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Quantum technologies with trapped electrons

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At the University of Sussex we are developing a novel planar Penning trap technology. We are particularly focused on the applications of trapped electrons in quantum technology, specifically as a quantum microwave transducer. The potential applications span across various domains, including fundamental physics measurements, such as determining the neutrino mass, and technologies such as quantum radar, quantum microwave microscopy, and mass spectrometry. We have coined the expression Geonium Chip for our novel trap in honour of the pioneering work of Dehmelt, who first introduced the concept of 'Geonium' to describe a cloud of electrons confined in static fields. In my talk I will introduce our ion trap and discuss some of the elements that make it a scalable and readily deployable quantum technology. One of the most significant advantages over conventional Penning traps lies in our innovative tuneable planar magnetic field source, capable of producing homogeneous magnetic fields of 0.5 T. This breakthrough marks the initial stride towards obviating the necessity for large, non-scalable, and exceedingly expensive superconducting solenoids. Moreover, we are currently advancing this magnetic field source to its next iteration, which will operate in a persistent mode and incorporate a pioneering flux-pumping technique. Another departure from conventional traps involves the method of loading electrons where traditional techniques such as field-emission-points have been replaced by an approach harnessing the photoelectric effect to maximise deployability. Finally, we are pushing to the limit the detection system electronics by developing a broadband detection circuit with a simple resistor that enables the detection of single electrons as well as heavier particles, catering to a wide range of applications.

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