EURAMET
European Association of National Metrology Institutes

CCT/14-52

EURAMET TC Thermometry

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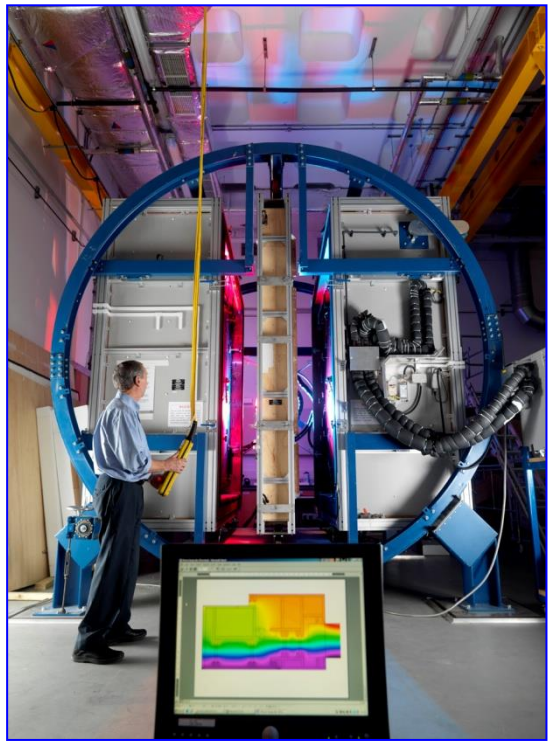
Technical Committee for Thermometry

Thermometry (main field)

Humidity (sub-field)

Thermophysical Quantities of Materials



Working Groups (WGs)

- The technical work is performed by four WGs:
  - **WG on CMC Review (since 2000):**
    - Intra-RMO reviews (EURAMET CMCs to be submitted to CCT WG8)
    - Inter-RMO reviews (other RMO's CMCs submitted to CCT WG8)
  - **WG on Strategy (since 2009):**
    - Generates and updates the roadmaps
    - Supports and coordinates the participation of the TC-T in the EMRP/EMPIR programmes
  - **WG on Best Practice (since 2009):**
    - Supports assessments and improve measurement procedures by updating existing and creating new guidelines and other best practice documents
  - **WG on Thermophysical Quantities of Materials,TQM (since 2010)**

Regional comparisons completed since last CCT meeting (2012)

Comparison	Quantity	Participants
EURAMET.T-K3.1	Bilateral comparison of the realisations of the ITS-90 at the fixed points of Hg, H_2O, Ga, Sn and Zn	**VSL**, BIM
EURAMET.T-K3.3	Bilateral comparison of the realisations of the ITS-90 over the range 83.8058 K to 933.473 K	**CEM**, LACOMET
EURAMET.T-K5	Comparison of local realizations of the ITS-90 between the silver point and 1700 °C using vacuum tungsten-strip lamps as transfer standards	**VSL**, CEM, IPQ, MIKES, MKEH, SMU, UME
EURAMET.T-K6.1	Bilateral comparison of the realisations of local dew/frost-point temperature scales in the range -70 ºC to +20 ºC	**MIKES**, HMI
EURAMET.T-K7.1	Bilateral comparison of water triple point cells	**SMU**, CMI
EURAMET.T-K7.2	Bilateral comparison of water triple point cells	**VSL**, INTiBS
EURAMET.T-K7.3	Bilateral comparison of water triple point cells	**VSL**, GUM

Regional comparisons in progress

Comparison	Quantity	Participants	Protocol available	Measurements started	Measurements completed	Draft A available	Draft B available
EURAMET.T-K1	Realisations of the ITS-90, 2.4 K to 24.5561 K, using rhodium-iron resistance thermometers	**PTB**, INRIM, INTiBS, VSL, NPL	Yes	Yes	Yes	Expected SEP2014	Expected OCT2014
EURAMET.T-K3.2	Comparison of the realisations of the ITS-90 over the range 83.8058 K to 692.677 K	**UME**, DMDM, EIM, NIS	Yes	Yes	Yes	Expected JUL2014	Expected SEP2014
EURAMET.T-K3.4	Comparison of the realisations of the ITS-90 over the range 83.8058 K to 692.677 K	**MIRS/UL-FE/LMK**, DMDM, HMI, UME	Yes	Yes	Yes	Expected DEC2014	Expected FEB2015
EURAMET.T-K3.5	Comparison of the realisations of the ITS-90 over the range 83.8058 K to 933.473 K	**VSL**, ROTH+CO. AG	Yes	Yes	Yes	Expected MAY2014	Expected JUN2014
EURAMET.T-K4.1	Bilateral comparison of the realisations of the ITS-90 at the freezing point of Al (660.323 ºC) and Ag (961.78 ºC)	**LNE-INM**, KIM-LIPI	Yes	Yes	Expected JUN2014	Expected SEP2014	Expected OCT2014
EURAMET.T-K8	Comparison in dew-point temperature +30 ºC to +95 ºC	**PTB**	Yes	Yes	Yes	Expected DEC2014	Expected FEB2015

Regional comparisons initiated

Comparison	Quantity	Participants	Protocol available	Measurements started	Measurements completed	Draft A available	Draft B available
EURAMET.T-K8.1	Comparison in dew-point temperature +30 ºC to +95 ºC	**PTB**, E+E, INTA, MBW	Expected MAY2014	Expected SEP2014	Expected DEC2014	Expected DEC2014	Expected FEB2015
EURAMET.T-K9	Regional extension of CCT-K9	**LNE-INM** + 31 Labs	Expected MAY2014	Expected SEP2014	Expected DEC2015	Expected MAR2016	
EURAMET.T-S3	Comparison of the calibration of Pt/Pd thermocouples from 419.527 ºC (freezing point of zinc) up to 1492 ºC (Pd-C eutectic fixed point)	**CEM** + 18 labs	Yes	Yes	Expected OCT2015	Expected FEB2016	Expected MAY2016
EURAMET P1189	Comparison of the realisations of the relative humidity in the range from 10% to 95% at temperatures from -10 °C to 70 °C	**MIRS/UL-FE/LMK** + 20 labs	Yes	Yes	Expected DEC2014	Expected APR2015	
EURAMET P13YZ	Comparison of the realisations of relative humidity in the range from 10% to 95% at temperatures from -40 °C to 20 °C	**INTA** + 11 labs	Expected MAY2014	Expected OCT2014	Expected FEB2016	Expected JUN2016	

Intra-RMO CMC Review Process

- Cyclic process with one year period:

Deadline	Action	Output	Required by:
End February	Submission new or modified entries (and, if needed, supporting information)	Correct Excel file format (only for new and modified entries)	Contact persons
End May	CMC Review group response (and, if needed, request of additional supporting information)	“Acceptance” or “under review with request of supporting information”	CMC Review Group
End June	Submission of additional supporting information	Uncertainty budgets, internal reports, literature references	Contact persons

- Review performed by WG on CMC Review
  - Two experts for each group of services
  - Coordinated by the WG chair

Batches of EURAMET CMCs published in the KCDB since last CCT Meeting (2012)

Batch	Services	Number of CMCs
EURAMET.T.10.2012	Humidity (5), Thermocouples (75), Industrial Resistance Thermometers (19), Fixed Points and SPRTs at Fixed Points (2)	101
EURAMET.T.11.2012	Fixed Points and SPRTs at Fixed Points (2)	2
EURAMET.T.12.2013	Fixed Points and SPRTs at Fixed Points (160)	160
EURAMET.T.13.2013	Ultra-Low and Very Low Temperature Devices and Thermometers (5)	5
EURAMET.T.14.2013	Radiation Thermometry (24)	24
EURAMET.T.15.2014	SPRTs at Fixed Points (8)	8
EURAMET.T.16.2014	Humidity (33)	33

Total: 333

- One new batch (radiation thermometry CMCs) is currently under inter-RMO review

EURAMET Joint Programmes

- Two consecutive metrology research programmes, jointly funded by the EU and a large majority of EURAMET countries:
  - EMRP: launched in 2007, 7 calls from 2007 to 2013, 23 EURAMET countries, 400 M€ budget, end in 2017
  - EMPIR: launched in 2014, 7 calls from 2014 to 2020, 28 EURAMET countries, 600 M€ budget, end in 2024

- The engagement of the EURAMET TC-T community is coordinated by the Strategy WG:
  - Web-based share-point used to collect ideas for potential research topics
  - On the basis of the submitted ideas, the Strategy WG proposes how to approach bidding into the call

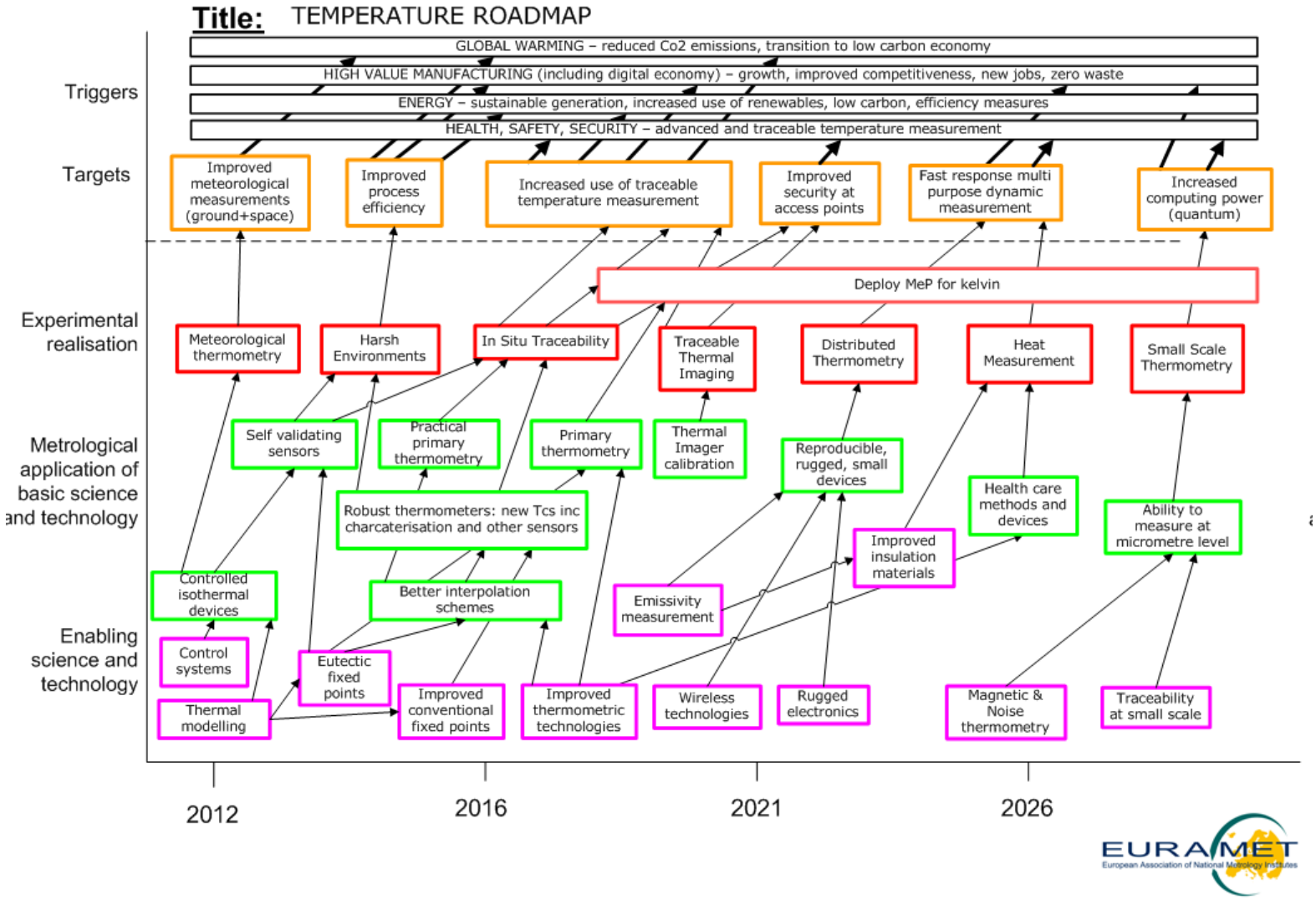
EURAMET TC-T Joint Research Projects (JRPSs)

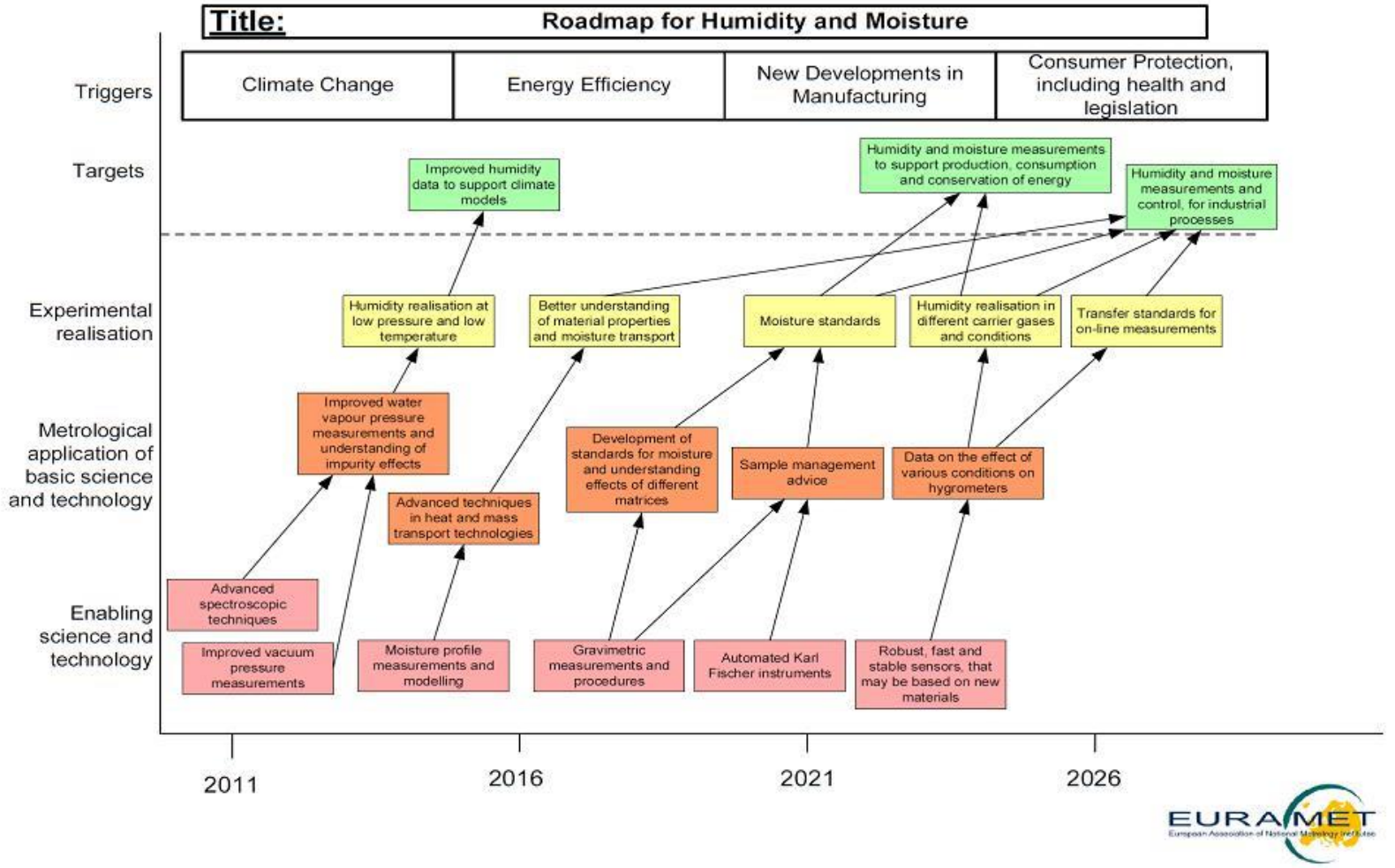
- Implementing the New Kelvin (InK), G. Machin
- High Temperature Metrology for Industrial Applications (HiTeMs), G. Machin
- Novel Techniques for Traceable Temperature Dissemination (NOTED), D. del Campo
- Metrology for Meteorology (MeteoMet), A. Merlone
- Metrology for Moisture in Materials (METefnet), M. Heinonen

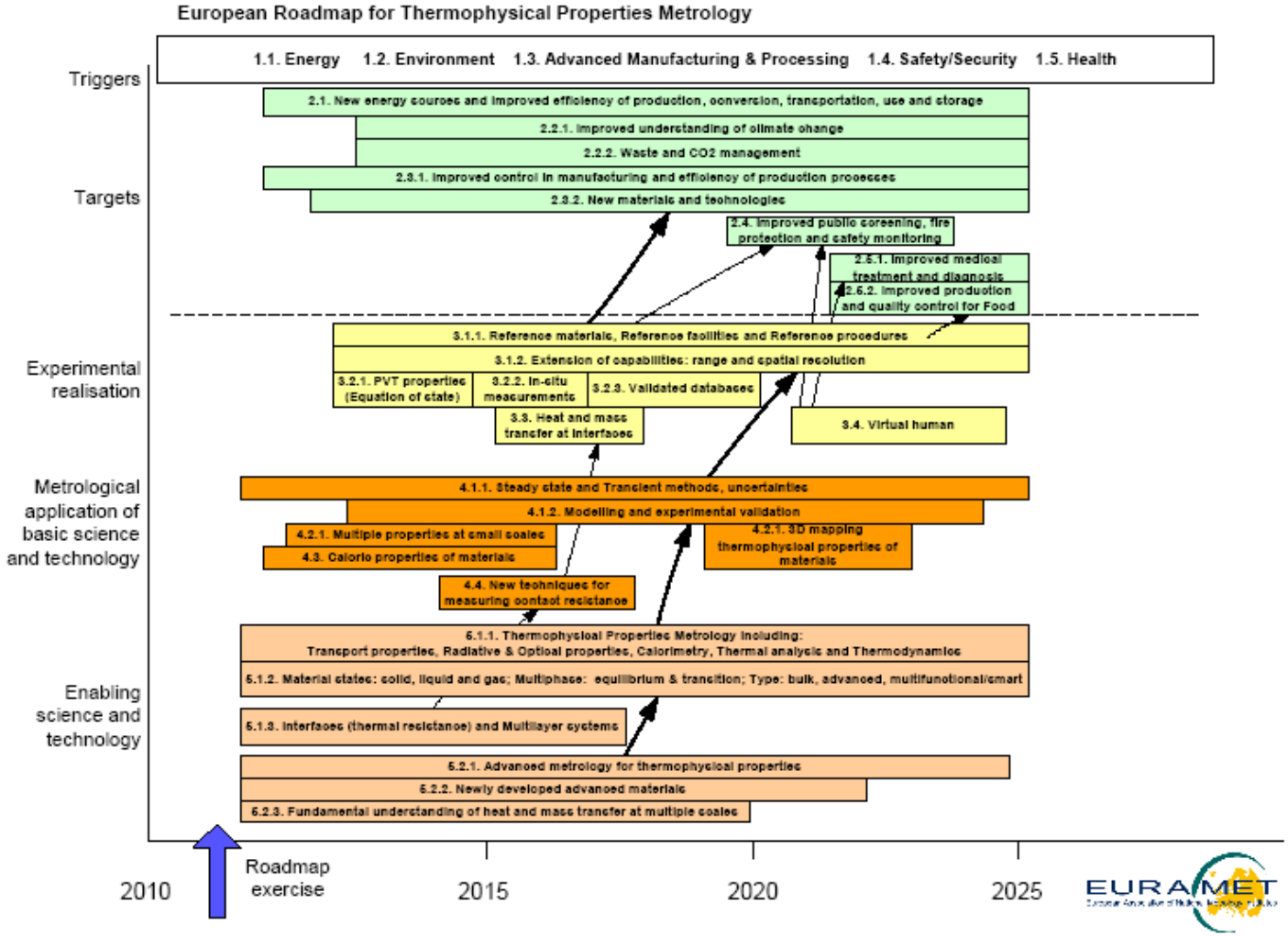
- EMRP/EMPIR are inducing radical changes in the EURAMET metrology landscape:
  - Relevant EU funding received by the NMI/DIs through EMRP/EMPIR
  - National metrology programmes are becoming strongly EMRP/EMPIR-driven
  - Beyond base maintenance of facilities, only residual funding and resources available for non-EMRP/EMPIR traditional activities (like KCs)

EURAMET TC-T Roadmaps

- Part of a larger process undertaken by the EURAMET metrology TCs to guide the direction of metrology research of the EURAMET NMI/DIs over the next decade
- EURAMET TC-T generated and periodically updates technical roadmaps for 1) Thermometry, 2) Humidity and Moisture and 3) Thermophysical quantities
- Roadmap :
  - Identifies the societal grand challenges and other high-level drivers that need to be addressed (the triggers)
  - Formulates concrete targets where the thermometry community could contribute to address the triggers
  - Identifies the metrology and background science required to meet the targets
- Presented at TEMPMEKO2013 conference, corresponding three papers will be published in the IJOT


Title: TEMPERATURE ROADMAP
Triggers
GLOBAL WARMING – reduced Co2 emissions, transition to low carbon economy
HIGH VALUE MANUFACTURING (including digital economy) – growth, improved competitiveness, new jobs, zero waste
ENERGY – sustainable generation, increased use of renewables, low carbon, efficiency measures
HEALTH, SAFETY, SECURITY – advanced and traceable temperature measurement
Targets
Improved meteorological measurements (ground+space)
Improved process efficiency
Increased use of traceable temperature measurement
Improved security at access points
Fast response multi purpose dynamic measurement
Increased computing power (quantum)
Deploy MeP for kelvin
Experimental realisation
Meteorological thermometry
Harsh Environments
In Situ Traceability
Traceable Thermal Imaging
Distributed Thermometry
Heat Measurement
Small Scale Thermometry
Metrological application of basic science and technology
Self validating sensors
Practical primary thermometry
Primary thermometry
Thermal Imager calibration
Reproducible, rugged, small devices
Health care methods and devices
Ability to measure at micrometre level
Robust thermometers: new Tcs inc charcaterisation and other sensors
Improved insulation materials
Enabling science and technology
Controlled isothermal devices
Better interpolation schemes
Emissivity measurement
Control systems
Eutectic fixed points
Thermal modelling
Improved conventional fixed points
Improved thermometric technologies
Wireless technologies
Rugged electronics
Magnetic & Noise thermometry
Traceability at small scale
2012
2016
2021
2026


Title:
Roadmap for Humidity and Moisture
Triggers
Climate Change
Energy Efficiency
New Developments in Manufacturing
Consumer Protection, including health and legislation
Targets
Improved humidity data to support climate models
Humidity and moisture measurements to support production, consumption and conservation of energy
Humidity and moisture measurements and control, for industrial processes
Experimental realisation
Humidity realisation at low pressure and low temperature
Better understanding of material properties and moisture transport
Moisture standards
Humidity realisation in different carrier gases and conditions
Transfer standards for on-line measurements
Metrological application of basic science and technology
Improved water vapour pressure measurements and understanding of impurity effects
Advanced techniques in heat and mass transport technologies
Development of standards for moisture and understanding effects of different matrices
Sample management advice
Data on the effect of various conditions on hygrometers
Enabling science and technology
Advanced spectroscopic techniques
Improved vacuum pressure measurements
Moisture profile measurements and modelling
Gravimetric measurements and procedures
Automated Karl Fischer instruments
Robust, fast and stable sensors, that may be based on new materials
2011
2016
2021
2026
EURAMET


European Roadmap for Thermophysical Properties Metrology
Triggers
1.1. Energy
1.2. Environment
1.3. Advanced Manufacturing & Processing
1.4. Safety/Security
1.5. Health
Targets
2.1. New energy sources and improved efficiency of production, conversion, transportation, use and storage
2.2.1. Improved understanding of climate change
2.2.2. Waste and CO2 management
2.3.1. Improved control in manufacturing and efficiency of production processes
2.3.2. New materials and technologies
2.4. Improved public screening, fire protection and safety monitoring
2.5.1. Improved medical treatment and diagnosis
2.6.2. Improved production and quality control for Food
Experimental realisation
3.1.1. Reference materials, Reference facilities and Reference procedures
3.1.2. Extension of capabilities: range and spatial resolution
3.2.1. PVT properties (Equation of state)
3.2.2. In-situ measurements
3.2.3. Validated databases
3.3. Heat and mass transfer at interfaces
3.4. Virtual human
Metrological application of basic science and technology
4.1.1. Steady state and Transient methods, uncertainties
4.1.2. Modelling and experimental validation
4.2.1. Multiple properties at small scales
4.3. Caloric properties of materials
4.2.1. 3D mapping thermophysical properties of materials
4.4. New techniques for measuring contact resistance
Enabling science and technology
5.1.1. Thermophysical Properties Metrology including:
Transport properties, Radiative & Optical properties, Calorimetry, Thermal analysis and Thermodynamics
5.1.2. Material states: solid, liquid and gas; Multiphase: equilibrium & transition; Type: bulk, advanced, multifunctional/smart
5.1.3. Interfaces (thermal resistance) and Multilayer systems
5.2.1. Advanced metrology for thermophysical properties
5.2.2. Newly developed advanced materials
6.2.3. Fundamental understanding of heat and mass transfer at multiple scales
2010
Roadmap exercise
2015
2020
2025
EURAMET