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Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



The Italian Research Center in High Performance Computing, Big Data and Quantum Computing

Spoke 10: Quantum Computing

High Performance Computing and Quantum Computing – Fifth Edition

15 december 2022, CINECA; Bologna

The Italian Research Center in High Performance Computing, Big Data and Quantum Computing

Innovation in simulations, high-performance computing and big data

SoA infrastructure: integrating existing resources and promoting new technologies

Supporting scientific research and entrepreneurial innovation

One of the five National Centres established by the PNRR

319.938.979,26 €

The Italian Research Center in High Performance Computing, Big Data and Quantum Computing

Headquarters at the
Bologna Technopole

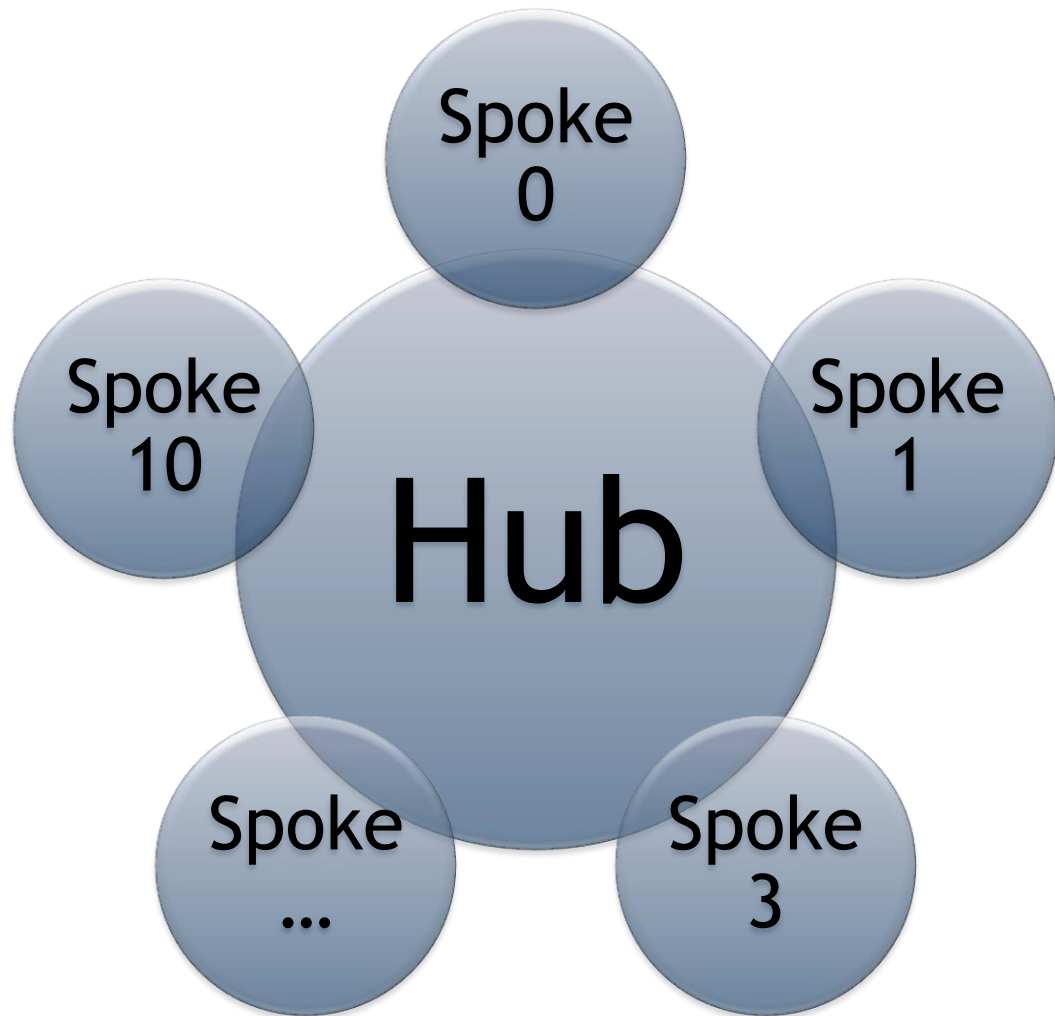
Activities started on
1 September 2022

Official kick-off at Bologna Technopole on
25-26 November 2022

Created and managed by the
ICSC Foundation

319.938.979,26 €

Organization in "thematic" Hubs and Spokes



**Organized according to the
HUB and SPOKE model**

**HUB: carries out
management and
coordination activities**

**SPOKE: carry out research
and innovation activities**

The Spokes

spoke 0

SUPERCOMPUTING
CLOUD
INFRASTRUCTURE



spoke 1

FUTURE HPC
& BIG DATA

spoke 2

FUNDAMENTAL
RESEARCH
& SPACE ECONOMY

spoke 3

ASTROPHYSICS
& COSMOS
OBSERVATIONS

spoke 4

EARTH
& CLIMATE

spoke 5

ENVIRONMENT
& NATURAL
DISASTERS

spoke 6

MULTISCALE MODELLING
& ENGINEERING
APPLICATIONS

spoke 7

MATERIALS
& MOLECULAR
SCIENCES

spoke 8

IN-SILICO
MEDICINE
& OMICS DATA

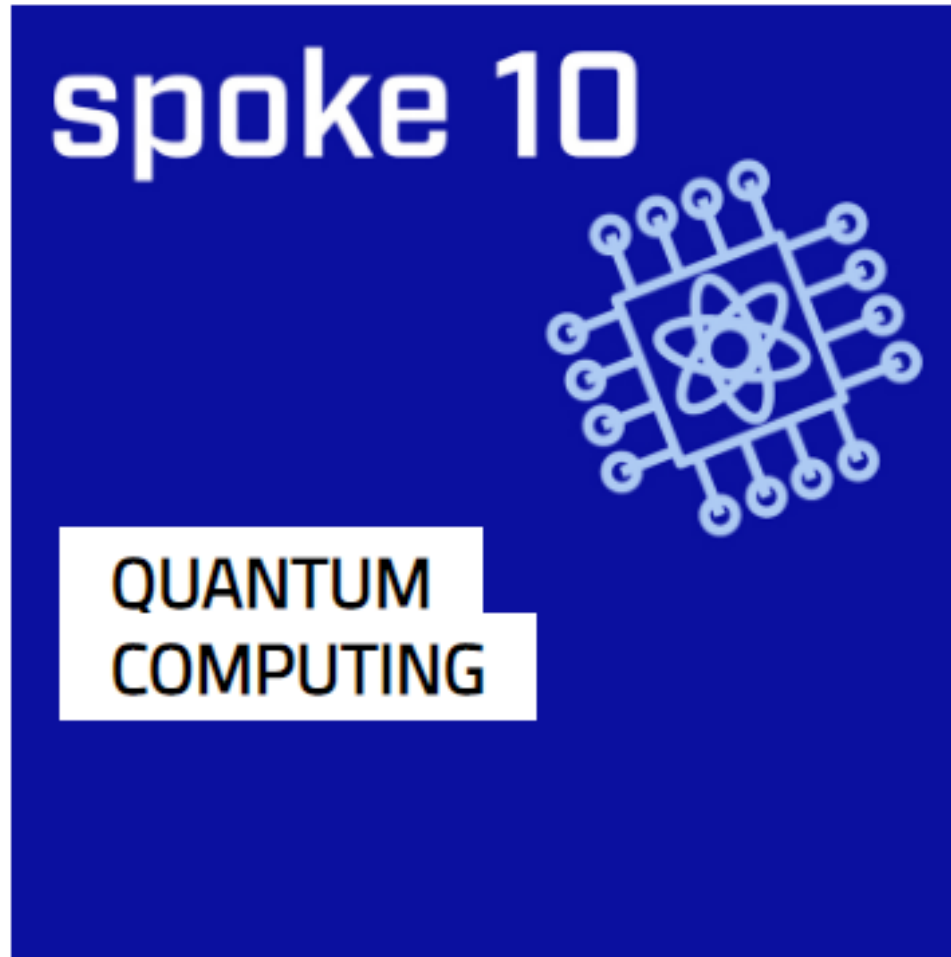
spoke 9

DIGITAL SOCIETY
& SMART CITIES

spoke 10

QUANTUM
COMPUTING

Spoke 10: Quantum Computing



Budget:
30 mil. di €

15 research institutions

Politecnico di Milano

Università di Padova

CINECA

Consiglio Nazionale delle Ricerche (CNR)

Istituto Italiano di Tecnologia (IIT)

Istituto Nazionale di Astrofisica (INAF)

Istituto Nazionale di Fisica Nucleare (INFN)

Università di Bari

Università di Bologna

Università di Catania

Università di Milano-Bicocca

Università di Napoli

Università di Pavia

Università di Pisa

Università di Roma-Sapienza



14 founding companies

Autostrade

Engineering

Enel

Eni

Ferrovie dello Stato Italiane

Fincantieri

Fondazione per l'Innovazione Urbana

Humanitas

IFAB

Intesa Sanpaolo

Leonardo

SOGEI

Thales Alenia Space

TERNA

Unipol Sai

Many other interested companies

CNH Industrial

Kmrosso

Atos

Bip

Prometeia

Quantyca

Seco

E4 Computer Engineering

Esteco

Bonfiglioli

Confindustria Emilia

Agile Labs

...

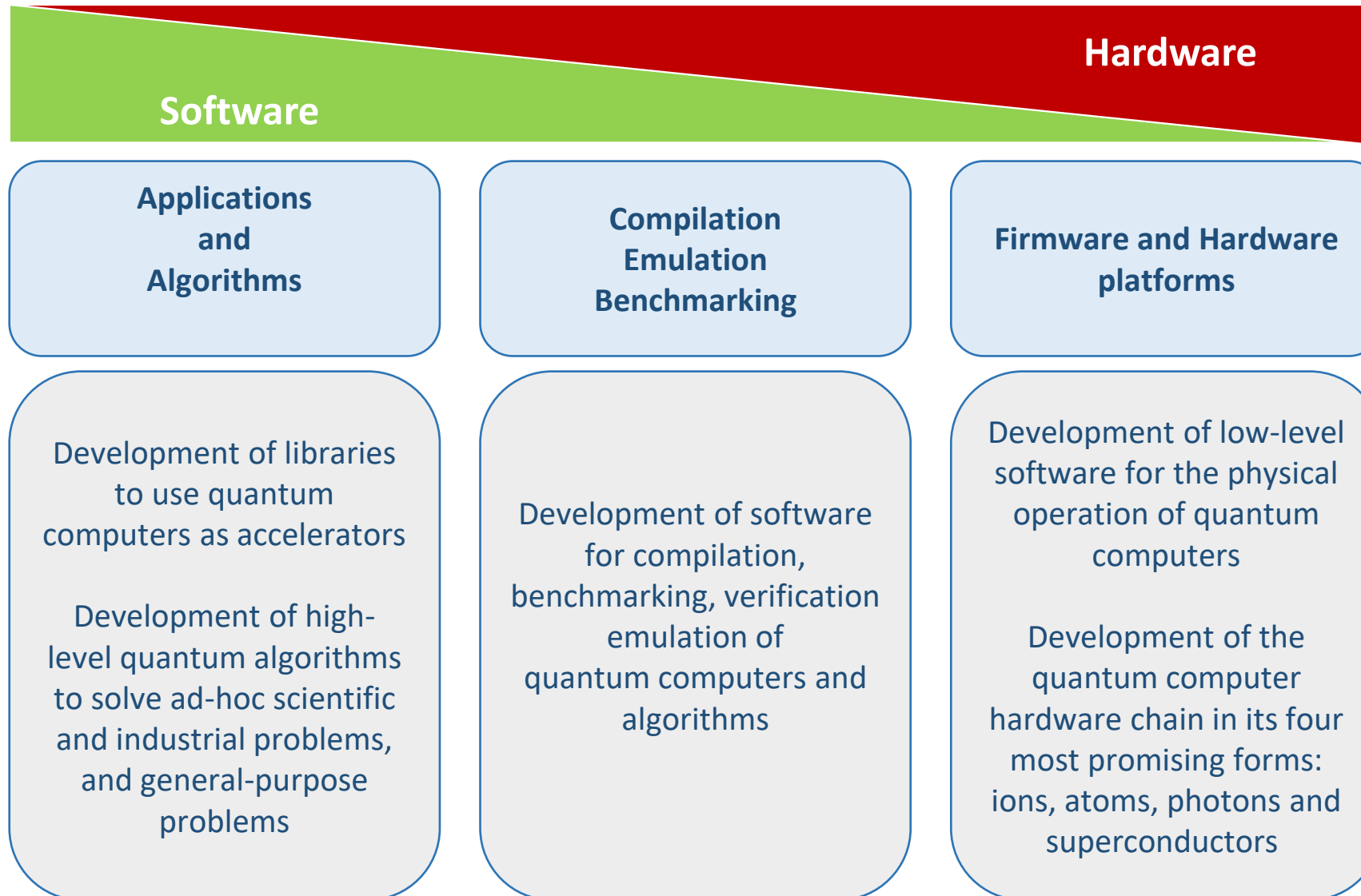


Objectives

Research and development of quantum computers
“scalable” and “reliable”

Using quantum computing
for the solution of complex problems

The research landscape



Organization in Layers and Workpackages

WP1. Software

Layer 1. Applications

Layer 2. Algorithms

WP2. Middleware

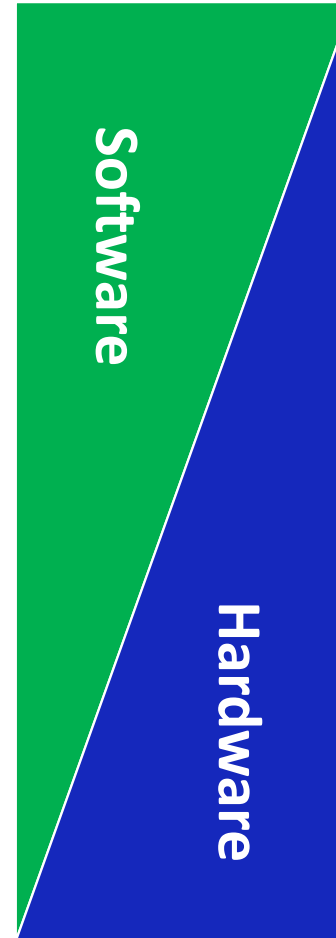
Layer 3. Emulation

Layer 4. Compilation

WP3. Hardware

Layer 5. Firmware

Layer 6. Hardware





Organization in Layers and Workpackages

WP1. Software

Layer 1. Applications

Layer 2. Algorithms

WP2. Middleware

Layer 3. Emulation

Layer 4. Compilation

WP3. Hardware

Layer 5. Firmware

Layer 6. Hardware

Leader: INFN

Development of quantum software for algorithms applications (scientific and industrial)

- T1.1 New algorithms
- T1.2 Applications and use cases



Organization in Layers and Workpackages

WP1. Software

Layer 1. Applications

Layer 2. Algorithms

WP2. Middleware

Layer 3. Emulation

Layer 4. Compilation

WP3. Hardware

Layer 5. Firmware

Layer 6. Hardware

Leader: CINECA

Software development for
compilation, benchmarking,
validation, and emulation

- T2.1 Compilation
- T2.2 Emulation



Organization in Layers and Workpackages

WP1. Software

Layer 1. Applications

Layer 2. Algorithms

WP2. Middleware

Layer 3. Emulation

Layer 4. Compilation

WP3. Hardware

Layer 5. Firmware

Layer 6. Hardware

Leaders: CNR, Catania

Development of low-level software for the physical operation of quantum computers. Hardware development and support.

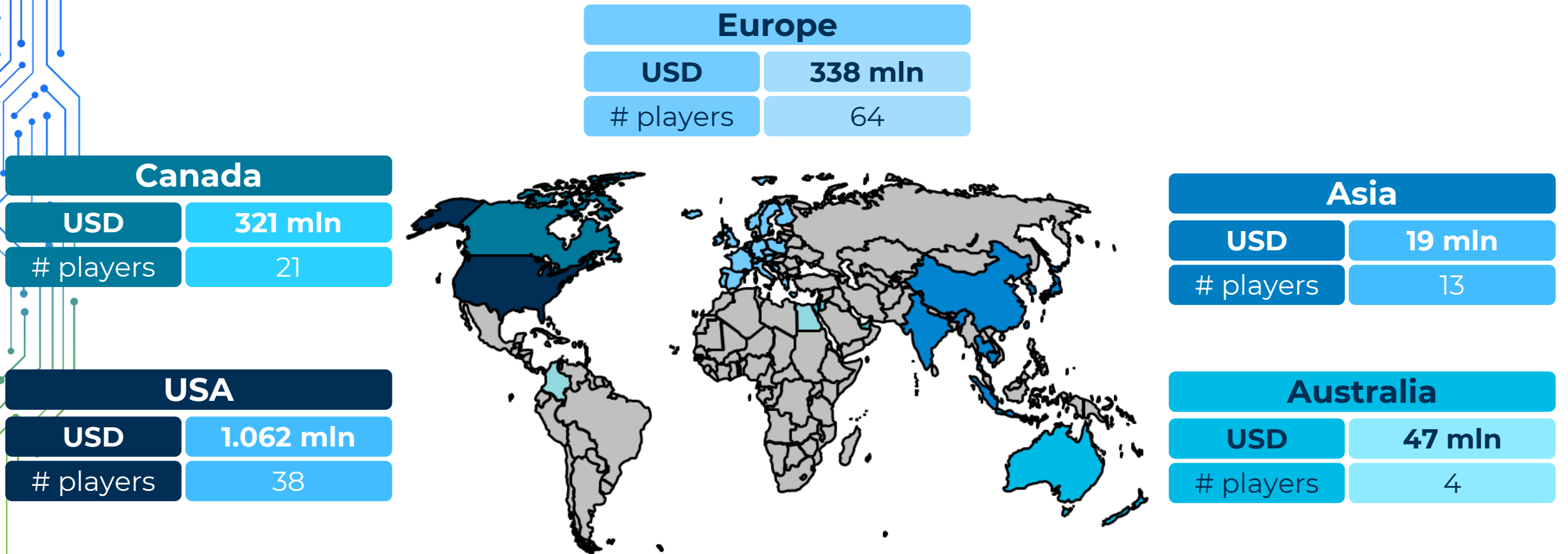
- T3.1 Photonic hardware
- T3.2 Superconducting circuits
- T3.3 Atomic hardware
- T3.4 Models and firmware





The global landscape on Quantum Computing

Private investments



Public investments

Canada

USD 0,79 mld

period 2010-2019

€/anno 74 mln

USA

USD 1,2 mld

period 2018-2022

€/anno 250 mln

Europe

USD 8,9 mld

period 2014-2029

€/anno 517 mln

Russia

USD 0,79 mld

period 2020-2024

€/anno 165 mln

Asia

USD 12,4 mld

period 2014-2030

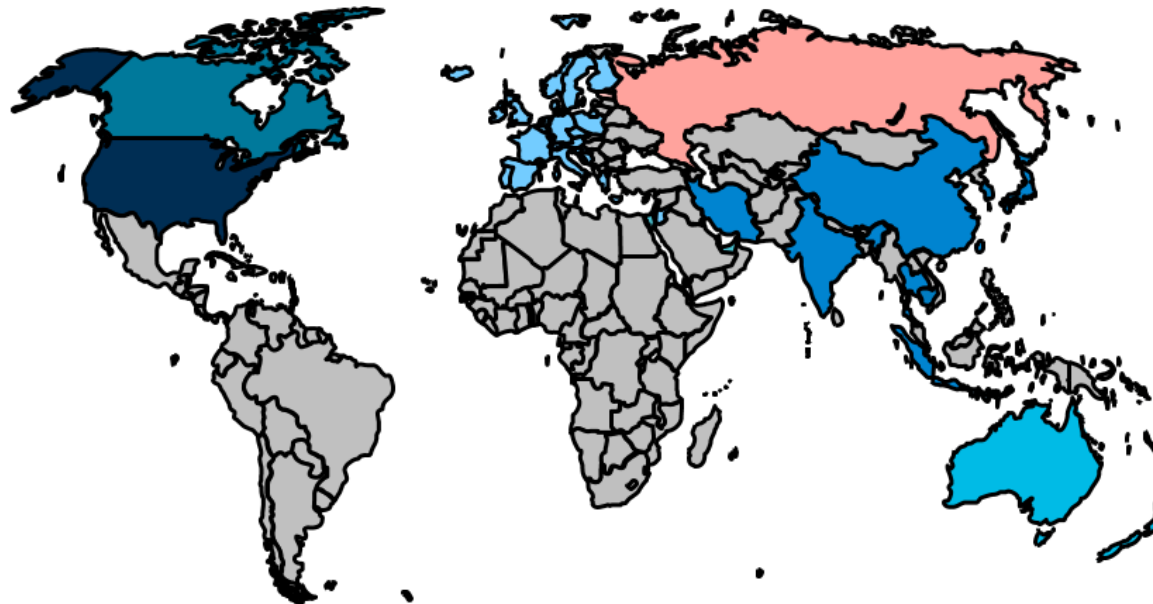
€/anno 613 mln

Australia

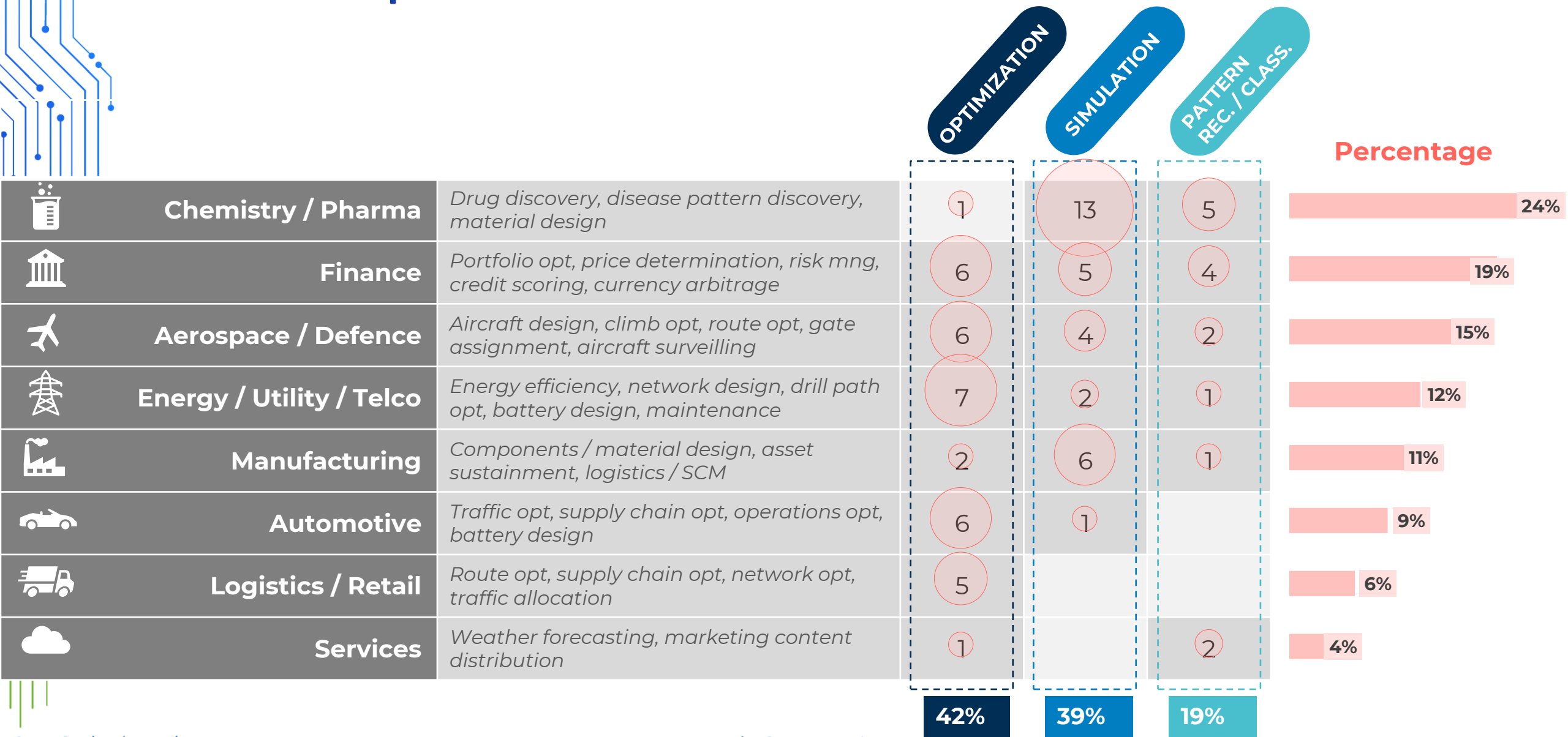
USD 0,09 mld

period 2016-2025

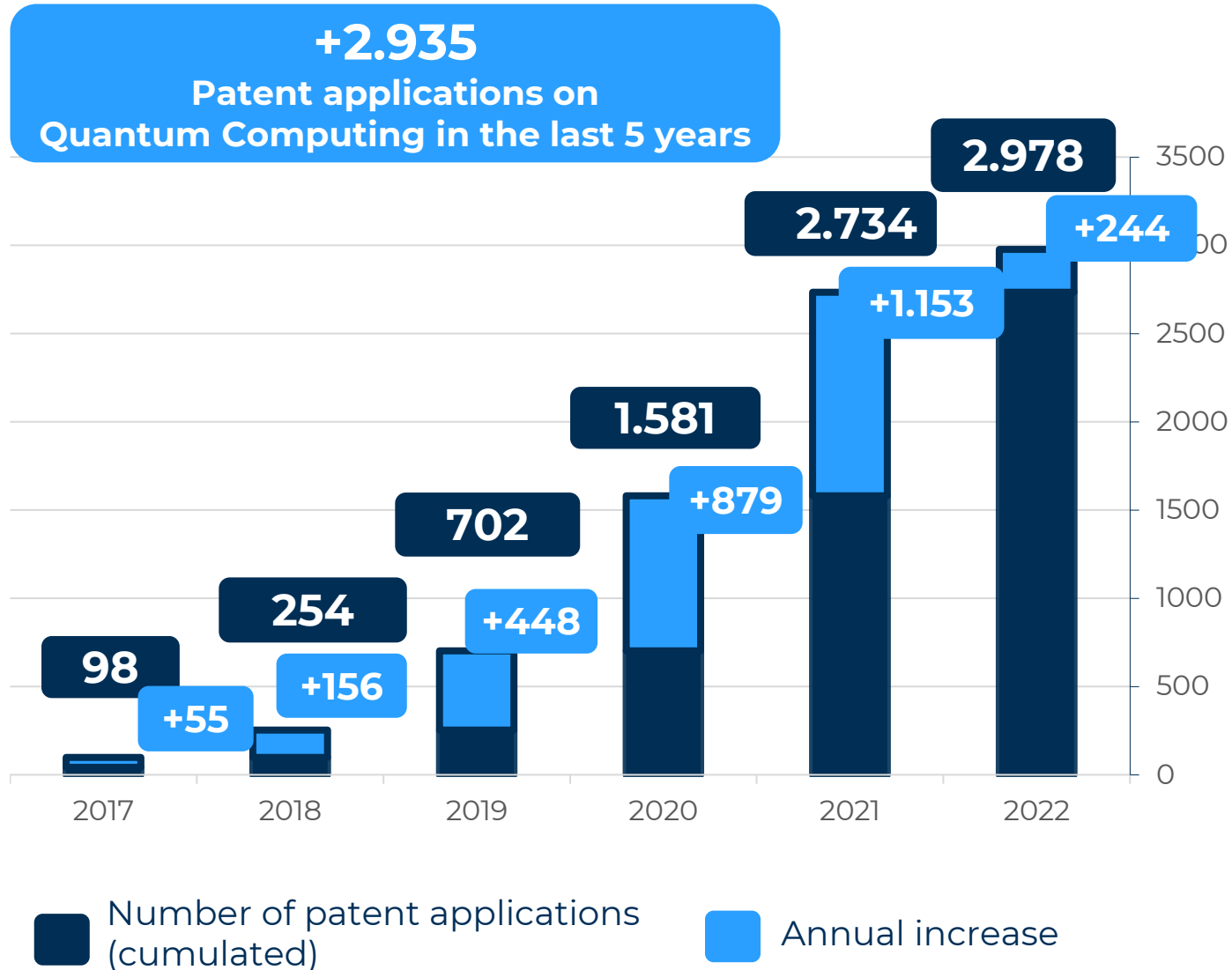
€/anno 9 mln



Industrial problems and areas

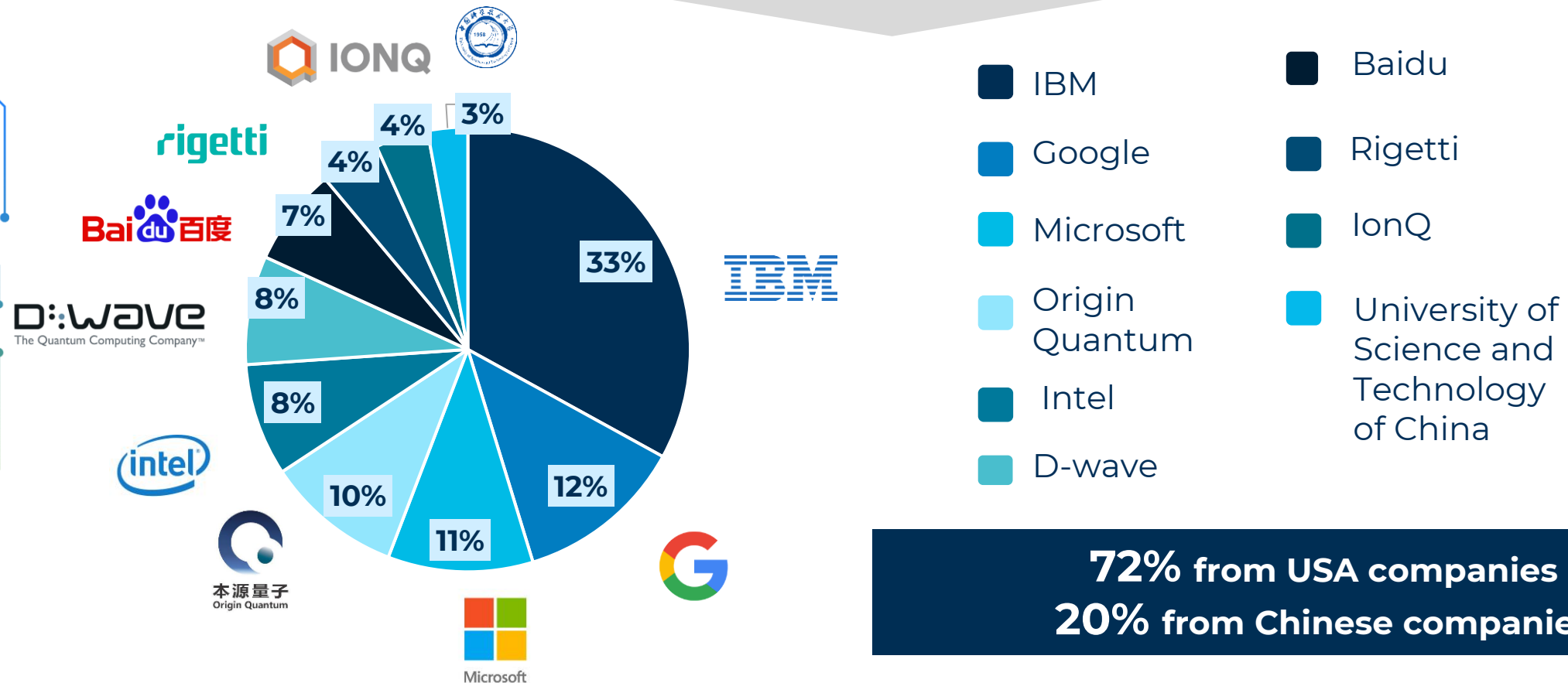


Patents on Quantum Computing



Patents on Quantum Computing

Breakdown of the main 10 applicants:
1,100 patents

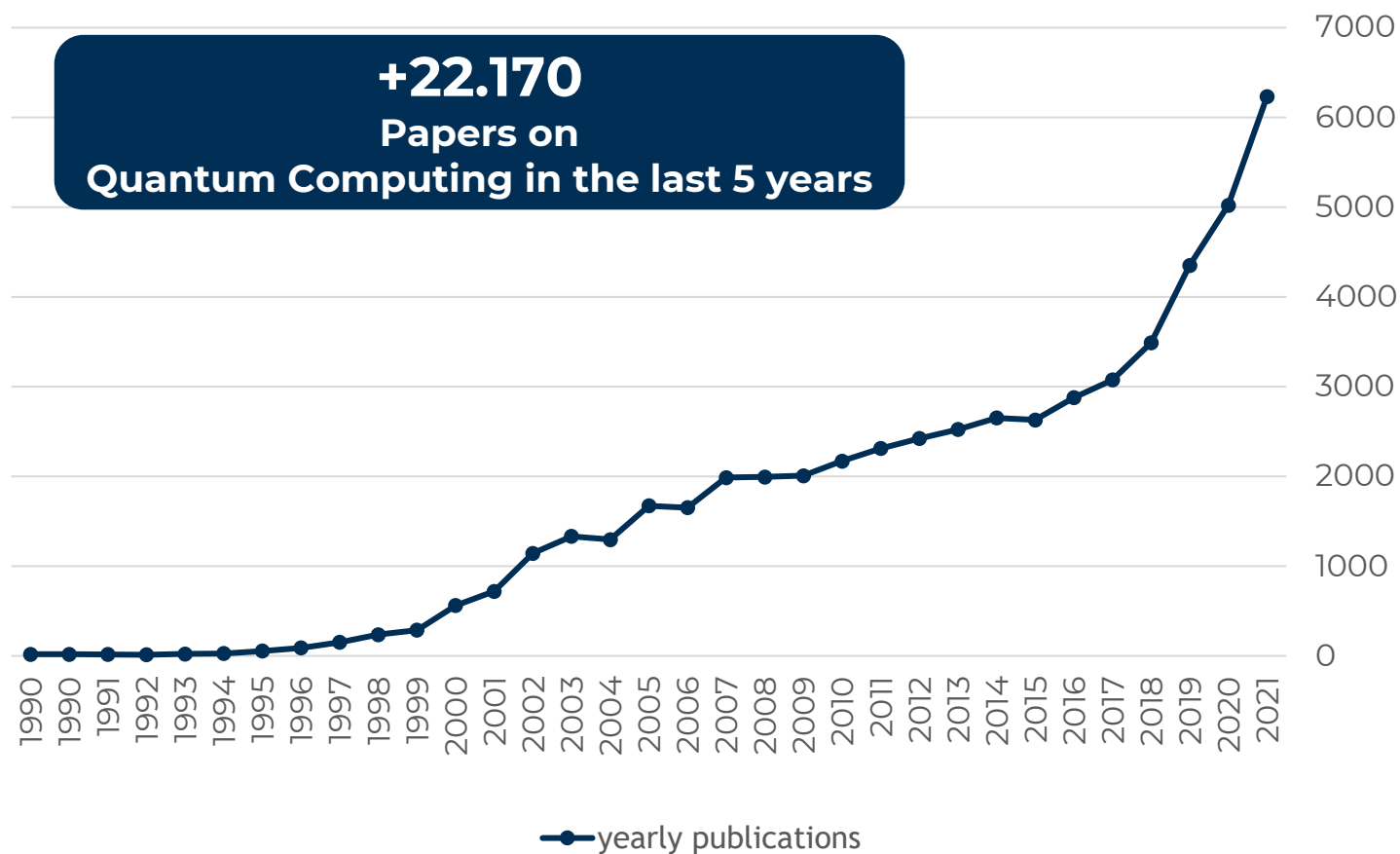


72% from USA companies
20% from Chinese companies

Academic research

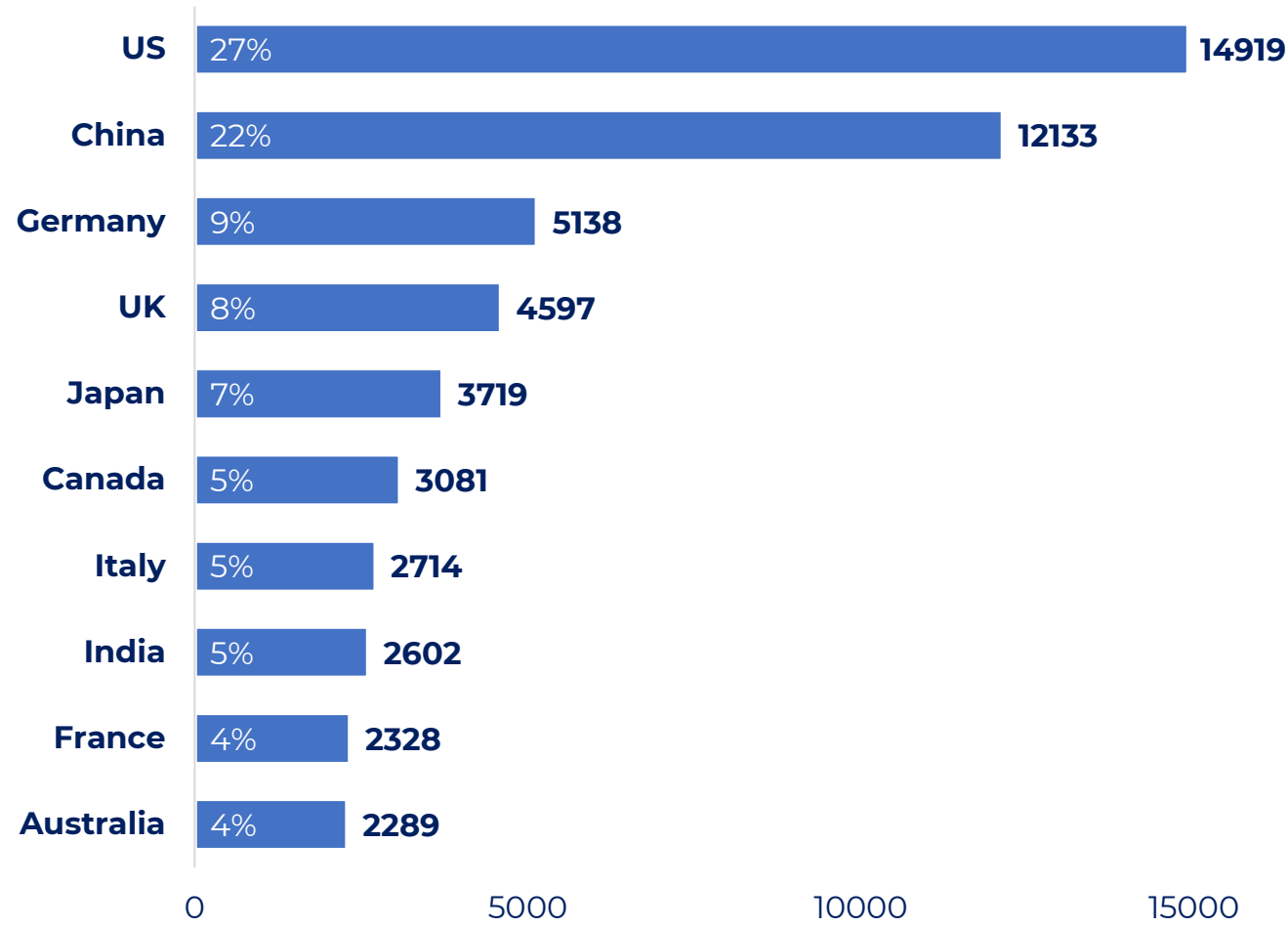
56.161 papers since 1990

+22.170
Papers on
Quantum Computing in the last 5 years



Publication rate increases after 2015

Top 10 countries (# of papers)





Thanks

autore nome cognome

Bologna, 25/26 novembre 2022