VIPERLAB

HZB Helmholtz Zentrum Berlin

HZB STABILITY LAB

VIPERLAB Webinar

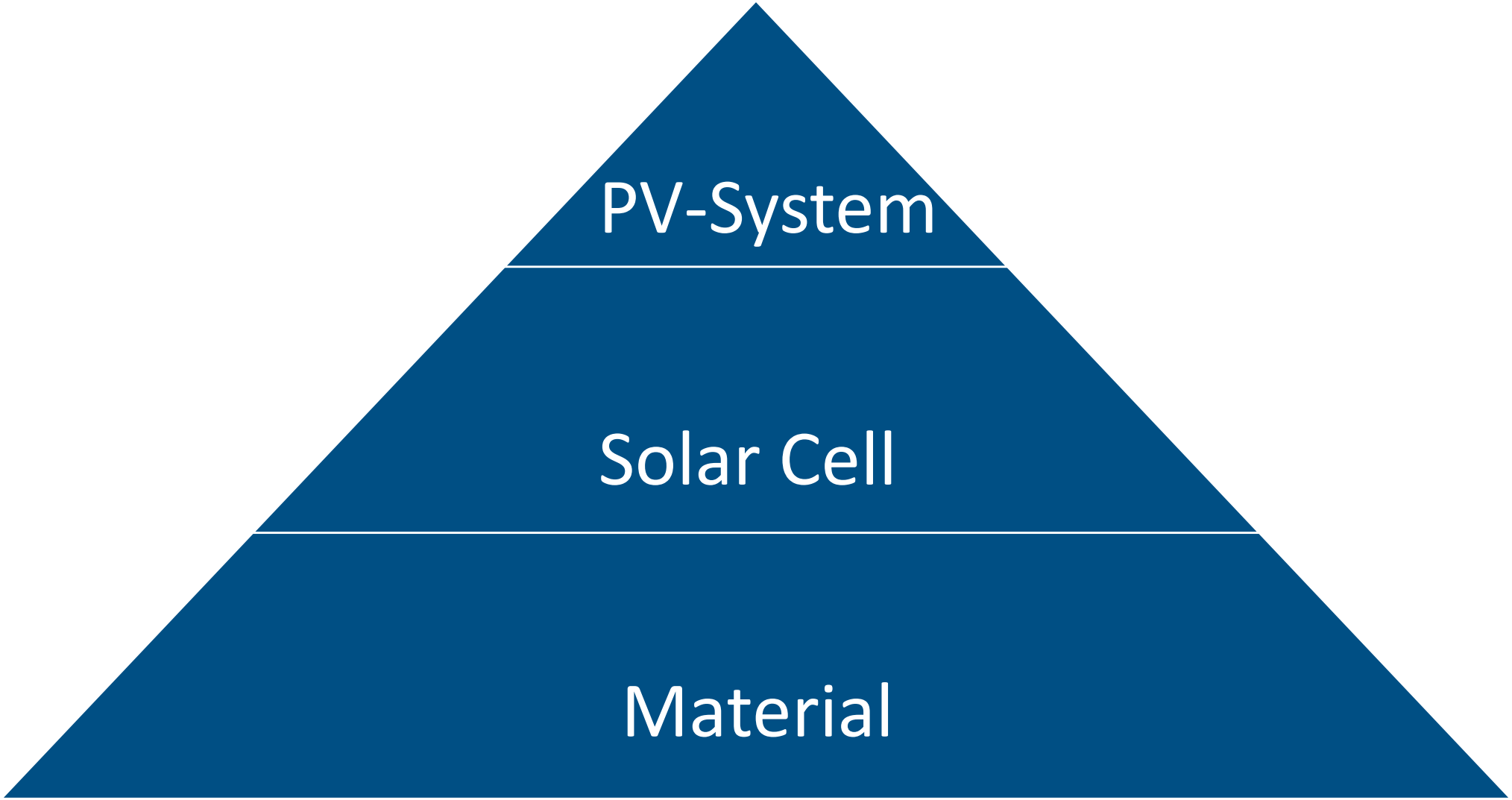
Dr. Hans Köbler

26.01.2023

Apply now!

Deadline 28.2.23

STABILITY ASSESSMENT



01 High-Throughput Ageing System

MAIN FEATURES

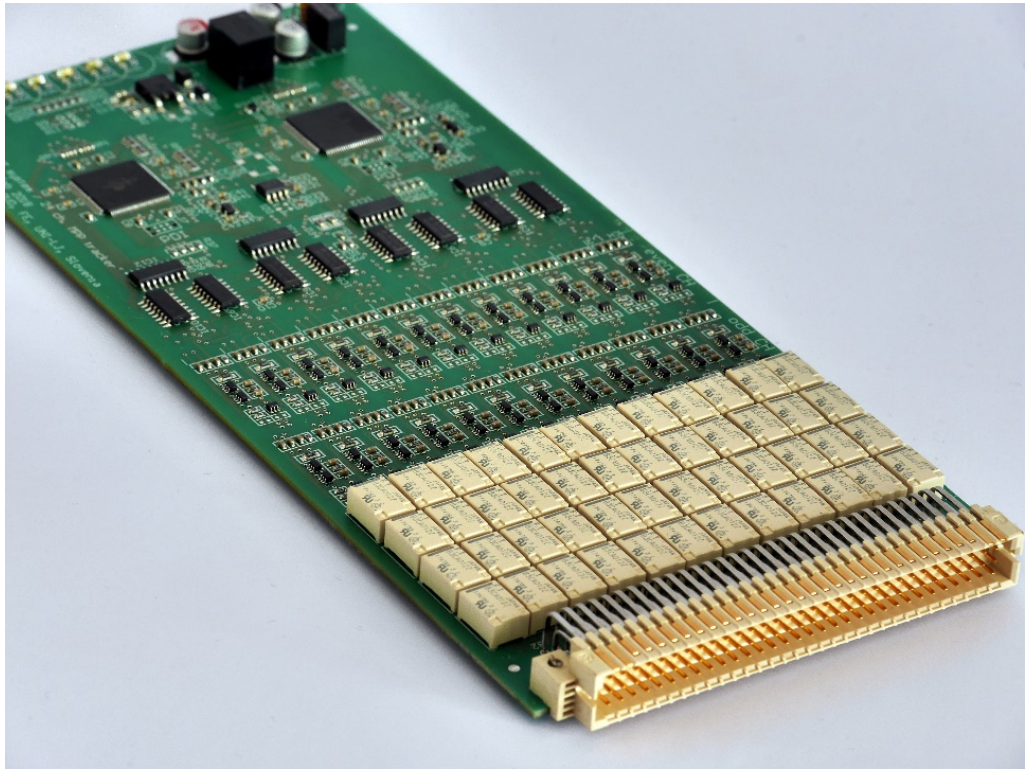
- ageing at MPP
- high-throughput - reliable statistics
- atmosphere control
- substrate temperature control

384 pixels of parallel MPP-tracking!

ELECTRONIC AGEING LOAD

- MPPT
- V_{oc}
- J_{sc}
- constant voltage

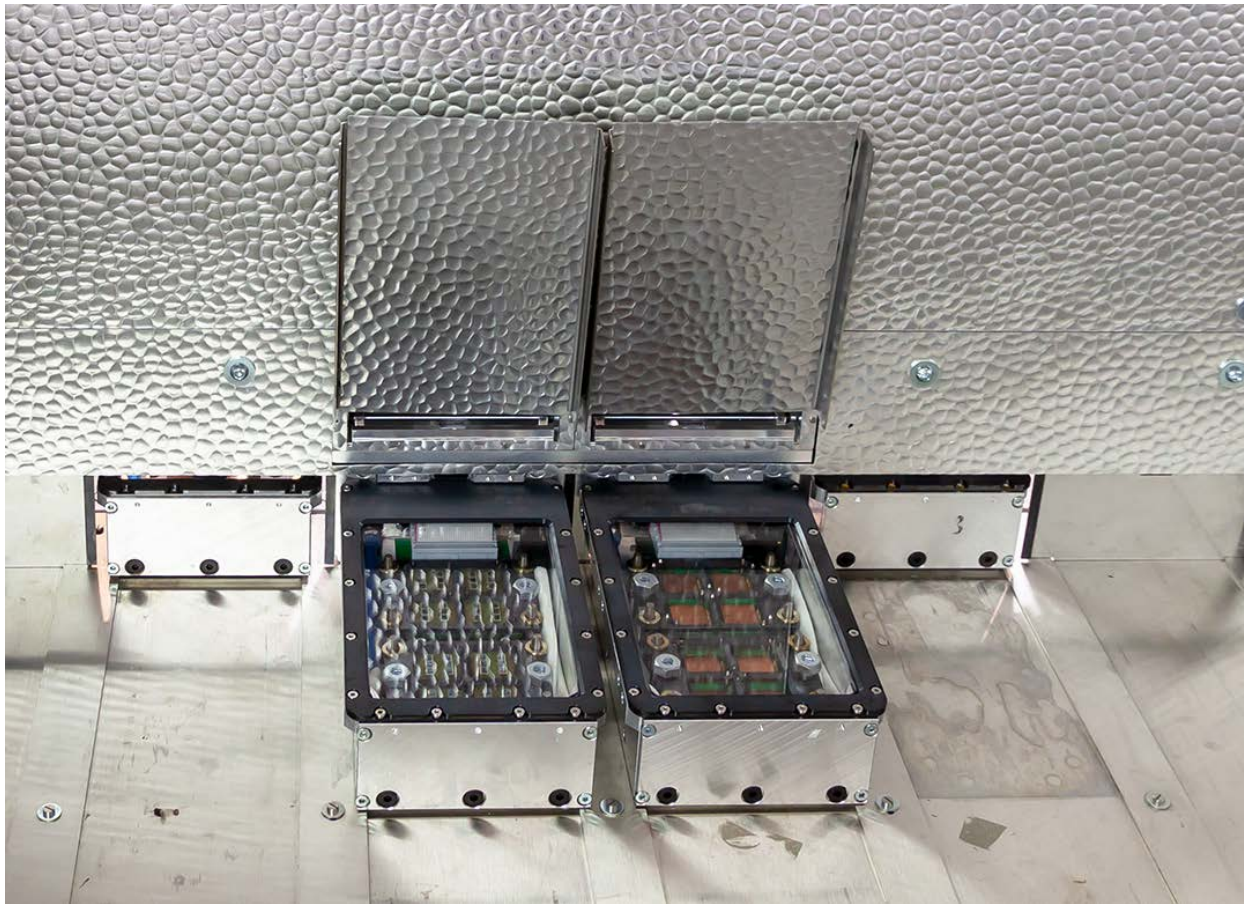
additionally: sequential JV-scans



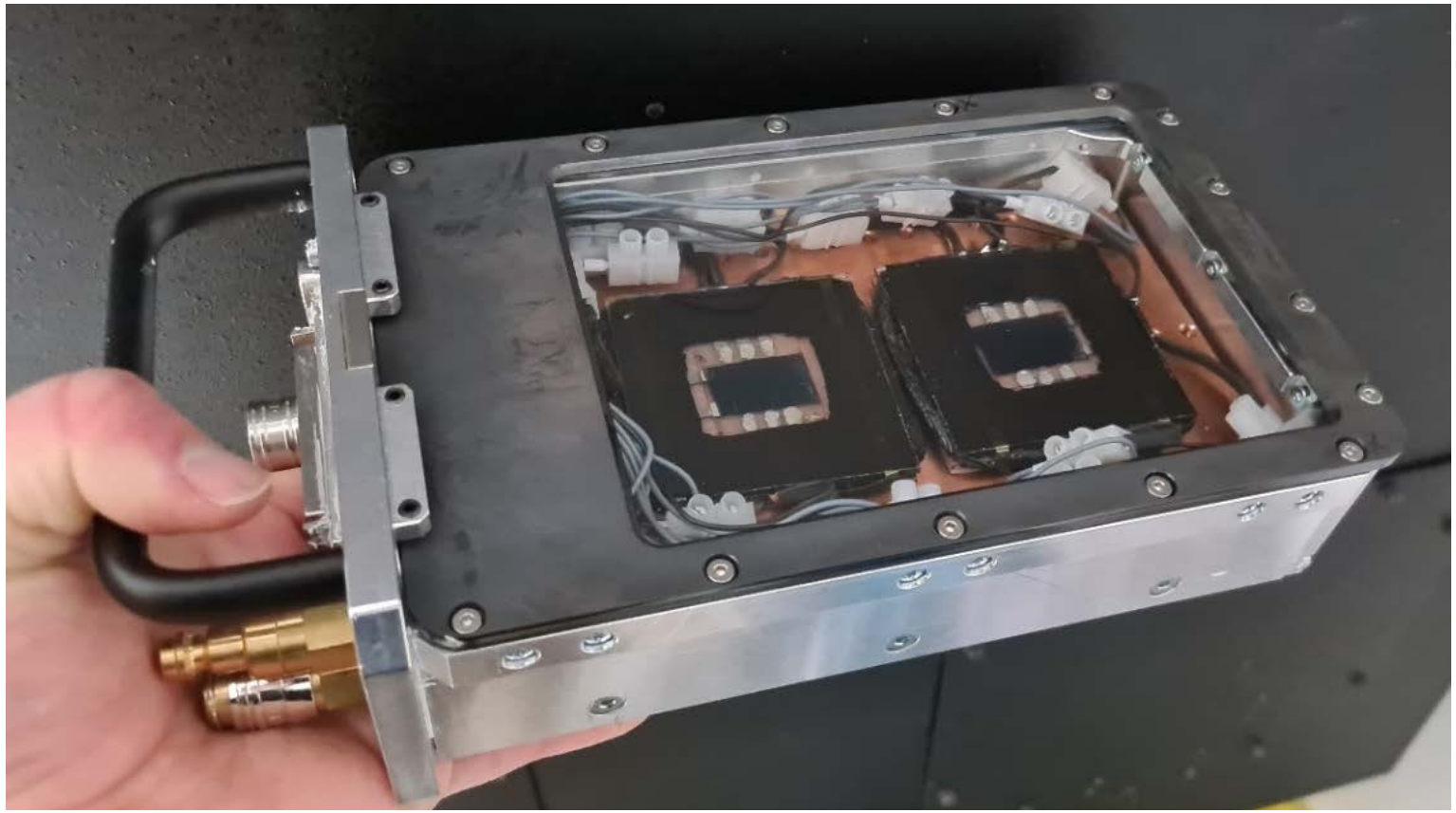
AGEING CONDITIONS

- air, dry air or N_2
- sample temperature: -10 to 85 °C
- temperature cycles
- biasing

AUTOMATED DARK-LIGHT CYCLING

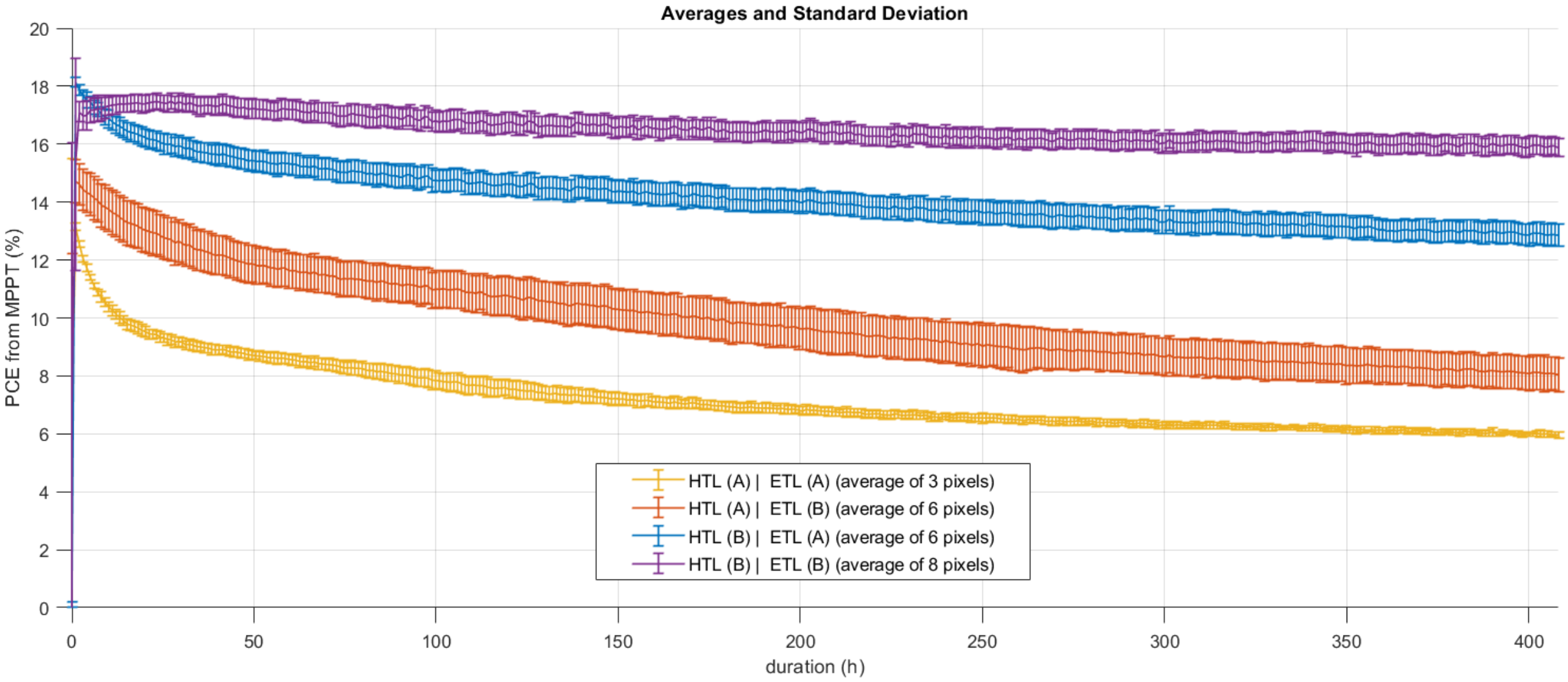


FLEXIBLE CONTACTING



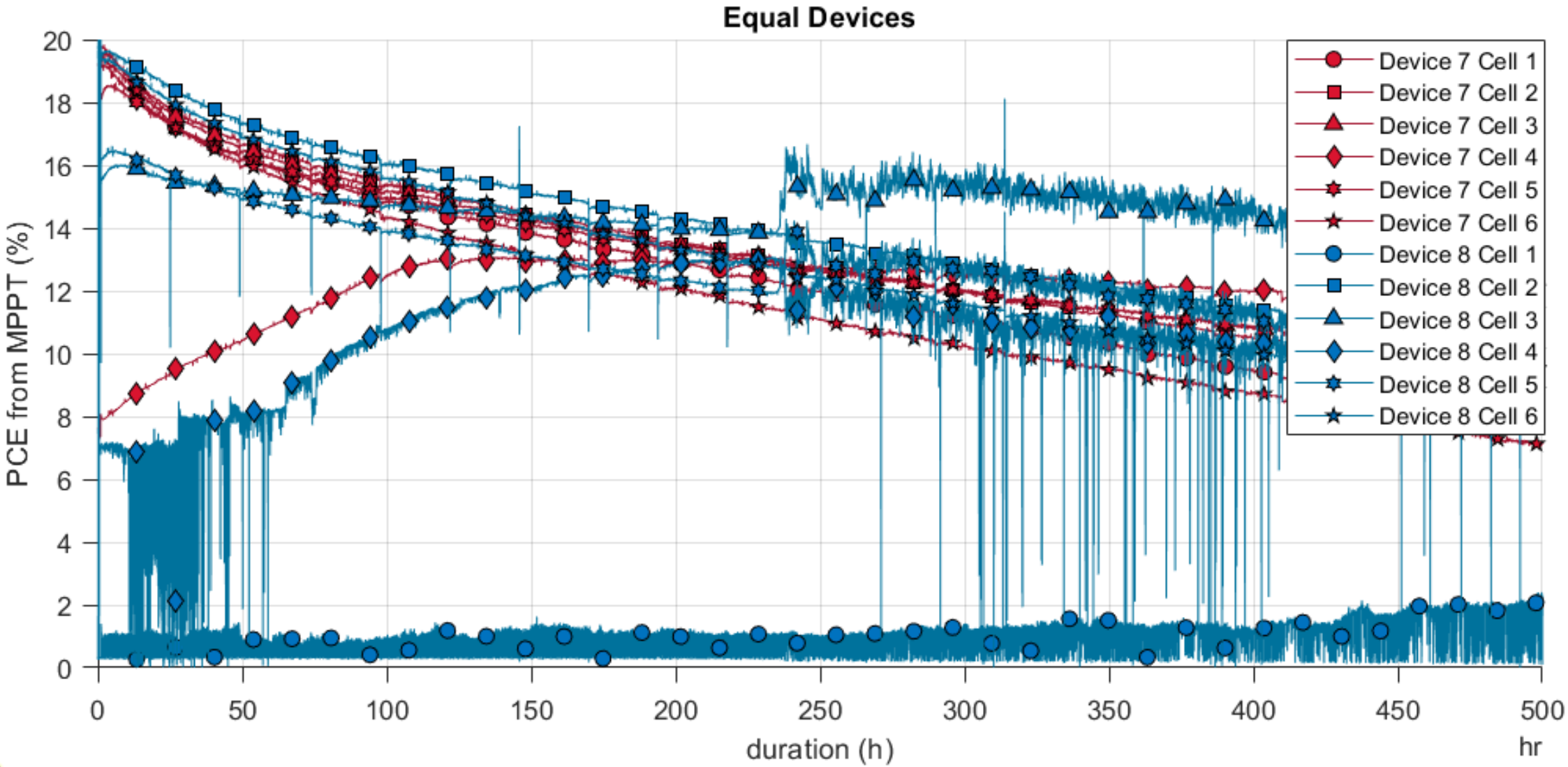
WE CAN ACCEPT ANY LAYOUT!

AUTOMATED PLOTTING



Köbler, H. et al. High-Throughput Aging System for Parallel Maximum Power Point Tracking of Perovskite Solar Cells. Energy Technol. 10, 2200234 (2022).

DATA FILTERING



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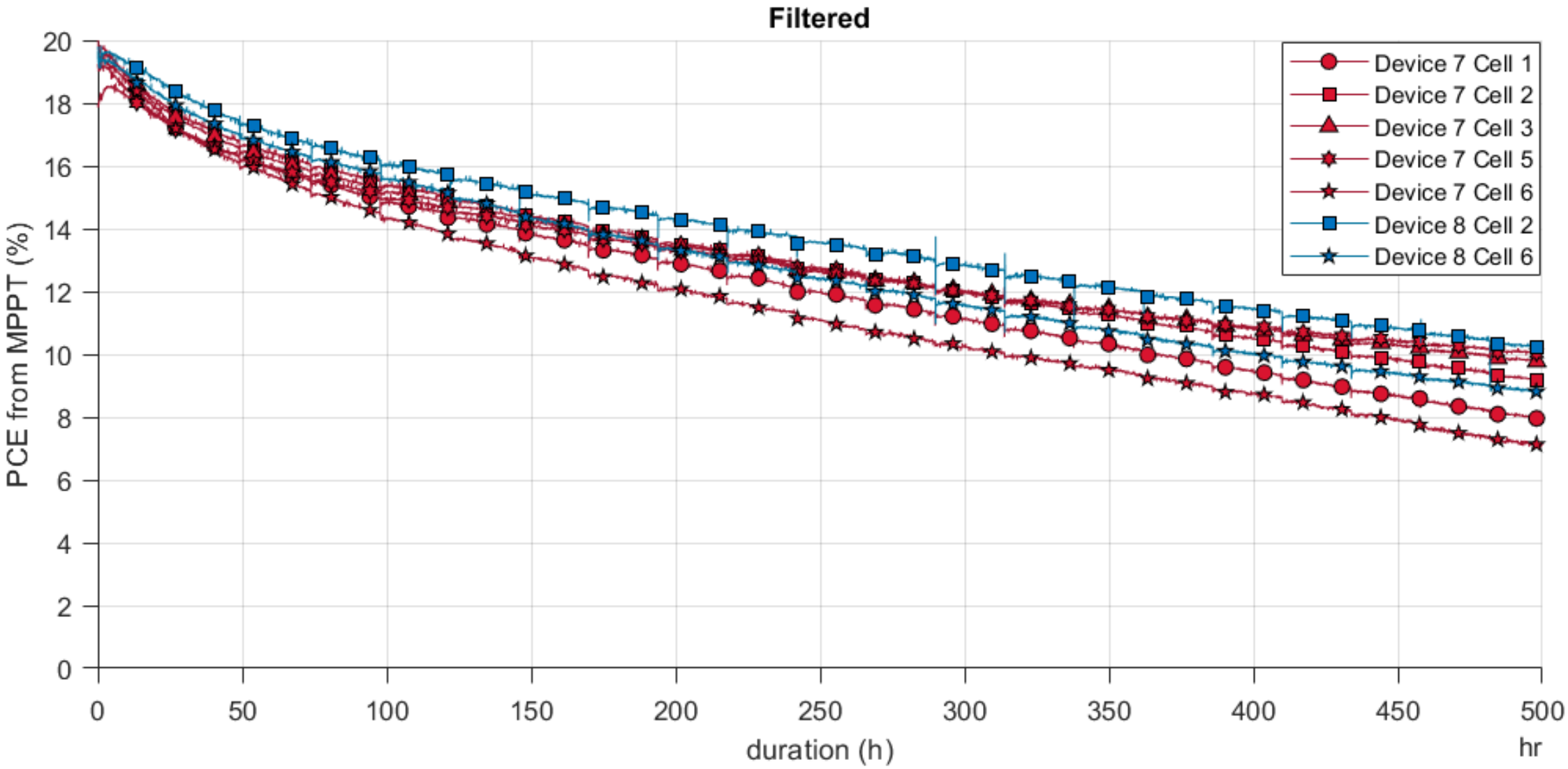

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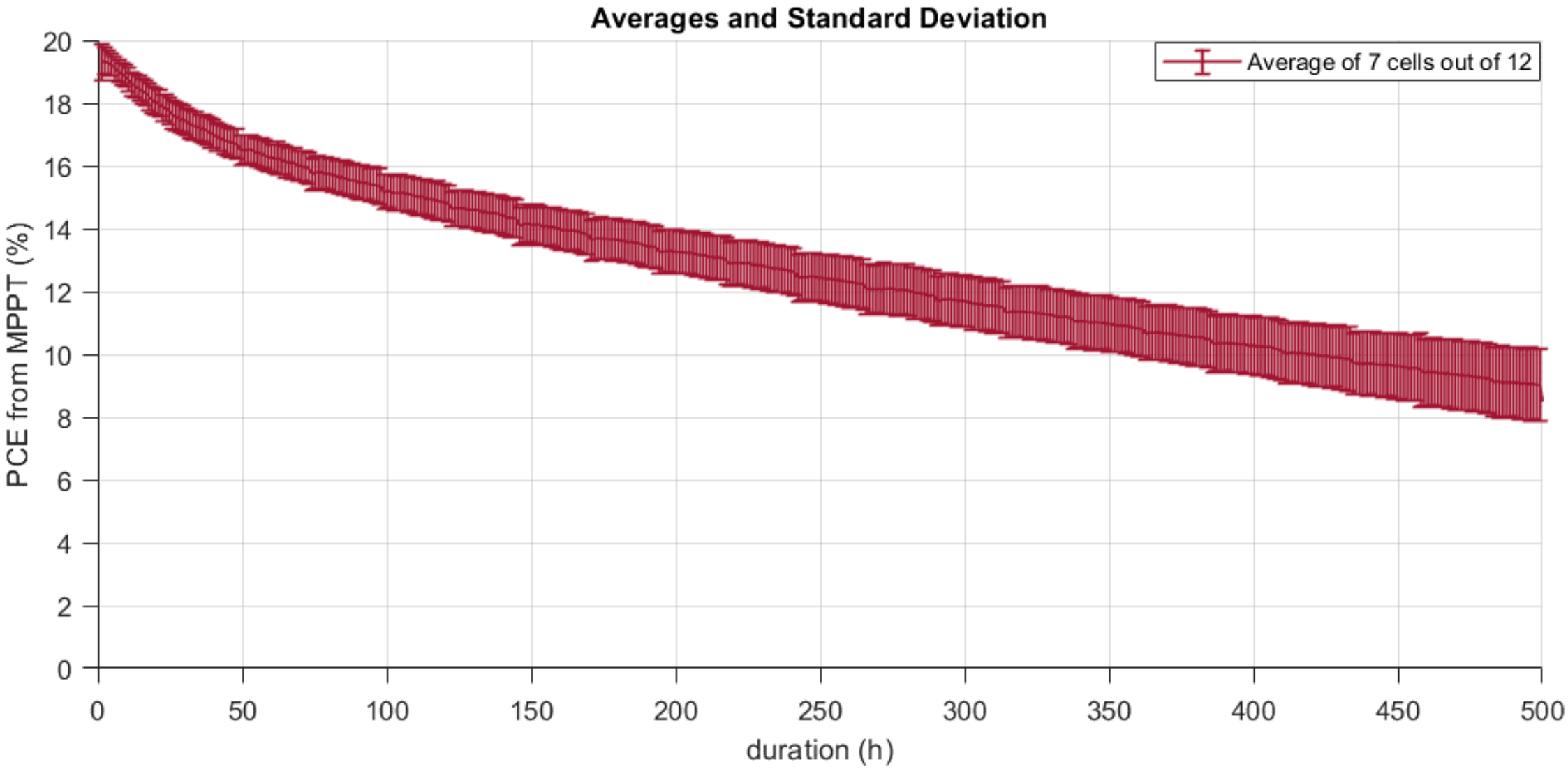

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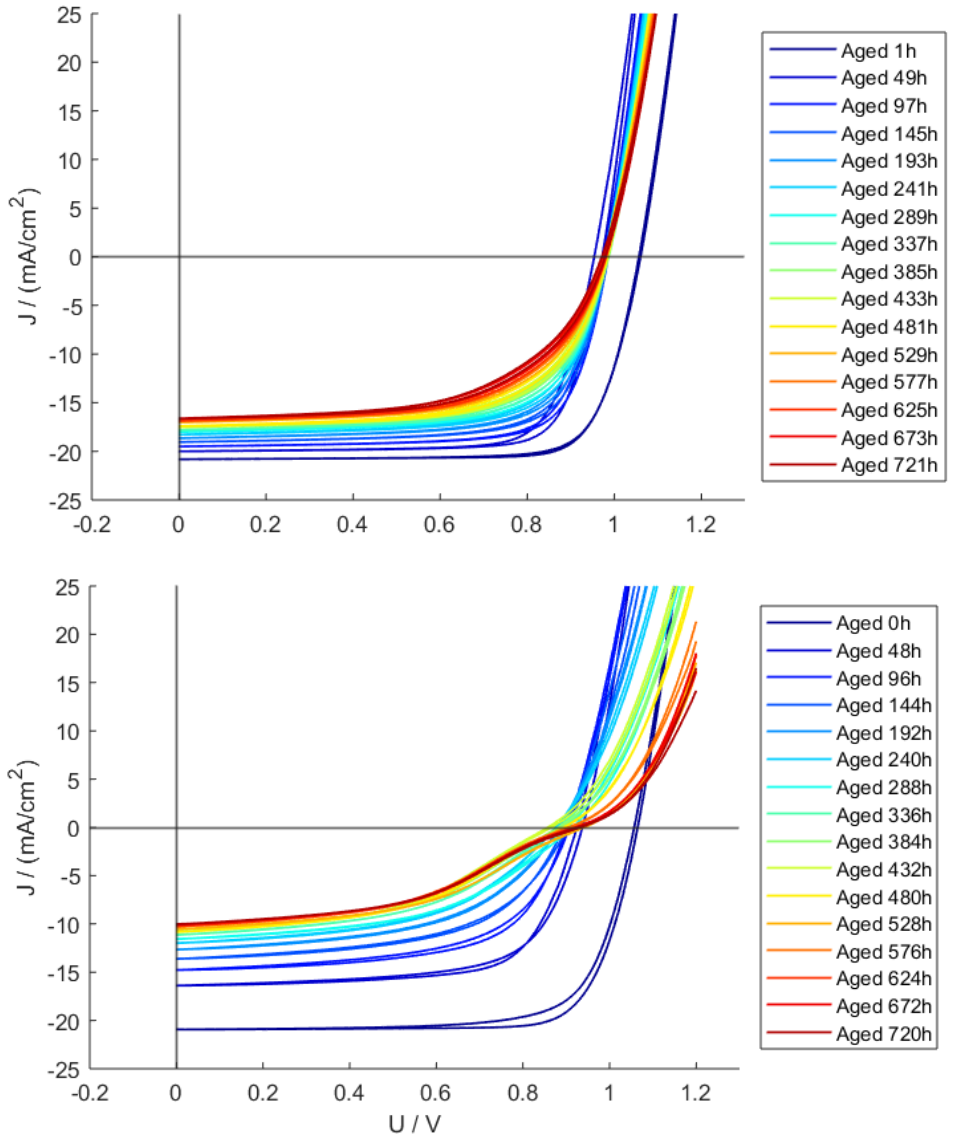
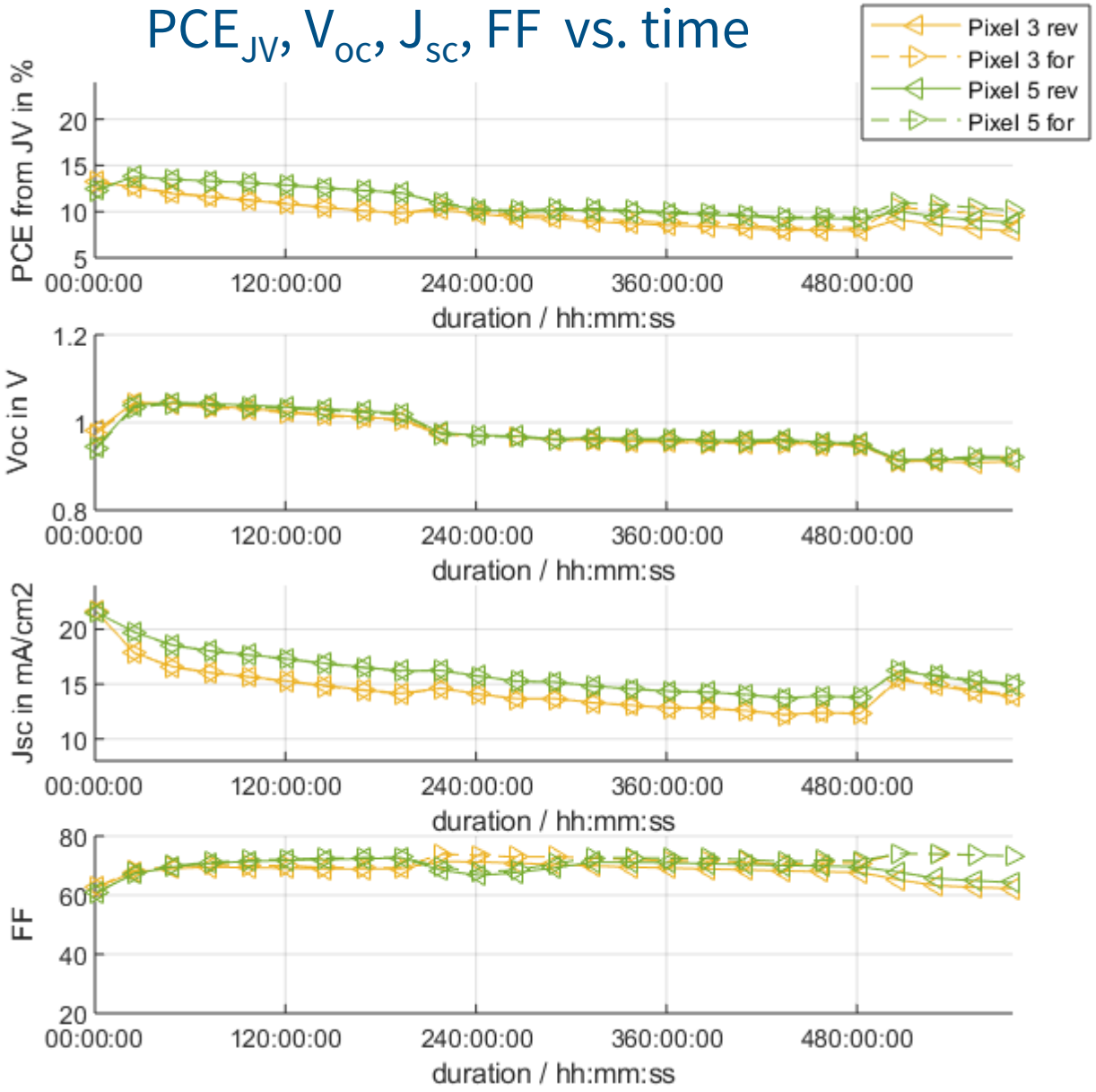
Stacked JV



PCE_{JV}, V_{oc}, J_{sc}, FF vs. time



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nature energy

CONSENSUS STATEMENT

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OPEN

Consensus statement for stability assessment and reporting for perovskite photovoltaics based on ISOS procedures

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M. V Khenkin et al., “Consensus statement for stability assessment and reporting for perovskite photovoltaics based on ISOS procedures,” Nat. Energy, vol. 5, no. 1, pp. 35–49, 2020.

17 OF 34 ISOS-PROTOCOLS ACCESSED

Table 1 | Overview of existing ISOS protocols and suggested additional protocols that account for the properties of perovskite materials and devices

Test ID	Light source	Temperature	Rel. humidity		Environment/Set-up	Characterization light source	Load
Dark storage (ISOS-D)							
ISOS-D-1	None	Ambient (23 ± 4 °C)	Ambient	✓	Ambient air	Solar simulator or sunlight	OC
ISOS-D-2	None	65, 85 °C	Ambient	✓	Oven, ambient air	Solar simulator	OC
ISOS-D-3	None	65, 85 °C	85%	✓	Env. chamber	Solar simulator	OC
Bias stability (ISOS-V)							
ISOS-V-1	**None**	**Ambient (23 ± 4 °C)**	**Ambient**	✓	**Ambient air**	**Solar simulator**	**Positive: V_{MPP}; V_{OC}; E_g/q; J_{SC} Negative: $-V_{OC}$, J_{MPP}[a]**
ISOS-V-2	**None**	**65, 85 °C**	**Ambient**	✓	**Oven, ambient air**	**Solar simulator**	
ISOS-V-3	**None**	**65, 85 °C**	**85%**	✓	**Env. chamber**	**Solar simulator**	
Light-soaking (ISOS-L)							
ISOS-L-1	Solar simulator	Ambient (23 ± 4 °C)	Ambient	✓	Light only	Solar simulator	MPP or OC
ISOS-L-2	Solar simulator	65, 85 °C	Ambient	✓	Light & temperature	Solar simulator	MPP or OC
ISOS-L-3	Solar simulator	65, 85 °C	~50%	✓	Light, temperature & RH	Solar simulator	MPP
Outdoor stability (ISOS-O)							
ISOS-O-1	Sunlight	Ambient	Ambient	✓	Outdoor	Solar simulator	MPP or OC
ISOS-O-2	Sunlight	Ambient	Ambient	✓	Outdoor	Sunlight	MPP or OC
ISOS-O-3	Sunlight	Ambient	Ambient	✓	Outdoor	Sunlight and Solar simulator	MPP
Thermal cycling (ISOS-T)							
ISOS-T-1	None	RT to 65, 85 °C	Ambient	✓	Hot plate/ oven	Solar simulator	OC
ISOS-T-2	None	RT to 65, 85 °C	Ambient	✓	Oven/env. chamber	Solar simulator	OC
ISOS-T-3	None	−40 to + 85 °C	< 55%[b]		Env. chamber	Solar simulator	OC
Light cycling (ISOS-LC)							
ISOS-LC-1	**Solar simulator/ Dark Cycle period: 2, 8, or 24 h Duty cycle: 1:1 or 1:2**	**Ambient (23 ± 4 °C)**	**Ambient**	✓	**Light only**	**Solar simulator**	**MPP or OC**
ISOS-LC-2		**65, 85 °C**	**Ambient**	✓	**Light & temperature**	**Solar simulator**	**MPP or OC**
ISOS-LC-3		**65, 85 °C**	**< 50%**	✓	**Light, temperature & RH**	**Solar simulator**	**MPP**
Solar-thermal cycling (ISOS-LT)							
ISOS-LT-1	Solar simulator	Linear or step ramping between room temp. and 65 °C	Monitored, uncontrolled	✓	Weathering chamber	Solar simulator	MPP or OC
ISOS-LT-2	Solar simulator	Linear ramping between 5 °C and 65 °C	Monitored, controlled at 50% beyond 40 °C		Env. chamber with sun simulator	Solar simulator	MPP or OC
ISOS-LT-3	Solar simulator	Linear ramping between −25 °C and 65 °C	Monitored, controlled at 50% beyond 40 °C		Env. chamber with sun simulator and freezing	Solar simulator	MPP or OC

M. V Khenkin et al., "Consensus statement for stability assessment and reporting for perovskite photovoltaics based on ISOS procedures," Nat. Energy, vol. 5, no. 1, pp. 35–49, 2020.

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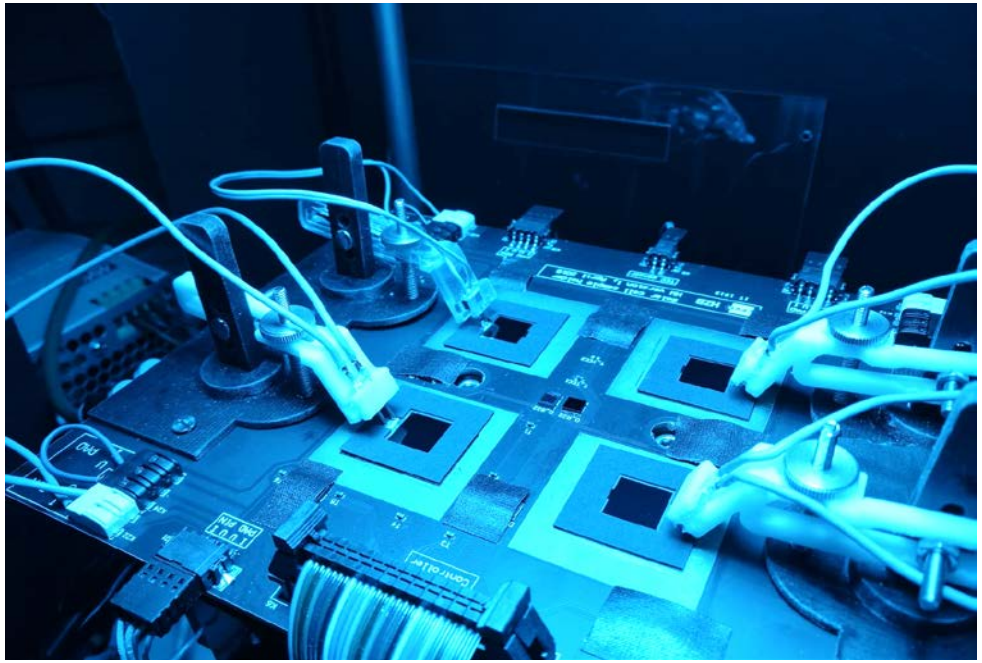
Bor Li

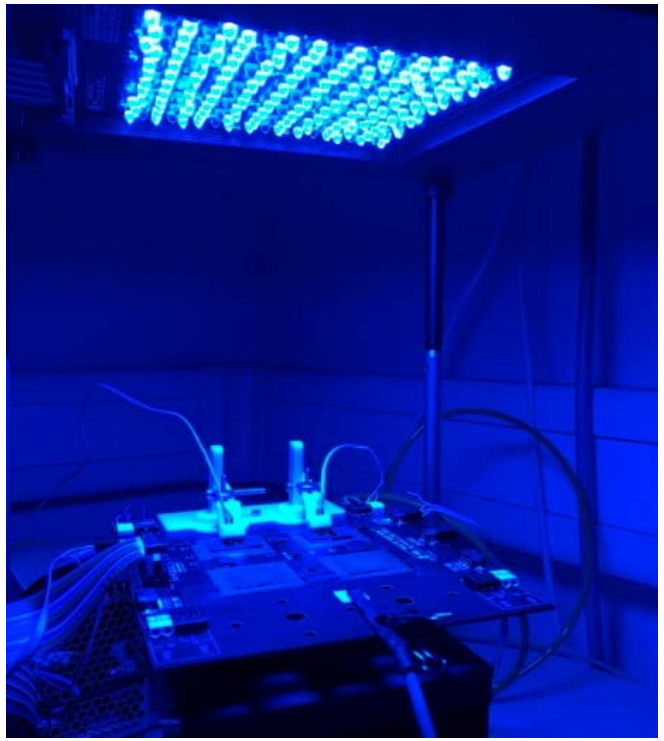
TARIS - FEATURES

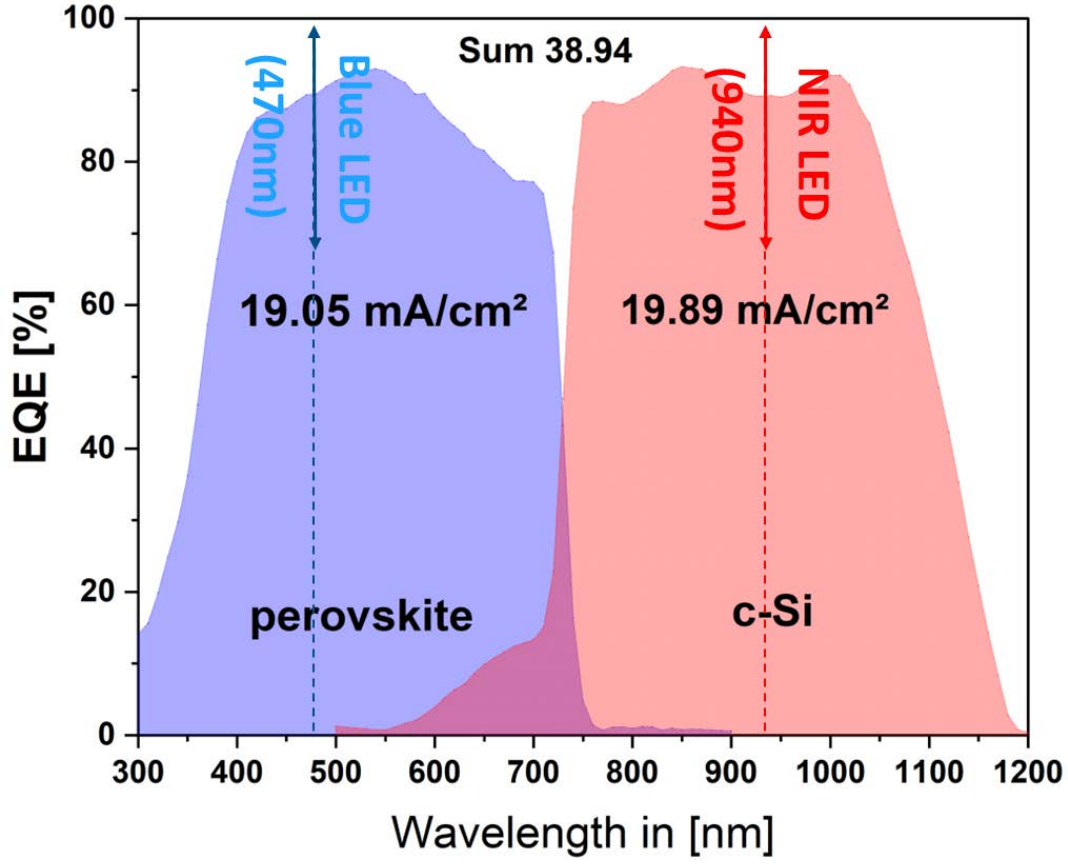
- long-term MPP tracking
- up to 20 tandem devices
- illumination area of 7.5cm x 7.5cm
- sample temperature 25-65 °C
- air or N_2

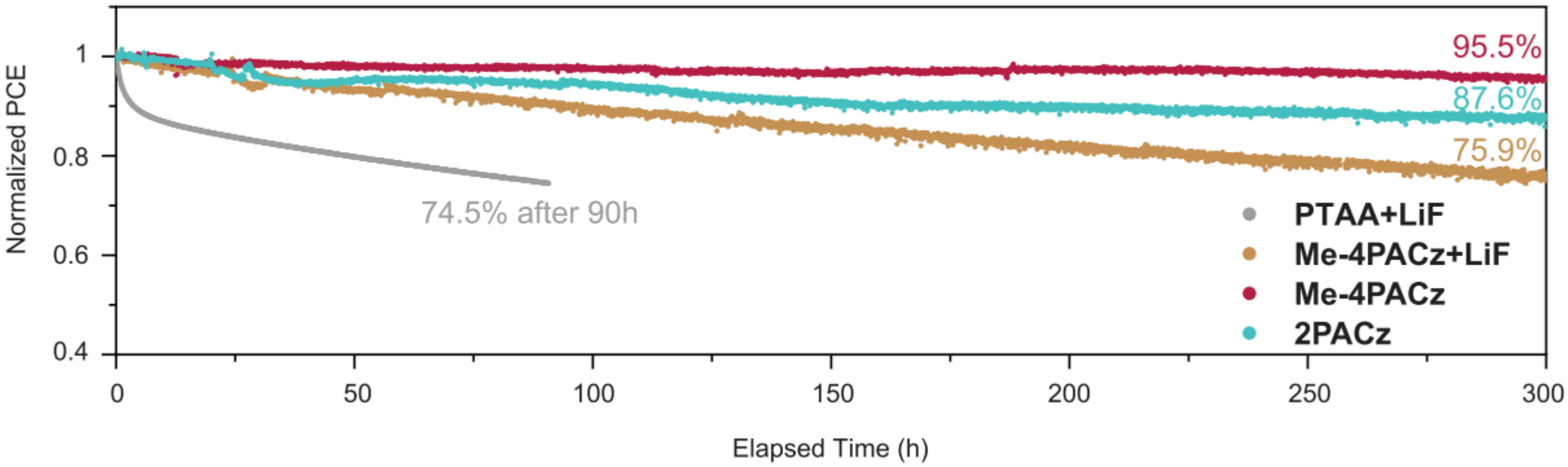


TUNEABLE LIGHT SOURCE

- independent tuning of blue and red LED array
- simulate different spectral conditions
- age bottom and top cell independently







Al-Ashouri, A. *et al.* Monolithic perovskite/silicon tandem solar cell with 29% efficiency by enhanced hole extraction. *Science (80-.).* **370**, 1300–1309 (2020).

THANK YOU FOR YOUR ATTENTION!

APPLY FOR ACCESS!

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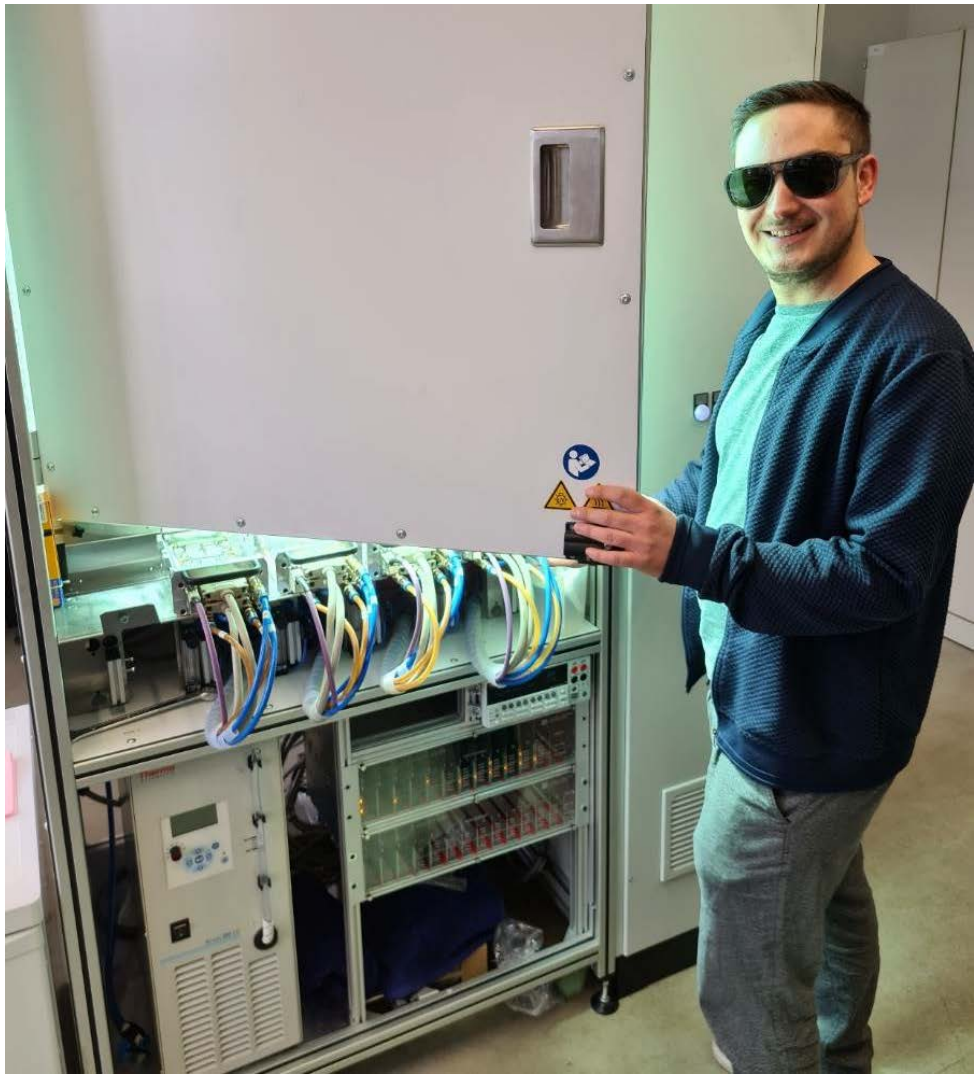

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