APROS related work at the Budapest University of Technology and Economics

András CSIGE
Budapest University of Technology and Economics
Department of Nuclear Energy

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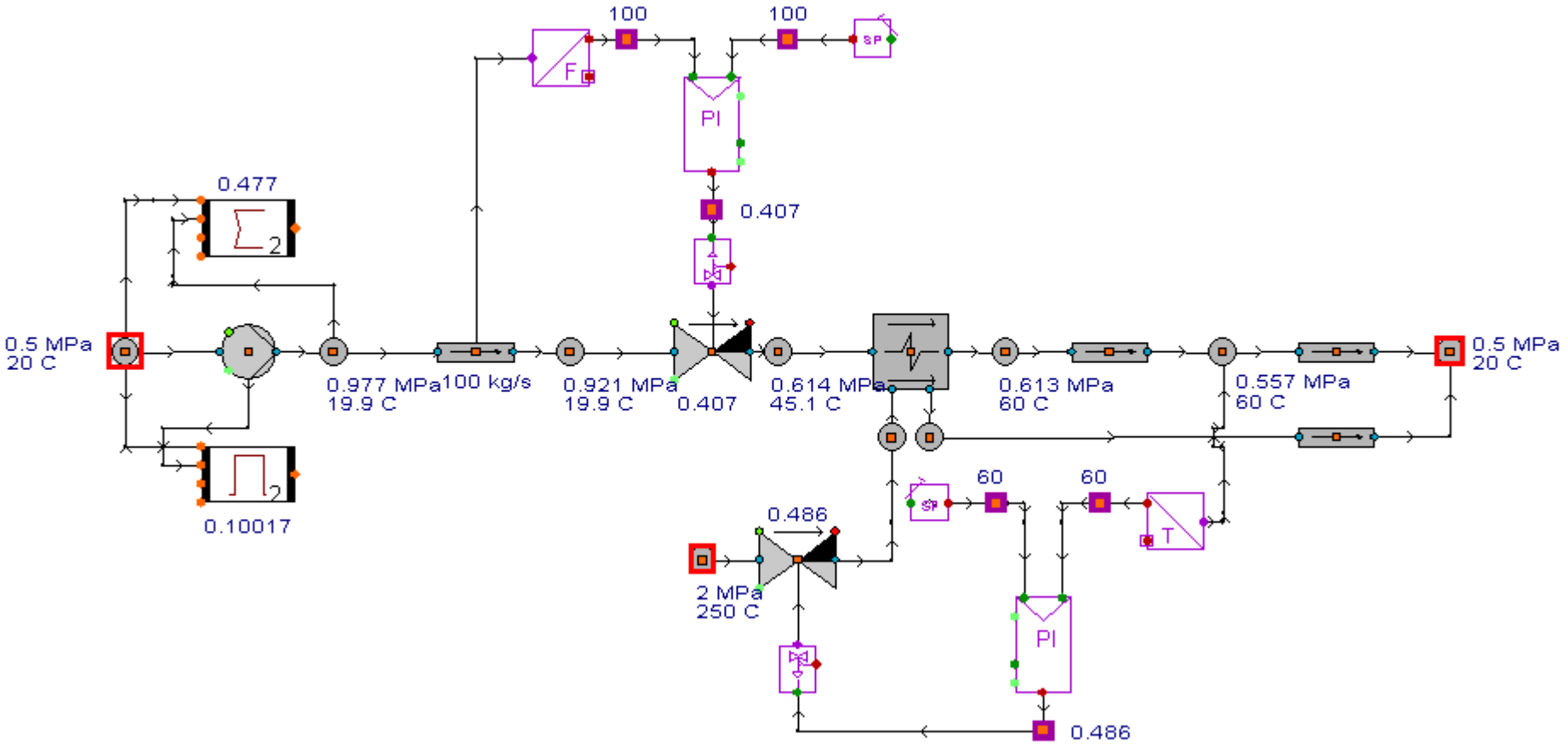
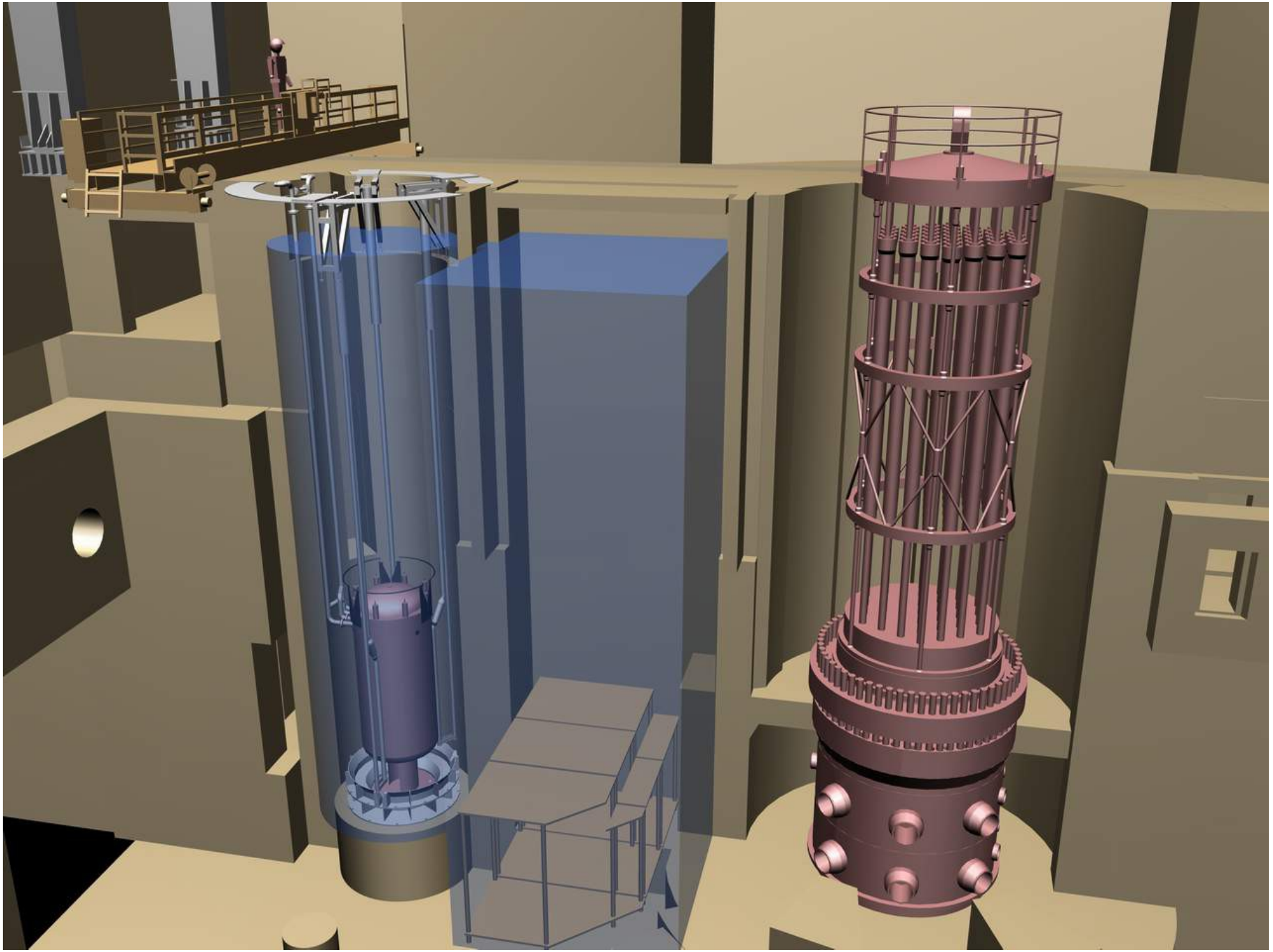
Introductory APROS student exercise



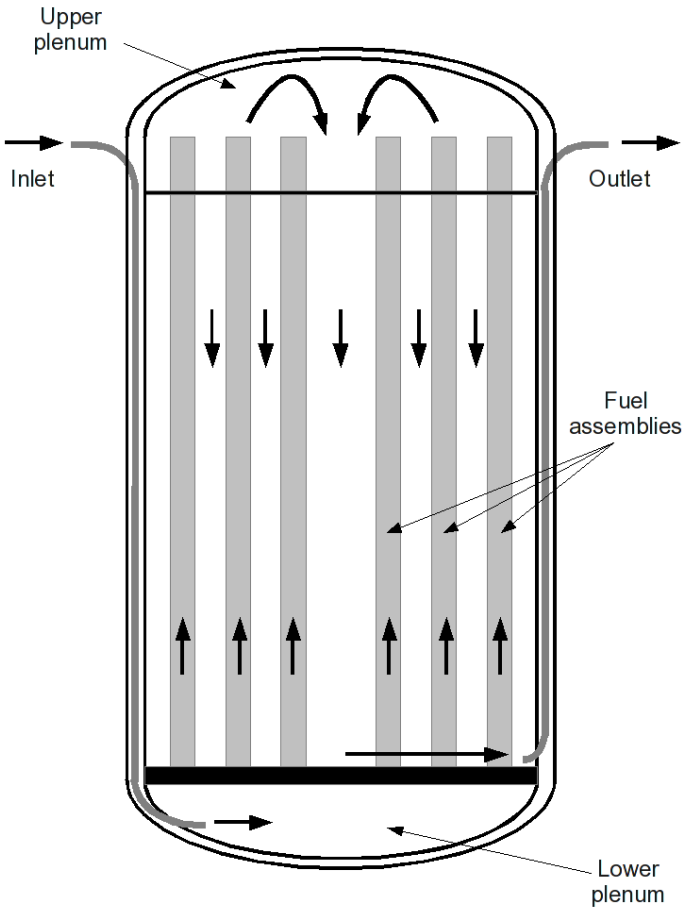
- GUI: points, pipes, pumps, valves, heat exchangers
- CLI: show/list, calculation level components
- Flow and temperature control circuits
- Slave copy, “not in simulation”, boundary condition modules

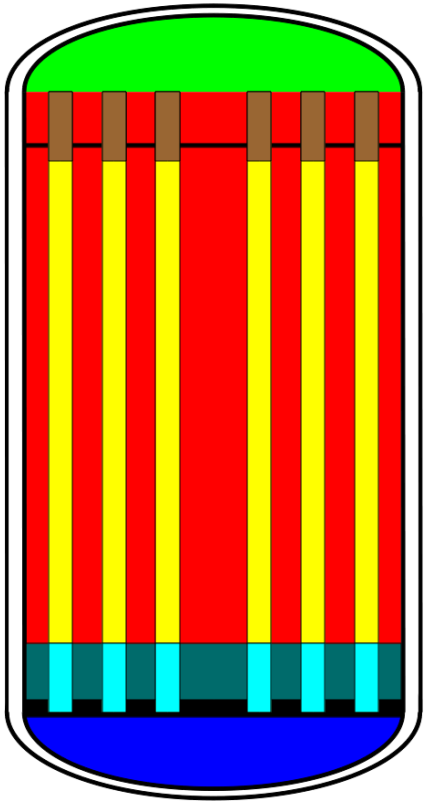
Advanced APROS student exercise: AMDA tank

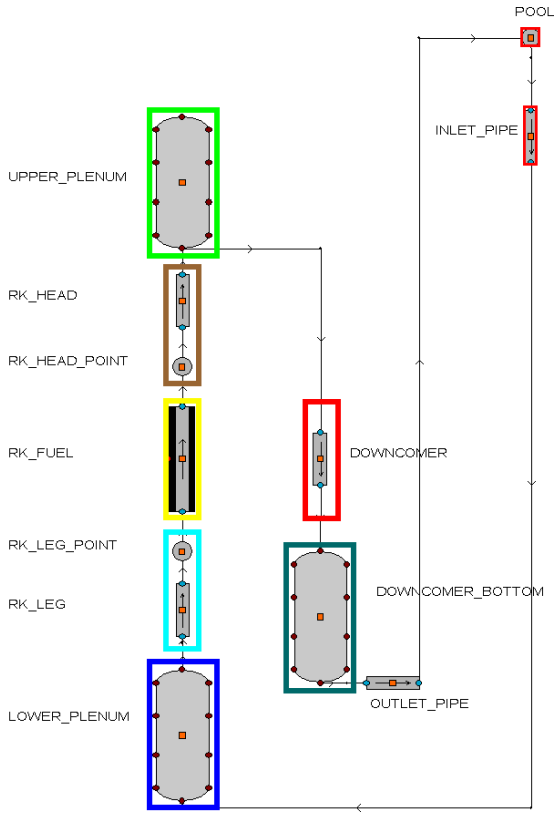


"Those who cannot remember the past are condemned to repeat it."

Advanced APROS student exercise: AMDA tank

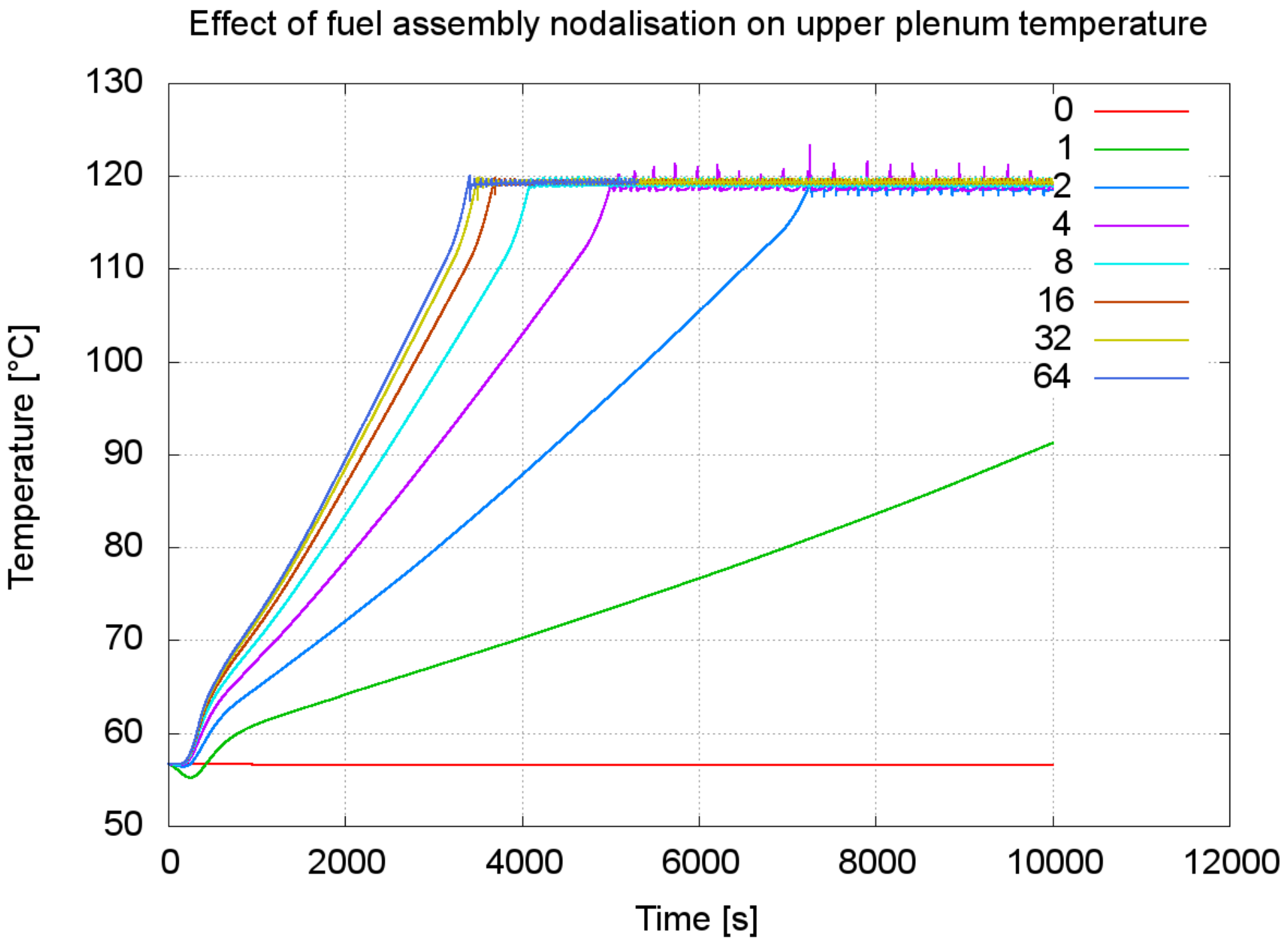




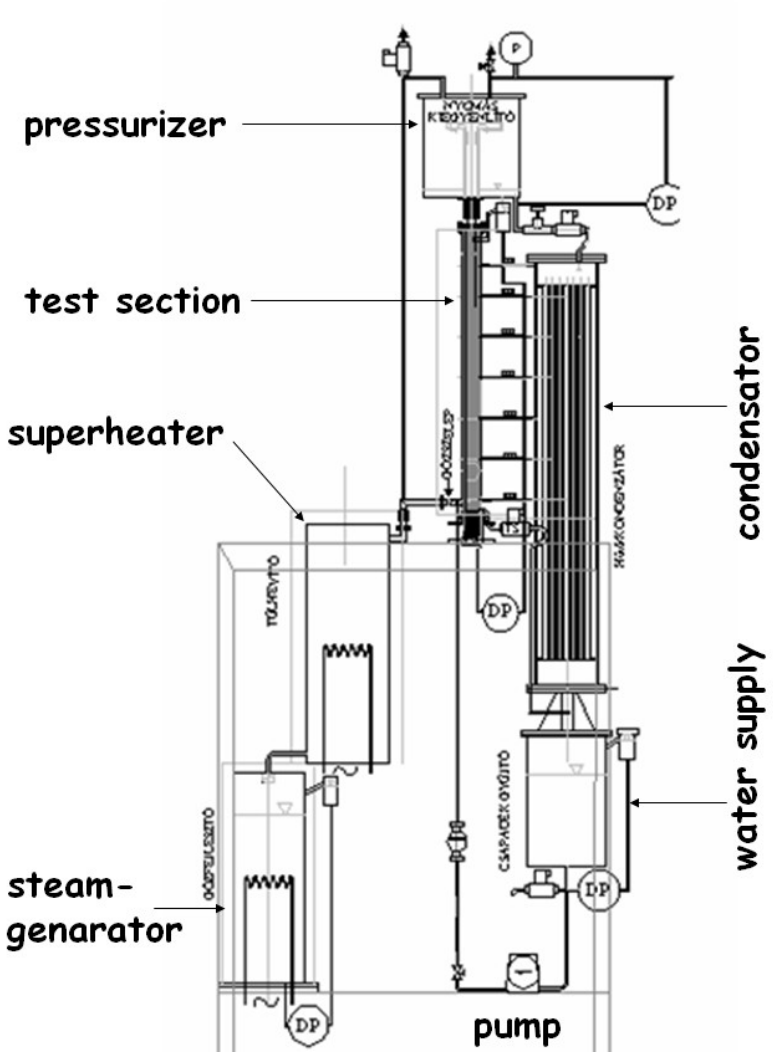


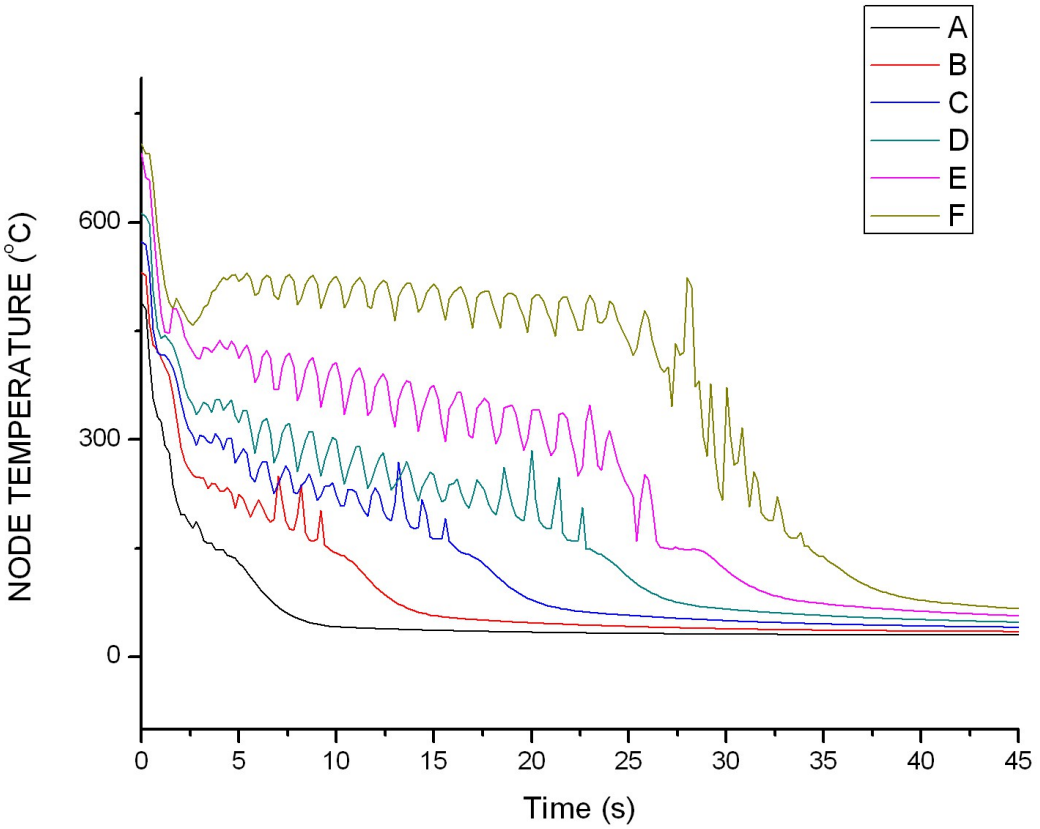
- Calculating necessary geometrical parameters and building the model of the AMDA tank
- Studying the effect of bypass on flow pattern

Advanced APROS student exercise: AMDA tank



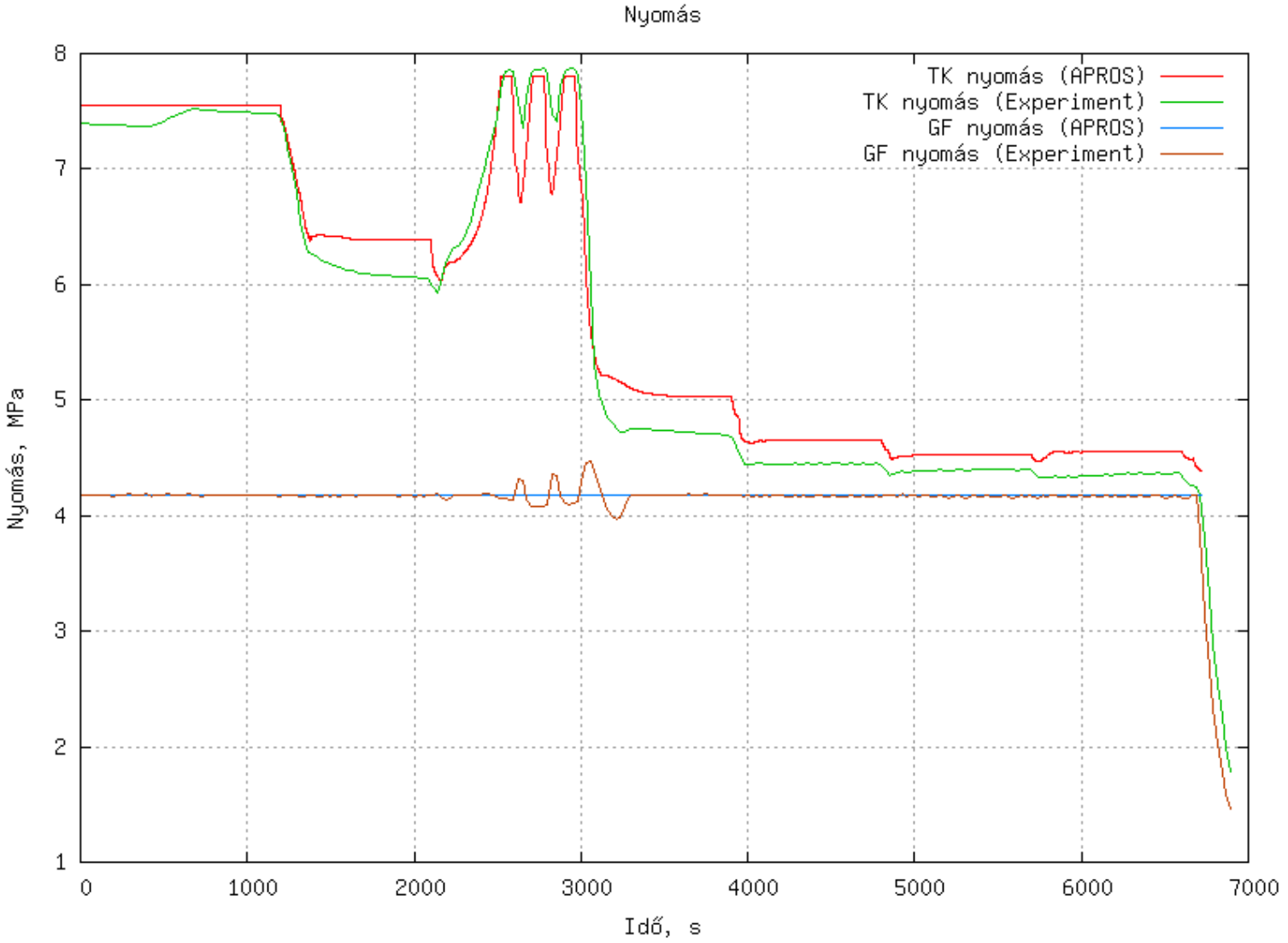
Example BSc thesis work: CODEX model

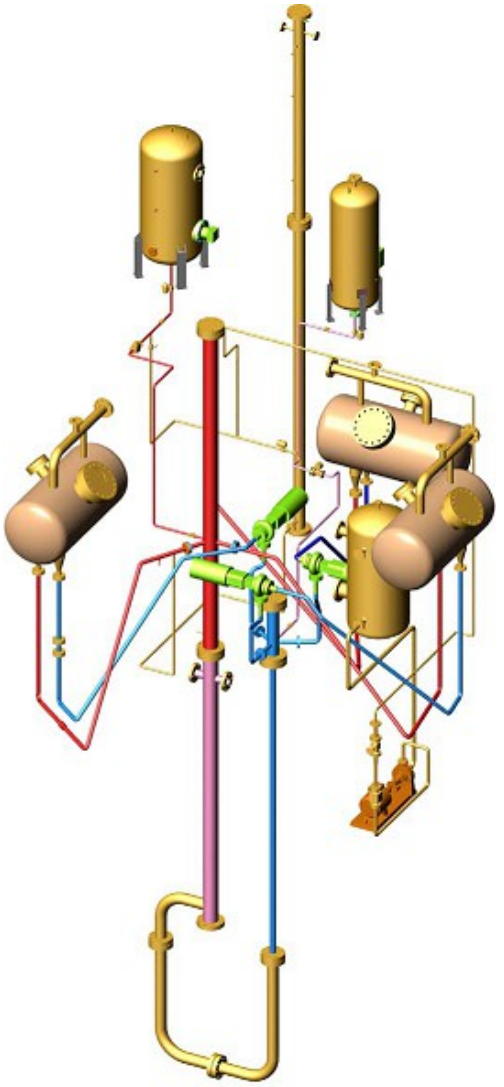




- Experimental investigation of the coolability of a ballooned VVER 440 fuel bundle
- Modeling the reflooding and cool-down with APROS

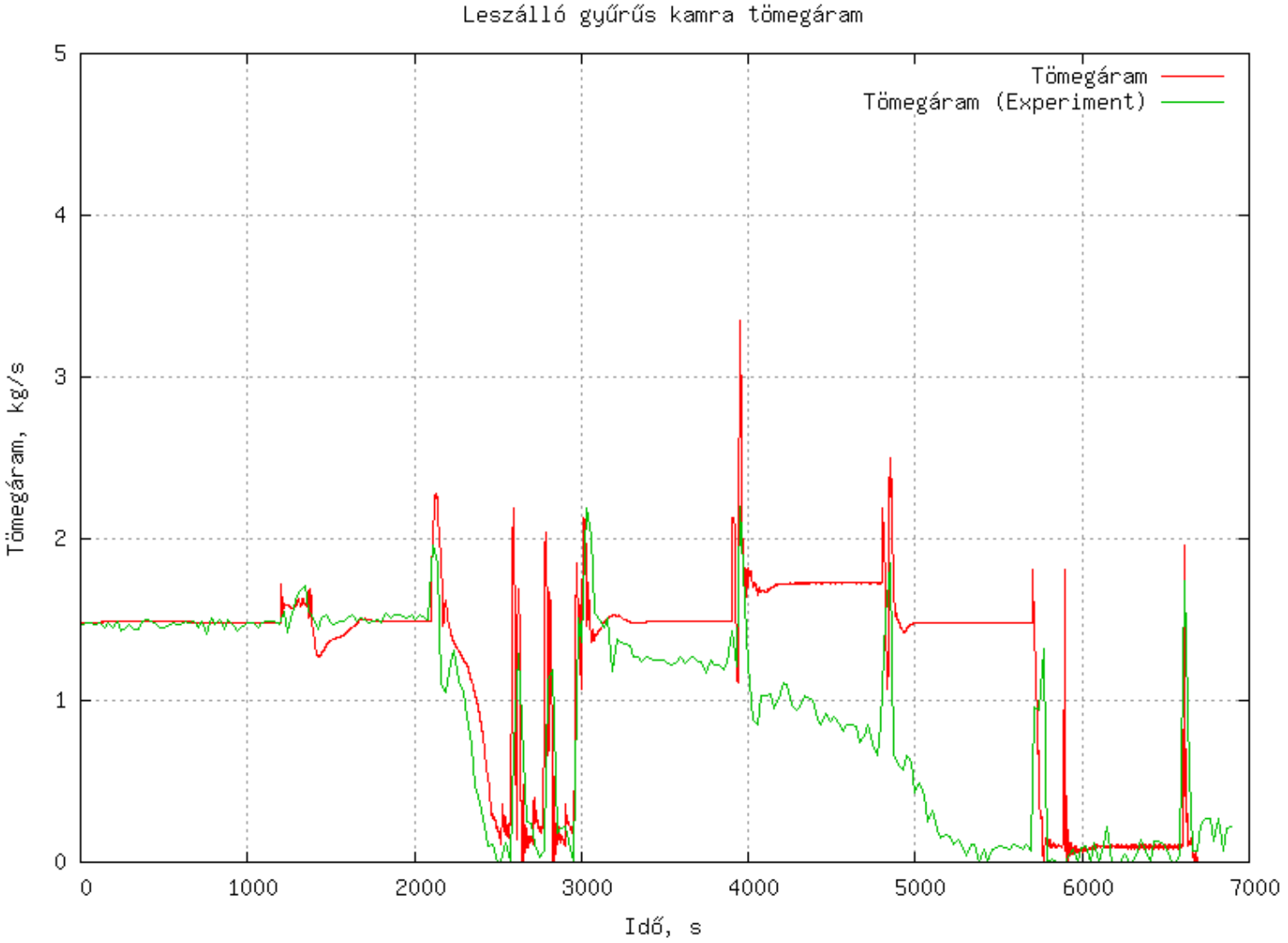
Example MSc thesis work: PACTEL model

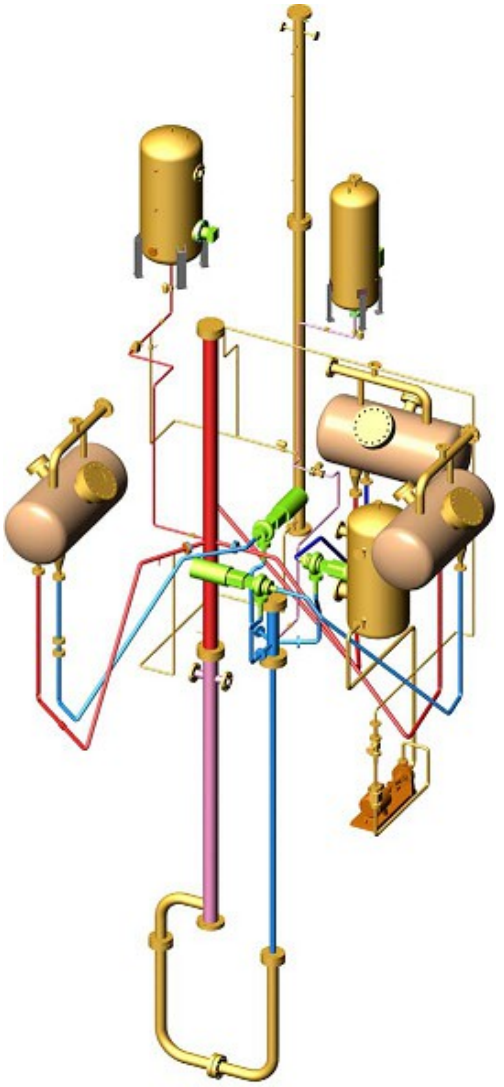




- 3-loop integral test facility for VVER-440 NPP
- ISP-33: One- and two-phase natural circulation with reduced primary coolant inventory

Example MSc thesis work: PACTEL model





- General behavior of the system was well predicted
- Problems with calculated loop and DC mass flows

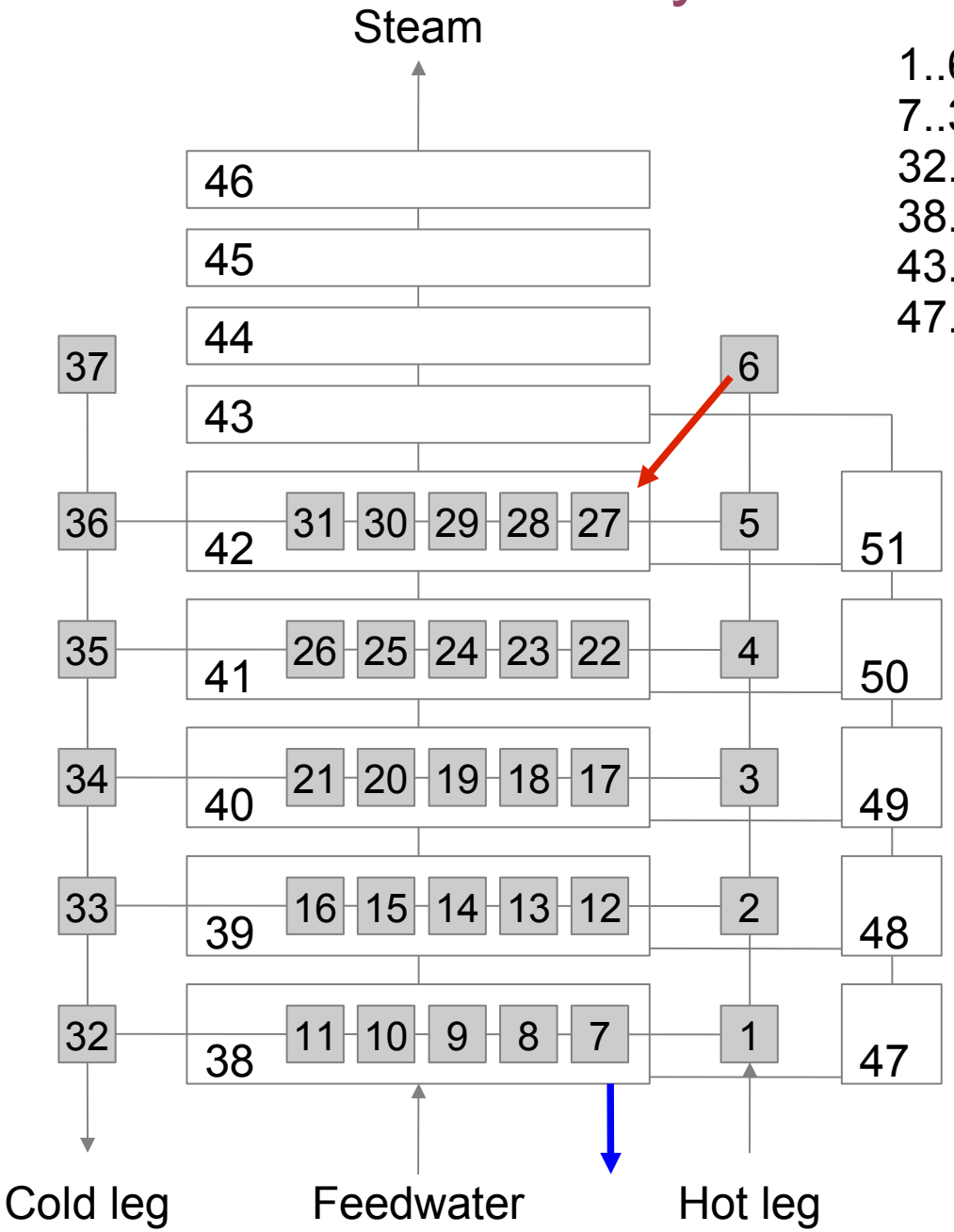
PHARE project: VVER-440 model development

- Paks-specific VVER-440/213 APROS model is under development (and in use) since 2000.
  - Detailed model of primary and secondary circuit
  - I&C: realistic model of control circuits and SCRAM signals
- PHARE project between 2004-2006:
  - Extension of the plant analyzer with containment model
  - Test calculation: LBLOCA
  - Extension of the plant analyzer with severe accident capabilities
  - Test calculation: Station black-out, comparison to MELCOR results

SG blowdown system for PRISE management

- Primary-to-secondary leakage was not a DBA case for the VVER-440/213 NPP.
- Primary coolant can fill the secondary side of the steam generator, and escape to the environment through the SG safety valves (Rivne NPP, 1982).
- SG safety valves are not designed for 2-phase blowdown, may fail to close, injected ECCS water can not be recirculated.
- PRISE management strategy: depressurization below SG safety valve closure pressure before the SG secondary side is filled up with water.
- New, automatic system for blowing down water to the containment from the SG.
- New operator procedures: primary depressurization with ECCS spray into the pressurizer, secondary depressurization with BRU-A valves, shutting down ECCS, checking core outlet subcooling margin.

SG blowdown system for PRISE management

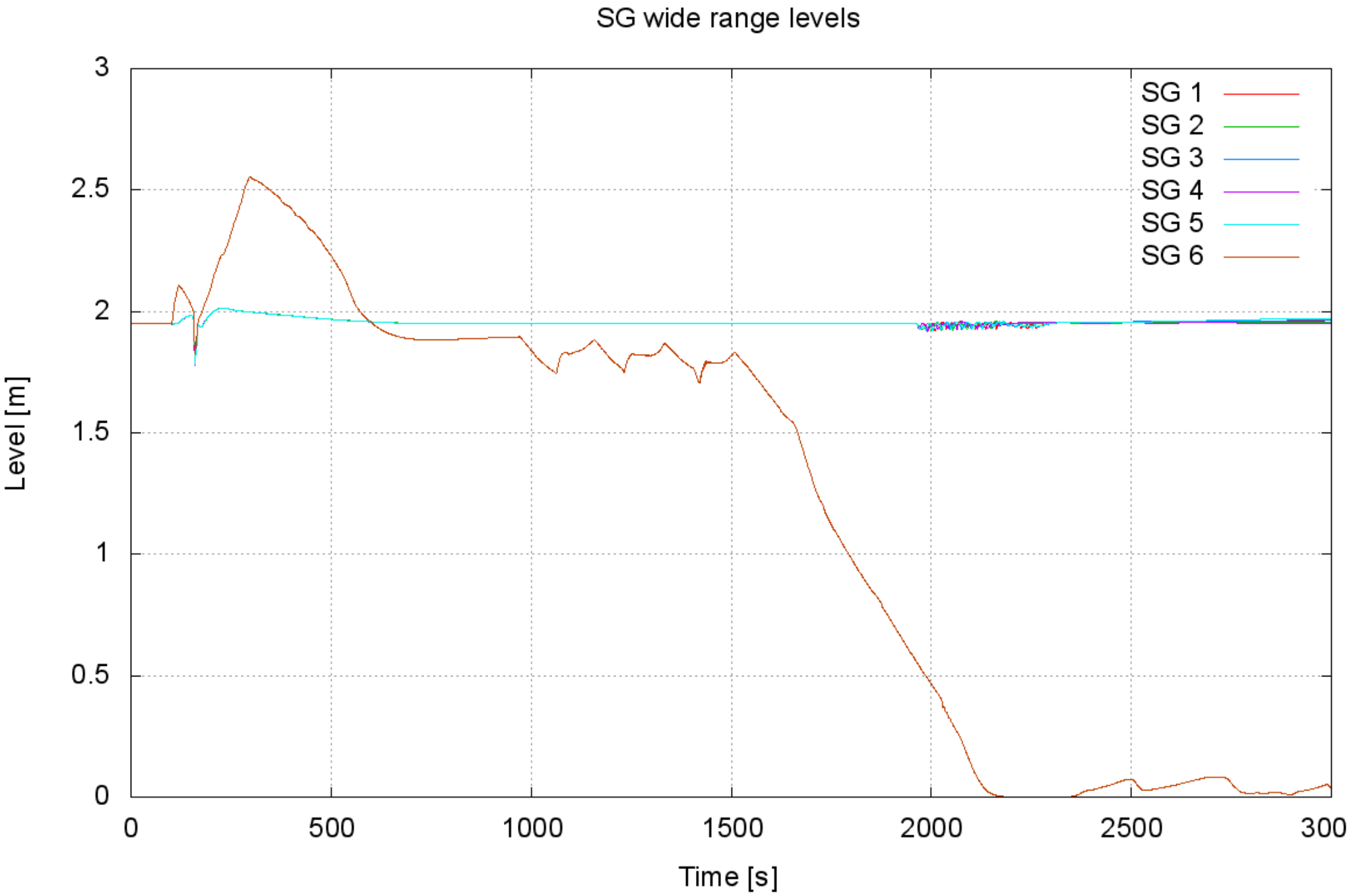


1..6	Hot collector
7..31	Heat exchanger tubes – primary side
32..37	Cold collector
38..42	Heat exchanger tubes – secondary side
43..46	Steam dome
47..51	Secondary side recirculation

Collector break

Water blowdown

SG blowdown system for PRISE management



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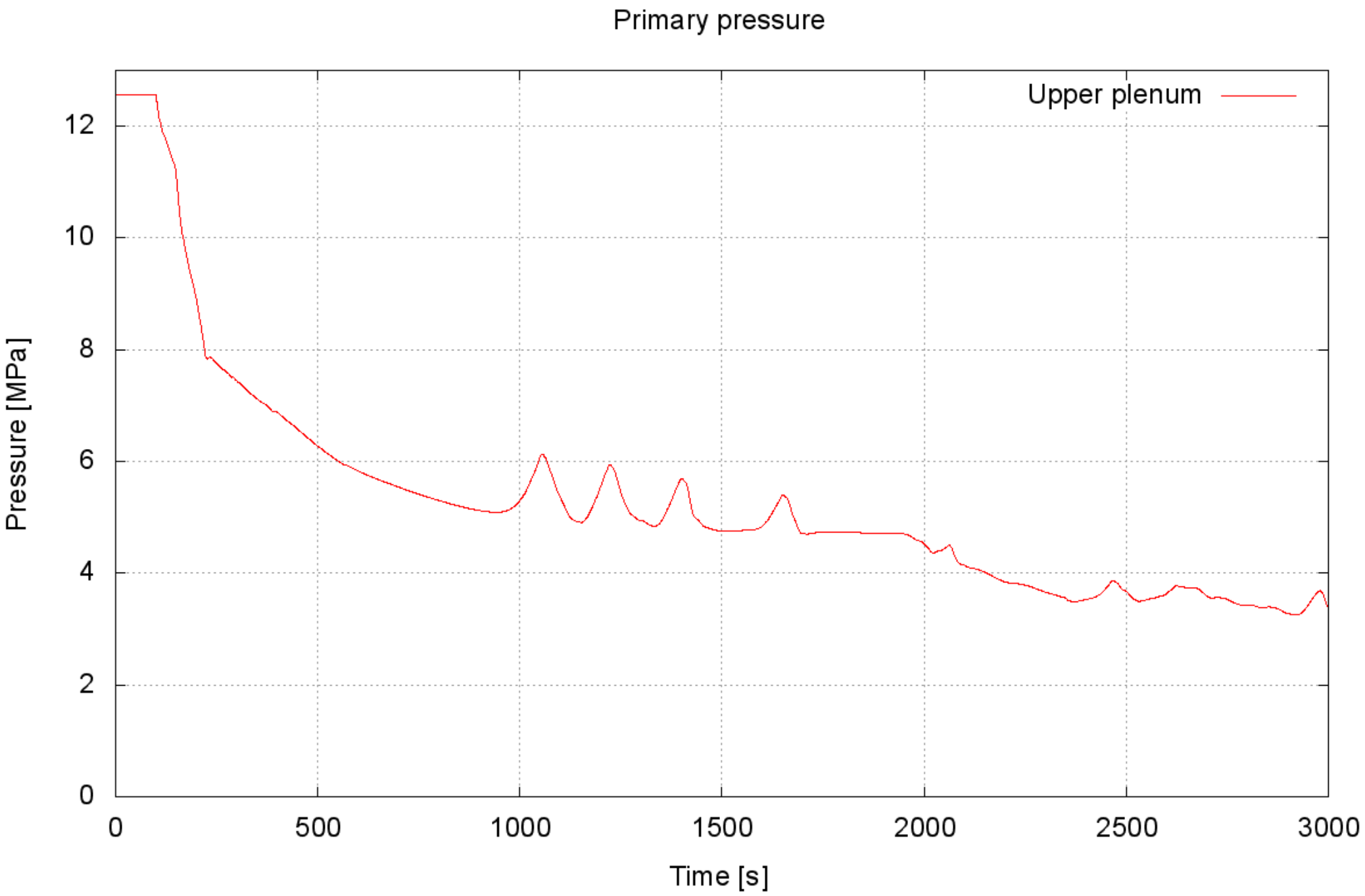
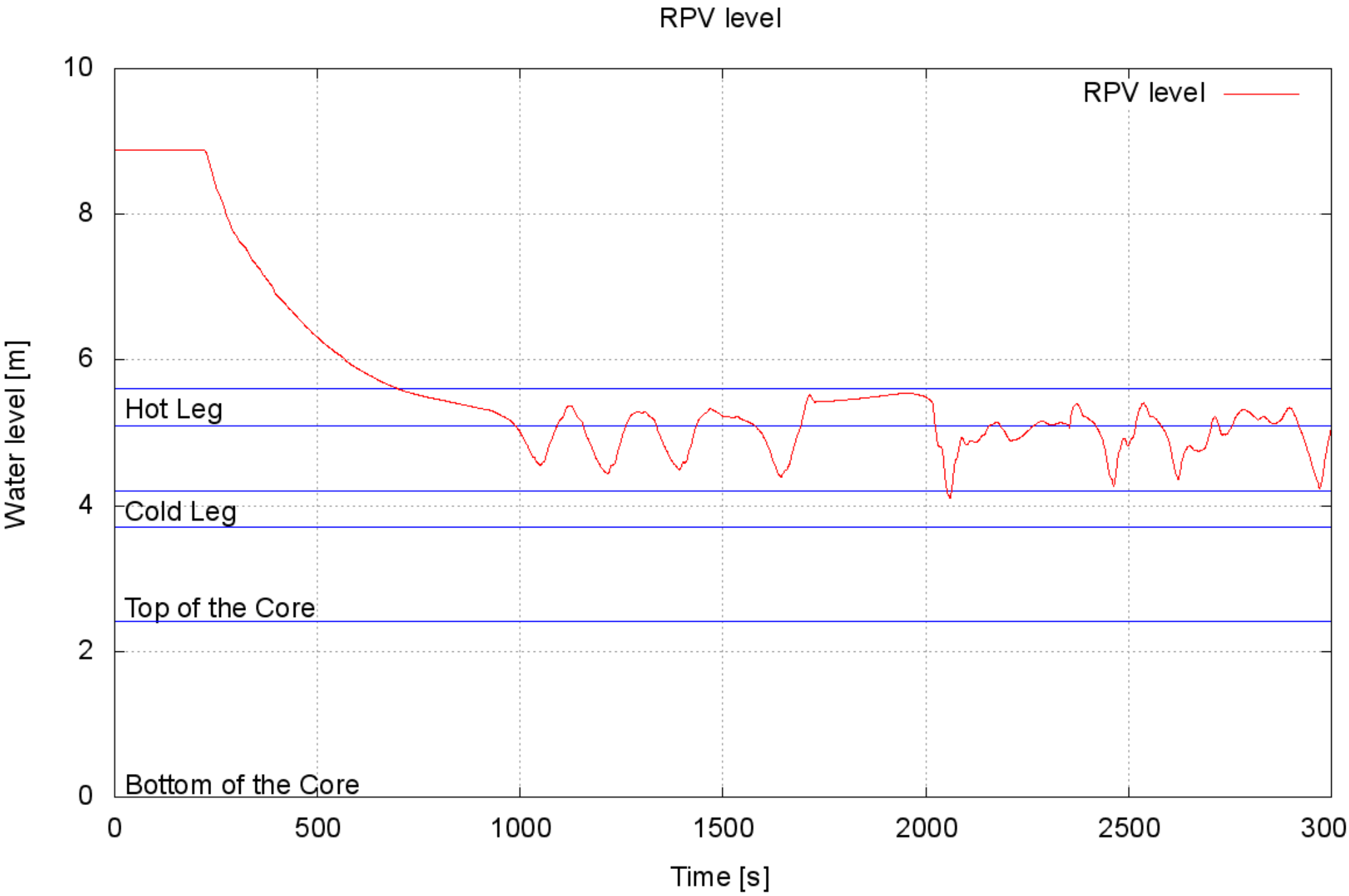
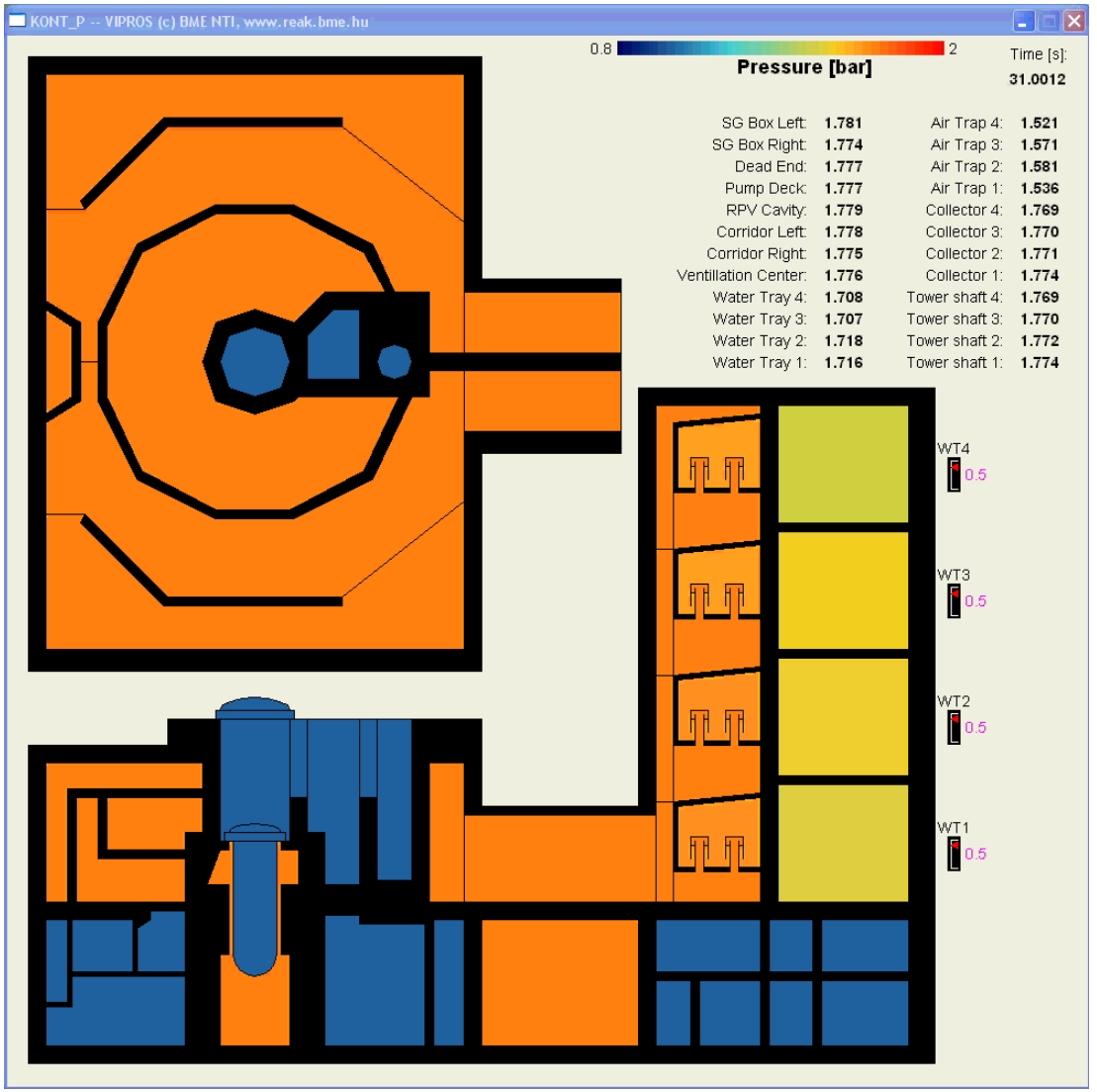


SG blowdown system for PRISE management



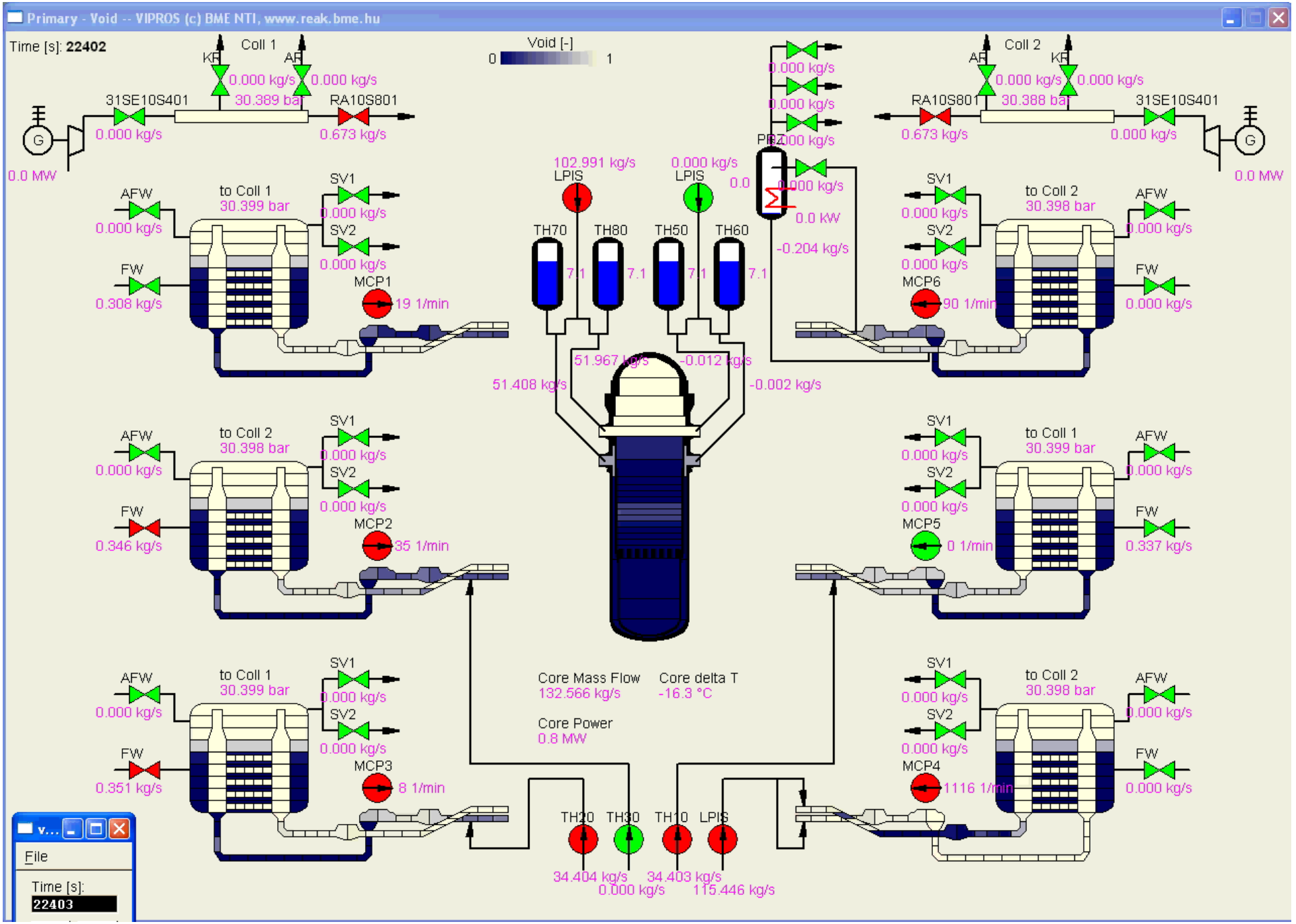
Visualization of the results: VIPROS

- Post-calculation visualization tool.
- Still images and animations.
- Multi-platform (Linux, Windows)
- Written in C++ with FLTK.
- Color-coded areas, bar-graphs, numerical values.



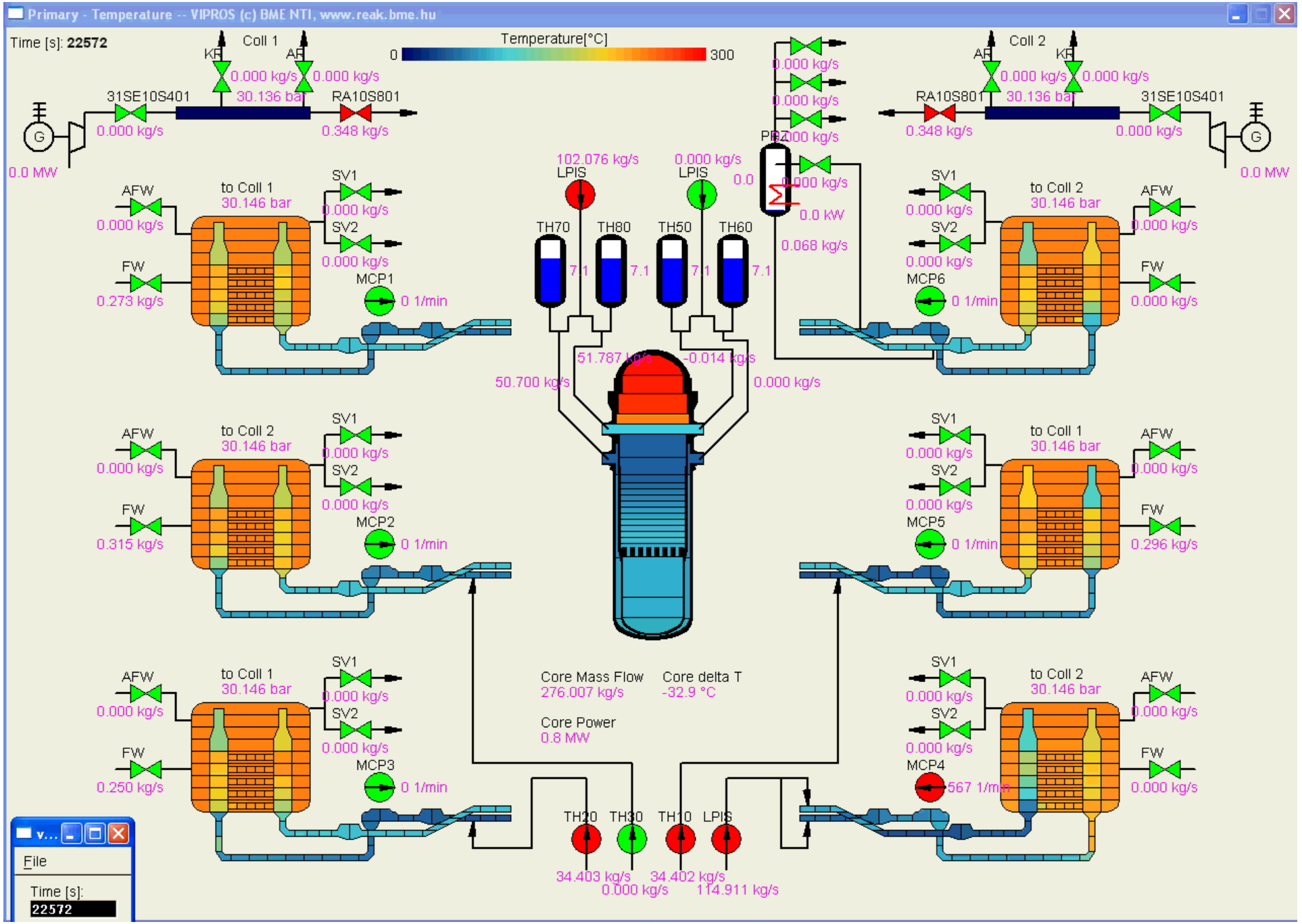
Pressure in the hermetic compartments

Visualization of the results: VIPROS



Primary circuit – void fractions

Visualization of the results: VIPROS



Primary circuit – temperatures