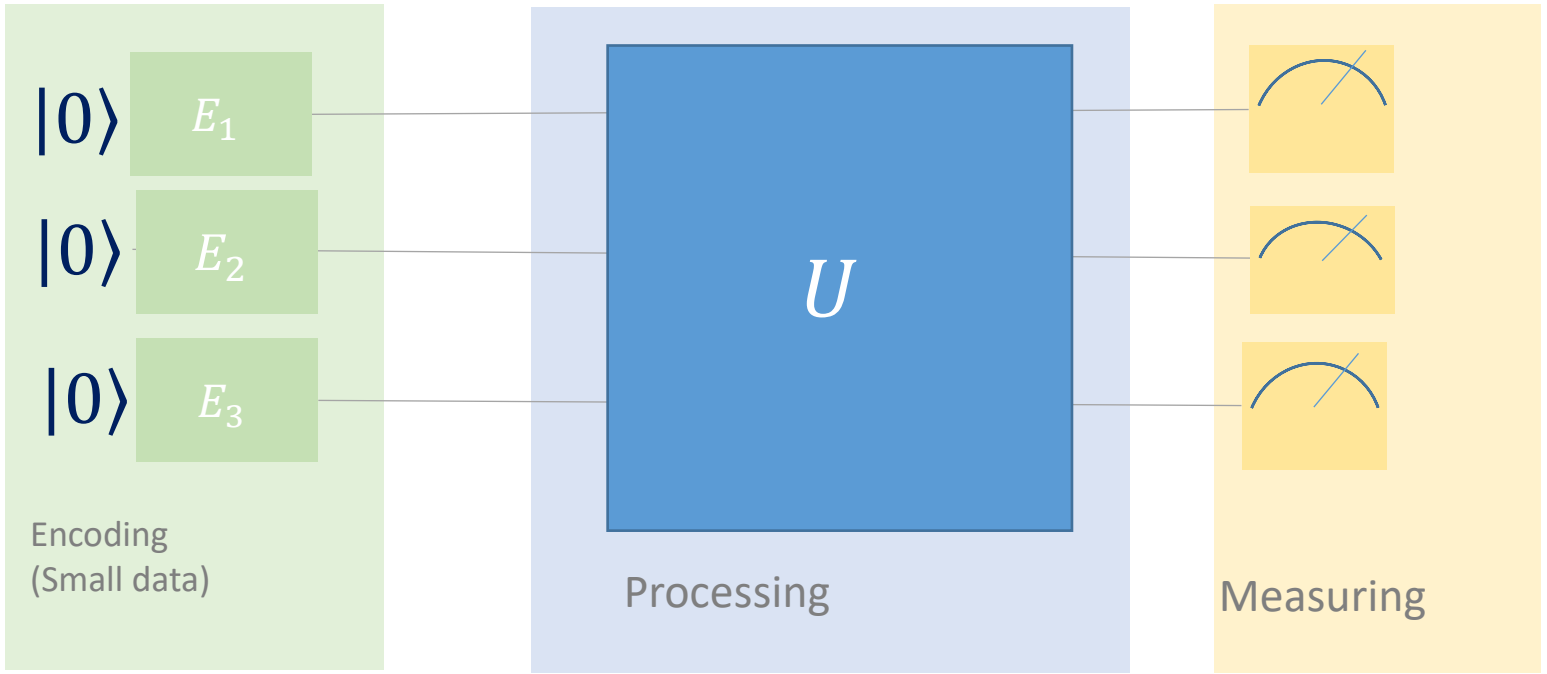
From the need to hybridize algorithmically to the need to integrate QPUs with CPUs

J. Mikael, EDF, E. Vergnaud, Teratec TQCI
Conference on QPU/CPU Integration

The first generation of Quantum Algorithms

QPU



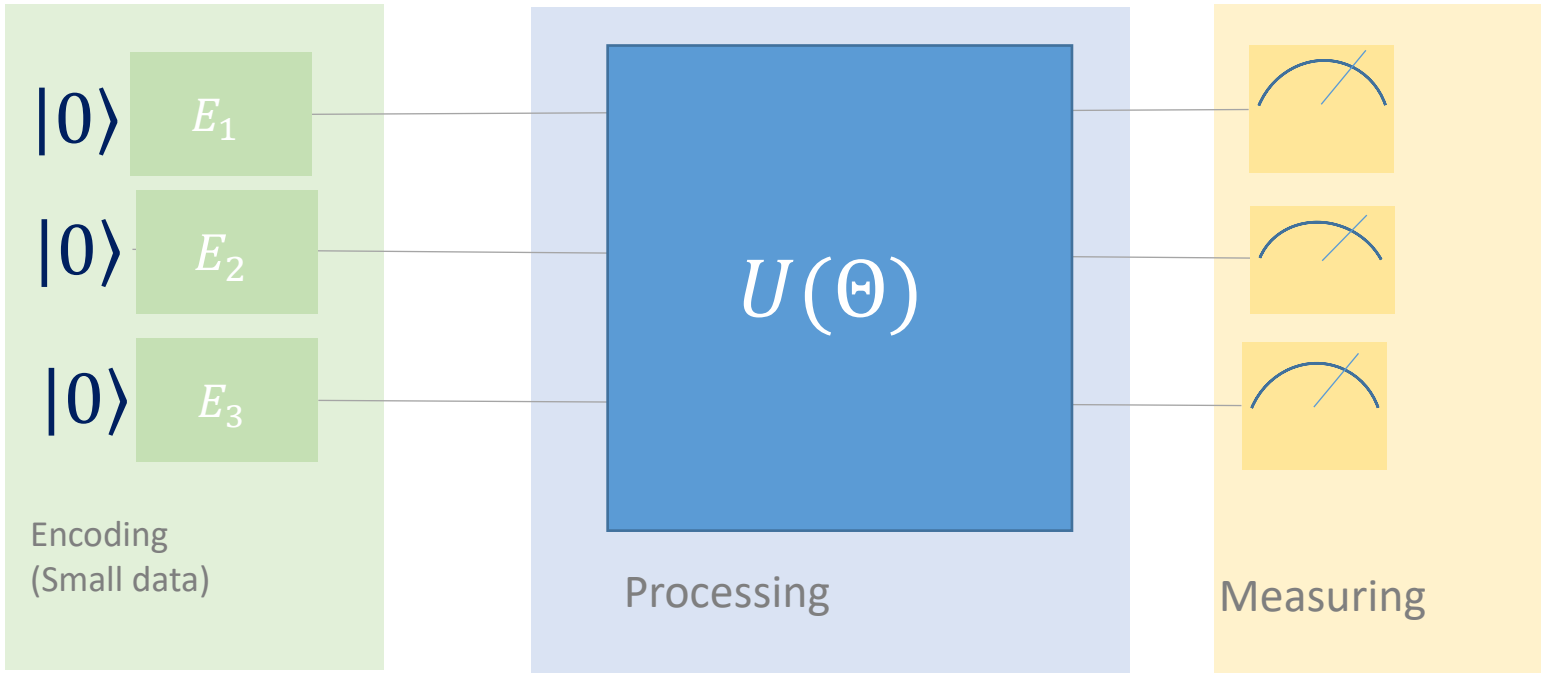
- Shor Factoring algorithm

-Grover (Unstructured DB Search)

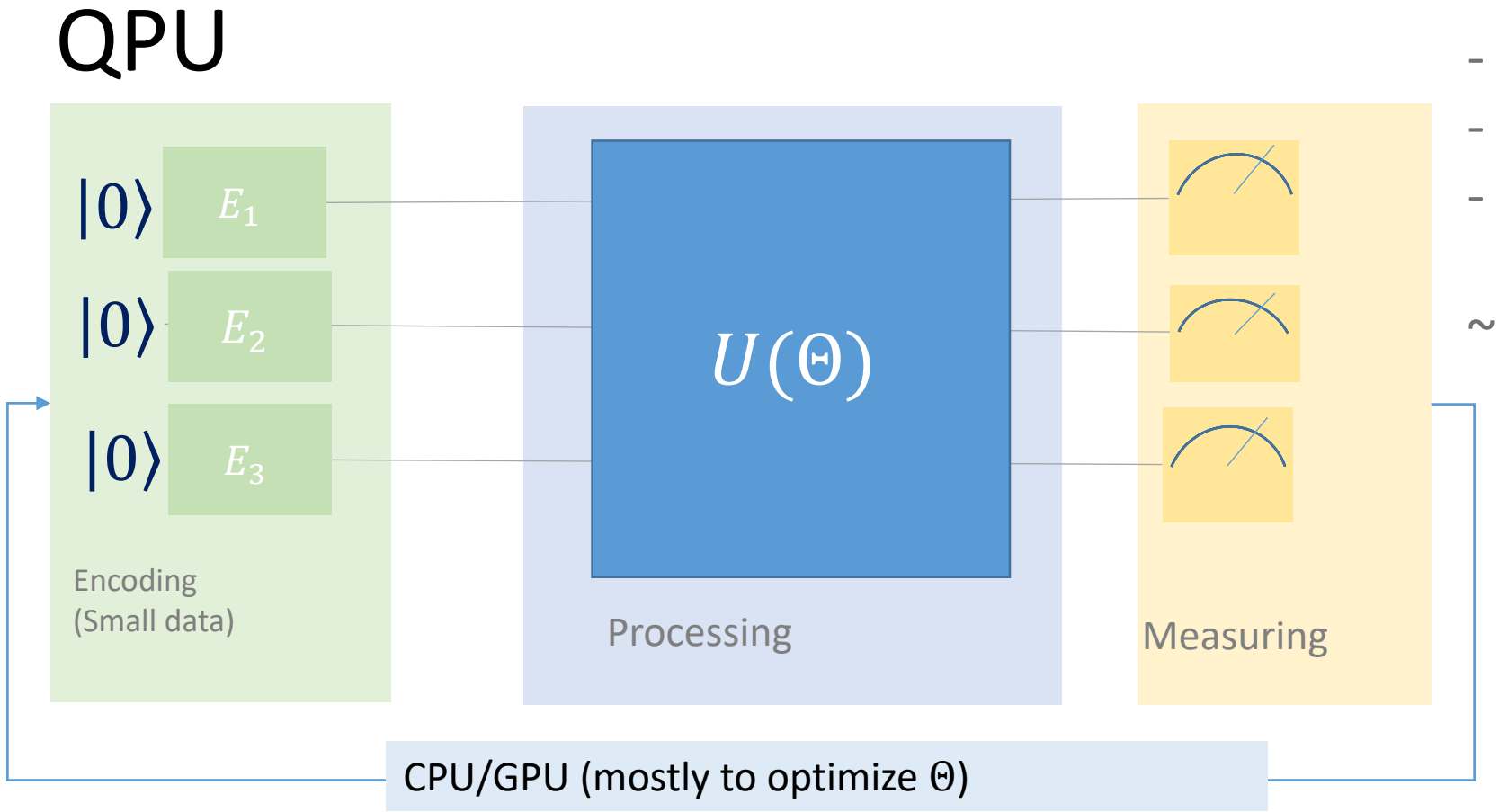
- HHL (Linear system of equations) & Phase estimation

The first generation of Quantum Algorithms + Parameterization

QPU



The second generation of Quantum Algorithms

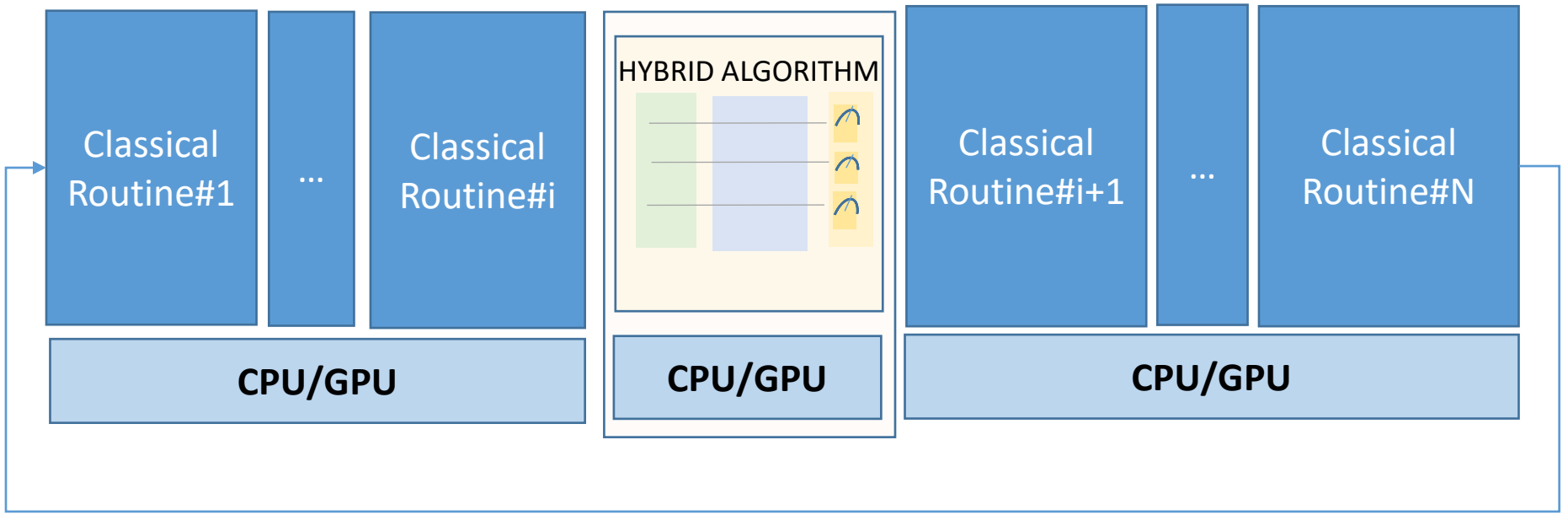


- QAOA (Optimization)
- VQLS (Linear systems)
- PQC (involved in QML)

~ most of NISQ algorithms

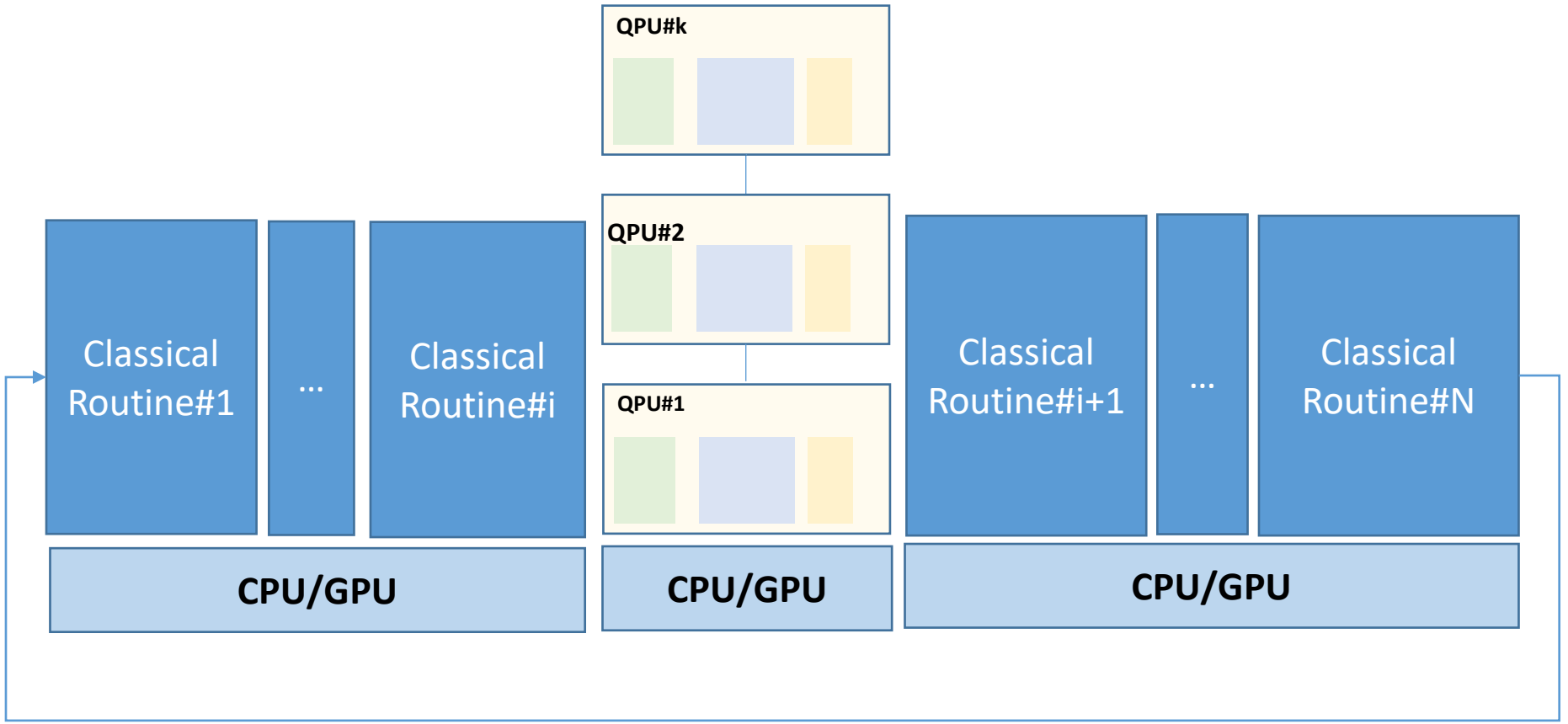
The algorithms under study today

Current state-of-the-art algorithms



Branch and Price with RQAOA sub routine
Generative Adversarial Network with quantum update
Classical algorithm with Grover search
Topological Data Analysis

A possible future



Open Questions related to hybridation

How to build an architecture hybrid algorithms that maximizes the use of the expensive QPU?

How a clever integration can

- help producing more efficient algorithms?
- lead to energy consumption advantage?
- help reducing the NISQ uncertainty ?

What to put together with QPU? CPU? GPU?

How to link together QPUs?

Today's Program / Morning

09:30 10:50 Session 1. Architecture, Code development, compilation and runtime - Chairman Cyril. Baudry :

- Quantum Computing in the Cloud with Amazon Braket : Sebastian Stern, Specialist Solution Architect Quantum Computing, AWS
- Large scale quantum/HPC hybridization with Atos QLM : Arnaud Gazda, Expert Quantum R&D Engineer, ATOS
- Quantum + Classical computation: Quantum Middleware : Ismael Faro, Distinguished Engineer, Chief Architect Quantum Computing Cloud and Software, IBM

10:50 11:20 Coffee Break

11:20 11:50 The impact of latency reduction on quantum algorithms, Vivien Londe, Microsoft

11:50 12:50 Presentation and objectives of the Quantum Energy Initiative – Focus on Hybridation and the case-study of cat-qubits (A. Auffèves from CNRS MajuLab and the QEI, O. Ezratty from the QEI and T. Péronnin from Alice&Bob)

IBM

Atos

aws

Microsoft

#QEI
the quantum energy initiative

ALICE & BOB

EDF

TQCI Teratec Quantum Computing Initiative

Today's Program / Afternoon

13:45 16:45 Session2. On the hardware side; integration of CPU/QPU - Current experiments/Next Scientific and technical obstacles - Chairman Alain Refloch

- Bringing GPU acceleration to Quantum-Classical Computing : François Courteille, Principal Solutions Architect, NVidia
- Quantum interconnects to scale-up quantum technologies : Tom Darras, CEO WeLinq
- A quantum pricing-based column generation framework for hard combinatorial problems, Wesley da Silva Coelho, Louis-Paul Henry Quantum Application Engineer, Loïc Henriet, CTO, Pasqal
- Single-Photon based Quantum Computers available in the cloud : Metrics and Benchmarks" Shane Mansfield, Chief Research Officer and Jean Senellart, Chief Product Officer, Quandela
- Primitives and circuit optimization, Blake Johnson, Quantum Platform Lead, IBM
- An HPC & QC integrated platform : Jacques-Charles Lafoucrière, Head of HQI program, CEA
- Building the first of its kind hybrid quantum/classical hosting environment, Richard St Pierre, directeur général de la Zone d'Innovation Quantique de Sherbrooke, Laurent Bernou-Mazars, CTO et co-fondateur d'Exaion

16:45 17h:00 Coffee Break

Today’s Program / Afternoon

17:00 17h30 The impact of compilation in the implementation of quantum computing - Simon Martiel, Quantum Computing Researcher, Atos

17:30 18:00 Integrating High-Performance Computing with Quantum Computing - Scott Pakin, Scientist, Los Alamos National Laboratory
18:00 18:15 Conclusion (E. Décossin)

18h15 - 19h:00: Cocktail

Atos

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