The telescope rod at the Quickcheck makes it possible to reach modules that are further away

Supporting electroluminescence inspection in the field with AI

Artificial intelligence is transforming electroluminescence inspection from a laboratory-bound diagnostic into a scalable, field-ready tool. It enables faster, more consistent evaluation of photovoltaic modules under real operating conditions.

Electroluminescence (EL) inspection is one of the most informative methods for assessing the condition of photovoltaic modules. In manufacturing, EL images are already used routinely to detect microcracks, inactive areas and other process-related defects.

In the field, however, the same principle has traditionally been harder to apply. Modules are installed, access is limited, operating conditions change continuously and inspection campaigns must fit into tight maintenance windows.

This is exactly the context in which artificial intelligence becomes useful: not as a replacement for proven imaging methods, but as a force multiplier that makes field inspection faster, more consistent and more scalable.

The key question is not whether EL imaging works in the field. It does. The real question is how to make it practical under real-world conditions and how to convert captured images into decisions quickly enough to support service teams and asset owners. This is where the inspection platform matters.

Hardware determines what kind of data can realistically be acquired on site; AI determines how efficiently that data can be evaluated. MBJ Solutions addresses this challenge with three field-oriented systems that cover different levels of diagnostic depth: the MBJ Mobile Lab, the MBJ Mobile EL and, most prominently, the MBJ Quickcheck.

Each of these systems solves a different field problem. The Mobile Lab is designed for in-depth, laboratory-like analysis in a mobile format. Integrated into a trailer, container or van, it combines high-resolution electroluminescence imaging with an A+A+A+ LED sun simulator for IV-curve measurement and power analysis.

This makes it more than an imaging platform: it creates a data-rich basis for AI-assisted evaluation, where luminescence findings can be assessed together with electrical performance data.

In practice, AI can help prioritize suspicious modules, apply consistent defect criteria across large test campaigns and support correlation between visible EL anomalies and measured IV deviations. For warranty clarification, project-related incoming-goods checks or detailed failure analysis in solar parks, that combination of broad measurement scope and more standardized interpretation is a major advantage.

The Mobile EL addresses a different need. It is portable, comparatively lightweight and designed specifically for high resolution EL imaging of large modules in warehouses, installation sites and other field environments. The software stitches up to three captured images into one full EL view for grading and reporting.

Here, AI adds value primarily on the image-evaluation side: it can assist in detecting defect patterns, reduce operator dependence in repetitive review tasks and make judgments more consistent across large module batches. It is therefore well suited where high image quality is needed, but the full measurement range of a Mobile Lab is not required.

In standard configuration, operation takes place at night or in darkened environments, with a daylight option available for selected applications. This makes the Mobile EL an effective bridge between factory-grade EL evaluation and field-ready deployment.

The MBJ Quickcheck takes this field logic one step further. Unlike conventional EL-based

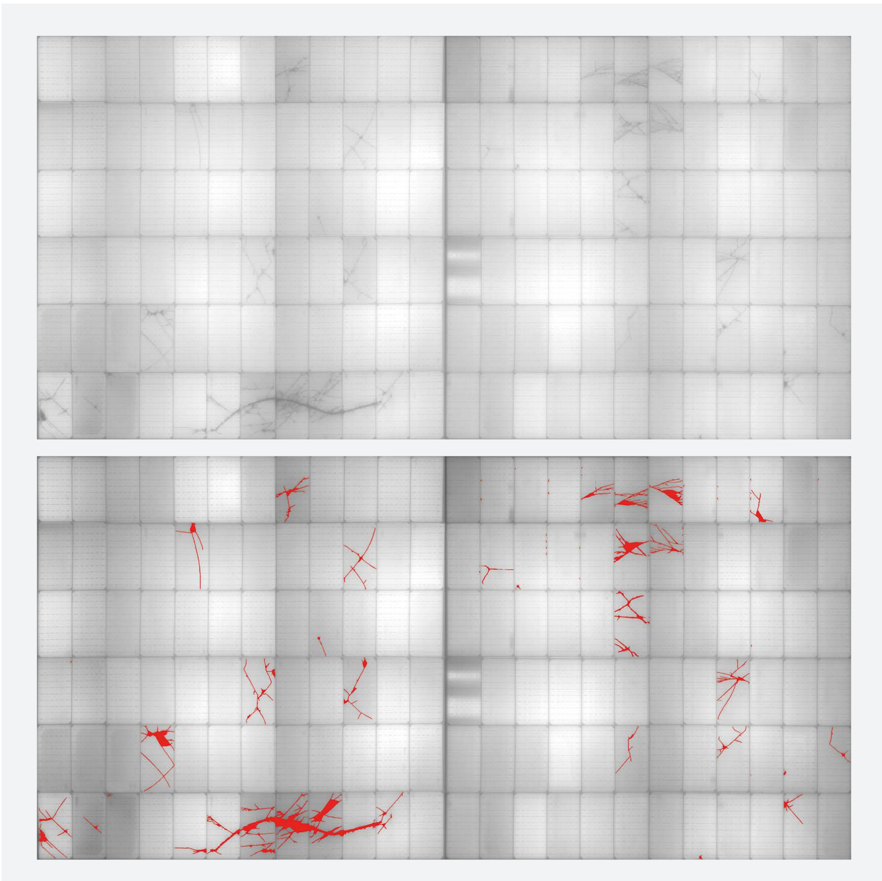


Image of a module tested onsite with the MBJ Mobile Lab with automatic defect detection approaches, it is designed for rapid inspection of installed modules while they remain in operation. There is no need for a conventional laptop-centered measurement station and, crucially, no need to electrically disconnect the module from the photovoltaic system for every inspection step.

Instead, the system combines an integrated camera, battery, LED illumination and onboard computer in a single portable measurement head. The operator works through a smartphone, conveniently mounted on the telescopic guide bar handle, or optional virtual-reality interface, sees live images during scanning and stores relevant images directly on site. The telescope rod makes it possible to reach modules that are further away, which is particularly relevant on large installations and difficult roof geometries.

This workflow also changes how image information is built up onsite. Instead of relying on a single isolated capture, the operator scans the module step by step in a structured manner while viewing the live image on a smartphone or tablet and storing relevant images directly at the point of inspection.

Single images can be stitched together to represent a full module and the result is no longer just a set of local snapshots but a spatially coherent representation of the scanned module area.

That is highly relevant for AI support: defect predictions can then be interpreted in context, not only frame by frame. Suspicious regions can be marked where they actually occur on the module surface, which makes crack structures, clustered inactive areas and other extended patterns easier to understand operationally.

This change in workflow is more significant than it may sound at first. Classical field EL inspections can be technically informative but operationally expensive because they often require downtime, string intervention and a relatively elaborate setup.

Quickcheck is intended to reduce exactly that burden. It enables luminescence-based inspection within the string and under real operating conditions, turning the inspection process from a relatively invasive specialist procedure into a much lighter screening and triage tool.

For service teams, that means more modules can be checked per day. For plant operators, it means that diagnostic coverage can be expanded without a proportional increase in downtime or labor intensity.

The measurement principle behind Quickcheck also explains why the system is so well suited for AI-supported field work. A compact hood-like imaging setup creates controlled local conditions at the module surface. A reference image is recorded with the LED illumination switched off, capturing the background signal. Then an integrated near-infrared source at 850 nm excites the cells optically, and the emitted luminescence is recorded with a sensitive InGaAs camera equipped with a 1150 ± 25 nm bandpass filter.

By capturing alternating LED ON and LED OFF images and subtracting the reference from the illuminated image, the system obtains a clean luminescence result in which electrically active areas appear bright and damaged or inactive regions appear dark. In practical terms, this produces EL-like diagnostic information under field conditions and during daylight-oriented inspection workflows.

That makes the Quickcheck especially interesting for AI integration. In a conventional offline workflow, image acquisition and image evaluation are separate steps. With the Quickcheck, the operator scans the module, the system delivers live images, stores relevant captures and can evaluate them in real time.

If those captures are merged into a combined inspection view, the AI prediction becomes more useful still: it is no longer tied only to isolated frames, but to a larger visual map of the inspected area. In practice, this means that anomalies can be highlighted with spatial context, documented immediately and checked again while the module is still accessible. Real-time AI, therefore, shortens not only the path from measurement to decision, but also the path from local indication to module-level understanding.

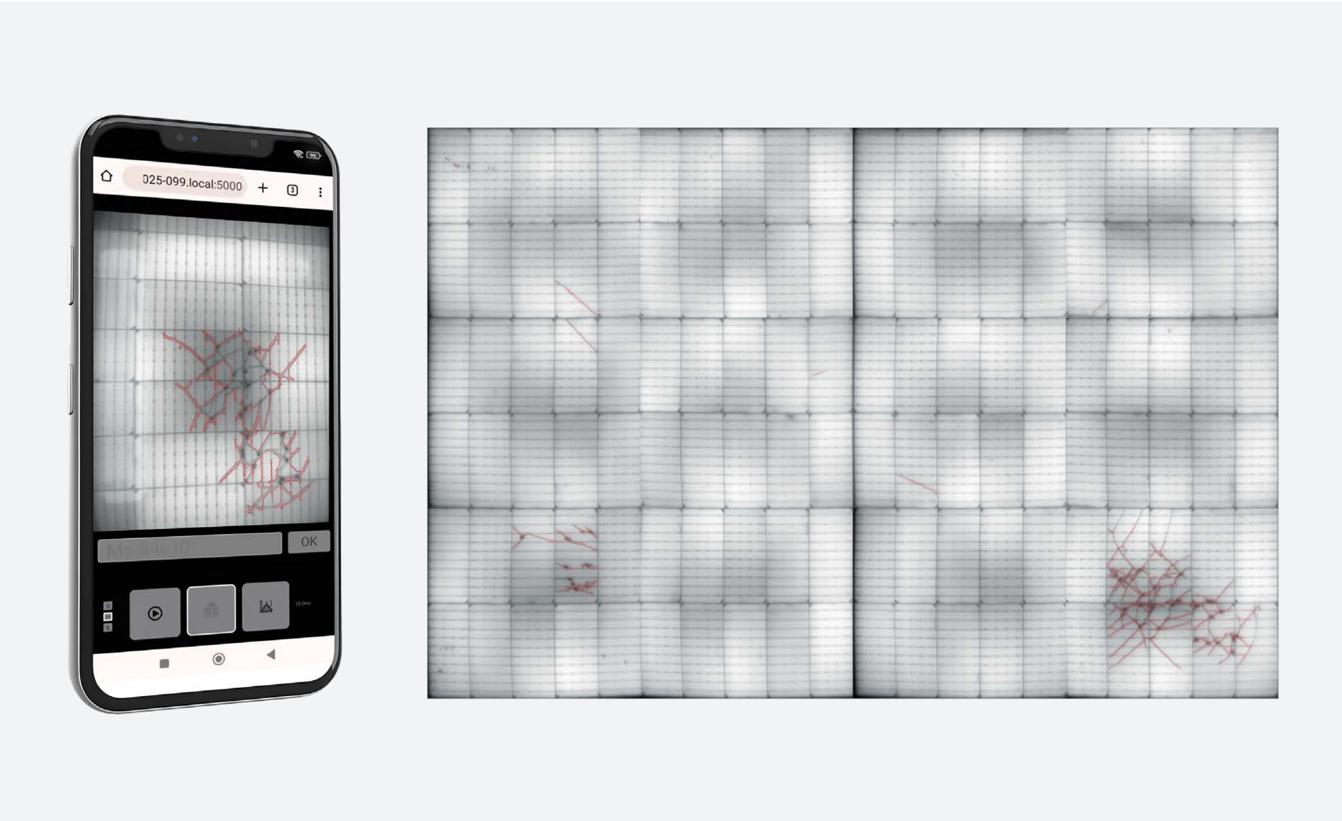
This is where the role of AI should be described carefully. AI is not useful because it looks modern. It is useful because field inspection creates a volume and consistency problem. A specialist can interpret EL or EL-like images very well, but manual review across hundreds or thousands of modules becomes time-consuming and variable.

A trained AI model applies the same criteria every time. It does not lose concentration, and it does not become less consistent after a long day in a solar park. For screening tasks in particular, this consistency is a major benefit.

At MBJ, this AI capability builds on experience from production-integrated inspection, where AI-based evaluation is already used to detect defects such as microcracks, inactive areas and soldering-related anomalies at industrial throughput.

The Mobile Lab is designed for in-depth, laboratory-like analysis in a mobile format

AI dramatically reduces the amount of manual first-level screening required before expert judgment can be applied where it matters most.



Stitched Image of a module tested with MBJ Quickcheck with automatic defect detection

The underlying toolchain for data management, annotation and model training is developed in-house, which is important because field conditions differ fundamentally from factory environments. In production, imaging geometry, lighting, handling and module types are comparatively controlled.

In the field, modules age, soiling varies, thermal history differs and damage mechanisms reflect transport, installation stress, wind and snow loads or long-term operation. A field-capable model, therefore, cannot simply be copied from a production line and expected to work perfectly everywhere. It has to be trained and refined on field-relevant data.

This continuous learning aspect is particularly important for Quickcheck. Because the system is meant to support rapid onsite decisions, the defect catalog must remain closely aligned with what operators actually encounter in installed systems. AI becomes most valuable when it acts as an assistant: highlighting suspicious regions, drawing attention to anomalies, helping the operator avoid oversight and structuring the documentation.

The final technical judgment still belongs to experienced engineers and service specialists, especially in borderline cases. But AI dramatically reduces the amount of manual first-level screening required before expert judgment can be applied where it matters most.

When comparing the three systems, their complementary roles become clear:

- The Mobile Lab is the choice when maximum diagnostic depth is required onsite: EL, IV, diode testing and optional electrical safety testing in one mobile setup.
- The Mobile EL is a strong option where high-resolution EL imaging and structured reporting are needed with a transportable and proven field workflow.
- The Quickcheck, by contrast, is the most direct answer to the challenge of scalable screening in operating plants. It is lighter, faster to deploy, less invasive and structurally better suited for real-time AI assistance during inspection itself.

For the photovoltaic sector, this matters because the installed base is aging and inspection demand is rising faster than expert capacity. The bottleneck is no longer only image acquisition. It is the ability to convert inspection data into actionable maintenance decisions across entire portfolios.

A purely manual workflow struggles to scale to that requirement. AI-supported systems offer a way to pre-screen, prioritize and standardize. They do not eliminate the need for expertise; they make expertise deployable across a much larger number of modules.

In that sense, AI does not replace proven PV inspection methods. It allows them to operate at field scale. And among the available field systems, the MBJ Quickcheck shows this most clearly: by combining non-invasive luminescence imaging, immediate operator feedback and real-time AI-supported defect recognition in a compact portable device, it points toward a future in which high-quality module diagnostics can be performed faster, earlier and with far less operational friction than before.

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