

SUPSI

Pre-normative characterization of multi-junction photovoltaic modules

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Workshop | Lifetime and Reliability Issues in PV | Thursday 10 Sep 2015

SUPSI: supporting PV innovation



**TISO 10 kW:
1° grid-connected PV system in EU**



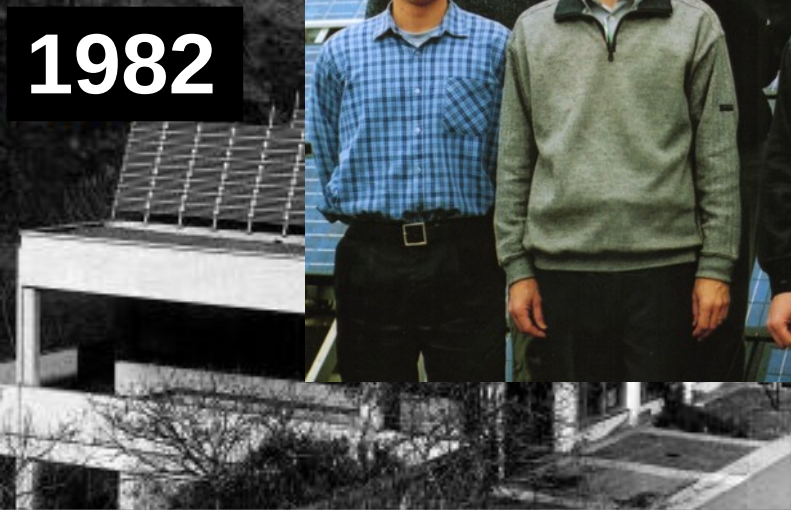
SUPSI: supporting PV innovation

1992



Outdoor testing

1982



TISO:
1° grid-connected PV system in EU

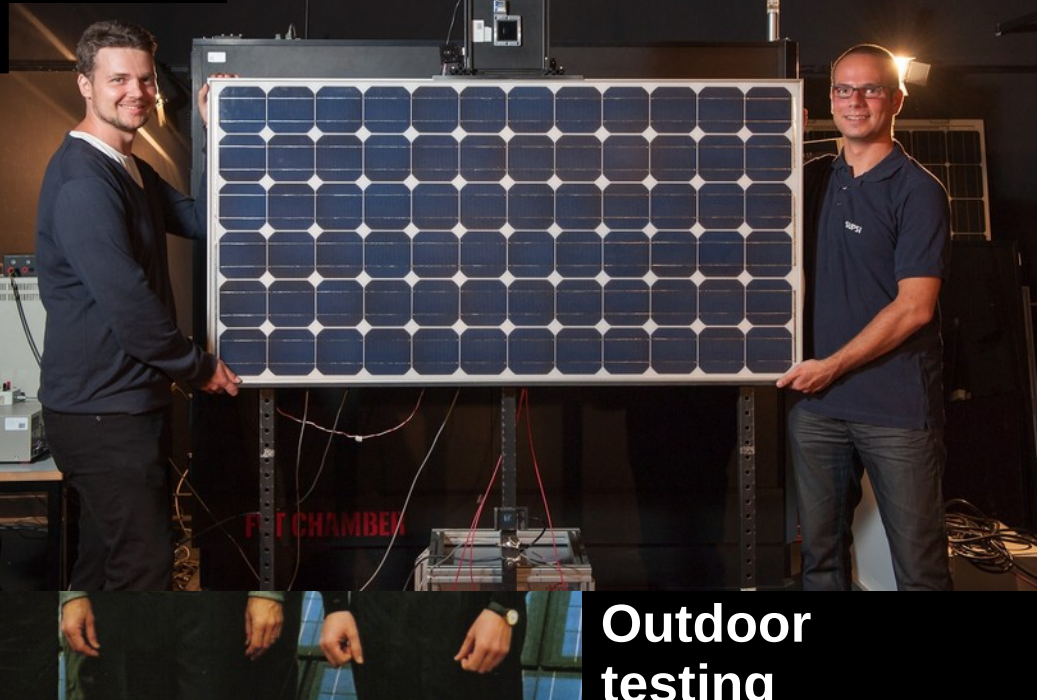


SUPSI: supporting PV innovation

1992



2000



Indoor testing

Outdoor testing

1982



TISO:
1° grid-connected PV system in EU



SUPSI: supporting PV innovation

1992



2000



2010



ISO 17025 accreditation

Indoor testing

Outdoor testing

TISO:
1° grid-connected PV system in EU



SUPSI: supporting PV innovation

1992



2000



2010



2014

electrosuisse >>



CB Testing Laboratory

accreditation

Indoor testing

Outdoor testing

TISO:
1° grid-connected PV system in EU

TISO: 30+ years ago



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TISO: 30+ years ago



TISO: 30+ years ago

37 W_{peak} c-Si modules by ARCO Solar

module efficiency: 10%

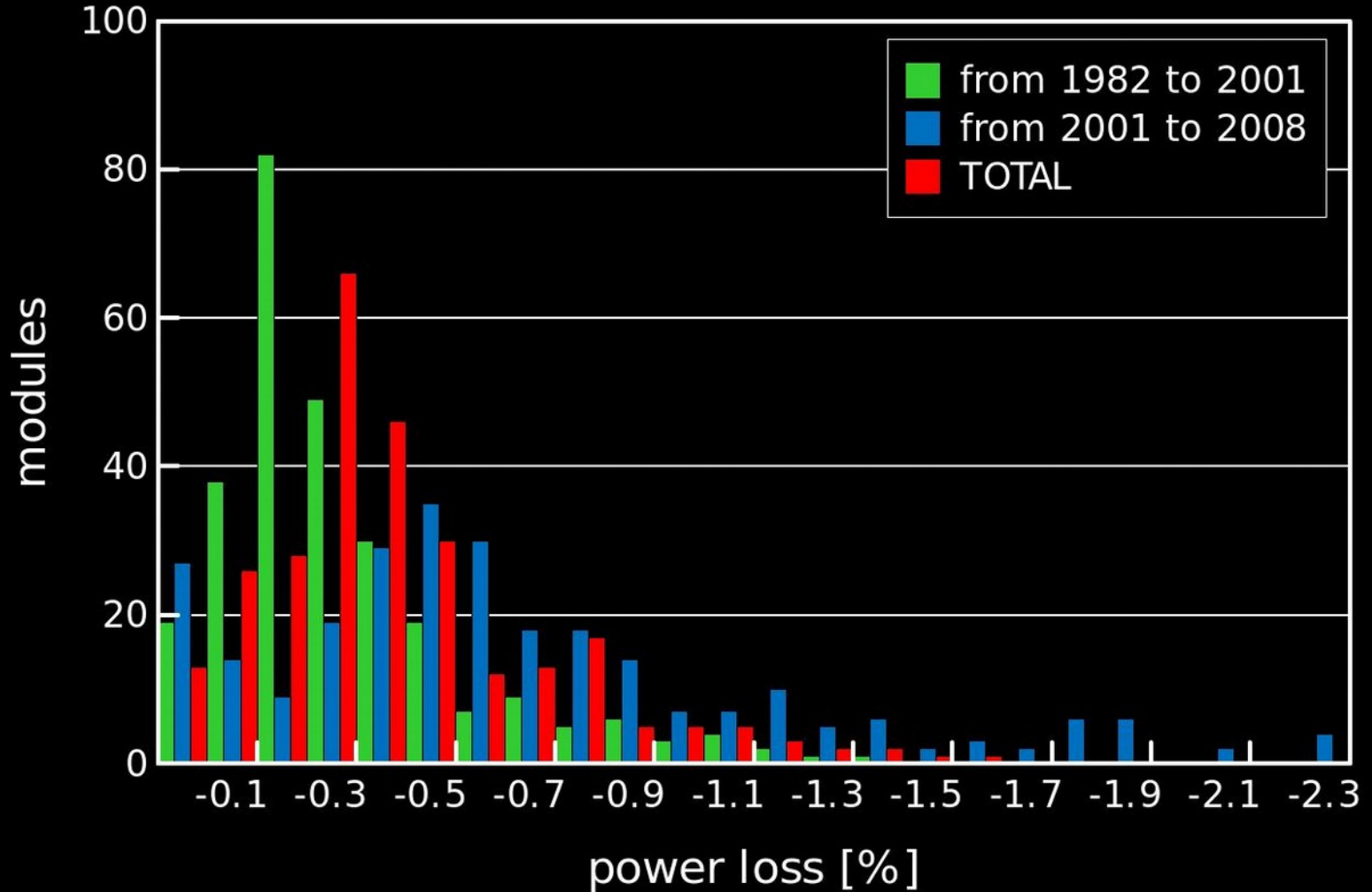
3 strings, 8×12 modules each

total: 288 modules

total power: 10.6 kW_{peak}

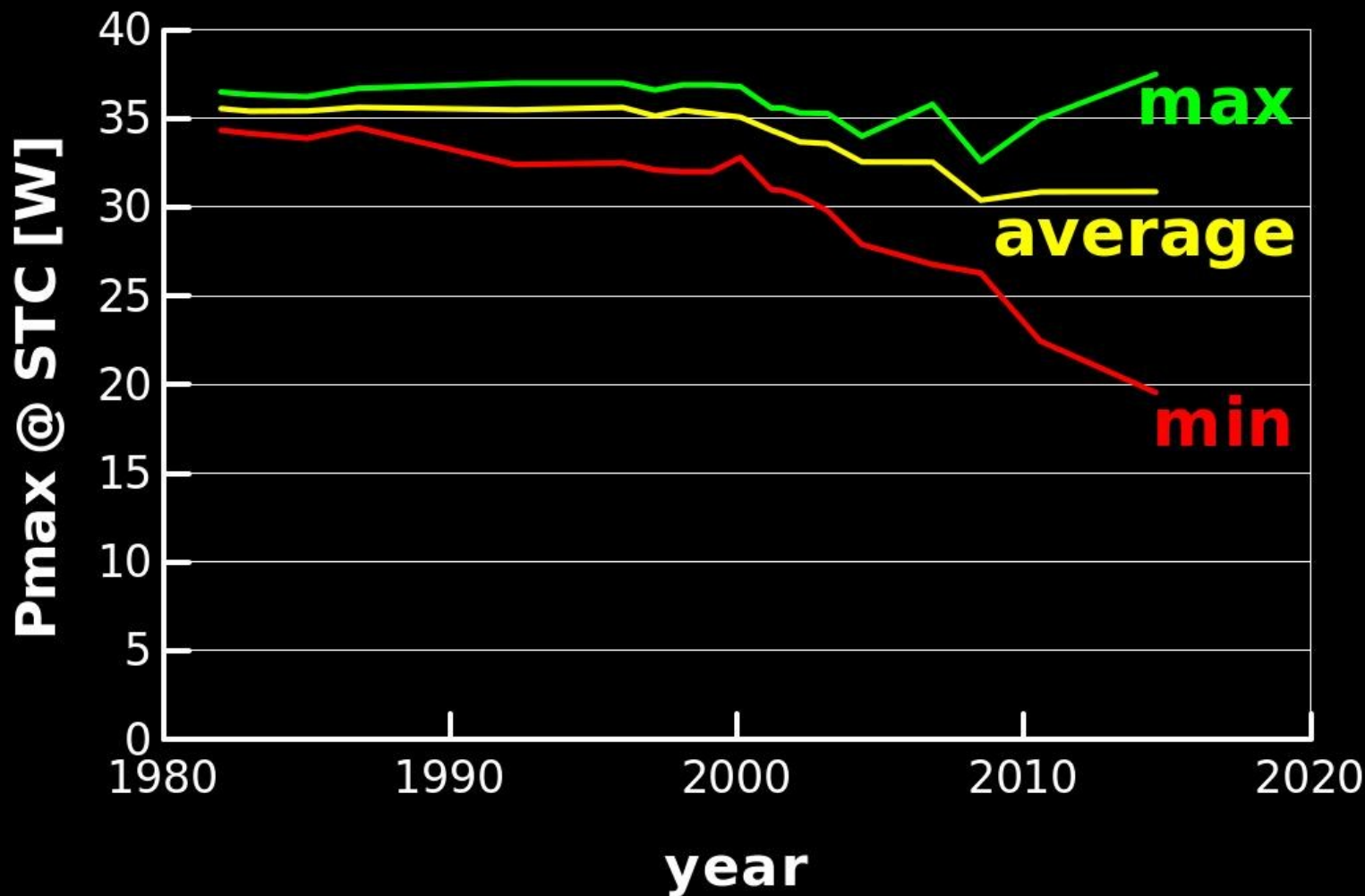


TISO: 30+ years ago



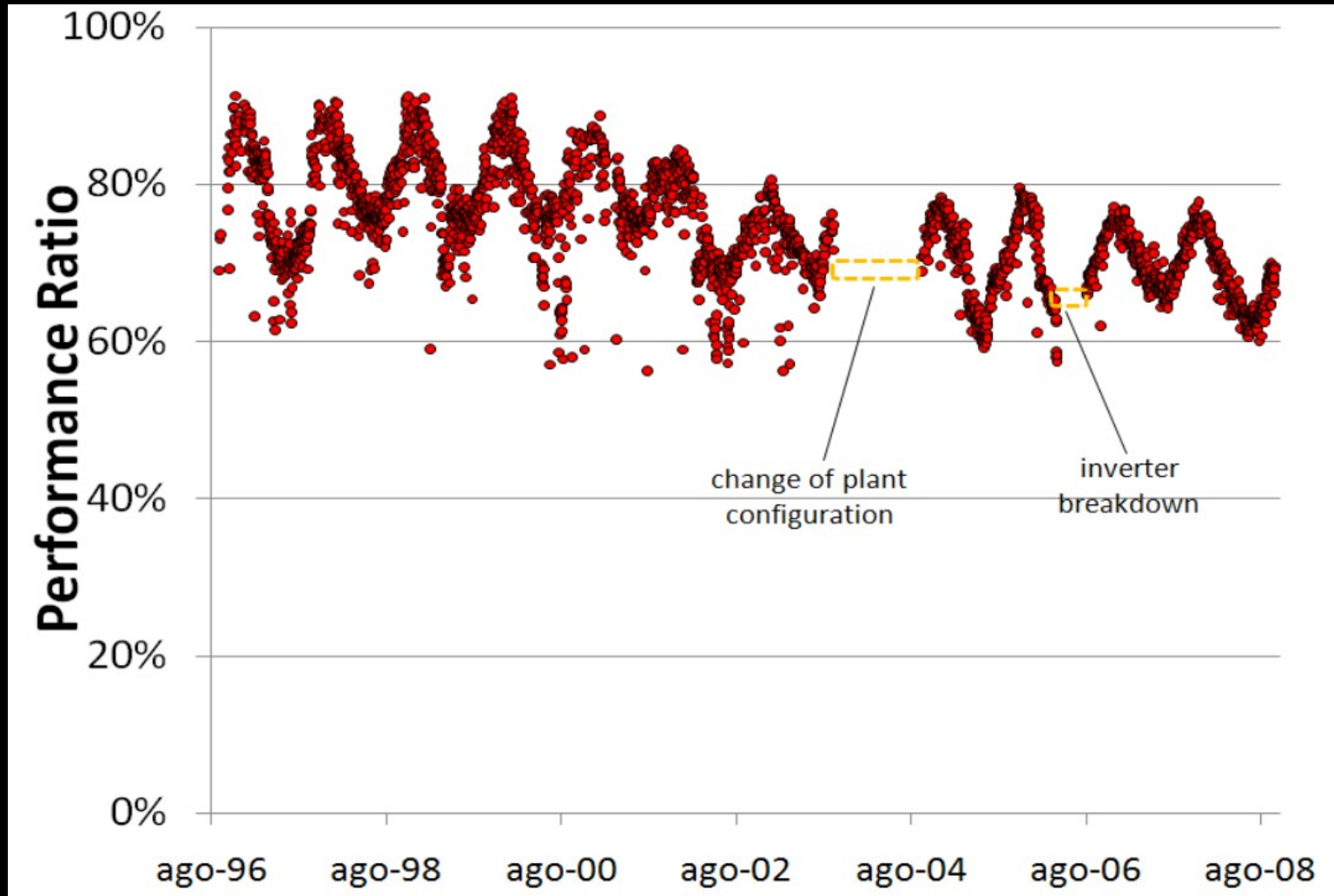
Friesen, Chianese, Realini, Friesen, Burà, Virtuani, Strepparava, Meoli, *Proc. 27th EUPVSEC (2012)*

TISO: 30+ years ago



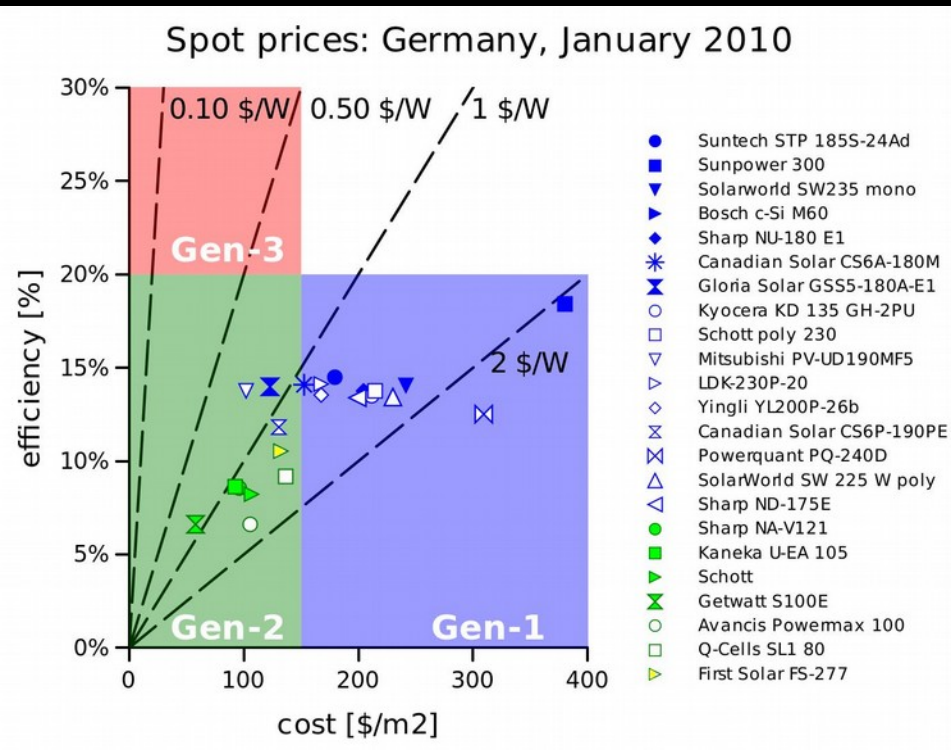
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TISO: 30+ years ago



Fanni, Realini, Burà, Chianese, *European Energy Conf.*, Barcelona (2010)

Towards new generation?

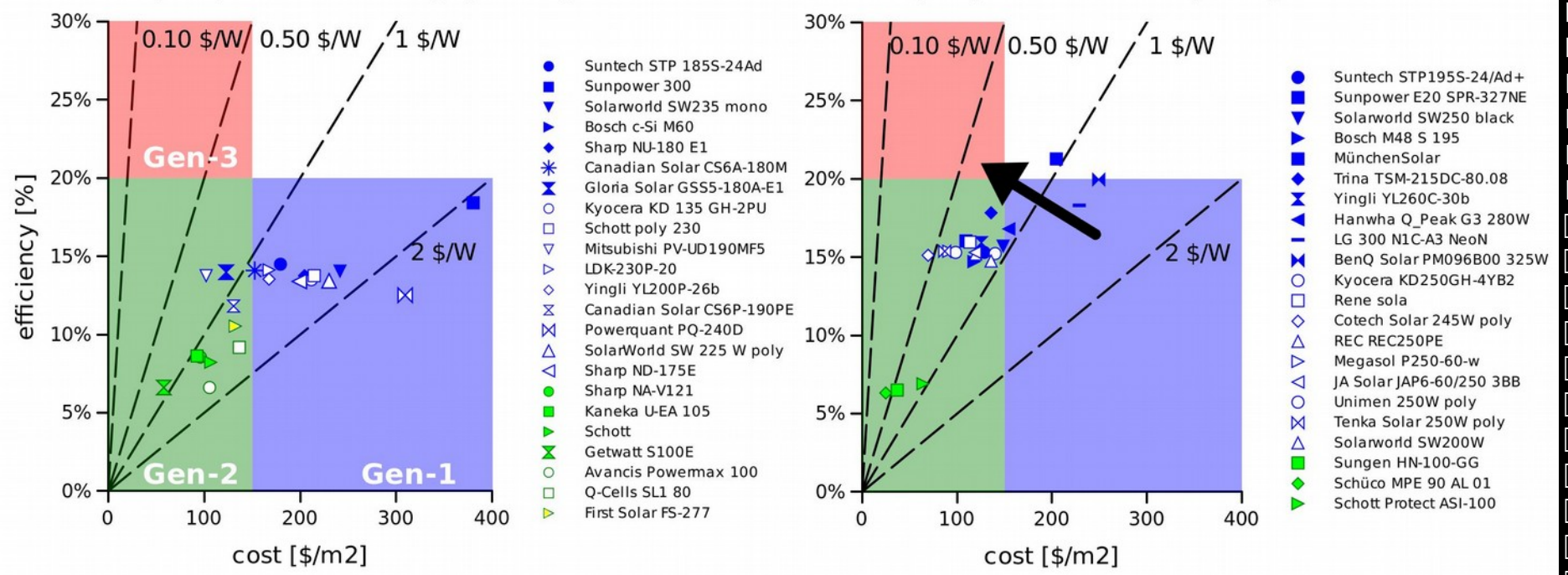


Pravettoni, Manni, Strepparava, *Coatings*, to be published

Towards new generation?

Spot prices: Germany, January 2010

Spot prices: Germany, August 2014

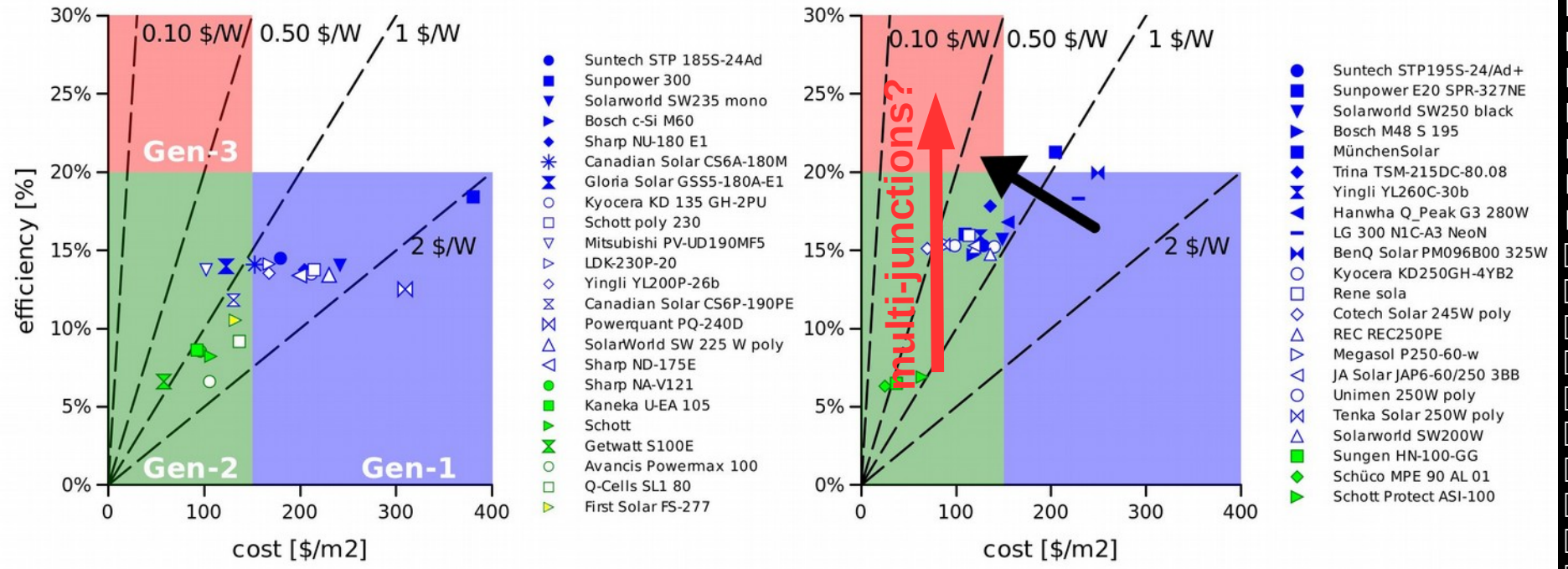


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Towards new generation?

Spot prices: Germany, January 2010

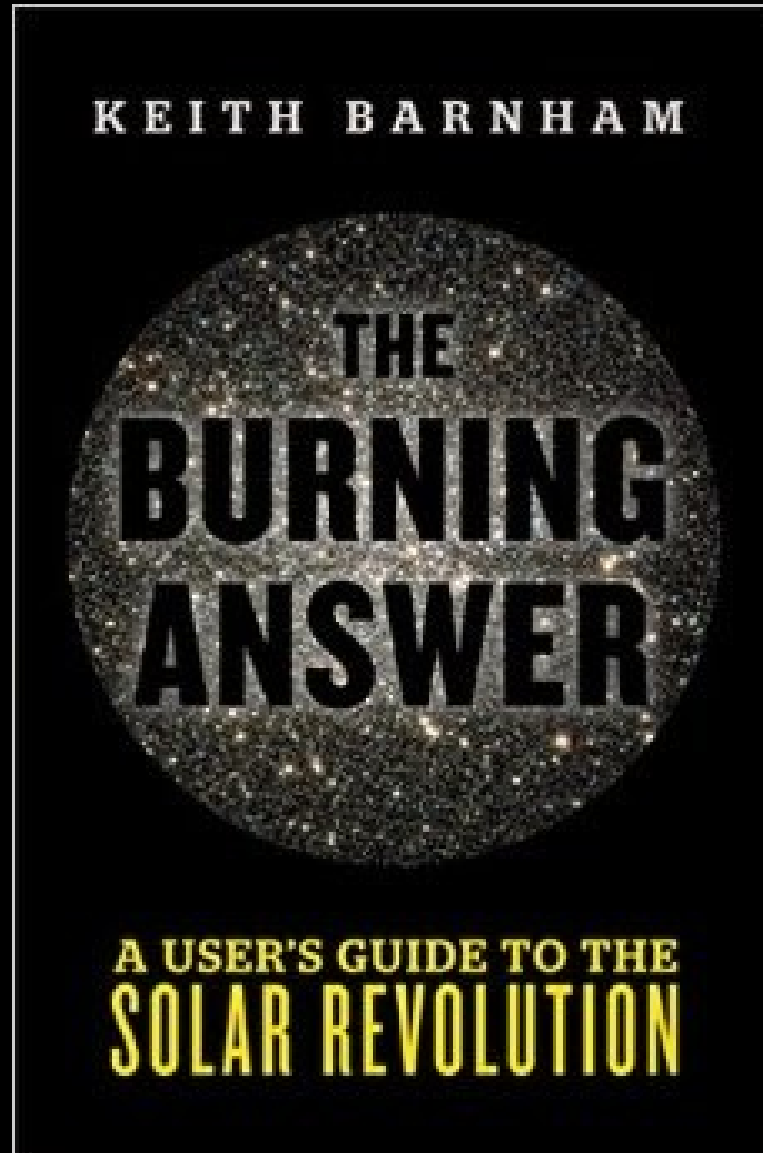
Spot prices: Germany, August 2014



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How multi-J may show
the same reliability as
the “good old silicon”?



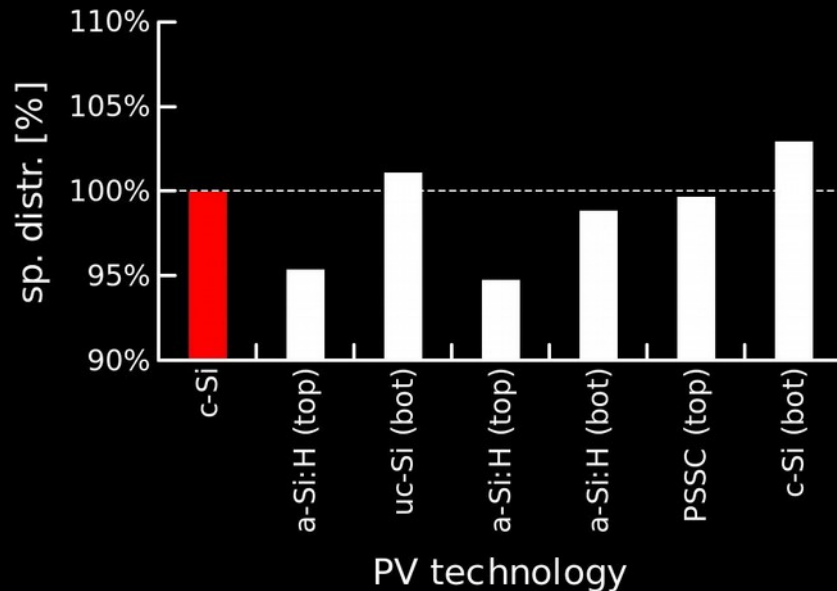
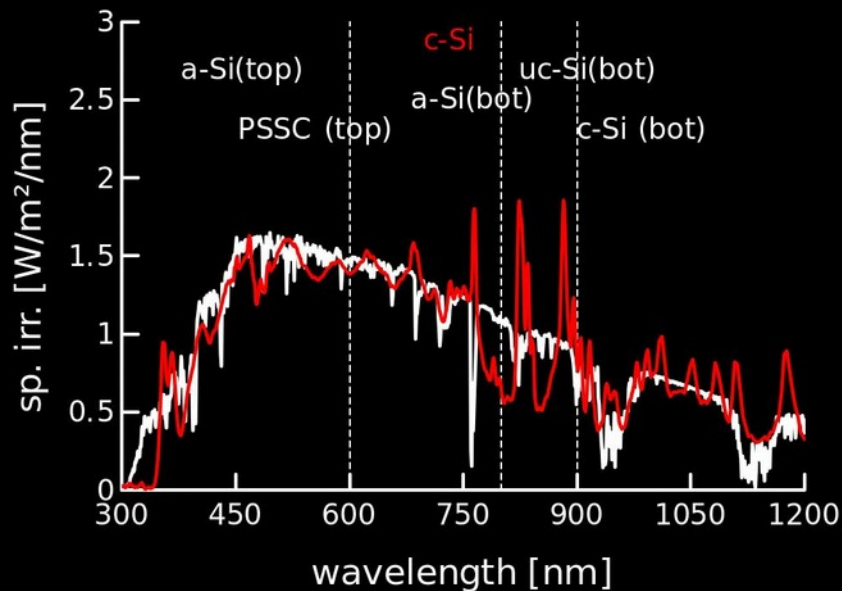


Electrical characterization of multi-junction modules

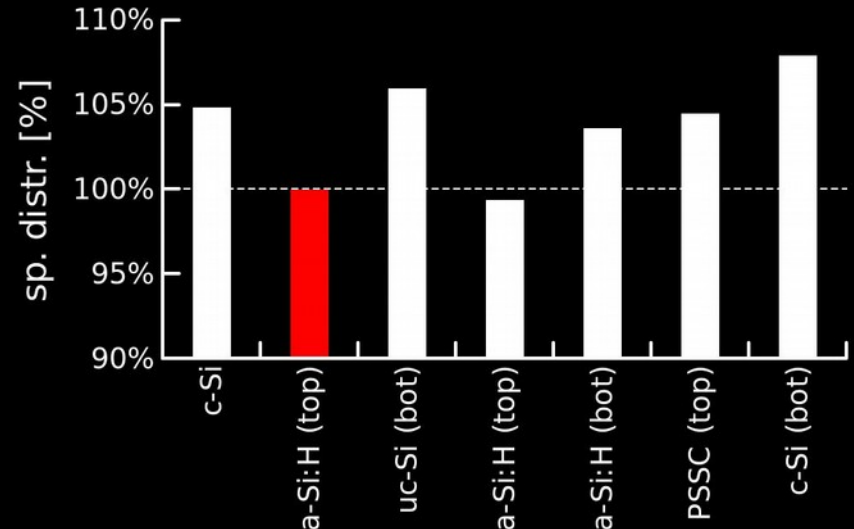
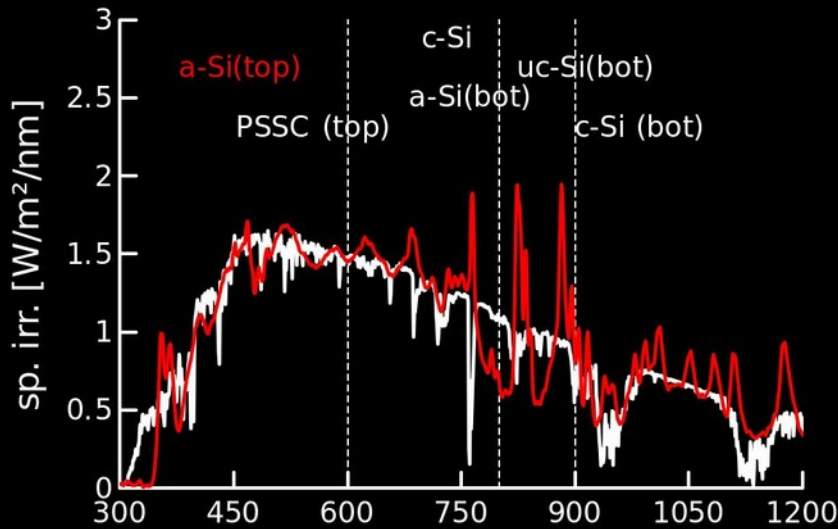
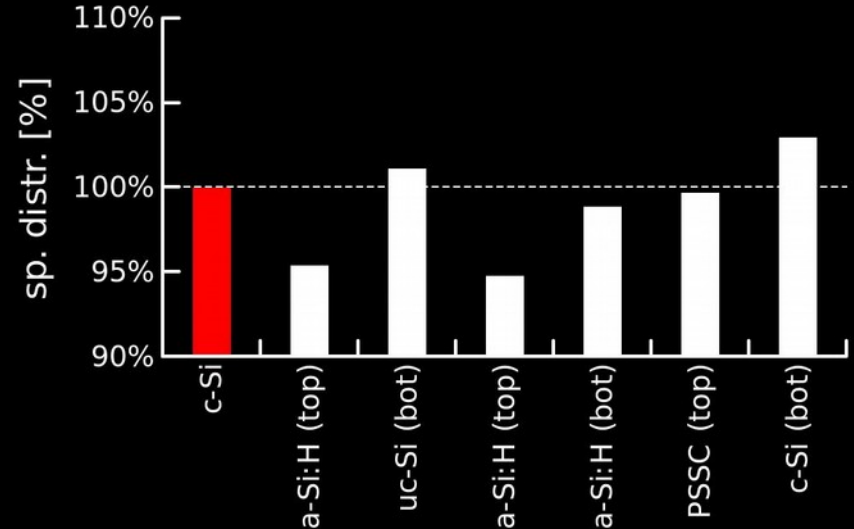
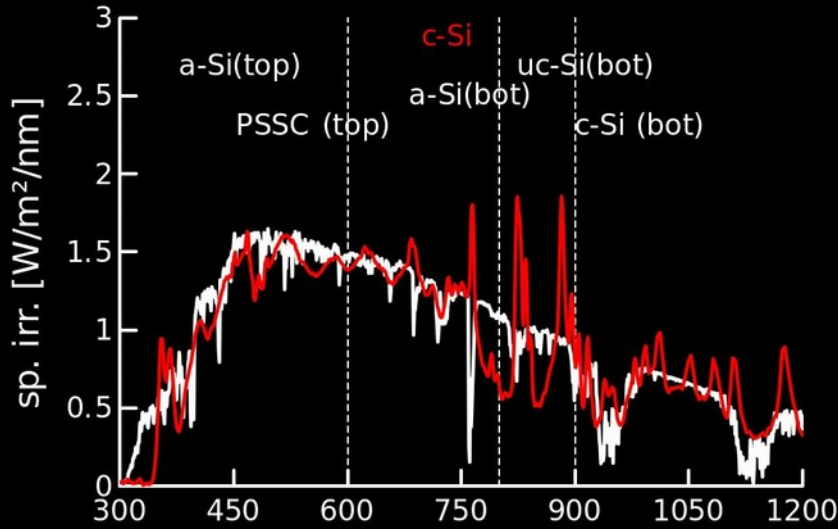
- 1) spectral responsivity measurement
- 2) best reference cell selection
- 3) calculation of the spectral mismatch
- 4) spectral tuning to decrease spectral mismatch
- 5) correction to STC



Spectral tuning: theory



Spectral tuning: theory

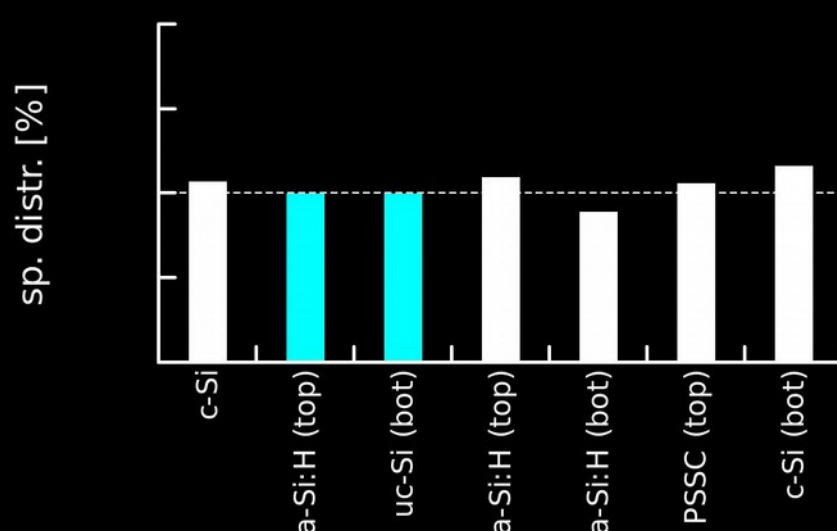
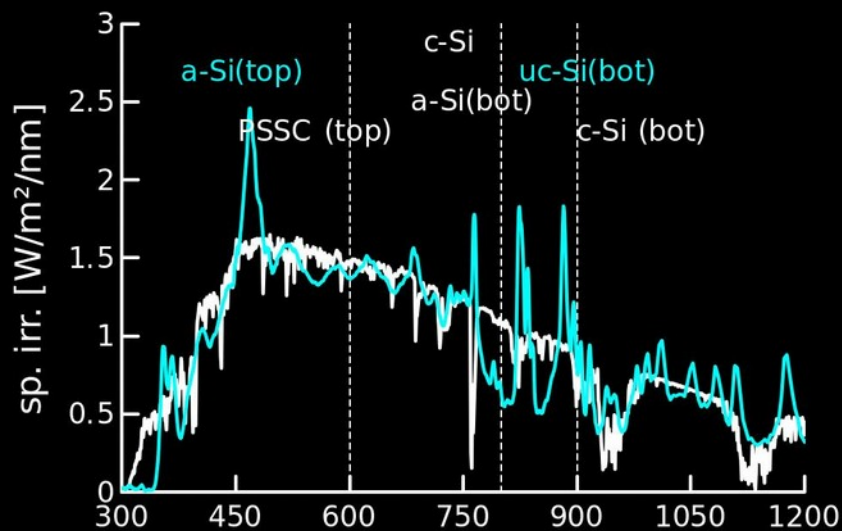
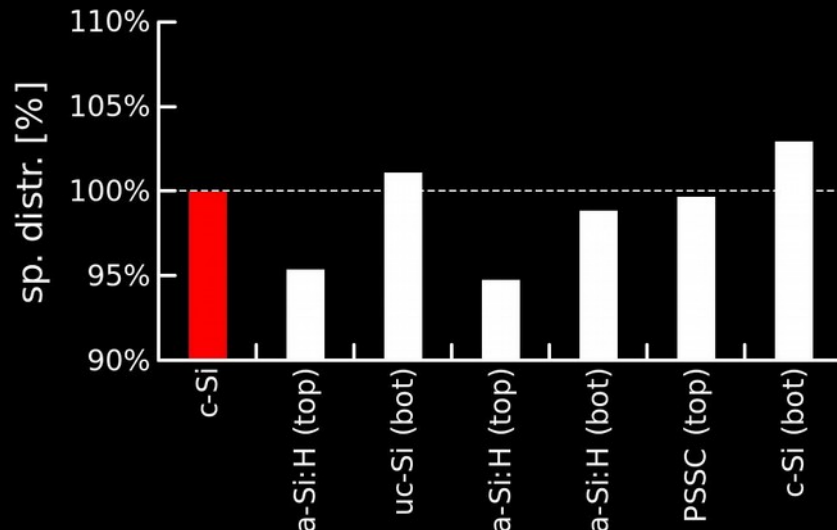
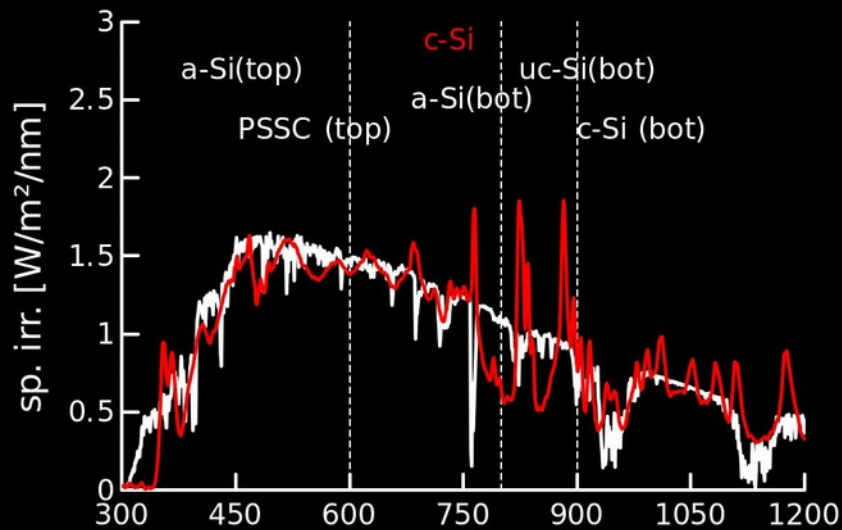


wavelength [nm]

PV technology



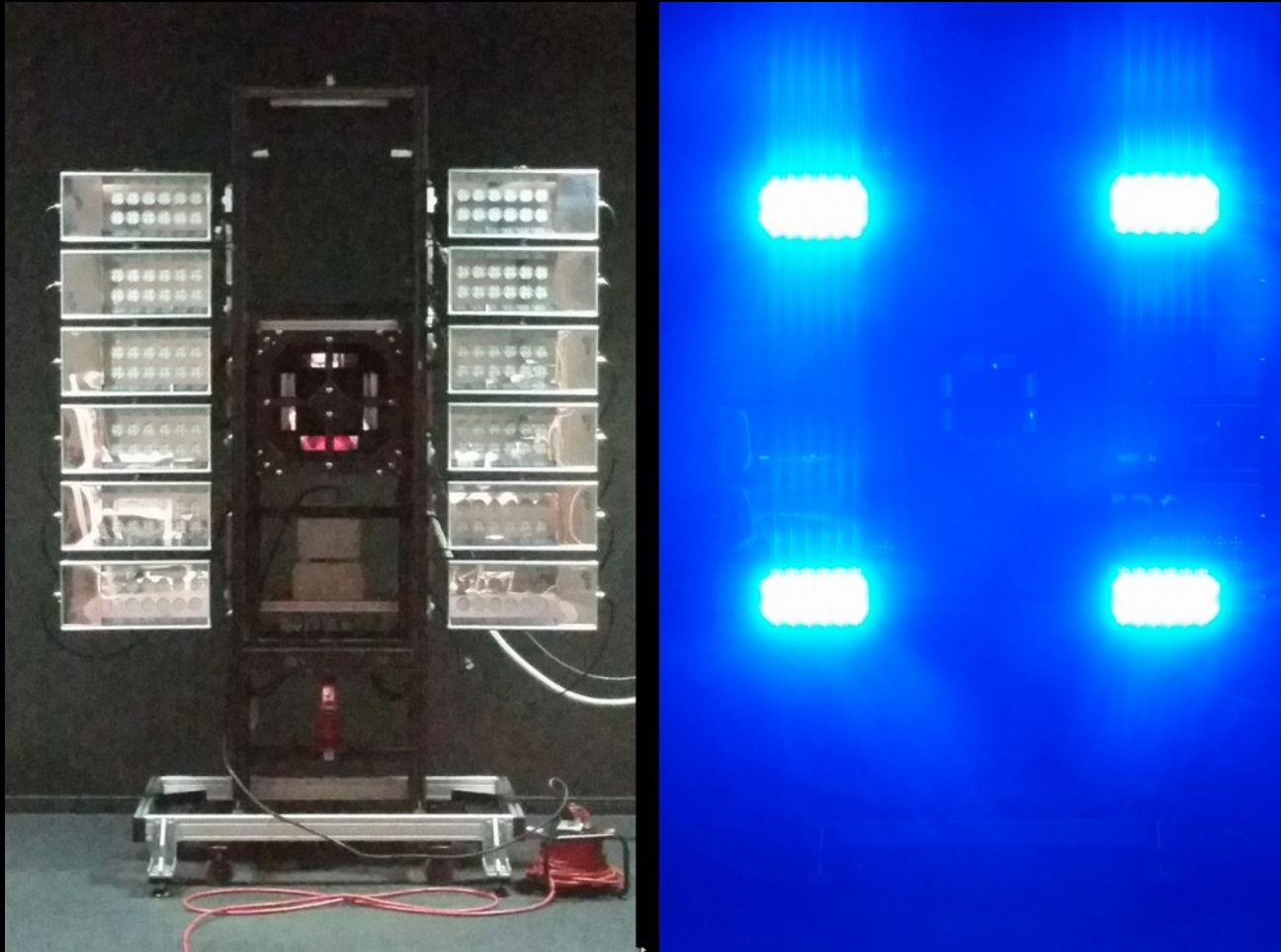
Spectral tuning: theory



PV technology



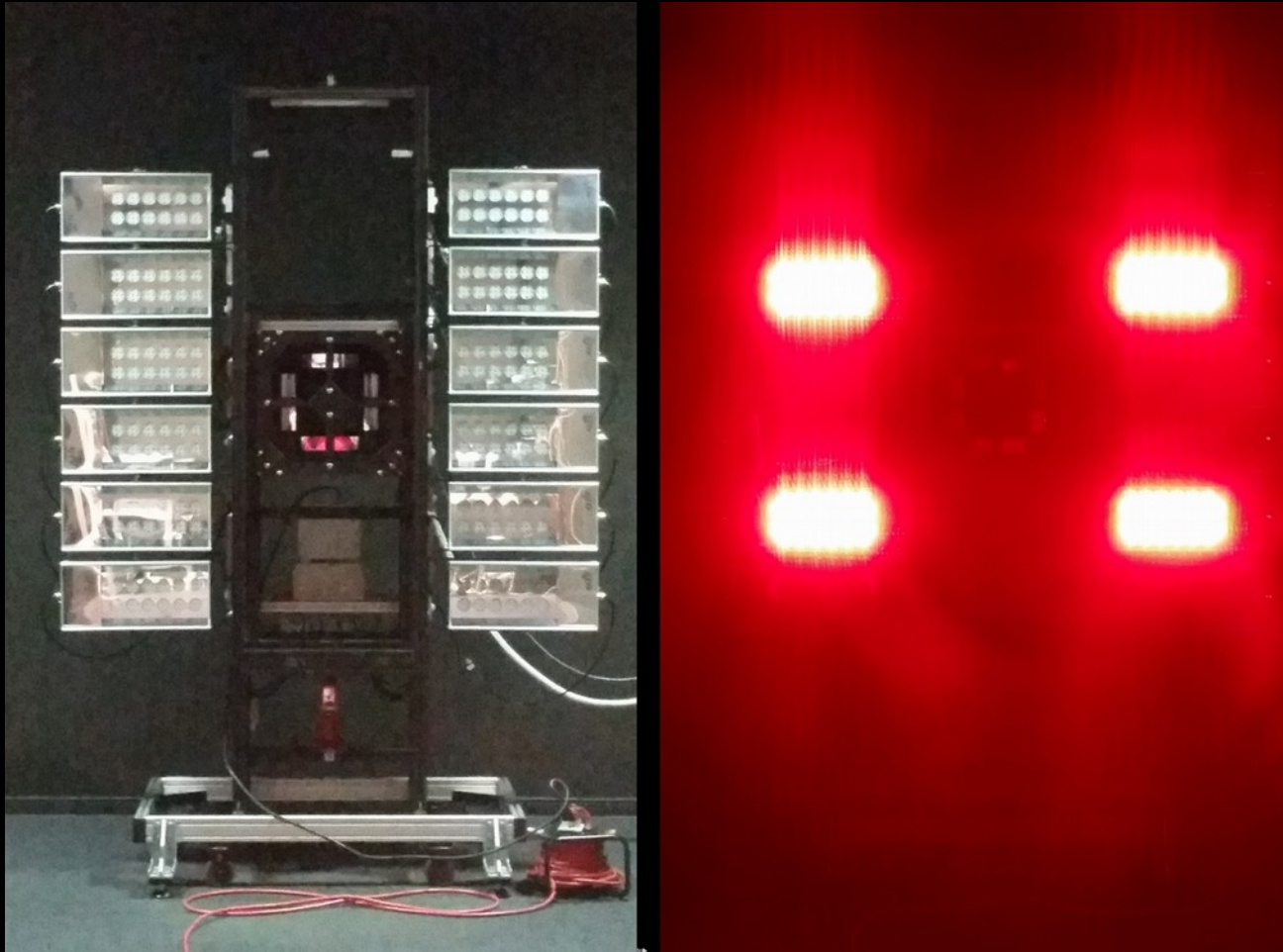
Spectral tuning for modules



Pravettoni, Manni, Dittmann, 31st EU PVSEC, Hamburg (2015)



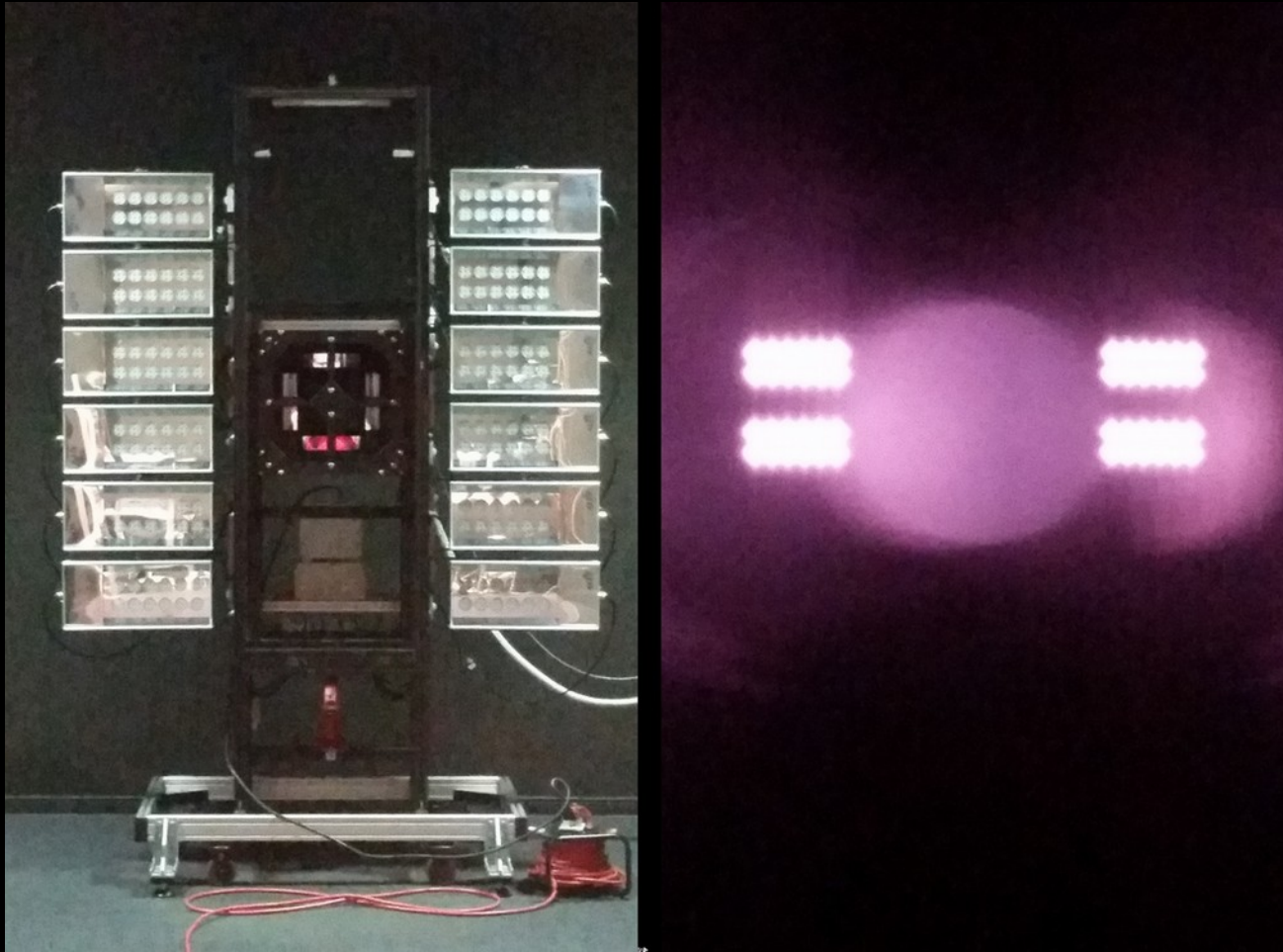
Spectral tuning for modules



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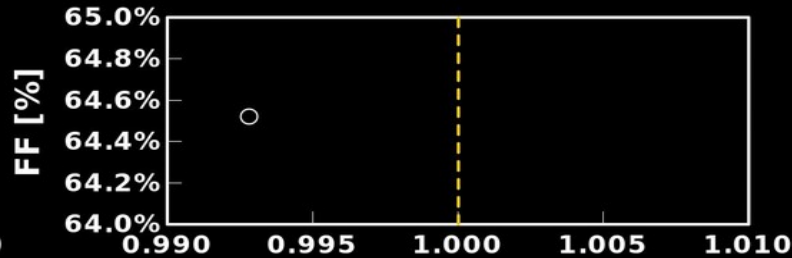
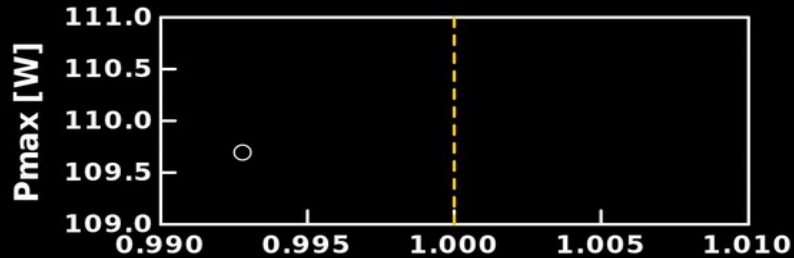
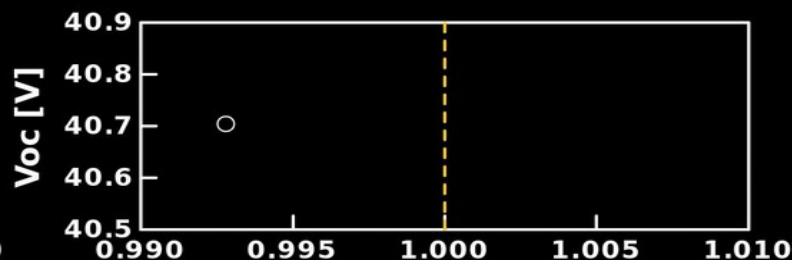
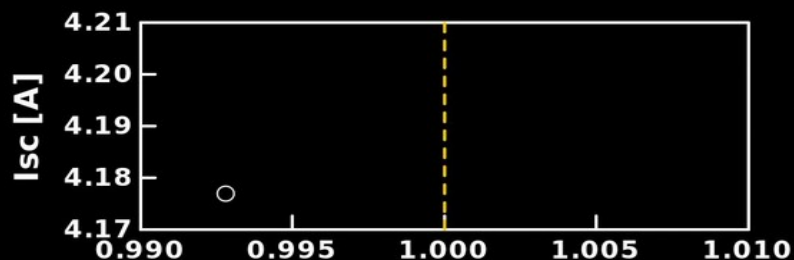
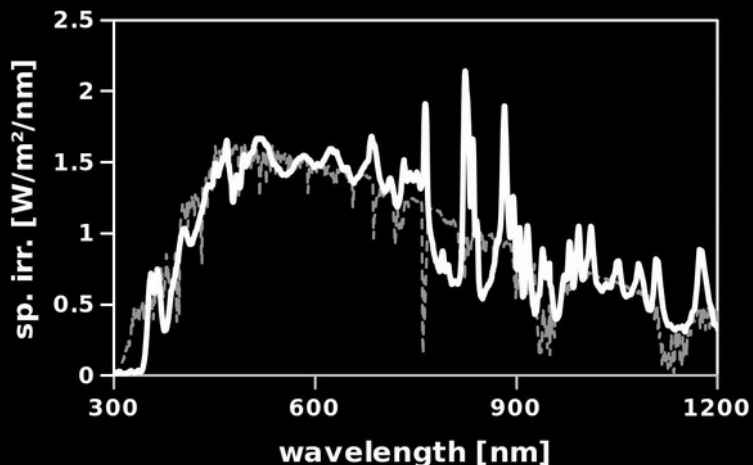
Spectral tuning for modules



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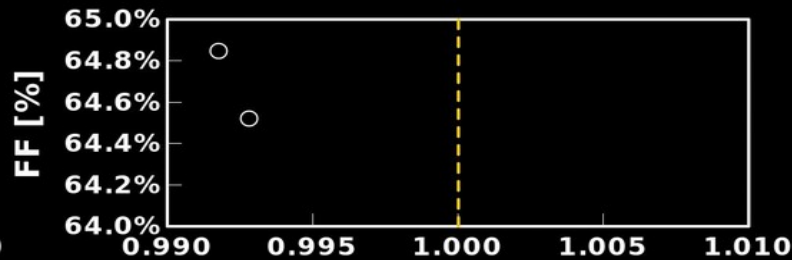
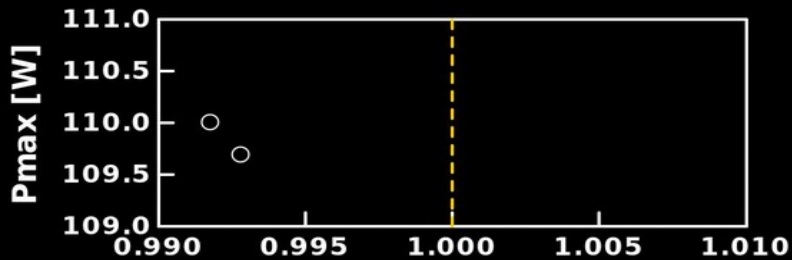
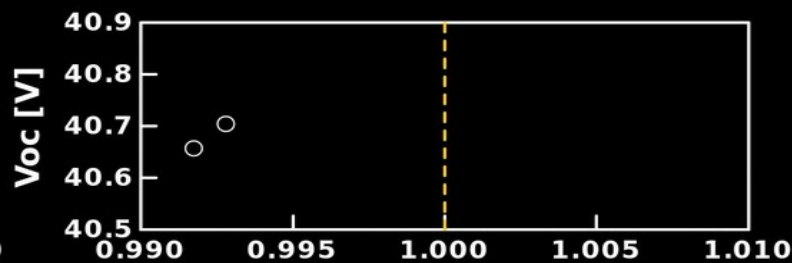
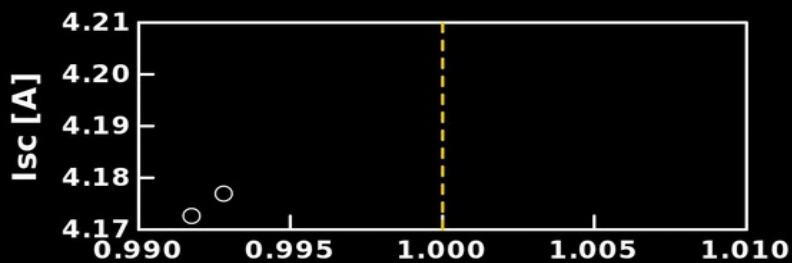
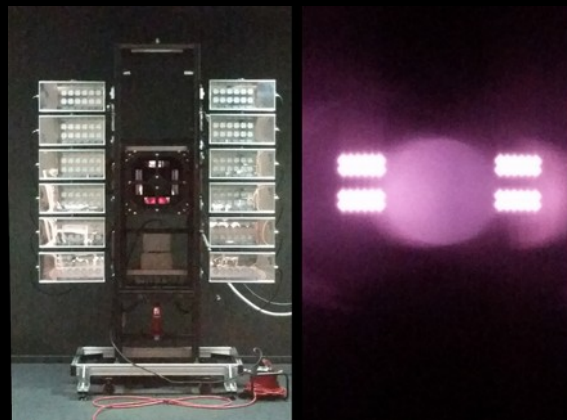
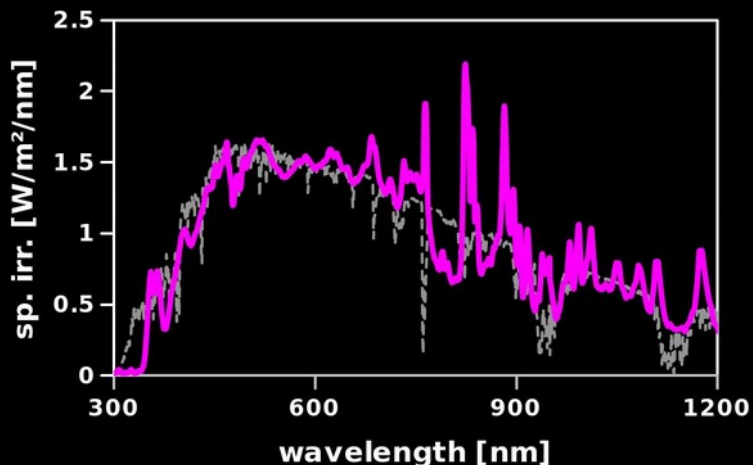
An example: a-Si:H/ μ c-Si:H



spectral mismatch

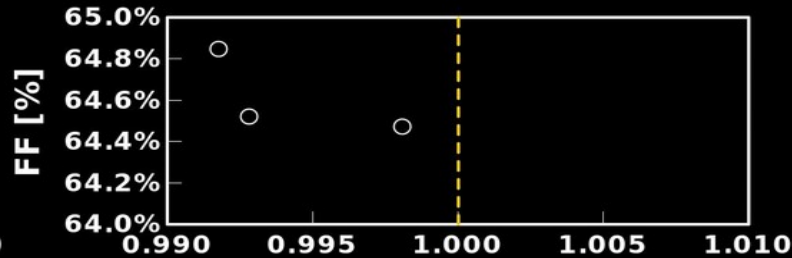
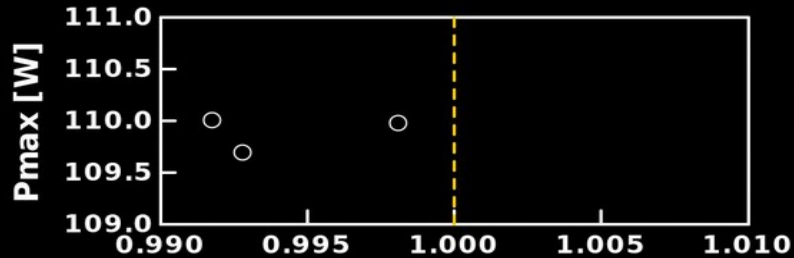
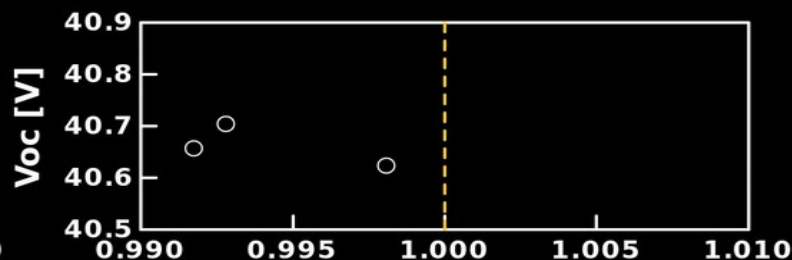
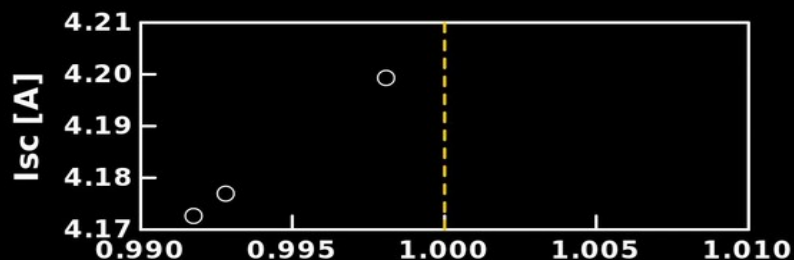
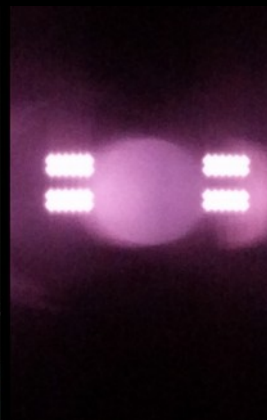
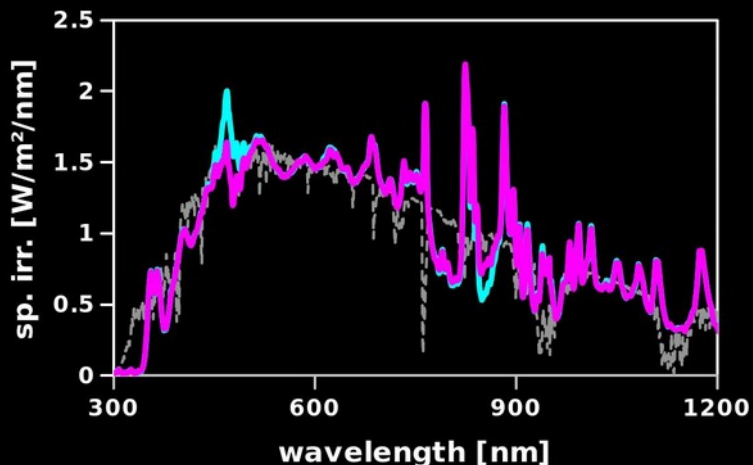


An example: a-Si:H/ μ c-Si:H



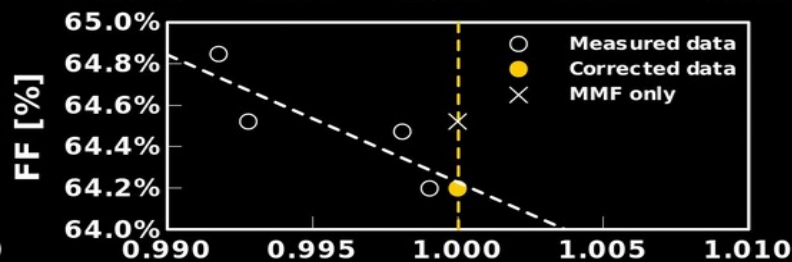
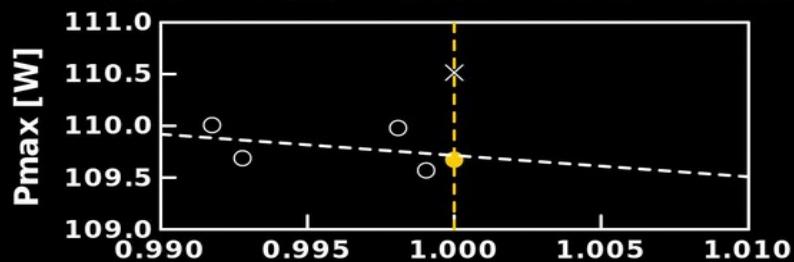
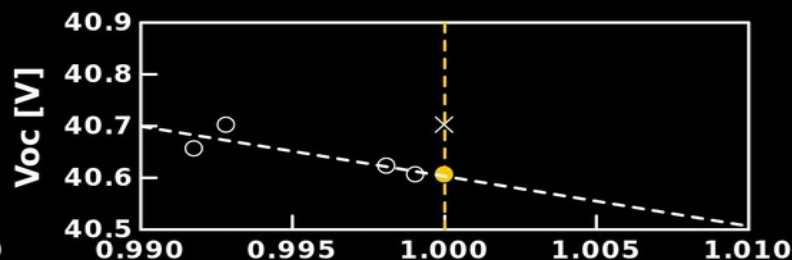
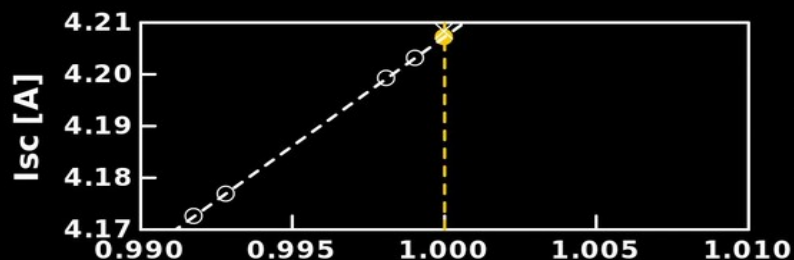
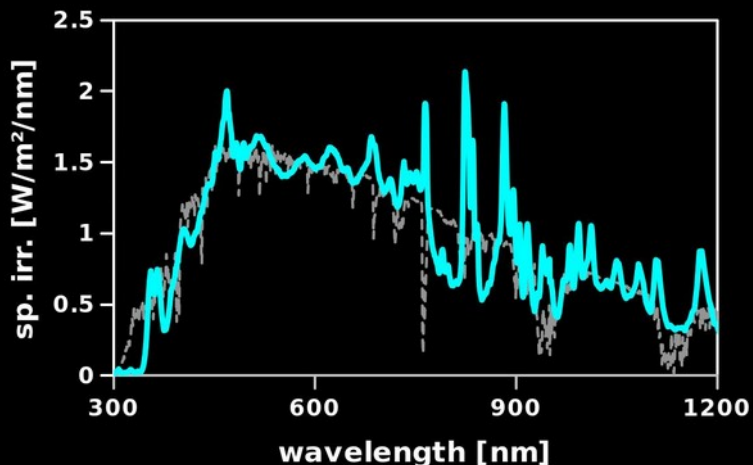
spectral mismatch

An example: a-Si:H/ μ c-Si:H



spectral mismatch

An example: a-Si:H/ μ c-Si:H



spectral mismatch

Conclusions

Multi-J may enter PV history, as TISO did

Normative activity is ongoing to improve reliability of new generation PV

Multi-J characterization has been challenging so far

Novel solutions to allow spectral tuning at module level were developed at SUPSI

Acknowledgments

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