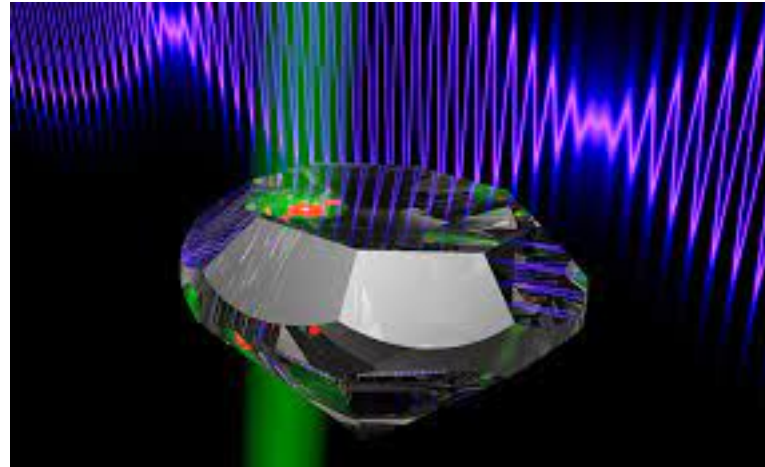


QUANTUM TECHNOLOGIES ACTION CONCEPT

MAIN BRANCHES OF QUANTUM TECHNOLOGY



Sensing and Metrology

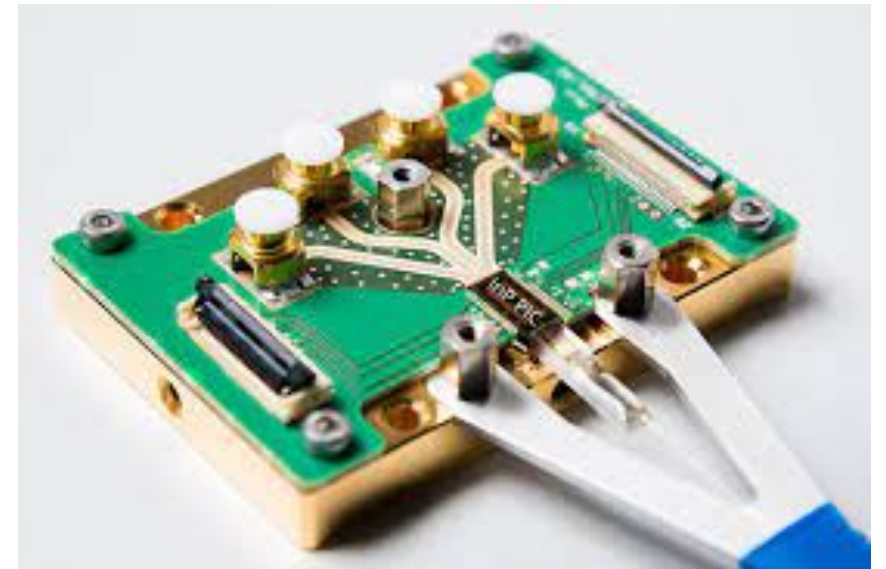


Computing and Simulation

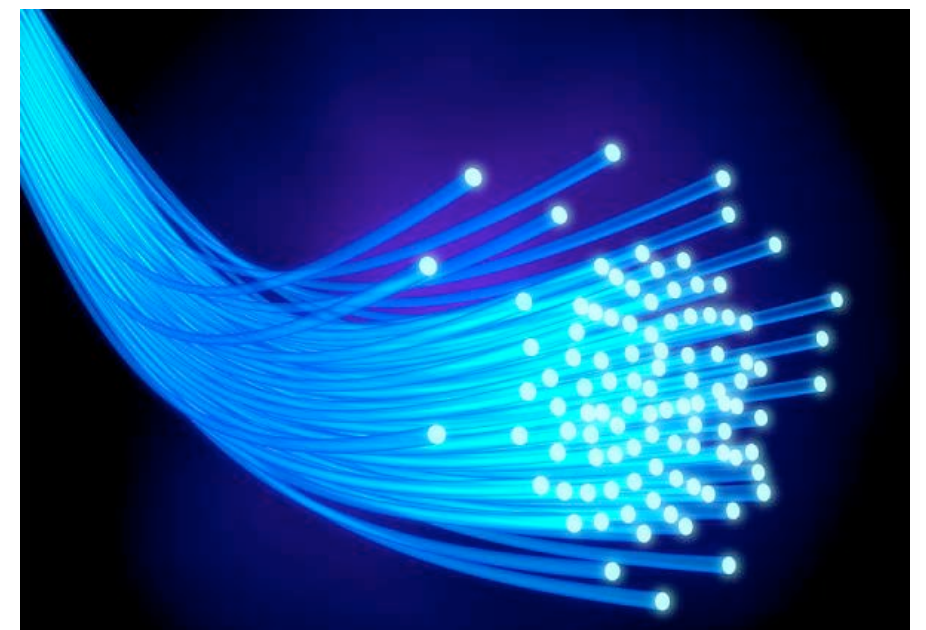
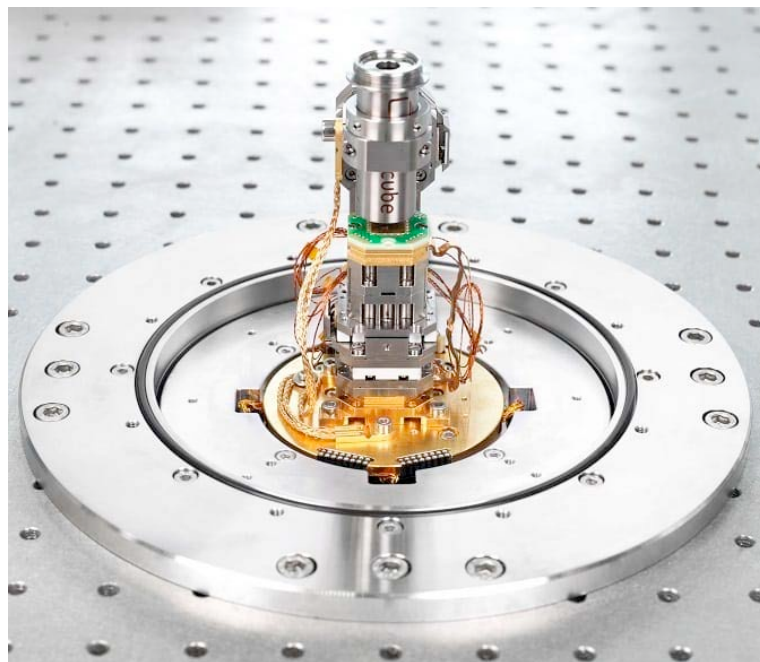


Communication and PQC

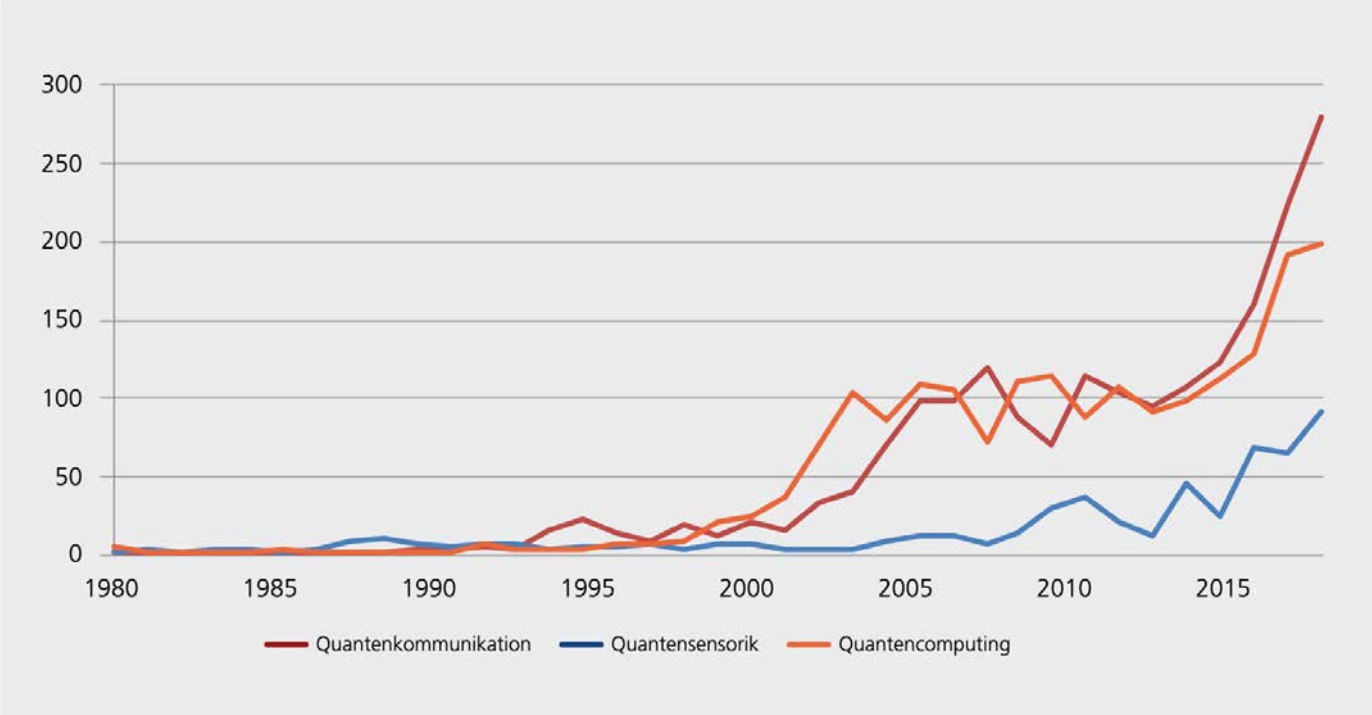
MAIN BRANCHES OF QUANTUM TECHNOLOGY



Enabling Technologies



CURRENT STATE OF AFFAIRS



New patents worldwide

Current German funding

ca. **2 Bill. EUR** in economy stimulus package

Patents

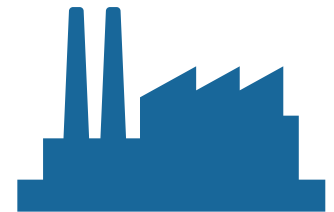
China	52 %
USA	24 %
EU (G)	12 % (4 %)
Japan	8 %

Publications

EU (G)	23 % (4 %)
China	21 %
USA	11 %
UK	4 %

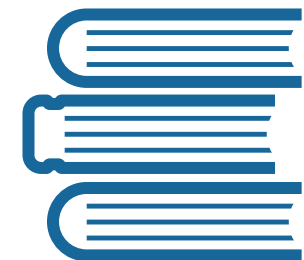
CURRENT STATE OF AFFAIRS – GERMAN STRENGTHS

- Strong industrial sector with many potential users
- Part of EU market
- Large public funding into quantum tech
- Strong foundational research; research on all platforms
- Well established quantum metrology
- Good collaboration between academia-industry due to joint research
- Strong university education



CURRENT STATE OF AFFAIRS – GERMAN WEAKNESSES

- Only few research groups in quantum information theory
- Support of talents could be improved on
- Quantum computing tech development behind North America
- Little venture capital
- Potential customers still hesitant
- Bureaucracy complicates start-up founding



MAIN GOALS OF NATIONAL STRATEGY

- Guarantee German and EU **technology sovereignty**
- Drive research to **product development**
- Educate and gain more **professionals**
- Highlight the chances of QT to broader audience/industry
- Use QT to face current social/economical problems

THREE BRANCHES OF STRATEGY

- I. Make QT more accessible for economy, society and public institutions
- II. Advance QT development
- III. Create the conditions for a strong quantum ecosystem

MAKING QUANTUM TECHNOLOGY ACCESSIBLE

Providing funding

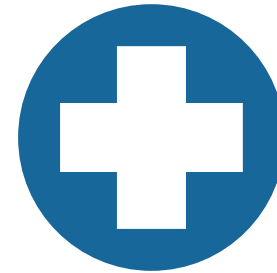
- Joint applied research projects (like BMBF, BMWK)
- Order quantum products directly via DLR
- Continue research in federal funded institutions
- Deep Tech and Climate and High-tech Founder funds; government participation in start-ups

In total ca. **3. Bill. EUR** for Quantum Tech over next 4 years

MAKING QUANTUM TECHNOLOGY ACCESSIBLE

Quantum Sensing

- Sensing for climate, mobility, aerospace, medicine
- Bring applications of quantum sensing to the market via funded projects
- Push quantum metrology for QT quality control



MAKING QUANTUM TECHNOLOGY ACCESSIBLE

Quantum Communication and PQC

- Short term: Communication and PQC for high-security applications
- Long term: Connect quantum devices
- Bring different stakeholders in industry and academia together
- Create a well-connected quantum comm industry to create full-stack soft- and hardware
- Develop quantum comm systems, e.g. quantum repeaters, tokens and their resilience
- Provide infrastructure
- Migrate all systems to PQC



MAKING QUANTUM TECHNOLOGY ACCESSIBLE

Quantum Computing

- Long term development needed (5-15 years)
- First applications in optimization of logistics and simulation of chemical processes
- Continued development of all physical platforms
- Largest predicted value creation in software solutions
- Full-stack with focus on software; early end-user involvement



ADVANCING QUANTUM TECHNOLOGY DEVELOPMENT

- Funding of enabling technologies
- Working towards more German participation in international standardization panels
- Create bench marking infrastructure for standardization
- Increase number of professionals via outreach activities in schools, new postgraduate programs

A STRONG QUANTUM ECOSYSTEM

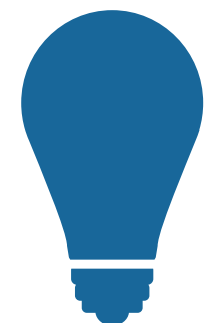
Strengthening the ecosystem

- Funding of joint research of industry and academia to foster connections
- Research orders by DLR to attract foreign know-how to Germany
- Focused networking events and seminars to identify cross topics



Bolster innovative enterprises

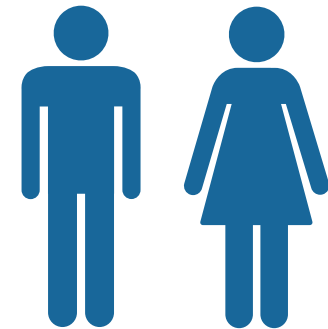
- Support quantum tech technology transfer and spin-offs at universities and institutes
- Specific support of small and middle sized companies
- Provide young businesses access to QT test hardware and expertise
- Public venture investments (HTGF and DTCF)



A STRONG QUANTUM ECOSYSTEM

Fighting the skilled worker shortage

- Highlight different career perspectives in the sector
- Gather input from end-users and industry to adapt research and education policies
- Easier access to QT outside of physics
- Engage students via prizes, quantum fellowships
- Scientific outreach in schools and in general to motivate broader public
- Qualify experienced workforce to switch into QT sector



Monitoring of current developments

- Regular meetings of government with experts



MLESTONES – QUANTUM COMPUTING

- Development of a QC with 100 individual controllable qubits
- Development of a specialized QC hardware
- Having at least 60 end-users of QC in Germany
- Push international competitive ecosystem (TOP 3 in EU, same level as USA and Japan)
 - ▶ Revenue, number of professionals and profit of companies
 - ▶ Patent numbers in QC
 - ▶ Percentage of coverage of QC-relevant technologies by industry



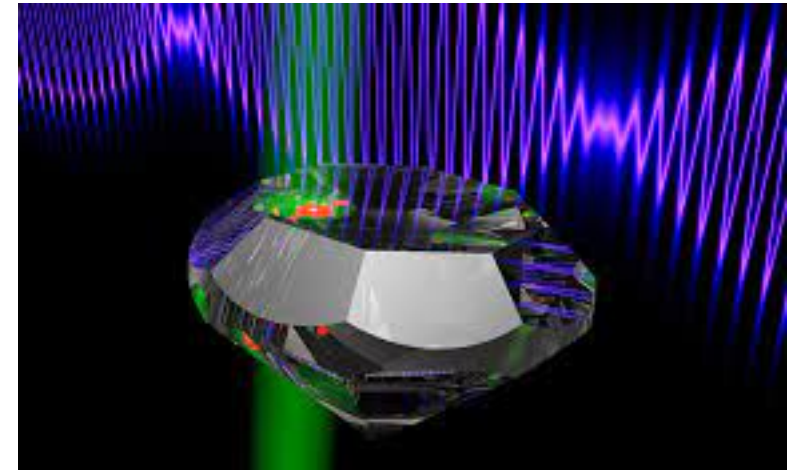
MLESTONES – QUANTUM COMMUNICATION AND PQC

- Quantum-secured test routes of selected public institutions
- More start-ups in Germany
- National fiber backbone for quantum communication
- Demonstration of first quantum repeater field trials
- Launch of first satellites for QKD
- Provide national strategy how to migrate to PQC in Germany
- Continuation of PQC migration to safety-critical areas
- Integration of PQC into broadly useable IT-security solutions



MLESTONES – QUANTUM SENSING AND STANDARDIZATION

- Five new quantum sensing products on the market
- Optical clocks for next generation of Galileo clocks
- Infrastructure to characterize and standardize quantum components and to benchmark



LONG TERM OUTLOOK – VISION 2036

- QT are core components in many different economical sectors
- EU technologically independent in QT
- Quantum sensors established in construction, medicine and signal processing
- Universal error correcting quantum computers, made in Germany, in chemical and pharmaceutical industry, finance
- PQC between government agencies and in private critical applications
- Quantum communication used EU wide for high-security
- German activities foundation for an international quantum based standardization system

CURRENT RESEARCH PROGRAMS BY THE BMBF



<https://www.forschung-it-sicherheit-kommunikationssysteme.de/>

<https://www.quantentechnologien.de/>