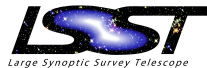


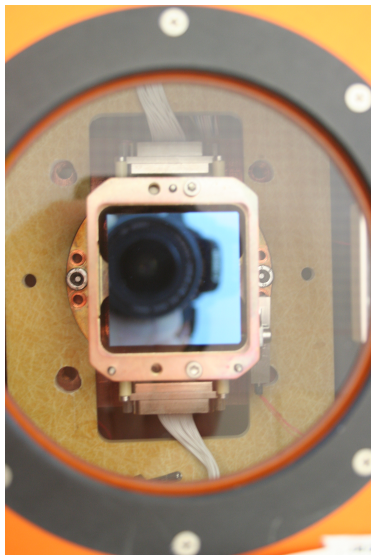
# Optical bench design for the caraterization of distortions in LSST candidate sensors

Rémy Le Breton - Pierre Antilogus and Nicolas Regnault

LPNHE

Biennale LPNHE - Tirrenia - 2015/10/07

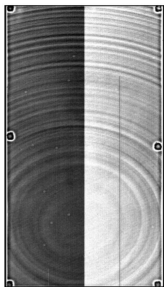




CCD E2V-250

- 4cm  $\times$  4cm CCD.
- 16.4 megapixel.
- Focal plane = 189 CCD.
- "Thick CCD", more sensitive in I.R.

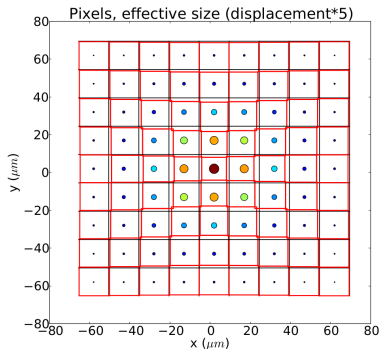
# Tree rings and Brighter fatter



Plazas *et al.* 1403.6127

DECam CCD

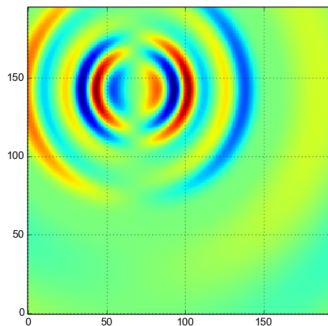
- Variation can reach  $\pm 1\%$  on normalized flat-field (g-band).



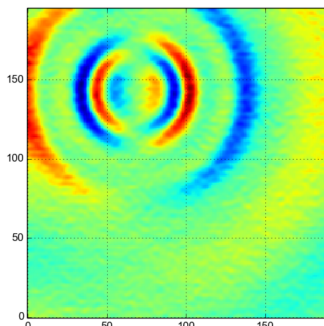
Guyonnet *et al.* 1501.01577

- Variation in size reaches almost 2% from zero to saturation for LSST E2V candidates.

# Simulation validation : results



x component of the **true**  $\vec{\delta}$



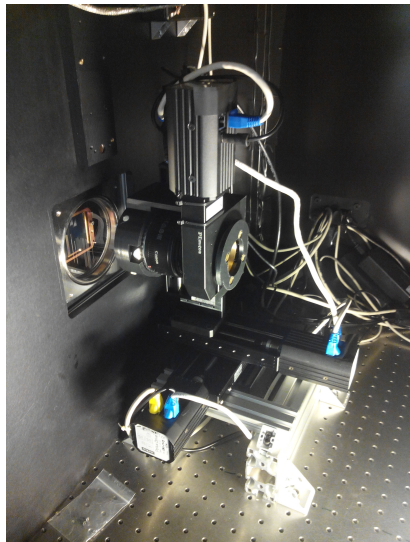
x component of the **fitted**  $\vec{\delta}$

- Reconstruction of a  $\vec{\delta}$  of 0.01 pixel RMS ?
- Good final  $\chi^2$ .
- Validation of the method : we can map static distortions.



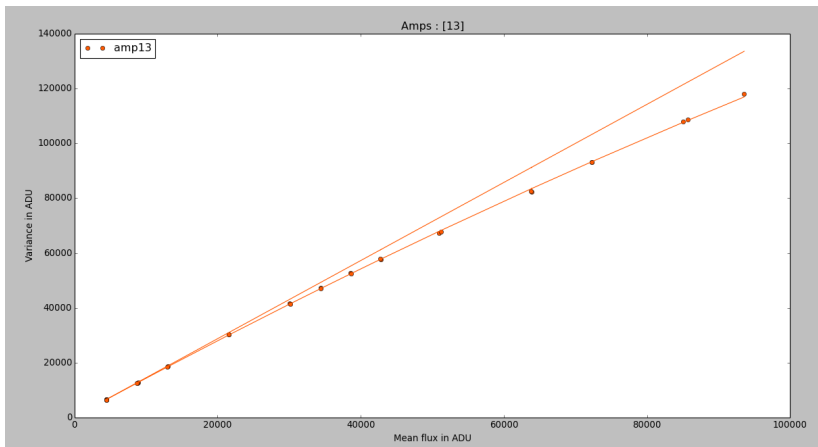
# Optical bench

- Experiments done in clean room.
- Setup inside a black box.
- XYZ and rotating motor.
- Pixel pitch of fringes from 6 to 13 px and from 15 to 25 px.
- Using test targets. (transmission sinusoidal pattern + Ronchi)
- Canon lens + integrating sphere.

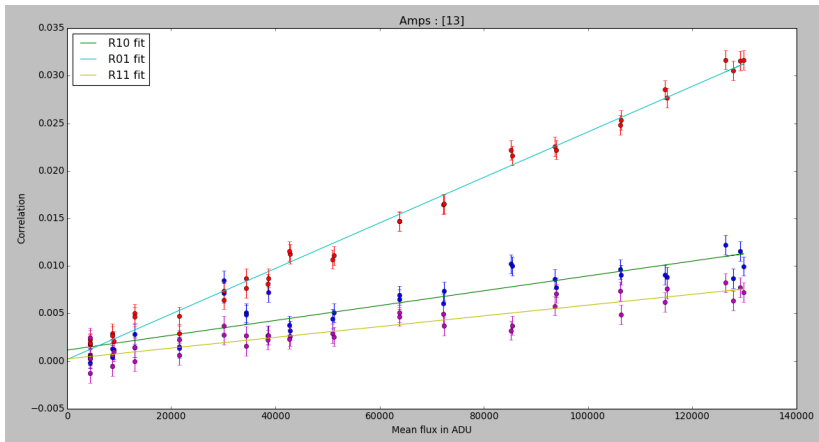


- Study of the Brighter fatter : development of a new method of measurement, and comparison with canonic one (Augustin Guyonnet's measurement of correlations).
- Study and improvement of the stability of the optical bench.

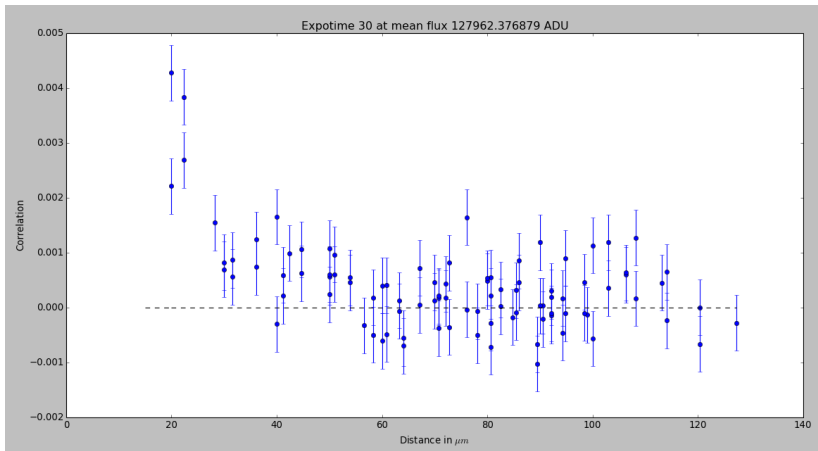
# Photon Transfer Curve (PTC)



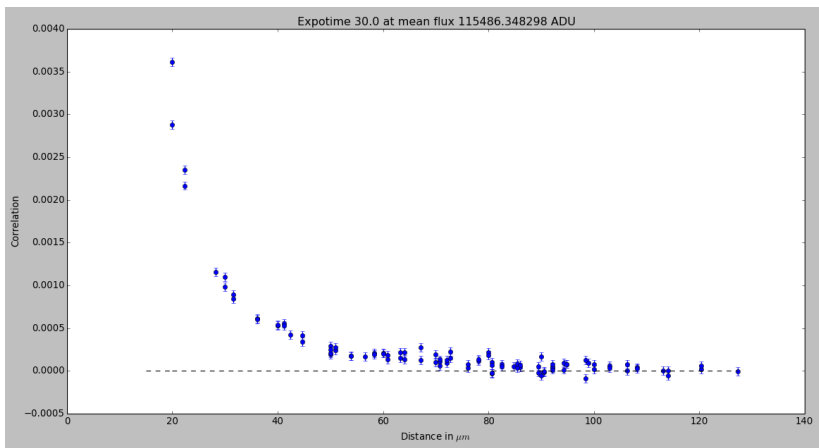
# Correlations of nearest pixels



# Correlations : 2 pairs of uniform illuminations

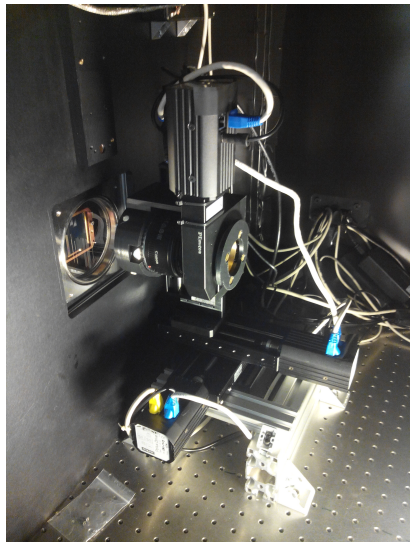


# Correlations : 420 pairs of uniform illuminations



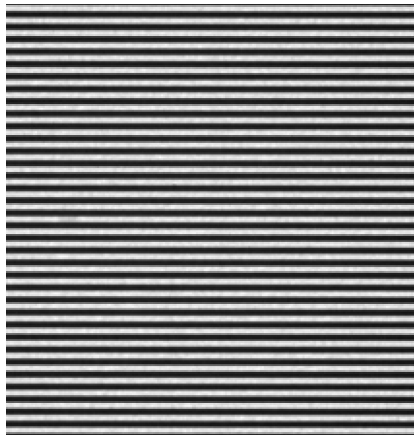
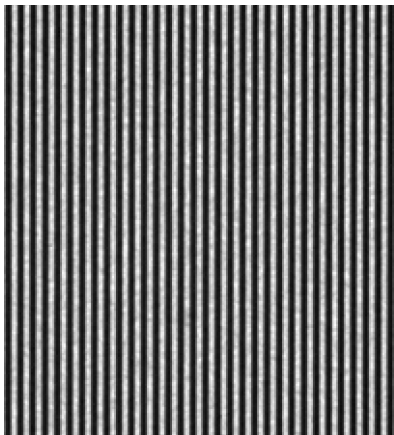
# Optical bench stability

- Laser = coherent light  $\rightarrow$  false correlations...
- Meanwhile, using spectral lamp : XeHg and QTH.
- Stability of the lamps.
- Stability of focus as a function of the position.
- Vibrations.
- Stability of positions.



## Brighter Fatter : ramps in flux

- Imaging fringes parallel to rows and columns.
- Images with pixel pitch of 6.4 px (Setup 2 with Ronchi target).





# Cut on Ronchi parallel to row

- First step : select focused fringes area (500x500 px).
- **Second step** : compute pitch with a fit of FFT maximum.
- **Third step** : fold (wrt the computed pitch) the signal of several columns.
- Fourth step : bin the folded signal (right plot).

