EMPIR
EURAMET
The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

MetHyInfra

## METHYINFRA

# Cryogenic Flow vs. Gas Flow

20IND11

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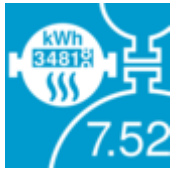
# How To

- **Liquified hydrogen not possible due to safety risks**
  - Alternative: Measurements with liquified nitrogen ($LN_2$) and liquefied helium (LHe)
  - Interdisciplinary cooperation between:
    - Dep. 1.45 

Flow Measurement and data analysis
    - Dep. 7.43 

Cryo-Infrastructure, measurement campaign
    - Dep. 7.52 

Provision of assembly site, assembly assistance

# How To

## LIFTER



0,5 – 1,3 bar pressure

## FLOW-CONDITIONING



Venturnozzle + perforated plate
T-Measurement with TVO-Sensors

## MUT-Section



Coriolis Meter
Vakuum isolated< 1x $10^{-5}$ mbar

## EVAPORATER



controllable

# How To

EVAPORATER

LFE-PANEL

controllable

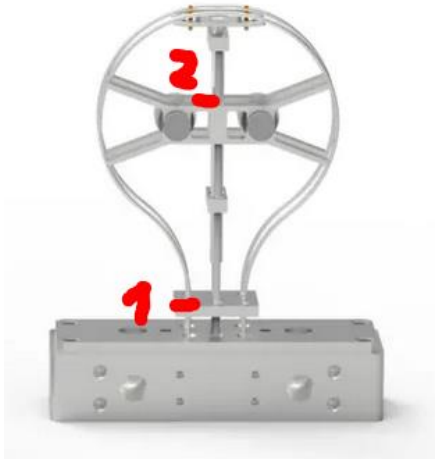
5 LFE Mass flow Air: 0,01 – 40 kg/h
Pabs, Pdiff und T-Sensors
SI-traceable

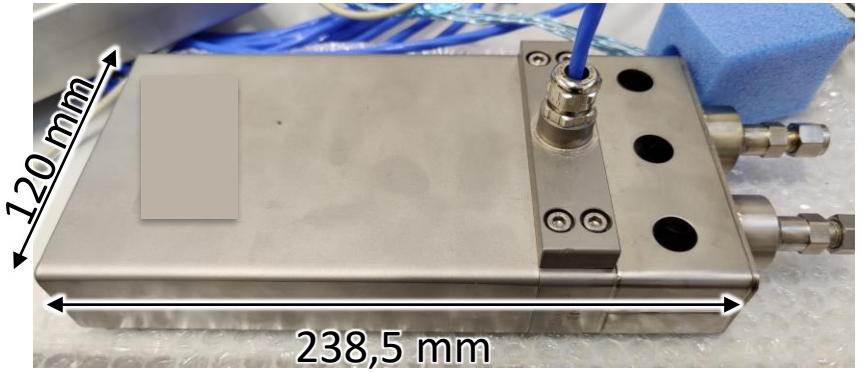
Atmosphere

Helium recovery

# Measurement Device – Liquid phase

- Coriolis
  - cryo & vacuum compatible
  - thin PTFE insulated cables
  - perforated housing
    (no virtual leaks)
  - Retention by 2 PTFE plates with finger contacts
  - Two T-sensors (1: Tube, 2: Cross)



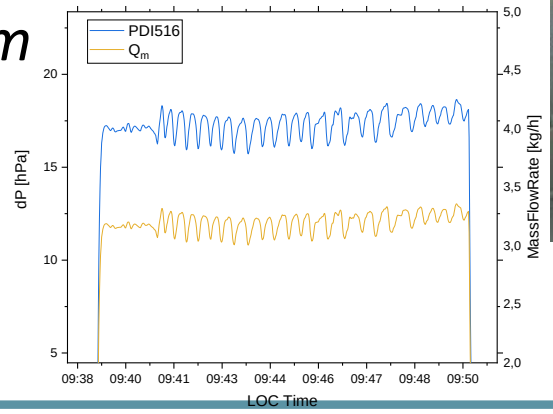




# Measurement Campaign

October 2022 – LN2, January 2023 – LN2

Februray 2023 – LN2 & LHe

- **EXPERIENCES**
  - Flow – *is not always constant*
  - *Depending on fluid phase*
  - *Depending on inlet pressure*
  - *Dynamic system*

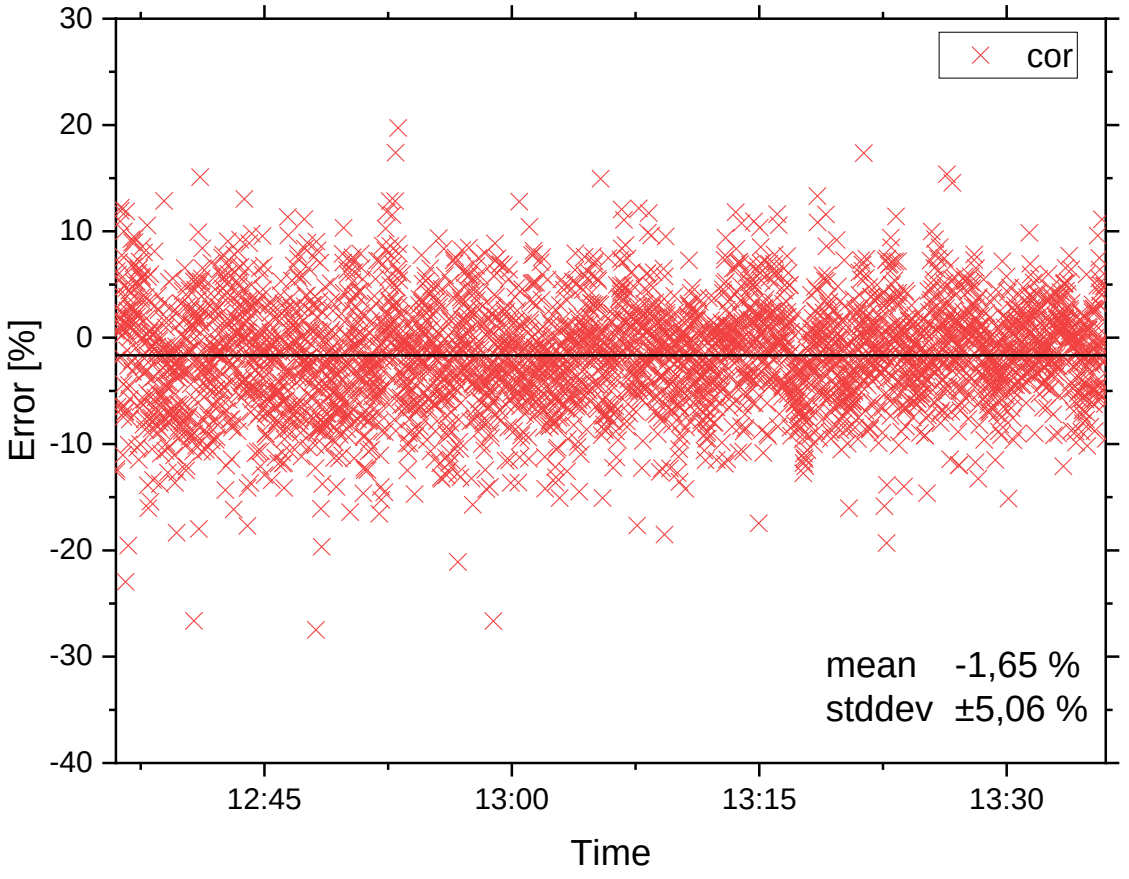



Time

# Measurement Campaign

- Challenge
  - **How to determine the zero point at operating conditions**
  - manufacturer information Zero Drift of 0,003 kg/(h ·°C)
  - First approach of zero correction with point at ambient conditions
  - Errors:

| Ambient Conditions Coriolis ↔ ref. Nozzles | Measurement Campaign Coriolis ↔ LFE |
|---|---|
| e=0,70 % ± 0,153 % | e=-1,65 % ± 5,06 % |



# Outlook

- Zero point attention
- Taking time to cool the system
  - All sensors should achieve process conditions
- End of measurement in Berlin in April → facility will move to Braunschweig → ?
- Calibration of the coriolis
  - With water → July 2023
  - With air at different temperatures (Zero Point and flow behaviour) → July/August 2023

internal

external

MetHyInfra

This project (20IND11 MetHyInfra) has received funding from the EMPIR programme co-financed by the Participating States and from the European Union's Horizon 2020 research and innovation programme.

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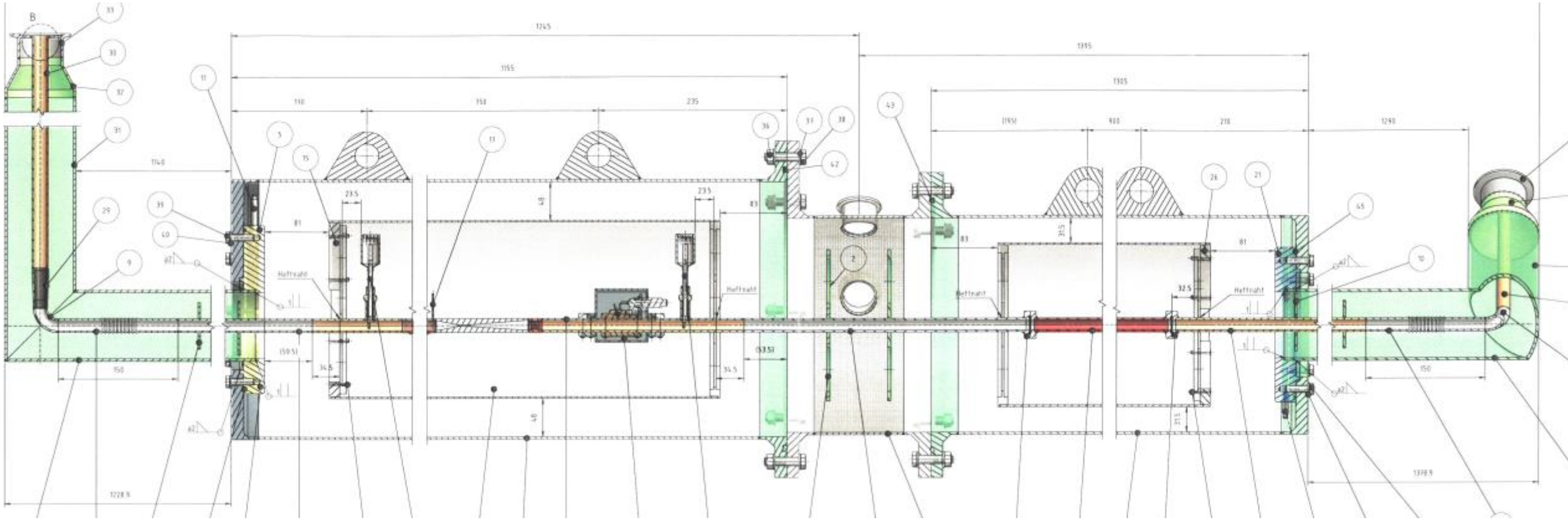
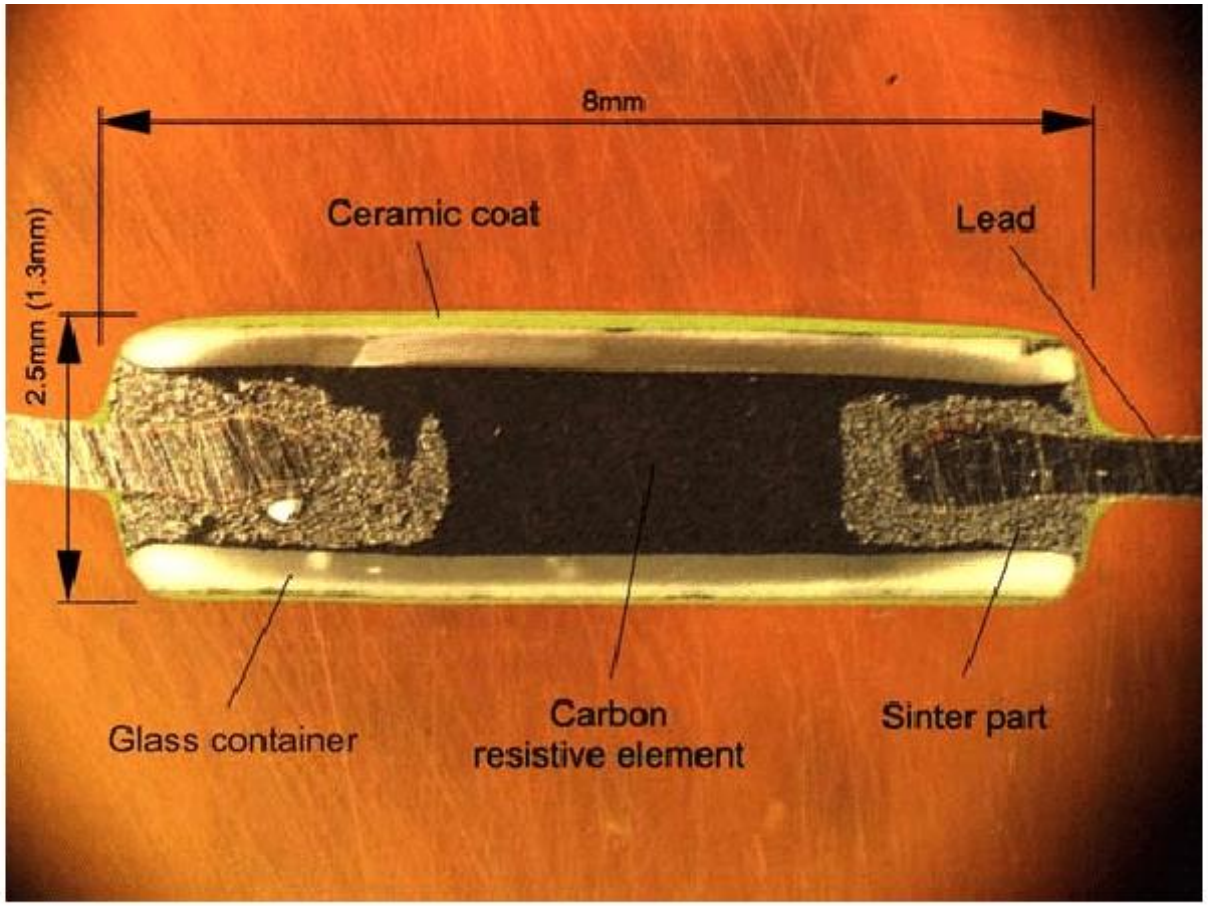
# DETAIL KIT-kit



# TVO




Mechanical behavior of carbon ceramic TVO temperature sensors - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Micrograph-of-the-TVO-sensor_fig1_256691177 [accessed 16 Feb, 2023]