ASTRI Astrofisica con Specchi a Tecnologia Replicante Italiana

cta cherenkov telescope array

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The ASTRI SST-2M Illuminator

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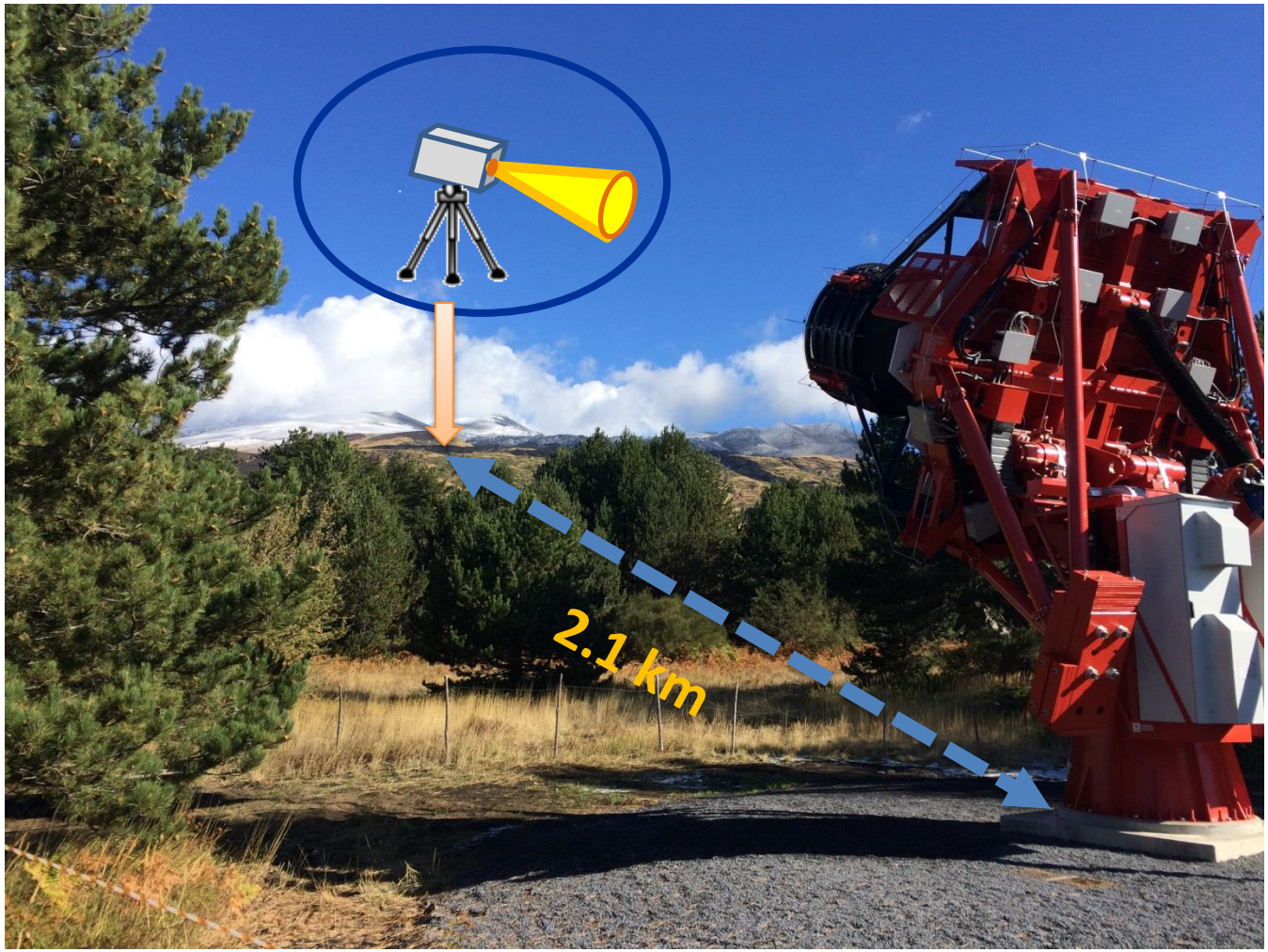
the illuminator and the ASTRI-SST-2M calibration strategy

- **In support to the ASTRI SST-2M end-to-end calibration, a portable ground light source has been designed to illuminate the whole telescope aperture from several hundred meters distance**

- **The ground light source will be used during the commissioning phase to measure the telescope actual spectral, temporal, spatial and linearity of the end-to-end response**

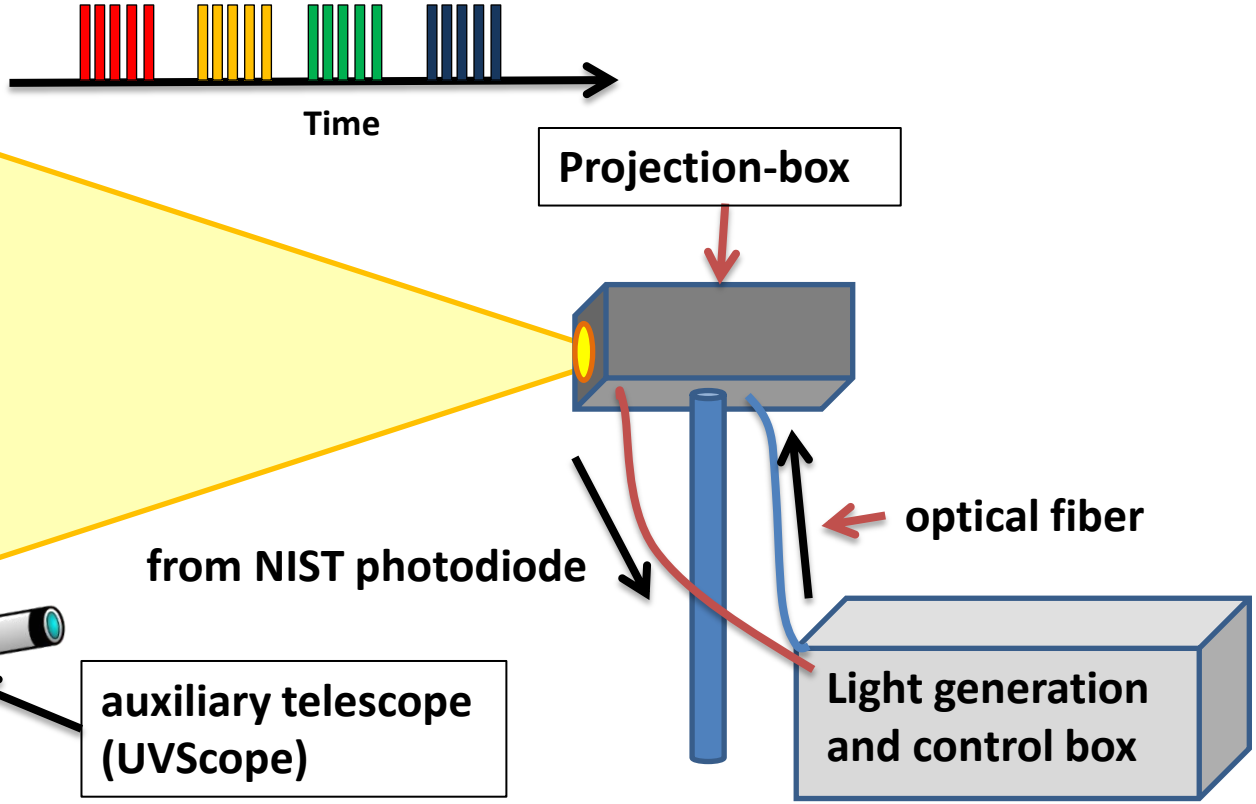
- **Results will be used to:**
  - **fine tuning the physical parameters of the ASTRI SST-2M Montecarlo code**
  - **obtain, for each camera pixel, the end-to-end corrective factor for the flat fielding of sky images**

Illuminator position

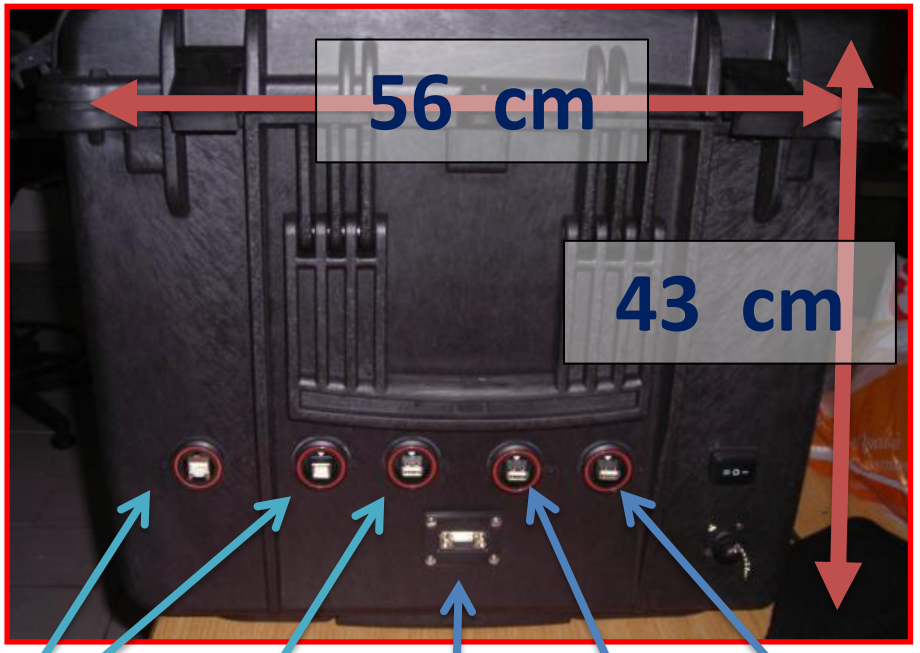


- **The Illuminator will be positioned on the slopes of Mt. Etna, at ~ 2 km distance from the ASTRI SST 2M telescope location (Serra La Nave)**

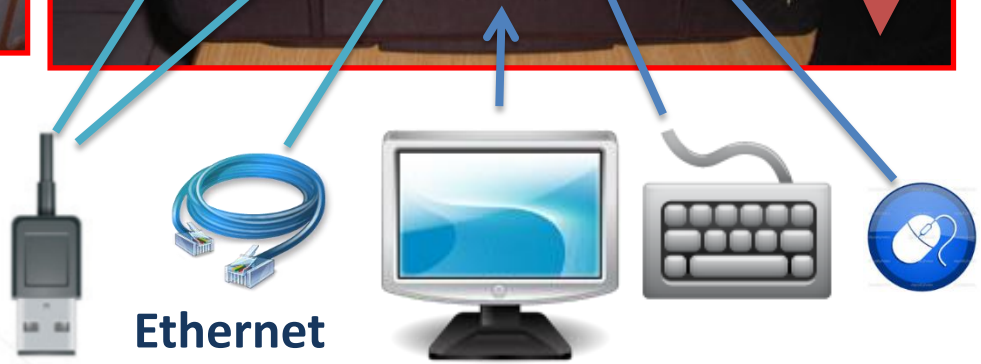
The Illuminator



- Light is generated inside the control box and delivered to the projection box through an optical fiber
- A NIST calibrated photodiode inside the projection box is used to monitor the ouput light flux
- A calibrated auxiliary telescope (UVscope) placed near the telescope aperture, allows to completely eliminate the uncertainty due to the atmospheric transmission



heavy duty, waterproof (IP67), polypropylene case

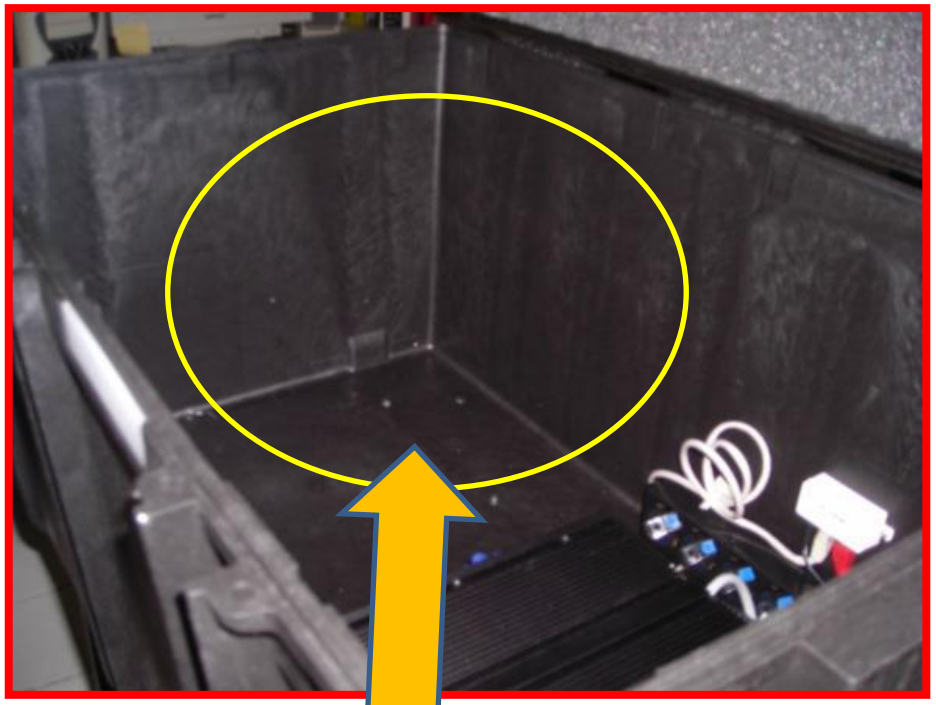


Control box interfaces

Inside the control box

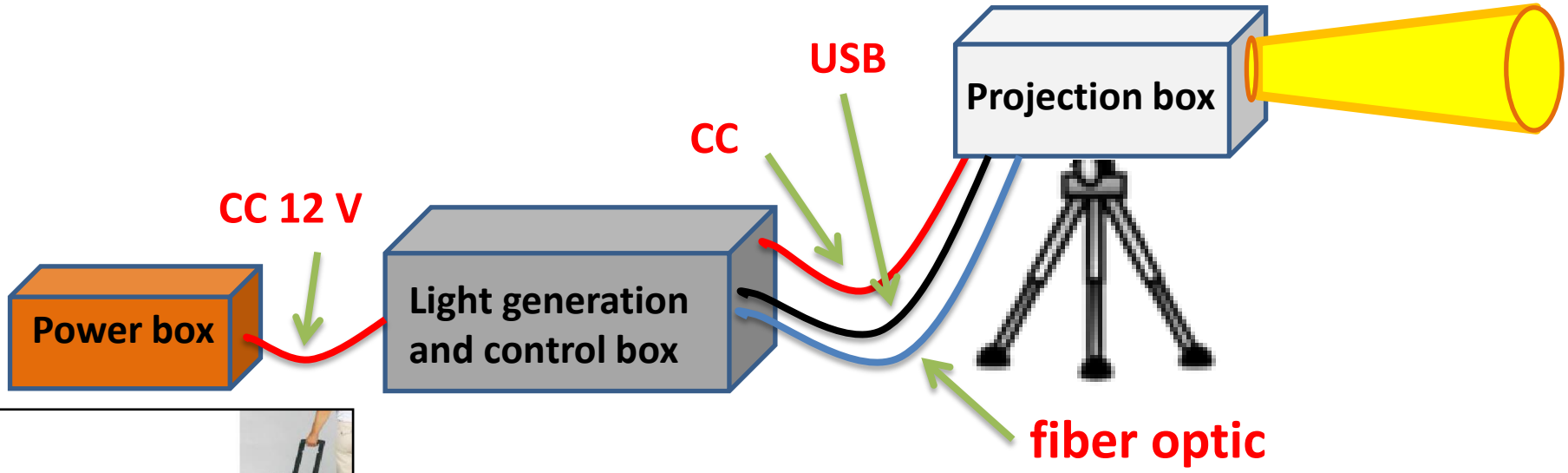
DC/AC inverter

Local PC
- RS232: 8
- USB: 4



… plenty of room for:
- battery pack
- Wi-fi system
- Optical generation devices
- ….

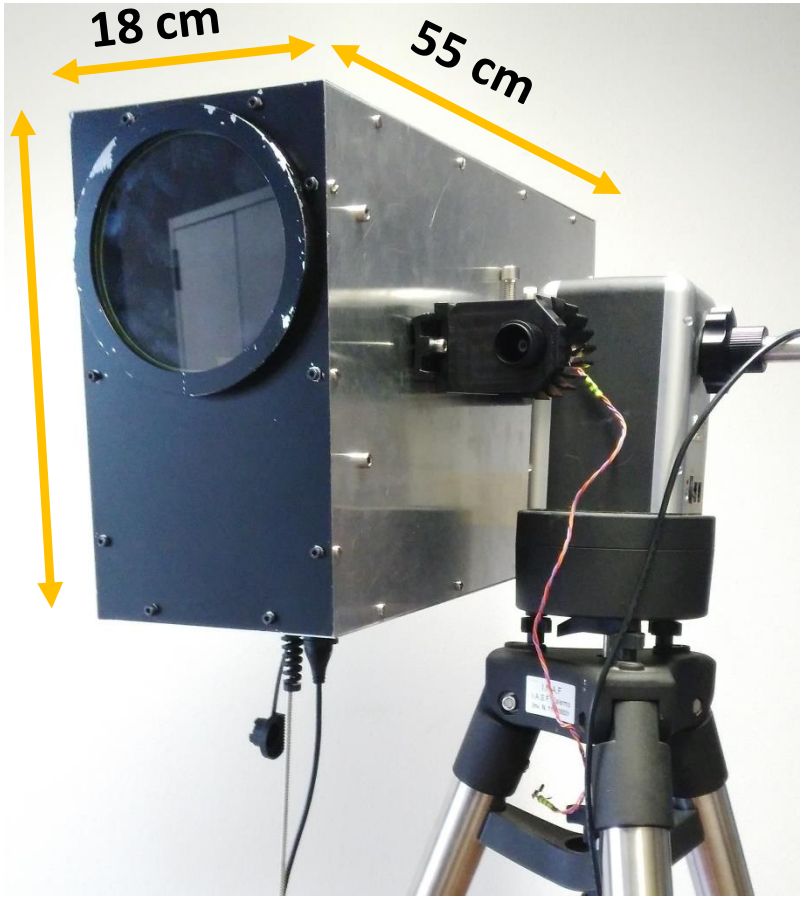
The power box

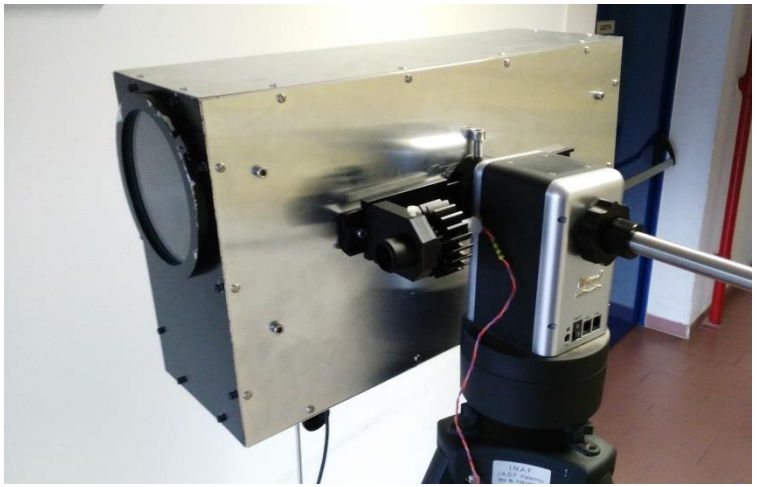


- Type: AGM (Absorbent Glass Mat)
- 12V/100 AH
- 323x170x214 mm
- 32.8 Kg

- The battery, currently installed inside the control box, makes it quite heavy and difficult to transport
  - Battery will be moved on dedicated IP67 trolley-box

The light projection box





The optical system is contained in a lightweight aluminium case that can be mounted on any common (manual or motorized) telescope mount for pointing

Illuminator status

- The projection box of the Illuminator has been installed on a motorized mount ready to start laboratory tests on the projected beam
- To be done before open-air nightly measurments:
  - Water-tight box sealing
  - Thermal insulation
  - Heaters to prevent condensation

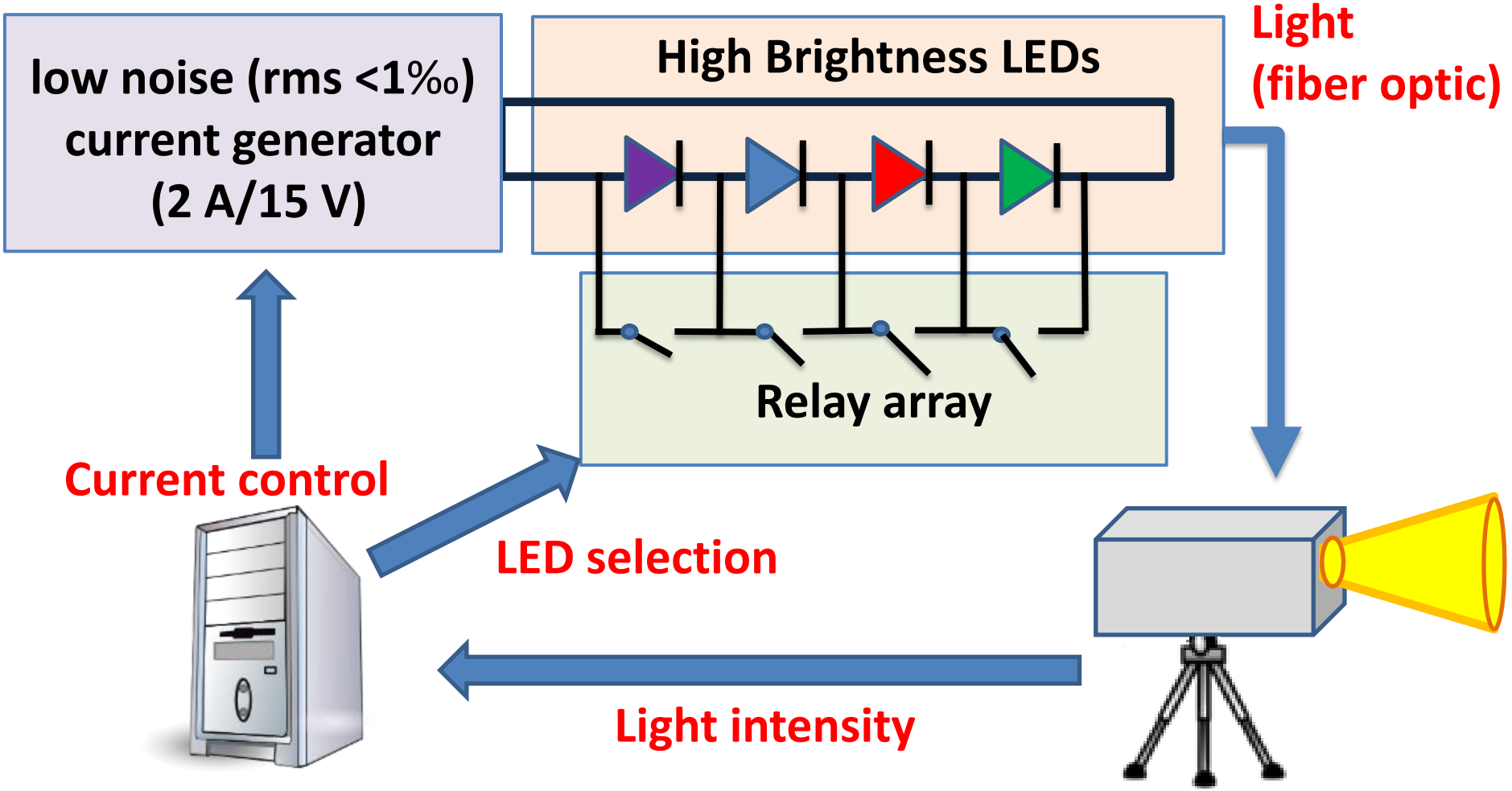
Motorized Alt-Azimuthal mount

Fiber optic

USB cable signals:

- NIST sensor measurements
- Photodiode Temperature
- Humidity
- Entrance window Temperature

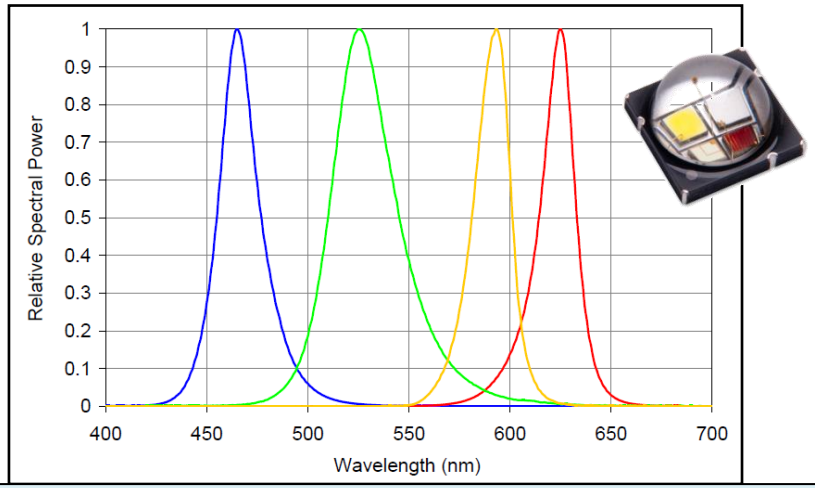
Multicolor CW LED sources



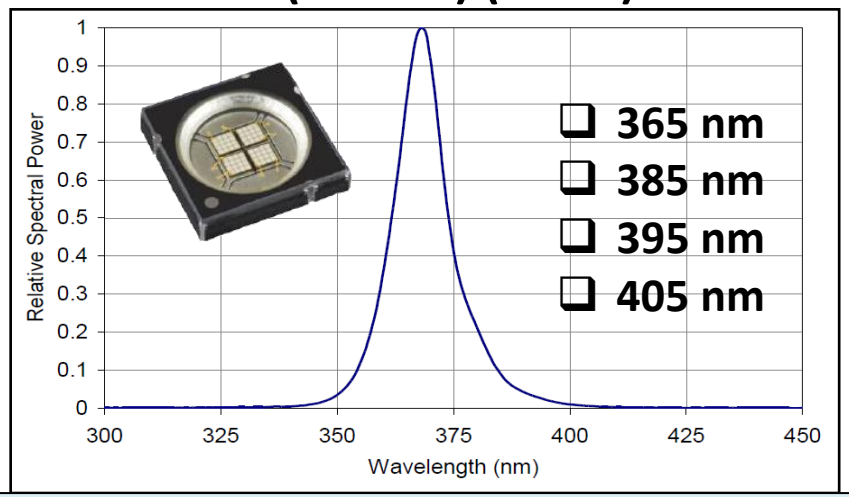
LED current (rms <1‰) will be finely adjusted in order to keep the output light flux at the pre-selected level (<1‰)

Multicolor LED sources

Visible: P >>1 W (<< 100 €)

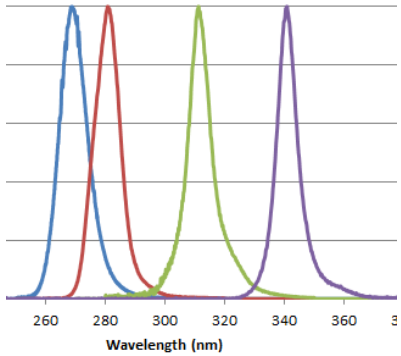


UV-A (P > 1W) (100 €)



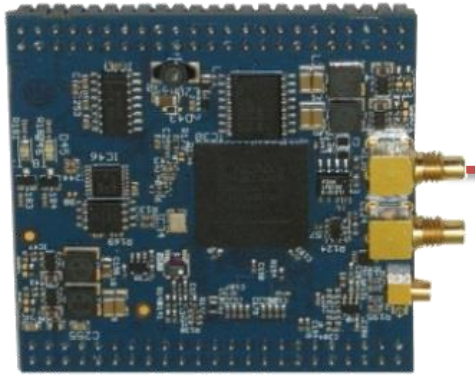
The visible and the UV-A (>365 nm) spectral region are rather well covered by High Brightness LEDs (> 1W/die).

- **265 nm 10 mW: 1k€**
- **280 nm 25 mW: 1k€**
- **310 nm 25 mW: 1k€**
- **340 nm 10 mW: 880 €**



LED emitters are also available in the spectral region below 365 nm but it is TBV if their brightness (<25 mW/die) is enough for their use as light sources for the illuminator.

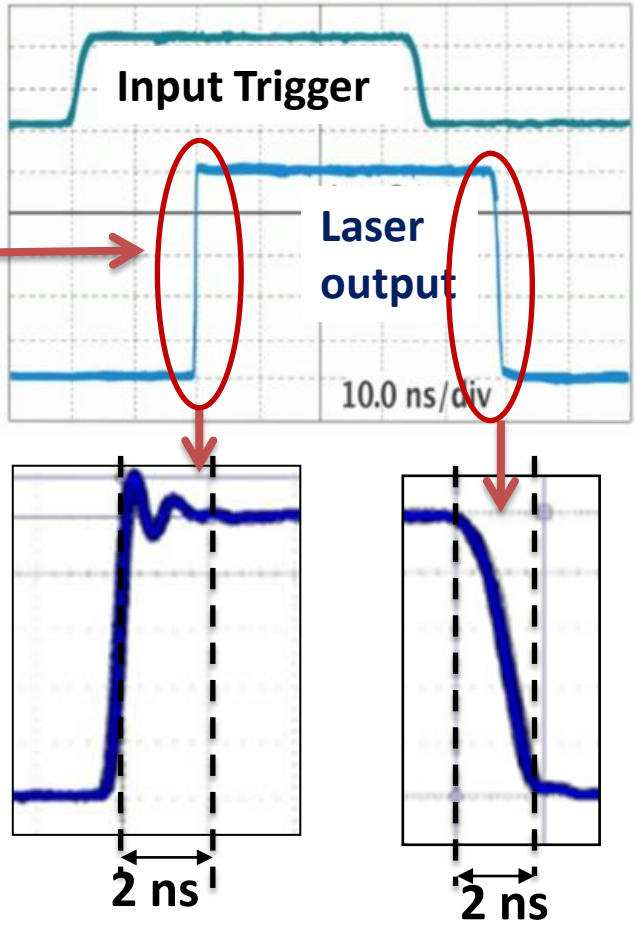
ns-pulser



- Variable pulse width: from 2 ns in 1 ns step
- USB 2.0 control

laser diode

- Analog and digital modulation
- Rise and fall time: < 2ns
- Thermoelectric cooler (TEC)
- Optical power: up to 200 mW
- USB 2.0 and RS-232 control



Control of:
- Pulse width
- Repetition rate

Control of Laser current

Variable pulse length will allow to calibrate the camera timing response

Requirements for additional light sources

- **The first Illuminator prototype will be equipped with:**
  - **a single CW/ns pulsed laser light source (405 nm)**
  - **a multi color HB LEDs CW/pulsed (obtainable pulse length TBV)**
- **Other optical sources can be accommodated inside the illuminator control box provided they have:**
  - **Compact and reasonable size**
  - **Standard connector for fiber optic (e.g. SMA)**
  - **Computer control via USB (or RS232)**
  - **Precisely adjustable power**
  - **Input for external trigger**
  - **Standalone GUI (for Windows)**
  - **Communication protocol manual (!)**

Possible ns-pulsed/multi-wavelength lasers system

- Integrated 5 laser bay mount
- Analog and digital control
- USB and RS-232 interface for control from host computer

Fiber optic Beam combiner
8 input – 1 output

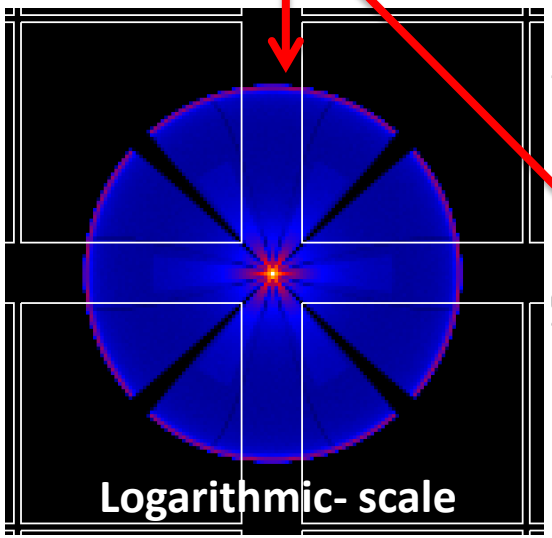
Example of available wavelengths:

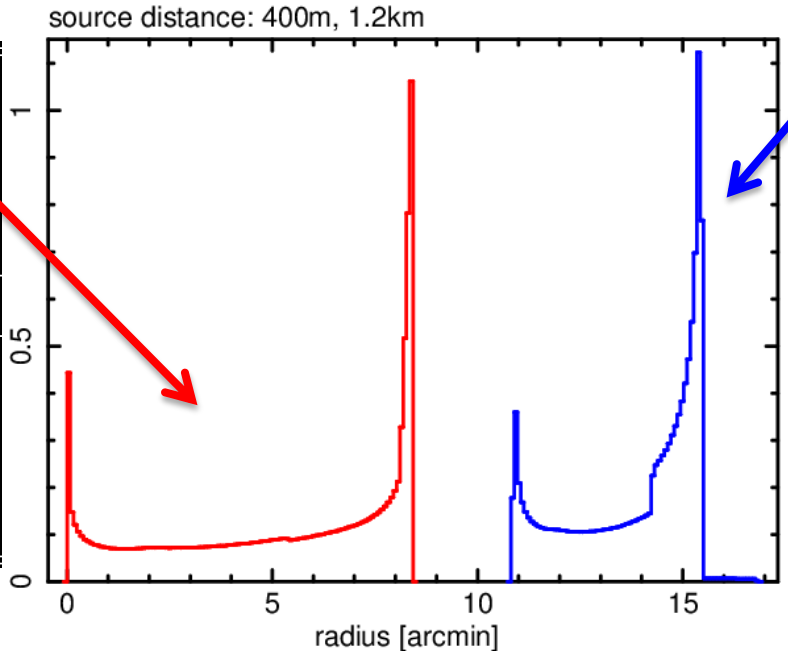
- **375 nm 50 mW: 10k €**
- **405 nm 100 mW: 5k €**
- **445 nm 75 mW: 7k €**
- **488 nm 50 mW: 6k €**
- **640 nm 40 mW: 2k €**

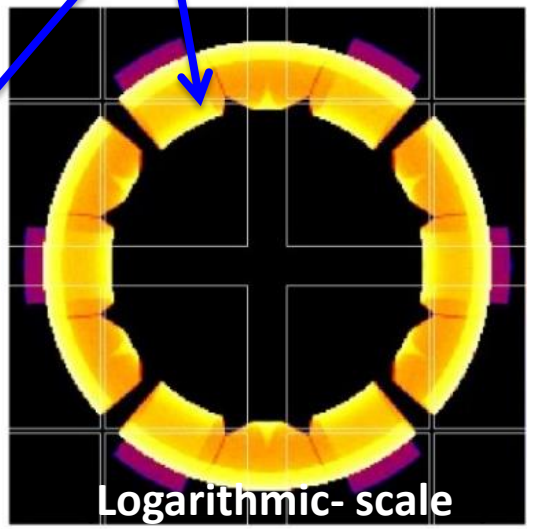
ASTRI PSF vs. distance

On-axis PSF at 1200 m

On-axis PSF at 400 m



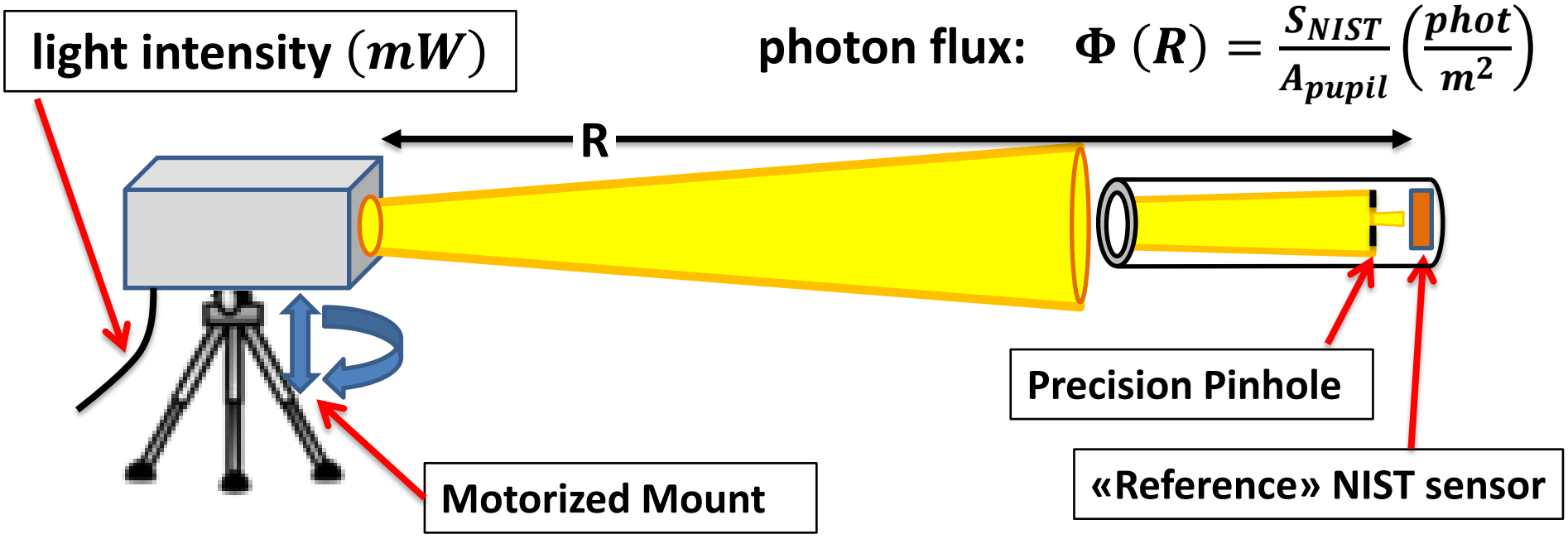




PSF images and the relative radial distributions for an on-axis point sources placed at 400 m and 1.2 km from the ASTRI telescope aperture.

To limit the influence of the variable atmospheric attenuation, the illuminator could be placed at ≈ 1 km distance from ASTRI telescope aperture, obtaining a PSF good enough for an accurate verification of its Montecarlo model.

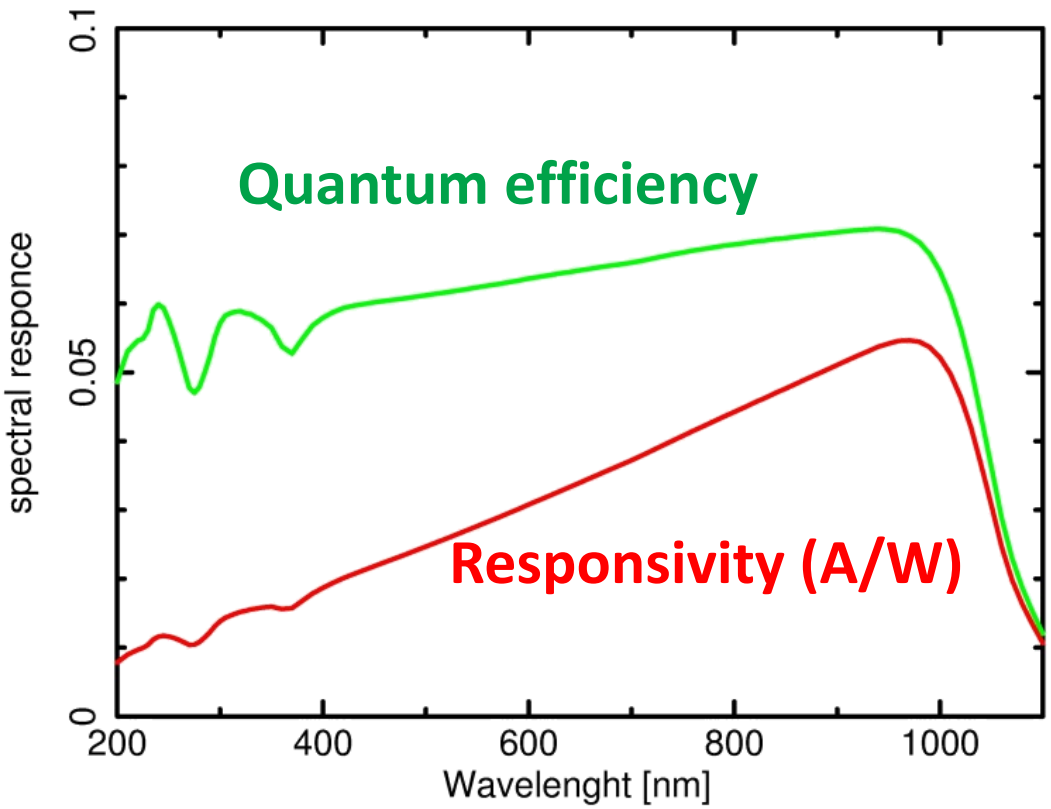
Calibration of the projected beam



- A NIST calibrated photodiode inside the illuminator light-box continuosly monitor the light intensity at the entrance of its optical system
- The projected light beam will be calibrated, as a function of wavelenght, by means of a 2nd NIST sensor (or a calibrated PMT), with a precision entrance pupil, placed at certain distance from the illuminator
- To verify the spatial uniformity of the light beam, a 2D Azimuth/Elevation scanning will be performed by means of a motorized mount

NIST-calibrated Si Photodiode

- Ø 9.5 mm
- λ: 200 nm – 1100 nm
- 50 nW – 50 mW
- resolution: 1 nW
- NTC Thermistor
- Response Time: < 1 µs
- Linearity: ± 0.5%
- Measurement Uncertainty
  - ±5% 200 – 450 nm
  - ±3% 451 – 1000 nm



Spectral responce of the Si-photodiode used for the absolute calibration of the illuminator

The ASTRI-SST 2M portable illuminating system

Projection box:

- Light weight, for easy installation on elevated (fixed or motorized) mounts
- output flux monitored by a NIST calibrated photodiode
- uniform far-field illumination pattern

Control box:

- battery powered
- computer with local control interfaces
- wireless system for remote control
- generation of ns-pulsed and CW light at several wavelengths
- adjustable pulse length (from 2ns in step of 1ns)
- continuously adjustable flux intensity