

# Basic Science and Quantum technologies

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## Basic science: Revolutions do not announce themselves!

It took 40 years until the ideas of the 2022 Nobel Laureates came to applications and made the EU a key place for quantum science and technology. This would not be possible without strong support for basic science research.

Basic science research is absolutely key for education, outreach, and diversity & inclusion

By doing fundamental research, we educate students differently than if we do mission-oriented applied R&D. This difference is already visible at universities with industry-oriented quantum technology research. Basic-science PhD researchers

- learn how to attack and solve seemingly unsolvable problems
- work independently which prepares them uniquely to become a future CEO or professor
- learn how to cope with “failures” and that they are in fact great opportunities

Basic science attracts the most curious and ingenious students. If we don't educate them properly, we lose many to other continents, for instance in the quantum technology sector that is largely in the hands of multinationals outside the EU.

Outreach is very different from basic science researchers and applied ones - curiosity can be raised in most people, and curiosity can exceptionally well be communicated from basic science researchers. Besides its intrinsic value, basic science provides a nursery for well-trained, yet also flexible, “quantum engineers”, which fills the growing demands of a future quantum industry whose scope is still difficult to predict. Now there is a lack of a quantum workforce, 20 years ago, quantum research was seen as obscure.

Basic science education also enables the foundation for vertical scaling of technology. For example, learning partial differential equations will have implications on quantum, car industry, and even futuristic AI, etcetera.

We do not know which workforce is needed in future - basic science education prepares them best for these unknown challenges!

Diversity & inclusion is strongly increased in basic science research, since players from a broad background and fully EU-wide can participate - many basic research fields do not require access to large cryogenic facilities, for instance.

## Basic science research key for future technology developments

Funding technology development without funding basic science does not work in the long run - semiconductor electronics would not have matured so quickly and replaced mechanical logic or radio

tubes, if quantum mechanics would not have been explored with large efforts decades before - visionary researchers have realized the tremendous potential of electron waves in crystalline lattices. Equally, or even more, basic science research is very much essential for present-day and future quantum technologies - also because it is not yet clear which particular quantum technology will enable breaking the scalability barrier, and different technologies are needed for different quantum technology applications.

Current collaborative R&D quantum technology projects funded by the EU are the result of previous fundamental research funding - to continue this in future, funding of collaborative fundamental research is essential. Breakthroughs need collaboration of complementary fundamental researchers - pan-EU projects are essential, not only ERC-funded projects.

### Basic science funding is effective

Basic science covers areas that are risky but that, when successful, might provide disruptive competitive advantages. For instance, only basic science funding can support the integration of the different quantum platforms toward hybrid architectures that could enhance the pros and mitigate the cons. We all know that the cost of funding basic science is essentially negligible compared to the cost of translating results into high-TRL products. Those responsible for the politics of technology-based economic growth should regard the outputs of basic science as the raw material. Even though it is quite cheap, this raw material is not currently being effectively extracted, in the sense that we are nowhere near saturation: doubling basic science funding from its current level will yield almost twice as much in terms of interesting results that could, in later stages, yield technology-based economic growth.

By keeping basic research alive, Europe shields its strategic agenda in quantum technologies against unexpected upcoming changes of paradigm, and has a chance to introduce such changes itself. In brief, basic science is very likely a good investment even on purely economic grounds.

<https://www.science.org/doi/10.1126/science.aaw2373>