IGtH Institut für Geotechnik
Leibniz Universität Hannover

FFI FERNWÄRME FORSCHUNGSINSTITUT

Session 26: Future district heating production and systems

"Development of an empirical method for the determination of thermal conductivity and heat losses for pre-insulated plastic bonded twin pipe systems"

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Supported by:

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on the basis of a decision by the German Bundestag

1. Motivation and Introduction
2. Reservations and Advantages of PTPS
3. Methodology
4. First Results
5. Summary and Outlook

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Motivation and Introduction

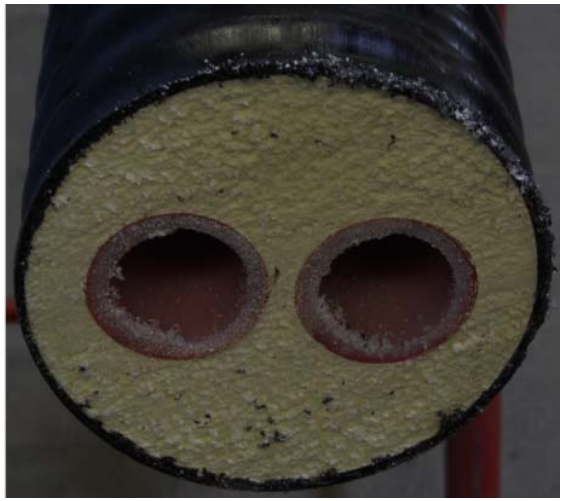
Motivation and Introduction

Affordable and Clean Energy: Energy Turnaround and "Heat Turnaround"

- Efficient energy systems for
  - Heat Supply
  - Heat Utilization
- District Heating (DH) enters focus of interest for politics, communities, …

How to develop DH?

- More efficient systems for Heat Distribution, such as "**P**lastic bonded **T**win **P**ipe **S**ystems"



Reservations and Advantages of PTPS

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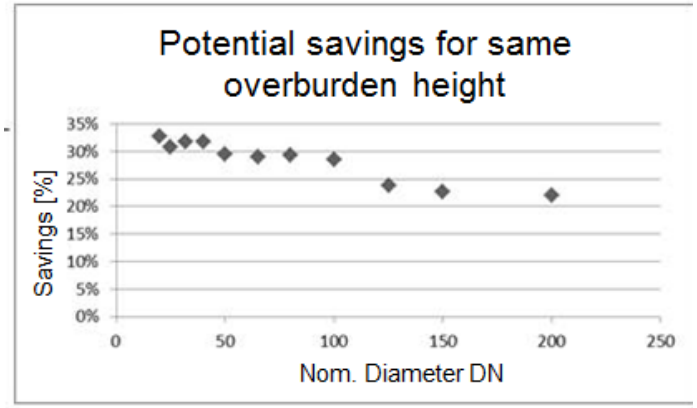
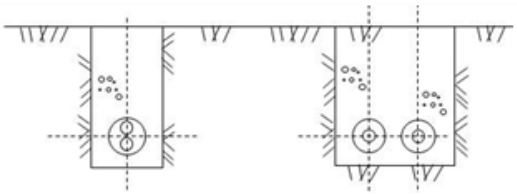
"**P**lastic bonded **T**win **P**ipe **S**ystems" a technology with many potentials …

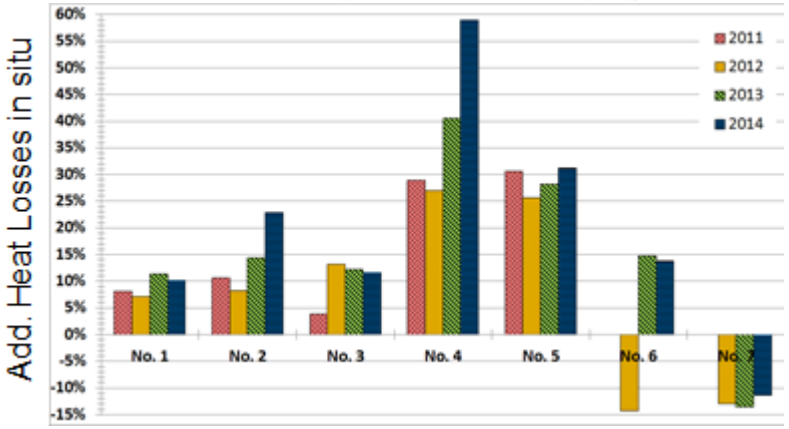
- Diminished heat losses
- Diminished costs for civil engineering
- Support DH expansion (for existing and new DH networks; …)





… and open questions

- ? Quantification of Heat Loss
- ? Interaction with soil/ bedding material
- ? Internal Stresses



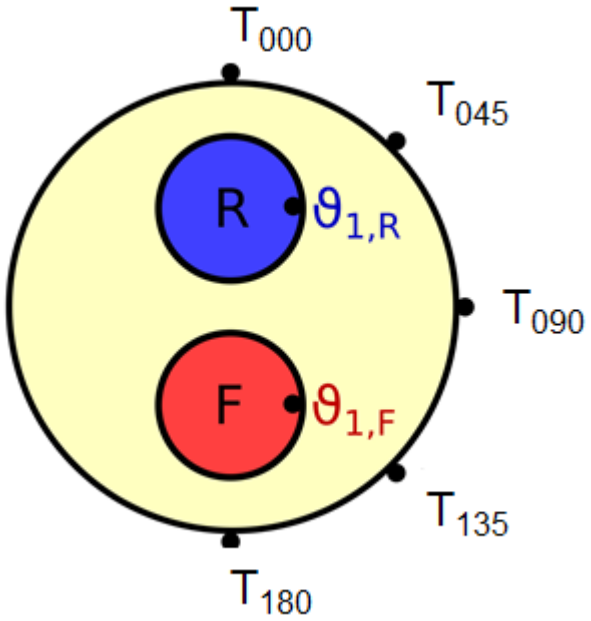
Methodology

Aim of Project:

1. Metrological Procedure to determine
   - ❖ Thermal Conductivity of Insulation
   - ❖ Heat Losses

   1st Step: Determination of Temperatures on Casing of PTPS T = T(φ)
2. Examination of stresses occurring
   - ❖ Inside PTPS
   - ❖ Outside PTPS

   1st Step: Determintation of Temperatures on Casing of PTPS T = T(φ) for Calibration



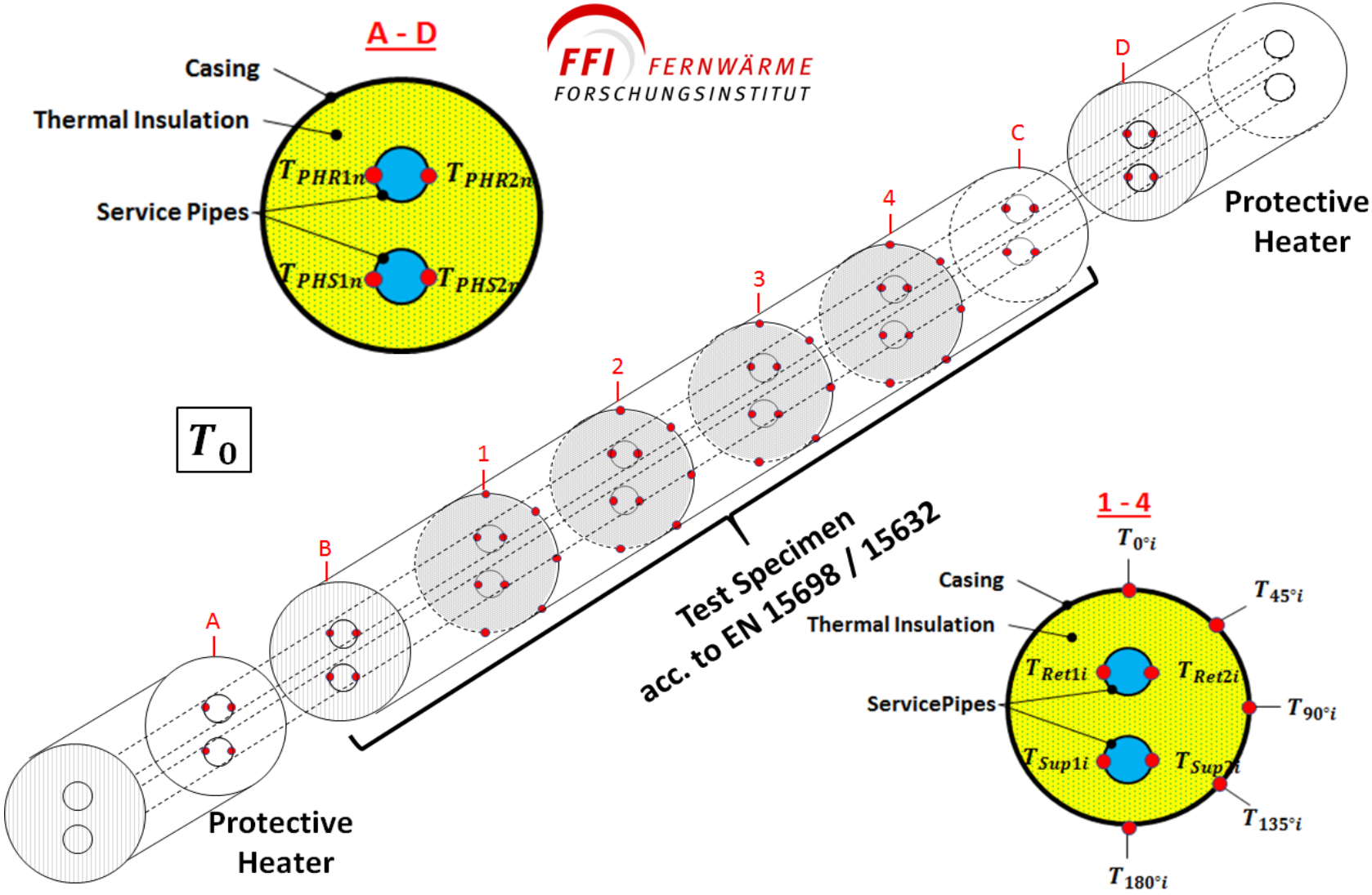
Methodology

Metrological Procedure to determine
Thermal Conductivity λ and Heat Losses q [W/m]

Experimental Set-Up for PTPS within a climate chamber basing on EN ISO 8497:

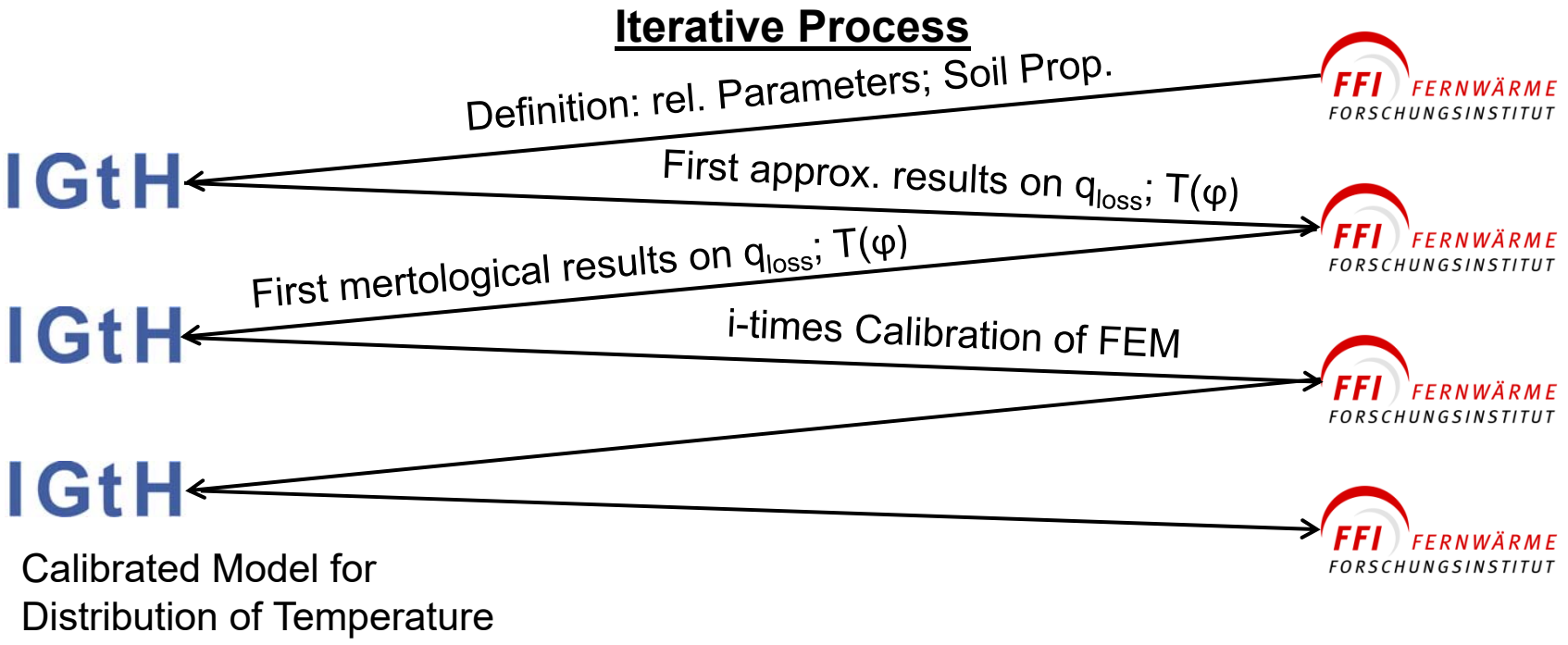
- Protective Heaters at each end of test specimen for minimizing influences of axial heat losses $q_{ax} \approx 0$ ($dT \approx 0$)
- Distribution of Temperatures on Casing $T = T(\varphi)$ at 4 cross sections
- Basing on heat losses q_{loss}, Thermal Conductivity λ shall be derived: $\lambda = \lambda\ (T = 50°C;\ p \approx 1bar) = \lambda_{50}$

Methodology



Methodology

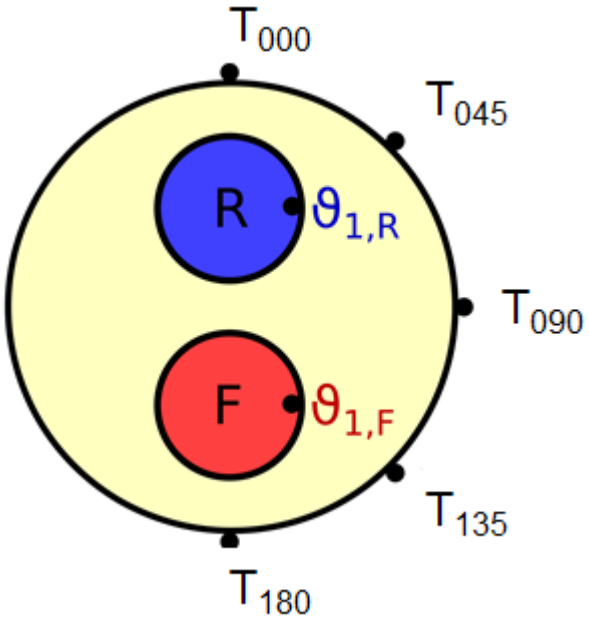
FEM-Simulation of Temperature Distribution within PTPS as a basis for Examinations on internal and external stresses

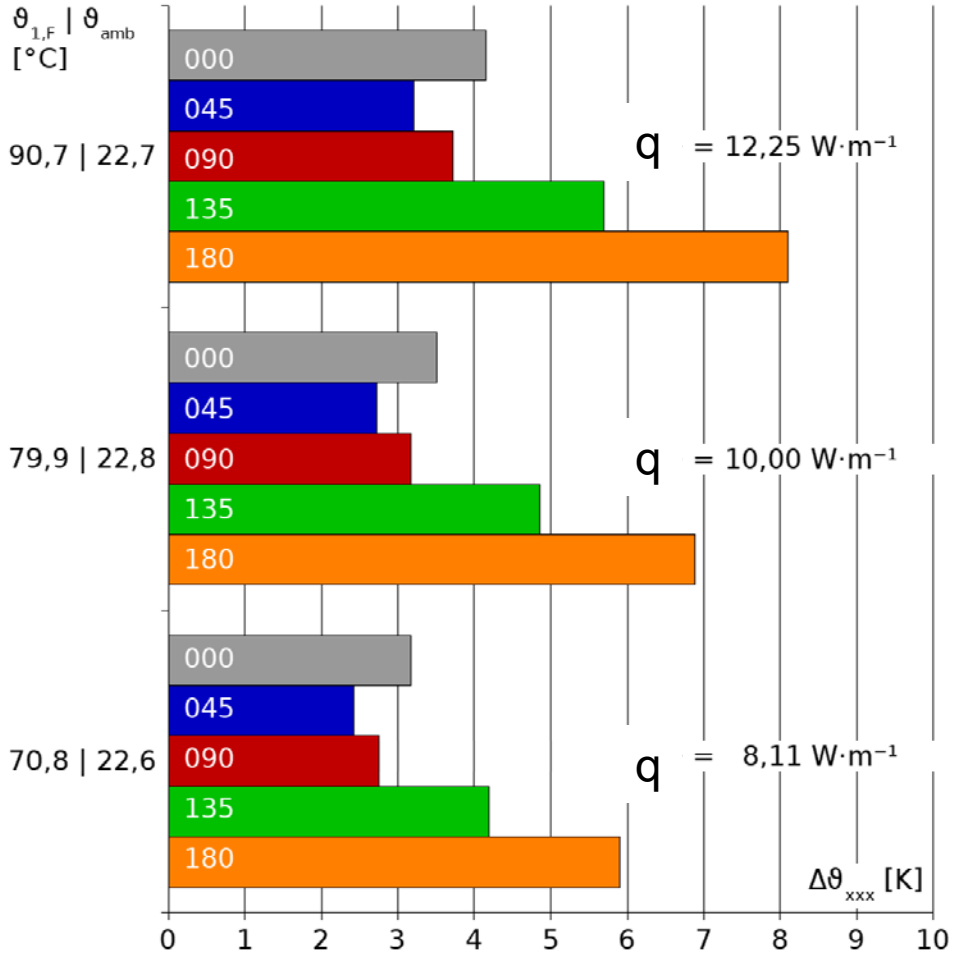


Calibrated Model for Distribution of Temperature

First Results

Metrological Procedure to determine
T = T(φ) & Heat Losses q [W/m]





First Results

FEM Simulation to determine
T = T(φ) & Heat Losses q [W/m]

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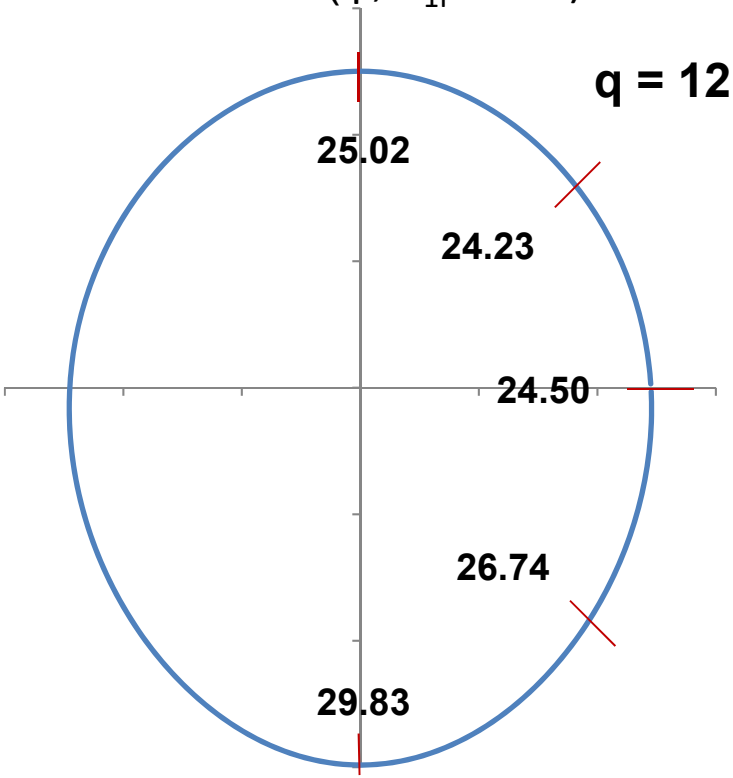
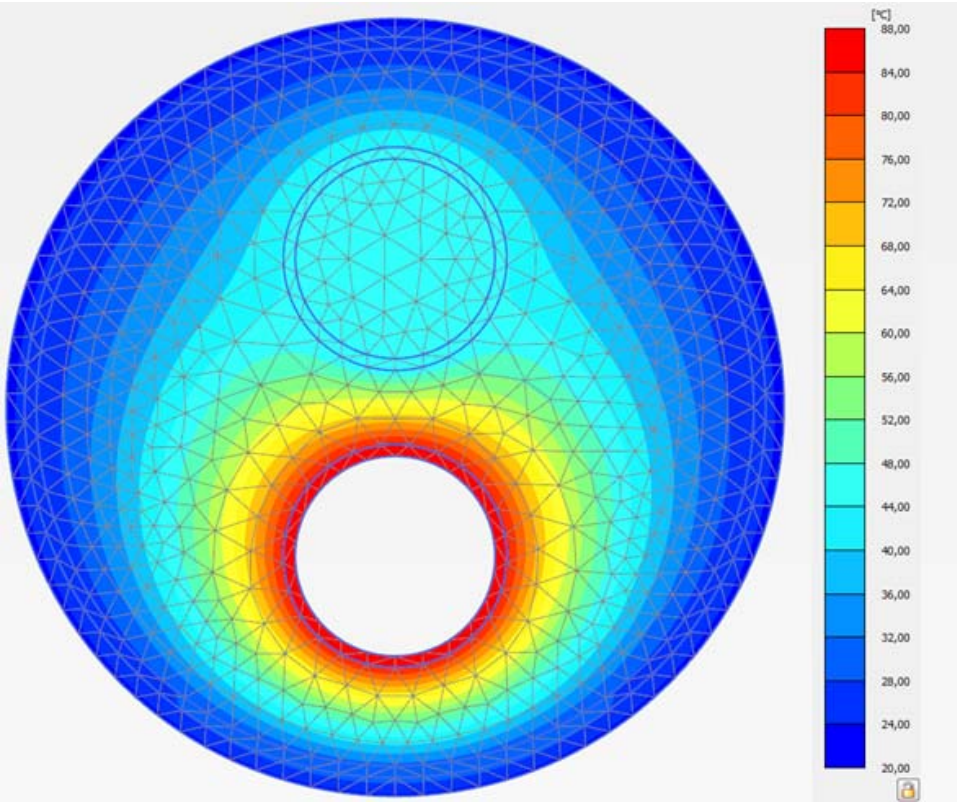
$T = T(\varphi; \vartheta_{1F}=85°C)$

q = 12.1W/m



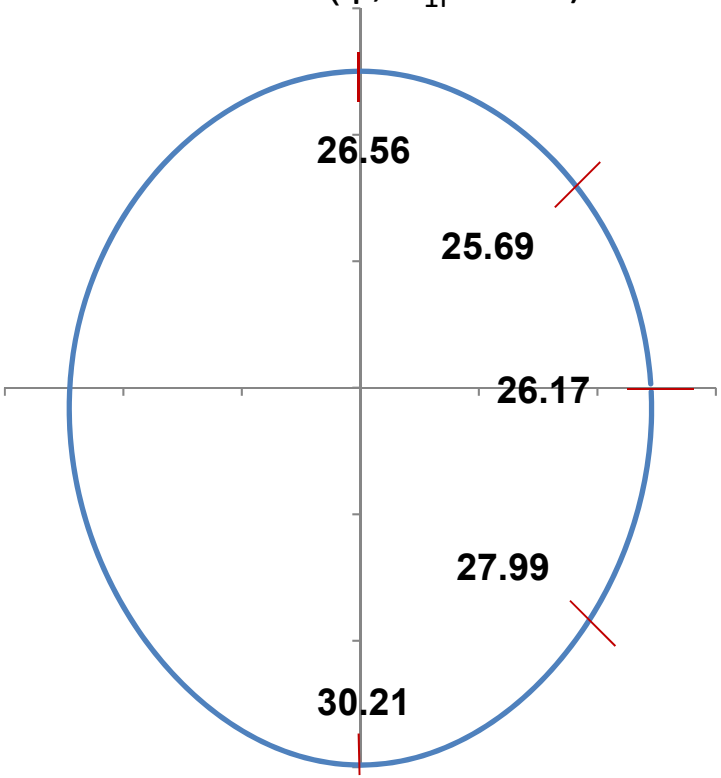


Summary and Outlook

Summary

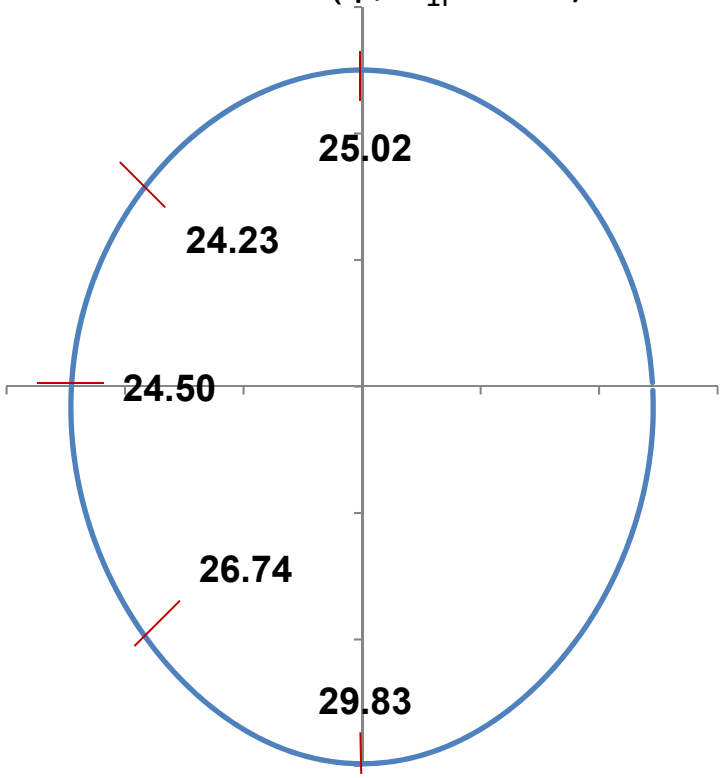
Comparison of Metrological Procedure and FEM-Simulations to determine **T = T(φ)** & Heat Losses q

T = T(φ; ϑ_{1F}=85°C)



DN 50+50/200	
Pos. [°]	$\lvert\Delta\vartheta\rvert$ [K]
0	1.54
45	1.46
90	1.67
135	1.25
180	0.38

T = T(φ; ϑ_{1F}=85°C)



Summary and Outlook

Summary

Comparison of Metrological Procedure and FEM-Simulations to determine T = T(φ) & **Heat Losses q**

DN 50+50/200				
$\vartheta_{1,F}$ | ϑ_{Amb} [°C]	Measured q [W/m]	$\vartheta_{1,F}$ | ϑ_{Amb} [°C]	FEM q [W/m]	Deviation [%]
70.8 | 22.6	08.11	70.0 | 22.5	09.23	+14.0
79.9 | 22.8	10.00	80.0 | 22.5	11.17	+11.2
90.7 | 22.7	12.25	90.0 | 22.5	13.12	+07.1

Summary and Outlook

Outlook

Identification of potential reasons for deviations:

- Influence of thermal bdry. layer outside PTPS
- Process of Production of PTPS (continuous, non-continuous)
- Local deviations in foam quality and properties

Integration within FEM models

Summary and Outlook

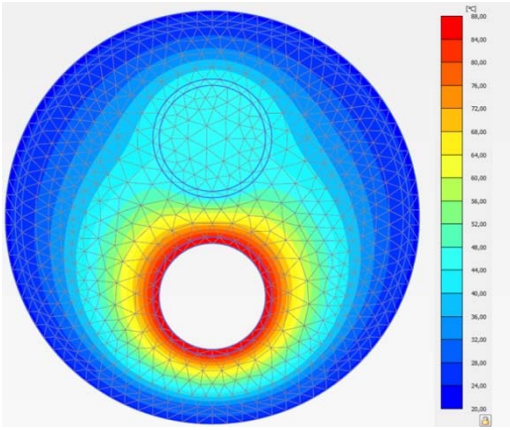
Outlook

Metrological Measurements on Interaction of

- Soil/ Bedding on Heat Losses occurring
- DH-network operation in situ on Heat Losses

FEM Simulations considering

- Internal and external stresses
- Thermal interactions of Return and Forward Flow



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Thank you for your attention!

Are there any comments and questions?

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