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| C:\Users\David\Documents\presentaciones\00-logo\EPFL\EPFL-main.jpgEmbedded Systems Laboratory (ESL)  Director: Prof. David Atienza Alonso  |  [http://esl.epfl.ch](http://esl.epfl.ch/) |  |
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**Design of an integrated capacitor-based DC-DC for Fuel Cell Array liquid cooling technology**

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**Project Description**

With the spread of Artificial Intelligence (AI) applications and web services in our everyday life, computing requirements on data-centers are skyrocketing. The problem is particularly critical when considering AI workloads which performances scale with their memory bandwidths. In this context, High-Performance Computing (HPC) architecture designers bring the different elements of a server (CPU, GPU, Memories, etc.) closer and closer to each other. Thereby, thermal dissipation constraints make conventional cooling techniques non-sufficient.

Fuel Cell Array (FCA) is a liquid cooling technology developed in the ESL Laboratory. Coolant is injected inside microchannels etched on the chip substrate. Oppositely to regular water-based liquid cooling technologies, FCA uses two different chemical species reacting with each other along the microchannel. Thanks to these electrochemical reactions, FCA behave a bit like an electronic blood: they both extract the heat generated in the chip and bring power locally. In 2020, ESL received the Best Paper Award from the International Computer Society Annual Symposium on VLSI on the integration of DC-DC converters to maximize the energy extracted from FCA microchannels.

In this project, we propose to follow up on these works and implement a real DC-DC. The work will consist of the design and simulation of a multi-stage configurable DC-DC in 28nm CMOS high-performance technology, explore the design space, and maximize the converter efficiency. Then, in collaboration with the Ph.D. student working on the topic, the proposed DC-DC will be modeled and introduced in a complete simulation benchmark featuring thermal and electrical simulations under realistic AI workloads. We expect out of this work a publication in a top conference.

The project will be carried out at the [Embedded Systems Laboratory (ESL)](https://www.epfl.ch/labs/esl/), inside the Swiss Federal State Institute of Technology (EPFL) one of the world's top-class universities. ESL is an active group (22 Ph.D. students among 40 members) involved in many research aspects. The student will be under the supervision of and Ms. Halima Najibi, Dr. Alexandre Levisse, and Prof. David Atienza.

**Project objectives:**

1. Understanding of the theory behind FCA technology and previous works. Familiarization with the design tools.
2. Design of a block diagram of a configurable multi-stage DC-DC converter.
3. Transistor-level schematic design of the converter. Variability and thermal simulations to validate the functionality and performances.
4. Layout of the proposed architecture. Parasitic extraction and comparison versus the non-extracted design.
5. Modeling of the proposed DC-DC converter for fast design space exploration.

**Required knowledge and skills:**

* Advanced knowledge on digital and analog circuit design
* Good analytical skills
* Good background on computer architecture

**Appreciated skills:**

* Scientific curiosity
* Good communication skills
* Advanced English
* Good competences to work autonomously
* Teamwork

**Type of work:** 20% theory analysis, 80% design and simulation