Forschungsfabrik Mikroelektronik Deutschland

Fraunhofer Group for Microelectronics in Cooperation with Leibniz Institutes FBH and IHP

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Cryogenic read-outs: Status and Outlook to the Future

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Quantum Computing

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Cryogenic RF-electronics

Read outs: Low-noise amplifiers near the Quantum-noise-limit

$$SNR \sim \frac{n}{1 + T_n / T_Q}$$

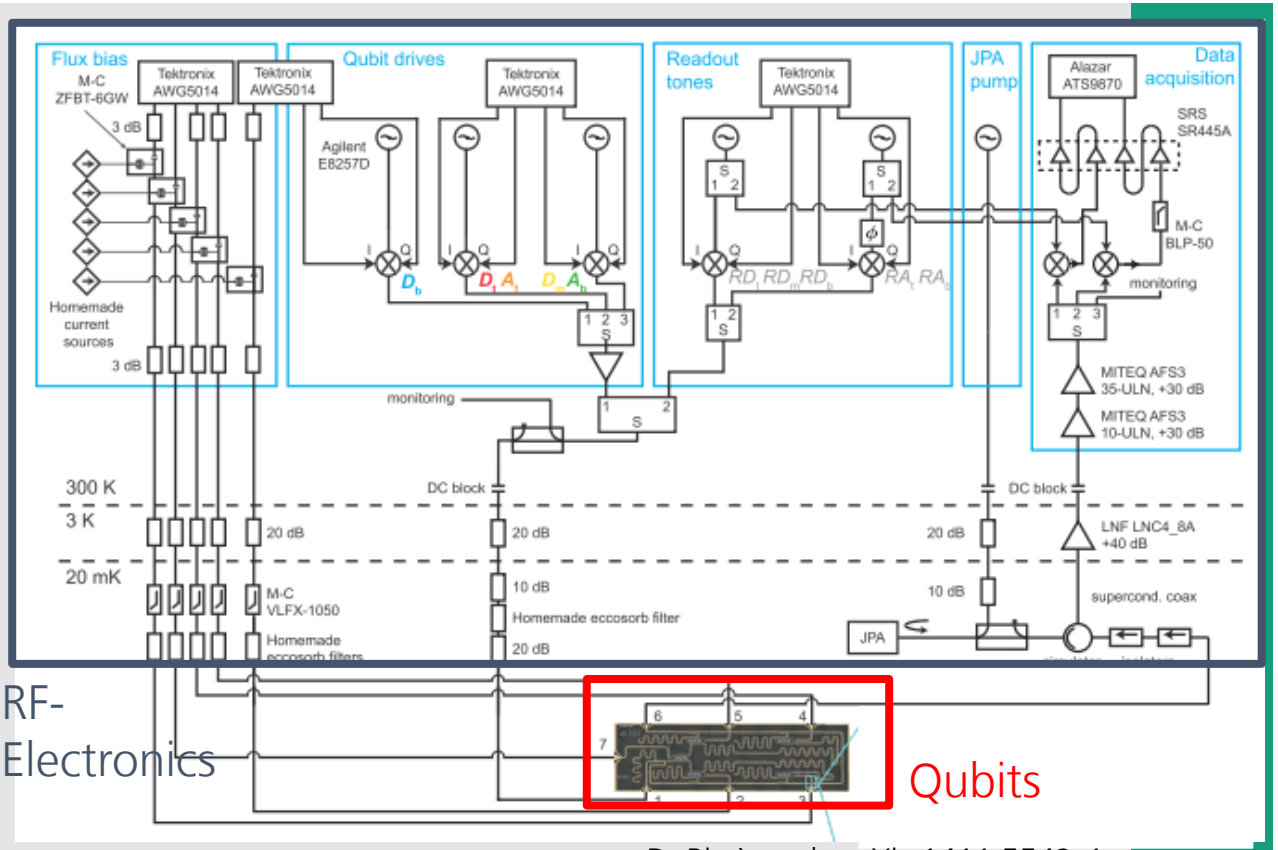
n # of photons

T_n RF-noise-temperatur

T_Q Quantum-Limit

➡ Signals: < -140 dBm

Set- and control-circuits



D. Ristè et al., arXiv:1411.5542v1

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Heritage: Cryogenic Low-noise Amplifiers

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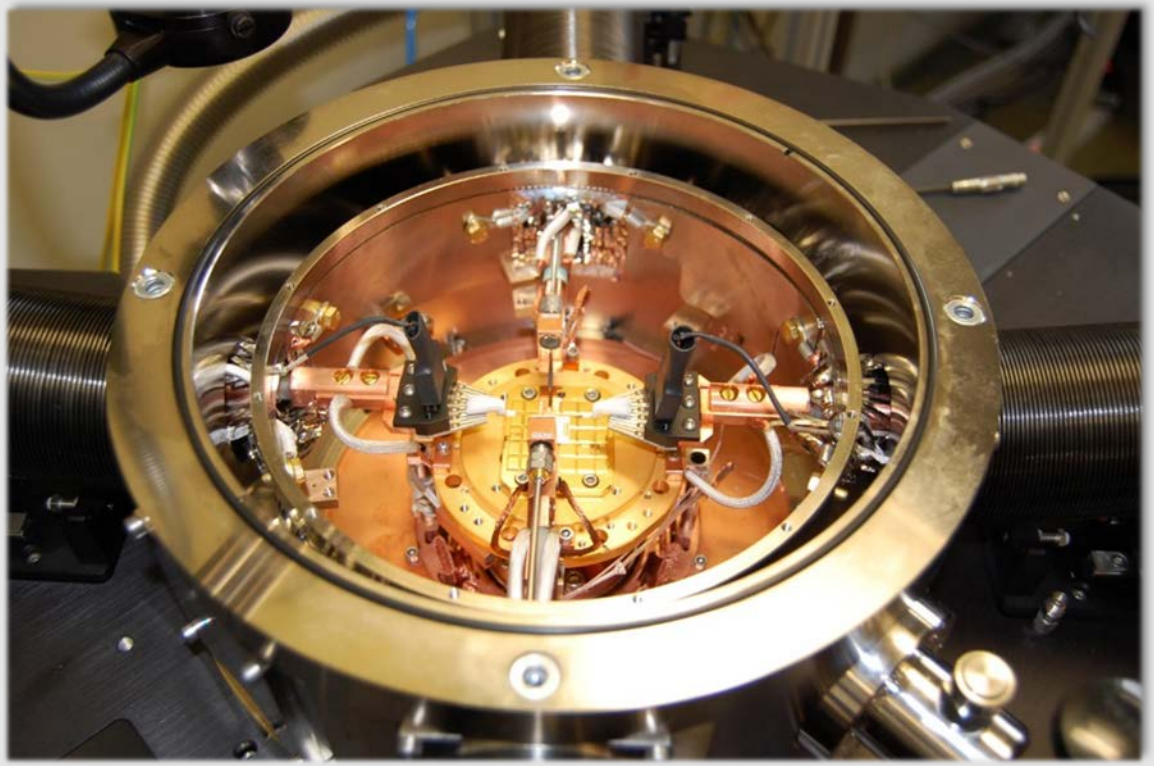
https://www.ska.ac.za/



Signals: -260 dBm (10^{-29} W)

Cryogenic 1.5 – 6 GHz LNA MMIC

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3-stage LNA MMIC

Size: 4 mm x 1.5 mm

Frequency range: 1.5 – 6 GHz

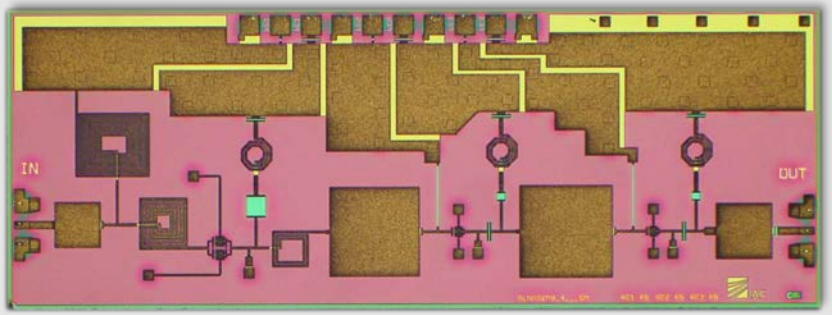
Fraunhofer IAF 50 nm mHEMT:

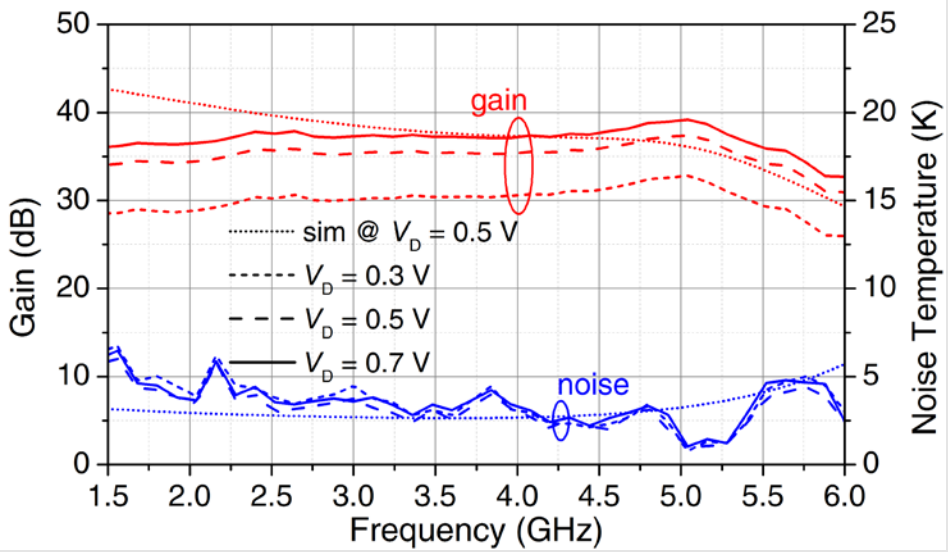
Average T_n: 3.2 K

Gain ≈ 35 dB

Ambient temperature:

T_{amb}: 11 K





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Low-noise Amplifiers near the Quantum Noise Limit

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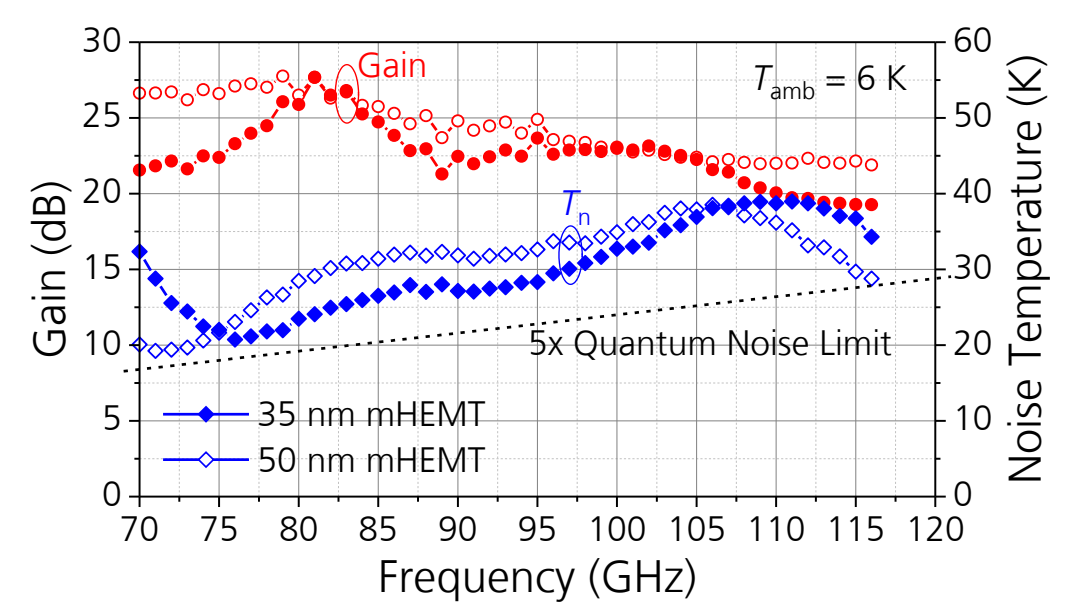
3x3 receiver arrays (75—116 GHz)

Ambient temperature:
T_{amb}: 6 K

Higher frequency read outs to reduce temperature issue



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Scalable III-V Integration with Silicon

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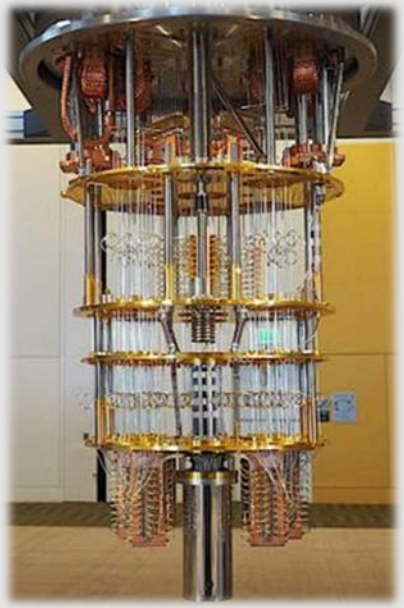
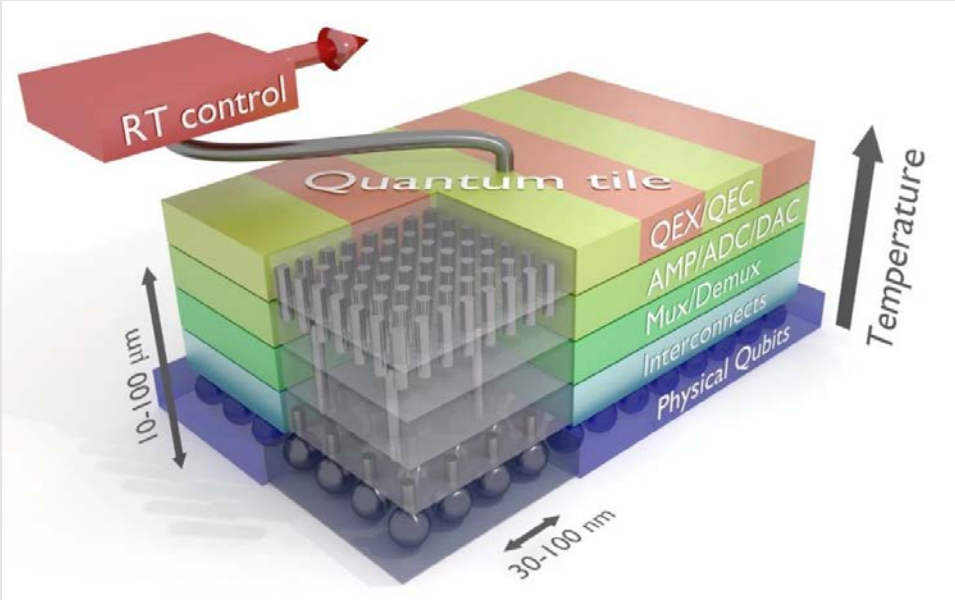
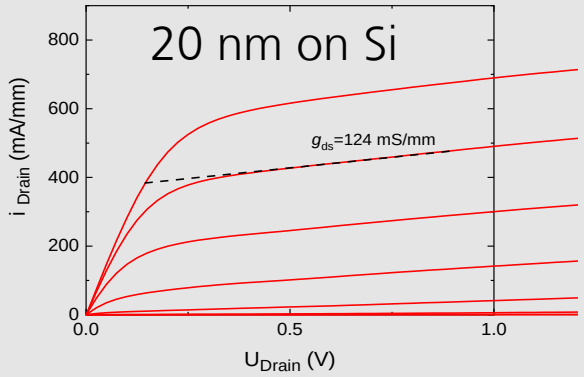
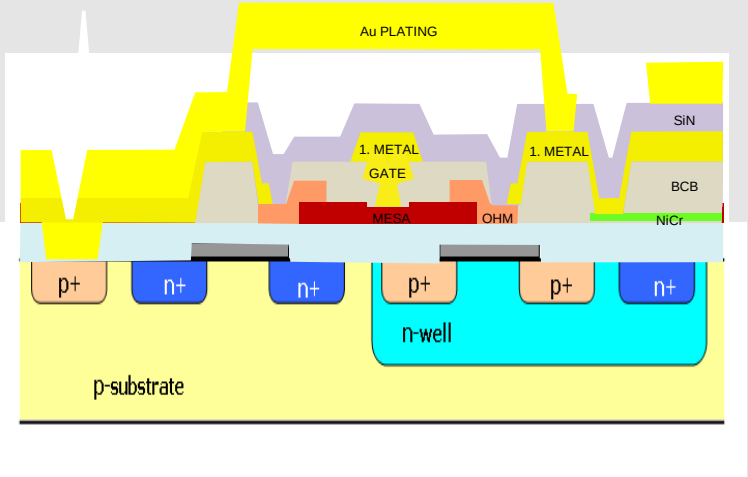
72 Qubits → >500 Qubits









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Diamond NV Centers: Room Temperature

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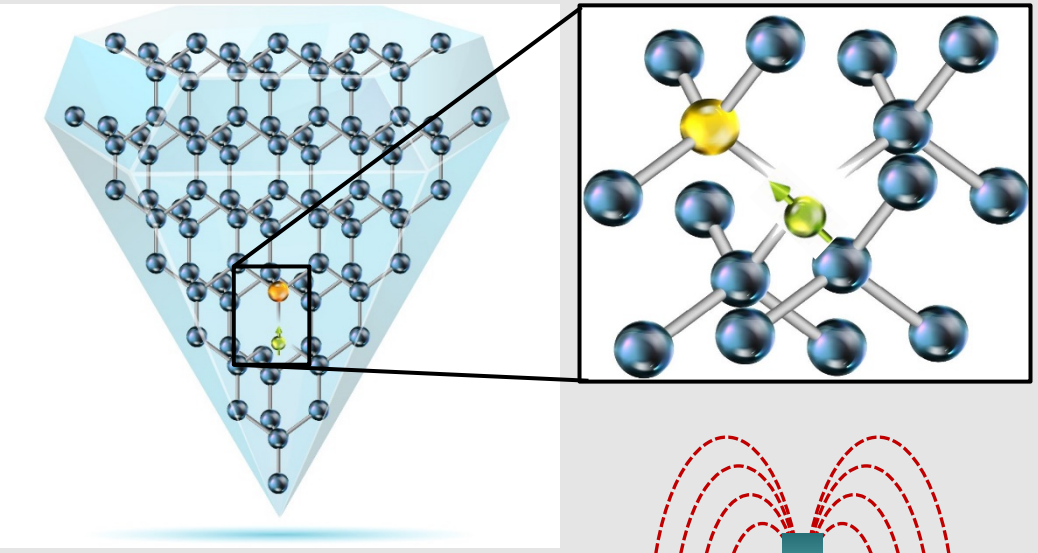
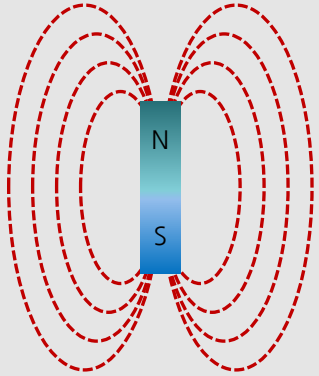
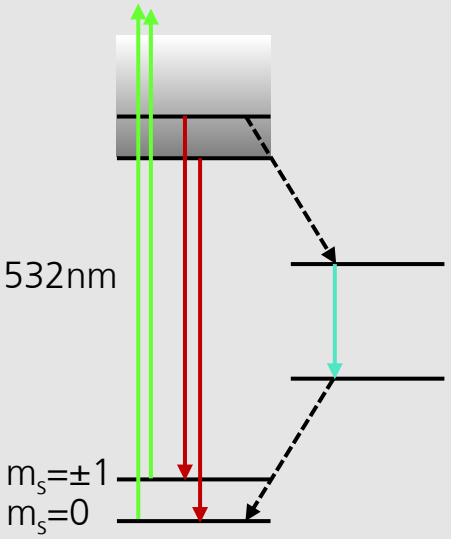
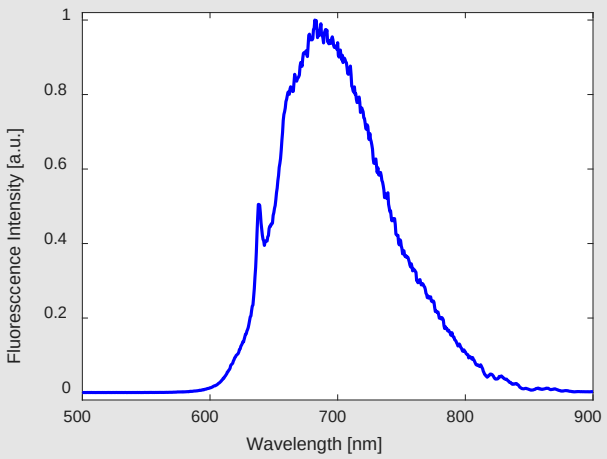


24°C







Future:
Integrated read out at microwave frequencies

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Your Contact

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