Fisica Fondamentale

- Quantum science ⇨ technologies (TC)
- Ultracold atoms (F. Cataliotti)
- Cold anti-atoms (G. Testera)
- Axions (G. Carugno)
- Fundamental questions
  - … quantum gravity (G. Carugno)
  - … quantum foundations…

What next - Fisica Fondamentale

4-6 May 2015 *Firenze, GGI*
Europe/Rome timezone

Antimatter, Axions, Cold Gases, Quantum Simulations

Dates: from 04 May 2015 14:00 to 06 May 2015 13:00

Timezone: Europe/Rome

Location: *Firenze, GGI*
Firenze, Arcetri

Chairs: Pascazio, Saverio
Testera, Gemma
Carugno, Giovanni

Additional info: Scientific Committee:

T. Calarco (Univ. Ulm)

M. Inguscio (INRIM and Univ. Firenze)

A. Lerda (INFN and Univ. Torino)

A. Masiero (INFN and Univ. Padova)

E. Nappi (INFN Bari)

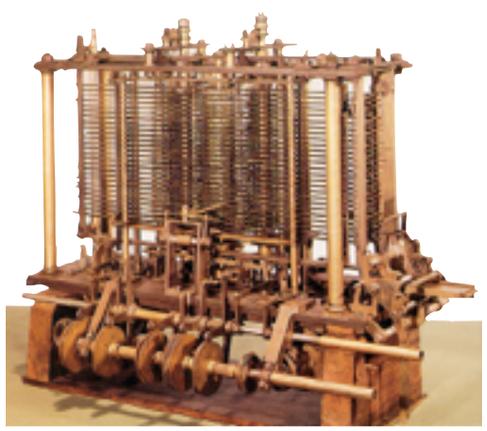
M. Pallavicini (INFN and Univ. Genoa)

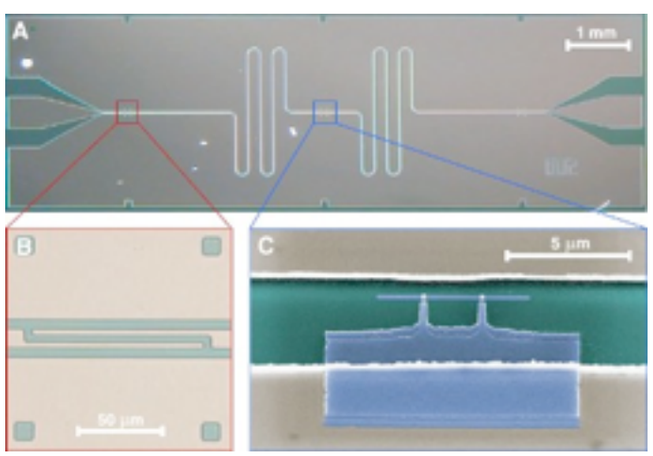
http://bit.ly/1xyBJ80

https://agenda.infn.it/conferenceDisplay.py?ovw=True&confId=9367

the future
IS quantum

- Basic science is motivated by the quest to understand the world
- It is a long-term undertaking, but...
- ...it results in **transformative** (as opposed to incremental) changes in technology, and...
- ...it's exactly these changes that define the modern society



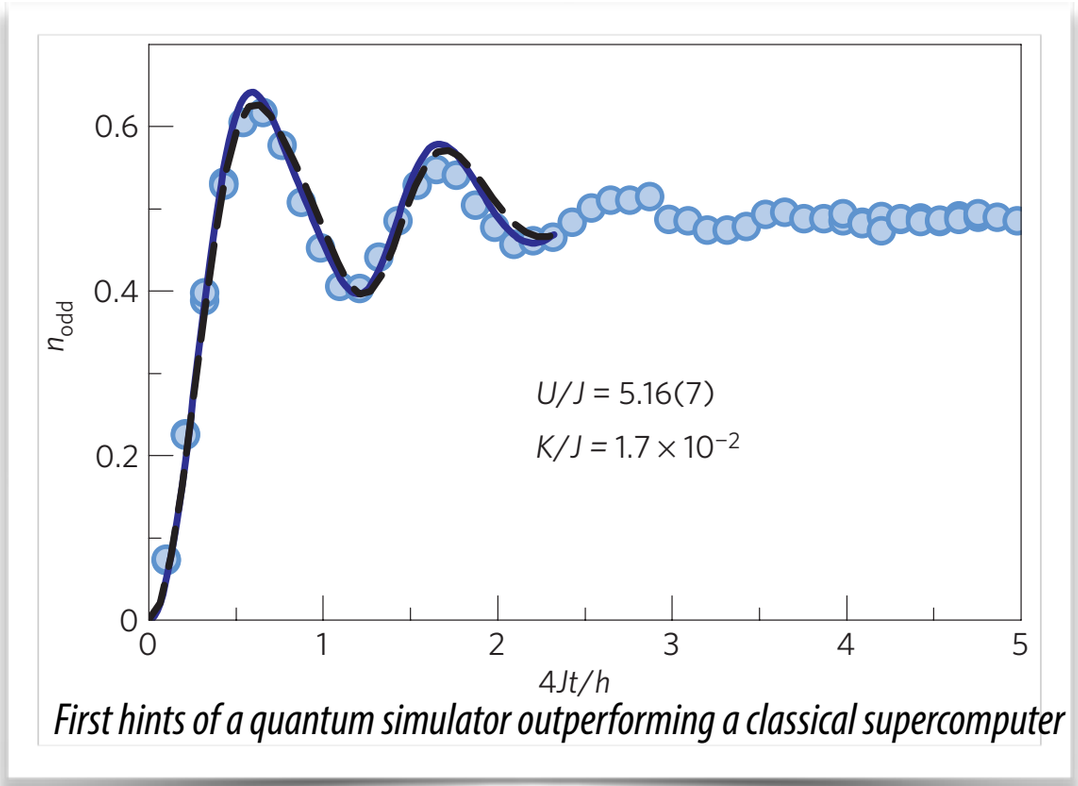


"quantum information is a radical departure in information technology, more fundamentally different from current technology than the digital computer is from the abacus".

W. D. Phillips, 1997 Nobel laureate
member of the EU Integrating Project AQUTE

quantum computers/simulators

- Next thing on the horizon (3-5 years)



First hints of a quantum simulator outperforming a classical supercomputer

- ***Impact***: Provide **answers** to problems that are fundamentally **beyond classical computing capabilities**

- ***Example***: The development of **high-temperature superconductors** via a quantum simulator would enable **lossless electric transmission lines**

"...trying to find a computer simulation of physics, seems to me to be an excellent program to follow out...and I'm not happy with all the analyses that go with just the classical theory, because nature isn't classical, dammit, and if you want to make a simulation of nature, you'd better make it quantum mechanical, and by golly it's a wonderful problem because it doesn't look so easy."

R. P. Feynman, 1965 Nobel laureate
Simulating physics with computers, Int. J. Theor. Phys. 21, 467 (1982)

quantum communication

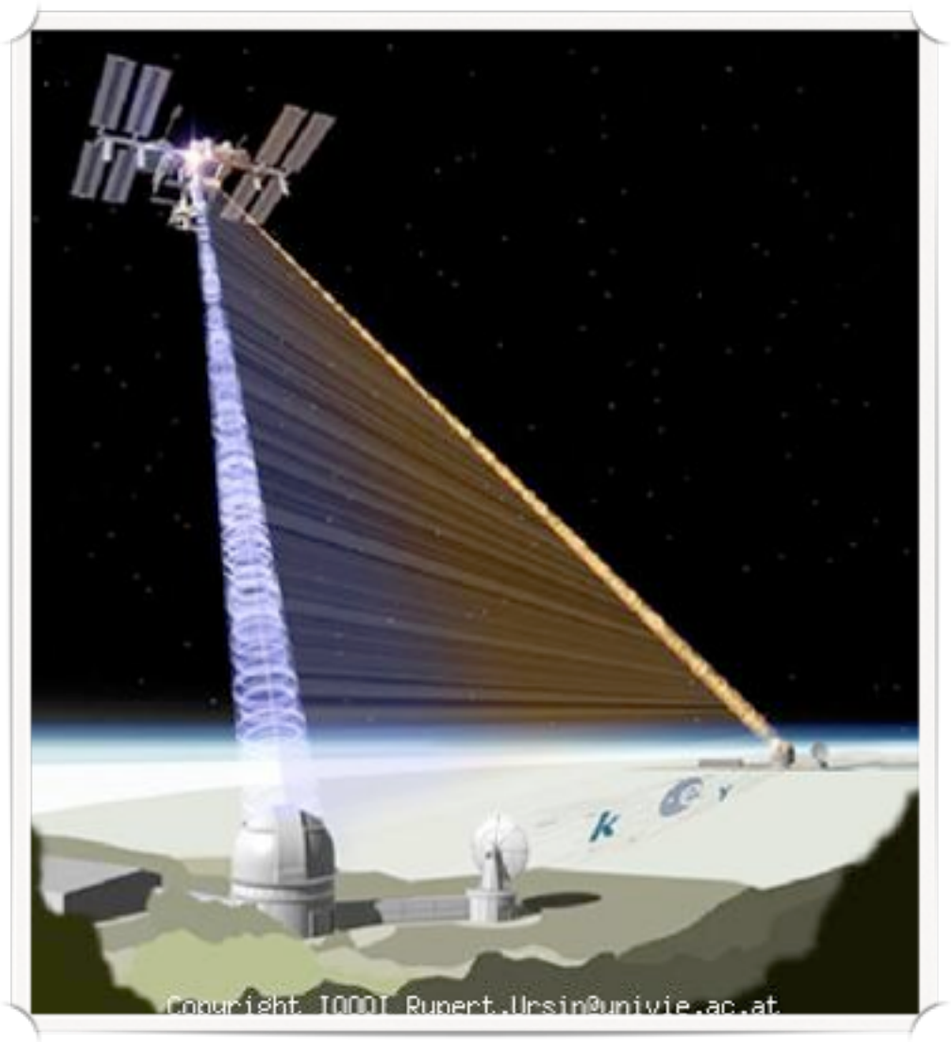
- Already a real-world technology

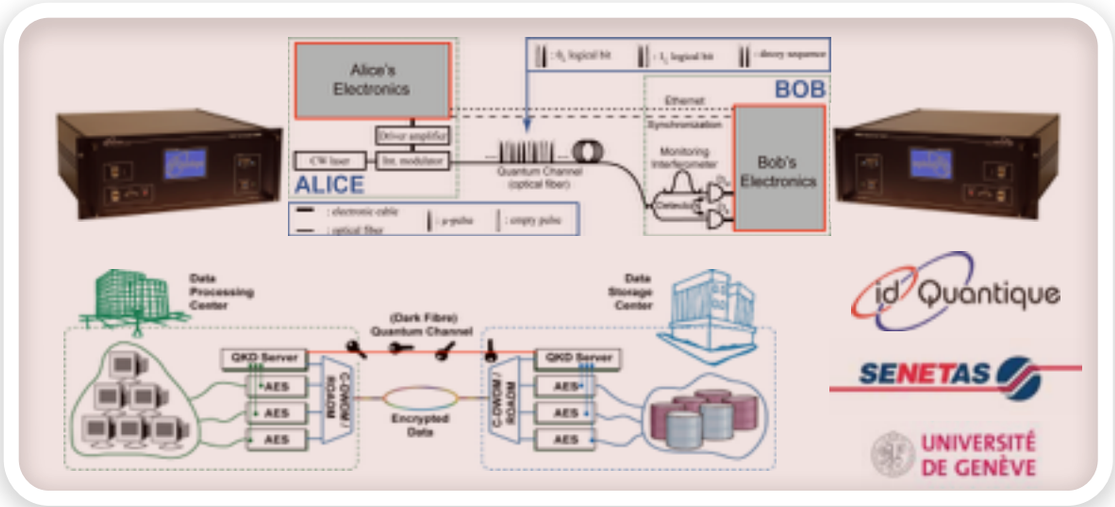
> **"Beyond approximately 10 years into the future, the general feeling among ECRYPT partners is that recommendations made today should be assigned a rather small confidence level, perhaps in particular for asymmetric primitives (ie public key)."**

2008 ECRYPT NoE report (conventional cryptography community)

- Vision: **Consumer quantum cryptography** (quantum bank card/ATM, quantum door/car key...)

- Security (**e-commerce; smart grids**...)





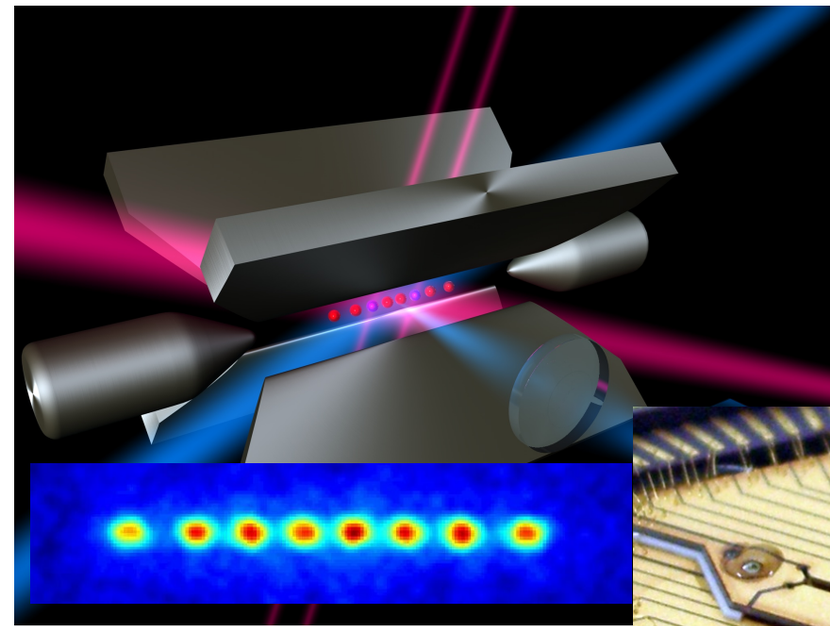
- Challenges: **Continental-scale** quantum communication (***quantum repeaters***)

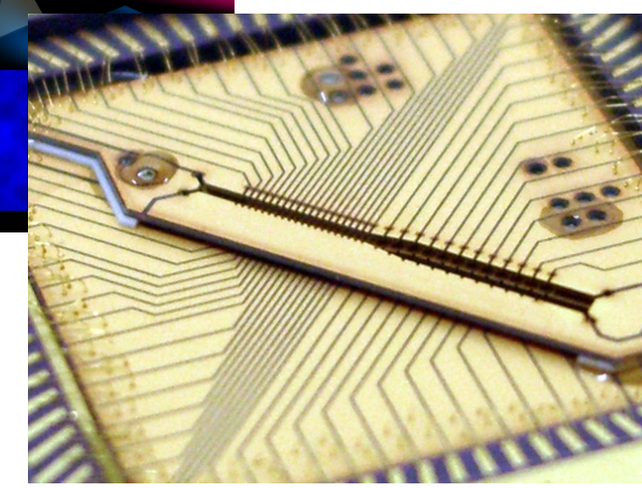
- European scientific community/SMEs leading at world level

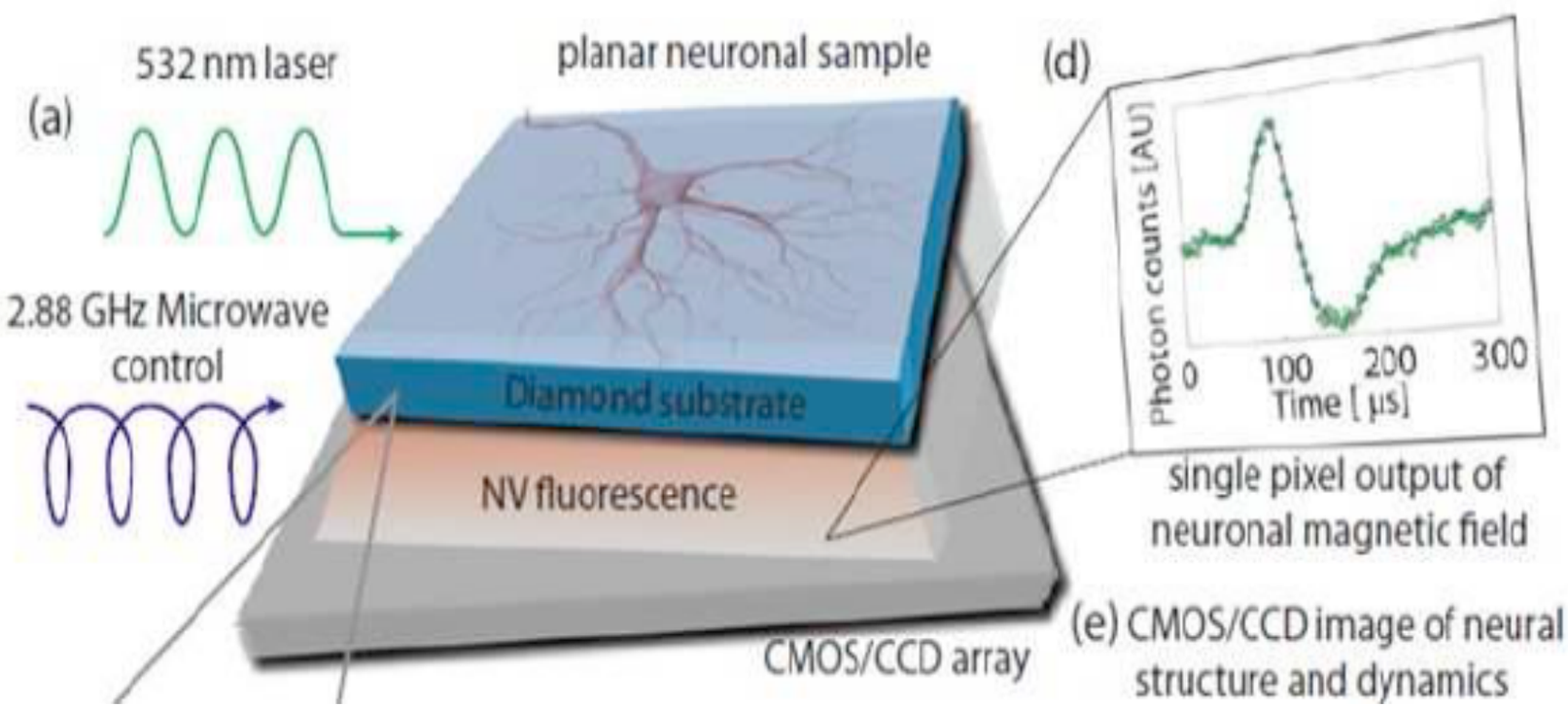
Security

quantum metrology and sensing

- Potential in many areas
- Quantum-logic based metrology: ultra-precise **atomic clocks** for **navigation** (building on e.g. ESA Galileo satellites)
- Sensing: sub-micron **imaging of tissues** for early detection and **diagnosis** of health problems







Health

second quantum revolution

potential outcomes

most impact

- Ultrafast, “smart” computers
- Quantum internet (absolute security)
- Custom-designed quantum materials
- Quantum sensors
- Atomic clocks

shortest time frame