Quantum Delta NL in a nutshell
Why?
- Quantum Technology (QT) is a fundamentally new and game changing technology.
- Applications contribute to sustainable development goals including climate change, health and food production. The expected world market is € 40 – 89 billion in 2040 driven by a limited number of hotspots.
- There’s a unique opportunity for NL to become one of these hotspots and create a new high-tech industry building on our leading position.
- If we act NOW, NL can create 30,000 high-tech jobs and a cumulative BBP impact of € 5 – 7 billion. This aligns with the EU strategy for technological sovereignty.

How?
- QDNL is structured in three technology demonstrators, four generic action lines and shared cleanroom facilities. The program is led by a national organization that connects all parties in the ecosystem.

What?
- QDNL is a comprehensive program to turn the NL into a Silicon Valley for Quantum Technologies. Actions target all aspects of the ecosystem: talent, R&D, entrepreneurship, market creation and societal impact.
- QDNL also refers to the community of people, companies, research centers, government organizations, end users and facilities involved in QT. QDNL aims to break down barriers between these actors and offer an inclusive culture to accelerate growth and collaboration.

Milestones

- **2027**
  - 100 startups, 2000 PhDs and engineers and 3 corporate R&D labs
  - **Budget**
  - 615 M€
Why?
- Quantum computers operate in a way that resembles nature.
- They solve problems out of reach of classical computers such as designing materials and medicine or complex optimization problems.
- With Quantum Inspire (QI) we unlock the power of our quantum computers to the world. End users from industry and society can experiment with state-of-the-art technology.
- The value creation is done on European soil. An early stake is vital for our future competitiveness and technological sovereignty.

How?
- QI as a physical facility is based in Delft. A national team develops the technology and use cases. Promising technology is integrated in the physical platform.
- QI is engaging in European consortia in the context of Digital Europe, the Quantum Flagship and EuroHPC.
- QI runs on promising quantum processors, including spin qubits and superconducting qubits, and can be integrated with classical supercomputers at SURF.

What?
- QI is the first European Quantum Computer available in the cloud, accessible to all:  www.quantuminspire.com
- QI showcases promising tech solutions for the entire stack of quantum computing.
- QI develops the market: end users get hands-on experience and co-create use cases with QDNL experts.

**Milestones**

<table>
<thead>
<tr>
<th>Budget</th>
<th>2024</th>
<th>2027</th>
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<tbody>
<tr>
<td>90M €</td>
<td>Applications in chemistry and energy</td>
<td>100 end users</td>
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CAT 1: Quantum computer
Action Line 1: Research and innovation

Why?
- The development of quantum technology in the Netherlands is supported by a solid basis of innovative research.
- Continued funding in research and innovation is crucial to ensure a pipeline of new ideas and tech solutions and to guarantee that the Netherlands stays at the international forefront of this highly competitive field.

How?
- NWO will issue yearly ‘thematic’ open calls where all Dutch quantum researchers can apply.
- The target is to solidify and strengthen the basis of the CAT programs. Fundamental research from this action line can grow into technology development within the CATs.
- Young talent is stimulated to apply and multidisciplinary collaboration with humanities is encouraged.

What?
- Research projects that cover quantum computing, quantum networking, quantum sensing, quantum simulation, quantum algorithms and post-quantum cryptography.
- The research will be aligned with the European Quantum Flagship. Collaborative research with groups in the US or Japan will be made possible.

Milestones
- 2027
  - NL scientific position nr.1 (now 3)

Budget
- 42 M€
Action Line 1: Research and innovation
CAT 2: Quantum network

Why?
- Sending quantum information and linking quantum systems enables fundamental secure communication.
- Quantum networks will ensure our digital sovereignty by connecting banks, governments entities, hospitals and other critical infrastructures.
- The quantum network (QN) provides the fundament for the next generation digital infrastructure.
- The NL are in a unique position to realize the QN now with leadership in science and in existing digital infrastructures.

How?
- A first of its kind physical infrastructure that connects multiple quantum processors.
- QN consists of the latest quantum-hardware and -software and serves as national testbed for new applications such as secure online quantum computing.
- QN will be open for users to learn, engage with and validate industrial applicability of quantum technology.
- QN will connect other EU networks within the context of EuroQCI and the Quantum Flagship using fiber and satellite links.

What?
The network will consist of three pillars:
- R&D network to develop hardware and software, integrate key components and assess innovation in the concept phase.
- Operational network based on state-of-the-art technology. Due to the open character of this physical network players from all sectors can connect, develop and test their hardware, software and/or applications.
- Quantum network construction support for commercial roll-out of quantum networks and services.

Milestones

<table>
<thead>
<tr>
<th>Year</th>
<th>Milestone</th>
<th>Budget</th>
</tr>
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<tbody>
<tr>
<td>2023</td>
<td>QN with 3 quantum processors</td>
<td>62M€</td>
</tr>
<tr>
<td>2026</td>
<td>QN with ≥ 5 quantum nodes</td>
<td></td>
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</tbody>
</table>
CAT 2: Quantum network
Action Line 2: Quantum ecosystem

Why?
- New business is born in a climate where talent, knowledge and funding meet under the right conditions. Such an innovative ecosystem requires stimulation, fostering and acceleration.

How?
- A new “House of Quantum” is the focal point of the ecosystem as part of a national campus with topnotch lab and office facilities.
- A national valorization team for tech transfer and a flexible IP policy. The SME program and local field labs stimulate end users and industry to engage.
- An ambitious startup program to incubate and accelerate 100 startups, including facilities for (pre)seed capital that allows scale up in Europe.

What?
- An inspiring environment where the entire community of students, researchers, entrepreneurs and investors co-create without barriers and restrictions.
- Excellent conditions to innovate: shared facilities and housing, IP framework and funding mechanisms for incubation and commercialization of ideas.

Budget 182M€
Milestones
2024
Opening of House of Quantum
100 startups and 125 engaged European companies
Action Line 2: Quantum ecosystem
CAT 3: Quantum sensors

**Why?**
- Quantum sensing leads to better MRI methods, new atomic clocks to monitor earth and climate change, localization without satellites and many more applications.
- Quantum sensing is the low hanging fruit of quantum technologies: first generation applications already exist and further innovations can reach the market soon.

**How?**
- Foster an ecosystem of technology developers and end users to create new applications from TRL 4 and higher.
- Via open calls new components for quantum sensors are developed.
- When operational, public private partnerships will be started to accelerate industrialization.

**What?**
A testbed for the most promising applications of quantum sensors:
- Sensors based on ultracold atoms used for clocks, network synchronization, soil research and navigation (this links with Photondelta).
- Spin based sensors such as gyroscopes, magnetometers, scanning-probe and nano MRI tools.
- Sensors relevant for the defense and security.
- Mechanical sensors used for measurement of pressure, temperature, voltage, mass and g-forces in navigation.

**Milestones**
- **2025**: 20 new identified products
- **2027**: > 60 companies and 25 startups involved

**Budget**
- **29 M€**
CAT 3: Quantum sensors
**Action Line 3: Human capital**

**Why?**
- Talent is the motor of Quantum Delta NL.
- Education is crucial to maintain scientific excellence, attract international top talent and educate the quantum workforce of the future.
- Complement academic talent with practical education to ensure technology transfer towards industry and application in society.

**How?**
- Create quantum technology courses at all educational levels with targeted and one-off impulses.
- Develop Learning & Talent Centers that will connect educational institutions with each other and with the industry.
- Recruit international top talent for key positions in the ecosystem.

**What?**
- A strong university base: new quantum Minor and Master tracks.
- Arouse interest in the youngest generation and realize more HBO- and MBO-education tracks.
- Additional possibilities for (international) top talent and sabbaticals in NL for scientists, industrialists, entrepreneurs and investors.

**Budget**

<table>
<thead>
<tr>
<th>2023</th>
<th>2027</th>
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<tbody>
<tr>
<td>One entry-pass to the complete QDNL</td>
<td>2500 graduated students per year</td>
</tr>
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</table>
Action Line 3:
Human capital
Cleanroom facilities

Why?
- Cleanroom facilities are too expensive for individual research centers or (startup) companies to deploy.
- NanoLabNL provides the essential facilities for nanofabrication, with cleanrooms at five locations in NL.
- NanoLabNL is essential for Quantum Delta NL. Other technology fields such as health, space, semicon and photonics will also benefit from the facilities.

How?
- Renew the machinery of NanoLabNL by focusing on local quantum ecosystems in Delft, Eindhoven, Twente, Groningen and Amsterdam.
- Link with the startup and SME support programs from AL-2.

What?
- Renew equipment and machinery to the latest state-of-the-art and to advancements in quantum device manufacturing.
- Investments to ready the NanoLab facilities for higher technology readiness levels.
- Easy and flexible access for the scientific and commercial QT user community, including startups.

Milestones

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
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<tbody>
<tr>
<td>2021</td>
<td>Final plan for high-TRL investments</td>
</tr>
<tr>
<td>2023</td>
<td>&gt; 50% of base infra tendered and procured</td>
</tr>
</tbody>
</table>

Budget $150M€
Cleanroom facilities
Action Line 4: Societal impact

Why?
- To make the Netherlands “Quantum Ready” attention is needed for the ethical, legal and societal aspects of quantum technology.
- Opportunity to engage society and create ground rules for safe and sustainable use of QT. NL can play an international pioneering role to address these aspects early on.

How?
- Collaboration in the quadruple helix – science, industry, government and society, and evidence-based interventions, are at the heart of the ELSA action line.
- The Living Lab QT and Society builds on research collaborations between universities, the public and private sector and is based in the House of Quantum.

What?
- A Living Lab QT and Society with two new interdisciplinary university positions.
- A desk that guides questions from society and industry with a practical toolkit for responsible innovation and entrepreneurship.
- Covenant signed by private and public entities for sustainable and safe use of QT.

Milestones
- **Budget** 20M€
- **2021** Living Lab QT and Society founded
- **2025** Covenant for ethical and sustainable use of QT
Action Line 4:
Societal impact
Who is Quantum Delta NL?

- A broad team from scientific, technological, business and policy communities took the initiative for the National Agenda Quantum Technology in 2019 supported by the entire national field.
- In 2020 the team was institutionalized in a newly formed foundation Quantum Delta NL. This foundation is mandated to coordinate and execute the National Agenda including its starting grant of 23M€.
- In December 2020 the foundation submitted the complete execution program to the National Growth Fund, accompanied with around 80 letters of support.
- Explicit attention is given to the diversity challenge that is deeply rooted in this technological field.

**Executive and Supervisory board Quantum Delta NL**

Carlo Beenakker (Lorentz Instituut, aQa), Frank Dirne (TU/e, NanoLabNL), Freeke Heijman (Quantum Delta NL, QuTech), Guus Rijnders (UT, NanoLabNL), Jesse Robbers (Quantum Delta NL, TNO), Job Nijs (Braventure), Kareljan Schoutens (QuSoft), Nils Beers (Techleap), Rogier Verberk (TNO), Ronald Hanson (QuTech), Ronny van ‘t Oever (MinacNed, NanoNextNL), Servaas Kokkelmans (QT/e).

**Team members**

Anneke Verkerk (TU Delft), Erwin Buitelaar (Quantum Delta NL), Hugo Gelevert (TNO), Ingrid Romijn (QuTech), Irene Rompa (Quantum Delta NL), Jenny Boks (QuTech), Nynke Minnema (MinacNed), Ton van’t Noordende (PHX), Ulrich Mans (Quantum Delta NL), Victor Land (QuSoft), Wieteke de Boer (NWO).

[www.quantumdelta.nl](http://www.quantumdelta.nl)