

The Erlangen National High Performance Computing Center (NHR@FAU) is looking for a

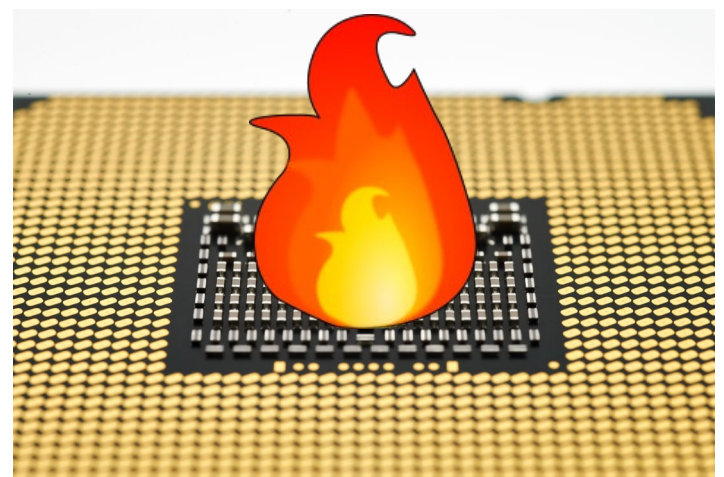
## Master thesis student for

# Power and Energy Consumption Analysis of Modern CPUs and GPUs in High Performance Computing

The thesis will be supervised by and conducted in the Research division at NHR@FAU, led by Prof. Dr. Harald Köstler.

### Description

While power dissipation and energy consumption were, for a long time, mainly of interest on mobile devices, they are becoming prime target metrics in all fields of computing, including High Performance Computing (HPC). Server-grade CPUs and GPUs have recently entered new ranges of maximum power dissipation – a single device can easily “burn” several hundred watts. With energy prices soaring, understanding the influence factors for power and energy consumption on such devices is becoming paramount in research and industry. Which instructions burn more energy than others? Can I set an optimal clock frequency? How much performance must I sacrifice for reduced power and energy consumption? Does it make sense to use fewer cores or streaming processors than available on the chip? Is a power cap useful, and what impact does it have on performance?



Working on this thesis, you will learn how to design and conduct experiments that can help answer such questions. You will develop insights that could be invaluable not only from a research point of view but also for daily operations in a HPC computing center such as NHR@FAU.

### Within the master thesis, the focus will be in the following areas:

- Getting familiar with power and energy measurement facilities on the compute node level
- Defining simple benchmarks for studying power and energy on GPUs and CPUs
- Running the benchmarks on NHR@FAU’s 5-Petaflop Top500-class “Fritz” and “Alex” supercomputers
- Setting up phenomenological analytic power models for CPUs and GPUs and deriving energy optimization strategies
- Investigation of the energy properties of SIMD (Single Instruction Multiple Data) instructions in HPC code

Working on these topics, you will have the chance to work with **state-of-the-art supercomputing technology** in a scientific environment. We foster **scientific thinking** and proper **data presentation skills**.

### Required skills

- Profound knowledge of C/C++ and/or Fortran
- Knowledge of high-performance parallel computer architecture and of code parallelization with OpenMP (as taught, e.g., in the lecture “Programming Techniques for Supercomputers”)
- Some CUDA knowledge is advantageous, but not strictly necessary
- Knowledge of basic performance modeling strategies (e.g., Roofline)
- Excellent communication skills in English and/or German

Please direct any inquiries or applications to

Georg Hager <[georg.hager@fau.de](mailto:georg.hager@fau.de)>  
Gerhard Wellein <[gerhard.wellein@fau.de](mailto:gerhard.wellein@fau.de)>