# Indoor PV Glare Measurement Testbench for Luminance Analysis

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**This poster presents an indoor photovoltaic (PV) glare measurement testbench designed for controlled and reproducible luminance characterization. RAW imaging and radiometric calibration are used to derive absolute luminance values in cd/m², enabling quantitative glare assessment under standardized lab conditions.**

## Introduction

- Rapid expansion of PV has increased the relevance of glare in certain configurations → concerns for safety and visual comfort.
- Reliable measurement methodologies are required for objective assessment and comparison.
- I.e., this **indoor dual-axis testbench for standardized PV glare evaluation** [1].
  - Independent rotation of the module and camera to precisely define incidence and reflection angles.
  - Photographed images are processed through a calibrated algorithm to extract maximum luminance values, presented in a glare assessment report.

## Methodology

- A PV module is placed on the testbench, with the camera centered.
- Two different measurement methodologies (I & II) are performed:

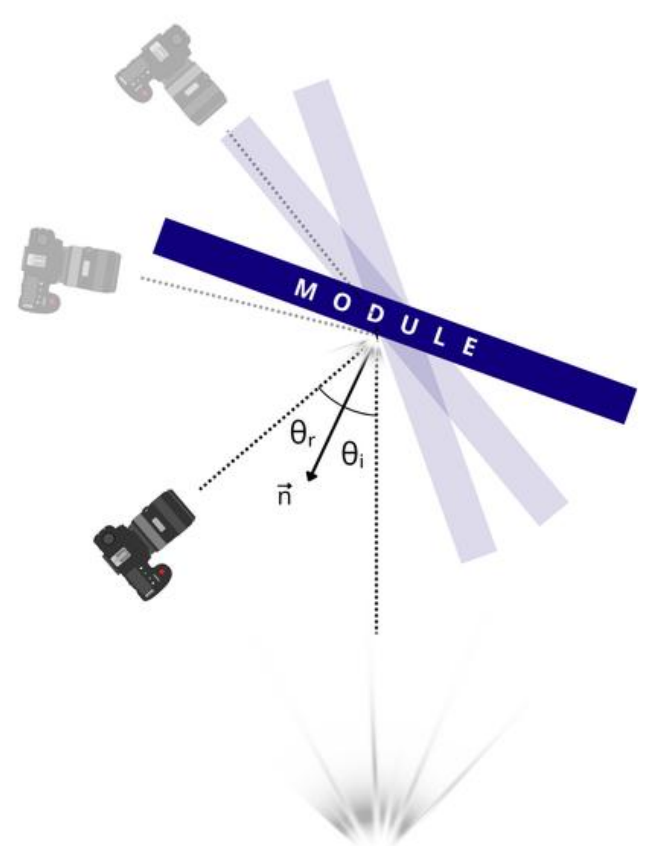



*Figure 1*: Methodology I. **Incidence angle ($\theta_i$) = reflection angle ($\theta_r$)**, if the maximum luminance occurs under specular reflection [2].

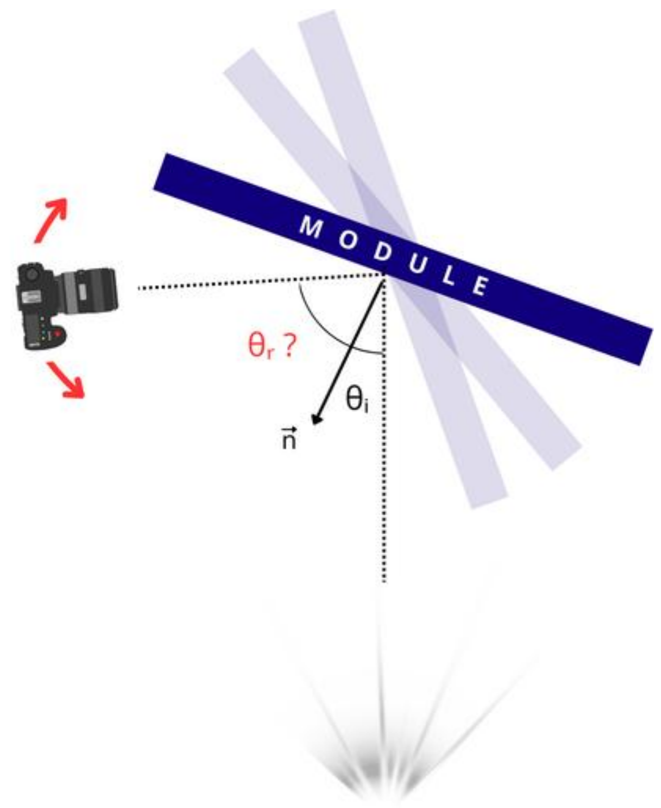
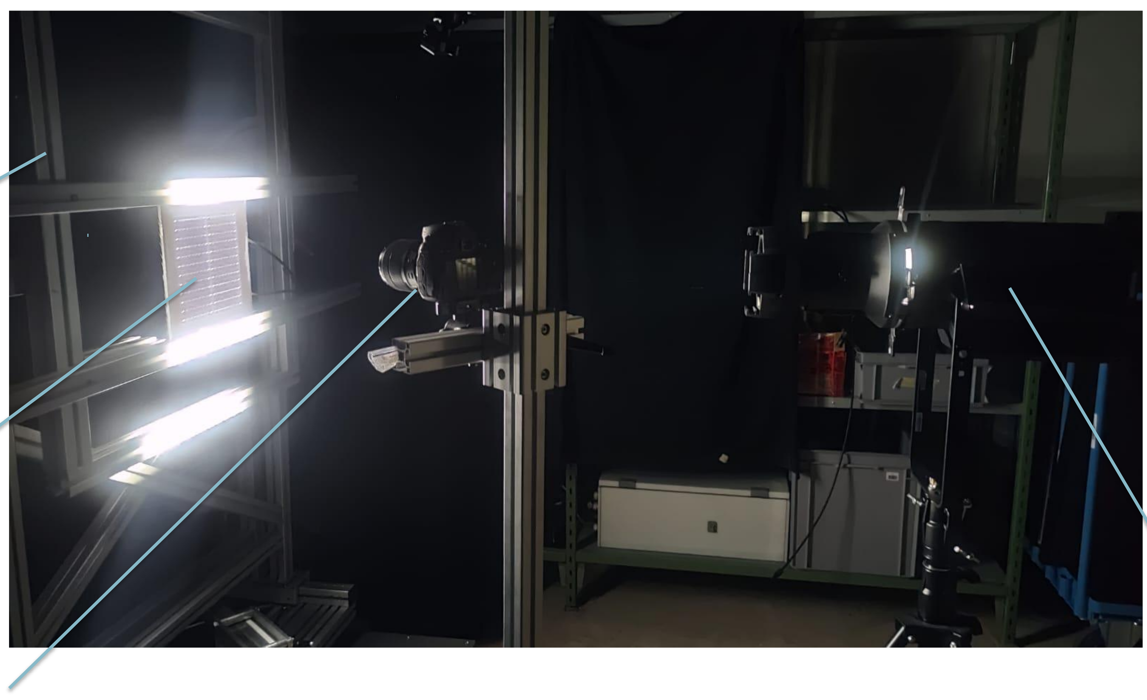



*Figure 2*: Methodology II. If not, incidence angle ($\theta_i$) fixed, **reflection angle ($\theta_r$) adjusted iteratively** until the maximum luminance is identified.

Rotating testbench

PV module



Camera

Light beam

*Figure 3*: Image of the operating test bench, at methodology I. Not to scale.

Images are computed through an algorithm that extracts, calibrates, and scales the luminance values to assess the module's level of reflection on outdoor conditions.

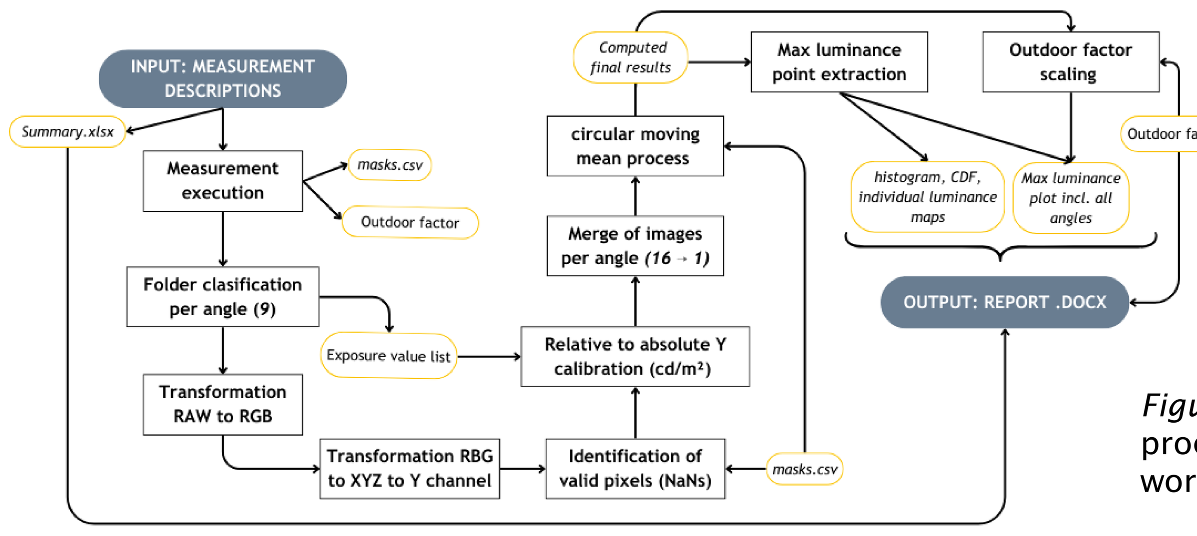



*Figure 4*: Image - processing algorithm workflow.

## Results

**Methodology I:**

- Glare spots in Figure 5 brighter around the geometric center of the module, except in higher angles.
- Comparation of maps across angles → The larger the incident angle, the higher the luminance.

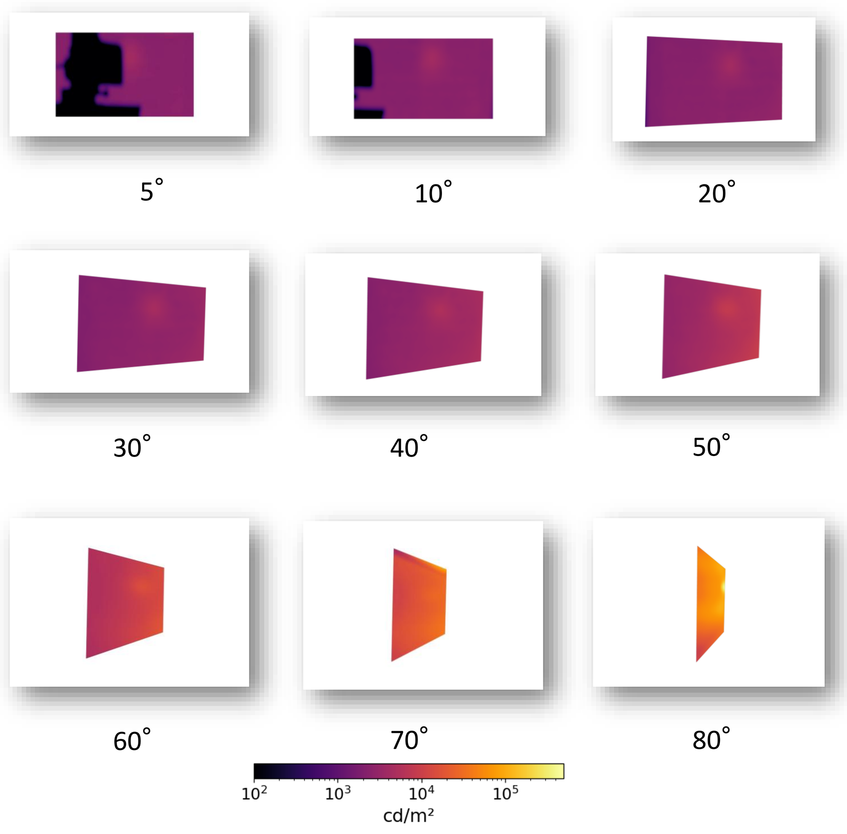



*Figure 5*: Luminance maps of an example PV module, taken at specular condition (method I).

**Methodology II**:
Higher luminance values observed at a different reflection angle (Θr) between the incidence angles 40º and 70º, as seen in red in Figure 6.

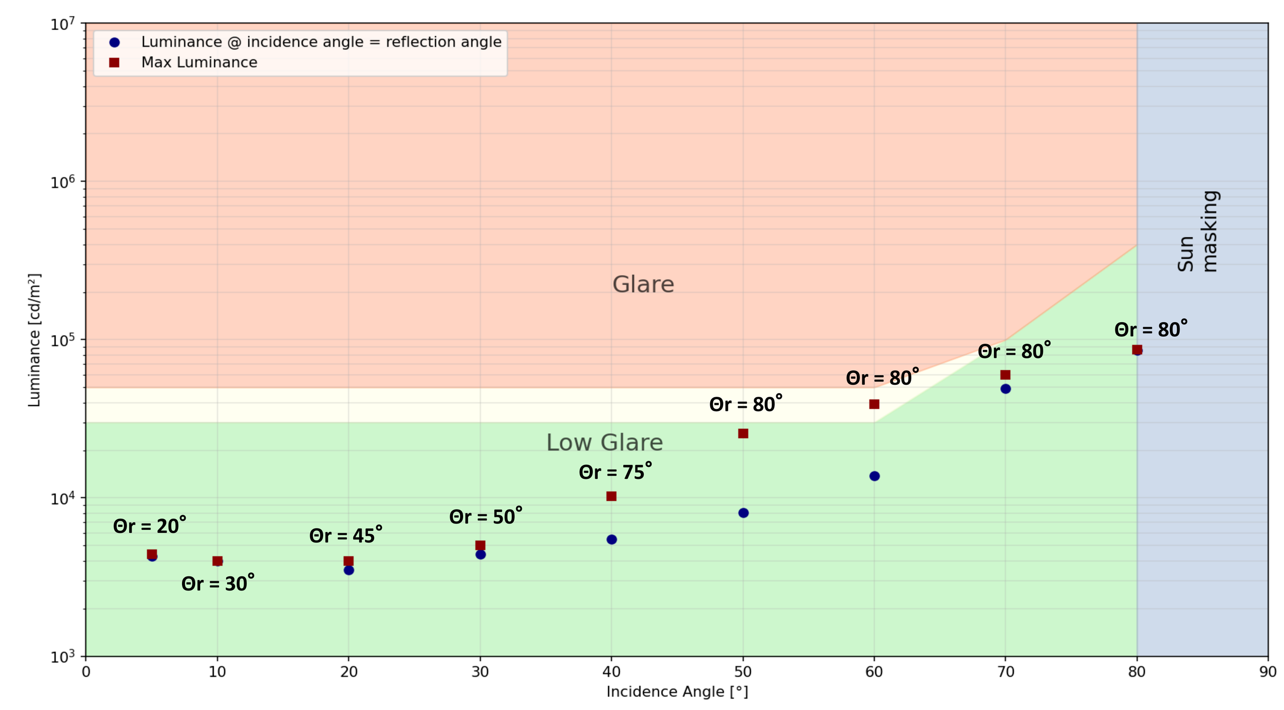



*Figure 6*: Luminance curves representing both measurement methodologies.
The reflection angle (Θr) at which the second measurement is taken is tagged in the plot.

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## Conclusion

- The testbench enables **objective correlation** between controlled laboratory measurements and real glare conditions by reproducing the full geometric configuration through complementary measurement methodologies.
- It provides a better understanding of the glare's behavior for future standardization and potential regulatory frameworks.
- As a laboratory-based solution, it offers a practical tool for manufacturers to support decision-making in glare-sensitive applications.

## References

[1] Bucher, C.; Bohren, A.; Hess, D.; Hassani, S.E.; Hügi, M. (2023) Two-Dimensional Representation of the Bidirectional Reflectance Distribution Function of Photovoltaic Modules. In Proceedings of the Conference: European Photovoltaic Solar Energy Conference and Exhibition (EU PVSEC).

[2] Bucher, C (2021). Reflexionen an Photovoltaikanlagen - Ursachen und Lösungen. In bulletin.ch (Vol. 10). Electrosuisse. https://doi.org/10.24451/arbor.16392. [Online; accessed 20-03-2026].

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