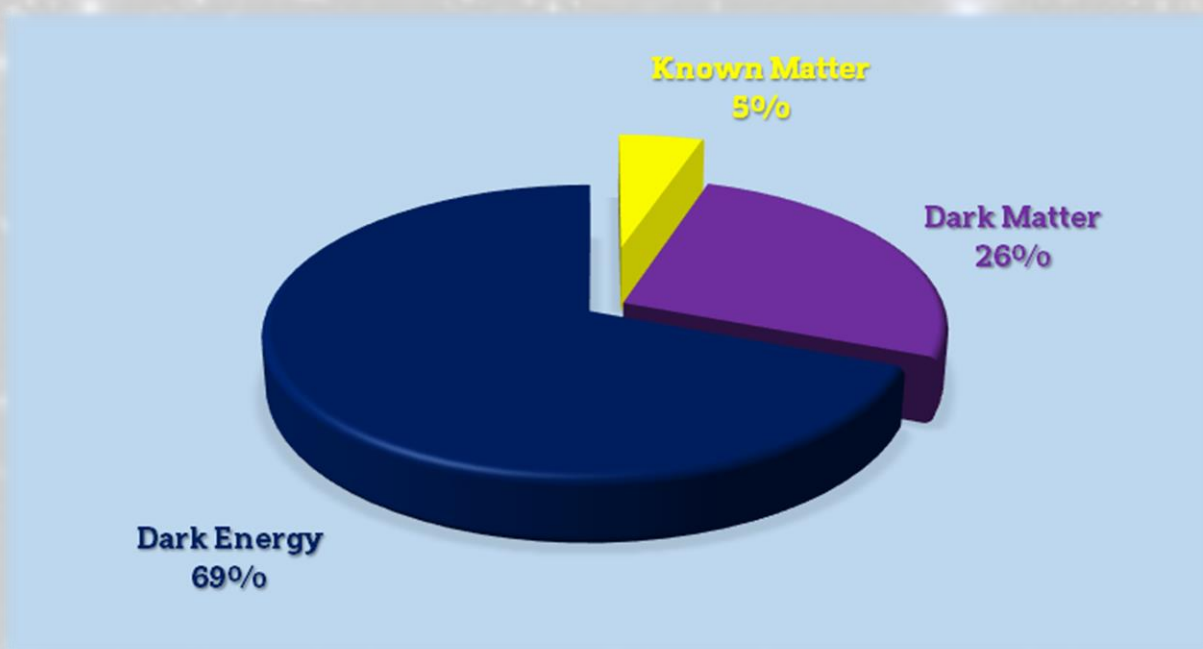


# EUCLID Phase Diversity Calibration How and Why?

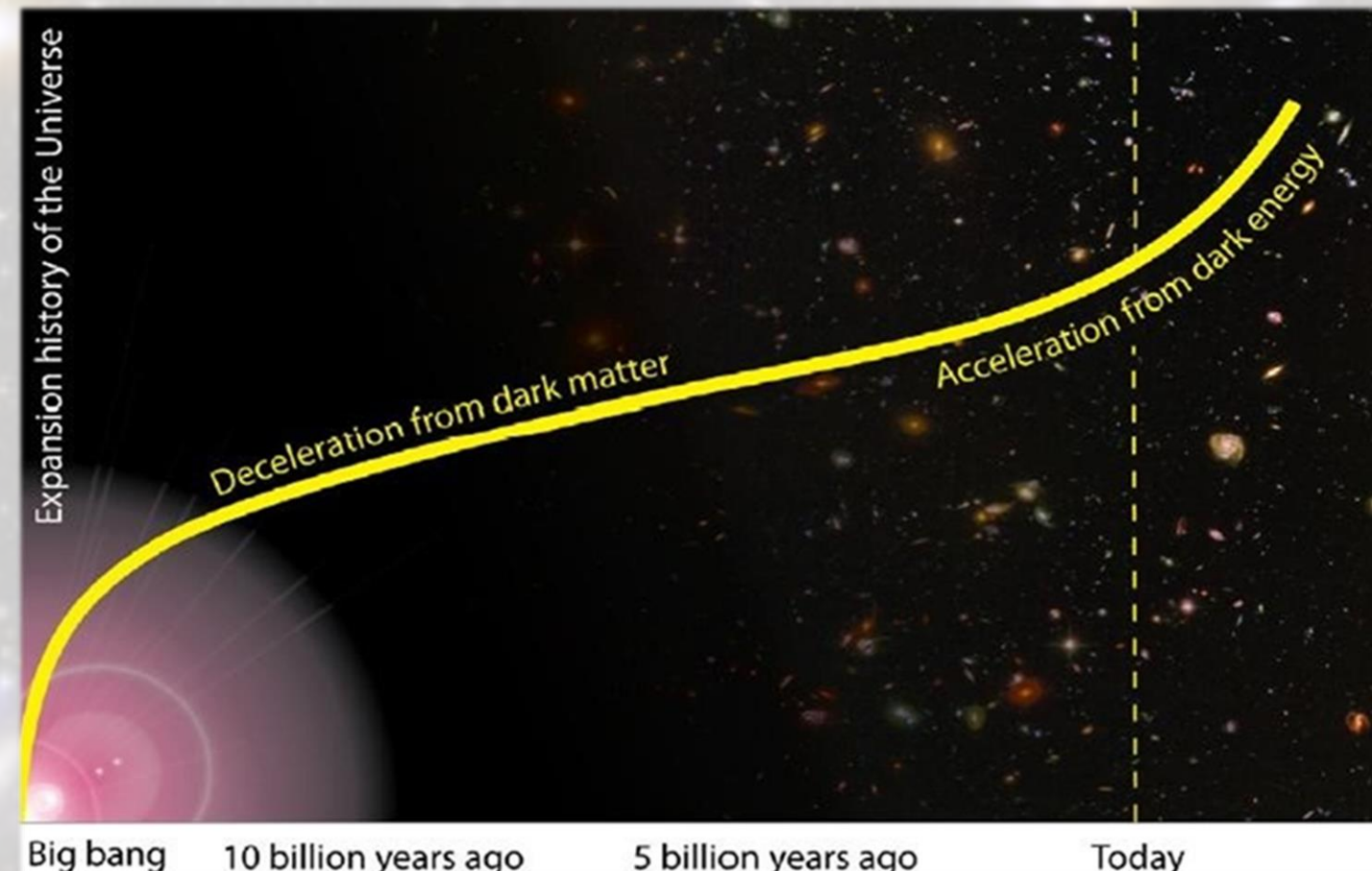
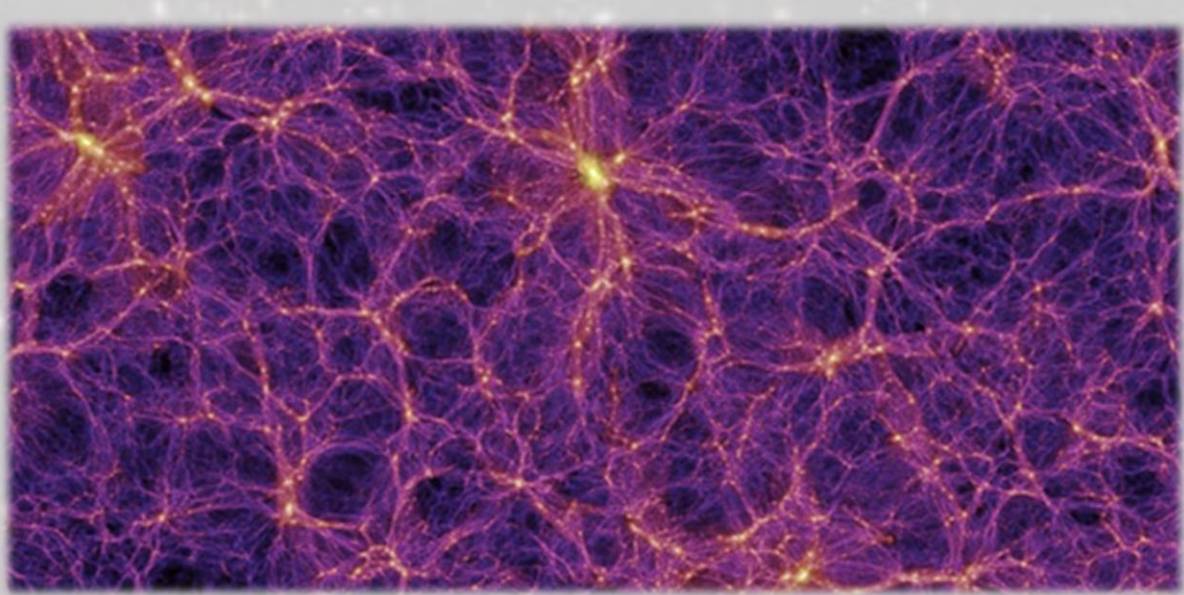
Nicolas Th  ret<sup>1</sup>, Edoardo Cucchetti<sup>1</sup>, Christophe Latry<sup>1</sup>, Antoine Basset<sup>1</sup>, Alexandre Delahaye<sup>2</sup>, Daniel Coelho<sup>2</sup>  
<sup>1</sup> Centre National d'Etudes Spatiales, Toulouse – <sup>2</sup> MAGELLIUM, Toulouse

## EUCLID Mission

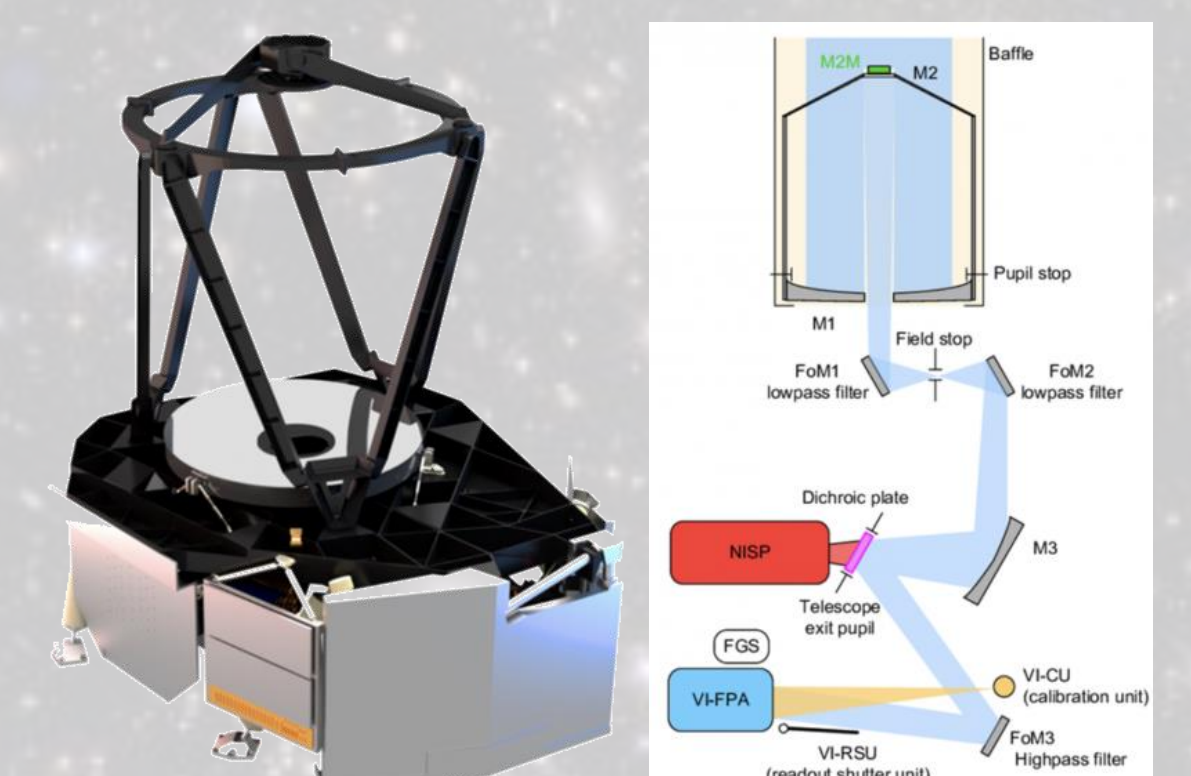
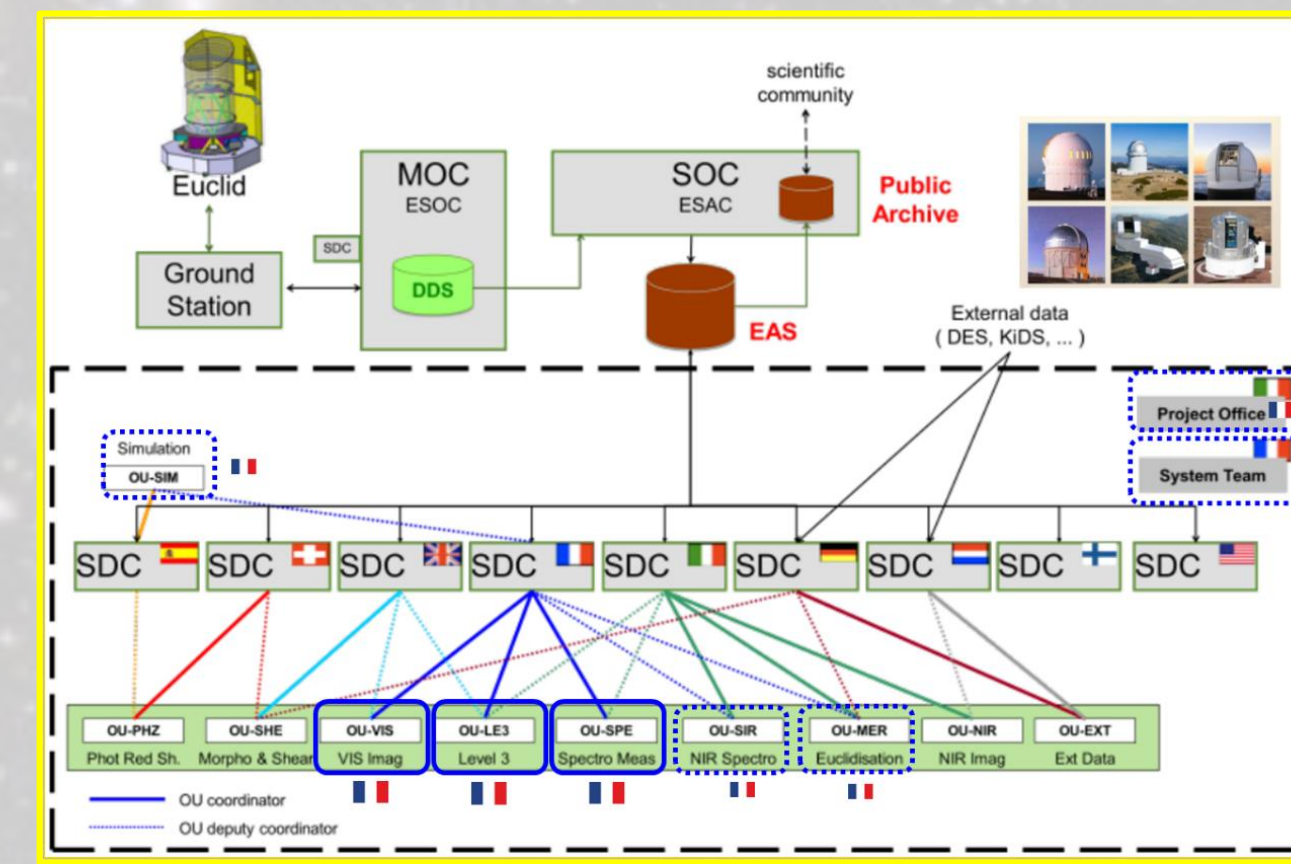
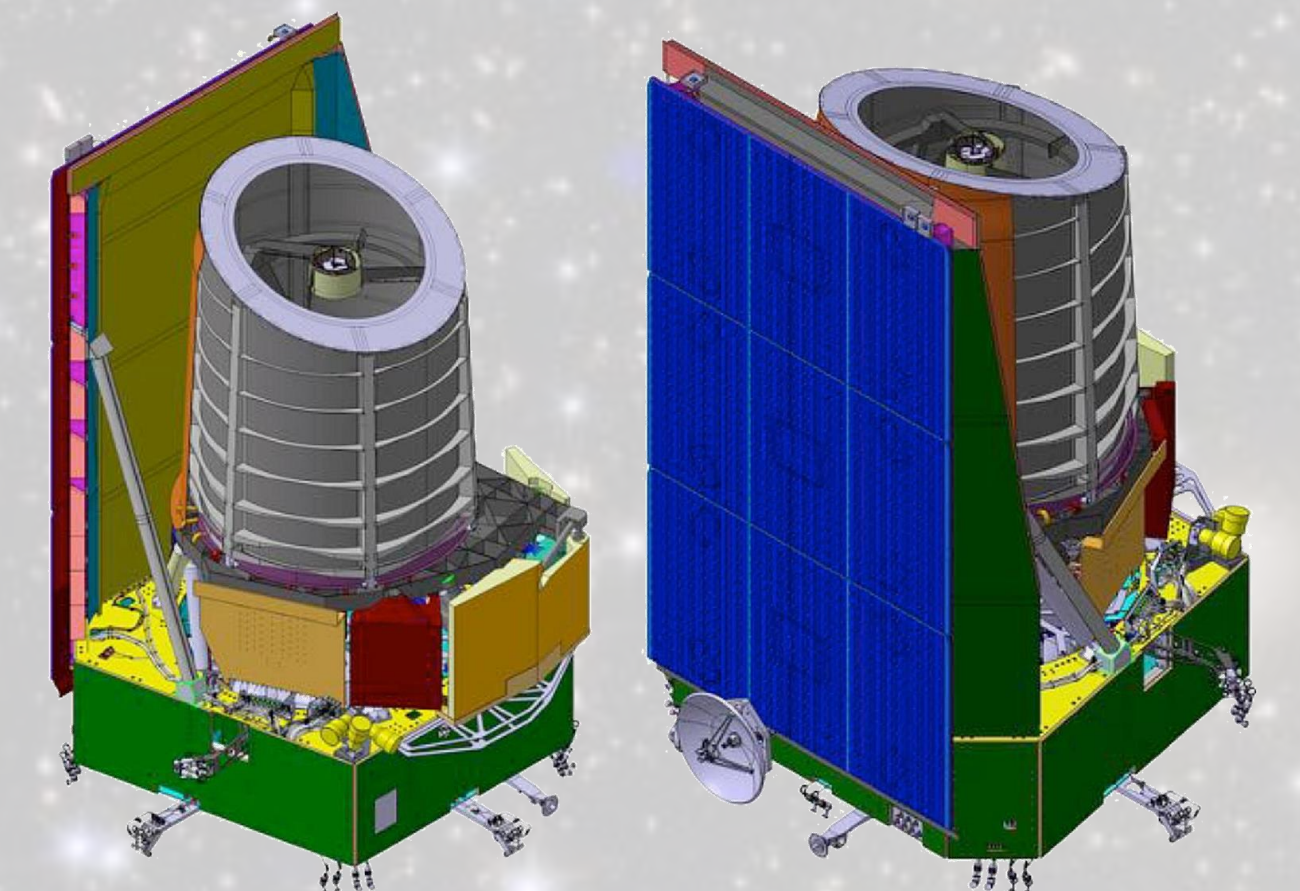
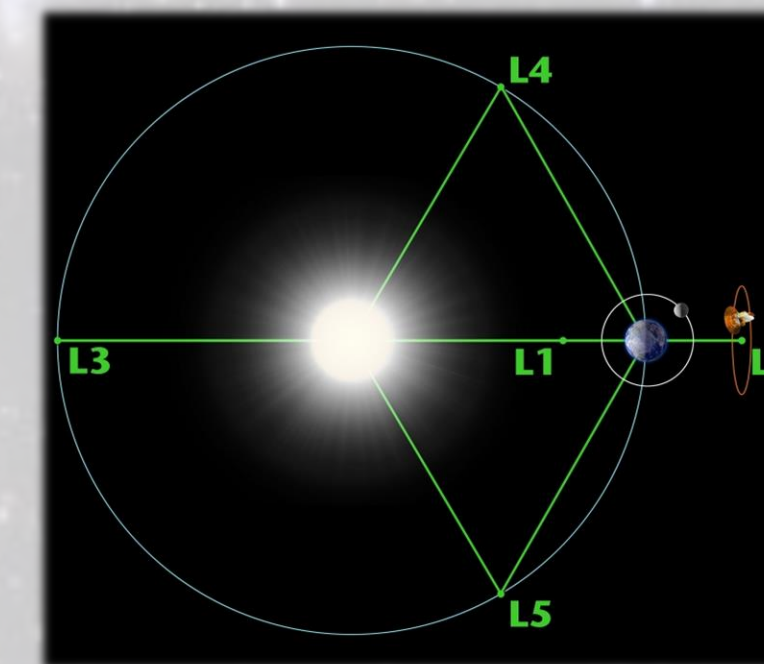
Bring light on Dark Matter and Dark Energy



We know only 5% of the Universe!



## EUCLID System

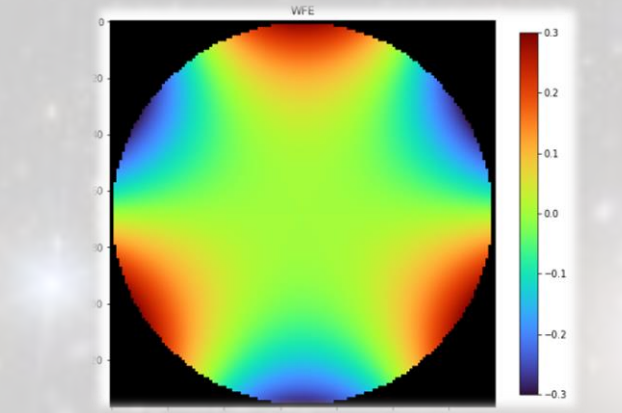
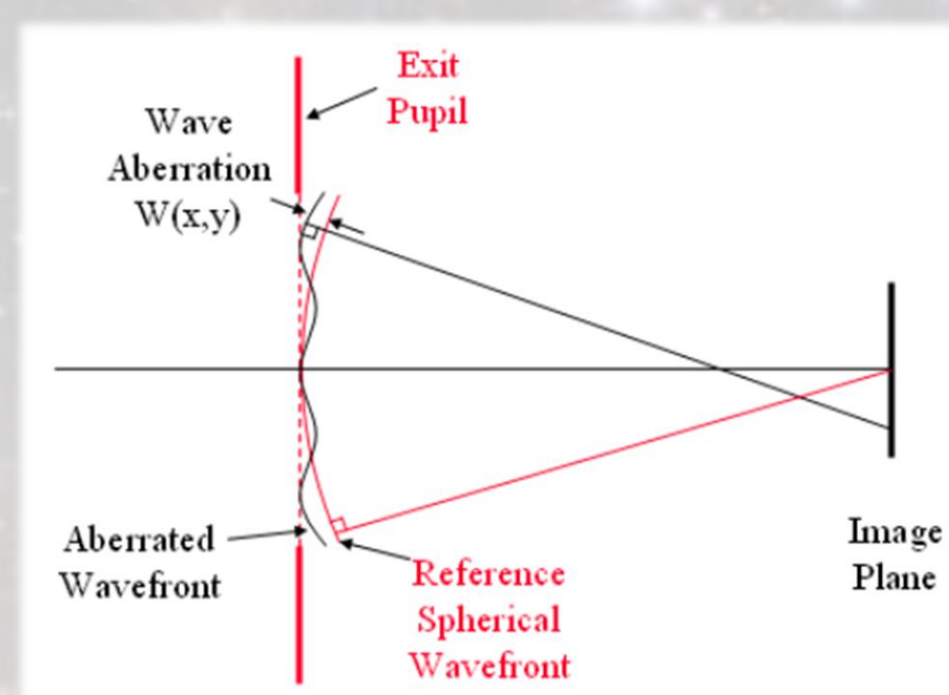
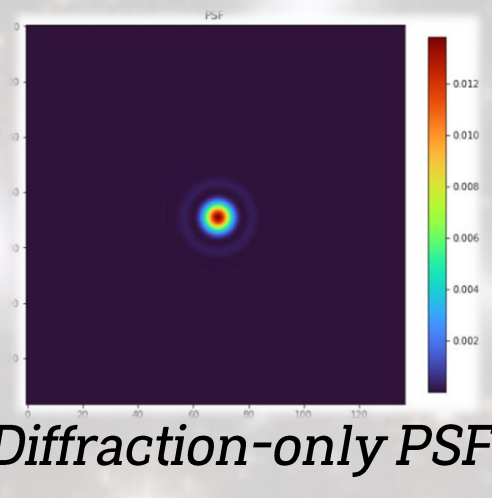
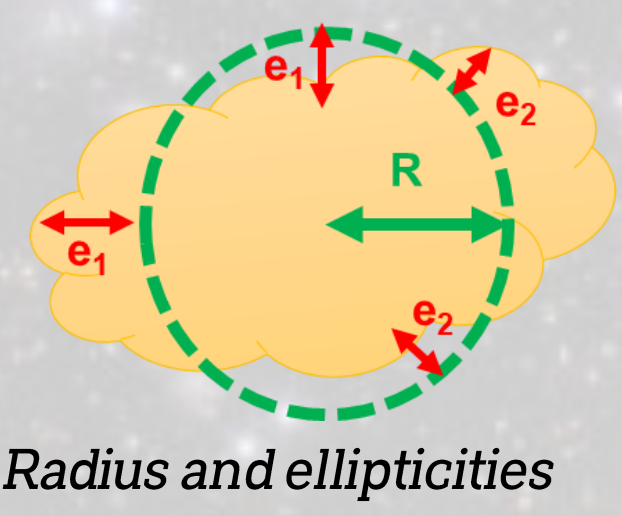


## Weak Lensing measurement

Indirect WL measurement based on deformation of galaxies over the Field of View (FoV)

Contributors:

- The real shape of the galaxies: **unknown!**
  - Statistical approach  $\Rightarrow$  with many galaxies (wide field of view)
- The weak lensing gravitational effect: **what we are looking for!**
  - Seen as a "shear" component correlated over a given part of the sky
- The transfer function of the instrument: **what we want to calibrate**, in order to subtract it
  - The image of a monochromatic point source is called PSF (Point Spread Function)
  - This PSF is further distorted by several effects including optical aberrations

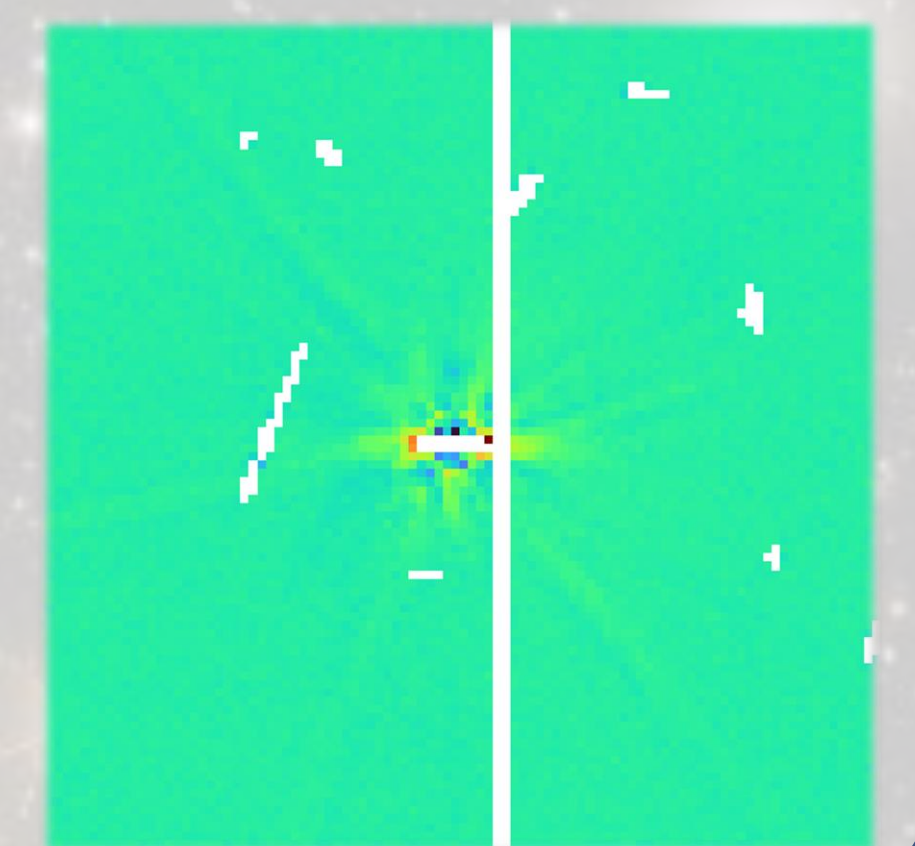
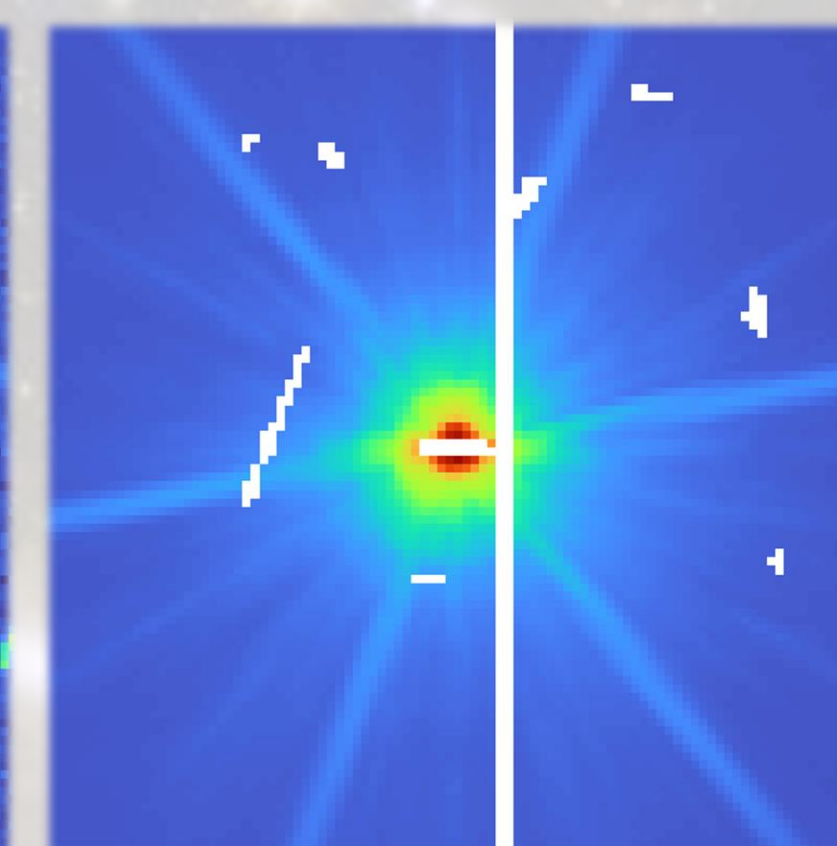
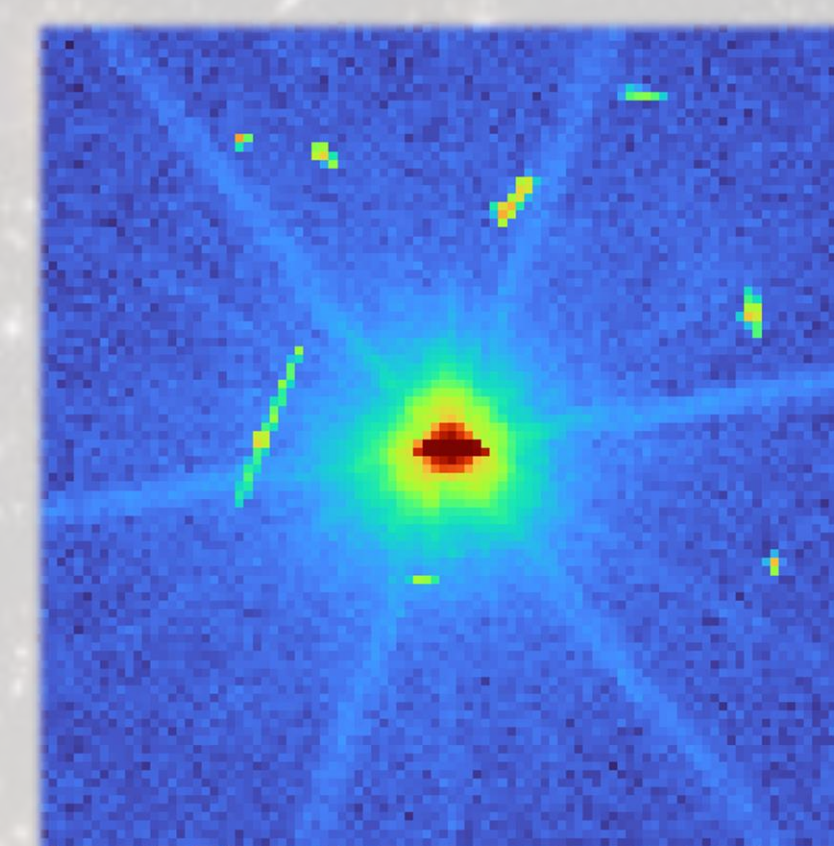
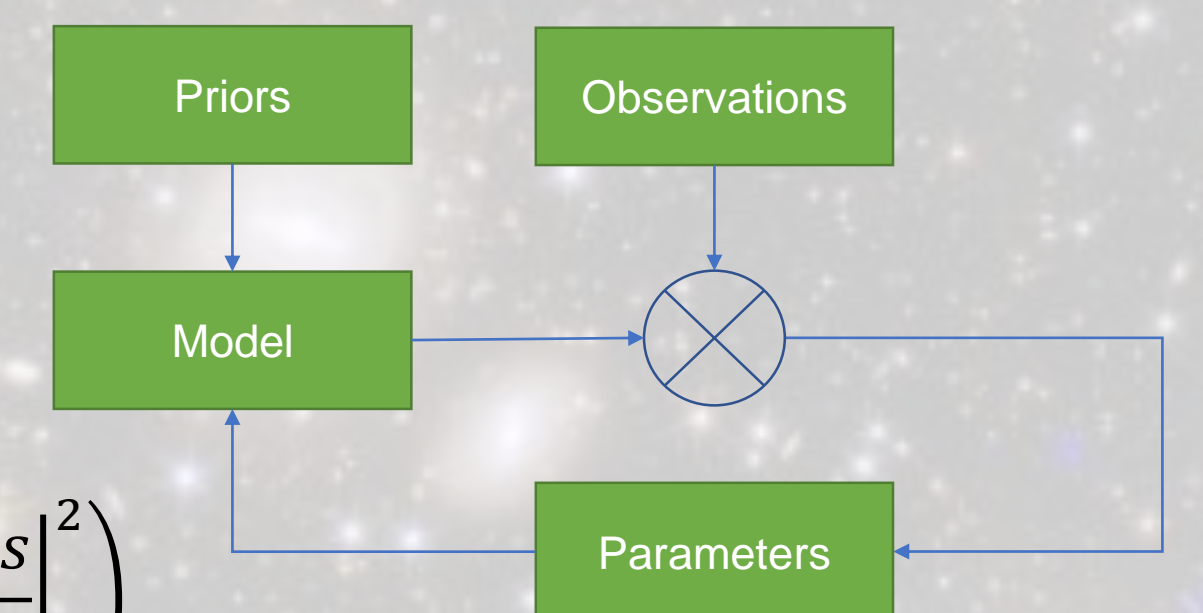


## Phase Diversity Calibration

Compute the parameters  $p_i$  of a parametric model based on Fourier optics

- To fit stars observations with supposedly known spectra (Spectral Energy Density)
- With different focus position to remove the ambiguities and improve the accuracy
- Including priors from ground calibration and optical models

$$\operatorname{argmin}_{\{p_i\}} \left( \frac{\| \text{Model}(p_i) - \text{Observations} \|^2}{\text{noise}_{std}} \right)$$



## Many assumptions

CCD position  
 Polarization  
 Dichroic plate  
 Brighter-Fatter Effect  
 Detectors normalization  
 Optical transmission  
 Charge Transfer Inefficiency  
 Quantum efficiency  
 Frames definition  
 Occultation mask  
 Detector diffusion  
 Shutter  
 Surface Figure Error  
 Galaxies detection  
 Stars position  
 M2 position  
 Pupil geometry  
 Conventions  
 Cosmic rays detection  
 AOCs stability  
 Ice deposit  
 Detector non linearity  
 X-rays avoiding  
 Aliasing  
 Thermal stability  
 Star identification  
 FoV dependency

## Calibration Operational Scenario

80 days as a minimum

- Thermal stabilization: 7 days
- Observations: 1 day per focus position

- Phase Diversity
- In Focus measurements only

