

# Wagner: Formal Models for Sound Processing

## Internship proposal

MINES ParisTech (ex. École des mines de Paris)

The ANR FEEVER project intends to foster the development of the Faust functional programming language and ecosystem for efficient digital audio signal processing. In order to study certain formal properties and extensions of Faust programs — such as operational behavior or program logics — we have introduced the WAGNER [1] language, a functional synchronous language (see for instance [2], ask us for many more references). WAGNER acts as a high-level intermediate target language for the Faust compiler — available in an experimental branch — but can be also related to a formal version of more recent developments such as the MathWorks Audio System Toolbox. We propose three lines of work:

**Typing and Semantics** WAGNER type system is based on co-effects and a simple notion of type polarity, with a straightforward operational semantics, and an efficient virtual machine related to the original semantics via logical relations. You will work with us in extending the type system and improving the operational semantics and proofs. Students should be familiar with the theory of type systems for functional programming languages.

**Mechanized Semantics** We have developed a basic WAGNER model mechanized in Coq-MathComp, enough to already prove quite interesting properties. You will extend this model to accommodate some additional features, as well as complete the part pertaining to WAGNER's VM. Some proficiency in Coq plus a basic understanding of the Mathematical Components library is recommended. We'd be happy however to take a candidate willing to learn the library.

**Type Inference and Compilation** We have developed a preliminary OCaml-based compiler for WAGNER; the compiler is capable of performing some basic type inference and code generation. You will work on improving the type inference strategy by adding bidirectional type checking, and fine tuning the current interpreter for WAGNER's VM. Familiarity with OCaml and type inference is recommended.

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## References

- [1] E. J. Gallego Arias. *Experiments in Certified Digital Audio Processing*. 1h Seminar. <http://www.cri.ensmp.fr/people/gallego/slides/SpecFun-04-2016/>. 2016.
- [2] A. Guatto. “A Synchronous Functional Language with Integer Clocks”. PhD thesis. École Normale Supérieure Paris, 2016.