

Waste Disposal R&D @ SCK•CEN

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Expert Group Waste & Disposal

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STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

- A multi-disciplinary approach
- Waste types
- Disposal types
- Experiments and Modelling
- International perspective
- Conclusion

Our Research Includes...

**Ethics & Social
Aspects**

Geology

Hydrogeology

**Safeguards &
Monitoring**

Material Science

**Performance
Assessment**

Radiochemistry

Geomechanics

Geochemistry

Geomicrobiology



Waste Types

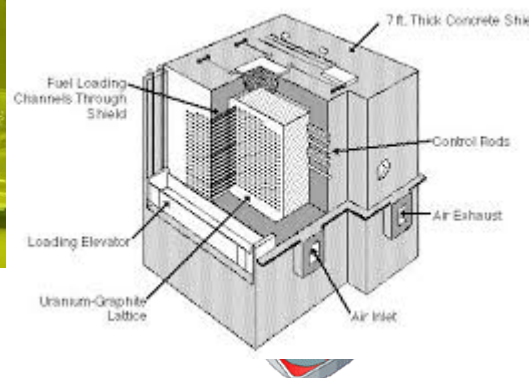
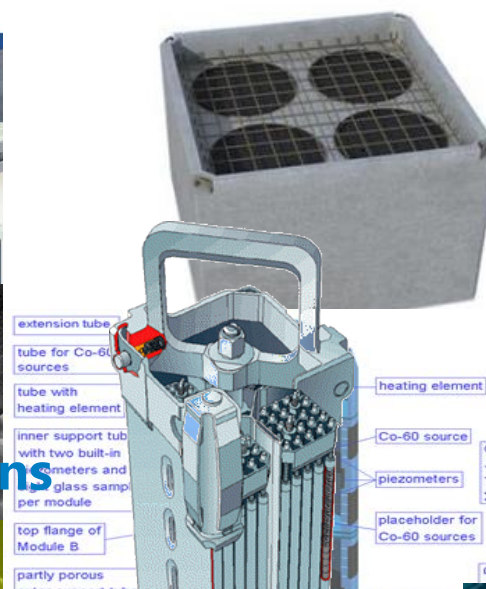
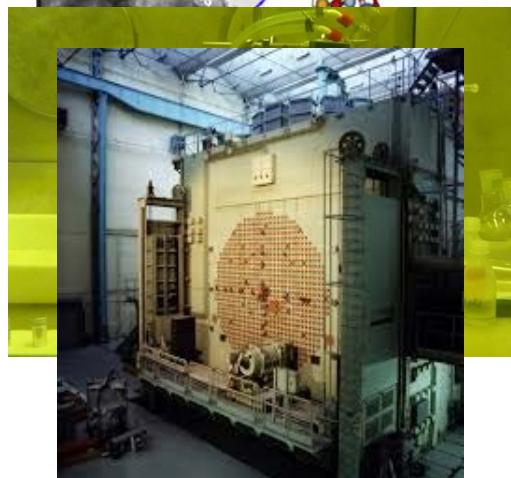
- Low level and cemented waste



- Spent fuel

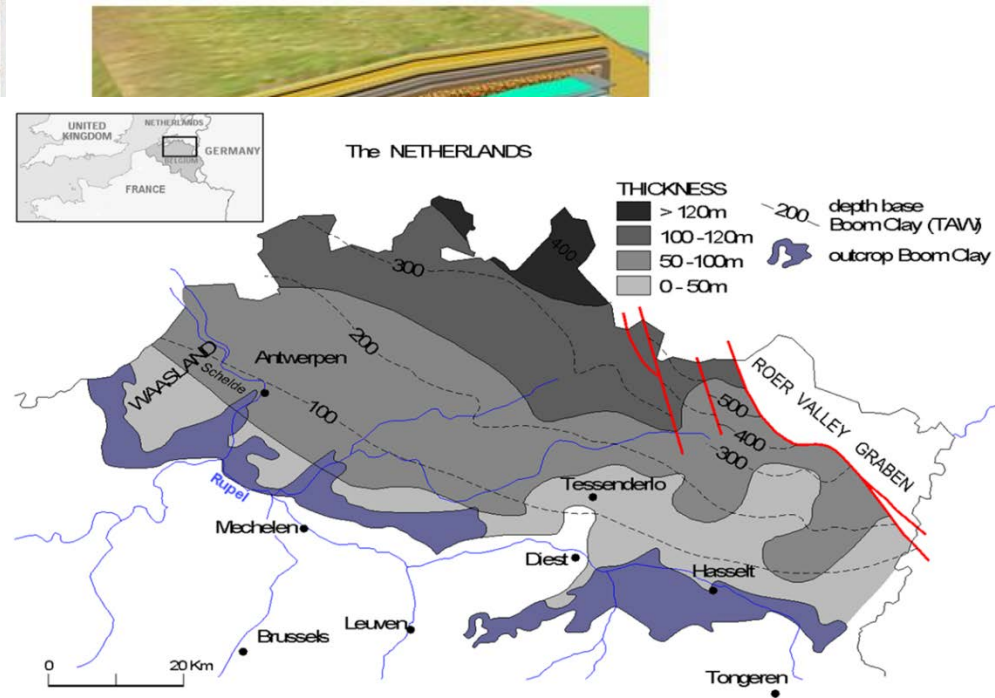
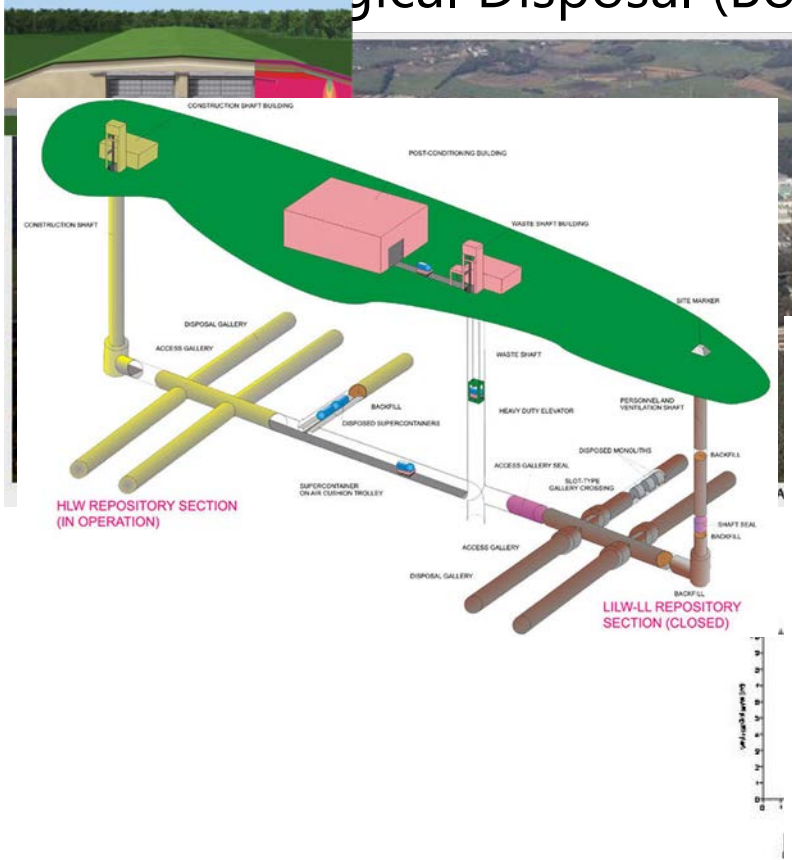


- No industrially mature solutions



Disposal Types

- Surface Disposal (CAT site, Dessel)
- Deep Geological Disposal (Boom Clay, Ypresian clays)

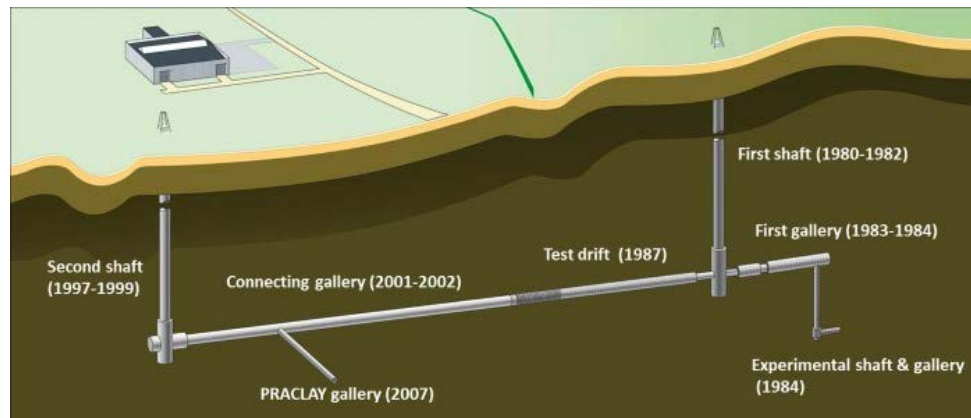


With a Unique Infrastructure

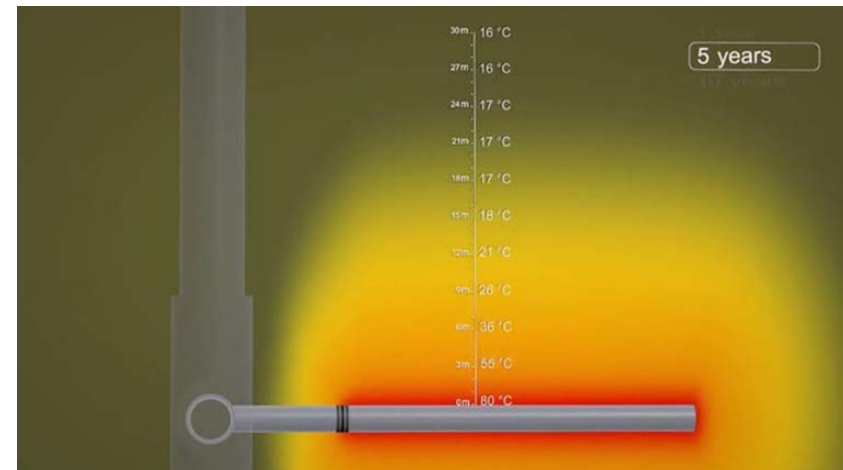
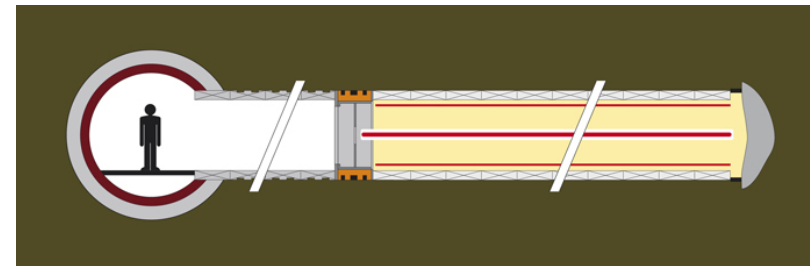
- HADES Underground Research Laboratory – EIG EURIDICE



EIG EURIDICE GIE



PRACLAY *in situ* heater experiment

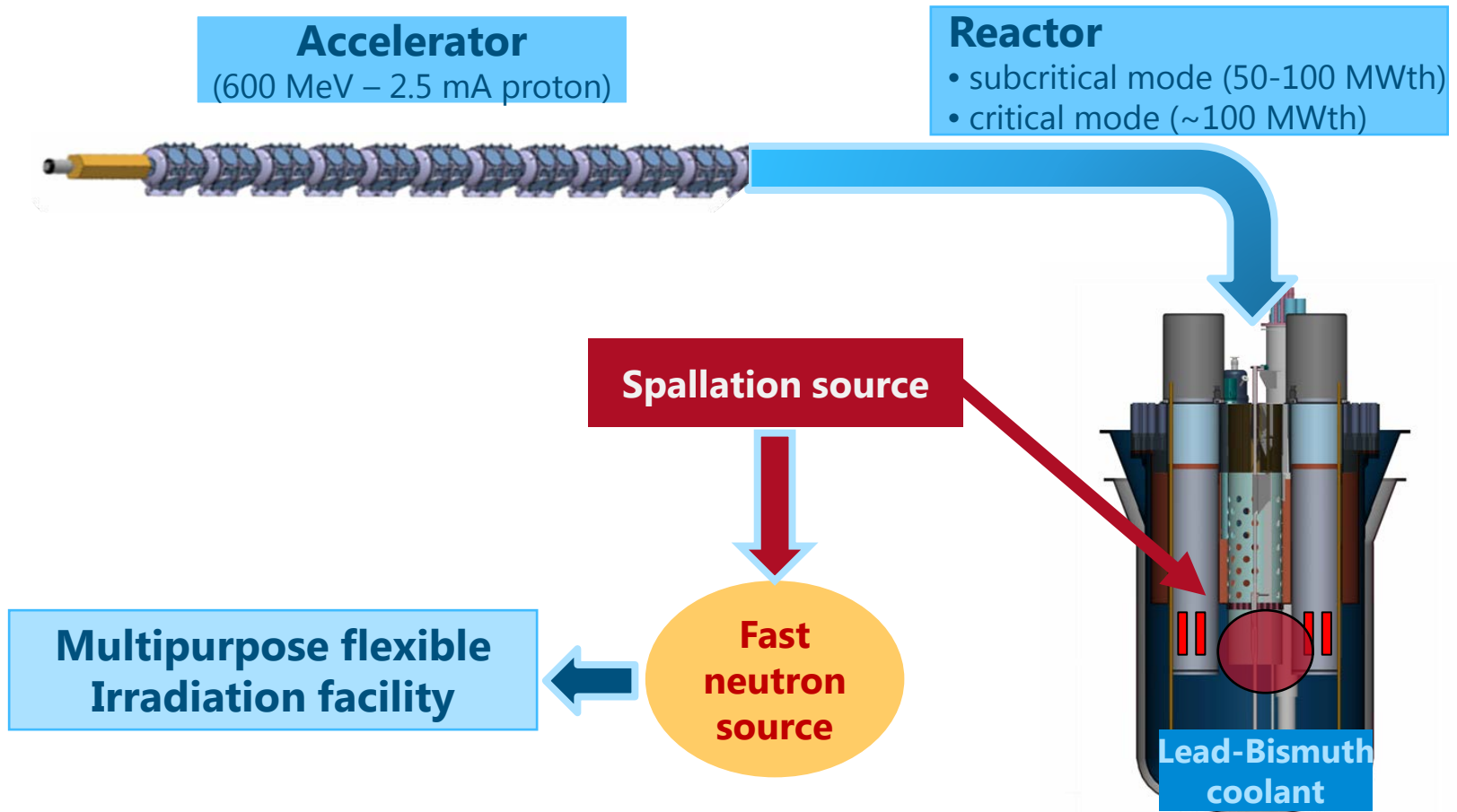


Ready to answer to societal concerns

- Main research organisation within the Belgian Programme on radioactive waste disposal
 - Coordinated by WMO ONDRAF/NIRAS
 - Strongly linked through EIG EURIDICE
- Own R&D complementing these activities
 - Dotation from FOD Economy
- Independent research
- High quality, assessed by peers
- High level of multi-disciplinarity
- Importance of social sciences group (PISA)

With an eye on the future

- MYRRHA



With an eye on the future

● MYRRHA

Material research
 $F_{\text{Fast}} = 1 \text{ to } 5.10^{14} \text{ n/cm}^2.\text{s}$
($E_n > 1 \text{ MeV}$) in large volumes

Fuel research
 $\Phi_{\text{tot}} = 0.5 \text{ to } 1.10^{15} \text{ n/cm}^2.\text{s}$



Fission GEN IV



Fusion

$F = 1 \text{ to } 5.10^{14} \text{ n/cm}^2.\text{s}$
(ppm He/dpa ~ 10)
in medium-large volumes

50 to 100 MWth
 $\Phi_{\text{Fast}} = \sim 10^{15} \text{ n/cm}^2.\text{s}$
($E_n > 0.75 \text{ MeV}$)

Waste

Multipurpose
Ybrid
Research
Reactor for
High-tech
Applications

$F_{\text{th}} = 0.5 \text{ to } 2.10^{15} \text{ n/cm}^2.\text{s}$
($E_n < 0.4 \text{ eV}$)

**Radio-
isotopes**



**Fundamental
research**

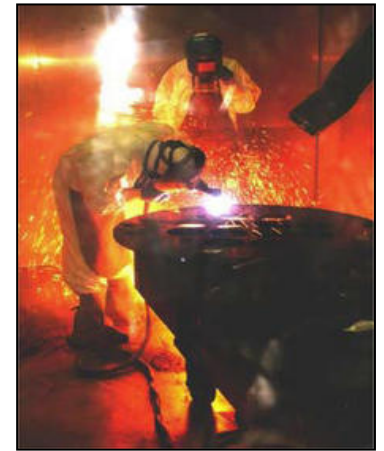
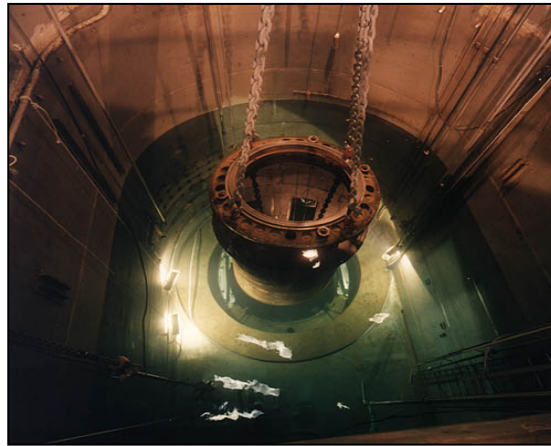
High energy LINAC
600 MeV – 1 GeV
Long irradiation time



**Silicon
doping**

$F_{\text{th}} = 0.1 \text{ to } 1.10^{14} \text{ n/cm}^2.\text{s}$
($E_n < 0.4 \text{ eV}$)

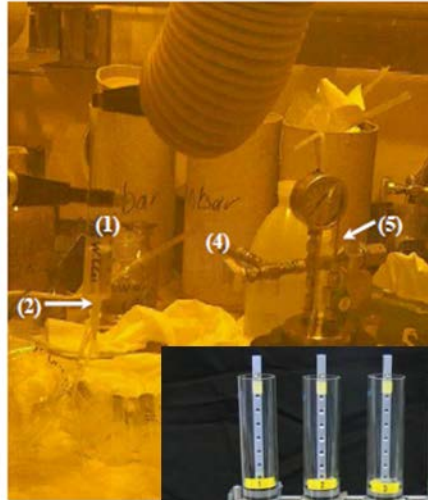
From Cradle to Grave



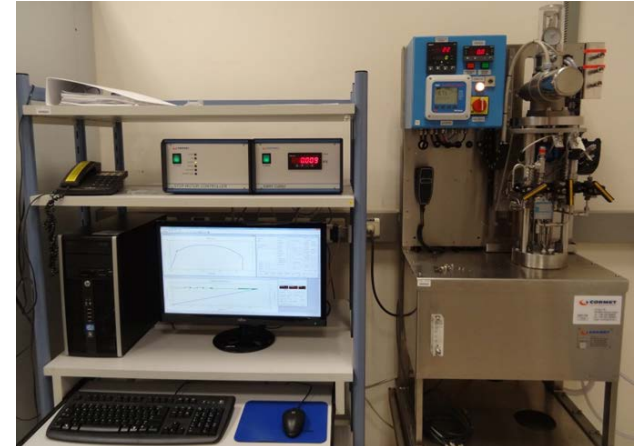
- Hands-on experience in waste characterisation, dismantling, decontamination and decommissioning
- BR3 reactor (SCK•CEN), Thetis reactor (Ugent), Belgonucléaire

Experimental Research...

- In the lab...



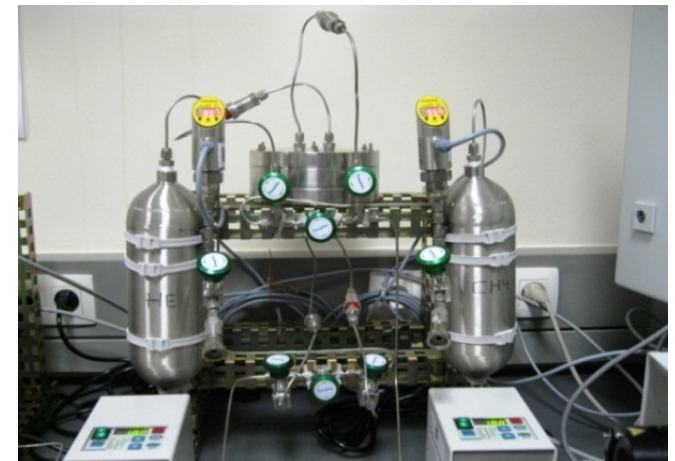
Leach tests with spent PWR fuel (hot cell)



Stress Corrosion Cracking in autoclave



Diffusion experiments
(> 25 years)



Gas through-diffusion setup

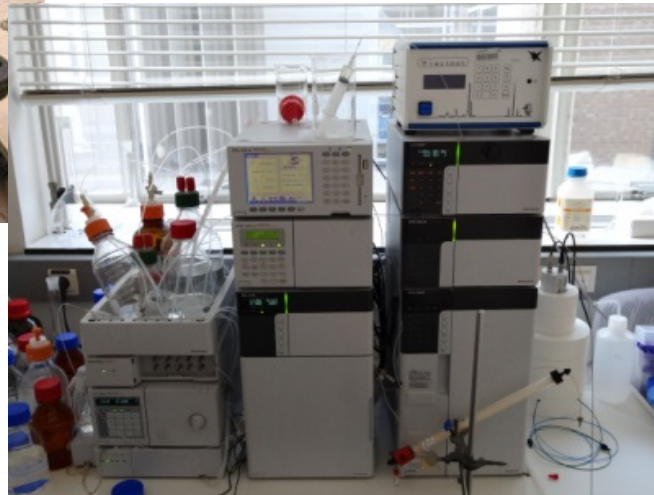
Experimental Research...

- In the lab...



Oedometer setups for swelling behaviour of Eurobitum

Analytical equipment (e.g. HPLC-SEC for studying size distribution of organic colloids)



Glove boxes for working under controlled (anoxic) atmosphere

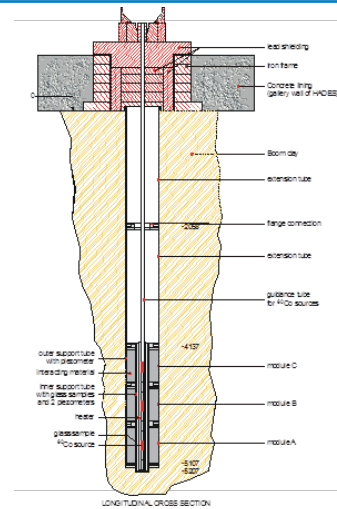


Experimental Research...

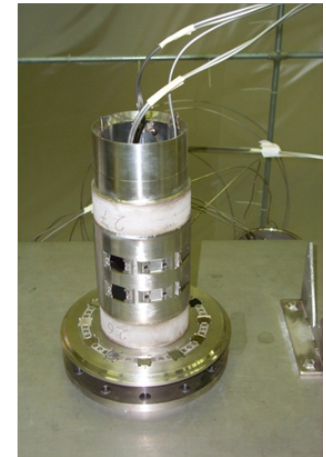
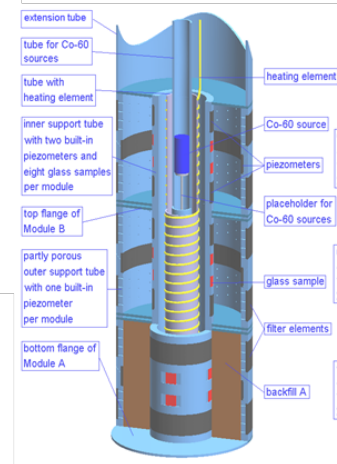
● And in situ...



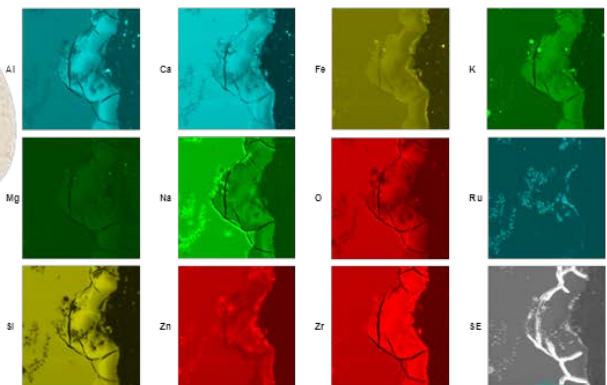
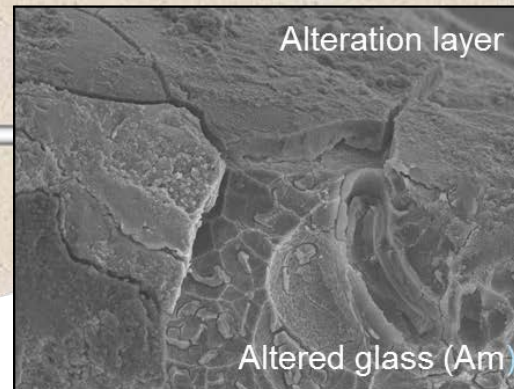
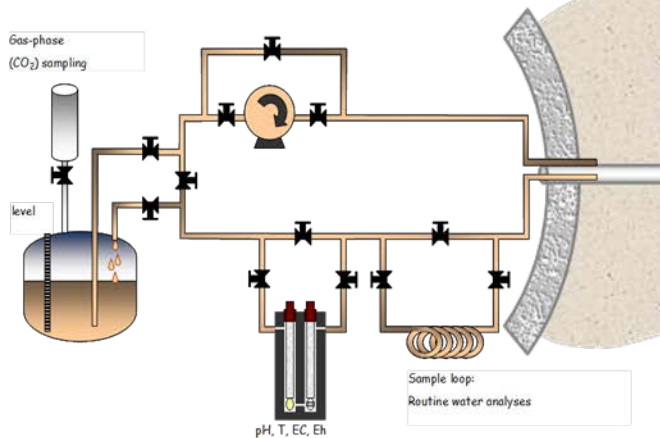
Excavation and construction techniques



CORALUS integrated *in situ* test



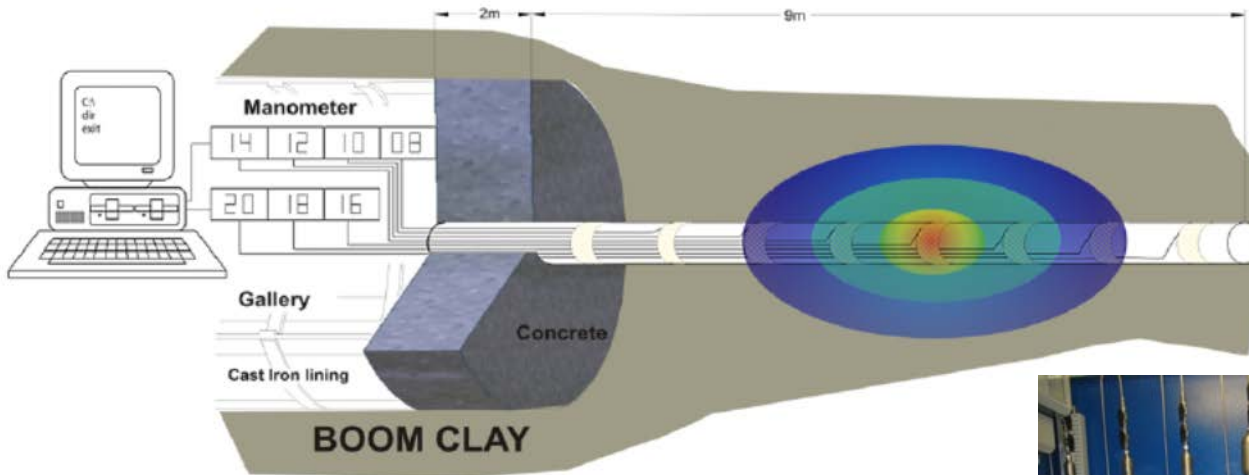
Alteration of SON68 glass



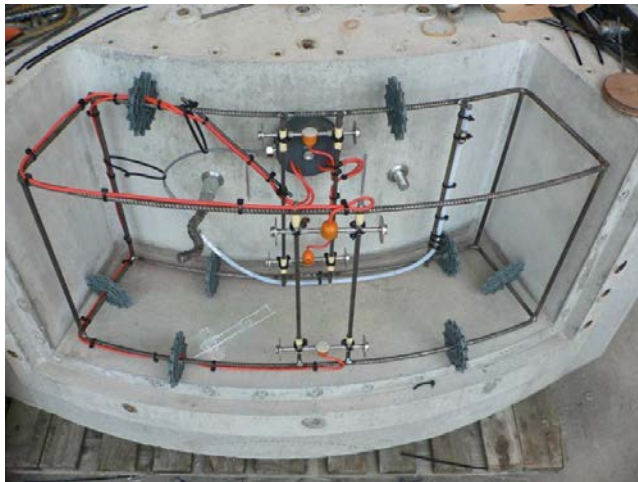
Experimental Research...

- And in situ...

Long-term *in situ* migration experiments



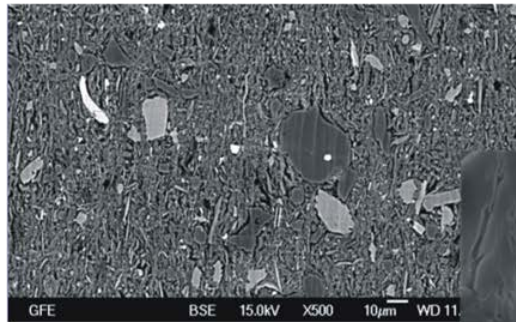
Mont Terri
BN Experiment



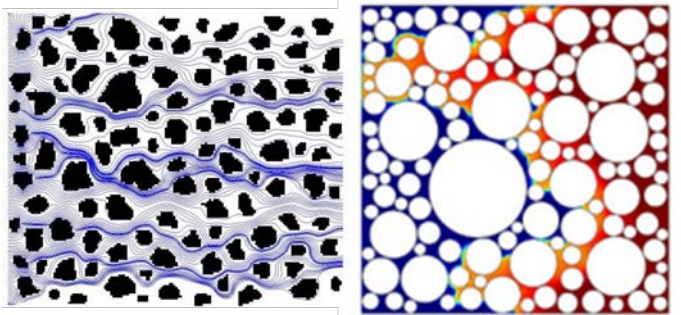
Instrumentation & Monitoring



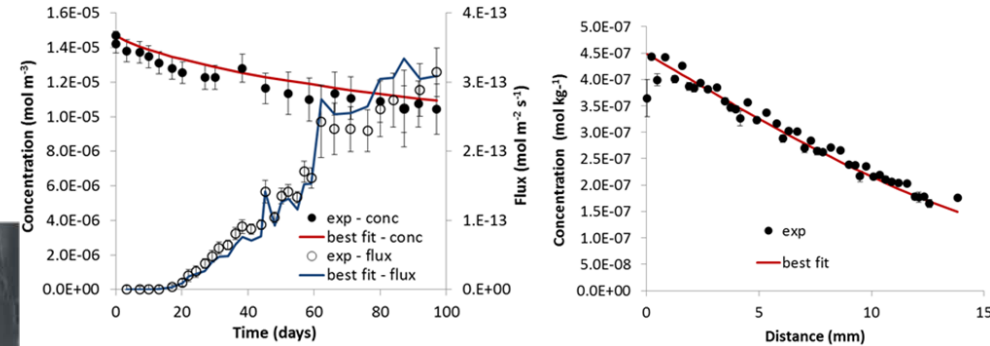
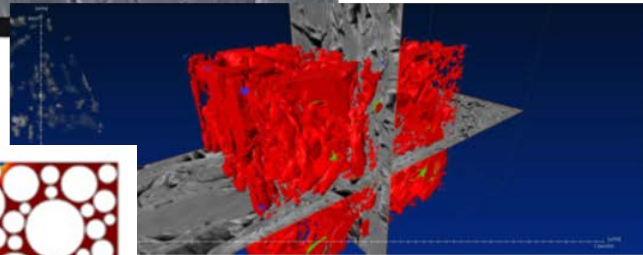
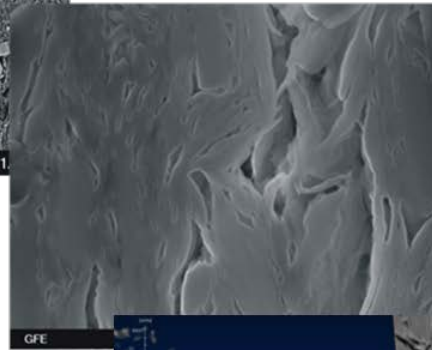
● From the micro-scale



3-D FIB-SEM reconstruction of porosity in compacted Boom Clay (with RWTH Aachen)



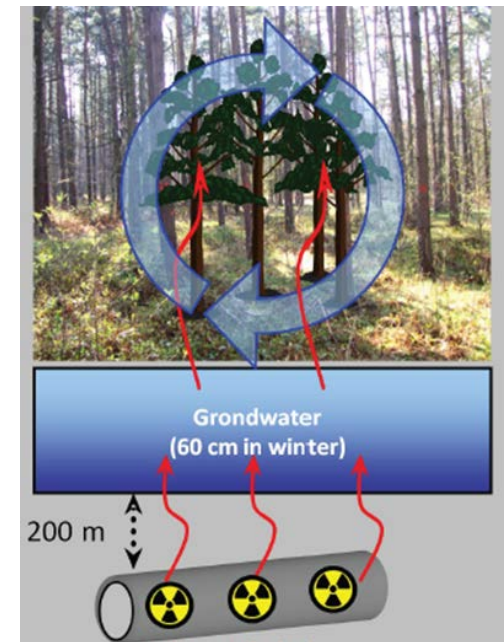
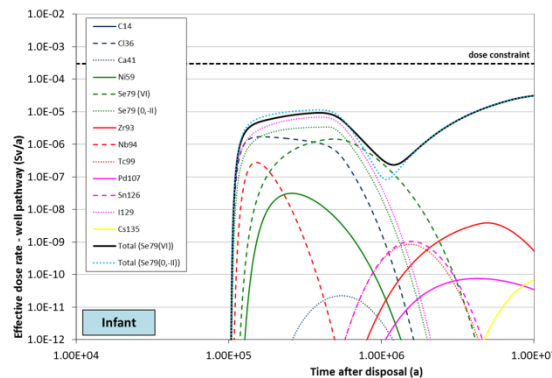
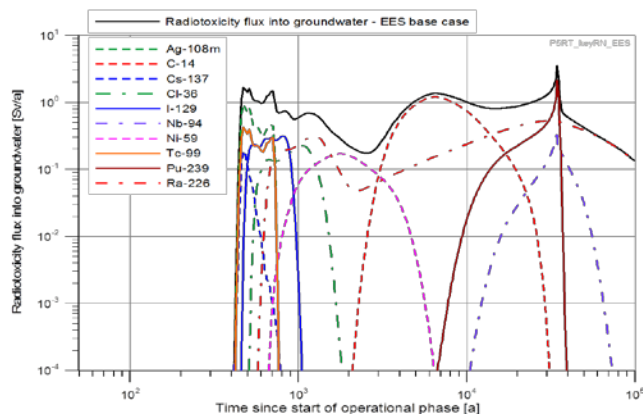
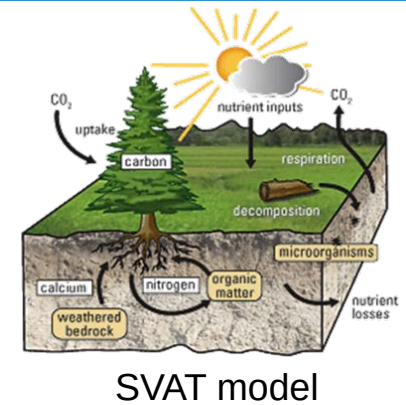
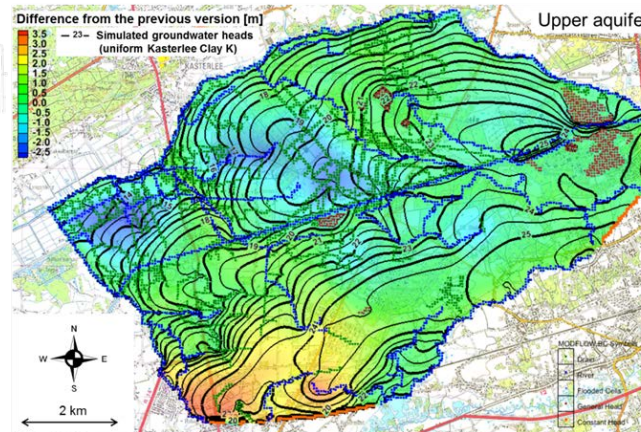
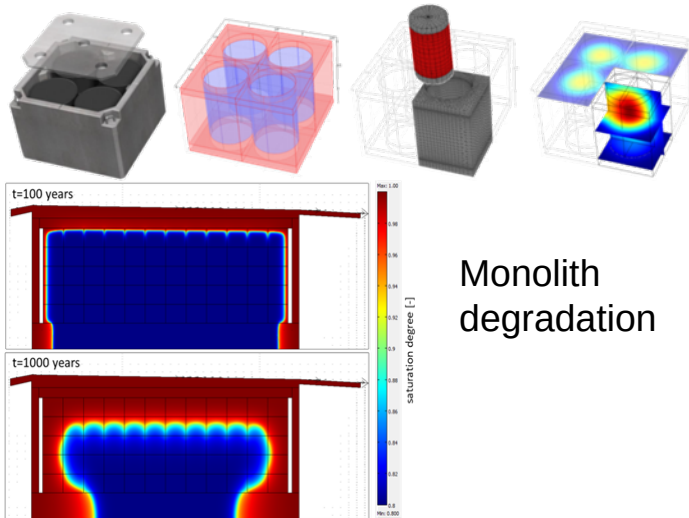
Lattice-Boltzmann modelling



Modelling of a through-diffusion experiment, taking into account double layer diffusion

... and Modelling

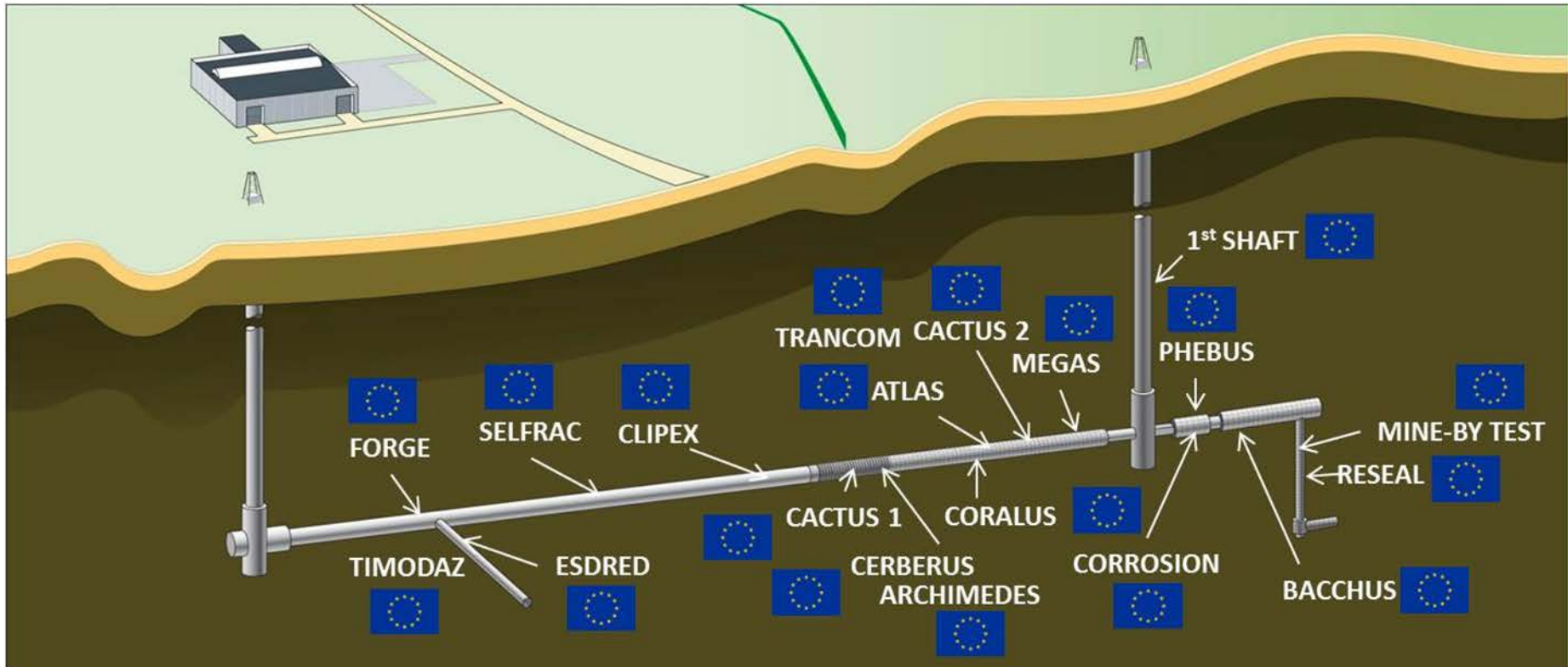
● To the macro-scale



Performance assessment modelling for surface and deep geological disposal

In an international context

- From the early start...



In an international context

- ... to the present and into the future



- NEA/OECD
 - Radioactive Waste Management Committee (RWMC)
 - Integration Group for the Safety Case (IGSC)
 - Clay Club
 - Preservation of Records, Knowledge and Memory (RK&M)
 - Forum on Stakeholder Confidence (FSC)
- IAEA
 - URF Network
- Strong link with COVRA/OPERA (NL)
- Strong link with FR/CH/GE (CEA, PSI, KIT-INE, FZJülich, MontTerri)

A quick eye on future perspectives

- Confidence building
 - Demonstration of our knowledge in complex environments and on longer time scales
 - High gradients (cement-clay-waste interfaces)
 - Demonstration *in situ*
 - (artificial) radionuclides vs naturally occurring elements
 - Thermo-Hydro-Mechanical-Chemical-Bacteriological-Radiological coupling
- Transferability and transposability
 - From generic studies to site-specific information
- Long-term monitoring ↔ Societal interactions

- Very multi-disciplinary team...
- Focussed on the Belgian Programme...
- With an eye to the world...
- In a long-term commitment to society...
- We are ready to answer your questions

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- Thank you!

