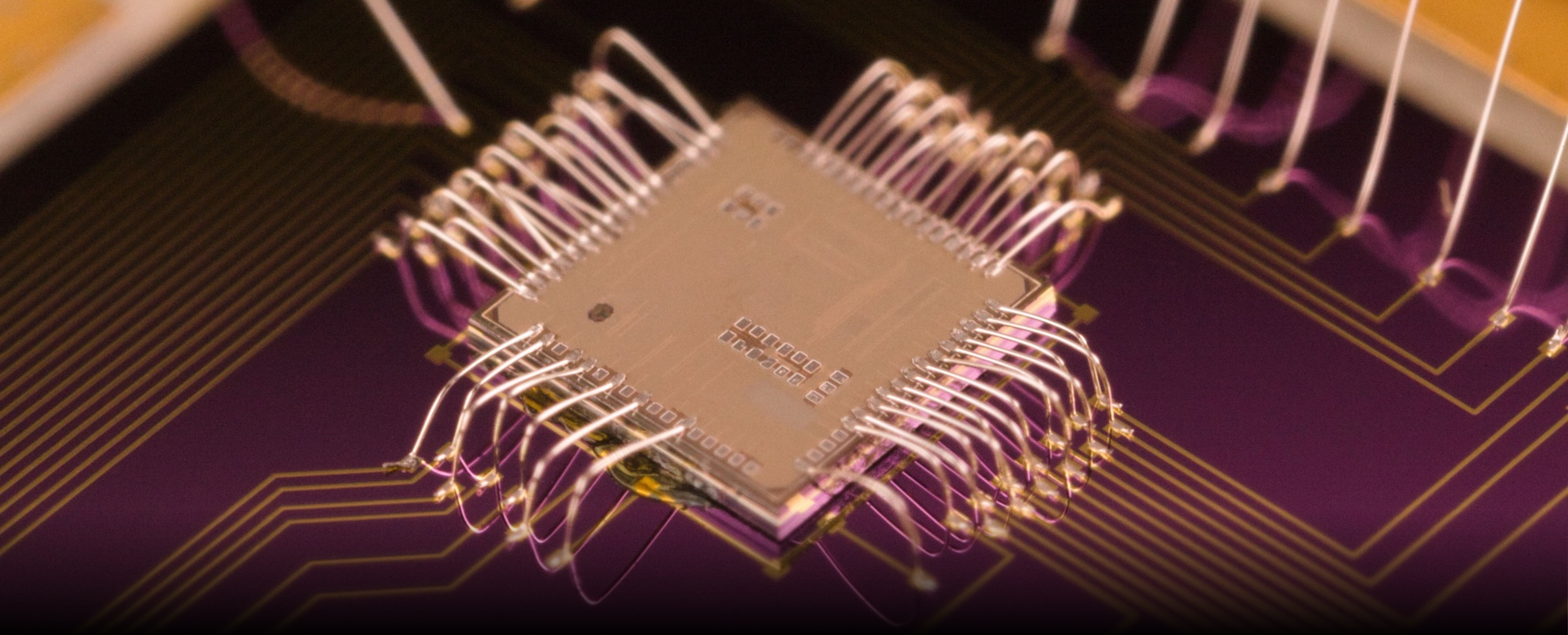


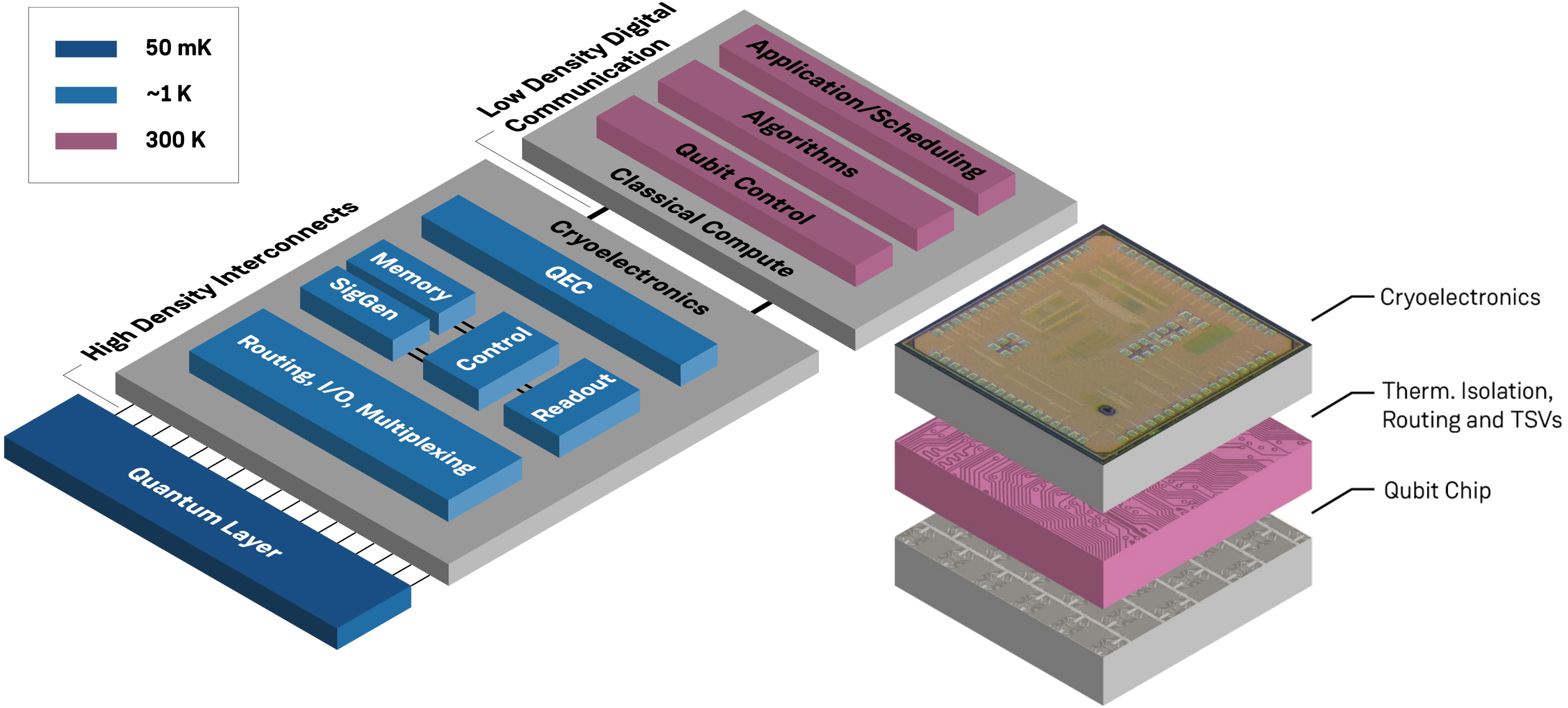
Qubit bias using a CMOS DAC at mK temperatures

<u>Rene Otten</u>, Lea Schreckenberg, Patrick Vliex, Julian Ritzmann, Arne Ludwig, Andreas D. Wieck & Hendrik Bluhm

QuTech Quantum Technology Group RWTH AACHEN UNIVERSITY JÜLICH Forschungszentrum

C5L-C

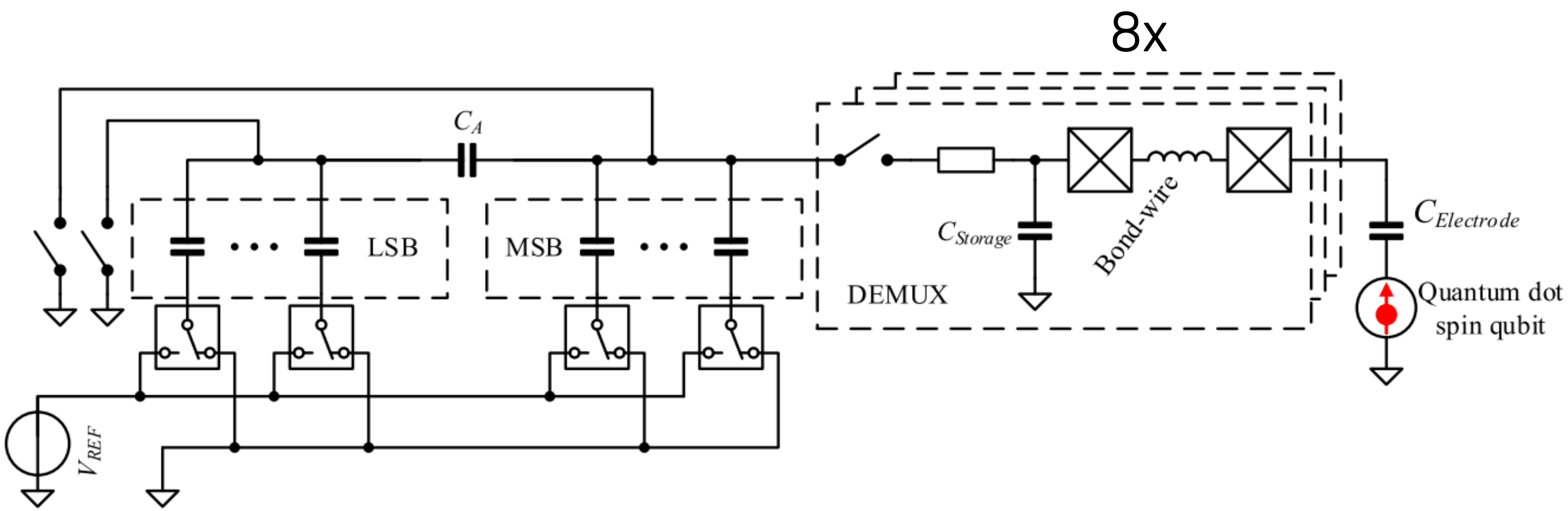
Introduction



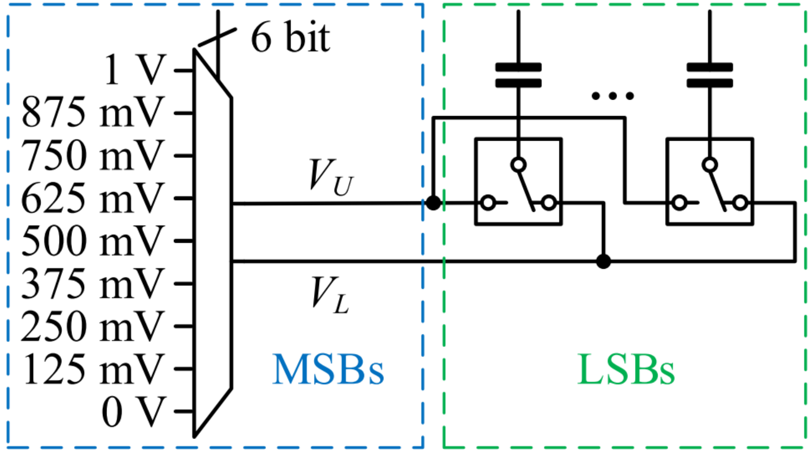
Fully Autonomous DC Bias-DAC Operating at <50mK

See also
Pauka, S.J., Das, K., Kalra, R. et al. Nat Electron (2021)
Xue, X., Patra, B., van Dijk, J.P.G. et al. Nature (2021)

DAC Architecture & Design Considerations

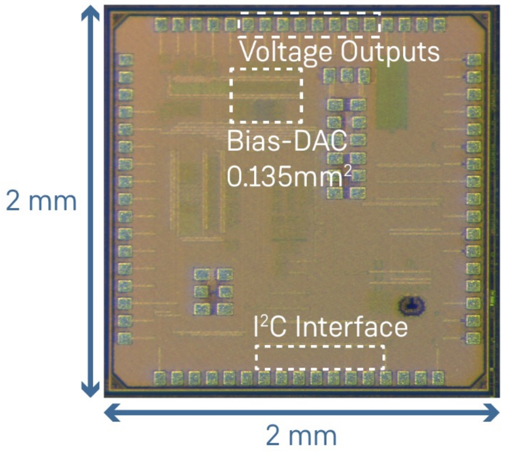


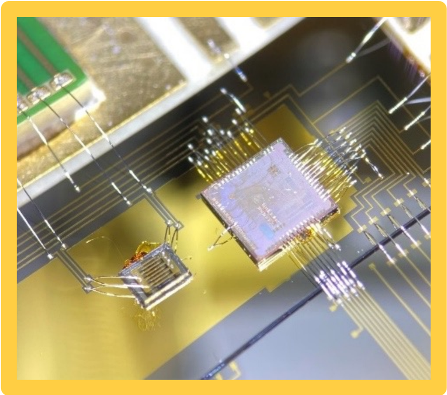
Process	65 nm CMOS
Resolution	13 bit
Range	0 – 1 V
Power Consumption	< 400 µW

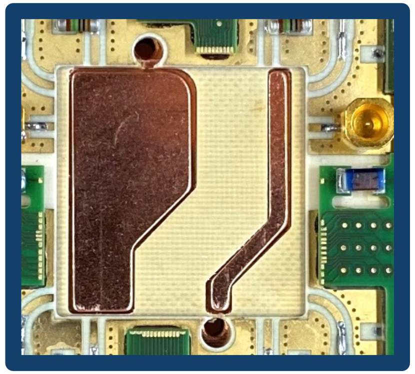


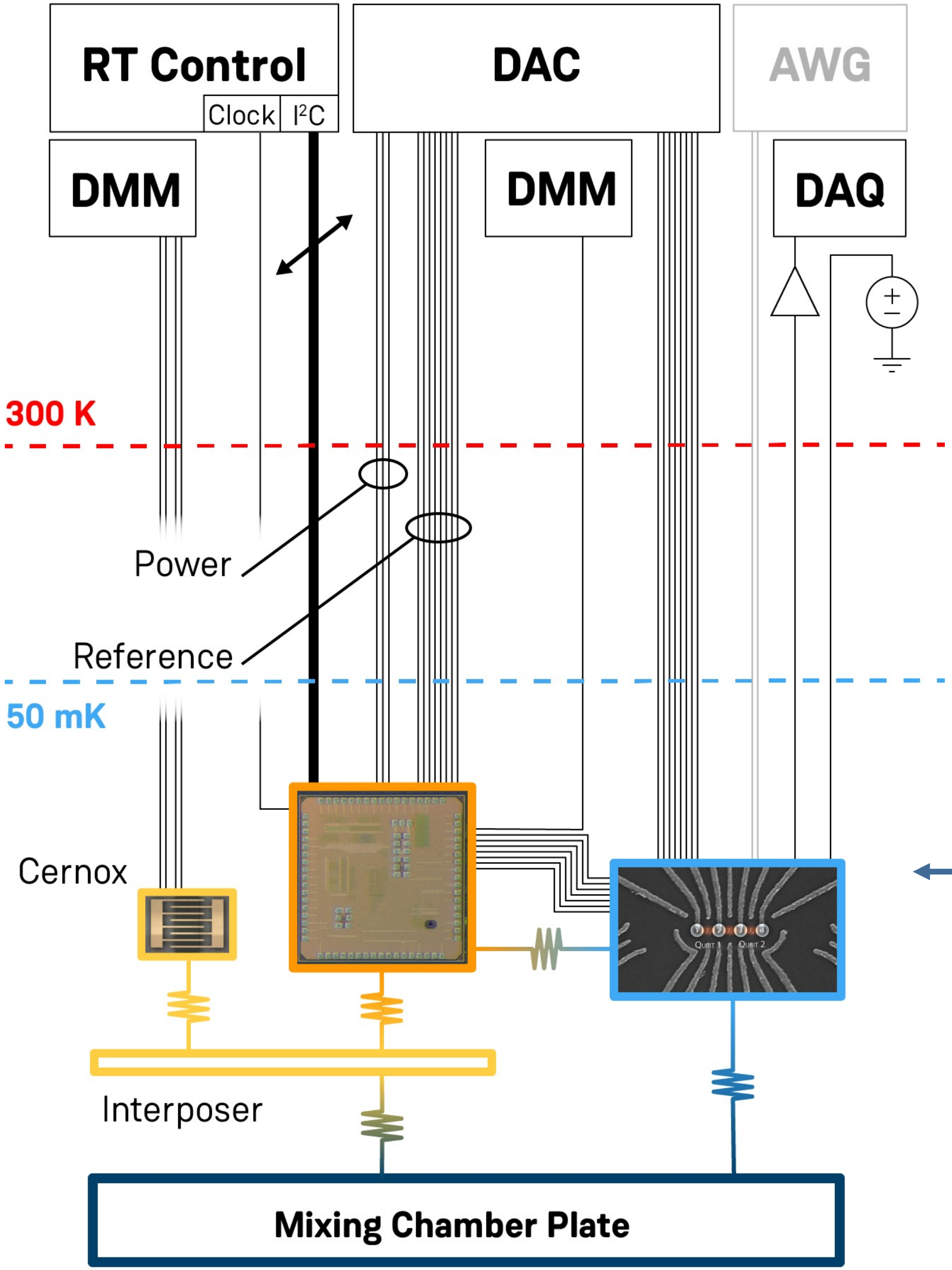
P. Vliex et al., IEEE SSC Letters, vol. 3, 2020, pp. 218–221.
Lotte Geck et al. 2020 Quantum Sci. Technol. 5 015004

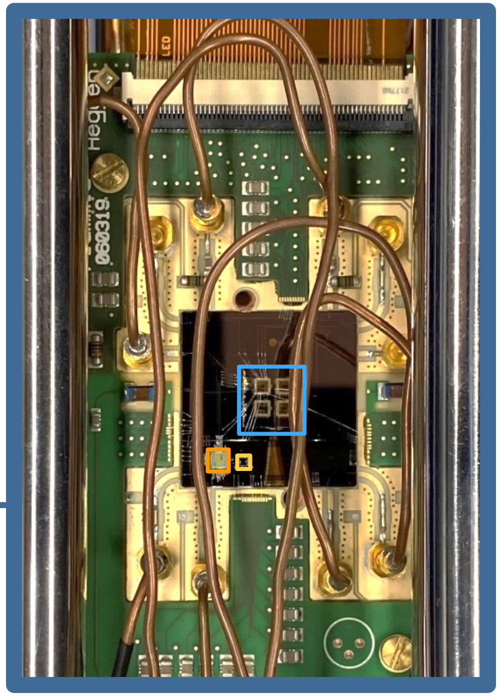
Cryostat Wiring



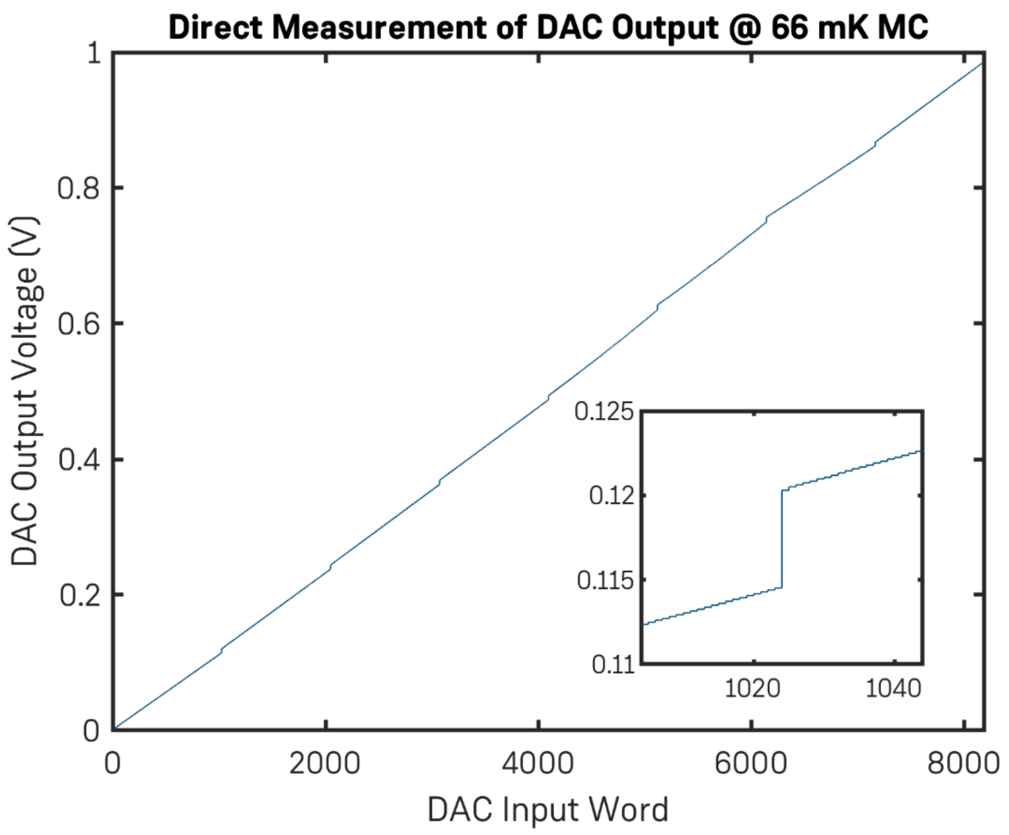




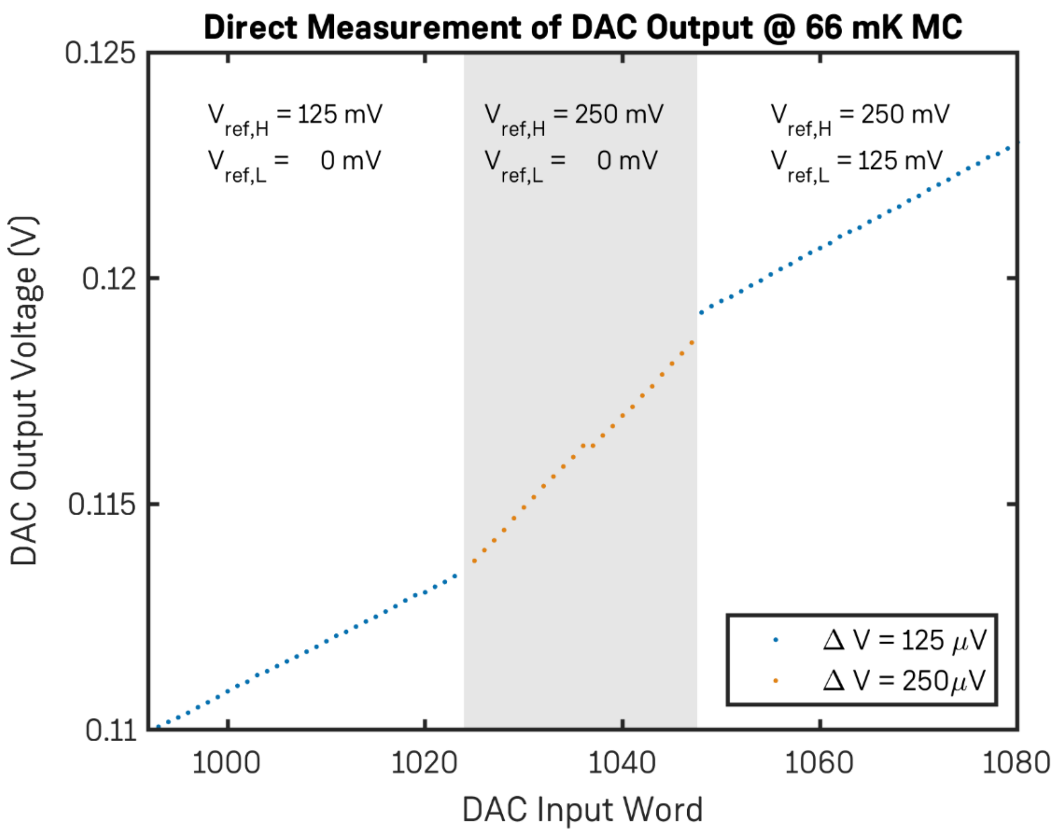




Direct DAC Output Voltage Characterization



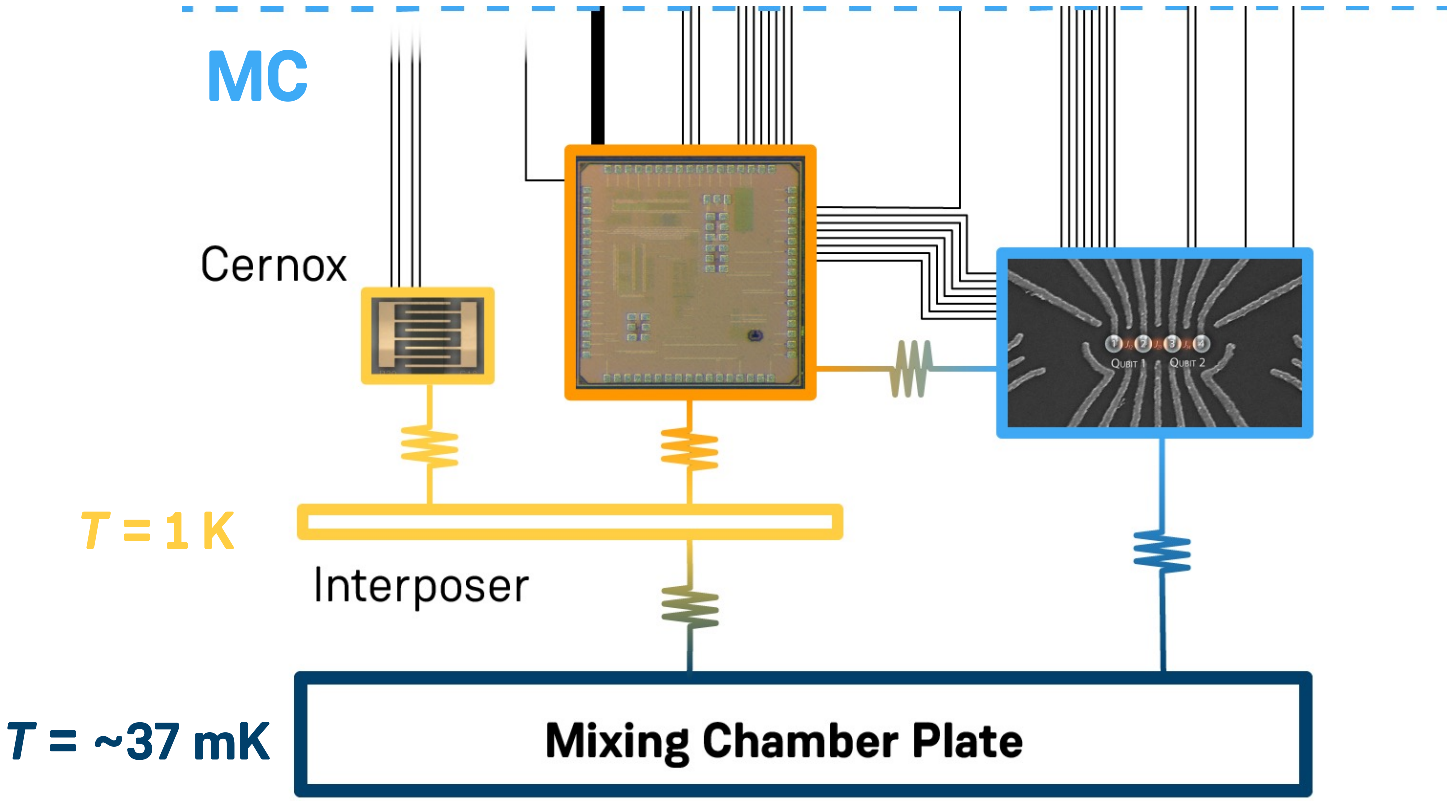
Stray capacitances lead to gain error



We can bridge these gaps by overlapping reference voltages

JÜLICH Forschungszentrum

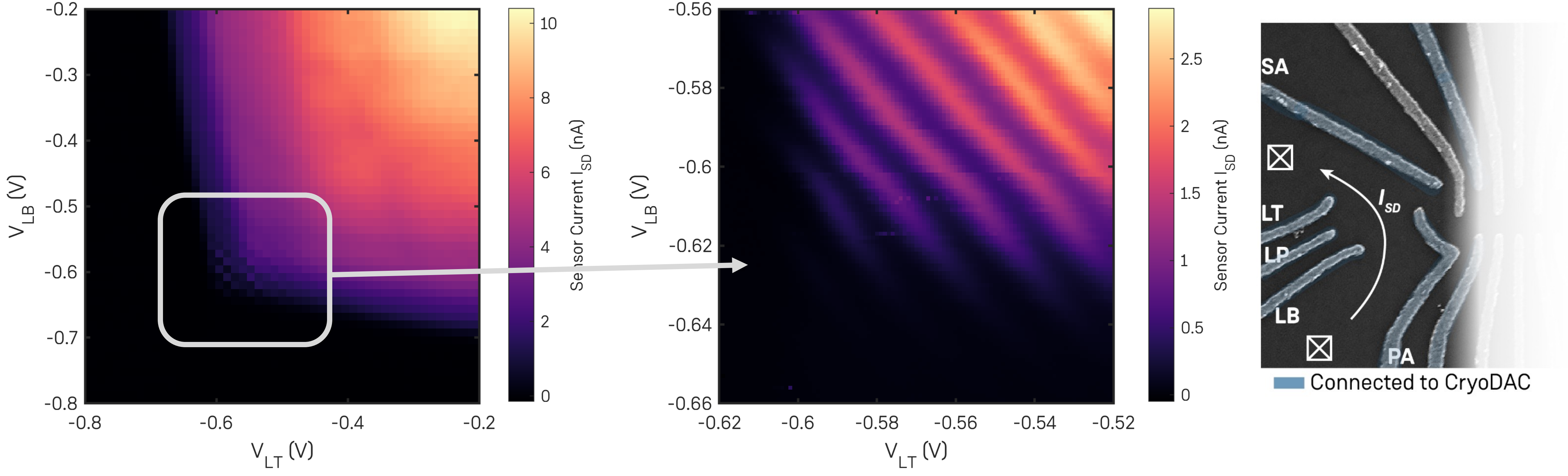
DAC Temperature & Power Consumption



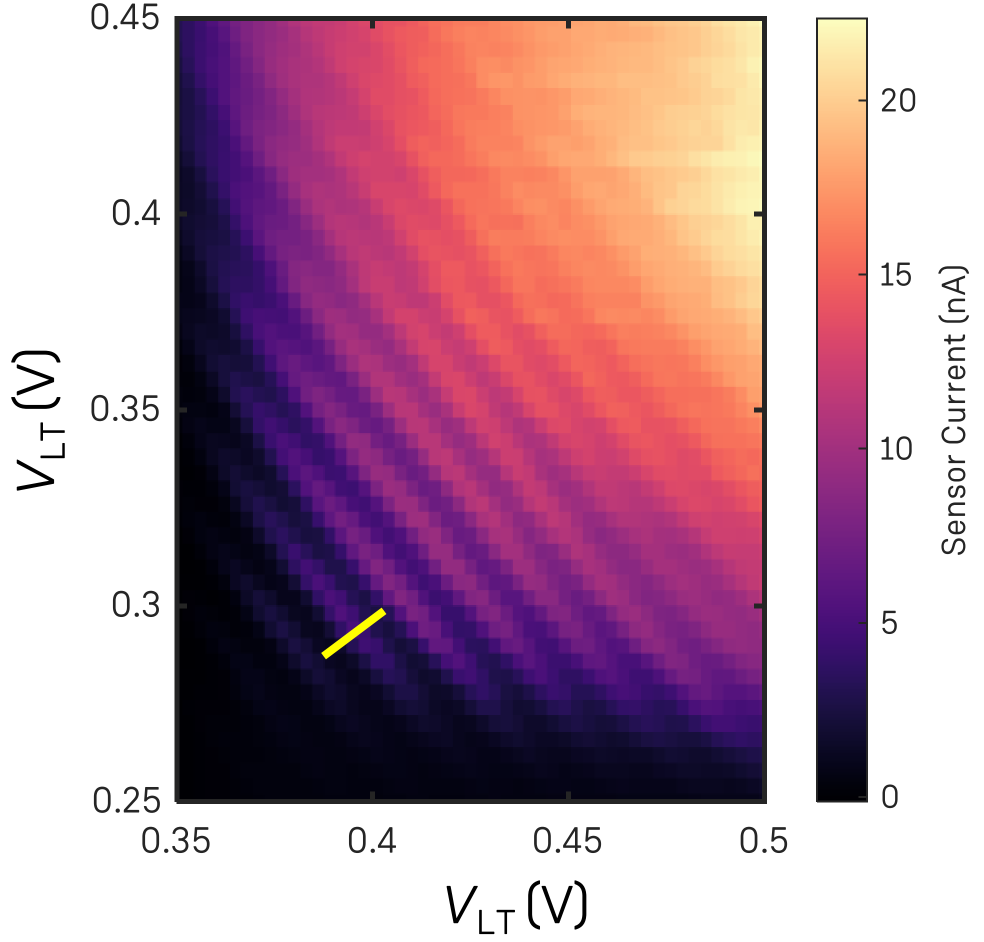
Power Consumption in at <1K

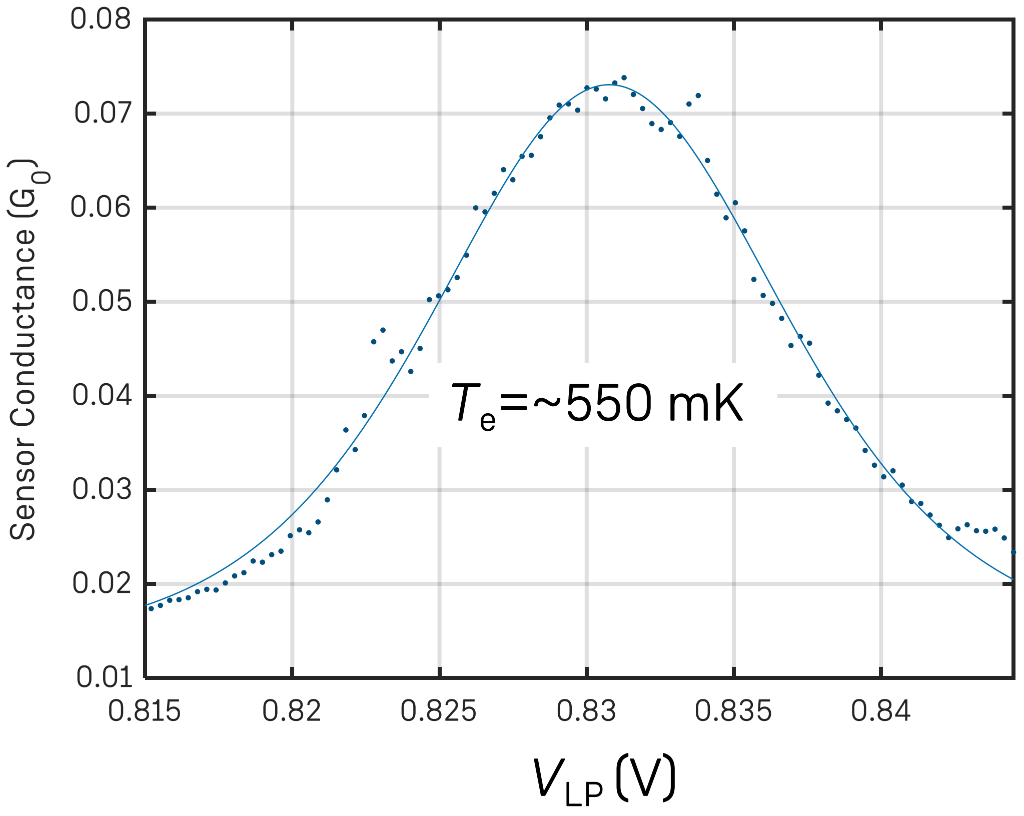
P_{all} ~ 30 μW (I²C, 10 MHz Clock, DAC)
P_{DAC} ~ 13μW

Sensor Dot Measurement using Cryo-DAC



Coulomb Diamonds und Electron Temperature

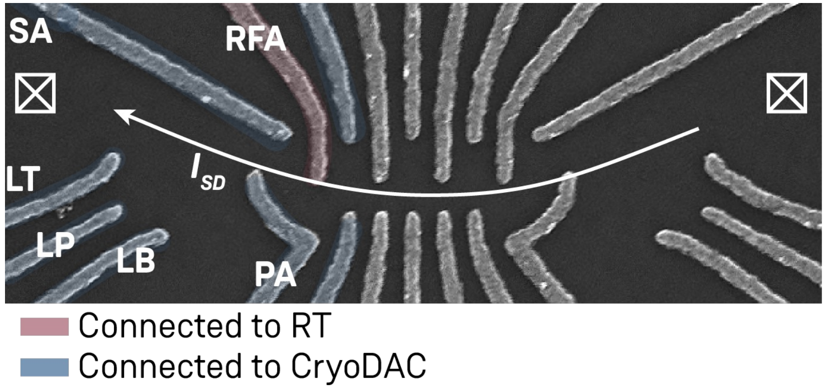


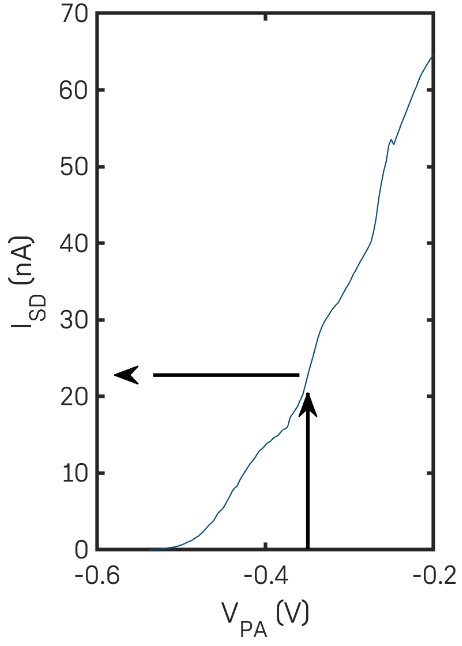


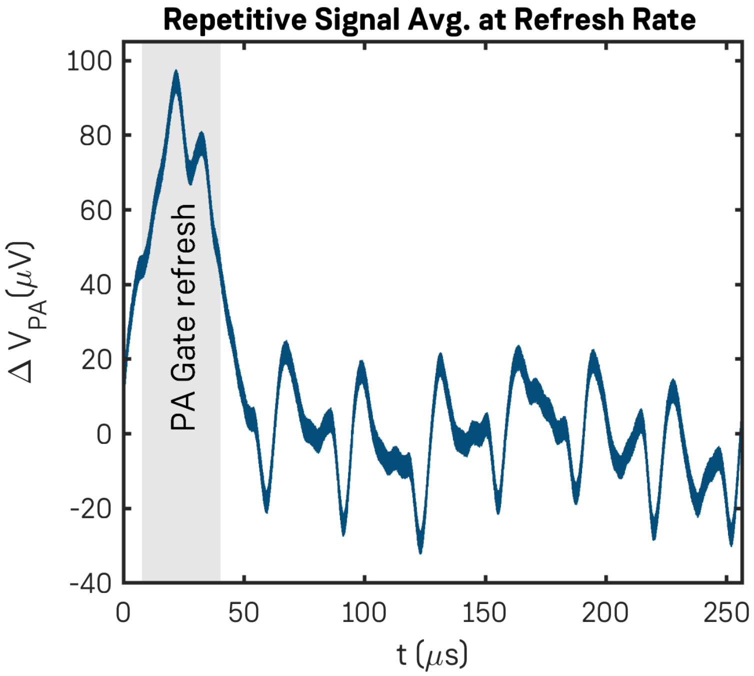
$$G = \frac{G_0}{\cosh^2\left(\frac{\alpha_{LP}(V_{LP}-V_0)}{2k_B T_e}\right)}.$$

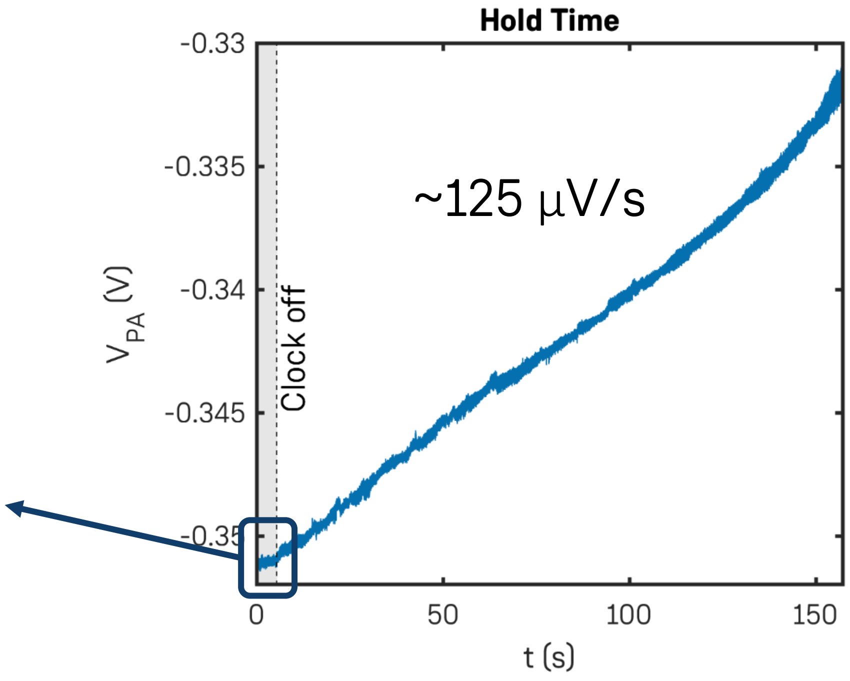
JÜLICH Forschungszentrum

DAC Voltage Stability









10 Hz Gate Refresh

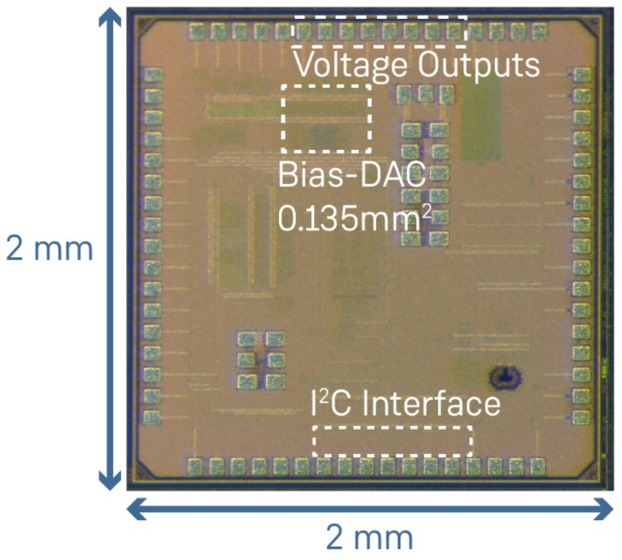
~3000 gates per cycle

13 µW DAC Power

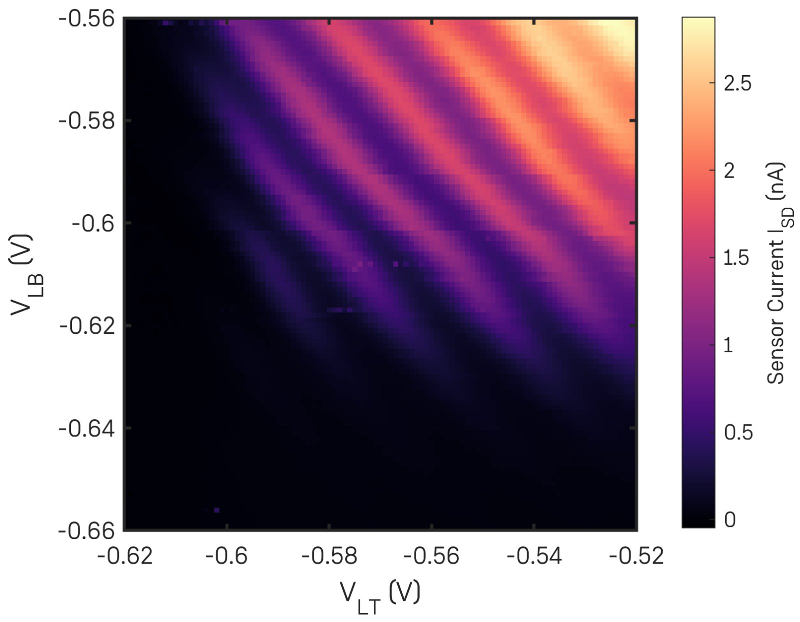
4 nW per channel

Conclusion

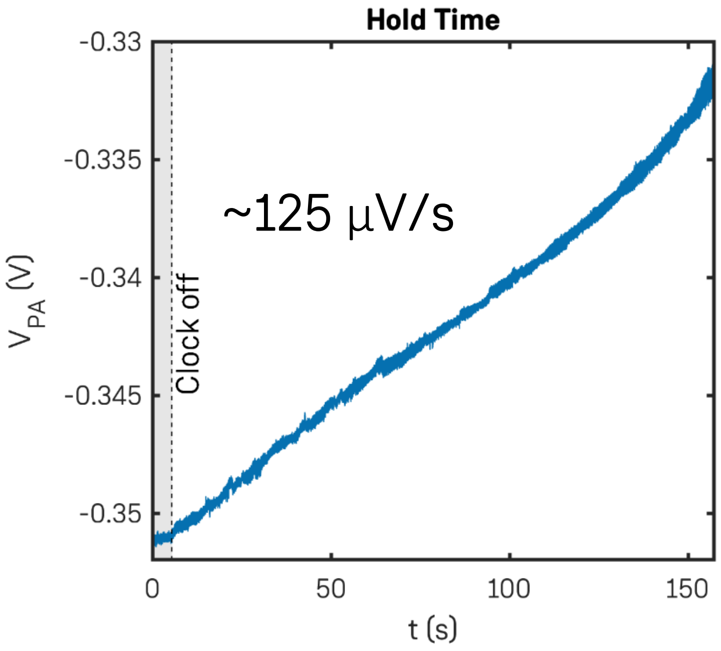
CryoDAC
Operating at <50 mK



First Measurements on
Qubit Device

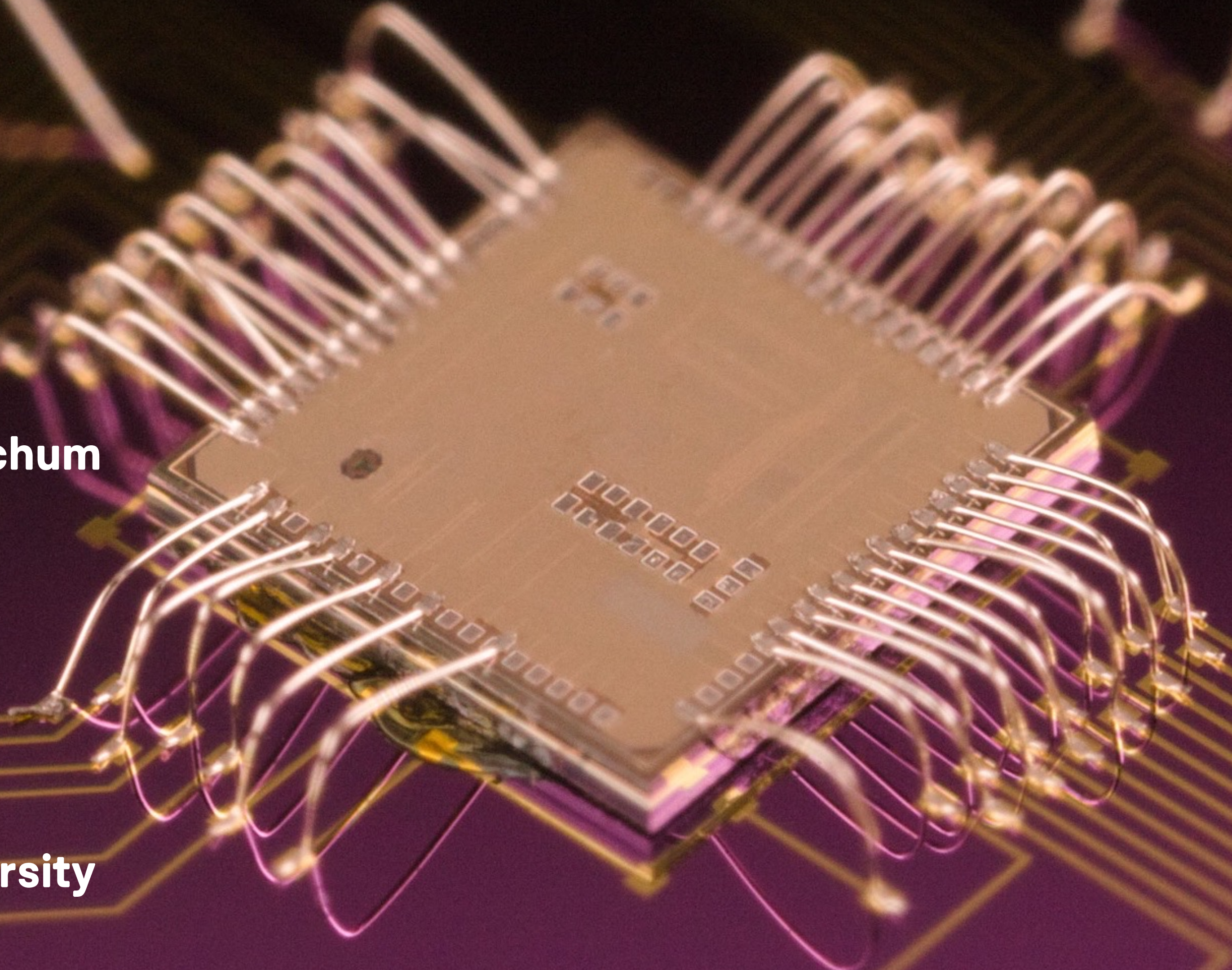


Low Operating
Frequencies Possible



Fully Autonomous DC Bias-DAC Operating T_{MC} = 37mK

Thank you!



ZEA-2/FZJ
Lea Schreckenberg
Patrick Vliex

Ruhr Universität Bochum
Julian Ritzmann
Arne Ludwig
Andreas D. Wieck

RWTH Aachen University
Matthias Künne
Simon Humpohl
Hendrik Bluhm

JÜLICH Forschungszentrum

QuTech Quantum Technology Group | RWTH AACHEN UNIVERSITY

We are looking for Postdocs!