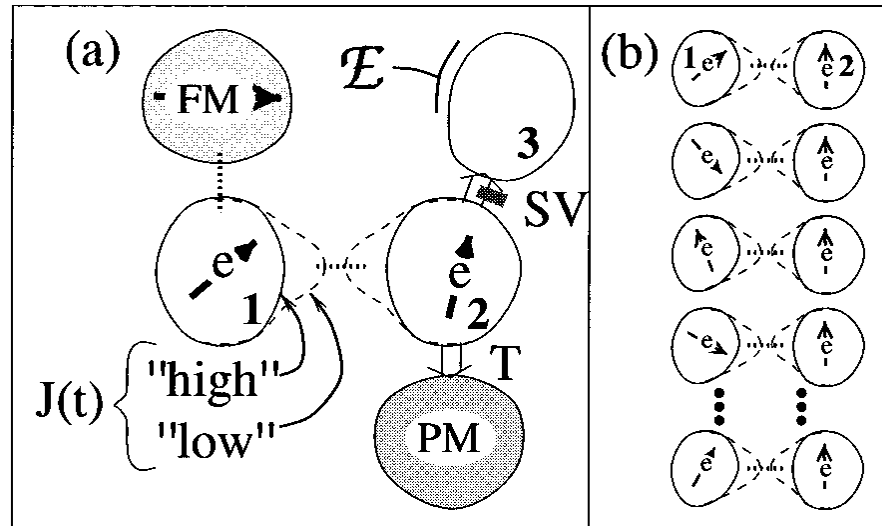# Solid state Q-bits

Realizing spin Q-bits

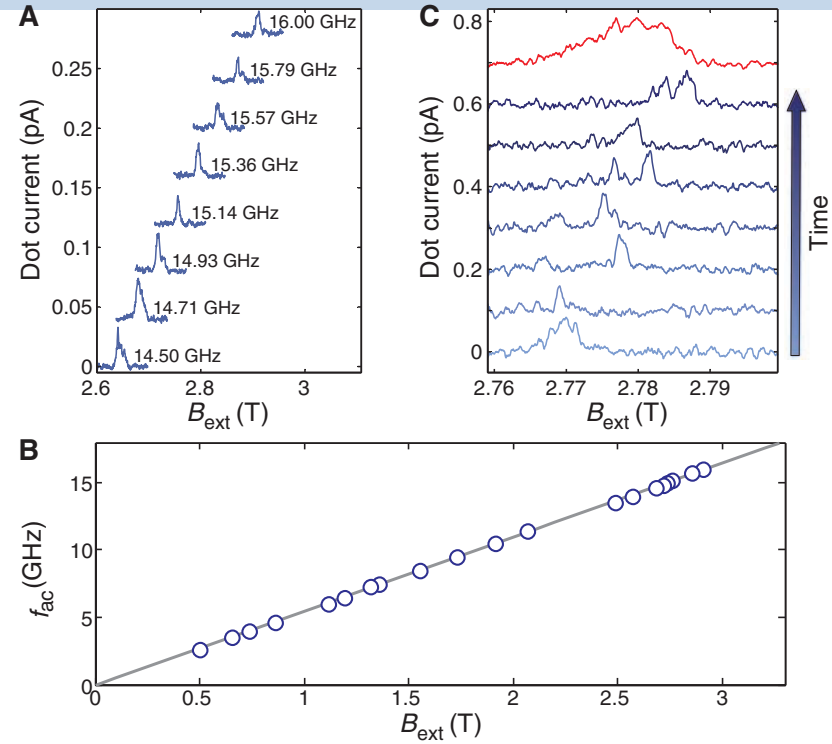$$H_s(t) = J(t)\vec{S}_1 \cdot \vec{S}_2 \, ,$$
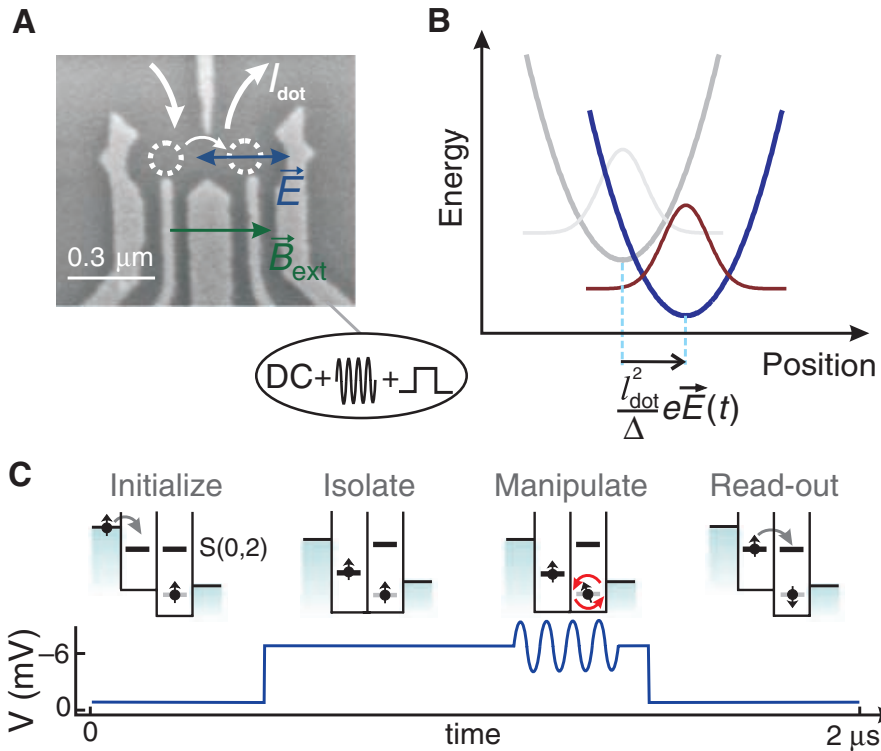
➡ Swap operation

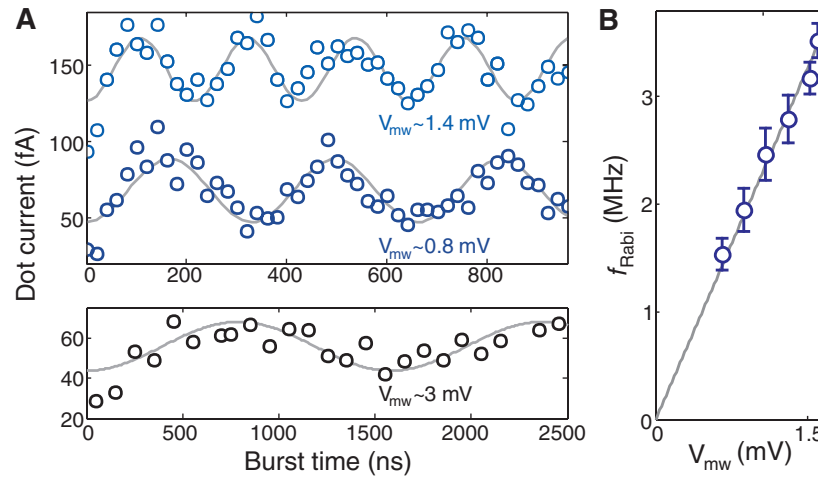➡ XOR gate = any quantum computation

[Loss and Vincenzo, PRA 57, 120 (1998)]

Coherent spin control

A

0.3 μm

$\vec{E}$
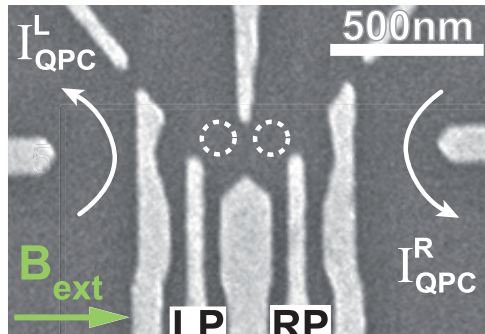
$\vec{B}_{ext}$

B

Energy

Position

$$\frac{l_{dot}^2}{\Delta} e\vec{E}(t)$$

DC + ⌁⌁⌁ + ⎍

C

Initialize   Isolate   Manipulate   Read-out

S(0,2)

V (mV)

−6

0

0   time   2 μs

A

Dot current (pA)

16.00 GHz
15.79 GHz
15.57 GHz
15.36 GHz
15.14 GHz
14.93 GHz
14.71 GHz
14.50 GHz

0.25
0.2
0.15
0.1
0.05
0

2.6   2.8   3

B_{ext} (T)

C

Dot current (pA)

0.8
0.6
0.4
0.2
0

2.76   2.77   2.78   2.79

B_{ext} (T)

Time

B

f_{ac} (GHz)

15
10
5
0

0   0.5   1   1.5   2   2.5   3

B_{ext} (T)

Rabi oscillations:

A

Dot current (fA)

150
100
50

$V_{mw}\sim1.4$ mV
$V_{mw}\sim0.8$ mV

0   200   400   600   800

60
40
20

$V_{mw}\sim3$ mV

0   500   1000   1500   2000   2500

Burst time (ns)

B

f_{Rabi} (MHz)

3
2
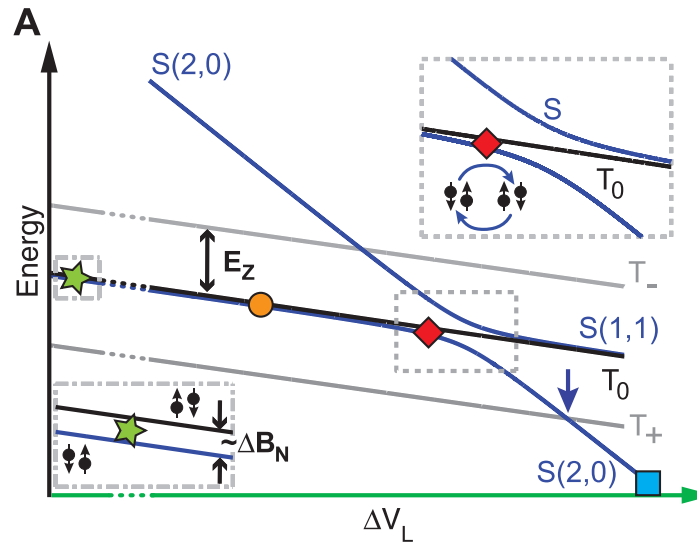1
0

0   1.5

V_{mw} (mV)

[Nowack et al,
Science 318, 1430 (2007)]

Coherent spin control

Device

Working points
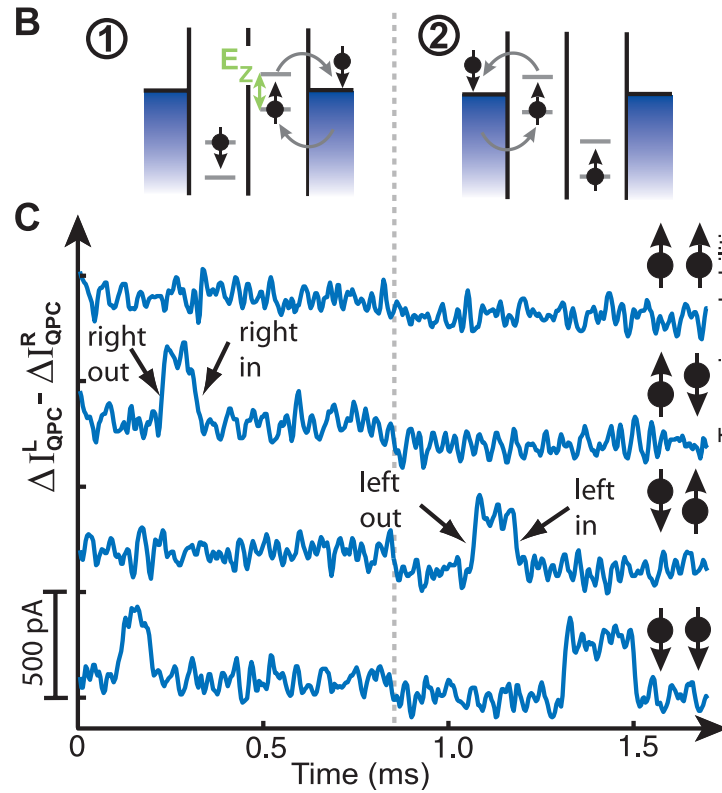

Preparation S(2,0) state
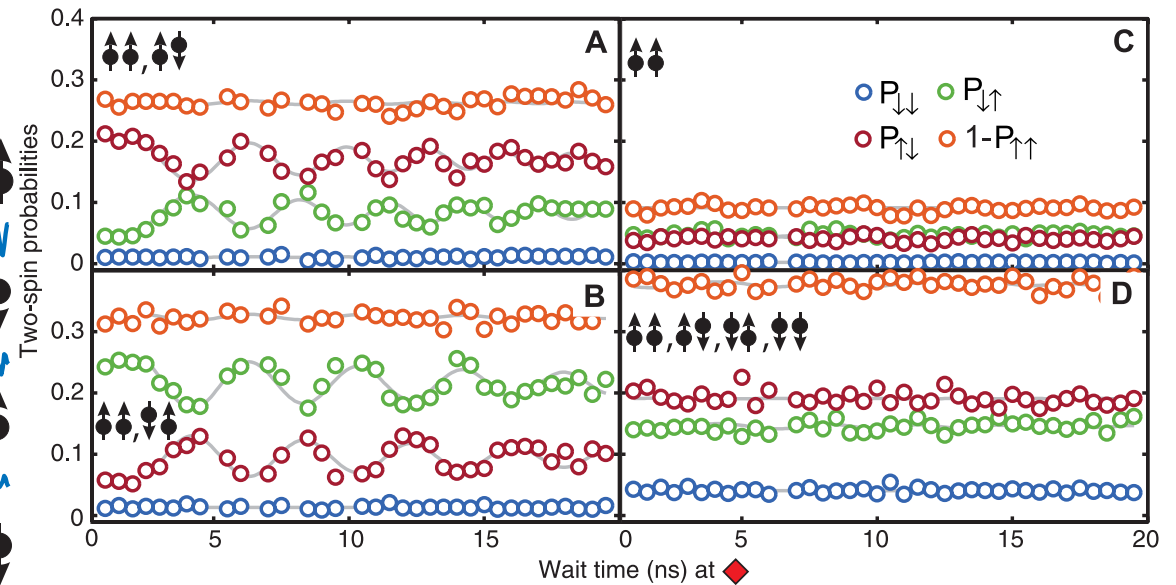
operation
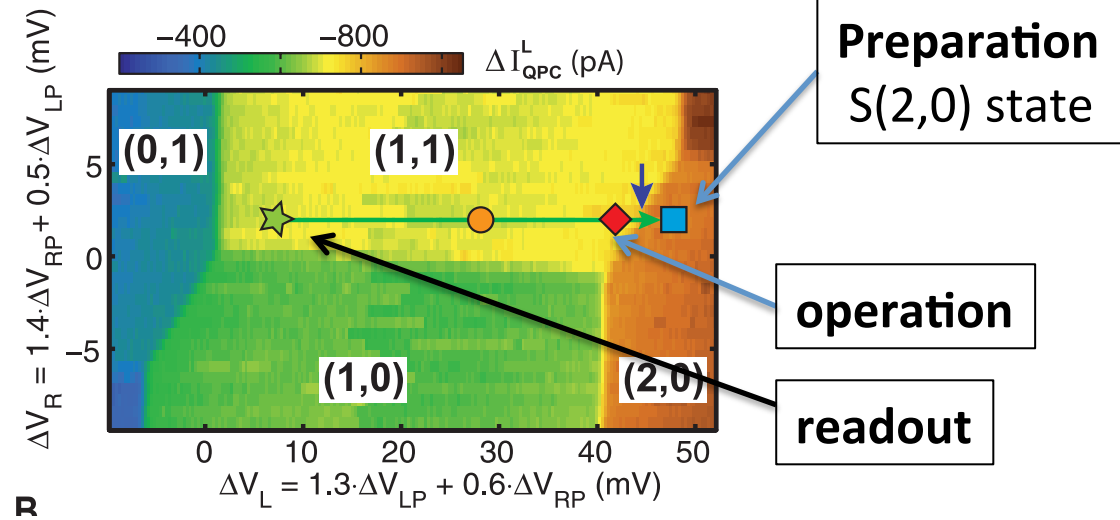
readout

[Nowack et al,
Science 333, 1269 (2011)]

Coherent spin control

Single shot readout:

Probability oscillations:

[Nowack et al, Science 333, 1269 (2011)]