The Impact of Ionizing Radiation on Qubits

Antti P. Vespalainen, Amir H. Karamlou, John L. Orrell, Akshunna S. Dogra, Ben Loer, Francisca Vasconcelos, David K. Kim, Alexander J. Melville, Bethany M. Niedzielski, Jonilyn L. Yoder, Simon Gustavsson, Joseph A. Formaggio, Brent A. VanDevender and William D. Oliver

A joint collaboration between

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We have measured the impact of ionizing radiation on qubit coherence times.

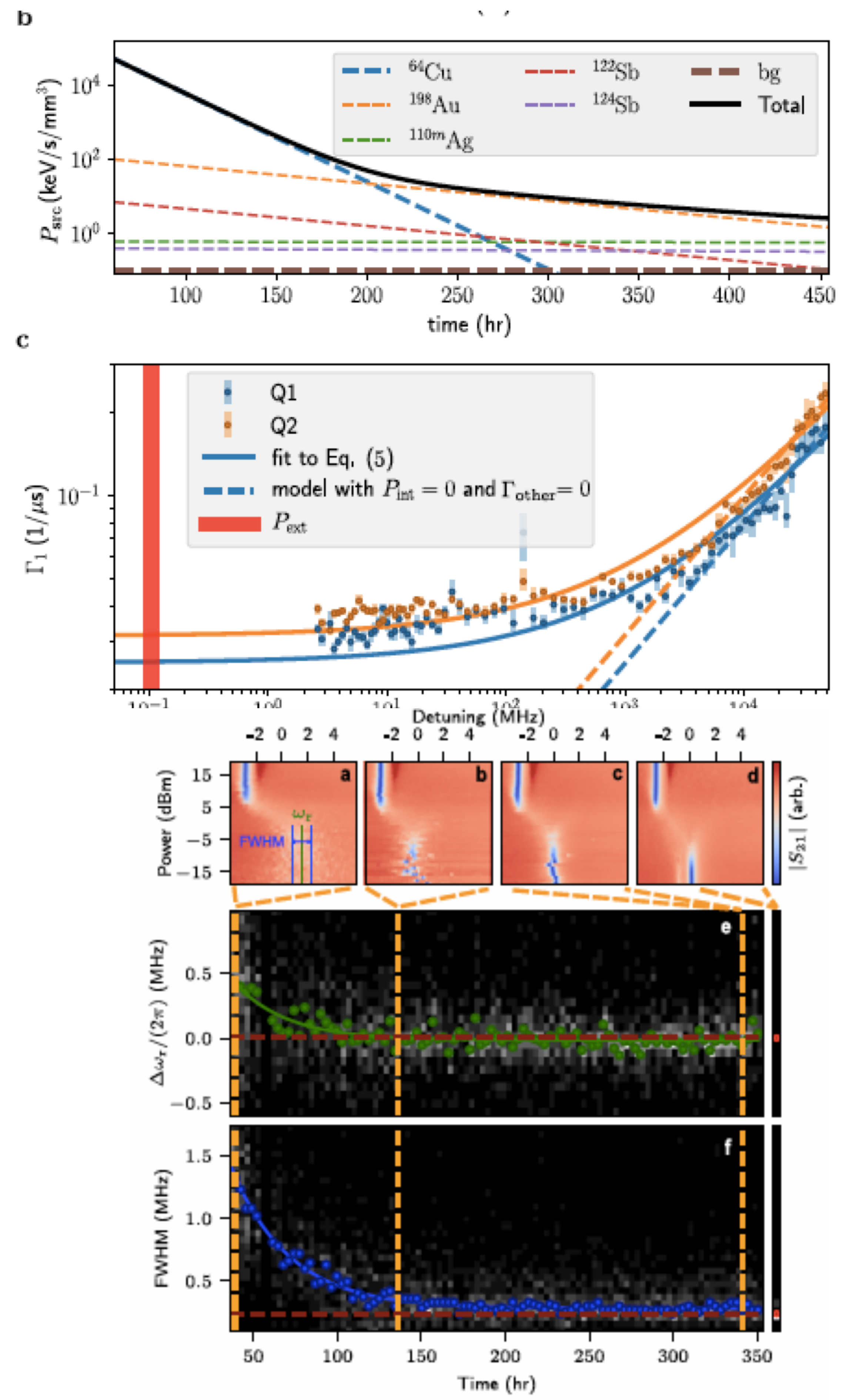
Environmental radioactivity will poison qubit performance at the few millisecond level, unless mitigating measures are taken.

Calibration Results

Because the lifetime of the ^{64}Cu is known, we can map incident radioactivity (power) as a function of time (top figure).

We measure a strong correlation between coherence time on qubits and incident power/ time evolution (middle figure).

Other metrics also show strong correlations with the decay time of the ^{64}Cu source, such as the qubit resonator frequency and width, consistent with a quasiparticle recombination model.



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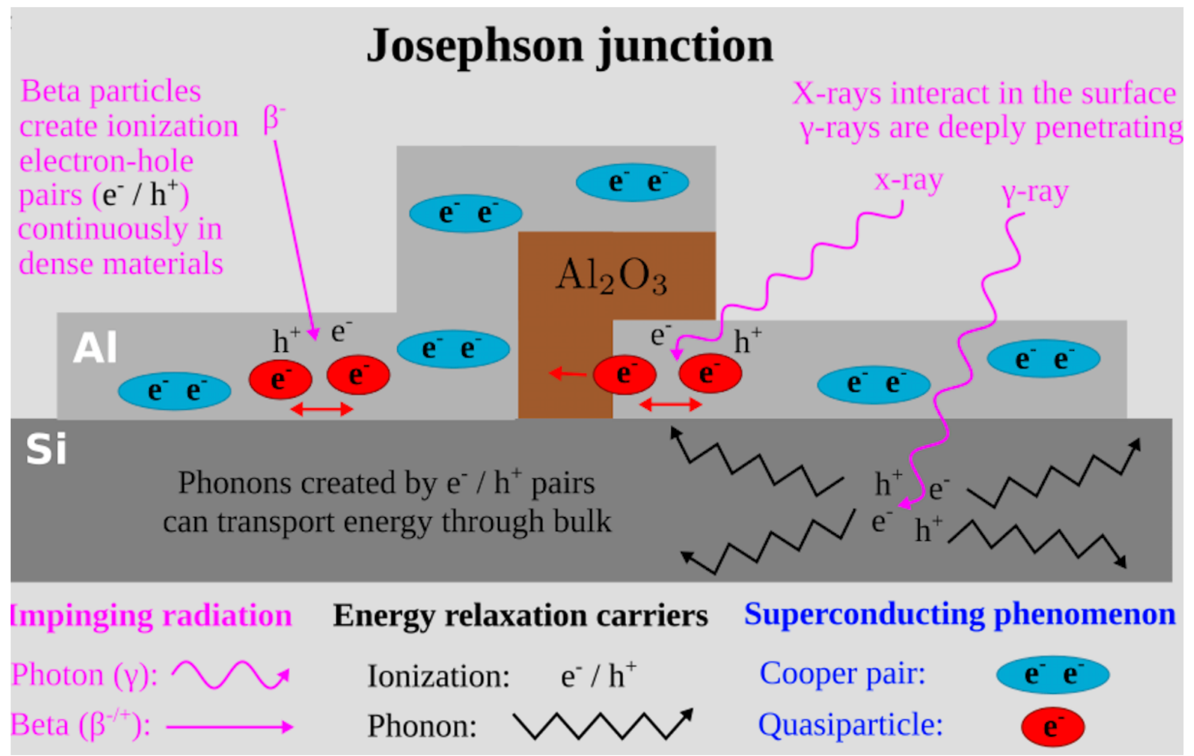
Hypothesis

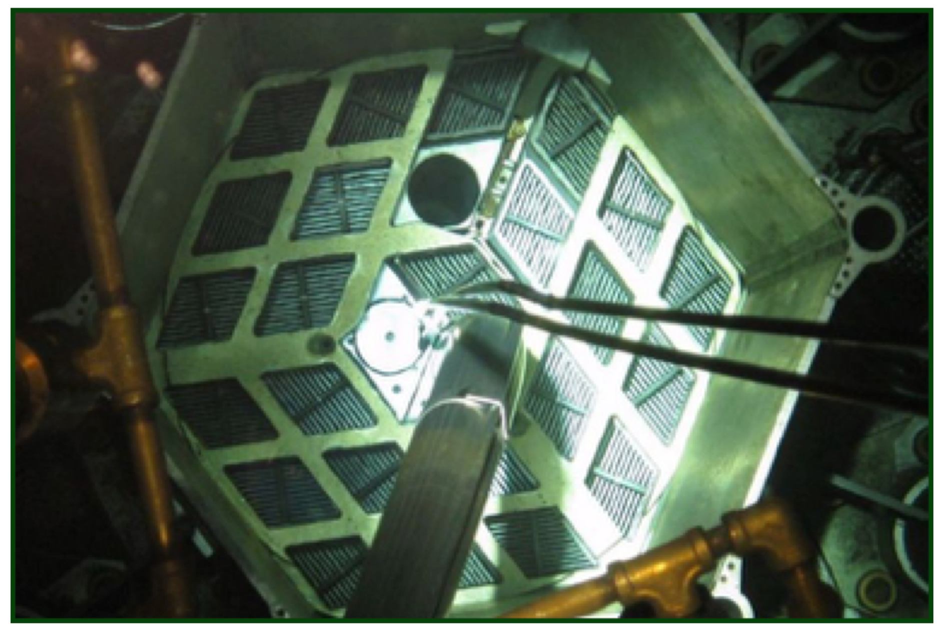


We wish to test whether background radioactivity poisons the performance of qubits.

Radioactivity from the concrete (U, Th, K), fridge components and cosmic rays (μ) could all contribute.

We can test this hypothesis by first calibrating the impacts of a radioactive source on qubit lifetimes, and then shielding from environmental effects.

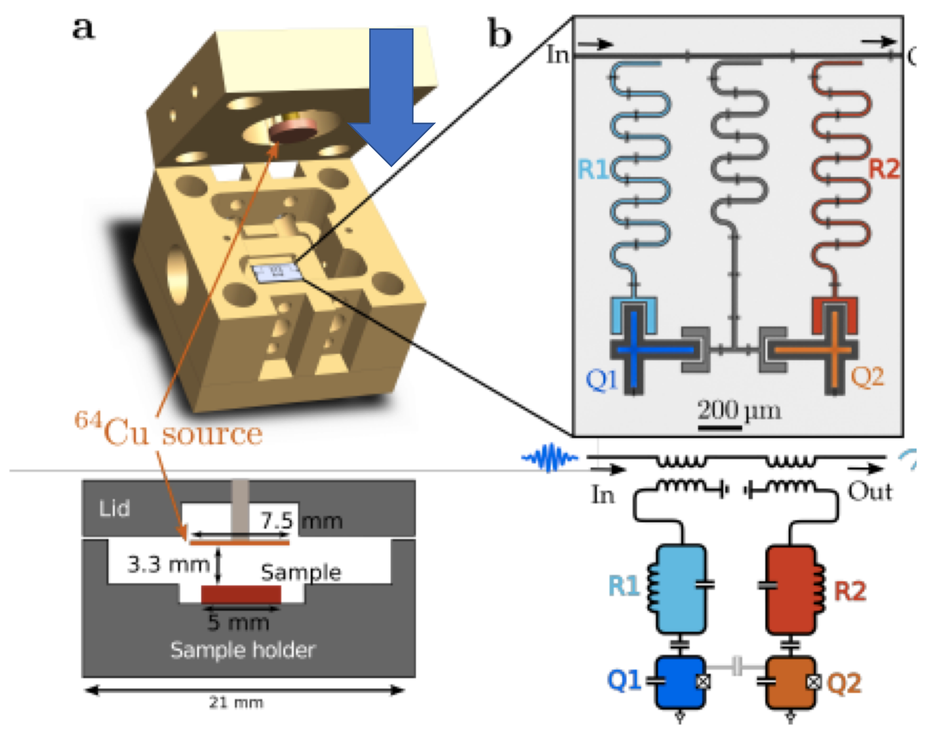
Experimental Setup



^{64}Cu production within MIT research reactor.

We use **^{64}Cu** (12.7 hour half-life **$\beta^{+/-}$** emitter) to introduce radioactivity on two superconducting qubits (fig a & b).

Produced at the MITR, can observe coherence time over many lifetimes of the source.



Shielding Results

Finally, we can remove incident radiation from the surroundings by installing a movable lead shield which surrounds the qubits.

Shield is raised and lowered in repeatable cycle to to measure impact on coherence time.

Radiation becomes a dominant factor for coherence times greater than 4 ms.