

## Annex 2

# TECHNICAL REVIEW REPORT

## Information and Communication Technologies ICT

Project acronym: MALICIA  
Project title: Light-Matter interfaces in absence of cavities  
Grant agreement number: 265522  
Funding scheme: CP-STREP  
Project starting date: 01/02/2011  
Project duration: 36 months  
Coordinator: Dr Prof. Francesco Saverio CATALIOTTI  
Project web site: <http://www.maliciaproject.eu>

Period covered by the report: Period No. 2, from 01/02/2012 to 31/01/2013  
Place of review meeting: Brussels  
Date of review meeting: 25 March 2013

Experts: Dr Prof. Charles S. Adams, Durham University  
Dr Prof. Ruth Oulton, University of Bristol  
Dr Clara Ines Osorio, FOM Institute AMOLF

Project officers: Matteo MASCAGNI, Teresa DE MARTINO

Individual report
Consolidated report

## 1. OVERALL ASSESSMENT

### Executive summary

Main scientific/technological achievements of the project:

The consortium fulfilled most of the objectives for the period. The main scientific achievement was deterministic teleportation between two macroscopic ensembles of Cesium atoms (WP2). This was identified as a Highlight of the project so far.

Adherence to the work plan:

Overall the original work plan continues to be followed closely. We choose to highlight two areas.

First due to several technical problems in the development of microcells, this technology is not yet at the position to fulfil all the scientific aims of WP2. However, proof-of-principle experiments have been done using macrocells and it is expected that, once the microcells are ready, it will be possible to repeat the experiments with them.

Second a major concern is about the future of WP3 given the results obtained by other groups outside the consortium and by the partners. As we suggest below the coordinator may wish to consider an amendment to Annex 1 (the description of work) in order to reformulate an integrated programme of work for this work package.

Take-up of the recommendations from previous review:

Most of the recommendations from the previous report were taken into account. There are some recommendations that still apply to this period (see 1b), for instance acknowledging MALICIA properly in all publications. In this second review we strongly urge the MALICIA consortium to acknowledge ALL publications pertaining to MALICIA in the correct way.

In addition, we made the recommendation that the budget report should detail major (>few k euros) costs to the project. We note that UCPH has only described a 50.442keuro spend as “travel and equipment”. Details of this expenditure should be given.

Use of resources:

This year the resources have been used more efficiently. But (with the exception of AU) the percentage of the budget spent during the last two years continue being lower than expected.

Some details of expenditure on travel are not clear. It would be helpful to give details of travel expenditure and the relevance to MALICIA.

Impact:

The number of MALICIA associated publications and talks given by MALICIA partners during the last year indicate that the impact of the consortium continues to grow.

### Recommendations concerning the period under review

#### General Recommendations

The deliverables should include the list of publications associated with them, both in the text of the deliverables and in the project periodic report.

The deliverables and the project periodic report should describe explicitly the deviations from the work plan. This includes a deviation in D2.2, D2.5, D3.2

There is no mention of Milestones MS2 and MS3 which should have been completed by Month 24 in the report, although they were discussed to our satisfaction at the Review Meeting. The report should include a more complete description of the milestones achieved in the period.

The proof-reading of the periodic report and the deliverables need to be checked more carefully.

Figures with illegible labels should be legible in the report.

#### Publications and dissemination

MALICIA should be acknowledged in the publications using the exact sentence given in Annex I, p38.

Wherever possible, publications should be posted on the arXiv server or similar, with the latest published content version on the arXiv server.

The website should include an actualized list of publications.

#### Use of Resources

The part of Table 3.1 corresponding to UCPH should describe in more detail the ‘Other indirect costs’.

#### Recommendations concerning future work

The reviewers recommend that the objectives, milestones and deliverables remain as proposed except for WP3 – the cold atom interface. The work performed this year on slow light is well aligned with the overall objectives of MALICIA but as there are no more milestones the future direction is uncertain. The plan seems to be to move away from atom-light interfaces towards multi-path interferometry. The panel feel that the coordinator should consider persisting with work on atom light interfaces as cold atoms offer great potential for longer term memory and exploring schemes to counter dephasing. For example, one could convert the slow light EIT experiment to a light storage experiment and subsequently investigate microwave or rf control of the stored light. This could also link to the ideas on multipath interferometry that were explored previously.

#### Assessment

Excellent progress (the project has fully achieved its objectives and technical goals for the period and has even exceeded expectations).

■ Good progress (the project has achieved most of its objectives and technical goals for the period with relatively minor deviations).

Acceptable progress (the project has achieved some of its objectives; however, corrective action will be required).

Unsatisfactory progress (the project has failed to achieve key objectives and/or is not at all on schedule).

## 2. OBJECTIVES and WORKPLAN

### a. Progress towards project objectives

Overall progress towards the main objectives is good. The objectives were to create cavity-free quantum optical technologies using three experimental approaches that may be integrated with each other to form a system of single photon sources, memories and massively entangled systems. Progress in each workpackage is good, with WP4 focussing on quantum interfaces. Progress towards these goals has been good, and we note that the CRAB optimisation tool has been used in several of the WPs.

### b. Progress in individual work packages

As stated above, progress on all WorkPackages is as expected apart from: The technical issues associated with the cell with buffer gas and alkane coatings in WP2; and reporting of progress on the theory of emission from arrays of microcells in WP1. As we detail above, some of the Deliverables in WP3 are no longer applicable, and recommendations have been made by the Reviewers as above.

### c. Milestones and deliverables

#### D1.2 Theory of light emission from an array of microcells

Status: Rejected

The text of the deliverable did not explain the progress on the theory for arrays of microcells. It is not clear from the Deliverable report whether the results presented concern arrays or single cells. However, from the Review Meeting it was clear that arrays of microcells have proven difficult to fabricate. The Deliverable report should reflect this fact, and include a discussion of the alternative approaches used.

#### D1.3 Optimized pulse shapes for optimal single-photon output from microcells

Status: Accepted

The participants demonstrated that directional emission of single photons from a micro cell of Rubidium atoms is possible by pulse optimization.

#### D2.3 Protocol for long-lived entanglement in room temperature atomic ensembles

Status: Accepted

#### D2.4 Quantum noise measurement and demonstration of an entangled state of two microcells and its application

Status: Accepted

The foreseen work described for this deliverable included the measurement of the quantum projection spin noise of the atoms, which was achieved by the partners. Due to the delay in the development of microcells, the rest of the work was not possible. The partners have shown, however, very interesting results using macro cells as the deterministic macroscopic teleportation between two Cesium cells.

#### D2.5 Evaluation of quantum interface of light with an atomic ensemble in a microcell and characterization

Status: Accepted

There is a mismatch between the name of the deliverable, the text, and the results described during the review meeting. For example, a description of the optical coupling is described,

but the “degree and decay of spin polarization...[and]....coherent superposition of two hyperfine states...” stated in the original deliverable description are not described. The results as described in the Review Meeting are however convincing and the deliverable is accepted.

D3.2 Long lived memory with ultracold atoms  
Status: Accepted

D4.2 Theoretical model for Rydberg blockade induced optical nonlinearities for two-photon gates

Status: Accepted

As for D2.5, the results described in the deliverable and in the review meeting do not correspond with the plan, however those results are convincing and the deliverable is accepted. The deviations from the planned deliverable should be described, along with any publications resulting from the deliverable.

STATUS OF DELIVERABLES			
No.	Title	Status (Approved/Rejected)	Remarks
D1.2	Theory of light emission from an array of microcells	Rejected	An array of microcells is not mentioned, and therefore does not answer the deliverable.
D1.3	Optimized pulse shapes for optimal single-photon output from microcells	Approved	
D2.3	Protocol for long-lived entanglement in room temperature atomic ensembles	Approved	
D2.4	Quantum noise measurement and demonstration of an entangled state of two microcells and its application	Approved	
D2.5	Evaluation of quantum interface of light with an atomic ensemble in a microcell and characterization	Approved	The results obtained are not clearly described in the deliverable.
D3.2	Long lived memory with ultracold atoms	Approved	
D4.2	Theoretical model for Rydberg blockade induced optical nonlinearities for two-photon gates	Approved	The results obtained are not clearly described in the deliverable.

d. Relevance of objectives

With the exception of WP3, the objectives for the coming period are relevant and achievable.

### 3. RESOURCES

#### a. Assessment of the use of resources

As far as can be assessed the use of resources seems appropriate. Occasionally additional details would have been helpful on exactly which named person was paid from MALICIA or made a particular visit to another group or conference.

#### b. Deviations

There were no major deviations with respect to the planned use of resources.

#### 4. MANAGEMENT, COLLABORATION AND BENEFICIARIES' ROLES

a. Technical, administrative and financial management of the project

The project management including the coordination between WPs is good and effective. The quality of the report and the deliverables improved and most recommendations from last periodic review were implemented. The information delivered was complete, but only arrived to the reviewers shortly before the meeting.

b. Collaboration and communication

The fact that the information and results is rapidly shared among the beneficiaries shows that the collaboration and communication between them is good and effective. We note that although no face-to-face meetings have been arranged specifically for MALICIA, meetings tend to occur at conferences etc, which appears to be adequate.

c. Beneficiaries' roles

All beneficiaries have contributed work and results to both Reporting periods, and resource allocation does not deviate widely for any of the beneficiaries. The contribution of each beneficiary is clear.

## 5. USE AND DISSEMINATION OF FOREGROUND

### a. Impact

It is likely that the project will have a considerable impact on the field, especially given the results on pulse shape optimization and decoherence induced entanglement.

### b. Dissemination

The strategies for dissemination of project results have been effective. The results are being published in well known journals, and in many cases open access versions are available via the arXiv. There have been an important number of talks where the results of MALICIA were presented to the scientific community. Regarding the website, in general the information is complete, but the list of publications is not actualised.

### c. Links with other projects and programmes

During this year, the consortium have keep benefiting from the links with other European projects. As described on the project periodic report, the partners of MALICIA are also involved on IP AQUTE, CP QIBET, INT “coherence” and CA “QUIE2T”, for which there is a considerable flux of information between projects.

## 6. OTHER ISSUES

Name(s) of expert(s): Dr. Ruth Oulton, Dr. Clara Osoro, Prof. Charles Adams

Date: 12<sup>th</sup> April 2013

Signature(s): Ruth Oulton, Clara Osoro, Charles Adams