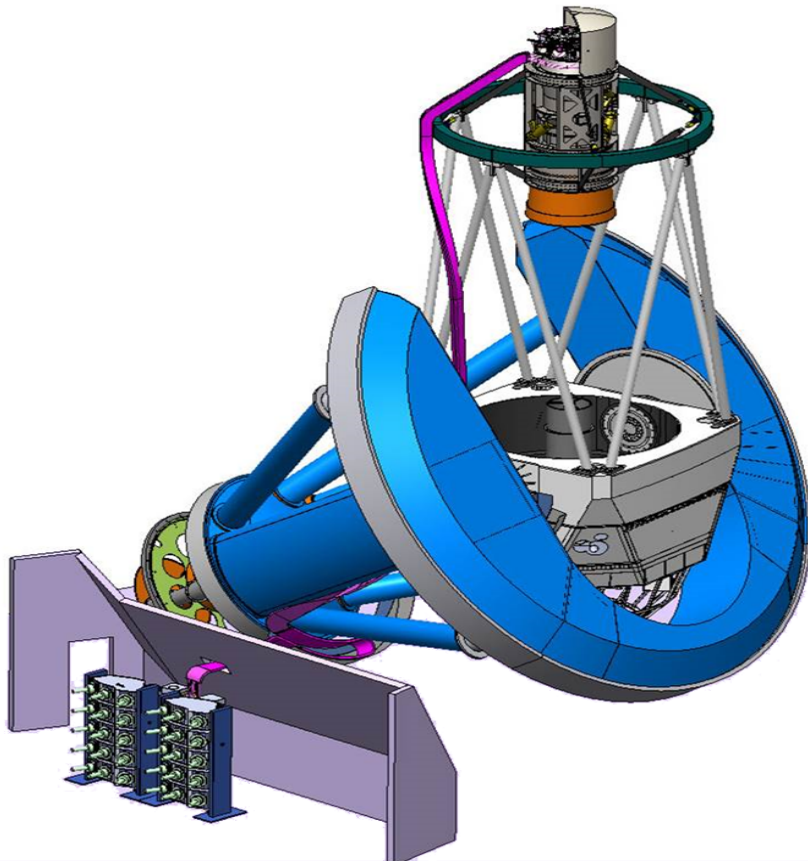


DESI *in-situ* Calibration System status



Laurent Le Guillou (Sorbonne Univ./LPNHE)
Sonia Karkar (IN2P3/LPNHE)
Julien Guy (IN2P3/LPNHE)

*DESI France, LPNHE Paris
Feb. 2nd, 2018*

Christophe Balland, Julien Coridian, Patrick Ghislain, Jean-François Goulian, Julien Guy,
Sonia Karkar (project engineer), Laurent Le Guillou, Michael Roynel



Talk outline

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

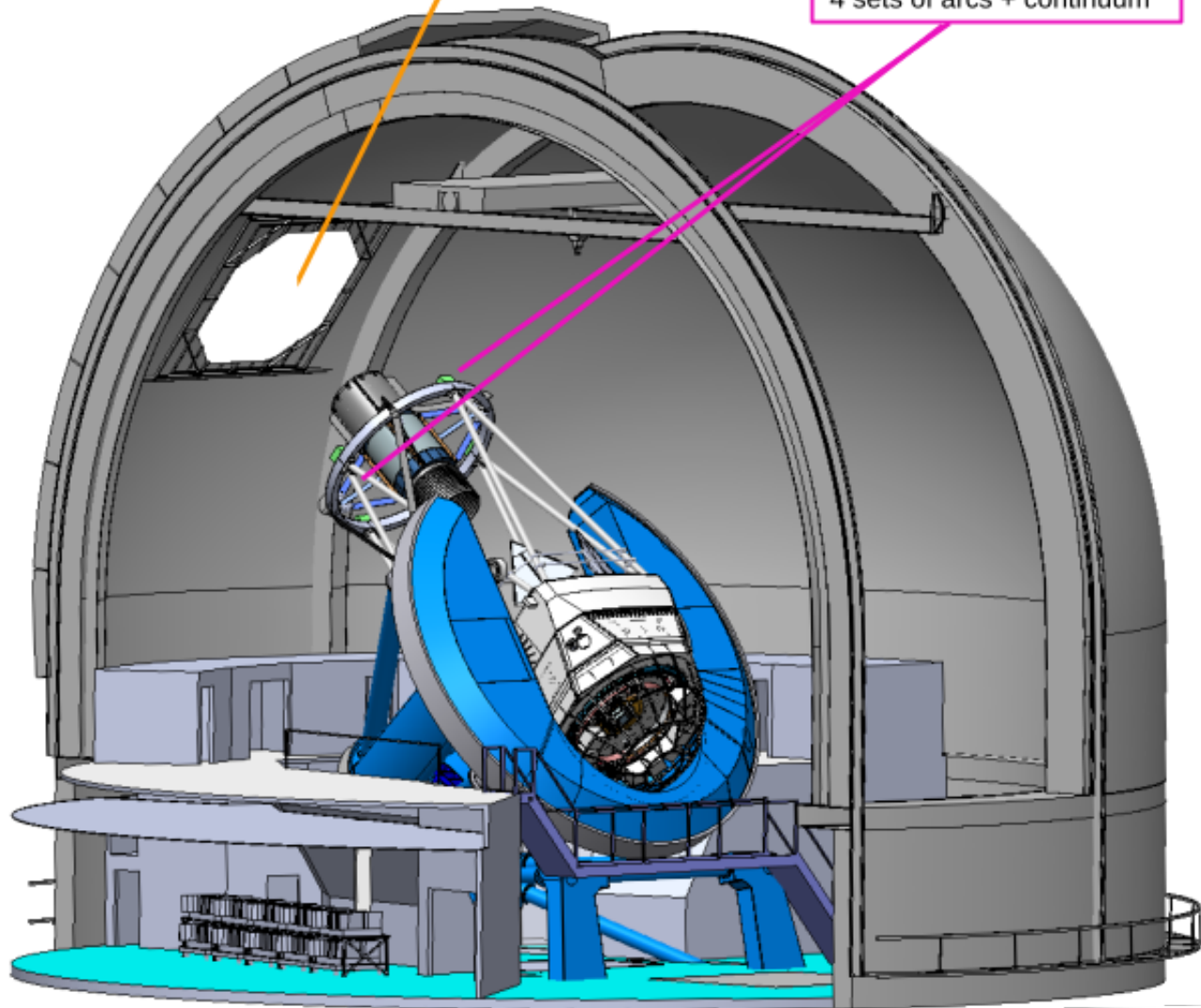


Dome Flat Screen

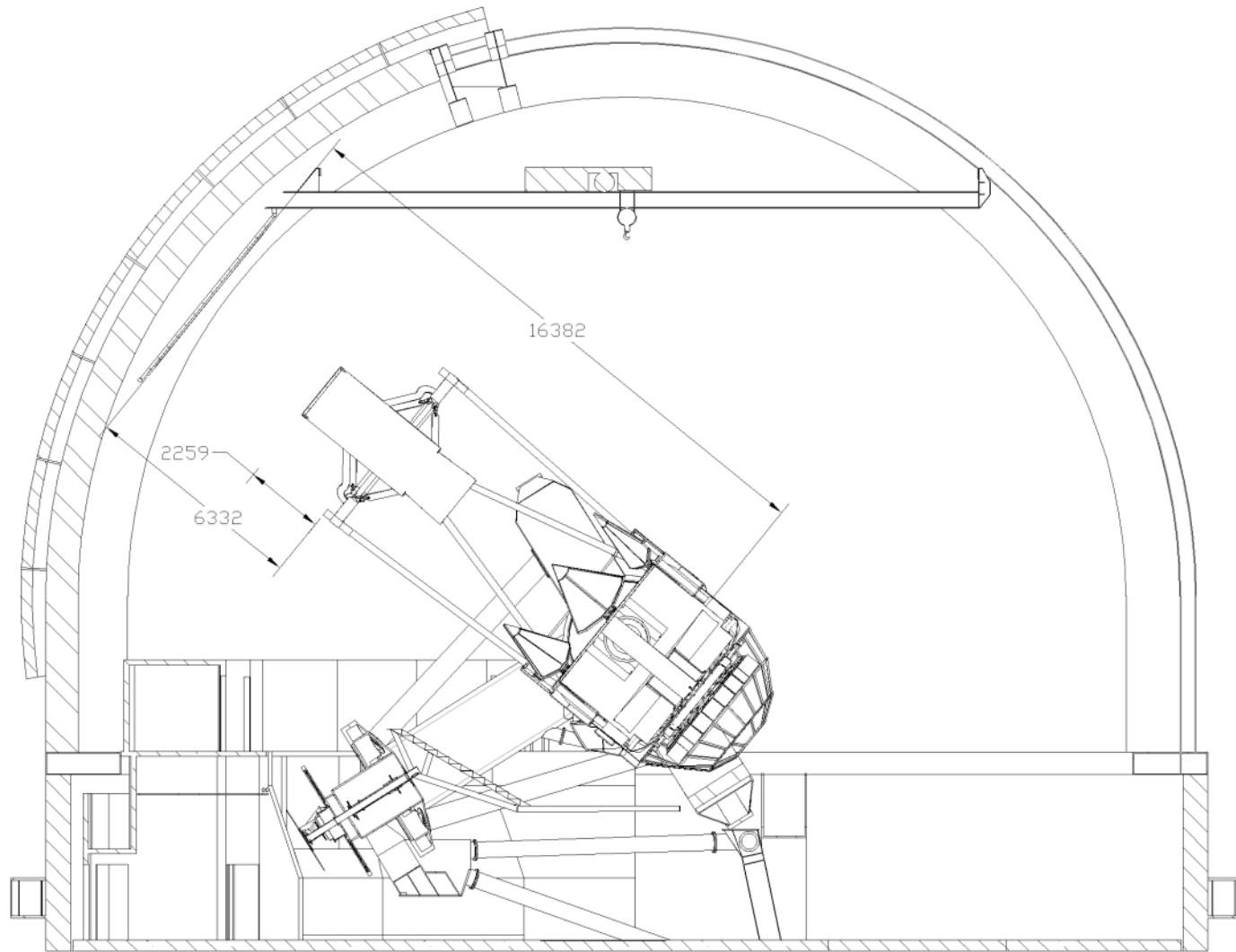
Screen used to project light onto
Slight modification of current screen

Calibration Lamps

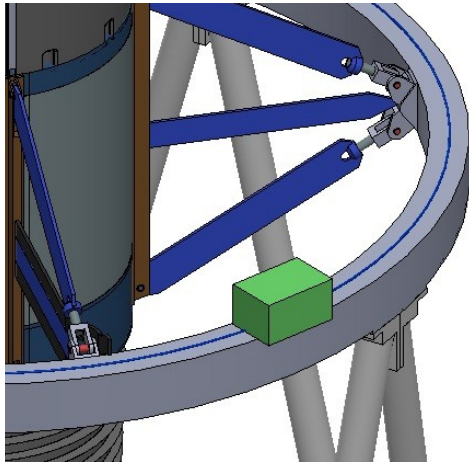
4 sets of arcs + continuum



Telescope and Dome dimensions



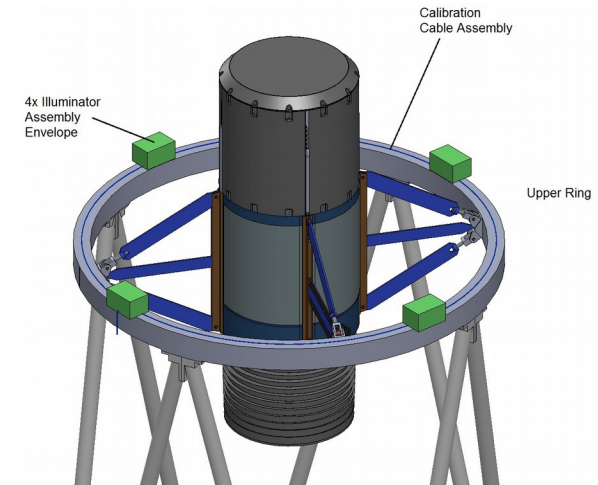
Rationale



- **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

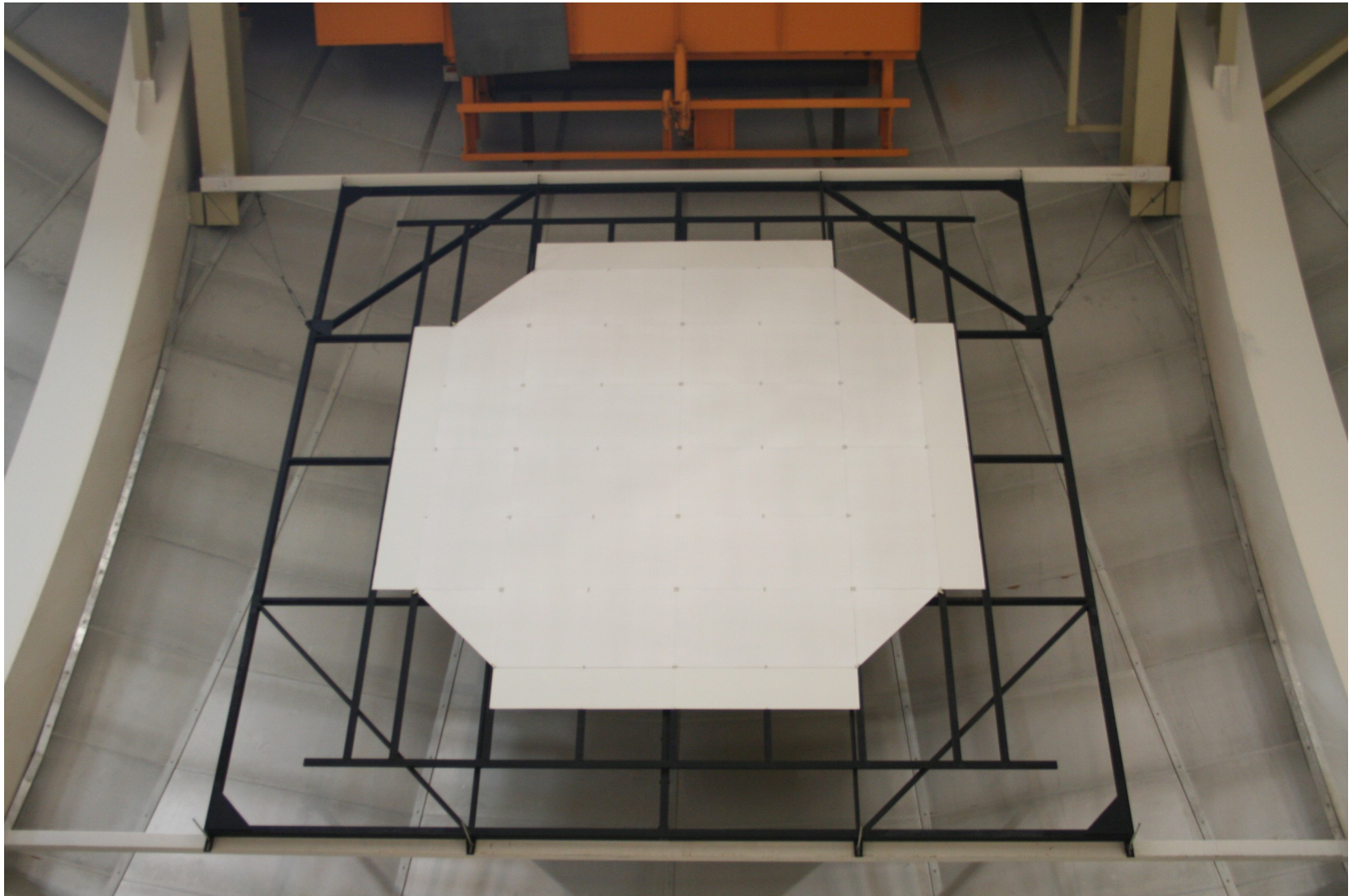


Calibration System Requirements (DESI-1067)

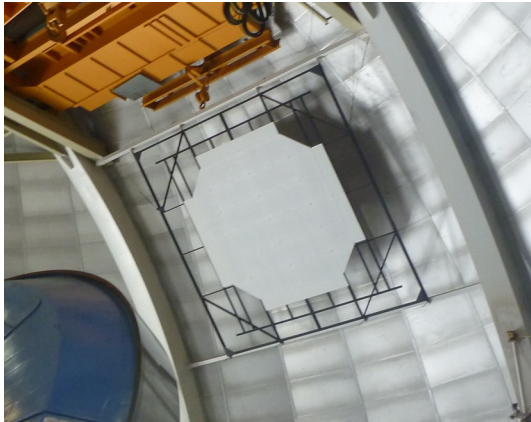
Req't Name	Requirement	Rationale	Verification method
Bandpass	360-980 nm	Required for z range of Ly-alpha QSOs and ELGs (DESI-0318)	Laboratory tests: measure lines lamps spectrum
Pupil Uniformity	20% (azimuthally averaged)	PSF stability of 3% req. IN.FBR-5013, (DESI-0581 v8)	Measured lamp luminance plus 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 Å (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



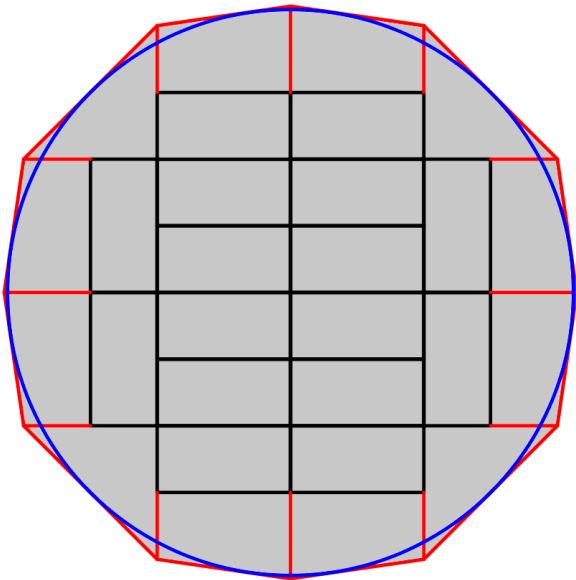
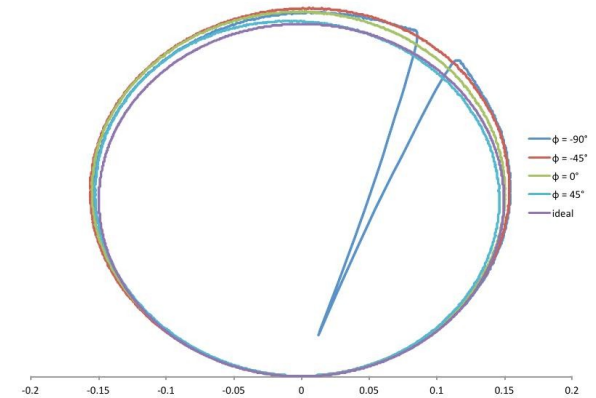
Lambertian Screen Upgrade



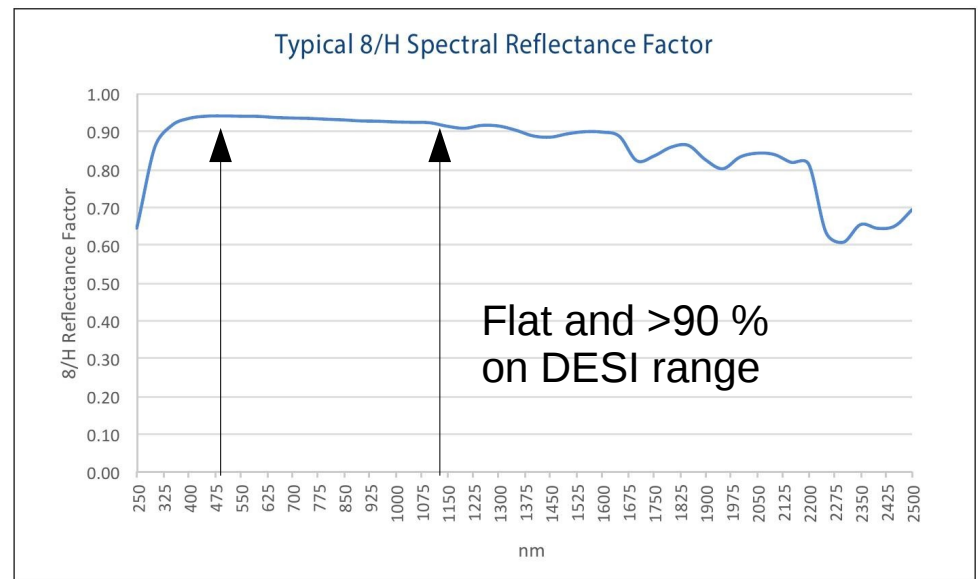
« Permafect » coating :
→ Lambertian reflectivity

Replacing all panels for better uniformity

Permafect - 94 BRDF at 20° Incident Beam



Typical 8/H Spectral Reflectance Factor



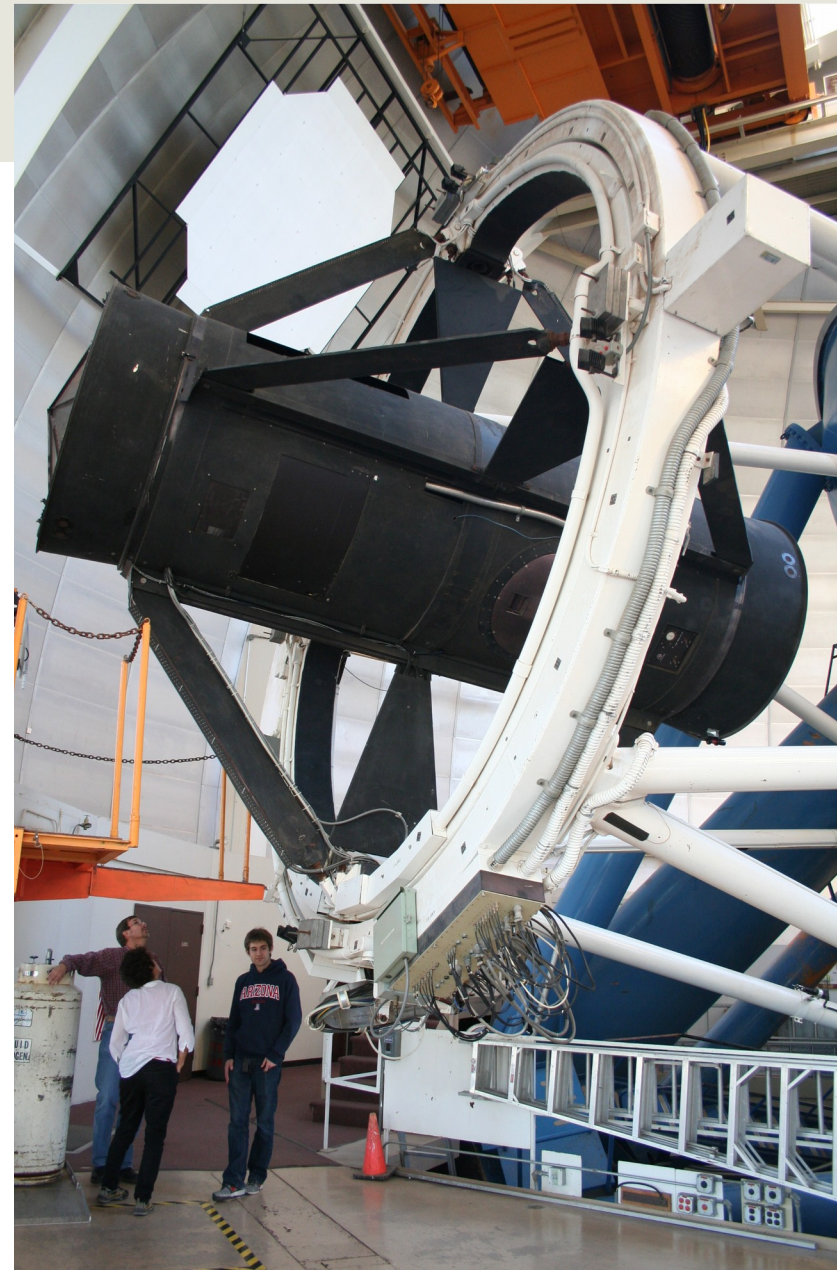
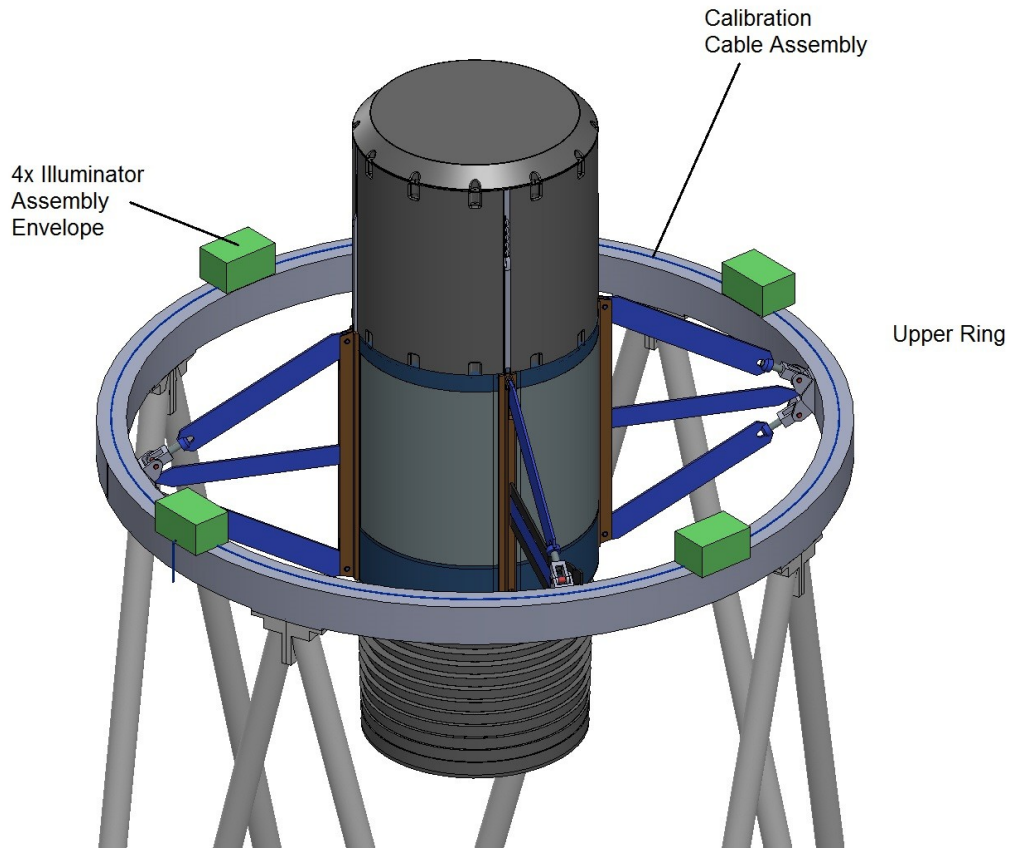
Larger screen installed at Mayall (one wrong panel)



Larger screen installed at Mayall (panel replaced)



Four Source boxes



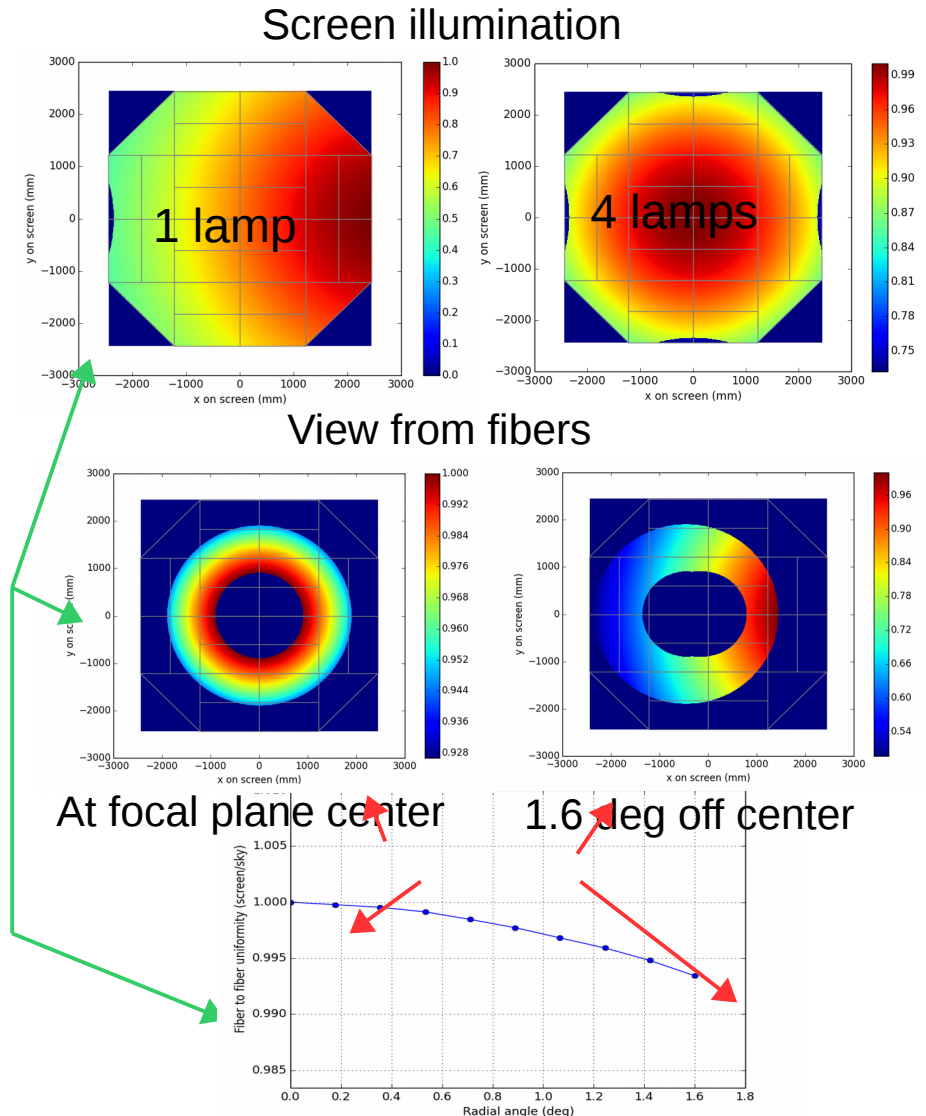
Dark Energy Spectroscopic Instrument

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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*



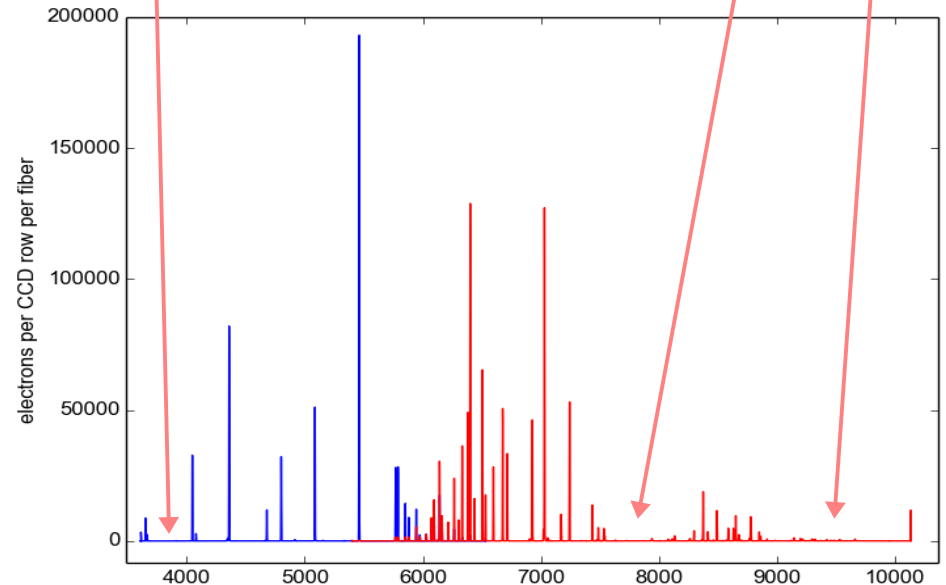
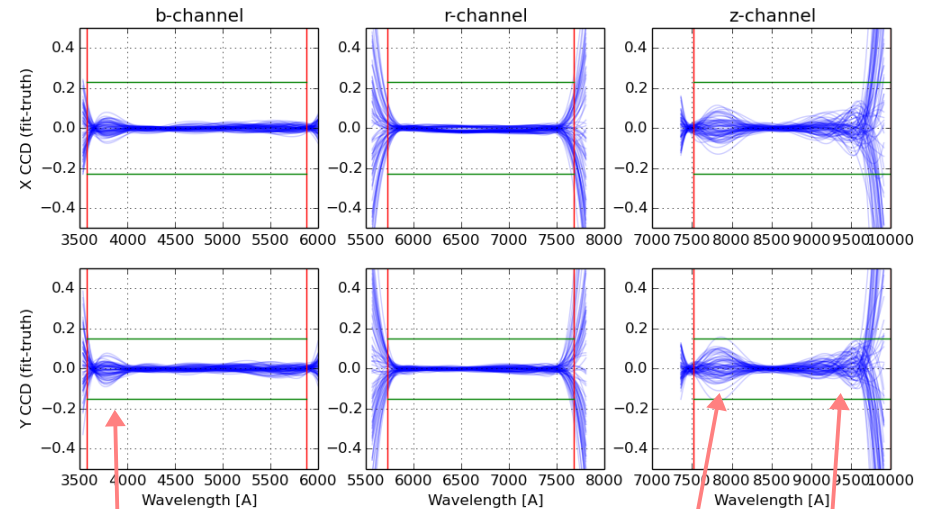
Spectral sources (arcs): spectral lines coverage

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

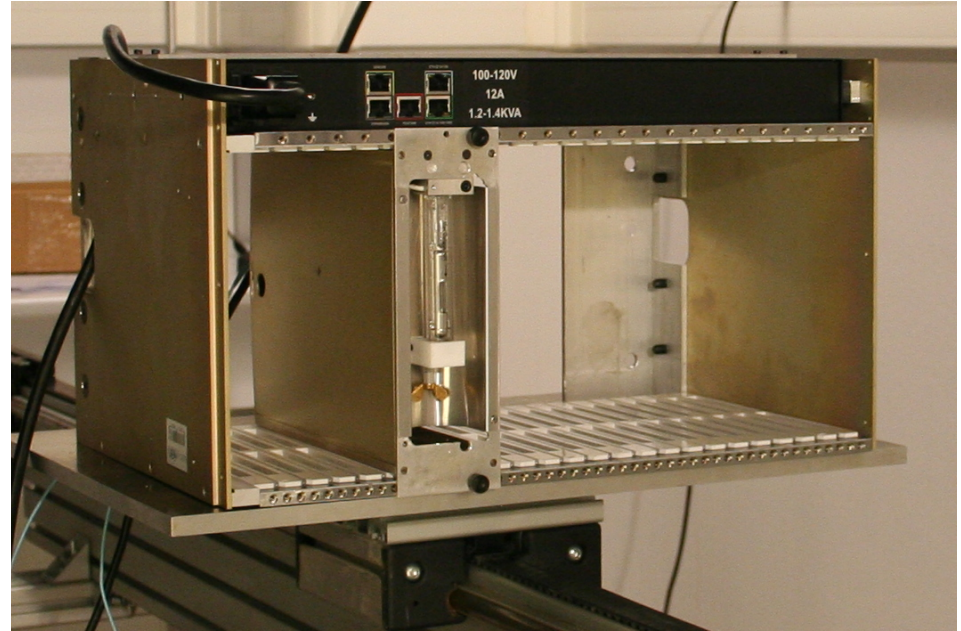
Lack of lines coverage affects the precision of the wavelength solution

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

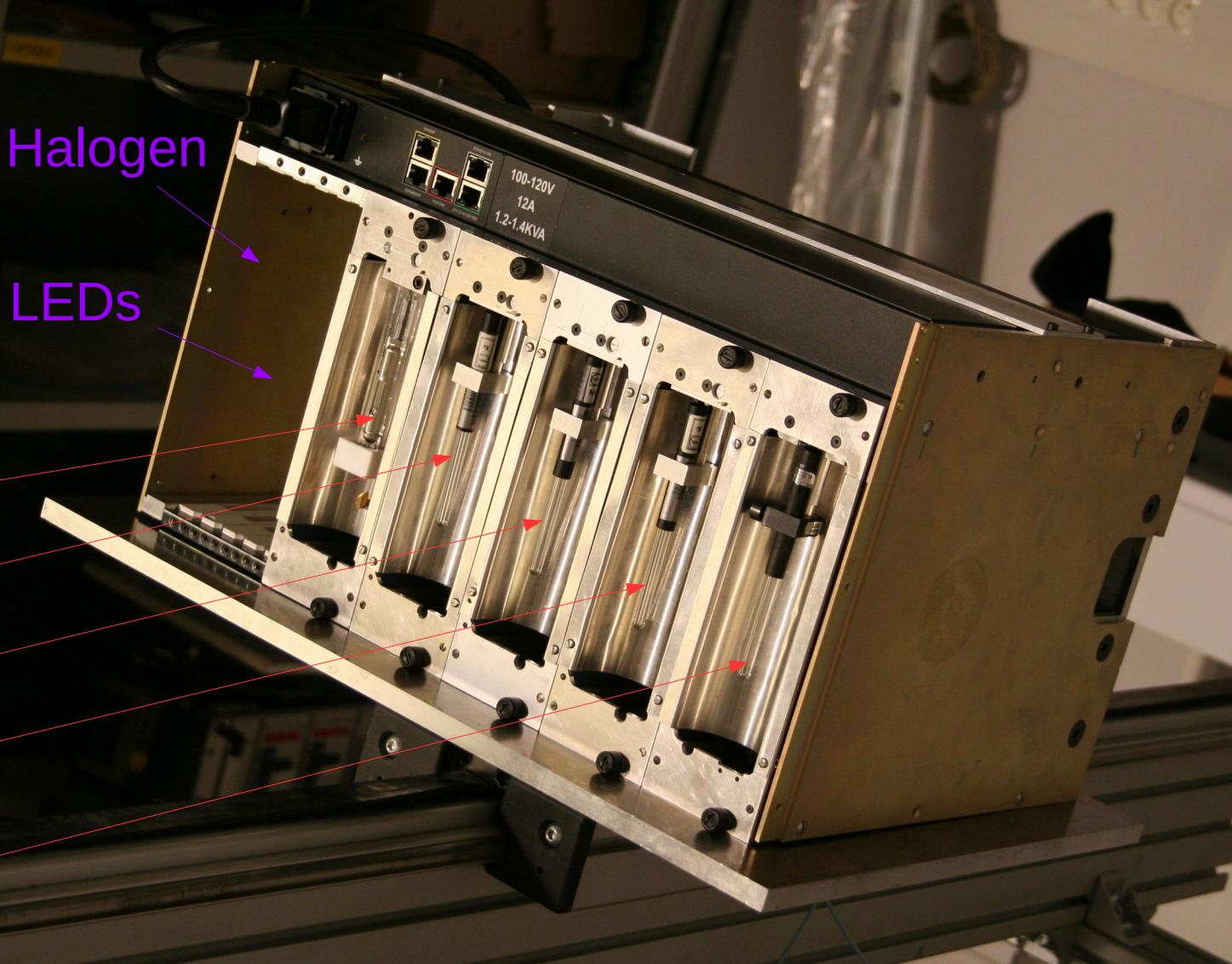


Concept: 4 Sources Boxes, removable drawers

- **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)



Halogen

LEDs

Cd

Xe

Ne

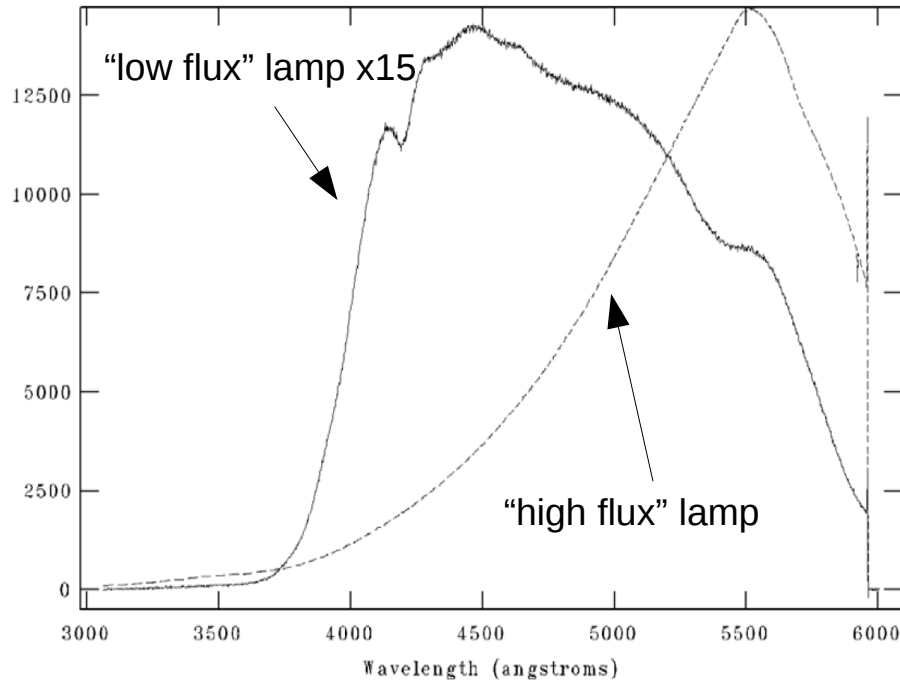
Kr

Hg(Ar)



Continuum lamps

NOAO/IRAF V2.16 joyce@fungo.tuc.noao.edu Mon 13:36:03 21-Apr-2014
[domelow.cal]: domeflat low_52 100. ap:1 beam:0

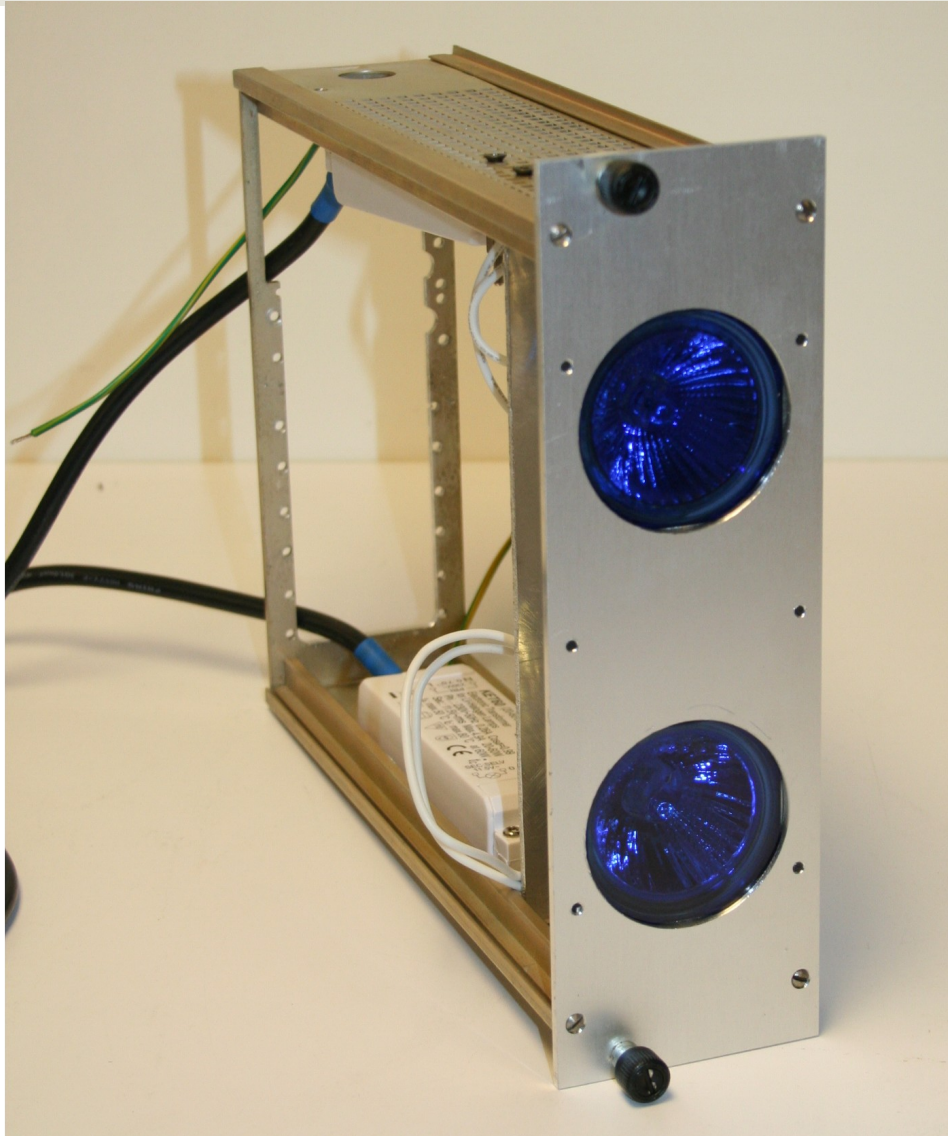


current continuum lamps (halogen)
available at the Mayall
“low flux” lamps have a blue filter to
balance their spectrum.

- **Coverage problems and flux instability** with the existing continuum lamps
- **Adding an additional set of powerful LED** for the blue part



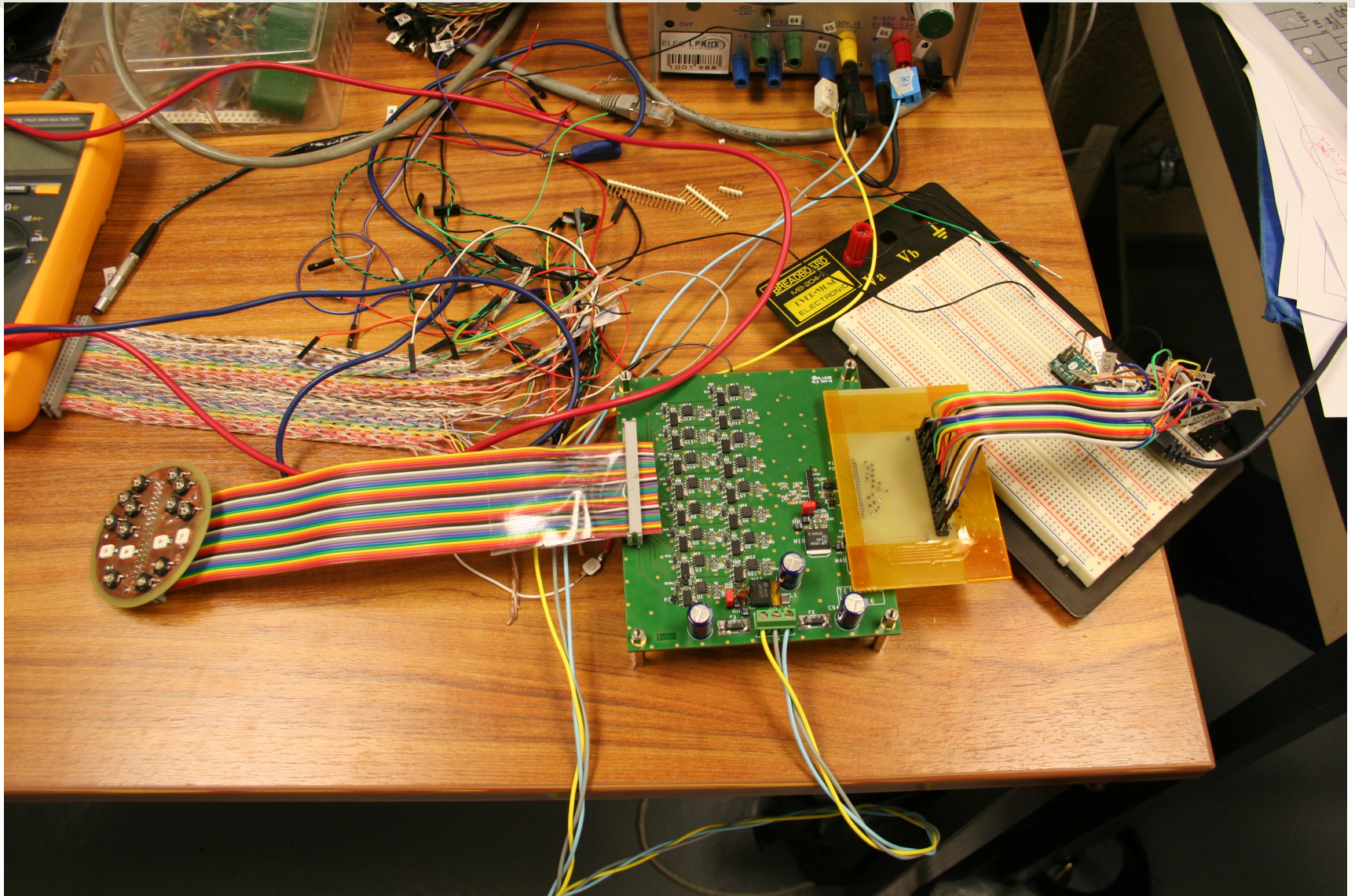
Continuum lamps: halogens + blue filter



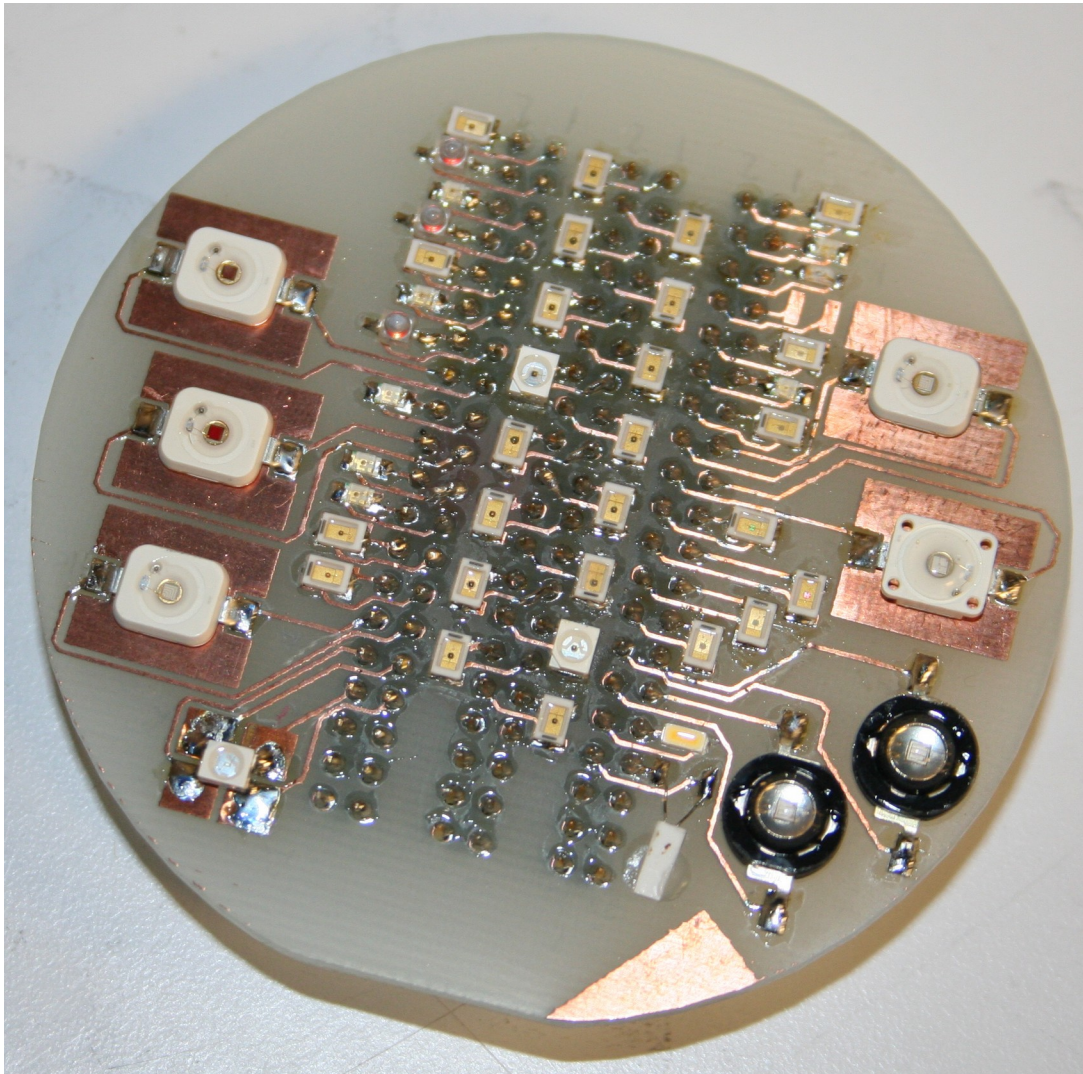
- Baseline : one drawer with **halogen lamps** and a **blue filter** to reduce the red part of the spectrum
- Spectra taken on our spectrophotometric testbench, data analysis ongoing (uncertainties with the throughput of our monochromator).
- **Not much flux below 400 nm** ; add UV & blue LEDs to complete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



Synthetic continuum with LEDs



Continuum lamps in Blue/UV: LED selection



- With the halogen lamps, not enough flux in UV / blue for the continuum lamps (B arm) :

Not much flux below 400 nm

- add a **special lamp drawer** with **UV & blue LEDs** (one per box)
- On-going effort : **spectrophotometric measurements on test bench**
- Goal : **select a LED set to cover the range of the B arm**
- Late delivery of 4 LED drawers



Boxes (crates) anodized and reassembled

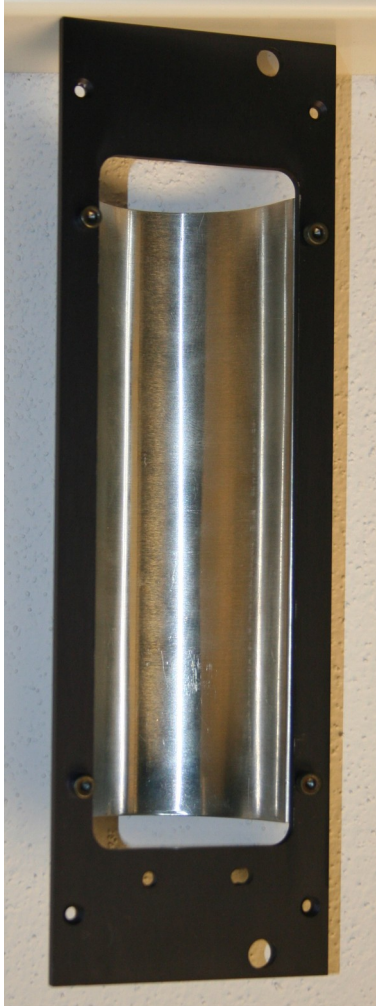




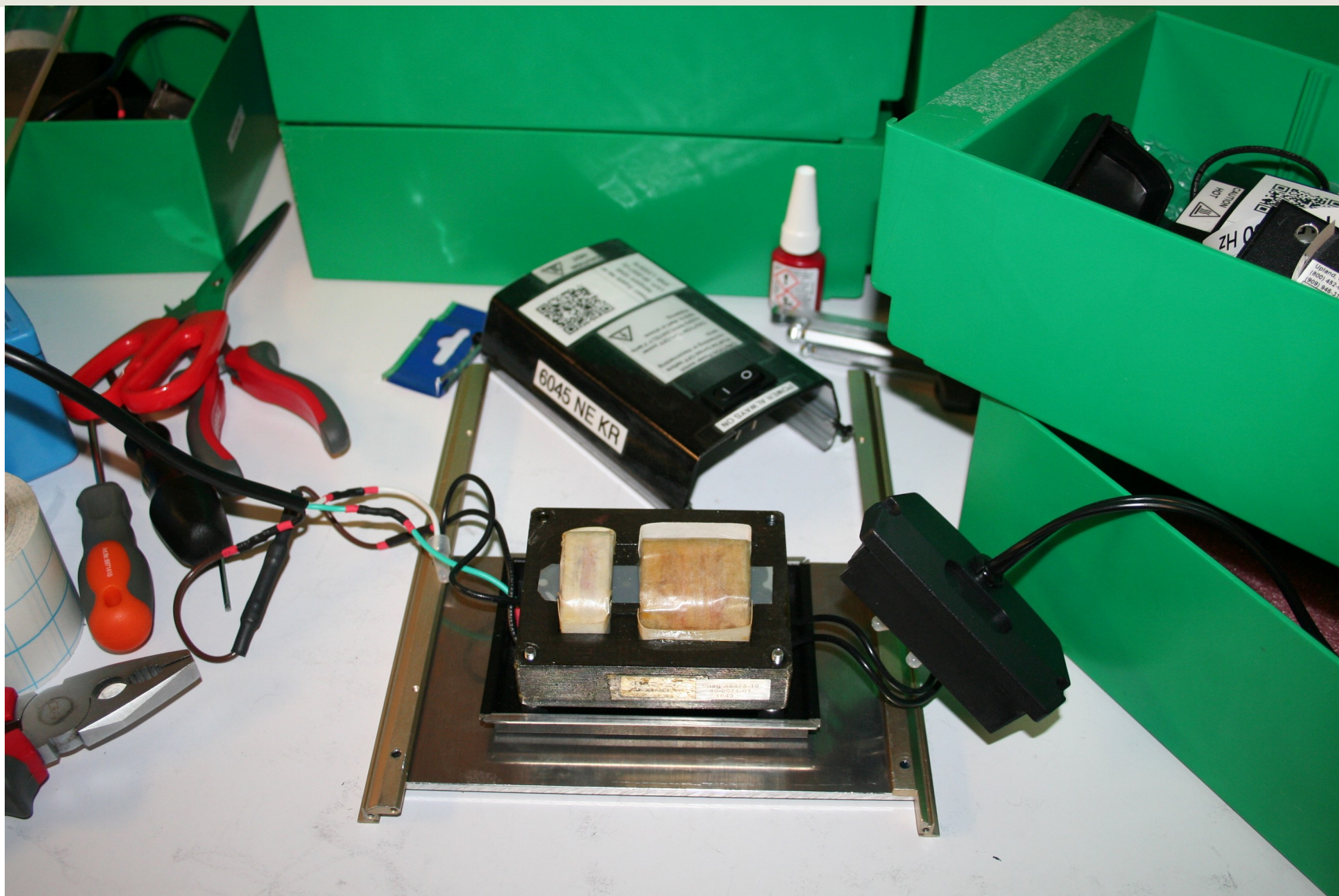
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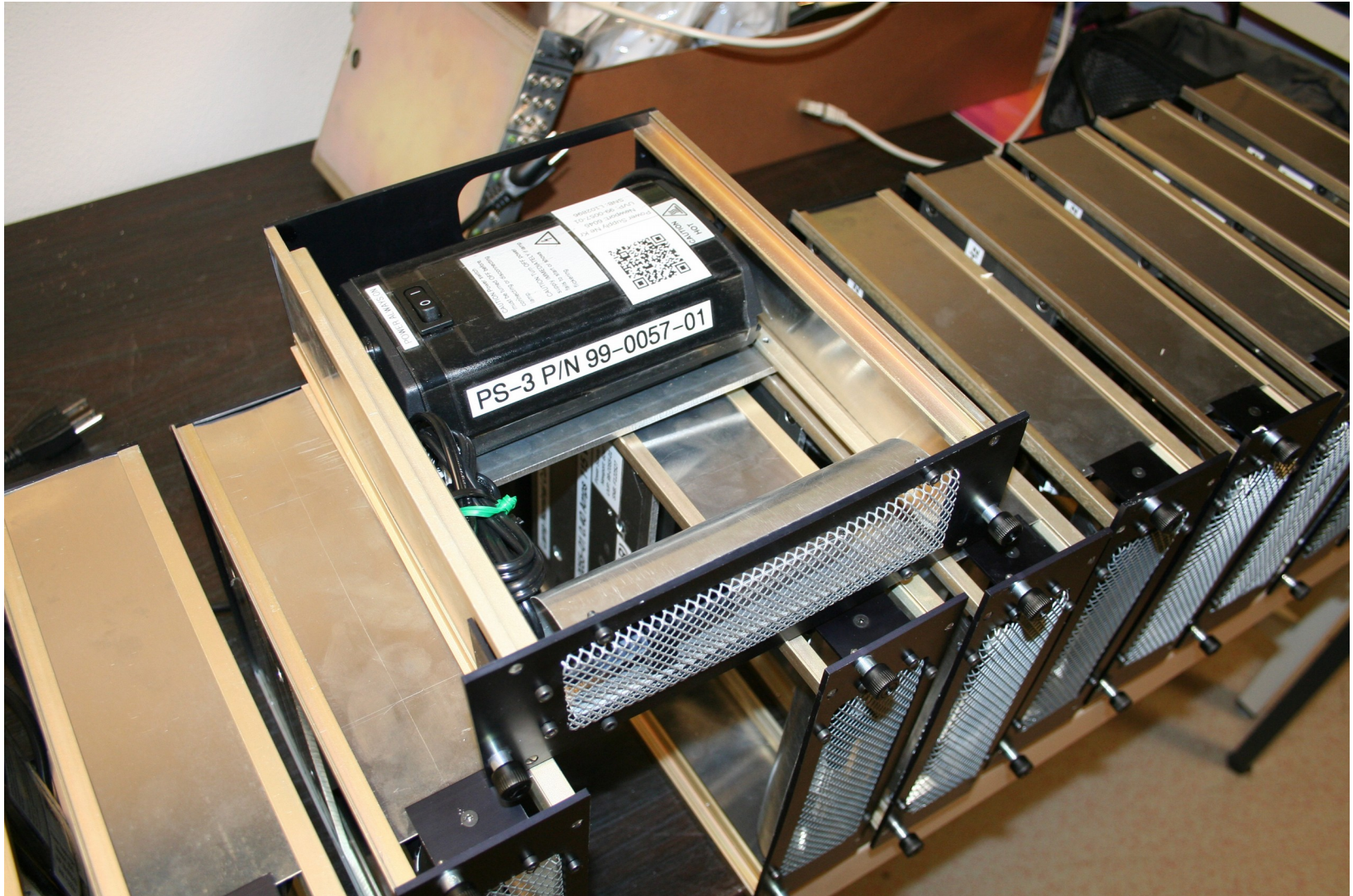
Drawers anodized, on-going re-assembly



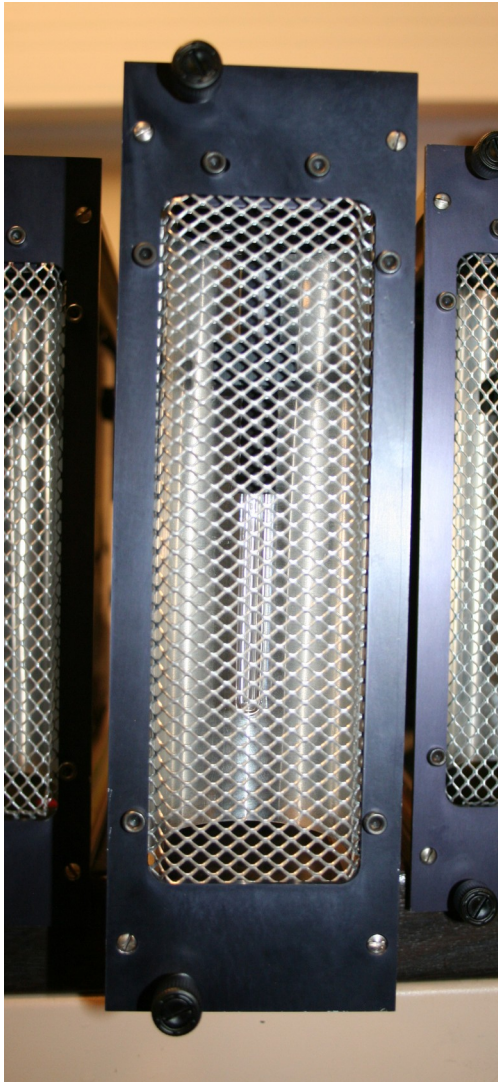
Spectral Lamp Drawers: HV Power Supply



Spectral Lamp Drawers: Assembly



Spectral Lamp Drawers: Assembly

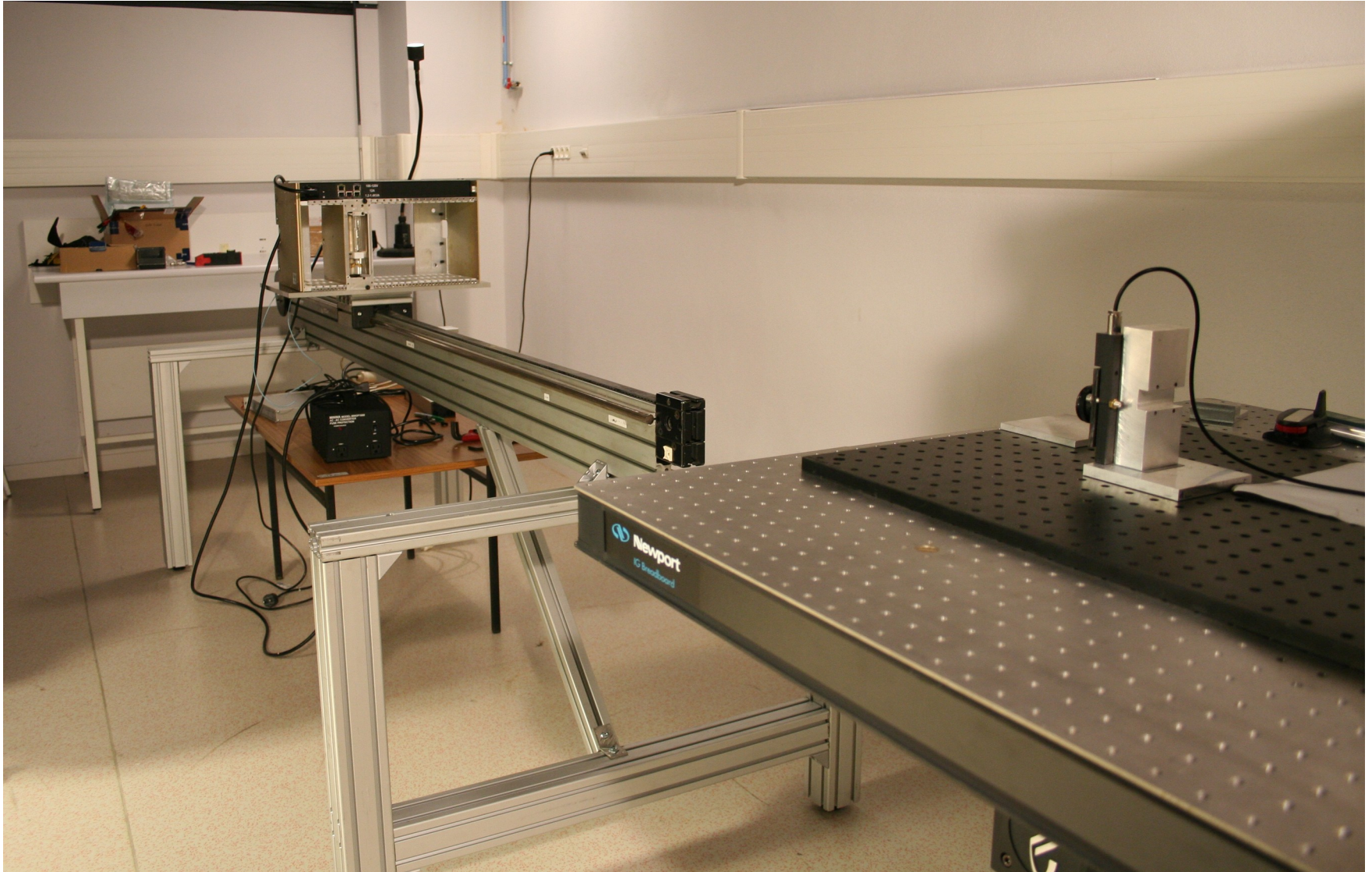


Tests before shipping

- **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)



Dark Energy Spectroscopic Instrument

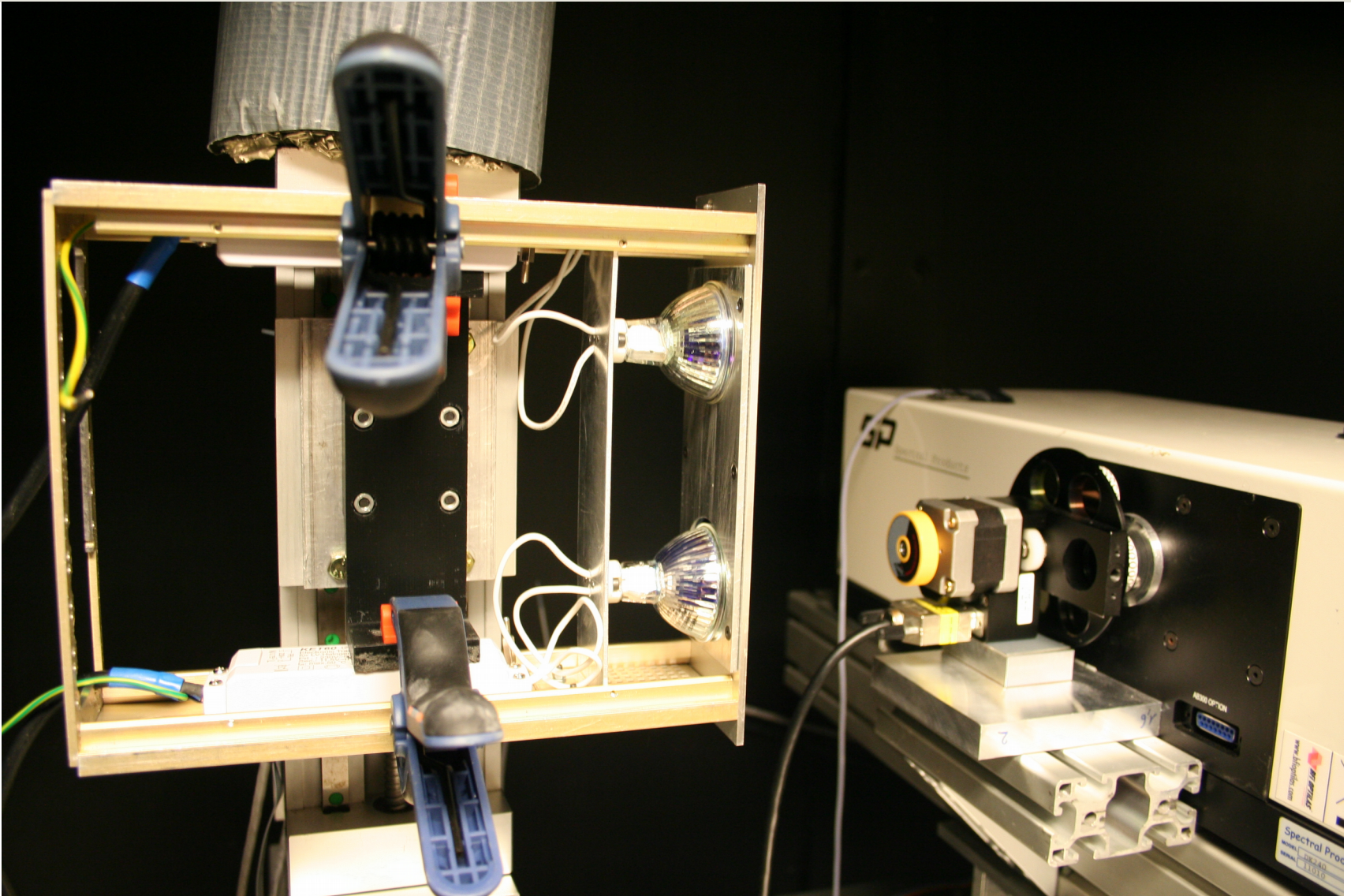
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Tests in climate chamber: works -20°C to $+40^{\circ}\text{C}$



Lamps: spectro-photometric tests



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Planned mechanical tests (rotation of the boxes)



We will fix the boxes on the LSST filter carousel mechanical testbench



Planning: milestones

- ◆ **(re)Assembly of the boxes and spectral drawers** (Jan. '18)
- ◆ **Complete tests** (to be achieved late Feb. 2018)
- ◆ **Shipping to Kitt Peak** (Early March 2018)
- ◆ **Mounting the crates on upper ring** (April 2018)
- ◆ **Commissioning** (2019)
- ◆ **Continuum lamps (late delivery):**
 - ◆ **halogens + blue filters:** first half of 2018
 - ◆ **UV/blue continuum with LEDs:** late 2018 / early 2019

