State-of-the art 4-D (space + time) simulations of underground construction (tunnels, caverns) are usually based on volume methods (i.e. Finite Element Method, FEM) and require a significant amount of effort by experts. The dream of engineers of a simulation "at the touch of a button" is far from being realised. The aim of the project is to make a giant leap towards the realisation of this dream by developing a simulation method that is fast and user friendly. The first step towards achieving this is to change from a volume to a surface based method (the Boundary Element Method, BEM). Significant advances were made in the last decade by the proposers, concerned with the application of the BEM to underground construction in projects, which were funded by FWF and the European Union. The developments included the treatment of non-linear material behaviour, heterogeneous ground conditions, ground support and sequential excavation/construction. However, in practical applications of the method to large-scale underground construction projects the effort in the generation of the mesh was still found significant and computation times long.
To achieve the aims of making the simulation nearly automatic and fast, two aspects need to be addressed: Mesh generation and computation time. In recent times iso-geometric methods have gained popularity in the FEM. Using these methods, the problem boundary can be described very accurately by a few Non-uniform rational B-Splines (NURBS). We propose to extend this concept to the BEM. The major challenges of the project are to develop a method that does not require the generation of a surface and volume mesh (required for the non-linear analysis) and to significantly reduce the computation times for large-scale, three-dimensional, nonlinear problems. To meet theses challenges, innovations in applied mathematics and mechanics are proposed. The final outcome will be a simulation methodology for underground construction that would be superior in terms of user friendliness and computation times to existing methods.