

★ The exhilarating world of quantum computing is still in its infancy, but the potential benefits are vast. **Prof Eugene S. Polzik** explains how the QUROPE project is helping to turn a groundbreaking vision into a viable future for our Information and Communication Technologies society

# Getting Europe ready for the second quantum revolution

The field of Quantum Information Processing and Communication (QIPC) may today be considered as still in its infancy, with the first groundbreaking papers appearing only about fifteen years ago. Nevertheless, it is currently one of the most active fields of research in natural sciences world-wide; while stemming in part from its multidisciplinary nature, covering research areas that range from theoretical and experimental physics to computer science, mathematics and material sciences, this is certainly also due to the truly vast potential this sector holds for future applications. The enormity of its possible impact is reflected in

its frequent description as the 'second quantum revolution', promising a radical change in the way we compute and communicate today.

While some of the prospects are obvious, readily understood and considered by researchers to be achievable, the notion of how exactly the field will develop and what the impact will be is difficult to predict with certainty. Some of the concrete targets set out by today's research are to develop a whole new breed of computers, perhaps a thousand times more powerful than today's machines, and to work towards a technology that will allow us to communicate in absolute

security. Advances in these areas would open up a whole new world of possibilities for our modern information and communication society.

In Europe, the QIPC community is vibrant and thriving with dozens of institutions involved in various fields of research and other related activities. European scientists have always been at the forefront when it comes to setting the agenda for the world-wide efforts in QIPC. This was recognized early on by FET- the Future and Emerging Technologies part of the IST Research Program of the European Commission. By promoting the rapid recognition of its

potential, its vision and support were crucial for the development of QIPC in Europe. QIPC has been a FET proactive initiative in the Fifth and Sixth Framework Programs (FP) for research of the EC. The investment has been approximately €50m for each of these FP's four year period, with some 60 projects being funded, involving research groups from more than 30 countries.

In spite of these efforts, it was felt that there has been a lack of structure and coordination on a trans-national level, with no attempt having been made to get all the parties involved that have potential interest in QIPC research, from academic, educational and political institutions, to industrial and commercial stakeholders.

## QUROPE

The QUROPE project was the first of its kind to address this issue and fill the gap. Funded under the FET-Open initiative of the EC's Sixth Framework Program for research, it started in 2006 and is now in its third and final year. Being a Coordination Action (CA) project, as opposed to the more common and specialized research projects, its major goal is to build a Europe-wide infrastructure which will provide a focal point for QIPC activities. It has attracted 35 partners, 10 of which are actively involved in the project's work packages, as well as more than 100 affiliated members from 16 different countries across Europe.

Following its community building and strategic vocation, QUROPE has been organizing conferences, seminars and workshops to bring together not just academic researchers but industry executives who have an interest in the development of QIPC, as well as political representatives. The project also pursues a public mission to bring QIPC to a wider audience by participating in industrial and technological fairs with presentations and stands, and by reaching out to the wider general public with non-technical articles in political magazines and popular science magazines.

## A Roadmap for QIPC Research

However, the one major target and objective of QUROPE is to define a common vision and a future roadmap for research into quantum information technology in Europe. The pursuit of this objective has led to a remarkable result. In an impressive joint effort, 40 of the most prominent European scientists contributed to put together a QIPC Strategic Report, which gives an overview of ongoing and planned research activities in Europe. This report constitutes a unique

document, containing a detailed technical assessment, a summary of long and medium-term goals and an outline of visions and challenges for QIPC in Europe, and represents the scientists' clear vision for building a coherent European research area.

Designing and maintaining the roadmap, continually updating it and adapting it to changing trends, has been one of the major achievements of the QUROPE project, as has been the production of several other strategic documents. This work serves to provide both the European Commission and national agencies with guidance when it comes to funding specific research areas.

## Looking ahead

The QUROPE project has played an important role in the area of QIPC by promoting activities and pushing coordination measures on a European level. To meet the continuing need for such services and coordination efforts, which will support the future sustainability of the field, a new Coordination Action programme is being prepared that will take over and continue the tasks of its predecessor. The CA QUIE<sup>2</sup>T ('Quantum Information Entanglement-Enabled Technologies') initiative, which will run under the EU's Seventh Framework Program, will maintain and expand a set of high-quality coordination measures specifically designed for the European QIPC research area. It is committed to setting up an ultimately sustainable research architecture and to promoting it at the European level. This architecture will be structured around a set of four Virtual Institutes (VIs), mapped to the four major QIPC sub-domains: Quantum Computation, Quantum Communication, Quantum Information and Quantum Technologies. In a broader context, this initiative can be appreciated as not only an action to provide coordination measures for scientific research areas, but a novel restructuring of the community around the Virtual Institute concept.

The QIPC community is standing at a crossroads today, where decisions have to be made that consolidate the huge impetus that was built up in recent years and ensure the future sustainability of the field. Transnational collaborations of existing QIPC research programs in Europe have to be reinforced and the current fragmentation into national programs needs to be overcome. The stakes are high, as with any field of activity that carries the prospect of changing our lives. The CA QUIE<sup>2</sup>T initiative is prepared to contribute its share to this task. ★

## At a glance

**Full Project Title**  
Quantum Information Processing and Communication in Europe (QUROPE)

**Project Partners**  
35 legal partners and 43 affiliated members from 16 countries

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Eugene Polzik is Professor of Physics at the Niels Bohr Institute in Copenhagen. He received his PhD degree from St. Petersburg University in 1980. He is a member of the Royal Danish Academy and Fellow of OSA and APS. Since 2001 he has lead the Danish National Research Foundation Center for Quantum Optics. His research interests are focused on quantum interface between photons and atoms, in particular on using collective excitations in atomic ensembles.

