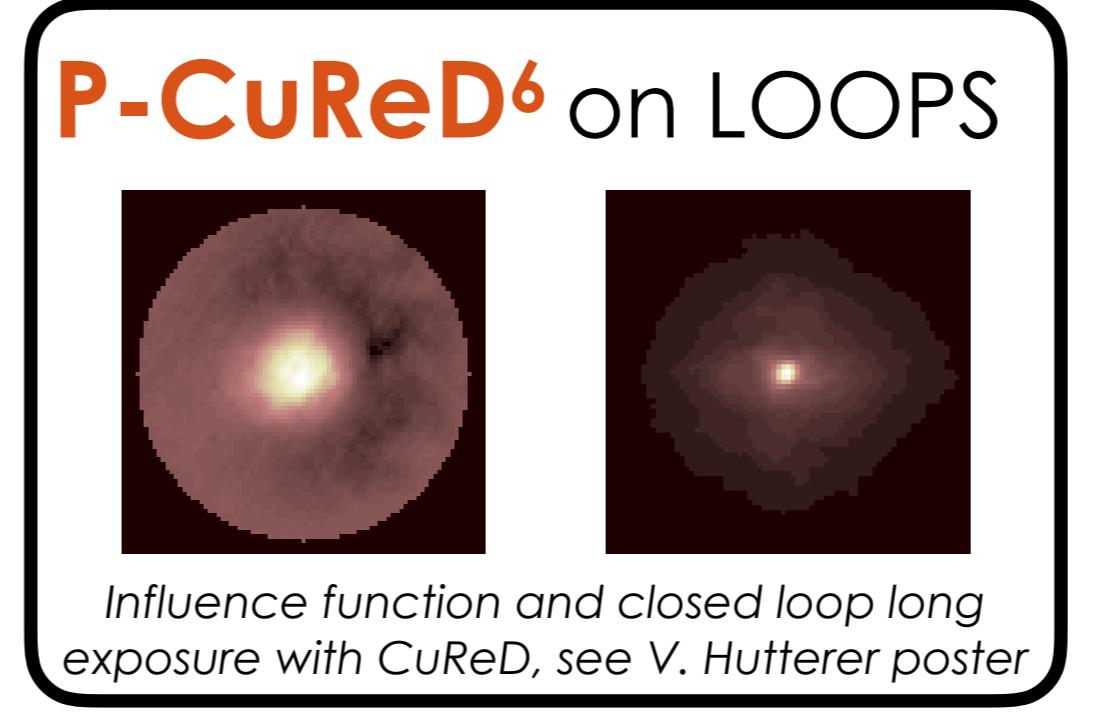
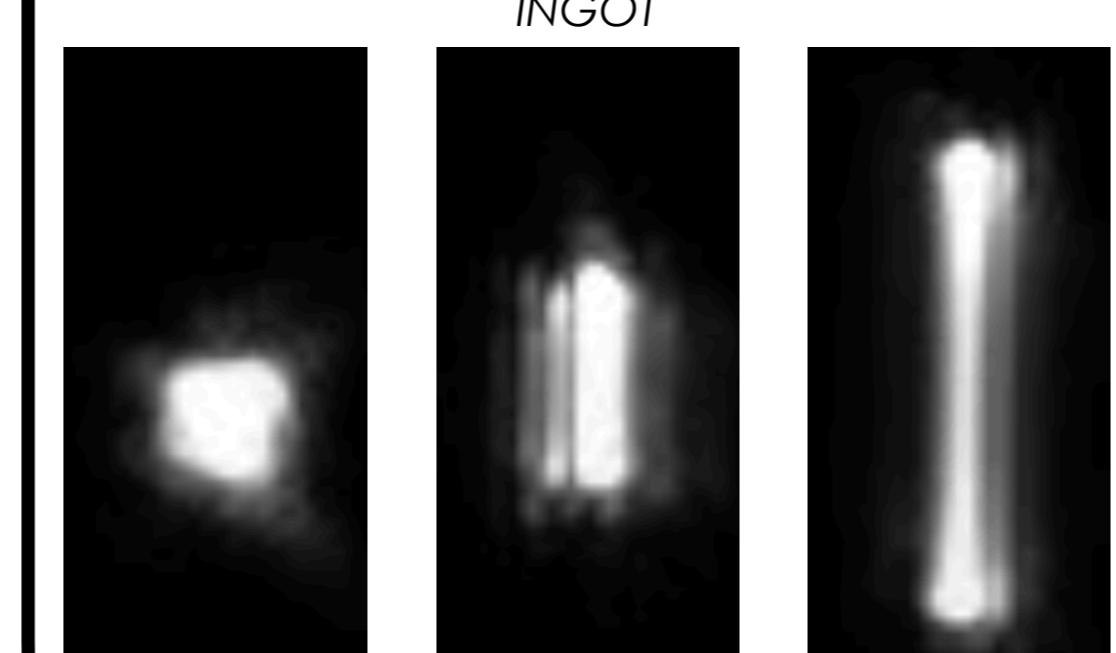
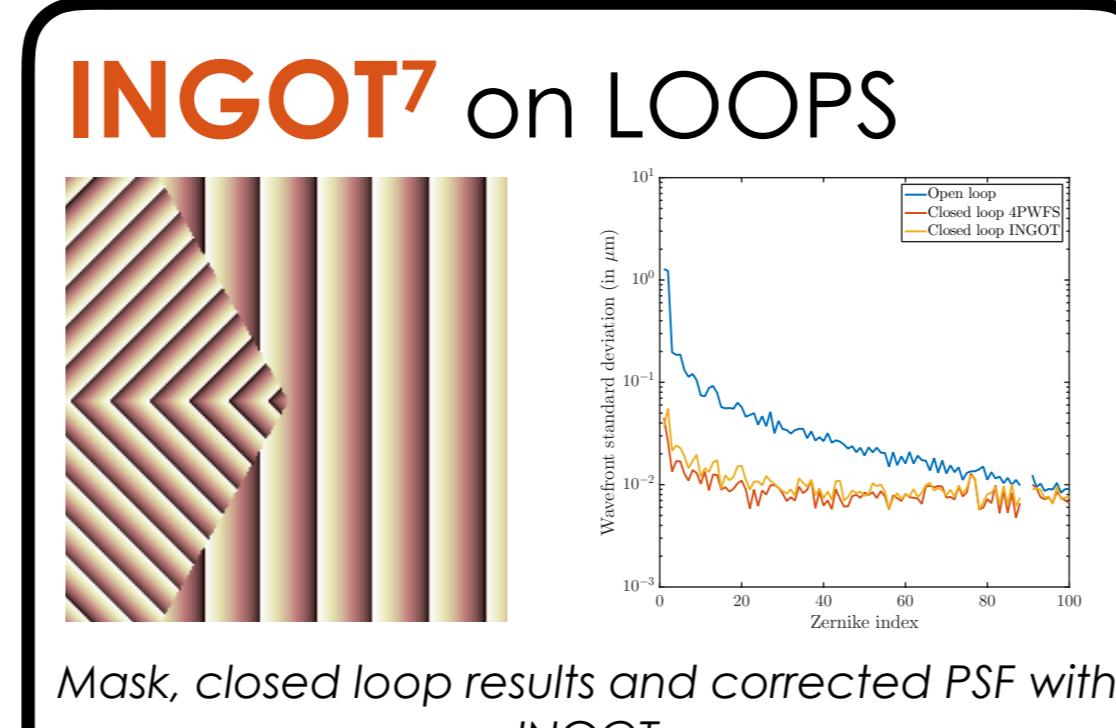
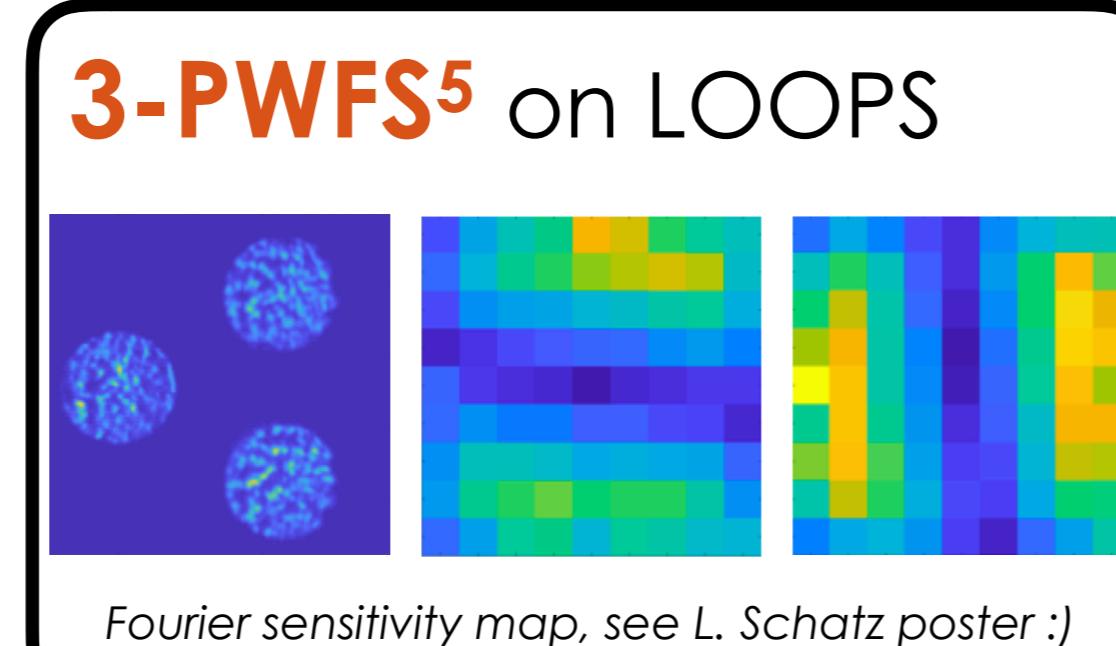
Entirely controlled with the almighty OOMAO



## Closed-loop results



Closed loop WFS signal and PSF for 3, 4, 5 and 100-faced pyramids



Add a SLM in the pupil plane to generate turbulence with adjustable parameters ( $r_0$ ,  $L_0$ , PSD, etc.)

Remote operation of the bench

Characterize precisely the modulation mirror to produce more accurate paths and control it with MATLAB

Feel free to come with your ideas !

<sup>1</sup>Adaptive optics with programmable Fourier-based wavefront sensors: a spatial light modulator approach to the LOOPS testbed, Janin-Potiron et al., JATIS (2019, in press)

<sup>2</sup>Special offer: A new WaveFront Sensor for just Pi/2 euros !, Fauvarque et al. (see presentation tomorrow @ 4PM)

<sup>3</sup>Variation around a pyramid theme: optical recombination and optimal use of photons, Fauvarque et al., Optics Letters (2015)

<sup>4</sup>Modal gain optimization of the Pyramid Wave-Front Sensor using a convolutional model: from theory to experimental validation, Chambouleyron et al. (from this afternoon presentation)

<sup>5</sup>Development of the Three Sided Pyramid Wavefront Sensor, Schatz et al. (see poster right now)

<sup>6</sup>Model-based wavefront reconstruction tested on the LOOPS bench, Hutterer et al. (see poster tomorrow)

<sup>7</sup>INGOT WFS for LGSS: first results from simulations, Portoluri et al. (see presentation on Thursday)