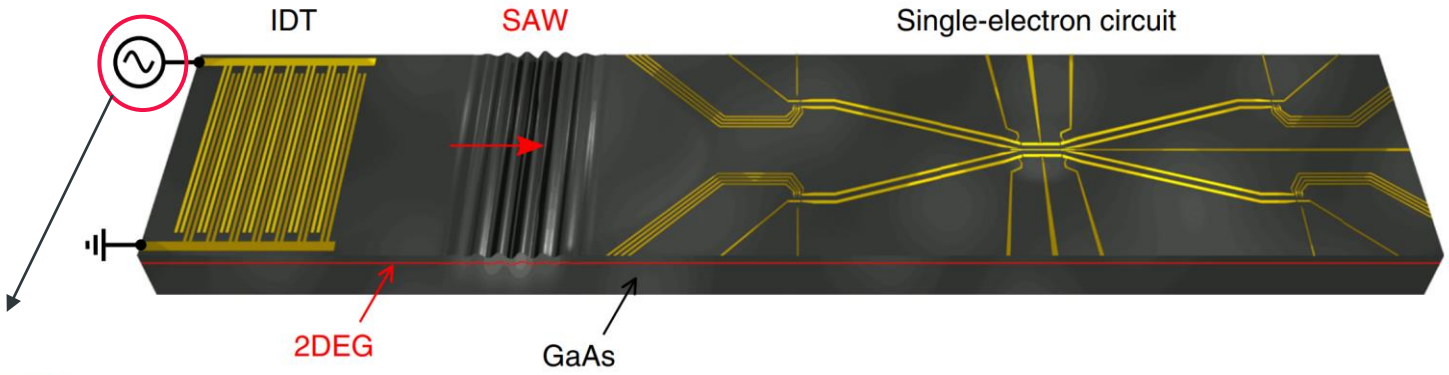
Generation of a Single-Cycle Acoustic Pulse: A Scalable Solution for Transport in Single-Electron Circuits

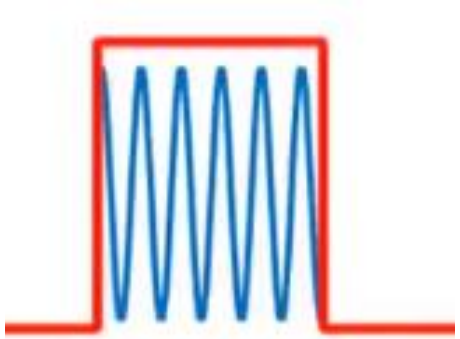
Junliang Wang et al. PRX12 031035, Electronic flying Qubits Group, CNRS

Spin Journal Club, University of Basel – IBM Zurich, 5/5/23, Aldo Tarascio

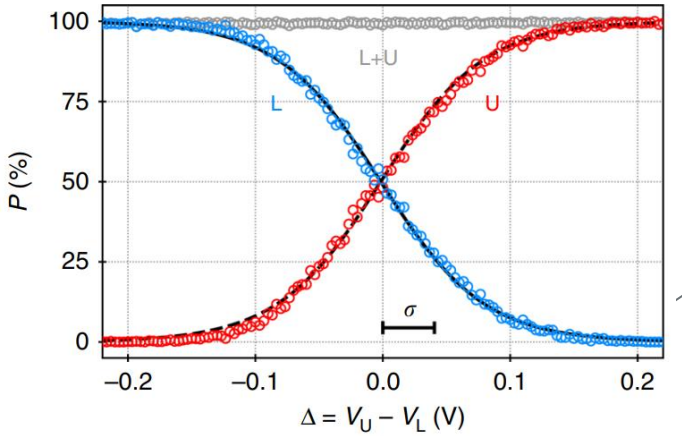
Flying electrons

- On piezoelectric substrates you can create Surface acoustic waves by applying a voltage



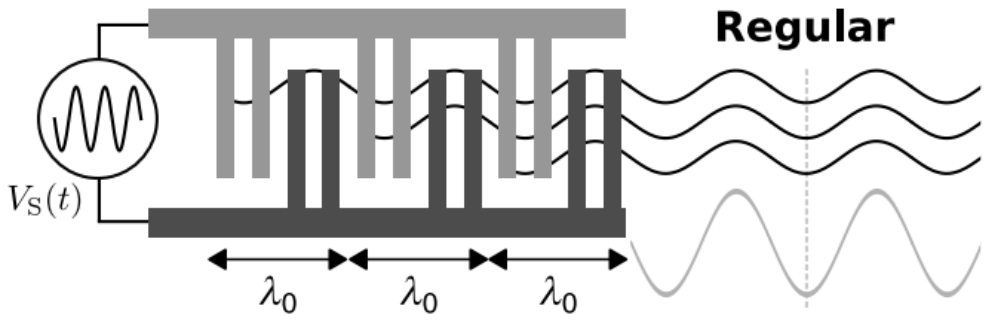


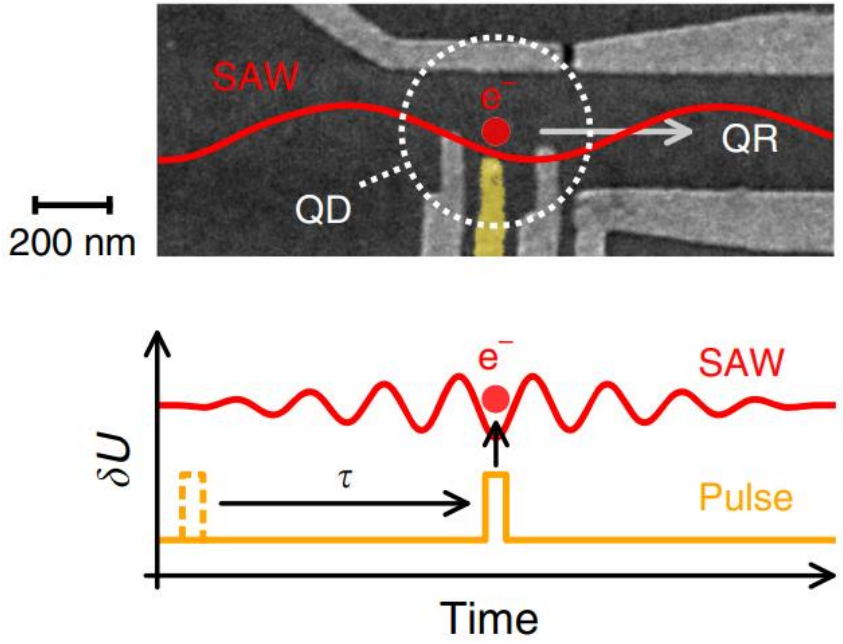
2.77Ghz



S.Takada et al, Nat Commun 10, 4557 (2019)

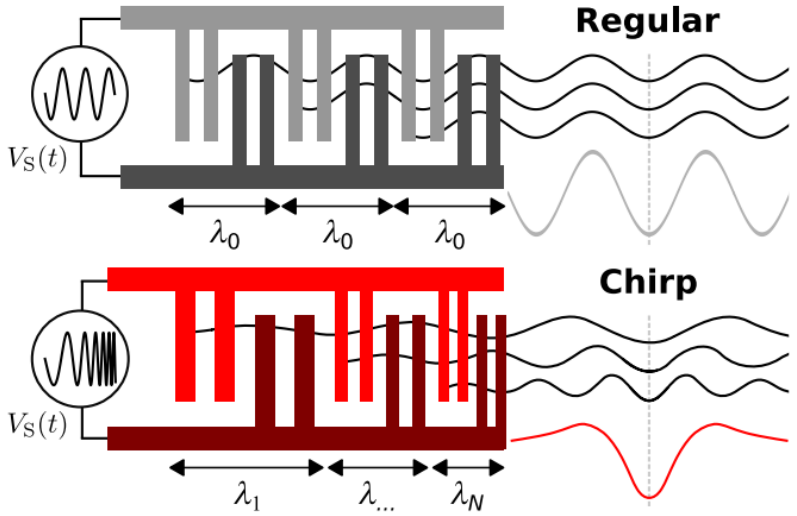
Pushing the electron in the QR over a large SAW train

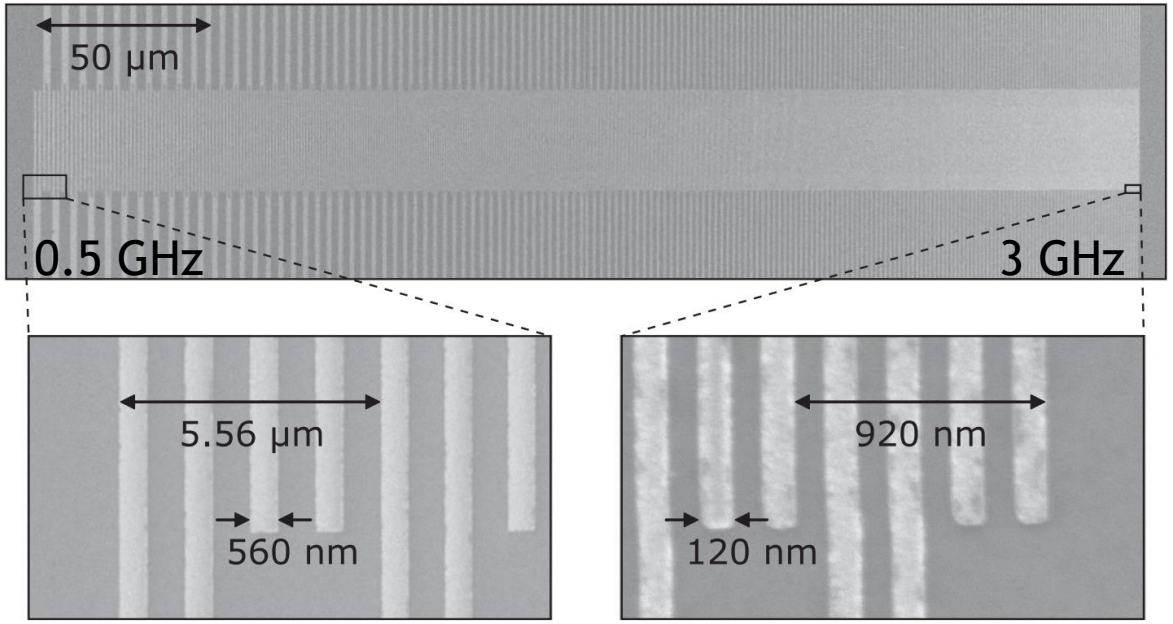


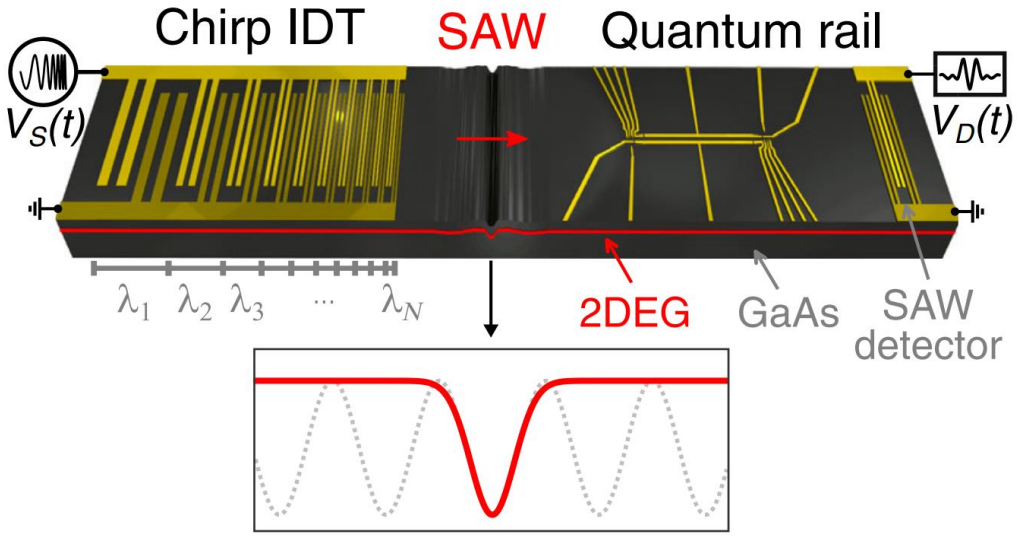


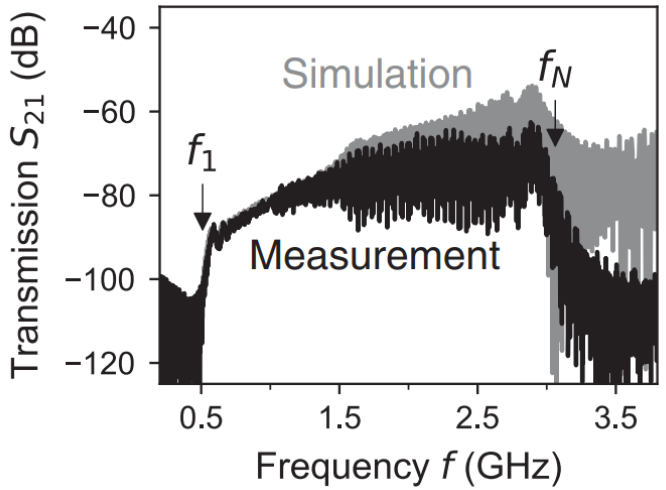
S.Takada et al, Nat Commun 10, 4557 (2019)

Making a strongly compressed acoustic pulse

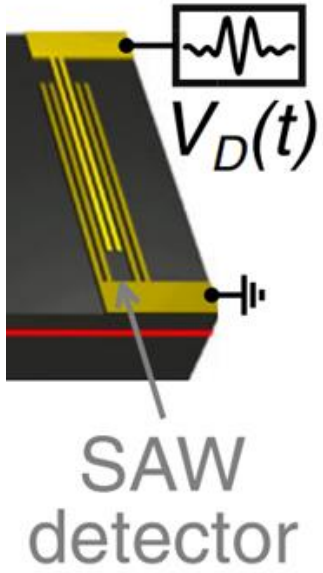


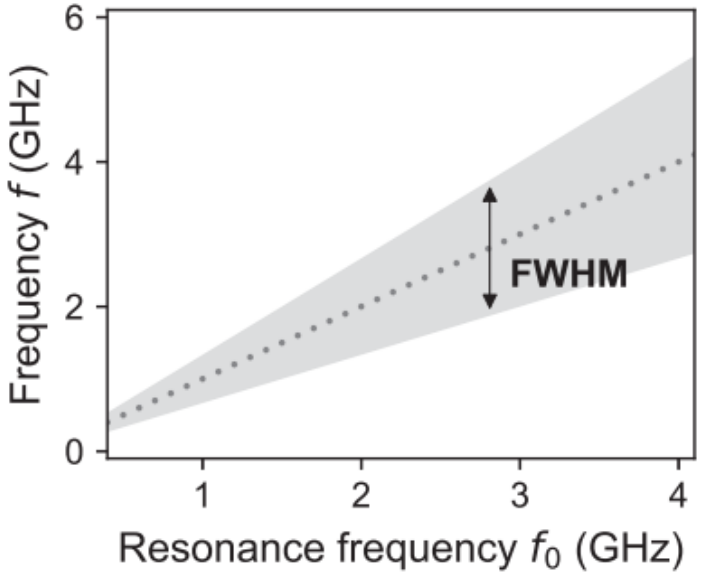


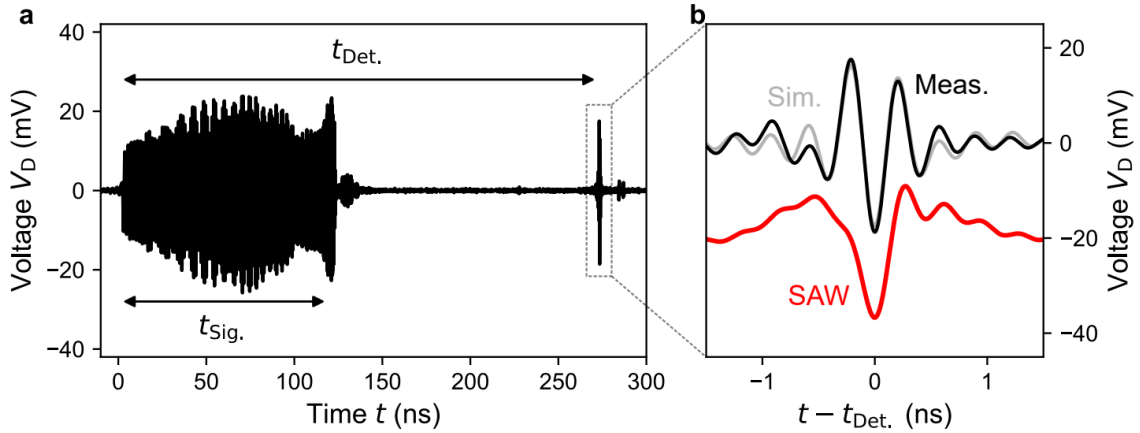




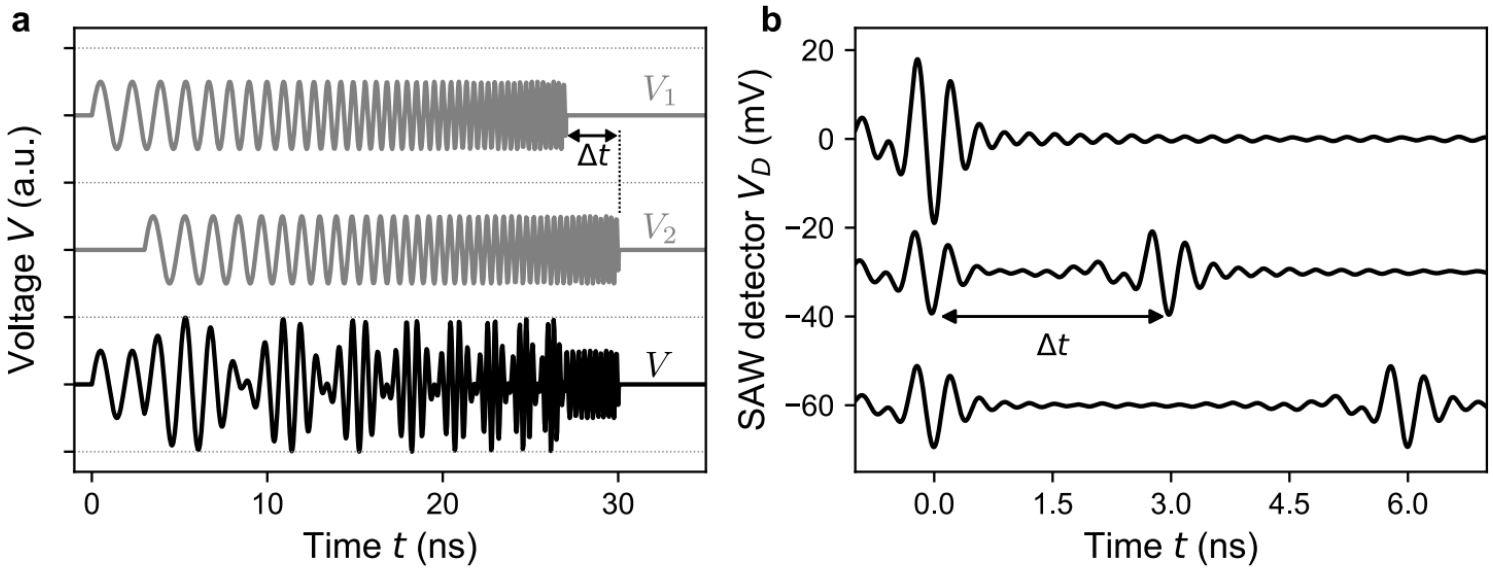
The acoustic pulse detector

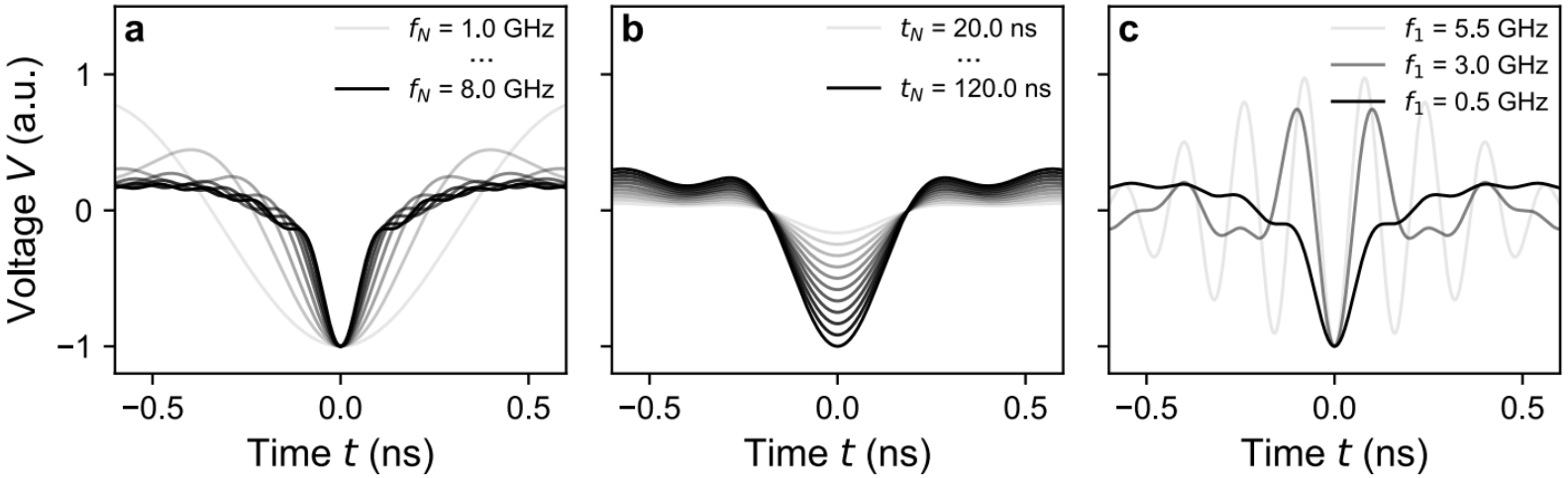






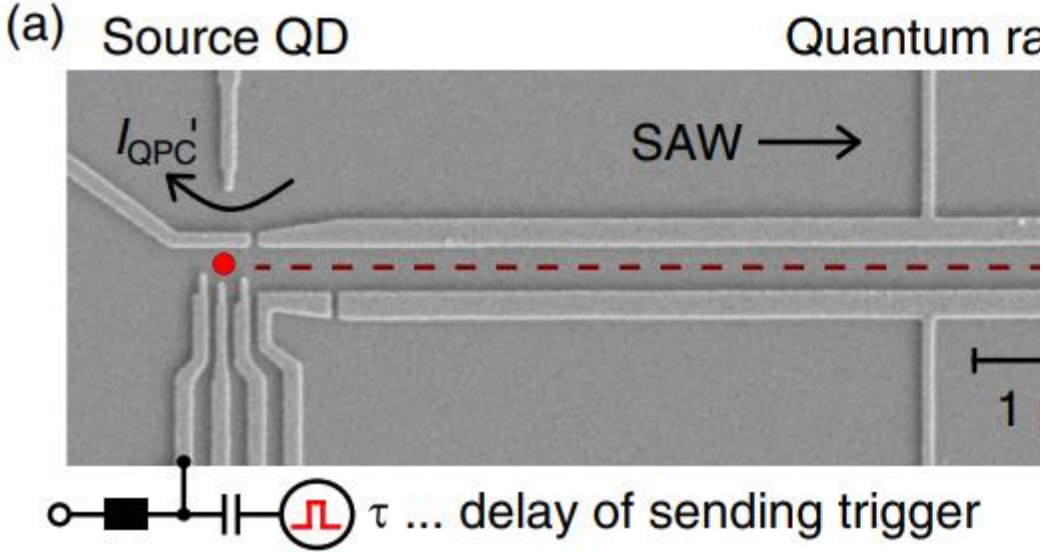
Acousto-electric wave engineering



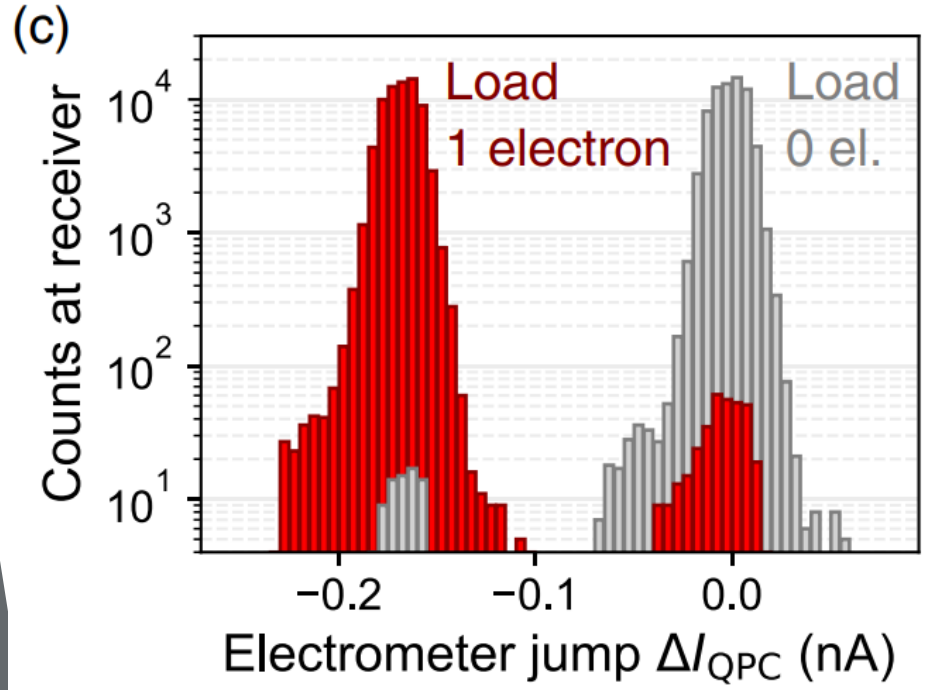


Junliang Wang Wang. Surface acoustic waves as testbed for electron flying qubits. Physics [physics]. Université Grenoble Alpes [2020-..], 2022.

The experiment

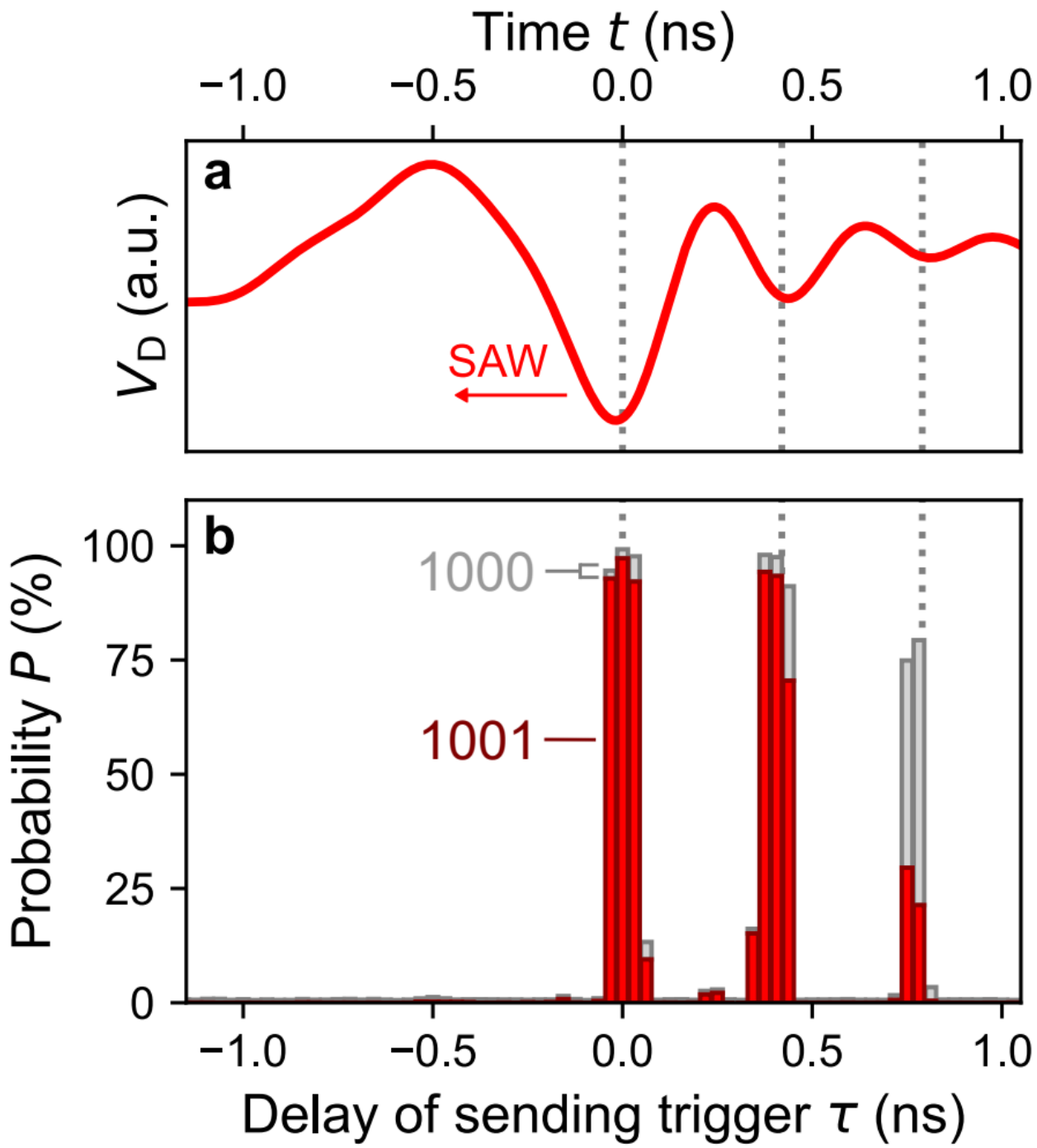


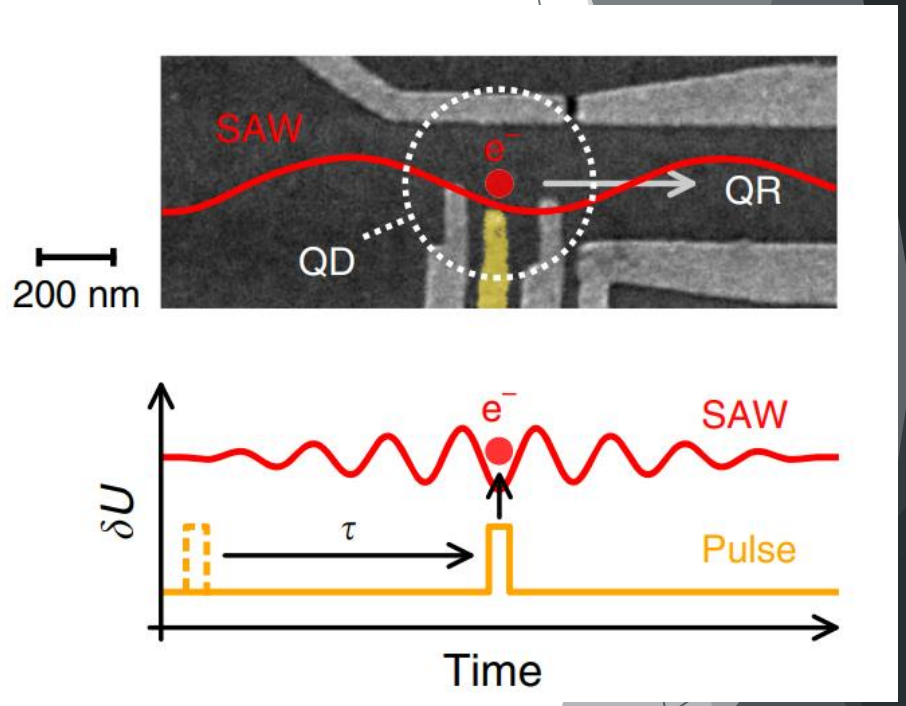
Probabilty	Code	Value (%)
Transfer 2el.	2002	92.1
Missed 1el. error	2001	6.7
Missed 2el. error	2000	1.2
Sending error	2100 + 2200	0.0
Loading error	0000 + 1000	0.0
Inflow	0001 + 0002	0.1



(d)

Probabilty	Code	Value (%)
Transfer	1001	99.4
Catching error	1000	0.4
Sending error	1100	0.0
Loading error	0000	0.1
Inflow (1 el.)	0001	0.1
Inflow (2 el.)	0002	0.0


Time t (ns)
−1.0
−0.5
0.0
0.5
1.0
a
V_D (a.u.)
SAW
b
Probability P (%)
100
75
50
25
0
1000
1001
Delay of sending trigger τ (ns)


SAW
e⁻
QR
QD
200 nm
e⁻
SAW
δU
τ
Pulse
Time

Conclusion and future prospective

- Good generation of compressed acoustic pulses
- Reliable transport for 99.4% of electrons

- Future quantum experiments on interference and entanglement exploiting spin and charge degree of freedom with single flying electrons