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Frédéric Joliot/Otto Hahn
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TOPIC ⑤

5.2 MULTI-PHYSICS ANALYSIS

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One of the more challenging multi-physics problems in engineering is the solution of the coupled temperature/fluid and neutron/nuclide fields for the analysis of nuclear reactors. In an effort to improve the efficiency and economics of nuclear power, there has been growing interest within the U.S. nuclear community to expand the role of full physics, high fidelity computer simulations in nuclear reactor analysis.

During the past fifteen years, Professor Downar and his students have been part of the team developing the advanced light water reactor analysis code TRACE at the U.S. NRC. One of their principal contributions has been the development of the nodal neutronics code PARCS which calculates the time dependent flux/power distribution in the reactor core. PARCS has been coupled to both TRACE and RELAP5 thermal-hydraulics codes which are currently used to certify the safety performance of all U.S. reactors and many of the other reactors around the world.

The U.S. NRC coupled code system is shown below in Figure 1. The U.S. NRC supports the cross section generation code TRITON which is part of the ORNL SCALE software system. However, GENPMAXS and PARCS also processes data from several of the popular commercial cross section codes such as CASMO and HELIOS.

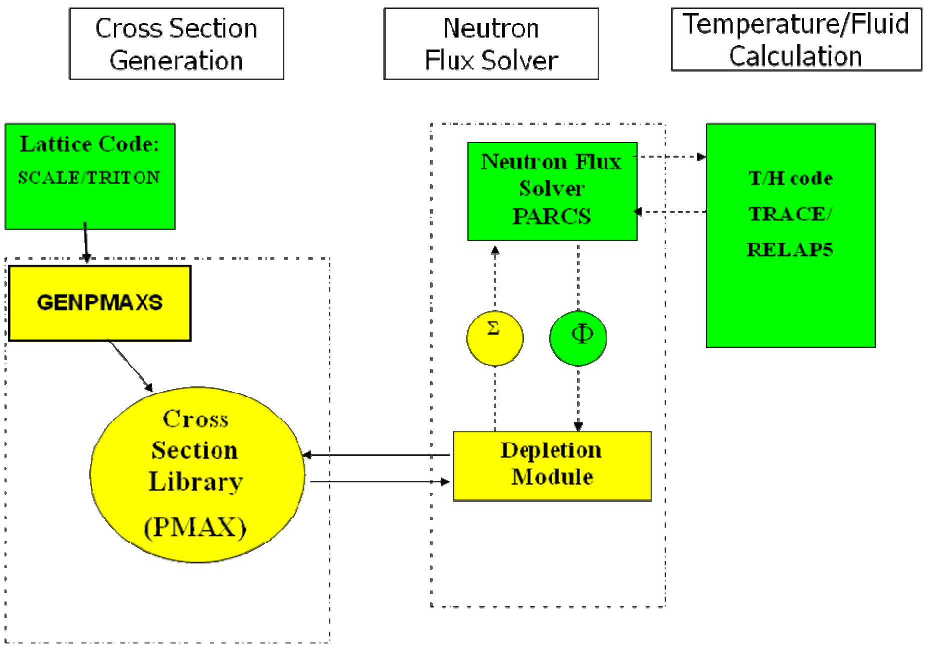

Figure 1 U.S. NRC Coupled Code System

The U.S. NRC coupled code system has been applied to several coupled code benchmarks to include the OECD PWR Main Steam Line Break Benchmark, the OECD BWR Peach Bottom Turbine Trip Benchmark, and the BWR Ringhalls Stability Benchmark. The TRACE coupled code system has also been applied to the Oskarshamn Stability event from February, 1999, which had a decay ratio of great than one and current efforts and an OECD benchmark has been prepared for the Oskarshamn event. Professor Downar will discuss the application of the TRACE/PARCS coupled code system during the workshop.

For the past 10 years, Professor Downar and his students have also been sponsored by the U.S. DOE and EPRI to develop an advanced neutronics/thermal-hydraulics coupled code based on the integral neutron transport code DeCART which they have coupled to the commercial computational fluid dynamics (CFD) code, STAR-CD. The coupled code system is depicted below in Figure 2.

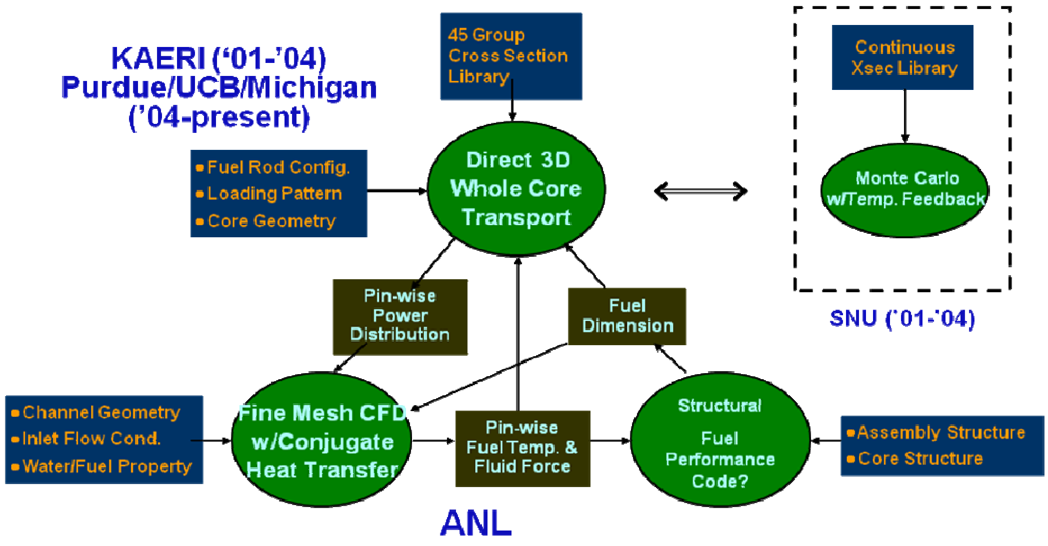

Figure 2 Advanced Coupled Code System: The Numerical Nuclear Reactor

The DeCART and STAR-CCM+ code is now part of the virtual reactor being developed by the DOE Reactor Simulation Hub being led by ORNL. In the presentation, Professor Downar will discuss the development, application, and performance of the coupled TRACE/PARCS and STAR/DeCART coupled codes to the steady-state and transient analysis of the Pressurized Water Reactor.

References

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