FRAUNHOFER INSTITUTE FOR SOLAR ENERGY SYSTEMS ISE

Project FRESH NRG GA 308792, Collaborative Project
FP7-ENERGY-2012-1-2STAGE

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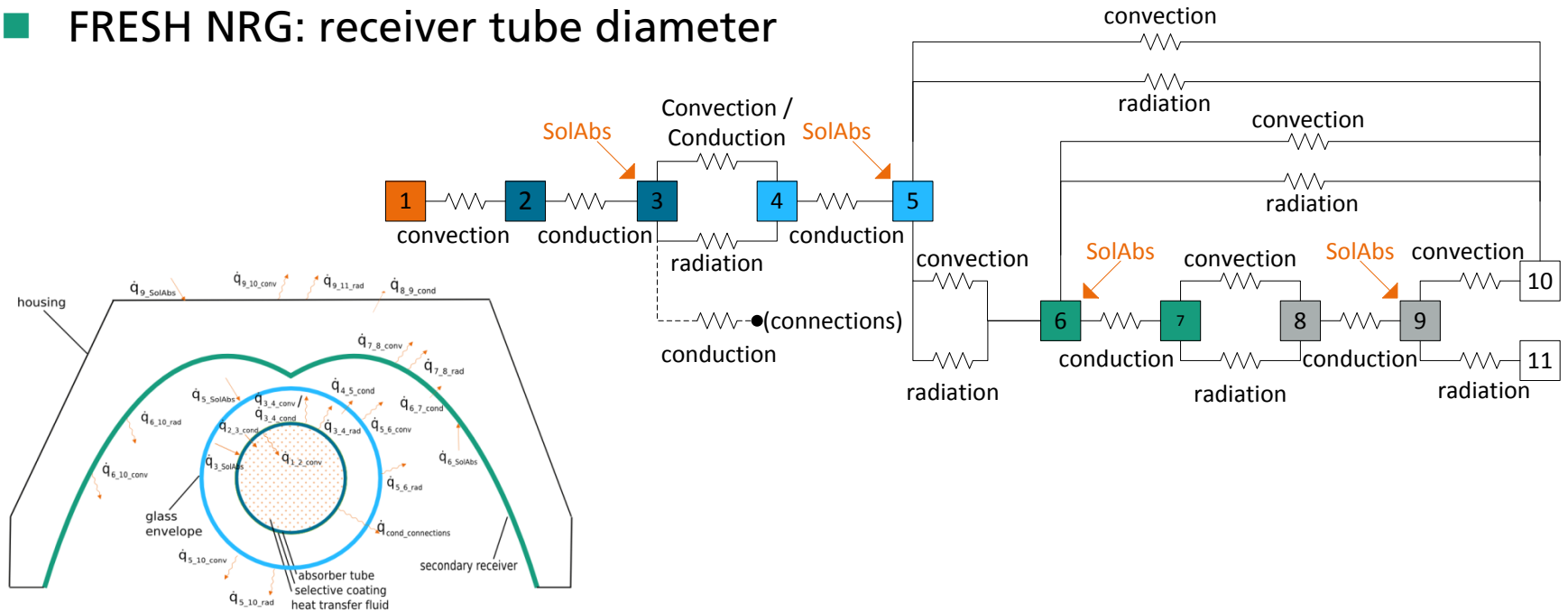
OVERVIEW

Tasks of Fraunhofer ISE in FRESH NRG

- Design optimisation through detailed modelling
  - Thermal modelling and simulation
  - Optical modelling and simulation
- Quality assessment and performance testing
  - Optical Lab tests – QA of primary mirrors
  - Optical field tests and other tests
  - Performance testing of prototype collector – Lab test
- Conclusions
- Outlook - Topics for ST Roadmap and future R&D

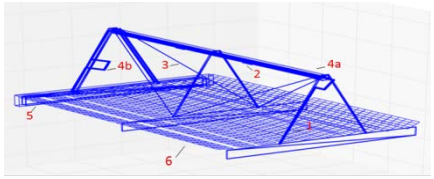
Design Optimisation Through Detailed Modelling
Thermal Modelling

- Heat loss model of LFC receiver: thermal resistance model TRM ➔
- Overall optimisations of optical gains vs. thermal losses
- FRESH NRG: receiver tube diameter

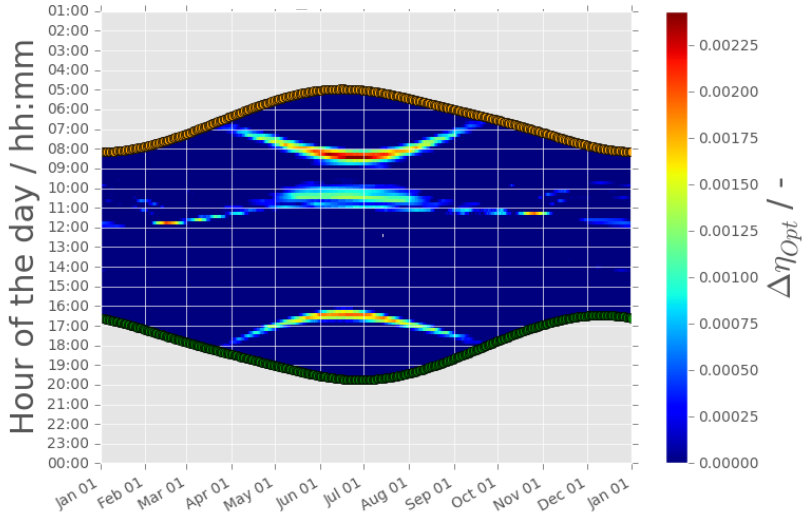


Design Optimisation Through Detailed Modelling
Optical Modelling

- Detailed ray tracing models
  - Material properties, opt. errors
  - Details of collector geometry
  - …



- Assessment of optical yield, IAM and collector efficiency
- Detailed loss analysis
- Assessment and optimisation of collector design



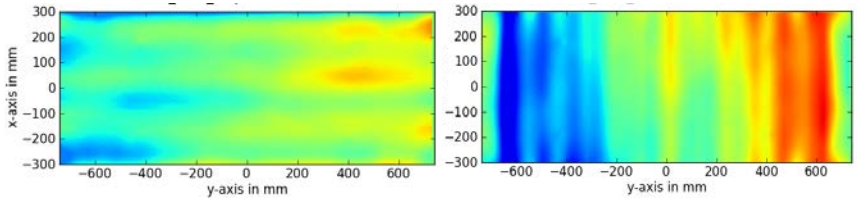
Example: Change of momentary optical efficiency resulting from a slight modification in coll. design

Quality Assessment and Performance Testing
Optical lab testing of primary mirror quality

- Analysis of accuracy of primary mirrors (surface slope) using
- Deflectometry (Fringe reflection)

➡ Detailed 2D map of surface slope deviations

- Quality assessment of manufacturing process
- Used in optical simulations
- collector design considering ‚real' properties of mass manufactured components



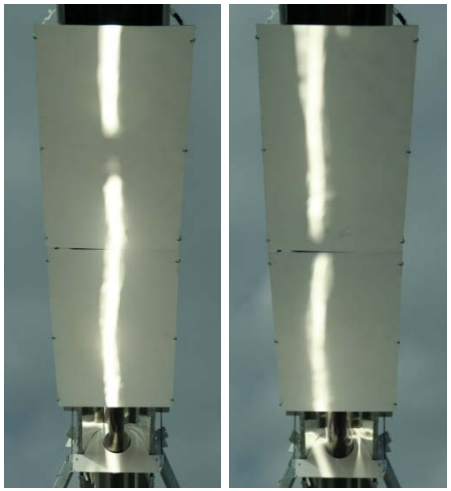
Surface slope deviations of LFC primary mirrors measured using deflectometry (fringe reflection)

Quality Assessment and Performance Testing
Optical tests and other tests in the field

- Deflectometry
- Luminance imaging, optical loss analysis
- Surveying / tachymetry of collector mounting and orientation

➡ Pointing and tracking accuracy , … - verification of function

Field measurements: Deflectometry



Luminance of focal line / loss analysis

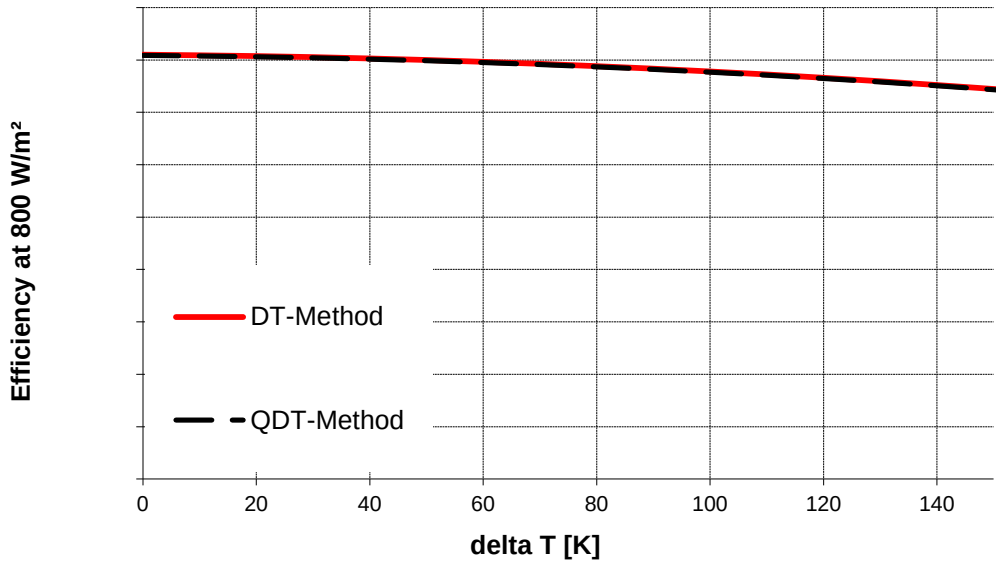
Tachymetry

Quality Assessment and Performance Testing
Laboratory Prototype of FRESH NRG Collector

- 12 m long collector prototype installed on roof of Fraunhofer ISE
- Performance test according to international standard EN ISO 9806 (2013)
- Pressurised water circuit, tested at temperatures up to 220°C

Quality Assessment and Performance Testing
Laboratory Prototype of FRESH NRG Collector

- Efficiency curve and IAM - Measurement vs. detailed simulation
- Collector performance is outperforming project goals (evaluation of last high temperature measurements ongoing work, still pending)

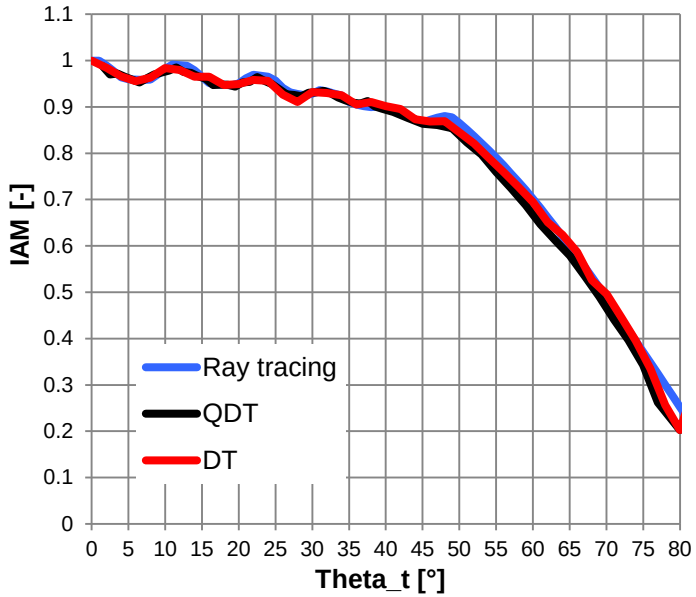


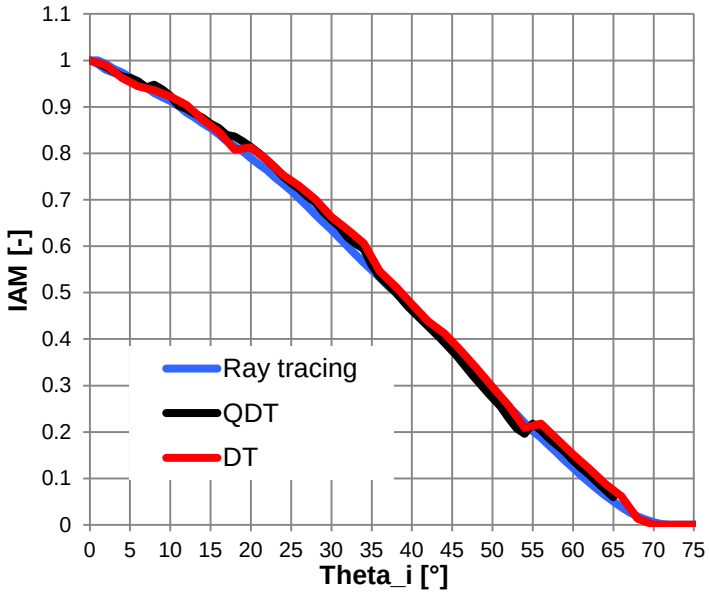
Measured collector efficiency

DT: Dynamic testing
QDT: Quasi dynamic testing

Quality Assessment and Performance Testing
Laboratory Prototype of FRESH NRG Collector

- Transversal and longitudinal IAM - Measurement vs. detailed simulation
- Collector performance is outperforming project goals (evaluation of last high temperature measurements ongoing work, still pending)
- Excellent agreement between measurement and simulation





Conclusions

- Detailed measurement of characteristics are provided (materials, components, collector); results are used in
- Detailed modelling (thermal and optical) and yield prediction
- Optimisation of design, feedback and QA to manufacturing
- Collector performance testing

➡ Very good agreement between simulation and measurement

➡ Result: FRESH NRG collector is outperforming project goals

➡ Technically sound solutions exist and can be provided to the market

Outlook - Topics for ST Roadmap and future R&D

Technically sound solutions exist and can be provided to the market, both in terms of characterisation and products. Yet,

- Further cost reduction and efficiency improvements are desirable

- These are supported by further R&D, e.g. on
  - Material improvements (e.g. coatings, durability)
  - Industrial manufacturing, quality assurance (QA) in manufacturing and installations, production automisation, high volume production
  - Operation and maintenance, standardisation of systems, balance of plant, in-situ performance assessment
  - Technical transparency for comparison and buying decision through further standardisation

Thank you for your attention!

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