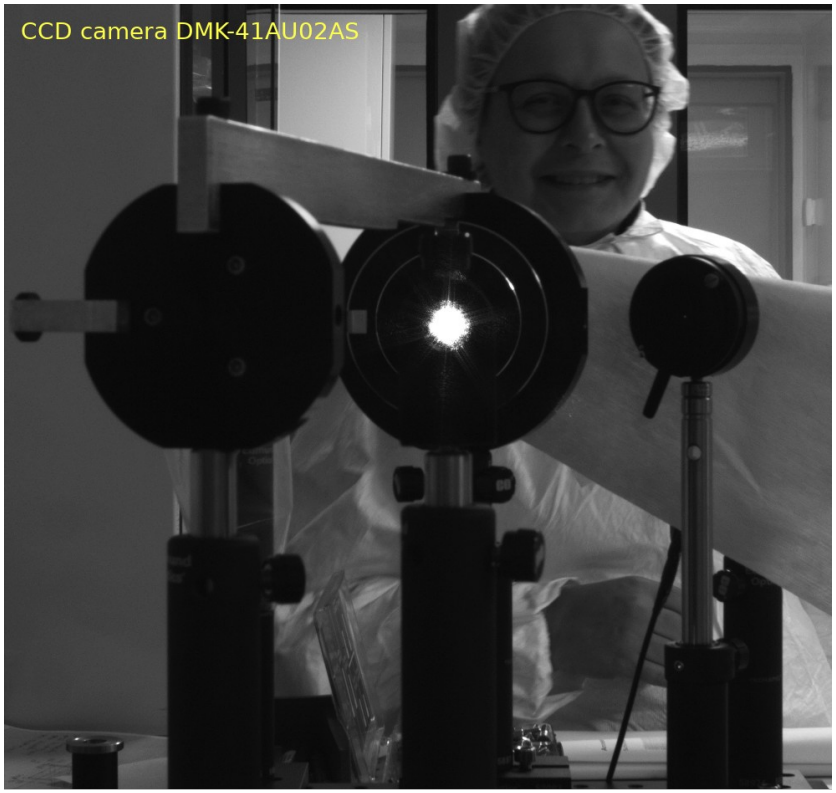

A test bench to characterize holographic gratings for AuxTel at LPNHE

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LSST DESC Calibration Workshop
LPNHE, Paris, 2018-10-02

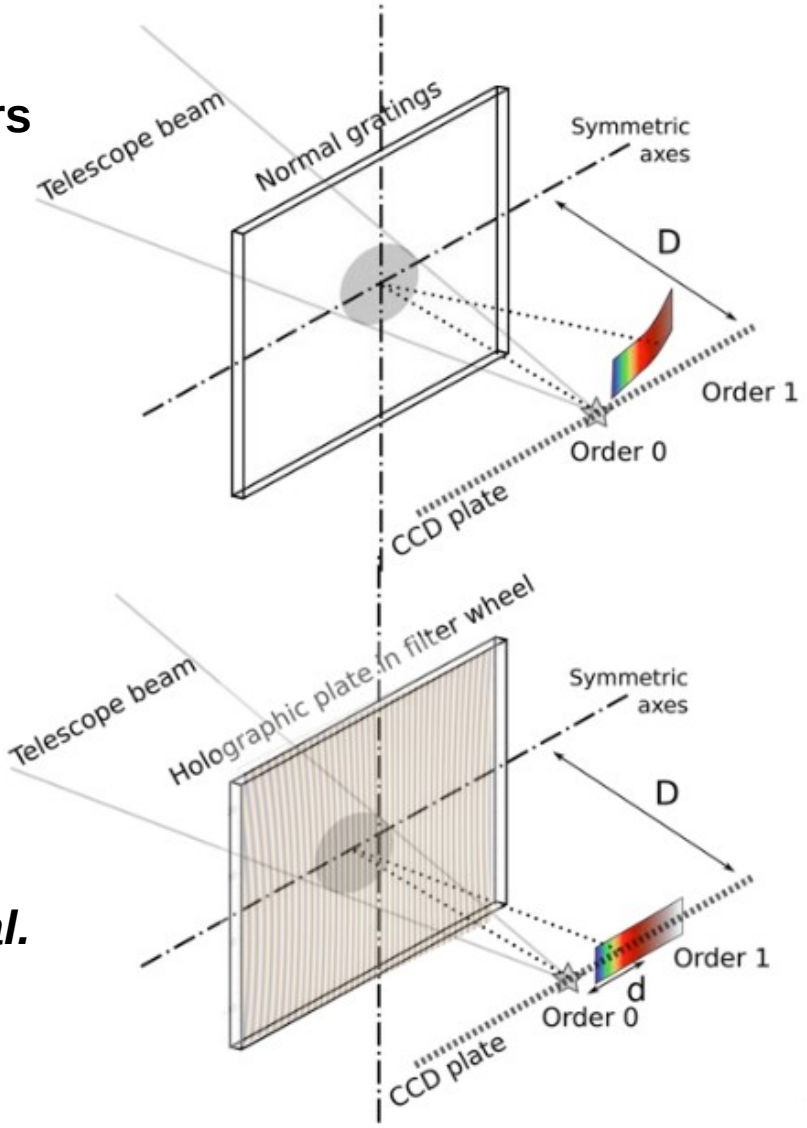
LAL : Sylvie Dagoret-Campagne, Marc Moniez, Jérémy Neveu, Olivier Perdereau
LPNHE : Pierre Antilogus, Pierre Astier, Marc Betoule, Patrick Ghislain, Claire Juramy-Gilles, Laurent Le Guillou, Philippe Repain, Eduardo Sepulveda, Arthur Vattier

Talk outline

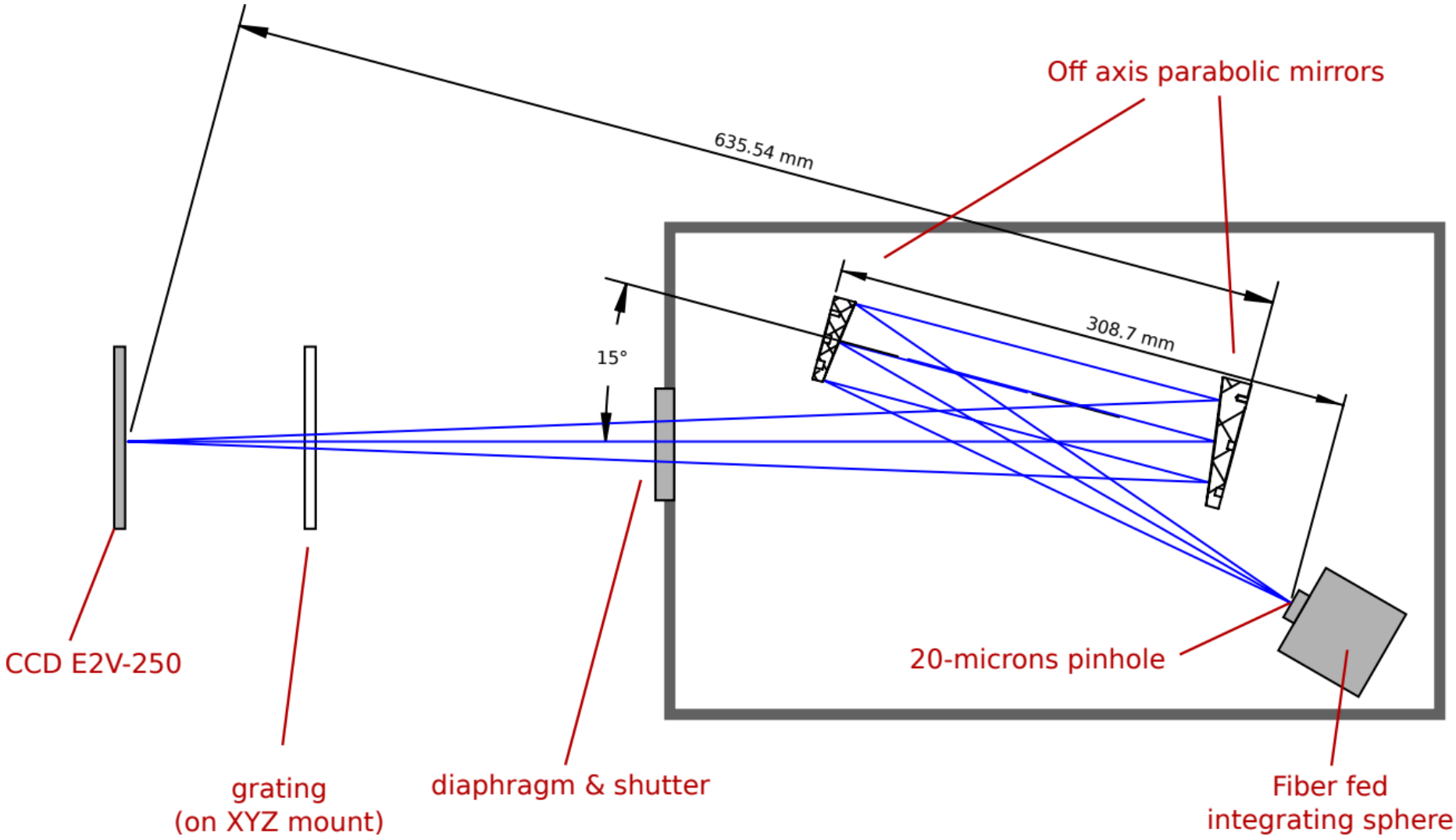
- **Context : Holographic gratings for AuxTel (HOE)**
- **Optical setup : λ-tunable convergent beam**
- **Integration within the LPNHE testbench for LSST CCD**
- **Focusing tests : Thorlabs grating vs holograms**
- **Measuring throughput / diffraction efficiency for each grating**
- **Conclusions & perspectives**

Holographic gratings for AuxTel

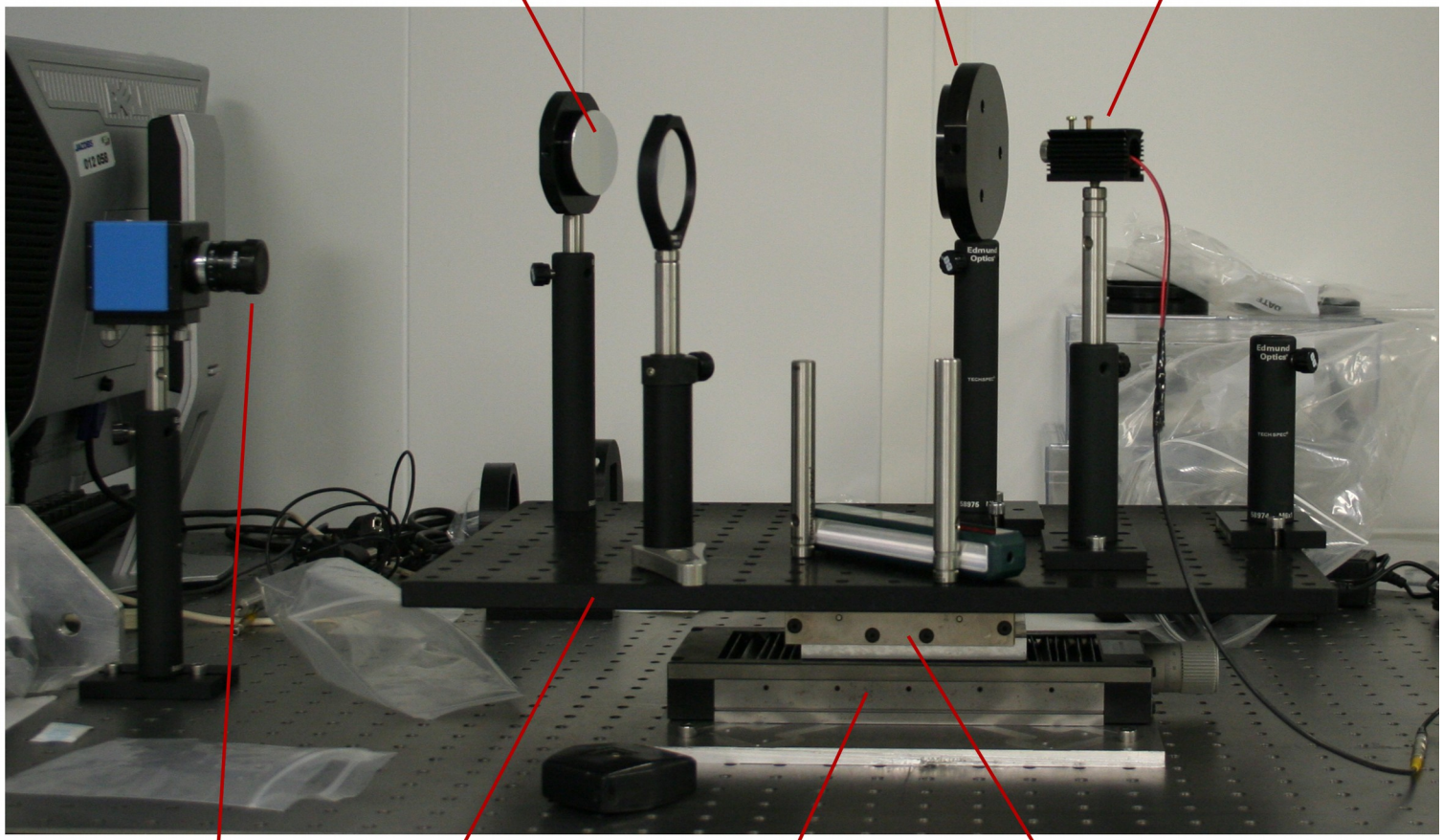
- **Goal :** measure **atmospheric absorption** by extracting **slit-less spectra** of **standard stars**
- Fast switching between imaging / spectroscopy modes
- Optical element **parallel to the CCD plane** to be put in one slot of the **gratings wheel**
- **Standard gratings** :
  - **Defocus** with the **diffraction angle**
  - Not designed for a **convergent beam**
- Proposal : a tailored **Holographic Grating**
  - **All wavelengths are focused (1st order)**
  - Limited distorsions
- **Prototypes tested at CTIO par M. Moniez *et al.***
- Needed **: a testbench to characterize the produced holograms**



Convergent beam : optical setup

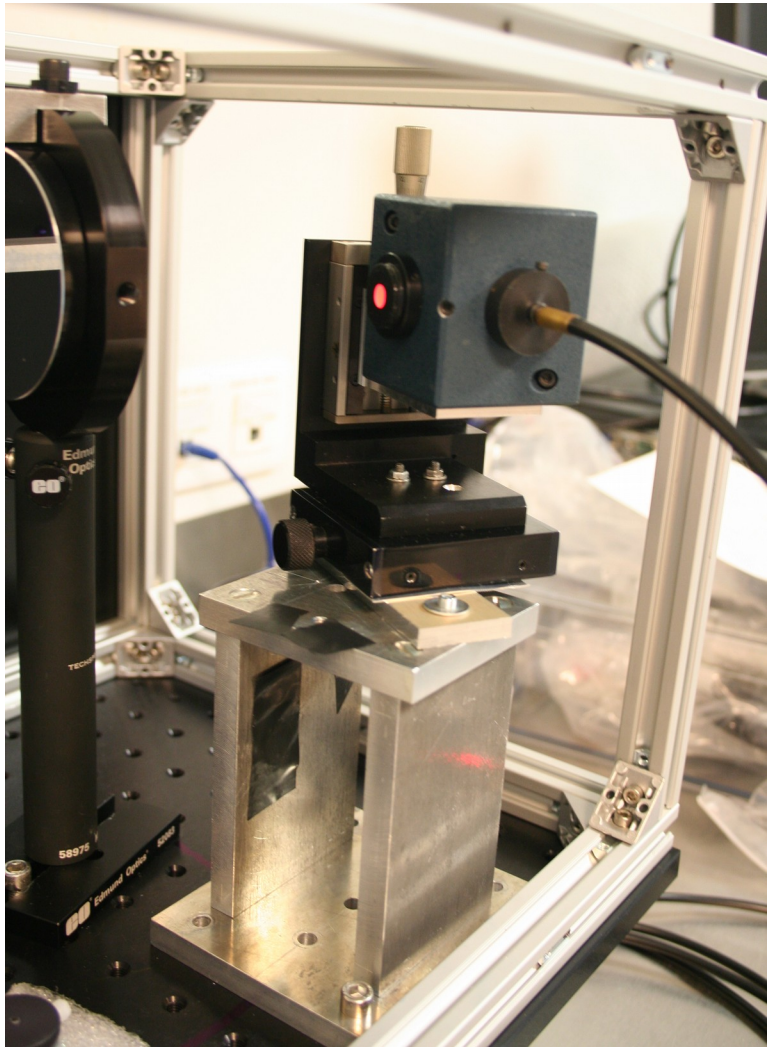


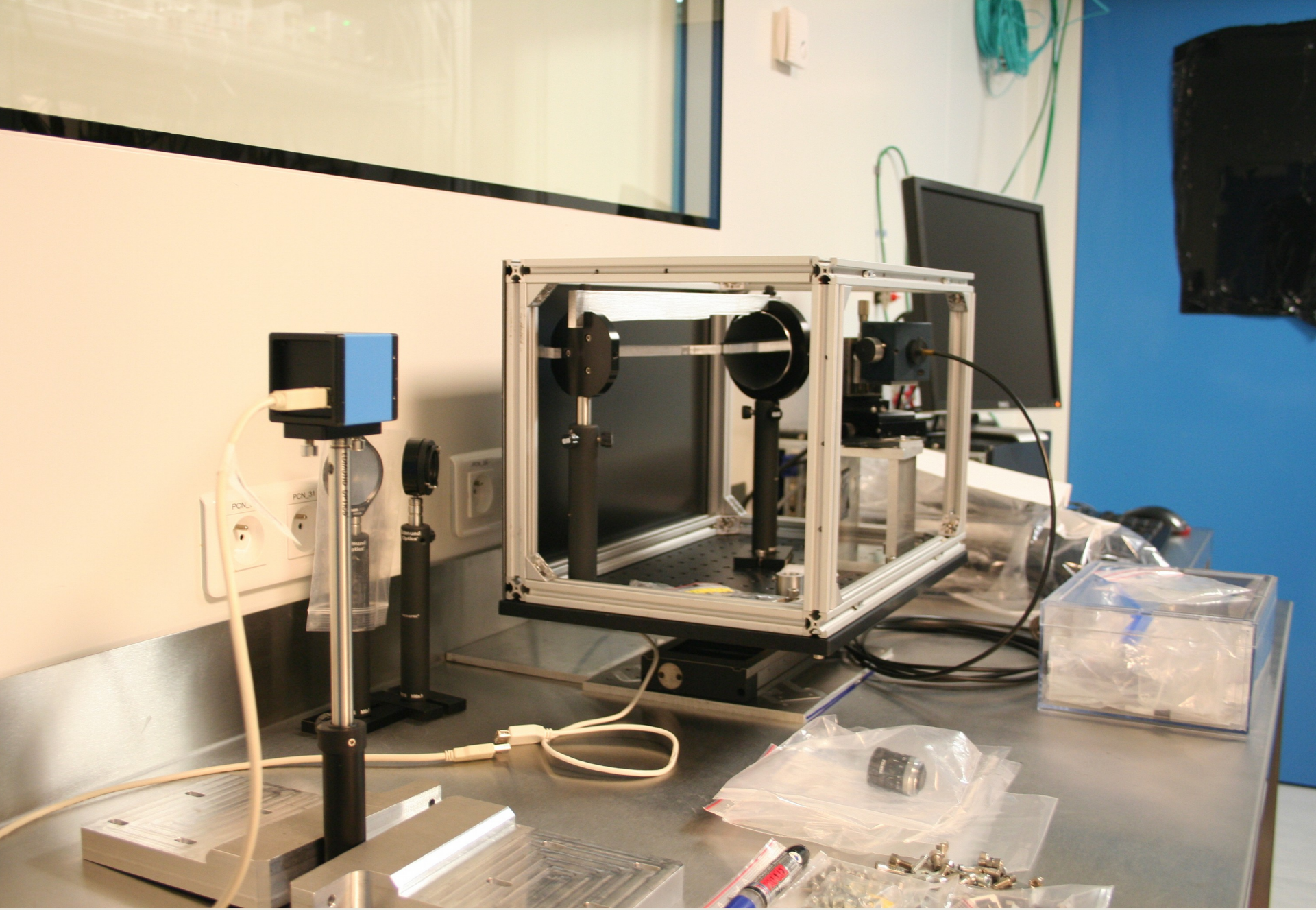
Convergent beam : optical setup



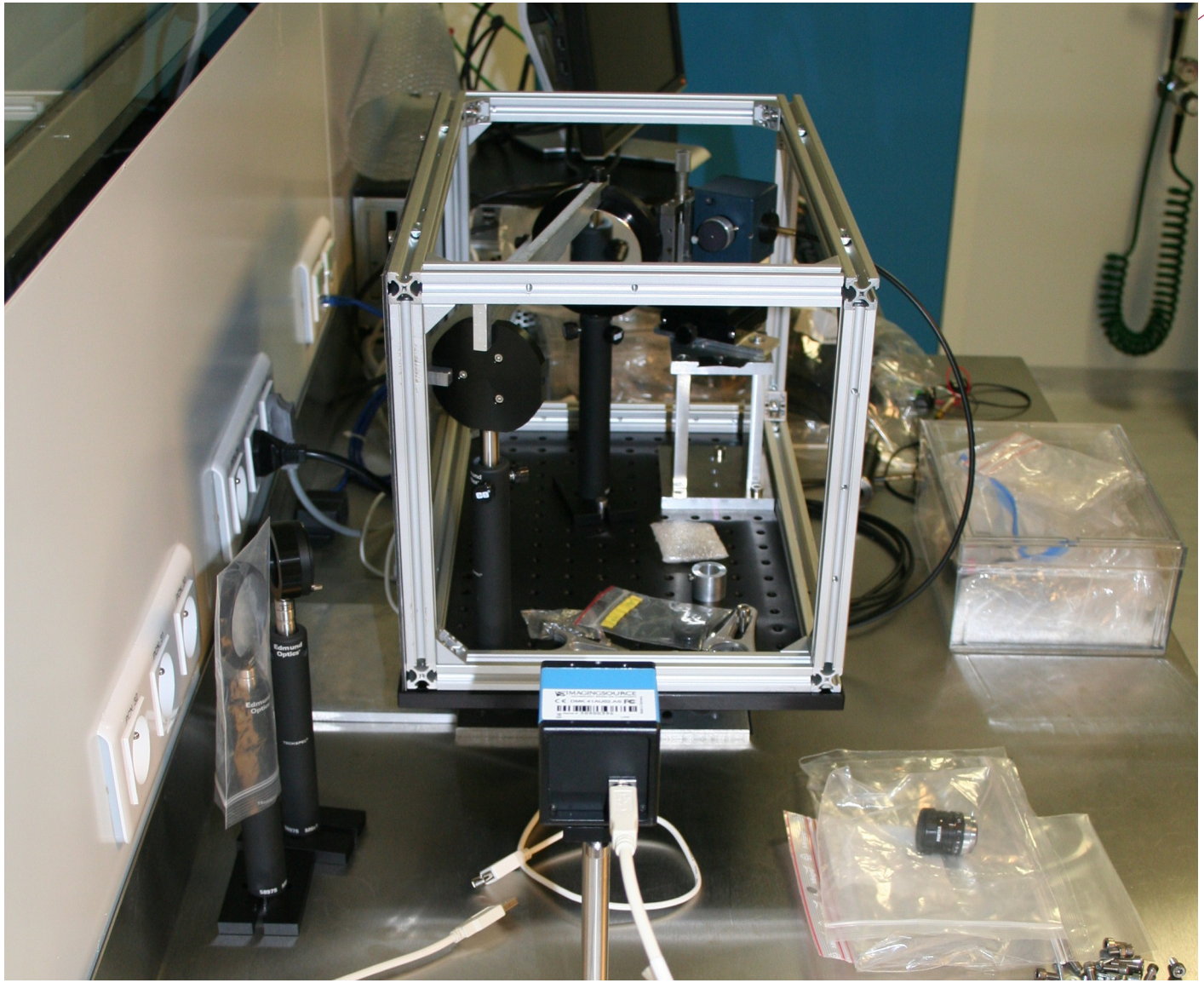
Convergent beam : optical setup

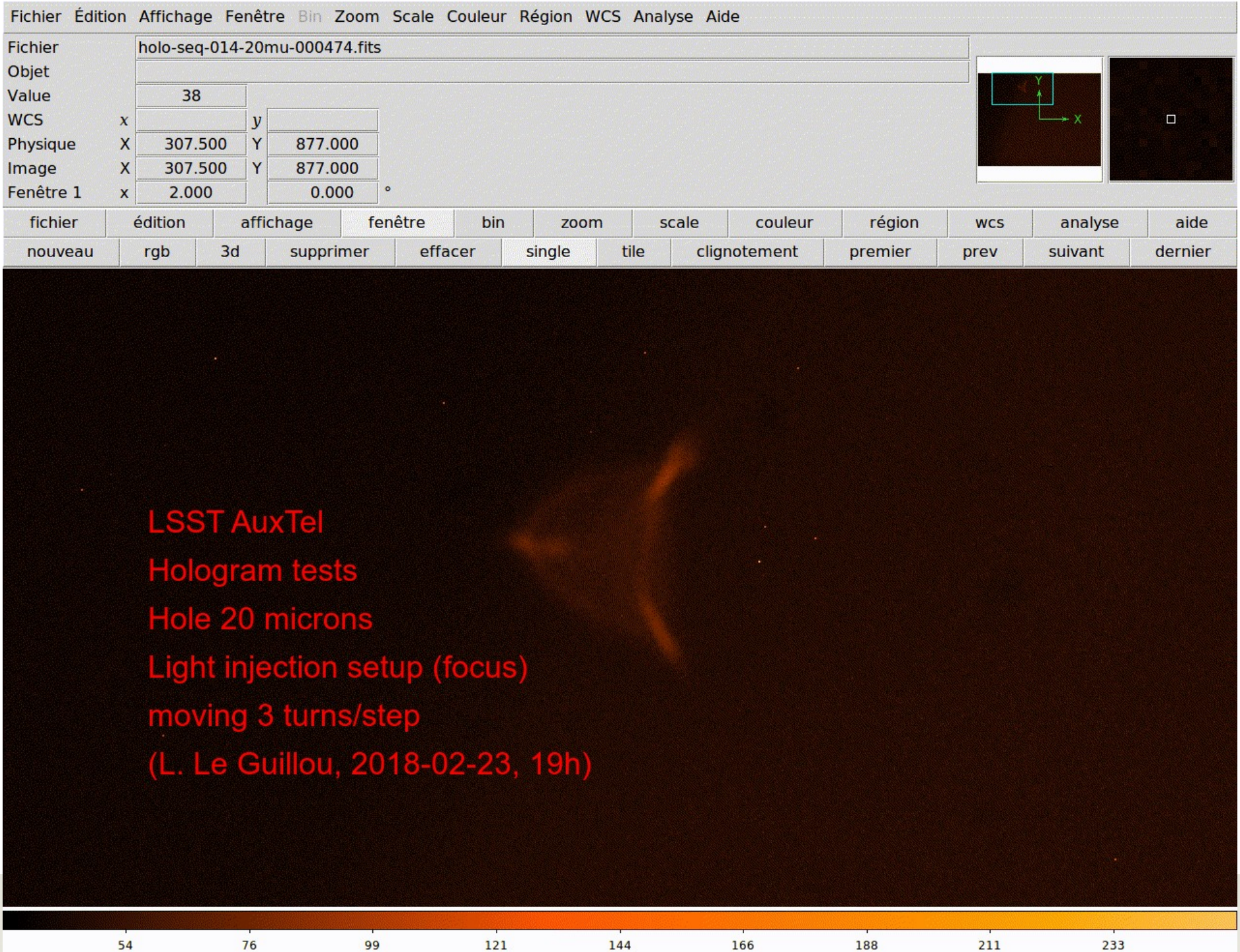
- Source : **integrating sphere**
- **Fiber fed** :
  - Lamps : incandescent, LEDs, HgAr
  - Continuum (QTH) + monochromator
- Exit = mirror focal point :
  - → **pinhole** (20 microns)
  - → expected image 40 microns





Focusing

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Objet
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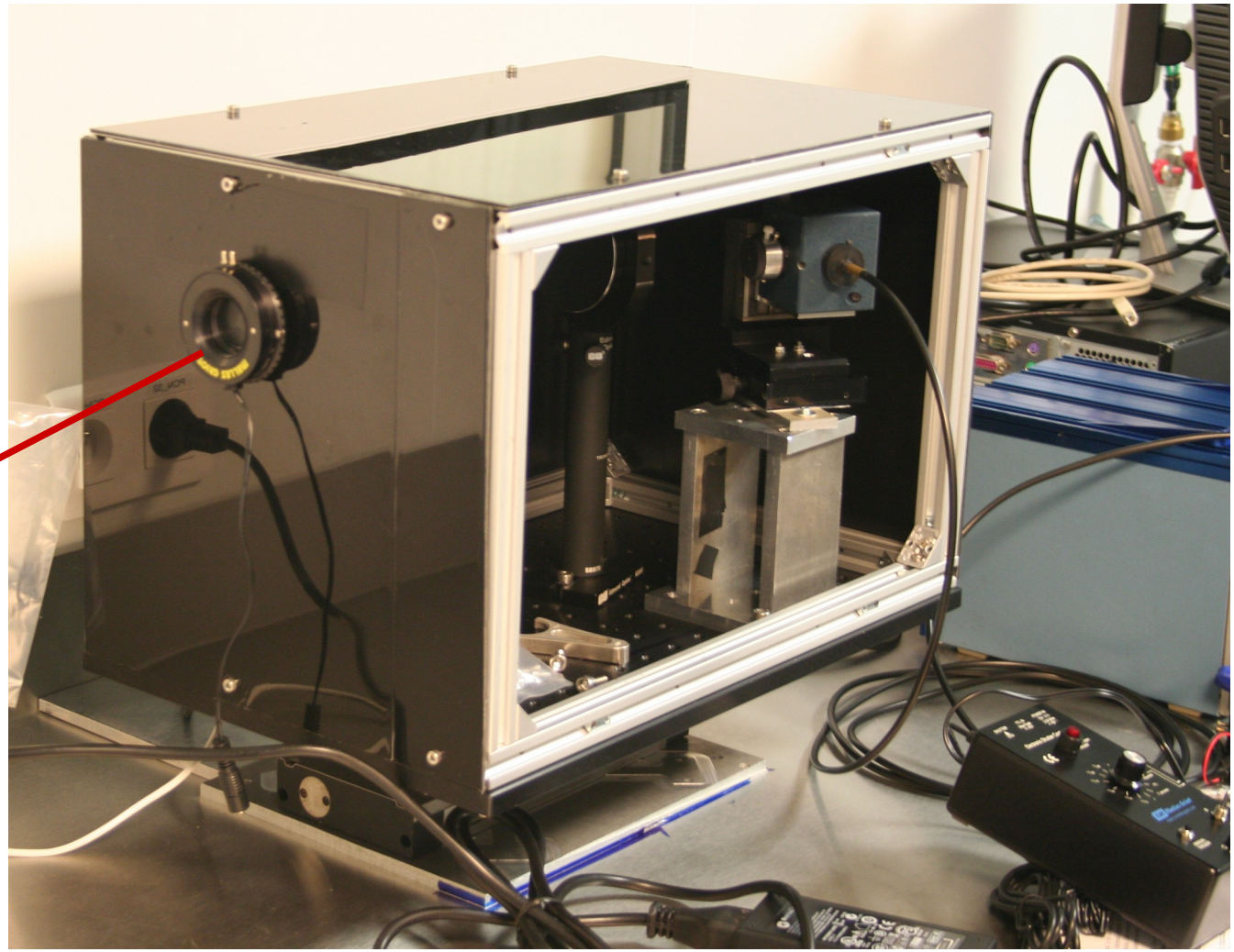
nouveau rgb 3d supprimer effacer single tile clignotement premier prev suivant dernier
LSST AuxTel
Hologram tests
Hole 20 microns
Light injection setup (focus)
moving 3 turns/step
(L. Le Guillou, 2018-02-23, 19h)
54 76 99 121 144 166 188 211 233

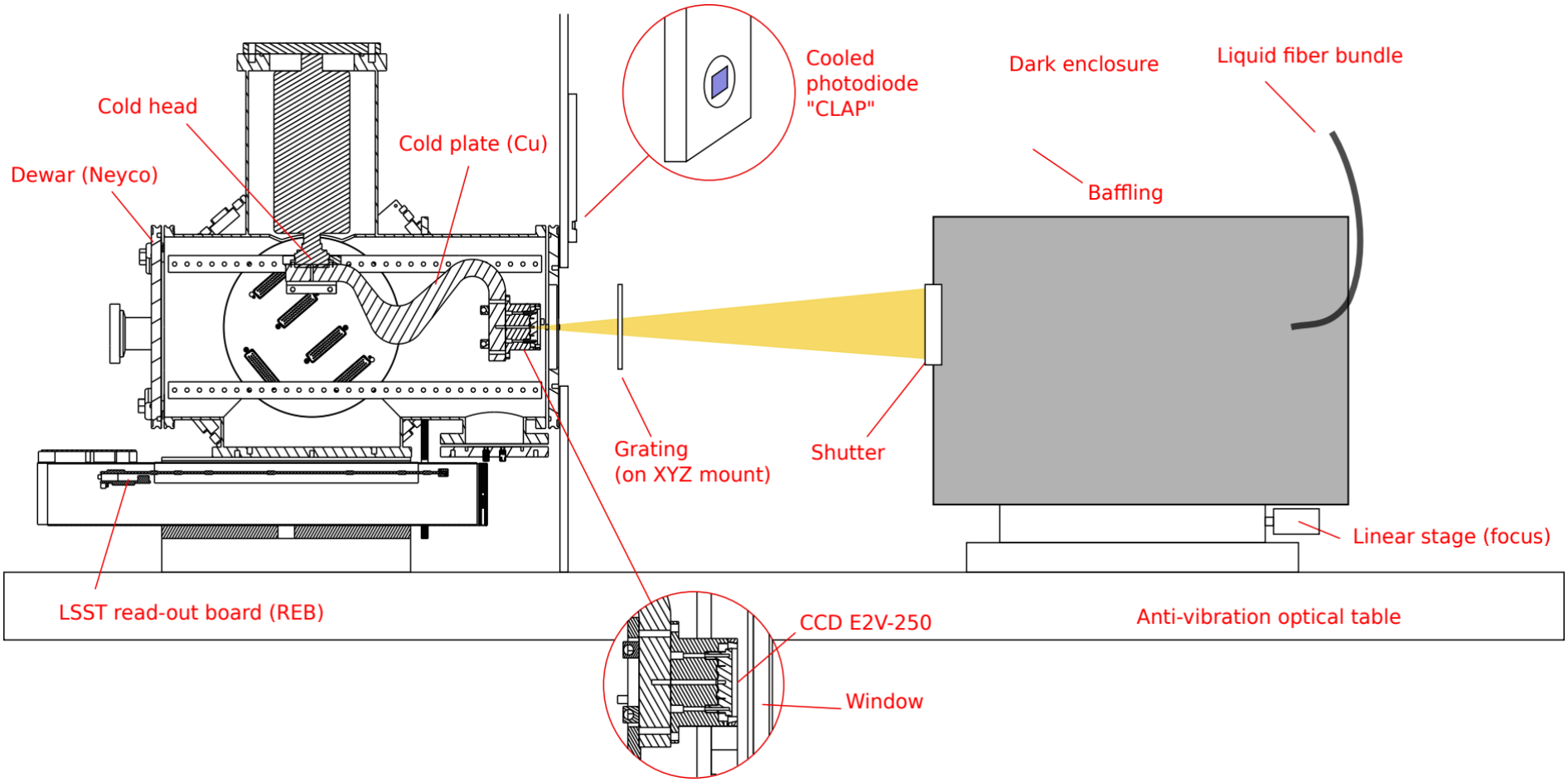
Baffling & shutter

- **Shutter** : **triggered** by the **LSST REB** (« SHU » line)
- Beam : f/15 to f/...

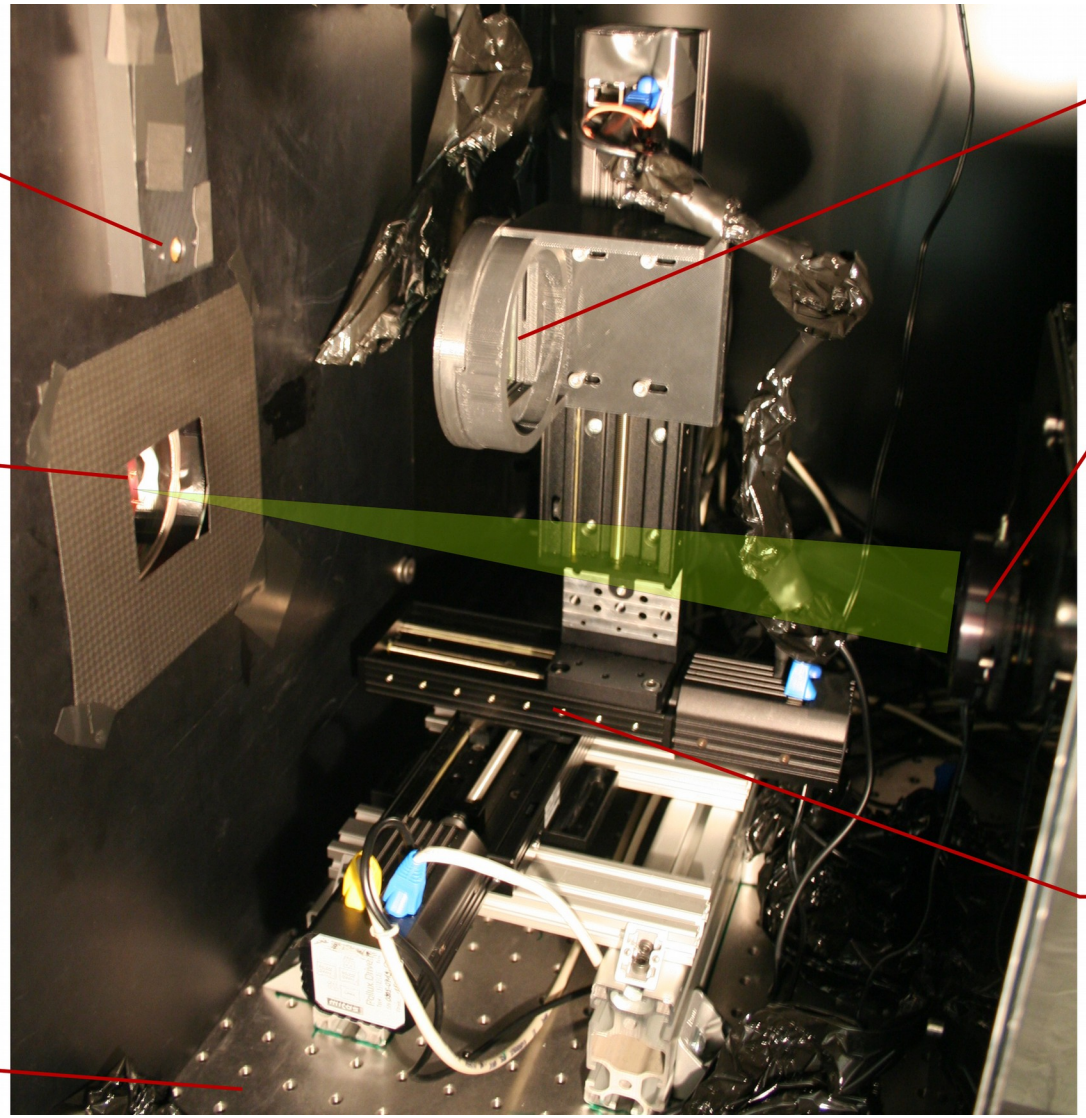
  (diaphragm)



Integration within the CCD testbench

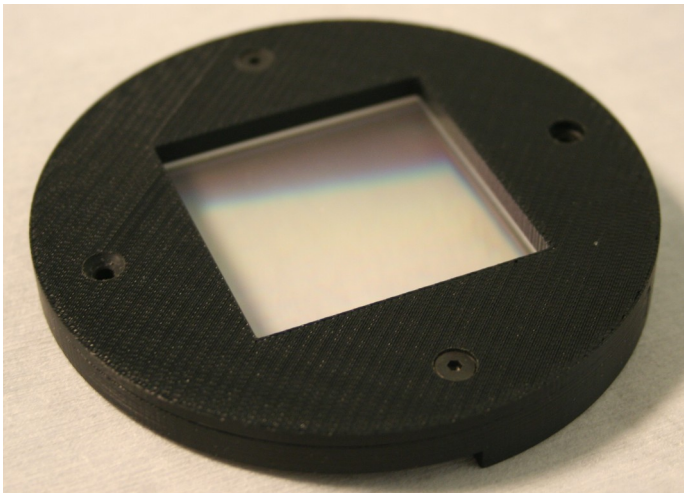


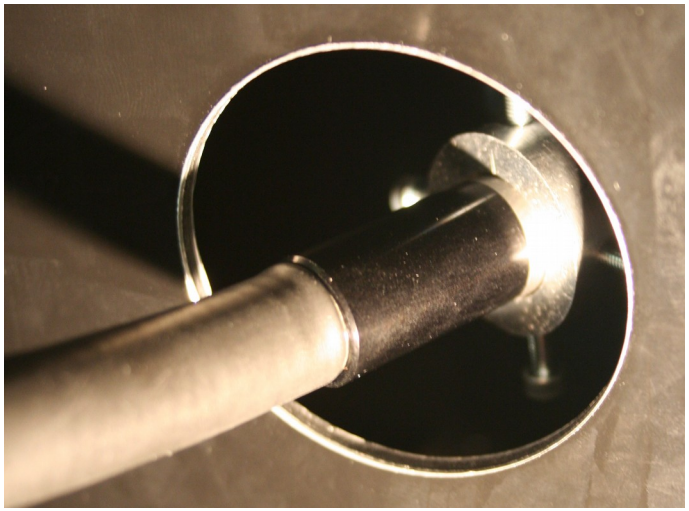
Integration within the CCD testbench



Integration within the CCD testbench

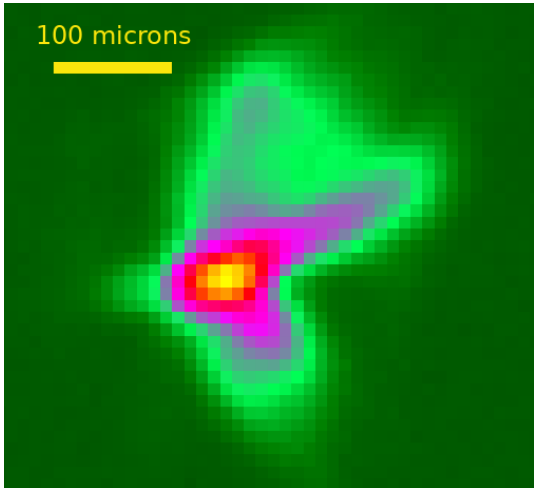
- Beam focused on the CCD E2V-250
- Frames read using the LSST REB
- Each grating to be characterized is mounted on a **3D printed removable support**
  → easy to exchange gratings on the setup
- The illuminator system is **fiber fed** :
  - Liquid fiber bundle fed by a **monochromator** and a continuum lamp → **wavelength scans**
  - Hg(Ar) PenRay lamp (Oriel 6035)
    → **focusing performance**
- XYZ motorized mount (0.4 microns resolution) :
  - **Precise positioning** of the grating in the beam
  - **Throughput / diffraction efficiency** : obtained by taking frames while **moving the grating in / out of the beam**

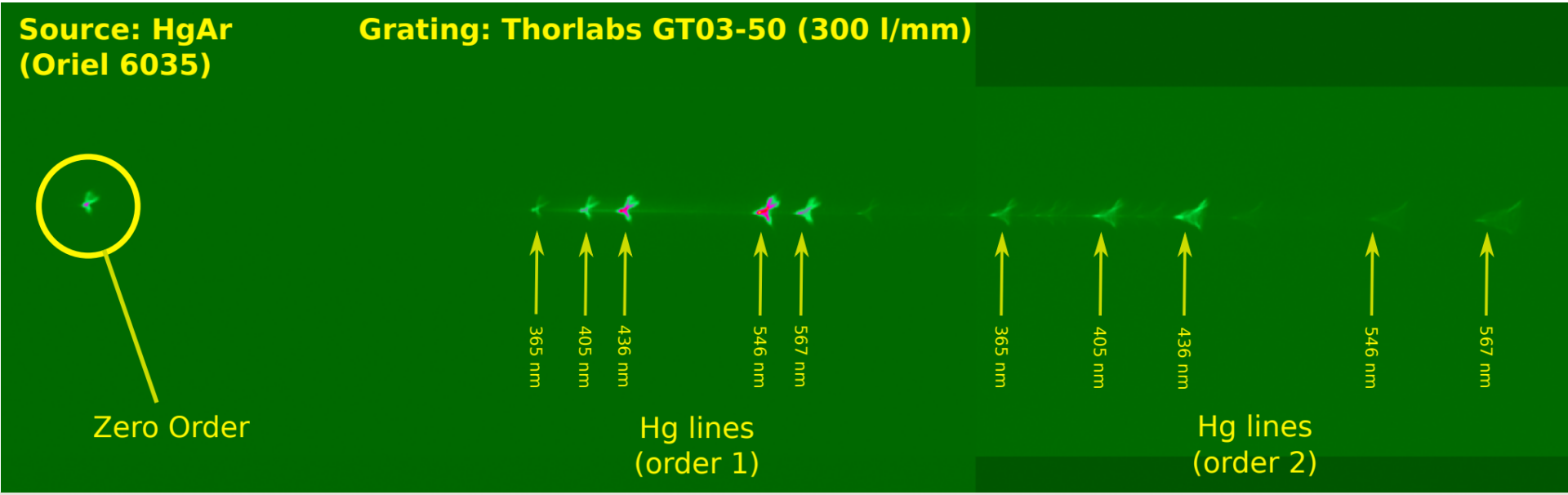




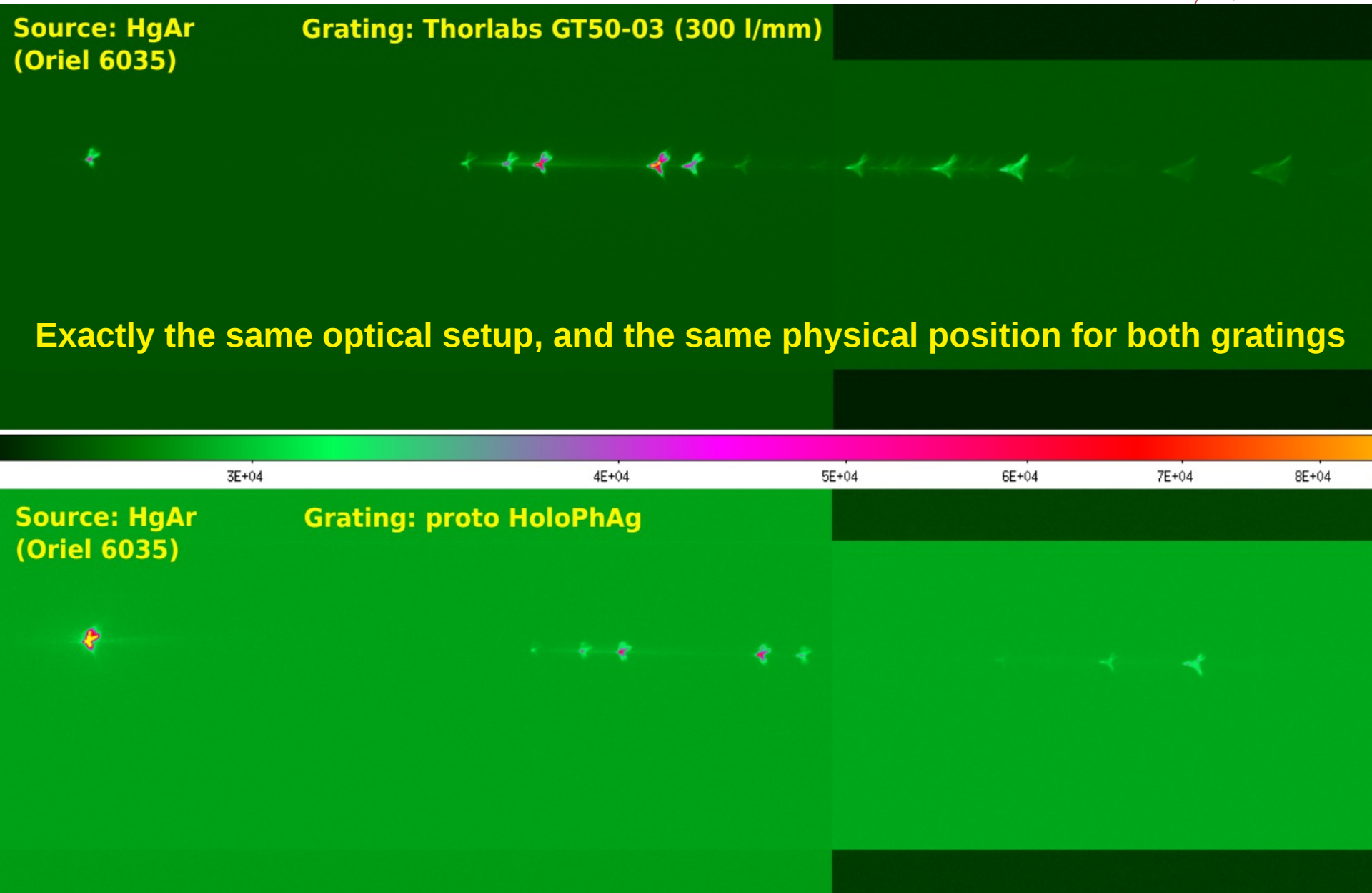
Test with Thorlabs GT50-03 grating

- Grating : blazed transmission grating, GT50-03, 300 g/mm
- Light source : PenRay Hg(Ar) *(Oriel 6035)*
- **Defocusing** with **increasing wavelength** clearly visible
- Our PSF is not circular, as we already know
- Small enough compared to AuxTel expected seeing

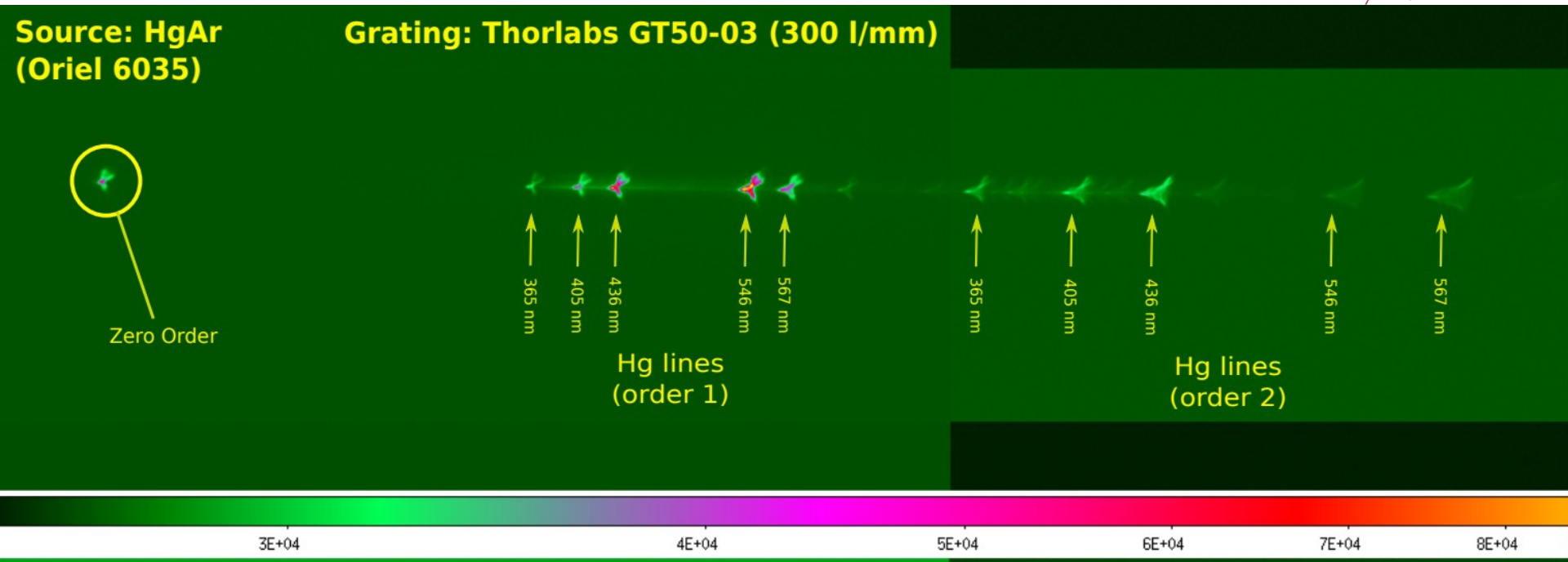


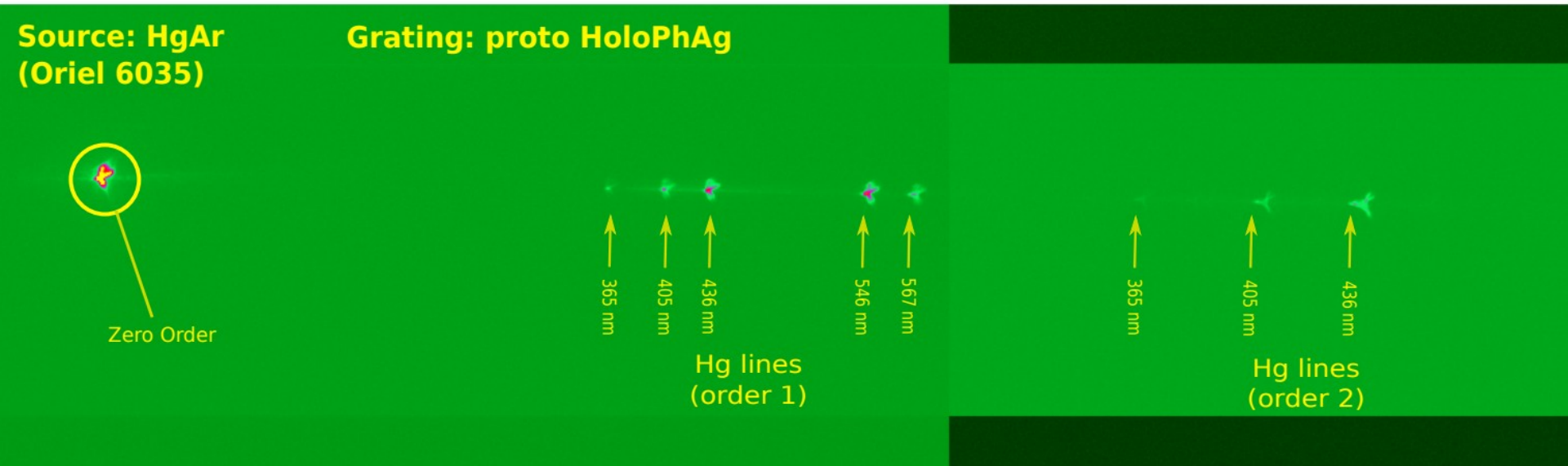


Focus : GT50-03 vs. hologr. HoloPhAg



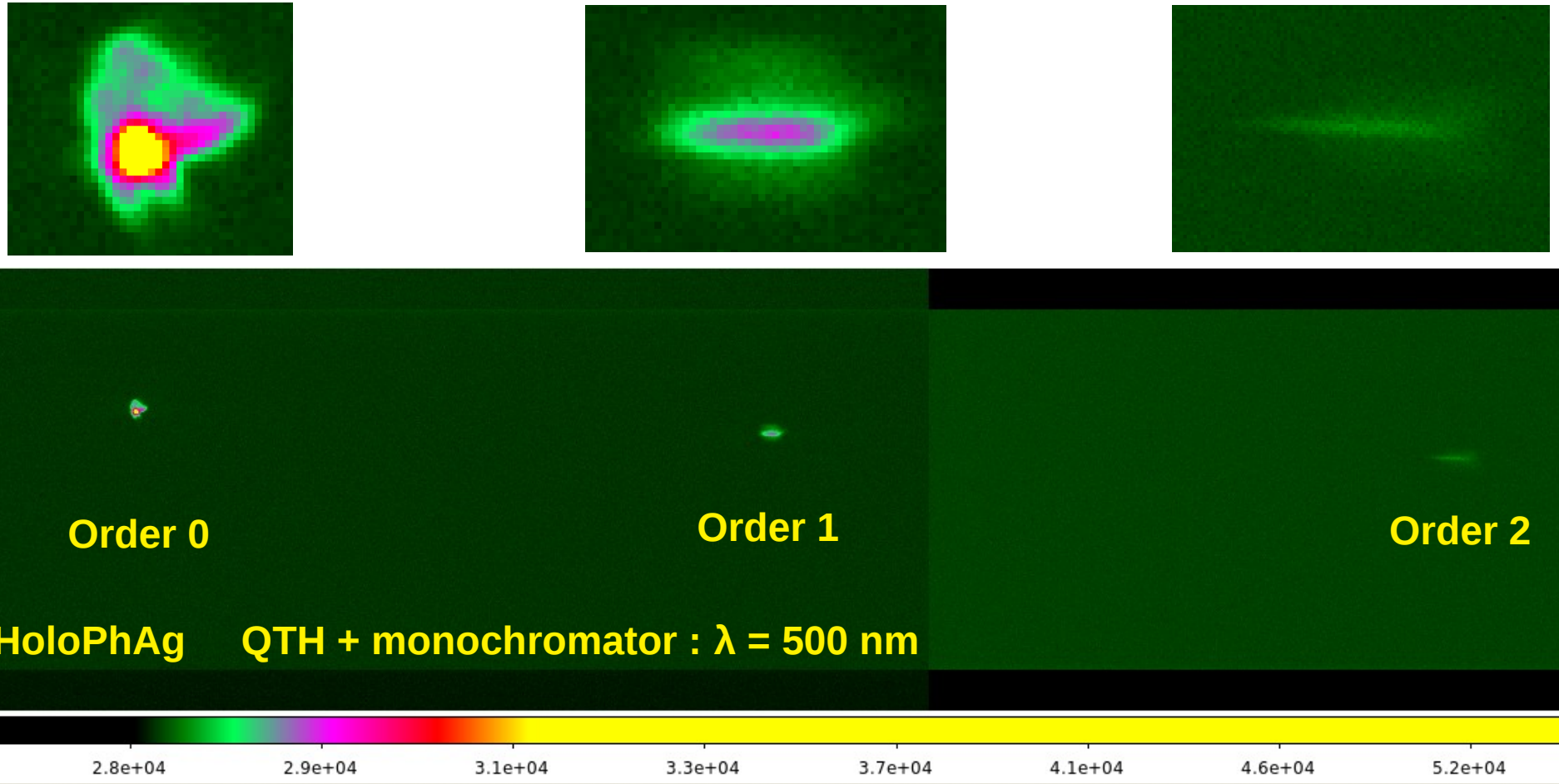
GT50-03 vs. hologram HoloPhAg





Throughput (efficiency)

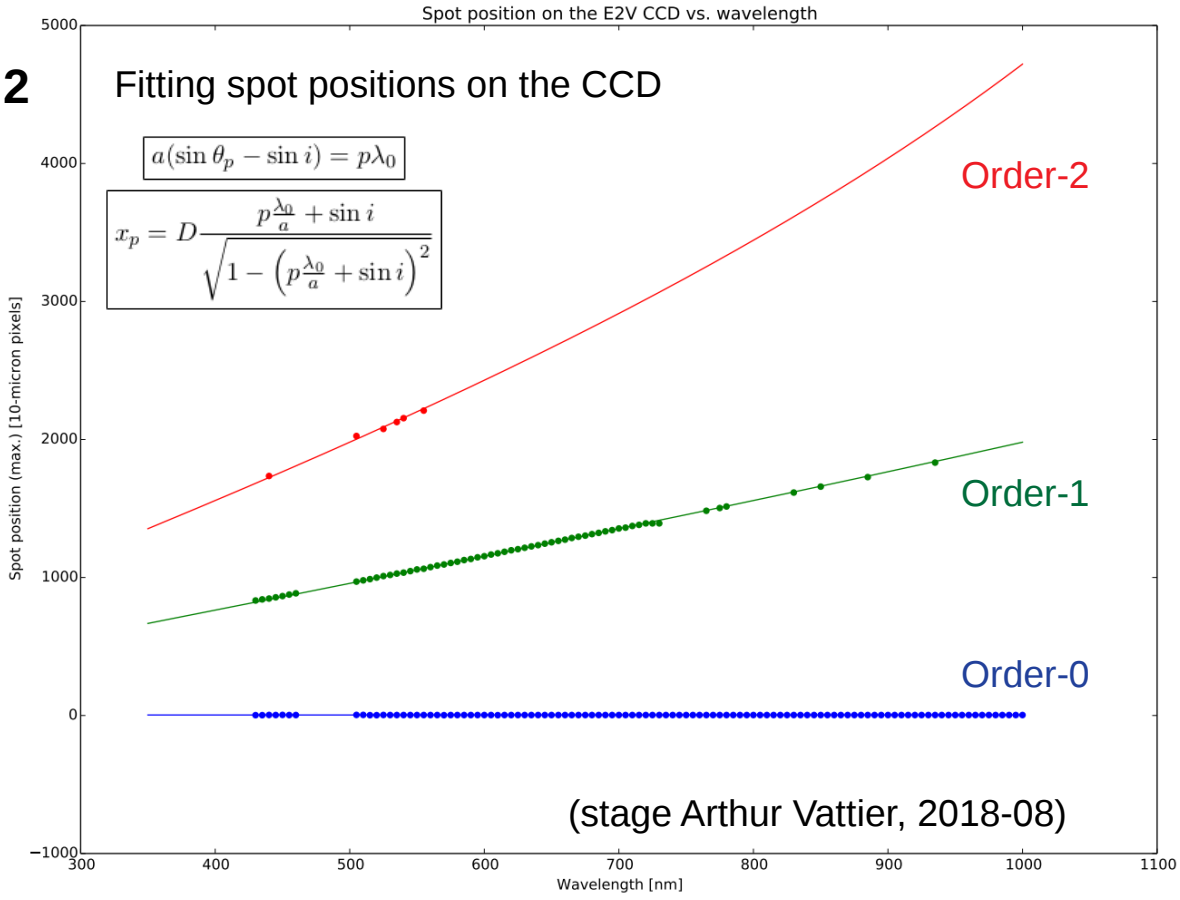
- **Scanning in wavelength** with QTH lamp and monochromator ;
- **XYZ mount : grating in the beam / out of the beam** : ON / OFF CCD frames



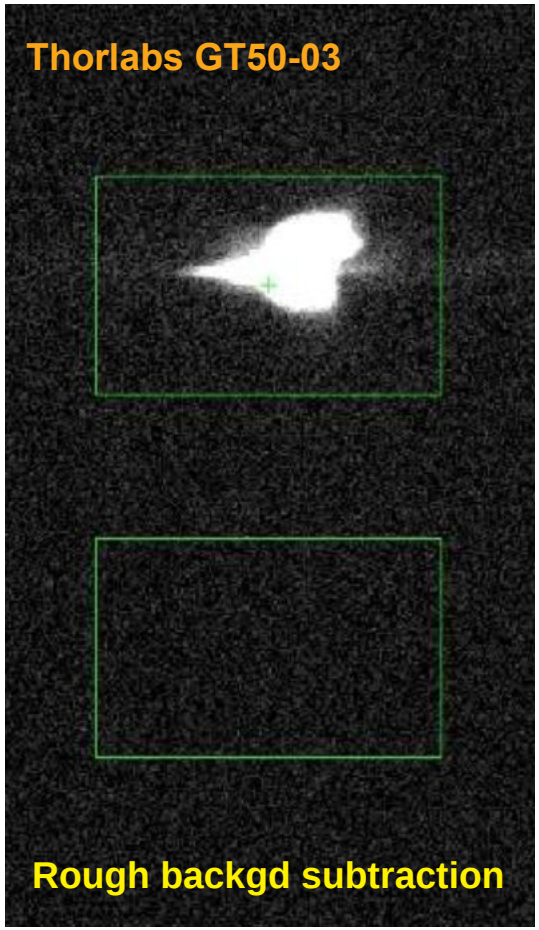
Gratings diffraction efficiency: analysis

- Scanning in wavelength with QTH lamp and monochromator ;
- ON / OFF CCD frames
- **Aut. detection of orders 0, 1, 2**
- **Fitting** spot positions
- Estimating the **total flux** (box) for each order (subtr. backgd)
- Estimating the Ratio :

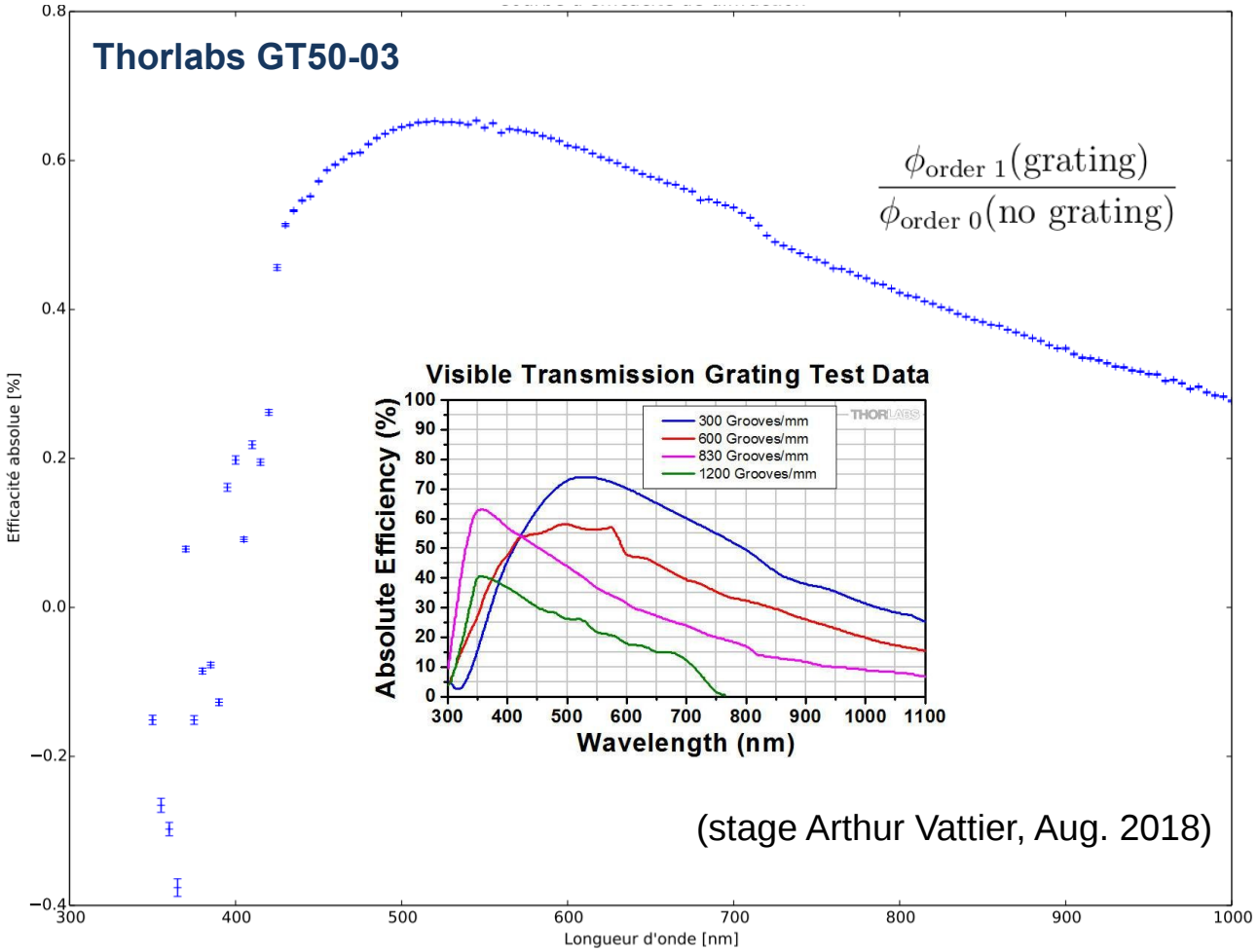
$$\frac{\phi_{\text{order 1}}(\text{grating})}{\phi_{\text{order 0}}(\text{no grating})}$$



Diffr. efficiency for Thorlabs GT50-03



Ratio : order-1 (grating) / order-0 (no grating)

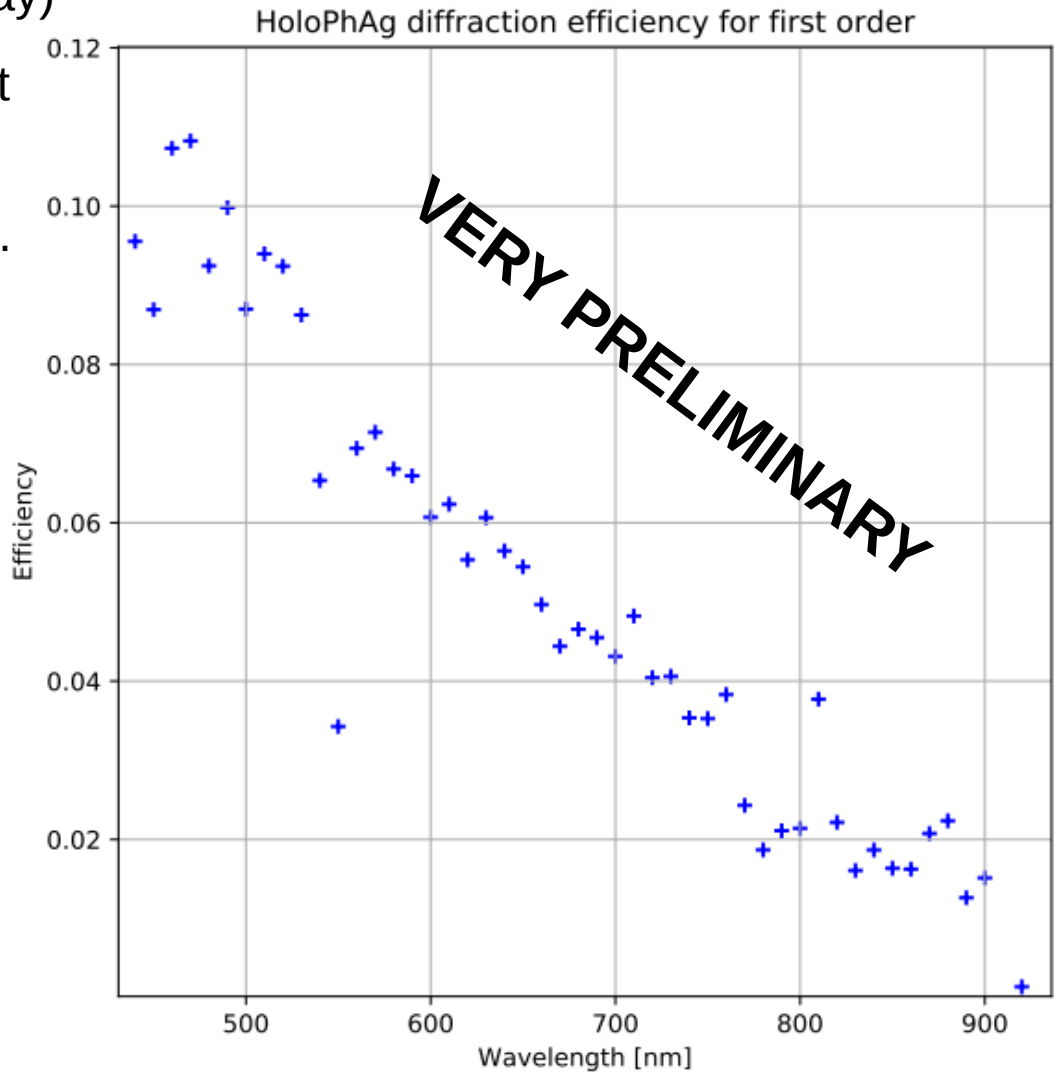


(stage Arthur Vattier, Aug. 2018)

Diffr. efficiency for HoloPhAg proto.

- **Very preliminary** result (yesterday)
- QTH lamp bulb **is dying** ; no light
- No flux in UV/blue, will use powerful (500 W) Hg(Ne) instead.

→ Still some work to do...



Conclusion : Work in Progress

- A **dedicated testbench** built at LPNHE to **characterize holographic gratings**, candidates for the AuxTel instrument
- Validated with an ordinary grating (GT50-03) and **holographic prototypes used at CTIO**
- **Data analysis to be completed**
- Will be used to **characterize all the holographic prototypes**
- Goal : measuring throughput / diffraction efficiency for each grating
- To be continued...