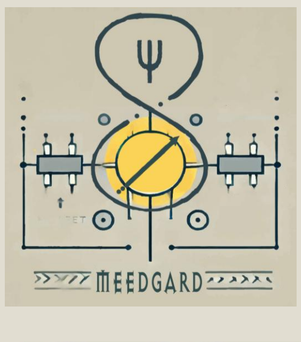
MEEDGARD

Memory-**E**nhanced **E**ntanglement **D**istribution with **G**allium **Ar**senide Quantum **D**ots



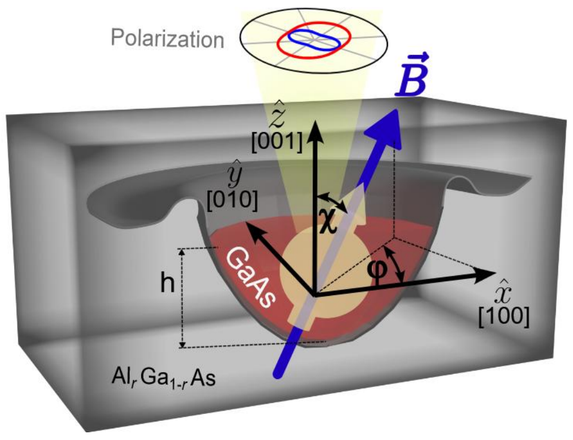
A multiqubit register accessed by light

The MEEDGARD project team will combine the expertise of multiple research groups with complementary skills and foci to achieve an all-in-one device delivery: a semiconductor quantum dot (QD) system capable of producing entanglement between a matter qubit and a photonic qubit and storing this information in nuclear spins with 90% fidelity for 100 milliseconds, a 100,000-fold improvement over previous QD-based result [1].

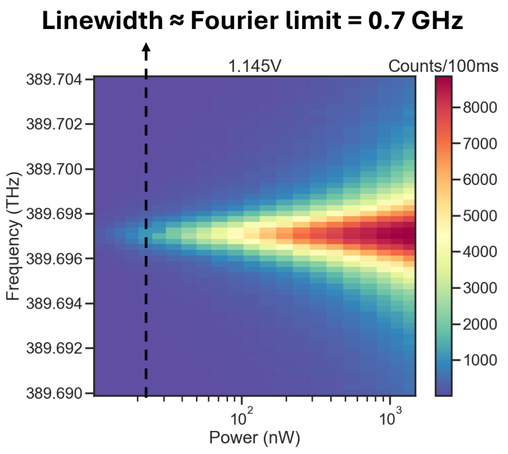
June 2024 — **Nov 2025** — May 2027

WP1: QD fabrication and model validation

Led by Michał Gawełczyk and Armando Rastelli



Optical and magnetic dipoles governed by growth parameters *r, h* and magnetic field **B**

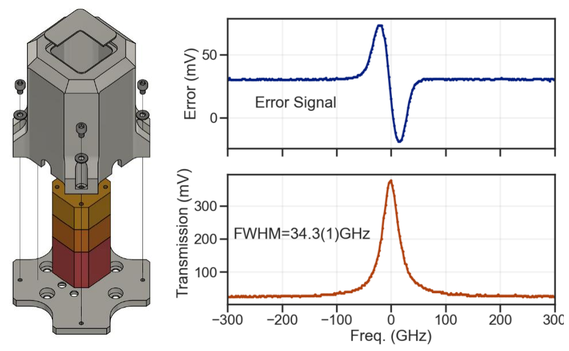


Excitation-power-dependent photon emission of a GaAs QD

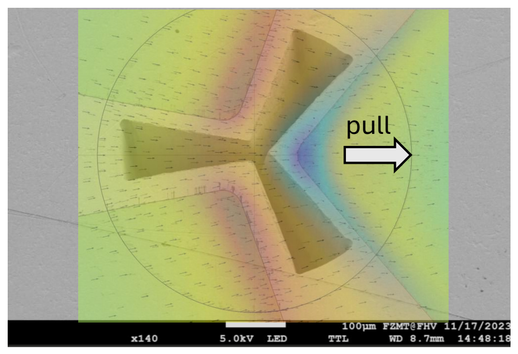
- Predictable and designable spin-photon interface in GaAs quantum dots [2,3]
- Fourier-limited (noise-free) photon emission

WP2: Strain-engineerable QD devices in open cavity

Led by Sandra Stroj and Armando Rastelli



Frequency-stabilized open cavity

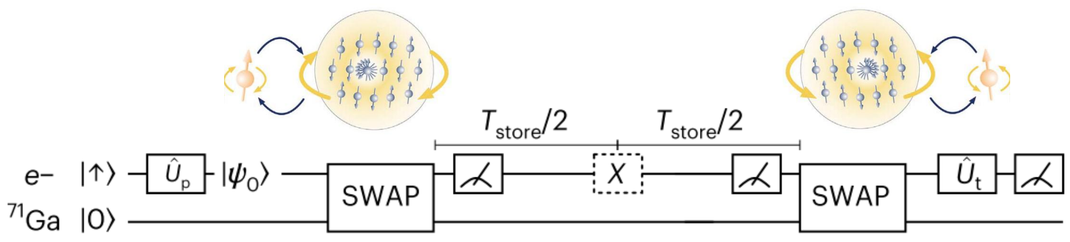


SEM image of laser cut piezo-actuator and FEM-simulated uniaxial strain-profile

- Frequency-locked open cavity for enhanced light-matter interaction and >50% photon collection efficiency in fibre [4]
- Integrated piezoelectric actuator for exerting up to 1% strain in arbitrary in-plane direction → full control over electron-nuclear coupling

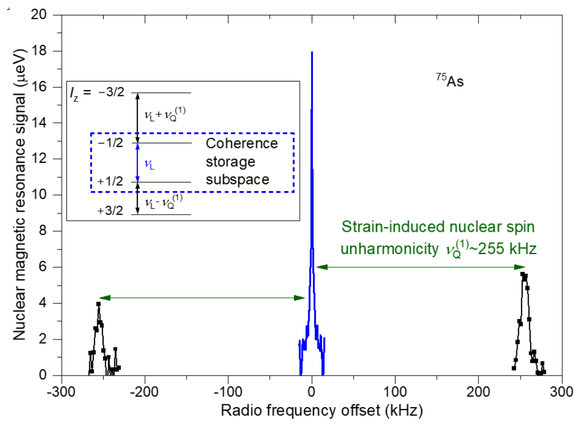
WP3: Strain-activated, decoupled quantum memory

Led by Evgeny Chekhovich



Qubit storage and retrieval sequence to/from nuclear register

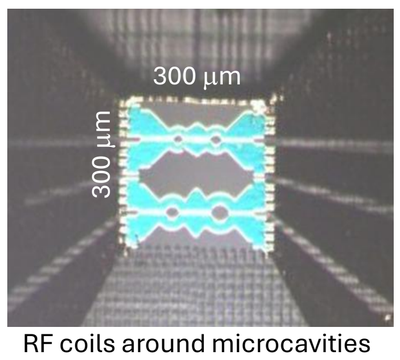
- Coherent transfer of an electron-spin qubit to the nuclear many-body register and back (total fidelity: 70 %) [5]



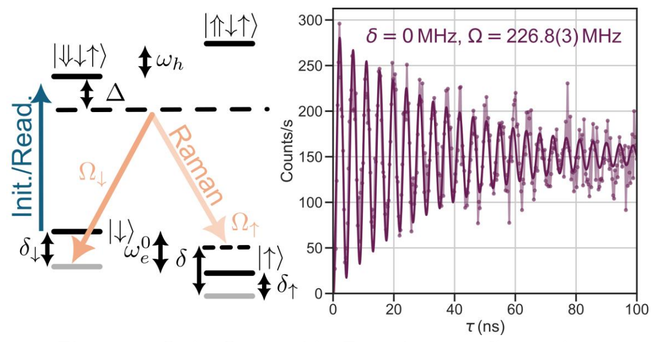
- Quadrupolar anharmonicity in nuclear subspace induced by strain-engineering
  → Isolation of storage subspace
- CHASE-40 dynamical decoupling sequence
  → Nuclear coherence time from 0.46 ms to **100 ms** [6]

WP4: 100 ms storage of spin-photon entanglement

Led by Dorian Gangloff and Mete Atatüre



RF coils around microcavities



Electron Spin Control in Faraday configuration

- Open-cavity-integrated RF coils for in-situ NMR → Dynamical decoupling of nuclear spin register for > 100 ms storage time.
- Single-shot readout *and* spin-control in Faraday configuration [7]

WP5: Management, dissemination and exploitation of results

Led by MEEDGARD PIs

- Monthly WP meetings and trimesterly consortium meetings
- Annual in-person meeting and community workshop
- Website: meedgard.phy.cam.ac.uk
- Outreach project QuanTour (thesciencetalk.com/quantour)

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[1] Stockill et al, *Nat Comm* **7**, 12745 (2016)
[2] Schimpf et al, *PRX Quantum* **6**, 040309 (2025)
[3] Shofer et al, *Phys. Rev. X* **15**, 021004 (2025)
[4] Tomm et al, *Nat Nanotech* **16**, 399-403 (2021)
[5] Appel et al *Nat Phys* **21**, 368-373 (2025)
[6] Dyte et al, arXiv:2502.11092 (2025)
[7] Koong et al, arXiv:2509.14445 (2025)