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Tunnel coupling characterization between quantum dots and donor-like transitions in silicon

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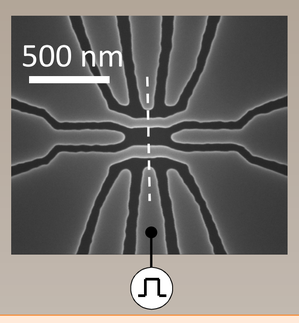
Introduction

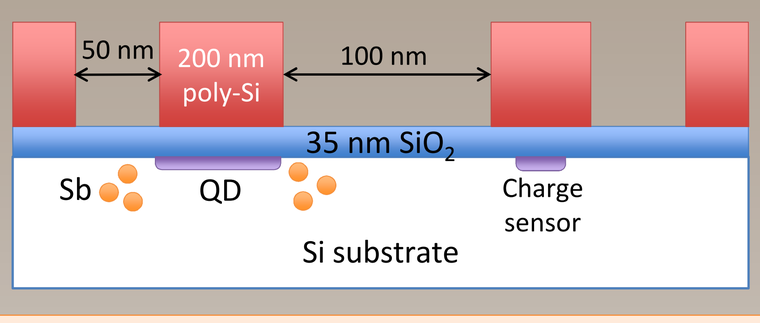
The goal of this project is to characterize electron tunnel rates between a gate-defined quantum dot (QD) and donors in silicon using remote sensing and fast electrical pulses. Here we present preliminary results of pulsing across a charge conserving transition.

Experiment

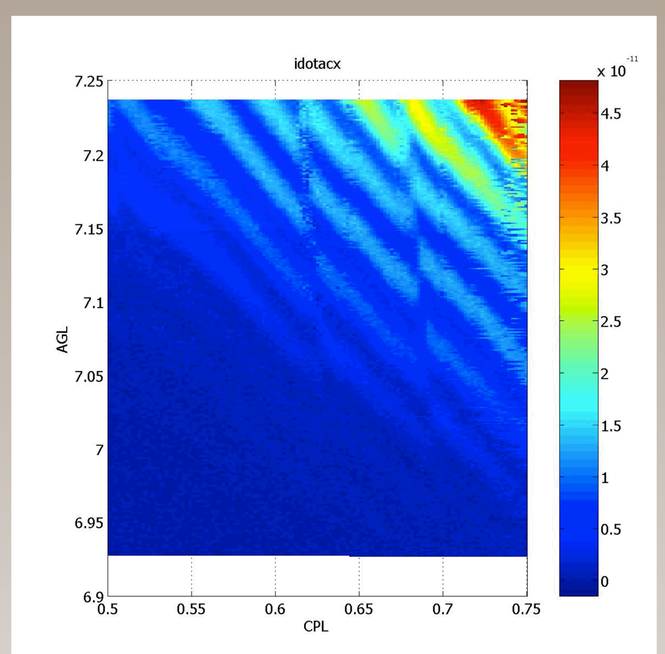
SEM



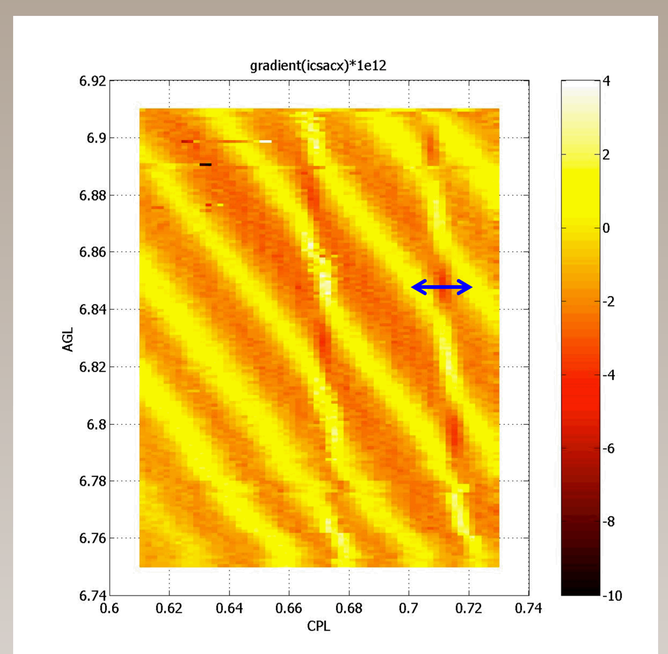
Cross-sectional schematic



Transport through dot



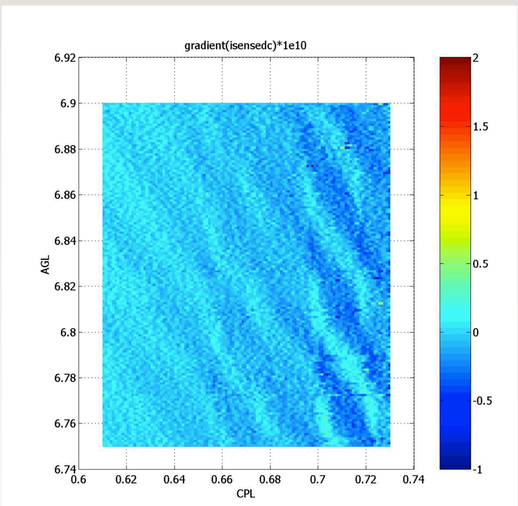
Charge sensing



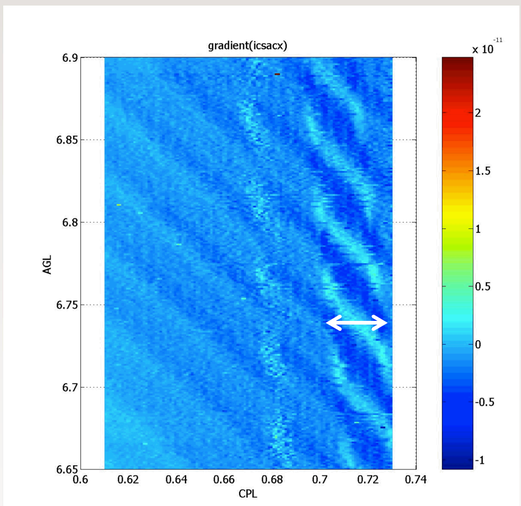
- Si-MOS gated wire design
- Sb implants on both sides of lower wire
- Upper wire used as charge sensor
- Charge offsets seen in transport through dot correlate well with charge conserving transitions observed using remote sensing

Results/Discussion

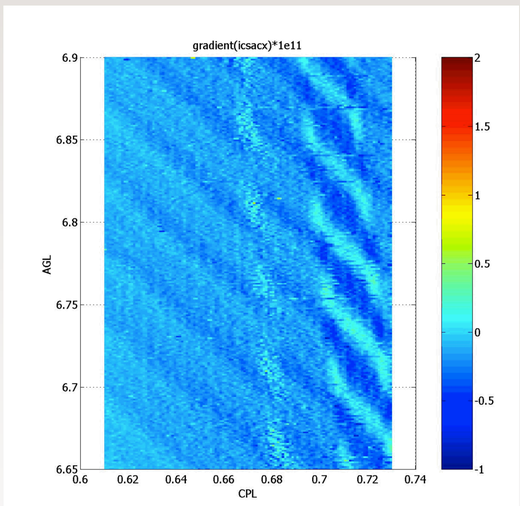
f = 100 Hz



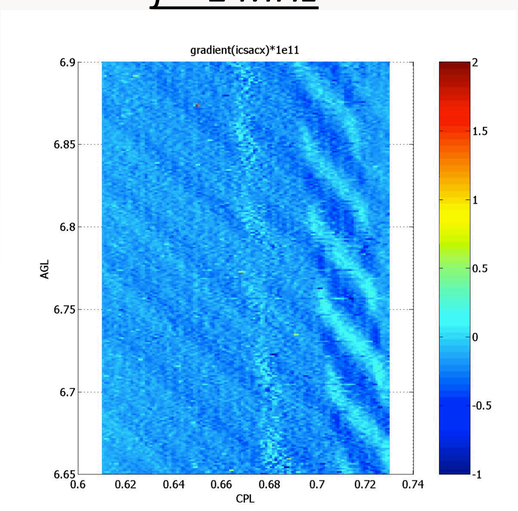
f = 10 kHz



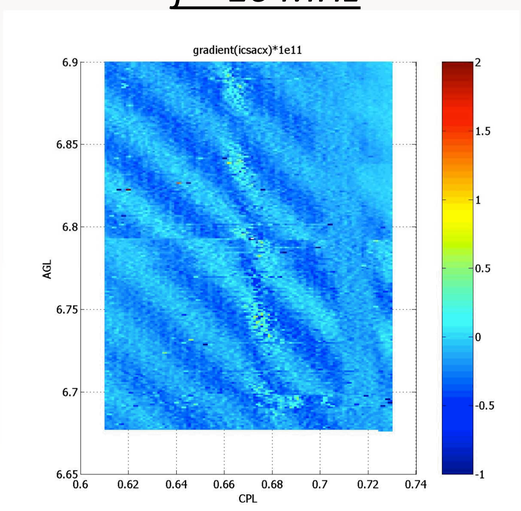
f = 100 kHz



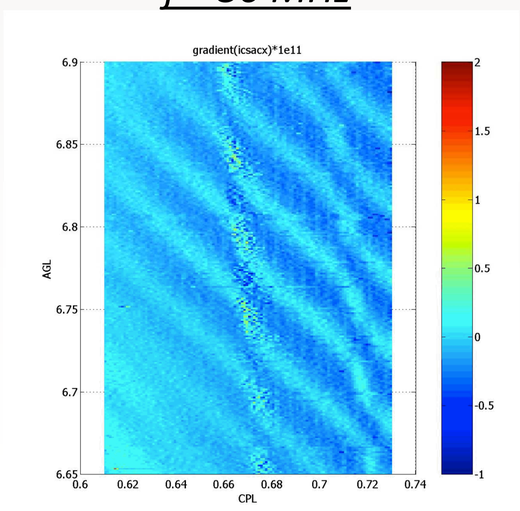
f = 1 MHz



f = 10 MHz



f = 30 MHz



- 20 mVpp square wave applied to lower center plunger
- Doubling of transition lines is observed for one transition up to 1 MHz
- The other transition shows doubling at lower frequencies on the order of 100 Hz

Future Work

- Donor-QD tunnel rate dependence on QD tuning
- Excited state spectroscopy of donor-QD transition
- Energy and rate dependence of pulsing on tunnel coupling

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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