



A PORTRAIT OF THE GLOBAL PATENT LANDSCAPE IN QUANTUM TECHNOLOGIES

WHITE PAPER | FEBRUARY 2026

TABLE OF CONTENTS

EXECUTIVE SUMMARY	4
1 GLOBAL PATENT FAMILY LANDSCAPE OF QUANTUM TECHNOLOGIES	6
2 DETAILED ANALYSIS – INTERNATIONAL PATENT FAMILIES	10
3 SITUATION BY COUNTRY / REGION	14
4 EUROPEAN LEADERS BASED ON THE NUMBER OF PATENT FAMILIES	21
5 DEEP DIVE: QUBIT PLATFORMS	23
CONCLUSIONS	26
REFERENCES & BIBLIOGRAPHY	28
GLOSSARY OF ABBREVIATIONS	29
DEFINITIONS	30
APPENDIX A: SEARCH METHODOLOGY	31

ACKNOWLEDGEMENTS

This white paper was prepared by the QuIC IP&Trade Working Group. The main contributors were:

Rob Harrison, (Sonnenberg Harrison)

Maximilian Keck, (Hoffman Eitle)

Dolores Modic, (Nord University)

Guido Paola (Quantum Delta NL), lead author

Erik Visscher, (De Vries & Metman)

Julian Wienand (Bardehle Pagenberg)

INTRODUCTION

This white paper presents an overview of the patent landscape in quantum technologies, with a more detailed analysis of the situation in **Quantum Computing, Quantum Communication and Quantum Sensing**, followed by a closer look at four of the main qubit platforms (physical realisations of qubits) for Quantum Computing: **superconducting/transmon qubits, spin qubits, trapped ions and cold atoms**.

This is the third edition of this white paper. In this edition, the analysis is based on active patents and patent applications that were published **before 30 June 2025**, providing a full overview of patent applications filed in the whole year 2023 given that there is a delay of 18 months between the first filing and the publication of a patent application.

This study also focuses on the European position in the global patent landscape, and identifies the main European players in quantum technology from an IP perspective.

This study includes the following topics:

- Analysis of the key patent assignees in quantum technologies
- A closer look at the situation in Europe and its competitive position
- Comparison with last year's trends in quantum patenting

We will first analyse the situation for simple patent families – these have a single patent/patent application in the family. We will see that there has been a **30 %** average increase in patenting in quantum technology overall in the period 2017–2023. In the field of Quantum Communication (average **27 %** increase), there has been a particular spurt in recent years, with almost **29 %** for the period 2022–2023.

After that, we will analyse the situation for international patent families, which must have at least two patent representatives in at least two jurisdictions or must be filed as international patent applications or as European patent applications at the European Patent Office (EPO). We will see that Chinese assignees dominate the patent landscape thanks to the filing of

many national Chinese patents but fall short as assignees of international patents. When looking at the number of international patent applications, US-based assignees dominate the global landscape, but European assignees have the highest increase rate per year in the period 2020–2023. IQM Finland is the only European company present in the top 50 assignees of patent families in quantum technologies when considering simple patent families. However, many more European assignees appear in the top 50 assignees when analysing the situation for international patent families.

We will look at the patent landscape for four regions – the US, China, Japan and Europe – by analysing the top patent assignees of US, Chinese, Japanese and European patent families. We will see that the top 20 assignees of US, Chinese and Japanese patent families are, as expected, mostly based in the US, China and Japan. At first sight, in Europe the situation differs: the four top assignees of European patent families are all US-based: IBM, Google, Microsoft and Northrop Grumman. However, when looking at the total number of European patent families, the largest share of those (**41 %**) are still owned by European assignees, while **35.6 %** are owned by US-based assignees. It appears that in Europe the situation is more fragmented than in other regions, especially in the US. This is driven by the presence of many companies in Europe with smaller patent portfolios (1 to 11 patent families). In contrast in the US, a large part of the quantum patent portfolio is owned by fewer US-based companies (“big techs”). When looking at the relative weight of domestic assignees of domestic patent families, European assignees still lag behind compared to Japanese (**44 %**), US (**54 %**) and Chinese assignees (**91 %**).

IQM is the biggest European patent assignee overall, while among European Research and Technology Organisations (RTOs), the French Centre national de la recherche scientifique (CNRS) is the biggest assignee. Almost **75 %** of all European assignees of patent families in quantum technology are companies, while the rest of the European patent assignees in quantum technology are governmental or academic entities.

IBM is the top patent assignee in superconducting/transmon qubits. In Europe, IQM, TU Delft and Alice & Bob also appear among the top 20 assignees in this category.

IBM is also the top patent assignee in spin qubit technology, and in Europe, TU Delft, the French Alternative Energies and Atomic Energy Commission (CEA) and Terra Quantum are also among the top 20 patent assignees in this category.

IonQ is the top patent assignee for the trapped ions platform, and the European company Pasqal is the top patent assignee for cold/neutral atoms technology.

Appendix A describes in detail the search methodology and the search queries used for this study.

Please note that **the Quantum Technology domain is currently highly dynamic in terms of invention filings** and accordingly the number of patent families may be evolving quite significantly.

1 GLOBAL PATENT FAMILY LANDSCAPE OF QUANTUM TECHNOLOGIES

Figure 1 shows the numbers of patent families (with one or more family members) and the respective weights for each of the three segments:

- Quantum Computing
- Quantum Communication (quantum cryptography and quantum information networks)
- Quantum Sensing

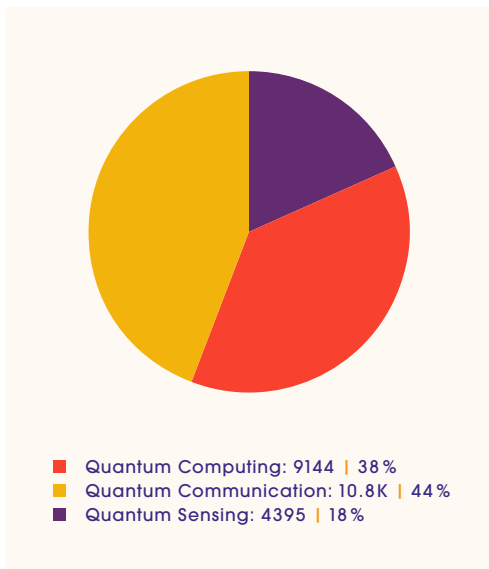


Figure 1: Number of patent families by quantum technology segment

Quantum Computing and Quantum Communication are noticeably stronger than Quantum Sensing.

This effect is also clear from Figure 2, which shows the number of patent filings by earliest priority year in the three categories of Quantum Computing, Quantum Communication and Quantum Sensing.

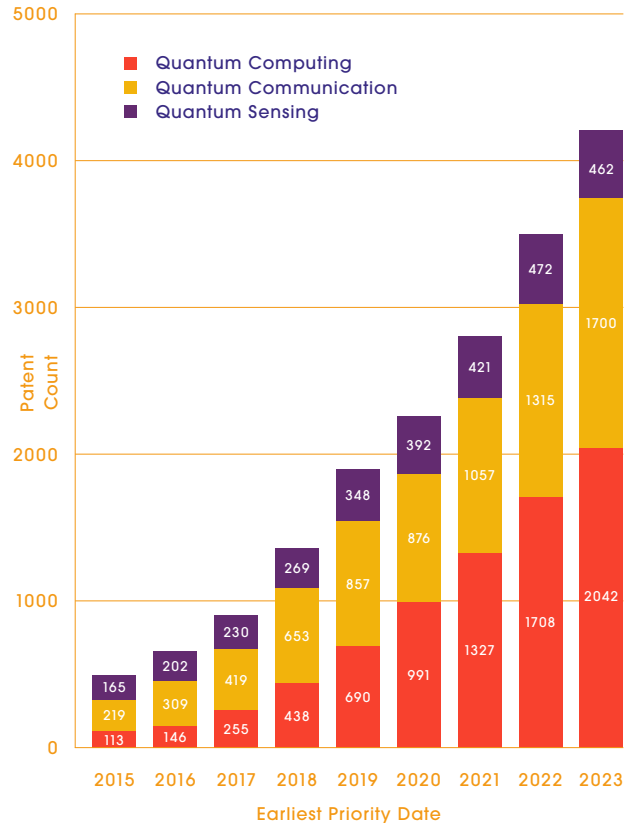


Figure 2: Global segmentation - number of patent families by earliest priority year

The average growth per year is quite strong with around 30% for the 2017–2023 period, but growth rate slowly decreased during the last year.

For Quantum Computing, the average growth over this period is 43%. For Quantum Communication, the average growth over the same period is 27%, with a notable growth of 29% in the year 2022–2023 – greater than the growth of patent families in Quantum Computing in the same period (only about 20%).

Table 1 shows the annual growth rates of active patent families in the period 2017–2023 for Quantum Communication, Quantum Computing, and Quantum Sensing.

Growth rate per year	Quantum Communication	Quantum Computing	Quantum Sensing	Total
2017 / 2018	56	72	17	50
2018 / 2019	31	58	29	39
2019 / 2020	2	44	13	19
2020 / 2021	21	34	7	24
2021 / 2022	24	29	12	25
2022 / 2023	29	20	-2	20

Table 1: Patent filings yearly growth rates for the period 2017–2023 in Quantum Communication, Quantum Computing and Quantum Sensing

Figure 3 (→ PAGE 8) shows the number of patent families held by key players (top 50 assignees). The bars are coloured to indicate the country/region of origin of the player – the US, China, Europe, Japan, Korea or Canada.

A key takeaway from Figure 3 (→ PAGE 8) is that Chinese assignees dominate the rankings in terms of the total number of active patent families (although as we will see in the next

section, Chinese assignees mostly file and own domestic patent families). Chinese company **Origin Quantum** has overtaken IBM as the **top patent assignee** in terms of the total number of active patent families (reversing their last year’s relative positions). The top ten patent owners are still dominated by Chinese players: **six Chinese companies and academic institutions rank in the top ten** (for the number of active patent families), along with three US companies and one Japanese company.

IQM Finland¹ is the first and only European company to rank in the top 50 in this graph.

The graph shown in Figure 4 (→ PAGE 9) is similar to the graph in Figure 3 (→ PAGE 8), but the data is grouped, rather than by country of origin of the assignees, by the three main quantum technology segments: Quantum Computing, Quantum Communication and Quantum Sensing.

Chinese companies are also investing significantly (based on the number of patent families) in **Quantum Computing**, as well as Quantum Communication. Origin Quantum and Baidu are the Chinese leaders in Quantum Computing in terms of absolute number of active patent families filed.

The domain Quantum Communication is dominated by companies and academic institutions from China and Japan.

¹ **European innovative actor in Quantum Computing**

IQM was founded in 2018 in Finland by a group of scientists as a spin-off of VTT Technical Research Center of Finland. IQM is building full-stack quantum computers on a superconducting qubit platform and has recently announced (November 2025) plans to invest over € 40m to expand its state-of-the-art production facility in Finland, enabling it to scale production of full-stack quantum computers to over 30 per year. IQM has a strong focus on innovation and has consistently ranked as the top European patent assignee in quantum technologies in the last few years. (3) (4)

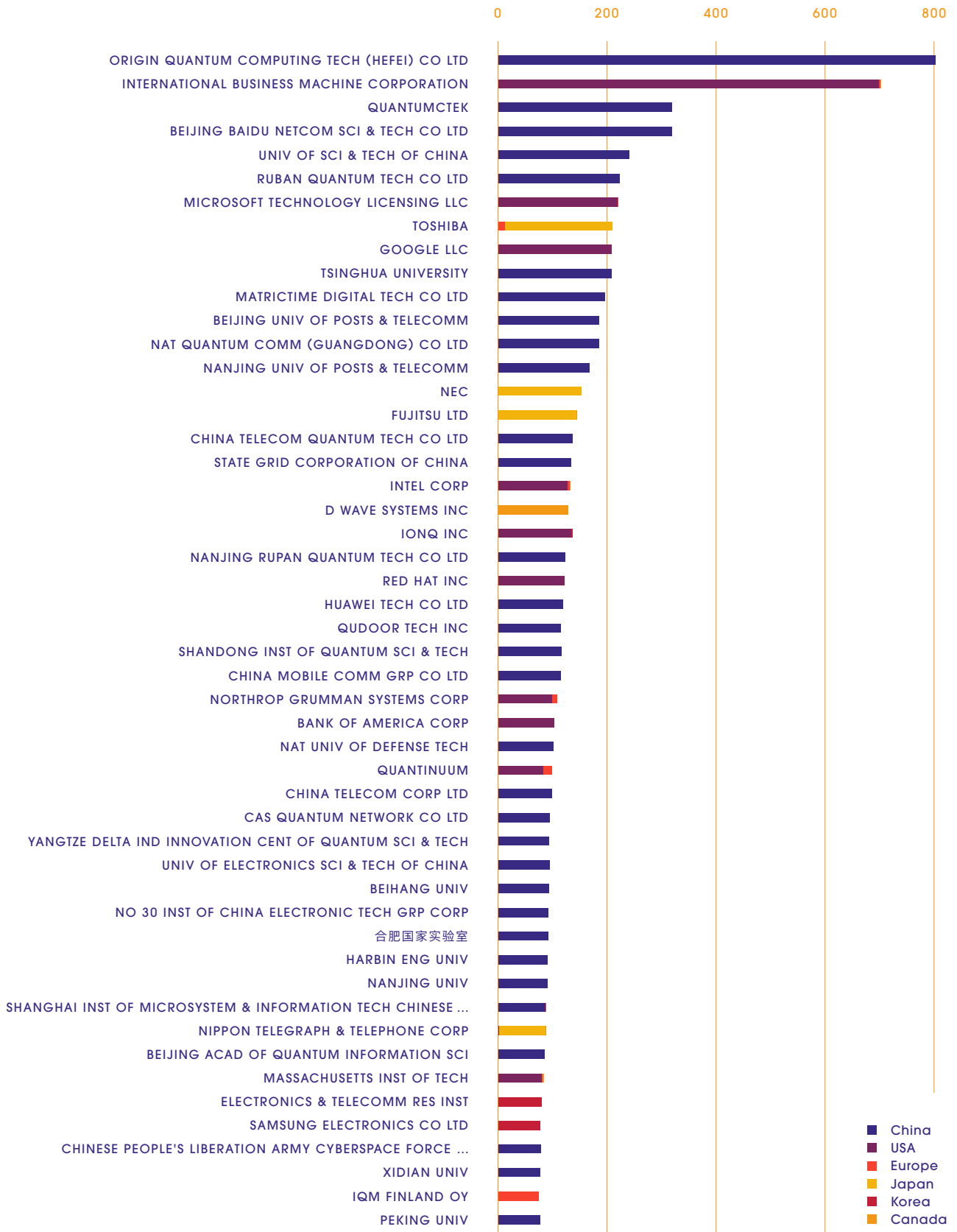


Figure 3: Global segmentation – number of active patent families held by main players by country of origin

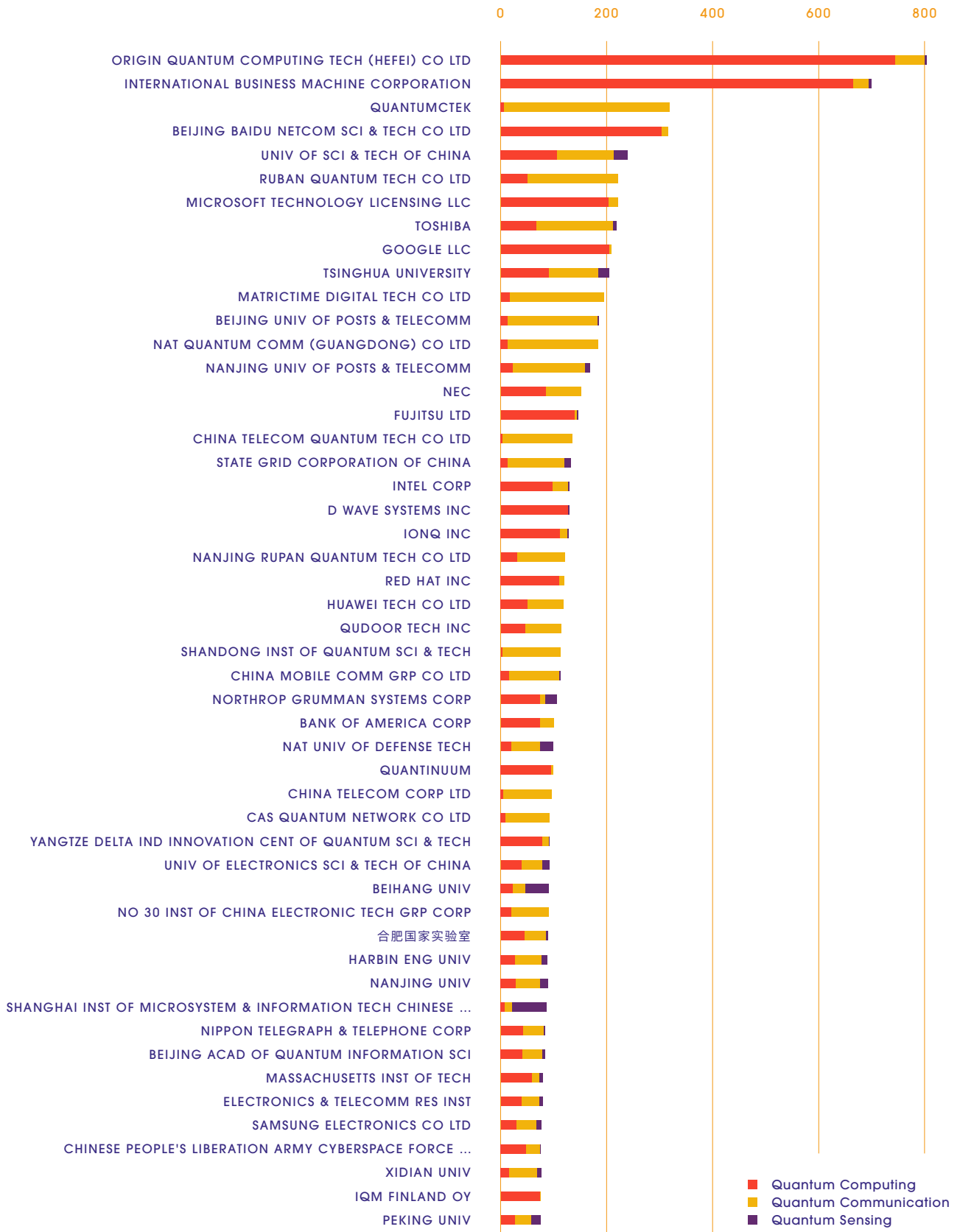


Figure 4: Global segmentation - number of active patent families held by main players by domain

2 DETAILED ANALYSIS – INTERNATIONAL PATENT FAMILIES

Figures 3–4 (→ PAGE 8–9) in the previous section of this study show the number of patent families for the global top 50 patent assignees, split by quantum technology domain and country/region of origin of the assignee. These figures include patent families which only have a single patent or patent application in the family. For example, a single national patent or single national patent application would be counted as one patent family.

To get a more nuanced view on the overall patent landscape, it is worthwhile to take a closer look at international patent families. In this section, we will consider international patent families which have been granted patents in multiple (two or more) countries or regions, or patent applications that have been filed or are intended to be filed or protected in multiple countries or regions via an international patent application (PCT) or a European patent application. We will then compare the results with the results of the previous section.

Figure 5 (→ PAGE 11) shows the ranking of the top 50 patent filers in quantum technology, based on the definition of international patent families given above, split into the segments Quantum Computing (red), Quantum Communication (yellow) and Quantum Sensing (purple). The top patent assignee is now IBM, followed by Toshiba and Microsoft.

Figure 6 (→ PAGE 12) shows the same graph, but coloured by country/region of origin of the top 50 patent assignees. It is noticeable that, in this context, the Chinese company Origin Quantum ranks only tenth in the top 50 patent assignees list, and the rest of the top ten patent assignees are based in the US and Japan.

However, while US and Japanese big-tech companies visibly dominate in terms of the total number of active international patent families owned, there are 17 European companies with more than 25 international patent families among the top 50 patent assignees, indicating that

European companies are particularly active in international patent filings.

This trend becomes more evident in Figure 7 (→ PAGE 13), which shows the number of international patent families versus the year of the earliest priority (i.e., first filing), grouped by country/region of origin of the patent assignees. Europe exhibits an average year-to-year growth from 2017 to 2023 of **28.7 %** per year, while growth in the US for the same period was **4.3 %** per year. Japan, China, Korea and Canada all exhibit average growth of international patent families of slightly more than **30 %** (**33 %** for China). However, if we look at just the last 4 years (2020–2023), we see that Europe has the highest average year-to-year growth in the number of international patent families filed, with **25.9 %**, while China's growth is just **8.3 %** and the US shows a decrease in filings of **–10.6 %**.

Figure 8 (→ PAGE 13) compares the results of Figure 7 (→ PAGE 13) with the overall patent portfolios (including national and international patent families) of China- and US-based assignees. In 2023, the ratio of international patent families versus the total number of patent families was **44.5 %** for US-based assignees and just **6 %** for China-based assignees, i.e., the majority of patent filings for China- and US-based assignees are national patents.

Figures 7–8 (→ PAGE 13) provide a clear indication that the quantum patent portfolios of US and Chinese assignees have been focusing on internal rather than foreign markets, especially in the last few years. This contrasts with the patent portfolios of European companies, which focus more on foreign markets. However, it must be noted that since the US and China represent much bigger markets than any European national market, the US and China might also consciously protect their innovations in their respective home markets to effectively maximise costs/benefits for their patent portfolios.

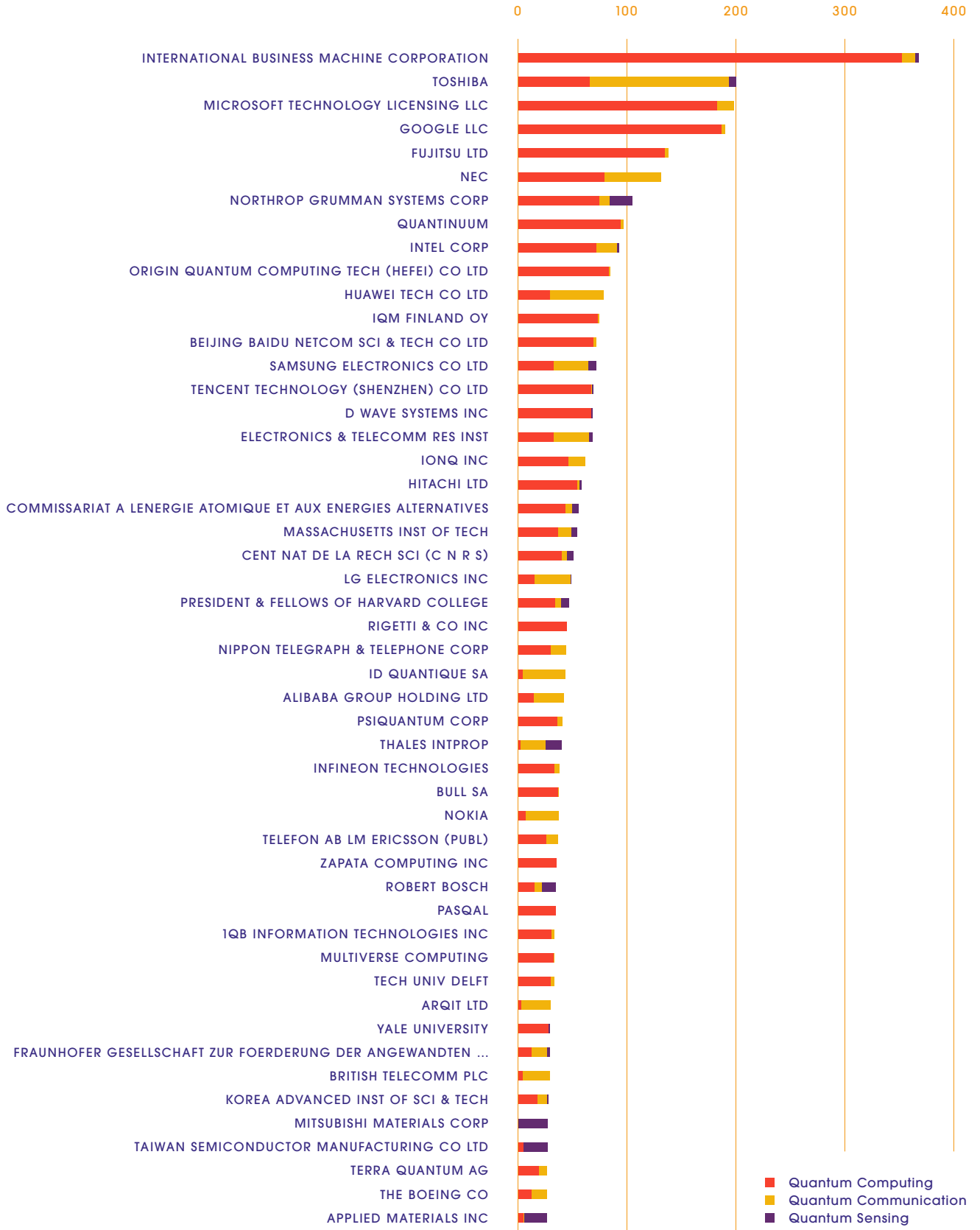


Figure 5: Global segmentation - number of active international patent families by main players and technology

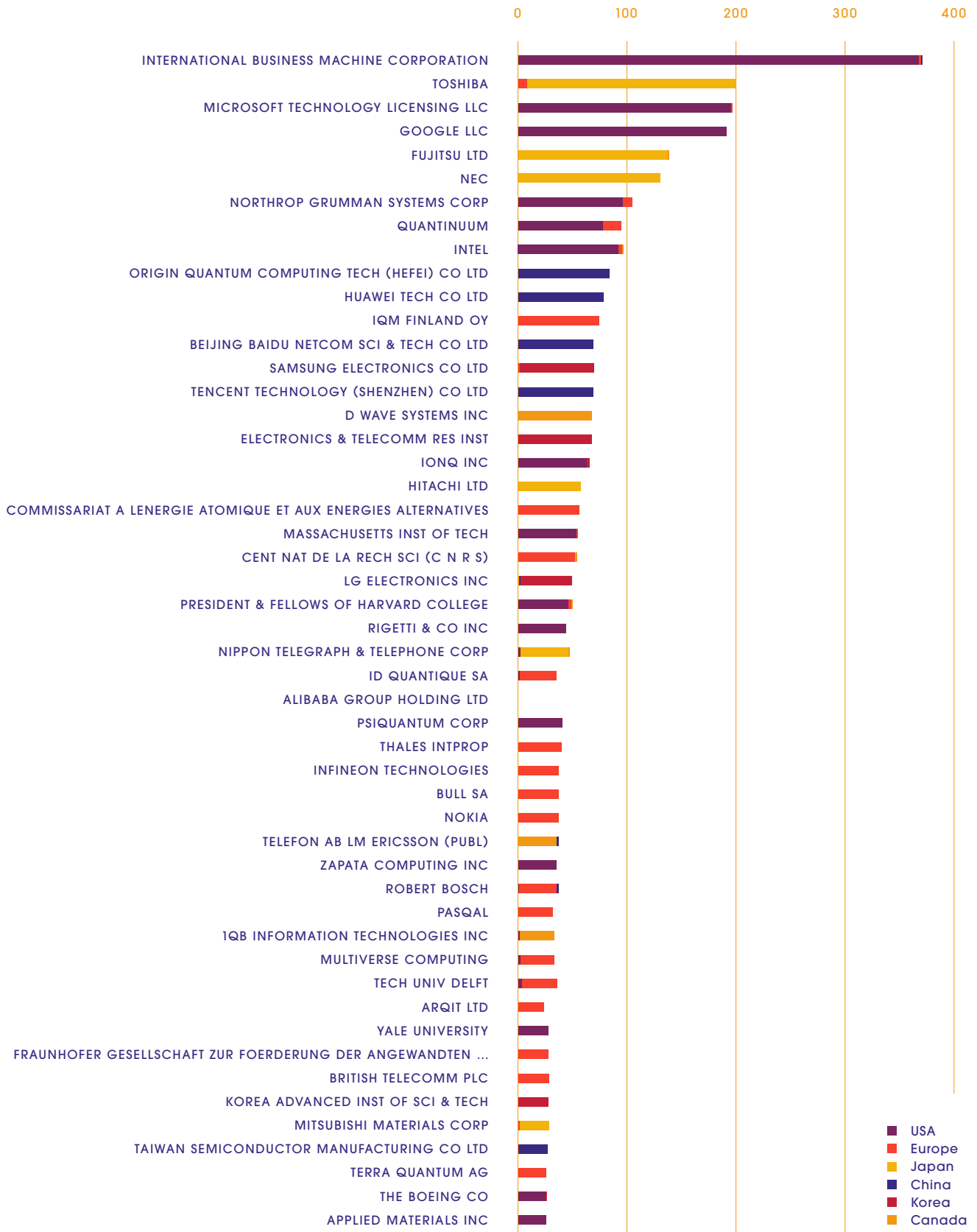


Figure 6: Global segmentation - number of active international patent families by main players and their country of origin

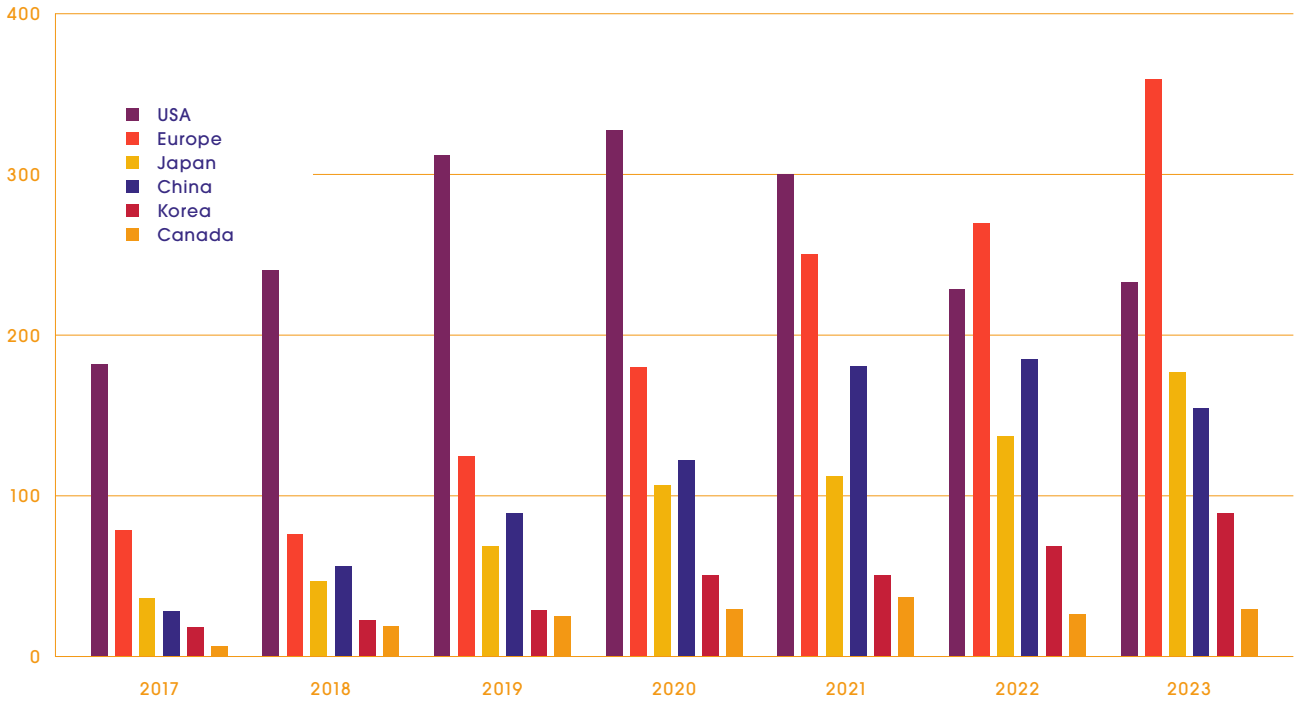


Figure 7: Global segmentation – number of active international patent families grouped by country of origin of the patent filers

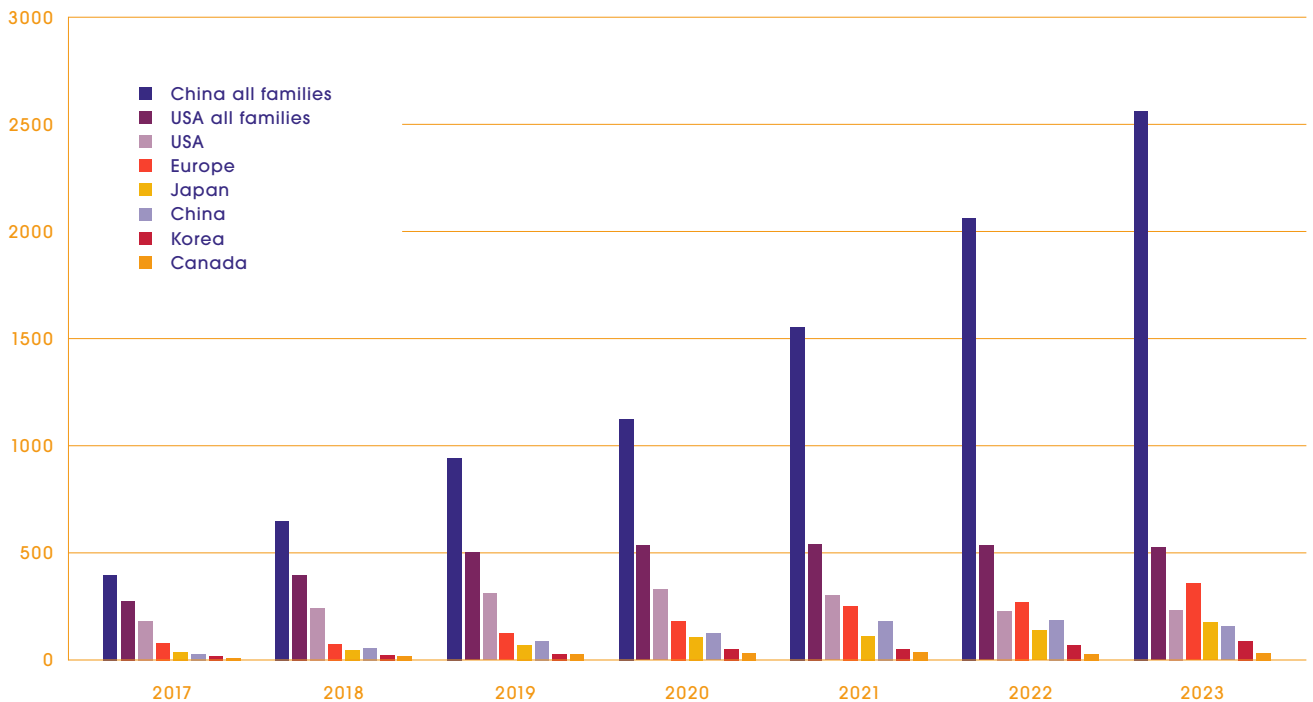


Figure 8: Global segmentation – number of active international patent families grouped by country of origin of the patent filers compared to the total number of patent families (domestic + international) for US and Chinese companies

3 SITUATION BY COUNTRY / REGION

This section analyses the main players for each country / region of protection (i.e., on each market).

Please note that in this chapter, we consider patents and patent applications in the country/region where the application was filed. So for example, in China, we consider all applications filed in China, thus also national Chinese patents.

3.1 SITUATION ON THE US MARKET: US PATENTS

Figure 9 below shows the main patent assignees for US patents, colour-coded by region of business (i.e., active patents and patent applications filed at the United States Patent and Trademark Office).

As expected, the majority of US patent families go to US-based big-tech companies – IBM, Microsoft, Google. However, Japanese companies Toshiba, NEC and Fujitsu all rank in the top 20 US patent families.

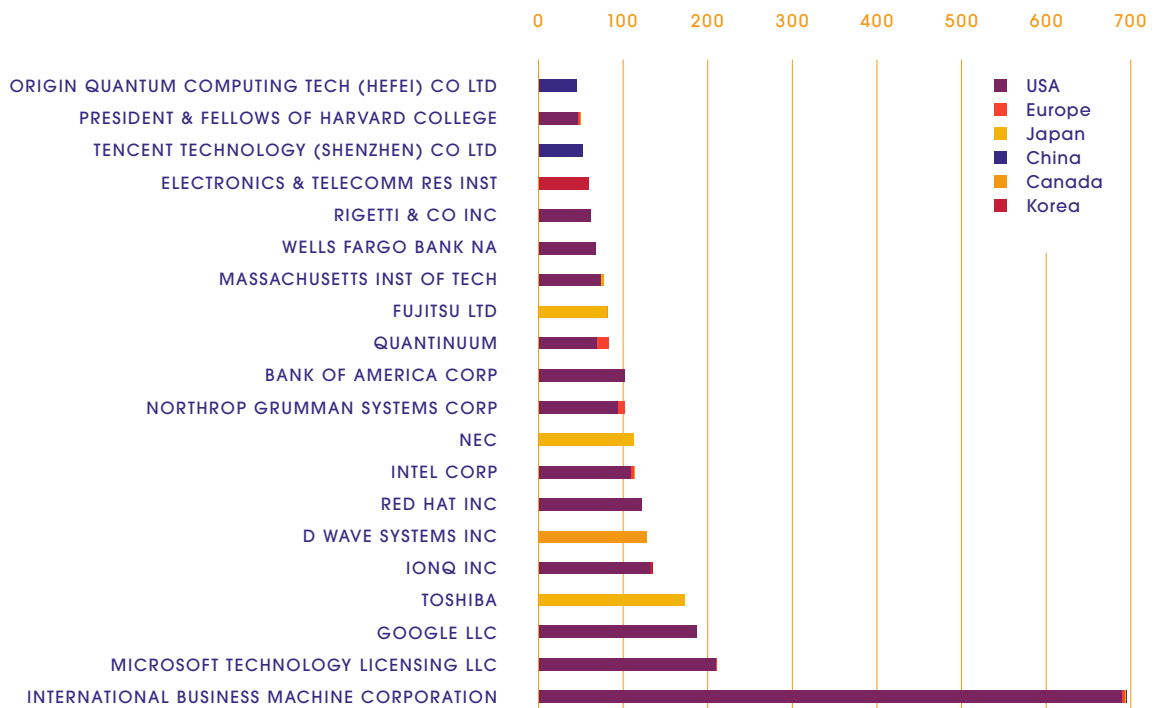


Figure 9: Top 20 assignees of US quantum technology patents, ranked on number of US patents and patent applications

3.2 SITUATION ON THE CHINESE MARKET: CHINESE PATENTS

Figure 10 below shows the main assignees for Chinese patents, colour-coded by region of business (i.e., active patents and patent applications filed at the China National Intellectual Property Administration).

Chinese assignees dominate in terms of the number of Chinese patent families: the top 20 assignees of Chinese patent families are all Chinese except for two US companies: IBM (ranked 5th) and Google (ranked 15th).

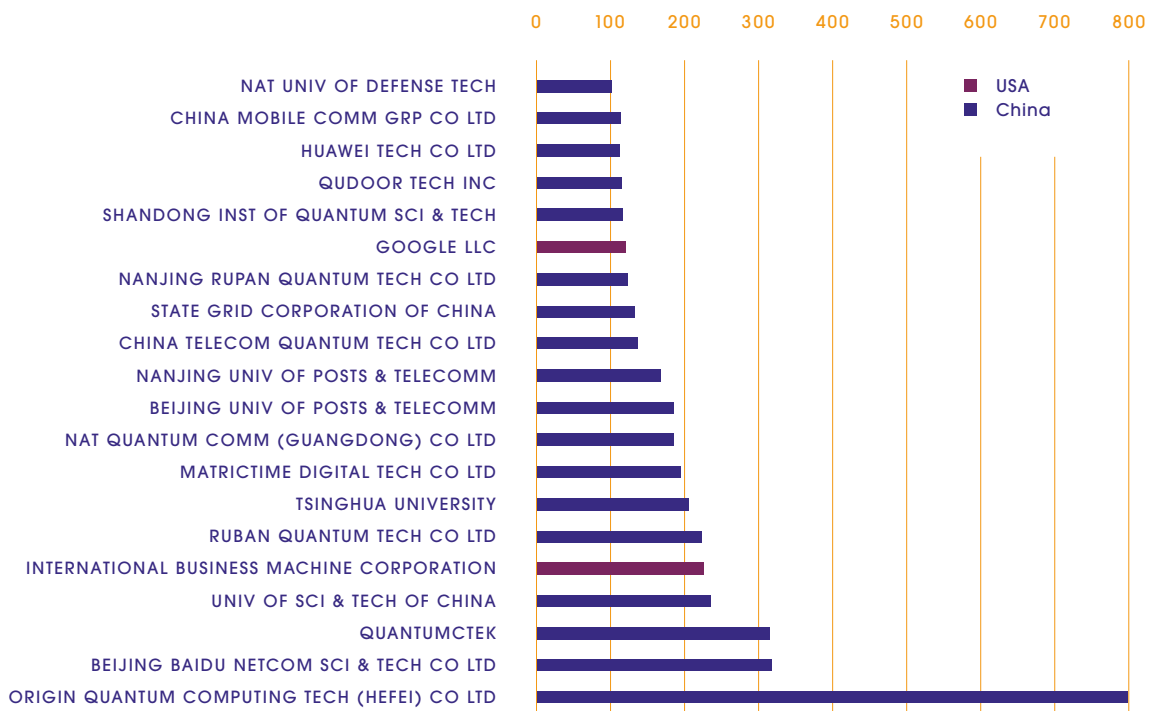


Figure 10: Top 20 assignees of Chinese quantum technology patents, ranked on number of Chinese patents and patent applications

3.3 SITUATION ON THE JAPANESE MARKET: JAPANESE PATENTS

Figure 11 below shows the main assignees for Japanese patents, colour-coded by region of business (i.e., active patents and patent applications filed at the Japan Patent Office).

IBM is the top assignee of Japanese patents, followed by Japanese companies Toshiba, NEC, Fujitsu and Nippon Telegraph.

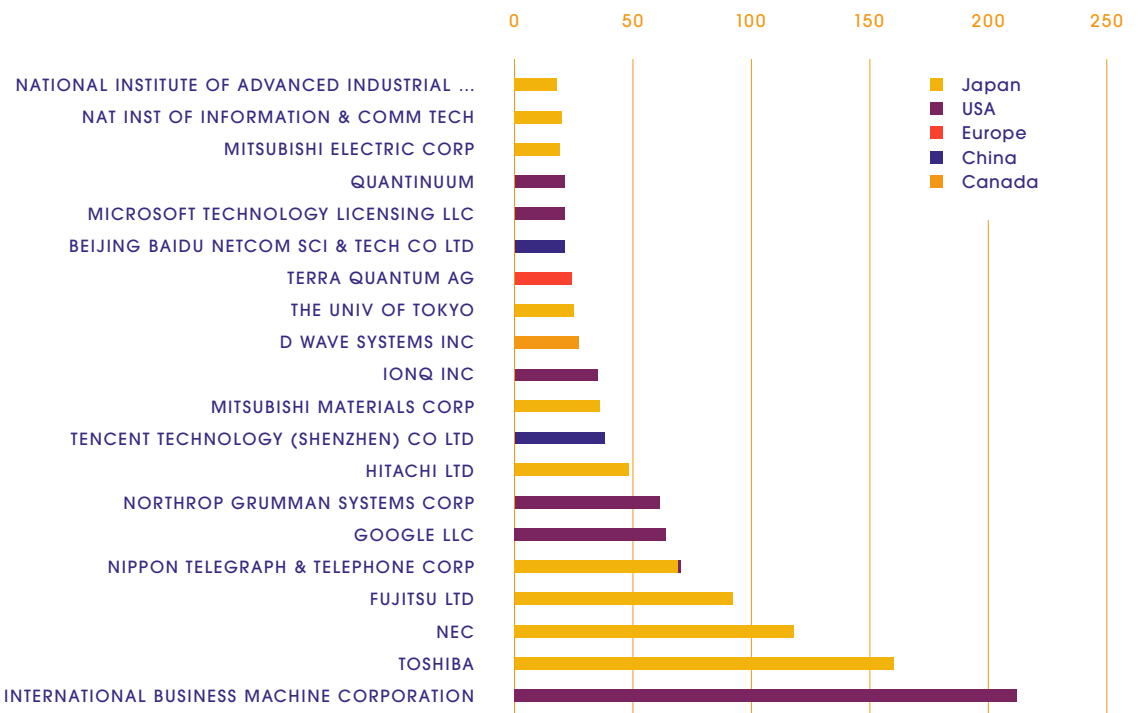


Figure 11: Top 20 assignees of Japanese quantum technology patents, ranked on number of Japanese patents and patent applications

3.4 SITUATION ON THE EUROPEAN MARKET: EUROPEAN PATENTS

Turning to focus on the **European market**, we consider all the companies and academic institutions that have filed patents and patent applications **at the EPO**.

Figure 12 below shows the top 25 assignees for active patents and patent applications filed or granted at the EPO (the colour indicates the country of origin/business of those assignees).

Among the top 25 assignees of patents or patent applications filed with or granted by the EPO, **the four first positions are taken by US companies**. The **CNRS**¹, at No. 7, is the first European academic/governmental institution; **Deutsche Telekom** and **IQM** rank respectively at positions 10 and 11.

Although **Quantinuum**² is a UK-based company, its strong patent activity is largely driven by its US branches. In fact, as we will see in Figure 13, much of Quantinuum’s European portfolio is owned by its US branches.

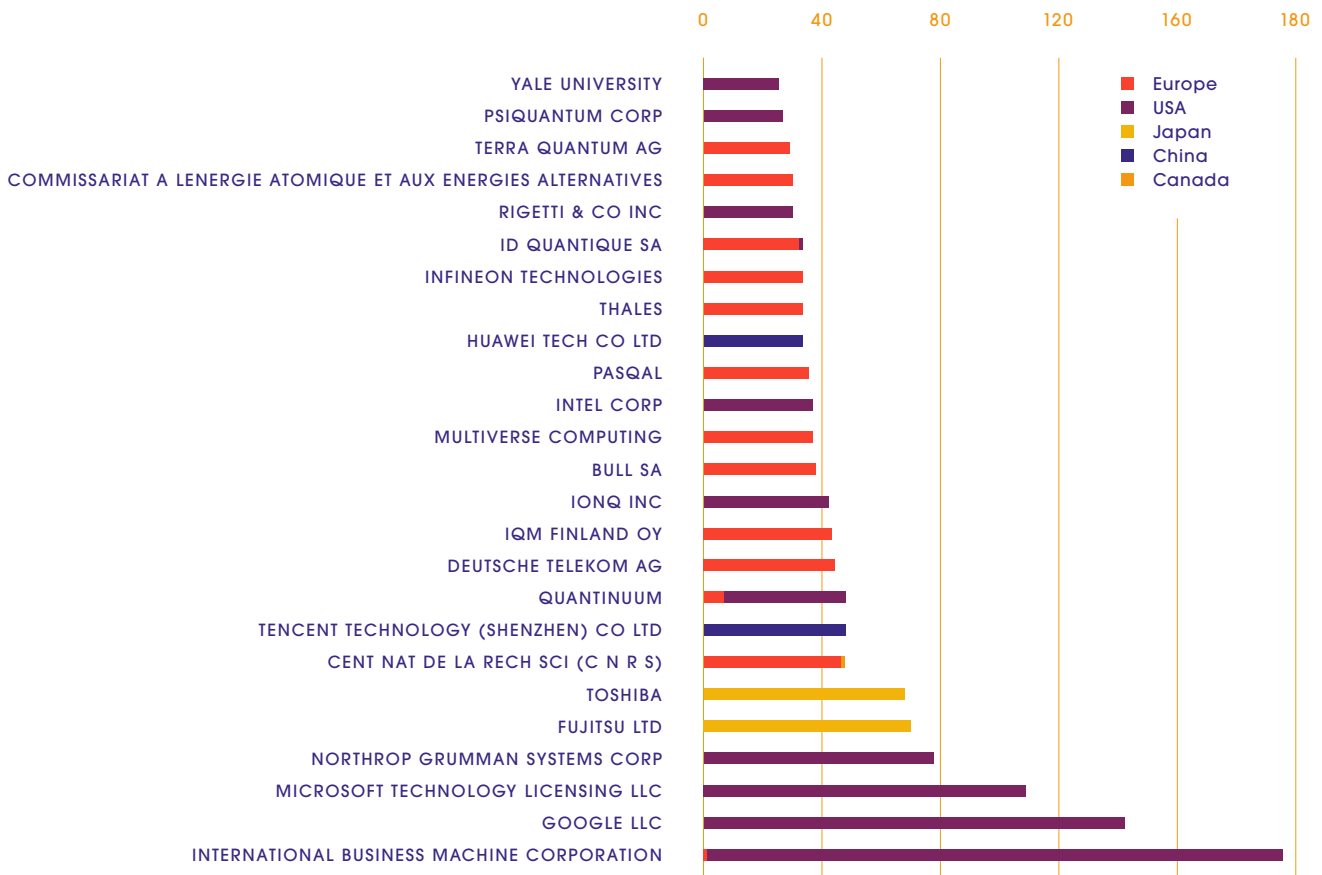


Figure 12: Top 25 assignees of European quantum technology patents, ranked on number of patents and patent applications filed at the EPO

1 Top European research organisation

CNRS is the French National Centre for Scientific Research. With more than 33,000 staff members, it is the single largest fundamental research organisation in Europe and one of the largest in the world. The CNRS is active in all scientific fields and not only in quantum research. It has a budget of over € 4 billion and it consistently ranks as the first European RTO in terms of the number of patent families filed/owned in quantum technologies (a mix of Quantum Computing, Quantum Communication and Quantum Sensing). (5)

2 Quantinuum was formed from the merger of Cambridge Quantum and Honeywell Quantum Solutions

In the top 25 listings, European assignees are represented by two RTOs (French CNRS and CEA) and nine companies (IQM, Bull, Infineon, Deutsche Telekom, Terra Quantum, Thales, Multiverse Computing, Pasqal and ID Quantique¹). Infineon, Deutsche Telekom, Terra Quantum and ID Quantique have substantially increased their portfolios in the last few years, focusing respectively on trapped ion technology, quantum communication, quantum algorithm/superconducting QPU/QKD, and QKD systems.

In Table 2, we compare the trends against the findings of last year’s study. Although no direct comparison of the absolute numbers between the two studies is possible, in general we observe a strong change of trends.

EPO patents or patent applications **originating from a European country** now represent **41 %** of all published European patents and patent applications in quantum technologies, bringing European companies into the lead for their own market. While **US companies and academic institutions retain a strong European patent portfolio with a 35.6 %** share of the total of European patents and patent applications, this is a substantially lower share than indicated by last year’s study (1). The global number of active European patent families published between 1 July 2024 and 30 June 2025, shown under *Number of EP patent families* in Table 2, is considerable (1184), representing about 42 % of the total number of European patent families published by 30 June 2025 (2779), and a relative increase of 74.5 %. Of the European patent families published in this period, 42 % (493) are held by European assignees, 32 % (378) by US assignees, and only 6 % (72) by Chinese assignees. In summary, European assignees can claim the largest weighted increase (**31 %**) in EP patent families between 1 July 2024 and 30 June 2025 (see the rightmost column of Table 2). This appears to be one of the reasons for the abrupt trend shift in favour of European assignees.

Relative weight by country/region of origin	Percentage of EP patent families		Number of EP patent families	Weighted increase of EP patent families in 2024/2025
	2025 study	2024 study		
Europe	41 %	31 %	493	31 %
US	35.6 %	46 %	378	23.7 %
China	5.6 %	9 %	72	4.5 %
Japan	9.2 %	8 %	115	7.2 %
Korea	1.2 %	2 %	28	1.8 %
Canada	2.7 %	NA	33	2.1 %
Other	4.6 %	4 %	65	4.1 %
Total	100 %	100 %	1184	74 %

Table 2: Weight of EP patent families by country of origin of the assignee for 2024, 2025, and weighted increase between 1 July 2024 and 30 June 2025

Figure 13 (→ PAGE 19) shows the number of entities (companies, RTOs, universities) with at least one European patent or patent application in their portfolio. There are about 230 European entities and roughly 130 US entities with active European patent portfolios. Figure 14 shows the distribution of European entities based on the number of European patents/patent applications and Figure 15 shows the same graph for US entities.

Figures 14–15 (→ PAGE 19) show that in the US there are a small number of entities who have large portfolios of European patents and patent applications (two US assignees with portfolios bigger than 72 European patents/patent applications). In contrast, in Europe there are many assignees with smaller European portfolios (188 European assignees versus 113 US assignees with a European patent portfolio of just 1 to 6 European patents/patent applications). The situation in Europe seems more fragmented, with the presence of many more companies having small patent portfolios.

¹ ID Quantique has been recently acquired by IonQ

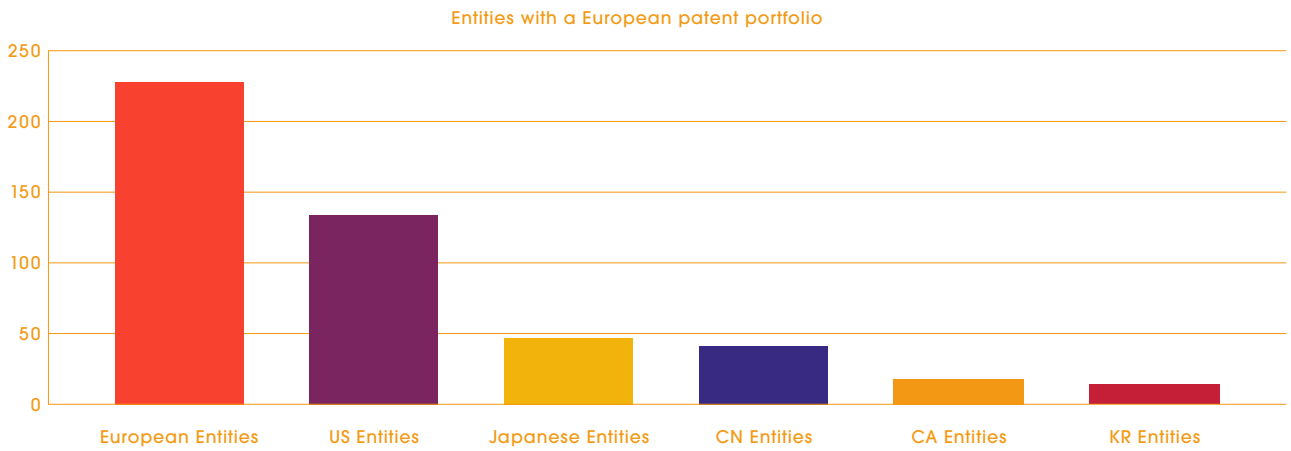


Figure 13: Number of entities having at least one or more European patent or patent application, by country of origin

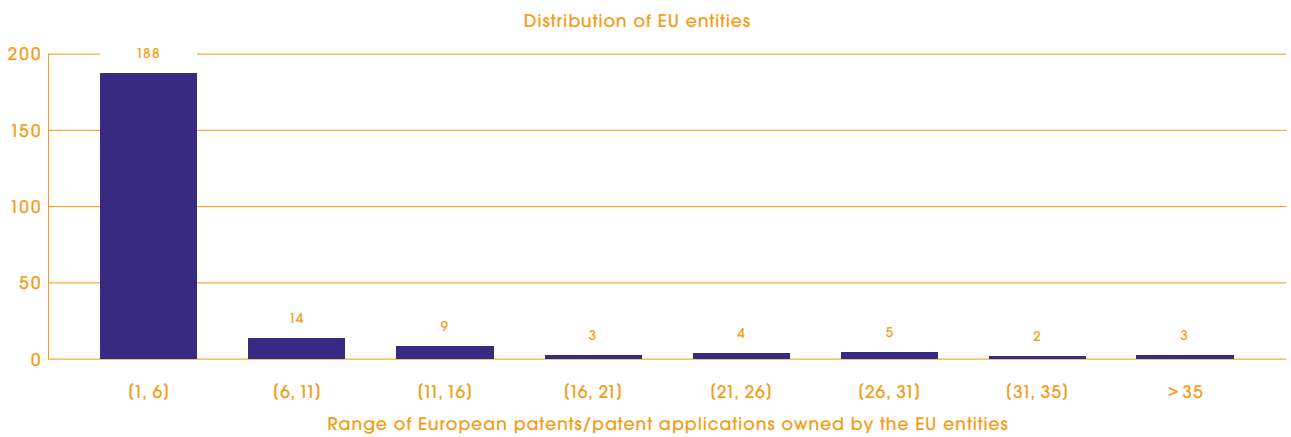


Figure 14: Distribution of EU entities by the number of European patents/patent applications in their portfolio

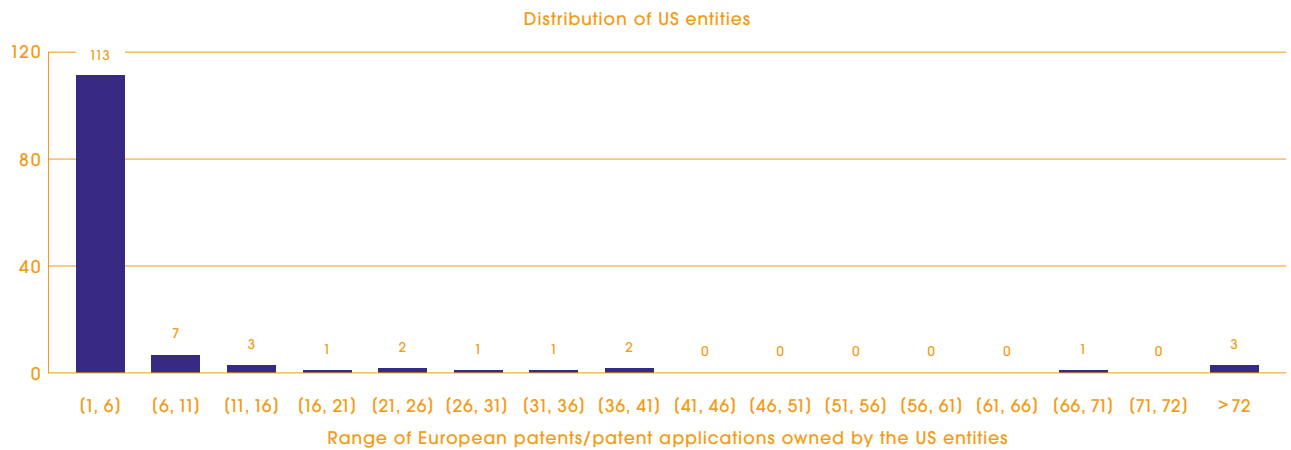


Figure 15: Distribution of US entities by the number of European patents/patent applications in their portfolio

3.5 COMPARISON OF PATENTS BY COUNTRY / REGION

Figure 16 shows the patent families by country/region of protection (for European (EP) patent families¹, US patent families, Chinese (CN) patent families², Japanese (JP) patent families, Korean (KR) patent families and Canadian (CA) patent families), split by country/region of origin of the assignees. We can see that Korean patent families and Canadian patent families are mostly owned by Japanese and US assignees, while in all other regions, the respective domestic assignee is the most prevalent.

Table 3 then presents the “reverse” chart, showing a comparison by country/region of origin, split by country/region of protection (i.e., for each patent family originating from a country/region: number of EP patents, US patents, CN patents, JP patents, KR patents and CA patents).

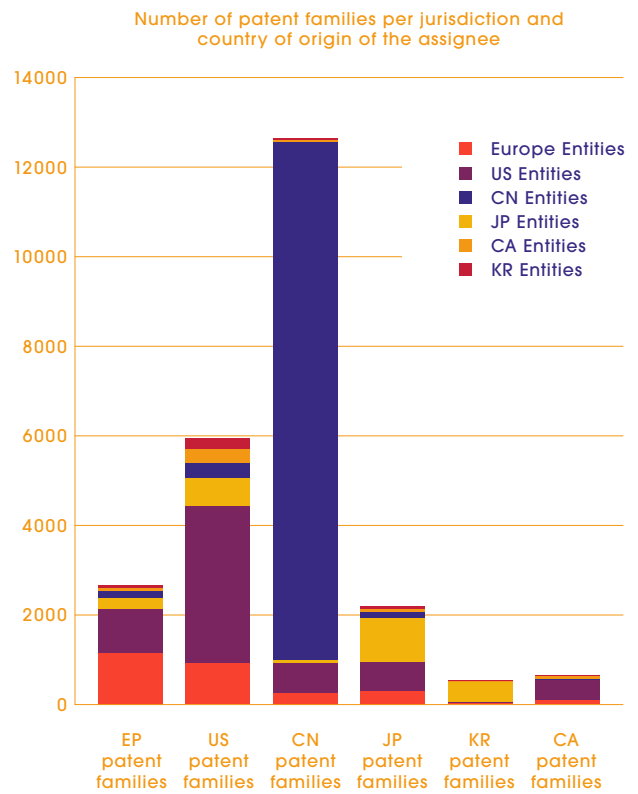


Figure 16: Comparison by country/region of protection, split by country/region of origin

Relative weight by region	Country / region of protection					
	EP patents	US patents	Chinese patents	Japanese patents	Canadian patents	Korean patents
Europe	41%	15%	2%	13%	12%	4%
USA	35%	56%	5%	30%	69%	6%
China	6%	6%	91%	6%	1%	2%
Japan	9%	10%	1%	44%	4%	87%
Korea	1%	4%	0%	1%	0%	1%
Other	3%	5%	0%	3%	11%	1%
Canada	5%	4%	1%	2%	3%	0%
Total	100%	100%	100%	100%	100%	
Relative weight of patents	11%	24%	51%	9%	3%	2%

Table 3: For each country/region of protection, relative weight by country/region of origin

1 EP patents are patents filed and/or granted at the EPO
 2 including all Chinese national patents

4 EUROPEAN LEADERS BASED ON THE NUMBER OF PATENT FAMILIES

Table 4 below shows the domain split within the corpus of patent families with European assignees:

Europe - number of active patent families	Number of active patent families	% of total
Quantum Computing	1120	53%
Quantum Communication	649	31%
Quantum Sensing	329	16%
Total	2089	

Table 4: Weight of quantum technology domains for Europe

Figure 17 (→ PAGE 22) shows the top 50 European assignees in terms of the total number of patent families owned/filed by quantum technology domain (Quantum Computing, Quantum Communication and Quantum Sensing). Unsurprisingly, IQM is the top European assignee overall, followed by CNRS and Bosch.

As shown in Figure 17 (→ PAGE 22), the three domains are much more balanced in Europe than internationally – in particular, Quantum Sensing is fairly well represented, while the leading companies in the global comparison are biased heavily towards Quantum Computing.

Focusing on companies:

- In **Quantum Computing**, IQM, Infineon, Bull, Pasqal, Multiverse Computing, and eleQtron have the largest portfolios.
- In **Quantum Communication**, the most active companies in terms of patent filings are ID Quantique, Deutsche Telekom, Nokia, British Telecom, ARQIT, and Thales.
- In **Quantum Sensing**, Bosch, Thales, Quantum Technologies and ASM are leading the race.

Focusing on RTOs/academia:

We can see that RTOs are fairly strong in Europe: in particular the CNRS, the CEA, Fraunhofer, TU Delft, Forschungszentrum Jülich, and Oxford University are all very active.

- In **Quantum Computing**, CNRS, TU Delft, CEA, and Forschungszentrum Jülich have the largest portfolios.
- In **Quantum Communication**, the most active RTOs are CNRS, CEA and TNO (the Netherlands Organisation for Applied Scientific Research).
- In **Quantum Sensing**, CEA and CNRS are leading.

Figure 18 further shows a split of European assignees by type: almost 75 % of the European assignees are companies, while the remainder are mostly academic or governmental institutions or individual inventors.

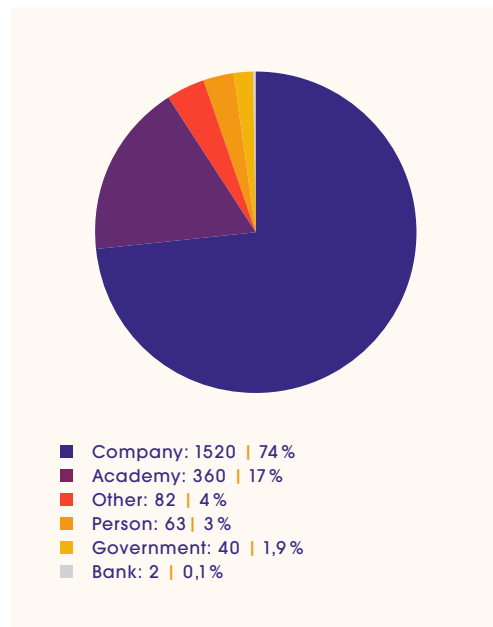


Figure 18: European patent assignees by type of entity

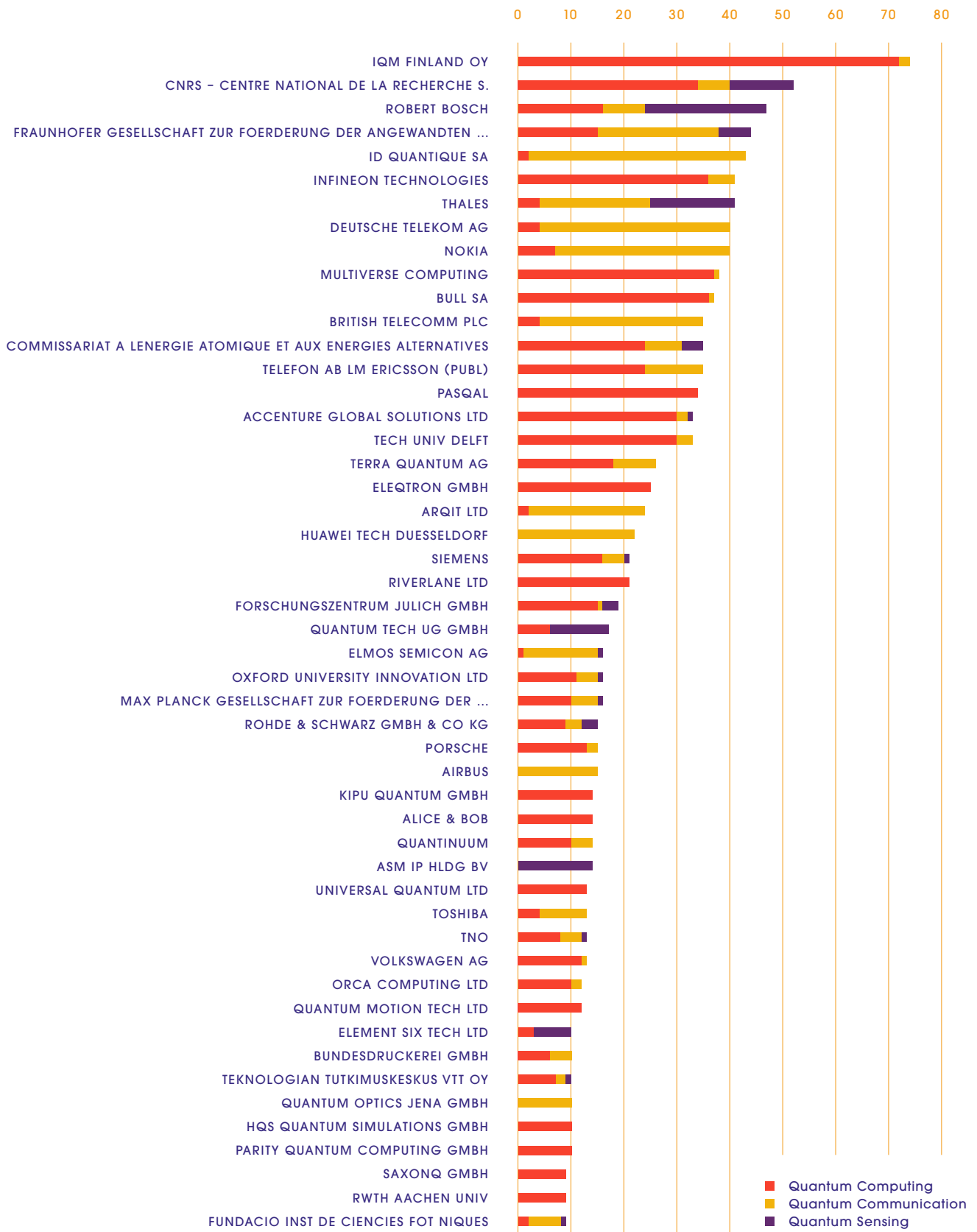


Figure 17: Top 50 patent assignees (companies and RTOs) in Europe, based on number of patent families, by domain

5 DEEP DIVE: QUBIT PLATFORMS

In this section, we investigate the patent landscape for the four major qubit platforms¹ for Quantum Computing applications: superconducting/transmon qubits, spin qubits, trapped ions and cold atoms. These qubit platforms have been chosen in this study for their relevance in the Quantum Computing patent landscape, in light of the strong commercial interest that is currently building around these technologies.

Figure 19 (→ PAGE 24) shows the top 20 assignees in superconducting/transmon qubit technology. IBM has the largest patent portfolio of active patent families in this subcategory. European IQM, TU Delft and Alice & Bob also appear among the top 20 assignees for this technology.

Figure 20 (→ PAGE 24) shows the top 20 assignees in spin qubit technology. IBM is again leading, followed by the Canadian company D-Wave Systems and the Chinese company Origin Quantum. European RTOs TU Delft and CEA also appear among the top 20 assignees.

Figure 21 (→ PAGE 25) shows the top 20 assignees in trapped ion qubit technology. IonQ is dominating in this technology with the largest patent portfolio of active patent families, followed by the Chinese company Qudoor and Europe-based Quantinuum – which, however, has a strong presence in the US (in fact, most of the Quantinuum patent families for trapped ion technology are in the name of US branches of the company). Europe's eleQtron and Universal Quantum also rank among the top 20 assignees.

Figure 22 (→ PAGE 25) shows the top 20 assignees in cold atom technology for Quantum Computing. This is the only technology for Quantum Computing analysed in this study to have a European company, Pasqal², as the largest player in terms of number of active patent families. However, Pasqal is an outlier, as there are no other European entities which rank among the top 20 patent assignees in cold atom technology. Most of the other entities are Chinese or US-based.

1 Qubit platforms

Superconducting qubits are quantum bits using superconducting circuits cooled to near absolute zero. They are a leading platform for building quantum computers due to the potential for control and scalability. Transmons are the most prevalent type of superconducting qubit.

Spin qubits are qubits that encode the quantum information in the spin of subatomic particles, commonly of single electrons. They became one of the leading qubit platforms thanks to their compatibility with existing semiconductor manufacturing processes, which might pave the way to off-the-shelf miniaturisation and scalability potential.

Trapped ions use individual, electromagnetically suspended charged atoms (ions) in a vacuum to act as qubits for computation. They are likewise a leading qubit platform, chosen for the long coherence time and high fidelity operation of the qubit.

Cold atoms or neutral-atom qubit platforms use individual atoms of gases such as rubidium or strontium as qubits. These atoms are also cooled down to near absolute zero but with a system of lasers to slow down the atoms. The atoms are manipulated in the space by focused beams of light called "optical tweezers". An increasing number of companies are developing and patenting cold atom qubit platforms as building blocks for quantum computers.

- 2 **Pasqal** is a French company founded in 2019 as a spinoff from Institut d'Optique. Pasqal emerged from groundbreaking research in neutral atom quantum computing led by 2022 winner of the Nobel Prize in Physics, Alain Aspect, who is co-founder and scientific advisor of the company. (6)

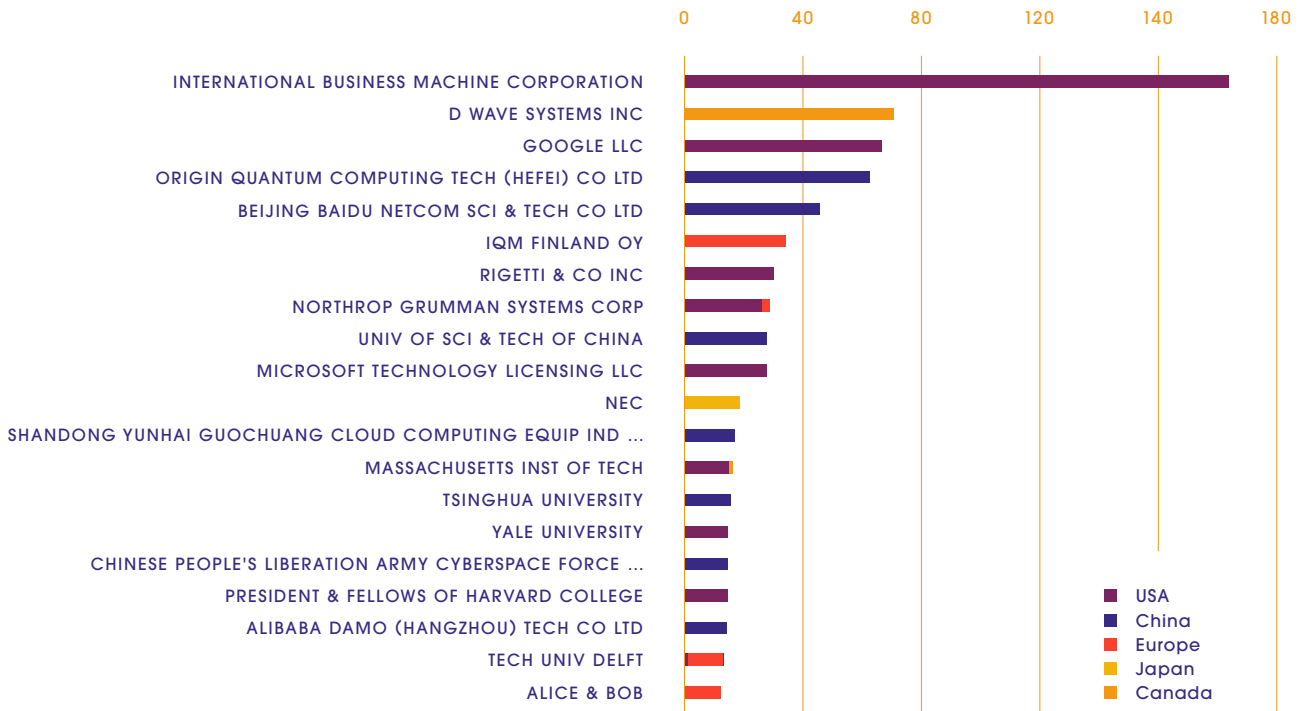


Figure 19: Top 20 companies & RTOs by region of origin, based on the number of active patent families in superconducting/transmon qubits for Quantum Computing

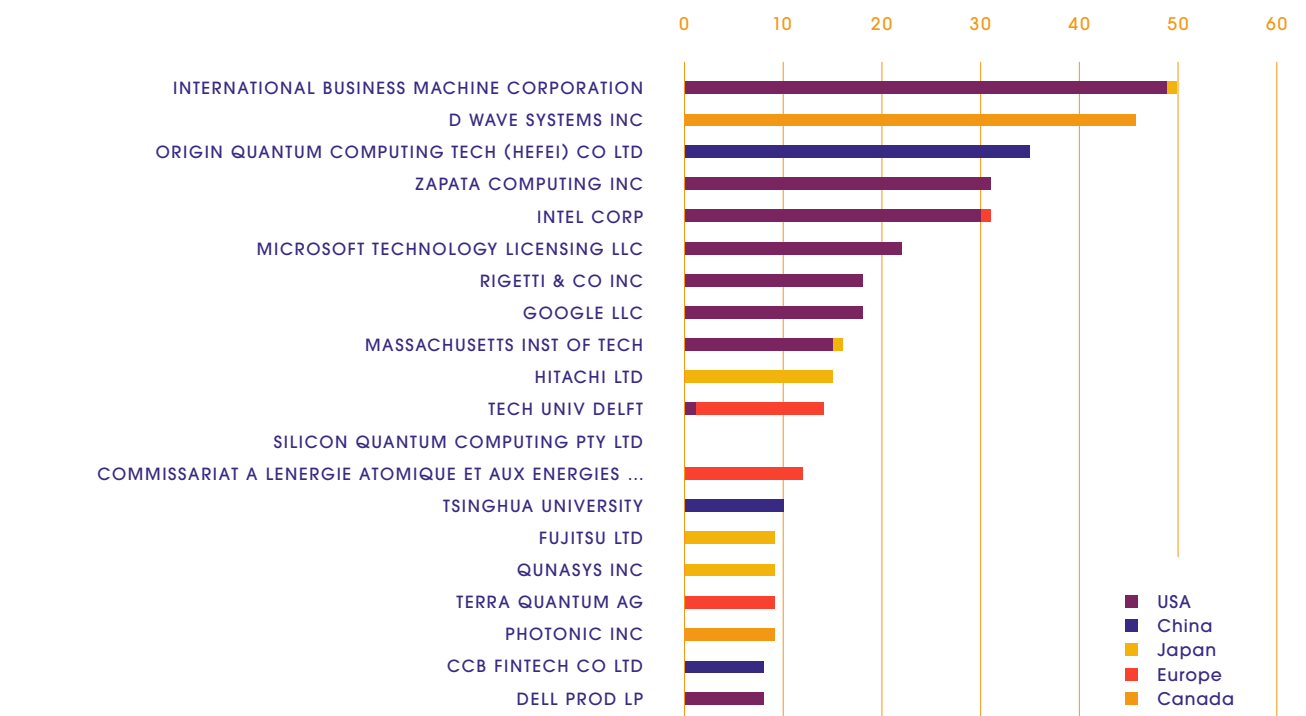


Figure 20: Top 20 companies & RTOs by region of origin, based on the number of active patent families in spin qubits for Quantum Computing

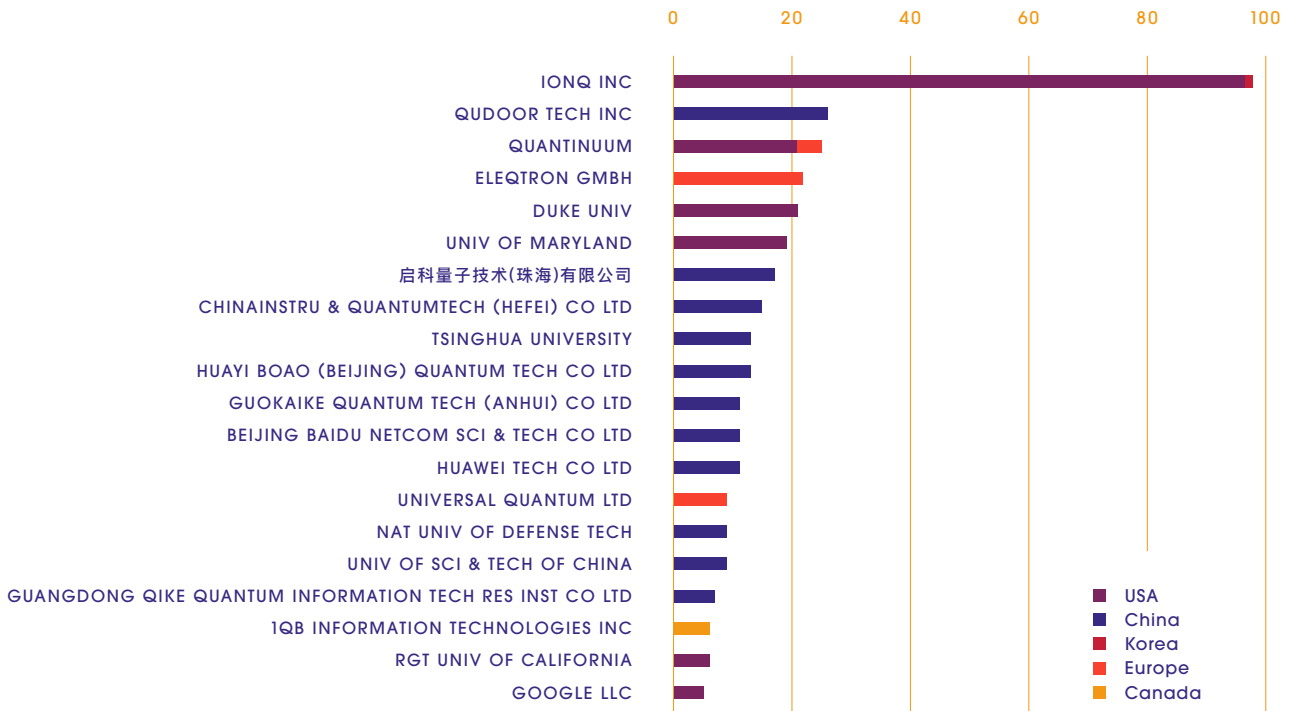


Figure 21: Top 20 companies & RTOs by region of origin, based on the number of active patent families in trapped ions for Quantum Computing

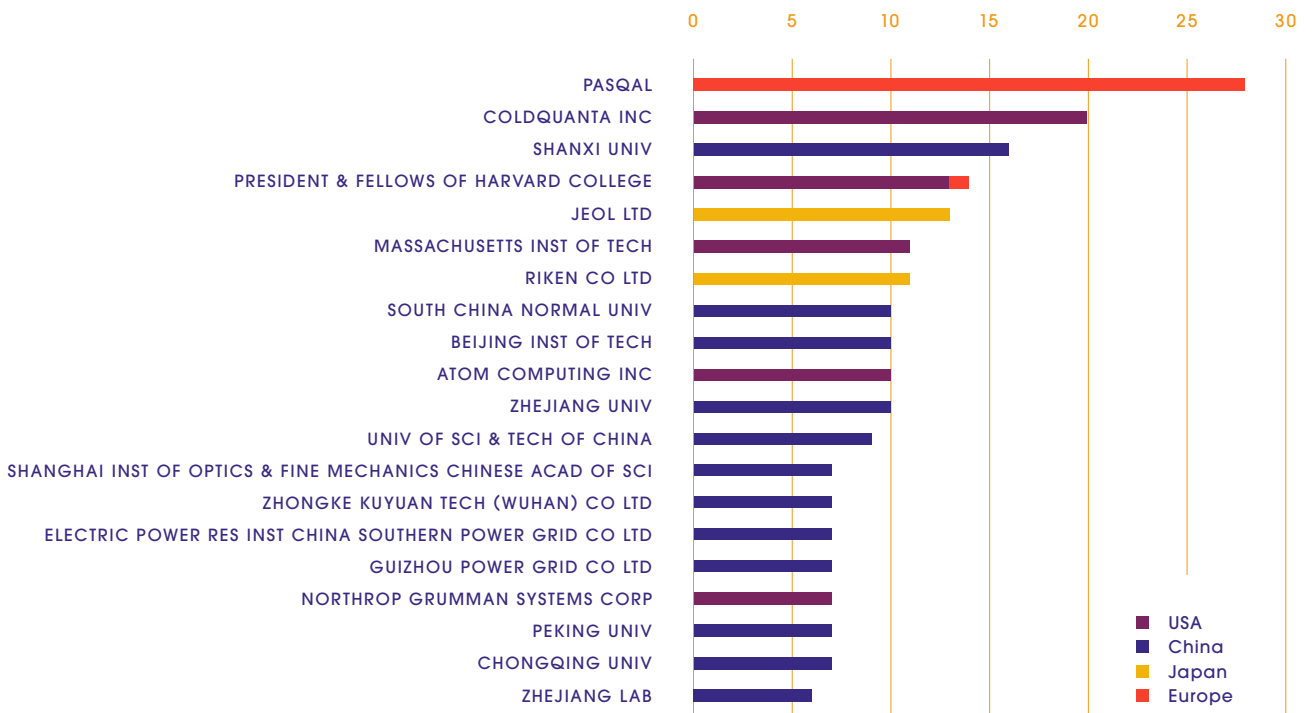


Figure 22: Top 20 companies & RTOs, based on the number of active patent families in cold atoms for Quantum Computing

CONCLUSIONS

In this year's white paper, we still see a consistent global growth of quantum technology patent families. The Quantum Communication sector has seen the biggest increase, with **29 %** growth from 2022 to 2023, followed by Quantum Computing with about **20 %** growth in the same two-year period. This is also the first year in which the Quantum Communication sector has surpassed the Quantum Computing sector in terms of the global number of active patent families falling within each sector (about 11,000 active patent families in Quantum Communication versus about 9000 in Quantum Computing). This shows that players in the Quantum Communication sector are increasingly investing in IP, reflecting more consolidated products and services in the Quantum Communication market.

While US and Chinese entities still dominate the global IP quantum landscape in terms of the number of active patent families owned by national assignees, (about two thirds of assignees of active patent families are Chinese and about a fifth are US-based), Europe is progressing well. European assignees are consistently filing more international patent applications, with a growth rate of about **26 %** in the four-year period 2020–2023, while US-based assignees and Chinese assignees have consistently slowed down filing of international patent families and are focusing more on their respective domestic markets. European assignees lead in terms of total number of active international patent families owned in years 2022 and 2023.

The majority of European patent assignees (almost **73 %**) are companies, followed by academia at **17 %**, while just **2 %** of patents are assigned to government entities, indicating that innovation in quantum technologies is not just led by academia.

Interestingly, the quantum industry in Europe is more fragmented than in the US: many more companies with small European patent portfolios are present (1 to 11 patent families) while in the US the scene is dominated by big-tech firms (IBM, Google, Microsoft) with more than 100 European patent families.

In this fragmented European IP landscape, European entities should invest more in IP to be able to build competitive large patent portfolios. This may require major financial investments in IP or an aggregation of IP efforts at European level through specific stimulating instruments.

There has been a considerable jump in the number of active European patent families, with patent publications between 1 July 2024 and 30 June 2025 accounting for about **42 %** of the total volume of European patent families published up to 30 June 2025. This indicates an increasing interest in the European market in general. More than **40 %** of this considerable number of European patent families were filed by or are in the name of European assignees. This has put European entities in the lead for their own market, something that seemed quite unlikely to occur only one year ago when US entities owned the relative majority (**46 %**) of European patent families.

For the first time, we have attempted a further breakdown in the field of Quantum Computing, looking at four major qubit platforms: superconducting qubits, spin qubits, trapped ions, and cold atoms. While superconducting qubits and spin qubits are dominated by two North American players, IBM and D-Wave, a European company, Pasqal, is leading cold atom Quantum Computing. In general, the breakdown per qubit platform reflects the global picture. With the exception of Pasqal in cold atom technology, there are no European entities able to compete with the key players in the other qubit technologies, confirming once more the fragmentation of the European quantum industry across small and medium enterprises with smaller patent portfolios.

Although we see an improvement of the European IP position in the global patent

landscape in quantum technologies, the competitiveness of European companies could still be at risk if companies do not undertake structural investments in patents. As such, our key recommendation remains largely unchanged from last year's study (1):

More investments should be made by the EU or the individual Member States through specific financial instruments or funding opportunities to stimulate the creation (and maintenance) of competitive patent portfolios by European entities in strategically relevant quantum technologies.

REFERENCES & BIBLIOGRAPHY

- (1) QulC: "A Portrait of the Global Patent Landscape in Quantum Technologies - White Paper", January 2025
- (2) INPI (Institut National de la Propriété Industrielle): "L'informatique Quantique Dans Les Brevets en 2024"
- (3) Website: "About IQM - Leader in Quantum Computing"
- (4) Website: "Quantum: IQM to Invest €40M in Finland Production Facility Expansion | Inside HPC & AI News"
- (5) Website: "Centre national de la recherche scientifique (CNRS)"
- (6) Website: "Our history - Pasqal"
- (7) EPO: "Quantum computing - Insight report", January 2023
- (8) EPO: "Landscape study on patent filing - Quantum metrology and sensing", September 2019

GLOSSARY OF ABBREVIATIONS

CEA

Commissariat à l'énergie atomique et aux énergies alternatives / French Alternative Energies and Atomic Energy Commission

CNRS

Centre national de la recherche scientifique / French National Centre for Scientific Research

CPC

Cooperative Patent Classification

EPO

European Patent Office

ESI

ElectroSpray Ionisation

ESR

Electron Spin Resonance

IP

Intellectual Property

MALDI

Matrix-Assisted Laser Desorption/Ionisation

MRI

Magnetic Resonance Imaging

NMR

Nuclear Magnetic Resonance

NV centre

Nitrogen Vacancy Centre

PCT

Patent Cooperation Treaty

PQC

Post-Quantum Cryptography

QKD

Quantum Key Distribution

QPU

Quantum Processing Unit

QuiC

European Quantum Industry Consortium

RTO

Research and Technology Organisation

SQIF

Superconducting Quantum Interference Filter

SQUID

Superconducting QUantum Interference Device

WDM

Wavelength-Division Multiplexing

DEFINITIONS

EPO member state

The EPO currently has 39 member states, comprising all the Member States of the EU together with Albania, Iceland, Liechtenstein, Monaco, Montenegro, North Macedonia, Norway, San Marino, Serbia, Switzerland, Turkey, and the UK.

Europe

In this study, Europe includes the EU27, Iceland, Norway, Switzerland, and the UK.

International Patent Family

An international patent family in this study is defined as a patent family having patent family members published by at least two different patent authorities or filed under the patent cooperation treaty (PCT) or at the EPO.

Patent Cooperation Treaty

By filing one international patent application under the PCT, applicants can simultaneously seek protection for an invention in a large number of countries.

Patent Family

A patent family is a collection of patent applications covering the same or similar technical content (same invention). The applications in a family are related to each other through priority claims (EPO website).

Priority Country

The Priority Country is the country where the patent is first filed before being extended to other countries (European Commission IP Helpdesk Website).

Priority Date

The Priority Date is the first filing date of a patent application, anywhere in the world (normally in the applicant's domestic patent office), to protect an invention (European Commission IP Helpdesk Website).

APPENDIX A: SEARCH METHODOLOGY

We used “Patsnap” (a patent search & analysis tool) to perform our various searches and analyses relating to quantum technology and to create the databases of patent families discussed in this white paper.

The scope of the study is limited to patent publications only; design and utility models are excluded from the search.

The cut-off date of all searches is 30 June 2025. The reader should take into account that there is an 18-month delay between the date of the first filing of a patent application and the date of the first publication of the patent application. In other words, this study includes only patent families with a first filing date before 1 January 2024. Therefore, in this study we have access to a complete dataset for patent families with a priority date falling in the whole year 2023.

Only active patent families were considered; abandoned patents, withdrawn patents or expired patent publications are excluded from this study. Unless otherwise specified in the text, the searches were performed considering simple patent families and not international patent families. The patent families were all grouped using the “Patsnap family” category in Patsnap, which should reduce duplicated results.

Please note also that there is no “perfect patent search”. There is always a trade-off between having an excessively broad search which would also cover patent families outside the target search field and an excessively narrow search which would discard some relevant patent families in the target search field.

The trade-off is thus between:

- having the highest number of relevant patent families;
- keeping false positives to an acceptable level.

Keyword searches are performed on the original English text and the English translations of the original non-English text on the abstract, title and independent claims of the patent publication for Quantum Computing, Quantum Communication and Quantum Sensing. For the qubit platform searches we extend the search to all claims.

QUANTUM COMPUTING AND QUANTUM SIMULATION

We use the CPC codes

- G06N10
- G06N99 + keywords
(QUANTUM OR (QUANTUM COMPUT*))

Rationale

The rationale for choosing these IPC/CPC codes is the following:

G06N10 covers patents in “Quantum computing, i.e. information processing based on quantum-mechanical phenomena”.

G06N99 covers patents in computing “not provided for in other groups of this subclass”. Therefore, for this uncategorised class we also use a keyword search. The same search query is used in the INPI study (2).

Furthermore, we exclude from the search QKD or quantum cryptography related families by excluding the following keywords:

((QUANTUM *CRYPT*) OR (QUANTUM KEY#) OR QKD)

QUANTUM COMMUNICATION

We divide Quantum Communication into two parts. We use the following CPC codes for quantum cryptography:

H04L-009/0852

Quantum cryptography (transmission systems employing electromagnetic waves other than radio waves, e.g. light, infrared H04B 10/00; wavelength-division multiplex systems H04J 14/02; WDM arrangements H04J 14/03)

H04L-009/0855

... involving additional nodes, e.g. quantum relays, repeaters, intermediate nodes or remote nodes

H04L-009/0858

Details about key distillation or coding, e.g. reconciliation, error correction, privacy amplification, polarisation coding or phase coding

We use the following CPC code for quantum information networks:

H04B-010/70

Photonic quantum communication

We merge this search based on CPC code with a search based on keywords.

For quantum cryptography:

((QUANTUM CRYPTO*) OR (QUANTUM ENCRYPT*) OR (QUANTUM CRYPT*))

We exclude **post-quantum cryptography** from this search, which does not use quantum-mechanical properties: ((POST QUANTUM CRYPT*) OR PQC)

For quantum internet:

((QUANTUM NETWORK#) OR (QUANTUM COMMUNICATION#) OR (QUANTUM INTERNET) OR (QUANTUM INFORMATION NETWORK#) OR (QUANTUM TELEPORTATION#))

And we subtract from this search the search query for Quantum Computing.

Rationale

The rationale for choosing a mix of CPC code and text-based search is that CPC codes do not currently offer extensive coverage in this domain (a few hundreds of patent families).

QUANTUM SENSING

We use the following CPC codes:

G01R-033/0354

SQUIDS

G01R-033/0356

... with flux feedback

G01R-033/0358

... coupling the flux to the SQUID

G01R-033/326

Arrangements or instruments for measuring magnetic variables... involving a SQUID

We combine this search with another search based on keywords:

((ATOMIC VAPOR*) OR (COLD CLOUD#) OR ((TRAPPED ION) AND QUANTUM) OR (RYDBERG ATOM*) OR ((BOSE EINSTEIN) \$SEN CONDENSATE) OR ((SINGLE SPIN#) AND (NMR OR (QUANTUM DOT#))) OR (SQUID*) OR (SQIF*) OR (JOSEPHSON) OR (CHARGE QUBIT#) OR (FLUX QUBIT#))

We add the following searches as well:

- SQUID, SQIF
- Cold atoms: +COLD ATOM+
- NV centres:

(NV \$SEN CENT+) OR (NITROGEN VACANCY \$SEN CENT*) OR (NITROGEN DEFECT# \$SEN CENT*) OR (DIAMOND LATTICE#) OR (DIAMOND \$SEN NITROGEN VACANCY)

We restrict (with an AND operator) these searches with a keyword search:

(MAGNETOMET* OR INTERFEROMET* OR GYRO* OR ACCELERO* OR ROTAT* OR GRAVIT* OR PRESSURE OR RADAR# OR LIDAR# OR LADAR# OR SENSOR# OR SENSING)

Finally, we subtract the search query for Quantum Computing.

Rationale

Again, we use a mix of CPC code and text-based search since CPC codes do not currently offer extensive coverage in this domain (a few hundreds of patent families).

QUBIT PLATFORMS

In this section of the study, we attempted to drill down to selected qubit platforms with a focus on Quantum Computing. This is the first year we are attempting this deep dive, and the results should be interpreted with caution as the search procedure is still being refined.

Superconducting/transmon qubits

We use the following keyword search to look for transmon/transmon-related phrasing and Josephson/qubit hardware terms:

((((OSCILLATION*) OR (TRANSMON*) OR (CAPACITIVELY \$PREO SHUNT*) OR "CAPACITIVELY-SHUNTED" OR (CAPACITIVELY \$PREO SHUNTED \$PREO SUPERCOND*) OR (ANHARMONIC \$PREO SUPERCOND*) OR "WEAKLY ANHARMONIC OSCILLATOR" OR (SUPERCONDUC*) OR ("JOSEPHSON") OR (JOSEPHSON \$PREO JUNCTION*) OR (CIRCUIT \$PREO QED*) OR CQED*) AND ((QBIT*) OR (QUBIT*) OR ((QUANTUM \$PREO (BIT*)) OR (QBIT* \$PREO READOUT*) OR (JOSEPHSON \$PREO JUNCTION*))))))

We exclude from the search common non-qubit domains like mass spectrometry, detectors, MKIDs, classical microwave filters:

(DETECTOR OR MAGNETOMETER OR ((MASS) \$PREO (SPECTROM*) OR (MASS-SPECTROMET*) OR (MASS \$PREO SPECTR*) OR (BOLOMETER*) OR (ION))

We exclude some possibly noisy classes like chemical analysis, measurement, classical communications/electronics:

G01N*

Investigating or Analysing Materials by determining their chemical or physical properties

G01R*

Measuring electric variables, measuring magnetic variables

H04L*

Transmission of Digital Information

H03*

Electrical circuits for a variety of applications

NOT CPC:(G01N* OR G01R* OR H04L* OR H03*)

And we include CPC classes related to quantum and superconducting-device, and to broad semiconductor manufacturing techniques and general digital data processing means, which, in combination with the keywords above, are likely to capture some relevant patent families:

G06N10*

Quantum computing, i.e. information processing based on quantum-mecahnical phenomena

H01L39*

Relates to superconductive devices

H01L2224*

Assembly techniques, binding methods and packaging structure for semiconductor devices

H01L23*

Constructional details, packaging, and assembling of semiconductor devices and other solid-state devices

G06F*

Electrical digital data processing

CPC:(G06N10* OR H01L39* OR H01L2224* OR H01L23* OR G06F*)

Rationale

Again, we use a mix of CPC code and text-based search since CPC codes do not currently offer extensive coverage in this domain.

Spin qubits

We use the following keywords for core spin qubit families:

```
((SPIN*) OR (DONOR* $PREO ATOM*) OR (PHOSPHORUS $PREO DONOR*) OR "SI:P" OR "SI:BI" OR "ST" OR "HYBRID" OR "ESR" OR (SINGLET* $PREO TRIPLET*) OR "EXCHANGE-ONLY" OR "HYBRID" OR (SINGLET-TRIPLET*) OR (RESONANT $PREO EXCHANGE*) OR ((COLOR) $PREO (CENTER*)) OR (ELECTRON $PREO RESERVOIR*) OR NV OR (NV $PREO CENTER*) OR (NITROGEN $PREO VACANC*))
```

And we combine them with keywords related to quantum/device context:

```
(QBIT* OR QUBIT* OR (QUANTUM $PREO BIT*) OR (QUANTUM $PREO COMPUT*) OR (QUANTUM INFORMATION) OR (QUANTUM $PREO PROCESSOR*) OR (QUANTUM $PREO GATE*) OR (SPIN $PREO READOUT) OR (CHARGE $PREO SENSOR*) OR (PAULI $PREO BLOCKADE) OR (SPIN* $PREO BLOCKADE*))
```

We exclude spectroscopy and magnetic sensing domains:

```
ESR OR (ELECTRON* $PREO SPIN* $PREO RESONANCE*) OR NMR OR (NUCLEAR $PREO MAGNETIC* $PREO RESONANCE*) OR (MAGNETIC* $PREO RESONANCE* $PREO IMAGIN*) OR MRI OR MAGNETOMETER* OR (ATOMIC* $PREO MAGNETOMETER*) OR (SPIN* $PREO LABEL*) OR (SPIN* $PREO PROBE*) OR (MASS* $PREO SPECTROMET*) OR MALDI OR ESI OR (ION* $PREO MOBILITY*)
```

We exclude general semiconductor devices with spin but no qubits:

```
((SPIN* $PREO INJECTION*) OR (SPIN* $PREO DIFFUSION*) OR (SPIN* $PREO RELAXATION*) OR (SPIN* $PREO LED*) OR (MAGNETIC* $PREO RANDOM* $PREO ACCESS* $PREO MEMOR*) OR (QUANTUM $PREO WELL* $PREO LASER*) OR (OPTICAL $PREO MODULATOR*))
```

We include helpful CPC classes for quantum devices:

G06N10*

Quantum computing, i.e. information processing based on quantum-mechanical phenomena

H01L29*

Details of semiconductor bodies or of semiconductor devices not provided for in group H01L 21/00 or H01L 22/00

H01L21*

Processes or apparatus adapted for the manufacture or treatment of semiconductor or solid state devices or of parts thereof

H01L31*

Semiconductor devices sensitive to infrared radiation, light, electromagnetic radiation of shorter wavelength, or corpuscular radiation and specially adapted either for the conversion of the energy of such radiation into electrical energy or for the control of electrical energy by such radiation; Processes or apparatus specially adapted for the manufacture or treatment thereof or of parts thereof; Details thereof

G11C19*

Digital stores in which the information is moved stepwise, e.g. shift registers

Finally, we subtract from this search the searches for trapped ions and cold atoms.

Trapped ions

We use the following keyword search for trapped ion technology:

```
((((ION* $W5 TRAP*) OR (ION-TRAP*) OR (TRAPPED-ION*)))
```

And we combine this with keywords related to quantum/device context:

```
((((QUANTUM) $PRE0 (COMPUT*)) OR (QUANTUM) OR (QUBIT*) OR ((QUANTUM) $PRE0 (BIT*)) OR (QBIT*) OR (QUANTUM INFORMATION) OR (QUANTUM GATE) OR (QUANTUM PROCESSOR) OR (COMPUT*))
```

We exclude patent families associated with mass spectrometry related firstly with the following keyword search:

```
(MASS $PRE0 SPECTR*)
```

and secondly by excluding CPC code H01J49/00 (Particle spectrometers or separator tubes).

Cold atoms

We use the following keywords for core patent families relating to cold atoms:

```
((NEUTRAL $PREO ATOM*) OR (NEUTRAL-ATOM*)
OR (RYDBERG*) OR (RYDBERG $PREO ATOM*) OR
(RYDBERG-STATE*) OR (RYDBERG $PREO BLOCKADE*)
OR (OPTICAL $PREO TWEEZER*) OR (OPTICAL-
TWEEZER*) OR (OPTICAL $PREO TWEEZER* $PREO
ARRAY*) OR (OPTICAL-TWEEZER-ARRAY*) OR (OPTICAL
$PREO LATTICE*) OR (ATOM $PREO ARRAY*) OR
(SINGLE-ATOM*) OR (SINGLE $PREO ATOM*) OR
(ATOM-BY-ATOM*) OR "ATOM BY ATOM" OR (OPTICALLY
$PREO TRAPPED $PREO ATOM*) OR "OPTICALLY-
TRAPPED" OR (OPTICAL $PREO TRAP*) OR (ATOM
$PREO TRAP*) OR (MAGNETO-OPTICAL $PREO TRAP*)
OR "MOT" OR (OPTICAL $PREO TWEEZER* PLATFORM*)
OR (NEUTRAL $PREO ATOM* QUANTUM) OR (NEUTRAL-
ATOM* $PREO QUANTUM) OR (NEUTRAL-ATOM* $PREO
QUBIT*) OR (ATOM* $PREO ARRAY* $PREO QUANTUM)
OR (RYDBERG $PREO QUBIT*) OR "RYDBERG QUANTUM"
OR "RYDBERG QUANTUM PROCESSOR" OR (OPTICAL
$PREO TWEEZER* $PREO QUANTUM $PREO PROCESSOR*)
OR (SINGLE $PREO ATOM* $PREO QUBIT*) OR (TWEEZER
$PREO ARRAY*)) )
```

We combine this search with keywords related to quantum/device context:

```
((QUBIT* OR (QUANTUM AND BIT*) OR (QBIT*) OR
"QUANTUM" OR ((QUANTUM) $PREO (PROCES*)) OR
(QUANTUM $PREO COMPUT*) OR (QUANTUM $PREO
SIMULATOR*) OR (QUANTUM $PREO SIMULATION*)
OR "QUANTUM INFORMATION" OR (QUANTUM $PREO
GATE*) OR (TWO-QUBIT $PREO GATE*) OR (MULTI-
QUBIT*) OR "ANALOG QUANTUM" OR "DIGITAL
QUANTUM"))
```

We exclude trapped ions and mass spectrometry related patents

```
NOT (((ION $PREO TRAP*) OR (TRAPPED $PREO ION*)
OR (ION* $PREO TRAP* QUBIT*) OR (MASS $PREO
SPECTROMET*) OR MALDI OR ESI OR "TIME OF FLIGHT"
OR "TOF"))
```



CONTACT

All inquiries should be directed to
info@euroquic.org