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# Testing, Simulating, and Profiling Designated Problems for CASL

## Thermal-Hydraulic Sub-channel Code for Light Water Reactors Transient Analyses (COBRA-TF)

Simulation is an essential step for future implementations of more efficient and safer reactor components. In nuclear technology, this translates to cost reduction, fuel improvements, waste reduction, and safety enhancement. CASL's mission is to apply existing modeling and simulation capabilities and develop advanced capabilities to create a usable environment for predictive simulation of light water reactors.

## Research objectives

Provide developers with useful information to aid program optimization

- Dynamic program analysis
- Code's performance and behavior
- Frequency and duration of function calls

## COBRA-TF behavior

- Test and simulate designated problems
- Profile code's behavior
- Collect, organize, analyze, and visualize results
- Provide feedback to developers

Profile output

| % | cumulative seconds | self seconds | calls | self s/calls | total s/calls | name |
|---|---|---|---|---|---|---|
| 45.48 | 765.52 | 765.52 | 1122 | 0.00 | 0.00 | xschem_ |
| 11.08 | 952.09 | 186.57 | 124634943 | 0.00 | 0.00 | tgas_ |
| 6.59 | 1063.09 | 111 | 1122 | 0.00 | 0.00 | result_channel_ |
| 5.84 | 1161.36 | 98.27 | 45936 | 0.00 | 0.00 | sstemp_ |
| 5.81 | 1259.22 | 97.86 | 1122 | 0.00 | 0.00 | temp_ |
| 4.23 | 1330.38 | 71.16 | 1122 | 0.00 | 0.00 | result_ |

Description

| Description | Called by | Calls |
|---|---|---|
| linearizes the momentum, continuity and energy equations | outer | intfr gssolv fillro vdrift tgas veloc sat dvdhl xtra1 dvdpv dvdhv |
| Calculates vapor temperature and specific heat capacity cp of vapor | cobrai prep3d xschem post3d prop | |
| Prints the sub-channel results of the calculation at specified time intervals | edit | prop sat |
| calculates the steady state temperatures for fuel rods | heatin | gauss |
| Calculates temperature at the new time step for fuel rods and unheated conductors | heat | gauss |
| Prints solution results at specified intervals | edit | sat |

Figure 1. Top seven time-consuming functions of COBRA-TF

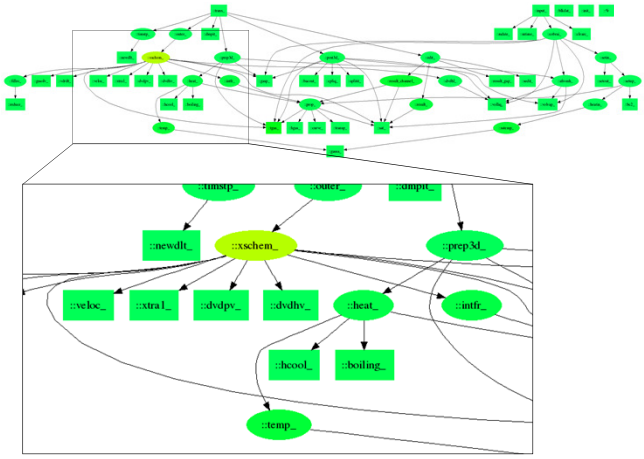


Figure 2. Call graph for better understanding of the COBRA-TF behavior

Figure 3. The Consortium for Advanced Simulation of Light Water Reactors (CASL) is the first DOE energy innovation hub; CASL is designed to bring together scientists and engineers from private and public institutions to achieve high-priority energy goals. http://www.casl.gov

The research showed that during this particular simulation, 56.56% of the time is being spent at two subroutines

- 45.48% of time spent at subroutine xschem
- 11.08% of time spent at subroutine tgas

The overall performance of the program can be greatly enhanced by implementing xschem and tgas routines.

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