



European Metrology Research Programme

Excellent science

An overview of the funded projects from the Targeted Programme Open Excellence.

The aim of these projects is to enable future measurement methods through excellent science.

The projects have no specific strategic theme but will bring together the best scientists in Europe to explore new techniques that have not yet been applied in measurement science.

Quantum tools for better time

Using quantum entanglement to improve optical clocks

The detection of a quantum state can involve the destruction of that state. This law of quantum physics is one factor currently limiting the stability of the new generation of optical atomic clocks, which could redefine the second, the SI unit of time. A potential solution to solve their stability issues is to use quantum entanglement.

Entanglement allows two atoms, or ions, to exhibit the same properties as one another without being physically linked. This means that it is possible to observe the state of one of these atoms, or ions, without destroying the state of the other.

This project will use techniques based on quantum entanglement to improve the short term stability of optical atomic clocks beyond the current limitations. The results will improve precision spectroscopy based on scalable entanglement and have a direct impact on a wider range of quantum sensors such as accelerometers, gravimeters, gyrometers and magnetometers.

Project EXL01: Quantum engineered states for optical clocks and atomic sensors

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Quantum communication and security

Communicating with single photons

Photons are particles of light well suited to applications such as quantum communication, quantum computing and quantum metrology. This is because they travel at the speed of light and interact weakly with their surroundings, whilst being easily manipulated.

However, the lack of single photon sources is limiting their use. For example, quantum key distribution and quantum cryptography offer theoretically failsafe computer security but are vulnerable to attack without a true single photon source. The realisation of a practical quantum computer also requires near perfect single photon sources.

This project will develop compact and efficient single photon sources and use them to improve measurement performance. The devices developed will also represent a breakthrough in the acceptance and uptake of single photon sources by end-users and the standardisation of the components will help accelerate the development of quantum communications.

Project EXL02: Single-photon sources for quantum technologies

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www.ptb.de/emrp/siqute-project.html



Towards quantum computing

Controlling single-photon microwave radiation on a chip

The ability to build nanoscale electronic devices and operate them at very low temperatures allows scientists to use quantum physics to their advantage, in a range of applications. However, future progress in superconducting quantum computing technology depends on the availability of chips that can work at the single-photon, or few-photon, level.

There is currently no way to reliably detect single microwave photon events. This project will address this by developing novel microwave sources and detectors at the single-photon level and improving the performance of cryoelectronic quantum devices, which have recently benefited from improved on-chip cooling technologies.

The project could eliminate a major barrier for the progress of quantum devices and support the development of signal amplifiers for wireless communications and radiation measurements. In addition, the devices developed could be used in the realisation of a practical quantum computer based on solid-state quantum bits.

Project EXL03: Measurement and control of single-photon microwave radiation on a chip

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Exploiting electron spin

Putting the theory of spintronics and spin-caloritronics into practice

Spintronics is a technology that exploits a fundamental quantum property of electrons, known as spin, as well as the magnetic and electronic properties. This technology has led to important scientific discoveries and industrial applications such as computer hard disk drives.

Spin caloritronics is the combination of spintronics and thermo-electricity, and focuses on the interaction of electron spins and heat currents. Its novel effects could also, like spintronics, have industrial applications but first the theory needs to be put into practice.

This project will investigate and develop nanoscale magnetic devices to build the fundamental understanding of spintronics and spin-caloritronics. This knowledge will underpin research and development and lead to future applications in computing, data storage and measurement science. The project will also publish a series of guidelines to make reliable measurements of spintronics and spin-caloritronics, representing the first step towards standardisation in the field.

Project EXL04: Spintronics and spin caloritronics in magnetic nanosystems

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Europe's National Measurement Institutes working together

The majority of European countries have a National Measurement Institute (NMI) that ensures national measurement standards are consistent and comparable to international standards. They also investigate new and improved ways to measure, in response to the changing demands of the world. It makes sense for these NMIs to collaborate with one another, and the European Association of National Metrology Institutes (EURAMET) is the body that coordinates collaborative activities in Europe.

EURAMET has implemented the European Metrology Research Programme (EMRP), a project programme organised by 23 NMIs and supported by the European Union, which will have a value of over 400 M€. The EMRP facilitates the formation of joint research projects between different NMIs and other organisations, including businesses, industry and universities. This accelerates innovation in areas where shared resources and decision-making processes are desirable because of economic factors and the distribution of expertise across countries or industrial sectors.

EURAMET wants to involve European industry and universities at all stages of the programme, from proposing Potential Research Topics to hosting researchers funded by grants to accelerate the adoption of the outputs of the projects.

Full details can be found at: www.euramet.org

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