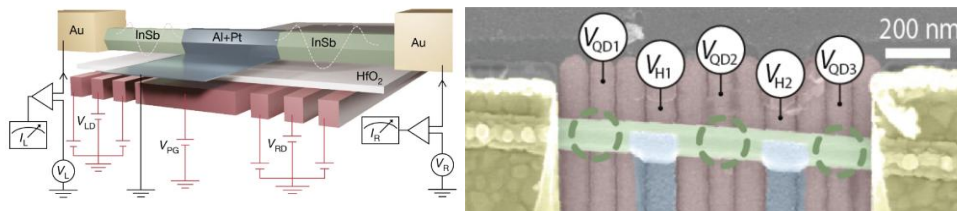


Kouwenhoven lab MEP Projects 2026

We are looking for motivated master students to work on the first generation of quantum dot-based Majorana qubits. Students should be finished with all courses before starting, and preferably have excellent grades in related courses (for example Quantum Hardware, Mesoscopic Physics, etc).

Majorana bound states are predicted to appear in arrays of quantum dots coupled by superconductors when the coupling parameters have been finetuned. Recent advances in materials and understanding of the physics of superconductor-semiconductor systems has allowed the detection of Majorana signatures in arrays (called Kitaev chains) of two and three quantum dots [1,2]. This has opened the door to quantum information experiments with Majorana bound states .



Left : a schematic of a 2-site Kitaev Chain [1] **Right** : an image of a 3-site Chain [2]

MEP projects typically include nanofabrication, conducting cryogenic measurements with a dilution refrigerator, and carrying out measurement analysis or simulations. Ongoing projects are :

<p>Majorana parity qubit based on two-site Kitaev chains</p> <p>Coupling two chains with four Majorana states allows encoding a qubit into the parity of the two chains. Control over the couplings within and between the chains allows for universal qubit control.</p>		<p>[3]</p>
<p>Braiding with two-site Kitaev chains</p> <p>Majorana modes are predicted to have non-abelian statistics which can be demonstrated through “braiding”, i.e. coherently exchanging the Majoranas in space.</p>		<p>[4]</p>
<p>Qubit based on three-site Kitaev chains</p> <p>As three-site Kitaev chains are more robust to charge noise than two-site chains, a three-site qubit will likely have better coherence properties.</p>		<p>[5]</p>

[1] Dvir, Tom, et al. "Realization of a Minimal Kitaev Chain in Coupled Quantum Dots." *Nature*, vol. 614, no. 7948, 2023, pp. 445–450

[2] Bordin, Alberto, et al. "Signatures of Majorana Protection in a Three-Site Kitaev Chain." *arXiv*, 29 Feb. 2024, arxiv.org/abs/2402.19382

[3] Pan, Haining, et al. "Rabi and Ramsey Oscillations of a Majorana Qubit in a Quantum Dot-Superconductor Array." *arXiv*, 23 July 2024, arxiv.org/abs/2407.16750

[4] Miles, Sebastian, et al. "Braiding Majoranas in a Linear Quantum Dot-Superconductor Array: Mitigating the Errors from Coulomb Repulsion and Residual Tunneling." *arXiv*, 27 Jan. 2025, arxiv.org/abs/2501.16056.

[5] Bordin, Alberto. *Engineering the Kitaev Chain*. Delft University of Technology, 2025