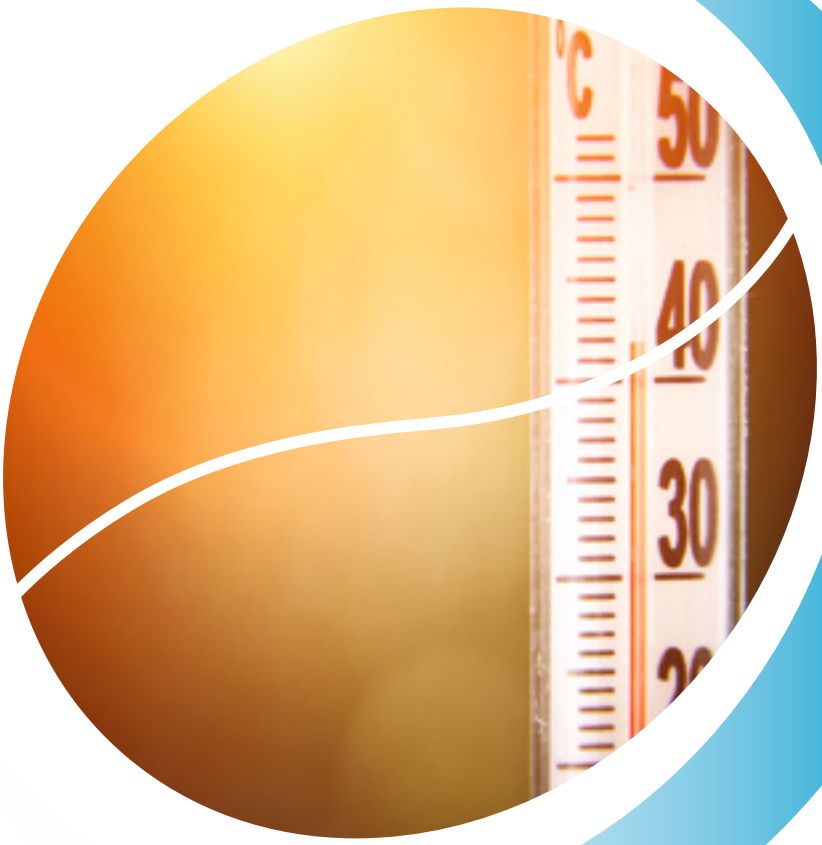
EURAMET Summer School on Thermal Metrology

EIM, Thessaloniki, 17 – 21 September 2018



Hosted by
National Quality Infrastructure
System of Greece
Hellenic Institute of Metrology (EIM)

An initiative of EURAMET´s Technical
Commitee for Thermometry

Thermometry

EURAMET's first 'Summer School on Thermal Metrology' offers metrologists new to thermometry a sound introduction to the field. Taught by world leading experts from the thermometry and measurement community, the summer school will provide insight into the theory, practice, and metrological infrastructure of the related measurement fields: temperature, humidity, and thermophysical quantities.

The course is primarily aimed at staff of EURAMET's member National Metrology Institutes and associated Designated Institutes with less than 2 years' experience in the field of thermal measurements, or those who need to gain experience in another aspect of thermometry. As well as a valuable opportunity to network with colleagues at an early stage of their careers, an important part of the course will be a day spent in the laboratory getting hands-on experience in contemporary thermometry, humidity, and thermophysical quantities measurement.

Over 40 students will be part of the 2018 course. Although mainly attending from EURAMET member countries, several guests from other Regional Metrology Organisations are participating.

The Summer School was the initiative of EURAMET's Technical Committee for Thermometry (TC-T) and is jointly organised by EURAMET, the TC, and this years' hosting institution the Hellenic Institute of Metrology (EIM), the National Metrology Institute of Greece.

Lecture sessions will be held in the Hotel Olympia, Thessaloniki, with laboratory sessions taking place in the Hellenic Institute of Metrology (EIM) and the Aristotle University of Thessaloniki (AUTh).

EURAMET Technical Committee for Thermometry

Temperature is one of the most frequently measured physical quantities in science and industry. That implies that precise knowledge of temperature and related quantities is fundamentally important for the development of new and more efficient production techniques saving energy and other resources and reducing waste and for control of societal problems of environment, climate and safety.

The Technical Committee of Thermometry is concerned with all issues of measurement of

- Temperature,
- Humidity and moisture, and
- Thermophysical quantities of materials;
- As well as with scales, standards and reference materials necessary for metrology in these fields.

The types of cooperation within TC-T are the same as for other EURAMET Technical Committees:

- Cooperation in research,

- Comparison in measurement standards,
- Traceability,
- Consultation on facilities.

The Technical Committees are responsible for the execution of the activities required by EURAMET as Regional Metrology Organisation (RMO) for the fulfilment of the Mutual Recognition Arrangement of the International Committee of Weights and Measures (CIPM-MRA).

Subcommittee Humidity

EURAMET TC-T has one Subcommittee, the SC Humidity, which is concerned with all issues of measurement of humidity and moisture, as well as with standards and references necessary for developing the metrology in the field.

Furthermore, TC-T has four working groups:

TC-T Strategy Working Group

The role of the TC-T strategy working group is to put in place the necessary structures, foster collaboration and research to ensure that the EURAMET TC-T continually meets its objective in a timely manner.

TC-T Best Practice Working Group

The purpose of this working group is to transfer knowledge within the EURAMET member institutes, to accredited calibration laboratories and beyond. The WG monitors the current status of existing guidelines and other best practice documents and identifies needs for new ones. When technically necessary existing documents are updated, new documents are proposed and prepared. The WG monitors needs for training of NMI personnel and stakeholders. When needed, training courses or training programmes are initiated.

TC-T Thermophysical Quantities of Materials Working Group

This working group is focused on studying issues of measurement of thermophysical quantities of materials (TQM). Its outcomes are used to enhance and support needs and developments of industry and society. This goal is achieved through mobilising the TQM community, targeting and completing gaps of the research programmes, building capacities, and disseminating scientific knowledge.

TC-T CMC Review Working Group

The aims and purpose of this working group are to:

- Provide input into the CCT WG-CMC for the development of protocols defining the procedure and technical criteria by which temperature, humidity and thermophysical property CMCs are reviewed, use the agreed protocols to perform reviews of temperature, humidity and thermophysical property CMCs,

- Verify that claimed values are realistic and to ensure consistency between laboratories,
- Validate temperature, humidity and thermophysical property CMCs from other RMOs to ensure consistency of the claimed values between the different metrology regions,
- Ensure that approved CMCs are published on the BIPM-KCDB Appendix C.

Useful resources

A number of web resources are available which contain valuable information for EURAMET thermometry experts.
The main web portals of EURAMET and BIPM are the most important sources:

- www.euramet.org and
- www.bipm.org.

The Technical Committee for Thermometry web pages offer access to all projects conducted within the committee (https://www.euramet.org/technical-committees/tc-t/).

Additional useful hyperlinks:
General metrology vocabulary (VIM3) and Guide for measurement uncertainty (GUM) https://www.bipm.org/en/publications/guides/;
BIPM CCT Guides to Thermometry https://www.bipm.org/en/committees/cc/cct/thermometry-guides.

EURAMET Calibration Guidelines https://www.euramet.org/calibration-guidelines

Hellenic Institute of Metrology (EIM)

EIM was founded in 1994 as a legal entity, under private law, supervised by the General Secretariat of Industry of the Ministry of Economy & Development. At present, EIM together with the Hellenic Standardization Organization (ELOT) comprise, as independent units, the National Quality Infrastructure System (NQIS), which is a legal entity of the Ministry of Economy & Development under private law.
The facilities and the laboratories of EIM are located in the Industrial Area of Thessaloniki and operate in two independent building facilities. The main activities of EIM cover the area of Scientific Metrology and include:

- The realisation of the basic and derived SI units and the maintenance of the respective national standards of Greece.
- The development of measurements methods and techniques.
- The support of the metrology system of Greece.
- The operation of calibration laboratories and the issuing of calibration certificates.
- Performance of measurements for type approval of measuring equipment.
- The promotion of metrology.
- The development and provision of reference materials.
- The representation of Greece in international metrology organisations and fora.

EIM operates the following national laboratories within its premises:

- Mass, Volume, Flow, Pressure and Force in the field of Mechanical Measurements,
- Temperature & Relative Humidity, Dimensional Measurements, Acoustics and Vibrations in the field of Physical Measurements,
- Electrical Measurements at High Frequencies, Electrical Measurements at Low Frequencies and Time-Frequency.

In addition, two Designated National Laboratories operate under the umbrella of EIM, namely:

- The National Laboratory for Chemical Metrology (EXHM/GCSL-EIM) within the premises of the General Chemistry State Laboratories (GCSL) in Athens,
- The National Laboratory for Ionizing Radiation (IRCL/GAEC-EIM) within the premises of the Greek Atomic Energy Commission (GAEC).

EIM makes the top part of the metrological system of Greece, which includes more than 40 accredited calibration laboratories and more than 300 testing laboratories. EIM provides active support to the Metrological System including calibration services to disseminate measurement traceability to SI units (about 600 calibration certificates/year), ILCs to support accreditation according to ISO 17025 (more than 20 schemes/year), training and metrological support (organising several programmes in Greece and abroad), as well as dissemination of knowledge in metrology (relations with universities and participation in conferences and events).

EIM has been an active member of EURAMET since late 90's, participating in the respective TCs and EURAMET activities, as well as in bilateral and multilateral cooperation and projects, including EMRP and EMPIR projects. The laboratories of EIM have 120 CMC entries published and total 155 with the two DIs (EXHM and IRCL).

EIM implements an integrated Management System which covers the requirements of ISO 17025 for calibration & measurements activities, ISO 17043 for ILCs and ISO 9001 for the rest of the activities.

Agenda

Monday, 17 September 2018 Hotel Olympia Thessaloniki		
08:00 - 08:30	Registration	
08:30 - 09:00	Course opening and overview	Tanasko Tasić, Evmorfia Kokkini, Graham Machin
09:00 - 09:15	Greeting from the host	Panagiotis Charoupias
09:15 - 10:00	Ice break session – the most difficult thermal measurement I have made	Several speakers

10:00 - 11:15	Overview of the SI and international metrology, CGPM, CIPM, BIPM, CCT, RMOs, EURAMET, TCs, TC-T	Susanne Picard, Tanasko Tasić Dolores del Campo, Miruna Dobre
11:15 - 11:45	Discussion and coffee break	
11:45 - 12:30	The redefinition of the SI with emphasis on the kelvin (including *MeP*-K)	Graham Machin
12:30 - 13:30	Introduction to uncertainty of measurement	Stephanie Bell
13:30 - 14:30	Lunch	
14:30 - 15:15	How do you know what the temperature is (the nature of temperature, thermal physics, temperature scales, ITS-90)?	Michael de Podesta
15:15 - 16:30	Traceability and uncertainty in temperature measurement	Steffen Rudtsch
16:30 - 16:45	Coffee break	
16:45 - 17:15	Overview of contact thermometry	Jonathan Pearce
17:15 - 17:45	Overview of non-contact thermometry	Mohamed Sadli

Tuesday, 18 September 2018 Hotel Olympia Thessaloniki

Humidity fundamentals

09:00 - 10:00	Humidity fundamentals (basic definitions in hygrometry)	Stephanie Bell
10:00 - 10:30	Traceability routes to accurate humidity measurements	Domen Hudoklin
10:30 - 11:00	Coffee break	
11:00 - 12:00	Humidity generation principles	Vito Fernicola
12:00 - 13:00	Relative humidity and dew-point sensors types	Eric Georgin
13:00 - 14:00	Lunch	

Thermophysical quantities fundamentals

14:00 – 14:30	Introduction	Jean-Rémy Filtz
14:30 - 15:30	Thermophysical Quantities (1) Basics - Solids	Jean-Luc Battaglia
15:30 - 16:00	Coffee break	
16:00 - 17:00	Thermophysical Quantities (2) Basics - Fluids "Reference Values and Reference Correlations for the Thermal Conductivity and Viscosity of Fluids"	Marc Assael
17:00 - 18:00	Thermophysical Quantities (3) Basics – Gases	Miguel Villamañan
19:00	Get together reception	

Wednesday, 19 September 2018 Hotel Olympia Thessaloniki

Parallel Session A1: Thermometry: Contact thermometry - morning

08:30 - 09:15	Fixed points	Jonathan Pearce
09:15 - 10:00	PRTs (resistance measurement, bridge linearity, operating principles, what makes a good thermometer, materials, oxidation, handling annealing, common sources of uncertainty)	Steffen Rudtsch
10:00 - 10:45	Uncertainty analysis – SPRTs	Andrea Peruzzi
10:45 - 11:15	Coffee break	
11:15 - 12:30	Thermocouples (the basics, thermovoltage measurement, thermocouple types, homogeneity, practical use, calibration, drift, uncertainty budgets)	Frank Edler
12:30 - 13:15	Other contact probes and common measurement scenarios (e.g. liquid in glass, PRTs, thermistors, diodes & bandgap devices, thermochromic paint, quartz resonance, fibre optic)	Michael de Podesta
13:15 - 14:30	Lunch	

Parallel Session A2: Thermometry: Non-contact thermometry - afternoon

14:30 - 15:15	ITS-90 realisation and mise-en-pratique in radiation thermometry, sources (fixed point blackbodies, VTBB, HTBBs, HTFPs)	Mohamed Sadli
15:15 - 16:00	ITS-90 realisation - methods and instruments (pyrometers, monochromator-based spectroradiometers, extrapolation methodologies, characterisation of SSE, spectral responsivity, linearity)	Stephan Briaudeau
16:00 - 16:30	Coffee break	
16:30 - 17:15	Techniques for the calibration of radiation thermometers, blackbody sources and thermal imaging systems and the evaluation of uncertainties	Helen McEvoy
17:15 - 18:00	Thermodynamic temperature	Klaus Anhalt
18:00	Guided city walk	

Wednesday, 19 September 2018 Hotel Olympia Thessaloniki

Parallel Session B: Humidity

09:00 - 10:00	Design of a secondary RH calibration setup	Eric Georgin
10:00 - 11:00	Design of a dew-point calibration setup (secondary and primary)	Vito Fernicola
11:00 - 11:30	Coffee break	

11:30 - 13:00	Uncertainty analysis – dew-point	Stephanie Bell
13:00 - 14:00	Lunch	
14:00 - 15:00	Uncertainty analysis – relative humidity	Domen Hudoklin
15:00 - 16:00	Uncertainty contributions from a hygrometer (chilled-mirror hygrometer, RH impedance sensor)	Eric Georgin
16:00 - 16:30	Practical considerations: couplings, leakages, heating, tube materials	Domen Hudoklin
16:30 - 17:00	Discussion	
18:00	Guided city walk	

Wednesday, 19 September 2018 Hotel Olympia Thessaloniki

Parallel Session C: Thermophysical Quantities

08:30 - 09:15	Grand Challenges & Thermophysical Quantities Metrology	Jean-Rémy Filtz
09:15 - 09:45	Thermal properties metrology - Some historical milestones	Bruno Hay
09:45 - 10:45	Traceability of Thermal Conductivity Measurements	Jiyu Wu
10:45 - 11:15	Coffee break	
11:15 - 12:15	Radiative Properties - Measurement techniques (Pro/Cons), Uncertainties, Standards, CRMs, Applications	Klaus Anhalt
12:15 - 13:15	Measurements of thermal transport properties of solids from macro to nano scales	Bruno Hay
13:15 - 14:30	Lunch break	
14:30 - 15:30	Calorimetry: Specific heat and enthalpy of fusion of solids	Refat Razouk
15:30 - 16:30	Thermal Expansion - Measurement techniques (Pro/Cons), Uncertainties, Standards, CRMs, Applications	Sergei Kondratiev
16:00 - 16:30	Coffee break	
16:30 - 17:30	Thermophysical Quantities Metrology - International Activities Overview	Jean-Rémy Filtz
18:00	Guided city walk	

Thursday, 20 September 2018 Hellenic Institute of Metrology (EIM)

08:30	Transport of participants to EIM	
9:00 - 17:00	Hands-on training at EIM laboratories	

1. Temperature measurement: contact

Realisation of TPW, calibration of SPRT at fixed points (e.g. realisation of fixed points of Hg and Ga), calculation of a,b coefficients, uncertainty components	Jovan Bojkovski, Andrea Peruzzi, Evmorfia Kokkini, Miruna Dobre

Usage of automatic resistance bridges

Calibration of TC at fixed points, uncertainty components

Usage of digital voltmeter

Secondary contact (calibration by comparison, uncertainties, equations)

2. Temperature measurement: non-contact

Secondary calibration of non-contact thermometer (traceability, BB, uncertainties, problems (e.g. size of source, pixels at thermal vision cameras) — Helen McEvoy, Klaus Anhalt, Frédéric Bourson

Grey body calibration of industrial non-contact thermometers

3. Humidity

RH & dew-point sensors - show different RH and dew-point sensors and discuss their operation — Eric Georgin, Vito Fernicola, Domen Hudoklin

Prepare the secondary calibration setup (RH and dew-point) and discuss critical points

Run the setup at selected point and discuss the results

Coffee and lunch breaks will be announced in the sessions

Thursday, 20 September 2018 Aristotle University of Thessaloniki (AUTh)

08:30 Participants walk to the AUTh

09:00 - 13:00 Introduction of the techniques:

1. Thermal Conductivity measurement

Transient hot-wire instrument for liquids, gases, or nanofluids (Absolute technique with 0.5% uncertainty) — Marc Assael, Bruno Hay, Jean-Rémy Filtz

Transient hot-wire instrument for solids (Absolute technique with 2% uncertainty)

Guarded heat-flow instrument for solids and thin films (Relative technique with 5% uncertainty)

2. Viscosity measurement

Vibrating-wire instrument for liquids, gases (Absolute technique with 0.5% uncertainty)

Cone and plate viscometer for non-Newtonian liquids (Relative technique with 5% uncertainty)

Concentric cylinders viscometer for non-Newtonian liquids (Relative technique with 10% uncertainty)

Coffee and lunch breaks will be announced in the sessions

Friday, 21 September 2018 Hotel Olympia Thessaloniki

09:00 - 10:30	Further talks and open forum for discussing students' questions	
10:30 - 11:00	Coffee break	
11:00 - 12:30	Future developments in thermal metrology	Graham Machin, Mohamed Sadli, Andrea Peruzzi, Jean-Remy Filtz
12:30 - 13:00	Closing of the event	
13:00 - 14:00	Lunch	

Lecturers

Klaus Anhalt
PTB, Germany

Klaus Anhalt studied experimental physics in Marburg, Manchester and Berlin and obtained his PhD at the Technische Universität Berlin in 2008. Since 2002, he has been a researcher at the Physikalisch-Technische Bundesanstalt, the national metrology institute in Germany, in the division "Detector Radiometry and Radiation Thermometry". He has more than 15 years' experience in the fields of radiometry, radiation thermometry, high-temperature fixed-points, and emissivity measurements. He is a co-opted member of the CCT working group on Radiation Thermometry and a member of the EURAMET TC-T CMC Review Group.

Konstantinos D. Antoniadis
Aristotle University of Thessaloniki, Greece

Konstantinos D. Antoniadis received his PhD in Chemical Engineering from Aristotle University of Thessaloniki (AUTh), Greece, and has more than 10 years' experience in developing methods measuring the thermophysical properties of solid and composite materials at very low uncertainty. For the last three years he has been teaching a course in "3D-CAD design and optimisation with

Solidworks" at the Chemical Engineering Department of AUTh. Konstantinos is also a participating member on ASTM International on the Working Group for Thermal Measurements.

Marc J. Assael
Aristotle University of Thessaloniki, Greece

Marc Assael is Professor of Thermophysical Properties at the Aristotle University of Thessaloniki (AUTh), Greece. Joining AUTh in 1982 as Lecturer in Heat Transfer in the Faculty of Chemical Engineering, Marc founded Thermophysical Properties Laboratory and served as the Faculty's Chairman between 1995 and 1997. In 1998, Marc was TEPCO Chair Visiting Professor in Keio University, Japan, and since has held the position of Adjunct Professor in Jiaotong University, China. Marc has published and contributed to a number of books in the field of thermophysical properties, and acts as a referee and associate editor on several journals.

Jean-Luc Battaglia
Université de Bordeaux, France

Jean-Luc Battaglia is a professor in Fluid Mechanics and Thermal Sciences at the University of Bordeaux, and Deputy Director of the Mechanical Engineering Institute. In 2015, Jean-Luc was made an IEEE Fellow in nanotechnology for contributions to the development of Thermal Microscopy. He is currently a member of the administrative council of the French Society in Thermal Science, and expert at the French National Research Agency. Jean-Luc has also worked on the editorial board of a number of well-respected journals, and since 1994 has supervised 20 PhD students.

Stephanie Bell
NPL, United Kingdom

Dr Stephanie Bell is a lead scientist at NPL, working on humidity measurement and calibration. Her interests include humidity measurement techniques; primary humidity standards; humidity quantities, units and conversions; measurement of moisture in materials; and uncertainty evaluation. Stephanie chairs humidity committees nationally (BSI) and internationally (CIPM CCT Working Group for Humidity), and leads NPL's humidity training course. She is a UKAS assessor for accreditation of humidity calibration laboratories, and a Fellow of the Society of Environmental Engineers.

Jovan Bojkovski
MIRS/UL-FE/LMK, Slovenia

Jovan Bojkovski is a professor at the University of Ljubljana in the Faculty of Electrical Engineering, teaching measurement related courses, with expertise in thermometry. Since 1999, Jovan has also been the Slovenian Contact Person in EURAMET Technical Committee for Thermometry, and is currently chairperson for the BIPM CCT Working Group for Calibration and Measurement Capabilities.

Frédéric Bourson
LNE-Cnam, France

Frédéric Bourson joined the radiation thermometry department of LNE-Cnam in 2003, and since has been actively involved in the European and international projects devoted to non-contact and primary thermometry. In particular, he has contributed to activities related to high-temperature fixed points (HTFPs), ITS-90, and thermodynamic temperature measurements, and led two projects dedicated to the new generation of HTFPs. In the frame of the CIPM MRA, Frédéric is the calibrations and studies supervisor of LNE-Cnam.

Stéphan Briaudeau
LNE-Cnam, France

Stéphan Briaudeau is the Head of the High Temperature department at LNE-Cnam, France, and coordinator of the EURAMET Joint Research Project 'Photonic and Optomechanical Sensors for Nanoscaled and Quantum Thermometry' (PhotOQuanT). Alongside his research, Stéphan also supervises thermometry PhD students as well as the Cnam national engineer diploma 'Instrumentation and Quality'.

Michael de Podesta
NPL, United Kingdom

Michael de Podesta is a physicist specialising in temperature metrology in the NPL Temperature and Humidity Group. Michael led the research team that produced NPL's estimate of the Boltzmann constant and has published estimates of the difference between thermodynamic temperature and the International Temperature Scale of 1990. He is interested in all aspects of metrology and communicating measurement science to the public. He writes a blog at http://protonsforbreakfast.org.

Dolores del Campo
CEM, Spain

Dolores del Campo is responsible for thermometry and gases metrology at CEM, primarily working on the maintenance and dissemination of Spanish national standards for temperature and reference gases. With more than 25 years' experience in metrology, Dolores has participated in a number of research projects in SI, industry, energy, and environment. In particular, she coordinated the EMRP project NOTED 'Novel Techniques for Traceable Temperature dissemination'. Currently, Dolores chairs the EURAMET Technical Committee for Thermometry.

Miruna Dobre
SMD, Belgium

Miruna Dobre has been head of the thermometry laboratory at the Belgian National Metrology Institute (SMD) since 2003. Her main research interests are in environmental applied metrology and contact thermometry. She joined SMD after a research career in thermodynamics and fluid mechanics, working in Romania at the Internal Combustion Engine Institute (Master) and Belgium at Université de Louvain (UCL). Since 2013, Miruna has coordinated the Belgian research in metrology and currently chairs EURAMET's Technical Committee for Interdisciplinary Metrology.

Frank Edler
PTB, Germany

Frank Edler is the head of the Thermoelectrics Working Group at PTB, with more than 25 years' experience in thermocouple and noise thermometry. Frank began working at PTB in 1990, and is currently in charge of developing new methods for realising and disseminating high temperature scales using contact thermometers, and investigating the transport properties of thermoelectric materials. Since 1997, Frank has been a member of CCT task group Guides in Thermometry.

Vito C. Fernicola
INRIM, Italy

Vito Fernicola works in thermal measurements and standards at INRIM, the Istituto Nazionale di Ricerca Metrologica, and is involved in the development of primary humidity standards, moisture in materials metrology, fibre optic and dielectric thermometry, and instrumentation and sensors

for industrial measurements. Vito also teaches Thermal Measurements and Controls at the Politecnico of Torino. He is a delegate at the CIPM/CCT and EURAMET TC-T, where he is chairing the Subcommittee Humidity. Vito is currently a member of the Board of Directors of INRIM and Vice-president of ACCREDIA, the Italian accreditation body.

Jean-Rémy Filtz
LNE, France

Jean-Rémy Filtz is the Director in charge of Scientific and Industrial Metrology at LNE. Prior becoming Director, he spent several years at LNE as expert and head of the Thermal and Optical Metrology Division and later, within the framework of the joint metrology laboratory LNE-Cnam, head of the Energy and Photonics Division. As Vice-president of CFM (French College of Metrology) Jean-Rémy has been involved as a Member of the Organising Committee and President of the Scientific and Technical Committee of the International Metrology Congress, and under BIPM-CCT and EURAMET TC-T is chairing the groups in charge of Metrology for the Thermal Quantities of Materials.

Eric Georgin
LNE-CETIAT, France

Eric Georgin received his PhD in Mechanical Engineering from Bordeaux University, France. At LNE-CETIAT he is in charge of two calibration laboratories: the French national hygrometry reference standard, and secondary level thermometry standards. He has more than 10 years' experience in hygrometry research, focused on the development of humidity and moisture measurement standards. Eric has been involved in several EMRP and EMPIR research projects related to hygrometry and is Contact Person at EURAMET TC-T Subcommittee Humidity and also at CCT WG-Hu.

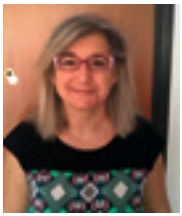
Bruno Hay
LNE, France

Bruno Hay is the head of the Materials Department at LNE, covering activities related to the metrology of thermophysical properties and characterisation of nanomaterials. Since joining LNE in 1992, Bruno has been working on the characterisation of thermal properties of materials, and contributed to nearly 15 international joint research projects – including EMRP and EMPIR joint research projects. He is the French representative in the Task Group for Thermophysical Quantities of the BIPM-CCT.

Domen Hudoklin
MIRS/UL-FE/LMK, Slovenia

Domen Hudoklin has 18 years of experience in hygrometry. His research is focused in development and maintenance of humidity measurement standards, design of measurement principles in hygrometry and design of humidity and moisture sensors. He has been actively involved in several EMRP and EMPIR research projects related to hygrometry. Domen is coordinating the largest EURAMET interlaboratory comparison in the field of relative humidity and is member of EURAMET TC-T´s Subcommittee Humidity.

Evmorfia Kokkini
EIM, Greece



Evmorfia Kokkini has been Head of Temperature and Humidity Measurements Laboratory of Hellenic Institute of Metrology (EIM) since 2001, and is responsible for realising the relevant Greek national standards. She has conducted research in thermometry and humidity measurements for more than twenty years, organising and providing training to metrology experts during this time. Evmorfia is also the Technical Assessor of the Greek Accreditation Body (ESYD) in the measurement fields of temperature and humidity, and represents Greece in EURAMET's Technical Committee for Thermometry.

Sergey Kondratev
D.I. Mendeleyev Institute for Metrology (VNIIM), Russia

Sergey Kondratev has been a researcher at the D.I. Mendeleyev Institute for Metrology for nine years. Over the last five years, he has been working in the laboratory of thermal expansion of solids. Sergey's main area of research is thermal expansion at high temperatures. Recently, he became the Russian representative at the CCT-Task Group of Thermophysical Quantities.

Graham Machin
NPL, United Kingdom

Graham Machin is an NPL Fellow and science leader of NPL's Temperature and Humidity Group. He has more than 25 years' experience in thermometry research, and currently holds a visiting senior researcher position at the National Institute of Metrology, China. He is visiting Professor of Thermometry in Harsh Environments (University of Strathclyde), visiting Professor of Clinical Thermal

Imaging (University of South Wales) and Distinguished Visiting Fellow (colaborador honorífico) (University of Valladolid). He has been chair of the EURAMET Technical Committee for Thermometry (TC-T), and is currently chair of the CCT working group for noncontact thermometry. Graham was awarded the Institute of Measurement and Control (InstMC) Callendar Medal in 2012 for "outstanding contributions to the art of temperature measurement" and the prestigious visiting fellowship of the Chinese Academy of Sciences (2017). He is currently the President of the InstMC.

Helen McEvoy
NPL, United Kingdom

Helen McEvoy is a Senior Research Scientist within the Temperature and Humidity Standards group at NPL. Her work includes maintaining, improving, and disseminating the temperature scale using radiation thermometry. Currently, Helen is also a Work Package Leader in the EMPIR project 'Implementing the new kelvin 2' (InK2), and is coordinating an international key comparison in high temperature radiation thermometry (CCT-K10). Helen sits on the British Standards Institute (BSI) committee for clinical thermometer and thermography standards and the International Electrotechnical Commission (IEC) committee.

Jonathan Pearce
NPL, United Kingdom

Jonathan Pearce is a Principal Research Scientist in the Temperature & Humidity group at NPL and head of the contact thermometry technical area, specialising in temperature measurement with thermocouples and resistance thermometers. Presently, Jonathan is also responsible for the realisation and dissemination of the International Temperature Scale of 1990 (ITS-90), and coordinates the EMPIR joint research project 'EMPRESS2' developing temperature measurement solutions for high value manufacturing. Jonathon is the UK representative on the EURAMET Technical Committee for Thermometry.

Andrea Peruzzi
VSL, Netherlands

Andrea Peruzzi is the lead scientist for temperature, humidity, mass, pressure and viscosity at VSL, the Dutch Metrology Institute. Since 2005, Andrea has represented the Netherlands in the CCT and in the EURAMET TC-T, as well as chairing the EURAMET TC-T from 2010 to 2014. He is currently chair of the CCT WG on Key Comparisons. Andrea's current research interests include isotopic and chemical impurities in the triple point of water, non-uniqueness of the ITS-90, and high-accuracy deep-ocean thermometry.

Susanne Picard
BIPM

Susanne Picard is the BIPM KCDB Coordinator and the Executive Secretary of the Consultative Committee for Thermometry (CCT). Having initially joined the BIPM Length Section, Susanne later moved to the Ionizing Radiation Department where she developed a graphite calorimeter to determine absorbed dose to water in high-energy photon beams. Since 2015 she in charge of the BIPM Key Comparison Database and the development of a new KCDB platform.

Refat Razouk
LNE, France

Refat Razouk is a physical instrumentation engineer at the French national metrology institute (LNE), and is currently involved in the development of a reference facility for specific heat measurement by drop calorimetry at very high temperatures and the enhancement of thermal conductivity measurements by high temperature guarded hot plate apparatus. Refat has worked for several years as a metrologist in temperature and humidity measurements, and was involved in the EMRP project 'Metrology for decommissioning nuclear facilities', where he developed calorimeter prototypes and electrical simulators measuring thermal power.

Steffen Rudtsch
PTB, Germany

Steffen Rudtsch is the Head of Department for Temperature at PTB, Germany's NMI. Steffen began his research career with a PhD in Physics at Brandenburg Technical University, Germany, later becoming the Head of the Laboratory for Thermophysical Property Measurements. Steffen is also currently a member of working groups of the Consultative Committee for Thermometry and the PTB contact person for EURAMET's Technical Committee for Thermometry.

Mohamed Sadli
LNE-Cnam, France

Mohamed Sadli completed his PhD in the metrological applications of pressure-controlled heat-pipes in thermometry at LNE-Cnam, France before moving to the radiation thermometry group. Since January 2018, Mohamed has been the Head of the Temperature Division at LNE-Cnam, leading and coordinating the research activities in thermometry. He represents France at the EURAMET TC-T and is a technical assessor for several accreditation bodies in contact thermometry and radiation thermometry.

Tanasko Tasić
EURAMET

Tanasko Tasić is the EURAMET Capacity Building Officer, responsible for facilitating calls for EMPIR research project proposals and researcher mobility grants, and for coordinating EURAMET training activities. Prior to joining the EURAMET Secretariat in 2014, Tanasko worked at the Slovenian NMI, MIRS, as the Head of the Sector for IT in metrology, and later as Acting Director. He was active in international bodies dealing with metrological software WELMEC WG7 and chairing OIML TC5, as well as several capacity building projects for NMIs abroad. Tanasko also has significant experience in manufacturing measurement instruments, having worked in research and development, and as the head of a testing laboratory.

Miguel A. Villamañan
Universidad de Valladolid, Spain

Miguel Villamañan is professor of thermodynamics at the School of Engineering of the University of Valladolid, Spain. Starting in the field of thermophysical quantities with his PhD at the Centre de Thermodynamique et Microcalorimetrie, CNRS - Marseille and Blaise Pascal Université - Clermont Ferrand, France, continued with postdoctoral research at Resselaer Polytechnic Institute, Troy, New York, USA. Miguel later set up a research group, TERMOCAL, in Spain, researching the thermophysical properties of fluid mixtures.

Jiyu Wu
NPL, United Kingdom

Jiyu Wu is a Principal Research Scientist and a Chartered Engineer with extensive experience in high temperature thermal conductivity metrology. Her work at the National Physical Laboratory (NPL) focuses on the development of National Standard level thermal conductivity measurement facilities, and thermal conductivity of reference materials. She recently led the EMRP joint research project 'Metrology for thermal protection materials'.

Parts of the Summer School on Thermal Metrology were supported by

Isothermal Technology Ltd. (Isotech),
Pine Grove, Southport,
Merseyside, PR9 9AG, UK
www.isotech.co.uk

KAMBIČ, laboratorijska oprema d.o.o.,
Metliška cesta 16,
SI 8333 SEMIČ, Slovenia,
www.kambic.com

MAIN SOUTIONS LTD
38, Argostoliou str.
18345 – Moschato
GREECE
www.mainsolutions.eu

This training course is funded by the EMPIR Human and Institutional Capacity Building.

EURAMET e.V.
Bundesallee 100
38116 Braunschweig
Germany

Phone: +49 531 592 1960
Fax: +49 531 592 1969
E-mail: secretariat@euramet.org
www. euramet.org