

# Development of thermometry at ČMI

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The Czech Metrology Institute (CMI) provides services in three major metrology areas:

- Fundamental Metrology: this includes research & development in metrology, including maintenance and development of national standards.
- Dissemination of Units — Industrial Metrology: mainly top level any atypical calibrations of standards and measuring instruments both in the Czech Republic and abroad.
- Legal Metrology: regulated measurements, including type approvals of legal metrology instruments, initial and periodic verification of measuring instruments, metrological supervision, and conformity assessment in metrology.

At a minimum, our vision is to develop CMI into a regional centre of multifaceted metrological services at the highest levels of metrological traceability with a maximum thrust in research and development in metrology, especially in the European context of participating in the projects of the European Research Area (ERA) in EURAMET, under the program EMRP and EMPIR — European Metrology Research Program.

In 1993, a decision to build a primary temperature laboratory was made. After basic metrological evaluation and key international comparison, a national standard in temperature range from  $-38\text{ °C}$  to  $+419\text{ °C}$  was declared in 2003.

Rapid development of industry and laboratory personnel strengthening of primary and secondary temperature laboratories allow the construction and purchase of modern measuring instruments and adding several new fields in connection with thermal quantities of materials. CMI in this field has become a well-established partner in various industries such as automobile, petrochemical and aerospace. In 2011, national standard expanded to temperature range from  $-196\text{ °C}$  to  $+1084\text{ °C}$ .

CMI non-contact laboratory went through significant improvement during past 5 years. Laboratory provides realisation of the international temperature scale in temperature range from  $-30\text{ °C}$  to  $+1800\text{ °C}$  on different levels of the accuracy. Highest traceability level is secured by fixed points, and those values are disseminated through the reference infrared thermometers to the blackbodies, which serves as a reference bodies for the general calibration work of the laboratory. Commercially available devices and also devices made by own design are used for the work in the laboratory.

The laboratory is also dedicated to research and activities, such as measurements associated with determining the emissivity of the surface of various materials, or preparation of own design fixed points (both contact and non-contact), including eutectic. Since 2010, the development of energy gases under increased pressure humidity generator was conducted. Currently, the primary standard has been built and declared as a national standard. Intensive research in the area of thermal quantities is performed. It focuses on development of equipments for thermal conductivity and capacity measurements. CMI is developing the apparatuses for thermal conductivity measurement of insulation materials, which is based on the Guarded Hot Plates, steady-state technique for measuring thermal conductivity, and highly humid environmental chamber with separate areas. This apparatus ought to be used to test effects of different environmental conditions on each of the tested specimen.

In past three years the lab for measurement of thermophysical properties of materials has advanced in measurements of thermal conductivity and specific heat capacity. CMI participated in EMRP project Thermo “Metrology for Thermal Protection Materials” which developed a batch of high-temperature thermal insulation materials for guarded hot plate (GHP) method. At the end of Thermo, CMI participated with their new HTGHP apparatus in interlaboratory comparison of thermal conductivity measurement using guarded hot plate method up to 650 °C. Currently, the novel material for manufacturing of heater plates is investigated in order to improve the measurement capabilities of CMI HTGHP apparatus in near future.

In parallel, CMI built new small guarded hot plate apparatus with the aim to cover a wider range of materials for which the thermal conductivity data are required (e.g. composite materials). With this new apparatus CMI was involved in EMRP project VITCEA “Validated inspection techniques for composites in energy applications” within the task of characterization of thermophysical properties of GFRP (glass fibre reinforced plastic) and CFRP (carbon fibre reinforced plastic) materials.

In past few years the adiabatic calorimeter has been built to enable primary heat capacity measurements of solids and liquids at CMI laboratory. The adiabatic calorimeter was also used within the VITCEA project for heat capacity measurements of samples of composite materials. During the same time period an effort was put also in development of transient plane source method as an alternative to GHP method enabling relatively fast thermal conductivity measurements.

Following pictures show the laboratory of contact, non-contact thermometry, humidity and thermophysical properties.





### **Proposed area of interest**

During recent years, a big development in the area of thermometry, humidity and thermophysical quantities have been made. Laboratory results are very well recognized by thermometry community. We can contribute mainly in following areas:

- 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.

In the last four years we contributed at several European projects (EMRP), where the majority of scientific effort are made now.

### **List of publications related to CCT activities, where we are contributing either as main or co-author during past 3 years**

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