

FE /LUCOEX Experiment Mont Terri:

Progress WP 2: Bentonite backfilling



Hanspeter Weber

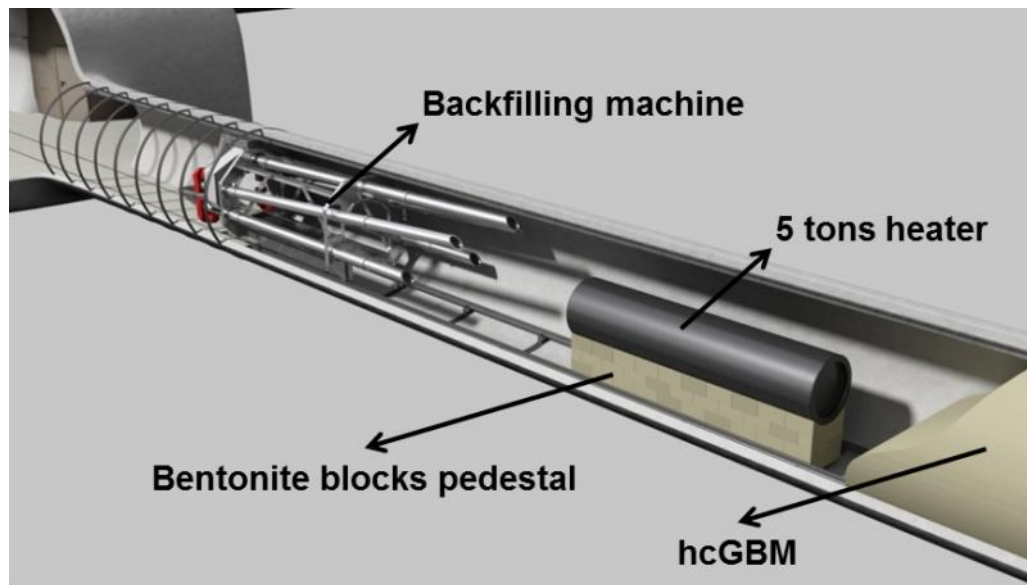
Aspö 13 May 2014



nagra.

FE / LUCOEX Experiment

- Main aims of the experiment:
 - Investigation of **THM** response of Opalinus Clay and bentonite buffer to heating
 - Demonstration of the feasibility of **one-to-one emplacement**



- Secondary, but as well important aims:
 - Stability of bentonite block pedestals
 - Target emplacement dry density: 1.45 g/cm^3 to 1.50 g/cm^3 and homogeneous distribution

International Public Tender for Bentonite Material

- Public tender for four WPs:
 - WP1: raw bentonite material (natural sodium bentonite)
 - WP2: drying of raw bentonite material (to 5% wc)
 - WP3: Pelletizing of raw bentonite material (to 2.0 dd)
 - WP4: Mixing of the granular bentonite material
- 7 companies submitted an offer
(6 including raw material)
- The procedure to select the candidate(s) to perform the mandate was based on:
 - Price
 - Quality
 - Delivery time and interface management

Quantities of Bentonite Materials

- **Raw material:** Natural sodium bentonite
- **Bentonite blocks** → 70 tons for pedestals

Cubic and curved

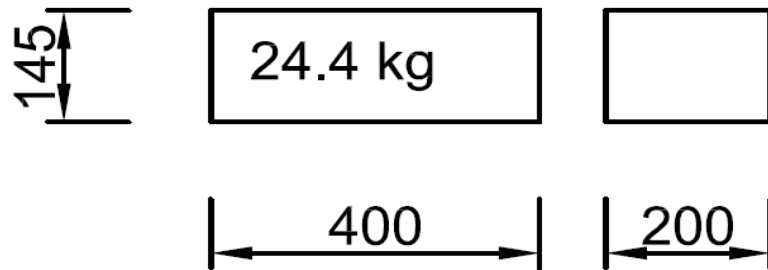
- Pre-production: Strength, stability & RH
 - QC during production
 - Packaging and Storage
- highly compacted Granulated Bentonite Mixture (**GBM**)
 - 340 tons
 - High Emplacement dry density
 - High Pellet dry density and QC
 - Mixture dry density and QC

Bentonite Blocks



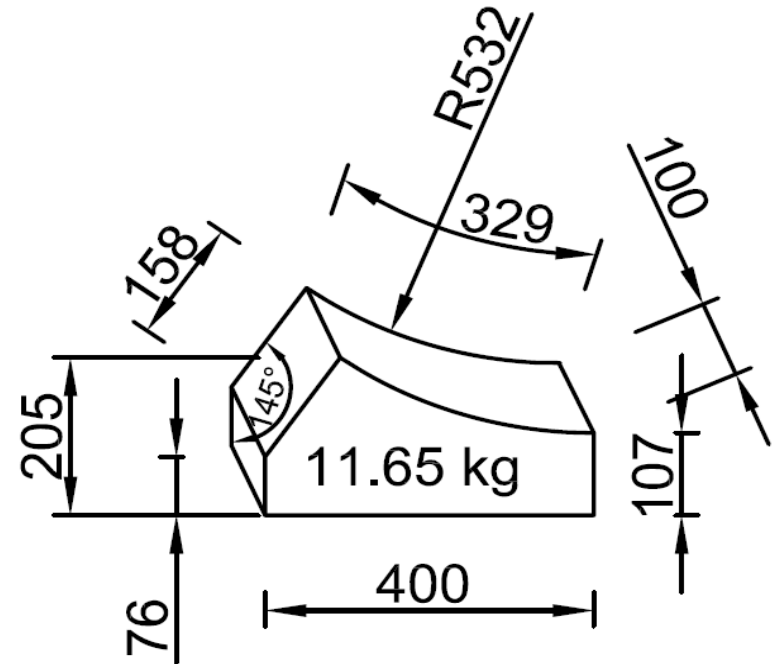
Bentonite Blocks

Ordinary
bentonite blocks



2461 Pieces
produced in March 2014

Top layer blocks



588 Pieces
produced in March 2014

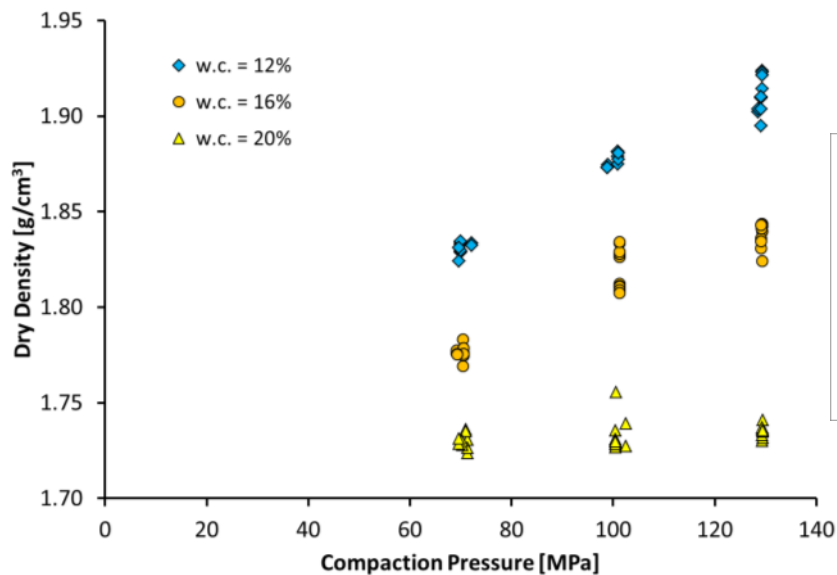
Pre-production

Production of 90 blocks of Gelclay WH2, Wy bentonite (110x300x200)mm³

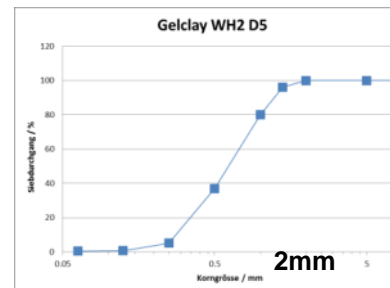


LAVIOSA MPC
78520 Limay FRANCE

Bony S.A.
St. Etienne (F) in Nov. 2012



By uniaxial
compression, short
residence time in
compression chamber
Raw material:



Mixed at different w.c.



Bentonite block Long-term Loading Tests



**70 Mpa
12% wc**



**130 Mpa
12% wc**



**70 Mpa
20% wc**



**130 Mpa
20% wc**

Bentonite Blocks: production and QC

- On the basis of the laboratory results and BLL test performed on the blocks issued from the pre-production, we decided to produce blocks:
 - Using a natural sodium bentonite
 - Using a raw material at 19 +/-1%
 - Using the highest available compaction pressure (130MPa)
- Procedure: One company (MPC) responsible for:
 - Raw material
 - Adjustement of water content
 - Fabrication of moulds
 - Production of blocks
- Variables to be controlled during block production (rejection criteria)
 - Water content (19+/-1%): 2/ton before compaction
 - Dimensions (target deviation: 0.5mm and required: 0.85mm): each block
 - Geometric density (2.08 +/-0.02 g/cm³): each block
 - No visible cracks allowed (picture of each block)

Production: set-up 1600 ton press and robot

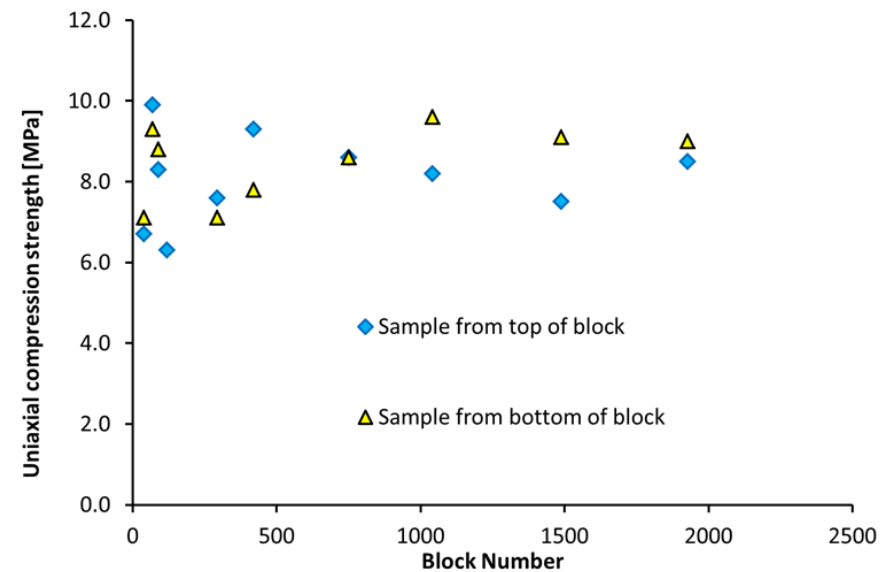
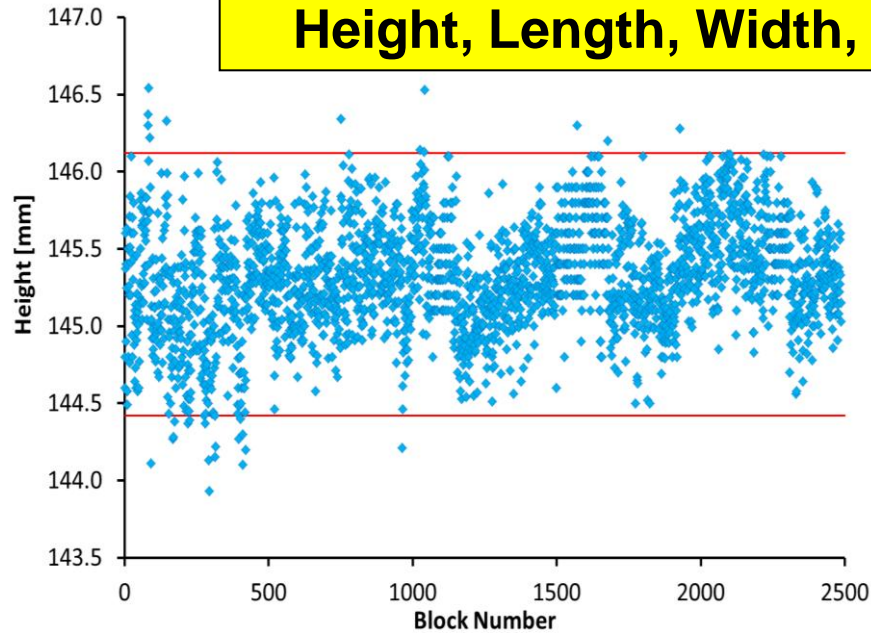


Production: set-up 1600 ton press and robot

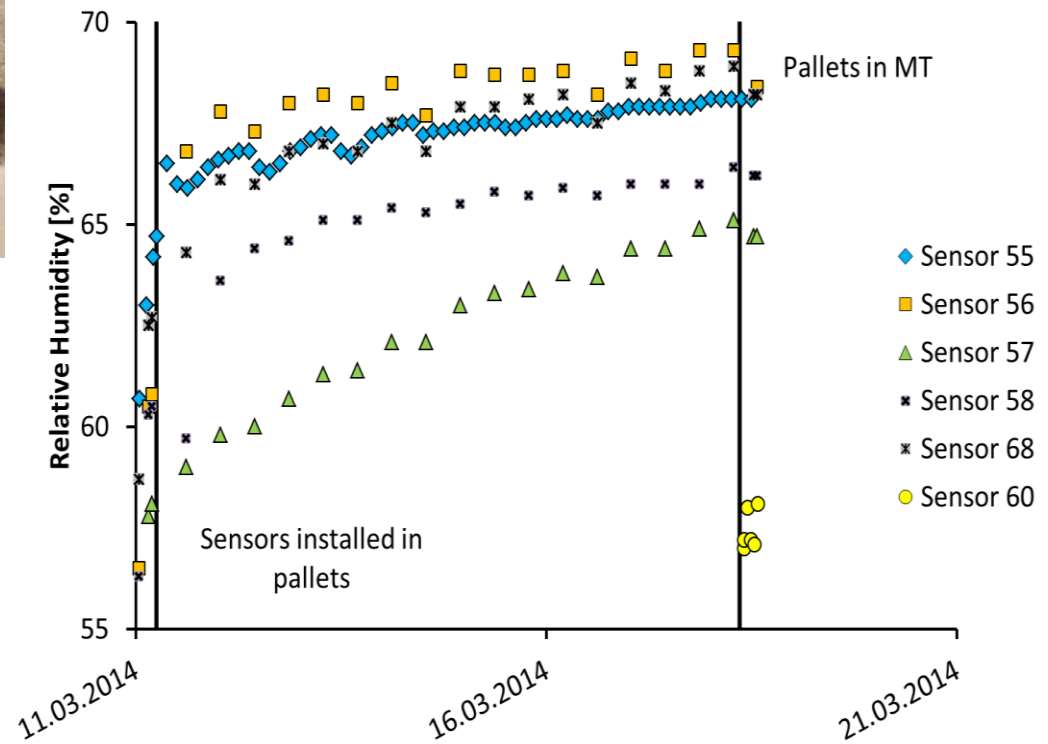


Production: QC

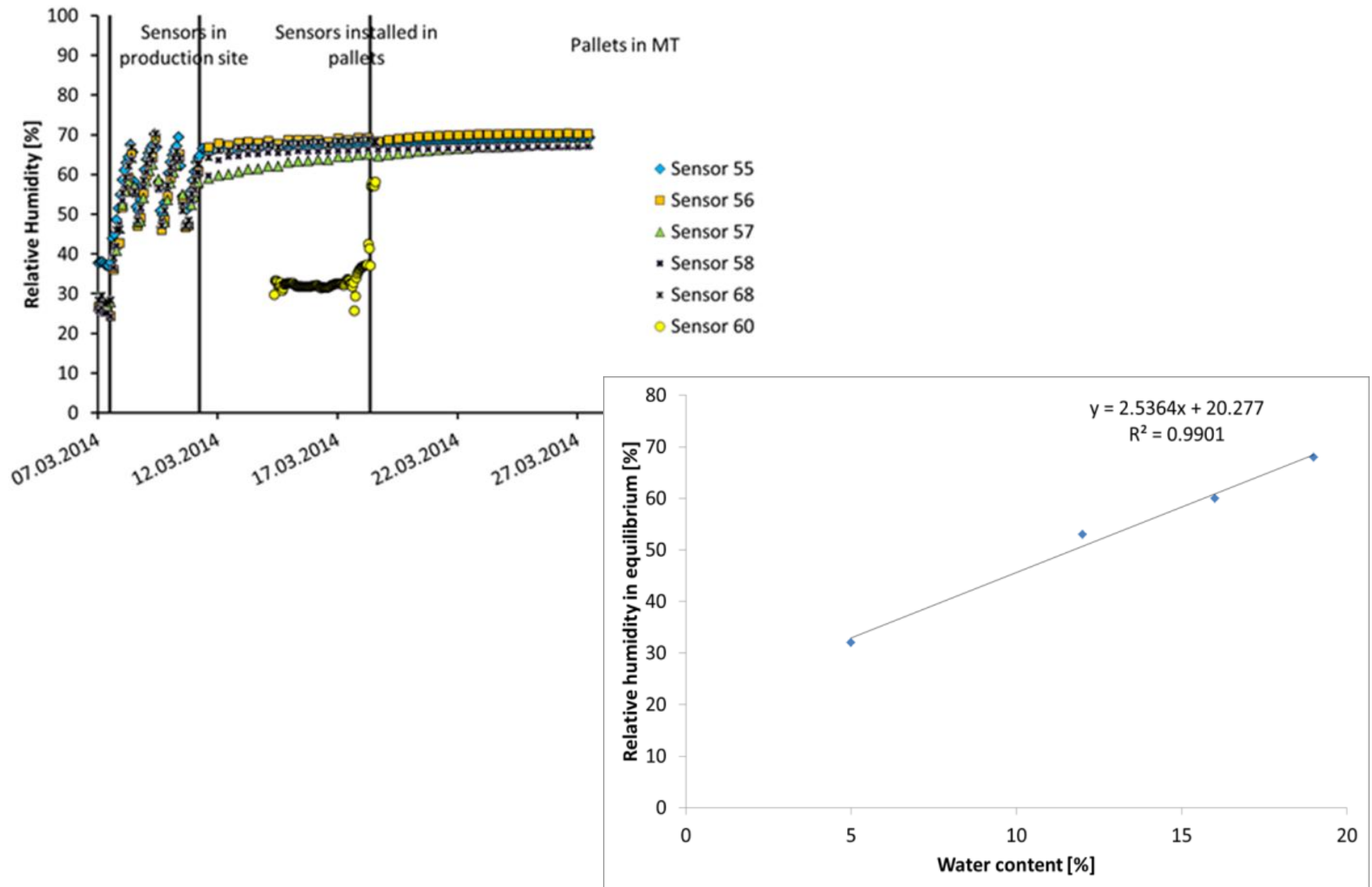
Height, Length, Width, density



Storage of blocks in Mont Terri Rock Laboratory



Storage of blocks in Mont Terri Rock Laboratory



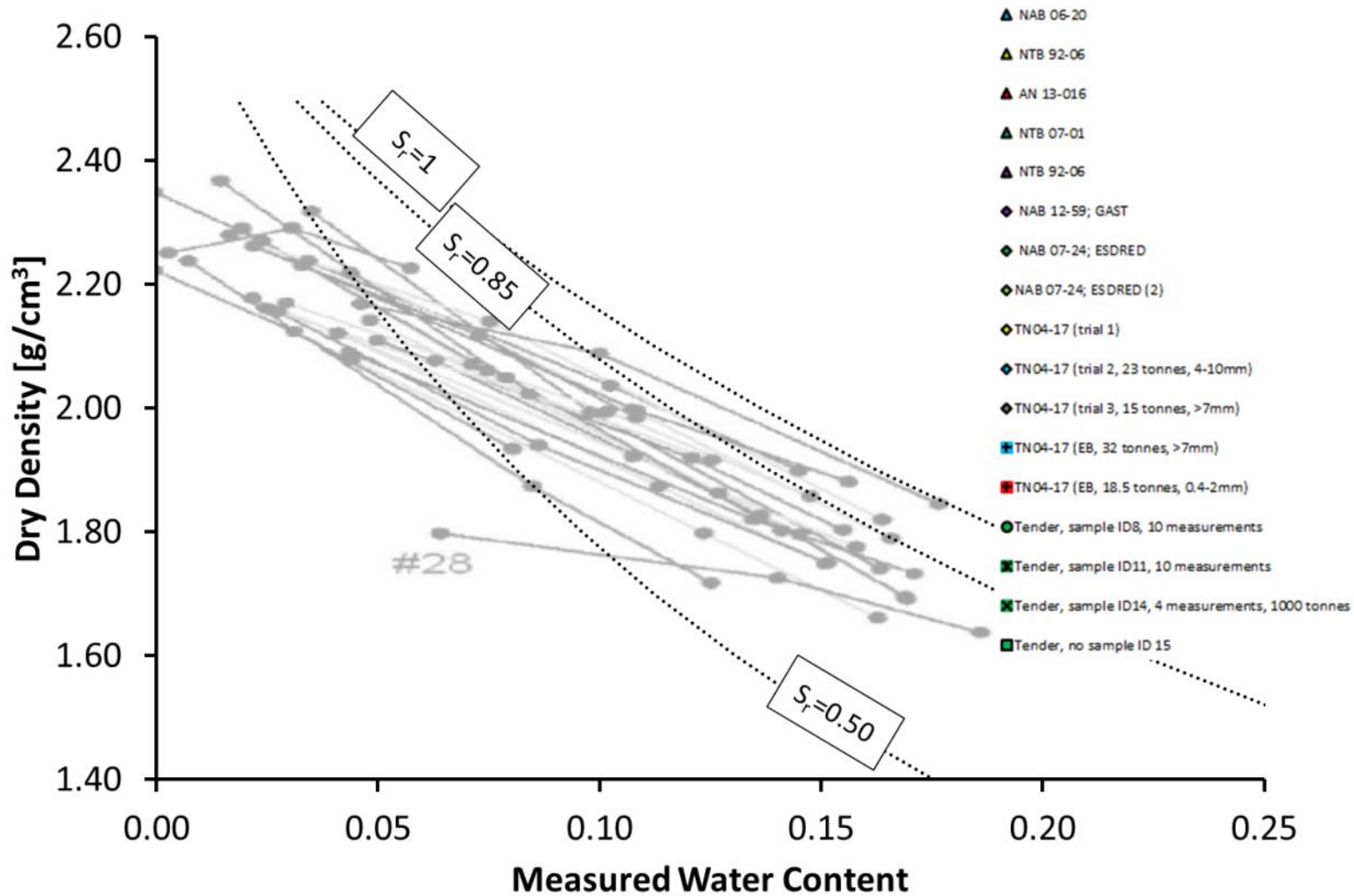
Conclusions (bentonite blocks)

- **Relevant parameters in block production:**
 - **Raw material type (mineralogy)**
 - **Grain size distribution**
 - **Water content**
 - **Compaction pressure**
- **For one type of bentonite (natural sodium bentonite) optimal water content and compaction pressure were identified and we have relatively good confidence that the produced blocks have the required characteristics**
- **Further improvement possible with respect to**
 - **Raw material bentonite type (mineralogy)**
 - **Grain size distribution**
 - **High density fine grains**

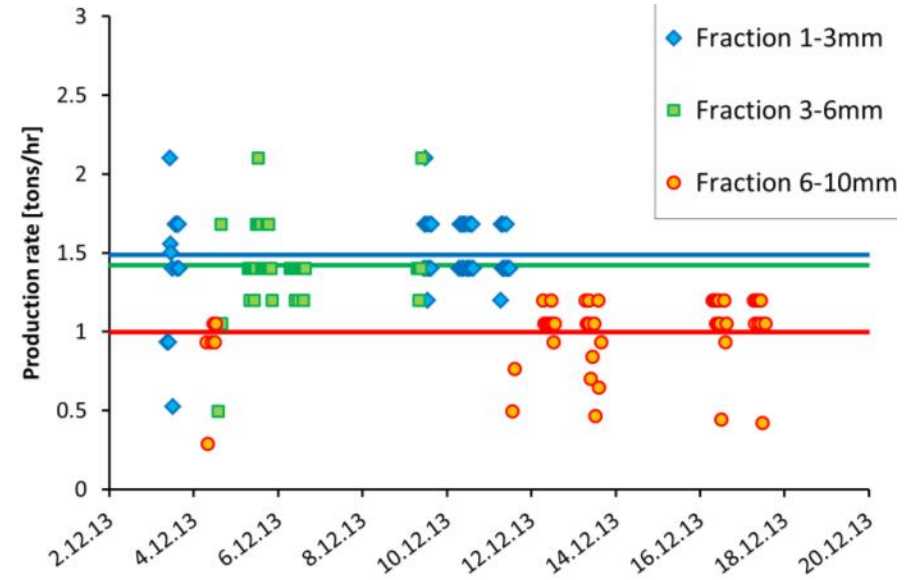
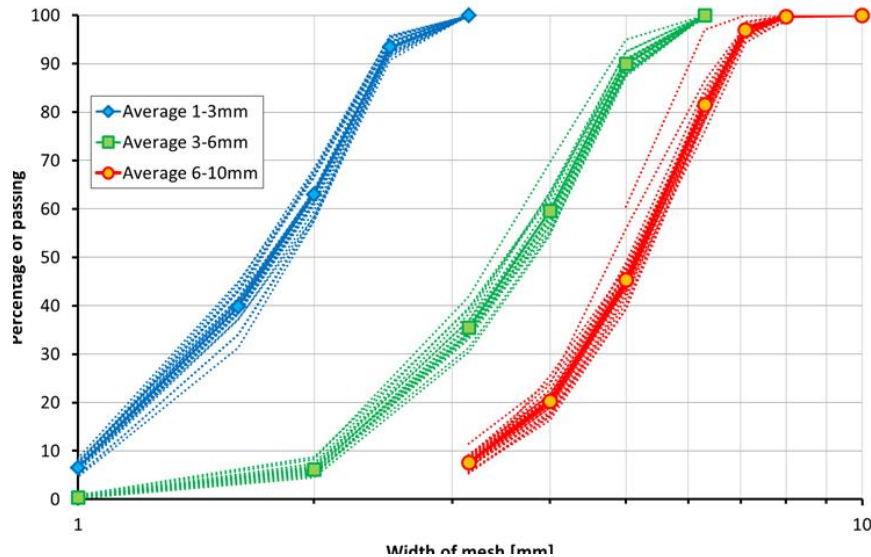
Bentonite Granulate Mixture (Pellets)



hcGBM: pellet dry density



hcGBM: pellet dry density



1-3mm fraction



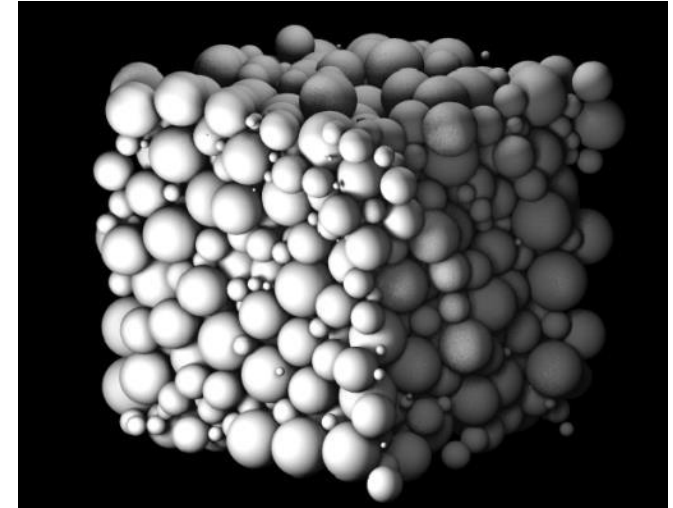
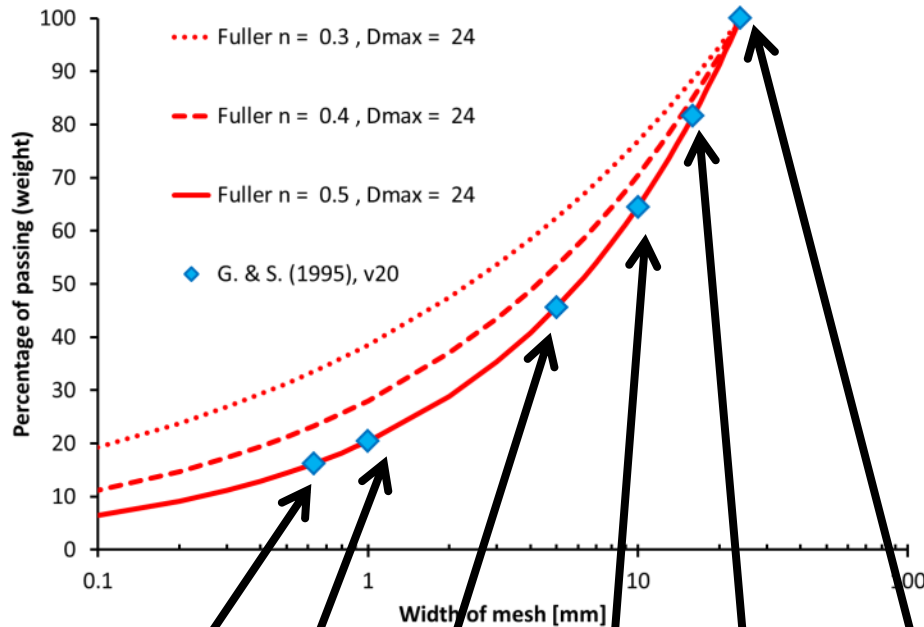
3-6mm fraction



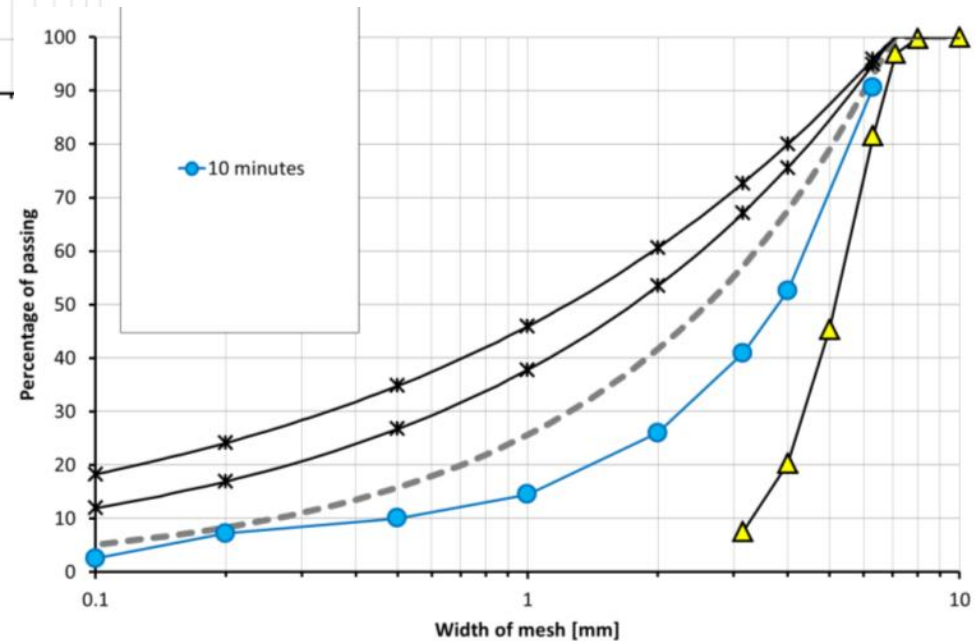
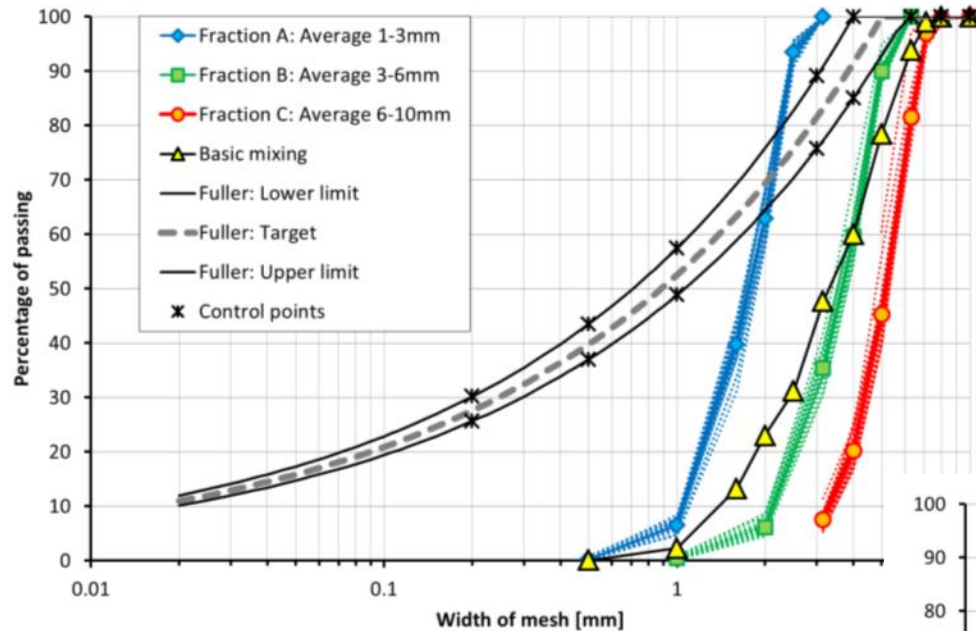
6-10mm fraction

Granular bentonite mixture

Mixture: decrease inter-pellet porosity

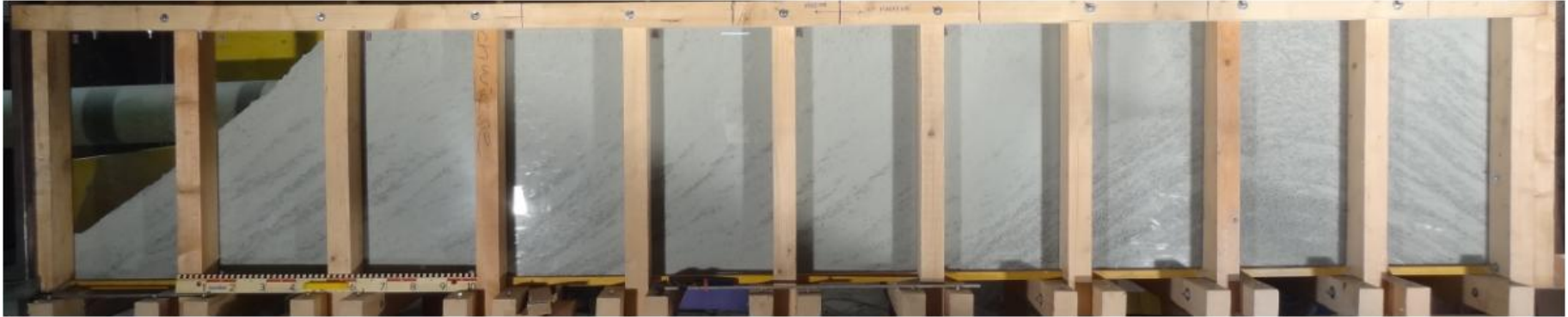


Mixing tests at Rettenmaier in industrial mixer

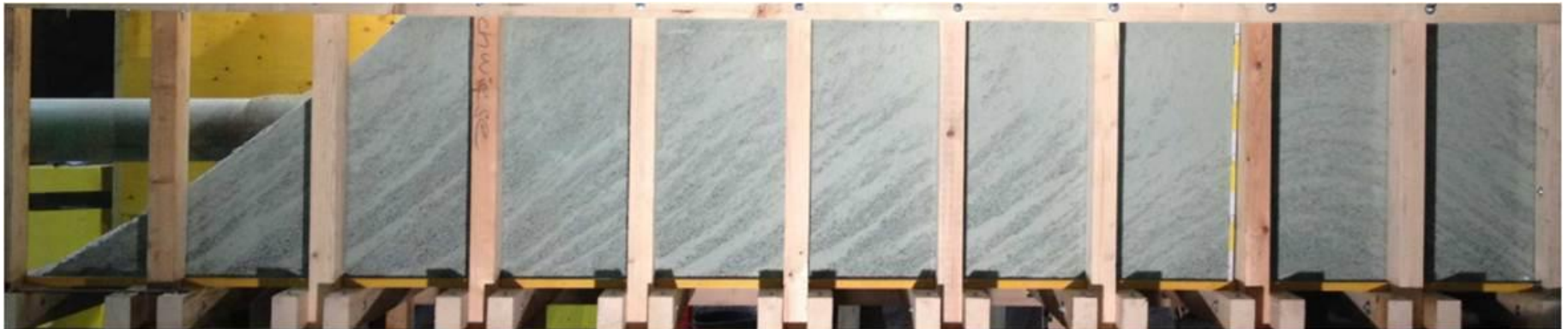


Emplacement Testing

New Material 2013-2014



Old Material 2012 and before



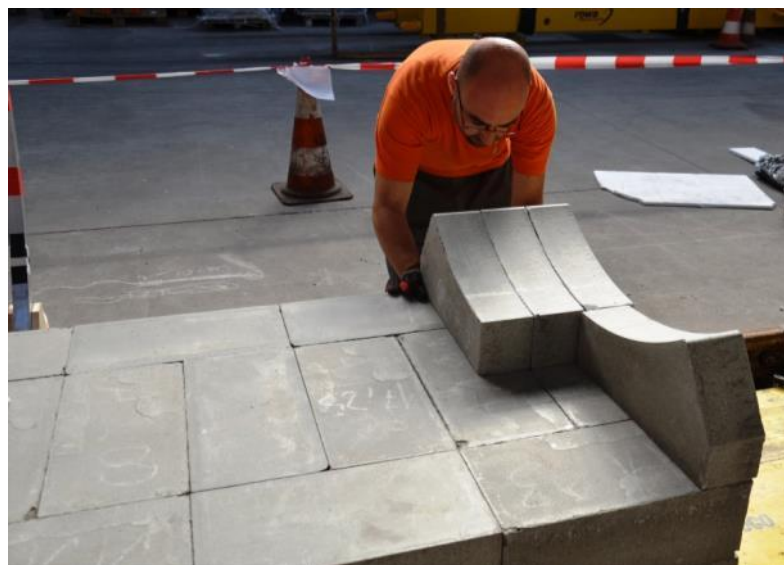
Grono Testing Auger May 2014



Grono Testing Auger May 2014



Grono Testing Bentonite Pedestal May 2014



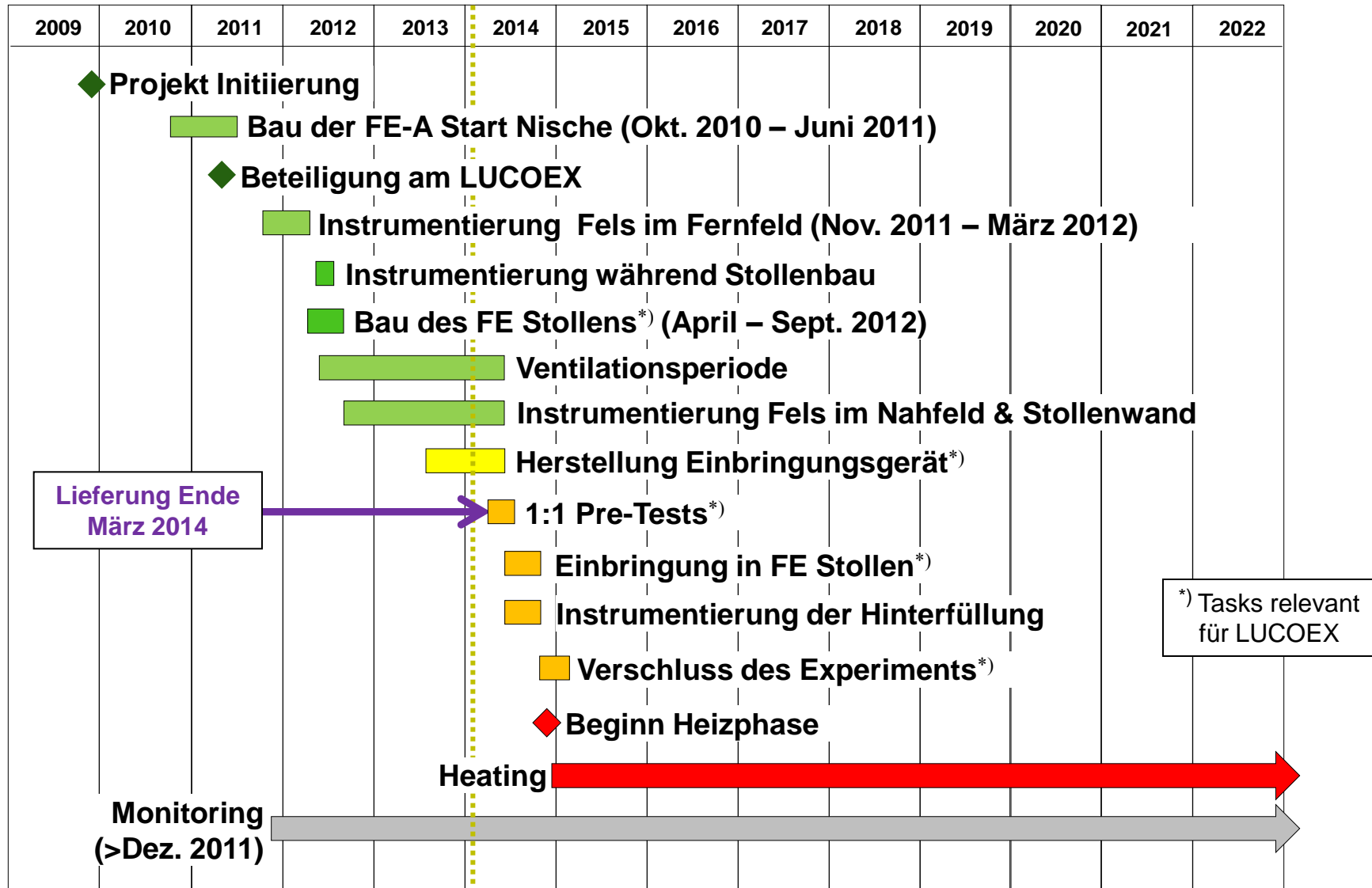
Grono Testing Bentonite Pedestal May 2014



Grono Testing Bentonite Pedestal May 2014



FE/LUCOEX experiment time plan





**Thank you for your
attention**

nagra.