Investigation of optimal operating point for hole spin qubit

Marion BASSI
V. Schmitt[1], E. Rodriguez Mena[2], B. Brun-Barrière[1], J. C. Abadillo-Uriel[2], S. Zihlmann[1], B. Bertrand[3], H. Niebojewski[3], M. Vinet[3], R. Maurand[1], Y.-M. Niquet[2], X. Jehl[1], S. De Franceschi[1]

1-Univ. Grenoble Alpes, CEA, Grenoble INP, IRIG-Pheliqs, Grenoble, France. 2-Univ. Grenoble Alpes, CEA, IRIG-MEM-L Sim, Grenoble, France. 3-Univ. Grenoble Alpes, CEA, LETI, Minatec Campus, Grenoble, France.

CEA Grenoble (17 Avenue des Martyrs 38000 GRENOBLE France)

marion.bassi@cea.fr

In the scope of building quantum processors, enhancing quantum bit operation speed and coherence time is of crucial interest.

Hole spin qubits in semiconductors have emerged as a promising candidate thanks to the possibility to perform electrically-driven spin control via their intrinsic spin-orbit interaction. [1] When a spin qubit is coupled to an electrical field, however, it is inherently sensitive to charge noise. A recent experimental study demonstrated the evidence of operational sweet spots minimizing the impact of charge noise and leading to an enhanced hole-spin coherence time [2]. Based on theoretical calculations, it should be possible to find sweet spots where qubit coherence and qubit driving speed are simultaneously maximized, resulting in a regime of so-called reciprocal sweetness [3].

Here we present a first experimental study addressing this possibility in a Si-MOS device made in a foundry-compatible fabrication platform. For a single hole spin, we first measure the angular dependence of the longitudinal spin-electric susceptibility (LSES), which measures the sensitivity to charge noise. We find the existence of sweet line of zero LSES as theoretically predicted [3]. We then investigate the correlation between this angular dependence and that of the qubit Rabi frequency.

References

[1] Bosco et al. PRX Quantum (2021)
[2] Piot et al. Nat. Nano. (2022)
[3] Michal et al. arXiV. (2022)

Figures

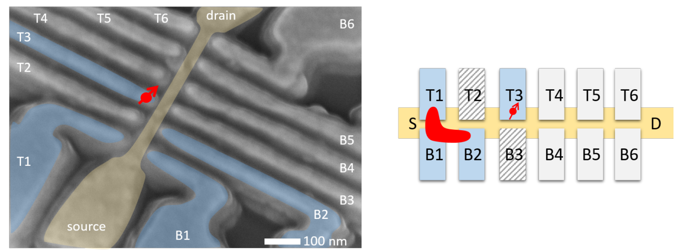

Figure 1: Left panel: false-coloured SEM picture of Si-MOS device showing the silicon nanowire (yellow), and the 6 split-gates on top. Light-blue gates indicate that there are accumulated with charges. The hole spin qubit lies below gate T3. Right panel is a simplified cartoon of the device with corresponding colours. Additionally, red shape illustrates the charge reservoir used for single-shot spin readout.

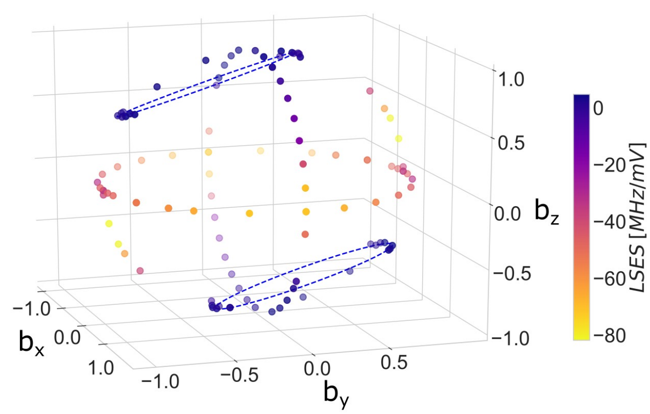

Figure 2: Longitudinal Spin Electric Susceptibility (LSES) as a function of magnetic-field orientation. Purple points correspond to LSES~0 MHz/mV, highlighting insensitivity to charge noise.