# QuReP

## Quantum Repeaters for Long Distance Fibre-Based Quantum Communication

**Project reference:** 247743
**Instrument:** STREP


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**Web site**

http://quantumrepeaters.eu

**Timeline**

Start Date: 01/01/2010

End Date: 31/12/2012

**Budget**

Overall Cost: 2 481 878,00 €

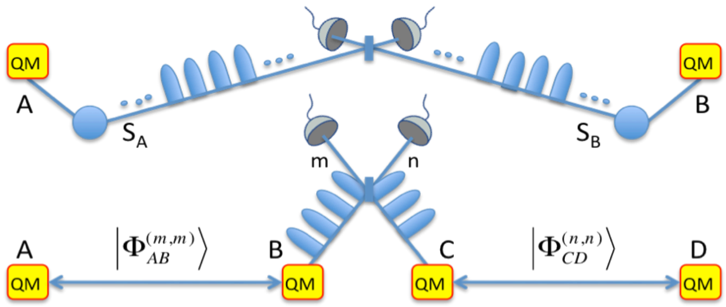
Funding: 1 900 000,00 €

**Project Partners**

- Université de Genève, CH
- Lunds Universitet, SE
- CNRS, Centre National de la Recherche Scientifique, FR
  - Laboratoire Aimé Cotton
  - Laboratoire de Chimie de la Matière Condensée de Paris
  - Université Pierre et Marie Curie
- Universität Paderborn, DE
- ID Quantique SA, CH

## Vision & Aim

The goal of QuReP is to develop a Quantum Repeater - the elementary building block required to overcome current distance limitations for long-distance quantum communication. Quantum Repeaters are the analogue of classical optical amplifiers that permit the cascading of successive fibre optic communication links. Quantum Repeater technology is centred around quantum light-matter interactions at the quantum level in ensembles of rare earth ions frozen in a crystal that store quantum information by coherent control of the quantum degrees of freedom. A clear and well-defined architecture and protocol for a complete Quantum Repeater can be realised with entangled photon pair sources that couple the Quantum memories to fibre optic communication systems.




*The Multi-Mode Quantum Repeater scheme, using pair sources and multi-mode memories. (top) The sources $S_A$ and $S_B$ each emit a photon pairs into a sequence of time bins. The detection of a single photon behind the beam splitter at the central station projects the quantum memories (QM) at A & B into an entangled state for that temporal mode (time-bin). (bottom) If entangled states have been established between the m-th time bins in QM-A and –B and between the n-th time bins QM-C and –D, an entangled state between the m-th time bin in QM-A and the n-th time bin in QM-D can be created by reconverting the memory modes into photonic modes and combining the appropriate time bins on a beam splitter. Cascading this process distributes the entanglement over greater and greater distances.*

The proof of principle has been shown for all aspects of this approach and QuReP now aims to bridge the gap between fundamental research and industrial projects. The main technological result of the QuReP project will be a quantum repeater. The outcome of the QuReP project will serve as the basis for an industrial initiative, developing the first quantum repeater products. Considering the state of the art, potential difficulties and the chosen development approach, it is reasonable to assume that this technology could be translated into products in the next 10 years with spin-off technologies emerging in the interim period. We bring together the leading European groups in quantum communication, quantum memories, photonic sources and rare-earth-ion spectroscopy and materials as well as a leading quantum communication technology SME to move what has been fundamental research towards commercial feasibility. There are already niche markets for quantum repeaters, should they exist, and the market is expected to grow significantly in the next 10 years.