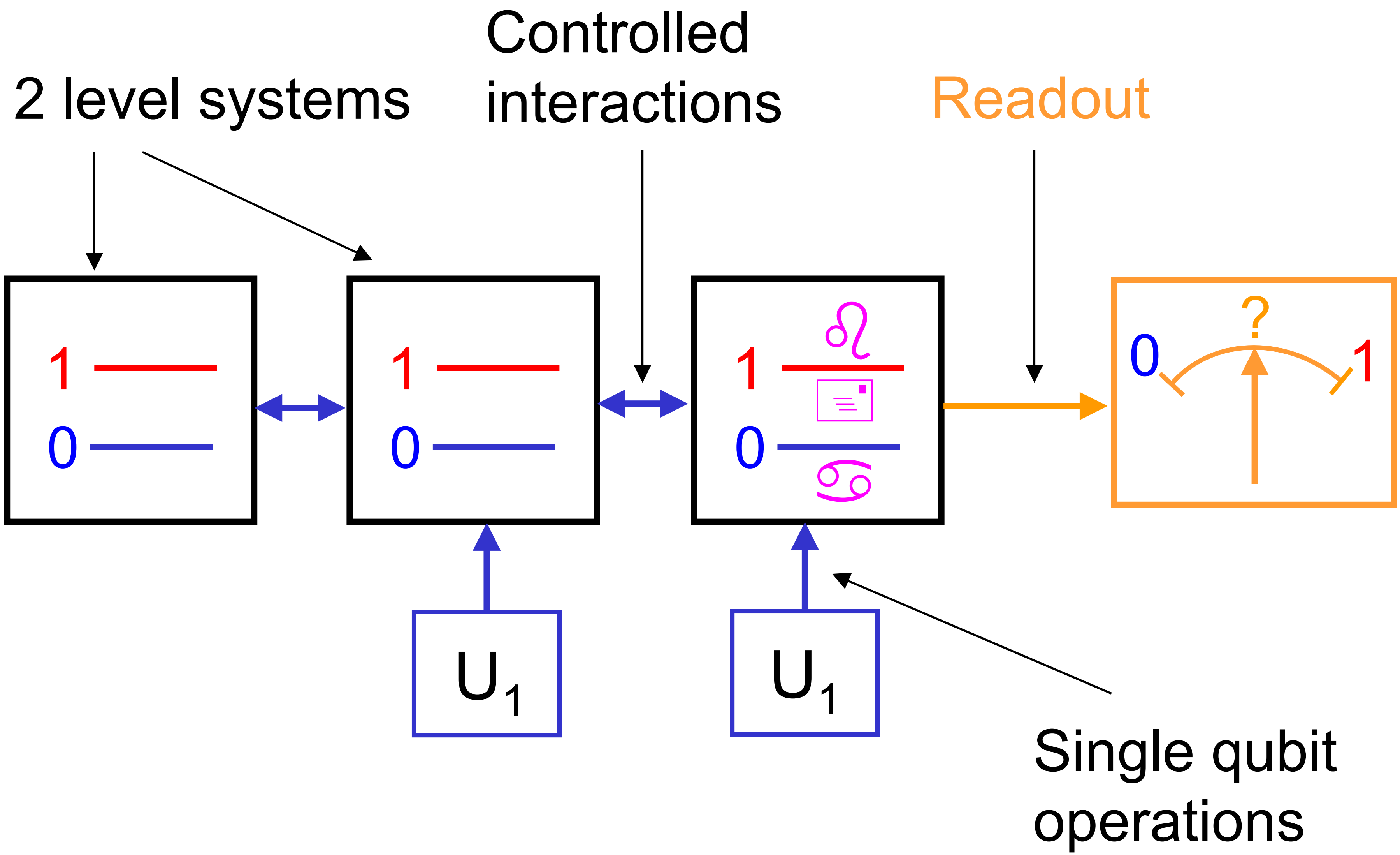
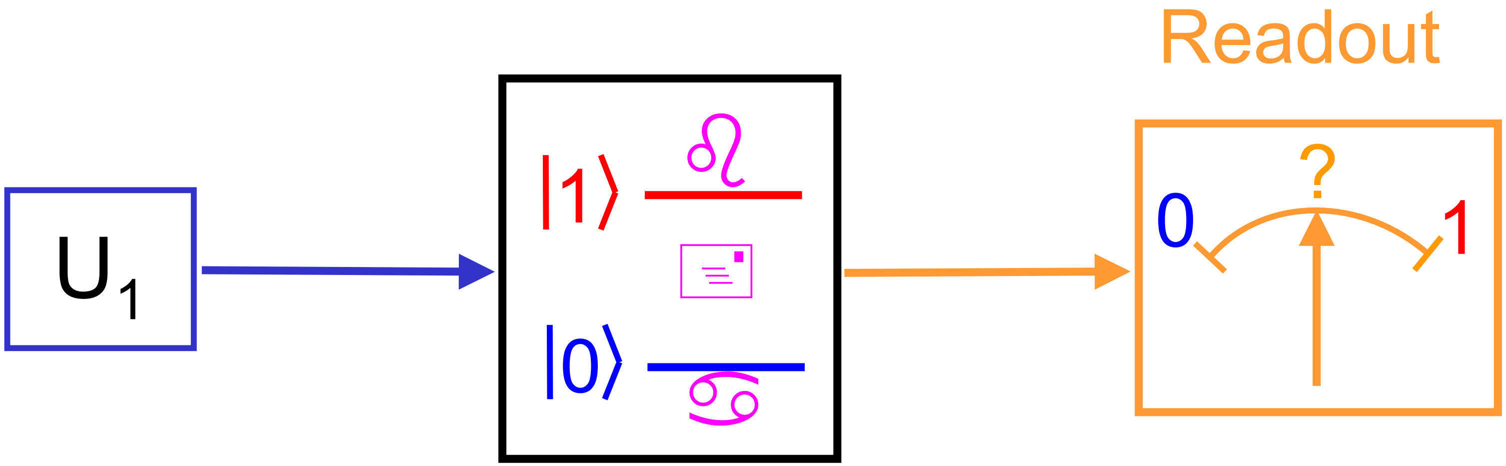
Quantum processor



Manipulation and measurement of the quantum state of a superconducting circuit



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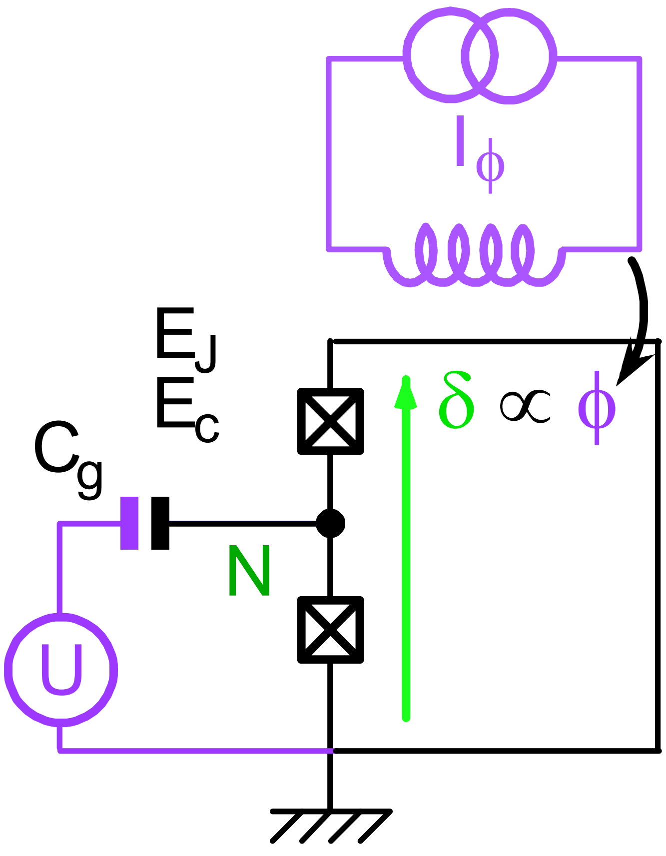
The Quantronium: a split-junction Cooper pair box



$N_g = C_g U/2e$

$$\hat{H} = E_c(\hat{N} - N_g)^2 - E_J^{eff}(\delta)\cos\hat{\theta}$$

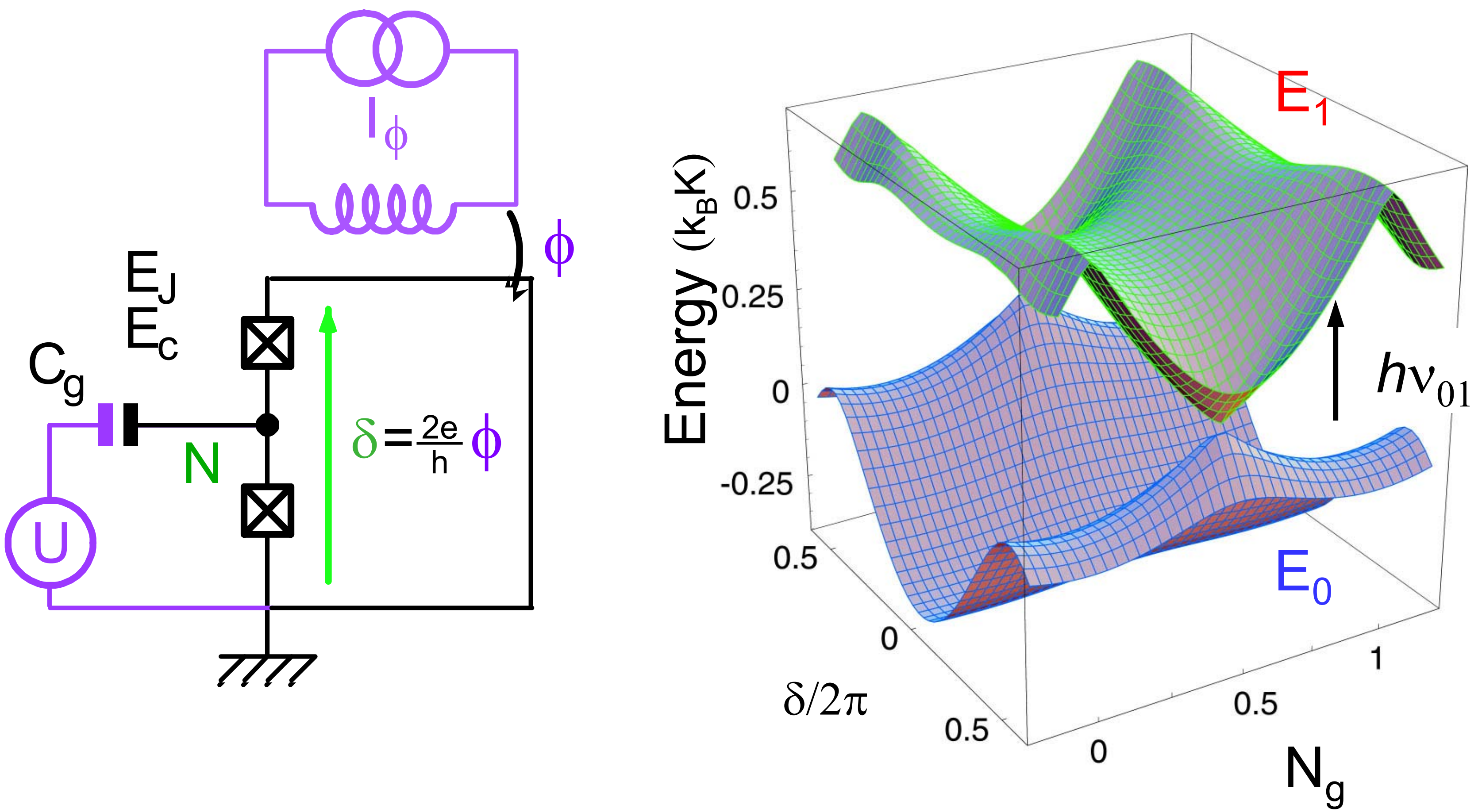
$$\downarrow$$

$$E_J^{eff}(\delta) = E_J \cos\frac{\delta}{2}$$

2 control knobs

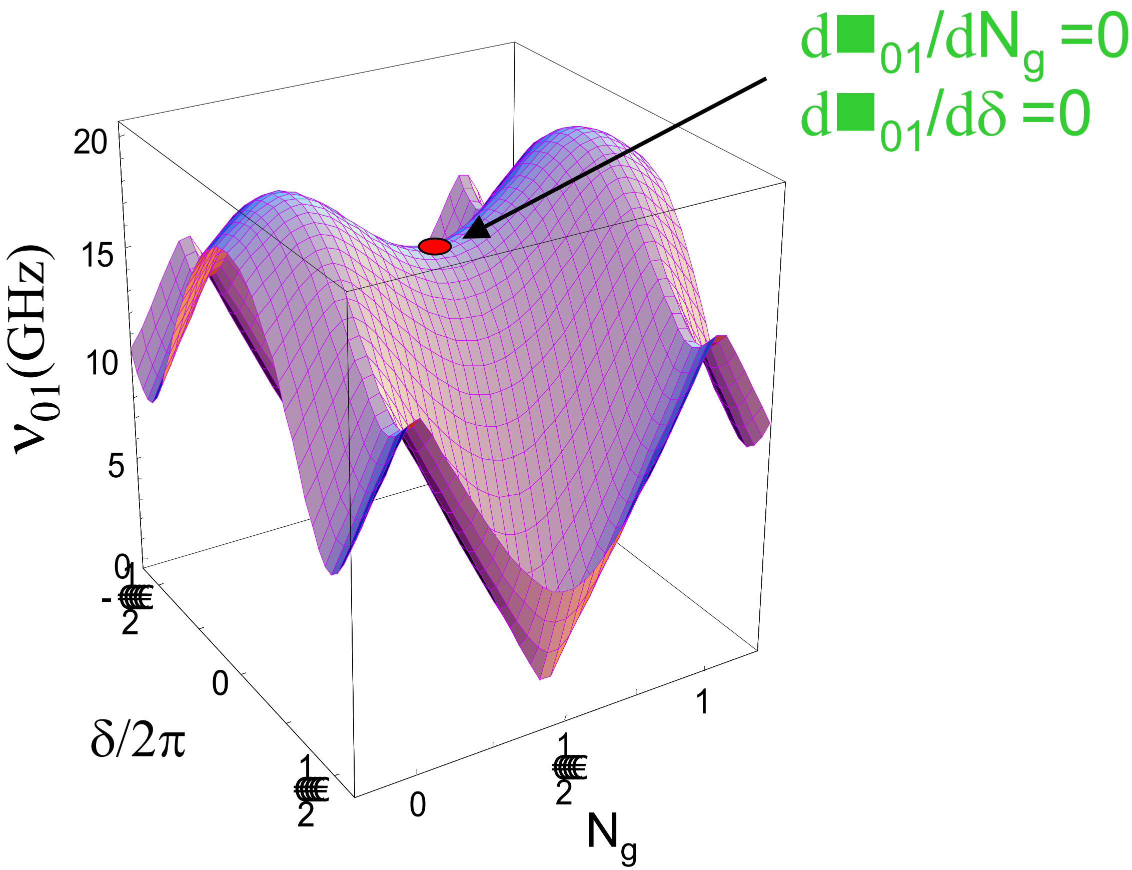
$\boxed{N_g \quad \text{and} \quad \delta}$

Energy diagram

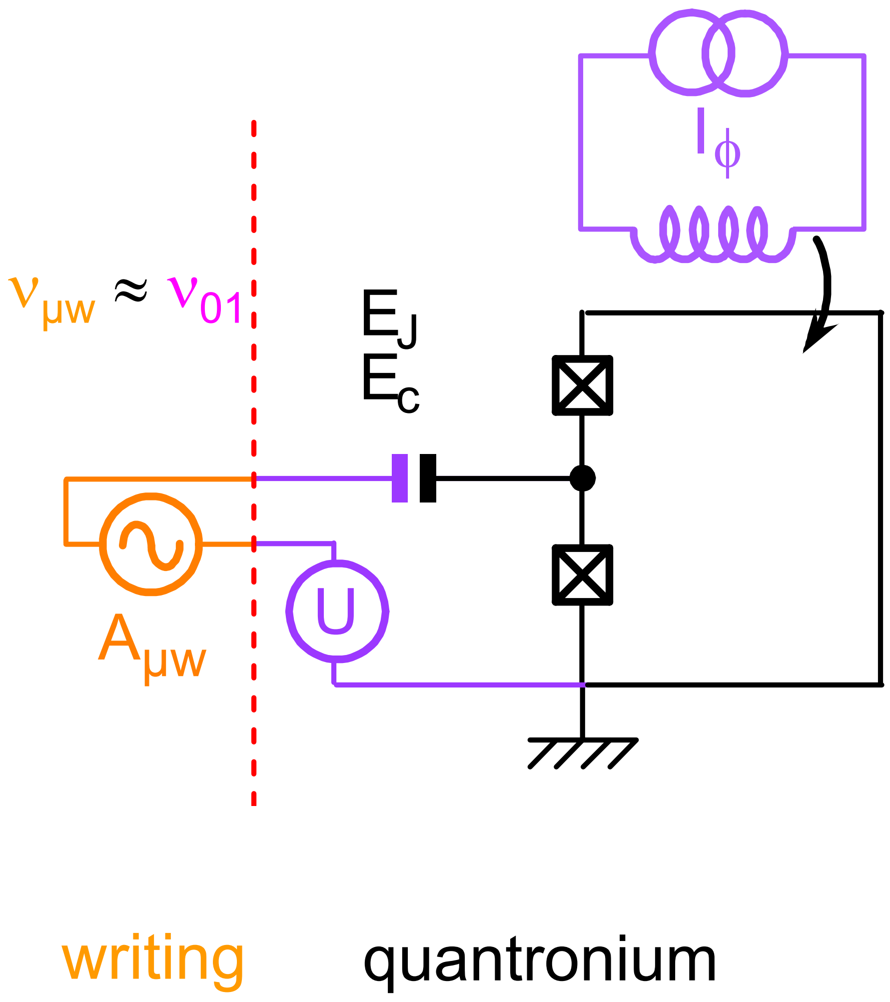


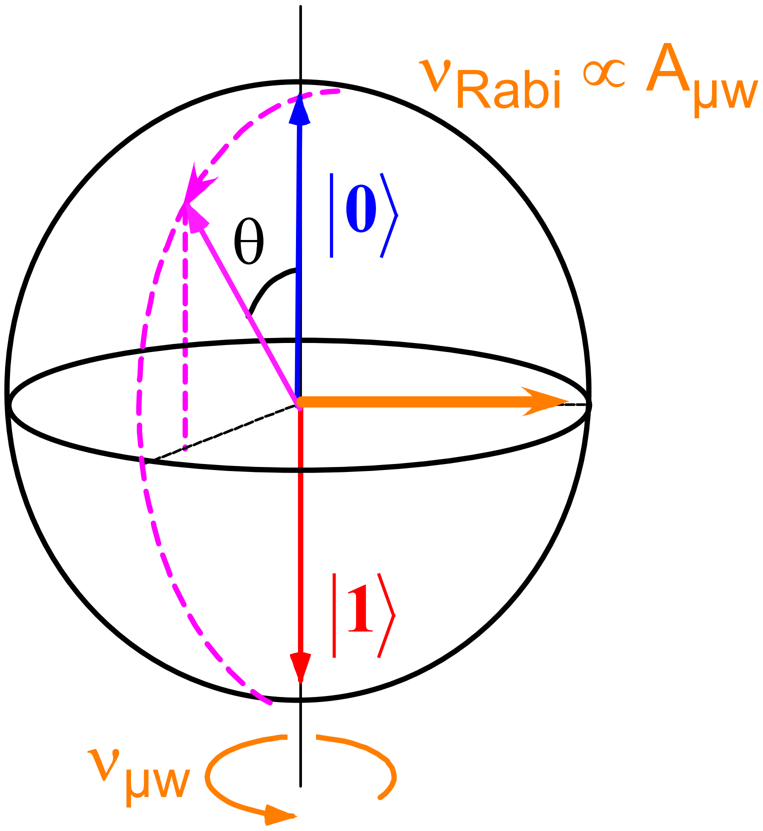
E_J=0.86 k_BK
E_C=0.68 k_BK

A perfect hiding spot

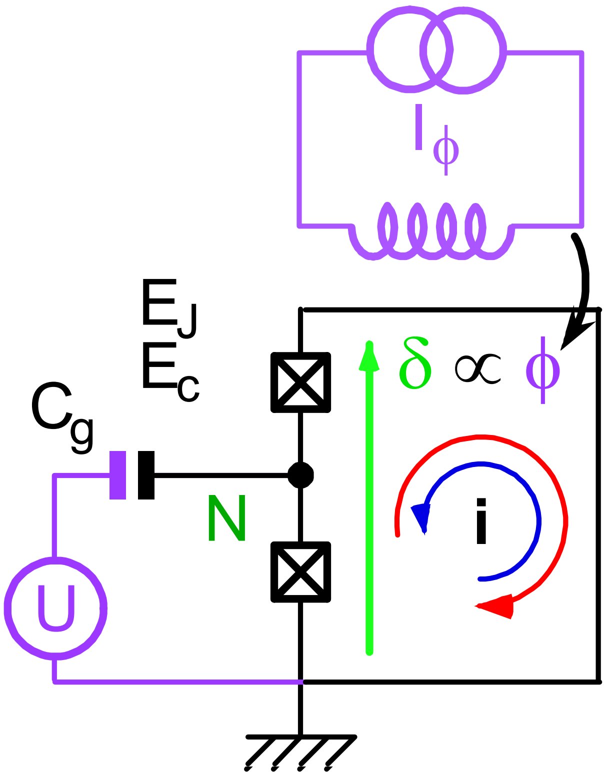


State manipulation using the charge port

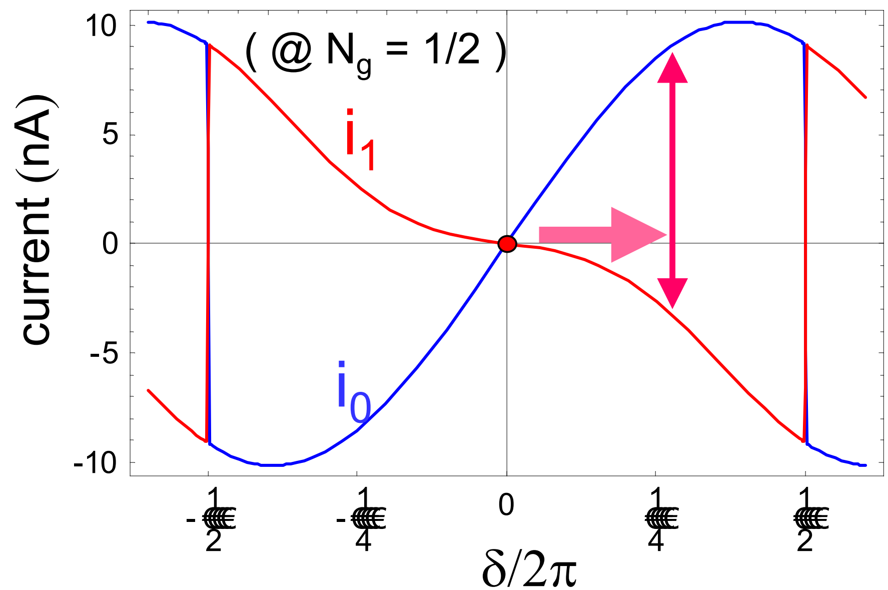




State measurement using the phase port

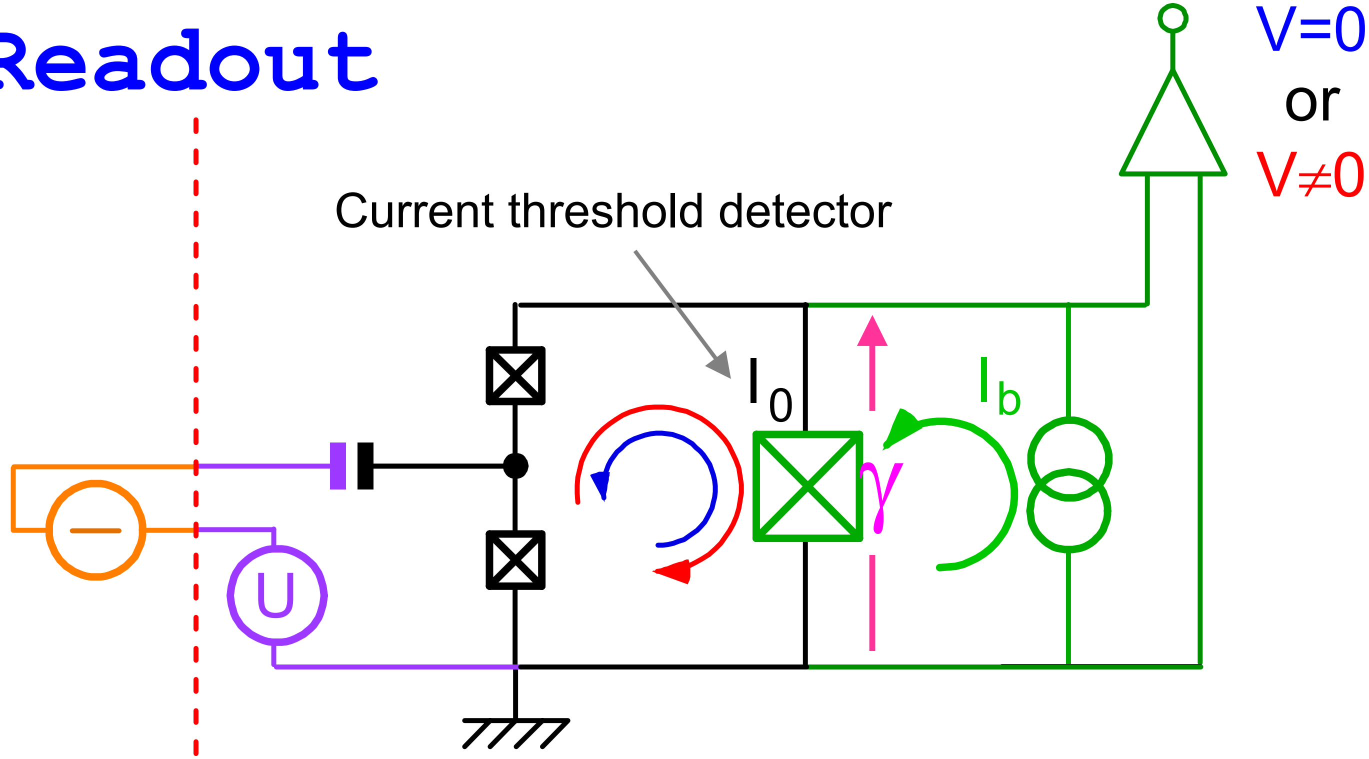


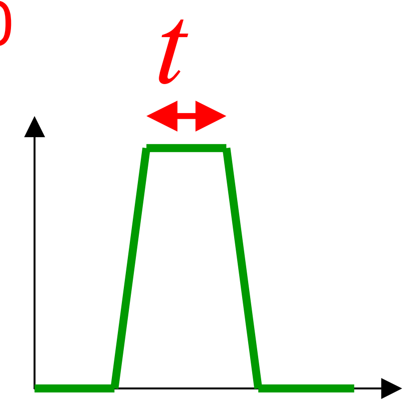
persistent currents $$i_j = \frac{1}{\varphi_0}\frac{\partial E_j}{\partial \delta}$$



Differential Signal $$i_1 - i_0 = 4\pi e \frac{\partial \nu_{01}}{\partial \delta}$$

Readout

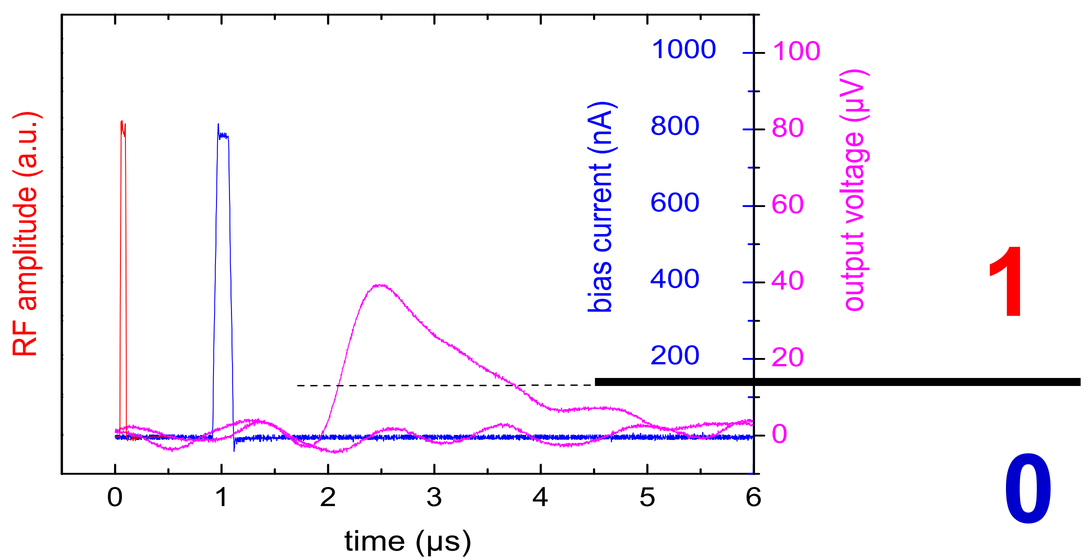




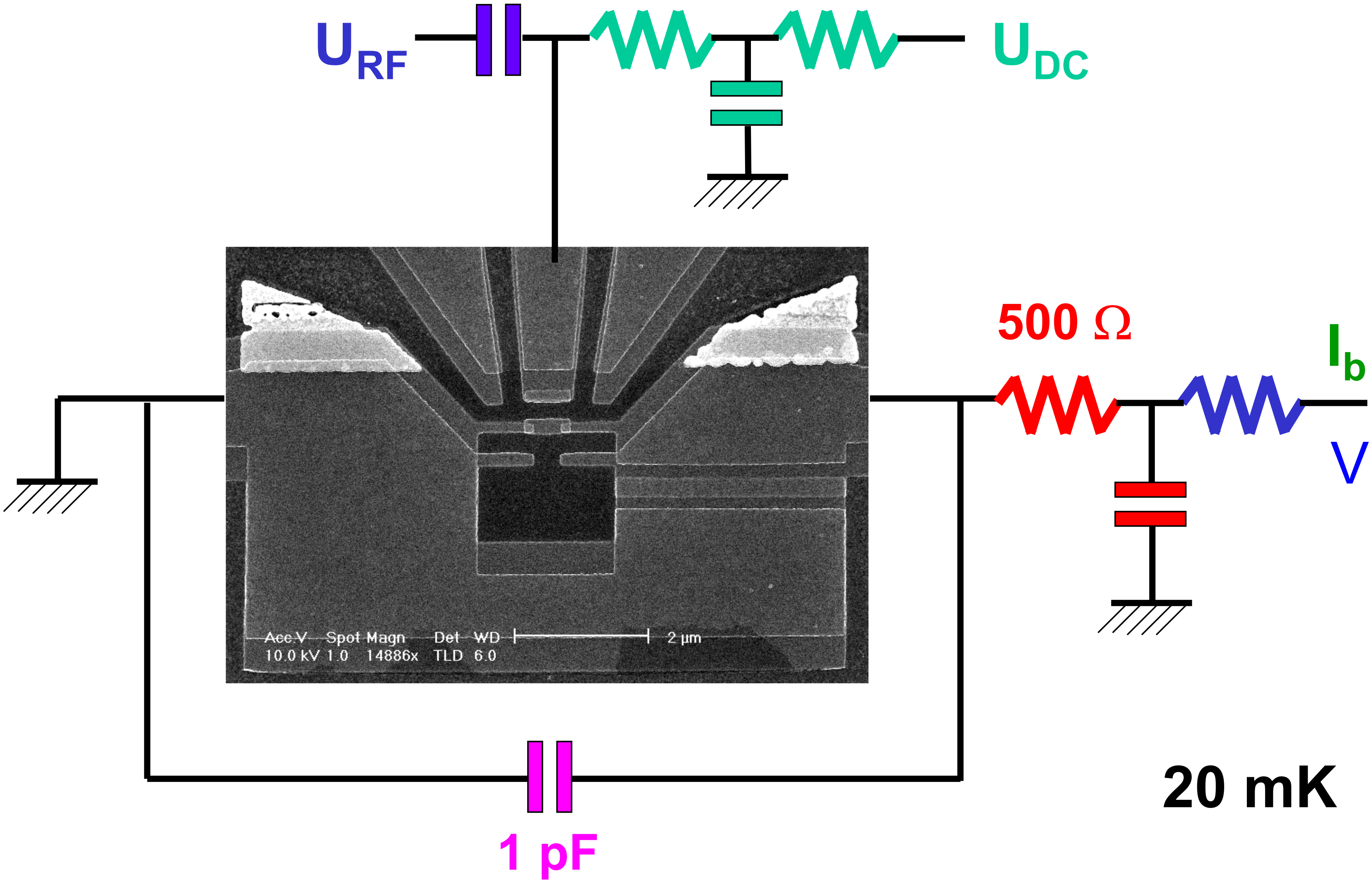
$\Gamma_1 t >>1$

$\Gamma_0 t <<1$

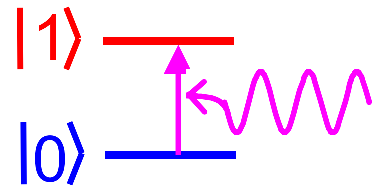
discrimination

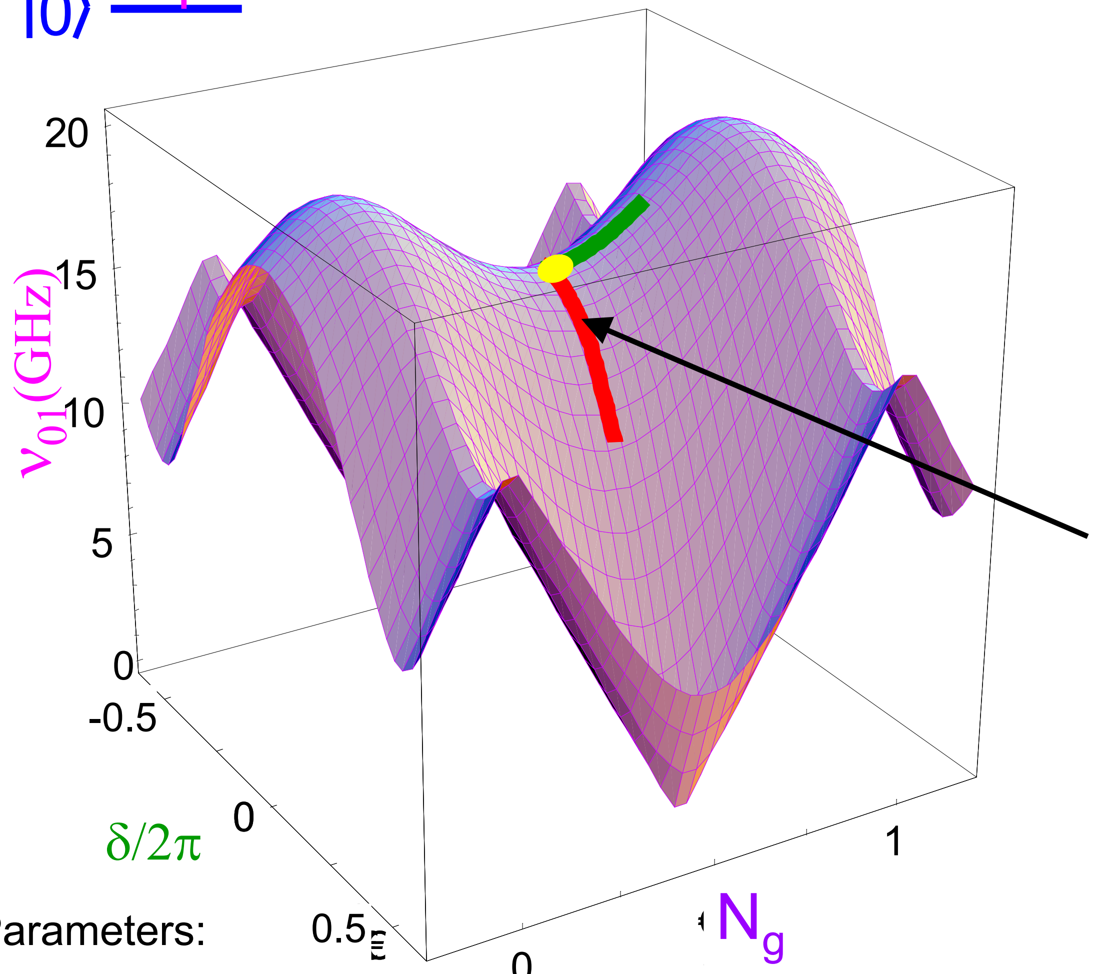


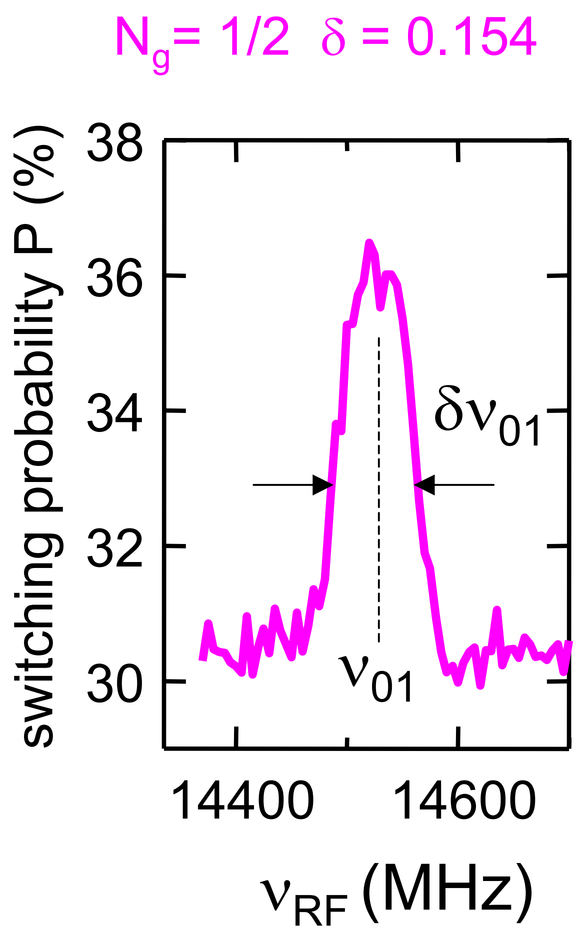
Implementation



Spectroscopy $\nu_{01}(N_g,\delta)$





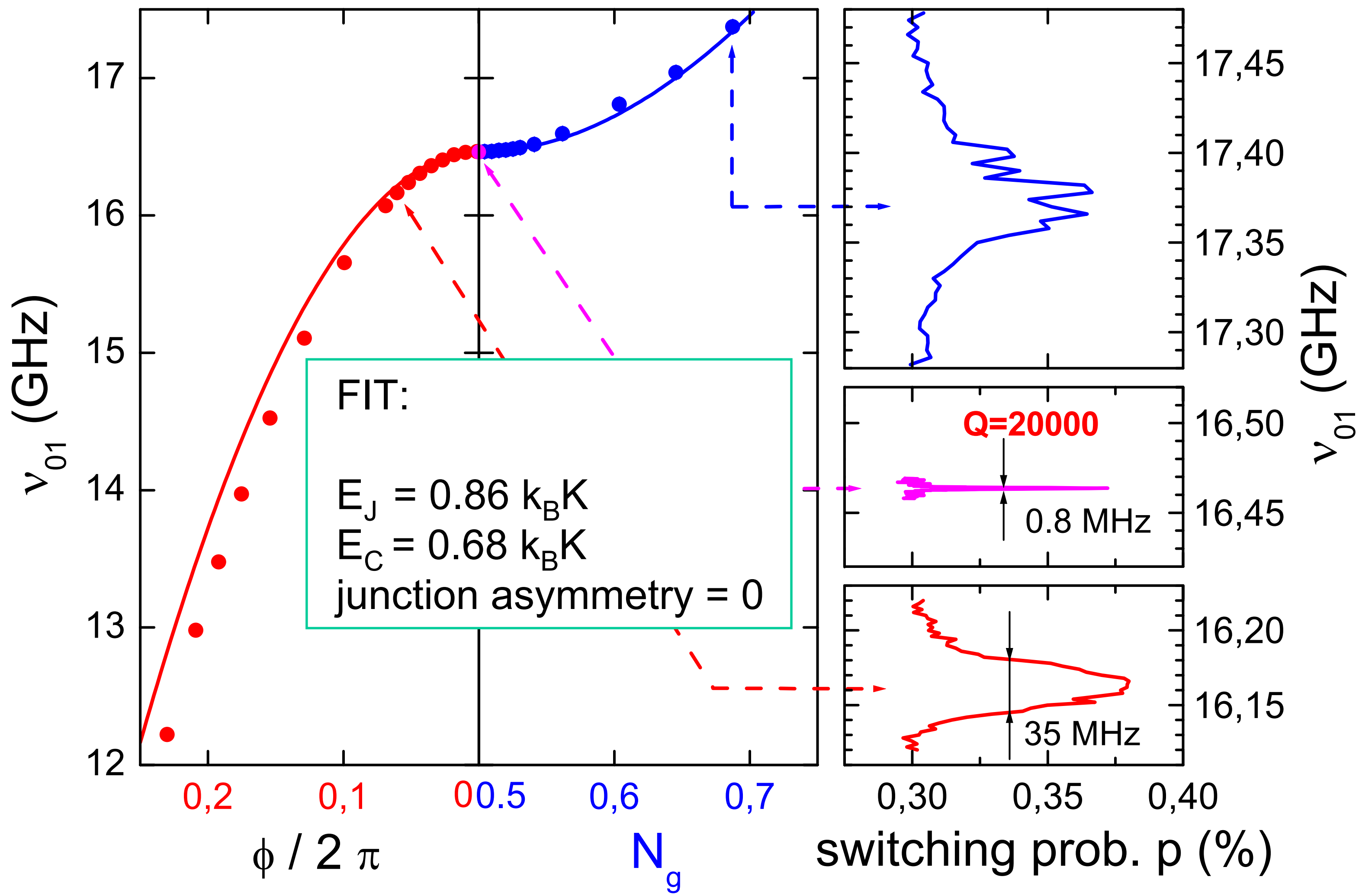


Parameters:

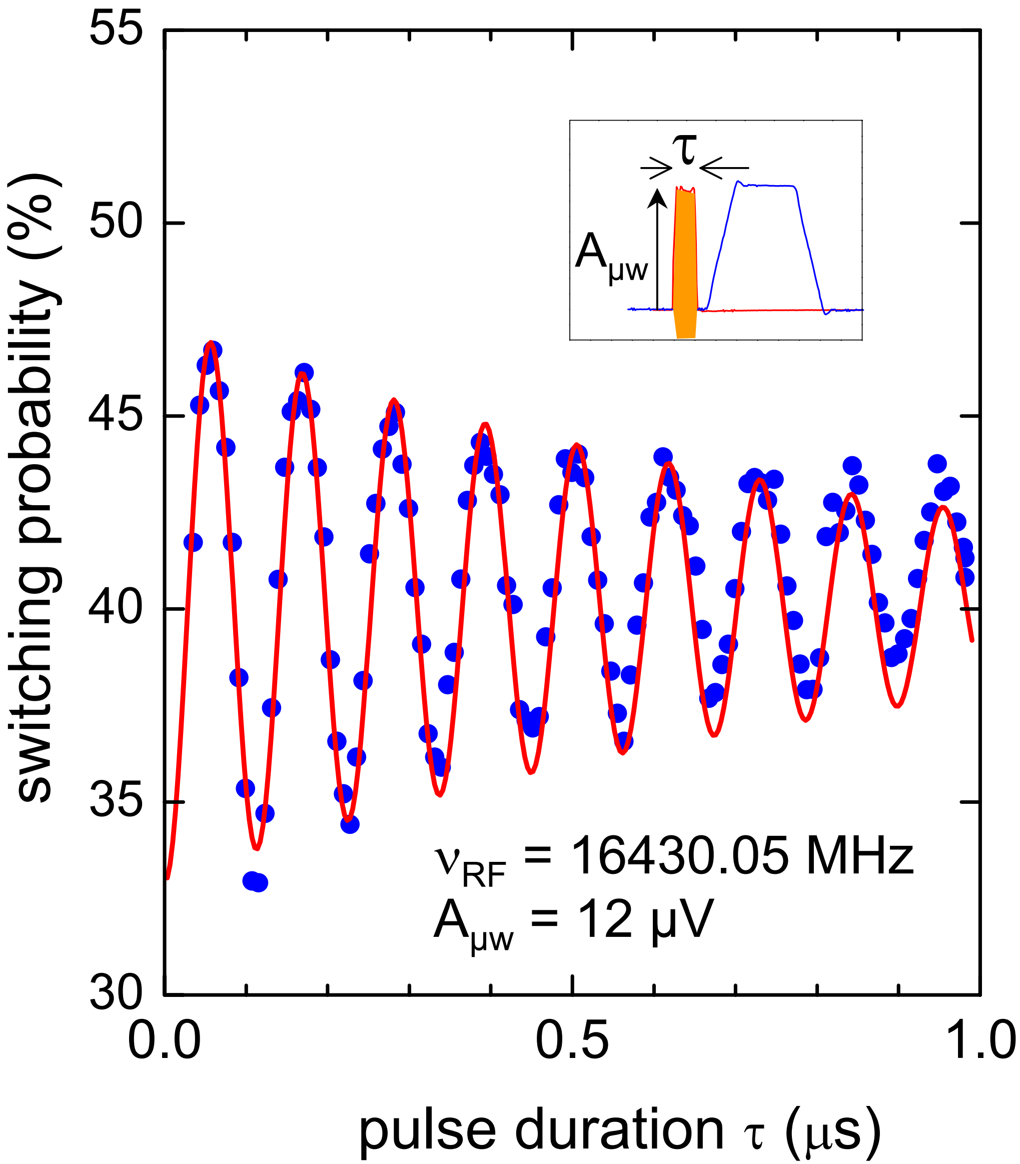
E_J=0.86 k_BK

E_c=0.68 k_BK

Level spectroscopy $\nu_{01}(Ng, \phi/2\pi)$

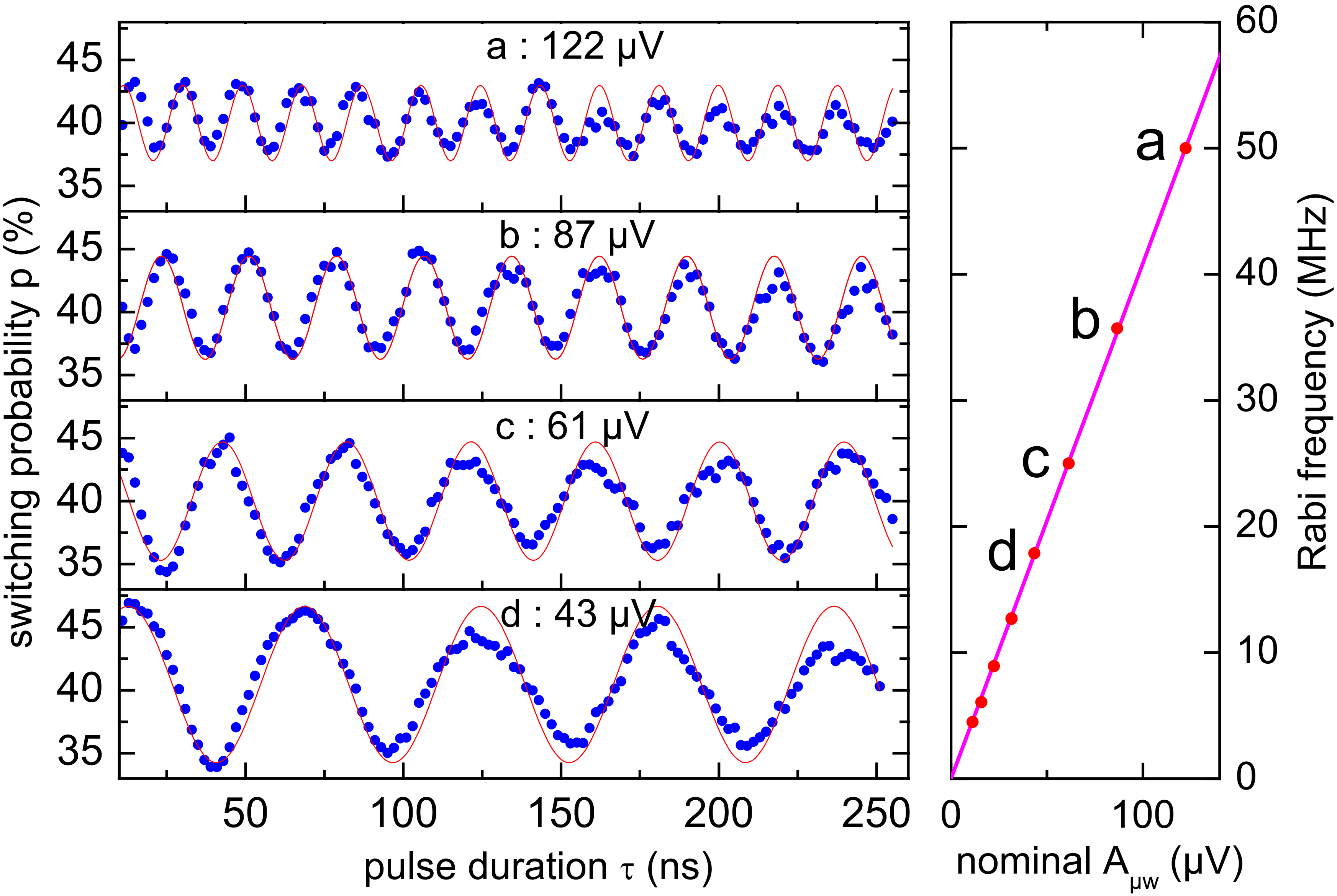


Controlled μw driven rotations

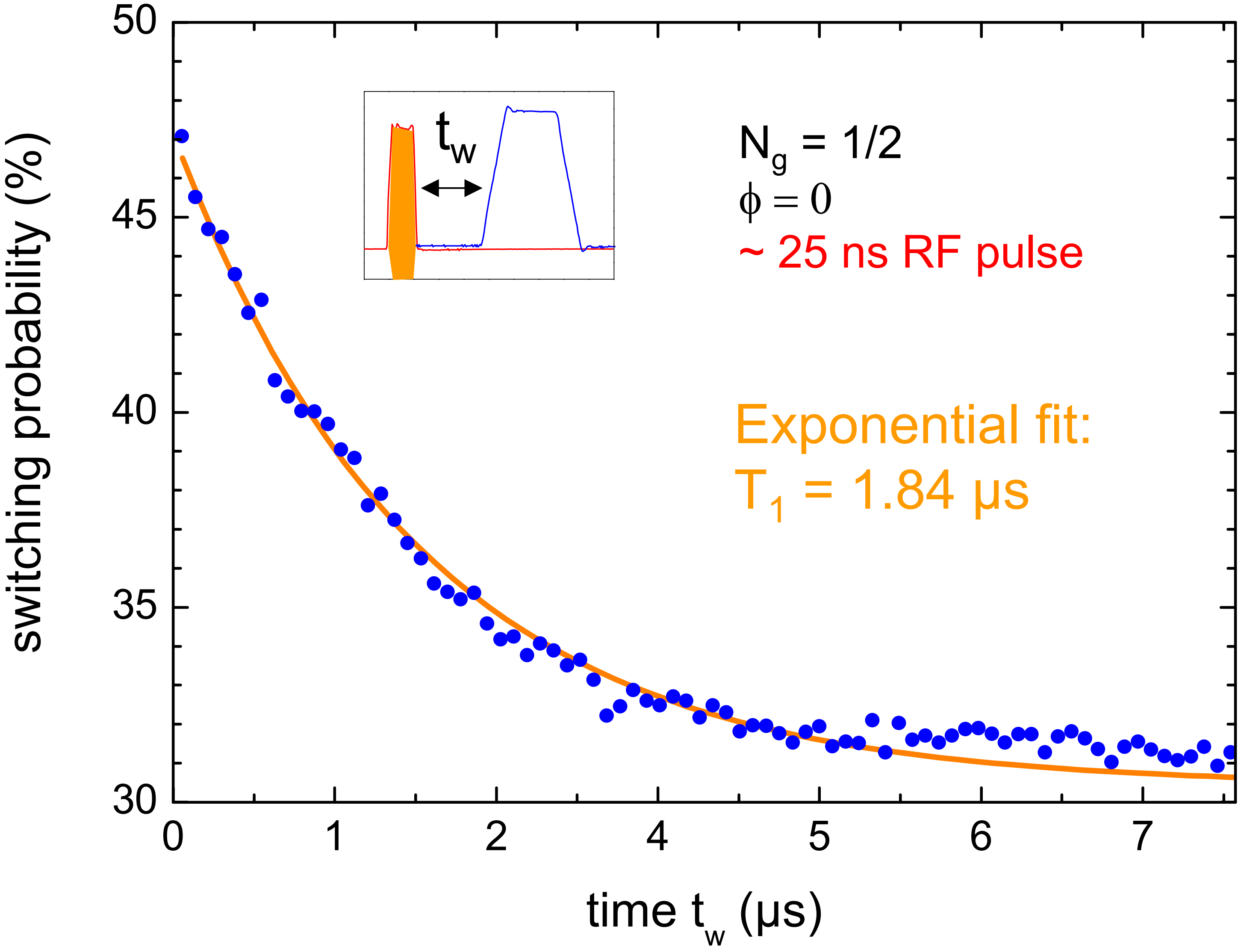


Rabi oscillations

Rabi frequency versus μw amplitude

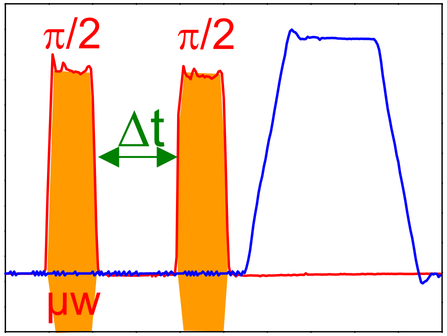


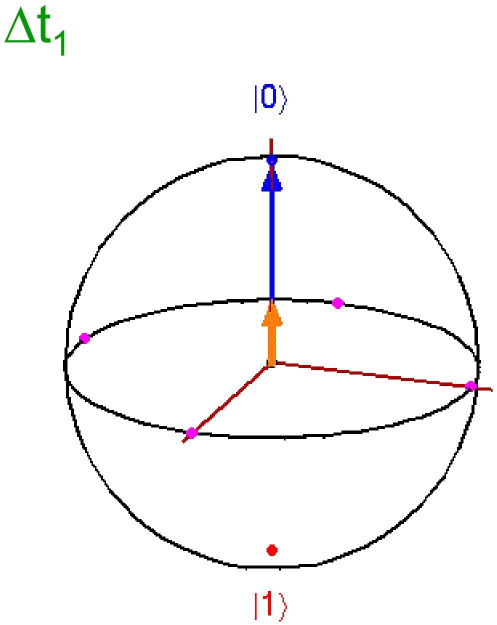
Measurement of the relaxation time

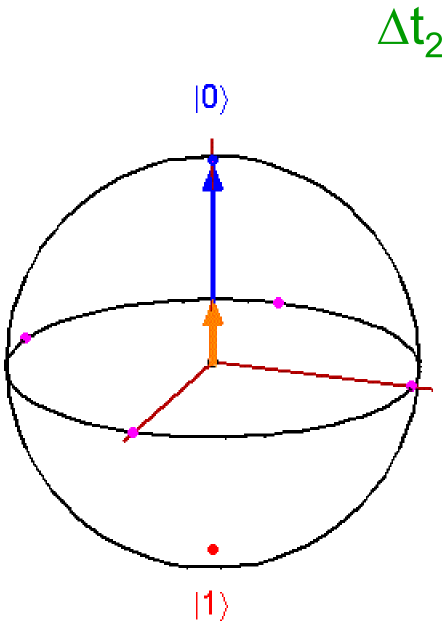


Decoherence during free evolution: principle of measurement

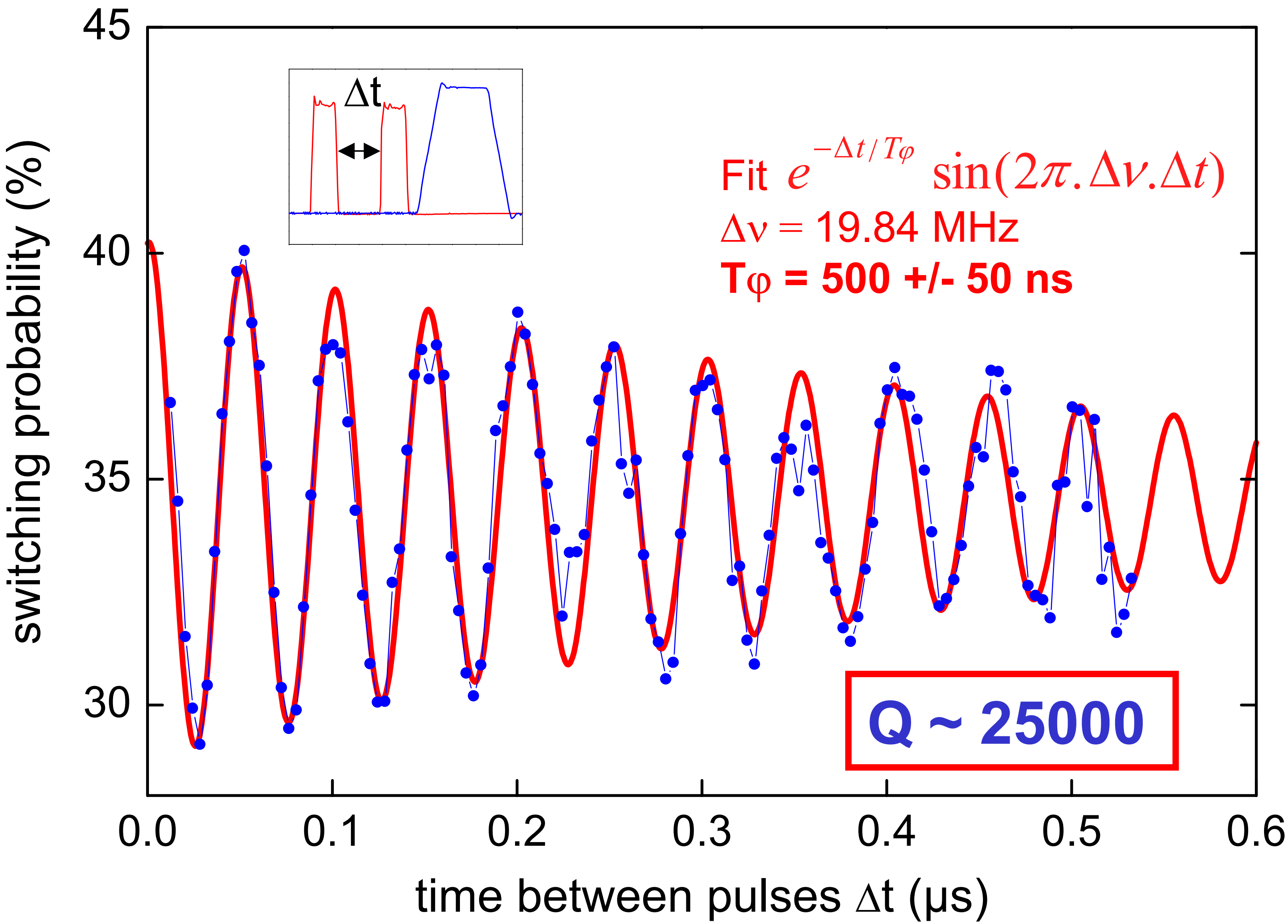
Ramsey sequence



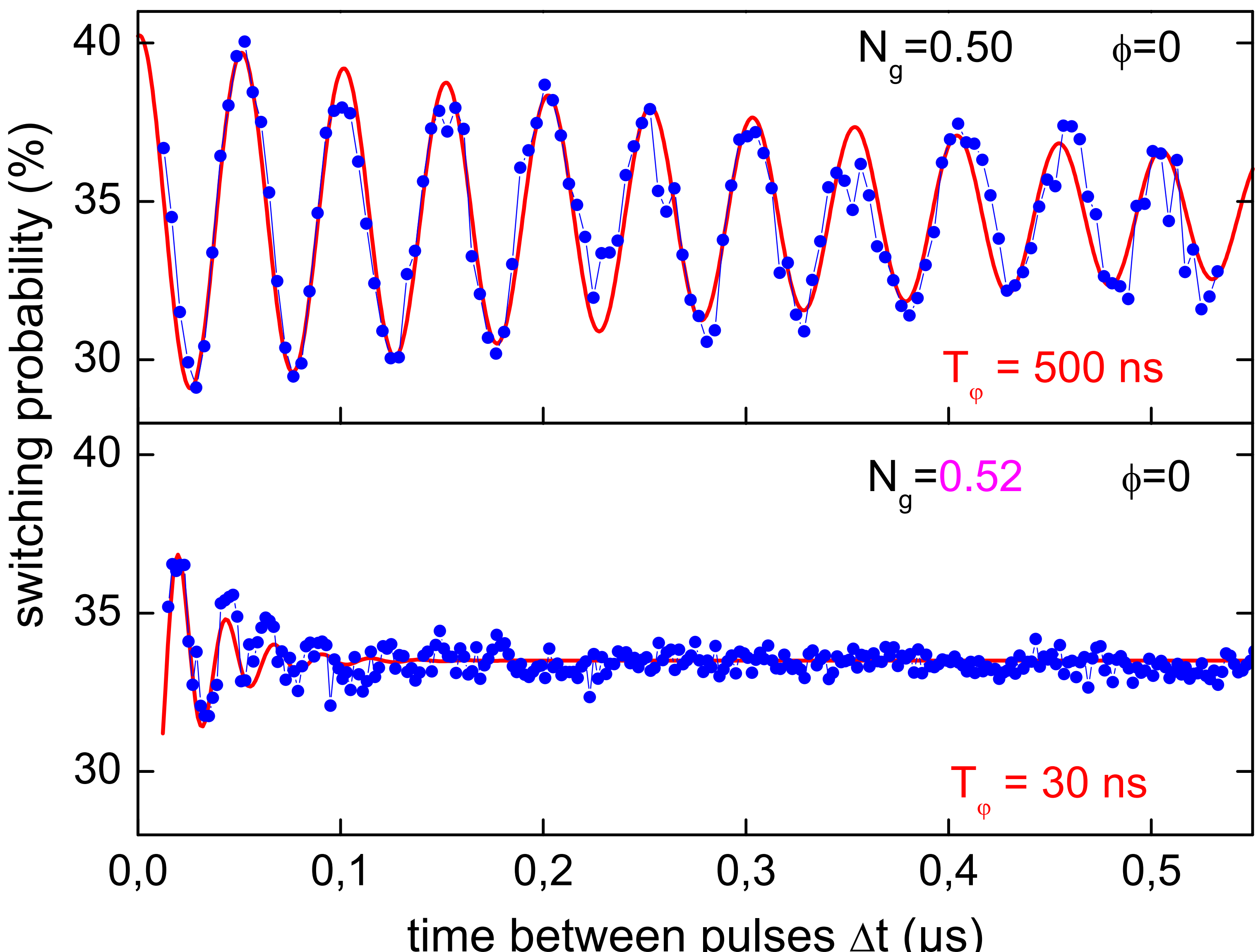




Measurement of the coherence time

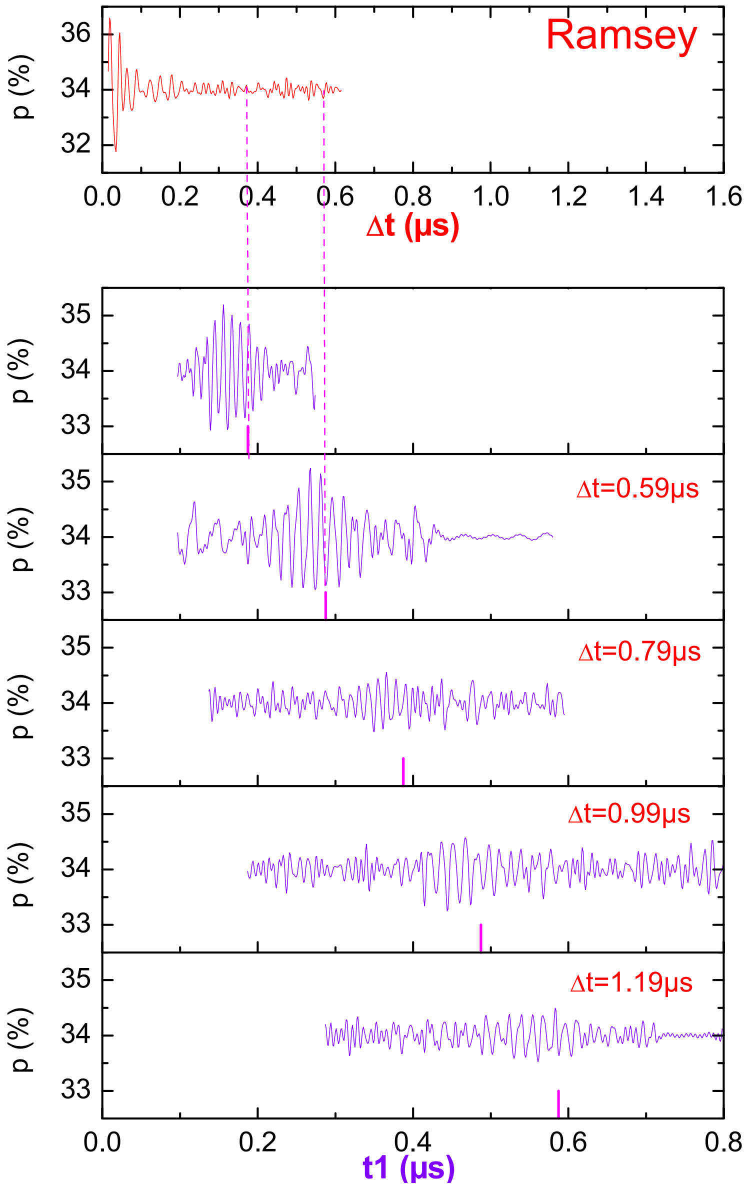


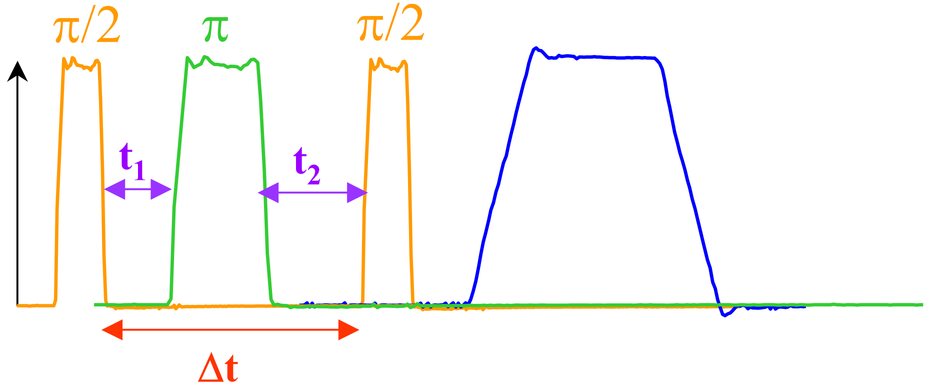
Coherence time at the optimal point...and 2% x 2e away



Three pulses:spin-echoes

$\phi = 0$, $\Delta Ng = 2\% \times 2e$





compensating low frequency ν_{01} fluctuations

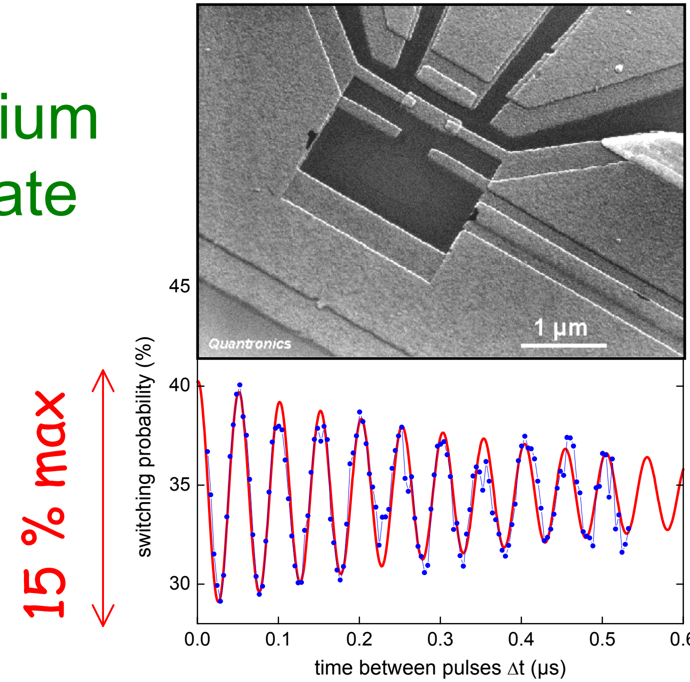
Conclusions

New quantum circuit: Quantronium

- preparation of any arbitrary state
- **Tφ > 8000 /** ν_{01}

-towards single shot readout

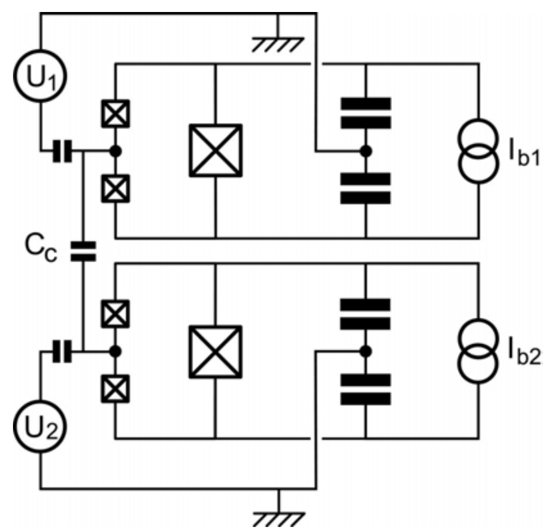
- low apparent polarization: imperfect readout?



Perspectives

2 capacitively coupled quantroniums

Production of Bell's states or quantum gate ...



$$|01\rangle + |10\rangle$$

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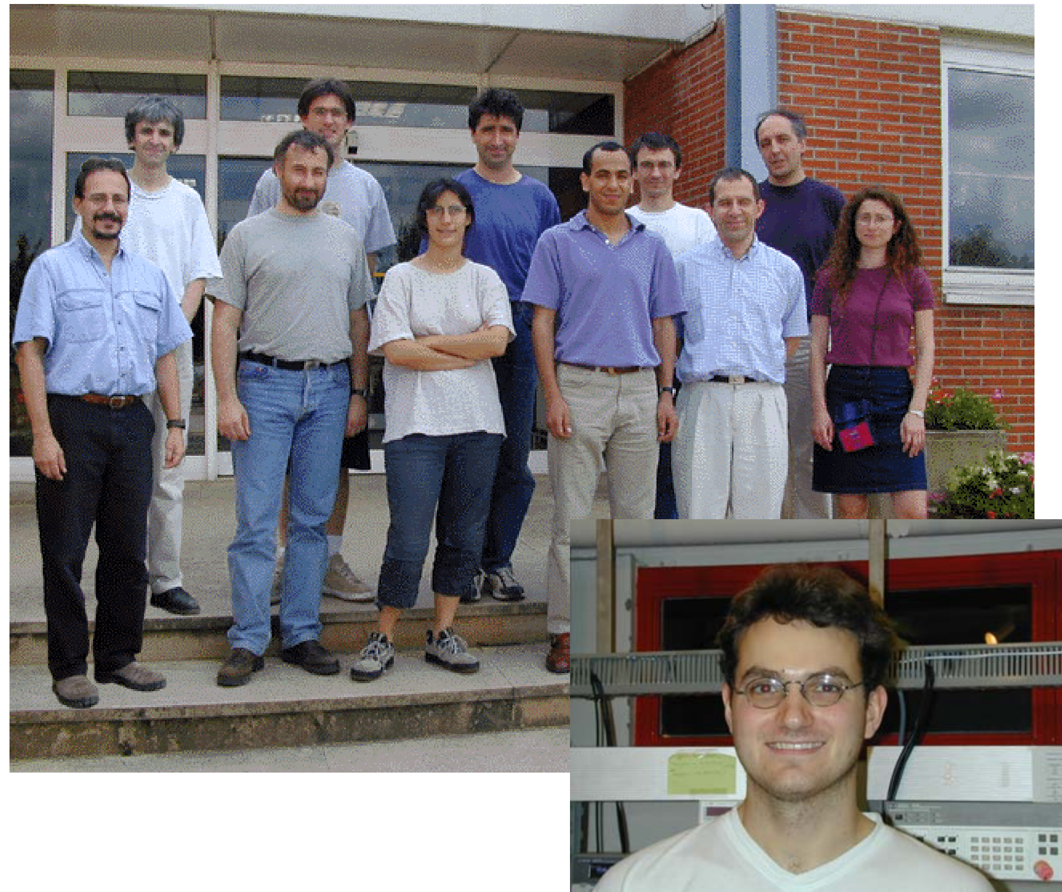

D. VION
G. ITHIER
A. AASSIME
P. JOYEZ
H. POTHIER
M. DEVORET
(now at Yale)

C. URBINA
D. ESTEVE
P. ORFILA
P. SENAT

and previously
P. LAFARGE
V. BOUCHIAT
A. COTTET

G. ITHIER

ist information society technologies

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