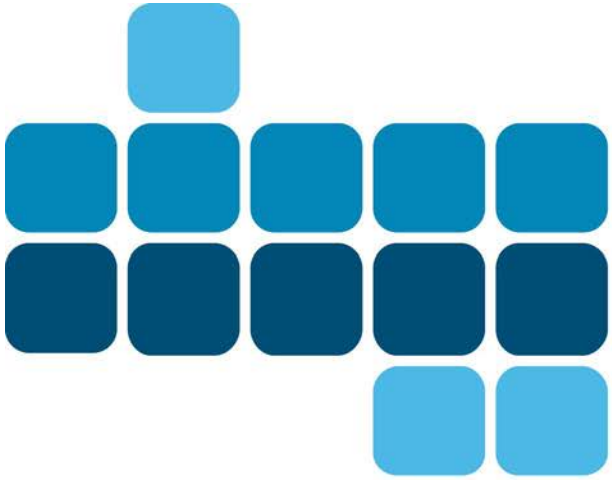
Leibniz Universität Hannover

Institut für Werkstoffkunde



ENTRIA

ENTSORGUNGSOPTIONEN FÜR RADIOAKTIVE RESTSTOFFE:
INTERDISZIPLINÄRE ANALYSEN UND
ENTWICKLUNG VON BEWERTUNGSGRUNDLAGEN

Die Bedeutung der Rückholbarkeit als Option im Zusammenhang mit dem Wunsch und der Notwendigkeit eines Langzeit-Monitorings

The importance of retrievability in the context of long-term monitoring

Karlsruhe 19.10.2016

Thomas Hassel

Monitoring – definition

„Systematic surveillance of processes by technical tools“

what?

Systematic surveillance :

- Monitoring of defined parameters
- Monitoring has to take place in defined time intervals

when?

Pre-assigned definitions are necessary

- Goals of monitoring
- Intervention thresholds

why?

Monitoring - definition

„Systematic surveillance of processes by technical tools“

Technically detectable values:

- Processes / parameters have to be detectable by sensors
- If a direct measurement is not feasible, sometimes the parameters can be derived from other measureable parameters

how?

Reasons for Monitoring

Goals of Monitoring

- Gaining access to data and produce knowledge
- Confirmation of hypotheses
- Validation of action
- Gaining of a better understanding of phenomena

→ Derivation of actions

Monitoring in the deep geological disposal

Monitoring can be divided in the following sections

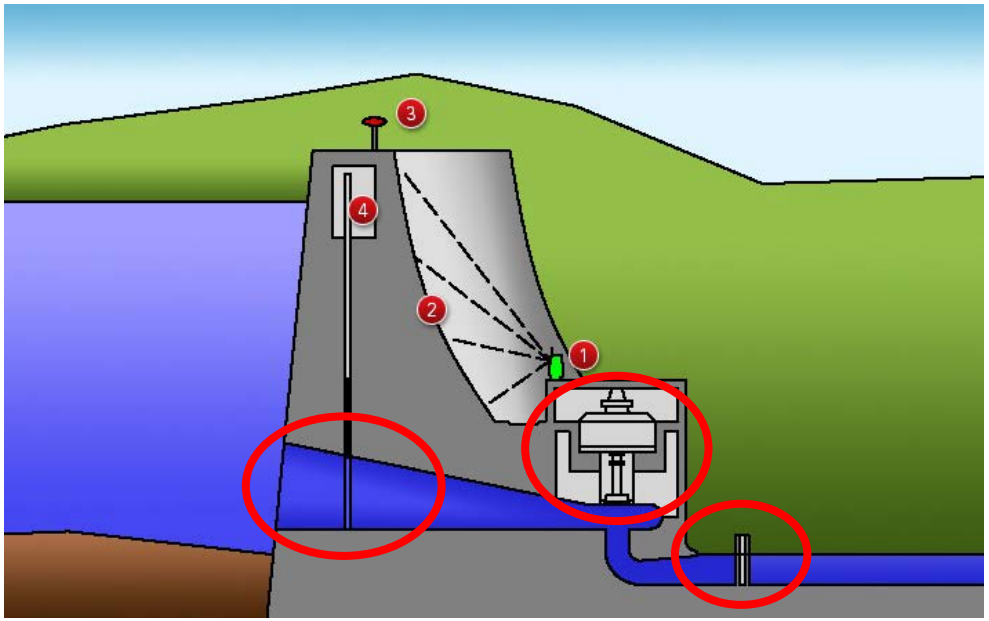
- **Technical monitoring**
- **Geotechnical monitoring**
- **Geological monitoring**

There are floating borders between these three aspects, but the barriers locate them good enough.

Examples: hydro-electric power plant - monitoring of technical components

- Detection of vibrations (e.g. turbine blades, water shots and nozzles)
- Detection of temperatures (e.g. bearings, transformators)

- Monitoring during several decades
- Sensors are accessible
- Incorrect measurements are easy to be identified and damaged sensors are easy to be replaced



schematic bank dam [source: Allsat]

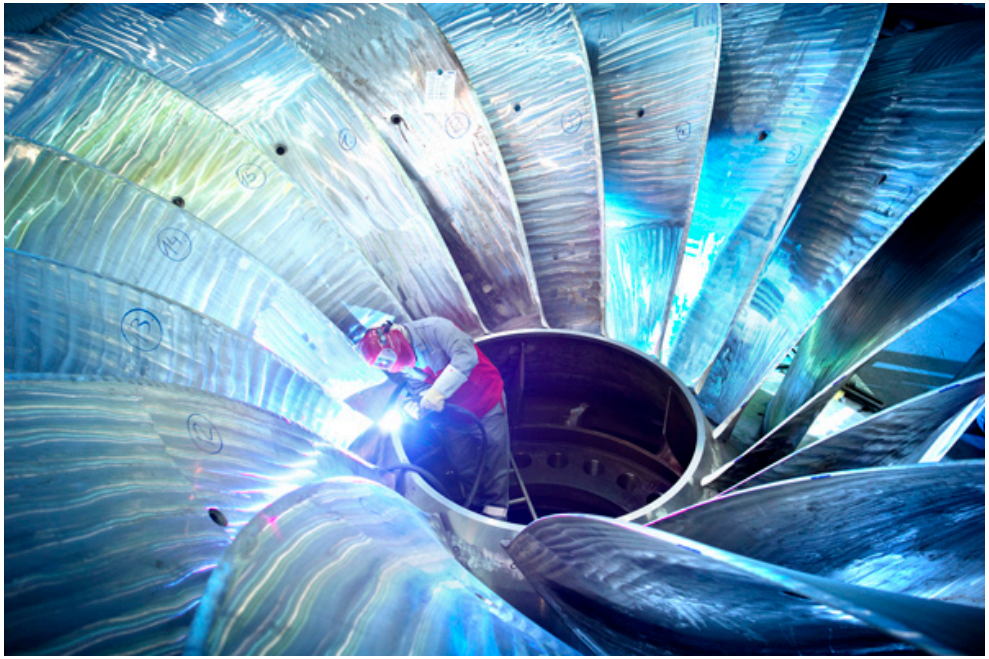
Consequences

[source: www.ewm-group.de]

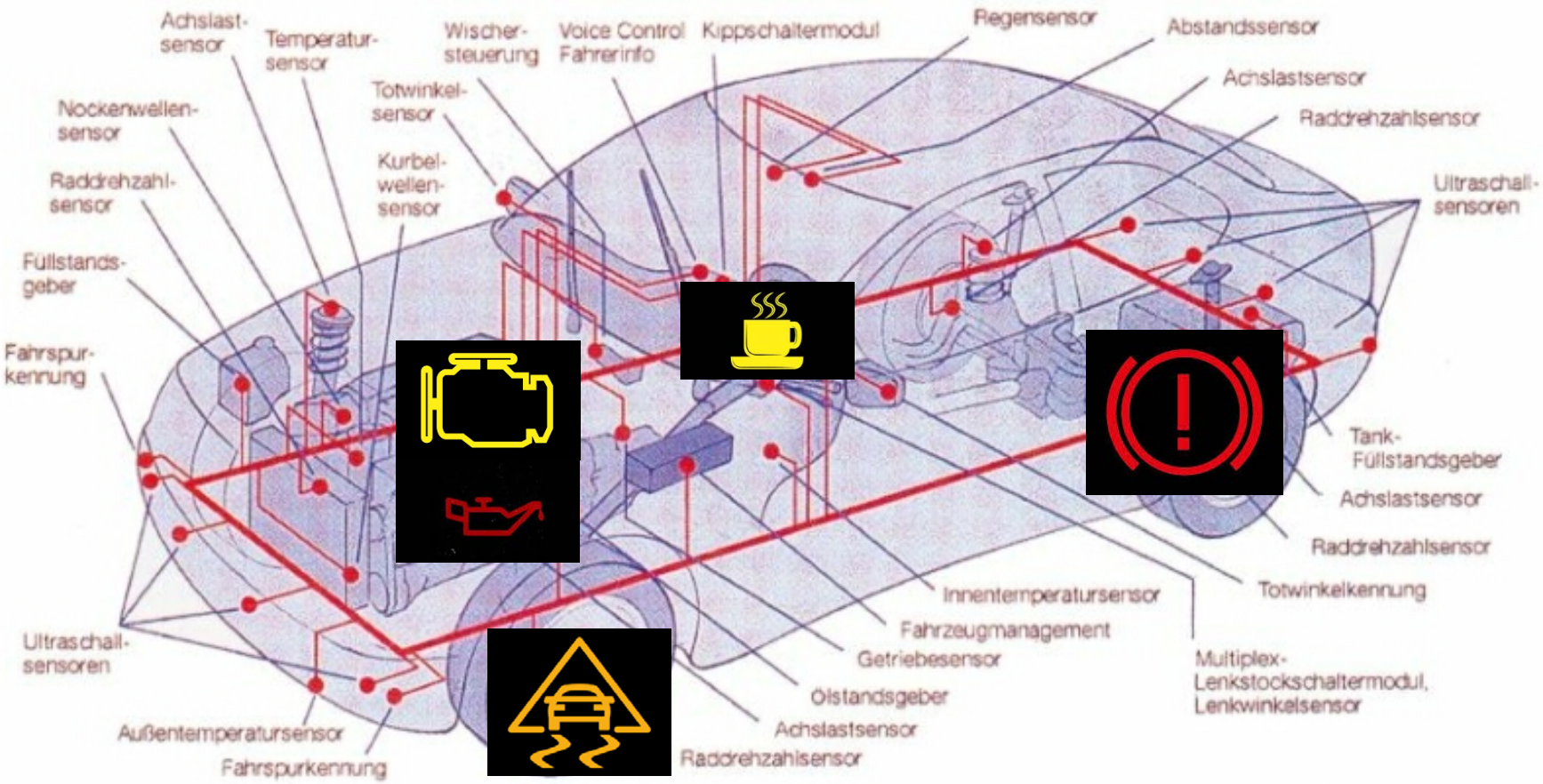
- Increasing of life-time
- Access to the technical components
- Manual processes possible

- Quality and safety control
- Possibility of maintenance
- Retrofitting during the time of usage

[source: www.ewm-group.de]



Examples: Car
- fully sensor controlled



[source: www.road-and-motor.ch]

Consequences

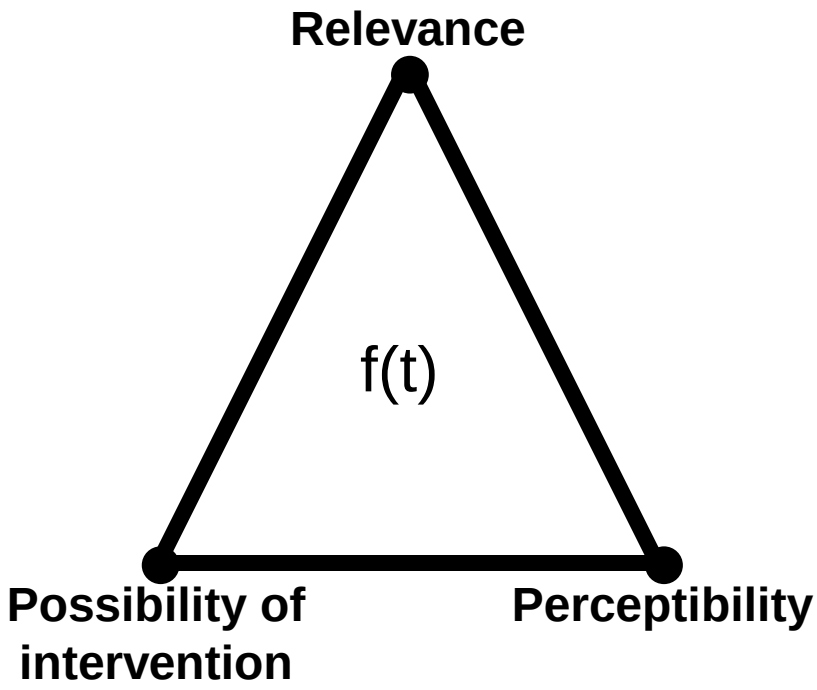
- Requirements:
  - Robustness
  - Price
  - Size
  - Accuracy

- Increased comfort
- Damage prevention
- Safety concept
- Performance
- Blue technology
- etc.

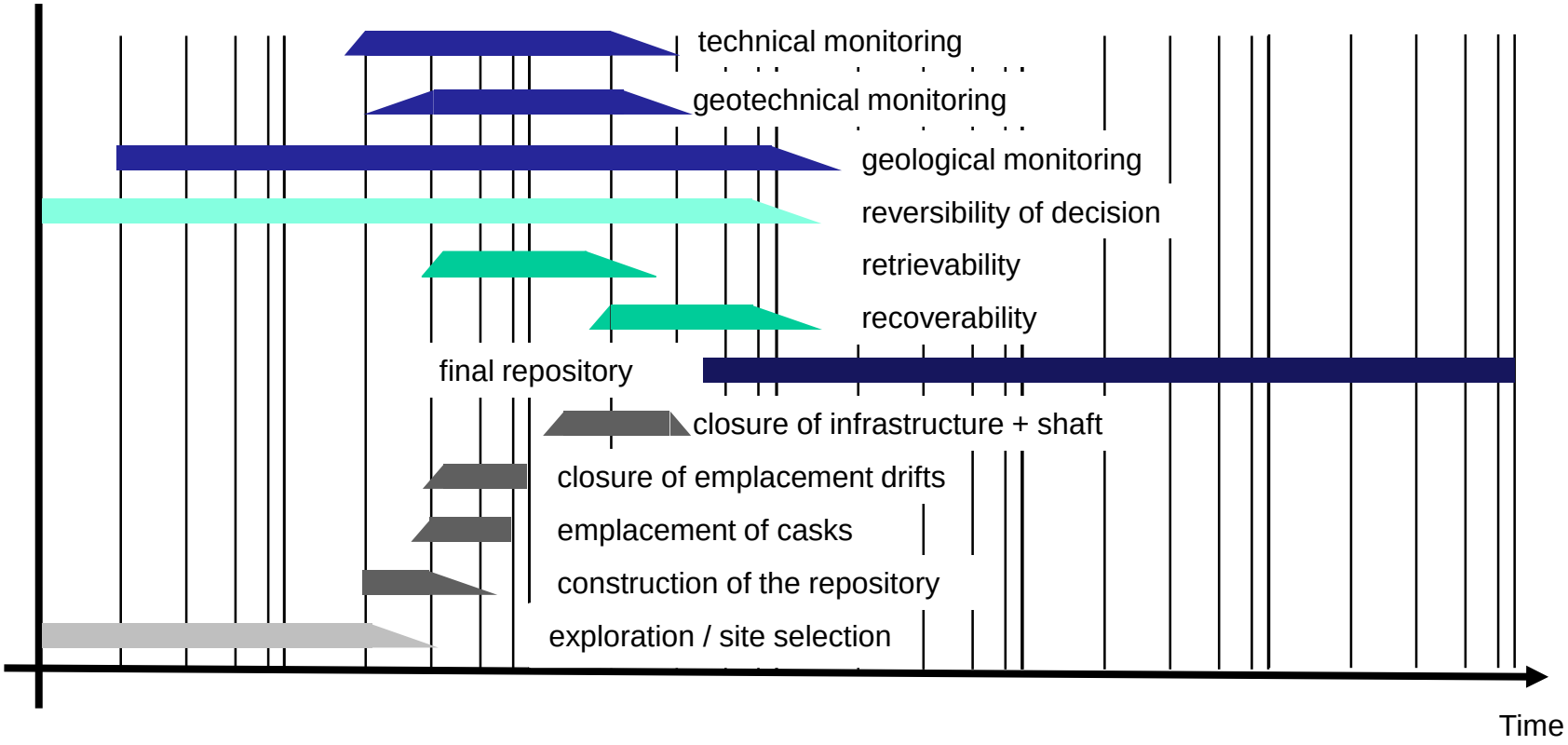
- Sensor indications:
  Electrical, magnetical, electromagnetical, thermal, mechanical and chemical measurement of parameters

[source: www.de.123rf.com]

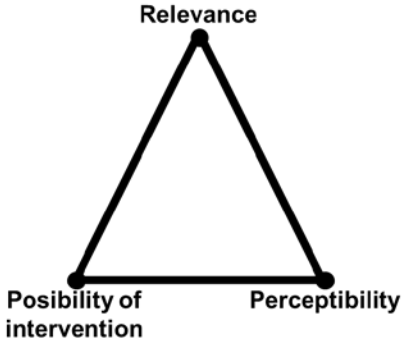
Monitoring – triangle of requirements



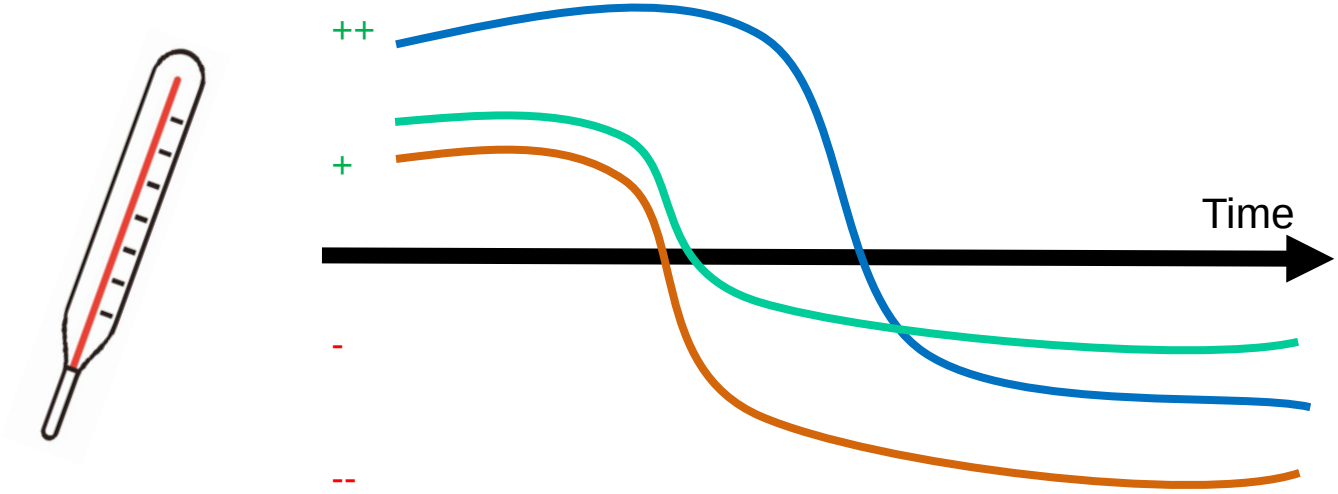
Timeline of geological storage



Monitoring – triangle of requirements - example



temperature on the container surface:



Challenges of monitoring in a geological repository

Challenges:

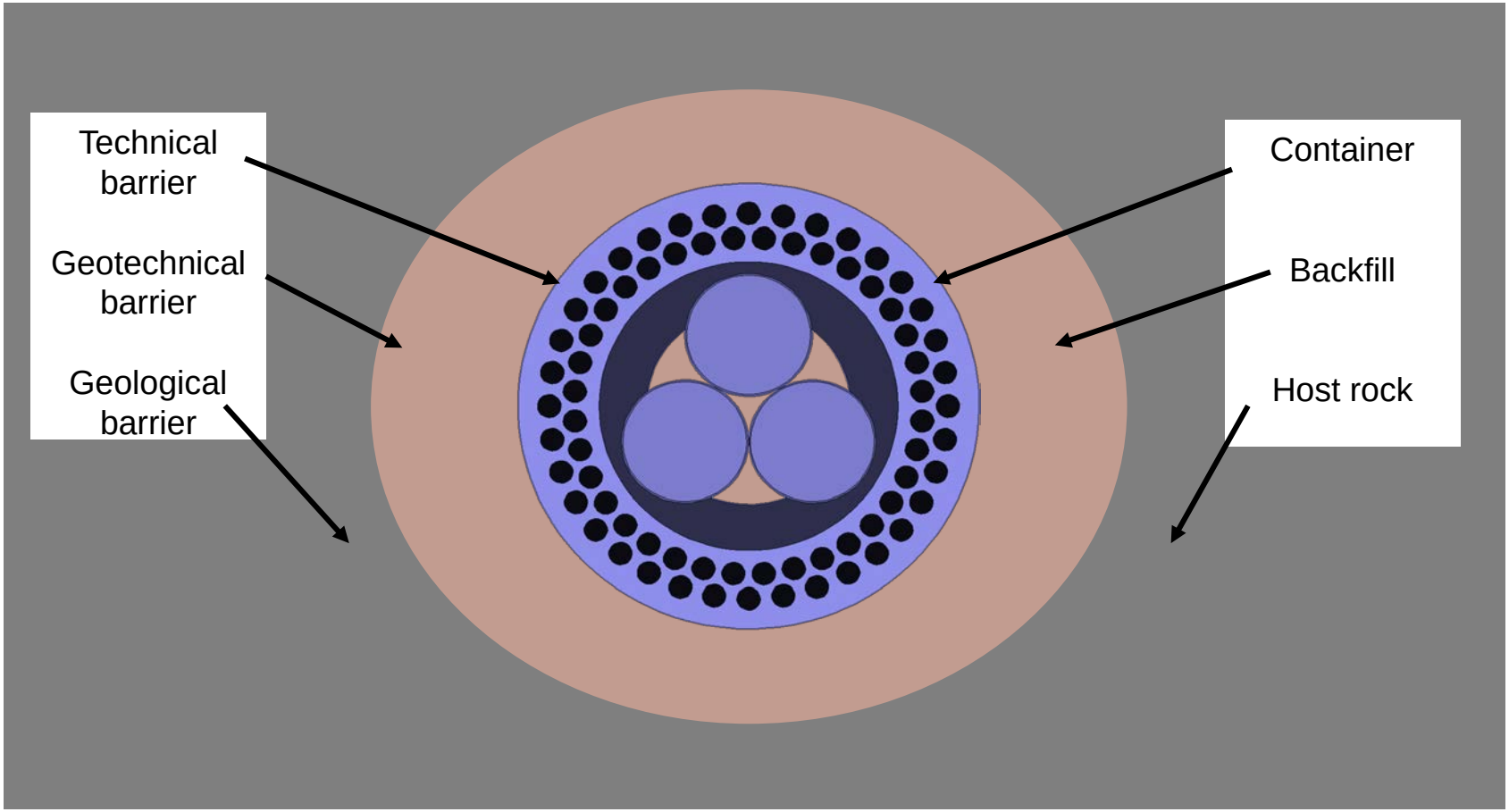
- Environmental conditions
- Accessibility
- Possibility of intervention

Requirements:

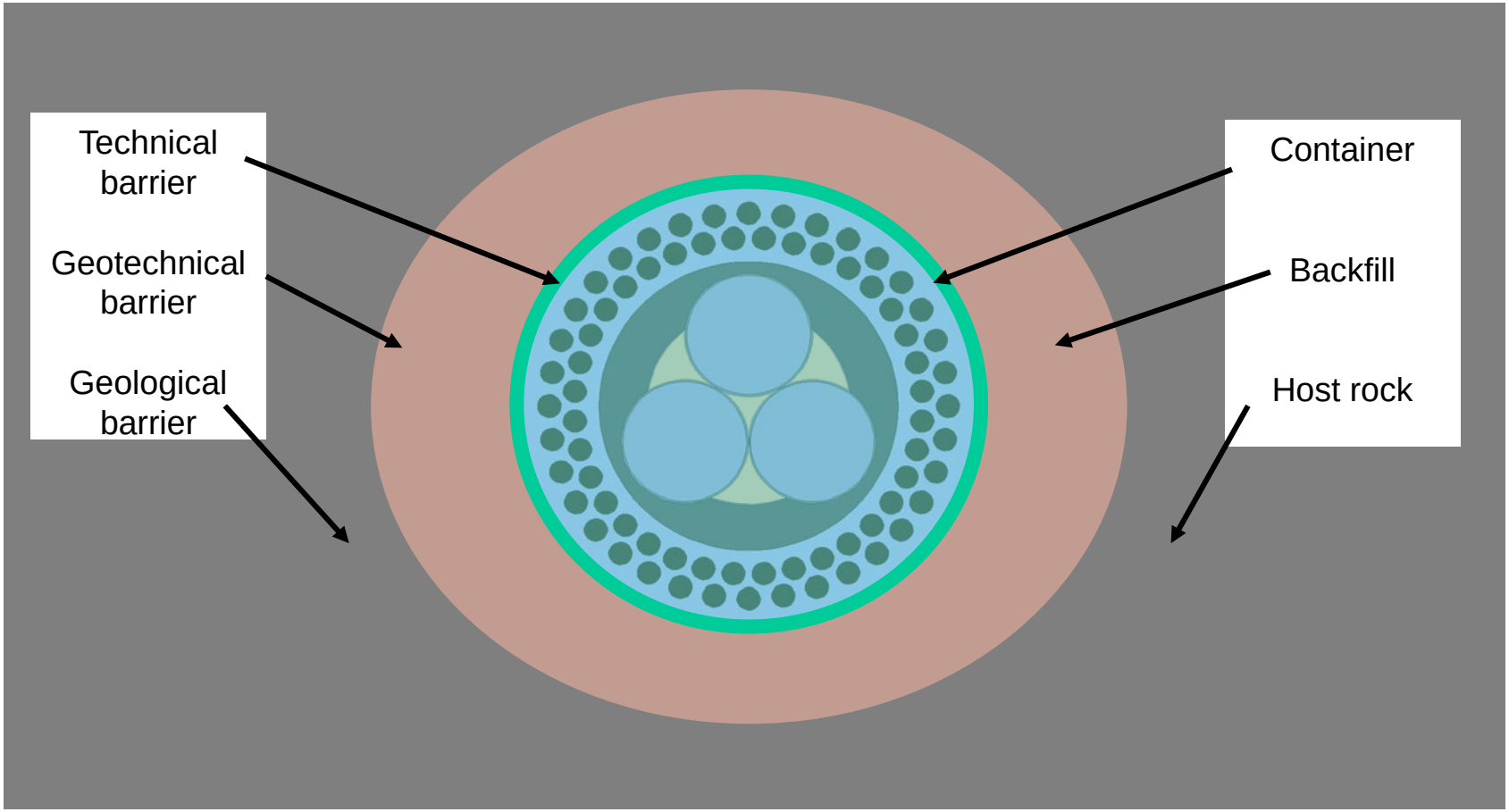
- No disturbance of the barriers
- **Maintenance-free sensors**
  - alt. exchangeable sensors
- **Transfer of the collected data**
- **Ensuring energy supply**

container after heating experiment [source: GRS]

Barrier system for deep geological disposal with retrievability



Barrier system for deep geological disposal with retrievability – The technical barrier



The first barrier to monitor might be the container

- In the former concepts, the containers only contain the nuclear inventory
- After being filled, they would be closed hermetically
- Into the final storage the containers have are treated as a „Black Box“
- Only passive signals are measurable (temperature, radiation)
- The principle of external and active monitoring may provide further information about the container status
- No direct access after installation of the backfill barrier
- No cable connections possible after backfilling

Which information could be available or measurable

Following the methodology of the none-destructive testing technologies:

- Visual – during the interim storage phase
- Acoustic – applied during the drilling technology with great success
- Electrical – natural electro motoric forces
- Thermal – containment temperature etc.
- Barometric – pressure switch e.g. CASTOR
- Radiologic – during the interim storage phase
- Material specific – evaluation of corrosion
- Gaseometric – corrosion products (hydrogen formation)
- Mechanical – residual stress and deformations

In the current German situation no final storage container exists!

The retrievability concept implicates the monitoring of all barriers.

The development of new final storage containers provides the opportunity to implement instrumentation for monitoring into intelligent casks

Conclusion

- The wish for retrievability requires an adapted monitoring concept
- Every barrier which can deliver data should be monitored
- The functions of the container that can be monitored in closed disposal should be defined
- Proof of concept should be part of the risk management
- Decisions in the phase of retrievability can only be made on the base of good / reliable data
- Who makes decisions on the monitored database