Call 2017

Q-Clocks

Cavity Enhanced Quantum Optical Clocks

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INRiM ISTITUTO NAZIONALE DI RICERCA METROLOGICA

l'Observatoire de Paris SYRTE Systèmes de Référence Temps-Espace

UNIVERSITY OF COPENHAGEN

National Research Council of Italy

UNIWERSYTET MIKOŁAJA KOPERNIKA W TORUNIU

ICFO The Institute of Photonic Sciences

https://q-clocks.inrim.it/

SUCCESS STORY (highlights)

- **CHALLENGE** – Entangled and quantum engineered states were not suited for Optical Clocks. Developed protocols useful for metrological applications in the optical domain.
- **SOLUTION** – Develop new experimental configurations and new theoretical protocols and the idea to resolve the challenge.

SUCCESS STORY (highlights)

PLANNED AND SURPRISING/UNPLANNED OUTCOMES -

- Study of superradiant pulsed emission and work toward continuous emission.
- Observation of Spin squeezing in QND measurement.
- Development of protocols to protect quantum enhancement through hybrid clock operation.
- Maximisation of light coupling in bad cavity regime realising a lattice with commensurate spacing to clock transition.

IMPACT (RRI aspects)

GENDER: 33% of new jobs were assigned to female scientists.

OPEN SCIENCE: 22 papers published on ISI-journal (plus 11 proceedings) following full open access policy.

SCIENCE EDUCATION: Organization of a free-of-charge scientific workshop for students and young scientists. Staging 8 top-level speakers and counting over 800 accesses to the web platform.

PUBLIC ENGAGEMENT: liaisons are established with international metrological bodies like, e.g. BIPM and EURAMET. Outreach activities for students and the general public were prepared.

ETHICS: Despite clocks generally being considered dual-use technology, no ethical issues are foreseen in our research activities.

IMPACT (potential users)

- Q-Clocks can be qualified as a fundamental research project.
- The superior stability of quantum-enhanced optical clocks will likely result in a big advantage in clock sensing (e.g. gravity sensing, low energy physical theory tests, DM search). Q-clocks are still at low TRL 2 and 3.
- Large resources are currently being invested worldwide in the realization of transportable commercial “standard” optical clocks and relative components (e.g. lasers systems, ultra-stable cavities, optical combs and chip-scale optical combs).
- Industrial realization can be expected not before ten years.

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