Visualization Tool VIRTUS

Klaus Wieczorek, Steffen Masik,
Joachim Behlau, Christian Müller

5th US/German Workshop on Salt Repository Research, Design, and Operation
Santa Fé, September 7-11, 2014

A joint project of

GRS BGR DBETEC Fraunhofer IFF

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

What is VIRTUS?

- VIRTUS is a “virtual underground laboratory” which can illustrate repository concepts, geologic situations and physical processes taking place in an underground lab or a repository.

- It centrally provides the necessary consolidated data (geologic models, mine structures, material data for numerical simulation).

- It provides means for the integrated visualization and evaluation of various types of information.

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Concept of the “Virtual URL”

- Components:

Software platform for visualization of - geology - mine structures - THM simulation results	**Database** for material parameters - host rock - geotechnical components - waste forms	Input/output **interfaces** to process level codes (PLC)

- Features:
  - Provides combined view of URL or repository structure & processes
  - Makes available consolidated data on material behavior
  - Easy access to all information via “hot spots”

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

VIRTUS Data Exchange

VIRTUS
Project data, material database, literature, user data,…

Geologic models (Mine structures)

Geologic models
Combined models

Simulation results

Combined models
Material data

CAD program
(openGEO)

Process Level Codes
(CODE_BRIGHT, JIFE, FLAC^{3D})

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

VIRTUS Functionality & Workflow

Import, check, and processing of the **geologic model**

Mine structure generation or import

Model **combination**

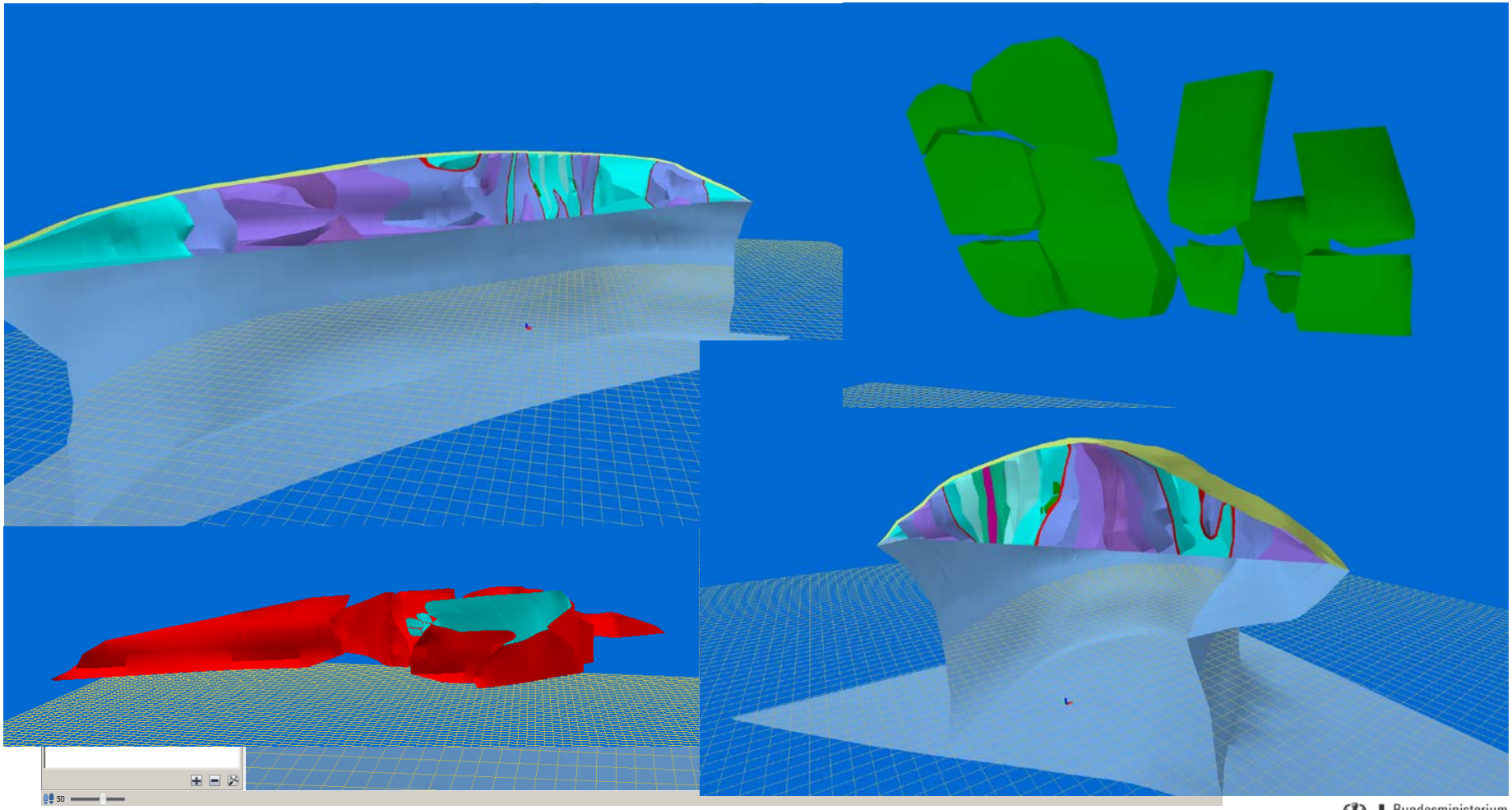
Export of model and material data **to PLC**

FE mesh generation and PLC simulation (outside VIRTUS)

Import and **Visualization** of simulation results

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

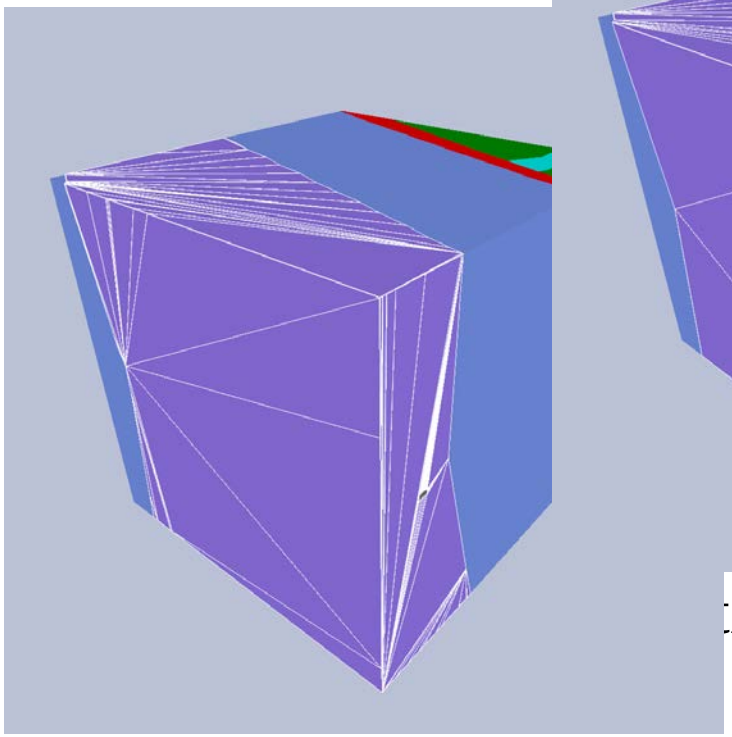
Geology: Virtual Salt Anticline

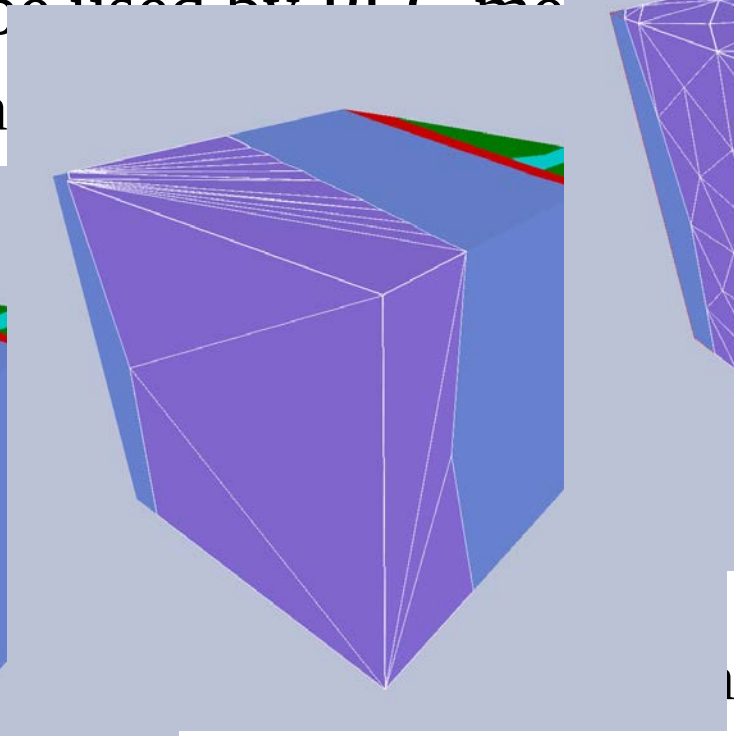


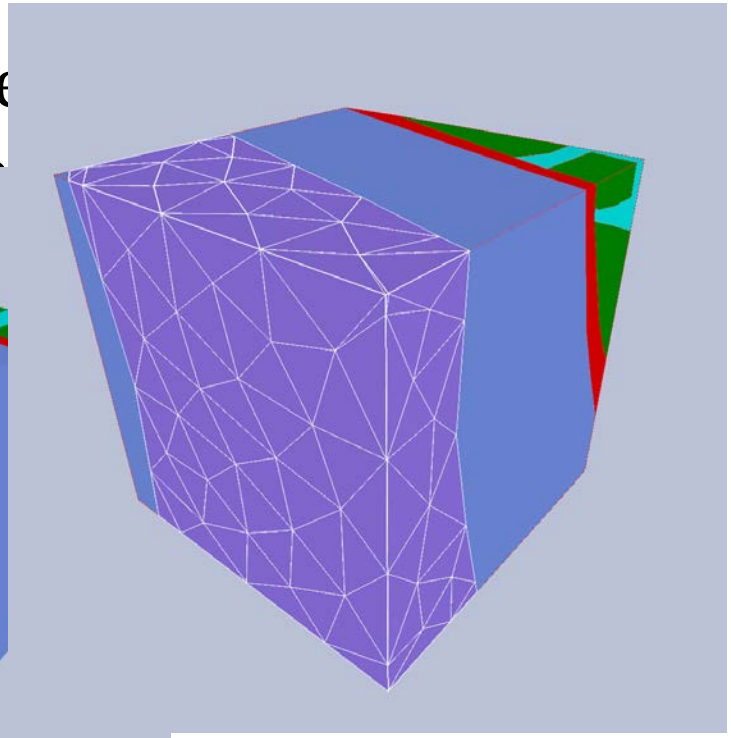
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Geology: Geometry Processing

- Geologic surface model needs to me
  requirements to b
  - Closeness of each





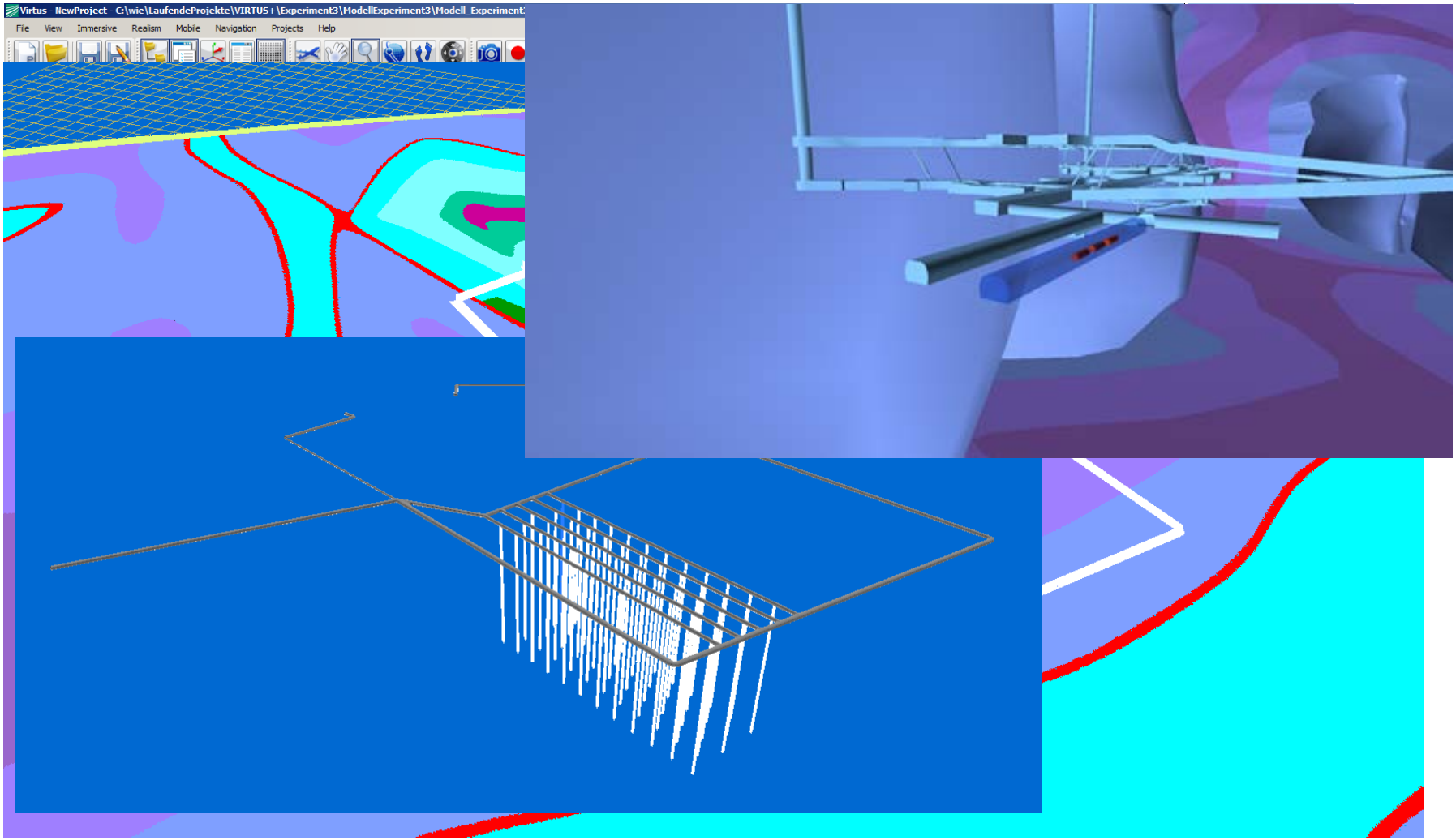


improvement)

tion and regularization

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

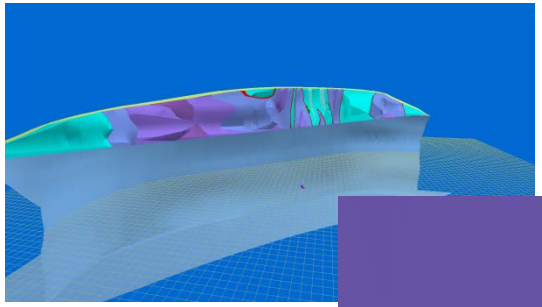
Mine Structure

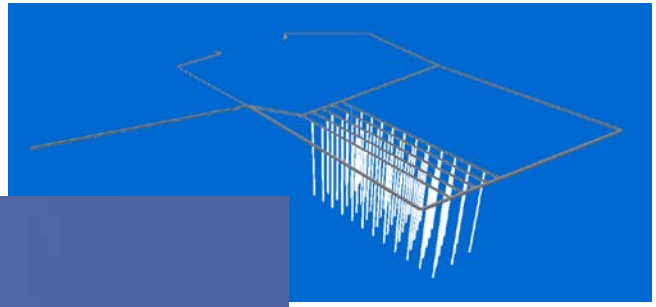


Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Combination of Geology and Mine

- From the separate geometric models of geology and mine structure, a combined surface model is created

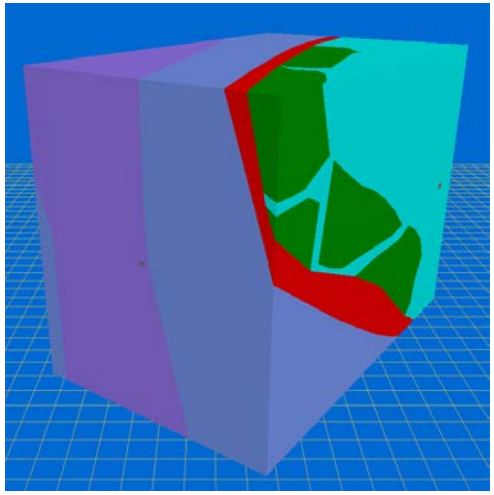




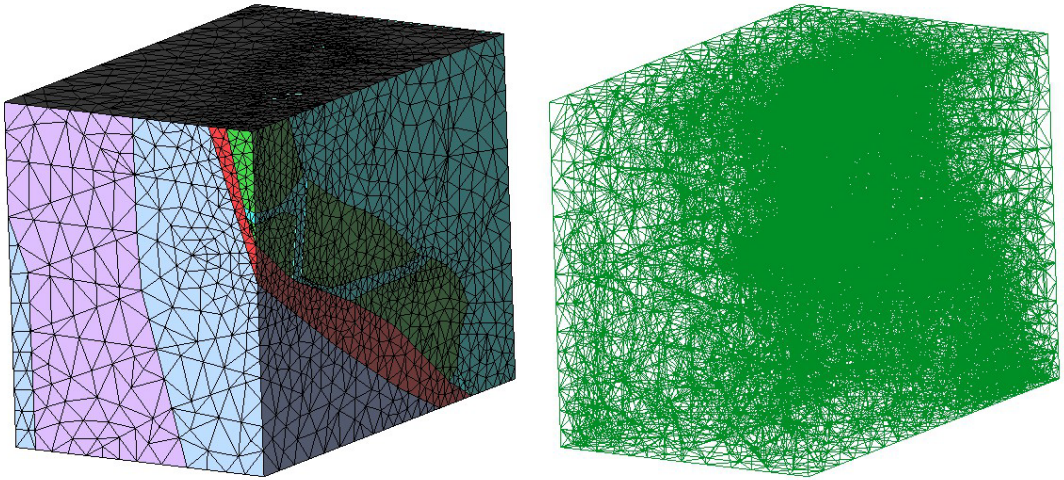
Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Export to PLC and Meshing

- Cuboid sections from the combined model an be freely defined for export (various formats available)
- FE meshing by PLC pre-processors



Cube section from VIRTUS

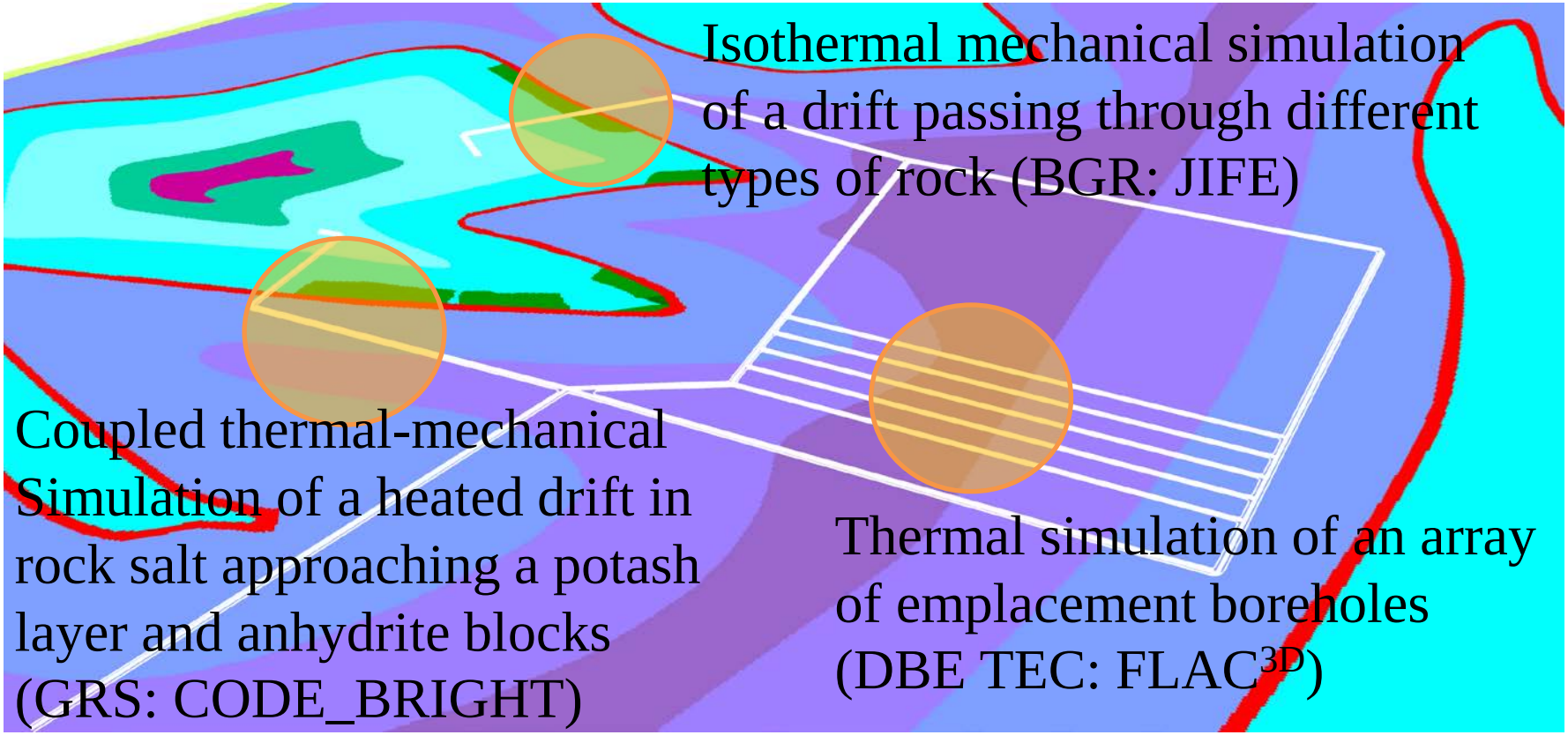


FE mesh (GiD) in different representations

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

PLC Simulation

- PLC simulation of 3 demonstration experiments



Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Result Import and Visualization

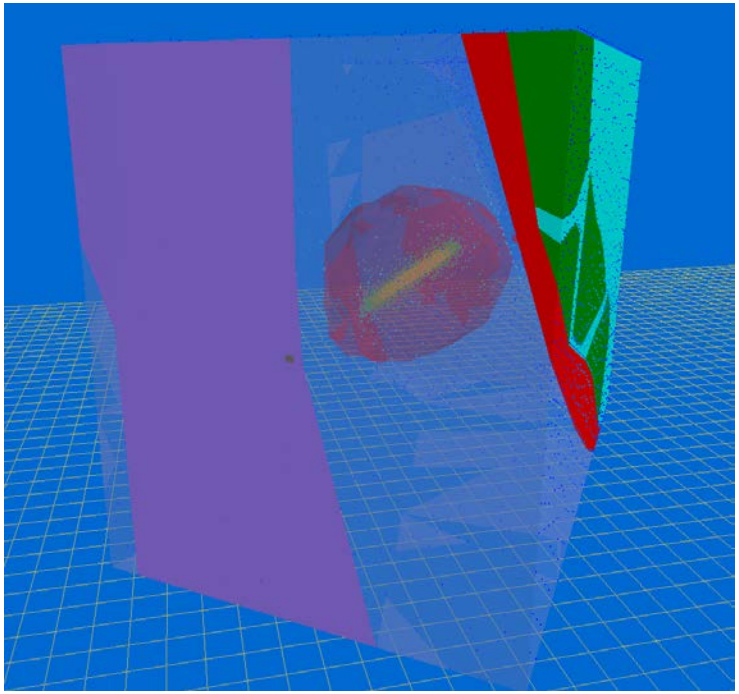
- Thermal data: temperature and heat flow
- Hydraulic data: fluid pressure, flow rates, saturation
- Mechanical data: stress, deformation, porosity

Result data can be

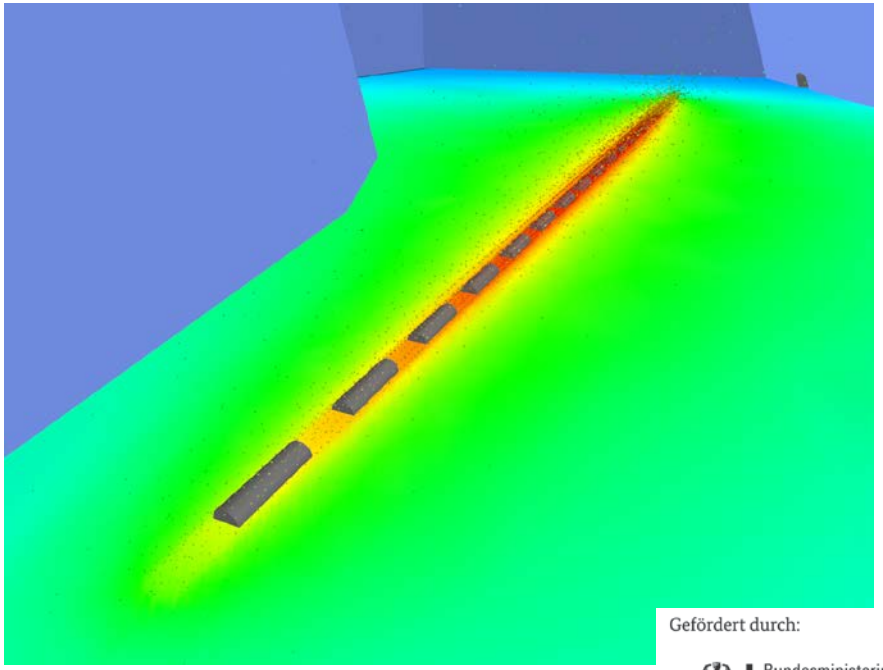
- Scalars (temperature, porosity,…)
- Vectors (heeat flow, deformation,…)
- Tensors (stress, strain,…)

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Visualization: Scalar



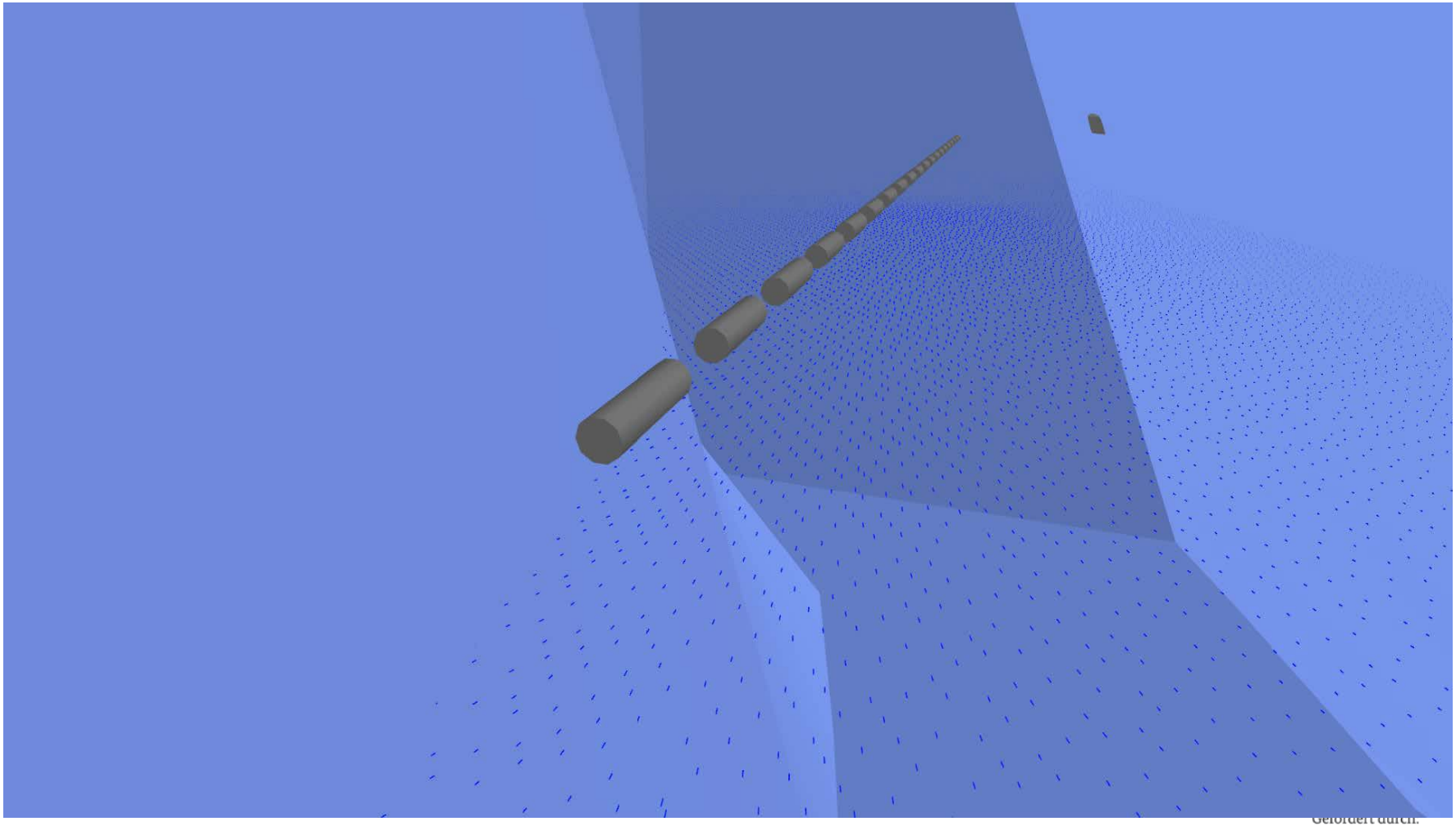
Temperatur field of a drift charged with 20 POLLUX containers 200 years after emplacement (red: 50°C iso-surface)



Horizontal section in the plane of the containers: temperature field

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Visualization: Vector



Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

Benefits from a Virtual URL

Design of meaningful **experiments**

Enhancement of the **understanding of coupled processes**

Creation of **realistic models** for simulations

Researcher

Convincing **demonstration** of concepts and results to the public

Comparison of different simulations for **benchmarking or optimization** purposes

Implementer

Regulator

Planning of repository **layout** in a given geology

Evaluation of results to make sure **safety criteria** (maximum temperatures, acceptable stress states) are met

VIRTUS Project Partners

Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH

- Project management, database (with IFF)

Federal Institute for Geosciences and Natural Resources (BGR)

- Geologic models

DBE Technology GmbH

- Mine layout

GRS/BGR/DBE TEC: Material data evaluation, PLC simulation

Fraunhofer Institut fuer Fabrikbetrieb und –automatisierung (Contractor)

- Software platform
- Visualization

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Status and Prospects

- The current phase of the VIRTUS project is ending in October 2014
- The VIRTUS features presented are implemented (testing and improvement is continuing)
- Simulation of three prototypical experiments is continuing
- Tools for model and result evaluation and comparison have not yet been implemented
- VIRTUS has been developed as a virtual URL in salt, but is highly flexible. Little effort is needed to use it with other geologies or other process level codes

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Acknowledgments

The VIRTUS partners express their thanks to the German Bundesministerium fuer Wirtschaft und Technologie (Federal Ministry of Economics and Technology) for funding the project under FKZ 02 E 10890.

Thank you for listening!

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages