Optical Qualification of Parabolic Trough Receivers with a Solar Simulator Bench of the 2nd Generation

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DLR

Motivation of DLR to do qualification of parabolic trough receivers

- DLR goal: **Support the market launch of solar thermal power**

- Strategy
  - measurement technology development, publication, standardization
  - independent measurement services
  - …

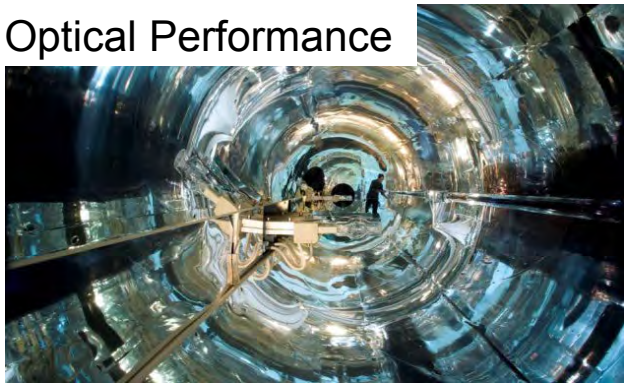
- Measurements relevant for
  - EPC
  - plant operator
  - manufacturers

→ **Reduced cost of solar thermal power**
  - best receiver for money
  - reduced risk costs

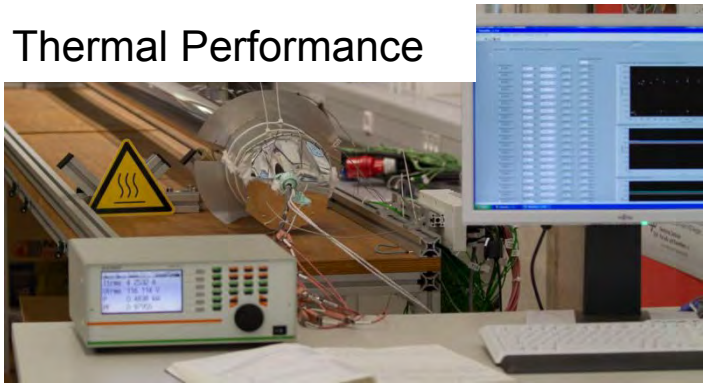
Parabolic Trough Receiver Testing at DLR

Performance Tests

Optical Performance

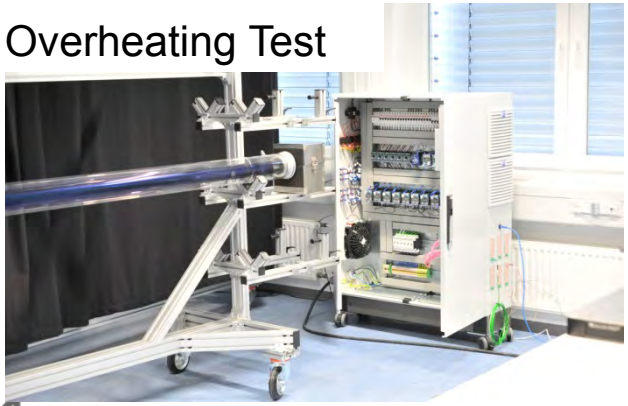


Thermal Performance

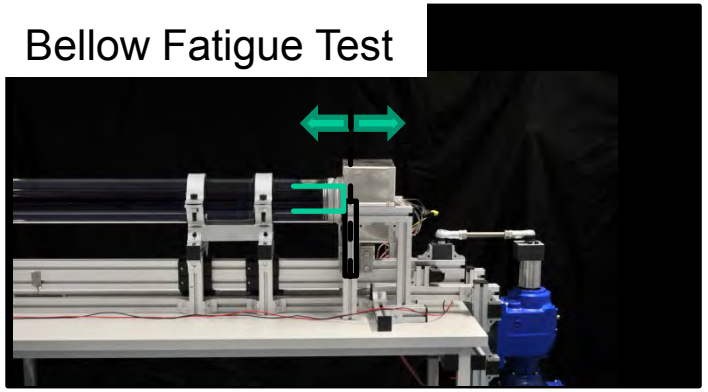


Acellerated Ageing

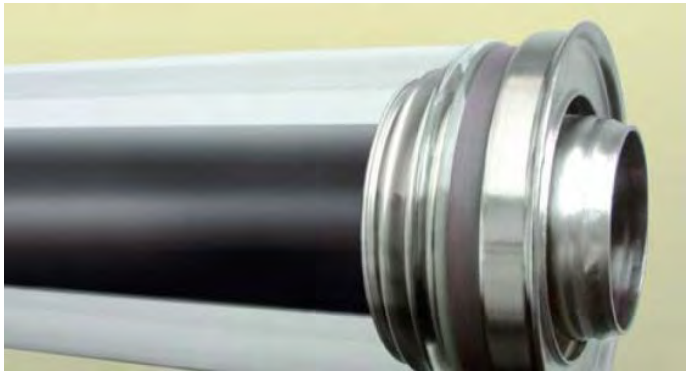
Overheating Test



Bellow Fatigue Test



Performance Parameters



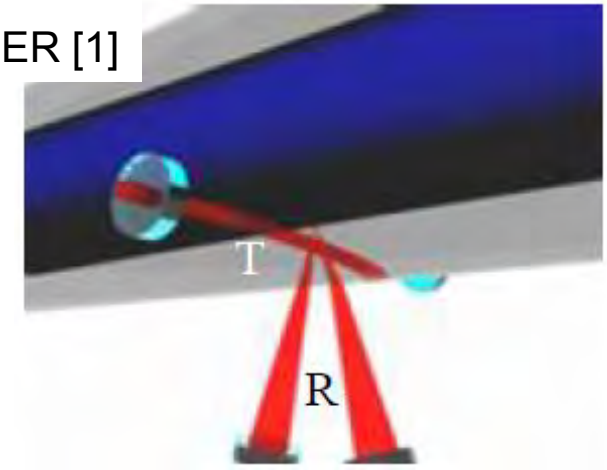
$$P_{coll} = \eta_{opt,rec} P_{in} - P_{th,loss}$$

- Optical efficiency $\eta_{opt,rec}(T)$
- Thermal loss power $P_{th,loss}(T)$

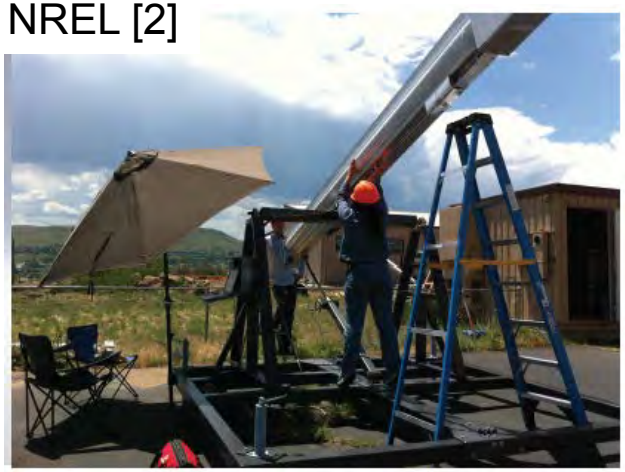
Non-destructive optical efficiency measurement at independent research institutions

DLR ElliRec, OptiRec

CENER [1]



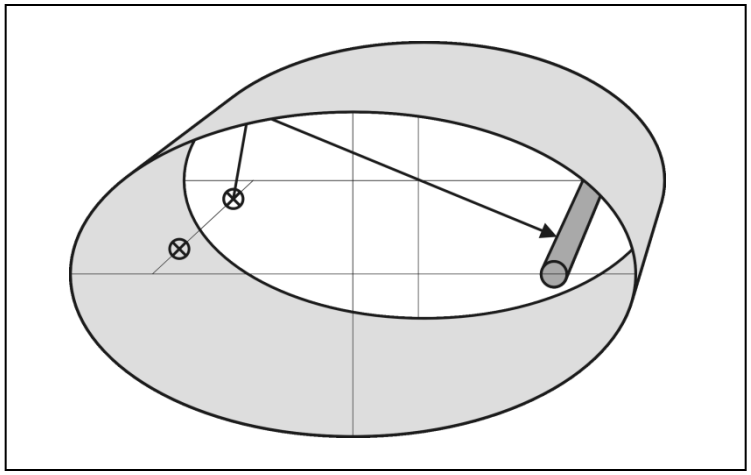
NREL [2]



DLR/Ciemat Kontas, Sandia Aztrac

[1] SolarPACES Granada 2011, Mateu
[2] SolarPACES Granada 2011, Kutscher

Solar Simulator Receiver Test Bench



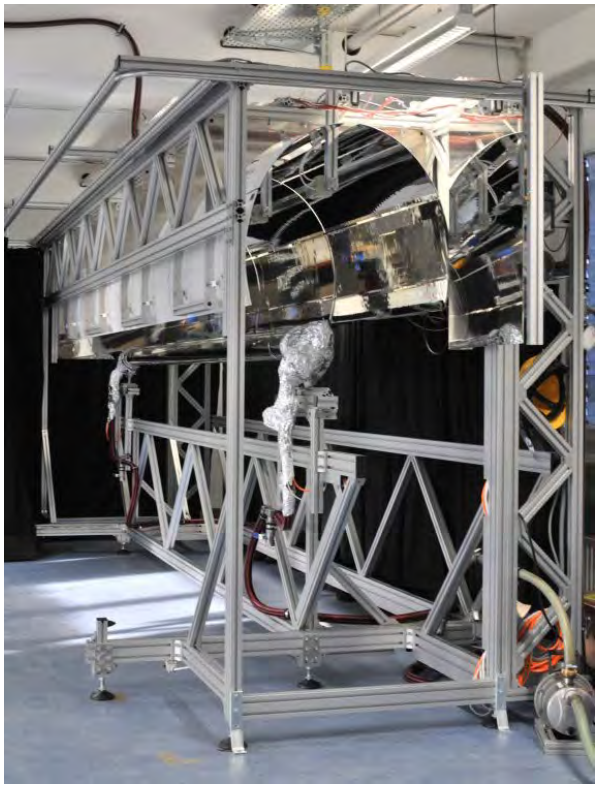
Principle
- calorimetric measurement of optical efficiency

Conditions
- solar simulator lamps
- elliptical mirror trough with flat end mirrors
- receiver at room temperature
- relative measurement (reference receiver)

Test benches

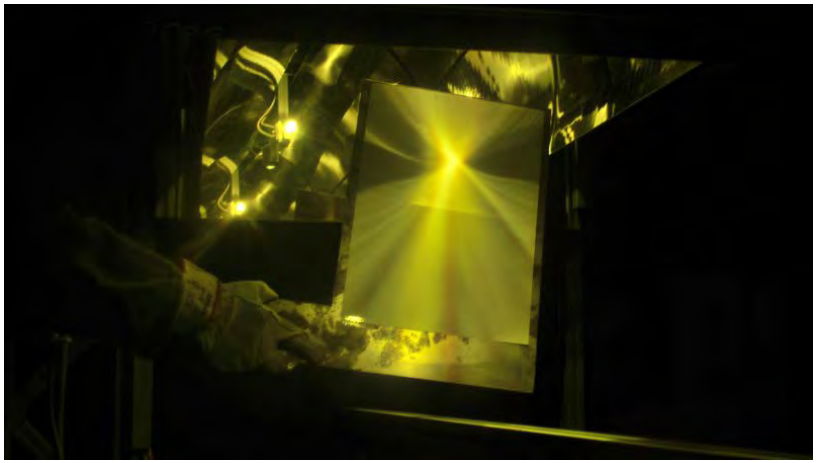
1st generation, ElliRec

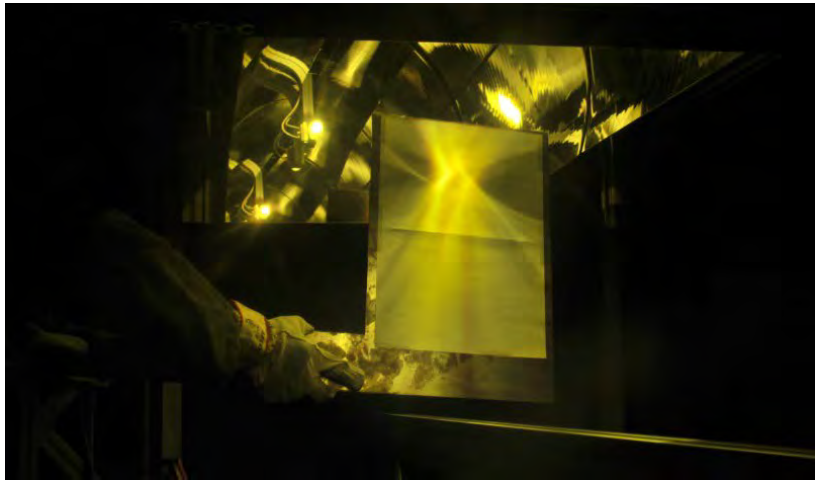
2nd generation, OptiRec



Test bench comparison

	1st Generation ElliRec	2nd Generation OptiRec
lamps	metal halide	metal halide
mirror	aluminum	glass
ellipse orientation	horizontal	vertical
semi major axis	1026 mm	500 mm
semi minor axis	700 mm	400 mm
numeric excentricity	0.73	0.6
lamps	4x 4kW	6x 2.5 kW
receiver change during operation	no	yes
flow rate	850 l/h	850 l/h
displacement body	yes	yes





Transfer to Real Collector

	Solar field	Solar simulator
Irradiance, spectral	ASTM 173d	lamp * mirror
Irradiance, spatial	homogenious	homogenious
Irradiance, circumferential	inhomogenious	inhomogenious
Irradiance, angular	all positions see all angles	angles and positions correlated
Temperature	300… 400 ° C	room temperature

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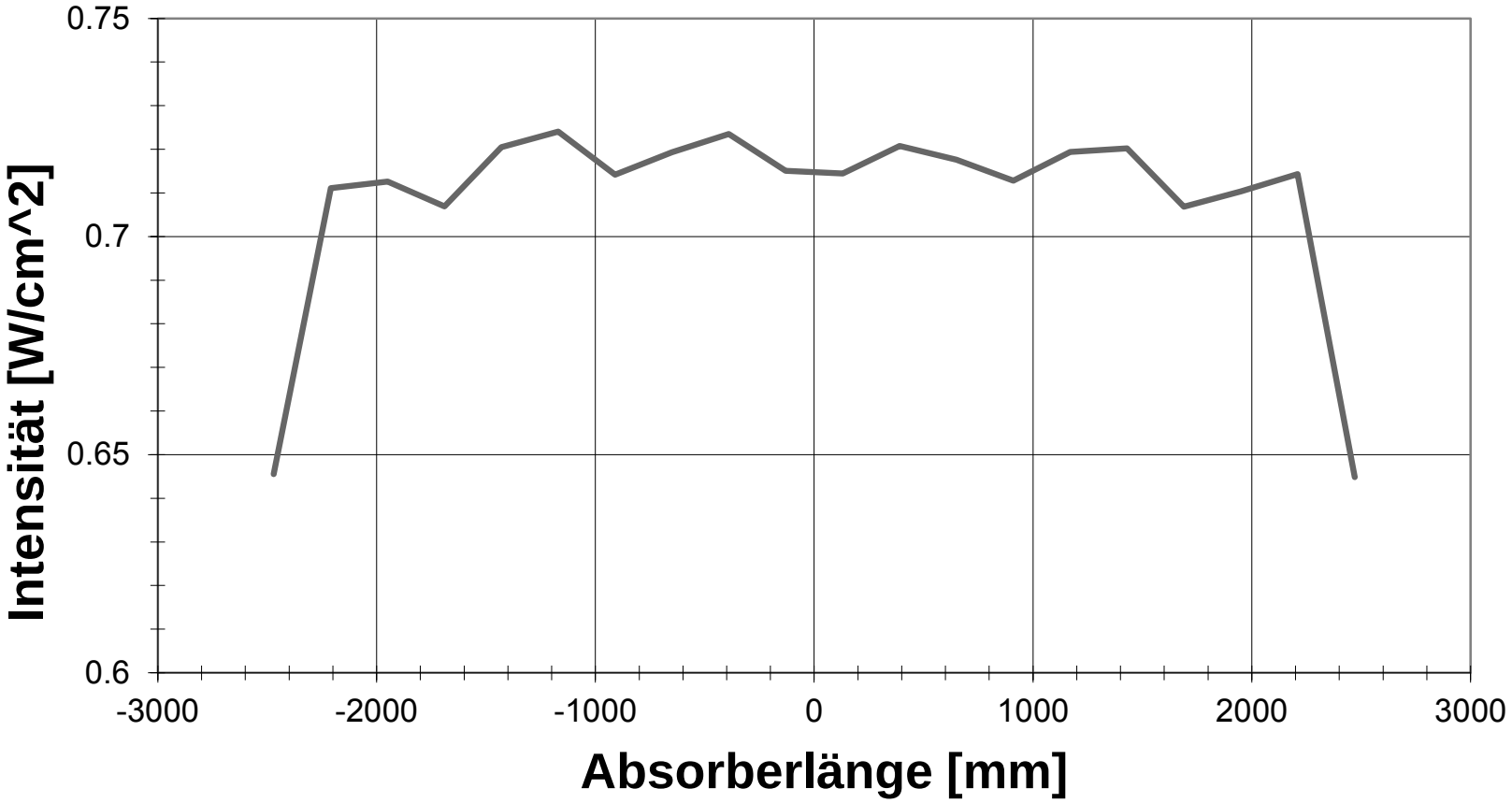
Temperature	300… 400 ° C	RT

Längsverteilung über den Umfang gemittelt (Simulation)



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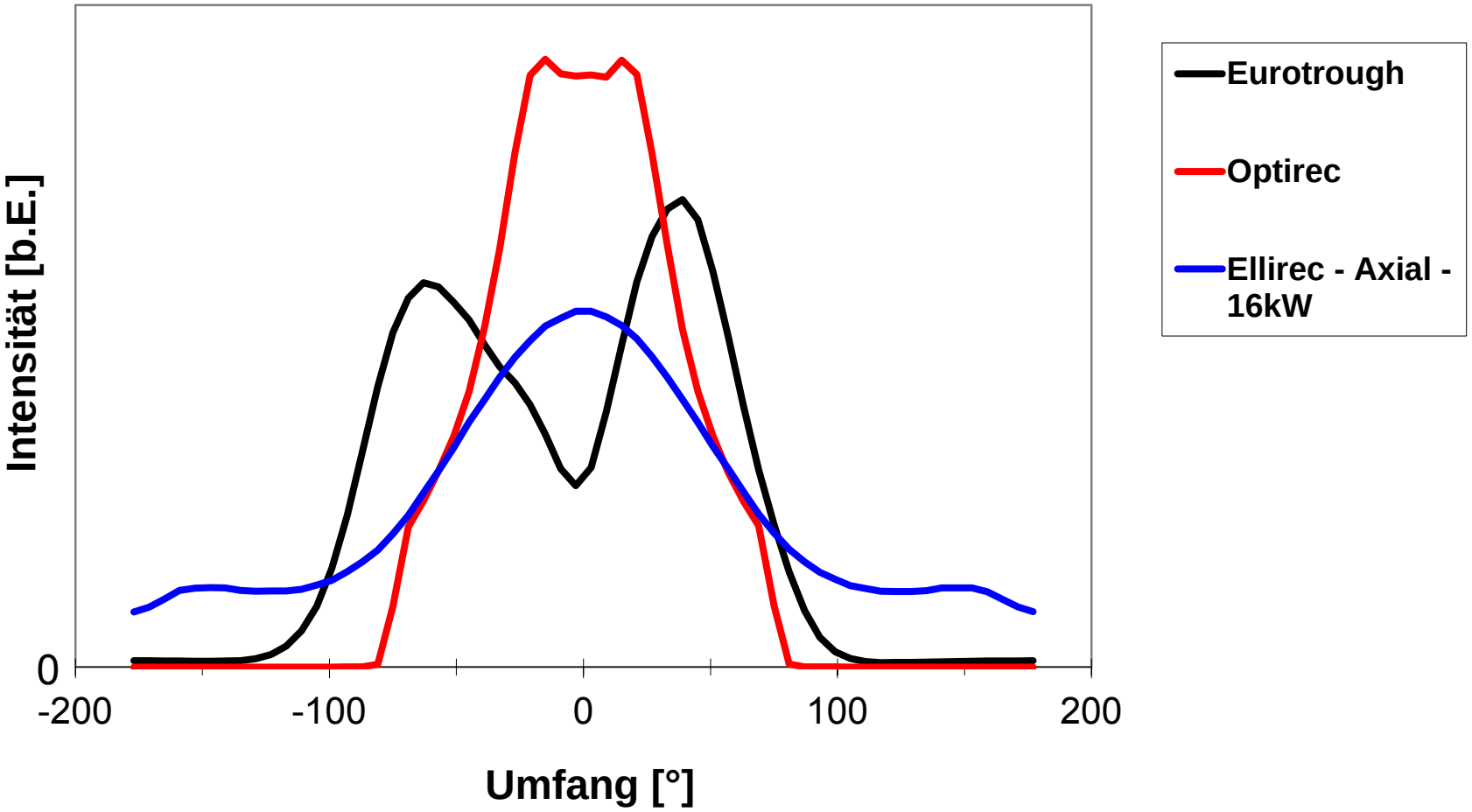
Umfangsverteilung gemittelt über die Absorberlänge
skalierte Flächen



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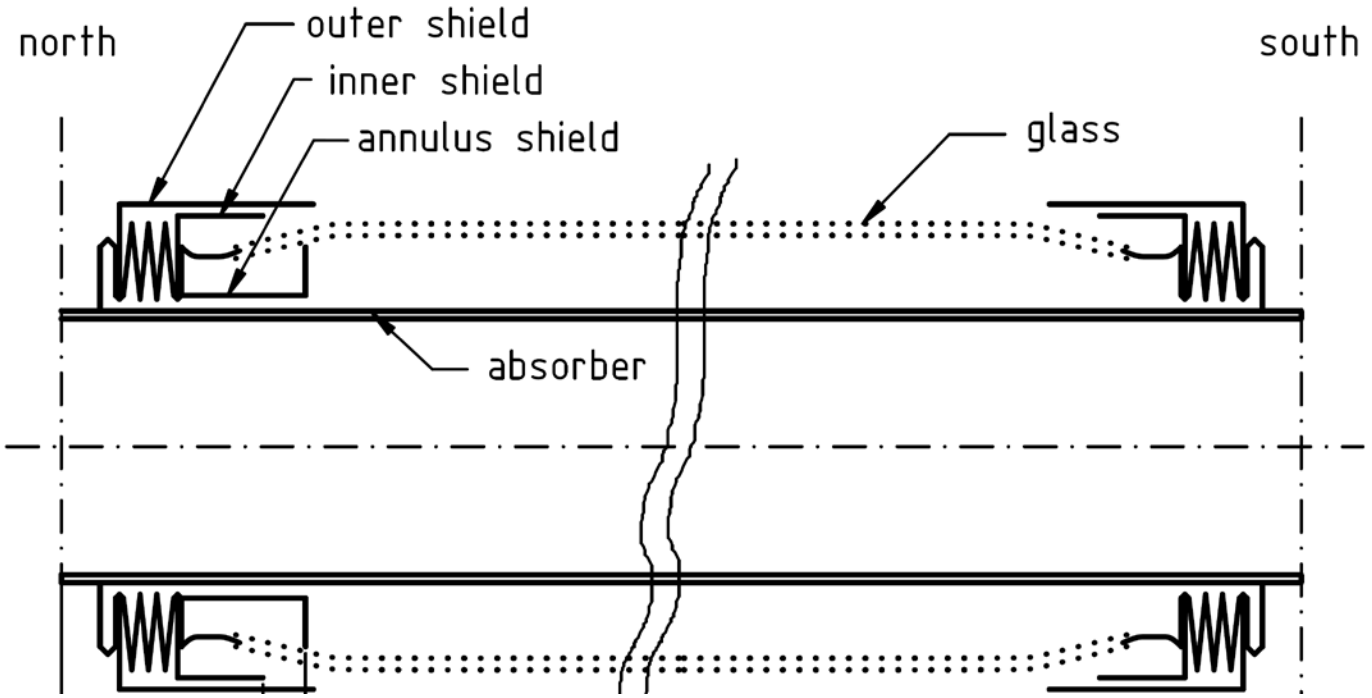
Correction for optical efficiency at operating temperature



Approximation:
incidence angle = 0

Conclusion and Outlook

- 2nd generation of linear focus solar simulator test bench, has been developed, 1st measurements have been performed

- High reproducibility $\sigma \sim 0.2$ %

- Investigation of systematic effects ongoing
  - spectral
  - angular