

Call 2021 Final Evaluation



QUANTERA

TOBITS

Non-Abelian anyons for topological qubits

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on behalf of the TOBITS consortium



1 Sep 2022 – 28 Feb 2026 • 42 months
5 institutions in 4 countries

tobits.eu

COLLABORATION (overview)

GEOGRAPHICAL BREADTH

5 institutions / 4 countries

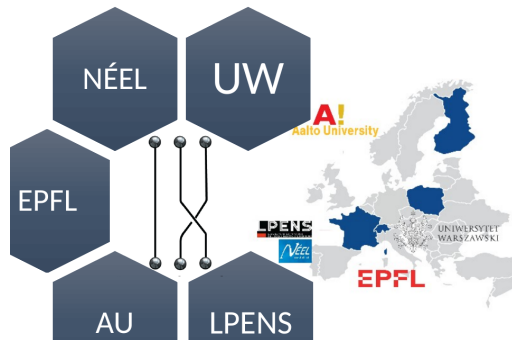
Aalto University (FI) · EPFL (CH) · Institut Néel/CNRS (FR)
LPENS/ENS-CNRS (FR) · University of Warsaw (PL)

Widening-country partner: Poland / UW

COMPLEMENTARITY

Methods: interferometry · thermal QH · QPC noise · FCI/topological theory.

Platforms: GaAs/AlGaAs, graphene/hBN, TMDs, multilayer/moiré graphene.



Aalto ↔ UW

Graphene-QPC experiments + tight-binding/RMT modelling → 2026 shot-noise preprint.

UW visits to Aalto, Nov 2023 and 2025

NÉEL + LPENS

Theory–experiment work on fractional-QH physics in MoS₂ → *Nature Electronics* (2024).

new TMD platform

Shared fabrication / infrastructure

EPFL used the **NÉEL cleanroom** for sample fabrication; EPFL–NÉEL tested AFM anodic oxidation for cleaner QPCs.

sample exchange + joint devices

COLLABORATION (people, mobility & networks)



Nicolas Regnault

LPENS



Benjamin Sacépé

Institut Néel



Jakub Tworzydło

UW



Mitali Banerjee

EPFL



Manohar Kumar

Aalto – coordinator



All-PIs meeting, LPENS Paris
in-person consortium coordination



UW → Aalto staff exchange
QPC modelling; visits Nov 2023 and
2025

WIDER EUROPEAN LINKS



QuantERA MAGMA: QH/Sc
probe (Kumar–Schmidt).

InstituteQ: electron-hole
interferometry / magnetometry.

How collaboration worked: visits/exchanges • cleanroom sharing • sample exchange • shared codes • joint-PhD plan • joint proposals.

MEETING TIMELINE

Paris
Kick-off meeting

07 Nov 2022

Milan
One-year meeting + consortium
conference/session (04–08 Sep)

07 Sep 2023

Lausanne
Third-year meeting

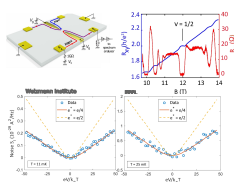
15 Dec 2025

Zoom
half-yearly
coordination

SUCCESS STORY (highlights)

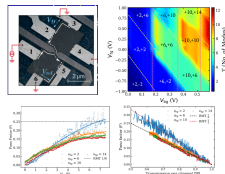
CHALLENGE: distinguish genuine topological/anyonic signatures from ordinary charging or mode mixing.

STRATEGY: complementary materials + low- T transport/noise + realistic modelling + topological theory.



$e/4$ charge at $\nu = 1/2$ in GaAs
Two independent setups: $e^*/e \simeq 0.25$.

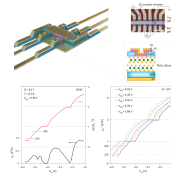
Unplanned landmark result in a candidate non-Abelian state; not a direct braiding proof.



Graphene QPCs: conductance to noise

Half-quantized plateaus: non-topological confined-geometry mechanism.

Follow-up theory: $F = 1/3$ for $N_L = 0$, versus $F \simeq 1/4$ for higher Landau levels.



Fractional QH states in bilayer MoS₂

Evidence for $\nu = 4/5$ and $2/5$ fractional-QH states.

Unplanned expansion to a new semiconducting TMD platform.

Workplan / evaluation: technical and recruitment problems delayed some device milestones (6-month extension). Mitigation: shared infrastructure, fabrication changes and broader platforms. Reviewer: research deliverables adequately addressed; delays reasonably justified.

SCIENTIFIC OUTPUTS

42

DISTINCT SCHOLARLY
OUTPUTS

2 PhD +
1 MSc

completed theses

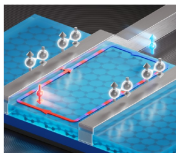
+ 2 PhDs continuing

Open dissemination: arXiv /
open journals / Zenodo data
and software.

Patents: none reported.

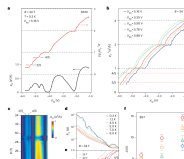
QUALITY AND REACH

Accepted/published work includes (open access) **Nature**, **Nature Electronics**, **Nature Physics**, **Nature Communications**, **Communications Materials**, **Physical Review Letters**, **PRB** and **PRR**.



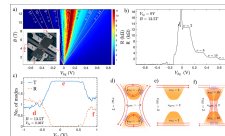
**Chiral supercurrent in QH
Josephson junctions**
Nature 624, 545 (2023)

Graphene quantum-Hall /
superconducting hybrid
platform.



**FQH phases in
high-mobility MoS₂**
Nature Electronics 7,
1117–1125 (2024)

Bilayer MoS₂: 4/5 and 2/5
fractional quantum-Hall states.



**Half-quantized Hall
plateaus in confined
graphene**
Communications Materials
(2026)

Followed by the Aalto–UW
mode-mixing / shot-noise
Comm. Mat. in review

Dissemination via consortium-led scientific events: the Milan conference and the Twente workshop.

IMPACT & WHAT'S NEXT

IMPACT / POTENTIAL USERS

Primary impact: fundamental science

Foundations in quantum-Hall interferometry, topological transport and 2D quantum materials.

Technology route: ultrafast, high-sensitivity quantum-Hall magnetometry.

Potential users: research groups now; later quantum-hardware and precision-instrumentation

Fundamental-science consortium: no industrial partner; no patents reported.

Reviewer: main impacts are scientific; fast/high-sensitivity magnetometry identified as technologically viable.

WHAT'S NEXT

ARCHES – EIC Pathfinder Open 2026

proposal submitted; under evaluation

Four TOBITS partners continue:

EPFL · NÉEL/CNRS · Aalto · UW

Scientific route

QH/SC + QAH/SC hybrid devices
interferometric, noise and microwave probes of non-Abelian excitations

Target

microwave-compatible superconducting QH gatemon.

TOBITS: scientific foundations



ARCHES: hybrid topological devices / quantum technology



IMPACT – RRI ASPECTS

GENDER & INCLUSION

3 / 6 listed TOBITS-funded appointments were women.

- ▷ Proactive outreach to female candidates.
- ▷ Female PI at EPFL: visible role model and network.
- ▷ Education activities also close to gender balance.

OPEN SCIENCE

- ▷ Publications via open journals and/or arXiv.
- ▷ Data/software on Zenodo; software and teaching projects on GitHub.
- ▷ LPENS DiagHam resource for many-body calculations.

EDUCATION & TRAINING

- ▷ AScl International Summer Research Programme (Aalto).
- ▷ Cryocourse 2023 / European Microkelvin Platform.
- ▷ Research-style BSc/MSc team projects at UW: quantum transport, Kwant and reproducible tutorials.

PUBLIC / EUROPEAN ENGAGEMENT

- ▷ Milan conference (~40); Twente workshop (~60).
- ▷ QuantERA-II participation in European basic-science thematic work.
- ▷ Contribution to the Quantum Flagship *Strategic Research and Innovation Agenda (SRIA)*.

Funded within the QuantERA II Programme; EU H2020 research and innovation programme, GA No.101017733.

Final review: education/public engagement – Yes; gender equality and Open Science – Yes.

Ethics: no ethical issues identified.

