3rd meeting of the Board of Funders

Brussels, 30 June 2016

The new Flagship on Quantum Technologies State of Play

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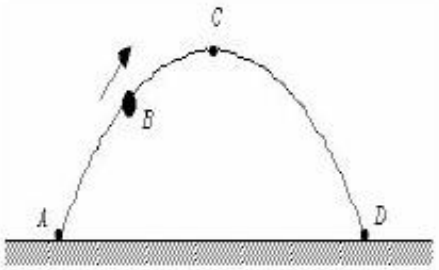
European Commission

Quantum mechanical properties open a new realm of possibilities

In the macroscopic world the laws of classical mechanics rule

Isaac Newton
(1643-1727)

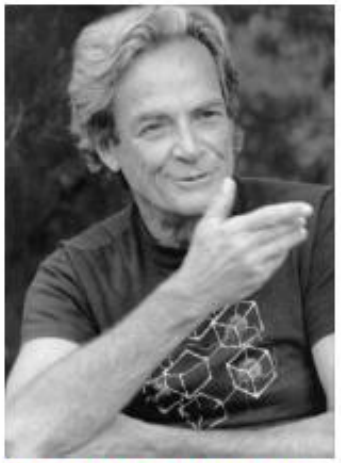


$$F_m = ma; \quad a = \frac{d^2x}{dt^2}$$

Characteristics of classical behavior:

- **Deterministic**: end result of a physical situation can be predicted deterministically and is always the same given equal starting points
- **Causal**: action is reaction – one thing leads to another

On a subatomic scale, the laws of quantum mechanics rule



Richard Feynmann
(1918 –1988)

$$H(t)|\psi(t)\rangle = i\hbar\frac{\partial}{\partial t}|\psi(t)\rangle$$

Characteristics of quantum mechanics:

- **Superposition**: object can have multiple states simultaneously
- **Entanglement**: quantum states of particles are correlated even though spatially separated
- **Measurement paradox**: measurement affects outcome, there is no single outcome unless it is measured

SOURCE: Press search

Quantum Technologies are devices and systems exploiting quantum effects

They can be grouped into three categories:

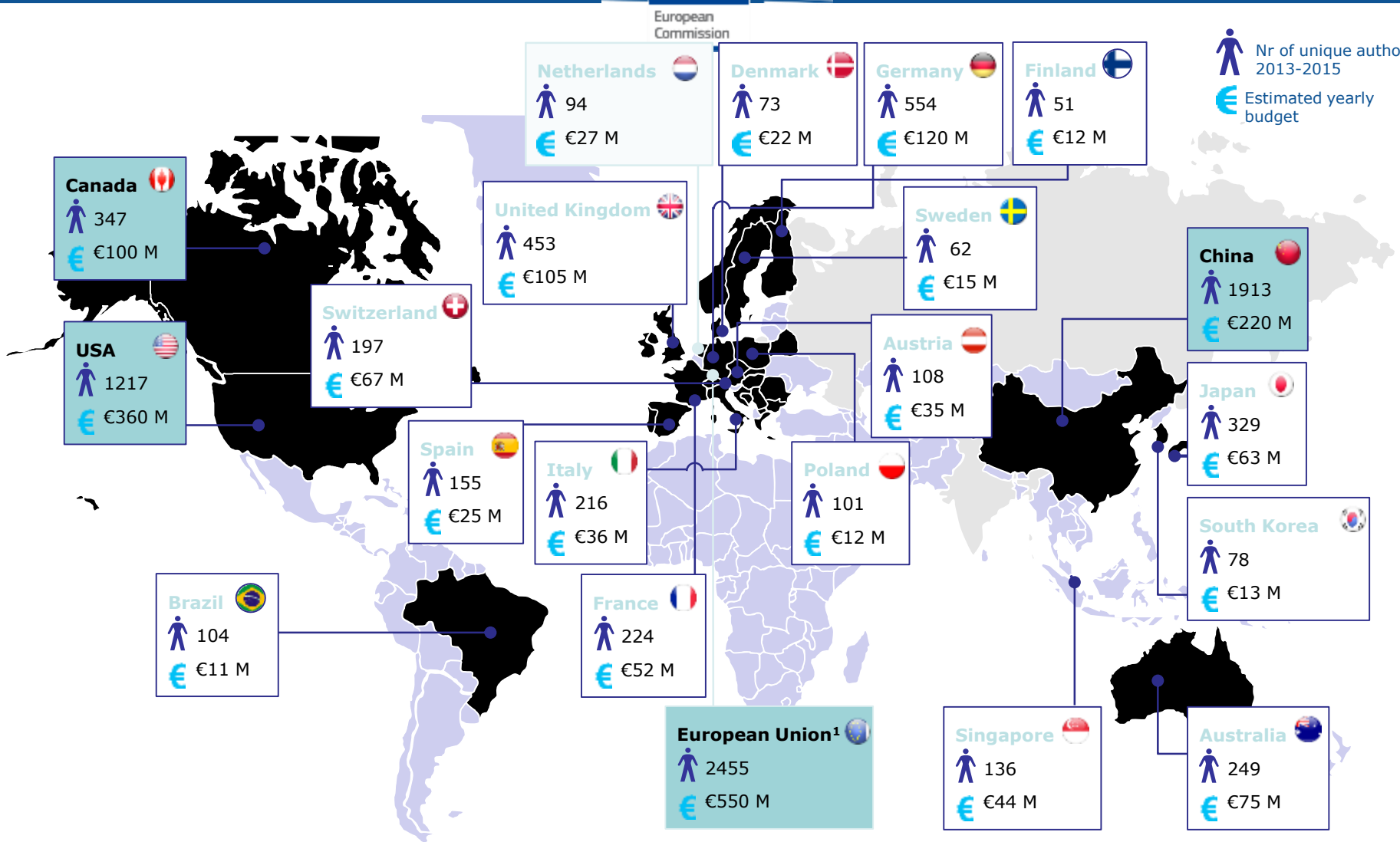
1. **quantum computers & simulators**
2. **quantum sensors**
3. **quantum communication**

Strategic game-changing technology
Breakthrough applications expected in health, energy, security, environment…

EU investments pioneered in FET…

- >20 years of EU investment
  - **Sensors, communication/QKD, computing**
  - **World-class scientific and technical expertise**
  - **Nobel prize laureates**
- Steady increase of EU funding : ~500M€
  - **FET (~250M€), ERC (~100M€), MSCA (~125M€) EMRP/EMPIR (metrology)**
  - **35 FP7 FET projects**
- Several National initiatives launched / in preparation
  - **Netherlands (QuTech 146M€/10y), UK (460M€/5y)**

~7000 researchers
1.5 B€/y-> 5B€/y



1 Combined estimated budget of EU countries

SOURCE: Publication search, Mac Kinsey

EU Challenge

Turning science excellence into industrial success…

- Maintain research excellence in EU
- Expand to engineering
- Stimulate innovation
- Stimulate industrial involvement
  - **Engage with industry, funders & investors**
  - **Joint agenda going beyond research**
  - **Join forces and coordinate at EU level**
    - No single country can do it alone

…before Asian and US competitors dominate the market

Why now?

- Keep EU scientific leadership while preparing EU for exploitation and future industrial take-up
- Build on strong interest from Member States
  - **ERANET Cofund with 22 MSs** (under evaluation)
  - **National initiatives : Netherlands, UK**
  - **Large support from MS**
- Increasing interest from European industry
  - **Bosch, Thales, IMEC, ASML, Safran, Airbus, ATOS/Bull…**
  - **High-tech SMEs : E2V, MuQuans, IDQuantique…**
- Global competition very active
  - **US, Canada (1,2B€), China**
  - **Scientific & Technological competition**
  - **Industry engaged: MS, Google, Intel, IBM, Lockheed Martin, Toshiba…**

Main QT events in 2015-2016 (1/2)

- *05/15: EC workshop on industrialization of QT*
- *07/15: Visit of Commissioner Oettinger to Institute of Quantum Technologies in Ulm*
- *10/15: Commissioner Oettinger hosted a QT Industry roundtable & stakeholder meeting with Minister Kamp*
- *10/15: Visit of Commissioner Oettinger to QuTech lab at TU Delft together with Minister Kamp*
- *12/15: STOA Annual Lecture on QT in the EP by Serge Haroche (Nobel laureate)*
- *06/04/16 STOA Event on QT at the European Parliament with Commissioner Oettinger & Minister Henk Kamp*

Main QT events in 2015-2016 (2/2)

- *02-04/16 QT Manifesto published & endorsed by 3500 stakeholders*
- *19/4/16 EC Communication on European Cloud Initiative proposing a flagship*
  - **+ Staff Working Document on Quantum Technology**
- *17-18/05/16 QT conference under the Dutch Presidency*
  - **Announcement of the QT flagship & next steps**
  - **Handover of the Manifesto to Oettinger & Kamp**
- *26/05/16: Competitiveness council conclusions*

"WELCOMES the discussion on the Commission's proposal to prepare for the launch of an ambitious flagship initiative in close cooperation with Member States and relevant stakeholders to unlock the full potential of quantum technologies and accelerate their development and take-up in commercial products."

Quantum Manifesto

A joint call for action to Europe from Academia and Industry

1. Why Europe needs to act now
2. Launch of an ambitious European programme
3. R&D goals for quantum technologies

http://qurope.eu/manifesto

- **Endorsed by more than 3500 stakeholders from science and industry in EU and globally**

Next steps

- *Establish an High Level Steering Committee (HLSC) with a 1 year mandate to prepare the flagship :*
  - **Strategic research agenda**
  - **Governance**
  - **Implementation options**
- *Collaborate with Member States on flagship preparation*
  - *Support letter received from several Member States*
  - *30/6 Meeting of the Board of Funders to discuss the approach & relation with HLSC*
- *Q4/2016 Second Industry roundtable hosted by Oettinger*
  - **Mid-term report of HLSC and input to WP preparation**
- *06/2016- 06/2017 Preparing H2020 Work Programme for 2018-20*
  - **Call for flagship ramp-up phase**
- *QT as part of discussions on H2020 successor*
  - **Full scale deployment phase of QT flagship**

Thank you for your attention