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Swiss Federal Institute of Technology Zurich

Computational Seismology Group

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Postdoctoral research position: Full-waveform modeling and inversion across the scales

The Computational Seismology Group at ETH Zürich is seeking to appoint a postdoctoral researcher to work on *Salvus*, an open-source framework for full-waveform modeling and inversion (<http://salvus.io>). The position is full-time (100 %) for a duration of 24 months, with possibility for extension. Earliest starting date is 1 June 2017.

Background:

Salvus is a modular open-source code package for large-scale waveform modelling and inversion built on the basis of modern programming principles. This project will enable *Salvus* to (1) harness large homogeneous and various heterogeneous HPC architectures that are available today, (2) easily adapt to future architectures, requiring minimal code modifications, and (3) execute continuous unit-, integration- and performance-tests.

The project is intended to position *Salvus* as a top wavefield modelling and inversion package in the exascale era. To ensure performance of *Salvus* on today's and tomorrow's supercomputing platforms, work will focus on cross-architecture developments, code and I/O optimisation, and systematic testing and validation. This will be complemented by actions to increase and broaden the usability and impact of *Salvus*. They include workflow developments, the implementation of frequency-domain solvers, and extensions of the physics that can be modelled.

The successful candidate will be embedded into the team of *Salvus* developers and users covering a wide range of fields, including Computational Science, Applied Mathematics, Seismology, Exploration and Environmental Geophysics, Geothermal Energy, and Geofluids. She or he will have access to *Piz Daint*, currently Europe's fastest supercomputer, located at the Swiss National Supercomputing Center (CSCS, www.cscs.ch).

Apart from the core responsibilities listed below, the successful candidate will have considerable freedom of research in order to develop an independent scientific career. Topics of interest to the group include, but are not limited to real-world waveform modeling and inversion applications, the development of methods for uncertainty analysis, and the transfer of *Salvus* to new domains outside traditional seismology.

Core responsibilities:

- Cross-architecture developments, leveraging *Salvus*' mixin-based design to implement hardware-specific versions of compute-intensive code segments, while leaving most of the code unchanged.
- General code optimisations to achieve maximal performance from single nodes to full machine runs. This involves the implementation of optimal degree of freedom ordering in *PETSc DMPlex*, optimal load balancing, and hybrid parallelism.

- I/O optimisation to handle the enormous data volumes needed in adjoint simulations. Sub-tasks include the incorporation and extension of a previously developed wavefield compression library, and the interfacing to modern parallel seismic data formats.
- Workflow developments to facilitate the solution of large-scale inverse problems, including the automatic orchestration of a large number of HPC jobs.

Expected qualifications:

Applicants are expected to have the following qualifications:

- PhD degree in a related field, e.g., geophysics, computer science, physics, applied mathematics, ... ,
- excellent programming skills and experience in object oriented programming (preferred languages: C++ & Python),
- strong knowledge in scientific computing on HPC platforms,
- previous experience with PETSc and/or CUDA,
- experience with finite-element methods, numerical wave propagation, and/or inverse problems.

Furthermore, the successful candidate is expected to have excellent organizational, communication and interpersonal skills that allow her or him to work in a highly collaborative and interdisciplinary environment.

Application:

To apply for this position, please send your full resume, cover letter and the names of three references to Prof. Andreas Fichtner (andreas.fichtner@erdw.ethz.ch). **The position will remain open until filled.**