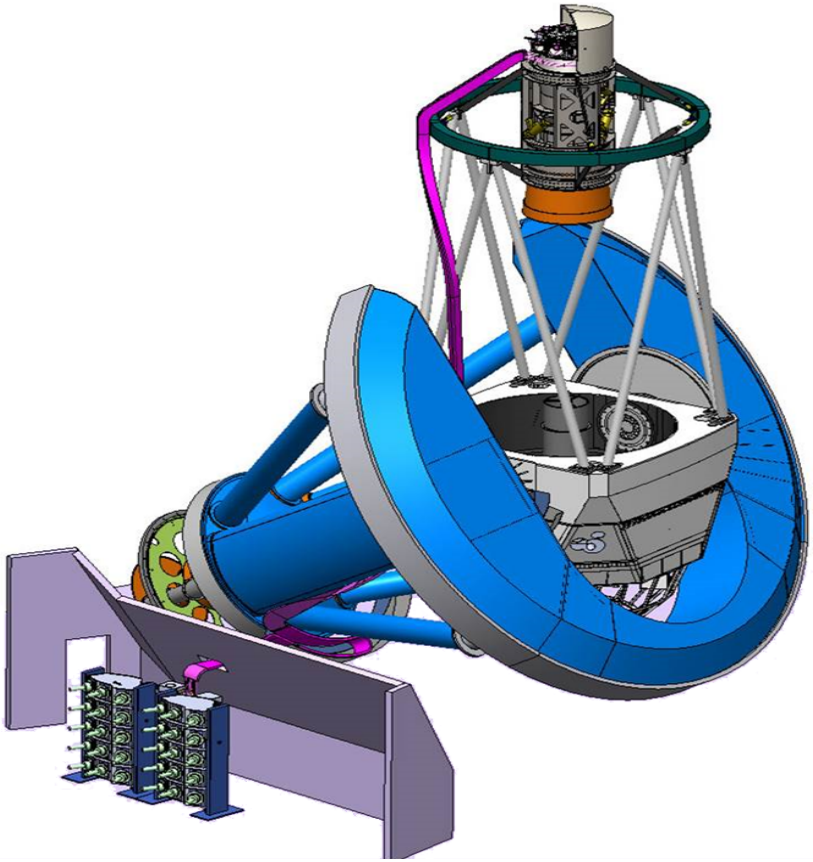


in-situ Calibration System: status

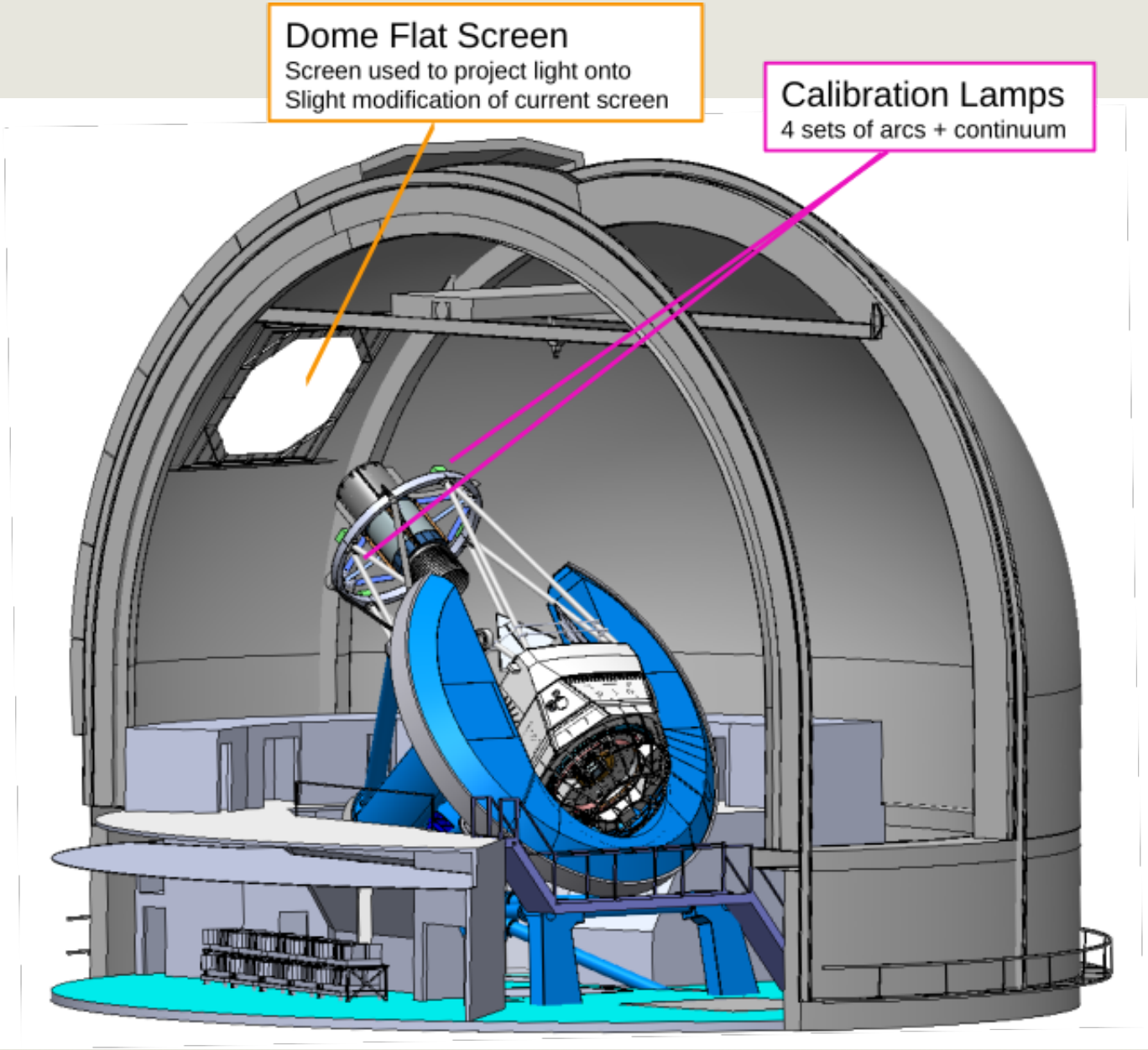
Laurent Le Guillou (UPMC/LPNHE)
Sonia Karkar (IN2P3/LPNHE)
Julien Guy (IN2P3/LPNHE)

DESI Spectrograph Telecon
Nov. 21st, 2017

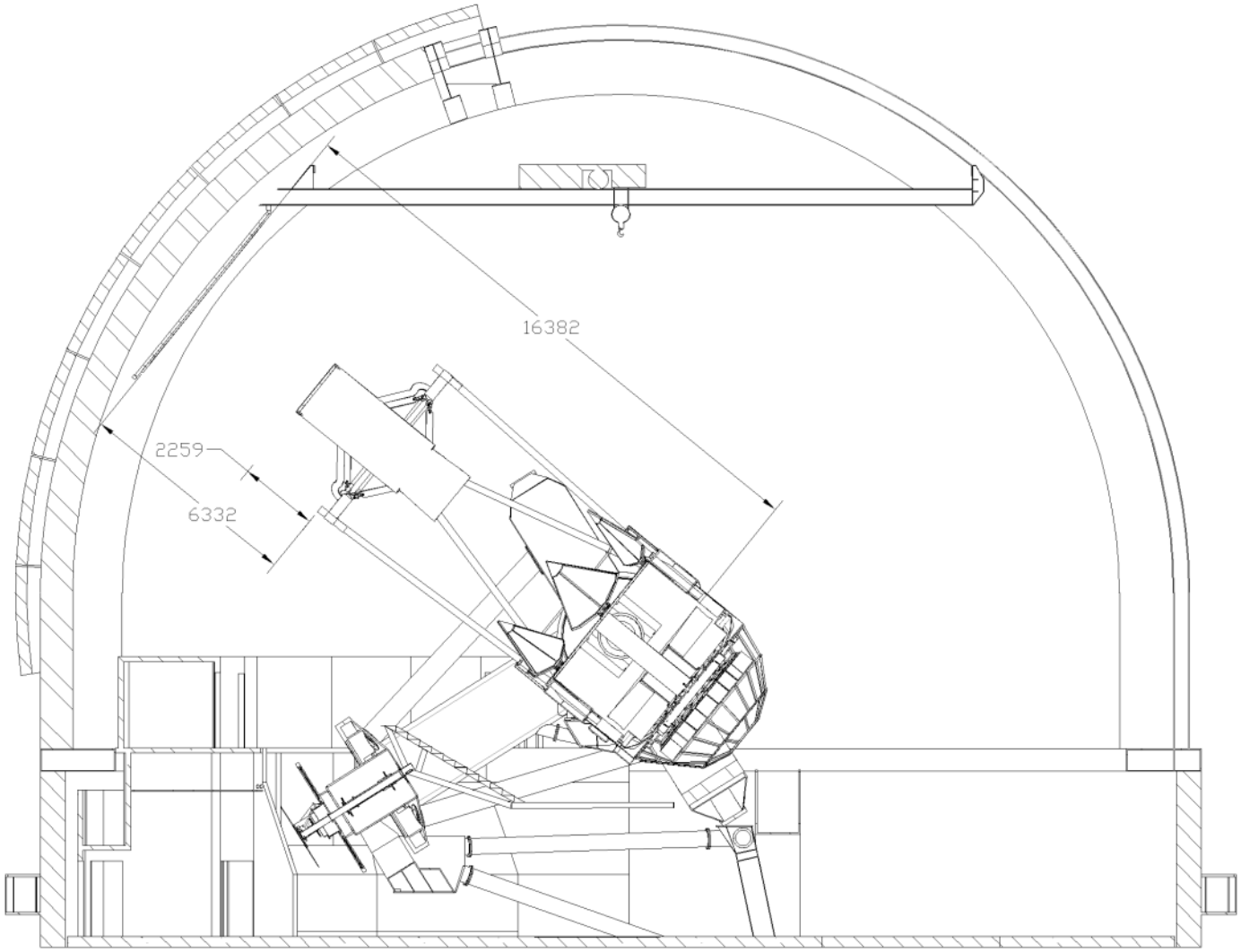
Christophe Balland, Julien Coridian, Patrick Ghislain, Julien Guy, Sonia Karkar (project engineer), Laurent Le Guillou

Talk outline

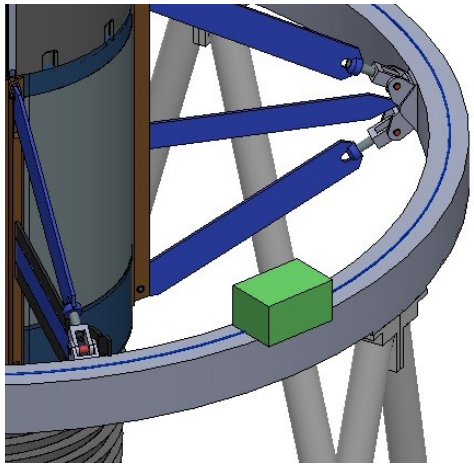
- **Overview**
- **Lambertian diffusion screen**
- **Calibration light sources (boxes)**
  - Boxes assembly
  - Tests plan
- **Planning**


Dome Flat Screen
Screen used to project light onto
Slight modification of current screen
Calibration Lamps
4 sets of arcs + continuum

Telescope and Dome dimensions



Rationale



- **Spectral lamps** to get the wavelength solution (CCD pixels to wavelength)

  → required : enough well separated atomic lines

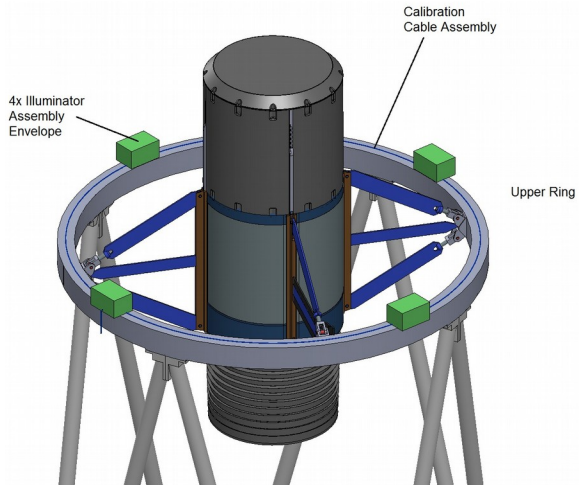
- **Continuum lamps** for flats (fiber to fiber uniformity)

  → required : a « flat » enough spectrum on the whole spectro range (350 – 1000 nm)

- **Spatial uniformity / pupil uniformity :**

  → 4 identical boxes on the upper ring

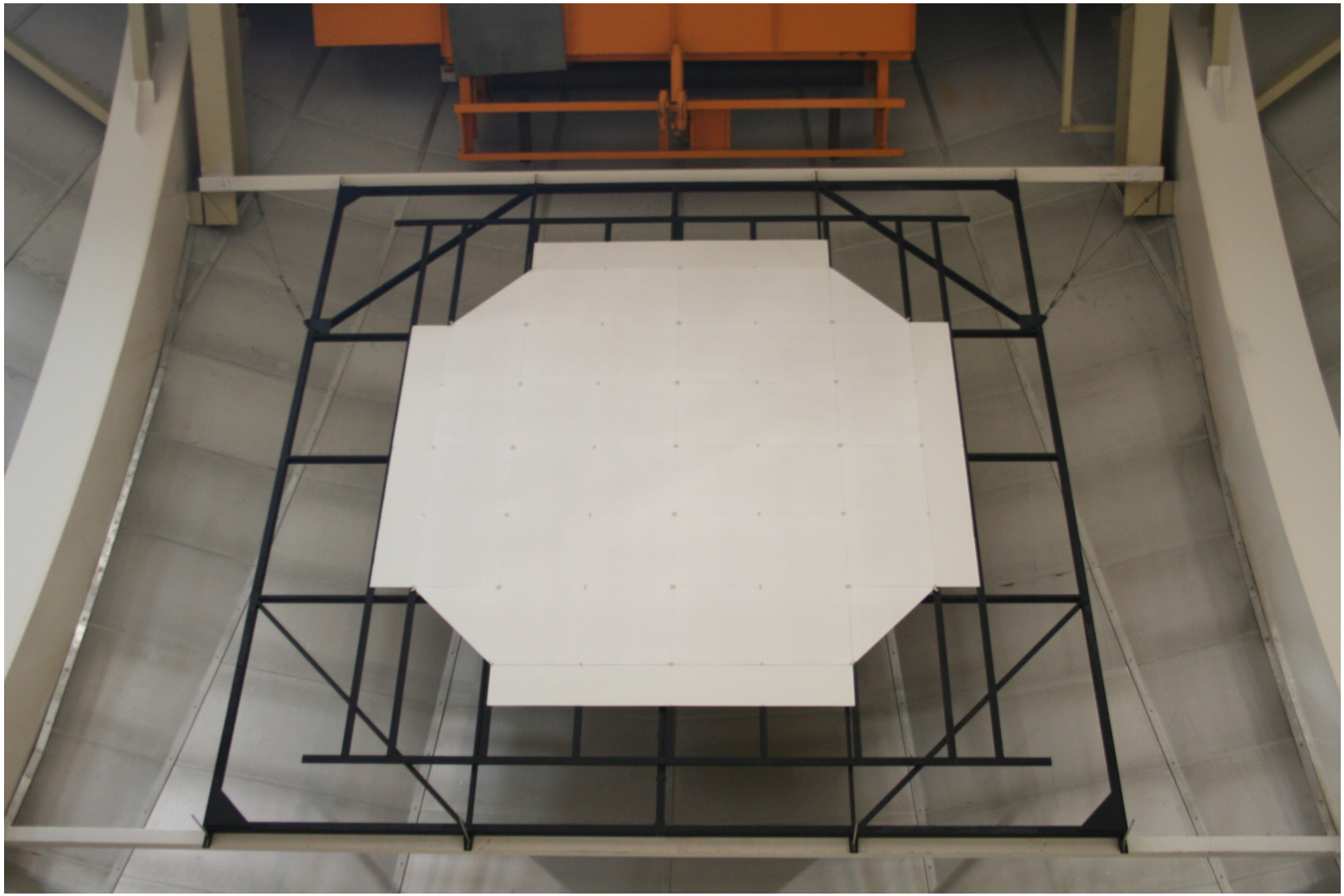
  → A quasi perfectly lambertian diffusion screen



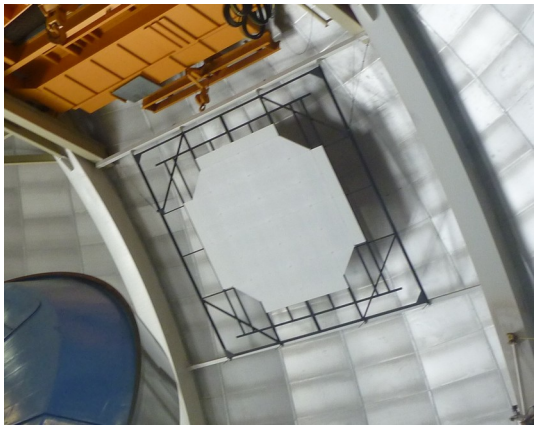
Calibration System Requirements (DESI-1067)

Req't Name	Requirement	Rationale	Verification method
Bandpass	360-980 nm	Required for z range of Ly-alpha QSOs and ELGs (DESI-0318)	Laboratory tests: measure lines lamps spectrum
Pupil Uniformity	**20%** (azimuthally averaged)	PSF stability of 3% req. IN.FBR-5013, (DESI-0581 v8)	Measured lamp luminance plus analysis
Field Uniformity	**5%** (relative to the telescope field response to a constant sky intensity)	ELG redshift efficiency and catastrophic failure rate unchanged	Measured lamp luminance plus analysis
Spectral Line Coverage	Wavelength calibration precision better than 0.15 pixel or 0.08 A (this requires "approximately" a max. **bright line separation of 40 nm**)	Required for accurate spectral extraction. (DESI-318)	Laboratory tests: measure lines lamps spectrum
Continuum flatness	Maximal spectral variation of a **factor 10 (max/min) in counts**	Calibration images above noise and below non-linear regime & brighter-fatter effect	Laboratory tests: measure continuum lamps spectrum

Dome Screen: the existing screen was too small

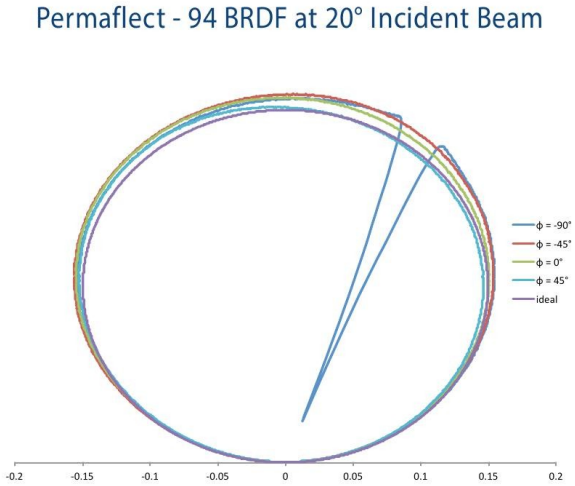


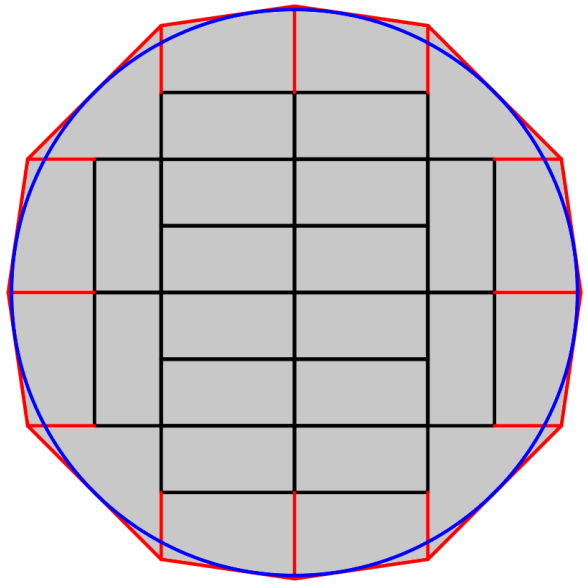
Lambertian Screen Upgrade

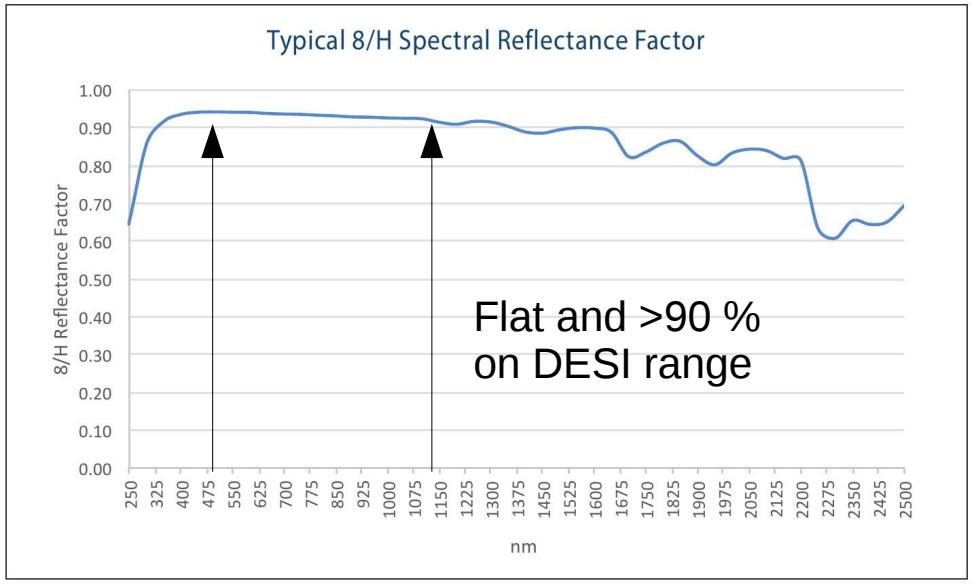


« Permaflect » coating :
→ Lambertian reflectivity

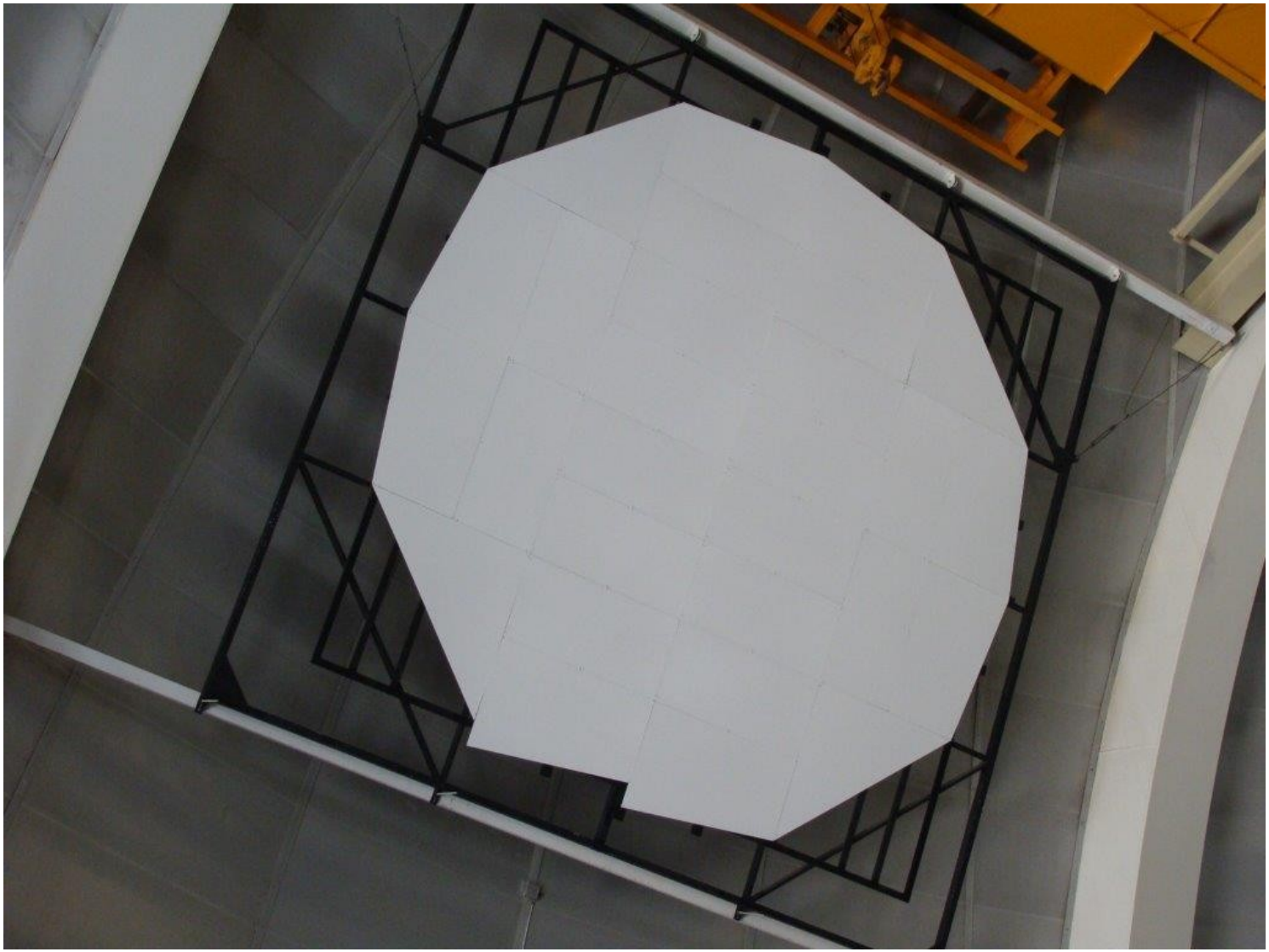
Replacing all panels for better uniformity



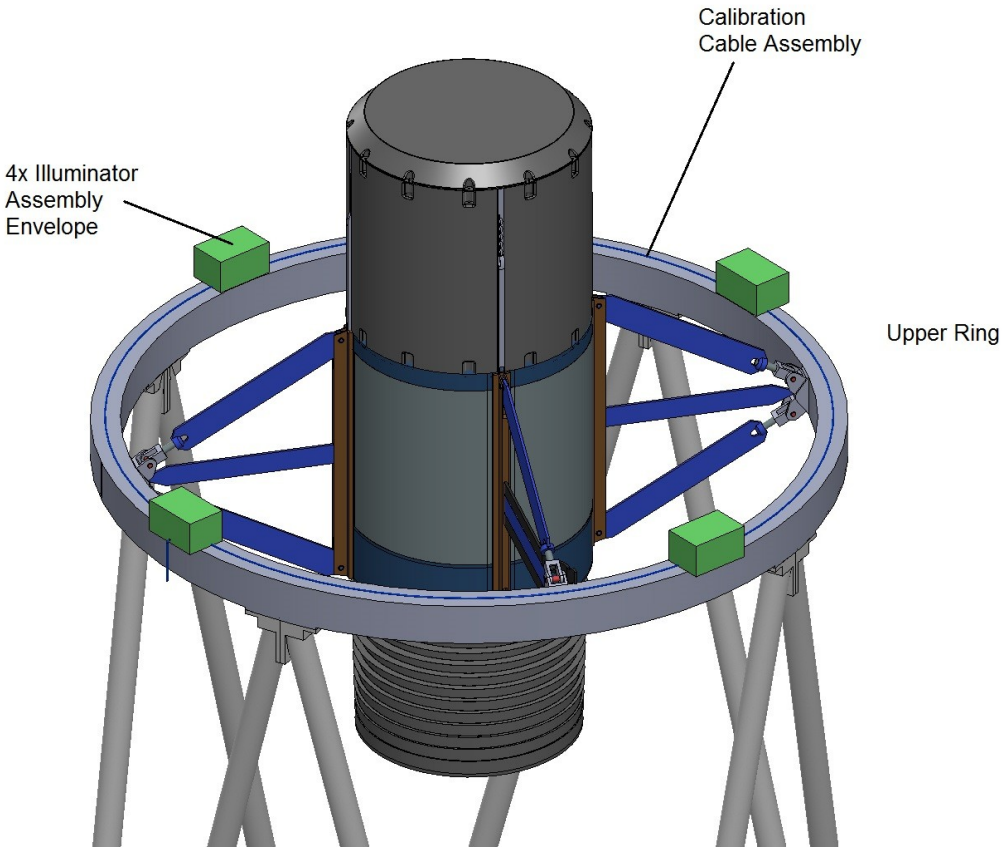


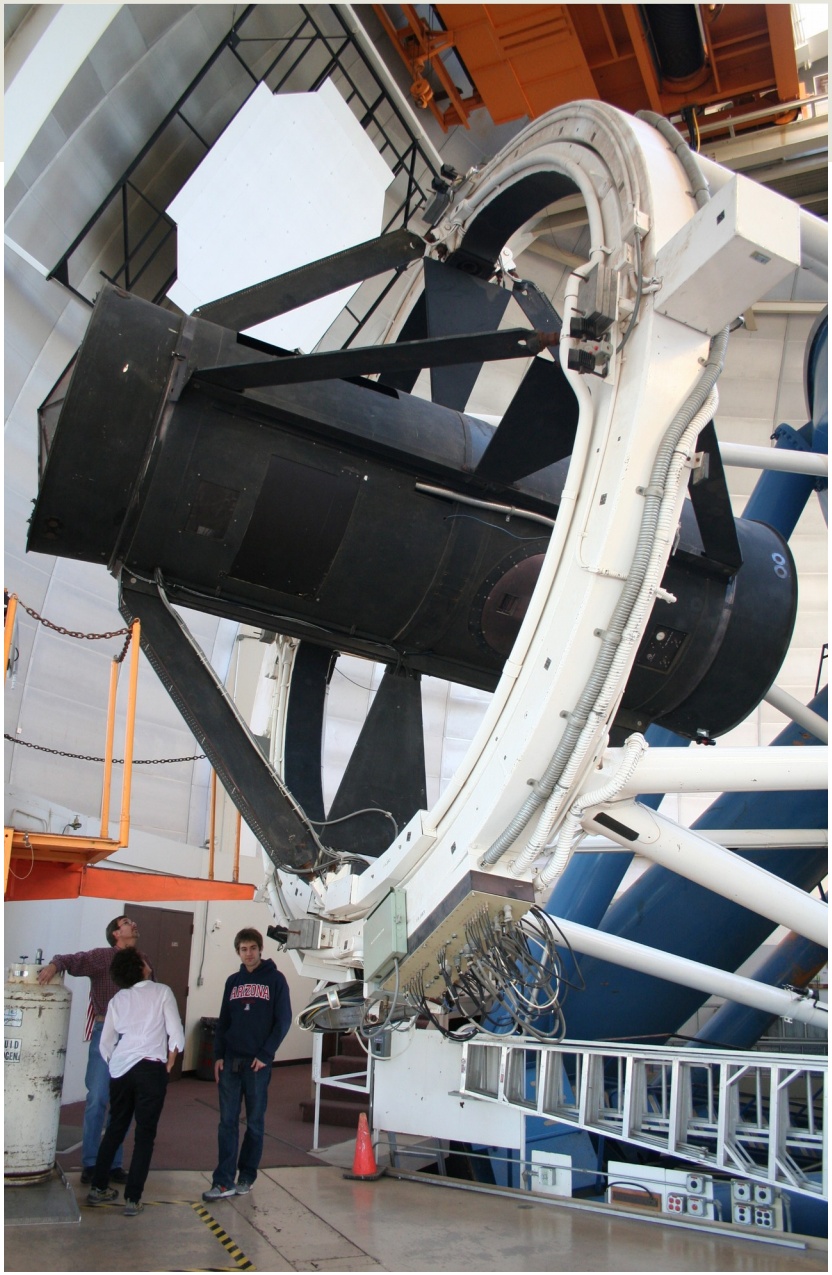


Larger screen installed at Mayall (panel fixed since)



Four Source boxes



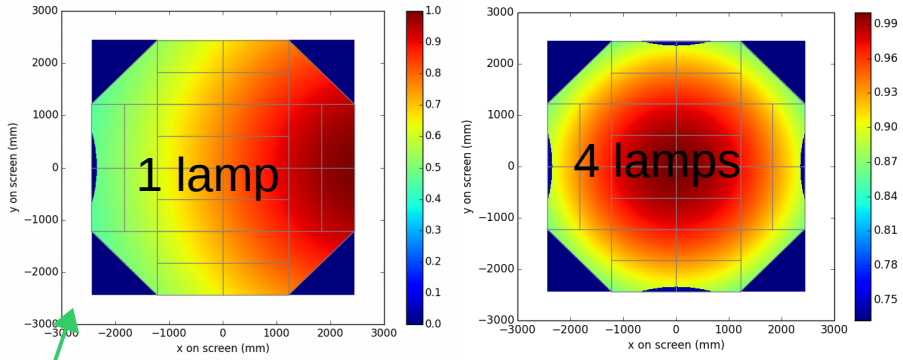


Four Sources Boxes should be enough

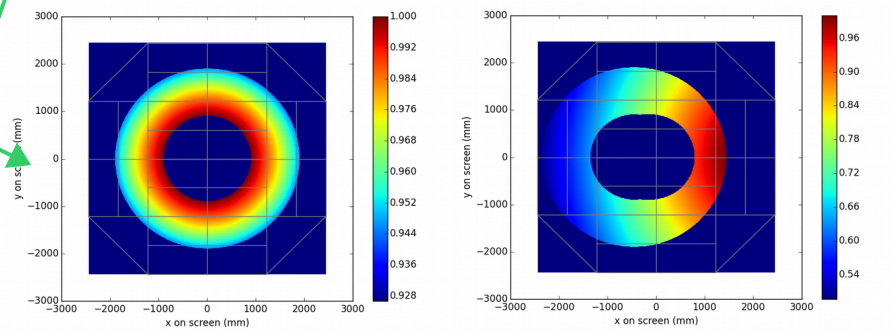
- First study by P. Jelinsky, using ray tracing ✓
  - Define need for 4 sets of lamps
  - Careful analysis of fiber to fiber uniformity

- New code (J. Guy), purely geometrical, interfaced with DESI model
  - Reproduce previous results ✓
  - Investigate effect of intensity variation of lamps *On going*

Screen illumination

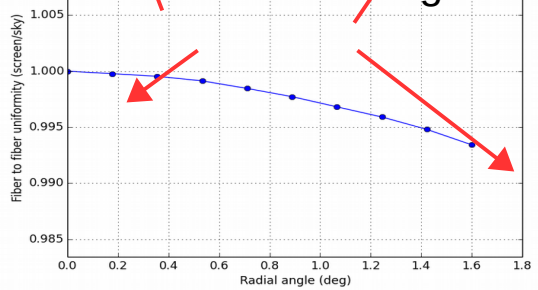


View from fibers



At focal plane center

1.6 deg off center



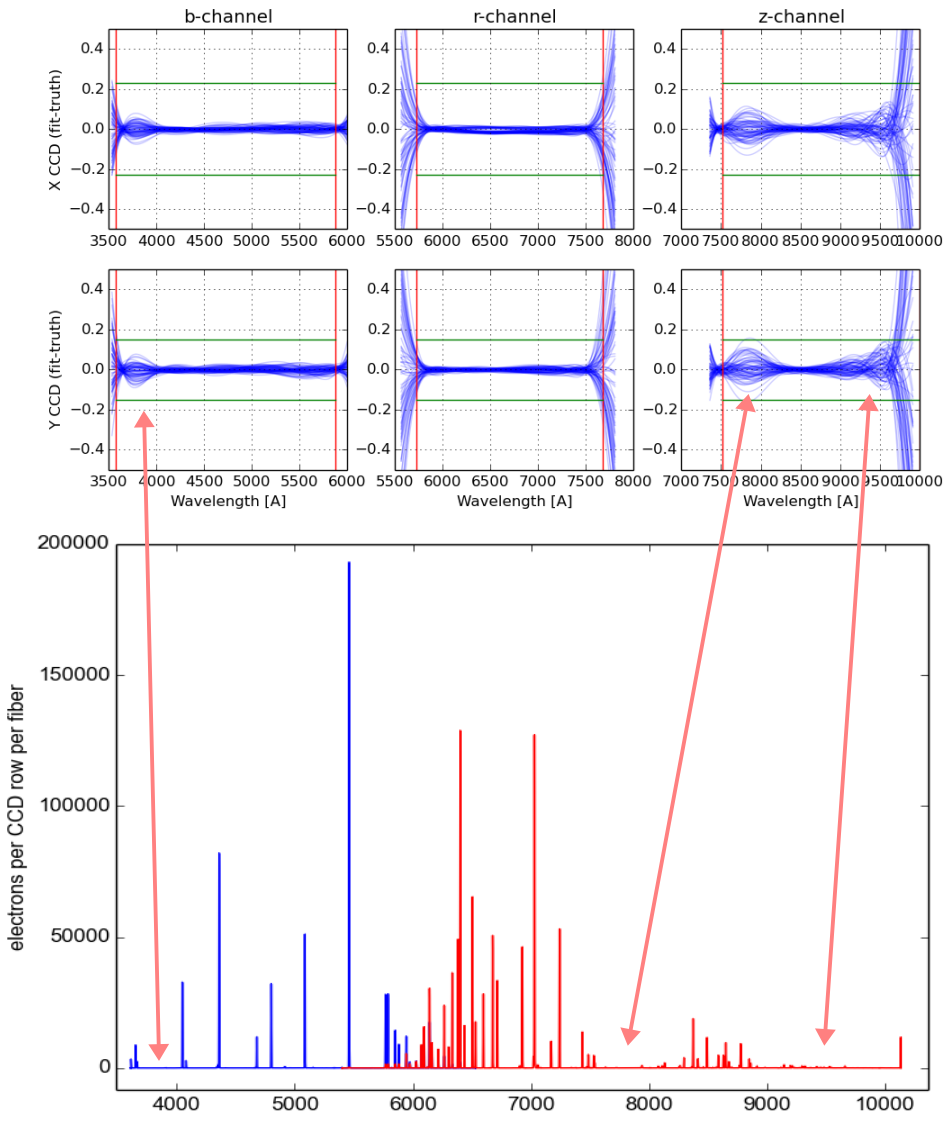
Spectral sources (arcs): spectral lines coverage

Impact the wavelength solution:

- Rough estimate with MC gives 40 nm max. spacing
- Example with third pipeline data challenge (DC3) of DESI and SDSS/BOSS lines

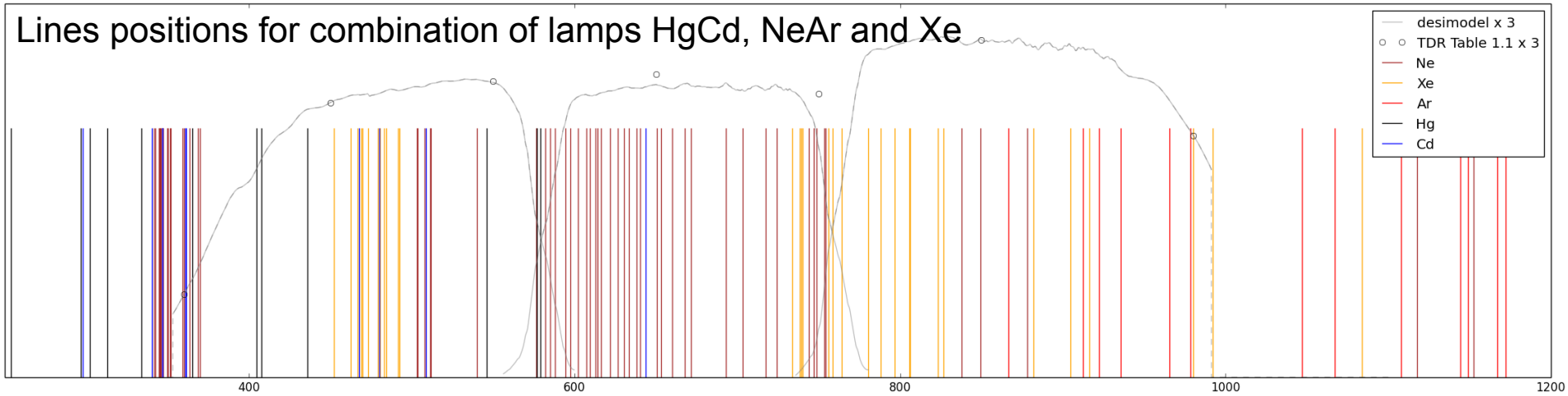
Lack of lines coverage affects the precision of the wavelength solution

combination of 5 lamps to get enough well separated lines: **Hg(Ar), Cd, Ne, Kr, Xe**



Spectral sources

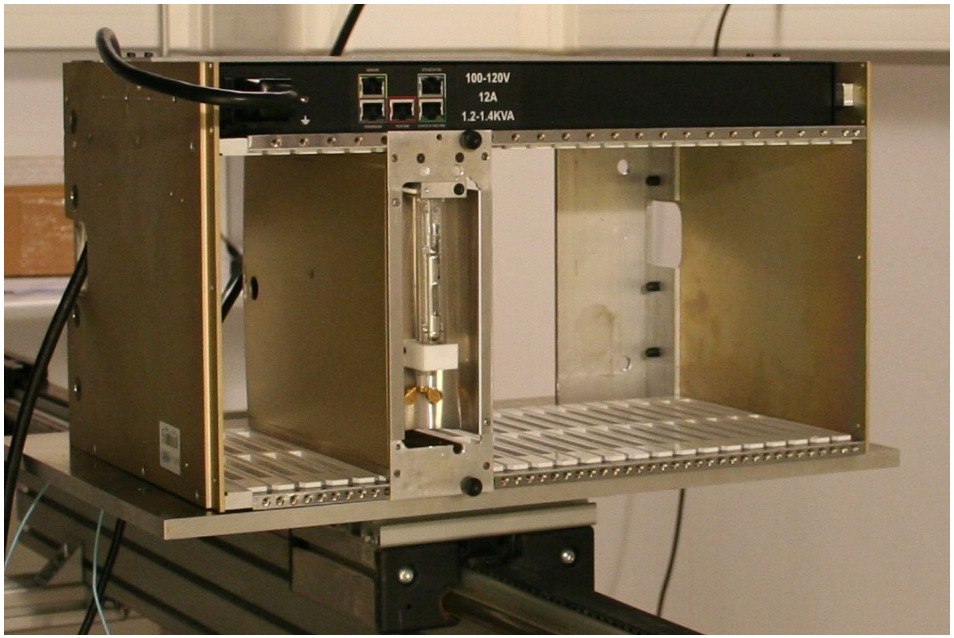
- Spectrum data from manufacturers / NIST atomic lines



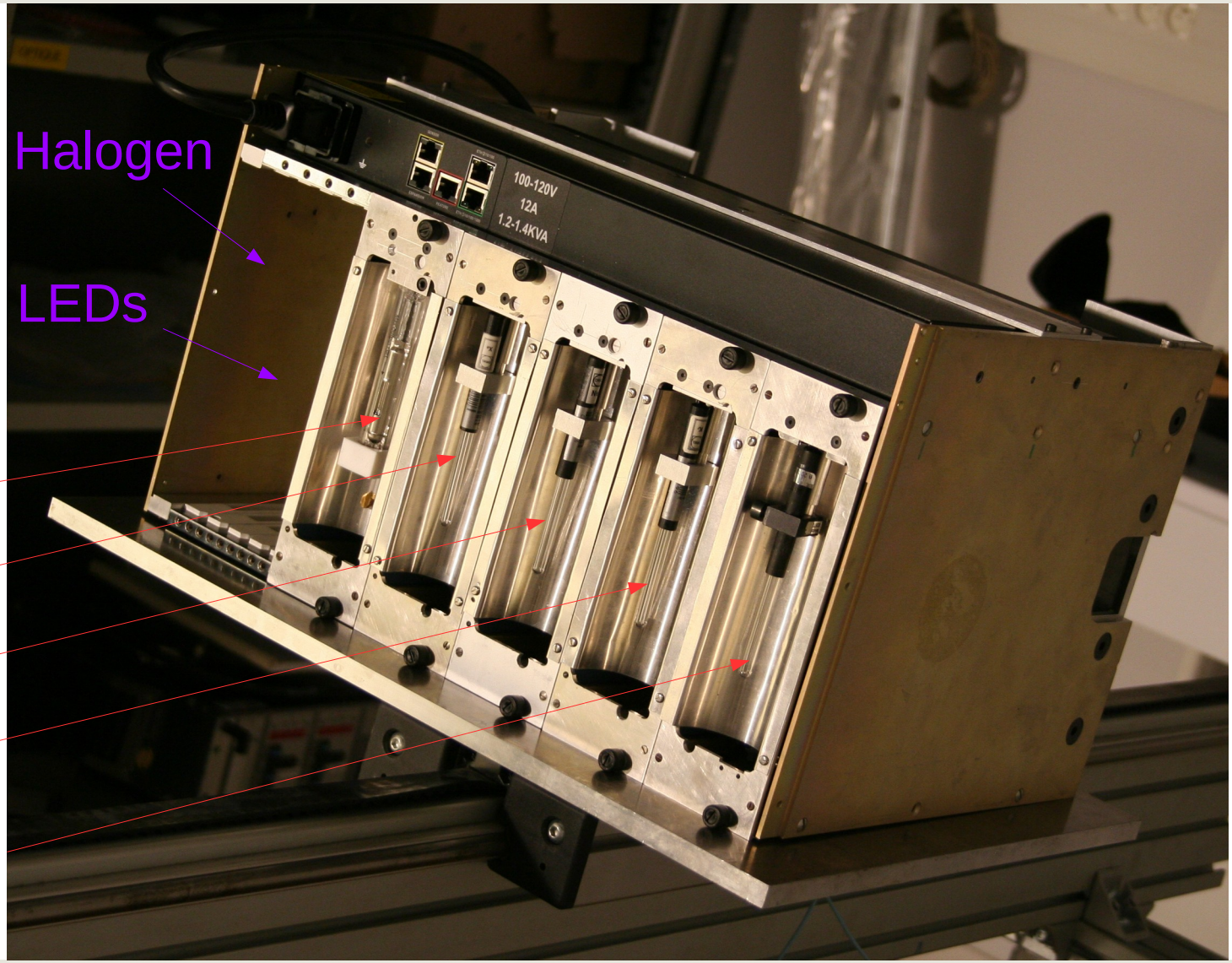
Spectral lamps from UVP/Pen-Ray. Tested and validated.

Concept: 4 Sources Boxes, removable drawers

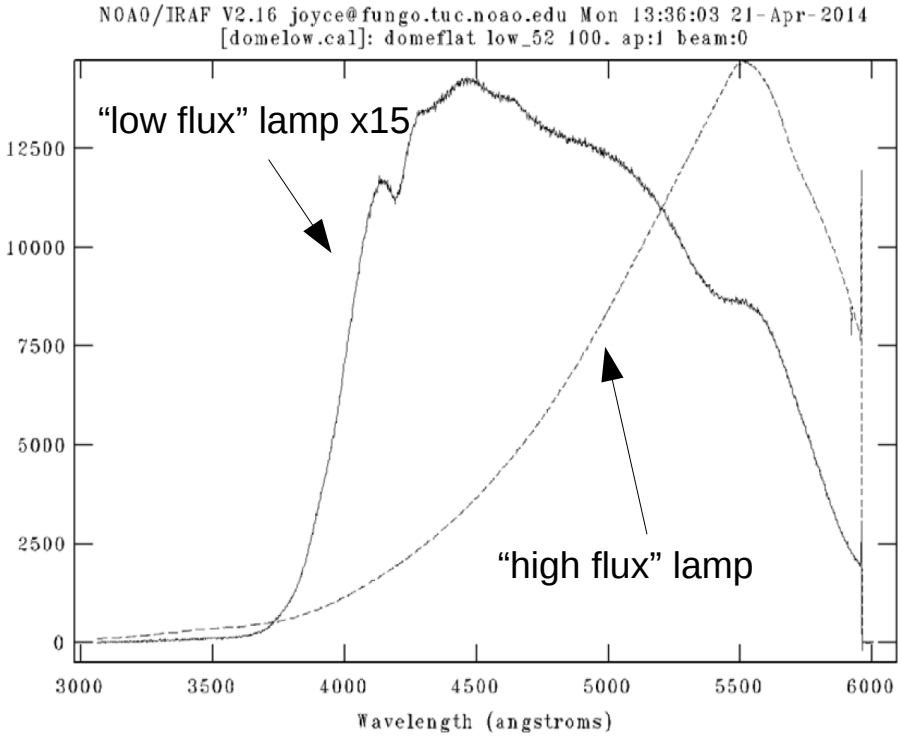
- **One drawer per lamp**, containing the lamp and its power supply
- Boxes (crates) following the **NIM crate** geometric specs, removable drawers too.
- **Power supply** provided by a **PDU** (**Raritan**, 8 sockets), **Ethernet remote control** (ssh, SNMP, etc).
- Temperature & humidity sensors attached to the PDU : integrated alarm system.
- The 4 PDU may be **chained** (USB) to appear as a unique device.



Spectral lamps selected: Cd, Xe, Ne, Kr, Hg(Ar)



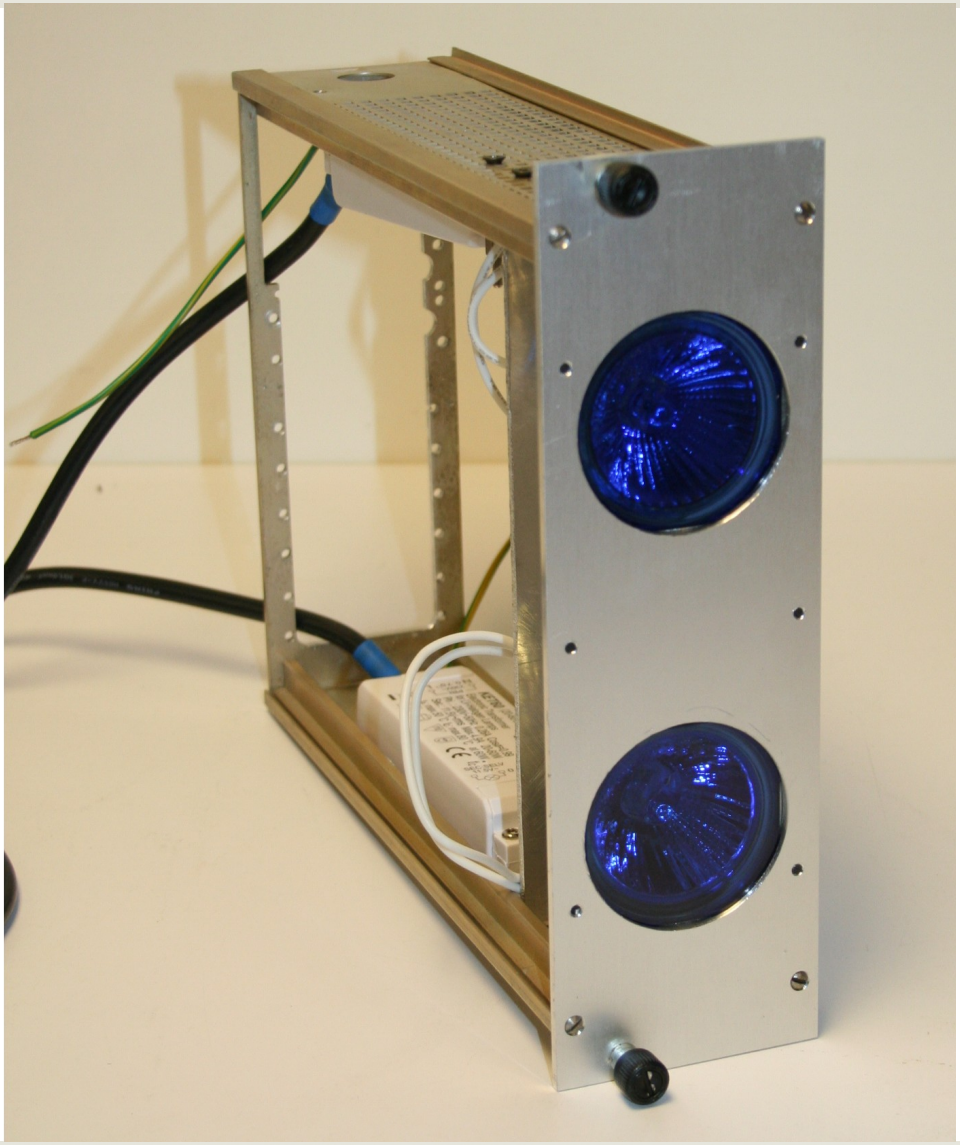
Continuum lamps



current continuum lamps (halogen) available at the Mayall
"low flux" lamps have a blue filter to balance their spectrum.

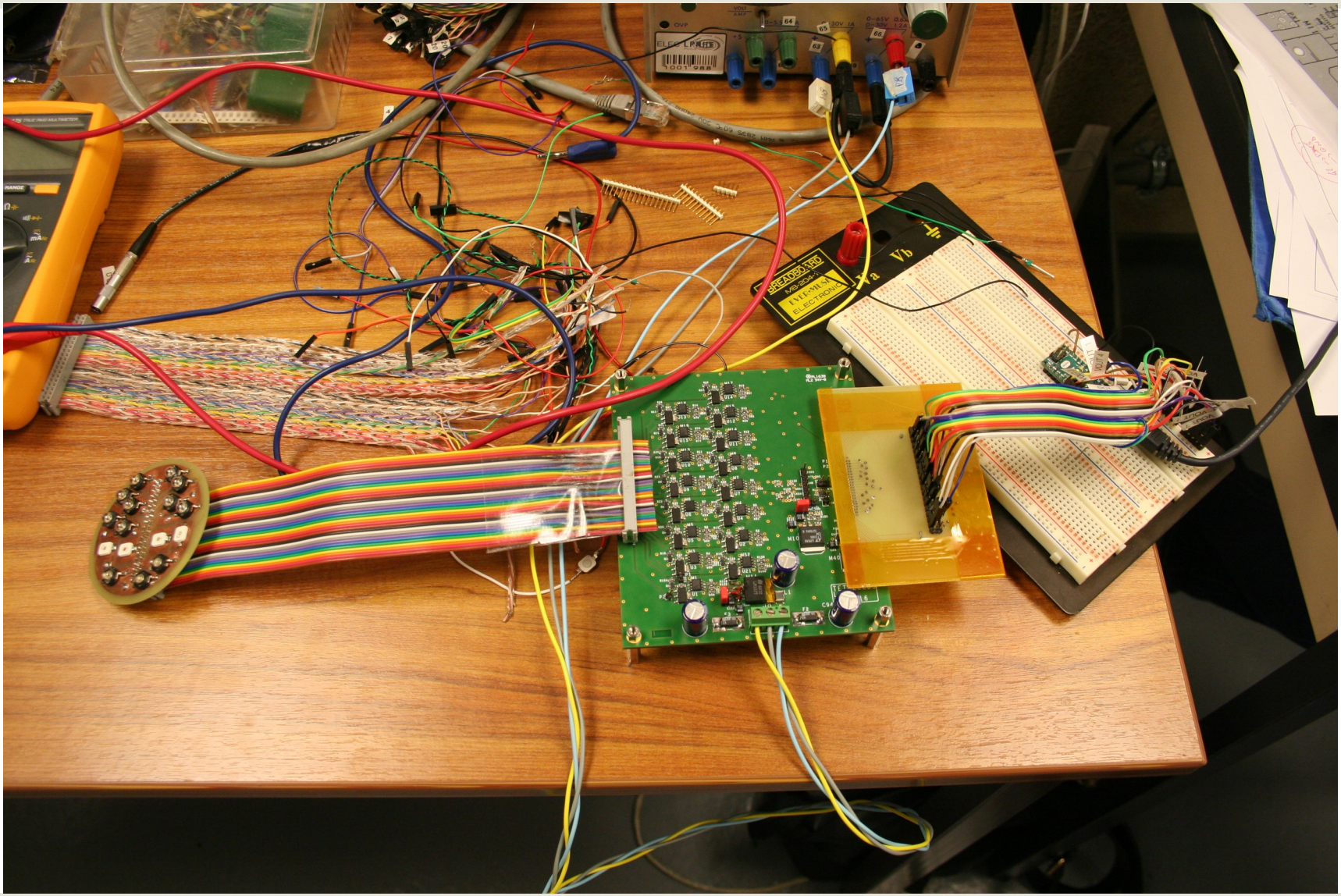
- **Coverage problems** and **flux instability** with the existing continuum lamps
- **Discussion on a additional set of powerful LED** (with P. Martini)

Continuum lamps: halogens + blue filter



- Baseline : one drawer with **halogen lamps** and a **blue filter** to reduce the red part of the spectrum
- Spectra taken on our spectro-photometric testbench, data analysis ongoing (uncertainties with the throughput of our monochromator).
- **Not much flux below 400 nm** ; possibility to add UV LEDs to complete (tests on-going)

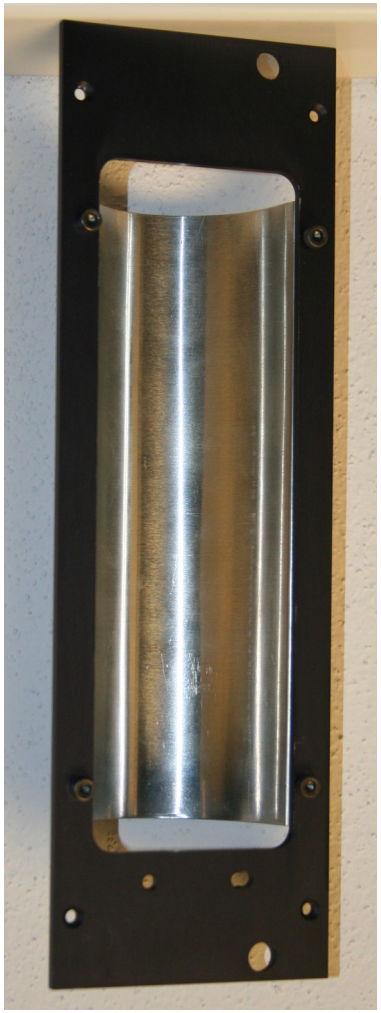
Synthetic continuum (350-1000nm) with LEDs



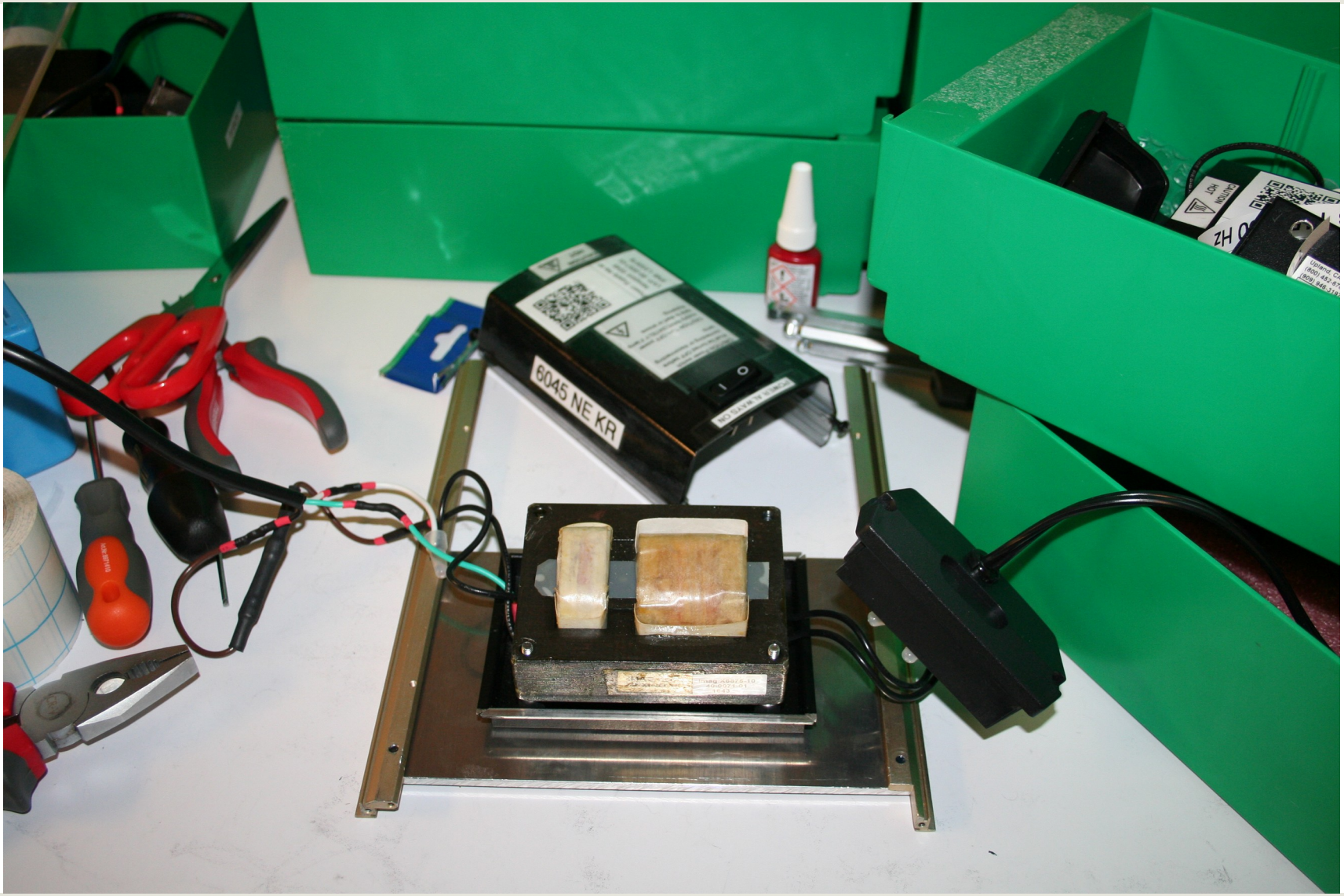
Boxes (crates) anodized and reassembled


100-120V
12A
1.2-1.4KVA

Drawers anodized, on-going re-assembly



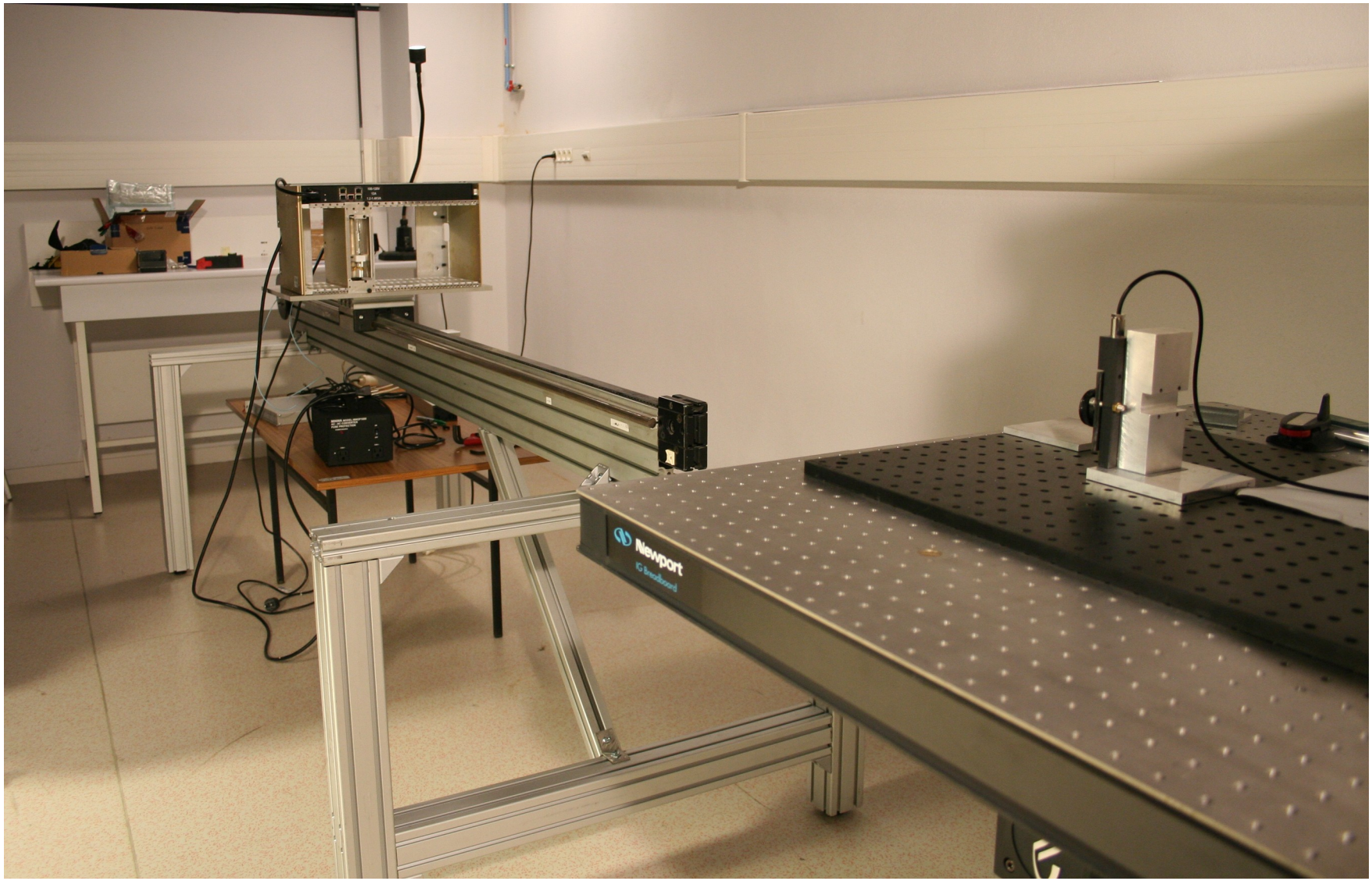
Spectral Lamp Drawers: HV Power Supply



Tests before shipping

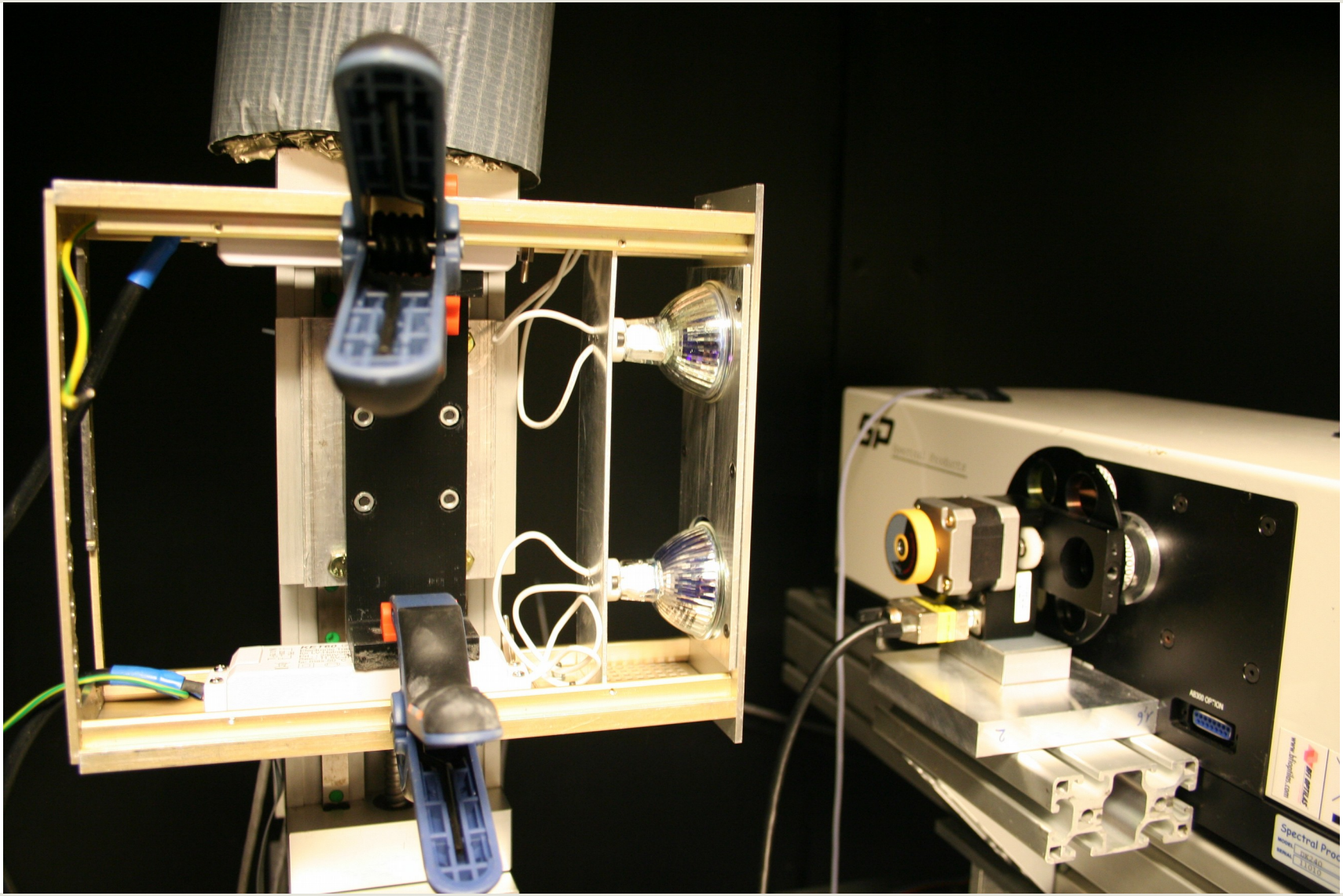
- **Functional tests** (partly completed)
  - PDU, power/current limits, heating, PDU control, DESI ICS
  - Thermal tests (climate chamber), choosing PDU sensors limits...
- **Lamps** (partly done)
  - Stability, photometric level (double check), spectra…
  - Heating time, Lamp aging
  - Continuum lamps : checking the beam shape (screen distance) for uniformity
- **Mechanical tests** (to do on reassembled boxes)
  - Mechanical checks : boxes attached on the LSST carousel testbench

Photometric measurements (photometric bench)



Tests in climate chamber: works -20°C to +40°C

Lamps: spectro-photometric tests



Planned mechanical tests (rotation of the boxes)

Planning: milestones

- **(re)Assembly of the boxes** and **spectral drawers** (nov. 2017)
- **Complete tests** (expected to be achieved late Jan 2018)
- **Shipping to Kitt Peak** (early Feb. 2018)
- **Mounting the boxes on upper ring** (April 2018)
- **Commissioning** (end 2018)
- **Continuum lamps**:
  - Plan A : **halogens + blue filters:** early Feb. 2018
  - Plan B : continuum with **LEDs:** late 2018 / early 2019