Modelling and optimization of transient processes in parabolic trough power plants with single-phase heat transfer medium

Sollab Doctoral Colloquium 2014, June 23, Odeillo, France

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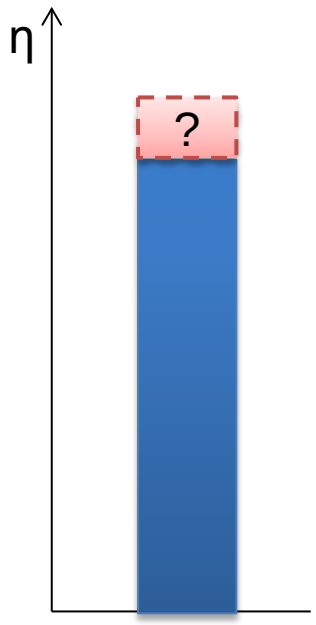
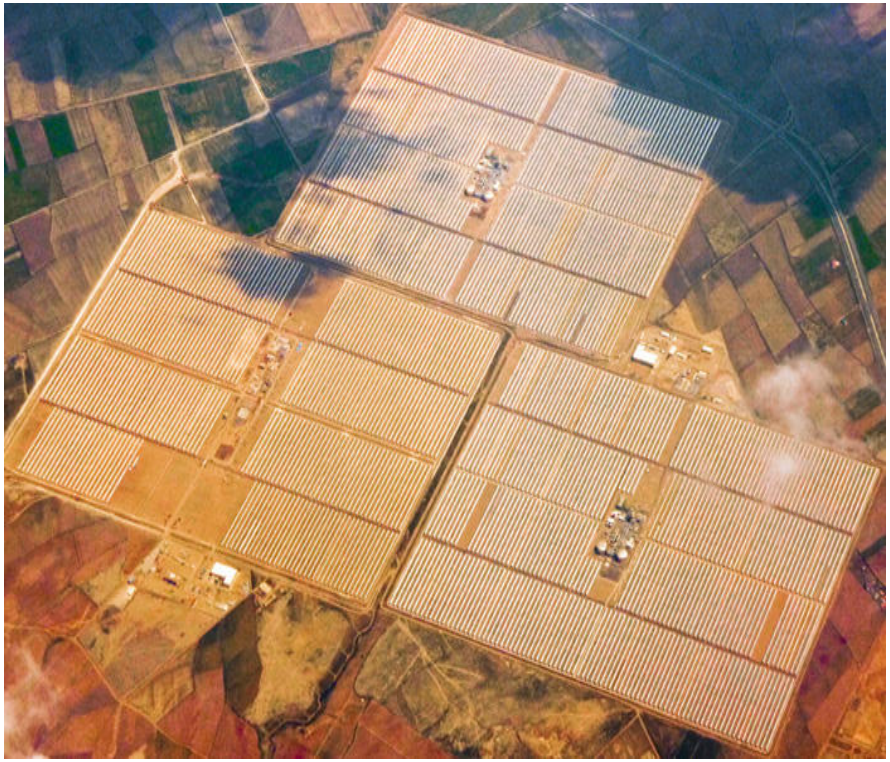
Motivation
Why more optimization?



- Optimizing **process control** not only efficiency of components
- Building of new plants offer the possibility to integrate more control measures
- We seek to represent a **whole** field with multiple loops in “real” weather conditions

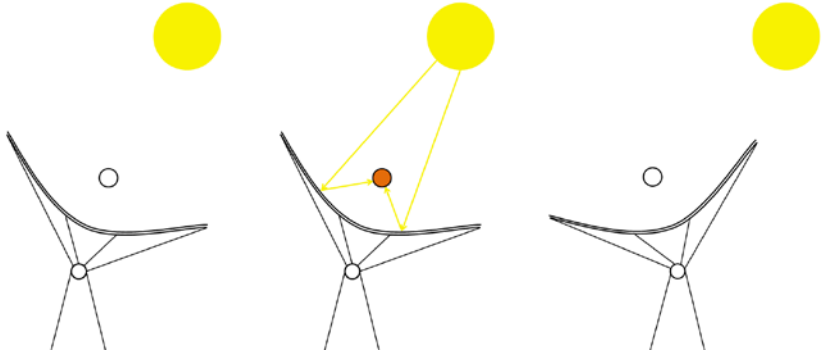
Motivation

How should the “operators” react to passing clouds?



Andasol thermal PP

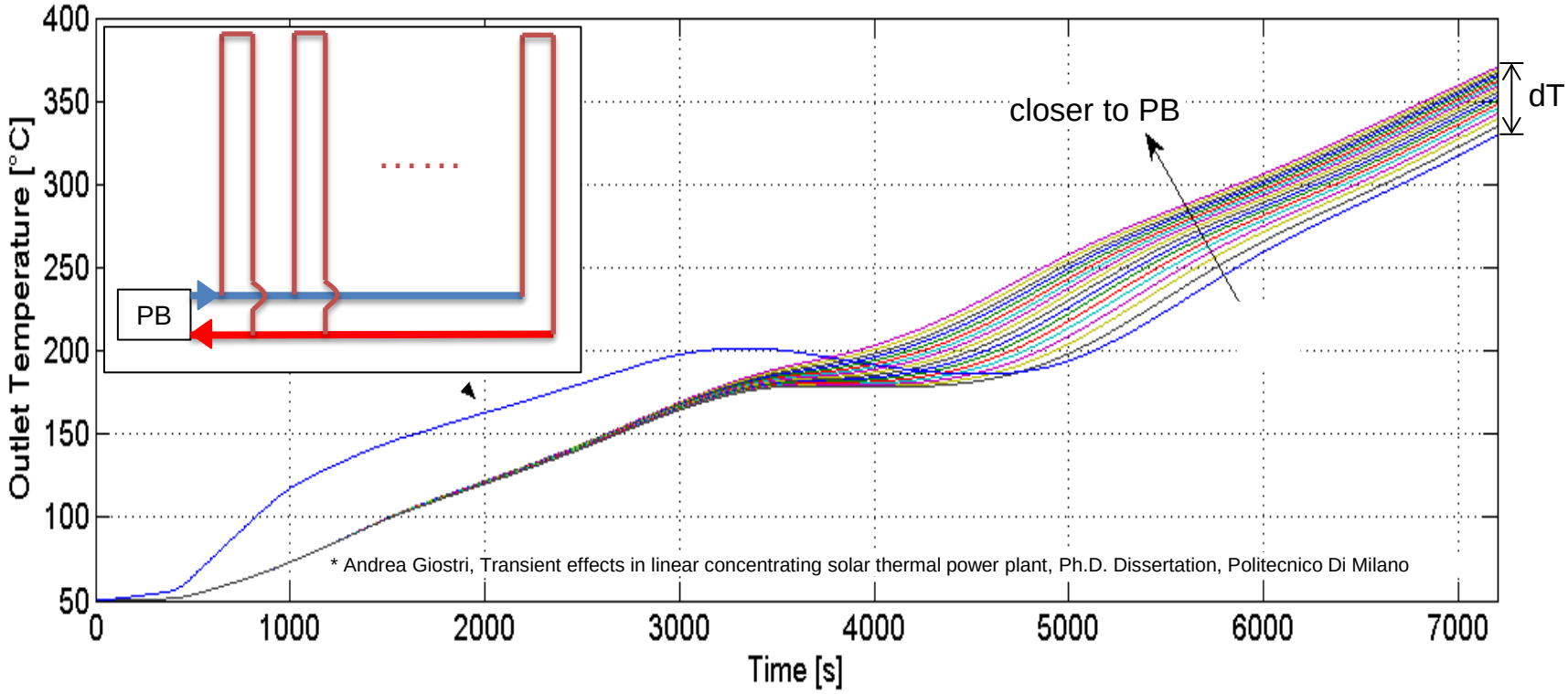
- Find optimal solutions to **balance** the increase in fluid temperature, losses due to defocusing of the parabolic mirrors and pumping power
- This is especially interesting for **molten salt** systems where the temperature limits (upper and lower) play an important role
- Could the control be **automated**?



Unshaded PTCs

Motivation

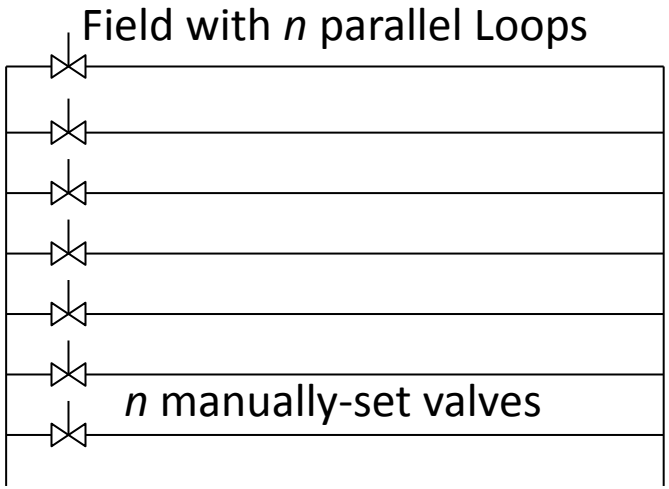
Could we further optimize start-up processes?



- Estimate the ideal mass flow as a function of time to achieve more efficient start-up procedures and avoid hydraulic unbalances

Motivation

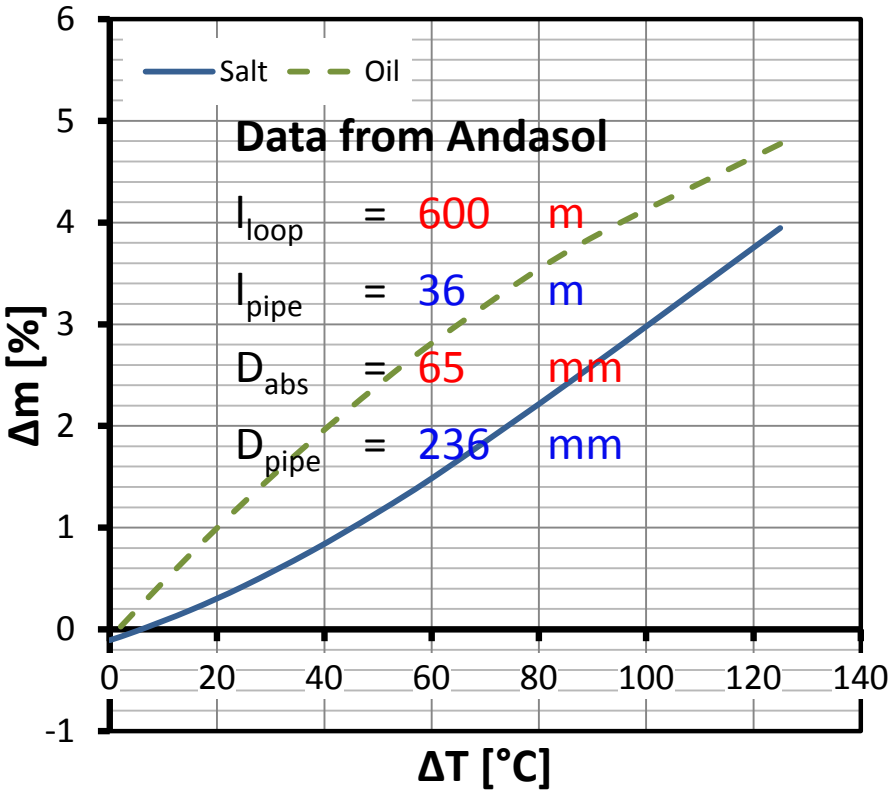
Could we make the hydraulic calibration process easier and more flexible?



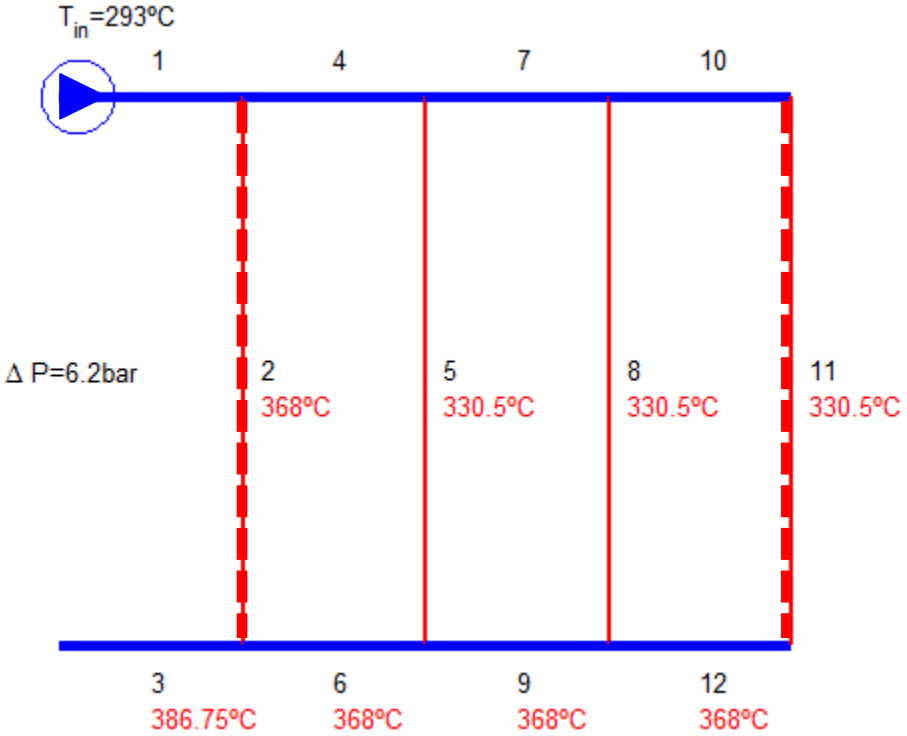
- A numerical tool could help with calibrating the hydraulic network to balance the mass flow rates in the parallel loops
- A steady-state calibration is not sufficient

Motivation

Mass flow variations with temperature difference between loops



Simulation set up for a network with 4 loops



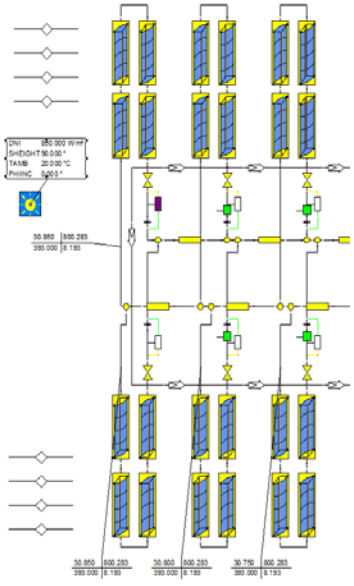
Δm and ΔT are the difference between the 1st and last loops in the network

Proposed Simulation Model

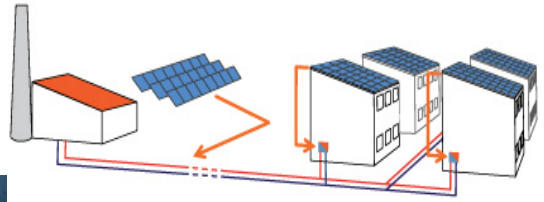
- **The numerical tool should be able to:**
  - Map the *hydraulic network* for multiple loops (including mass flow distributions)
  - Account for *time varying* weather conditions (DNI, T_{amb},…)
  - Be *robust* and *reliable* even with varying model parameters
  - Be *fast* for online computations with changing conditions, for example, passing clouds

Proposed Validation Methods

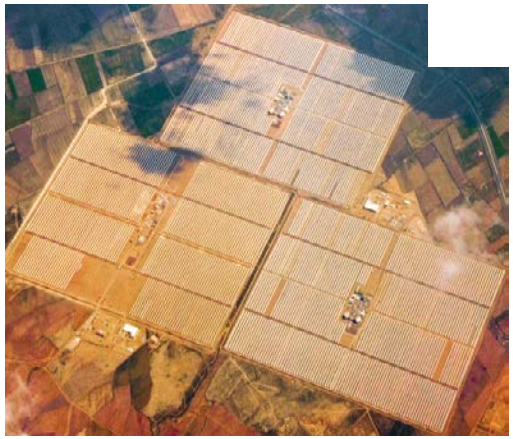
1. Comparing with single loop data, from either available numerical, analytical or experimental results
2. Comparison of mass flow distribution for multiple loops with either existing models or data from other applications (e.g. district heating)
3. Ideally, would be the comparison with data from fully operational solar thermal power plants (e.g. Andasol)



Schenk, H., Modelica model



http://www.solar-district-heating.eu/SDH.aspx



The PhD project

Phase I: development of the tool

Phase II: Applications

May 2014

- Selection of the basic equations
- Description of mass flow distributions
- Selection of suitable solution schemes
- Implementation
- Validation

- Optimization of the start-up processes
- Control strategies in the case of passing clouds

May 2017

Reminder! ☺

Monday 23 June

Change to local time

23 JUN 2014 - 13:00 Local time **GROUP B** Arena Corinthians Sao Paulo	NETHERLANDS	18:00	CHILE
23 JUN 2014 - 13:00 Local time **GROUP B** Arena da Baixada Curitiba	AUSTRALIA	18:00	SPAIN
23 JUN 2014 - 17:00 Local time **GROUP A** Estadio Nacional Brasilia	CAMEROON	22:00	BRAZIL
23 JUN 2014 - 17:00 Local time **GROUP A** Arena Pernambuco Recife	CROATIA	22:00	MEXICO

Thank you for your attention!
Questions?

http://www.schott.com/newsfiles/20070531190120_Solar.jpg