

E
Pilot
R
QIST
A

QIPC Roadmap updates

T. Calarco, D. Binosi

7th European QIPC Workshop The Royal Society, London,
Friday 13 October 2007





ERA-Pilot started 01.02.2005; last for 24 months (possible extension of 9 months)

- Develop a generally accepted strategy for the future of QIPC in Europe
- Map EU QIPC actors (159 groups & 78 funding agencies) and activities
- Map QIPC actors and activities worldwide
- Coordinate national research activities and policies



QUROPE started 01.09.2006; last for 36 months

- Common vision & strategy
- Public outreach & dissemination
- Web portal & info exchange
- Conferen training + I
- Establish
- Internatic

•WP2 (Common vision): P.Zoller, T.Calarco, D.Binosi

representing it towards the EC

•Support function: training and conf.s organization

•'Lobbying' for focusing attention on the research field

•WP1 (Roadmap): R. Fazio, T.Calarco, D.Binosi

•Proposition function: addressed to funding agencies (national & EU)

•Elaborating guidelines for funding the research field





QIPC Strategic Report (EU QIPC Roadmap)

Who

- St
- 1s
- 1s
- PU
- FE
- 2n
- 20
- Up
- 1



V.I.D

It is an
decad

group

in the
A
date
(2005)

next


ERA-Pilot WP1 - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://qist.ect.it/

ERA-Pilot Project on ... JaxoDraw: Feynman d... La Repubblica.it » Ho... Trenitalia HEP Search Google Scholar Mail :: Welcome to We... Quantiki

ERA-Pilot WP1



ERA-Pilot Roadmap : Quantum Information Sciences & Technologies

QIPC Strategic Report

File	Description	Type	Date
StrategicReport-v-1.2.pdf Download	Version 1.2 of the QIPC Strategic Report. State-of-the-art updated to November 2005, some changes/addenda in the experiment as well as in the theory sections.	pdf	2006-03-17

Other documents

File	Description	Type	Date
EU_US_comparison.pdf Download	Comparison between the US and EU QIPC roadmaps	pdf	2006-02-23

Done



EU QIPC Roadmap: the European flavor

1
Purpose

2
Results

3
Future

QIST ERA-PILOT PROJECT

QIPC

**QUANTUM INFORMATION PROCESSING AND
COMMUNICATION**

Strategic report on current status, visions and goals for research in Europe

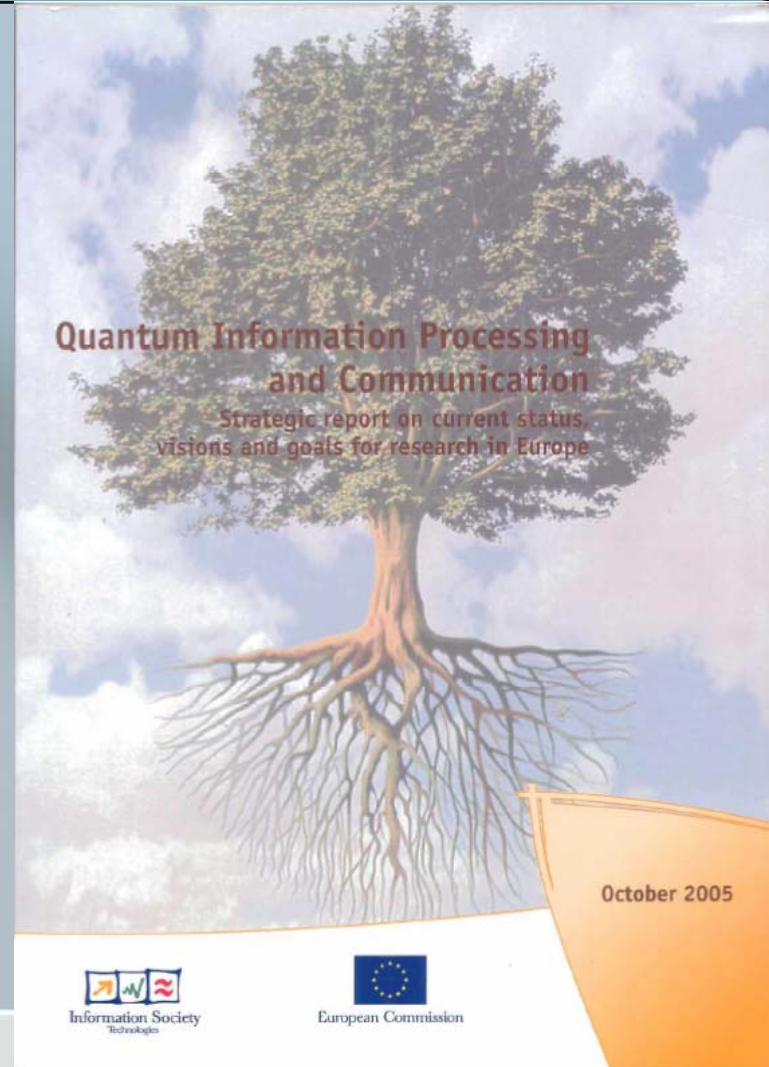
Version 1.2, February 2006

Editing author: Peter Zoller
Institut für Quantenoptik und Quanteninformation
Österreichische Akademie der Wissenschaften
Technikerstrasse 21 a
A-6020 Innsbruck
E-mail: peter.zoller@uibk.ac.at

Contributing authors: Th. Beth (Karlsruhe), R. Blatt (Innsbruck), H. Briegel (Innsbruck),
D. Bruss (Düsseldorf), T. Calarco (Trento), J.I. Cirac (MPQ Garching),
D. Deutsch (Oxford), J. Eisert (London & Potsdam),
A. Ekert (Cambridge), C. Fabre (Paris), N. Gisin (Geneva),
P. Grangier (Orsay), M. Grassl (Karlsruhe), S. Haroche (ENS Paris), A.
Imamoglu (ETH Zürich), A. Karlson (EC Brussels),
J. Kempe (LRI Orsay), L. Kouwenhoven (TU Delft), S. Kröll (Lund),
G. Leuchs (Erlangen), M. Lewenstein (Barcelona), D. Loss (Basel),
N. Lütkenhaus (Erlangen), S. Massar (Brussels), J. E. Mooij (TU Delft),
M. B. Plenio (London), E. Polzik (Copenhagen), S. Popescu (Bristol),
G. Rempe (MPQ Garching), A. Sergienko (Boston), D. Suter (Dortmund),
J. Twamley (Maynooth), G. Wendin (Göteborg),
R. Werner (Bamberg), A. Winter (Bristol), J. Wrachtrup (Stuttgart),
F. Zanardi (Torino), A. Zeilinger (Vienna), P. Zoller (Innsbruck)



Editing assistant: D. Binosi (Innsbruck)

 ERA-PILOT PROJECT "Quantum Information Sciences and Technologies"
Workpackage 1 website: <http://www001003.uibk.ac.at/qist>
<http://qist.ect.it>



**Quantum Information Processing
and Communication**
Strategic report on current status,
visions and goals for research in Europe

October 2005



EU QIPC Roadmap: the European flavor

Executive summary, introduction (why, what), international context, funding

Q. Communication

- Fiber based
- Free space
- Q. Memories
- Q. Repeaters
- Q. Interfaces
- Q. Protocols



Q. Information theory

- Q. algorithms
- Computational models and architectures
- Q. Simulations
- Error correction + purification
- Entanglement
- Noisy comm. channels



Q. Computation

- Trapped ions (electrons)
- Neutral atoms
- Optical traps, Cavity QED, Atom chips
- Supercond. JJ
- Quantum dots
- Linear optics
- Impurity spins / molecular magnets

Fundamental issues in QIPC

Q. mechanics, decoherence,...

Commercial exploitation

Communication, computing, metrology and q. technologies

1
Purpose

2
Results

3
Future



EU QIPC Roadmap: How to contribute

The QIPC roadmap is a 'living document' open to the community discussion. Suggestions for changes/addenda are welcome any time; keep however in mind that this is a position document, and has two basic roles to fulfill:

Prescriptive role

i.e., the identification of the organizational, investment and infrastructure developments (in particular the need of a dedicated QIPC ERA – European Research Area) that would be necessary in order to keep the European QIPC research at the forefront;

Descriptive role

i.e., analyzing the state-of-the-art of different QC implementations and the likely progress (at five and ten years) that could be achieved in the latter.

not a compilation of the most recent results/developments in the different QIPC fields;

but, rather,

it monitors and review the long-term broader developments/research activities.

1

Purpose

2

Results

3

Future



EU QIPC Roadmap: How to contribute

Minor changes/addenda

- Make a concrete proposal for modification, working on the current text.
- Use the track changes feature of Word (Shift+Ctrl+E) to help us keep track of the proposed changes/addenda (or highlight them, or write them in a different color)
- The version you deliver should be ready to be published *as it is* in the document.

New subsections

- Prepare a complete and ready-to-be-included subsection.
- Take as a model the structure of the ones where you think your contribution should be added
- The version you deliver should be ready to be published *as it is* in the document.

Mail the file to era-qist@ect.it, and in the mail please write a few (5/10) lines of motivation as for why you think that it is important that the suggested changes/addenda appears in the next update of the QIPC Strategic Report.

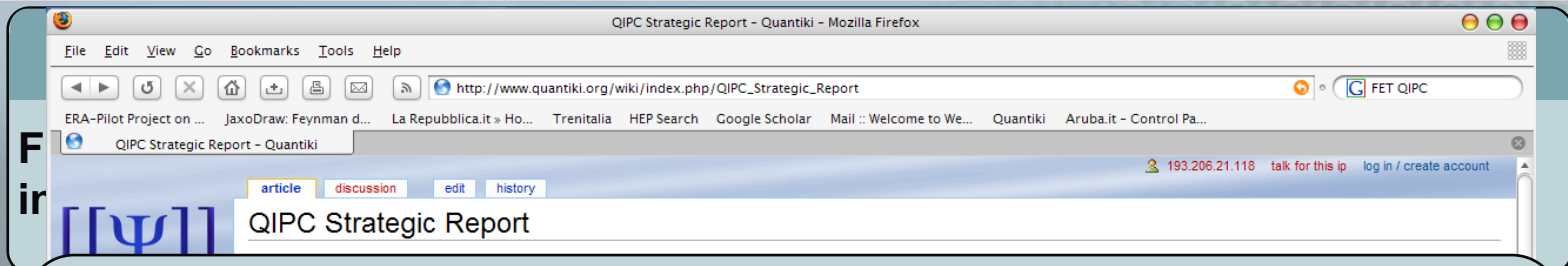
What happens next?

ERA-Pilot WP1 will take care of sending your proposal to the relevant person in the roadmap committee who will take the final decision of its inclusion/revision/rejection (which will be notified through an e-mail containing the motivation for the decision) discussing it with other members when necessary.

1
Purpose

2
Results

3
Future



- Freely editable version of the roadmap (and QICS, see later on) are available
- Constantly monitored, relevant contributions will be sent to the roadmap committee following the afore-described iter

Disclaimer

- WP1 will not make any warranty (neither explicit nor implicit) that whatever a user can add to the Quantiki version of its documents (regardless of its relevance to the subject), will be published in the final version delivered to the European Commission.
- No part of the Quantiki version of the WP1 documents should be quoted as an excerpt coming from a WP1 document unless that part appears also in their WP1 official versions
- Moreover, in no case should the ERA-Pilot QIST Workpackage 1 be held responsible for any kind of content that users may add in the Quantiki version of its documents.

1
Purpose

2
Results

3
Future



Changes in the Oct 2006 release of the Report (v-1.3)

- Executive summary completely rewritten, containing:
 - Overview of QIPC research and its 5/10 years goals per subfield (computation, communication, theory)
 - Summary of short and long term goals
 - Synergies and integration
- QIPC research in Europe updated
- Updated short- and long-term goals for semiconductor quantum dots and for impurity spins
- Some small changes/addenda in the theory section (Quantum Algorithms and Complexity, Geometric and topological methods for fault tolerant quantum computing, Noisy communication channels, Spin-off to other fields)

1

Purpose

2

Results

3

Future



EU/US Roadmap Comparison

- Compare or research
- Done
- Show thinking

Top-...

- EU roadmaps
- community
- committed
- the TEF
- Broad documents

1 Purpose

2 Results

3 Future

ERA-Pilot Roadmap :
Quantum Information Sciences & Technologies

QIPC Strategic Report

File	Description	Type	Date
StrategicReport-v-1.2.pdf Download	Version 1.2 of the QIPC Strategic Report. State-of-the-art updated to November 2005, some changes/addenda in the experiment as well as in the theory sections.	pdf	2006-03-17

Other documents

File	Description	Type	Date
EU_US_comparison.pdf Download	Comparison between the US and EU QIPC roadmaps	pdf	2006-02-23

General

Logic

S

ffs)



US Quantum Repeaters roadmap

- **Result from a workshop held in Harvard in Nov. 2005**
- **Absence of rigid time-scales** (as in the EU roadmap and opposed to the Quantum Computing/Cryptography US roadmaps)
- **Contains contributions of several EU scientists**
- **Common goals**
 - **Quantum state transmission over a quantum channel**
 - **Generate entanglement between separated memories**
 - **Purify quantum state / verify obtained state**
 - **Connect segments / Bell measurements**
 - **Scale**

1
Purpose

2
Results

3
Future



1
Purpose

2
Results

3
Future

Quantum Information Classification Scheme - Quantiki - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.quantiki.org/wiki/index.php/Quantum_Information_Classification_Scheme

ERA-Pilot Project on ... JaxoDraw: Feynman d... La Repubblica.it » Ho... Trentitalia HEP Search Google Scholar Mail :: Welcome to We... Quantiki Aruba.it - Control Pa...

Quantum Information Classification Sch...

193.206.21.118 talk for this ip log in / create account

[[Ψ]]

Quantum Information Classification Scheme

Quantum Information Classification Scheme© (QICS) [edit]

The Quantum Information Classification Scheme© has been elaborated by the ERA-Pilot WP1 with the ambitious goal of producing a classification scheme of QIST related topics that can be widely accepted by the research community. The classification scheme developed so far has been evidently inspired by the APS PACS scheme (the ultimate goal would be to have it compatible with PACS and eventually to join the latter). The scheme is arranged hierarchically, by subdivision of the whole spectrum of subject matter in the QIST areas into segments and then repeating the process of subdivision down to four levels (Categories, Topics, Fields, and Sub-fields). Therefore, as already happens in the APS PACS, similar subjects will be found grouped closely together, with browsing up and down near any entry revealing closely related entries.

QICS are available in different formats (html, pdf) from the [ERA-Pilot QIST WP1 web site](#), which provides also a search engine for them. Moreover WP1 is contacting several journals in order to run a large scale test for these codes. The purpose of this test would be twofold: from the one hand it would spread the QICS inside the QIPC community; on the other hand, we expect it to trigger community feedback in the form of comments, suggested changes and/or new codes, that can be either sent directly to the ERA-Pilot WP1 through the [QICS feedback form](#) available at the ERA-Pilot WP1 website, or implemented directly in this Wiki version of the QICS. Both community suggestions will be continuously addressed, and if relevant will appear in subsequent updates of the codes (which are scheduled to take place every two-to-three months). What you find in these pages will always be the most up-to-date version of the codes.

Journals that have agreed to run the QICS test (by sending a special note in the acknowledgement of receipt of a paper inviting the authors of the QIST and related areas to provide their QICS codes in addition to the usual PACS ones, with the former appearing in the printed version of the paper) are the following:

- The European Physics Journal D (see full announcement [here](#))

You are reminded that the Quantiki version of the QICS should be regarded as an unofficial version of the QICS, and QICS codes that appears in these pages but NOT in the [official QICS list](#) should not be used until they are approved and included in the latter (read also this [Disclaimer](#) if you have not done it yet).

Category: ERA Quantiki Project





PACS Changes

Based on QICS; accepted to appear in the 2008 release
Actual numbers will appear in September 2007

Changes

03.67.Lx Quantum computation → 03.67.Lx Quantum computation architectures and implementations
 03.67.Dd Quantum cryptography → 03.67.Dd Quantum cryptography and communication security
 03.67.Mn Entanglement production, characterization, and manipulation (see also 03.65.Ud Entanglement and quantum nonlocality; for entanglement in Bose-Einstein condensates, see 03.75.Gg) → 03.67.Mn Entanglement measures, witnesses, and other characterizations (see also 03.65.Ud Entanglement and quantum nonlocality)

Additions

03.67.Aa Quantum algorithms, protocols, and simulations
 03.67.Bb Entanglement production and manipulation (for entanglement in Bose-Einstein condensates, see 03.75.Gg)

Splittings

89.70.+c Information theory and communication theory (for telecommunications, see 84.40.Ua; for optical communications, see 42.79.Sz)
 into

89.70.-a Information and communication theory (for telecommunications, see 84.40.Ua; for optical communications, see 42.79.Sz)

89.70.Aa Entropy and other measures of information
 89.70.Bb Computational complexity
 89.70.Cc Communication complexity
 89.70.Dd Channel capacity and error-correcting codes

1

Purpose

2

Results

3

Future



Work ahead

- **Roadmap:**
 - **Update international part** (input from QUROPE WP8 needed)
 - **Rewrite some sub-sections** (e.g., neutral atoms); **Restructure theory part** (?)
 - **Rethink the way updates are carried on** (e.g., satellite meetings of the committee during QUROPE conferences)
- **Porting to QUROPE of all ERA-Pilot WP1 tools** (e.g., databases, share document portal, etc.)
- **Address any feedback we get from the community**

1
Purpose

3
Future

3
Future