In the concluding part of our feature on the exciting work being undertaken by the QUROPE project, **Dr Eugene Polzik** highlights the vital nature of continued research into the complex world of quantum computing, and the future applications in which it could be deployed

Projects: The field of quantum computing is still relatively new, yet much has already been researched. How does the QUROPE project differ from those that preceded it?

Dr Eugene Polzik: The project is a coordinated effort between the entire European information community. We aim to develop a strategic vision and a road map within quantum information science, through high level conferences and discussions between leading scientists. The aim of QUROPE is to define the goals to build a community of quantum information scientists.

P: How is the project structured? Have you had to make compromises between your short and long-term objectives?

EP: We have 100 groups across Europe working in the field of quantum information science, and we decided at some point that it would be important to structure those groups, to unify them, to define both the short and long-term goals.

P: Is your research essentially fundamental in nature or does it have practical applications? If so what benefits does quantum information provide compared to more established methods of communication?

EP: Certainly most of us are doing fundamental research, but the beauty of this field is that most fundamental research also seems to offer promising practical applications. The security of quantum communication is protected by the laws of quantum physics, so it's possible to immediately identify eavesdropping.

P: Did QUROPE set out with a specific applied focus, or are you pursuing more of an exploratory philosophy?

EP: Four years ago, when QUROPE started, it became clear that the field of quantum information processing is just growing enormously in different directions, with, in many cases, scientists within different disciplines speaking different languages. So providing a common platform, developing strategic goals and developing the knowledge between disciplines, while developing short and long-term goals were the incentives.

P: Has your project drawn on previous research into quantum mechanics or does it represent a significant break from convention?

EP: The project certainly builds on the very foundations of quantum mechanics; it's based on the fundamentals of quantum mechanics as we know them from the work of the '30's and '40's, but the field has been enriched enormously by the current generation of scientists. For example, Shor's algorithm requires a large-scale computer, with more than 100 quantum bits involved, and the development of such a computer is still a long way into the future. However, in the process of developing the field, people identified other applications; probably one of the most important amongst these is the area of quantum simulators i.e. simulating new materials.

P: As a relatively young field there must be enormous potential for exploring research in quantum information?

EP: Yes, absolutely. Our work is mostly exploratory, if you ask leading scientists what their goal is they will tell you that it's to find out something new, something that was impossible yesterday and to find a way to do it.

P: Does the project place equal emphasis on its research into quantum communications as it does on quantum cryptography?

EP: Quantum cryptography is part of quantum communication. There are other protocols in quantum communications; like quantum secret sharing and applications like quantum voting and quantum auctions. Quantum cryptography is just something which has been developed first and is furthest advanced.

P: What are the other areas the project is addressing in terms of quantum applications? Are they entirely separate from each other, or do advances in one area lead on to improvements in another?

EP: Certainly all parts of the project are interconnected, and one of QUROPE's main goals is to keep different parts in contact with each other, those parts being; quantum communication and its physical implementation, quantum computing and its physical implementation and the development of new quantum algorithms. These three parts are intimately connected, and breakthroughs in one of them are immediately reflected in another.

P: Do you believe the attributes of quantum computing make them relevant to the commercial marketplace?

EP: Quantum Information scientists are researching modelling new materials or ultra-sensitive sensors, measurement devices based on quantum operations and entanglement. So it's not just about security. The idea that quantum computing will replace a laptop is the wrong thinking, but on the other hand, when the transistor was invented it was thought that its only application purpose would be to work in hearing aids.

P: Is there a consensus on the importance of quantum computing, future research and how close are you to developing a unified strategy?

EP: We have defined strategic goals within the quantum information science for the next few years. However, the field is extremely lively and the goals will change as we make progress. The community is now well unified and i think in that respect QUROPE has been a success.

P:So is research into quantum information ongoing? Is there still potential of further improvement?

EP: Yes, absolutely. As with any exciting new area of science, we don't necessarily know where we will be in 10 years. I think the field has a very bright future. We just learned that a new Coordination Action within QIPC has been approved by the European Commission. ★