Communication, dissemination and exploitation plan

D7.1

Grant Agreement No.	101135931
Project Start Date	01.01.2024
Duration of the project	42 months
Deliverable Number	D 7.1
Deliverable Leader	INRiM
Dissemination Level (PU, SEN)	PU
Status	Final version
Submission Date	24.06.2024
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Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement N° 101135931.

PU=Public, SEN=Sensitive, limited under the conditions of the Grant Agreement

Modification Control

VERSION	DATE	DESCRIPTION AND COMMENTS	AUTHOR
0.1	11.01.2024	First Draft	Giulia Aprile / Andrea Piazzolla INRiM
0.2	20.05.2024	Second Draft	Giulia Aprile - INRiM Axel Schoenbeck - UHAM
0.3	24.06.2024	Third Draft, following the revisions by the internal experts	Giulia Aprile - INRiM
1.0	30.06.2024	Final version	Giulia Aprile - INRiM

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List of Acronyms

Acronym	Full name
CA	Consortium Agreement
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

Table of Contents

1.Introduction

1.1 Purpose of this document

QUANTIFY will provide a Communication, dissemination and exploitation Plan (D7.1 M06) to effectively manage, measure and maximize impact of its results. This 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 thank 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.

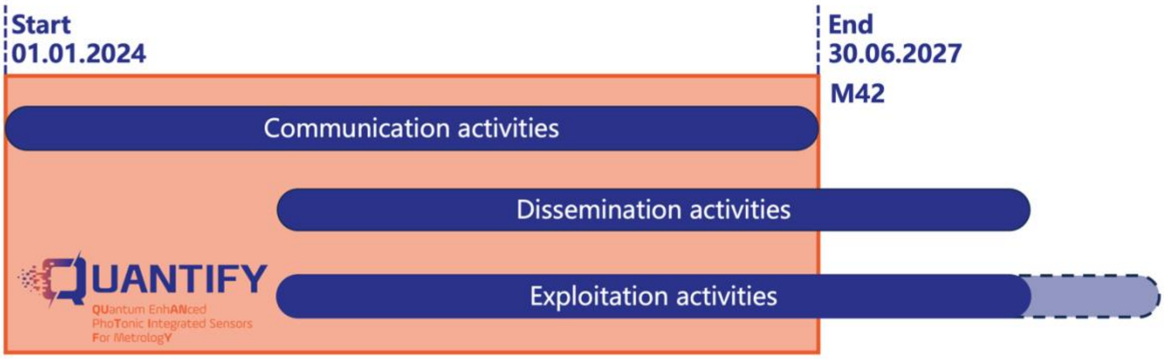


Figure 1 – Development of the Communication, Dissemination, and Exploitation activities

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 this Plan during the lifespan of the project (D7.3 M24, D7.5 M41) according to the results and their strategic impact. In the next three sections the initial strategies and the structures of this Plan are 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 M€ TOTAL BUDGET: 4 M€ PROJECT WEBSITE: quantify-project.eu CONSORTIUM: 13 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
3	Université Paris Cité	UPCité	France
4	Conservatorie National des Arts et Metiers	CNAM	France
5	Laboratorie National de Metrologie et d'Essais	LNE	France
6	Fundacio Institut de Ciencies Fotoniques	ICFO-CREA	Spain
7	Universiteit Gent	UGent	Belgium
8	Lionix International BV	Lionix INT. BV	Netherlands
9	QuiX QUANTUM BV	QUIX QUANTUM BV	Netherlands
10	Thales	THALES	France
11	Universitaet Hamburg	UHAM	Germany

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 we should: ensure a coordinated and continued communication, generating high-quality content ensure appropriate visibility to the project through all the stakeholders; define the key audiences, strategies to maximise the impact of the project results and deliverables, the channels, and feasible KPIs; establish the tools for an efficient tracking of the project's dissemination results and its subsequent assets against the target stakeholder groups; Support and facilitate the organization of workshops, events and training that maximize the impact and exploitation opportunities of the project; establish 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" we will consider specific strategies. For the Communication activities we will identify Stakeholders, define and segment the target audience, including researchers, industry partners, policymakers, and the general public. We will develop clear, concise messages that explain the technology concepts, their significance, and potential impact. We will utilize various communication channels such as project websites, social media, press releases, and blogs. Different tools to engage different audiences. We will participate in and organize events, workshops, and conferences to present our goals, our activities, our results and gather feedback.

The dissemination activities will 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 will 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 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 will be 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.

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) will be 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 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 will be tailored according to the target audience and the objective set out in the sections dedicated to Communication, Dissemination, and Exploitation.

2. Communication Plan

QUANTIFY will make continuous efforts for the communication in terms of project progresses, results and impacts in favor of the identified target groups. The communication activities will start at the outset of the project, they will cover the whole project life cycle. Their aim is to reach multiple communities, informing and engaging with society to make them aware of how they can benefit from the research this Consortium is developing. The main objective of the Communication Plan is to create an impactful communication strategy that raises awareness about the QUANTIFY project, its objectives, and achievements, while also strengthening its brand and engaging with a diverse range of audiences. A communication plan is defined to answer the following questions: What is our goal? To whom will the message be sent? Why is the target group relevant? What is the message? What is the channel for dissemination? What should be the perceived value that we target? This communication management will allow us to set clear objectives and KPIs to monitor the actions taken and their results to review them 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
This communication plan was created to respond the three needs: • give visibility and raise awareness about the project; • communicate the project steps and results; • evaluate the impact of the project results.
Target
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.
Messages
The specific messages are: • 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
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) [2] supports (roll-ups, technical sheet, flyers, videos, merchandising, notes, etc...).

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). In addition, 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 will be constantly monitored (once per month – starting from June 2024 - the KPIs for the QUANTIFY website and posts will be checked) and updated by M24 (December 2025). If necessary, the set targets will be updated to ensure the maximization of the communication activities.

The first implementation of the communication strategy took place during the project kick-off meeting of the project in January in Turin. In Annex 1 of this Plan, the posts and the first KPI values are reported.

Table 4 - Communication Plan - Planned activities and relevant KPIs

<table>
<tr><th colspan="5">OC1. Give visibility and publicize the project</th></tr>
<tr><th colspan="5">Target audience: Scientific communities, European companies and SMEs and Policy makers</th></tr>
<tr><th>Message</th><th>Channel</th><th>Activities</th><th>KPIs</th><th>Target</th></tr>
<tr><td rowspan="5">Starting the QUANTIFY project/Project Kick-Off</td><td>QUANTIFY website</td><td>Information about the project</td><td>N. of visitors;
Stay-on-page time;
Project updates;</td><td>100/year
60 s
2/month</td></tr>
<tr><td>Press</td><td>Press release</td><td>N. press release</td><td>1/year</td></tr>
<tr><td>International and European Scientific Conference</td><td>Talks</td><td>N. talks</td><td>3/year</td></tr>
<tr><td>LinkedIn, Facebook, Instagram</td><td>Post with video interviews;</td><td>Engagement rate*
CTR ****</td><td>≥ 3%
≥ 1%</td></tr>
<tr><td>YouTube</td><td>Video interviews</td><td>Views and watch time**</td><td>≥ 100 - ≥ 1.2</td></tr>
<tr><th colspan="5">Target audience: Policy makers</th></tr>
<tr><td>Starting the QUANTIFY project/Project Kick-Off</td><td rowspan="3">Press release</td><td rowspan="3">Press release</td><td rowspan="3">N. press release</td><td rowspan="3">1/year</td></tr>
<tr><td>How the project results will impact Society daily life</td></tr>
<tr><td>The project will enable actions for student involvement</td></tr>
<tr><th colspan="5">Target audience: Schools</th></tr>
<tr><td rowspan="3">Scientific research is exciting and yields useful results</td><td>LinkedIn e Instagram</td><td rowspan="3">Research outreach project for high schools</td><td>Engagement rate*
CTR ****</td><td>≥ 3%
≥ 1%</td></tr>
<tr><td>QUANTIFY website</td><td>N. of visitors;
Stay-on-page time;</td><td>100/year
60 s</td></tr>
<tr><td>Call for interest</td><td>N. of schools involved</td><td>≥ 1</td></tr>
<tr><th colspan="5">Target audience: Universities</th></tr>
<tr><td rowspan="3">Scientific research is exciting and yields useful results</td><td>QUANTIFY website</td><td rowspan="3">Workshops
Lectures</td><td>N. of visitors;
Stay-on-page time;</td><td>100/year
60 s</td></tr>
<tr><td>Communication activities</td><td>N. workshops/lectures</td><td>3/year</td></tr>
<tr><td>LinkedIn e Instagram</td><td>Engagement rate*
CTR ****</td><td>≥ 3%
≥ 1%</td></tr>
<tr><th colspan="5">Target audience: The generic public</th></tr>
<tr><td>Starting the QUANTIFY project/Project Kick-Off</td><td rowspan="2">Instagram – Reel
Facebook – Reel
YouTube – Reel</td><td rowspan="2">Dissemination reels</td><td rowspan="2">Views and interactions***</td><td rowspan="2">≥ 100 - ≥ 100</td></tr>
<tr><td>How the project results will impact on Society</td></tr>
</table>

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	Post with 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%

* Engagement rate = (n. likes + n. sharing + n. comments / n. 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: (total clicks / 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.

For each of them the relevance, the expectation, the entry point and the control KPIs are reported. QUANIFY Consortium choose the previous relevant targets for the following reasons:

European Companies and SMEs

Innovation and Competitiveness: Quantum sensors can significantly enhance the performance of various industrial applications, offering European companies and SMEs a competitive edge in the global market

Market Adoption: Dissemination activities can help these companies understand the potential applications and benefits of quantum sensors, fostering quicker adoption and integration into their products and services.

Collaborative Opportunities: Engaging with European companies and SMEs can lead to collaborations that drive further research, development, and commercialization of quantum sensor technologies.

Scientific and Academic Community

Research Advancements: The scientific and academic community plays a crucial role in advancing the fundamental research underlying quantum sensors. Dissemination activities ensure that researchers stay informed about the latest developments and can build upon them.

Knowledge Sharing: Dissemination fosters a collaborative environment where scientists can share knowledge, methodologies, and results, accelerating the pace of discovery and innovation.

Training and Education: Involving the academic community helps in training the next generation of scientists and engineers in quantum technologies, ensuring a skilled workforce for the future.

National Metrology Institutes

Standards and Calibration: NMIs are responsible for maintaining measurement standards. Quantum sensors promise unprecedented accuracy, and dissemination activities can help NMIs develop new standards and calibration techniques.

Validation and Certification: NMIs can validate and certify quantum sensor technologies, providing credibility and assurance to industries and other stakeholders.

Collaborative Research: NMIs can collaborate on research projects, leveraging their expertise in precision measurements to advance the development and application of quantum sensors.

Policy Makers

Informed Policy Making: Policy makers need to understand the implications and potential of quantum sensors to create informed policies that support scientific research, technological development, and industrial application.

Funding and Support: Dissemination activities can highlight the importance of quantum sensors to policy makers, potentially leading to increased funding and support for related research and development initiatives.

Regulatory Frameworks: Policy makers can develop appropriate regulatory frameworks to ensure the safe and effective deployment of quantum sensor technologies in various sectors.

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 will 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.

Table 5 - Dissemination Plan - Expectation and relevant KPIs

European companies and SMEs
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. **Expectation:** We will expect to expand the sensors application field, improving their performance with in-field application. **Entry point:** We will 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. **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
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. **Expectation:** We will expect to expand the application field and explore new possibilities with new enabling research lines. **Entry point:** We will disseminate by university lectures, public lectures, workshops, attending to scientific conference, ** publications (preferably, under gold open access journals). *** **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
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. **Expectation:** We will expect to improve the performance of our sensors, the measurement capabilities and the accuracy budgets. **Entry point:** We will disseminate by meetings, international comparisons, dedicated round robins. **KPI:** n. of round robins (3); n. of international comparison performed (3).
Policy makers
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. **Expectation:** We will expect to enable communication channels that lead to the creation of new jobs in quantum sensor research and new supporting infrastructures. **Entry point:** We will disseminate by dedicated meetings and press release. **KPI:** n. of press release (6); n. of recruitment calls enabled by the results of this project (5).

*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. QUANTFIY 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.

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 the 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 2023 [3], expects the total global quantum computing market to be worth $9B - $93B and the sensing market to be worth $1B - $6B in 2040. In 2025, the markets sizes are expected to reach volumes of $330M in computing and $600M in sensing. 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 QUANTIFYs 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 strategic pricing model for quantum technologies is another critical challenge. The sales cycle for expensive and complex products is typically long, which can result in a critical capital gap, especially for newly established startups. Pricing strategies must reflect the value proposition to end-users while considering the costs associated with developing and manufacturing quantum hardware. To mitigate capital shortages at the start of the exploitation phase, it is essential to begin early with customer education and onboarding. Engaging potential customers through workshops, demonstrations, and pilot projects can accelerate deal closures and enable a quicker transition from introduction to market adoption of the QUANTIFY tech.

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 QUANTIFYs 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)
State Of The Art
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.
Progress Beyond State Of The Art (updated)
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 $LiNbO_3$ (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.
Intentions for exploitation
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.
Exploitable Results and Strategy to move to commercial exploitation
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 stablished 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.

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 Vpi 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 puls.

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 TriplexTM 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)
State Of The Art
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 ~m^2 surface areas, and with non-miniaturized OPMs of comparable dimensions.
Progress Beyond State Of The Art (updated)
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.
Intentions for exploitation
Quantum enhanced on-chip OPMs.
Exploitable Results and Strategy to move to commercial exploitation
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. **Key partner/s and customer sectors, stakeholders:** OPM providers, Battery manufacturers, Geotechnical / geophysical industries, Medical imaging system providers. **Product/specific project result of interest:** Miniaturized, quantum-enhanced OPM. **Follow-up after Project conclusion and expected timeframe (years):** IP protection, market research, licensing – 1-5 years. **Business opportunities with timeframe (years) after project:** Licensing to customer described above – 1-5 years.

Rb-based two-photon optical clock (CSEM)
State Of The Art
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.
Progress Beyond State Of The Art (updated)
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. 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.
Intentions for exploitation
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.
Exploitable Results and Strategy to move to commercial exploitation
Key partner/s and customer sectors, stakeholders: Atomic clock providers, Metrology laboratories, Space agencies, Network management companies (wired and wireless). **Product/specific project result of interest:** miniature two-photon atomic clock. **Follow-up after Project conclusion and expected timeframe (years):** Industrial business partner selection, licensing – 2-4 years. **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).

Optomechanical thermometer (USo, TRT, CNAM, LNE, CNRS, INRiM)
State Of The Art
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. 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.
Progress Beyond State Of The Art (updated)
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 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/√ τ, 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/√. 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 consists 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 know 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 uT. 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.

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 marked 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 marked 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 marked 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 marked: 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 marked 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 mention 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 and the required amount of funding, capital can also be risen 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 marked 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 in the update of this plan at M24 (D7.3 - Establish a review for the Communication, dissemination and exploitation Plan & further development strategy to continue developments beyond the end of the project) and then at M41 (D7.5 - Final Exploitation, Dissemination and Impact report).

5. IP Management

The Consortium will follow Grant Agreement and Consortium Agreement rules and regulations to manage IPR issues. The Consortium may consider implementing an extra agreement, among partners involved in the invention, for IP management if necessary.

6. Conclusion

This plan started in January 2024, in correspondence with the kick-off meeting, with specific actions of the launch and life of the project.
With this document, the QUANTIFY Consortium has provided the first version of the Communication, Dissemination, and Exploitation strategy for the various target groups.

This plan commenced in January 2024, aligning with the kick-off meeting, and includes specific actions for the launch and lifespan of the project.

Seven exploitable results have been identified, and an initial exploitation strategy for each has been defined. These strategies will be further detailed with clear actions as the QUANTIFY results become more concrete. Another critical step will be confirming (or modifying) the final TRL value that the Consortium identified at the project's start. These values, reported in the Table 9 below, represent the planned final point of the developed technologies and will be updated as the results become tangible.

Table 9 - Exploitable results and their R&I maturity before and after the project

Exploitable results	TRL Before	TRL After	Leading partner
Photonic integrated squeezed light source	**1**	**5**	**UHAM/NoisyLab**
Periodically poled waveguides and modulators	2	5	CSEM
Achieve a hybrid photonic integrated platform through micro transfer printing technology	4	5	UGent/IMEC
Optically Pumped Magnetometer	2	4	ICFO
Rb-based two-photon optical clock	2	3	CSEM
Optomechanical thermometer	2	4	USo
Characterization assessment and measurement set-up	5	9	INRIM

However, it is worth noting that the QUANTIFY project has already planned to develop a more concrete exploitation strategy for the **on-chip photonic integrated squeezed light source**, the final, cutting-edge, technology we are going to develop. The results of this project will speed up the commercialization of commercial on-chip squeezed light sources and help identify first use cases to bring this important technology to market.

Specifically, the University of Hamburg, through its spin-off NoisyLab, one of the world's leading research bodies for squeezed light sources, will develop a technology validation plan and a commercial exploitation strategy for this promising technology. This technology validation plan includes a feasibility study and theoretical analysis to extend photonic integrated squeezed laser application, e.g. 1550 nm for optical communication and quantum computing. Together with our partners CSEM and QuiX QUANTUM BV, a leading photonic quantum technology company based in Enschede, the Netherlands, the intention is to establish a development strategy to continue QUANTIFY developments beyond the end of the project. The modalities of collaboration and the exploitation strategies will be handled in a flexible and efficient way, always keeping in mind the main destination objective of "strengthening European capacities in key parts and future supply chains".

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. After the QUANTIFY project, Noisy Labs is committed to push the development of the integrated squeezed light source to higher TRL via self-funded R&D activities. Noisy Labs will participate in joint research projects within the academic research bodies to use first prototypes in proof-of-concept applications (TRL 5 and 6). Our prime focus will be European initiatives to advance integrated quantum photonic computing chips. After establishing a product roadmap, Noisy Labs will work with industry partners leading the application of quantum technologies. Besides quantum computing, Noisy Labs foresees applications of on-chip squeezed light sources in biosensing, optomechanics and quantum key distribution.

In parallel, QuiX QUANTUM, developing PIC based universal quantum computers, would need hundreds to thousands of squeezed light sources, impossible with current bulk technology. The PICSq is then the only way to address the scalability approach and QuiX QUANTUM will perform a proof-of-concept to immediately show the large commercial potential. Together with UHAM, QuiX QUANTUM will evaluate the developed devices and, if successful, it will integrate them with its smallest integrated photonics quantum processors and make them available on a commercial basis.

A complete fabrication plan to scale up the PICSq and the most promising technologies to production, particularly the photonic integrated squeezed light source, will be handled with the update of the deliverable (M24). The first draft of our fabrication plan provides a structured approach to transition from laboratory-scale prototypes to mass-produced quantum sensors and photonic components. By focusing on process optimization, quality control, and strategic collaborations, the project aims to bring advanced quantum-enhanced sensors to market, driving innovation and meeting the growing demand for high-performance sensing technologies.

Finally, the exploitation plan must be linked to a sustainability plan that identifies resources required to sustain outcomes, considers IPR issues, and determines funding strategies. Therefore, the next version of this document will address a sustainability strategy and, if necessary, a more detailed IPR management plan.

Annex 1 – Communication activities: from M1 to M6

Within this Annex the engagement related to the implementation of the first communication actions (posts and website) from M1 to M6 is reported.
It is worth to remember how we measure the KPIs related to the engagement:

Engagement rate = (n. likes + n. sharing + n. comments / n. 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.

We decided to monitor also the Click-Through Rate, which is a key performance metric in social media marketing. It helps gauge the effectiveness and relevance of the content to the audience. CTR represents the percentage of viewers who clicked on a link, call-to-action, or advertisement from the total number of impressions it received. It's a vital indicator of how engaging and compelling the content is to the target audience.

CTR = 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: (total clicks / total impressions) * 100

The set target is 1%, a CTR 0.5-1% is strong, top-performing ads achieving CTRs of 1-2% or higher.

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.

The number of followers on 31 December 2023, and on 20 June 2024, are reported below for the involved social media:

LinkedIn: 3717 (4325 on 20 June 2024)

Facebook: 2338 (2534 on 20 June 2024)

Instagram: 398 (535 on 20 June 2024)

YouTube: 406 subscribers

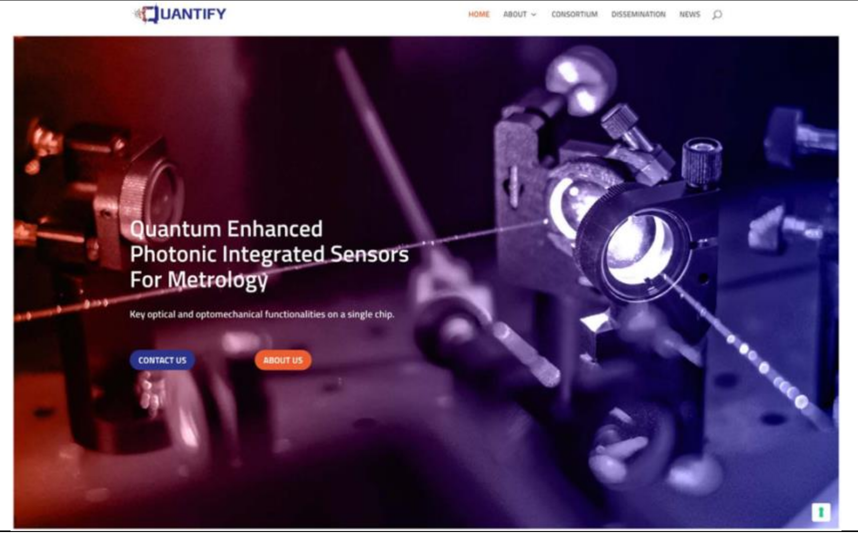
The *OC1 - Give visibility and publicize the project* and its communication activities along with the KPIs and the set targets, are reported below in Table 10.

In light green all the activities already implemented, related to the message “Starting the QUANTIFY project/Project Kick-Off", are highlighted.

Table 10 - Communication Plan - Planned activities and relevant KPIs. Insight message: “Starting the QUANTIFY project/Project Kick-Off"

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	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: The generic public				
Starting the QUANTIFY project/Project Kick-Off	Instagram – Reel Facebook – Reel YouTube – Reel	Dissemination reels	Views and interactions***	≥ 100 - ≥ 100
How the project results will impact on Society				

Table 11 - Engagement monitoring - Website, from M1 to M6

Website – quantify-project.eu		
	**N. of visitors**	**1602**
	Stay-on-page time [s]	**432**
	Project updates	**5 news, 1 deliverable, 1 video**
	Data is collected on 15th June 2024.	

As reported in Table 11, according to the set targets (N. of visitors 100/year and Stay-on-page time 60 s), the first version of the project website was very effective, exceeding expectations.

According to the KPI Project updates, the set target - 2/month - the set target does not seem to be met (7 updates): 12 updates were expected in 6 months. However, the target was designed to monitor communication actions once the project was fully operational, while the period considered (M1-M6) is a particular period because it coincides with the start of the project and the scientific and management activities, including the preparation of the website and its contents. Therefore, the result of 7 updates in the first 6 months of the project appears consistent with the project's status.

Table 12 - Engagement monitoring – LinkedIn (Event post), from M1 to M6

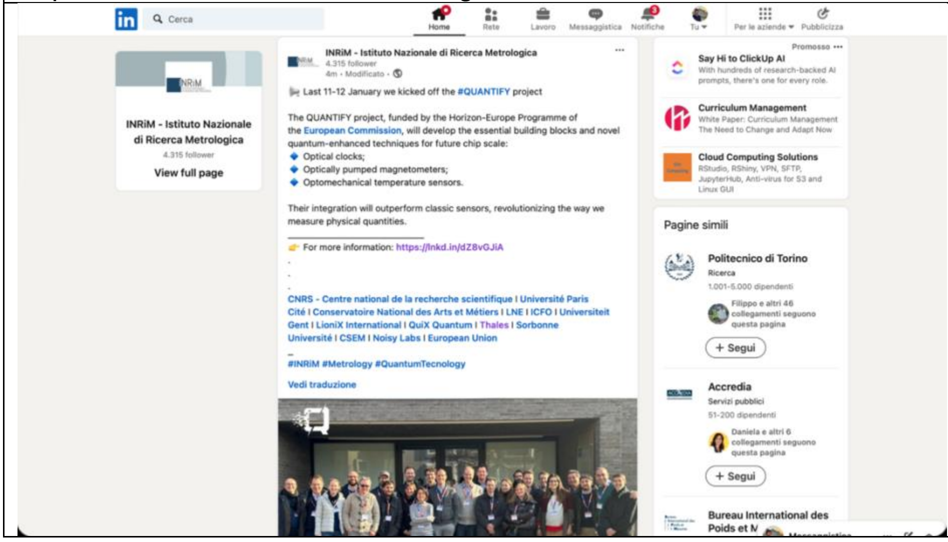
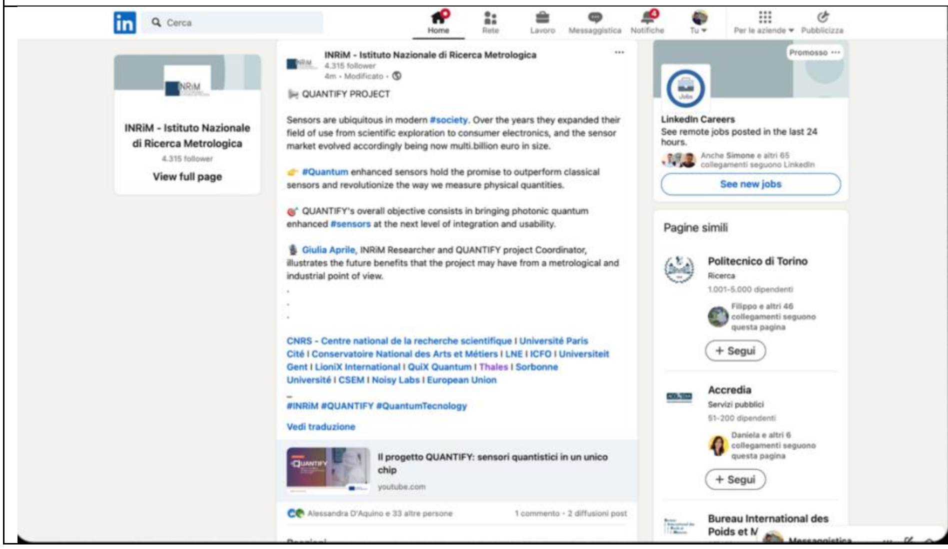
LinkedIn – Event post (format: Carousel)		
Date: 22.01.2024 Topic: QUANTIFY Kick-Off Meeting		
	Reactions Comments Reposts Clicks Interactions Views Unique views **Engagement** **CTR** *Data is collected on 15th June 2024.*	67 2 6 564 639 3610 2359 **17.7%** **15.6%**

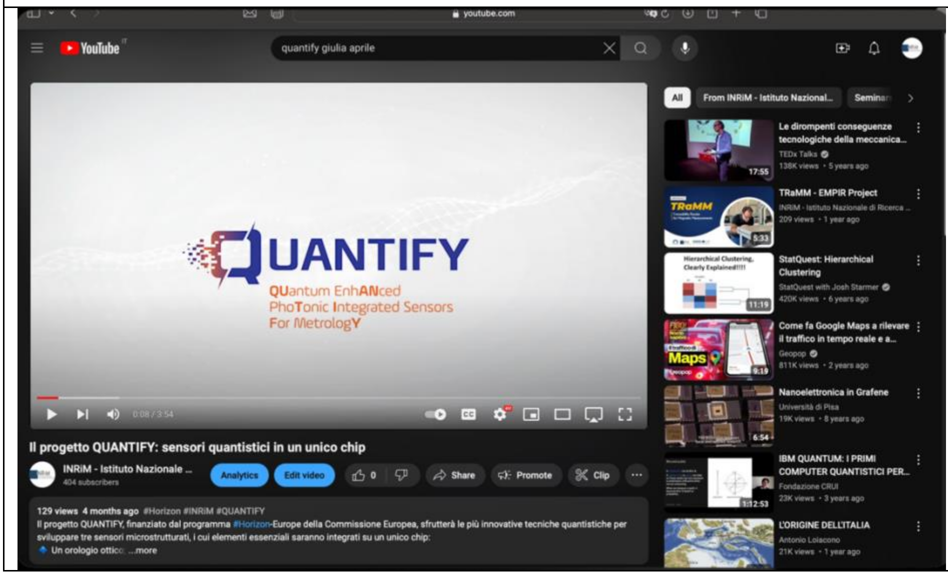
Table 13 - Engagement monitoring – LinkedIn (Video repost), from M1 to M6

LinkedIn – Media (format: Video repost)		
Date: 06-02-2024 Topic: QUANTIFY Interview		
	Reactions Comments Reposts Clicks Interactions Views Unique views **Engagement** **CTR** *Data is collected on 15th June 2024.*	34 2 2 38 75 2310 1675 **3.2%** **1.6%**

As reported in

Table 12 and Table 13, according to the set targets (Engagement rate ≥ 3%, and CTR ≥ 1%) the first LinkedIn posts were effective, and they exceeded expectations.

Table 14 - Engagement monitoring – YouTube (Video), from M1 to M6

YouTube – Media (format: Video)	
Date: 06-02-2024 Topic: QUANTIFY Interview Typology: media	
	**Views: 129** **Watch time: 2.9 s** *Data is collected on 15th June 2024.*

As reported in Table 14, according to the set targets (Views and watch time ≥ 100 - ≥ 1.2), the first YouTube video was effective, being in line with expectations.

Annex 2 – Dissemination activities: from M1 to M6

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

In the first 6 months of the project, the first dissemination activities occurred, regarding the participation in conferences through the technical, scientific and academic communities.

The dissemination actions already carried out are listed in the Table 15 below, in relation to the target audience.

Table 15 – Dissemination Plan – Expectation and relevant KPIs. Insight: activities already carried out.

Technical, scientific and academic community		
INRiM	Master's degree	Public and Political Communication
	Place, Date	Turin, 17.03.2024
	Lesson Title	The communication plan for a research project
INRiM	Conference	Technical Committee -Time and Frequency, Annual meeting 2024
	Place, Date	Paris, 17.04.2024
	Talk title	QUANTIFY: Project Overview

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