Quantum AI

Modeling TLS scrambling due to radiation impacts

Eric Mascot
Alex Bilmes, Max Schaefer, Jenna Bovaird, Kevin C Miao,
Alex Opremcak, Noah Kurinsky
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Google

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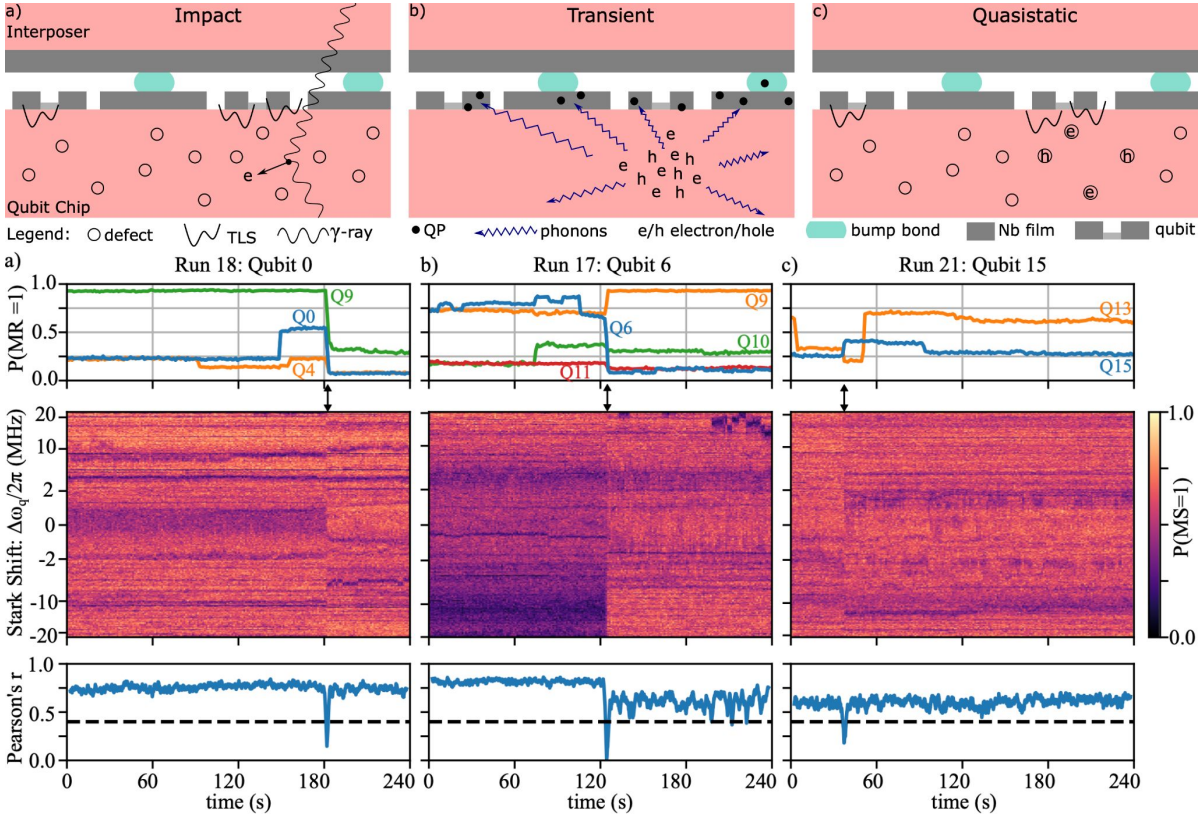
Motivation

EM simulations

G4 simulations

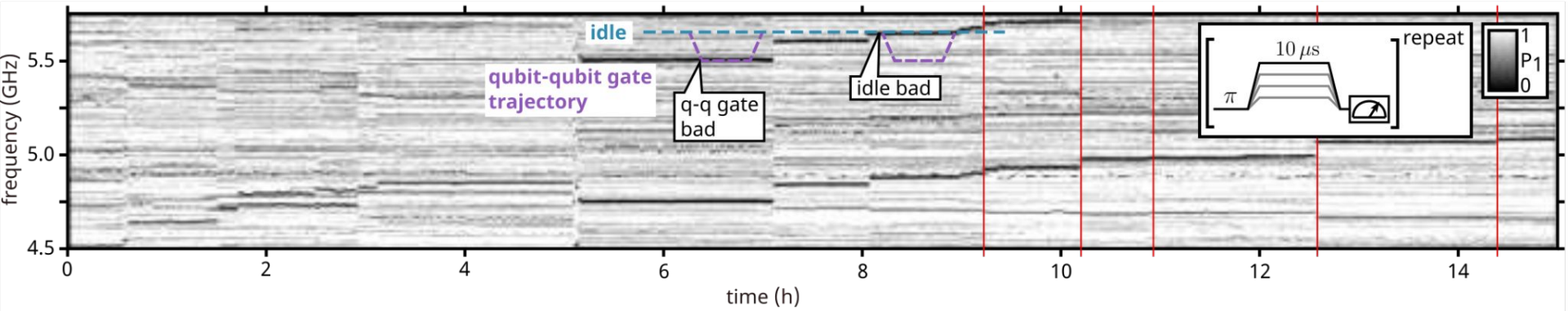
Results

What is TLS scrambling?

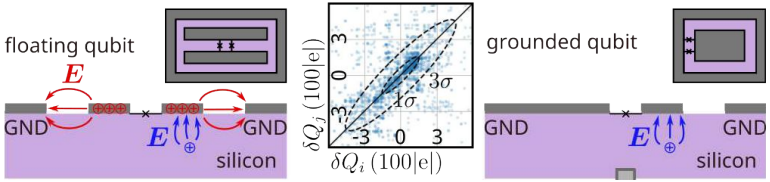


Thorbeck et al. PRX Quantum **4**, 020356 (2023)

Why do we want to mitigate TLS scrambling?



TLS spectroscopy

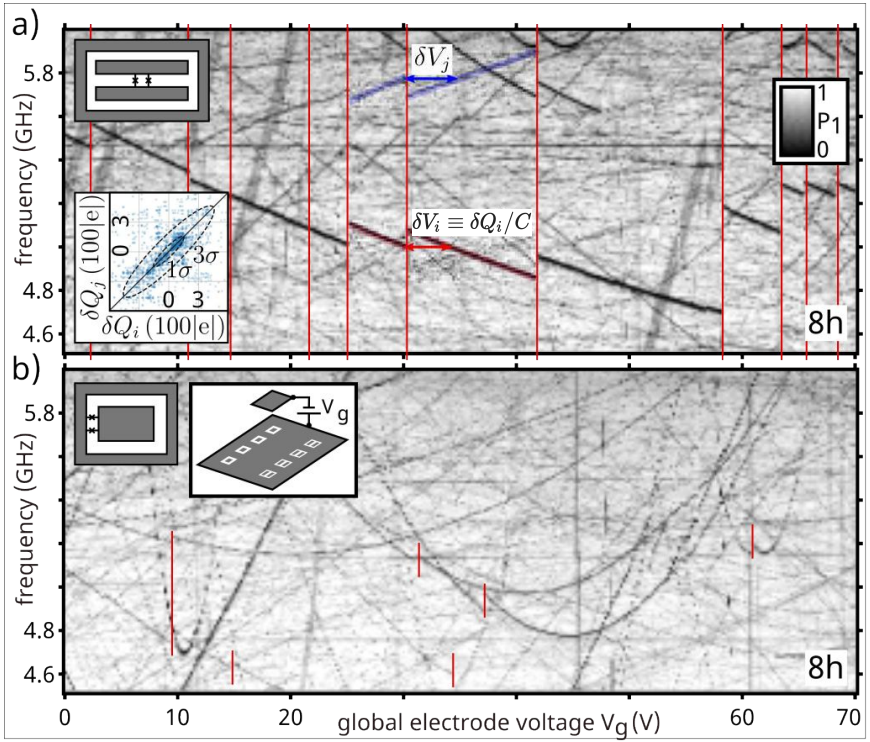


$$\omega_{\mathrm{TLS}} = \sqrt{\Delta_i^2 + (\varepsilon_i + 2\boldsymbol{p}_i \cdot \boldsymbol{E})^2}$$

TLS frequency can be tuned using a global DC electrode

Scrambling events show correlated jumps

Scrambling events are rare for grounded qubits



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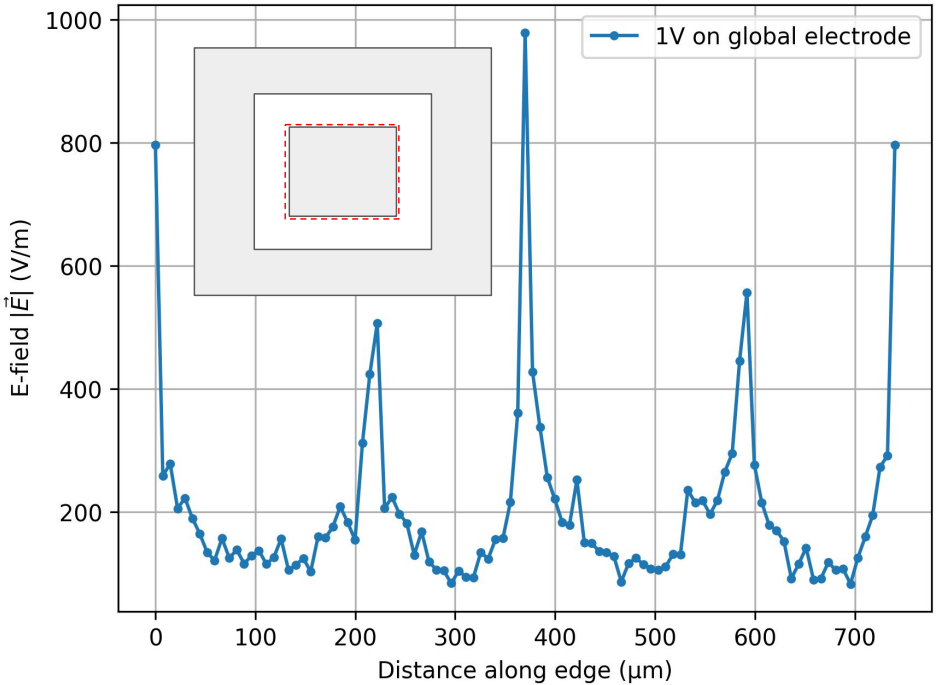
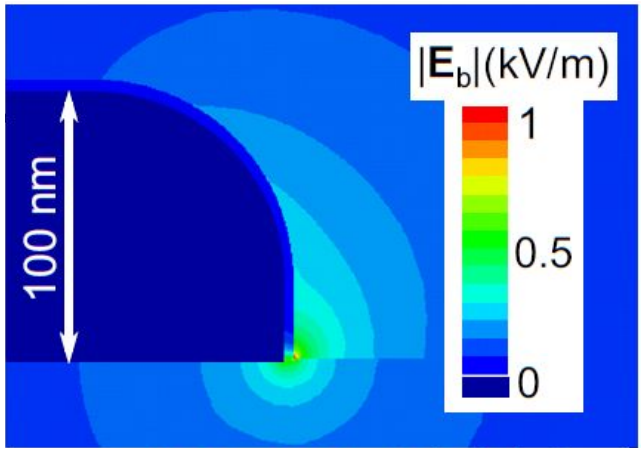
Ansys simulation of E-field from global electrode



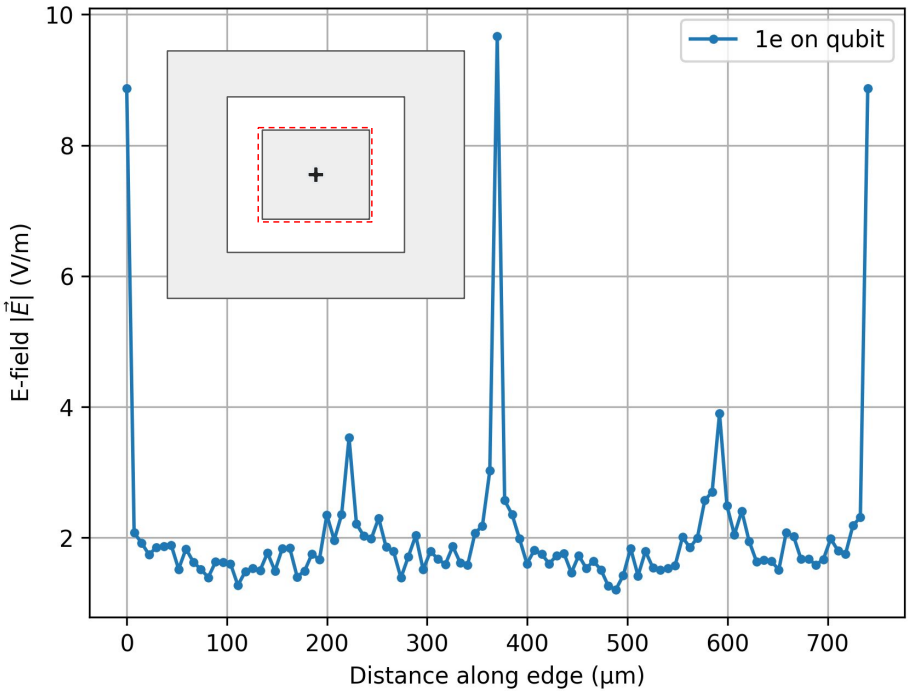


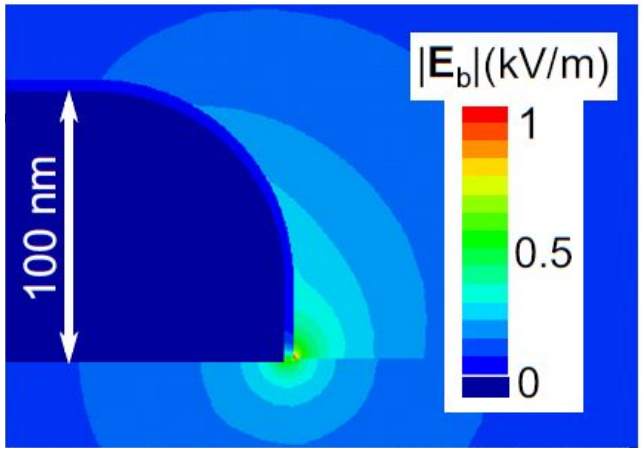
Bilmes et al. Scientific Reports **10**, 3090 (2020)

The strongest fields are at the edge of the qubit near the qubit-substrate interface

We will focus on surface TLS at this edge

Ansys simulation of E-field from charged qubit



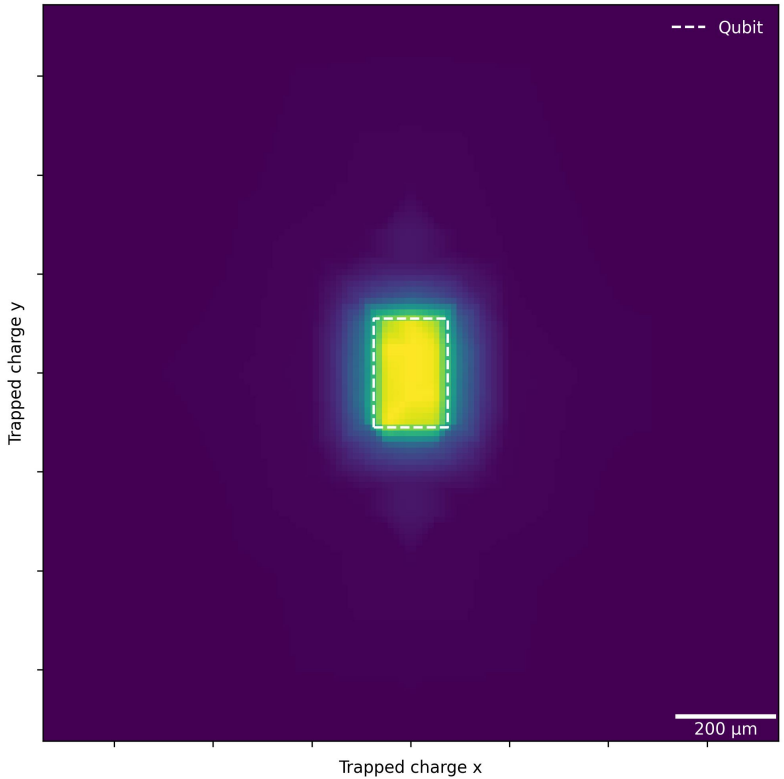


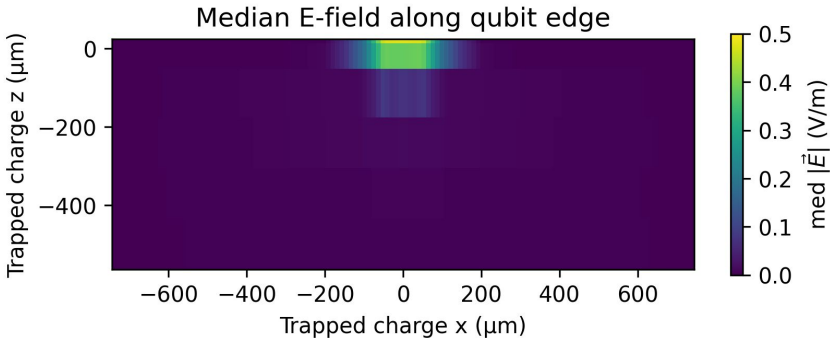
Bilmes et al. Scientific Reports **10**, 3090 (2020)

The strongest fields are at the edge of the qubit near the qubit-substrate interface

We will focus on surface TLS at this edge

Ansys simulation of E-field from trapped substrate charge





Fields from trapped charges in the substrate are local

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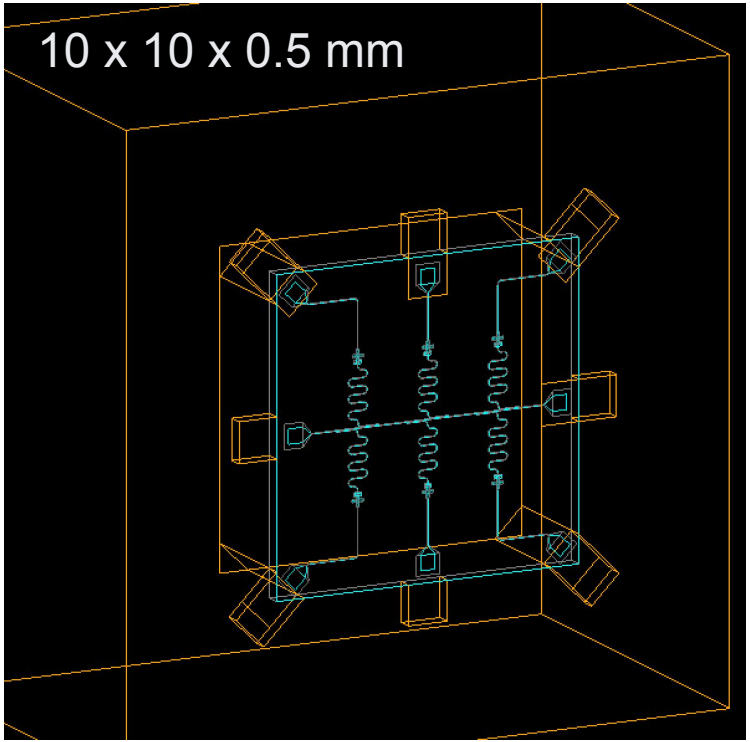

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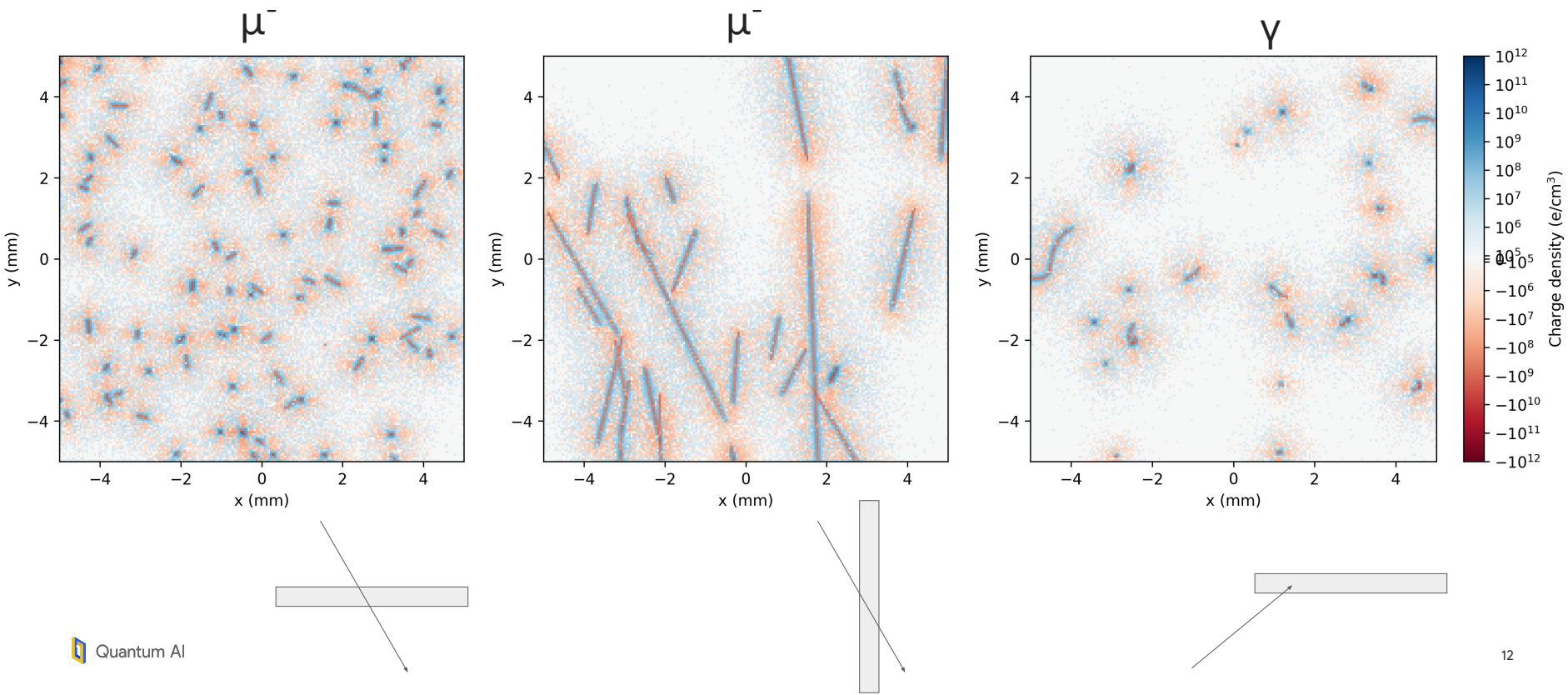
https://github.com/G4CMP/G4CMP/tree/feature/RISQTutorialExample/examples/RISQTutorial

Charge density of trapped electrons and holes



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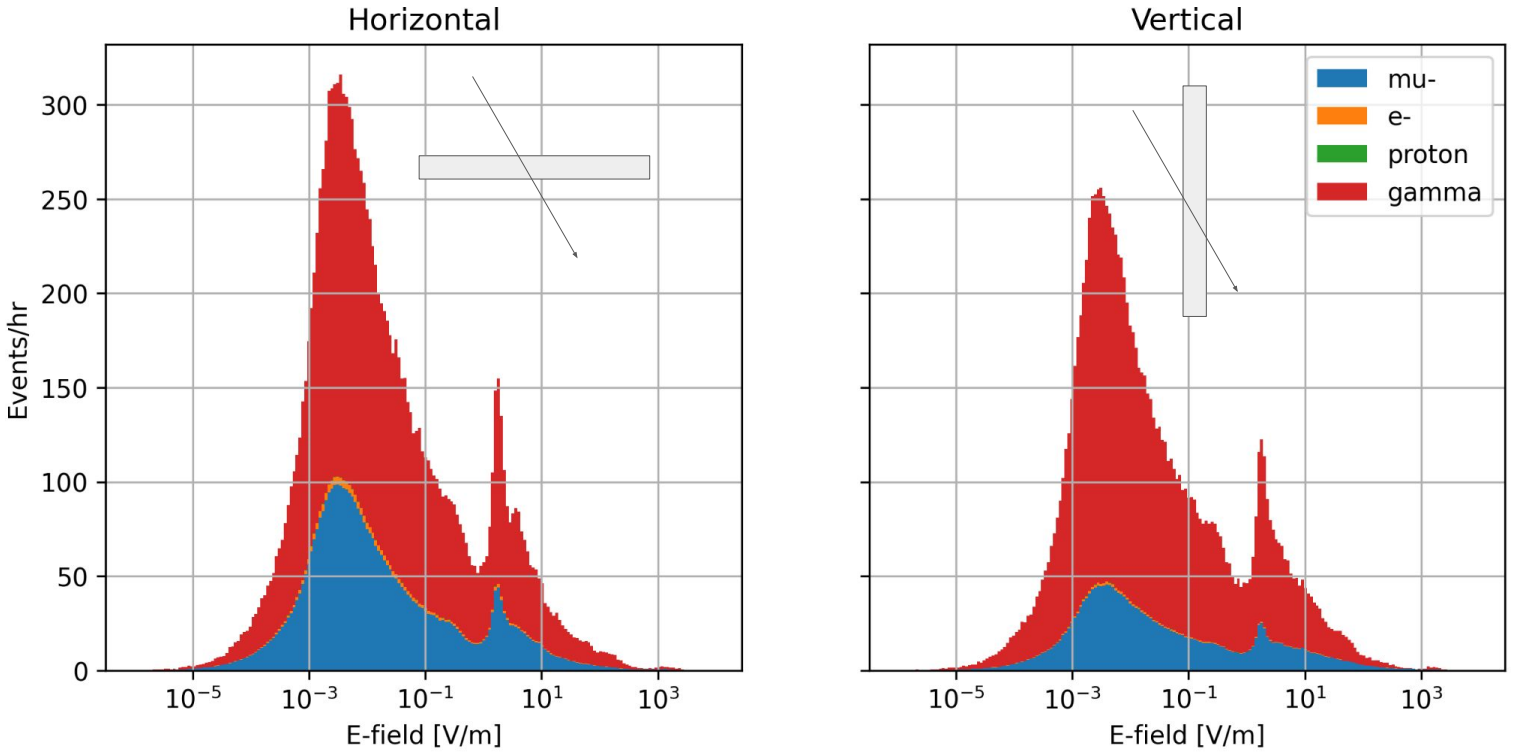
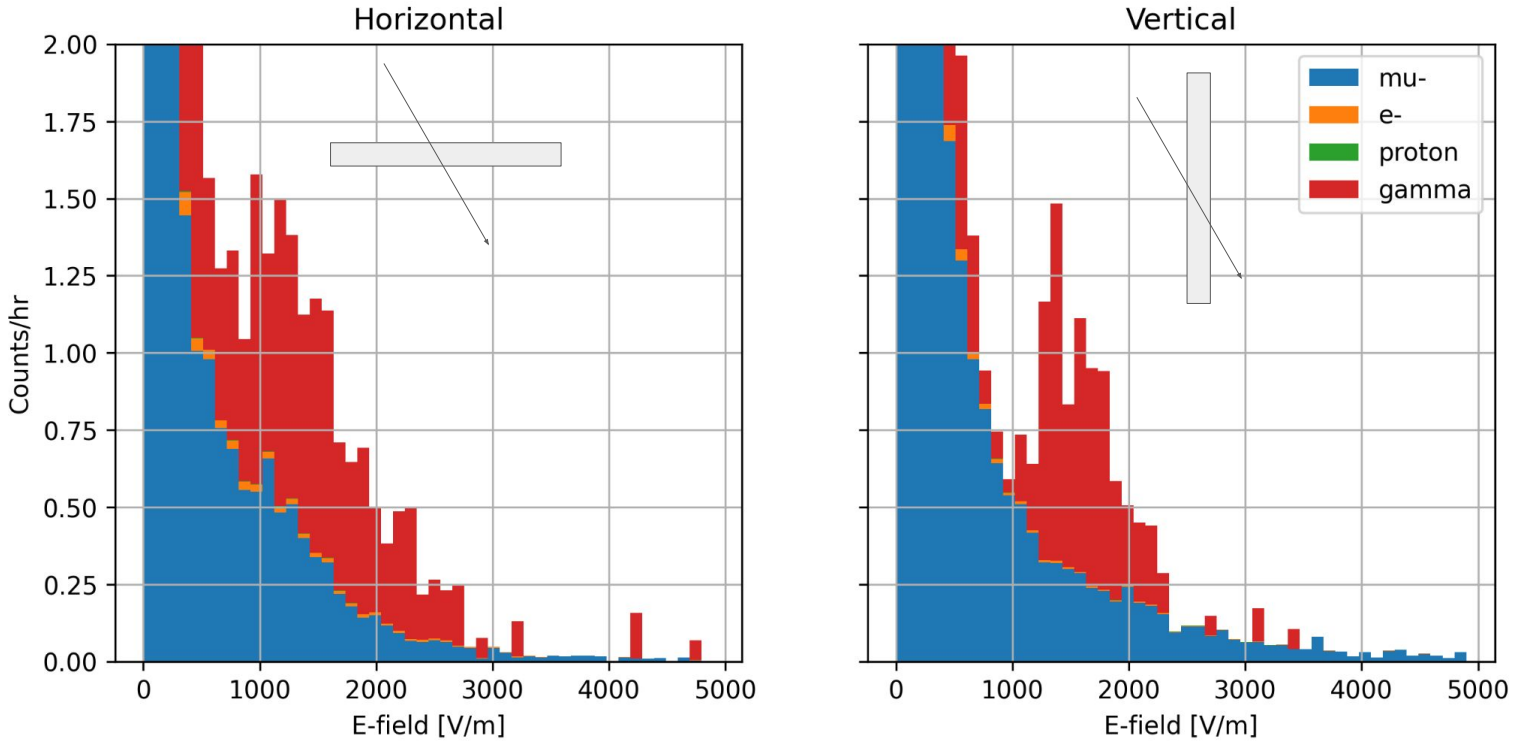
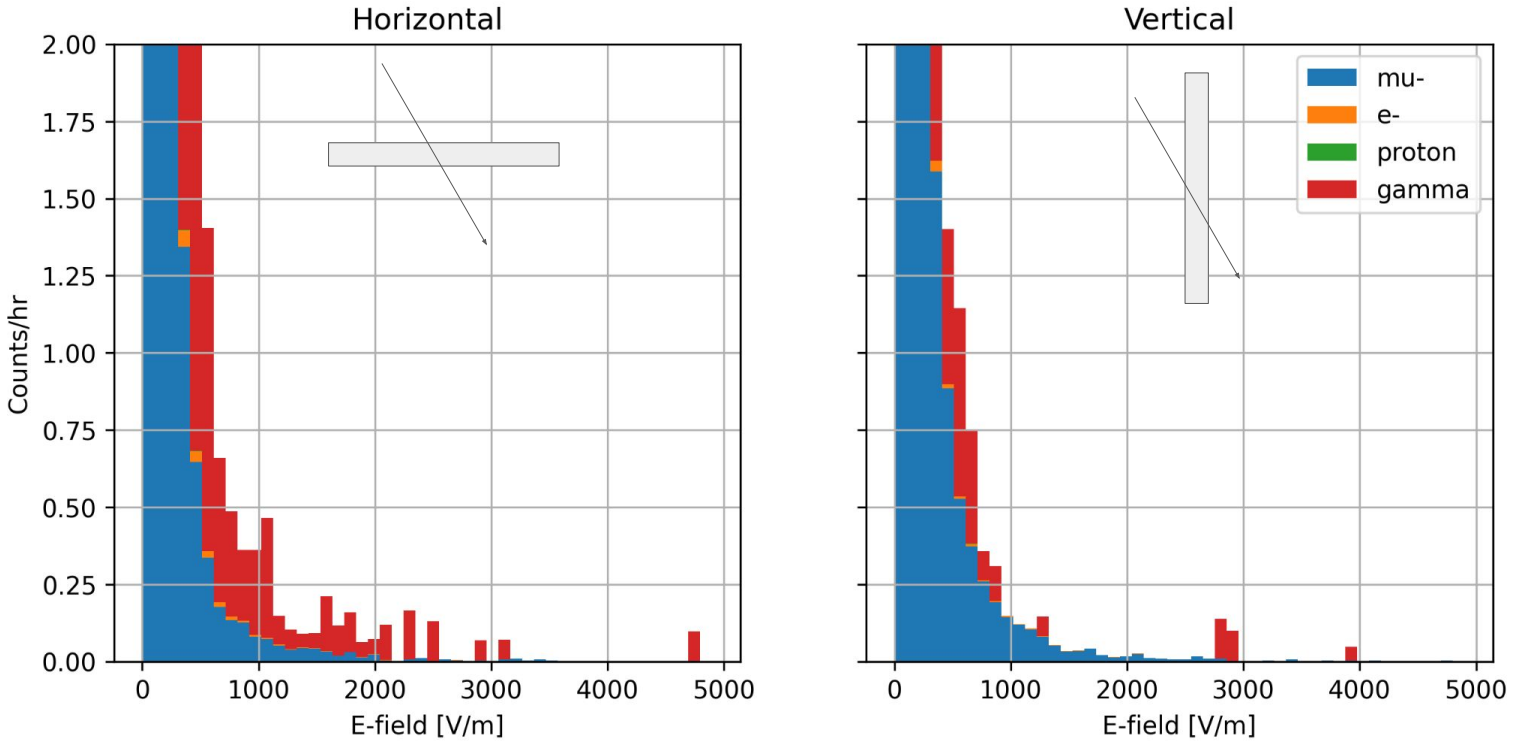
E-field jump distribution for floating qubit



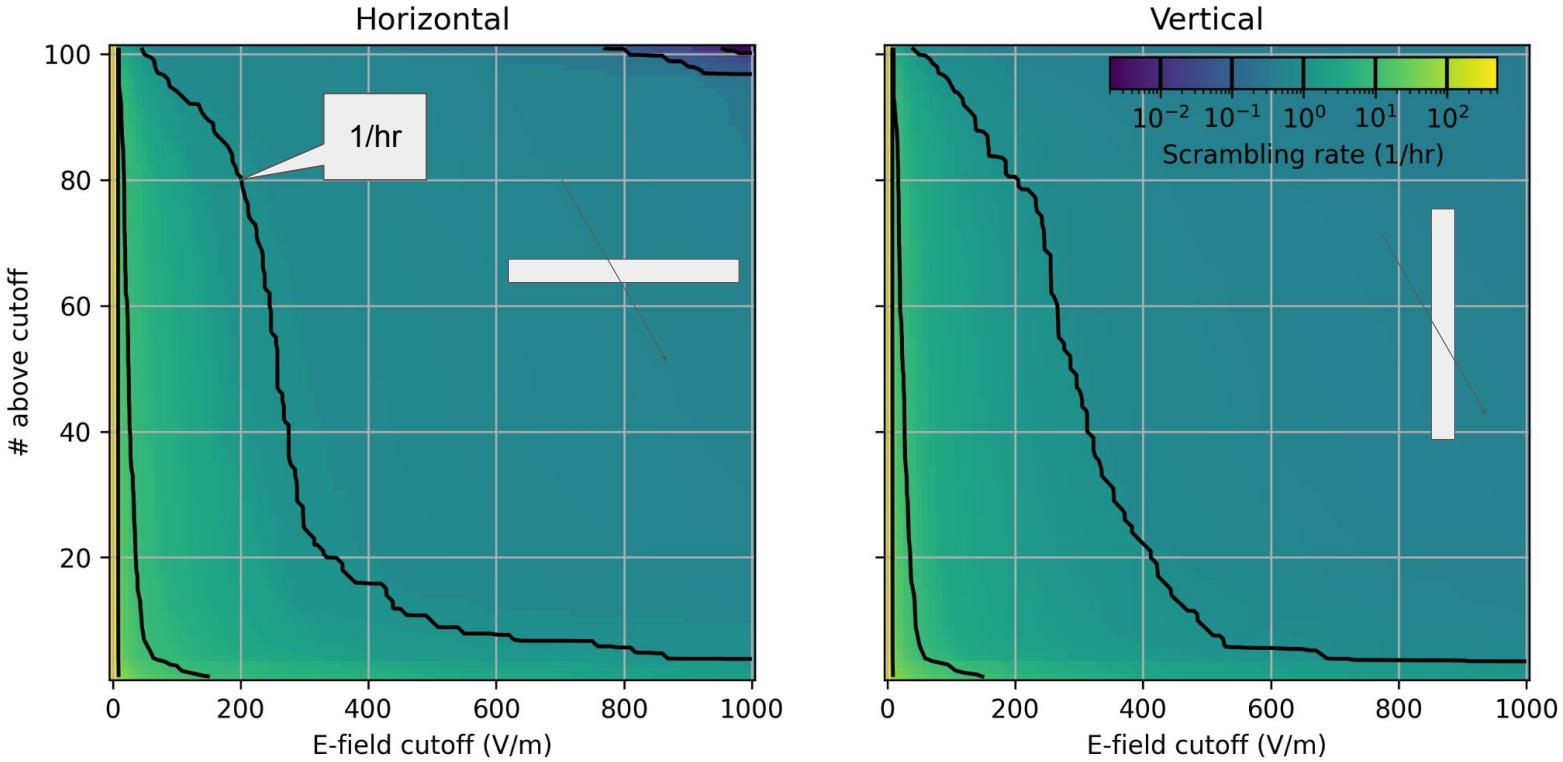
E-field jump distribution for floating qubit



E-field jump distribution for grounded qubit



Scrambling rate



Thank you!

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