Modern2020

Demonstration of monitoring implementation at repository-like conditions (WP4) Approach and Key Messages

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This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement n° 662177

Why Demonstration ?

Seeing is believing

Implementation of monitoring set-ups at real scale, and at (geotechnical) conditions similar to a repository, offers a tangible environment to assess the topics investigated / developed in the Modern2020 project

- the monitoring strategy concepts
- the (innovative) monitoring technologies
- the (public) stakeholder engagement

In addition, it provides, in itself, also relevant input on the factors that determine the succesful performance of a monitoring system, such as:

- installation and interaction with construction
- long-term management of monitoring systems
- …

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Outline

- Demonstrators in this Work Package
- Do we recognize the concepts in previous setups?
- Conclusions and Key Messages

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Tasks in the Demonstration WP

Field tests and synthesis

- Four demonstrators (T4.1 to T4.4)
  - ✓ "EBS Monitoring Plan" – POSIVA (FIN) *(virtual demonstrator)*
  - ✓ "High Activity Monitoring Cell" - "(A)HA" – Bure, ANDRA (F)
  - ✓ "Long-Term Rock and Buffer Monitoring" – LTRBM – Tournemire, IRSN (F)
  - ✓ "Full-Scale Emplacement" (FE, Mt Terri) and "Test and Evaluation of Monitoring Systems" (TEM, Grimsel) – NAGRA (CH)
- Assessment & Synthesis (with other cases) in T4.5
  - ✓ Synthesis of lessons learnt in four demonstrators, complemented with other cases

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WP4 - Demonstration

T4.1 EBS Monitoring Plan (POSIVA)

- overall objective: demonstrate the applicability of EBS monitoring strategies for long-term monitoring setups used for the operation of spent fuel deposition in ONKALO
- Demonstration of the applicability of monitoring strategies
  - ✓ Focus on showing compliance with the safety case and covering primarily long-term monitoring aspects
  - ✓ Including the needs defined and identified in WP2 and the newest technologies developed in WP3
- Development and design of a monitoring system
  - ✓ 1st part: investigation of the latest EBS monitoring technologies to identify the potentials, limitations and restraints of different available techniques, equipments and/or procedures
  - ✓ 2nd part: development and design of a monitoring plan

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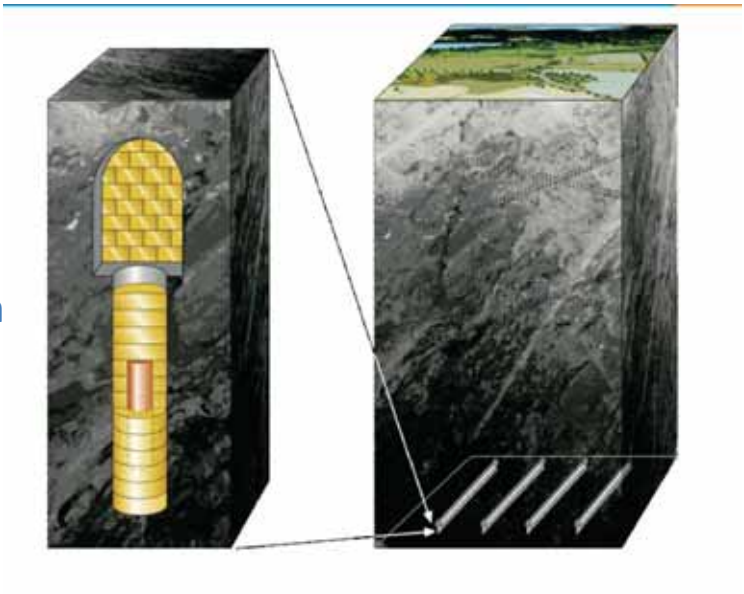
WP4 - Demonstration

T4.1 EBS Monitoring Plan (POSIVA)

- Desk study, based on the KBS-3V concept
- Testing of the WP2 screening methodology
- POSIVA concept based on passive safety
  - ✓ (very) limited monitoring (if any) in real repository



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WP4 - Demonstration

T4.1 EBS Monitoring Plan (POSIVA) – pros and cons of instrumentation

- Advantages:
  - ✓ Possible to increase the knowledge of the THM processes
  - ✓ To be able to give feedback to design during installation period
  - ✓ Gives more points to compare to modelling, much better use of the data from the ERT
- Disadvantages
  - ✓ Complicated installation (Risk for delay and increasing cost)
  - ✓ The track record of measurements is not great
  - ✓ More disturbances to the system
  - ✓ Is extensive instrumentation in full scale tests an efficient way to build knowledge on evolution? Are there more efficient ways?

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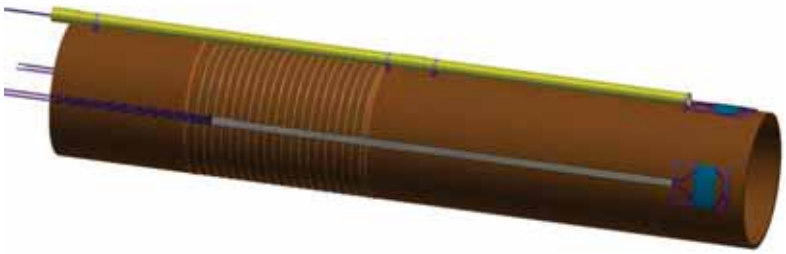
WP4 - Demonstration

T4.2 (A)HA (ANDRA)

- demonstration of monitoring a disposal cell (tube)
  - ✓ required to ensure retrievability
  - ✓ ovalisation of steel tube by optical fiber sensors



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WP4 - Demonstration

T4.2 (A)HA (ANDRA)

- (to be completed: actual implementation, with relevant dates and first results)

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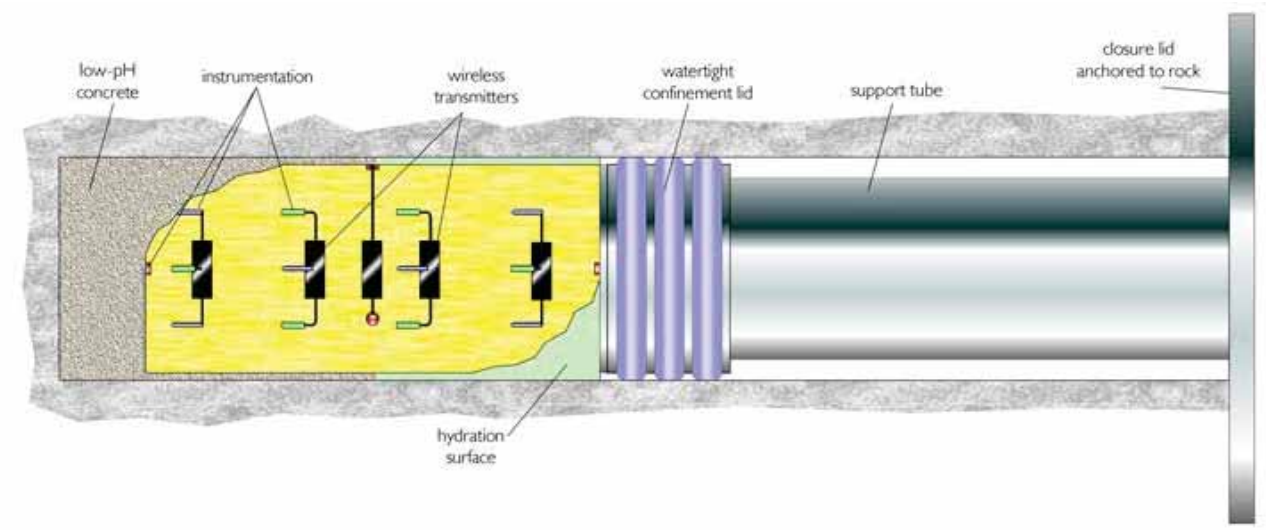
WP4 - Demonstration

T4.3 LTRBM (IRSN)

- demonstration of different (wireless) monitoring technologies for buffer and host rock (clay)



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WP4 - Demonstration

T4.3 LTRBM (IRSN)

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WP4 - Demonstration

T4.4 FE & TEM

- continuation of two field set-ups
  - ✓ Mont Terri: Full-Scale Emplacement (FE)
    - field performance of innovative sensing techniques, with focus on
      - distributed fiber optic temperature measurement
      - TDR monitoring technology
  - ✓ Grimsel Test Site: Test and Evaluation of Monitoring (TEM)
    - assessing wireless monitoring devices > 10 y after installation

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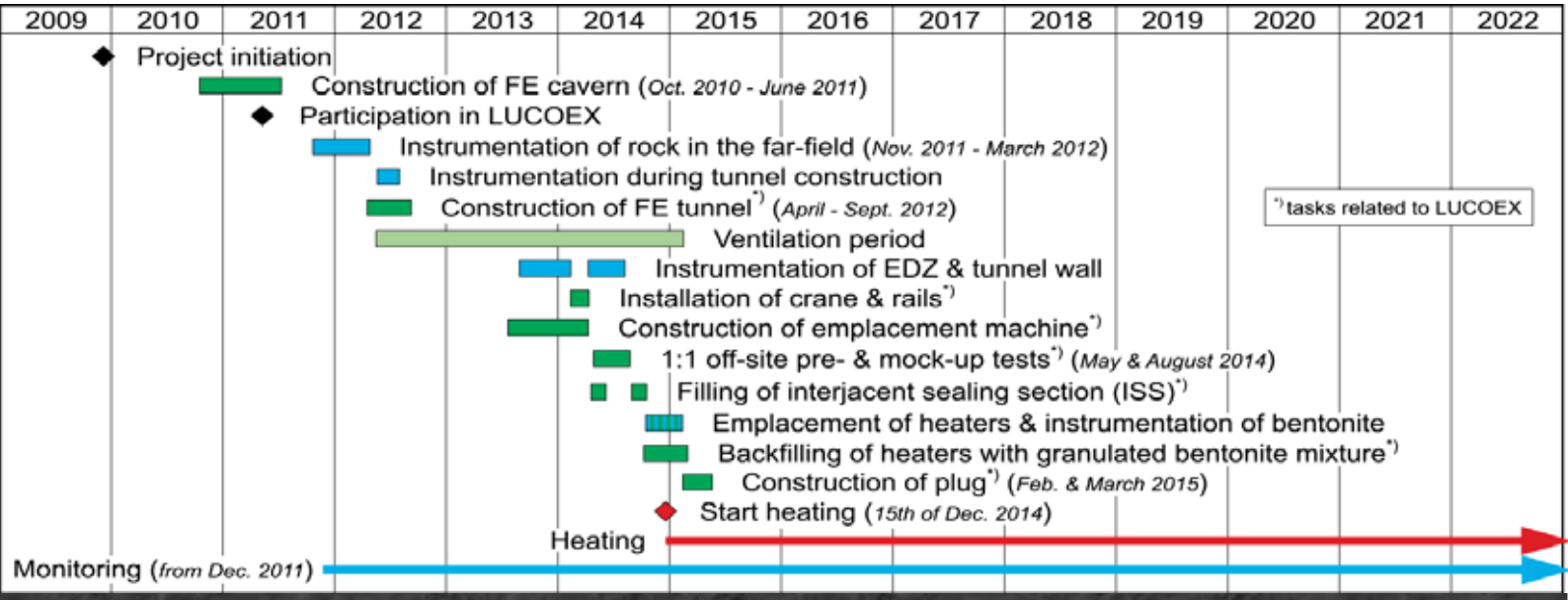
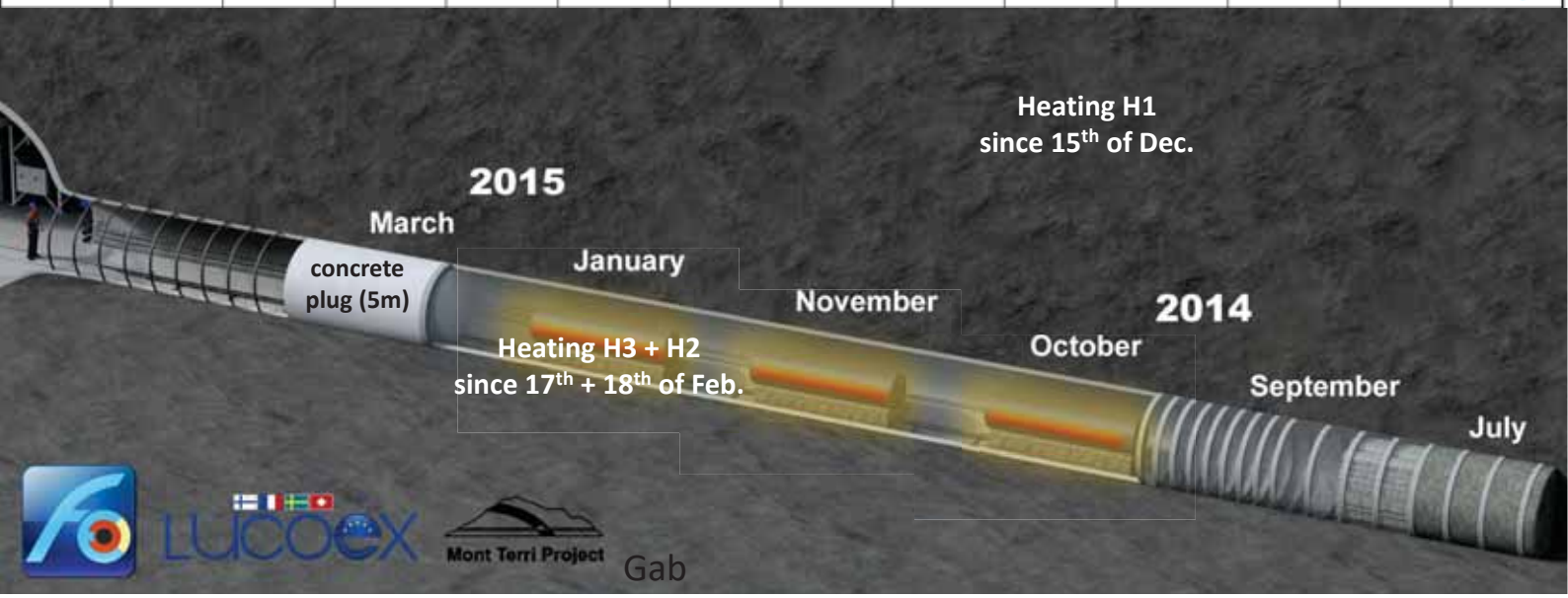
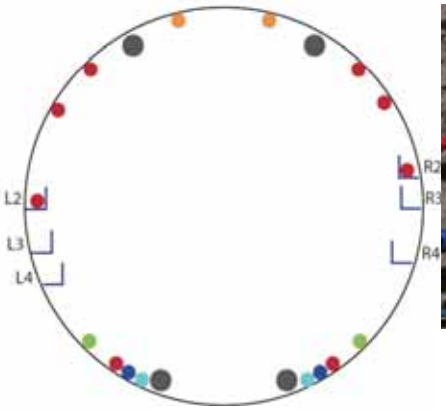

2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Project initiation
Construction of FE cavern (Oct. 2010 - June 2011)
Participation in LUCOEX
Instrumentation of rock in the far-field (Nov. 2011 - March 2012)
Instrumentation during tunnel construction
Construction of FE tunnel*) (April - Sept. 2012)
Ventilation period
Instrumentation of EDZ & tunnel wall
Installation of crane & rails*)
Construction of emplacement machine*)
1:1 off-site pre- & mock-up tests*) (May & August 2014)
Filling of interjacent sealing section (ISS)*)
Emplacement of heaters & instrumentation of bentonite
Backfilling of heaters with granulated bentonite mixture*)
Construction of plug*) (Feb. & March 2015)
Start heating (15th of Dec. 2014)
Heating
Monitoring (from Dec. 2011)
*) tasks related to LUCOEX

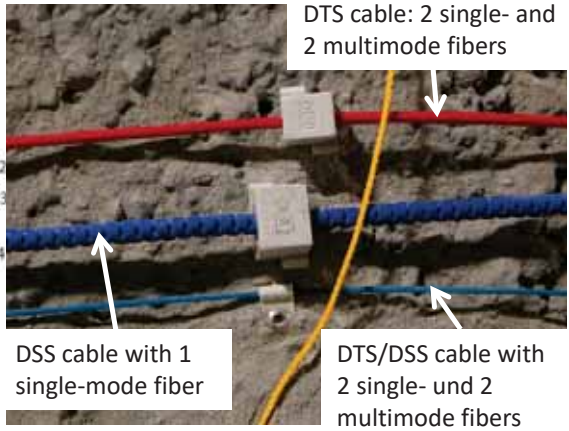

Heating H1
since 15th of Dec.
2015
March
January
November
2014
October
September
July
concrete
plug (5m)
Heating H3 + H2
since 17th + 18th of Feb.
LUCOEX
Mont Terri Project
Gab

FO cables installed in FE tunnel

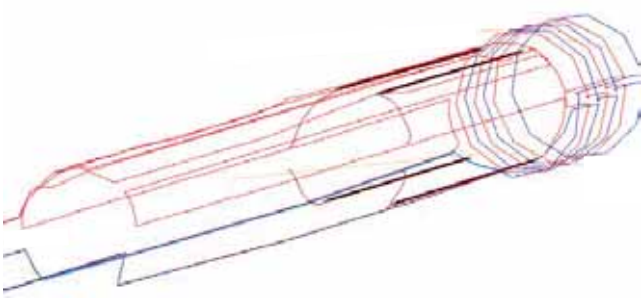
tunnel view



fibers map



Fibre-optic cables for distributed strain and temperature sensing (cables with single and/or multimode fibres) were installed at FE tunnel wall and in boreholes.



3D fibers map of tunnel wall

- Brugg Cable in A11, A10 610 m*
- AFL 200 m
- Brugg Heating 265 m
- Brugg Standard 362 m
- Brugg V3 strain 205 m
- Smartrods 4 x 8 (4 x135) m

* Not shown in graph

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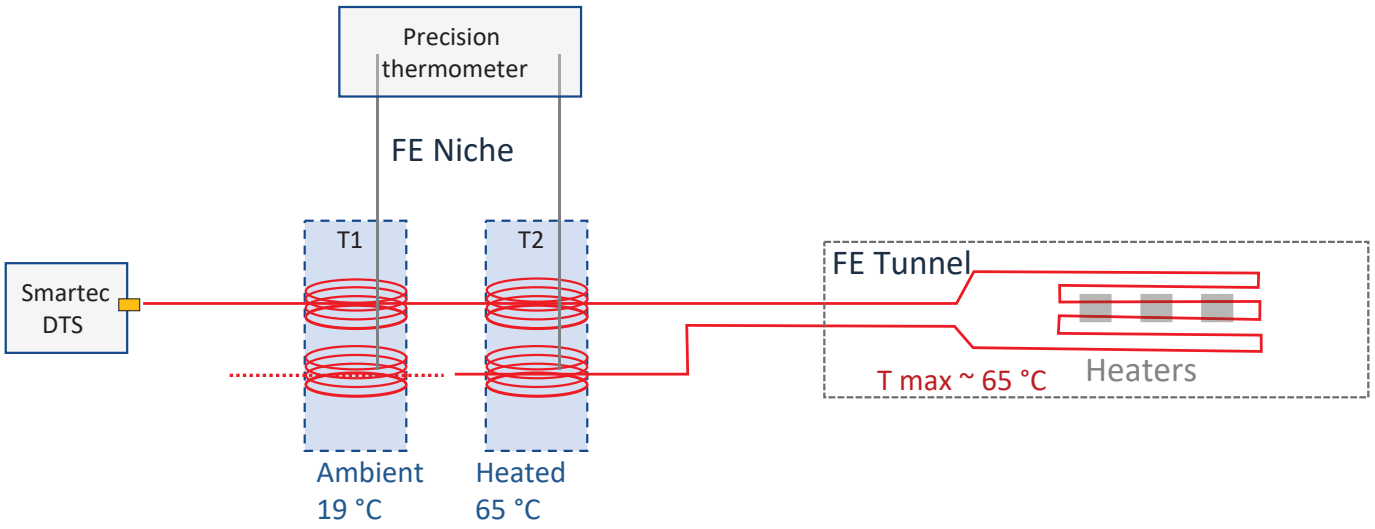
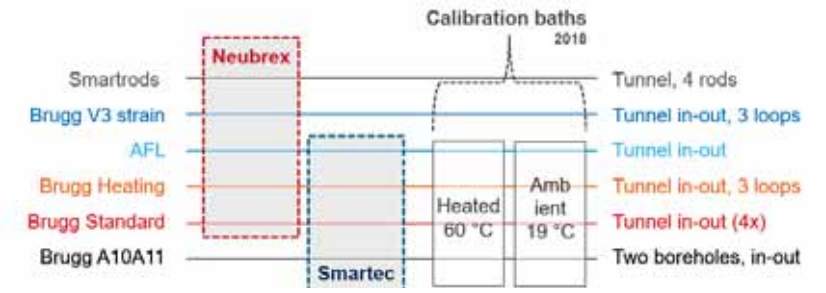
nagra.

Continuous DTS Calibration System



Four cable types per bath, run through each bath twice (outbound and return)



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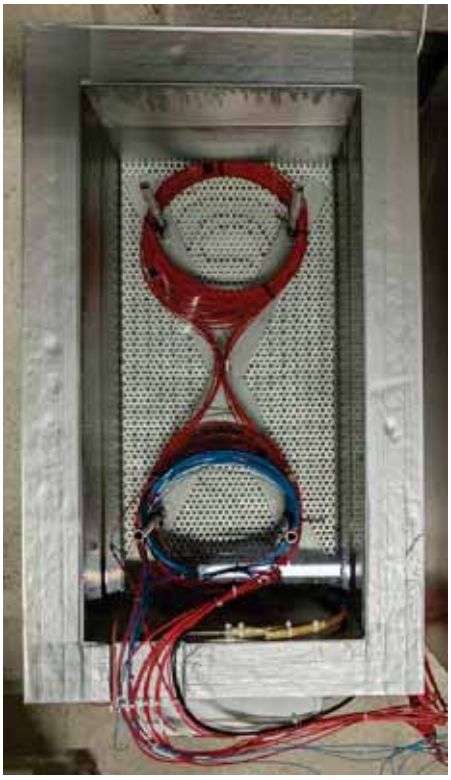
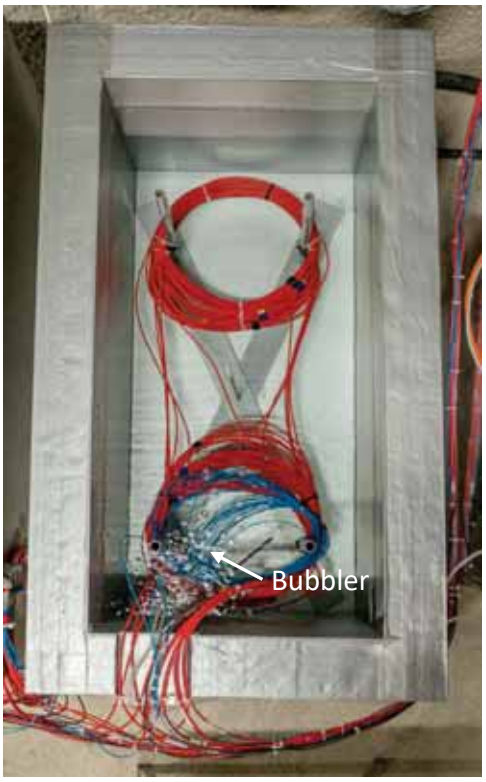
Permanent calibration setup for DTS

CB1: Heated bath



CB2: Ambient T. bath



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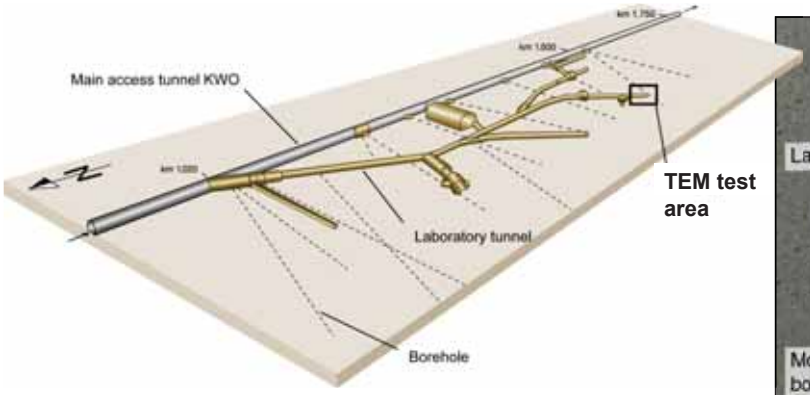
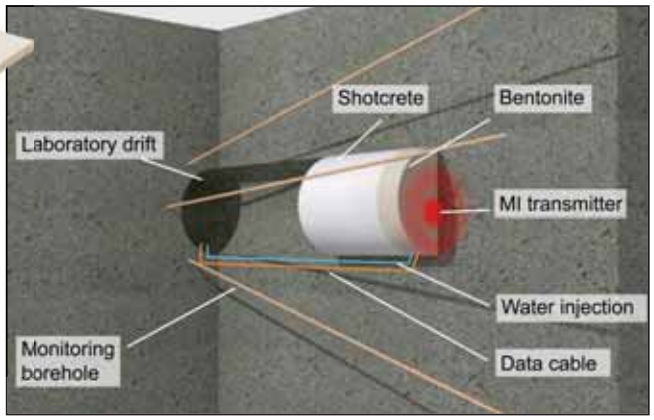
TEM: Location and Construction





Test construction (2007)

Instrumentation

Bentonite buffer construction

Completed bentonite buffer

Shotcrete

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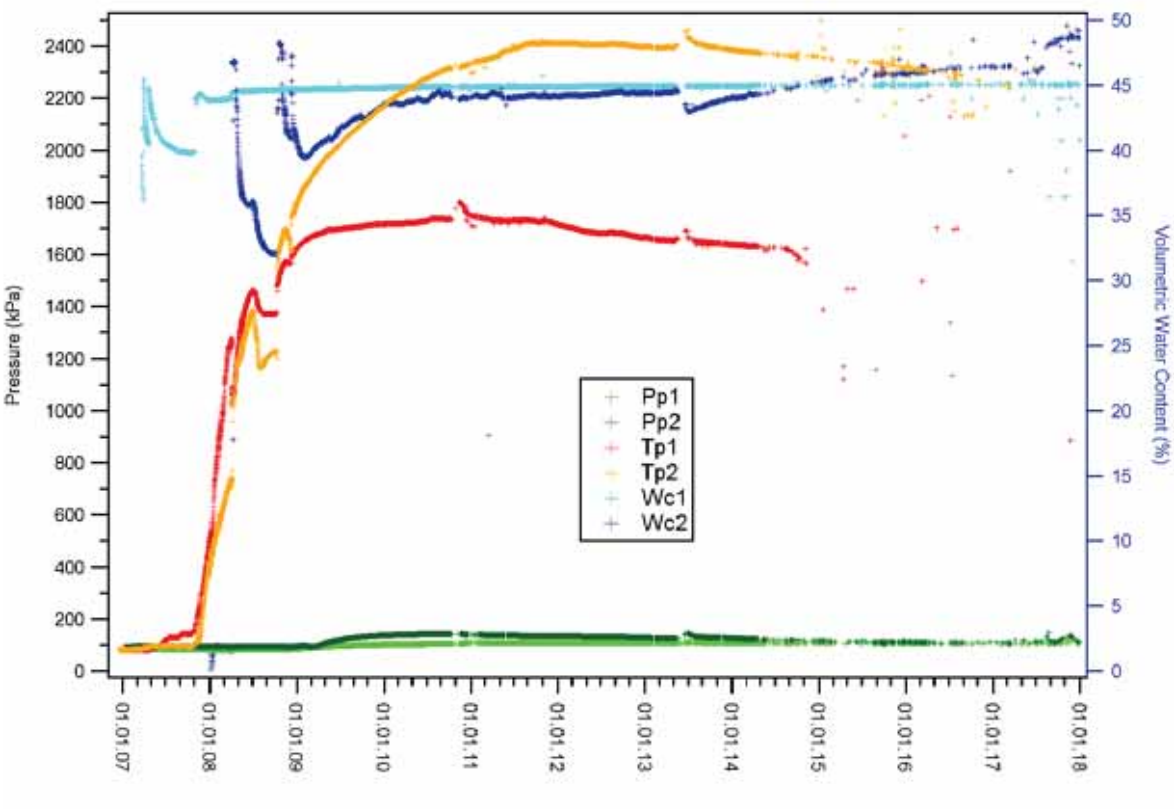
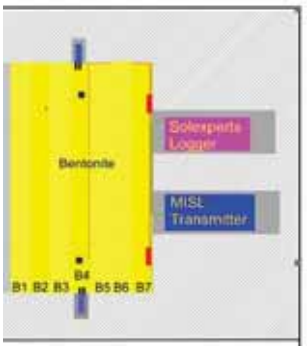
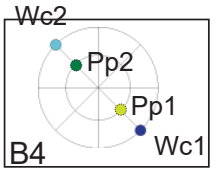
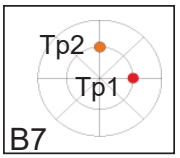
Wireless Monitoring Data (MISL)









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WP4 - Demonstration

Conclusions from demonstrators

- From strategic considerations (POSIVA) to very detailed issues (calibration of fiber optic sensors)
- From minimal monitoring (POSIVA) to detailed monitoring (ANDRA) during operational phase
- Actual performance of demonstrators
  - ✓ limited time ! (few months) for dedicated demonstrators in current project
  - ✓ relevance of long-term roadmap for such demonstrators
    - e.g. Swiss demonstrators – continuation from ESDRED and LUCOEX EC projects
  - ✓ discussion how to continue (typically within national programmes)

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Integration of existing cases with field demonstrator experiences

Overall objective:

- To test that, based on URL experience, parameters such as identified in D2.2 can be monitored in real-world situations

- Input from
  - ✓ Modern2020 demonstrators
  - ✓ Other (existing) cases

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WP4 - Demonstration

T4.5 Assessment / synthesis of other cases

- Revisit other relevant setups (demonstrators) to extract information on how Modern2020 concepts have been applied
- WP2 – monitoring strategy into implementation
  - ✓ how have parameters been selected
  - ✓ decisions made based on monitoring results
- WP3 – monitoring technology
  - ✓ which sensors have been selected
  - ✓ conventional versus innovative technologies (evolution over the last decades)
  - ✓ (track record)
- WP4 – actual performance of demonstrator versus expectations
- WP5 – external involvement
  - ✓ field setup and monitoring data discussed by external parties (e.g. universities / local stakeholders / regulator …)
  - ✓ can monitoring act as a connection – “matchmaker” between technology (implementor) and public (society)

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WP4 - Demonstration

T4.5 Assessment / synthesis of other cases

- setups considered
  - ✓ FEBEX (GTS, CH)
  - ✓ GCR (Bure, F)
  - ✓ PRACLAY
  - ✓ Prototype Repository (Äspö, S)
  - ✓ EB (Mont Terri, CH)
- typical aspects
  - ✓ decision making
  - ✓ long-term – project follow-up, evolution in monitoring technology

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WP4 - Conclusions

Currently on-going

- systematic link from monitoring strategy into implementation
- strong influence of national context / programmes
- advance in application of novel technologies
  - ✓ what are critical success factors
    - e.g. distributed fiber optic techniques – calibration, data management, visualisation
- more potential on the role of demonstrators with regard to the engagement of public stakeholders

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