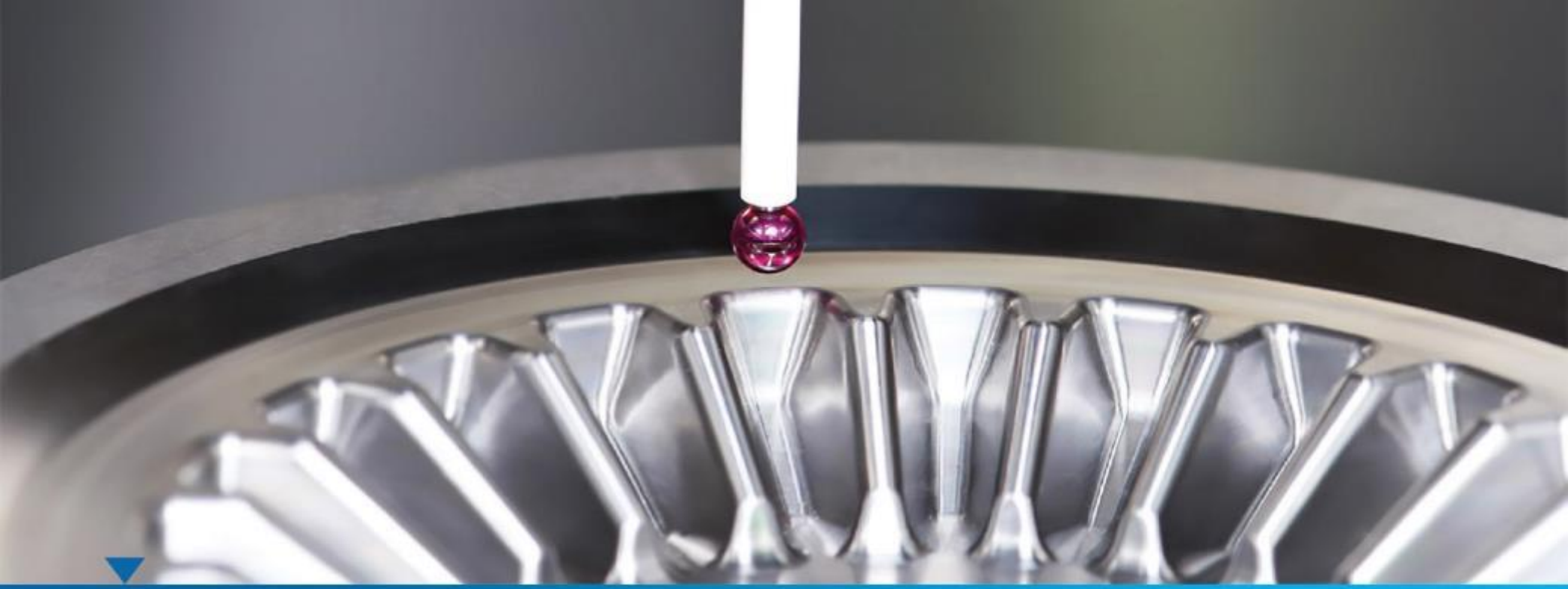


Czech Metrology Institute
Temperature & Humidity & Thermal quantities

CZECH METROLOGY INSTITUTE

CCT Meeting, Paris, 2017

CCT/17-24

Contact Thermometry

- Contact thermometry:
  - ITS-90 temperature scale - Ar, Hg, TPW, Ga, In, Sn, Zn, Al-Cu, Al, Ag-Cu, Ag, Au, Cu, Pd, Pt
  - Measurements by comparison (-80 °C to 1800 °C) - alcohol, water, oil and salt baths, different types of furnaces with blocks (dry well)
- Whole range CMC and Accreditation

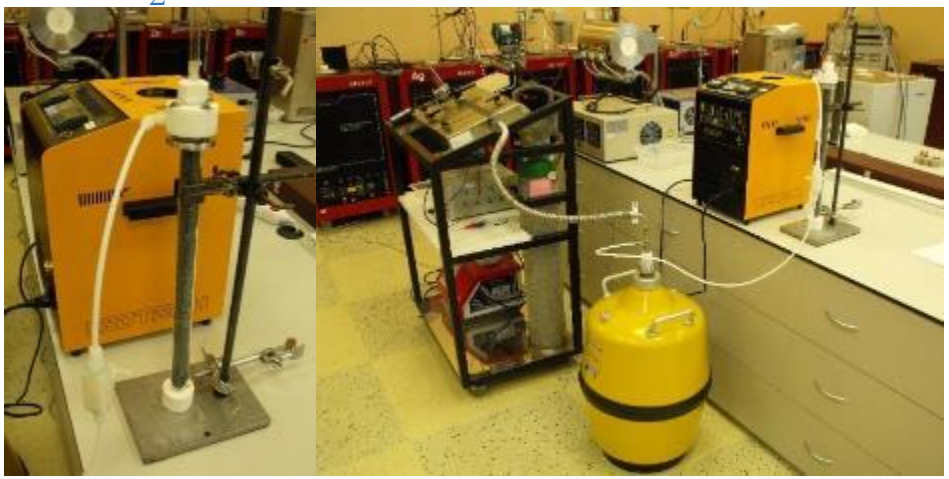

Contact Thermometry - Alternative fixed points

Experiment with:

- CO_2
- Al-Cu
- I_2

Inflex $t_{I_2} = (113.290 \pm 0.006)$ °C

1/F $t_{I_2} = (113.293 \pm 0.003)$ °C



Inflex $t_{Al-Cu} = (548.137 \pm 0.004)$ °C

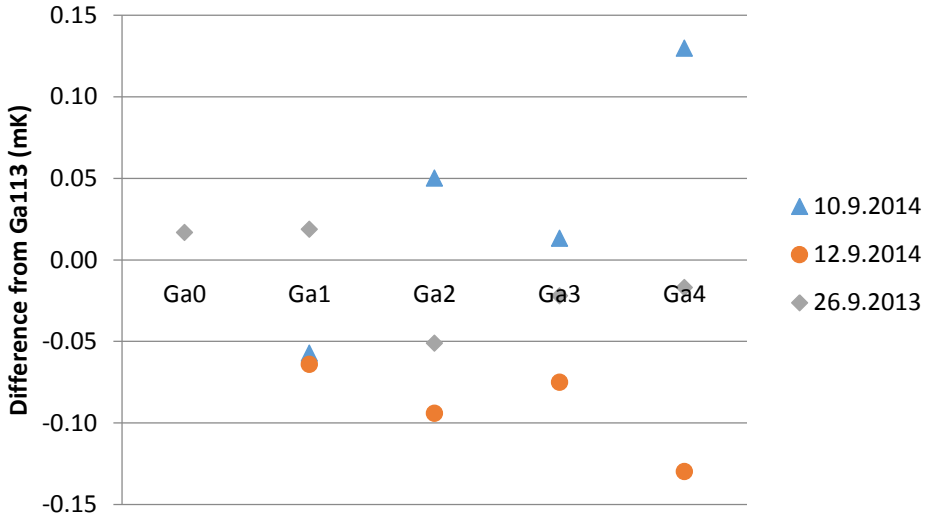
1/F $t_{Al-Cu} = (548.149 \pm 0.003)$ °C

CO_2 $(-56.564 \pm 0{,}002)$ °C

CO_2 7h plateau, 80g

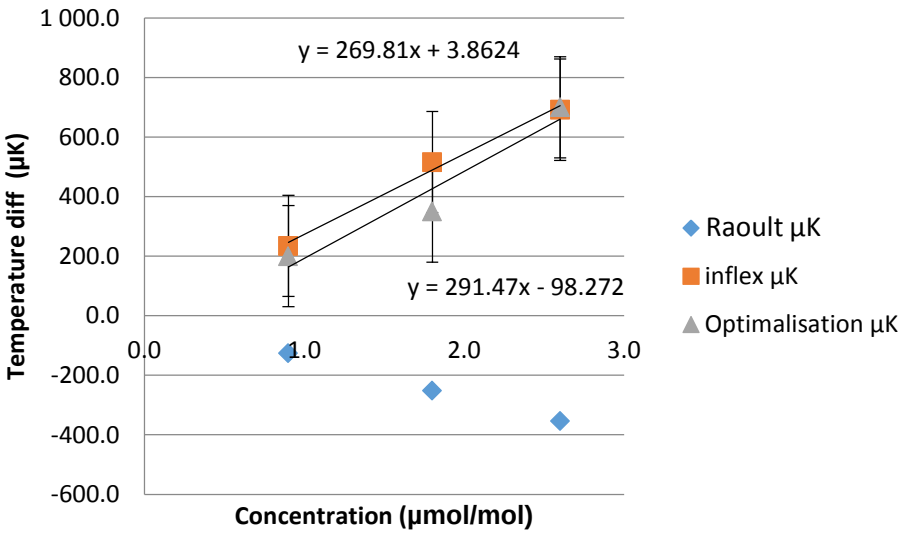
Contact Thermometry - Doping experiments

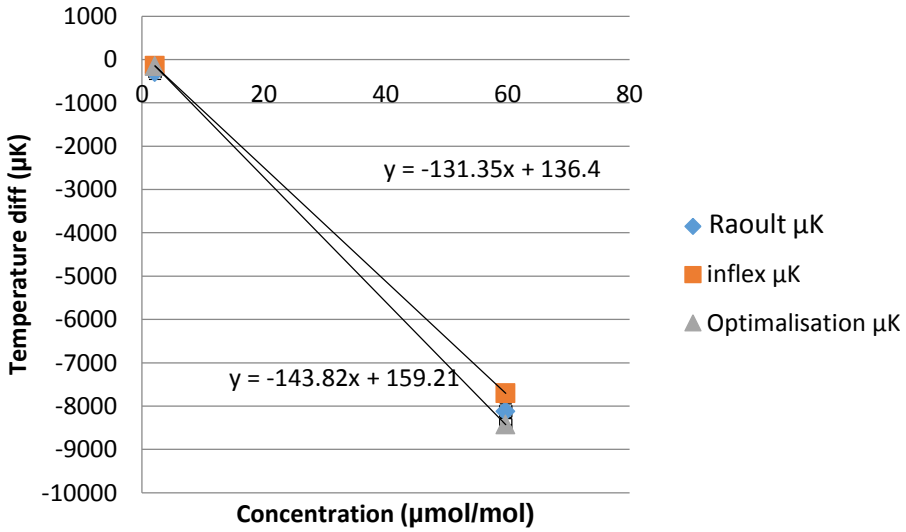
- Sheill calculation of c, m, k
- Modified Sheill
- Inflex x end point
- Proper mixing x waiting time
- Doping as pure or oxide
- Ga with Ni, Pb
- Al with Ni, Pb

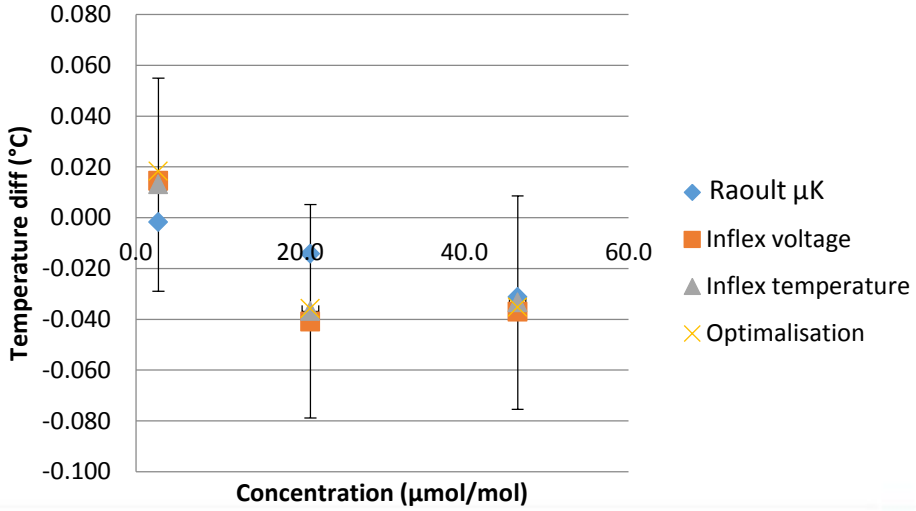


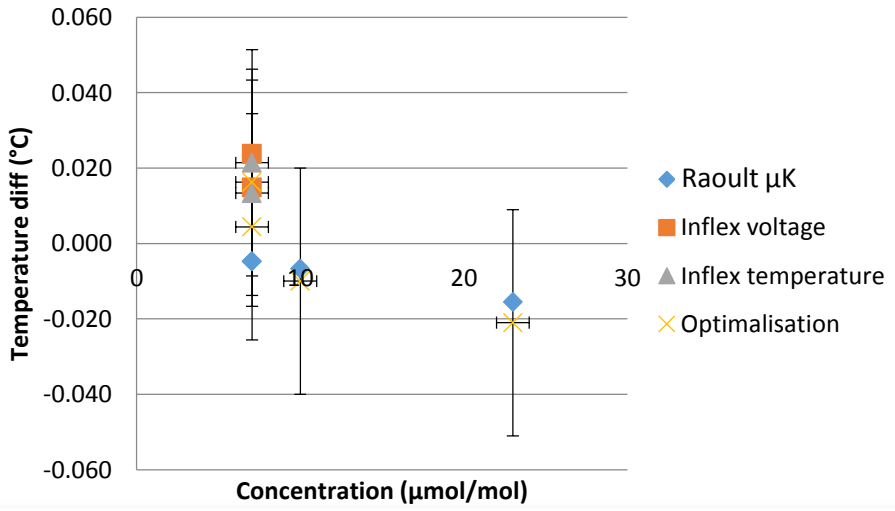
$$T_{f,imp}(F) \approx T_f - K_f\, x_{imp,l}\, (k_0 - 1)F^{k_0 - 1} + K_f\, x_{imp,l}\, (k_0 - 1)(1 - F)^{k_0 - 1}$$

Contact Thermometry - Doping experiments





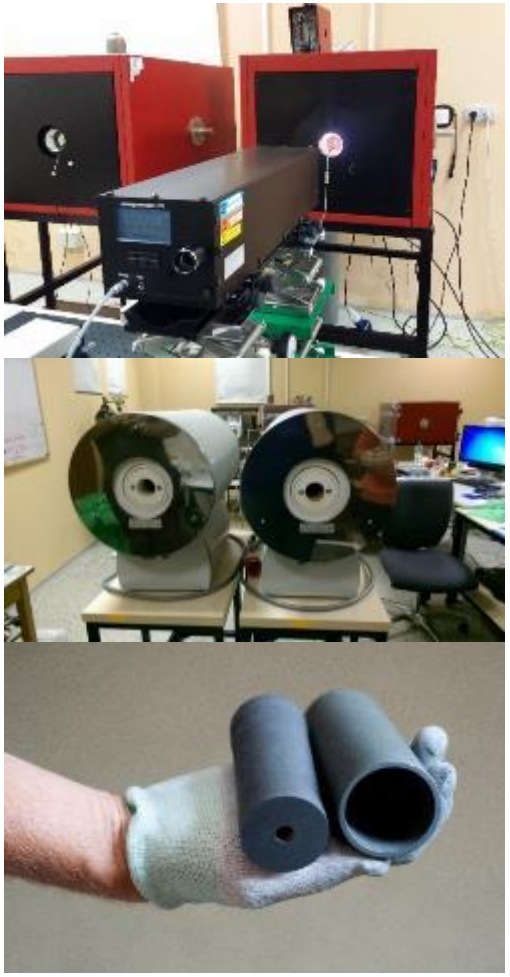




5

Non – contact thermometry

- Fixed points
  - In, Sn, Al and Cu
- LP5 (650 nm and 1.6 μm)
- Traceability for lower temperatures (<1000 °C)
  - SPRT
  - Pt-Au
- 2015 – establishments of the radiation thermometry national standard in range (-30 to 1800) °C
- Whole range CMC and Accreditation (-30 °C to 1800 °C)



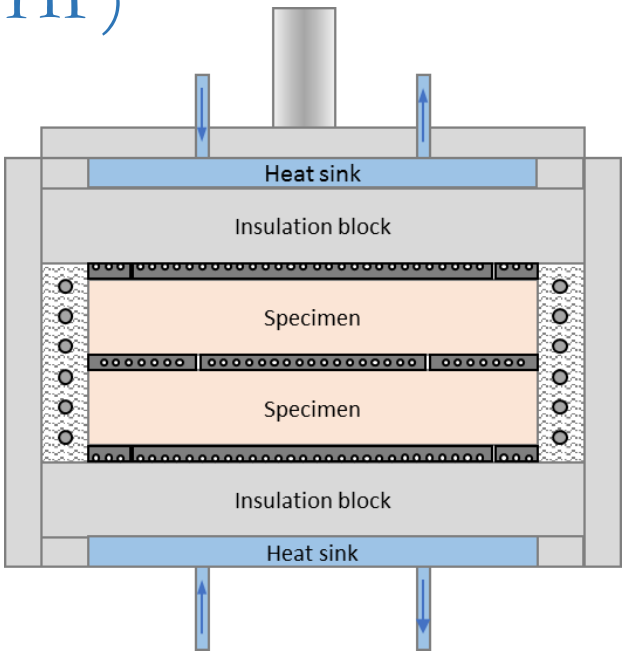
Humidity

Property	Type 1	Type 2
	Specification	Specification
Medium	air, nitrogen, methane, natural gas	air
Pressure	101.325 kPa to 15 MPa	atmospheric
Dew point	(-70 to +40) °C	(-50 to +20) °C
Uncertainty (k=2)	(0.08 to 0.5) °C	(0.14 to 0.3) °C

Thermal quantities- improvements

High-Temperaure Guarded Hot Plate (HTGHP)

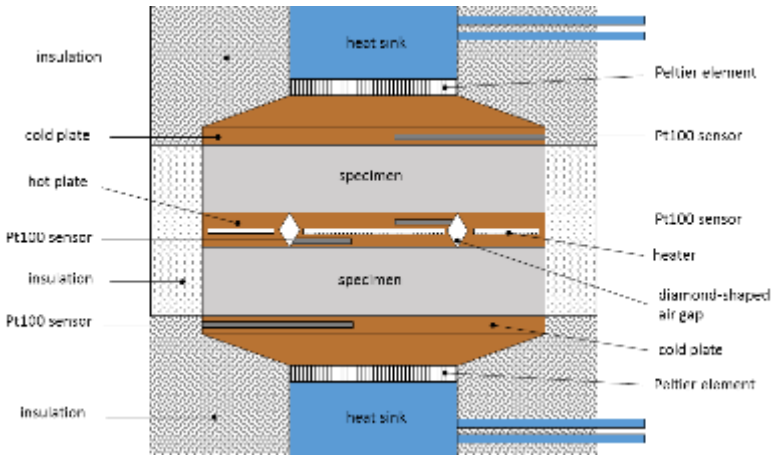
- high-temperature thermal conductivity measurements for insulating materials
- old heater plates are being replaced
- investigation of new suitable material for heater plates up to 850 °C
- was employed in EMRP Thermo inter-laboratory comparisons (2016)
- using new high-temperature reference material developed in this project

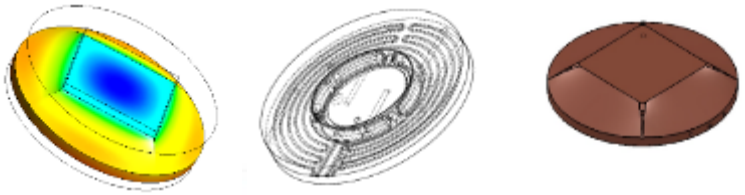


Thermal quantities- improvements

Small Guarded Hot Plate (SGHP)

- new apparatus
- employed in European metrology projects (EMRP VITCEA, EMPIR Eura-Thermal)
- enables thermal conductivity measurements for composite materials, ceramics, etc.
- double/single specimen
- temperature range (0 to 80) °C





Thermal quantities- improvements

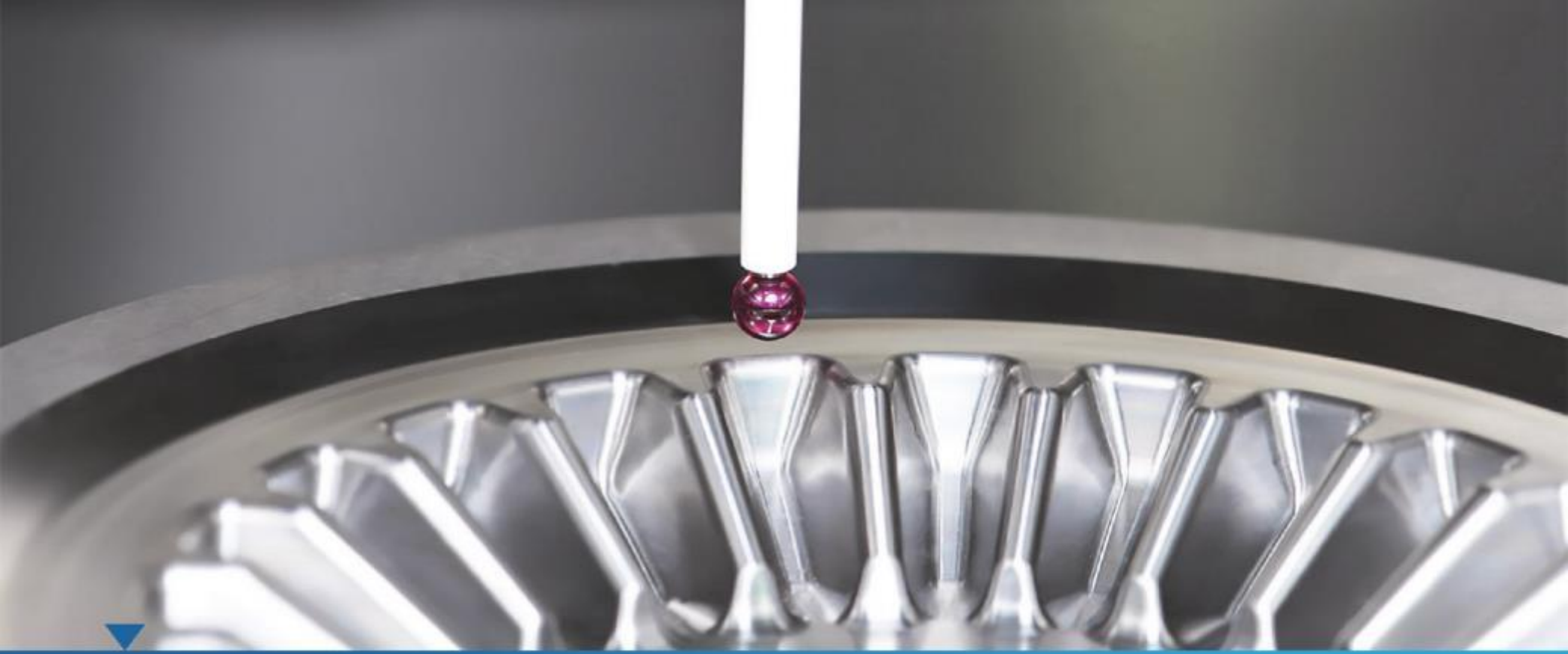
Adiabatic calorimeter

- heat capacity measurements
- minor upgrades performed
- employed in EMPIR VITCEA for heat capacity measurements of composite materials (CFRPs/GFRPs)
- temperature range ~(0 to 80) °C




Areas of interests

- Industrial thermometry
- Using of alternative methods for uncertainty propagation in interpolation
- Radiation thermometry for temperatures lower than 1000 °C
- Thermal imagers
- Humidity generators at elevated pressure
- High temperature Guarded hot plates for insulation materials



THANK YOU FOR YOUR ATTENTION!

CZECH METROLOGY INSTITUTE

Okružní 31, 638 00 Brno, Czech Republic,
www.cmi.cz
ČMI OI Praha, Radiová 3, 102 00 Praha 10,
rstrnad@cmi.cz
https://www.cmi.cz/sluzby_1012