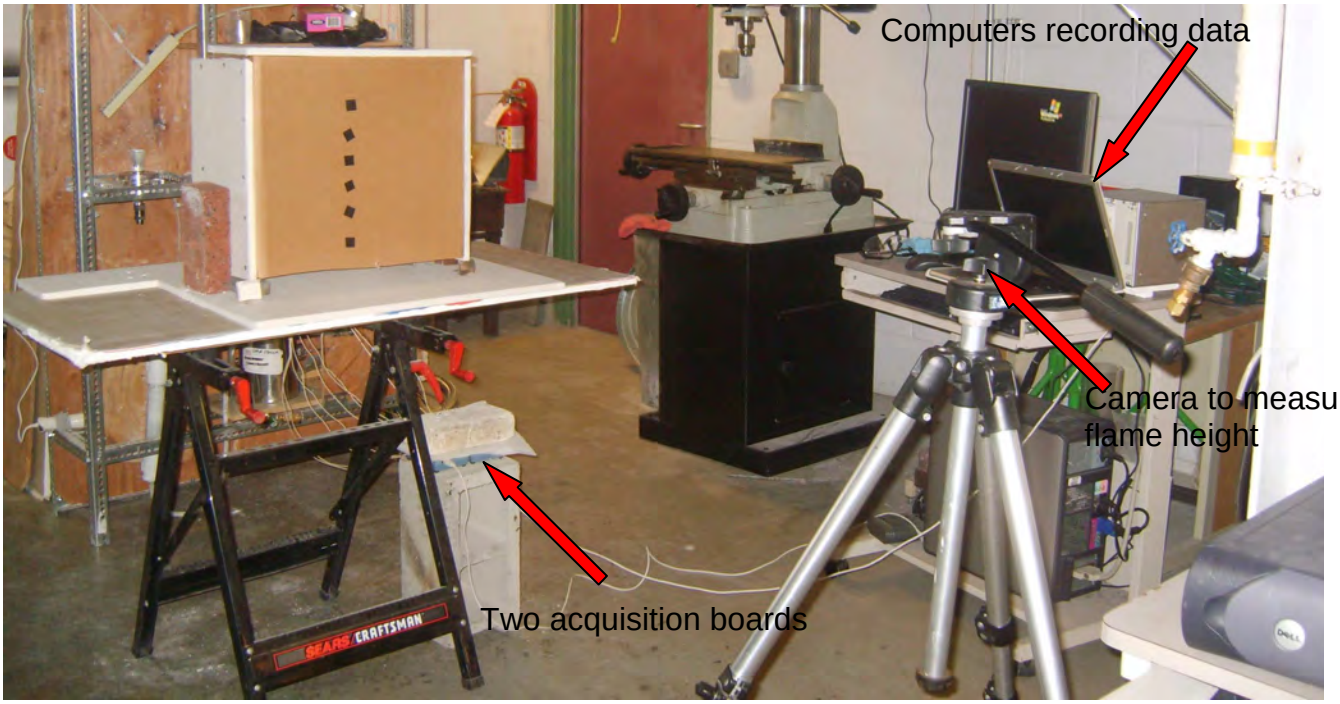
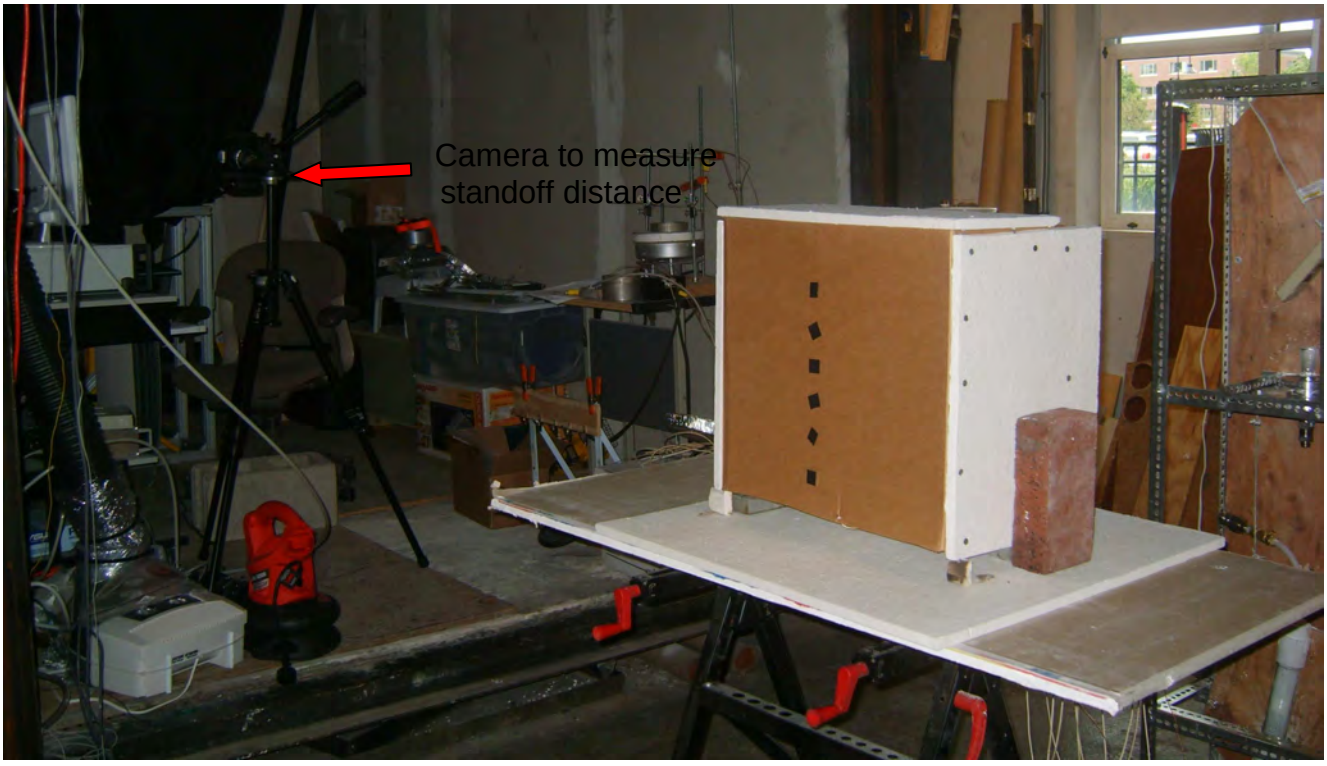
II "Half" box

1. Set-up

- **Experiment set-up**

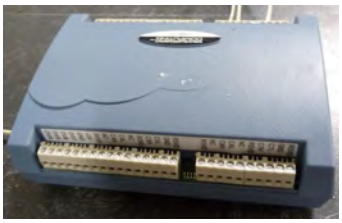




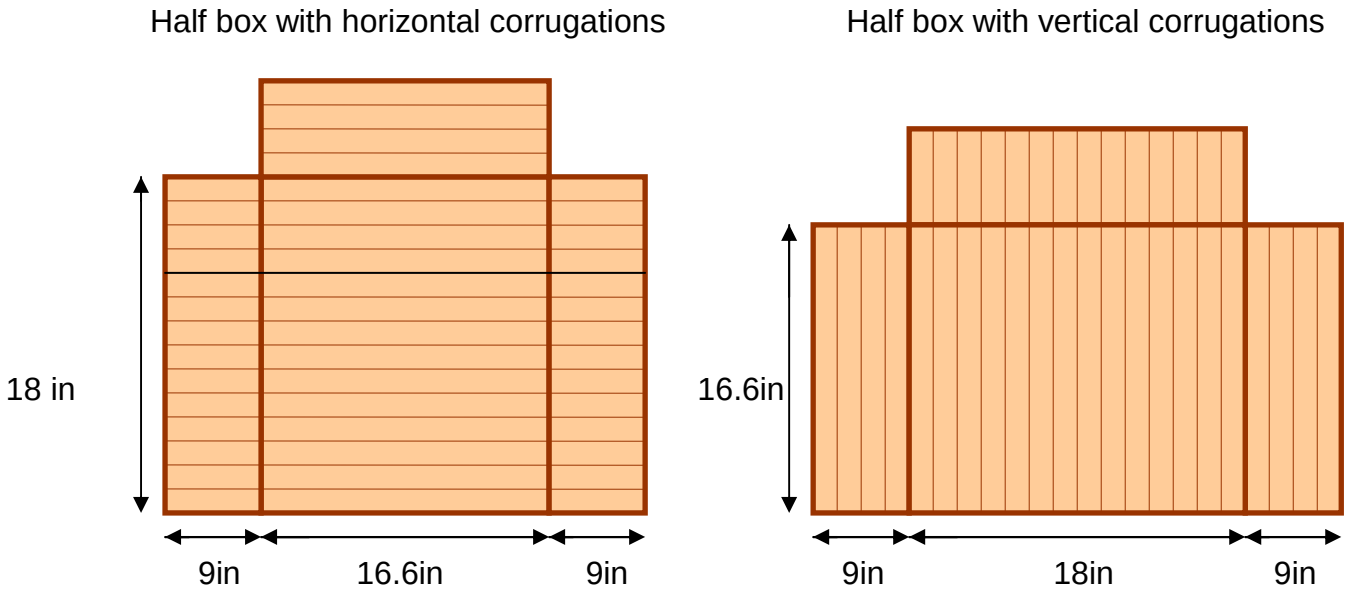
Four tests have been conducted, with two kinds of cardboard: one with vertical corrugations and the other one with horizontal corrugations.
The flame standoff distance, flame height, and incident flux will be measured as a function of time.
The flame standoff distance will be measured using a high-resolution digital camera mounted on the side of the apparatus. In order to measure the pyrolysis length, thermocouples mounted on the exposed face will be used to track the location of the flame front. The flame height will be measured with a camera placed in front of the exposed face. And at least the incident flux will be measured thanks to six thin skin calorimeters mounted on the cardboard

The box will be ignited at the base of the vertical exposed face using ethanol and will be placed under a hood.

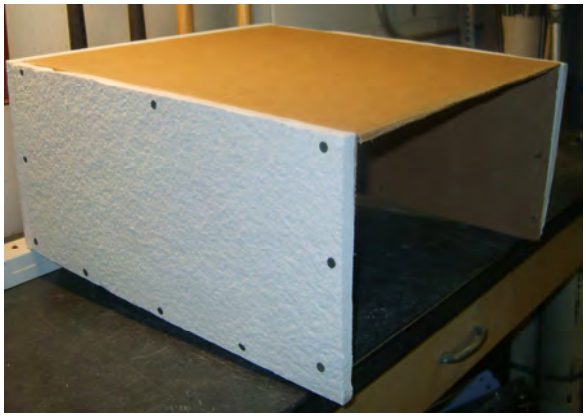
The data are recorded with the software TRACERDAQ. The acquisition board can record eight channels so, the six thin skin calorimeters are connected to one acquisition board and the six thermocouples to a second one. The two acquisition boards are connected by usb to a computer

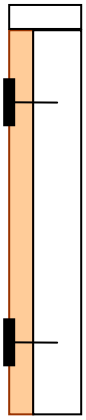


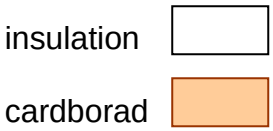
- **Pattern of the half boxes**



Insulations are mounted on the top and the two sides of each box, and fixed with screw.

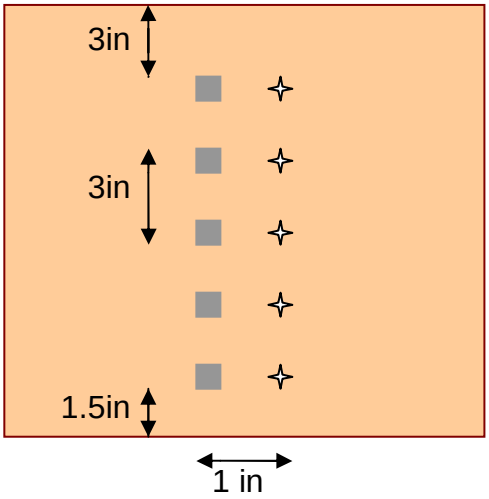




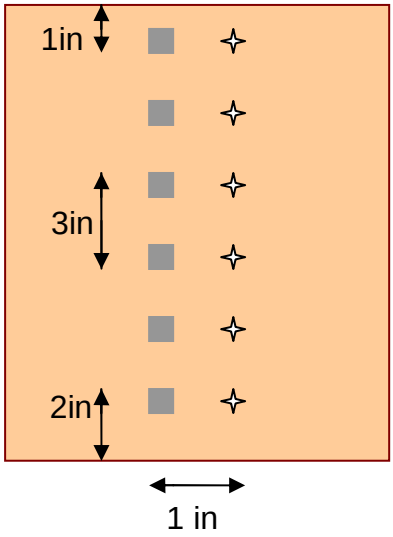


➢ Instrumentation of the front side

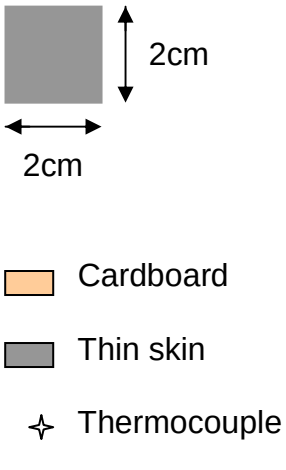
Vertical corrugations



Horizontal corrugations

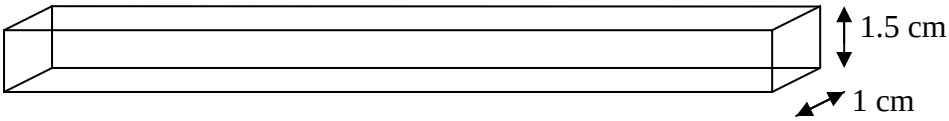


Thin Skin



➢ Ignition set up

In order to can reproduce the experiment and verify is repeatability a way of ignition should have been made. Indeed an ignition with a simply torch can't assure the repeatability of the test. So an ignition with alcohol had been chosen. 5ml of ethanol are verse in a rectangular receipt deep of 1 cm and with the length and the width of the front side of the cardboard.

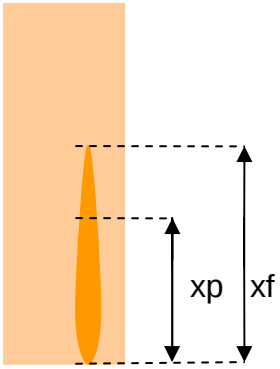


The receipt is placed just behind the face to ignite, very close to the cardboard.

2. Result

➢ Flame height

Measures of the flame height are made with the software IMAGE J, which allow to measure pixels of a picture. Knowing a distance thank to a rule on the picture, it is possible to convert pixels in centimeters.

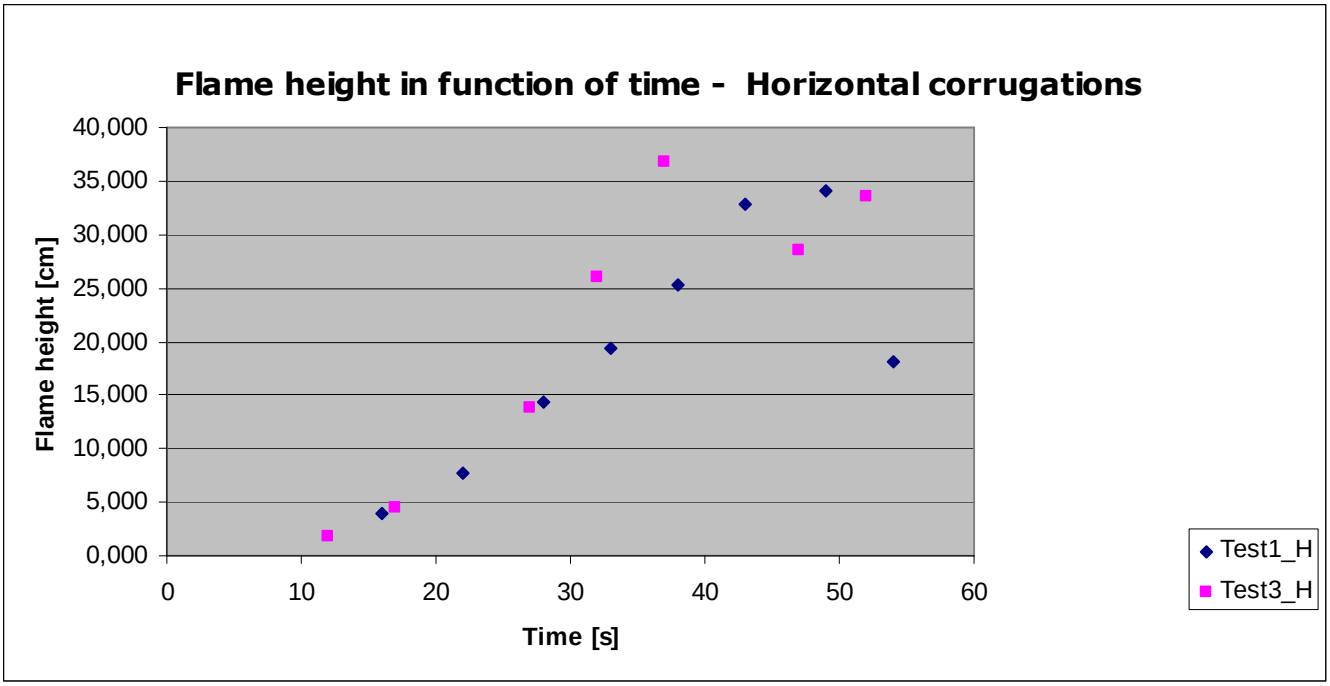


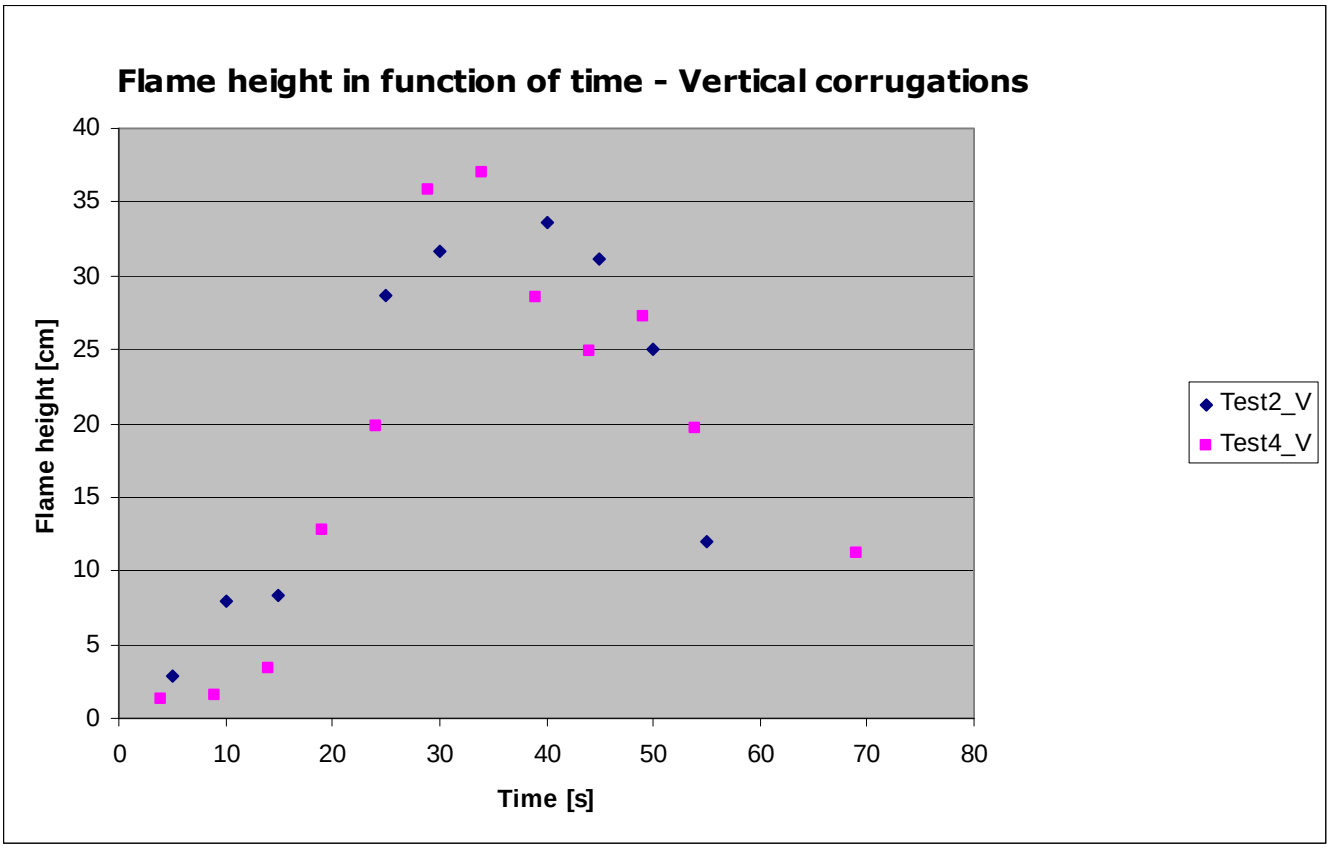
As the half box of cardboard is wide, an average of the flame height on the width has been done.

Cardboard
Flame

Xp : Pyrolysis lenght

Xf : Flame height

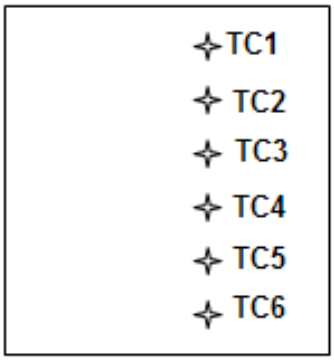


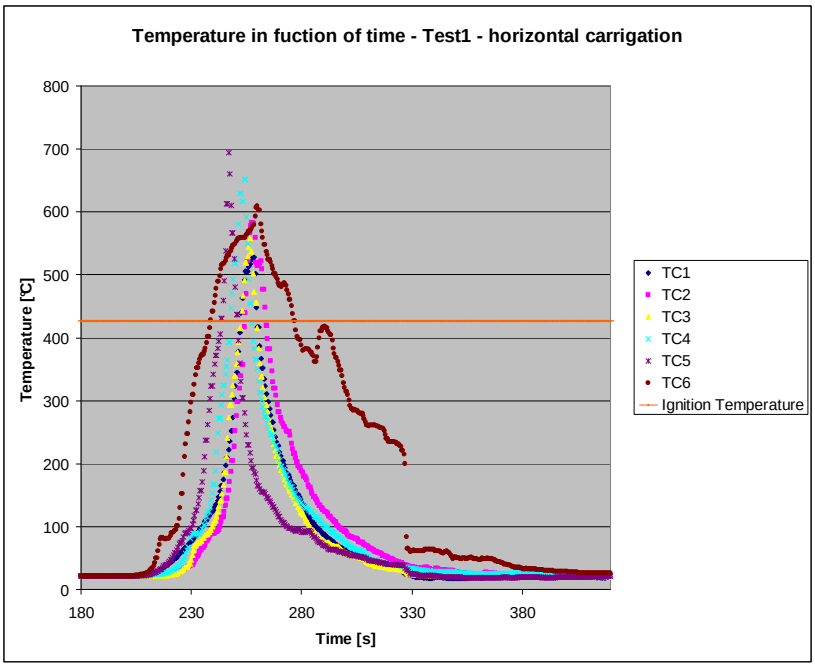


Experiments for vertical corrugations cardboard match as well as experiment for horizontal corrugations, the curves have the same look.
The maximum of flame height is reached more quickly for a cardboard with vertical corrugations than a horizontal corrugations. But the flame height decrease before the extinction of the fire even tough in the case of horizontal corrugations the decrease is less important because the maximum is reached few times before the extinction.
Vertical corrugations seem to help flames to go up and spread on the cardboard.

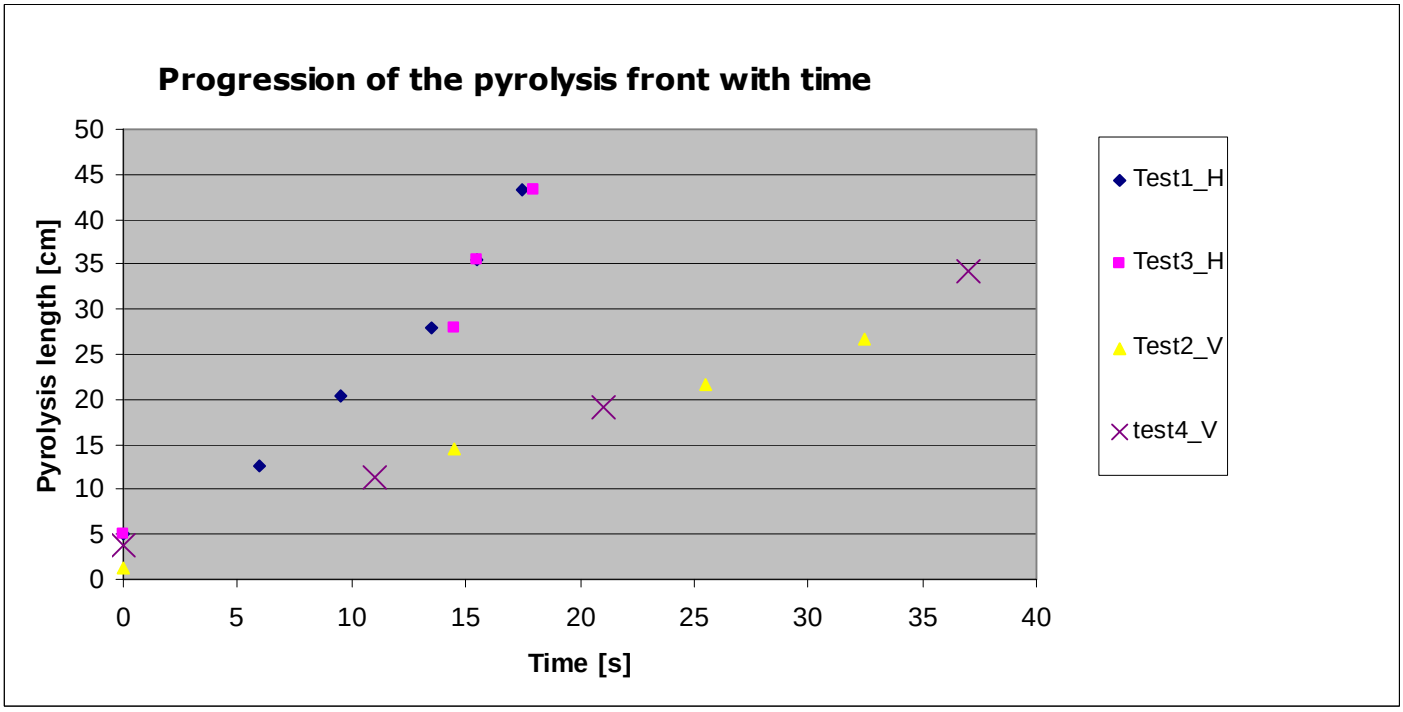
➢ Pyrolysis length

The pyrolysis length is the height of burned cardboard.
Measures of pyrolysis length are made thanks to the data of the thermocouples.Indeed thanks to this data we can get the temperature in function of time for each thermocouple, which we know the position on the cardboard.



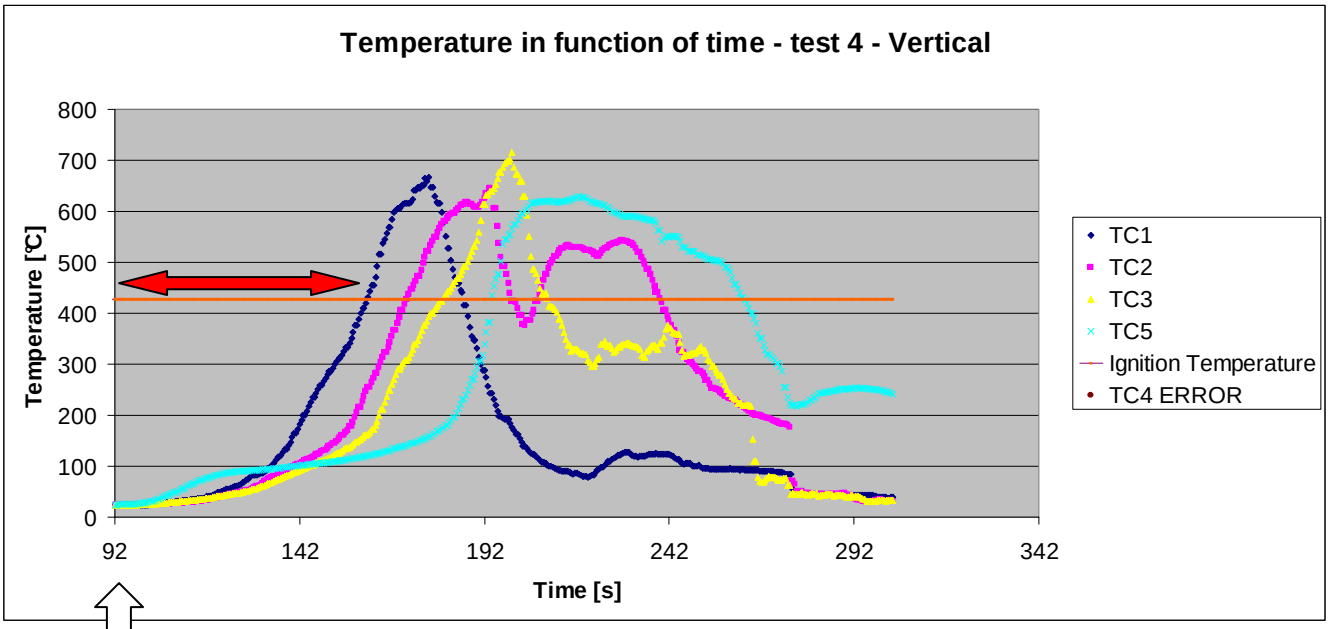


The ignition temperature of cardboard is 427°C, so as soon as one temperature reach this value we can match a thermocouple positon (one pyrolysis length) to a time



Once again, the two experiments from vertical corrugation cardboard match as well as the two experiments from horizontal corrugation cardboard.
The pyrolysis length of horizontal corrugation advances more quickly and begin earlier than the cardboard with vertical corrugation.

For the forth test the pyrolysis begin very late, because of the course of the fire, which didn't spread on the entire exposed face of the cardboard but more on the right.
As a consequence compare to the other tests the thermocouples'temperature take more time to increase. That is why the pyrolysis length begin so late.

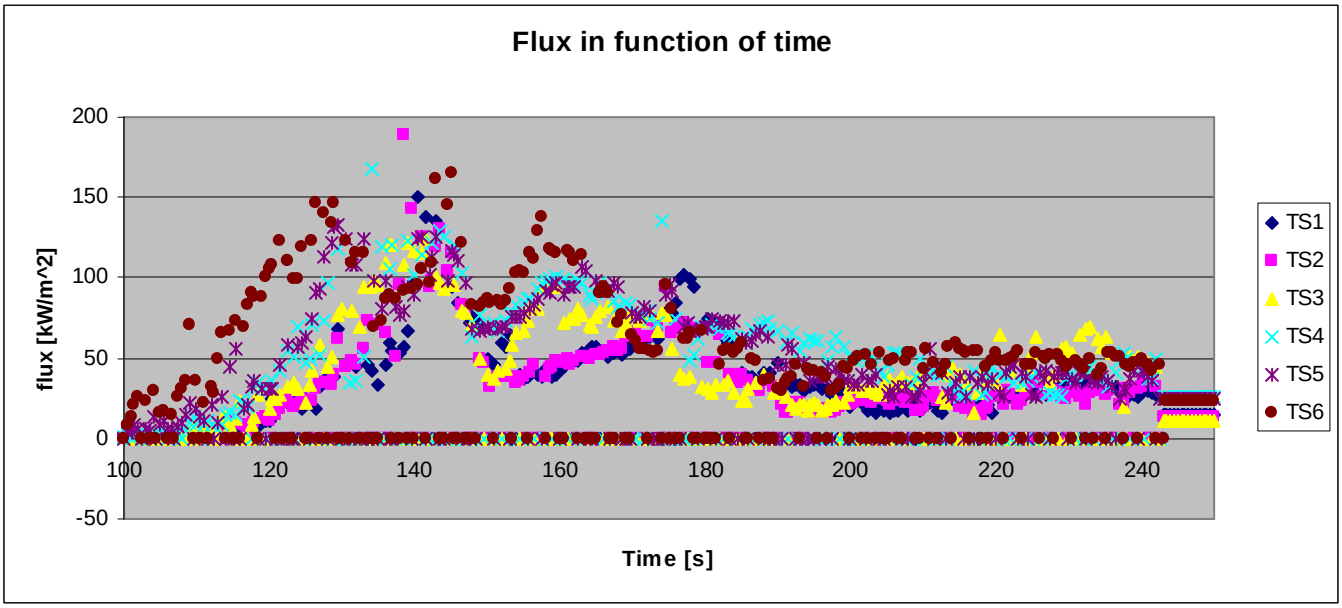


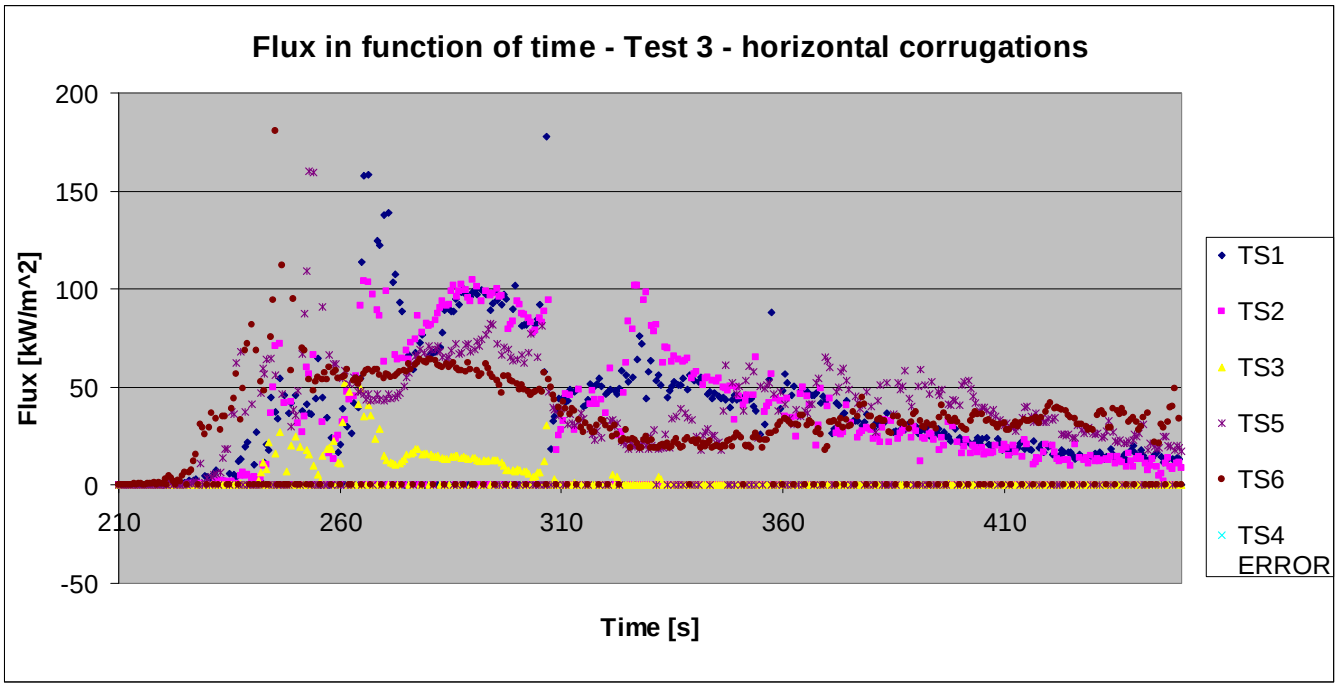
Ignition

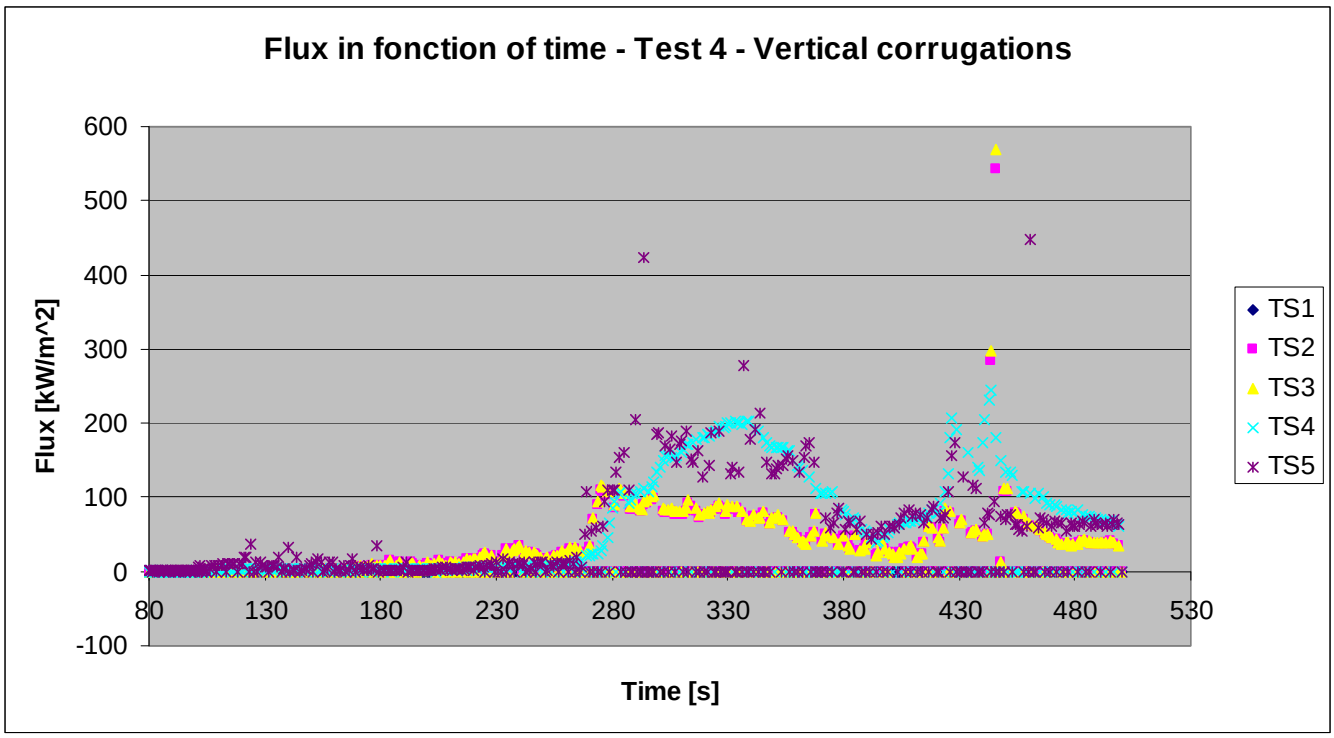
Now here the pyrolysis length in function of the flame height. Only the result for the test 1, 2 and 3 are presented because of the wrong positon of pyrolysis length of the fourth test.

➢ Incident Flux arriving on the exposed face of the half box

To measure the flux I used the thin skin calorimeter, which I explained the principle before. I got only three record data because of a problem of time set-up for the first test.

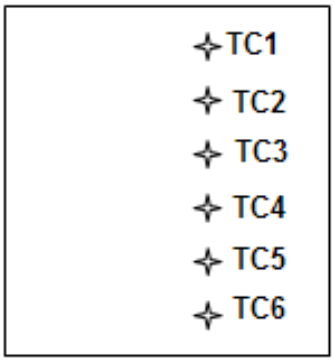


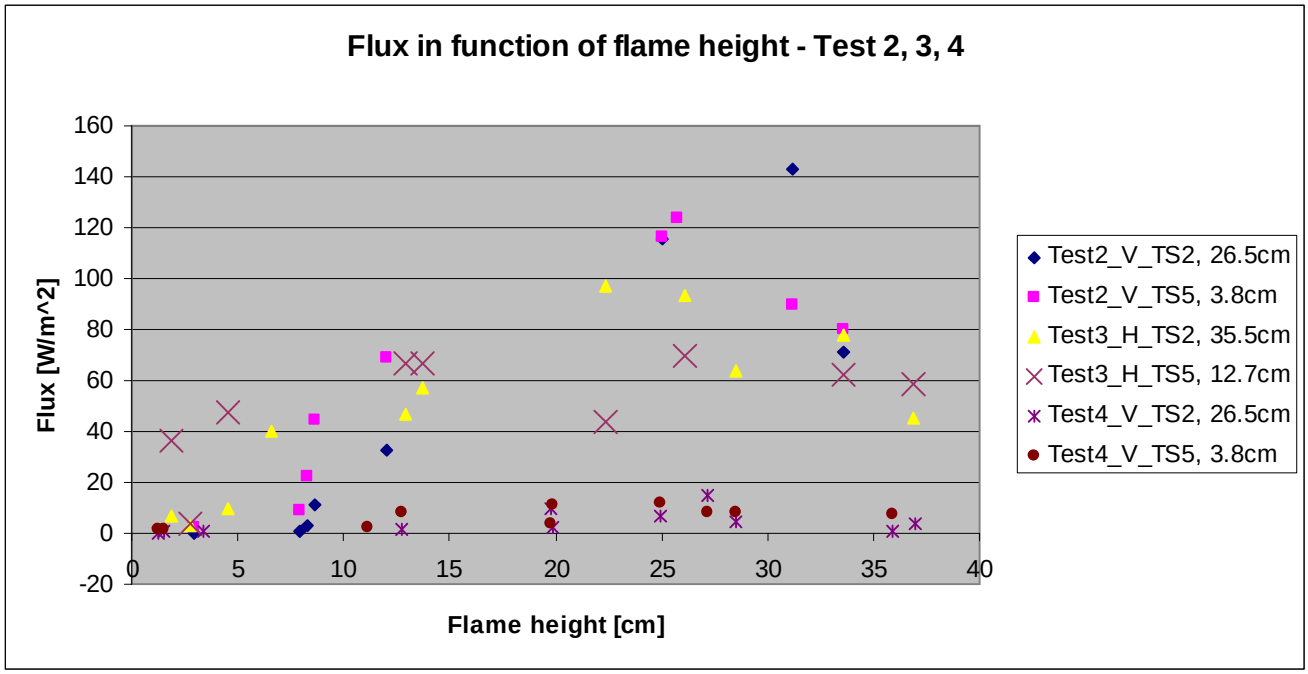




➢ Flux in function of the flame height

Flux from the thin skin number two and number five




Flux in function of flame height - Test 2, 3, 4
Flux [W/m^2]
160
140
120
100
80
60
40
20
0
-20
0
5
10
15
20
25
30
35
40
Flame height [cm]
Test2_V_TS2, 26.5cm
Test2_V_TS5, 3.8cm
Test3_H_TS2, 35.5cm
Test3_H_TS5, 12.7cm
Test4_V_TS2, 26.5cm
Test4_V_TS5, 3.8cm