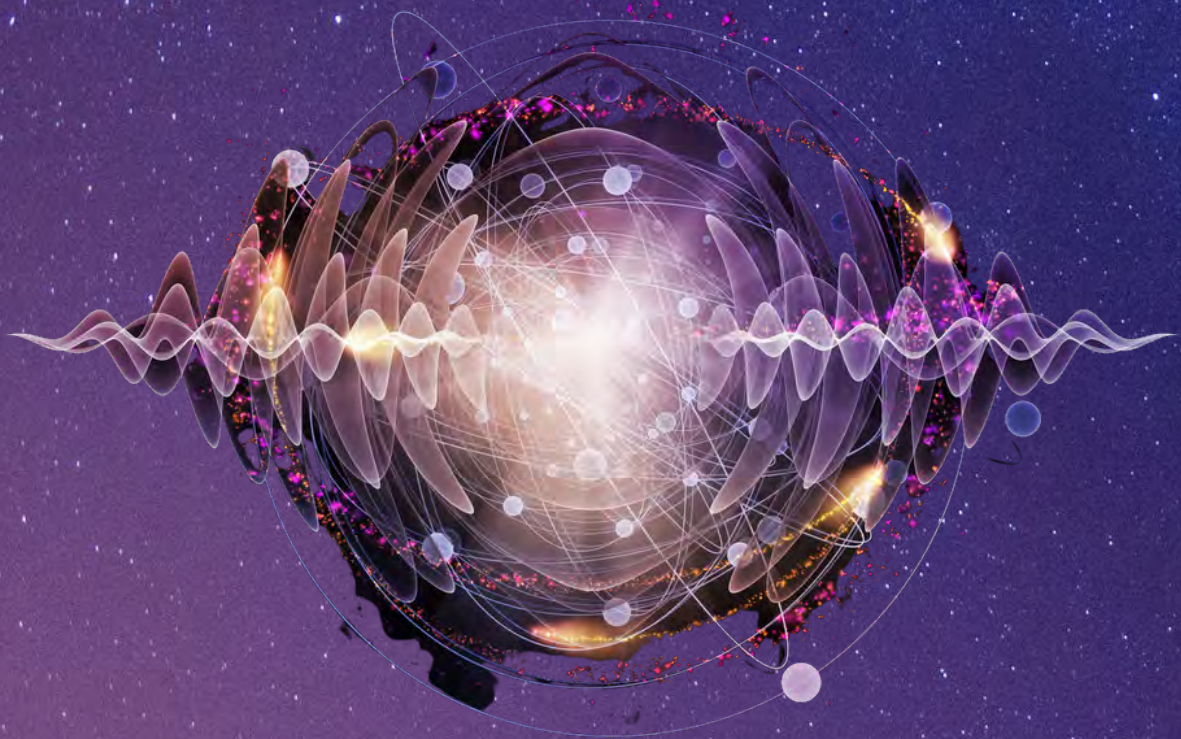


# UNDERSTANDING QUANTUM TECHNOLOGIES

HOW CAN THE GRAND EST REGION BECOME A  
NEW QUANTUM HUB?



INSA STRASBOURG  
DECEMBER 6TH 2021



OLIVIER EZRATTY

**INSA** INSTITUT NATIONAL  
DES SCIENCES  
APPLIQUÉES  
STRASBOURG





# FOREWORD



**PIERRE GRUSSENMEYER**  
INSA STRASBOURG RESEARCH DEAN

Welcome at INSA Strasbourg, a Graduate School of Science and Technology with more than 2000 students studying in the field of Engineering and Architecture. INSA Strasbourg is part of the INSA Group (National Institutes of Science and Technology), a distinctive French Group of Graduate engineering schools that promotes the core values of the INSA model such as diversity, humanism, excellence, innovation and strategic foresight. INSA schools provide a diversity of tracks and disciplines at all levels, from Bachelor up to PhD for both degree-seeking students and exchange students. Today we meet to talk about Quantum Technology. More and more research projects are developed in this field and it is therefore very important to better understand what we are talking about. That's why we invited several academic partners, ecosystem players, local and regional authorities and private partners and experts to meet and contribute to the creation of a so-called Quantum Hub in the Grand Est Region. We know that many applications will strongly change in the near future due to Quantum Science. Olivier Ezratty, author of the book "Understanding Quantum Technologies" will tell us about future revolutions in various fields such as quantum physics, quantum computing engineering, quantum computing hardware, quantum enabling technologies, etc. I would particularly like to thank the different speakers for their contributions and the colleagues from the ISIS Institute of the University of Strasbourg with whom we are organizing this event. We believe that designing a quantum engineering training accessible to all specialties in engineering science, including issues of inclusive and equity is a challenge for the coming months.





# FOREWORD



**SHANNON WHITLOCK**  
Executive Committee QMat  
Coordinator aQCess

The early development of quantum sciences has had a long and rich history in Strasbourg, with great figures like Braun, Weiss, Néel, and Perey, having spent decisive parts of their careers in Strasbourg. Today, quantum science and technology (QST) and its interfaces is a rapidly growing priority area spanning several institutes in Strasbourg and partners across the Region Grand Est and the Upper Rhine Valley. It is an integral part of the University of Strasbourg's "Initiative of Excellence" strategy to enhance the visibility and attractiveness of research and education, and has culminated in a number of individual recognitions as well as large national and international projects, such as the first University Research School in quantum in France "QMat – Quantum Science and Nanomaterials", the Trinational Doctoral School "QUSTEC – Quantum Science and Technology at the European Campus", and the new platform "aQCess – Atomic Quantum Computing as a Service" supported by the ANR EquipEx+ programme and the French National Quantum Plan. A new "European Center for Quantum Sciences" (CESQ) in Strasbourg aims to foster further links with a strong focus on multidisciplinary application. Now is the perfect time to establish a quantum hub in the East of France and shape the future in quantum science and technologies.



**ISABELLE KUHN**  
Grand E-nov+ Executive Vice President  
Support and Digital

La Région Grand Est bénéficie de tous les atouts pour devenir un futur hub quantique et l'est déjà à bien des égards. Elle dispose de 5 grandes universités (UHA, UL, Unistra, URCA, UTT) et d'EPST (INRIA, CNRS) actifs dans les différentes disciplines afférentes à l'avènement de l'ordinateur quantique. Ces forces académiques portent de nombreux projets comme par exemple le projet international AQCESS visant à construire un ordinateur quantique en utilisant des atomes piégés par des lasers. De plus, les chercheurs travaillant dans ces universités ont acquis des compétences sur toute la chaîne de valeur allant de la physique théorique au développement de code permettant de tirer parti de la puissance de l'ordinateur quantique. Enfin, la Région compte un simulateur quantique basé à l'URCA qui permet d'appréhender cette technologie en vue d'une intégration rapide par les entreprises en tant qu'innovation de rupture. La Région souhaite ainsi en lien avec la stratégie nationale d'accélération développer toutes ces forces de recherche, s'appuyer sur les grandes écoles d'ingénieurs (telles que l'INSA), sur les structures de transfert de technologies, sur les acteurs de l'innovation, afin de constituer un hub quantique ouvert sur l'Europe.





# PROGRAM

OPEN REGISTRATION

8:30 AM



**OPENING ACT**

9:00 AM

PIERRE GRUSSENMEYER

NEIL ABOURG



**QUESTION-AND-ANSWER GAME**

9:30 AM

**WITH OLIVIER EZRATTY**

MODERATOR: KAOUTAR BENLAMINE

**BREAK 10:30 AM**



**ROUND TABLE 1**

10:45 AM



**QUBIT PLATFORMS**

**& QUANTUM COMPUTERS**

MODERATOR: INÈS JORGE

SPEAKERS: J. ATTIA, K. BENLAMINE, C. BOUAZZA,

O. EZRATTY, S. WHITLOCK



**TABLE RONDE 2**

11:25 AM

**DE LA FORMATION INITIALE**

**A L'INNOVATION QUANTIQUE**

MODÉRATRICE: RACHEL GUEZ

INTERVENANTS: D. CAVALLUCCI, G. CHEVEREAU,

C. GENET, M. KUREK, E. SMIGIEL



**CLOTURE EVENEMENT**

12:05 PM

ISABELLE KUHN

**MASTER OF CEREMONIES**

ALINA HOLCROFT





# SPEAKERS



**Jonathan J. Attia** - Chairman of Feynman Foundation; Chair of IEEE P2995 - Quantum Algorithm Design and Development Working Group; Chair of IEEE P3120 - Quantum Computing Architecture Working Group. He is the inventor of several dozen international patents in the field of cryptography, author, associate researcher at UMR 7321 (CNRS). Jonathan will share his experience in standardizing quantum computing technologies.



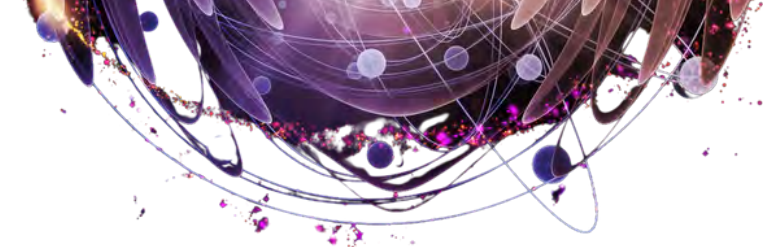
**Kaoutar Benlamine** is currently an associate professor of mathematics and computer science in INSA Strasbourg. She obtained her PhD in Quantum Machine Learning from Sorbonne Paris Nord University. She holds an Engineering Degree in Computer Science & Statistics from INSEA, as well as a Master's Degree in Data Science and Machine Learning from Sorbonne Paris Nord University. Her research activities are focused on quantum learning, unsupervised learning and clustering.



**Chayma Bouazza** is leading the business development activities and international expansion at PASQAL. She received her doctorate from University PSL – ENS Ulm for her work on quantum gases in Jean DALIBARD's group. After her PhD, she joined a consulting company specialized in innovation, where she worked on a wide range of topics (smart mobility, digital transformation, etc.). She joined PASQAL in November 2020.



**Denis Cavallucci** full professor, head of a research team at ICube namely CSIP (Design, Information systems and Inventive processes). Denis Cavallucci has conducted research in Inventive Design for the past 25 years and is a recognized international expert in the domain of Inventive Problem Solving with over 200 scientific publications, twenty patents with industry partners. Member of the board of Elsevier's Computers in Industry journal his center of interest is to build AI-based tools to bring R&D activities into 4.0 era.



# SPEAKERS



**Guillaume Chevereau** - Trained physicist who worked as a researcher mostly in biophysics. Working at ENS de Lyon, he studied the mechanics and thermodynamics of nucleosome assembly on DNA. Later, he joined IST Austria and worked in the field of microbiology, investigating the role of drug interactions in bacterial models. Since 2014, he is full time lecturer at INSA Strasbourg, teaching various subjects ranging from classical mechanics to introductory courses in quantum computing.



**Olivier Ezratty** - Consultant, author, trainer and speaker of digital technologies and their applications in traditional industries such as media, industries and services. He published the ebook Understanding Quantum Computing in September 2018 and updated in September 2019 and 2020, then in English with Understanding Quantum Technologies, published in September 2021 (836 pages).



**Cyriaque Genet** obtained his PhD in Quantum Physics in 2002 (University Pierre and Marie Curie (UPMC), Paris) working on the Casimir effect under the supervision of Serge Reynaud. He then joined the group "Quantum Optics and Quantum Information" of J.P. (Han) Woerdman in the Huygens Laboratory at Leiden University, Netherlands. In 2004, he was recruited at the French National Center for Scientific Research (CNRS) to join the team of Thomas Ebbesen at the Institute of Supramolecular Science and Engineering (ISIS) in Strasbourg.



**Michel Kurek** is an engineer specialized in computer science, applied mathematics, finance and design, deployment and management of projects with a strong technological and innovation dimension. He has spent more than 25 years in the finance industry and is now involved in the development of the quantum technologies ecosystem. He is Vice Chairman of Feynman Foundation, member of Le Lab Quantique and QuantX.



# SPEAKERS & MODERATORS



**Eddie Smigiel** - Lecturer at INSA Strasbourg where he teaches physics, signal processing and digital electronics. He is a researcher at the Archives Henri Poincaré, AHP-PReST UMR 7117 CNRS, University of Lorraine, University of Strasbourg where he works mainly in physics didactics. His current research focuses on the very early introduction (in high school) of quantum technologies. He is a member of GIREP, the international research group in physics education.



**Alina Holcroft** - Master of Ceremonies - Ambassador of Vulnerables in Tech and Quantum Innovation, Alina is currently in charge of Research at INSA Strasbourg, with the fundamental mission of listening and supporting the research community in their research projects, particularly in technologies and applied science. Alina is also Vice Chairman of the Feynman Foundation, a public utility foundation in Brussels.



**Rachel Guez** - Moderator - Rachel is a manager with extensive experience in organizing and leading teams and networks. With a strong interest in public interest issues, she specializes in social innovation and CSR. At the Feynman Foundation, she is responsible for the coordination of the chapters. The chapters gather actors of the quantum sphere identified in different locations, on which the FF relies to weave links with the local quantum ecosystems.



**Inès Jorge** - Moderator - Inès is a 2019 graduate student in electrical engineering from INSA Strasbourg, who won first prize in the finals of the Great Est Region price for "My thesis in 180 seconds" after a brilliant presentation of her thesis on predictive maintenance of lithium batteries in electric vehicles, which she is conducting as part of the Interreg VEHICLE and HALFBACK projects. Inès Jorge's thesis is directed by Prof. Romuald Boné and supervised by Dr. Tedjani Mesbahi and Dr. Ahmed Samet in the Data Science and Knowledge (DKS) and Heterogeneous Systems and Microsystems (HSM) research teams of the ICube laboratory.





# SUMMARY

In this unique event in Strasbourg on December 6th 2021, Olivier Ezratty present his book “Understanding Quantum Technologies 2021”, its purpose, origin, challenges, original pedagogical content and some “making of” insights in an open discussion with Kaoutar Benlamine, PhD on Quantum Machine Learning.

The event will also feature two panel discussion to offer a perspective on how France and the Grand Est Region are positioned in quantum technologies and its related skills development efforts, in quantum platforms, quantum computing but also in initial training and development of a quantum ecosystem in Grand Est Region.





## EVENT HOSTED BY



INSA Strasbourg is a member of the INSA French network of engineering schools, one of the largest networks with over 80.000 INSA engineers worldwide. INSA Strasbourg is a “Grande École” - an engineering and architecture graduate school under the control of the Ministry in charge of higher education. Its missions are to train engineers and architects in five years (Master Level), to conduct high-level research in science and technology, to provide continuing education for engineers and technicians, to facilitate professional integration and to promote a science and technology-focused culture. Based in Strasbourg, at the centre of Europe, INSA Strasbourg hosts 2000 students.



The QMat “initiative of excellence” is an Interdisciplinary Thematic Institute of the University of Strasbourg and international integrated MSc and PhD program, which empowers the next generation of students, scientists and engineers to shape the future in quantum science and nanotechnology. Each year QMat selects approximately 35 Master students and 10 doctoral researchers to be part of the programme and provides an enhanced curriculum putting them at the forefront of international research at the interfaces between physics, material science, chemistry and engineering.

## IN ASSOCIATION WITH



Agence régionale d'innovation et de prospection internationale. Nous avons été créée en 2018 sous l'impulsion de la Région Grand-Est et de la CCI Grand-Est. Nous comptons aujourd'hui 80 collaborateurs et 7 points de présence sur l'ensemble de la région. Nos deux grandes missions sont d'une part d'accompagner les entreprises et les territoires dans leur projet d'innovation et de transformation et d'autre part de maximiser les implantations d'investisseurs directs étrangers, via des actions de prospection internationale. A ceci se rajoutent des dispositifs que nous opérons au titre la Région : Grand Testeur qui vise à favoriser la transformation des territoires via l'expérimentation, Scale'nov qui a pour objectif d'accompagner des startups dans leur accélération via un programme à la fois collectif et individuel sur une période de 3 ans, ainsi que des appuis financiers et la Commande Publique Grand Est qui a pour objectif de favoriser l'accessibilité des marchés publics aux entreprises, en particulier les TPE-PME. Enfin, l'agence a également pour mission de structurer des filières d'avenir parmi lesquelles l'énergie, l'image ou le numérique.



The Feynman Foundation (FF) is a public utility foundation based in Brussels (BE) and recognized by Royal Decree on September 16, 2021. FF's goal is to contribute to the development of quantum technologies for Humanity in line with the objectives of sustainable development. Progress in Quantum technologies has enabled the emergence of a new generation of devices, which could revolutionize fields as diverse as sensors/metrology, telecommunications and computing. The Feynman Foundation aims to bring the quantum community together and to promote quantum science and technology as a common good by supporting quantum application with high societal impact by privileging open science, open-source software and open hardware.



Founded in 2019, PASQAL develops and markets Quantum Processing Units (QPUs) that have the potential to address complex computing issues, from fundamental science to real-world grand challenges. The company is a spin-out from Institut d'Optique in Palaiseau, one of the leading quantum research centers in the world. Our QPUs are built based on a neutral atom technology. Atoms are added one-by-one. Therefore, the system provides a high flexibility level allowing to investigate different geometries, paving the way towards a Universal Quantum Processor. In addition, our technology is seen as the most scalable one as of today, setting the blueprint for a 1000-qubit processor by 2023. Having proven its ability to address problems that are intractable for classical High-Performance Computers, our technology has now reached a level of maturity allowing its implementation in QPUs which will be commercially available to many end-users. The computational power will be available through appliances in HPC centers and on the cloud with QPUs operated at PASQAL's premises. The QPUs are well suited for applications such as quantum machine learning, optimization and quantum simulation where it has already proven a quantum advantage.

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