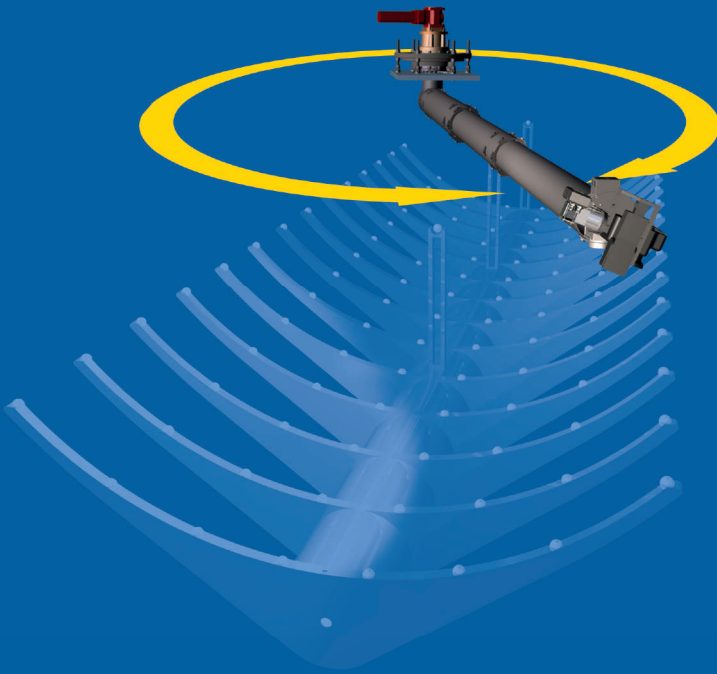


PHOTOGRAMMETRIC MEASUREMENT SYSTEM **QFOTO**

Inline Quality Control for Solar Concentrator Structures



QFoto is a 3D measurement system for automatic surveying of concentrating solar collector structures. It is based on the well-established method of close-range digital photogrammetry and it is typically integrated in parabolic trough and heliostat assembly lines. The system inspects the position and orientation of the mirror support elements, the position of the receiver supports and of other relevant reference points. The software for automatic measurement and analysis can be flexibly adapted to the specific requirements of the client's project. Using a single high-definition camera with self-calibration, the system guarantees high measurement precision even under changing ambient temperatures.

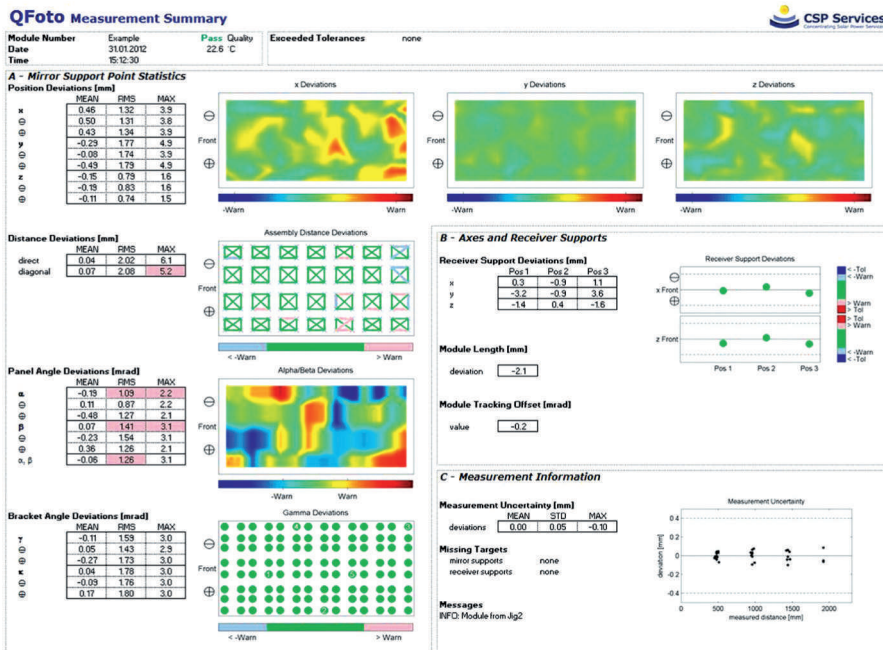
QFoto integrates CSP Services' recognized solar field quality expertise into your project.

QFoto works with custom-made high-precision measurements targets and adapters with retro-reflective surfaces for any concentrator type. Specific and robust targets and adapters are available for mirror support positions and angles, for receiver support and rotation axis positions and for other relevant module dimensions. After each measurement, an evaluation report summarizes the main results for all coordinates as well as mirror tilt angles, mirror support angles and distances, including measurement accuracy checks. The quality assessment according to defined tolerances evaluates the pass/fail rating for the whole module and indicates it to the operators by a signal light. The output includes statistical quality analysis of the production period.

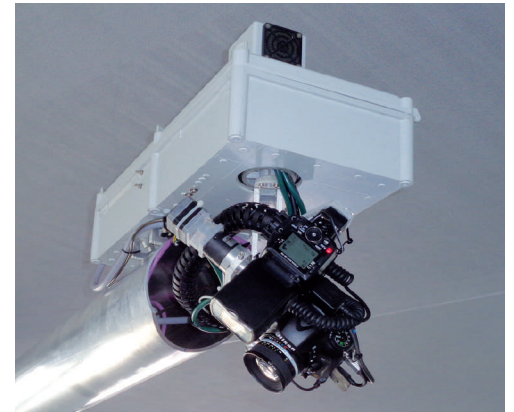


Control cabinet for automatic measurement, evaluation and output with signal light for pass or fail result

QFoto Measurement Details



QFoto measurement summary example for parabolic trough structure from data evaluation report



Measurement camera with flash on pan-tilt-roll head, mounted on rotary arm above structure

System Features

- Camera installed on rotary arm above measurement object
- Application for parabolic trough, heliostat and dish structures
- Automatic measurement (after preparation with targets)
- Contact-free 3D measurement
- In-situ camera calibration for temperatures up to 55 °C
- Compensation of thermal expansion of measurement object
- Correction of cantilever arm and receiver support tilt
- Module rotation axis or optical axis as reference
- Calculation of mirror panel tilt angles
- Calculation of mirror support angles (optional)
- Computation of deviations from nominal values
- Comparison of deviations to allowed tolerances
- Module quality report
- Final pass/fail signal via signal light
- Statistical output of process stability (optional)
- Uncertainty for 3D coordinates: < 0.5 mm (for x, y, z)
- Uncertainty of mirror tilt angles: < 0.2 mrad
- Uncertainty for mirror support angles: < 2 mrad



Orientation measurement adapter for simultaneous determination of mirror support position and angle

QFoto has demonstrated reliable operation in concentrator assembly lines in Europe, North and South America, Africa and Asia.

Until 2015, the concentrator quality of more than twenty CSP plants totaling 1'800 MW of electrical power and more than 13 million m² aperture area has been checked with the QFoto system.

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