21.05.2025

Welcome to TriOS

Short introduction

2011

2016

2019

Founded in 1998

2011: TriOS moved to Rastede with 20 employees

Currently ~100 employees

TriOS Optical Sensors

TriOS

Sustainability: Solar Panels, geothermal energy, natural habitats and recycling

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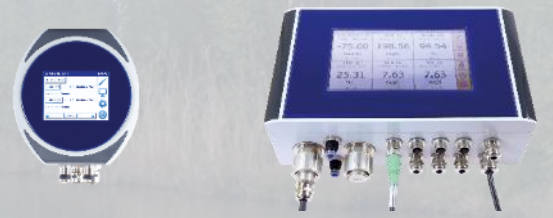
Portfolio

Photometer

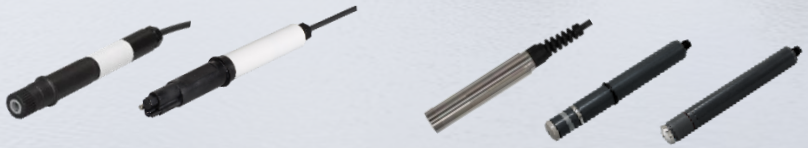
Radiometer

Fluorometer

Controller

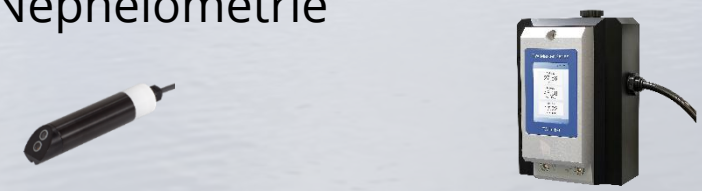


eCHEM



Zubehör

Nephelometrie



Systeme

RAMSES >1900 devices since 1998

ACC-VIS	ARC-VIS
	
VIS irradiance	VIS radiance

For the 20th anniversary
RAMSES got new features like
G2 webbrowser
Modbus RTU
+ internal temperature sensor
+ inclination sensor for 360° for x, y, z axes (no up and down)

We service sensors sold in 2002 until today

- Very long lifetime
- traceable history of calibrations and repairs

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Calibration and Interfaces

	RAMSES
Calibration	NIST Standard Traceability Calibrated DXW-1000 W (max. running time 50 hours)
Temperature	Darkpixel compensation Internal Temperature not yet implemented into calibration
Interfaces	RS-232 or RS-485 Modbus RTU & Ethernet available

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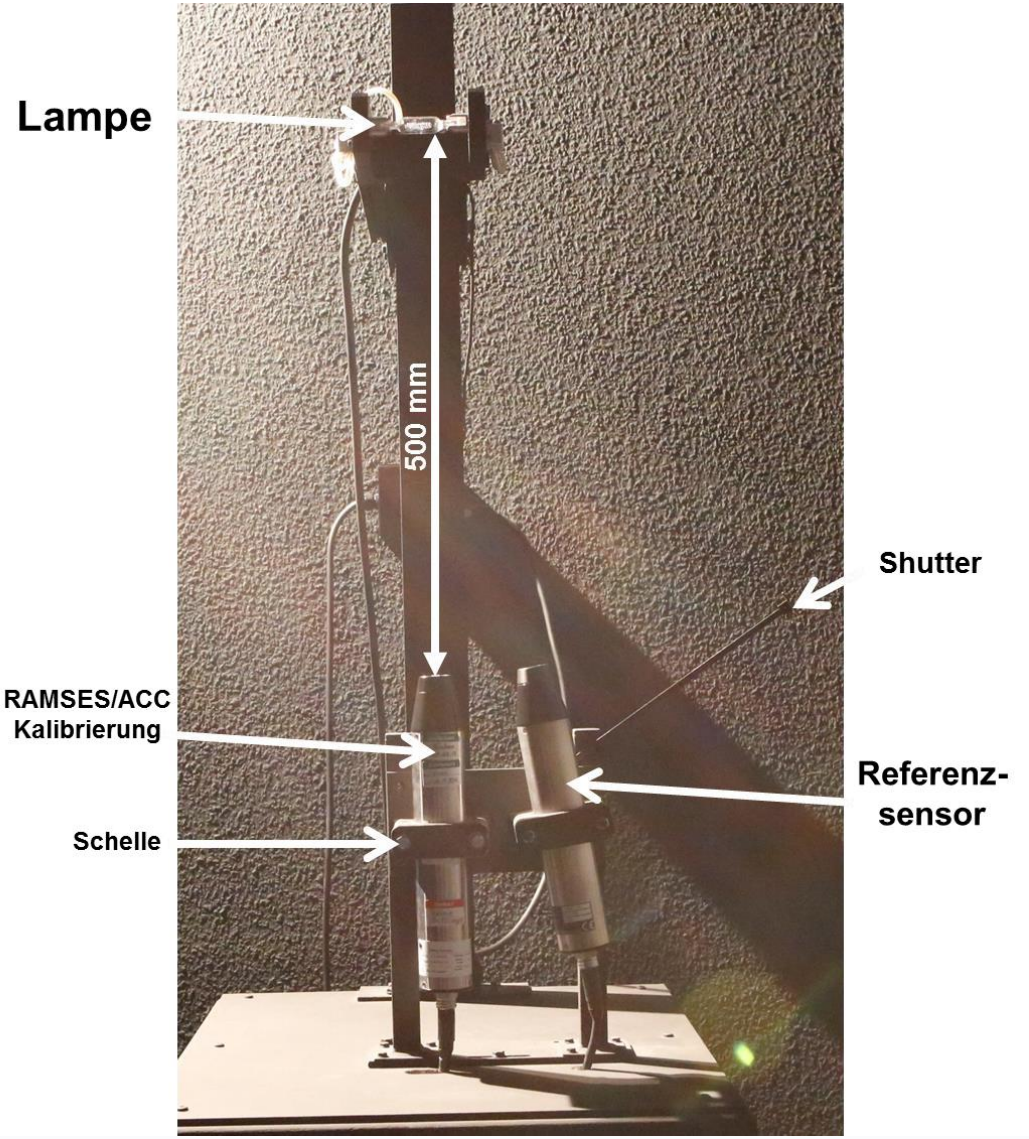
Calibration: Irradiance



Static procedure
Room temperature between 21°C and 24°C
Distance measured with a ruler and laser beam
Reference sensor

Warm-up time lamp until stable readings @8 A

Warm-up time sensor: 16 measurements

Calibration sensor: 16 measurements
Scatter: 16 measurements

Water calibration (cosine collector fully covered with water):
directly after air calibration 16 measurements
Scatter: 16 measurements

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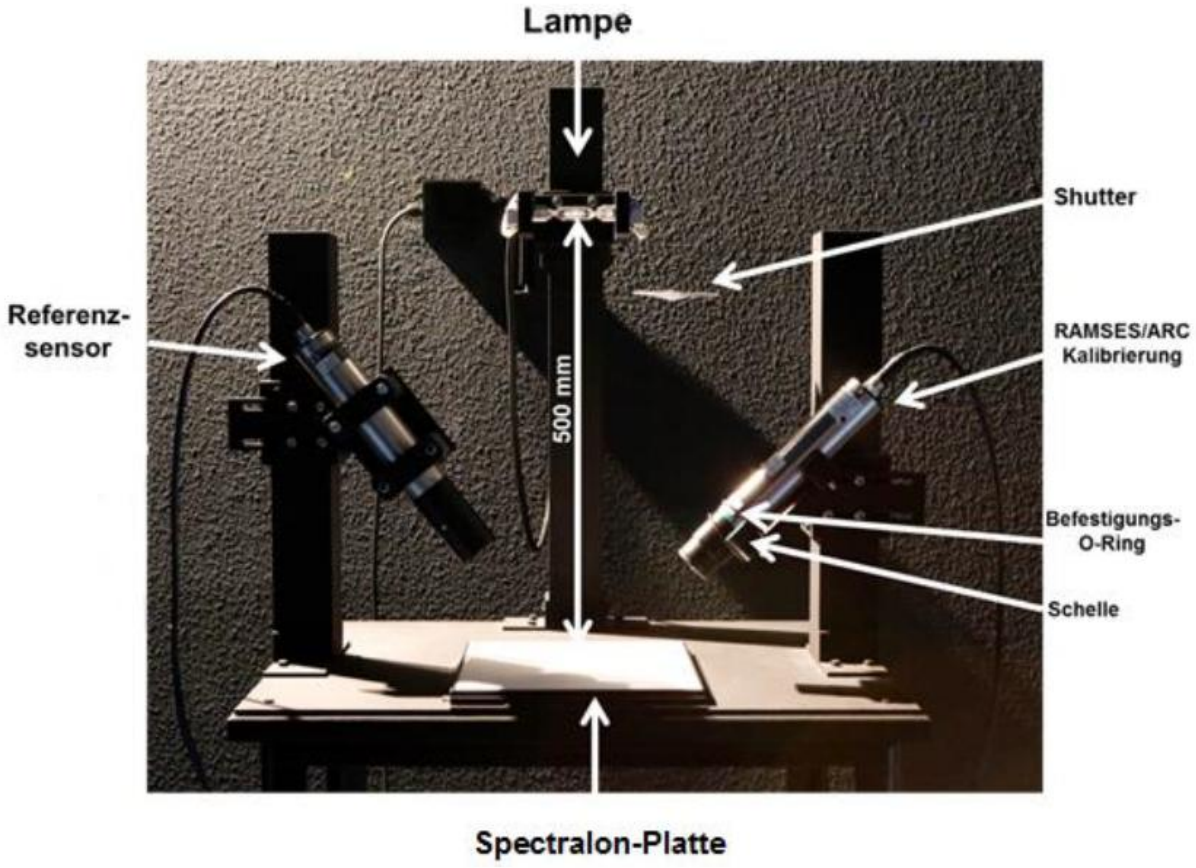
Calibration: Radiance



Static procedure since 2007
Room temperature between 21°C and 24°C
Reference sensor

Warm-up time lamp until stable readings @8 A

Warm-up time sensor: 16 measurements

Calibration sensor: 16 measurements
Scatter: 16 measurements

Water calibration: theoretical (Ohde und Siegel, 2003)

$$n_g(\lambda) = 1.4424 + \frac{7.1661}{\lambda - 144.7170}$$

Refraction index: 1.460082 @550 nm

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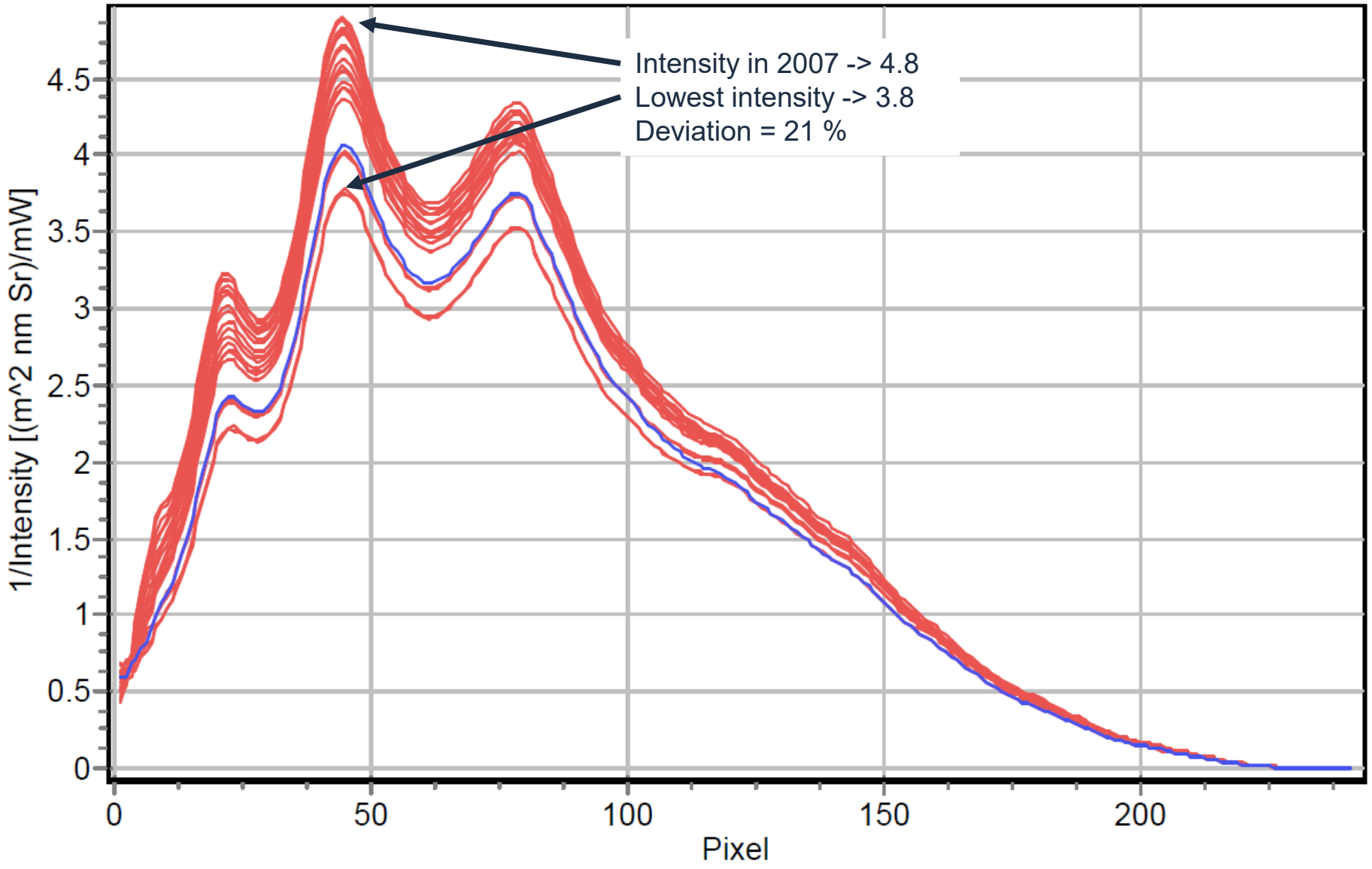
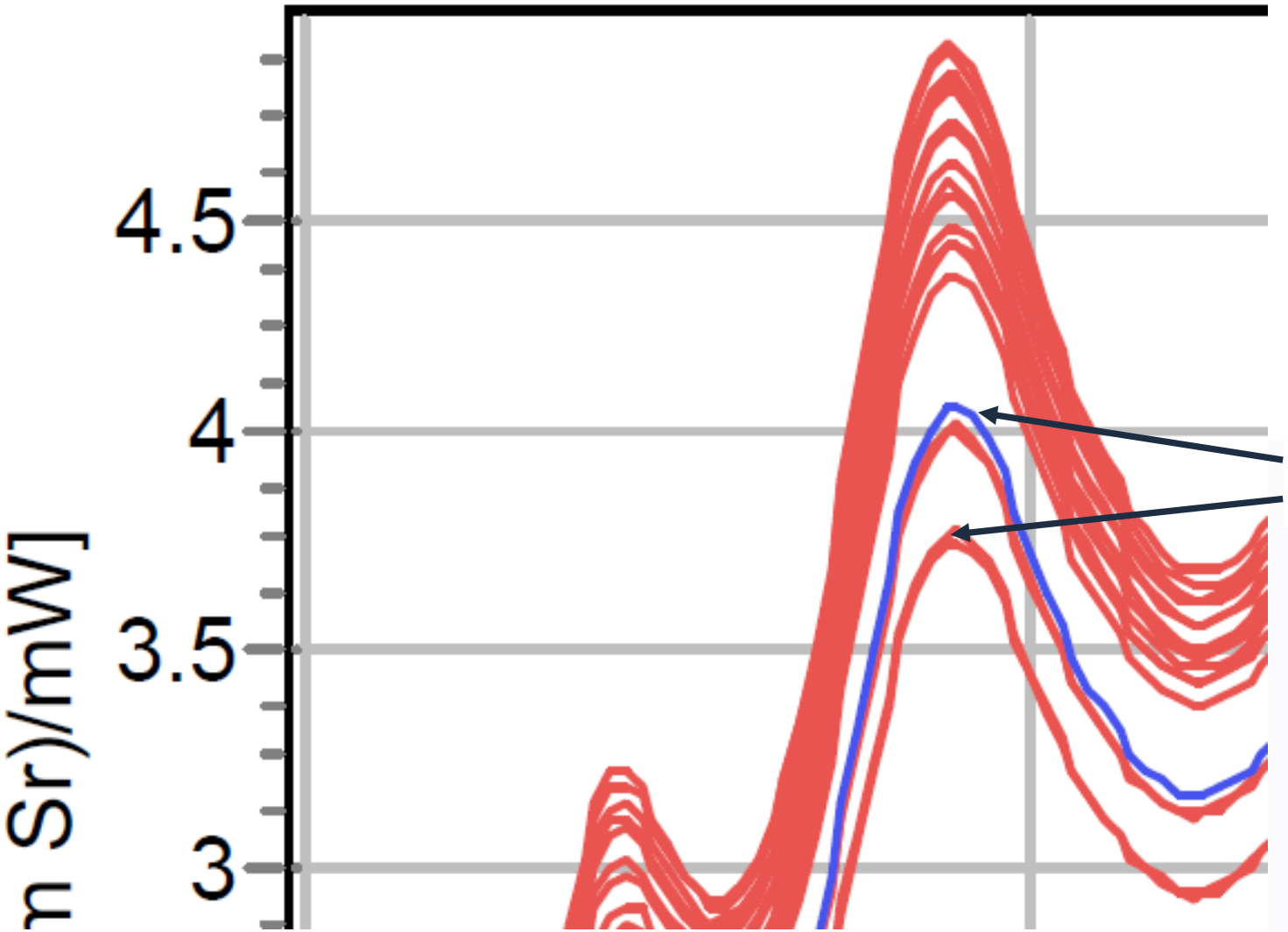
Traceability since 2007 until 2024



Device type:
ARC (radiance)

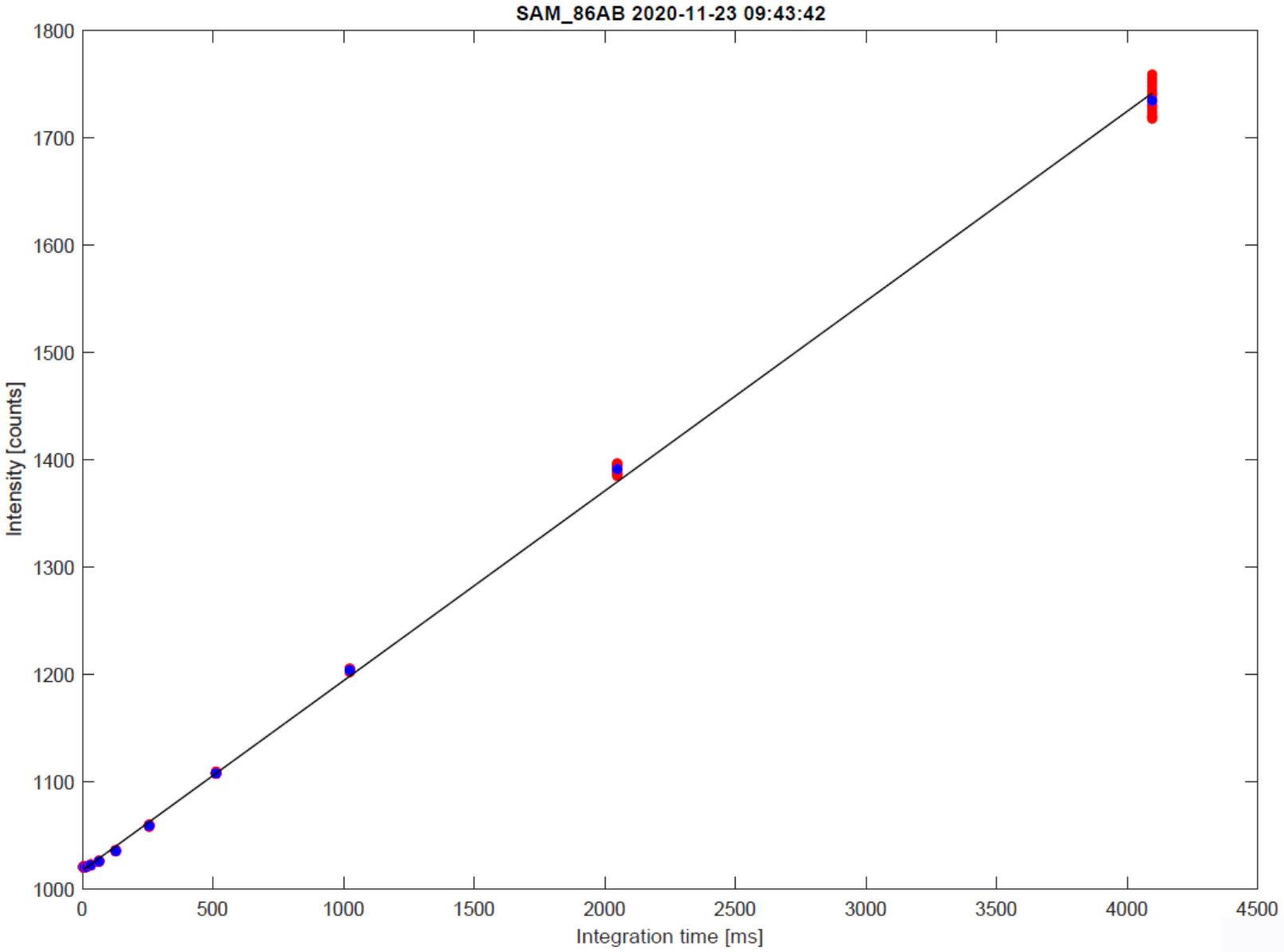
TriOS
Optical Sensors

Traceability since 2007 until 2024



TriOS
Optical Sensors

Calibration: dark measurements



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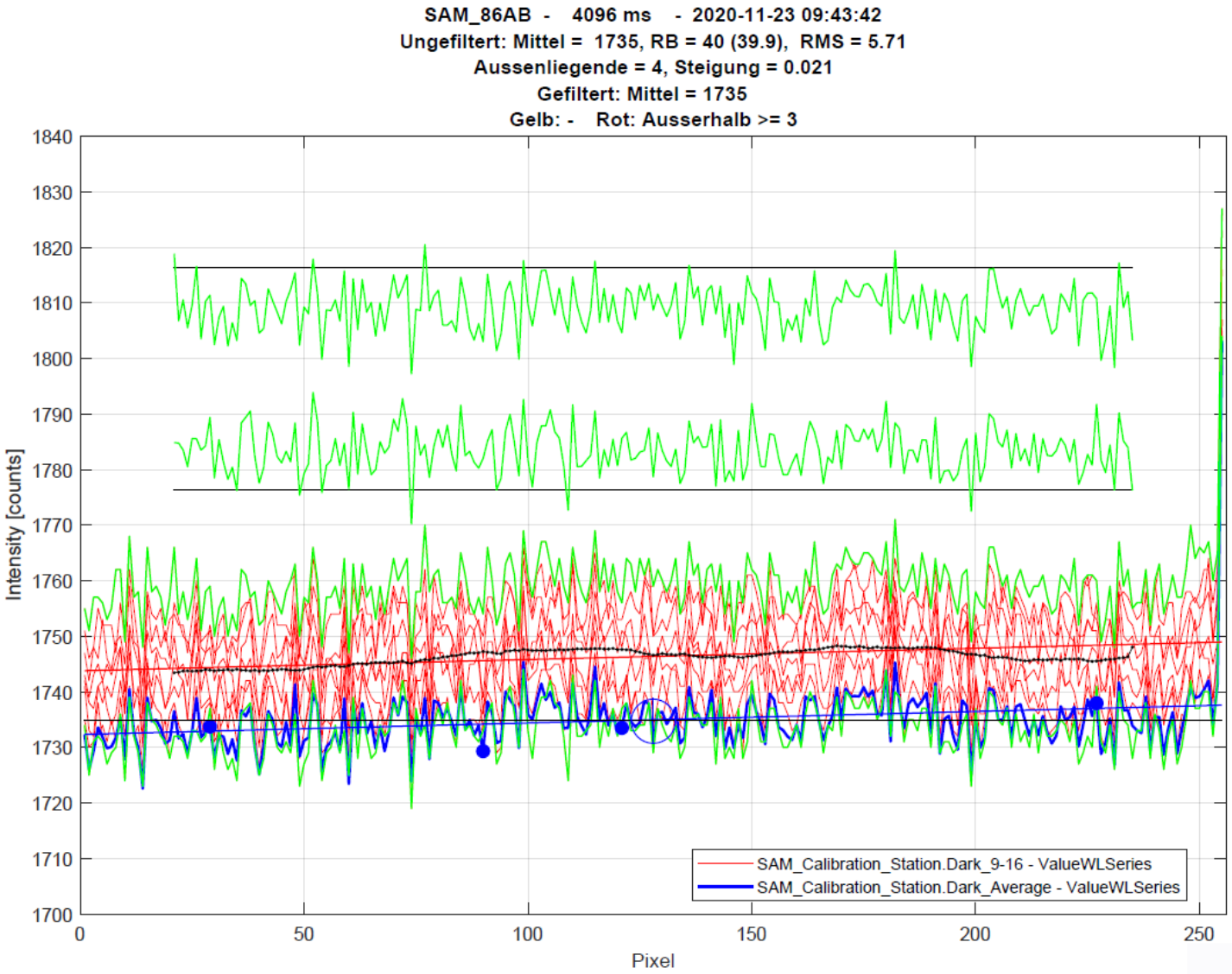
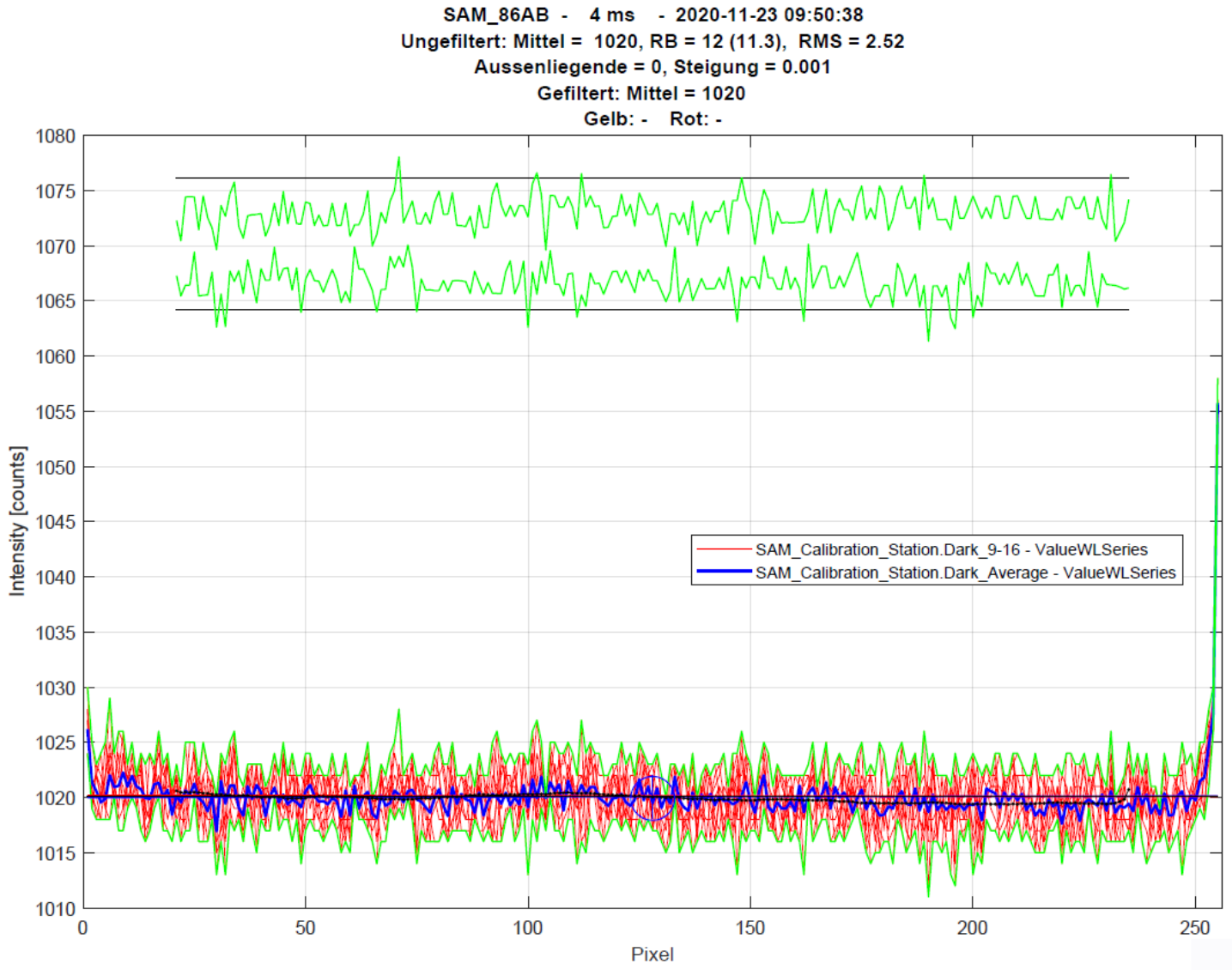
Calibration: dark measurements



Calibration: dark measurements



Calibration and Characterisation

Table 3.1. Basic requirements on the type and occurrence of calibrations and main characterizations of field radiometers supporting ocean color validation activities.

	Regular	Occasional	Initial	Class-based
Radiometric responsivity	X			
Spectral response		X		
Out-of-band & stray light		X		
Immersion factor (irradiance)			X	
Immersion factor (radiance)				X
Angular response			X	
Linearity				X
Integration time				X
Temperature response				X
Polarization sensitivity				X
Dark-signal	X			
Temporal response				X
Pressure effects				X

✓

specified by Carl Zeiss

✓

✓

theoretical
on request (since 2016 new material)

✘ (on request)

✓

dark pixel, specified by Carl Zeiss

✘

✓

✘

✘

Source: *IOCCG Protocol Series (2019). Protocols for Satellite Ocean Colour Data Validation: In Situ Optical Radiometry. Zibordi, G., Voss, K. J., Johnson, B. C. and Mueller, J. L. IOCCG Ocean Optics and Biogeochemistry Protocols for Satellite Ocean Colour Sensor Validation, Volume 3.0, IOCCG, Dartmouth, NS, Canada.*

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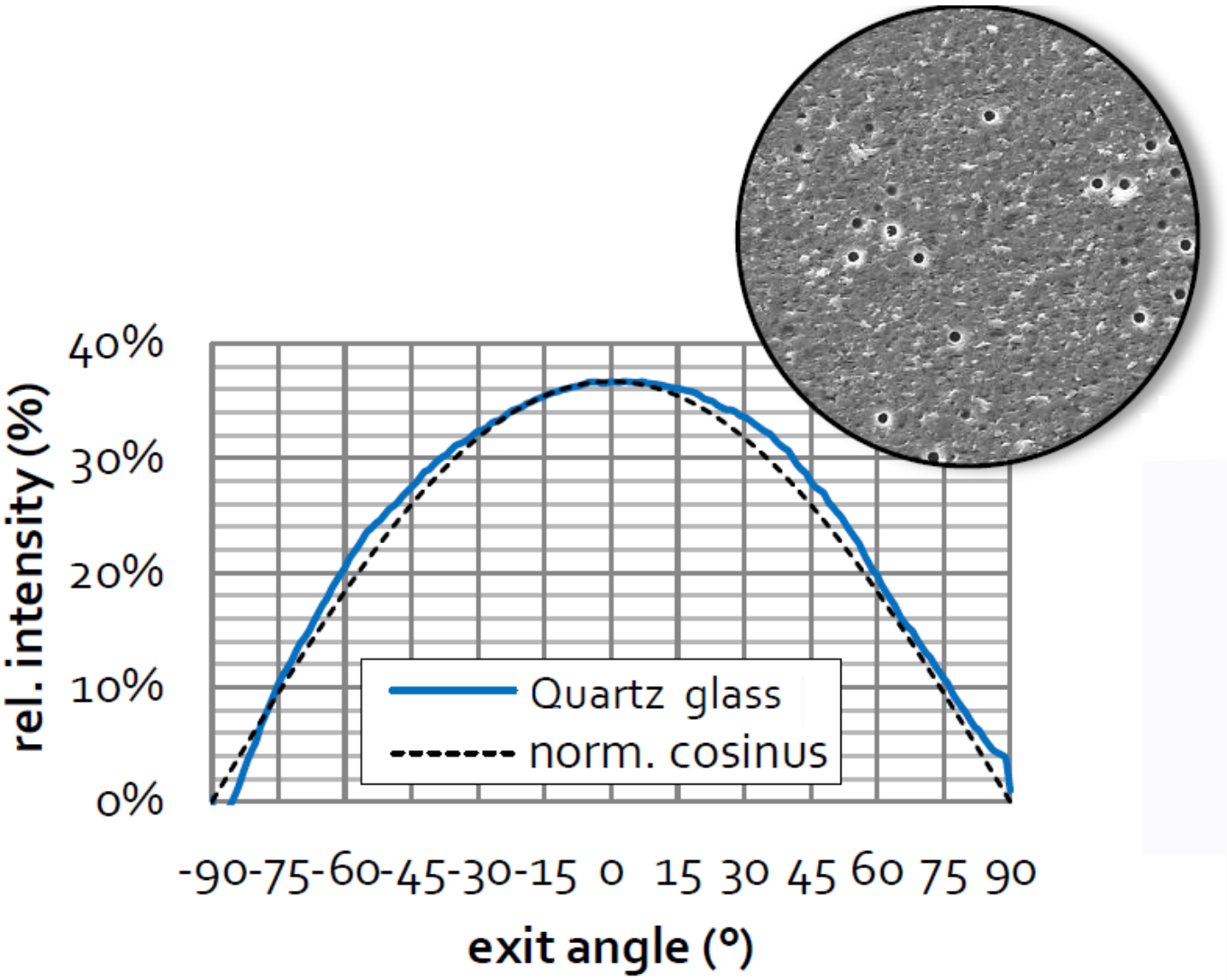
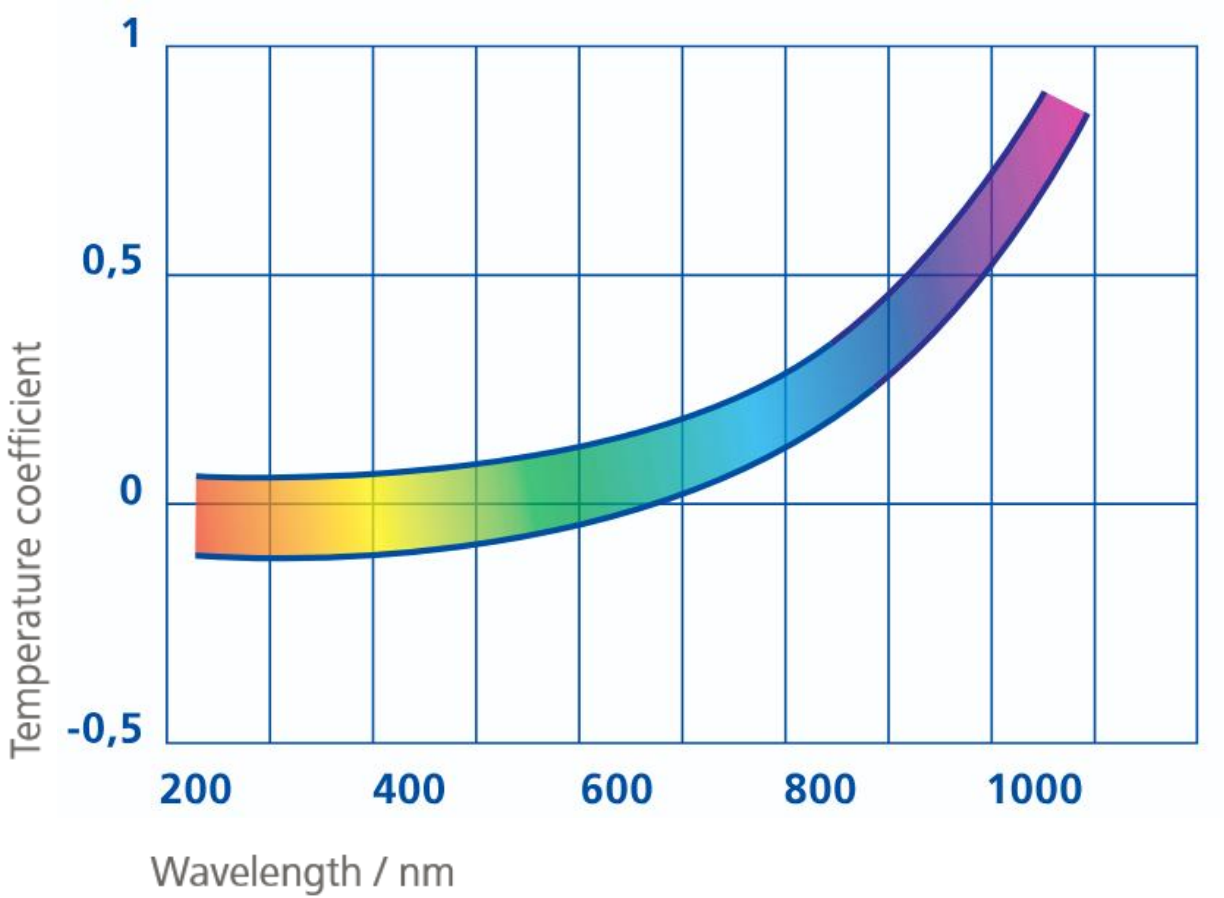
Characterisation: Angular response



Characterisation



As the graphic shows, a change of temperature T does not cause any change in sensitivity. In the range up to 1100 nm, the sensitivity even increases as the temperature rises. At temperatures between - 50 and + 50 °C, the sensitivity changes by less than 1% in the range of 1 to 1.55 µm, even for InGaAs photodiode arrays. Only outside of the specified range is a stronger temperature influence caused by a different coating. (Falling temperatures cause reduced sensitivity on the band edge.) The photodiode arrays used do not show any deterioration in the signal-to-noise ratio. Only the dark current I dark increases with rising temperature, resulting in a reduction of the dynamic range.

Source: Brochure „BR_Spectrometer_Modules_EN.pdf“ by Carl Zeiss
https://asset-downloads.zeiss.com/catalogs/download/spc/adb036b4-b2e5-48d2-ae76-3903ddfe9c06/BR_Spectrometer_Modules_EN.pdf

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Characterisation: Conclusion

Spectral response	performed by Carl Zeiss in advance
Stray light matrix	done during every calibration
Determination of immersion factors for irradiance sensors	done during every calibration
Determination of immersion factors for radiance sensors	theoretical (Ohde & Siegel, 2003)
Determination of angular response of irradiance sensors in air	available on request
Measuring FOV of the radiance sensors in air	available on request
Determination of the non-linearity	not available
Determination of the dark signal	done during every calibration (all IT‘s)
Determination of the thermal sensitivity	specification by Carl Zeiss
Determination of the polarisation sensitivity	not available
Determination of the temporal response	not available
Determination of the wavelength scale	performed by Carl Zeiss in advance
Determination of the signal-to-noise ratio	specified by Carl Zeiss

RAMSES Technical specification

	ACC			ARC	ASC
					
	UV	UV/VIS	VIS	VIS	VIS
Wavelength range* [nm]	280...500	280...720	320...950	320...950	320...950
Detector*	256 Channel silicon photo diode array				
Pixel dispersion* [nm/ pixel]	2.2	2.2	3.3	3.3	3.3
Wavelength accuracy*	0.2	0.2	0.3	0.3	0.3
Usable channels	100	200	190	190	190

	ACC-UV	ACC-VIS	ARC-VIS	ASC-VIS
	UV A / UV B irradiance	VIS irradiance	VIS radiance	VIS scalar irradiance
Wavelength range*	280...500 nm	320...950 nm		
Type Saturation (IT: 4 ms)**	20 W m^{-2} nm^{-1} (at 300 nm) 17 W m^{-2} nm^{-1} (at 360 nm) 18 W m^{-2} nm^{-1} (at 500 nm)	10 W m^{-2} nm^{-1} (at 400 nm) 8 W m^{-2} nm^{-1} (at 500 nm) 14 W m^{-2} nm^{-1} (at 700 nm)	1 W m^{-2} nm^{-1} sr^{-1} (at 500 nm)	20 W m^{-2} nm^{-1} (at 400 nm) 12 W m^{-2} nm^{-1} (at 500 nm) 15 W m^{-2} nm^{-1} (at 700 nm)
Type NEI** (IT: 8 s)**	0.85 µW m^{-2} nm^{-1} (at 300 nm) 0.75 µW m^{-2} nm^{-1} (at 360 nm) 0.80 µW m^{-2} nm^{-1} (at 500 nm)	0.4 µW m^{-2} nm^{-1} (at 400 nm) 0.4 µW m^{-2} nm^{-1} (at 500 nm) 0.6 µW m^{-2} nm^{-1} (at 700 nm)	0.25 µW m^{-2} nm^{-1} sr^{-1}	0.8 µW m^{-2} nm^{-1} (at 400 nm) 0.6 µW m^{-2} nm^{-1} (at 500 nm) 0.8 µW m^{-2} nm^{-1} (at 700 nm)
Collector	Kosinus		FOV: 7° in air	Spherical, 2 Pi
Accuracy	Better than 6...10% ***		Better than 6% ***	Better than 5% ***
Integration time	4 ms...8 s			

*) Specifications of Carl ZEISS AG, Germany **) Integration time ***) Depends on wavelength range ****) Noise-equivalent irradiance

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Future calibration plans

Temperature compensation

New generation of RAMSES has an internal temperature sensor

Thank you!

Questions?

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