

**ETH** zürich

# Master of Science in Quantum Engineering

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# What is Quantum Engineering?

## Quantum engineering

Article [Talk](#)



WIKIPEDIA  
The Free Encyclopedia

From Wikipedia, the free encyclopedia

**Quantum engineering** is the development of technology that capitalizes on the laws of quantum mechanics. Quantum [engineering](#) uses quantum mechanics as a toolbox for the development of [quantum technologies](#), such as [quantum sensors](#) or [quantum computers](#).

Mechanical engineering

*G*

Classical mechanics

Electrical engineering

*e*

Electromagnetism

Quantum engineering

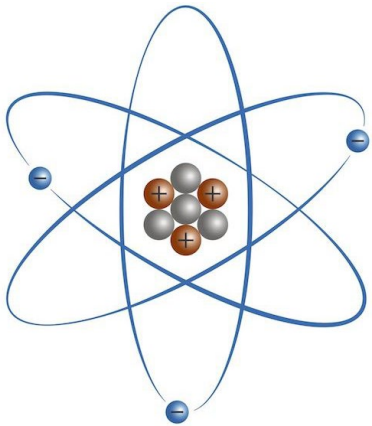
*h*

Quantum mechanics

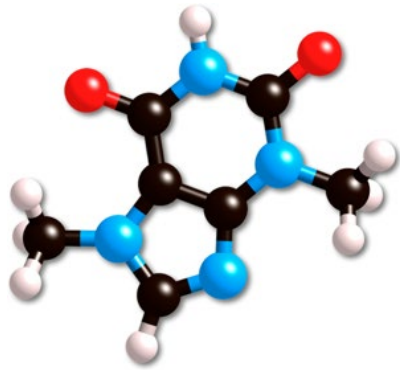
# Exquisite control of materials at the nanoscale

## Quantum materials

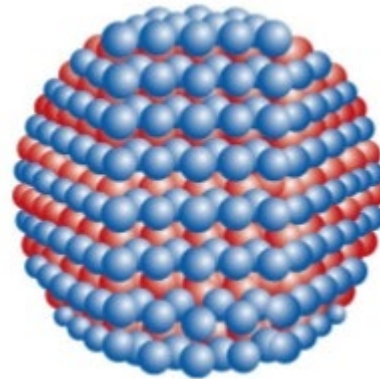
### Atoms



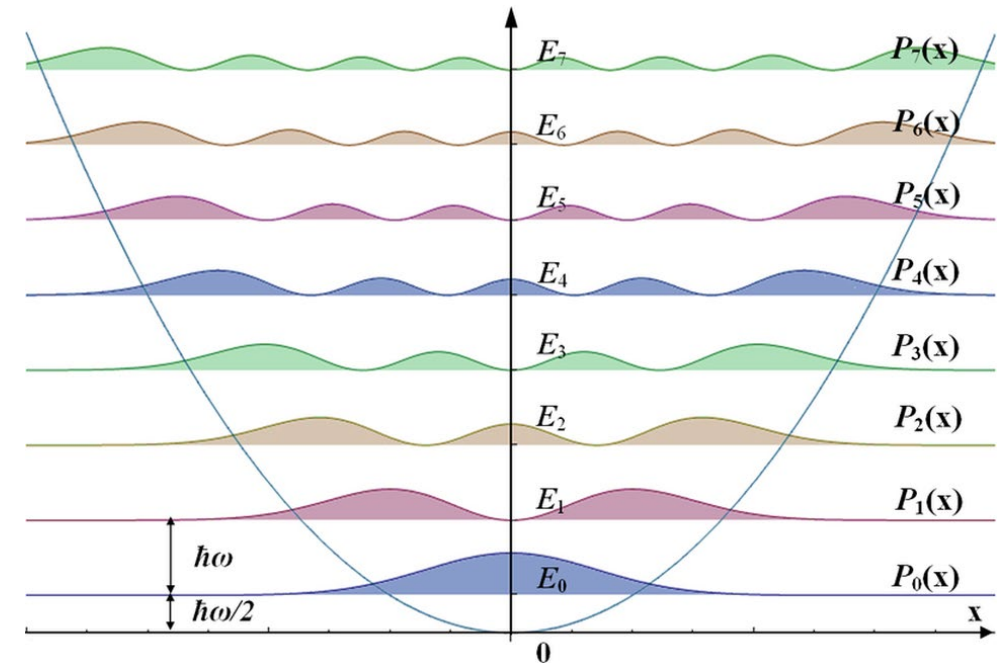
### molecules



### quantum dots



## Particle in a box

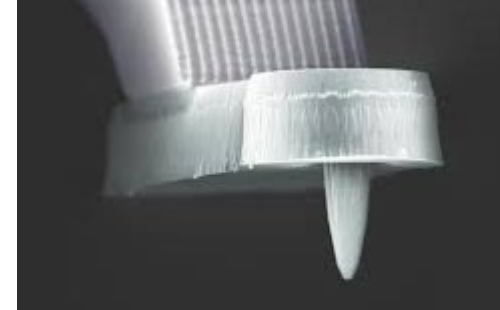


## Superposition and entanglement as resources for quantum tech

# Quantum tech. could disrupt several fields of applications

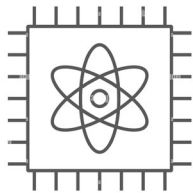


**Quantum sensing**

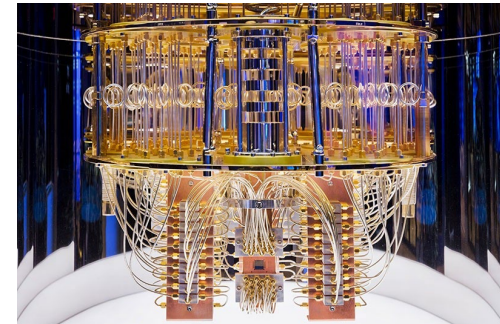


$$\frac{| \text{key} \rangle + | \text{key} \rangle}{\sqrt{2}}$$

**Quantum communication**



**Quantum computing**

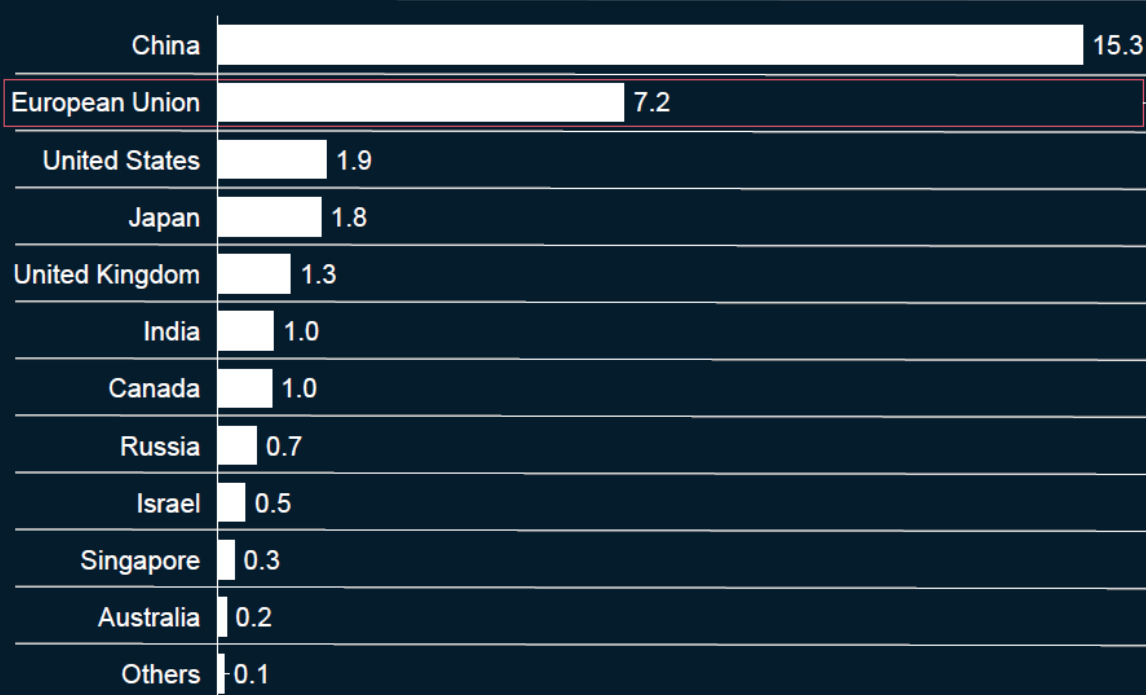


# Quantum tech. could disrupt several fields of applications

## Quantum Market

### Announced planned governmental funding<sup>1</sup>

\$ billion

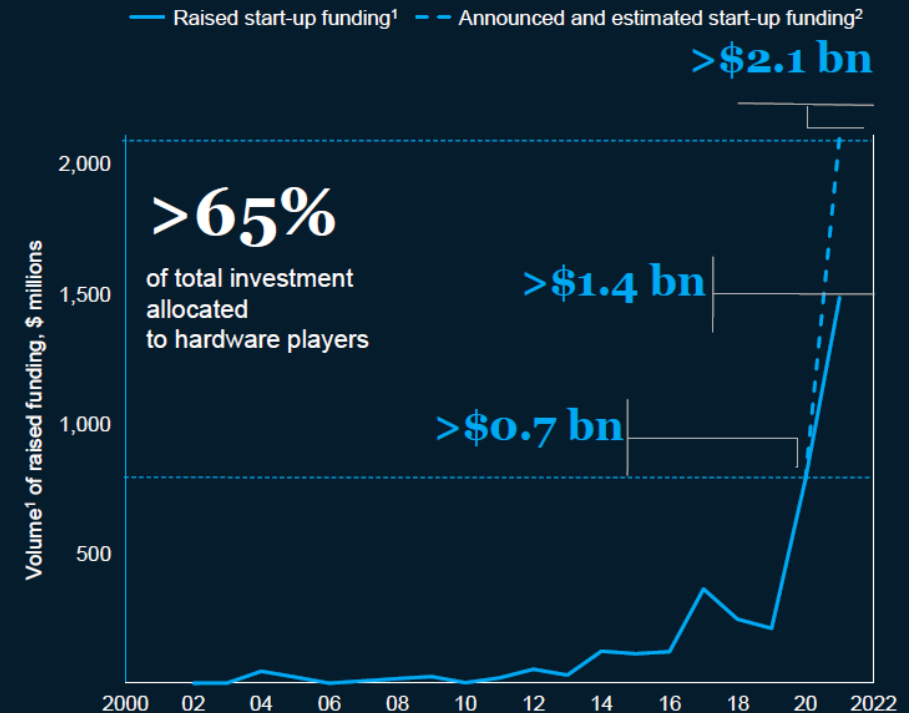


1. Total historic announced funding; timelines for investment of funding vary per country

Source: Johnny Kung and Muriam Fancy, *A quantum revolution: Report on global policies for quantum technology*, CIFAR, April 2021; press search June 2021

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

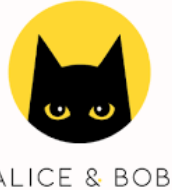
Not exhaustive



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

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

Source: Crunchbase; PitchBook; McKinsey analysis



Zurich  
Instruments





**Talent shortage might be the bottleneck  
for unlocking the possible value**



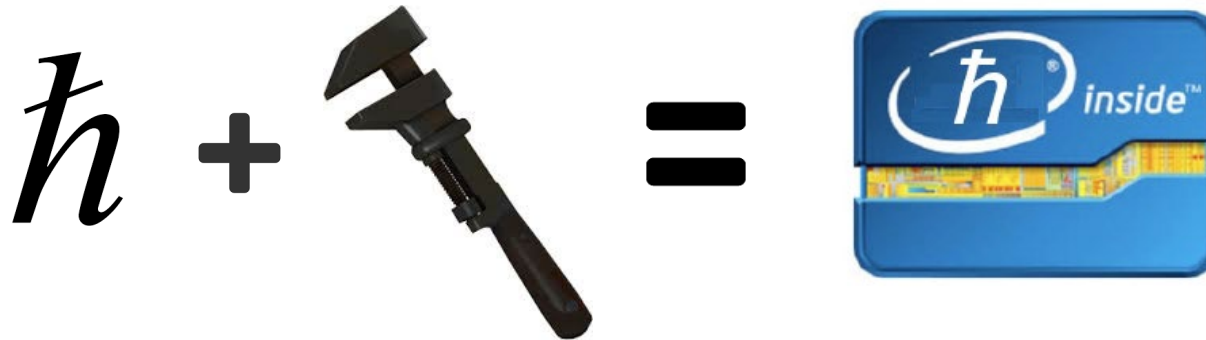
**Develop a master program to fulfill the  
demand of quantum engineers**

# Master of Science in Quantum Engineering

DITET &amp; DPHYS

Start: Sept. 2019

- Training at the interface of science and technology
- Define quantum science as an engineering toolkit
- Quantum technology in the hands of engineers



**Quantum Engineering** is the development of technology that capitalizes on the laws of quantum mechanics



# Master of Science in Quantum Engineering

## Key aspects of the program:

- **Tutor-based system** (personalized study plan)
- **Case Studies: Application of Quantum Technology**  
(build a class feeling, first contact with ETH Profs and leading companies)
- **Quantech workshops - Project-based learning**  
(tackle a real quantum challenge)



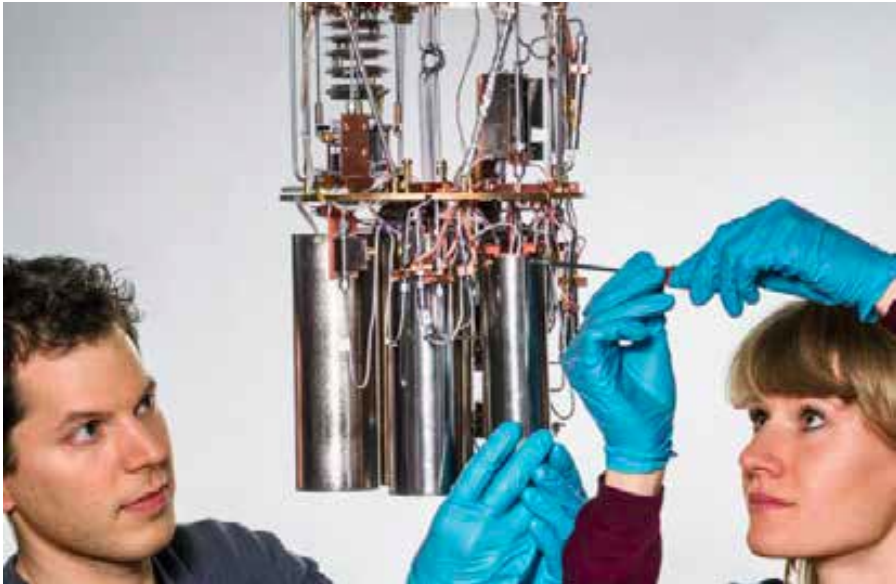
# Case Studies: Applications of Quantum Technology (HS2024)

## Format

Case studies:	Quantum Sensing	Quantum Information Processing	Quantum Algorithms
Academic insights	Degen, Novotny (Sept. 30)	Home, Xu (Oct. 28)	Reyes, Reiher (Nov 25)
Industrial insights	QZabre, CSEM (Oct. 7)	NVIDIA, NeQxt (Nov. 4)	IBM, Moody's (Dec 2)
Hands-on	Hands-on Quantum Sensing (Oct. 14)	Hands-on Quantum Computing (Nov. 11)	Entrepreneurial skills (Dec. 9)
Brainstorming	Students' presentations – brainstorming	Students' presentations – brainstorming	Hands-on Entrepreneurial skills

# Quantech Workshops

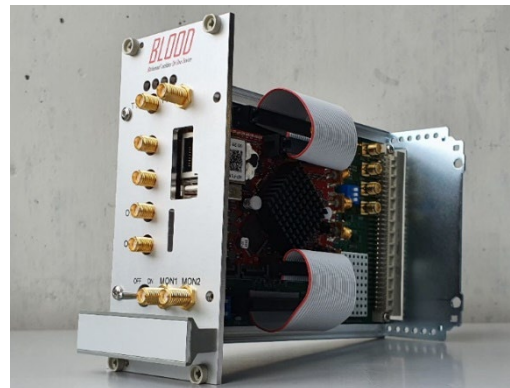
The mission of the ETH based internship is a project-oriented learning



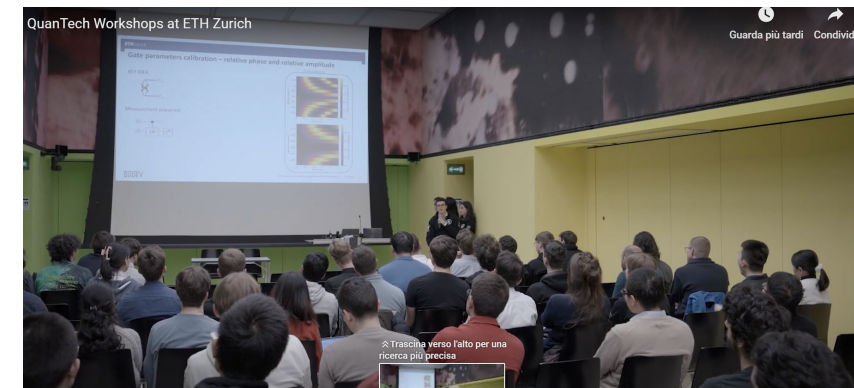
Students work in groups:

- **Conceive and draft a project proposal**
- If successful, **implement the project** in
- Presentation of the results in a **QuanTech symposium** at the end of the semester

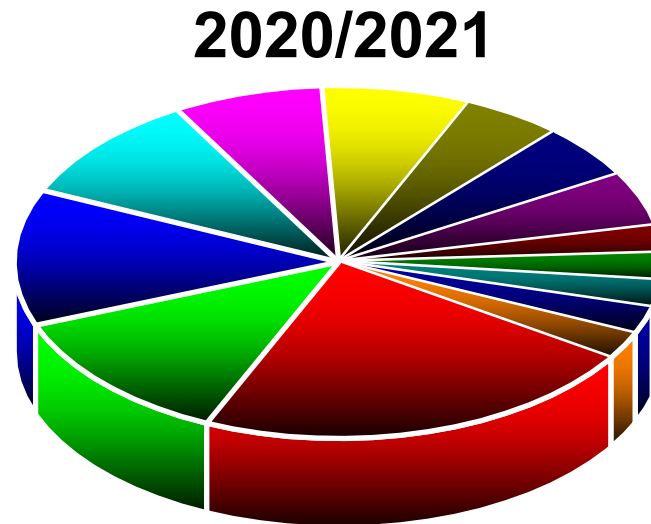
Hardware and software-based projects



Quantech Symposium



# Master of Science in Quantum Engineering



- International pool of students
  - 2019/2020 - 25 students
  - 2020/2021 - 40 students
  - 2021/2022 - 44 students
  - 2022/2023 - 37 students
  - 2023/2024 - 32 students
- Different background (electrical engineering, physics, computer science)
- Highly motivated

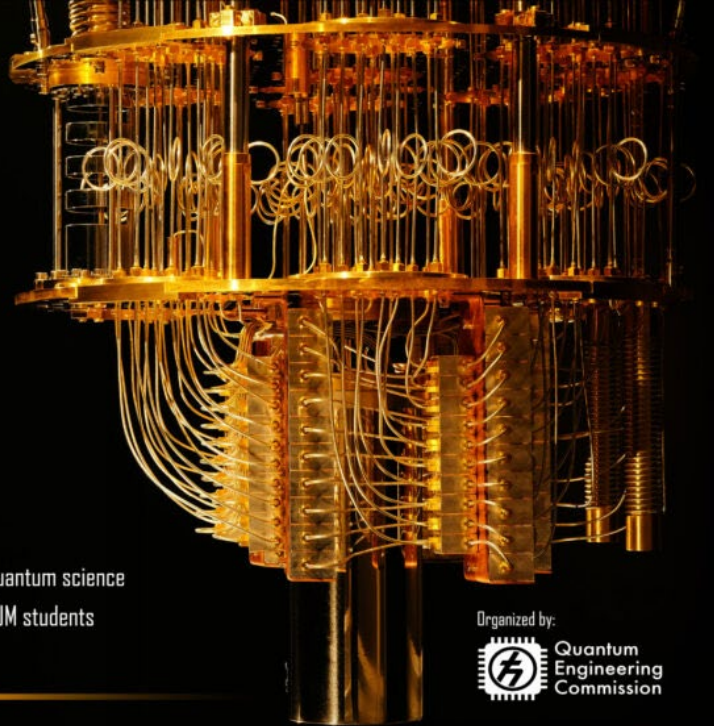
# Student's association – QE Commission

QEC @ AMIV an der ETH



- Welcome activities for new students
- Quantum Paper Club
- Sport activities
- QEC Hackathon


<https://qec.amiv.ethz.ch/>





Sponsored by:

IQM QUANTINUUM QUANTUMCENTER  
IBM Quantum vöeth Fachverein  
Verband der Studierenden  
an der ETH

April 8 to 10, 2022

 **QEC**  
**Hackathon**  
The Future is Quantum

 Tackle the hardware & software challenges of quantum science  
Join a multidisciplinary team of ETH, EPFL and TUM students  
From beginner to expert!

Organized by:  
 Quantum  
Engineering  
Commission

More than 100 participants ...

# Student's association – QE Commission

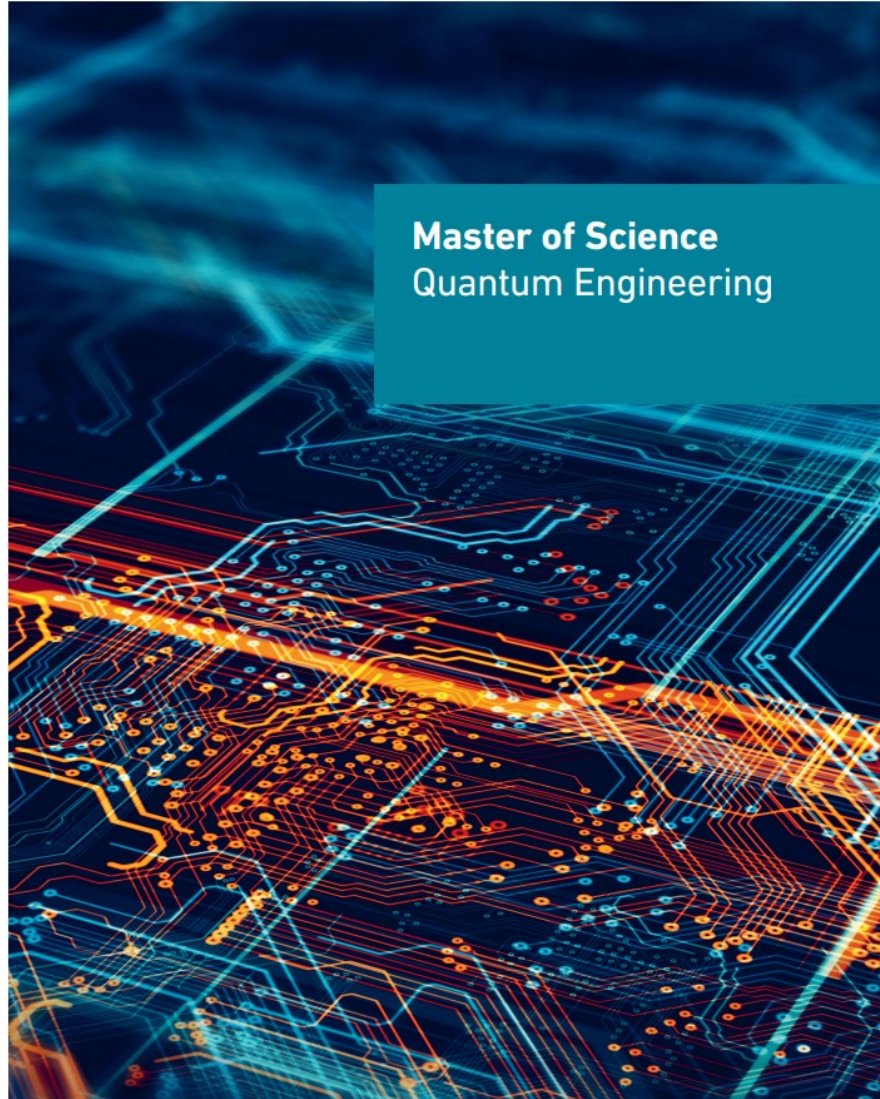
QEC @ AMIV an der ETH



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Master of Science  
Quantum Engineering

## Application



Why Quantum Engineering?

Window #1:

1 Nov - 15 Dec for all students

Window #2:

1 Apr - 30 Apr only for students with Bachelor's degree from a Swiss university

**<https://master-qe.ethz.ch/>**



**Prof. Novotny**  
**MSc QE Programme Director**



**Prof. Frimmer**  
**MSc QE Managing Director**

**innovædum**  
Advancing education at ETH

**Thank you!**

