# Microwave Device Characterisation using a Quantum Diamond Microscope

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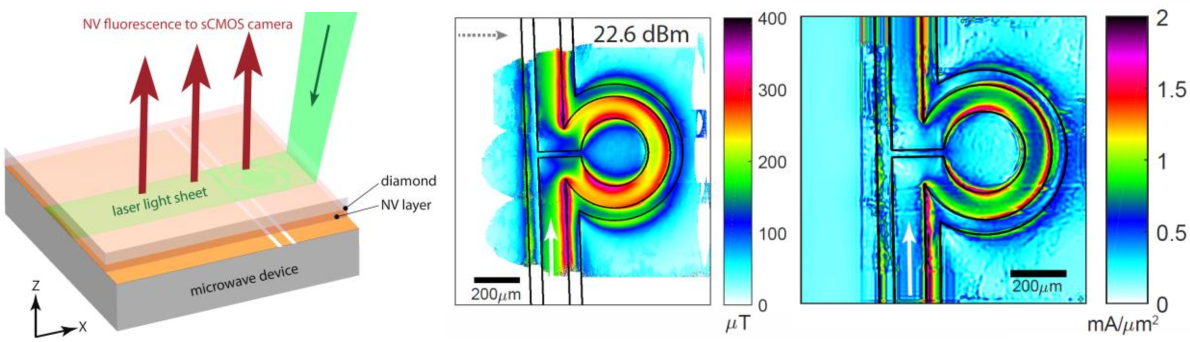
Microwave devices form the backbone of many scientific and technological applications, from quantum devices (atom chips, ion traps, atomic clocks, qubits...) to telecommunications (wifi, mobile phones...). There is great interest in techniques to image the microwave near-fields close to such devices, which promise to transform device development, characterisation, and debugging. We have developed techniques for imaging magnetic fields at microwave frequencies (GHz to tens of GHz) using both atomic vapor cells [1-3] and nitrogen-vacancy (NV) centres in diamond [4-5]. We detect the fields through coherent Rabi oscillations driven on transitions within the atoms or NV centres. Compared to traditional antenna-based microwave imaging, our techniques represent a fundamentally new approach to microwave sensing, providing intrinsically calibrated measurements with high spatial and temporal resolution.

I will present results from our new widefield imaging system based on dense ensembles of NV centres. We have realised a system with 0.5 mm$^2$ field of view, comparable to the state of the art for such 'quantum diamond microscopes', and sub-millisecond temporal resolution, exceeding the state of the art by close to an order of magnitude. Along with micrometer-order spatial resolution, these provide a capability unmatched by any other microwave imaging technology. I will describe our imaging system, and present characterisations of a selection of microwave devices, including a novel prototype atom chip.




*Left: Microscope schematic. A microwave device is positioned underneath a diamond with a thin layer of NV centres, which are used to image the microwave near field produced by the device. Middle: Experimentally obtained image of the microwave near field above an omega-loop structure. Right: Microwave current distribution extracted from the microwave field image.*

## References

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