Solar testing in climate chambers

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RDM CAMPUS ROTTERDAM

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Costs are not the issue anymore...

improving reliability is key.

Gujarat, India

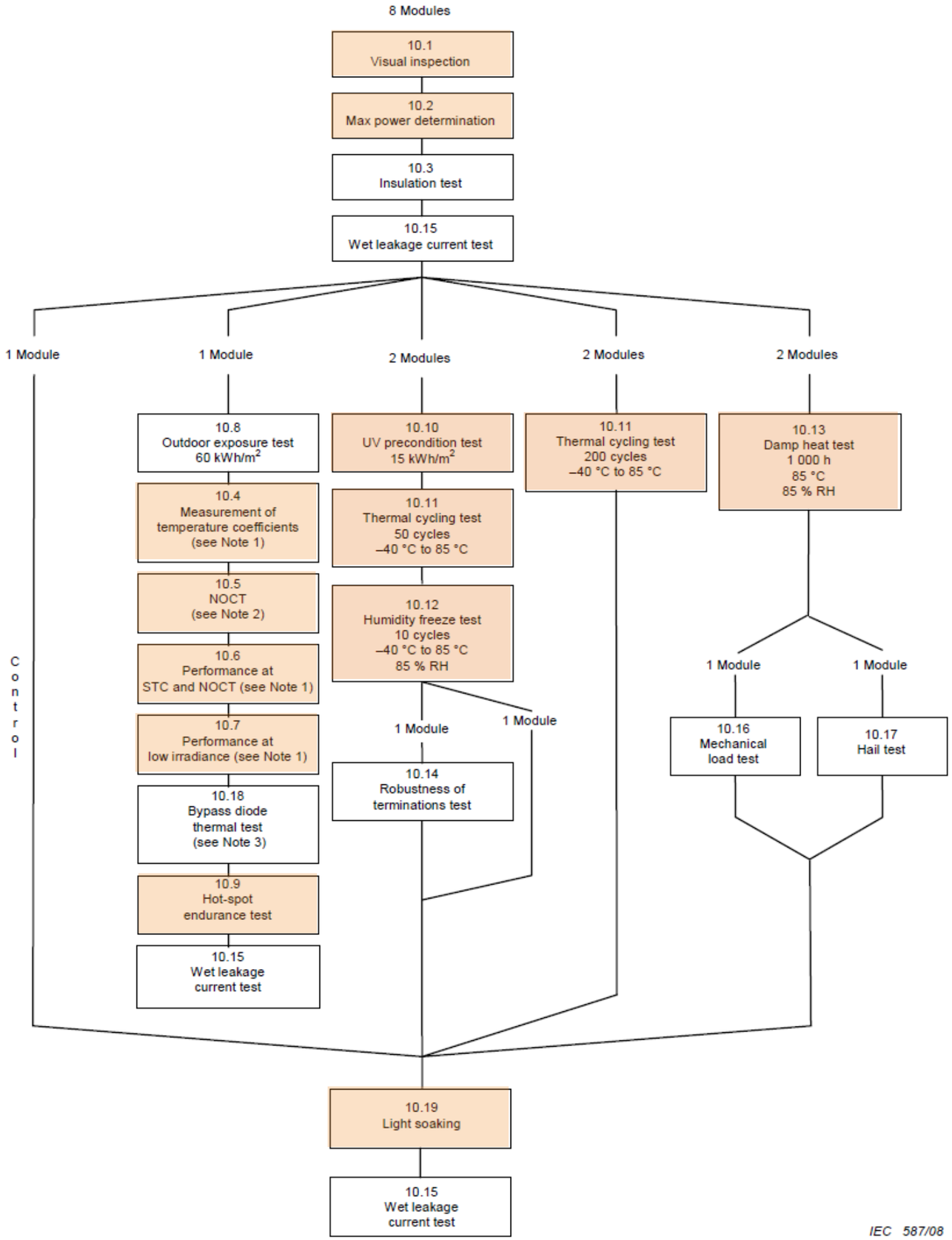
Testing PV modules

IEC 61215 & 61646

Performance testing

Weathering

Accelerated Life testing



TNO innovation for life

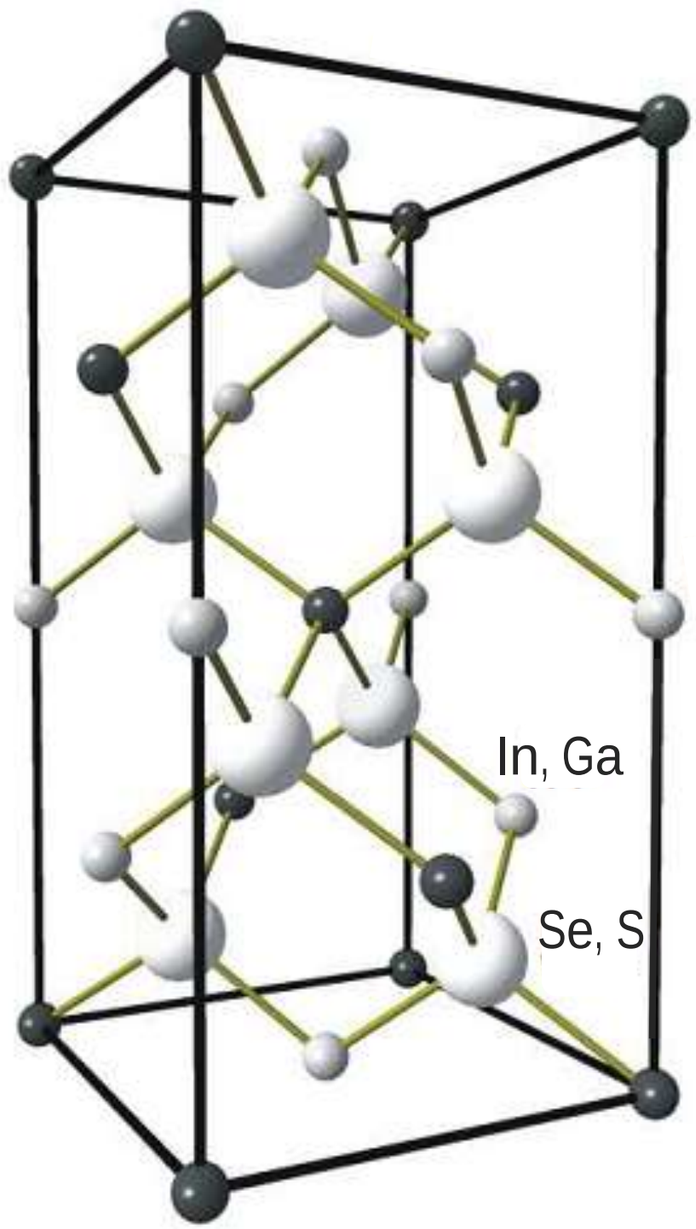
hielkema TESTEQUIPMENT B.V.
Temperature (& humidity) chambers

Performance testing + Weathering + Accelerated life testing

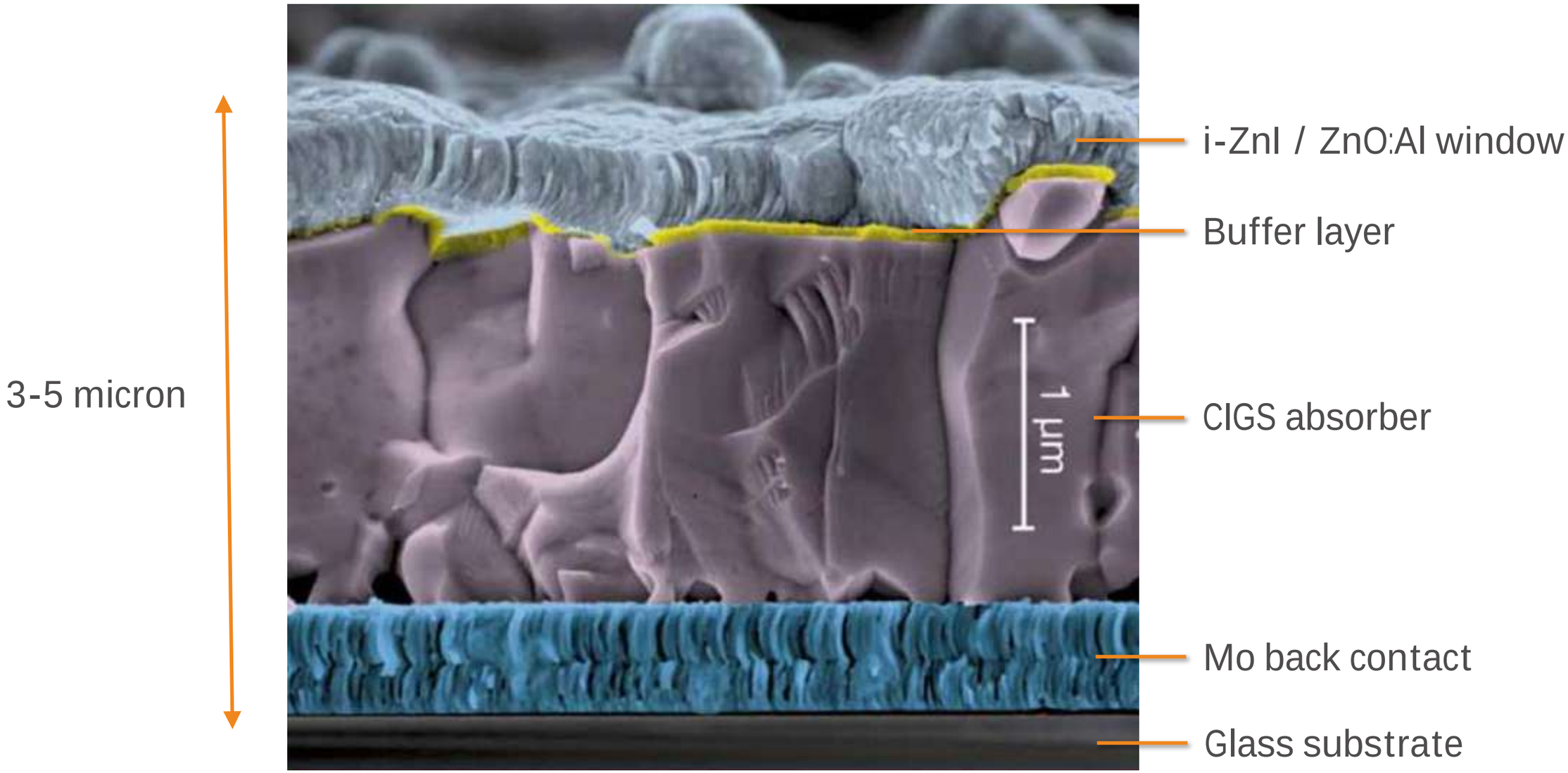
In one test setup

Reliability testing of CIGS cells

- Copper Indium Gallium Selenide / sulfur: $Cu(In,Ga)(Se,S)_2$



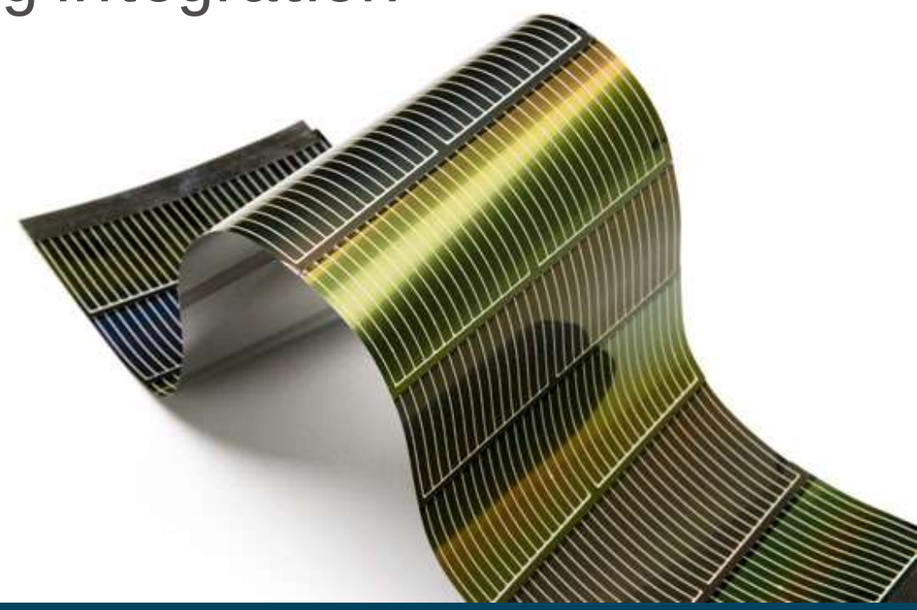
CIGS solar cells / modules



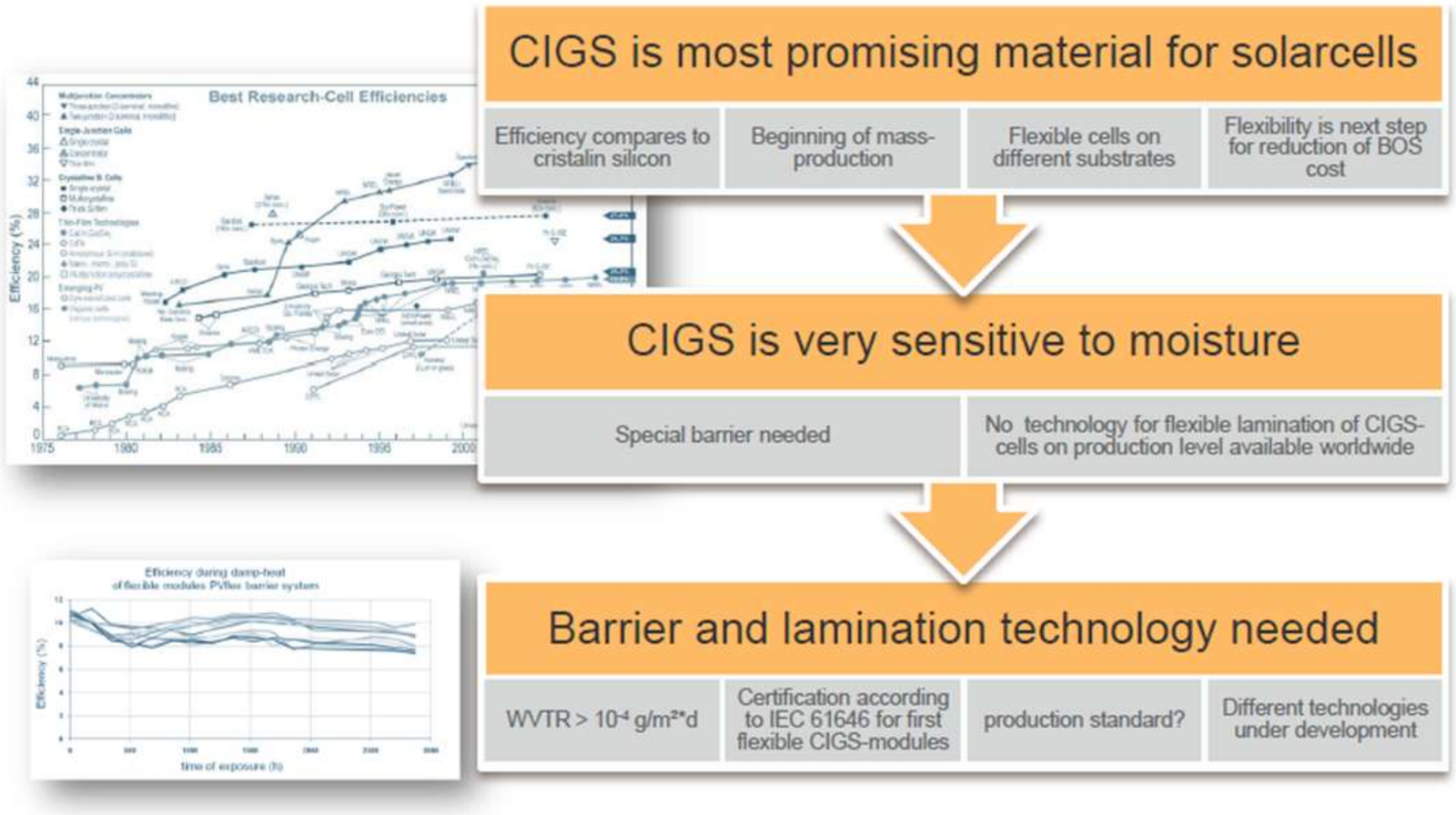
Source: Friedlmeyer 2010

Benefits of CIGS solar cells / modules

- High efficiencies (20.3%)
- Thin film solar cell (flexibility)
- Low cost (€ / W_p) potential due to high efficiencies and low material usage (per m^2 module)
- Nice black colour makes it suitable for building integration



Main challenge



Water is the biggest enemy in combination with light and electrical loads.

How to find weaknesses

Loads

- Temperature
- Moisture
- Light
- Electrical load

Place a CIGS cell or mini-module under one or more loads

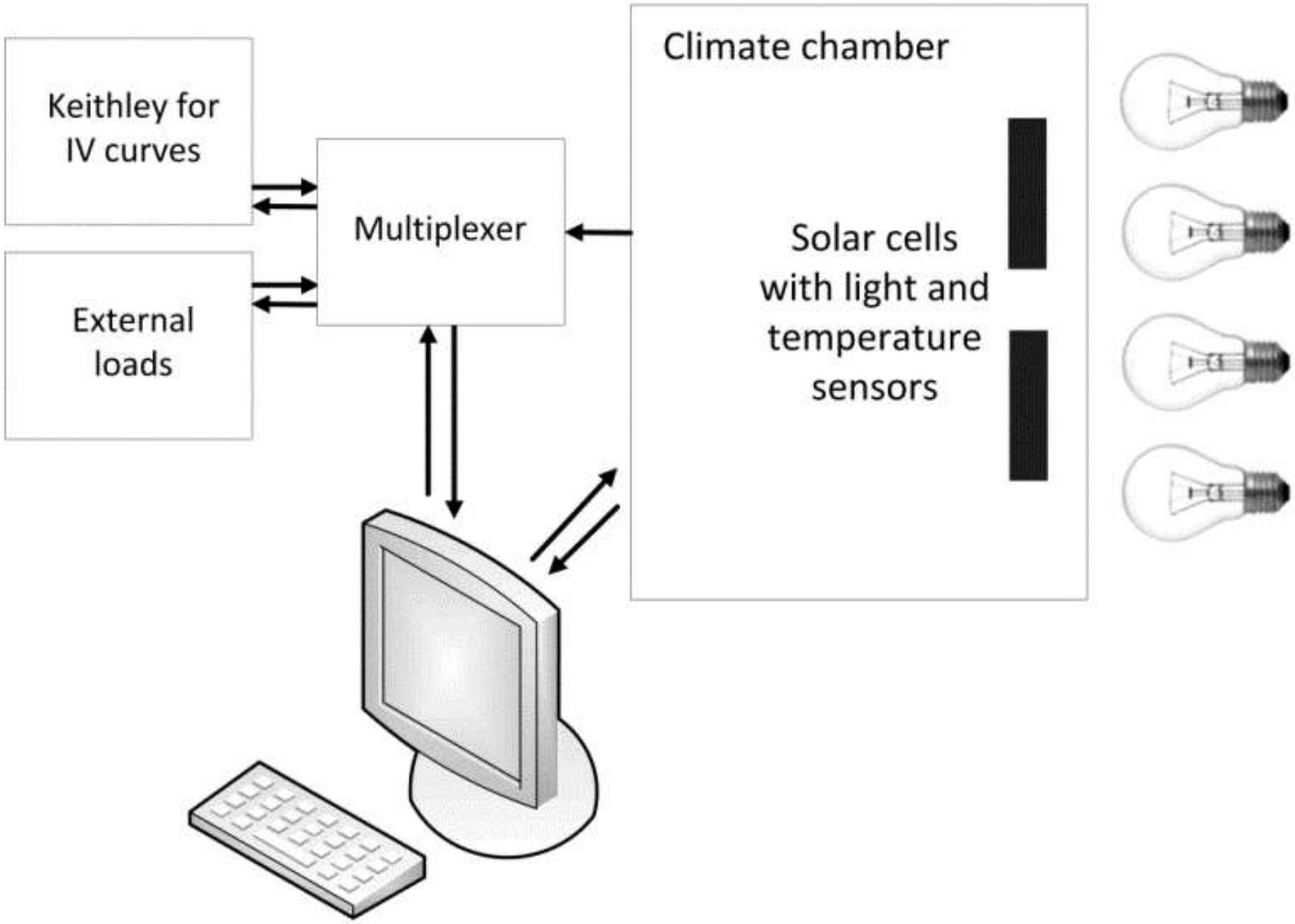
In-situ measuring of degradation of CIGS cells

Removal of cells from setup when they break down

Chemical analysis of the cells before and after degradation:

XRD, XPS, SEM-EDX, EL, ...

The test setup



The test setup

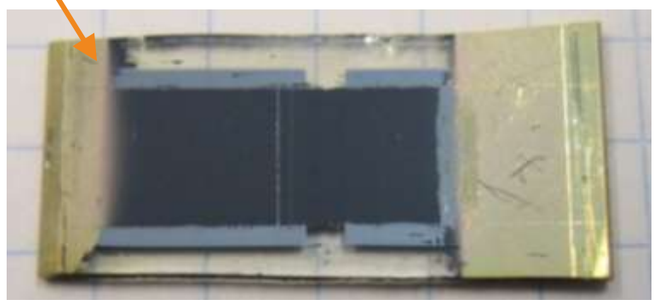
Eternal Sun climate chamber solar simulator

The samples

- Both single and ‘mini-modules’
- A non-degrading metal is used as contact

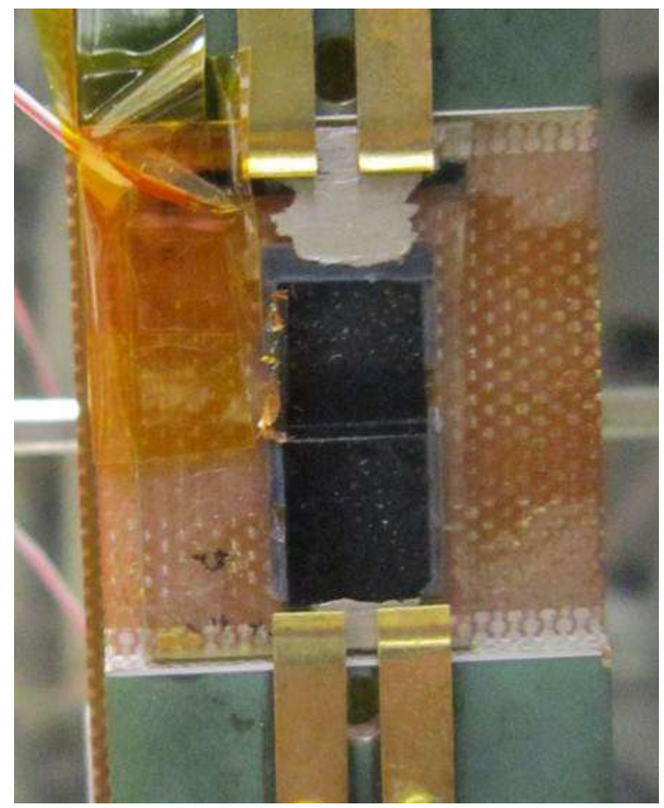
Contacts

Single cell
with silver contacts



Mini-module
with gold contacts

Four point probe connection



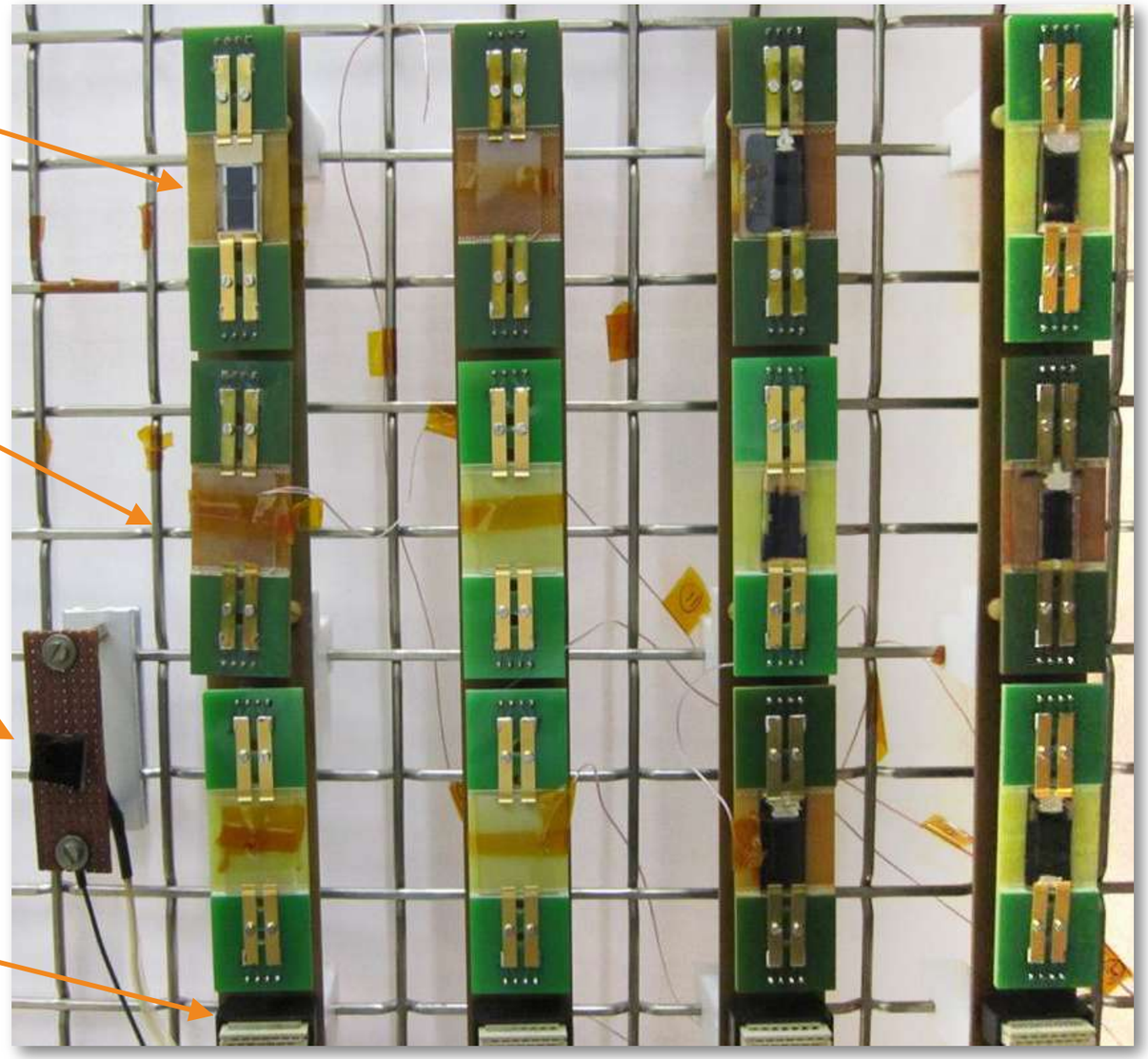
Test layout

CIGS cells

Thermocouple
on every cell

Photodiode

Interconnection
Damp heat
resistant

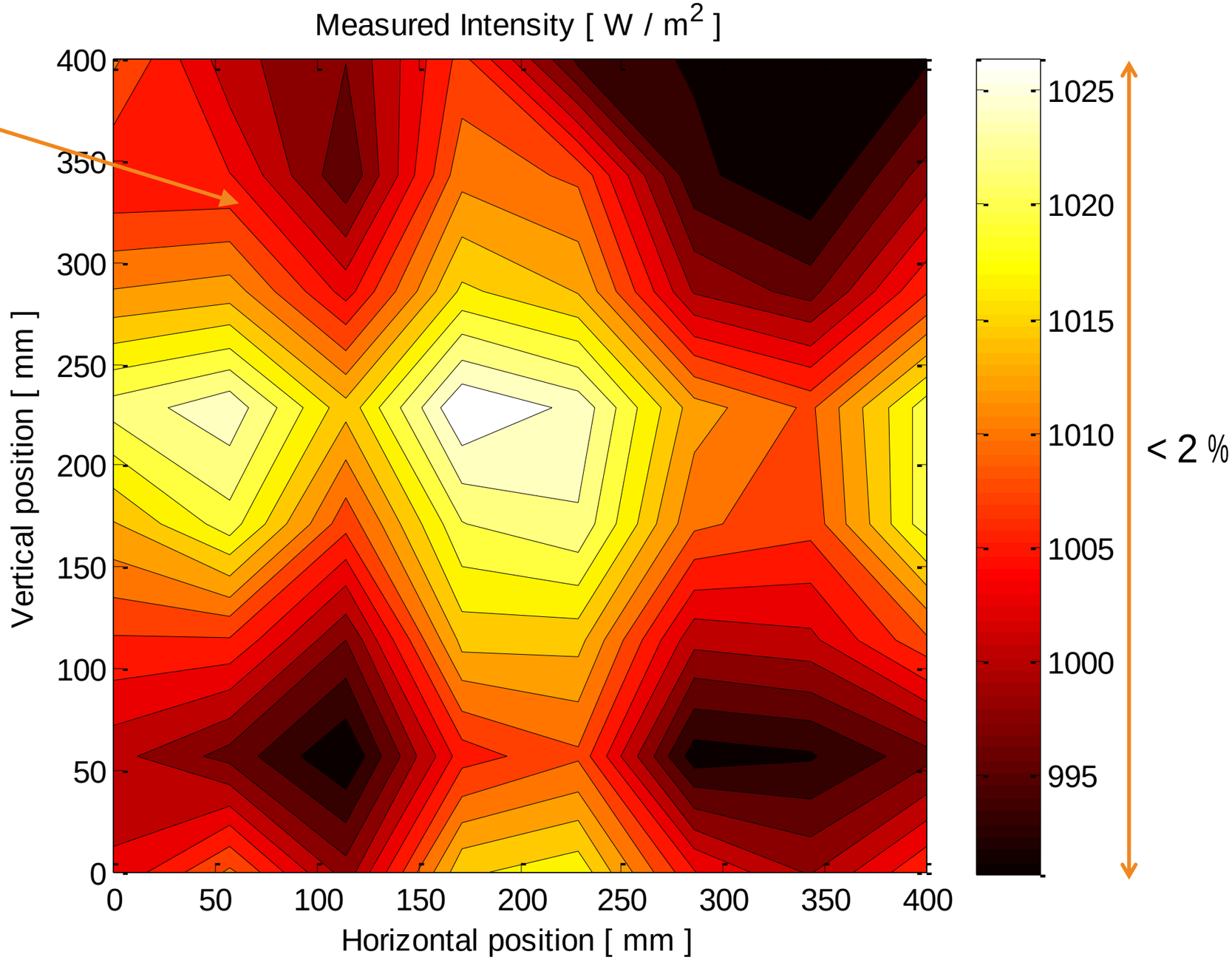


Test layout: light uniformity < 2%

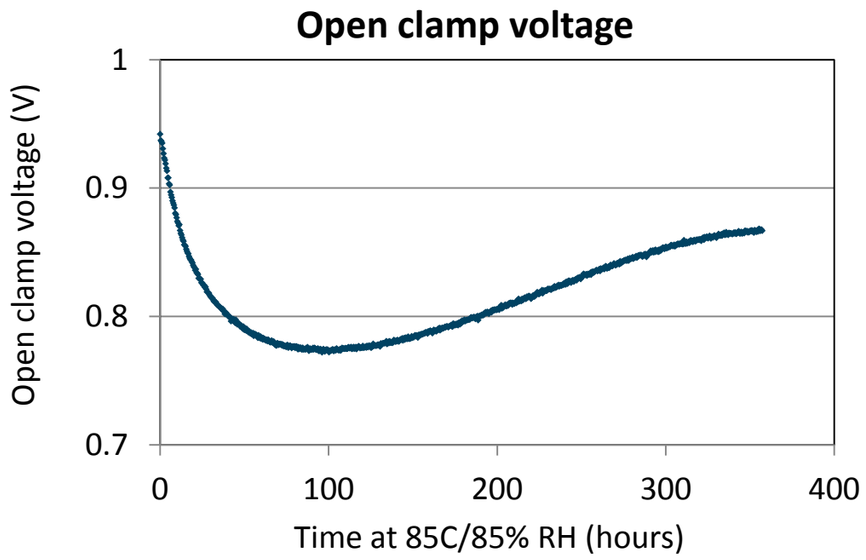
CIGS cells

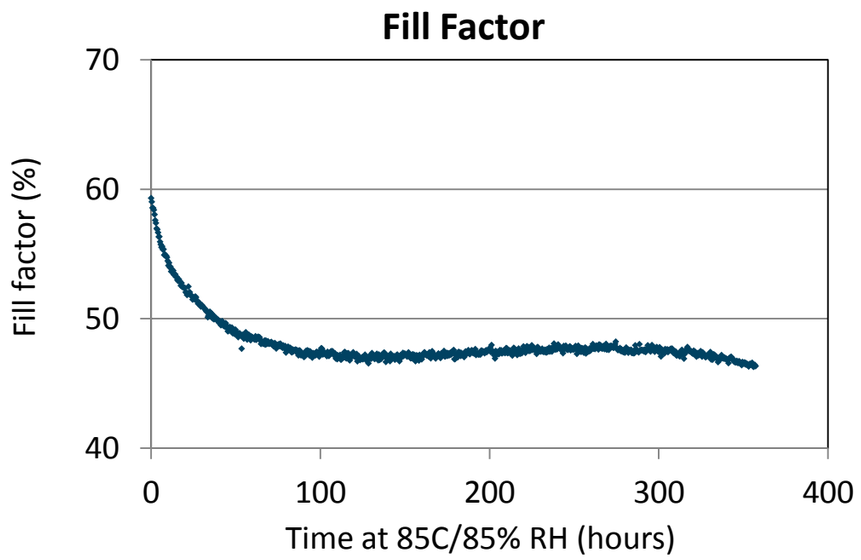
Class A

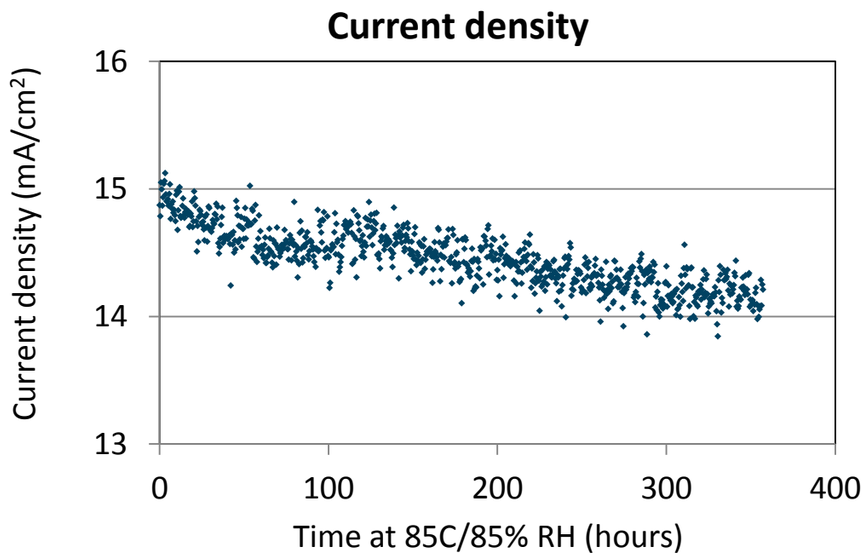
IEC 60904
(solar simulation standard)

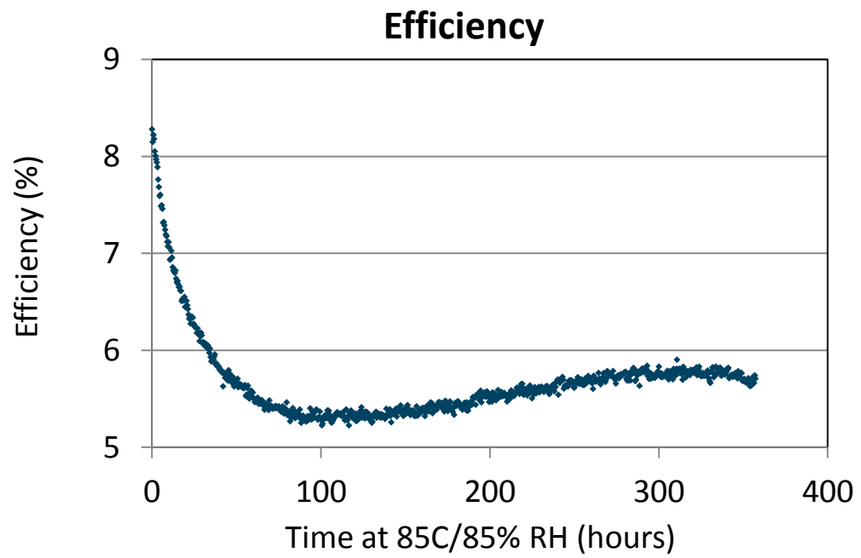


Multiple cell parameter results



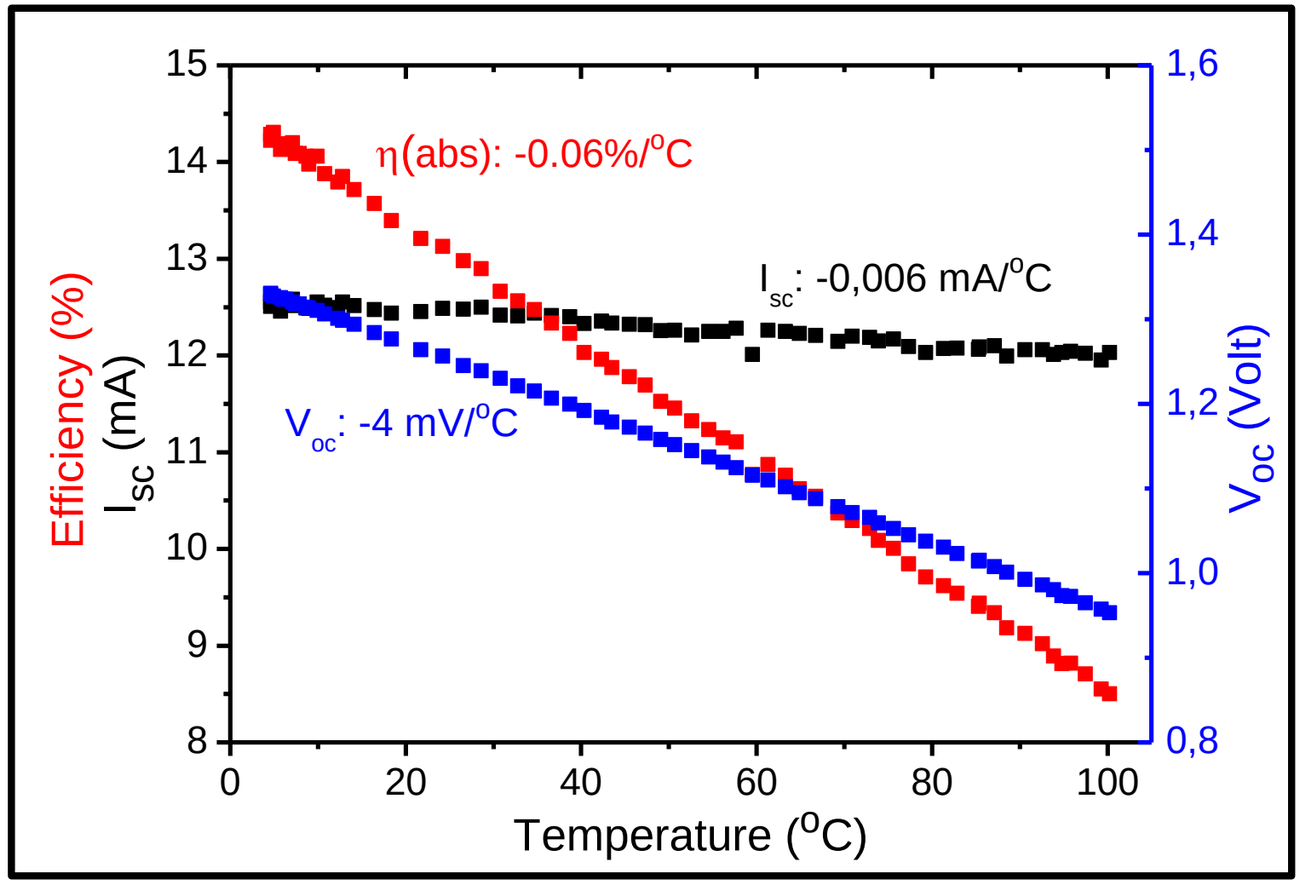






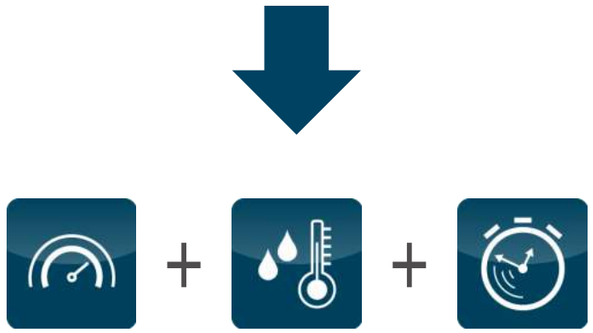
Temperature dependency

The setup can also be used to determine temperature dependency of many cell parameters



Summary

AAA-accuracy solar simulation inside in climate chamber



Improve PV reliability faster and easier

Thank you

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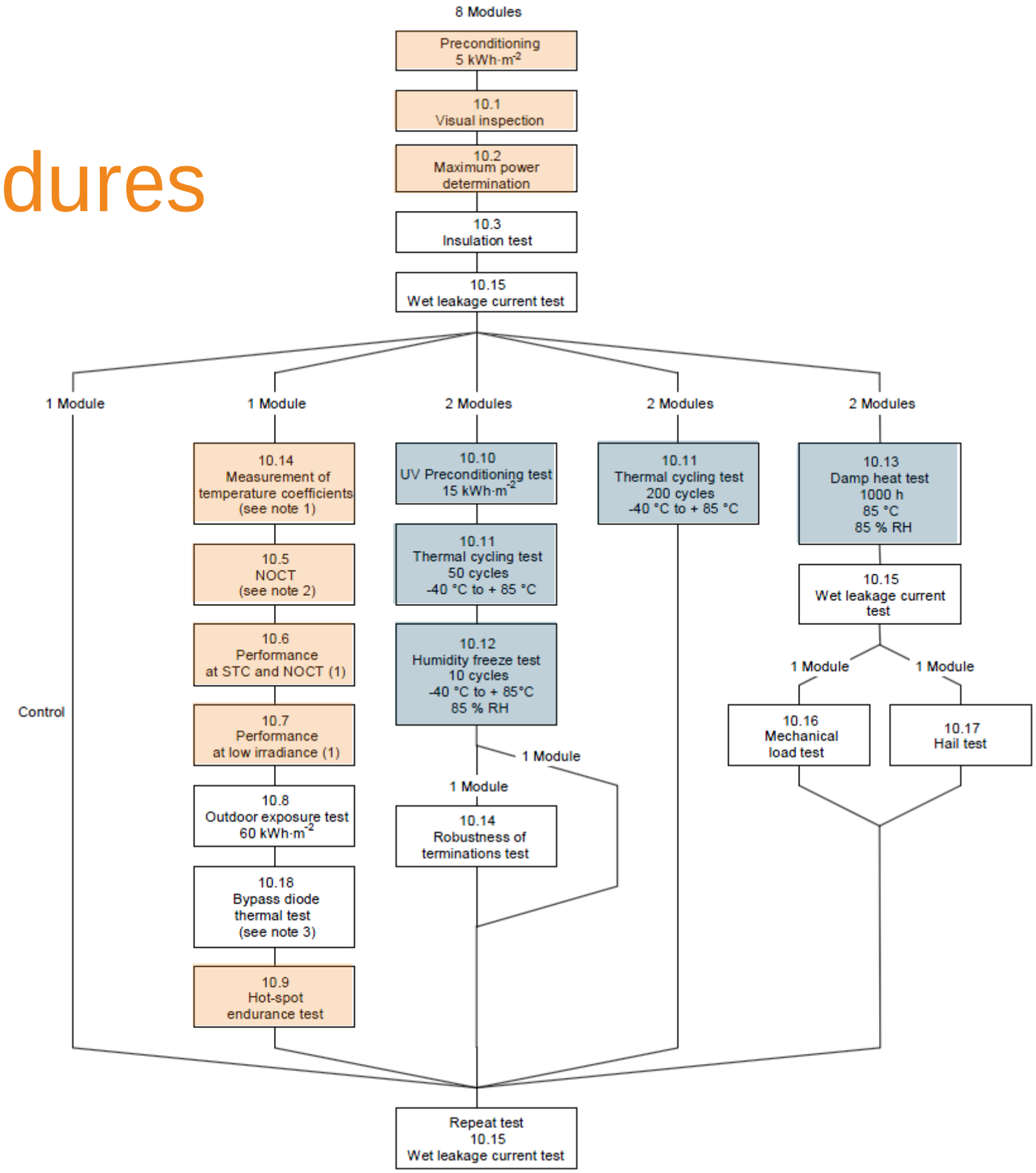
Eternal Sun solar simulation test procedures

IEC 61215: Crystalline silicon PV modules

Design qualification and type approval



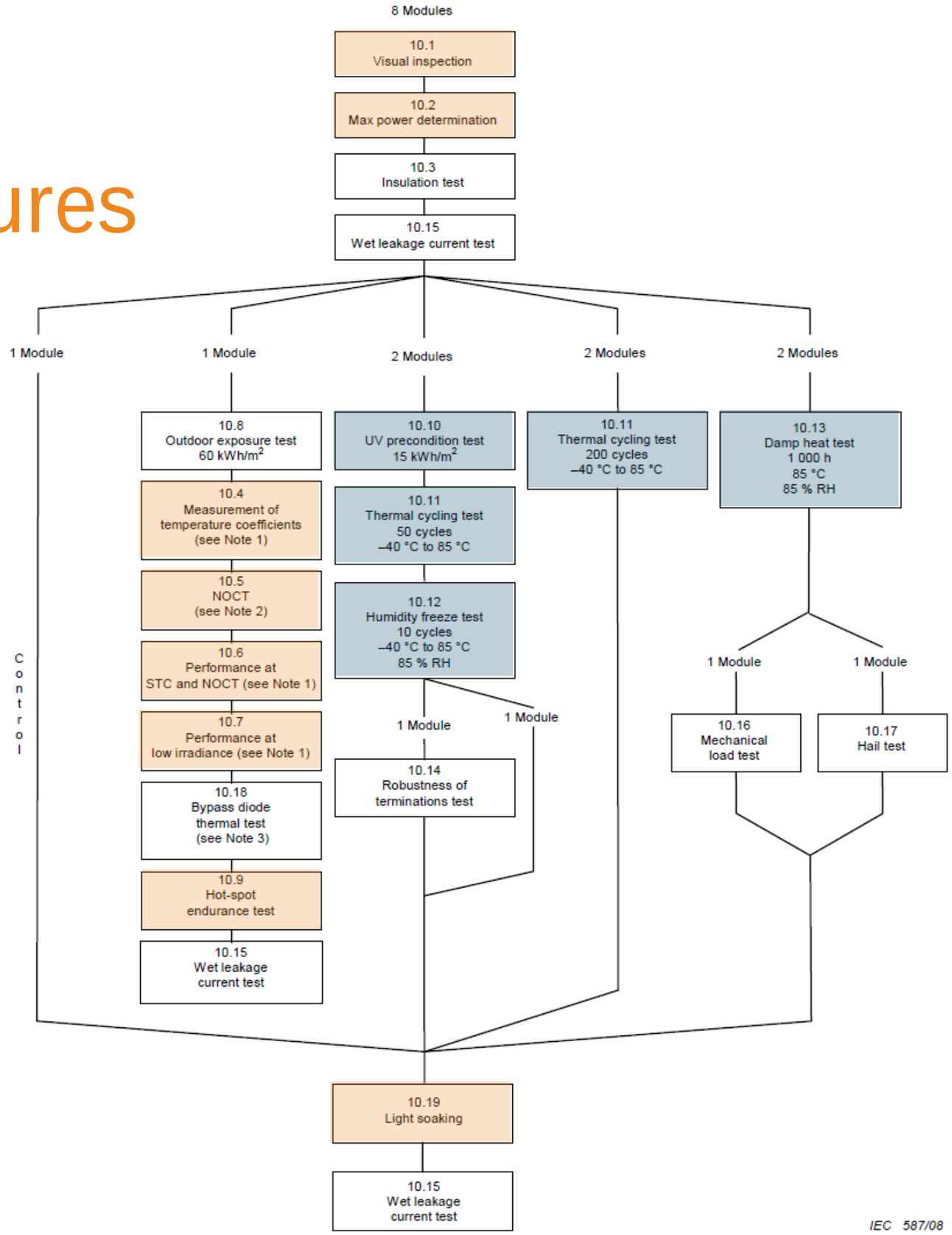
Eternal Sun Large area solar simulator scope

Eternal Sun Climate chamber solar simulator additional scope

Eternal Sun solar simulation test procedures

IEC 61646: Thin-film PV modules

Design qualification and type approval



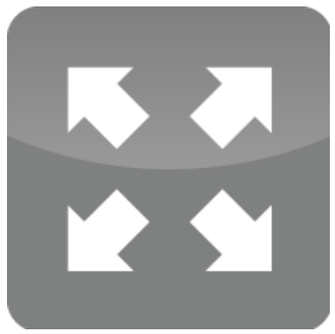
Eternal Sun Large area solar simulator scope

Eternal Sun Climate chamber solar simulator additional scope

About Eternal Sun

The unique benefits of Eternal Sun products are:

AAA-accuracy



Any size

Steady-state

Large area solar simulator

Performance and degradation testing

- ✓ AAA class steady-state or long pulse
- ✓ Suited for testing new module types & large sizes
- ✓ Flexible in use & operational in different angles
- ✓ Small footprint & turn-key

Climate chamber solar simulator

Accelerated lifetime testing and weathering

- ✓ Sunlight, humidity and temperature cycling
- ✓ AAA class steady-state or long pulse sunlight inside climate chamber
- ✓ Computer controlled integrated system
- ✓ Turn key operation

In-line solar simulator

In-line performance testing and inspection

- ✓ In-line, sunny side down testing
- ✓ One module every 10 seconds
- ✓ One second IV sweep for any module technology
- ✓ Production line tuning

Roll to roll solar simulator

Roll to roll performance testing and inspection

- ✓ Roll to Roll PV testing
- ✓ Easy mounting of rolls of different sizes
- ✓ 1 module every 4 seconds
- ✓ 1 second IV sweep for any module technology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Toilets


KATTE
KATTE


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