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First helium measurements with a new cryogenic flow meter

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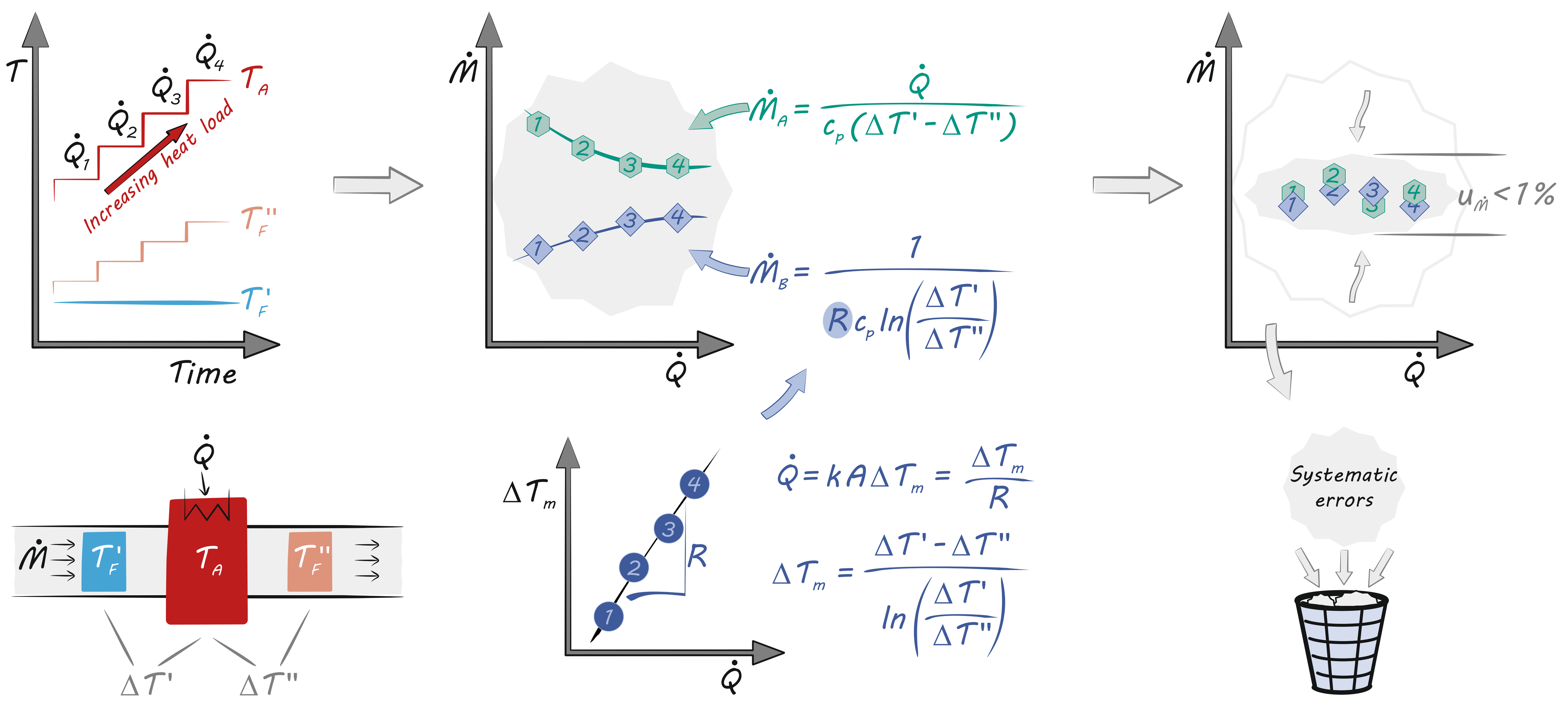
The Cal²-Flow measurement principle

Measurement / Data evaluation / Minimization



Error handling

Removal of systematic errors:

$x^* = x - F_x$

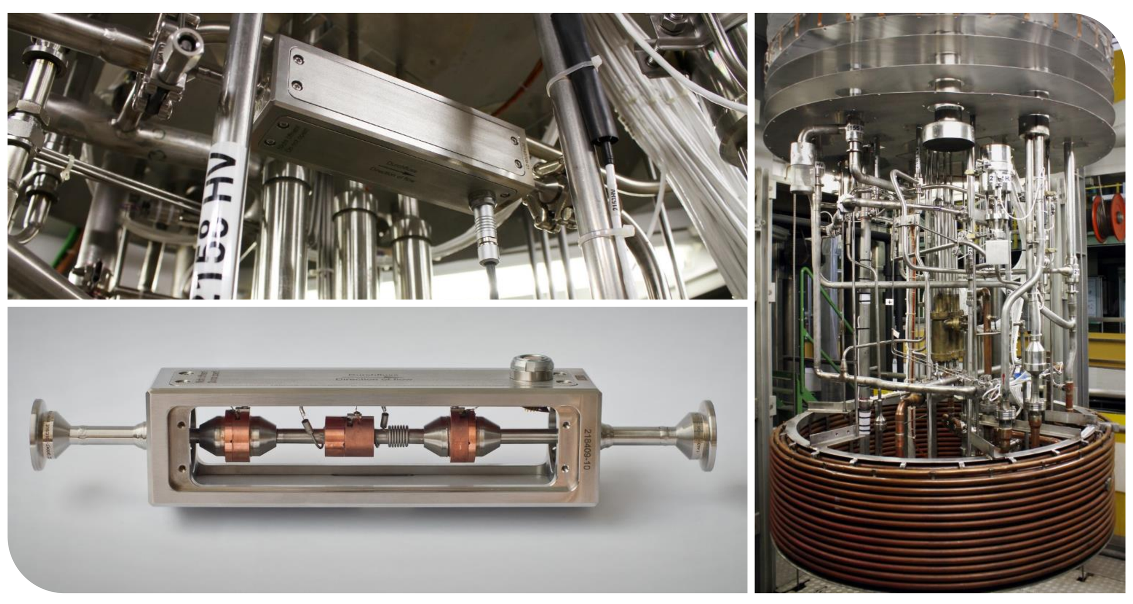
- x^*: Error-free parameter
- x: Measured parameter
- F_x: Systematic error of x

- Heat load:
  $\dot{Q}^* = \dot{Q} - F_{\dot{Q}} = \dot{Q} - (a_0 + a_1\dot{Q})$
- Inlet temperature difference:
  $\Delta T'^* = \Delta T' - F_{\Delta T'} = \Delta T' - a_2$
- Outlet temperature difference:
  $\Delta T''^* = \Delta T'' - F_{\Delta T''} = \Delta T'' - a_3$
- Free minimization parameters:
  a_0, a_1, a_2, a_3

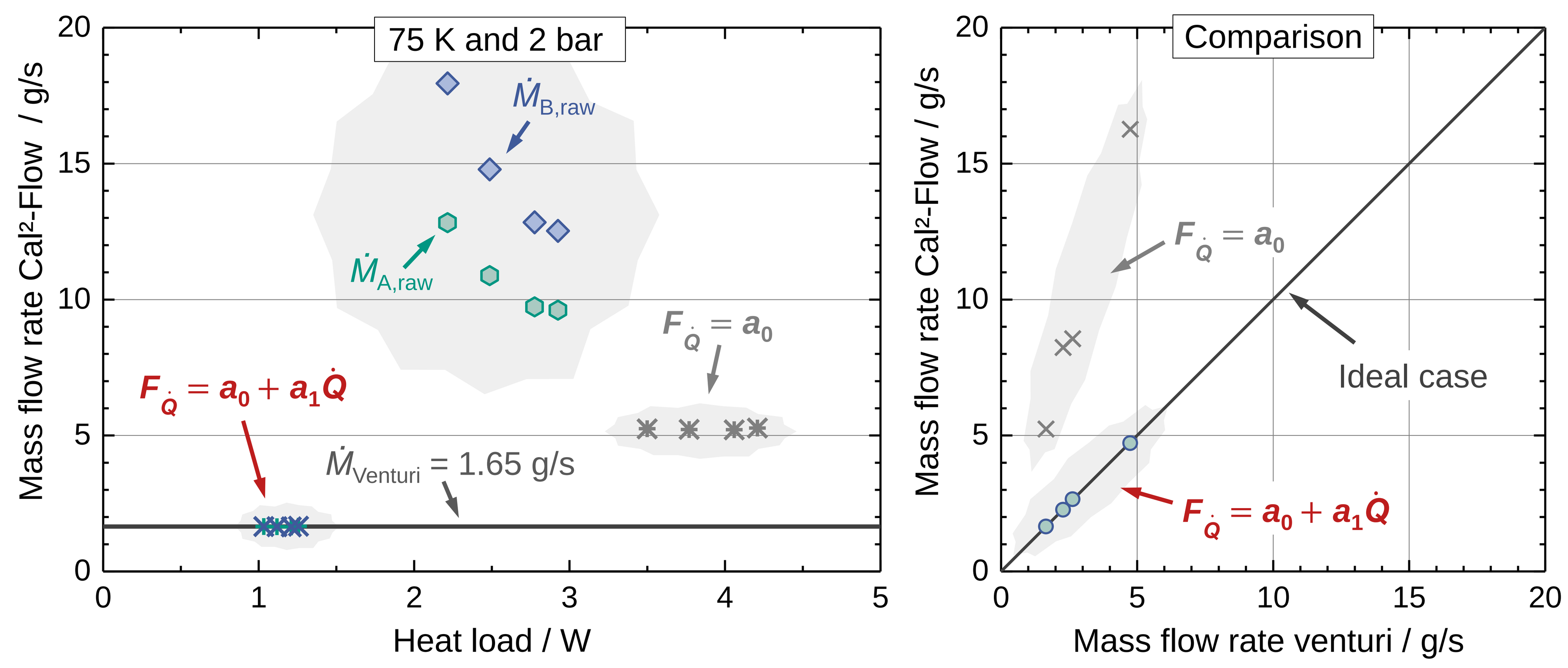
Experimental setup and results

Installation within the TOSKA facility

- Installation inside a cryostat of a 2 kW helium refrigerator
- Venturi tube for reference measurement
- Measurement at 20 K and 75 K and $\dot{M}$ = 1.65 …4.75 g/s
- Sensor tube diameter: 6 mm, total length: 280 mm
- Temperature measurement with 3 Cernox sensors



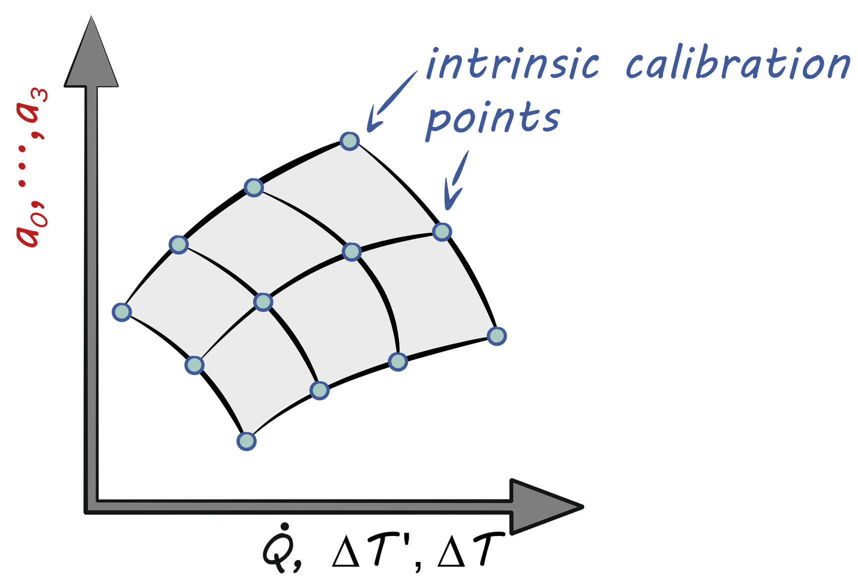
Experimental results



- Linear error dependence of heat load ($a_0 + a_1\dot{Q}$) and constant offsets of temperature measurements (a_2, a_3) yields agreement with the reference measurement within its uncertainty
- Fit with $F_{\dot{Q}} = a_0$ does not describe the systematics sufficiently

Outlook

- Further measurements down to 5 K and up to 12 g/s
- Programming of self-developed electronics and implementation of auto-calibration routine
- Implementation of characteristic maps for $a_0 \ldots a_3$ for analogue (transient) flow measurement
- Field test with up to 10 sensors



Literature

Grohmann, S. (2014): A new method for flow measurement in cryogenic systems. *Cryogenics*, vol. 60, March–April 2014, pp. 9-18.

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