Monitoring the combustion process directly on the grate of Municipal Solid Waste Incinerators

Jean-Pierre Schosger & Jiri Martinec

The Combustion Layer Sensor history and background

- knowledge of the combustion process

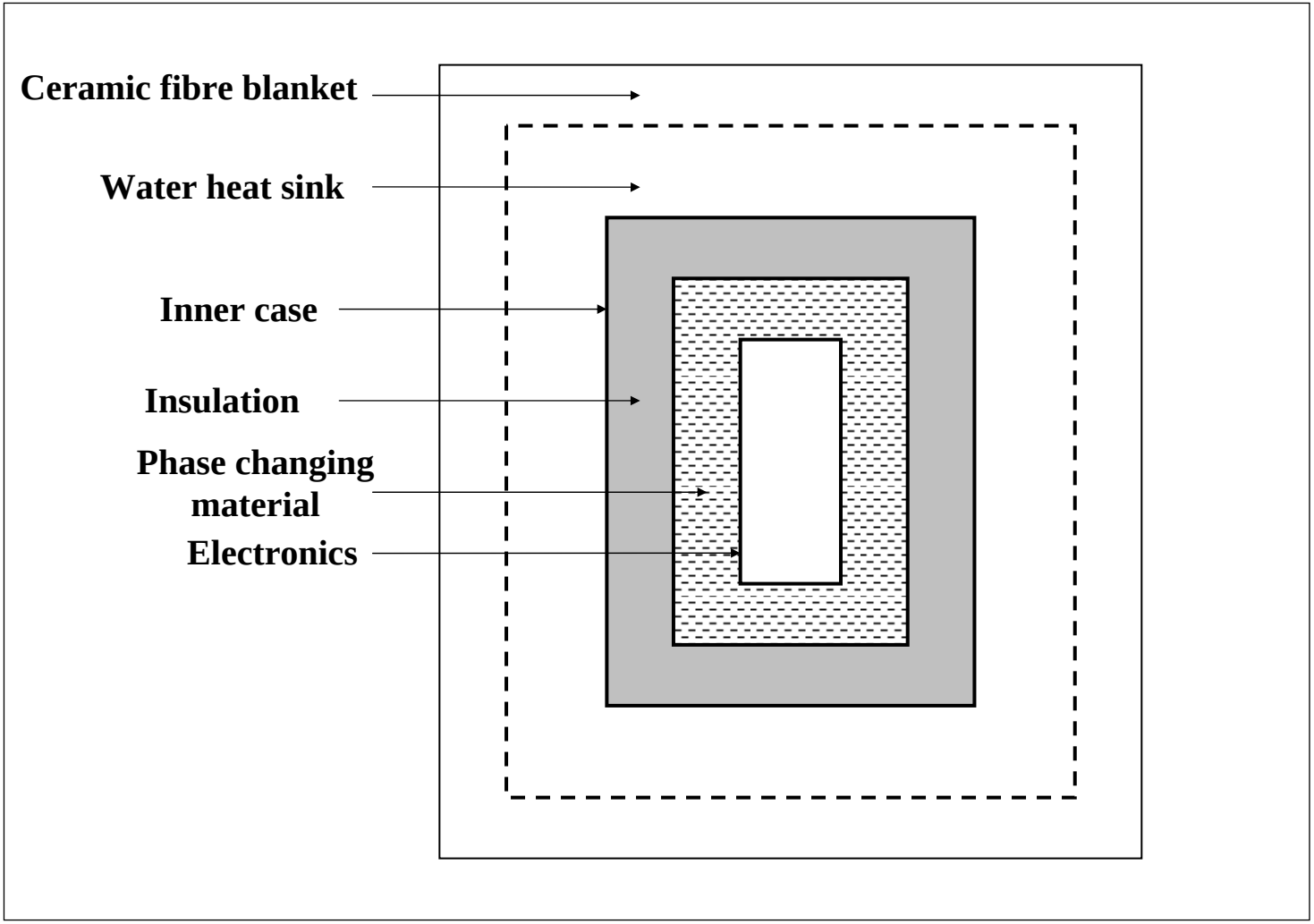
- the origin of the measuring instrument is at the Sheffield University Waste Incineration Centre (SUWIC), measurement of the external temperature and oxygen.

- further development within a PhD (J. Martinec).

- successful experimental trials with CO concentration measurement.

- new ideas for development after the data evaluation.

The main structure of the instrument

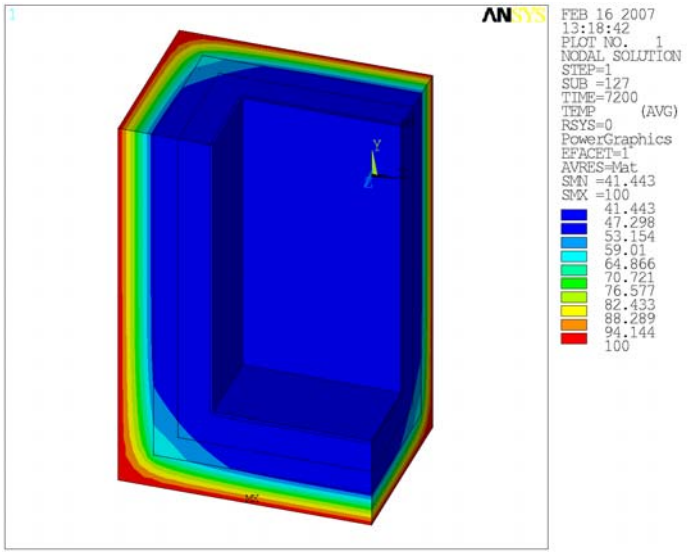


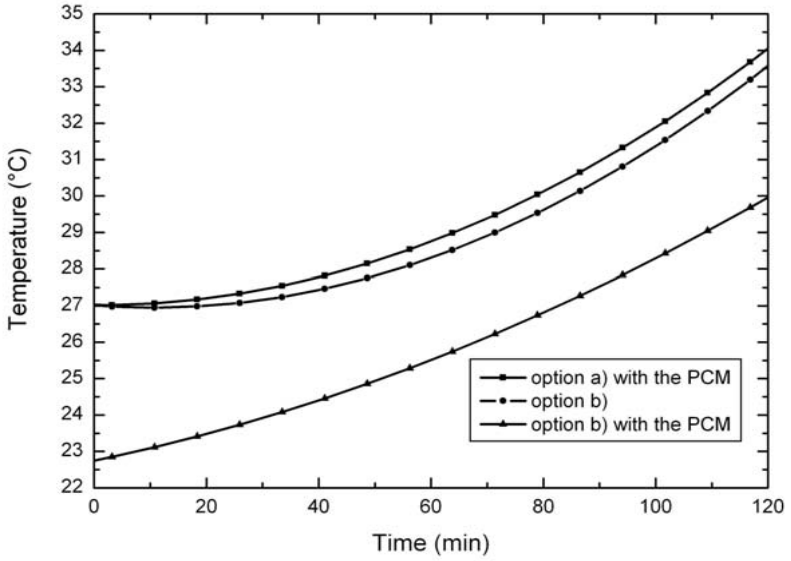
The thermal protection of the instrument

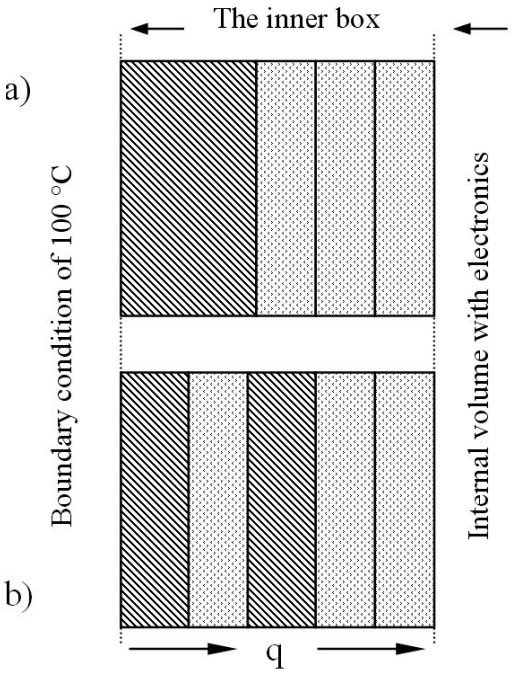
- high external temperature of the incineration process (maximum temperatures higher than 1200 °C, duration up to three hours, etc.).
- the need of keeping the internal temperature under some level (defined by the operating temperature of the used components).
- previous concept of the thermal protection.

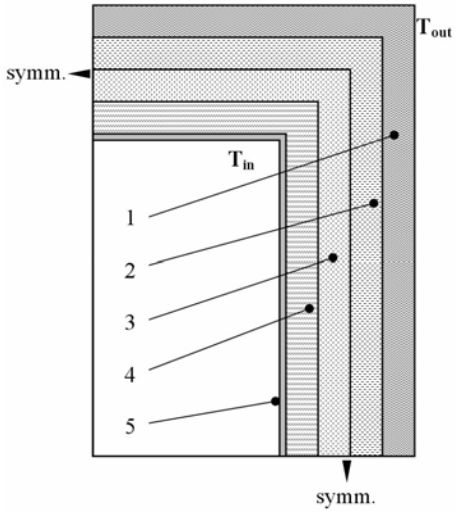
Definition of the thermal "challenges"

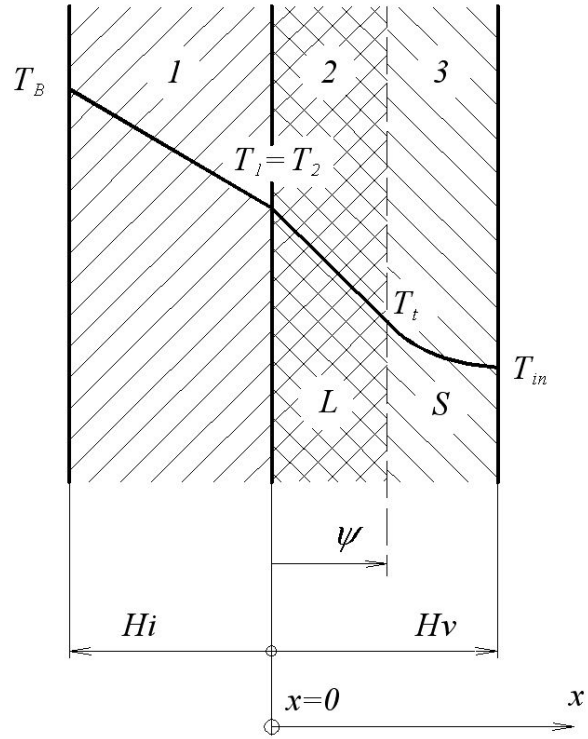
- decreasing the the thermal conductivity (using materials with the low conductivity coefficient)
- storing the heat within the system.
- protecting the inner volume against heat from the flue gas sample.
- improving the protection by theoretical simulations and comparing it with the experimental tests.

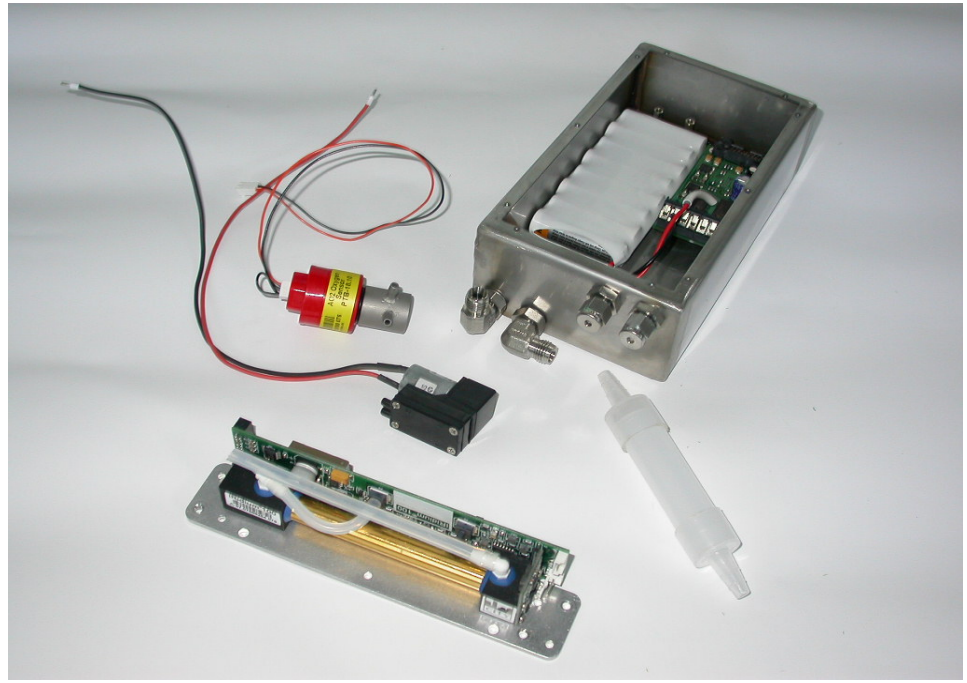

ANSYS
FEB 16 2007
13:18:42
PLOT NO. 1
NODAL SOLUTION
STEP=1
SUB =127
TIME=7200
TEMP (AVG)
RSYS=0
PowerGraphics
EFACET=1
AVRES=Mat
SMN =41.443
SMX =100
41.443
47.298
53.154
59.01
64.866
70.721
76.577
82.433
88.289
94.144
100

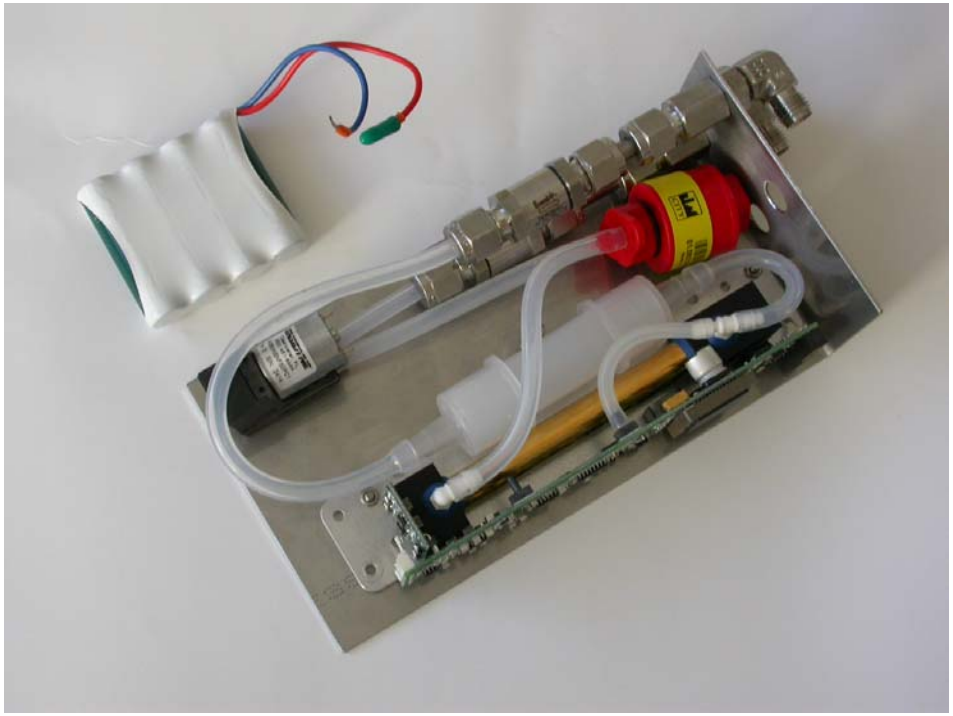

Temperature (°C)
Time (min)
option a) with the PCM
option b)
option b) with the PCM

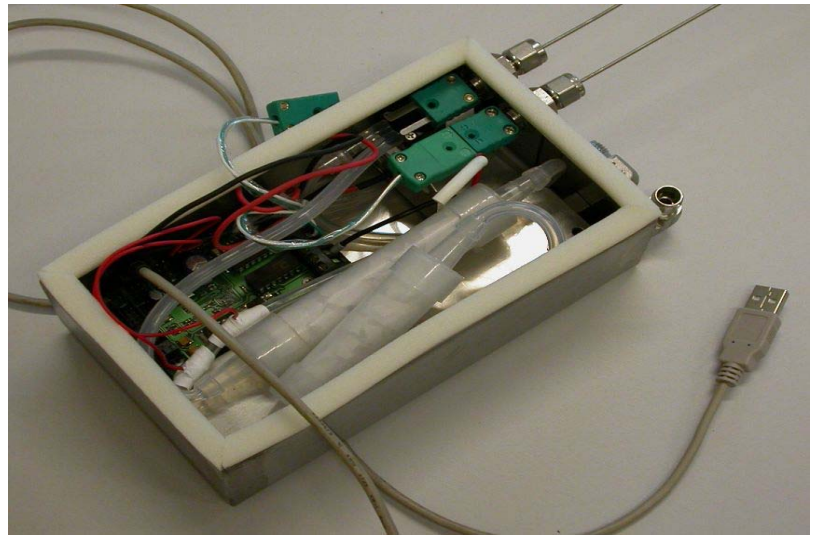

a)
b)
The inner box
The innermost box
Boundary condition of 100 °C
Internal volume with electronics
q

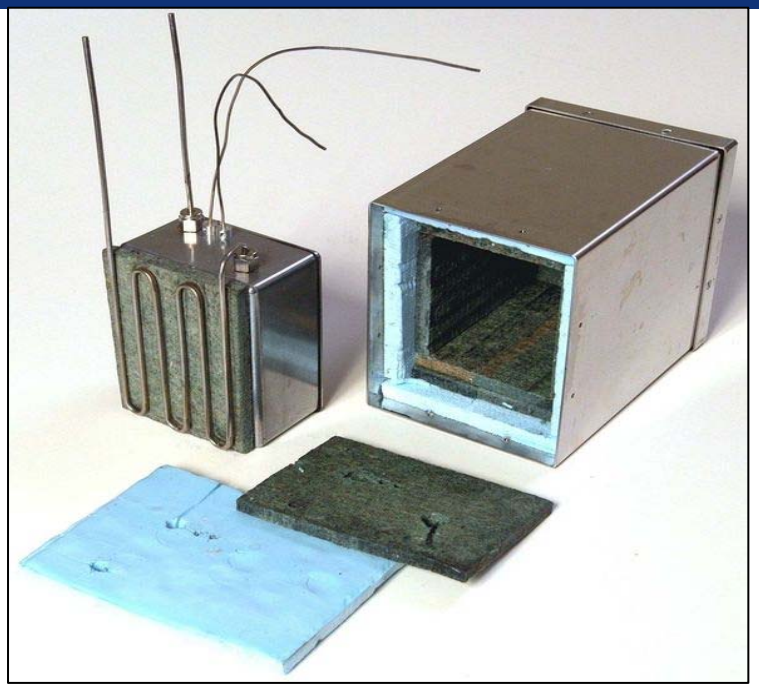

symm.
T_out
T_in
1
2
3
4
5
symm.

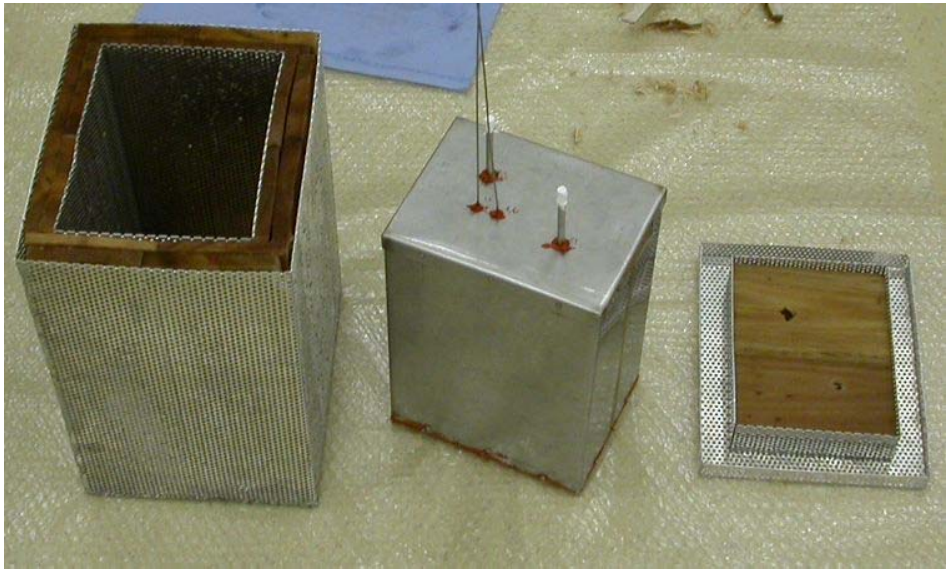

- polystyrene
- PCM
T_B
1
2
3
T_1 = T_2
T_t
T_in
L
S
ψ
Hi
Hv
x=0
x





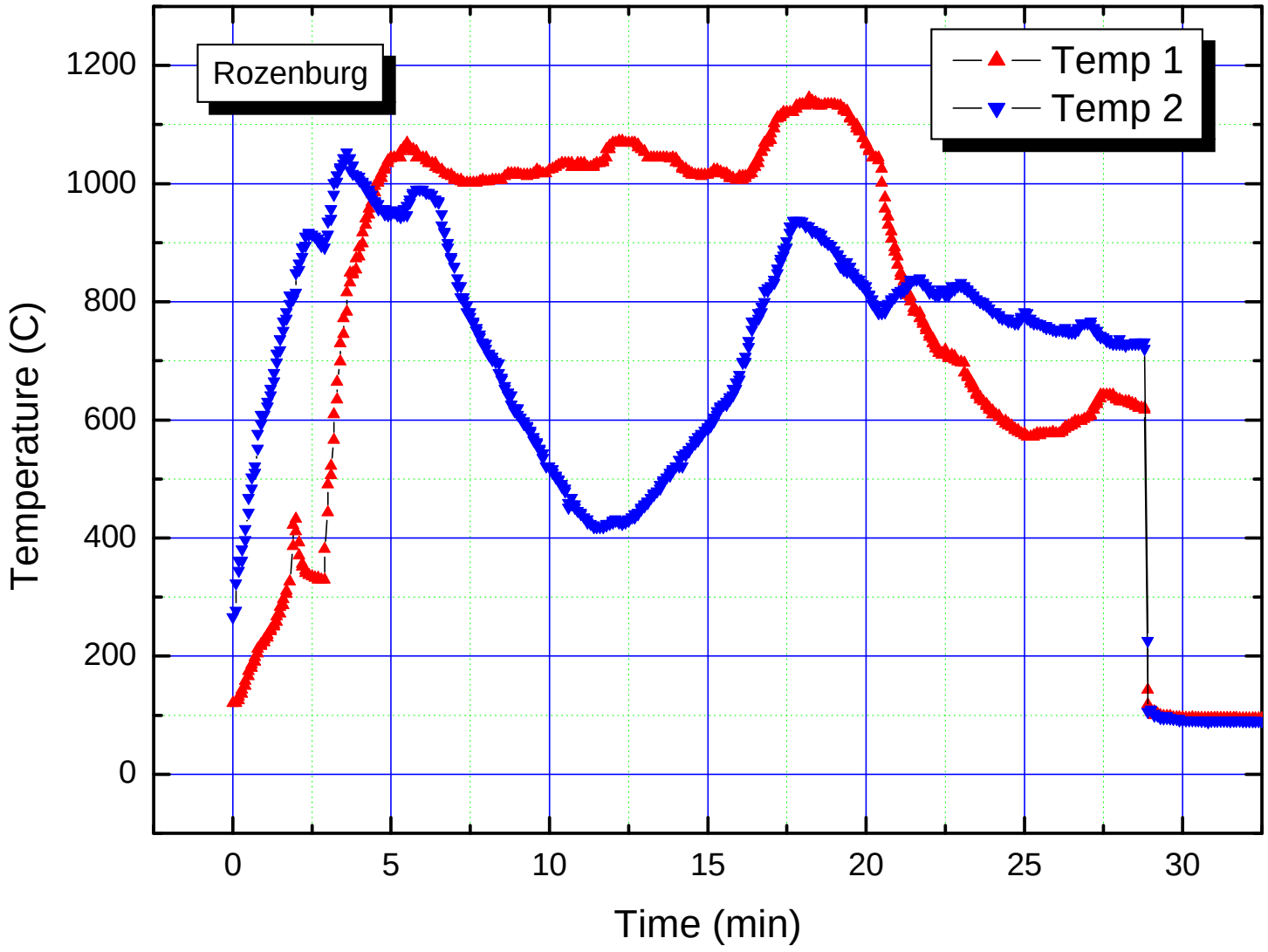


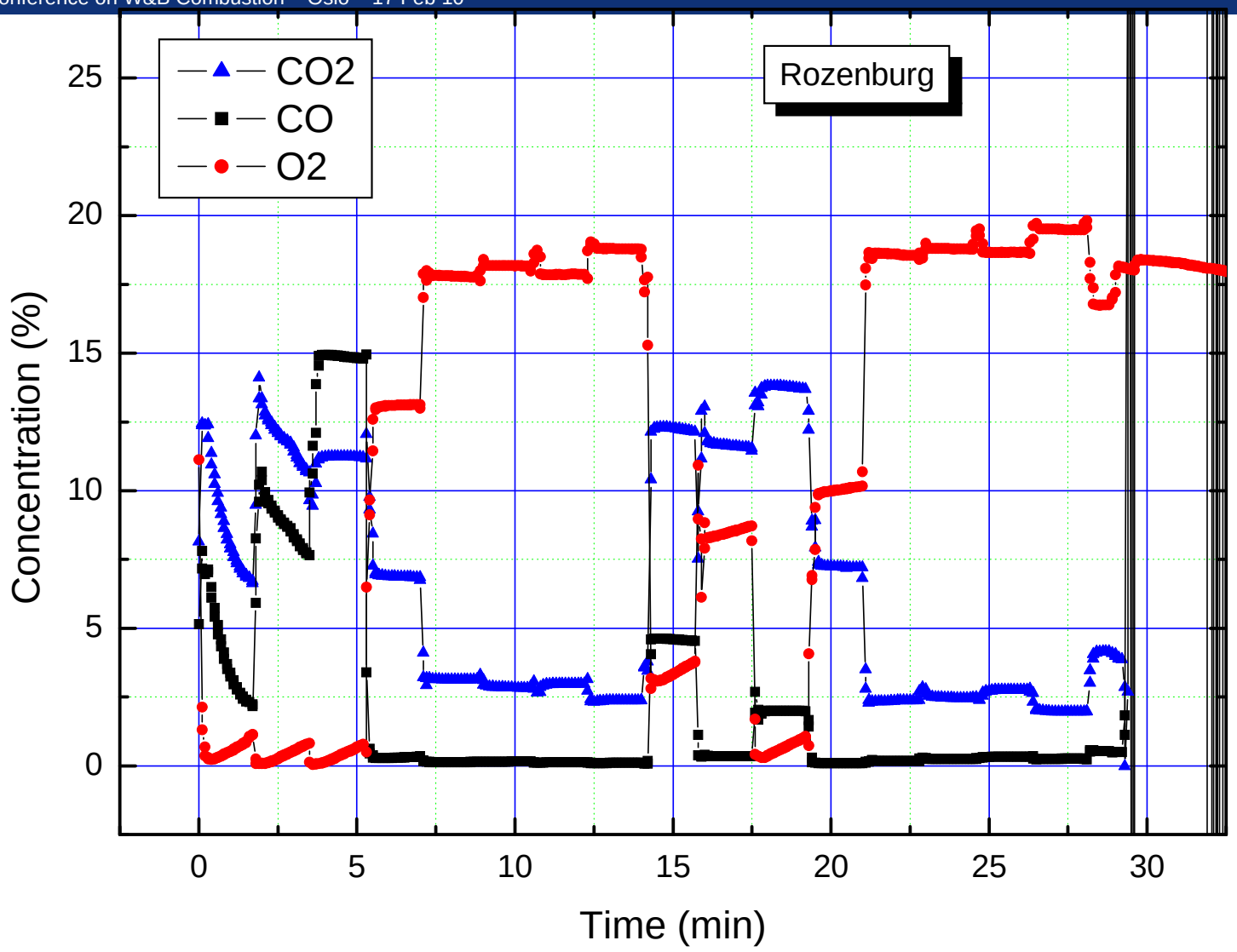


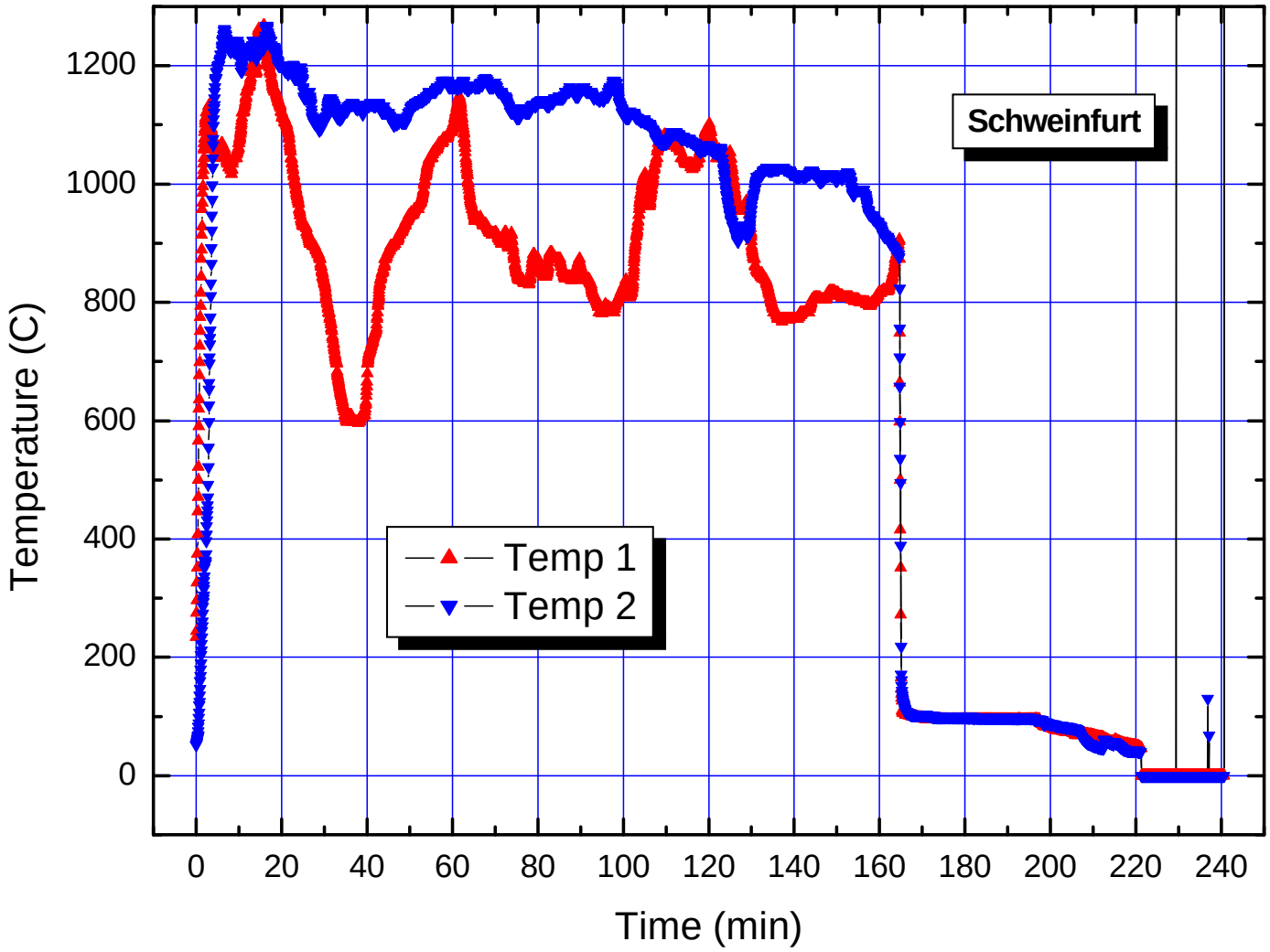


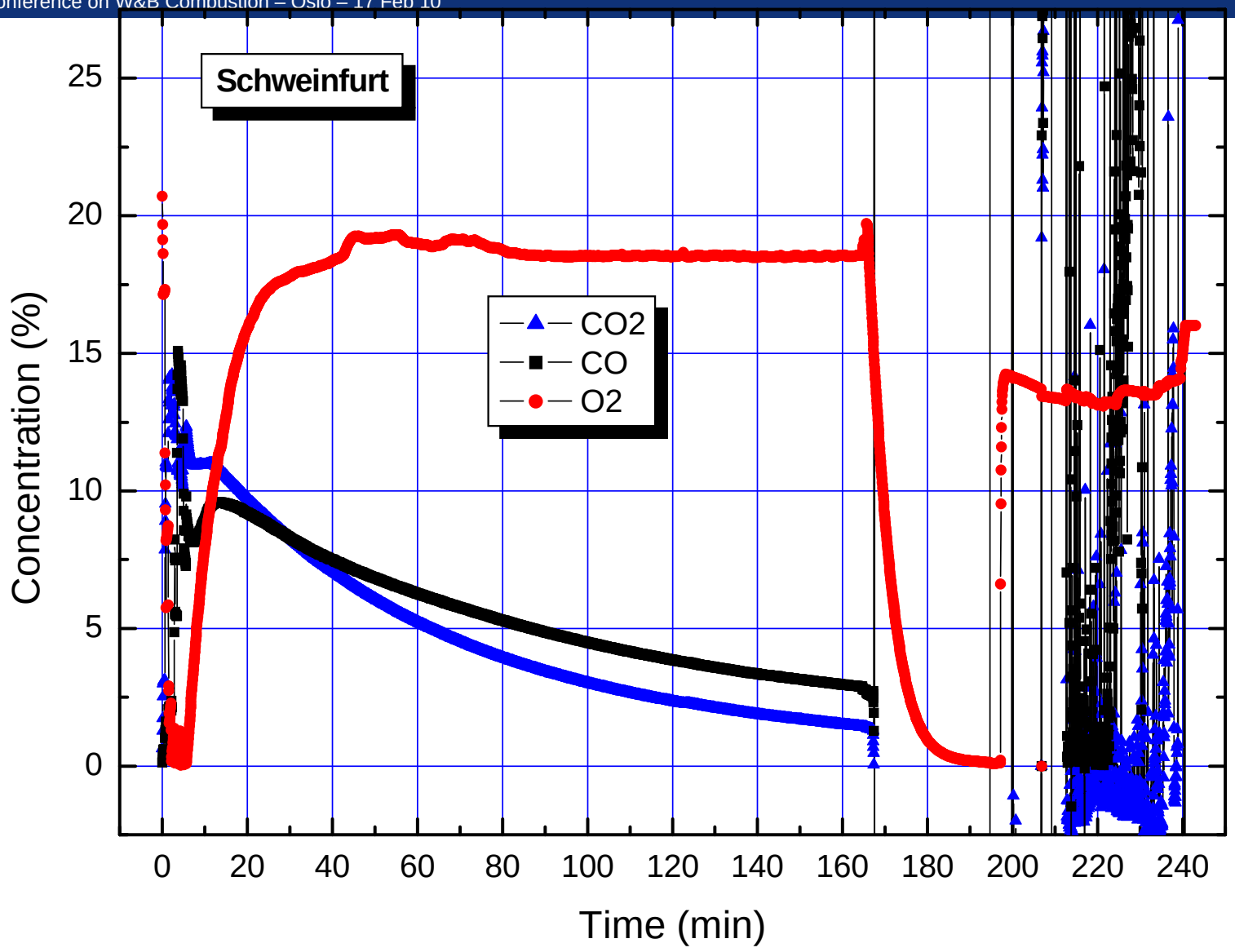
A full-scale demonstration of the CLS

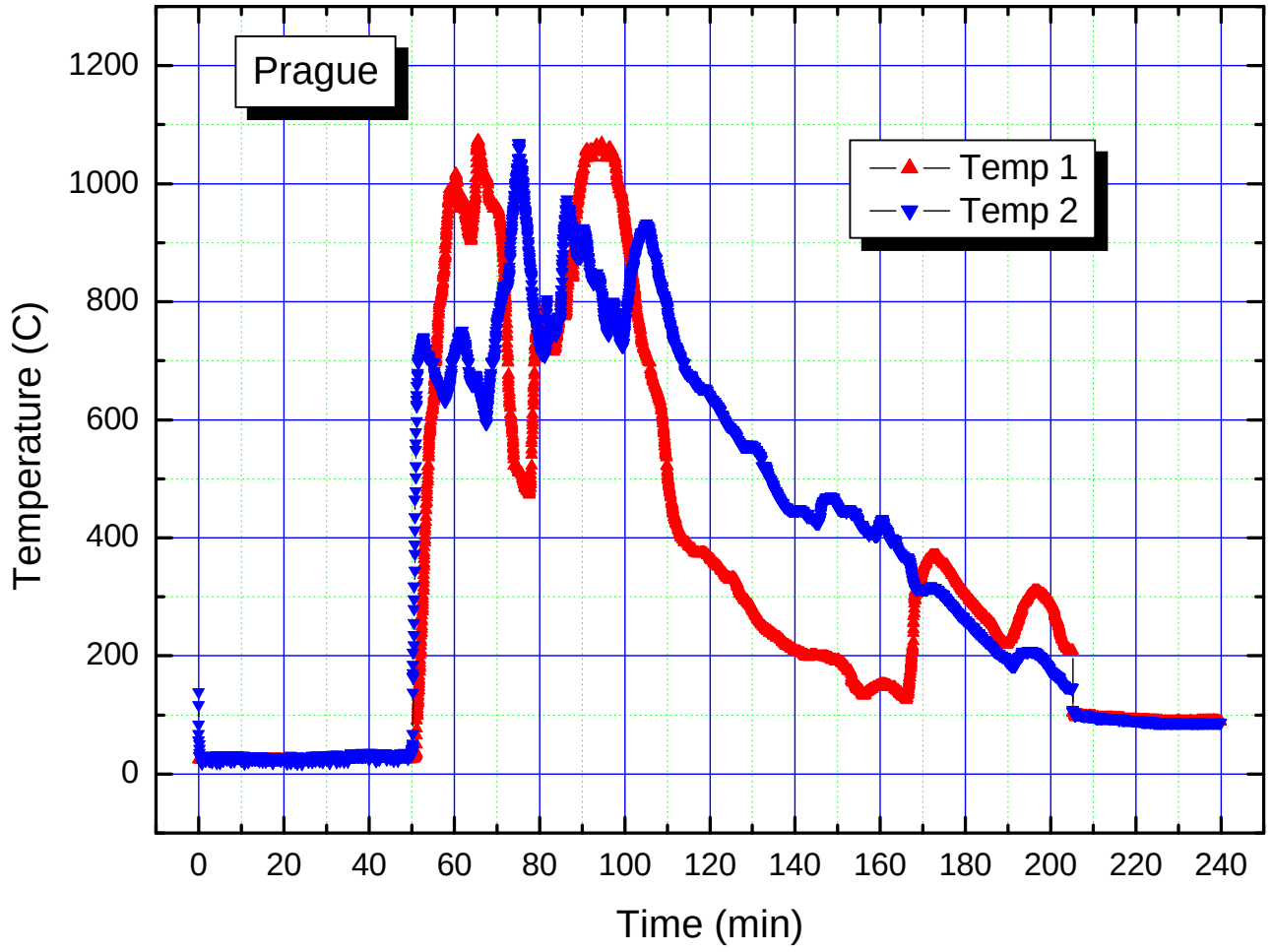
- Rozenburg (NL)
- Amsterdam (NL)
- Schweinfurt (D)
- Praha (CZ)

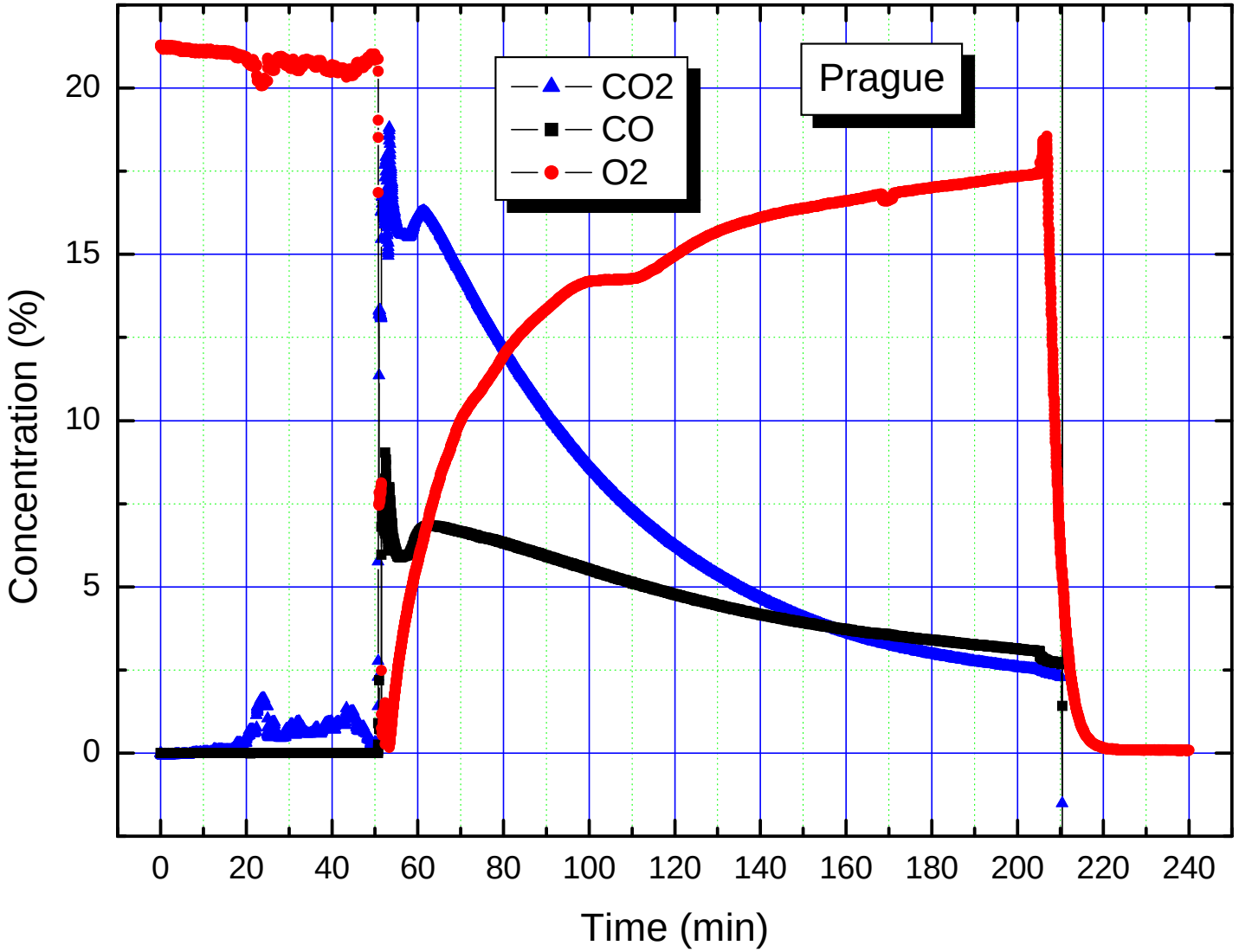

Rozenburg
Temp 1
Temp 2
Temperature (C)
Time (min)
0
200
400
600
800
1000
1200
0
5
10
15
20
25
30


CO2
CO
O2
Rozenburg
Concentration (%)
Time (min)
0
5
10
15
20
25
30


Schweinfurt
Temp 1
Temp 2
Temperature (C)
Time (min)
0
200
400
600
800
1000
1200
0
20
40
60
80
100
120
140
160
180
200
220
240


Schweinfurt
CO2
CO
O2
Concentration (%)
Time (min)
0
5
10
15
20
25
0
20
40
60
80
100
120
140
160
180
200
220
240


Prague
Temp 1
Temp 2
Temperature (C)
Time (min)
0
200
400
600
800
1000
1200
0
20
40
60
80
100
120
140
160
180
200
220
240


Prague
CO2
CO
O2
Concentration (%)
Time (min)
0
5
10
15
20
0
20
40
60
80
100
120
140
160
180
200
220
240

Second series of measurements

- Qualification tests of Version III (on-line monitoring)
- In collaboration with KEMA (Ash analyses)
- Test at EUROPARK/Coevorden (NL/D) and in Twence (NL)

Test at EUROPARK Coevorden

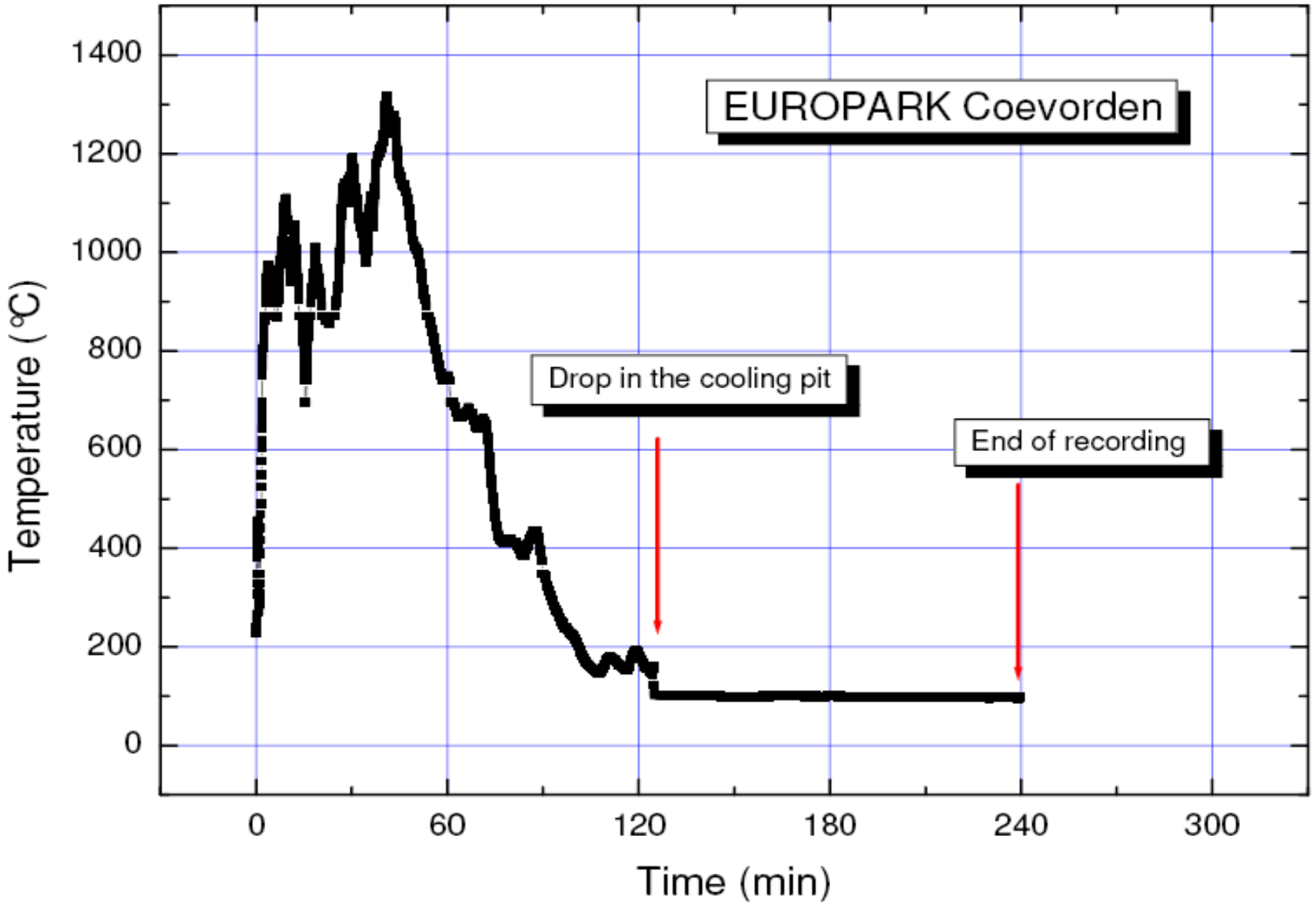
Test at EUROPARK Coevorden

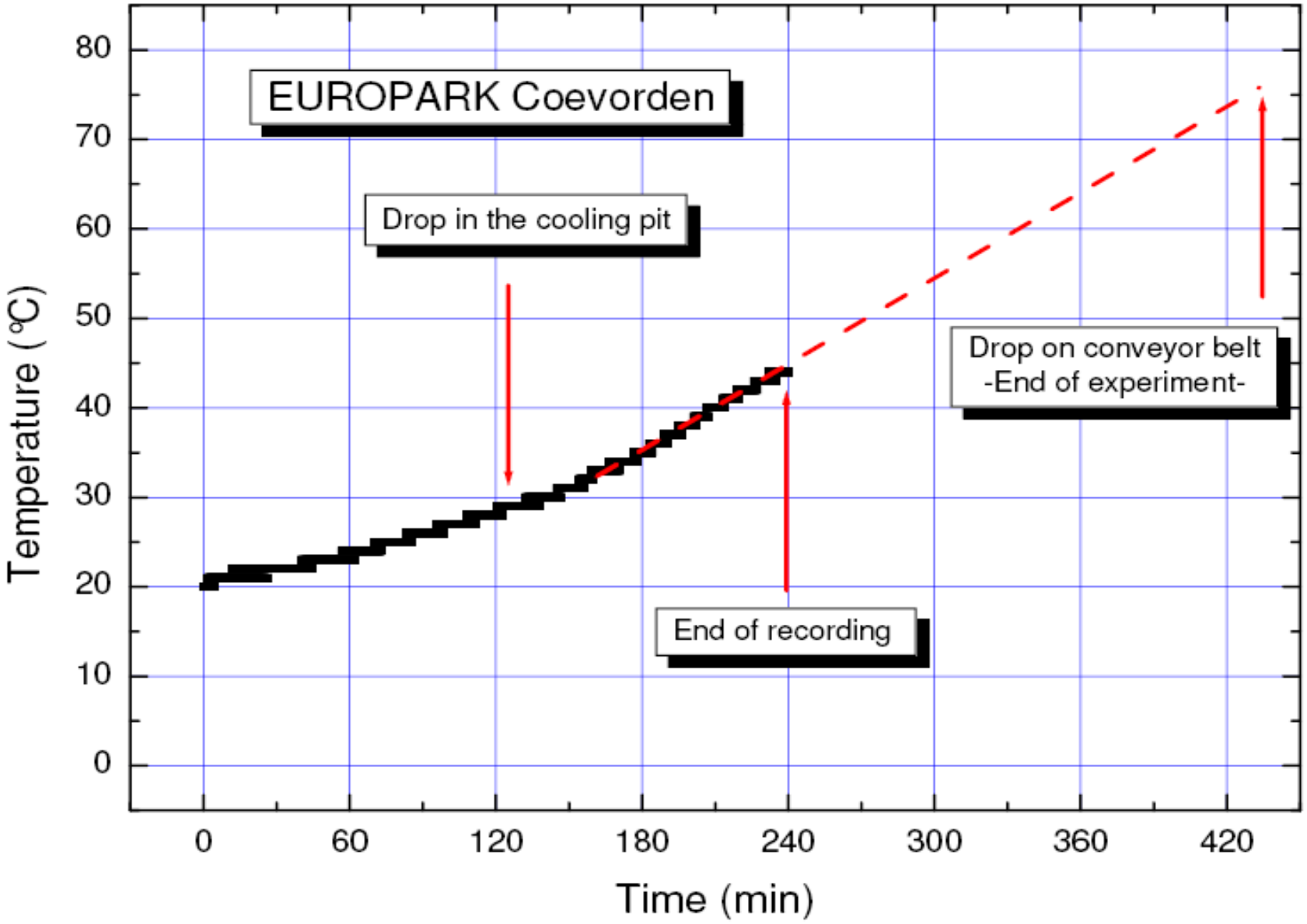
Extreme conditions (worst seen):

- Residence time in the hopper: 1 hour and 15 minutes
- Residence time on the grate: 2 hours
- Residence time in ash cooling: 5 hours and 15 minutes

Total duration: 8 hours and 30 minutes

Test at EUROPARK Coevorden

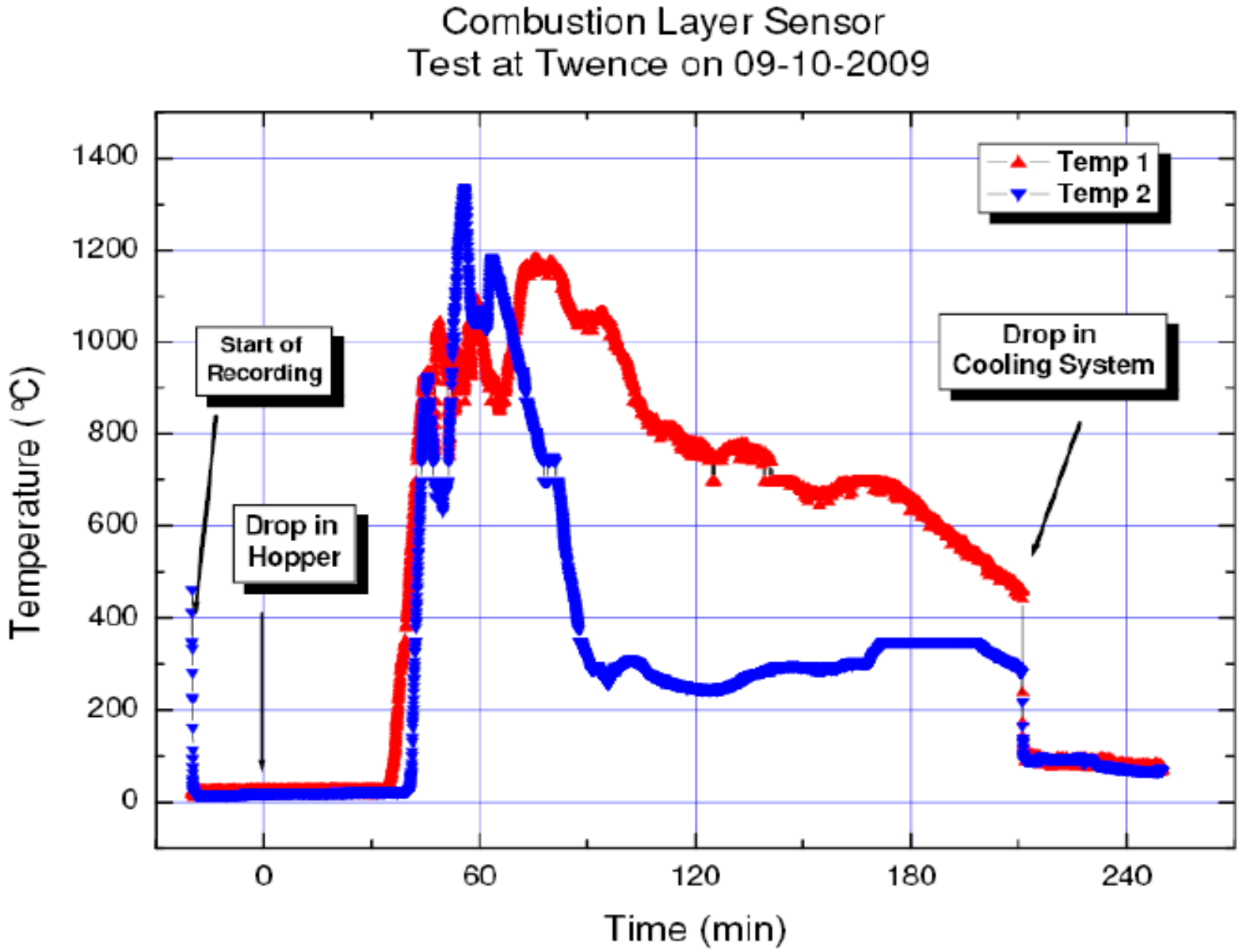

EUROPARK Coevorden
Drop in the cooling pit
End of recording
Temperature (°C)
Time (min)
0
200
400
600
800
1000
1200
1400
0
60
120
180
240
300

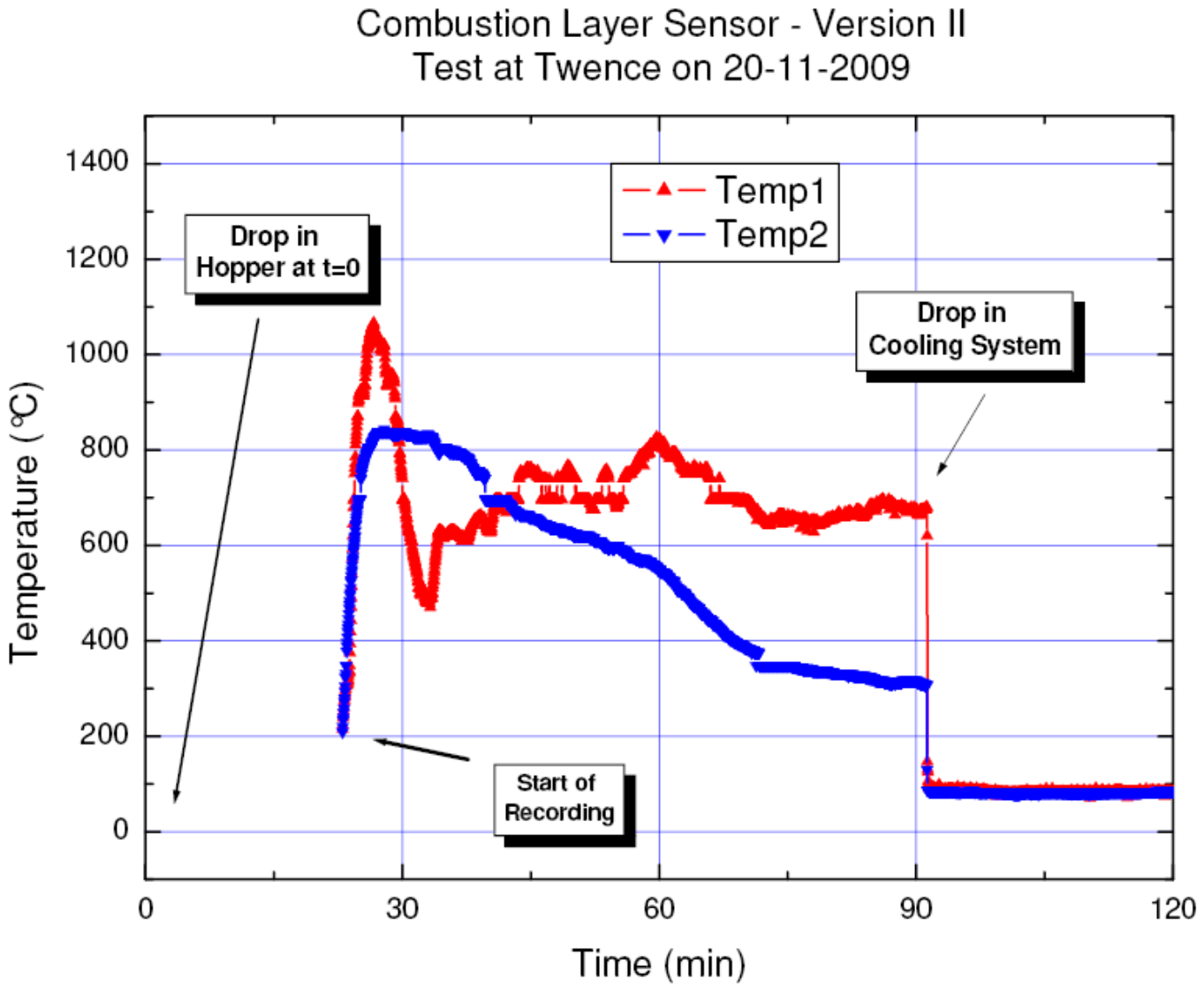

EUROPARK Coevorden
Drop in the cooling pit
Drop on conveyor belt
-End of experiment-
End of recording
Temperature (°C)
Time (min)
0
10
20
30
40
50
60
70
80
0
60
120
180
240
300
360
420

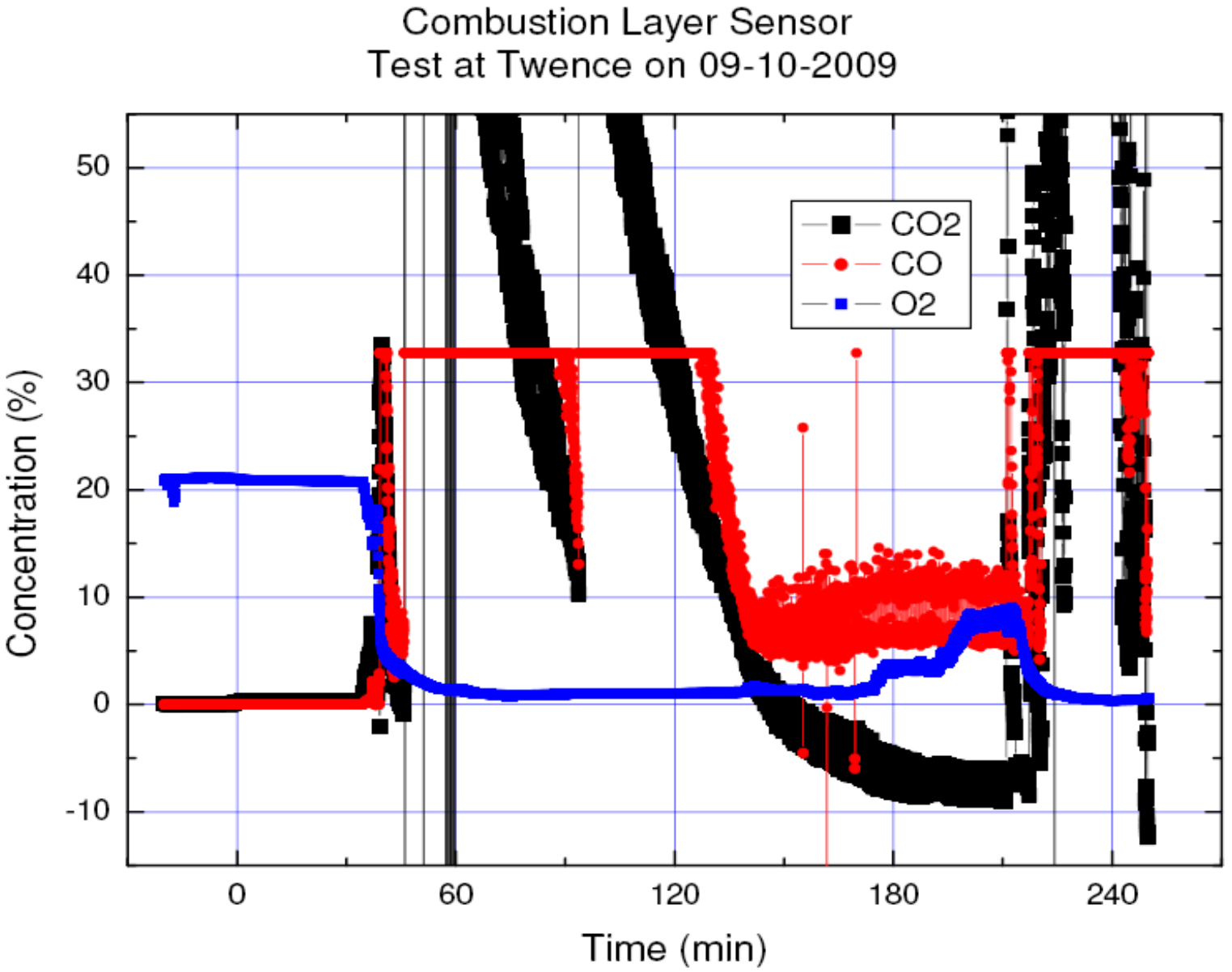
Tests at Twence

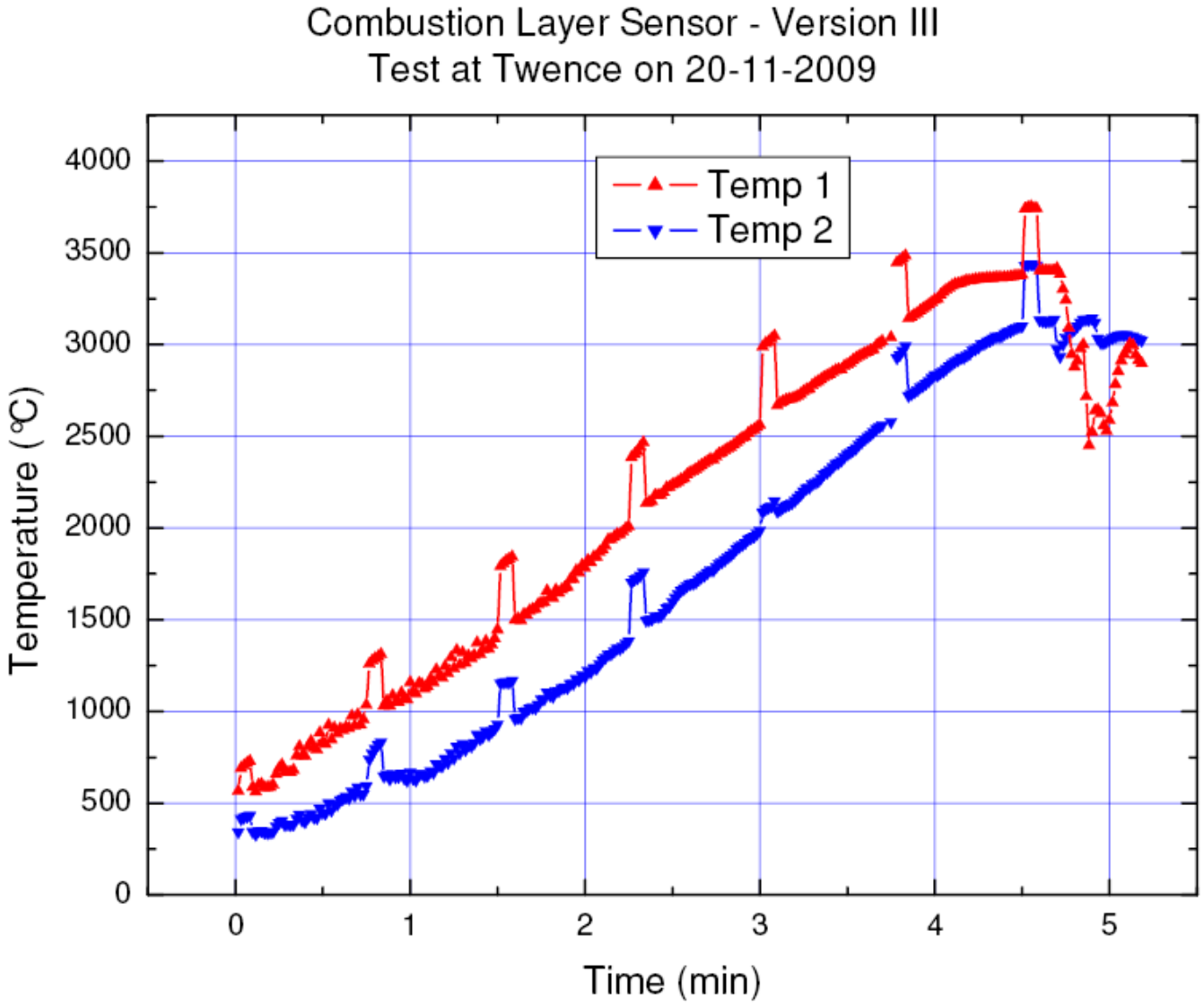
Version II
test on 09-10-09
Line 1

Version II and III
Two tests on 20-11-09
Lines 1 and 3


Combustion Layer Sensor
Test at Twence on 09-10-2009
Temp 1
Temp 2
Start of Recording
Drop in Hopper
Drop in Cooling System
Temperature (°C)
1400
1200
1000
800
600
400
200
0
0
60
120
180
240
Time (min)


Combustion Layer Sensor - Version II
Test at Twence on 20-11-2009
Temp1
Temp2
Drop in Hopper at t=0
Drop in Cooling System
Start of Recording
Temperature (°C)
Time (min)
0
200
400
600
800
1000
1200
1400
0
30
60
90
120


Combustion Layer Sensor
Test at Twence on 09-10-2009
Concentration (%)
50
40
30
20
10
0
-10
0
60
120
180
240
Time (min)
CO2
CO
O2


Combustion Layer Sensor - Version III
Test at Twence on 20-11-2009
Temp 1
Temp 2
Temperature (ºC)
Time (min)
0
500
1000
1500
2000
2500
3000
3500
4000
0
1
2
3
4
5

Conclusions and further development

- application of the sensor for Temperature measurement has been proved
- application of the sensor for carbon monoxide, carbon dioxide and oxygen concentration measurement has been proved but remains fragile
- Qualification of Version III
- Other tests in the incinerators (Duiven)

Thank you very much

for

your attention !