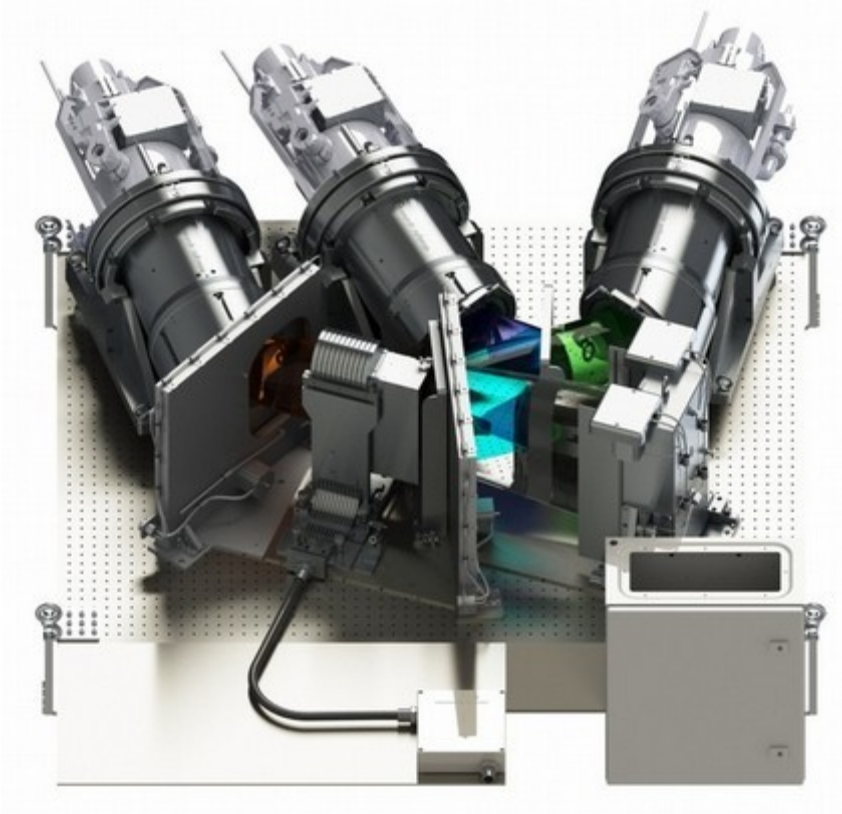


DESI Spectrograph: Throughput Measurement

Laurent Le Guillou (UPMC/LPNHE)

DESI France Workshop
Paris/Saclay, Nov. 17th-18th, 2016

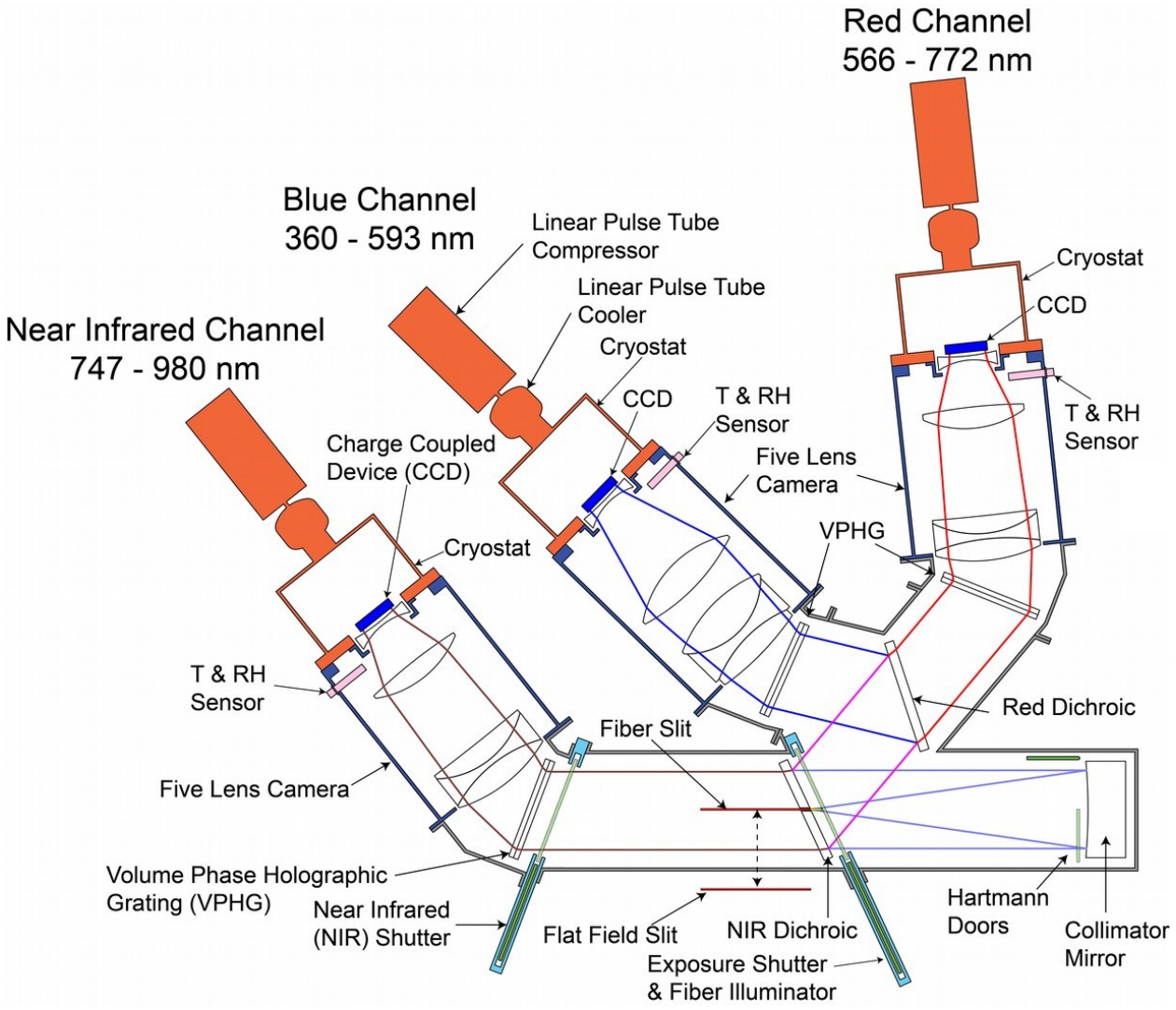
Julien Coridian (electronics), Patrick Ghislain (mechanics), Julien Guy (scientist),
Sonia Karkar (project engineer), Laurent Le Guillou (scientist), Yann Orain (mechanics),
Philippe Repain (mechanics), Eduardo Sepulveda (electronics)

Talk outline

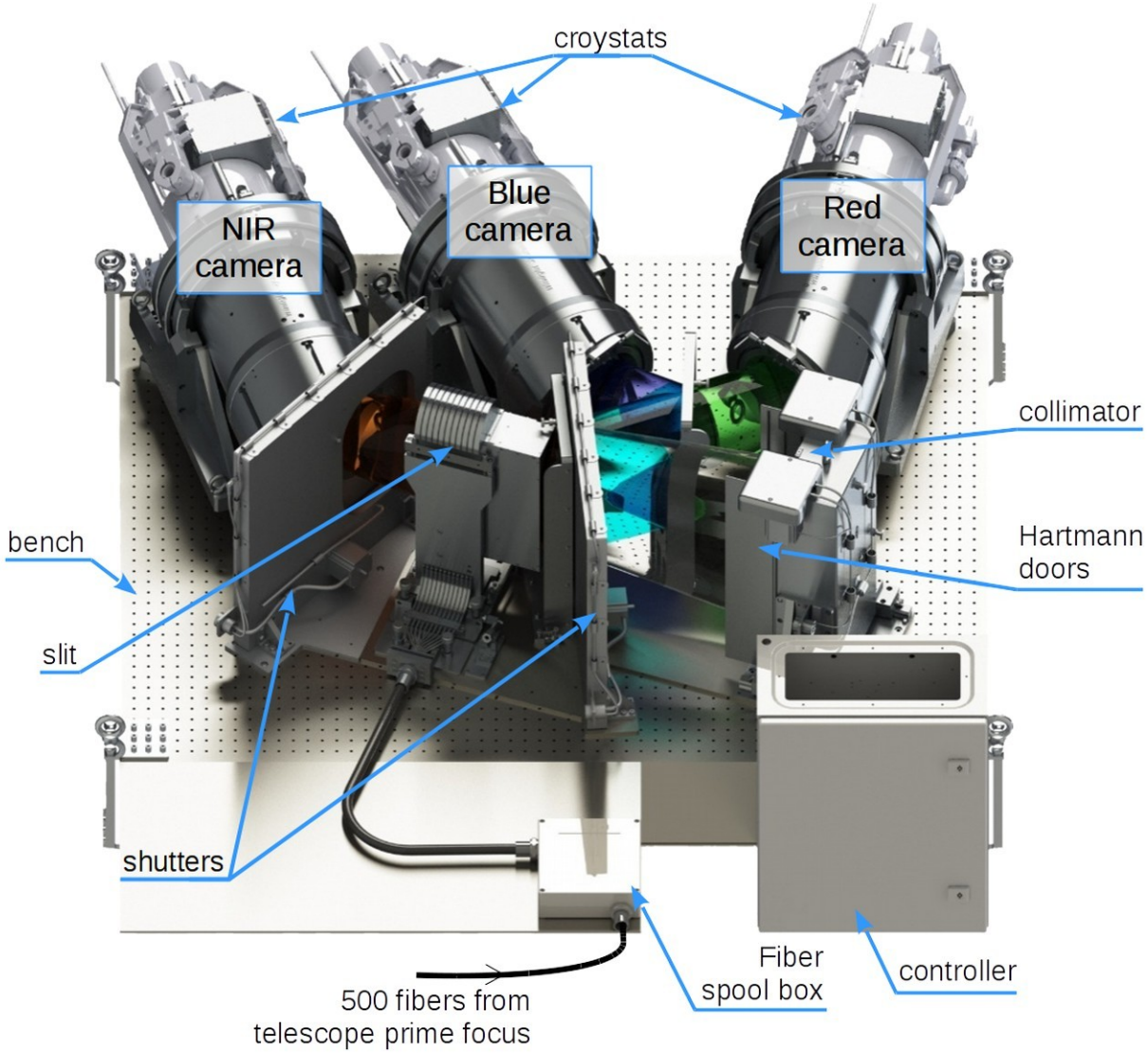
- **The DESI spectrograph**
- **Throughput Measurement: Motivations & Principle**
- **Flux Calibration Device for the Test Fiber Slit**
  - Mechanical design
  - Photodiode (inter)calibration(s)
- **Installation at Winlight**
  - Integration in the AMU testbench
  - First tests and measurements
- **Next steps...**

The DESI spectrograph

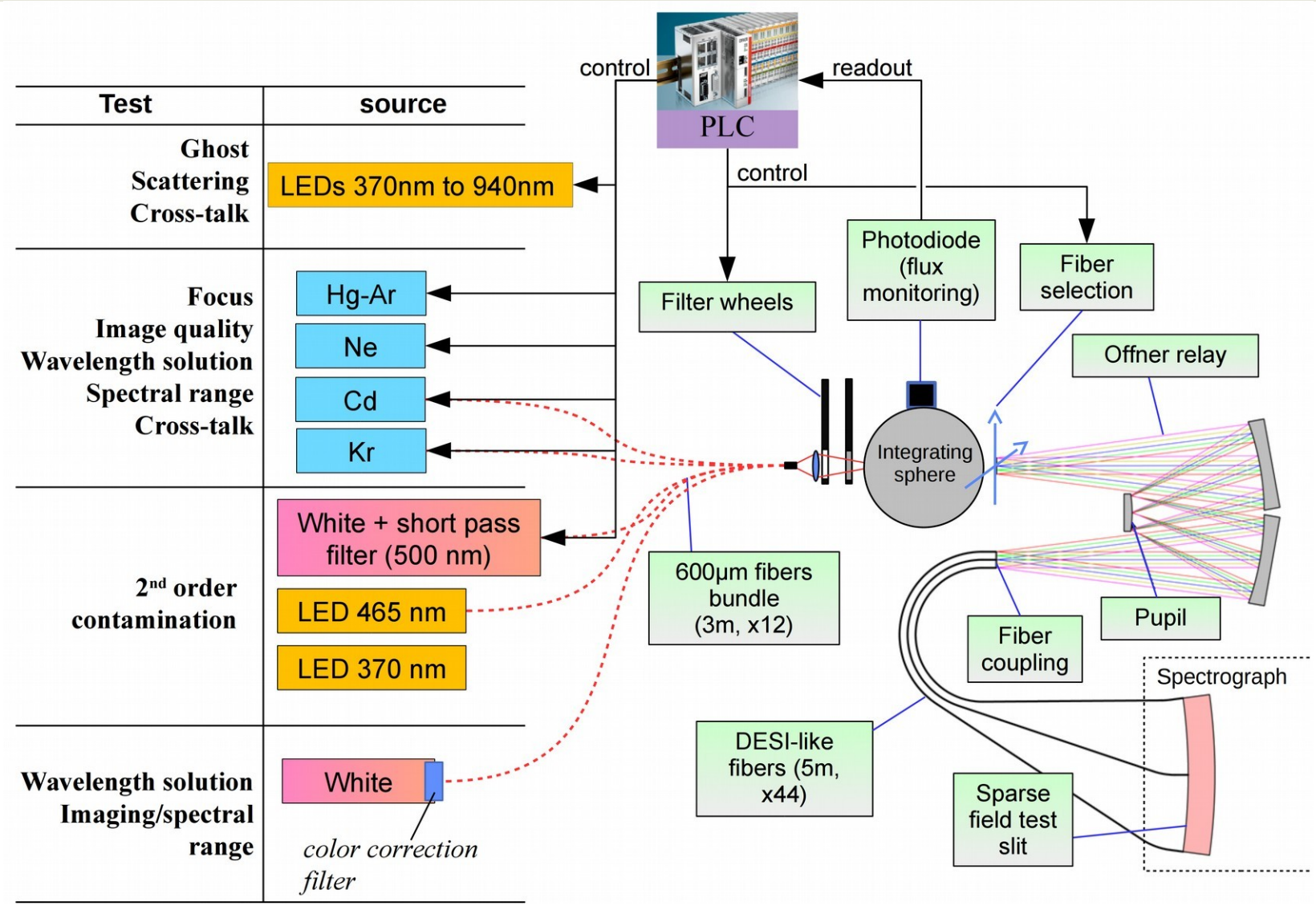
- 10 identical spectrographs
- 10 x 500 fibers
- 3 arms :
  NIR, Red, Blue



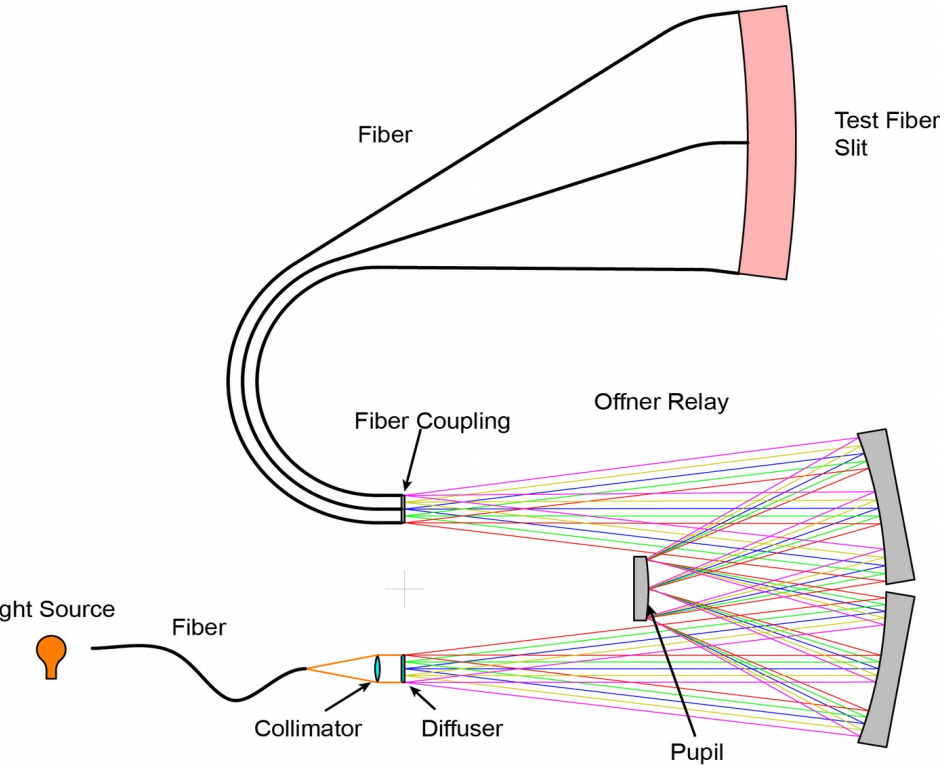
The DESI spectrograph

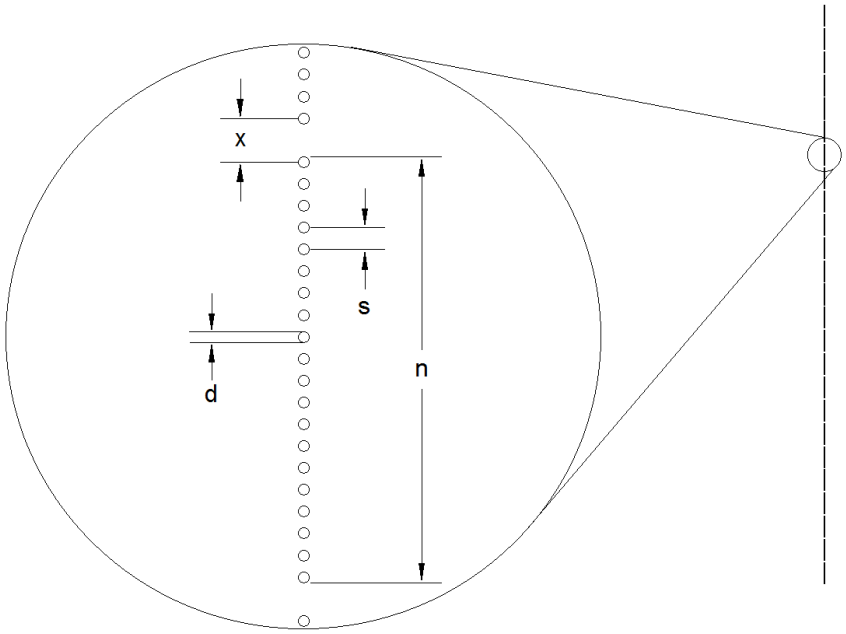


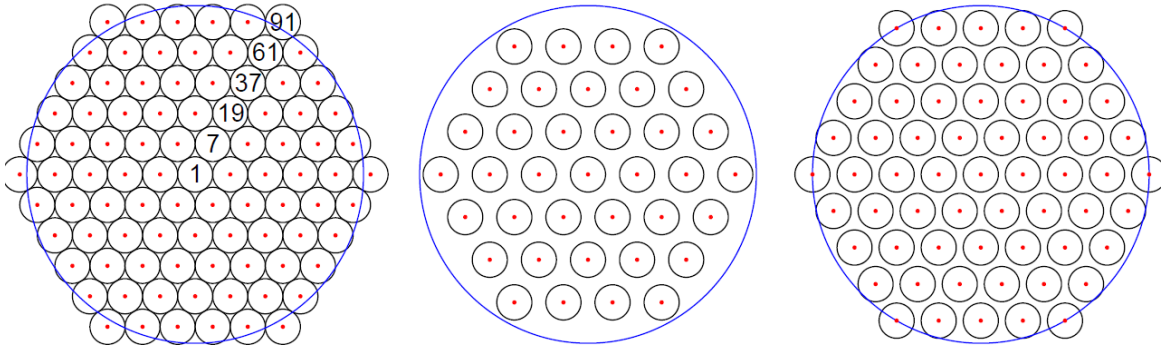
Illumination Testbench (AMU)



Fiber slit(s): light injection



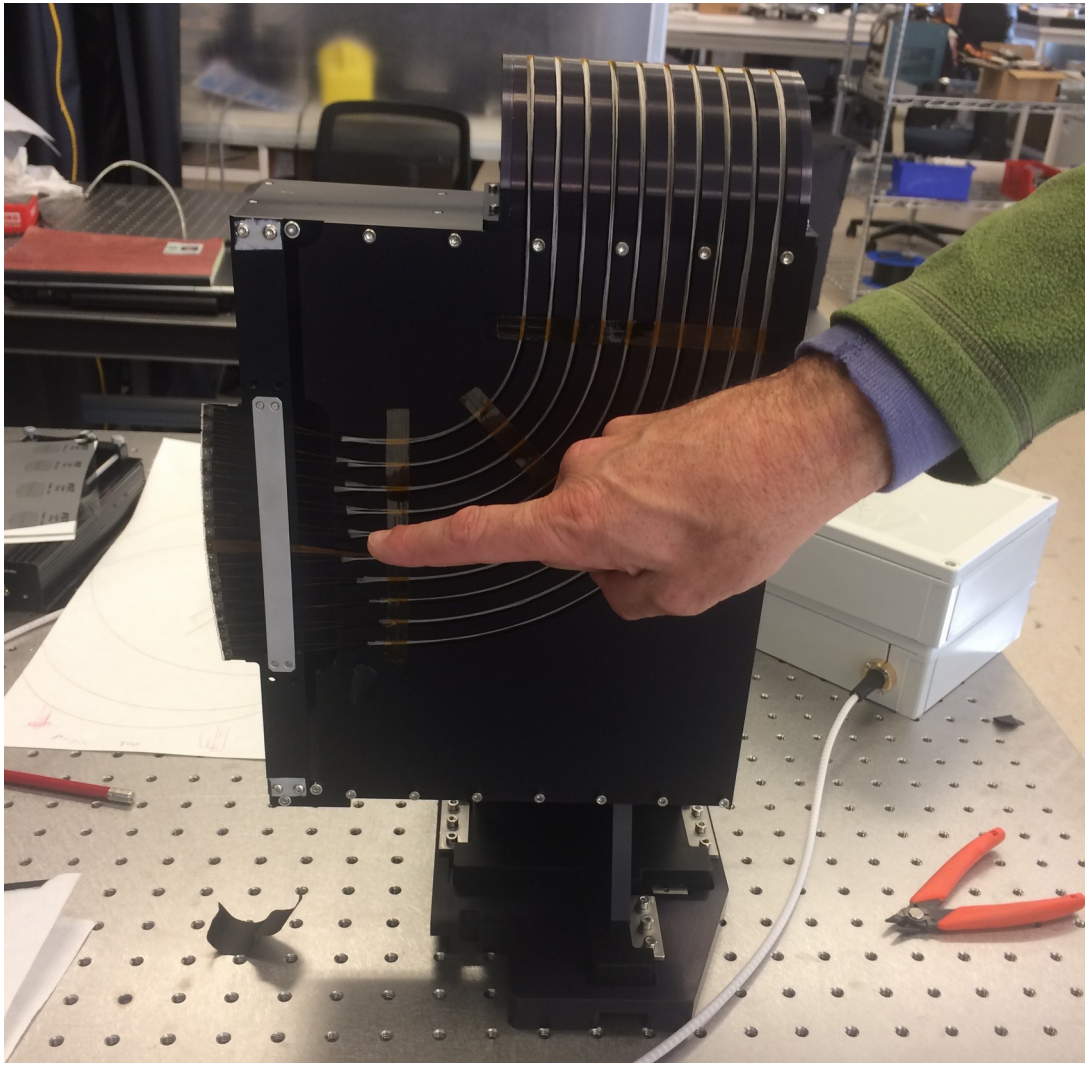




Fiber slit(s): “sparse fiber slit”

- 21 well separated fibers
- May be illuminated individually (AMU bench)

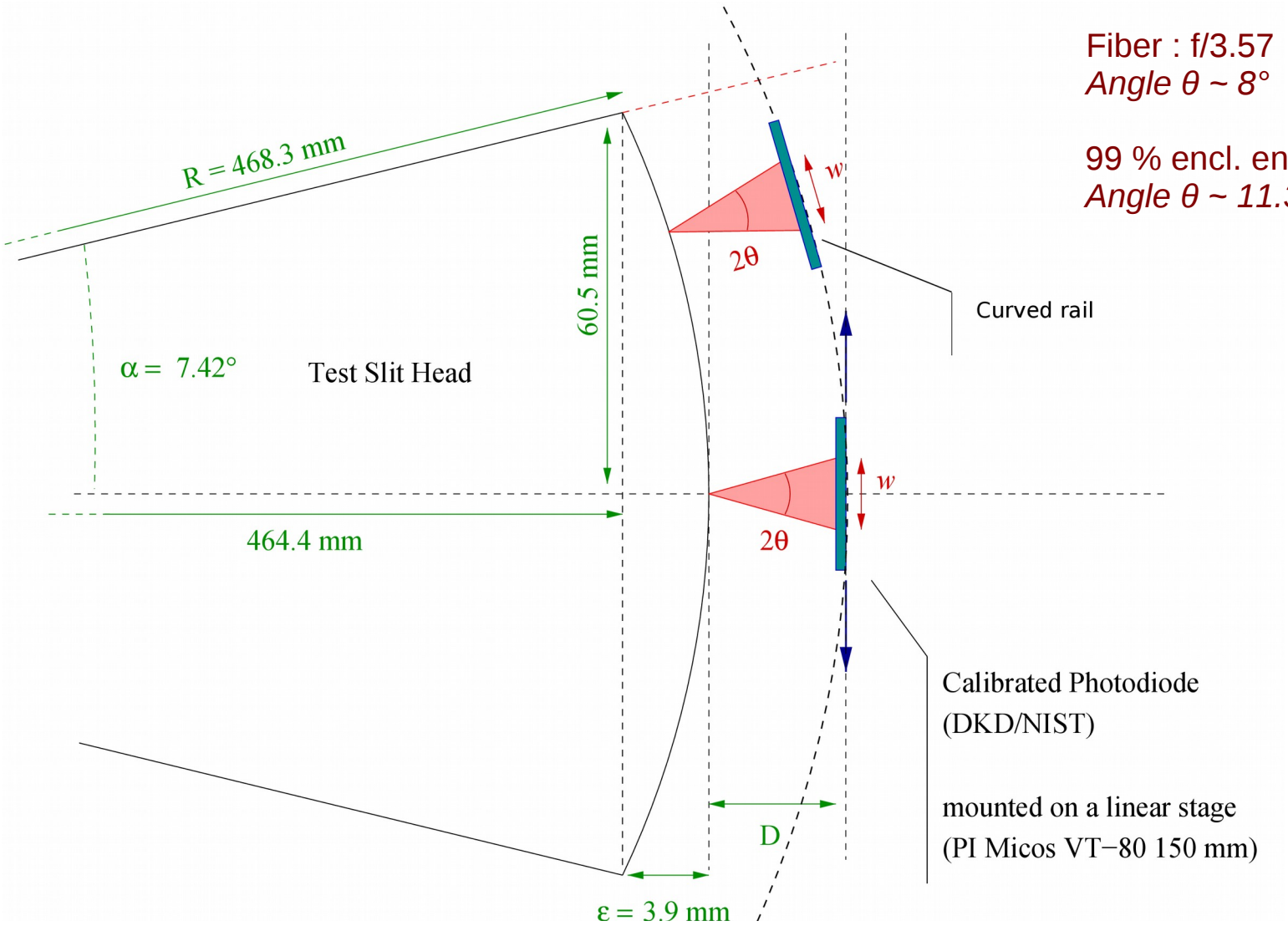
Fiber : f/3.57
Angle θ ~ 8°



Throughput measurement proposal

- **Critical** : Misestimating the spectrograph throughput may endanger the DESI science (and the mistake may be done 10 times!)
- Measurement to be done during **slit removal/reinstall** repeatability test (limited overhead)
- **Calibration of the total flux** at the exit of each fiber of the sparse fiber slit
- **Proposed Procedure** : for the same illumination setups (LEDs)
  - **(1) Sparse Test Slit inside the spectrograph** : integrated flux measured on the CCD for the 3 arms of the spectrograph ;
  - **(2) Sparse Test Slit outside of the spectrograph, in front of our device** : flux (in the same illumination conditions) measured by our calibrated photodiode
  - **Ratio (1)/(2)** gives **throughput** (from fiber exit to the CCD included)

Mechanical design

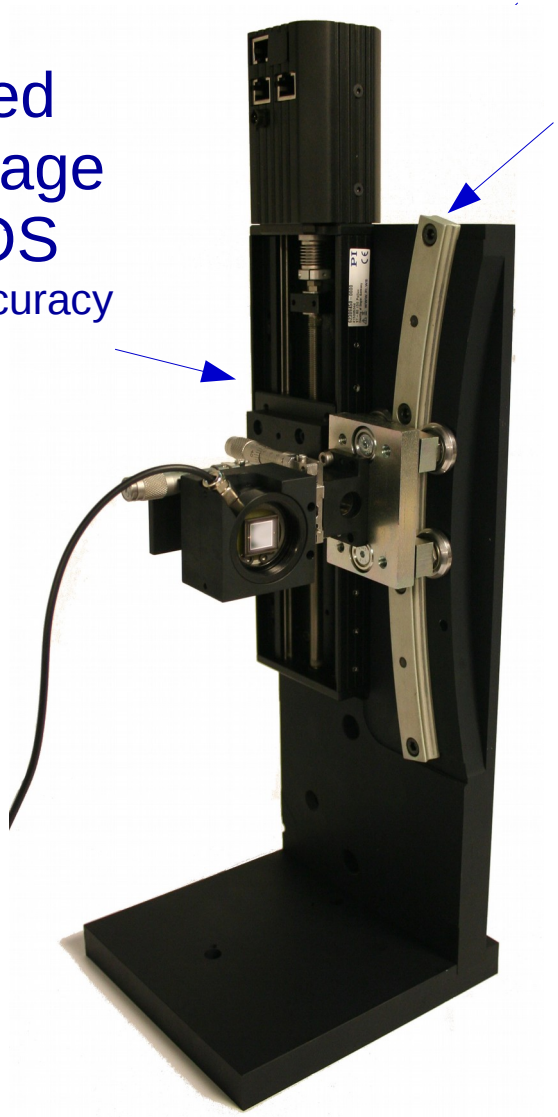


Fiber : f/3.57
Angle θ ~ 8°

99 % encl. energy : f/2.5
Angle θ ~ 11.3°

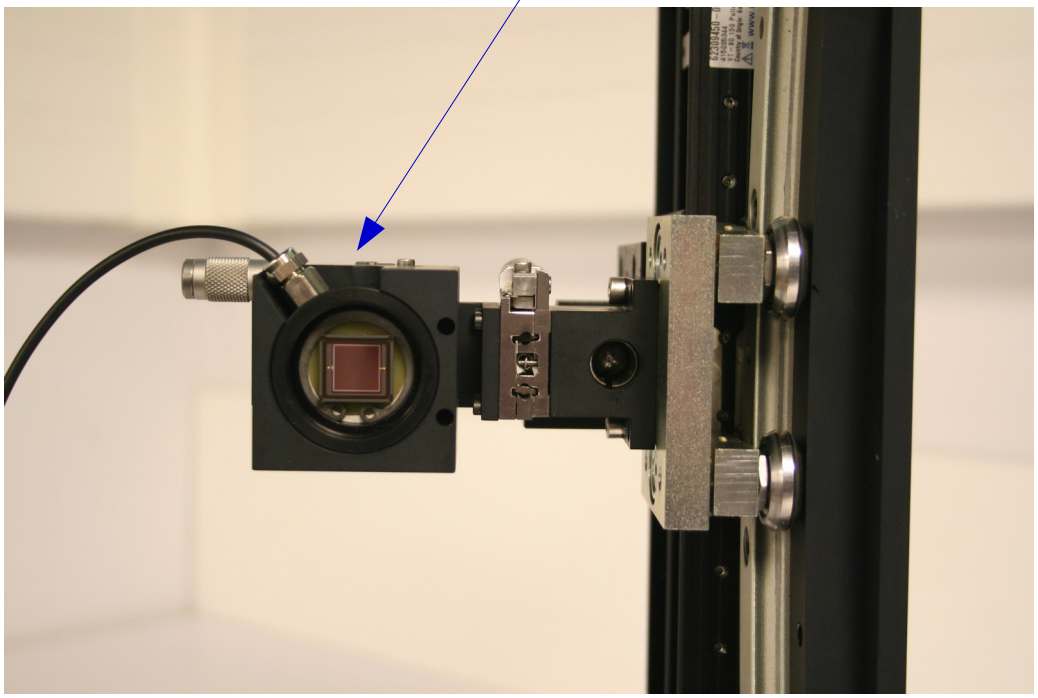
Throughput measurement device

Motorized linear stage Pi/MICOS
<0.4 µm accuracy

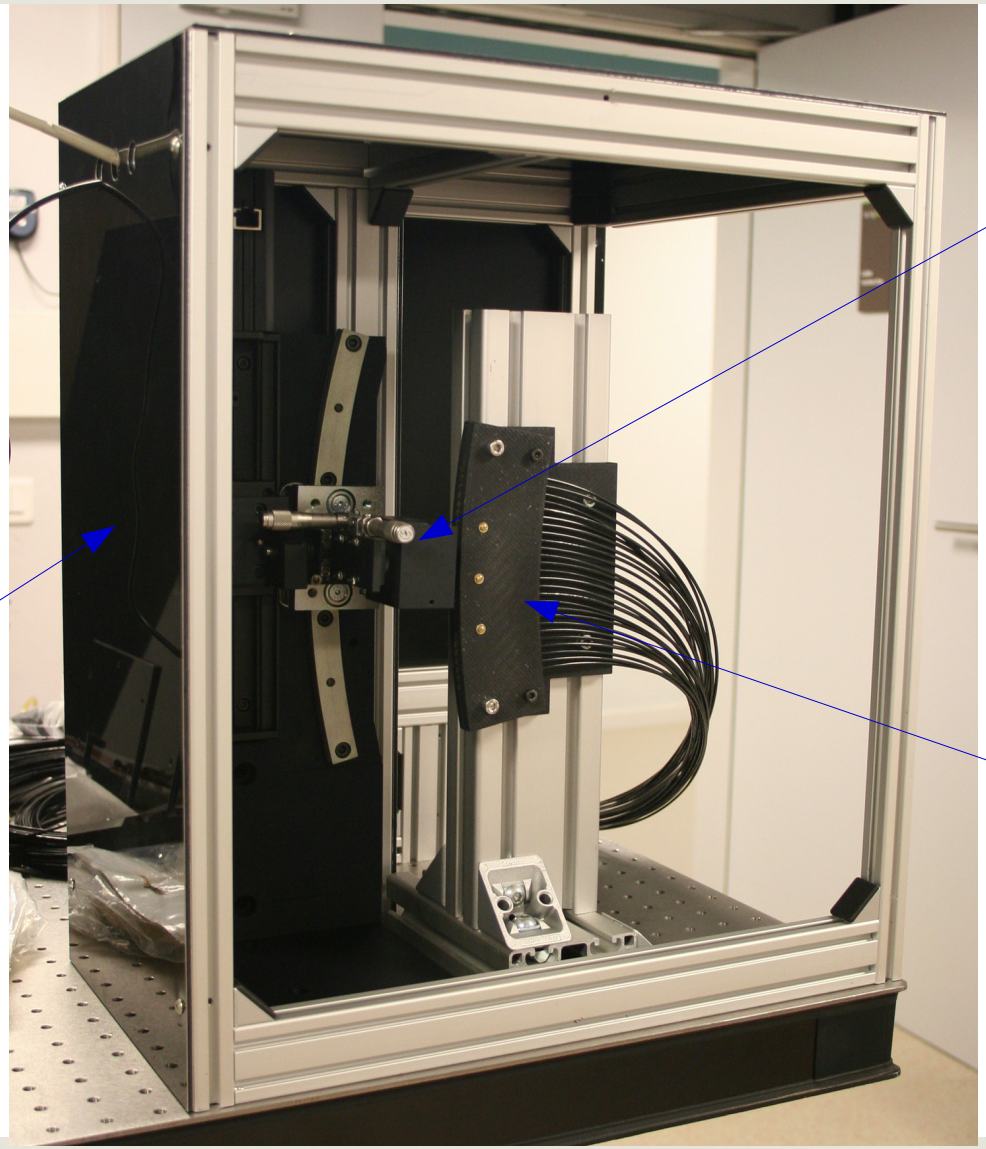


Curved rail
(radius 500 mm)

Calibrated Photodiode
10x10 mm²



Throughput measurement device



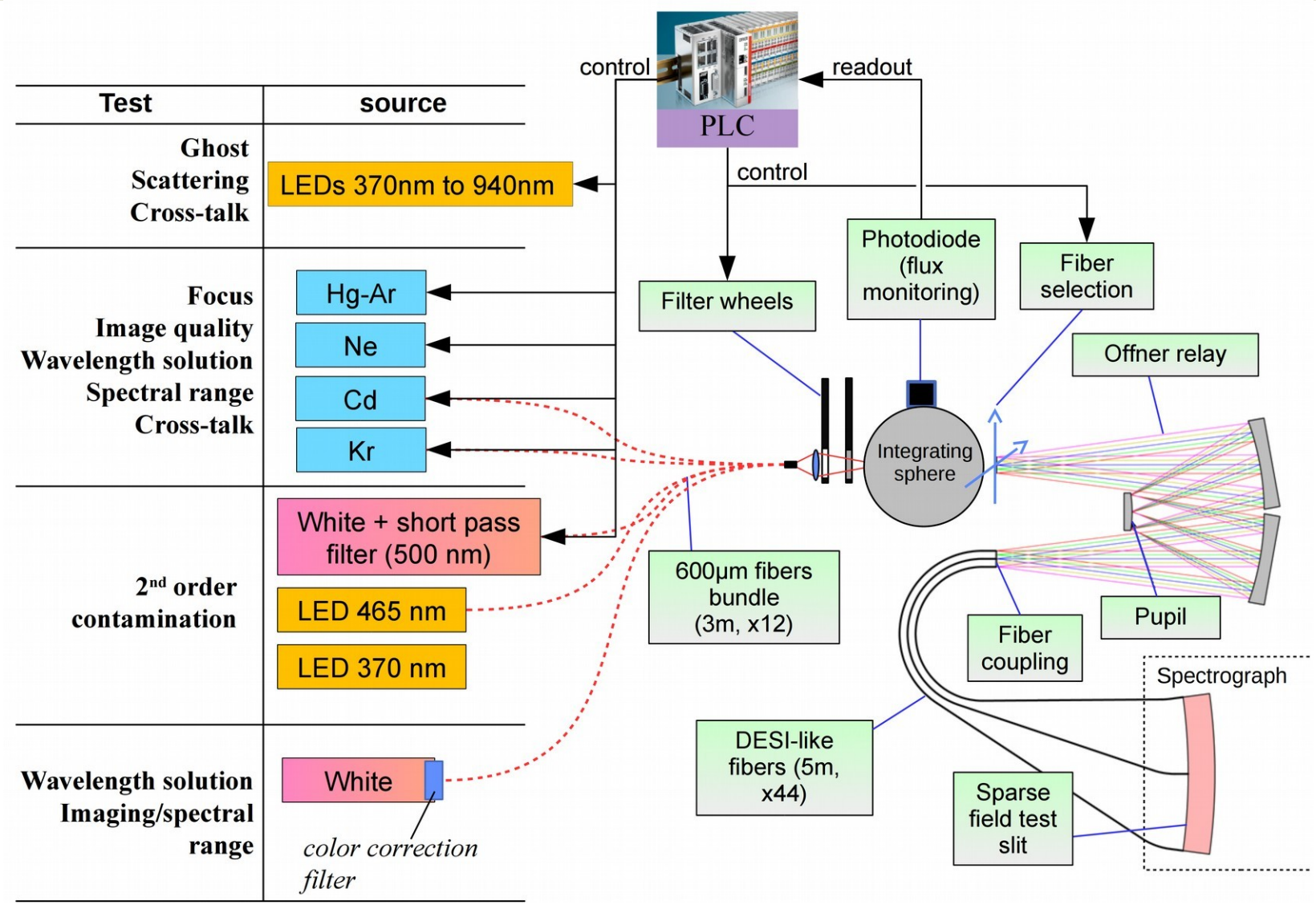
Calibrated Photodiode

- MD-37-SU100 **calibrated** (**spectral responsivity** [A/W])
  - **DKD** (DE) **certified absolute calibration**
  - 2 % on 250 – 1100 nm.
- Size : 10x10 = 100 mm²
- Photodiode current readout : picoammeter

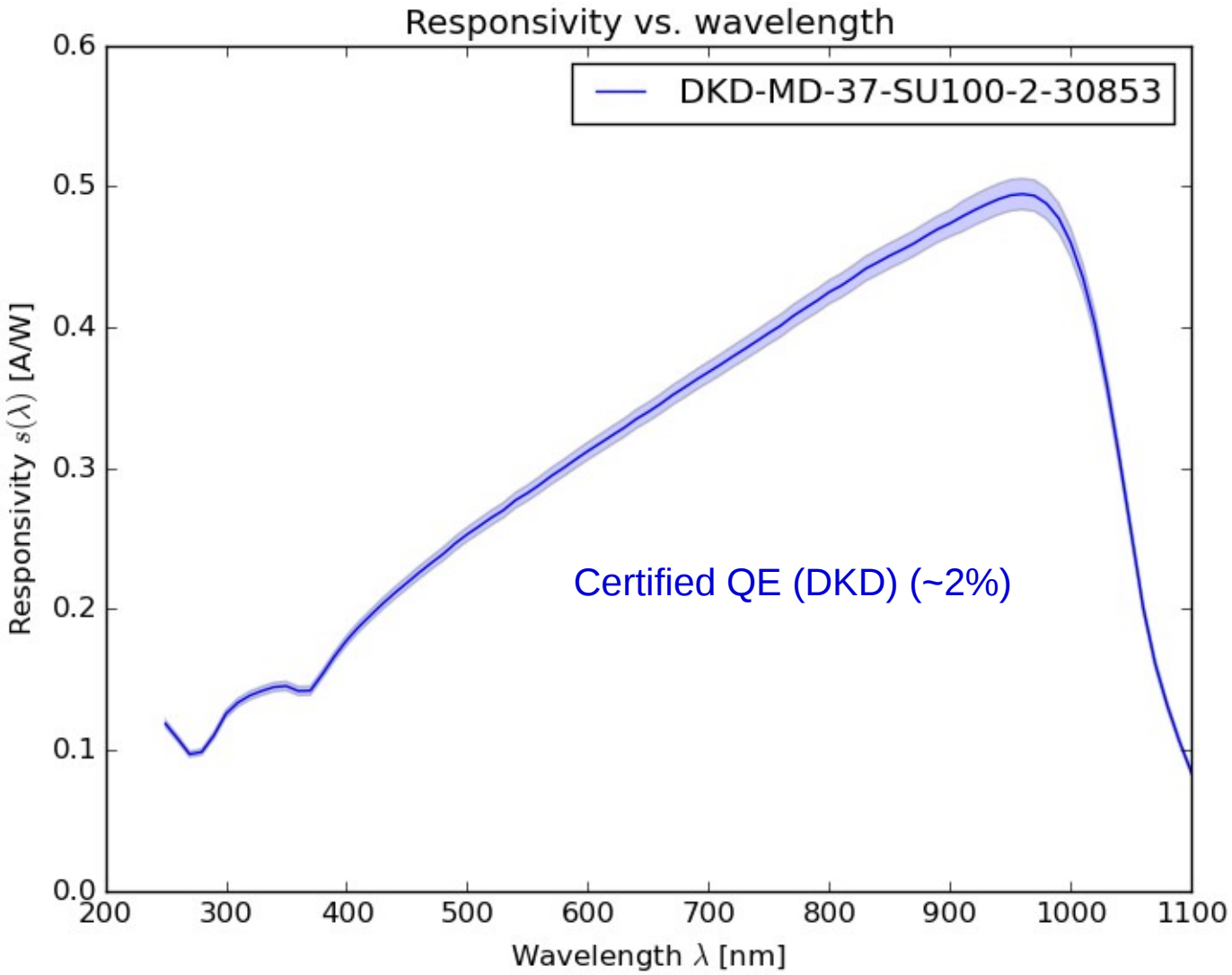
  Keithley 6514, or better **6482** (2 channels), (fA)
- **Simultaneous monitoring** of :
  - Light flux in the integrating sphere
  - Light flux exiting the fiber

    → Control of the **illumination stability**

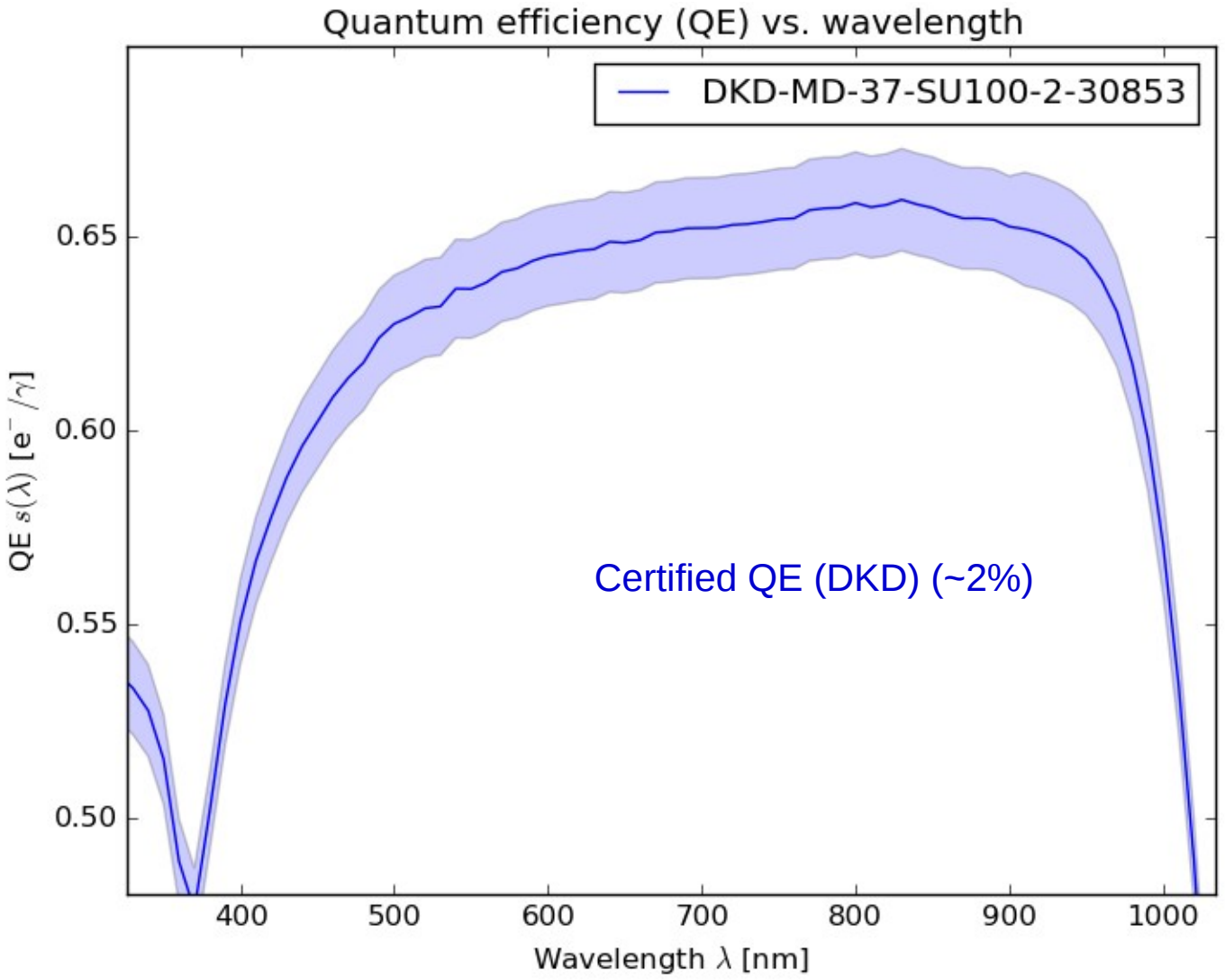
Illumination Testbench (AMU)



Photodiode Calibration (DKD certified)

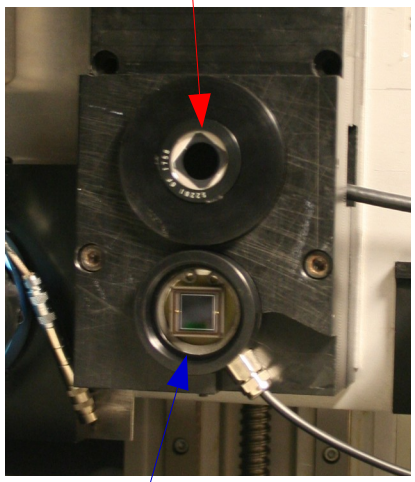


Photodiode Calibration (DKD certified)

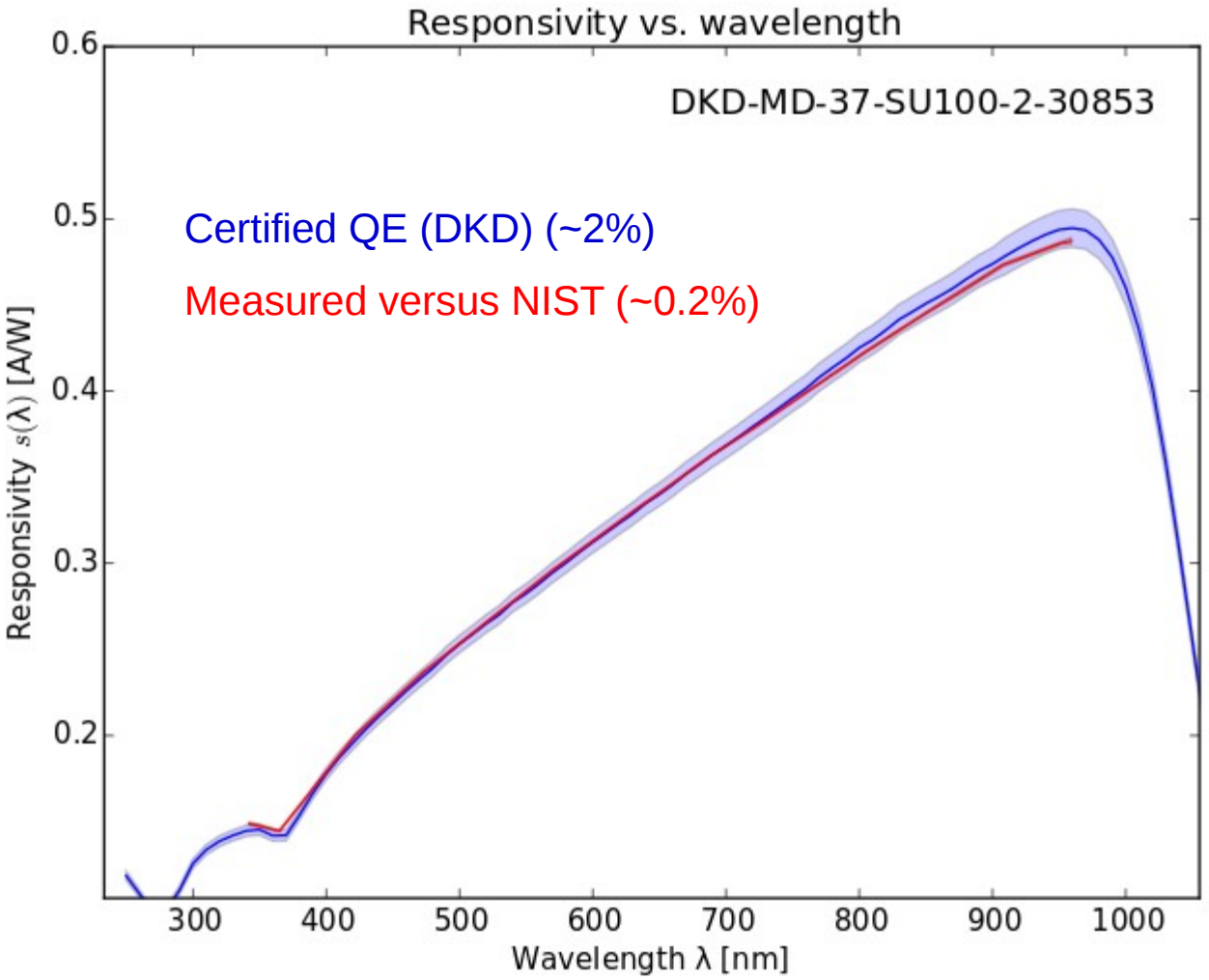


Photodiode Calibration & checks at LPNHE

NIST (0.2%)

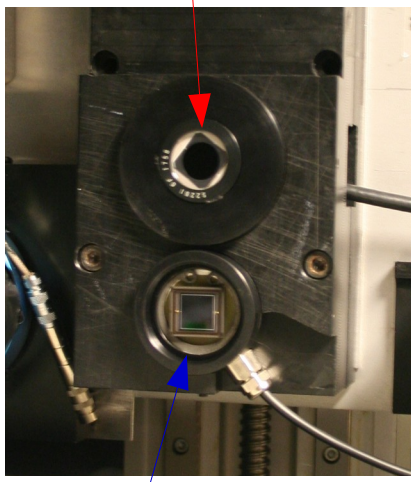


DKD

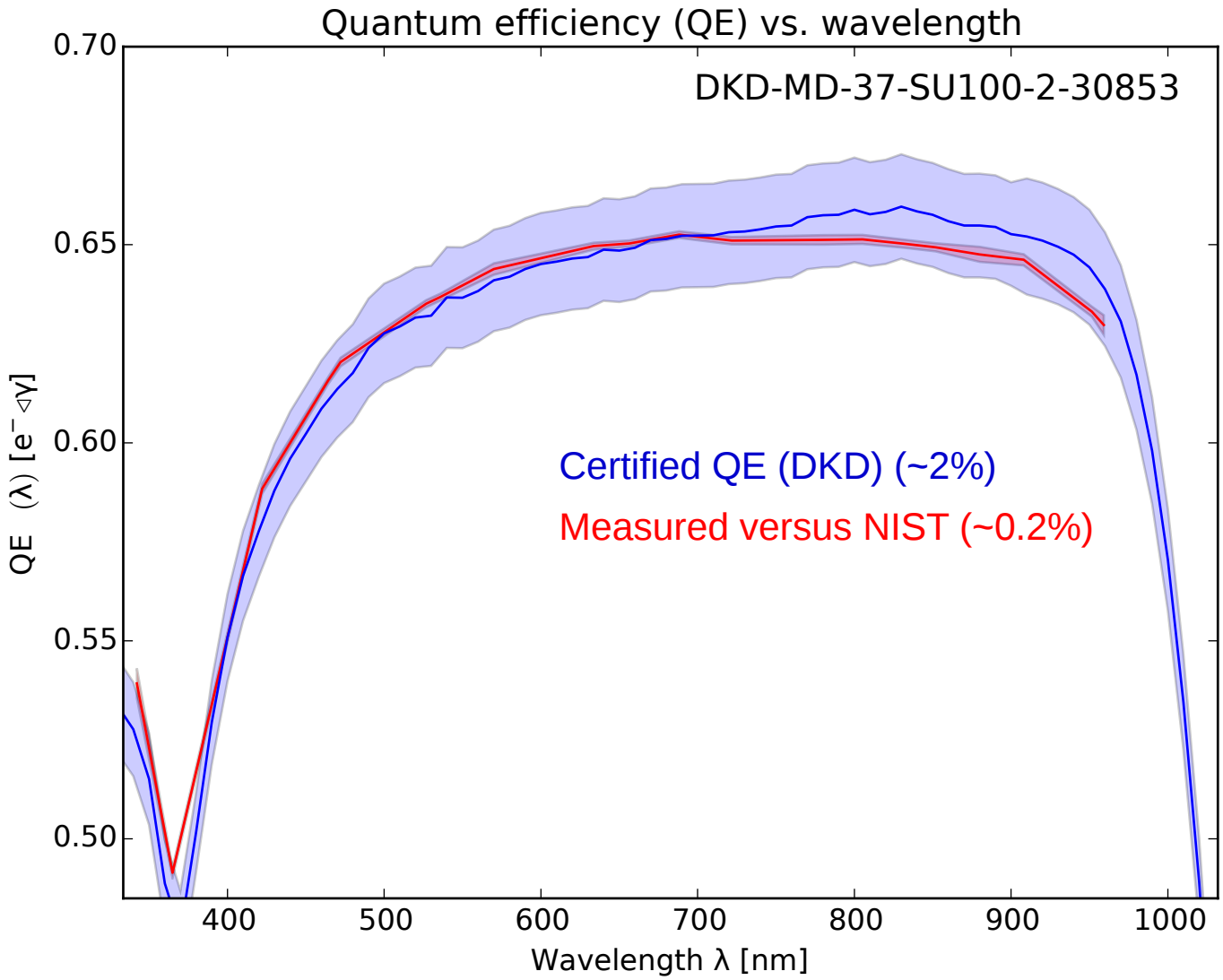


Photodiode Calibration & checks at LPNHE

NIST (0.2%)

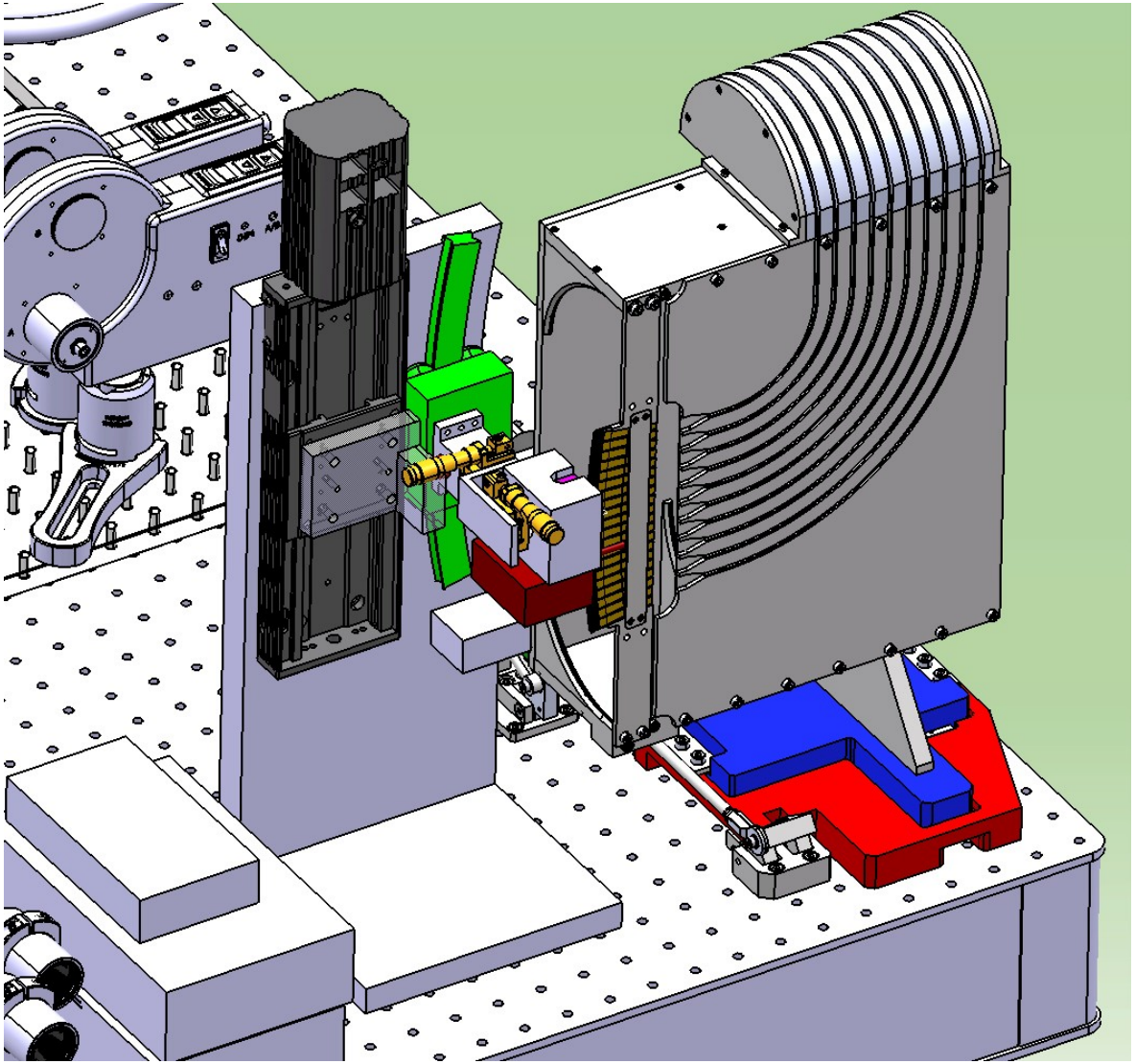


DKD

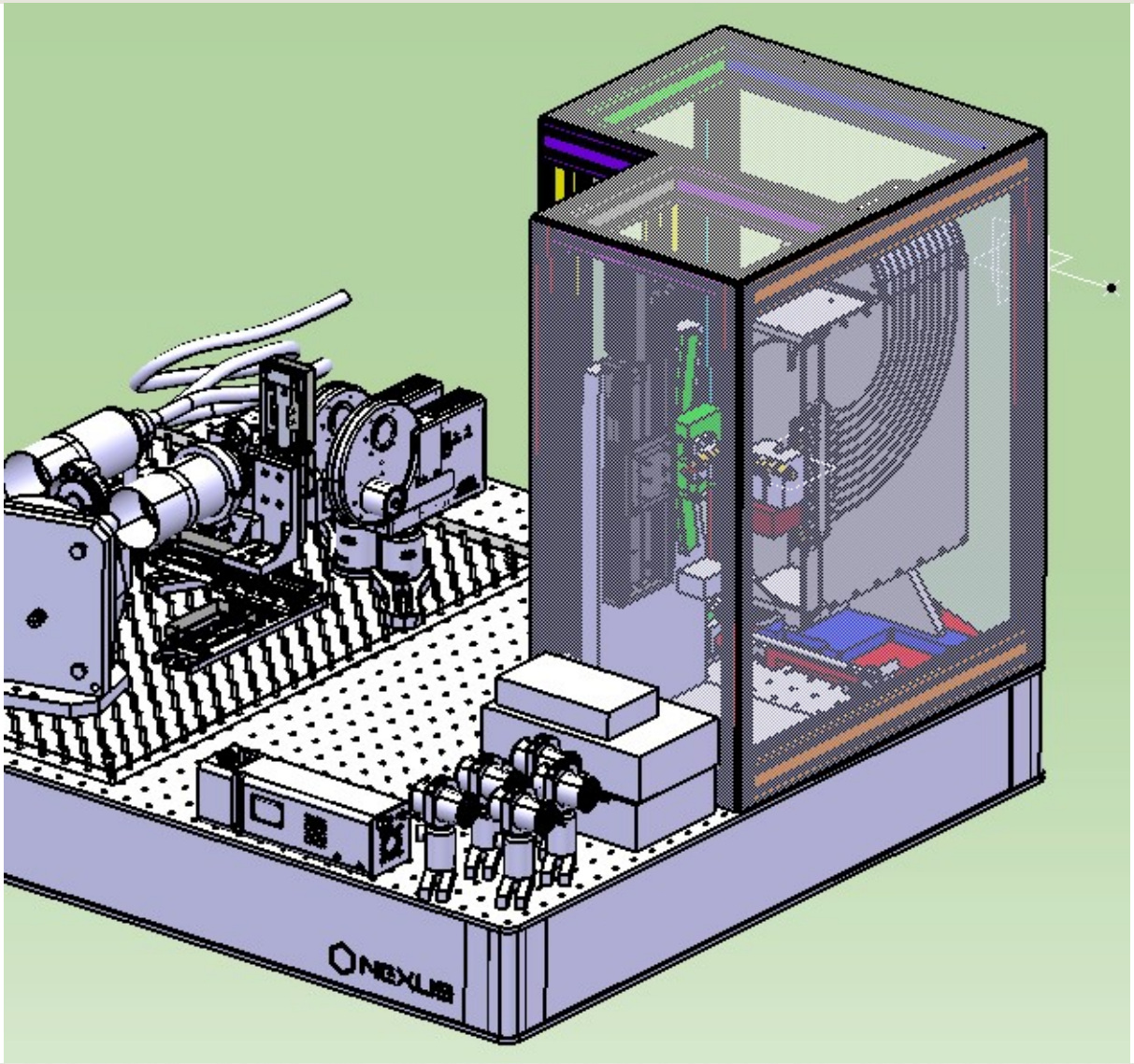


Integration on the AMU Testbench

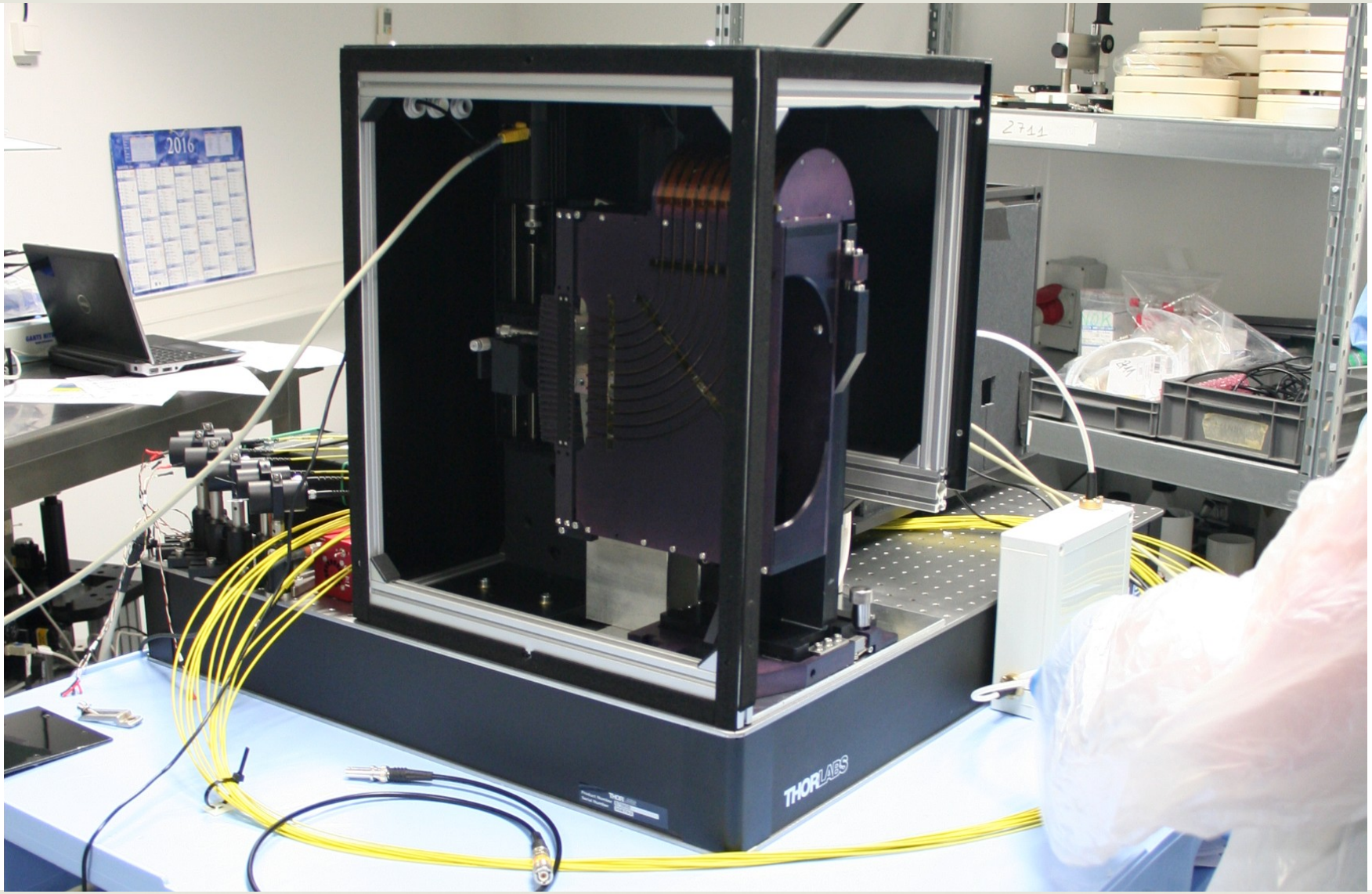
- **Challenging mechanical interface** between the fiber slit and our device (collision with fiber ends should be avoided at all cost!!)
- **Integration within the AMU testbench software** and the **ICS** (Xavier Regal, AMU)



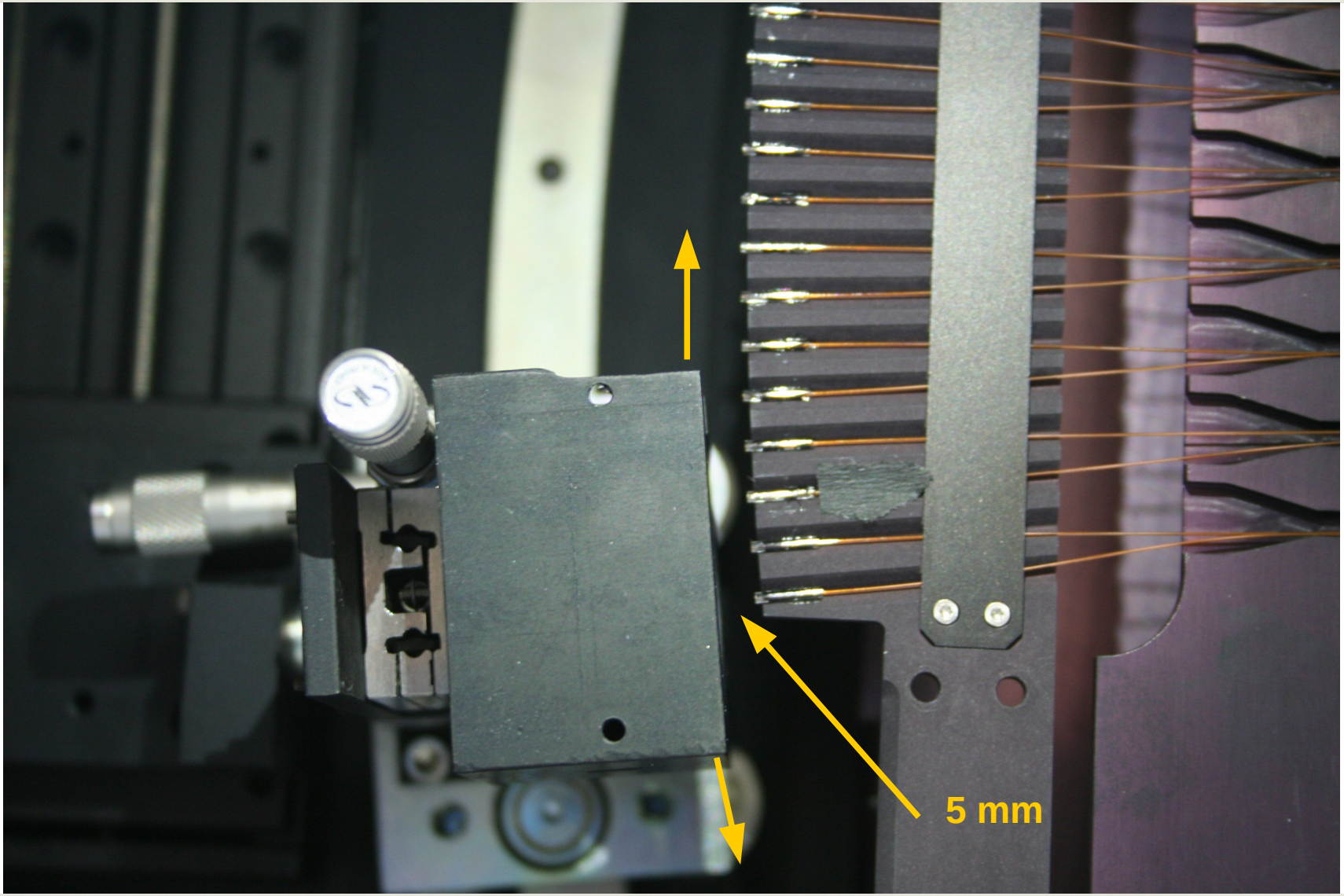
Integration on the AMU Testbench (dark box)



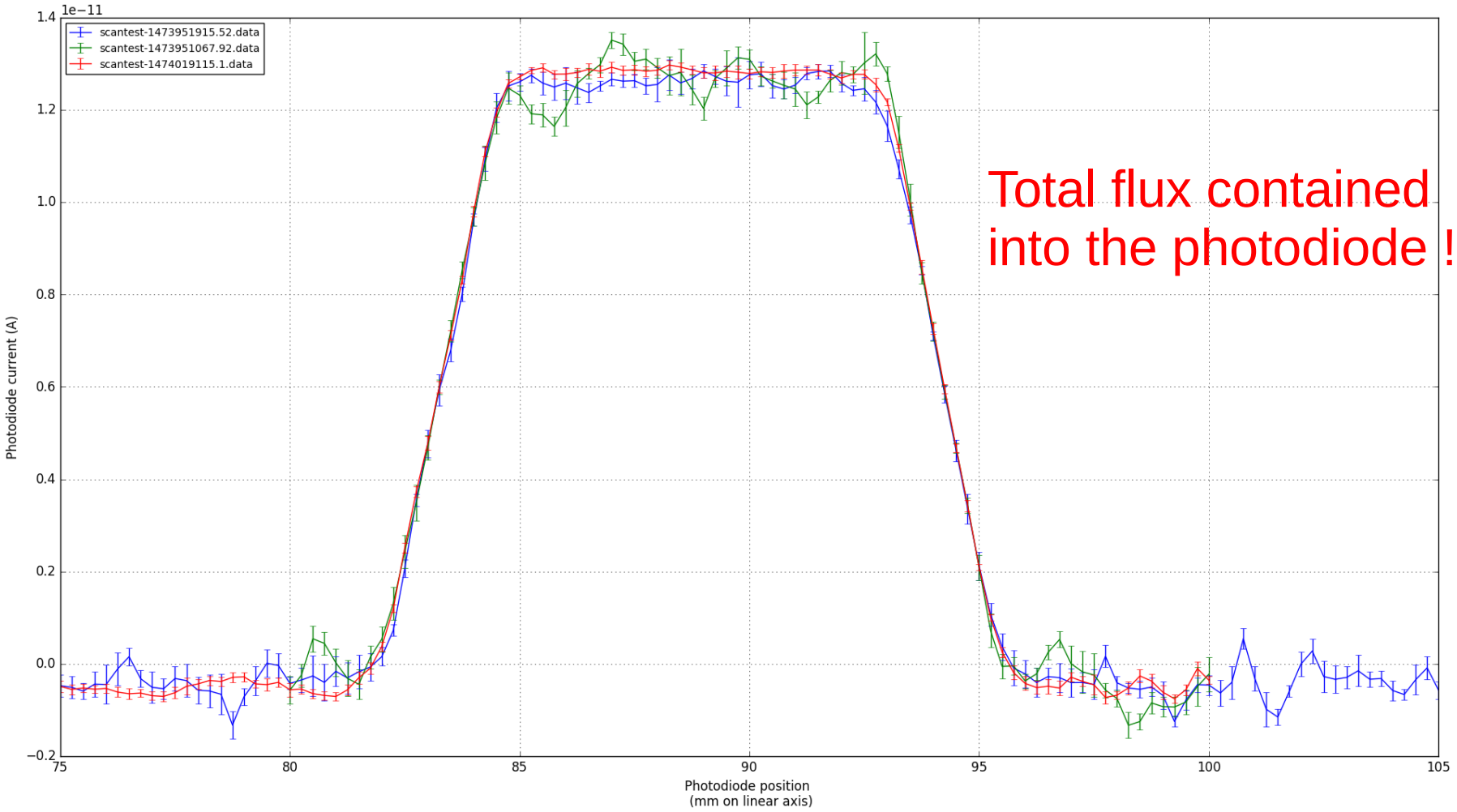
Installation at Winlight (sept. 2016)



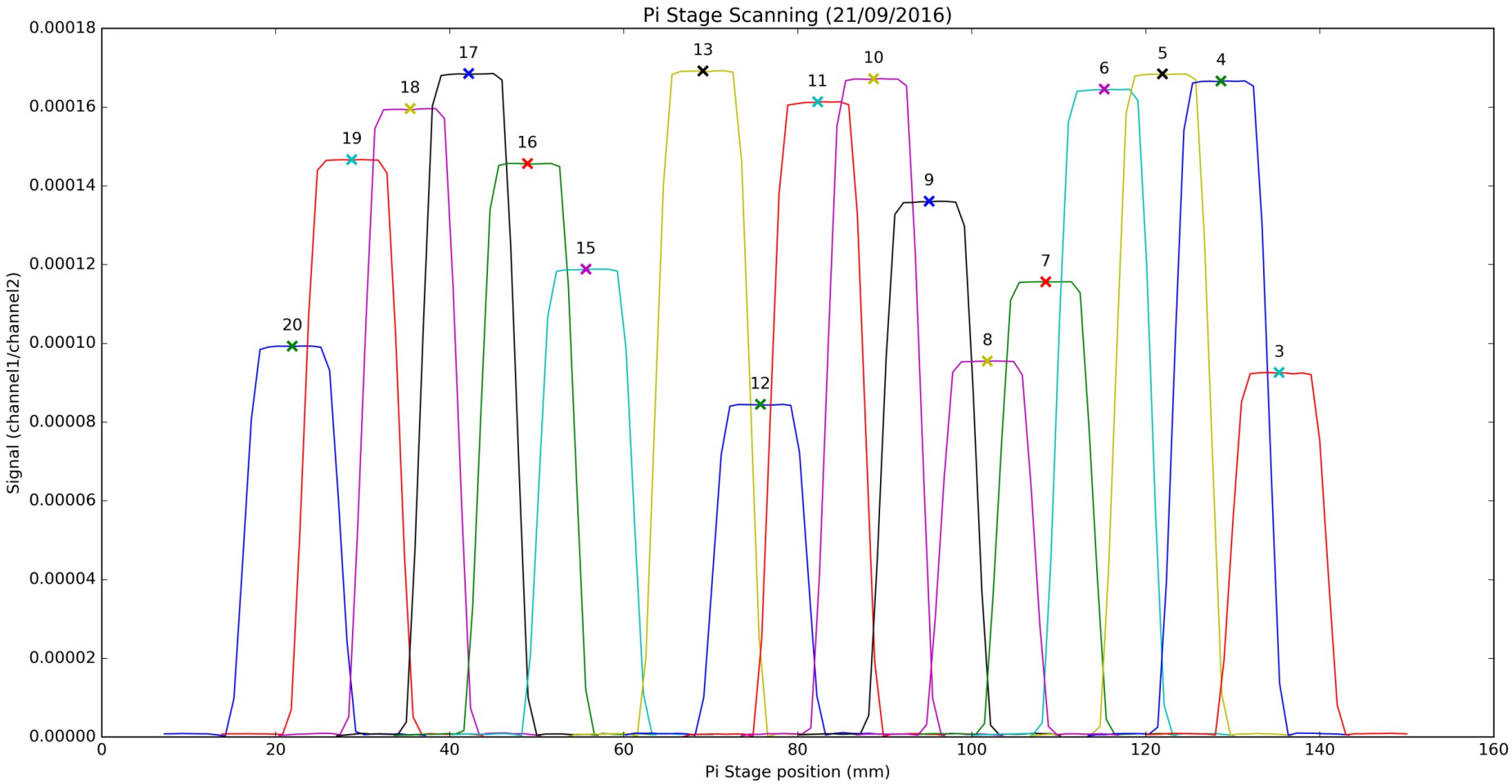
Installation at Winlight (sept. 2016)



First “scans” by moving the photodiode

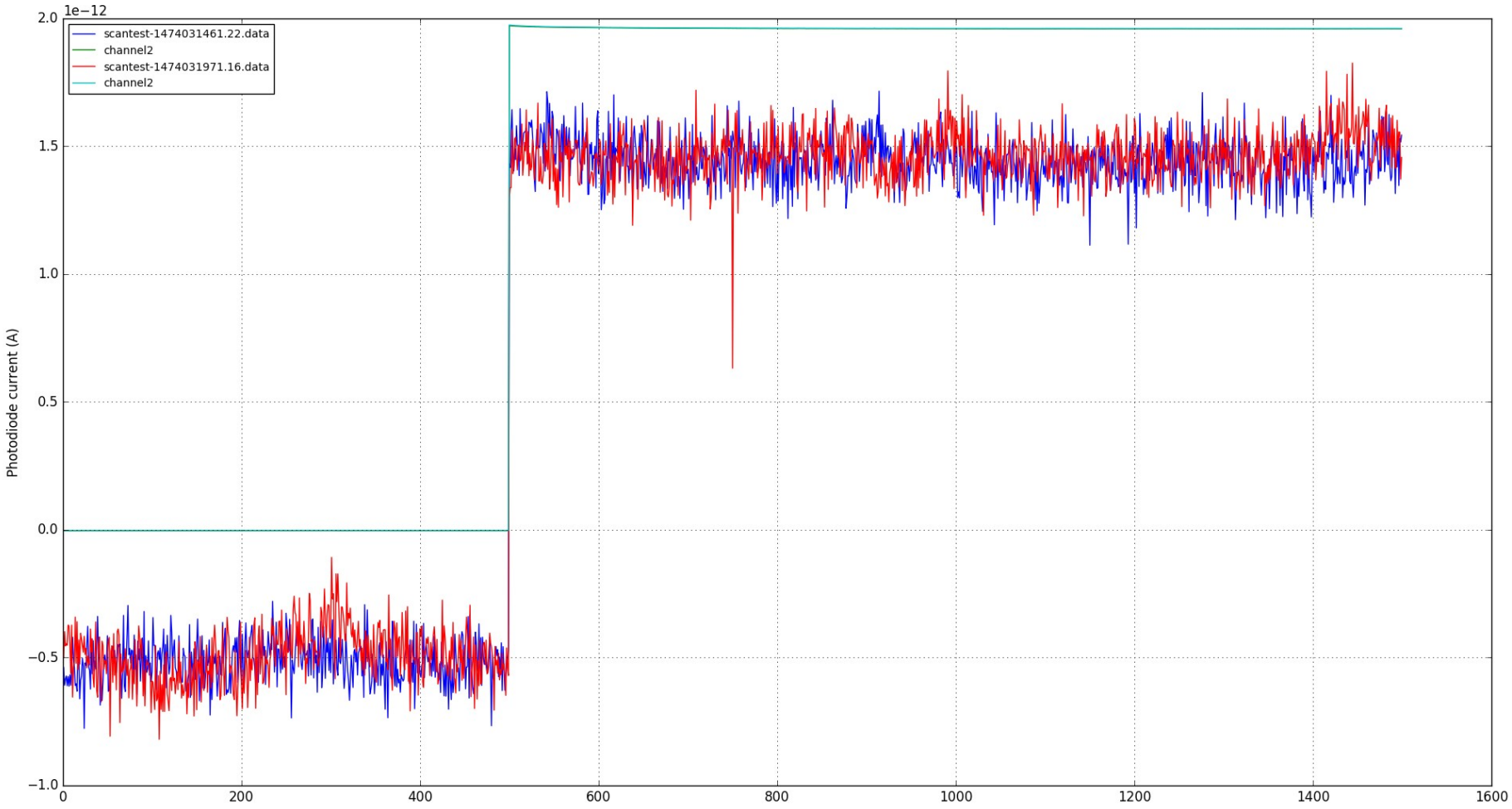


Scan of all the sparse slit fibers (S. Royanette)

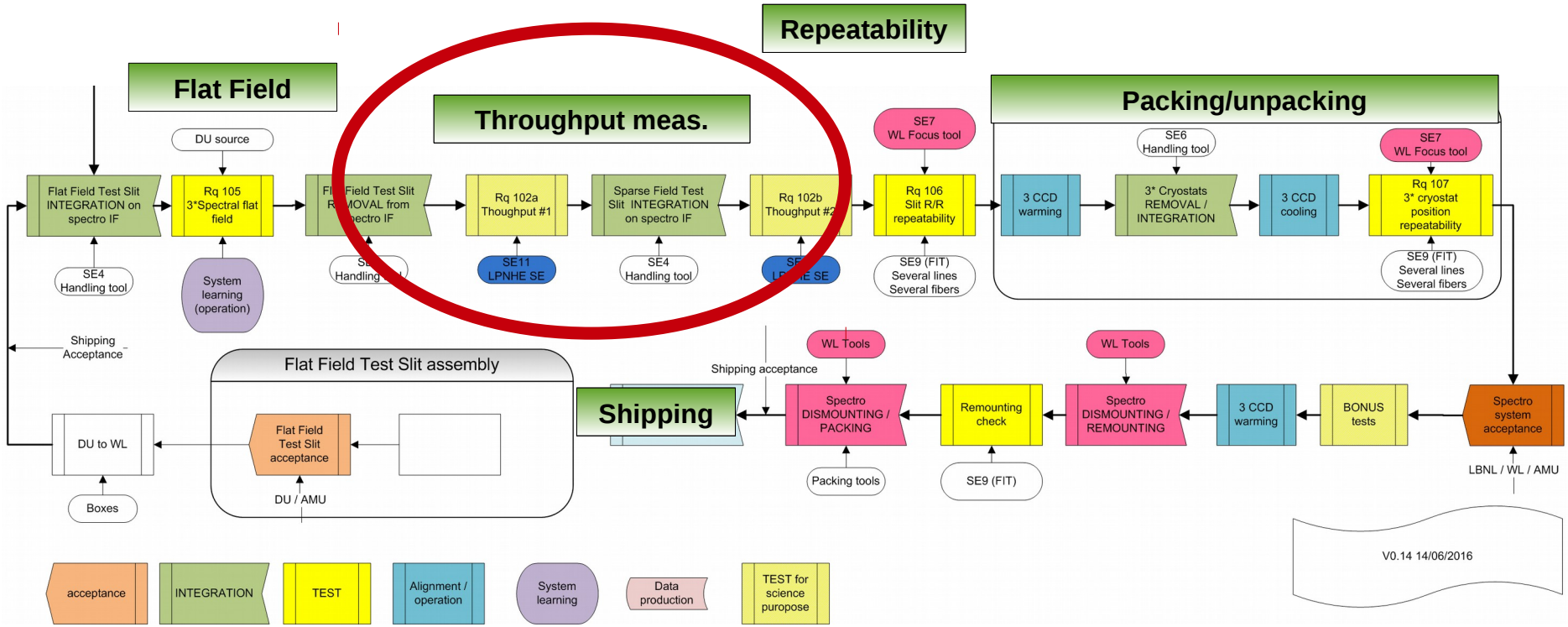


1 broken fiber; last one unreachable (mechanical limit)

Illumination stability



Integrated in the Spectrograph Tests (AMU)



Conclusions, and next steps

◆ Throughput measurement device **built, tested and installed on AMU testbench** at Winlight**.**

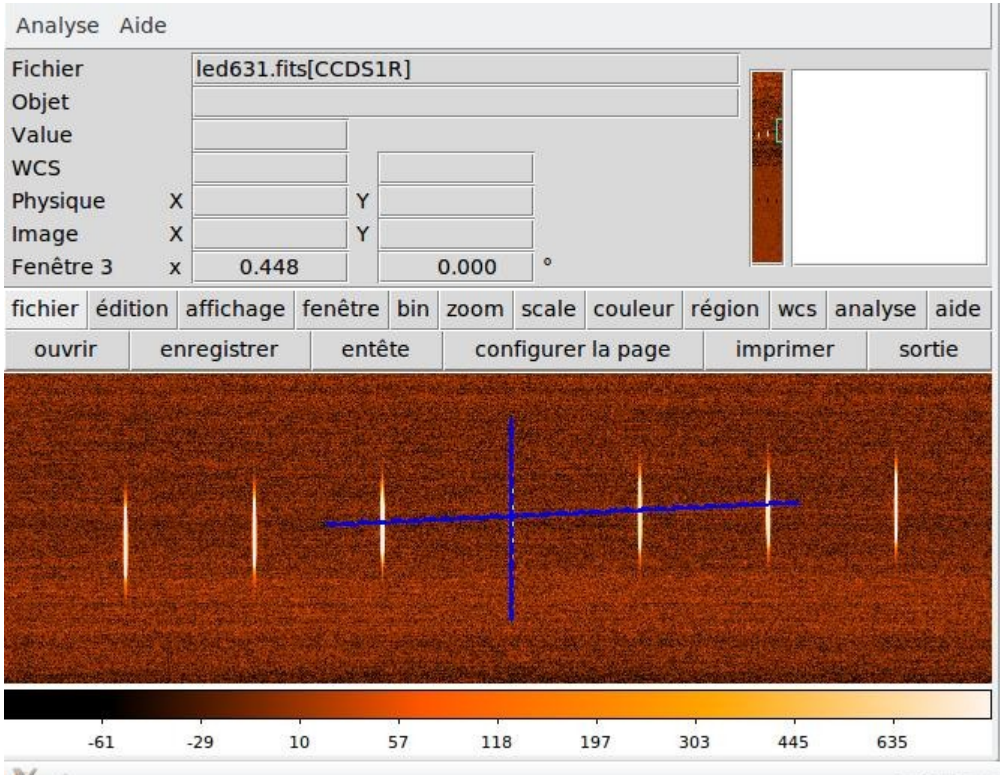
◆ On going improvement on the **photodiode current noise**.

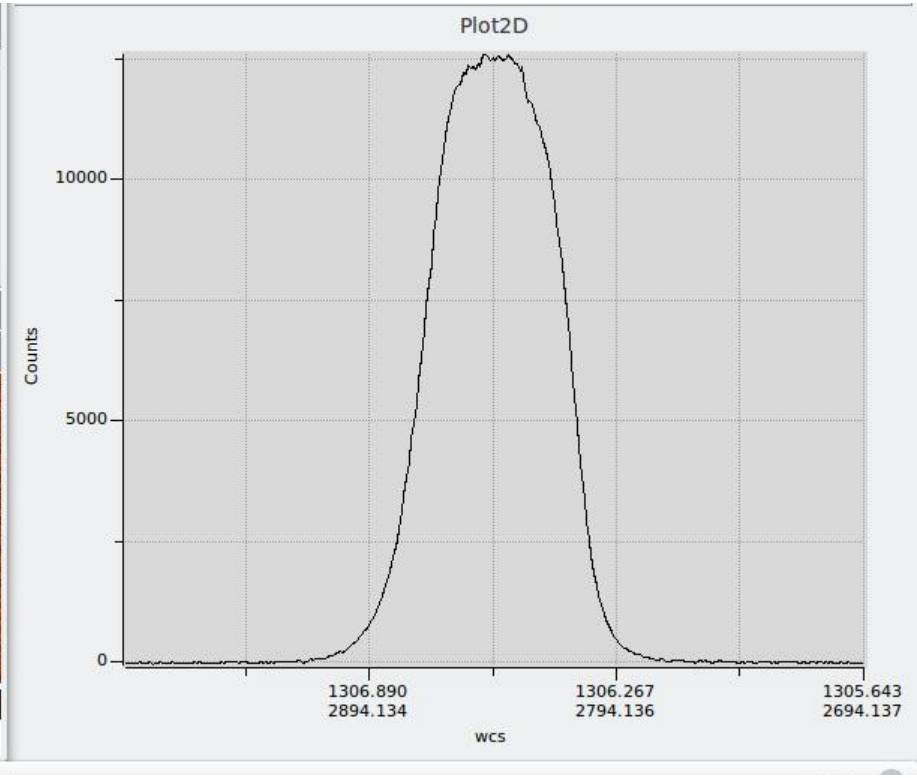
◆ Needed to complete the throughput measurement:

- Pipeline & spectra extraction for LED sources (J. Guy)
- A good knowledge of the sensors, esp. the **CCD gains** (NIR, Red, Blue)
- Charact. of the neutral densities and spectro. shutter.

◆ Cycles of Sparse Slit head **insertion/extraction** to do the measurement (expected early 2017).

LED spectra


Analyse Aide
Fichier led631.fits[CCDS1R]
Objet
Value
WCS
Physique X Y
Image X Y
Fenêtre 3 x 0.448 0.000 °
fichier édition affichage fenêtre bin zoom scale couleur région wcs analyse aide
ouvrir enregistrer entête configurer la page imprimer sortie
-61 -29 10 57 118 197 303 445 635


Plot2D
Counts
10000
5000
0
1306.890
2894.134
1306.267
2794.136
1305.643
2694.137
wcs