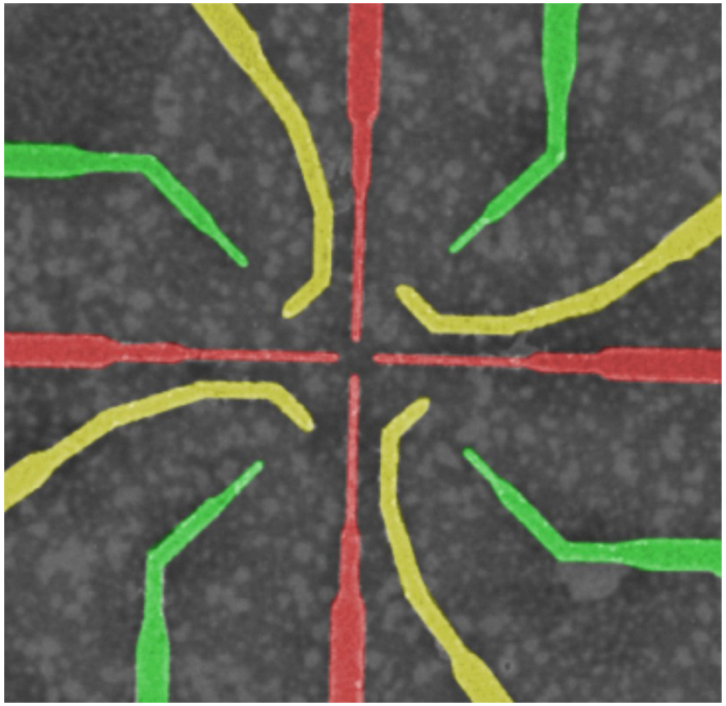
A few-electron quadruple quantum dot in a closed loop



R. THALINEAU, S. HERMELIN, A. WIECK, C. BAUERLE, L. SAMINADAYAR, T. MEUNIER

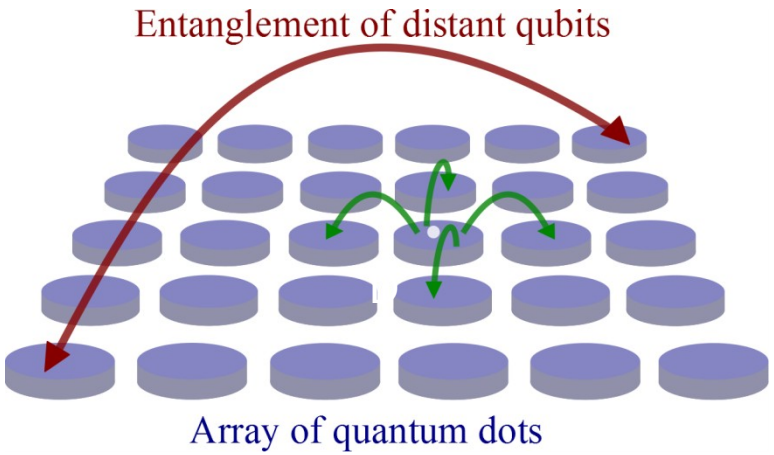
APL **101**, 103102 (2012)

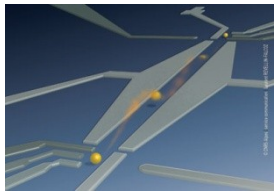
NEEL Institute
Quantum Coherence Group
Grenoble (France)

Context and motivations

Control the path of a single electron in semiconducting nanostructure

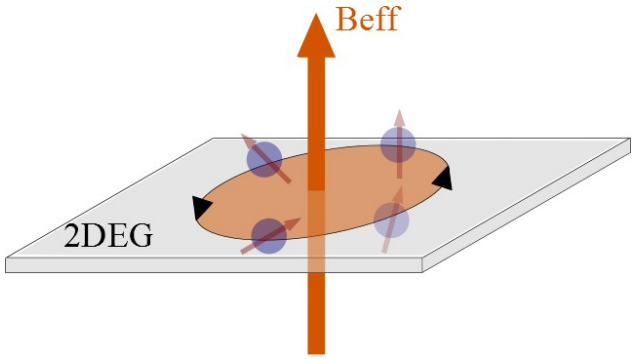
Scale up the number of spin qubits interacted together





Hermelin & al, Nature (2011)
McNeil & al, Nature (2011)

Coupled to SO interaction : interesting way to manipulate coherently a single electron spin



$L_{SO} \sim 5\mu m$

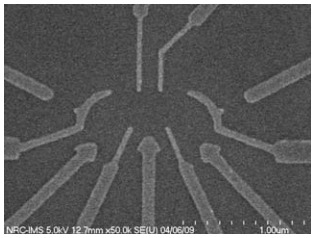
$L_{dot-dot} \sim 100nm$

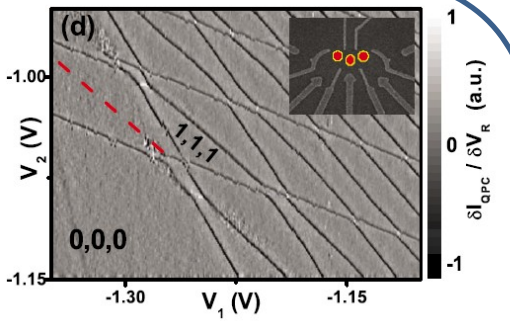
Nowack & al, Science (2007)
San Jose & al, PRB (2008)
Golovach & al, PRB (2010)

State of the art

Triple quantum dots in series

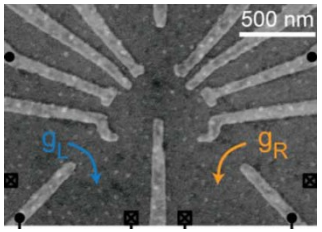
Few electron regime ✓

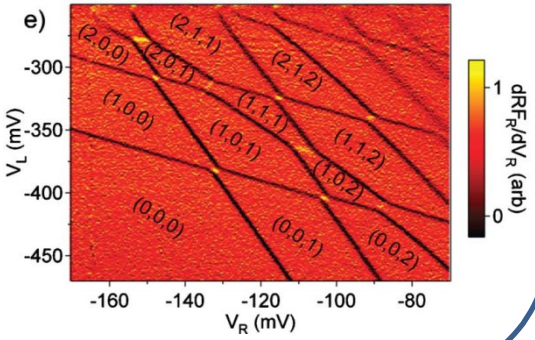




Gaudreau & al, APL (2009)

No transport allowed along a closed path ✗



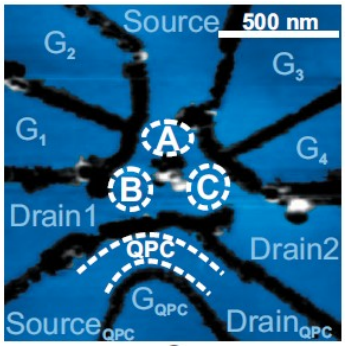


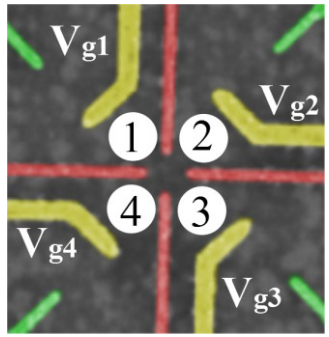
Laird & al, PRB (2010)

Triple quantum dots in a star-like configuration

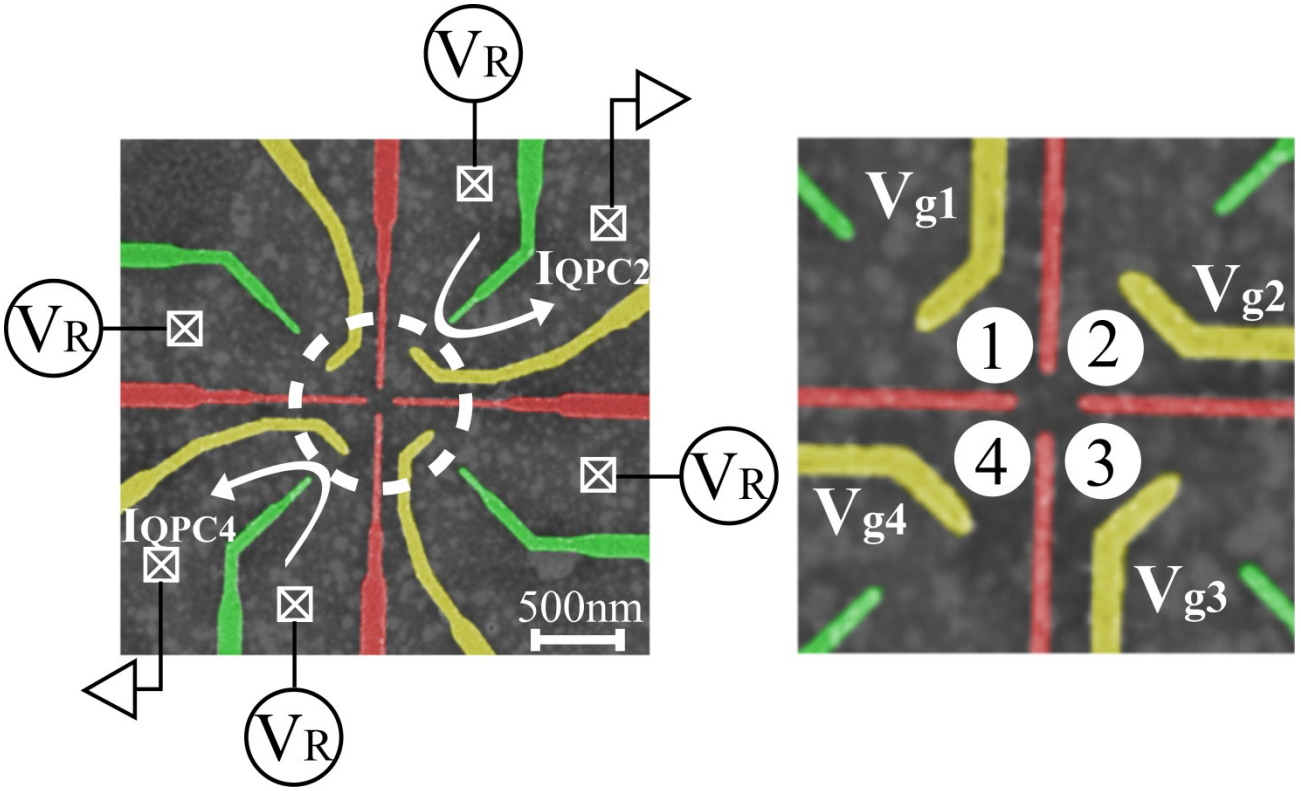
Few electron regime ✗

Rogge & al, PRB (2008)



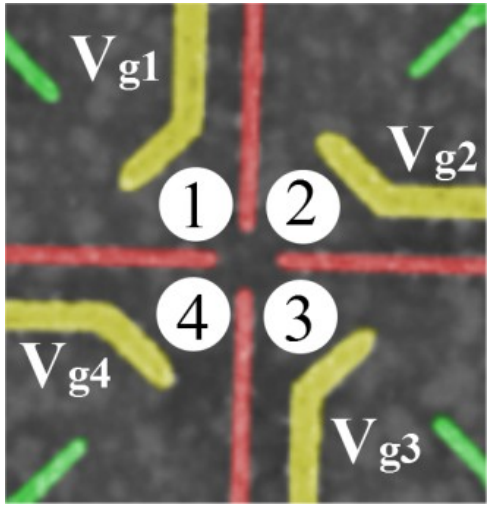


Geometry



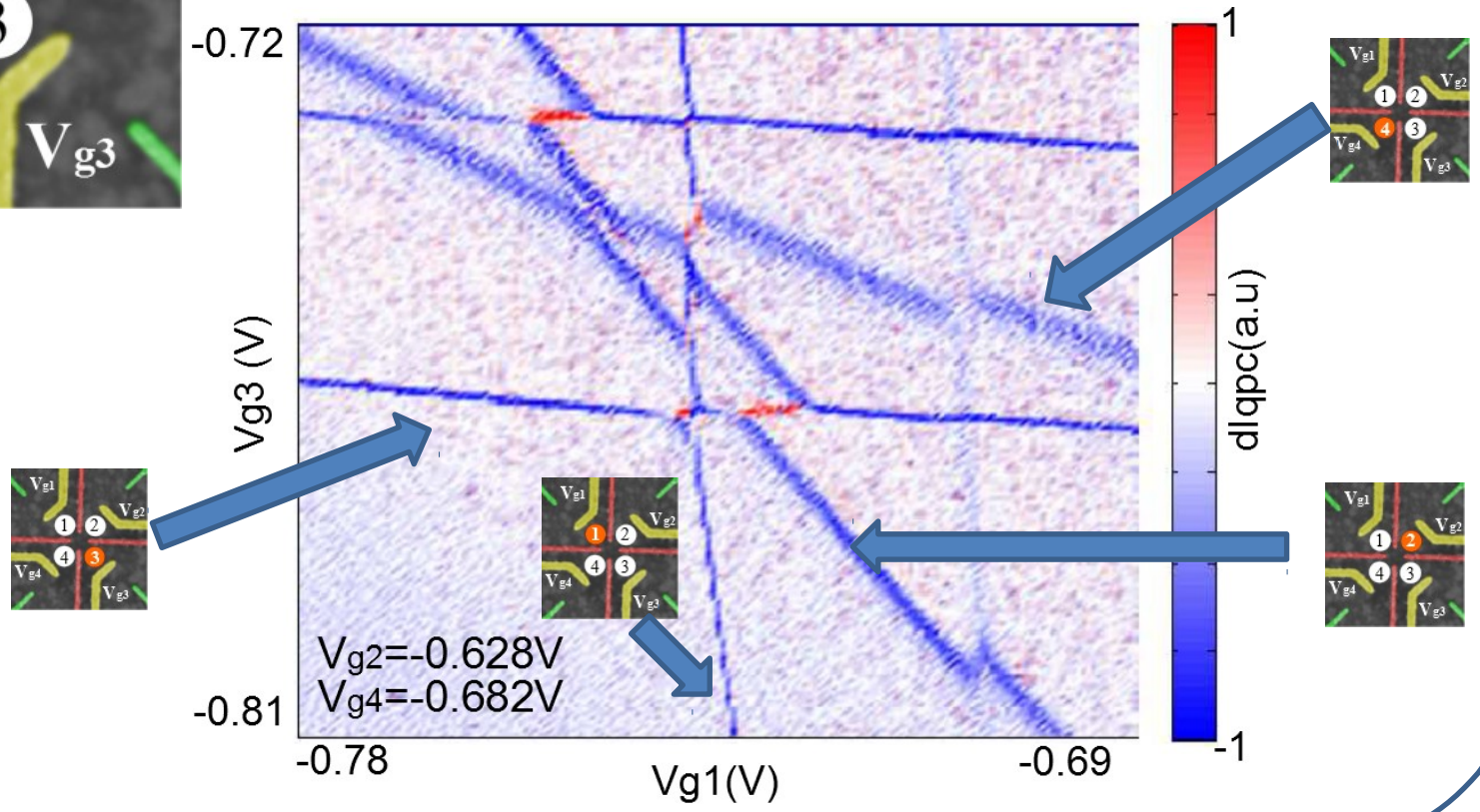
- Red gates : tunnel barriers between dots
- Yellow gates : tunnel barriers between dots and reservoirs and to control the electrochemical potential of each dot
- Green gates : QPC (electrometer)

Stability diagram

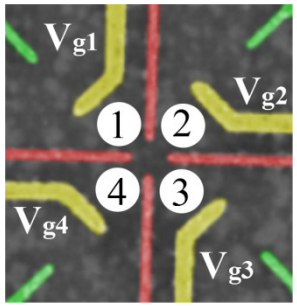


Vg2 and Vg4 are fixed
Vg1 and Vg3 are swept

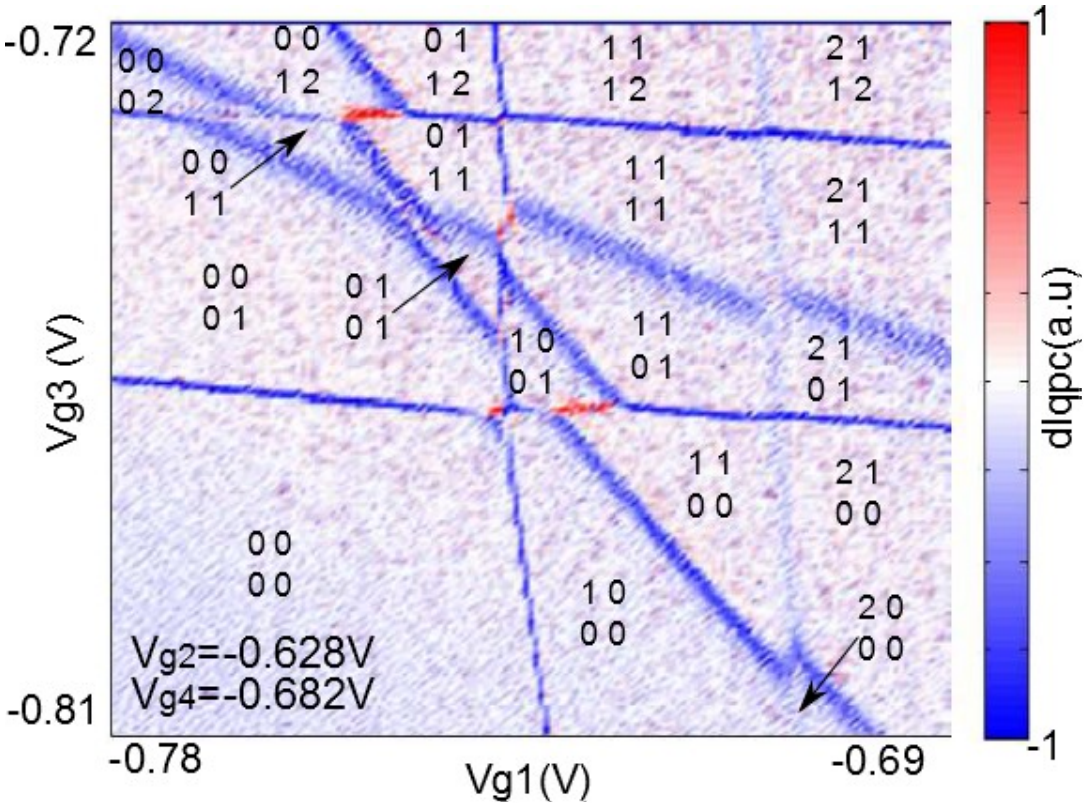
$dI_{qpc} = d(I_{qpc1}+I_{qpc2})/dVg$



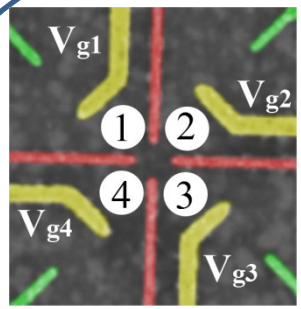
Stability diagram

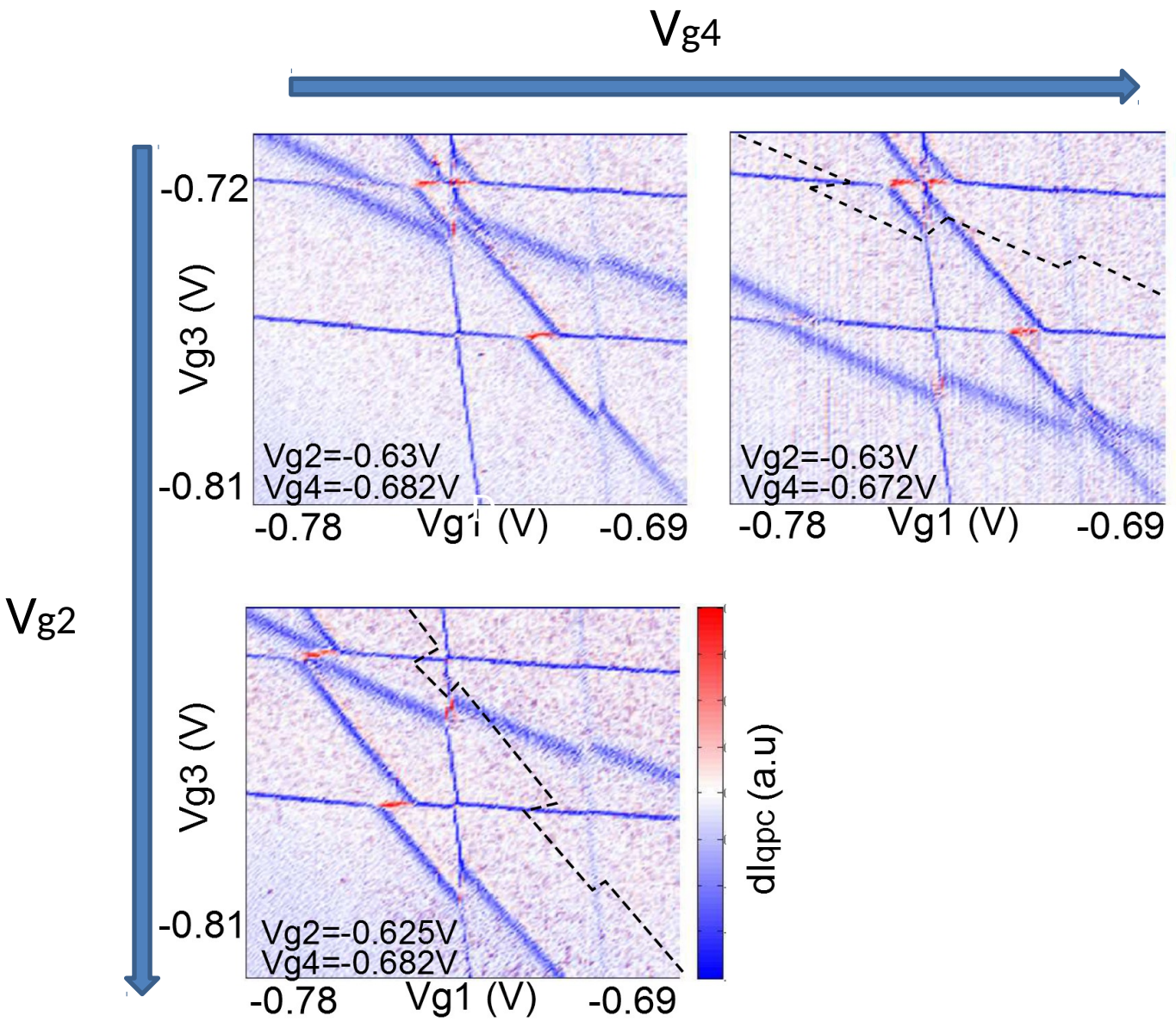


Vg2 and Vg4 are fixed
Vg1 and Vg3 are swept

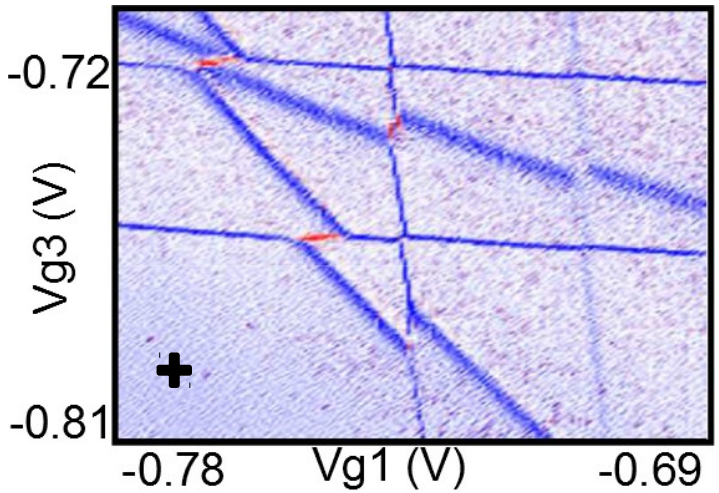


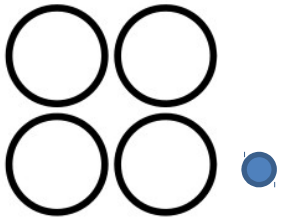
Control of each quantum dot

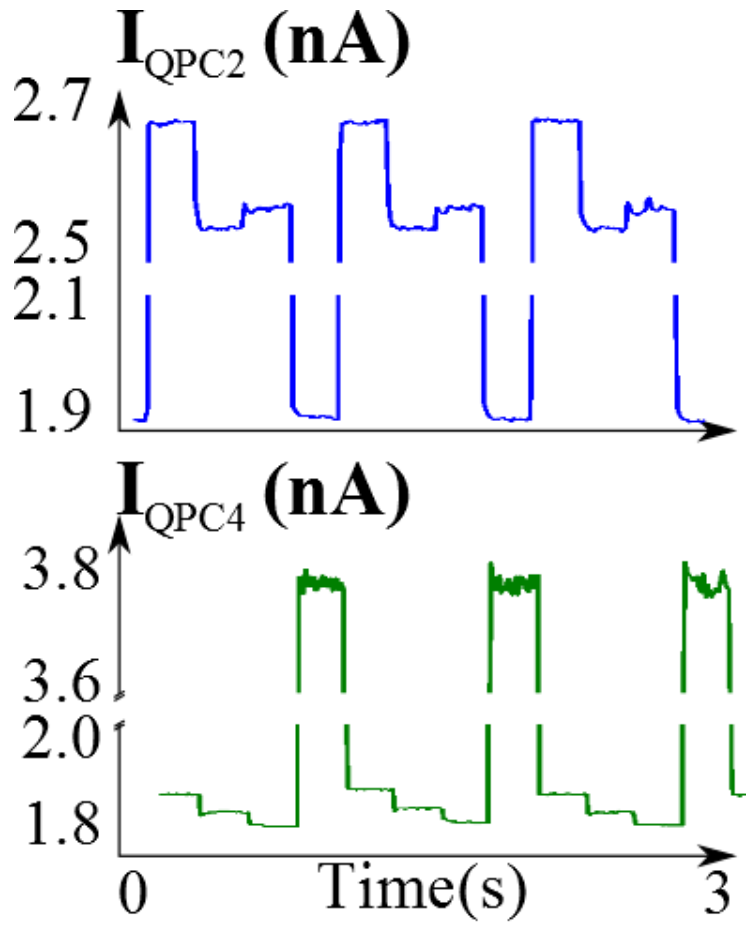


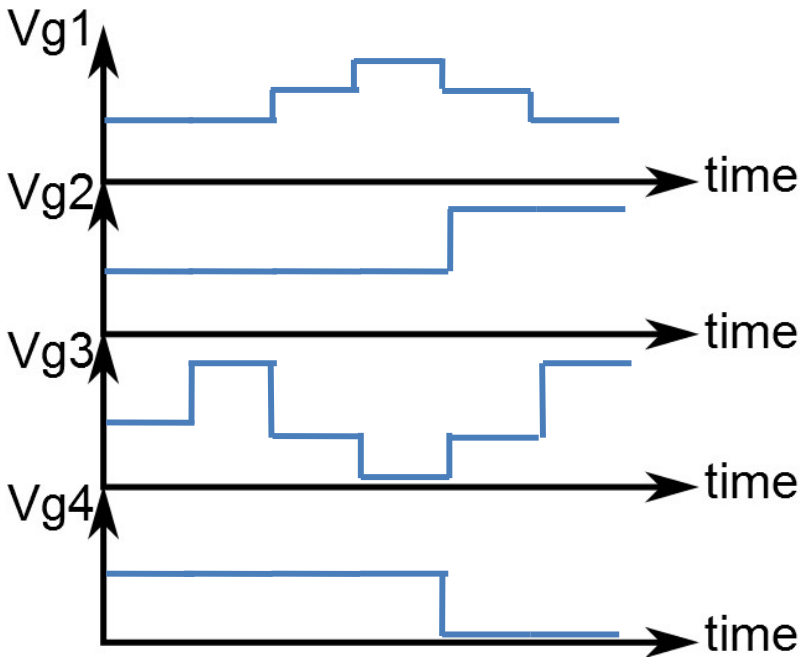


Single electron transport



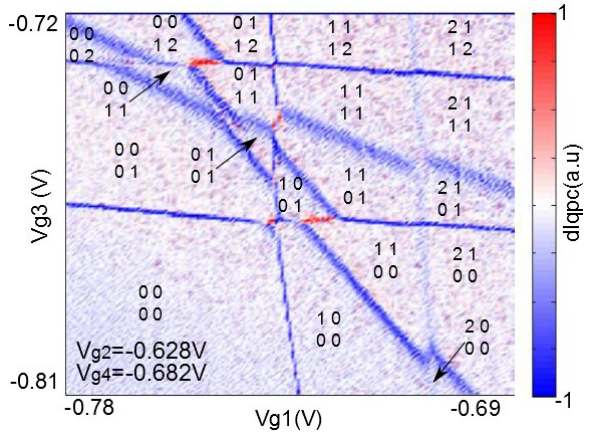




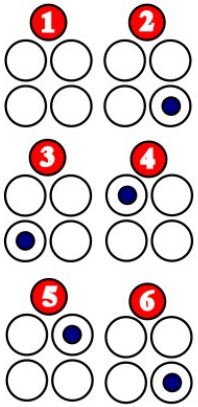


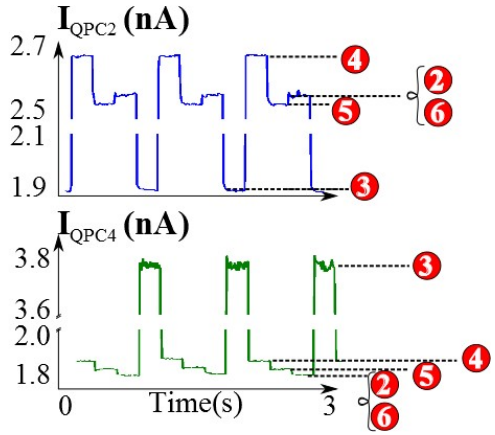
Conclusion and perspectives

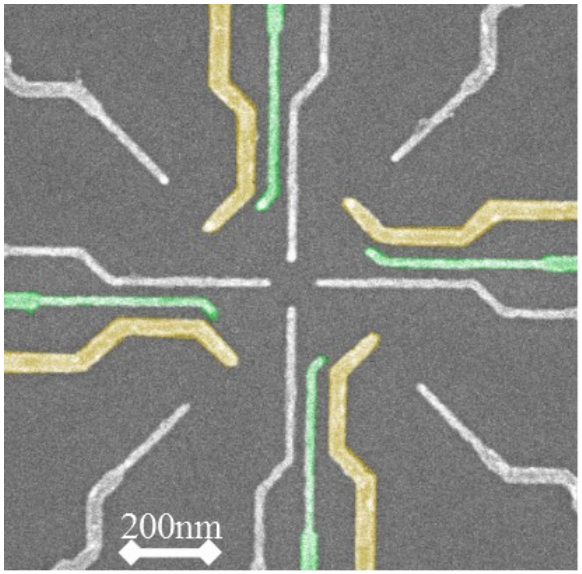
A quadruple quantum dot in the few electron regime



Single electron transport along a closed path







- Increase the tunability of the device by adding a set of gates in order to reach the GHz tunneling regime

Thank you for your attention

Any questions ?

Few electron regime