A glowing blue microchip is the central focus, set against a dark blue background of intricate circuit patterns. The chip itself is a square with a grid-like surface, and a bright, multi-pointed starburst of light emanates from its center, casting a soft glow over the surrounding circuitry. The overall aesthetic is futuristic and technological.

“Quantum Technologies:
areas of improvement or how
not to slide into quantum
winter”

**Science for everybody
creating a diverse
academic environment**

WHO AM I?

PROF. DR. H. LIEBELT

**Technical University Deggendorf
Director MA „HPC and Quantum Computing“
Director BA „Datacenter Management“
Director Research and Teaching Data Center
Director IT-Center, CISO**

Intel

Quantum Computing Lead, EMEA



Foto Credit: Prof. Li

AGENDA



Quantum Reality Check

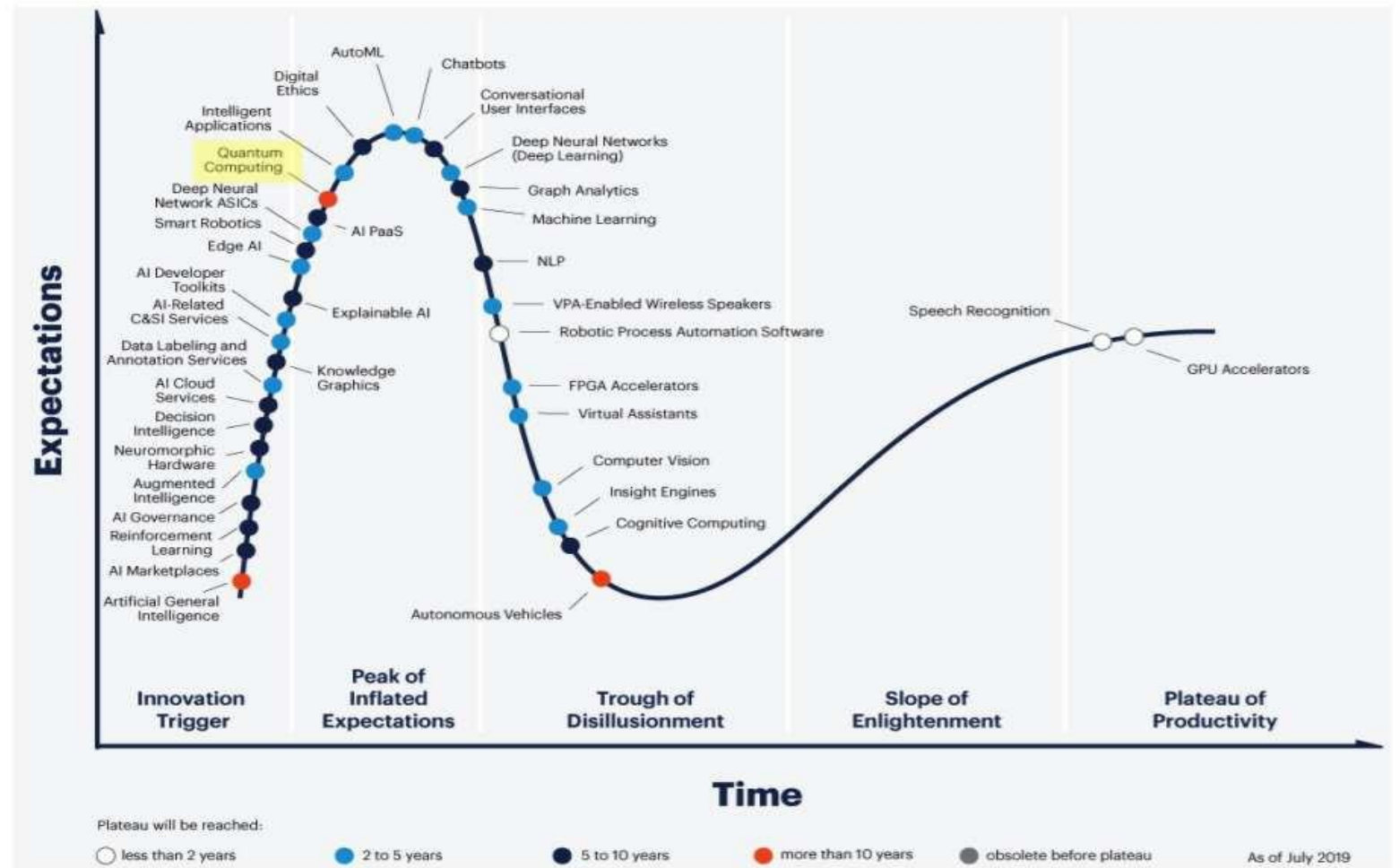
What's missing?

Why diversity is important and
how do we manage?



2019 – QC HYPE CYCLE

Keep in mind:
Quantum computing
will be disruptive
and the next big
thing of mankind.



The 2019 Gartner Hype Cycle for Artificial Intelligence, with quantum computing highlighted in yellow. Credit: Gartner



Classical Computer

Z22-Computer,
1955

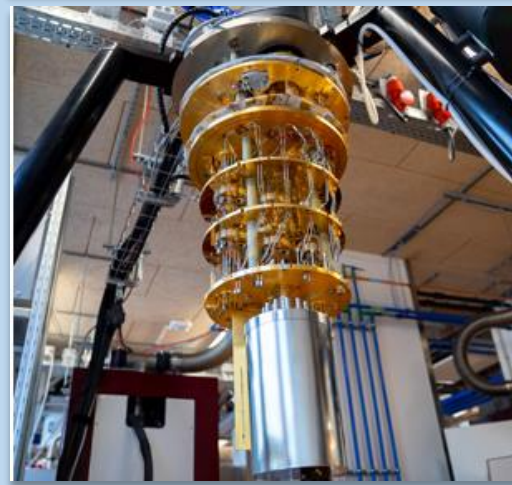


SuperMuc-NG
LRZ, 2020



Quantum Computer

Quantum
Computer 2020



ANTICIPATING
the FUTURE



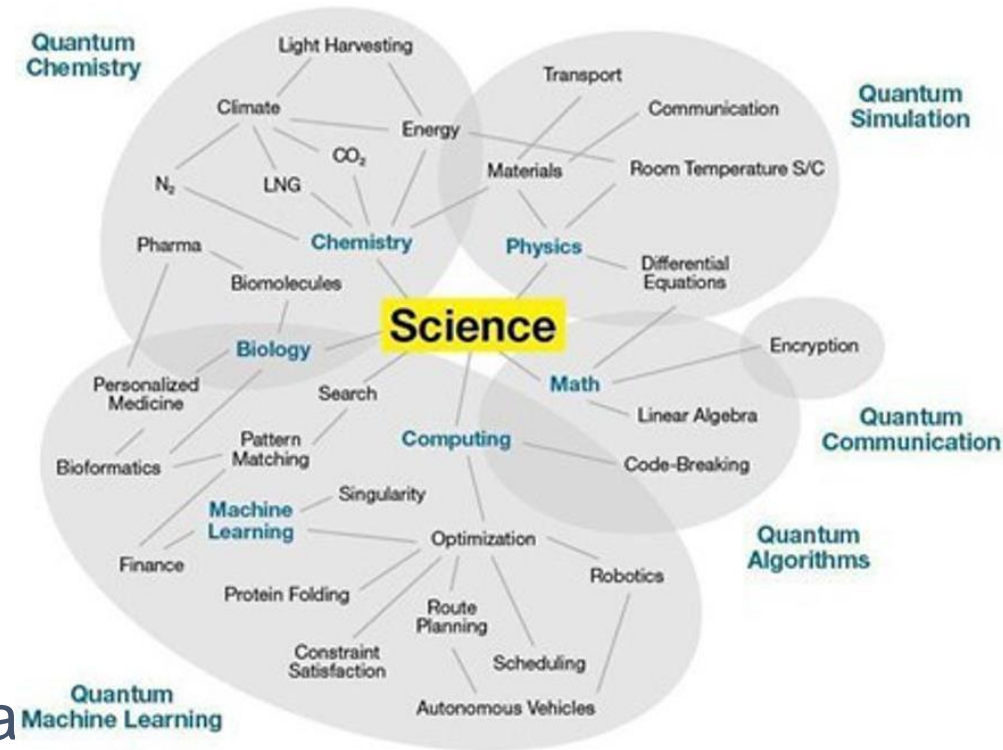
RESEARCH

Expanding the Frontier



The World is dreaming that Quantum Computing may solve these applications exponentially faster than classical computers

- **Chemistry**
 - New catalysts, batteries
- **Materials**
 - Designing new materials
- **Medical**
 - Drug design, protein folding
- **Financial**
 - Portfolio management, options pricing, risk a
- **Travel & Logistics**
 - Shipping, routing, disruption management



gartner.com/SmarterWithGartner

Source: Adapted from Pete Shadbolt and Jeremy O'Brien
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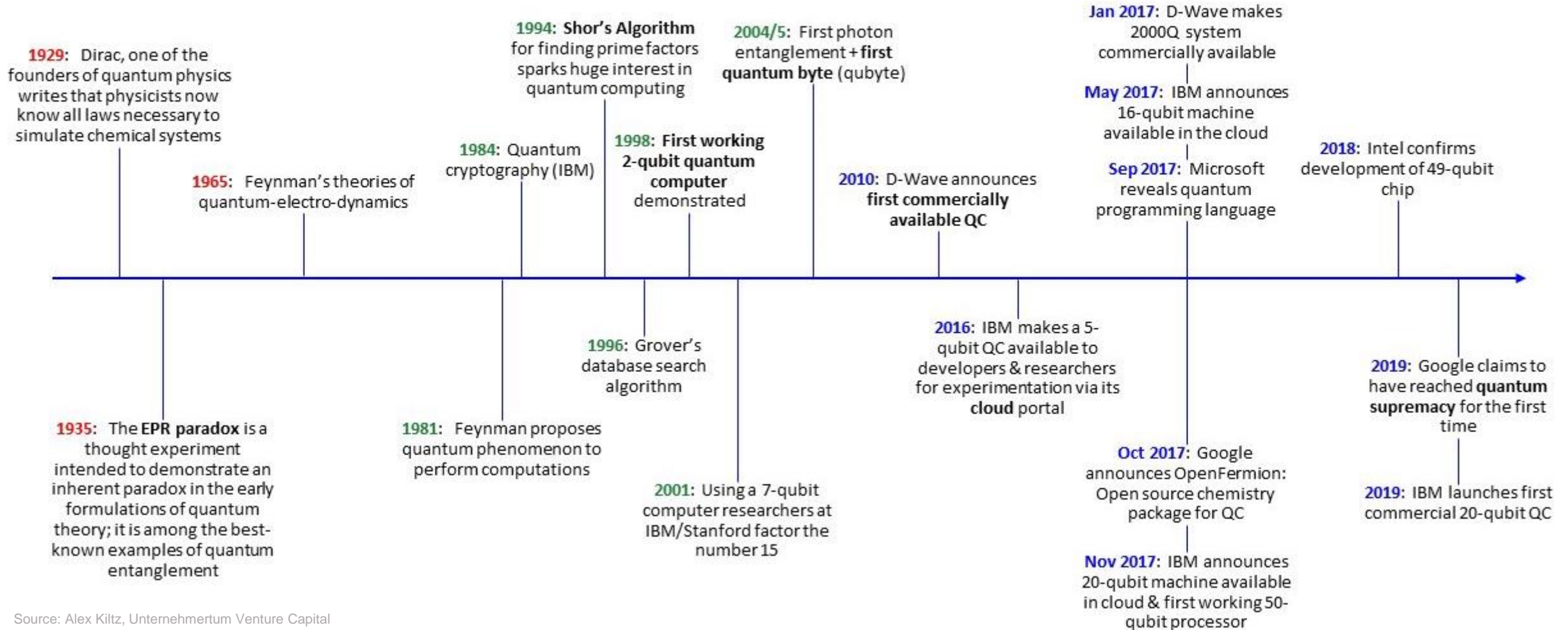
Gartner.

History and Evolution of Quantum

The Foundations

From Theory to Praxis

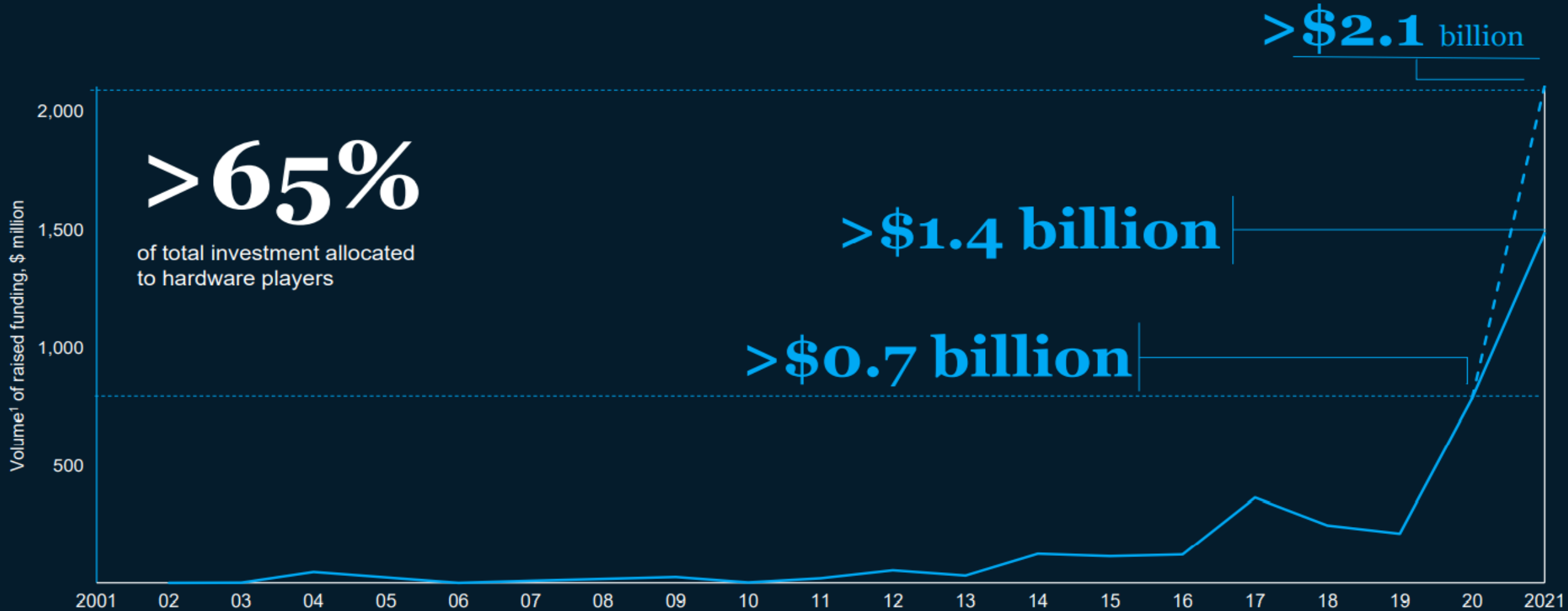
Commercialization & Cloud



QT start-up investment activity surpassed \$1.4 billion in 2021, more than double that of 2020...

Not exhaustive

— Raised start-up funding¹ - - Announced and estimated start-up funding²



1. Based on public investment data recorded in PitchBook; actual investment is likely higher.

2. Public announcements of major deals; actual investment is likely higher as for 7 out of 20 deals done in 2H2021 the deal size was not disclosed.

FUNDING

PUBLIC AND PRIVATE FUNDING CONTINUES TO SKYROCKET AROUND THE WORLD, WITH NORTH AMERICA STILL INVESTING THE MOST.

Global market participation is increasing

While the United Kingdom began catching up to North America in the first half of 2021, it made no new deals in the second half

China still has the most patents, which is conducive to rapid technology progress

- QT founding and investment activity surpassed \$1.4 billion in 2021, more than double that of 2020
- Major deals for 2021 extend to software and QComms players
- China committed \$15 billion over five years for QT;
- EU announced \$7.2 billion

The QT market is still concentrated in North America

North America still leads the QT market, ~40% of players and over 60% of all start-up funding

Ten out of the 12 biggest hardware players are based in North America

China has the broadest commercial implementation of QComms.

Japan has the most players in the industry adopting QT in some part of their operations



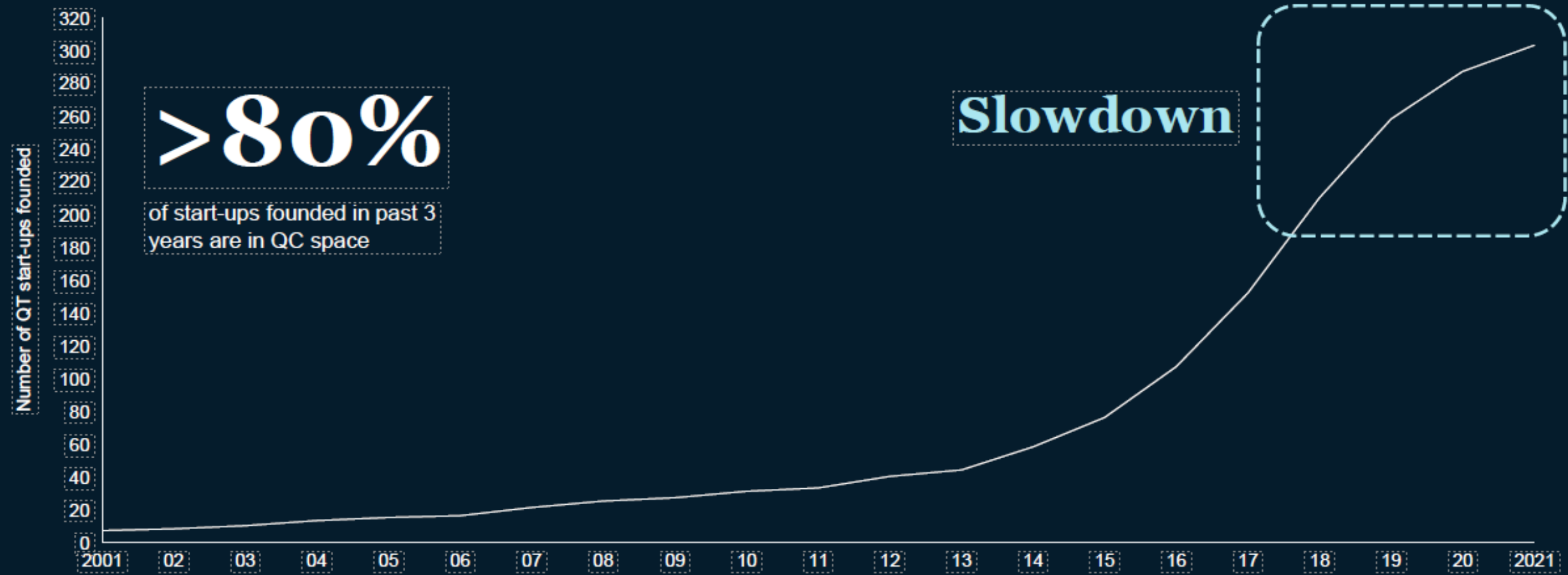
MAJOR DEVELOPMENTS 2021/22

- While the United States and Canada have been market leaders for the last decade, China and the European Union are determined to catch up and have announced significant public funding
- More players across industries will move from precompetitive explorations of QC into competitive research (partly in “stealth mode”)
- In QComms and QS, many products will move from the prototype stage to commercialization; this will likely lead to an increase in application and services players
- Several large investment rounds have already been announced for 2021 (eg, IonQ, ~\$650m; ArQit, ~\$345m; Cambridge Quantum Computing, ~\$300m; Xanadu, ~\$100m), suggesting that the investment activity around QC will continue to grow
- Chinese researchers made a claim to quantum supremacy (for a boson-sampling problem) in December 2020, and local research is expected to yield more breakthrough results backed by government funding for QC



Not exhaustive

Number of start-ups founded to date



>80%
of start-ups founded in past 3 years are in QC space

Slowdown

CHALLENGES

ARCHITECTURE FOR A COMPLETELY NEW KIND OF COMPUTER

Application Algorithms

Compilers/Runtimes

Control Electronics

Quantum Chip

Challenges at each level

- New execution model
- Error mitigation & resilience
- Scalability
- Interconnect complexity
- Qubit device design

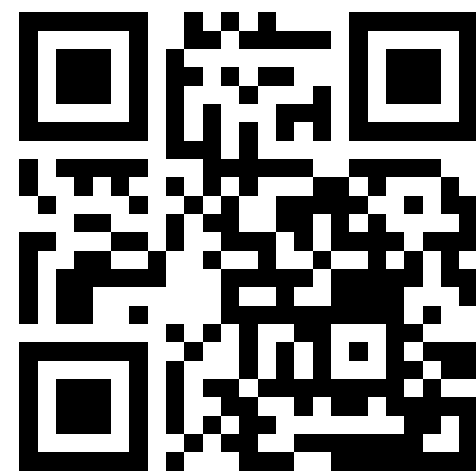




DO YOU HAVE ENOUGH BRAIN POWER TO TACKLE THE BEAST?

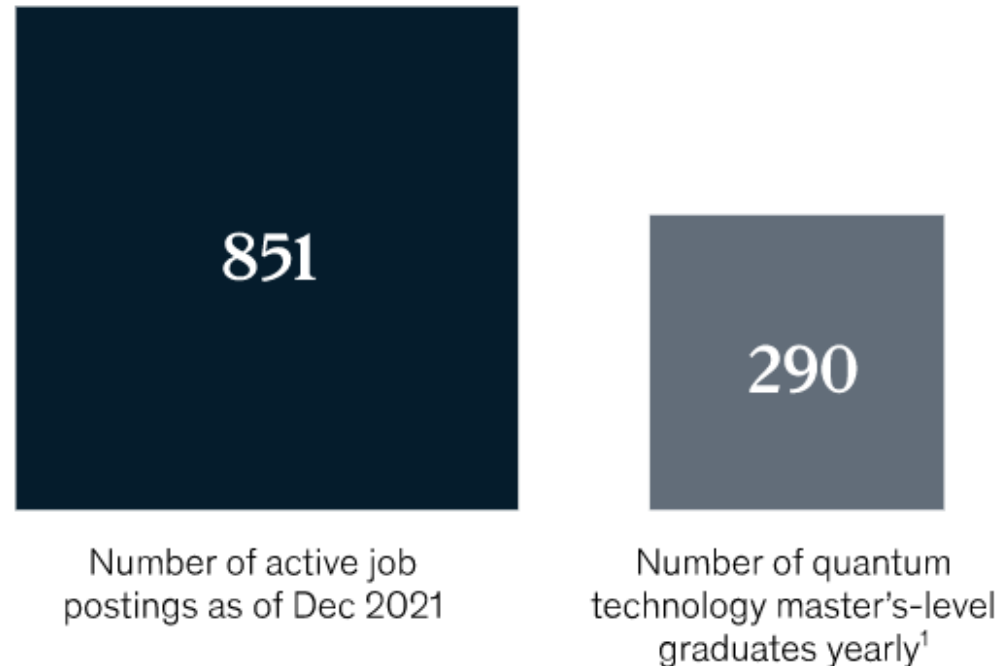
Tweedback ID:

<https://tweedback.de/ebb8>



CHALLENGES TALENT GAP

The number of job postings outstrips qualified talent by as much as three to one...



...but upskilling graduates in related disciplines can help close the gap.

350,000
graduates in quantum
technology-relevant fields²

7 new universities with quantum research groups

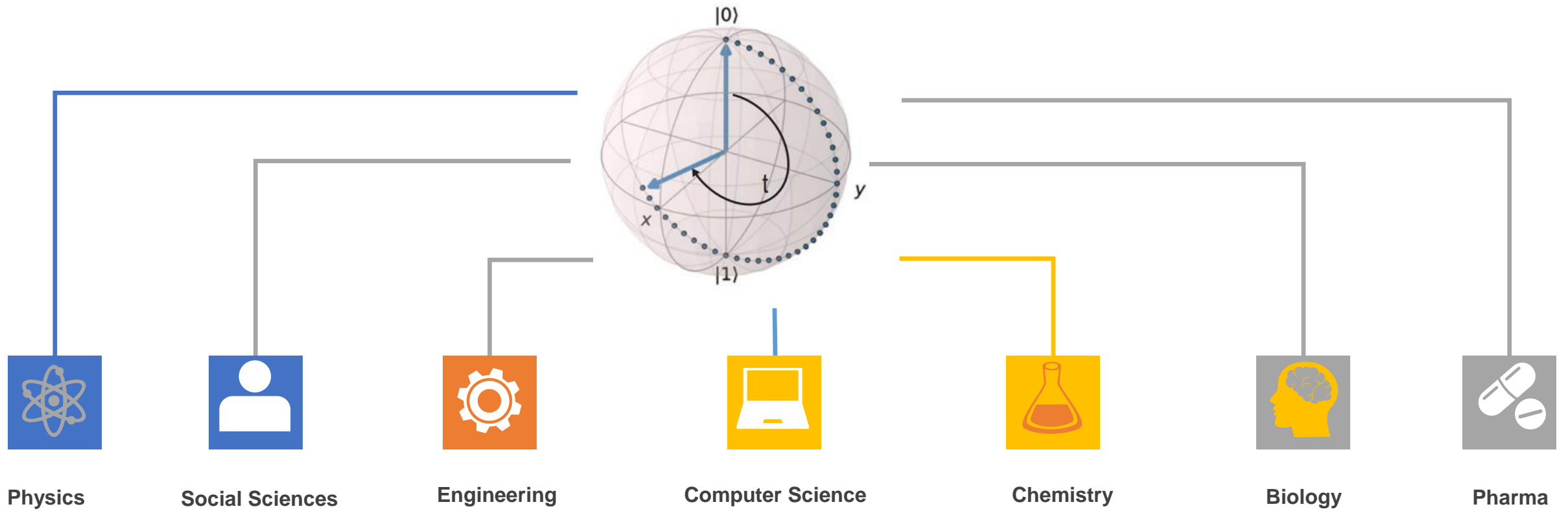
The European Union has the highest concentration of QT talent.

¹ Estimate based on the number of universities with such programs and how many students graduate per year.

² Graduates of master's level or equivalent in biochemistry, chemistry, electronics and chemical engineering, information and communications technology, mathematics and statistics, and physics.

Source: OECD; Quantum Computing Report, quantumcomputingreport.com

INTERDISCIPLINARY FIELD



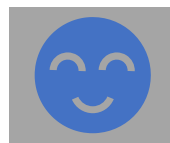
WHY DO WE NEED DIVERSITY?

- Are we prepared?

Diversity is about recognizing and celebrating differences

Equity focuses on providing pathways to equal access

Inclusion focuses on making people accepted, valued and empowered to be their full selves at work



Where are we NOW?

Women STEM workers went from 8% in 1970 to 27% today

25%

computer science

15%

engineering

48%

Life sciences

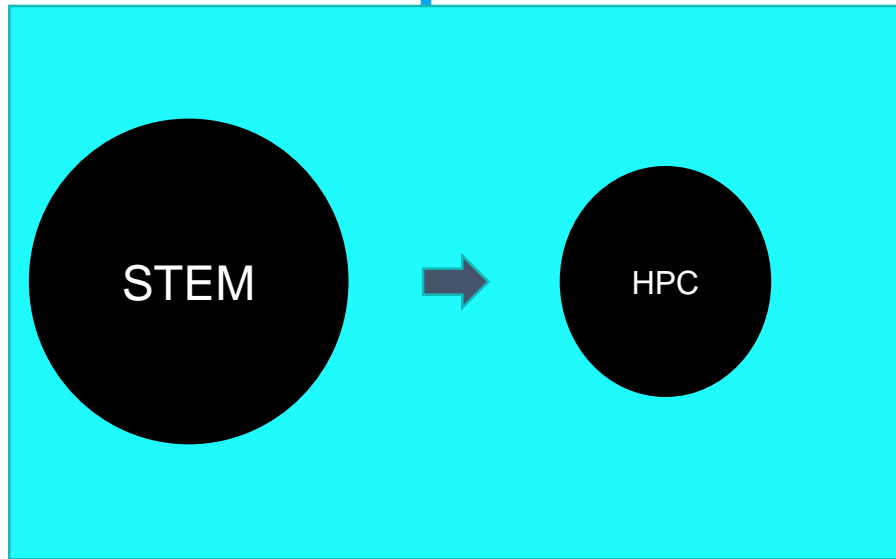
such as biological or agriculture sciences

40%

Physical Sciences

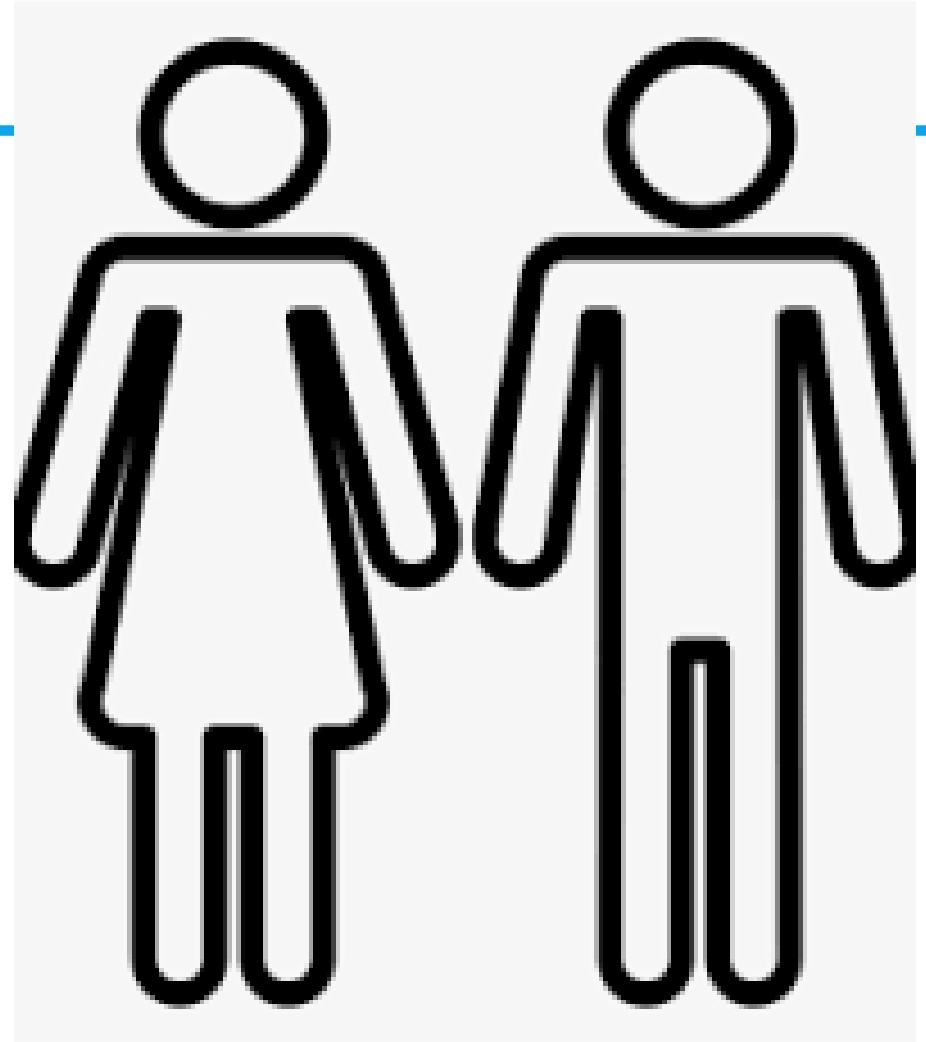
such as astronomy, physics or chemistry), jumping to 40 percent in 2019, up from just 22 percent in 1990





Women representation
in STEM: **Low**

HPC & QC - A niche
within STEM: **Naturally,
even lower**

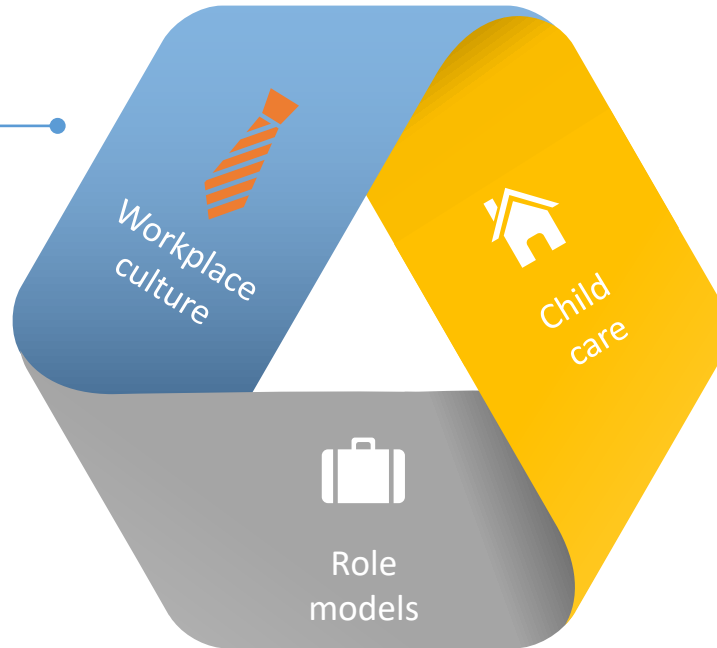


Diverse Workforce

ISSUES

47%

workplace culture is the biggest barrier for women embarking on a STEM career.



17%

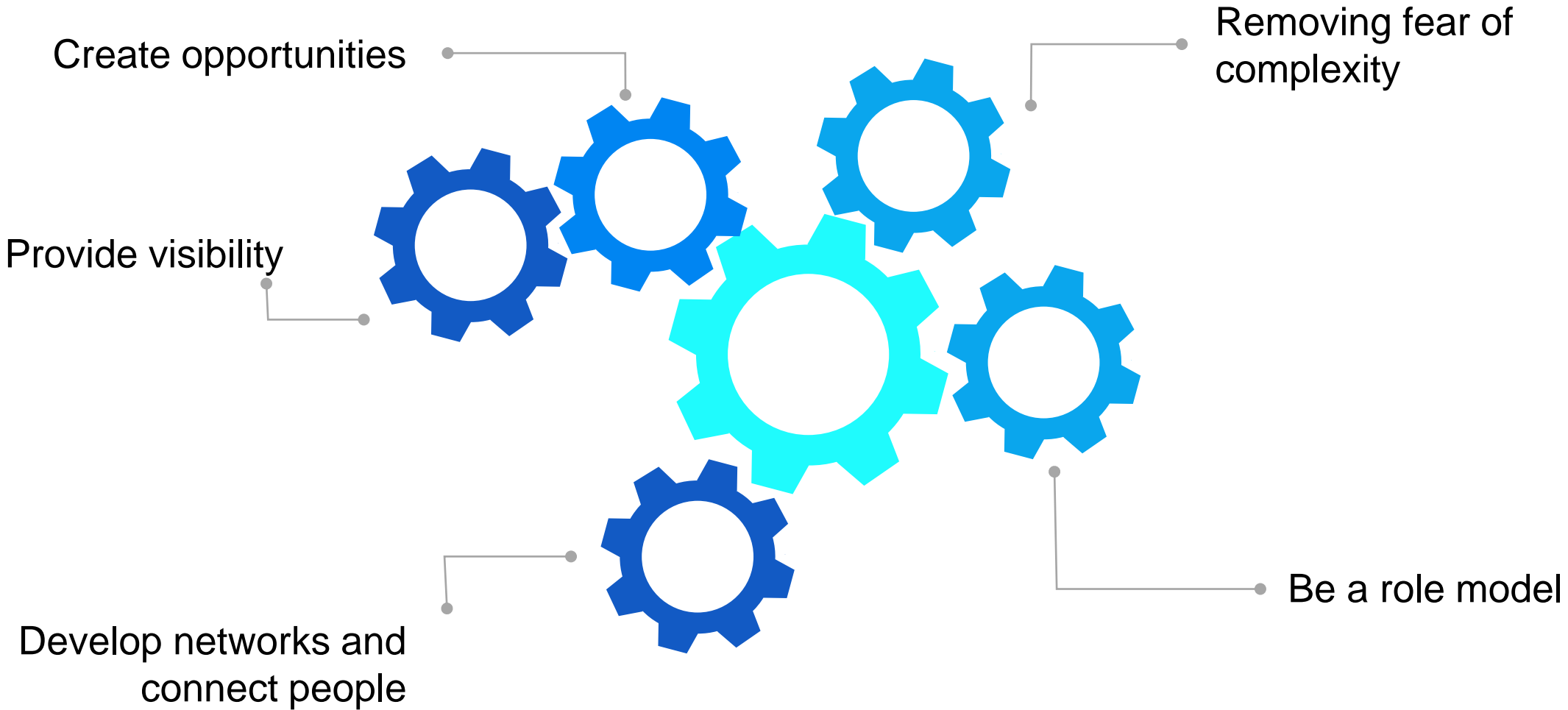
lack of child care/maternity leave

15%

absence of female role models in the workplace



NEXT STEPS

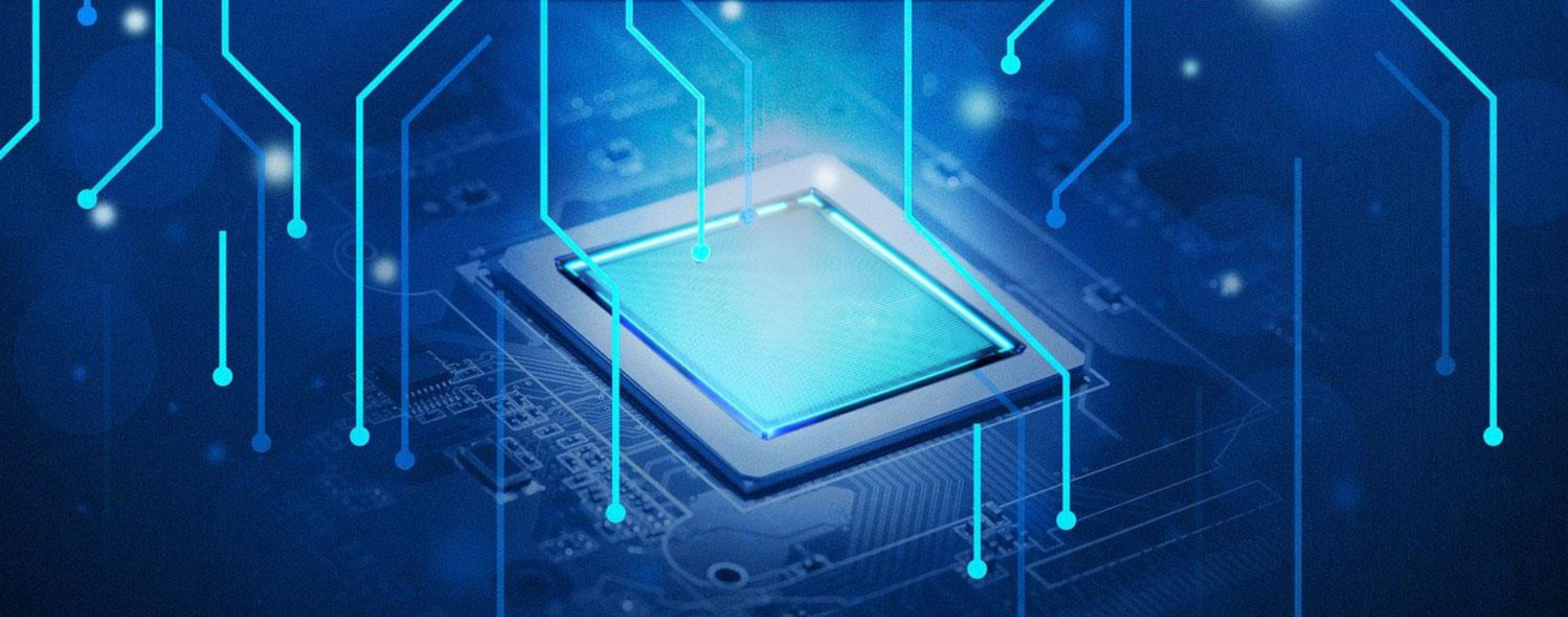


THD

STATISTICS

- 8 faculties
 - 8429 students
 - 41% international students
 - 182 professors
 - 439 lecturers & assistant lecturers
 - 818 support staff
-
- Applied Economics (School of Management)
 - Applied Healthcare Sciences
 - Applied Natural Sciences and Industrial Engineering
 - Civil and Construction Engineering
 - Computer Science
 - European Campus Rottal-Inn
 - Electrical Engineering and Media Technology
 - Mechanical Engineering and Mechatronics





Thank you!



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Faculty of Computer Science

Professors

Professor

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