

Sky tests of a 10-m baseline Carlina prototype

A new class of interferometers:
the Diluted Telescopes

Plan

I. Introduction and goal of the experiment

II. Primary mirrors coherencing

III. The Focal gondola

IV. Results and conclusions

International context

Carlina: a study for the Post-VLTI/E-ELT...



VLTI



Keck



CHARA

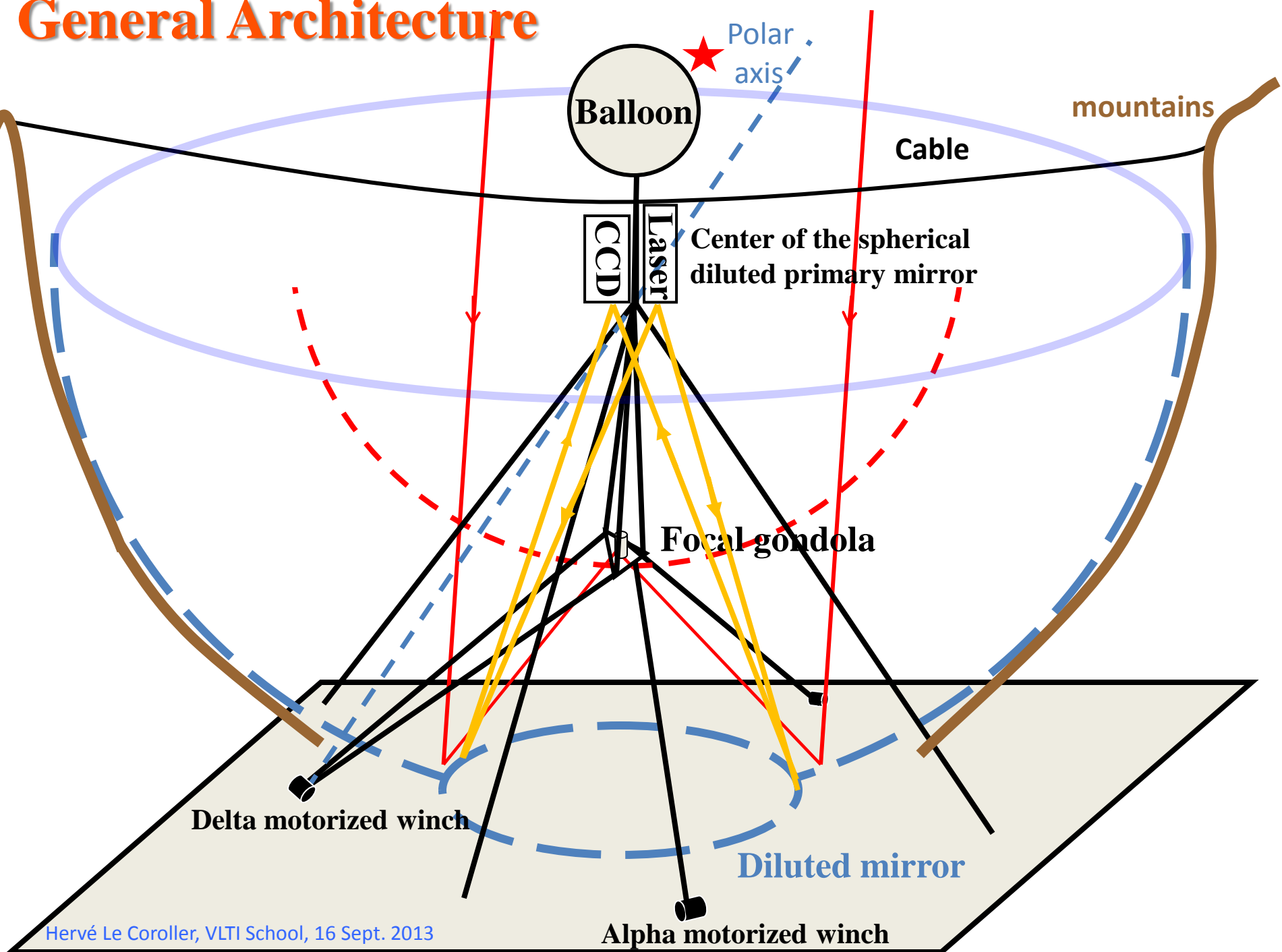


LBTI



MROI.....

General Architecture

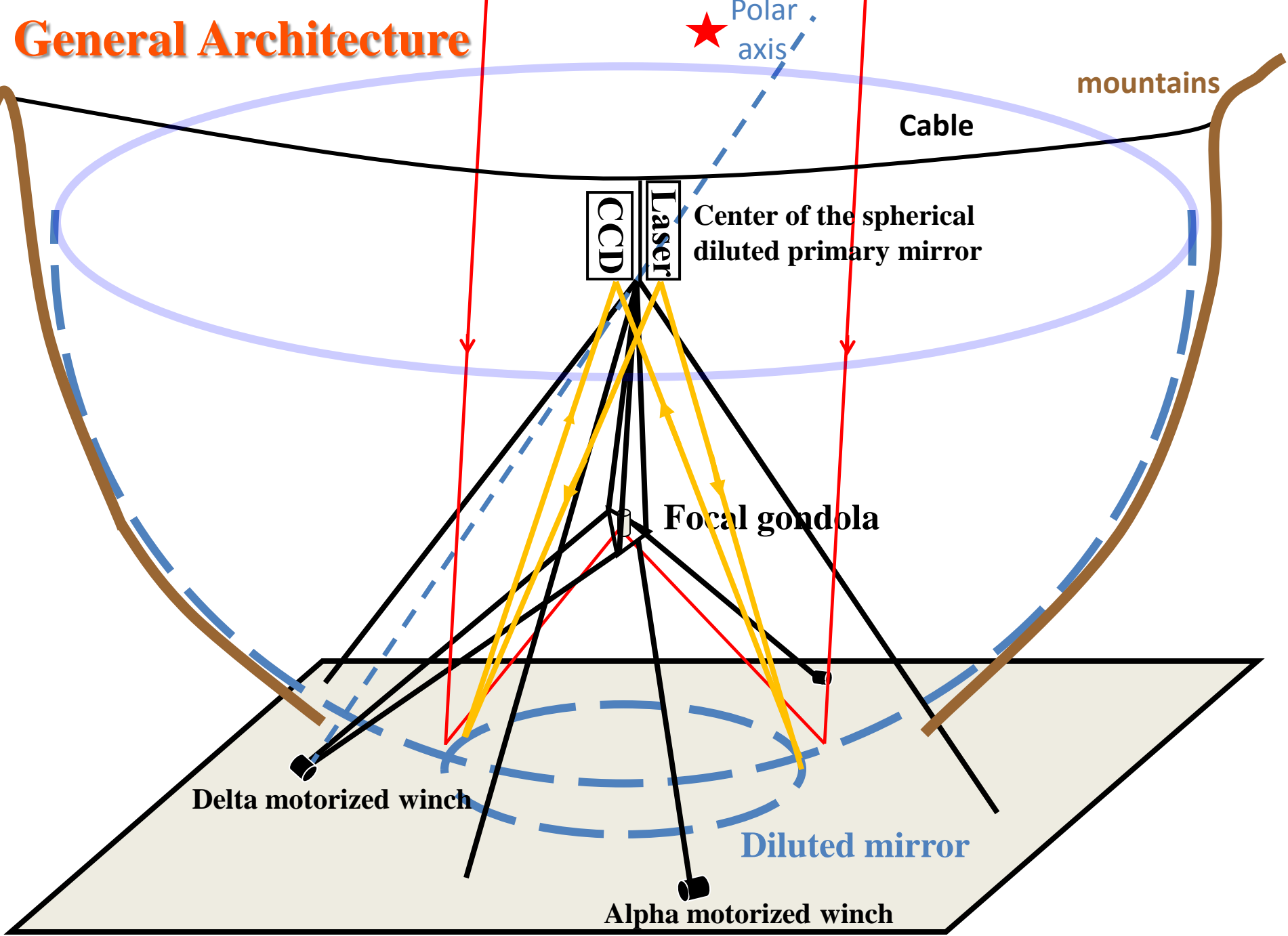


Goal of the Carlina experiment at Haute-Provence Observatory

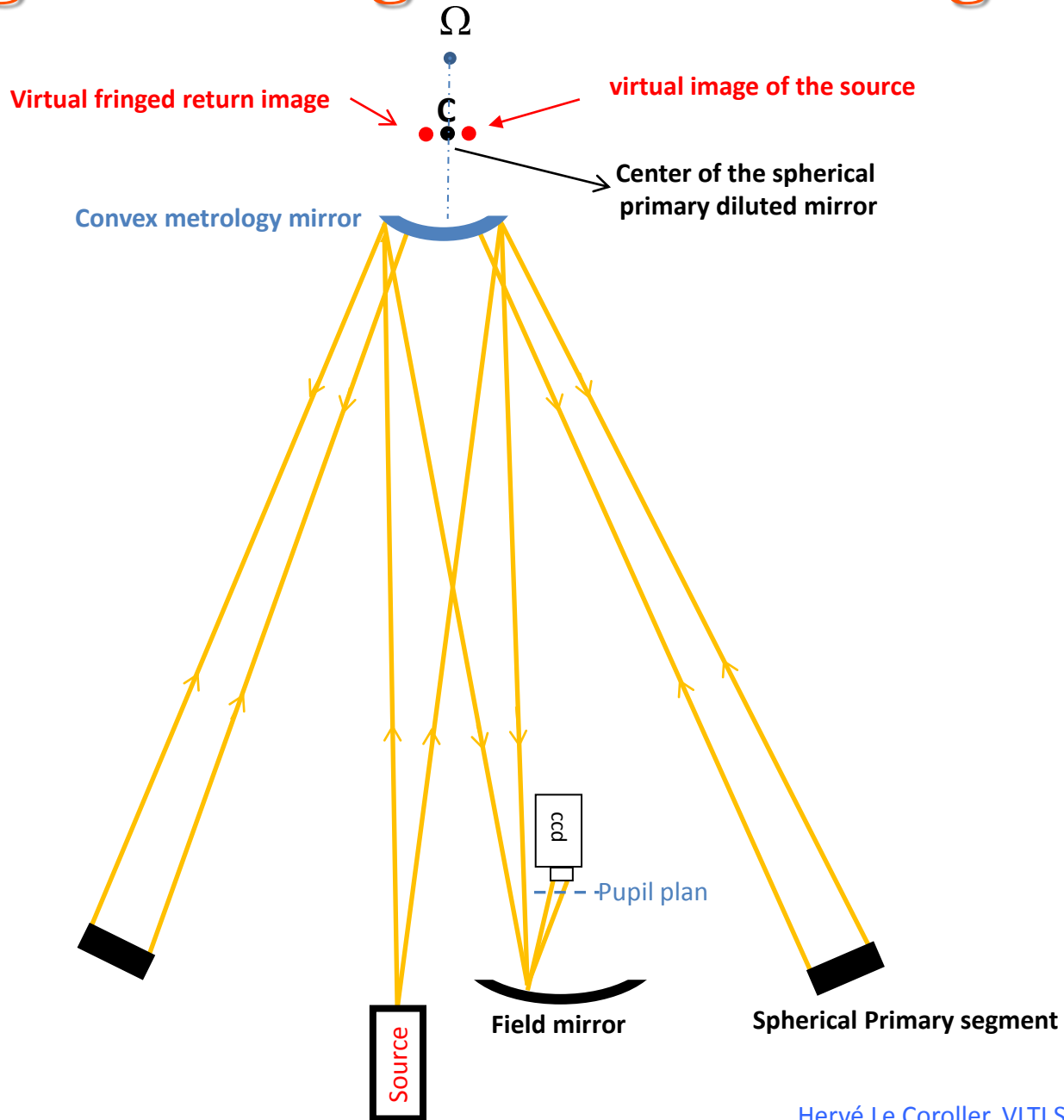
- I. Find the opto-mechanical solutions to stabilize the gondolas attached under cables, and to be able to record fringes ✓
- II. Measure in real condition the performances of the Carlina interferometer (sensitivity, S/N of the visibilities, etc.)

II. Primary mirrors coherencing

General Architecture



Drawing describing the coherencing technic



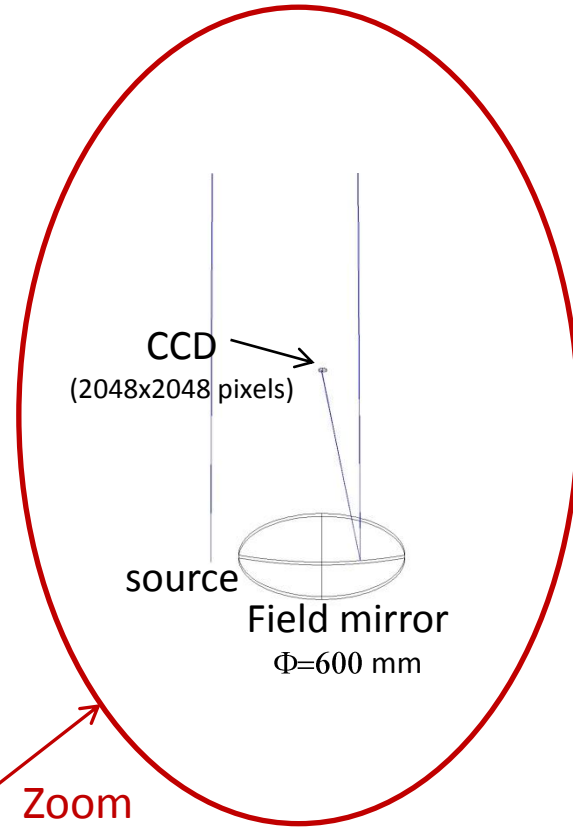
Opto-mechanical study of the OHP prototype

Zemax study

+C
Convex metrology Mirror
 $\phi=250$ mm; $R=2$ m

71.17 m

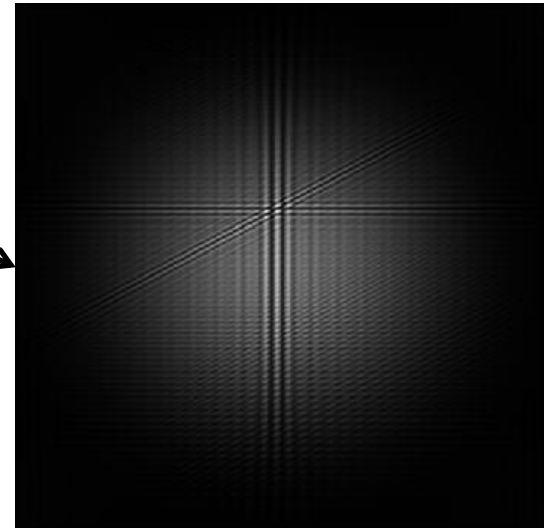
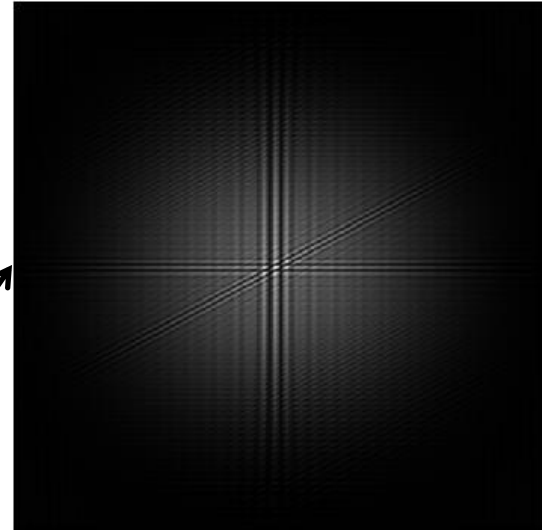
9m



Primary mirror
 $\Phi=250$ mm

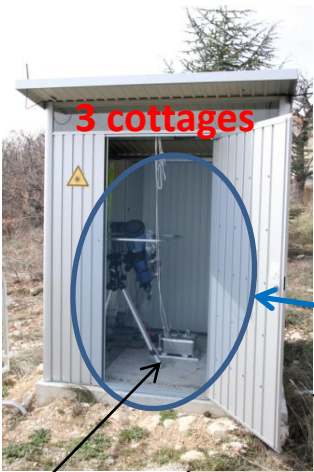
Image
without
piston error

Image
with
 $5 \mu\text{m}$ piston error

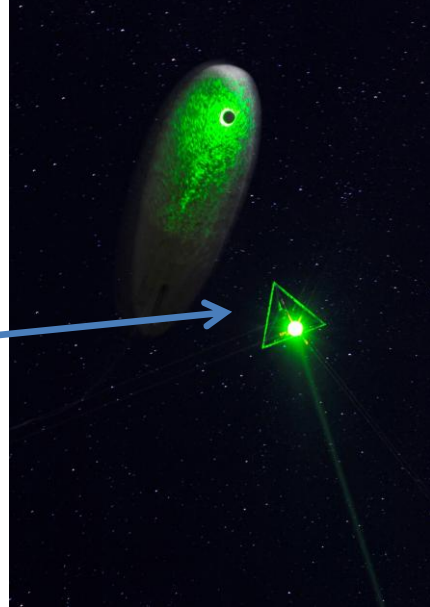
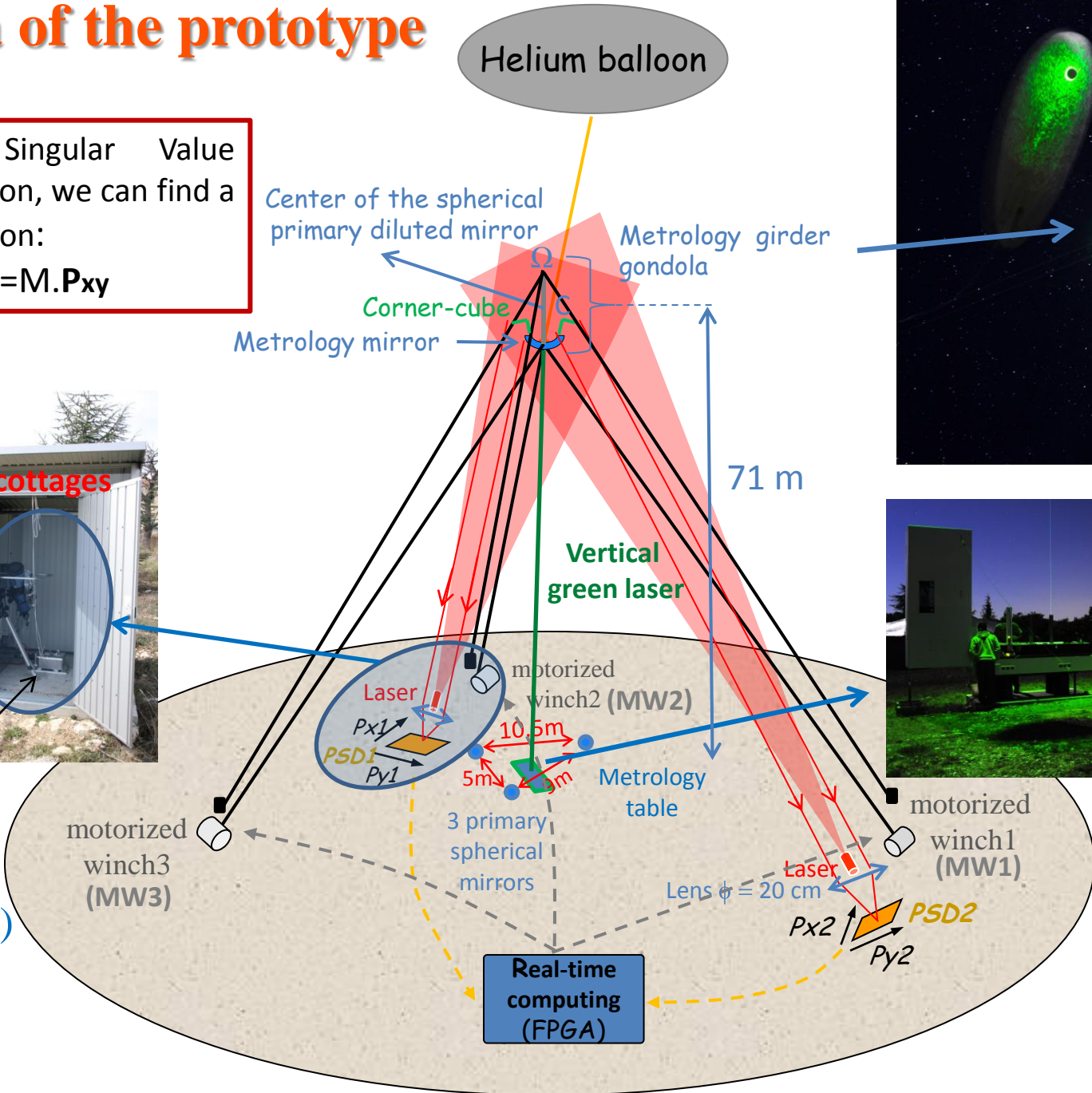


Schema of the prototype

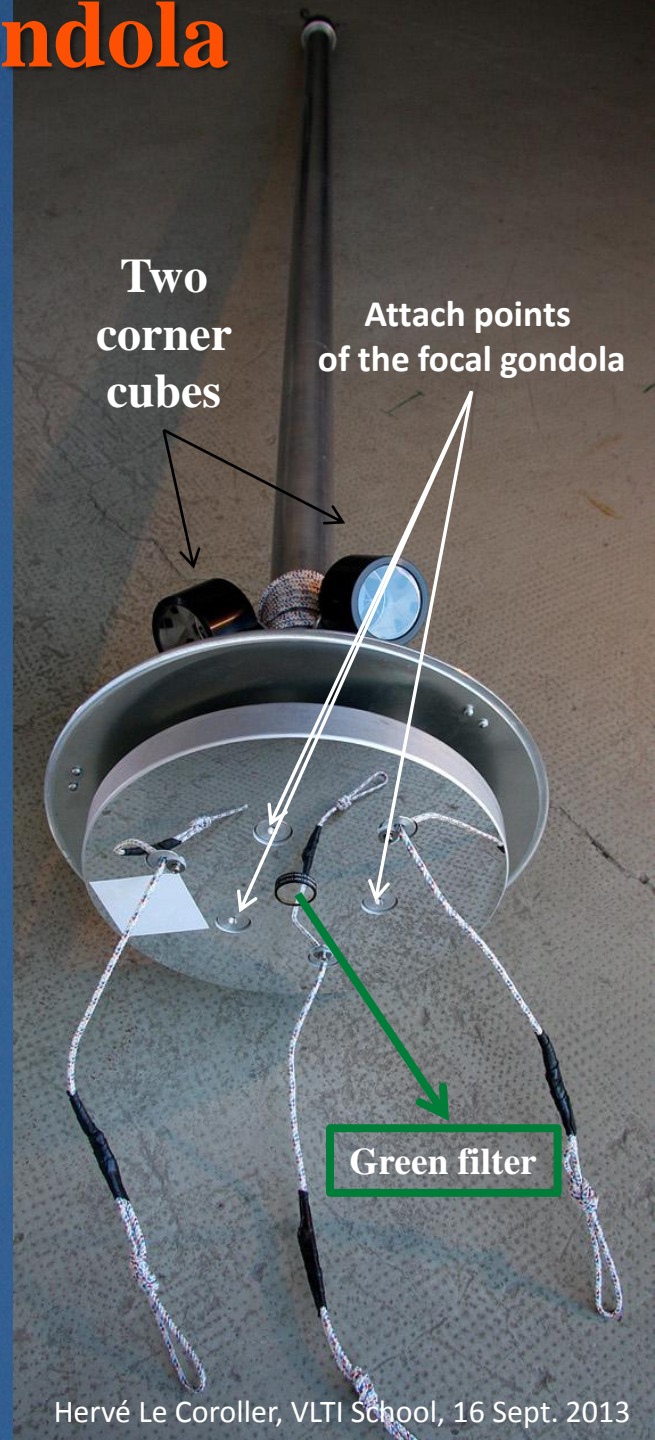
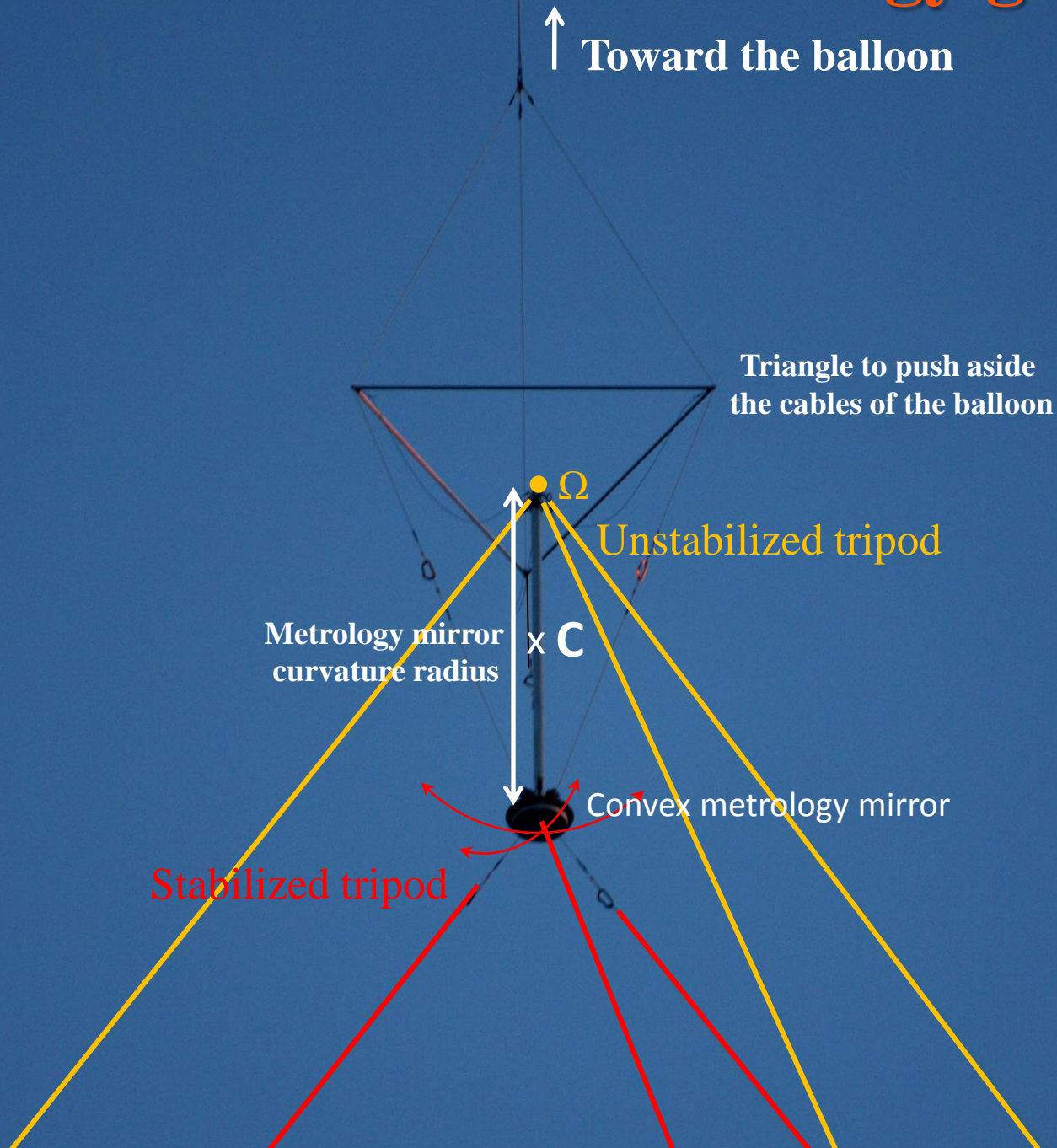
Using a Singular Value Decomposition, we can find a linear equation:
 $\Delta L = M \cdot P_{xy}$



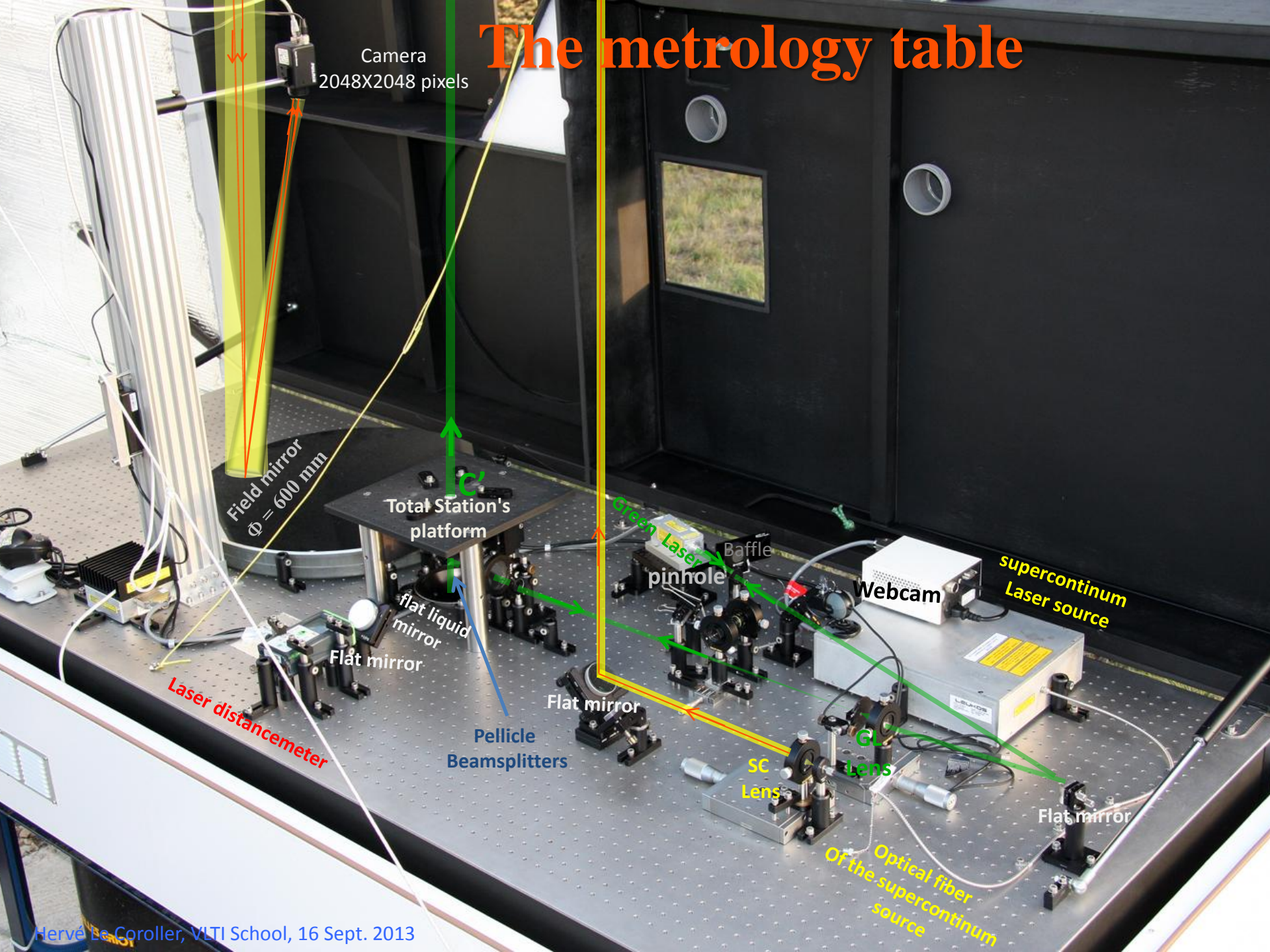
motorized Winch (R. Sottile)



Girder metrology gondola



The metrology table



Camera
2048X2048 pixels

Field mirror
 $\Phi = 600 \text{ mm}$

Total Station's
platform

flat liquid
mirror
Flat mirror

Laser distance meter

Pellicle
Beamsplitters

Flat mirror

Green Laser
pinhole
Baffle

Webcam
supercontinuum
Laser source

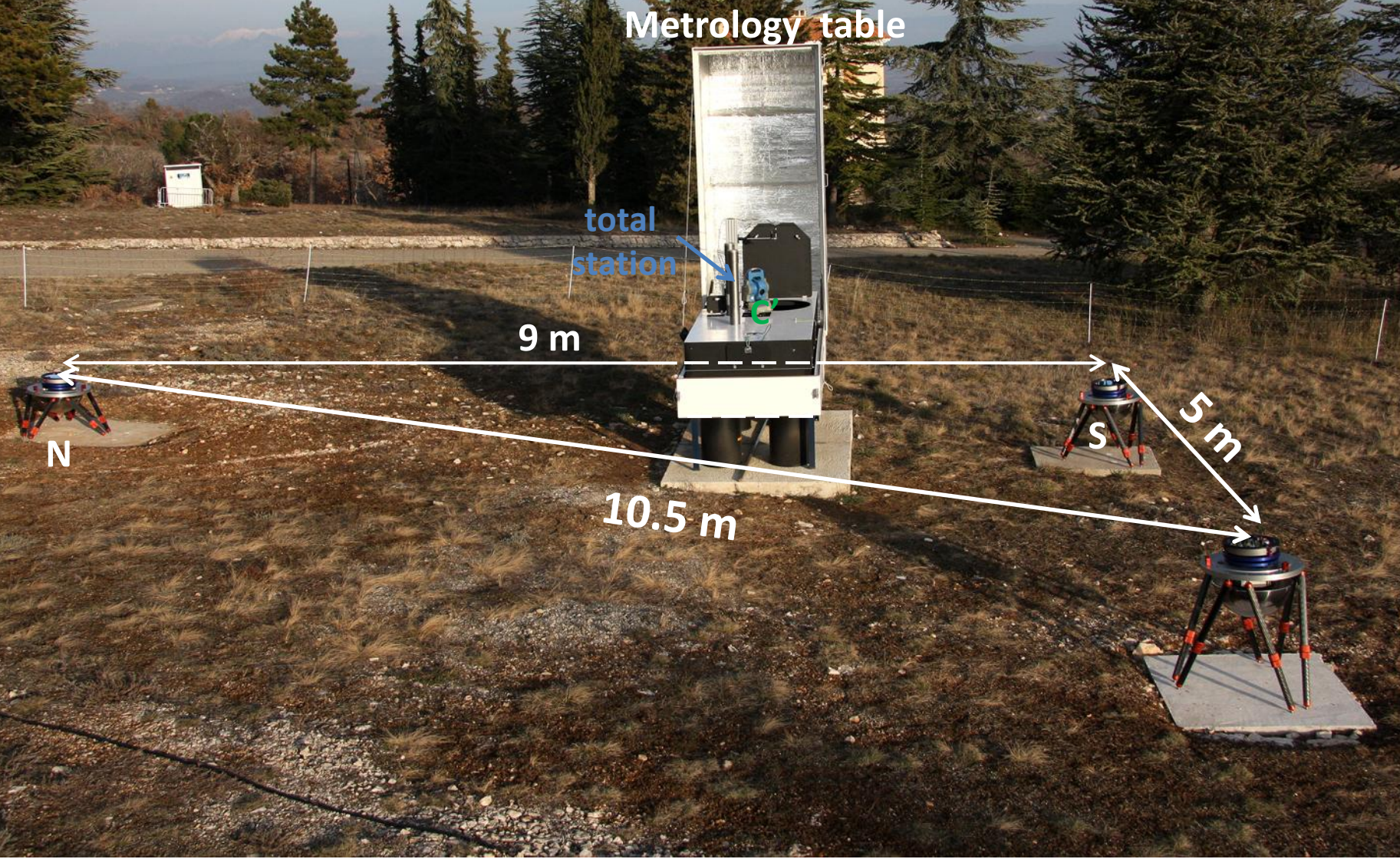
SC
Lens

Lens

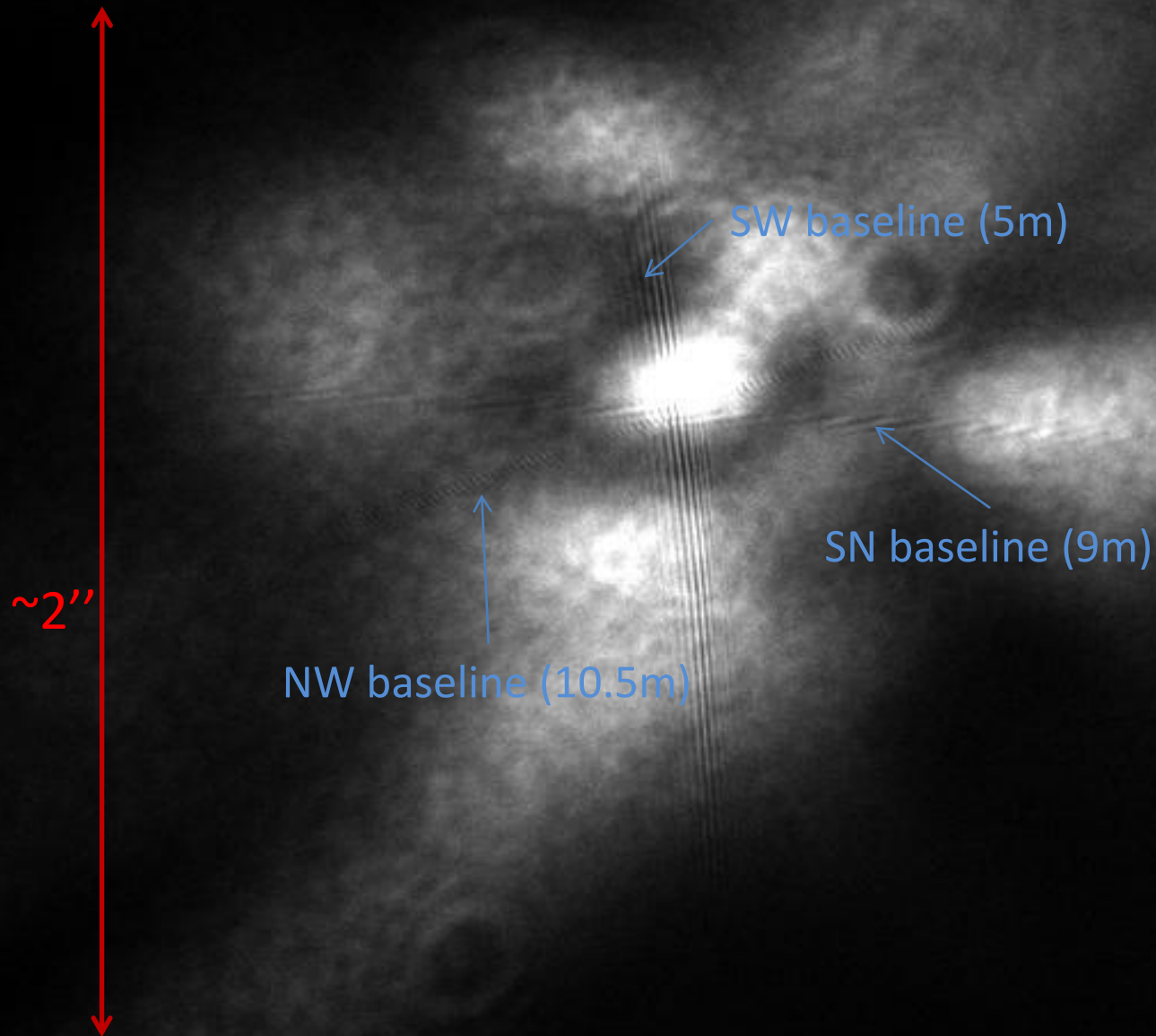
Optical fiber
Of the supercontinuum
source

Flat mirror

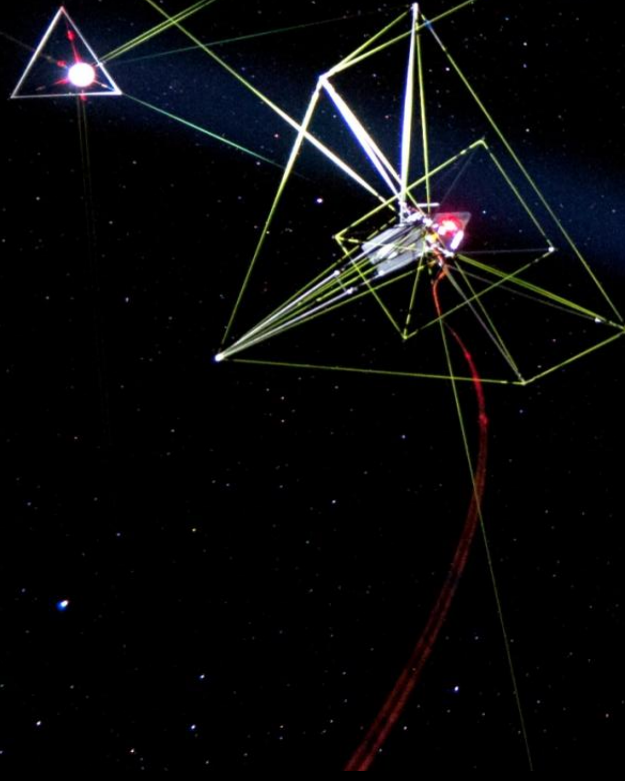
Carlina mirrors arround the metrology table



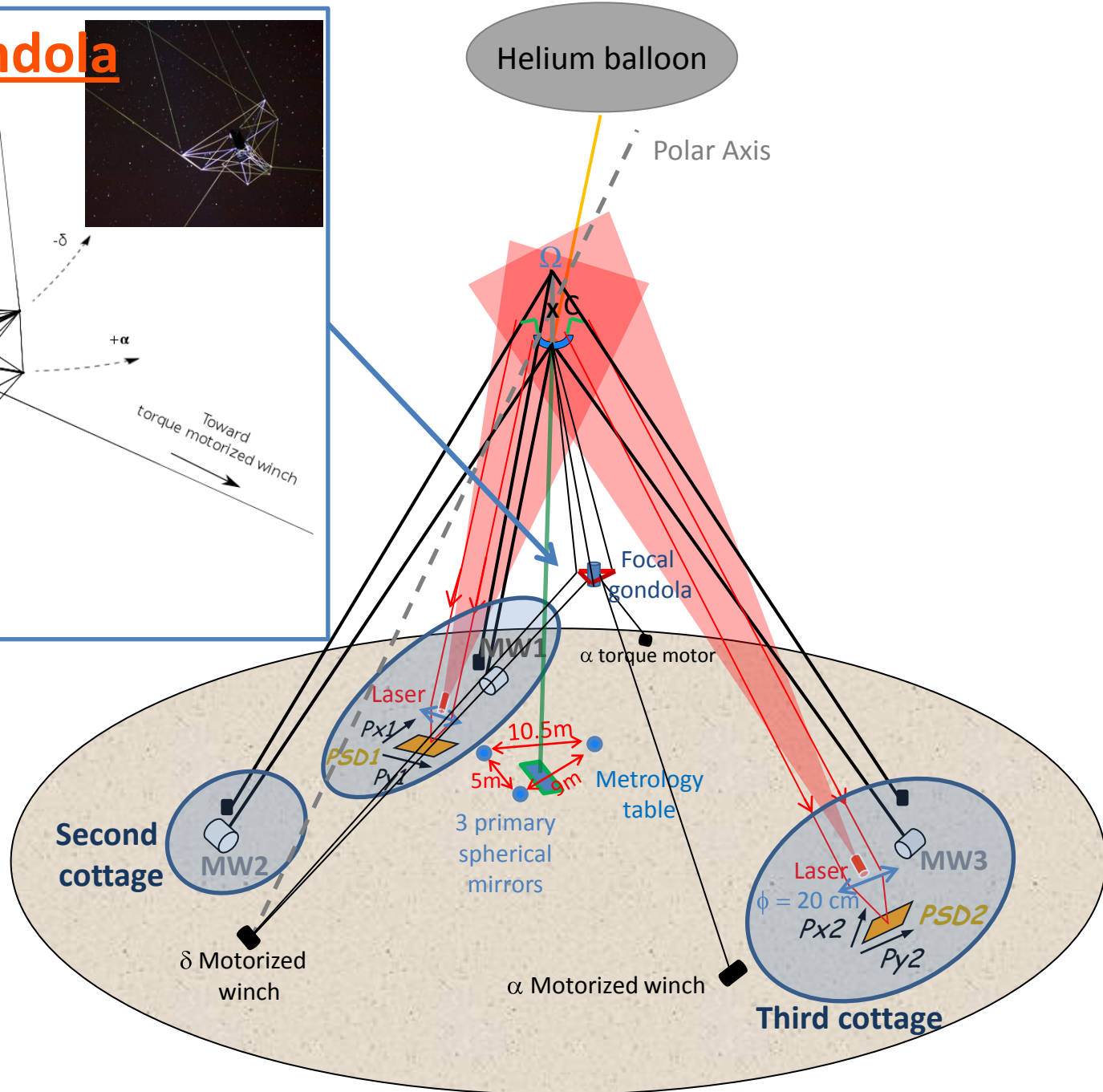
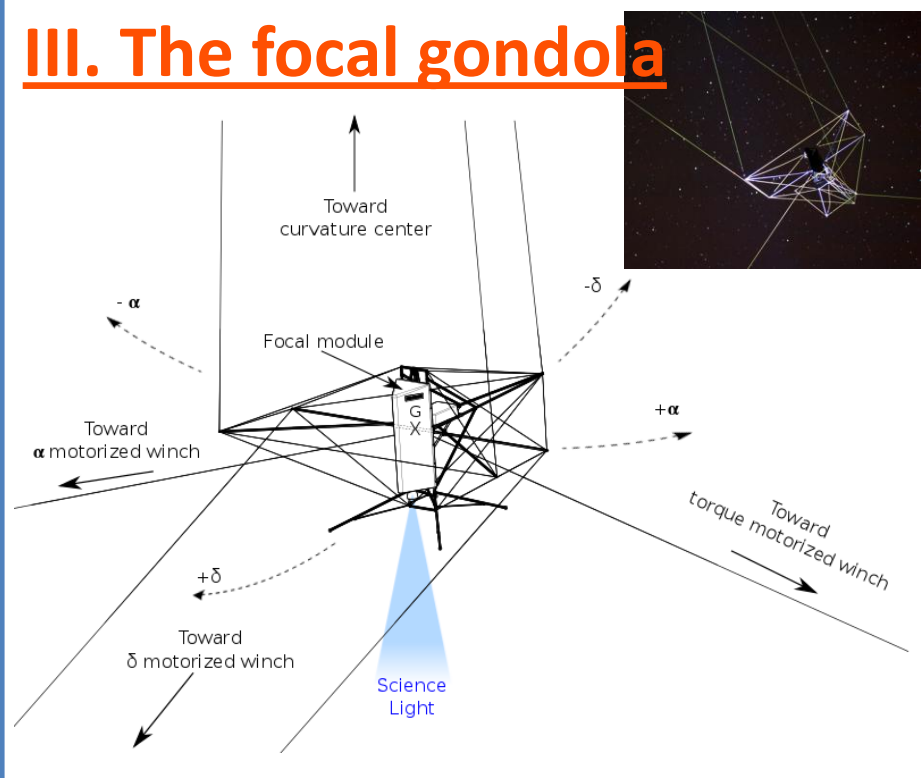
Metrology fringes



III. The Focal gondola

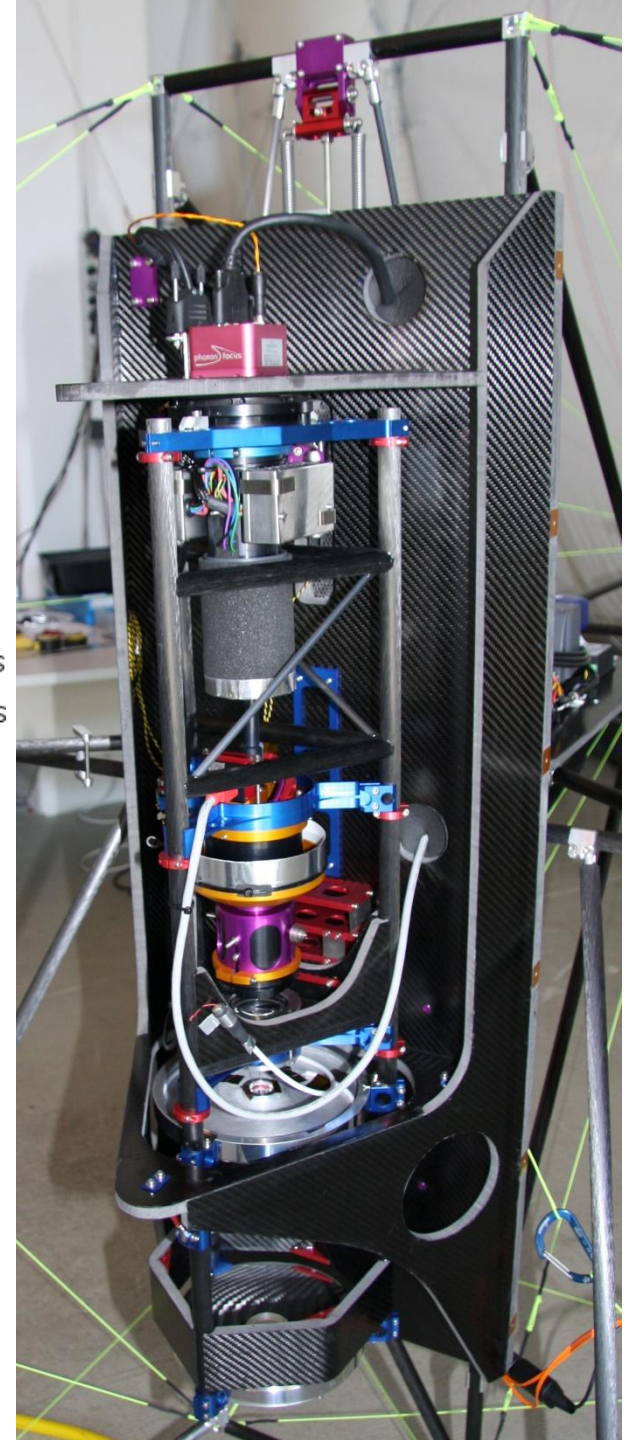
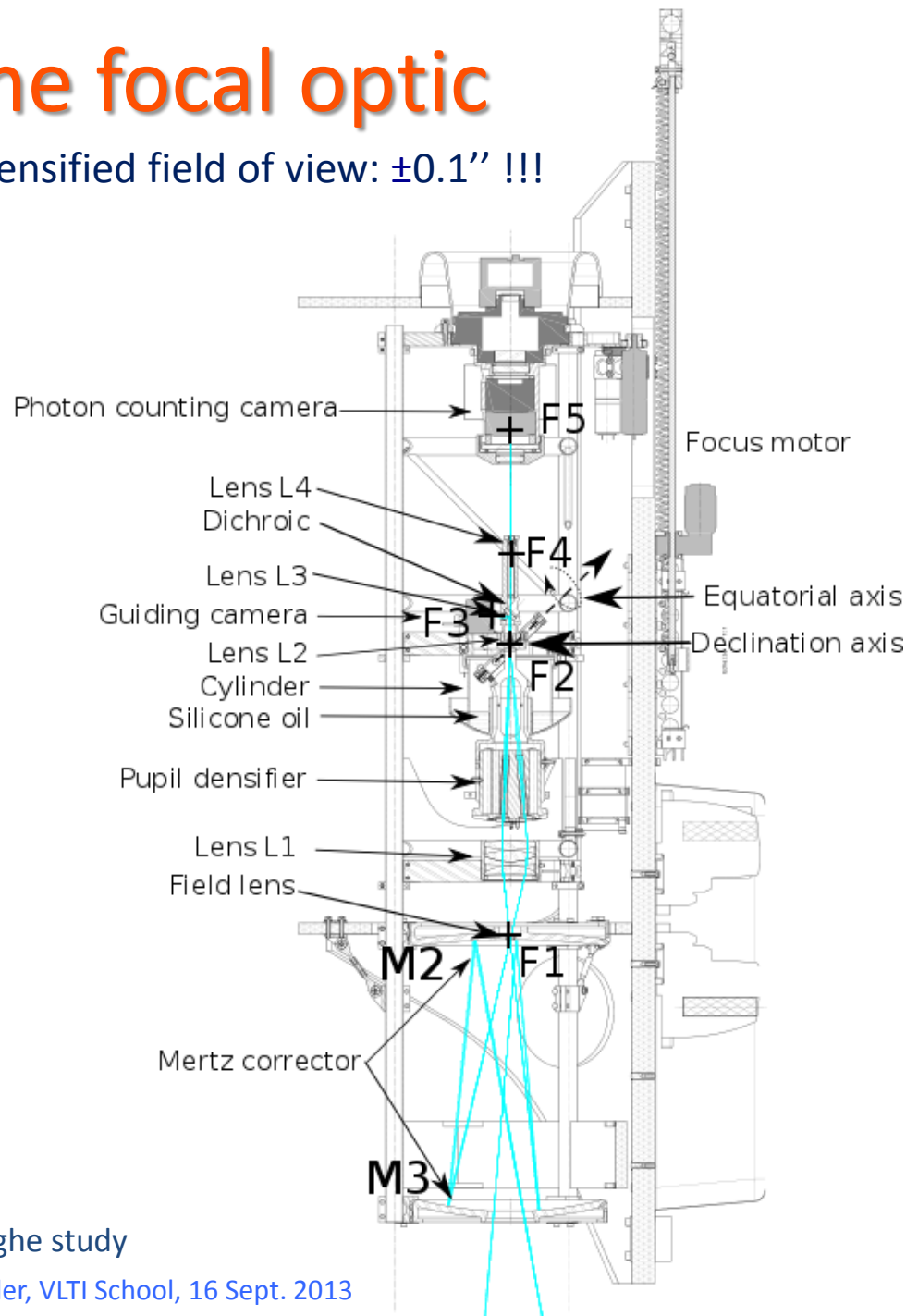


III. The focal gondola



The focal optic

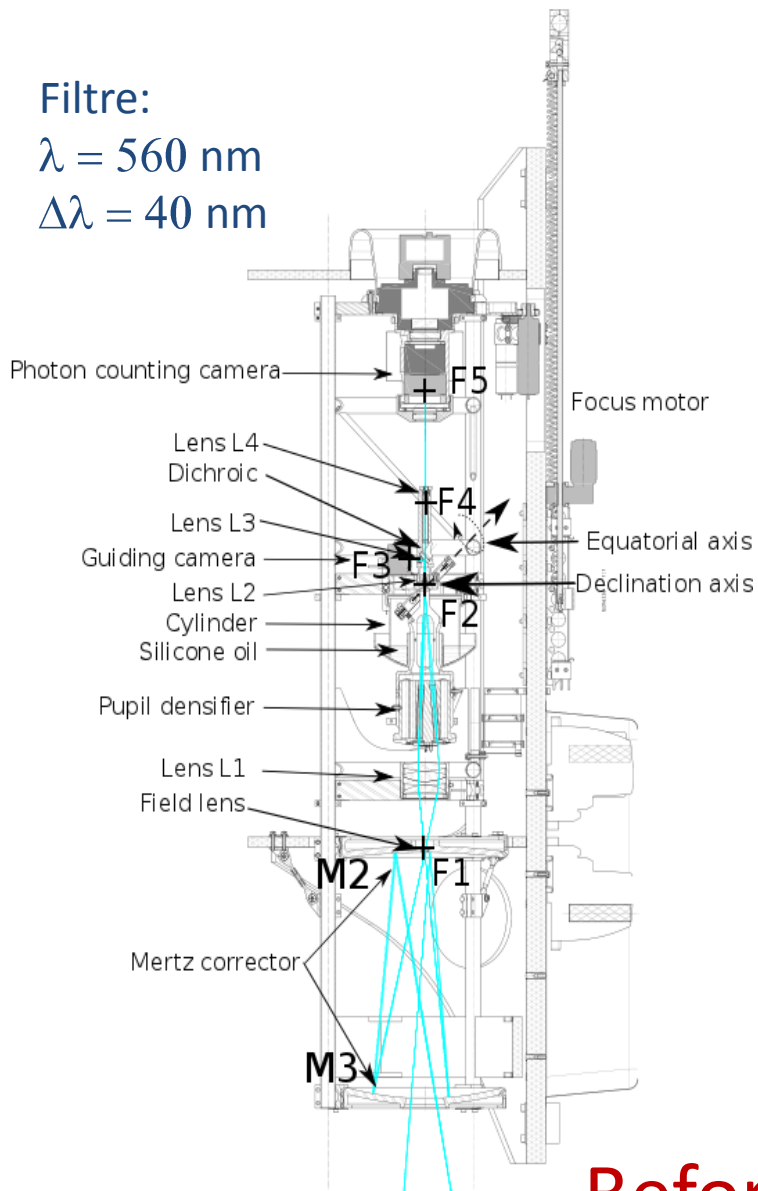
Densified field of view: $\pm 0.1''$!!!



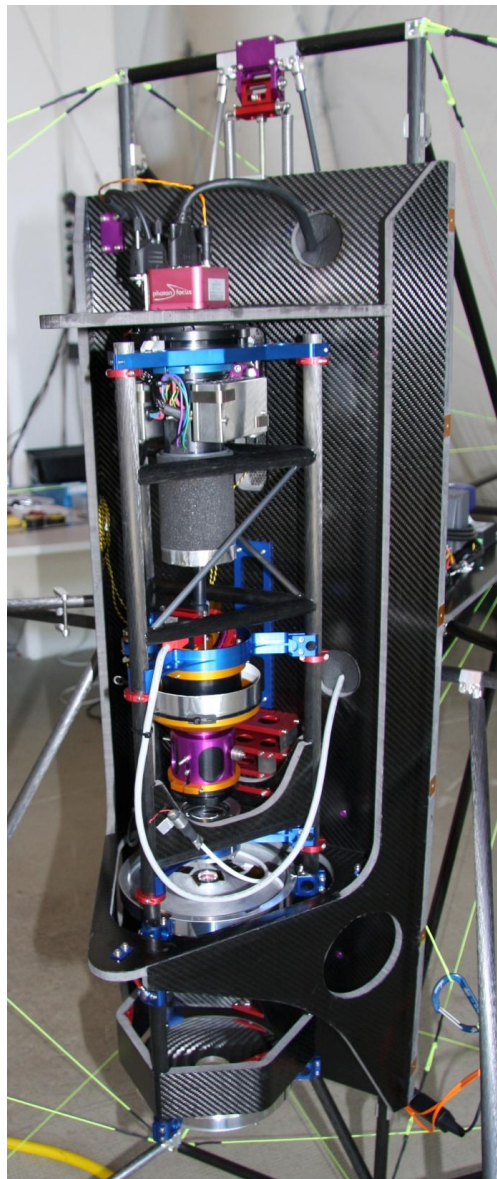
Densified mode

Science camera field : $\pm 0.1''$!!!

Filtre:
 $\lambda = 560 \text{ nm}$
 $\Delta\lambda = 40 \text{ nm}$

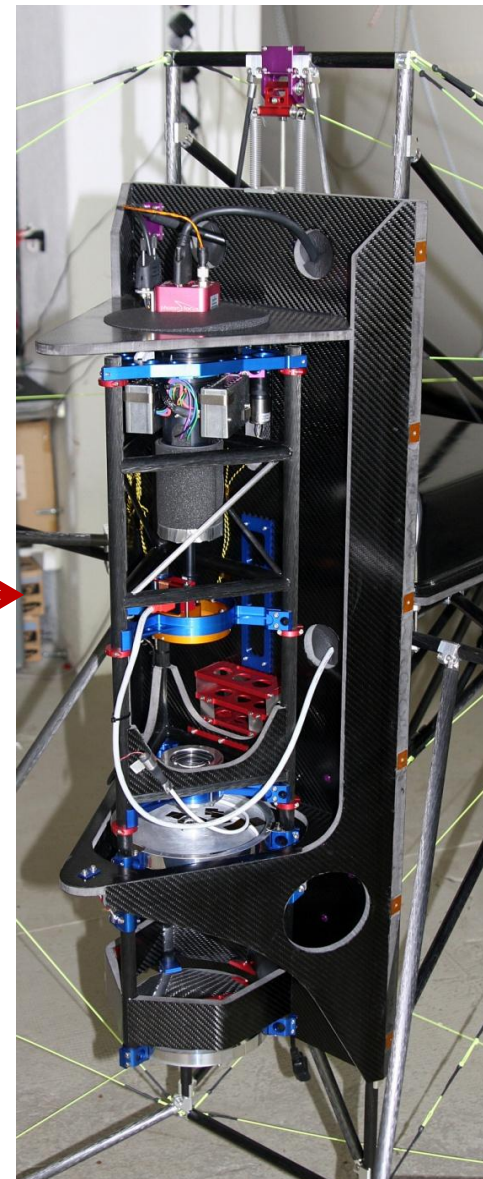


Before

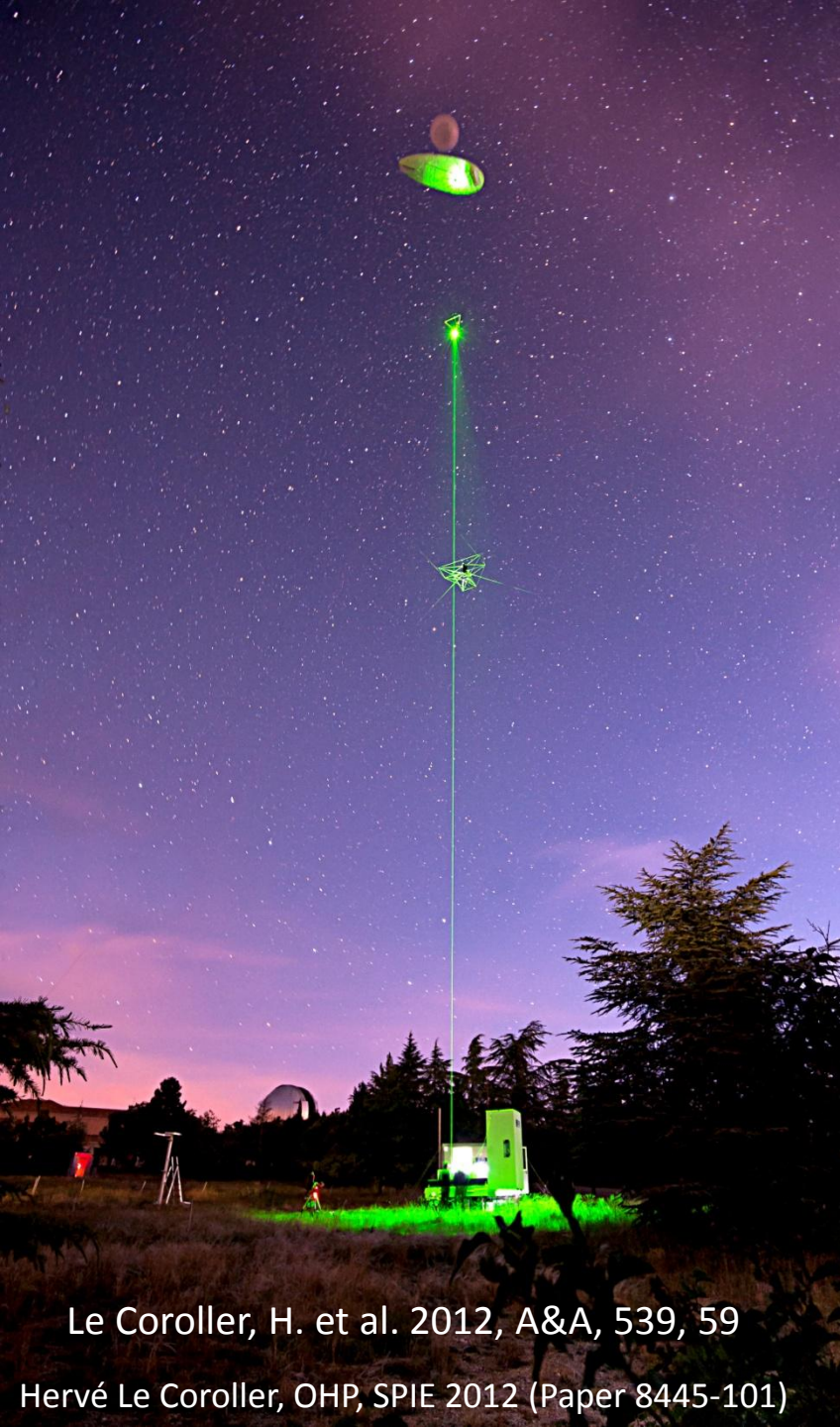


Fizeau mode

Science camera field $\pm 1''$



After



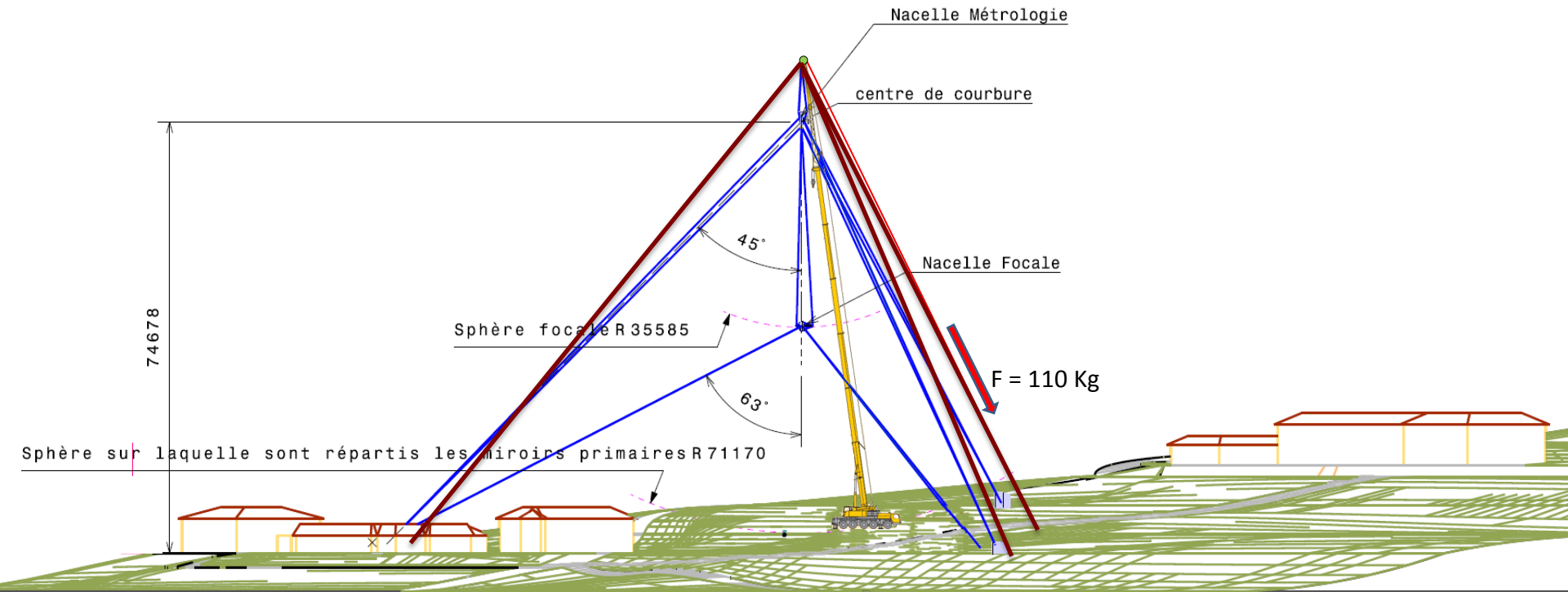
**Difficult to observe again
with
1-2 balloons !!**

Le Coroller, H. et al. 2012, A&A, 539, 59

Hervé Le Coroller, OHP, SPIE 2012 (Paper 8445-101)

Hervé Le Coroller, VLT School, 16 Sept. 2013

A Crane: a heavy but stable solution to replace the balloon !



Carlina with a Crane



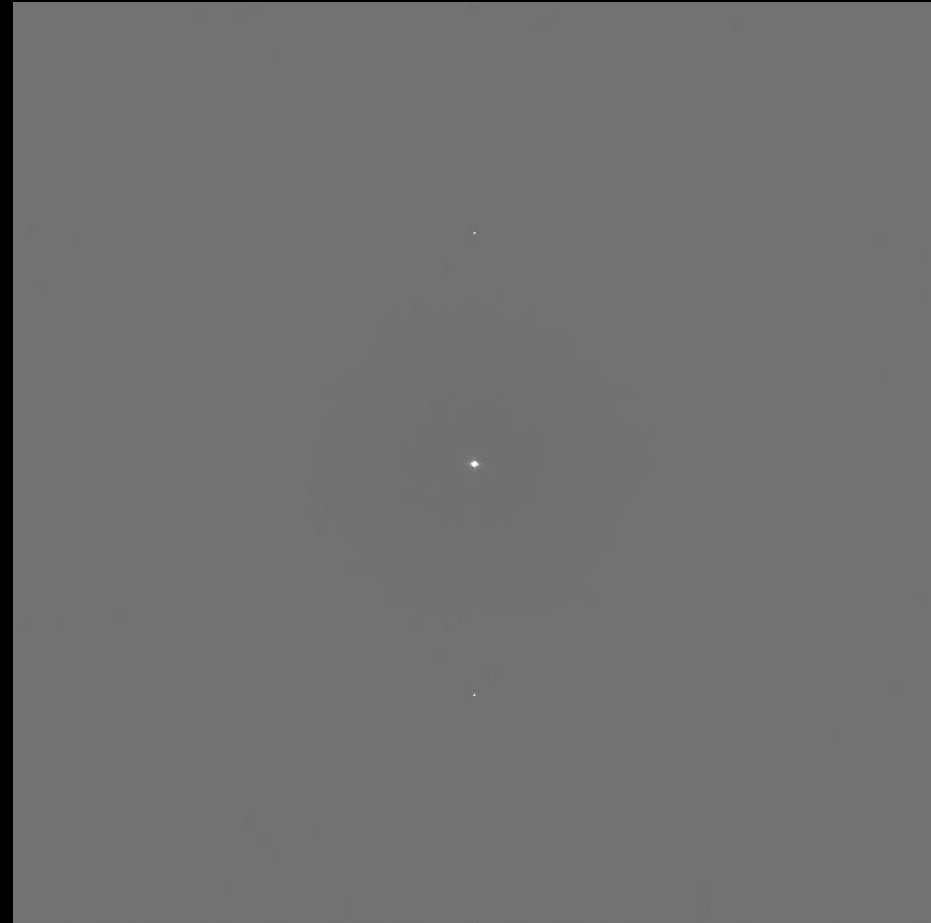
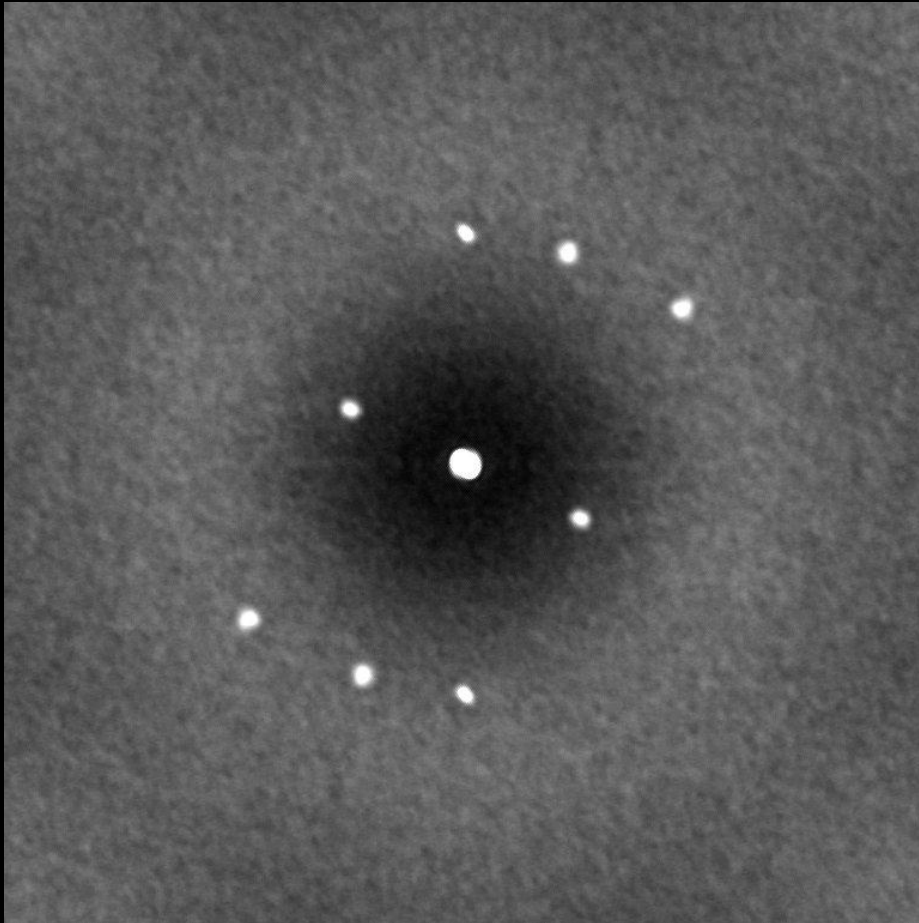
IV. Results and conclusions

Observation

Power spectrum of a Fizeau recombination in laboratory

Power spectrum of a Fizeau recombination:

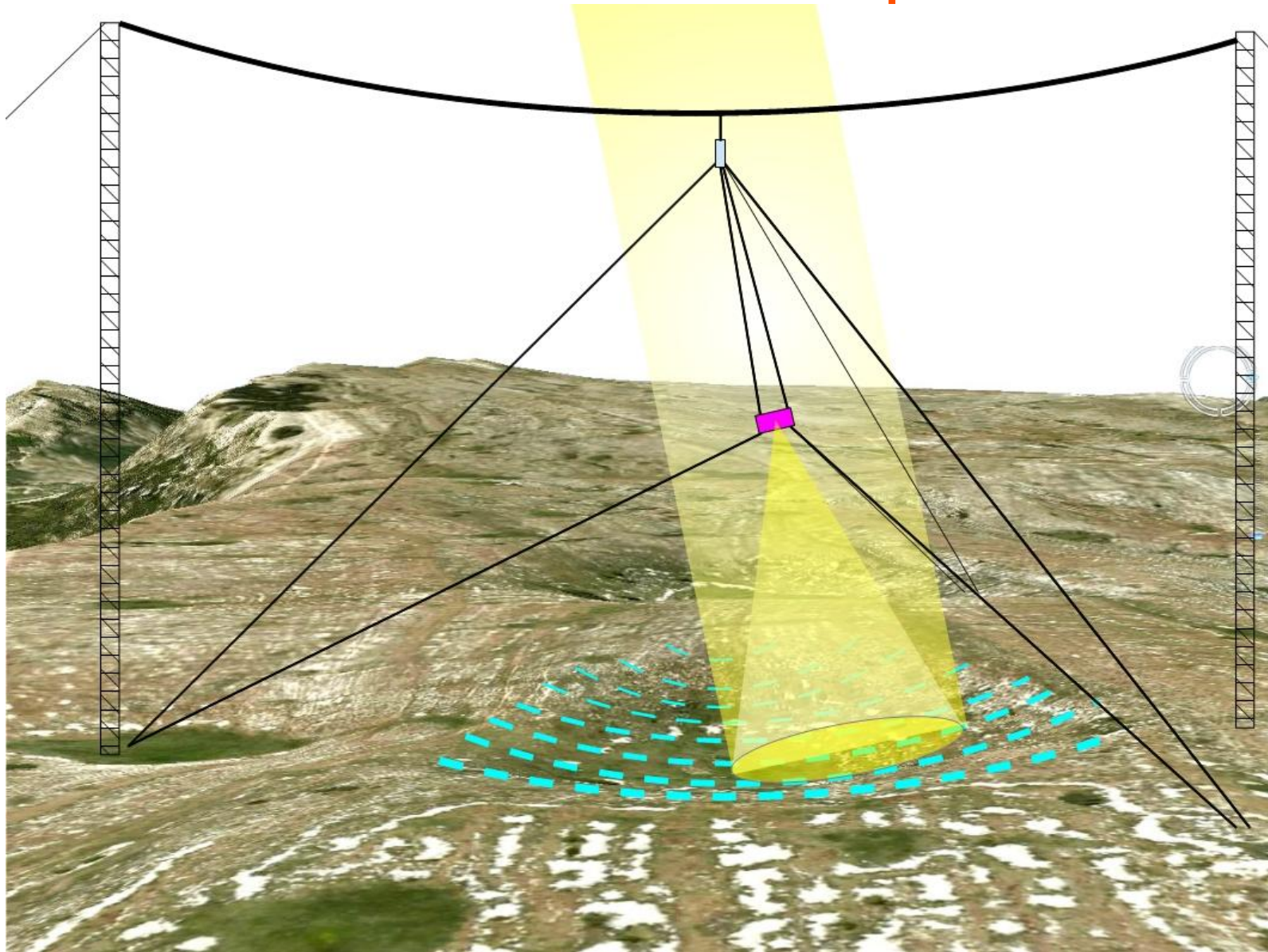
- Stars O AND mv = **3.7**
- 1 baseline (5m)
- tracking 5 min (10 000 exposures of 5 ms)
- mean : 700 ph/exposure with $\Delta\lambda=80\text{nm}$; $\lambda=560\text{ nm}$



Possible reasons that could explain why we didn't detect the fringes !

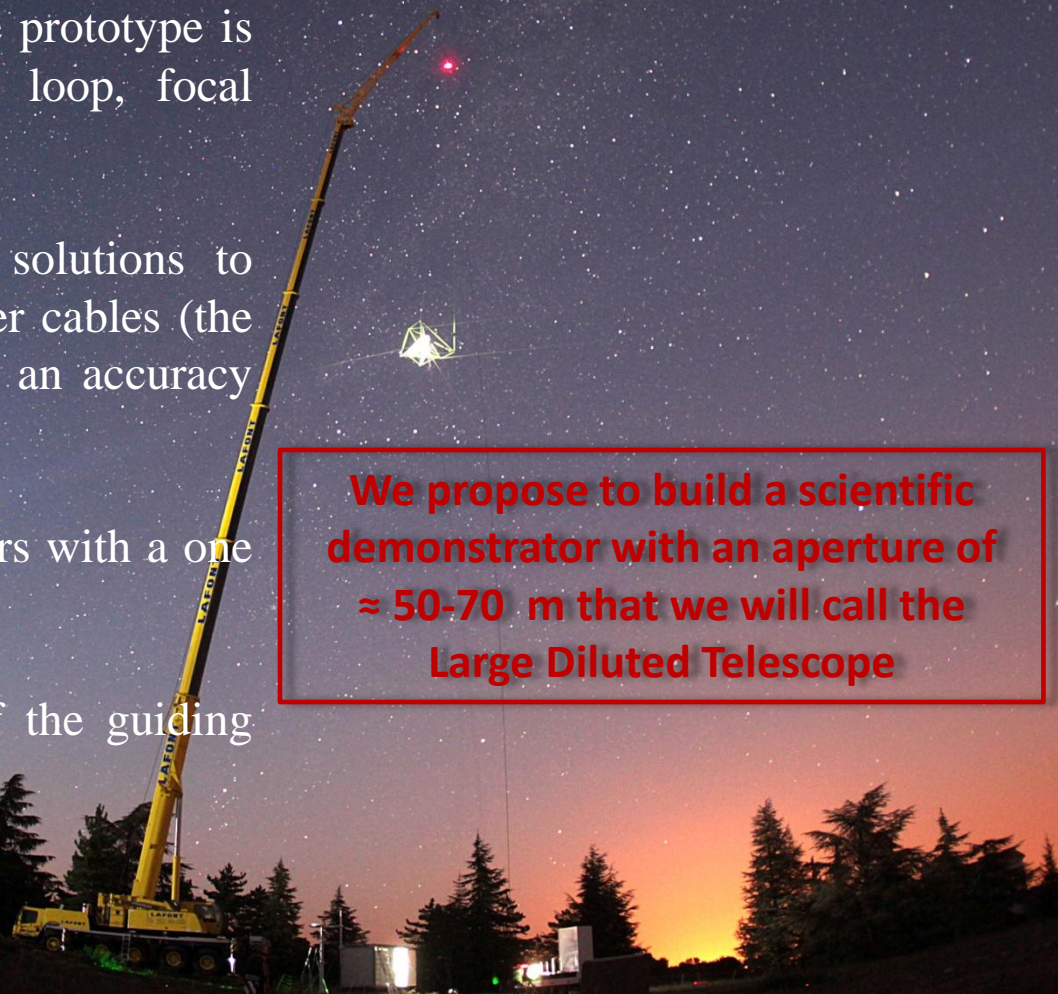
- Vibration of the cables transmitted to the focal optic.
- The bad atmospheric turbulence at OHP
- Our simple focal Fizeau recombiner not well adapted to the atmospheric turbulence
- Problem with the corrector of spherical aberation !?

Diluted Telescope



Conclusion


- ✓ After 10 years of development, the prototype is now completed (metrology, servo loop, focal gondola, etc.)
- ✓ We have found opto-mechanical solutions to stabilize the gondolas attached under cables (the metrology mirror is stabilized with an accuracy of 200 microns !!)
- ✓ We have aligned the primary mirrors with a one microns accuracy.
- ✓ We have measured the quality of the guiding system (1-2" in a low wind)



We propose to build a scientific demonstrator with an aperture of $\approx 50-70$ m that we will call the Large Diluted Telescope

Colloquium on the futur of the interferometry

- I. Current Interferometers and future development for these facilities
- II. Unique Science and technologies that will allow to design future interferometers with extremely high performances
- III. Problem of sensitivity of interferometers and quality of the observables in interferometry
- IV. Optimized beam combiners for present and future interferometers
- V. Progress in data reduction and image reconstruction techniques
- VI. Discussion on the future of interferometry (EII/ASHRA)



International colloquium at Haute-Provence Observatory, France


Improving the performances of current optical interferometers & future designs

23-27 September 2013

Main topics of this workshop include :

- Optical designs for the future interferometers
- Techniques to improve the accuracy of the measurements (visibility, closure-phases, etc.)
- Progress on the delay-line performances
- Solutions without delay-lines
- Technologies that could allow larger apertures at lower cost (ex: lightweight replica mirrors)
- Optimized beam combiners (integrated optics, temporal hypertelescope, pupil densifier, etc.)
- Fringe tracking systems
- Laser telemetry applied to interferometry
- Progress in image reconstruction techniques (strategy about the ideal uv coverage depending on the observed astrophysical objects, etc.)
- Progress in the field of nulling interferometry (report of observations at the limit of the performances of the present systems)

Please, draw me an interferometer



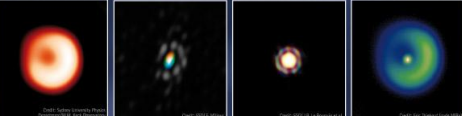
The timeline shows the evolution of interferometry from 1873 to 2010. Key milestones include: 1873 (International colloquium at Haute-Provence Observatory, France), 1919, 1974, 1985, 1988, 1989, 1995, 1996, 1999, 2001, 2001, 2004, 2005, and 2010. Each year is accompanied by a small image of an interferometer or related technology.

SOC :

- Jean-Philippe Berger
- Olivier Chesneau
- Hervé Le Coroller (CHAIR)
- Michel Lintz
- Fabien Malbet (CO-CHAIR)
- Bertrand Mennesson
- John Monnier
- Guillaume Montagnier
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- Hervé Le Coroller
- Guillaume Montagnier
- Jean-Paul Payan
- Mélody Didier
- Thierry Botti



Four astronomical images showing the results of interferometry, likely of a star or planet, demonstrating the high resolution achieved.

<http://www.obs-hp.fr/~hlecorol/workshopOHP/>