Improving single-qubit coherence

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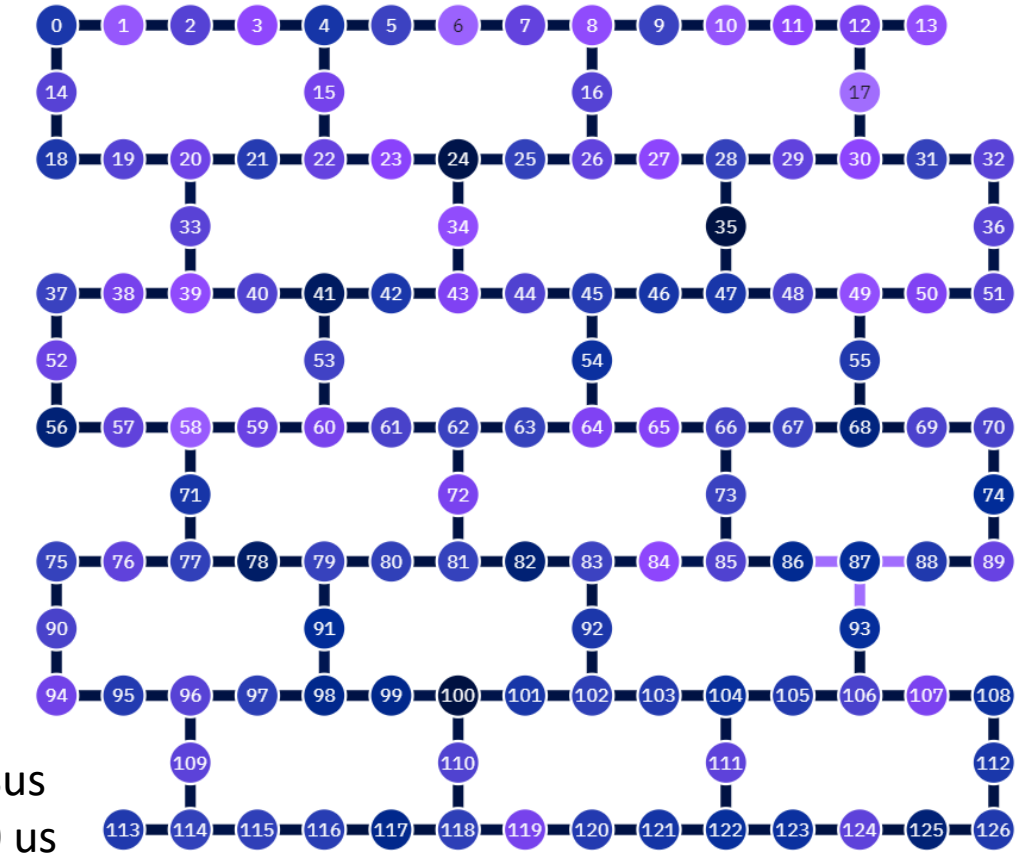
Impact of design on coherence time

- We achieved $T_1 \sim 30\mu s$ (EPR)
  - Good result, but it can be improved further.
- Improving T_1 may be impactful for two reasons:
  1. Increasing gate fidelity.
  2. Better chances to measure a photon multiple times through QND (e.g. Schuster's scheme).
- Some improvement should be achievable by optimizing the qubit layout.

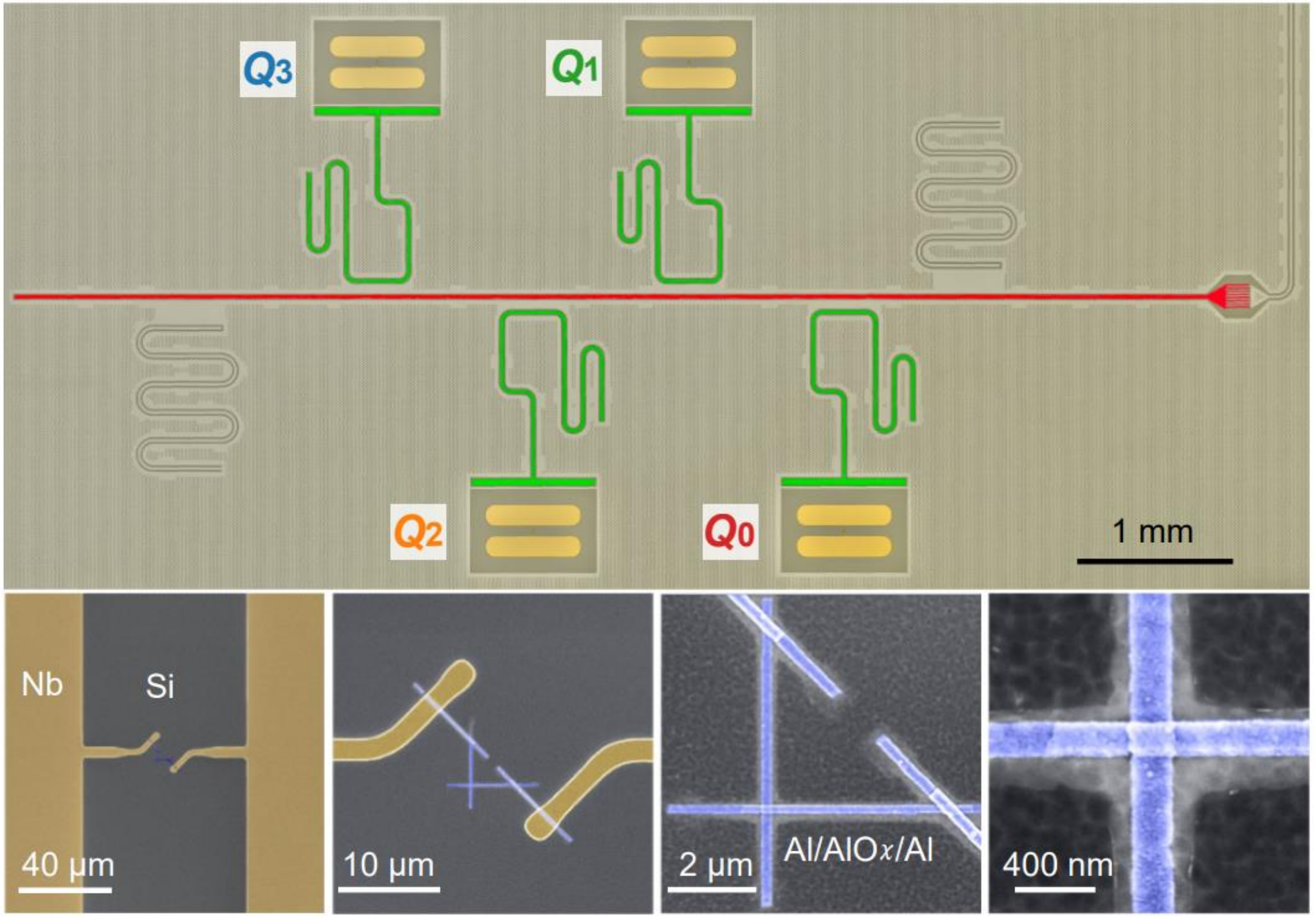


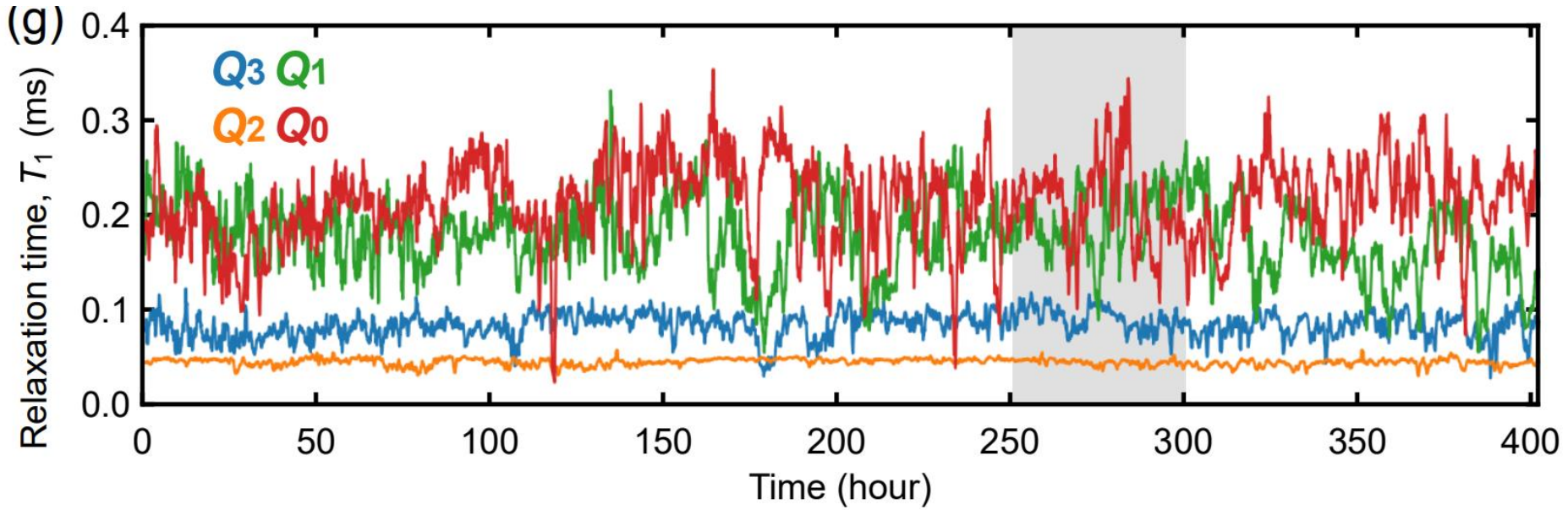
IBM Eagle r3
Median T1: 228us
Median T2: 130 us

EPFL qubits

- Floating.
- Res. Driven.
- Purcell filters.
- Nb on high res. Si.
- Al/AlOx/Al jj.

https://doi.org/10.48550/arXiv.2305.02591 (Kono et al.)





Parameter	Q_0	Q_1	Q_2	Q_3
Qubit frequency, $\omega_q/2\pi$ (GHz)	4.794064 ± 8e-6	5.20603 ± 20e-6	5.721 ± 100e-6	6.23127 ± 30e-6
Anharmonicity, $\alpha/2\pi$ (GHz)	0.272	0.266	0.263	0.250
Relaxation time, T_1 (ms)	0.21 ± 0.06	0.18 ± 0.05	0.04 ± 0.005	0.08 ± 0.02
Ramsay dephasing time, T_{2*} (ms)	0.1 ± 0.05	0.06 ± 0.03	0.02 ± 0.01	0.06 ± 0.03
Echo depfasing time, T_{2e} (ms)	0.29 ± 0.09	0.22 ± 0.07	0.08 ± 0.01	0.08 ± 0.03
Simulated purcell limit (ms)	127	35	26	0.2
Resonator frequency, $\omega_r/2\pi$ (GHz)	7.07605	6.97984	6.885998	6.797376
External coupling rate, $\kappa_{ex}/2\pi$ (MHz)	1.85	1.06	0.102	0.52
Internal loss rate, $\kappa_{in}/2\pi$ (MHz)	0.11	< 0.01	0.02	0.01
Dispersive shift for E, $\chi_{GE}/2\pi$ (MHz)	0.65	0.95	1.7	6.6
Dispersive shift for F, $\chi_{GF}/2\pi$ (MHz)	1.04	1.55	-	-

KQCircuits design software

- Built as an extension of Klayout.
- Allows exports to Ansys, Elmer, Sonnet.
- Excellent waveguide management wrt Qiskit Metal.
- Easy to build custom elements.