

Communication, dissemination and exploitation plan (update)

D7.3

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Modification Control

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List of Acronyms

Acronym	Full name
CA	Consortium Agreement
CDE Plan	Communication Dissemination and Exploitation Plan
CTR	Click Through Rate
EIC	European Innovation Council
ERN	European Researchers' Night
GaP	Gallium Phosphide
GKP qubit	Gottesman-Kitaev-Preskill quantum bit
IPR	Intellectual Property Rights
KPI	Key Performance Indicator
LiDAR	Light Detection and Ranging
LNOI	Lithium Niobate On Insulator
MEMS	Micro Electro-Mechanical Systems
NMI	National Metrology Institute
OMO	Optomechanical Oscillator
OMT	Opto Mechanical Thermometer
OPM	Optically Pumped Magnetometer
PhC	Photonic Crystal
PIC	Photonic Integrated Circuit
PICSq	Photonic Integrated Circuit Squeezer
PPLN	Periodically-Poled Lithium Niobate
RTO	Research Technology Organization
SiN	Silicon Nitride
SME	Small-Medium Enterprise
SWaP	Size Weight and Power consumption
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TFLN	Thin-Film Lithium Niobate
TPOC	Two-Photon Optical Clock
TRL	Technology Readiness Level
VC	Venture Capital

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1.Introduction

1.1 Purpose of this document

QUANTIFY provided a Communication, dissemination and exploitation Plan ([D7.1 M06](#)) to effectively manage, measure and maximize impact of its results. The document describes the approaches and strategies to communication, dissemination and subsequent exploitation of the results. The communication and the dissemination part will describe how the Consortium is going to target different audiences to promote project and its results, from academic groups to industry and wider general audience through well-planned and ad-hoc actions that will be checked, reviewed and implemented to maximize results. The exploitation plan will describe the strategies and steps to create technological deployment of the results, e.g. via the potential founding of start-ups/spin off and/or the interaction and involvement with the industrial sector.

In details, according to the [European Commission](#) [1]:

- **Communication** means to inform, promote and communicate your action, your activities and results through a multitude of audiences, including the media and the public, and possibly engaging in a two-way exchange. The aim of the Communication is engaging stakeholders, attract the best experts to your team, generate market demand, raise awareness of how public money is spent, and show the success of European collaboration. To do this you should have a well-designed strategy, conveying clear messages and using the right media channels.
- **Dissemination** means to make your knowledge and results public (free of charge) for others to use. The Dissemination aims is to maximize impact results, allow other researchers to go a step forward, contribute to advancement of the state of the art, make scientific results a common good. It makes research results known to various stakeholder groups (like research peers, industry and other commercial actors, professional organizations, policymakers) in a targeted way, to enable them to use the results in their own work. To do this you should publish your results on: scientific magazines, scientific and/or targeted conferences and databases.
- **Exploitation** means to make concrete use of results, during and after the project's implementation, for commercial purposes but also for improving policies, and for tackling economic and societal problems. The aim of the exploitation is leading to new legislation or recommendations, find a benefit of innovation, the economy and the society, help to tackle a problem and respond to an existing demand. To do this you should create roadmaps, prototypes, softwares, share knowledge, skills, and data.

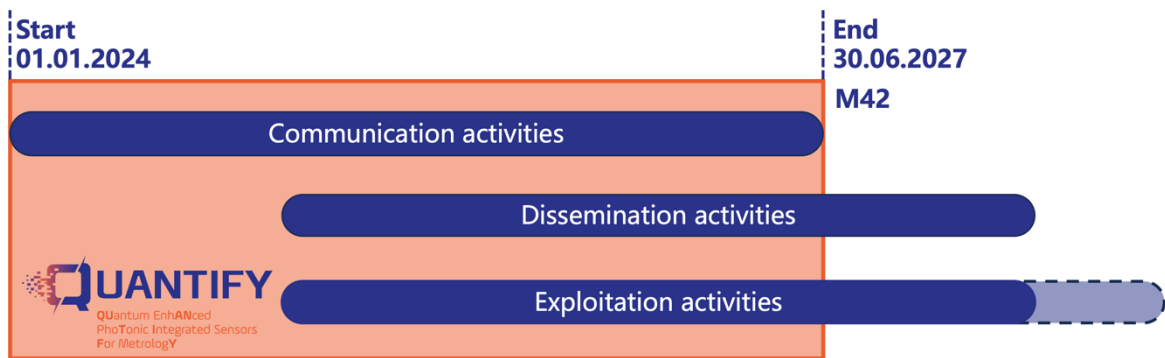


Figure 1 – Development of the Communication, Dissemination, and Exploitation activities

Figure 1 shows when the communication, dissemination, and exploitation actions should be implemented: communication activities start and end with the project; dissemination begins as soon as the results are available; and exploitation starts towards the end and continues beyond, once there are exploitable results.

The coordinator and the Executive Board have the responsibility to assess and review the Plan during the lifespan of the project (D7.3 M24, D7.5 M41) according to the results and their strategic impact.

This document represents the first update to the Consortium CDE Plan, the deliverable D7.3 M24. Indeed, in the next sections communication, dissemination and exploitation strategies will be discussed and updated. In addition, the strategies implemented in the first two years of the project will be reported.

1.2 General Project Information

Table 1 - Project details

QUANTIFY: Quantum enhANced phoTonic Integrated sensors For metrologY	
CALL/TOPIC:	Digital and emerging technologies for competitiveness and fit for the Green Deal (HORIZON-CL4-2023-DIGITAL-EMERGING-01)
GA NUMBER:	101135931
DURATION:	42 MONTHS (01 JANUARY 2024 – 30 JUNE 2027)
EU CONTRIBUTION:	3,6 M€
TOTAL BUDGET:	4,6 M€
PROJECT WEBSITE:	quantify-project.eu
CONSORTIUM:	15 PARTNERS (7 EU COUNTRIES)
PROJECT COORDINATOR:	Giulia Aprile (INRiM, IT)

Table 2 - QUANTIFY Consortium

N.	Partner name	Partner short name	Country
1	Istituto Nazionale di Ricerca Metrologica	INRiM	Italy
2	Centre National de la Recherche Scientifique	CNRS	France
2.1	Université Paris Cité	UPCité	France
3	Conservatoire National des Arts et Metiers	CNAM	France
3.1	Laboratoire National de Metrologie et d'Essais	LNE	France
4	Fundacio Institut de Ciencies Fotoniques	ICFO-CREA	Spain
5	Universiteit Gent	UGent	Belgium
6	Lionix International BV	Lionix INT. BV	Netherlands
7	QuiX QUANTUM BV	QUIX QUANTUM BV	Netherlands
7.1	QuiX QUANTUM GmbH	QUIX QUANTUM GMBH	Germany
8	Thales	THALES	France
9	Universitaet Hamburg	UHAM	Germany
10	Sorbonne Universite	SU	France
11	Centre Suisse d'Electronique et de Microtechnique SA – Recherche et Developpement (Associated partner)	CSEM	Switzerland
12	Insitut Za Fiziku	IoPZg	Croatia

1.3 Main objectives

Quantum-enhanced sensors and integrated key building blocks developed thanks to QUANTIFY know-how and abilities will revolutionize the way we measure physical quantities. For this reason, each block has an individual path to maximize the impact and deserves to this end an effective exploitation plan with an adequate dissemination-communication strategy and intellectual property protection.

As stated in the project proposal, the objectives of the WP7 Dissemination, exploitation, and impact are to:

- O7.1 - Develop a communication, dissemination and exploitation successful strategy;
- O7.2 - Develop its researched technology concepts;
- O7.3 - Realized hardware towards commercial applications and devices.

To fulfill the first objective, the Consortium ensures a coordinated and continued communication, generating high-quality content ensure appropriate visibility to the project through all the stakeholders; defines the key audiences, strategies to maximise the impact of the project results and deliverables, the channels, and feasible KPIs; establishes the tools for an efficient tracking of the project's dissemination results and its subsequent assets against the target stakeholder groups; supports and facilitates the organization of workshops, events and training that maximize the impact and exploitation opportunities of the project; establishes long-lasting relationships and impacts that will span beyond the lifetime of the project.

To fulfill the objective "O7.2 - Develop its researched technology concepts" the Consortium is considering specific strategies. For the Communication activities we identify Stakeholders, define and segment the target audience, including researchers, industry partners, policymakers, and the general public. We are developing clear, concise messages that explain the technology concepts, their significance, and potential impact. We are utilizing various communication channels such as project websites, social media, press releases, and blogs. Different tools to engage different audiences. We are participating in and organizing events, workshops, and conferences to present our goals, our activities, our results and gather feedback.

The dissemination activities include: i) publishing research findings in high-impact scientific journals, conference proceedings, and industry magazines; ii) ensuring that publications are accessible to a wider audience through **open access** platforms, helping to engage a broader audience; iii) using

online repositories and databases to share research data, software, and tools developed during the project; iv) actively collaborating with Partners.

The exploitation activities include: i) identifying and protecting intellectual property (IP) through patents copyrights, and trademarks. Developing an IP strategy to manage and commercialize the results; ii) conducting market analysis to identify potential market needs; iii) developing business models and commercialization strategies to bring the results to market. This could include licensing agreements, spin-offs, or partnerships with existing companies; iv) implementing pilot projects or proof-of-concept demonstrations to validate the technology concepts in real-world settings; v) seek funding and investment opportunities from venture capital, grants, and other financial sources to support further development and commercialization.

All the previous activities need to be regularly monitored in progress, adjusting plan as needed. To maximize results of our exploitation strategy it will be fundamental receive feedback from stakeholder and incorporate them into the development process. The development of a sustainability plan could be necessary to ensure the long-term impact and continuation of the project beyond its initial funding period.

By strategically combining communication, dissemination, and exploitation activities, we can effectively share, and bring to the market the developed technologies, ensuring they reach their full potential and make a meaningful impact.

Within the Chapters 2, 3 and 4 the Communication, Dissemination and Exploitation strategies for the QUANTIFY project will be detailed, updated respect to the first version, together with a monitoring system based on effectively Key Performance Indicators, which will accompany the project throughout its duration, providing important feedback on the actions taken and allowing for adjustments along the way.

1.4 Specific target groups

In this sub-chapter, the specific groups targeted by the project are listed, towards which it plans to direct communication and dissemination actions, and with which it expects to have an impact.

The following groups will be targeted via specifically tailored communication and dissemination materials and strategies. The objective is to cover the full exascale ecosystem and showcase the power of QUANTIFY beyond its usual public and by reaching out to new population segments.

- Project Partners (internal communication). Internal communication among partners is crucial for the correct advancement of the project and the achievement of its goals, and QUANTIFY has implemented a strong internal communication strategy that facilitates scientific collaboration, information flow among partners, reporting, and coordination.
- Researchers. The research community beyond the project partners is a key target audience. High-profile events and contents will be delivered for the communities of researchers that will use QUANTIFY results in the materials science domain.
- European companies and SMEs. To reach their full potential for impact, the QUANTIFY results must make their way towards industrial applications. Potential industrial users of the lighthouse codes are therefore a key target community for our communication and dissemination activities, and a crucial potential actor for exploitation of QUANTIFY results.
- Policy makers. QUANTIFY will develop contents and activities oriented to inform and support decision making by the competent stakeholders in the rapidly evolving European quantum sensors landscape. Such materials will be produced through two different approaches: (i) The curation of articles and events specifically designed for policy makers, and (ii) the design of open-science events based on the RRI principles that allow the co-creation of documents reflecting the interests, concerns and opportunities defined by different stakeholders.
- European citizens/Civil Society and General public. The new edition of QUANTIFY will multiply its efforts to reach out to European citizens through engaging outreach events and contents. ERN and other local events will be populated with QUANTIFY experts and outreach materials. Such actions will pursue a favorable opinion towards European investments and capabilities in frontier computing and codes and contribute to attracting new talent to computing-related disciplines. To do so, one of the innovative approaches embraced by QUANTIFY is the development of specific content to be used by the educational community in the classroom, mainly in secondary school.
- Academic community. The scientific results of the project will target the communities of researchers and scientists operating in the fields of quantum devices, optics, time and

frequency. The researchers are committed in terms of knowledge exchange, co-authored publications in scientific journals and conference proceedings, collateral research spin-off, people engagement and training, writing proposals for funds raising. Other scholars and research organizations in the field are being encouraged to exchange approaches and expertise in order to create new collaborations and go beyond the QUANTIFY project's aims. Master's and PhD students, as well as young researchers, are being targeted to boost the development of high- skilled professional profiles.

- End-users.
- Metrological Community/NMIs. Their expertise and deep specialization in precision measurements ensures that the project benefits from cutting-edge knowledge and practices in metrology. In addition, they can provide essential services for calibrating and validating the performance of quantum sensors, ensuring their accuracy and reliability; they can guide the Consortium meet all necessary regulatory and compliance standards, facilitating smoother market entry. Lastly, NMIs have extensive networks within the scientific, industrial, and governmental sectors. Their involvement can facilitate collaborations, increase the project's visibility, and enhance the dissemination of results to the other relevant stakeholders.
- Other EU projects/initiatives. The QUANTIFY project will benefit from the interaction with other European projects that are investigating novel design/manufacturing strategies for structural components to reduce the overall footprint of the production process. In particular, the consortium identified three EU projects, e.g., PATTERN, LOLIPOP, and CLUSTEC, that treat similar topics. During the QUANTIFY project lifetime, roundtables, seminars, and symposiums will be organized among the partners of the mentioned projects.

1.5 Available channels

QUANTIFY project uses various channels to effectively reach out to different audiences, including a revamped project website, social media platforms with video content, webinars, media relations, conferences, flyers, and outreach events. These channels are used to showcase project developments, promote events and results, and share technical information. QUANTIFY will also create educational content to be used in high school classrooms or during dissemination to the general public.

The main channels created by the project to effectively reach out different audiences include:

- Project website – quantify-project.eu.
- Project Repository – Teams Channel;
- Public trusted repository – [Community within Zenodo](#);
- Social Networks – [LinkedIn](#), [Facebook](#), [YouTube](#), [Instagram](#)*;
- Webinars, seminars;
- Training events;
- Outreach events and activities.

The main scientific conferences and industry forums the Consortium is interested in attending are listed within the Chapter 3 - Dissemination Plan.

**INRiM's network of social channels (LinkedIn, Facebook, YouTube, Instagram) are exploited to maximize the dissemination of the project results.*

1.6 Messages to be transferred

In this subchapter, the key messages that the Consortium plans to convey throughout the lifespan of the project are listed below.

Innovation and Impact: "Our project aims to pioneer cutting-edge research and innovative solutions that address critical challenges in new-gen quantum sensors" // "The outcomes of our project are expected to significantly impact sensors on-a-chip, driving advancements and fostering sustainable growth."

Collaboration and Partnerships: "We bring together a Consortium of leading experts and organizations from across Europe to collaborate on groundbreaking research and development." // "Our project fosters strong partnerships with academia, industry, and policymakers to ensure comprehensive and impactful results."

Scientific Excellence: "Our research is grounded in scientific excellence, leveraging the latest methodologies and technologies to achieve high-quality outcomes." // "We are committed to advancing the frontiers of knowledge through rigorous research and innovative approaches."

Societal Benefits: "The project is dedicated to delivering tangible benefits to society, including improved healthcare, and enhanced technological capabilities." // "Our work aims to address pressing societal issues and contribute to the well-being and prosperity of European citizens."

Transparency and Accessibility: "We prioritize transparency in our research process, making our findings and methodologies accessible to the public and stakeholders." // "Our project is committed to open science practices, ensuring that our results are widely disseminated and available for further use and development."

Economic Growth and Job Creation: "By fostering innovation and technological advancement, our project aims to stimulate economic growth within Europe." // "We are focused on translating our research into practical applications that can drive economic development and competitiveness."

Education and Training: "We are committed to enhancing education and training opportunities, equipping the next generation of researchers and professionals with the skills and knowledge they need to excel." // "Our project includes initiatives to support educational outreach and capacity-building activities across Europe."

Prospects: "The innovations and findings from our project will lay out the groundwork for future research and development, opening new avenues for exploration and application." // "We envision a future where our research contributes to a more innovative, inclusive, and sustainable Europe."

These key messages, in the first two years of the project, have been tailored according to the target audience and the objective set out in the sections dedicated to Communication, Dissemination, and Exploitation.

2. Communication Plan

QUANTIFY is making continuous efforts for the communication in terms of Consortium presentation, project progresses, results and impacts in favor of the identified target groups. This communication activities are monitoring with clear KPIs with the aim of taking actions to achieve the expected results more efficiently and effectively. The QUANTIFY Communication tool, objectives, target, and messages are reported in the Table 3 below. These elements represent the backbone of the QUANTIFY Communication strategy, which is reported within the subchapter 2.1.

Table 3 - Communication strategy: objectives, targets, messages, and tools

Objectives
<p>This communication plan was created to respond the three needs:</p> <ul style="list-style-type: none"> • give visibility and raise awareness about the project; • communicate the project steps and results; • evaluate the impact of the project results.
Target
<p>The target addressed by the following communication plan are: the Scientific Communities; the companies interested in increasing the TRL of the miniaturized sensors; the policymakers; the schools and universities; the generic public.</p>
Messages
<p>The specific messages are:</p> <ul style="list-style-type: none"> • QUANTIFY project kick-off; • How the project results will impact daily life; • The project includes actions to involve students; • Scientific research is exciting and yields useful results; • Result of student involvement actions; • Concrete impact of the results.
Communication tools required
<p>The communication strategy is made up of actions with the aim of informing and promoting the QUANTIFY project. The actions are implemented through specific communication tools: Project website, Social media channels (YouTube, LinkedIn, Facebook), Press releases, Workshops and talks at International Conferences, Trainings and project with schools and Academia, the Communication Pack (D7.2, downloadable on QUANTIFY website or on ZENODO) [2] supports (roll-ups, technical sheet, flyers, videos, merchandising, notes, etc...).</p>

Planned communication activities

Preliminary actions were necessary to implement the activities listed in the previous table: develop the visual and the brand identity, provide guidelines for supporting communication tasks, have a project website. These actions were completed, and they are described within the Communication Pack [2] of QUANTIFY (downloadable on QUANTIFY [website](#) or on [ZENODO](#)). As mentioned above, to maximize the dissemination and reach a higher number of people INRiM's network of social channels of YouTube, LinkedIn, Facebook and Instagram are exploited. Indeed, INRiM's social media channels have a steadily growing number of followers. For this reason, it seemed like a winning choice to support QUANTIFY's communication plan through these channels.

In the Table 4 below, for each objective the target audiences are identified. For each target audience the objective is targeted in different messages. Each message has different channels, related activities, KPIs and a planned target.

The Communication Plan is constantly monitored and here updated by M24 (December 2025). In Annex 1 of this Plan, the posts and the KPI values up to M24 are reported.

Table 4 - Communication Plan - Planned activities and relevant KPIs

OC1. Give visibility and publicize the project				
Target audience: Scientific communities, European companies and SMEs and Policy makers				
Message	Channel	Activities	KPIs	Target
Starting the QUANTIFY project/Project Kick-Off	QUANTIFY website	Information about the project	N. of visitors; Stay-on-page time; Project updates;	100/year 60 s 2/month
	Press	Press release	N. press release	1/year
	International and European Scientific Conference	Talks	N. talks	3/year
	LinkedIn, Facebook, Instagram	Post with video interviews;	Engagement rate* CTR ****	≥ 3% ≥ 1%
	YouTube	Video interviews	Views and watch time**	≥ 100 - ≥ 1.2
Target audience: Policy makers				
Starting the QUANTIFY project/Project Kick-Off	Press release	Press release	N. press release	1/year
How the project results will impact Society daily life				

The project will enable actions for student involvement				
Target audience: Schools				
Scientific research is exciting and yields useful results	LinkedIn e Instagram	Research outreach meetings for high schools	Engagement rate* CTR ****	≥ 3% ≥ 1%
	QUANTIFY website		N. of visitors; Stay-on-page time;	100/year 60 s
	Call for interest		N. of schools involved	≥ 1
Target audience: Universities				
Scientific research is exciting and yields useful results	QUANTIFY website	Workshops Lectures	N. of visitors; Stay-on-page time;	100/year 60 s
	Communication activities		N. workshops/lectures	3/year
	LinkedIn e Instagram		Engagement rate* CTR ****	≥ 3% ≥ 1%
Target audience: The generic public				
Starting the QUANTIFY project/Project Kick-Off	Instagram – Reel Facebook – Reel	Dissemination reels	Views and interactions***	≥ 100 - ≥ 100
How the project results will impact on Society	YouTube – Reel			
OC.2 Disseminate the project's results				
Target audience: Scientific communities, European companies and SMEs				
Project's outcomes	QUANTIFY website	Papers description	N. of visitors; Stay-on-page time;	100/year 60 s
	Press	Press release	N. press release	1/year
	Scientific papers	Papers	N. scientific papers	5/year
	International and European Scientific Conference	Talks	N. talks	3/year
	LinkedIn	Posts and video interviews;	Engagement rate* CTR****	≥ 3% ≥ 1%
	YouTube	Video interviews	Views and watch time**	≥ 100 - ≥ 1.2
OC.3 Impact of project results				
Target audience: Policy makers				
Concrete impact of the project results	Press release	Press release	N. press release	2
Result of student involvement actions				
Target audience: The generic public				

Concrete impact of the project results	Facebook, Instagram	Posts	Engagement rate* CTR ****	≥ 3% ≥ 1%
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* Engagement rate = $(n. \text{ likes} + n. \text{ sharing} + n. \text{ comments} / n. \text{ followers}) * 100$

** View and watch time = n. of times a user stays on the social profile viewing >50% of the content and the total viewing time (recorded when the user plays the video for >2 seconds) for the single video in relation to the previously uploaded videos.

*** Views and interaction = n. of times a user stays on the social profile page viewing at least 50% of the content and n. of time a user interacts with the post.

**** CTR, or Click-Through Rate, measures the ratio of users who click on a specific link to the number of total users who view the ad or post (impressions). The formula is: $(\text{total clicks} / \text{total impressions}) * 100$.

3. Dissemination plan

The QUANTIFY Dissemination Plan is addressed to four main target groups:

- European companies and SMEs;
- Technical, scientific and academic community;
- National Metrology Institutes;
- Policy makers.

The reasons for choosing these relevant targets are listed within the [D7.1 page 18](#). For each of them the relevance, the expectation, the entry point, and the control KPIs are reported.

By targeting these groups, the dissemination activities of QUANTIFY can ensure that the benefits of the research are maximized, leading to technological advancements, economic growth, and societal benefits. In the Table 5 below the dissemination activities, which have started to cover the project results, are listed. According to the results, with the aim to enabling the take-up and use of results, other audiences could be further individuated.

The Dissemination Plan is constantly monitored and here updated by M24 (December 2025). In Annex 2 of this Plan, the dissemination events up to M24 are reported.

Table 5 - Dissemination Plan - Expectation and relevant KPIs

European companies and SMEs
<p>Relevance: The primary target of the dissemination strategy of QUANTIFY are the European companies and SMEs interested in using or selling quantum sensors. We will disseminate the characterization report of each sensor and their performances, offering them the evidence of the competitive advantage of the developed sensors in terms of product performance, size and development cost.</p> <p>Expectation: We expect to expand the sensors application field, improving their performance with in-field application.</p> <p>Entry point: We disseminate by direct contacts, leveraging the Partners' network, dedicated workshop hosted by Partner and presiding over the most strategic exhibition events*, where stakeholders and venture capital can be engaged.</p> <p>KPI: n. of dedicated workshops (2); n. of in-field applications after 3 years from the end of the project (3); n. of improved technical KPIs (from the Annex 1 to the GA, DoA - Excellence) after 3 years from the end of the project (8).</p>
Technical, scientific and academic community
<p>Relevance: An important target group is the technical, scientific and academic community interested in sensor research, optimizing the fabrication workflow and improving the integration level.</p> <p>Expectation: We expect to expand the application field and explore new possibilities with new enabling research lines.</p> <p>Entry point: We disseminate by university lectures, public lectures, workshops, attending to scientific conference, ** publications (preferably, under gold open access journals). ***</p> <p>KPI: n. of international conference participations (15); n. of published papers (10); n. of submitted proposals enabled by the results of this project after 3 years from the end of the project (3).</p>
National Metrology Institutes
<p>Relevance: A strategic target group is represented by the E-NMIs. We will share the developed metrological measurement protocols to improve their robustness, to enlarge the know-how on the quantum enhanced sensor measurements and to increase the performance of the sensors and their characterization reports thanks to the expertise of the metrological community.</p> <p>Expectation: We will expect to improve the performance of our sensors, the measurement capabilities and the accuracy budgets.</p> <p>Entry point: We will disseminate by meetings, international comparisons, dedicated round robins.</p> <p>KPI: n. of round robins (3); n. of international comparison performed (3).</p>
Policy makers
<p>Relevance: Another strategic target group is represented by the Policy makers. The goal is to make decision makers aware of the competitive advantage that research on enhanced quantum sensors can bring to society and companies. We will disseminate our Exploitation report and the concrete strategic impacts and results of our work.</p> <p>Expectation: We expect to enable communication channels that lead to the creation of new jobs in quantum sensor research and new supporting infrastructures.</p> <p>Entry point: We disseminate dedicated meetings and press releases.</p> <p>KPI: n. of press release (6); n. of recruitment calls enabled by the results of this project (5).</p>

*Exhibition of interest: Laser World of Photonics, SEMICON EU, International Metrology Congress (CIM), Space Tech Expo, Quantum Tech, Medica, ComPamed.

**Conferences of interest: Laser Science to Photonic Applications (CLEO US/Europe), Photonic West, Advanced Solid State Lasers, European Frequency and Time Forum (EFTF), International Symposium on Temperature and Thermal Measurements in Industry and Science (TEMPMEKO); International Conference on Low Temperature Physics (LT30), European Magnetic Sensors and Actuators (EMSA), Joint European Magnetic Symposia (JEMS), European Quantum Technologies Conference (EQTC).

***Publishing companies: Optica Publishing Group, Springer Nature group (Nature photonics, International Journal of Thermophysics), Science, American Physical Society (APS), American Institute of Physics (AIP), IOP Publishing (Metrologia), Wiley Online Library; Elsevier (Cryogenics, Physics Letter A), MDPI (Sensors), IEEE Xplore (IEEE Trans. on Magnetics). Particular attention to the selection of gold open access publishing companies will be addressed.

4. Exploitation strategy

Sensors play a crucial role in today's technology landscape. They provide the necessary data inputs that allow for real-time decision-making, monitoring, and control. These applications demand increasing sensitivities. In many cases, the technology has already been pushed to the quantum limit, at which quantum physical phenomena limit the sensitivity and accuracy of the sensors.

QUANTIFY aims at pushing sensing beyond classical capabilities and the boundaries set by quantum effects for real world applications. The project covers the development of new enabling technologies as well as cutting edge sensing systems to achieve that goal. Enabling technologies include periodically poled waveguides and modulators as well as a new hybrid photonic integrated platform through micro transfer printing. These advancements allow for the development of photonic integrated squeezed light sources, a key technology to push sensing beyond the limits set by quantum shot noise.

These foundational advancements allow the Consortium to develop new cutting-edge sensing technology.

QUANTIFY focuses on three major applications:

1. ***Optically pumped magnetometers:***

Magnetometers have a wide range of applications. For example, they are used in the non-invasive detection of charge states in Li-ion cells for identifying and localizing defects, and for sensing capacity loss mechanisms. In the healthcare sector, magnetometers are used to measure the magnetic fields emitted by the brain. However, current solutions are costly and complex as, for example, cryogenics are required. The OPM based magnetometers to be developed in QUANTIFY will be significantly cheaper and will also provide a quantum advantage by utilizing polarization squeezed light in the readout scheme to enhance the sensitivity and bandwidth beyond current capabilities.

2. ***Rb-based two photon optical clocks:***

High-precision clocks are essential for deploying accurate frequency standards outside the laboratory for applications like network synchronization, secure communication or satellite-based navigation system. Microwave clocks, the gold standard of today, are complex with large footprints. QUANTIFY will develop two-photon optical clocks which are more compact and less complex. QUANTIFY will also use squeezed light to enhance the performance of the

clock, providing a highly stable, compact and cost-effective system.

3. **Optomechanical thermometer:**

Accurate measurements of temperatures are important in a wide range of industries like aerospace and the maritime industry.

In all these industries, the accurate calibration of the sensor must be ensured and maintained over time, as sensor retrieval and recalibration are not feasible.

QUANTIFY will develop a new thermometer and provide new standards for self-calibrated embedded sensor applications.

All systems will be analyzed and benchmarked by INRiM to ensure traceability to SI units. INRiM will develop dedicated metrological protocols to achieve this goal and will thus strengthen the trust of applicants in QUANTIFY technology during the exploitation phase. To further strengthen the results, CNAM and LNE, two French metrology institutes, will also be responsible for the characterization of the thermometer.

Apart from these major developments, the project has demonstrated that technologies developed to achieve the end goal of the QUANTIFY project also have market potential. The Consortium identified seven innovations worthy to be mentioned within the Innovation Radar Questionnaire proposed by the European Commission. This questionnaire aimed to identify, with a bottom-up logic, the most relevant application developed within the Horizon Europe projects, which could influence the future market and reinforce the European value-chain. The list of the innovations identified by the Consortium are reported in the table below.

SUMMARY OF PROJECT INNOVATIONS	
1	Engineered periodically poled waveguides and electro-optic modulators for efficient on-chip laser frequency conversion.
2	Photonic integrated circuits for on-chip squeezed light generation at 780 nm.
3	Microtransfer-printed integration of PP-LNOI structures, GaP photonic cavities, and photonic tunable lasers (780 and 1560 nm) on a unified photonic platform.
4	Development of Rb MEMS cells and chip scale narrow linewidth laser for a compact optical frequency standard
5	Development of an optomechanical on-chip sensor designed for optical, mechanical and quantum thermometry
6	High-efficiency balanced photodetector (600–900 nm) for Rubidium-based quantum sensing.
7	Quantum-enhanced optically pumped magnetometer using miniaturized vapor cells for sensitive magnetic field measurements.

The Innovation Radar Team, after a careful review, included in the list also the following innovations:

- Photonic integrated tunable narrow-linewidth laser at 780 nm for Rb D2 line excitation;
- Quantum enhanced two-photon optical clocks, for low-power, low-noise, and high-stability two-photon spectroscopy;
- Miniaturized quantum memories based on Rb MEMS cell and PIC laser source for enhancing quantum sensors performance.

These innovations were included within the European Portal [Innovation Radar](#), the official database that highlights technologies with highest potential impact and market uptake. The innovation title and the main information were reported below as they were reported within the European portal.

High-efficiency balanced photodetector (600–900 nm) for Rubidium-based quantum sensing.

Market maturity: Tech Ready
Market creation potential: High
Project: QUANTIFY
Innovation Topic: Other

UNIVERSITY OF HAMBURG - Germany



Photonic integrated circuits for on-chip squeezed light generation at 780 nm.

Market maturity: Exploring
Market creation potential: High
Project: QUANTIFY
Innovation Topic: Other

CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE
MICROTECHNIQUE SA - RECHERCHE ET
DEVELOPPEMENT - Switzerland
UNIVERSITEIT GENT ♀ - Belgium



Development of Rb MEMS cells and chip scale narrow linewidth laser for a compact optical frequency standard.

Market maturity: Exploring
Market creation potential: No MCP category
Project: QUANTIFY
Innovation Topic: Other

CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE
MICROTECHNIQUE SA - RECHERCHE ET
DEVELOPPEMENT - Switzerland



Photonic integrated tunable narrow-linewidth laser at 780 nm for Rb D2 line excitation.

Market maturity: Exploring
Market creation potential: No MCP category
Project: QUANTIFY
Innovation Topic: Other

LIONIX INTERNATIONAL BV - The Netherlands
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE
CNRS - France



<p>Engineered periodically poled waveguides and electro-optic modulators for efficient on-chip laser frequency conversion.</p> <p>Market maturity: Exploring Market creation potential: No MCP category Project: QUANTIFY Innovation Topic: Other</p> <p>9 INDUSTRY, INNOVATION AND INFRASTRUCTURE</p>	<p>CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE MICROTECHNIQUE SA - RECHERCHE ET DEVELOPPEMENT - Switzerland</p>
<p>Microtransfer-printed integration of PP-LNOI structures, GaP photonic cavities, and photonic tunable lasers (780 and 1560 nm) on a unified photonic platform.</p> <p>Market maturity: Exploring Market creation potential: No MCP category Project: QUANTIFY Innovation Topic: Other</p> <p>3 GOOD HEALTH AND WELL-BEING 4 QUALITY EDUCATION 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE</p>	<p>UNIVERSITEIT GENT ♀ - Belgium</p>
<p>Quantum-enhanced two-photon optical clocks for low-power, low-noise, and high-stability two-photon spectroscopy.</p> <p>Market maturity: Exploring Market creation potential: No MCP category Project: QUANTIFY Innovation Topic: Other</p> <p>3 GOOD HEALTH AND WELL-BEING 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE</p>	<p>CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE MICROTECHNIQUE SA - RECHERCHE ET DEVELOPPEMENT - Switzerland</p>
<p>Quantum-enhanced optically pumped magnetometer using miniaturized vapor cells for sensitive magnetic field measurements.</p> <p>Market maturity: Exploring Market creation potential: No MCP category Project: QUANTIFY Innovation Topic: Other</p> <p>3 GOOD HEALTH AND WELL-BEING 7 AFFORDABLE AND CLEAN ENERGY 8 DECENT WORK AND ECONOMIC GROWTH 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE</p>	<p>FUNDACIO INSTITUT DE CIENCIES FOTONQUES ♀ - Spain CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE MICROTECHNIQUE SA - RECHERCHE ET DEVELOPPEMENT - Switzerland</p>
<p>Development of an optomechanical on-chip sensor designed for optical, mechanical and quantum thermometry.</p> <p>Market maturity: Exploring Market creation potential: No MCP category Project: QUANTIFY Innovation Topic: Other</p> <p>9 INDUSTRY, INNOVATION AND INFRASTRUCTURE</p>	<p>SORBONNE UNIVERSITE - France CONSERVATOIRE NATIONAL DES ARTS ET METIERS ♀ - France THALES - France</p>

Miniaturized quantum memories based on warm Rb MEMS cells and PIC laser source for enhancing quantum sensors performance.

Market maturity: Exploring

Market creation potential: No MCP category

Project: QUANTIFY

Innovation Topic: Other

INSTITUT ZA FIZIKU ♀ - Croatia

ISTITUTO NAZIONALE DI RICERCA METROLOGICA ♀ -
Italy



In parallel to this, each partner is collaborating to co-create an exploitation strategy which necessarily needs a multiple hands approach to address the complexity of the project. This collaborative effort emphasizes the importance of the Consortium's cohesion to fully harness the project's potential and achieve a tangible impact.

Within subchapter 4.1, a market analysis on quantum technology is reported. It helps to understand primarily the dimension of the impact created by the project, to understand the market demand, and to identify different market segments.

Within subchapter 4.2, seven exploitable results are identified. For each of them, a strategy to move to commercial exploitation is reported.

4.1 Quantum technology market analysis

Quantum technology market analysis and potential

Quantum technology is a rapidly advancing field with the potential to influence multiple industries. It encompasses three primary sectors: sensing, computing, and communication. QUANTIFY focuses on innovations in quantum sensing and quantum computing.

Quantum computing involves a supply chain that consists of five distinct layers: the hardware layer, the computing layer, the software layer, the service layer, and the end-user layer. About half of the total value generated within this supply chain is concentrated in the hardware layer. This trend underlines the critical importance of developing robust, scalable, and efficient quantum hardware components. Similarly, in the domain of quantum sensing—which includes applications such as high-precision measurements, navigation, and imaging—the hardware layer is also expected to account for a significant portion of the value generated. The precision and functionality of quantum sensors heavily rely on the advancements and reliability of the hardware utilized, drawing a parallel to the hardware-centric value distribution observed in quantum computing.

Our development project is centered on the hardware layer. By concentrating on hardware innovation, we anticipate significantly contributing to both quantum computing and quantum sensing sectors and driving innovation in these markets.

McKinsey, in its marked report published in 2025 [3], expects the total global quantum computing market to be worth \$45B - \$131B and the sensing market to be worth \$18B - \$31B in 2040. As mentioned before, about 50% of these markets will be captured by hardware. These estimates illustrate the huge potential in the quantum computing area. QUANTIFY is positioned in this area with its squeezed light sources, which will be used for sensing but can also be exploited for photonic quantum computing. It also shows that growth rates are expected to be smaller in sensing, however, applications are already more mature, and the sensing market is already more established. QUANTIFY is positioned to capture a significant fraction of this established market via its magnetometers, temperature sensors and two photon atomic clocks.

Detailed analysis on the market sizes and expected market shares of the respective technologies will be conducted by the partners while refining the exploitation plans of the individual developments.

Market restrains analysis

Entering the market for quantum technologies, while promising substantial opportunities, also entails several significant risks and barriers that need to be navigated. These challenges include technological unfamiliarity, regulatory hurdles, strategic pricing difficulties, and geopolitical factors, all of which can impact market penetration and sustainability.

Low customer awareness

One of the primary challenges lies in the novelty of quantum technologies. The technology in our project is relatively new, which means that potential users, including industries and broader markets, need to be educated about the capabilities and advantages of these quantum systems. Building trust in the reliability of our systems beyond innovators and early adopters is crucial for market acceptance. We plan to address this challenge through establishing traceability protocols at INRIM, ensuring the accuracy and reliability of our technologies. Additionally, execution of well-defined pilot projects will be integral to our exploitation strategy, providing demonstrable evidence of the technology's effectiveness and fostering confidence among potential users.

Lengthy and Costly Approval Procedures in Medical Applications

Quantum technologies like QUANTIFY's magnetometers, hold significant potential for medical applications. However, entering the medical market entails navigating through lengthy and expensive approval procedures, which can be a substantial barrier. Rigorous testing and validation is required to ensure safety and efficacy, which can extend development timelines and increase costs significantly. Hence, our exploitation plan must emphasize securing adequate funding to support these extended approval processes. Another strategic step involves close collaboration with regulatory authorities early in the development phase to streamline these processes as much as possible.

Strategic Pricing and Capital Gaps

Defining a robust and sustainable pricing strategy for quantum technologies represents a key challenge. The commercialisation of complex and high-cost products is typically characterised by long sales cycles, which may lead to significant financing gaps, particularly for newly established companies. Pricing models must therefore adequately reflect the value delivered to end-users while taking into account the substantial costs associated with the development, validation, and manufacturing of quantum hardware.

To address potential capital shortages during the initial exploitation phase, early engagement with prospective customers is essential. Structured customer education and onboarding activities—such as workshops, technical demonstrations, and pilot projects—can facilitate market understanding, reduce time to commercial uptake, and support a smoother transition from technology introduction to market adoption of QUANTIFY outcomes.

In parallel, early and proactive engagement with venture capital investors is of strategic importance. Establishing stable relationships with representatives of venture capital funds can help bridge the financing gap between proof-of-concept and large-scale, economically sustainable production, particularly in the case of hardware solutions requiring capital-intensive manufacturing processes and specialised equipment.

Trade Barriers and Geopolitical Tensions

Finally, trade barriers and global geopolitical tensions represent external risks that can affect both the target market size and the supply chains. Restrictive trade policies, tariffs, and export controls can limit market access and increase costs for components essential to technology. Moreover, geopolitical tensions can affect the stability and predictability of supply chains, potentially causing disruptions in the availability of critical materials or technologies. These factors can reduce the potential economic value created by quantum technologies. Our strategy must therefore include diversifying supply chains, fostering international collaborations, and maintaining flexibility to adapt to changing geopolitical landscapes.

Mitigation efforts of these challenges will be critical part of QUANTIFY's exploitation strategy.

4.2 Intention of exploitations of the QUANTIFY Consortium

The following tables (grouped all together in Table 6) summarize the intentions for exploiting each valuable result the project is set to develop. All partners plan to exploit the results through knowledge transfer activities, which could be facilitated by the interested industries and companies supported by the internal Technology Transfer Offices. After two years from the start of the project, these exploitation activities will be more detailed, based on the obtained results.

Each table has four sections: State-of-the-art, Progress beyond the state-of-the-art, Intention for exploitation, and Exploitable results and strategy to move to commercial exploitation.

Table 6 - Exploitable results and intentions for exploitation

Photonic integrated squeezed light source (CSEM, UHAM, QuiX QUANTUM BV)
<p>State Of The Art</p> <p>Squeezed light is an essential enabling resource in quantum sensing and quantum computing. State-of-the art sources rely on parametric down-conversion in bulk crystals to generate squeezed states of light. This concept has already proven its usefulness in gravitational-wave detection. Major gravitational-wave detectors that are involved in the observation of the gravitational universe are equipped with squeezed light sources to enhance their sensitivity beyond the quantum noise limit. Many more sensing applications will profit from squeezed light. Enhancement beyond the quantum noise limits will be demonstrated in this project for optically pumped magnetometers and two photon atomic clocks. Apart from sensing, squeezed light is an essential resource for photonic quantum computing and an enabler for this technology. Squeezed light could be used to generate GKP-qubits, which are as of today the qubits that have the lowest intrinsic error correction threshold. For the photonic platform this implies that even photon loss up to certain amount can be fully corrected.</p>
<p>Progress Beyond State Of The Art (updated)</p> <p>QUANTIFY aims at generating squeezed light in integrated photonic circuits instead of bulk materials, offering the potential for building more compact and highly scalable sources. By using thin film LiNbO₃ (TFLN) and micro transfer printing, a high degree of integration is achievable and high volume production will be enabled, making squeezed light accessible for sensing and quantum computing applications.</p>
<p>Intentions for exploitation</p> <p>The integrated on-chip squeezed light source will be exploited by Noisy Labs, an affiliate partner of UHAM, focusing on commercial sources of squeezed light. Today, Noisy Labs offers squeezed light sources and matching accessories for the efficient detection and integration of squeezed states of light in optical setups. Noisy Lab's devices generate squeezed states in a bulk crystal cavity enhanced nonlinear process. The PICSq developed in QUANTIFY will be a complementary product in the portfolio of Noisy Labs and will broaden the accessible markets of the company.</p>
<p>Exploitable Results and Strategy to move to commercial exploitation</p> <p>Key partner/s and customer sectors, stakeholders: Key partners for the development of commercial integrated squeezed light sources are CSEM and UGent-IMEC as the providers of the key technologies. Noisy Labs, with its already established customer base, will contribute access to the market of applicants and end-users and thus ensure an efficient and timely exploitation close to the needs of customers. CSEM has established an open-access foundry for TFLN PICs and is developing the technology to manufacture nonlinear TFLN PICs on wafer scale. CSEM is planning to place itself as the TFLN PIC supplier for quantum applications.</p>

Product/specific project result of interest: Specifically, integrated squeezed light sources are of interest for the exploitation as they will be applied in many sensing and computing applications.

Follow-up after Project conclusion and expected timeframe (years): After conclusion of the QUANTIFY project, Noisy Labs will engage in the development of commercial prototypes of integrated sources for squeezed light and will test these in first proof-of-principle applications with customers. In parallel, the sources will be optimized in terms of the squeeze factor that can be achieved. Customer feedback will be considered regarding the connectivity of the device. The time frame for these projects is 2-4 years after the termination of QUANTIFY.

Business opportunities with timeframe (years) after project: The utility and usefulness of squeezed light has already been demonstrated in many sensing and computing applications, indicating the tremendous business opportunity for this technology. Now, it is of utmost importance to engage in the development of demonstrators for squeezed-light enhanced sensing devices and quantum computers with the stakeholders. Mass adoption of these new sensing technologies and first useful quantum computers is expected to start 4 – 8 years after the completion of the QUANTIFY project.

Periodically poled waveguides and modulators (CSEM)

State Of The Art

Current commercial Lithium Niobate periodically poled (PPLN) devices and modulators are made with bulk crystals or large cross section waveguides with low refractive index contrast. The most common methods to achieve such waveguides are by proton exchange or by Titanium or Zinc indiffusion. Better beam quality and higher damage threshold can be achieved in ridge waveguides, obtained from bulk lithium niobate crystals by etching or precise dicing. Presently, PPLN waveguide are commercially available from Covesion, NTT, HCPhotonics, OXIDE and AdVr. Lithium niobate modulators are now the standard in telecommunication industry and can be provided by many different providers such as IXBlue and AFR, Agiltron, Thorlabs etc..

Progress Beyond State Of The Art (updated)

The TFLN technology allows to process periodically poled waveguides and modulators at wafer scale, enabling scaling up of the production in larger photonic integrated circuits, together with other components for signal processing and routings. Also, such waveguides show a larger field confinement with respect to commercial waveguides, allowing for a substantial increase in efficiency. Indeed, the intrinsic second harmonic generation efficiency is expected to increase by 10-20 times and the modulator V_{π} can be reduced by 2-3 times in thin film technology.

Intentions for exploitation

As a private-public, non-profit RTO, CSEM mission is to enable competitiveness through innovation by developing and transferring world-class technologies to industry. Other avenues of exploitation of results are by generating IP and by the creation of start-ups. CSEM will capitalize on its achievement in establishing world's first open-access TFLN PIC foundry to supply the industry with PPLN PICs and efficient modulators. CSEM will work on a business plan to place its foundry as a key supplier for thin film PPLN in next 4 years.

Exploitable Results and Strategy to move to commercial exploitation

Key partner/s and customer sectors, stakeholders: In QUANTIFY, both UHAM, and its start-up NoisyLabs and QuiX QUANTUM BV are key partners for the benchmark and exploitation of the developed PPLNs and thin film modulators for the generation of nonclassical states of light and fast tuneable interferometers. High speed and low loss integrated modulators are crucial for building and scaling photonic quantum computers, ion-trapped and atom-trapped quantum computers since it is essential to quickly transfer or propagate a quantum state with a light pulses. In general, and outside the realm of quantum sensors and the QUANTIFY consortium, such components are of importance in communication, and laser systems for spectroscopy and LiDARs.

Product/specific project result of interest: Specifically, D2.2 “Realization of PIC and MEMS components” and D2.3 “Photonic integrated laser, squeezers and OMO on Triplex™ motherboard” will provide the technological background for the assessment of the feasibility and performance of PPLN and modulators.

Follow-up after Project conclusion and expected timeframe (years): CSEM has already an open foundry service for LNOI technology for small series production. The PPLN and modulators developed in QUANTIFY will strengthen this offer by adding new building blocks to the available process design kit (1-2 years).

Business opportunities with timeframe (years) after project: for high-volume production, CSEMs’ strategy is still quite flexible: while a spinning-off strategy is encouraged, technology transfer and licensing can also be put in place (3-4 years). CSEM remains agile towards the market pull for the PPLN and modulators and will enjoy its fabrication facility upgrade in 3-4 years.

Achieve a hybrid photonic integrated platform through micro transfer printing technology (UGent-IMEC)

State Of The Art

Die-level micro-transfer printing of a variety of materials for photonic integrated circuits is the standard practice today. The work to show reliability and yield needs to happen by moving towards wafer-level micro-transfer printing. This will only happen for a subset of materials and is not yet demonstrated/published by our knowledge.

Progress Beyond State Of The Art (updated)

For Quantify specific materials and devices, namely PP-LNOI waveguides and GaP PhC cavities, need to be micro-transfer printed with a focus on low loss coupling and maintaining device/material performance after print.

Intentions for exploitation

UGent can license the technology or create spin-off for particular application cases where the USP comes also from the use of the micro-transfer printing. The transfer printing technology is very generic so applicable to multiple applications. In the quantify project the focus is on quantum sensors and here the quantify end-user companies could be interested to improve the sensitivity of the sensor by reducing the on-chip losses and coupling losses by tight integration.

Exploitable Results and Strategy to move to commercial exploitation

Key partner/s and customer sectors, stakeholders: X-Celeprint (IP company), X-FAB (for volume production); potential customers include the QUANTIFY end-user companies.

Product/specific project result of interest: integration of PP-LNOI and GaP PhC cavities on SiN by means of micro-transfer printing.

Follow-up after Project conclusion and expected timeframe (years): within 1 year after the project we will discuss with the end-users if they want to engage in a follow-up project. will discuss with the end-users if they want to engage in a follow-up project.

Business opportunities with a timeframe (years) after the project: Same as above.

Optically Pumped Magnetometer (ICFO)
<p>State Of The Art</p> <p>Commercial OPMs are used for geophysical, space science, and medical applications, and researched for other applications including non-destructive testing, underwater communications, and quality control of electrical systems such as batteries. Both sensitivity and SWAP are important to many of these applications, and miniaturization is a main topic of OPM R&D. Meanwhile quantum noise increases as the sensor is miniaturized, making quantum noise control more critical for miniaturized and next-generation OPMs. OPM sensitivity beyond the standard quantum limit has thus far been demonstrated only with table-top squeezers occupying ~m² surface areas, and with non-miniaturized OPMs of comparable dimensions.</p>
<p>Progress Beyond State Of The Art (updated)</p> <p>QUANTIFY aims to demonstrate squeezed light sources suitable for OPMs operating beyond the standard quantum limit, i.e., with suitable wavelength, linewidth, power, and squeezing levels, in PIC implementations, thereby reducing the footprint of the squeezer by orders of magnitude, with corresponding improvements in weight and power. In parallel, QUANTIFY will develop quantum-enhanced OPMs employing miniaturized vapor cells, enabling similar advances in miniaturization on the OPM side.</p>
<p>Intentions for exploitation</p> <p>Quantum enhanced on-chip OPMs.</p>
<p>Exploitable Results and Strategy to move to commercial exploitation</p> <p>Here we describe only OPM exploitation. See above section "Photonic integrated squeezed light source" for other exploitable results specific to the PIC squeezed light source.</p> <p>Key partner/s and customer sectors, stakeholders: OPM providers, Battery manufacturers, Geotechnical / geophysical industries, Medical imaging system providers.</p> <p>Product/specific project result of interest: Miniaturized, quantum-enhanced OPM.</p> <p>Follow-up after Project conclusion and expected timeframe (years): IP protection, market research, licensing – 1-5 years.</p> <p>Business opportunities with timeframe (years) after project: Licensing to customer described above – 1-5 years.</p>

Rb-based two-photon optical clock (CSEM)
<p>State Of The Art</p> <p>Two-photon optical clocks represent a cutting-edge advancement in timekeeping technology, leveraging the precision of atomic transitions induced by two-photon excitation. These clocks utilize the coherent interaction of two photons to excite atoms to higher energy states, achieving ultra-narrow linewidth transitions, which significantly reduces systematic uncertainties. This method allows for higher stability and accuracy compared to traditional single-photon clocks. The technology benefits from reduced Doppler broadening and shifts, as the two-photon process effectively cancels out first-order Doppler effects. Current research focuses on optimizing laser systems, reducing environmental perturbations, and enhancing quantum state manipulation techniques.</p>
<p>Progress Beyond State Of The Art (updated)</p> <p>Miniaturization of clocks has several benefits for the industry. In addition to smaller footprints, reduced power consumption is also targeted. In QUANTIFY, we will rely on specifically designed MEMS cells, instead of the traditional glass blown ones, to further comply with large scale production strategies. A laser in a compact package will be specifically designed and integrated to the physics package of the two-photon miniature optical clock.</p>

<p>Miniaturization of clocks traditionally poses a challenge in term of frequency stability. Care will be taken to minimize these detrimental effects, based on previous experience in miniaturization of coherence population trapping (CPT) based atomic clocks. In addition, quantum-based techniques, relying on squeezed states of light, will be implemented to further improve on the clock frequency stability.</p>
<p>Intentions for exploitation</p>
<p>CSEM's well-established European network in the time and frequency domain and in space industry will allow to identify the most suitable industrial partners to strengthen the European capacities in key parts and future supply chains. As for all developments by CSEM, technology transfer to an existing partner, or creation of a spin-off company for industrialization and commercialization of technology will also be supported.</p>
<p>Exploitable Results and Strategy to move to commercial exploitation</p>
<p>Key partner/s and customer sectors, stakeholders: Atomic clock providers, Metrology laboratories, Space agencies, Network management companies (wired and wireless).</p>
<p>Product/specific project result of interest: miniature two-photon atomic clock.</p>
<p>Follow-up after Project conclusion and expected timeframe (years): Industrial business partner selection, licensing – 2-4 years.</p>
<p>Business opportunities with timeframe (years) after project: Licensing to industrial business partner (2-4 years), Follow-up projects with space agencies and metrology laboratories (1-4 years).</p>

<p>Optomechanical thermometer (USo, TRT, CNAM, LNE, CNRS, INRiM)</p>
<p>State Of The Art</p>
<p>Nanoscale cryogenic primary thermometers as Coulomb Blockade Thermometry already exist, operating from 0.6 K to 25 K as well as primary magnetic field fluctuation thermometer operating below 1K are both limited by their upper temperature range together with a relative uncertainty limited to 1%. While there is a strong demand on sensor technology (high pressure liquid hydrogen tank technology) able to cover from cryogenics (below 1K) up to room temperature (300 K), none of these existing techniques operates on such a large temperature range. Additionally, these applications require self-calibration (i.e. primary thermometry) as it is impossible to calibrate them in situ. Beyond these primordial considerations, other limiting features of these primary thermometers need to be addressed for their broad dissemination, namely their size or their fragility.</p> <p>A group at NIST has used a mesoscopic optomechanical device consisting in a photonic/phononic 1D ladder. The high frequency (GHz range) of the mechanical resonance of such 1D optomechanical resonator is a way to keep the mechanical resonator as close as possible to its ground state to perform quantum measurements without the use of active cooling techniques. Thermodynamic temperature of such a system has been determined using quantum optomechanical correlations to make absolute calibration via optical detection up to ambient temperature. Even if in 9, a relative uncertainty on thermodynamic temperature of about 10% from 10K to 300 K has been demonstrated, no metrological measurements were performed. Moreover, the technology developed by NIST shows several deadlocks preventing the essential dissemination of a new primary temperature sensors as a metrological standard: thermalization of the resonator, optical packaging and intercomparison with metrological reference.</p>
<p>Progress Beyond State Of The Art (updated)</p>
<p>Within the frame of Quantify, we will develop a new thermometry platform using Silicon Nitride or large band-gap material as Gallium Phosphide to prevent two photons absorption, and bi-dimensional optomechanical crystal to multiply and enhance thermalization channels. This innovative optomechanical thermometer will be implemented on a Silicon on Insulator platform</p>

addressed with optical fiber glued on chip. This optical packaging will allow efficient and standardized quantum demonstration of a primary optomechanical thermometer using different techniques (asymmetric resolved side band or quantum correlations) depending on the temperature range from below 1 K to approximately 100K. To further enlarge the temperature range, up to room temperature, photonic crystals, fabricated on the same chip, will be added allowing for relative temperature measurements. Finally, this innovative and complete platform will be compared to metrological references.

Intentions for exploitation

The IP generated in this project can be exploited in several ways. It can be licensed to commercial partners interested in developing commercial sensors based on our optomechanical thermometer. The formation of a spin-off company placing this technology in the market can also be envisioned.

Exploitable Results and Strategy to move to commercial exploitation

The development and the metrological validation of optomechanical quantum temperature sensors solves the problem of drift of embedded sensors. These mesoscopic sensors will enhance the reliability of temperature for applications in fields such as transportation industry, space instrumentation, engine monitoring, power plant safety and consumer electronics. Control over chemical or biological reactions requires accurate temperature monitoring in lab-on-a-chip applications, precision engineering robots and measurement equipment need accurate temperature control to reach sub-micron precision and stability, and future quantum computing equipment needs on-chip nanoscale temperature metrology. More generally, optomechanical sensors developed in this project will have three advantages: robustness (to mechanical shocks, electromagnetic field, high energy particles, nuclear irradiation, and chemical species), sensitivity, and self-calibration.

A wider impact of these sensors is foreseen in the field of metrology as the sensors based on quantum standards may renew thermometric methods in future years. As such sensors do not require any calibration against standard artifacts, metrological skill will shift from calibration service to sensor integration and expertise on systematic effects. These sensors are expected to have a wide impact on temperature metrology standardization, which may one day replace the platinum resistance thermometers currently widely used in process control or inspection. The primary thermometers we will engineer operate at mesoscopic scales and may push the advances in biology research, health, environment and nuclear safety. The demonstration of the viability of these optomechanical sensors will also open the way to their use in other metrology fields such as pressure, radiometry or nano-force measurements.

Key partner/s and customer sectors, stakeholders: Industrial players in the fields of transportation, space instrumentation, engine monitoring, power plant safety, consumer electronics, lab-on-chip applications and quantum computing equipment

Product/specific project result of interest: Optomechanical quantum temperature sensors to solve the problem of drift of embedded sensors.

Follow-up after Project conclusion and expected timeframe (years): 1-3 years.

Business opportunities with timeframe (years) after project: 2-5 years.

Characterization assessment and measurement set-up (INRiM, CNAM, LNE)

State Of The Art

The metrological assessment, the performance characterization and the calibration of sensors are well known and state-of-the-art practices in metrological laboratories. Therefore, the major challenge within this project is the adaptation of the sensor characterization procedures and set-ups to quantum enhanced miniaturized sensors. Furthermore, once the performance evaluation procedures will be defined, the main ambition of this project is the traceability to primary standards. These last procedures are not yet properly defined out in today's scientific community.

For each sensor, a specific procedure will be implemented to refer the quantum miniaturized sensors to its related primary standard.

The characterization of the TPOC will be made through the Caesium primary atomic frequency standard, e.g. the INRIM's Cs Fountain. In particular, the stability of a laser radiation frequency locked to the atomic transition reference (87Rb) is performed at the state-of-the-art using an optical frequency comb referred to a primary frequency standard in the microwave or in the optical domain. The microwave primary frequency standards at the state-of-the-art are laser cooled Cs Fountains, that offer a relative instability of about $1e-13/\sqrt{\tau}$, in terms of Allan deviation, where τ is the measurement time. Optical primary frequency standards at the state-of-the-art are the so-called optical clocks, and they achieve a relative instability lower than $1e-15/\sqrt{\tau}$. The accuracy of an atomic standard is based on the evaluation of the main biases that affect the atomic transition frequency with respect to the situation of unperturbed (undressed) atom.

The characterization of the OPM will consist in three steps: first, nulling the environment magnetic field to a level below a few tens of nT; second, submitting the magnetometer to a spatially homogeneous magnetic field of known intensity by using calibrated coils; third, comparing the readout of the magnetometer with the expected field value. The repeatability of the magnetometer is checked by repeating the characterization after an adequate amount of time, whereas stability against temperature is normally not taken into account in laboratory conditions, as metrological laboratories operate under controlled temperature.

Finally, as far as thermometers are concerned in the cryogenic range between 4 K and 300 K, they are now calibrated according to the prescriptions defined in the International Temperature Scale of 1990 (ITS-90 or T_{90}), an approximation of the thermodynamic temperature T . After the redefinition of the kelvin in 2018, the best estimates of the differences ($T - T_{90}$) was updated in 2022. The results, based on primary thermometry methods like AGT, show values of accuracy and repeatability beyond the ones achieved by photonic and optomechanical nanothermometers today, which also suffer from the scarcity of data and independent studies.

Progress Beyond State Of The Art (updated)

The miniaturized optical clock instability will be characterized using the best metrological techniques and at the same time using a Cs fountain and an Ytterbium optical clock. This has not yet been done at this level so far, and we will characterize the long-term stability, beyond 10000 s of measurement time, that is not present in literature. The accuracy of the clock will be evaluated performing specific tests on the main biases, pushing the improvement of the accuracy reached so far, that is limited to $2e-11$ for this type of clock.

In order to characterize a miniaturized, optically pumped quantum magnetometer, the laboratory procedures must be improved beyond the state of the art. In particular, the optical excitation and readout setups must be integrated with the equipment for nulling the environment magnetic field and for applying a field of known intensity; the procedure for compensating the environment magnetic field must be automated to ensure that stability characterizations can be performed on the time scale of several hours; the linearity of the response of the magnetometer must be checked in the low-range of applied field values, by adding to the metrological chain a calibrated fluxgate for extending the applied field values below 1 μ T.

The characterization of the optomechanical thermometer will be significantly enhanced through statistics and quality of uncertainty assessments that will be highly improved by performing a series of measurements at different metrology laboratories, in extended and selected temperature ranges, to provide the richer and more densely packed data sets and results needed to strengthen the confidence in the new technologies.

Intentions for exploitation

The metrological assessments of the three sensors will be exploited to further increase the skills of the metrological community networks and the interested companies.

Exploitable Results and Strategy to move to commercial exploitation

To straighten metrological assessment of cutting-edge quantum enhanced sensors developed in WPs 3 – 5, at the end of the project, comparison measurements (round robins) and reference to primary standards will be arranged between several European NMIs. Comparisons are the most widespread tool for comparing measurement results performed by calibration laboratories in the relevant measurement sector, following international rules and best practices. They are an important element for monitoring the quality of calibration results, and constitute an effective means of verifying the technical competence of participants to the round robin.

The comparison activity will involve the calibration of the traveling quantum sensors (OPM, TPOC, OMT) by the reference laboratory standards suitable for the comparison (for example INRiM) and the circulation of the quantum sensors among the participants who perform its calibration. The calibration results of the quantum sensors and the participating laboratories are compared according to the standard statistical methods. For these round robins, stakeholders and interested third parties will be invited to participate.

On the other hand, reference to primary standards is the only way to ensure the accuracy and traceability of measurements, guaranteeing the quality and reliability of commercialized products. Another area of exploitation of the results will be linked to the knowledge transfer, in terms of measurements management, that NMIs could be done through the interested industries and companies supported by the internal Technology Transfer Officer.

Finally, the developments of specific metrological protocols for advanced, miniaturised quantum sensors will be exploited with specific services offered to scientific laboratories and companies involved in their development, production and commercialization.

From the point of view of the NMI partners of the project (INRiM, CNAM, and LNE), the goals of the round robins and the exploitation activities are improving the measurement capabilities of the NMIs on the last-generation quantum sensors, improving the measurement accuracy and the performance of the sensor and disseminate the results in their countries, since advanced quantum standards would have a disruptive impact on calibration protocols in the traceability chain of the country.

From a broader perspective, the goal of these round robins and the exploitation activities is to enhance knowledge and develop operational setups that ensure interested companies can commercialize robust and accurate sensors. These companies can rely on established measurement setups and solid metrological assessments to develop their commercial products.

Key partner/s and customer sectors, stakeholders: NMIs, interested companies, Society.

Product/specific project result of interest: metrological assessments and cutting-edge characterization set-ups for the latest generation of on-chip quantum sensors.

Follow-up after Project conclusion and expected timeframe (years): the round robins can be implemented once the on-chip quantum-enhanced sensors are ready and characterized by the involved NMIs. A reasonable timeframe for this is within 24 months after the end of the projects. Following this period, knowledge transfer to interested industries can commence. Indeed, to establish specific metrological protocols for the miniaturized quantum sensors approved by the Metrological Community, a 5-year timeline is more appropriate.

Business opportunities with timeframe (years) after project: the interested companies need precise and reliable standard protocols to ensure the commercialization of valid products. Both the application of that protocols and the knowledge transfer related to them can be a business opportunity to a new start-up or to the NMIs involved.

Miniaturized Quantum Memories fo sensing applications (IoPZg, INRiM)
<p>State Of The Art</p> <p>Atomic quantum memories (QMs) enable on-demand storage and retrieval of photonic quantum states. Several systems and different protocols have been used to implement QMs. Laser-cooled atomic ensembles, and atomic ensembles in rare-earth-ion doped crystals achieve long storage times, high fidelity and high storage efficiency. However, their operation relies on technically demanding conditions, including ultra-high vacuum or cryogenic temperatures, leading to large size, mass, and power consumption that hinder practical deployment. QMs implemented in the warm atomic vapors are receiving growing attention in the literature. They demonstrate promising memory performances, are compatible with single-photon sources, and are technologically simple, making them particularly appealing for real-world applications.</p> <p>The commercial potential of QMs is currently focused on areas such as quantum communication and quantum computing. While several companies and research groups worldwide are actively developing QMs, technology is not yet mature enough for widespread commercial adoption. Key challenges include improving stability, fidelity, and scalability. Commercially available quantum memory offered by Qunnect company has performance specifications of ~95% fidelity, ~160 μs storage time, and ~5% efficiency for memory operation at the few-photon level. The device is housed in a standard 2U rack-mountable case. It operates with a warm Rb vapor contained in a cylindrical glass cell that is 80 mm long and 25.4 mm in diameter, and an external cavity diode laser.</p>
<p>Progress Beyond State Of The Art (updated)</p> <p>We will test building blocks developed within QUANTIFY project, such as MEMS cells and PIC laser, for their application in quantum memories, contributing to the further miniaturization of quantum memory devices. The cylindrical glass cell used in state-of-the-art quantum memories will be replaced with a miniaturized MEMS cell. The cell has approximate dimensions of 4 × 7 mm with a length of 1 mm and will be filled with rubidium vapor. In addition, the ECDL laser will be replaced by a miniaturized PIC laser. Key challenges include achieving sufficient optical thickness of the rubidium vapor in the MEMS cell, which is necessary for efficient photon storage, as well as ensuring the stability of the PIC and sufficient bandwidth of the EIT window.</p> <p>In addition, we will explore whether squeezed light sources can enhance the performance of QMs, potentially leading to the future development of QMs with improved performance compared to the current state-of-the-art.</p>
<p>Intentions for exploitation</p> <p>On-chip QMs for applications in quantum sensing, quantum communication, and quantum computing.</p>
<p>Exploitable Results and Strategy to move to commercial exploitation</p> <p>Key partner/s and customer sectors, stakeholders: Quantum computers based on neutral-atoms providers, Quantum networks providers, Metrological laboratories, Squeezed light-sources providers.</p> <p>Product/specific project result of interest: Miniaturized QMs. Miniaturized quantum memories based on warm rubidium MEMS cells and PIC laser sources, aimed at enhancing the performance of quantum sensors, represent an innovation recently recognized by the EU through its inclusion in the Innovation Radar portal. The market maturity of this innovation is currently at the “Exploring” stage. According to the JRC’s Market Creation Potential indicator framework, this innovation addresses the needs of existing markets and customers.</p> <p>Follow-up after Project conclusion and expected timeframe (years): IP protection, industrial business partner selection, licensing – 2-5 years.</p> <p>Business opportunities with timeframe (years) after project: Licensing to industrial business partner – 2-5 years, Follow-up projects with metrology laboratories and Squeezed light-sources companies (1-5 years).</p>

4.3 Actions to develop the Exploitation Plan

Based on what is described in the previous paragraphs, here we present a plan to identify main steps and activities for the final QUANTIFY Exploitation Plan. The plan will include 6 key topics to address for the exploitation.

1. Market Analysis

The market analysis for each QUANTIFY technology is essential to identify potential commercial opportunities. The key steps include assessing demand, evaluating the competitive landscape and alternative solutions, identifying the target entry market in which the most value can be delivered and performing a final SWOT analysis.

- Demand assessment: The potential demand for QUANTIFY technologies in the end-user applications must be assessed and determined. This is done in a top-down approach by studying and analyzing available market reports. This will be complemented by gathering bottom-up information from interviews with stakeholders in the respective industries on their perspective on the market size and technology application areas.

- Competitive landscape: The alternatives to the solutions provided by QUANTIFY must be analyzed and compared to the QUANTIFY offering. Alternatives include competing technologies as well as work-arounds users turn to in order to solve their problems. This analysis results in a clear value proposition, pointing out the added value and benefits of QUANTIFY developments.

- Identification of target entry market: The demand assessment and analysis of the competitive landscape will allow for the identification of target markets to which the QUANTIFY technology can be sold first. The previous analyses will pinpoint to uncontested niches that can be targeted and from which the adoption of QUANTIFY technologies can be driven.

- SWOT analysis: For each technology of the QUANTIFY project, a SWOT analysis will summarize the efforts of the market analysis. The SWOT analysis summarizes Strengths, Weaknesses, Opportunities, and Threats for the technologies, allows for a clear understanding of the solutions' position in the market and serves as the basis for the development of the exploitation strategy.

2. Commercialization Strategy

Based on the results of the marked analysis and the technological outcomes of the QUANTIFY project, a business model will be developed for the exploitation of each technology. The considerations will involve strategic decisions such as whether to manufacture and supply entire sensing solutions to be sold directly to the end user or focusing on components to be integrated in solutions provided by another party. Licensing to a third party is also an option for commercialization. These decisions influence the final product and will determine the cost structure, revenue streams and pricing strategies.

Pathways towards product development and raising the TRL level will also be included in the commercialization strategy as the QUANTIFY technology will have to be scaled from lab-scale prototypes to commercially viable products. If this will be done via a Spin-off creation or strategic partnerships with existing commercial entities will be evaluated.

Given the significance of the quantum technologies we are developing in QUANTIFY, it is crucial to ensure that our innovations comply with European regulations. Therefore, by M24, we will develop and report within this updated Plan (M24) a **compliance plan**, which will include the periodic revision of the *export control policy* applicable to our innovations. This will ensure full adherence to European regulatory requirements, build trust with our stakeholders, and enhance the credibility of our innovations.

3. Technology Transfer

The efficient exploitation of QUANTIFY technology requires timely communication with the technology transfer offices of the respective institutions to explore opportunities for IP-Transfer and align them with the envisioned commercialization strategy. QUANTIFY will ensure that this is taken care of and engage in discussion with the institution's representatives. Apart from that, the relationships with stakeholders in the exploitation process like suppliers and customers must be built and fostered early on to evaluate the potential for co-development opportunities, funding and technology scaling.

4. Funding Opportunities

The commercialization and exploitation of the QUANTIFY technology requires additional funding. Defining a strategy for the acquisition is part of the exploitation plan. Different sources of funding will be considered in the process:

- Research grants: The funding landscape will be scanned for opportunities within the EU programs or national funding bodies and the writing of proposals will be initiated. In this framework, it is worth mentioning the [EIC Transition Open call](#),^[4] which leverages the outcomes of ongoing or completed projects to validate and demonstrate technology in application-relevant environment (starting at TRL 3/4 aiming to achieve TRL 5/6) and develop business and market readiness.
- Venture capital/angel investors: In dependence on the maturity of the technology, the business case and the required amount of funding, capital can also be raised towards VCs and angel investors. The partners will connect early on with stakeholders in the field to evaluate their exploitation strategy with them and determine the investor readiness level of the technology.
- Strategic partners: Strategic partners with a high level of interest in QUANTIFY technology also represent a potential funding source for the exploitation. Exploitation can be funded in Public-private partnerships and progress towards market readiness thus be made in joint development projects.

5. Regulatory and Compliance Considerations

Quantum technology is widely recognized as a critical and transformative sector, with the potential to revolutionize various industries including computing, communication, and security. Given its far-reaching implications, it is essential that developments and the exploitation of quantum technologies align comprehensively with regulatory standards set at the European Union level. Compliance with these regulations not only ensures that technological advances are legally sound but also addresses broader ethical, safety, and socio-economic considerations.

Adhering to regulatory requirements is pivotal for several reasons. Firstly, it significantly enhances trust among stakeholders, which includes investors, partners, consumers, and regulatory bodies themselves. Stakeholders are more likely to engage with and support organizations that demonstrate a robust commitment to regulatory compliance. This trust is fundamental to fostering long-term partnerships and securing continued investment. Secondly, consistent adherence to regulations boosts the credibility of both the innovations

4. Fabrication Plan for Quantum Sensors and Photonic Components

Overview

This fabrication plan outlines the main lines for a strategy for scaling the production of quantum sensors and photonic components from laboratory prototypes to chip-scale manufacturing. One of the objectives of this project is to develop advanced quantum-enhanced sensors and photonic components and integrate them on-a-chip that can be produced at scale. The plan focuses on the technological processes, quality control, and collaborative efforts required to transition from research to production. In Table 7 the main objectives of this plan are listed.

Table 7 -Fabrication Plan for quantum sensors and photonic components: objectives

Objectives
Optimize quantum sensors requirements - Focus on refining the design and functionality of quantum sensors, ensuring they meet performance benchmarks and are compatible with scalable manufacturing processes.
Integrate Photonic Components: Develop photonic integrated circuits (PICs) that incorporate quantum sensors and all the needed photonic components, leveraging advanced photonic integration techniques to ensure compactness and reliability.
Establish scalable fabrication processes: Define and implement fabrication processes that can be scaled from small batch laboratory production to larger-scale manufacturing.

Scale from laboratory to production

A strategy to scale up from laboratory to production can be summarized in six phases. In the Table 8 below, we report each phase and its description.

Table 8 - From laboratory to production: strategic phases

Prototype Development	Design and Simulation: Utilize state-of-the-art simulation tools to design quantum sensors and photonic components. Validate designs through extensive simulations.
	Initial Fabrication and Testing: Fabricate initial prototypes using laboratory-scale equipment. Conduct rigorous testing to assess performance and identify any design modifications needed.
Process Optimization	Material Selection: Choose materials that optimize performance and are compatible with mass production techniques.
	Fabrication Techniques: Develop and refine fabrication techniques such as lithography, etching, and deposition to achieve the required precision and performance.
	Quality Control Protocols: Implement strict quality control protocols to ensure consistency and reliability of the components.
Pilot Production	Small Batch Production: Begin producing small batches of quantum sensors and photonic components. Use these batches to refine manufacturing processes and address any scalability issues.
	Performance Validation: Perform detailed performance validation of the small batch products to ensure they meet the necessary specifications.
Scale-Up to Full Production	Manufacturing Facility Preparation: Set up or upgrade manufacturing facilities to handle larger-scale production. This includes acquiring the necessary equipment, training personnel, and solve issues regarding the packaging of the PIC (e.g. electronic and optical interfaces have to communicate with low losses). Finding a scalable and cost-effective solution for the packaging of electronic and photonic components is a challenge that should be taken into account imaging a full production process.
	Automation and Efficiency Improvements: Incorporate automation technologies to enhance production efficiency and consistency.
	Supply Chain Management: Establish a robust supply chain for raw materials and components to ensure a steady and reliable production flow.

Mass Production and deployment	High-volume manufacturing: Transition to high-volume manufacturing, utilizing the optimized processes and equipment. Here, the commissioning of equipment for the characterization and testing of the PICs' performance will be crucial for monitoring and optimizing production processes
	Market readiness: Prepare the quantum sensors and photonic components for market deployment, ensuring they meet regulatory standards and market requirements.
	Continuous Improvement: Implement a feedback loop from market performance to continuously improve the product and manufacturing processes.
Collaboration and partnerships	Industry Partners: Work with industry partners specializing in semiconductor manufacturing and photonic integration to scale up production capabilities.
	Research Institutions and Universities: Collaborate with academic partners to leverage cutting-edge research and innovations.
	Regulatory Bodies: Engage with regulatory bodies to ensure compliance with industry standards and obtain necessary certifications.

These six phases are theoretically very well-structured. However, it seems appropriate to also formulate a parallel plan, perhaps more realistic. In fact, it seems wise to chart an intermediate path, compared to the more challenging task of mass-producing a complex photonic chip. Therefore, a simpler initial approach could be to use standard photonic components to build the sensors. This will reduce the constraints and efforts required for PIC production, but it will entail additional effort for chip packaging. It is important to be aware of this trade-off and take it into account when a mitigation strategy will be defined.

Further, and more detailed, analysis of all these aspects will be conducted once the project results are more concrete. We therefore expect to define it at the end of the project at M41 (D7.5 - Final Exploitation, Dissemination and Impact report).

5. IP Management

QUANTIFY adopts a structured and proactive approach to the management of intellectual property (IP), with the objective of maximising the exploitation potential of project results while preserving scientific openness and timely dissemination. The Consortium recognises that several of the technologies developed within the project may have significant innovation and commercial potential, and therefore require careful handling prior to public disclosure.

To this end, QUANTIFY encourages all partners to systematically assess whether research results intended for publication may be suitable for intellectual property protection, in particular through patenting. This assessment is performed at partner level, with the support of institutional Technology Transfer Offices where available, and in coordination with the project's exploitation and management activities. When appropriate, partners may temporarily delay dissemination in order to allow for IP evaluation and, if justified, the filing of patent applications, in full compliance with the Grant Agreement and the Consortium Agreement.

This “publish or protect” approach is implemented in a pragmatic and proportionate manner, ensuring that only results with genuine exploitation potential are subject to IP protection procedures, while fundamental research outputs continue to be disseminated without unnecessary delay. The project management supports this process by promoting IP awareness within the Consortium and by ensuring alignment between IP decisions, dissemination activities, and the overall exploitation strategy of QUANTIFY.

Through this balanced framework, QUANTIFY aims to protect valuable innovations, foster future industrial uptake, and contribute effectively to the European quantum technology ecosystem.

6. Conclusion

This plan started in January 2024, in correspondence with the kick-off meeting, with specific actions of the launch, development and life after of the project.

With this document, the QUANTIFY Consortium has provided an update version of the Communication, Dissemination, and Exploitation strategy for the various target groups.

Overall, the dissemination and communication performance of the QUANTIFY project during the first 24 months can be considered excellent and well above expectations. Although the dissemination Key Performance Indicators (KPIs) were originally defined for the end of the project, a substantial proportion of them has already been achieved, and in some cases nearly reached, at mid-project stage. The high number of international conference participations, invited talks, workshops, and peer-reviewed publications demonstrates the strong scientific visibility of QUANTIFY and the relevance of its results within the quantum technologies community.

The breadth and quality of the dissemination activities carried out so far reflect the high level of engagement of the Consortium partners and confirm the project's strong positioning across scientific, technical, and academic audiences at both European and international levels. In particular, the number of published papers and high-profile conference contributions highlights the scientific maturity of several project outcomes, despite the intrinsic technological complexity and ambition of QUANTIFY.

While no press releases have been issued during the first reporting period, the Consortium recognises their importance as a complementary dissemination channel targeting a broader, non-specialised audience. Press and outreach activities are therefore planned and will be actively implemented within the first six months of the next reporting period, in line with the expected KPIs and the overall communication strategy of the project.

In conclusion, the dissemination and communication activities conducted to date provide strong evidence of the project's impact, visibility, and momentum, positioning QUANTIFY very favourably to further strengthen its outreach, communication, and exploitation actions in the second half of the project.

In addition, at this stage, QUANTIFY clearly positions itself as a high-potential project, capable of generating enabling technologies that extend beyond the original research objectives. In the coming months, as project activities further mature and systematic performance monitoring of the developed quantum sensors progresses, the Consortium will be in a stronger position to assess how this innovation potential can be effectively translated into deployable, high-impact technologies. This evolution will be key to determining how QUANTIFY's results can ultimately support both scientific

advancement and societal needs, paving the way for future exploitation and real-world adoption of quantum-enhanced sensing solutions.

The Consortium identified seven innovations to be highlighted within the Innovation Radar Questionnaire, and they are reported within the Table 9.

Table 9 – Innovations identified by the Consortium for the Innovation Radar Questionnaire

Innovations	Leading partner
Engineered periodically poled waveguides and electro-optic modulators for efficient on-chip laser frequency conversion	CSEM
Photonic integrated circuits for on-chip squeezed light generation at 780 nm	CSEM
Microtransfer-printed integration of PP-LNOI structures, GaP photonic cavities, and photonic tunable lasers (780 and 1560 nm) on a unified photonic platform	UGent
Development of Rb MEMS cells and chip scale narrow linewidth laser for a compact optical frequency standard	CSEM
Development of an optomechanical on-chip sensor designed for optical, mechanical and quantum thermometry	SU
High-efficiency balanced photodetector (600–900 nm) for Rubidium-based quantum sensing	UHAM
Quantum-enhanced optically pumped magnetometer using miniaturized vapor cells for sensitive magnetic field measurements	ICFO-CREA

However, the identification and inclusion of more QUANTIFY technologies within the European Commission’s Innovation Radar clearly demonstrate that the results generated by the project go beyond scientific excellence and are recognised as innovations with tangible exploitation and market potential. The Innovation Radar assessment, based on a bottom-up evaluation of project outputs, highlights those technologies that are most likely to influence future markets and contribute to strengthening the European industrial and technological value chain. The fact that multiple QUANTIFY developments were selected—both those proposed by the Consortium and those independently identified by the Innovation Radar team—confirms the strategic relevance, originality, and maturity of the technologies emerging from the project.

This recognition reinforces QUANTIFY’s positioning as a high-potential project within the European quantum technologies landscape, capable of delivering enabling technologies that address concrete industrial and societal needs. The identified innovations span a broad spectrum, from photonic integration and laser technologies to quantum-enhanced sensing and time-frequency standards, reflecting the systemic and cross-cutting nature of the project. Such diversity of exploitable results increases the likelihood of multiple exploitation pathways, including technology licensing, integration into existing industrial platforms, and the development of new products or services by industrial partners.

Looking ahead, the Consortium considers the next phase of the project to be critical for consolidating and validating the exploitation potential of these innovations. As the project advances and the performance of the developed quantum sensors is further monitored, characterised, and

benchmarked, QUANTIFY will be able to better assess the readiness of its technologies for real-world deployment. This phase will be instrumental in determining how the identified innovation potential can be translated into robust, scalable, and reliable solutions that deliver concrete benefits to both science and society.

In this context, QUANTIFY will continue to align its exploitation strategy with the evolution of the technical results, fostering close interaction between research partners and industrial stakeholders. This approach aims to ensure that the most promising innovations are effectively brought “from concept to application,” contributing to the emergence of high-value European technologies in quantum sensing, metrology, and photonic integration.

Annex 1 – Communication activities: from M7 to M24

This Annex reports the engagement related to the implementation of communication actions (social media posts and website content) carried out from M7 to M24.

Below is a reminder of how the engagement-related KPIs are measured:

Engagement

rate

Engagement rate = (number of likes + number of shares + number of comments / number of followers) × 100

Views

and

watch

time

Views and watch time refer to the number of times a user views more than 50% of the content on the social media profile, as well as the total viewing time. Viewing time is recorded when a user plays a video for more than 2 seconds and is analysed in relation to previously uploaded videos.

Views

and

interactions

Views and interactions indicate the number of times a user views at least 50% of the content on the social media profile page and the number of times a user interacts with a post.

In addition, we decided to monitor the **Click-Through Rate (CTR)**, a key performance metric in social media marketing that helps assess the effectiveness and relevance of content for the audience. CTR represents the percentage of viewers who clicked on a link, call-to-action, or advertisement out of the total number of impressions received. It is a crucial indicator of how engaging and compelling the content is for the target audience.

CTR is calculated as the ratio of users who click on a specific link to the total number of users who view the advertisement or post (impressions), according to the following formula:

$$\text{CTR} = (\text{total clicks} / \text{total impressions}) \times 100$$

The target CTR is set at 1%. A CTR between 0.5% and 1% is considered strong, while top-performing ads typically achieve CTRs of 1–2% or higher.

INRiM's social media channels show a steady growth in the number of followers. For this reason, they were identified as an effective means to support the QUANTIFY communication plan.

The number of followers as of 31 December 2023, 20 June 2024, and 31 December 2025 for the relevant social media platforms is reported below:

- **LinkedIn:** 3,717 (4,325 as of 20 June 2024; **6,829 as of 31 December 2025**)
- **Facebook:** 2,338 (2,534 as of 20 June 2024; **2,709 as of 31 December 2025**)
- **Instagram:** 398 (535 as of 20 June 2024; **770 as of 31 December 2025**)
- **YouTube:** 406 subscribers (**458 subscribers as of 31 December 2025**)

Activities already implemented and related to Objectives **OC1 – Give visibility and publicize the project** and **OC2 - Disseminate the project’s results** and they are highlighted in light green in Table 10.

Table 10 - Communication Plan - Planned activities and relevant KPIs.

OC1. Give visibility and publicize the project				
Target audience: Scientific communities, European companies and SMEs and Policy makers				
Message	Channel	Activities	KPIs	Target
Starting the QUANTIFY project/Project Kick-Off	QUANTIFY website	Information about the project	N. of visitors; Stay-on-page time; Project updates;	100/year 60 s 2/month
	Press	Press release	N. press release	1/year
	International and European Scientific Conference	Talks	N. talks	3/year
	LinkedIn, Facebook, Instagram	Post with video interviews;	Engagement rate* CTR ****	≥ 3% ≥ 1%
	YouTube	Video interviews	Views and watch time**	≥ 100 - ≥ 1.2
Target audience: Policy makers				
Starting the QUANTIFY project/Project Kick-Off	Press release	Press release	N. press release	1/year
How the project results will impact Society daily life				
The project will enable actions for student involvement				
Target audience: Schools				
Scientific research is exciting and yields useful results	LinkedIn e Instagram	Research outreach meetings for high schools and university	Engagement rate* CTR ****	≥ 3% ≥ 1%
	QUANTIFY website		N. of visitors; Stay-on-page time;	100/year 60 s

	Call for interest		N. of schools involved	≥ 1
Target audience: Universities				
Scientific research is exciting and yields useful results	QUANTIFY website	Workshops Lectures	N. of visitors; Stay-on-page time;	100/year 60 s
	Communication activities		N. workshops/lectures	3/year
	LinkedIn e Instagram		Engagement rate* CTR ****	≥ 3% ≥ 1%
Target audience: The generic public				
Starting the QUANTIFY project/Project Kick-Off	Instagram – Reel Facebook – Reel	Dissemination reels	Views and interactions***	≥ 100 - ≥ 100
How the project results will impact on Society	YouTube – Reel			
OC.2 Disseminate the project's results				
Target audience: Scientific communities, European companies and SMEs				
Project's outcomes	QUANTIFY website	Papers description	N. of visitors; Stay-on-page time;	100/year 60 s
	Press	Press release	N. press release	1/year
	Scientific papers	Papers	N. scientific papers	5/year
	International and European Scientific Conference	Talks	N. talks	3/year
	LinkedIn	Posts and video interviews;	Engagement rate* CTR****	≥ 3% ≥ 1%
	YouTube	Video interviews	Views and watch time**	≥ 100 - ≥ 1.2

Throughout 2025, QUANTIFY's social media communication strategy was implemented along four complementary and clearly defined lines of action:

1. **Public outreach and citizen engagement**

QUANTIFY was promoted to the general public through targeted dissemination activities carried out during the event "*Domenica in Scienza: Un viaggio nel mondo delle misure*", held on Sunday, 25 May 2025. This initiative aimed to enhance public awareness of the project, its objectives, and its societal relevance by engaging citizens in an accessible, science-oriented environment.

2. **"Meet the Partner" communication campaign**

The "*Meet the Partner*" campaign was developed to present the members of the QUANTIFY

consortium, while simultaneously illustrating the specific expertise, roles, and contributions of each partner within the project. In addition, the campaign highlighted the distinctive characteristics and objectives of the individual Work Packages, thereby reinforcing the visibility, coherence, and transparency of the project structure.

3. Dissemination of participation in international events

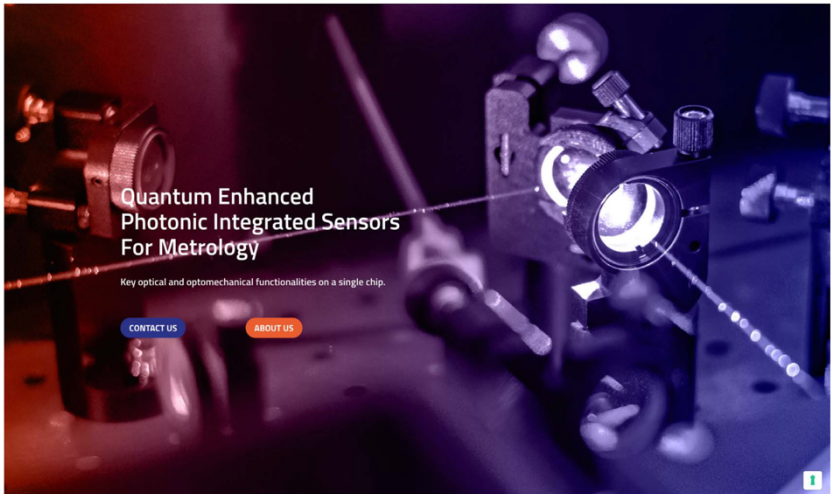
Communication activities also focused on disseminating QUANTIFY’s participation in international meetings, conferences, and workshops. These actions aimed to demonstrate the project’s active involvement within the international scientific and professional community and to underline its contribution to high-level discussions relevant to the project’s thematic areas.

4. Promotion of project results and key developments

The fourth line of action concerned the dissemination of project results, major milestones, and other significant developments related to QUANTIFY. This included the communication of preliminary findings, key achievements, and important project-related news, contributing to sustained visibility and stakeholder engagement.

The following sections provide a detailed analysis of each communication campaign, together with the corresponding posts published across different social media platforms.

Table 11 - Engagement monitoring - Website, from M7 to M24

Website – quantify-project.eu		
	N. of visitors	1.010
	Stay-on-page time [s]	2,6
	Project updates	<u>4 deliverables,</u> <u>9 news,</u> <u>4 graphic materials</u> <u>6 publications</u>
	<i>Data is collected on 31th December 2025.</i>	

As reported in **Errore. L'origine riferimento non è stata trovata.**, according to the set targets (N. of visitors 100/year and Stay-on-page time 60 s), the website of the project still remain very effective, exceeding expectations.

According to the KPI Project updates, the set target - 2/month - the set target does not seem to be met (23 updates): 36 updates were expected in 18 months. However, all the important news were reported, such as the public deliverables and the scientific publication in open access, in addition the two social media campaigns helped the project to maintain high visibility.

Public outreach and citizen engagement

To support QUANTIFY's public outreach and citizen engagement activities, a total of **three posts were published on LinkedIn, three on Facebook, and three on Instagram**. These posts highlighted the project's presence at the INRiM event "*Domenica in Scienza: Un viaggio nel mondo delle misure*", showcasing the interactive initiatives and dissemination activities carried out during the event. The multi-platform approach ensured broad visibility and maximized engagement with diverse audiences, effectively extending the impact of the event beyond its physical participants.

Table 12 - Post 1 – Published on 06 May 2025

LinkedIn / Facebook / Instagram		
Date: 06.05.2025		
Topic: The agenda of the event		
	<p>Reactions Comments Reposts Clicks Interactions Views Engagement CTR</p> <p>35 0 5 694 734 1742 42,14 % 39,84 %</p> <p><i>Data is collected on 31 December 2025</i></p>	
	<p>Impressions Clicks Interactions Views</p> <p>678 7 46 1225</p> <p><i>Data is collected on 31 December 2025</i></p>	

	<p>Interactions Views</p> <p><i>Data is collected on 31 December 2025</i></p>	<p>17 333</p>
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This post introduced the agenda of the “*Domenica in Scienza*” event and was published simultaneously on **LinkedIn, Facebook, and Instagram**.

- **LinkedIn:** The post achieved **1,742 views** and **734 interactions**, corresponding to an **engagement rate of 42.14%**. It generated **694 clicks** with an exceptional **CTR of 39.84%**, supported by **35 reactions** and **5 shares**, highlighting strong audience interest and engagement.
- **Facebook:** The post reached **1,225 views**, with a coverage of **678 users**, **46 interactions**, and **7 clicks**, demonstrating moderate engagement on this platform.
- **Instagram:** The post recorded **333 views** and **18 interactions**, effectively reaching the platform’s audience.

Overall, the post successfully promoted the event program across multiple platforms, maximizing visibility and driving audience interest in attending the event.

Table 13 - Post 2 – Published on 17 May 2025

Facebook / Instagram		
Date: 17.05.2025		
Topic: Book your experience		
	<p>Impressions Clicks Interactions Views</p> <p><i>Data is collected on 31 December 2025</i></p>	<p>202 5 6 228</p>
	<p>Interactions Views</p> <p><i>Data is collected on 31 December 2025</i></p>	<p>15 678</p>


This post focused on the booking of visits to the event, encouraging audience participation and facilitating engagement prior to the event.

- **Facebook:** The post reached **228 views**, with a coverage of **202**, generating **6 interactions** and **5 clicks**, reflecting modest engagement.
- **Instagram:** The same content achieved **678 views** and **15 interactions**, showing stronger visibility and interest on this platform.

The post effectively supported pre-event engagement and provided audiences with actionable information to participate in the activities.

Table 14 - Post 3 – Published on 23 May 2025

LinkedIn / Facebook / Instagram		
Date: 23.05.2025		
Topic: Focus on the dissemination activities		
	<p>Reactions Comments Reposts Clicks Interactions Views Engagement CTR</p>	<p>9 0 1 193 203 911 22,28 % 21,19 %</p> <p><i>Data is collected on 31 December 2025</i></p>
	<p>Impressions Clicks Interactions Views</p>	<p>300 1 11 367</p> <p><i>Data is collected on 31 December 2025</i></p>

	<p style="text-align: center;">Interactions Views</p> <p style="text-align: center;"><i>Data is collected on 31 December 2025</i></p>	<p style="text-align: center;">10 688</p>
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This post highlighted the science communication and dissemination activities carried out during the event.

- **LinkedIn:** The post received **911 views** and **203 interactions**, resulting in an **engagement rate of 22.28%**, with **193 clicks** and a **CTR of 21.19%**, supported by **9 reactions** and **1 share**, confirming strong interest in the content.
- **Facebook:** The post recorded **367 views** with a coverage of **300 users**, **11 interactions**, and **1 click**, indicating moderate engagement.
- **Instagram:** The post achieved **688 views** and **10 interactions**, reaching a substantial portion of the platform's audience.

This post effectively showcased QUANTIFY's dissemination efforts, reinforcing the project's visibility and impact among both the professional and general audience.

Table 15 - Post 4 – Published on 27 May 2025

LinkedIn		
Date: 27.05.2025		
Topic: Focus on QUANTIFY stand		
	Reactions Comments Reposts Clicks Interactions Views Engagement CTR	30 0 3 379 412 1174 35,09 % 32,28 %
<i>Data is collected on 31 December 2025</i>		

This post summarized the outcomes of the event and showcased key moments and achievements.

- LinkedIn:** The post achieved **1,174 views** and **412 interactions**, corresponding to an **engagement rate of 35.09%**. It generated **379 clicks**, with a **CTR of 32.28%**, supported by **30 reactions** and **3 shares**, demonstrating strong audience interest and effective post-event communication.

This post successfully consolidated the visibility gained during the event and highlighted QUANTIFY’s active engagement with the public, contributing to sustained interest and awareness of the project.

Meet the Partner Campaign | July 15 to October 20 (in progress)

As part of the “Meet the Partner” communication campaign, a total of **eight posts** were published on **LinkedIn**, with the objective of introducing the members of the QUANTIFY consortium and highlighting their respective roles, expertise, and contributions within the project.

Table 16 - Post 1 – Published on 15 July 2025

LinkedIn		
Date: 15.07.2025		
Topic: Meet the Partner – INRiM (Giulia Aprile)		
	<p>Reactions 53 Comments 4 Reposts 4 Clicks 156 Interactions 217 Views 3777 Engagement 5,75% CTR 4,13%</p> <p><i>Data is collected on 30 December 2025</i></p>	

The first post of the “Meet the Partner” campaign achieved strong visibility and engagement. With 3,777 views and 217 interactions, it recorded an engagement rate of 5.75%, indicating a high level of audience interest. The post generated 156 clicks, corresponding to an excellent CTR of 4.13%, well above the project target. Engagement was further supported by 53 reactions, 4 comments, and 4 reposts, confirming the effectiveness of the content in attracting attention and stimulating interaction.

Table 17 - Post 2 – Published on 28 July 2025

LinkedIn		
Date: 28.07.2025		
Topic: Meet the Partner – CNRS (Rémy Braive)		
	<p>Reactions Comments Reposts Clicks Interactions Views Engagement CTR</p> <p><i>Data is collected on 30 December 2025.</i></p>	<p>14 0 2 44 60 1987 3,02% 2,21%</p>

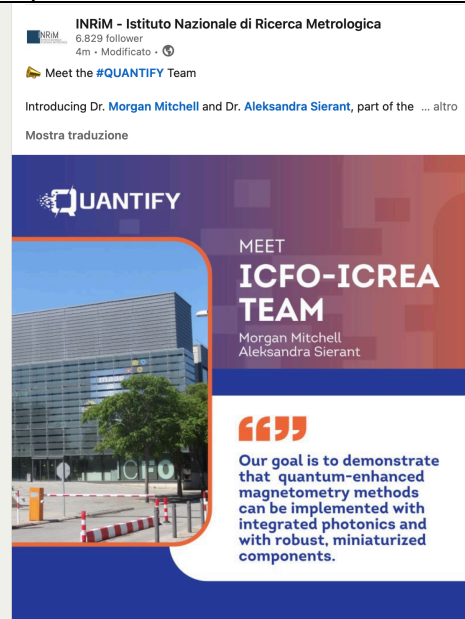
The second post reached 1,987 views and generated 60 interactions, resulting in an engagement rate of 3.02%. A total of 44 clicks were recorded, with a CTR of 2.21%, indicating good content relevance. User engagement included 14 reactions and 2 reposts, while no comments were recorded.

Table 18 - Post 3 – Published on 11 August 2025

LinkedIn		
Date: 11.08.2025		
Topic: Meet the Partner – LNE (Olga Kozlova)		
	<p>Reactions</p> <p>Comments</p> <p>Reposts</p> <p>Clicks</p> <p>Interactions</p> <p>Views</p> <p>Engagement</p> <p>CTR</p> <p><i>Data is collected on 30 December 2025.</i></p>	<p>15</p> <p>0</p> <p>1</p> <p>46</p> <p>62</p> <p>1683</p> <p>3,68%</p> <p>2,73%</p>

This post obtained 1,683 views and 62 interactions, corresponding to an engagement rate of 3.68%. The post generated 46 clicks and a CTR of 2.73%, demonstrating a solid capacity to drive traffic. Interaction metrics included 15 reactions and 1 repost, with no comments reported.

Table 19 - Post 4 – Published on 25 August 2025

LinkedIn		
Date: 25.08.2025		
Topic: Meet the Partner – ICFO-ICREA Team		
	<p>Reactions</p> <p>Comments</p> <p>Reposts</p> <p>Clicks</p> <p>Interactions</p> <p>Views</p> <p>Engagement</p> <p>CTR</p> <p><i>Data is collected on 30 December 2025.</i></p>	<p>24</p> <p>0</p> <p>1</p> <p>63</p> <p>88</p> <p>1783</p> <p>4,99%</p> <p>3,57%</p>

The fourth post achieved 1,763 views and 88 interactions, resulting in an engagement rate of 4.99%, among the highest within the campaign. It generated 63 clicks, with a CTR of 3.57%, confirming strong audience interest. The post received 24 reactions and 1 repost, with no comments recorded.

Table 20 - Post 5 – Published on 08 September 2025

LinkedIn		
Date: 08.09.2025		
Topic: Meet the Partner – Universiteit Gent Team		
	<p>Reactions Comments Reposts Clicks Interactions Views Engagement CTR</p> <p><i>Data is collected on 30 December 2025.</i></p>	<p>6 0 0 5 11 543 2,03% 0,92%</p>

This post recorded lower visibility, with 543 views and 11 interactions, corresponding to an engagement rate of 2.03%. It generated 5 clicks, resulting in a CTR of 0.92%, slightly below the project target. Engagement was limited to 6 reactions, with no comments or reposts.

Table 21 - Post 6 – Published on 22 September 2025

LinkedIn		
Date: 22.09.2025		
Topic: Meet the Partner – University of Hamburg (Axel Schönbeck)		
	<p>Reactions Comments Reposts Clicks Interactions Views Engagement CTR</p> <p><i>Data is collected on 30 December 2025.</i></p>	<p>11 0 0 4 11 590 1,86% 0,68%</p>


The sixth post reached 590 views and generated 11 interactions, leading to an engagement rate of 1.86%. A total of 4 clicks were recorded, with a CTR of 0.68%. No comments or reposts were observed, indicating a relatively modest level of audience engagement.

Table 22 Post 7 – Published on 06 October 2025

LinkedIn		
Date: 06.10.2025		
Topic: Meet the Partner – CSEM (Laurent Balet)		
	<p>Reactions Comments Reposts Clicks Interactions Views Engagement CTR</p> <p><i>Data is collected on 30 December 2025.</i></p>	<p>7 0 0 11 18 758 2,37% 1,45%</p>

This post achieved 758 views and 18 interactions, corresponding to an engagement rate of 2.37%. It generated 11 clicks and a CTR of 1.45%, meeting the minimum target threshold. Engagement consisted of 7 reactions, with no comments or reposts.

Table 23 - Post 8 – Published on 20 October 2025

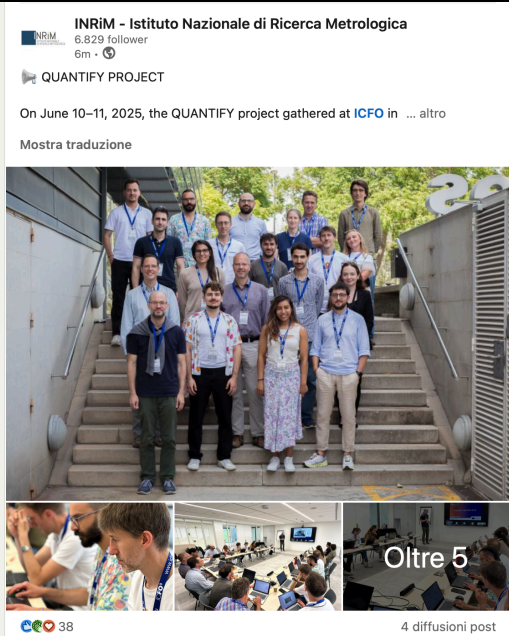
LinkedIn		
Date: 20.10.2025		
Topic: Meet the Partner – Institute of Physics, Zagreb (Ticijana Ban)		
 <p>INRIM - Istituto Nazionale di Ricerca Metrologica 6.829 follower 2m · 🌐</p> <p>Meet the #QUANTIFY Team</p> <p>Let's introduce Ticijana Ban, senior researcher at the Center for ... altro</p> <p>Mostra traduzione</p> <p>QUANTIFY</p> <p>MEET TICIJANA BAN Institute of Physics, Zagreb</p> <p>Our goal is to develop a miniaturized quantum memory based on a MEMS cell and a PIC laser.</p> <p>👍❤️👍 25</p> <p>4 diffusioni post</p>	<p>Reactions 25</p> <p>Comments 0</p> <p>Reposts 4</p> <p>Clicks 32</p> <p>Interactions 61</p> <p>Views 1428</p> <p>Engagement 4,27 %</p> <p>CTR 2,24 %</p> <p><i>Data is collected on 30 December 2025.</i></p>	

The final post of the campaign recorded 1,428 views and 61 interactions, resulting in a high engagement rate of 4.27%. It generated 32 clicks, corresponding to a CTR of 2.24%. Interaction metrics included 25 reactions and 4 reposts, confirming a strong closing performance for the campaign.

Participations in international scientific events

In this context, **two dedicated social media posts** were published on LinkedIn. The first post focused on the **QUANTIFY Annual Meeting**, showcasing the progress achieved, the coordination among consortium partners, and the strategic discussions supporting the advancement of the project. The second post highlighted **QUANTIFY’s participation in the European Quantum Technology Conference 2025**, emphasizing the project’s visibility within a major international forum and its contribution to the broader quantum technology landscape.

Table 24 - Post 1 – Published on 12 June 2025

LinkedIn																	
Date: 12.06.2025																	
Topic: Annual Meeting in Castelldefels																	
	<table border="1"> <tr> <td>Reactions</td> <td>38</td> </tr> <tr> <td>Comments</td> <td>0</td> </tr> <tr> <td>Reposts</td> <td>4</td> </tr> <tr> <td>Clicks</td> <td>1028</td> </tr> <tr> <td>Interactions</td> <td>1070</td> </tr> <tr> <td>Views</td> <td>2824</td> </tr> <tr> <td>Engagement</td> <td>37,89 %</td> </tr> <tr> <td>CTR</td> <td>36,4 %</td> </tr> </table> <p><i>Data is collected on 30 December 2025.</i></p>	Reactions	38	Comments	0	Reposts	4	Clicks	1028	Interactions	1070	Views	2824	Engagement	37,89 %	CTR	36,4 %
Reactions	38																
Comments	0																
Reposts	4																
Clicks	1028																
Interactions	1070																
Views	2824																
Engagement	37,89 %																
CTR	36,4 %																

The post dedicated to the QUANTIFY Annual Meeting achieved outstanding performance in terms of both visibility and user engagement. It recorded 2,824 views and an exceptionally high number of interactions (1,070), corresponding to an engagement rate of 37.89%. The post generated 1,028 clicks, resulting in an excellent CTR of 36.4%, significantly exceeding the project’s target values. Engagement was further supported by 38 reactions and 4 reposts, confirming the strong interest of the audience in the project’s coordination activities and scientific progress. These results highlight the effectiveness of the content in attracting attention and encouraging active user interaction.

Table 25 - Post 2 – Published on 14 November 2025


LinkedIn		
Date: 14.11.2025		
Topic: European Quantum Technology Conference 2025		
	<p>Reactions Comments Reposts Clicks Interactions Views Engagement CTR</p>	<p>23 0 3 135 161 1132 14,22 % 11,93 %</p>
<p><i>Data is collected on 30 December 2025.</i></p>		

The post focusing on QUANTIFY’s participation in the European Quantum Technology Conference 2025 achieved solid and consistent performance. With 1,132 views and 161 interactions, it recorded an engagement rate of 14.22%, indicating a high level of audience interest. The post generated 135 clicks, corresponding to a CTR of 11.93%, well above the project benchmark. Engagement metrics included 23 reactions and 3 reposts, while no comments were recorded. Overall, the post effectively reinforced the project’s visibility within a major international conference and highlighted its active role in the European quantum technology community.

Promotion of project results and key developments

The fourth line of action focused on the dissemination of project results, major milestones, and other significant developments related to QUANTIFY. In this context, **one dedicated social media post** was published to communicate a major milestone achieved by the project. The post announced the selection of several innovations developed within QUANTIFY by the **European Commission** for inclusion in the **Innovation Radar**, the official European database showcasing innovations with the highest potential impact and market uptake in the field of Quantum Technologies. Specifically, out of **34 innovations** identified overall, **7 originated from the QUANTIFY project**, underscoring the high scientific quality, technological maturity, and expected societal impact of the project’s results. This communication activity played a key role in reinforcing QUANTIFY’s positioning as a leading Horizon Europe project and in showcasing its contribution to innovation at European level.

Table 26 - Post 1 – Published on 17 December 2025

LinkedIn																	
Date: 17,12.2025																	
Topic: Innovation Radar																	
	<table border="1"> <tr> <td>Reactions</td> <td>17</td> </tr> <tr> <td>Comments</td> <td>0</td> </tr> <tr> <td>Reposts</td> <td>2</td> </tr> <tr> <td>Clicks</td> <td>26</td> </tr> <tr> <td>Interactions</td> <td>45</td> </tr> <tr> <td>Views</td> <td>1075</td> </tr> <tr> <td>Engagement</td> <td>4,19 %</td> </tr> <tr> <td>CTR</td> <td>2,42 %</td> </tr> </table> <p><i>Data is collected on 30 December 2025.</i></p>	Reactions	17	Comments	0	Reposts	2	Clicks	26	Interactions	45	Views	1075	Engagement	4,19 %	CTR	2,42 %
Reactions	17																
Comments	0																
Reposts	2																
Clicks	26																
Interactions	45																
Views	1075																
Engagement	4,19 %																
CTR	2,42 %																

The post dedicated to the communication of QUANTIFY’s recognition within the **European Commission Innovation Radar** achieved solid performance in terms of visibility and engagement. It recorded **1,075 views** and **45 interactions**, corresponding to an **engagement rate of 4.19%**, indicating a good level of audience interest in the project’s results and achievements.

The post generated **26 clicks**, resulting in a **CTR of 2.42%**, which is well above the project benchmark and confirms the effectiveness of the content in driving user action. Engagement was further supported by **17 reactions** and **2 reposts**, while no comments were recorded.

Overall, the post successfully highlighted a major project milestone and reinforced QUANTIFY's positioning as a high-impact Horizon Europe project, contributing to sustained visibility and stakeholder engagement at European level.

Annex 2 – Dissemination activities: from M7 to M24

The dissemination activities are reported within Chapter 3 – Dissemination Plan.

European companies and SMEs
KPI: n. of dedicated workshops (2); n. of in-field applications after 3 years from the end of the project (3); n. of improved technical KPIs (from the Annex 1 to the GA, DoA - Excellence) after 3 years from the end of the project (8).
Technical, scientific and academic community
KPI: n. of international conference participations (15); n. of published papers (10); n. of submitted proposals enabled by the results of this project after 3 years from the end of the project (3).
National Metrology Institutes
KPI: n. of round robins (3); n. of international comparison performed (3).
Policy makers
KPI: n. of press release (6); n. of recruitment calls enabled by the results of this project (5).

In the first 24 months of the project, the first dissemination activities occurred, regarding the dedicated workshop, the participation in conferences, the published papers through the technical, scientific and academic communities and the press release through the policy makers.

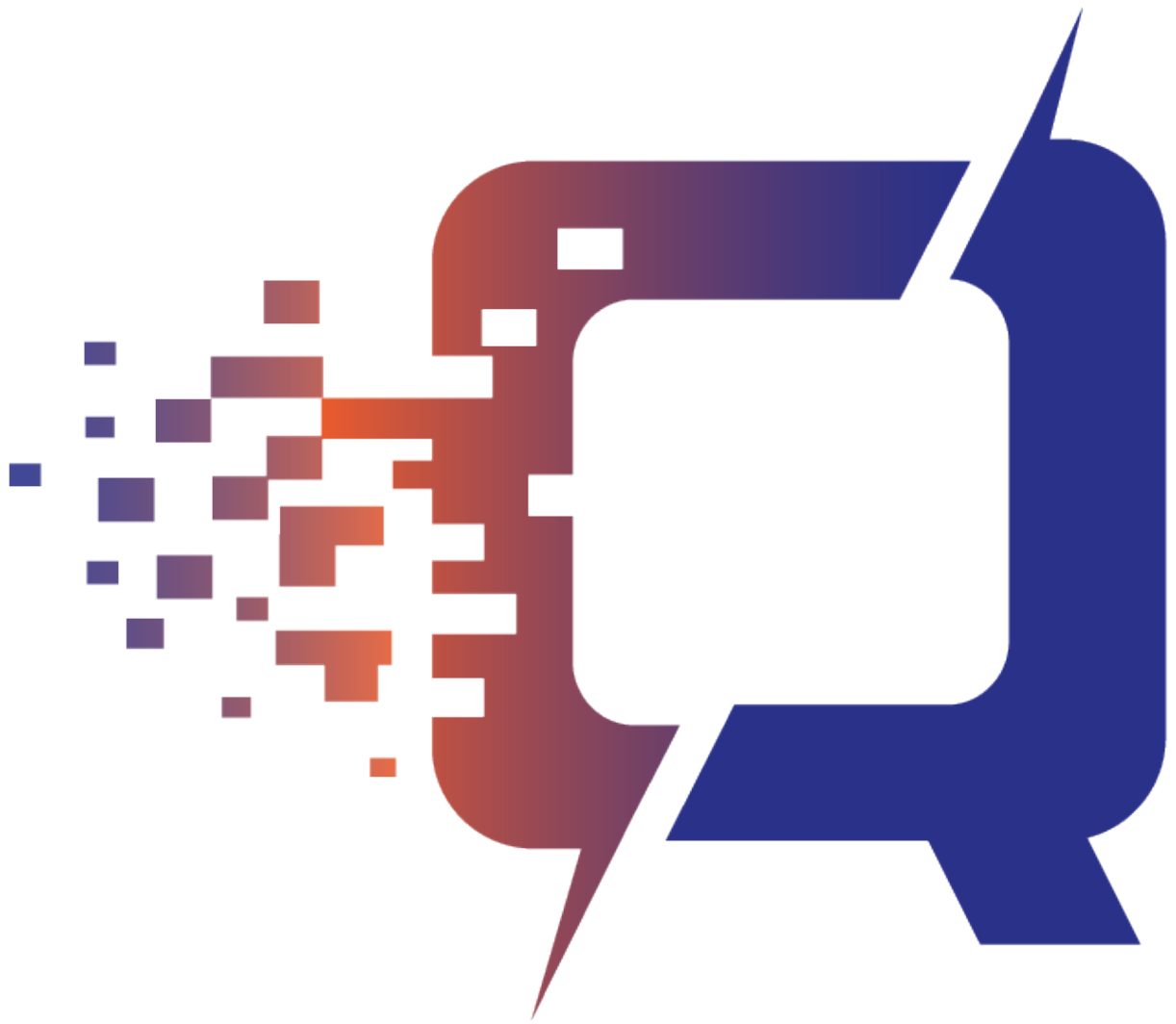
The dissemination actions already carried out are listed here:

- n. of dedicated workshops (**2 delivered, 2 expected**):
 - 1) On February 3–4th 2025, the QUANTIFY project organized together with other 3 EU-project (ELENA, Clustec, uTP4Q) the “Quantum Applications in Integrated Photonics”workshop held in Ljubljana.
 - 2) On September 18–19th, 2025, the IoPZg staff organized of a regional workshop with the aim of raising awareness of quantum technologies.The workshop, entitled **Zagreb–Trieste–Ljubljana Quantum Technologies Workshop: Focus on Experiments**, was held in Zagreb at the Institute of Physics, CALT building. The workshop was attended by around 30 participants, including approximately 20 PhD students and postdoctoral researchers.
- n. of international conference participations (**12 delivered, 15 expected**):
 - 1) Invited talk at “The redefined kelvin – progress and prospects ” A Royal Society Theo Murphy Discussion meeting, 24-25 February 2025, “Thermometry with optomechanical resonantors:from photonic and noise thermometry towards quantum thermometry”.

- 2) Oral Presentation at TEMPMEKO - ISHM 2025 (Reims, France, 20-24 October 2025) titled «Thermometry with optomechanical resonators from 4 K to 300 K ».
 - 3) Oral presentation at "Measuring by light 2025 (MBL2025)", Delft, Netherlands, 1-3 April 2025, "Towards quantum thermometry with optomechanics".
 - 4) Oral presentation at “Technical Committee -Time and Frequency”, Annual meeting 2024, Paris, 17.04.2024 “QUANTIFY: Project overview”.
 - 5) Poster presentation at European Quantum Technology Conference 2024 – QUANTIFY: Project overview;
 - 6) Poster presentation at European Quantum Technology Conference 2025 – QUANTIFY: Project overview;
 - 7) Oral presentation at Nanoinnovation 2024
 - 8) Poster presentation at CEWQO29 - 06/2025, GRS Quantum Sensing poster presentation at the Quantum Optics XI conference held in Krakow, Poland, 1-5 September 2025, titled "Quantum sensors: Strontium optical atomic clock and Quantum memories on MEMS cell.
 - 9) Talk and two posters during GRS Quantum Sensing in Les Diablerets, Switzerland, 12 July 2025. Presentation on WP3 results;
 - 10) Talk and two posters at WOPM, PSI Switzerland, 6-8 August 2025;
 - 11) Talk and two posters during Quantum Optics in Krakow, Poland, 1-5 September 2025. Presentation on WP3 results;
 - 12) Talk during CEWQO29, Wilnus, Lithuania, 23-27 June 2025. Presentation on WP3 results.
- n. of published papers (**6 delivered, 10 expected**):
 - 1) Gozzelino, M. et al. “Activation and characterization of Rb MEMS cells with an automatic system at wafer level” - <https://doi.org/10.1016/j.sna.2025.116621>
 - 2) Zarraoa, L. et al. "Quantum jump photodetector for narrowband photon counting with a single atom." - <https://doi.org/10.1103/PhysRevResearch.6.033338>
 - 3) Hernández Ruiz, M. et al. “Cavity-enhanced detection of spin polarization in a microfabricated atomic vapor cell” - <https://doi.org/10.1103/PhysRevApplied.21.064014>
 - 4) Raghavan, H. et al. “Functionalized millimeter-scale vaporcells for alkali-metal spectroscopy and magnetometry” - <https://doi.org/10.1103/PhysRevApplied.22.044011>
 - 5) Piñol, E. et al. "Telling different unravelings apart via nonlinear quantum-trajectory averages." - <https://doi.org/10.1103/PhysRevResearch.6.L03205>
 - 6) Briant, T. et al. „Photonic and Optomechanical Thermometry” – <https://doi.org/10.3390/opt3020017>.
 - n. of press release (**0 delivered, 6 expected**).

References

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- [2] - Aprile, G. (2024). Communication Pack. Zenodo. <https://doi.org/10.5281/zenodo.12599374>
- [3] - McKinsey & Company, Quantum Monitor 2025: From concept to reality, McKinsey Digital, 2025. McKinsey & Company. (April, 2023). *Quantum Technology Monitor*. Available online [here](#).
- [4] – European Innovation Council – EIC Transition - https://eic.ec.europa.eu/eic-funding-opportunities/eic-transition_en



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For Metrolog**Y**