# Quality diagnostics and prediction of PV cell energy production using AI methods

**prof. Dr hab. inż. Damian Grzechca, Dr inż. Krzysztof Hanzel, Dr inż. Łukasz Chruszczyk**
*DOMINIK DUDA, MARCIN MORKA, MARCEL KUCZEK, ZAOHUI CHEN, FATIMA EZ-ZAHIRI, JULIA ILEWICZ, HAECHAN SHIN*

**Project Assumptions**

The project assumptioms involved building the measurement platform, establishing communication with measurement devices, and developing a data acquisition application. This enabled effective data collection, which was then used to create and optimize diagnostic models. Finally, the results were presented clearly, and comprehensive project documentation was prepared.

**Achieved Goals**

The project achieved all goals by developing a fully automated station for precise I-V measurements of PV cells under controlled conditions. The system combines an ESP32 with environmental sensors, custom firmware, and a MATLAB interface for real-time control and data logging. The adjustable platform and automated procedure using the R&S NGU401 SMU ensure accurate, repeatable results, supporting future AI-based diagnostics and degradation analysis.

**Applied implementation methods**

As part of the project, a detailed experimental setup has been designed to control light sources and measure the current-voltage characteristics of PV cells. Tests will include damage scenarios such as surface matting, artificial cracks, UV-C exposure cycles, and impact resistance. Environmental conditions inside the chamber will be carefully monitored to ensure controlled experiments. Collected data will be analyzed using AI techniques to develop diagnostic methods and predictive algorithms for assessing PV cell quality.

**Achieved results**

As part of the project, an advanced measurement station was built with automatic sample positioning, light control, and precise environmental sensing. Using an ESP32 microcontroller, modern sensors, and MATLAB software, it enabled detailed IV measurements of PV cells under various defect conditions. The collected data supported the development of an AI model for diagnosing defect types and severity. The project also helped participants gain skills in data analysis, AI, teamwork, and advanced measurement technologies.

**Additional project details**

In summary, the successful implementation of the photovoltaic cell measurement station highlighted the value of international teamwork. The team's diverse technical, educational, and cultural backgrounds greatly enriched each project stage — from design to testing. This diversity enabled the creation of an innovative, precise, and modular system. Smooth communication and effective task distribution ensured efficient project execution and quick problem-solving. Overall, the project showed that international collaboration not only improves technical outcomes but also strengthens teamwork, adaptability, and interdisciplinary skills, offering valuable experience for future academic and professional work.

Finansowanie badań: Inicjatywa Doskonałości - Uczelnia Badawcza