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LUND  
UNIVERSITY



AstraZeneca



**SWELife**  
Innovation Programme for Life Science

# Swedish Quantum Life Science Centre

2023-10-27

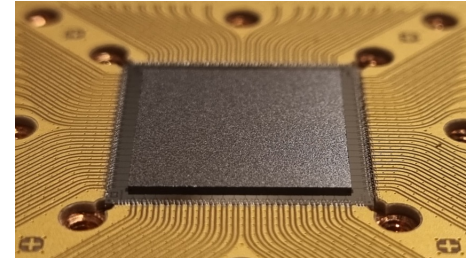
Ebba Carbonnier  
Director

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# Agenda

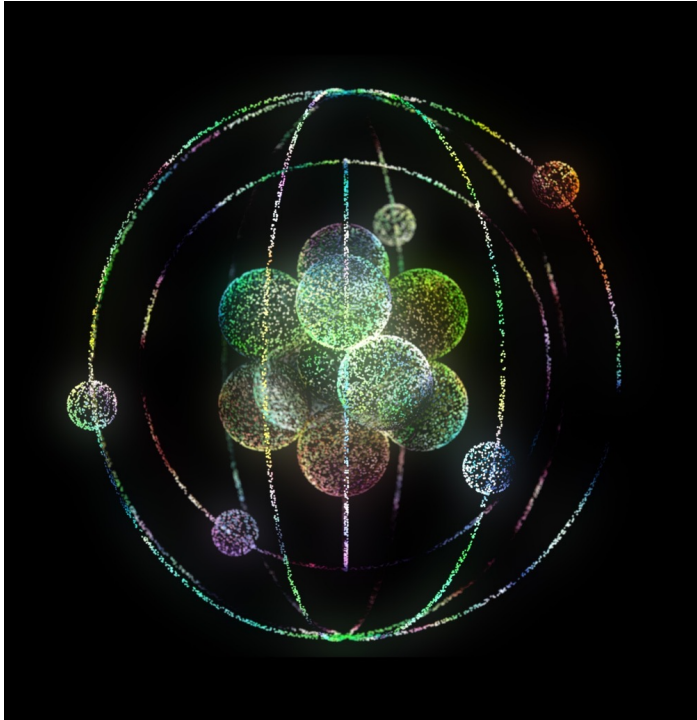
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- **Why** Quantum Life Science?
- **Where?**
- **How?**
  - Examples of our Quantum Life Science projects

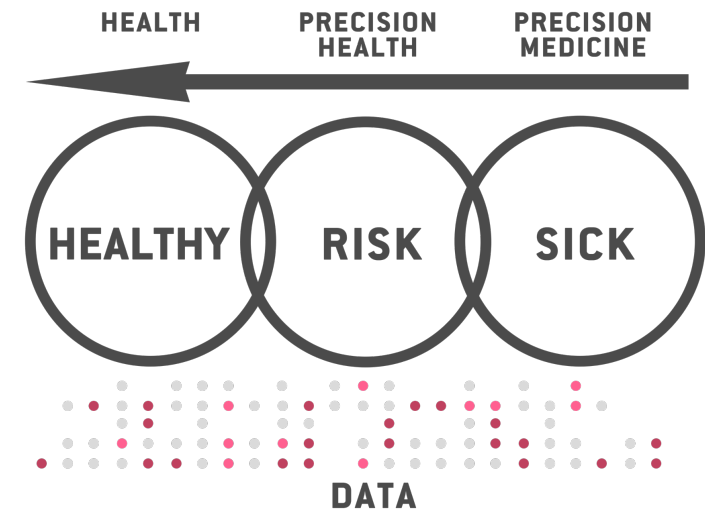


# Background - why QLS?

Quantum Mechanics as the Operating System of Nature

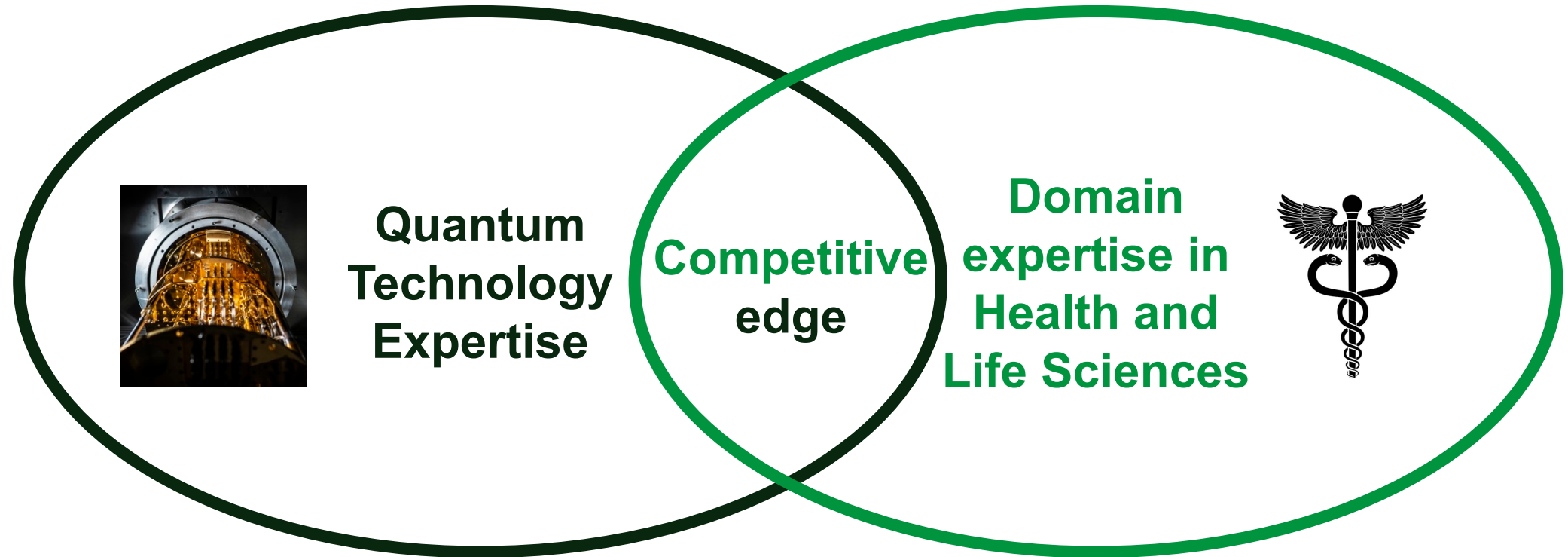


Highly relevant for understanding our molecular biological processes



# Why Quantum Life Science in Sweden?

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# Quantum Life Science World Wide

CC Prestudy 

























Nordic Quantum Life Science Round Table







 QLS Centre

SE QLS Companies

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







# Nordic QLS RT



Nordic Quantum Life Science Round Table in Finland, 2023, Nov 14-15



Nordic Quantum Life Science Round Table

2021



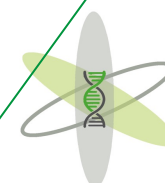
Nordic Quantum Life Science Round Table

2022



Nordic Quantum Life Science Round Table

2023



Nordic Quantum Life Science Round Table

2024



Nordic Quantum Life Science Round Table

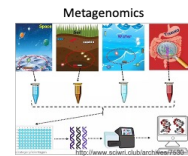
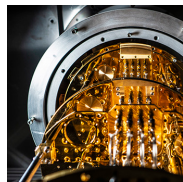
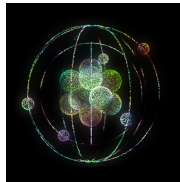
2025

2018

2019

2020

Quantum Life Science



Protein folding



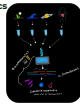
# Fast facts Swedish QLS Centre

Goal: development of Quantum Life Science (QLS) applications

## Eight QLS projects in Sweden

### 1. QC and Metagenomics

- 1. DNA sequencing where the comparison with the reference is computationally heavy
- 2. Search space in the quantum
- 3. Multiple quantum algorithms
- 4. Quantum hardware
- 5. Quantum software
- 6. Quantum hardware
- 7. Quantum software
- 8. Quantum hardware



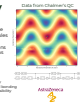
### 2. QC and Protein Folding

- 1. Protein folding
- 2. Quantum simulation
- 3. Quantum hardware
- 4. Quantum software
- 5. Quantum hardware
- 6. Quantum software
- 7. Quantum hardware
- 8. Quantum software



### 3. Quantum Chemistry

- 1. Quantum chemistry
- 2. Quantum simulation
- 3. Quantum hardware
- 4. Quantum software
- 5. Quantum hardware
- 6. Quantum software
- 7. Quantum hardware
- 8. Quantum software



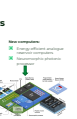
### 5. Quantum Sensors now and later

- 1. Quantum sensors
- 2. Quantum simulation
- 3. Quantum hardware
- 4. Quantum software
- 5. Quantum hardware
- 6. Quantum software
- 7. Quantum hardware
- 8. Quantum software



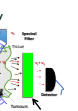
### 6. AI for Quantum Sensors

- 1. AI for quantum sensors
- 2. Quantum simulation
- 3. Quantum hardware
- 4. Quantum software
- 5. Quantum hardware
- 6. Quantum software
- 7. Quantum hardware
- 8. Quantum software



### 7. Quantum Spectroscopy

- 1. Quantum spectroscopy
- 2. Quantum simulation
- 3. Quantum hardware
- 4. Quantum software
- 5. Quantum hardware
- 6. Quantum software
- 7. Quantum hardware
- 8. Quantum software



### 8. Cleveland Clinic pre-study

- 1. Cleveland Clinic pre-study
- 2. Quantum simulation
- 3. Quantum hardware
- 4. Quantum software
- 5. Quantum hardware
- 6. Quantum software
- 7. Quantum hardware
- 8. Quantum software



Workpackages & Deliverables	2022			2023			2024			2025			2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>WP1: QLS Milieu management</b>																
Conferences	1.2				1.3				1.4				1.5			
Reports					1.7	1.8			1.9				1.10			
Processes & prestudy					1.12	1.13	1.14									
<b>WP2: Quantum microscopes</b>																
Quantum microscope 1	2.1				2.2				2.3				2.4			
Quantum microscope 2		2.4							2.5				2.6			
Quantum microscope 3									2.7				2.8			
<b>WP3: Quantum spectroscopy</b>																
System development					3.1, 3.2				3.3				3.4			
Phantom measurements									3.4				3.5			
Human measurements									3.6				3.7, 3.8			
<b>WP4: Quantum in-vivo imaging</b>																
Methods development	4.1				4.2				4.3				4.4			
Human measurements									4.4				4.5			
AI-based methods									4.4				4.5			
<b>WP5: Quantum Computing</b>																
Surveys & overview	5.1				5.2				5.3				5.4			
Proof of concept/principle									5.4				5.5			
Utilization									5.4				5.5			
<b>WP6: Neuromorphic and AI methods</b>																
Algorithms	6.1								6.3				6.4			
Reservoirs					6.2				6.3				6.4			
Reports & plans	6.8				6.5				6.6				6.7			
<b>WP7: Benchmarking protocols and health economy</b>																
Reports	7.1				7.2				7.3				7.4			
Evaluation & benchmarking					7.6				7.7				7.8			
Impact & sustainability	7.10															
<b>WP8: Data interoperability and regulatory aspects</b>																
Sustainability & economy	8.1								8.5				8.6			
Reports	8.3, 8.8				8.4				8.5				8.6			
Networks	8.9				8.10								8.7, 8.10			

Title	Name	Organization
Executive Director, Head of	Anders Broo	AstraZeneca
Professor	Anders Irbäck	Lund university
MD Professor, Director Sahlgrenska U. Hospital	Ann-Marie Wennberg	Sahlgrenska U. Hospital
MD Professor, Dean North	Anna Martling	Ki and K
Professor	Carsten Petersen	Lund university
Associate professor, Director	Daniel Lundqvist	Ki
Director QLS Centre SE	Ebba Carbonnier	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 Schneideman	Chalmers/GU
Strategic Communication	Karin Lilja	Swelife
MD PhD	Karin Westlin	Ki and K
Research scientist	Laura Garcia-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	Per Sikora	Göteborgs universitet
MD Professor	Per-Olof Berggren	Ki
Science writer	Punit Rajah	SAS Institute
Professor	Stefan Kröll	Lund university
Professor	Val Zwilller	KTH
QLS PhD student	Vilma Canfjorden	Göteborgs universitet

## SE QLS Companies

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

## QLS Centre Leadership

- **Anna Martling - Steering Committee**  
Professor and Dean of KI North at Karolinska Institutet, Senior Consultant at Karolinska University Hospital
- **Ann-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

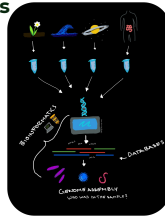


# Eight QLS projects in Sweden



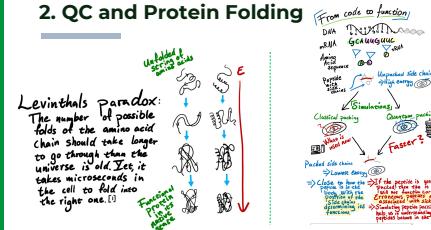
## 1. QC and Metagenomics

- 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



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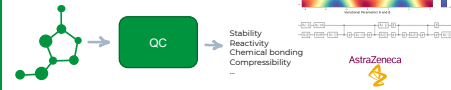
## 2. QC and Protein Folding



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## 3. Quantum Chemistry

Quantum Computer → Towards more accurate descriptions of molecules  
Accelerating simulations of the molecular origins of life (long term)



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## 4. Quantum Microscopy and Radiology

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

- Start-ups:**
- Quantum Scopes AB – builds turn-key quantum microscopes
  - Single Photon Quantum Radiology AB – develops visual light alternatives to X-rays



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## 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 tools

- Functional neuroimaging (MEG)
- Heart function (MCC)
- Spino- and neuro-graphy
- Molecular biology/assays

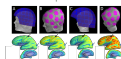
### New quantum sensors

- 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-only methods
- Richer information at lower radiation dosages than today
- Applications available across lifespan, from babies to elderly
- Brain-computer-interfaces



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## 6. AI for Quantum Technology

### Understand your environment:

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

### Interpret the data:

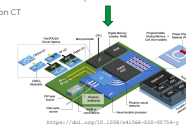
To separate signal from noise, use deep learning and for precision medicine, use supervised learning and merge individual data with sensor data multimodally.

### New instruments:

- Quantum microscopy
- Superconducting quantum interference MEG
- Single-photon CT

### New computers:

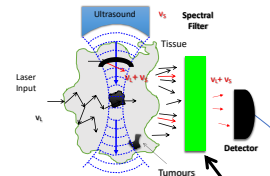
- Energy-efficient analogue reservoir computers
- Neuromorphic photonic processor



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## 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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## 8. Cleveland Clinic pre-study

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



IBM plans to install its first private-sector, on-premises quantum computing system in the U.S. at Cleveland Clinic. Cleveland Clinic also plans to receive first, next-generation IBM 1,000+ qubit quantum system in the coming years.

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# Thank you from the Swedish QLS Centre!

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Quantum  
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 Vetenskapsrådet

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Quantum Technology

