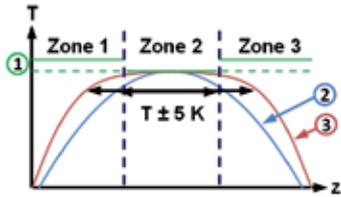
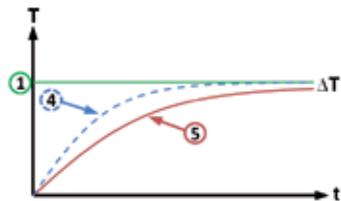


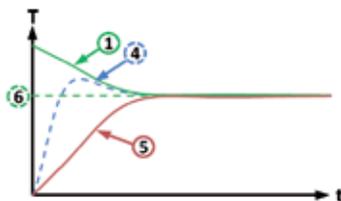
# Control Alternatives for Tube Furnaces



Three-Zone Furnace Chamber Control



Furnace control



Charge control

1. Furnace setpoint value
2. Actual value furnace chamber, 1-zone
3. Actual value furnace chamber, 3-zone
4. Actual value furnace chamber
5. Actual value load/bath/muffle/retort
6. Charge setpoint value

## Three-Zone Furnace Chamber Control

The temperature is measured by thermocouples positioned outside of the working tube, one in the middle and two on the sides. The outer zones are controlled with a setpoint-offset in relation to the middle zone. This allows the heat loss at the ends of the tube to be compensated to ensure an extended zone of constant temperature ( $\pm 5 \text{ K}$ ).

## Furnace Chamber Control

with temperature measurement in furnace chamber outside the working tube.

- Advantages: Thermocouple protected against damage and aggressive load, very even control, attractive price
- Disadvantage: Temperature difference between displayed temperature on the controller and inside the tube

## Extension Package for Furnace Chamber Control

with additional temperature measurement in the working tube and display of the measured temperature

## Charge Control

with temperature measurement both in the furnace chamber outside the working tube as well as in the working tube.

- Advantages: Very precise and rapid control adjustment
- Disadvantage: Costs

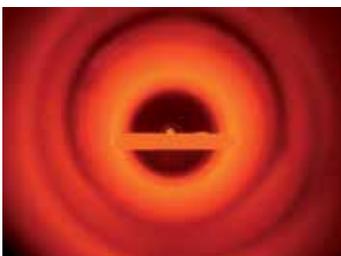
## Furnace Chamber vs. Charge Control Comparison

### Furnace Chamber Control

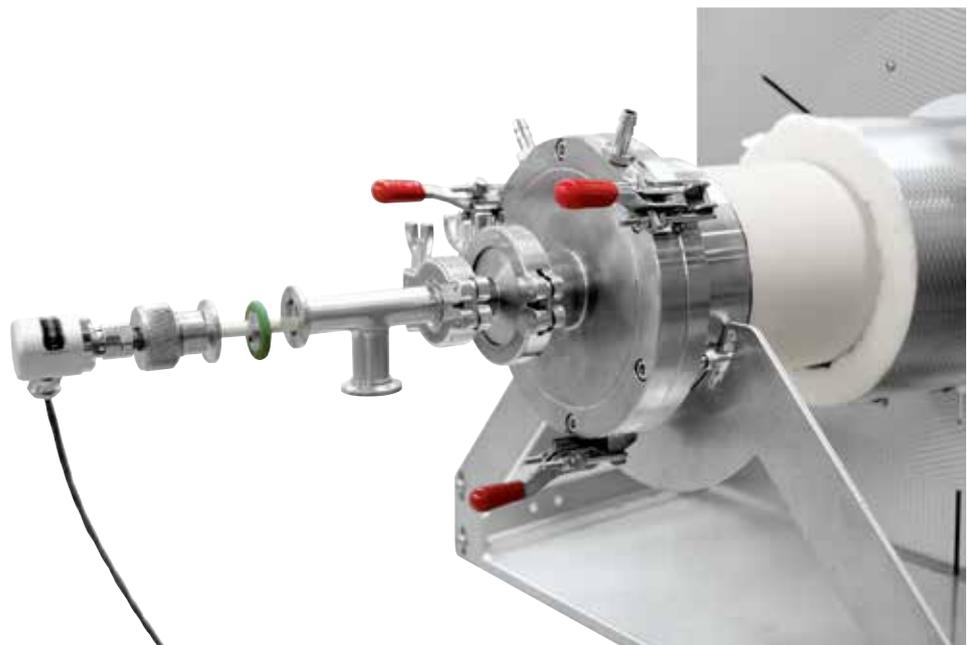
Only the furnace chamber temperature is measured and controlled. Regulation is carried out slowly to avoid out-of-range values. As the charge temperature is not measured and controlled, it may vary a few degrees from the chamber temperature.

### Charge Control

If the charge control is switched on, both the charge temperature and furnace chamber temperature are measured. By setting different parameters the heat-up and cooling processes can be individually adapted. This results in a more precise temperature control at the charge.



Sintering under hydrogen in a tube furnace of RHTH product line



Thermocouple for charge control in the RHTH 120/600/18 furnace