LSST-France : Bench sensors studies

Pierre Antilogus[1], Pierre Astier, Marc Betoule, Augustin Guyonnet, Claire Juramy, Sonia Karkar, Rémy Le Breton, Laurent Le Guillou, Nicolas Regnault[1], Philippe Repain, Stefano Russo, Eduardo Sepulveda

LPNHE

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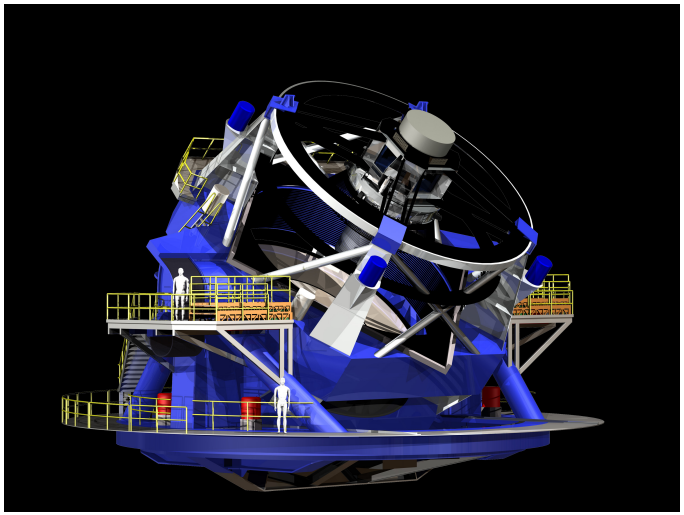
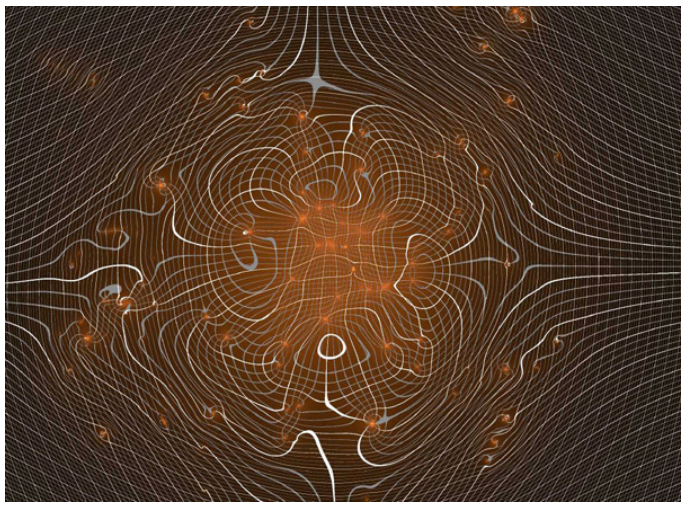
[1] Phd advisors

Science

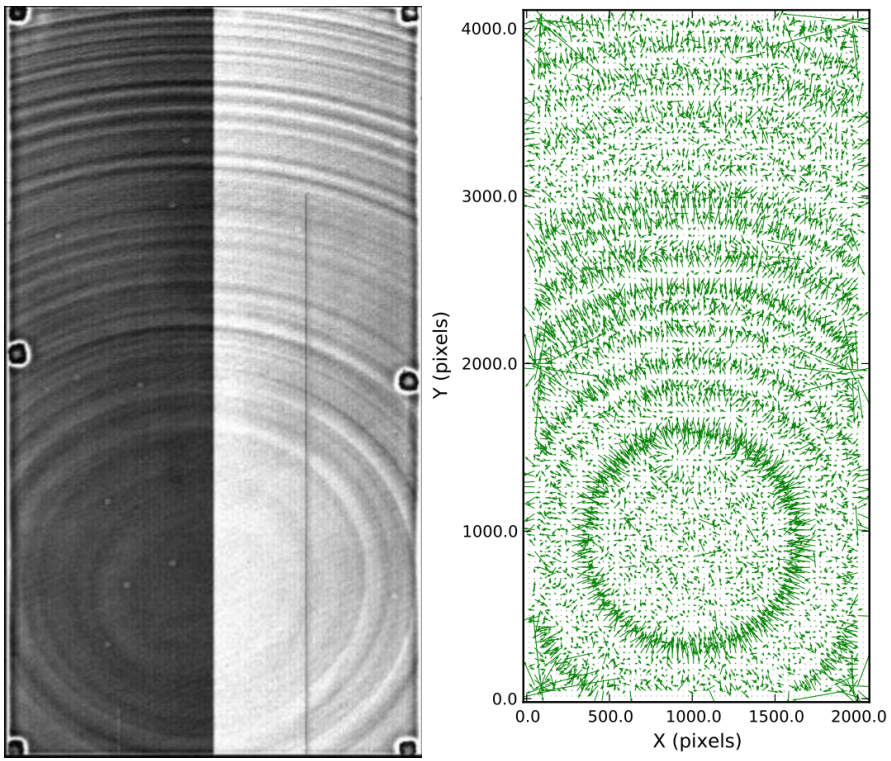


- Measure strong and weak lensing.
- Photometric and astrometric precision is needed.
- LSST website gallery

- Photon path inside the telescope ?
- In the focal plan ?
- The sensors' pixel grid are distorted by static and dynamic effects.
- See : P. Astier 1503.04096



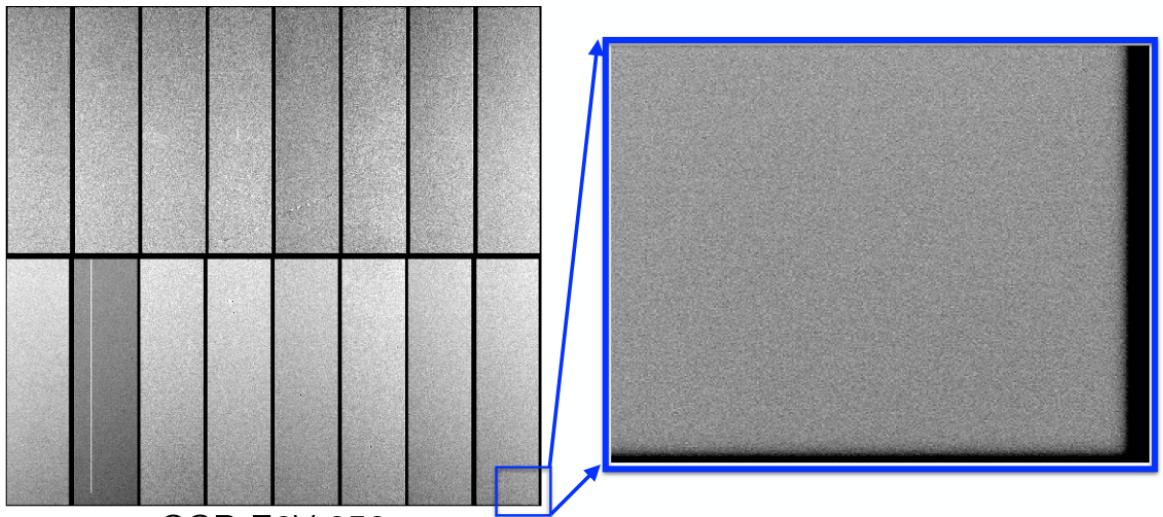
Static effects : Tree-rings



Plazas *et al.* 1403.6127 DECam CCD

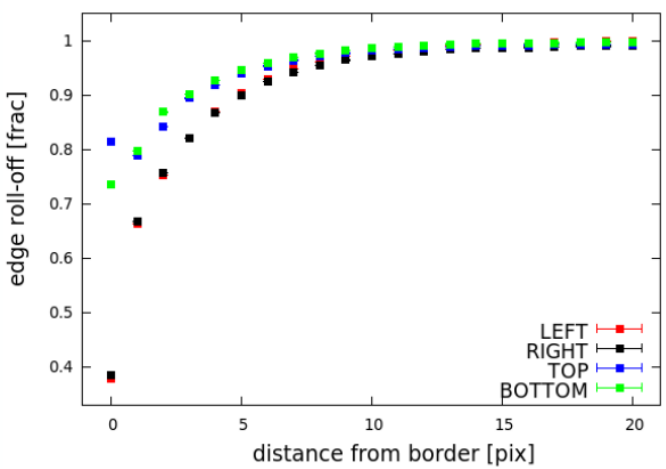
- Circular patterns on flat-field.
- Variation can reach $\pm$ 1% on normalized flat-field (g-band).
- Astrometric residuals correlated to tree-rings patterns.

Static effects : Edge effects



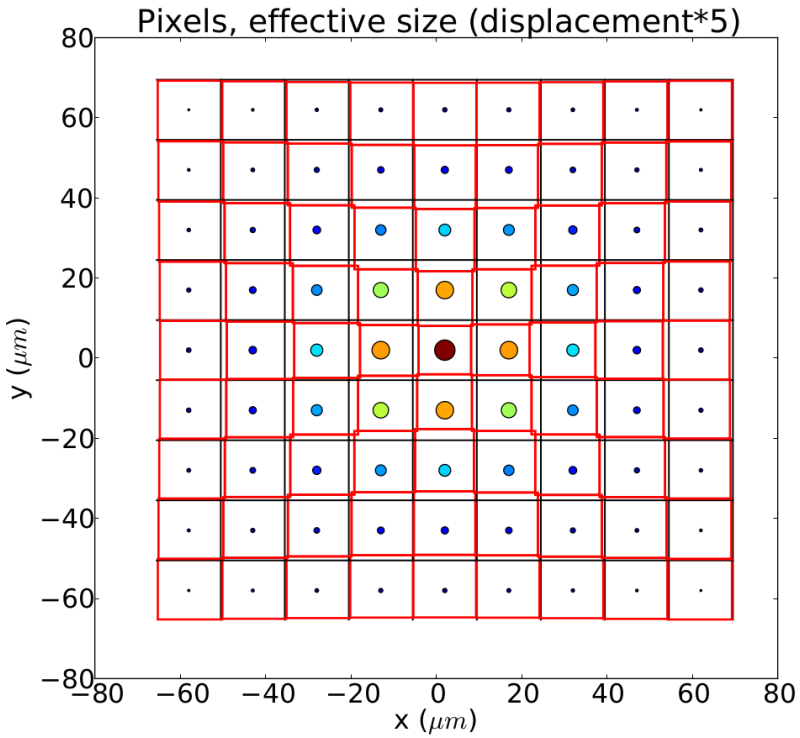
CCD E2V-250

Profiles of the four edges



- Decrease in flux near sensor edges.
- Guyonnet, SAWG meeting 23/03/15.

Dynamic effects : Brighter-fatter



Guyonnet *et al.* 1501.01577

- Pixel size modified with flux increase.
- Variation in size reaches almost 2% from zero to saturation for LSST E2V candidates.

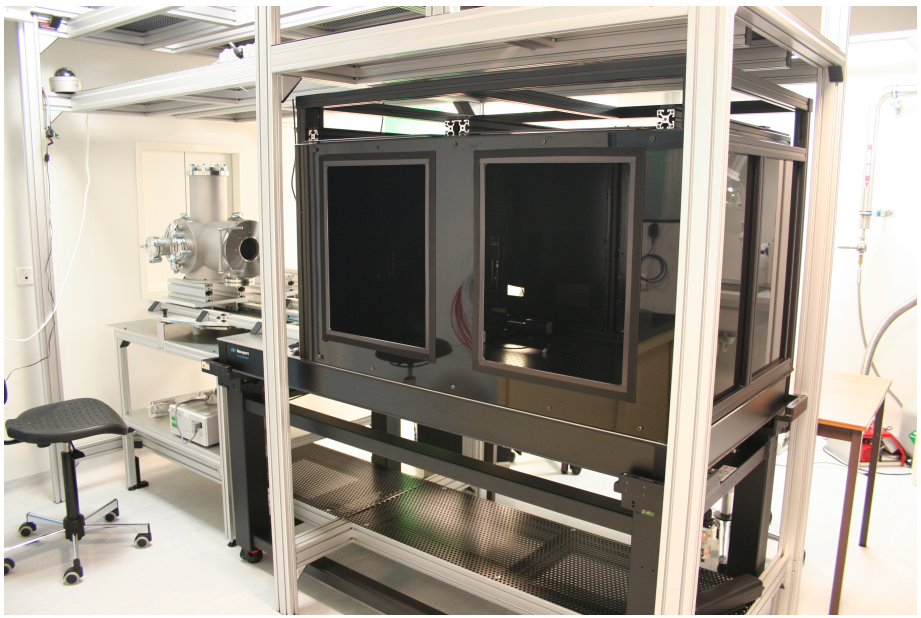
Sensors caracterization

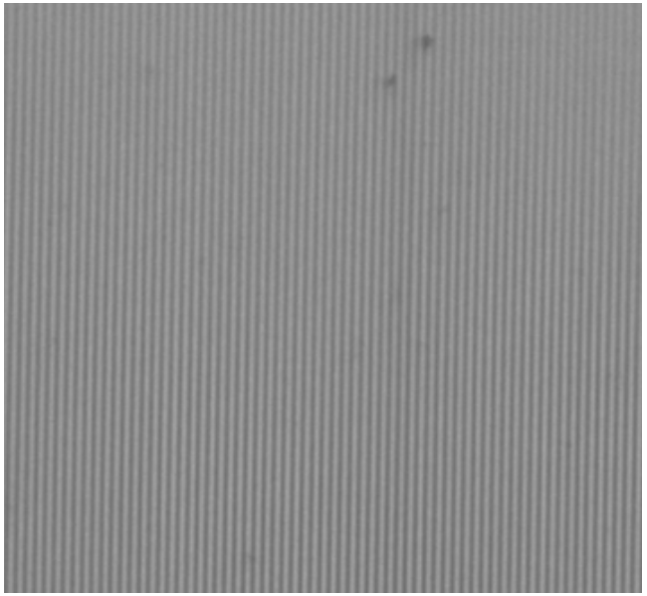
LPNHE commitement :

- Engaged to caracterize a fraction of LSST sensor candidates.
- Go beyond E2V (ITL) standard tests.

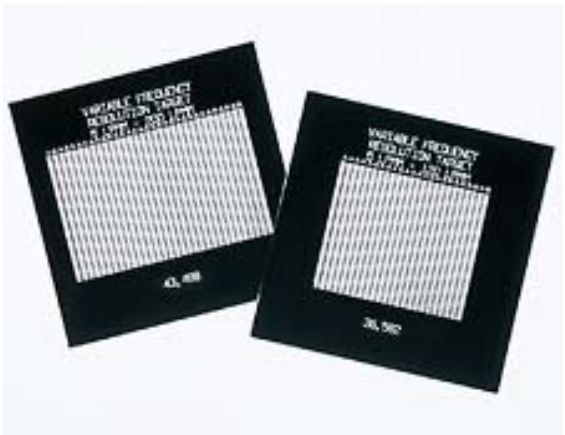
Method :

- Optical bench at LPNHE.
- Flat-fields, modulated illuminations.

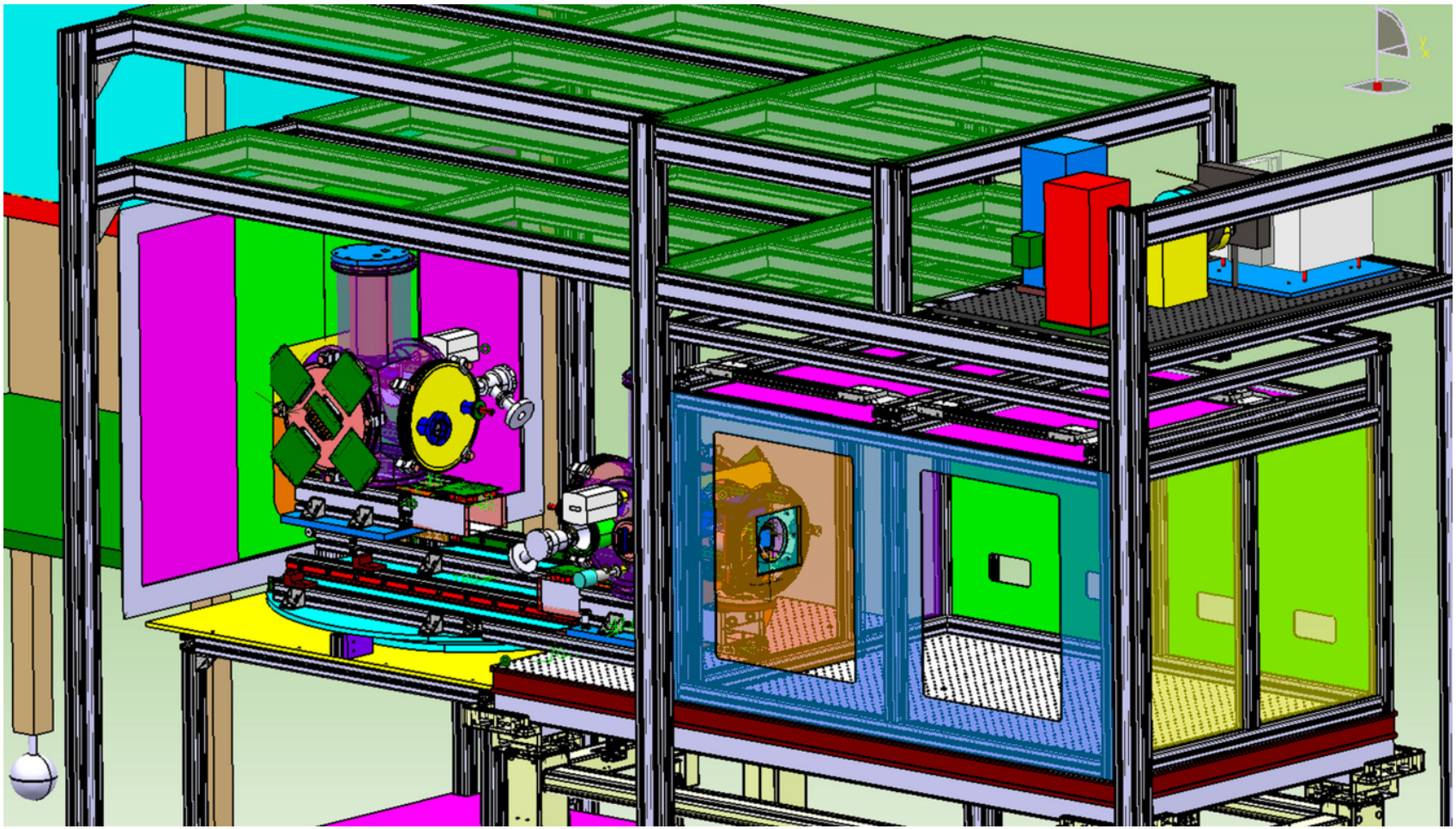




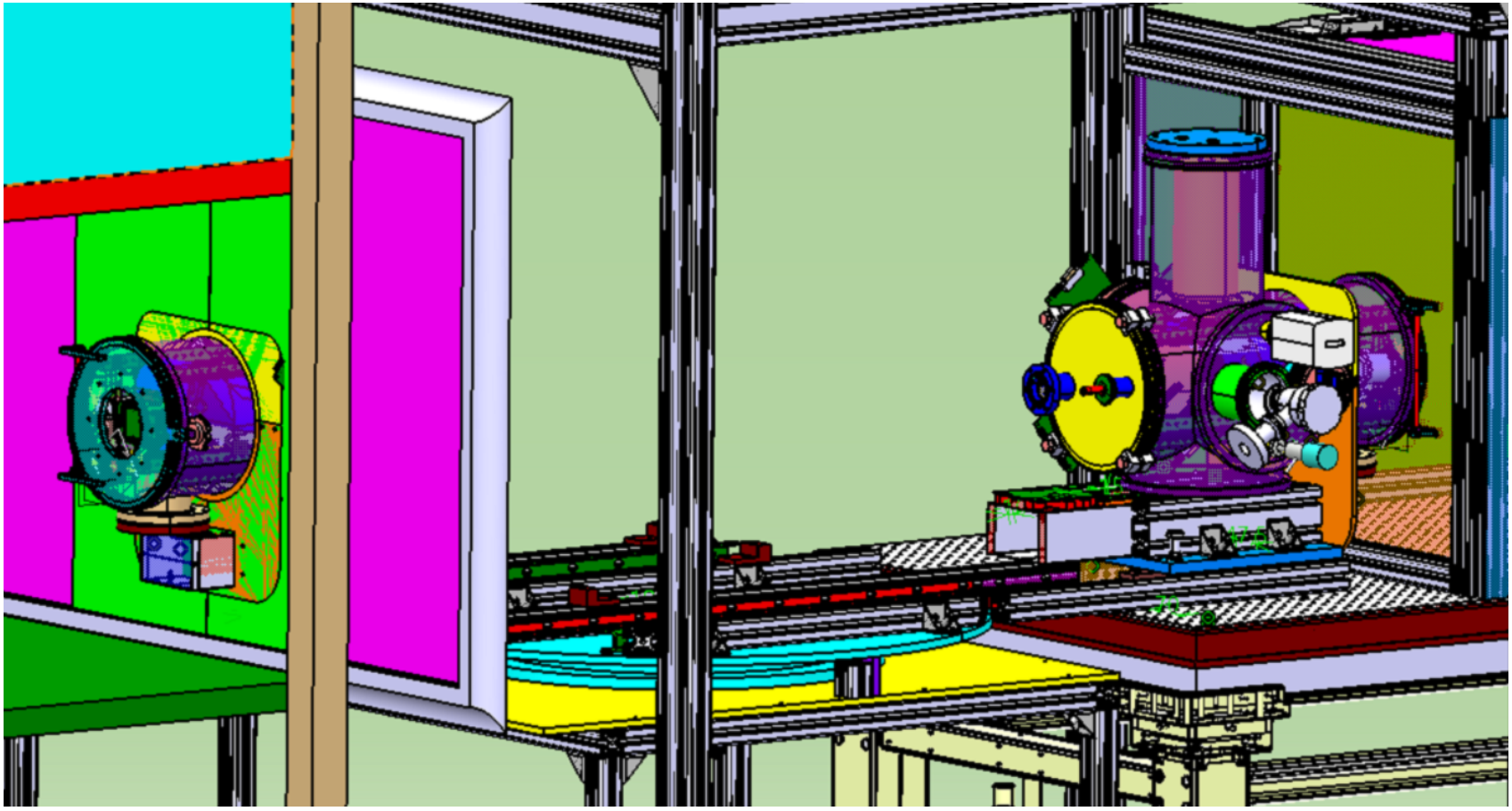
Real data



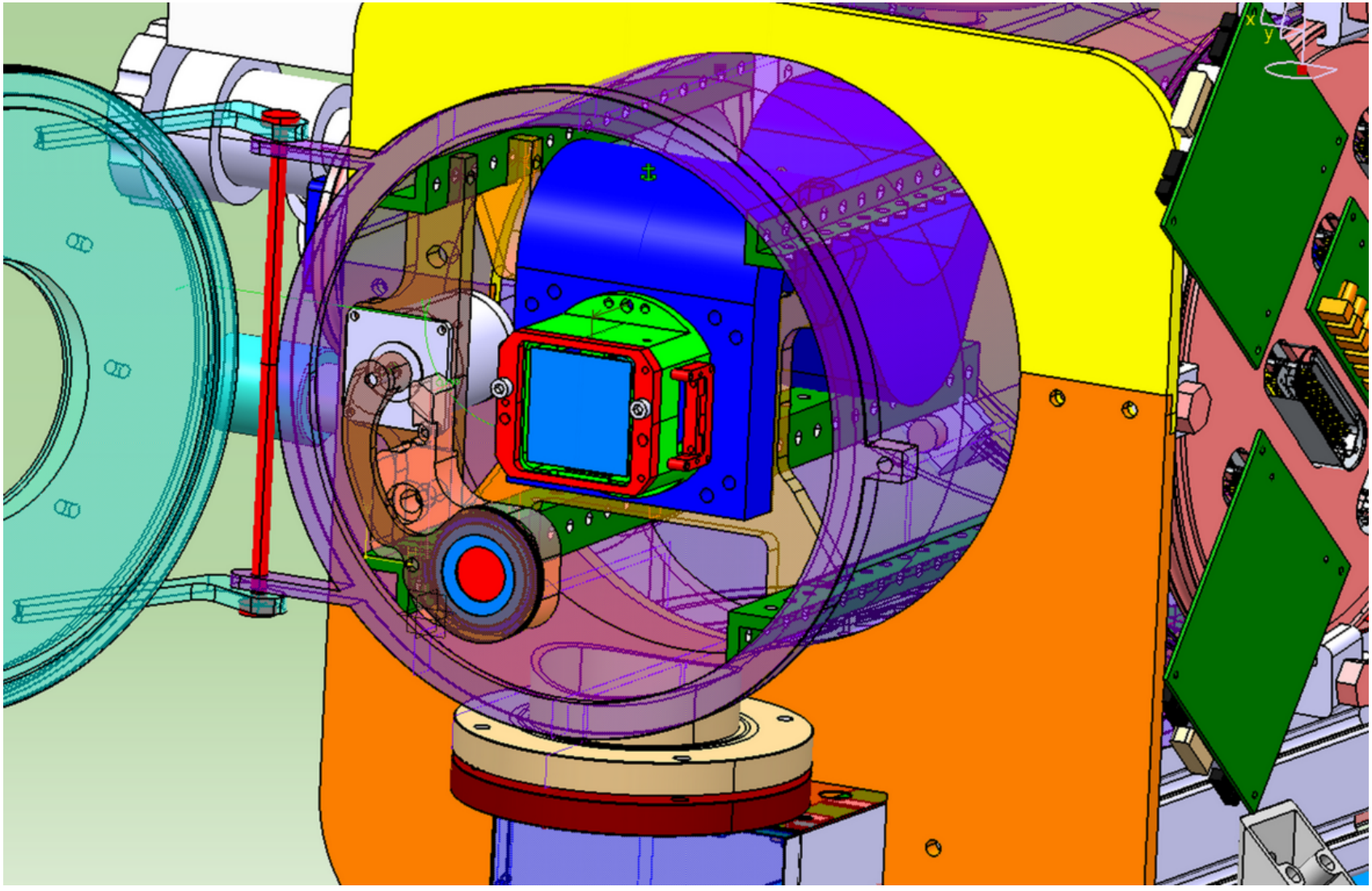
Optical bench



Carousel

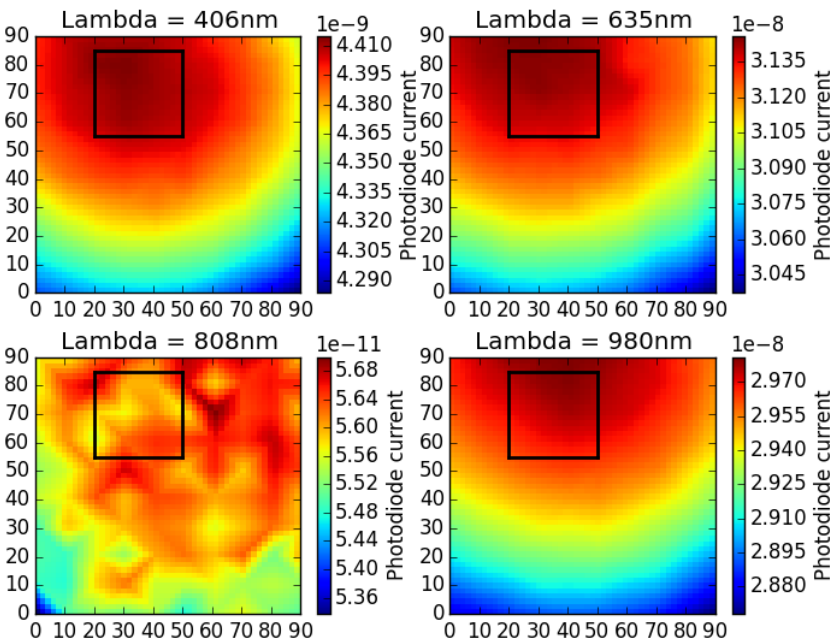


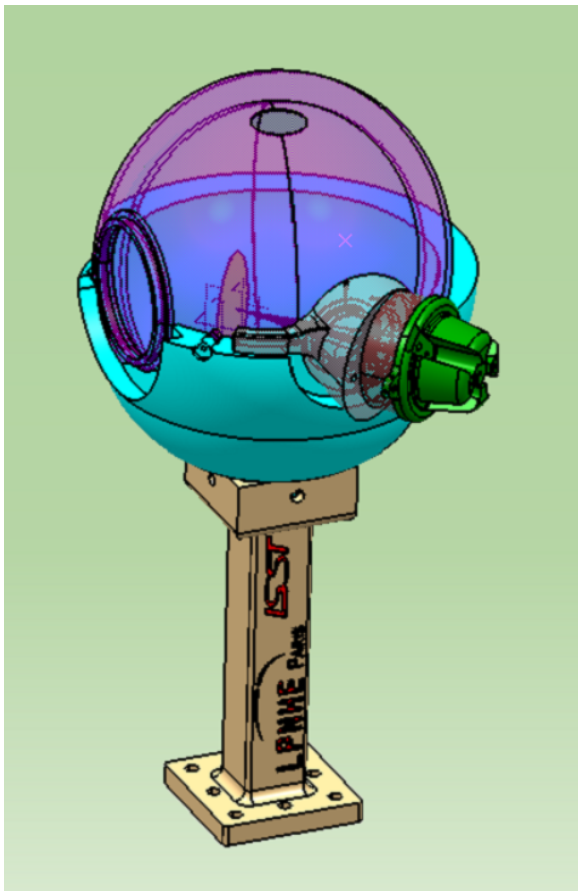
Gain : Iron 55



Flat-fields

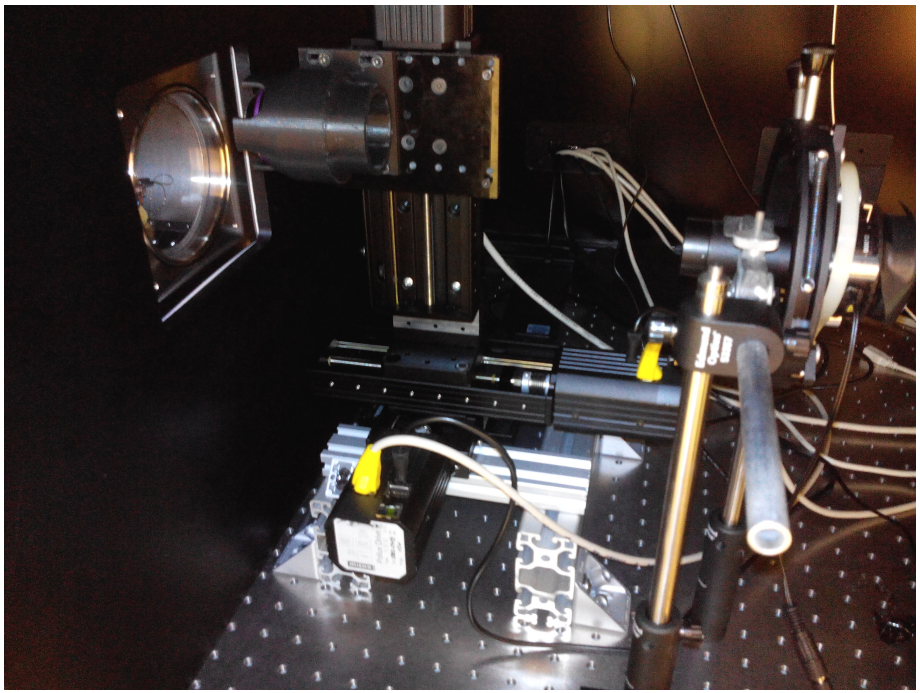
- Integrating sphere.
- From 0.15% to 1% uniform beam over the CCD.
- Tree-rings, edge effects.

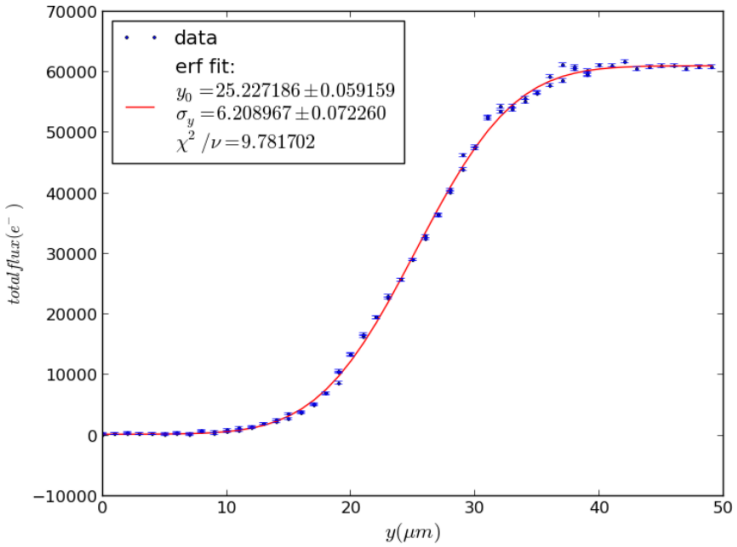


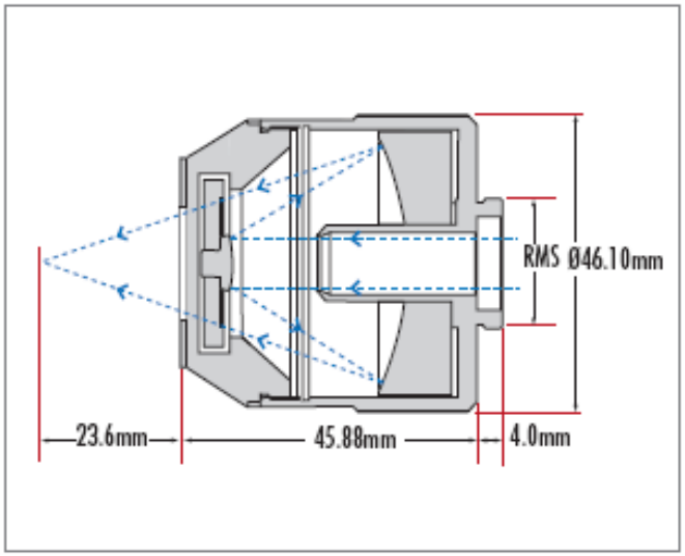


Spots

- Production of sub-pixel spots.
- Inversed microscope objective.
- High displacement precision.
- Local study of diffusion (and BF).







LSST Dark Energy Science Collaboration (DESC)

DESC Sensor Anomalies Working Group (SAWG) :

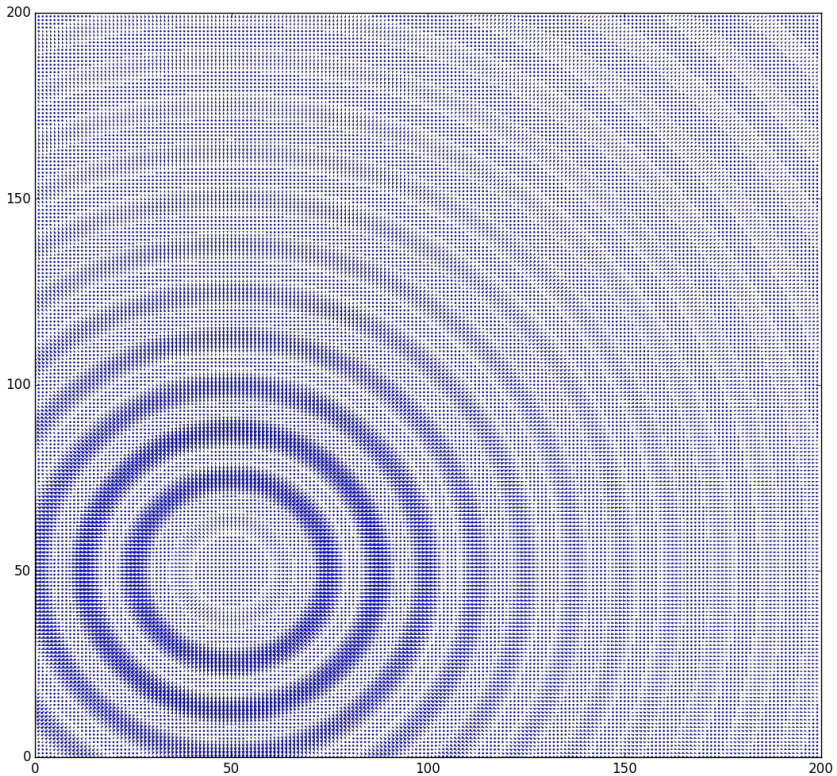
- Convener : A. Nomerotski.
- Teleconferences every two weeks.
- With BNL, Harvard, UC Davis.

Topics :

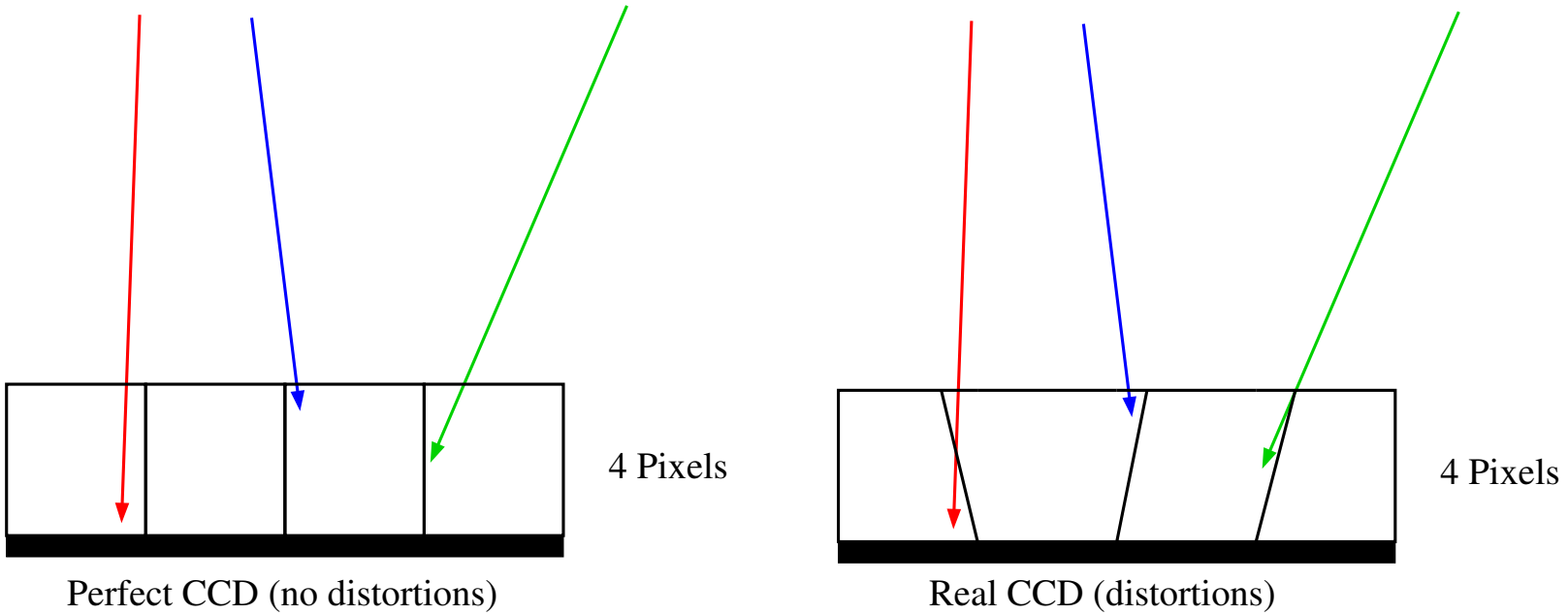
- Goal : To remove the sensors' intrumental signature.
- Static (edge roll off) and dynamic (Brigther-Fatter) distortions.
- Phosim simulation.
- Pixel size metrology.
- CCD contamination as a sensor anomaly.

My thesis

- To study fine effects in CCD sensors.
- To build a fitter to map the distortions.
- First : working with static distortions (tree-rings).



Framework



- In a real CCD, a photon may be collected in a wrong pixel.
- Map the distorted pixel grid.
- Reconstruct correct photon path.
- Reach true correction to measured fluxes.

Mapping the static distortions

=> Developp an analysis tool for LSST sensors

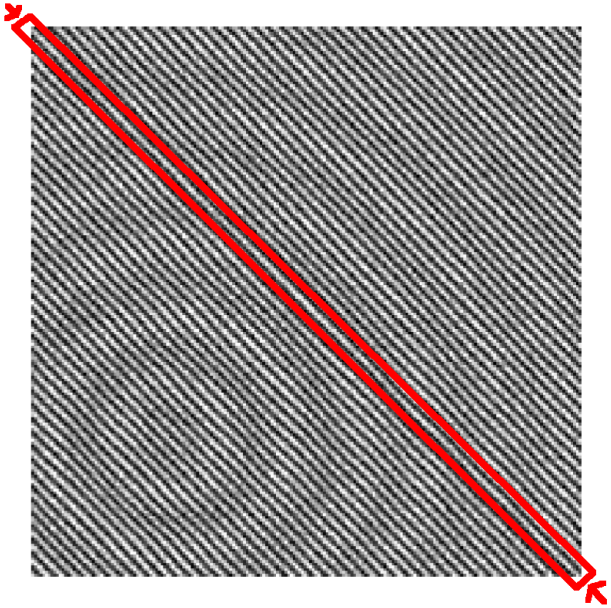
Model :

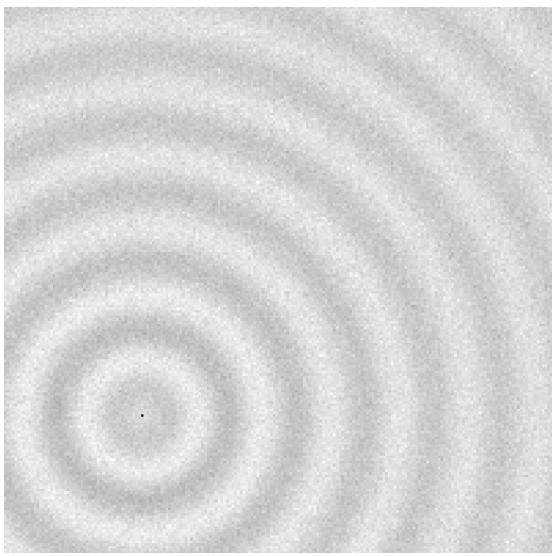
- Displacement field $\overrightarrow{\delta}(x, y)$.
- Change in the size of the pixels.
- $\overrightarrow{X'} = \overrightarrow{X} + \overrightarrow{\delta}$ with $\overrightarrow{X}$ in pixel.
- Charge conservation leads to :

$$I'(\overrightarrow{X'}) = I(\overrightarrow{X})(1 - div\,\overrightarrow{\delta} + o(\delta^2))$$

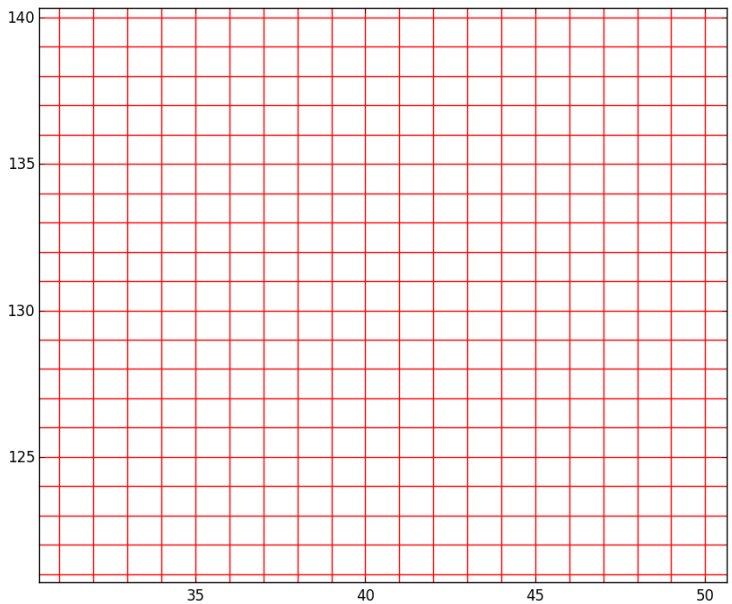
Method :

- Spline decomposition of $\overrightarrow{\delta}$.
- Distortions can be map using a series of modulated illuminations and flat-fields.
- Simulated images.
- Noise model (read + flux).

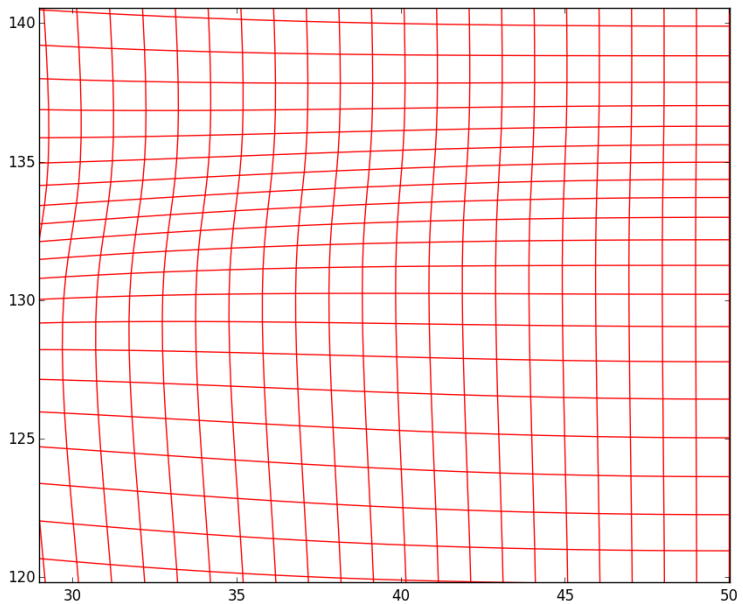




Zoom on the pixel grid

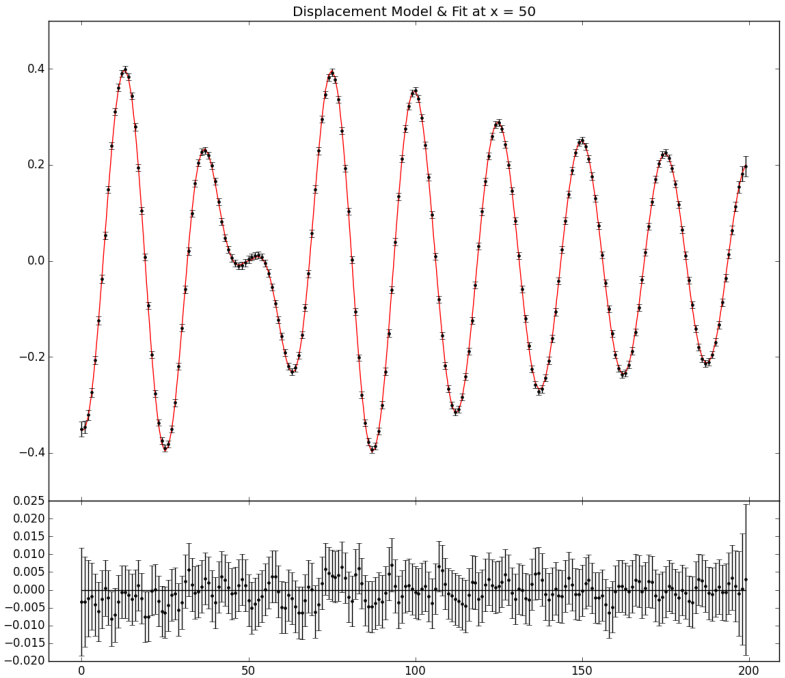


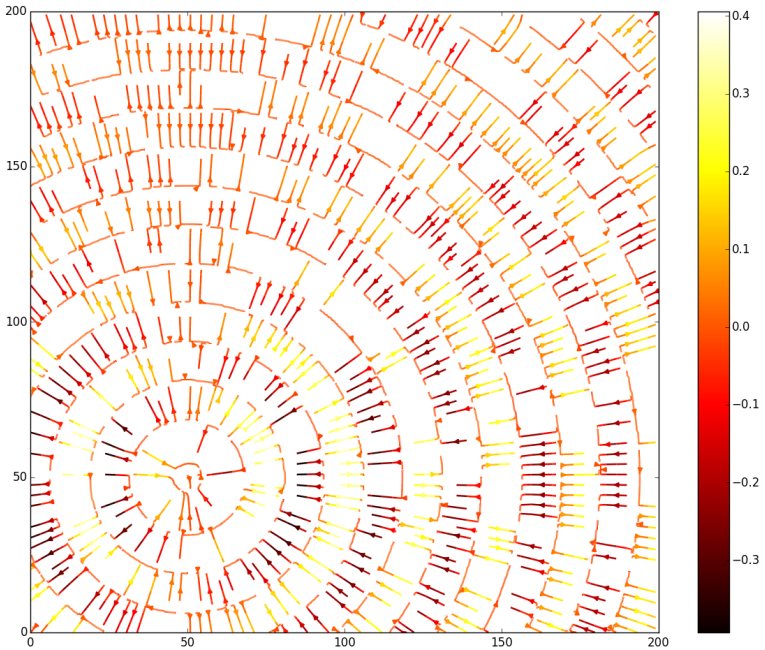
Non distorted grid



distorted grid (x5 effect)

My ongoing work





Simulations :

- Validating the method.

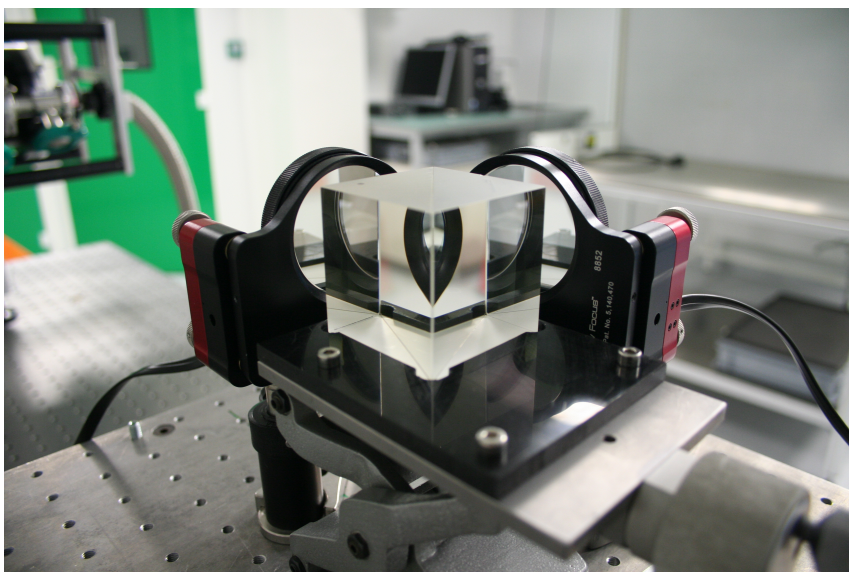
Next Steps :

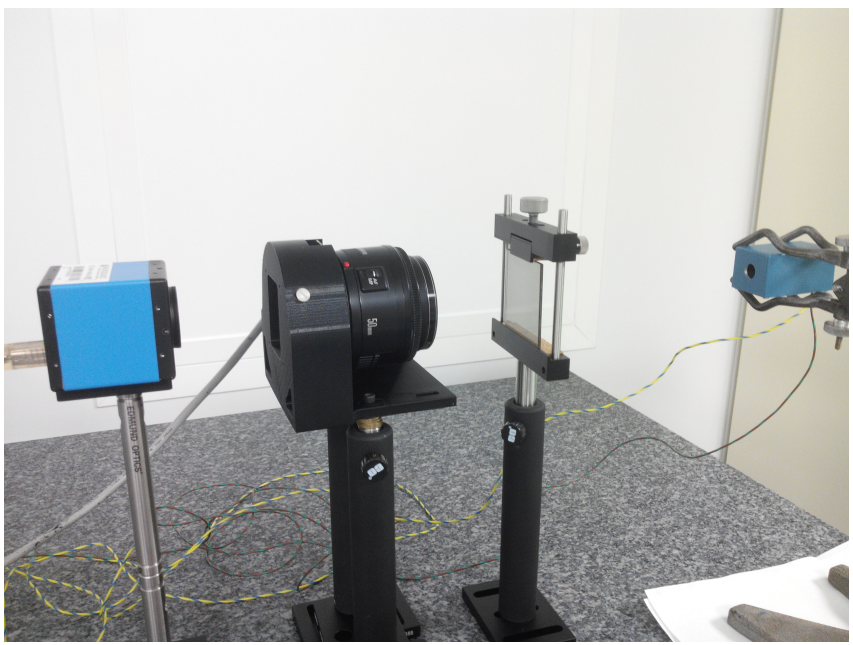
- Take real data on the optical bench, and work with them.
- Include dynamic effects such as brigther-fatter.

Taking data

Two ways to produce modulated patterns :

- Projection of target (ronchi, sinusoidal).
- Michelson interferometer.





Conclusion

Au LPNHE :

- Élaboration des outils d'analyses.
- Prise de données.

Pour l'analyse :

Recherche de collaborateurs !

Back-up slides

Integrating sphere