

# DISSEMINATION, COMMUNICATION AND EXPLOITATION PLAN

Grant Agreement number 22HLT01  
Project short name QUMPHY  
Project full title Uncertainty quantification for machine learning models applied to photoplethysmography signals  
Dissemination, Communication and Exploitation Plan  1<sup>st</sup> (Initial (Month 6))  
 2<sup>nd</sup> (Periodic 1)  
 3<sup>rd</sup> (Interim 2 - if applicable)  
 4<sup>th</sup> (Periodic 2)

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**Report Status:** Classified C-UE/EU-C – EU CONFIDENTIAL under the Commission Decision No2015/444

**TABLE OF CONTENTS**

1	Dissemination, communication, and exploitation requirements .....	3
1.1	Management of IPR.....	3
1.2	IPR protection .....	3
1.3	Quality of information.....	3
1.4	Open access (publications and data).....	3
1.5	Use of participant logos and project templates, and visual guidelines.....	3
1.6	Use of the European flag, the granting authority's special logo and acknowledgements.....	4
2	Dissemination and communication (Task [X.1]) .....	5
3	Exploitation .....	18
3.1	Exploitation and uptake activities (Task [X.2]) .....	18
3.2	Key exploitable results (KER).....	19

# 1 Dissemination, communication, and exploitation requirements

## 1.1 Management of IPR

The management of IPR is based on the procedures and agreements included in the project's Grant Agreement (GA) and Consortium Agreement (CA). Background IPR, results (foreground IPR), and existing patents, have been identified in the Annex I of the project's GA and in the CA. If new results are generated during the project, details of ownership and any IPR restrictions will be added as an update to the CA. Further advice will be sought from the European IP Helpdesk <https://intellectual-property-helpdesk.ec.europa.eu> if required.

The management of IPR will be discussed at each Project Management Board meeting. Each new result generated and its potential for exploitation will be discussed, and IP protection mechanisms will be identified to preserve the ownership of the results. The % ownership will be discussed, if there are multiple owners, as will access rights to determine who is entitled to use the results during / after the project, and on what terms. Thus far, no new results (foreground IPR) have been generated by the project.

In addition, the project's plans for dissemination and communication will continue to be enforced to ensure that the project's results can be made available rapidly (within 15 days), unless they are subject to any protection mechanisms, e.g., the results cannot be disseminated until a patent application has been submitted. This plan has been used effectively thus far and all dissemination and communication items have passed through scrutiny by the Project Management Board.

The patent landscape associated with the project will be regularly investigated (at least annually) to ensure that the project continues to have freedom-to-operate.

Further updates will be provided in subsequent versions of the DCE Plan.

## 1.2 IPR protection

Provide a statement confirming that "all participants have adhered to the requirements of the project's GA and CA with respect to IPR protection (GA Article 16 and its Annex 5) for this reporting period" <b>OR</b> List any exceptions to this	All participants have adhered to the requirements of the project's GA and CA with respect to IPR protection (GA Article 16 and its Annex 5) for this reporting period.
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## 1.3 Quality of information

Provide a statement confirming that "all participants have adhered to the requirements of the project's GA and CA with respect to the guidelines for dissemination and communication (GA Article 17 and its Annex 5) for this reporting period" <b>OR</b> List any exceptions to this	All participants have adhered to the requirements of the project's GA and CA with respect to the guidelines for dissemination and communication (GA Article 17 and its Annex 5) for this reporting period.
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## 1.4 Open access (publications and data)

Provide a statement confirming that "all participants have adhered to the requirements of the project's GA and CA with respect to open access (GA Article 17 and its Annex 5) for this reporting period" <b>OR</b> List any exceptions to this	All participants have adhered to the requirements of the project's GA and CA with respect to open access (GA Article 17 and its Annex 5) for this reporting period.
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## 1.5 Use of participant logos and project templates, and visual guidelines

*There are no restrictions on the use of the participant's logos on project documentation.*

*The project’s branding will enable all participants to communicate about the project with the target audience, and the general public, in a uniform and proficient manner. Branded items include the project logo.*

*The logo was designed to be easy to recognise and to act as the trademark of the project. The project logo, shown below, will be used throughout the project’s lifetime in all dissemination and communication activities including the webpage, technical documents, guidelines, social media, deliverables, journal papers, presentations, training courses etc. The project logo is available for download on the project website. The project’s visual guidelines, including a description of how to use the logo, are described in a document, which is available on the project website as well.*



*The project will use the Metrology Partnership’s deliverable cover sheet template which displays all of the information required by EURAMET.*

*All templates must be strictly respected, in line with the project’s visual guidelines, by the participants.*

**1.6 Use of the European flag, the granting authority’s special logo and acknowledgements**

<p>Provide a statement confirming that “all participants have adhered to the requirements of the project’s GA and CA with respect to the use of the European flag, the granting authority’s special logo and acknowledgements (GA Articles 17.2, 18, 29.2 and their Annex 5 (if applicable)) for this reporting period”</p> <p><b>OR</b></p> <p>List any exceptions to this</p>	<p>All participants have adhered to the requirements of the project’s GA and CA with respect to the use of the European flag, the granting authority’s special logo and acknowledgements (GA Articles 17.2, 18, 29.2 and their Annex 5 (if applicable)) for this reporting period.</p>
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## 2 Dissemination and communication (Task [X.1])

Activity title (Activity number)	Due date (as per Annex 1)	Status: inactive, on schedule, delayed to MXX completed MXX	Objective of each activity	Summary of cumulative progress and future plans for the completion of each activity. This should include: <ul style="list-style-type: none"> <li>- Target audience</li> <li>- Message disseminated / communicated</li> <li>- Intended outcome / effect on the target audience</li> <li>- Summary of progress</li> <li>- Next steps</li> </ul>
Stakeholder committee (A3.1.1)	M36	on schedule	To create a Stakeholder Committee of at least 8 members including from the measurement supply chain, standards developing organisations, and end users representing at least 4 European countries.	<p><u>Target audience:</u> Digital healthcare companies, device manufacturers, clinicians, standardisation bodies.</p> <p><u>Message disseminated / communicated:</u> Benefit of inputting into the work that the project is doing, early access to the results.</p> <p><u>Intended outcome / effect on the target audience:</u> Results that are tailored to their requirements for greater traceability/accuracy/improved quality control etc.</p> <p><u>Summary of progress:</u> The project created a Stakeholder Committee of 9 members including from the measurement supply chain (NMIs, DIs, and medical device calibration services), standards developing organisations, and end users (clinical practitioners, and manufacturers of medical and healthcare products, etc.), representing at least 4 European countries. The aim of the Stakeholder Committee is to clarify the needs of the various interested parties and to feed these into the project.</p> <p>A first stakeholder workshop in accordance with A3.1.9 has been held in M3.</p> <p>A second additional stakeholder workshop has been held in M10 to discuss the selection of appropriate benchmark problems and respective datasets.</p> <p><u>Next steps:</u> Further members for the committee will be actively sought and the needs of the stakeholders will continue to be clarified in the following activities: A2.1.2, A2.2.2 and A2.2.4.</p> <p>The Stakeholder Committee also has an important role to play in the communication and dissemination of project outputs and will be actively encouraged to share project results via their various networks.</p>
Webpage (A3.1.2)	M36	on schedule	To reach out to, and	<p><u>Target audience:</u></p>



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			communicate with, a wide audience including the consortium. To provide a means for members of the target audience to contact, and perhaps become involved in, the project	<p>Consortium, NMIs/DIs, academia, industry, general public, end users (e.g., digital healthcare companies, device manufacturers, clinicians) and other projects.</p> <p><u>Message disseminated / communicated:</u> Importance and value of the project's research.</p> <p><u>Intended outcome / effect on the target audience:</u> Better understanding of the project and to become engaged.</p> <p><u>Summary of progress:</u> A project webpage <a href="http://www.qumphy.ptb.de">www.qumphy.ptb.de</a> has been created by the coordinator, PTB, with public access and a part restricted for participants only. It went live in M1 of the project. It uses responsive design, to enable a seamless browsing experience from various devices. The webpage, as the main media hub of the project, is easy to navigate and it is dynamic as it is regularly being updated by PTB with information such as news, events, training material, project reports, papers published by the participants, project meetings and the project's promotional material including its publishable summary and e-newsletters. In addition, the webpage acknowledges funding from the European Partnership on Metrology. Participants, especially the work package leaders, are being encouraged to provide additional content for the webpage.</p> <p><u>Next steps:</u> To attract more visitors, the webpage will continue to be promoted at every available opportunity including in presentations and posters at events and training activities, in the project's e newsletters / flyers, on social media, in press releases and when interacting with networks. In addition, new webpage content will be promoted by sharing it on social networks.</p>



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Conferences (A3.1.3)	M36	on schedule	To interact with the target audience at 15 conferences to generate visibility for the project and disseminate its results; to actively engage additional stakeholder contacts	<p><u>Target audience:</u> NMI/Dis, academia, end users (e.g., digital healthcare companies, device manufacturers, clinicians).</p> <p><u>Message disseminated / communicated:</u> Benefits of the project developments (e.g., uncertainty quantification of machine learning applied to photoplethysmography signals).</p> <p><u>Intended outcome / effect on the target audience:</u> Better understanding of the project’s planned developments. Ability to provide feedback on these plans. Ability to join the stakeholder committee or the communications database.</p> <p><u>Summary of progress (see O&amp;I report):</u> The consortium has participated in 8 conferences in the first 18 month</p> <table border="1" data-bbox="958 943 1561 1417"> <thead> <tr> <th><u>Conferences</u></th> <th><u>Date / location</u></th> </tr> </thead> <tbody> <tr> <td>Computing in Cardiology 2023</td> <td>October 2023, USA</td> </tr> <tr> <td>International Conference on Biomedical Technology 2023</td> <td>November 2023, Germany</td> </tr> <tr> <td>14th Metrology for Digital Transformation Day - Artificial Intelligence (M4DT-SIM-MWG-14)</td> <td>November 2023, online</td> </tr> <tr> <td>EMN Mathmet Annual General Meeting 2024</td> <td>June 2024, France</td> </tr> <tr> <td>The 26th International Conference-School “Advanced Materials and Technologies 2024”</td> <td>August 2024, Lithuania</td> </tr> </tbody> </table>	<u>Conferences</u>	<u>Date / location</u>	Computing in Cardiology 2023	October 2023, USA	International Conference on Biomedical Technology 2023	November 2023, Germany	14th Metrology for Digital Transformation Day - Artificial Intelligence (M4DT-SIM-MWG-14)	November 2023, online	EMN Mathmet Annual General Meeting 2024	June 2024, France	The 26th International Conference-School “Advanced Materials and Technologies 2024”	August 2024, Lithuania
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Papers (A3.1.4)	M36	inactive	To submit 10 papers	<p><u>Target audience:</u> NMI/Dis, academia, end users (e.g., digital healthcare companies, device manufacturers, clinicians), standardisation bodies.</p> <p><u>Message disseminated / communicated:</u> NMI/Dis and academia: Project's developments (e.g., new techniques) will create opportunity for further innovations. End users: Project's development (e.g., new methodology) will improve the development of healthcare software based on machine learning. Standardisation bodies: Project's development (e.g. uncertainty quantification best practice) will increase acceptance and trust in the new methodology.</p> <p><u>Intended outcome / effect on the target audience:</u> NMI/Dis and academia: Opportunity to advance work in this area. End users: Opportunity to use project results. Standardisation bodies: Opportunity to implement project results.</p> <p><u>Summary of progress:</u> <u>The consortium has:</u> 3 published open access peer-reviewed papers (see <a href="#">EURAMET repository link</a>) 2 papers that have been submitted and are awaiting publication 5 drafted papers</p> <p><u>Next steps:</u> The following papers are planned for the remainder of the project:</p> <ul style="list-style-type: none"> <li>- Description of the benchmark problems and respective datasets</li> <li>- Evaluation of Accuracy and uncertainty of machine learning models to the benchmark problems</li> </ul>



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Flyer and Poster (A3.1.5)	M3	completed (M3)	To prepare a project flyer and project poster addressing all relevant information about the project and the participants	<p><u>Target audience:</u> NMIs/DIs, academia, industry, other projects.</p> <p><u>Message disseminated / communicated:</u> Promote information about the project structure, consortium and the importance of the basic principles of metrology and its implication for PPG measurements.</p> <p><u>Intended outcome / effect on the target audience:</u> Better understanding of the need and impact of the project.</p> <p><u>Summary of progress (see O&amp;I report):</u> The project flyer and poster have been created by the end of M3 and are available for download on the project homepage.</p> <p><u>Next steps:</u> Not applicable.</p>
e-newsletters (A3.1.6)	M36	on schedule	To make an annual e-newsletter available on the project website and mail it to the stakeholder committee.	<p><u>Target audience:</u> Consortium, NMIs/DIs, academia, industry, standardisation bodies, other projects.</p> <p><u>Message disseminated / communicated:</u> Newsletters 1 and 2: Importance and value of the project including information about its participants and upcoming events. Newsletters 3: Importance and value of the project including an overview of latest project outcomes.</p> <p><u>Intended outcome / effect on the target audience:</u> Increased awareness and understanding of the project, opportunity to sign up to future alerts.</p> <p><u>Summary of progress (see O&amp;I report):</u> No newsletter has been produced yet.</p> <p><u>Next steps:</u></p>



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				Newsletters 1 and 2 will be sent around M21 and M30, respectively, informing stakeholders about the latest outputs of the project. Newsletters 3 will be sent out in M36. This newsletter will provide more information about the final project results and the main outcomes.
Standardisation (A3.1.7)	M36	on schedule	To engage with standardisation working groups to encourage them to incorporate results from the project into their standards	<p><u>Target audience:</u> Standardisation bodies (e.g., BIPM JCGM WG 1, ISO/TC 69).</p> <p><u>Message disseminated / communicated:</u> Project developments (e.g. uncertainty quantification best practice) will help EU-wide uniformity and trust in safety assessment of machine learning application in healthcare devices.</p> <p><u>Intended outcome / effect on the target audience:</u> Standards body develops standards based on the results of the project.</p> <p><u>Summary of progress (see O&amp;I report):</u> The consortium is currently working on the development of outputs relevant to standards committees.</p> <p><u>Next steps:</u> The following committees will meet in the remainder of the project.</p> <ul style="list-style-type: none"> <li>- BIPM JCGM Working Group 1 (Uncertainty) (LNE to attend)</li> <li>- ISO/TC 69 (NPL to attend)</li> <li>- UK National AI Standards Hub (NPL to attend)</li> <li>- IMEKO TC (IPQ to attend)</li> </ul>
Networks /networking (A3.1.8)	M36	on schedule	To identify and gain additional contacts with potential stakeholders	<p><u>Target audience:</u> NMIs/DIs, academia, standardisation bodies, digital healthcare companies, medical device manufacturers.</p> <p><u>Message disseminated / communicated:</u> Inform about the benefits of the project according to their interest</p>



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				<p><u>Intended outcome / effect on the target audience:</u> Members of scientific, metrological and industrial networks become project stakeholders. Develop synergies and collaborate / organise joint initiatives to reduce duplicated effort.</p> <p><u>Summary of progress (see O&amp;I report):</u> Initial contact with scientific, metrological and industrial networks has been made. Further contact was made to explore if they would like to become project stakeholders.</p> <p><u>Next steps:</u> Further networks (e.g., VascAgeNet) will be contacted to increase visibility of the project and attract additional stakeholders.</p>
Workshops (A3.1.9)	M30	on schedule	To host 2 stakeholder workshops to inform stakeholders about the new methods and techniques developed as outcomes from the project	<p><u>Workshop 1: Initial Stakeholder Workshop</u></p> <p><u>Target audience:</u> NMIs/DIs, academia, standardisation bodies, digital healthcare companies, medical device manufacturers.</p> <p><u>Message disseminated / communicated:</u> Importance and relevance of the project in relation to their needs and describe the benefits of being involved/engaged.</p> <p><u>Intended outcome / effect on the target audience:</u> Increased understanding of the project's planned developments, and an ability to provide feedback on these plans.</p> <p><u>Summary of progress (see O&amp;I report):</u> A 1-day stakeholder workshop was organised and held online in M3. The workshop was promoted by e-mail to the stakeholders. Out of the 9 invited stakeholders, 2 delegates joined the workshop.</p> <p><u>Next steps:</u> Not applicable.</p>



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				<p><u>Workshop 2: Stakeholder Workshop on Benchmark Problems and Datasets</u>  <u>Target audience:</u>                      NMIs/DIs, academia, standardisation bodies, digital healthcare companies, medical device manufacturers.  <u>Message disseminated / communicated:</u>                      Project developments (good practice guide, software repository, benchmark problems) will improve confidence and reliability in machine learning applications in digital healthcare for PPG signals. Feedback from the target audience is welcome and helps to steer the project's key exploitable results towards maximum relevance for end users.  <u>Intended outcome / effect on the target audience:</u>                      Present potential benchmark problems and respective datasets and discuss their relevance and reasonability with clinicians and medical healthcare companies.</p> <p><u>Workshop 3: Final Stakeholder Workshop</u>  <u>Target audience:</u>                      NMIs/DIs, academia, standardisation bodies, digital healthcare companies, medical device manufacturers.  <u>Message disseminated / communicated:</u>                      Project developments (good practice guide, software repository, benchmark problems) will improve confidence and reliability in machine learning applications in digital healthcare for PPG signals.  <u>Intended outcome / effect on the target audience:</u>                      Ability and knowledge of how to implement project developments and hence benefit from a reliable uncertainty estimation of machine learning in digital healthcare.  <u>Summary of progress (see O&amp;I report):</u>                      No work has started on this workshop yet.  <u>Next steps:</u>                      This workshop is currently planned for M30 of the project.</p>



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Training courses (A3.1.10)	M36	inactive	To hold a 1-day webinar on the new benchmarks, methods and techniques developed in the project	<p><u>Target audience:</u> NMI/DIs, academia, standardisation bodies, digital healthcare companies, medical device manufacturers.</p> <p><u>Message disseminated / communicated:</u> Encourage the participants to use the new benchmarks, software and good practice guide developed in the project.</p> <p><u>Intended outcome / effect on the target audience:</u> Greater understanding of how to implement new methods and techniques.</p> <p><u>Summary of progress (see O&amp;I report):</u> One training course has been held in the first 18 months of the project.</p> <p><u>Next steps:</u> Based on the presentations made at the third stakeholder workshop (A3.1.9) a webinar will be developed by NPL and PTB explaining (a) the benchmarking problems and datasets giving guidance on their use, and (b) the framework for independently reviewing machine learning models proposed by industry to assist them in getting regulatory approval.</p>
Videos (A3.1.11)	M36	inactive	To prepare e-training educational material on PPG signals, ML models and UQ methods	<p><u>Target audience:</u> NMI/DIs, academia, standardisation bodies, digital healthcare companies, medical device manufacturers.</p> <p><u>Message disseminated / communicated:</u> Explanation of the scientific background and the applied methods for an easy understanding of the benchmark problems and good practice guide.</p> <p><u>Intended outcome / effect on the target audience:</u> Greater understanding of how to use the benchmark problems, the good practice guide and the software repository for quality control by digital healthcare and stakeholder communities.</p> <p><u>Summary of progress (see O&amp;I report):</u> No material has been created in the first 18 month of the project.</p> <p><u>Next steps:</u></p>



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				Educational material such as short articles, blog posts or videos on PPG signals, ML models and UQ methods will be created by the consortium and made publicly available on the project website. It will also be promoted on the participant's websites, through the project's Stakeholder Committee and available social media platforms.
Social media (A3.1.12)	M36	inactive	To establish a trusted network of followers, which will enlarge the project's outreach to broad and targeted audiences	<p><u>Target audience:</u> Consortium, NMIs/DIs, Academia, Industry, Public, End users, other projects, Stakeholders</p> <p><u>Message disseminated / communicated:</u> Importance and relevance of the project.</p> <p><u>Intended outcome / effect on the target audience:</u> Greater awareness about the project's activities and more engagement with the project.</p> <p><u>Summary of progress (see O&amp;I report):</u> A QUMPHY discussion group has been initiated on LinkedIn.</p> <p><u>Next steps:</u> All participants will continue to highlight their activities, publications, and their participation in events, meetings, conferences etc. Participants will include the QUMPHY hashtag in relevant posts and to retweet posts from the QUMPHY LinkedIn page.</p>
Good practice guides (A3.2.2)	M36	inactive	To disseminate a good practice guide to end users	<p><u>Good Practice Guide:</u> Uncertainty quantification of machine learning models applied to PPG signals</p> <p><u>Target audience:</u> NMIs/DIs, academia, industry, standardisation bodies, other projects.</p> <p><u>Message disseminated / communicated:</u> Implementing good practice into the process will result in better quality and a more accurate machine learning in healthcare applications.</p> <p><u>Intended outcome / effect on the target audience:</u> Better understanding of machine learning and uncertainty quantification in application including PPG signals to enhance reliability in software outputs.</p>



Activity title (Activity number)	Due date (as per Annex 1)	Status: inactive, on schedule, delayed to MXX completed MXX	Objective of each activity	Summary of cumulative progress and future plans for the completion of each activity. This should include:  - Target audience - Message disseminated / communicated - Intended outcome / effect on the target audience - Summary of progress - Next steps
				<p><u>Summary of progress:</u> Work on the good practice guide has not started yet.</p> <p><u>Next steps:</u> It is planned to start drafting the good practice guide in M21. The good practice guide will be communicated by email distribution through the stakeholder committee, by direct contact with stakeholders and via the participant's networks. Ongoing feedback on content etc. will be sought from the stakeholder committee to ensure relevance to the user community.</p>
Software repository (A3.2.3)	M36	on schedule	To provide an open-source software repository containing the machine learning models, uncertainty quantification methods and comparison of results	<p><u>Target audience:</u> NMIs/DIs, academia, industry, standardisation bodies, other projects.</p> <p><u>Message disseminated / communicated:</u> Code basis for uncertainty quantification applied to PPG signals and examples on how uncertainties should be computed.</p> <p><u>Intended outcome / effect on the target audience:</u> The software repository yields a good starting point for the target audience to implement scientifically sound uncertainty quantification into applications.</p> <p><u>Summary of progress (see O&amp;I report):</u> A software repository has been initiated and is publicly available. An automatically generated documentation of the code has been set up and is available online (<a href="https://gumphy-software.readthedocs.io/en/latest/">https://gumphy-software.readthedocs.io/en/latest/</a>). The machine learning models and uncertainty quantification methods already developed as part of Tasks 1.1 and 1.2 have been integrated into the software repository.</p> <p><u>Next steps:</u> Further uncertainty quantification methods will be included into the software repository by M21. Evaluation scripts for the comparison of several of the machine learning models performing on the benchmark datasets will be included until M33.</p>
Benchmark problems (A3.2.4)	M36	on schedule	To create 5 benchmark problems comprising a	<p><u>Target audience:</u> NMIs/DIs, academia, industry, standardisation bodies, other projects.</p> <p><u>Message disseminated / communicated:</u></p>



Activity title (Activity number)	Due date (as per Annex 1)	Status: inactive, on schedule, delayed to MXX completed MXX	Objective of each activity	Summary of cumulative progress and future plans for the completion of each activity. This should include: <ul style="list-style-type: none"> <li>- Target audience</li> <li>- Message disseminated / communicated</li> <li>- Intended outcome / effect on the target audience</li> <li>- Summary of progress</li> <li>- Next steps</li> </ul>
			collection of PPG signals for a set of clinically relevant measurement problems	Using the Benchmark problems and their respective datasets helps to clarify how uncertainty quantification of machine learning approaches applied to PPG signals should be done, yields reference performances and allows the target audience to compare results. <u>Intended outcome / effect on the target audience:</u> The target communities will use the benchmark problems to test their own machine learning applications against the baseline described in the good practice guide. Achieving similar or better results (better precision, smaller uncertainties) on the benchmarks improves the trust in the specific application of the target user. <u>Summary of progress (see O&amp;I report):</u> Potential benchmark problems have been identified, and open-source data sources have been gathered. Discussions with stakeholders and other target groups such as clinicians and digital health companies have been undertaken to ensure practical relevance of the benchmark problems. <u>Next steps:</u> The data will be collected, prepared and uploaded to a trusted repository (Zenodo), accompanied by sufficient meta data, by M25.
Framework for independent evaluation of ML models (A3.2.5)	M36	inactive	To draft a proposal for a framework for independent review of machine learning models	<u>Target audience:</u> NMIs/DIs, academia, industry, standardisation bodies, other projects. <u>Message disseminated / communicated:</u> The interface allows the target audience to test specific machine learning models independently and compare the performance results (precision, uncertainty) to the models investigated in this project. <u>Intended outcome / effect on the target audience:</u> Industry developing machine learning solutions for problems involving PPG signals use the framework to compare their results to the project output and gain insight about reliability and uncertainty of their implemented approaches. <u>Summary of progress (see O&amp;I report):</u> Work on the framework has not started yet. <u>Next steps:</u> After the performance comparison of the machine learning models investigated in the project the framework with an easy-to-use interface to test arbitrary machine learning models will be implemented by M35.

### 3 Exploitation

#### 3.1 Exploitation and uptake activities (Task [X.2])

<b>Activity description (activity number)</b> [do not include activity 1 as its outcomes will be detailed in Section 3.2]	<b>Due date (as per Annex 1)</b>	<b>Status:</b> <i>inactive, on schedule, delayed to MXX, completed MXX</i>	<b>Key exploitable result (KER)? (Yes/no)</b> [If yes – add to Section 3.2 - do not complete the 3 columns to the right] [If no – complete the following columns]	<b>Target groups</b>	<b>Intended impact / effect on the target audience</b>	<b>Summary of cumulative progress towards the completion of each activity. This should include:</b> <ul style="list-style-type: none"> <li>- the activities undertaken to proactively encourage the uptake of result by end users</li> <li>- details of which users have expressed interest in the results</li> <li>- explain and justify any deviations from the original plan</li> <li>- next steps</li> </ul>
Good practice guide (A3.2.2)	M36	inactive	yes	n/a	n/a	n/a
Software repository containing ML models and UQ methods (A3.2.3)	M36	on schedule	yes	n/a	n/a	n/a
Benchmark problems with datasets and meta data descriptions (A3.2.4)	M36	on schedule	yes	n/a	n/a	n/a
Framework for independent evaluation of ML models (A3.2.5)	M36	inactive	yes	n/a	n/a	n/a

### 3.2 Key exploitable results (KER)

Please complete one table for each KER.

Key exploitable result (KER)		No. 1
Title		Good practice guide
Related activity (or task/WP)		A2.2.1, A2.2.7
Lead participant (organisation short name), contact name (bold) and other contributing participants (organisation short name)		NPL, PTB, CMI, IMBiH, IPQ, LNE, KCL, FC, Uni-Oldenburg, KTU, UCAM, SectorHealth, THM, FVB, UGent, SURREY
Background/ overview	Problem /need being addressed	Currently there exist no guides or standards on how to quantify performance and uncertainties of machine learning application in PPG signals.
	Briefly describe the KER e.g. new technology /solution, product, evidence, service, teaching course, improvement /modification to specific background etc.	The consortium will create a good practice guide describing the developed machine learning models, uncertainty quantification methods and benchmark datasets. The good practice guide will include the evaluation of accuracy and uncertainty of the machine learning models with respect to the uncertainty quantification methods for the different developed benchmark problems.
	Briefly describe the expected outcome	Implementing the good practice guidelines into the development of machine learning solutions by digital healthcare companies will result in better quality and a more accurate machine learning in PPG applications. Clinicians and other end users benefit from the good practice guide by a clear understanding of how accuracy and uncertainty of a machine learning solution were obtained.
	Briefly describe the expected impact	Better understanding of machine learning and uncertainty quantification in application including PPG signals to enhance reliability in software outputs allows faster certification of digital healthcare products and medical devices including machine learning approaches.

Key exploitable result (KER)		No. 1
<b>Innovative potential</b>	How is the KER going beyond the state-of-the-art (what will it enable that was not possible before)?	Currently there exist no guides or standards on how to quantify performance and uncertainties of machine learning application in PPG signals. The good practice guide provides a first baseline towards comparative accuracy and uncertainty determination in healthcare applications.
	Is the KER disruptive (will it displace established processes /products /services)? Give brief details.	No
<b>Target group(s)</b>	Who will use the KER?	NMIs/DIs, academia, industry, standardisation bodies, other projects
	Contacts available: Y/N	Yes
<b>Competition and Unique Selling Proposition (USP)</b>	Are there competitive solutions already available?	No
	What is the competitive advantage of the KER in relation to existing solutions (USP)?	n/a
<b>Stakeholders / collaborators involved in the KER (i.e. from outside of the consortium)</b>	Will a stakeholder / collaborator (from outside of the consortium) contribute background or new results to the exploitable result?	No
	Details of contribution	n/a
<b>Exploitation Pathway</b>	How will you access the market? e.g. direct industrial use, technology transfer, patent / license agreement, publication, sale, spin-off, spin-out, joint venture etc.	The good practice guide will be openly available for use in science and industry.

Key exploitable result (KER)		No. 1
	Describe dissemination activities	The good practice guide will be available as a download on the project website.
	Describe exploitation activities	Presentation on scientific conferences. Advertisement through the project website and institutional websites of the consortium. E-mail notification to the stakeholder committee.
	Are there barriers/obstacles for end users to take up your KER? If so, how might you overcome these?	No
	How your result can feed back to policy making and how it contributes to EU priorities	The described methods can be used as a foundation towards standardisation of machine learning in metrology.
IPR (If applicable)	Which background /existing /prior (e.g. patents etc.) will be part of the KER?	n/a
	Which member of the consortium owns this background?	n/a
	Which member(s) of the consortium will (co-)own the KER and how (e.g. shares, ownership agreement)?	n/a
Progress	Please describe progress that has been made in this reporting period (refer to dissemination and exploitation activities from earlier)	inactive

Key exploitable result (KER)		No. 1
	Which end users have expressed interest in the results?	n/a

Key exploitable result (KER)		No. 2
<b>Title</b>		Software repository containing machine learning models and uncertainty quantification methods
<b>Related activity (or task/WP)</b>		A2.2.5, A2.2.6
<b>Lead participant (organisation short name), contact name (bold) and other contributing participants (organisation short name)</b>		<b>PTB</b> , NPL, CMI, IMBiH, IPQ, LNE, KCL, FC, Uni-Oldenburg, KTU, UCAM, SectorHealth, THM, FVB, UGent, SURREY
<b>Background/overview</b>	Problem /need being addressed	A tested and validated implementation of the models, methods and results described in the good practice guide for easy access by the target end users is required.
	Briefly describe the KER e.g. new technology /solution, product, evidence, service, teaching course, improvement /modification to specific background etc.	Code basis for uncertainty quantification applied to PPG signals and examples on how uncertainties should be computed accompany the methods described in the good practice guide (see KER No. 1).
	Briefly describe the expected outcome	A software repository containing all the models and methods described in the good practice guide (see KER No. 1) alongside scripts which reproduce the comparison performance results included in the good practice guide.

	Briefly describe the expected impact	Easy access to the developed models and methods by the end users.
<b>Innovative potential</b>	How is the KER going beyond the state-of-the-art (what will it enable that was not possible before)?	The results described in the good practice guide can easily be reproduced and the provided scripts explain how the software repository can be utilised and adapted the end user's application.
	Is the KER disruptive (will it displace established processes /products /services)? Give brief details.	No
<b>Target group(s)</b>	Who will use the KER?	NMIs/DIs, academia, industry
	Contacts available: Y/N	Yes
<b>Competition and Unique Selling Proposition (USP)</b>	Are there competitive solutions already available?	No
	What is the competitive advantage of the KER in relation to existing solutions (USP)?	n/a
<b>Stakeholders / collaborators involved in the KER (i.e. from outside of the consortium)</b>	Will a stakeholder / collaborator (from outside of the consortium) contribute background or new results to the exploitable result?	No
	Details of contribution	n/a
	How will you access the market? e.g. direct	The software repository is open access and available to the public.

<b>Exploitation Pathway</b>	industrial use, technology transfer, patent / license agreement, publication, sale, spin-off, spin-out, joint venture etc.	
	Describe dissemination activities	The software repository is openly available for everyone as a git repository. A documentation of the code is hosted on an online website.
	Describe exploitation activities	Presentation on scientific conferences. Advertisement through the project website and institutional websites of the consortium. E-mail notification to the stakeholder committee.
	Are there barriers/obstacles for end users to take up your KER? If so, how might you overcome these?	No
	How your result can feed back to policy making and how it contributes to EU priorities	n/a
<b>IPR (If applicable)</b>	Which background /existing /prior (e.g. patents etc.) will be part of the KER?	n/a
	Which member of the consortium owns this background?	n/a
	Which member(s) of the consortium will (co-)own the KER and how (e.g. shares, ownership agreement)?	n/a

<b>Progress</b>	Please describe progress that has been made in this reporting period (refer to dissemination and exploitation activities from earlier)	A software repository has been initiated and is publicly available ( <a href="https://gitlab.com/qumphy/qumphy-software">https://gitlab.com/qumphy/qumphy-software</a> ). Content will be added to the repository as the project progresses. An automatically generated documentation of the code has been set up and is available online ( <a href="https://qumphy-software.readthedocs.io/en/latest/">https://qumphy-software.readthedocs.io/en/latest/</a> ).
	Which end users have expressed interest in the results?	n/a

<b>Key exploitable result (KER)</b>		<b>No. 3</b>
<b>Title</b>		Benchmark problems with datasets and meta data descriptions
<b>Related activity (or task/WP)</b>		A2.1.4, A2.1.5
<b>Lead participant (organisation short name), contact name (bold) and other contributing participants (organisation short name)</b>		<b>THM</b> , PTB, CMI, IMBiH, IPQ, LNE, KCL, KTU, FC, NPL, UCAM, UGent, Uni-Oldenburg, SURREY, SectorHealth, FVB
<b>Background/overview</b>	Problem /need being addressed	Currently there exist no benchmark problems in PPG applications to evaluate and compare machine learning solutions against.
	Briefly describe the KER e.g. new technology /solution, product, evidence, service, teaching course, improvement /modification to specific background etc.	The consortium will create 5 benchmark problems comprising a collection of PPG signals for a set of clinically relevant measurement problems. The accompanying datasets will be in an open format and will be ready for use by developers of machine learning models for analysing PPG signals and by medical device manufacturers. The benchmark problems will include guidance documentation and examples, to support the continued use of the datasets by the community of end-users beyond the end of the project.

	Briefly describe the expected outcome	The benchmark problems will be described in the good practice guide (see KER No. 1). The accompanying datasets will be publicly available and include meta data describing their application and usage.
	Briefly describe the expected impact	End users will use the datasets to benchmark their machine learning applications against the results described in the good practice guide.
<b>Innovative potential</b>	How is the KER going beyond the state-of-the-art (what will it enable that was not possible before)?	Currently there exists no common benchmark problems involving PPG signals to test machine learning applications against.
	Is the KER disruptive (will it displace established processes /products /services)? Give brief details.	No
<b>Target group(s)</b>	Who will use the KER?	NMIs/DIs, academia, industry, other projects
	Contacts available: Y/N	Yes
<b>Competition and Unique Selling Proposition (USP)</b>	Are there competitive solutions already available?	No
	What is the competitive advantage of the KER in relation to existing solutions (USP)?	n/a

<b>Stakeholders / collaborators involved in the KER (i.e. from outside of the consortium)</b>	Will a stakeholder / collaborator (from outside of the consortium) contribute background or new results to the exploitable result?	Yes
	Details of contribution	Stakeholders as well as clinicians and digital healthcare companies will consult on the choice of the benchmark problems to assure their practical relevance.
<b>Exploitation Pathway</b>	How will you access the market? e.g. direct industrial use, technology transfer, patent / license agreement, publication, sale, spin-off, spin-out, joint venture etc.	Publication of a paper describing the benchmark problems. Direct use by other scientists and industry.
	Describe dissemination activities	Publication of a paper describing the benchmark problems. Description of the benchmark problems in the good practice guide (see KER No. 1). Upload datasets and accompanying description and meta data to a trusted open access repository (Zenodo).
	Describe exploitation activities	Presentation on scientific conferences. Advertisement through the project website and institutional websites of the consortium. E-mail notification to the stakeholder committee.
	Are there barriers/obstacles for end users to take up your KER? If so, how might you overcome these?	No
	How your result can feed back to policy making and how it contributes to EU priorities	n/a

<b>IPR (If applicable)</b>	Which background /existing /prior (e.g. patents etc.) will be part of the KER?	n/a
	Which member of the consortium owns this background?	n/a
	Which member(s) of the consortium will (co-)own the KER and how (e.g. shares, ownership agreement)?	n/a
<b>Progress</b>	Please describe progress that has been made in this reporting period (refer to dissemination and exploitation activities from earlier)	Potential benchmark problems have been identified and open-source data sources have been gathered. The datasets are currently under preparation.
	Which end users have expressed interest in the results?	n/a

<b>Key exploitable result (KER)</b>	<b>No. 4</b>
<b>Title</b>	Framework for independent evaluation of ML models
<b>Related activity (or task/WP)</b>	A2.3.1, A2.3.2, A2.3.3
<b>Lead participant (organisation short name), contact name (bold) and other contributing participants (organisation short name)</b>	<b>Uni-Oldenburg</b> , THM, PTB, CMI, IMBiH, IPQ, LNE, KCL, KTU, FC, NPL, UCAM, UGent, SURREY, SectorHealth, FVB

<b>Background/ overview</b>	Problem /need being addressed	Provide an interface for end users to test their own machine learning applications against established results.
	Briefly describe the KER e.g. new technology /solution, product, evidence, service, teaching course, improvement /modification to specific background etc.	The consortium will draft a proposal for a general-purpose interface, comprising a data format and protocol for communicating with machine learning software, to support the implementation of the framework for independently reviewing machine learning models.
	Briefly describe the expected outcome	Software providing an easy-to-use interface for end users to test their machine learning applications.
	Briefly describe the expected impact	End users can evaluate their own machine learning applications independently and compare against established results given e.g. by the developed good practice guide (see KER No. 1).
<b>Innovative potential</b>	How is the KER going beyond the state-of-the-art (what will it enable that was not possible before)?	No common evaluation framework to access the models and methods developed in this project exists so far.
	Is the KER disruptive (will it displace established processes /products /services)? Give brief details.	No
<b>Target group(s)</b>	Who will use the KER?	NMIs/DIs, academia, industry, other projects
	Contacts available: Y/N	Yes

<b>Competition and Unique Selling Proposition (USP)</b>	Are there competitive solutions already available?	No
	What is the competitive advantage of the KER in relation to existing solutions (USP)?	n/a
<b>Stakeholders / collaborators involved in the KER (i.e. from outside of the consortium)</b>	Will a stakeholder / collaborator (from outside of the consortium) contribute background or new results to the exploitable result?	No
	Details of contribution	n/a
<b>Exploitation Pathway</b>	How will you access the market? e.g. direct industrial use, technology transfer, patent / license agreement, publication, sale, spin-off, spin-out, joint venture etc.	Direct use by other scientists and industry.
	Describe dissemination activities	The framework will be openly accessible through a git repository (see KER No. 2). A description of the framework will be included the online documentation of the software repository.
	Describe exploitation activities	Presentation on scientific conferences. Advertisement through the project website and institutional websites of the consortium. E-mail notification to the stakeholder committee.
	Are there barriers/obstacles for end users to take up your KER? If so, how might you overcome these?	No

	How your result can feed back to policy making and how it contributes to EU priorities	n/a
<b>IPR (If applicable)</b>	Which background /existing /prior (e.g. patents etc.) will be part of the KER?	n/a
	Which member of the consortium owns this background?	n/a
	Which member(s) of the consortium will (co-)own the KER and how (e.g. shares, ownership agreement)?	n/a
<b>Progress</b>	Please describe progress that has been made in this reporting period (refer to dissemination and exploitation activities from earlier)	Work on the framework has not started yet.
	Which end users have expressed interest in the results?	n/a

