Postdoctoral Researcher Position

Laboratory: Centre de Nanosciences et de Nanotechnologies (C2N)
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Experimental Demonstration of Learning in Neuromorphic Hybrid CMOS-Memristor Systems

The use of memristors, or resistive memory, as artificial synapses is a major lead to advance the field of brain-electronics, or neuromorphic computing, and reduce dramatically the energy consumption of artificial intelligence. CMOS-based artificial synapses suffer from their large area and volatility, whereas **memristor-based synapses provide nonvolatile, fast, compact, and multivalued synapses featuring a rich physics that can be harnessed by brain-inspired principles**[1,2,3]**.**

In recent years, in collaboration with LETI and Aix-Marseille Université, we have designed and fabricated various neuromorphic designs associating CMOS-circuits and memristor-based synapses[3,4,5]. These demonstrators offer a wide flexibility allowing to test various concepts of brain-inspired computing to implement inference and learning. They can also allow testing unconventional ideas such as Bayesian learning[5] and metaplasticity[6]. **Currently, we have only exploited a fraction of the capabilities of these designs. The postdoctoral scholar will join our characterization effort to try advanced concepts of learning on these fabricated circuits, as well as test their capability in various environments (high temperature, radiation,…).**

The postdoctoral scholar will collaborate actively with students working on theoretical ideas, as well as participate to student mentorship. He/she will have access to our extensive characterization lab, including a dedicated Cascade 200mm semi-automated probe station, a Keysight B1500A analyzer with B1530 modules, wire bonding facilities, and various electronic equipment.

Testing the implementation of neural networks on neuromorphic systems involves significant programming, therefore, the postdoc should be comfortable with programming (our current test system uses Python). Some experience with FPGA would be also a major advantage, but is not mandatory. Experience with neural networks or neuromorphic circuits is recommended, but this postdoc project might also be an opportunity to enter this field for a candidate with strong characterization experience. The postdoc project can be adapted to candidates with experience characterizing systems, circuits, and/or devices.

Our lab is located on the new campus of Université Paris-Saclay, featuring multiple academic and industrial labs, engineering schools, restaurants, shops, and sports facilities, as well as beautiful and protected forests.

The postdoc is funded by European grants with an initial, renewable appointment of 18 months.

[1] *D. Marković, A. Mizrahi, D. Querlioz, J. Grollier, "Physics for neuromorphic computing", **Nature Reviews Physics**. 2020 2(9):499.*
[2] *A. Mizrahi, … , J. Grollier, D. Querlioz, "Neural-like computing with populations of superparamagnetic basis functions", **Nature Communications** 9, Article number: 1533 (2018).*
[3] *M. Bocquet, T Hirztlin, …, D. Querlioz, "In-memory and error-immune differential RRAM implementation of binarized deep neural networks". In 2018 IEEE International Electron Devices Meeting (**IEDM**).*
[4] *T. Hirtzlin, …, D. Querlioz, "Hybrid analog-digital learning with differential rram synapses." In 2019 IEEE International Electron Devices Meeting (**IEDM**).*
[5] *T. Dalgaty, …, D. Querlioz, E. Vianello. "In situ learning using intrinsic memristor variability via Markov chain Monte Carlo sampling". **Nature Electronics**. 2021 Feb;4(2):151-61.*
[6] *A. Laborieux, …, D. Querlioz, "Synaptic metaplasticity in binarized neural networks". **Nature communications** 12(1), 1, 2021.*

Skills to be learnt: The postdoc will learn about novel ideas for neuromorphic computing and AI, as well as emerging memory technology. He/she will develop and learn several methodologies of simulation and experimental characterization. The project is highly adapted to a subsequent career in academia in an Electrical Engineering or Applied Physics department.