

## Swiss Mobile Flasher Bus

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### One year operation of the mobile flasher

- A throughput of up to 200 modules per day could be reached at customer's site (one flash each).
- Five different module technologies (cr.Si, HIT, a-Si/uc-Si, CIS, CdTe) were tested at the EKZ reference field the second time.
- The measurement uncertainty was analysed.
- The spectral response measurement on module scale was added as a new test feature.

### Calculation of the uncertainty

- All measurements of the SMFB are referred to a set of four polycrystalline silicon modules which were measured at the ISE Fraunhofer Institute in Freiburg.
- The uncertainty of the temperature correction was measured at different module temperatures (see Fig. 1).
- The expanded combined uncertainty for power measurements of cr.-Si modules is 3.2% (module temperature 15°C - 35°C).

### Low irradiance measurement

- Different low irradiance characteristics may contribute up to 4% difference in annual yield.
- The SMFB is equipped with 4 masks to block the irradiance, additionally the power of the lamp can be adjusted thus values between 70 to 1100 W/m<sup>2</sup> can be reached.
- Increase of 2% for cr.-silicon at 400 W/m<sup>2</sup>; up to 6% for CdTe was measured (see Fig. 2)

### Spectral response measurement on module scale

- The SMFB has been equipped with 15 band pass filters in the range of 400 nm to 1100 nm.
- Now it is possible to measure the photo current on module level.
- The mean of the standard deviation calculated for each wavelength range between measurement results with the SMFB and results of ISE is only 0.7%.

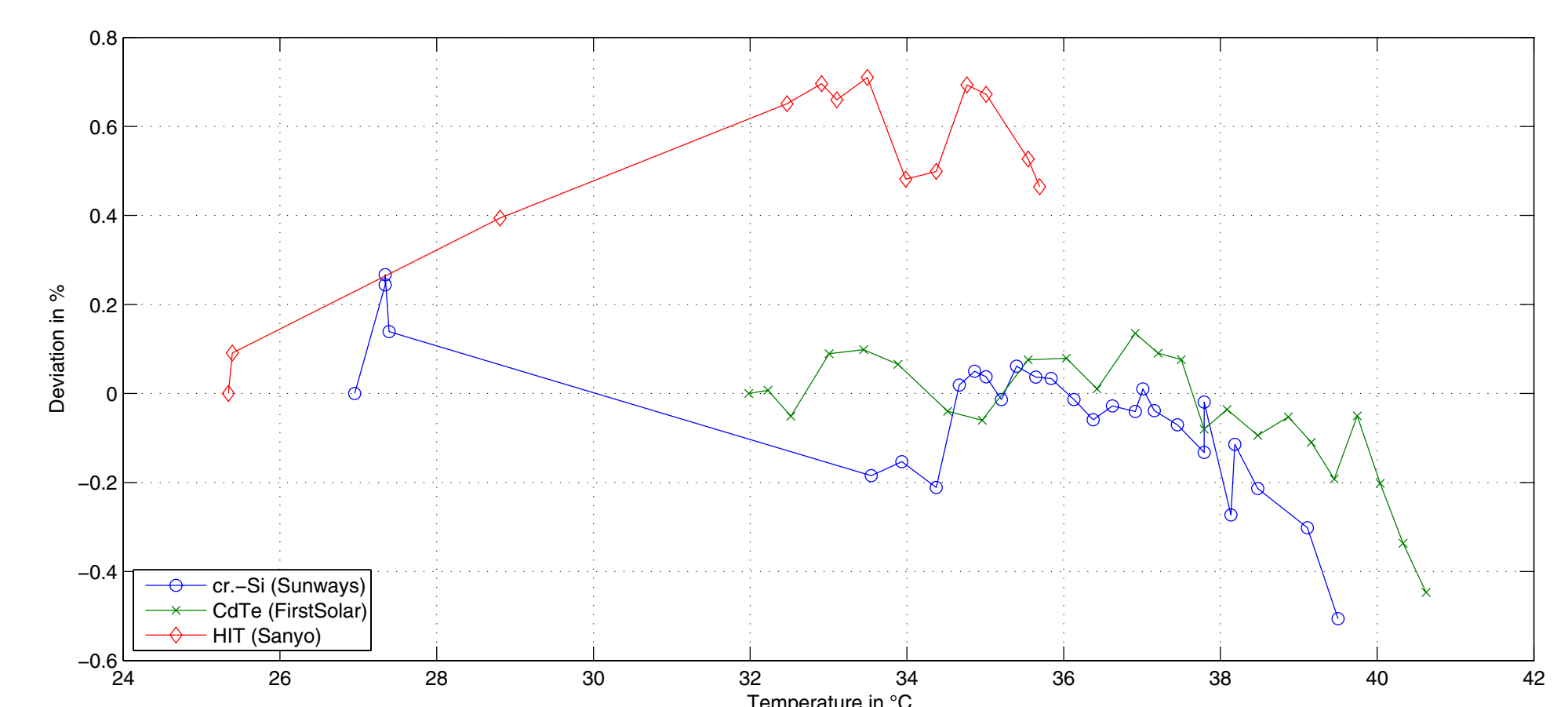


Fig. 1: Measured module nominal power after temperature correction versus module temperature

	limit	distribution	variance
Reference module	1.00	G	1.00
Temperature uncertainty	0.50	R	0.08
Optical uniformity	0.89	R	0.26
Misalignment DUT	0.60	R	0.12
Position reference cell	0.12	R	0.01
Electrical reproducibility	0.18	G	0.03
Spectral mismatch	0.50	G	0.25
Miscellaneous	1.50	R	0.75
		Σ	2.51
		2*sqrt(Σ)	3.2%

Tab. 1: SMFB uncertainty budget for crystalline Si modules (95% confidence)

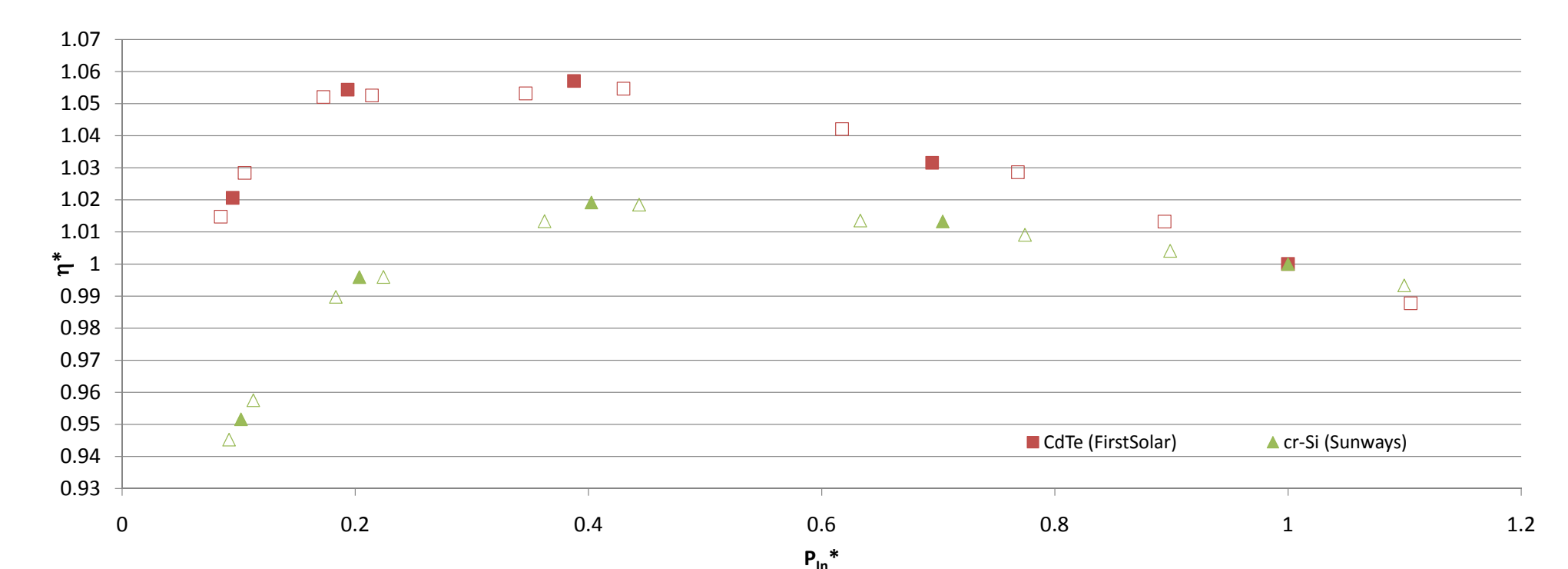


Fig. 2: Module efficiency at low irradiance ( $n^* \rightarrow V_{oc} * FF$  normalized to STC;  $P_m^* \rightarrow I_{sc}$  normalized)

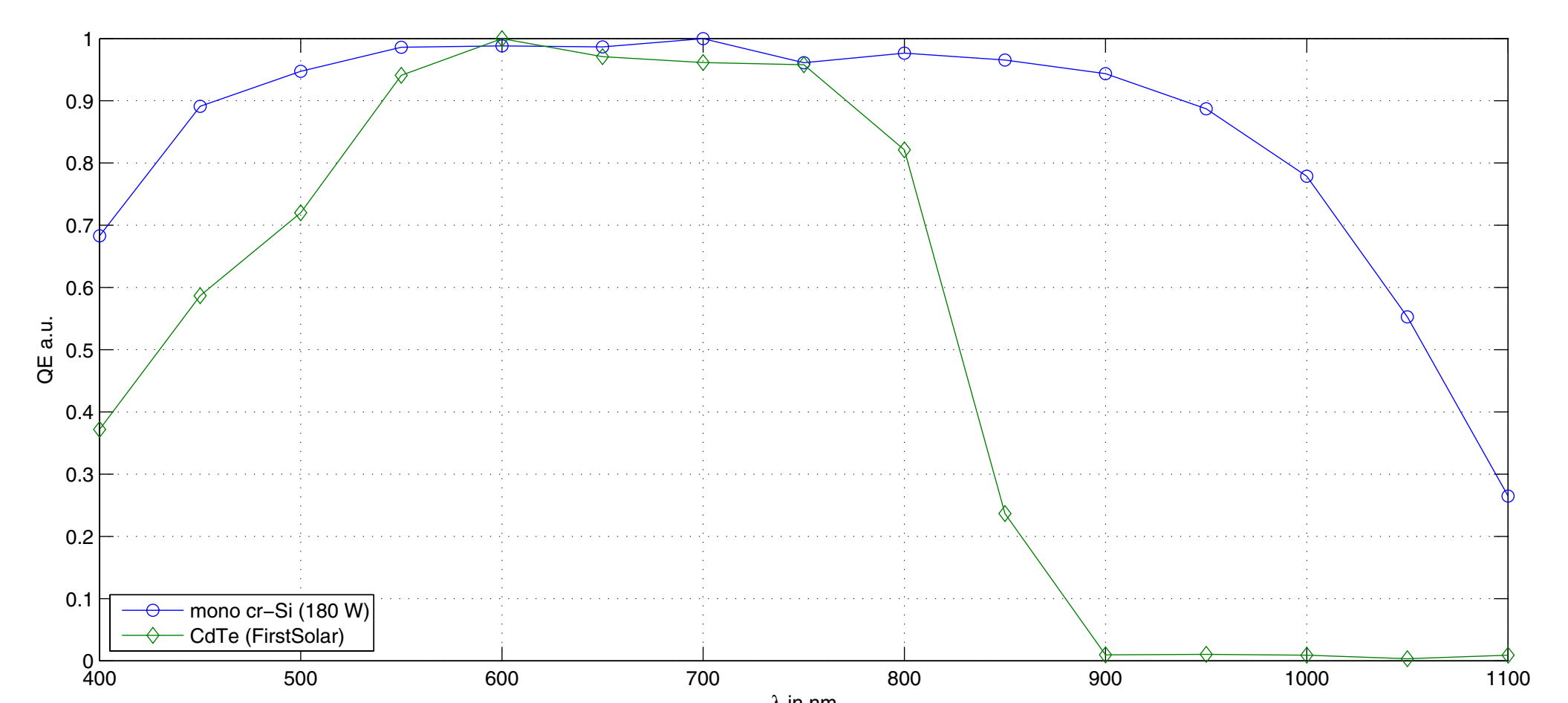


Fig. 3: Spectral response module characteristic of mono cr. silicon (180 Wp) and CdTe (FS275).

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