

# **Quantum Flagship and Quantum Technology research in the Czech republic**

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*Any sufficiently advanced technology is indistinguishable from magic. Clark's third law*

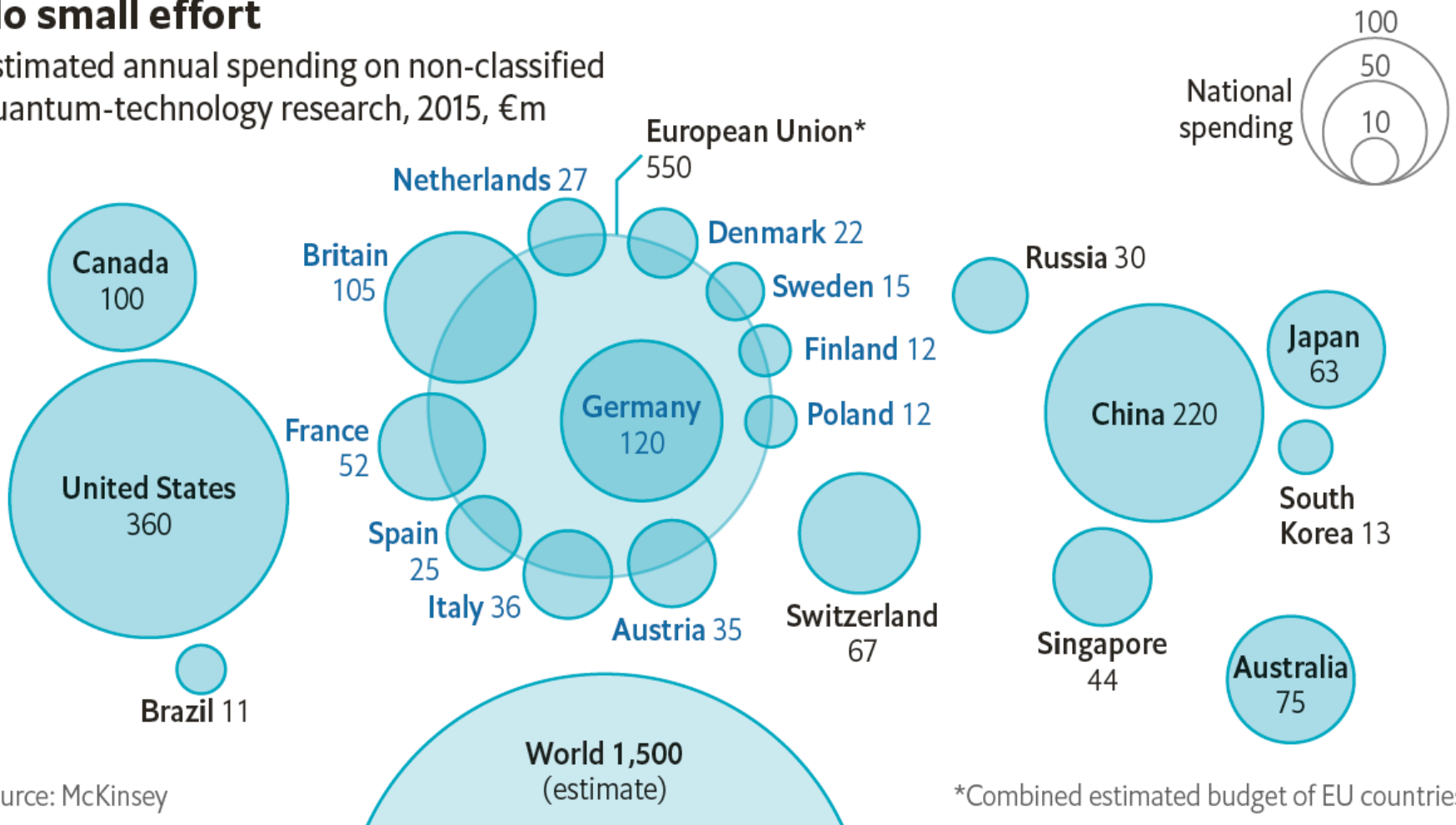
# Second Quantum Revolution

- Quantum physics has already many practical applications: Semiconductor components, Lasers, Nuclear energy, New materials (graphen, nano-materials), Hard discs (GMR), Medicine (NMR), etc.
- But it has many strange and counterintuitive features: Intrinsic randomness, Measurement affects the system, Entanglement .
- Quantum effects offer solutions to some tasks which cannot be solved by “classical” means: Quantum cryptography, Quantum computation, Quantum sensing, etc.

# Second Quantum Revolution

## No small effort

Estimated annual spending on non-classified quantum-technology research, 2015, €m



Source: McKinsey

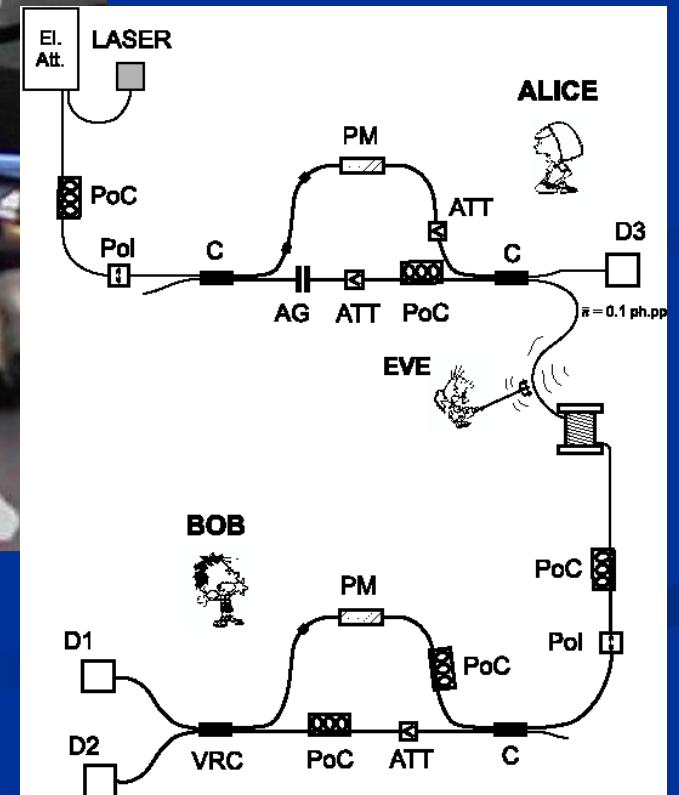
# Czech Quantum Community

- **Faculty of Science, Palacký University, Olomouc**  
(including Joint Laboratory of Optics with Czech Academy of Sciences)
  - 1998 – Prototype of a fully functional QKD device.
  - *Optical implementation of quantum gates and devices.*
  - *Quantum communication, Quantum key distribution*
  - *Sources of non-classical light, Quantum state engineering, Sensing of non-classical light.*
  - *Quantum tomography and State estimation,*
  - *Metrology and spectroscopy with laser cooled ions (with ISI).*
  - *Interaction of light with atomic ensembles.*
- **FNSPE, Czech Technical University, Prague**
  - *Quantum walks and Quantum networks.*
  - *Quantum nano-photonics and nano-plasmonics*

# QKD experiment in Olomouc - 1998



Phase encoding  
813 nm, 500 m



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# Czech Quantum Community

- **Faculty of Informatics, Masaryk University, Brno**
  - *Quantum information theory and quantum cryptography.*
- **Institute of Sci. Inst., Czech Academy of Sciences, Brno**
  - *Metrology and spectroscopy with laser cooled ions (with UPOL).*
  - *Sensing and manipulation of quantum motion (with UPOL)*
- **Faculty of Biomed. Eng., Czech Technical University, Kladno**
  - *Quantum sensing using color centers in diamond.*
- **CEITEC, Brno**
  - *Self-assembled layers of molecular qubits.*
- **Heyrovsky Inst. of Phys. Chem., Czech Acad. of Sci., Prague**
  - *Quantum computation and simulation in chemistry.*

# Czech Quantum Community

- **Faculty of Science, Masaryk University, Brno**
  - *Numerical simulations of solid-state quantum devices.*
- **Mathematical Inst., Czech Academy of Sciences, Prague**
  - *Quantum and classical communication complexity.*
- **Faculty of Math. and Phys., Charles University, Prague**
  - *Quantum computing of statistical physics phenomena.*
- **Czech Metrology Institute, Prague, Brno**
  - *Single ion optical clock.*
  - *Quantum standards for metrology, Quantum radiometry.*

# National Initiative for Quantum Technologies

- An informal pool of people working in this field in the Czech republic.
- Its purpose is:
  - Exchange of information about quantum flagship and similar research programs.
  - Coordination of activities towards the Czech government and the European Commission
  - Negotiation with the government about the Czech participation in programs like QuantERA and flagship, about a potential national program supporting development of quantum technologies etc.

**[www.nikt.cz](http://www.nikt.cz)**

# QuantERA

- 2014 – Konrad Banaszek: “Why the Czech republic does not want to join QuantERA?”
- Endless negotiations with the Czech government.
- 2016 – Success. CR on board.  
(thanks to I. Jex, J. Lazar, J. Bouda, P. Pracna, A. Marks, R. Plaga)
- 2017 – The first call (36 M Eur).                      26 funded projects.  
Czech groups participate in **4 projects**:
  - **CUSPIDOR** Single Photon Sources based on Quantum Dots (MU Brno)
  - **HYPER-U-P-S** Hyper-entanglement from ultra-bright photon pair sources (UP Olomouc)
  - **NanoSpin** Spin-based nanolytics (IOCB Praha)
  - **TheBlinQC** Theory-Blind Quantum Control (UP Olomouc)
- 2019 – The next call (20 M Eur), deadline: February 18  
**[www.quantera.eu](http://www.quantera.eu)**

# Quantum Flagship *qt.eu*

- UK – Quantum Hubs (270 M GBP),  
NL – QuTech (135 M EUR), ...  
China – Quantum communication  
satellite (2016)
- 2016 – Quantum manifesto



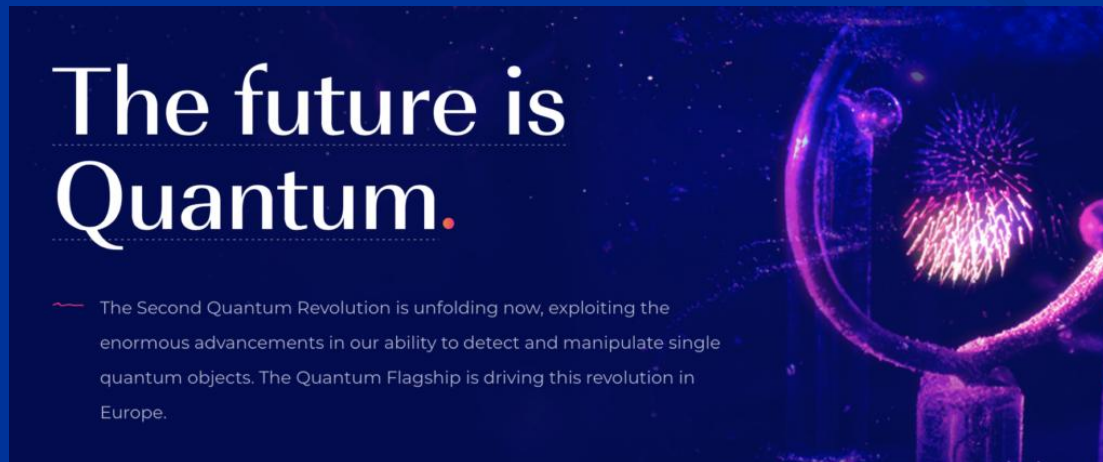
- May 2016 – Quantum Europe, Amsterdam  
*EU Commissioner for Digital Economy and Society, Günther Oettinger, announced the investment of one billion Euro in a new Flagship on quantum technologies*

# Quantum Flagship *qt.eu*

- **QSA** Quantum Coordination and Support Action  
*From 2017-12-01 to 2019-03-31 (500 k Eur)*

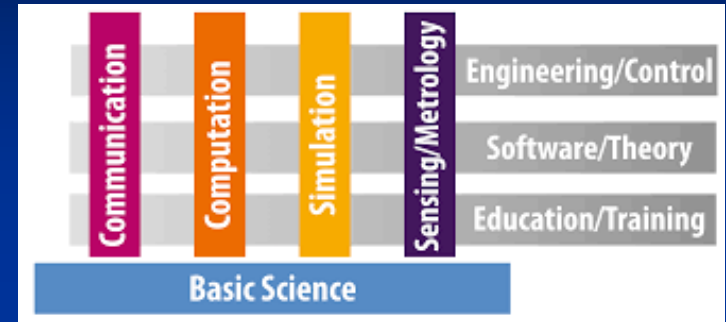
Scientific community should be more involved in shaping the flagship.  
Even small countries should be somehow represented.  
⇒ Quantum Community Network

- **QFlag** Quantum Technology Flagship Coordination and Support Action  
*From 2019-04-01 to 2022-03-31 (2 699 k Eur)*



# Quantum Flagship *qt.eu*

- October 2017 – First Flagship Call (FET Flag RIA, ramp-up phase)  
110 + 20 M Eur  
**139** (49+90) proposals submitted,  
**19** (12+7) funded



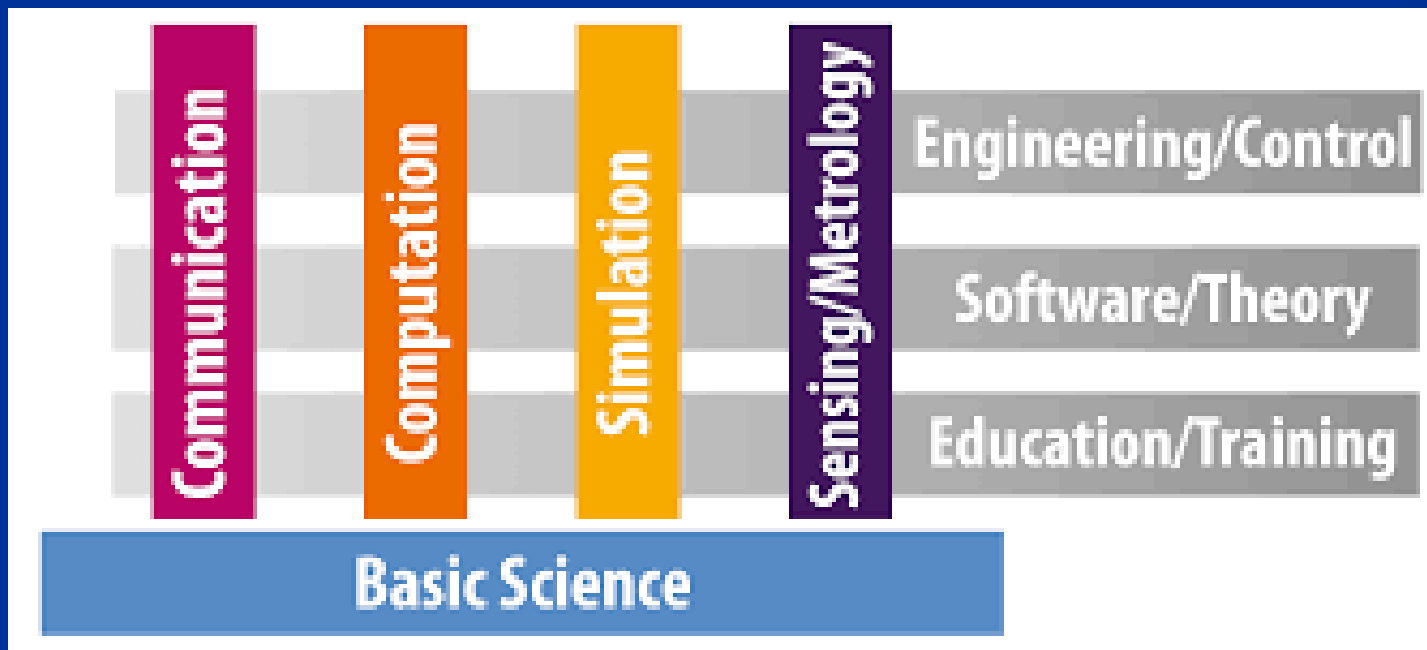
Czech participation: 7 submitted (6x UP, 1x MU), 1 funded  
**CiViQ** Continuous Variable Quantum Communications (UP Olomouc)

- October 2018 – Quantum Flagship Kickoff meeting in Vienna
- February 18 – 22, 2019, Grenoble, EQTC – the first international conference of the European Quantum Flagship,

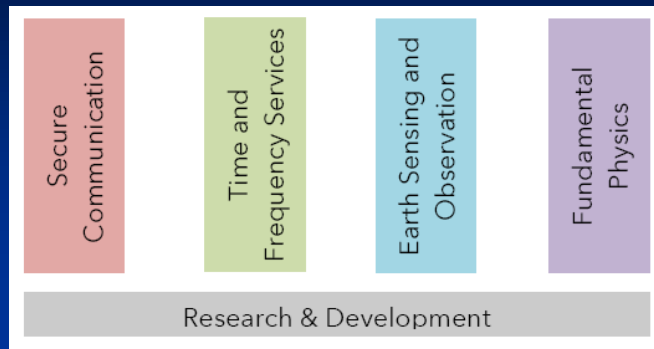


# Quantum Flagship *qt.eu*

- After the Graphene Flagship and the Human Brain Project, the Quantum Flagship is the third large-scale research and innovation initiative of this kind (but its organization will be different)
- Quantum Technology will be funded with at least 1 000 000 000 Euro by the EC

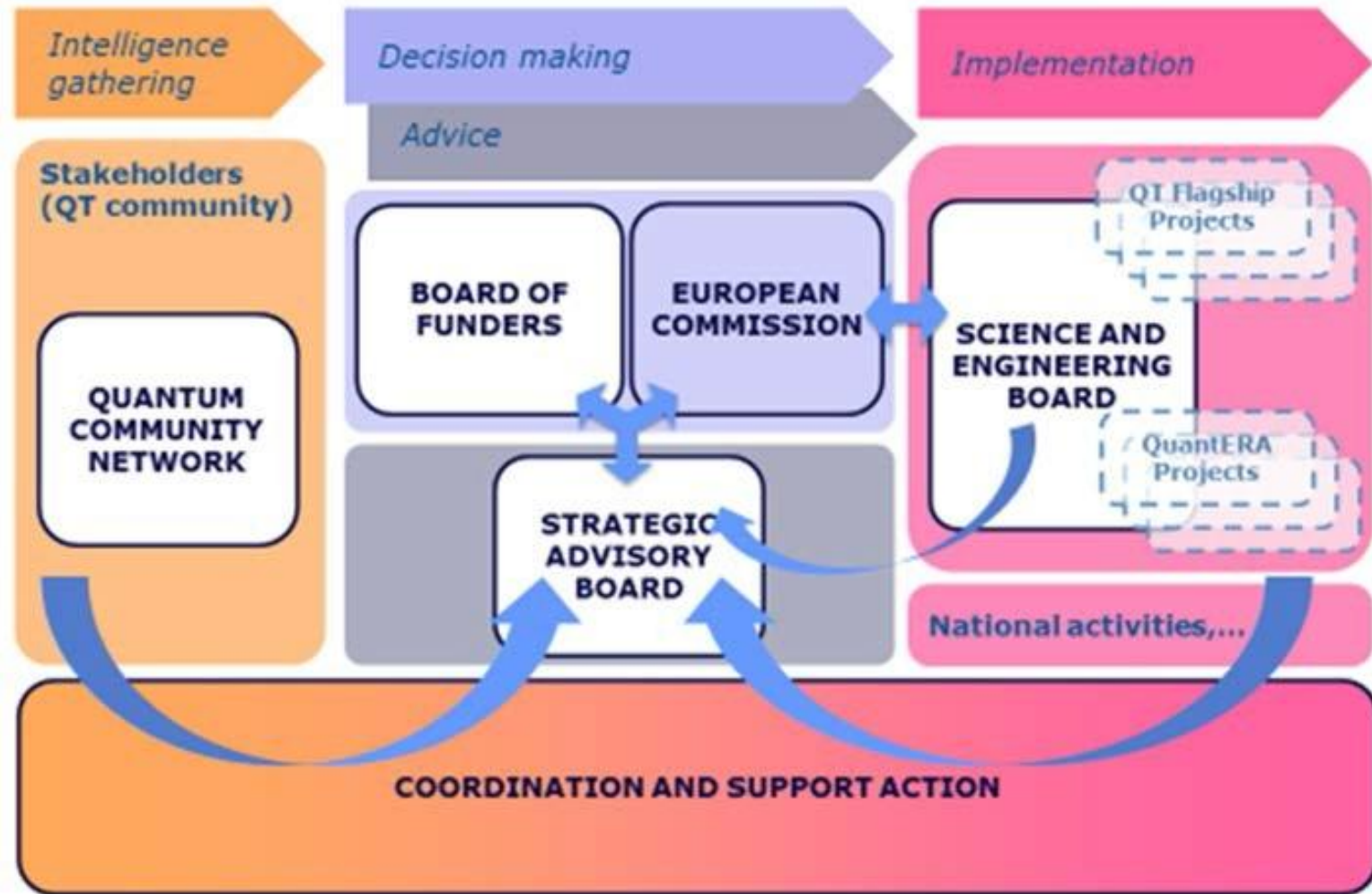


# EU QT Ecosystem



# Quantum Flagship *qt.eu*

## QT Flagship Governance



# Horizon Europe (FP 9)

- Missions ?
  - Narrow scope, oriented on particular technology (European quantum computer, Pan-European quantum communication network).
  - No support for basic research.
- Strong effort of scientific community to continue with the Flagship in its current form (possibly in parallel to Missions).

## Czech Republic

- No program dedicated to Quantum Technologies.
- Little influence on European research and development policy.

# Thank you for your attention

