From the plant layouts to an optimized 3D PWR-KWU containment model with GOTHIC 8.3 (QA)

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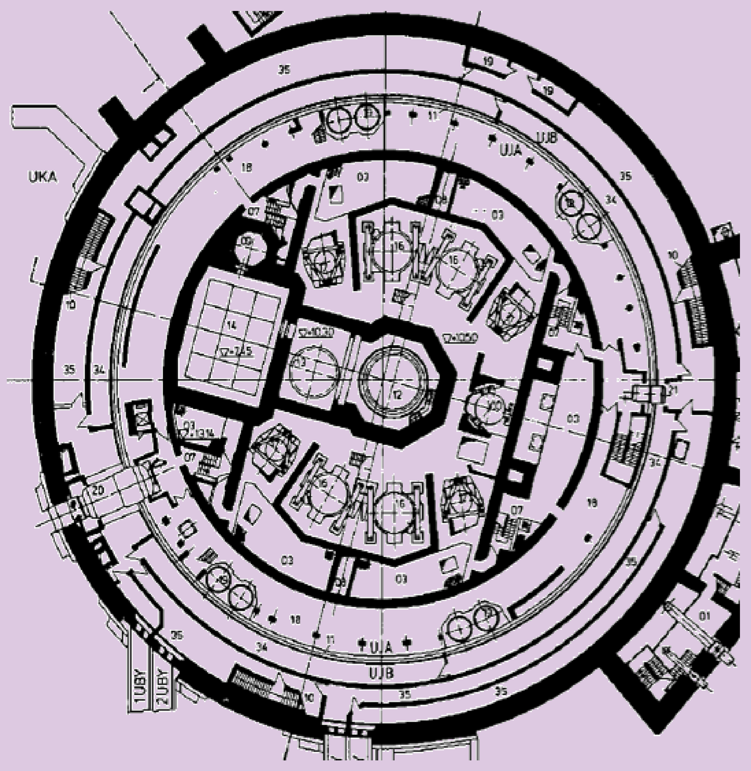
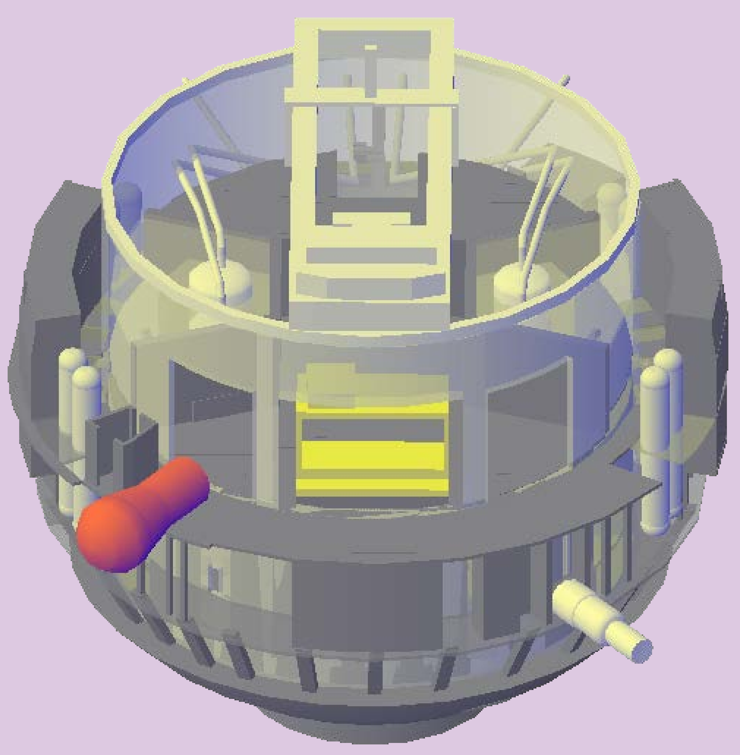
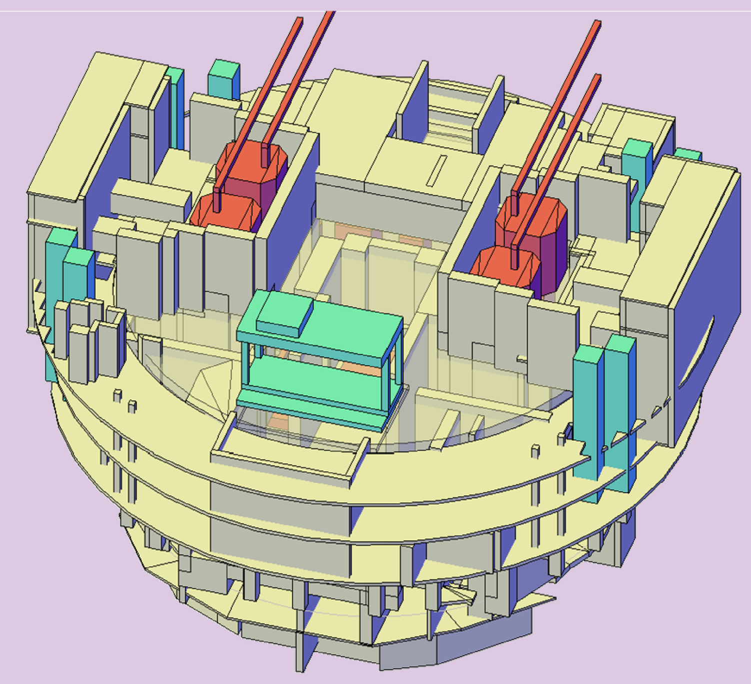
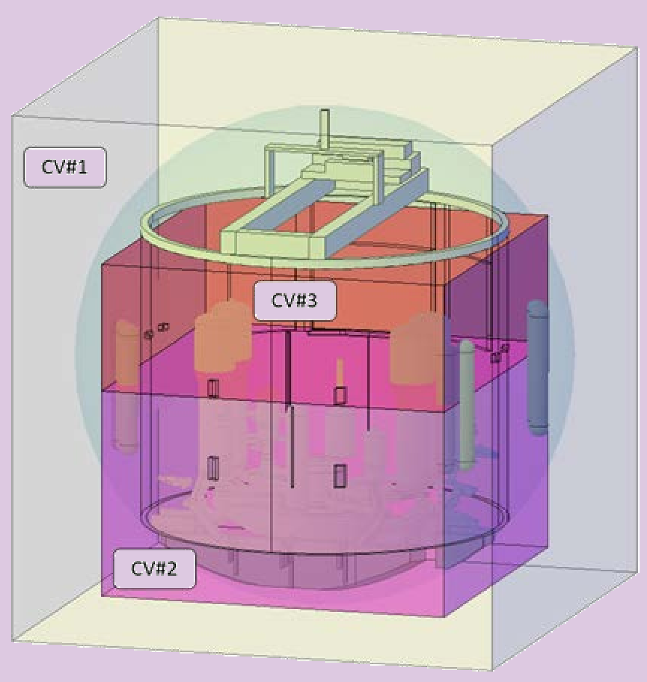
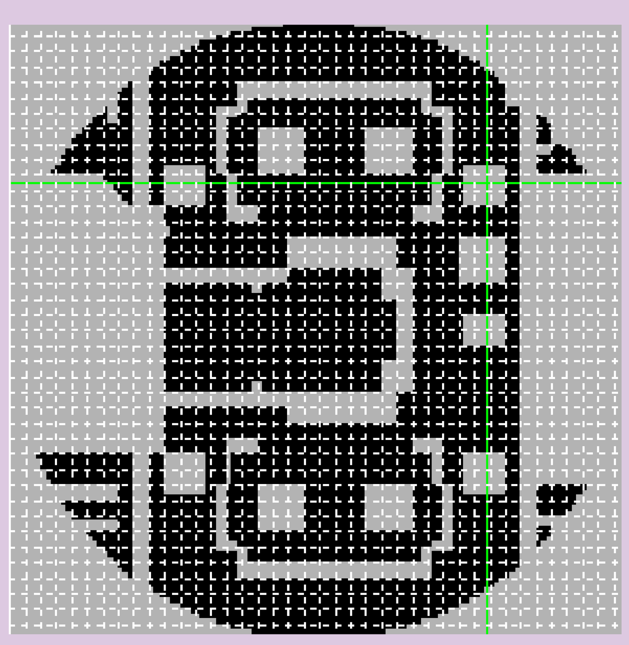




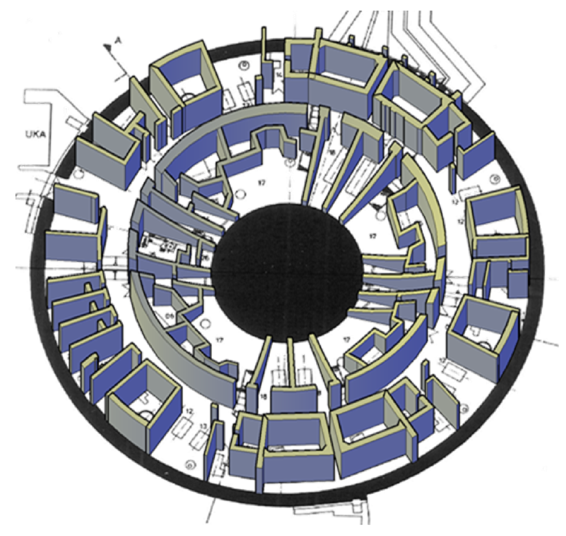


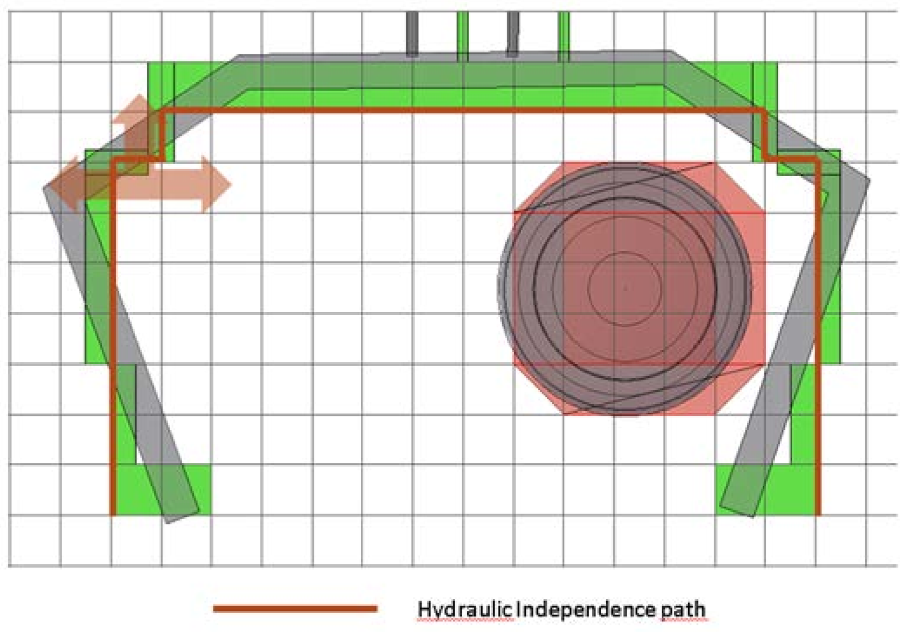




1. Detailed CAD 3D model

Using Computational Aided Design (CAD) software as a cornerstone of the modelling process serves as a bridge between the containment layouts and the thermal-hydraulic models. Detailed 3D CAD models permit a thorough evaluation of free volumes, heat transfer surfaces, flow paths position and **nodalization strategies**, in a data-traceable environment. This containment model is built with extreme attention to detail, regarding both main and secondary structures and components, aiming for an **enhanced representation of containment phenomena** throughout the numerous compartments.



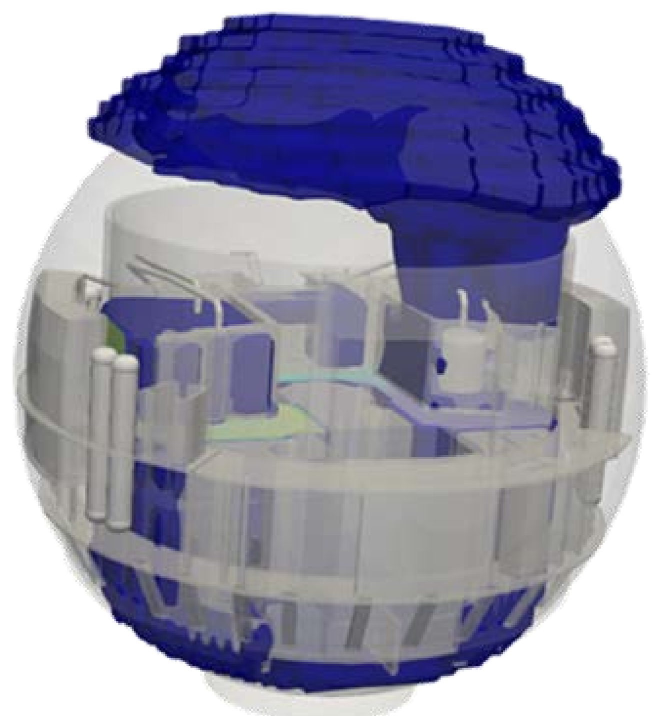


2. Simplified CAD model

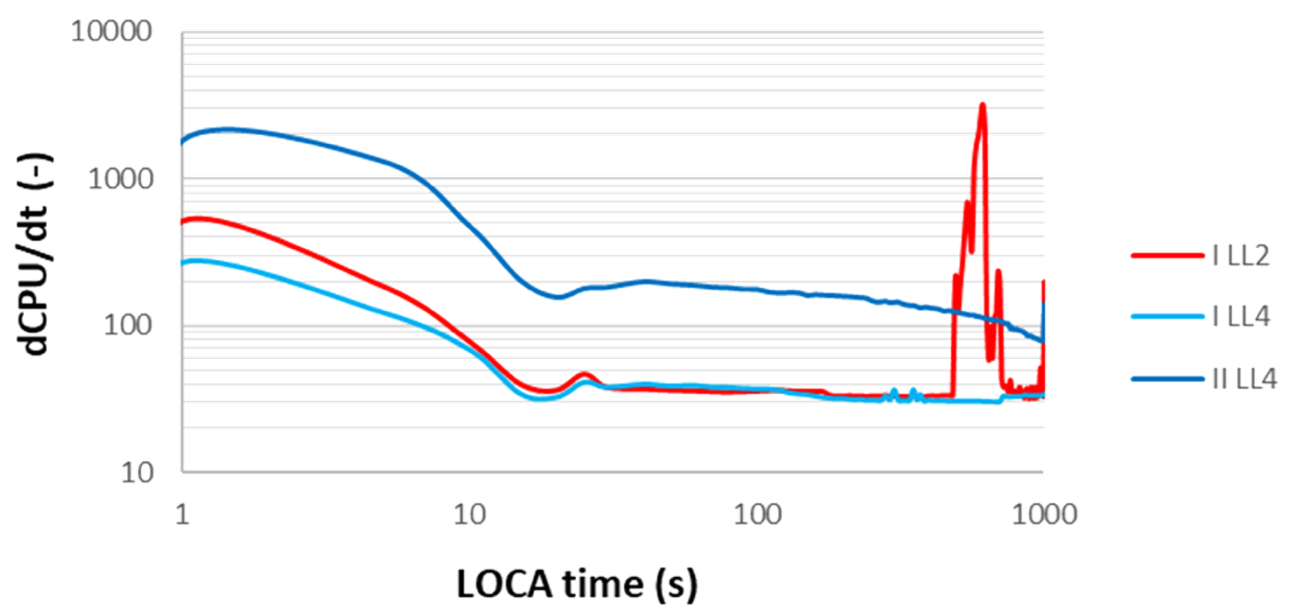
To *a priori* avoid some problematic geometrical configurations when exporting the model to GOTHIC, an intermediate model is built. The adaptation is done with simple blocks, fitted in homogeneous orthogonal meshes, and assuring the **hydraulic independence** between rooms. Also, surfaces and free volumes are kept with a maximum error of 3%. These simplifications follow in the footsteps of previous methodological efforts to **avoid numerical instabilities** and enhance the robustness of the models.

3. Air-tightness test and definition of model strategies

Several tests are performed in crucial compartments to check if the model implementation in GOTHIC is successful. These are done by simulating hydrogen releases and tracking the gas behavior to **detect geometrical incongruities**. Moreover, the geometry is verified for different mesh sizes (1 m^3 to 8 m^3 orthogonal cells), to assure its **robustness** in scenarios where coarser or finer refinements in each control volume may be needed. Then, three models are created, ranging from 12000 to 85000 computational cells.

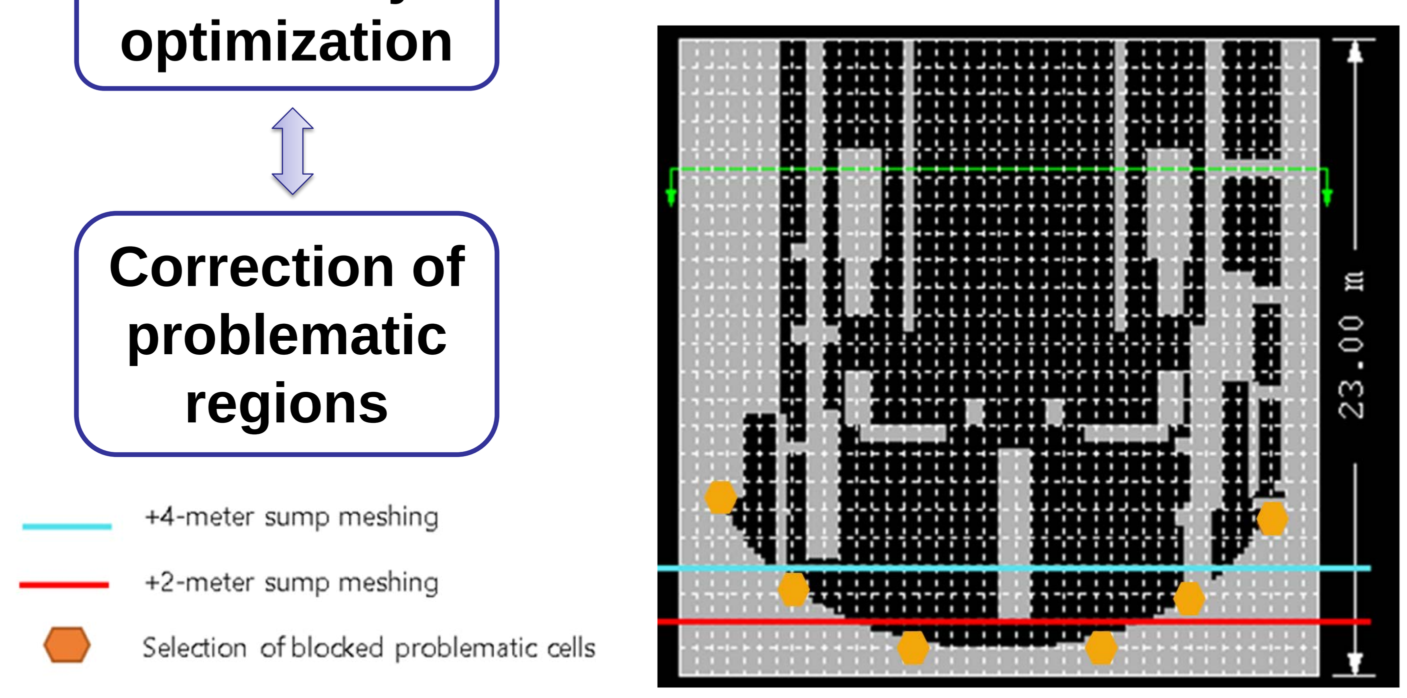


CPU time tendencies



Geometry optimization

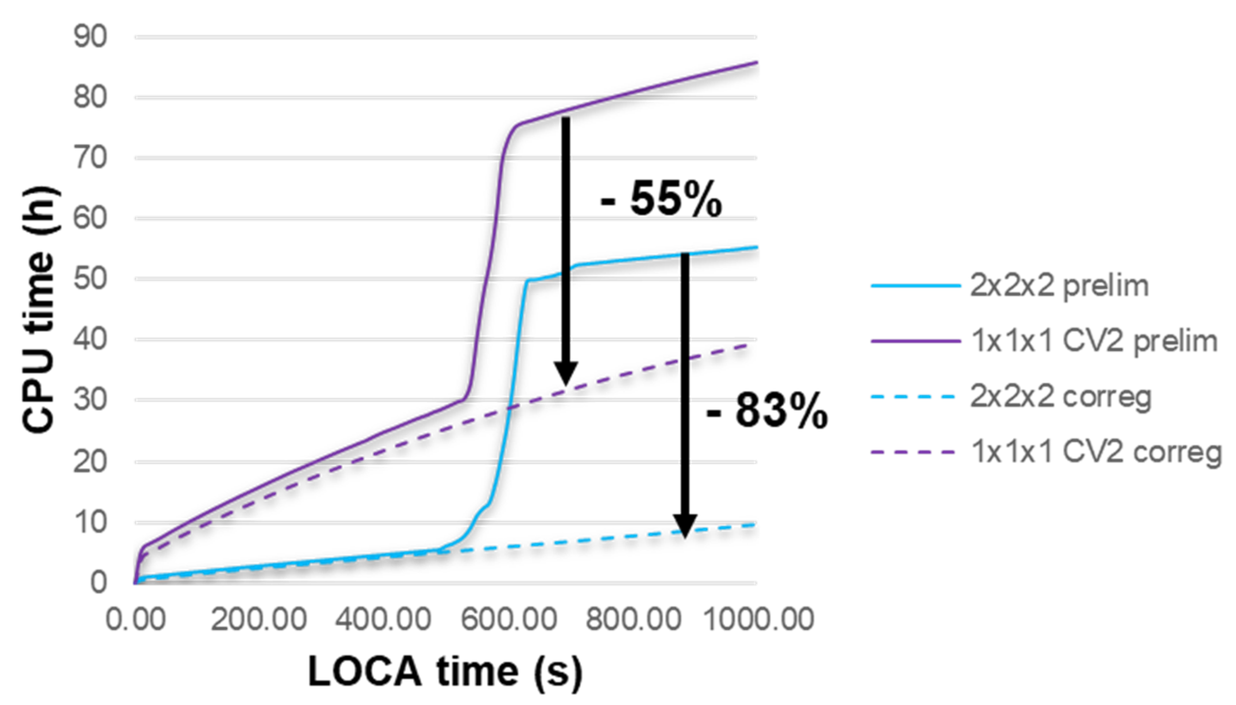
Correction of problematic regions



4. Assessment of model stability and optimization of computational cost

To search for possible numerical instabilities, a fast cold-leg LB-LOCA release is simulated. The idea is to **detect and correct local problematic configurations**, to boost model performance. By studying the CPU time tendencies, a period of high computational effort was seen at the middle of the transient, due to the accumulation of water in the sump region. Also, during the first seconds of the blowdown stage, some configurations that were not avoided in the simplification process were detected. Then, the coarsening of the sump area and the blocking of some cells resulted in the **reduction of CPU effort in one order of magnitude**. Moreover, it was seen that the direction of the injection of mass and energy releases can increase simulation times, as was the case for the models with the highest steam flow velocities.

CPU time reduction



Conclusions

- The creation of adapted models from detailed ones produces robust 3D models subdued to lower simulation efforts, thus allowing to perform more sensitivities with them.
- Model construction and pre-processing can be balanced by the implementation of preventive methodologies and the analysis of local computational instabilities.
- The thorough analysis of synergies between geometry and limiting phenomena can furtherly reduce computational times in at least one order of magnitude.

This project has received funding from the Euratom research and training programme 2019-2020 under Grant Agreement nº945057