

STARTING FROM THE LOCAL EQUILIBRIUM OR COMING FROM THE DYNAMIC END: A COMPARISON OF METHODOLOGIES IN PROCESS MODELING¹⁾

1) as suggested by K. Hack

Contents

1. Introduction
2. Simulation of the **cement clinker burning process**
3. Simulation of **tunnel kiln firing of refractories**

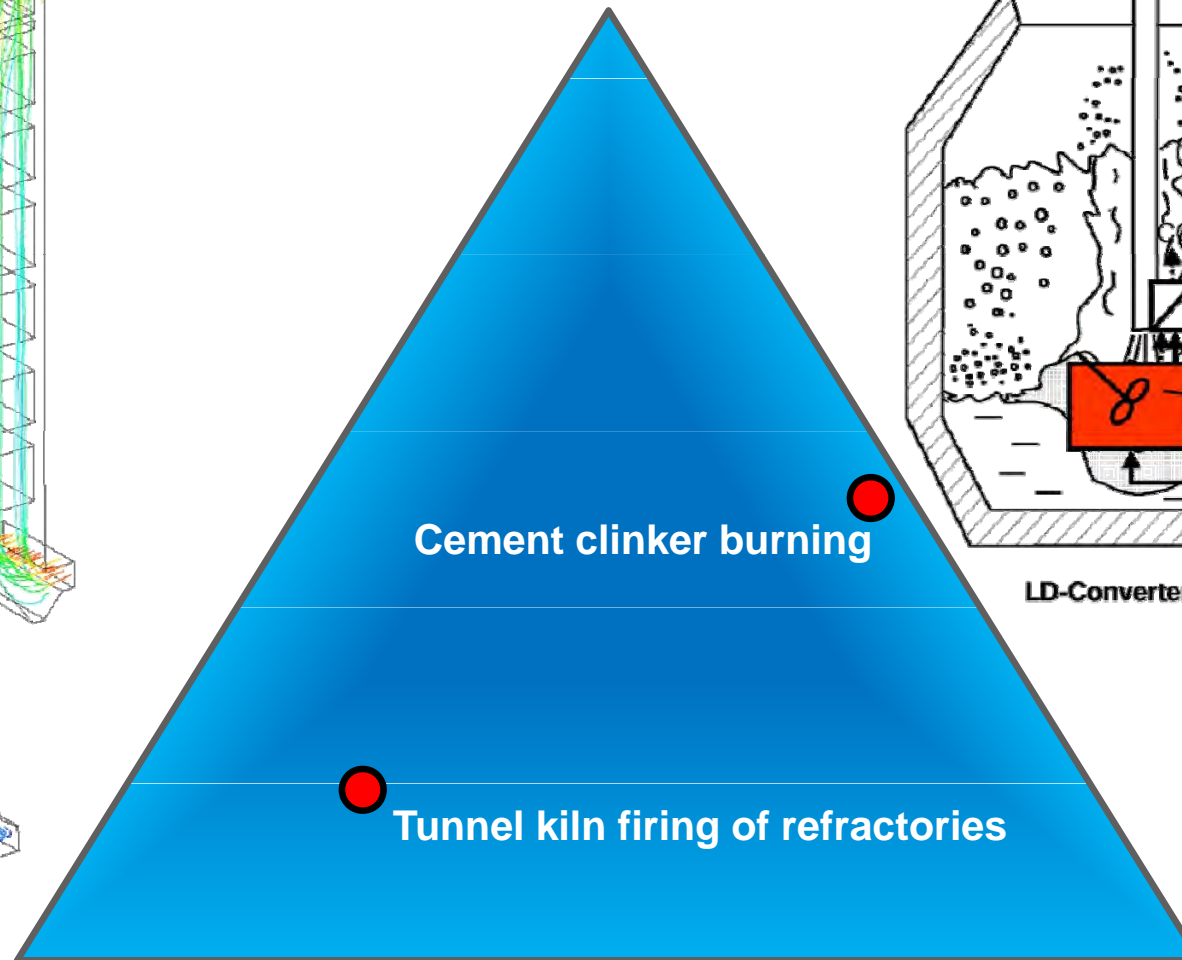
1. Introduction

What do we need to describe a process sufficiently?

Global (Local) Equilibrium

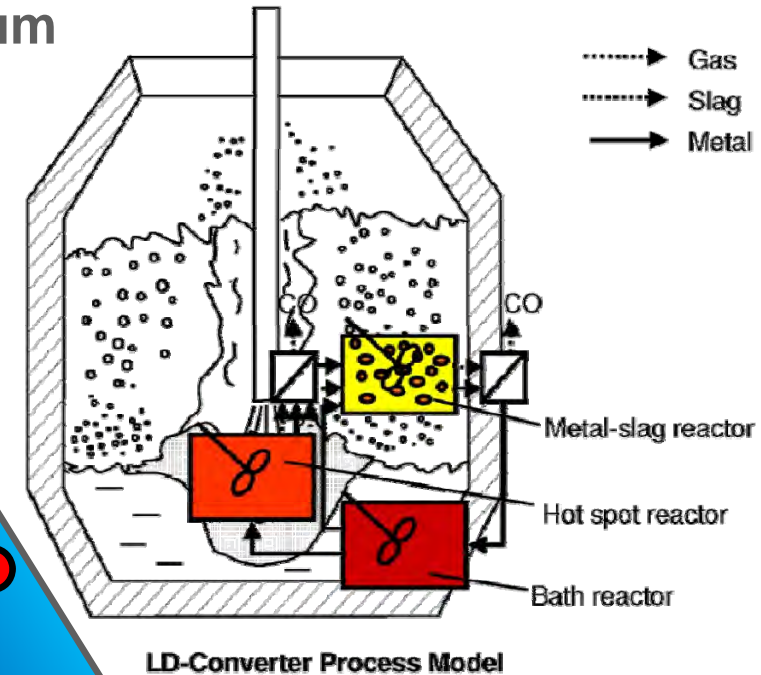


M. Weghaus, 2006



Fluid Dynamics

Kinetics

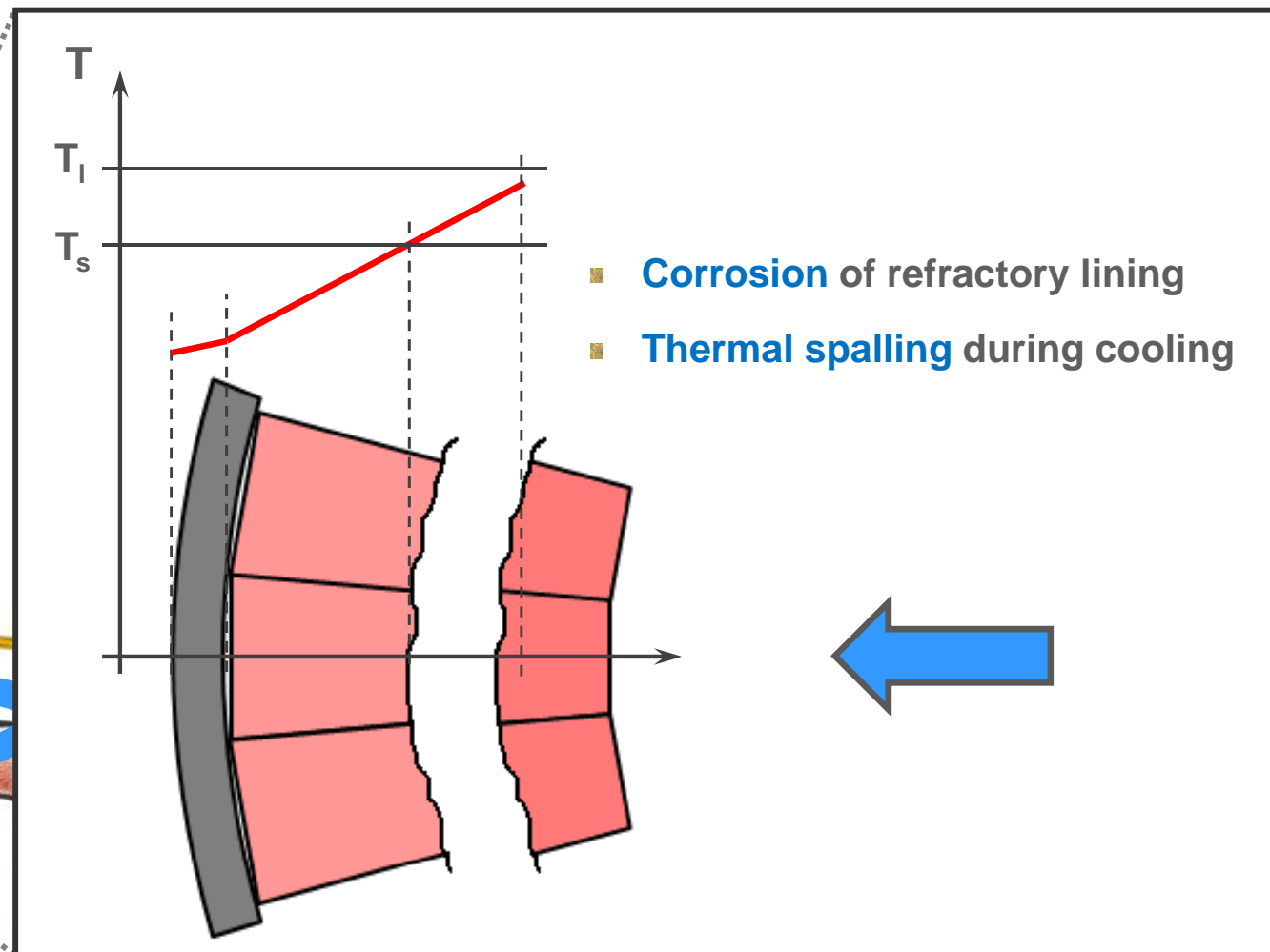
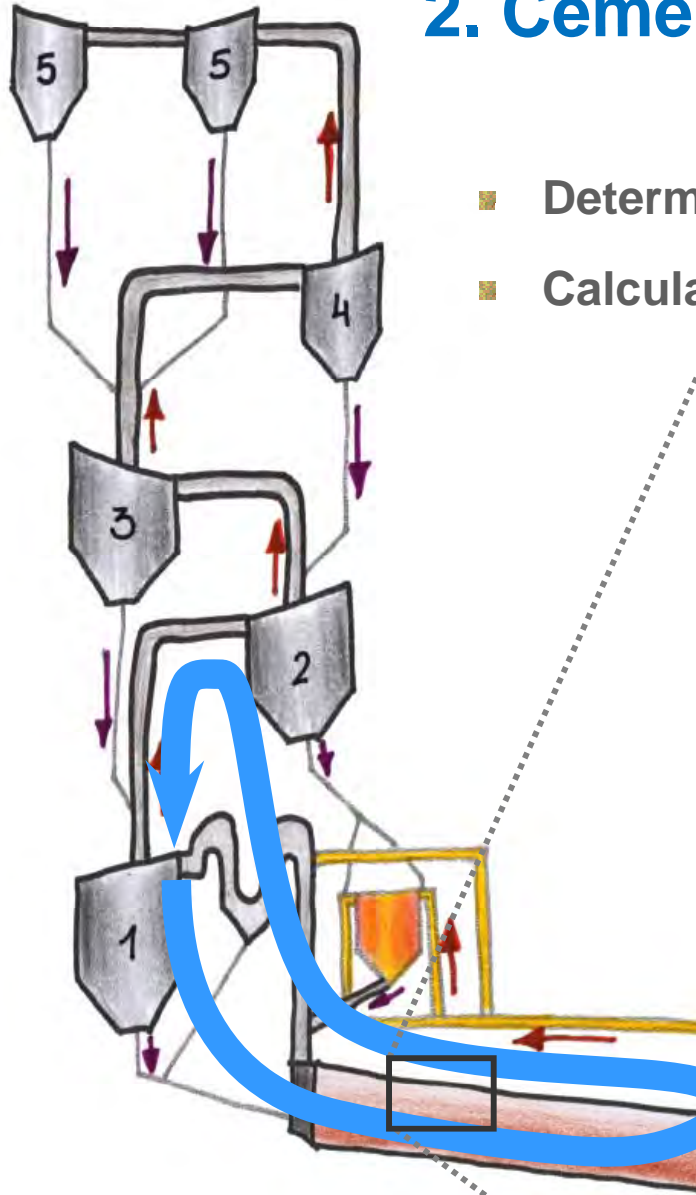


P. Monheim, 2002

2. Cement clinker burning process

Project objectives

- Determination of the **chemical loading of refractories**
- Calculation of the **infiltration profiles of volatiles in the lining**

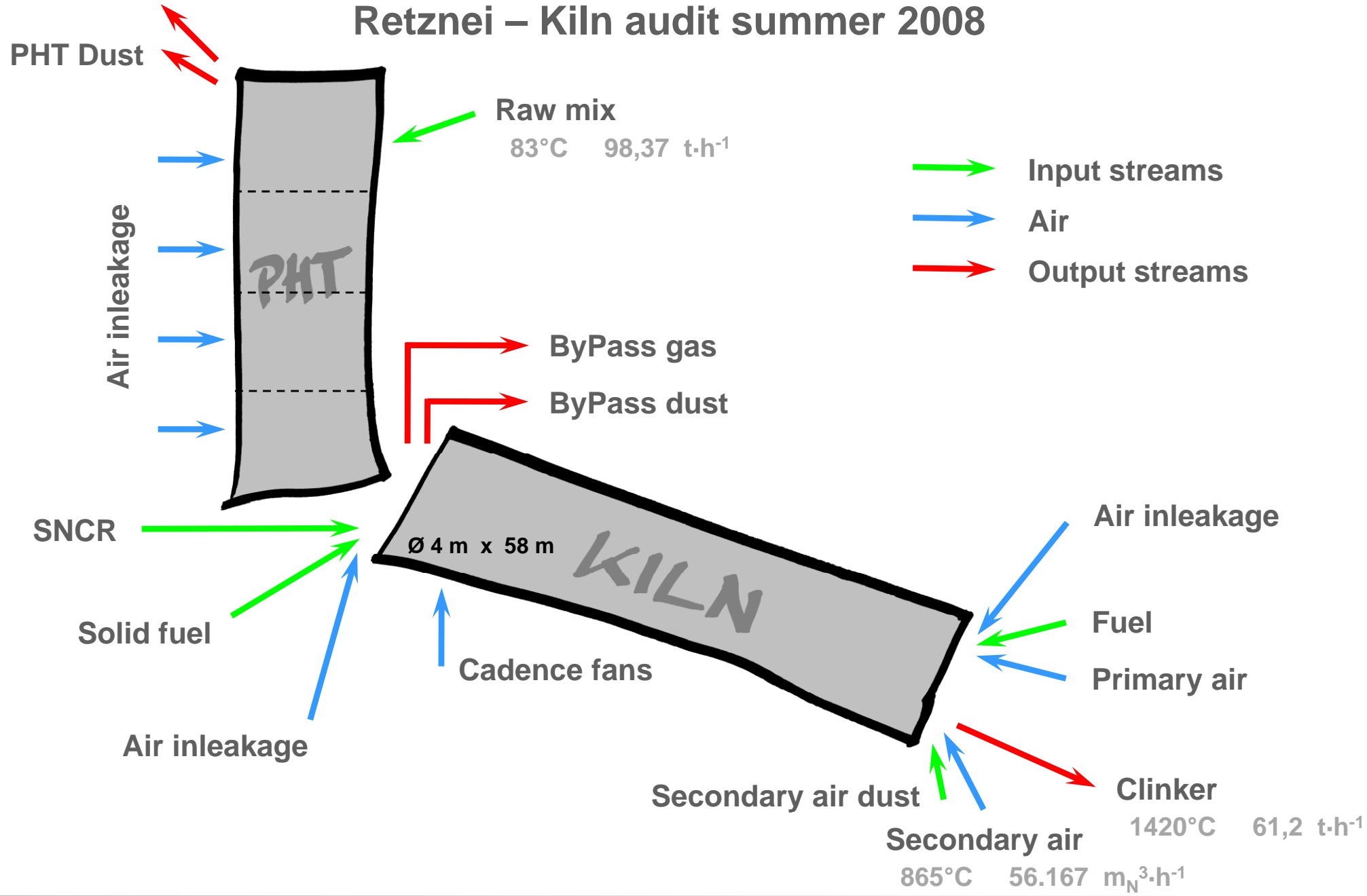


PHT gas

375°C 98.464 m_N³·h⁻¹

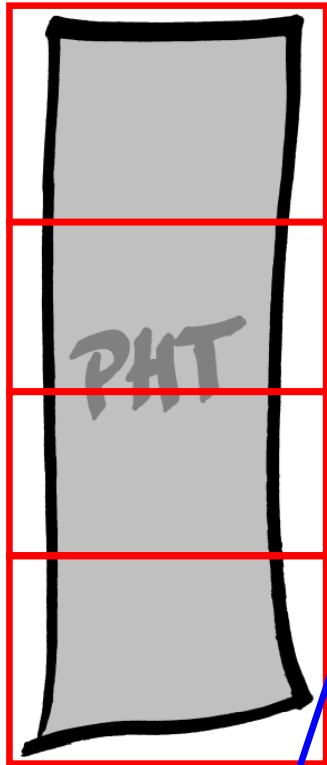
2. Cement clinker burning process

Retznei – Kiln audit summer 2008



2. Cement clinker burning process

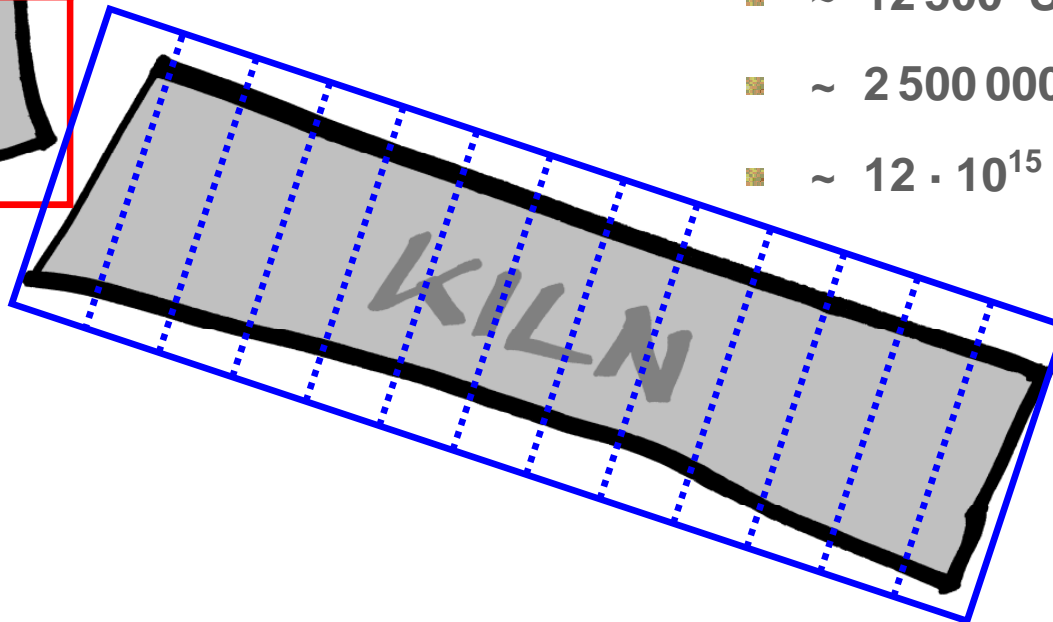
Retznei – Total process model



- Setup of reactors
 - 4 Preheater stages
 - 58 Kiln segments (à 1 m)

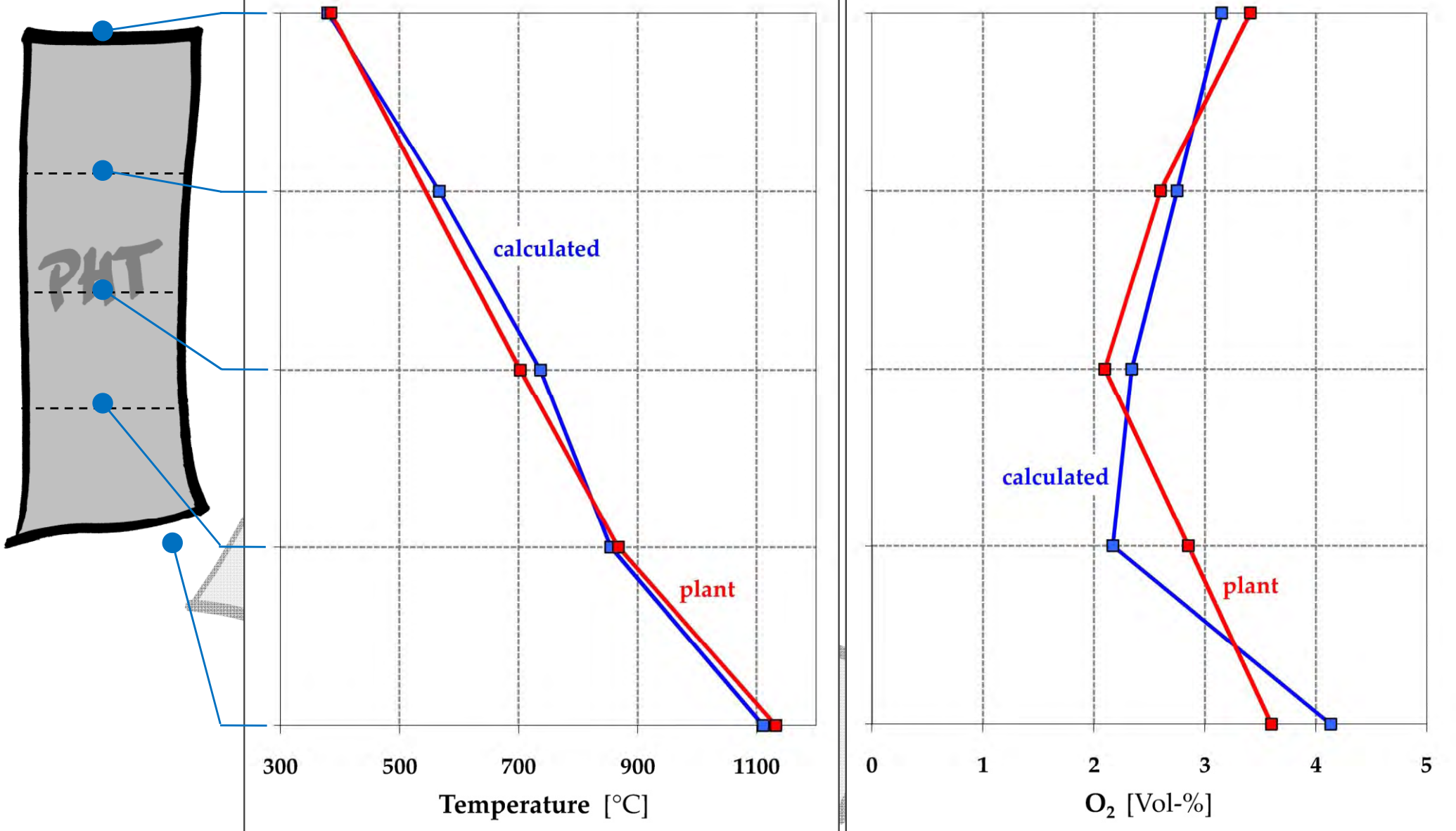
- Facts and figures

- complexity similar to FE-simulations
- ~ 12 500 SimuSage components
- ~ 2 500 000 calculated equilibria
- ~ $12 \cdot 10^{15}$ floating point operations



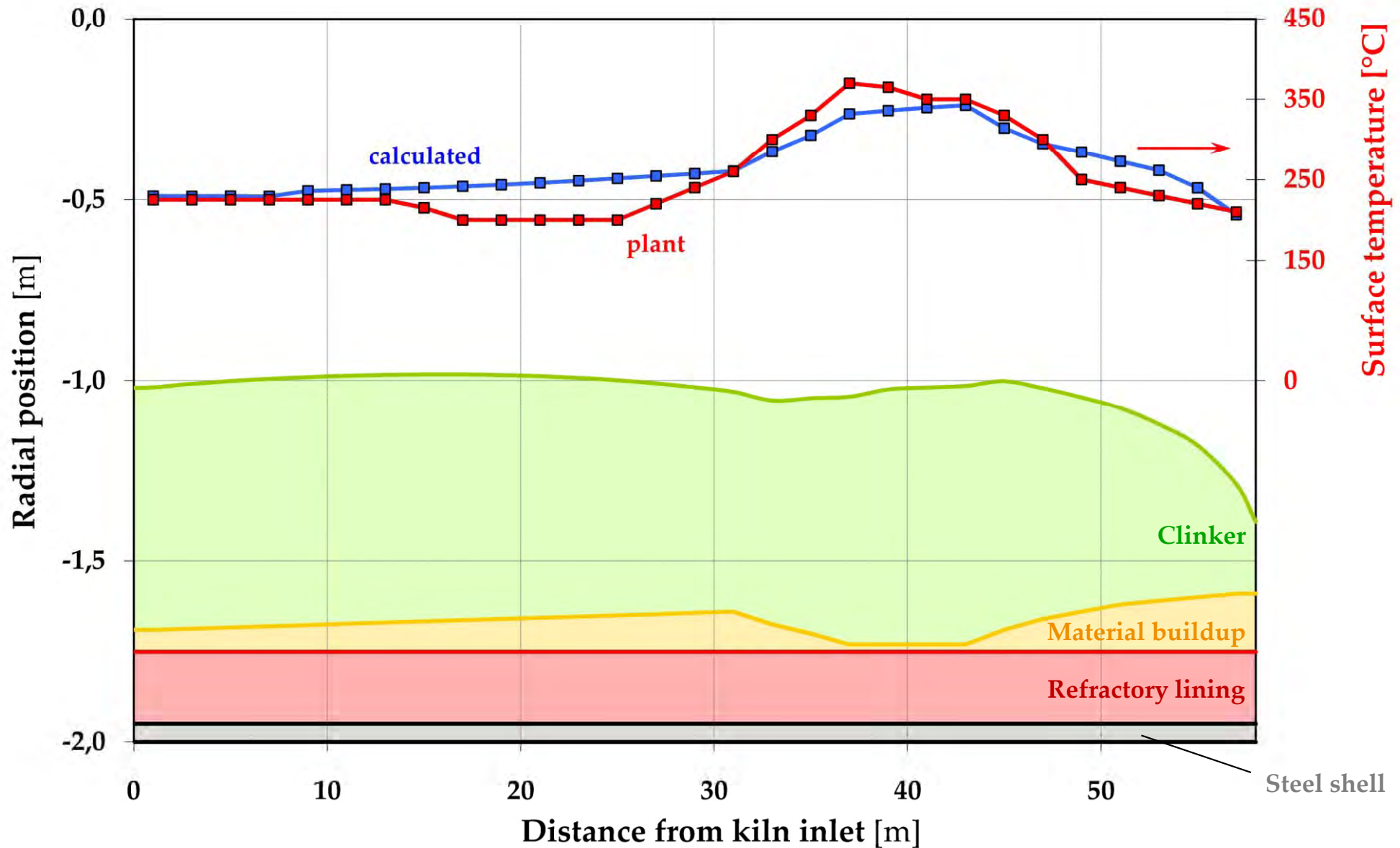
2. Cement clinker burning process

Retznei – Simulation results – Preheater tower gas



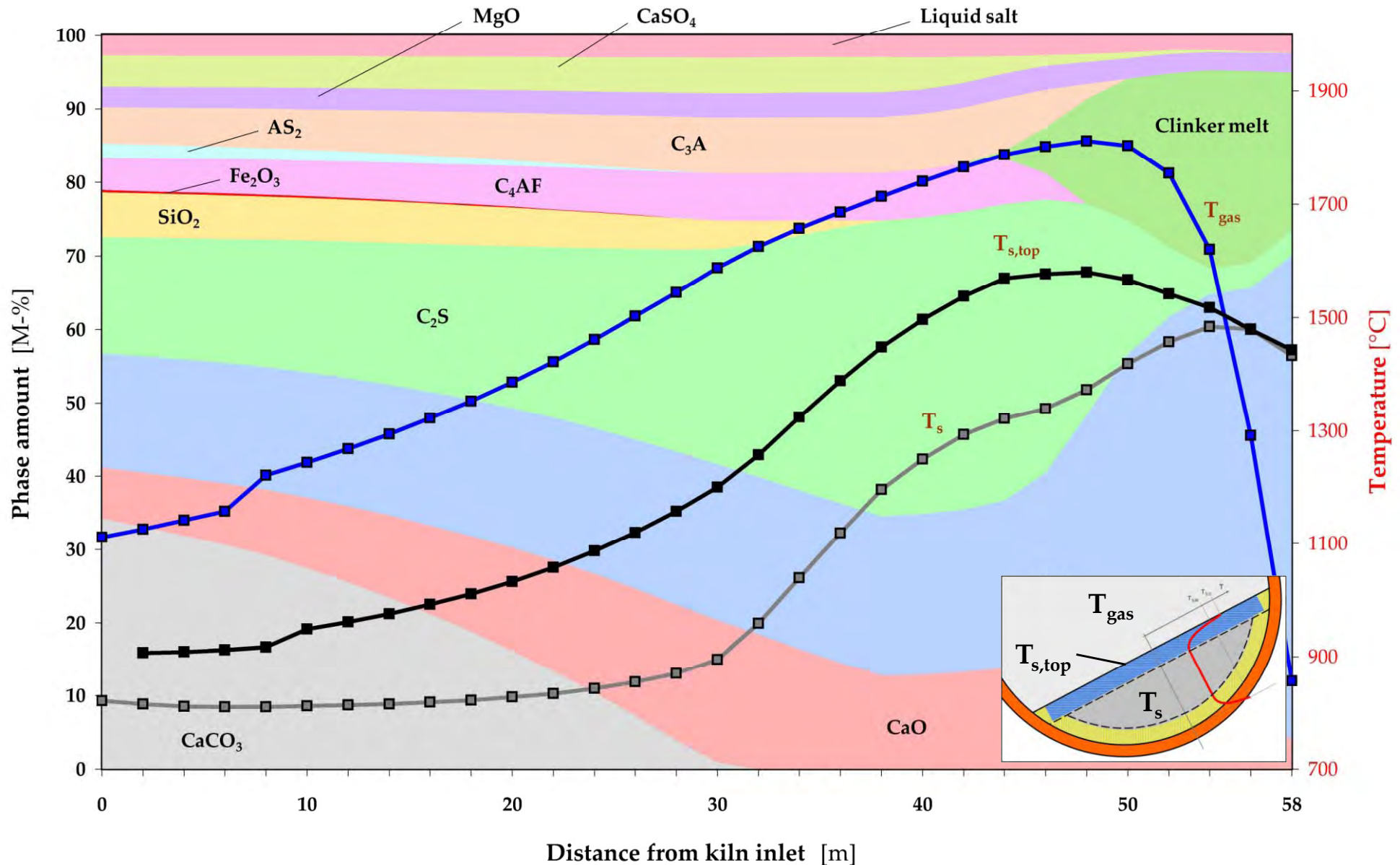
2. Cement clinker burning process

Retznei – Simulation results – Longitudinal section of kiln



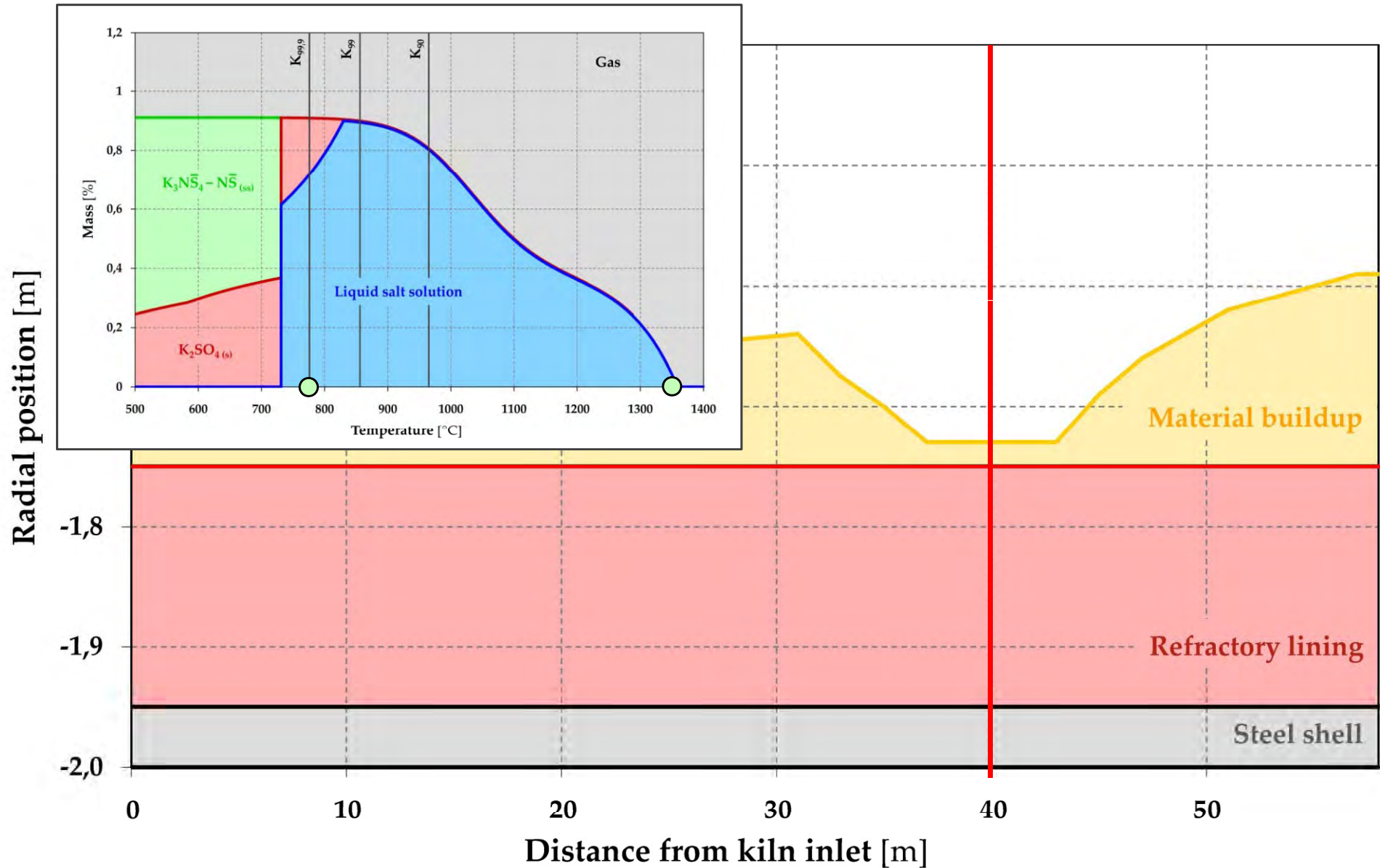
2. Cement clinker burning process

Retznei – Simulation results –Phase composition material bed in the kiln



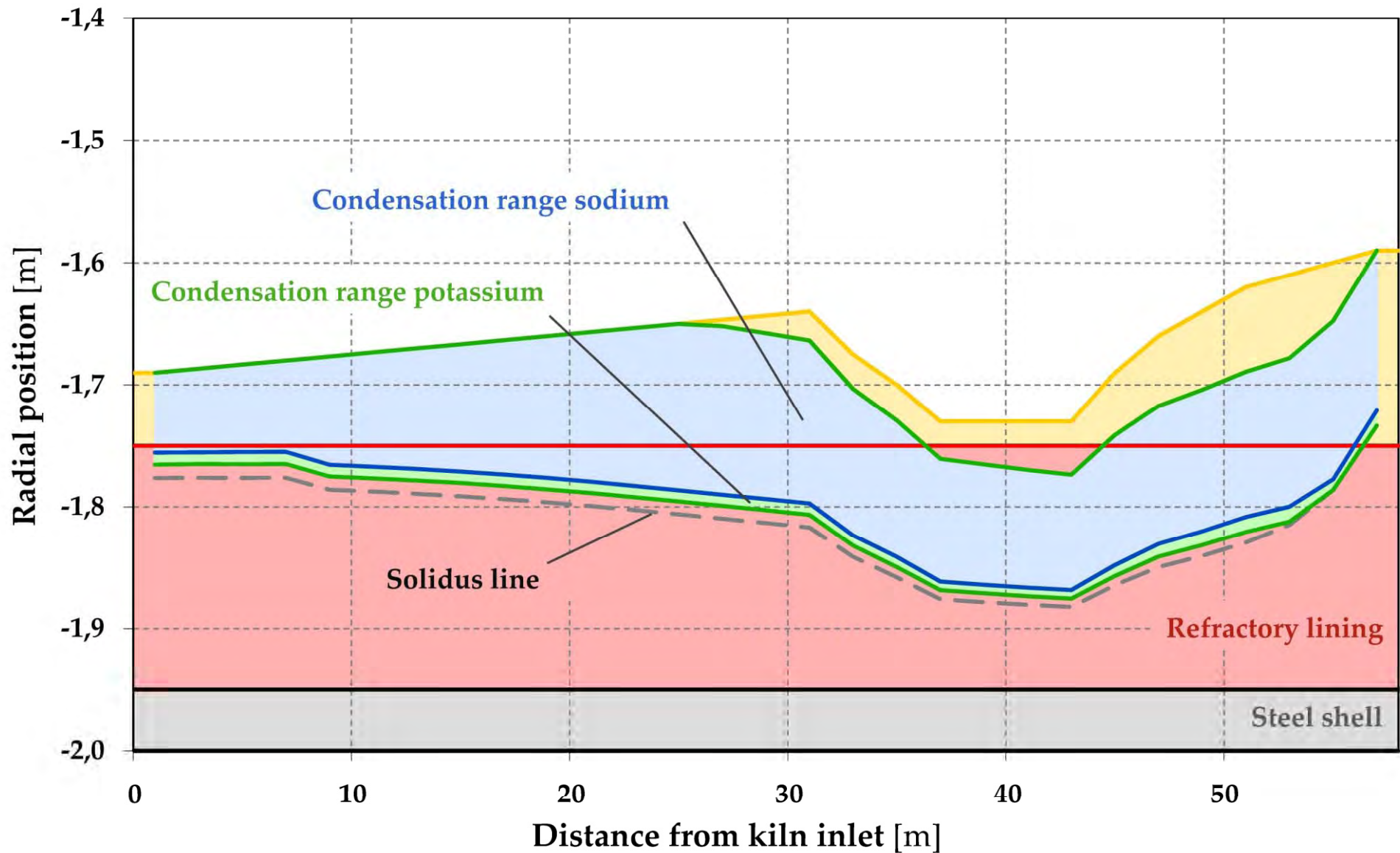
2. Cement clinker burning process

Retznei – Condensation of alkali salts in the kiln lining



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Retznei – Condensation of alkali salts in the kiln lining



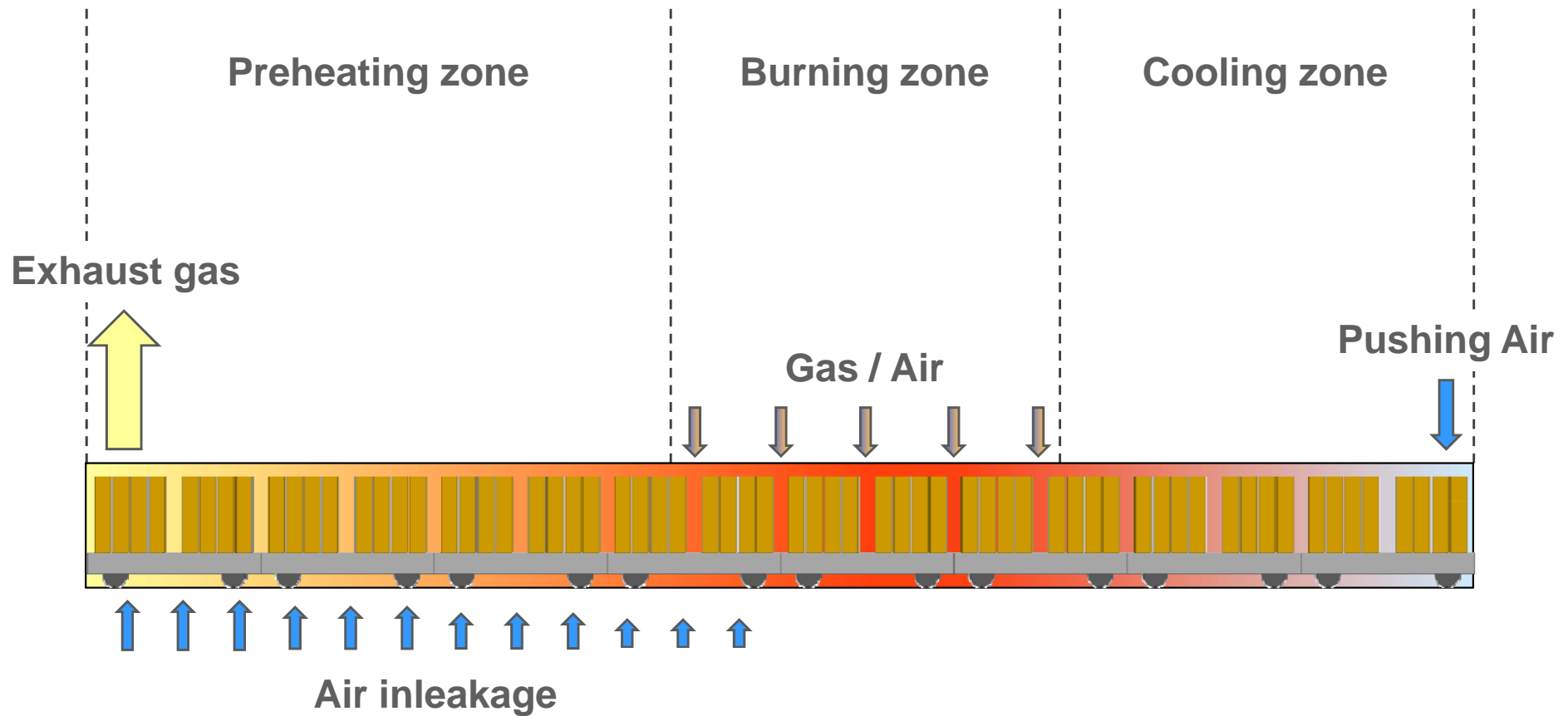
3. Tunnel kiln firing of refractories

Introduction



3. Tunnel kiln firing of refractories

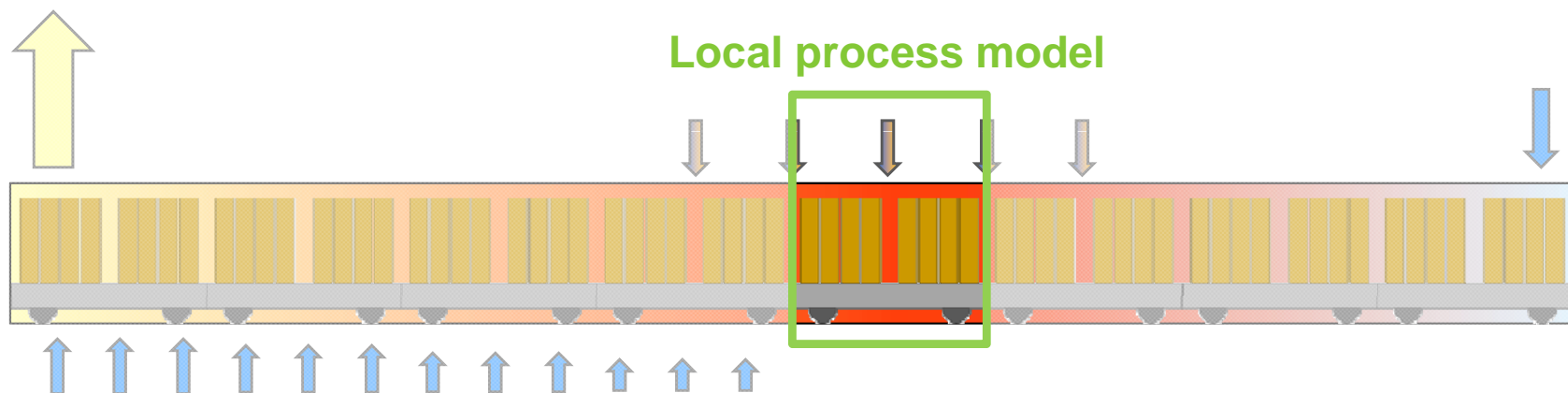
Introduction



3. Tunnel kiln firing of refractories

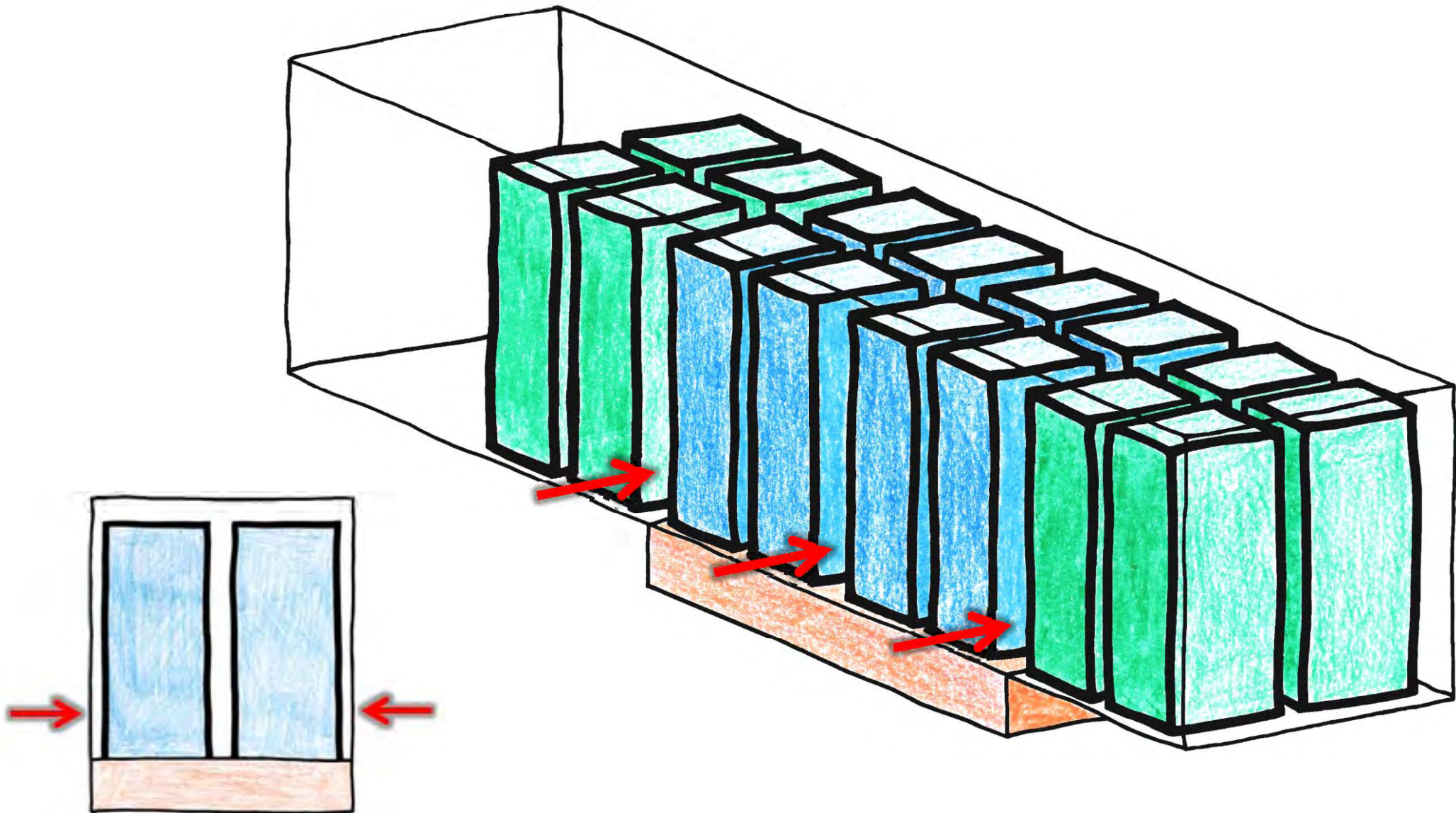
Project objectives

- Determine the **influence of process parameters** on
 - product quality
 - process control
- Some examples of **process parameters** of interest
 - Burner position
 - Kiln car pushing frequency
 - Kiln car setup scheme
- Make use of **OpenFOAM**



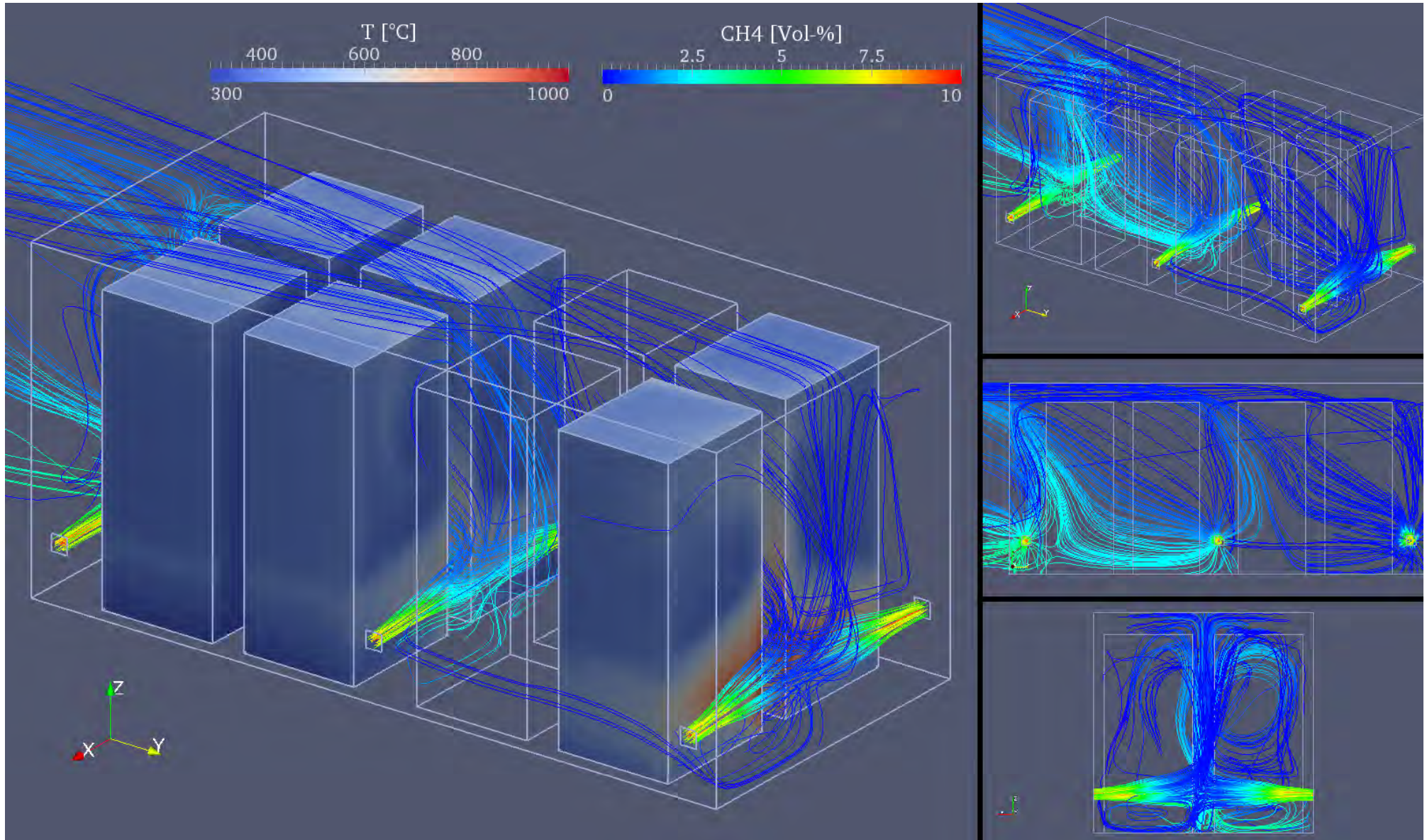
3. Tunnel kiln firing of refractories

Reference setup – Opposite position at the bottom



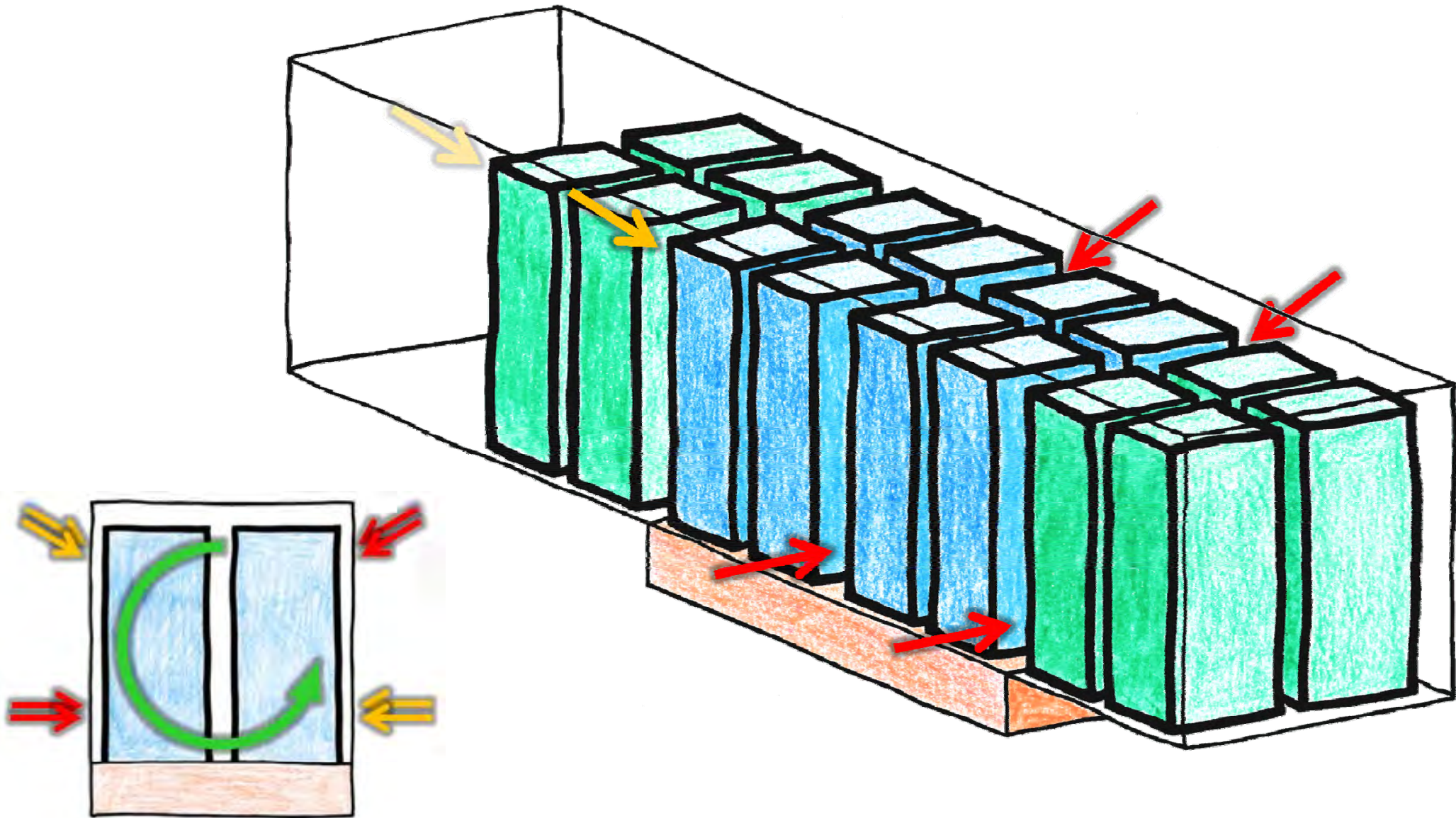
3. Tunnel kiln firing of refractories

Reference setup – Opposite position at the bottom



3. Tunnel kiln firing of refractories

Modified altered positioning of top and bottom burners



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Modified altered positioning of top and bottom burners

