Development of a low-cost measurement bench for monitoring perovskite solar cells under real outdoor working conditions

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SIRTA
Site Instrumental de Recherche par Télédétection Atmosphérique

Study of PSC ageing under outdoor conditions

Perovskite Solar Cells (PSC) :

- **Promising** technology (higher efficiency than silicon)
- Challenges : **stability issues**, **degradation**

Outdoor conditions :

- **Variations in sunlight** throughout the day
- Partial shading (**cloud cover**)
- **Weather** conditions (rain)

Measurement limitations :

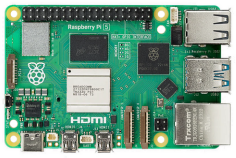
- Few Source Measure Units (**SMU**) available (**costly**)

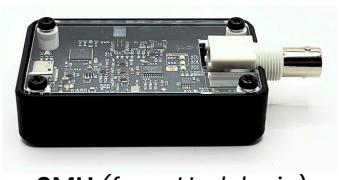
Design of a low-cost testing platform

Specifications :

- Standard SMU **accuracy** ☑
- **Compact** and **affordable** architecture ☑
- **Individual** cell measurements ☑
- Remotely controllable (**VNC** mode) ☑
- **Python** programming ☑

Components of the measurement bench :



Raspberry PI 5 +  **µSMU** *(from Undalogic)*

Fully automated PV cell monitoring cycle

Daily monitoring cycle :

Night mode :

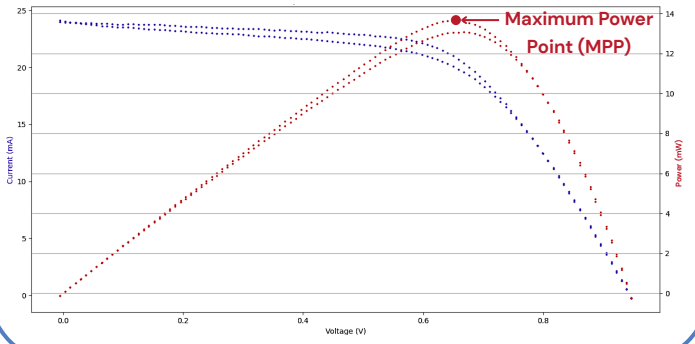
- Calculation of **sunrise** and **sunset** hours
- Cell in **short-circuit** (less degradation mode)

Day mode *(sunrise → sunset)* :

- Maximum Power Point Tracking (**MPPT**)
- **Current-Voltage sweeps** (every hour)

Perovskite cell I-V curve :

Hysteresis is observed due to **ion migration**. The **faster** the voltage sweep, the **more pronounced** the hysteresis.



Improvement of existing MPPT algorithms

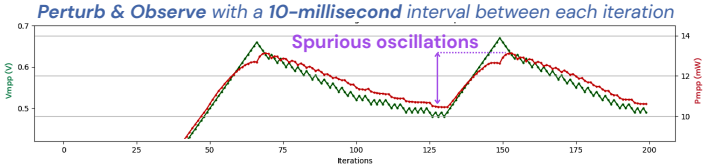
Purpose :

Tracking algorithms operate the cell at **maximum** power.

Challenges with perovskites :

The current MPPT algorithm (**Perturb & Observe**) fails to find the MPP in real time (**oscillations** due to hysteresis).

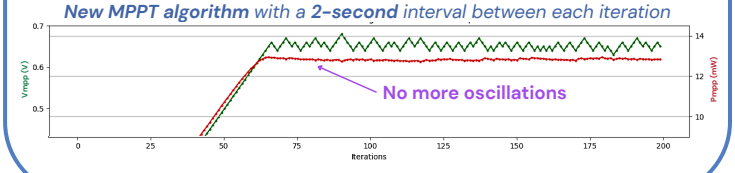
Perturb & Observe *with a* ***10-millisecond*** *interval between each iteration*



Solution under development :

New MPPT algorithm that accounts for the **stabilisation time** of the cell (due to **ion migration**).

New MPPT algorithm *with a* ***2-second*** *interval between each iteration*



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