Quantum Technologies Careers Fact Sheets

What careers are there in the quantum sector?

Where could a career in quantum technology take me?

How can I get there?

This set of careers fact sheets is designed to answer all of these questions and many more!

Quantum technologies harness quantum physics to gain a functionality or performance which is otherwise unattainable – the functions of quantum technologies are derived from science that cannot be explained by classical physics, such as Newton's Laws of motion, thermodynamics, or Maxwell's equations of electromagnetism.

The field of quantum technologies is rapidly growing as the technologies advance towards commercialisation, and because of this, the career opportunities within the field are expanding exponentially! There is genuine enthusiasm for quantum technologies matched by heavy investment across the globe, as the UK National Quantum Technologies Programme and similar government initiatives across the world are striving to stimulate a quantum economy.

There are many different career pathways in quantum. Alongside obvious roles such as quantum researchers, quantum engineers and cryptographers, there is also a plethora of support roles, which are crucial to the field and to growing a quantum economy, for example: project managers, business development managers, software developers, communications specialists, patent officers and many more. All of these roles show that you don't need to have a physics background to work in quantum, there really is a role for everyone, no matter what their background is!

Research software engineer

As a research software engineer, you will work with physicists and other software engineers to develop bespoke software programs for quantum applications. You could work for a research group within academia or for a company which carries out research. You will use your coding skills to research, develop, design and test new programs that will enable problems to be solved and new quantum devices to operate and communicate with other devices.

What does the role involve?

- Working with hardware engineers to understand technology software requirements
- Developing bespoke software for quantum technologies
- Testing new pieces of software
- Maintaining software by finding and fixing bugs
- Updating and adapting software by designing and implementing new features
- Writing software specifications

Where would I work?

Offices, sometimes remote working.

What subjects should I do well in at school?

Computer Science, Physics, Mathematics.

What qualifications do I need?

Minimum bachelor's degree in Computer Science, Physics, Mathematics, Engineering or another similar discipline.

What skills and attributes are required?

In depth knowledge of coding languages (e.g. C, C++, Python, Linux, Rust etc), ability to work independently and as part of a team, knowledge of cryptography, knowledge of quantum hardware, problem solving skills, analytical skills, attention to detail, adaptability.

What work experience would be helpful?

Software development experience, experience of research projects (even if just a project as part of an undergraduate degree) familiarity with collaboration tools such as Jira, commercial experience (could be from an internship).

What about career progression?

Research software engineers often move around and work on different projects. Progression isn't often linear; it could be that moving from academia to research or vice versa offers the opportunity to take up a more senior role.

CASE STUDY

Ania Brown

Ania studied for an undergraduate degree in Physics and Information Technology in Australia before undertaking a master's degree in Tokyo. She moved to the University of Oxford to work as a Research Software Engineer, on a project called QuEST. Ania worked to develop and speed up code that enabled quantum computers to be simulated on classical computers. She has now taken up a role in industry, to find out how the role of Research Software Engineer differs in academia and industry. Find out more about Ania's journey at: (*tinyurl.com/careersinquantum*).

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Outreach officer

As an outreach officer, you will be responsible for carrying out public engagement and outreach work for your institution. These roles are most commonly held at universities and other research institutions, rather than private companies. You will organise events and create resources that enable the general public and schools to learn about, understand and engage with the research taking place.

What does the role involve?

- Devising a public engagement strategy
- Organising events and media campaigns
- Attending and facilitating events
- Creating a variety of resources such as posters, leaflets, videos and so on
- Working with researchers to create interactive demonstrations for use at events
- Communicating with schools and other public groups
- Communicating with other organisations or research groups to create joint public engagement or outreach activities
- Sometimes outreach roles require postholders to carry out fundraising activities or funding applications

Where would I work?

Offices within campuses or research facilities. Sometimes domestic travel is required.

What subjects should I do well in at school?

English, Mathematics, Science.

What qualifications do I need?

You do not need a background in quantum for this role, however, you should be interested in the field and have good foundational qualifications in subjects such as English, Mathematics and Science.

What skills and attributes are required?

Good communication, presentation skills, ability to understand and communicate complex scientific concepts to non-specialist audiences, organisation, creativity, problem solving, initiative, prioritisation, passionate about science and technology, ability to work effectively as part of a team.

What work experience would be helpful?

Experience of organising and working at events.

What about career progression?

Outreach officers can move into more senior roles by, for example, working for a larger project or institution, or alternatively, they could move to work in related but more senior roles such as leading events teams within a university or even organisations such as charities.

CASE STUDY

Dr Simon Foster

Simon studied Physics with Space Science at undergraduate level and subsequently for a PhD in solar physics at the University of Southampton. He then worked as a researcher at Imperial College London, investigating the link between solar spots and climate change. Following that, Simon became a climate change consultant and subsequently a physics teacher in a sixth from college. He now works at Imperial College London as the Engagement Lead, helping to make the work of the researchers there accessible to all; he also features in several science related TV shows too. Find out more about Simon's journey at: (*tinyurl.com/careersinquantum*).

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Patent attorney

As a patent attorney you will be responsible for submitting applications, on behalf of a company or an individual, to the government, in order to protect inventions and give the owners legal rights with regards to their intellectual property. You could work at a private practice which represents numerous clients, in the law department at a large company, or in a government department.

What does the role involve?

- Meeting with inventors to discuss their inventions
- Analysing the technicalities of inventions to determine whether they are novel and innovative
- Creating legal documents surrounding the inventions
- Applying to patent offices for patents
- Answering questions on applications and making amendments
- Liaising with solicitors to enforce patents where required
- Keeping abreast of changes and new developments within the field you work

What subjects should I do well in at school?

Patent attorneys can work in any discipline, however, fields such as Chemistry, Physics, Mathematics, Computer Science and Engineering have a high demand so excelling in those subjects, along with English, at school would be beneficial.

What qualifications do I need?

A bachelor's degree (at least a 2:1) in a Science, Engineering, Mathematics, or another technical subject. Once you hold a trainee patent attorney position you will study for professional qualifications.

Where would I work?

Company or government offices. Sometimes remote working. Travel to clients is common.

What skills and attributes are required?

Technical understanding relevant to the field you are working in, ability to learn and work independently, communication, ability to express technical information clearly and concisely, good interpersonal skills, attention to detail, analytical skills, time management, organisation.

What work experience would be helpful?

Undertaking an internship or a summer placement at a patent office would be highly beneficial. Shadowing a patent attorney or attending an open day would be other useful activities.

What about career progression?

This career path has many opportunities for progression. Once registered, patent attorneys can take on the responsibility of mentoring trainees. Progression could involve becoming the manager of a team of attorneys, becoming an associate partner and eventually a partner within a law firm.

CASE STUDY

Dr Rachel Free

Rachel studied double Mathematics, Chemistry and Physics at A Level and initially studied Chemistry at university, before swapping to Experimental Psychology. Rachel went on to study for a master's degree in AI before undertaking a PhD in Vision Science. She then trained to become a patent attorney and now heads up a team of patent attorneys at CMS, an international Law Firm based in London, working on protecting computing related inventions, including some quantum technologies. Find out more about Rachel's Journey at: (*tinyurl.com/careersinquantum*).

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Quantum researcher in academia

As a quantum researcher in academia, you would be based in a university and would conduct research into cutting edge technologies. You would design and model new technologies or carry out experiments using them. Alongside your research you may contribute to wider university life, for example, through teaching or supervising students.

What does the role involve?

- Applying for grants to fund research projects
- Planning, managing and conducting research projects
- Designing and testing new technologies
- Analysing results and drawing conclusions
- Writing scientific papers
- Attending conferences and presenting results
- Teaching or supervising students
- Attending meetings
- Administration

Where would I work?

Laboratories and offices within campuses or research facilities. Sometimes fieldwork could be involved. Domestic and international travel is common.

What subjects should I do well in at school?

Computer Science, Mathematics, Physics, Electronics, Chemistry.

What qualifications do I need?

Minimum bachelor's degree but ideally PhD in Computer Science, Electronic Engineering, Mathematics, Physics (or related field).

What skills and attributes are required?

Good written and verbal communication, proficient in IT, knowledge and application of programming languages, time management, problem solving, critical thinking, ability to work in a team and individually, project management, inquisitiveness, determination, resilience.

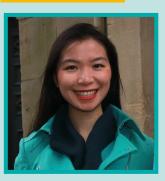## What work experience would be helpful?

Experience carrying out research projects, writing scientific reports, teamwork.

What about career progression?

This career pathway offers a great deal of progression, once a researcher has obtained a PhD they can move on to become a postdoctoral researcher, lecturer, senior lecturer and eventually a professor. Often academic researchers can also act as consultants to government and industry regarding their particular field, sometimes contributing to policies etc. Some academics also set up start-up companies to commercialise their technologies.

CASE STUDY

Dr Zixin Huang

Zixin studied Physics and Chemistry at undergraduate level, at the University of Sydney, before undertaking a PhD in quantum photonics at the same institution. She then moved to the University of Sheffield to work as part of the Quantum Communications Hub on quantum measurements testing (metrology) and (quantum enabled) super-resolution imaging technologies. She has since obtained a fellowship and moved to the Sydney Quantum Academy. Find out more about Zixin's journey at: (*tinyurl.com/ careersinquantum*).

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Business development manager

As a business development manager, you will be responsible for identifying and encouraging engagement between businesses or between businesses and research projects/facilities. You will build new relationships regularly, maintain contacts, create networks and always be on the look out for opportunities for new partnerships.

What does the role involve?

- Identifying collaboration opportunities
- Developing networks between companies, academic and government institutions
- Liaising between researchers/technical personnel and non-technical personnel to identify opportunities for new projects and partnerships
- Maintaining a full understanding of the quantum and funding landscapes and any gaps or areas for development within them
- Attending conferences and networking events

Where would I work?

Company/university/research facility offices. Sometimes remote working. Domestic travel is common. Sometimes international travel may be required.

What subjects should I do well in at school?

There are no specific subject requirements for this role, you can enter it from any background, however, good communication and networking skills are vital.

What qualifications do I need?

You can enter a career in business development from any background, you do not need to have a background in quantum. However, a bachelor's degree in a relevant subject such as Computer Science, Physics or Mathematics would be beneficial.

What skills and attributes are required?

Communication, networking, presentation, organisation, ability to learn quickly, strategic thinking, innovative thinking, creativity, problem solving, ability to work as part of a team and individually.

What work experience would be helpful?

Experience of working in quantum would be beneficial, this could be through an internship or placement.

What about career progression?

Business development managers hold crucial roles within their organisations and can sometimes be promoted to directors within the companies/institutions that they work for.

CASE STUDY

Kevin McIver

Having studied for an undergraduate degree in Mathematics and Physics, Kevin became a physics teacher, before moving into a role within vocational education where he worked to support companies to provide staff training. Kevin then moved into a business development role at the Institute and Faculty of Actuaries before he married his business development skills with his background in physics, to become a business development manager at QuantIC, the UK Quantum Technology Hub in Quantum Enhanced Imaging. Find out more about Kevin's Journey at: (*tinyurl.com/careersinquantum*).

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Quantum hardware engineer

As a quantum hardware engineer, you will work for a company and will use your understanding of engineering, physics, electronics and computer science to design new and innovative quantum technologies. For example, you could design new technologies for quantum computers, devices for ultimately secure quantum communications systems, quantum sensors or new quantum imaging technologies that enable non-invasive medical scans to take place.

What does the role involve?

- Working as part of a team on various research projects
- Designing and testing new technologies
- Analysing data to understand device performance
- Characterising new devices
- Writing research papers
- Attending conferences
- Carrying out field trials

Where would I work?

Laboratories and offices. Sometimes fieldwork could be involved.

What subjects should I do well in at school?

Physics, Computer Science, Electronics, Engineering, Mathematics, Design & Technology.

What qualifications do I need?

Minimum bachelor's degree but ideally PhD in experimental or applied Physics, Electrical Engineering, Mechanical Engineering or Computer Science.

What skills and attributes are required?

Good written and verbal communication, presentation skills, project management, adaptability, ability to multitask, understanding of coding languages such as python, good manual dexterity, logical thinking, innovative nature.

What work experience would be helpful?

Experience carrying out scientific research projects, software development using languages such as python, laboratory experience, commercial experience (could be gained from an internship).

What about career progression?

Progression in this career pathway could be through becoming a senior engineer and leading a team within a company, it could also be moving to a more senior role at a different company or even into academia.

CASE STUDY

Cassandra Mercury

Cassandra began by obtaining an undergraduate degree in Mechanical Engineering and subsequently a Master's in Aeronautical Engineering. She then went on to work in the Jet Propulsion Laboratory of NASA and at another company working as a Test and Development Engineer. Cassandra is now the Space Quantum Technology Lead for a space engineering company developing technologies for quantum communications in space. Find out more about Cassandra's journey at: (*tinyurl.com/ careersinquantum*).

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Research project manager

As a research project manager, you work at a university or government facility and will have overall oversight of research projects. You will use your organisation and managerial skills to take responsibility for monitoring the progress of the research projects against delivery targets and for the day-to-day management of administration associated with the projects.

What does the role involve?

- Developing project plans
- Monitoring project progress
- Identifying risks for the project and planning mitigations
- Managing budgets
- Facilitating communication between people and teams
- Writing reports
- Working with legal teams to draw up contracts for partnerships
- Being the main point of contact for the project(s)
- Being involved in the recruitment and supervision of staff

Where would I work?

Offices within campuses or research facilities. Sometimes domestic travel is required.

What subjects should I do well in at school?

Mathematics, English, Science, IT, Business Studies.

What qualifications do I need?

GCSE as a minimum. There are no specific subject requirements for this role, however, good qualifications in core subjects such as Mathematics, English and Science are beneficial.

What skills and attributes are required?

Organisation, prioritisation, methodical ways of working, attention to detail, financial management, communication, problem solving, negotiation, proficient in IT, teamwork, flexibility.

What work experience would be helpful?

Hands-on experience of managing a budget and writing reports would be beneficial, as would experience of working as part of a large team.

What about career progression?

Project managers can start off managing one relatively small project at a university but can go on to manage multimillion pound projects which span across several universities and even countries.

CASE STUDY

Dr Georgia Mortzou

After studying archaeology and anthropology at postgraduate level for a number of years, Georgia decided that a career in academia was not for her and so she chose instead to pivot and pursue a career in research support within the Quantum Communications Hub, based at the University of York. This gives Georgia the best of both worlds – not having to carry out research herself but being involved in discussions about new ideas and new potential projects. Find out more about Georgia's Journey at: (*tinyurl.com/careersinquantum*).

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Quantum technologist in industry

As a quantum technologist (also often called quantum scientists or quantum specialists) in industry, you will work in private company laboratories (or offices if your work is theoretical) to develop new technologies or to improve existing products or approaches. You will work within a team to design and test the technologies and sometimes carry out field trials where these devices are deployed into the real world for tests. Elements of your work are likely to be highly confidential, protected by patents and not able to be discussed with those outside of the company!

What does the role involve?

- Planning, managing and conducting research projects
- Designing new technologies
- Testing new technologies
- Developing manufacturing processes for technologies
- Conducting field trials
- Analysing results and drawing conclusions
- Writing scientific papers and/or business reports
- Attending conferences, user engagement events and trade shows
- Meeting with potential users of technologies

Where would I work?

Company laboratories and offices. Occasionally required to conduct fieldwork.

What subjects should I do well in at school?

Computer Science, Mathematics, Physics, Electronics, Chemistry.

What qualifications do I need?

Minimum bachelor's degree but ideally PhD in Computer Science, Electronic Engineering, Mathematics, Physics (or related field).

What skills and attributes are required?

Good written and verbal communication, proficient in IT, knowledge of various computer programming languages, time management, problem solving, ability to work in a team and individually, project management, inquisitiveness, innovative nature.

What work experience would be helpful?

Hands-on experimental experience, industry placements (e.g. during graduate studies), experience of using various computer programming languages e.g. python, Java, C++ etc.

What about career progression?

Quantum technologists can undergo several promotions within their careers, from beginning as junior members of the team to leading a team or multiple teams, to eventually heading up a company.

CASE STUDY

Dr Ryan Parker

Ryan began by studying for an undergratuate degree in Chemistry and subsequently a PhD in quantum technologies through the Quantum Communications Hub. He then went on to be a Research Specialist in Quantum Technologies at BT where he worked with customers to understand their needs and carry out technology trials. He subsequently became a Quantum Specialist at ArQit. Find out more about Ryan's journey at: (*tinyurl.com/ careersinquantum*).

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Cryptographer

As a cryptographer in the quantum sector, you may work within a university, company or government organisation such as the National Cyber Security Centre. You will use a variety of mathematical techniques to find and develop quantum-safe solutions to problems that conventional cryptography faces. You will develop new forms of cryptography that are resistant to attack by quantum computers and help to make sure that the world's cyber security is future-proofed, ready for a world where powerful quantum computers exist.

What does the role involve?

- Identifying threats and risks to cryptographic systems
- Keeping up to date with advances in cryptography and in computing technologies
- Reading research papers
- Keeping abreast of attacks on cyber security systems
- Designing cryptographic schemes and testing them
- Collaborating with colleagues on research projects

Where would I work?

Offices, sometimes laboratories and/or other specialist research facilities.

What subjects should I do well in at school?

Computer Science, Mathematics, Physics.

What qualifications do I need?

Minimum bachelor's degree but ideally a PhD in Computer Science, Mathematics or Physics, with a focus on cryptography, cryptographic implementation or quantum computing.

What skills and attributes are required?

Problem solving, understanding of computer programming languages (e.g. Python, C/C++, Java), familiarity with computer hardware and software architecture and design, able to work as part of a team and independently, time management, logical thinker, inquisitiveness, determination.

What work experience would be helpful?

Experience carrying out research and publishing scientific papers, familiarity with conventional cryptography, coding experience, 'ethical hacking'.

What about career progression?

Progression in this career pathway can take many forms. Cryptographers can work in academia for many years, eventually working up to being professors, others eventually hold senior positions within companies. There are many opportunities for cryptographers to work for governments, working to protect cyber security and national infrastructure.

CASE STUDY

Dr Ciara Rafferty

Ciara completed a PhD in Applied Cryptography at Queen's University Belfast and is now a Lecturer in Cyber Security at Queen's. Ciara works as part of the Quantum Communications Hub and many European research projects. She works with experimental and theoretical colleagues to design and implement new cryptographic schemes that will enable us to keep our data secure, even when quantum computers arrive. Find out more about Ciara's journey at: (*tinyurl.com/careersinquantum*).

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Research communications specialist

As a research communications specialist, you will use your understanding of science along with your communications skills to spread the word about the cutting-edge research your project is undertaking with the general public, industry and government.

What does the role involve?

- Devising a communications strategy
- Planning communications campaigns
- Putting together a variety of materials including press releases, leaflets, website content and social media posts
- Developing imagery to support communications
- Creating videos to communicate the work of the project
- Communicating with researchers and writing reports
- Monitoring and evaluating the effectiveness of communications

What subjects should I do well in at school?

English, Mathematics, Science, IT, Graphic Design.

What qualifications do I need?

GCSE as a minimum. There are no specific subject requirements for this role, however, good qualifications in core subjects such as English, Mathematics and Science are beneficial, along with an interest in quantum. Training in aspects of graphic design and marketing/ communications, as well as an understanding of the media landscape, would also be beneficial but is not essential.

Where would I work?

Offices within campuses or research facilities. Sometimes domestic travel is required.

What skills and attributes are required?

Good communication, organisation, IT, graphic design, video editing, creativity, problem solving, ability to work independently and as part of a team.

What work experience would be helpful?

Experience of working with a variety of communications platforms (including web, print and social media) would be beneficial.

What about career progression?

Communications specialists can begin managing the communications of one research project within a university but can progress by becoming communications managers of larger projects or entire institutions, for example.

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Quantum entrepreneur

As a quantum entrepreneur, you will have an idea for an innovative practical application in the field of quantum technologies and will use your understanding of quantum technologies, combined with your business experience, to create a start-up company to commercialise your technologies and make them widely available.

What does the role involve?

- Development of technologies or services
- Raising funding
- Pitching to potential investors
- Marketing technologies or services
- Selling technologies or services
- Financial management
- Attending conferences and tradeshows
- Working with customers and clients
- Managing a team
- Project management

What subjects should I do well in at school?

Physics, Computer Science, Electronics, Business Studies.

What qualifications do I need?

There are no specific requirements for this role, however, quantum entrepreneurs often come from a background where they have gained technical qualifications such as PhDs in quantum technologies and have experience working directly with the technologies. However, given that a great deal of the work of this role is business related, any business or management qualifications would be highly beneficial.

Where would I work?

Offices, laboratories, sometimes remote working. Domestic (and sometimes international) travel is common.

What skills and attributes are required?

Understanding of quantum, understanding of the market for quantum technologies, good working knowledge of business practices (e.g. marketing, sales, finance, recruitment, etc.), time management, project management, people management, ability to manage intellectual property, good written and verbal communication, innovativeness, resilience, creativity.

What work experience would be helpful?

Hands-on experience of working with quantum technologies, commercial experience (could be from an internship or industry collaboration), sales experience, project and people management experience.

What about career progression?

Quantum entrepreneurs can grow their business from a small start-up to global corporations, therefore the progression opportunities are unlimited!

CASE STUDY

Dr Max Sich

Max undertook an undergraduate degree in Physics, with a specialism in quantum physics, followed by a master's in quantum, before undertaking a PhD at the University of Sheffield. He also studied remotely for a degree in Finance and Economics from the London School of Economics. Max held postdoctoral positions at the University of Sheffield, before leaving academia for a career in business and eventually launching quantum start-up, AegiQ. Find out more about Max's journey at: (*tinyurl.com/careersinquantum*).

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME