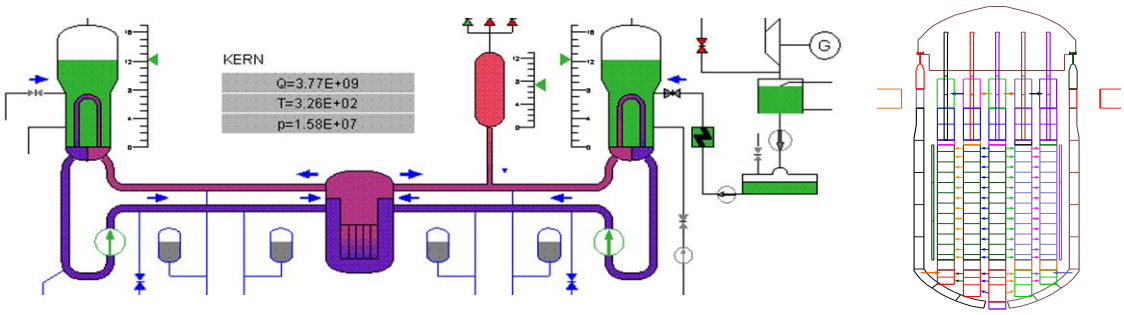
Bachelor's / Master's Thesis

Implementation and Benchmarking of Sparse-Matrix Solvers for Two-Phase Flow Applications

The **Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH** performs safety analysis for nuclear power plants. The focus is on the development of simulation codes which are used to predict hypothetic accidents. For the simulation of multi-phase flow phenomena in the cooling system of a nuclear power plant, the program **ATHLET** (Analysis of Thermal-Hydraulics of Leaks and Transients) is being developed at GRS. The cooling system is modeled as a pipe network and discretised with the finite volume method resulting in sparse linear systems of equations of dimension 1,000-100,000. Currently, two sparse-matrix methods for the computation of the Jacobian and the solution of the linearized system are available within ATHLET, one of them being the KLU solver (left-looking LU decomposition of Gilbert and Peierls). Since long-term transients have to be calculated, additional state-of-the-art solution methods shall be implemented.



Tasks:

- Integrate the **open-source tool PETSc** into ATHLET; PETSc provides a variety of different linear solvers (both direct and iterative) as well as preconditioners and is used intensively at SCCS.
- Identify and compare solvers of PETSc suitable for nuclear cooling systems using benchmark computations.
- Elaborate a recommendation for a specific solver/preconditioner combination for a concrete application problem depending on the resolution and the frequency of the updates of the Jacobian.

Optional Tasks (in case of a Master's Thesis):

- Implementation/usage and test of PETSc interfaces for parallel solvers
- Selection and tests of solvers fort the solution of the underlying non-linear system of equations.
- Analysis of the structure and properties of the Jacobian; usage of the SPAI preconditioner (Sparse Approximate Inverse) that is developed at the chair SCCS.

Prerequisites:

- Student of Informatics or Mathematics
- Basic knowledge of solution methods for linear and non-linear systems of equations
- Programming experience (C; Fortran advantageous)

This project is run in cooperation of the GRS with the chair of Scientific Computing in Computer Science (SCCS, Prof. Bungartz) of the TU München. The GRS is located on the campus of the TUM in Garching (Boltzmannstr. 14). **The thesis is payed according to a working student rate.**

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