Current Status of Modelling the Canister Retrieval Test and the Temperature Buffer Test

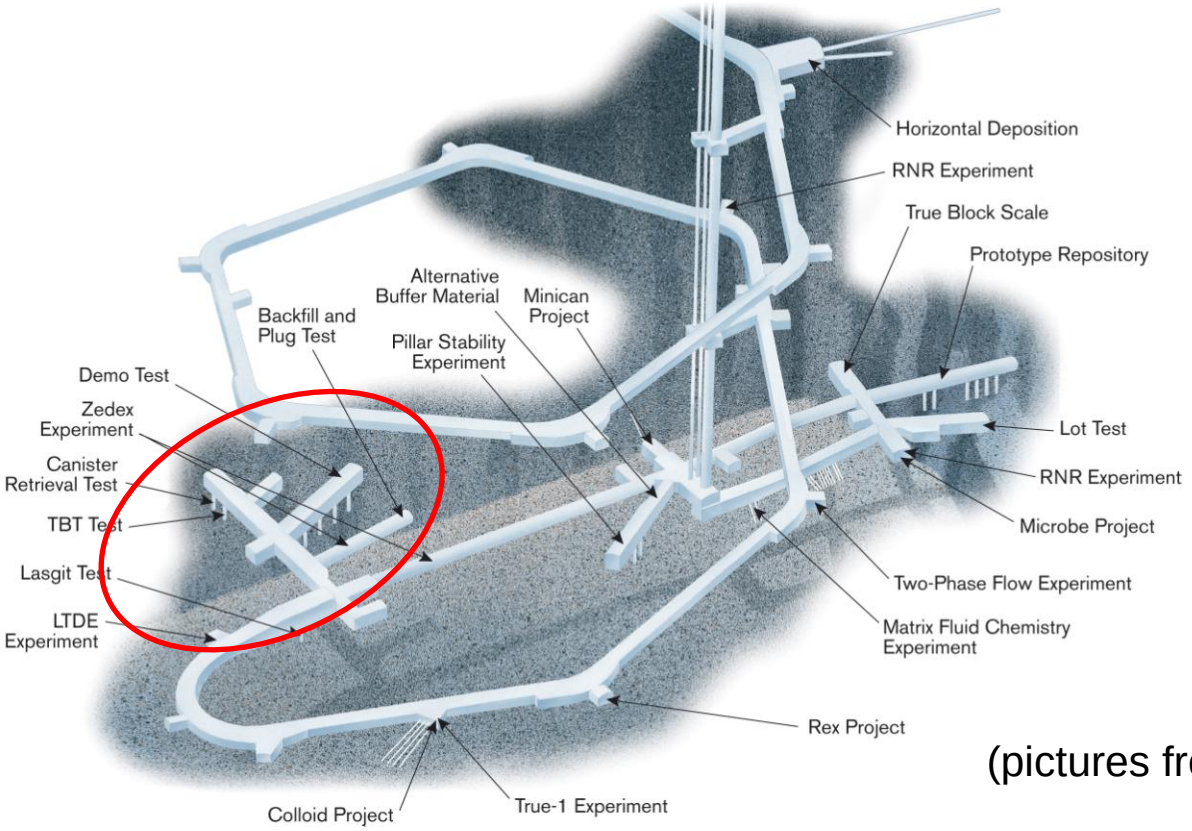
Thomas Nowak

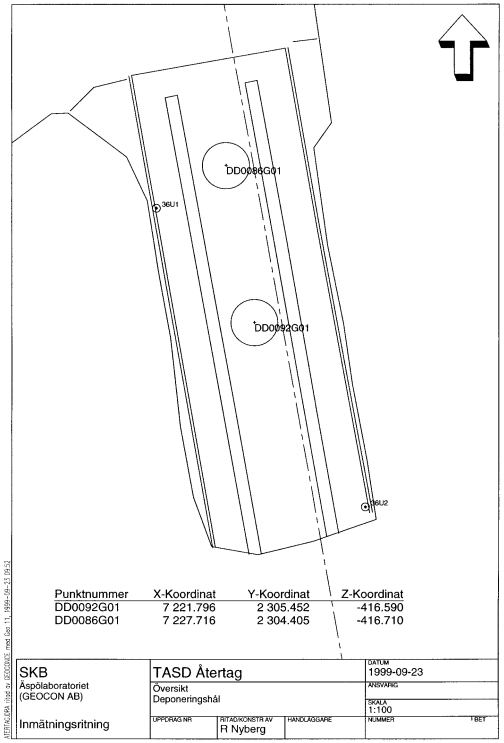
BGR Bundesanstalt für Geowissenschaften und Rohstoffe
GEOZENTRUM HANNOVER

Outline

- Model
- Results
  - CRT
  - TBT
- Outlook

Model
Domain

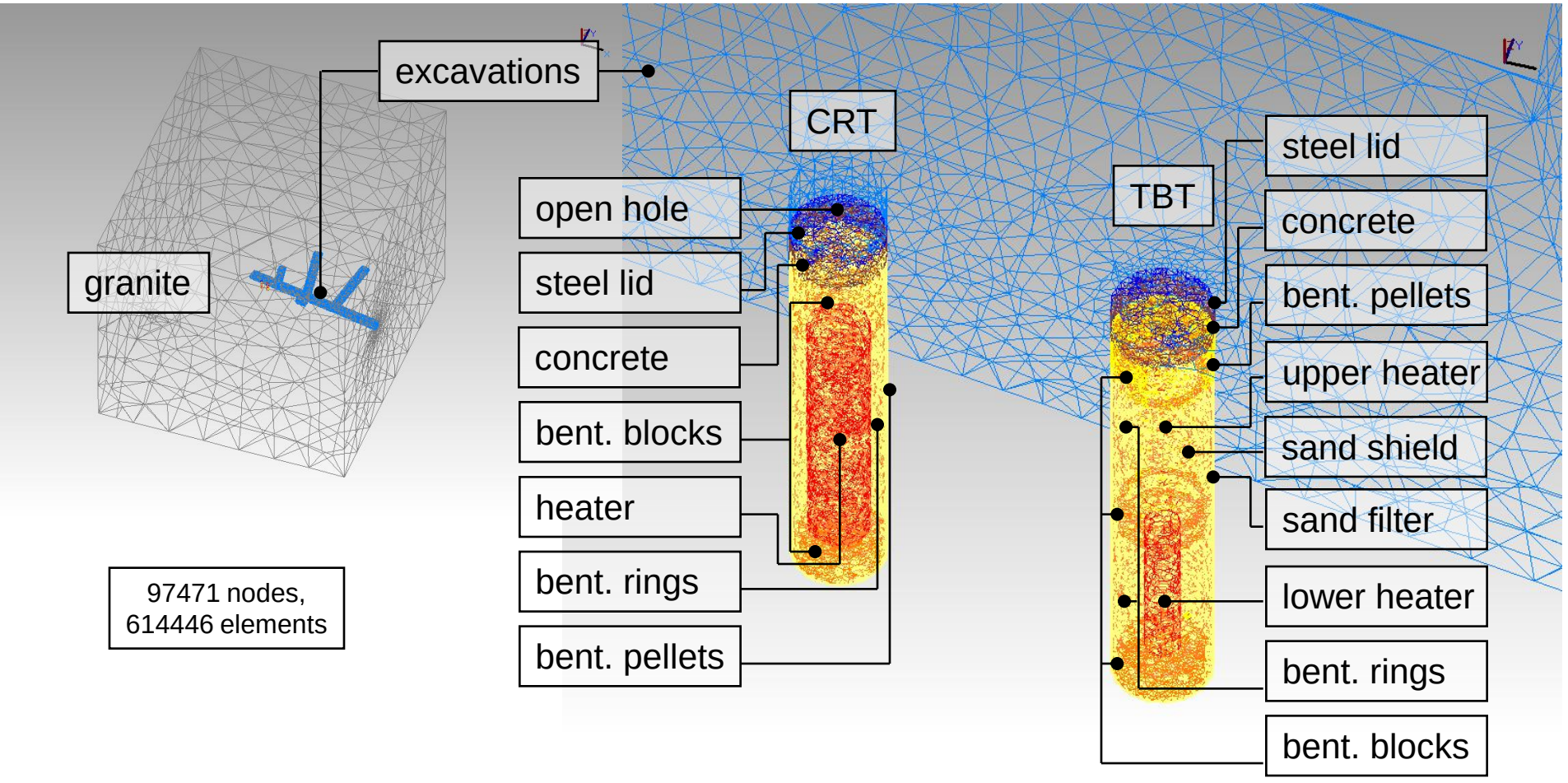




(pictures from SKB)

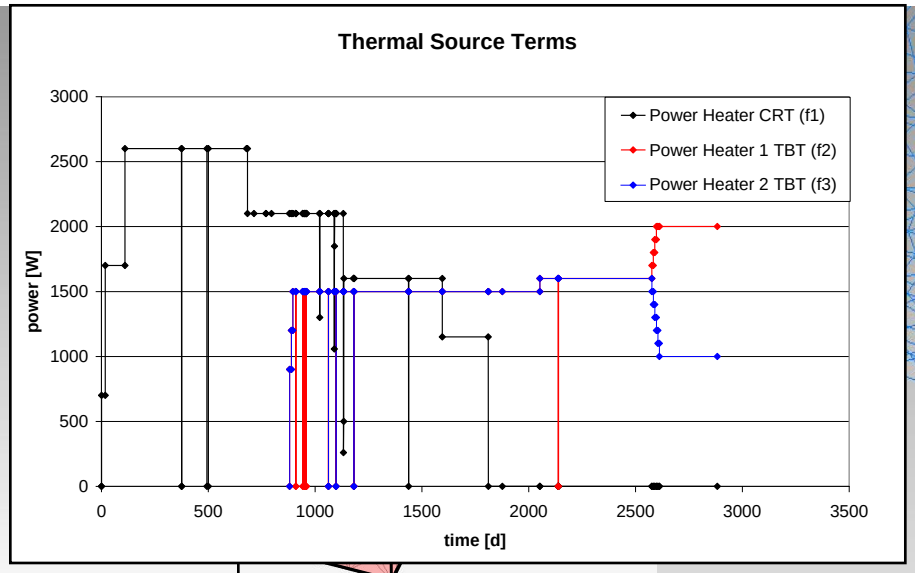
Model

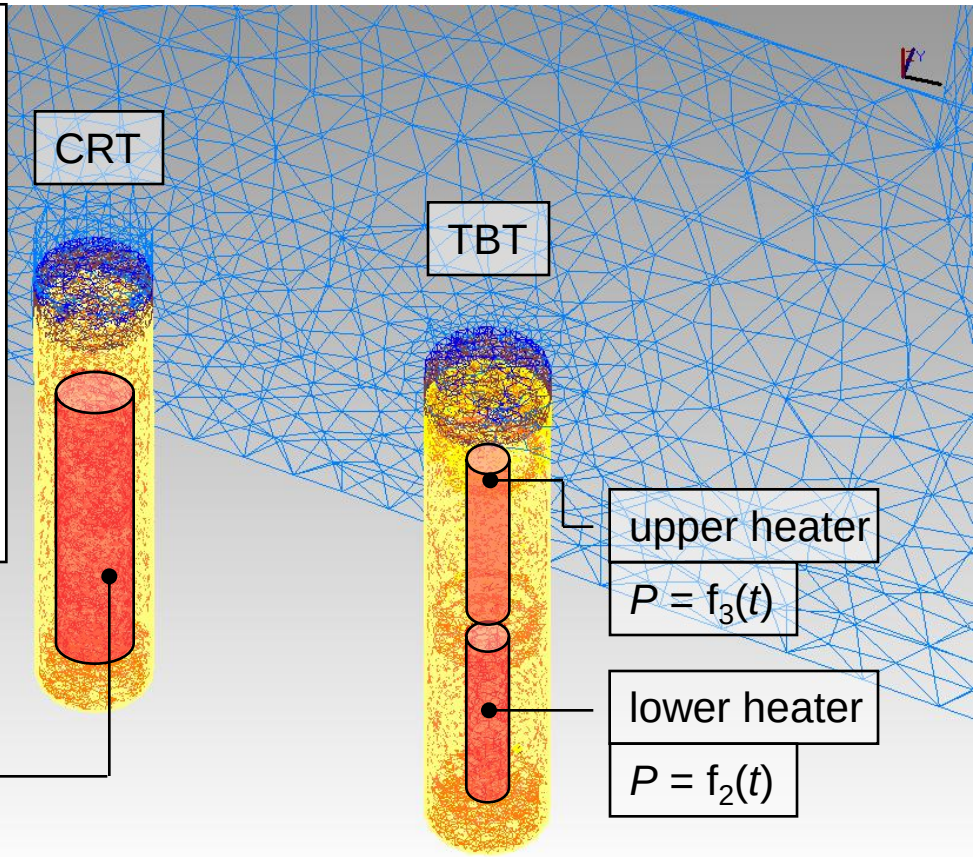
Mesh


excavations
granite
CRT
open hole
steel lid
concrete
bent. blocks
heater
bent. rings
bent. pellets
TBT
steel lid
concrete
bent. pellets
upper heater
sand shield
sand filter
lower heater
bent. rings
bent. blocks
97471 nodes,
614446 elements

Model

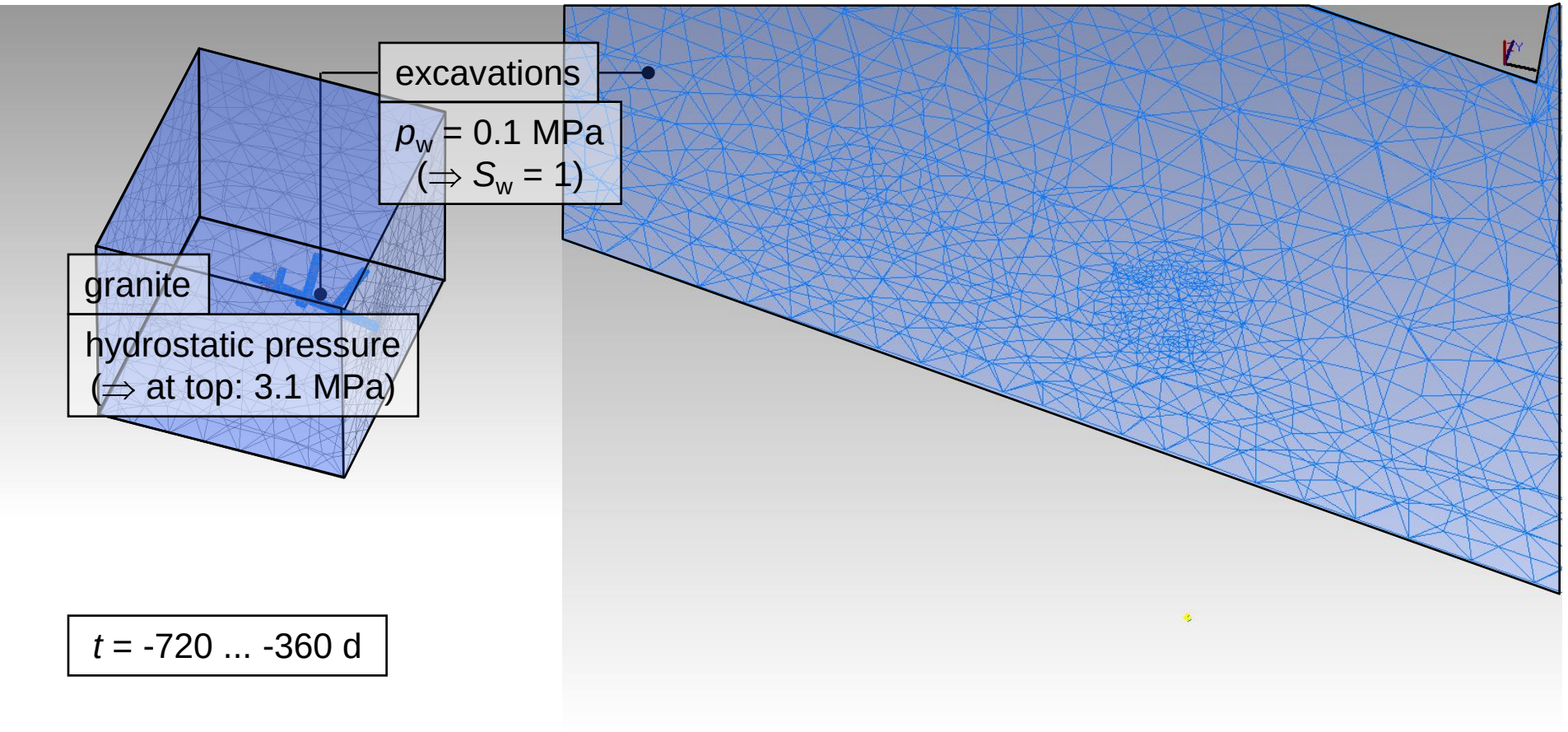
Boundary Conditions and Source Terms: Thermal





Model

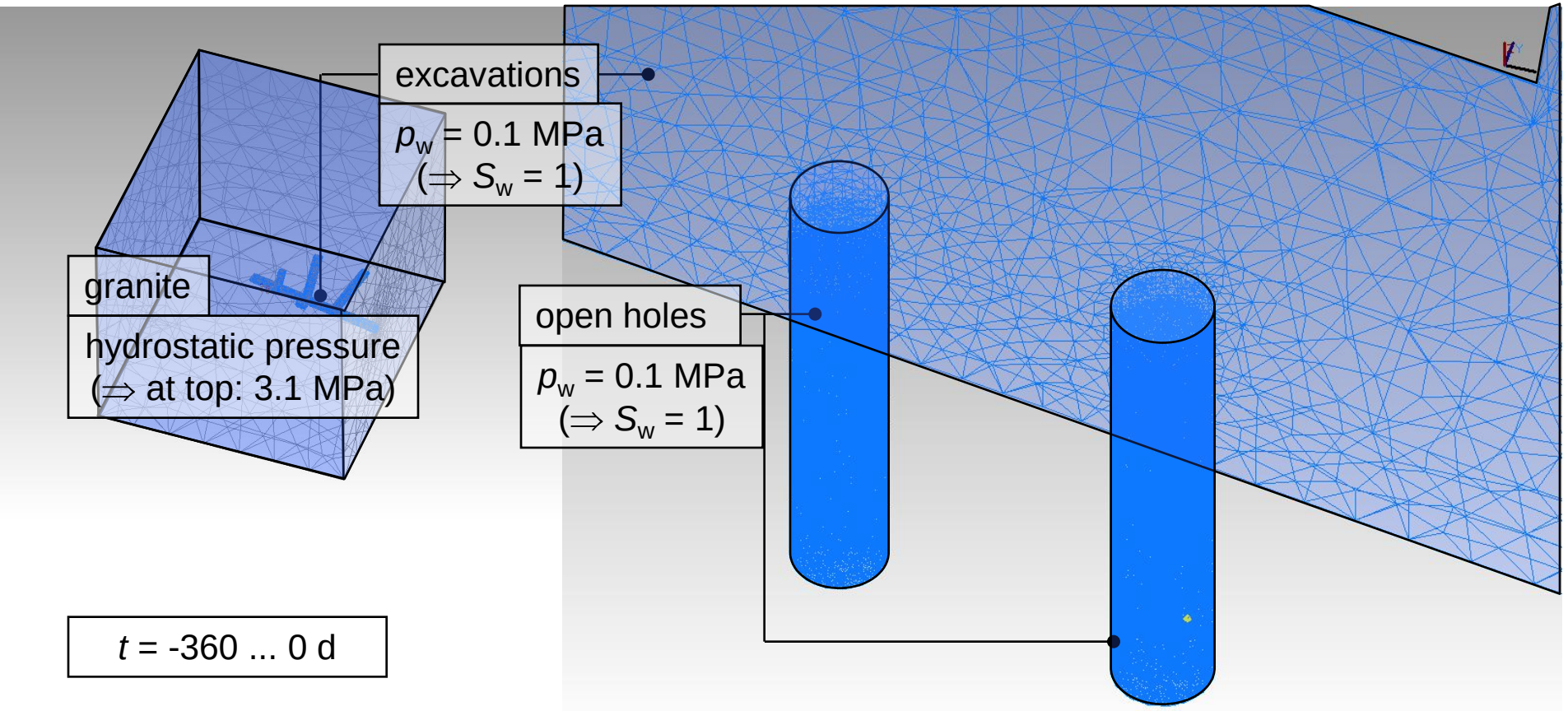
Boundary Conditions: Hydraulic



t = -720 ... -360 d

Model

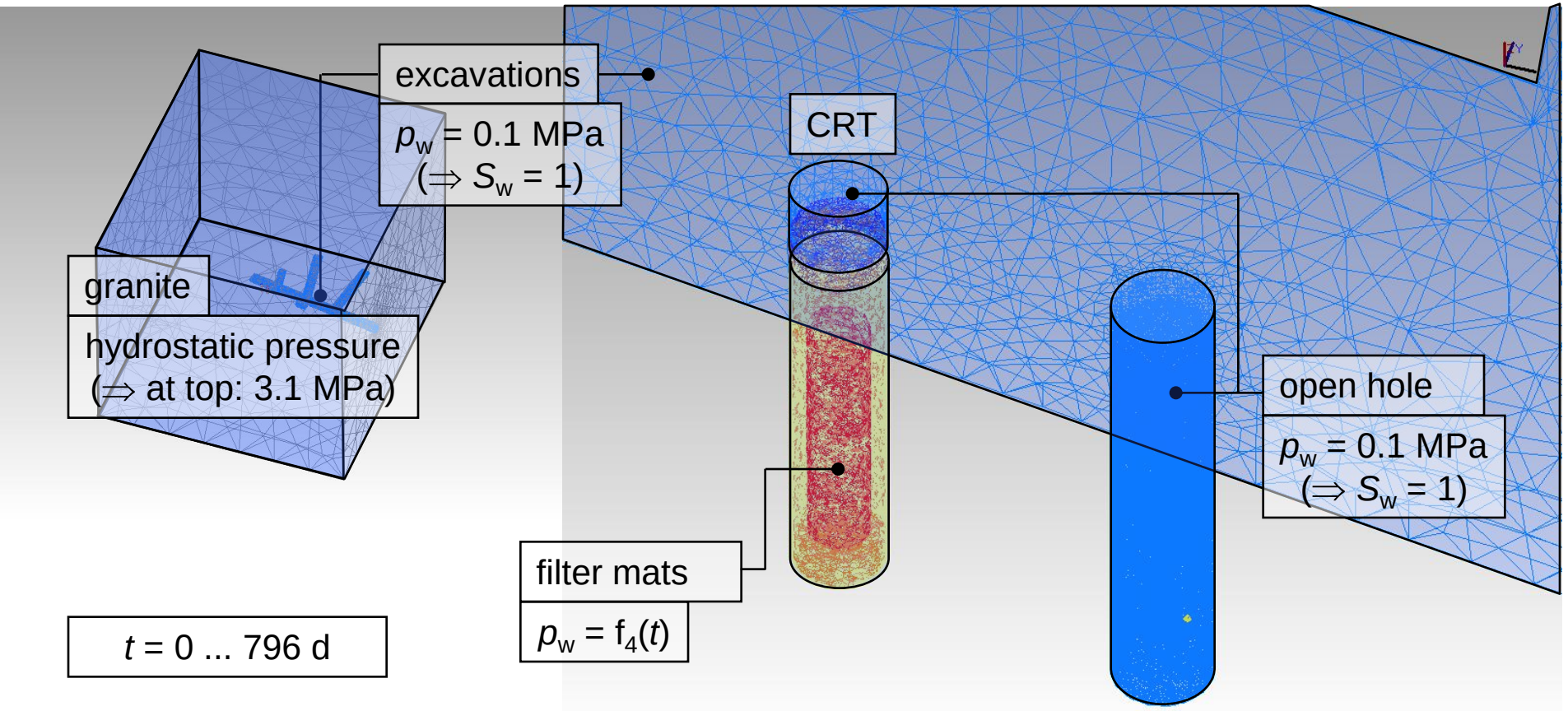
Boundary Conditions: Hydraulic



t = -360 ... 0 d

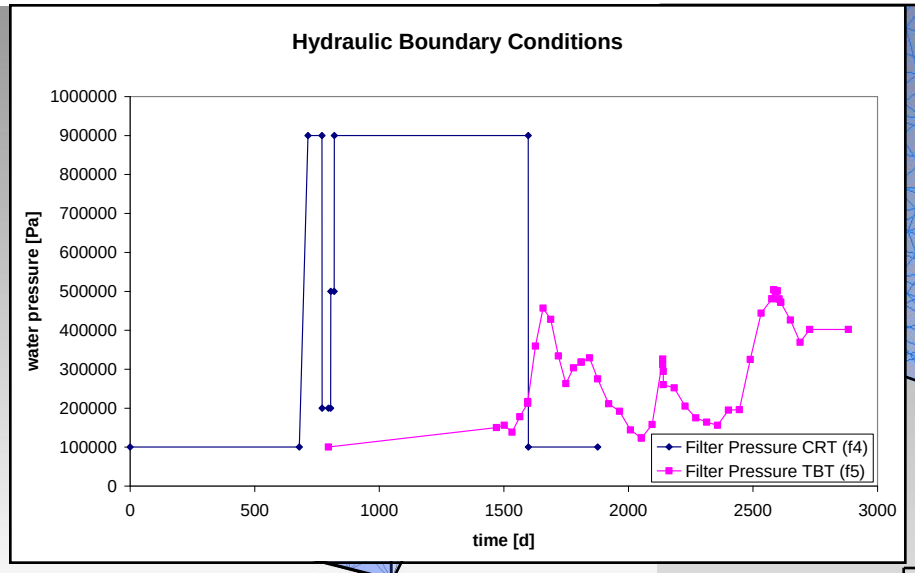
Model

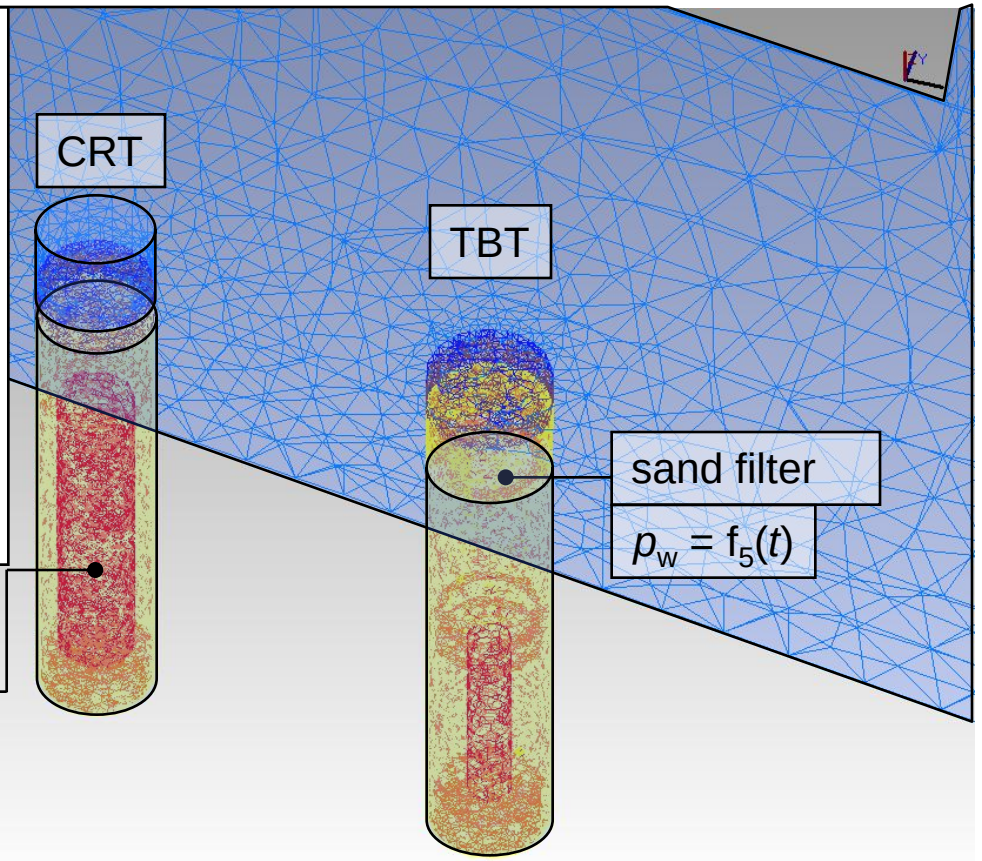
Boundary Conditions: Hydraulic



Model

Boundary Conditions: Hydraulic

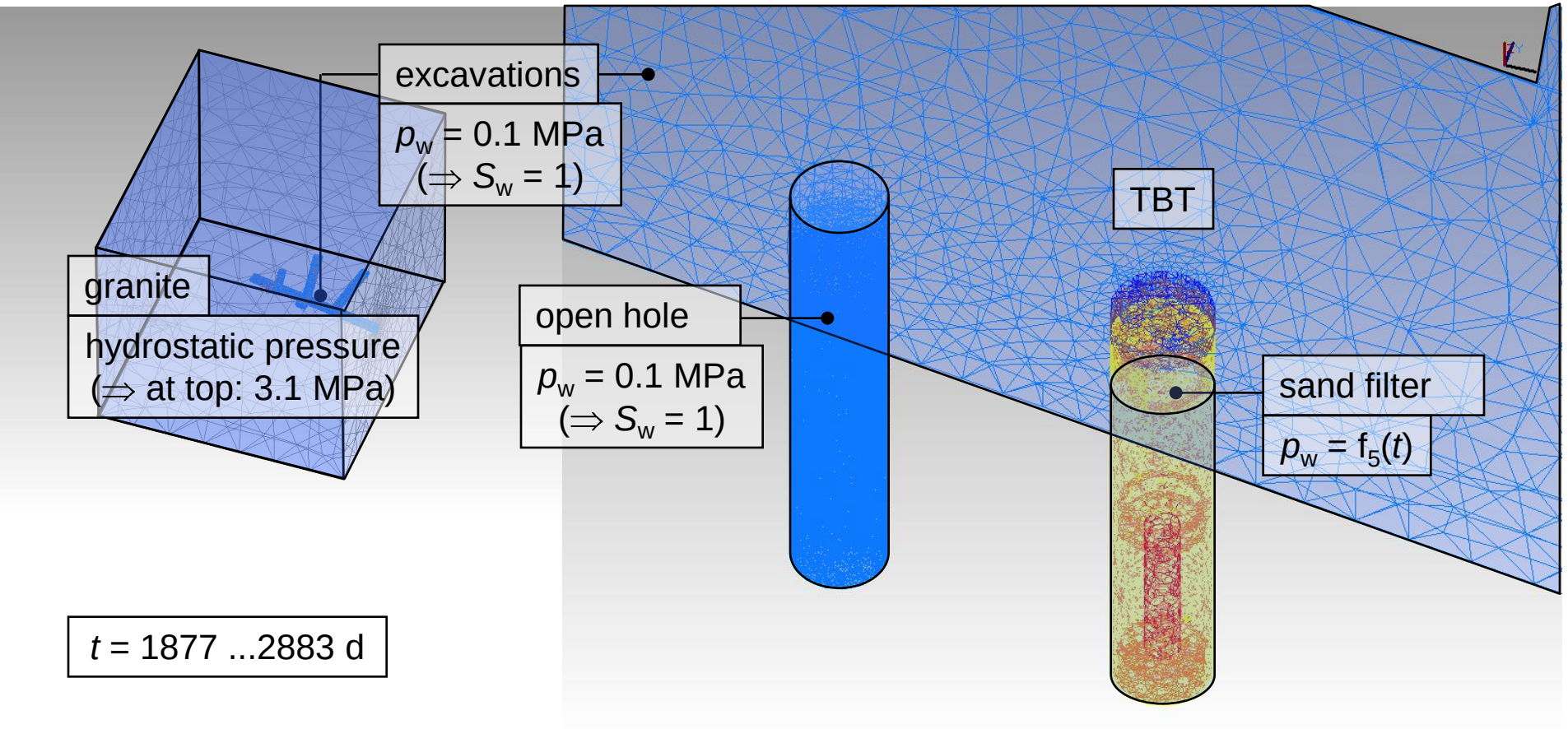




t = 796 ...1877 d

Model

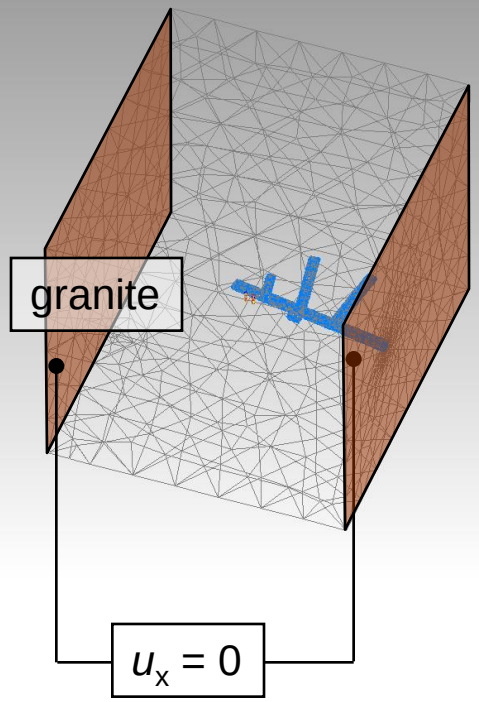
Boundary Conditions: Hydraulic

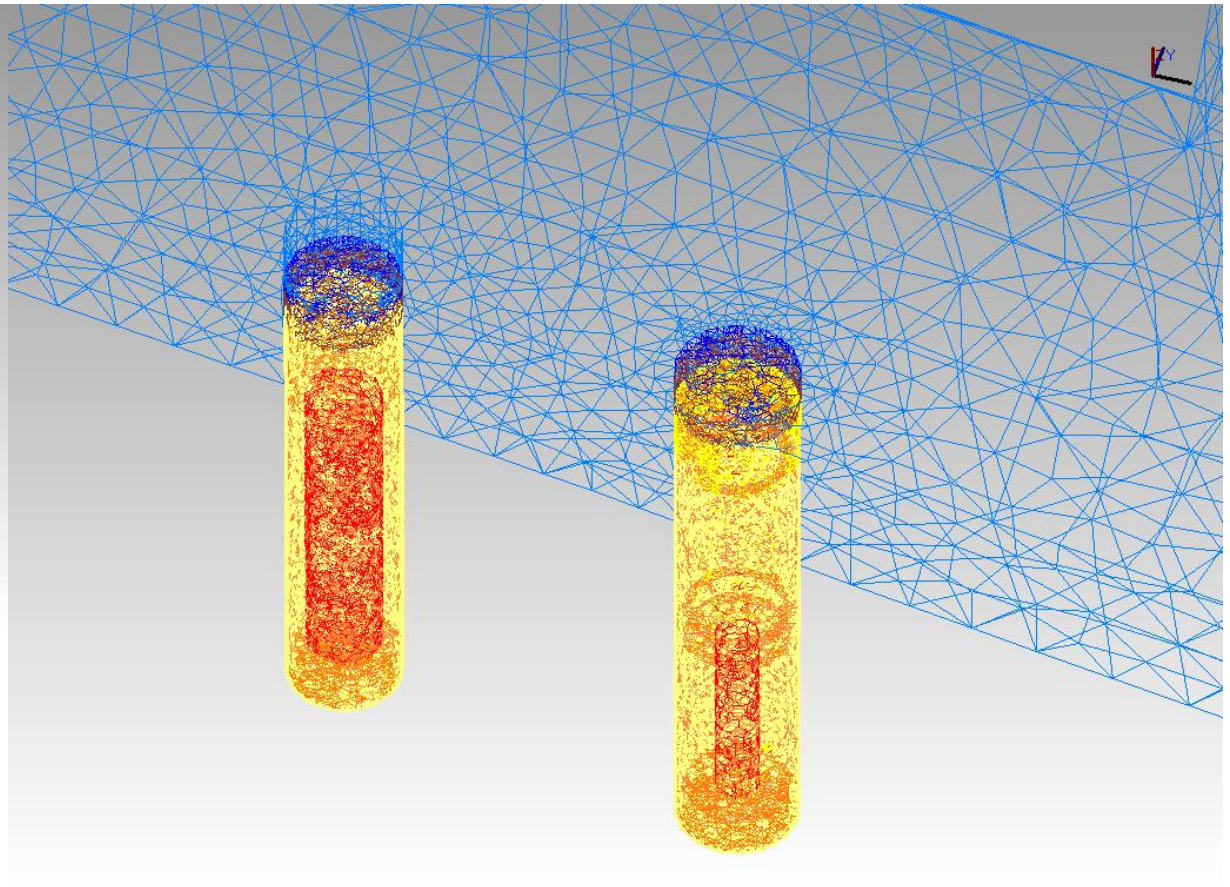


t = 1877 ...2883 d

Model

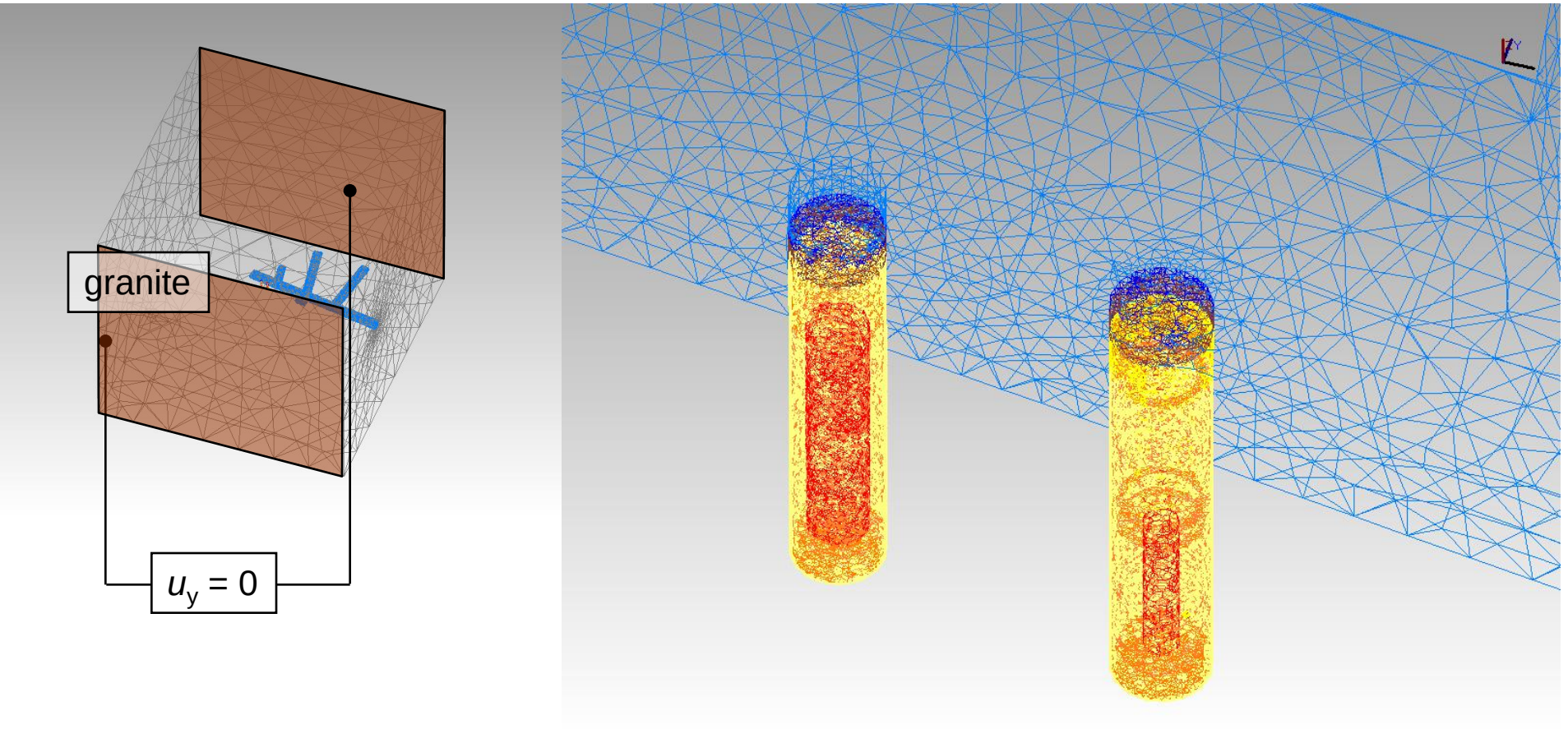
Boundary Conditions: Mechanical





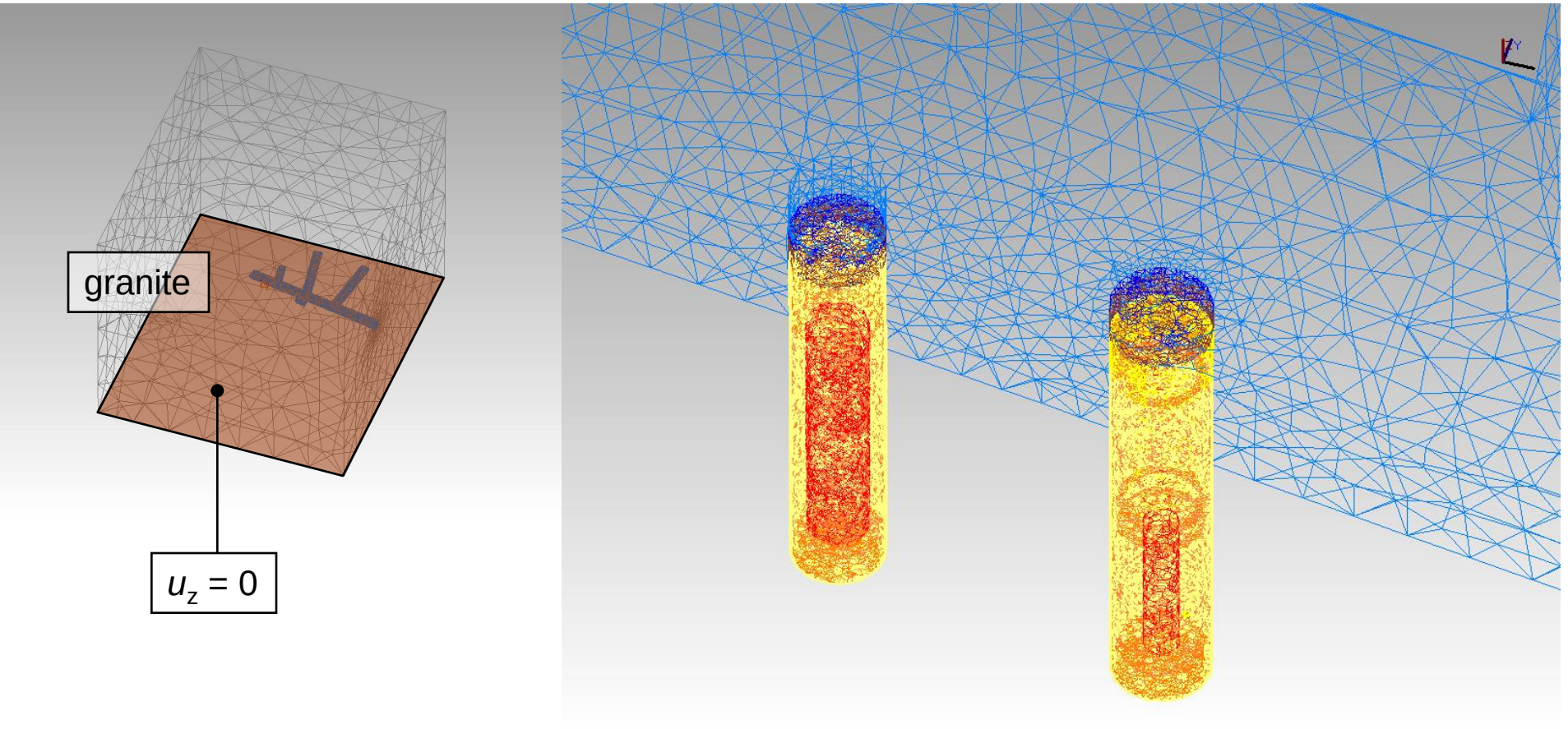
Model

Boundary Conditions: Mechanical



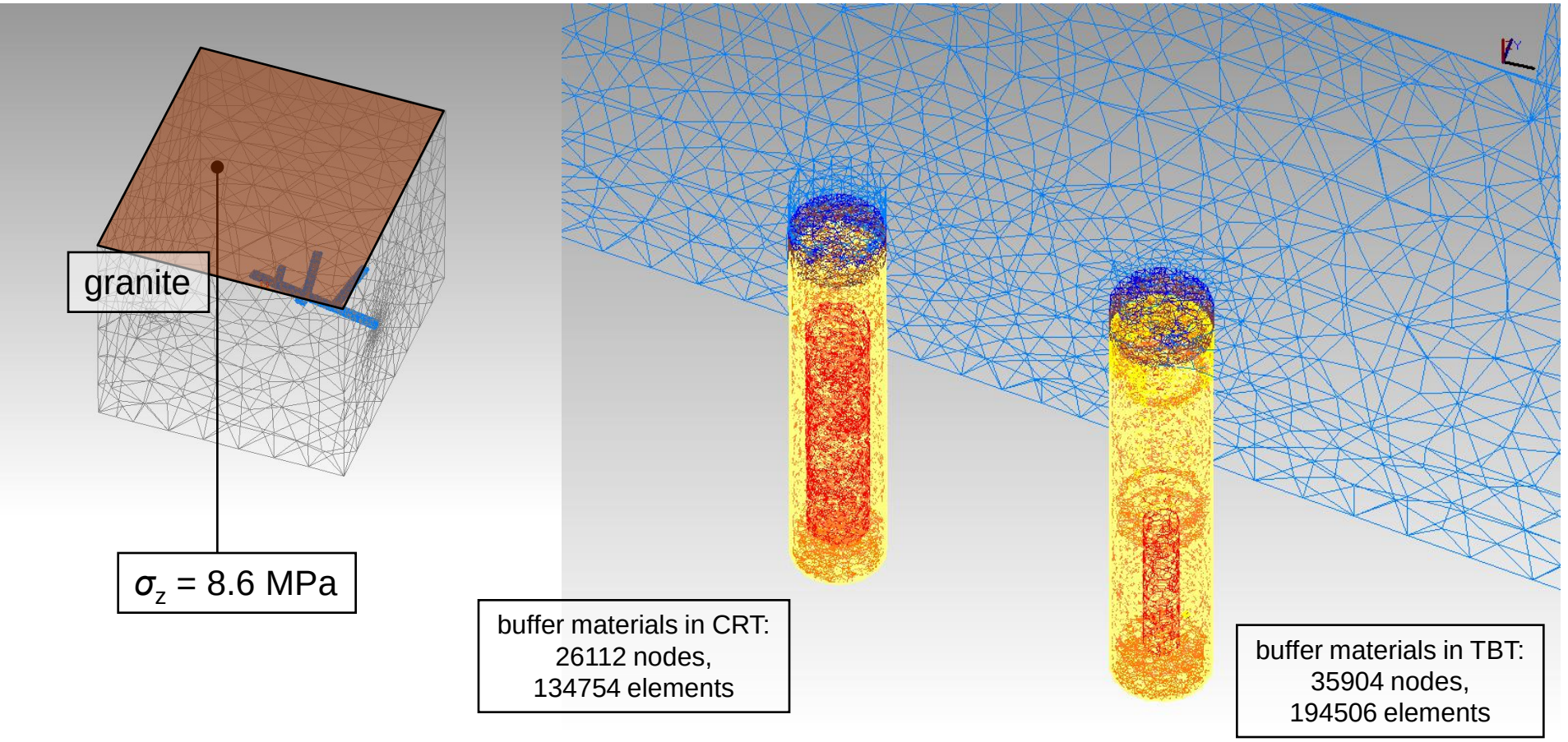
Model

Boundary Conditions: Mechanical



Model

Source Terms: Mechanical



Model

Hydraulic Properties

	exc.	steel lids	concr. plugs	heat.	bent. bl.	bent. rings	bent. pell.	rock	TBT sand	TBT shield
permeability [1E-20 m^2]	(not calculated)				0.2 (0.1...0.5)		1	5	5000	
porosity [-]					0.389	0.359	0.64	0.002	0.5	
rel. permeability [-]					S_w^3					
suction curve					BM1.1.1			BM2.1.1	(BM2.1.1) 7 kPa dry	
tortuosity [-]					0.6			-	1	
init. suction [MPa]					71.1	40.6	0			0.007
init. saturation [-]					0.751	0.849	1			0.008

Model

Mechanical Properties

	exc.	steel lids	concr. plugs	heat.	bent. bl.	bent. rings	bent. pell.	rock	TBT sand	TBT shield
Young's modulus [GPa]	(not calc.)	210	30	210	0.02		0.01	70	0.02	
Poisson's ratio [-]		0.3	0.15	0.3	0.44			0.3	0.44	
max. swelling pressure [MPa]		-			30		10	-		
thermal expansion [1E-5 K^{-1}]		1.2	1.0	0	0.3			0.38	0	0

$$\Delta \mathbf{p}_{sw} = \Delta S_w p_{sw}^{\max} \mathbf{I}$$

Model

Thermal Properties

	exc.	steel lids	concr. plugs	heat.	bent. bl.	bent. rings	bent. pell.	rock	TBT sand	TBT shield
heat capacity c_s [J/kgK]	1007	460	770	450	800			770	800	
heat conductivity λ_s [W/mK]	0.026	47	2.7	100	1.9		2.5	2.6	1.9	λ_{sat} = 1.8 λ_{sat} = 0.7
density ρ_s	1.19	7840	2400	8000	2780			2770	2780	

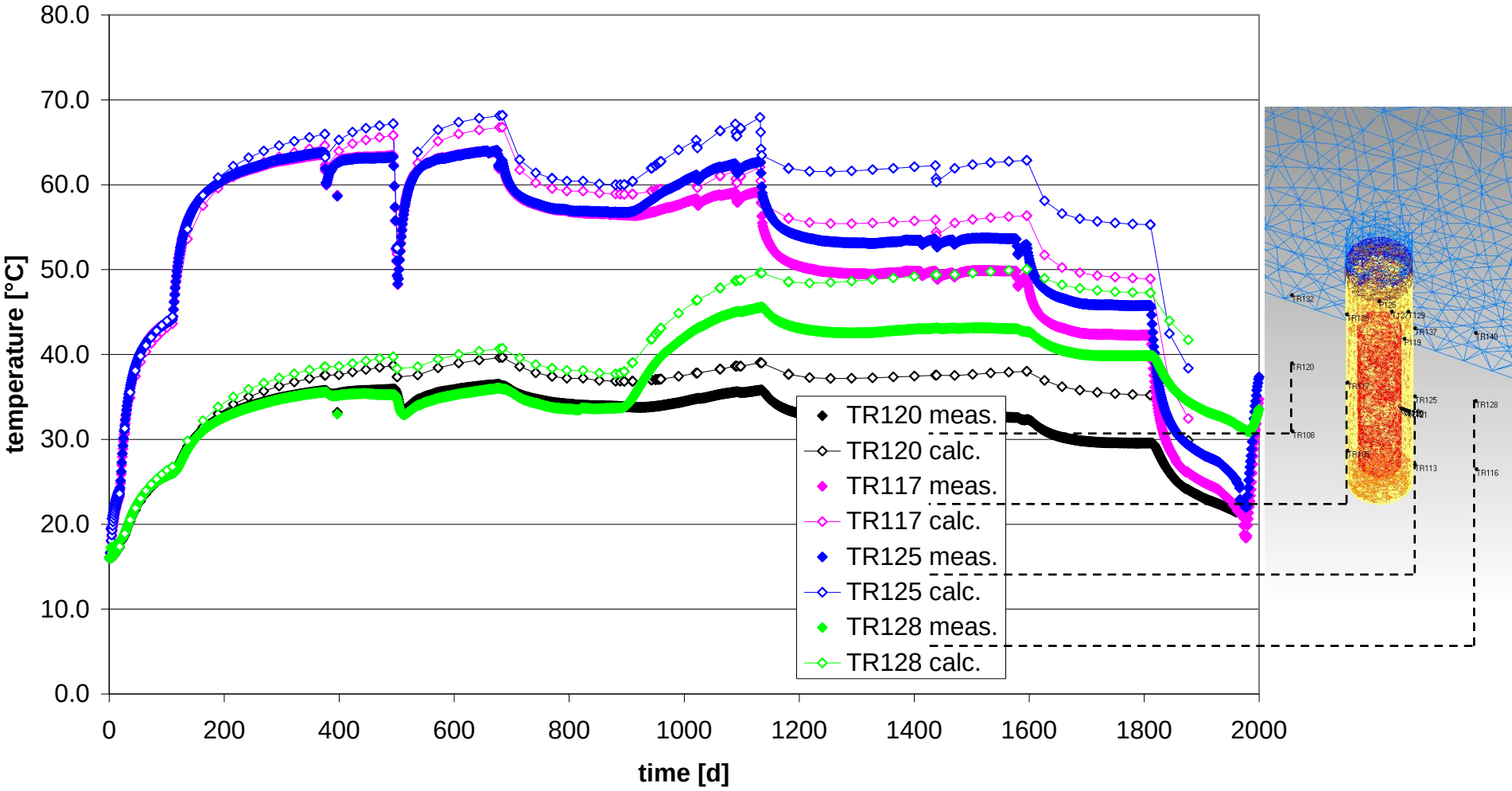
$$\lambda = (1-n)\lambda_s + nS_w\lambda_w + n(1-S_w)\lambda_g$$

$$c\rho = (1-n)c_s\rho_s + nS_w c_w\rho_w + n(1-S_w)c_g\rho_g$$

$$\lambda_w = 0.6$$
$$c_w = 4200$$
$$\rho_w = 1000$$

Results

CRT: Temperatures in the Rock



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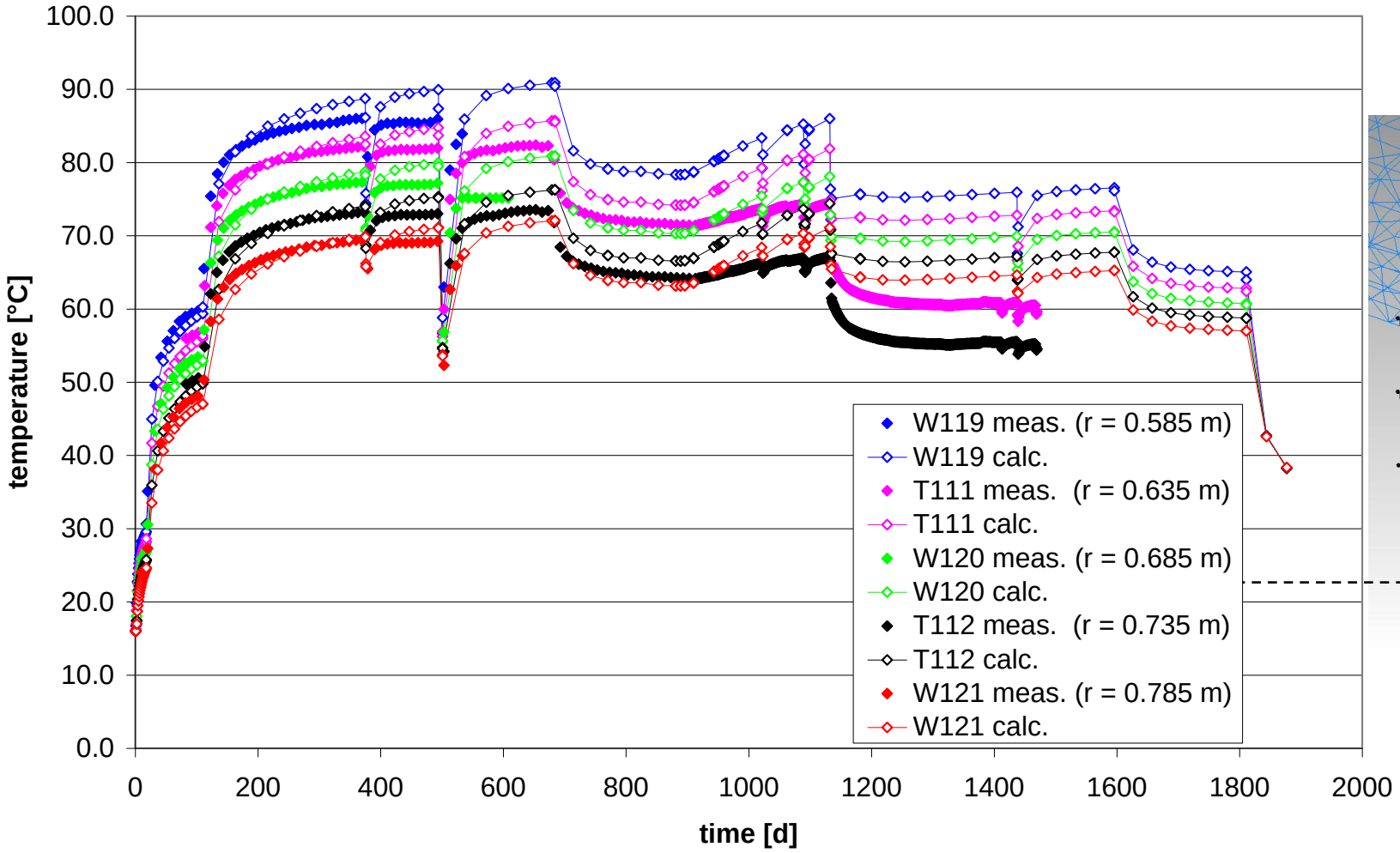
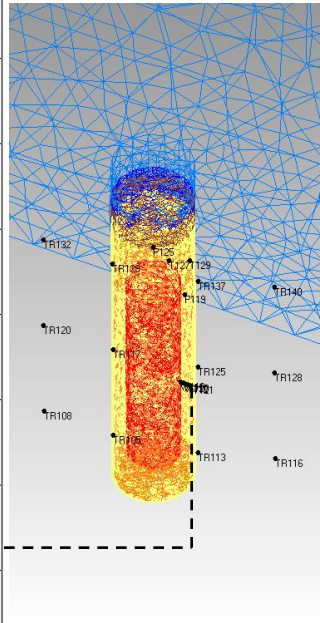
Results

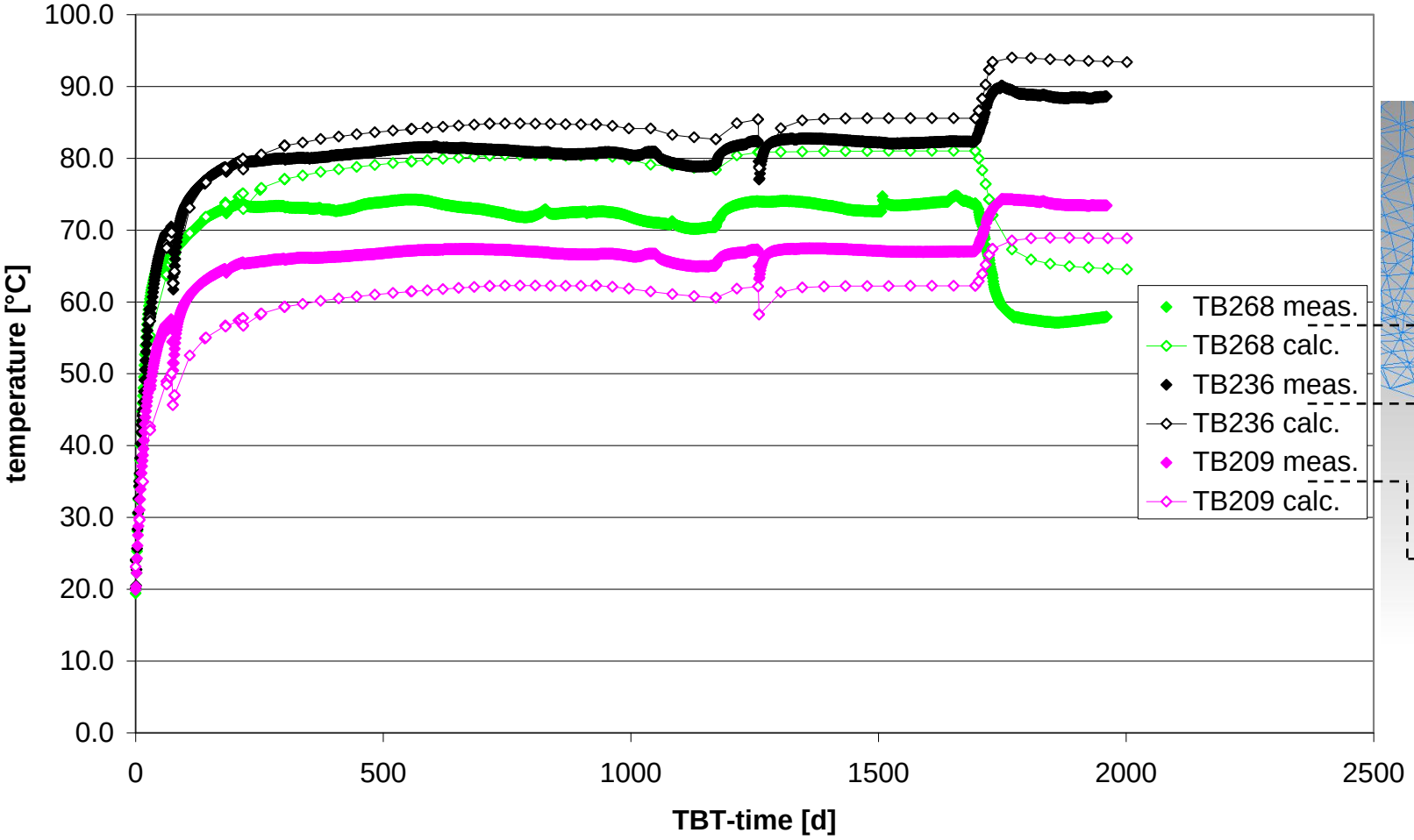
CRT: Temperatures in the Buffer (Ring 5)

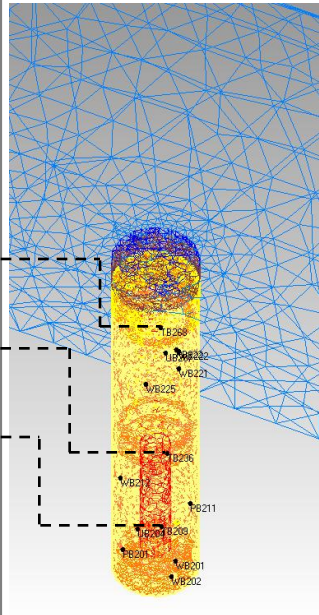




Results

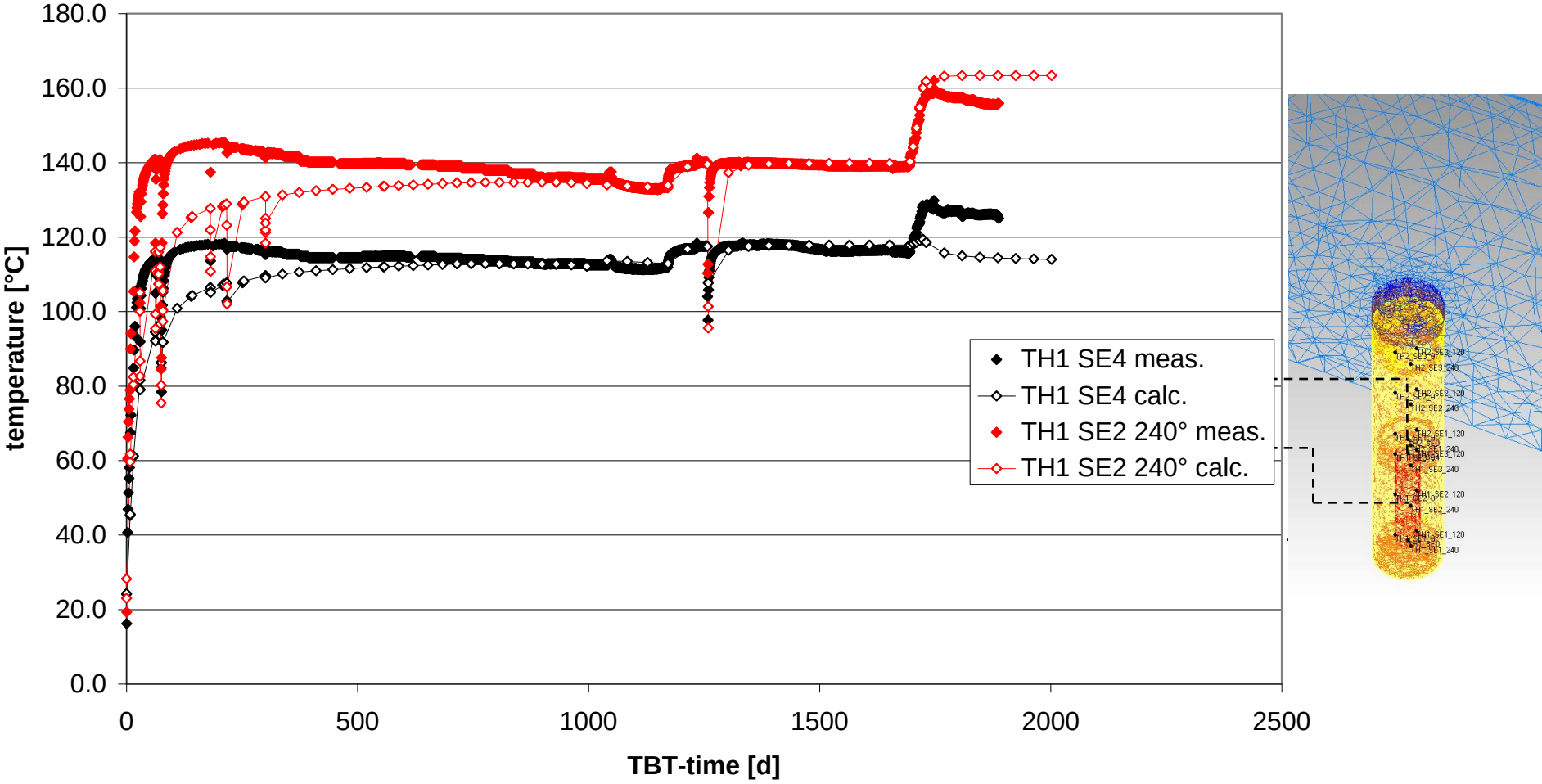
TBT: Temperatures in the Buffer





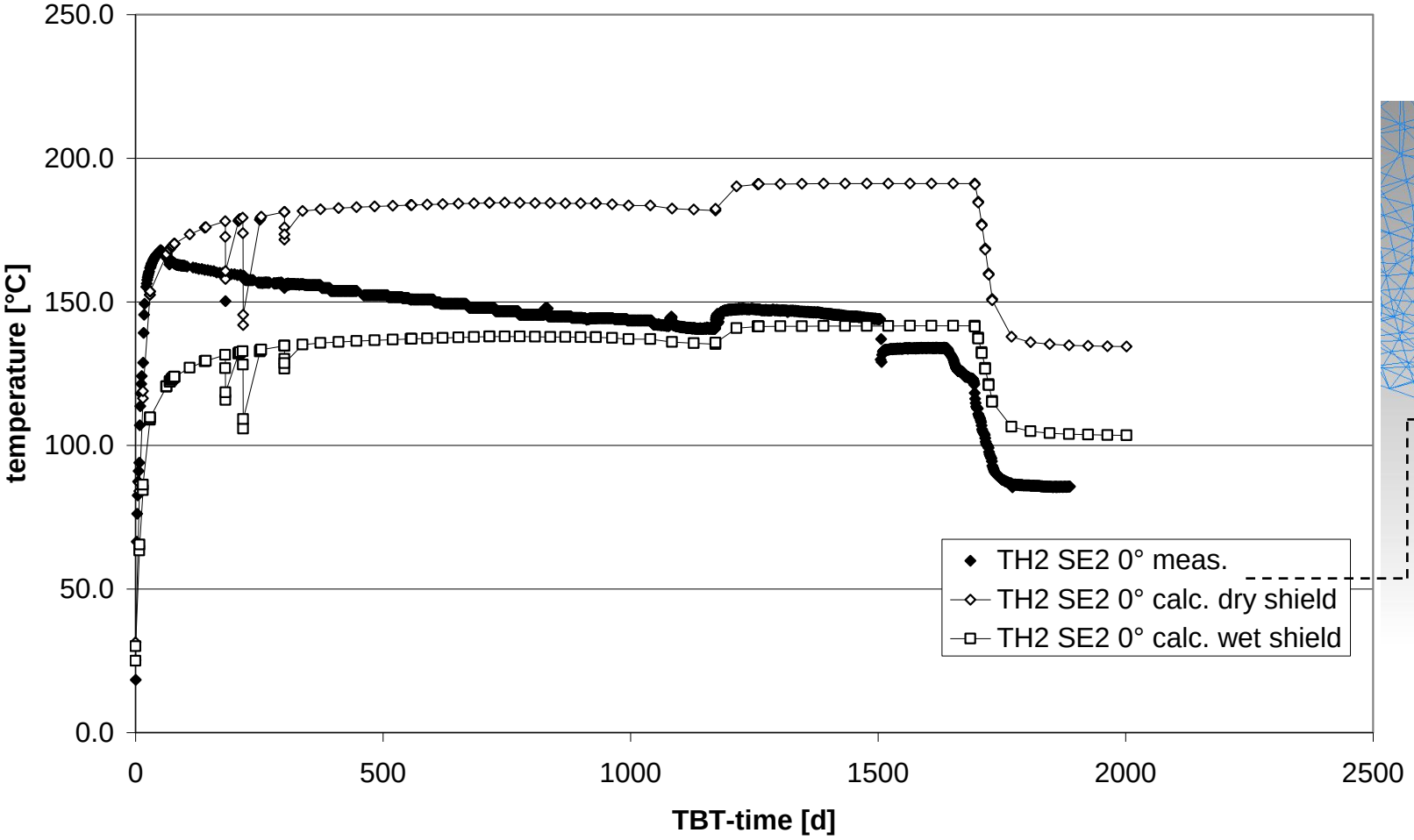
Results

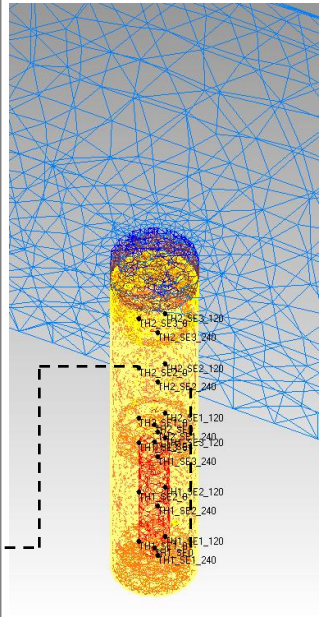
TBT: Temperatures on Lower Heater



Results

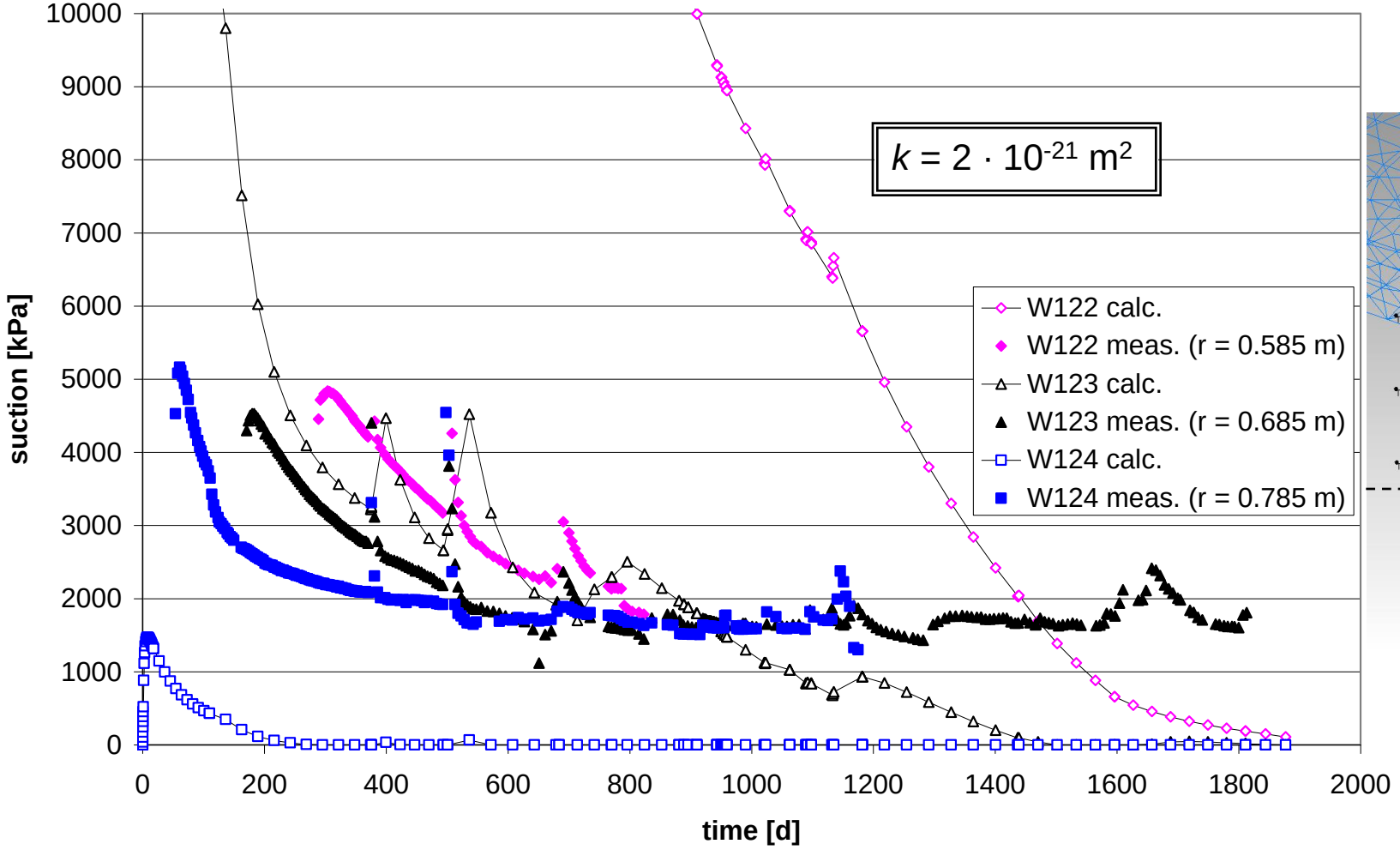
TBT: Temperatures on Upper Heater

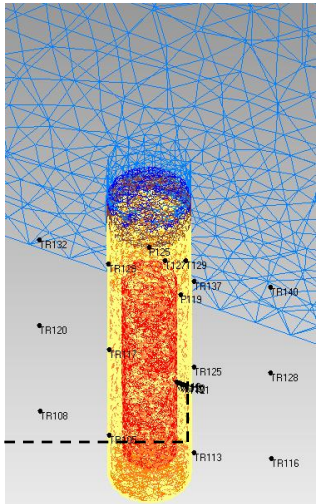




Results

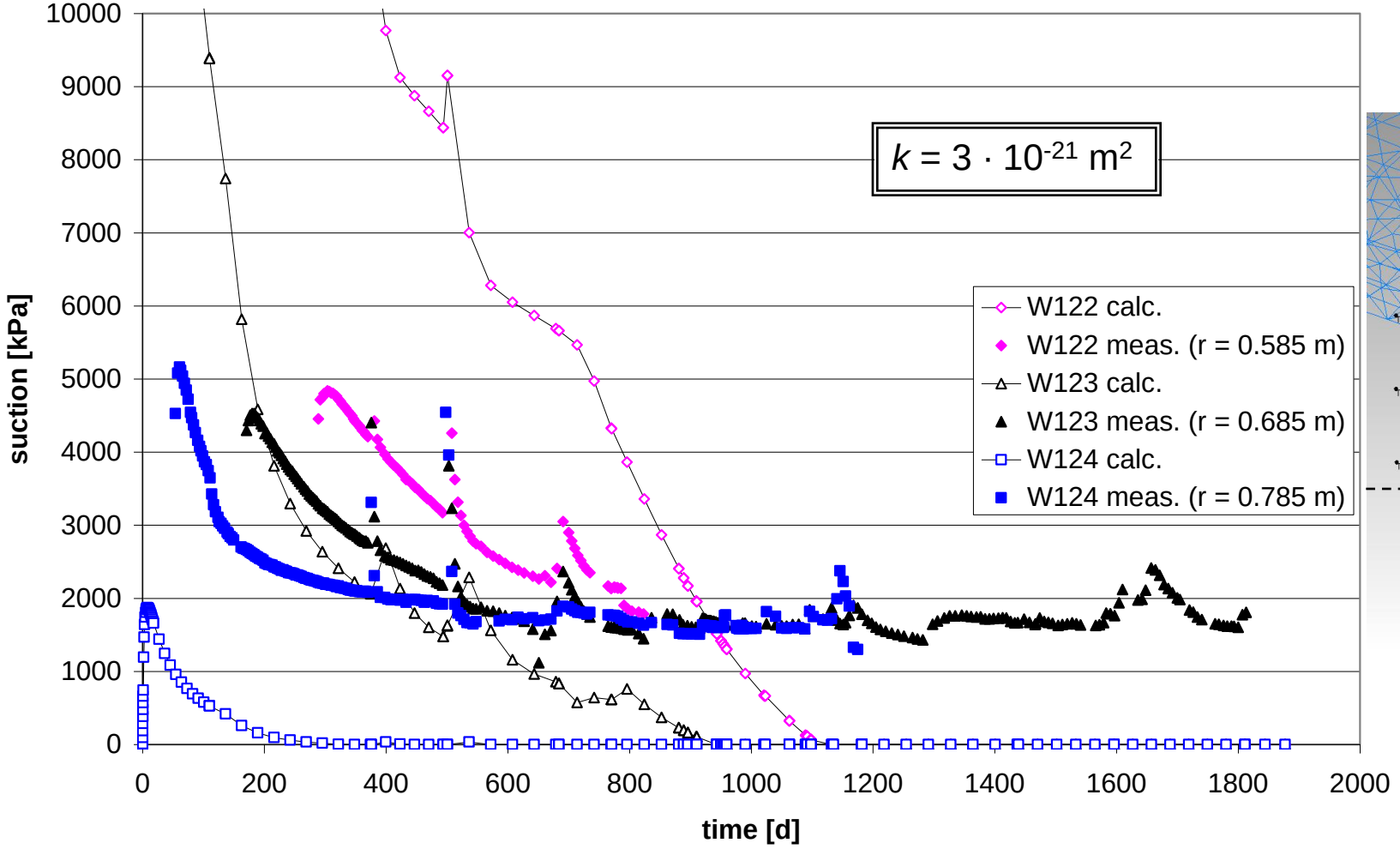
CRT: Suction in the Buffer (Ring 5)

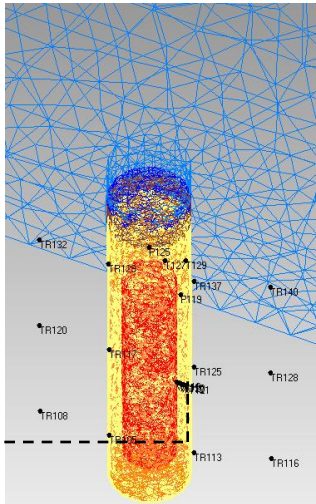




Results

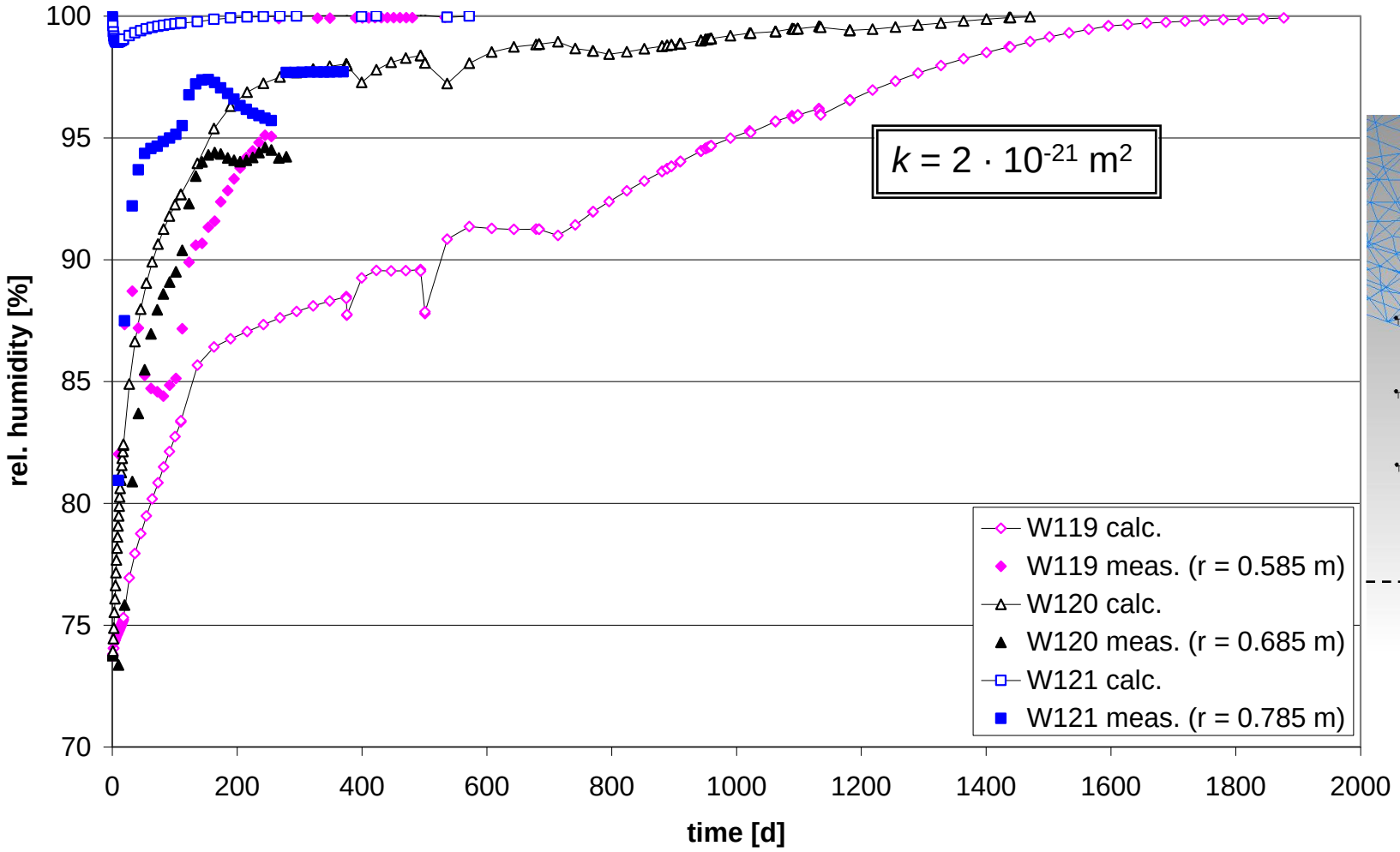
CRT: Suction in the Buffer (Ring 5)

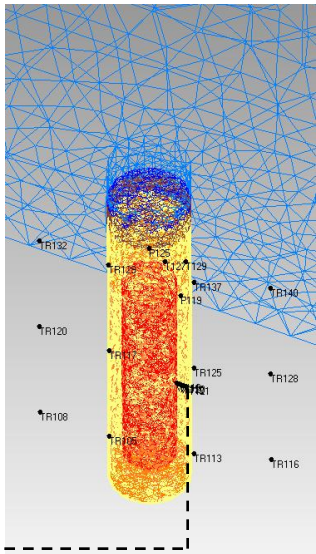




Results

CRT: Relative Humidity in the Buffer (Ring 5)





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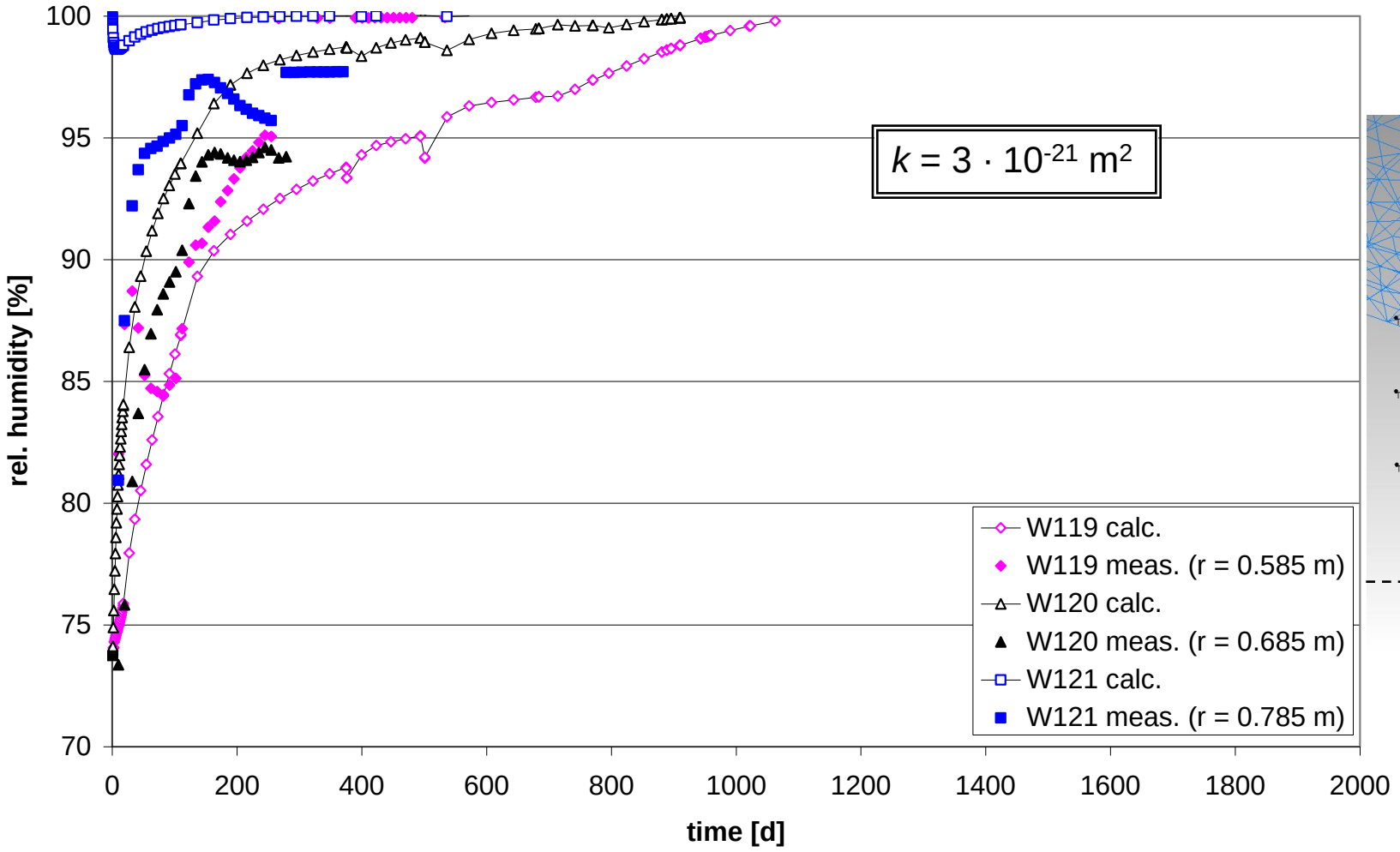
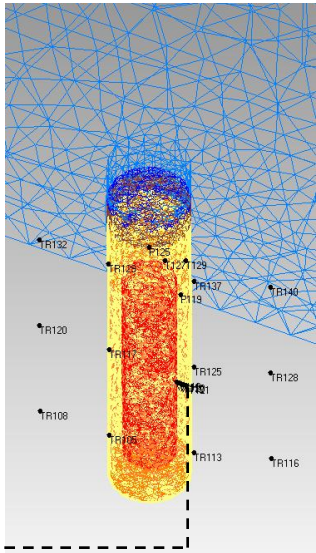
Results

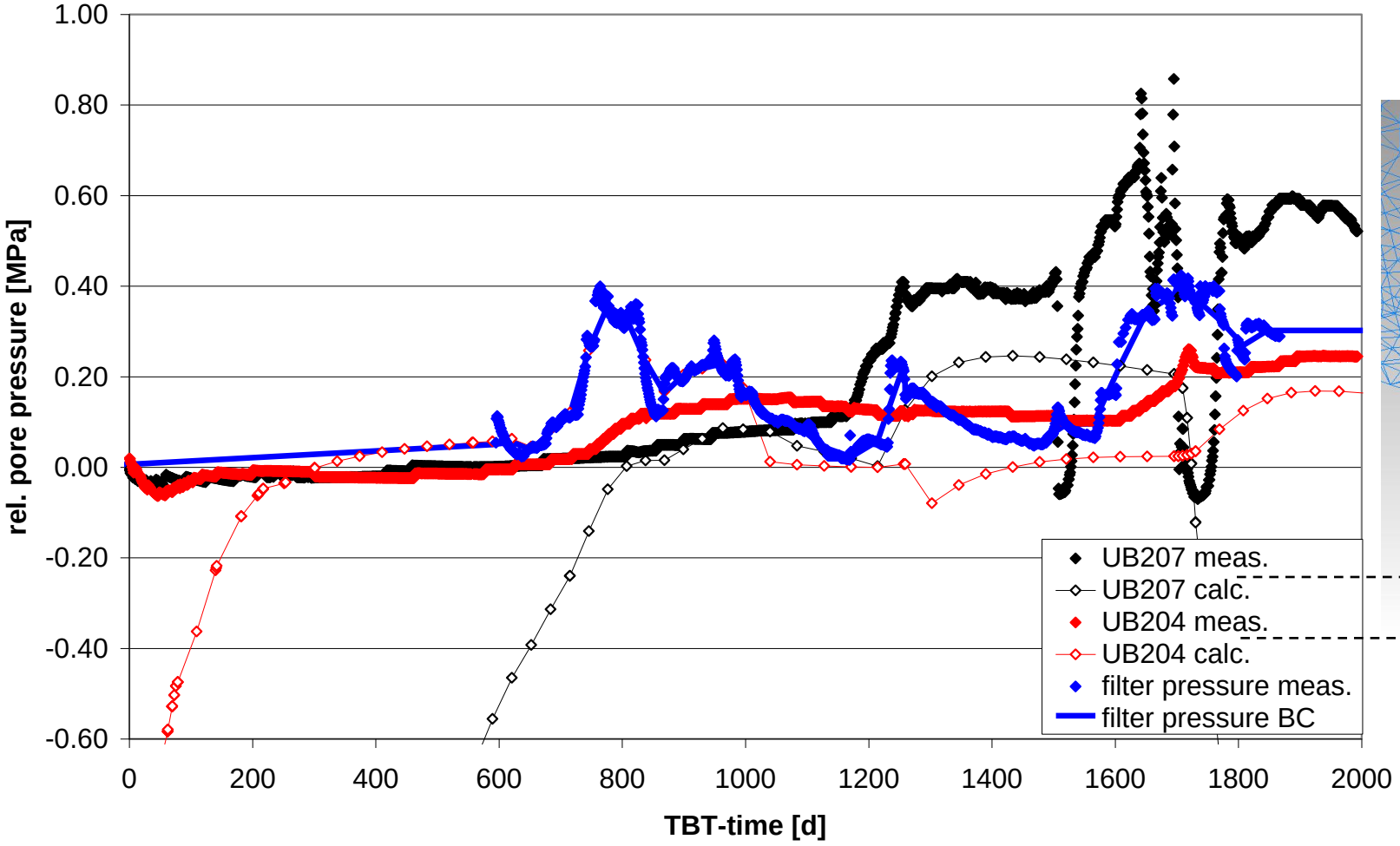
CRT: Relative Humidity in the Buffer (Ring 5)

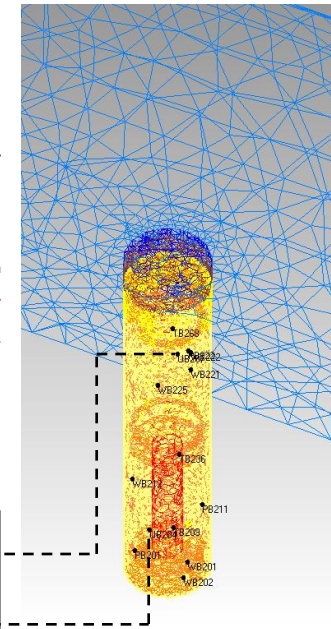




Results

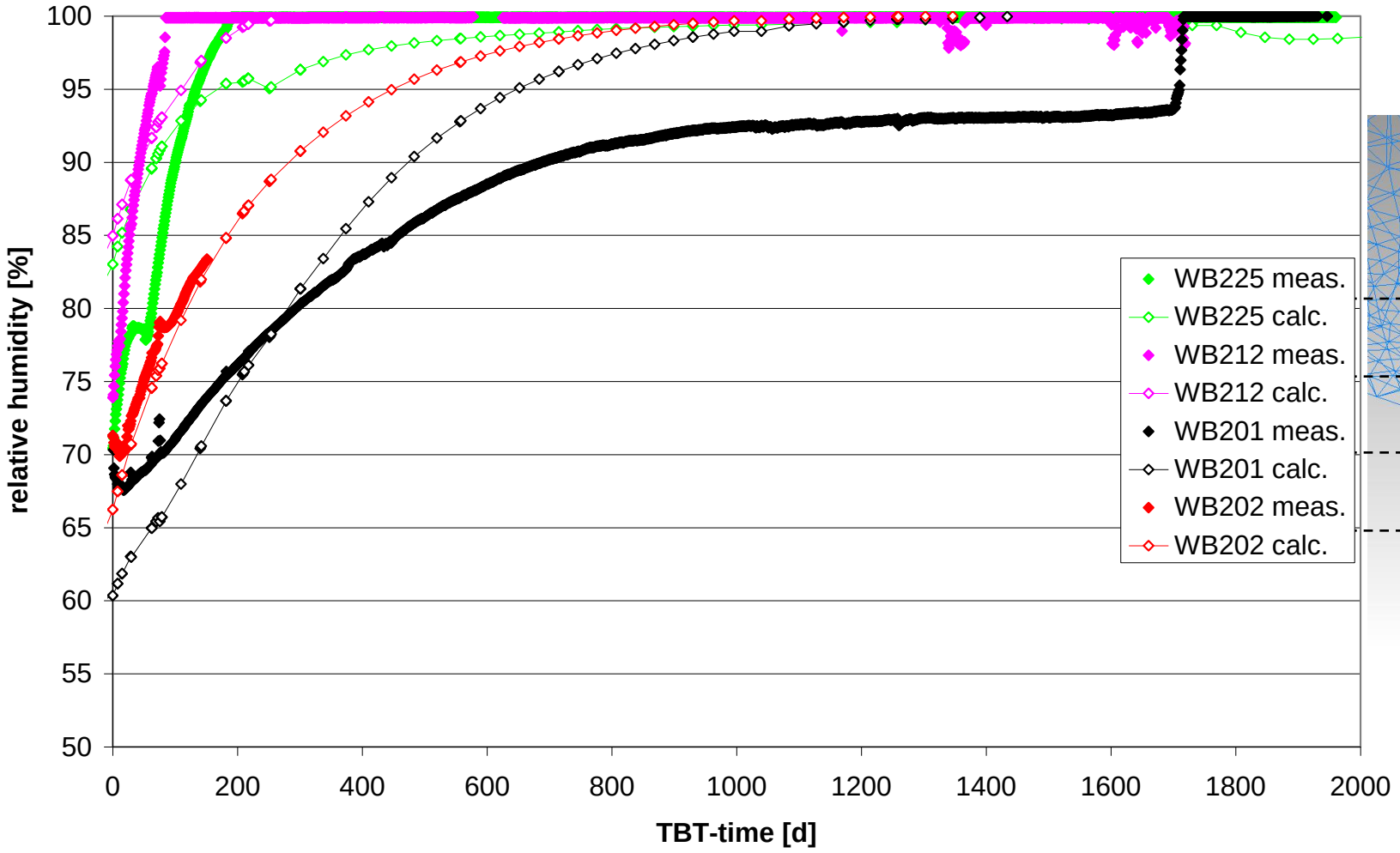
TBT: Pore Pressure in the Buffer

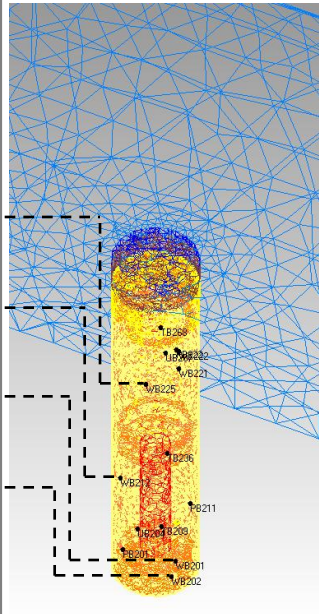




Results

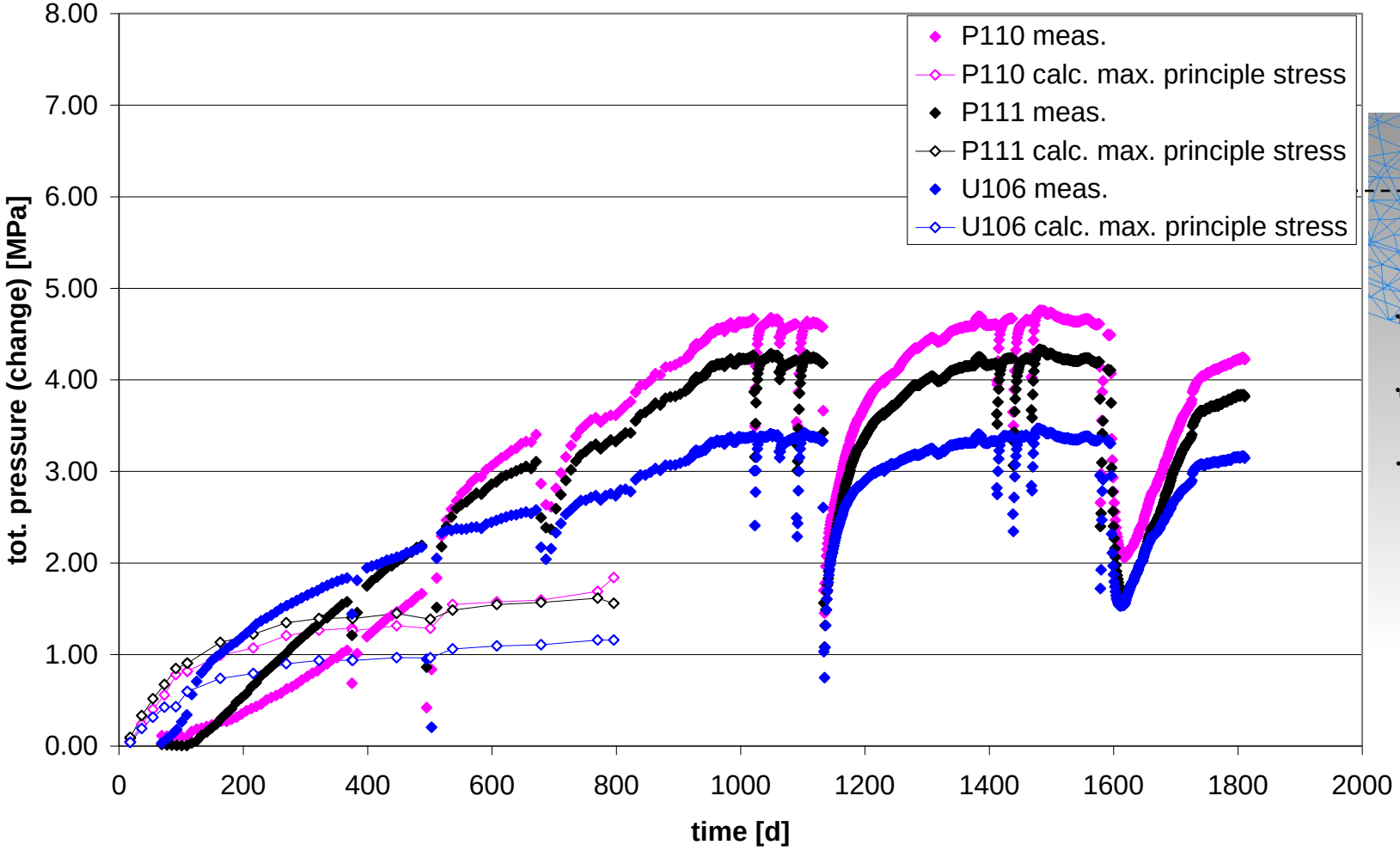
TBT: Relative Humidity in the Buffer

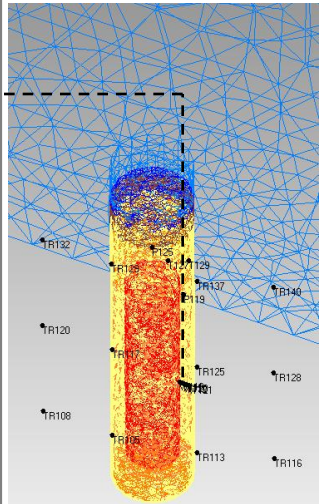




Results

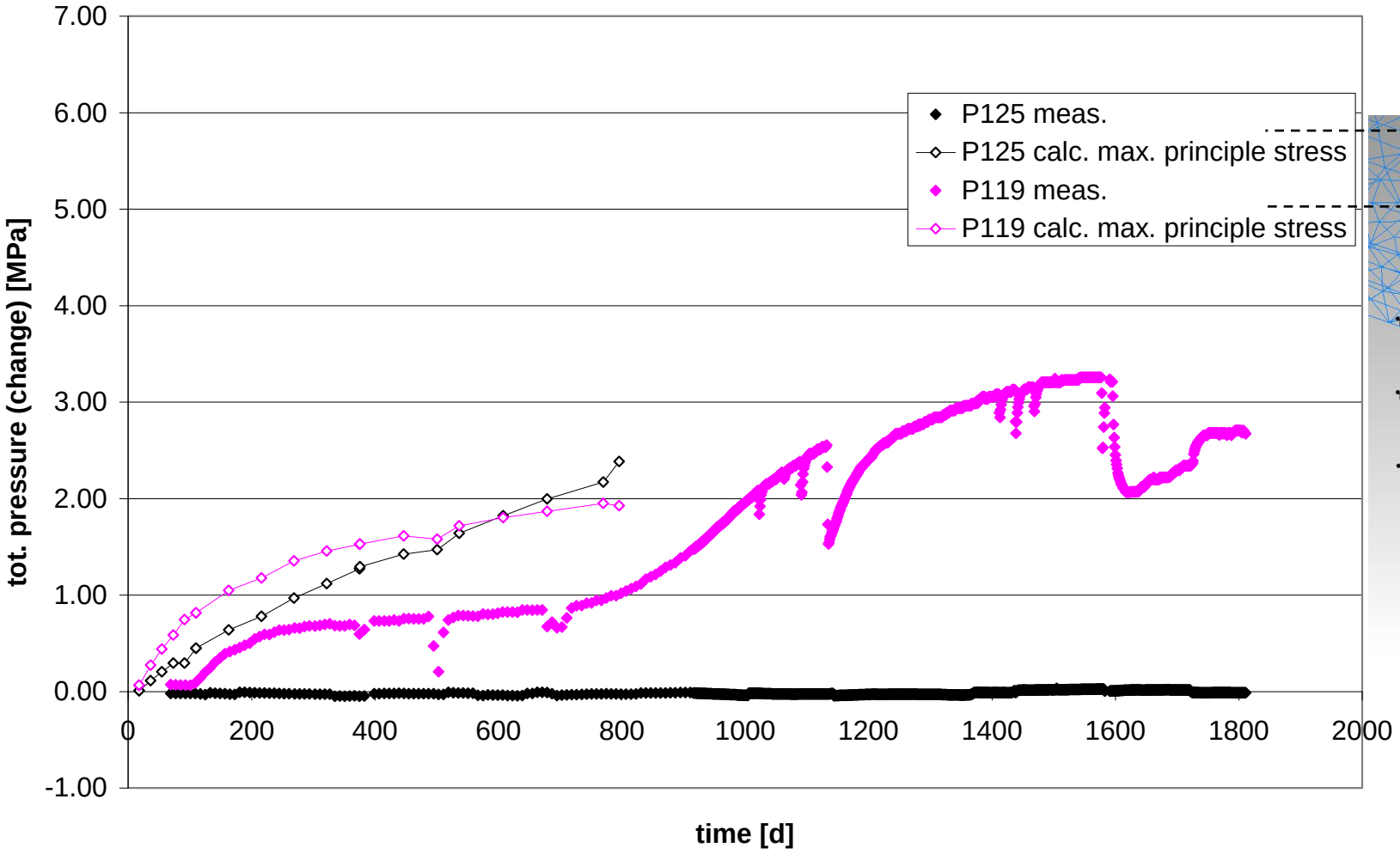
CRT: Swelling Pressure in the Buffer (Ring 5)

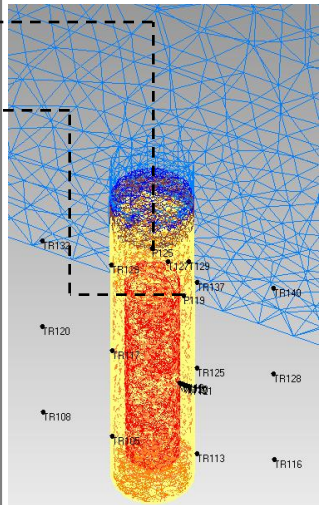




Results

CRT: Swelling Pressure in the Buffer (Ring 10 and Cylinder 3)





Outlook

- Parameter variation for swelling behaviour of pellets and rings/blocks
- Parameter variation for heater thermal expansion
- Reporting