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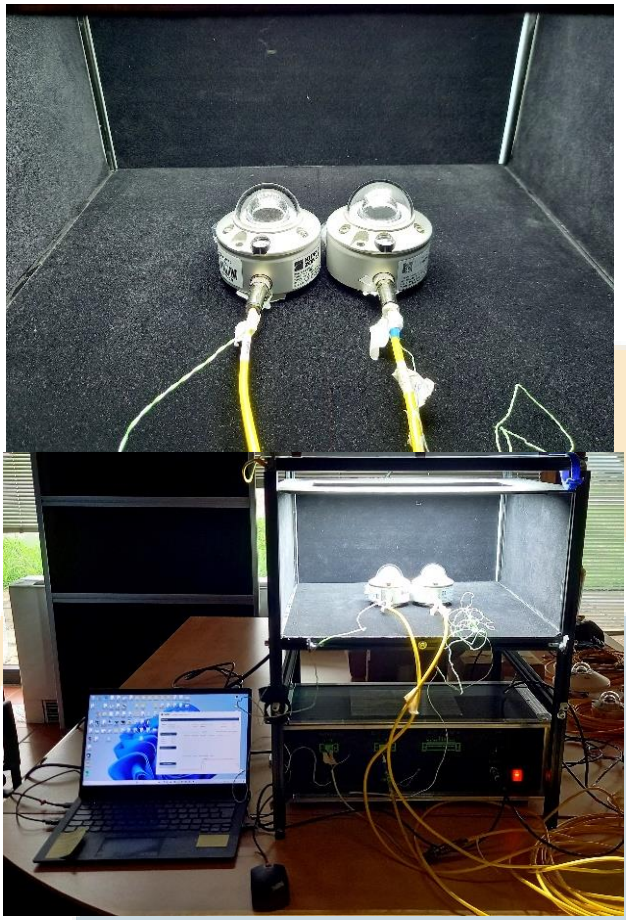
INSIGHTS No.5

On-site calibration of radiometric sensors (pyranometers) with oSole's portable Cal-Kit



1. oSole's Cal-kit allows

1. Performing an **indoor calibration** (with simulated sunlight according to the ISO 9847:1992 standard) by comparison against a calibrated reference sensor, reducing time, costs and the impact of unfavorable meteorological conditions (outdoor calibration). A close room (office, technical room, or other…) with controlled temperature is enough to perform a good calibration.
2. **Minimizing costs, time, and measuring time** (1-2 gg vs 4-6 weeks).
3. **Minimizing risks of sensors' loss, damage and delays** frequently reported during sensors' shipments.
4. Enable the **continuity of monitoring** over time, without interruptions in the monitoring data.
5. Possibility to recalibrate up to 15+ sensors per day.
6. The kit is versatile and allows recalibration of most sensors (manufacturers/models) including sensors with different outputs (analogue/mV, analogue-amplified/0-1V/4-20 ma, digital/modbus).

Cal-Kit

oSole has developed a **portable and patented kit [1]** to perform an **indoor calibration of pyranometers on-site** (or "close-to-site"). oSole offers directly calibration services or sells the full kit to whoever wants to perform testing services in full autonomy. oSole's portable kit ("***Cal-kit***") is used to perform re-calibration of pyranometers..

[1] **Italian patent:** "*Dispositivo e sistema portatile per calibrazione indoor di sensori radiometrici, in particolare piranometri*", # file: 102021000027080, award date: 10 Nov 2023.

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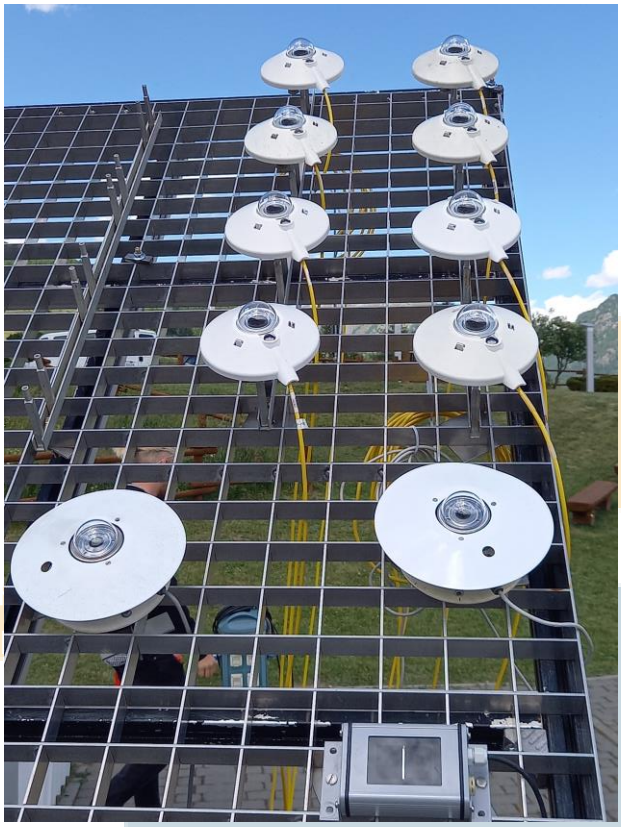
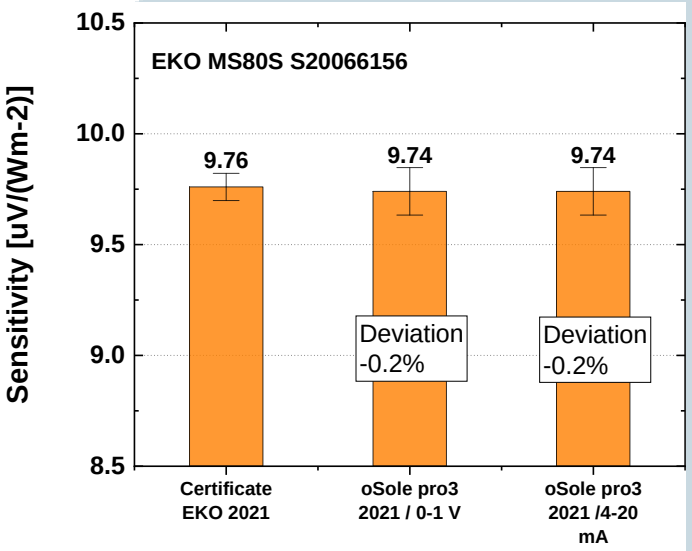
oSole's Cal-kit



The **measurement uncertainty** (k=2, i.e. with coverage factor of 95%) is UC = ±1.45 % [2].
Traceability to SI (International Metric System) and WRR (Word Radiometric Reference) is achieved through regular calibrations of the reference sensors performed at ISO 17025 accredited laboratories and through regular participation in international measurement campaigns organized by the Joint Research Centre JRC (European Commission)



Comparison of the sensitivity S values for an **EKO MS80-S** sensor as given by the **manufacturer** in the original certificate; and using **oSole's CalKit** for both analogue amplified outputs (0-1 V and 4-20 mA). The error bars represent the measurement uncertainty corresponding to a k=2 coverage factor (i.e. ±1.4%. for oSole's CalKit).

[2] The uncertainty of the sensitivity value S of the reference sensor.
[3] JRC/ESTI: European Solar Test Installation, https://joint-research-centre.ec.europa.eu/events/isrc-2023-06-26_en, n

2. oSole's cal-kit consists of:

1. An **artificial light source** (with appropriate spectral characteristics and uniformity on the measurement plane).
2. A **case** containing all the electronics (power supply , data recorder, ...)
3. An AC voltage stabilizer to offer greater measurement repeatability and accuracy.
4. A portable PC with proprietary SW and an MS-Excel macro for data analysis.
5. Mechanical parts and fastening structures.
6. Other: cables, temperature sensors for the pyranometers, ambient temperature and humidity sensors.
7. One or more reference sensors.

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oSole's Cal-kit

8.2.4 Recalibration

Recalibration of sensors shall be conducted in a manner that minimizes downtime and sensor outages in order to prevent interruption of monitoring. Effective methods may include:

- Exchanging installed sensors with new or recalibrated units
- Performing on-site recalibration of sensors where possible
- Providing redundant sensors and alternating laboratory recalibration schedules

For Class A systems, sensors shall be recalibrated once every 2 years, or more frequently per manufacturer recommendations.

For Class B systems, recalibrate sensors according to manufacturer recommendations.

IEC 61724 (PV system performance – Part 1: Monitoring) suggests performing on-site recalibration of sensor whenever possible.

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