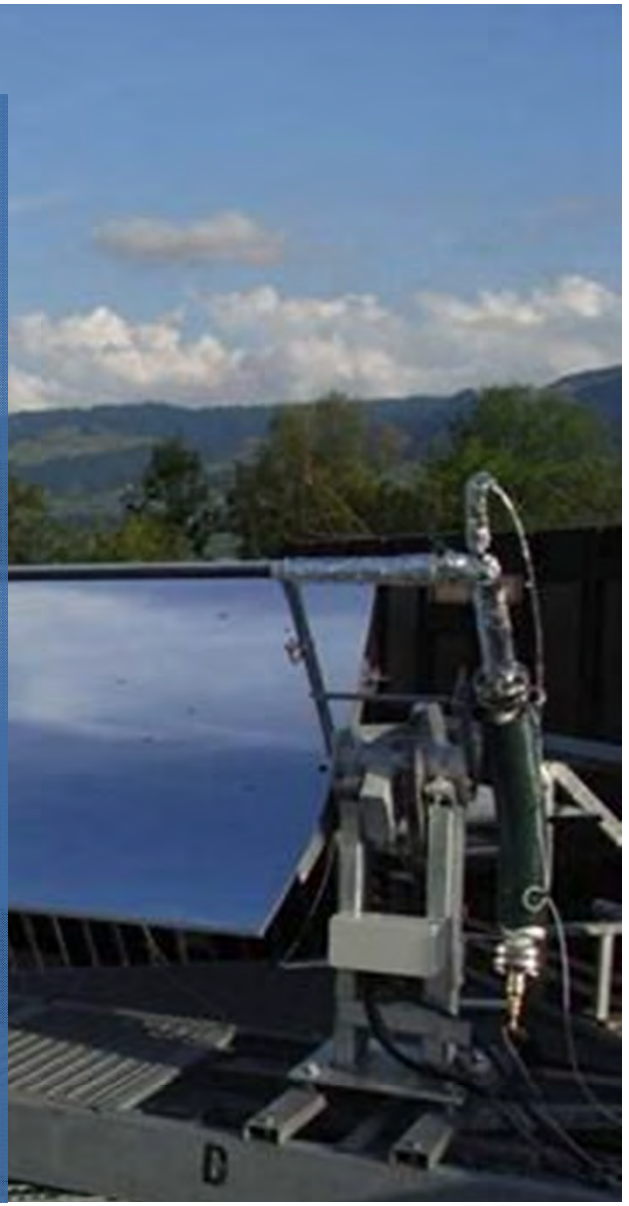
Receiver

heat loss method and measurement results



Marco Larcher
SPF - Institut für Solartechnik
University of Applied Sciences Rapperswil (HSR)

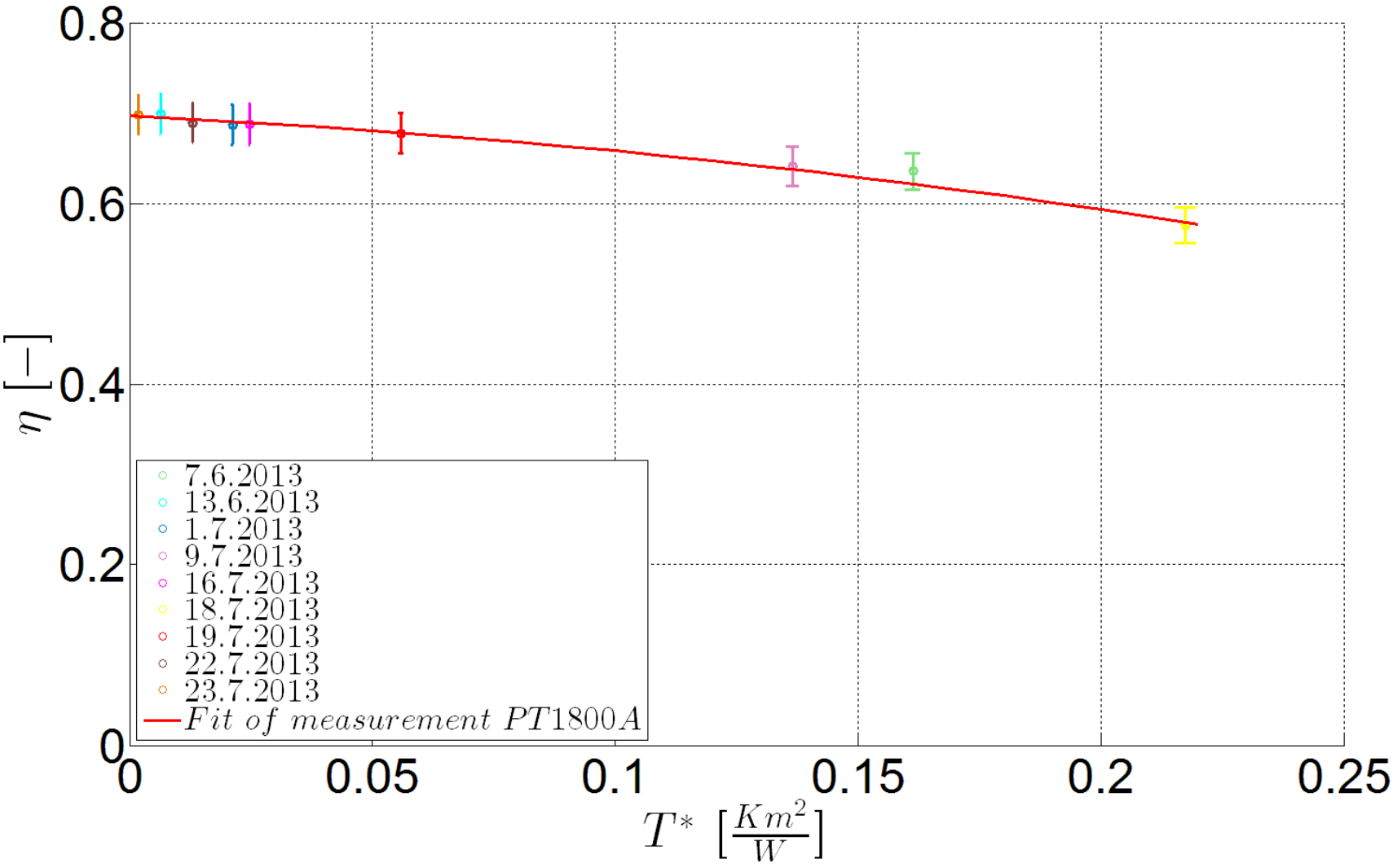
HSR
HOCHSCHULE FÜR TECHNIK
RAPPERSWIL
FHO Fachhochschule Ostschweiz

SPF
INSTITUT FÜR
SOLARTECHNIK

SPF Test Rig: HoTT200

- **Circuit specifications:**
  - Water as fluid (water-glycol mixture possible)
  - Mass flow range 100 kg/h up to 1500 kg/h,
    Two coriolis mass flow meters, accuracy ± 0.1%
  - Fluid temperature up to 200°C at 20 bar_a
  - Heating power: 10kW
  - Cooling power: 20kW (water & air cooling)

Efficiency curve



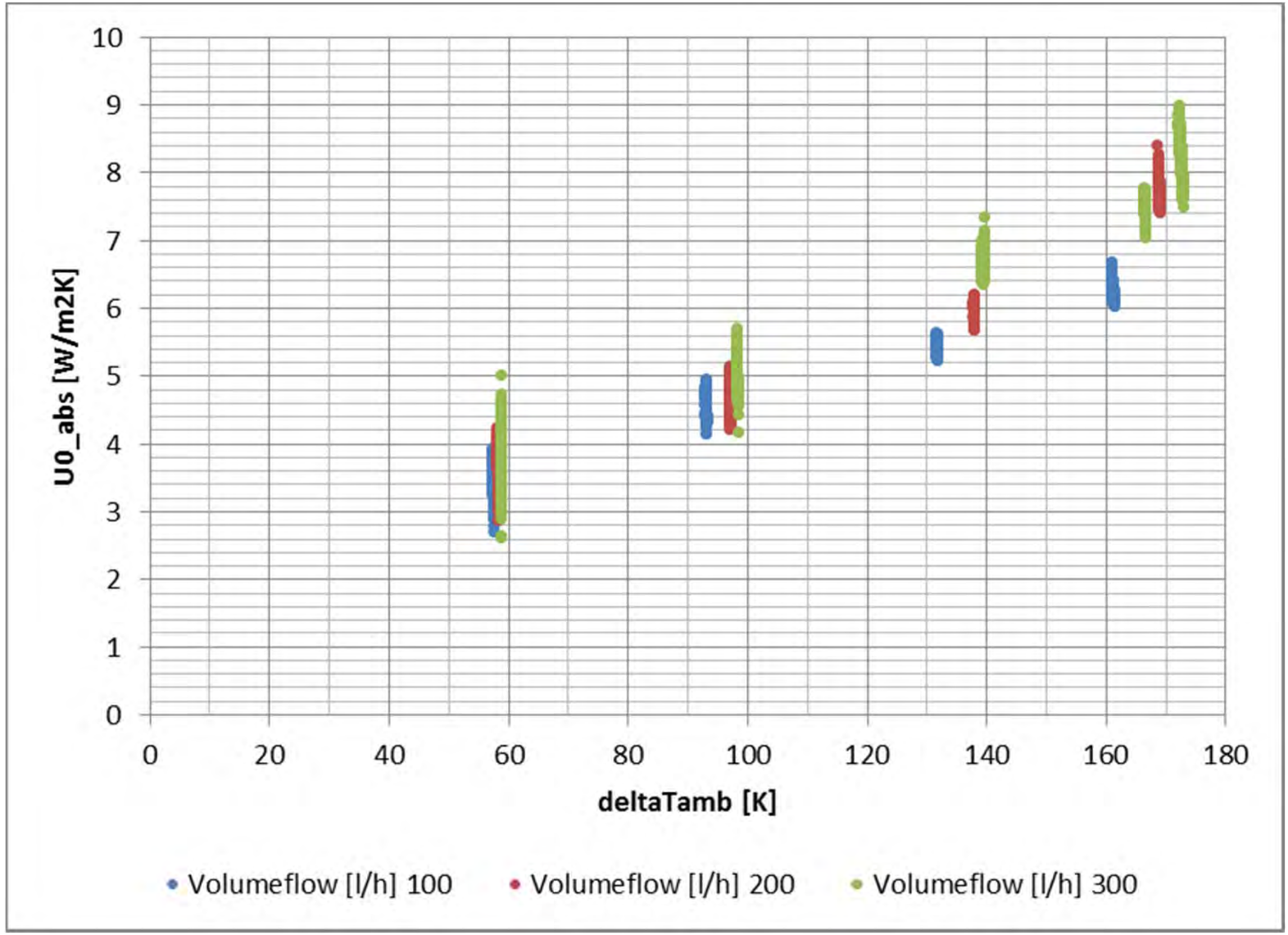
Why heat loss measurement?

- **Efficiency of a collector is a combination of optical efficiency and thermal losses**
  - $\eta_{coll} = \eta_{opt} - \frac{\dot{Q}_{loss}}{A_a \cdot I_{DN}}$
  - $\dot{Q}_{loss}$ heat losses of the collector ≈ heat losses of the receiver
- **To measure the hole efficiency curve of concentrating collector we need some clear days without clouds (minimum 3-5 days)**
- **Our idea to reduce the measurement duration (outdoor) is:**
  - Determine the optical efficiency at outdoor environment (at one sunny day!)
  - *Go into lab and measure the heat losses (independent of weather)* ← *focus*
  - Combine the two measurement for the efficiency curve of the collector

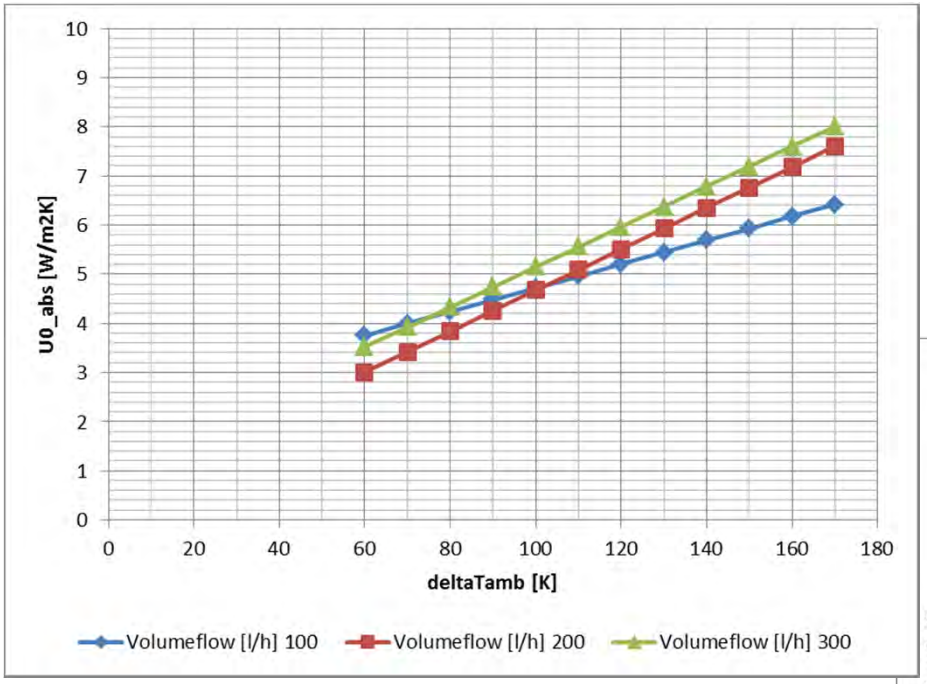
Thermal loss measurements at the SPF

- **Test collector/receiver:**
  - Length 4m, outer diameter of absorber 28mm
  - Not evacuated, with a selective coating
- **Measurements:**
  - Temperature drop over receiver (T_{in}, T_{out})
  - Ambient temperature (T_{amb})
  - Massflow ($\dot{m}$)
- **Calculation of the thermal loss coefficient $U_{0,abs}$**
  - $U_{0,abs} = \frac{\dot{Q}_{loss}}{A_{abs} \cdot \Delta T_{amb}} = \frac{\dot{m} \cdot c_p \cdot (T_{in} - T_{out})}{A_{abs} \cdot \left(\frac{T_{in} + T_{out}}{2} - T_{amb} \right)}$

Thermal losses results: 3 different flow rates

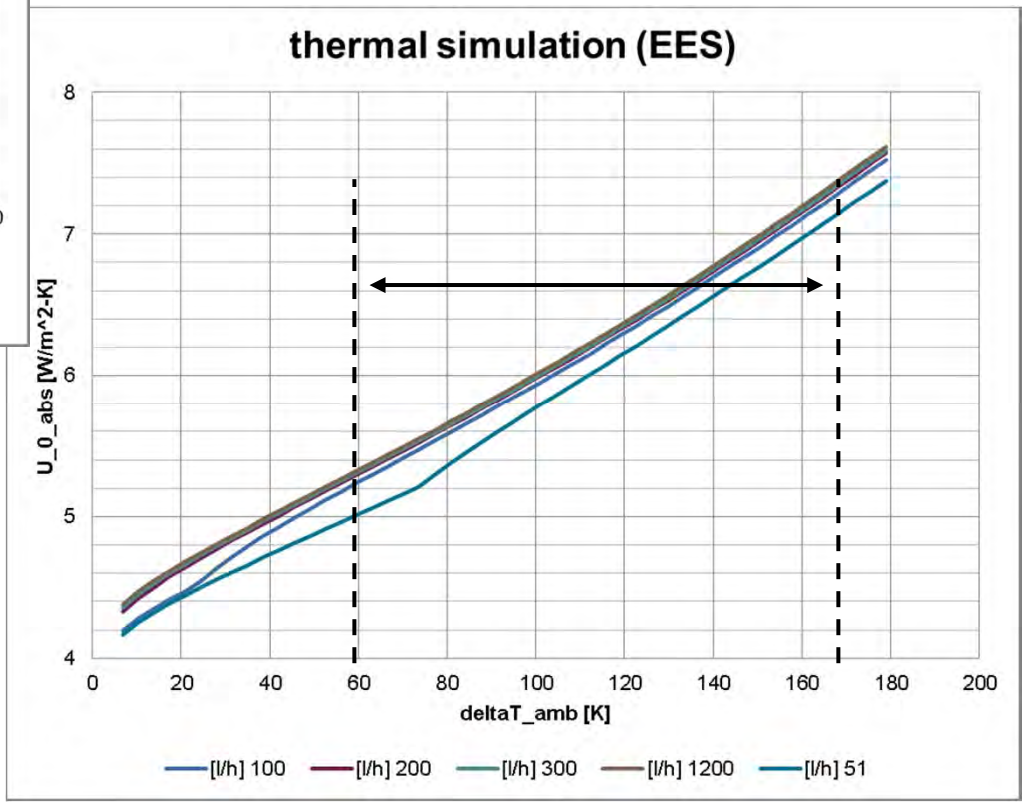


Thermal losses: measurement / simulation



heat loss simulation

heat loss measurement



To the Conclusion

- **Thermal loss measurement with flow trough absorber is…**
  - …close to the field reality
    - Flow conditions are measureable ➔ possibility for heat transfer optimization
  - …not easy to measure for evacuated receiver. The better the receiver the harder to measure. (small $\Delta T = T_{in} - T_{out}$)
  - However: Fast indicator for a first performance estimation
    → good (at least) for collector or receiver development
  - Further investigations need to be done to combine indoor and outdoor measurements for the efficiency curve