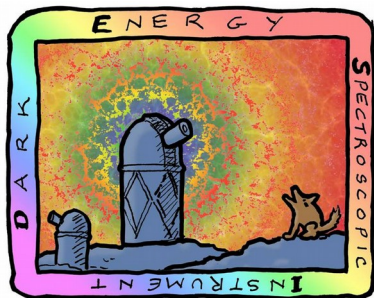


# DESI

Measuring the spectrograph throughput :

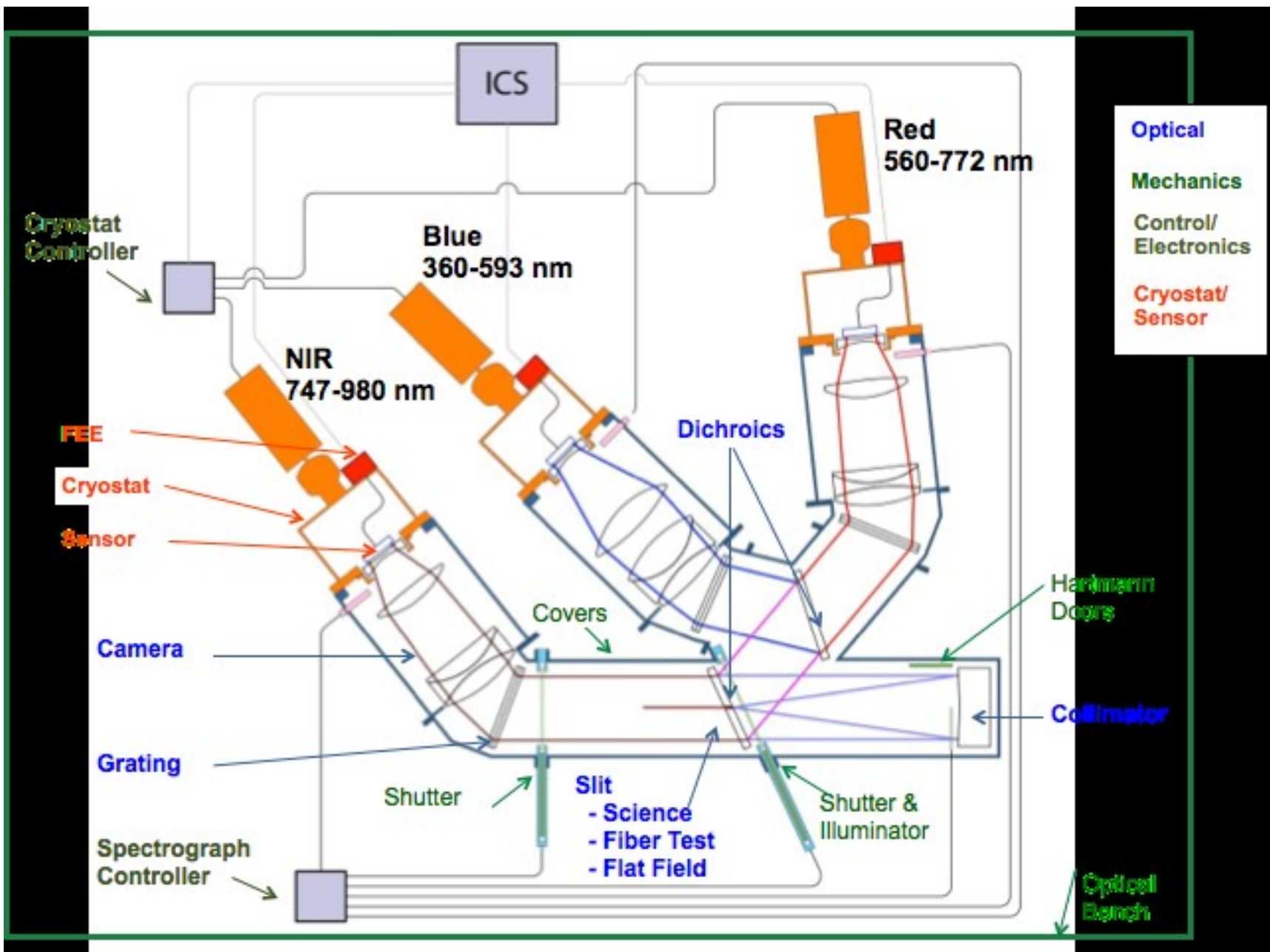
*A proposal*

J. Guy, L. Le Guillou, S. Karkar,  
C. Balland, K. Shahmanèche, E. Sepulveda



# Measuring the throughput

- Critical : misestimating the spectro. throughput may endanger the DESI science
- Throughput measurement may be done during the acceptance tests in Marseille (LAM/Winlight)
  - E.g : during fiber sparse field test slit removal/reinstall repeatability tests (Test 7.15 Acceptance tests)
  - Limited time overhead



ICS

Red  
560-772 nm

Blue  
360-593 nm

NIR  
747-980 nm

Cryostat  
Controller

FEE

Cryostat

Sensor

Dichroics

Covers

Camera

Hardman  
Doors

Grating

Collimator

Shutter

Slit  
- Science  
- Fiber Test  
- Flat Field

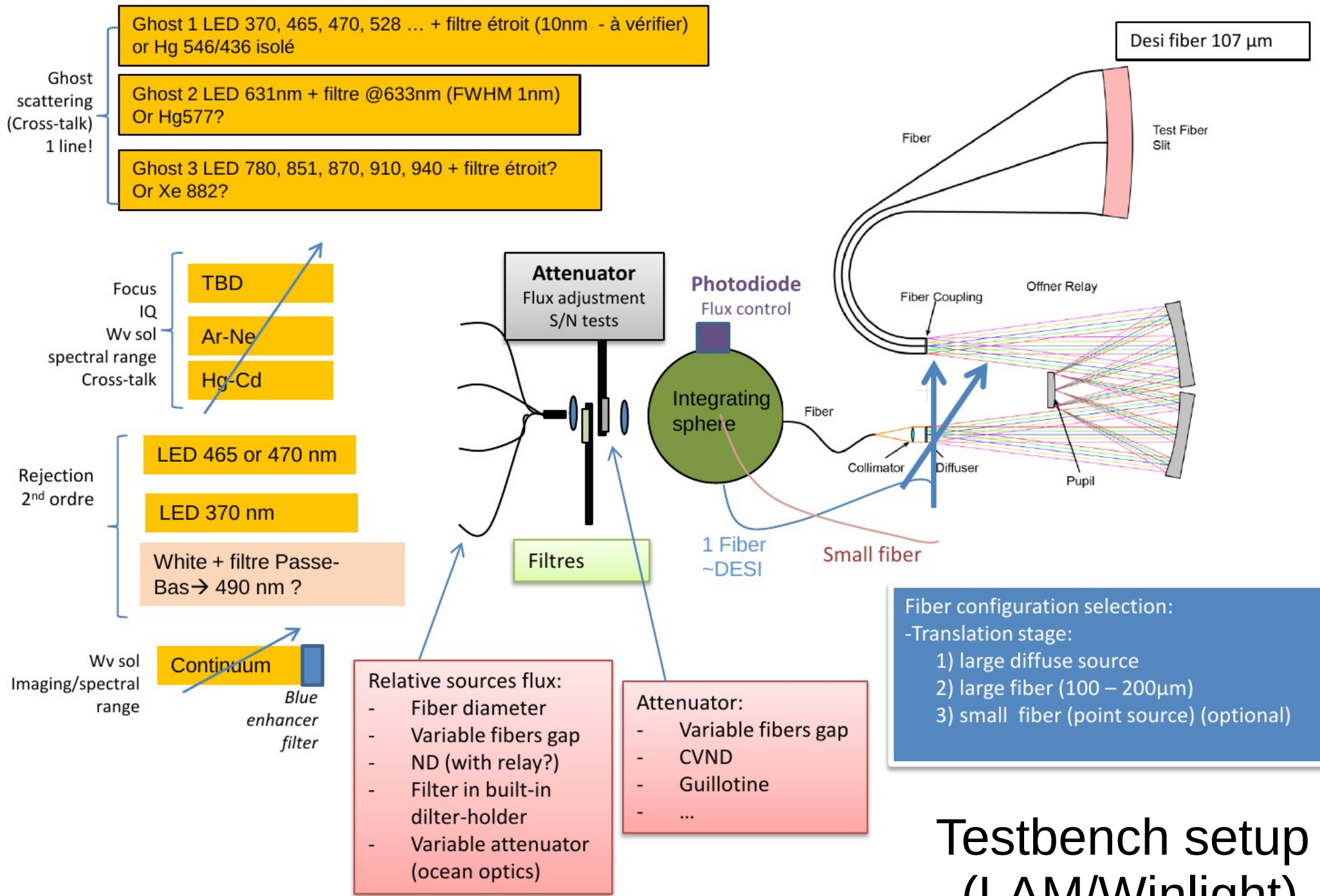
Shutter &  
Illuminator

Spectrograph  
Controller

Optical  
Bench

- Optical
- Mechanics
- Control/  
Electronics
- Cryostat/  
Sensor

Schéma (25/08/2015)



Ghost scattering (Cross-talk) 1 line!

- Ghost 1 LED 370, 465, 470, 528 ... + filtre étroit (10nm - à vérifier) or Hg 546/436 isolé
- Ghost 2 LED 631nm + filtre @633nm (FWHM 1nm) Or Hg577?
- Ghost 3 LED 780, 851, 870, 910, 940 + filtre étroit? Or Xe 882?

- Focus IQ Wv sol spectral range Cross-talk
- TBD
  - Ar-Ne
  - Hg-Cd

- Rejection 2<sup>nd</sup> ordre
- LED 465 or 470 nm
  - LED 370 nm
  - White + filtre Passe-Bas → 490 nm ?

- Wv sol Imaging/spectral range
- Continuum
  - Blue enhancer filter

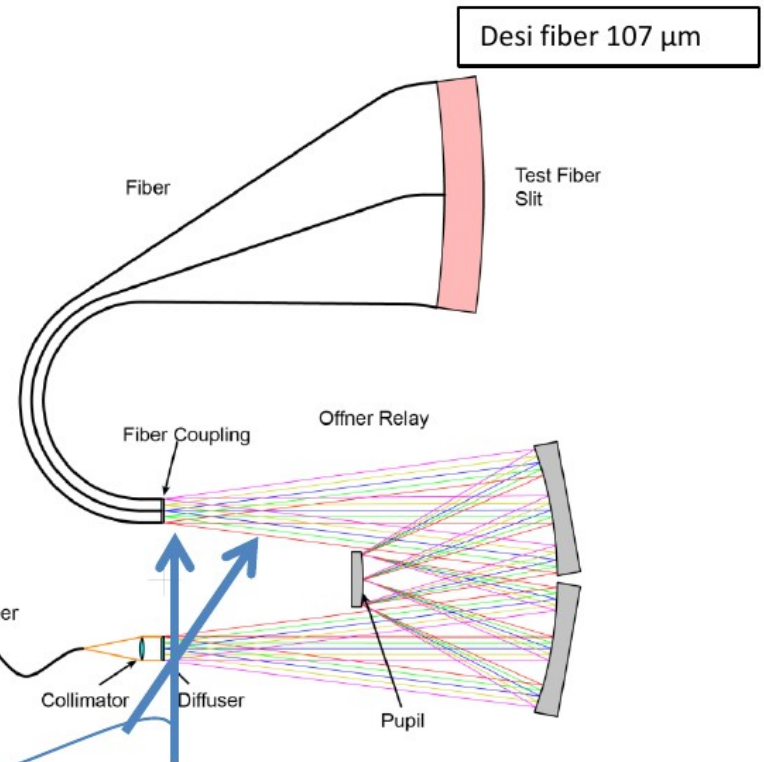
**Attenuator**  
Flux adjustment  
S/N tests

**Photodiode**  
Flux control

**Integrating sphere**

Fiber

Filtres



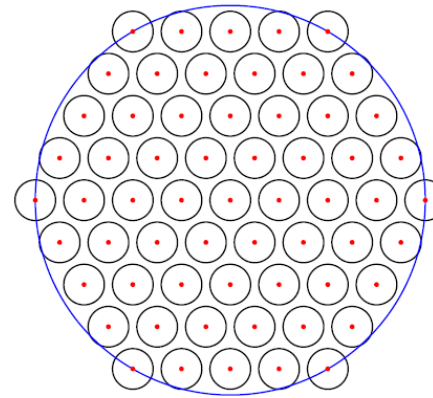
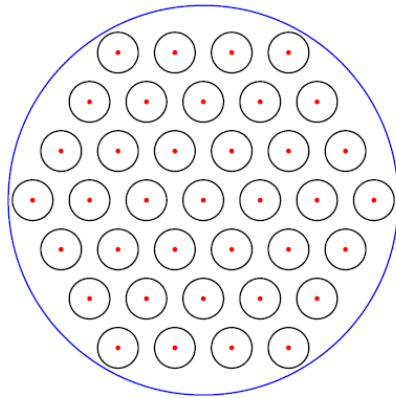
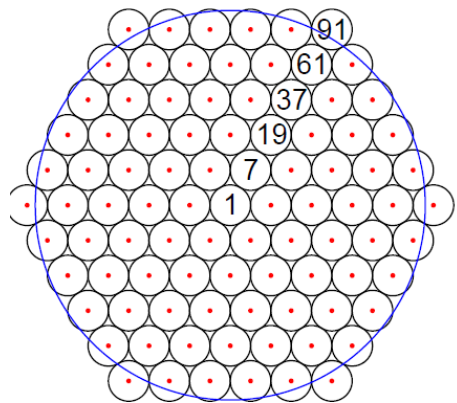
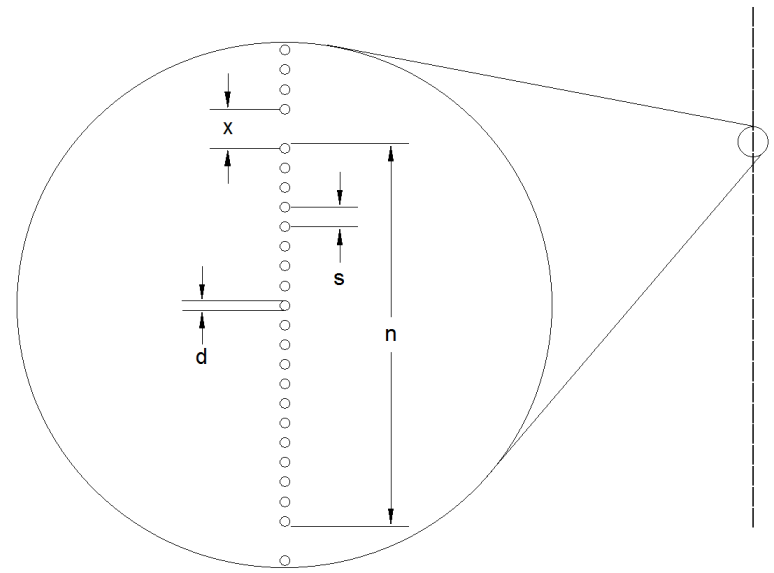
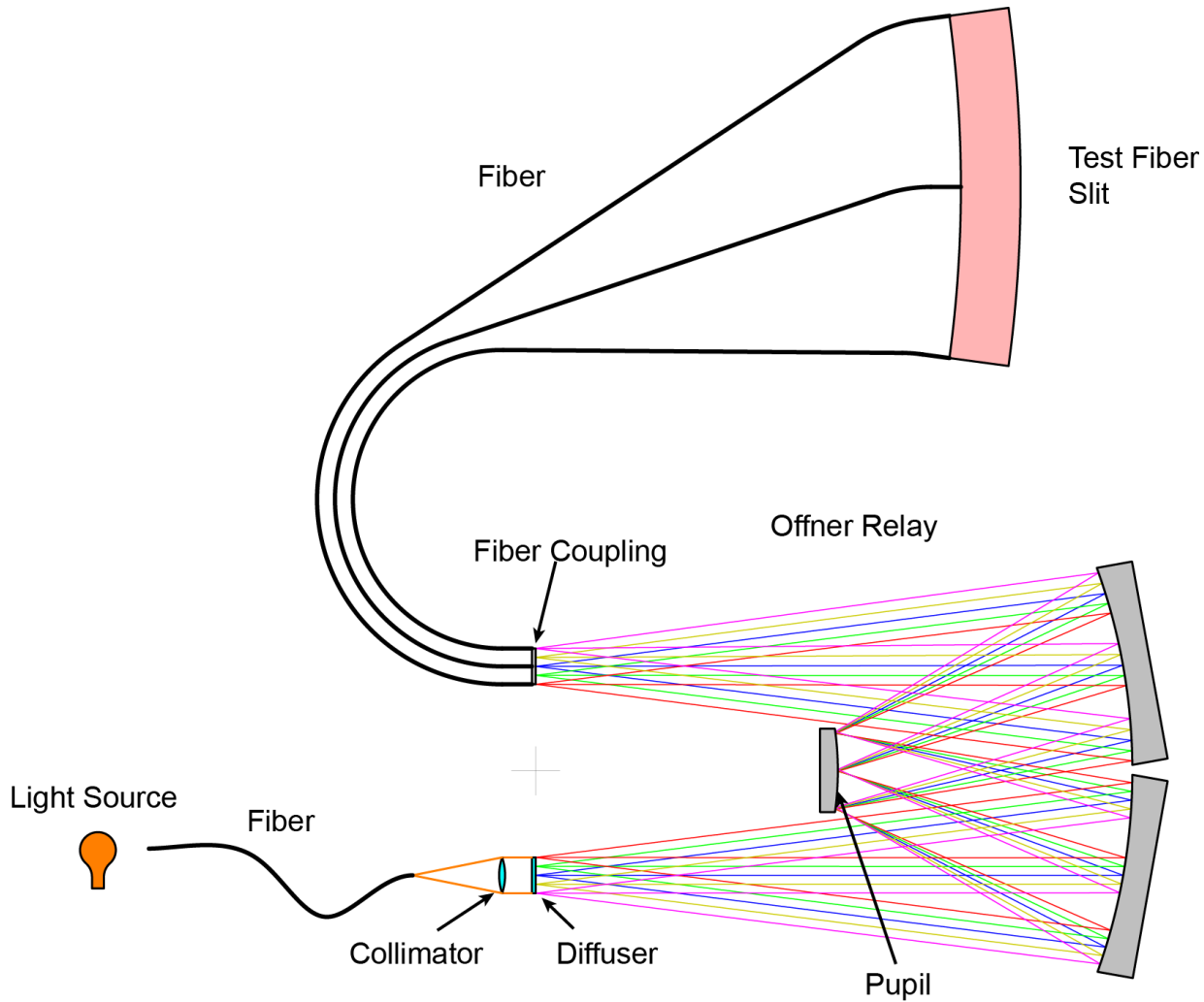
- Relative sources flux:
- Fiber diameter
  - Variable fibers gap
  - ND (with relay?)
  - Filter in built-in diliter-holder
  - Variable attenuator (ocean optics)

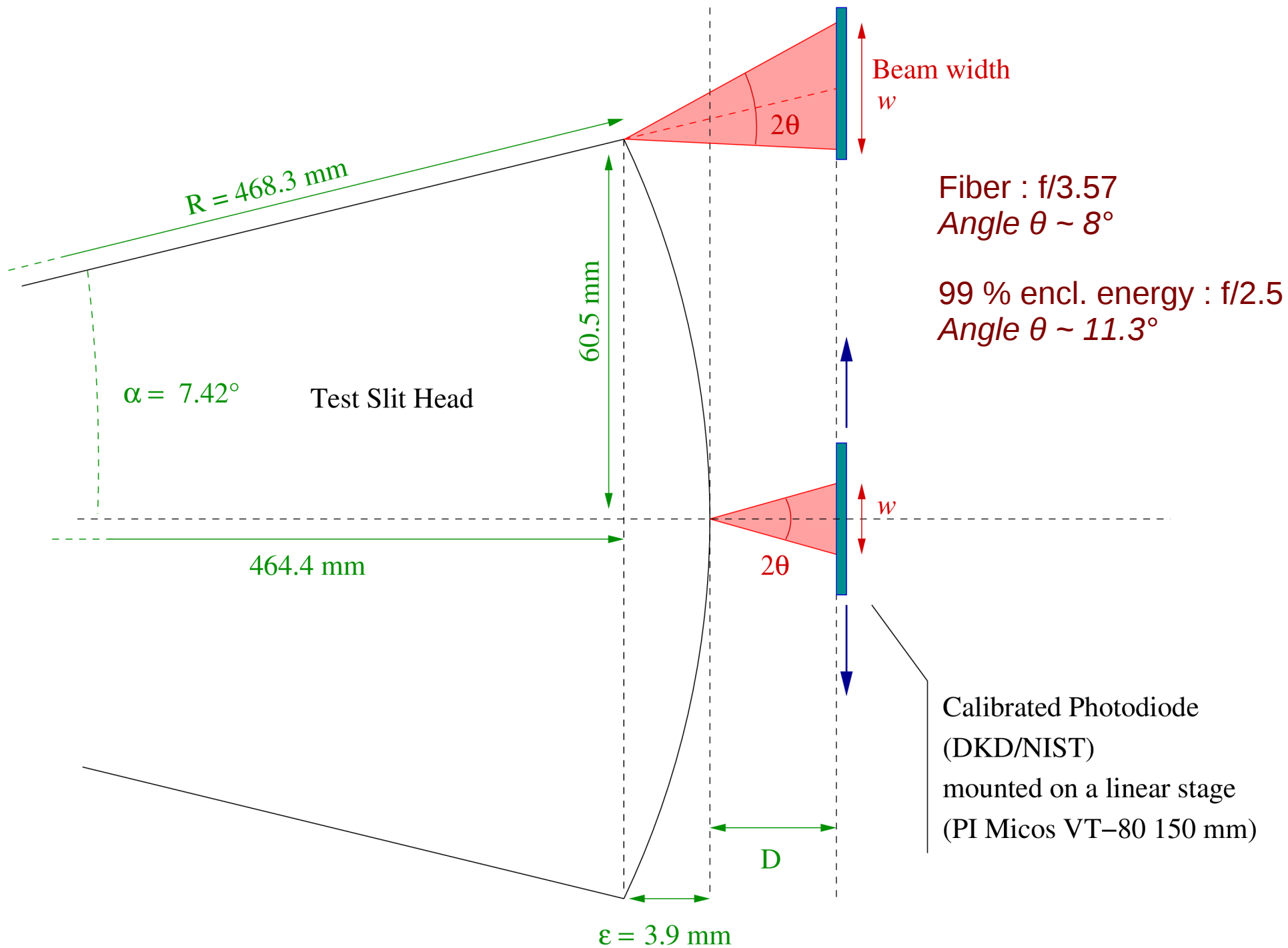
- Attenuator:
- Variable fibers gap
  - CVND
  - Guillotine
  - ...

- Fiber configuration selection:
- Translation stage:
    - 1) large diffuse source
    - 2) large fiber (100 – 200μm)
    - 3) small fiber (point source) (optional)

DESI

Testbench setup (LAM/Winlight)





# Beam size on the photodiode

- Beam lateral size

- At the center :  $w_{\min} = 2D \tan \theta$

- At the ends :  $w_{\max} = (D + \varepsilon) [\tan(\theta - \alpha) + \tan(\theta + \alpha)]$

*Angle  $\theta = 8^\circ$*

<i>D (mm)</i>	10	15	20
<i>W<sub>min</sub> (mm)</i>	2.8	4.3	5.6
<i>W<sub>max</sub> (mm)</i>	4.0	5.4	6.8

*Angle  $\theta = 11.3^\circ$*

<i>D (mm)</i>	10	15	20
<i>W<sub>min</sub> (mm)</i>	4.0	6.0	8.0
<i>W<sub>max</sub> (mm)</i>	5.7	7.7	9.7

*Angle  $\theta = 15^\circ$*

<i>D (mm)</i>	10	15	20
<i>W<sub>min</sub> (mm)</i>	5.4	8.0	10.7
<i>W<sub>max</sub> (mm)</i>	7.6	10.3	13.1

# Photodiode choice(s)

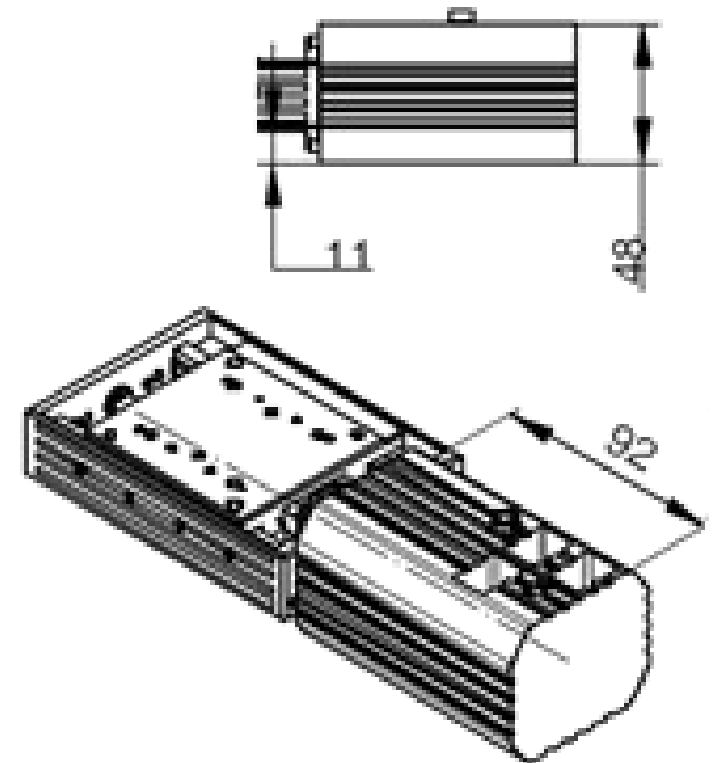
- MD-37-SU100 calibrated (spectral sensitivity)
  - DKD certified absolute calibration
  - A few % on 250 – 1100 nm.
  - Size : 100 mm<sup>2</sup>
- Current readout : electrometer  
(e.g. Keithley 6514)
- Other option :
  - Hamamatsu 100 mm<sup>2</sup>  
calibrated by NIST
  - Delays...





# Moving the photodiode : linear stage

- Linear stage Pollux VT-80  
from PI Micos : range 150 mm
- Uni-directional repeatability  $\sim 0.4 \mu\text{m}$
- Existing LPNHE software  
(LSST testbench)



# Measurement setup : a first sketch

# Measurement procedure

- Test fiber slit inside the spectro.
  - various illuminations (flux ramp, wavelength scans)
  - Light only through isolated fibers / fiber blocks
  - CCD spectra on the 3 branches
- Test fiber slit outside :
  - Fixed on a dedicated optical table (is that possible?)
  - same illuminations setups as before
  - measuring the total flux received by the photodiode in front of each fiber/fiber block.
- Test slit back inside : same illuminations...
- Repeat...
- Ratio : flux on CCDs / flux measured by the photodiode

# Next steps...

- Discussions with LAM, OHP, CPPM, Winlight
- Buy the hardware (photodiodes, linear stage...)
- Testbench study at LPNHE :
  - Building the measurement setup
  - Photodiode : precise measurement of the flux dependency with incidence angle (cosinus factor, reflectivity, dependency with  $\lambda$ )
  - Build a mockup of the test fiber slit, testbench checks

# Estimated costs (Hardware)

- Calibrated photodiodes (DKD) : ~2500 \$
  - NIST : ~5000 \$
- Linear stage : ~3000 \$
- Electrometer (Keithley 6514) : ~5000 \$
- Small optical table : ~600 \$
- Various parts ~500 \$