

New Approach to analyze cement hydration data using TAM Air



4th European Cement Calorimetry Conference
Dresden 2018

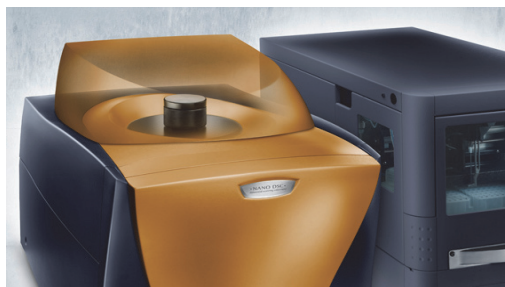


Microcalorimetry Product Line



MCDSC

NanoDSC - AS



8 Channel



3 Channel

TAM Air

NanoITC
Std Vol & Low Vol



Affinity ITC AS



TAM IV / 48

History of TAM Air

1st TAM Air

- 8 channels
- Data logging
- 5-60 ° C
- External steady state calibration

2000

3rd TAM Air

5-90 ° C

2005

3-channel calorimeter block

2010

5th TAM Air

- New design

Software
Cement Analysis

2015

2nd TAM Air

Internal steady
state calibration

Admix ampoule
for early reactions

4th TAM Air

- TAM Air Assistant
- Internal pulse calibration



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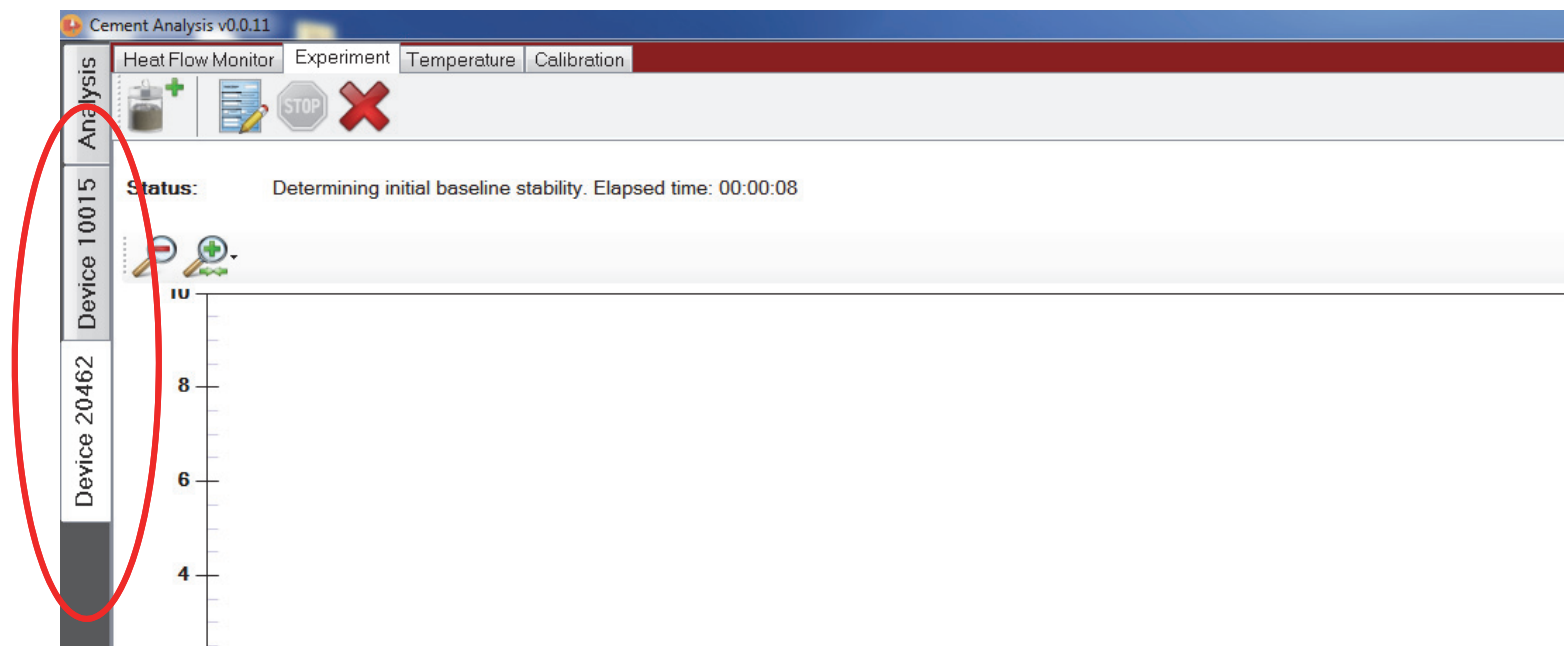
Cement Analysis Software



Released soon... Expected for Q1/19



Connect to Multiple Calorimeters



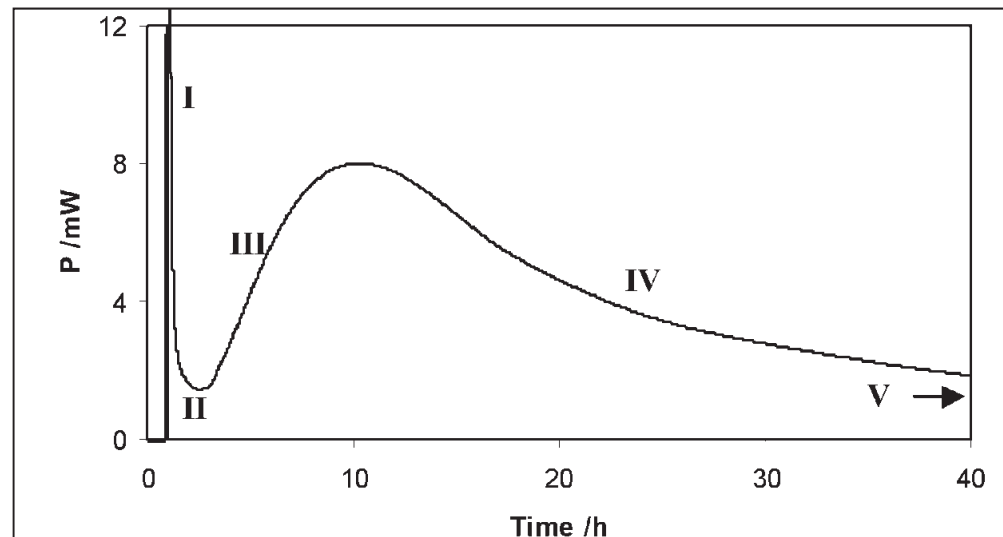
Easily connects to multiple TAM AIR units, older with Omron controller and new Discovery Style TAM AIR

Cement Hydration (Portland)

Dr. Sandberg, Grace Construction Products, US (2002)

The hydration process undergoes a number of phases (*Young, 1985*)

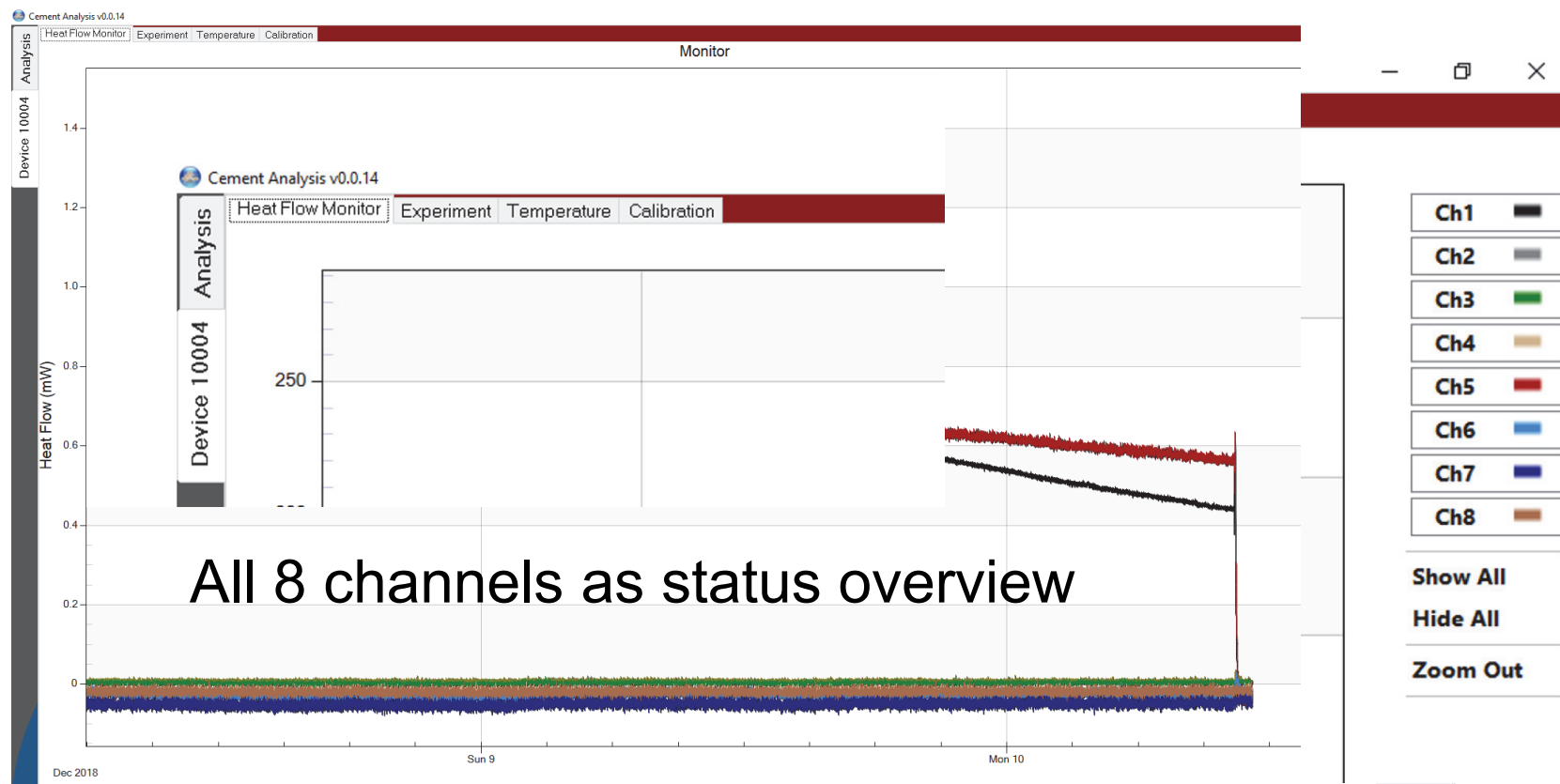
- (I) Rapid initial processes
- (II) Dormant period
- (III) Acceleration period
- (IV) Retardation period
- (V) Long term reactions



The phases has been described in more detail (*Sandberg, 2002*)

- (I) Dissolution of ions and initial hydration
- (II) Formation of ettringite
- (III) Initiation of silicate hydration
- (IV) Depletion of sulphate

Real-time Monitor All Channels



Calibration



Completed in TAM Assistant. Cement Analysis automatically imports values

Cement Analysis v0.0.14

Heat Flow Monitor Experiment Temperature Calibration

Analysis

Device 10004

Calibration Gains

☒ Current

Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

☐ Custom

Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

You can adjust values 'custom' if channels are run with an admix accessory.

Start A New Experiment

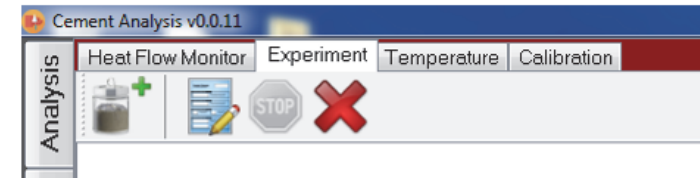


Experiment Name: Experiment 2

Folder: C:\Users\ApsLab\Documents

Operator: cfq

OK Cancel



Choose where to save
the data

Select the channels.
Channels already running
experiments are greyed
out

Choose one or more calorimeters:

☐ 1 ☒ 2 ☒ 3 ☒ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8

Select All Available

Enter Sample Information at Any Time



Sample Information Editor

Channel: 1 Normalization Units: [dropdown]

Sample Total

Total mass: [text] g ☐ Use Total mass to normalize data

Name: [text]
ID: [text]
Additional Info: [text]

Component

[dropdown] [unit dropdown] ☐ Use this component to normalize data

Mass: [text]
Name: [text]
ID: [text]
Physical Shape: [text]
Preparation: [text]
Additional Info: [text]

Cancel OK

Select what parameter to normalize data to (units & component)

Quick Component Setup

Name	Units	Ch1 Amount	Ch2 Amount	Ch5 Amount	Ch6 Amount
Cement	g				
Water	g				
Aggregate	g				
SO ₂	g				
SCM 1	g				
SCM 2	g				
Admixture 1	g				
Admixture 2	g				

Table already populated with common components

Add New Component OK Cancel

Collect baselines



Cement Analysis v0.0.14

Heat Flow Monitor Experiment Temperature Calibration

Analysis

Device 10004

Baseline Information

Initial Baseline

Stability Conditions: Moderate Maximum Time (min): 120

Baseline Duration (min): 30

Experiment Main

Collection Time (hr): Leave blank for indefinite.

☒ Final Baseline

Stability Conditions: Moderate Maximum Time (min): 120

Baseline Duration (min): 30

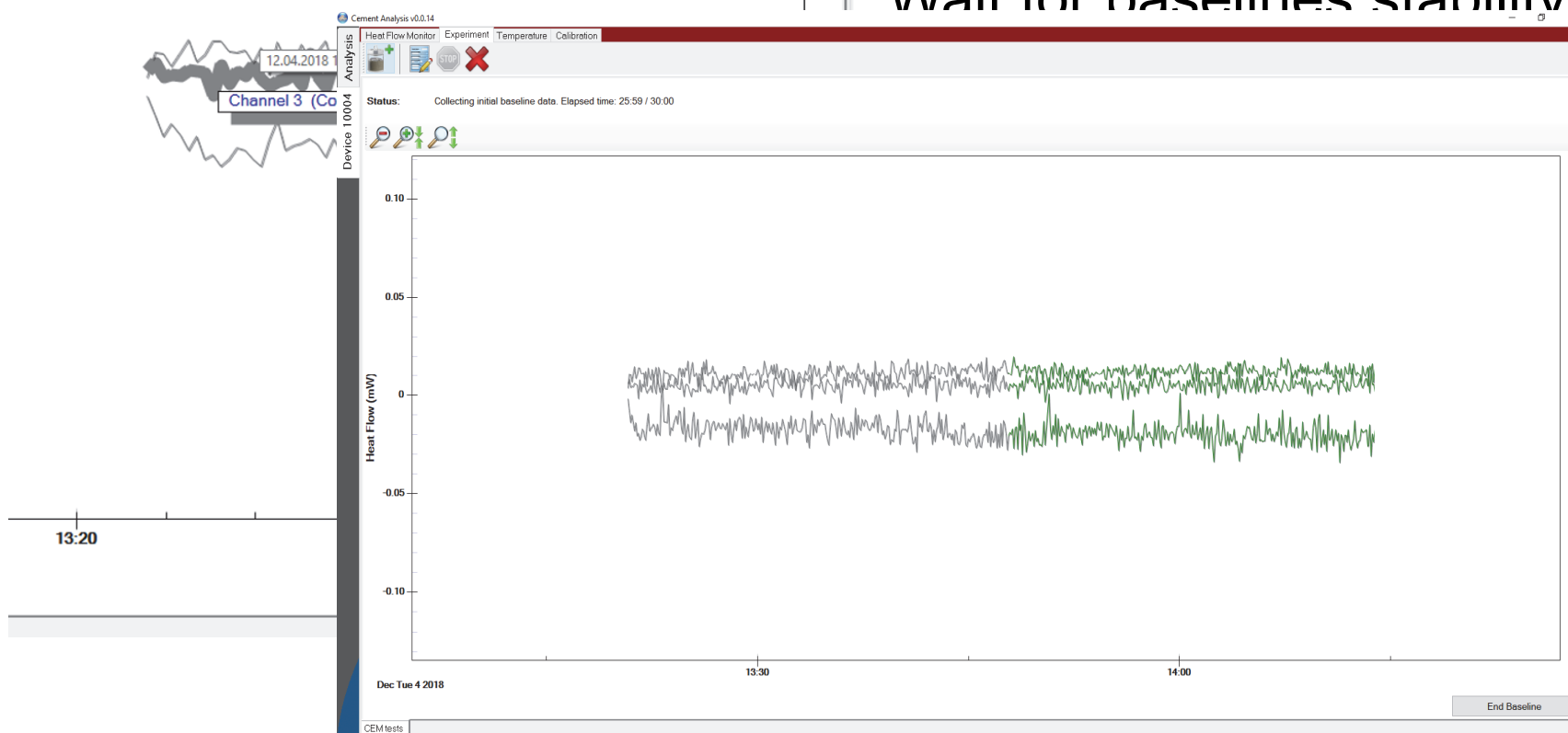
Decide about
baselines once

Decide about specific
experimental duration

Collect baselines



Wait for baselines stability



Let Software Track Times



Cement Analysis v0.0.14

Heat Flow Monitor Experiment Temperature Calibration

Analysis

Device 10004

Mix Start Times

Make sure to click on a Now button immediately after lowering the ampoule into the measuring position.

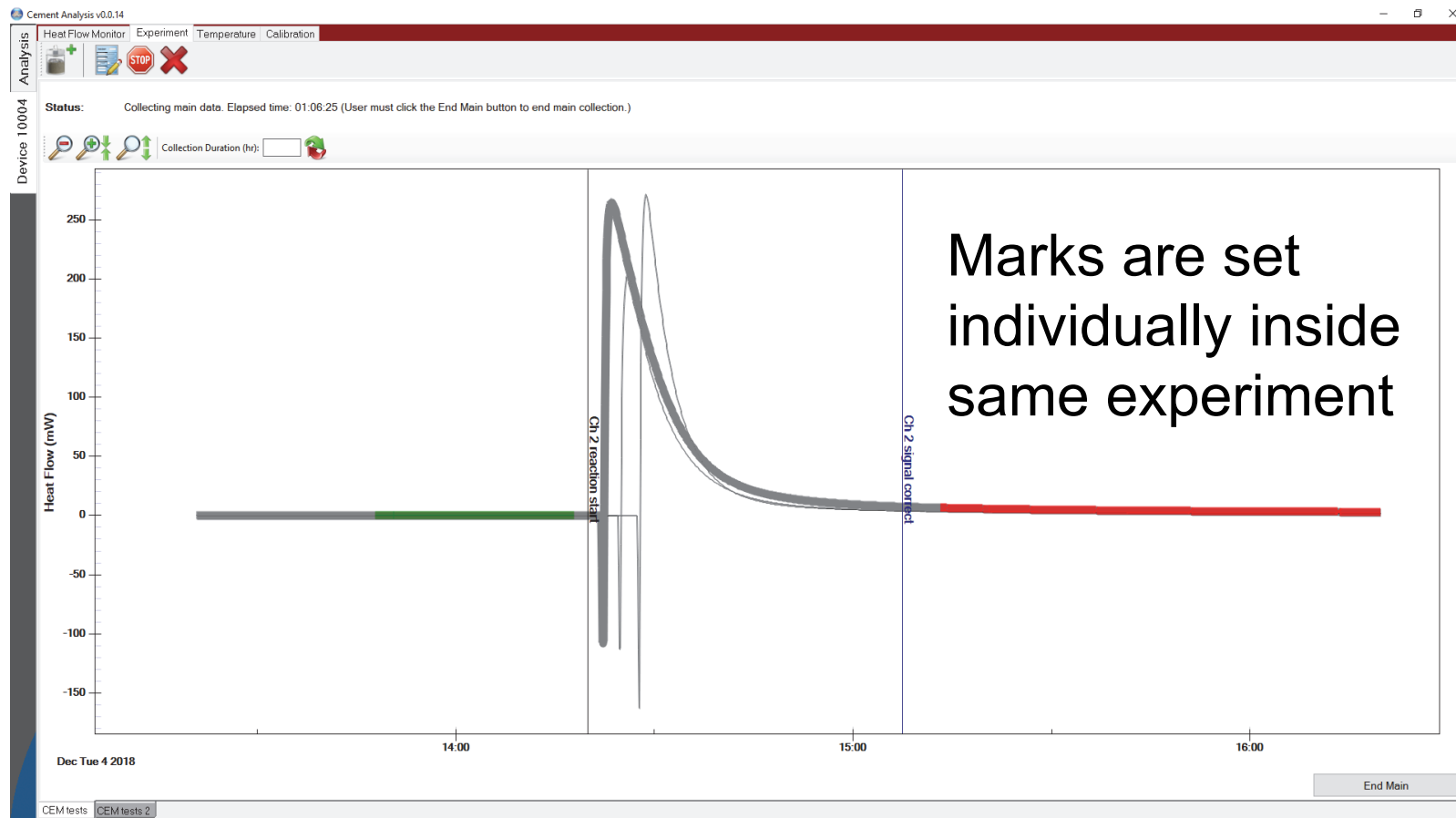
Channel 2 mixing was before 14:22:29 00:05:27

Channel 3 mixing was

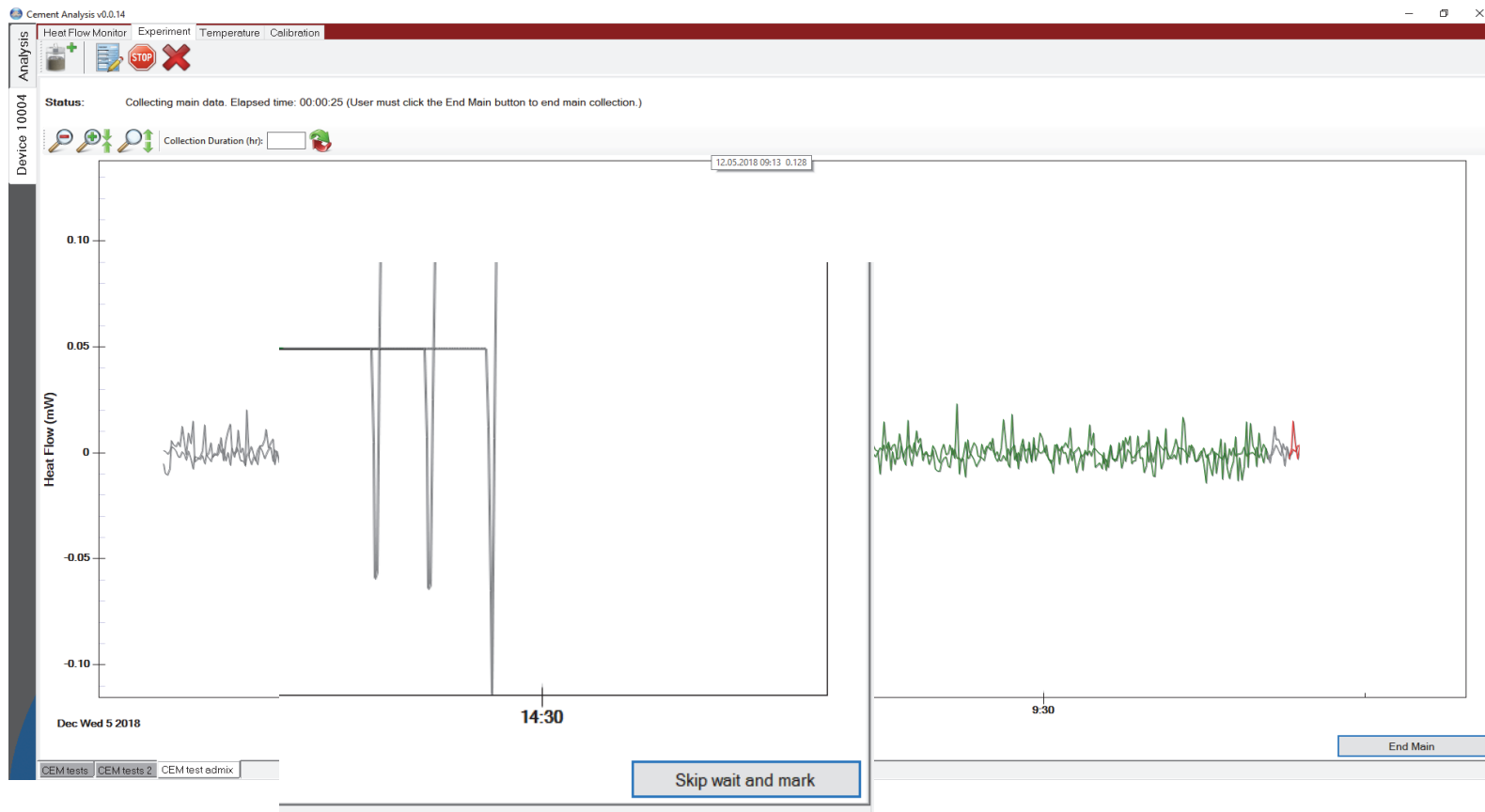
Channel 4 mixing was before 14:24:57 00:03:01

before Now 00:00

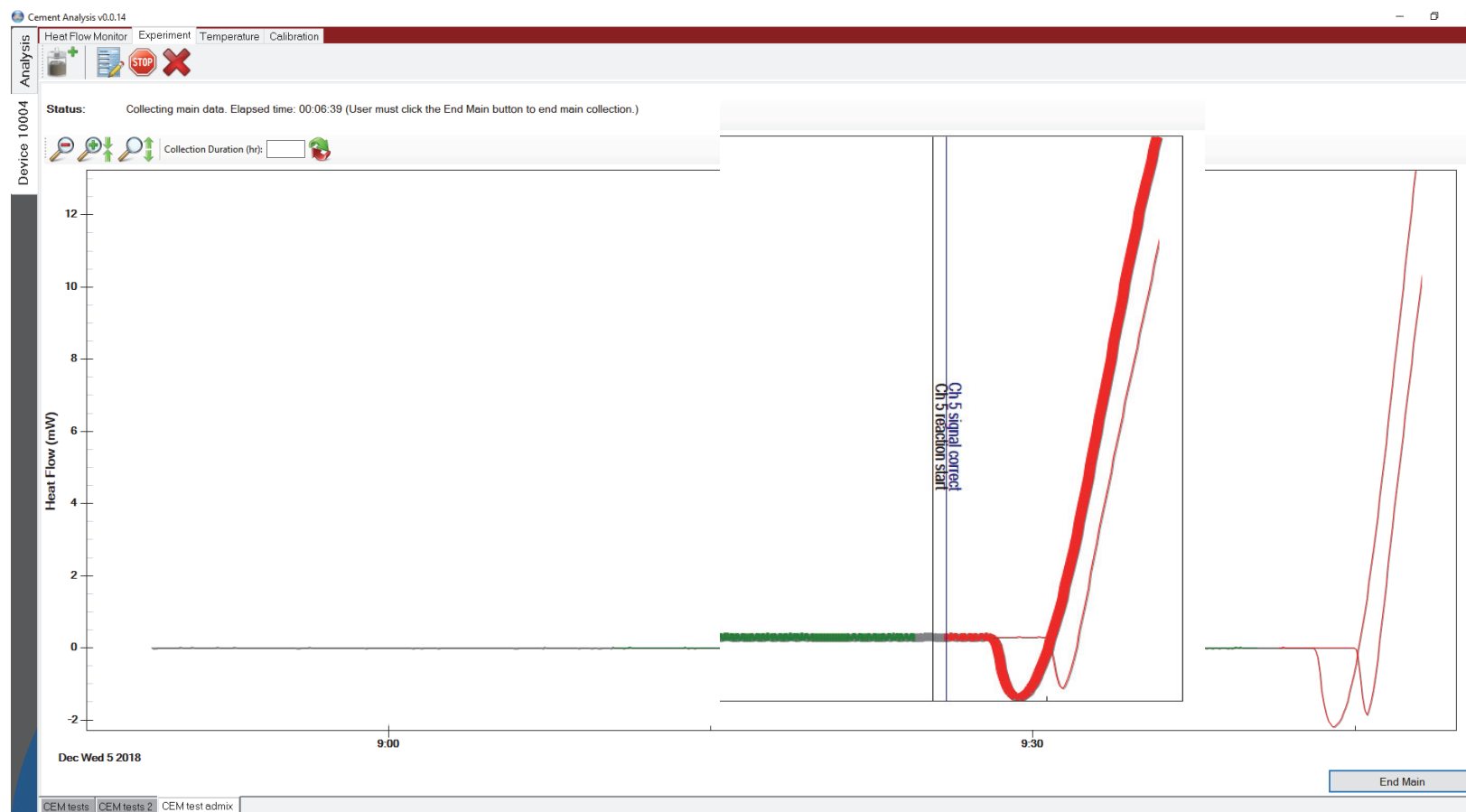
Let Software Track Times



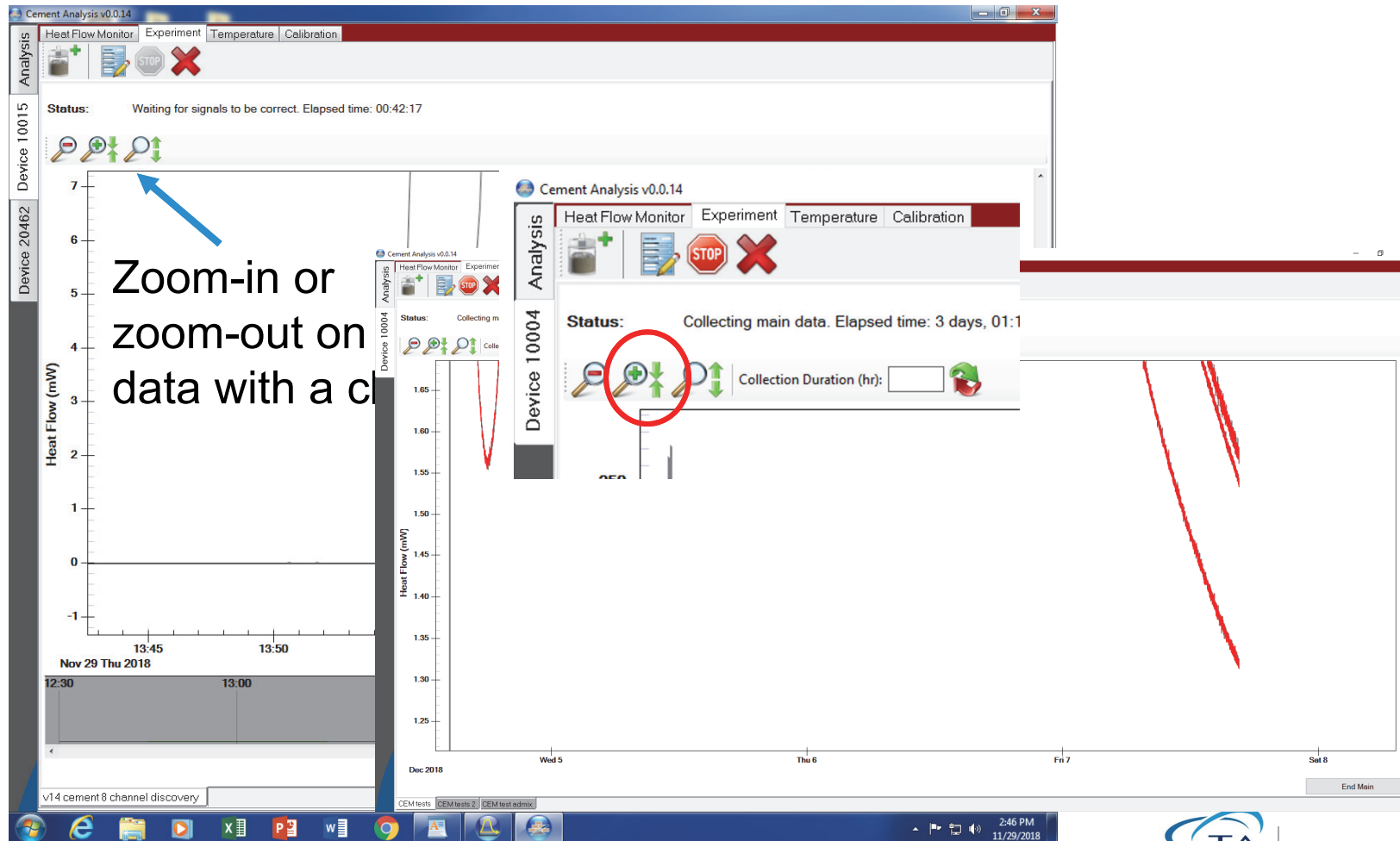
Admix ampoules – ‘complete integration’



Admix ampoules



Smart Zoom features

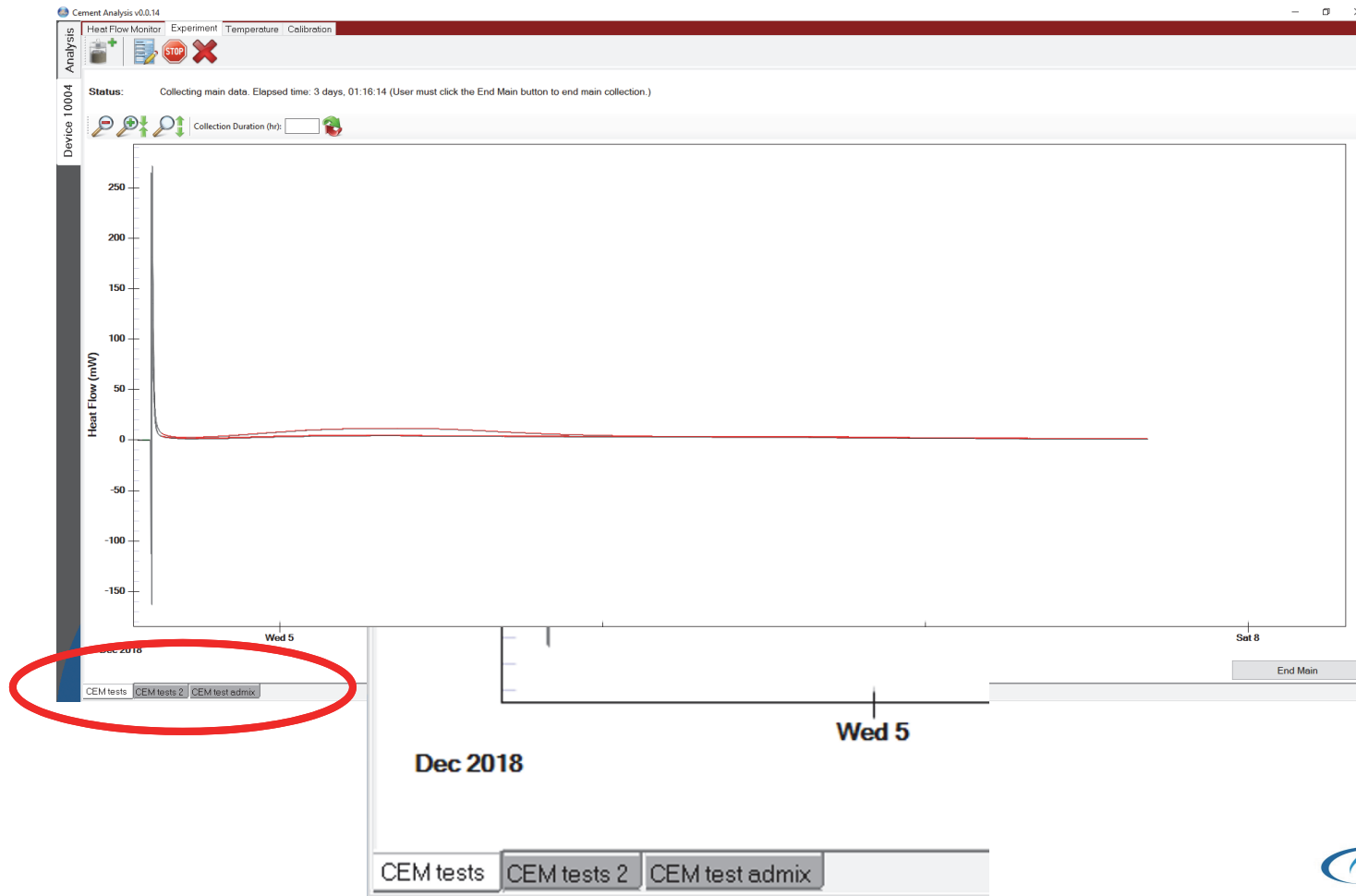


Zoom
to all

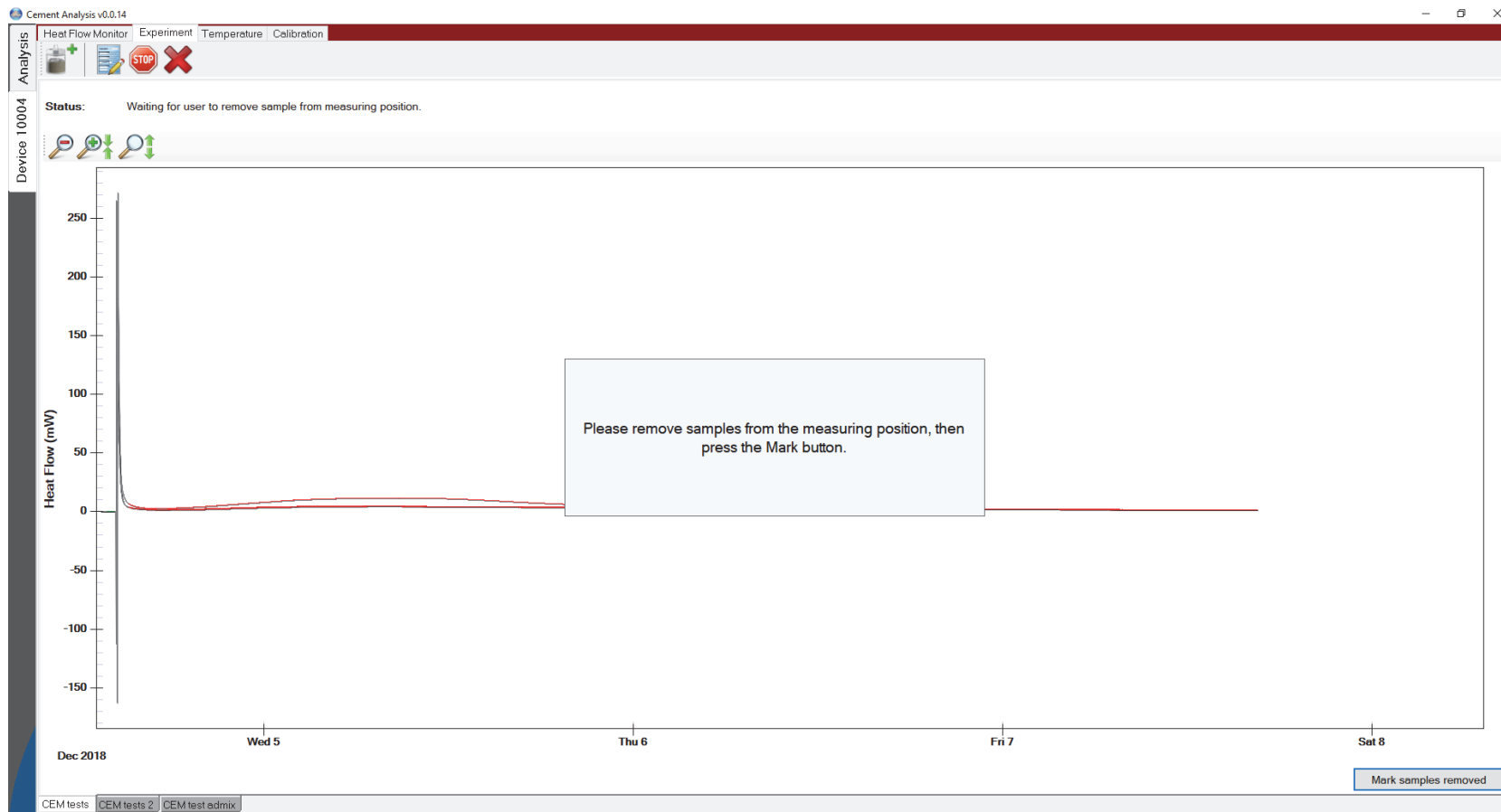


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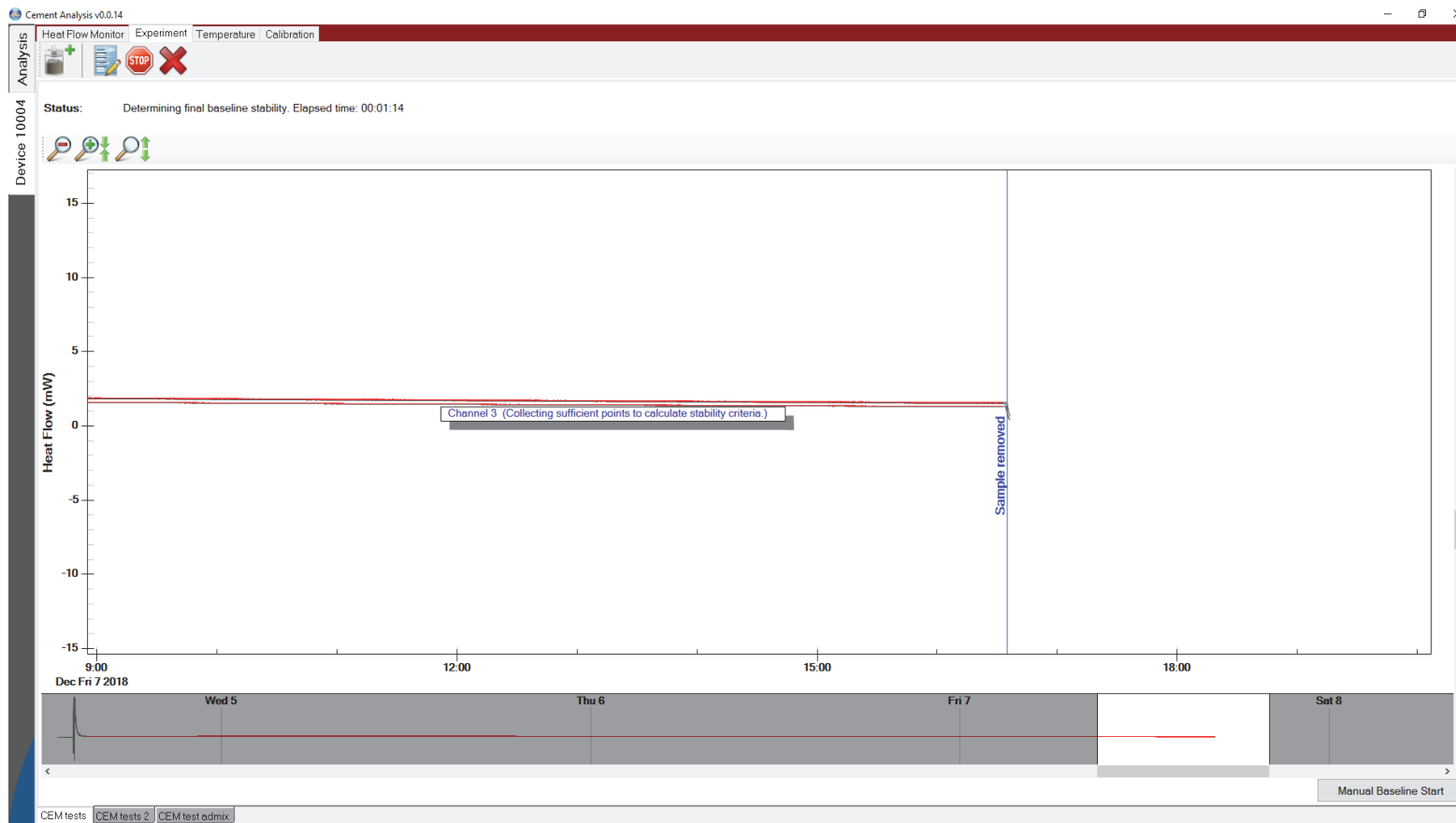
Main part of experiment



End of experiment



Remove samples



Fast & Simple Analysis



Cement Analysis v0.0.13

Experiment

Analysis

Sample Information: Channel **2** Normalization Units **g** Export Export All

Sample Total

Total mass: **6.9938** g ☐ Use Total mass to normalize data

Name: **CEM152.2**

ID:

Additional Info:

Component: **Cement** + + -

Mass: **4.9938** g ☒ Use this component to normalize data

Name: **Cement**

ID:

Physical Shape:

Preparation:

Additional Info:

Sample Info View Info Graph Report

Exit Analysis

CEM tests



Fast & Simple Analysis



Cement Analysis v0.0.13

Experiment

Analysis

Data Series To Include

- ☒ Channel 2
- ☒ Channel 3
- ☒ Channel 4

Data to include in table

- ☒ Sample ☒ Sample ID
- ☒ Normalized heat after 1 hour
- ☒ Normalized heat after 1 day
- ☒ Normalized heat after 3 days
- ☒ Normalized heat after 7 days
- ☐ Normalized heat after 10 days
- ☒ Time to peak from reaction start
- ☒ Peak max (after minimum)

Figures

- ☒ Normalized heat
- ☒ Normalized heat flow

Integration start time

☐ Dec 04, 2018 15:07:30

☒ At Signal Correct

Integration start time

☐ Dec 04, 2018 15:07:30

☒ At Signal Correct

☐ At Minimum

Onset of integration easily changed

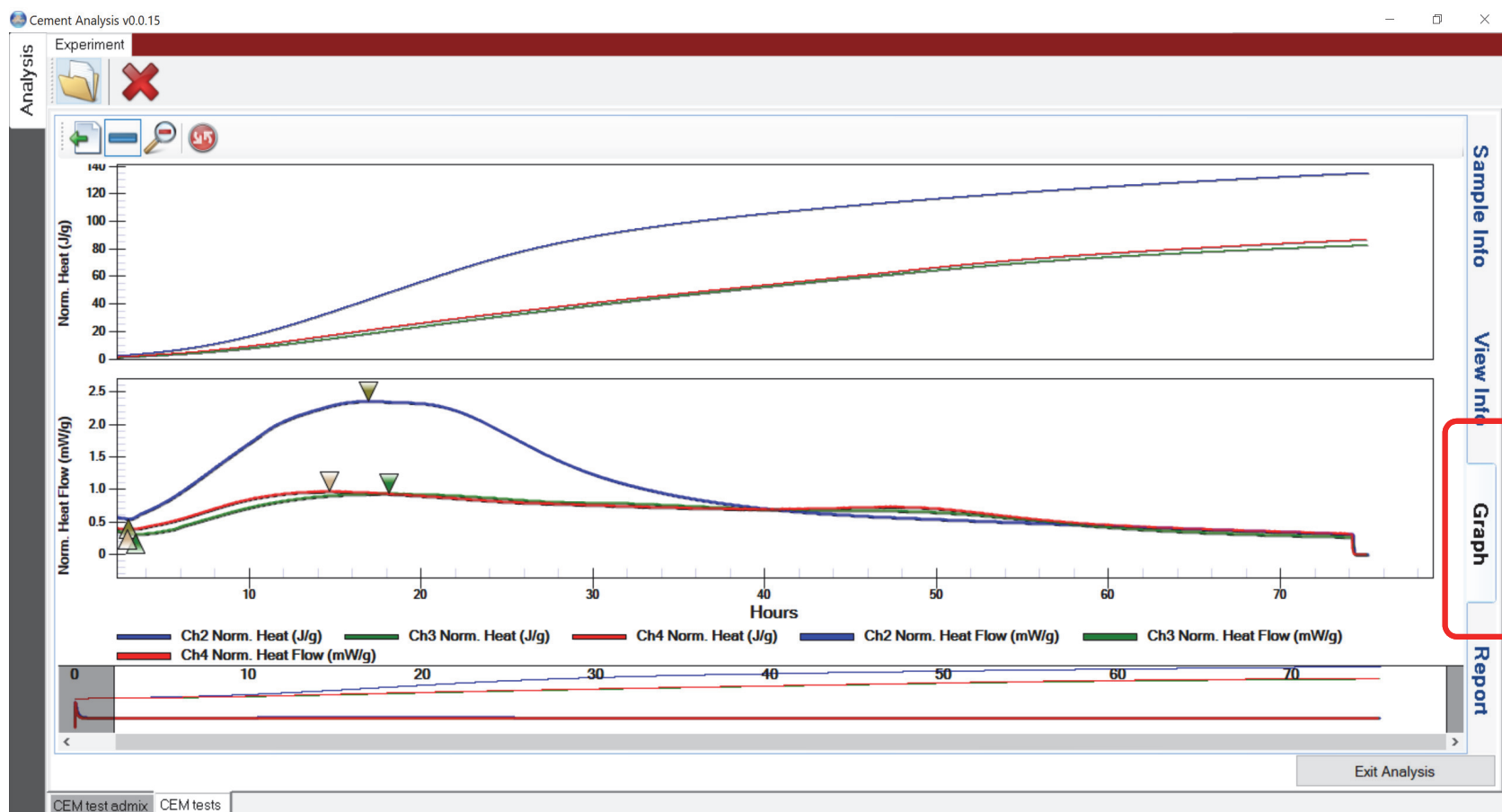
Sample Info

View Info

Exit Analysis

CEM tests

Analysis: Graphs



Analysis: Report



Cement Analysis v0.0.13

Experiment

Analysis

Export results

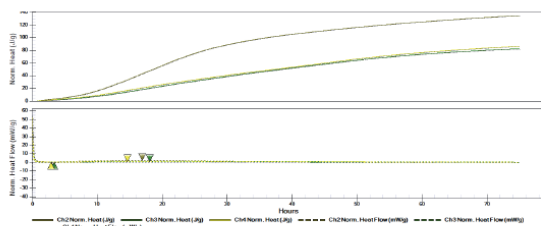
Calorimeter Channel	2	3	4
Sample	CEM I 52.2	CEM III / A 32.5	CEM III / B 42.5N
Sample ID			
Norm. Heat after 1 hour (J/g)	0.50303	0.27843	0.26739
Norm. Heat after 1 day (J/g)	72.007	30.074	32.412
Norm. Heat after 3 days (J/g)	133.56	81.416	85.177
Norm. Heat after 7 days (J/g)			
Time to peak (hr)	16.94	18.12	14.67
Peak max (mW/g)	2.3588	0.93416	0.96916

Sample Info View Info Graph

Report

CEM tests

Export to a PDF – automatically populates sections



Results			
Calorimeter Channel	2	3	4
Sample	CEM I 52.2	CEM III / A 32.5	CEM III / B 42.5N
Sample ID			
Norm. Heat after 1 hour (J/g)	0.50303	0.27843	0.26739
Norm. Heat after 1 day (J/g)	72.007	30.074	32.412
Norm. Heat after 3 days (J/g)	133.56	81.416	85.177
Norm. Heat after 7 days (J/g)			
Time to peak (hr)	16.94	18.12	14.67
Peak max (mW/g)	2.3588	0.93416	0.96916

Summary:
 Channel: 2
 Name: CEM tests
 Start time: Dec 04, 2018 13:20:47
 End time: Dec 07, 2018 17:28:52
 Operator:
 Results file path: C:\Users\Exhibition\Documents\TAM Air\cement a
 Sample: CEM I 52.2
 Sample ID:
 Total mass: 6.9938
 w/c: 0.4005
 Cement: 4.9938
 Water: 2

Summary:
 Channel: 3
 Name: CEM tests
 Start time: Dec 04, 2018 13:20:47
 End time: Dec 07, 2018 17:28:52
 Operator:
 Results file path: C:\Users\Exhibition\Documents\TAM Air\cement analysis\CEM tests.cmt
 Sample: CEM III / A 32.5
 Sample ID:
 Total mass: 7.0001
 w/c: 0.39999
 Cement: 5.0001
 Water: 2

Summary:

Channel: 2
 Name: CEM tests
 Start time: Dec 04, 2018 13:20:47
 End time: Dec 07, 2018 17:28:52

Operator:
 Results file path: C:\Users\Exhibition\Documents\TAM Air\cement analysis\CEM tests.cmt

Sample: CEM I 52.2

Sample ID:
 Total mass: 6.9938

w/c: 0.4005

Cement: 4.9938

Water: 2

Thank You

The World Leader in Thermal Analysis,
Rheology, and Microcalorimetry



TAM Air – 8 and 3 channel calorimeter

