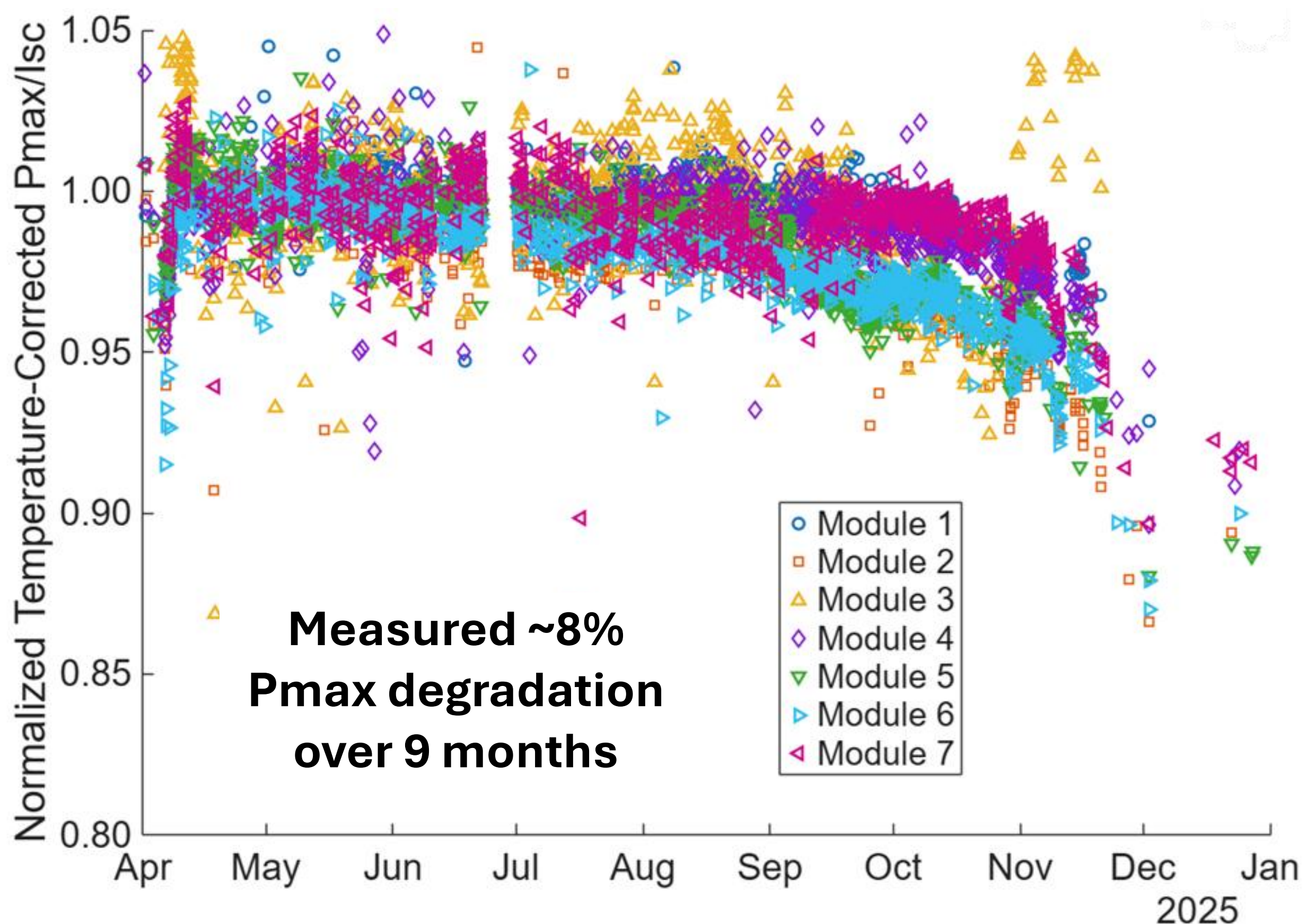


# Measuring Module Degradation With In-Situ IV

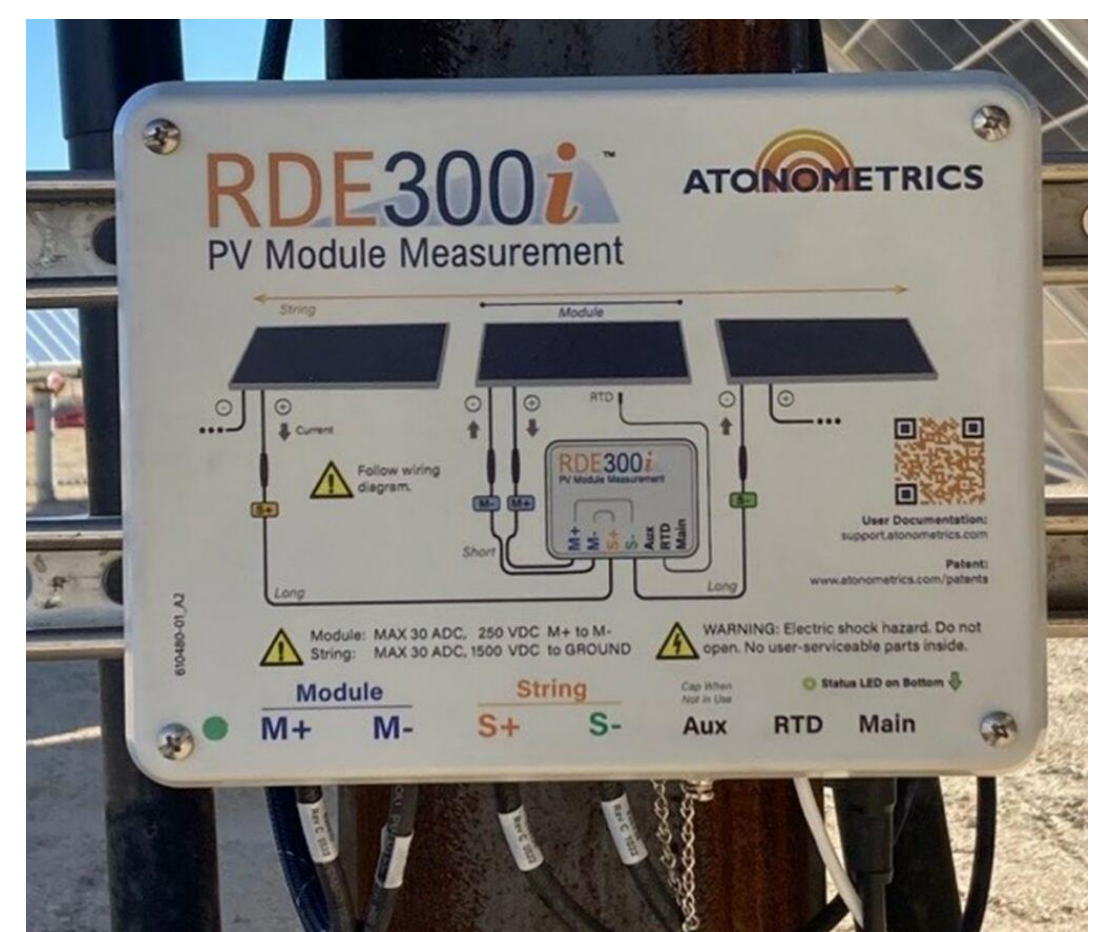
Michael Gostein, Kipp and Zonen

Field measurement of PV module degradation is challenging under operating conditions. In-situ IV offers a way to track performance change without removing modules. This example shows a **9-month measurement campaign** on operating modules in a utility-scale PV plant which detected a **large degradation rate** causing plant underperformance.



## Experiment and Data Analysis

- Tracked **seven modules** at distributed soiling stations in utility-scale PV plant—using the **clean modules** (cleaned ~weekly) in each soiling station module pair
- In-situ IV parameters sampled at 1-minute resolution
- Performance tracked using normalized temperature-corrected **Pmax / Isc ratio**—which approximates temperature-corrected relative module efficiency
- Data aggregated to hourly averages and normalized to values in May 2025



In-situ IV unit periodically measures IV sweeps and IV fit parameters, including Pmax and Isc