

TC-EM Highlights

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EURAMET General Assembly
Bucharest, Romania
2018-05-28 to 2018-06-01



Technical Committee for Electricity and Magnetism



32 Contact Persons **≈2100 CMCs (≈800 matrices)**

4 SubCommittees

SC-DC and Quantum Metrology

SC-Low Frequency

SC-RadioFrequency and Microwave

SC-Power and Energy

1 Working Group on Strategic Planning

1 Comparison Task Force

***n* Meetings**

1/yr TC-EM

1/yr all SCs (formal or informal)

1/yr EMPIR Call

+ scientific events



Technical Committee for Electricity and Magnetism



Running CMC set: [EURAMET.EM.15.2018](#)

276 new or modified entries, with 74 matrices

Total reformatting of all CMCs

on Cat. 8 [High voltage and current]

Cat. 9 [Other DC and low frequency measurements]

[Strategic planning of comparisons](#): implementation on TC-EM

Analysis of past comparisons

Analysis of a real need for comparisons

CCEM Classification: about 200 sub-sub categories

Connection to CCEM Key comparisons

Planning



**Electricity and
Magnetism**

New **Charter** of the TC, SCs and WGs

For each SC:

Identification of topics and CCEM Branches / services

Who has to deal with specific CMCs/comparisons is now clearly identified

TC-EM Subcommittee DC and Quantum Metrology (SC-DC&QM)

The Subcommittee covers the following topics:

- Quantum standards (JAVS, QHE, SET)
- Metrological triangle and fundamental tests
- Classical standards of voltage, current and resistance
- Spintronics, nanomagnetism
- New developments in quantum metrology

In the CCEM Classification of Services [Version No 7.6, 2011.03.17],

SC-DC&QM deals with the following branches:

1. DC voltage;
2. DC resistance;
3. DC current;
4. Impedance - *if based on quantum standards, together with SC-LF*
5. AC voltage (up to the MHz range) - *if based on quantum standards, together with SC-LF*
- 9.1 Electric charge - *not including partial discharge measurements.*

European Metrology Networks

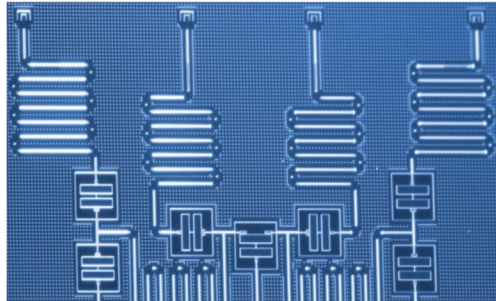


Direct participation of TC-EM people to EMN proposals for:

Smart Electricity Grids



Quantum Technologies



Possible **impact** on:

- SC-DC and Quantum Metrology
- SC-Low Frequency
- SC-Power and energy

Dedicated Working Group on Strategic Planning (WG-SP) meeting in July

Final Dissemination Workshop of EMPIR 2014 Projects!

14IND02 **PlanarCal**

Microwave measurements for planar circuits and components

14IND07 **3D Stack**

Metrology for manufacturing 3D stacked integrated circuits

14IND08 **EIPow**

Metrology for the electrical power industry

14IND10 **MET5G**

Metrology for 5G communications

14RPT01 **ACQ-PRO**

Towards the propagation of ac quantum voltage standards

Develop 5G [= International Telecommunication Union International Mobile Technology-2020] test bed and measurement tools

Minimise test and measurement in cost and time

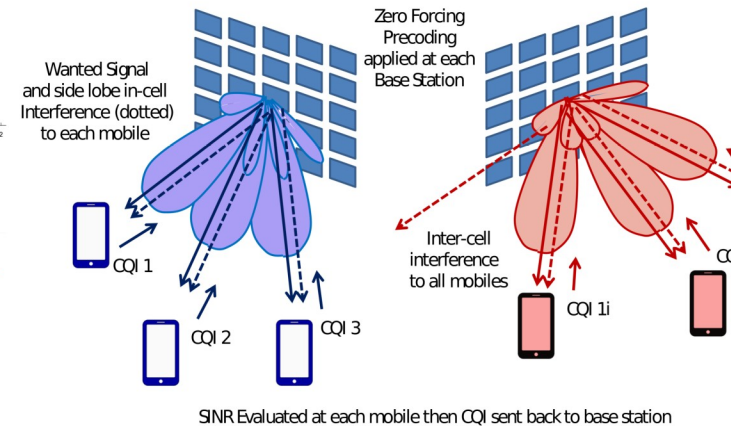
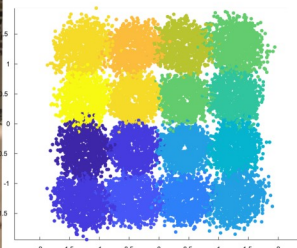
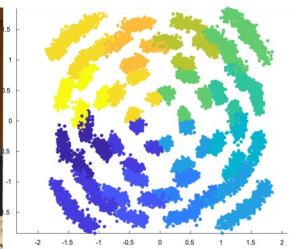
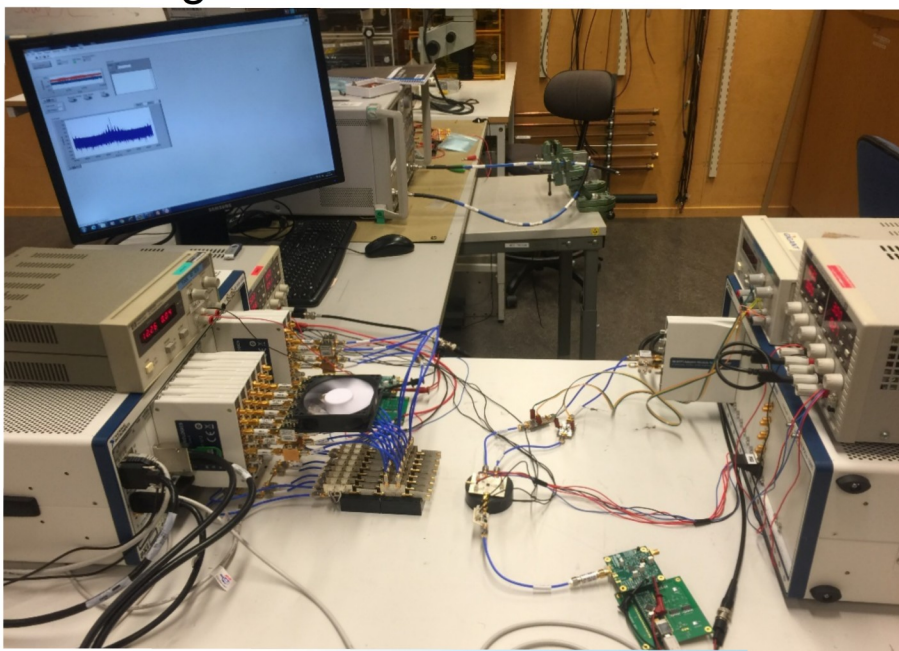
Reduce time to market for 5G products and services

Development of multiple-input, multiple-output (MIMO) testbeds

Frequencies up to 35 GHz (in the FR2 range, mm waves)

Outdoor testing facility and measurement activities

Large number of stakeholders



Measurement of integrated planar circuits and components from radio-frequency (RF) to sub-mm frequencies

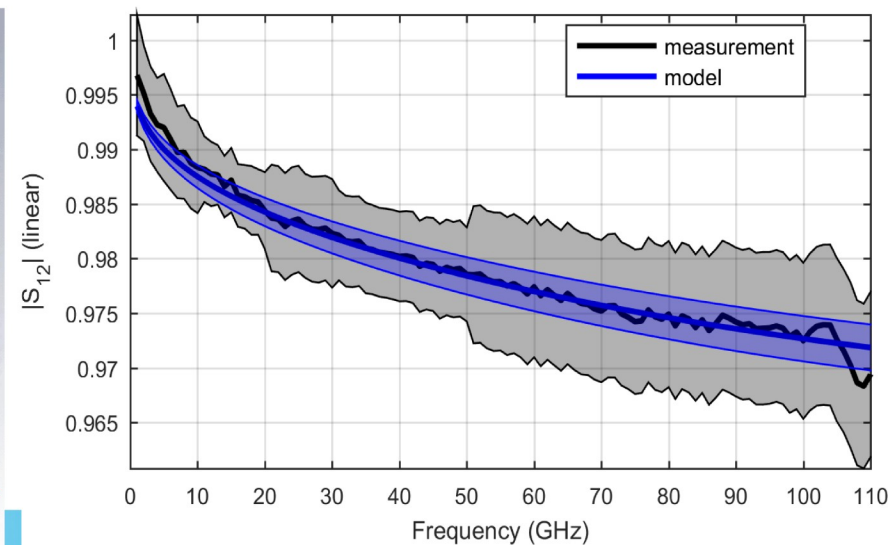
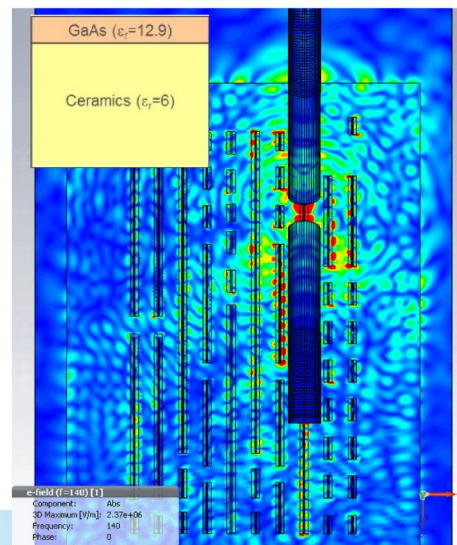
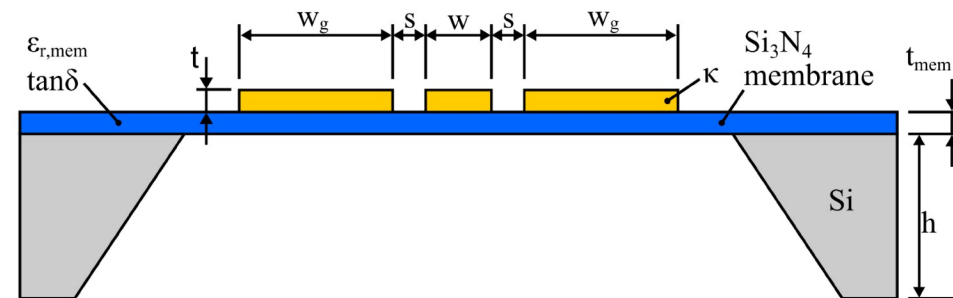
Traceability of s-parameters
On-wafer measurements

On-wafer measurements

Devices on membranes

Traceability of scattering parameters

Extension to 110 GHz



3D Stack

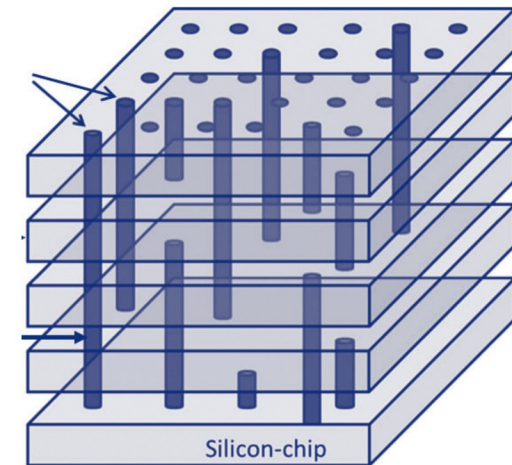
Metrology for manufacturing 3D stacked integrated circuits



Traceable 3D measurement of **dimensional**, **structural**, **electrical** and **thermal properties** of high aspect ratio through-silicon via (TSV) interconnections

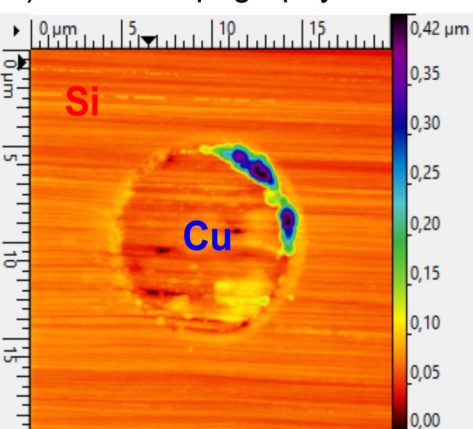
Wafer alignment, bonding, surface quality

Traceability of industrial equipment

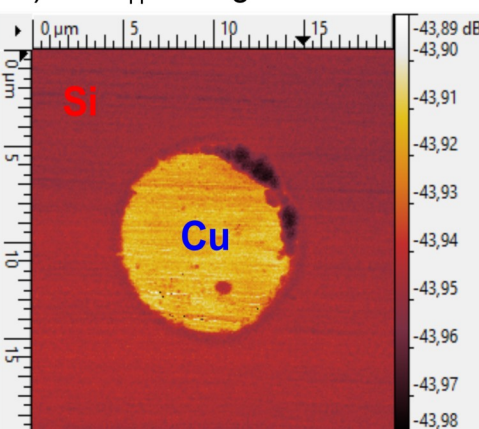


Comparison of AFM and MW microscopy

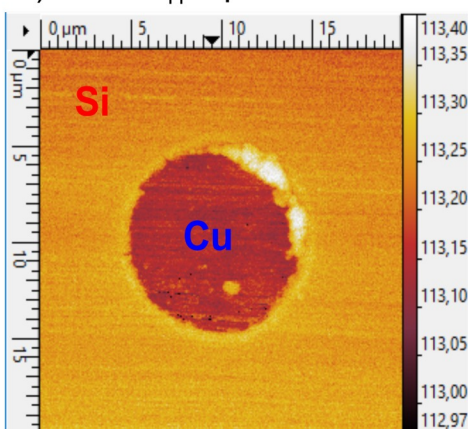
a) AFM topography



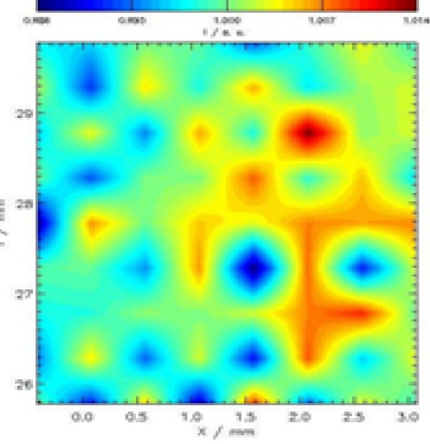
b) S_{11} – magnitude



c) S_{11} – phase



X-ray fluorescence maps



ACQ-PRO

Towards the propagation of ac quantum voltage standards

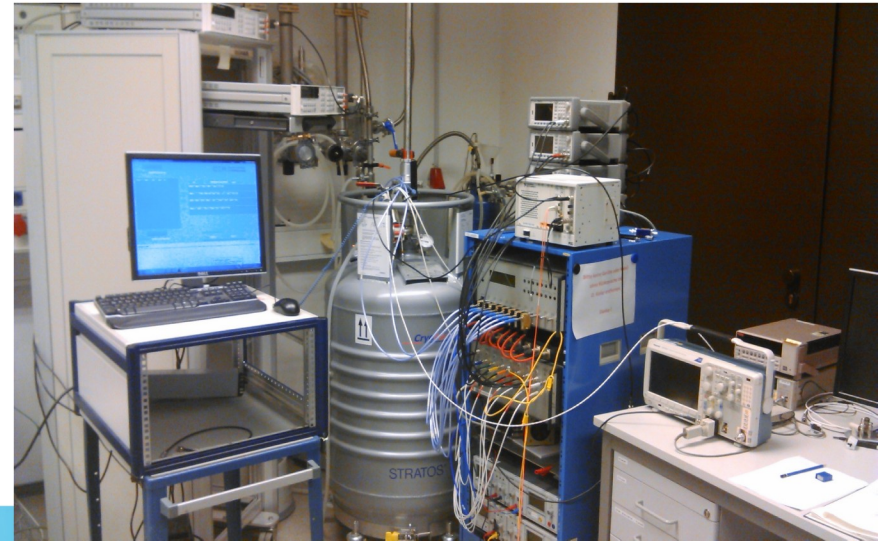
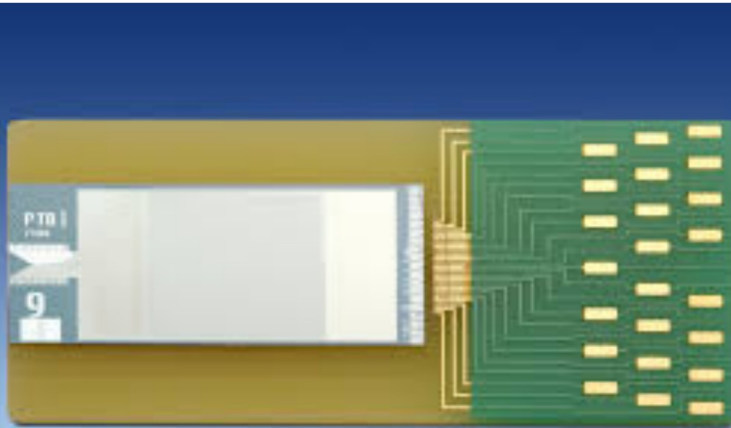
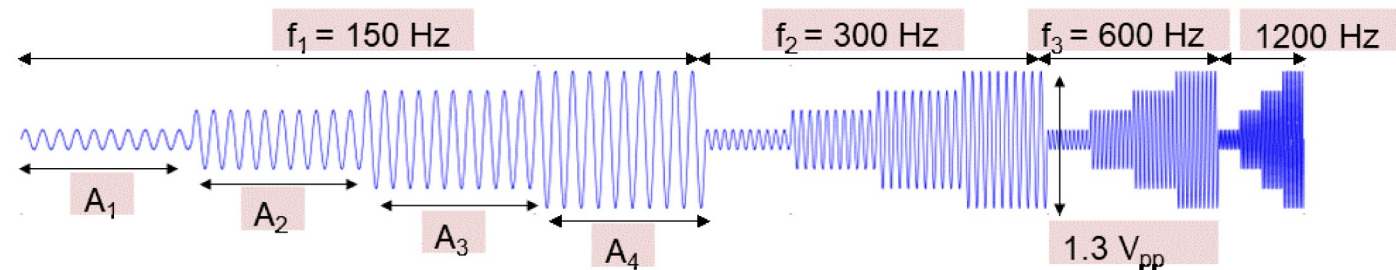


Design a new AC Josephson Voltage Standard JVS standard.

Good practise guide on the use of ACJVS

Individual strategic plans for ACJVS development in the NMI

Proposal of a new TC-EM Working Group



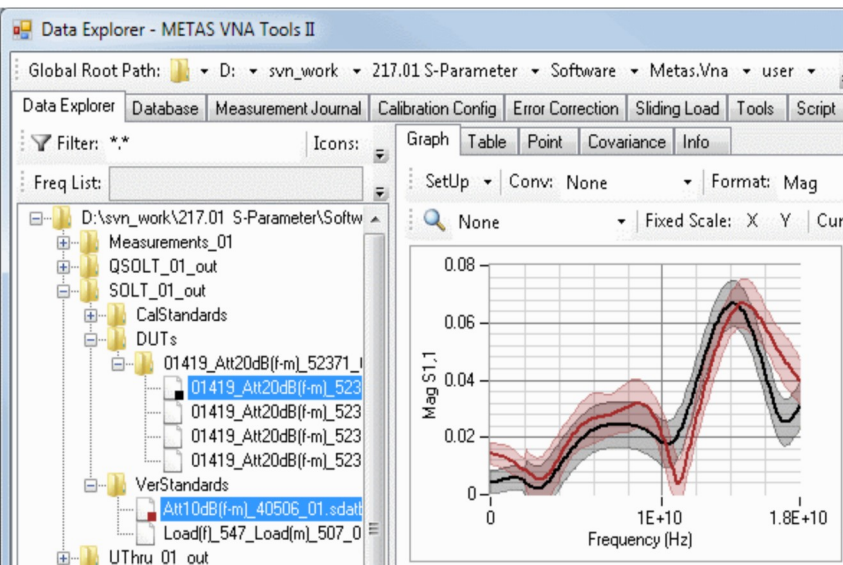
EURAMET cg-12: Guidelines on the Evaluation of Vector Network Analysers



Version 3.0
Totally rewritten!

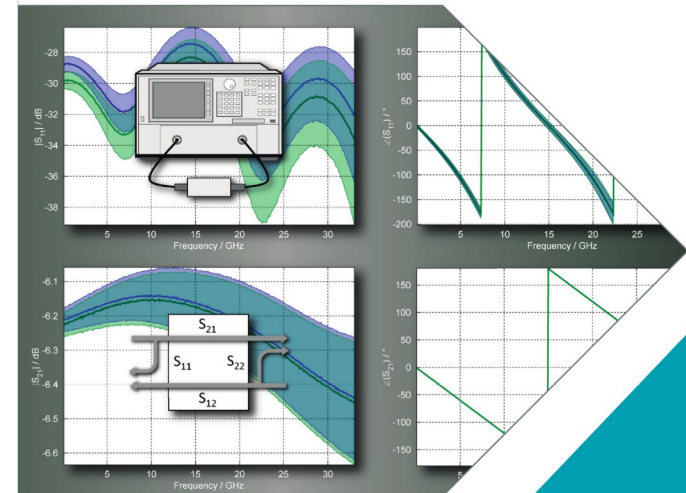
Compliant with GUM Supplement 2
Full analysis in the complex field
Matrix calculations

Software support



Guidelines on the Evaluation of
Vector Analysers (VNA)

EURAMET Calibration Guide No. 12
Version 3.0 (03/2018)



Electricity and
Magnetism

Conference on Precision Electromagnetic Measurements, CPEM 2018



several days of **electromagnetic metrology**, plus:

Joint CCM and CCEM WG on Monitoring the kilogram

Power and Energy Experts Meeting

CCEM WG on Radio Frequency (GTRF)

CCEM WG on Regional Metrology Organizations (WGRMO)

TC-EM DC and Quantum Metrology meeting

TC-EM Low Frequency meeting

TC-EM Working Group on Strategic Planning meeting

AC Josephson group (ACQ-PRO)

Chair: Francois Piquemal, LNE



**CONFERENCE ON PRECISION
ELECTROMAGNETIC MEASUREMENTS**

July 8 -13, 2018

PARIS • FRANCE

Thanks!

