TECHNISCHE UNIVERSITÄT DRESDEN

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A calorimeter for measurements of multilayer insulation at variable cold temperature

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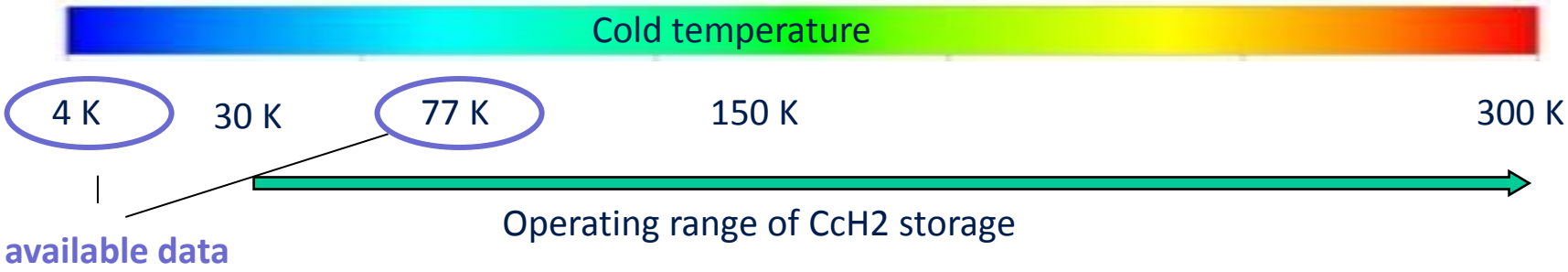
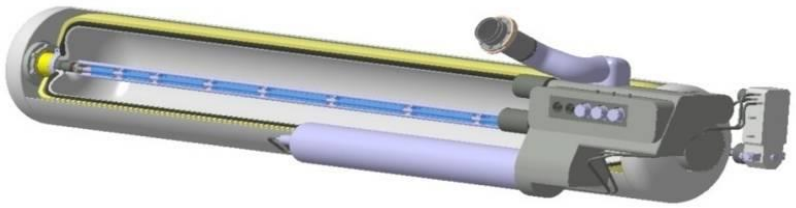
Motivation MLI measurements

- Evaluation of thermal performance over the complete temperature span between 30 K .. 300 K
- i.e. cryocooler applications or CcH2



- Measuring tasks:
  - **variable cold temperature**
  - different residual gas pressures
  - vertical and horizontal orientation



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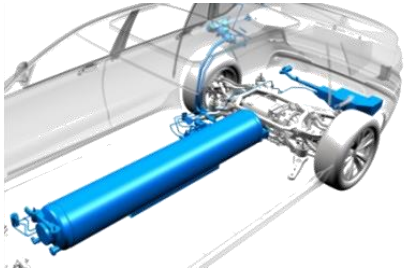
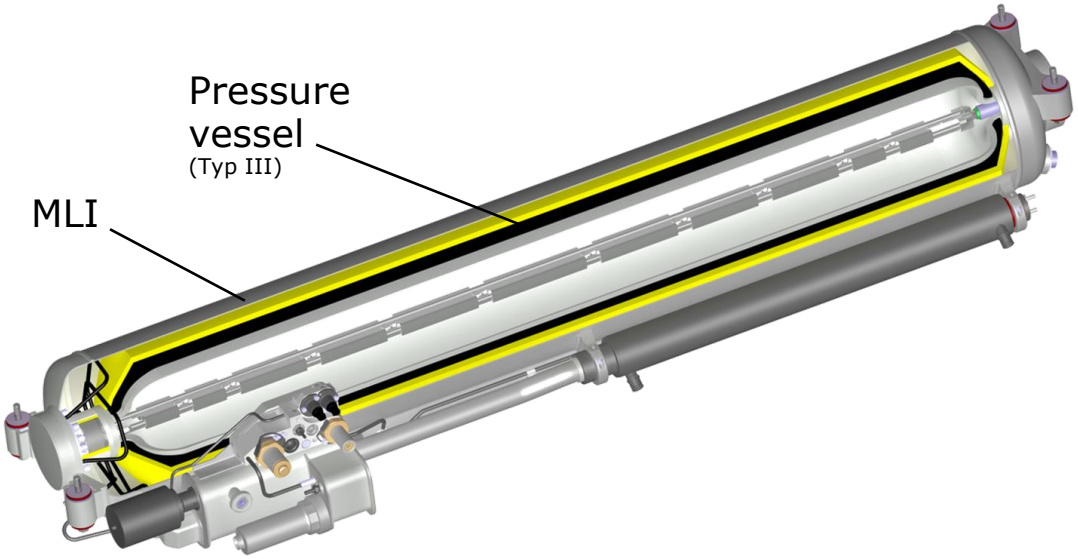




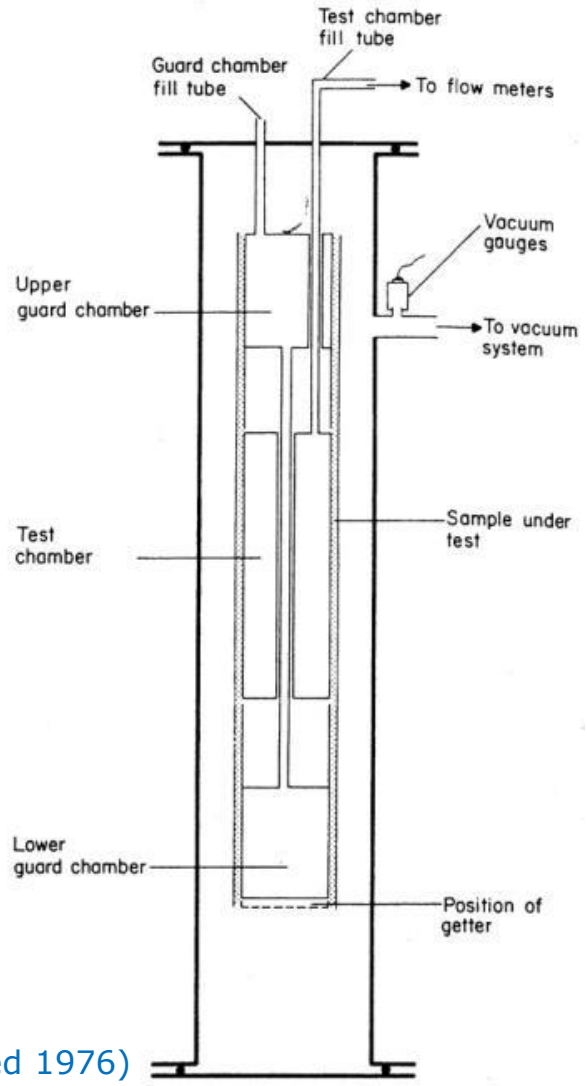
- Combination of high pressure vessel and cryogenic storage vessel
- insulated pressure vessel for gas storage at cryogenic temperature level
- components: vacuum vessel, typ III inner vessel und **Superinsolation**
- **T = 30 K … 300 K**

Experimental Investigation of Multilayer insulation (MLI)

- Literature review
  - **30** dedicated cryostats (partially out of service)
  - Cold temperature :

    LN_2 (26), LHe (8), other (3)
  - 26 bath cryostats

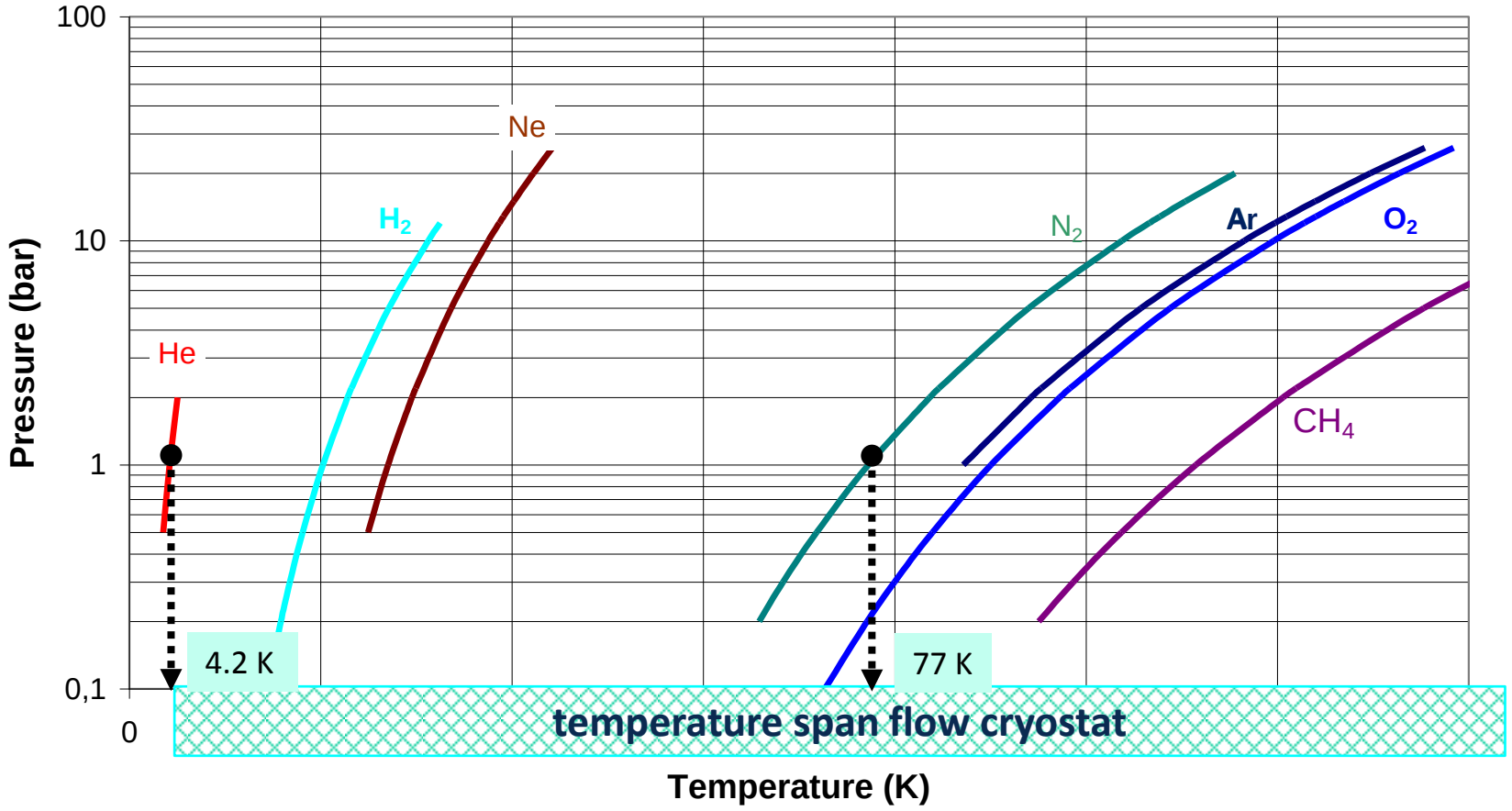
Inherent for all bath cryostats : **fixed cold temperature**



University of Southampton (published 1976)

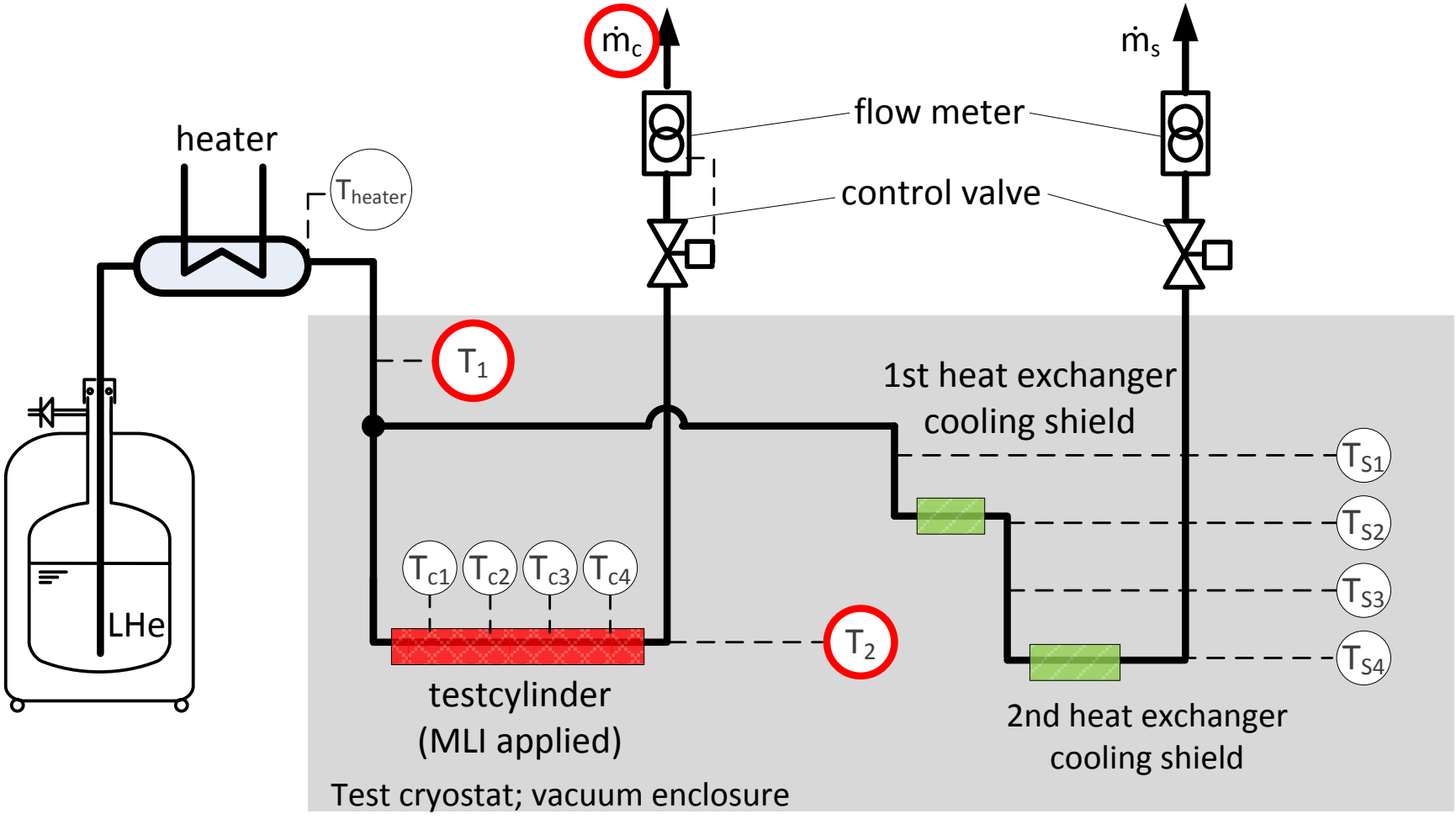
Experimental Investigation of Multilayer insulation (MLI)

- Vapor pressure curves



Cryostat – flow scheme and instrumentation

- flow cryostat, designed primarly for LHe / He cold gas respectively



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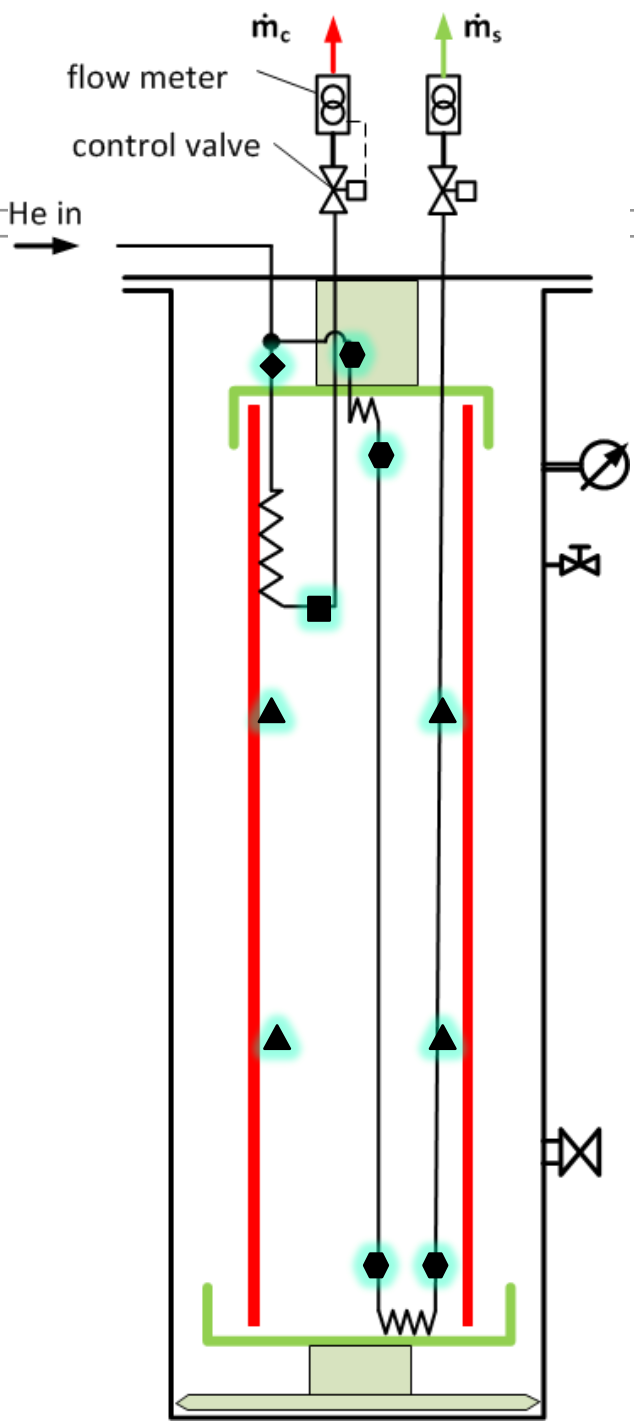
Cryostat – schematic

- flow cryostat
- cylindrical cold surface of 0.89 m^2
- calculation of the heat load onto the test cylinder using

- temperatur sensor
  - ◆ T_1: Si-Diode (cl. A)
  - ■ T_2: Si-Diode (cl. A)
  - ▲ T_{c1} … T_{c4}: Pt-100
  - ⬢ T_{s1} … T_{S4}: Pt-100

- He in preconditioned at selcted pressure (typ. 1.5 bar)
- mass flow: thermal mass flow meter (4 % FSO)



Measurement results

- Detail view of test data

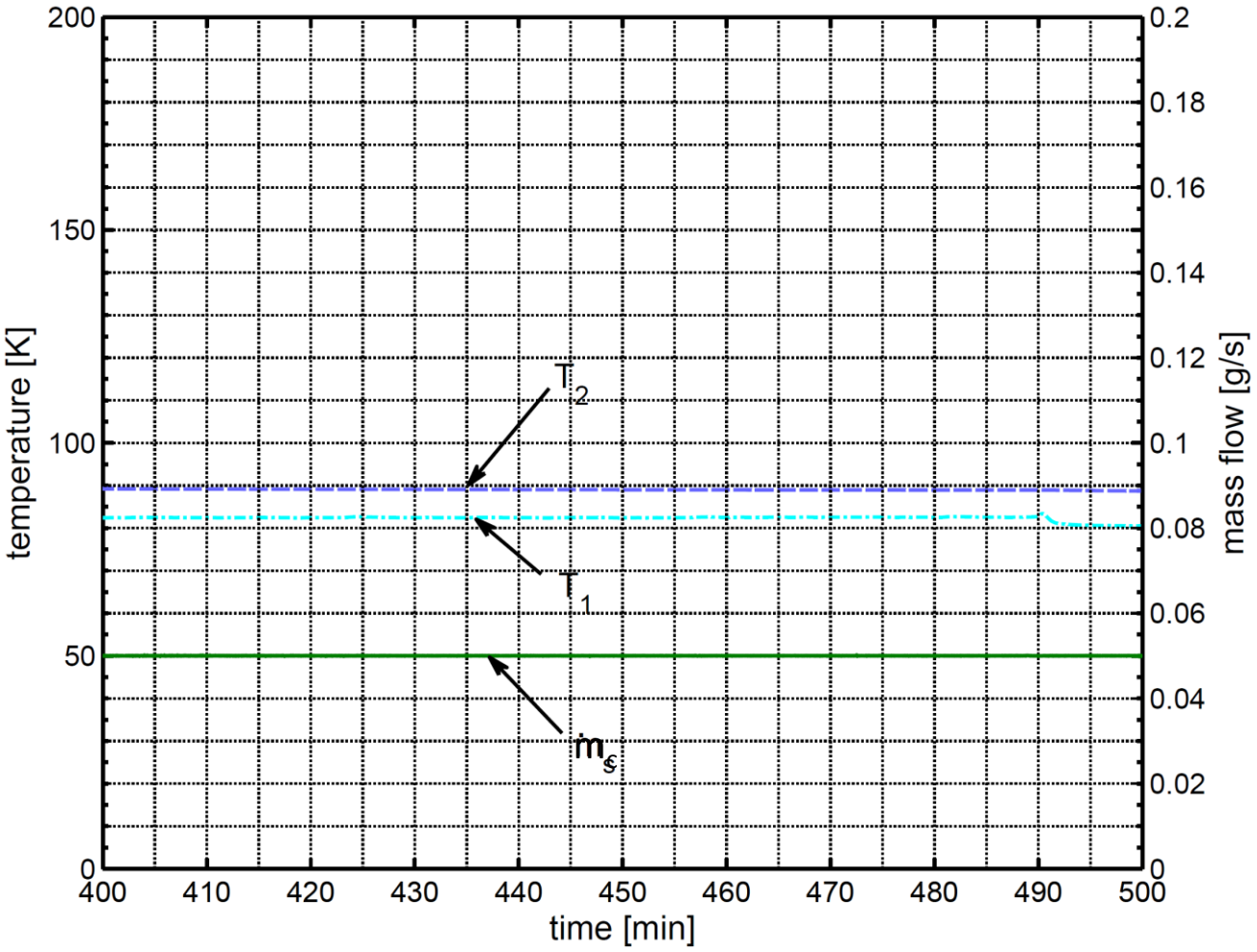
$$\dot{Q} = \dot{m}_c \cdot \int_{T_1}^{T_2} c_p dT$$

T1 = 82.7 K

T2 = 88.8 K

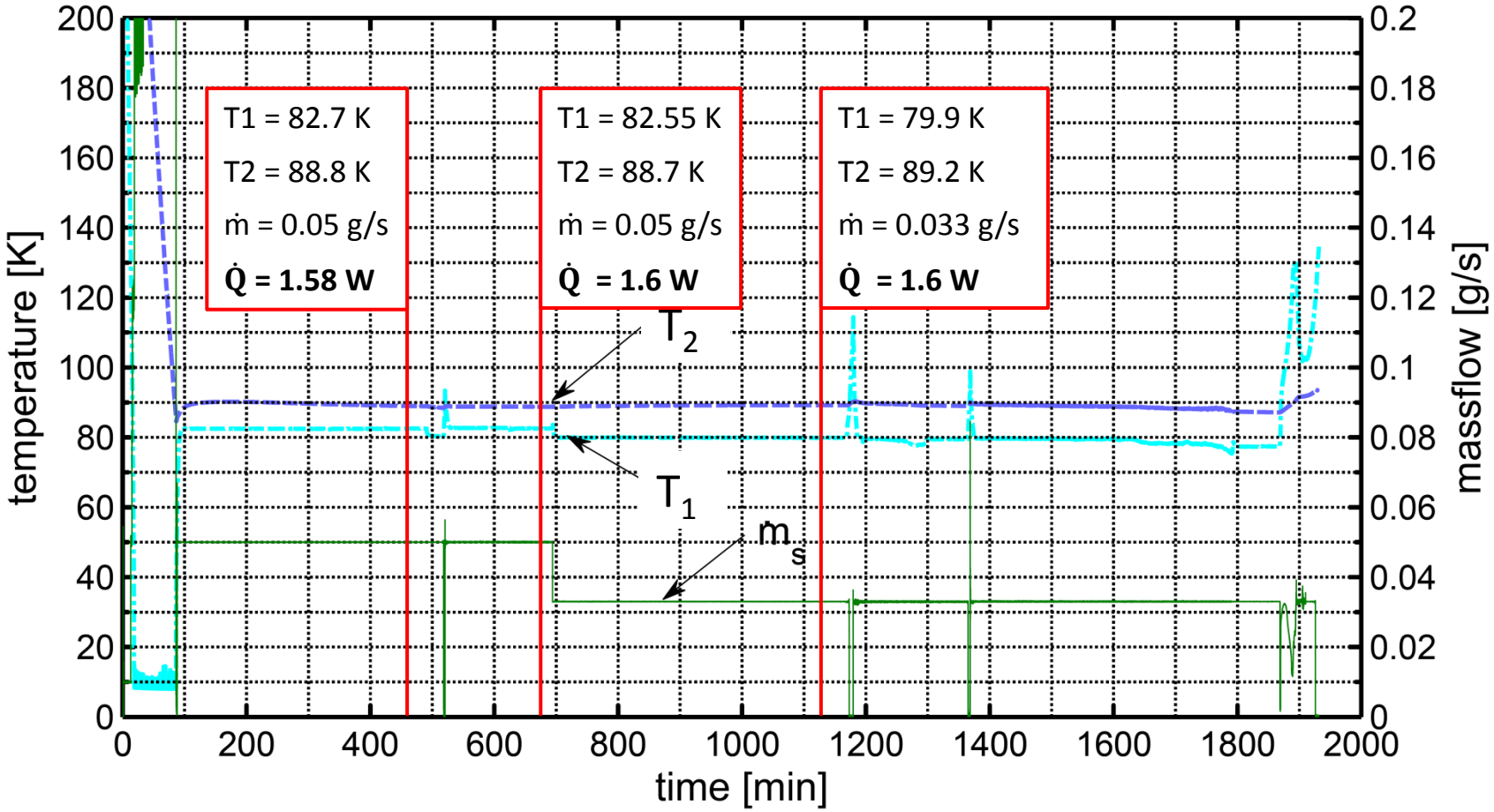
ṁ = 0.05 g/s

Q = 1.58 W



Measurement results

10 layer MLI, double side alumized mylar, @ **88 K**, high vacuum (**$p < 10^{-6}$ mbar**)



Conclusion

- A wide **temperature ran**ge from roughly **30 K to 300 K** is covered.
- The specimen is applied to **a cylindrical cold mass**.
- The cooling fluid mass flow and two temperatures are used to derive the heat flux onto the test cylinder.
- It is designed for operation in **vertical** as well as in **horizontal orientation**. Thus degradations due to gravimetric effects can be investigated.
- The cryostat was successfully put into operation. A standard test procedure is established.