UNIVERSITÀ DEGLI STUDI DI PADOVA

RICHIESTA DI FINANZIAMENTO PER PROGETTI STRATEGICI

Prot. STPD08ZXSJ

Project Principal Investigator	VILLORESI Paolo
PS Acronym	Q-FUTURE
Strategic Program Title	QuantumFuture Communications at the Quantum Limit
Scientific Areas	• 11: Information engineering - 70% • 02: Physics - 30%
List of the Research Units	• TICOZZI Francesco - INGEGNERIA DELL'INFORMAZIONE • BARBIERI Cesare - ASTRONOMIA • CARIOLARO Gianfranco - INGEGNERIA DELL'INFORMAZIONE

Executive summary:
Our society is being transformed by an ever increasing role of telecommunications and information networks. There is an need for new, safer and faster technologies.

Quantum physics has changed our understanding of the fundamental principles of nature and is currently changing our technological means. While a vast set of experiments established quantum theory as the most successful theory of modern science, novel possibilities for research are inherently inter-disciplinary and application-oriented. Indeed, the passage from classical to quantum information implies a substantial theoretical revolution, but also a drastic change in the implementation technologies. The advent of quantum communication offers not only challenging scientific and technological goals, but also a huge economic potential.

Our Strategic Project Quantum Future (QF) will focus its objectives on the communication at the quantum limit (in the following QC). QF has both short and long term goals which are expounded in this chapter. Our unique, worldwide recognized expertise (see the bibliography below) is in free space QC, both on the ground and in Space. We wish to motivate in more detail why we focus our research on free-space communication, which at present is relatively unexplored in comparison with communications via optical fibers, but at the same time attracting an increasing interest. Two reasons can be given for this choice:

- At a basic level, is the only possibility to confirm the validity of quantum mechanical laws over truly large distances (in the limit, over interplanetary distances);

- On the practical level, by its intrinsic flexibility with respect to different applications context.

Achieving the quantum limit in real-world free-space communications, in order to realize a decisive leap forward in the communication capacity, implies great difficulties in several areas, whose solutions are targeted in our objectives. It is important to emphasize that within each of these contexts, the project can take advantage of the competencies of all the operating units, as all share the scientific background and use common

implementing techniques. We will devote our efforts to explore topics, which have not yet been investigated, or not sufficiently developed:

1) Modeling of the atmospheric channel;

2) Development of Adaptive Optics Elements for QC;

3) Telescopes Design for QC;

4) Frequency and Time Synchronization for QC;

5) Optical Communication at the Quantum Limit;

6) Quantum Key Distribution enhancement.

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