

Fraunhofer CSP PV Days 2017

PID Field Experience

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Content

- ☀ PID history and definition
- ☀ Detection methods
- ☀ Possible solutions for PID affected systems
- ☀ Experiences with the regeneration of PID modules

Suncycle GmbH

Leading full service supplier in Europe

2007

Foundation of Suncycle Solar Services.

2,000,000

Industrially repaired and tested modules.

Close to customers

Fast access to destinations in Germany & EU.

International

Technical customer support in 5 languages.

Network of service engineers

Broad range of skills in local markets.

Individual

Modular service packages.

Unique

Suncycle's mobile labs for precise on-site tests.



After-Sales Services

- Complete outsourcing
- 1st to 3rd level support
- Hotline in 5 languages
- Suncycle - ticket system



Test & repair

- EL & IR thermography, flash- & isolation tests
- Diodes & junction box, frame & coating
- All components



Operations & Maintenance

- 24/7 yield & failure monitoring
- inspection & maintenance
- Repair-cost insurance



Recall management

- Product recalls
- Failure correction
- Process- & cost documentation



Engineering

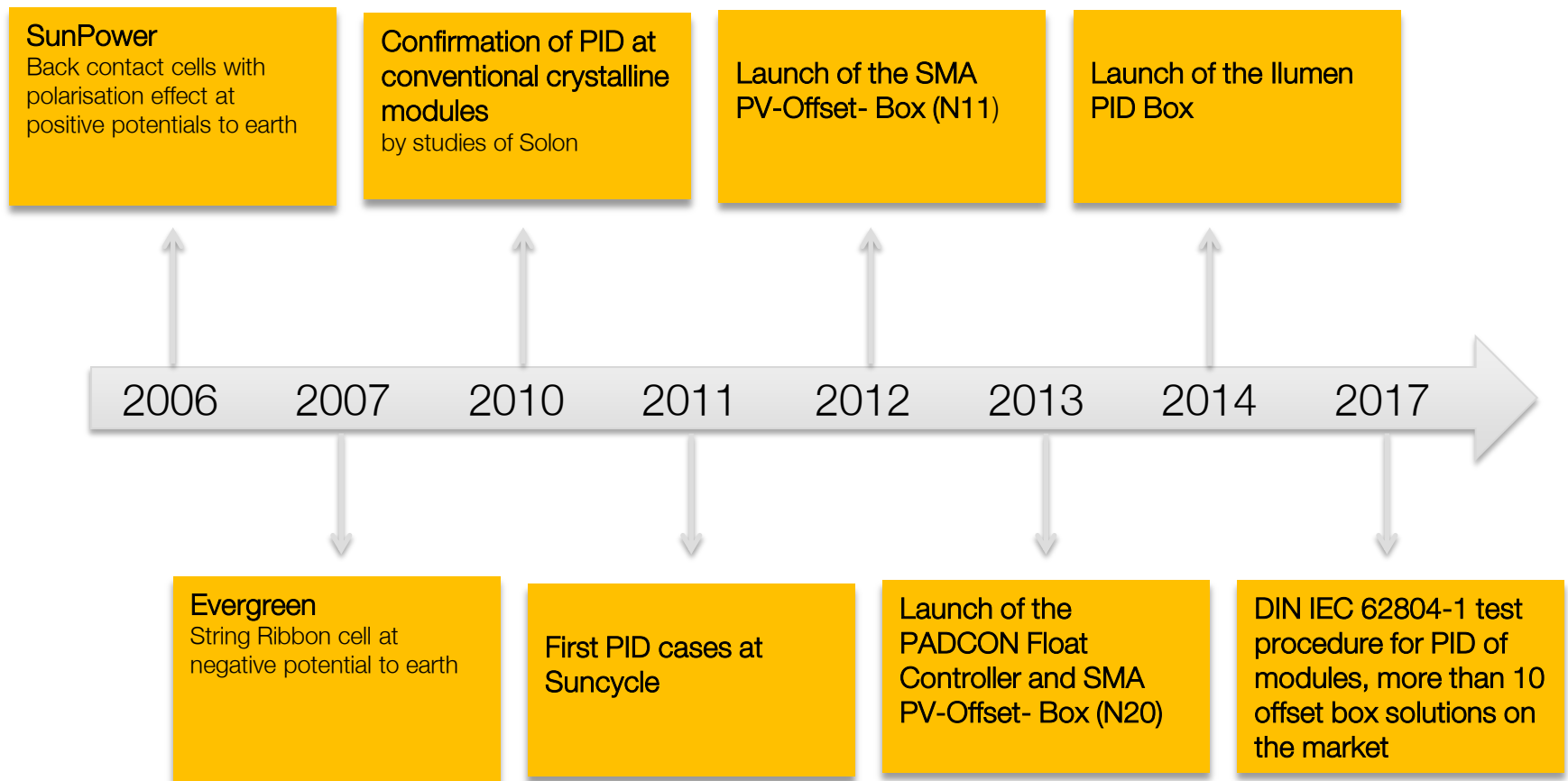
- Legally accepted reports
- Independent assessments
- Process developments & -certification



Supply chain solutions

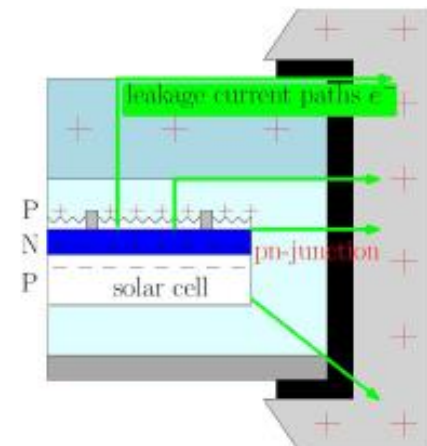
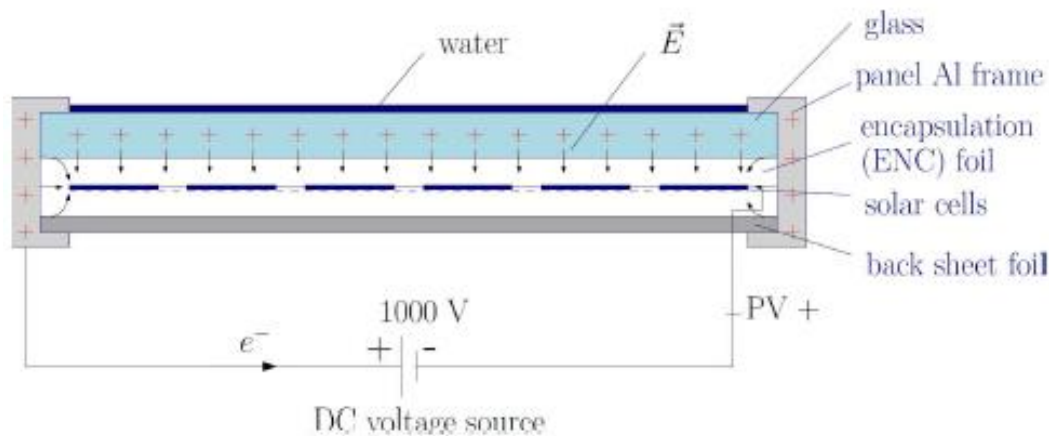
- Incoming & outgoing goods inspection
- Warehouse management
- Consignment stock

PID – still a relatively new topic



PID – Definition

- ☀ Power degradation of modules
 - ☀ at negative potential to earth (p-type)
 - ☀ at positive potential to earth (n-type)
- ☀ Leakage current flow from frame over glass surface to the cell surface



Source: <http://www.solon.com/>

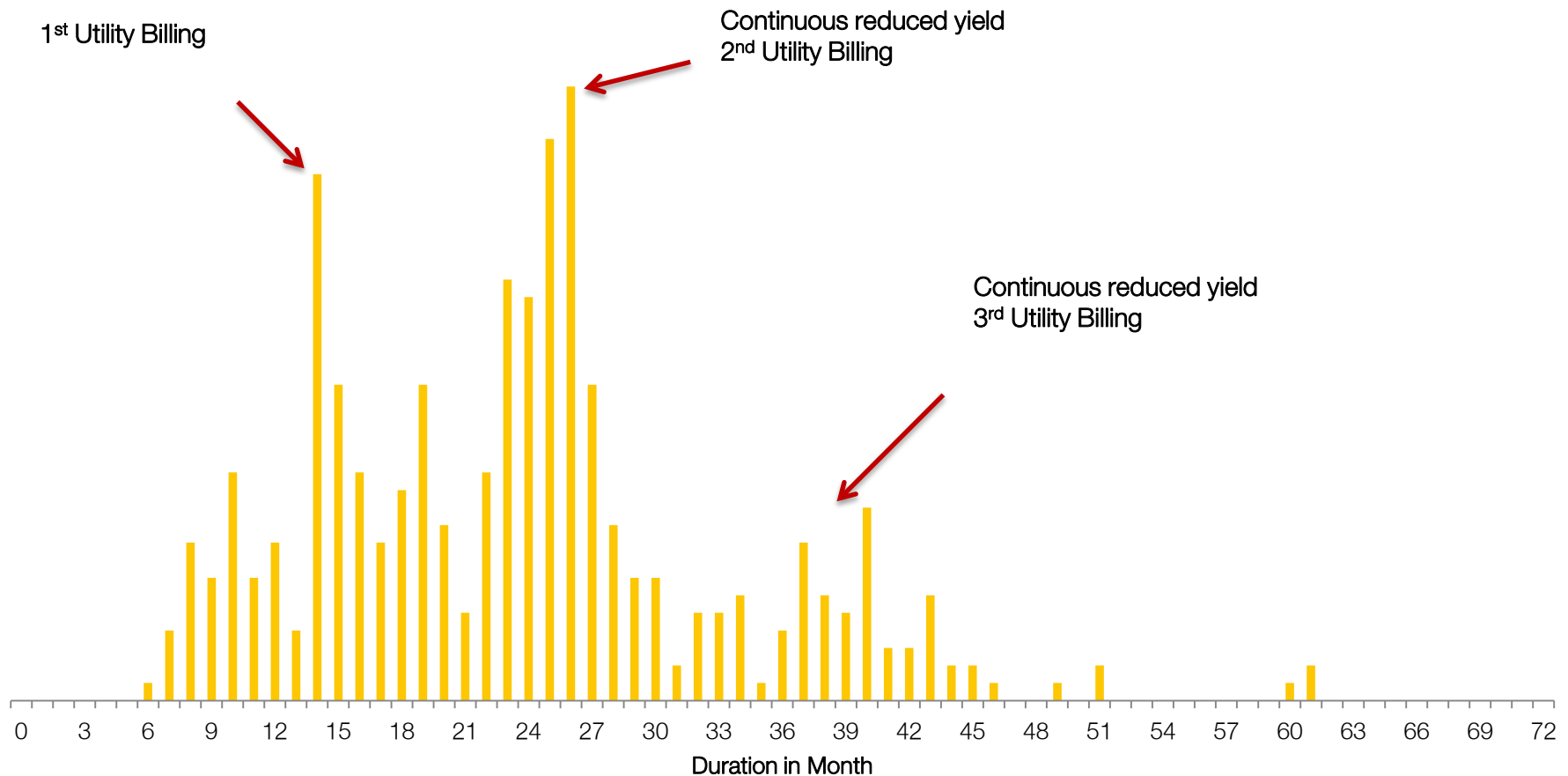
Accelerating factors for PID

- ☀ High string length
- ☀ High environmental temperatures
- ☀ High irradiation
- ☀ High air humidity
- ☀ Conductive deposits on the module surface (e.g. salt mist in costal areas)
- ☀ Module design and materials (Glass, EVA, Cells)



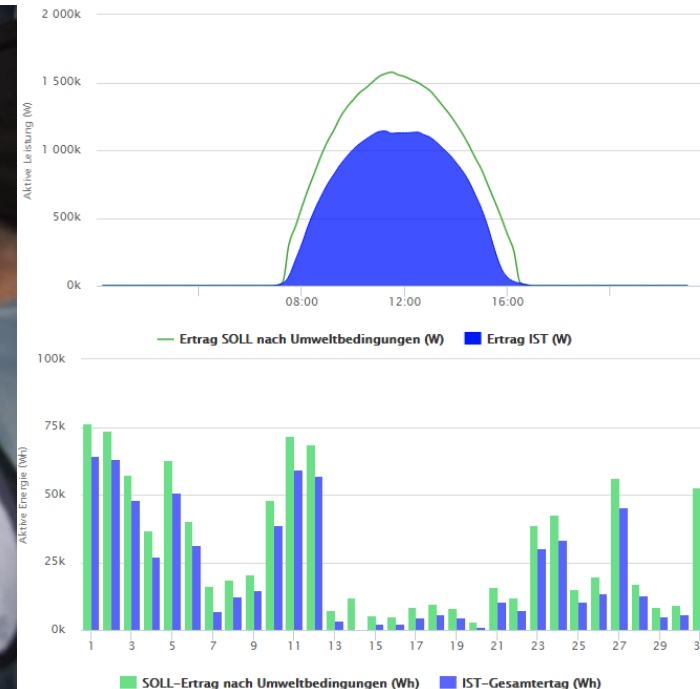
Complaints after the 1st and 2nd operational Year

Duration from Commissioning to first Complaint

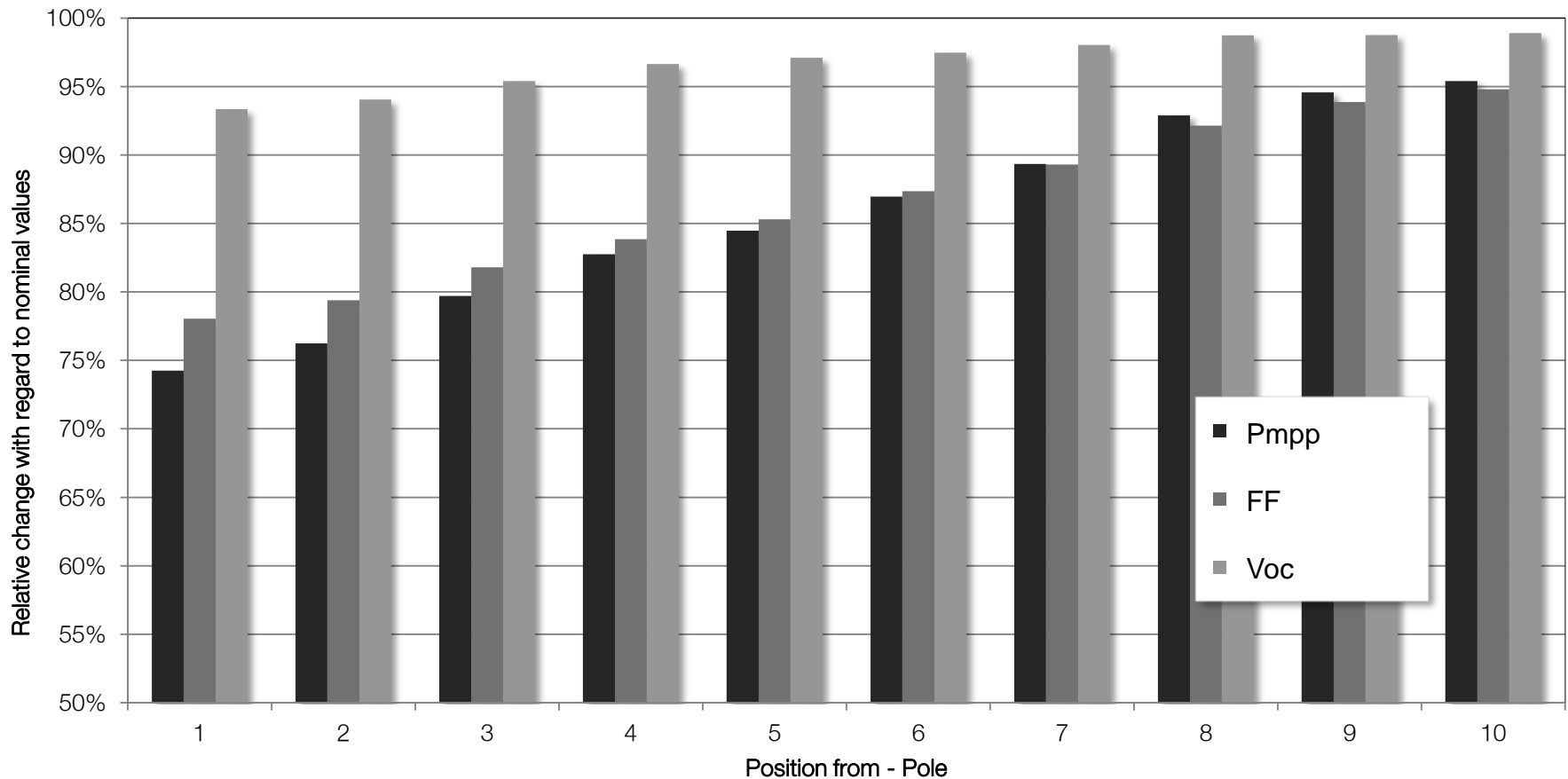


Simple but uncertain PID detection methods

- ☀ Continuous control of the system yield
- ☀ Measurement and comparison of module- and string Voc



PID Influence on different Measurement Values



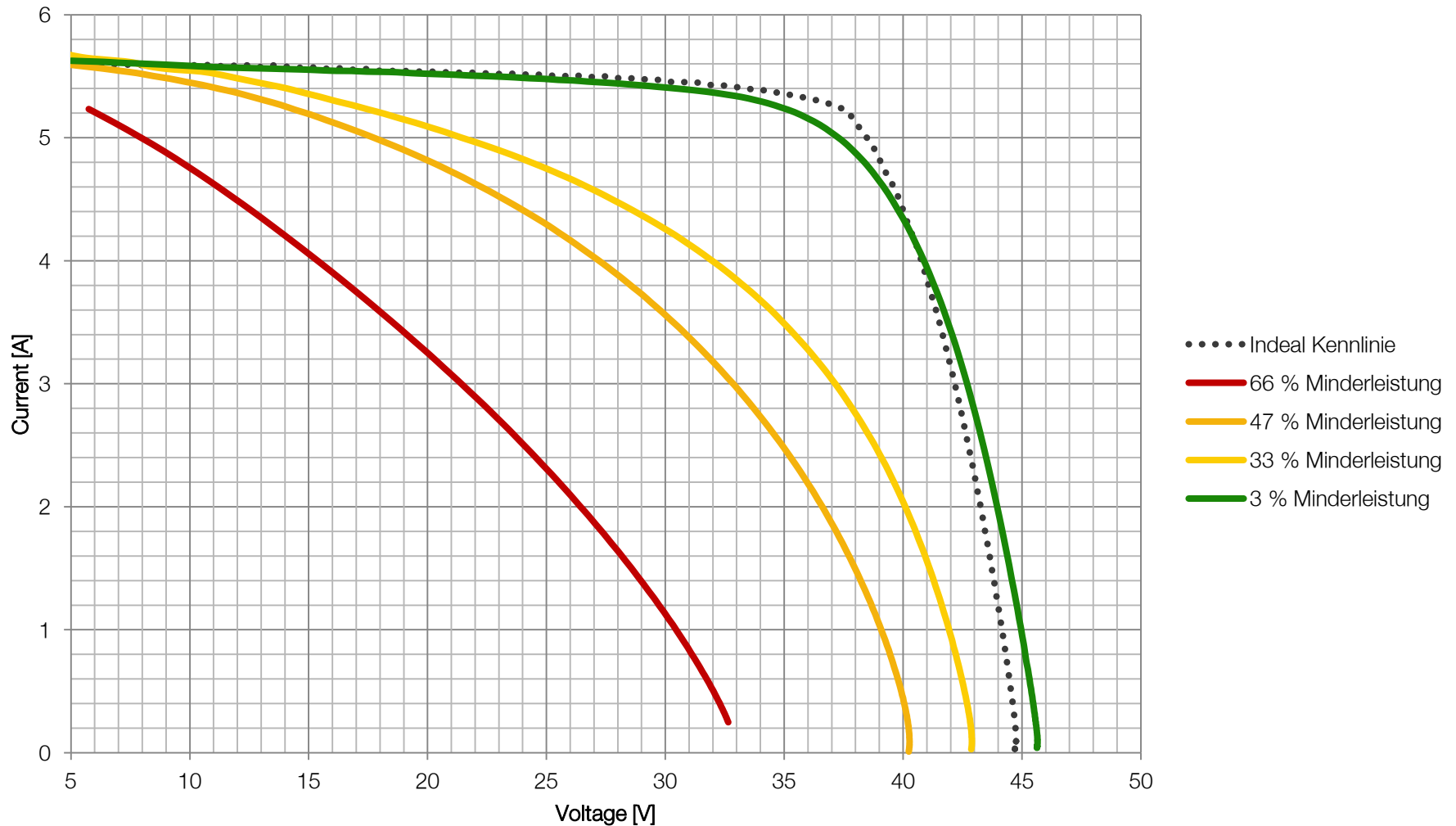
Average of IV-Curve Measurements of more than 5000 Modules

Safe PID detection with modern measurement technology

- ☀ Measurement of power
 - ☀ Outdoor IV Curve Measurements
 - ☀ Flash Test with mobile Lab
- ☀ Infrared thermography (IR)
- ☀ Electroluminescence inspection (EL)
- ☀ IR and EL Inspection with UAV / Drone



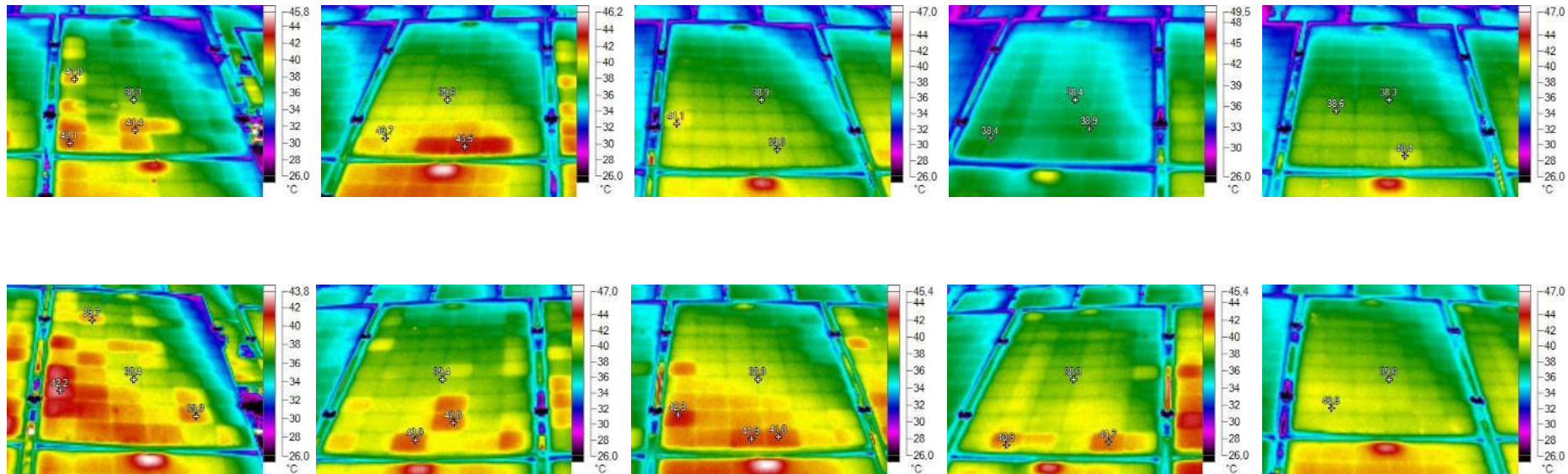
STC IV curves show effect of PID



Module power degradation depends on position

String	Module Position from negative Pole									
	1	2	3	4	5	6	7	8	9	10
1	-19%	-27%	-32%	-13%	-11%	-19%	-6%	-24%	-2%	0%
2	-19%	-36%	-20%	-16%	-19%	-10%	-8%	-6%	-4%	-6%
3	-45%	-63%	-56%	-49%	-37%	-29%	-27%	-11%	-6%	-4%
4	-21%	-36%	-27%	-10%	-15%	-23%	-13%	-16%	-5%	-2%
5	-26%	-34%	-31%	-23%	-19%	-19%	-6%	-18%	-11%	-3%
6	-31%	-34%	-53%	-43%	-28%	-43%	-36%	-22%	-15%	-10%
7	-42%	-41%	-29%	-24%	-20%	-10%	-8%	-21%	-5%	-2%
8	-23%	-28%	-5%	-36%	-18%	-18%	-14%	-15%	-5%	-6%
9	-12%	-60%	-51%	-30%	-10%	-43%	-31%	-17%	-2%	-2%
10	-59%	-32%	-13%	-19%	-39%	-9%	-12%	-9%	-5%	1%
11	-47%	-31%	-22%	-29%	-17%	-22%	-3%	-14%	-2%	-1%
12	-37%	-54%	-31%	-73%	-23%	-20%	-11%	-29%	-29%	-9%
13	-48%	-17%	-61%	-77%	-21%	-25%	-11%	-19%	-5%	-1%
14	-23%	-33%	-20%	-33%	-9%	-43%	-12%	-11%	-4%	0%
15	-27%	-26%	-27%	-30%	-13%	-24%	-7%	-20%	-6%	-5%
16	-30%	-33%	-30%	-22%	-17%	-15%	-13%	-12%	-8%	-7%
17	-62%	-38%	-5%	-14%	-67%	-21%	-23%	-12%	-12%	-3%
18	-72%	-33%	-34%	-12%	-9%	-17%	-11%	-15%	-8%	-7%
19	-16%	-35%	-21%	-60%	-3%	-12%	-23%	-13%	-7%	-2%
20	-52%	-10%	-27%	-5%	-22%	-27%	-4%	-13%	-6%	-5%
21	-16%	-57%	-30%	-54%	-28%	-33%	-10%	-12%	-9%	-9%
22	-66%	-54%	-20%	-22%	-19%	-22%	-15%	-14%	-7%	-8%
23	-18%	-53%	-6%	-35%	-11%	-19%	-18%	-11%	-8%	-6%

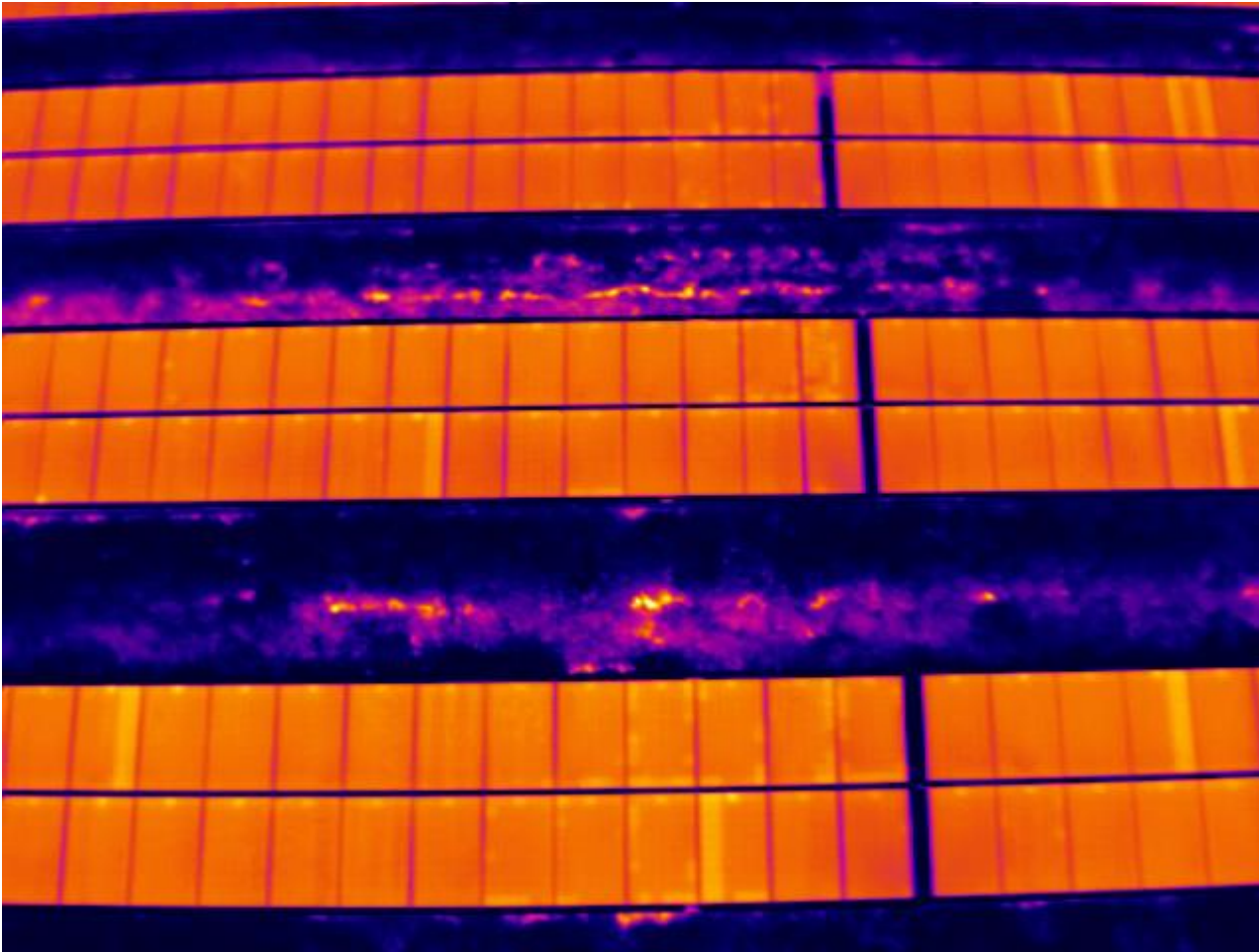
IR thermography shows PID affected podules



Module 1 – 5 of two Strings



IR thermography with Drone



PID detection with electroluminescence (EL)



EL inspection with drone



Source: Solartechnik Fladung www.solartechnik-fladung.de

PID – Regeneration methods

- ☀ Inverter with different topology and without negative potential to earth
- ☀ Earthing of inverters with transformer
- ☀ Positive offset voltage at night (Offset box)
- ☀ Star point injection



SMA



pidbull



ZHIWEI Environmental Technology



SolarMonitoring



Padcon



Illumen



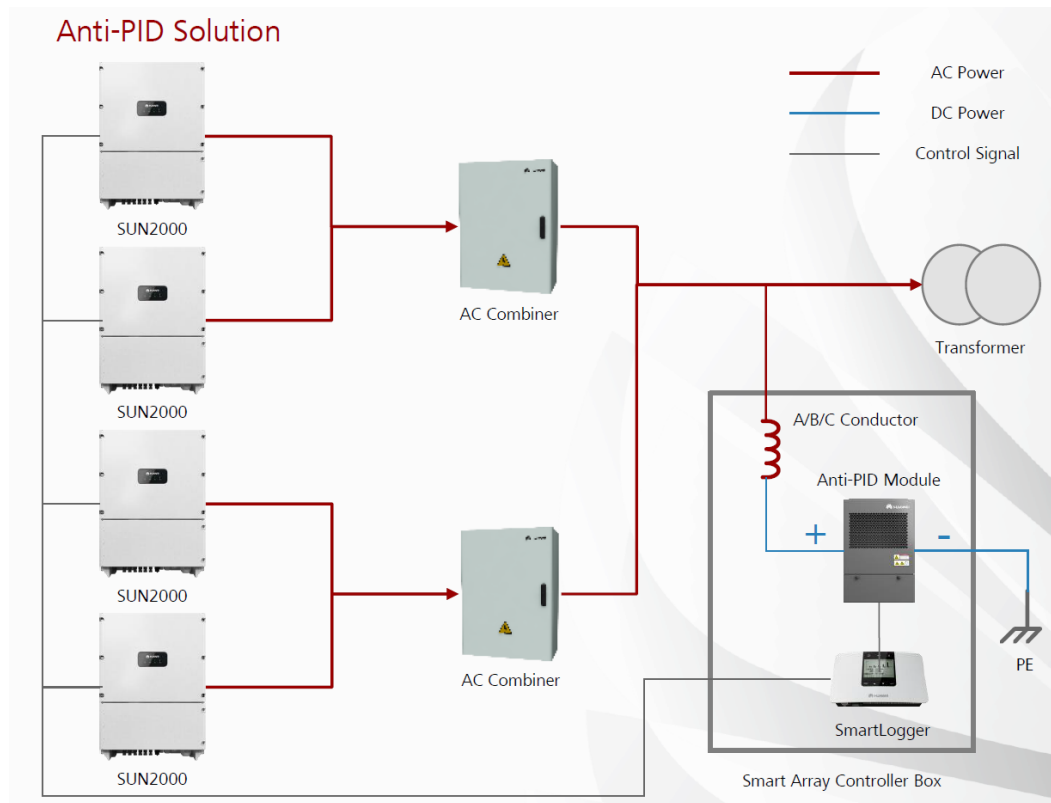
Zenergy Tech



JDA pidbos

PID – Regeneration methods

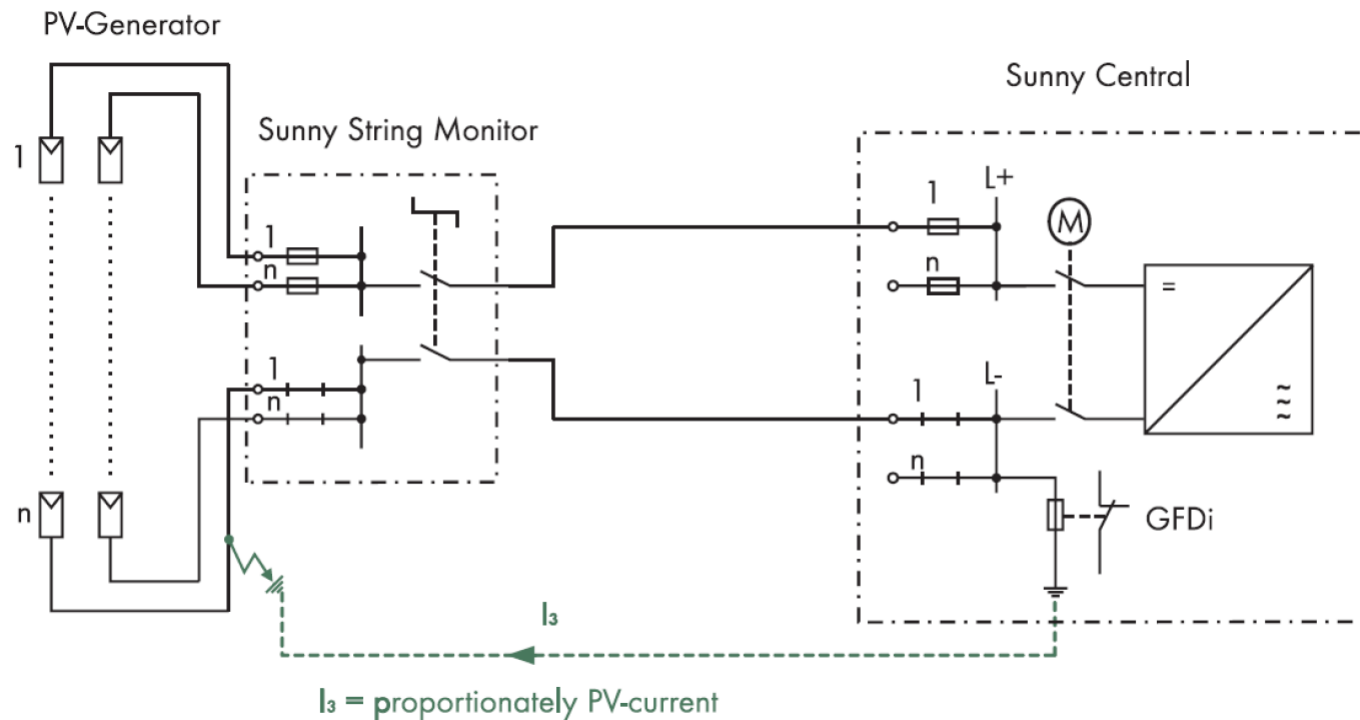
☀ Star point injection developed by Huawei and Sungrow



Source: Huawei – www.huawei.com/solar

PID – Regeneration methods

☀ Earthing / GFDI



Source: SMA – www.sma.de

PID – Regeneration methods

☀ Earthing / GFDI

- ☀ Safety risks (motor controlled GFDI, link with plant alarm system)
- ☀ Lower regeneration rate

☀ Offset box

- ☀ Safety risk with high output current
- ☀ Inverter manufacturer authorisation required (-> Illumen)
- ☀ Maintenance required
- ☀ Number of MPPT per box limited (2-3, or multiplexer)

☀ Star point injection

- ☀ Huawei and Sungrow inverter
- ☀ IT system with floating neutral conductor required
- ☀ Only day time operation (for string inverter)
- ☀ LV material requires higher insulation level
- ☀ Lower regeneration rate

PID – Regeneration challenges

☀ Low system insulation

- ☀ Offset boxes may be overloaded and stop operation
- ☀ Reduction of output voltage
- ☀ Device with higher output current capacity

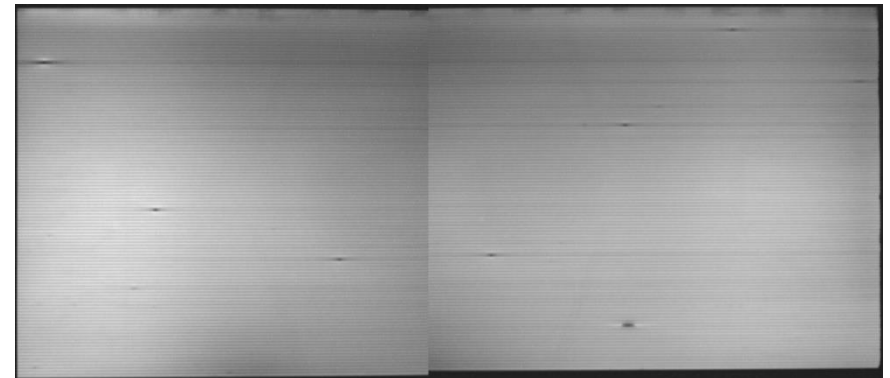
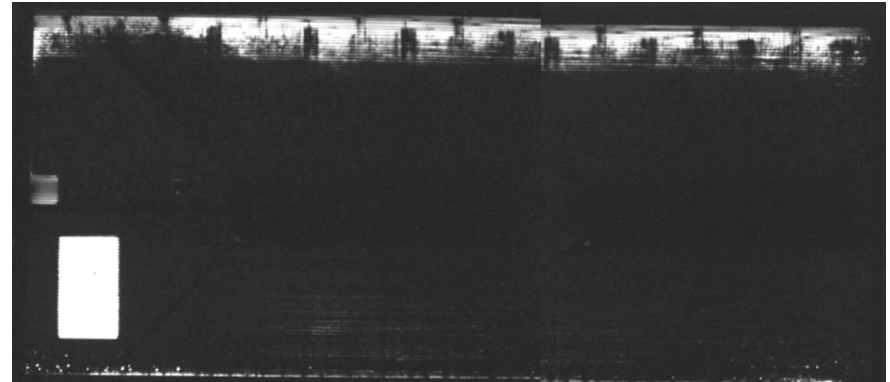
☀ Inverter compatibility

- ☀ Manufacturer authorisation required
- ☀ Offset box with galvanic separation
- ☀ Reduction of output voltage



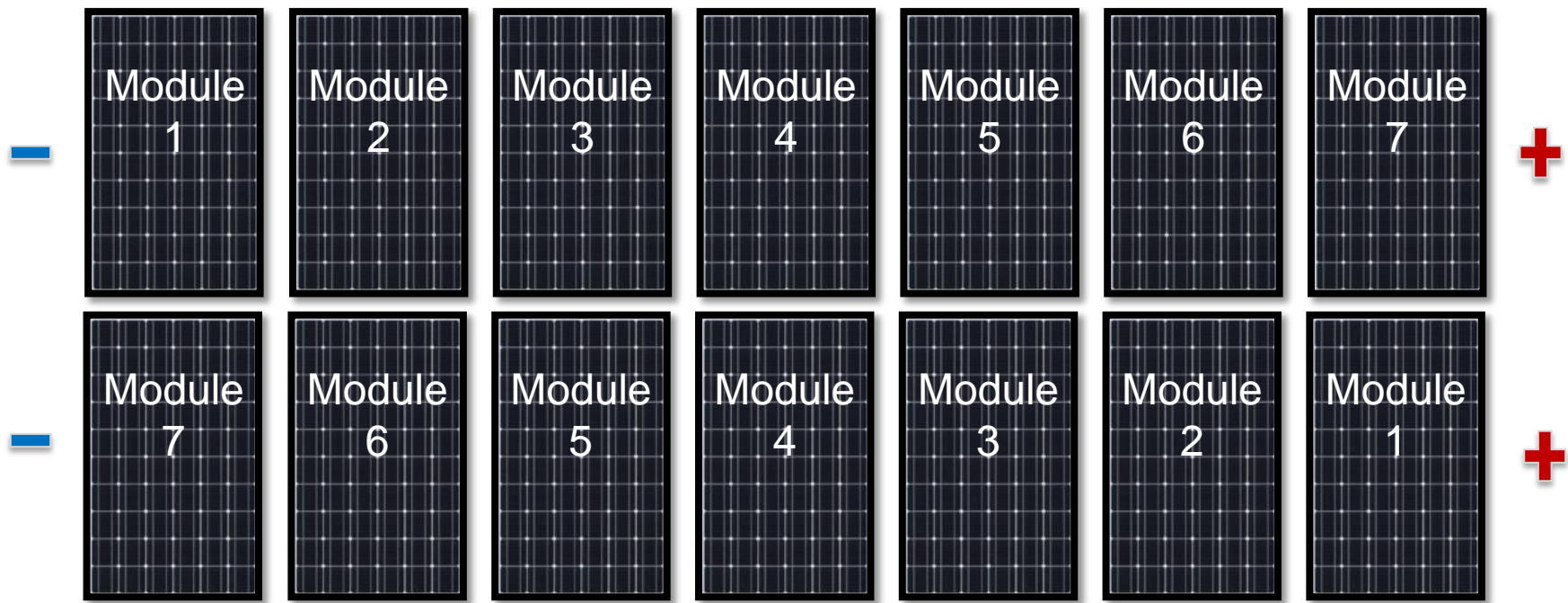
PID – Regeneration challenges

- ☀ PID of CIGS thin film modules
 - ☀ No regeneration possible
 - ☀ Replacement of affected modules
 - ☀ Installation of transformer inverters
 - ☀ Earthing
 - ☀ Repowering with crystalline modules



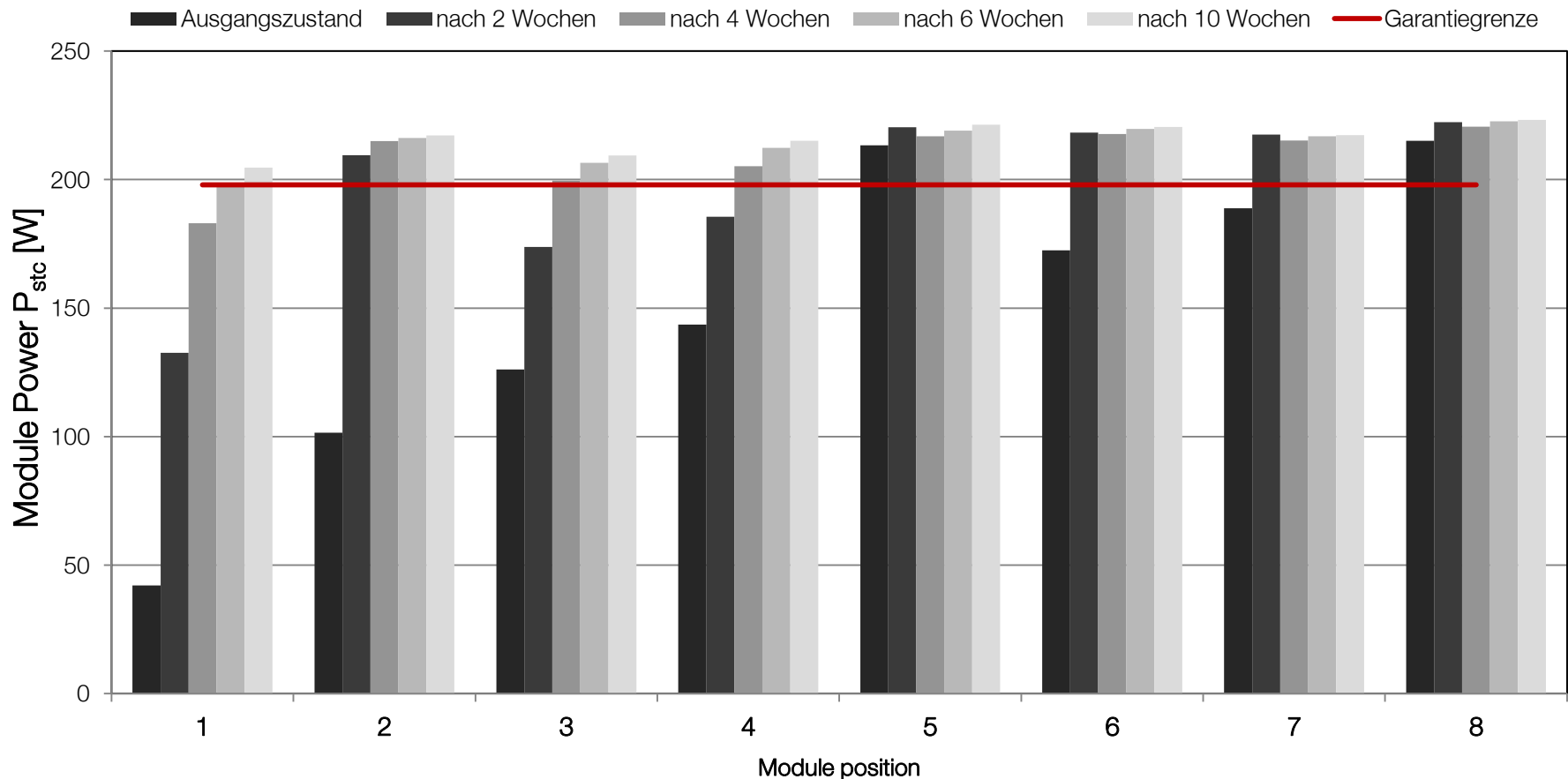
Accelerated PID regeneration

- Reversed order of the string connection supports regeneration

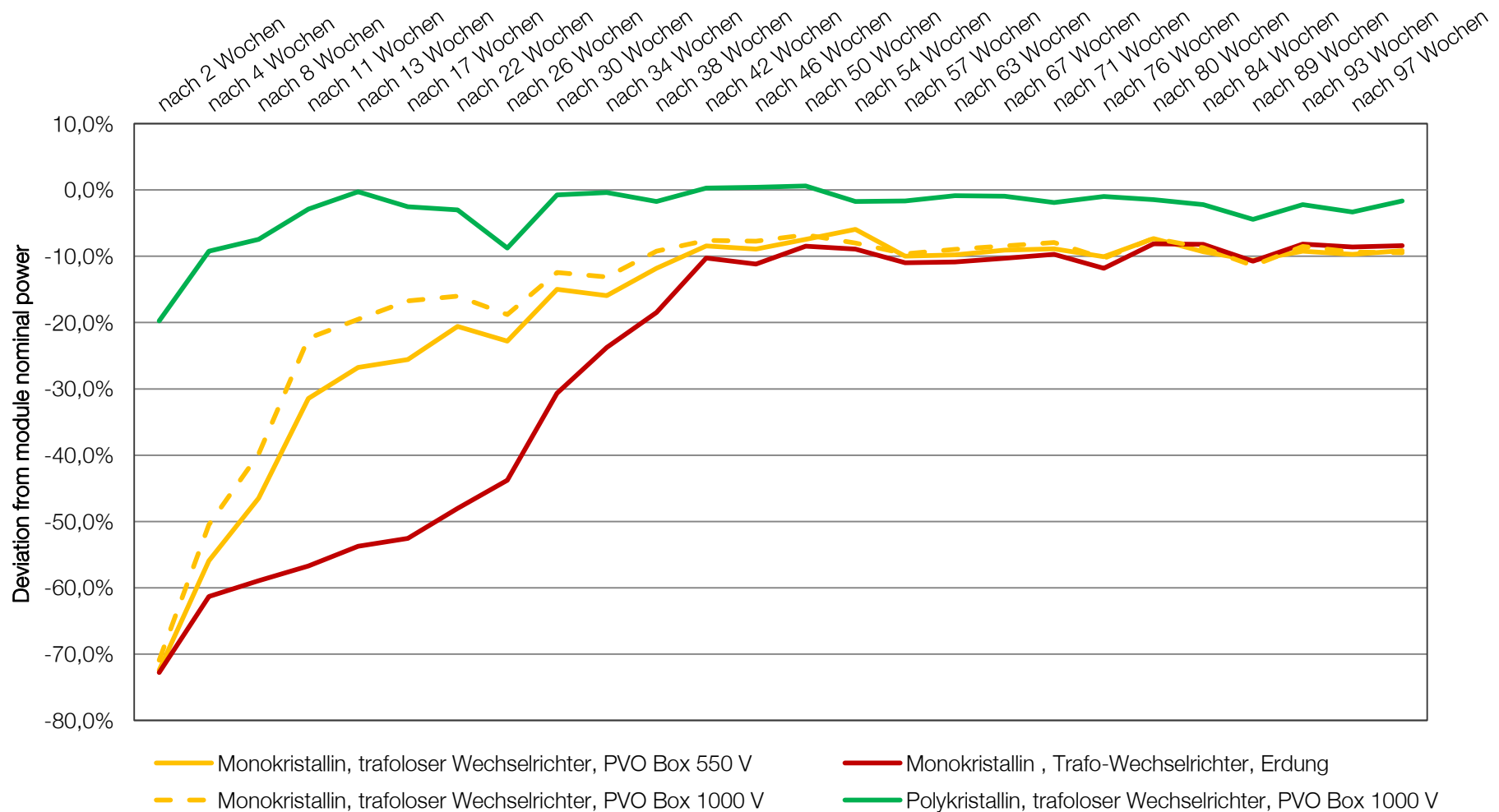


Combination of different regeneration measures

Regeneration by reversed order and earthing (String with 20 modules, data of modules 1 to 8)

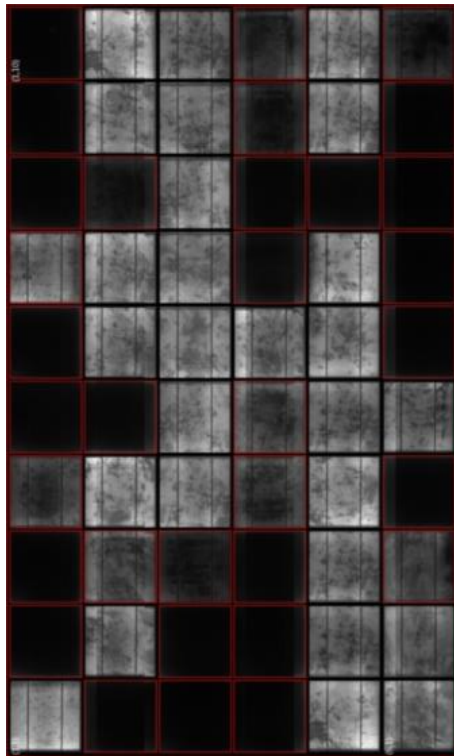


Comparison of different regeneration methods

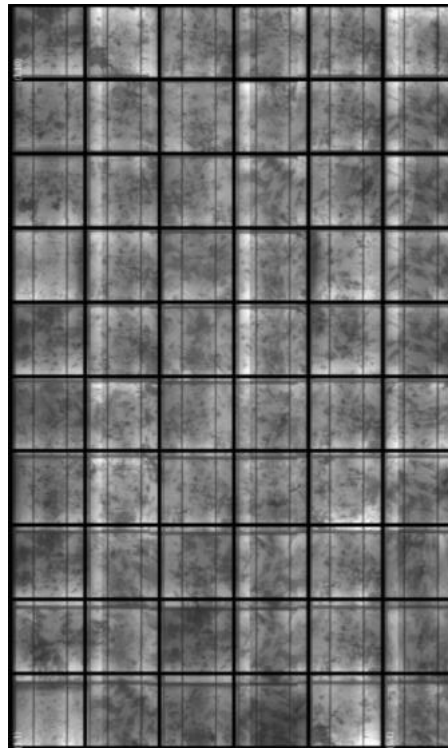


EL Test shows PID Regeneration

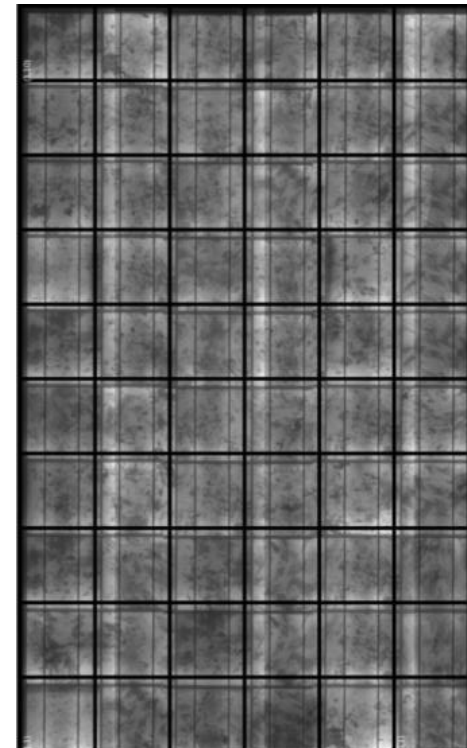
Transformerless Inverter with PVO Box 1000 V



Initial Measurement
Power: 58 %



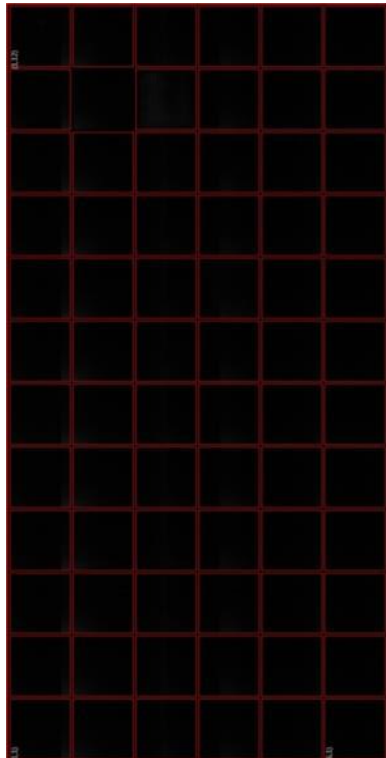
After 16 Weeks
Power: 91 %



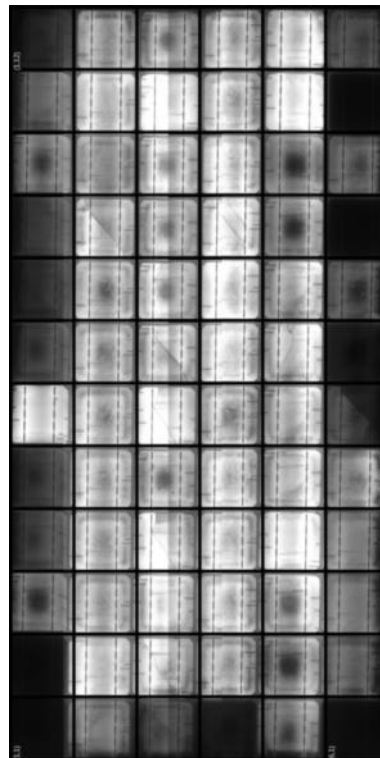
After 36 Wochen
Power: 100 %

EL Test shows PID Regeneration

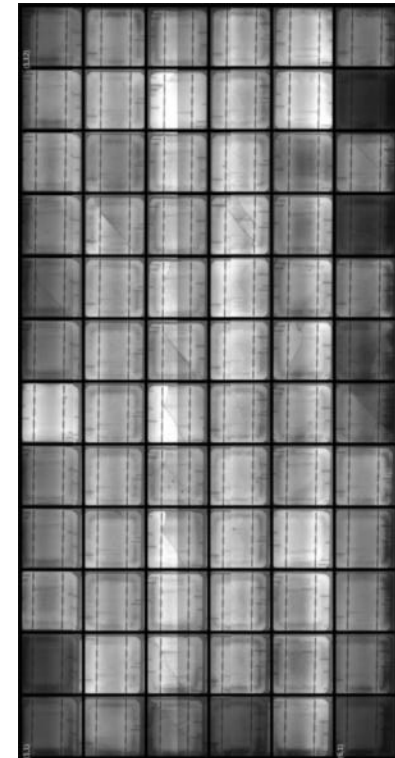
Transformerless Inverter with PVO Box 550 V



Initial Measurement
Power: 6 %



After 16 Weeks
Power: 64 %



After 36 Weeks
Power: 83 %

Summary and outlook

- ☀ PID effect is known by manufactures and measures at the module design level are implemented
- ☀ A high number of unrecorded PID cases is expected (Slow gradual degradations)
- ☀ Ensure effectiveness of regeneration measures
→ e.g. defect PVO Box, Insulation problems
- ☀ Not all modules recover completely
- ☀ Increase of system voltage towards 1500V

Many thanks for your attention!



Usage of a mobile test lab

- ☀ Suncycle Compact Test Unit (CTU):
Electroluminescence and flash test of STC Power



Target-oriented settlement of PID affected plants

