Jülich Centre for Neutron Science

MLZ Heinz Maier-Leibnitz Zentrum

Heat transfer analysis using FE-Method for the development of SANS-analyzer

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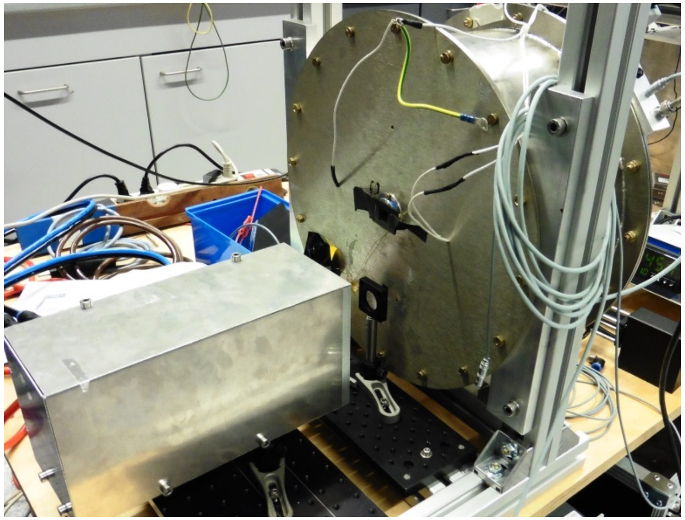
JCNS

- **Content**
  - Use and construction of the analyzer
  - The purpose of calculating
  - Using FEM for determining the temperature
  - Modeling and boundary conditions
  - Results
  - Summary

- **Use and construction of the analyzer**
  - In-situ compact 3He neutron spin filter analyzer for KWS instrument
  - The system is based on SEOP technique
  - The 3He cell is polarized at about 200˚C using high power laser
  - For homogeneous magnetic field the 3He cell and solenoid shielded with mu-metal sheet



The main components of analyzer are:

3He cell, oven, laser, mu-metal sheet and magnet coils

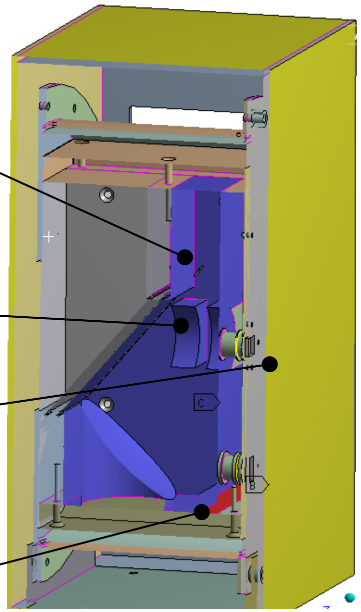
- **The purpose of calculating**

The cell is placed in an electrical oven

- Desired temperature :

T_3He cell: 200˚C

T_sample and at the mu-metal sheet: <40˚C



heater

Analyzer model
(cylinder form, section)

- **Using FE-Method for determining the temperature distribution**

- Experimental

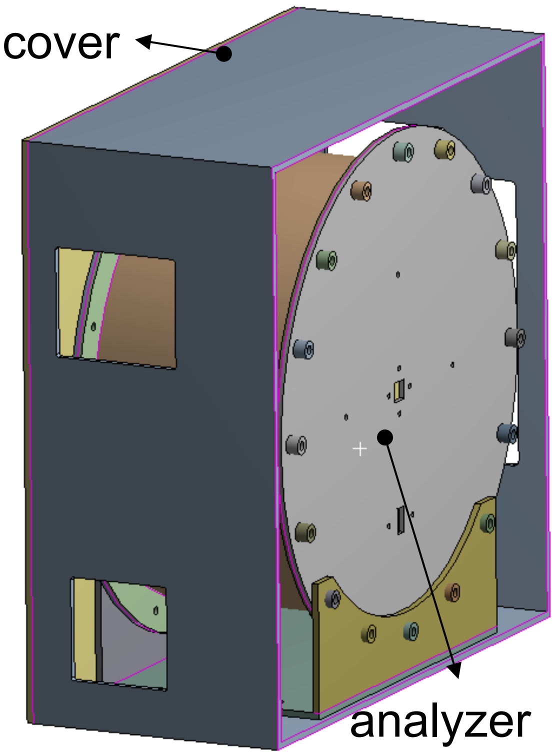
  or

- Using simulation methods
- Advantage in FEM:
  save time and money

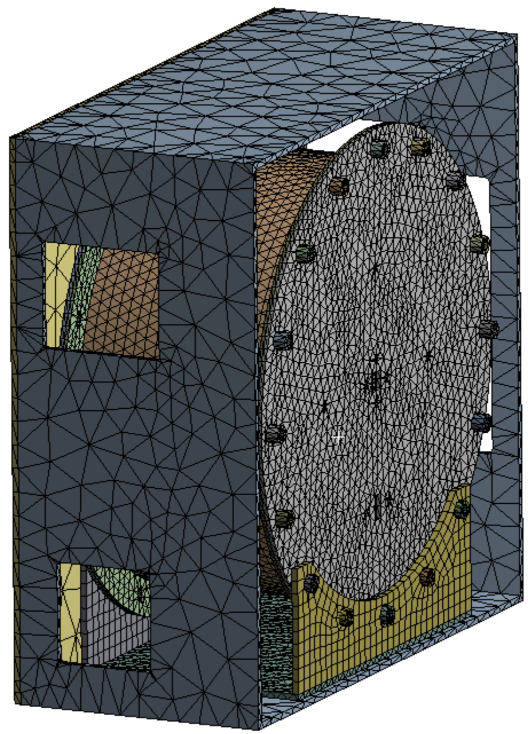
ANSYS®

Modeling and boundary conditions

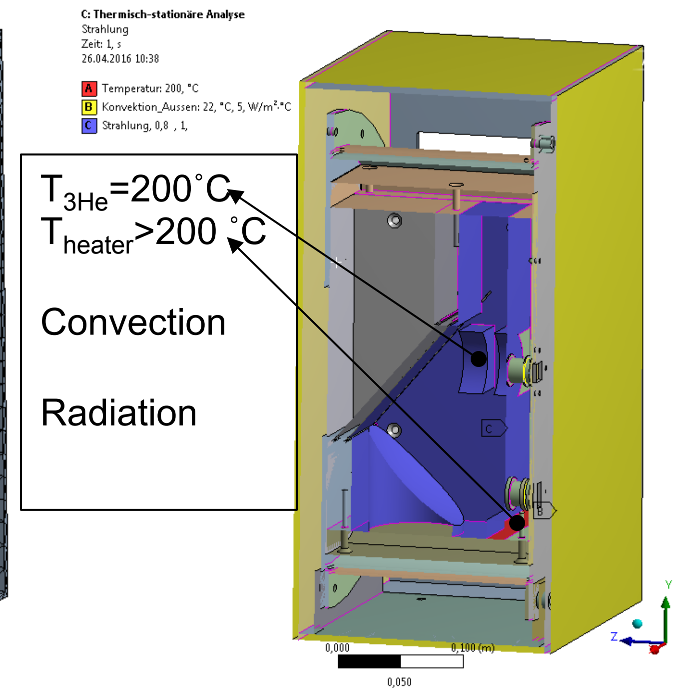
Heat transfer: convection, radiation and heat conduction



geometry



mesh



boundary conditions

Assumption: Glass transparency ignored , Laser heat not considered, Convec. coefficient: Literature (5-1000), Rad. coefficient: 0.8

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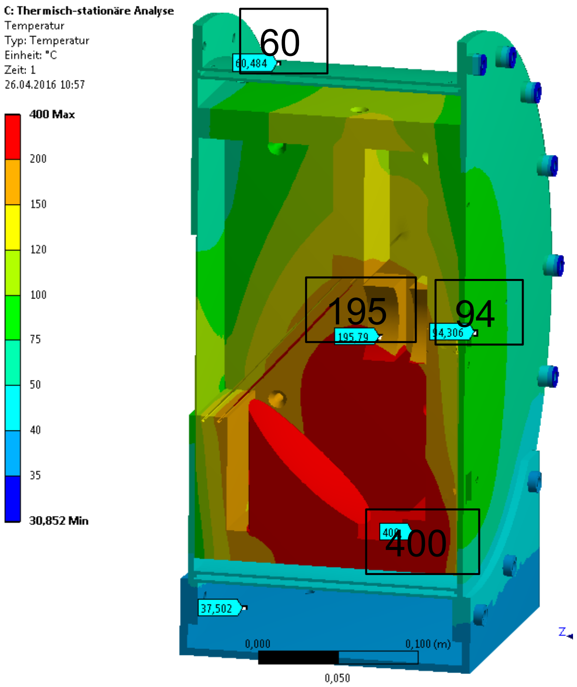
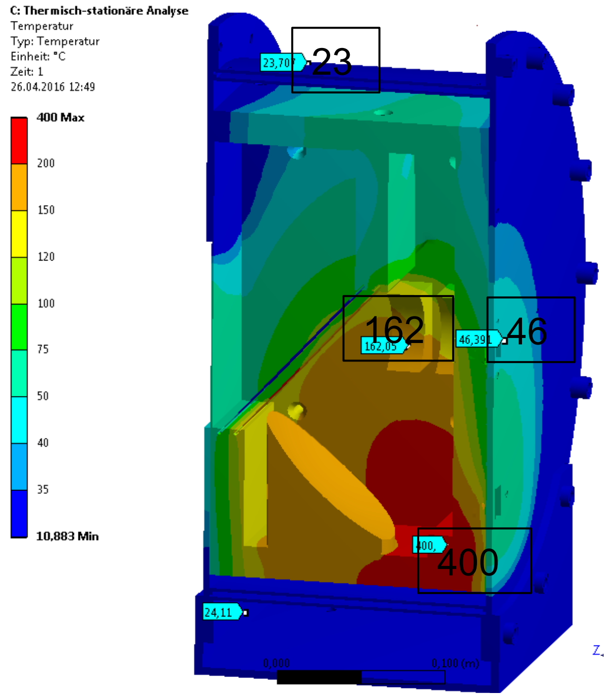
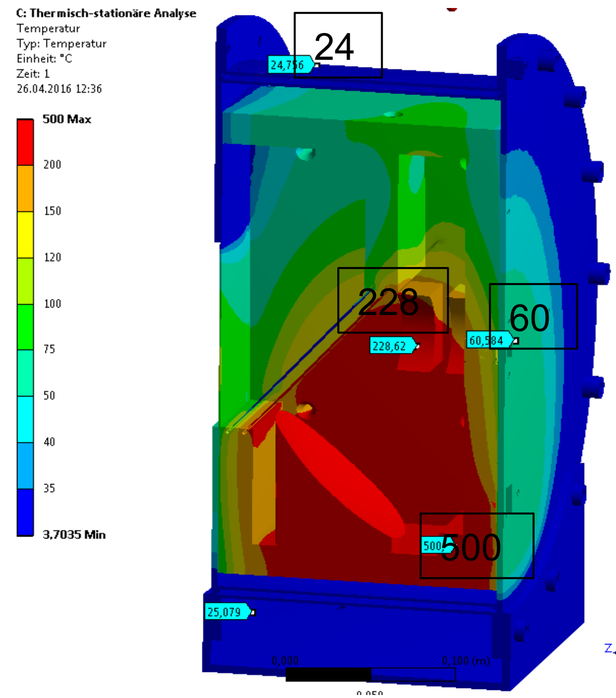
Results



T_{heater}=400°C
no convection α=0
W=406Watt

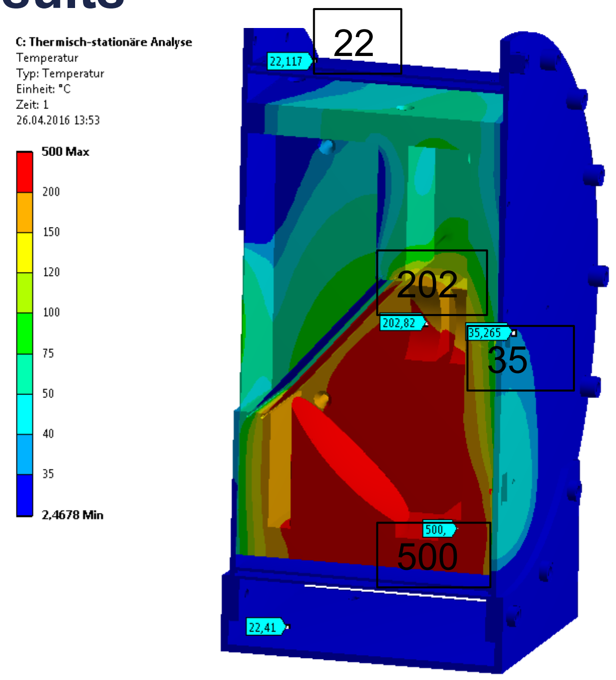


T_{heater}=400°C
normal air flow α=10
W=330Watt

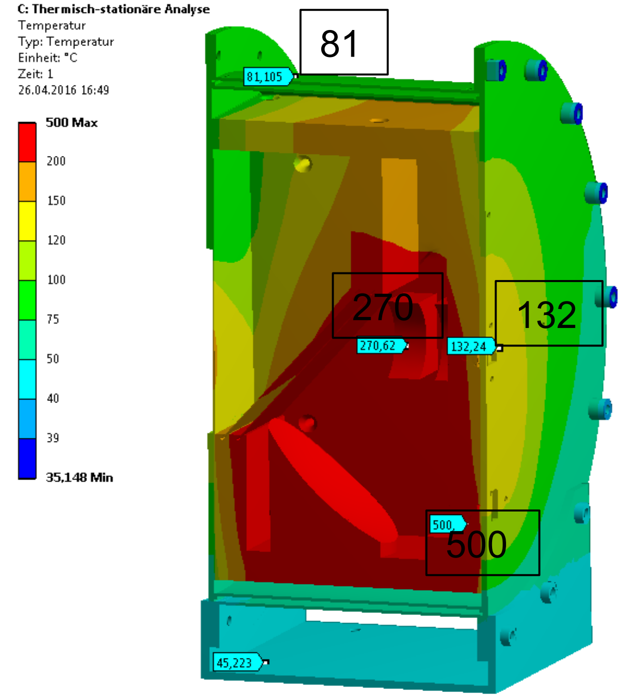


T_{heater}=500°C
normal air flow α=10
W=550Watt

Results



optimal setting



T_{heater}=500˚C
strong air flow α=50

W=516Watt

T_{heater}=500˚C
no convection α=0

W=734Watt

W=218Watt
required cooling power

- **Summary**

✓ By using FE-Method could determine the required cooling power.

✓ Previously, these temperatures were experimentally determined by using thermocouples. With thermal simulations the development time is shortened and costs can be reduced.

Thank you for your attention