European Commission

THE EU RESEARCH & INNOVATION PROGRAMME

2021 – 2027

Destination 4: Digital and emerging technologies for competitiveness and fit for the green deal

Research and Innovation

Destination 4 – Objective "European Innovation Leadership in Photonics"

European Commission

Work Programme topics – photonics and electronics

- HORIZON-CL4-2023-DIGITAL-EMERGING-01-51: Pervasive photonics - multi-technology integration for digital infrastructure, sensors and internet of things (Photonics partnership) (RIA)
- HORIZON-CL4-2023-DIGITAL-EMERGING-01-53: Versatile light sources and systems as tools for manufacturing and medical application (Photonics Partnership) (RIA)
- HORIZON-CL4-2023-DIGITAL-EMERGING-01-56: Photonic Strategies and Skills Development (CSA) (Photonics Partnership)
- HORIZON-CL4-2023-DIGITAL-EMERGING-01-57: Advanced imaging and sensing technologies (IA) (Photonics Partnership)
- HORIZON-CL4-2023-DIGITAL-EMERGING-01-11: Low TRL research in micro-electronics and integration technologies for industrial solutions (RIA)

December 2022

Pervasive Photonics

HORIZON-CL4-2023-DIGITAL-EMERGING-01-51

PROJECTS

- **RIA**
- EU contribution/project: **3-5 million Euro**
- Implementing the European Partnership Photonics

BUDGET

- **18 million Euro**
- Call in **2023**

TRL (TECHNOLOGY READINESS LEVEL)

- **From 2 to 5** by the end of the project

European Commission

Pervasive Photonics - **Expected Outcome**

- **Improved key metrics** for **communications** (speed, power consumption, density) or for **sensing** (sensitivity, compactness, power consumption)
- **New** photonic-enabled **sensing functions** or **computing paradigms** enabling new systems architectures
- Vital contribution to Technological Sovereignty, Green Deal, Digital Transformation or Competitiveness which **demonstrates new functionality, higher performance and more cost-effective systems** across multiple application domains
- Maintaining **European technology leadership** in the face of strong global competition

Pervasive Photonics - Scope

- Co-integration of photonics and microelectronics on single or multiple die ('chiplet' approach)
- Co-integration of multiple photonic IC material systems or components to address new wavelengths and sensor functions or new computing paradigms
- Work should cover at least two use cases linked to commercial applications e.g. in computing, communications, robotic and autonomous systems, sensors or Internet of Things

Proposals submitted under this topic should include a business case and exploitation strategy.

Versatile Light Sources and Systems …

HORIZON-CL4-2023-DIGITAL-EMERGING-01-53

PROJECTS

- **RIA**
- EU contribution/project: **3-5 million Euro**
- Implementing the European Partnership Photonics

BUDGET

- **18 million Euro**
- Call in **2023**

TRL (TECHNOLOGY READINESS LEVEL)

- **From 2 to 5** by the end of the project

European Commission

Versatile Light Sources - Expected Outcome

- Increased **manufacturing productivity** or increased **quality and speed of diagnosis results**
- Increased **accuracy and/or reduced feature size in microelectronics production** including packaging for the integration of photonic and electronic functionalities on chips;
- Increased **specificity of diagnosis** of human tissue, specific single cells, or molecular biomarkers in body liquids.

Versatile Light Sources - Scope

- Sources with multi-specification / multi-application potential
- Extended or new wavelength ranges, novel coherent sources
- Flexible and variable energy deposition (e.g. material processing, medical diagnosis)
- Versatility by flexible pulse shapes, repetition rates and intensities (continuous wave down to fs and bursts)
- Miniaturized light sources and lasers employing photonic integrated circuit technology
- Versatility by spectral tuneability, coherence and multi-wavelength emission
- Laser concepts and systems for multiphoton microscopy, spectroscopy and imaging

Proposals submitted under this topic should include a business case and exploitation strategy.

Photonic Strategies and Skills

HORIZON-CL4-2023-DIGITAL-EMERGING-01-56

PROJECTS

- **CSA**
- EU contribution/project: **1-3 million Euro**
- Implementing the European partnership Photonics

BUDGET

- **4 million Euro**
- Call in **2023**

TRL (TECHNOLOGY READINESS LEVEL)

not applicable

European Commission

Photonic Strategies and Skills - Expected Outcome

- Reinforced value chains and deployment of photonics technologies by **stronger cooperation of photonics stakeholders, clusters and end-users**
- Increased **competitiveness** of the European photonics sector and improved **access to finance** for the photonics sector in Europe;
- **More and better prepared professionals** in the photonics sector.

Projects are expected to contribute to at least one of the outcomes.

Photonic Strategies and Skills - Scope

Type 1: Supporting the industrial strategy for photonics in Europe (EU contribution around 3 million EUR):

- **development of strategic technology road-maps, strong stakeholder engagement**
- **coordination of regional, national and European strategies and priorities,**
- **fostering collaboration with other European Partnerships to identify synergies**
- **fostering strategic collaboration with financial institutions to improve financing conditions for Photonics industry,**

Type 2: Fostering careers in photonics (EU contribution around 1 million EUR).

- **Actions to encourage students to pursue a career in photonics, to make students more industry ready and to encourage innovation and entrepreneurship.**
- **seek synergies with the skills development activities called for in the Digital Europe programme**

European Commission

Advanced imaging and sensing technologies

HORIZON-CL4-2023-DIGITAL-EMERGING-01-57

PROJECTS

- **IA***
- EU contribution/project: **5-7 million Euro**
- Implementing the European Photonics partnership

BUDGET

- **20 million Euro**
- Call in **2023**

TRL (TECHNOLOGY READINESS LEVEL)

- **From 3 to 6-7** by the end of the project

*The funding rate is up to 60%, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

European Commission

Advanced imaging and sensing - Expected Outcome

- The development of next generations **sensory systems** based on photonic technologies
- Technology leadership in autonomous vehicles, robots and sensory systems; Growth in a number of strategic industries such as medical devices, automotive, manufacturing, agriculture & food, security of large added value which are in Europe.
- Contribution to the **Digital Green deal policy and/or to the technological sovereignty** of Europe

Advanced imaging and sensing - Scope

- **Innovative hardware and software approaches, or novel techniques with potential to outperform the current standards.**
- **The projects should demonstrate the technology in the form of a complete function (or building blocks) showing feasibility for future industrialization and addressing at least one of the following sectors: Automotive, Safety and security, Industry, Health, Agriculture and food.**
- **Technologies covering more than one application sectors above are encouraged, such as**
  - Long range, high speed, eye-safe imaging for automotive, security, and industrial systems
  - Imaging in presence of obscurants for medical, automotive, manufacturing, agriculture, food and security
  - spectroscopic imaging and sensing for medical, environmental, agriculture, food monitoring and security

Destination 4 - Objective "AI, Data and Robotics"

European Commission

HORIZON-CL4-2023-DIGITAL-EMERGING-01-01

Novel paradigms and approaches, towards AI-driven autonomous robots (AI, data and robotics partnership) (RIA)

We are looking for:

- Achieve substantial "next step autonomy" in robots, undertaking non-repetitive tasks in realistic settings, including Human-Robot interactions, as well as robots acting in isolation, demonstrated in key high impact sectors where robotics has the potential to deliver significant economic and/or societal benefits.
- Deliver a step change in autonomy essential for the diffusion of robots in various industries, sectors and services.
- Accelerate enabling conditions essential for the diffusion of robots in various industries, sectors and services.
- Project size ~8M€

HORIZON-CL4-2023-DIGITAL-EMERGING-01-01
Novel paradigms and approaches, towards AI-driven autonomous robots (AI, data and robotics partnership) (RIA)

We do NOT want:

- Proposals with limited ambition on robot autonomy delivering only incremental progress over the scientific state of the art.
- Non-realistic settings disconnected from actual needs of key industries, sectors and services (end-users involvement is key)
- Focus on low impact sectors with little potential to deliver economic or societal benefits.

- *DO NOT DEVIATE FROM ADMIN/FORMAL requirements: e.g. transfer of essential information to annexes to overcome page limits, font size and formatting imposed by the templates…*

HORIZON-CL4-2023-DIGITAL-EMERGING-01-01
Topic evolution

The main focus of this topic is new, but it has close relationship with some topics of the work-programme 2021-2022:

- HORIZON-CL4-2021-DIGITAL-EMERGING-01-11
  Pushing de limit of robotic cognition (RIA)
- HORIZON-CL4-2021-DIGITAL-EMERGING-01-12
  European Network of Excellence Centres in Robotics (RIA)
- HORIZON-CL4-2022-DIGITAL-EMERGING-02-06
  Pushing de limits of physical intelligence and performance (RIA)

This topic is complemented by the topic:

- HORIZON-CL4-2023-DIGITAL-EMERGING-01-02
  Industrial leadership in AI, Data and Robotics – advanced human robot interaction (IA)

HORIZON-CL4-2023-DIGITAL-EMERGING-01-01
Topic evolution

Current project portfolio of RIAs in robotics (Horizon Europe)

2021-DIGITAL-EMERGING-01-11 *Pushing de limit of robotic cognition*:

- *101070066 REGO*
- *101070292 HARIA*
- *101070254 CoreSense*
- *101070165 AGIMUS*
- *101070381 PILLAR-Robots*
- *101070227 CONVINCE*
- *101069536 MOZART*
- *101070136 IntelliMan*
- *101070310 SESTOSENSO*

2021-DIGITAL-EMERGING-01-12 European Network of Excellence Centres in Robotics

- *101070596 euROBIN*

5. Who are the types of main stakeholders that are addressed?

6. Is there a key group of actors (eg. Partnership or other) driving this?

HORIZON-CL4-2023-DIGITAL-EMERGING-01-01
Key actors

Types of stakeholders that are addressed:

- Academy and research organizations
- Robot system manufacturers and integrators
- End users
  - Pay attention to requirements on multidisciplinarity + SSH (if human interaction)

Key group of actors driving this:

- AI, Data and Robotics Partnership
  https://adr-association.eu/

The AI Data Robotics Association

NCPs are invited to encourage all their stakeholders to become member of the ADRA Association, take an active role in shaping the strategy, and benefit from the networking opportunities.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-01

Additional / background documents

- Horizon Europe: New Projects in Robotics and AI - June-November 2022 | Shaping Europe's digital future (europa.eu)

- Launch Event: Paving the way towards the next generation of R&I excellence in AI, Data and Robotics | Adra-e

Future Outlook

The AI Data Robotics Association

The AI, Data and Robotics Partnership is driving the future outlook in this area

https://adr-association.eu/

HORIZON-CL4-2023-DIGITAL-EMERGING-01-02

Industrial leadership in AI, Data and Robotics – advanced human robot interaction (AI Data and Robotics Partnership) (IA)

We are looking for:

- Proposals must target one of these two scopes (to be identified in the proposal):
  1. Development of innovative solutions to address major application-driven challenges (min 50% FSTP),
  2. Large scale pilots bringing major industries from key application sectors in Europe (FSTP optional)
- To reach the point where human robot interaction adds value and improves the quality of outcome for complex tasks.
- To address challenges in key industries and develop solutions that address human robot interaction at all levels from physical interaction to social interaction in a variety of working environments.
- Boost the innovation potential for wide uptake of AI, Data and Robotics.
- Proposals should include a clear business case and exploitation strategy.
- Project size ~10M€.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-02
Industrial leadership in AI, Data and Robotics – advanced human robot interaction (AI Data and Robotics Partnership) (IA)

We do NOT want:

- Academic exercises with limited potential for commercial exploitation of the results after the end of the project.
- Non-realistic settings disconnected from actual needs of key industries, sectors and services.
- Focus on low impact sectors with little potential to deliver economic or societal benefits.
- *DO NOT DEVIATE FROM ADMIN/FORMAL requirements: e.g. transfer of essential information to annexes to overcome page limits, font size and formatting imposed by the templates…*

HORIZON-CL4-2023-DIGITAL-EMERGING-01-02
Topic evolution

The main focus of this topic is new, but it has close relationship with some topics from the work-programme 2021-2022:

- HORIZON-CL4-2021-DIGITAL-EMERGING-01-11
  AI, data and Robotics for the Green Deal (IA)
- HORIZON-CL4-2021-DIGITAL-EMERGING-01-12
  AI, Data and Robotics at work (IA)
- HORIZON-CL4-2022-DIGITAL-EMERGING-02-05
  AI, data and robotics for industry optimisation (including production and services) (IA)
- HORIZON-CL4-2022-DIGITAL-EMERGING-02-07
  Increased robotics capabilities demonstrated in key sectors (IA)

This topic is complemented by the topic:

- HORIZON-CL4-2023-DIGITAL-EMERGING-01-01
  Novel paradigms and approaches, towards AI-driven autonomous robots (AI, data and robotics partnership) (RIA)

HORIZON-CL4-2023-DIGITAL-EMERGING-01-02
Topic evolution

Current project portfolio of IA (Horizon Europe):

101070080 DARROW
101070076 CLARUS
101070046 ALCHIMIA
101070115 TUBERS
101070496 Smart Droplets
101070405 DIGIFOREST
101070320 ROMAIN
101070321 GRINNER
101070524 RECLAIM

101070588 HACID
101069994 EARASHI
101070600 SOFTENABLE
101069499 FAIRWork
101070443 GEYEDANCE
101070440 FEROX
101070604 SIMAR

5. Who are the types of main stakeholders that are addressed?

6. Is there a key group of actors (eg. Partnership or other) driving this?

HORIZON-CL4-2023-DIGITAL-EMERGING-01-02
Key actors

Types of stakeholders that are addressed:

- Robot system manufacturers and integrators
- Tech-transfer institutions (e.g. DIHs, competence centers…)
- Academy and research organizations
- End users
  - Pay attention to requirements on multidisciplinarity + SSH (if human interaction)

Key group of actors driving this:

The AI Data Robotics Association

- AI, Data and Robotics Partnership https://adr-association.eu/

NCPs are invited to encourages all their stakeholders to become member of the ADRA Association, take an active role in shaping the strategy, and benefit from the networking opportunities.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-02

Additional / background documents

- Horizon Europe: New Projects in Robotics and AI - June-November 2022 | Shaping Europe's digital future (europa.eu)
- Launch Event: Paving the way towards the next generation of R&I excellence in AI, Data and Robotics | Adra-e

Future Outlook

The AI Data Robotics Association

The AI, Data and Robotics Partnership is driving the future outlook in this area

https://adr-association.eu/

Upcoming events / information days

Horizon Europe Cluster 4 “Digital, Industry and Space” Info Day

12 ~ 14 December 2022

https://research-innovation-community.ec.europa.eu/events/3jM2kV6qwHjteovSf3VOrp/overview

Destination 4 - Objective "European leadership in Emerging and Enabling Technologies"

European Commission

Low TRL research in micro-electronics and integration technologies for industrial solutions (RIA)

HORIZON-CL4-2023-DIGITAL-EMERGING-01-11

PROJECTS

- **RIA**
- EU contribution/project: **3-4 million Euro**

BUDGET

- **35 million Euro**
- Call in **2023**

TRL (TECHNOLOGY READINESS LEVEL)

Start at TRL 1-2

Achieve TRL 3-4

European Commission

Low TRL research in micro-electronics.. – Expected Outcome

- Innovative semiconductor and micro-nanoelectronic systems design concepts supporting:
    - very low energy consumption
    - integrated security
    - Connectivity
    - Sensing
    - Actuating
    - embedded functions suited to mixed analogue/RF and digital circuits

- Alternative semiconductor manufacturing process technologies able to sustain in the mid- and long-term the fast pace evolution:

    device performance, miniaturisation, cost, environmental footprint

- Very advanced packaging solutions:
    - extreme miniaturisation
    - integration of multiple functions such as communication (RF, mmW or THz), sensing, actuating, power management and active/passive integration

Low TRL research in micro-electronics.. – Scope

- Low-TRL research with high potential not yet demonstrated

  Segments of the value chain :

  Design, Fabrication process, Packaging

- Innovation focus:
  - Materials
  - Physics concepts
  - Device architecture
  - Integration technologies
- Provide a projection of the expected gains and main figures of merit of the proposed approaches.

Multi-disciplinary research activities: materials, processes, equipment, metrology, back-end processing, packaging, integration and tests.

International cooperation (e.g. Japan, South Korea, Taiwan) in support of EU policies

HORIZON-CL4-2023-DIGITAL-EMERGING-01-12: Adaptive multi-scale modelling and characterisation suites from lab to production (RIA)

Projects are expected to contribute to the following outcomes:

- Enable industry to more effectively develop new and work with existing advanced materials by building on digitally integrated and validated modelling and characterisation methods for enhanced materials knowledge along value chains.
- Accelerate the materials innovation process by allowing a better interpretation of available experimental data and by providing more effective guidance on further experiments.
- Overcome gaps in modelling and characterisation capabilities targeted at different stages in materials and production value chains by means of adapted and benchmarked suites covering all steps from materials design (including several scales, e.g. from molecular to macroscale) to product development.
- Achieve an integrated European materials platform, allowing a systemic use of tools and capabilities including materials modelling, characterisation, robotics, data documentation, ontologies, artificial intelligence and machine learning, which are orchestrated to accelerate the design, development and application of chemicals, materials and related processes and manufacturing.

Indicative budget of the call: 22 million EUR
EU contribution per project: 5 million to 7 million EUR
Type of Action: Research and Innovation Action (RIA)
TRL: Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project

European Commission

Destination 4 - Objective "Flagship on Quantum Technologies: a Paradigm Shift"

European Commission

Flagship on Quantum Technologies: a Paradigm Shift

Calls HORIZON-CL4-2023-DIGITAL-EMERGING-01-…

Ref	Name	Type	22.5	TRL	Budget	Topic coordinator	Opening – Closing
-40	Quantum Photonic Integrated Circuit technologies	RIA	Yes	2-3 → 4-5	12M€	Laurent Olislager	01/12/22 – 29/03/23
-41	Investing in alternative quantum computation and simulation platform technologies	RIA	Yes	3-4 → 5-6	20M€	Christian Trefzger	01/12/22 – 29/03/23
-43	Framework Partnership Agreement for developing large-scale quantum Computing platform technologies	FPA	Yes	4-5 → 6-7	N/A (SGA: 25M€)	Doru Tanasa	01/12/22 – 29/03/23
-50	Next generation quantum sensing and metrology technologies	RIA	Yes	2-3 → 4-5	10M€	Laurent Olislager	01/12/22 – 29/03/23

Flagship on Quantum Technologies

1. What are you looking for?

- Build on Flagship ramp-up success stories
- Move the technologies up the TRL scale
- Lab to Market
- Build EU quantum ecosystem

Flagship on Quantum Technologies

2. What do you NOT want?

- Pure academic consortia
- Splitting of competences, incoherent approaches
- Non-addressed weaknesses in terms of supply chain

Flagship on Quantum Technologies – Topic evolution

3. Is this new or has it been called before?

- Continuation of activities of the Quantum Flagship ramp-up phase & WP21-22
- Entering the technology demonstration phase (support deployment activities)
- In line with new Strategic Research and Industry Agenda

Flagship on Quantum Technologies – Topic evolution

4. Current project portfolio

- Quantum Flagship projects under H2020 and HE (RIAs & FPAs/SGAs)
  - Quantum computing (platforms, software, EuroHPC)
  - Quantum simulations
  - Quantum communications (infrastructure: EuroQCI)
  - Quantum sensing and metrology
  - Basic science
  - Pilot lines and testing facilities

QUANTUM TECHNOLOGIES
DG CNECT

RESEARCH BASED

HORIZON EUROPE

INFRASTRUCTURES

DIGITAL EUROPE

HORIZON EUROPE
2021-2027

QUANTUM FLAGSHIP

Bring quantum **technologies** from the **lab** to the **market** and consolidate European scientific **leadership** in quantum research

- **FUNDAMENTAL R&D**
- **TECHNOLOGY SUPPLY**

Digital EUROPE
2021-2027

From Lab to Market

- **Pilot Lines & Testing Facilities**

European Chips Act

Bolster Europe's competitiveness and resilience in Semiconductors & **Quantum chips** including **Production Facilities & Quantum Fund**

QUANTUM COMMUNICATION INFRASTRUCTURE (EuroQCI)

Build and **deploy** in the next decade a certified secure pan-European end-to-end QCI for **cybersecurity services**

- **QKD INFRASTRUCTURE**
  Terrestrial / Space

QUANTUM COMPUTING INFRASTRUCTURE (EuroHPC)

Build and **deploy** an infrastructure for high performance computing and quantum computing

- **HPC with QT Accelerators**
- **Stand-alone QT Computer**

DIGITAL DECADE

- 2025 – Europe's **first computer with quantum acceleration**
- 2030 - Europe to be at the **cutting edge of quantum capabilities**

ADVANCED DIGITAL SKILLS

Develop short term **training courses** and **Master programmes** in key capacity areas

Flagship on Quantum Technologies – Key actors

5. Who are the types of main stakeholders that are addressed?

- Research institutes, universities, RTOs, foundations, industry, SMEs & other organizations
- Key: academia & industry participation
- RTOs: role as facilitators for technology transfer
- Importance of SMEs and of potential users

Flagship on Quantum Technologies – Key actors

6. Is there a key group of actors driving this?

- The Quantum Flagship Community
  - Quantum Community Network (QCN)
  - European Quantum Industry Consortium (QuIC)
- The Quantum Flagship Governance
  - Strategic Advisory Board (SAB)
  - Quantum Coordination Board (QCB) (former SEB)
- CSA: QUCATS

Flagship on Quantum Technologies

7. Are there any additional / background documents?

- qt.eu – Resources
- Quantum (europa.eu)

- CNECT.C2
  High Performance Computing & Quantum Technologies
  cnect-c2@ec.europa.eu
  cnect-c2-evaluations@ec.europa.eu

Flagship on Quantum Technologies – Future outlook

8. Do you have information about future trends, emerging initiatives, roadmaps, key players in this area?

- Reference: Strategic Research and Industry Agenda

Upcoming events / information days

9. Please list upcoming information days and other events of relevance to this area.

- Horizon Europe Information Days – Cluster 4
- Destination 4 “Digital and emerging technologies for competitiveness and fit for the Green Deal”
- Quantum Technologies on 13 December afternoon

HORIZON-CL4-2023-DIGITAL-EMERGING-01-40: Quantum Photonic Integrated Circuit technologies (RIA)

Expected outcome:

- Improve over existing Photonic Integrated Circuits (PIC) technologies in terms of performance, functionality, manufacturing process efficiency and reliability, integration, and packaging in a manner that facilitates scalable manufacturing.
- Demonstrate the technology capability in key enabling Quantum PIC (QPIC) technologies with high potential impact on the quantum technology Industry, including applications in quantum sensing, communications, computation and simulation
- Preparing QPIC technologies for future Pilot Lines and Photonics hubs and open testing and experimentation facilities
- Exploit the potential of QPICs for a digital, green and healthy future in Europe by providing critical components and systems for next generation applications, products and processes. Develop tools for efficient design and prototyping of QPICs
- Secure Technological Sovereignty for Europe by maintaining leadership in QPICs
- Contribute to the objectives of Digital Transformation, Green Deal, Competitiveness and Economic Growth

HORIZON-CL4-2023-DIGITAL-EMERGING-01-40: Quantum Photonic Integrated Circuit technologies (RIA)

Scope:

Objectives include:

- Enhancement of PIC performance
- Incorporation of specific quantum functionality into PIC platforms
- Multi-technology integration
- Development of PICs capable of operating at cryogenic temperatures
- Development of the most promising methods for QPIC fabrication in monolithic, hybrid or heterogeneous integration techniques for different functionalities together with an identification of the most advantageous platform materials
- Assembly and packaging of PICs, taking the specific challenges of quantum systems into account and including integration of complementary and ancillary technologies where required
- Miniaturization of previously non-scalable quantum photonic systems by implementing them in PIC form.

Proposals should:

- Identify applications in quantum sensing, communication, computation and simulation; and test and evaluate the developed QPIC technologies in the context of such specific applications
- Address IP management strategy and collaboration with European industry and SMEs; technologies should be developed in a manner to facilitate scalable manufacturing

HORIZON-CL4-2023-DIGITAL-EMERGING-01-40: Quantum Photonic Integrated Circuit technologies (RIA)

EU contribution per project: EUR 4-6 million
Indicative budget of the call: EUR 12 million
Type of Action: RIA
TRL: Achieve TRL 4-5 by the end of the project
Eligible countries: EU Member States, Iceland and Norway

European Commission

HORIZON-CL4-2023-DIGITAL-EMERGING-01-41: Investing in alternative quantum computation and simulation platform technologies (RIA)

Expected outcome:

Projects are expected to contribute to the following outcomes:

- Mature alternative and promising quantum computation and simulation platforms which have the prospects of high scalability and programmability, and
- to complement the ones already supported by the Quantum Technologies Flagship

Scope (1/2):

To reach large-scale quantum computation and simulation, Europe needs:

- breakthroughs in scalability of quantum processors and simulators, devices and integrated platforms,
- full programmability of quantum computer or simulator

EU contribution per project: EUR 7-12 million
Indicative budget of the call: EUR 20 million
Type of Action: RIA
TRL: Achieve TRL 5-6 by the end of the project
Eligible countries: EU Member States, Iceland and Norway

European Commission

HORIZON-CL4-2023-DIGITAL-EMERGING-01-41: Investing in alternative quantum computation and simulation platform technologies (RIA)

Scope (2/2):

Work should address the development of alternative quantum computer and simulator systems and platforms, e.g. photonic or nitrogen vacancy-centre or hybrid systems, and should:

- Integrate key building blocks as individual quantum systems (i.e. >10 qubits for a quantum computer and >50 quantum units for a quantum simulator), control electronics, quantum software stack, use case applications, etc.

- Address scalability to large systems (>100 qubits for a quantum computer and >1000 quantum units for a quantum simulator), the verification and validation of the quantum computation or simulation, solving a concrete problem to demonstrate the quantum advantage.

- Quantum computation platform should explore fault-tolerance.

EU contribution per project: EUR 7-12 million
Indicative budget of the call: EUR 20 million
Type of Action: RIA
TRL: Achieve TRL 5-6 by the end of the project
Eligible countries: EU Member States, Iceland and Norway

European Commission

HORIZON-CL4-2023-DIGITAL-EMERGING-01-41: Investing in alternative quantum computation and simulation platform technologies (RIA)

Proposals should also cover:

1. Cooperation with complementary projects:
   - enabling quantum software stack (HORIZON-CL4-2021- DIGITAL-EMERGING-02-10: Strengthening the quantum software ecosystem for quantum computing platforms),
   - future Digital Europe Programme EuroHPC JU calls for acquisition and operation of quantum computers (integration with the HPC & data infrastructure, establish appropriate IP exploitation agreements).

2. Cooperation, coordination with the relevant (for the proposed platform) Quantum Flagship initiatives including:
   - FPAs establishing key EU fabrication processes, technologies and supply chain,
   - FPAs funded under HORIZON-CL4-2021-DIGITAL-EMERGING-02-17 (simulation) and HORIZON-CL4-2021-DIGITAL-EMERGING-02-15 (computing).

3. Any additional support they may receive from relevant national, or regional programmes and initiatives

4. Contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. Also contribute to spreading excellence across Europe, e.g., through the involvement of EU Widening Countries.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-43: Framework Partnership Agreement for developing large-scale quantum Computing platform technologies (FPA)

Expected outcome:

Projects are expected to contribute to the following outcomes:

- Demonstrate a universally programmable processor of at least 200 physical qubits (by 2027) operating in the NISQ domain including firmware and having sufficient coherence to perform computations involving all of its qubits; characterised with a hardware-agnostic test suite, including real-world applications, including for hybrid quantum/HPC computing, and the capability of out-performing classical computers on a number of relevant real-world use-cases; control needs to involve a low-level control system, a compiler and a scheduler.
- By 2029, build a full stack, highly connected, high fidelity quantum computer of at least one thousand physical qubits, exhibiting scalability and capable of out-performing classical computers on relevant real-world use-cases.
- Formulate standards and interface specifications for a complete software and hardware stack including remote, cloud-based access.

EU contribution per project: N/A FPA / EUR 25 million SGA
Indicative budget of the call: N/A FPA / EUR 25 million SGA
Type of Action: FPA
TRL: Achieve TRL 6-7 by the end of the project
Eligible countries: EU Member States, Iceland and Norway

HORIZON-CL4-2023-DIGITAL-EMERGING-01-43: Framework Partnership Agreement for developing large-scale quantum Computing platform technologies (FPA)

Scope (1/2):

Proposals for this FPA are expected to build on the quantum computing platforms supported under the Quantum Flagship ramp-up phase and should target:

- the development of open quantum computing platforms compatible with the fabrication techniques of the **semiconductor** industry (e.g. silicon spin qubits)
- the integration with the key building blocks such as quantum processors in the NISQ regime with control electronics, low-level software, verification and validation of the quantum computation, etc
- practical strategies towards the break-even point of fault tolerance to increase algorithmic depth (number of operations) for quantum computing on existing platforms.

- Quantum computation platform should explore fault-tolerance.

EU contribution per project: N/A FPA / EUR 25 million SGA
Indicative budget of the call: N/A FPA / EUR 25 million SGA
Type of Action: FPA
TRL: Achieve TRL 6-7 by the end of the project
Eligible countries: EU Member States, Iceland and Norway

European Commission

HORIZON-CL4-2023-DIGITAL-EMERGING-01-43: Framework Partnership Agreement for developing large-scale quantum Computing platform technologies (FPA)

Scope (2/2):

Proposals for this FPA should:

- describe how the activities carried out during the ramp-up phase will be continued involving the relevant disciplines ,technologies and stakeholders, how results of the ramp-up phase will be used, and how they will provide efficient coordination under strong scientific and engineering leadership
- address the development and integration in this platform of a full software stack, including a compiler and scheduler, programming tools, a suite of algorithms, use cases etc., that would allow them to showcase their capability of solving real and concrete computational problem(s) that demonstrate a quantum advantage and to make progress towards fault tolerance
- aim at the development of open quantum computer experimental systems, and work on the reduction of their form factor

EU contribution per project: N/A FPA / EUR 25 million SGA
Indicative budget of the call: N/A FPA / EUR 25 million SGA
Type of Action: FPA
TRL: Achieve TRL 6-7 by the end of the project
Eligible countries: EU Member States, Iceland and Norway

European Commission

HORIZON-CL4-2023-DIGITAL-EMERGING-01-43: Framework Partnership Agreement for developing large-scale quantum Computing platform technologies (FPA)

Proposals should also cover:

1. Cooperation with complementary projects:
   - enabling quantum software stack (HORIZON-CL4-2021- DIGITAL-EMERGING-02-10: Strengthening the quantum software ecosystem for quantum computing platforms),
   - future Digital Europe Programme EuroHPC JU calls for acquisition and operation of quantum computers (integration with the HPC & data infrastructure, establish appropriate IP exploitation agreements).

2. Any additional support they may receive from relevant national, or regional programmes and initiatives

3. Contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. Also contribute to spreading excellence across Europe, e.g., through the involvement of EU Widening Countries.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-50: Next generation quantum sensing and metrology technologies (RIA)

Expected outcome:

- Contribute to demonstrate the feasibility of next generation quantum sensing and metrology technologies and devices
- By showing disruptive progress in the performance, reliability and efficiency and application of such technologies and devices and by enhancing the TRL of all (essential) components necessary to build them

Scope:

Proposals should focus on next generation quantum sensors and metrology devices such as for example quantum enhanced spectroscopy and imaging, including entangled and/or superposition-based clocks, quantum opto-mechanical sensing devices, squeezed sates of light, point-defects in the solid-state (bulk or 2D materials)

Proposals should address:

- the development of new methods and techniques to achieve full control over all relevant quantum degrees of freedom and to protect them from environmental noise;
- and/or identify correlated quantum sates that outperform uncorrelated systems in a noisy environment and methods to prepare them reliably.

Proposed work should exploit quantum properties (such as coherence, superposition and entanglement) emerging in quantum systems to improve the performance of the targeted sensors technologies (e.g. in terms of resolution, sensitivity or noise), well beyond the classical limits.

HORIZON-CL4-2023-DIGITAL-EMERGING-01-50: Next generation quantum sensing and metrology technologies (RIA)

Scope: (continued)

- Proposals should target the development of laboratory prototypes demonstrating the practical usefulness of engineered quantum states of light/matter to improve sensing or imaging and develop and demonstrate optimized quantum software for detection applications in real-world applications.
- They should leverage interdisciplinary expertise and join forces with metrology institutes or other relevant technical fields to further advance the limits of sensors sensitivity and resolution and to implement the best control protocols, statistical techniques (e.g. Bayesian, among others) and machine learning algorithms as appropriate.
- Projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms and contribute to the governance and overall coordination of the Quantum Technologies Flagship initiative.

EU contribution per project: EUR 2-3 million
Indicative budget of the call: EUR 10 million
Type of Action: RIA
TRL: Achieve TRL 4-5 by the end of the project
Eligible countries: EU Member States, associated countries, OECD countries

Destination 4
Objective "Graphene: Europe in the lead"

European Commission

Graphene: Europe in the lead

- Starting point is the Graphene Flagship
- Build on its achievements, pursued R&I activities and accelerate the technology developments
- Concrete innovation opportunities and production capabilities
- Strong supply and value chains in graphene and 2D materials in Europe

Graphene: Europe in the lead

- First wave of topics in WP 2021-2022: RIAs and IA on electronics, energy, biomedical technologies, composites and a CSA

- **Second wave of topics in WP 2023 : 1 Dec 2022-29 March 2023, 18M€**
  - **Sustainable safe-by-design 2D materials technology (RIA)**
  - **2D materials of tomorrow (RIA)**

- Third wave planned in WP 2024
  - Follow up of 2D Experimental Pilot Line
  - Coordination of MS (CSA)

HORIZON-CL4-2023-DIGITAL-EMERGING-01-32:
Sustainable safe-by-design 2D materials technology (RIA)

We are looking for

- Development of Safe and Sustainable by Design two-dimensional materials (2DM) technology.
- Societal acceptance of 2DM and 2DM-based technologies.
- A set of robust and verified assays to support regulatory requirements for their registration and authorisation for use

HORIZON-CL4-2023-DIGITAL-EMERGING-01-32:
Sustainable safe-by-design 2D materials technology (RIA)

We are looking for

- Critical examination of 2DM health and environment issues
- Studies and tests of biocompatibility and safety of 2DMs and composites along their life cycle;
- Development of solutions to modulate potential risks by developing appropriate chemical/physical approaches towards safer manufactured materials and nanomaterials
- Safety assessment of 2DMs and composites at different TRL levels by developing best practices along the product development process

HORIZON-CL4-2023-DIGITAL-EMERGING-01-32:

Sustainable safe-by-design 2D materials technology (RIA)

We are looking for

- Proposals should:
  - ✓ comply with the Safe and Sustainable by Design framework and criteria[1].
  - ✓ also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.
  - ✓ indicate which chapters of the Strategic Research and Innovation Plan for chemicals and materials[3] they will contribute to.
- Indicative Budget: 6M€
- TRL: start at TRL 2-3 and achieve TRL 4-5
- Expected EU contribution per project:3-5M

1: https://publications.jrc.ec.europa.eu/repository/handle/JRC128591#:~:text=The%20SSbD%20is%20an%20approach,human%20health%20and%20the%20environment , 2: , 3/ https://ec.europa.eu/assets/rtd/srip/2022/

HORIZON-CL4-2023-DIGITAL-EMERGING-01-33:

2D materials of tomorrow (RIA)

We are looking for

- A broad portfolio of innovative two-dimensional materials (2DM), networks and multicomponent hetero-structures exhibiting new properties or complementary functionalities that will lead to breakthroughs in digital systems and devices.
  - Identify and demonstrate new properties and physical phenomena, and processes enabling new functionalities, and their implementation in proof-of-principle digital devices;
  - Develop new characterization methods and of controlled, ultra clean and large-scale synthesis, fabrication methods and design of 2D materials and hetero-structures based on novel approaches e.g. Artificial Intelligence assisting material assembly and material simulation, preparation and growth methods combined with the help of modelling and simulation….

HORIZON-CL4-2023-DIGITAL-EMERGING-01-33:
2D materials of tomorrow (RIA)

We are looking for

- Proposals should:
  - ✓ also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.

- Indicative Budget: 12M€
- TRL: start at TRL 2 and achieve TRL 4
- Expected EU contribution per project:3-4M€

Work Programme topic – topic evolution

3. Is this new or has it been called before?

- It is the continuation of the Graphene Flagship
- Follows the change of implementation from FPA/SGA vs RIA/IA + CSA
- There are other topics/initiatives in the WP out of “Graphene Europe in the Lead” where 2DM can compete

Work Programme topic – topic evolution

4. Current project portfolio

- Graphene Flagship

https://graphene-flagship.eu

- 2D experimental Pilot line

https://graphene-flagship.eu/innovation/pilot-line

5. Who are the types of main stakeholders that are addressed?

6. Is there a key group of actors (eg. Partnership or other) driving this?

Work Programme topic – Key actors

5. Who are the types of main stakeholders that are addressed?

- Both academic and industrial partners

6. Is there a key group of actors (eg. Partnership or other) driving this?

- Graphene Flagship consortium: https://graphene-flagship.eu/collaboration/our-partners/

Work Programme topic

7. Are there any additional / background documents?

- Consultation report on graphene and related materials, Jan 2020: https://digital-strategy.ec.europa.eu/en/library/consultation-report-graphene-and-related-materials-now-available

Future Outlook

8. Do you have information about future trends, emerging initiatives, roadmaps, key players in this area?

Technology and Innovation roadmap:
https://graphene-flagship.eu/innovation/industrialisation/roadmap/
Updated version to be published very soon

Upcoming events / information days

9. Please list upcoming information days and other events of relevance to this area

- Info Day cluster 4 (destination 4) :13th December 2022, 13:40-16:00