⟨EQUAL|TY⟩

Efficient QUantum ALgorithms for IndusTrY

WP6 Impact creation

D6.3 Dissemination & communication reports

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Document control

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Document description	This deliverable reports on the communication and dissemination activities executed during the first year of the EQUALITY project, including website and social media presence, scientific publications, press releases, organisation of and participation in events, and networking activities with other projects and initiatives. It also evaluates the accomplishment of the key performance indicators (KPIs) define in D6.2.

[1]R: Document, report (excluding the periodic and final reports); DEM: Demonstrator, pilot, prototype, plan designs; DEC: Websites, patents filing, press & media actions, videos, etc.; DATA: Data sets, microdata, etc.; DMP: Data management plan; ETHICS: Deliverables related to ethics issues.; SECURITY: Deliverables related to security issues; OTHER: Software, technical diagram, algorithms, models, etc.

[2]PU – Public, fully open, e.g., web (Deliverables flagged as public will be automatically published in CORDIS project's page); SEN – Sensitive, limited under the conditions of the Grant Agreement; Classified R-UE/EU-R – EU RESTRICTED under the Commission Decision No2015/444; Classified C-UE/EU-C – EU CONFIDENTIAL under the Commission Decision No2015/444; Classified S-UE/EU-S – EU SECRET under the Commission Decision No2015/444

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Abstract

A quantum revolution is unfolding, and European scientists are on the lead. Now, it is time to take decisive action and transform our scientific potential into a competitive advantage. Achieving this goal will be critical to ensuring Europe's technological sovereignty in the coming decades.

EQUALITY brings together scientists, innovators, and prominent industrial players with the mission of developing cutting-edge quantum algorithms to solve strategic industrial problems. The consortium will develop a set of algorithmic primitives which could be used as modules for various industry-specific workflows. These primitives include differential equation solvers, material simulation algorithms, quantum optimisers, etc.

To focus our efforts, we target eight paradigmatic industrial problems. These problems are likely to yield early quantum advantage and pertain to the aerospace and energy storage industries. They include airfoil aerodynamics, battery and fuel cell design, space mission optimisation, etc. Our goal is to develop quantum algorithms for real industrial problems using real quantum hardware. This requires grappling with the limitations of present-day quantum hardware. Thus, we will devote a large portion of our efforts to developing strategies for optimal hardware exploitation. These low-level implementations will account for the effects of noise and topology and will optimise algorithms to run on limited hardware.

EQUALITY will build synergies with Quantum Flagship projects and Europe's thriving ecosystem of quantum start-ups. Use cases will be tested on quantum hardware from three of Europe's leading vendors and two HPC centres. The applications targeted have the potential of creating billions of euros for end-users and technology providers over the coming decades. With EQUALITY, we aim at playing a role in unlocking this value and placing Europe at the centre of this development. The project gathers 9 partners and has a budget of €6M over 3 years.

Consortium

The EQUALITY consortium members are listed below.

Legal Name on Grant Agreement	Short name	Country
CAPGEMINI DEUTSCHLAND GMBH	CAP	DE
QU & CO AI BV	QC	FR
AIRBUS OPERATIONS GMBH	AOG	DE
DEUTSCHES ZENTRUM FUR LUFT - UND RAUMFAHRT EV (DLR)	DLR	DE
FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV (FHG)	ENAS	DE
INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET AUTOMATIQUE (INRIA)	INRIA	FR
UNIVERSITEIT LEIDEN (ULEI)	ULEI	NL
DA VINCI LABS	DVL	FR

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Disclaimer

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List of abbreviations

WP	Work package
KPI	Key Performance Indicator

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1. Executive Summary

This document is a deliverable of the EQUALITY project, funded under grant agreement number 101080142.

This deliverable “D6.3 Dissemination & communication reports” is part of Work Package 6 (WP6) “Impact creation” which “ensures communication and dissemination of EQUALITY project activities to different stakeholders: from researchers, industry, policymakers to the public”. D6.3 follows from “D6.2 Dissemination & communication plan” which presented the strategy for communication and dissemination of the EQUALITY project’s objectives and results.

This deliverable reports on the communication and dissemination activities executed during the first year of the EQUALITY project, including website and social media presence, scientific publications, press releases, organisation of and participation in events, and networking activities with other projects and initiatives. It also evaluates the accomplishment of the key performance indicators (KPIs) define in D6.2.

Da Vinci Labs (DVL) is WP6’s lead beneficiary and is responsible for the development of this report. The communication and dissemination activities will continue to be evaluated in M24 and M36, also as part of deliverable D6.3.

2. Communication and dissemination activities

EQUALITY’s communication is implemented through several activities, channels, and tools detailed in deliverable D6.2, alongside a timeline for execution and key performance indicators (KPIs). In the next sections, we present results from the following activities executed during the first year of the EQUALITY project:

- Website containing public domain information about the project aimed at different stakeholders and target audiences;
- Social media channels to engage and build relationships with different stakeholders and target audiences;
- Scientific publications for dissemination of key results produced during the project, accompanied by layperson summaries published on the project’s website and social media channels;
- Press releases to maximise the dissemination of project’s results and important milestones on the media;
- Promotional materials composing a communication kit with clear and simple language aiming to reach a variety of target audiences;
- Events organisation and participation to raise awareness around the project, its activities and expected results, and disseminate the relevant developments;
- Networking activities with other projects and initiatives to ensure the impact of the project’s results and to ensure the adoption of the project’s outputs.

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2.1. Website

The EQUALITY project website – http://equality-quantum.eu – contains public domain information about the project aimed at different stakeholders and target audiences.

Consortium partner DVL is responsible for keeping the website always up-to-date and functioning properly, solving any issues in a timely manner. The schedule for these updates depends on the specific needs of the website. Relevant website updates are communicated to consortium partners through internal channels and to target audiences through EQUALITY's social media channels.

Google Analytics is used to monitor the performance of the website (number of sessions, users, engagement time, etc.). Table 1 shows selected website statistics collected as of the delivery date of this document.

Table 1: Website selected statistics.

Website statistics	Year 1	Year 2	Year 3	Total
Users	1,100	-	-	1,100
Sessions	1,900	-	-	1,900
Pageviews	3,700	-	-	3,700
Engagement time	00:00:58	-	-	00:00:58
Main national origins	FR (236), US (206), DE (196), NL (80), IN (58)	-	-	FR (236), US (206), DE (196), NL (80), IN (58)

2.2. Social media

Social media are important communication tools to engage and build relationships with different stakeholders and to increase brand awareness for the project. Social media profiles on the platforms Twitter and LinkedIn were set up by M1:

- Twitter: https://twitter.com/equalityquantum
- LinkedIn: https://www.linkedin.com/company/equality-quantum/

Table 2 shows the social media KPIs for the project. As it can be seen, on LinkedIn EQUALITY has surpassed the Y3 follower KPI at 220 followers, while on Twitter/X the project has surpassed the Y2 follower KPI at 233 followers.

To assess their effectiveness, the project's social media accounts are monitored using the analytics provided by each platform. Tables 3 and 4 shows selected social media statistics collected as of the delivery date of this document.

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Table 2: Social media timeline and KPIs.

Activity	KPI	Year 1	Year 2	Year 3	Total
Social Media Channels	Twitter/X Followers	233 / 50	- / 200	- / 500	233 / 500
	LinkedIn Followers	220 / 50	- / 100	- / 200	220 / 200

Table 3: LinkedIn selected statistics.

LinkedIn statistics	Year 1	Year 2	Year 3	Total
Followers	220	-	-	220
Avg. new followers per month	18	-	-	18
Total number of posts	69	-	-	69
Total impressions	24,000	-	-	24,000
Total engagement*	1,600	-	-	1,600

*Sum of likes, clicks, comments and shares

Table 4: Twitter/X selected statistics.

Twitter/X statistics	Year 1	Year 2	Year 3	Total
Followers	233	-	-	233
Avg. new followers per month	19	-	-	19
Total number of posts	122	-	-	122
Total impressions	6,600	-	-	6,600
Total engagement*	300	-	-	300

*Sum of likes, clicks, comments and shares

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2.3. Press Releases and media coverage

To maximise the project's dissemination to the media, the consortium prepares press releases to promote EQUALITY's results and important milestones.

Table 2 shows the press release and media coverage KPIs for the project.

The first press release was prepared by DVL regarding the project start, with information of the project's goals, partners, funding, etc. The press release was distributed to all partners to be adapted by their respective communications offices as deemed necessary and published. Figure 1 shows the first press release.

As of the submission of this deliverable, EQUALITY has been mentioned in the media over 250 times, including paid media (press release distribution service), earned media (regular coverage of the project and its partners), and owned media (by partners themselves).

Earned mainstream media coverage are highlighted on Tables 6–10 and Figures 2–6.

Table 5: Press releases timeline and KPIs.

Activity	KPI	Year 1	Year 2	Year 3	Total
Press Releases	Number of Press Releases	1 / 1	- / 1	- / 1	1 / 3
	Total Coverage	289 / 250	- / 750	- / 1000	289 / 2,000
Mainstream Publications	Number of Articles	5 / 5	- / 10	- / 16	5 / 30
	Total Readership	>600,000* / 100,000	- / 300,000	- / 600,000	>600,000* / 1,000,000

*Potential audience exposed to the project.

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EQUALITY consortium selected by the EU's Horizon Europe Program to develop quantum algorithms for industrial applications

The project brings together scientists, innovators, and industrial players and will receive a cumulative six-million-euro funding from the European Commission over the next three years.

Berlin, January 30th – The EQUALITY[1] consortium composed of Airbus, Capgemini, Da Vinci Labs, Fraunhofer ENAS, German Aerospace Center, INRIA, Leiden University and PASQAL, has been selected by the EU's key funding program for research and innovation, Horizon Europe, to develop innovative quantum computer algorithms to solve strategic industrial problems.

By transforming current industrial interest into widespread adoption, EQUALITY objective is to solidify the link between strategic European industries and the emerging quantum ecosystem, while also contributing to technologies which are critical to the green transition. The project is one of three projects selected out of 51 submitted. The partners will receive a cumulative six-million-euro funding from the European Commission over the next three years.

The consortium will target eight paradigmatic industrial use cases - computationally complex and faced routinely by the industrial partners - that can benefit from the quantum-enabled speed-up: airfoil aerodynamics, battery design, fluid dynamics, space mission optimization, materials design, multidisciplinary optimization, space data analysis and fuel cell design. The computational requirements are enormous, forcing today engineers to use simplistic models or rely on expensive build-and-test cycles. This is exemplified in aerodynamics, where it is more feasible to test models in a wind tunnel than solving the difficult equations involved in simulations. Similarly complex situations are also found in Li-ion batteries and fuel cell simulations.

The opportunity provided by quantum computers to tackle such questions computationally promises a competitive edge for European industry. Moreover, energy-efficient aerodynamics and more durable and affordable batteries are critical to propelling these industries towards zero emissions.

Born in Europe over 100 years ago, quantum physics brought forth a technological revolution, enabling inventions such as semiconductors, lasers, fibre optics, and other technologies that are today ubiquitous in our lives. Now, during the second quantum revolution, Europe can take the lead once more in quantum science and technology.

Quantum computers, the exponents of this second revolution, can perform several operations that are too difficult, or even impossible, for regular processors. And as they approach widespread commercial application, they open up market opportunities in several sectors.

The use of today's quantum hardware, however, requires grappling with the limitations of this nascent technology. These bottlenecks limit the application of quantum computers to solve industrial problems. Therefore, it is important to create strategies and software approaches that maximize the hardware capabilities of available quantum computers from providers such as PASQAL.

[1] EQUALITY stands for Efficient 'QUAntum ALgorithms for IndusTrY'

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Figure 1: EQUALITY first press release.

Table 6: Information on mainstream publication #1.

Mainstream Publication #1	
Vehicle	La Tribune
Type	Online
Date	Nov. 30th, 2022
Title	With Da Vinci Labs, deeptech makes its home in Centre-Val de Loire (Translated from French)
Excerpt	"Da Vinci Labs, which plans to incubate around twenty startups specializing in quantum technology, AI and synthetic biology, has already won four collaborative research projects funded by the European Union. (...) Quantum algorithms developed by the EQUALITY program are simulating replacement materials for rare metals in the batteries of the future." (Translated from French)
Vehicle audience	> 180,000 avg. daily visitors in Nov. 2022*
URL	https://www.latribune.fr/technos-medias/innovation-et-start-up/avec-le-da-vinci-labs-la-deeptech-fait-son-nid-en-centre-val-de-loire-942741.html (Full article under subscription access)

* Source: https://www.acpm.fr/Support-Numerique/site/latribune-fr

Figure 2: Screen capture of mainstream publication #1.

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Table 7: Information on mainstream publication #2.

Mainstream Publication #2	
Vehicle	L'Usine Nouvelle
Type	Online
Date	Mar. 7th, 2023
Title	The European project EQUALITY aims to put quantum algorithms to work for industry (Translated from French)
Excerpt	"Funded to the tune of €6 million by Europe, the Equality project aims to design quantum algorithms to speed up the resolution of problems in aerodynamic simulation, materials modelling and fluid mechanics. The French contributors are Inria, Airbus and Pasqal, which will provide quantum computers to support the development of these algorithms." (Translated from French)
Vehicle audience	> 80,000 avg. daily visitors in Mar. 2023*
URL	https://www.usinenouvelle.com/article/le-projet-europeen-equality-veut-mettre-l-algorithmie-quantique-au-service-de-l-industrie.N2108311 (Full article under subscription access)

* Source: https://www.acpm.fr/Support-Numerique/site/usinenouvelle-com

Figure 3: Screen capture of mainstream publication #2.

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Table 8: Information on mainstream publication #3.

Mainstream Publication #3	
Vehicle	IT Industrie & Technologies, N°1060
Type	Print Magazine
Date	Apr. 1st, 2023
Title	The European project EQUALITY at the service of industry (Translated from French)
Excerpt	"Equality (Efficient quantum algorithms for industry): this is the name of the project selected in February by the European Commission as part of Horizon Europe. Endowed with 6.05 million euros, it will run until the end of 2025. These algorithms will accelerate fluid dynamics equations, fuel cell design and space data analysis." (Translated from French)
Vehicle audience	12,580 avg. print copies*
URL	NA

*Source: https://www.infopro-digital-media.fr/marque/industrie-et-technologie/

ALGORITHMIE QUANTIQUE

Le projet européen Equality au service de l'industrie

Equality (Efficient quantum algorithms for industry, ou algorithmes quantiques efficaces pour l'industrie) : voici le nom du projet sélectionné en février par la Commission européenne, dans le cadre d'Horizon Europe. Doté de 6,05 millions d'euros, il s'achèvera fin 2025. Ces algorithmes accéléreront les équations de la dynamique des fluides, la conception de piles à combustible ou encore l'analyse de données spatiales.

« Equality mobilisera 55 personnes dont 60 % de chercheurs, précise Wael Yahyaoui, le responsable des innovations technologiques de Capgemini Engineering et coordinateur du projet. Les trois partenaires académiques sont l'Inria en France, l'Institut Franhofer Enas en Allemagne [dédié à la nanoélectronique, ndlr] et l'université de Leiden aux Pays-Bas. » Côté institutionnel, l'Agence spatiale allemande (DLR) y participe également. Parmi les partenaires industriels et acteurs privés figurent Airbus, Daimler et le Da Vinci Labs, qui construit un bâtiment de 4 000 m² pour héberger des deeptechs à Reugny, en Touraine. Le français Pasqal, le néerlandais Qu&Co (qui a fusionné avec Pasqal en 2022), le finlandais IQM et l'autrichien AQT fourniront les calculateurs et logiciels quantiques.

Huit cas d'usage seront traités, dont l'optimisation de la planification des missions satellitaires, qui intéresse Airbus. Il est aussi question d'accélérer l'analyse des données spatiales acquises par satellite. La thématique du stockage d'énergie prend en compte l'étude de matériaux composant les batteries et la modélisation de batteries électriques lithium-ion et de piles à combustible. Equality devrait aussi se solder par des jeux d'algorithmes quantiques de base et polyvalents : solveur d'équations différentielles (stochastiques ou non), simulateur de chimie quantique… Le premier point d'étape et la feuille de route technologique sont prévus en avril. **Frédéric Monflier**

Figure 4: Screen capture of mainstream publication #3.

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Table 9: Information on mainstream publication #4.

Mainstream Publication #4	
Vehicle	BFM Business
Type	TV, Radio, Online
Date	Mar. 18th, 2023
Title	AI, quantum and synthetic biology under development at Da Vinci Labs (Translated from French)
Excerpt	"We're now in the second generation of quantum technology. We've already got some very well-developed companies like Pasqal, Qandela, Alice & Bob, who are going to develop the hardware, and on top of that we need to develop the algorithms. Pasqal is part of this EQUALITY consortium with INRIA in France, Capgemini and Airbus in Germany, and the idea is to use these quantum algorithms to simulate complex molecular systems (…), and for that to happen, classical simulations aren't enough, we need to have quantum first." (Xavier Aubry, Da Vinci Labs, Translated from French)
Vehicle audience	> 100,000 avg. daily visitors on the website* > 200,000 avg. daily watchers/listeners on TV/Radio*
URL	[1] https://www.bfmtv.com/economie/replay-emissions/01-business/ia-quantique-et-biologie-synthetique-se-developpent-au-da-vinci-labs-18-03_VN-202303180262.html [2] https://www.bfmtv.com/economie/replay-emissions/01-business/l-integrale-de-tech-co-business-du-samedi-18-mars_EN-202303180432.html

*Source: https://www.alticemedia-adsconnect.fr/nos-marques/bfm-business.html

Figure 5: Screen capture of mainstream publication #4.

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Table 10: Information on mainstream publication #5.

Mainstream Publication #5	
Vehicle	IT for Business
Type	Print/Digital Magazine (N°2283), Online Article
Date	May 1st, 2023 / May 24th, 2023
Title	A consortium to open up industrial opportunities for quantum technology (Translated from French)
Excerpt	"In a forest on the outskirts of Amboise (and near Le Clos Lucé, where Leonardo da Vinci lived), the Da Vinci Labs building will be completed in 2024, and will house the Equality consortium, among several other major public/private research projects. Members include Airbus, Capgemini, Fraunhofer ENAS (Electronic nano systems), German Aerospace Center (DLR), Inria, Leiden University, and French quantum computer manufacturer Pasqal." (Translated from French)
Vehicle audience	13,750 avg. copies, print and digital* >3,000 avg. daily visitors on the website*
URL	https://www.itforbusiness.fr/un-consortium-pour-ouvrir-des-debouches-industriels-au-quantique-62693 (Open Access)

*Source: https://www.itforbusiness.fr/publicite

Figure 6: Screen capture of mainstream publication #5, online version.

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radar r&d

Un consortium pour ouvrir des débouchés industriels au quantique

La start-up Pasqal, cofondée par le prix Nobel de Physique 2022 Alain Aspect, est l'un des fournisseurs d'ordinateurs quantiques du consortium.

Regroupant huit organismes publics et privés, Equality prépare activement les futures applications industrielles de l'informatique quantique. En particulier celles qui vont favoriser la transition verte.

C'est dans une forêt aux alentours d'Amboise (et près du Clos Lucé, où résida Léonard de Vinci) que sera achevée en 2024 la construction du bâtiment du Da Vinci Labs qui va notamment héberger, parmi plusieurs autres projets public/privé de recherche majeurs, le consortium Equality. Parmi ses membres figurent Airbus, Capgemini, Fraunhofer ENAS (Electronic nano systems), German Aerospace Center (DLR), l'Inria, Leiden University, et le constructeur français d'ordinateurs quantiques Pasqal.

Le consortium s'est donné pour objectif de développer des algorithmes quantiques pour des applications industrielles dans plusieurs disciplines, présentant toutes un intérêt pour la protection de l'environnement. Equality vise logiquement celles qui pourraient tirer bénéfice de la vitesse de l'informatique quantique : profilage aérodynamique, conception de batteries, dynamique des fluides, optimisation des missions spatiales, conception de nouveaux matériaux, etc. À l'heure actuelle, pour traiter ces problématiques, les scientifiques doivent simplifier les équations mises en jeu, employer des supercalculateurs ou construire de coûteux simulateurs physiques – par exemple des souffleries de plus en plus sophistiquées dans le domaine de l'aéodynamique.

Equality propose de développer des logiciels quantiques de pointe pour répondre à des problèmes industriels cruciaux, à la fois en termes de performances, mais aussi, et tout simplement si l'on ose dire, pour les résoudre. En effet, certaines équations mathématiques, comme l'équation de Navier-Stokes rencontrée dans la mécanique des fluides, n'ont tout bonnement pas de solutions mathématiquement exactes. Plus précisément, on ignore s'il en existe une et on ne fait qu'approcher des solutions à l'aide d'ordinateurs exigeant beaucoup de puissance. Sur cet exemple comme sur beaucoup d'autres, un ordinateur quantique serait bien plus efficace.

Il faut cependant préciser, comme le fait Xavier Aubry, fondateur et directeur de Da Vinci Labs, que *«le consortium ne cherche pas à produire des programmes quantiques généralistes pour résoudre tous les problèmes. Nous développons plutôt ce qu'il faudrait appeler des primitives quantiques qui seront réutilisables»*. Il cite l'exemple des méthodes de Monte Carlo quantiques – méthodes de simulation probabiliste de l'équation de Schroedinger – , utilisées notamment en physique nucléaire et dans tous les domaines où les spins jouent un rôle déterminant. *«Nos routines seront donc capables d'exploiter différentes techniques suivant le hardware auquel elles sont destinées.»*

Ajoutons que l'ordinateur du futur est toujours en construction. Les chercheurs effectuent donc des simulations de calcul quantique sur des superordinateurs classiques, en faisant appel à 20 ou 30 qbits de puissance dans un premier temps, puis en montant jusqu'à 100 qubits virtuels si les résultats sont satisfaisants. À ce stade des tests, un modèle simulant le bruit quantique spécifique à chaque matériel est intégré au simulateur, avant que l'ensemble ne soit testé sur un véritable ordinateur quantique.

Enfin, rappelons qu'il n'existe à ce jour pas de langage de programmation standard, et encore peu de compétences humaines dans ce domaine encore récent. Les scientifiques choisissent donc les ordinateurs quantiques qui engendrent le moins d'erreurs en fonction des problématiques et des équations qu'ils cherchent à résoudre. Pour l'heure, ceux d'Equality sont fournis par Pasqal (qui exploite notamment l'interaction de van der Waals entre atomes de Rydberg), IQM (supraconducteurs) et DLR (technologie des ions piégés), entre autres. La dotation du programme européen Horizon Europe, à hauteur de 6 M€/an pendant trois ans, est donc bienvenue pour financer ces investissements.

PIERRE BERLEMONT

Figure 7: Screen capture of mainstream publication #5, print version.

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2.4. Scientific publications

Key results produced throughout the project duration are disseminated in the form of article pre-prints, peer-reviewed articles in scholarly journals, articles in conference proceedings, monographs, patents, and research data (data underlying publications, curated data and/or raw data).

Table 11 shows the scientific publication KPIs for the project.

EQUALITY's first publication is available on arXiv. Authored by ULEI's Vedran Dunjko and collaborators, the paper "Reduce-and-chop: Shallow circuits for deeper problems" investigates to what extent it is possible to mimic the performance of a deeper quantum computation by using a shallower device many times. The group proposes a method inspired by the Feynman quantum-circuit simulation approach, where the circuit is cut and measured early on, and other circuits are run based on the outcomes.

Also available on arXiv, EQUALITY's second publication "A hybrid quantum algorithm to detect conical intersections" is authored by partners from Leiden University, PASQAL, and collaborators, and proposes a hybrid quantum classical algorithm to resolve the conical intersections with the help of the Berry phase. Due to its connection to the topology, such an algorithm is much more robust to errors and noise.

Details of both publications are show in Tables 12 and 13. They are also available on EQUALITY's website.

Table 11: Scientific publications timeline and KPIs.

Activity	KPI	Year 1	Year 2	Year 3	Total
Scientific Publications	Number of Publications	2 / 2	- / 5	- / 5	2 / 12
	Total Readership	NA* / -	- / -	- / -	- / 250,000

* ArXiv.org does not provide readership numbers.

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Table 12: Information on scientific publication #1.

Scientific Publication #1	
Lead partner	ULEI: Vedran Dunjko
Type	Preprint
Title	Reduce-and-chop: Shallow circuits for deeper problems
Authors	Adrian Perez-Salinas, Radoica Draskic, Jordi Tura and Vedran Dunjko
Abstract	State-of-the-art quantum computers can only reliably execute circuits with limited qubit numbers and computational depth. This severely reduces the scope of algorithms that can be run. While numerous techniques have been invented to exploit few-qubit devices, corresponding schemes for depth-limited computations are less explored. This work investigates to what extent we can mimic the performance of a deeper quantum computation by repeatedly using a shallower device. We propose a method for this purpose, inspired by Feynman simulation, where a given circuit is chopped in two pieces. The first piece is executed and measured early on, and the second piece is run based on the previous outcome. This method is inefficient if applied in a straightforward manner due to the high number of possible outcomes. To mitigate this issue, we propose a shallow variational circuit, whose purpose is to maintain the complexity of the method within pre-defined tolerable limits, and provide a novel optimisation method to find such circuit. The composition of these components of the methods is called reduce&chop. As we discuss, this approach works for certain cases of interest. We believe this work may stimulate new research towards exploiting the potential of shallow quantum computers.
Journal	-
Volume, page	-
Editor, publisher	-
Publication date	Dec. 22nd, 2022
URL	https://arxiv.org/abs/2212.11862
Identifiers	DOI: 10.48550/arXiv.2212.11862
Open access?	Yes
Additional information	-

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Table 13: Information on scientific publication #2.

Scientific Publication #2	
Lead partner	QC: Stefano Polla
Type	Preprint
Title	A hybrid quantum algorithm to detect conical intersections
Authors	Emiel Koridon, Joana Fraxanet, Alexandre Dauphin, Lucas Visscher, Thomas E. O'Brien, Stefano Polla
Abstract	Conical intersections are topologically protected crossings between the potential energy surfaces of a molecular Hamiltonian, known to play an important role in chemical processes such as photoisomerization and non-radiative relaxation. They are characterized by a non-zero Berry phase, which is a topological invariant defined on a closed path in atomic coordinate space, taking the value π when the path encircles the intersection manifold. In this work, we show that for real molecular Hamiltonians, the Berry phase can be obtained by tracing a local optimum of a variational ansatz along the chosen path and estimating the overlap between the initial and final state with a control-free Hadamard test. Moreover, by discretizing the path into N points, we can use N single Newton-Raphson steps to update our state non-variationally. Finally, since the Berry phase can only take two discrete values (0 or π), our procedure succeeds even for a cumulative error bounded by a constant; this allows us to bound the total sampling cost and to readily verify the success of the procedure. We demonstrate numerically the application of our algorithm on small toy models of the formaldimine molecule ($H_2C{=}NH$).
Journal	-
Volume, page	-
Editor, publisher	-
Publication date	Apr. 12nd, 2023
URL	https://arxiv.org/abs/2304.06070
Identifiers	DOI: 10.48550/arXiv.2304.06070
Open access?	Yes
Additional information	-

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2.5. Communication kit

A communication kit containing several resources are being developed as promotional material for the project, aiming to reach a variety of target audiences with clear and simple language, avoiding technical content as much as possible.

Already developed materials include:

- A poster which can be used by each partner at their own institutions and/or at events to capture the attention of passers-by, shown on Figure 8;
- A slide deck introducing the project to be used by itself or included in more general presentations as needed by the partners, shown on Figure 9;
- A video abstract to promote the project, shown on Figure 10 is in final stages of production and should be released shortly after the submission of this deliverable.

Other videos will be developed later in the project to showcase its results as shown on Table 14. Additional resources may be developed throughout the project as deemed necessary.

Table 14: Communication kit timeline and KPIs.

Activity	KPI	Year 1	Year 2	Year 3	Total
Project Videos	Number of Videos	1 / -	- / -	- / 2	1 / 2
	Total Viewership	- / -	- / -	- / 10,000	- / 10,000

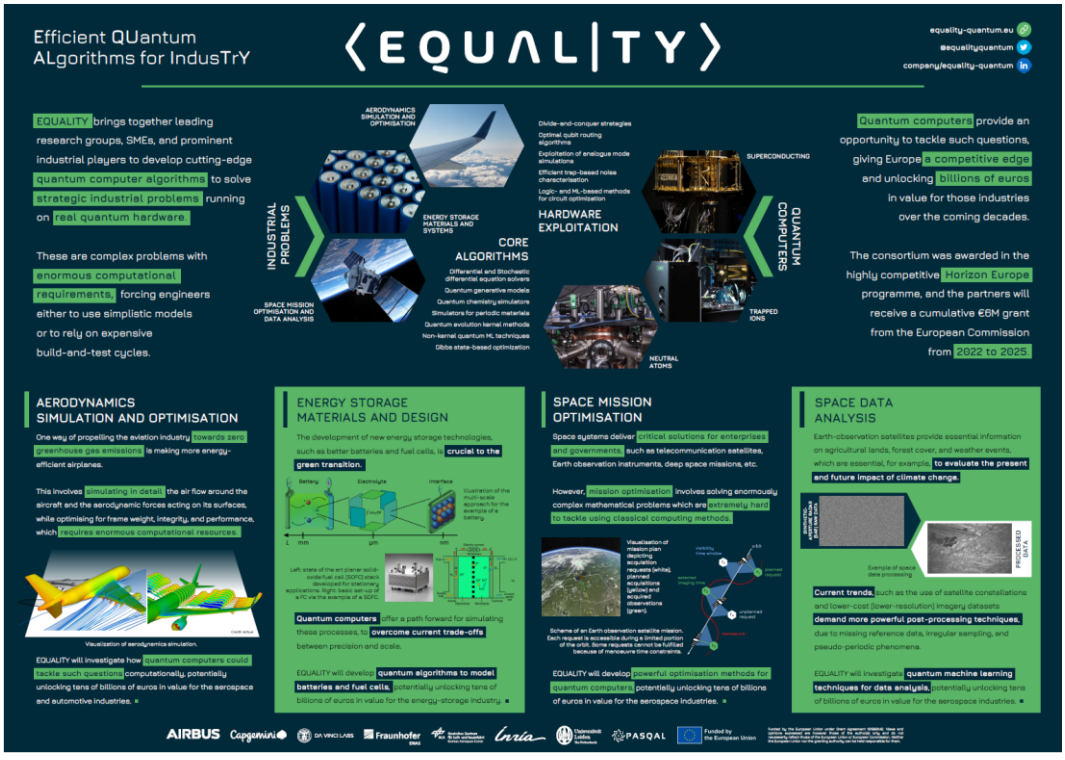

Figure 8: Screen captures of the first project poster.

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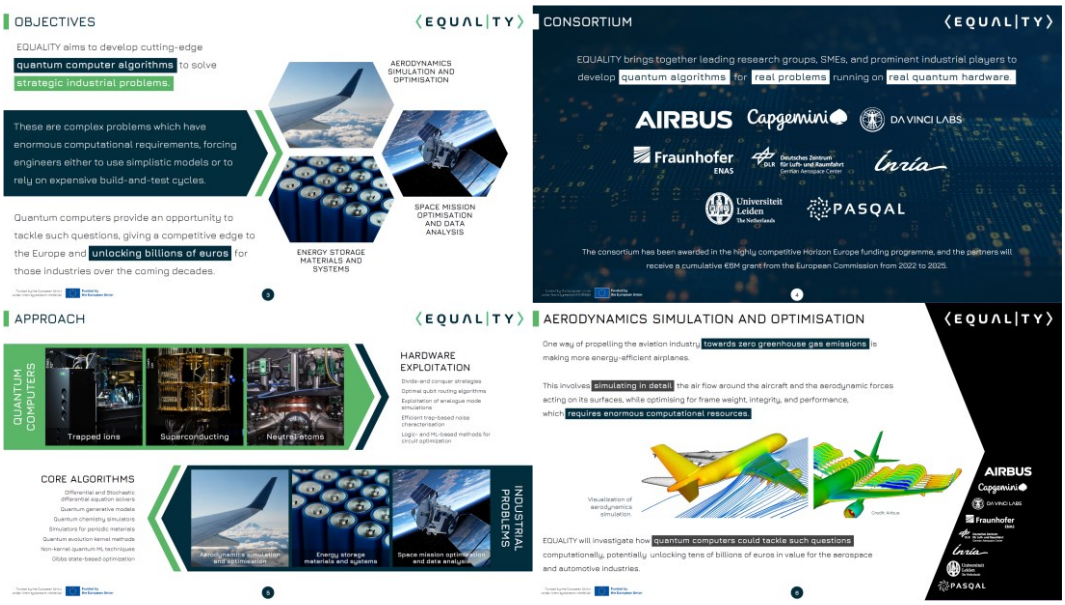

Figure 9: Screen captures of the project's slide deck

Figure 10: Screen captures of the project's video abstract.

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2.6. Event participation and organization

Events, including scientific and industry conferences, trade shows, workshops, and seminars, both virtual and physical, related to the partners' or the project's field of expertise, are prime opportunities to raise awareness around the project, its activities and expected results, and disseminate the relevant developments. Additionally, they provide partners with networking opportunities with researchers and stakeholders and establish and deepen ties with other EU-funded projects and initiatives and other groups in the scientific and industrial community.

Key performance indicators are shown in Table 15.

In 2023, EQUALITY partners have organized and attended several events at the local, national, EU and international levels presented in Tables 16–39 below.

Table 15: Event participation and organisation KPIs.

Activity	KPI	Year 1	Year 2	Year 3	Total
Event Participation	Poster Submissions	3* / 2	- / 4	- / 10	3* / 16
Webinar Organisation	Number of Webinars	-	-	- / 3	- / 3
	Number of Attendees	-	-	- / 240	- / 240

*In addition to 8 oral presentations (invited or contributed) in conferences, and several presentations in internal workshops.

Table 16: Information on event participation #1.

Event #1	
Event	Q2B 2022
Location	Silicon Valley, USA
Date	Dec. 6th – 8th, 2022
Description	Q2B is the premier conference on quantum technologies, defining the roadmap to quantum value. Celebrating its seventh year of bringing the quantum community together to share knowledge, assess technologies, identify business value, and develop essential skill sets.
Website	https://q2b.qcware.com/2022-conferences/silicon-valley/
Event type	Trade Show
Audience size	800+ attendees
Involved partners	AOG: Jasper Krauser
Additional information	Oral Presentation: Quantum Technologies at Airbus – Bringing Aerospace into the Quantum Era (https://www.youtube.com/watch?v=yRDcTO3oMuA)

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Figure 11: Image of event #1.

Table 17: Information on event participation #2.

Event #2	
Event	APS March Meeting
Location	Las Vegas, USA
Date	Mar. 5th – 10th, 2023
Description	The APS March Meeting brings together scientists and students from around the world to connect and collaborate across academia, industry, and major labs. Students, early-career physicists, and experienced professionals will benefit from the networking and learning at March Meeting.
Website	https://march.aps.org/ https://meetings.aps.org/Meeting/MAR23/APS_epitome
Event type	Conference
Audience size	13,000+ attendees
Involved partners	QC: Panagiotis Barkoutsos
Additional information	Oral Presentation: Quantum Scientific Machine Learning for Multiphysics simulations (https://meetings.aps.org/Meeting/MAR23/Session/M64.1).

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Table 18: Information on event participation #3.

Event #3	
Event	ModVal 2023
Location	Duisburg, Germany
Date	Mar. 21st – 23th, 2023
Description	ModVal 2023 is the 19th edition of an annual inter-national symposium on modeling and experimental validation in the field of fuel cells and batteries. The focus of ModVal is on the presentation and discussion of the latest research results, advances in modelling and experimental work on model validation for fuel cells, batteries and electrolysis.
Website	https://zbt.de/modval-2023/
Event type	Symposium
Audience size	200 attendees
Involved partners	ENAS: Andreas Zienert
Additional information	Participation without presentation for attendance and networking.

Table 19: Information on event participation #4.

Event #4	
Event	Quantum World Day
Location	Hamburg, Germany
Date	Apr 13th – 14th, 2023
Description	"For the exchange of information on activities in the Hamburg area DESY, UHH, TUHH, DLR and HQIC are organising jointly the annual World Quantum Day in Hamburg."
Website	https://indico.desy.de/event/38586/
Event type	Conference
Audience size	100+ attendees
Involved partners	CAP: Kirill Shiianov
Additional information	Participation without presentation for attendance and networking. Presentations were focused on the research activities happening in the Hamburg area, while networking activities were focused on different startups and industrial opportunities.

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Table 20: Information on event participation #5.

Event #5	
Event	Congress on Ionic Liquids (COIL-9)
Location	Lyon, France
Date	Apr 24th – 28th, 2023
Description	"COIL-9 showcases the latest, exciting developments in ionic liquids and related fields. COIL expects to gather balanced and diverse contributions from both established and new actors working in fundamental science and applications involving ionic liquids. Because ionic liquids are unique and offer immense possibilities, they gather an interdisciplinary community concerned with materials and processes at the core of a broad range of technologies. COIL aims to gather researchers from all areas where ionic liquids enable discovery and innovation guiding scientists and engineers from theory to reality."
Website	https://www.coil-9.congres-scientifique.com/
Event type	Conference
Audience size	280+ attendees
Involved partners	DLR: Max Schammer
Additional information	Oral Presentation: From bulk thermodynamics to Nano-structuring near electrified interfaces: a continuum transport theory for ionic liquids incorporating solvation effects.

Table 21: Information on event participation #6.

Event #6	
Event	Airbus Digital Innovation Summit
Location	Munich, Germany and Toulouse, France
Date	May 10th – 11th, 2023
Description	Airbus internal gathering to promote Digital Innovation within Airbus community.
Website	NA
Event type	Internal Conference
Audience size	400+ attendees
Involved partners	AOG: Jasper Krauser; CAP: Wael Yahyaoui
Additional information	Presence in Booth with presentation of a EQUALITY poster (See Figure 12).

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Figure 12: Image of event #6.

Table 22: Information on event participation #7.

Event #7	
Event	International Supercomputing Conference
Location	Hamburg, Germany
Date	May 21st – 25th, 2023
Description	The ISC High Performance conference and exhibition is an annual global gathering for HPC technology providers and users. It aims to foster the growth of a thriving community that now includes practitioners of machine learning, data analytics, and quantum computing.
Website	https://www.isc-hpc.com/
Event type	Conference
Audience size	3,000+ attendees
Involved partners	AOG: Gerd Büttner
Additional information	Oral Presentation: Quantum Computing@Airbus, Bring Aerospace into the Quantum Era.

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Table 23: Information on event participation #8.

Event #8	
Event	ENAS Technology Workshop
Location	Leisnig, Germany
Date	Jun. 1st, 2023
Description	NA
Website	NA
Event type	Workshop
Audience size	40+ attendees
Involved partners	ENAS: Andreas Zienert, Jörg Schuster, Xiao Hu
Additional information	Internal workshop, participation as speakers.

Table 24: Information on event participation #9.

Event #9	
Event	EQUALITY Project @Capgemini Webinar
Location	Online
Date	Jun. 1st, 2023
Description	Make sure you join our webinar about the EQUALITY project, in which we are developing cutting-edge quantum computer algorithms and exploring hardware strategies to solve strategic industrial problems. We target eight use cases: airfoil aerodynamics, battery design, fluid dynamics, space mission optimisation, materials design, multidisciplinary optimisation, space data analysis and fuel cell design. EQUALITY is a consortium of industry partners comprising Airbus, Capgemini, Da Vinci Labs, Fraunhofer ENAS, German Aerospace Center, INRIA, Leiden University and PASQAL, selected by the EU's key funding program for research and innovation, Horizon Europe.
Website	NA
Event type	Webinar
Audience size	60+ attendees
Involved partners	AOG: Gerd Büttner; CAP: Wael Yahyaoui; DLR: Birger Horstmann; ULEI: Alfons Laarman; QC: Panagiotis Barkoutsos
Additional information	Partner's internal dissemination of the project.

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Table 25: Information on event participation #10.

Event #10	
Event	France Quantum
Location	Paris, France
Date	Jun. 13th, 2023
Description	France Quantum was launched on November 17, 2021 at Station F when realizing that it's time to create a strong French ecosystem around quantum with the mission to gather and highlight the actors of the quantum sector. The initiative espouses an ecosystem philosophy, with the desire to be as inclusive as possible from Research labs, Startups, and Large corporations or anybody involved in quantum sector : By the ecosystem, For the ecosystem.
Website	https://www.francequantum.fr/
Event type	Conference
Audience size	700+ attendees
Involved partners	CAP: Wael Yahyaoui; DVL: Xavier Aubry, Farhang Hadad Farshi
Additional information	Participation without presentation for attendance and networking.

Table 26: Information on event participation #11.

Event #11	
Event	VivaTech 2023
Location	Paris, France
Date	Jun. 14th – 17th, 2023
Description	Viva Technology, or VivaTech, is an annual technology conference, dedicated to innovation and startups, held in Paris, France. VivaTech was founded in 2016 by Publicis Groupe and Groupe Les Echos. The first two days of VivaTech are for startups, investors, executives, students and academics, and it is open to the general public on the third day.
Website	https://vivatechnology.com/
Event type	Conference
Audience size	150,000+ attendees
Involved partners	CAP: Wael Yahyaoui
Additional information	Participation without presentation for attendance and networking.

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Table 27: Information on event participation #12.

Event #12	
Event	EQUALITY Project - ALGO @Capgemini Webinar
Location	Online
Date	Jun. 15th, 2023
Description	Make sure you join our webinar about the EQUALITY project, in which we are developing cutting-edge quantum computer algorithms and exploring hardware strategies to solve strategic industrial problems. This session will be dedicated to the quantum algorithms developed within the project
Website	NA
Event type	Webinar
Audience size	45 attendees
Involved partners	CAP: Kirill Shiianov, Wael Yahyaoui; QC: Lorenzo Cardarelli, Panagiotis Barkoutsos
Additional information	Partner's internal dissemination of the project.

Table 28: Information on event participation #13.

Event #13	
Event	EQUALITY Project @Capgemini ba.Connect event
Location	Online
Date	Jun 16th, 2023
Description	ba.Connect is a unique global online learning experience brought to you by the Business Analysis Community and Capgemini University: designed to help you develop the right skills to get the future you want. This will be a unique opportunity to connect with peers from our community, get inspired, and learn how you can develop. Whether you are new to our community or an experienced Business Analyst, there is something for everyone and we want you to feel welcome. This conference gives each participant an opportunity to create their own personalized schedule, blending cross-disciplined and community specific content.
Website	https://www.airmeet.com/e/ce611c90-f56b-11ed-8566-afb66ebaf6f5
Event type	Webinar
Audience size	1,400 attendees
Involved partners	CAP: Andreas Kötter, Wael Yahyaoui, Kirill Shiianov
Additional information	Panel Presentation: Quantum from 0 to 1, and what's in between.

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Table 29: Information on event participation #14.

Event #14	
Event	EQUALITY Project - HARD @Capgemini Webinar
Location	Online
Date	Jun. 20th, 2023
Description	This session will be dedicated to the techniques of efficient utilisation of quantum hardware, developed within the EQUALITY project by University of Leiden and partners. Quantum Computers of nowadays are not sufficiently large and prone to errors (which is referred to as Near-term Intermediate Scale Quantum devices, or NISQ), so to achieve any practical benefits using them in the near-term perspective, various approaches to efficient hardware utilisation are being developed.
Website	NA
Event type	Webinar
Audience size	45 attendees
Involved partners	CAP: Franziska Wolff, Kirill Shiianov; ULEI: Alfons Laarman; QC: Alexander Dauphin
Additional information	Partner's internal dissemination of the project.

Table 30: Information on event participation #15.

Event #15	
Event	EQUALITY Project - ENERGY @Capgemini Webinar
Location	Online
Date	Jun. 29th, 2023
Description	Make sure you join our webinar about the EQUALITY project, in which we are developing cutting-edge quantum computer algorithms and exploring hardware strategies to solve strategic industrial problems. Following the previous webinar, this session will be dedicated to strategic industrial problems in the energy storage domain.
Website	NA
Event type	Webinar
Audience size	30 attendees
Involved partners	CAP: Wael Yahyaoui, Franziska Wolff; DLR: Birger Horstmann, Max Schammer
Additional information	Partner's internal dissemination of the project.

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Table 31: Information on event participation #16.

Event #16	
Event	EQUALITY Project @Airbus Webinar iTalk
Location	Online
Date	Jun. 29th, 2023
Description	Make sure you join our webinar about the EQUALITY project, in which we are developing cutting-edge quantum computer algorithms and exploring hardware strategies to solve strategic industrial problems. We target eight use cases: airfoil aerodynamics, battery design, fluid dynamics, space mission optimisation, materials design, multidisciplinary optimisation, space data analysis and fuel cell design. EQUALITY is a consortium of industry partners comprising Airbus, Capgemini, Da Vinci Labs, Fraunhofer ENAS, German Aerospace Center, INRIA, Leiden University and PASQAL, selected by the EU's key funding program for research and innovation, Horizon Europe.
Website	NA
Event type	Webinar
Audience size	100+ attendees
Involved partners	AOG: Gerd Büttner; CAP: Wael Yahyaoui; DLR: Max Schammer; ULEI: Alfons Laarman; QC: Panagiotis Barkoutsos
Additional information	Partner's internal dissemination of the project.

Figure 13: Image of event #16.

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Table 32: Information on event participation #17.

Event #17	
Event	Chiral Matter: from quarks to quantum computers
Location	Tours, France
Date	Jul. 5th – 7th, 2023
Description	Chirality plays a key role in modern science and technology, from particle physics to pharmacology. With the recent advent of quantum computing, the studies of real-time quantum phenomena in chiral matter have become accessible. In this context, the conference aims to bring together scientists interested in various aspects of chiral matter and in applications of quantum computing to the description of real-time phenomena.
Website	https://www.lestudium-ias.com/events/chiral-matter-quarks-quantum-computers
Event type	Conference
Audience size	30 attendees
Involved partners	DVL: Xavier Aubry [1], Renan Picoreti, Farhang Hadad
Additional information	[1] Oral Presentation: EQUALITY: Efficient Quantum Algorithms for Industry.

Figure 14: Image of event #17.

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Table 33: Information on event participation #18.

Event #18	
Event	International Conference on Statistical Physics
Location	Chania, Greece
Date	Jul. 10th – 14th, 2023
Description	The conference is organized in the following three areas to cover all the topics of statistical physics: foundations and theoretical aspects of classical, quantum and relativistic statistical physics and thermodynamics, applications to physical systems, and applications to non-physical systems.
Website	http://www.sigmaphi.polito.it/
Event type	Conference
Audience size	500 attendees
Involved partners	QC: Panagiotis Barkoutsos
Additional information	Invited oral presentation: Quantum Scientific Machine Learning for Multiphysics simulations.

Table 34: Information on event participation #19.

Event #19	
Event	EQUALITY Project - Market analysis @Capgemini Webinar
Location	Online
Date	Jul. 12th, 2023
Description	This session aims to present Quantum Solutions' potential in the real business context and explore how to commercialise such deep technologies correctly. For that, we studied the potential outcomes of the EQUALITY project from the business perspective.
Website	NA
Event type	Webinar
Audience size	38 attendees
Involved partners	CAP: Wael Yahyaoui, Franziska Wolff, Kirill Shiianov
Additional information	Partner's internal dissemination of the project.

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Table 35: Information on event participation #20.

Event #20	
Event	QPL 2023
Location	Paris, France
Date	Jul. 17th – 21th, 2023
Description	Quantum Physics and Logic is an annual conference that brings together academic and industry researchers working on mathematical foundations of quantum computation, quantum physics, and related areas. The main focus is on the use of algebraic and categorical structures, formal languages, type systems, semantic methods, as well as other mathematical and computer scientific techniques applicable to the study of physical systems, physical processes, and their composition. Work applying quantum-inspired techniques and structures to other fields (such as linguistics, artificial intelligence, and causality) is also welcome.
Website	https://qpl2023.github.io/
Event type	Conference
Audience size	220+ attendees
Involved partners	ULEI: Alejandro Villoria, Alfons Laarman
Additional information	Poster presentation**:** A graphical notation of convex sums of unitaries for the ZX-calculus.

Table 36: Information on event participation #21.

Event #21	
Event	Workshop Frontiers of near-term quantum computing
Location	Gothenburg, Sweden
Date	Aug. 29th – Sep. 1st, 2023
Description	The workshop aims to bring together researchers from the fields of computer science, quantum information and chemistry to discuss theoretical and computational aspects of near-term quantum computing, the capabilities and limitations of current approaches, and strategies towards utilizing near-term hardware for solving practical problems.
Website	https://www.chalmers.se/en/conference/frontiers-of-near-term-quantum-computing/
Event type	Workshop
Audience size	60+ attendees
Involved partners	QC: Panagiotis Barkoutsos
Additional information	Invited oral presentation: Quantum Scientific Machine Learning as pathway towards practical quantum advantage.

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Table 37: Information on event participation #22.

Event #22	
Event	EASN International Conference
Location	Salerno, Italy
Date	Sep. 5th – 8th, 2023
Description	13th EASN International Conference will include several Plenary Talks by distinguished personalities of the European Aviation and Space sectors from the academia, industry, research community, and policymakers. The event will also give the opportunity to scientists and researchers from all over the world to present their recent achievements in a series of thematic sessions, organized by internationally recognized scientists.
Website	https://easnconference.eu
Event type	Conference
Audience size	470+ attendees
Involved partners	AOG: Gerd Büttner [1]; CAP: Andreas Kötter
Additional information	[1] Oral Presentation: Quantum@Airbus: Bring Aerospace into the Quantum Era.

Table 38: Information on event participation #23.

Event #23	
Event	Workshop & Autumn School: Quantum Computing and Simulations for Energy Materials
Location	Jülich, Germany
Date	Sep. 25th – 29th, 2023
Description	Emerging computational infrastructures of the future, such as quantum computing, will play a pivotal role in the research on materials for the energy transition. Quantum computing is specifically suited for the computational modelling of materials and chemical processes at an accurate quantum-mechanical level. This event will gather present and future pioneers of the application of quantum computing to the research on materials and chemistry for the energy transition.
Website	https://www.fz-juelich.de/en/jsa/events/workshop-autumn-school
Event type	Workshop / School
Audience size	30 attendees
Involved partners	AOG: Jasper Krauser; DLR: Birger Horstmann [1]; QC: Panagiotis Barkoutsos
Additional information	[1] Oral Presentation: Quantum Computing at Airbus – The Quantum Quest Towards Low-Carbon Aviation.

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Table 39: Information on event participation #24.

Event #24	
Event	European Quantum Technologies Conference
Location	Hannover, Germany
Date	Oct. 16th – 20th, 2023
Description	Every two years, the Quantum Flagship gathers the major European research and innovation networks at the European Quantum Technology Conference (EQTC). As the largest quantum event of its kind, we celebrate breakthroughs, highlight the pioneering work of European organisations and connect the dots within the community.
Website	https://eqtc2023.qvls.de
Event type	Conference
Audience size	700+ attendees
Involved partners	CAP: Andreas Kötter, Pablo-David Rojas
Additional information	[1] Poster presentation: EQUALITY - Efficient 'QUAntum ALgorithms for IndusTrY.

2.7. Networking

EQUALITY takes advantage of synergies and build networks with relevant stakeholders, local, national, European, and international communities, associations, initiatives, and projects to ensure the impact of the project's results and to ensure the adoption of the project's outputs.

Table 40: Information on networking activity #1.

Networking Activity #1	
Title	**Stablishing Unitary Fund activities in Europe**
Date	May 2nd, 2023
Description	Unitary Fund will open its first European office in Tours, France. Project partner DVL acted as an incubator for Unitary Fund's European operations, providing incorporation and fundraising advisory services. The non-profit's mission is to foster the quantum ecosystem with a microgrant program funding explorers worldwide to work on quantum projects like open-source quantum software, educational materials and workshops, a new quantum sensor prototype, and more.
Involved partners	DVL: Xavier Aubry
Additional information	Website: https://unitary.fund/ Press Release: https://unitary.fund/posts/2023_eu/

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