PARABOLIC TROUGH
OPTICAL PERFORMANCE ANALYSIS TECHNIQUES

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How to measure and improve parabolic concentrators?

- Collector efficiency depends on
  - optical properties α, ε, τ
  - geometric properties
    - concentrator shape
    - receiver size and position
    - tracking
  - thermal properties

- Captured fraction of rays: Intercept factor γ
- Measure for geometric properties
- Analysis with digital imaging techniques
- Analysis with Ray-Tracing tools

Contents

- Photogrammetric Geometry Measurement
- Flux Mapping in the Focal Region
- Flux Scanning in the Focal Region
- Ray-Tracing
- Statistical Ray-Tracing
- Conclusion

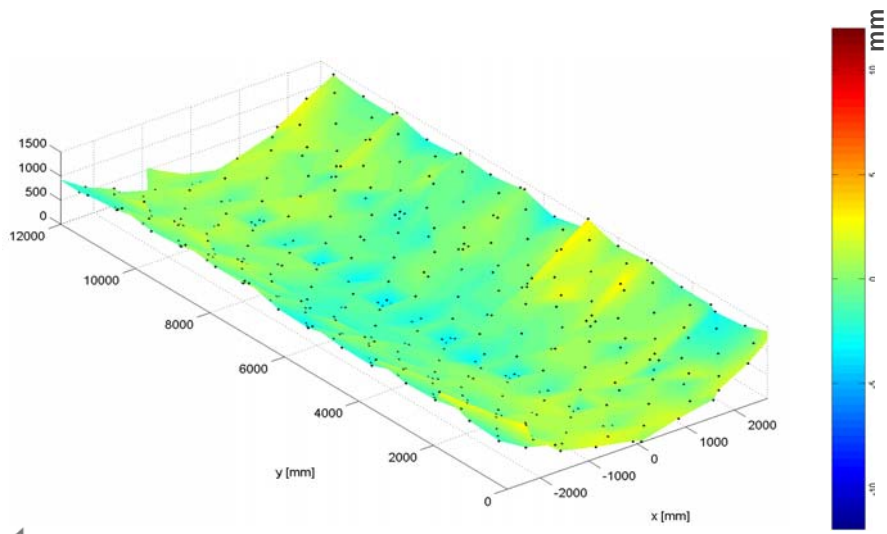
EuroTrough Collector at Plataforma Solar de Almería

Demonstration Loop at Kramer Junction (SkalET)

Geometry und Intercept Analysis with Photogrammetry

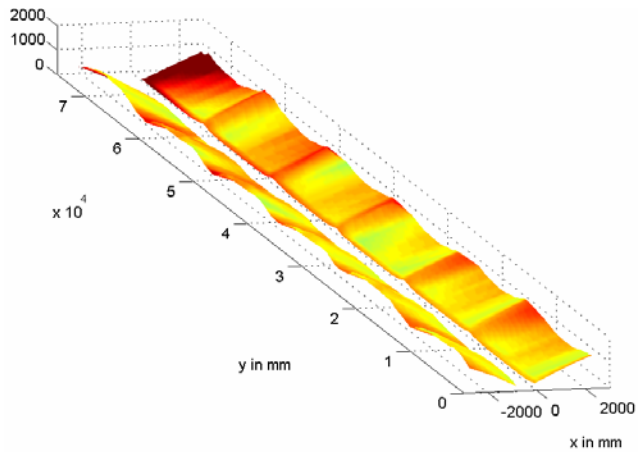
Photogrammetry on Concentrating Collectors

Concentrator Quality in 3 dimensions

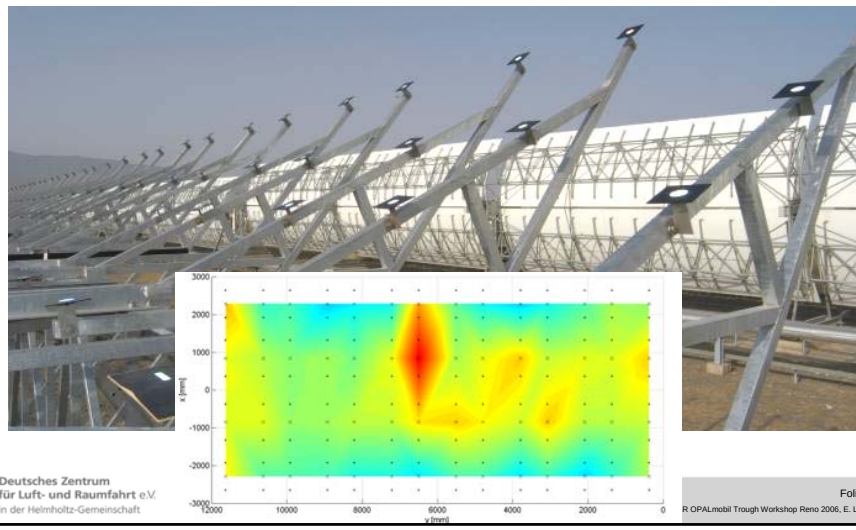


Geometric Precision over Large Collector Areas

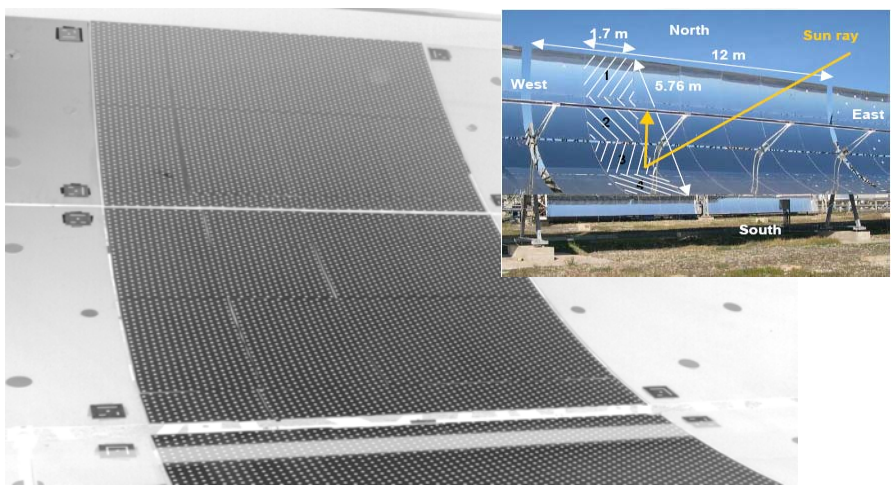
ET150 Collector Shape Variation from west horizontal position to east horizontal position (180° turn)
Deformations due to gravitational forces measured with Photogrammetry



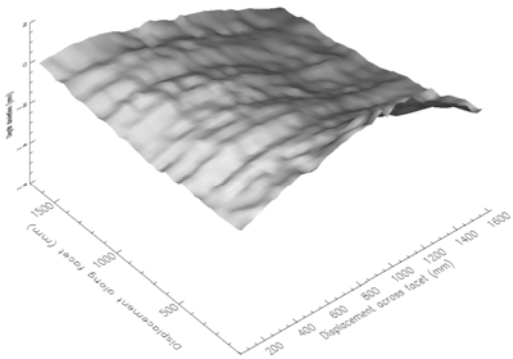
Quality Control during Collector Assembly



Photogrammetry on Reflector Surface

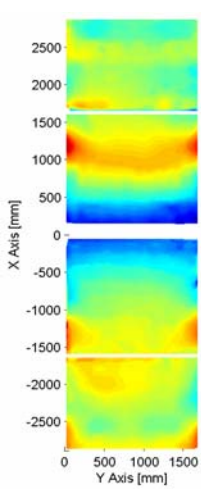


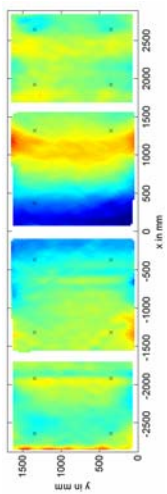
Photogrammetry on Mirrors



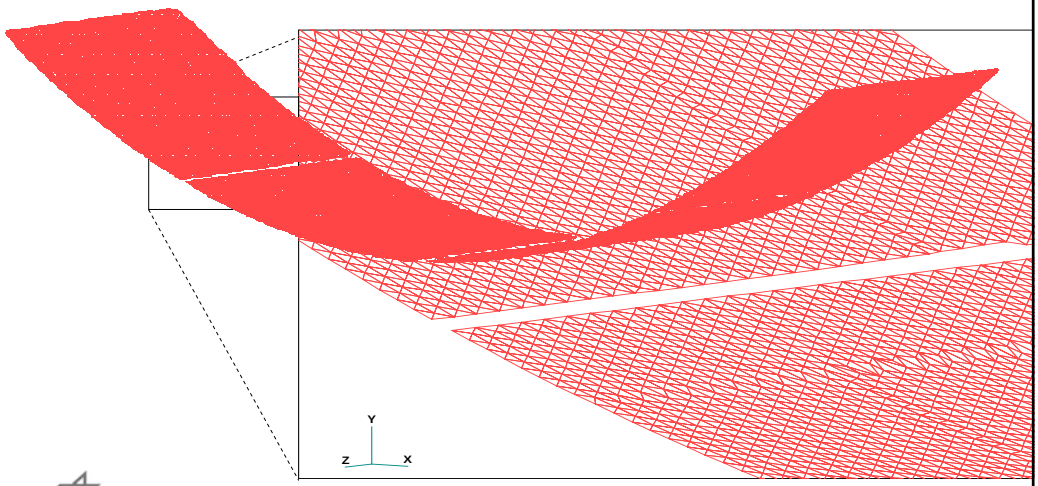
- Measure Mirror Shape
- Measure Slope and Slope Deviations
- Calculate Optical Efficiency
- Measure Deformation due to dead-load etc.

Photogrammetry Result Comparison

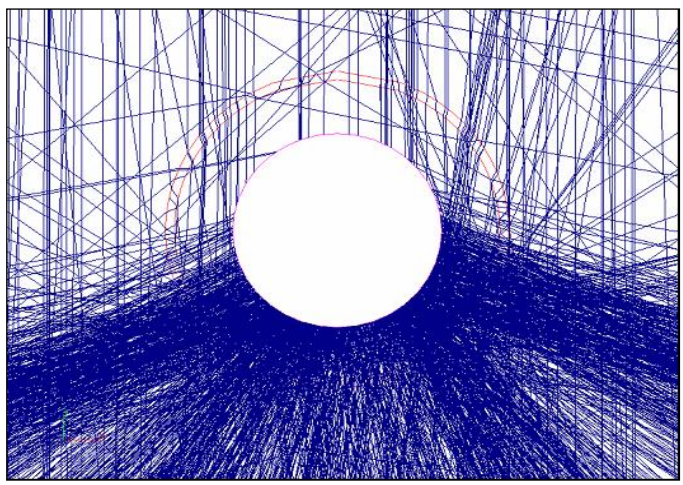




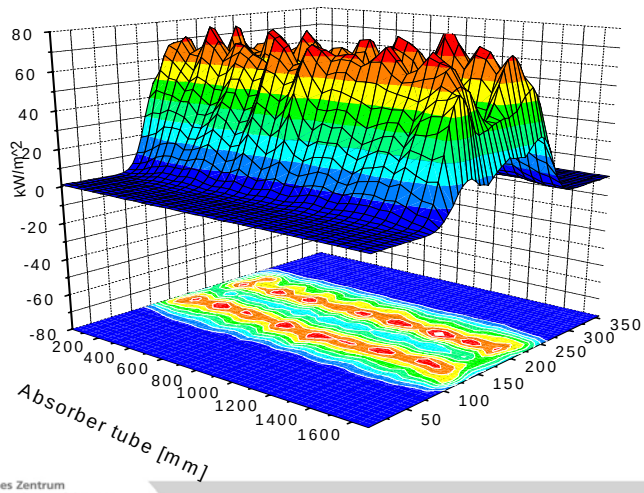
Photogrammetry, Simulation in OptiCAD



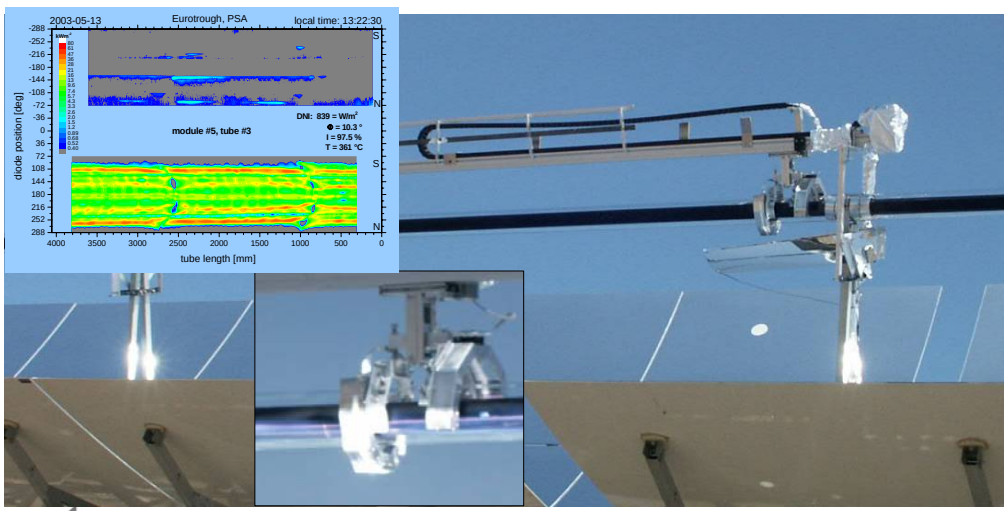
Raytracing with OptiCAD



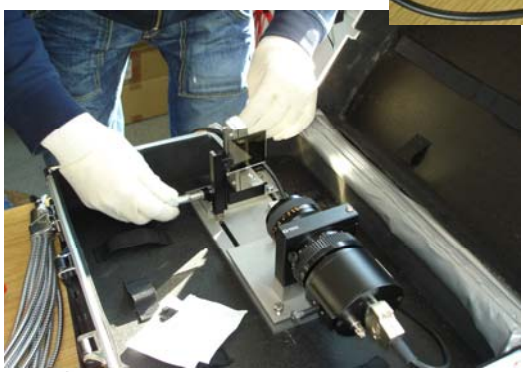
Flux Distribution on Absorber Surface (from Raytracing with real mirror geometry)



Parascan – Flux Mapping in the Focal Region

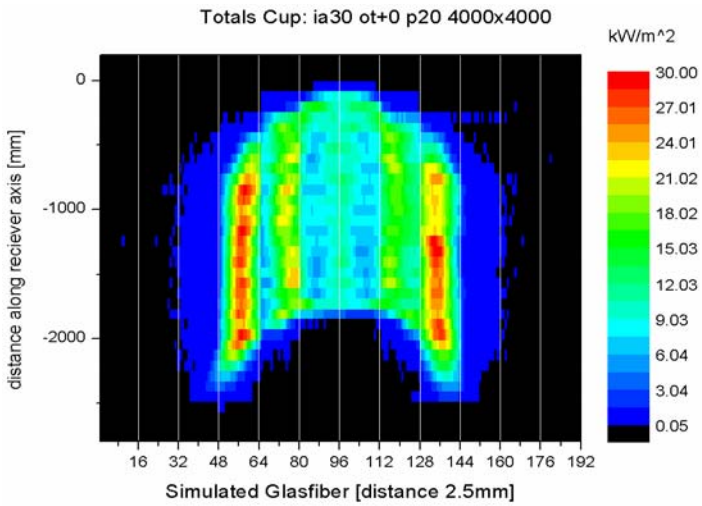


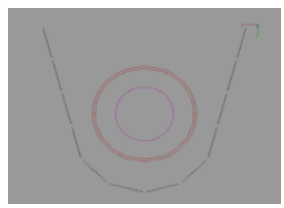
ParaScan – II



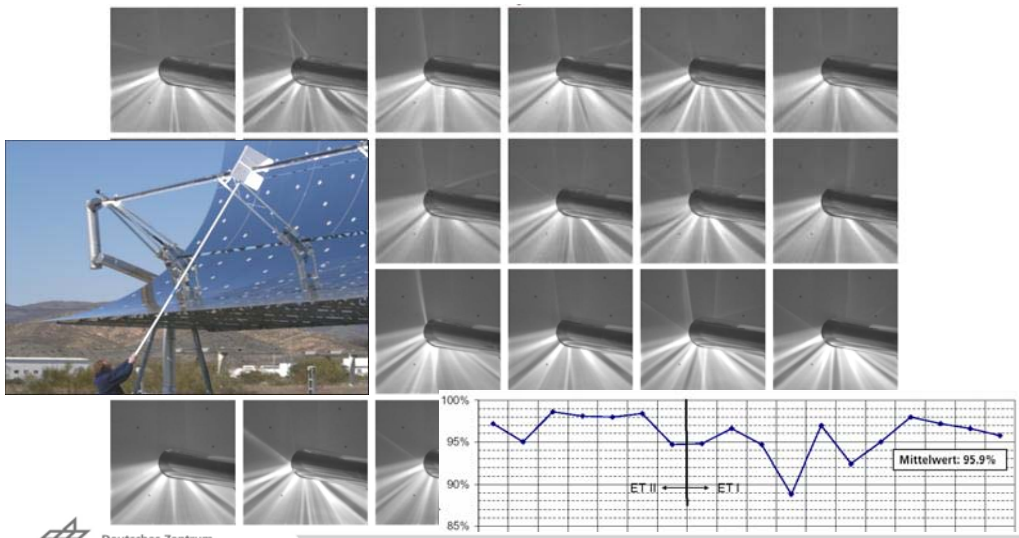
Flux Distribution in Measurement Plane

Total-Array; Incidence Angle 30°

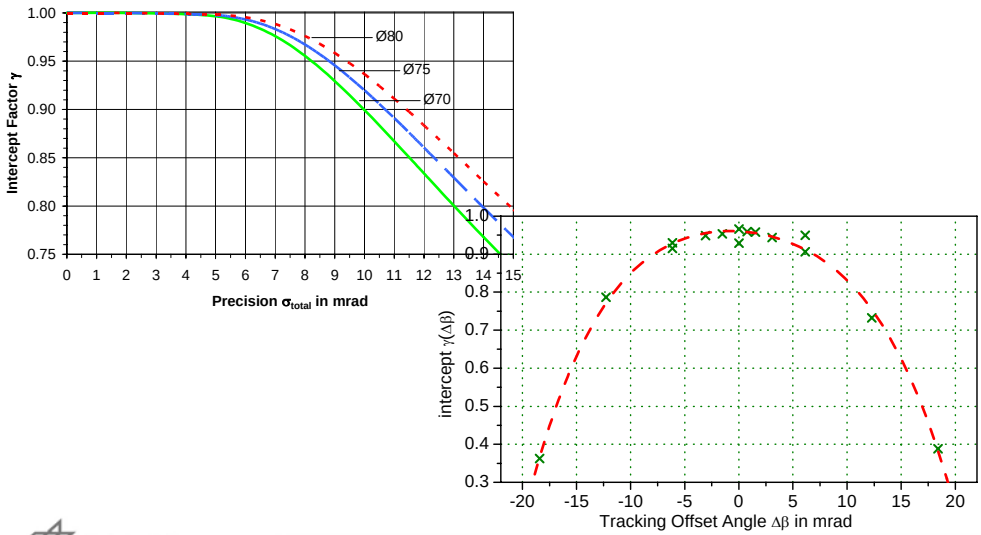




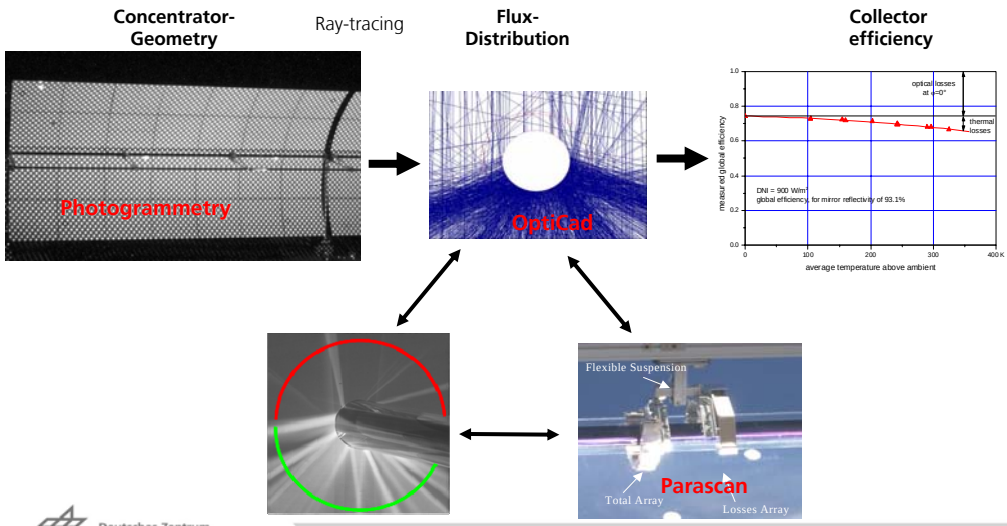
Optical Efficiency of EuroTrough-Collector



Ray-Tracing Analysis and Verification with Thermal Tests



Trough Analysis Techniques



Conclusions

- Solar Collector Field: Unusual Precision Requirements
- High Precision required for high performance
- Combination of conventional methods with digital photography
- Application to
  - Assembly Checking
  - Analysis of Prototypes and Components
  - Verification of Solar Field Performance
- Mobile Measurement Techniques available for
  - Geometry
  - Flux density
  - Optical efficiency
  - Irradiance
  - Thermal performance
- Results from EuroTrough at PSA and Skal-ET loop at KJC
- Outlook: Stationary Applications in Solar Field Assembly Quality Control
- Funding: German Ministry of the Environment (BMU), Contract no. 16UM0004