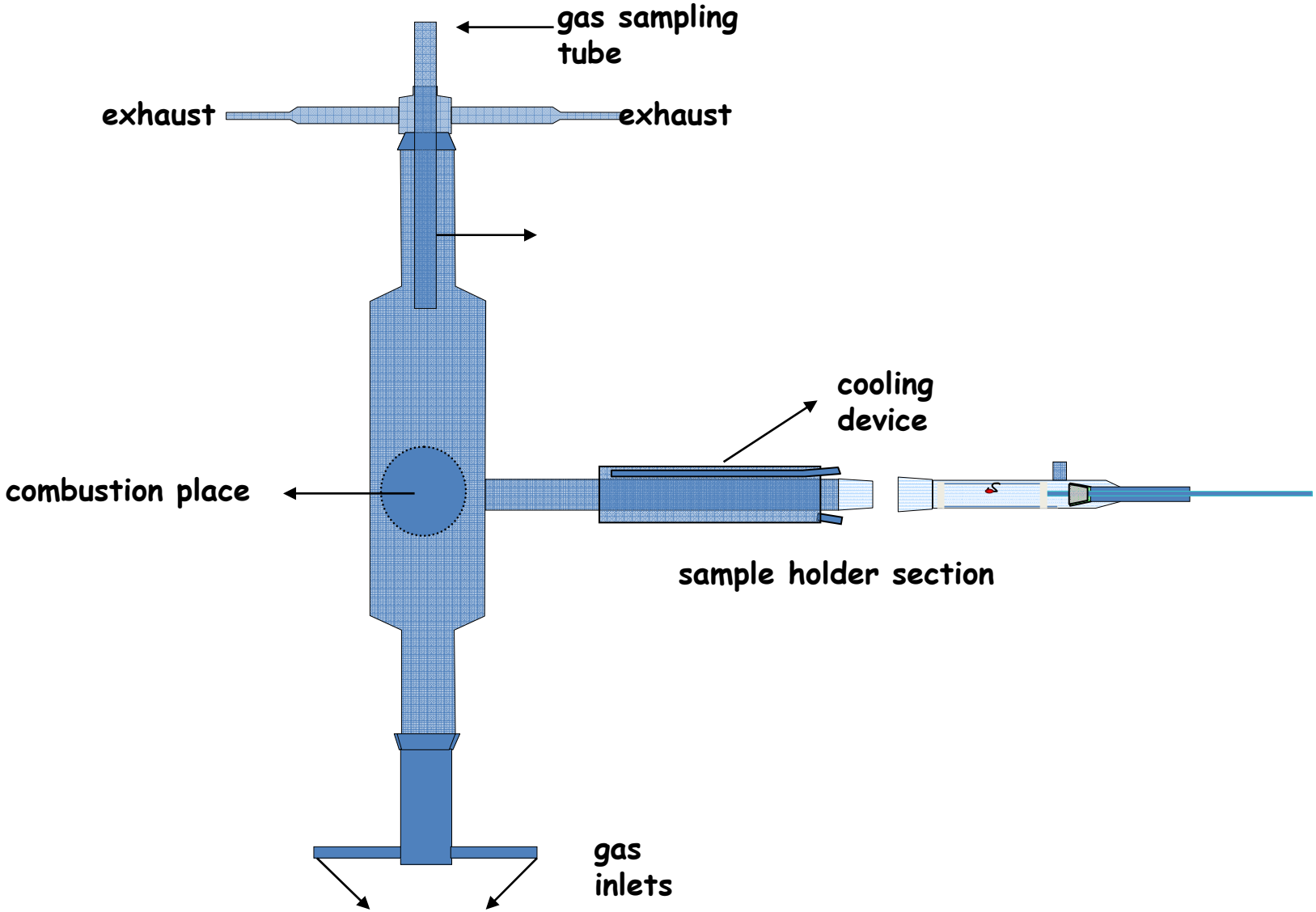
Single Droplet and Pressurized Thermogravimetric Analyzer Experiments

Nikolai DeMartini

Outline

- Uses
- Experimental Plan
- Typical data output and some comments on interpretation

Droplet Furnace



Single Droplet Reactor - Uses

- Combustion characterization for single particles
- Detailed combustion chemistry
  - Measurement of pyrolysis loss
  - Interupted droplet tests
  - Analysis of gases
- Low heating rate of sample because of relatively large size – therefore not useful for studying chemical kinetics

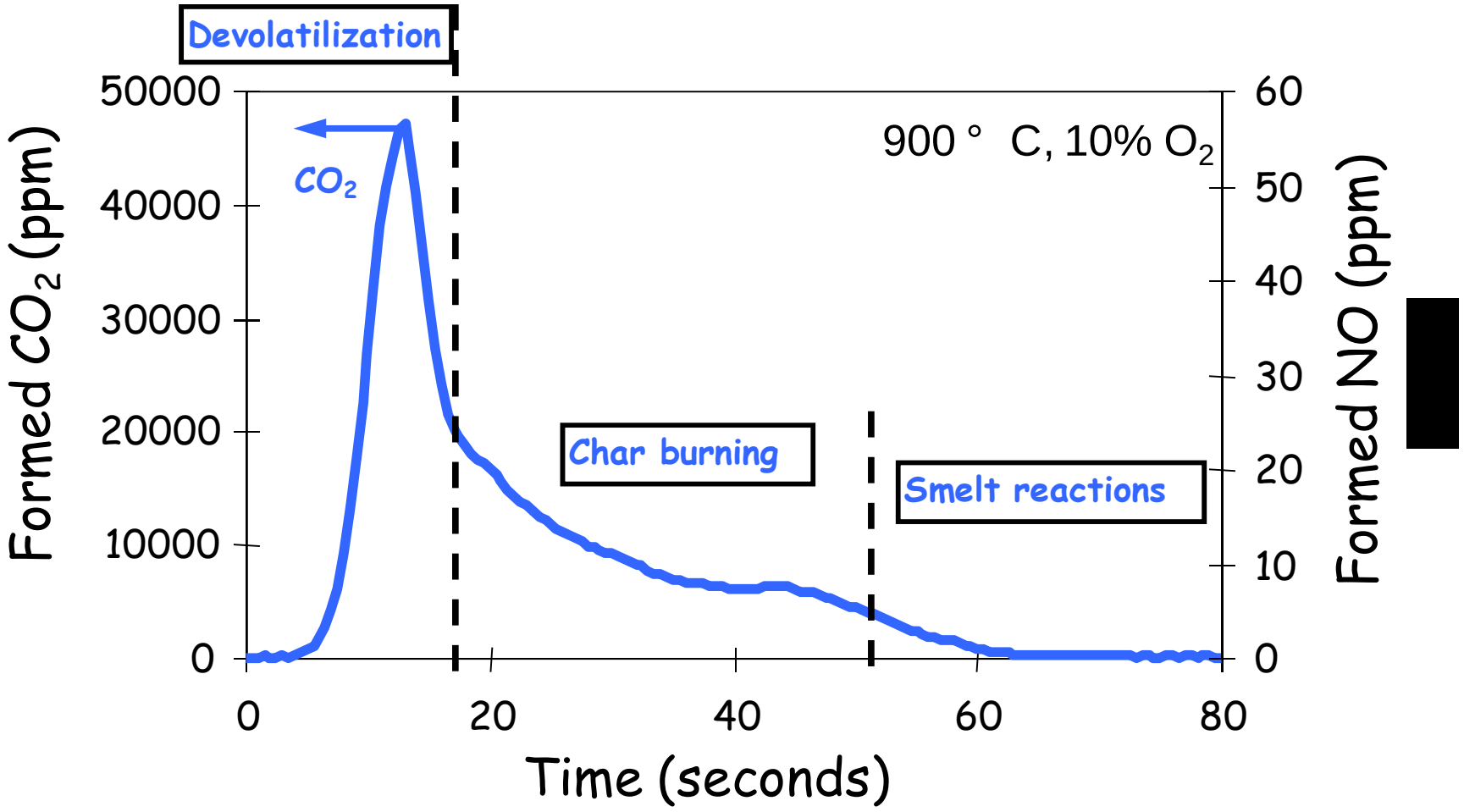
Combustion Analysis

- Digital video
- $CO+CO_2$ infrared analyzers
- SO_2 infrared analyzers
- NO chemiluminescence analyzer
- O_2 analyzer
- Catalytic converter for total reduced sulfur (TRS) and NO precursors

Duration of Combustion Stages

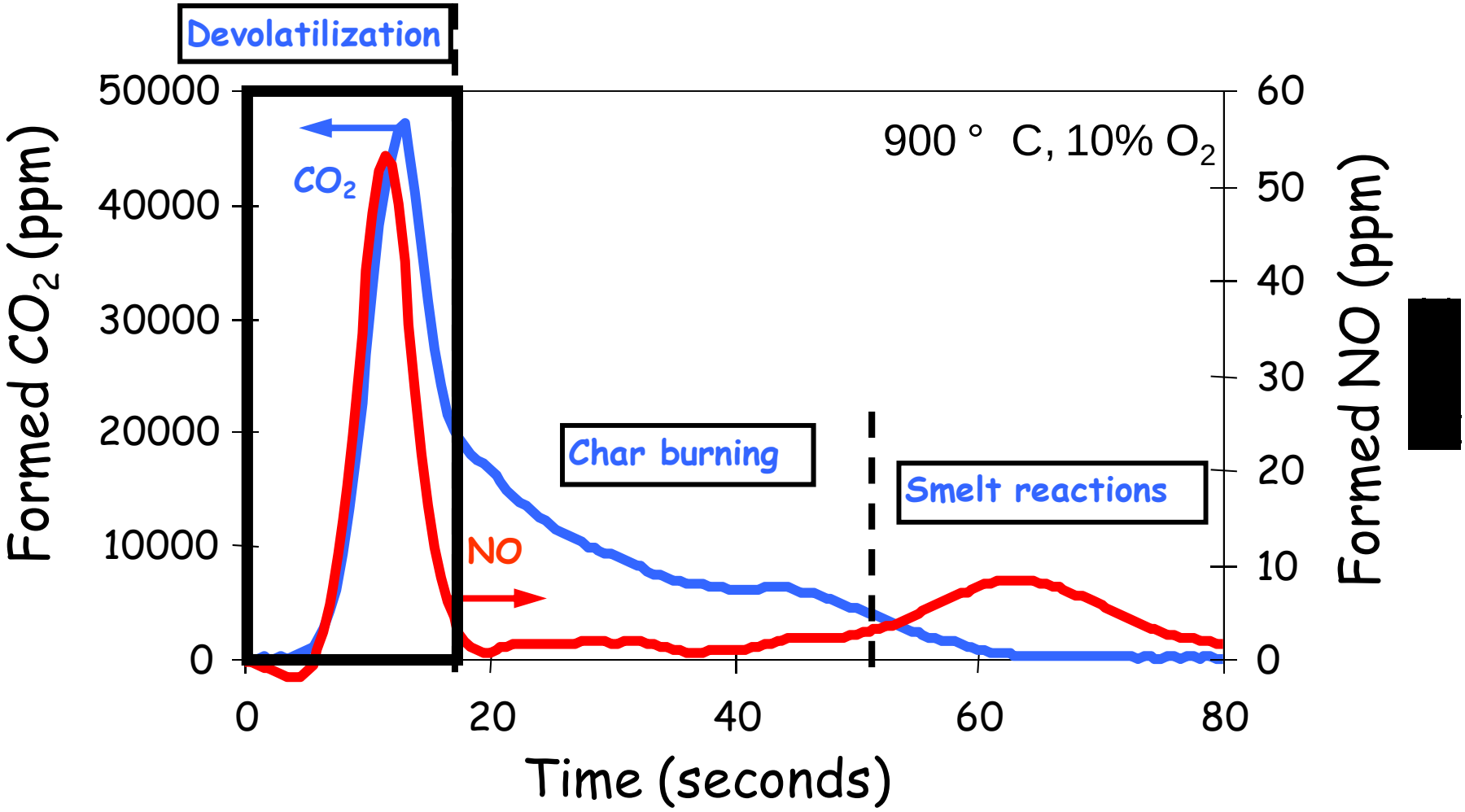
- Determined from droplet combustion videos
- Drying – time between insertion and flame
- Devolatilization – time from beginning to end of flame
- Char burning – time from end of flame to char collapse

Carbon Release – Black Liquor



Forssén et al. 2001

NO formation



Forssén et al. 2001

Experimental Plan – Single Droplet Reactor

- Bark, 1100 °C, 3 % O_2
- Wood, 1100 °C, 3% O_2
- Bark + Black Liquor, 50%/50% mixture by weight, 1100 °C, 3% O_2
- Wood + Black Liquor, 50%/50% mixture by weight, 1100 °C, 3% O_2
- Bark + Black Liquor, 50%/50% mixture by weight, 900 °C, 3% O_2

Daily Plan – Single Droplet Reactor

8:30 Reactor turned on (Luis)

9:15 Reactor at 900 °C, Calibrate Analyzers (Luis/Niklas)

9:45 Set reactor to 1100 °C and prepare samples (Luis/Niklas)

10:30 Begin burning 6 samples (students)

11:30 done, set reactor temp to 800 °C, download data (Niklas/Luis)

13:00 Increase reactor temperature to 1100 °C and prepare samples (Luis/Niklas)

13:30 Begin burning 6 samples (students)

14:30 done, turn off reactor furnace, download data (Niklas/LUis)

Experimental Plan – P-TGA

- Bark, 1000 °C, 1 bar total P, 0.2 bar CO_2/0.8 bar N_2
- Bark, 1000 °C, 1 bar total P, 0.2 bar CO_2/0.05 bar CO/0.75 bar N_2
- Bark, 1000 °C, 10 bar total P, 0.2 bar CO_2/0.05 bar CO/9.75 bar N_2
- Bark, 1000 °C, 10 bar total P, 2 bar CO_2/0.5 bar CO/7.5 bar N_2
- Bark, 1000 °C, 1 bar total P, 0.2 bar H_2O/0.05 bar H/0.75 bar N_2

Daily Plan – P-TGA

9:00 Prepare Reactor and Sample (Peter)

10:30 Gasify sample (Peter/students)

11:30 done, reduce reactor temperature download data (Peter)

13:00 Increase reactor temperature, prepare sample (Peter)

13:45 Begin gasifying sample (Peter/students)

14:45 done, turn off heater, download data (Peter)

Pressurized Thermogravimetric Analyzer (P-TGA)

- Temp up to
- Pressure up to

P-TGA - Uses

- Gives mass signal
- Has high heating rate for samples
- Used for studying kinetics of
  - Char gasification/oxidation
  - Adsorption reactions (such as SO_2 adsorption by limestone or dolomite for example)
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