

Quantum computing science: training and tools for physicists and “classical” computing engineers at IN2P3/CNRS

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A chronology

- 10 Sep. 2018:

The IN2P3 Scientific Director for computing and data addresses a message to all directors of the IN2P3 labs to encourage the participation to the forthcoming CERN OpenLab Workshop on QC from 5-6 Nov. 2018 (an invitation for both physicists and engineers).

- 26 Jun. 2019

Call for contributions at the “Prospectives nationale IN2P3 – calcul, algorithmes et données”, for nuclear, particle and astroparticle physics; a group of interest is built around the subject of quantum computing.

- 6 Sep. 2019

Meeting in Paris of a working group (~17) <https://indico.in2p3.fr/event/19662/> with a discussion about a possible workshop introducing the subject of quantum computing to an IN2P3 audience.

A chronology (cont.)

- 17/18 Oct. 2019

The session “Calcul et données” of the IN2P3 road map exercise is held at Clermont-Ferrand; this concludes with several “white paper” reports, one of them about emerging technologies, including QC.

<https://indico.in2p3.fr/event/19733/>

<https://webcast.in2p3.fr/container/journees-prospectives-calcul-algorithmes-et-donnees>

<https://prospectives2020.in2p3.fr>

- 2/3 Dec. 2019

“Journées thématiques IN2P3 – Quantum computing: state of the art and applications” workshop is organized at IPNO Orsay

<https://indico.in2p3.fr/event/19917/>

with 68 registered participants and ~30 who registered for the 2nd day tutorial and hands-on session.

A chronology (cont.)

At this workshop, contacts have been established with specialists from CEA and its partners and a large panorama of the technology research and the current applications has been presented to the participants: qubit technologies, circuits for quantum computing (hardware), many-body solutions using quantum devices, particle tracking strategies.

- 3 Feb. 2020

Invited laboratory seminar at CPPM Marseille “Quantum computing - an introduction for computer scientists”

<https://indico.in2p3.fr/event/20033/>

(to be repeated at LPC on 17 Apr.)

How can IN2P3 labs contribute ?

- keep up-to-date with the developments of this technology, for instance be able to understand and assess the announcements which punctuate the strong competition nowadays (see the Google announcement about reaching the quantum supremacy in Nature 23 Oct. 2019)
- prepare the transition of the “classical” computing engineer to the “quantum” version by offering seminars and tutorials in order to bridge with the new programming paradigm over the necessary knowledge of the quantum mechanics as the “hardware” component of this new kind of computing science
- discover and practice with the current languages for the programming of the quantum devices, use the real demonstrators like the IBM Quantum Experience, also use simulators (try to equip some computing centers ?)

Example: the tutorial session of the IN2P3 workshop

- a review of the “classical” circuits for the binary computing
 - universality of the set of gates
 - building reversible gates
 - generic function evaluation
- introduction on qubits
 - the “quantum reality” from the quantum mechanics postulates
 - a little of vector algebra, operators, measurements, errors
 - gates, universal gates, circuits, qubits entanglement
 - quantum teleportation of qubit state functions
 - generic function evaluation with example
- simulations with Quantum++ <https://github.com/vsoftco/qpp>
- simulations (teleportation) with myQLM from Atos
- demonstration of a real run with IBM Q processor and Qiskit

Foreseen activities in 2020

- theoretical studies on the interaction of qubits with their environment (IPNO)
- put together a “step in” training material for physicists and computing engineers, based on existing QC simulators and emulators, see a comprehensive list here
<https://quantiki.org/wiki/list-qc-simulators>
(LPC)