

A pulsed Tuneable LASer system for the characterisation of Spectrometers (ATLAS).

WP3510: Ground based instrument calibration

ESA/Ideas+ Task 3 phase 1 2015/03 – 2016/06

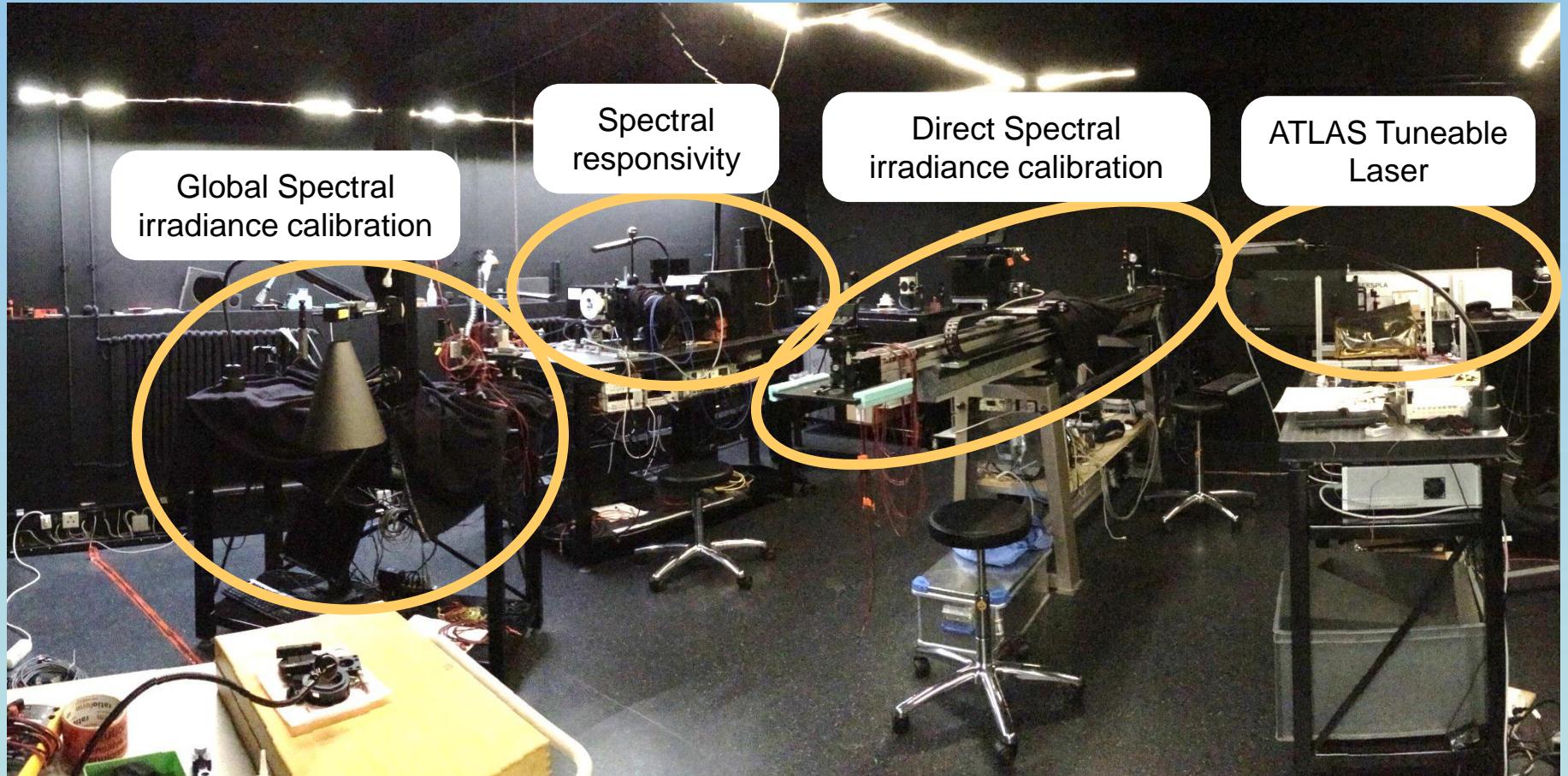
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Radiation Center, PMOD/WRC

Project Deliverables

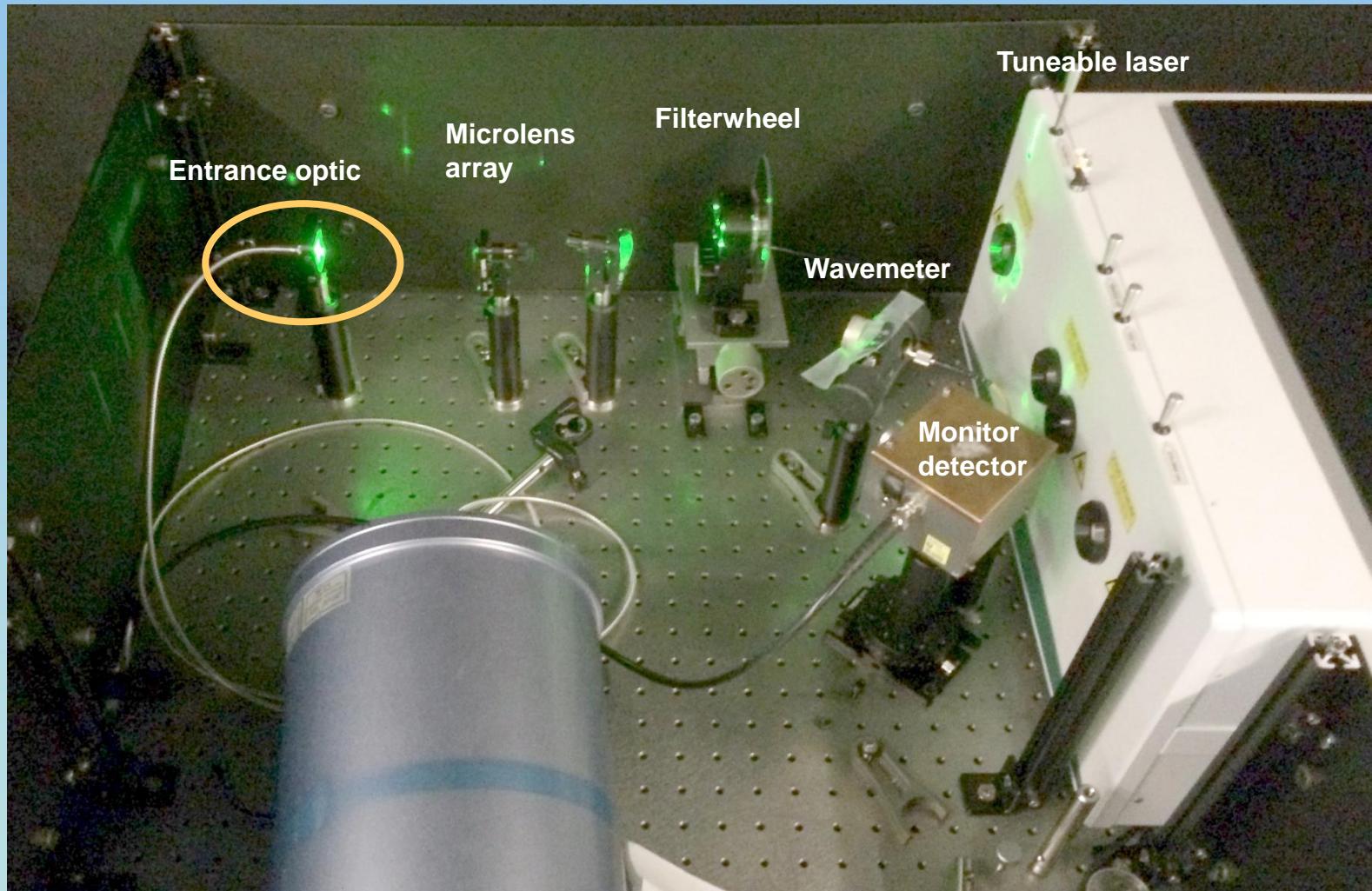
Project Duration : March 2015 – June 2016

- **WP1:** Commissioning of tuneable laser system.
- **WP2:** Radiometric characterisation of 2 array spectroradiometers using tuneable laser sources
- **WP3:** Development of correction methodologies for stray light and linearity

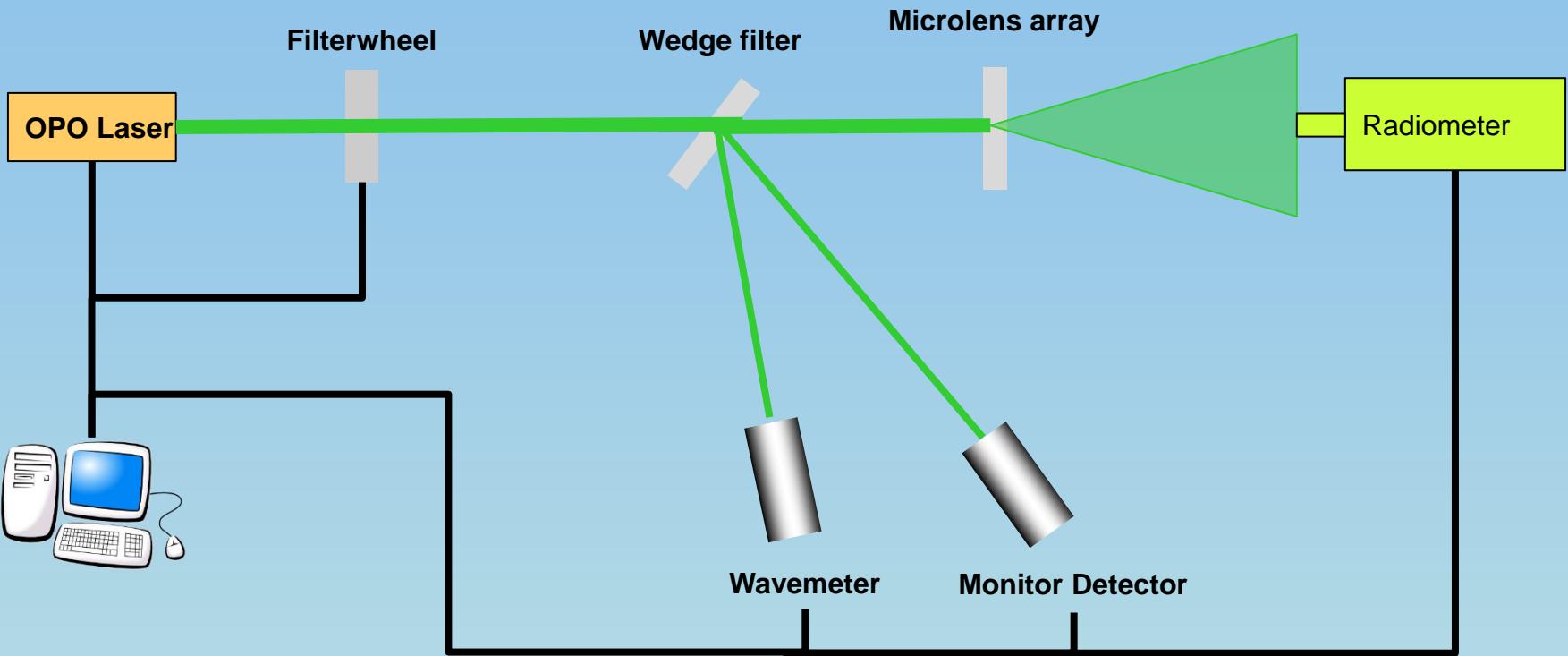
The optical laboratory of PMOD/WRC



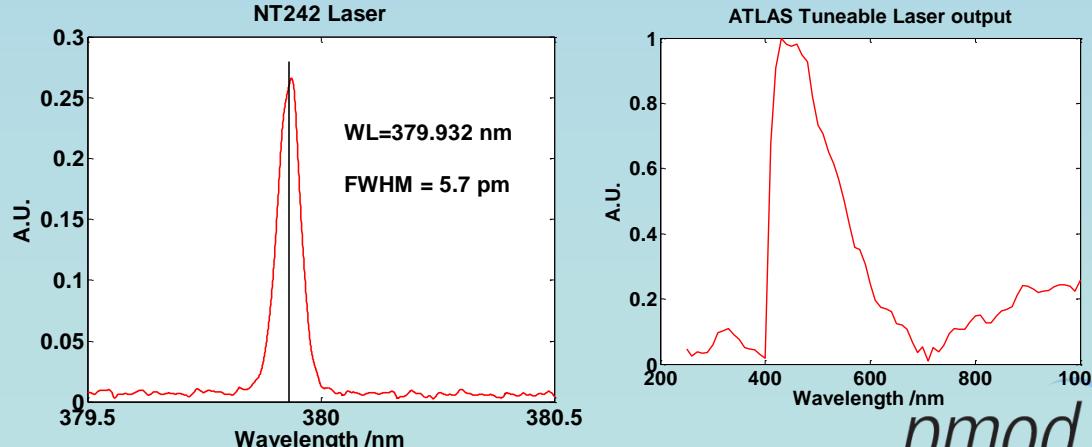
ATLAS Tuneable laser facility



Tunable laser setup at PMOD/WRC



- Tuning range 210 - 2600 nm
- Pulse 5 ns
- repetition rate 1000 Hz
- Pulse power at 450 nm ~300 mW



Instrument characterisations performed on the ATLAS setup

Completed :

- ❖ Phaeton/Avantes – DOAS/ mini MAXDOAS System
- ❖ PSR 006/ PMOD/WRC- spectral aerosol optical depth
- ❖ PFR N02 / GAWPFR – 4 channel Moonphotometer

To be done : (in ESA/Ideas+ Task 3 phase 2)

- Pandora #120 /PANDONIA
(deployed at PMOD/WRC since April 2016)



Spectroradiometer characterisations

- Phaeton Avantes 1509101U1 (cooled CCD version)
- PSR 006 Precision solar Spectroradiometer



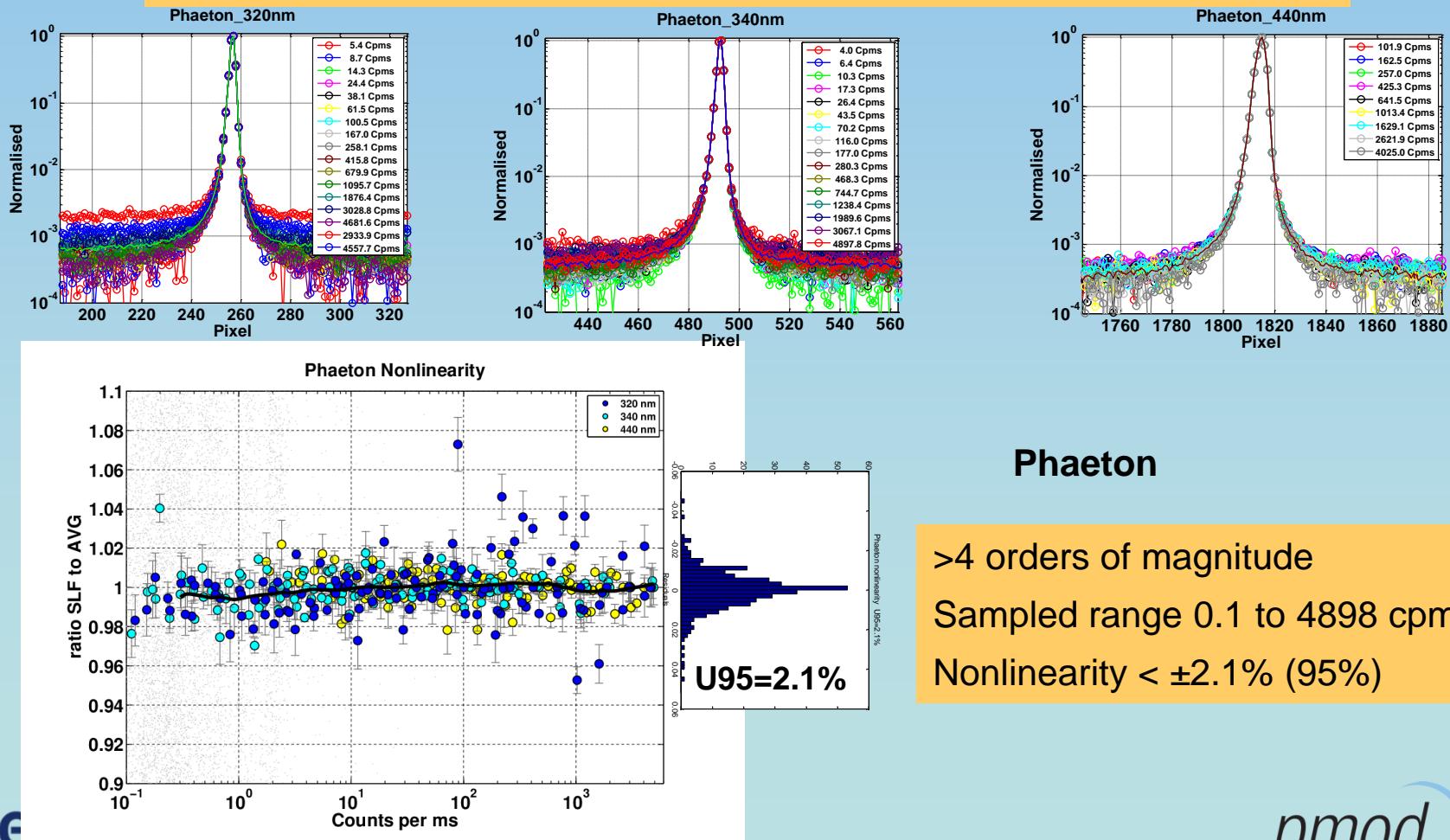
- 1) Linearity Characterisation at different wavelengths
 - a) Intensity fixed, varying integration time (electronic nonlinearity)
 - b) Varying intensity (photons/sec nonlinearity)
- 2) Line-Spread Function measurement
 - a) Slit function
 - b) Stray-light matrix

Linearity characterisation : photons/second

Each line-spread function contains a large range of intensities

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Several line-spread functions are measured for different intensity levels

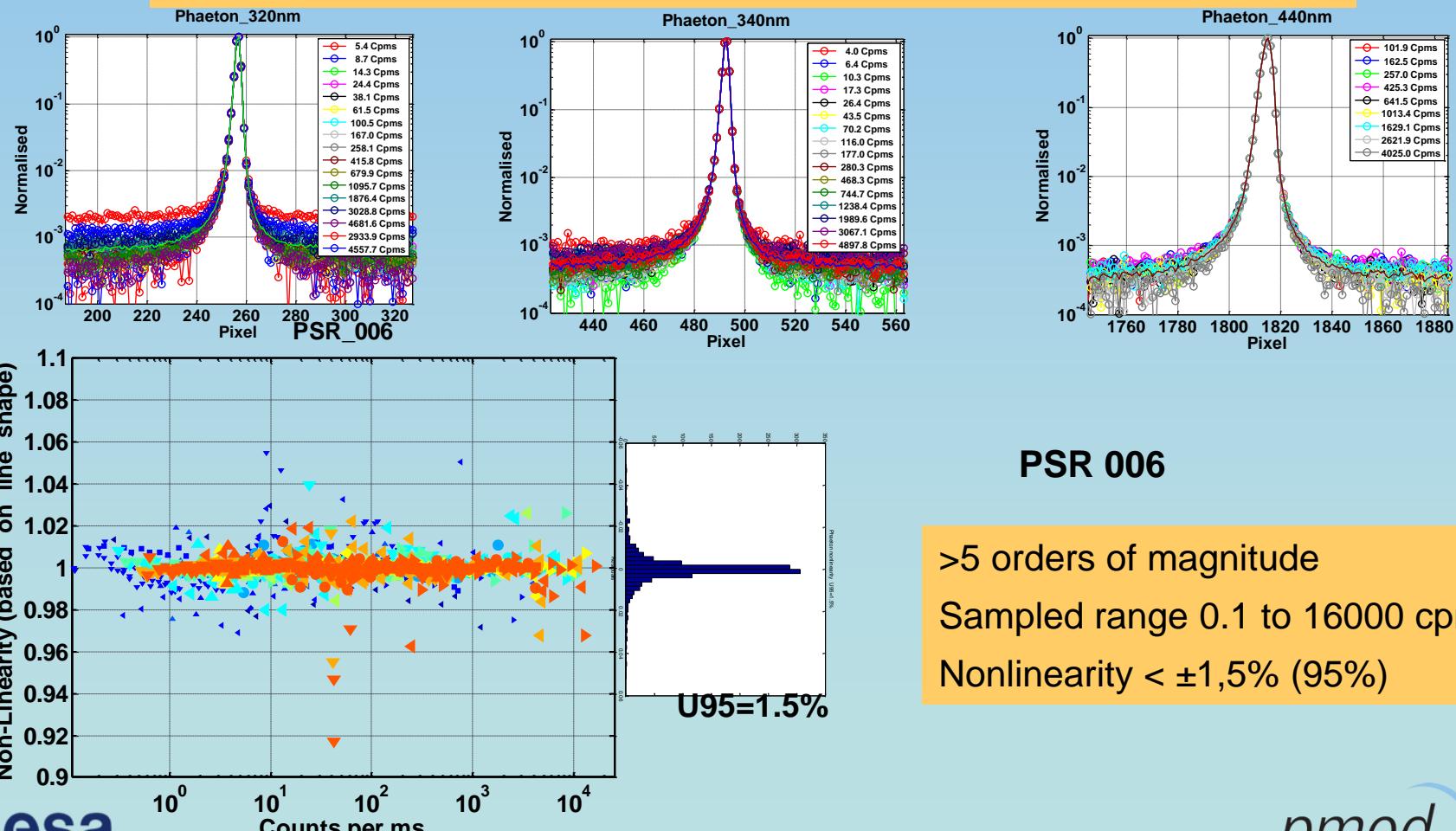


Linearity characterisation : photons/second

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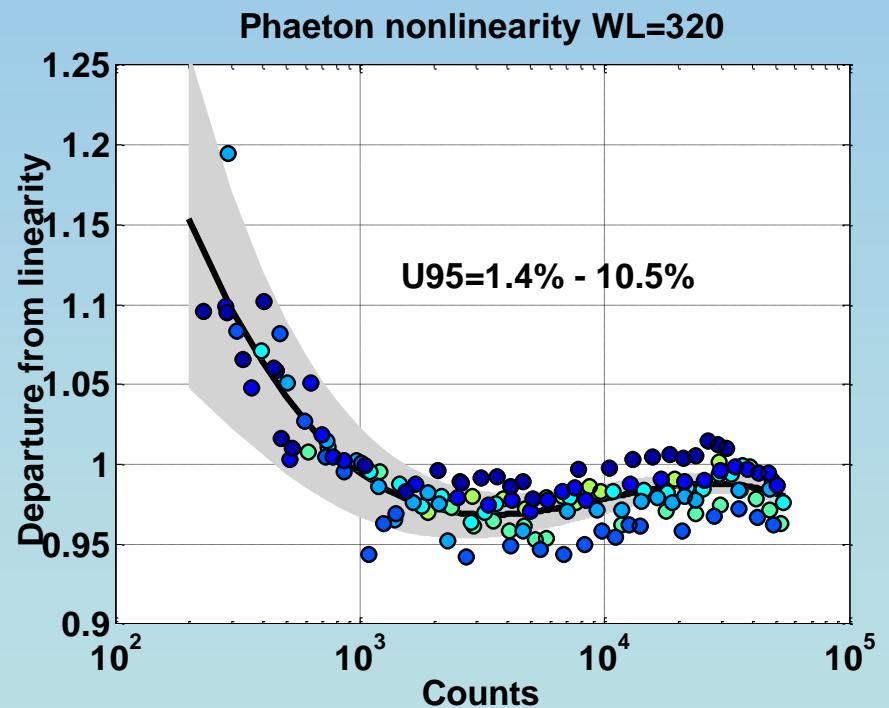
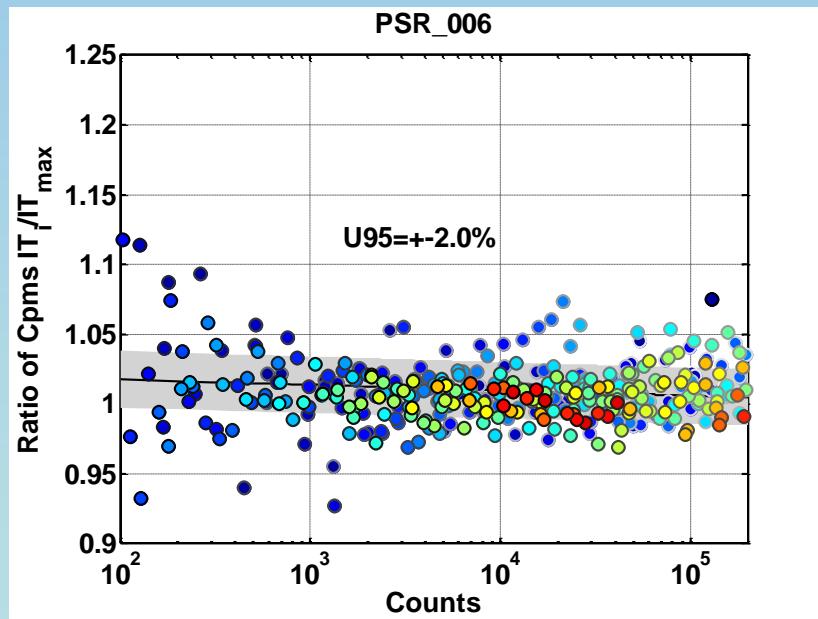
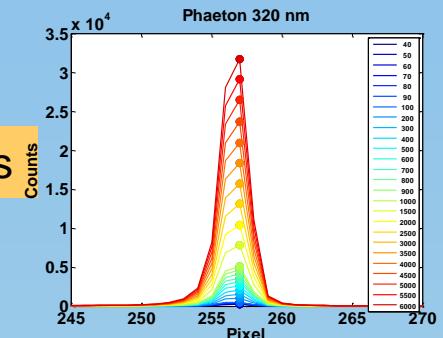
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Several line-spread functions are measured for different intensity levels



Linearity characterisation : count space

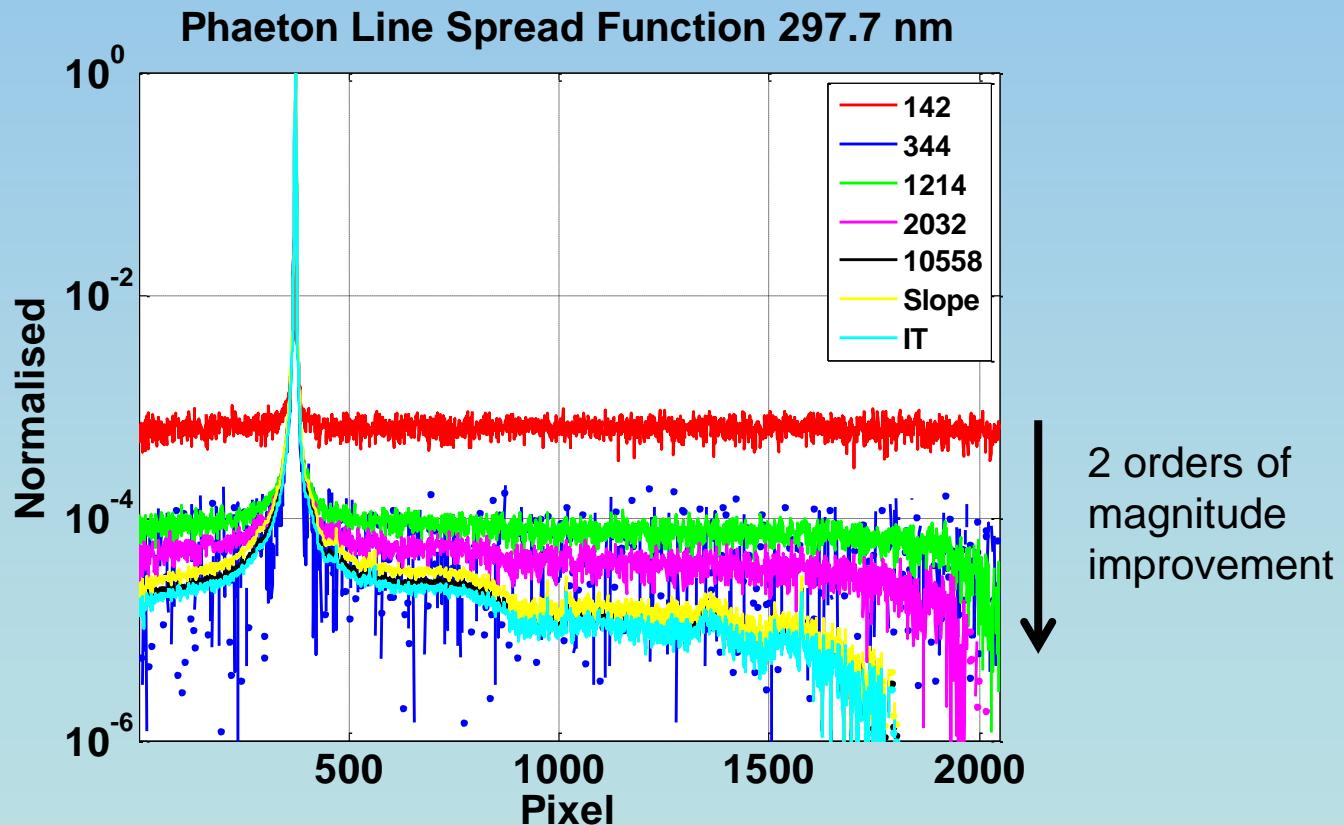
Constant Intensity, only variation of integration times



Significant nonlinearities of up to 15% at low counts

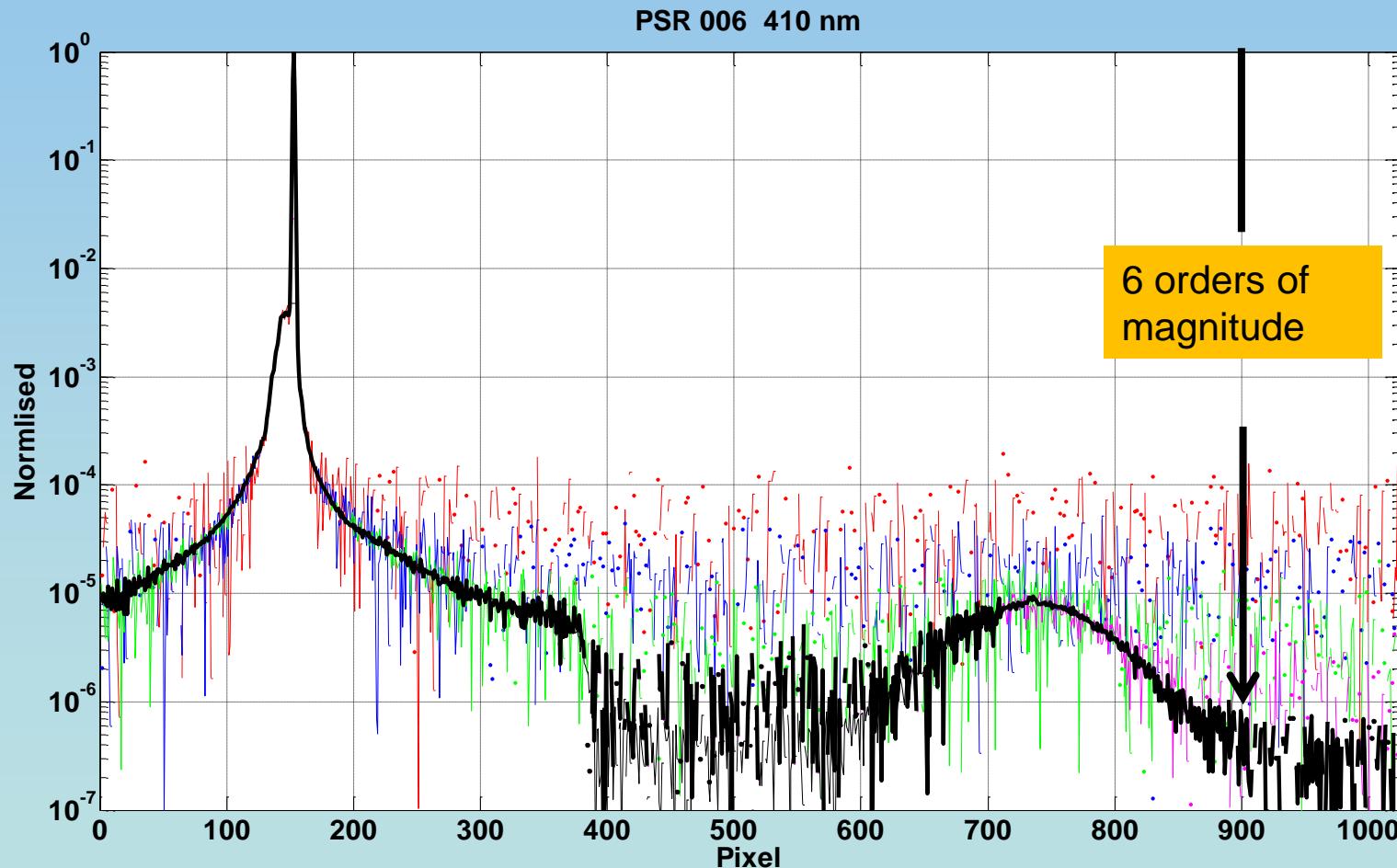
Line-Spread function measurement

To achieve sufficient dynamic range measurements at different saturation levels are combined into one line spread function



Line-Spread function measurement

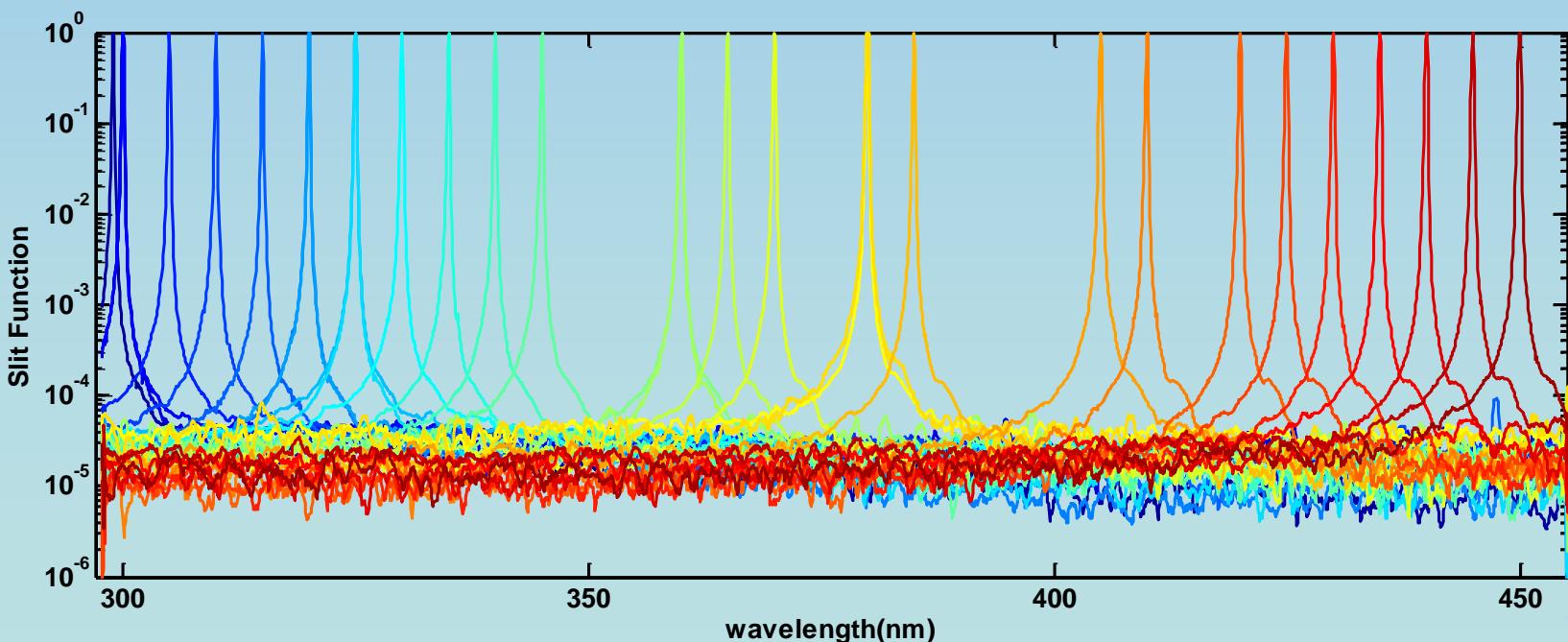
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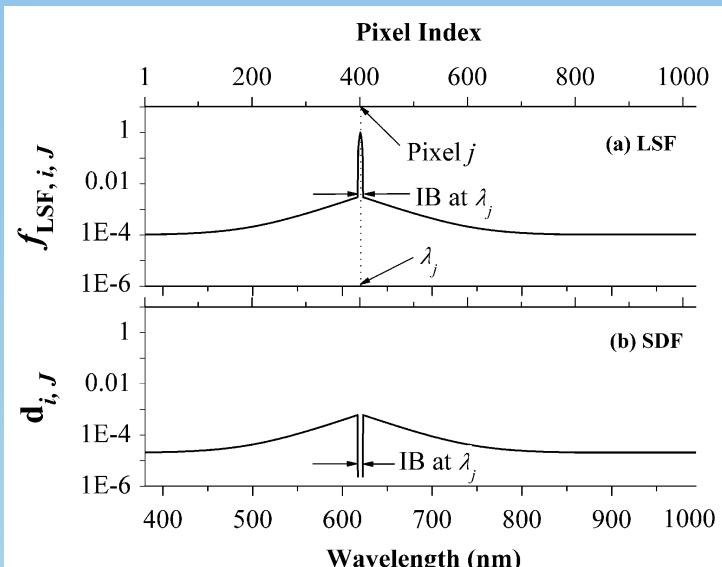
In-band Stray-light correction

The stray-light corrected in-band signal \mathbf{Y}_{IB} can be retrieved from the measurement by applying a stray-light correction matrix \mathbf{A}^{-1} to the measured signal, following the method of **Zong, 2006**.

$$\mathbf{Y}_{IB} = \mathbf{A}^{-1} \mathbf{Y}_{meas}$$

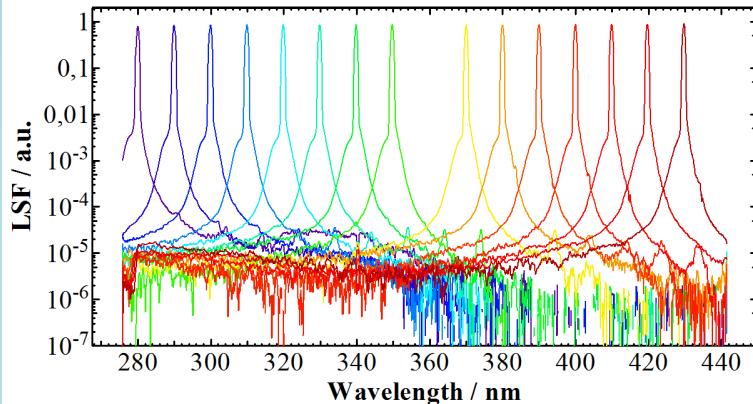


In-band Stray light correction procedure for array spectroradiometers



from Zong et al, 2006

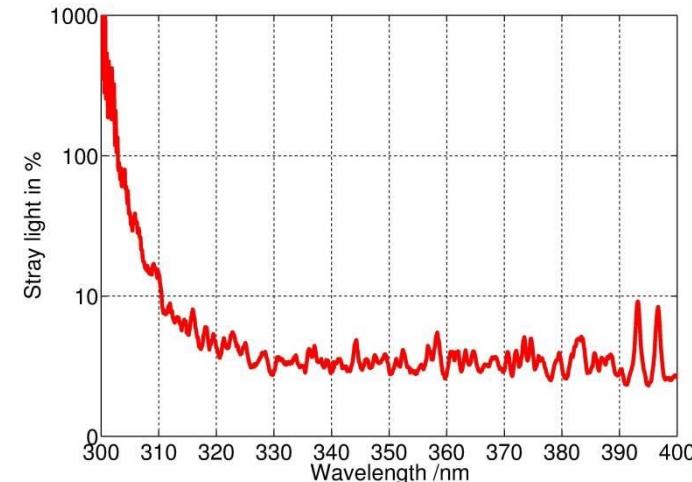
Slit Functions obtained from tuneable laser setup



$$Y_{\text{IB}} = A^{-1} \cdot Y_{\text{meas}} = C \cdot Y_{\text{meas}}$$

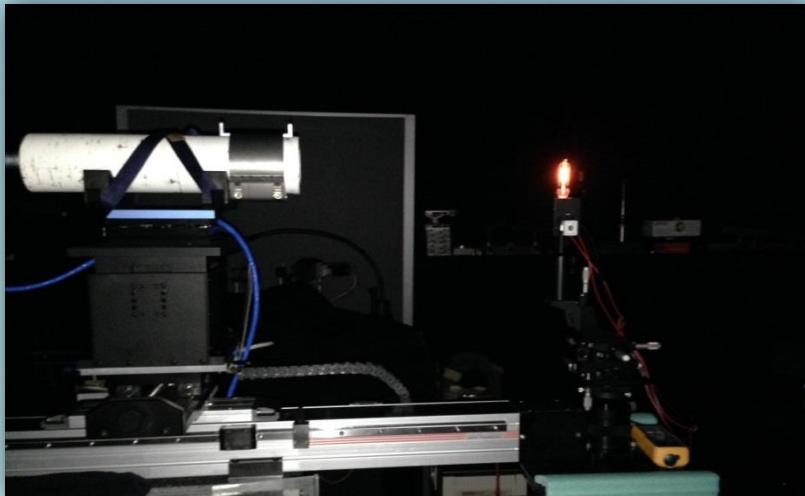
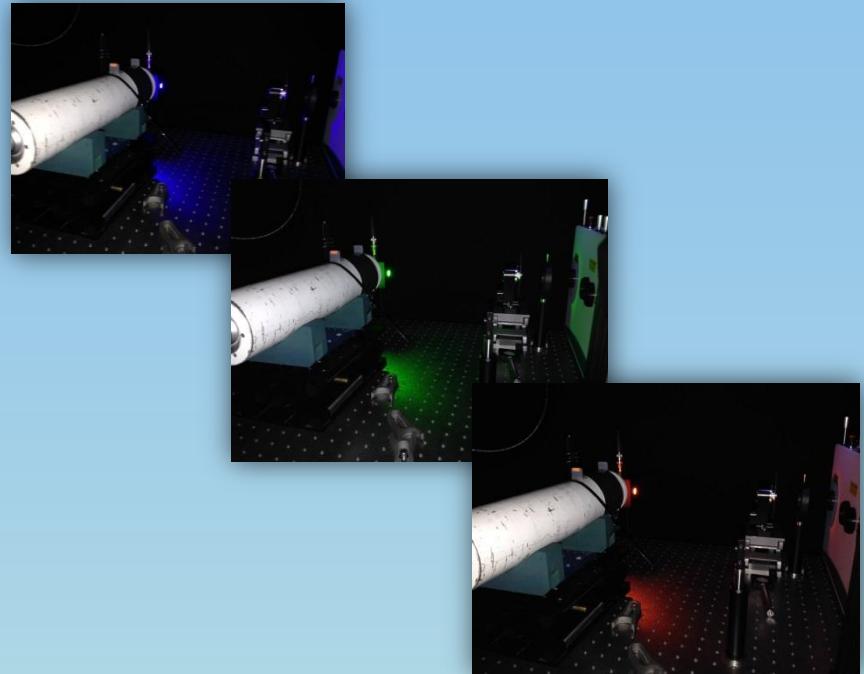
In-band straylight matrix

Calculated Straylight



Characterization of Moonphotometer (Lunar PFR)

- Linearity
- Determination of PFR internal gain
- Filter Function



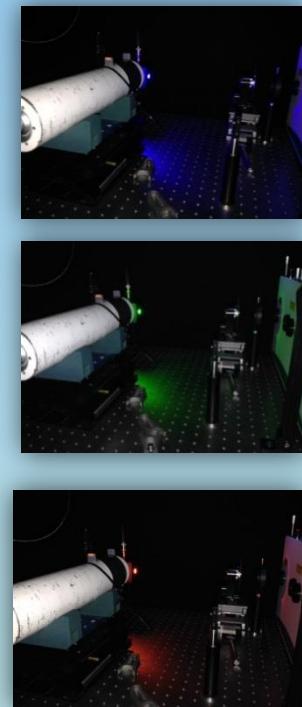
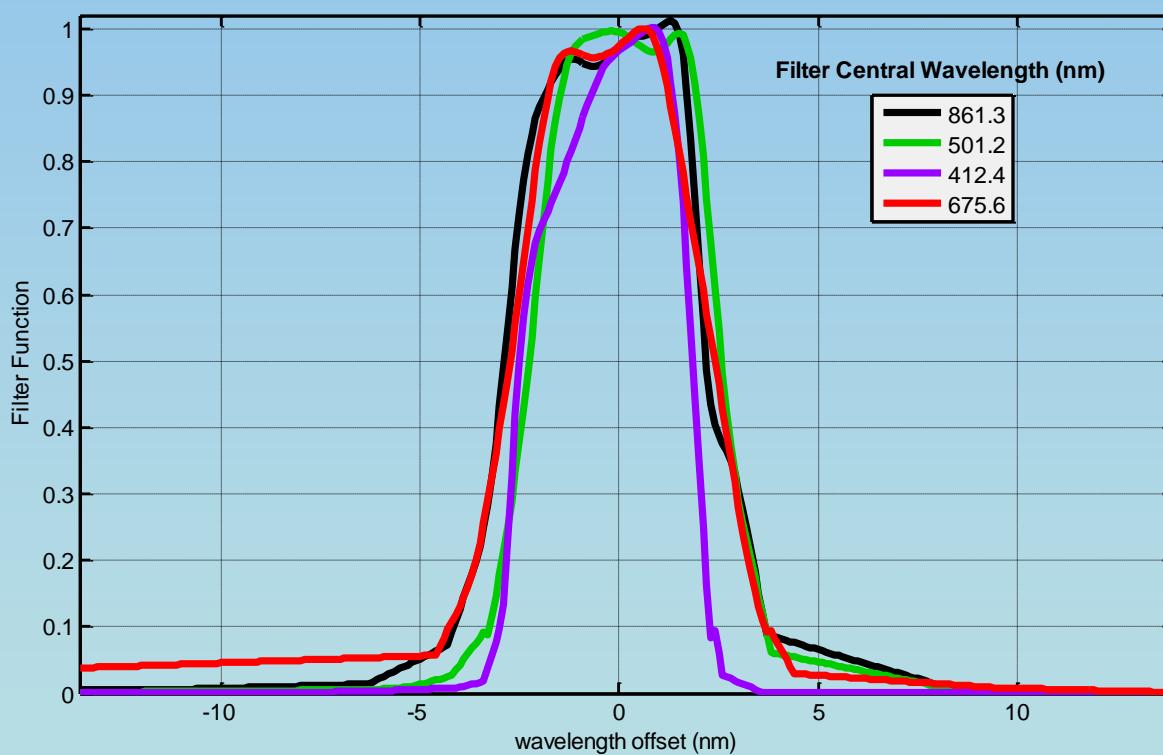
- Direct Irradiance Calibration Setup

Response (V/W.m⁻²)

Characterization of Moonphotometer

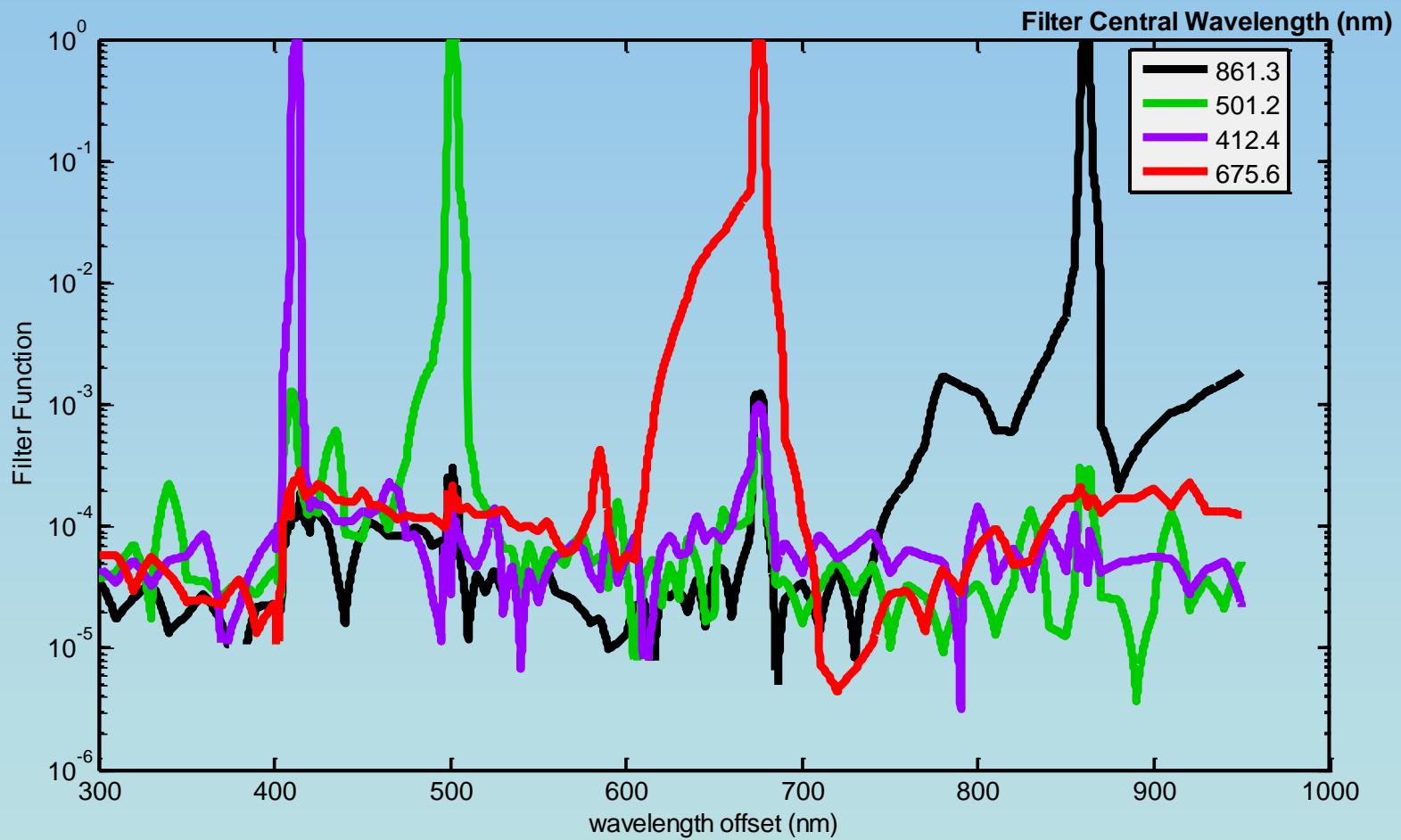
Filter Functions

Scanning Spectral region 300-950 nm

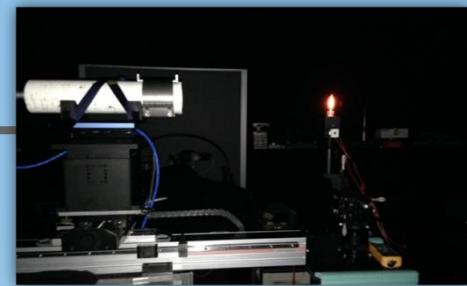


Characterization of Moonphotometer

Filter Functions – Out-of-band rejection

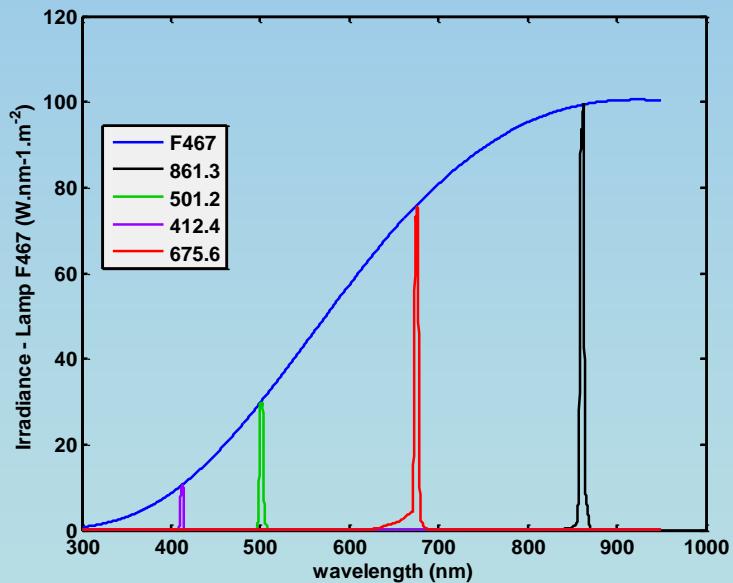


Characterization of Moonphotometer

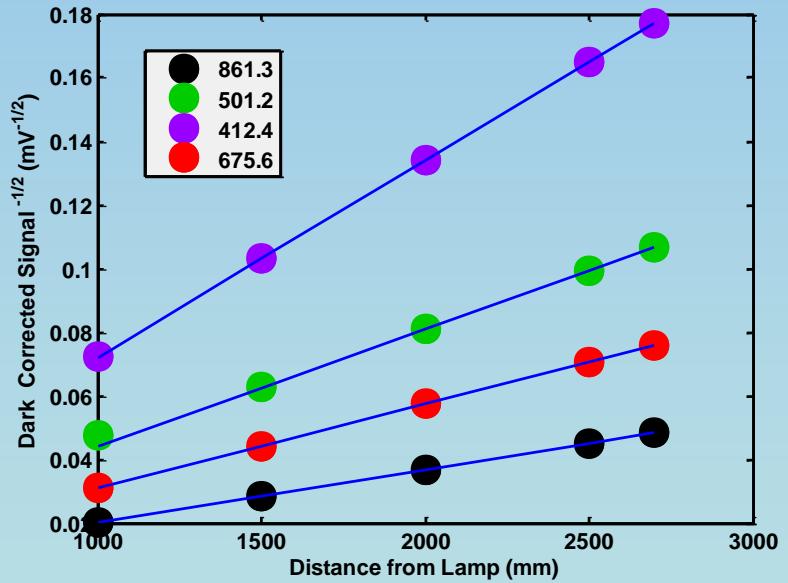


Direct Irradiance Setup – Responsivity V W⁻²m²

Irradiance at reference distance



Determination of reference plane



Distance
Reference Plane (detector) to Front window

ATLAS Project schedule, phase 1

Kick-Off (KO) 22 June 2015

Deliverable number	Deliverable Description	Due Date (KO+#month)	Work Packages	Progress
TD0	Brief Monthly Reports	Monthly	all	✓
TD1.1	Tuneable laser system operational	12.2015	WP1	✓ completed
TD1.2	SOP for LSF and Oor stray light	2.2016	WP1	✓ completed
TD1.3	SOP nonlinearity	3.2016	WP1	✓ completed
TD2.1	LSF, Oor stray light and linearity determined for System 1.	6.2016	WP2	✓ completed (Phaeton)
TD2.2	LSF, Oor stray light and linearity determined for System 2.	9.2016	WP2	✓ completed (PSR006) TBD (Pandora, phase 2)
TD3.1	Report on nonlinearity correction method	6.2016	WP3	In progress, 7.2016
TD3.2	Report on In-range and out-of-range stray light method	10.2016	WP3	In progress, 7.2016
TD4	Final report, Presentation	10.2016	all	

ATLAS Project schedule, phase 2

Kick-Off (KO) 5 July 2016

Deliverable number	Deliverable Description	Type	Due Date (KO+[#month])	Progress
T1.1	Report on the Wavelength calibration of ATLAS	report	KO+3	started
T2.1	Report on the field homogeneity of the beam conditioning unit	Report	KO+6	started
T2.1	Certificate for Linearity correction function	Calibration certificate	KO+9	
T2.2	Report on Bandpass and Line-Spread function and determination of stray-light matrix	Report	KO+10	
T2.3	Report on wavelength dispersion function	Report	KO+10	
T2.4	Calibration certificate for spectral irradiance	Calibration Certificate	KO+11	
T3.1	Dataset from one Pandora system deployed at PMOD/WRC	Data set	KO+15	
T3.2	Report on the comparison of the TCO with Dobson and Brewer	Report	KO+18	
T3.3	Report on the comparison of AOD to the WORCC reference Triad	Report	KO+18	