QUANDELA

From Science to Production

Jean Senellart, Chief Product Officer

Agenda

01 → Quandela, People Achievements so far

02 → A clear roadmap

03 → Breaking down challenges

04 → Pushing Integration

05 → Using Data

06 → Building Alliances

07 → Preparing for next next gen

08 → Conclusion

Photonic Quantum Computing leader in EU

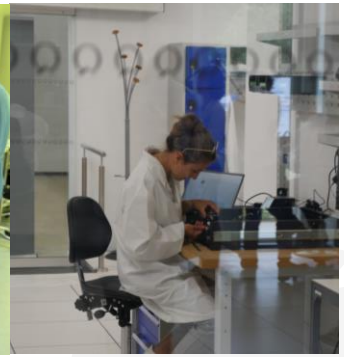
with a large team of experts in quantum photonic technologies

100 people dedicated to photonic quantum computing
>60 PhDs and engineers in algorithms, semiconductors, photonics

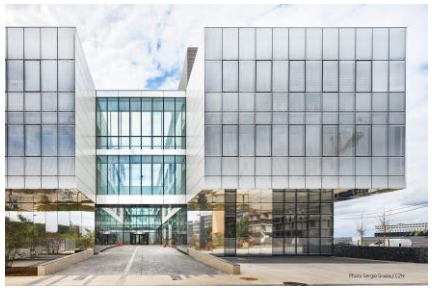
La FRENCH TECH

QUANDELA





R&D Centers




Production Centers


Offices based in
Paris
Munich
Seoul
Montreal

MosaiQ

Looking back at achievements

First Lab Prototype

TOWARD FTQC

Cloud operation
92%
of availability

- *First Fully Integrated*
- *Application Specialized*
- *Fully Upgradable*

2021 **Achernar**

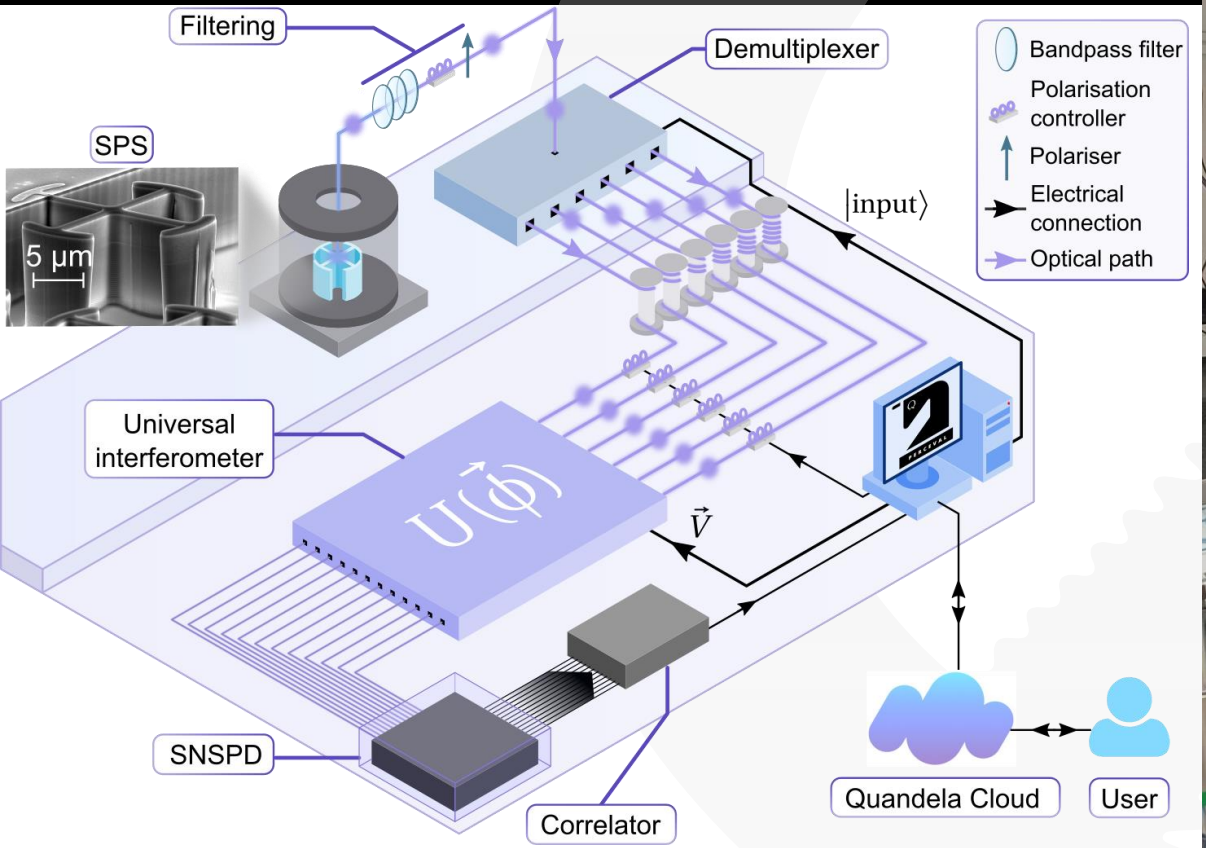
2022 **Ascella** - 6 qubits

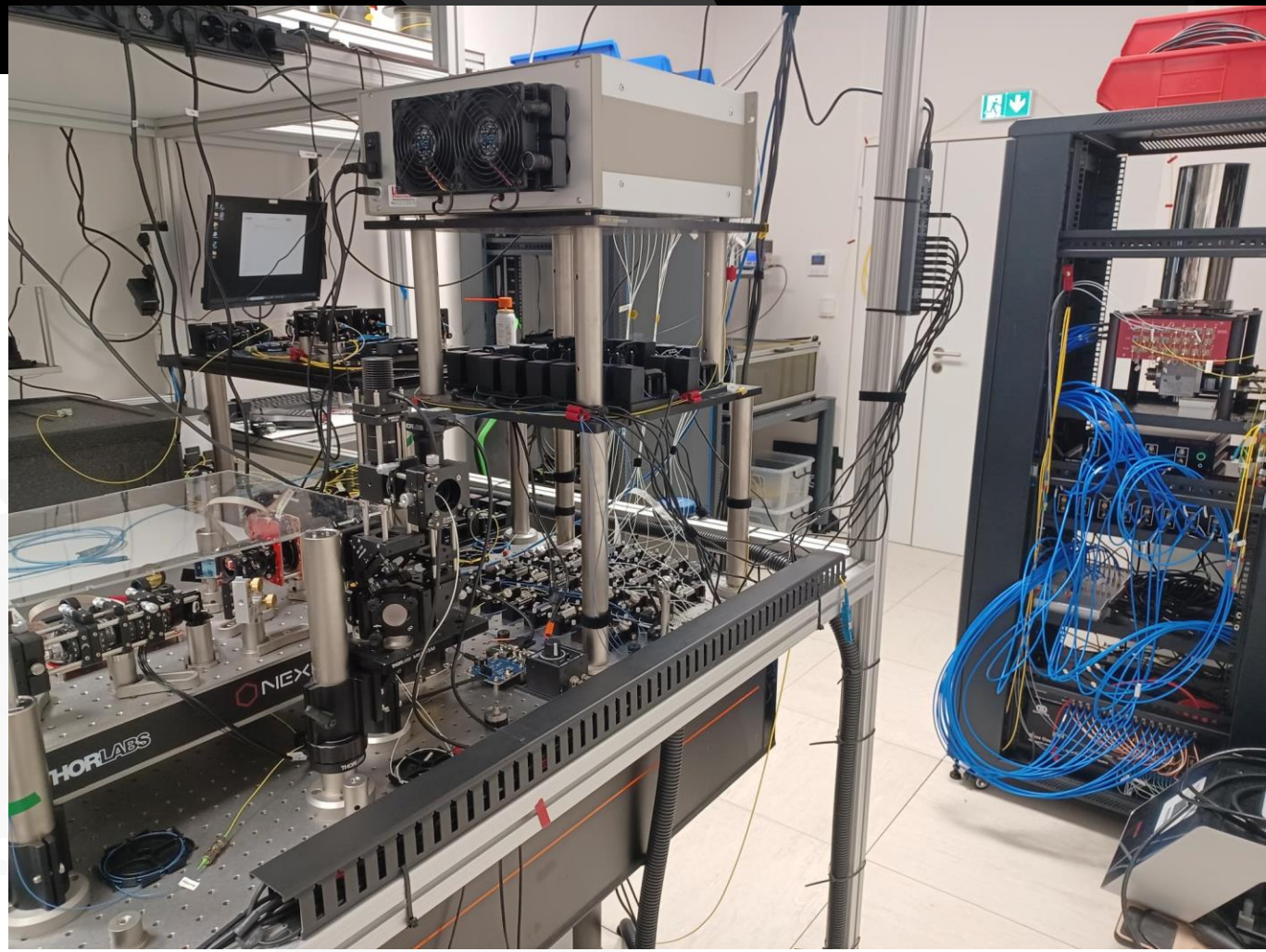
2023 **α-Crucis** - QRNG
Altair – 10 qubits QML

2024 *Production * 2*
Bélénos - 12 qubits

MosaiQ Industrialization Roadmap

2022 - First generation – Lab prototype



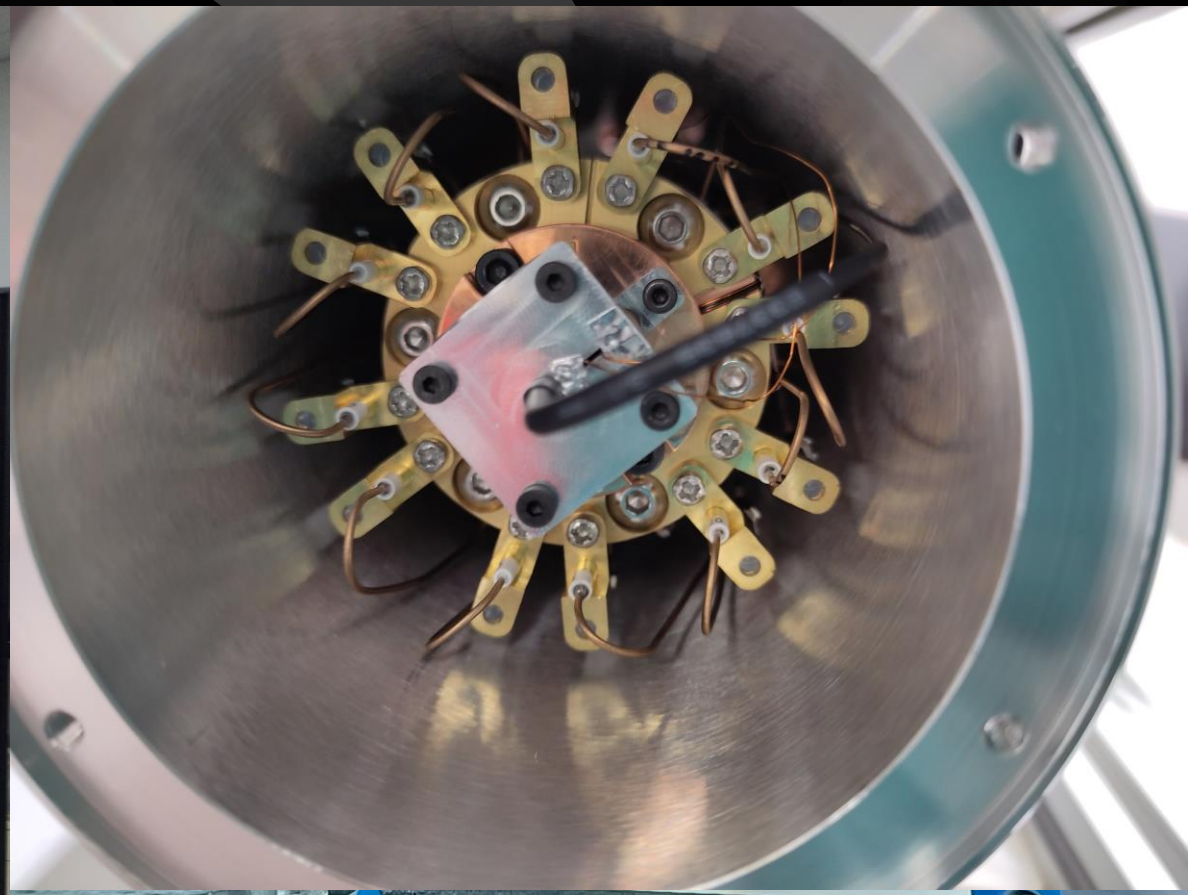


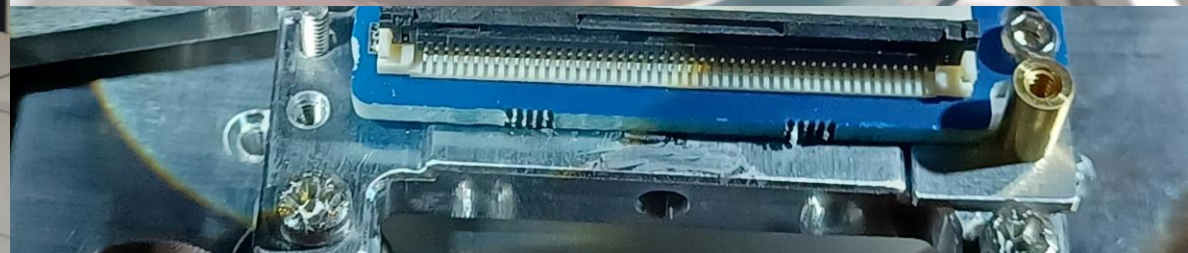
MosaiQ Industrialization Roadmap

2023 - Second generation – Data center compatibility

MosaiQ Industrialization Roadmap

2024 - Third generation - Modularity





A clear roadmap

Based on hard science

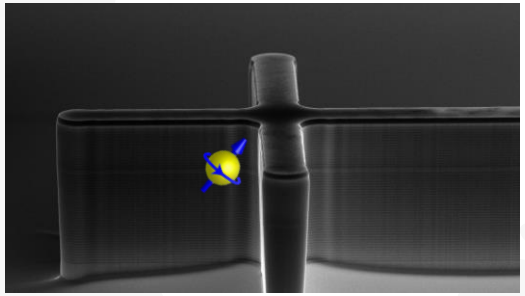
with quantitative and qualitative milestones

A clear roadmap

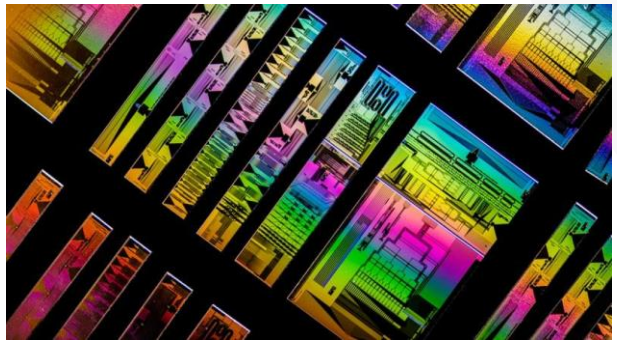
Based on Hard Science

A Spin-Optical Quantum Computing Architecture

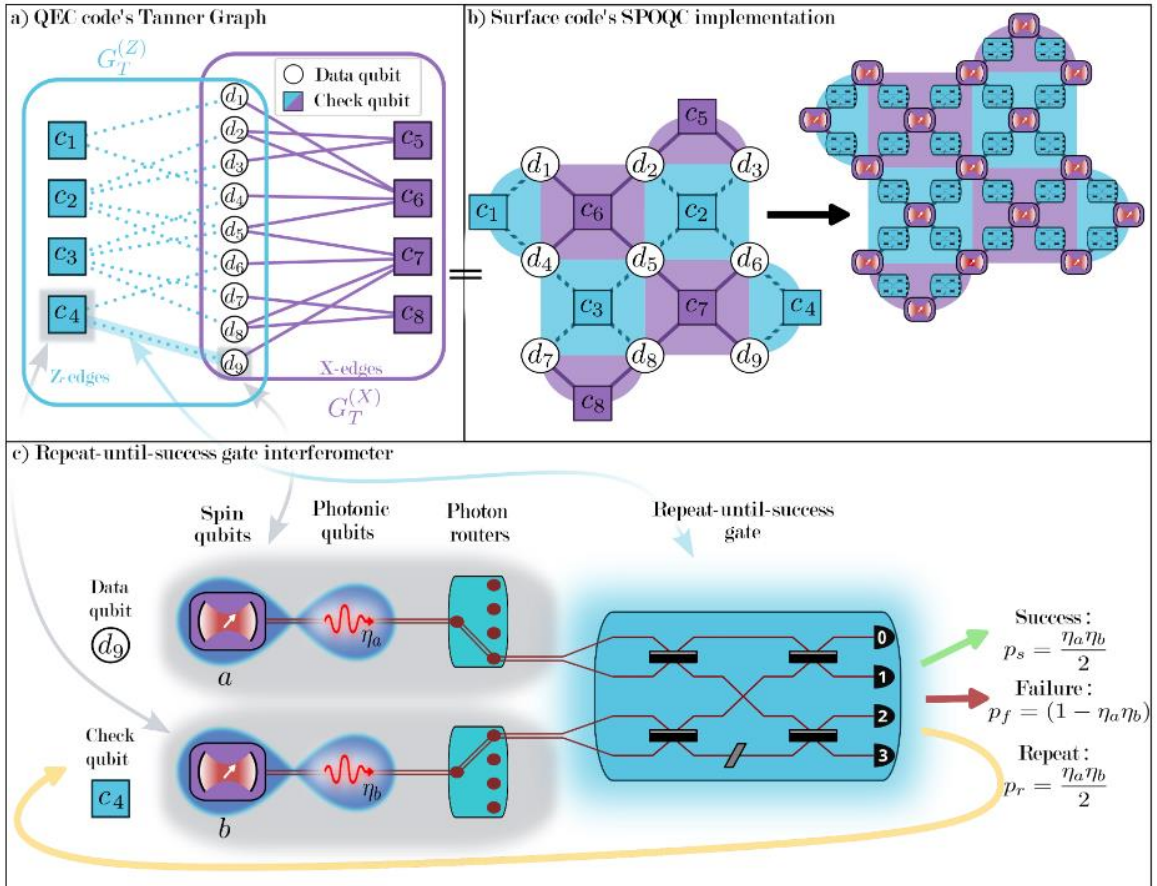
Grégoire de Gliniasty[1,2], Paul Hilaire[1], Pierre-Emmanuel Emeriau[1], Stephen C. Wein[1], Alexia Salavrakos[1], and Shane Mansfield[1]



Quantum Dot Spin-control



Linear optics



A clear Roadmap

with quantitative and qualitative milestones

		2023 ✓ **Integration and long-term operability**	2024 **Boosting gate fidelity via error mitigation**	2025 **Quantum computing utility**	2027 **Quantum computing scaling via modularity**	> 2028 **Quantum computing scaling via quantum networking**
Given value for our customers	QUANTUM PROCESSORS	**Ascella:** QOPS*=144 Physical qubits=6	**Altair:** QOPS*=400 Physical qubits=10 **Belenos:** QOPS*=576 CNOT error rate=1x10-3 Physical qubits=12	**Canopus**: QOPS*=2k Physical qubits=24	**Diadem:** QOPS*=10k CNOT error rate=1x10-4 Physical qubits=100	
		SINGLE PHOTONS		**CLUSTER PHOTON** DEVICES** Logical qubits***: implementation LOGICAL QUBITS	**Andromeda:** QOPS*=50k Logical qubits***=10	**Draco:** QOPS*= 10^6 Logical qubits***=50
	FOR APPLICATION DEVELOPERS	Provided Quantum Machine Learning and Variational Quantum Eigensolver algorithm to end customers.	Released **Cloud 2.0** introducing the "Toolbox": A set of solvers to tackle a variety of use cases.	Cloud Incorporation: Heuristic algorithms in quantum machine learning.	Cloud incorporation: • Vertical integration of specialized algorithms, • Cluster state computing framework.	Launching Quandela's general purpose quantum computing libraries.
		DISCOVERY	UTILITY		ADVANTAGE	GENERAL PURPOSE
Innovation	SOFTWARE & ALGORITHM	Introduced full software developer kit and REST APIs for cloud-connected Quantum Processor Units.	Launched Variational Quantum Eigensolver algorithms for graph-based problems.	• Quantum utility via QPU-GPU hybridization and quantum AI, • Logical qubits' resource estimate.	Developing dedicated error correction compilers and decoders.	Integrating distributed quantum computing full-stack middleware and software.
		FULL-STACK INTEGRATION	UTILITY		ERROR CORRECTIONS	
	MANUFACTURABILITY & INDUSTRIALIZATION	Launched the Paris (FR) quantum computer factory. Industry-grade semiconductor devices production: over #500 devices per year.	Expanded the Paris (FR) quantum computer factory.	Assembly capacity: 4 quantum computers a year.	Launching a second quantum computer factory.	Assembling large-scale, error-corrected quantum computers.
			QUANTUM COMPUTER FACTORY Launched Quandela's semiconductor devices pilot line (pre-industrial fabrication facility).	Expansion of the pilot-line to reach fabrication of several thousands' device per year.	Scaling of hardware modules production and performance.	
		QUANTUM COMPUTER FACTORY	SEMICONDUCTOR QUANTUM DEVICE FABRICATION FACILITY		MULTI-SITE, LARGE-SCALE PRODUCTION	QUANTUM-CENTRIC DATA CENTER

Breaking down challenges

Into smaller problems

With Multiple resolution paths

Breaking down challenges

Into smaller problems with multiple resolution paths

Today

Larger Chips	• Universal monolithic approach vs. reduced connectivity • Multi-chip integration • Coupling optimization
Fast Reconfig-uration	• Novel Materials exploration LiNbo, BTO • Room-temperature multi-chip integration • Scalable electronics development
Cluster States	• Spin control on quantum dots or time loops • Fusion gates development • Multiplexing strategies
Multiple Sources	• Multi-device indistinguishable photon generation • Single-device multiple source integration

FTQC via SPOQC

Pushing Integration

To the limit

Pushing Integration

To the limit

Footprint Reduction

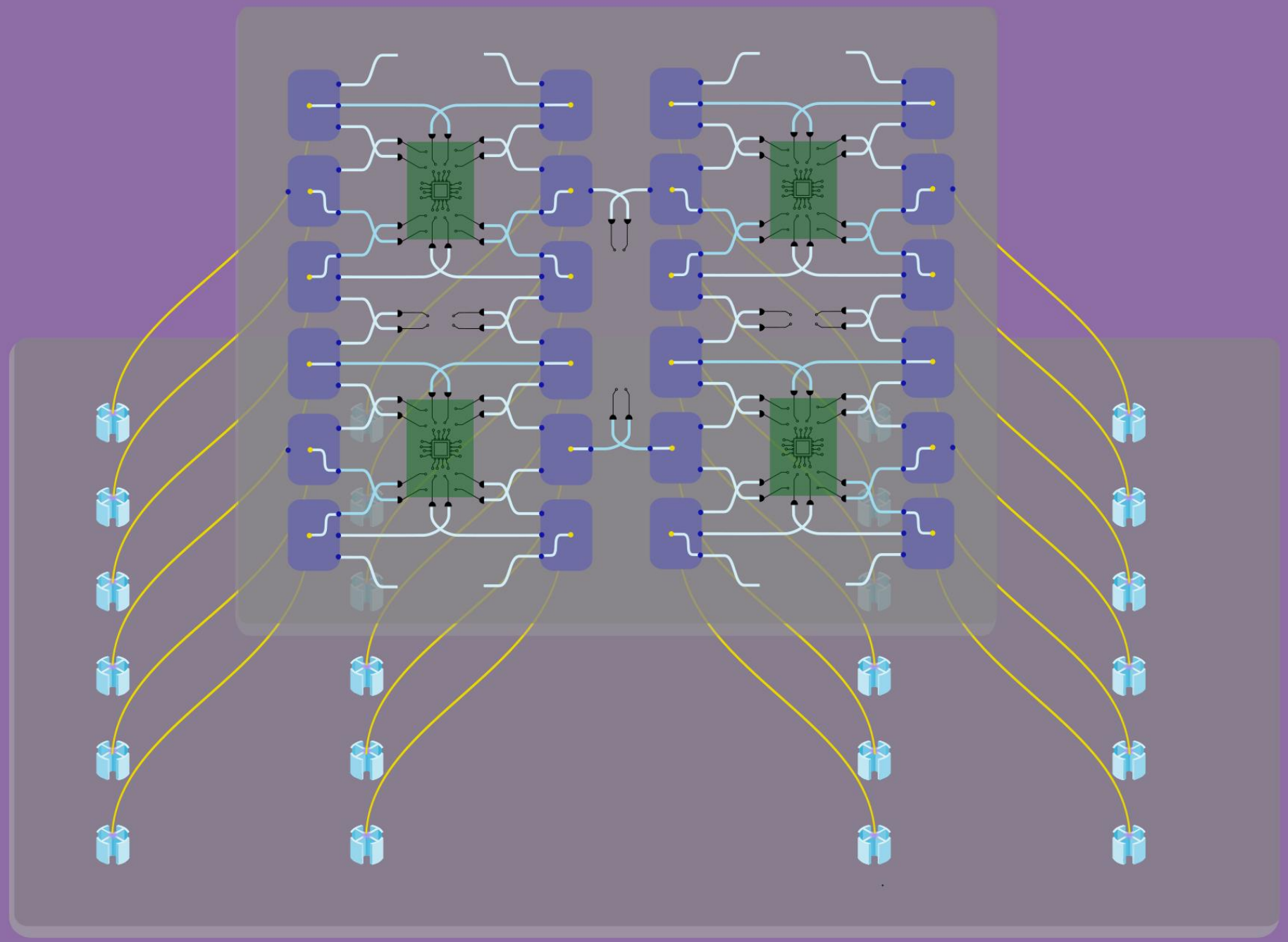
- First gen: 4x reduction
- Second gen: 2x further reduction

Drivers for Further Integration

- Spatial Efficiency (reduced size, less components => more density)
- Performance Enhancement (minimized transmission losses, improved coupling efficiency)
- Better system Control

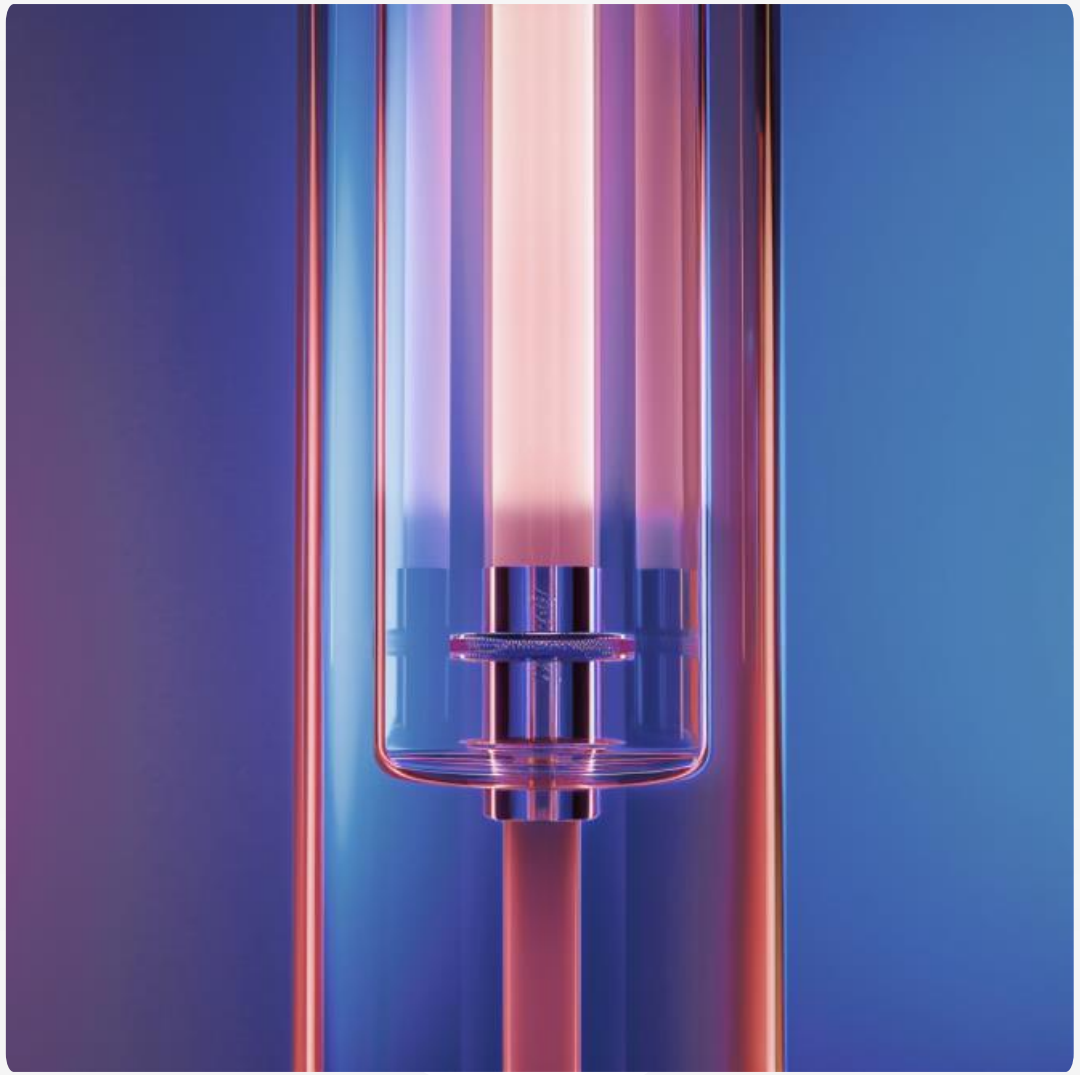
Full-Stack Integration Vision

- Co-integration targets: Single chip with : Single photon sources, Photonic circuits, Detectors
- **Emerging Challenges:**
  - Thermal management
  - Cryogenic control electronics



Using Data

A core Asset in Development



Using Data

A core Asset in Development

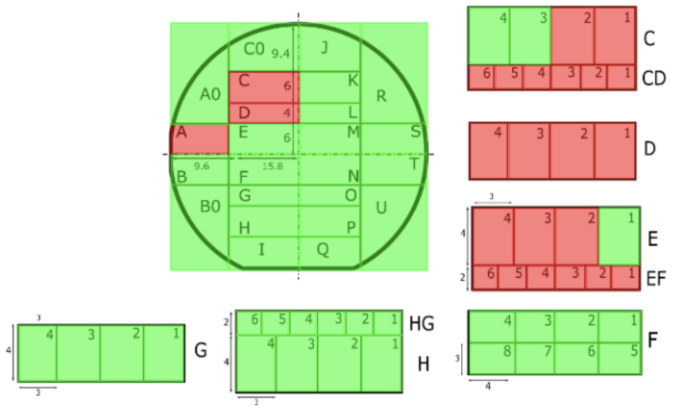
- **Complex System Challenges: Research-grade systems**
  - Multi-parameter design space
  - Intricate setup requirements
  - Complex calibration needs
  - **Going to non-simulability!**
- **Rich Data Foundation: 4 years of consolidated data across**
  - Fabrication metrics
  - System monitoring
  - Performance characterization

- **Data-Driven Acceleration:**
  - ML-Enhanced Development
    - ❑ Faster or novel design iterations
    - ❑ Reduced experimental overhead
    - ❑ Improved outcome prediction
  - Smart Calibration
    - ❑ Active parameter tuning
    - ❑ Real-time optimization
- **Benefits:**
  - Shortened development cycles
  - More informed design decisions
  - Enhanced system reliability
  - Streamlined optimization

AG042

Wafer Map

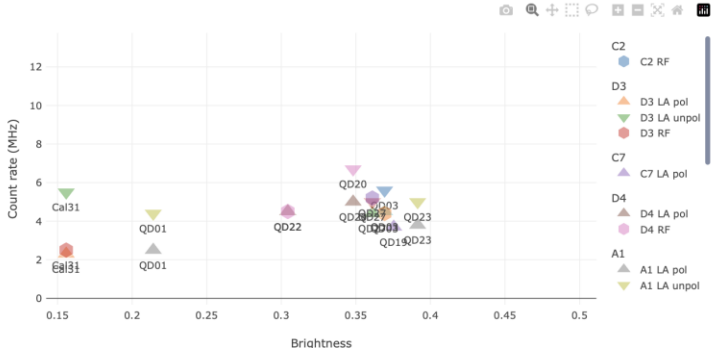
Default



Wafer Graph

X Axis: Brightness

Y Axis: Count rate (MHz)



AG042 > **E5**

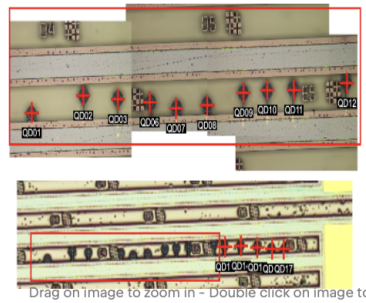
Sample status

Status: installed - C2N | In stock

Comment

Pigtailed

Sample Map



Drag on image to zoom in - Double click on image to zoom out

Show Indicator | Show Label

Summary

Q	8746 ± 508
Best Q	9075
Cavity	924.58 ± 0.34 nm

Quantum Dots

Search by: Name | Enter search key

Name	Cooldo_	BFL	g2	HOM	HOM corr	Decay	WL
QD01		0.21	0.016	0.917	0.948	175.176	924.6
QD02							
QD03							
QD06							
QD07							
QD08							
QD09							
QD10							
QD11							
QD12							

Total 15 | 10/page | 1 2 | Go to 1

Cooldown summary

Download report | Export CSV

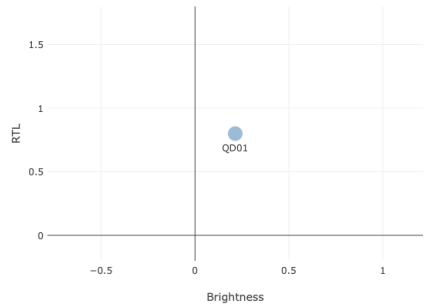
Cooldown: 2024-02-12

Pigtailed

Comment: IPVF, left stack

Summary Graph

X Axis: Brightness | Y Axis: RTL



Cooldown Management

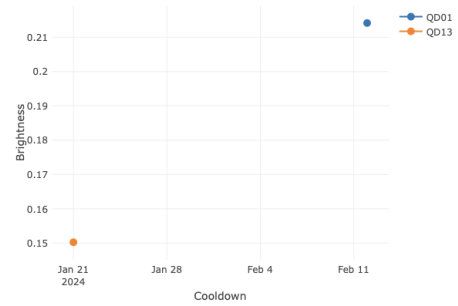
Export CSV

Search by: Name | Enter search key

Action	Name	Pigtailed	Comment
	2024-02-12	no	IPVF, left stack
	2024-01-21	no	

Cooldown Graph

Y Axis: Brightness



AG042 > **E5** > QD01

Quantum Dot Key Facts

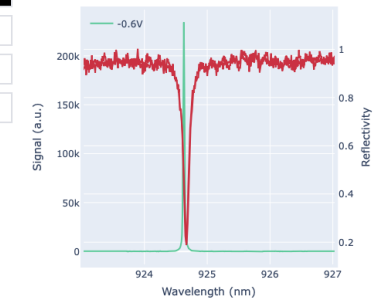
Cooldown: 2024-02-12 | Type: Please select | Description

Mode 1	Mode 2			LA pol	LA unpol	R
Q			Counts			
w_c		nm	APD QE			
FWHM		nm	T optics			
			T total			
Splitting		pm	**BFL**			
			Decay			
RTL			g2			
Rep rate		MHz	HOM			
			HOM corr			

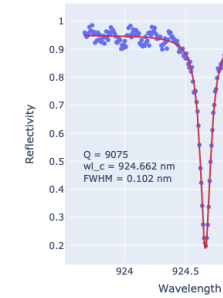
Cooldown: 2024-02-1

PL | LA pol | LA unpol | RF

PL



Cavity 1

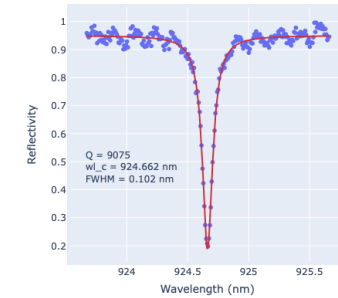


Double click here to edit comment

Q = 9076
wl_c = 924.662 nm
FWHM = 102 pm
Fit: Lorentzian

Double cli

Cavity 2



Building Alliances

Together stronger

Building Alliances

Together stronger

Our expertise centers on photonic quantum hardware and single-photon sources, building a practical quantum computer requires orchestrating many **complementary technologies and skills**.

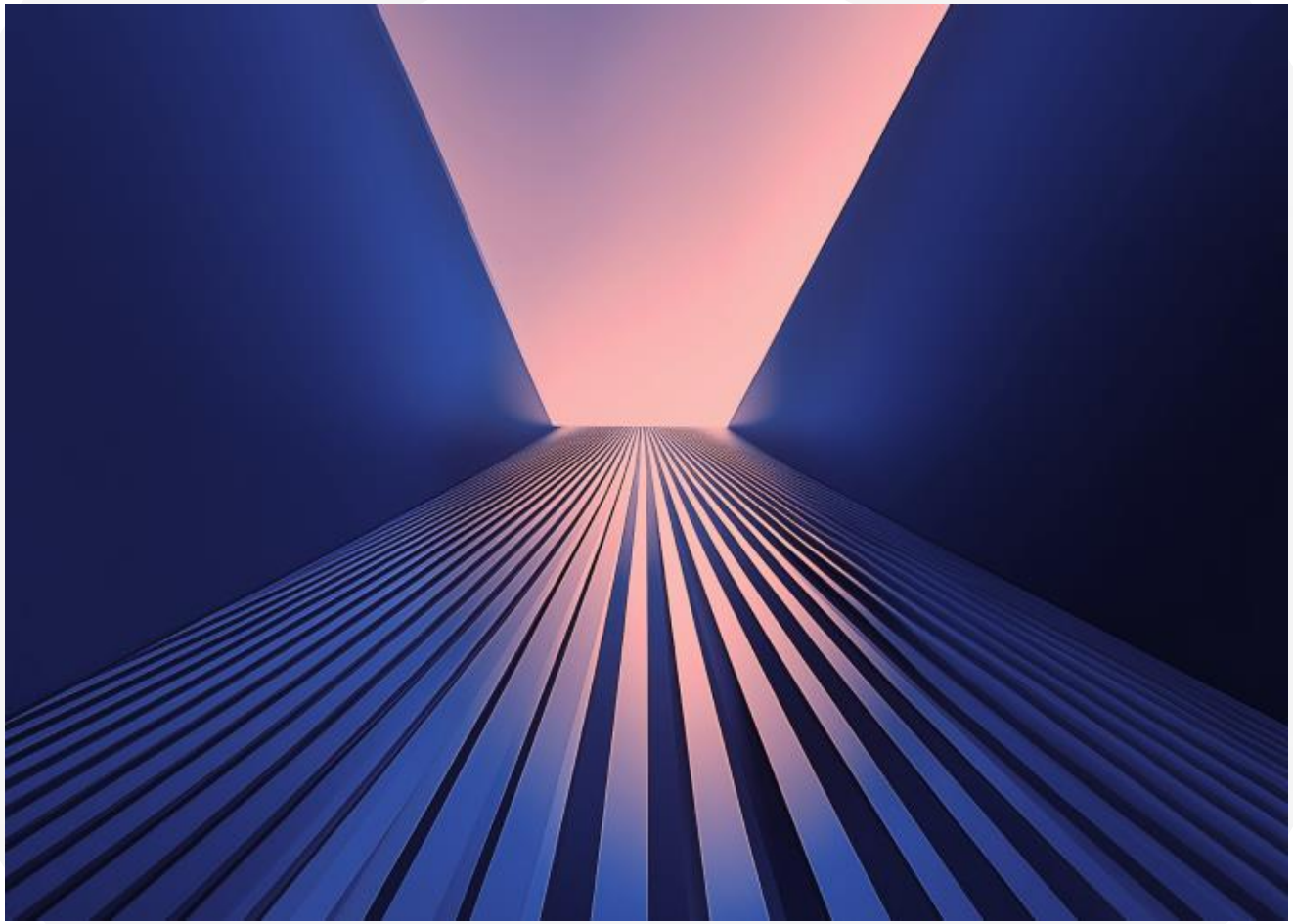
From materials science to cryogenics, from control electronics to compiler design, we're **forging strategic alliances** across the technology spectrum.

These partnerships, combined with our **growing network** of application developers and training specialists, are accelerating the path toward useful quantum computing.

Together, we're not just building components – we're creating an **ecosystem** where innovation at every layer of the quantum stack reinforces and amplifies our collective progress.

Preparing for next next gen

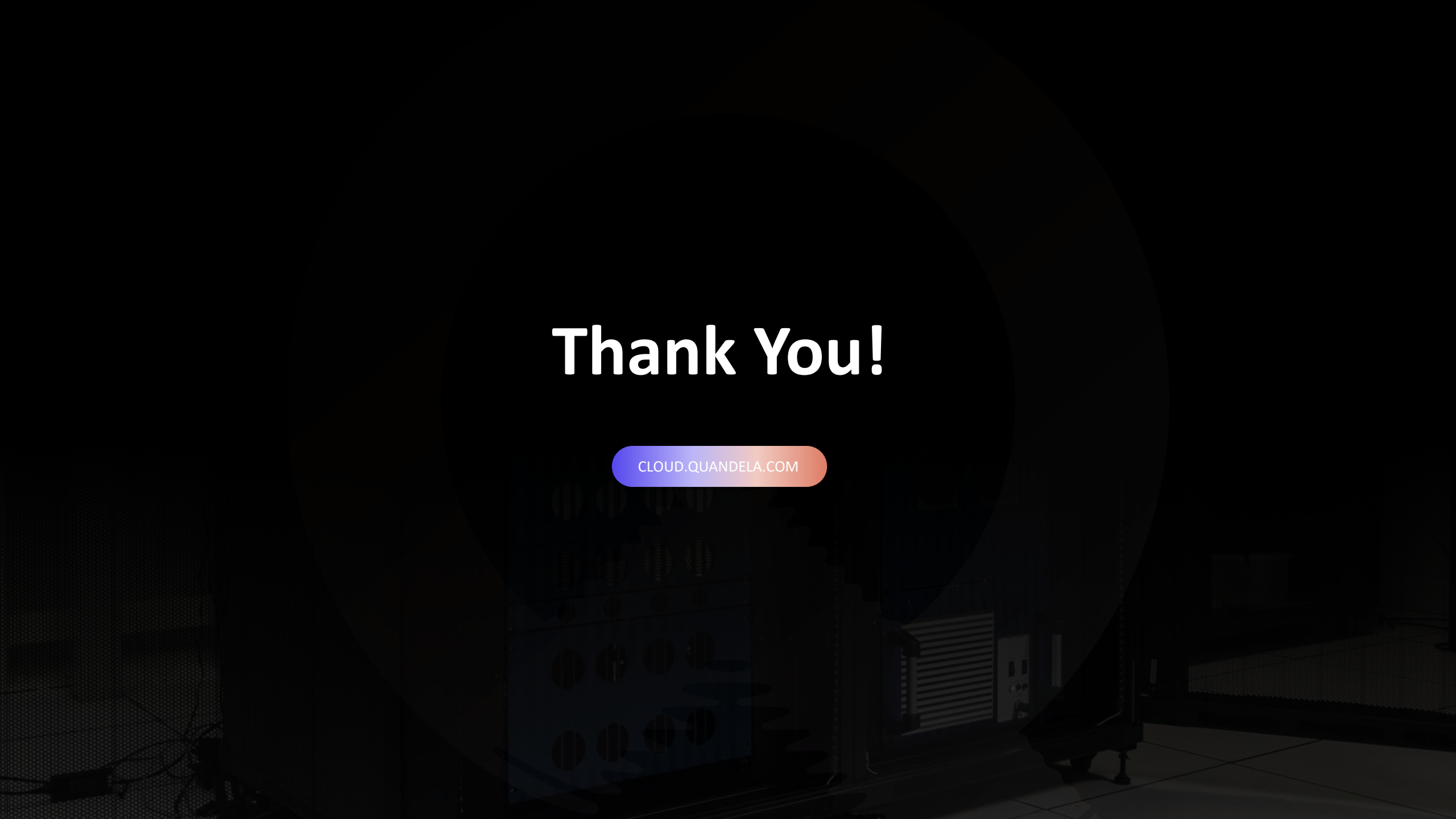
Back to the lab!



Preparing for next next gen

Back to the lab!

- **Intense development cycles in the factory and clean room**
  - Operating current systems
  - Developing next generation demands intense focus
  - Preparing milestones from the roadmap
- **Yet we must maintain our research momentum**
  - Exploring novel scientific paths
  - Investigating breakthrough technologies
  - Advancing fundamental understanding
- **Virtuous cycle: lab to factory and back**
  - Keeping the innovation pipeline flowing
  - Providing labs with new tools to deepen research


Thank You!
CLOUD.QUANDELA.COM