The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

The EMPIR Project 18SIB07 GIQS:
Graphene Impedance Quantum Standard

Establishing SI linked quantum traceability by exploiting the potential of graphene

The project

GIQS is a Joint Research Project of the European Metrology Programme for Innovation and Research (EMPIR), the main European program for research in metrology, coordinated by the European Association of National Metrology Institutes (EURAMET).

GIQS has a three-year span (2019-2022). The aim of GIQS is to enable an economically efficient traceability of impedance (resistance, capacitance, inductance) measurements to the defining constants (the Planck constant and the elementary charge) of the International System of Units (SI). New and easier to operate measurement bridges, convenient and easier to use graphene quantum standards, cryogenic systems, and methods to combine them will be developed.

Realisation of impedance units (ohm, farad, henry)
in the revised SI, traceable to fundamental constants

Shortening primary traceability chain of calibrations
at stakeholder sites

Strengthening calibration facilities
at smaller NMIs, calibration centers, industry

Electrical quantum standards
for all metrology institutes

Robust graphene-based quantum standards

Development of a cryo-cooler system
for all-in-one operation

The partners

Forthcoming event:

- Conference on Precision Electromagnetic Measurements, Denver, CO, USA, Aug 2020

Latest events

- GIQS papers presented at the International Conference on Quantum Metrology and Sensing, Paris, France, Dec 2019
- GIQS research activity presented at the EURAMET Technical Committee for Electricity and Magnetism, Bucharest, Oct 2019

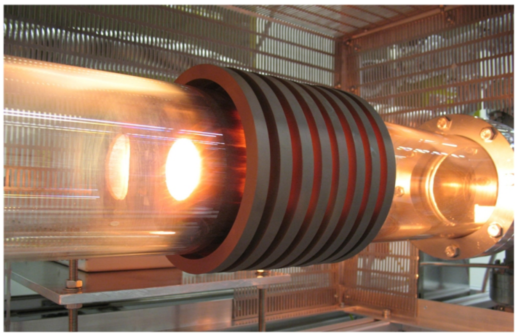
The project stakeholders include metrology organisations, research centers, calibration laboratories, industries which are interested in the project outcome and give input to maximise its impact on the T&M community.

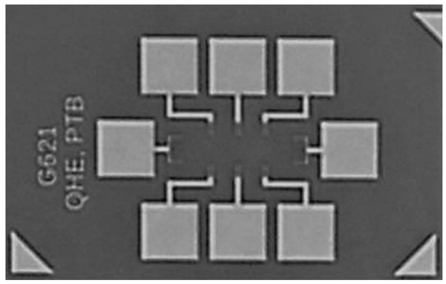
Want to join? Contact us!

EMPIR EURAMET
The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

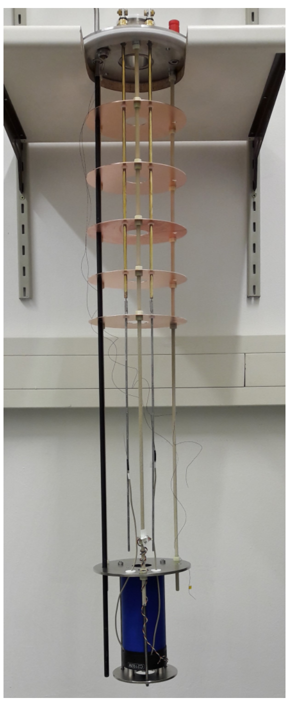
Progresses

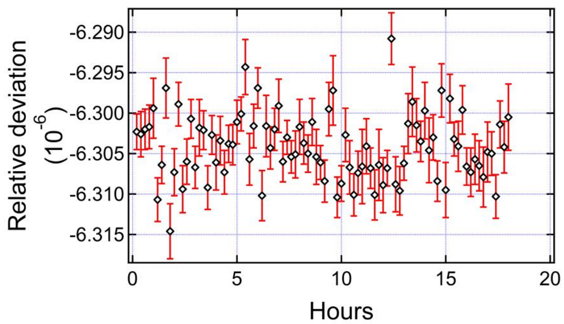
Graphene devices are being fabricated by polymer-assisted sublimation, at 1800 °C, and electron-beam litography





Cryogenic environments are being assembled. The operation in the ac regime ask for shielded devices and coaxial wiring. Noise generated by cryocoolers must be characterised.





Time series of dc comparisons between a quantum Hall device in the cryogen-free cryomagnet and a resistance standard.

User-friendly Impedance bridges capable to compare an impedance standard versus the quantized Hall resistance are under development.

The project workpackages

WP1: Graphene devices for AC-QHE applications

WP2: Digital- / Josephson impedance bridges for capacitance realisation

WP3: Graphene AC-QHR with digital and Josephson impedance bridges

WP4: Creating impact

Why graphene?

Quantum Hall effect is observed in two-dimensional electron systems under a magnetic field; the quantum Hall resistance is related to the electron charge and the Planck constant.

The exploitation of the quantum Hall effect for metrology purposes is based on gallium arsenide heterostructure devices, which require high magnetic fields (around 10 T) and temperatures below the liquid helium boiling point (4.2 K), therefore large and expensive cryomagnets are needed.

Graphene devices shows the quantum Hall effect at lower magnetic fields (below 5 T) and higher temperatures (4.2 K or above) that can be reached with smaller cryogen-free cryomagnets, allowing for continuous operation in the metrology laboratory.

The technology of graphene devices, however, requires improvement to achieve better device reliability, and the operation of graphene devices in the ac regime needs further investigation.

Research mobility grants (RMG) is an instrument to fund the participation of researchers from other EURAMET members to the GIQS project. If you are interested contact us!