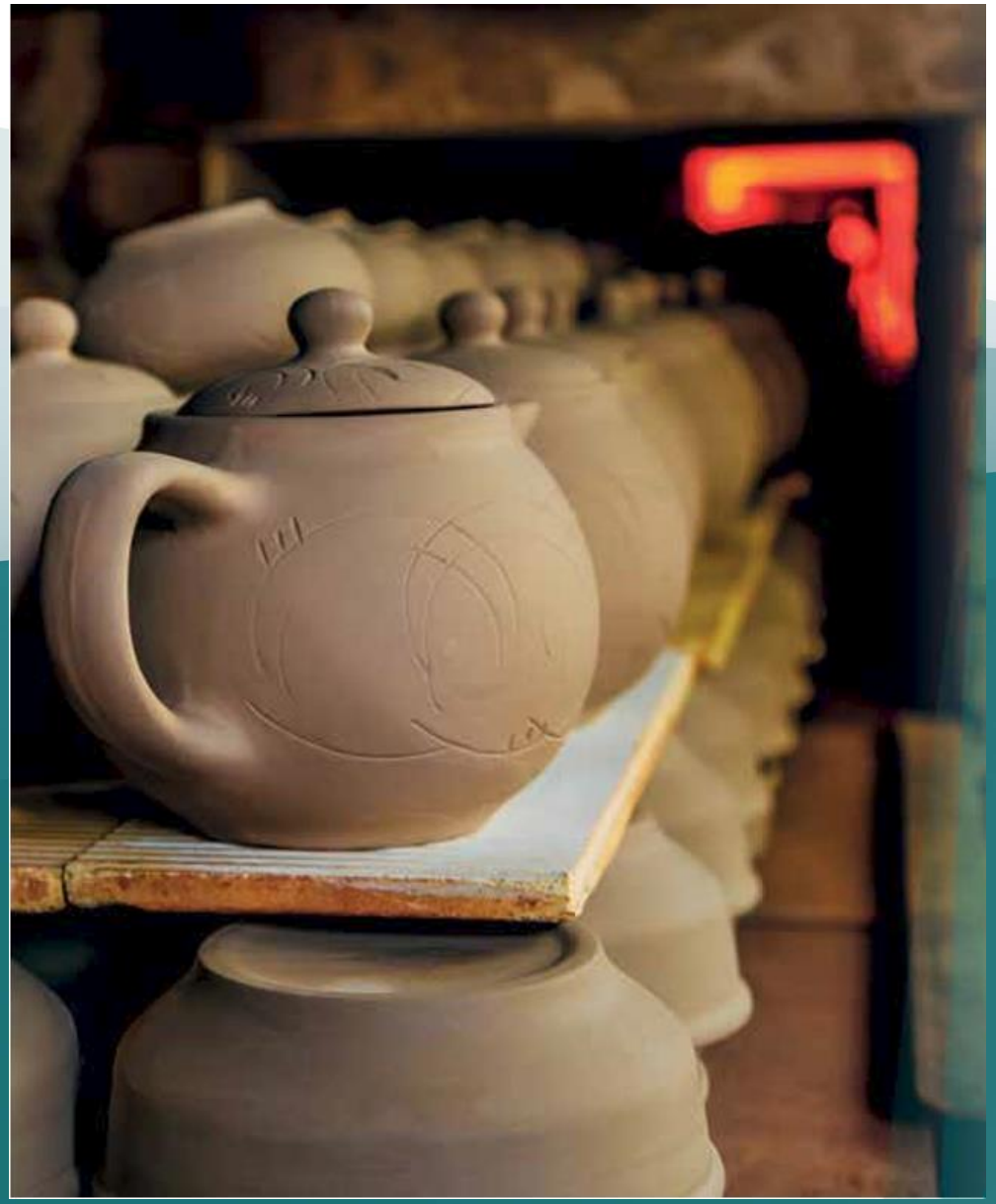
KINETICS NEO

NETZSCH

Leading Thermal Analysis



KINETIC MODELLING AND OPTIMIZATION OF SINTERING PROCESS

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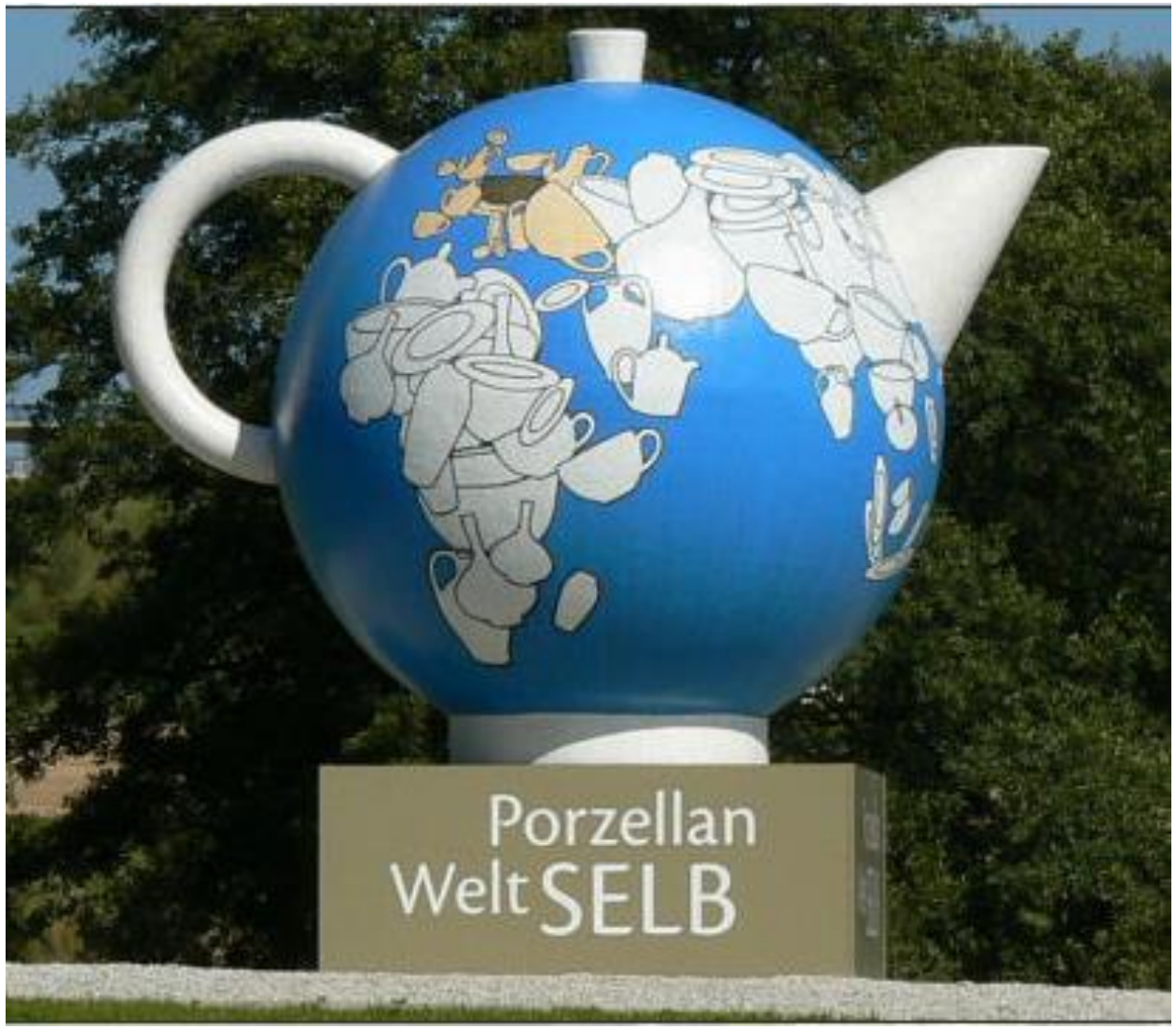
Selb in Germany – City of Porcelain



Problem: Find optimal temperature program to get the best quality

- Measurements
  - Shrinkage — *Dilatometry*
  - Phase transitions — *Differential scanning calorimetry*
  - Mass loss — *Thermogravimetry*
- Analysis — *Kinetics Neo software*

  how effects depend on the sintering conditions
- Kinetics modelling — *Kinetics Neo software*
  - Create the model to describe the sintering
- Predictions of sintering — *Kinetics Neo software*
  - Using kinetic model from kinetic modelling
- Optimizations of sintering processes *Kinetics Neo software*
  - Using kinetic model from kinetic modelling

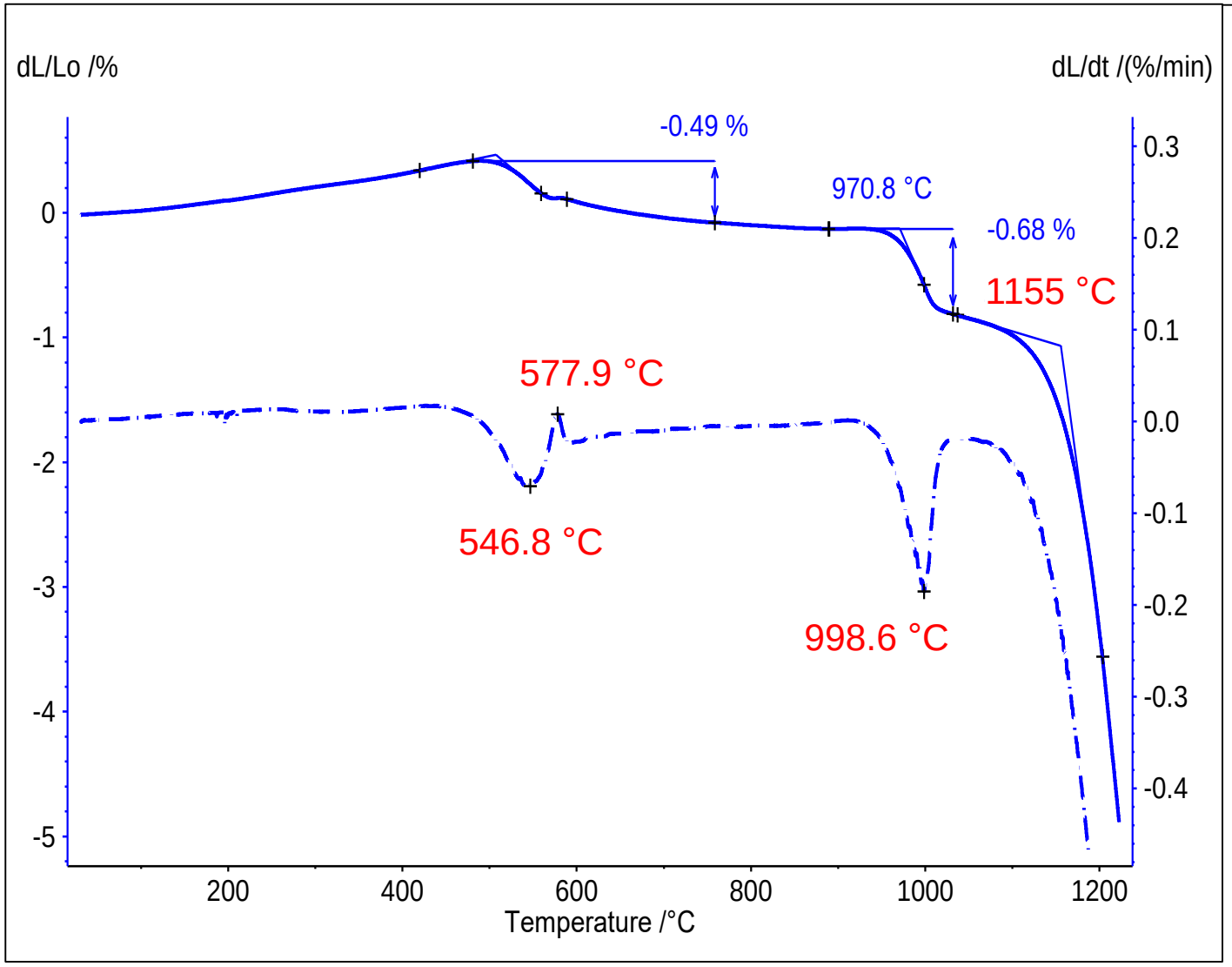
Dilatometry – length change during sintering measurement

DIL 402 *Expedis Classic*

specifically dedicated
to ceramic measurements

up to 1600 - 2800 °C

Porcelain green body: DILatometry



- 546°C loss of chemically bound water from kaolinite (dihydroxylation)
- 577°C quartz transition
- 998°C structural collapse of the metakaolinite and the formation of a γ-Al_2O_3 type spinel phase
- 1150°C -1200°C SiO_2 to the primary (2:1) mullite at about the formation of the secondary (3:2) mullite

DIL measurement on a porcelain green body, 10.01 mm, 10 K/min, air atmosphere

STA 449 F1 Jupiter

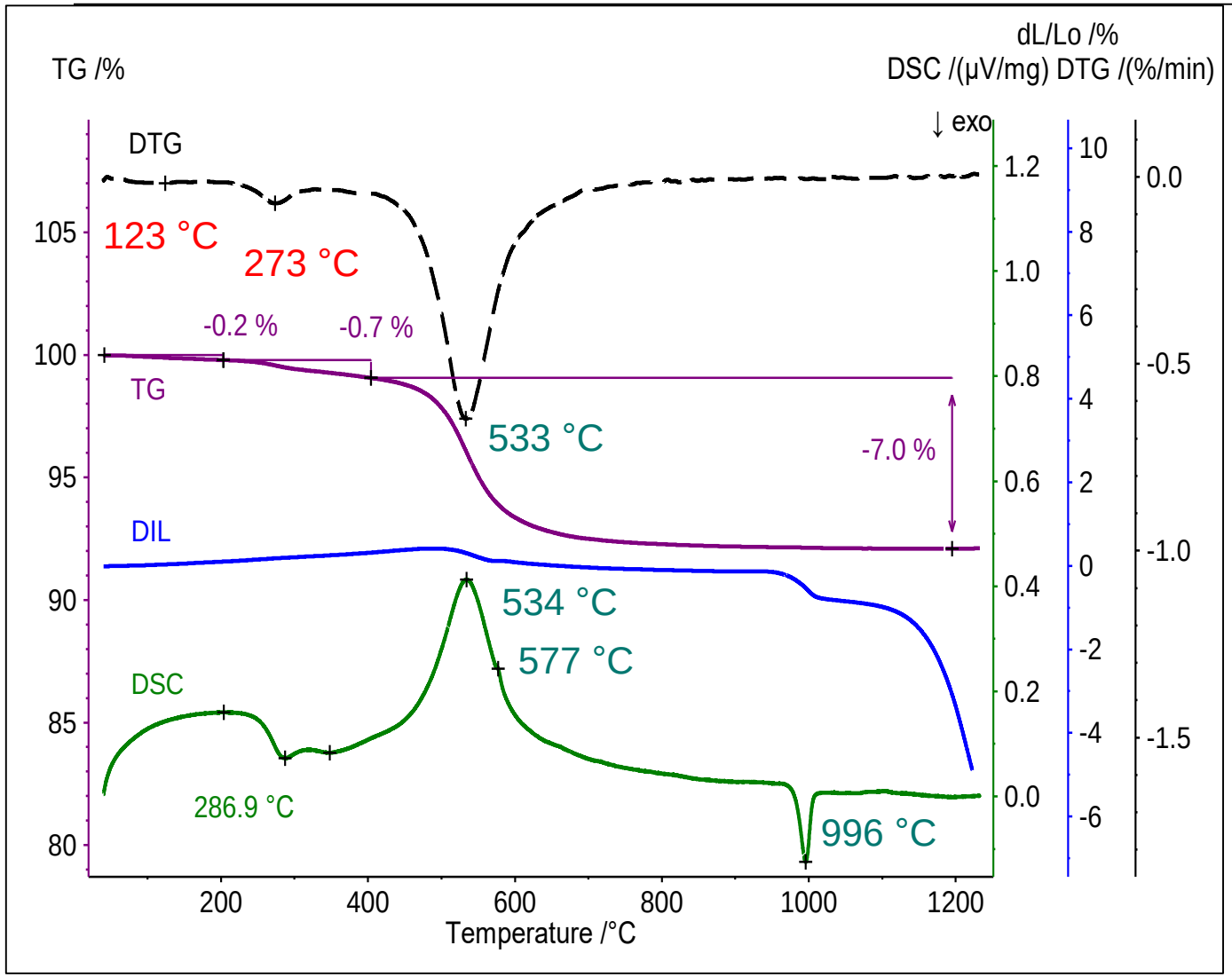
Differential scanning calorimetry – phase transitions and reactions
Thermogravimetry: mass loss

STA 44 F1 Jupiter

dedicated to high-temperature measurements

up to 1650-2000 °C

Measured effects: DSC and TG

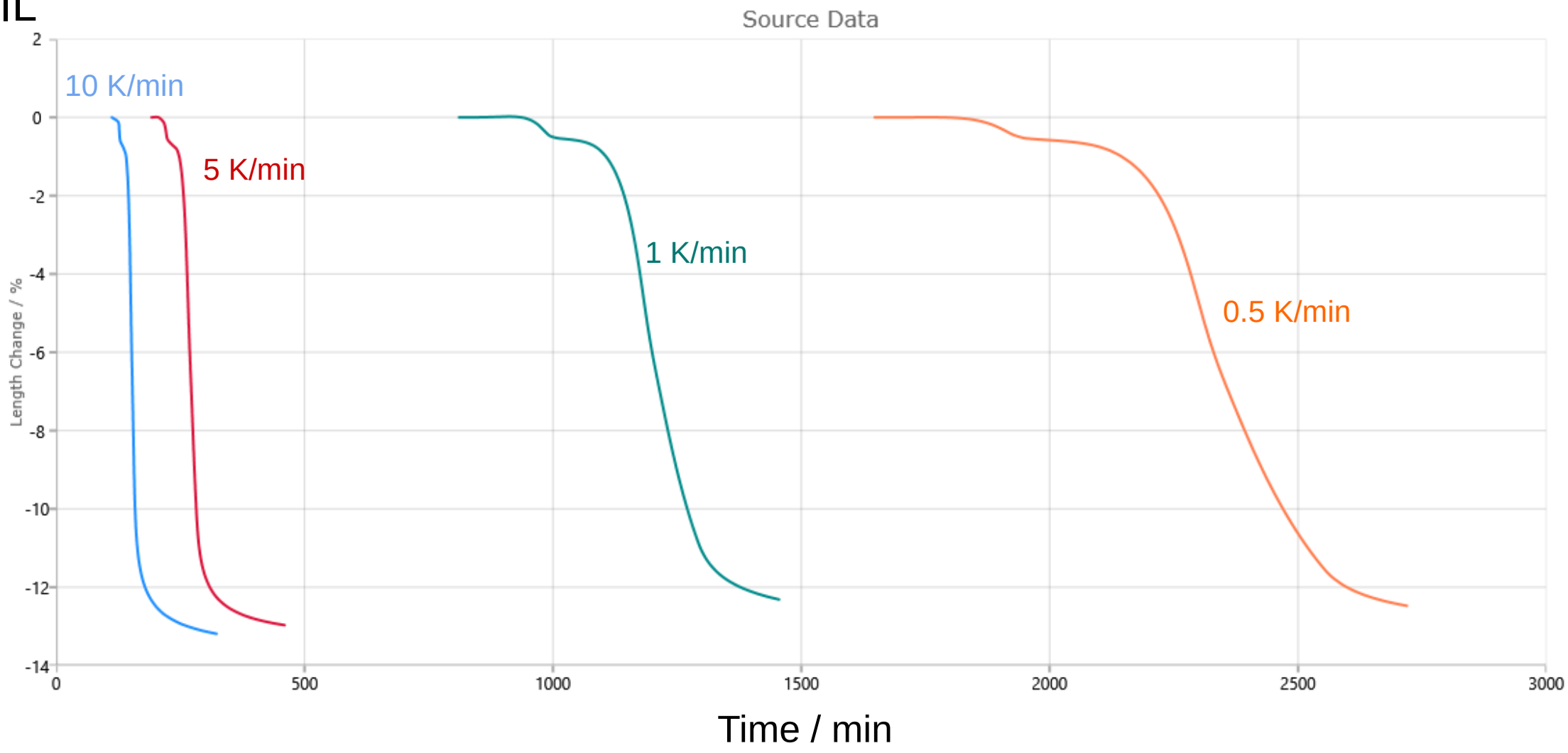


- 123°C loss of surface water
- 273°C Binder combustion
- 533°C loss of chemically bound water from kaolinite
- 577°C quartz transition
- 996°C structural collapse of the metakaolinite and the formation of a γ-Al_2O_3 type spinel phase
- 1150°C -1200°C SiO_2 to the primary (2:1) mullite at about the formation of the secondary (3:2) mullite

Comparison between DIL and STA results during heating to 1230°C;10 K/min, air atmosphere

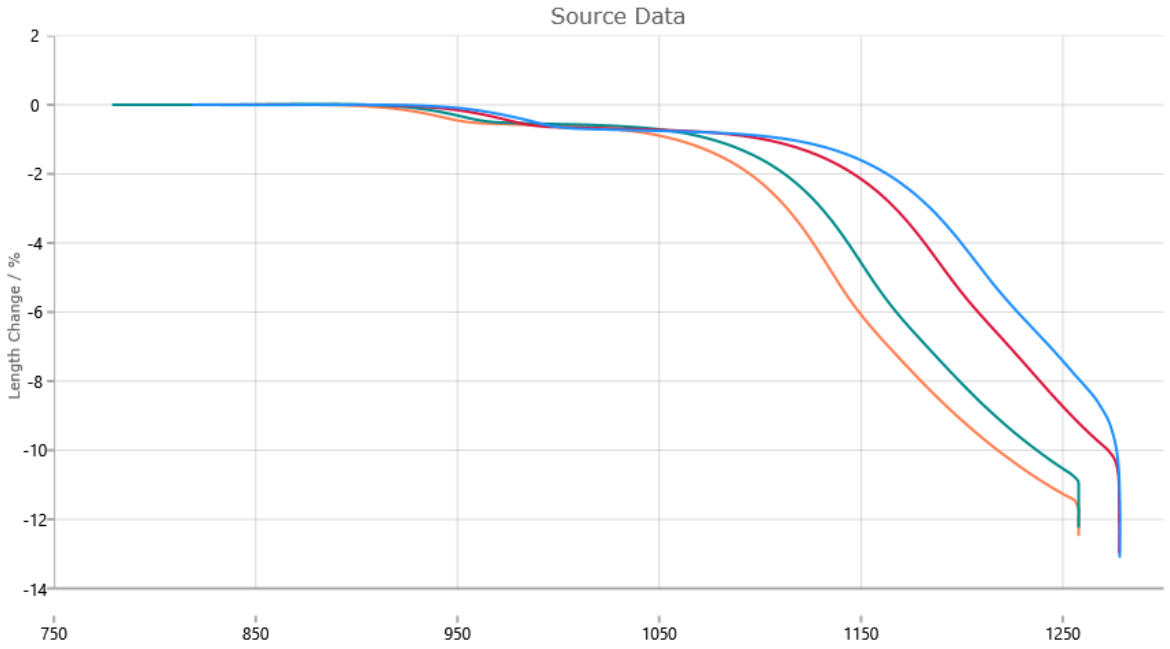
DIL Measurement: Porcelain sintering process

DIL

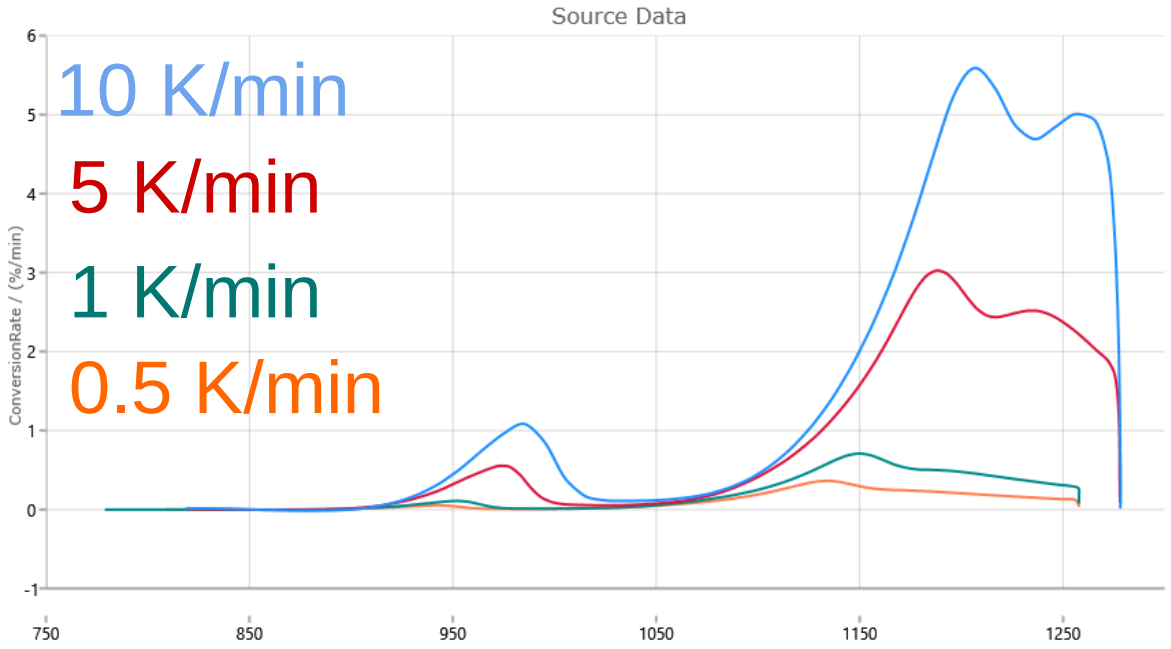


DIL Measurement: Porcelain sintering process

DIL



DDIL



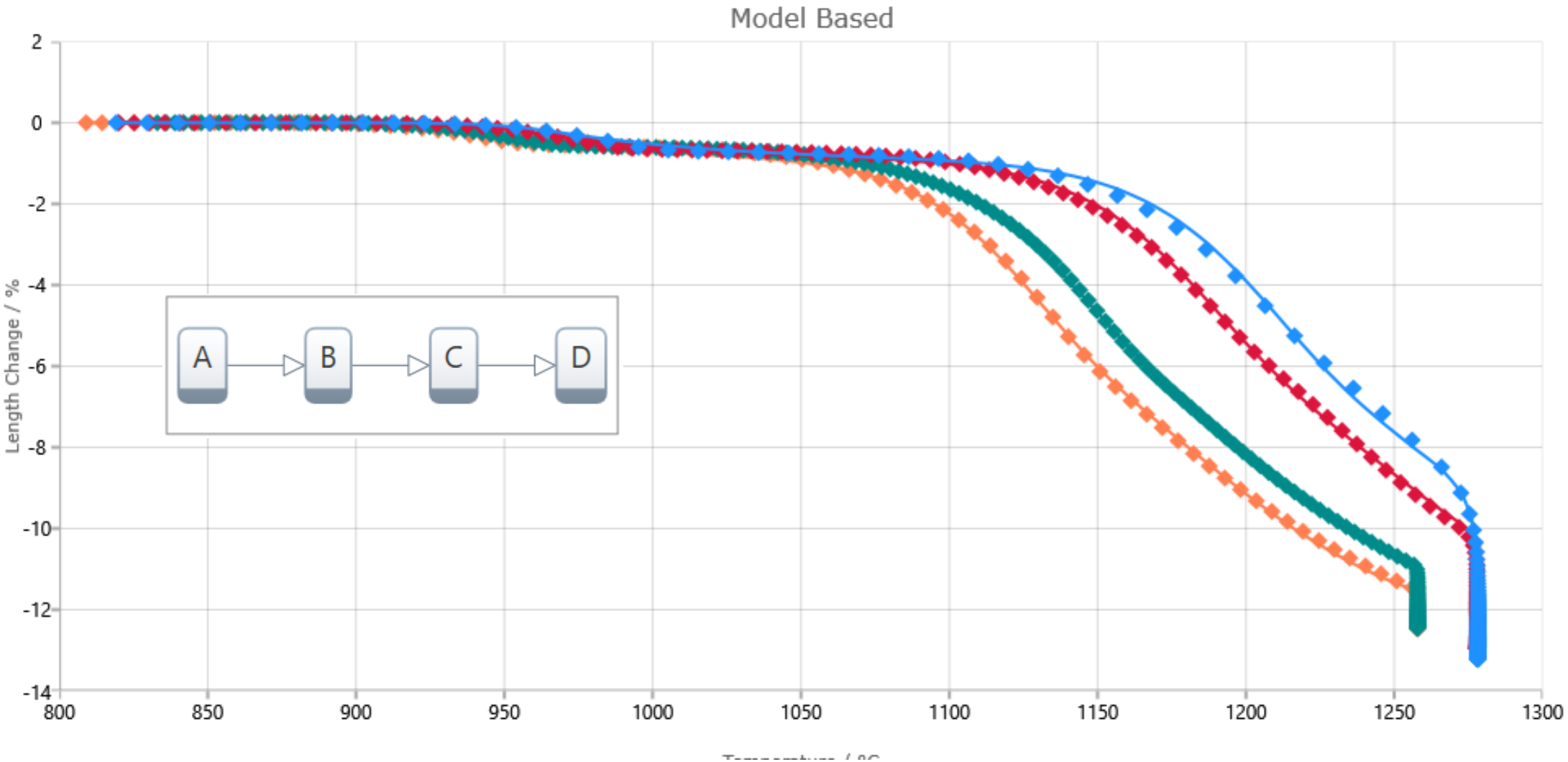
Main task:

1. Create one kinetic model which can describe the experimental data for different temperature conditions

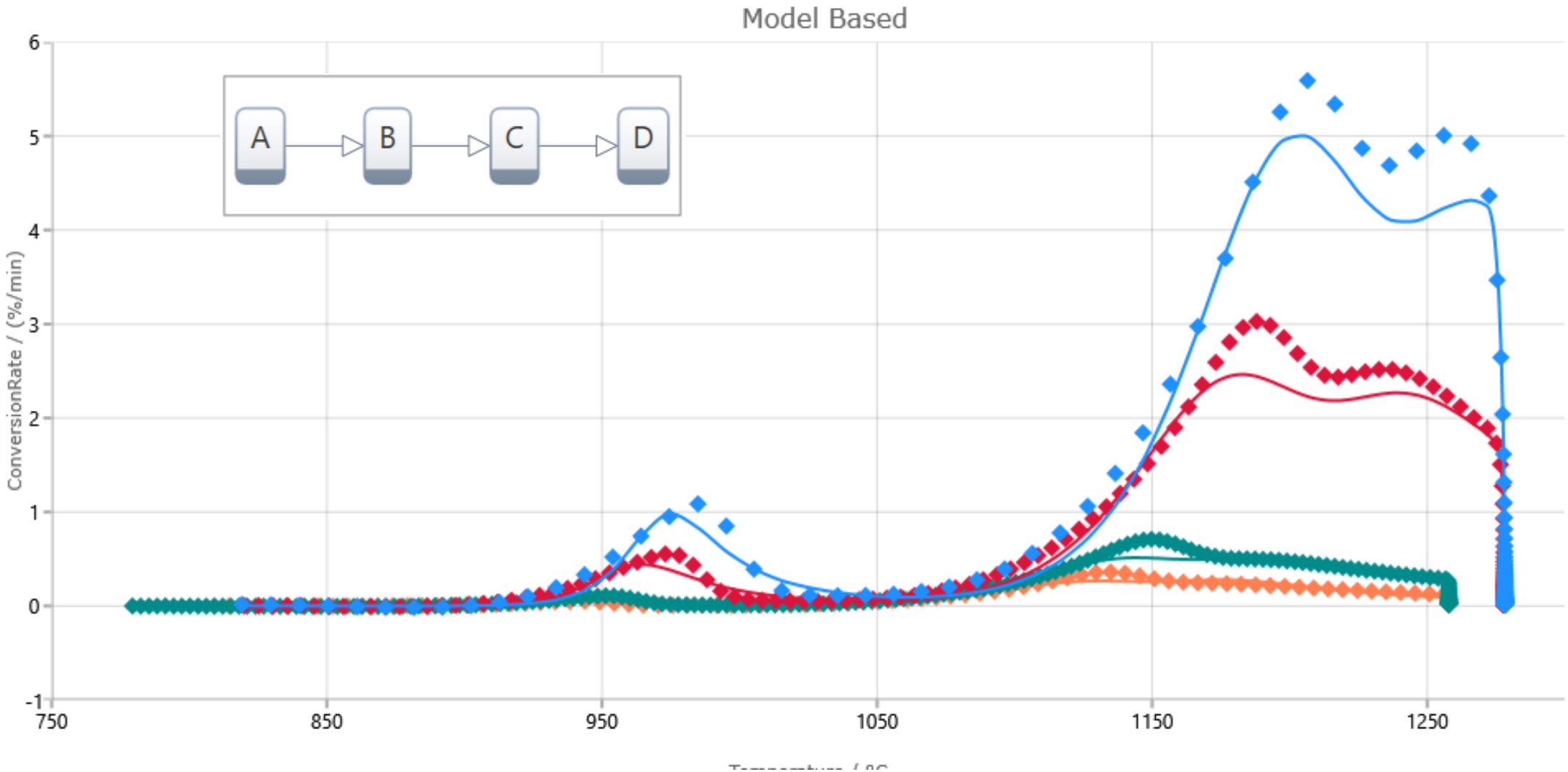
2. Use this kinetic model for prediction of reaction progress at the different temperature program.

3. Use this kinetic model for the process optimization

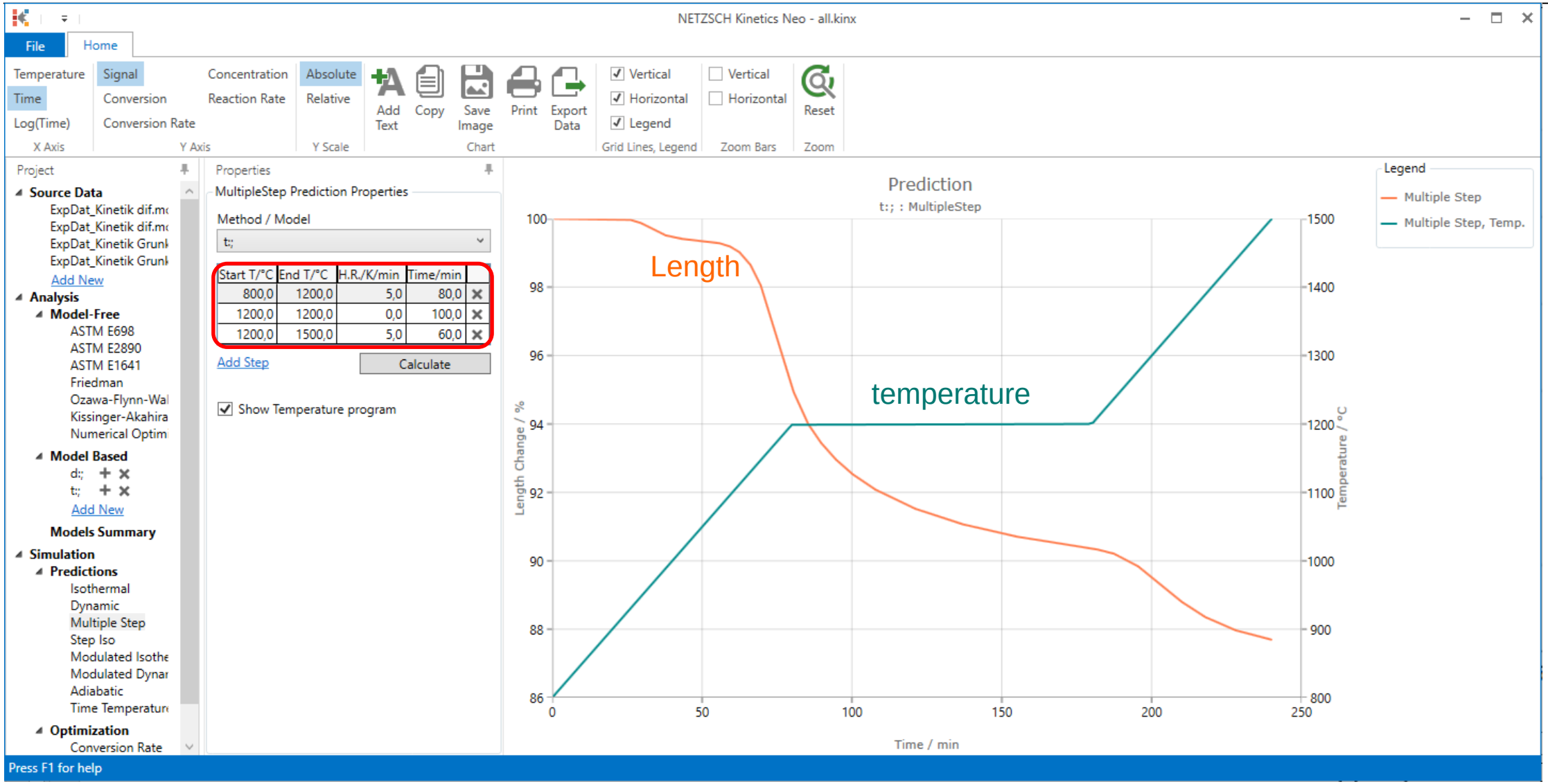
Porcelain sintering process
DIL Measurement and kinetic model



Porcelain sintering process
Conversion rate and kinetic model



Example:
Prediction of length for user's temperature program



Example:
Temperature optimization for constant sintering rate

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Properties

ConversionRate Optimization Properties

Method / Model

t:;

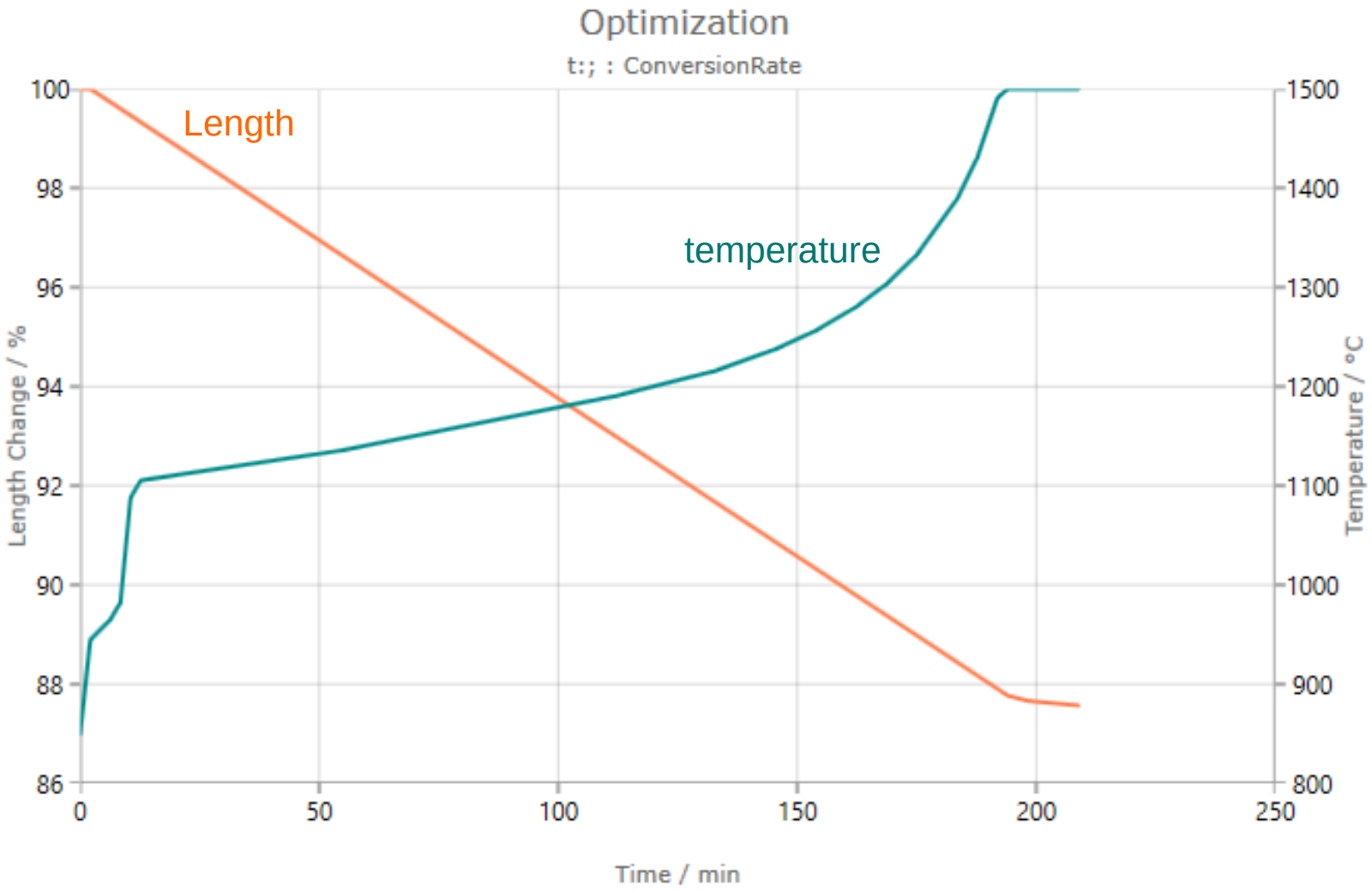
Minimal Temperature	850,00	°C
Maximal Temperature	1500,00	°C
Minimal Heating Rate	-5,00	K/min
Maximal Heating Rate	50,00	K/min
Conversion Rate	0,50	%/min

Calculate

Show Temperature program

Isoconversion Curves

All | None | Default | Custom



What makes Kinetics Neo so Valuable

NETZSCH

- Based on the latest technologies, contains improved fast and easy user interface.
- All model-free and model-based methods are included.
  The results from all of these methods can be statistically compared with one another.
- The powerful new numerical model-free method ensures fast determination of the best model-free solution.
- A visual kinetic model can be created quickly and easily using the model-based method.
- The kinetic model can contain any number of individual reaction steps in any combination.
  Reaction steps can be easily added, removed or changed by the user.
- The software provides the formal concentration of each reactant and reaction rate for each reaction step as a function of time or temperature.
- Predictions and optimizations can be achieved by means of both model-free and model-based methods.