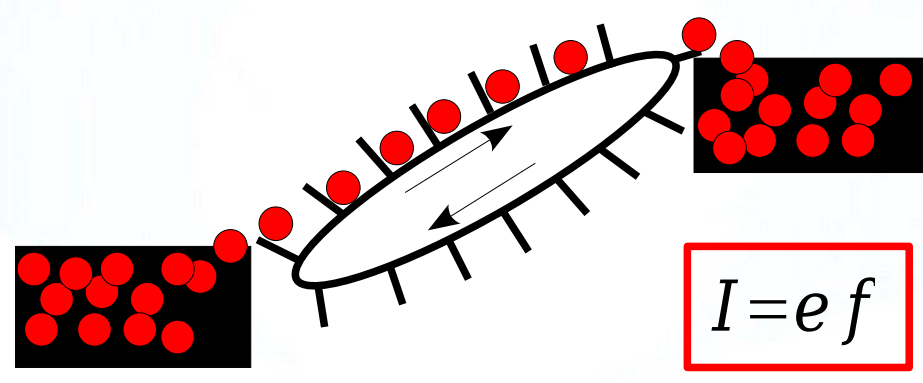


Towards an all-silicon electron pump: progress report



PNANO 2006 project,
ending 31st may 2010

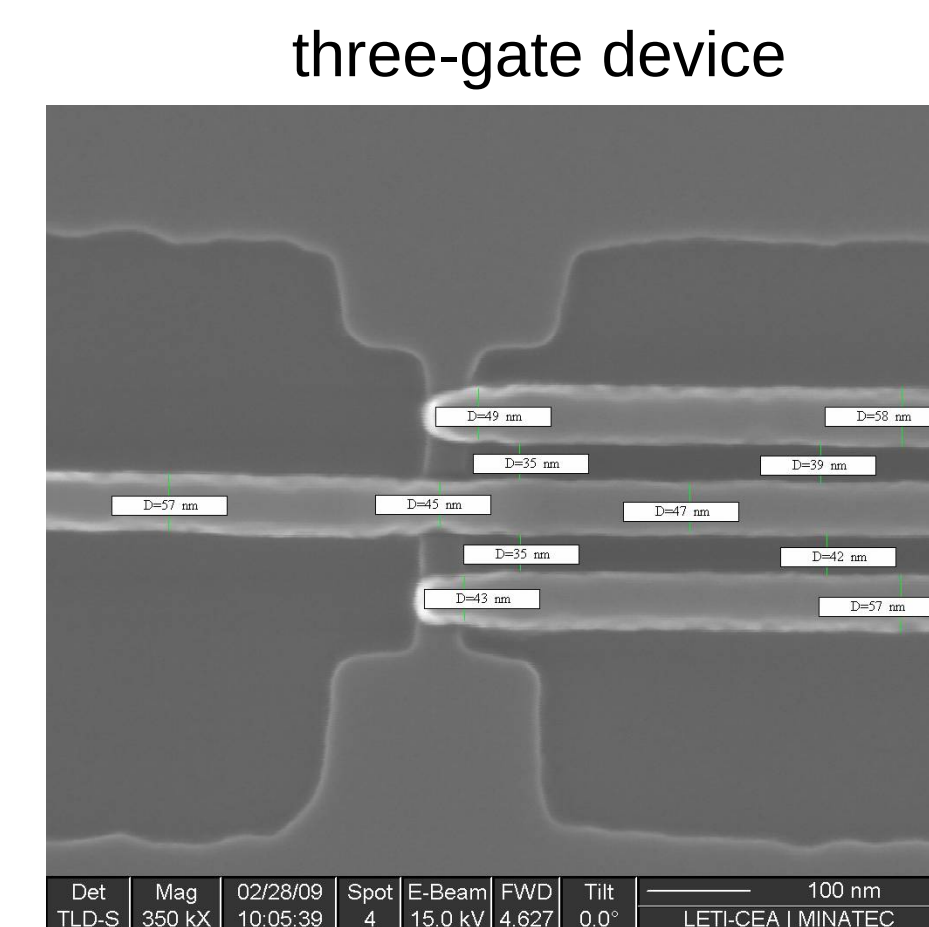
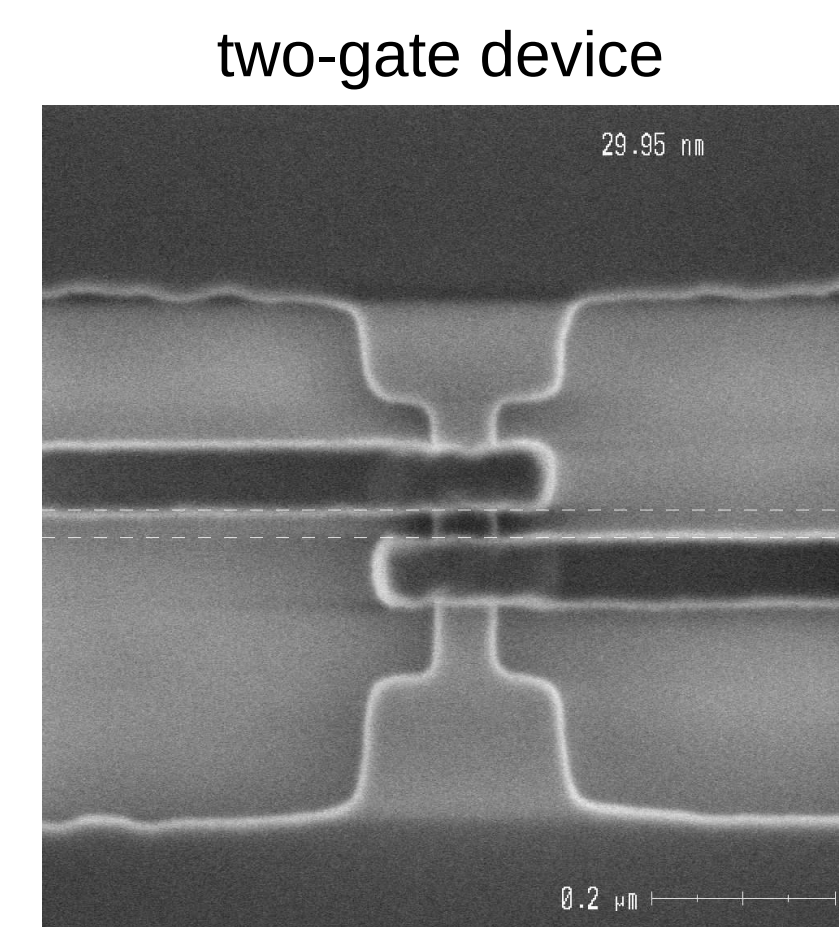
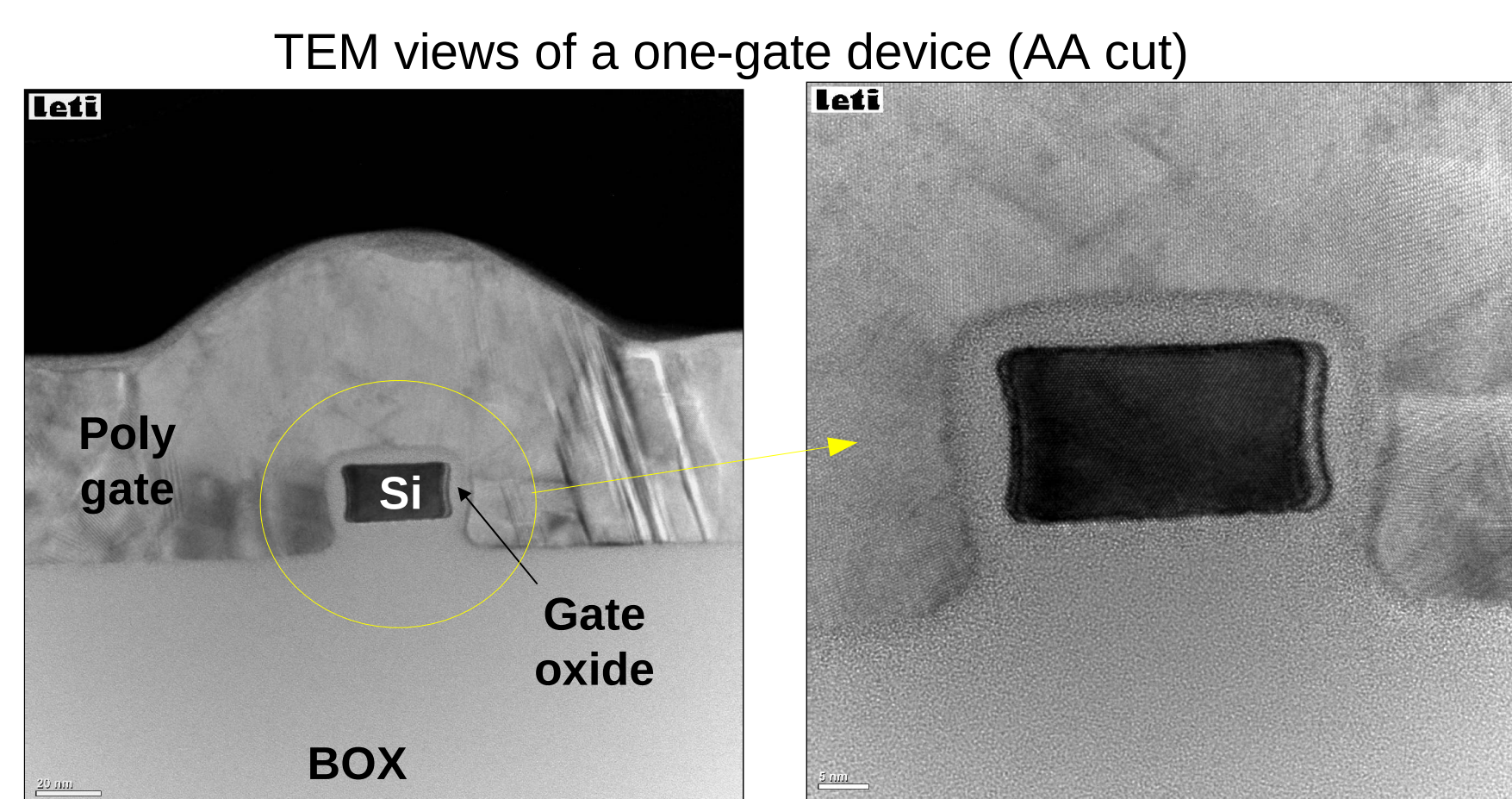
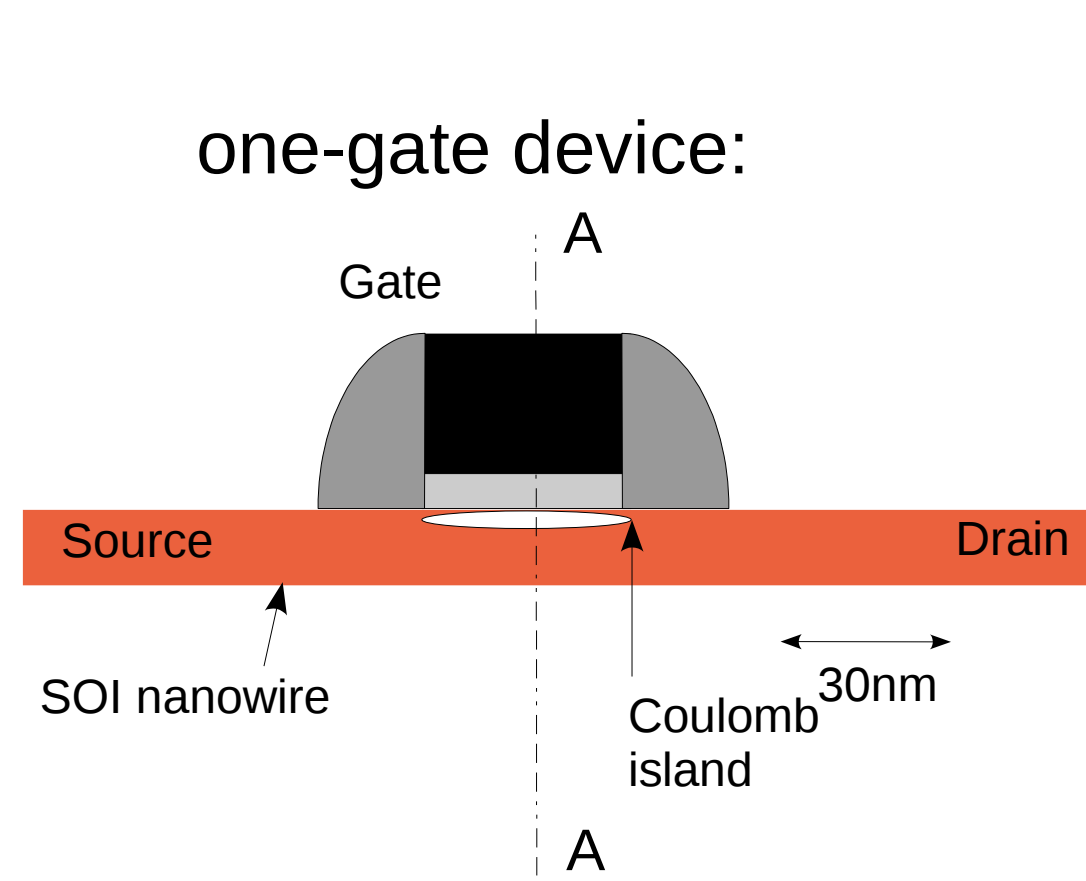
3 Partners:
* CEA-INAC-SPSMS
* LNE/CMSI (metrology)
* CEA-LETI

reminder: an electron pump is a 2-terminal device transferring electrons one-by-one, producing a dc current $I=ef$ if driven at frequency f .
Electron pumps have been fabricated in the past with Aluminium or GaAs technologies, but only very recently with silicon.
We present the design and preliminary measurements of the 1st CMOS compatible electron pump.

Fabrication (CEA-leti): 200mm CMOS platform on SOI.
dual e-beam process (active area and gate levels)

Well controlled multi-gate devices have been fabricated for the first time.
Single-gate devices show good single-electron transistor (SET) characteristics.

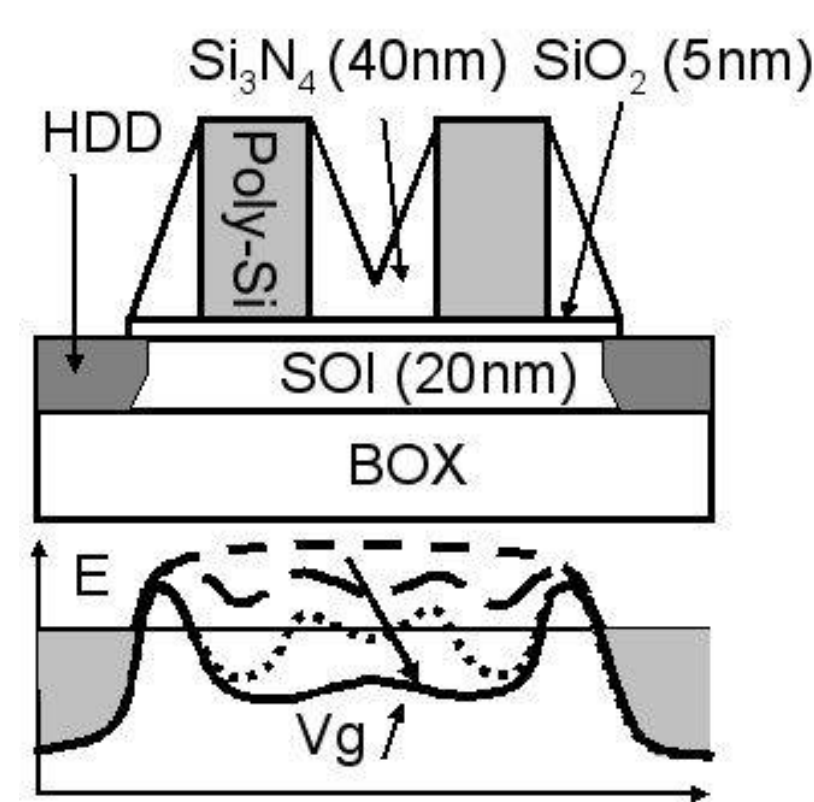
Optimization of the ebeam exposure doses and etching allowed to define very closely spaced gates.



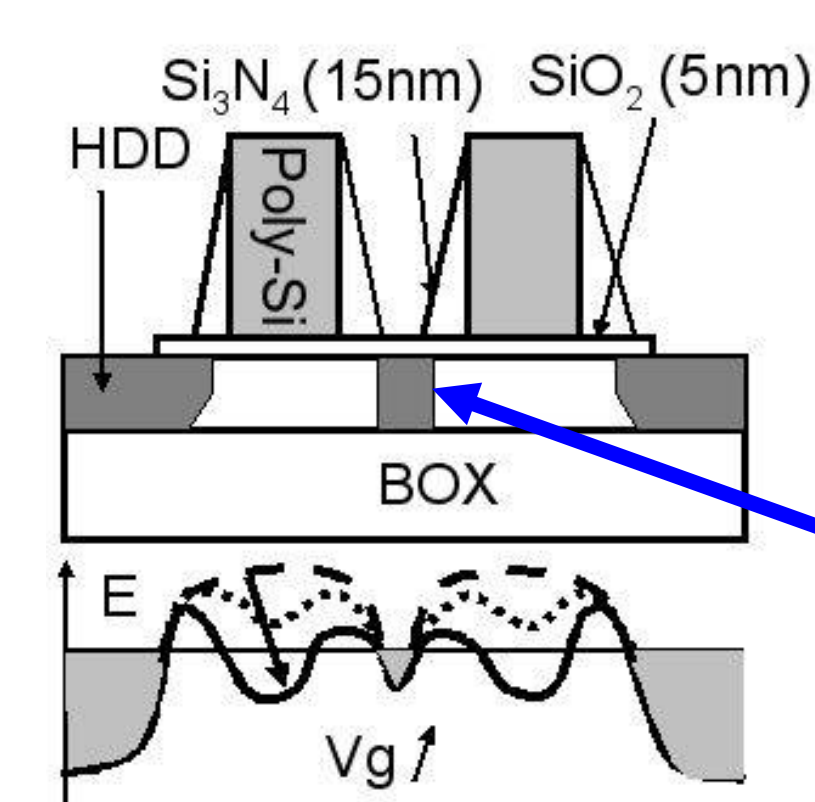
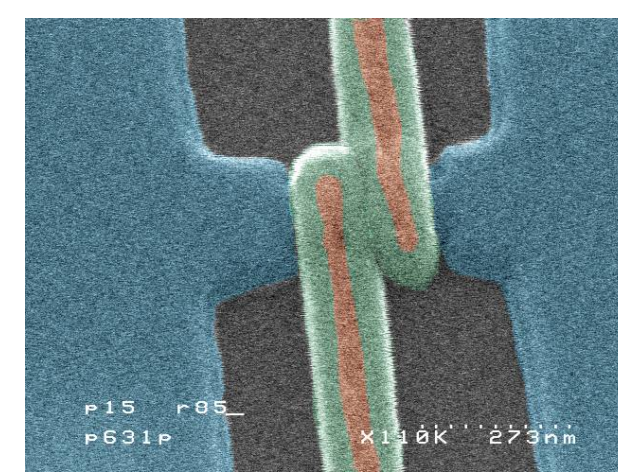
We show that a triple dot can be formed with only two gates: (submitted to Appl. Phys. Lett.)

Coupled MOS-SETs in series

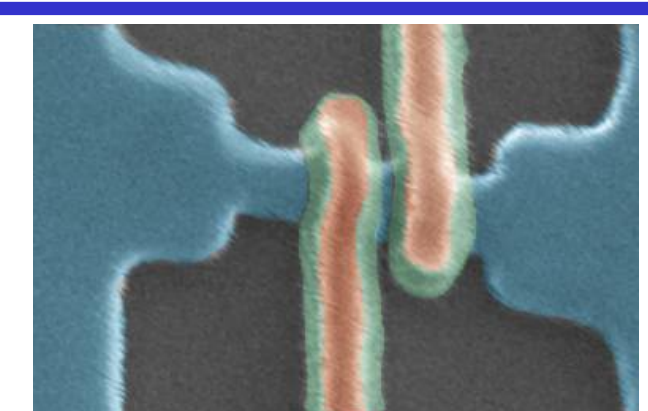
x Lg = 60nm W = 60nm
x Spacing between gates: 40nm
x Spacers length: 40nm



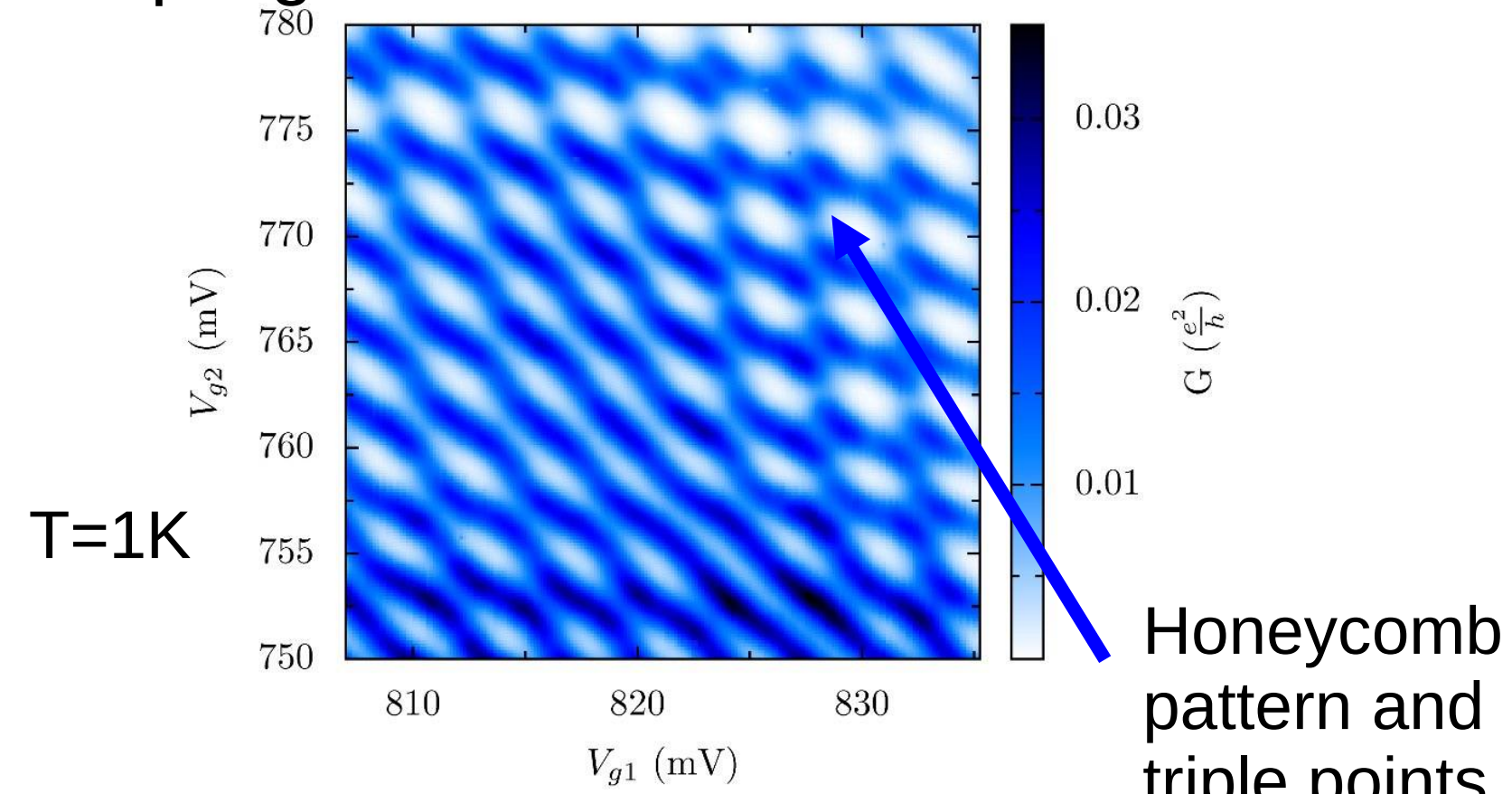
x Lg = 50nm W = 60nm
x Spacing between gates: 50nm
x Spacers length: 40nm



x Lg = 60nm W = 60nm
x Spacing between gates: 40nm
x Spacers length: 15nm



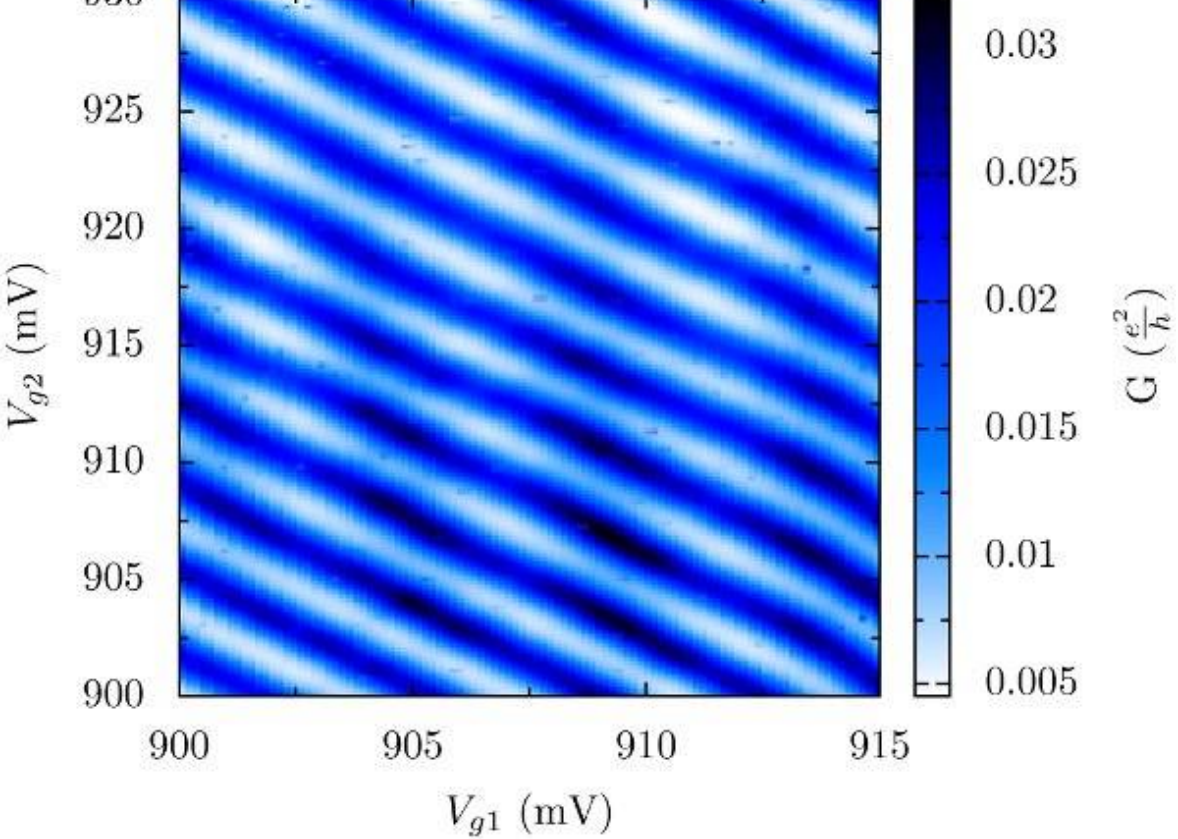
From two capacitively coupled dots with tunable interdot coupling...



Honeycomb pattern and triple points.

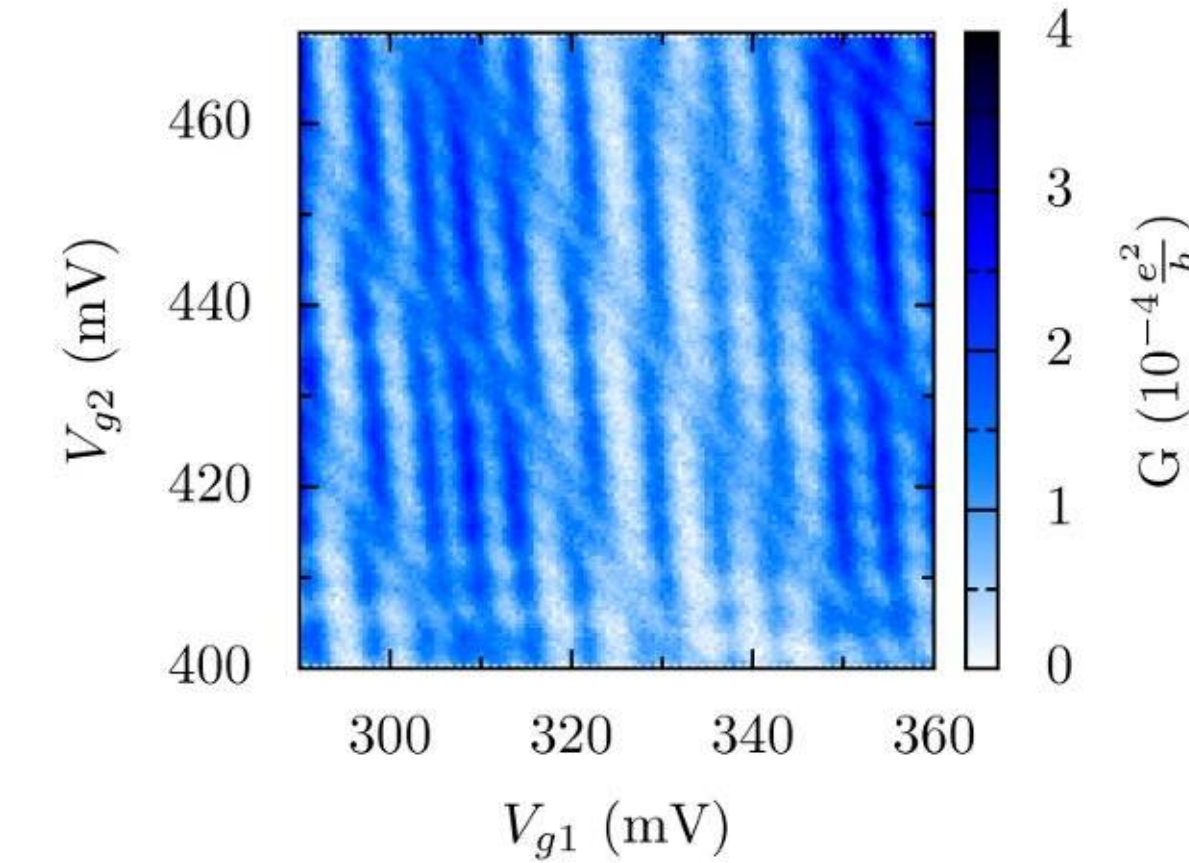
This is the regime adapted for single charge pumping

... to one single island.

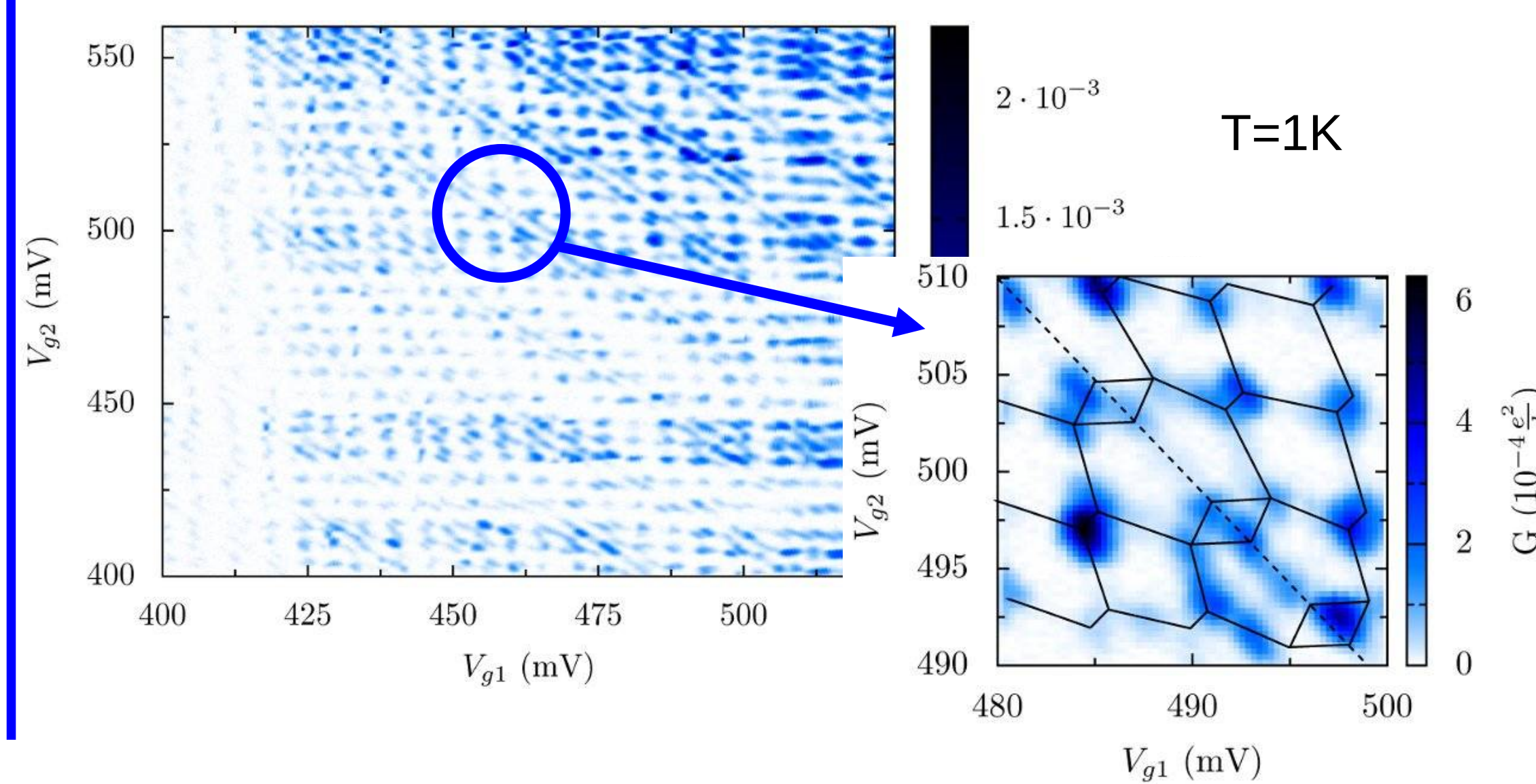


Honeycomb pattern with superimposed periodic antidiagonals:

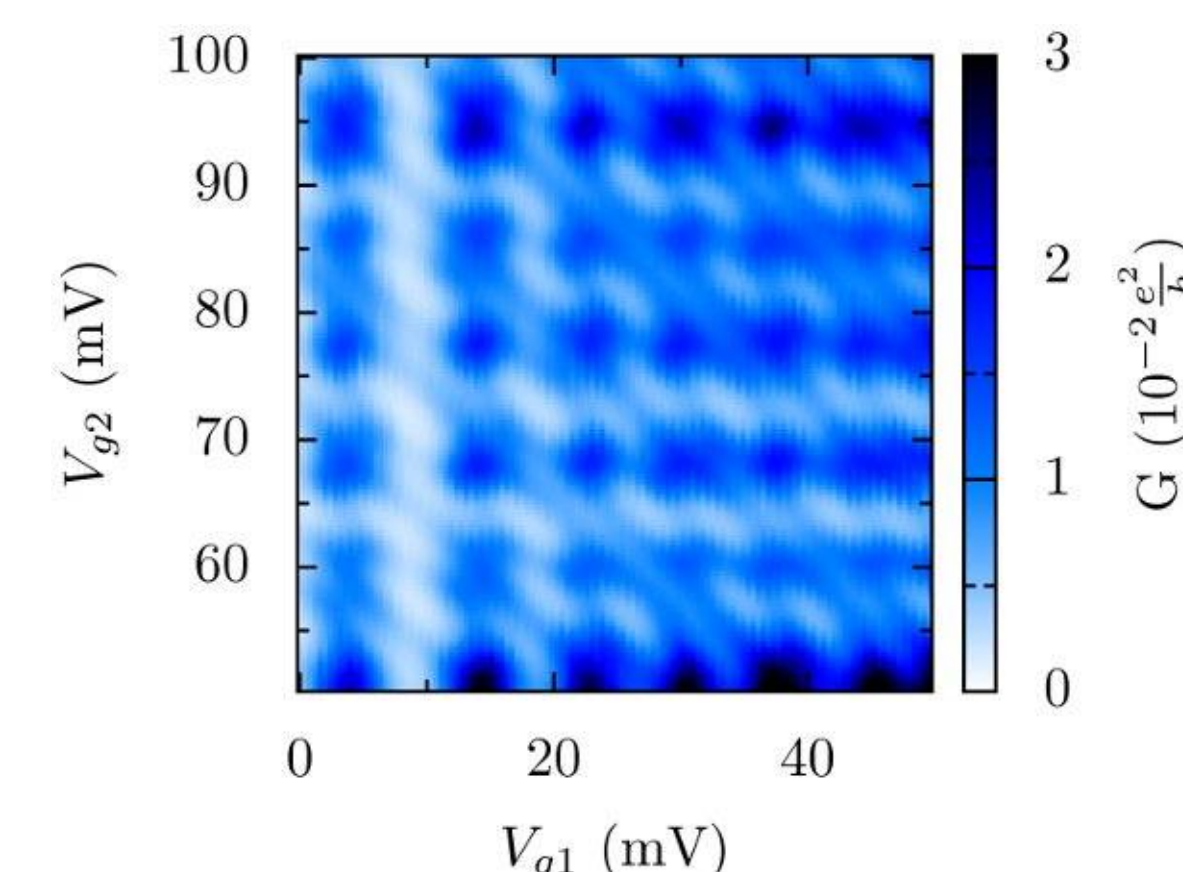
T=4K



Third dot ?

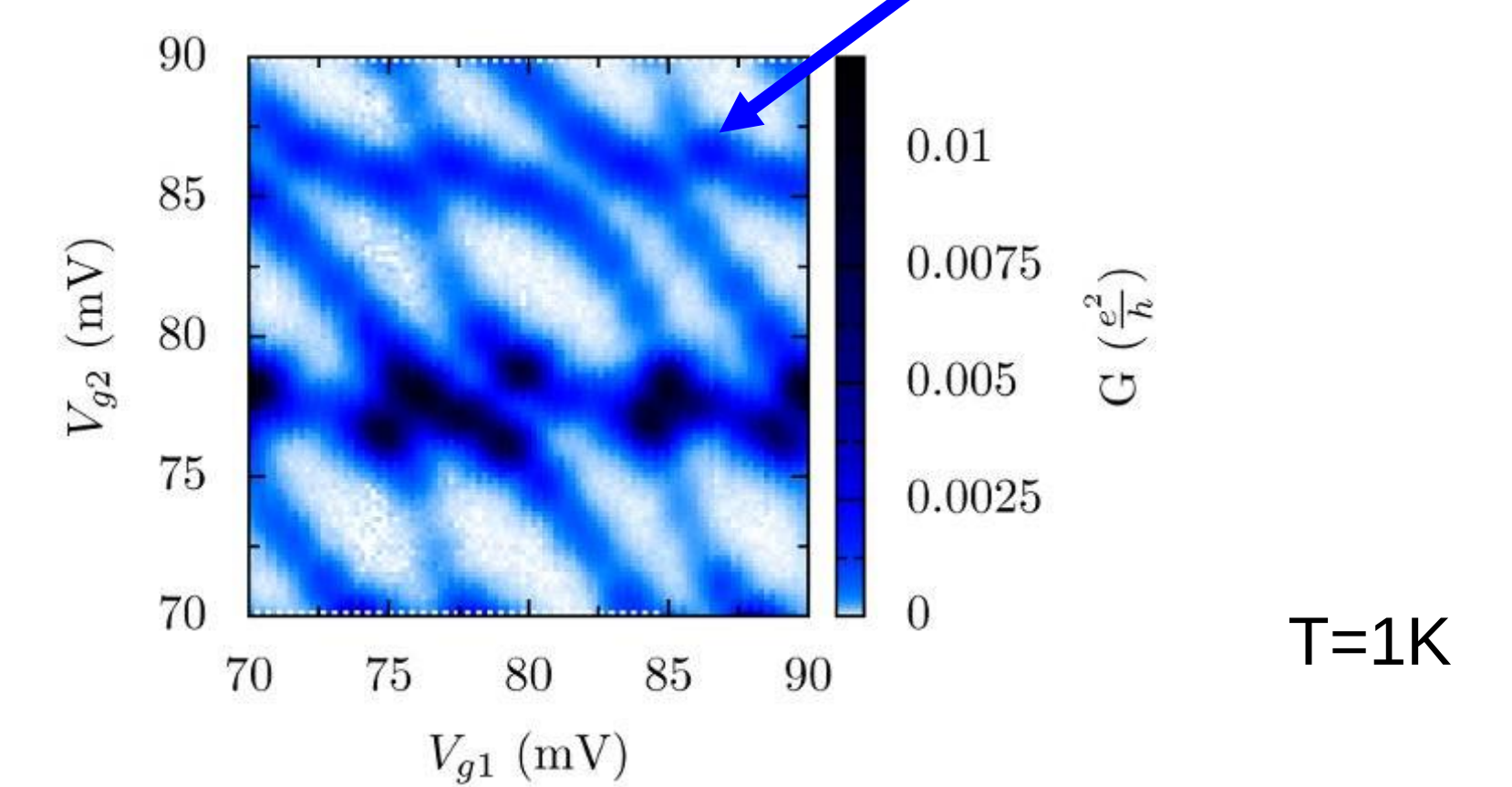


Same antidiagonal pattern but with a smaller period: bigger implanted central dot



T=4K

Hexagons are distorted at degeneracy of the central dot.



T=1K

conclusion

Electron pumps with 2 and 3 gates have been successfully fabricated for the first time in CMOS. (summer 2009)

Preliminary DC measurements have shown single (merged), double and triple dot behaviour in 2-gate devices, depending on the geometry, process, and electric field applied (gate voltage).

Pumping experiment is underway!