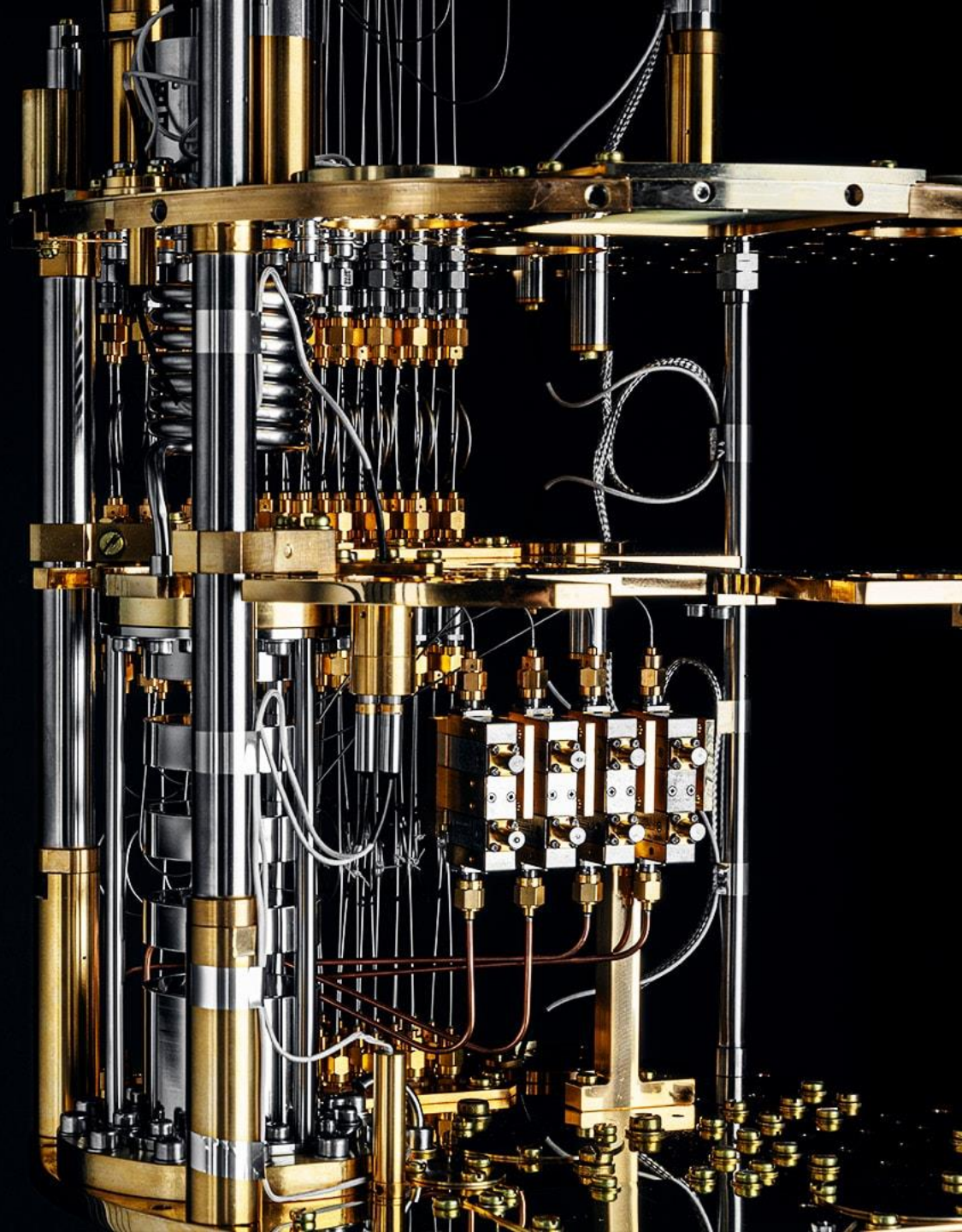# HPC + IQM

Janne Mäntylä

Head of Software Development

IQM builds and delivers full-stack quantum computers globally

- Global leader in delivering commercial full-stack quantum computers

- Global leader in developing innovative QPUs

- Open and transparent software stack with several well-defined APIs for integrations and enabling innovations
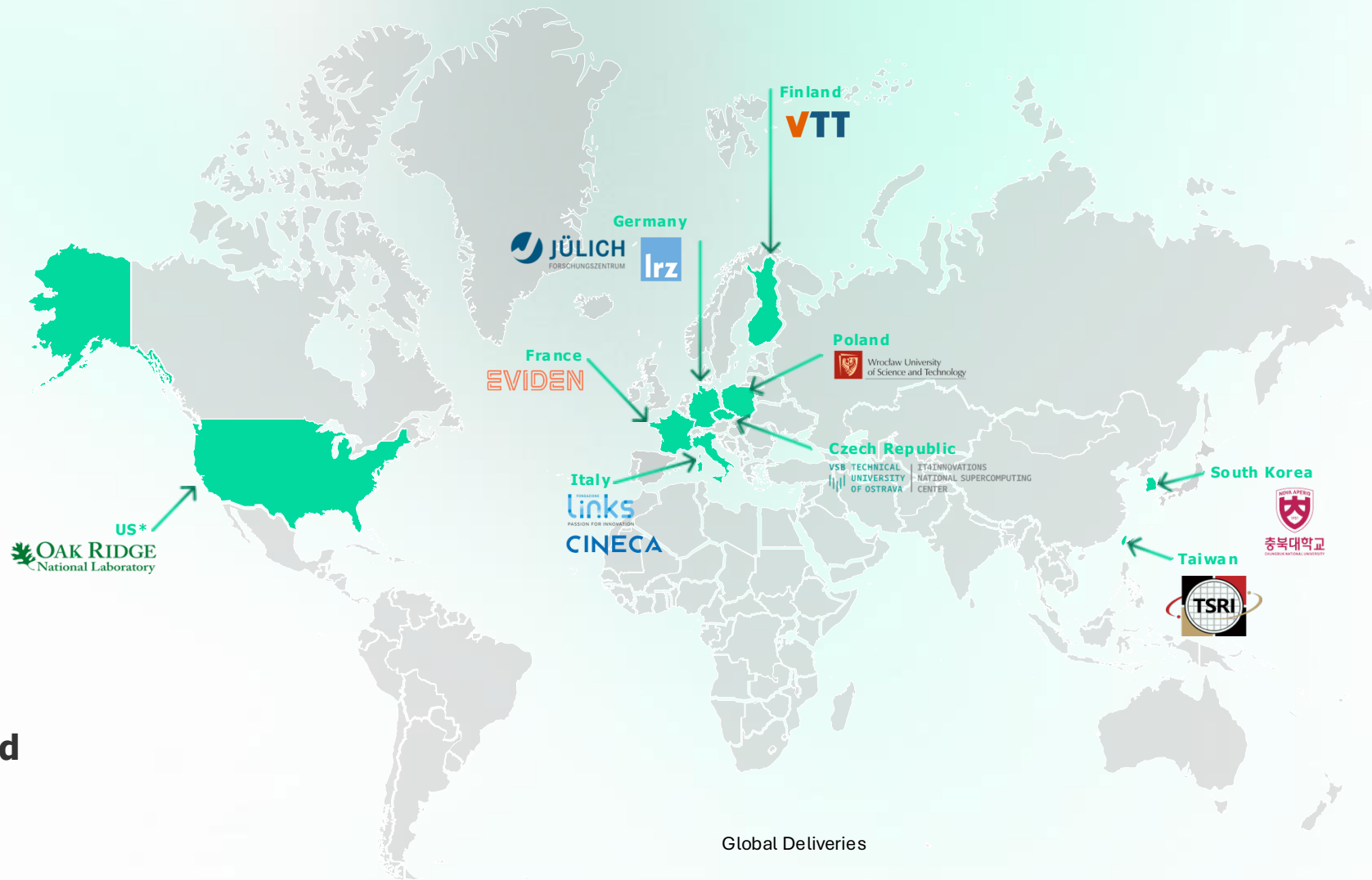
300+
Employees

125+
PhDs

15+
full systems sold

2018
Founded

150
qubit chip in development

IQM

IQM Customer Deliveries

Finland VTT

Germany JÜLICH FORSCHUNGSZENTRUM lrz

France EVIDEN

Poland Wrocław University of Science and Technology

Italy links PASSION FOR INNOVATION CINECA

Czech Republic VSB TECHNICAL UNIVERSITY OF OSTRAVA | IT4INNOVATIONS NATIONAL SUPERCOMPUTING CENTER

US* OAK RIDGE National Laboratory

South Korea 충북대학교 CHUNGBUK NATIONAL UNIVERSITY

Taiwan TSRI

10+ full systems
delivered and installed

Global Deliveries

*US Oak Ridge is Cloud delivery

IQM

Practical HPC+QC Integration is working in Munich and in Finland

Leibniz Supercomputing Centre (LRZ)

Extending quantum computing through subspace, embedding and classical molecular dynamics techniques
[arXiv:2505.16796 (2025)]

Tim Weaving; Thomas M. Bickley; Angus Mingare; Michael Williams de la Bastida; Shunzhou Wan; Martina Nibbi; Philipp Seitz; Alexis Ralli; Peter J. Love; Minh Chung; Mario Hernández Vera; Laura Schulz; Peter V. Coveney.

Since June 2024, high impact research has been done on integrated HPC+QC resources at LRZ/MQV using a software framework, MQSS, for workflow orchestration

VTT Q50

```
module use /appl/local/quantum/modulefiles
module load fiqci-vtt-qiskit

export DEVICES=("Q50")

source $RUN_SETUP

python -u first_quantum_job.py
```
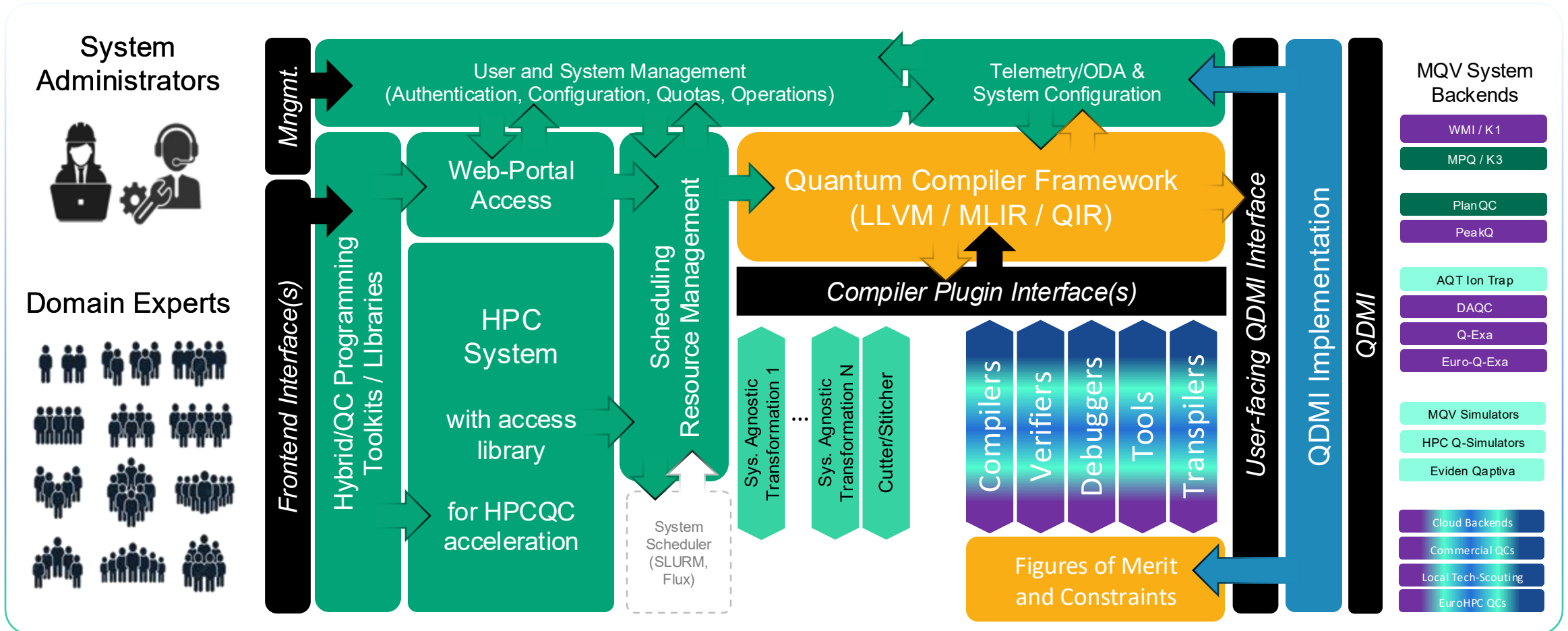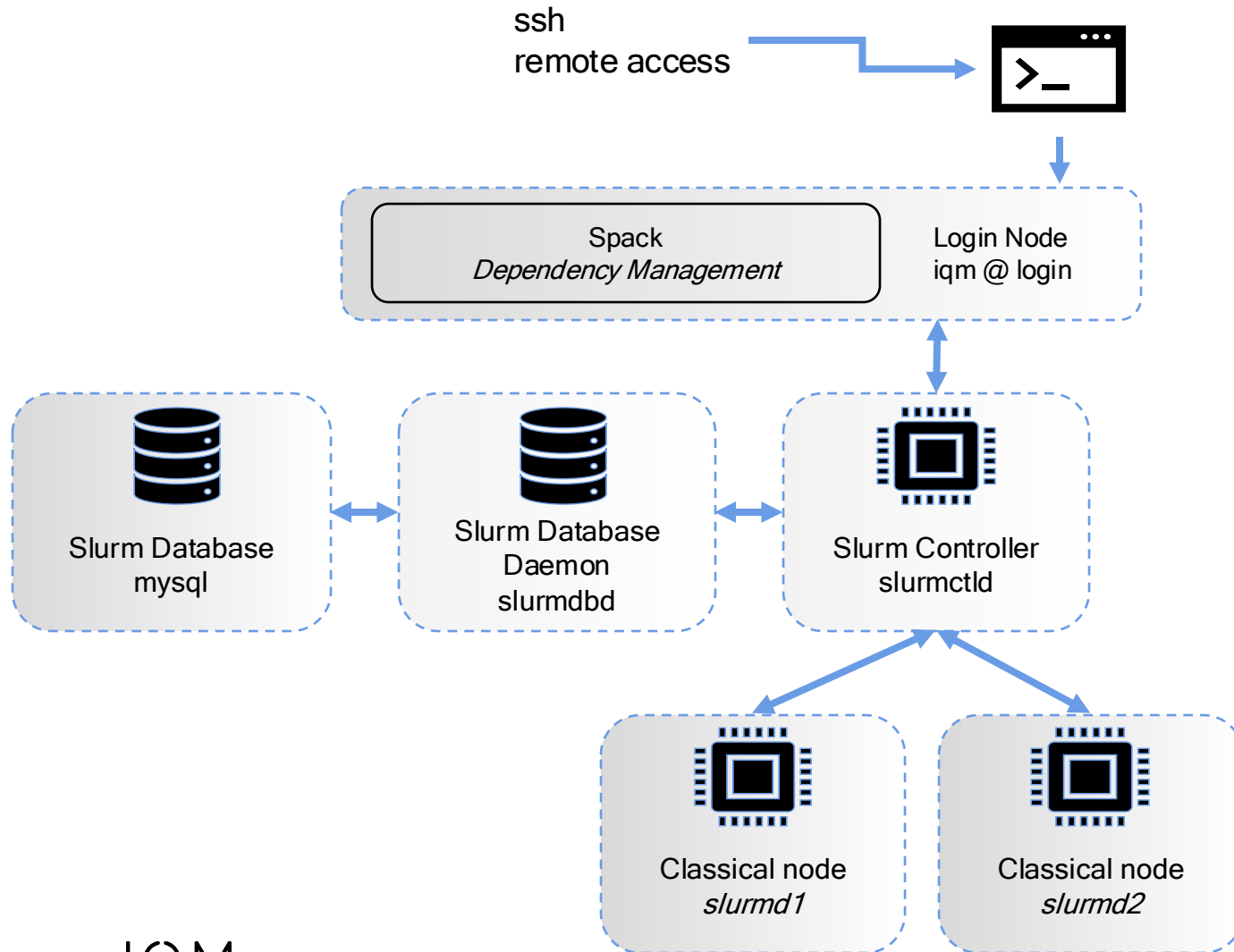
https://docs.csc.fi/computing/quantum-computing/first-quantum-job/

IQM is committed to future-looking frameworks

System Administrators

Domain Experts

Mngmt.

Frontend Interface(s)

User and System Management
(Authentication, Configuration, Quotas, Operations)

Telemetry/ODA &
System Configuration

Web-Portal Access

Hybrid/QC Programming Toolkits / Libraries

HPC System

with access library

for HPCQC acceleration

Scheduling Resource Management

System Scheduler (SLURM, Flux)

Quantum Compiler Framework
(LLVM / MLIR / QIR)

Compiler Plugin Interface(s)

Sys. Agnostic Transformation 1

Sys. Agnostic Transformation N

Cutter/Stitcher

Compilers

Verifiers

Debuggers

Tools

Transpilers

Figures of Merit and Constraints

User-facing QDMI Interface

QDMI Implementation

QDMI

MQV System Backends

WMI / K1
MPQ / K3
PlanQC
PeakQ

AQT Ion Trap
DAQC
Q-Exa
Euro-Q-Exa

MQV Simulators
HPC Q-Simulators
Eviden Qaptiva

Cloud Backends
Commercial QCs
Local Tech-Scouting
EuroHPC QCs

MQSS Core:

Front-End | Middle-End | Back-End | System | Interfaces /APIs | Plugins by Modality

IQM

MQSS
Munich Quantum
Software Stack

5

We need to start with the bare minimum

ssh
remote access

Spack
Dependency Management

Login Node
iqm @ login

Slurm Database
mysql

Slurm Database
Daemon
slurmdbd

Slurm Controller
slurmctld

Classical node
slurmd1

Classical node
slurmd2

**Our goal is to execute quantum jobs within the HPC environment with minimal disruption**

→ Add a quantum resource as a slurm node
→ Offload in a standard manner
→ Initiate, retrieve, and cancel jobs as needed

IQM

Adding Quantum as a slurm node

ssh
remote access

Spack
Dependency Management

Login Node
iqm @ login

IQM
offloader | local execution | use cases

Slurm Database
mysql

Slurm Database
Daemon
slurmdbd

Slurm Controller
slurmctld

Quantum Worker
quantumd

IQM
iqm-client

QDMI
Driver | Calibration | Qiskit Backend

Classical Worker
slurmd1

Classical Worker
slurmd2

IQM Radiance
(On-Prem)

IQM Resonance
(Cloud)

IQM

Highlights

→ Real integrated HPC+QC systems are available today!

→ Open and transparent stack with many APIs: https://docs.meetiqm.com/

→ Hybrid program representation?

→ End-to-end workflow and toolchain?
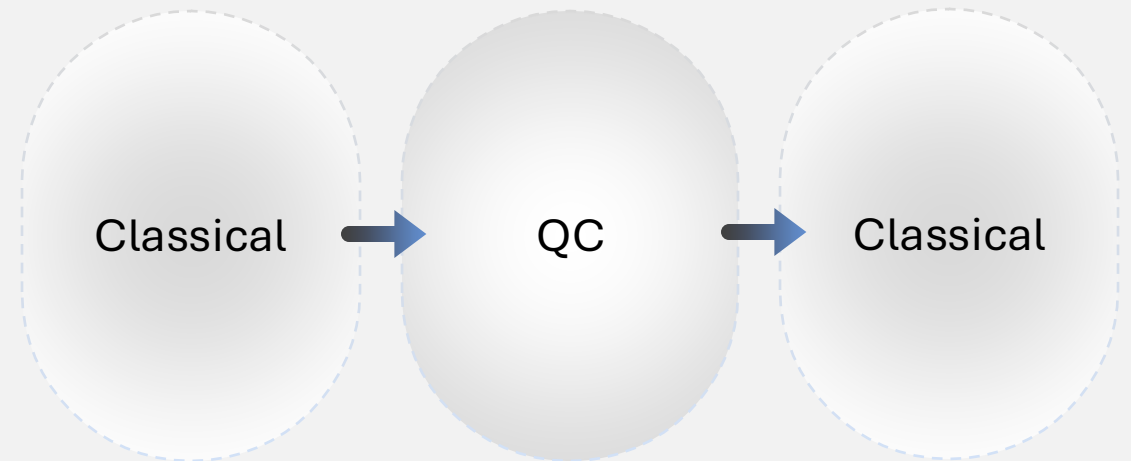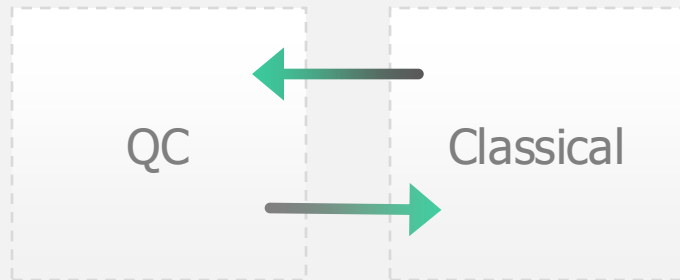
Thank you

Got questions? Just <u>contact</u> us!

Follow us on <u>LinkedIn</u> to stay informed with our latest news.

Janne Mäntylä

<u>meetiqm.com</u>

IQM