

Photovoltaic Module Reliability Testing: 400°C/hr



Early Failure Detection of Interconnection with Rapid Thermal Cycling in PV Modules

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Introduction & Procedures

Backgrounds

Ordinary Thermal Cycling [TC] (< 100 °C / hr)

- Qualification / Type Approval (TC 200) : Low Failure Rate

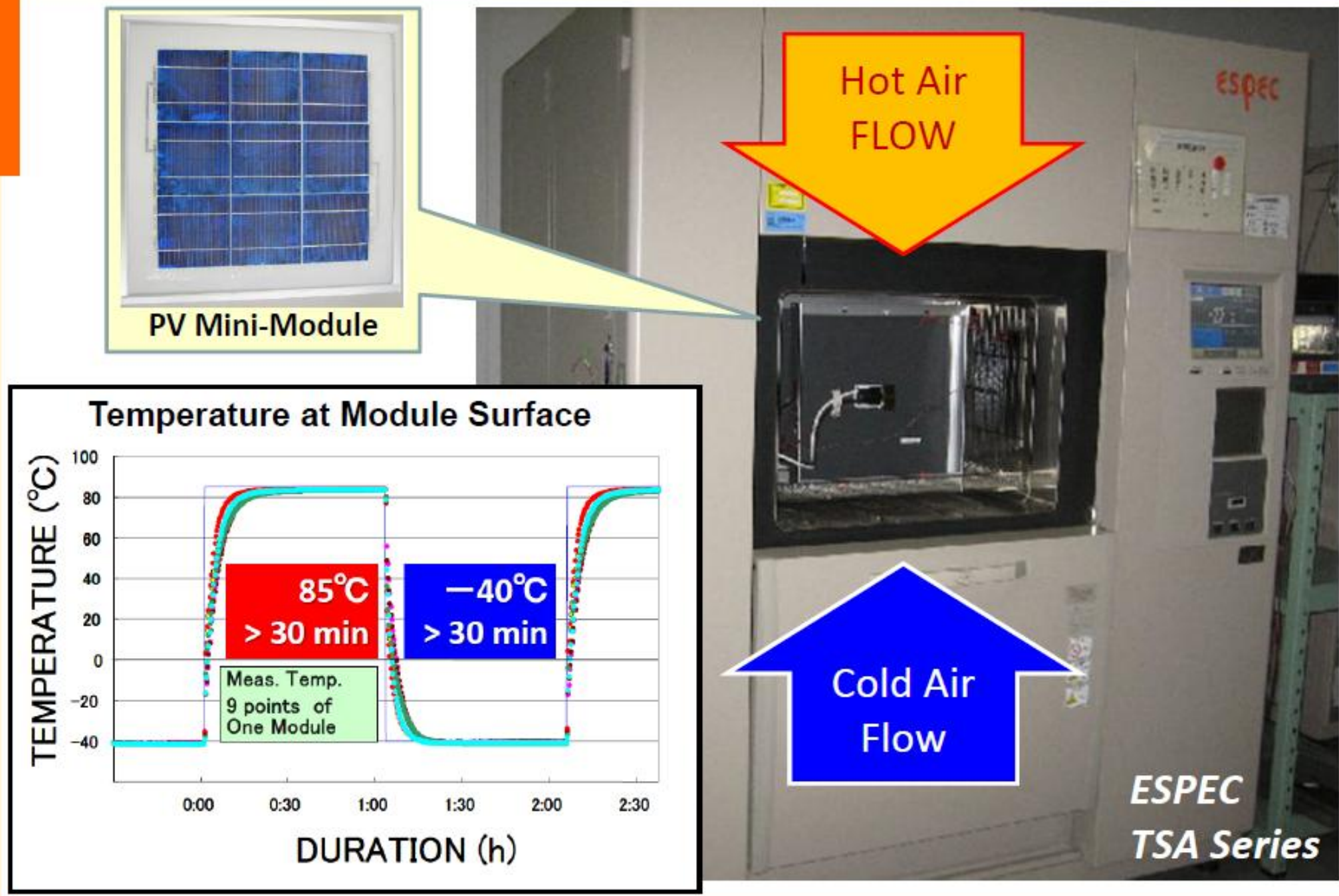
- Power-loss with the increasing of cycling number in TC

Osterwald <i>et al.</i>	: TC 400	< Δ 8 %	2000
Wohlgemuth <i>et al.</i>	: TC 1,500	< Δ 4 %	2008
Jaekel <i>et al.</i>	: TC 400	< Δ 3 %	2011
	: TC 500	< Δ 5.5 %	2011
Geipel <i>et al.</i>	: TC 400	< Δ 0.5 %	2011
Dethlefsen	: TC 400	< Δ 5 %	2011
Funcell	: TC 400	< Δ 0 %	2011
	: TC 600	< Δ 3 %	2011
	: TC 700	< Δ 4 %	2011

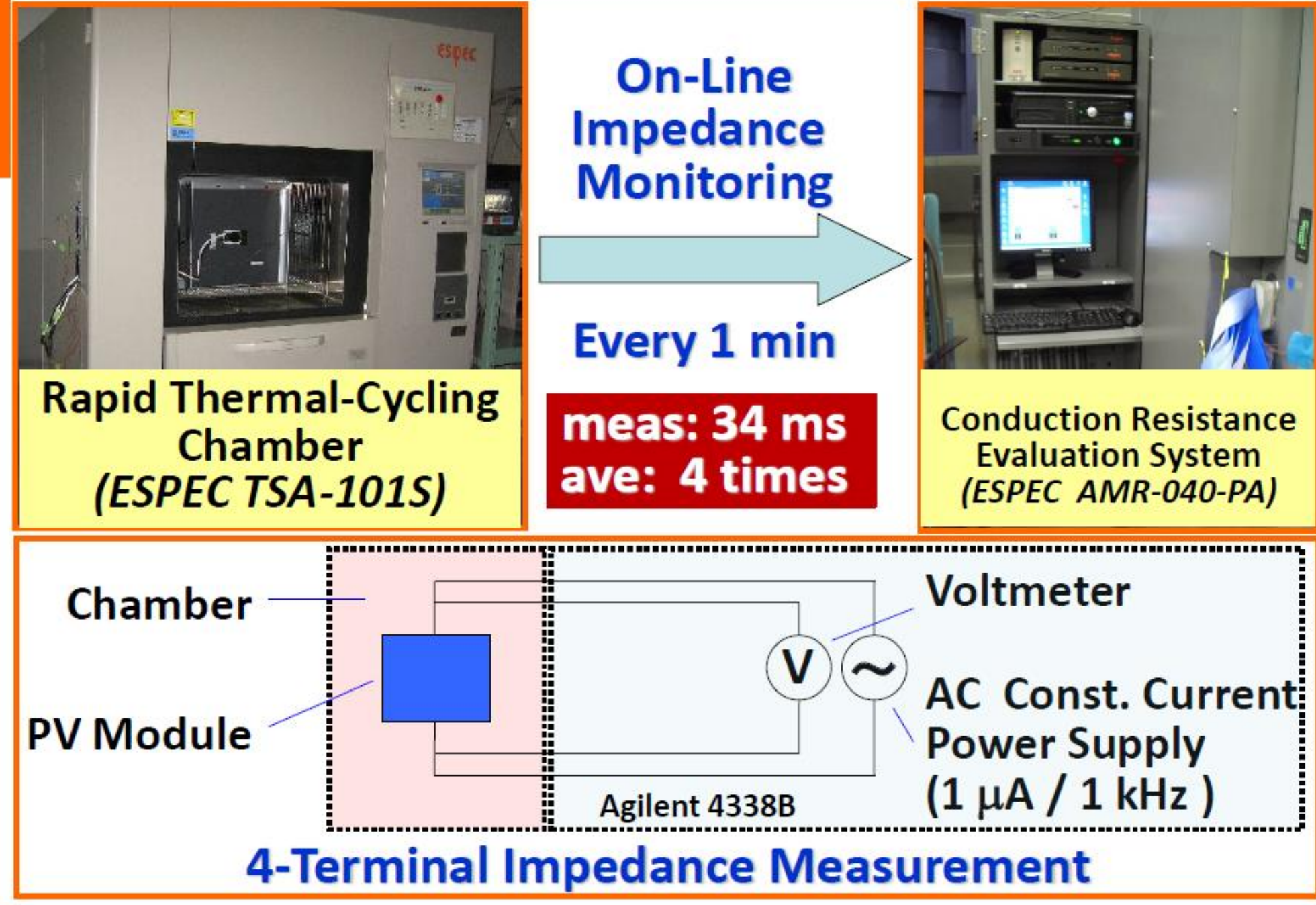
Require More Stress to Detect Thermal Fatigues ???

→ **Rapid Thermal Cycling** (ca. 400 °C / hr)

Rapid Thermal-Cycling Test : Equipment



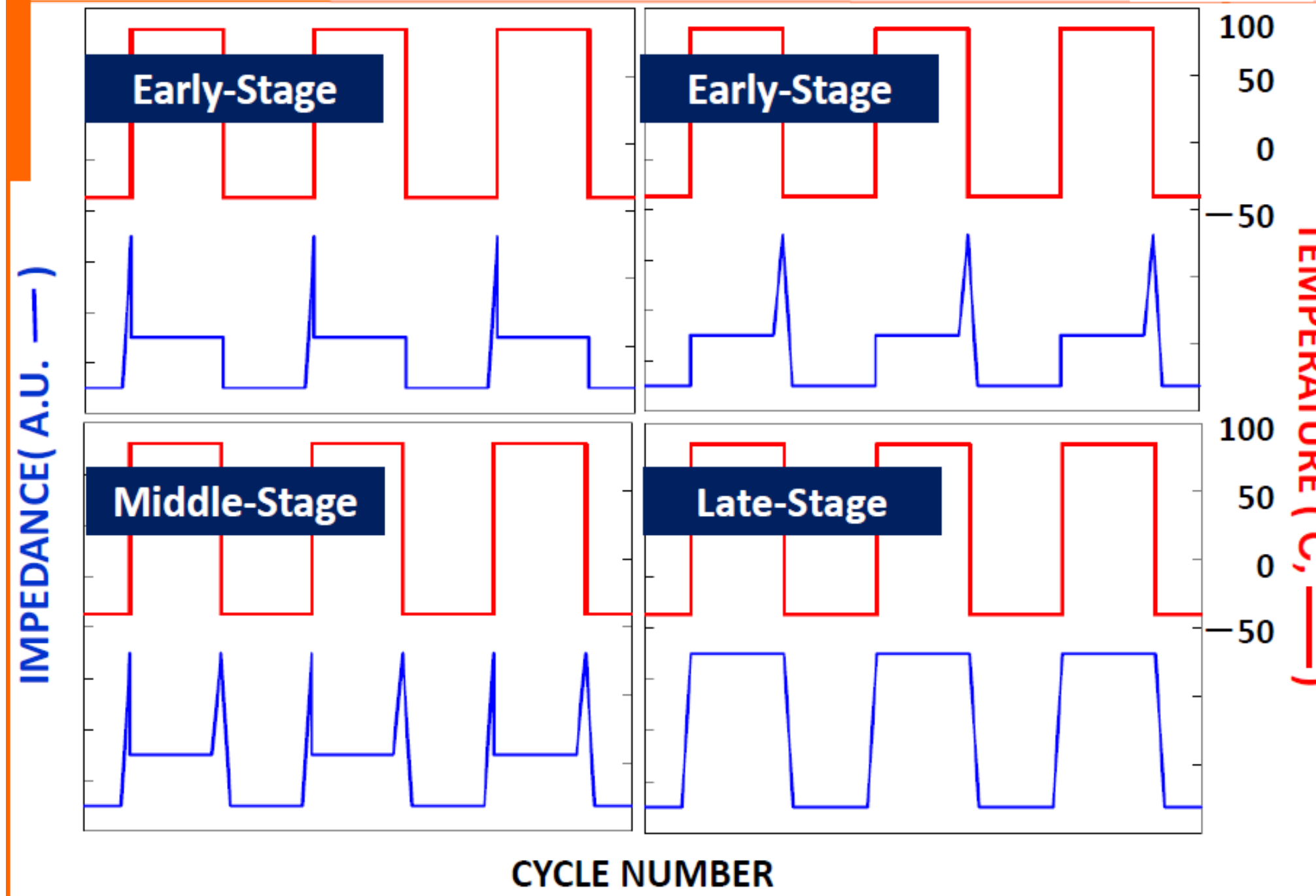
In Situ Monitoring of Module-Impedance



Summary & Schematic Conclusion

- The module impedance was measured with *in-situ* monitoring during rapid thermal-cycling.
- The impedance was stepwise elevated (Early -> Middle -> Late Stage), according to the increasing of cycle number in rapid thermal-cycling.
- All of modules were mostly deteriorated with the interconnection failures.
- The rapid thermal-cycling with *in-situ* monitoring of module-impedance may be a useful procedure for the early detection of interconnection failures.

Impedance Elevation during Rapid TC



Experimental Results

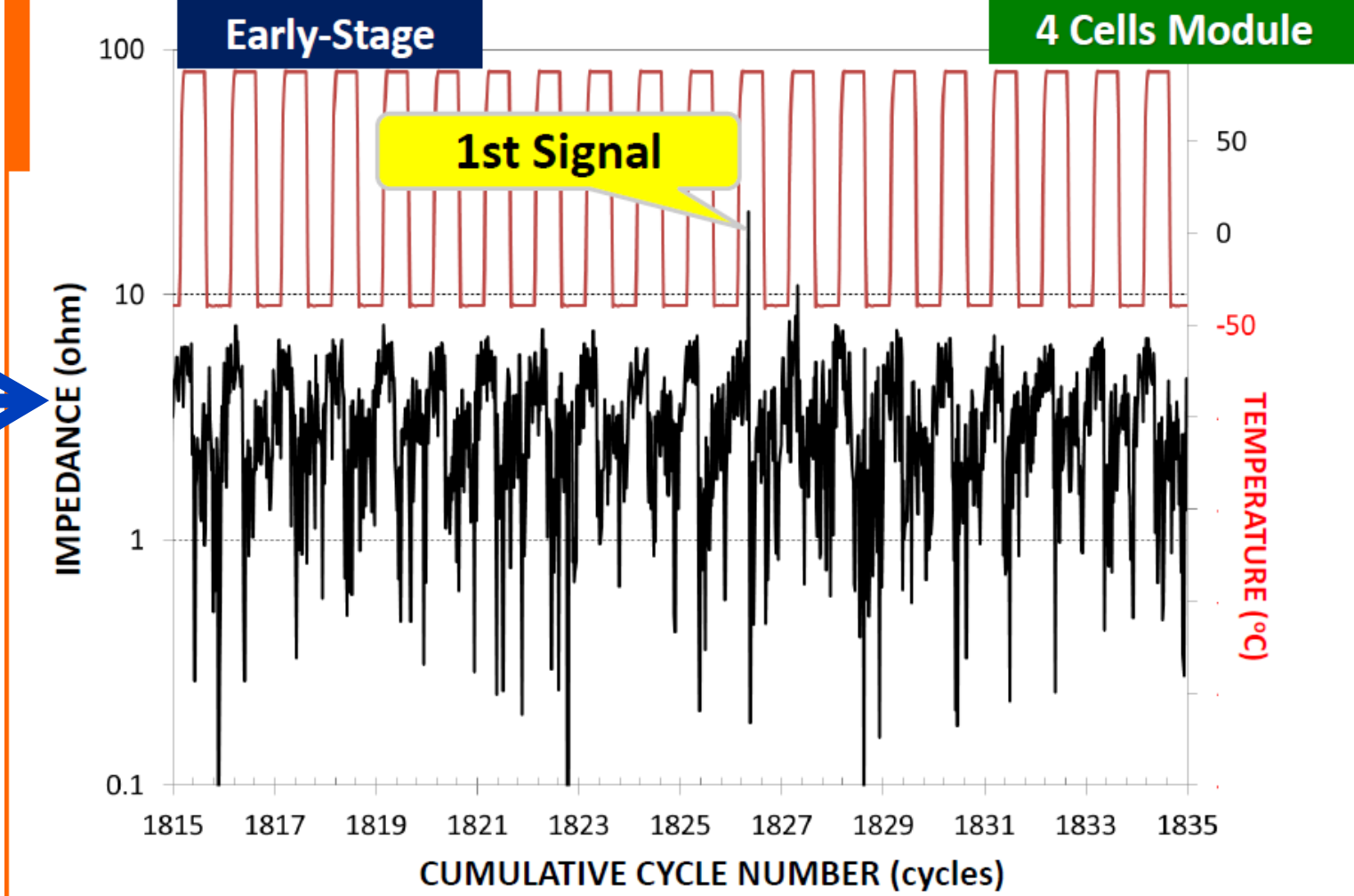
4 Cells Module

Multi-Crystalline Silicon PV Cells (156 x 156 mm)
- wired with Cu/Solder Tab-Line
- laminated with EVA and T/P/ T Back-Sheet
- held with Aluminum Frame



Module Size = 400 x 400 mm, Cell No. = 2 x 2 cells

Impedance Elevation during Rapid TC



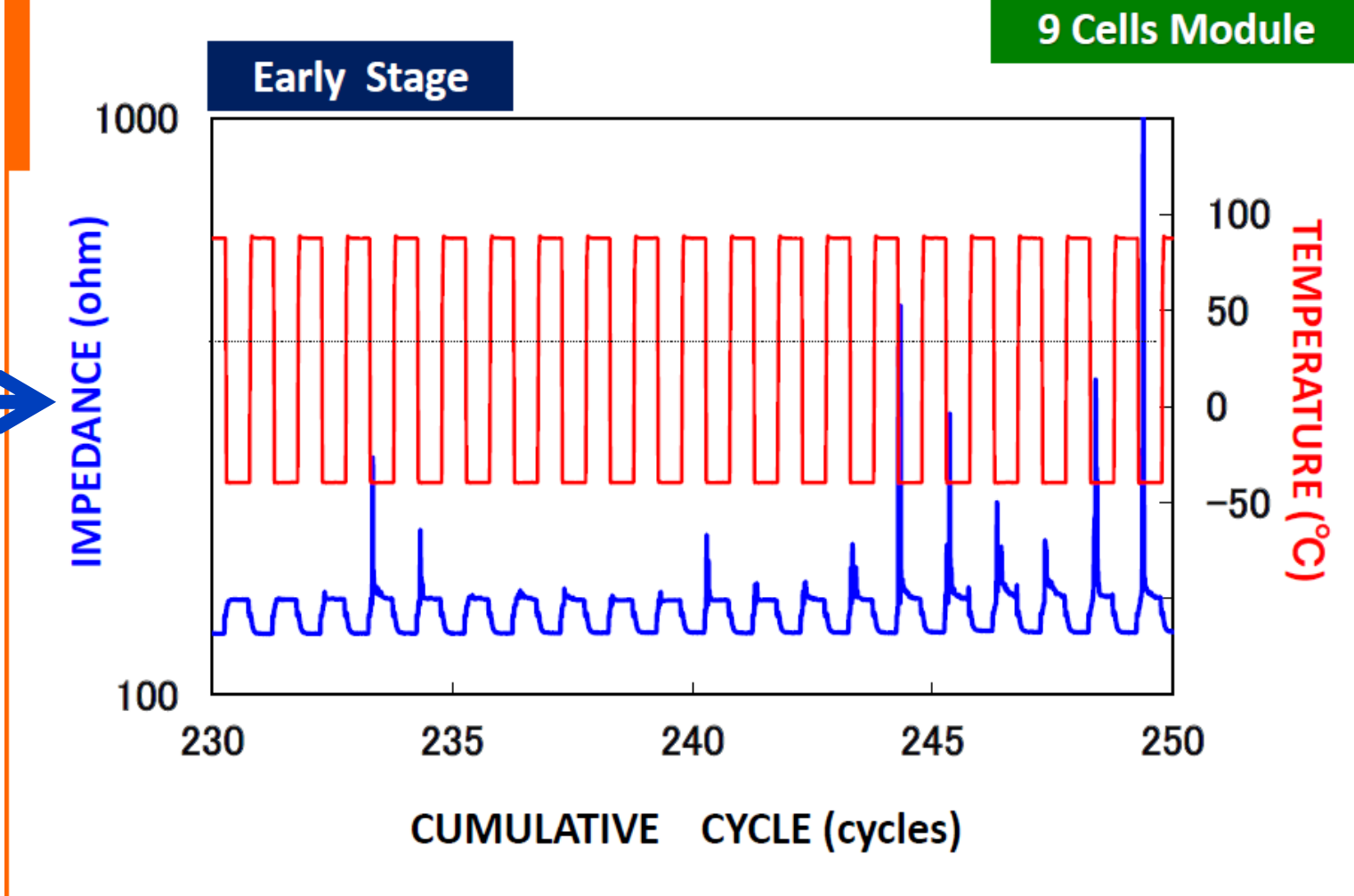
9 Cells Module

Multi-Crystalline Silicon PV Cells (100 x 100 mm)
- wired with Cu/Solder Tab-Line
- laminated with EVA and T/P/ T Back-Sheet
- held with Aluminum Frame

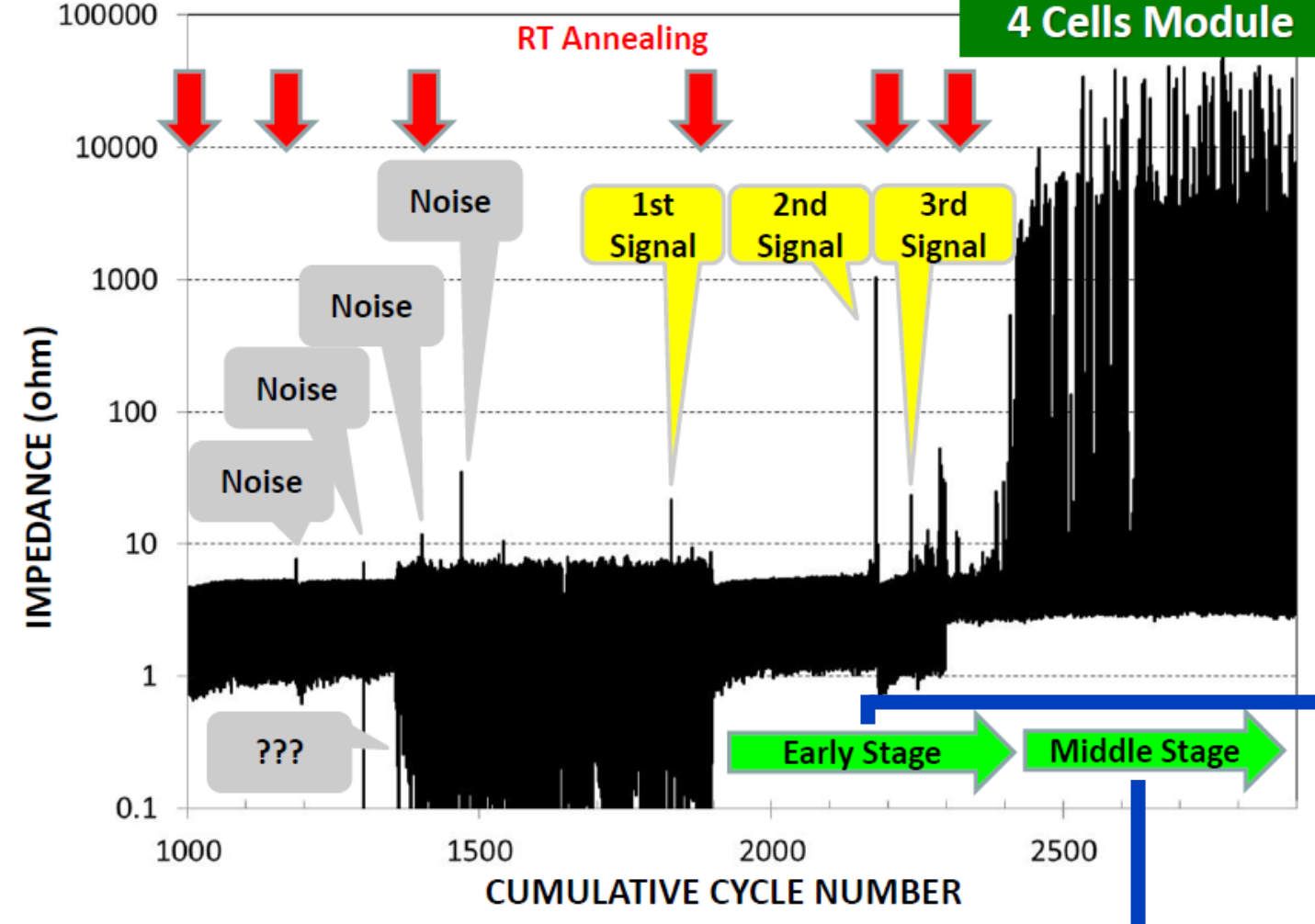


Module Size = 400 x 400 mm, Cell No. = 3 x 3 cells

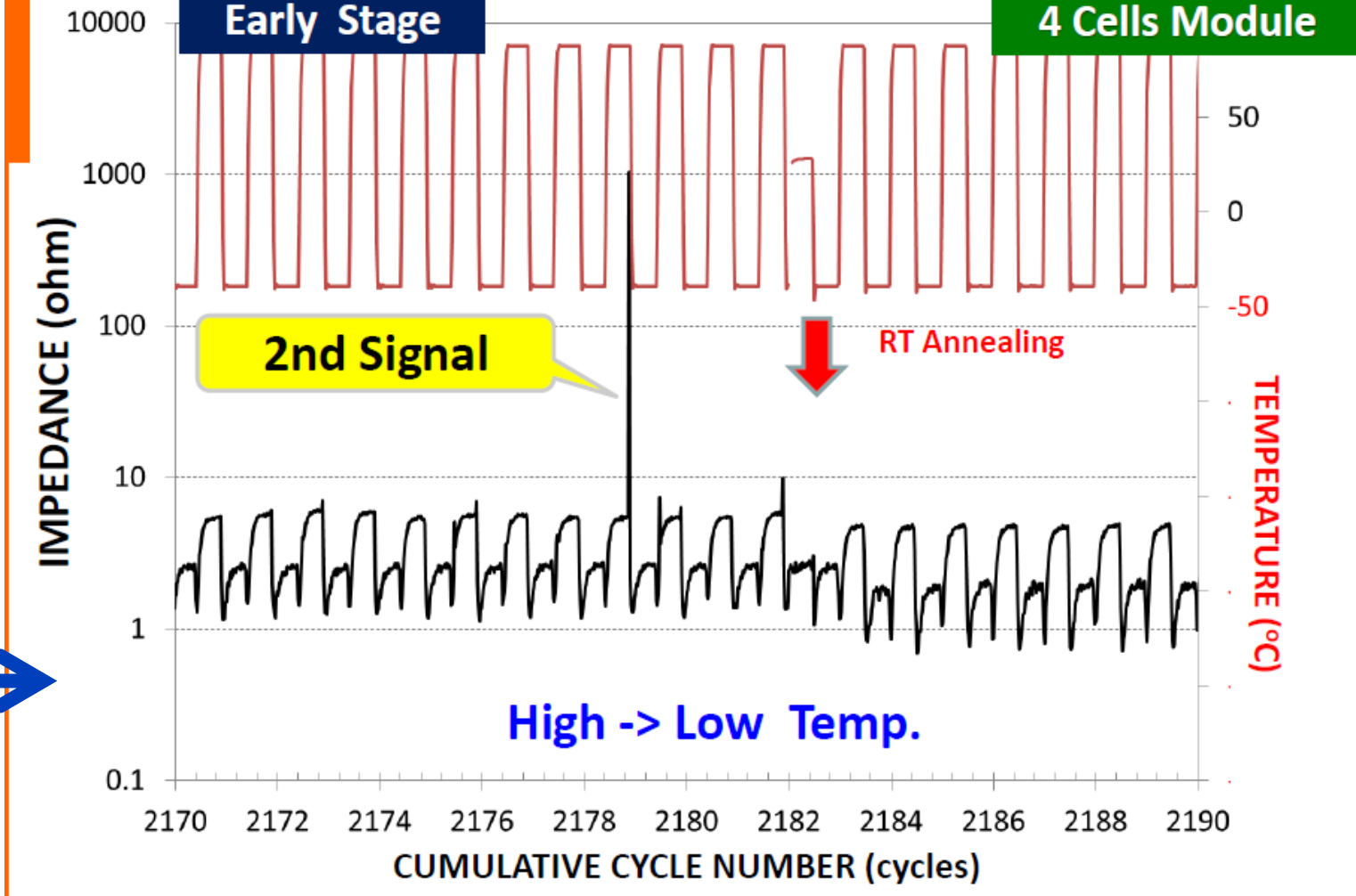
Impedance Elevation during Rapid TC



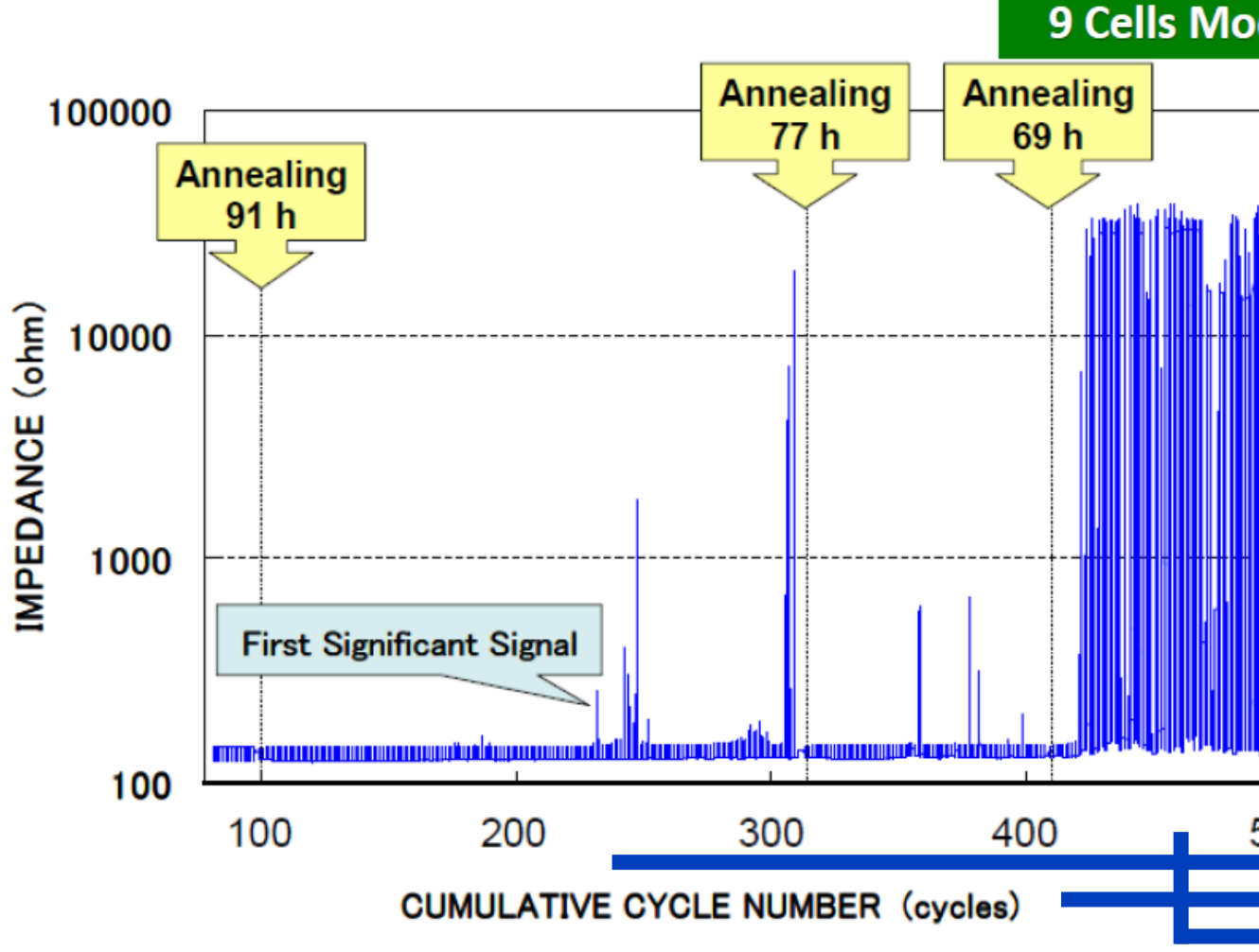
Impedance Elevation during Rapid TC



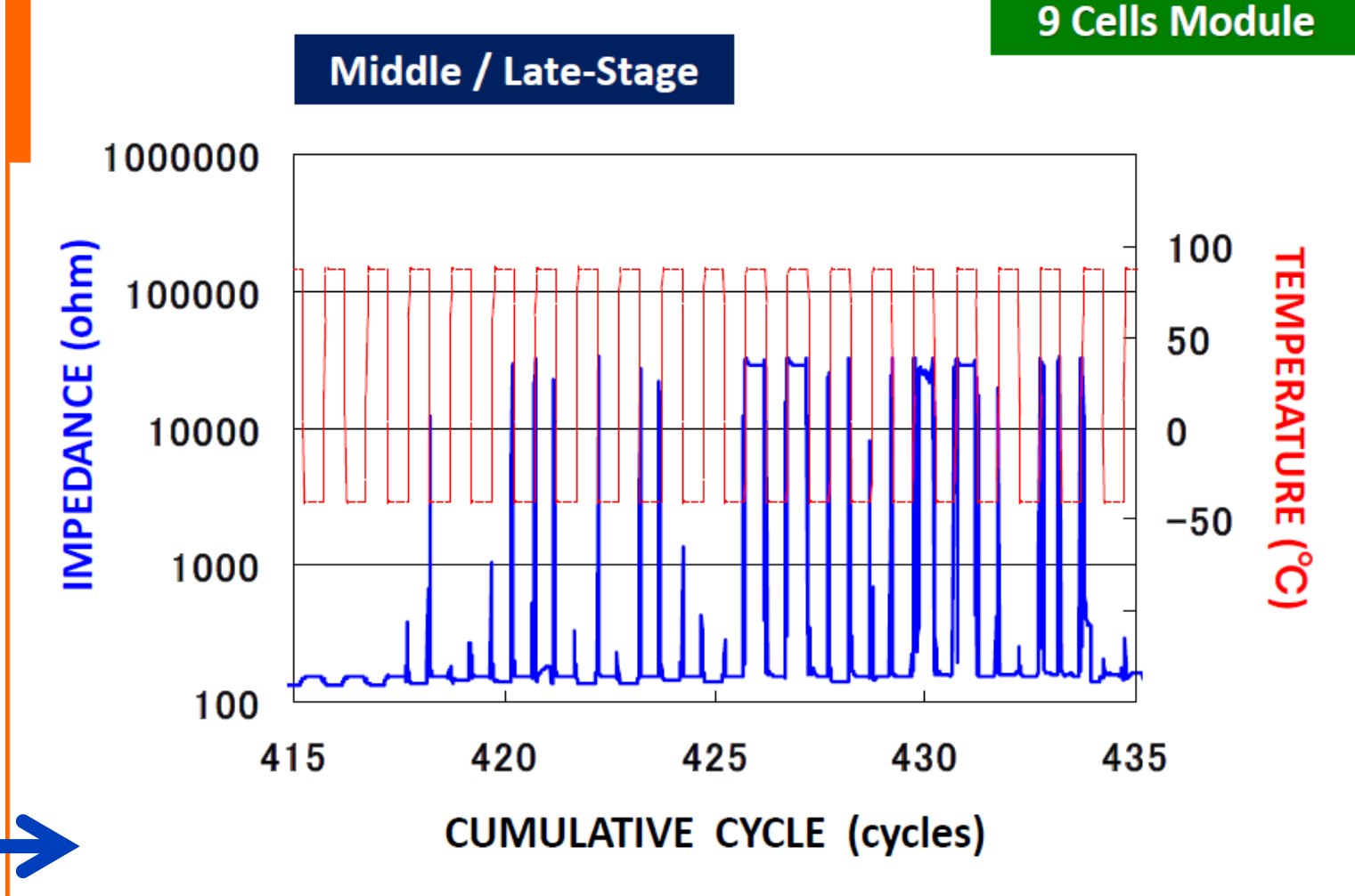
Impedance Elevation during Rapid TC



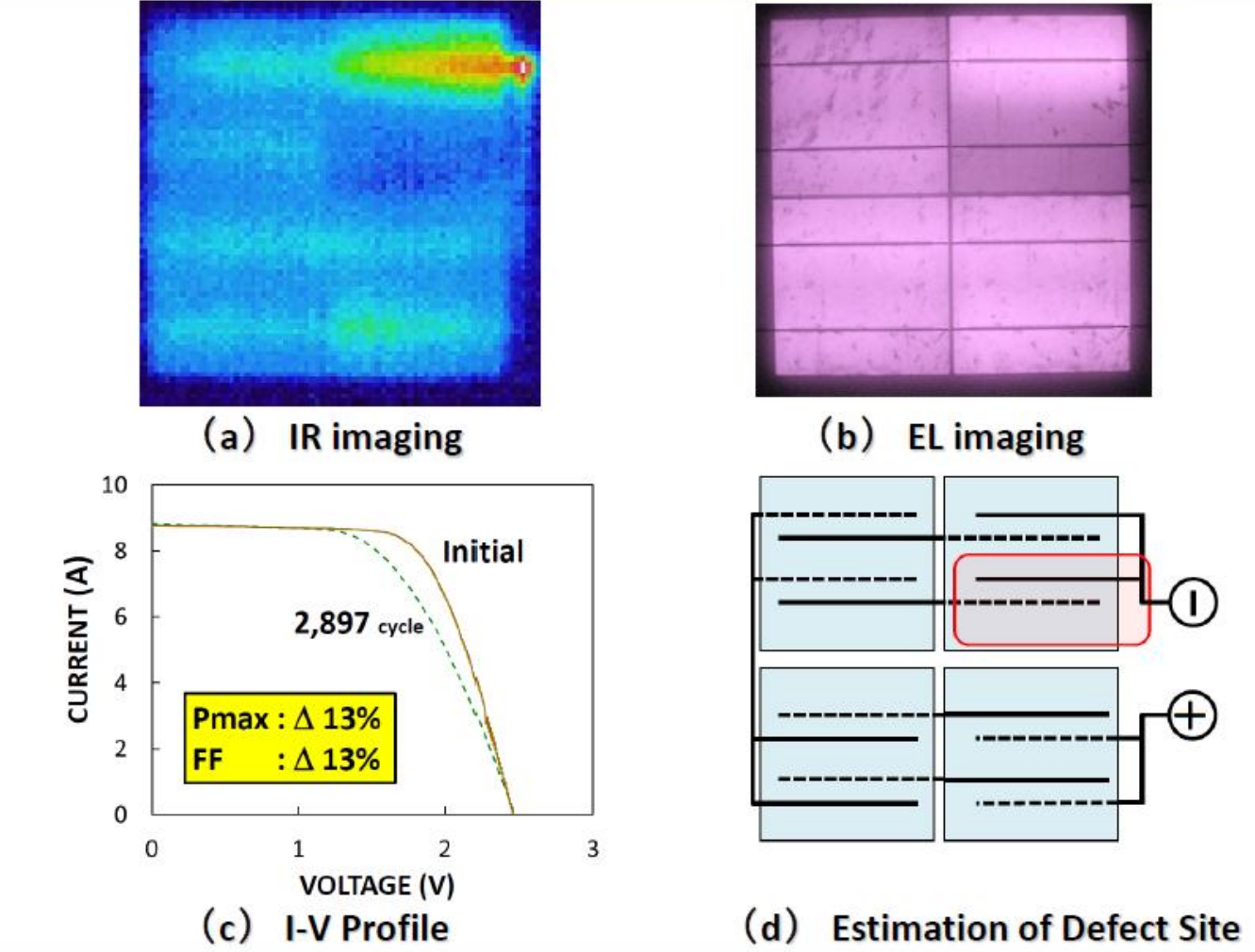
Impedance Elevation during Rapid TC



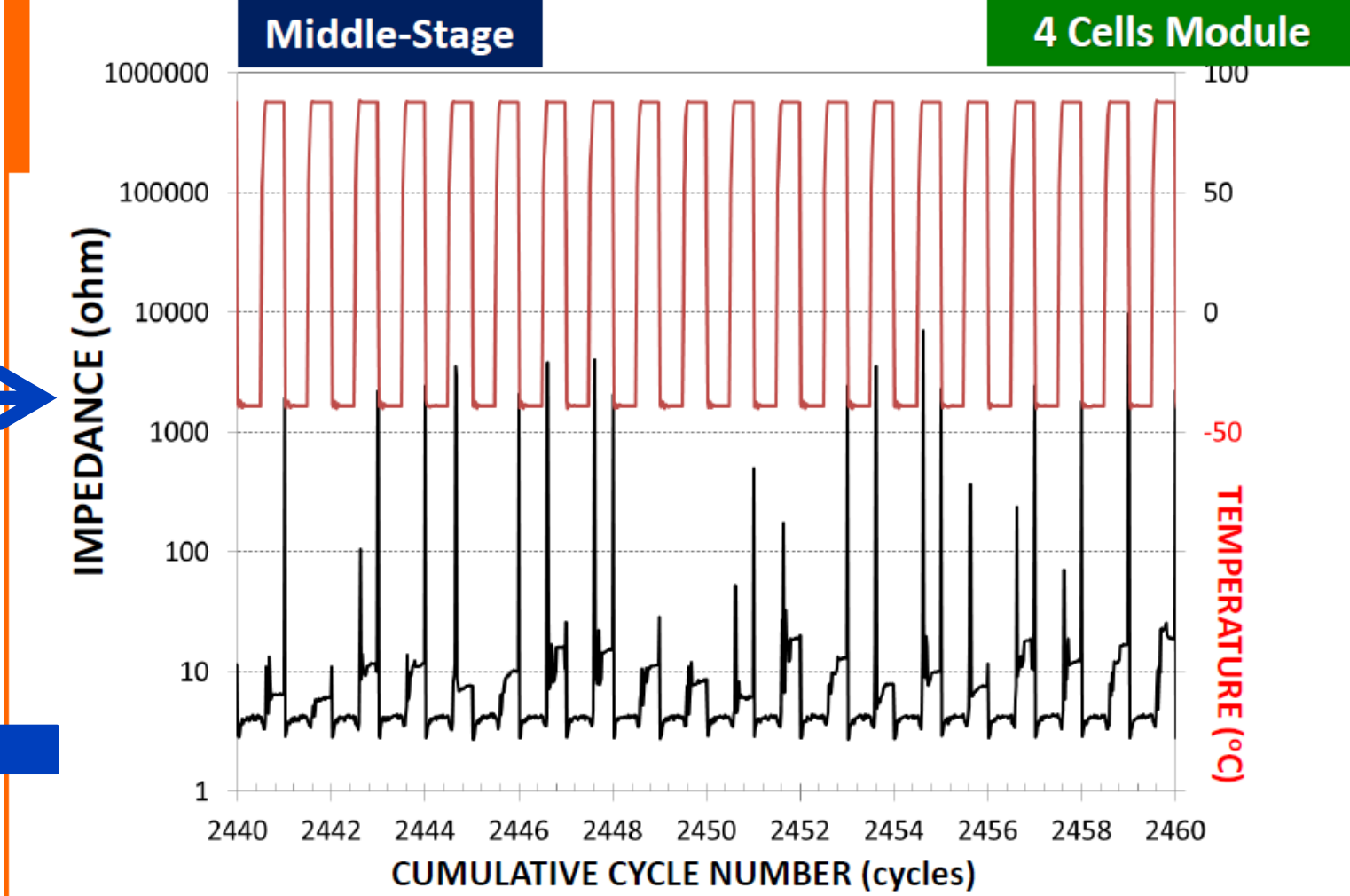
Impedance Elevation during Rapid TC



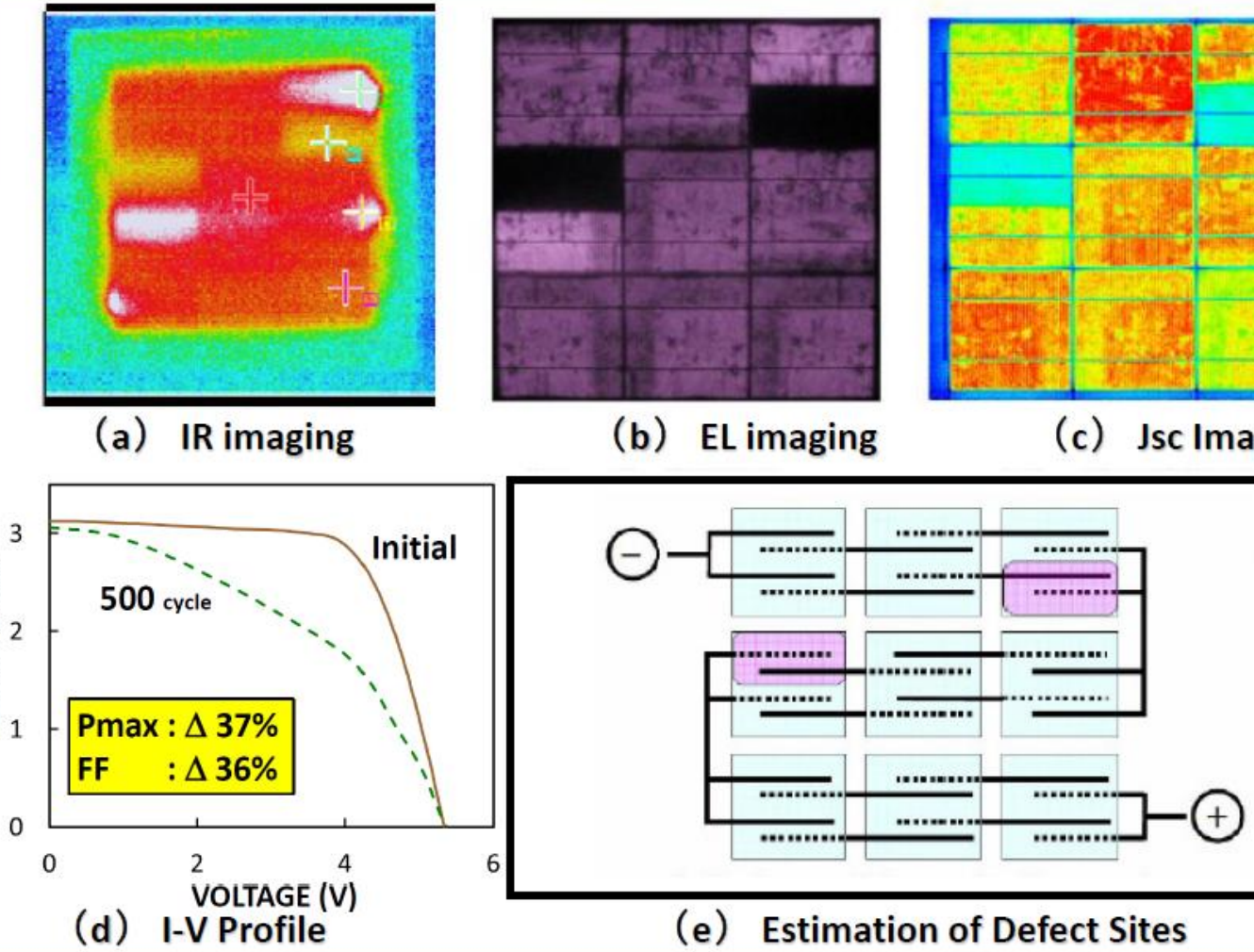
Characterization of PV Module at 2,897 cycles



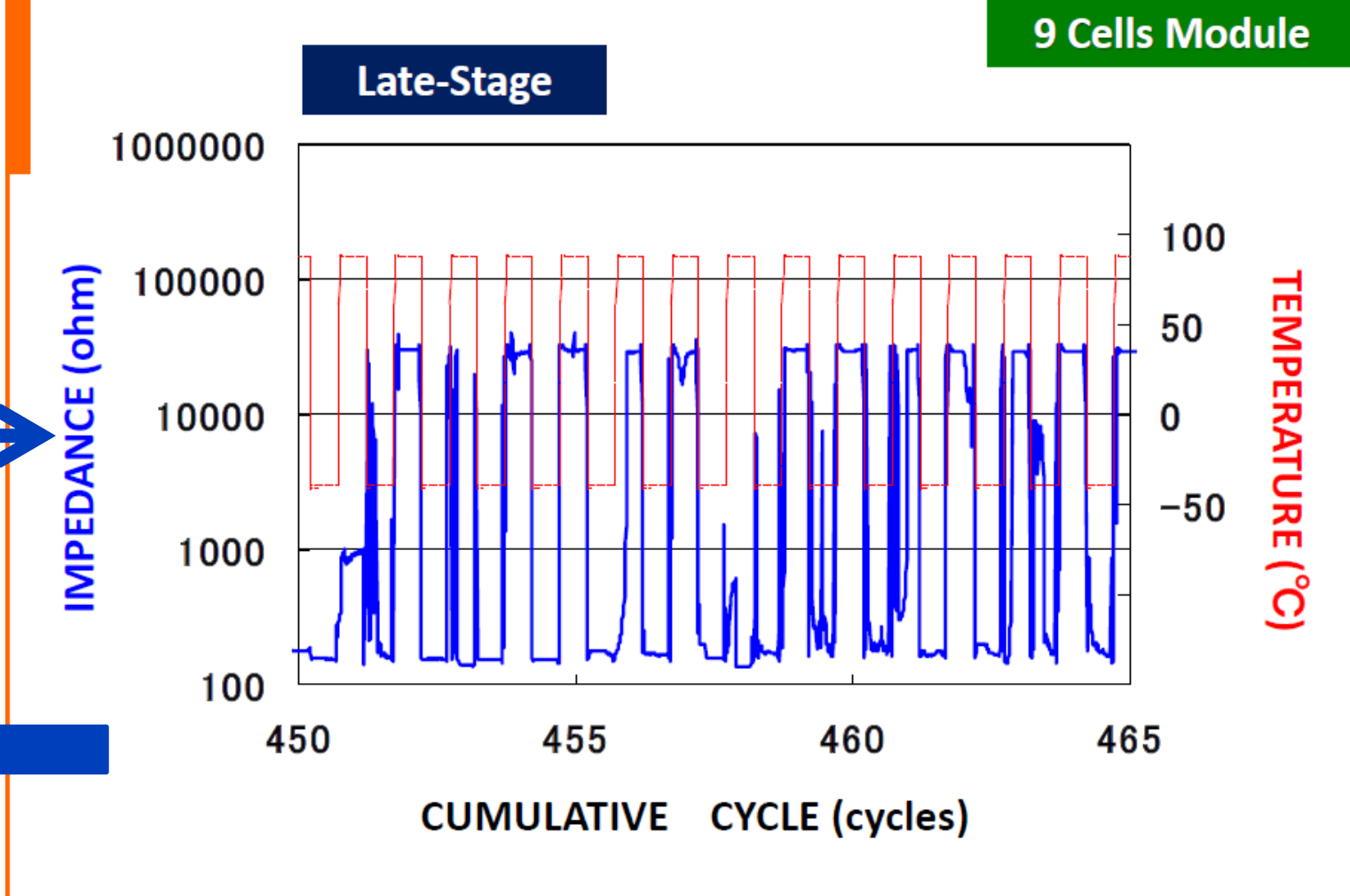
Impedance Elevation during Rapid TC



Characterization of PV Module at 500 cycles



Impedance Elevation during Rapid TC



For the Results in Commercial Mini-Module, Please Contact the Poster-Presenters.

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