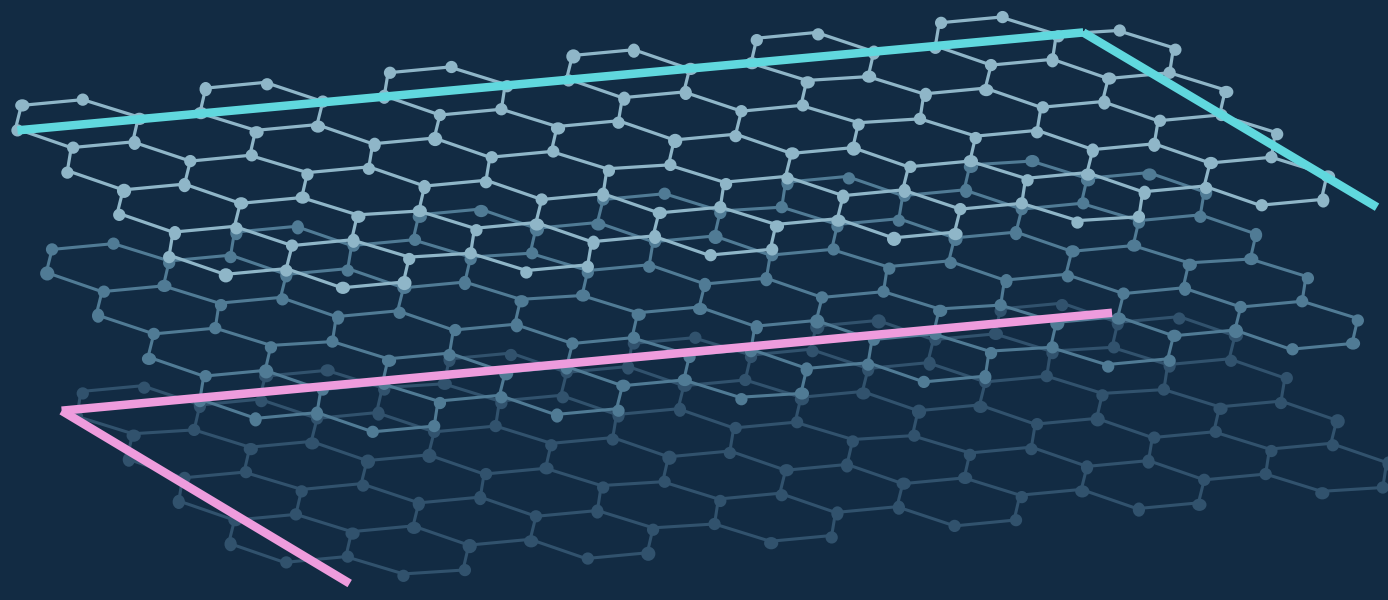


2DQUEST

Quantum Engineering in Superconducting Graphene for Topological Qubits

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Toward intrinsically protected qubits

2DQUEST aims to realize and detect chiral Majorana modes in graphene. Atomically sharp interfaces and electrical tunability offer complementary routes to topological superconductivity and the foundations for future qubits.

36

months

4

partners

3

countries

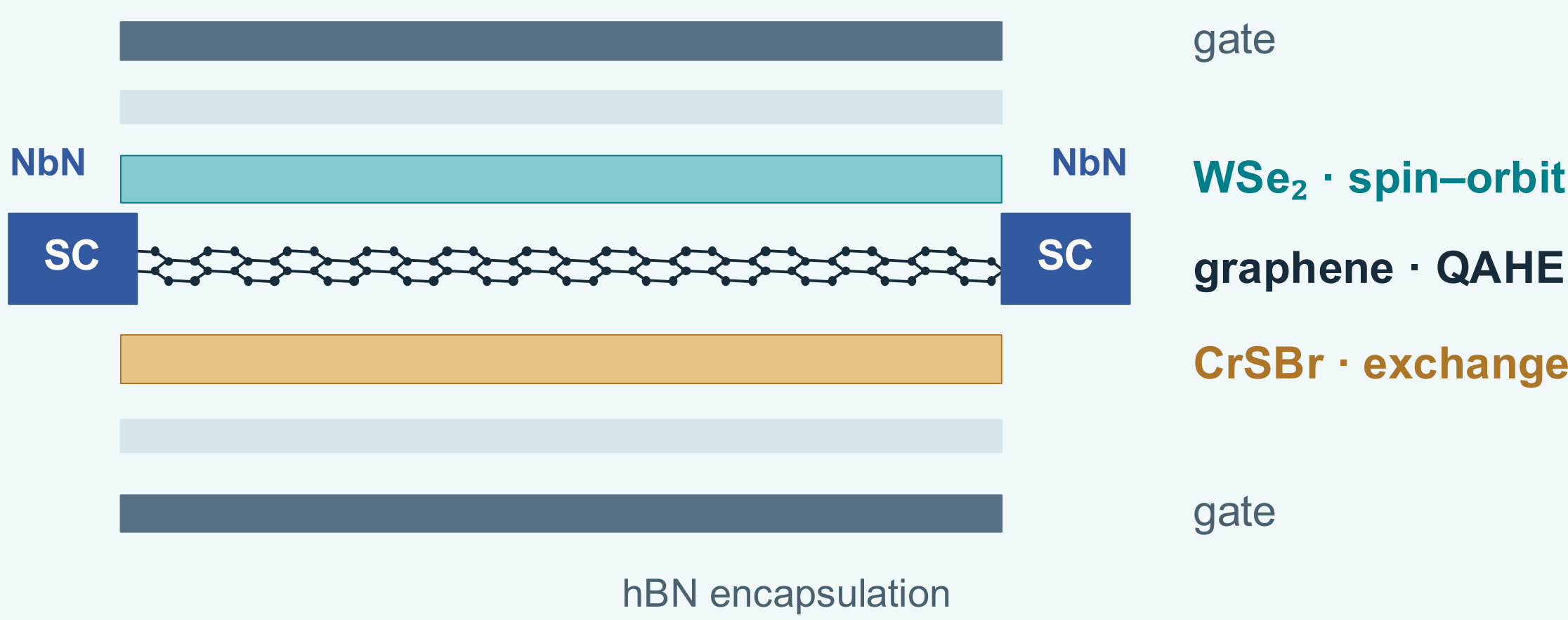
A complementary European consortium

01 | TWO COMPLEMENTARY ROUTES

ROUTE 1 / EXTRINSIC

Proximity-engineered graphene

Engineer the quantum anomalous Hall effect using spin–orbit and magnetic proximity, then add superconducting coupling. [1]

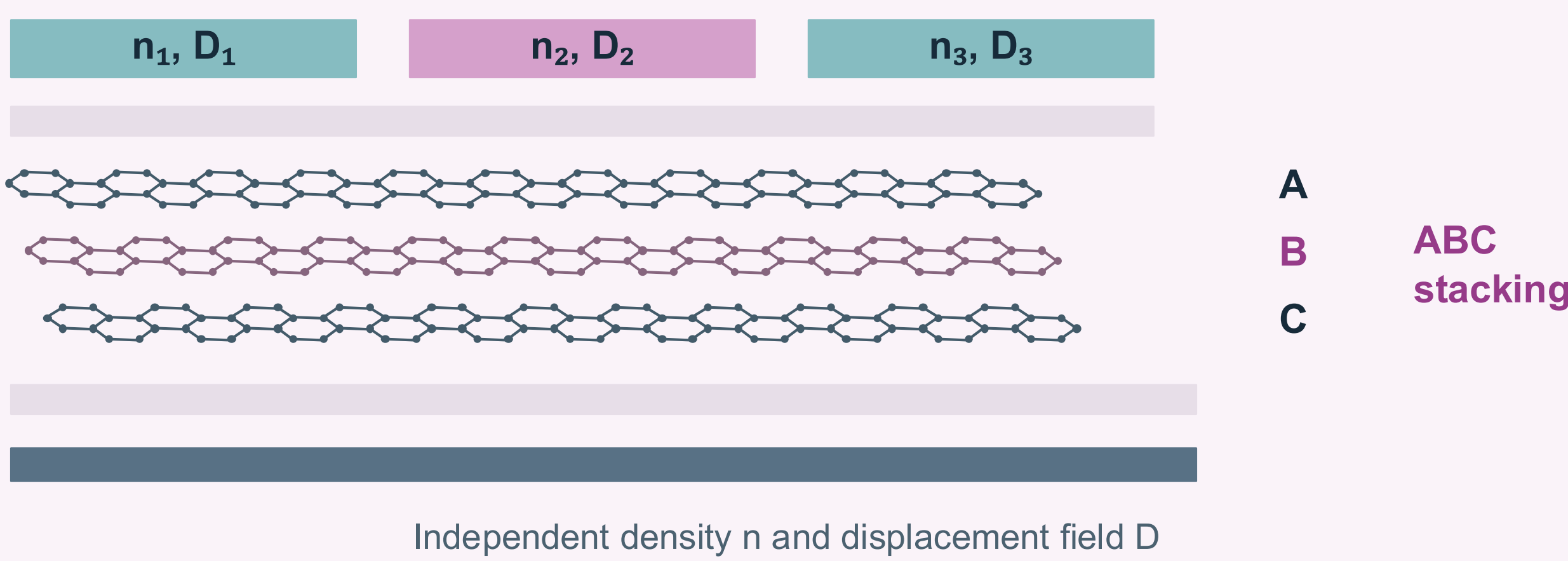


Target: gate-tunable topological superconductivity and a single chiral Majorana channel per edge.

ROUTE 2 / INTRINSIC

Rhombohedral multilayer graphene

Use intrinsic superconductivity in ABC-stacked graphene to seek interaction-driven chiral pairing without external superconducting proximity. [2,3]

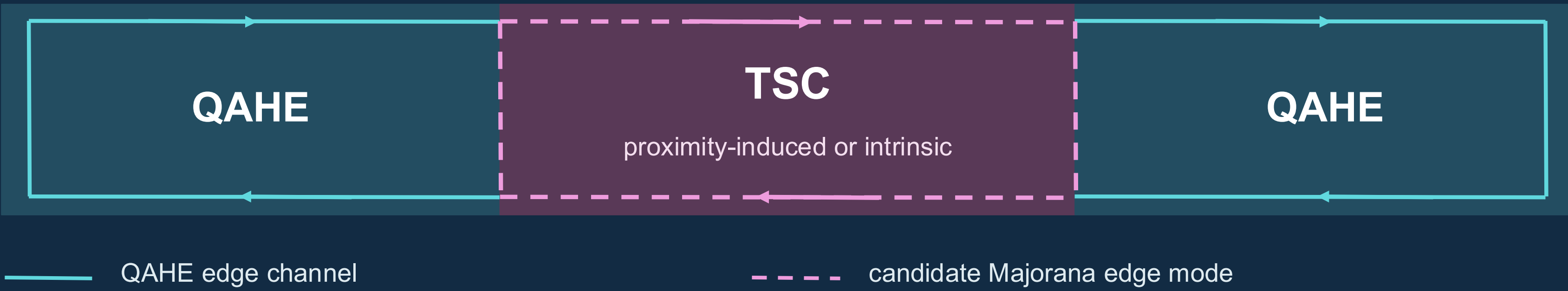


Target: chiral pairing, Majorana zero modes and edge channels under gate control.

SHARED DEVICE CONCEPT

QAHE–TSC–QAHE

Probe chiral Majorana edge transport in a gate-tunable junction.



QAHE = quantum anomalous Hall effect · TSC = topological superconductor

02 | CONVERGING EVIDENCE, NOT A SINGLE SIGNAL

G = e²/2h

TRANSPORT

Half-quantized conductance and nonlocal edge correlations.

4π

INTERFEROMETRY

SQUID-embedded junctions and current–phase relations.

Zero bias

LOCAL SPECTROSCOPY

Tunnelling at edges and vortex cores; field and phase dependence.

Validation principle: cross-check gate, magnetic-field and phase dependence against microscopic theory; no individual signature is treated as conclusive.

03 | PLAN & PREDICTIVE THEORY

Year 1 Platforms, fabrication and electronic structure.

Year 2 Superconducting phases and Josephson transport.

Year 3 Edge spectroscopy and Majorana cross-validation.

DFT → effective / BdG models → topology & transport

Many-body theory: Renormalization group, Fock Optimization of Real-space Giant Environment

04 | EXPECTED IMPACT

Quantum platforms. Design rules and gate-tunable devices for topological quantum electronics.

Open methods. Reusable simulation tools, FAIR data and reproducible detection protocols.

European expertise. Training and shared capabilities toward future fault-tolerant qubits.

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