Where Quantum and Fluids entangle

Quantum Computational Fluid Dynamics

Dissemination, Exploitation and Communication Plan

1st Update

Project number# 101080085

Call:	HORIZON-CL4-2021-DIGITAL-EMERGING-02
Topic:	HORIZON-CL4-2021-DIGITAL-EMERGING-02-10
Type of action:	HORIZON Research and Innovation Actions
Granting authority:	European Commission-EU
Project starting date: fixed date:	1 November 2022
Project end date:	31 October 2026
Project duration:	48 months
Project Coordinator:	University of Hamburg (UHH)
Deliverable number:	D10.3
WP contributing to the deliverable:	WP#10, Project and Data Management, Dissemination and Communication
Deliverable Type:	Report
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Dissemination level:	Public
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Prepared By:	Belda Atilla
Internal Reviewers:	

This project receives funding from the European Union's Horizon 2020 HORIZON Research and Innovation Actions Programme under Grant Agreement #101080085

Final Approval: Prof. Dr. Dieter Jaksch

Revision History

Version	Date	Who	Changes
0	13.06.2024	B. Atilla	1st update of Dissemination, Exploitation and Communication Plan

Executive Summary

QCFD (Quantum Computational Fluid Dynamics) is an EU-funded project under the Horizon 2020 programme/HORIZON Research and Innovation Actions /HORIZON-CL4-2021-DIGITAL-EMERGING-02 call for proposals.

Scientific and technological progress is broadly underpinned by the ability to accurately predict and optimise complex fluid flows which arise acrossthe physical and life sciencesincluding climate research, as well asin the energy, chemical, automotive, aircraft, and ship building industries. The wide separation of length and time scales that need to be covered when designing and optimising flows and a large number of design parameters make numerical simulations highly demanding. Current capabilities are thus insufficient to meet future demands of users in academia and industry.

The overarching goal of this project is to rise to this challenge by developing a versatile quantum algorithmic framework for efficiently solving a wide range of CFD problems without compromising on accuracy. The proposed methodology will be demonstrated on hardware developed in European Quantum Technology Flagship Projects and will prove the feasibility and advantages of our approach using a core set of CFD problems arising in the thermal management of battery-electric-vehicles (BEV). The approach will subsequently be extended to a wider class of flow configurations. Extensive validation and benchmarking will provide detailed quantitative information on hardware requirements for achieving a quantum advantage.

Here we present the first update of the Dissemination, Communication and Exploitation Plan. This document is a deliverable of Work Package 10, Project and Data Management, Dissemination and Communication of the project. It is a comprehensive document defining target audiences, types of topics and results for sharing and further dissemination as well as types of actions, activities and tools for joint dissemination activities of the QCFD Project. These activities are based on the cooperation of all partners and are strongly linked not only to the QCFD project objectives but also to the activities of particular work packages.

Due to the amendment (AMD-101080085-7) application process in the first year of the project, the first version of the Dissemination, Communication and Exploitation Plan was submitted on the 18th of April 2024 officially and the first updated version will be submitted on the 18th of June 2024.

This will be a dynamic document that will continuously be updated during the project. 2nd and 3rd updated versions will be published in months 24 and 36. The plan will be for use by all the partners involved in the QCFD project and form the basis of a common strategy for disseminating, communicating, and exploiting project results.

Contents

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List of figure and tables

List of abbreviations

Acronym / Short Name	Meaning
EU	European Union
EC	European Commission
QCFD	Quantum Computational Fluid Dynamics
UHH	University of Hamburg
TUHH	Technical University of Hamburg
FZL	Jülich Research Centre
TUM	Technical University of Munich
ENG	ENGYS SRL
TUC	Technical University of Crete
PlanQc	PlanQc GMBH
CDE	Communication, Dissemination and Exploitation
KPI	Key Performance Indicator
WP	Work Package
PO	Project Officer
SME	Small and Medium Enterprise
WP	Work Package
WPL	Work Package Leader

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1. Introduction

The communication activities should promote the entire action, both the project itself and its ongoing activities and results, to a wider range of audiences, including the public, traditional and social media.

Deliverable 10.3 is an is an updated version of deliverable 10.2 and outlines the key objectives, target audiences, and core messages of our communication and dissemination efforts. It presents the updates of the Dissemination, Exploitation and Communication Plan for the QCFD project, including the next activities foreseen for the 12 upcoming months, and the respective activities carried out during the first year of the project.

On the one hand, this Dissemination, Exploitation and Communication Plan sets out the plan for targeting the various relevant stakeholders in an effective manner, while also generally describing the intended applied and scientific dissemination and communication activities for the next project cycle. These include the project website, dynamic social media channels, printed materials, newsletters, press releases and contributions to scientific journals. Additionally, the QCFD Team delves into active participation in conferences, workshops, and events, recognizing their pivotal role in amplifying our project's impact.

The dissemination of project results and information to the wider public is very important to the QCFD Consortium and for this purpose, project updates have been shared via website and social media channels (Twitter, LinkedIn).

The document has been updated with the real activities performed during the first 19 months of the project.

2. Objectives

The key purpose of the QCFD communication strategy is to communicate the project scope, objectives, results and impacts properly and effectively to the interested audience and finally engage a variety of stakeholders in project activities.

The dissemination and exploitation measures aim to inform the target groups about the activities and the outputs of the project.

- to disseminate the project's results at dedicated events all around Europe as well as in scientific publications.
- valorize the results of the project during and after its lifetime.
- to ensure open access to results produced by the project.

3. Phases of the communication and dissemination strategy

The planning and execution of the project dissemination activities require a schedule closely aligned with key project deliverables and milestones. At this scope, the project will be organized around 3 phases:

Initial Awareness Phase (Month 0-12)

The initial awareness phase, spanning from Month 0 to Month 12, aimed to ensure the project was known to relevant stakeholders and the general public. During this phase, the project's graphical identity was established, including the project logo, branding guidelines, and templates for project documents and presentations. PIs participated in various events and made efforts to disseminate the project outputs.

Job advertisements related to the project were published on sectoral portals to reach scientists seeking employment in this field. A Project Kick-Off meeting was held at Hamburg University in Month 6, and the first QCFD Researchers Sync meeting was conducted online in Month 8. The first press release with the project was published during this period. Articles and data sets related to the projects started to be published.

Targeted dissemination phase (Month 12-36)

During the targeted dissemination phase, which spans from Month 12 to Month 36, efforts were made to enhance the understanding of the project results among external stakeholders, leading to greater engagement and better future uptake of the project outcomes. In this phase, the consortium enriched the project website with content including publications, meeting summaries, news updates, and deliverables.

Preliminary project results were shared with target audiences through publications in scientific journals and participation in conferences and workshops, as listed in the communication and dissemination activities. The first project coordination meeting was held at Hamburg University and attended by all partners. During this meeting, various coordination meetings were conducted, including the Principal Investigators Coordination Meeting, the Advisory Board Meeting, and a joint Principal Investigators & Advisory Board Meeting.

In addition to these communication activities, dissemination activities were actively pursued by the Principal Investigators through their participation in conferences, workshops, meetings, and training events. These activities provided opportunities to disseminate information about the QCFD project and its results.

Presentation of results (Month 36-48)

This represents the period just prior to the end of the project when the project reaches its most significant output. This will be the more active period matching with the finalization of the project and the publications of the final project results.

Details related to communication and dissemination activities can be found in Annex- 8.1. QCFD Communication and Dissemination Activities

4. Target audience

The consortium has identified several groups that have an interest in or are going to be affected by the QCFD project.

Different groups of stakeholders have diverse interests, and we will thus tailor communication and dissemination activities for different target groups. Specifically, we will distinguish between industrial stakeholders who could directly benefit from the project results and potentially invest in follow-on research projects, academic and industrial researchers with expertise in CFD and/or quantum technologies to build a broad research community working on QCFD problems, and lay audiences where the target is to raise general awareness of the potential of quantum computing in industrial applications.

We list the major communication channels and objectives for each target group in Table 1. The primary communication channels and planned dissemination activities are detailed in Table 2, while the activities executed according to these plans are documented in Annex- 8.1. QCFD Communication and Dissemination Activities

TABLE 1: Communication channels and aims

industry CFD experts	Channels: project website, social media channels, data repository, scientific publications, scientific talks and posters, dedicated workshop sessions.
	Aims: project involvement, commercial exploitation of quantum technologies.
OpenFOAM users and developers	Channels: OpenFOAM – QCFD software interface and documentation, dedicated workshop sessions, project website, social media channels.
	Aims: project involvement, extending the OpenFOAM open-source developer community to QCFD applications.
academic quantum computing and CFD community	Channels: scientific publications, scientific workshops, scientific talks and posters, data repository, QCFD software framework and documentation, project website, social media channels.
	Aims: Project involvement e.g. leading to new QCFD algorithms and/or proposals for optimized hardware architectures.
quantum hardware developers in industry and academia	Channels: scientific publications, scientific workshops, scientific talks and posters, data repository, project website, social media channels.
	Aims: Project involvement leading to a detailed understanding of QCFD hardware requirements and e.g. to QCFD optimized quantum hardware architectures in the longer term.
students	Channels: project website, social media channels, tutorial examples, online videos, semi-popular publications, student internships and undergraduate research projects.
	Aims: attract PhD students into the project's interdisciplinary field of science.
mass media	Channels: project website, social media channels, press releases.
	Aims: disseminate most important results widely, raise project awareness.
interested lay audiences	Channels: project website, social media, public talks, open house events.
	Aims: General awareness of the project.

TABLE 2: Description of communication channels and dissemination activities

scientific publications	These will be the main tool to communicate scientific advances and results. We will produce publications targeted at individual specialized target audiences in CFD research, quantum algorithms and optimization, and quantum hardware development as well as more general publications that target a wider interdisciplinary group of researchers. Publications will follow EU guidelines on open access publishing and properly acknowledge the QCFD project. We will

	publish in international peer-reviewed journals including Physical Review Letters/Research/A/B/E/X, Nature Family, Quantum, Quantum Science and Technology, New Journal of Physics, Computers & Fluids, AIAA J., J. Comput. Physics, Flow Turb. and Combustion, J. Structural and Multidisc. Optimisation, J. Num. Methods in Fluid Flow, ZAMM
scientific talks and posters	Talks and posters will attract stakeholder interest and be used to disseminate project results and the QCFD framework widely. We will adapt scientific talks to the target audiences in quantum technologies and CFD. Talks will provide unique opportunities to communicate the necessity of an interdisciplinary approach in developing quantum solutions for industrially relevant problems. Events that we aim to present our results at include EU Quantum Flagship events (e.g. EQTC), Quantum, QIM, ECCOMAS Congress, WCCM Congress, EUROGEN, AIAA Conf., MARINE, Int. Conf. CFD, GAMM.
project website	The website will provide project information, scientific results. It will contain sections dedicated to communicating with the major stakeholders listed above. The website design will be tested for different types of devices including phones, tablets and desktop computers.
social media channels	We will have a Twitter account for immediate communication of general project news and communicating directly with target audiences. We will also create a LinkedIn community group to bring together interested stakeholders.
online videos	We will create a project video accessible from the website and youtube that presents the project and general concept. Where appropriate and possible we will produce video abstracts for scientific publications (e.g. New Journal of Physics).
logo and templates	We will create a project logo and presentation templates (e.g. word, power point, keynote) accessible to all project partners.
data repository	Project data containing CFD and QCFD benchmark results will be published in institutional repositories including appropriate metadata in line with the project's data management plan and FAIR (Findability, Accessibility, Interoperability and Reusability) principles. The repository will be promoted on the project website.
OpenFOAM – QCFD software interface and documentation	Open-source software developed in this project will be published in a public access git format repository. It will be documented along the guidelines of the data management plan and be publicly accessible.
QCFD software framework and documentation	Open-source software developed in this project will be published in a public access git format repository. It will be documented along the guidelines of the data management plan and be publicly accessible.
tutorial examples	The website will contain a dedicated section containing tutorial QCFD and OpenFOAM – QCFD software interface examples. These will be explained in detail to aid interested researchers setting up their own QCFD calculations.

workshops	We will hold project workshops approximately after 18, 30 and 42 months of the project. These workshops will focus on communicating results to the CFD, quantum technologies and quantum computing communities. They will contain dedicated sessions for these target audiences and also plenary sessions for all. Round table and breakout discussions, poster and industry focussed sessions will be designed to maximise participant involvement in the workshops. Workshops in months 30 and 42 will also contain tutorial sessions on the structure and usage of the QCFD library. The OpenFOAM interface will be presented in detail in the workshop in month 42.
interactions with EU Flagship projects	Regular meetings, user forum, long-term visits, knowledge and technology exchange. We have established close contacts with the applicants for successor projects of Aqtion, OpenSuperQ and PASQuanS and agreed on closely collaborating with them during the implementation of the projects.
student internships and undergraduate research projects	We will advertise student research opportunities at the participating host institutions. We will attract undergraduate students with broad scientific interests and a background in physics, engineering, computer science, mathematics or a cognate subject to get involved in the project.
press releases	We will collaborate with the institutional public-relations offices to write press releases on highlight project research results and disseminate them widely.
semi-popular articles	We will describe the QCFD project and its general scientific approach, important results and possible impacts in semi-popular articles e.g. on theconversation.com
public talks & open house events	These will be used to communicate project results and its possible impacts to the general audience to raise general awareness.

5. Communication and dissemination rules

5.1. Communication within the QCFD consortium

Communication among partners was crucial to exchanging up-to-date knowledge and data across different WPs, enhancing, and optimizing external communication and dissemination.

The overall responsibility for WP#10, which included Project and Data Management, Dissemination, and Communication, belonged to UHH. However, the assigned lead beneficiary of this work package organized related CDE activities and materials and submitted them for consortium approval. Once approved, the actual plan was ready to be implemented. Upon completion of the CDE activity, a related activity report was prepared for the annual updates of the CDE Plan. All these phases were carefully managed and monitored within the project, ensuring proper mechanisms were in place to avoid deviations or potential failures while disseminating and/or exploiting results.

All partners regularly participated in communication and dissemination activities, specifically:

- Communicating their activities and disseminating their results to their respective networks, on social media, and through news on the project website,
- Contributing content to the newsletter (e.g., articles, interviews),
- Informing other partners of interesting, related initiatives and events they could participate in,

- Keeping track of their communication and dissemination activities by filling in a dedicated reporting table available in the MS-Teams of the project,
- Disseminating results and publications in open access.

Internal communication was ensured through regular exchanges of information via email and during regular meetings when all partners gathered to discuss achievements, upcoming activities, deadlines, and issues arising within the different work packages. WP leaders also presented main research advances during meetings or other WP leader meetings that were organized as needed.

5.2. Dissemination of own (including jointly owned) Results (Consortium Agreement, Article 8.4)

During the Project and for a period of 1 year after the end of the Project, the dissemination of own Results by one or several Parties including but not restricted to publications and presentations, shall be governed by the procedure of Article 17.4 of the Grant Agreement and its Annex 5, Section Dissemination, subject to the following provisions.

Prior notice of any planned publication shall be given to the other Parties at least 14 calendar days before the publication. Any objection to the planned publication shall be made in accordance with the Grant Agreement by written notice to the coordinator and to the Party or Parties proposing the dissemination within 30 calendar days after receipt of the notice. If no objection is made within the time limit stated above, the publication is permitted.

An objection is justified if

a) the protection of the objecting Party's Results or Background would be adversely affected, or

b) the objecting Party's legitimate interests in relation to its Results or Background would be significantly harmed, or

c) the proposed publication includes Confidential Information of the objecting Party.

The objection must include a precise request for necessary modifications.

If an objection has been raised the involved Parties shall discuss how to overcome the justified grounds for the objection on a timely basis (for example by amendment to the planned publication and/or by protecting information before publication) and the objecting Party shall not unreasonably continue the opposition if appropriate measures are taken following the discussion.

The objecting Party can request a publication delay of not more than 30 calendar days from the time it raises such an objection. After 7 calendar days the publication is permitted, provided that the objections of the objecting Party have been addressed.

In the dissemination of outputs within the scope of the project, PIs act in accordance with these guidelines.

5.3. Information on EU funding (as defined in Article 17.2 of the GA)

Unless otherwise agreed with the granting authority, communication activities of the beneficiaries related to the action (including media relations, conferences, seminars, information material, such as brochures, leaflets, posters, presentations, etc., in electronic form, via traditional or social media, etc.), dissemination activities and any infrastructure, equipment, vehicles, supplies or major result funded by the grant must acknowledge EU support and display the European flag (emblem) and funding statement (translated into local languages, where appropriate)

Quality of information — Disclaimer

Any communication or dissemination activity related to the action must use factually accurate information. Moreover, it must indicate the following disclaimer (translated into local languages where appropriate):

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.”

Applications For IPR Protection of Results

Include the following standard sentence in each application filed by or on behalf of a beneficiary:

"The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No:101080085".

Standards Incorporating Results

If results are incorporated in a standard, the beneficiary shall ask the standardization body to include the following statement in (information related to) the standard:

"Results incorporated in this standard received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No:101080085".

CDE Activities

The following must be included in all CDE activities:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No:101080085.

Infrastructure, Equipment, Major Results

The following must be displayed on all infrastructure, equipment and major results funded by the grant:

This [infrastructure][equipment][insert type of result] is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No:101080085.

When displayed together with another logo, the EU emblem must have appropriate prominence.

The documents prepared within the scope of the project, the website design and the use of promotional materials have all been carried out within these guidelines as can be seen in below.

Sample cover page template of the deliverable (usage of logo and disclaimer):

Quantum Computational Fluid Dynamics
Core Benchmark CFD Set
Project number 101080085

Call:	HORIZON-CL4-2021-DIGITAL-EMERGING-02
Topic:	HORIZON-CL4-2021-DIGITAL-EMERGING-02-10
Type of action:	HORIZON Research and Innovation Actions
Granting authority:	European Commission-EU
Project starting date: fixed date:	1 November 2022
Project end date:	31 October 2026
EU-Project duration:	48 months
Project Coordinator:	University of Hamburg (UHH)
Work Package Leader	Technical University of Hamburg (TUHH)
Cooperations	University of Hamburg (UHH), ENGYS (ENG)
Deliverable number:	D1.1
WP contributing to the deliverable:	WP#1 Core CFD Examples and Algorithms
Deliverable Type:	Data
Revision:	0
Dissemination level:	Public
Due Submission date:	30.04.2024
Prepared By:	TUHH, UHH, ENG
Internal Reviewers:	DJ, TR, PO, SB
Final Approval:	

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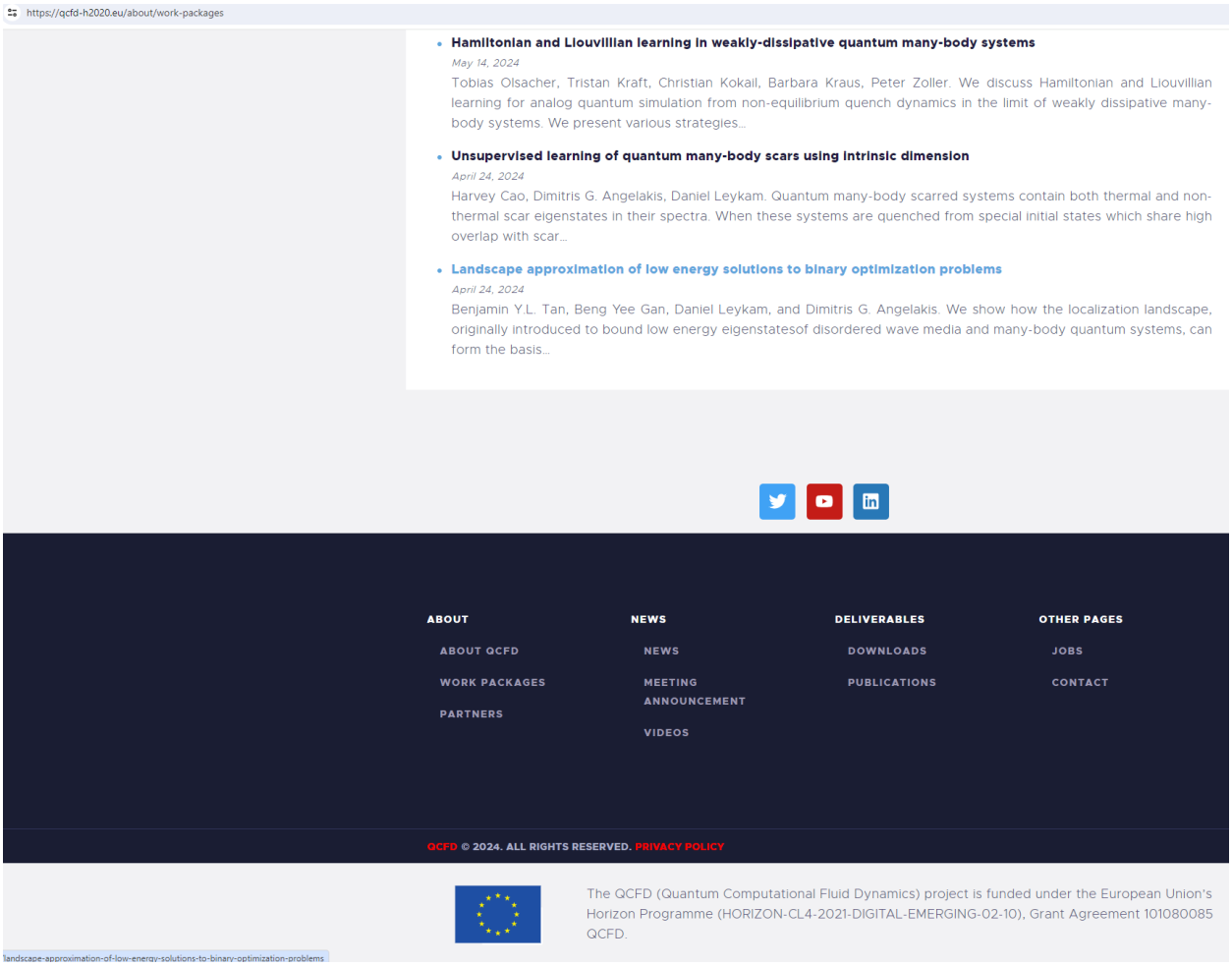
https://qcfd-h2020.eu/about/work-packages
Hamiltonian and Liouvillian learning in weakly-dissipative quantum many-body systems
May 14, 2024
Tobias Olsacher, Tristan Kraft, Christian Kokail, Barbara Kraus, Peter Zoller. We discuss Hamiltonian and Liouvillian learning for analog quantum simulation from non-equilibrium quench dynamics in the limit of weakly dissipative many-body systems. We present various strategies...
Unsupervised learning of quantum many-body scars using intrinsic dimension
April 24, 2024
Harvey Cao, Dimitris G. Angelakis, Daniel Leykam. Quantum many-body scarred systems contain both thermal and non-thermal scar eigenstates in their spectra. When these systems are quenched from special initial states which share high overlap with scar...
Landscape approximation of low energy solutions to binary optimization problems
April 24, 2024
Benjamin Y.L. Tan, Beng Yee Gan, Daniel Leykam, and Dimitris G. Angelakis. We show how the localization landscape, originally introduced to bound low energy eigenstatesof disordered wave media and many-body quantum systems, can form the basis...
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ABOUT QCFD
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QCFD © 2024. ALL RIGHTS RESERVED. PRIVACY POLICY
The QCFD (Quantum Computational Fluid Dynamics) project is funded under the European Union's Horizon Programme (HORIZON-CL4-2021-DIGITAL-EMERGING-02-10), Grant Agreement 101080085 QCFD.
landscape-approximation-of-low-energy-solutions-to-binary-optimization-problems

Design of Promotional Water Bottle

This project receives funding from the European Union's Horizon 2020 HORIZON Research and Innovation Actions Programme under Grant Agreement #101080085

6. Tools and channels

The project has been collecting, managing, and benchmarking research data. Data management is described in the 10.01 Data Management Plan.

The data collection strategy is designated to support the scope of scientific and development goals of QCFD. The results developed throughout the project will take the form of scientific publications, whose pre-refereed versions will be available, and outreach material to disseminate the key research advances to the community.

In line with the FAIR (Findability, Accessibility, Interoperability, and Reusability) principles, the project is committed to maintaining transparency throughout its data management processes. To this end, all disseminated information will be accompanied by detailed metadata and comprehensive documentation. This is aimed at facilitating a deeper understanding of the results and enabling the scientific reproduction of these outcomes.

A new branch was created under UHH's Sustainable Research Data Management portal ' https://www.fdr.uni-hamburg.de/search?page=1&size=20&q=QCFD '. This portal will ensure accessibility for project partners while adhering to protocols that respect intellectual property protection regulations for the public.

In addition, data here is stored publicly and its availability is communicated through QCFD's social media accounts and website.

The datasets produced during the 1st reporting period under the project can be found in Annex 8.2 QCFD Datasets Follow-Up.

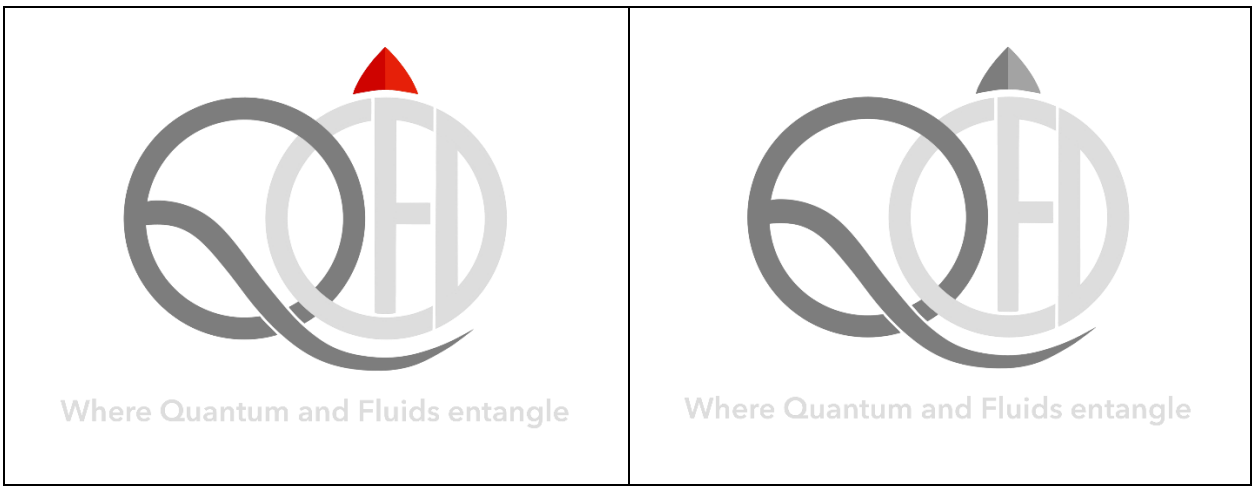
6.1. Use of graphic identity and EU visibility

A common graphic identity has been defined to allow for better visibility and recognition as well as branding of the QCFD project. All dissemination tools and activities have been referred to or include Project Name, Project Logo, Project Website and Information on EU funding. These have been consistently used for the project website and all other communication templates, such as Power Point, Word, posters and EC Report.

6.2. Project Logos

Where Quantum and Fluids entangle	Where Quantum and Fluids entangle

This project receives funding from the European Union's Horizon 2020 HORIZON Research and Innovation Actions Programme under Grant Agreement #101080085

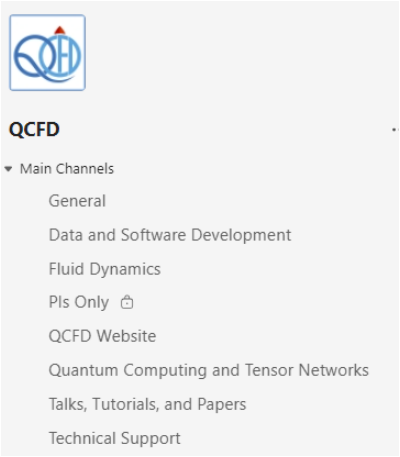


6.3. MS-Teams

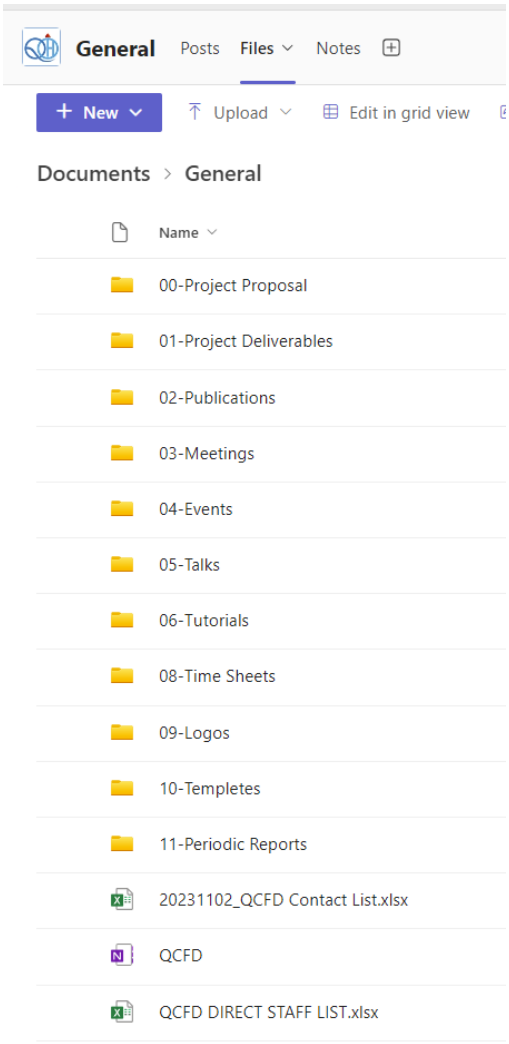
The QCFD team has been utilizing Microsoft Teams to enhance internal communication seamlessly and its centralized space feature for storing project-related documentation, ensuring accessibility for all team members. The key features contributing to this accessibility include:

- Creating and managing teams and channels
- Chat and file sharing
- Scheduling meetings and calls
- Project-wide announcements

MS-Teams' QCFD Teams has these channels under it.



Different filing structures were created under the channels according to the needs of the groups. The filing structure under the general channel is as follows:



6.4. Open Access to Scientific Data Tool

The project has been collecting, managing, and benchmarking research data. Data management is described separately in the 10.01 Data Management Plan.

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In addition, data here is stored publicly and its availability is publicly communicated through QCFD's social media accounts and website.

The datasets produced during the 1st reporting period under the project can be found in Annex 8.2 QCFD Datasets Follow-Up.

6.5. Project Website

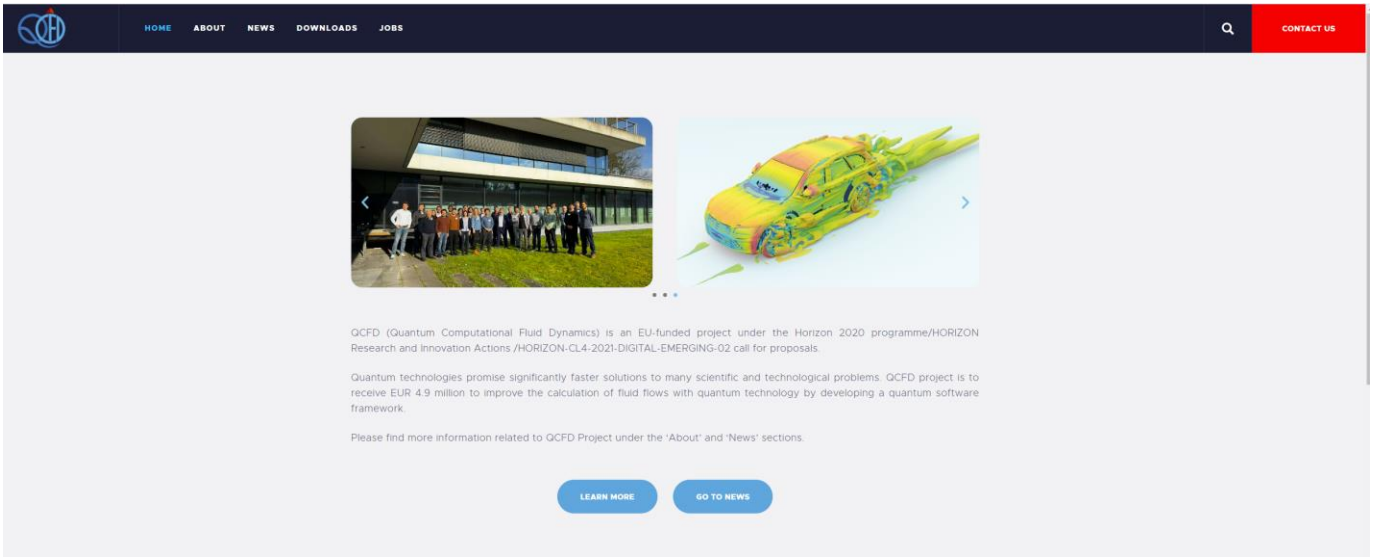
QCFD has developed a user-friendly project website under qcfd-h2020.eu and updates are ongoing.

The website provides the primary source of information for external parties, providing updates on project activities and achievements to all target audiences. The aim is to inform stakeholders and associated industries about project developments and present the project's achievements and the QCFD developments to the public.

All partners have been contributing to the website by providing relevant project information. All communication efforts by project partners and social media have been redirected to the QCFD website. Traffic to the website has been increased by creating mutual links between the partners' websites and other relevant websites.

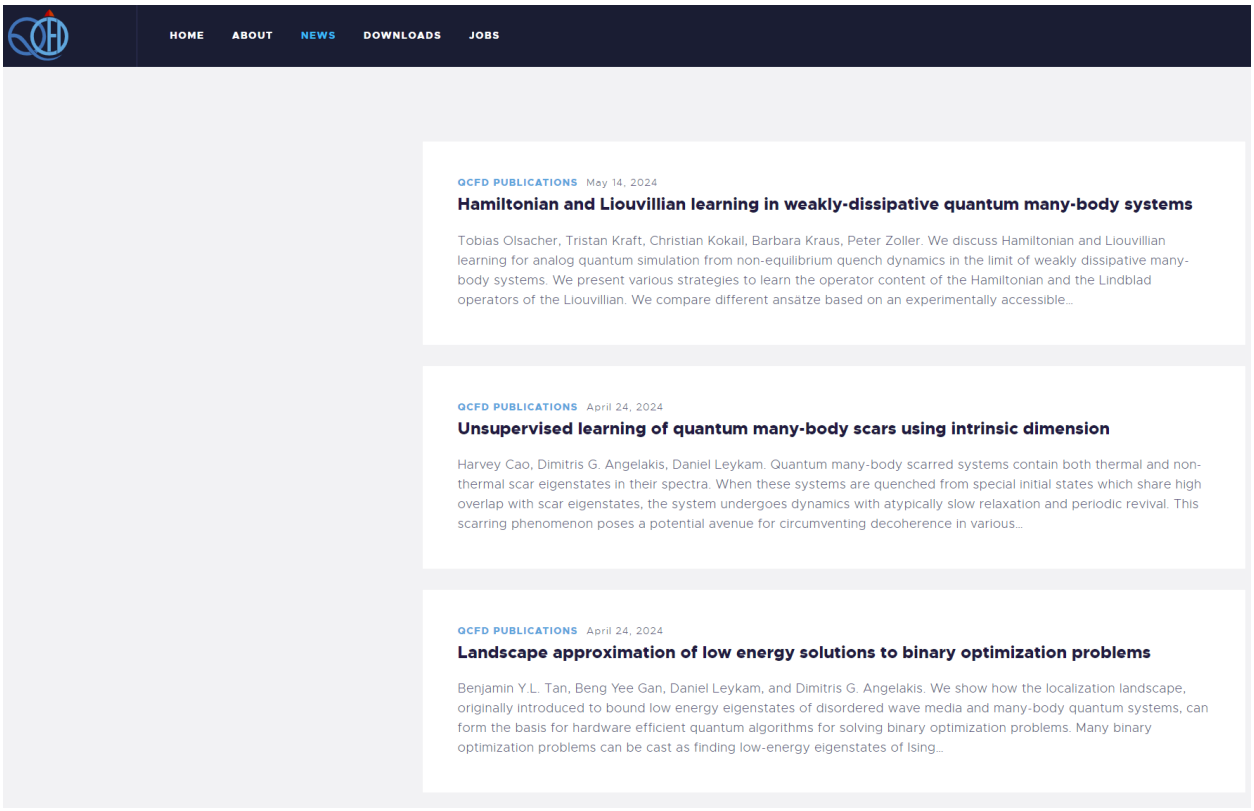
QCFD website is characterized by its easy navigability, simplicity and user-friendly features. On the menu, the following sections have been created: Home, About, News, Downloads, and Jobs.

6.5.1. Home Section

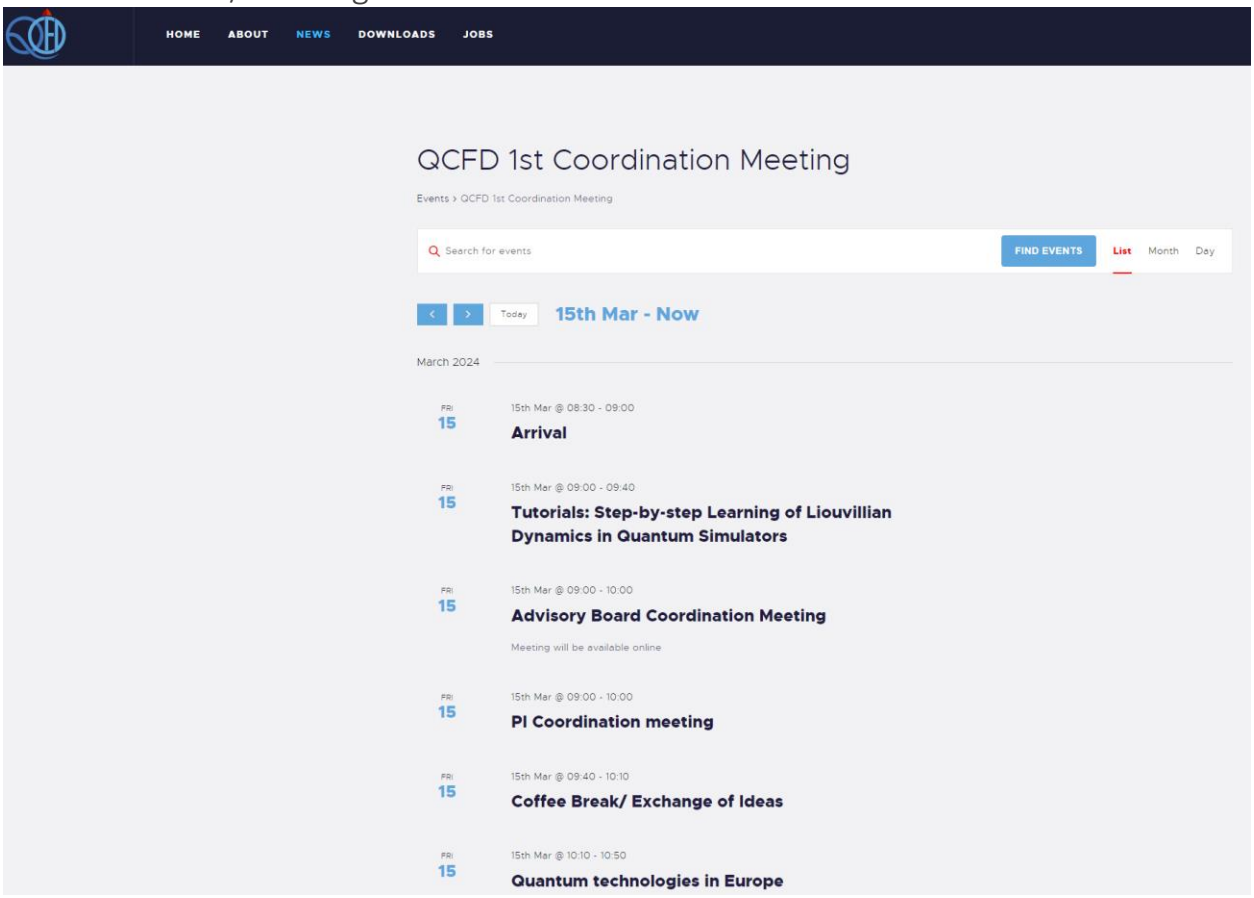


6.5.2. About Section

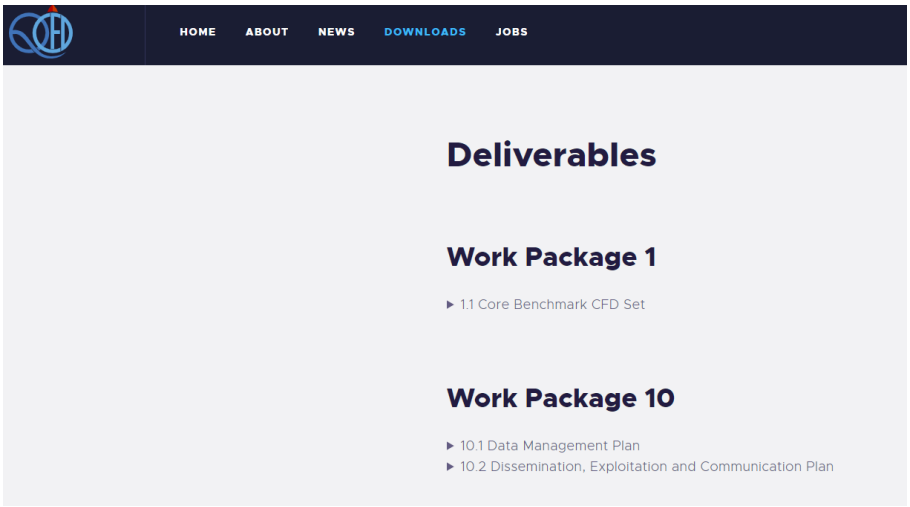
6.5.3. News Section



6.5.4. News/Meeting Section



6.5.5. Deliverables Section



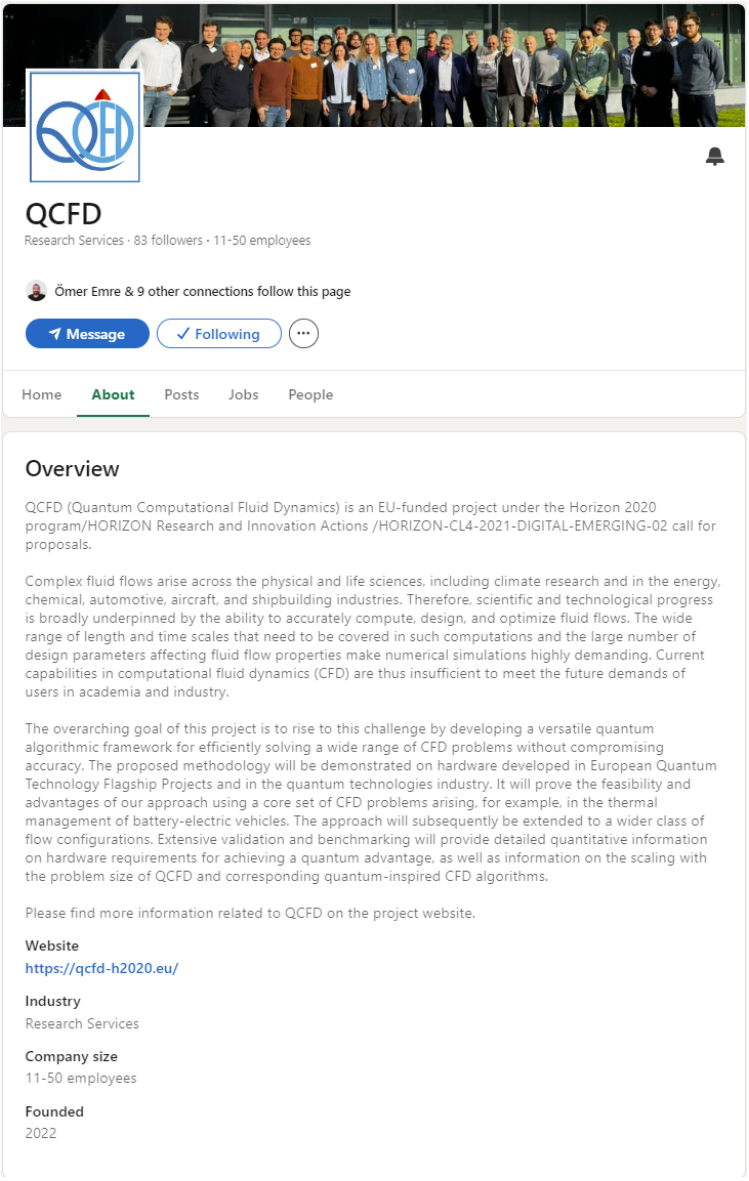
6.6. Social Media

The project's social media accounts have been created on Twitter, LinkedIn and YouTube to ensure wider dissemination to different age groups and target audiences. Social media has been used as a tool to announce project developments, but most importantly drive traffic to the project website.

Consortium partners have been following the project's social media channels and engaging with them as much as possible. Whenever possible, the partners have been sharing posts on their own corporate websites and social media networks.

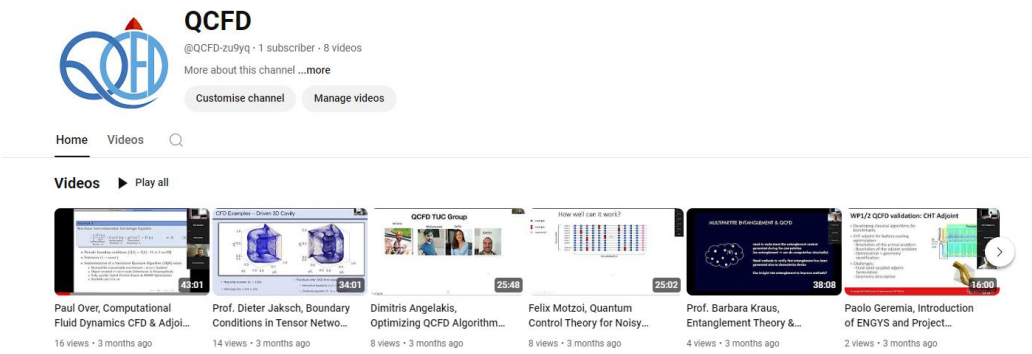
Posts published on social media are included in Annex 8.3. Social Media Posts

6.6.1 LinkedIn Account



6.6.2. Twitter Account

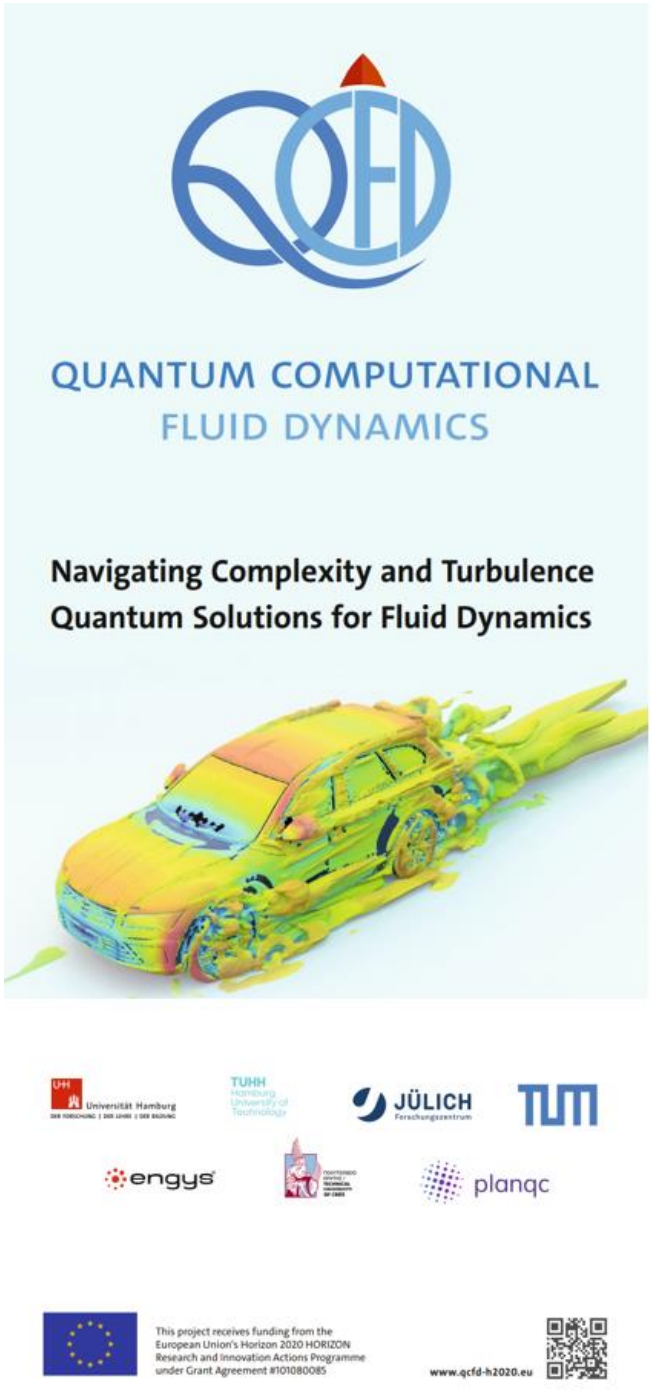
6.6.3. YouTube Account



6.7. Printed Material

During this reporting period only roll Up banners were used as printed material. These banners used during the 1st coordination meeting and the events in Hamburg University Activities to increase visibility related to QCFD project.

Design of Roll up Banners (usage of logo and disclaimer):



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6.8. Scientific Journals

Scientific papers were published in specialized international peer-reviewed journals like Physical Review A, AIAA Journal, Physical Review Fluids and Quantum 8 during the 1st reporting period. A list of publications can be found under Annex 8.4 QCFD Publications Follow Up.

6.9. Participation at Conferences, Workshops and Events

Project partners have been attending sector-related events, conferences, and workshops, to meet target groups, other stakeholders, public authorities, and the scientific community and to raise awareness about the project objectives and results. These events provide access to target audiences at local, national, European, and international levels. Activities attended can be found under Annex 8.1. QCFD Communication and Dissemination Activities.

7. Monitoring and Reporting

The monitoring system has been established related to publications; communication and dissemination activities, social media posts, datasets and the lists are given under annexes. These lists will be updated and submitted in the following dissemination reports.

8. Annexes

8.1. QCFD Communication and Dissemination Activities

QCFD Communications Activities							
Beneficiary	**Communication Activity Name***	**Description***	**Who? Target audience***	**How? Communication channel***	**Outcome***	**Status***	**Date**
All	Project Kick-off Meeting	Initial Meeting to discuss project objectives and milestones	- Industry, business partners	- Event (conference, seminar, meeting, workshop..)	Aggreed on project timeline and assigned tasks	Delivered	02-May-23
TUM	MCQST conference	Presentation of research results at the Munich Conference on Quantum Science and Technology	- Research communities	- Event (conference, seminar, meeting, workshop..)	Discussions with conference participants on the presented topic	Delivered	22-Jun-23
TUM	Beyond IID in Information Theory	Presentation of research results at the conference "Beyond IID in Information Theory"	- Research communities	- Event (conference, seminar, meeting, workshop..)	Discussions with conference participants on the presented topic	Delivered	11-Jul-23
All	QCFD - Researchers Sync	Informal get-togethers to exchange impressions between only researchers of the QCFD Project to avoid potential overlaps in our work and intensify internal communication.	- Industry, business partners	- Event (conference, seminar, meeting, workshop..)	Updated project status and information of upcoming steps	Delivered	18-Jul-23
TUM	International Quantum Tensor Network	Presentation of research results at the conference "International Quantum Tensor Network"	- Research communities	- Event (conference, seminar, meeting, workshop..)	Discussions with conference participants on the presented topic	Delivered	26-Jul-23
TUHH	ETN Summerschool	Attending of a Tensor Network Summer School and presentation of the research results	- Research communities	- Event (conference, seminar, meeting, workshop..)	Feedback on all aspects of the research results presented during the colloquium.	Delivered	11.09-15.09.2023
TUM	EQTC 2023	Presentation of research results at the conference at EQTC 2023	- Research communities	- Event (conference, seminar, meeting, workshop..)	Discussions with conference participants on the presented topic	Delivered	19-Oct-23

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QCFD Communications Activities							
Beneficiary	**Communication Activity Name***	**Description***	**Who? Target audience***	**How? Communication channel***	**Outcome***	**Status***	**Date**
All	Researchers Meeting 2.0	Presentation of the research progress of the researchers. Space for open exchange	- Industry, business partners	- Event (conference, seminar, meeting, workshop..)	Vivid discussion and potential collaborations on topic	Delivered	27-Oct-23
ENG	Researcher Discussions	Presentation of the research progress of the researchers. Space for open exchange	- Industry, business partners	- Event (conference, seminar, meeting, workshop..)	Exchange of material and ideas, potential collaborations on quantum algorithms for solving differential equations	Delivered	29-Nov-23
ENG	HPCQC Workshop	Attending of a high performance computing and quantum computing workshop.	- Research communities	- Event (conference, seminar, meeting, workshop..)	Vivid discussion with physicists of UniTrento with opportunity to present our work and communication with NVIDIA developers.	Delivered	14-15/Dic/2023
TUM	Workshop on Quantum Information SRS	Presentation of research results at the Workshop on Quantum Information SRS	- Research communities	- Event (conference, seminar, meeting, workshop..)	Discussions with conference participants on the presented topic	Delivered	25-Feb-24
All	1st Coordination Meeting	Project Coordination Meeting is a regular gathering designed to facilitate effective communication, coordination, and decision-making among the project's stakeholders. This meeting aims to ensure that all team members are aligned with the project's objectives, progress, and upcoming milestones. It provides a platform for discussing any challenges, brainstorming solutions, and making strategic adjustments as needed to keep the project on track.	- Industry, business partners	- Event (conference, seminar, meeting, workshop..)	Updated project status, resolved issues, action items and assignments, adjusted plans, stakeholder alignment, documentation of decisions, next meeting scheduled.	Delivered	14-15/Mar/2024
All	Principal Investigators Coordination Meeting	The QCFD consortium held a PI coordination meeting to discuss several key topics, including updates on the amendment process, budget considerations, deliverables, milestones, dissemination and exploitation of project results, periodic reporting, challenges, and risk updates. Representatives from all partners attended the meeting in person.	- Industry, business partners	- Event (conference, seminar, meeting, workshop..)	Updates and decisions on amendment process, budget, deliverables and milestones, dissemination and communication, periodic reporting, challenges and risks, next meeting	Delivered	15-Mar-24

QCFD Communications Activities							
Beneficiary	**Communication Activity Name***	**Description***	**Who? Target audience***	**How? Communication channel***	**Outcome***	**Status***	**Date**
All	Advisory Board Meeting	The advisory board has been provided with a summary report on the current project's progress. The board was asked to provide feedback on all aspects of the project and the research results presented during the workshop.	- Industry, business partners	- Event (conference, seminar, meeting, workshop..)	Feedback on all aspects of the project and the research results presented during the workshop.	Delivered	15-Mar-24
All	Principal Investigators& Advisory Board Meeting	After the end of the workshop during the coordination meeting, the PIs met with the advisory board members for feedback on the project's progress and possible improvements. The advisory board has been provided with a summary report on the current project's progress. The board was asked to provide feedback on all aspects of the project and the research results presented during the workshop.	- Industry, business partners	- Event (conference, seminar, meeting, workshop..)	Feedback on all aspects of the project and the research results presented during the workshop.	Delivered	15-Mar-24
TUHH	Volkswagen CFD Colloquium	Presentation of recent quantum CFD progress	- Industry, business partners	- Event (conference, seminar, meeting, workshop..)	Feedback on all aspects of the research results presented during the colloquium.	Delivered	18-Apr-24

QCFD Dissemination Activities						
Beneficiary	Dissemination activity name*	What Type of dissemination activity*	Who? Target audience Reached*	Why? Description of the objective(s) with reference to a specific project output (max 200 characters)*	Status of the dissemination activity*	Date
TUHH	Press Release	Other	Citizens	Announcement of project launch to the public	Delivered	20-Sep-22
UHH	Wilhelm and Else Heraeus Foundation	Conferences	Research communities	The Wilhelm and Else Heraeus Foundation is a private institution that supports scientific research and education with an emphasis on physics. The foundation is best known for organizing and funding a variety of events dedicated to the discussion of research results and the training of young scientists. Dieter Jaksch was invited talk at Ultracold Quantum Matter: Basic Research and Applications.	Delivered	13-Dec-22
FZJ	Research Paper Publication	Other scientific collaboration	Research communities	Hybrid discrete-continuous compilation of trapped-ion quantum circuits with deep reinforcement learning	Delivered	01-Jan-23
UHH	Nordita winter school 2023	Education and training events	Research communities	Nordita winter school 2023, Dynamics of Open Classical and Quantum Condensed Matter Systems, was organized on Jan 16-27, 2023 in Stockholm. The main audience of the school are PhD students, advanced Master's students and postdocs. Dieter Jaksch gave online lectures about Dynamical symmetries in open many-body quantum systems.	Delivered	23-Jan-23
FZJ	Research Paper Publication	Other scientific collaboration	Research communities	Experimental error suppression in Cross-Resonance gates via multi-derivative pulse shaping	Delivered	in press (arXiv 2-Mar-2023)

QCFD Dissemination Activities						
Beneficiary	Dissemination activity name*	What Type of dissemination activity*	Who? Target audience Reached*	Why? Description of the objective(s) with reference to a specific project output (max 200 characters)*	Status of the dissemination activity*	Date
UHH	CCQ 2nd Plenary Meeting: International Quantum Tensor Network	Conferences	Research communities	Dieter Jaksch was the invited talk at Flatiron institute New York (Dieter Jaksch: Tensor Networks for Computational Fluid Dynamics (simonsfoundation.org)) on Tensor Networks for Computational Fluid Dynamics	Status of the dissemination activity*	03-Mar-23
UHH	Research Paper Publication	Other scientific collaboration	Research communities	Variational Quantum Algorithms for Computational Fluid Dynamics	Delivered	01-May-23
UHH	SPICE Workshop 2023	Conferences	Research communities	Dieter Jaksch was invited talk: Dissipation induced non-stationary complex quantum dynamics, SPICE workshop on Non-equilibrium Quantum Materials Design, Universität Mainz, Germany.	Delivered	27-Jun-23
TUC	Periodically driven quesiperiodic systems 2023	Conferences	Research communities	Dimitris Angelakis invited talk: Quantum supremacy with analog quantum processors: Merging complexity theory to thermalization. Bangalore, India	Delivered	19-Jun-23
TUM	MCQST conference	Conferences	Research communities	Barbara Kraus was invited to give a talk "Gaining Confidence on the Correct Realization of Arbitrary Quantum Computations" at the MCQST conderence in Sonthofen, GER.	Delivered	22-Jun-23

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QCFD Dissemination Activities						
Beneficiary	Dissemination activity name*	What Type of dissemination activity*	Who? Target audience Reached*	Why? Description of the objective(s) with reference to a specific project output (max 200 characters)*	Status of the dissemination activity*	Date
TUC	Quantum Matter 2023	Conferences	Research communities	Dimitris Angelakis talk: Efficient Preparation of Ansatz States on Near-Term Quantum Computers	Delivered	23-May-23
UHH	DESOEQ (Designing out of equilibrium many-body quantum systems) 2023	Conferences	Research communities	DesOEQ23 is the final meeting of the UK Programme Grant "Designing out of equilibrium many-body quantum systems" (DesOEQ), which combines experimentalists and theorists from the Universities of Strathclyde, Cambridge, and Oxford Dieter Jaksch was an invited talk at the conference with his talk on Quantum Physics in Connected World to discuss the potential of quantum simulation to explore correlation effects.	Delivered	03-Jul-23
UHH	DOE ASCR 2023 workshop	Other scientific collaboration	Research communities	DOE white paper entitled 'Quantum-Enabled Computational Science and Engineering', got accepted to the DOE ASCR 2023 workshop. Dieter Jaksch discussed the paper at the ASCR Workshop on Quantum Computing and Networking and are currently applying for DOE funding to extend the QCFD approach to different types of industry optimization problems. There were roughly 200 people, mainly from US DOE funded research institutes working on quantum computing. They are partly very close to industry and partly academic. The workshop website is Home - ASCR Basic Research Needs in Quantum Computing and Networking (cvent.com)	Delivered	July 11-13, 2023

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QCFD Dissemination Activities						
Beneficiary	Dissemination activity name*	What Type of dissemination activity*	Who? Target audience Reached*	Why? Description of the objective(s) with reference to a specific project output (max 200 characters)*	Status of the dissemination activity*	Date
TUM	Beyond IID in Information Theory	Conferences	Research communities	Barbara Kraus was invited to give a talk "On the verification of quantum computations" at the conference "Beyond IID in Information Theory".	Delivered	11-Jul-23
TUM	International Quantum Tensor Network	Conferences	Research communities	Barbara Kraus was invited to give a talk "Using match gates to Gain confidence in the correct realization of arbitrary quantum computations" at the International Quantum Tensor Network conference in Burghausen, Germany.	Delivered	26-Jul-23
TUC	Research Paper Publication	Other scientific collaboration	Research communities	Shallow quantum circuits for efficient preparation of Slater determinants and correlated states on a quantum computer	Delivered	18-Aug-23
TUHH	ETN Summer School	Education and Training Events	Research Communities	Attending of a Tensor Network Summer School and presentation of the research results	Delivered	11-15-Sep-2023
UHH	ETN Summer School	Education and training events	Research communities	The school aims to teach young PhD students the basics of tensor-product states as well as the most recent technical developments. Dieter Jaksch gave Lectures at the summer school with his Tensor Networks for Computational Fluid Dynamics topic.	Delivered	15-Sep-23
TUM	Research Paper Publication	Other scientific collaboration	Research communities	Gaining confidence on the correct realization of arbitrary quantum computations	Delivered	21-Sep-23

QCFD Dissemination Activities						
Beneficiary	Dissemination activity name*	What Type of dissemination activity*	Who? Target audience Reached*	Why? Description of the objective(s) with reference to a specific project output (max 200 characters)*	Status of the dissemination activity*	Date
TUM	EQTC 2023	Conferences	Research communities	Barbara Kraus was invited to give a talk "" at the ECQT Conference 2023 in Hannover, Germany.	Delivered	19-Oct-23
FZJ	Research Paper Publication	Other scientific collaboration	Research communities	Reinforcement learning pulses for transmon qubit entangling gates	Delivered	In press (arXiv 6-Nov-2023)
UHH	Imperial College London	Education and training events	Research communities	Dieter Jaksch gave a tutorial lecture on: "Solving non-linear partial differential equations on quantum computers" and a more advanced talk on a similar topic to the group of people from traditional ICT and quantum computing research working together to understand how a quantum computer can help speed up some of the conventional computational tasks.	Delivered	20-Nov-23
ENG	Imperial College London	Other scientific collaboration	Research communities	Leonardo and Francesco presented in two different talks the results achieved so far on the resolution of PDEs through variational quantum algorithms.	Delivered	29-Nov-23
ENG	HPCQC 2023	Conferences	Research communities	The workshop has been dedicate to the dissemination of recent achievements at European level in the field of Quantum Computing and HPC.	Delivered	Dec 14-15, 2023
PlanQC	Research Paper Publication	Other scientific collaboration	Research communities	Tensor network reduced order models for wall-bounded flows	Delivered	08-Dec-23

QCFD Dissemination Activities						
Beneficiary	Dissemination activity name*	What Type of dissemination activity*	Who? Target audience Reached*	Why? Description of the objective(s) with reference to a specific project output (max 200 characters)*	Status of the dissemination activity*	Date
FZJ	Research Paper Publication	Other scientific collaboration	Research communities	Dispersive Qubit Readout with Intrinsic Resonator Reset	Delivered	01-Jan-24
TUC	Research Paper Publication	Other scientific collaboration	Research communities	Landscape approximation of low-energy solutions to binary optimization problems	Delivered	26-Jan-24
TUC	Research Paper Publication	Other scientific collaboration	Research communities	Unsupervised learning of quantum many-body scars using intrinsic dimension	Delivered	01-Feb-24
TUHH	Research Paper Publication	Other scientific collaboration	Research communities	Boundary Treatment for Variational Quantum Simulations of Partial Differential Equations on Quantum Computers	Delivered	08-Feb-24
FZJ	Research Paper Publication	Other scientific collaboration	Research communities	Gate-set evaluation metrics for closed-loop optimal control on nitrogen-vacancy center ensembles in diamond	Delivered	in press (arXiv 1-Mar-2024)

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QCFD Dissemination Activities						
Beneficiary	Dissemination activity name*	What Type of dissemination activity*	Who? Target audience Reached*	Why? Description of the objective(s) with reference to a specific project output (max 200 characters)*	Status of the dissemination activity*	Date
UHH	The American Physical Society March Meeting 2024	Conferences	Research communities	The APS March Meeting is the largest and most prestigious meeting of physicists in the world. More than 10,000 papers will be presented by eminent scientists in the field of physics, including condensed matter physics, materials physics, biological physics, chemical physics, polymer physics, magnetism, and computational physics. Dieter Jaksch was invited as invited talk on 'Variational Quantum Algorithms for Computational Fluid Dynamics'	Delivered	07-Mar-24
TUC	The American Physical Society March Meeting 2024	Conferences	Research communities	Talk by TUC group member on Recovering Electronic Correlation Energy from Hartree-Fock Circuit Ansatze on a Quantum Computer	Delivered	06-Mar-24
UHH	ISTA colloquium	Education and training events	Research communities	Dieter Jaksch was invited as speaker at ISTA Colloquium series which is weekly, institute-wide seminar. ISTA (IST Austria) is a multidisciplinary institution with research in mathematical and physical (MPS), information and system (ISS) and life sciences (LS).	Delivered	11-Mar-24
UHH	Research Paper Publication	Other scientific collaboration	Research communities	Partitioned Quantum Subspace Expansion	Delivered	13-Mar-24

QCFD Dissemination Activities						
Beneficiary	Dissemination activity name*	What Type of dissemination activity*	Who? Target audience Reached*	Why? Description of the objective(s) with reference to a specific project output (max 200 characters)*	Status of the dissemination activity*	Date
TUM	Co-organization of conference	Conferences	Research communities	Barbara Kraus co-organized a workshop/conference Exactly Solved Models and Quantum Computing at the Lorentz Center in Oort, NL.	Delivered	18-Mar-24
TUC	Research Paper Publication	Other scientific collaboration	Research communities	Nonlinear Quantum Dynamics in Superconducting NISQ Processors	Delivered	25-Mar-24
TUHH	VW CFD Workshop	Meeting	Industry, business partners	Thomas Rung is invited as the key speaker to the workshop. This workshop aims to bring together leading experts at the forefront of CFD developments with iindustrial experts. Topics addressed refer to optimization and the use quantum computing strategies in industrial CFD applications.	Delivered	18-Apr-24
FZJ	Research Paper Publication	Other scientific collaboration	Research communities	Correction formulas for the two-qubit Mølmer-Sørensen gate	Delivered	26-Apr-24
UHH	Airbus/BMW quantum challenge	Other	Industry, business partners	Students working on QCFD algorithms are participating in the Airbus/BMW quantum challenge 2024 (Airbus and BMW Quantum Computing Challenge 2024 | Airbus).	Ongoing	

QCFD Dissemination Activities						
Beneficiary	Dissemination activity name*	What Type of dissemination activity*	Who? Target audience Reached*	Why? Description of the objective(s) with reference to a specific project output (max 200 characters)*	Status of the dissemination activity*	Date
UHH	EQuAL Project	Other scientific collaboration	Industry, business partners	UHH established a joint project on combinatorial optimiziation problems with Lufthansa Industry Solutions and with Thales. The research there is not related to QCFD but will benefit from the expertise gained in this project.	Ongoing	
UHH	BMBF projects	Other scientific collaboration	Industry, business partners	UHH applied for three BMBF projects on benchmarking quantum computing platforms. These project proposals are all joint university/industry projects and would start in 2025.	Ongoing	
UHH	The Quantum Flagship board membership	Other scientific collaboration	Industry, business partners	The Quantum Flagship: One of the most ambitious long-term research and innovation initiatives of the European Commission. Dieter Jaksch is a member of the QCB board (Quantum Coordination Board | Quantum Flagship (qt.eu)) to represent QCFD there.	Ongoing	

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8.2. QCFD Datasets Follow Up

No	PID	Type of PID	Description of Dataset	Is this Dataset available in open access	Is the metadata of deposited data accessible through open access?
1	10.25592/uhhfdm.14234	DOI	A quantum-inspired approach to exploit turbulence structures	Yes	Yes
2	10.25592/uhhfdm.14123	DOI	Boundary Treatment for Variational Quantum Simulations of Partial Differential Equations on Quantum Computers	Yes	Yes
3	10.25592/uhhfdm.14244	DOI	Measurement and classical optimization strategies for quantum variational problems	Yes	Yes
4	10.25592/uhhfdm.14196	DOI	Quantum Computational Fluid Dynamics - WP Core Benchmark CFD Set: Deliverable 1.1. --- Periodic Channel Flow (PCF)	Yes	Yes
5	10.25592/uhhfdm.14204	DOI	Quantum Computational Fluid Dynamics - WP Core Benchmark CFD Set: Deliverable 1.1. --- Comparison: Finite Differences and Finite Volume Methods	Yes	Yes
6	10.25592/uhhfdm.14270	DOI	Quantum Computational Fluid Dynamics - WP Core Benchmark CFD Set: Deliverable 1.1. --- Shear Flow	Yes	Yes
7	10.25592/uhhfdm.14242	DOI	Quantum Computational Fluid Dynamics - WP Core Benchmark CFD Set: Deliverable 1.1. --- 2D Steady/Unsteady Heat Conduction	Yes	Yes
8	10.25592/uhhfdm.14236	DOI	Output Data of Tensor network reduced order models for wall-bounded flows	Yes	Yes
9	10.25592/uhhfdm.14200	DOI	Quantum Computational Fluid Dynamics - WP Core Benchmark CFD Set: Deliverable 1.1. --- Double-Bent Pipe	Yes	Yes
10	10.25592/uhhfdm.14232	DOI	Data sets and figures Master Thesis Variational quantum algorithms for the 1D Burgers' equation	Yes	Yes

11	10.25592/uhhfdm.14264	DOI	Tensor Methods for Solving Incompressible Navier-Stokes Equations and Transport Phenomena	Yes	Yes
12	10.25592/uhhfdm.14315	DOI	Quantum Computational Fluid Dynamics - WP Core Tensor Network QCFD Set: Deliverable 4.1 --- Two-Dimensional Point-Source Propagation	Yes	Yes

8.3. QCFD Social Media Posts

#	1
Date	07/05/2024
Post	🚀 We're thrilled to announce the launch of our LinkedIn page for the Quantum Computational Fluid Dynamics (QCFD) project, a pioneering initiative funded under the Horizon 2020 framework to revolutionize fluid dynamics through quantum computing. 🔍 The QCFD project aims to leverage the unprecedented capabilities of quantum computing to solve complex fluid dynamics problems faster and more accurately than ever before. Our multinational team of experts is working at the cutting edge of technology and science to create simulations that could transform industries ranging from aerospace to automotive and beyond. 🌐 Learn more about our mission, research, and the people behind the innovation by visiting our website: qcfd-h2020.eu 👥 Follow us to stay updated on our progress, insights, and breakthroughs as we advance the frontiers of both quantum computing and computational fluid dynamics. 💡 We believe in the power of collaboration and are open to engaging with industry and academic partners interested in quantum technology and fluid dynamics. Reach out to explore potential collaborations or to simply connect with our team. Join us on this exciting journey to redefine the possibilities of computational fluid dynamics with quantum technology!
#	#QCFD #QuantumComputing #FluidDynamics #Innovation #H2020 #QuantumTechnology #Quantum #QuantumComputationalFluidDynamics
@	UHH, TUHH, FZJ, TUM, ENG, PLANQC, TUC Dieter Jaksch, Thomas Rung, Felix Motzoi, Barbara Kraus, Paolo Geremia, Martin Kiffner, Dimitris G. Angelakis,
Image	

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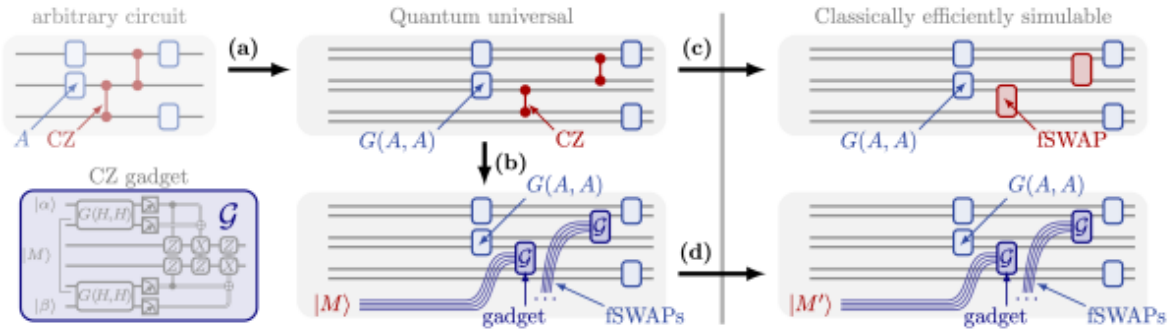
#	2
Date	07/05/2024
Post	☀️ As we continue to push the boundaries of quantum computational technology and fluid dynamics, we want to shine a spotlight on the exceptional consortium that powers the QCFD project. Our collaborative effort spans multiple countries and brings together leading academic institutions and industry partners dedicated to innovation and excellence. 🎓 Academic Partners: UHH, Universität Hamburg: Tensor-network based platform independent QCFD algorithms TUHH, Technische Universität Hamburg: Computational fluid dynamics with industrial applications FZJ, Forschungszentrum Jülich: QCFD algorithms for superconducting qubits TUM, Technical Universität München: Verification and benchmarking of QCFD algorithms TUC, Technical University of Crete: QCFD algorithms for atomic qubits and ion traps Specialists in quantum technology applications. 🏢 Industry Leaders: ENGYS: Computational fluid dynamics software for engineering solutions PlanQC GmbH: Quantum hardware and software development with Rydberg atoms 🤝 This diverse team not only brings a wealth of knowledge and expertise but also embodies the spirit of international cooperation and interdisciplinary collaboration. 🔗 Visit our partners' page to learn more about the organizations making the QCFD project a reality: https://qcfd-h2020.eu/about/partners 👀 Stay tuned as we delve deeper into the specific contributions of each partner and how they're helping us chart new territories in both quantum computing and computational fluid dynamics.
#	#Teamwork #Innovation #Collaboration #Research #QCFD #QuantumComputing #FluidDynamics #Innovation #H2020 #QuantumTechnology #Quantum #QuantumComputationalFluidDynamics
@	UHH, TUHH, FZJ, TUM, ENG, PLANQC, TUC Dieter Jaksch, Thomas Rung, Felix Motzoi, Barbara Kraus, Paolo Geremia, Martin Kiffner, Dimitris G. Angelakis,
Image	planqc JÜLICH Forschungszentrum engys ΠΟΛΥΤΕΧΝΕΙΟ ΚΡΗΤΗΣ TECHNICAL UNIVERSITY OF CRETE TUHH

#	3
Date	07/05/2024
Post	Reflecting on the Successful Kick-off of the Quantum Computational Fluid Dynamics (QCFD) Project 🚀 We are delighted to share highlights from the kick-off meeting of the QCFD project, which marked the official start of our ambitious journey in advancing computational fluid dynamics through quantum computing. 🗓️ This pivotal event, held on May 2023 brought together our esteemed partners, demonstrating the collaborative spirit and shared vision that defines the QCFD project. The meeting was hosted by the University of Hamburg 🌎 Global Participation on Key Sessions Participants from various countries shared their insights and expertise, enriching the dialogue and fostering an environment of mutual learning and support. 🔗 Visit our webpage to learn more about the below talks: https://qcfd-h2020.eu/events/category/kick-off-meeting-2023/list?eventDisplay=past ➢ The Structure of VQA (Variational Quantum Algorithms) ➢ Modeling, Simulation and Optimization Finite-Volume Method ➢ Introduction of ENGYS and Project Updates ➢ Entanglement Theory & Verification of Quantum Devices ➢ Quantum Control Theory for Noisy Intermediate-Scale Quantum Algorithms ➢ Optimizing QCFD Algorithms on Cold Ions, Atoms and Superconducting Hardware ➢ Boundary Conditions in Tensor-Network Computational Fluid Dynamics ➢ Computational Fluid Dynamics (CFD) & Adjoint Optimization
#	#KickOffMeeting #Teamwork #Innovation #Collaboration #Research #QCFD #QuantumComputing #FluidDynamics #Innovation #H2020 #QuantumTechnology #Quantum #QuantumComputationalFluidDynamics
@	UHH, TUHH, FZJ, TUM, ENG, PLANQC, TUC Dieter Jaksch, Thomas Rung, Felix Motzoi, Barbara Kraus, Paolo Geremia, Martin Kiffner, Dimitris G. Angelakis,
Image	

#	4
Date	08/05/2024
Post	🌟 We are excited to announce the completion of two critical deliverables under Work Package 10 of the Quantum Computational Fluid Dynamics (QCFD) project. 📊 Deliverable 10.1 - Data Management Plan 🌐 Deliverable 10.2 - Dissemination, Exploitation, and Communication Plan These documents lay the foundational strategies for data handling and communication, ensuring our research is effectively managed and shared. 🔗 Visit our webpage to download the documents: https://qcfd-h2020.eu/downloads/deliverables
#	#Data #Data Management #Research #QCFD #QuantumComputing #FluidDynamics #Innovation #H2020 #QuantumTechnology #Quantum #QuantumComputationalFluidDynamics
@	UHH, TUHH, FZJ, TUM, ENG, PLANQC, TUC Dieter Jaksch, Thomas Rung, Felix Motzoi, Barbara Kraus, Paolo Geremia, Martin Kiffner, Dimitris G. Angelakis,
Image	

#	5
Date	08/05/2024
Post	We are thrilled to share our recent arXiv publication titled "Gaining Confidence in the Correct Realization of Arbitrary Quantum Computations." The team, consisting of Jose Carrasco, Marc Langer, Antoine Neven, and Barbara Kraus has developed verification protocols that enhance confidence in the performance of quantum devices. 🎯 Key Insights: We've introduced verification circuits that closely resemble the original computation circuits but can be classically efficiently simulated under specific conditions. This makes it possible to test not just the ideal output but also the reliability of the quantum process itself. Our methods combine weak simulation, randomized compiling, and classical statistics to address the challenges of verifying quantum computations. 🌍 This research marks a step towards robust quantum computing, ensuring that both developers and users can trust the results produced by these powerful machines. 📚 Read our full paper here ' https://qcfd-h2020.eu/gaining-confidence-on-the-correct-realization-of-arbitrary-quantum-computations ' to dive deeper into our methods and findings. 🤝 Feel free to reach out if you're interested in collaborating or want to learn more about our work! https://qcfd-h2020.eu/
#	#QuantumComputing #QuantumVerification #Physics #Innovation
@	Jose Carrasco, Marc Langer, Antoine Neven, and Barbara Kraus
Image	

#	6
Date	05/07/2024
Post	We're thrilled to share research from Francesco Preti, Michael Schilling, Sofiene Jerbi, Lea M. Trenkwalder, Hendrik Poulsen Nautrup, Felix Motzoi, and Hans J. Briegel on the hybrid discrete-continuous compilation of trapped-ion quantum circuits using deep reinforcement learning. 🔍 Key Insights: Efficient Quantum Circuit Compilation: Our method significantly reduces the size of quantum circuits, crucial for combating environmental decoherence. Hybrid Optimization: By blending gradient-based and deep reinforcement learning techniques, we optimize both gate orderings and continuous parameters effectively. Practical Applications: This framework is not just theoretical—it's tested on classical simulations of trapped-ion systems and tailored for experimental setups. 🎯 This research pushes the boundaries of what's possible in quantum computing, paving the way for more efficient quantum algorithms and robust computing architectures. 📚 Read the full paper here: https://qcfd-h2020.eu/hybrid-discrete-continuous-compilation-of-trapped-ion-quantum-circuits-with-deep-reinforcement-learning
#	#QuantumComputing #AI #MachineLearning #Innovation #ResearchHighlight
@	Francesco Preti, Michael Schilling, Sofiene Jerbi, Lea M. Trenkwalder, Hendrik Poulsen Nautrup, Felix Motzoi, and Hans J. Briegel
Image	

#	7
Date	05/07/2024
Post	🎉 Exciting news from our team at Universität Hamburg and our collaborative partners across the globe! We're thrilled to share our recent research on "Variational Quantum Algorithms for Computational Fluid Dynamics." 🚀 This study delves into the utilization of quantum computing principles to revolutionize the field of computational fluid dynamics (CFD). By leveraging the unique capabilities of quantum systems, our approach targets problems that remain intractable on conventional supercomputers, particularly in the aeroscience sector. 💡 Our paper discusses the development of novel variational quantum algorithms that are designed to be noise-tolerant and capable of achieving quantum advantage with a relatively small number of qubits. These algorithms are tailored to optimize and solve complex optimization problems across various industries, including aerospace, energy, and more. 🌐 With quantum hardware advancements on the horizon, we are on the cusp of significant breakthroughs that could dramatically reduce computational costs and time, enhancing the accuracy and efficiency of CFD applications. 👥 Special thanks to Dieter Jaksch, Peyman Givi, Andrew J. Daley, Thomas Rung contributing to this groundbreaking work. Let's continue pushing the boundaries of what's possible! 📄 Dive into our full study here: https://qcfd-h2020.eu/variational-quantum-algorithms-for-computational-fluid-dynamics
#	#QuantumComputing #ComputationalFluidDynamics #Innovation #Research #Aeroscience #QuantumAlgorithms #Technology #Engineering
@	Dieter Jaksch, Peyman Givi, Andrew J. Daley, Thomas Rung.
Image	

#	8
Date	05/07/2024
Post	We are excited to share our latest publication on "Nonlinear Quantum Dynamics in Superconducting NISQ Processors", a collaborative effort by researchers from the Technical University of Crete as well as the Centre for Quantum Technologies, National University of Singapore 🔍 Our study shows how recently proposed quantum algorithms for QCFD problems can be implemented in real quantum hardware made of superconducting qubits. We discuss the requirement for large scale implementations and run our algorithms in cloud machines provided by IBM.Our investigation reveals that although quantum hardware noise impairs the evaluation of the energy cost function, certain instances of the problem consistently converge to the ground state. Our comprehensive analysis offers valuable insights into the practical implementation and advancement of the variational algorithms for nonlinear quantum dynamics 💡 Key Highlights: • Implementation of our algorithm on cloud-based IBM Q devices and study of its implementability • Insight into the robustness of QCFD algorithms against hardware-induced noise. 🔗 Read the full paper to explore how we tackled the ground state problem of the nonlinear Schrödinger equation and gain insights into the practical implementation and future potential of these algorithms. https://qcfd-h2020.eu/nonlinear-quantum-dynamics-in-superconducting-nisq-processors 🌐 Stay tuned for more updates from our team as we push the boundaries of what's possible with quantum technologies.
#	#QuantumComputing #NISQ #QuantumTechnology #Innovation #ResearchImpact
@	Muhammad Umer, Eleftherios Mastorakis, Sofia Evangelou, Dimitris G. Angelakis
Image	

#	9
Date	05/07/2024
Post	🌊 We're thrilled to unveil our latest research from the Clarendon Laboratory, University of Oxford, and the University of Hamburg. Our study presents a breakthrough in computational fluid dynamics (CFD) using quantum-inspired tensor network algorithms. 🔍 Focusing on wall-bounded flows, this work extends beyond the conventional direct numerical simulations (DNS) by employing tensor networks to efficiently simulate fluid dynamics under complex boundary conditions. Our framework utilizes matrix product states to represent velocity components, significantly reducing the complexity and computational resources required, showcasing an order of magnitude improvement in runtime on standard hardware setups. 🔢 Our model addresses the incompressible Navier-Stokes equations within a lid-driven cavity scenario, achieving excellent validation against low Reynolds numbers benchmarks and exploring high Reynolds dynamics. Notably, this methodology is not only faster but also scalable and adaptable to a broader range of flow types. 🌐 This research not only paves the way for practical quantum computational fluid dynamics but also demonstrates the potential for significant computational speed improvements in existing classical systems. 🔗 Dive into our full paper for a deep dive into the mechanics, results, and implications of this innovative approach: https://qcfd-h2020.eu/tensor-network-reduced-order-models-for-wall-bounded-flows 🤝 We thank our colleagues and the research community for their invaluable support and discussions that have greatly contributed to this project.
#	#FluidDynamics #QuantumComputing #TensorNetworks #Innovation #ResearchImpact #UniversityOfOxford #ComputationalScience
@	Martin Kiffner, Dieter Jaksch.
Image	

#	10
Date	05/07/2024
Post	We're thrilled to share our latest research on "Boundary Treatment for Variational Quantum Simulations of Partial Differential Equations on Quantum Computers," recently published and co-authored by a team from the Clarendon Laboratory, Hamburg University of Technology and ENGYS. 📈 In this study, we present a variational quantum algorithm tailored to solve initial-boundary value problems defined by second-order partial differential equations, making full use of the unique capabilities of current noisy intermediate-scale quantum (NISQ) hardware. 🔍 Key Highlights: ✓ Utilization of a hybrid classical/quantum computing setup. ✓ Efficient evaluation of objective functions via quantum measurements. ✓ Innovative treatment of boundary conditions specifically optimized for quantum hardware. ✓ This approach not only enhances the robustness and predictive accuracy of quantum simulations but also manages the gate complexity effectively, paving the way for new possibilities in computational fluid dynamics and other fields requiring high precision. 🔗 Dive into our full study here: https://qcfd-h2020.eu/boundary-treatment-for-variational-quantum-simulations-of-partial-differential-equations-on-quantum-computers
#	#ComputationalFluidDynamics #CFD #VariationalQuantumAlgorithms #QuantumComputing #BoundaryConditions #Engineering #Innovation #ResearchImpact #QuantumAlgorithms
@	Paul Overa, Sergio Bengoechea, Thomas Rung, Francesco Clerici, Leonardo Scandurra, Eugene de Villiers, Dieter Jaksch
Image	

#	11
Date	05/07/2024
Post	🔍 Key Highlights: ✓ Our method leverages additional classical processing with a polynomial overhead, beneficial for both near-term and early error-corrected quantum hardware. ✓ We provide a variance-based criterion for determining effective iterative sequences, demonstrating significant stability improvements. ✓ This research opens new avenues for computing accurate ground state energies of complex quantum systems, crucial for advancements in both fundamental research and applied chemistry. 📚 Read the full paper here: https://qcfd-h2020.eu/partitioned-quantum-subspace-expansion
#	#QuantumComputing #Research #Innovation #QuantumAlgorithms #OxfordUniversity
@	🤝 Collaborators: Tom O'Leary, Lewis W. Anderson, Dieter Jaksch, and Martin Kiffner
Image	

#	12
Date	13/05/2024
Post	🔍 Explore our project's detailed overview of #workpackages, each representing a critical facet of #quantumcomputing and #fluiddynamics research. Discover the specialized focus areas and collaborative efforts shaping our scientific endeavors. 🔗 Visit our webpage to reach the details about work packages: https://qcfd-h2020.eu/about/work-packages
#	#Innovation #H2020 #QCFD #Research #Physics
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#	13
Date	13/05/2024
Post	🌟 Exciting times at the University of Hamburg! We've just concluded two dynamic and fruitful days at the inaugural Coordination Meeting for the QCFD Project on March 14th and 15th, 2024. It was inspiring to witness such vibrant collaboration and the exchange of innovative ideas among all attendees. 🗓️ Our discussions were so engaging that we've seen the clear need to delve deeper into many topics. Therefore, we are excited to announce that we will be extending the duration of our next meeting. More details will be provided soon—stay tuned! 💼 Heartfelt thanks to each speaker who contributed their profound insights and expertise, significantly enhancing our discussions: -European Commission, Christian Trefzger, PhD, Quantum Technologies in Europe -Invited Talks -Eugene De Villiers, ENGYS, The Aerodynamic Development of the Lightship L1 Trailer -Michael Palm, Voith Turbo, CFD in Marine Engineering Applications - Voith's Perspective -Sebastian Blatt, planqc, Neutral-Atom Quantum Computing in the Munich Quantum Valley Partners' Presentations: -Dieter Jaksch, Universität Hamburg, Tensor Networks for Probability Simulation of Turbulent Reactive Flows -Sergio Bengoechea Lozano, Hamburg University of Technology, Boundary Condition Treatment for #VQA Simulations of #PDE Problems on QCs -Barbara Kraus, Technical University of Munich, Gaining Confidence About #Quantum Devices -José da Costa Jesus, Forschungszentrum Jülich, Steps Towards Implementation of QCFD on #QuantumHardware -Francesco Clerici, ENGYS, Progress Toward User-Space Interfaces for Quantum CFD -Dimitrios Angelakis, Technical University of Crete, Small Scale Implementations of QCFD #Algorithms in Cloud Quantum Processors: Challenges and First Results -Martin Kiffner, planqc, Towards QCFD on Neutral Atom #QuantumComputers 💼 A special acknowledgment to our advisory board members Andrew Daley, Michael Palm and Thomas Monz for their invaluable guidance and support. Looking forward to our continued progress and next steps together in advancing quantum #CFD!
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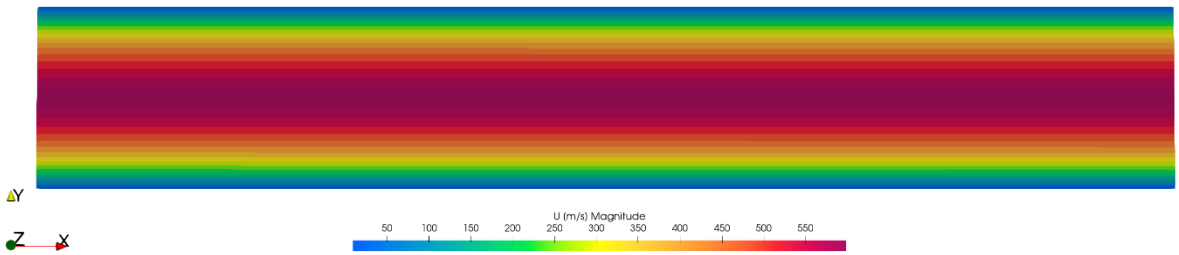
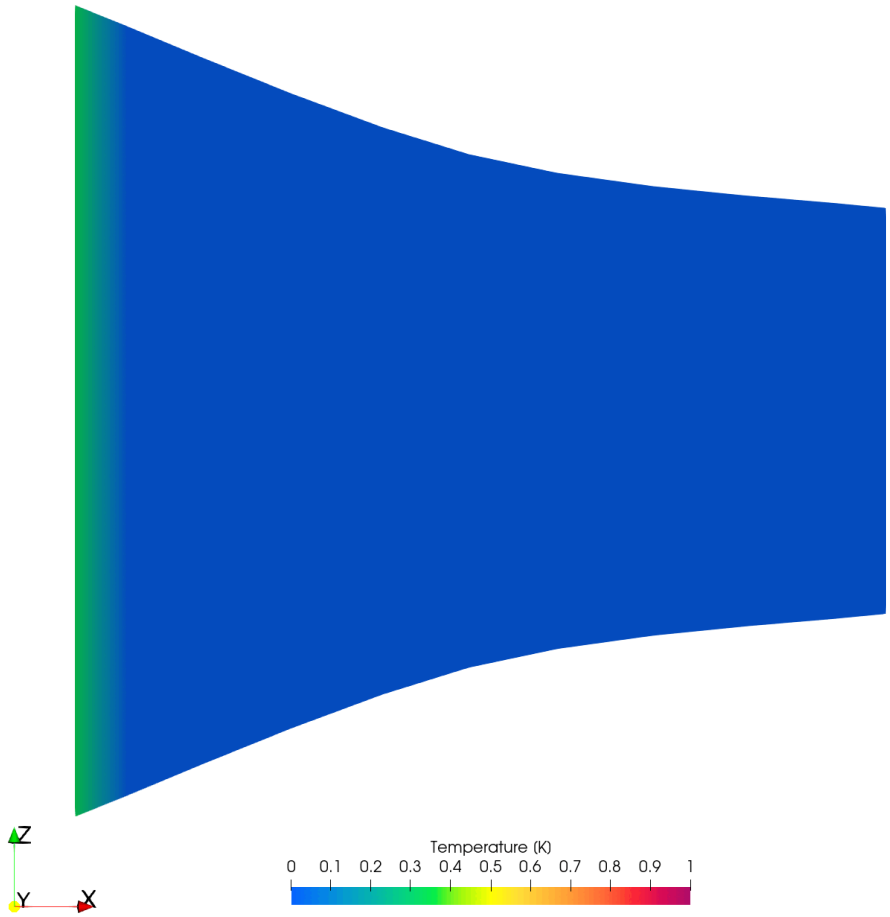
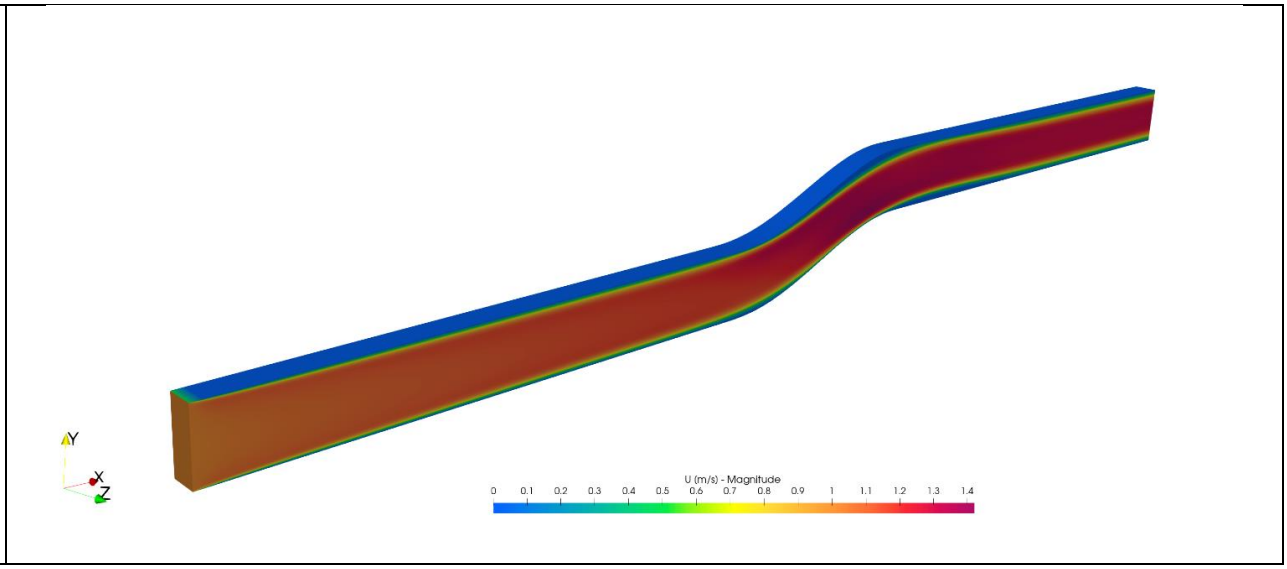
#	14
Date	13/05/2024
Post	🌟 We're thrilled to share that our team has reached a significant milestone in the Quantum Computational Fluid Dynamics (QCFD) project, funded by the European Union's Horizon 2020 program. As part of Work Package 1, we have completed the Core Benchmark CFD Set which provides some essential benchmarks for quantum/ quantum-inspired approaches on the path towards Computational Fluid Dynamics (CFD). 🎯 This deliverable is one tailor made basement towards the advent of an open-access quantum software framework, designed for a more efficient treatment of the industry's CFD problems. Our benchmarks allow comparisons of classical CFD methods with new quantum strategies, ensuring interfaces between scientific and industry-relevant standards. 🔗 For more details on our findings and to access the data, visit our dedicated repository: fdr.uni-hamburg.de/communities/qcfd. 🔗 Visit our webpage to download the Deliverable 1.1 - Core Benchmark CFD Set: https://qcfd-h2020.eu/downloads/deliverables
#	#QuantumComputing #FluidDynamics #Innovation #H2020 #QCFD
@	TUHH, UHH, ENG

Image	 Time: 0.000000 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X
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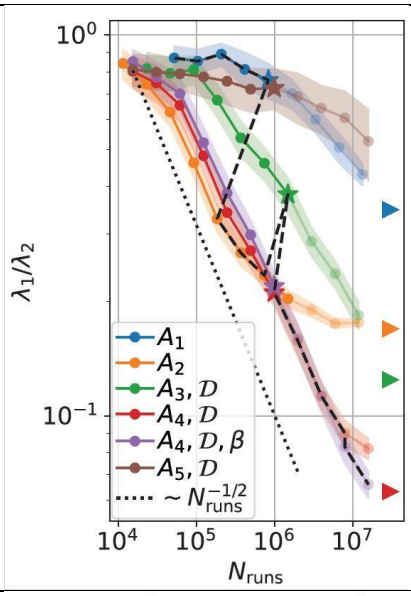
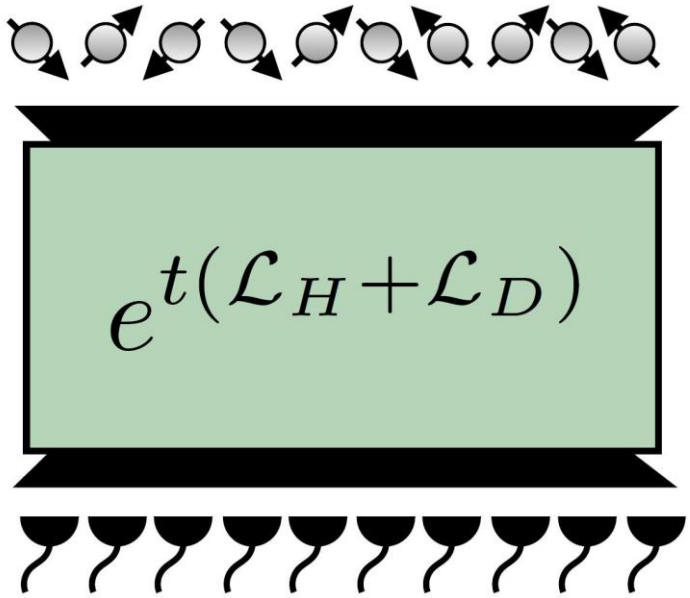
#	15
Date	14/05/2024
Post	🌟 We are excited to share our latest publication, "Hamiltonian and Liouvillian learning in weakly-dissipative quantum many-body systems," led by Tobias Olsacher, Tristan Kraft, Christian Kokail, Barbara Kraus, and Peter Zoller from the University of Innsbruck and Technical University of Munich. 🎯 In this study, we explore advanced strategies for learning Hamiltonian and Liouvillian dynamics in analog quantum simulators. Utilizing non-equilibrium quench dynamics, our approach is pivotal for characterizing quantum simulators, crucial in progressing toward quantum advantage. 🔍 Key insights include: • Strategies for (re-)parameterization approaches to optimize learning efficiency. • Methods to learn the operator structure of Hamiltonians and Liouvillians with a limited measurement budget. • Our results open exciting avenues for more accurate and scalable quantum simulations, enhancing the capability to solve complex quantum many-body problems in condensed matter physics, high-energy physics, and quantum chemistry. 📄 Read our full paper here: https://lnkd.in/emGVz2cy Feel free to reach out for collaborations or discussions!
#	#QuantumComputing #QuantumSimulation #QuantumMechanics #Research #Physics #Innovation
@	

Image	 10^0 10^{-1} λ_1/λ_2 A_1 A_2 $A_3, \mathcal{D}$ $A_4, \mathcal{D}$ $A_4, \mathcal{D}, \beta$ $A_5, \mathcal{D}$ $\sim N_{\text{runs}}^{-1/2}$ 10^4 10^5 10^6 10^7 N_{runs}
Image	 $e^{t(\mathcal{L}_H+\mathcal{L}_D)}$

8.4. QCFD Publications Follow Up

QCFD Partners' Publications Follow Up					
#	**Published on**	**Title of the journal**	**Title**	**Authors**	**Date of Publication**
1	Article in journal	Quantum 8	Hybrid discrete-continuous compilation of trapped-ion quantum circuits with deep reinforcement learning	Preti, Francesco; Schilling, Michael; Jerbi, Sofiene; Trenkwalder, Lea M.; Nautrup, Hendrik Poulsen; Motzoi, Felix; Briegel, Hans J.	1-Jan-23
2	Article in journal	NPJ Quantum Information	Experimental error suppression in Cross-Resonance gates via multi-derivative pulse shaping	B Li, T Calarco, F Motzoi	in press (arXiv 2-Mar-2023)
3	Article in Journal	AIAA Journal	Variational Quantum Algorithms for Computational Fluid Dynamics	Dieter Jaksch; Peyman Givi; Andrew J. Daley; Thomas Rung	1-May-23
4	Article in Journal	Physical Review A	Shallow quantum circuits for efficient preparation of Slater determinants and correlated states on a quantum computer	Chong Hian Chee; Daniel Leykam; Adrian M. Mak; Dimitris G. Angelakis	18-Aug-23
5	Arxiv.org		Gaining confidence on the correct realization of arbitrary quantum computations	Jose Carrasco, Marc Langer, Antoine Neven, Barbara Kraus.	21-Sep-23
6	Article in journal	Machine Learning: Science and Technology	Reinforcement learning pulses for transmon qubit entangling gates	Ho Nam Nguyen, Felix Motzoi, Mekena Metcalf, K. Birgitta Whaley, Marin Bukov, Markus Schmitt	In press (arXiv 6-Nov-2023)
7	Article in Journal	Physical Review Fluids	Tensor network reduced order models for wall-bounded flows	Martin Kiffner; Dieter Jaksch	8-Dec-23

This project receives funding from the European Union's Horizon 2020 HORIZON Research and Innovation Actions Programme under Grant Agreement #101080085

#	Published on	Title of the journal	Title	Authors	Date of Publication
8	Article in Journal	Physical Review A	Landscape approximation of low-energy solutions to binary optimization problems	Benjamin Y. L. Tan; Beng Yee Gan; Daniel Leykam; Dimitris G. Angelakis	26-Jan-24
9	Arxiv.org		Unsupervised learning of quantum many-body scars using intrinsic dimension	Cao, Harvey; Angelakis, Dimitris G.; Leykam, Daniel	1-Feb-24
10	Arxiv.org		Boundary Treatment for Variational Quantum Simulations of Partial Differential Equations on Quantum Computers	Paul Over, Sergio Bengoechea, Thomas Rung, Francesco Clerici, Leonardo Scandurra, Eugene de Villiers, Dieter Jaksch	8-Feb-24
11	Article in journal	NPJ Quantum Information	Gate-set evaluation metrics for closed-loop optimal control on nitrogen-vacancy center ensembles in diamond	P.J. Vetter, T. Reisser, M.G. Hirsch, T. Calarco, F. Motzoi, F. Jelezko, M.M. Müller	in press (arXiv 1-Mar-2024)
12	Arxiv.org		Partitioned Quantum Subspace Expansion	Tom O'Leary, Lewis W. Anderson, Dieter Jaksch, Martin Kiffner.	13-Mar-24
13	Arxiv.org		Nonlinear Quantum Dynamics in Superconducting NISQ Processors	Muhammad Umer, Eleftherios Mastorakis, Sofia Evangelou, Dimitris G. Angelakis.	25-Mar-24
14	ArXiv.org		Correction formulas for the two-qubit Mølmer-Sørensen gate	Susanna Kirchhoff, Frank K. Wilhelm, Felix Motzoi	26-Apr-24

This project receives funding from the European Union's Horizon 2020 HORIZON Research and Innovation Actions Programme under Grant Agreement #101080085