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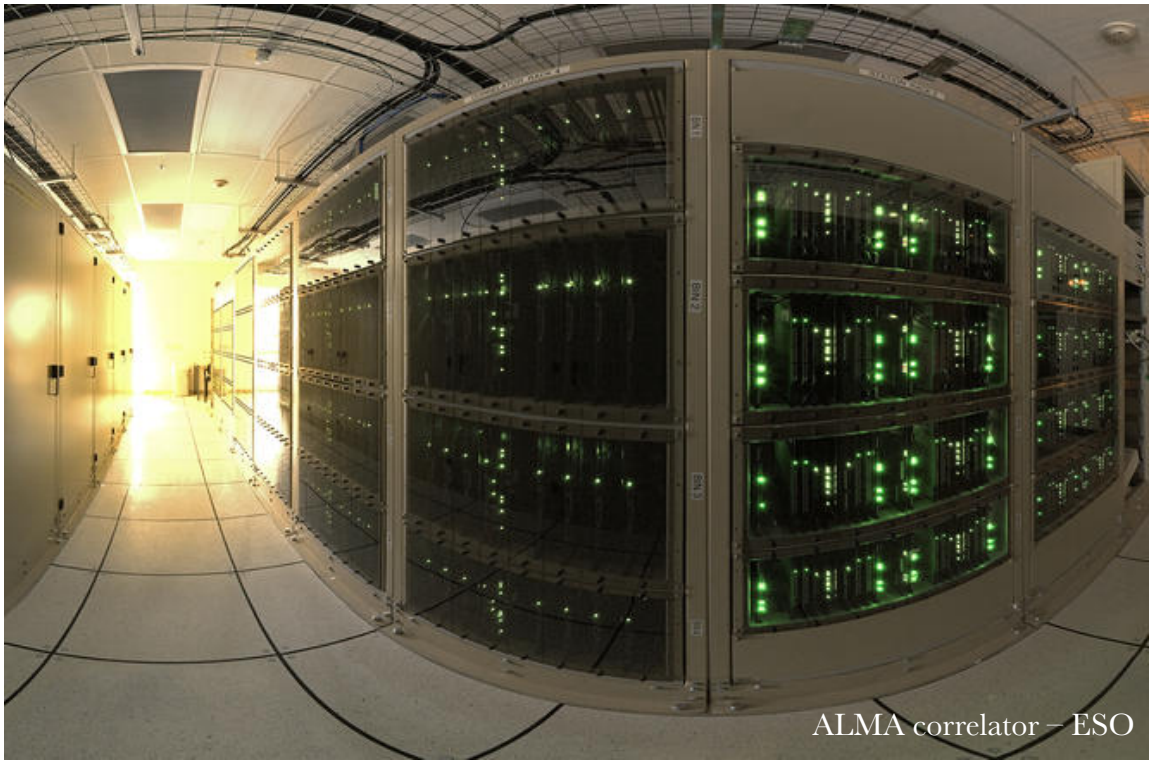
Superconducting Supercomputing

based on Josephson Junctions (S2J2)



ALMA correlator – ESO

AVIGNON – Palace of the Popes – Conclave room

14-16 March 2018

Superconducting Supercomputing

Scientific Program

Wednesday, March 14
14h-14h30 opening of the symposium
14h30-15h30 round table
Ecological, economic and industrial stakes of Big Data
with :
Pascal FEBVRE (FLUXONICS chairman, Université Savoie Mont-Blanc)
Gabriel MARQUETTE (CNRS/INSU, Paris)
Alain RAVEX (Cryoconsult)
Georges WAYSAND (Laboratoire Souterrain Bas-Bruit, Rustrel Pays d'Apt)

15h30-16h coffee break

16h-17h round table
Introduction to the world of Josephson junctions : Supercomputing, Quantum Computing
with :
Pascal FEBVRE (Université Savoie Mont-Blanc, France)
Coenrad FOURIE (Stellenbosch University, South Africa)
Hans HILGENKAMP (Twente University, The NetherLands)
Colin P. WILLIAMS (D-Wave Systems, Inc, Canada)

19h-20h public conference : **The computer coming in from the cold**

Dinner on your own

The computer coming in from the cold

by Pascal Febvre and Georges Waysand

Between 2011 and 2016 global data traffic has been multiplied by 4.5. Hence more data centre for storage and supercomputers for their digital processing. In France, as of 2015 the consumption of electrical energy data centres, mainly for cooling, would have exceeded that of the city of Lyon (about 3TWh per year). The rise of digital technologies has become a financial burden ... and a global environmental problem.

Indeed, conventional calculators based on semiconductor materials reach their performance limits in terms of miniaturisation, speed of calculation and energy efficiency. Until now, these limitations are partially offset by having several processors work in parallel (multi-core architectures), but at the cost of higher power consumption. So much so that the cooling of the most powerful machines is a major problem, as evidenced, for example, by the recent installation of Facebook's first data center in northern Sweden, 100 km from the Arctic Circle, where the average annual temperature is 2.4 ° Celsius.

There is now a technology, in pre-industrialisation phase in some countries, consuming 10,000 to 100,000 times less energy to perform the same operations. It relies on the use of superconducting materials, which have the property of no longer presenting electrical resistance below a certain temperature. It is therefore necessary to cool the circuits to a temperature close to -269 ° C for them to work. Contrary to popular belief, cooling technologies are now reliable and used daily for many applications (in hospitals with MRIs, at CERN, etc.). Cooling has a cost : to get 1 kW of cold power at -269 ° C, it takes about 250kW of electrical power. Despite this, the overall consumption of these supercomputers that come from the cold is still 10 to 100 times lower than current technologies, while being able to operate at clock speeds about 100 times higher than those of current computers ... we will talk about all of this.

Thursday, March 15

Session 1 : Needs of superconducting electronics : from fundamental physics to medicine

9h00–9h30 **Superconducting Digital Electronics – An overview**
Pascal Febvre – Université Savoie Mont Blanc – France

9h30–10h15 **Quantum Computing as a Business : the D-Wave Perspective**
Colin P. Williams – D-Wave Systems, Inc – Canada

In this talk, I will provide a commercial perspective on quantum computing, including an overview of quantum computing technology, the pros and cons of various implementation strategies, its potential to disrupt several major markets, and how the commercial perspective on quantum computing differs from that of academia. I will describe several applications of D-Wave quantum computers in optimization, machine learning, and simulation, and give a personal perspective on how the quantum computing field is likely to evolve.

10h15–10h30 coffee break

10h30–11h00 **Superconducting electronics for metrology**
Johannes Kohlmann – PTB – Braunschweig, Germany

11h00–11h30 **Status and Perspectives of the activities of Leibniz IPHT within the European FLUXONICS Foundry**
J. Kunert, U. Hübner, E. Il'itchev, R. Stolz, H. Schmidt – Leibniz Institute of Photonic Technology – Jena, Germany

11h30–12h00 **VTT superconductor foundry overview**
Visa Vesterinen – VTT Technical Research Centre of Finland Ltd – Espoo, Finland

12h30–13h30 Lunch at restaurant *Le Lutrin (Rue de La Balance, 84000 Avignon)*

14h00–14h45 **Towards the Square Kilometre Array**
Fabienne Casoli - Observatoire de Paris

14h45–15h15 : **Superconducting digital technology for processing microwave signals of antenna arrays**
Pascal Febvre – Université Savoie Mont Blanc – France

15h15–15h30 : coffee break

Session 2 : Superconductivity and cryogeny

15h30–16h15 **Cryogenics for superconducting and quantum computing – new challenges**
Alain Ravex – Cryoconsult – France

16h15–16h45 **Air Liquide industrial experience on superconducting devices cooling in the 1.8K - 4K range**
Simon Crispel – Air Liquide Advanced Technologies – France

16h45–17h00 **Discussion on cryogenic cooling**

19h30 Dinner at the *Carré du Palais* restaurant with Côtes du Rhône wine tasting (1 Place du Palais, 84000 Avignon)

Friday, March 16

Session 3 : Superconducting supercomputers : technological solutions, from hardware to software

9h00–9h45 **Superconducting microprocessors – The Japanese experience**
Akira Fujimaki – Nagoya University – Japan

9h45–10h15 **Self-shunted Josephson junctions : a solution for high integration of circuits**
Mikhail Belogolovskii – National Academy of Sciences – Kyiv, Ukraine

10h15–10h30 coffee break

10h30–11h00 **Superconducting Arithmetic Logic Units for supercomputers**
Ali Bozbey – TOBB University – Ankara, Turkey

11h00–11h30 **Electronic Design Tools for superconducting supercomputers**
Coenrad Fourie – Stellenbosch University – South Africa

11h30–12h00 **Definition of next steps and working groups – wrap-up**

12h30–14h Lunch at restaurant *Le Lutrin (Rue de La Balance, 84000 Avignon)*