n-QB Test in Santa Clara
March 21 to April 29, 2018

Green Power

Trina-nQB Combination Test Santa Clara
Set up of the test

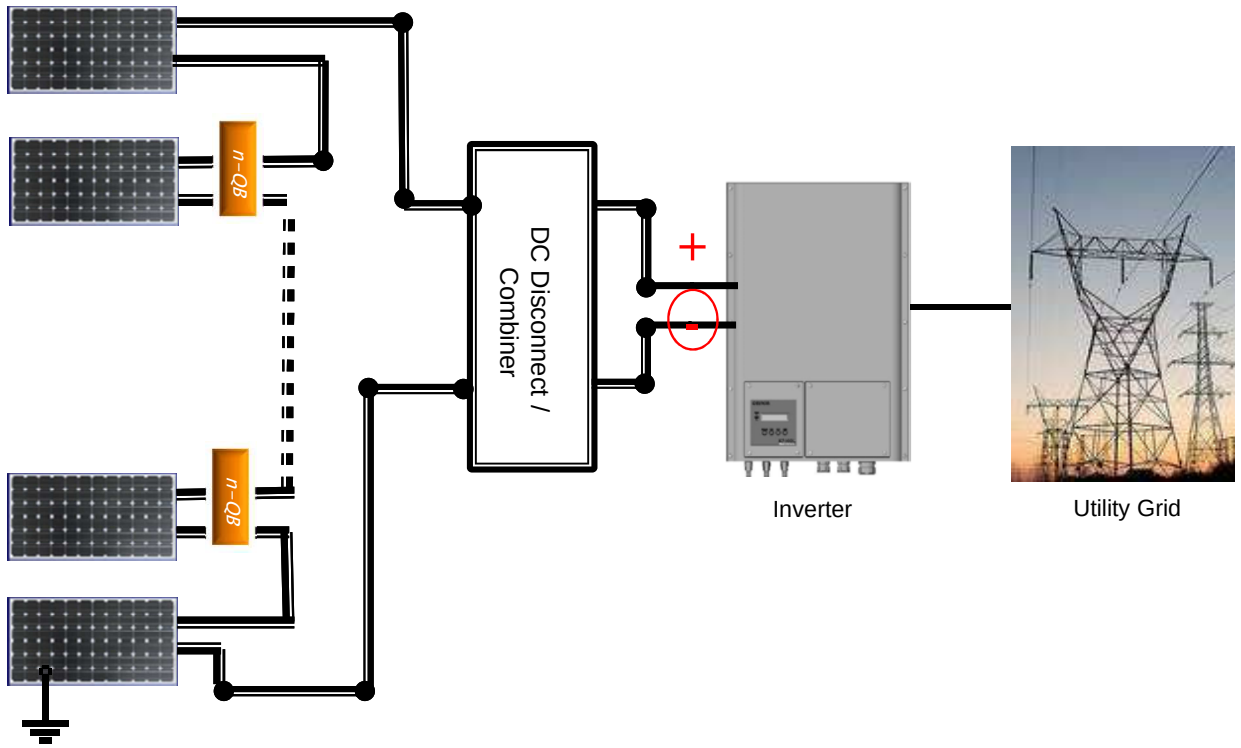
Test of Trina 265 watt –nQB combination

•Set up: 1 string made of 7 panels combined with nQB

•Test Period: Baseline test from March 21st, 2018 to April 3rd 2018; QB test from April 10th 2018 to April 29th 2018.

•Results: QB Gain about 9.1% considering average of all slopes (Power vs Irradiance), and 10.2% considering PR (Performance Ratio) increase. All calculations were based on data with Irradiance >100 Watt

*n*QB Connections to Modules & Grounding Testing in Santa Clara (California)



Analysis A: Daily Performance Ratio (PR)

Comparison between PR from before installation and PR from after QB installation

Performance Ratio Definition (CEI EN 61724):

$$PR = \frac{Y_f}{Y_r} = \frac{\frac{E_{sys}}{P_{nom}}}{\frac{E_{Irr}}{I_{ref}}}$$

Reference period: March 21s, 2018 to April 3rd, 2018 for the Baseline; April 10th 2018 to April 29th, 2018 for the QB test

Results for all days:

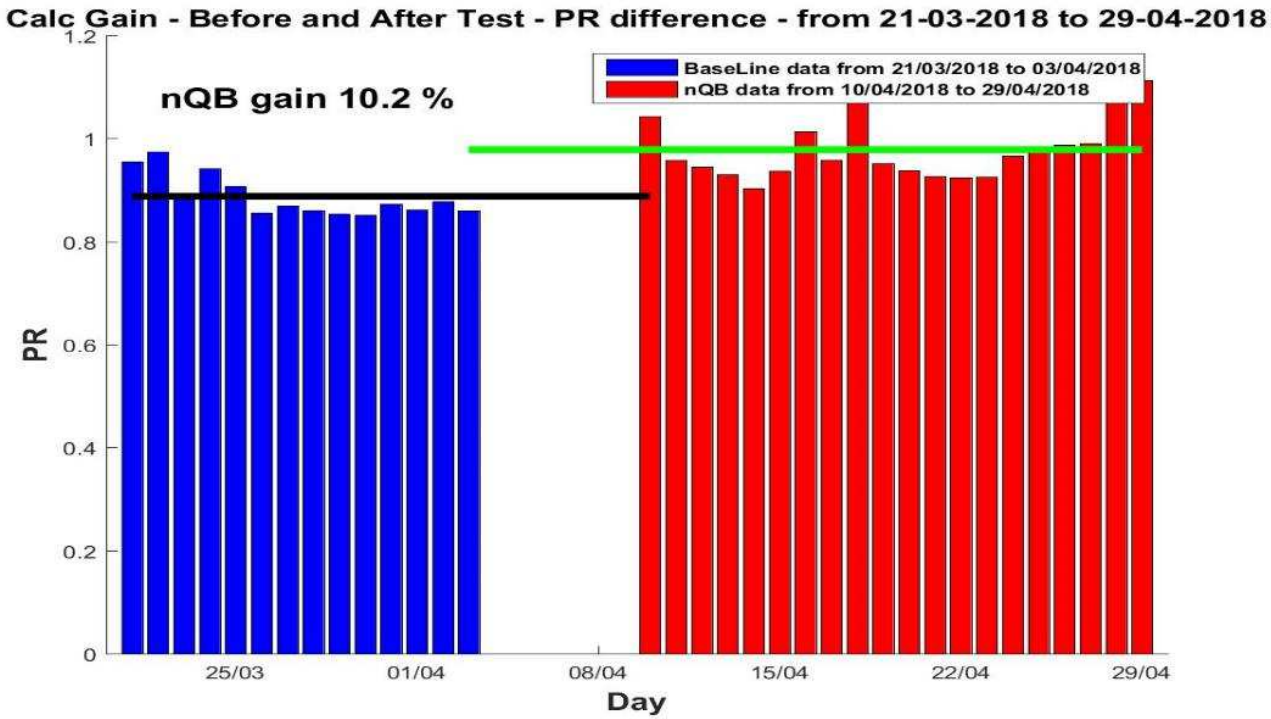
PR_{QB_before}=91.04%

PR_{QB_after}=100.3%

$$Gain_{QB} = 100 * \frac{PR_{QB_{After}} - PR_{QB_{Before}}}{PR_{QB_{Before}}} = 10{,}2\%$$

P_{nom}=7*265W=1855 W

I_{ref}= 1000 W/m2



Analysis B: Comparison of Slopes

Comparison between average of Power/Irradiance slopes before and after QB installation

Reference period: March 21st, 2018 to April 3rd, 2018 for the Baseline; April 10th 2018 to April 29th, 2018 for the QB test

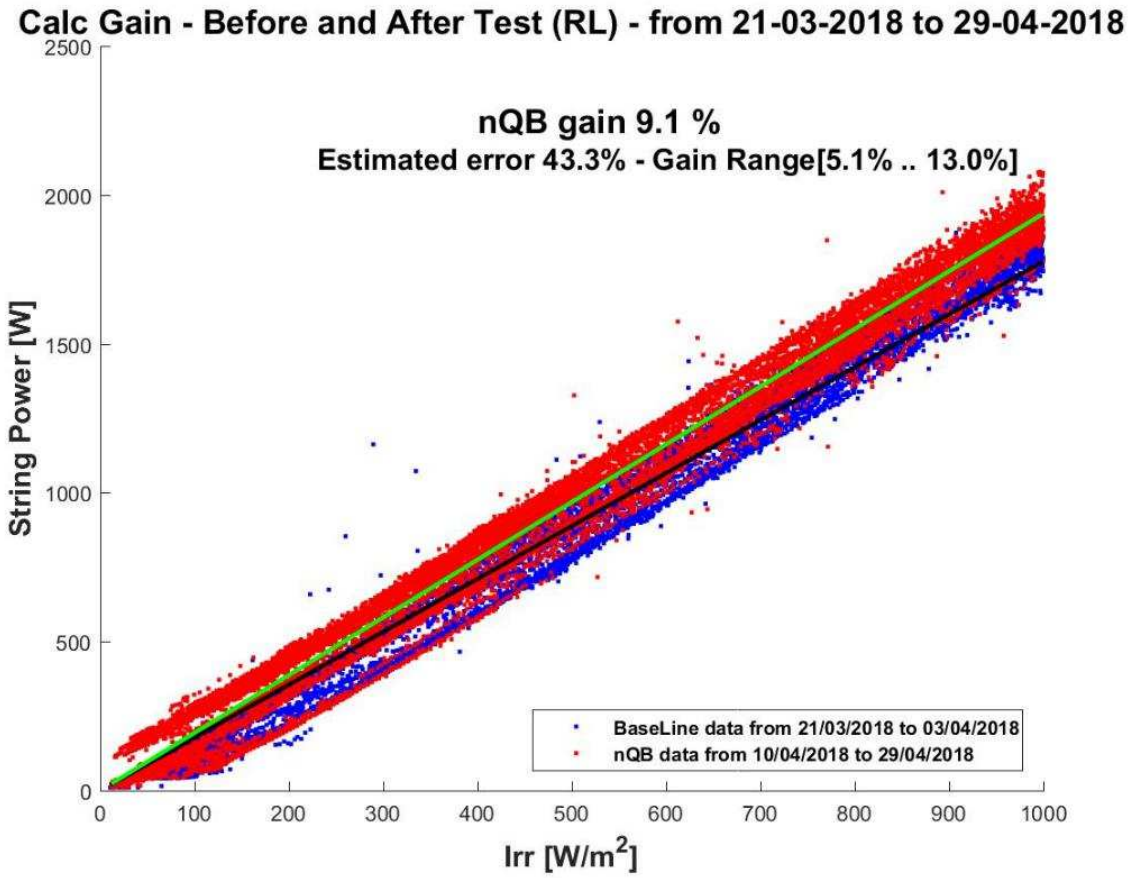
The power generated by the string must be corrected in temperature in accordance with the formula below

$$P_x = \frac{P_{Acq_x}}{\left(1 - \alpha(T_{rear_x} - 25\right)}$$

A linear regression on the first set of data is performed and the angular coefficient m_1 is determined. This leads to the calculation of the gain of nQB, which is given by the following formula.

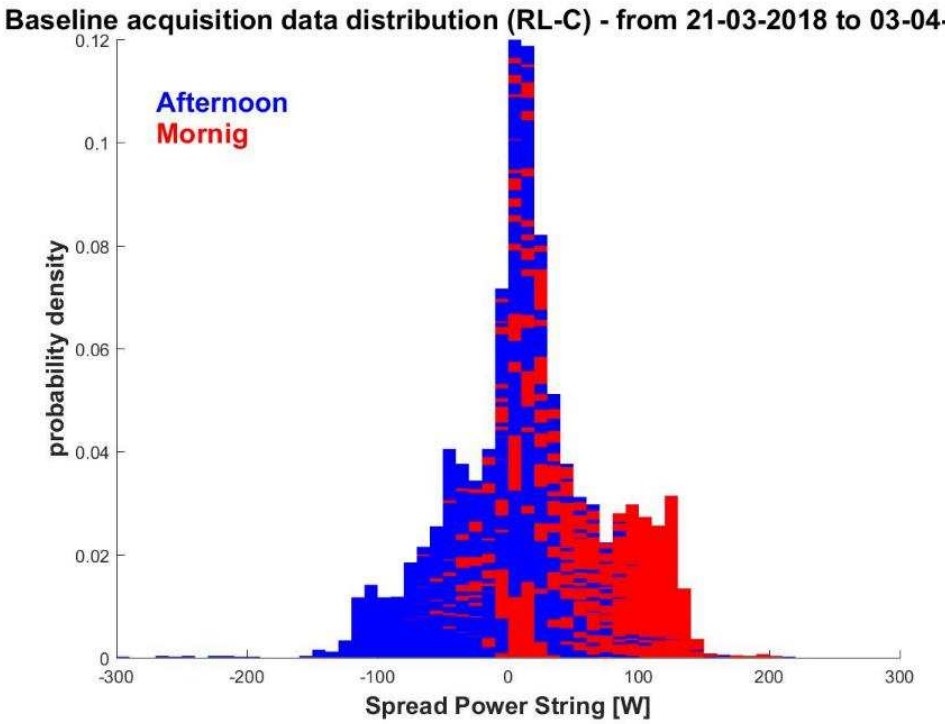
$$Gain = 100 * \frac{m_2 - m_1}{m_1}$$

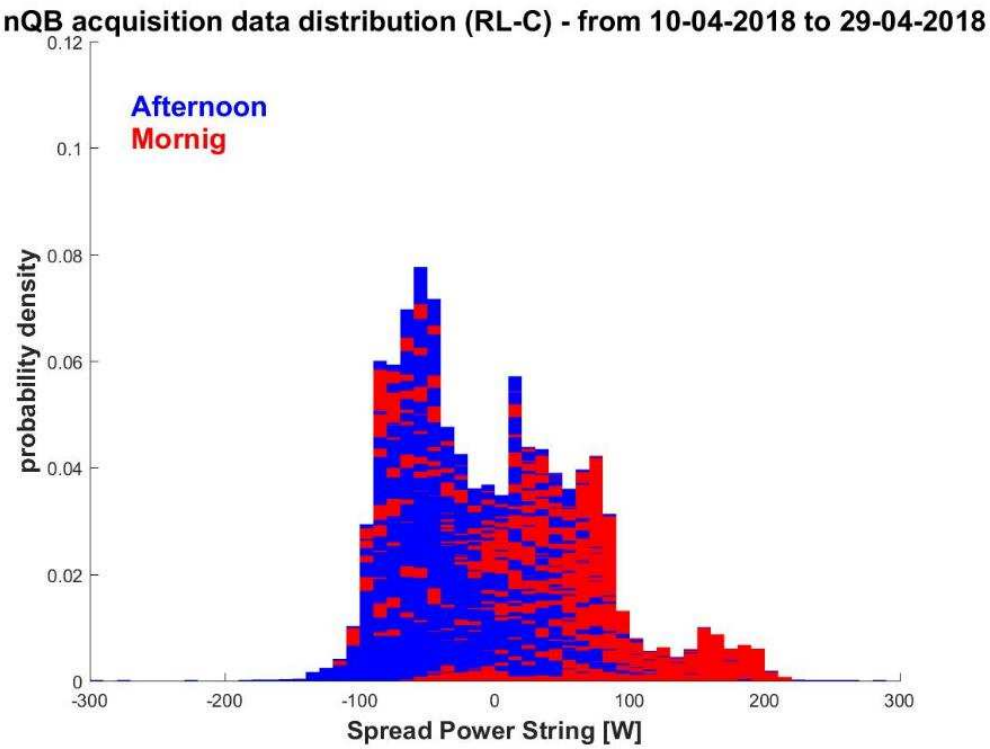
Calculated gain = 9.1%



Distribution of Temperature Corrected Power

Baseline Period & QB Test Period





Analysis C: Comparison of Power on Irradiance

Comparison of average of Power on Irradiance before and after QB installation

The powers, corrected in temperature, are calculated with the following

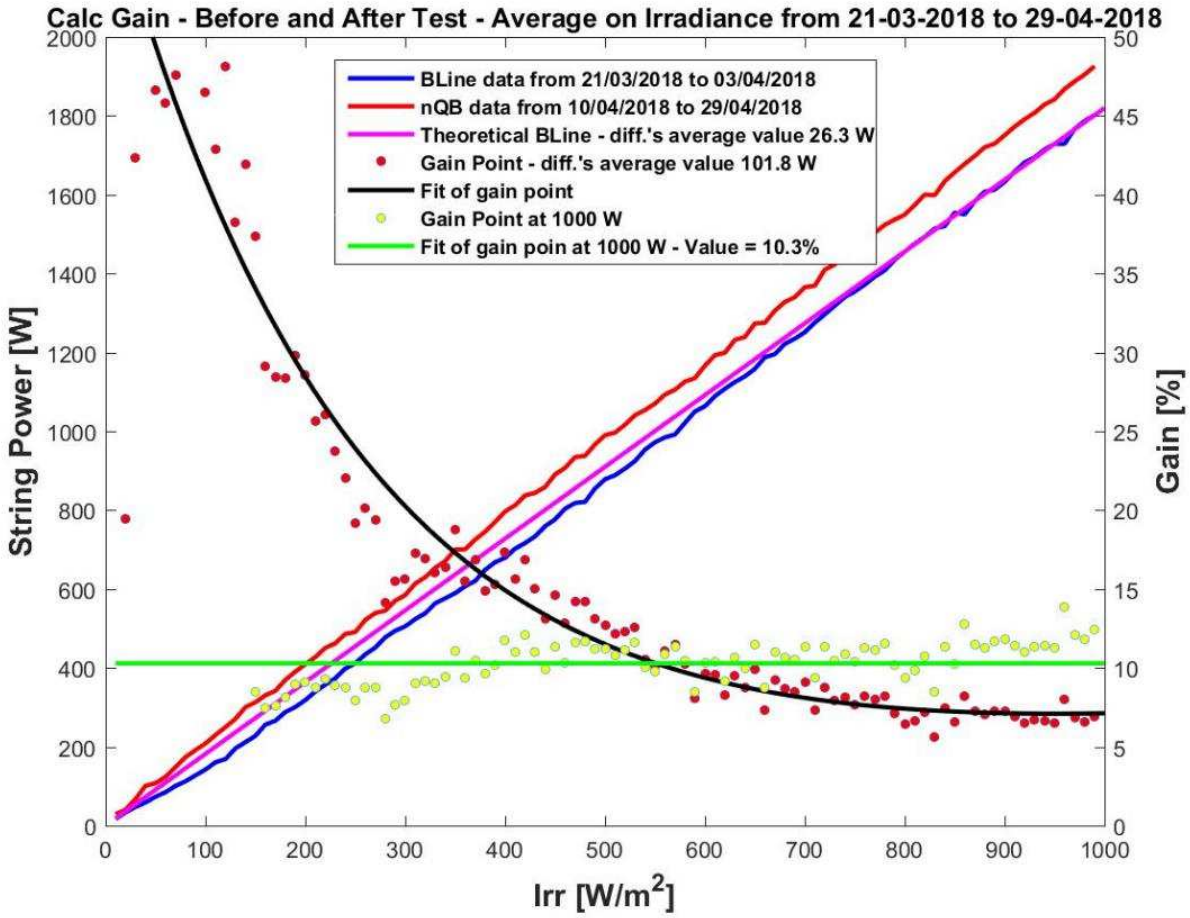
$$Power(Irr) = \sum_{n=1}^{nAcqPoint_{Irr}} Pstd_{Irr,n}$$

the gain points, red spots, are calculated by:

$$Gp = 100 * \frac{P_{nQB} - P_{BL}}{P_{BL}}$$

the fix gain points, yellow spots, are calculated by:

$$Gp_{fix} = 100 * \frac{P_{nQB} - P_{BL}}{1000}$$



Analysis D: Comparison of Power on Irradiance

Comparison of average of Power on Irradiance before and after QB installation

Comparison between average of Power/Irradiance slopes before and after QB installation

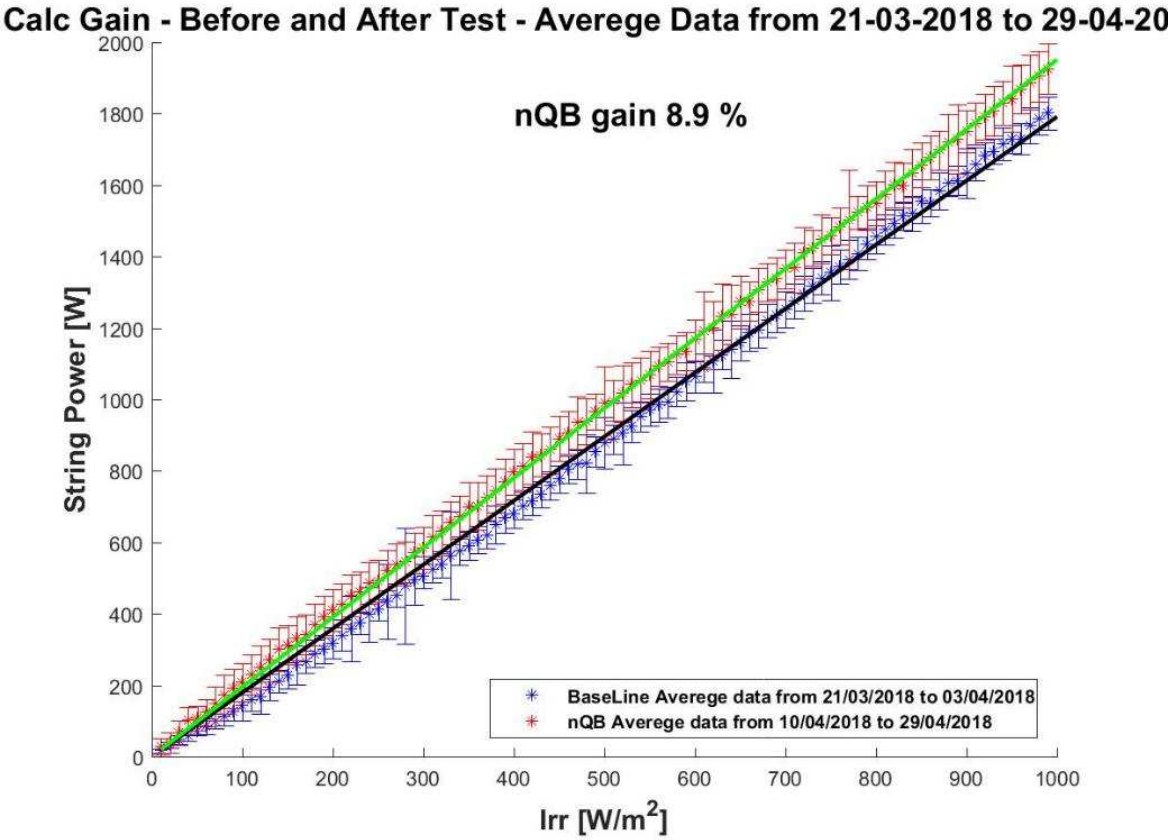
The powers, corrected in temperature, are calculated with the following

$$Power(Irr) = \sum_{n=1}^{nAcqPoint_{Irr}} Pstd_{Irr,n}$$

A linear regression on the first set of data is performed and the angular coefficient m_1 is determined. This leads to the calculation of the gain of nQB, which is given by the following formula.

$$Gain = 100 * \frac{m_2 - m_1}{m_1}$$

Calculated gain = 8.9%



Analysis E: Comparison of Theoretical vs Real Baseline

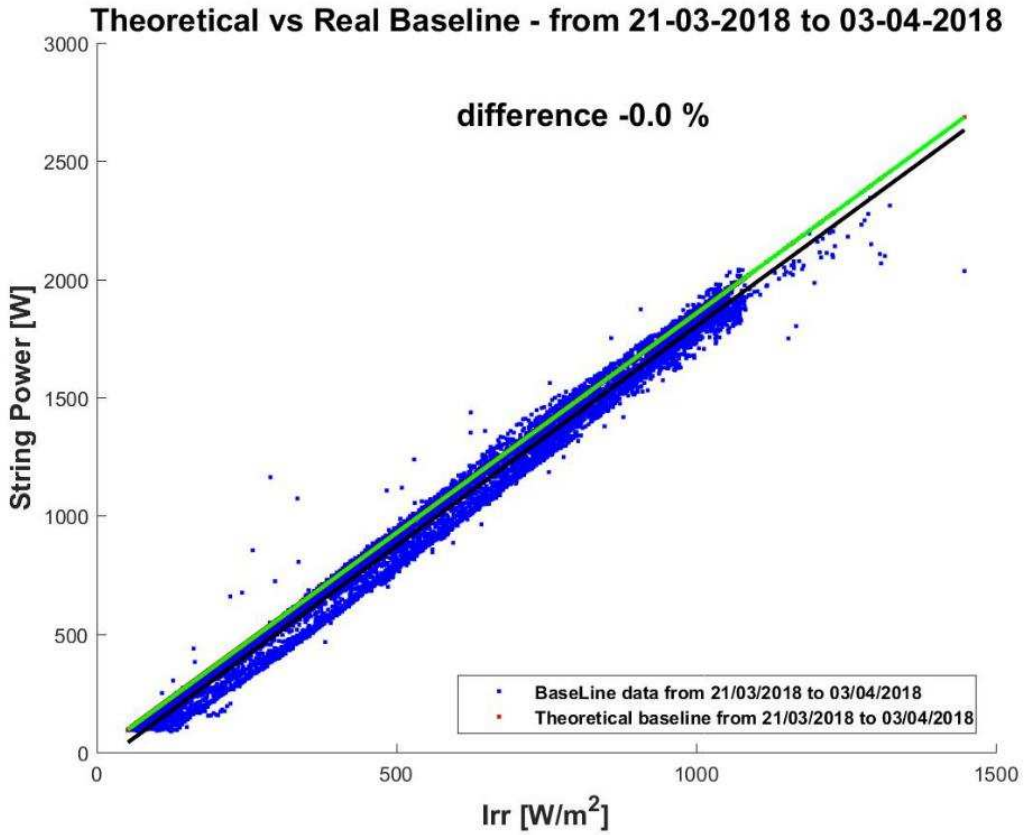
Comparison between average of Theoretical and Real Baseline slopes

the theoretical baseline is calculated using the following

$$Baseline(Irr)\ versus\ Power_{Mod} * \text{Number of Modules}$$

The power of Baseline has been corrected in temperature in accordance with the formula below

$$P_x = \frac{P_{Acq_x}}{\left(1 - \alpha(T_{rear_x} - 25\right)}$$



The Test System

QB String – 7 Modules of TSM-265PD05.08

Weather Station

Illumination

Data Acquisition System (DAQ)

Summary

- Results from QB testing at Santa Clara are as follows:
  - PR improvement = 10.2%
  - Improvement of the average slope calculated from Temperature corrected Power and Irradiance data between the Baseline period and the QB test period is 9.1%
  - Improvement of the average slope calculated from Temperature corrected Power and Irradiance data between the average Baseline period and the average QB test period is 8.9%