

# Quantum computing and systems, Atos perspectives

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Quantum Computing Workshop – LETI days

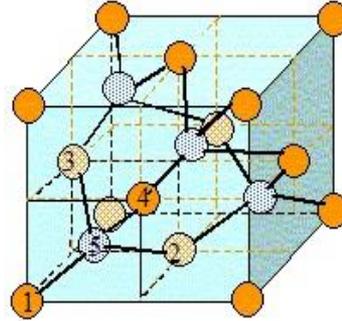
28 June 2019, Minatec - Grenoble

Philippe Duluc,

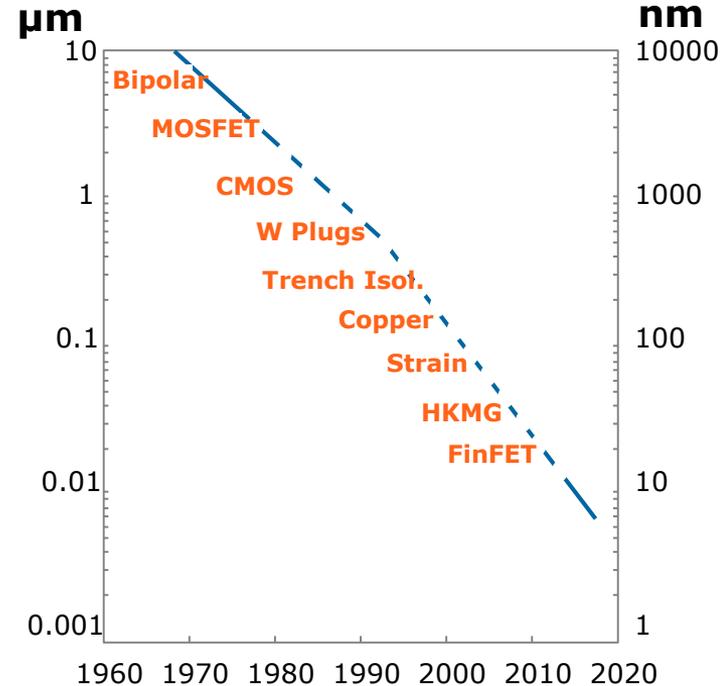
Atos CTO Big Data & Security

The Atos logo is displayed in a bold, white, sans-serif font. The letter 'o' is stylized with a circular cutout in the center. The logo is positioned in the bottom right corner of the slide.

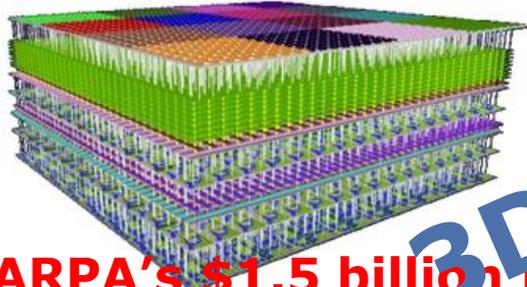
# The computing disruption for Atos



- ▶ Moore's law declining: 0,3 nm between 2 atoms in Silicon crystal, chip fabrication process < 10 nm
- ▶ obligation for Atos to find new directions in order to provide accelerations required by customers



# Alternatives?



3DCPU?

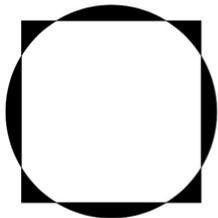
**DARPA's \$1.5 billion Electronics Resurgence Initiative (ERI): the Three Dimensional Monolithic System-on-a-Chip (3DSoC) program**

## Why Bio Computing ??

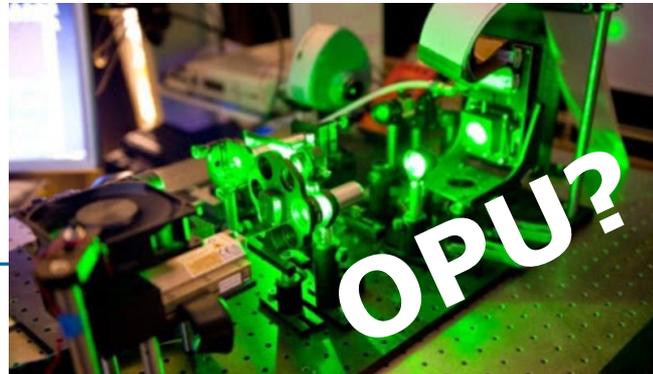
- Moore's Law states that silicon microprocessor complexity will double in every 18 months.
- One day this will no longer hold true when miniaturization limits are reached.
- Solving complex problems which today's supercomputers are unable to perform in stipulated period of time.
- Require a Successor to Silicon

BPU?

ABDULLAH FARHAD



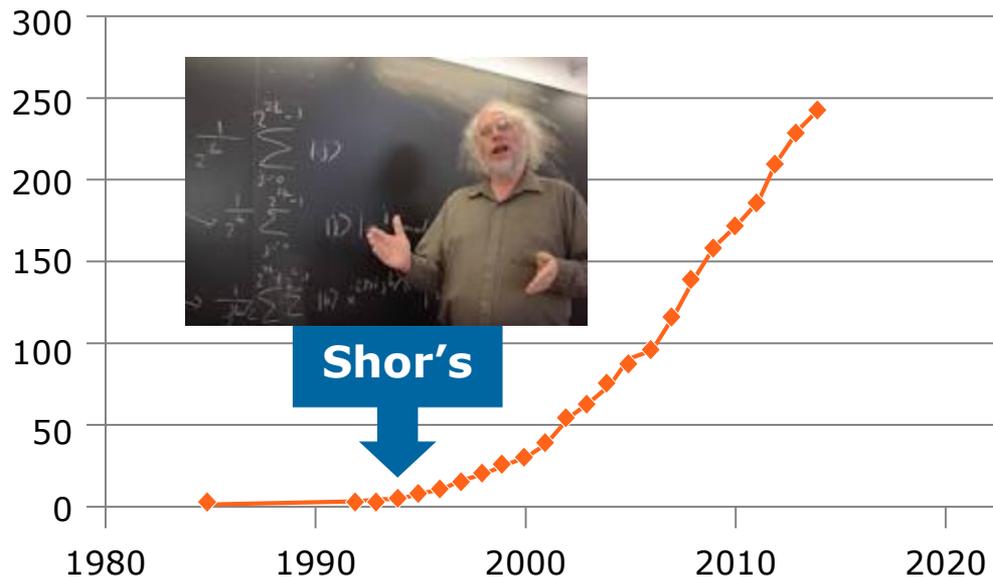
LightOn



OPU?

# Algorithmic innovation has launched the Quantum Big Race

QC Algorithms



[math.nist.gov/quantum/zoo](https://math.nist.gov/quantum/zoo)

# Atos Quantum : a long-term strategic R&D investment of disruptive innovation, set up in 2016

- ▶ Atos worldwide leader in supercomputing and European leader in cybersecurity

Quantum Computing will affect sooner and later Atos supercomputing customers and cybersecurity customers

- ▶ **Business rationale**
  - **strategic move to keep business leading positions**
  - **aiming mid-term RoI**
  - **in close touch with customers**



# Atos Quantum Program

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**Atos QLM**  
**Atos Quantum**  
**Learning Machine**

**Focus on quantum software, agnostic in quantum hardware:** commercialization (since 2017) of **Atos QLM** which is an appliance making easy to develop quantum algorithms (programming, optimising and testing via emulation up to 41 qubits), free distribution (since 2019) of **myQLM** software

**Atos Quantum**  
**Accelerator**

**R&D program with hardware partners:** to deliver in 2023 a **NISQ accelerator** (50 to 100 physical qubits) for hybrid supercomputing and driven by **Atos QLM**

**Atos Quantum-**  
**safe security**

**Aligned with NIST call for post-quantum standards:** preparing the cryptographies and hardware security modules, resistant to quantum attacks

# Atos QLM customers



Hartree Centre

Science & Technology Facilities Council

- ▶ commercial success in a new market
- ▶ huge interest immediately after announcement in July 2017
  - for education (universities)
  - for research (research centers, university labs)
  - for HPC ecosystems (post Moore's law)
  - for industry (first contracts)



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# No quantum business without customers

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▶ Why are customers going to invest in quantum computing ?

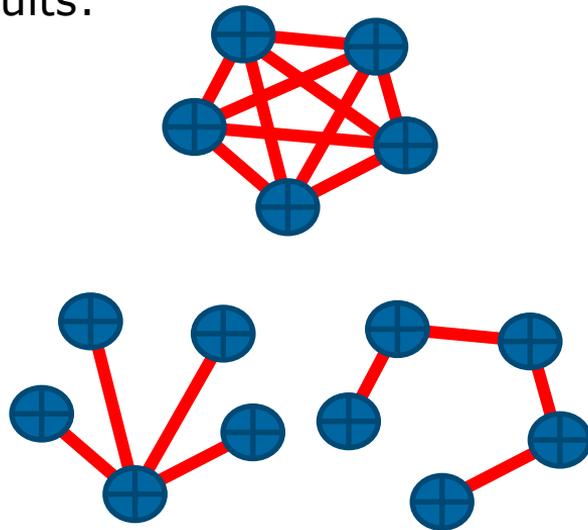
~~▶ Love of quantum physics ?~~



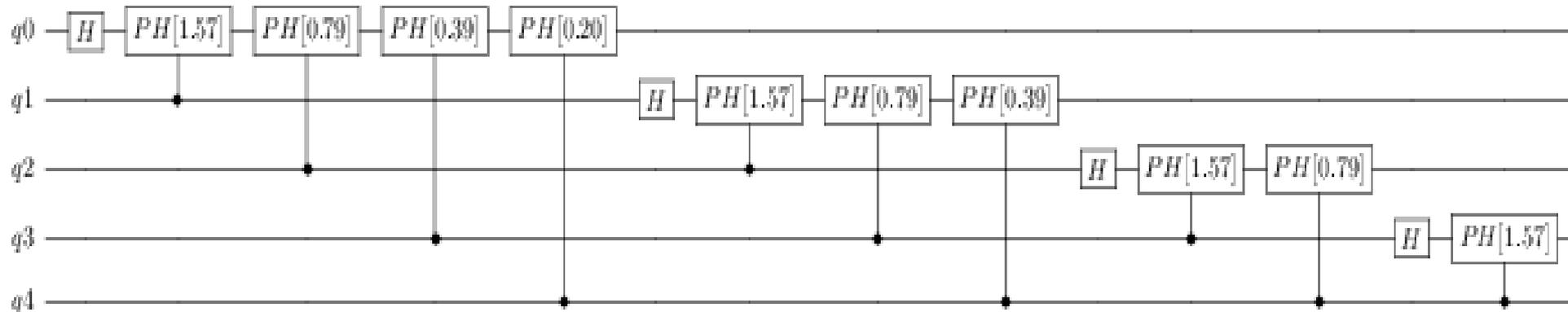
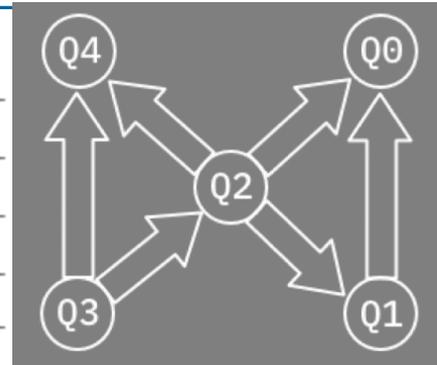
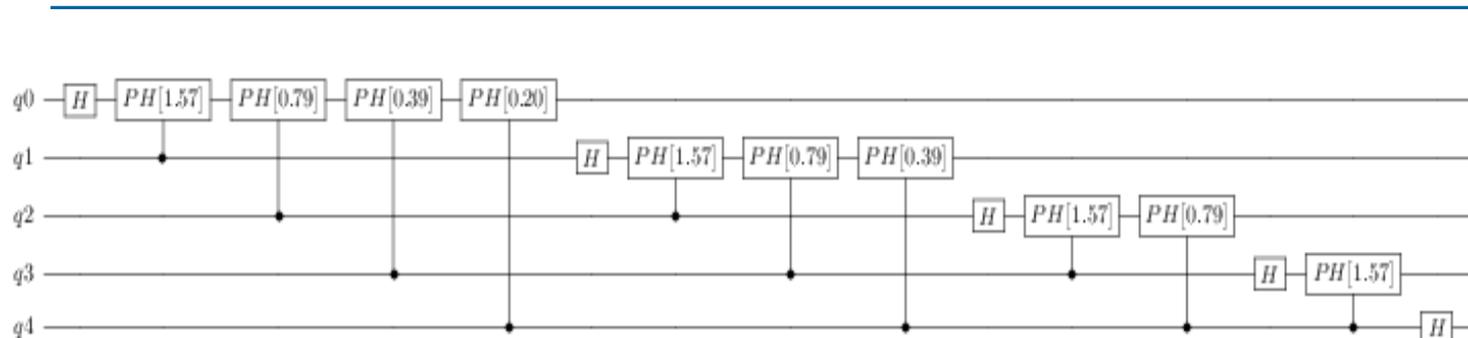
- ▶ To solve **business issues** they cannot solve with traditional IT, for value creation and differentiation
- ▶ By running **business applications** demonstrating quantum advantage
- ▶ Thanks to **quantum algorithms** with significant speedup, implemented in these applications
- ▶ And not too far (3 years max)

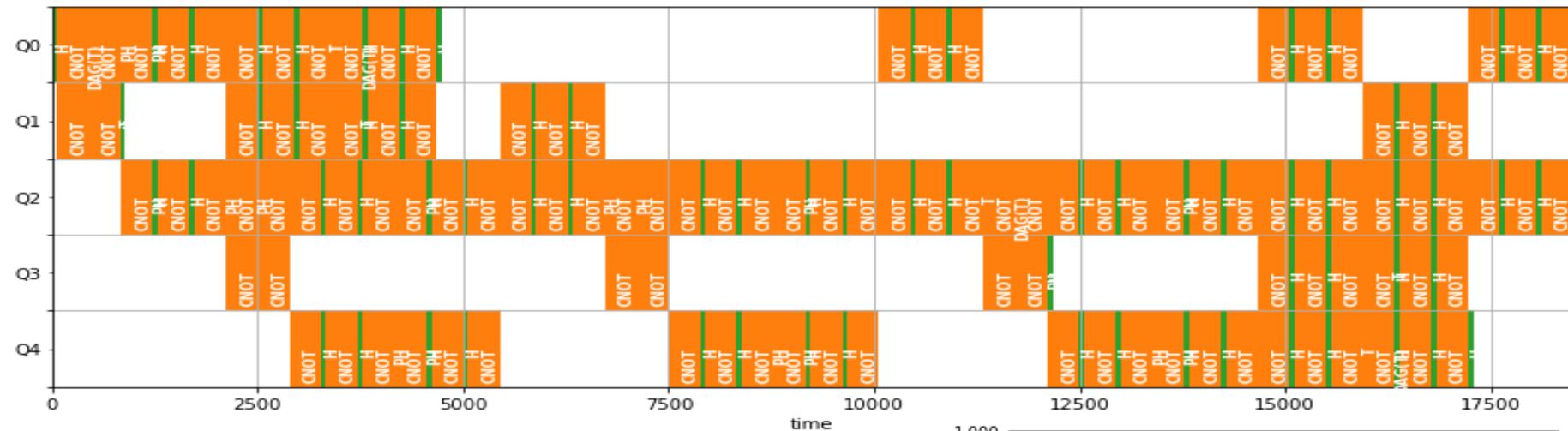
# Atos QLM is the perfect tool for measuring real speedup performances

- ▶ leading hardware technologies for qubits-based circuits:
  - trapped ions qubits
  - superconducting qubits
  - semiconducting qubits
- ▶ performances of algorithms are **HW dependent**:
  1. qubit topology, connectivity, gate limitation
  2. stability, quantum noise (decoherence)
  3. speed, shallowness, idling time
- ▶ **Atos QLM** integrates hardware constraints
  - powerful compiler and optimizers
  - testing more realistic (integrating noise models and topology)
  - true performance over present and future accelerators

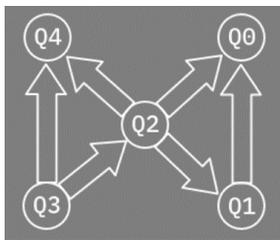


# Optimizing fidelity with QLM

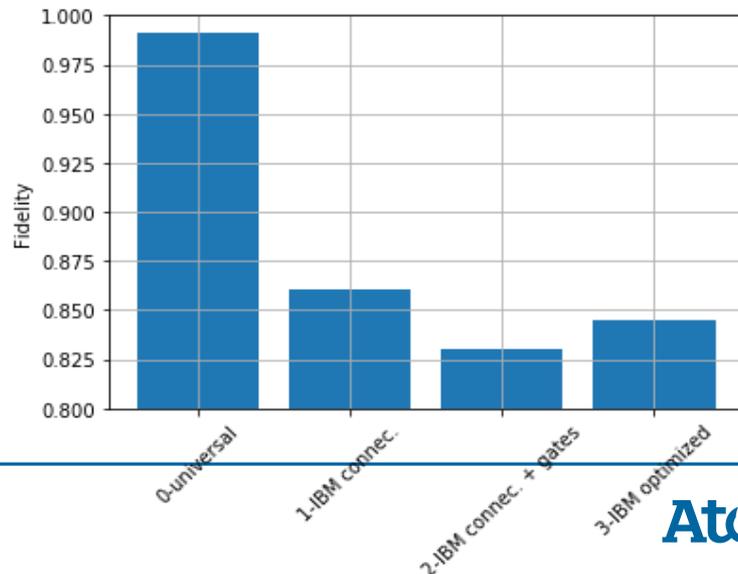




## Time representation with QLM



Connectivity constraints  
& gate limitations  
increase circuit length  
& require QLM optimizations



# Thanks

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For more information please contact: [philippe.duluc@atos.net](mailto:philippe.duluc@atos.net)

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