

Master thesis project

Exploring Higher Order Superconducting Magnetic Trapping

Background In our lab, we research into chip-based magnetic traps for superconducting particles. Our long-term goal is testing the foundations of quantum mechanics [1]. We have recently proposed the use of **higher order magnetic multipoles** as particle traps, which would enable producing anharmonic potentials and may eventually be used to create **quantum superpositions** [2]. We offer a Master thesis project to explore the possibilities of these traps, with the goal of observing the predicted nonlinear potential in an experiment. The project will involve **theoretical analysis**, sample **design and microfabrication**, and **cryogenic measurement**.

Master thesis project

The project consists of:

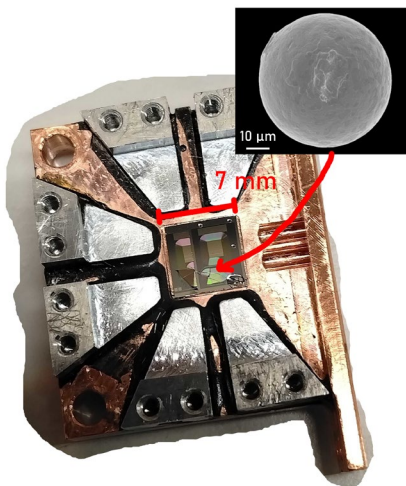
- Design and simulation of realistic chip-based particle traps with engineered nonlinearity
- Microfabrication of chip-based traps in Chalmers in-house cleanroom
- Device characterization at low temperatures

What will you learn

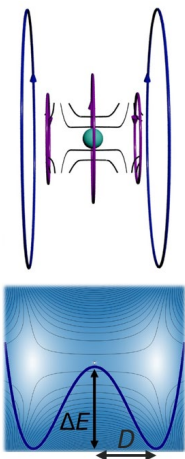
- Fabrication techniques and gain experience in the cleanroom
- Insight in how magnetostatic simulations are performed and how they are used for frontier research
- Cryogenic measurement techniques
- Teamwork in a stimulating research environment

References

- [1] M. Arndt, K. Hornberger, [Nat. Phys. 10, 271 \(2014\)](#)
- [2] J. Cunill-Subiranas, F. Resare et al., [arXiv:2607.03622 \(2026\)](#)
- [3] M.G. Latorre et al., [Phys. Rev. Applied 19, 054047 \(2023\)](#)



Chip-based single particle trap [3]



Anharmonic magnetic potential for generating non-classical motional states of microparticles [2]

Questions? Feel free to contact us:

Witlef Wieczorek, Professor, witlef.wieczorek@chalmers.se

Fabian Resare, PhD Student, resaref@chalmers.se

Thomas Penny, Postdoc, thomas.penny@chalmers.se