

A model kit for measuring the energy yield of different PV systems



Zürcher Hochschule
für Angewandte Wissenschaften

zhaw School of Engineering
IEFE Institut für Energiesysteme
und Fluid-Engineering
www.ife.zhaw.ch

Dieter Werner, Julian Baugatz, Chriatian Nagel
SOLARC Innovative Solarprodukte GmbH
Glogauer Strasse 21, D - 10999 Berlin
Email: info@solarc.de

Markus Klenk*, Hartmut Nussbaumer, Jan Meister
ZHAW SoE, IEFE, Technikumstrasse 9
8401 Winterthur, Schweiz
*Email: markus.klenk@zhaw.ch

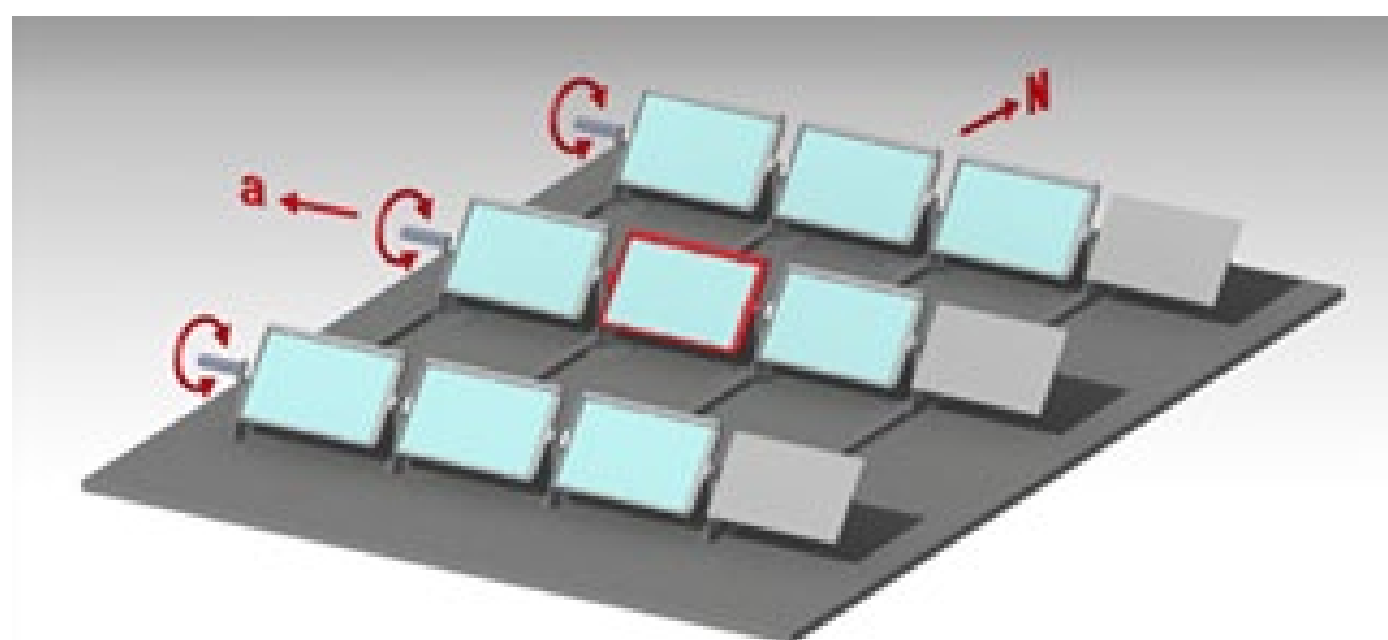
Concept

Approach

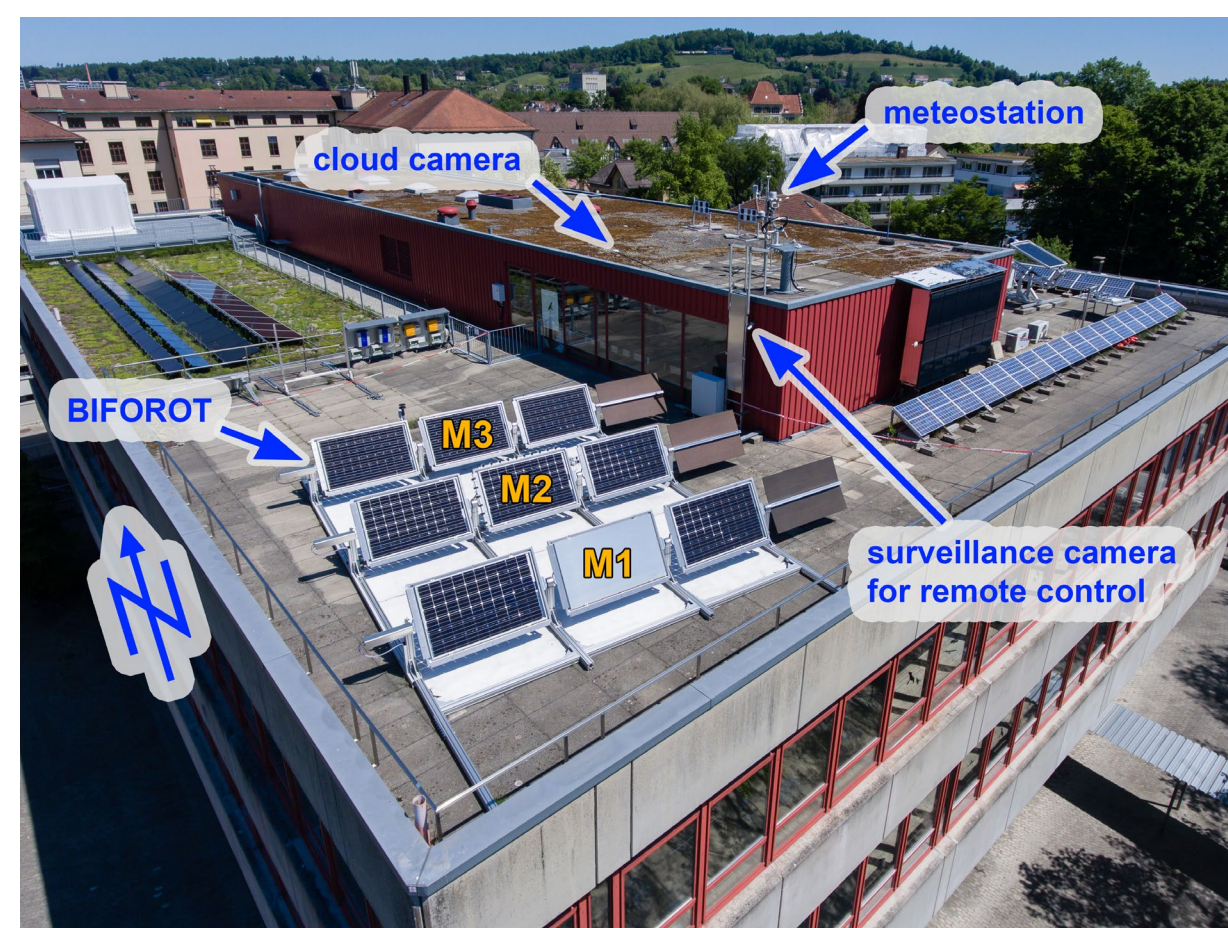
- Bifacial - Yield prediction by simulation accurate enough?
- Use test field -
- Bifacial very sensitive to changed configuration - Optimum? Comparison?
- Use miniaturized array instead of large test field?

Miniaturized array

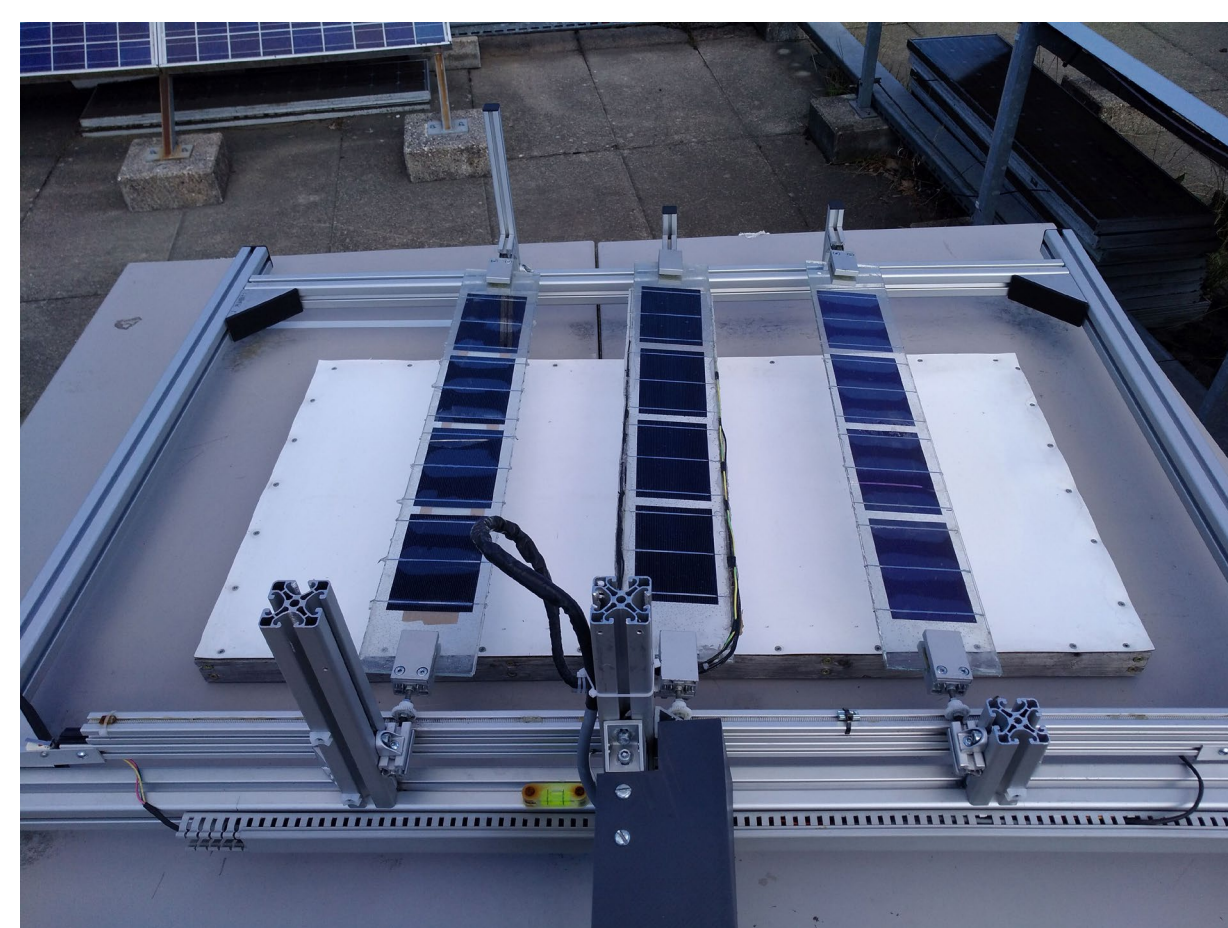
- Use small system instead of implementing a large one
- More flexible variation of mounting conditions
- Cheaper
- Systems running in parallel
- **Assignability of results?**



Measurement setup with permanently revolving modules. Height, distance between the rows and reflecting ground can be changed manually. The most relevant module in the center, which is best suited to represent the actual conditions in real installations, is marked red.



Large test array with commercial available 60 cell bifacial modules

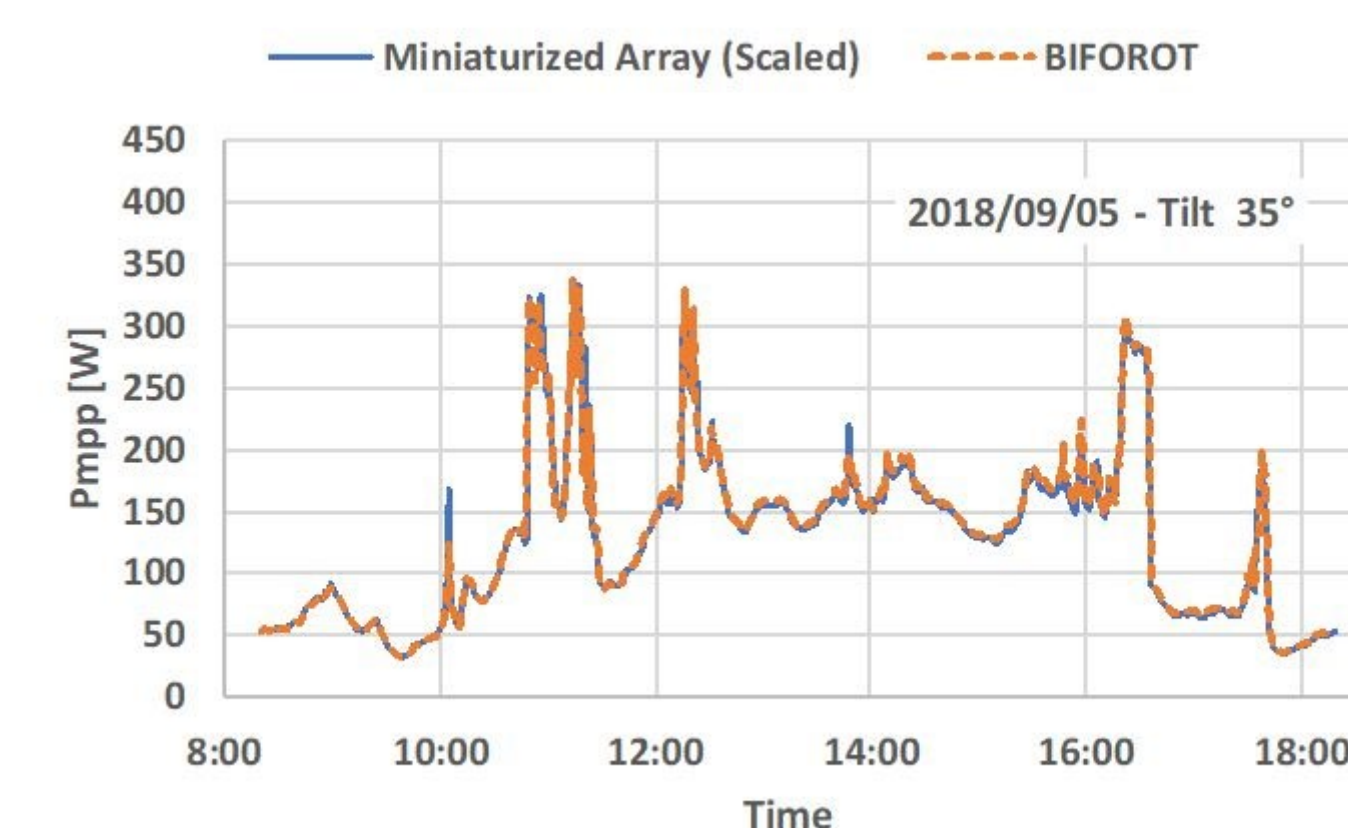
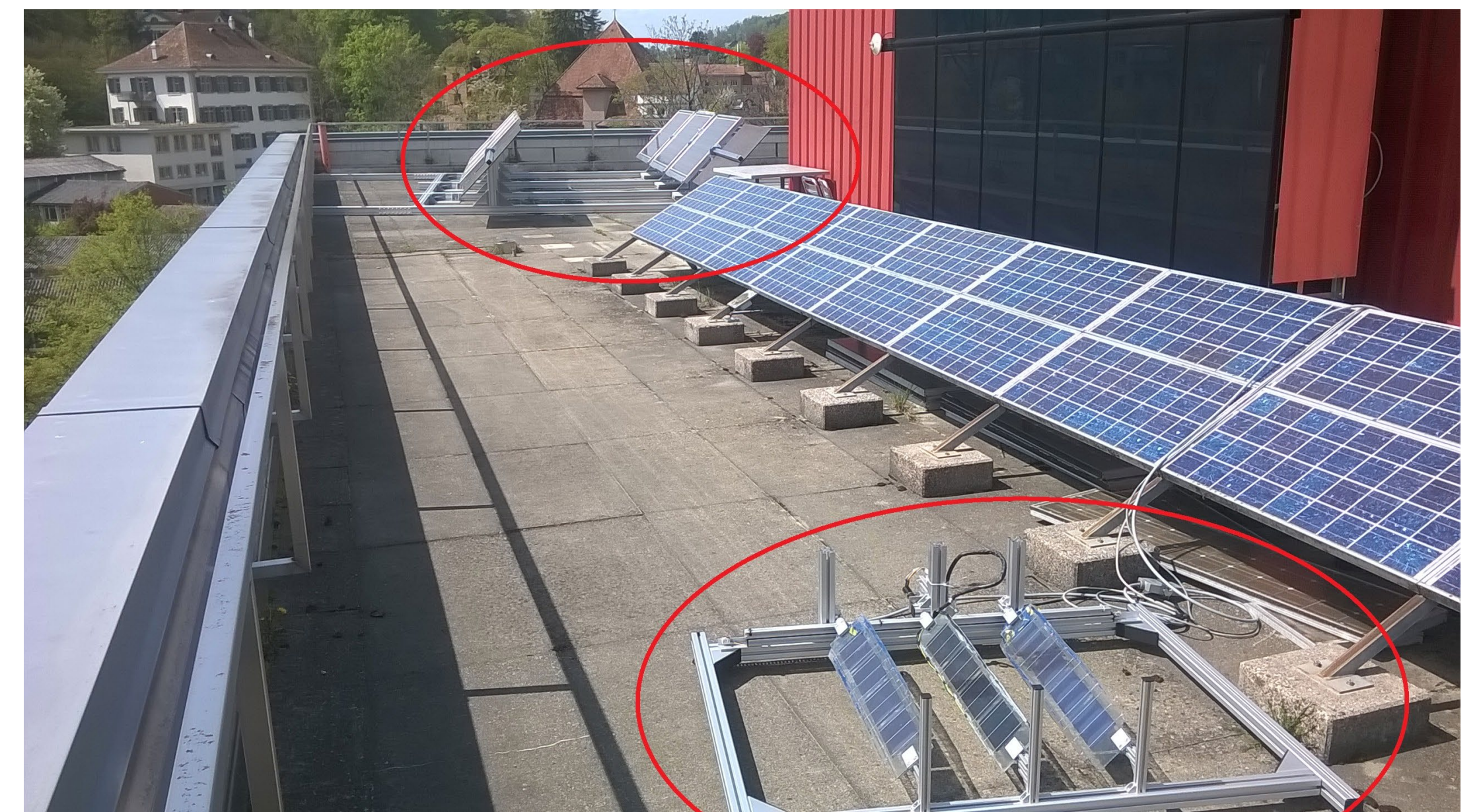


Miniaturized test array. The arrangement is the downscaled version of the large test array shown above.

Assignability exemplary tested with

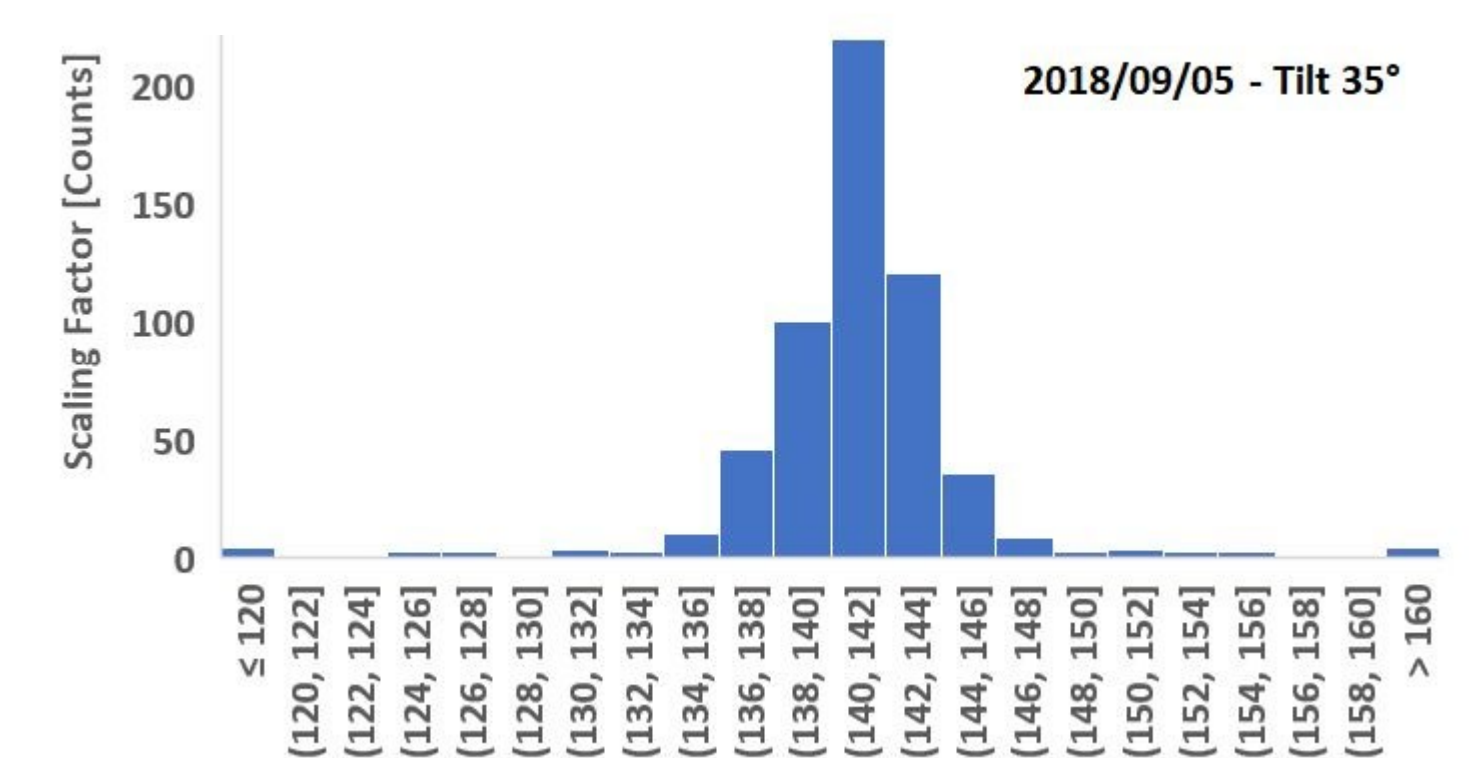
- Test assignability in general
- Permanently revolving modules
 - ⇒ tilt angle variation (height)
 - ⇒ 12 angles from 0° to 90° per minute
- More general test of assignability as for fixed

Run large and small test rig in parallel and find correlation factor



Pmpp of large test rig compared to output of small array after application of averaged correlation factor

Correlation factors for each time stamp
Averaged factor applied above



Commercial Product - All types of PV systems

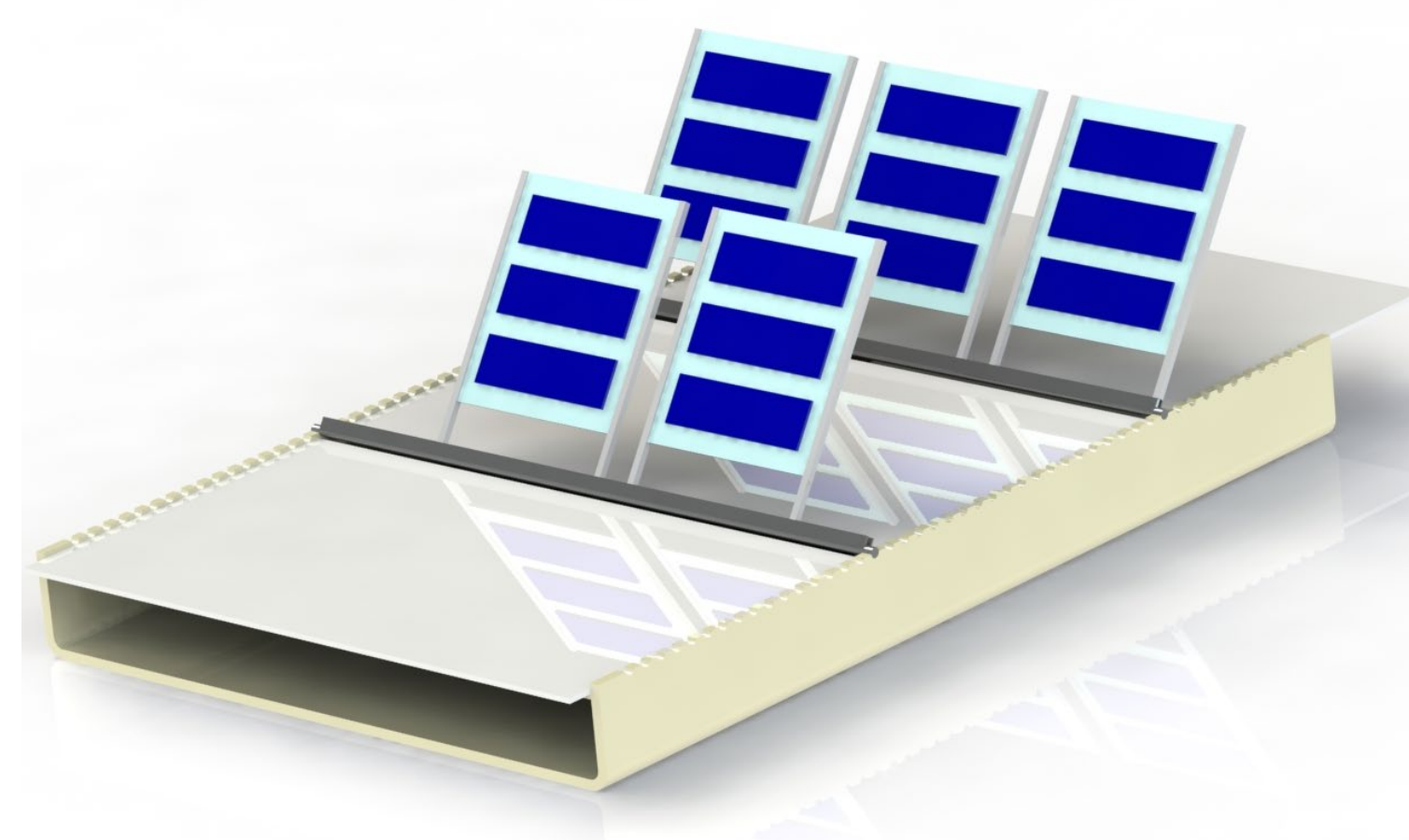
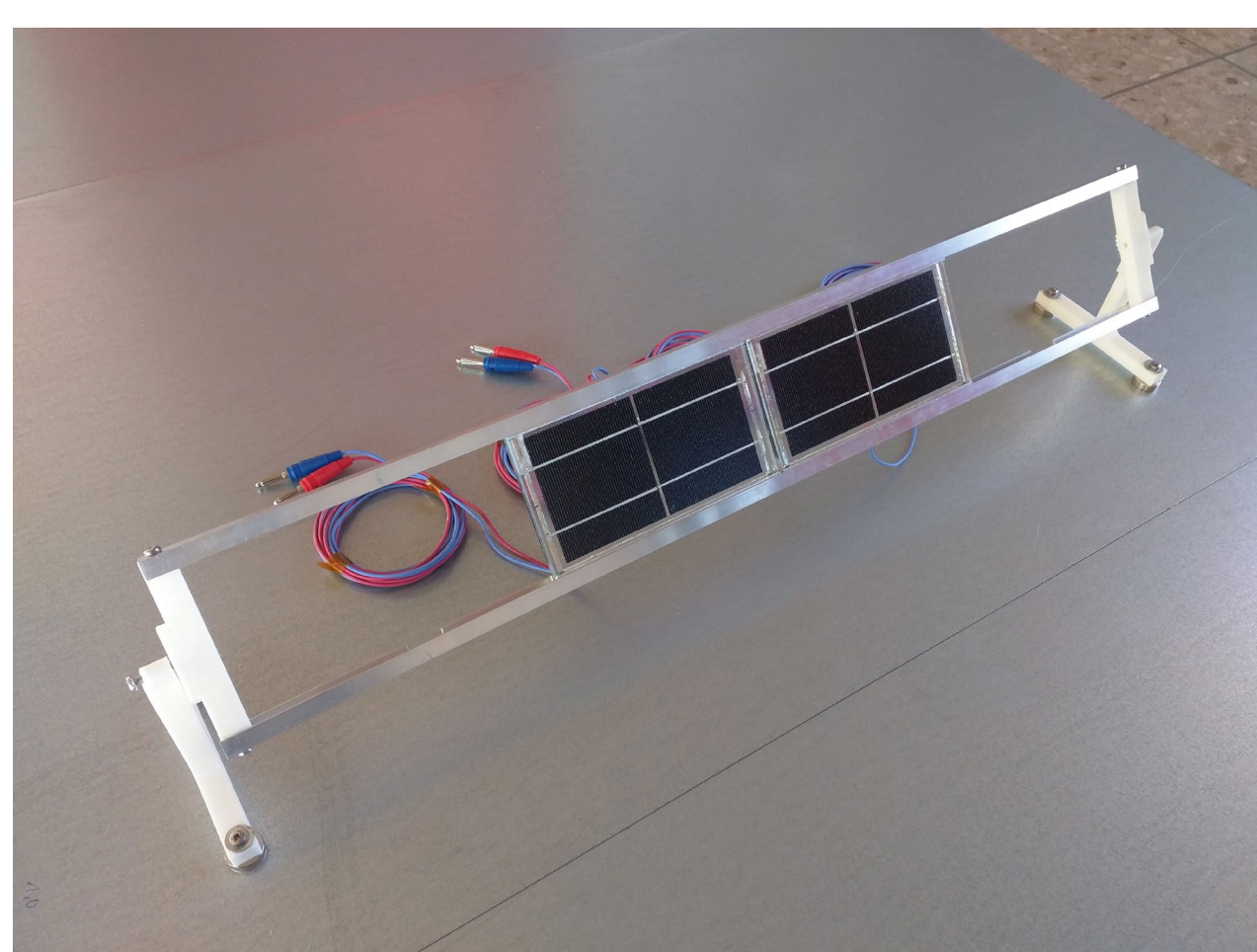
Cooperation with SOLARC Innovative Solarprodukte

- Manufacturer of special PV solutions and applications
- Also experienced in using / producing small cells and modules
- Offers adapted electronics for use of such small / special systems
- Offers data transfer solutions



Goal

- **No limitation to the introduced and tested specific setup**
- Develop a kit to rebuild your system of interest
- Based on replica of single modules
- Use different cell / module types, e.g. specific cells, mono / bifacial
- Arrange these units in various ways
- Compare different systems running in parallel directly
- Use of commercial products with proven reliability



Results & Conclusions

Summary (Solar Energy 179 (2019) 316-325)

- Averaged correction factor well suited to obtain congruence
- Very good congruence at daily level - expansion to longer term trials
- First miniaturized test rig not made for long term outdoor exposure
- Numerous down times
- Long term trial > 2 month - then mechanical break down
- Correlation factor stable if automated rules for data selection are applied to detect and remove erroneous data due to downtime, faulty measurement, etc.
- **Output of miniaturized systems can be assigned to the one of large installations**

