

SWElife
Innovation Programme for Life Science

WACQT



LUND
UNIVERSITY

AstraZeneca

Swedish Quantum Life Science Centre

2023-10-27

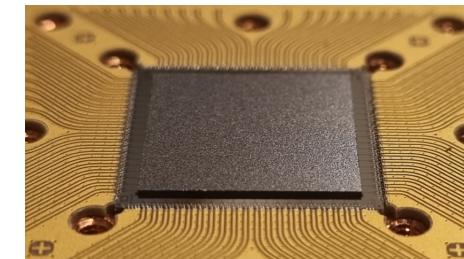
Ebba Carbonnier
Director

Agenda

- **Why** Quantum Life Science?

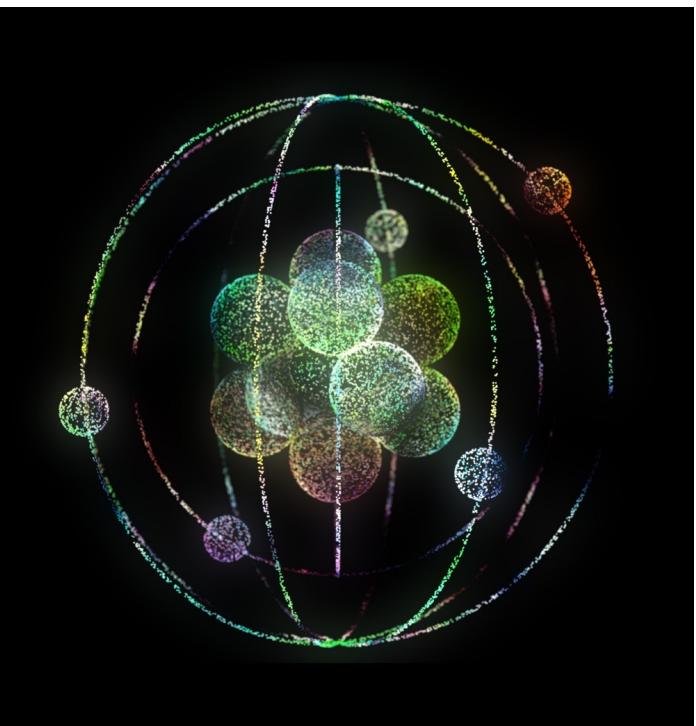
- **Where?**

- **How?**
 - Examples of our Quantum Life Science projects

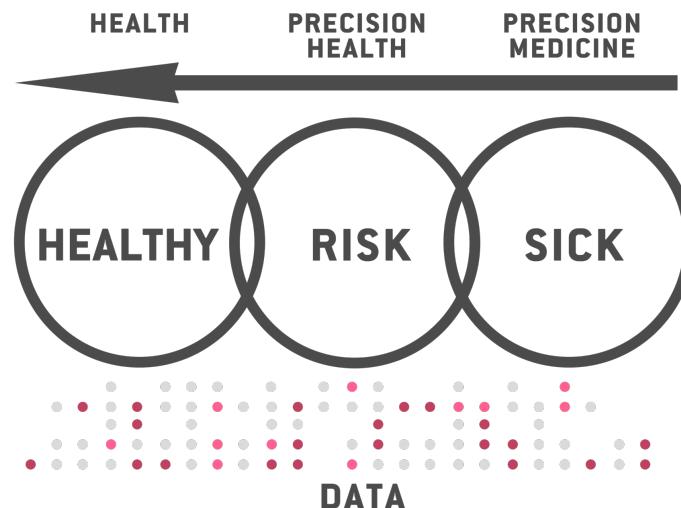


Background - why QLS?

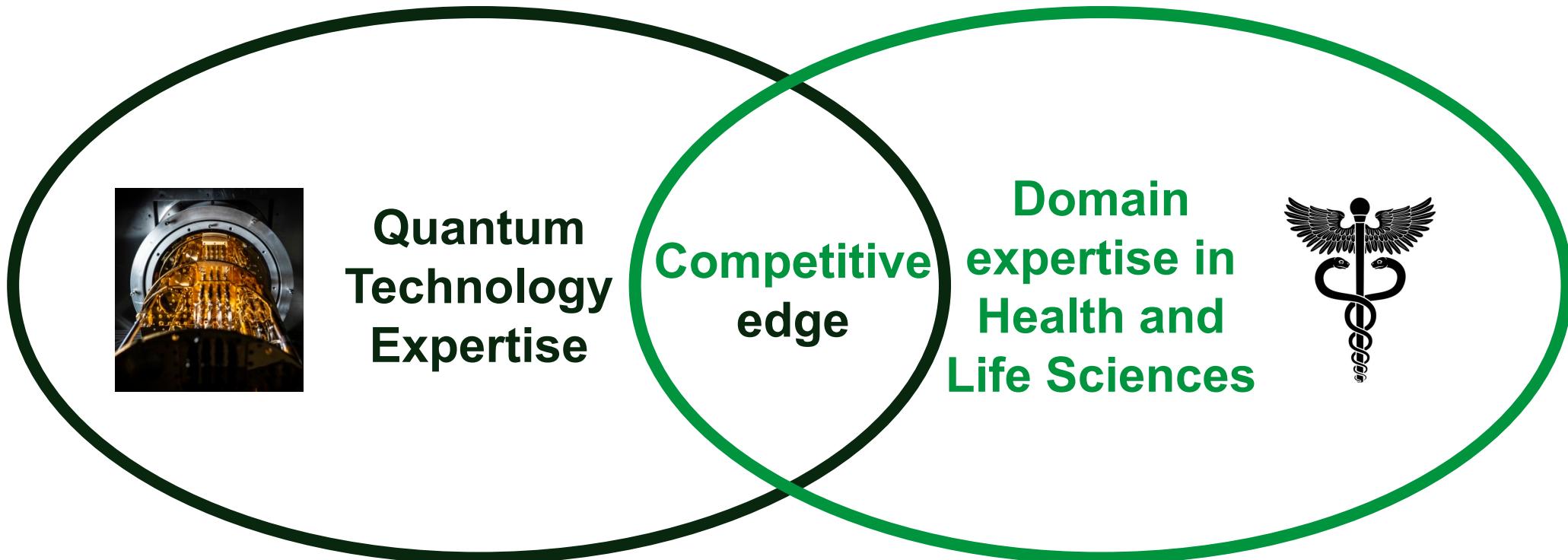
Quantum Mechanics as the
Operating System of
Nature



Highly relevant for
understanding our
molecular biological
processes



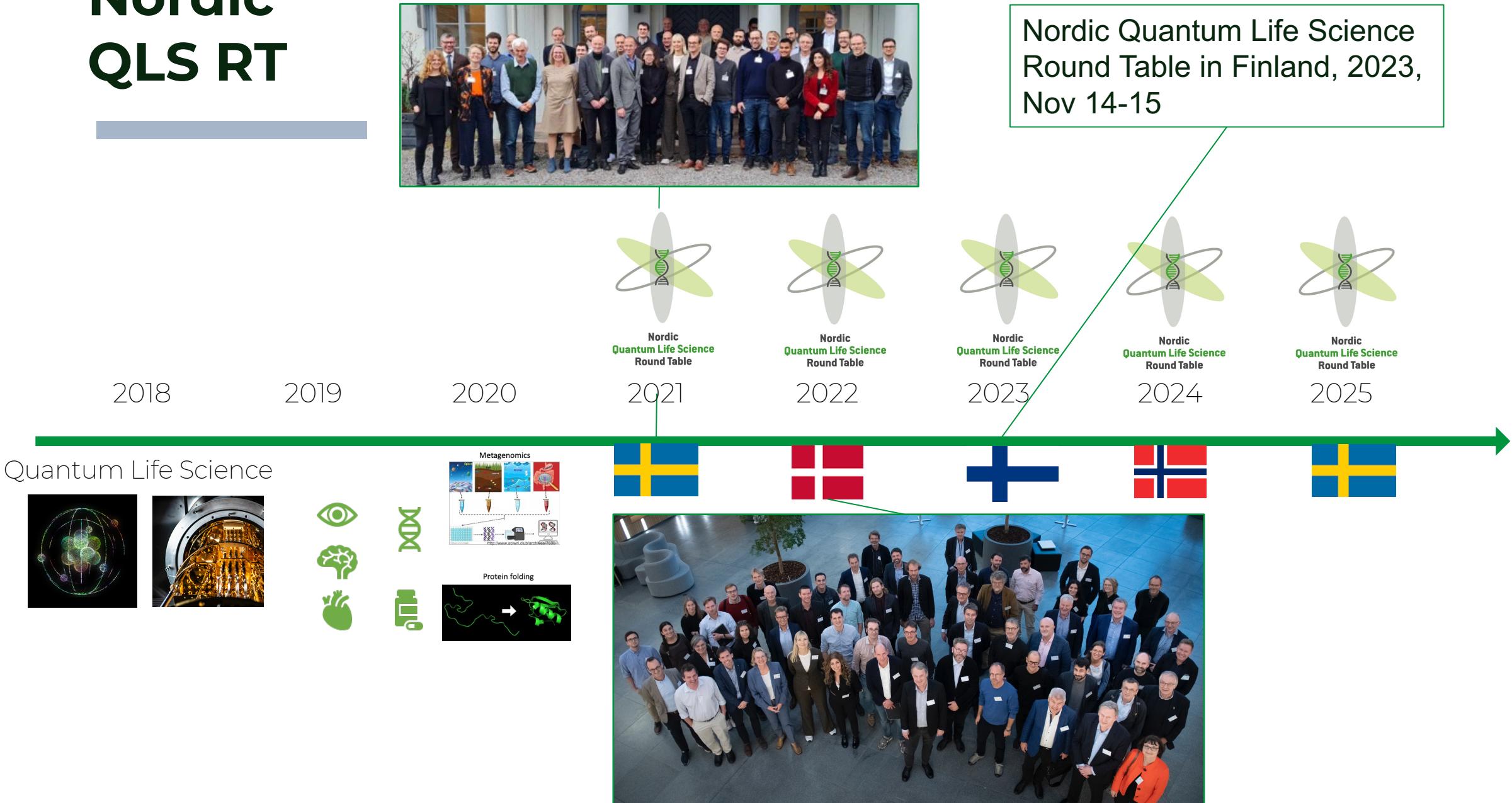
Why Quantum Life Science in Sweden?



Quantum Life Science World Wide



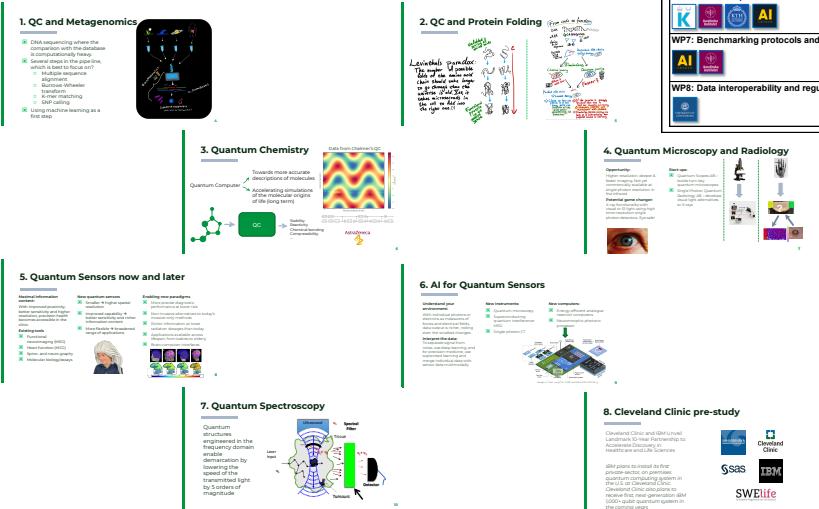
Nordic QLS RT



Fast facts Swedish QLS Centre

Goal: development of Quantum Life Science (QLS) applications

Eight QLS projects in Sweden



| Title | Name | Organization |
|--|---------------------------------|-----------------------|
| Executive Director, Head of C | Anders Broo | AstraZeneca |
| Professor | Anders Irbäck | Lund university |
| MD Professor, Director Sahlgrenska University Hospital | Sahlgrenska University Hospital | |
| MD Professor, Dean North | Anna Marttila | KI and K |
| Professor | Carsten Petersen | Lund university |
| Associate professor, Director Lundquist | Lundquist | KI |
| Director QLS Centre SE | Ebbe Carboneer | Swelife and KI |
| Professor | Erik Aurell | KTH |
| Professor, PI WACQT | Göran Johansson | WACQT/Chalmers |
| Professor | Göran Wendin | WACQT/Chalmers |
| QLS PhD student | Hanna Linn | WACQT/Chalmers |
| Director of R&D | Johannes Swartling | Spectracure |
| Project Manager | Justin Schneiderman | Chalmers/GU |
| Strategic Communication | Karin Lilja | Swelife |
| MD PhD | Karin Westin | KI and K |
| Research Scientist | Laura García-Alvarez | WACQT/Chalmers |
| Professor | Magnus Boman | KI and KTH |
| Associate professor | Martin Rahm | WACQT/Chalmers |
| CTO | Mikael Haglund | IBM |
| QLS Industrial PhD student | Mårten Skogh | WACQT/AstraZeneca |
| Head of GMS Data | Pek Sikora | Göteborgs universitet |
| MD Professor | Per-Olof Berggren | KI |
| Science writer | Puni Rajah | SAS Institute |
| Professor | Stefan Kröll | Lund university |
| Professor | Val Zwilfer | KTH |
| QLS PhD student | Vilma Canforde | Göteborgs universitet |

QLS Centre Leadership

- **Anna Martling - Steering Committee**
Professor and Dean of KI North at Karolinska Institutet, Senior Consultant at Karolinska University Hospital
 - **Anna-Marie Wennberg Larkö - Steering Committee**
Professor at University of Gothenburg, Hospital Director at Sahlgrenska University Hospital
 - **Daniel Lundqvist - Chair Steering Committee**
Associate Professor and Director of Centre for Imaging Research (CIR) at Karolinska Institutet
 - **Göran Johansson - Steering Committee**
Professor at Chalmers, PI at Wallenberg Center for Quantum Technology
 - **Magnus Boman - Steering Committee**
Professor at KTH, AI@KI Consultant at Karolinska Institutet

Ebba Carbonnier - Director, Swedish Quantum Life Science Centre



SE QLS Companies

- 1. SpectraCure
- 2. Deep Light Vision
- 3. Quantum Scopes
- 4. SPQR
- 5. AstraZeneca

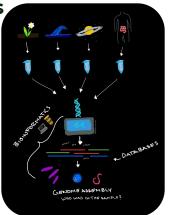


Eight QLS projects in Sweden

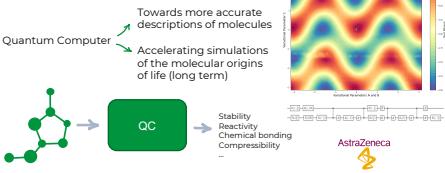


1. QC and Metagenomics

- DNA sequencing where the comparison with the database is computationally heavy
- Several steps in the pipe line, which is best to focus on?
 - Multiple sequence alignment
 - Burrows-Wheeler transform
 - K-mer matching
 - SNP calling
- Using machine learning as a first step



3. Quantum Chemistry



5. Quantum Sensors now and later

- Maximal information content:**
With improved proximity, better sensitivity and higher resolution, precision health becomes accessible in the clinic.
- Existing sensors:**
- Pulsed functional magnetic resonance imaging (fMRI)
 - Heart function (MCG)
 - Spin- and neuro-graphy
 - Molecular biology/assays

- New quantum sensors:**
- Smaller → higher spatial resolution
 - Improved capability → better sensitivity and richer information content
 - More flexible → broadened range of applications

- Enabling new paradigms:**
- More precise diagnostic performance at lower risk
 - Non-invasive alternatives to today's invasive methods
 - Lower energy requirements at lower radiation doses than today
 - Applications available across lifespan, from babies to elderly
 - Brain-computer-interfaces



7. Quantum Spectroscopy

Quantum structures engineered in the frequency domain enable demarcation by lowering the speed of the transmitted light by 5 orders of magnitude



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2. QC and Protein Folding

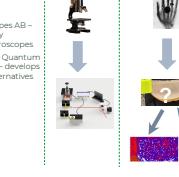
Levinthal's Paradox:
The number of possible folds of the amino acid chain should take longer to go around than the universe is old. Yet, it takes microseconds in the cell to fold into the right one. [1]



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4. Quantum Microscopy and Radiology

- Opportunity:**
Higher resolution, deeper imaging. Not yet commercialized, but available at single photon resolution in the infrared.
- Potential game changer:**
New functionality with visual or IR light using high time-resolution single photon detectors. Eye safe!



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6. AI for Quantum Technology

Understand your environment:

With individual photons or electrons as mediators of forces and physical fields, data output is richer, noting even the smallest changes

Interpret the data:

To keep up with the noise, use deep learning, and for precision medicine, use supercomputers and merge individual data with sense data multimodally

New instruments:

Quantum microscopy
Superconducting quantum interference MEG
Single-photon CT

New computers:

Energy-efficient analogue reservoir computers
Neuromorphic photonic processor

Single-photon CT

https://doi.org/10.1371/journal.pone.0257949.g002

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8. Cleveland Clinic pre-study

Cleveland Clinic and IBM Unveil Landmark 10-Year Partnership to Accelerate Discovery in Healthcare and Life Sciences



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Thank you from the Swedish QLS Centre!

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Ebba Carbonnier, MSc MBA
 Director
 Quantum Life Science Centre
 Karolinska Institutet
 +46 730 82 56 54
ebba.carbonnier@ki.se

Portfolio Manager, Swelife
 +46 730 82 56 54
ebba.carbonnier@swelife.se
www.swelife.se





Swedish
Quantum
Agenda



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VINNOVA

Vetenskapsrådet

WACQT | Wallenberg Centre for
Quantum Technology

