

# Masters Level Research Internship

## FPGA Audio Processing Core for DIY 3D-Printed Ambisonic Microphone

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### Technical Information

- **Employer:** CNRS (France)
- **Location:** Citi Lab (INSA Lyon), 6 avenue des arts, 69100 Villeurbanne (France)
- **Duration:** six months starting in February 2026
- **Salary:** “Gratification de stage”
- **Advisor:** Romain Michon (Inria)
- **Send your application to:** `romain.michon@inria.fr`

### Context

This internship will be carried out in the context of the 3DREAM project (<https://team.inria.fr/emeraude/3dream/>) which brings together the Emeraude team at CITI lab (Inria/INSA Lyon) and LMFA’s Acoustics Team at École Centrale de Lyon, towards developing an open-source, DIY ambisonic microphone. The end goal is to create a low-cost, waterproof, and field-ready prototype for autonomous recording in challenging environments (e.g., bio-acoustics, eco-acoustics applications, etc.).

This microphone will be based on MEMS capsules and an FPGA (Field-Programmable Gate Array), leveraging recent work of the Emeraude team on using this kind of processing platform for real-time audio DSP tasks [1].

The intern will focus on FPGA-based real-time audio processing, working alongside another intern responsible for hardware prototyping. The project builds on the SMALL library (<https://www.sekisushai.net/ambitools/2024/07/25/small.html>) and the Syfala Toolchain (<https://inria-emeraude.github.io/syfala/>) towards providing a robust, open-source solution for researchers and makers.

### Missions

- Interfacing MEMS microphones with an FPGA prototyping board.
- Writing a PCM transceiver in VHDL for decoding the signals produced by the MEMS microphones on the FPGA.
- Enabling multichannel audio recording on an SD card on the FPGA.
- Enabling multichannel real-time audio transmission over Ethernet on the FPGA.
- Potentially carrying out on-board audio DSP on the FPGA using the Syfala framework.

## Expected Skills

- Strong background in FPGA programming (VHDL, mostly).
- Background in C programming.
- Background in embedded systems (embedded Linux).
- Preferred but not mandatory: background in audio DSP.

## About Emeraude

The Emeraude team is based at CITI Lab at INSA Lyon (France). It gathers the strengths of Inria, INSA Lyon, and GRAME-CNCM. It specializes on embedded audio systems and their programming as well as arithmetic. It develops various tools such as the Faust programming language (a DSL for Real-Time audio DSP), Syfala (a tool to facilitate the programming of FPGAs for real-time audio DSP), and FloPoCo (a generator of arithmetic cores for FPGAs). The team hosts 6 faculty, 6 PhD students, 3 postdocs, 2 engineer, and multiple research interns. Additional information can be found on team website: <https://team.inria.fr/emeraude>. Even though the internship will take place within Emeraude, the official employer for the internship will be CNRS.

## References

- [1] Maxime Popoff. *Compilation of real-time audio DSP on FPGA*. PhD thesis, INSA de Lyon, December 2024.