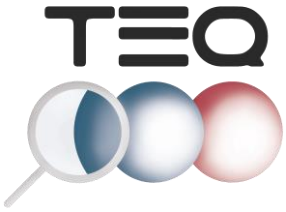
Horizon 2020
European Union funding
for Research & Innovation



DELIVERABLE 6.3

Video

Grant agreement n°:	**766900**
Project acronym:	**TEQ**
Project title:	**Testing the Large Scale limit of Quantum Mechanics**
Funding scheme:	**FET-OPEN**
Start date of project:	**01 January 2018**
Duration:	**48 months**
Due date of the Deliverable:	**31 December 2019**
Deliverable issued:	**26 November 2019**
Dissemination Level:	**Public**
Version:	**1.0**

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INTRODUCTION

This deliverable is part of the broader communication strategy of the project. As stated in the TEQ project proposal - Part B, effective communication is a core activity that involves the Consortium in many ways. TEQ fosters the building up of wide awareness and interest in the topics of the project and stimulates scientific endeavours that go far beyond the context defined by the work plan.
This deliverable falls into the Work Package 6 – Dissemination, that involves all partners of the Consortium and covers the full life of the project. As part of the Task 6.3 "Coordinate and promote external communication to targeted audiences" (Annex I to the Grant Agreement – Part A), the deliverable 6.3 could have included video-abstracts of relevant publications, video interviews, pedagogical videos.
The deliverable 6.3 was identified to be a video explaining the TEQ project aimed at: the general public with a general knowledge of science and physics; the scientific community interested in knowing what is the project about; funding agencies potentially interested in financing further research connected to TEQ. The final product would then be available for all project teams to distribute and disseminate through their channels as a project presentation.

OBJECTIVES

Create video material combining interviews and video footages from the labs that could explain the project in a scientific while accessible way to the general public, the scientific community and funding agencies.

ACHIEVEMENTS

A storyboard is put together and agreed among the partner, video-interviews are shot, video footages of labs are collected and the whole material is edited together in an organized and clear structure illustrating the project.

IMPLEMENTATION

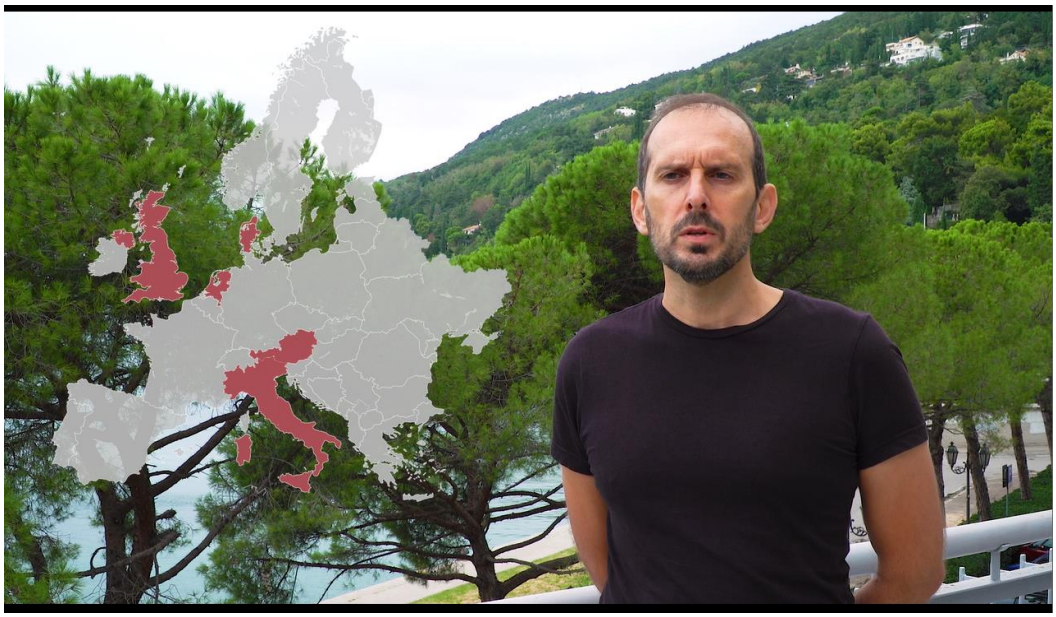
The work on the creation of the video started at the beginning of 2019 when the UniTs project team started brainstorming for the idea. The first idea was to create a video mixing animations with video-interviews of TEQ partners, being the Workshop on "Redefining the foundations of physics in the quantum technology era" the occasion to shoot the interviews in Trieste, in September 2019.
Then the team started looking for a company to produce it and had discussions with:

- Divulgando Srl (April 5, 2019), based in Trieste, Italy, specialized a very large spectrum of communication services (graphic design, visual identity, events, copywriting, audio/video recording).
- Aloop Visual & Science Srl (April 8, 2019): company based in Barcelona, Spain, specialized in illustration, animation and filming and especially video-abstract of scientific publications.

These discussions helped the UniTS team to understand what would better fit for the purpose in terms of type of video, length, quality. It was decided to exclude from the video the animations and to focus on showing the labs and the people working on the research.
It was decided to ask a third firm to make a proposal and an offer based on its experience on videos for educational institutions. The company Marco D'Agostini was first contacted in June and a meeting was carried out on July 17. The economic offer and the work plan proposal were convincing and it was decided to contract the company to carry out the work.

In the meantime, the Consortium partners were contacted in early August to inform them about the choices made for the deliverable and to ask to give inputs in form of text for the storyboard and short footages of the labs to include in the video together with the interviews.
The interviews were shot at the ICTP premises in Grignano – Trieste, indoor and outdoor, on September 18, 2019. The process of editing took about 2 months, being ended with the achievement of the deliverable on November 26. Some footages of partners' labs had to be shot again because of the low video quality and some details, like music, logos and illustrations, had to be carefully chosen and placed.
For the structure of the video, it was decided to stick to the scientific Working Packages, interviewing the leaders of the respective WPs including an initial overview by the PI.

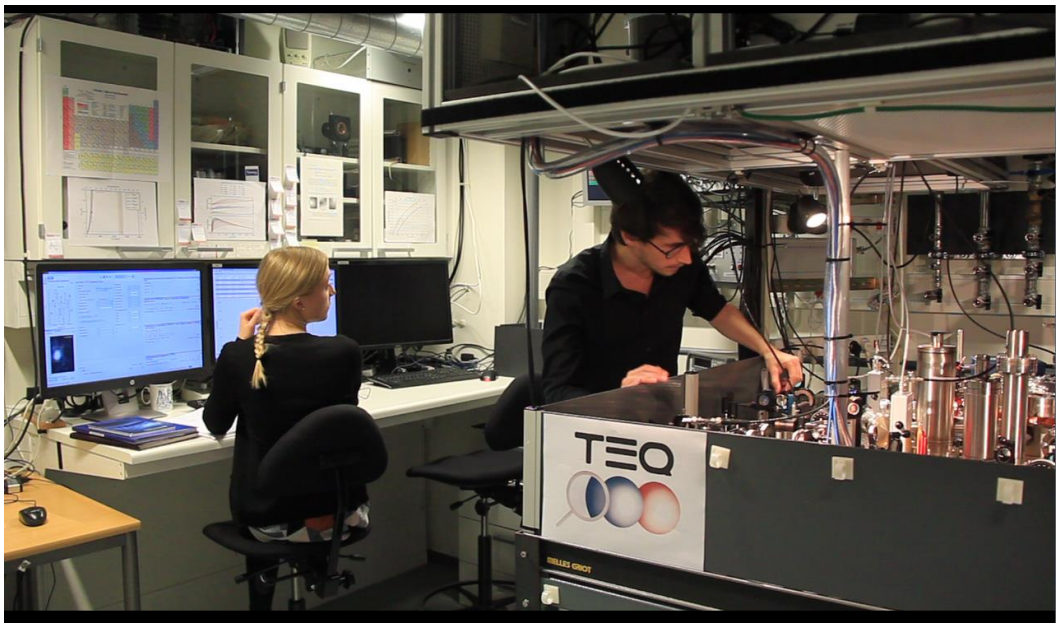
Overview
The TEQ project is a H2020 FET-OPEN funded by the European Commission in 2018 and lasting 4 years. The project has the ambitious objective of establishing the large-scale limit of quantum mechanics.
This is achieved by preparing a nanoparticle, trapping it with laser techniques, cooling it down to cryogenic temperatures, and monitoring its motion. Data will then be compared with theoretical predictions to assess whether quantum theory is right, or deviations have been observed. In the first case, quantum theory will be confirmed to an unprecedented degree of accuracy; in the second case, new physics will be discovered. In either case, a very important result.
These are the four parts which compose TEQ: Trapping of nanocrystals, cooling, testing and enabling the results.
The project consortium is composed of 8 institutions and 1 company, located in United Kingdom, Denmark, Austria and the Netherlands and Italy. The University of Trieste is the coordinator.



1. The TEQ Consortium illustrated in a map of Europe by the PI.

Trapping
The first part of TEQ is devoted to trapping of charged nanocrystals for test deviations to standard quantum mechanics, as predicted for example by spontaneous collapse models. The choice of nanocrystals has been made through intense discussions between the experimental and theory

partner of TEQ. This has led to the identification of several good candidates and first nanocrystals have been synthesized by TUD. The trap to hold the charged nanocrystals at cryogenic temperatures has been designed and constructed by AU, and is tested at UCL in room temperature experiments before installed in a cryogenic environment. In a collaboration between AU and INFN, extremely low-noise digital and analog voltage supplies for the trap are designed, constructed and tested in electronic workshops. Furthermore, at AU an operational ion trap is employed to carry out tests under conditions mimicking some of the features of the final TEQ-experiment.



2. A screenshot of the labs at Aarhus University where the trap is being built.

Cooling

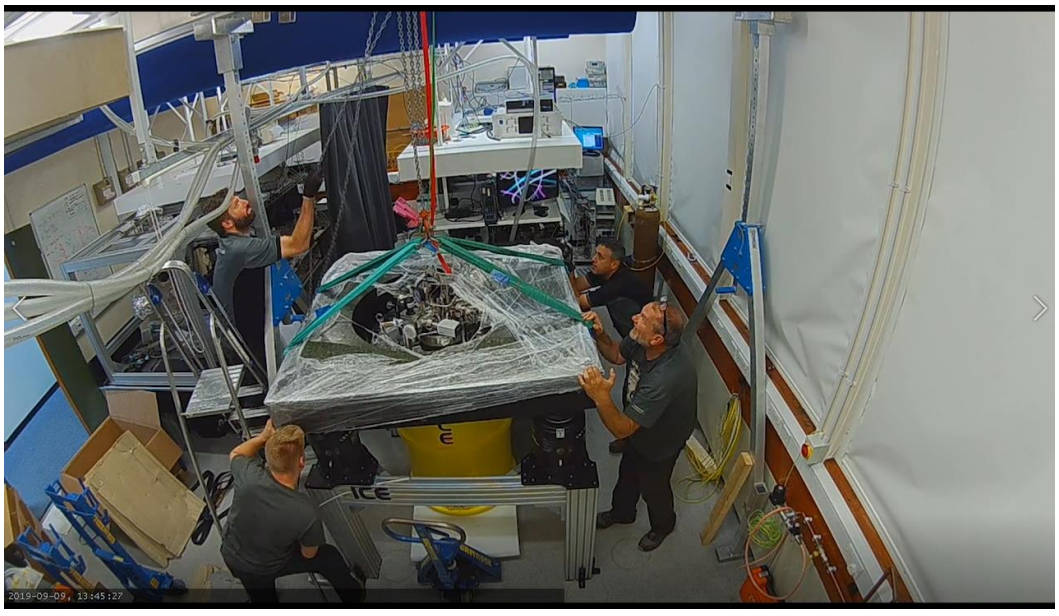
An important requirement for TEQ is to manipulate, detect and cool the charged nanoparticles in the Paul trap. The aim here is to understand and reduce the effects of both classical and quantum noises in this system so that deviations to quantum mechanics can be observed. As part of the programme we have demonstrated feedback cooling in the Paul trap and have begun to understand the important noise sources in the trap. Currently, this is voltage and charge noise, and we are systematically working to reduce this and other sources. On such noise includes motion of the trapped particles that is induced by the internal temperature of the trapped nanoparticles. This occurs through collisions with even the smallest quantity of background gas which gives Brownian motion like kicks to the trapped particle which could mimic collapse noise. To mitigate this, we are developing laser refrigeration techniques to minimise this internal temperature.

3. A screenshot of a footage showing M Squared Lasers assembling the lasers for cooling.

Testing

The central part of TEQ is to set up the main experiment, which is a 300 mK cryostat with ultra-high vacuum and vibration isolation. The cryostat will then host the Paul ion trap where a charged nano- or micro-particle will be trapped at low temperature. The TEQ experiment will test CSL in a non-interferometric way by detecting with high spatial resolution the motion of the particle in the trap. The predicted CSL noise will then induce a Brownian-like motion of the particle about its trapping position, if all other noises affecting the centre-of-mass-motion of the particle can be suppressed sufficiently well. The experiment foresees testing of mechanical and vibrational noise levels and the implementation of additional vibration isolation.

The technique to detect the motion of the particle is likely based on high-resolution optical imaging and together with TEQ theory partners we are working on the definition of the optimal detection mode in order to minimise the destructive effect of the detection on the motion of the particle itself.



4. A screenshot of the footage showing the assembly of the cryostat at labs of University of Southampton.

Enabling

You cannot build a palace without solid foundations, nevermind a project aiming at shaking our current understanding of nature at all scales.

Theoretical work will provide exactly the foundations of the TEQ palace: we will pursuit a theoretical framework able to attack, challenge and hopefully resolve some of the most important outstanding problems: is quantum theory sufficient to describe the quantum-to-classical transition? Can we identify unquestionable signatures of quantum ness in the dynamics of large-scale systems? Is a quantum formulation of gravity possible (and testable)? The TEQ team is perfectly placed to address these challenges and shed new light onto them!

5. The leader of the WP4 illustrating the theoretical part of the research.

Visionary perspectives on the study of the foundations of quantum mechanics

Imagination flies high when one hears the word "quantum" – not only that of scientists, but of any person who was ever exposed to the magic properties of the quantum realm. Properties such as the superposition of states and entanglement are not only studied by scientists to better understand the quantum nature of the Universe, but they are also becoming the fuel of the second quantum revolution producing new quantum technologies, of which the quantum computers are maybe the best example and also the mostly known one. Presently there are many laboratories spread around the world and using various quantum systems to put together more and more qubits, the quantum bit, towards powerful quantum computers which, one day, may replace our present computers.

The results and the work of the TEQ project will impact not only on fundamental physics, helping us to verify if world still behaves quantum when we deal with bigger and bigger objects, strengthening the quantum mechanics' role as a pillar of our understanding of the laws of nature and Universe, but will also make us more and more confident towards the realization of the new quantum technologies at all scales. And the quantum computer is only the beginning!

The TEQ community is sharing its results not only with the colleagues involved in quantum studies, but also with a larger scientific community, by publishing its results and presenting them in international workshops and conferences, and with whomever is wishful to share with us our work and our findings – from school children and students, to general public and …quantum enthusiasts.

6. A Consortium member giving a TED talk on the frontiers of quantum mechanics.

7. A screenshot of the last image of the TEQ video including all logos and names of the local PIs.

ISSUES MET AND SOLUTIONS

The deliverable was initially due August 2019 (M 20) but a shift to December 2019 (M24) was requested and granted by the PO on January 22, 2019. The reason for the shift was that video-interviews to be included in the video were to be shot at the occasion of the TEQ Workshop in September 2019 when all Local PIs of the project would come together in Trieste. Also, it was deemed the shift would not impact the research activity and was therefore acceptable.

CONCLUSION

The preparation of the video was fairly shared among the Consortium members and the final result was highly appreciated by the TEQ partners. The video was planned to be a balanced combination of structured explanations of the phases of the project involving the PI and the WP leaders. The rhythm between interviews and lab footages was planned to keep the viewer's attention high till the end of the video. Moreover, the video is divided in chapters recalling the initial illustration of the project's objectives done by the PI: the idea is to offer a structured story that brings the viewer through a path.

The final product is shared with the partners for dissemination through their institutional channels (websites, presentations, talks, etc.) and is posted on TEQ's Youtube channel, on the TEQ Website and on TEQ's social media accounts. The Consortium members are engaged to give maximum dissemination to the video to the scientific community, to the general public and to potential funding agencies.