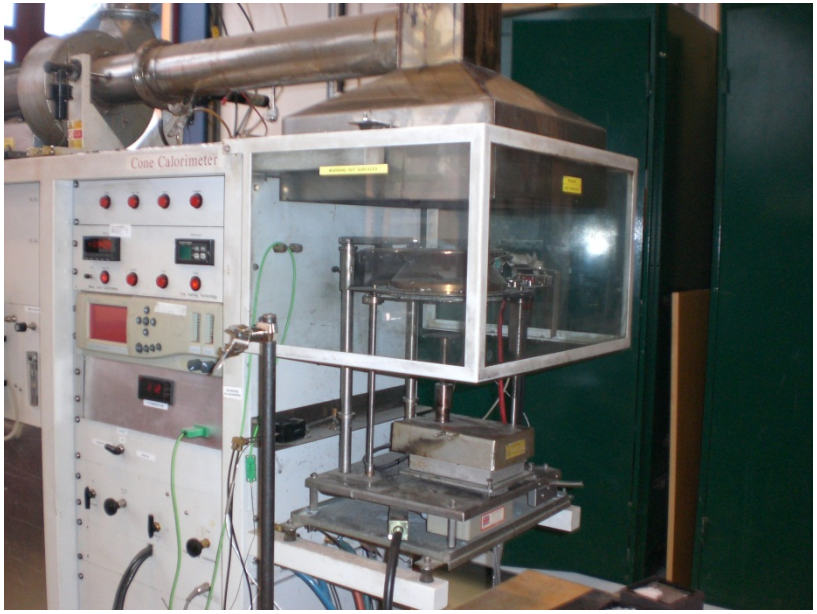
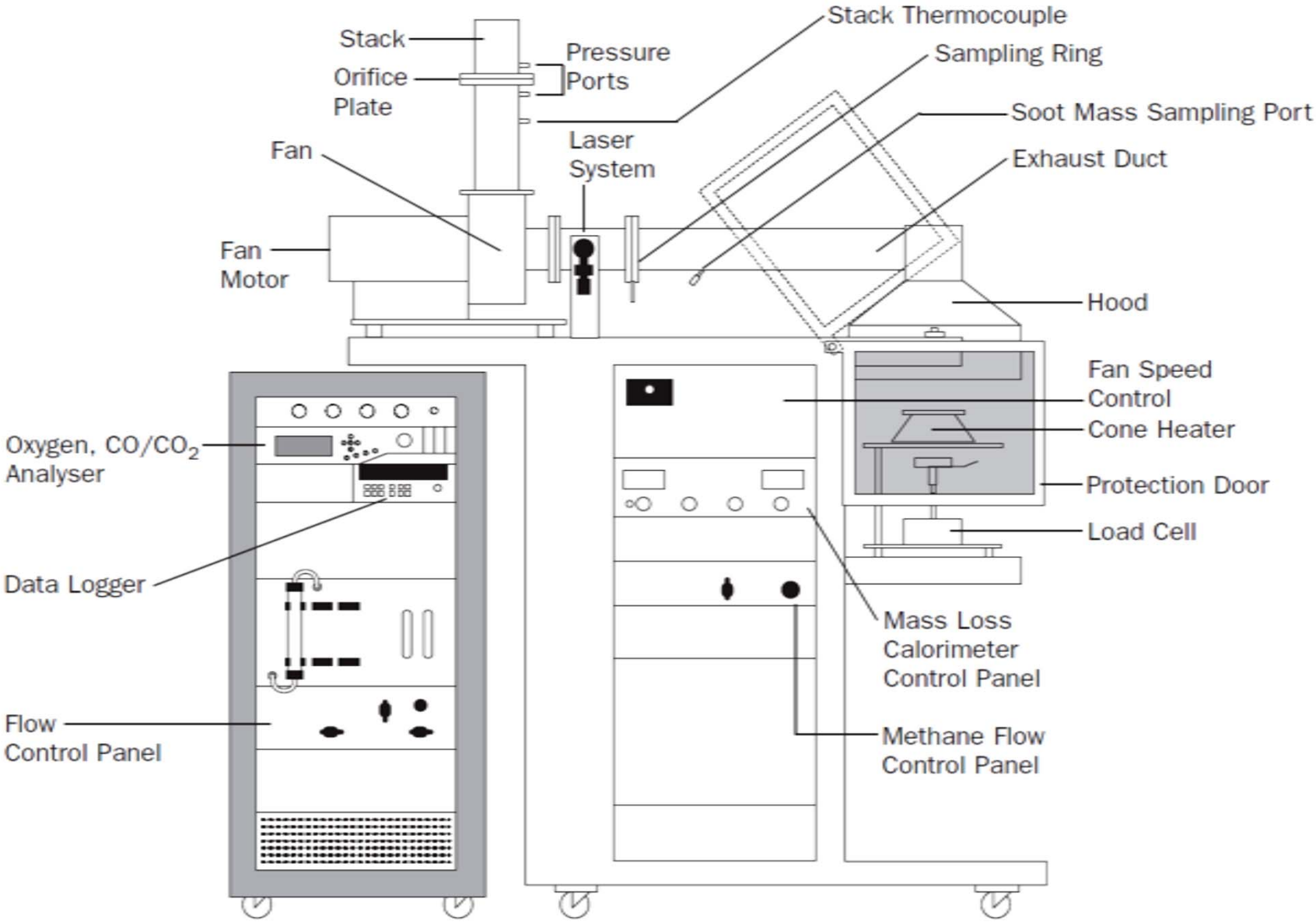
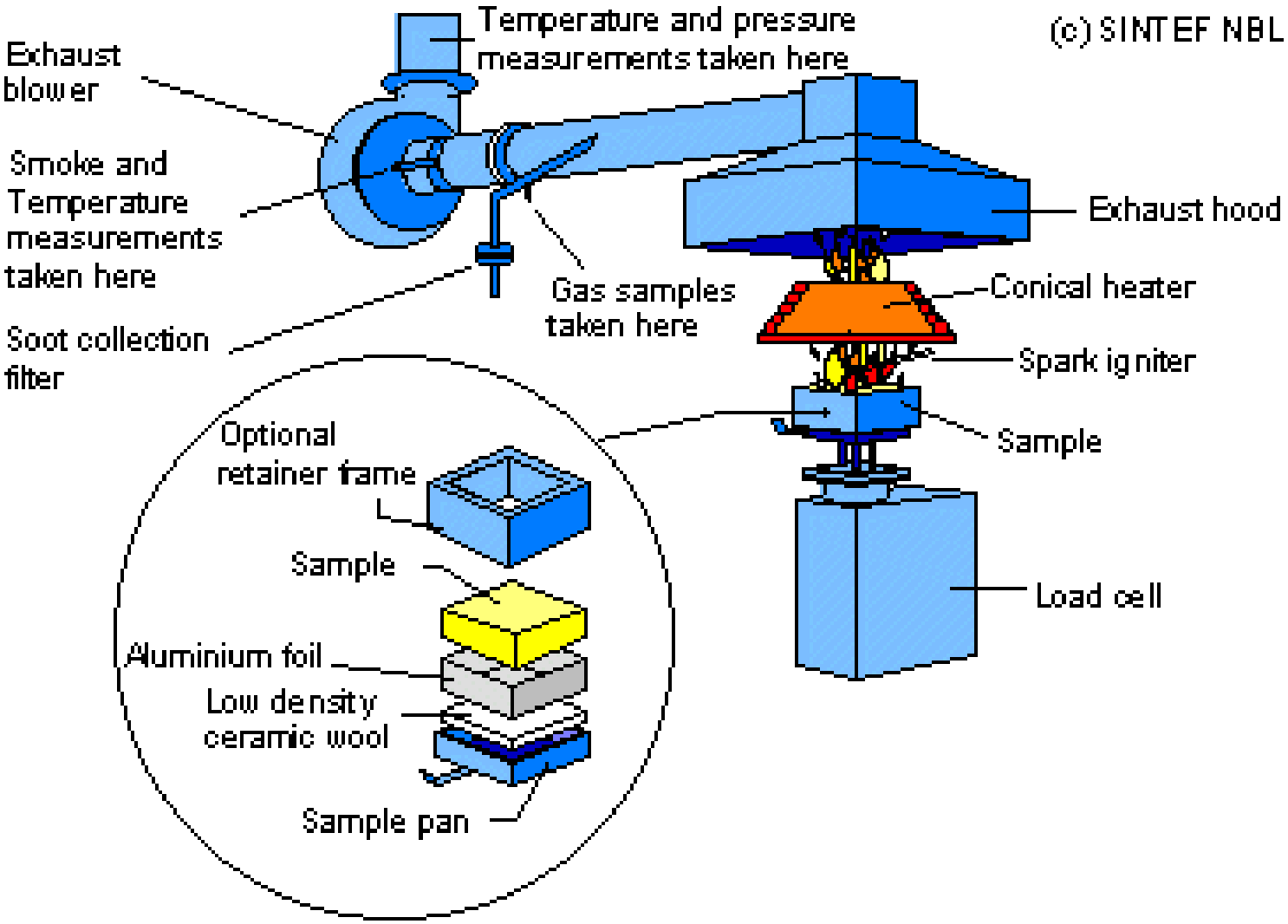
# Cone Calorimeter





Stack
Orifice Plate
Pressure Ports
Stack Thermocouple
Sampling Ring
Soot Mass Sampling Port
Exhaust Duct
Fan
Laser System
Fan Motor
Hood
Fan Speed Control
Cone Heater
Protection Door
Load Cell
Oxygen, CO/CO2 Analyser
Data Logger
Flow Control Panel
Mass Loss Calorimeter Control Panel
Methane Flow Control Panel


Temperature and pressure measurements taken here
(c) SINTEF NBL
Exhaust blower
Smoke and Temperature measurements taken here
Soot collection filter
Gas samples taken here
Exhaust hood
Conical heater
Spark igniter
Sample
Load cell
Optional retainer frame
Sample
Aluminium foil
Low density ceramic wool
Sample pan

# Fundamental Issues

- Heat Release Rate is obtained indirectly by measuring $O_2$ consumption
- Mass loss rate – real time by load cell
- Incident heat flux of 0 to 100 $kW/m^2$

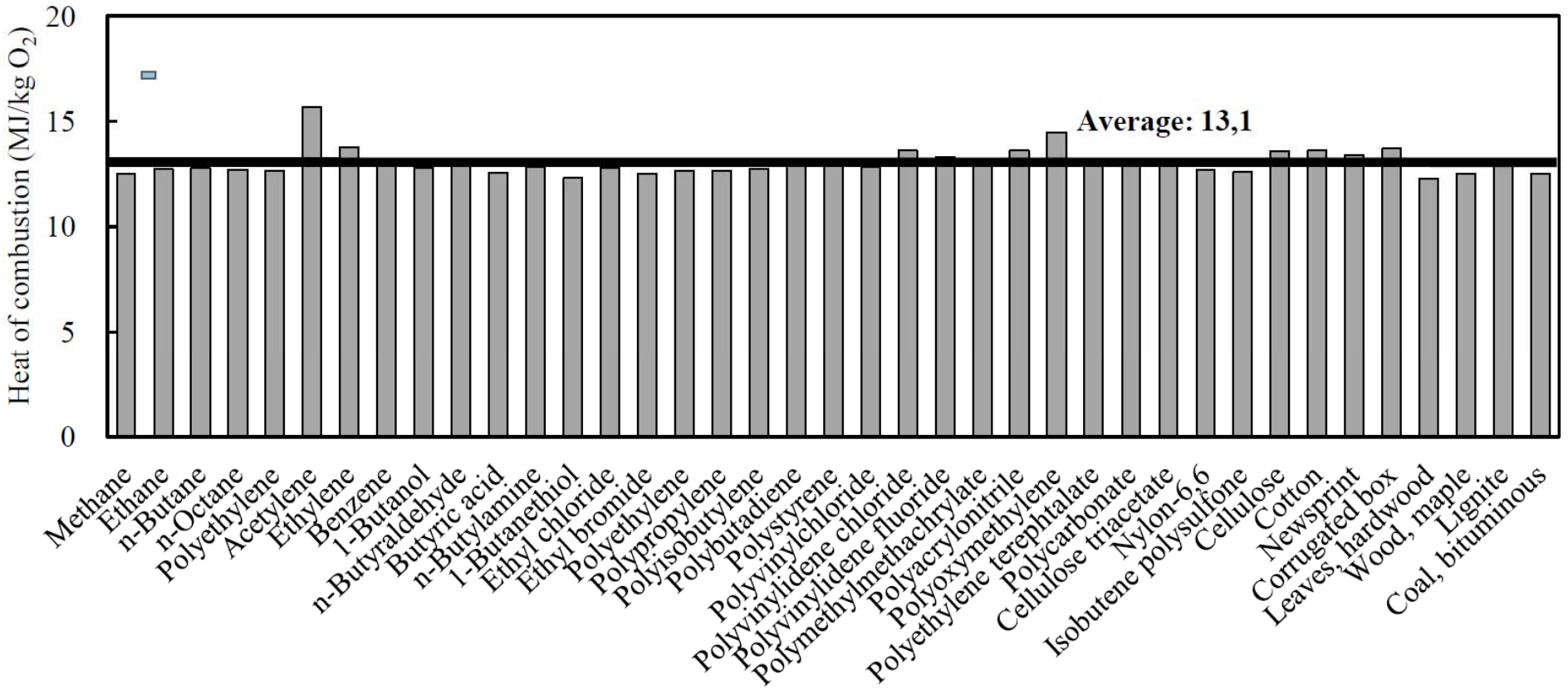
# $O_2$ Consumption

## COMPLETE COMBUSTION

- Main simplifying assumptions:
  - **Energy release per unit mass of $O_2$,constant E = 13.1 MJ/kg of $O_2$ consumed**
  - **Ideal gas law applies**
  - **$O_2$ depletion factor assumes each mole of air required for complete combustion is replaced by 1.105 moles of products**

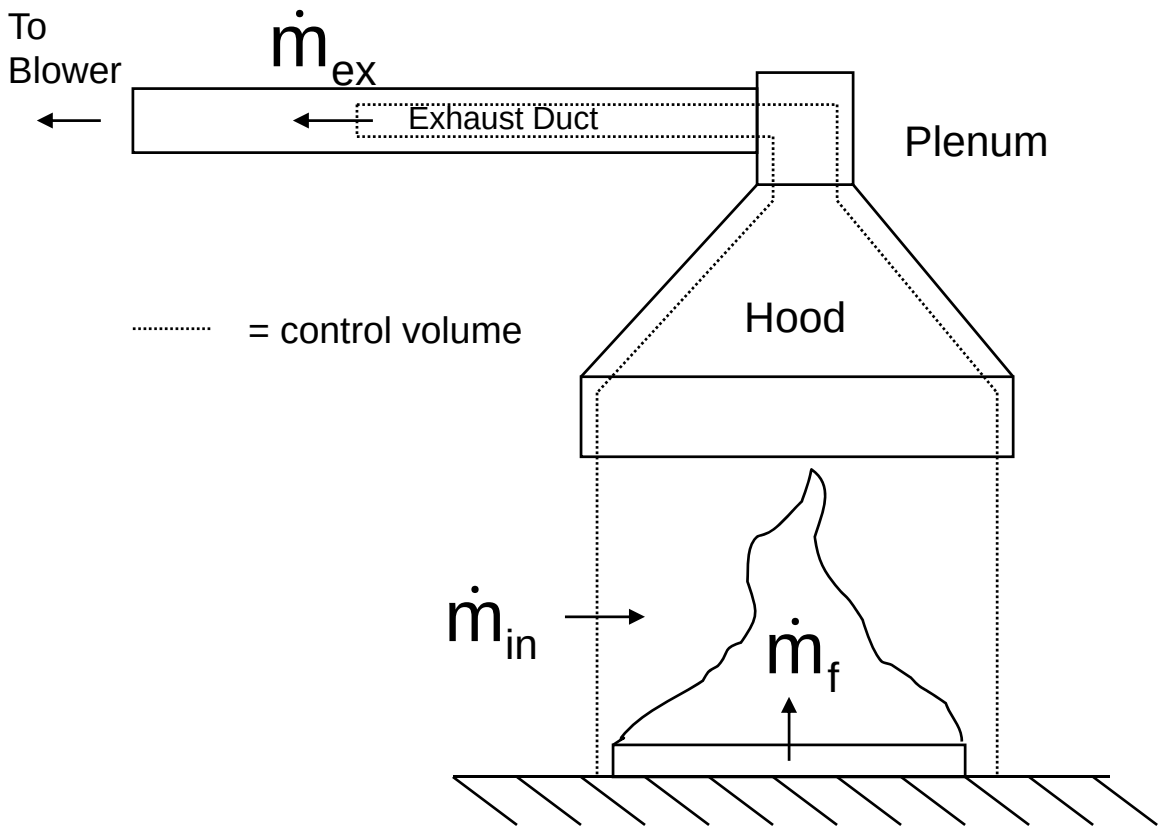
$$n_f + n_{air} = n_p \approx 1.105 n_{air}$$

# Energy Released per kg of $O_2$




HUGGETT, Clayton. 1980. Estimation of rate of heat release by means of oxygen consumption measurements. *Fire and Materials*. **4**(2), pp.61-65.

# $O_2$ Consumption




$$\Delta \dot{m}_{O_2} = \dot{m}_{O_2.in} - \dot{m}_{O_2.ex}$$

# Calculations

- Oxygen concentration is measured at the exhaust $\Delta\dot{m}_{O_2.ex}$
- Incoming oxygen concentration (air) $\Delta\dot{m}_{O_2.in}$
- Oxygen consumed : $\Delta\dot{m}_{O_2}$

$$\Delta\dot{m}_{O_2} = \dot{m}_{O_2.in} - \dot{m}_{O_2.ex}$$

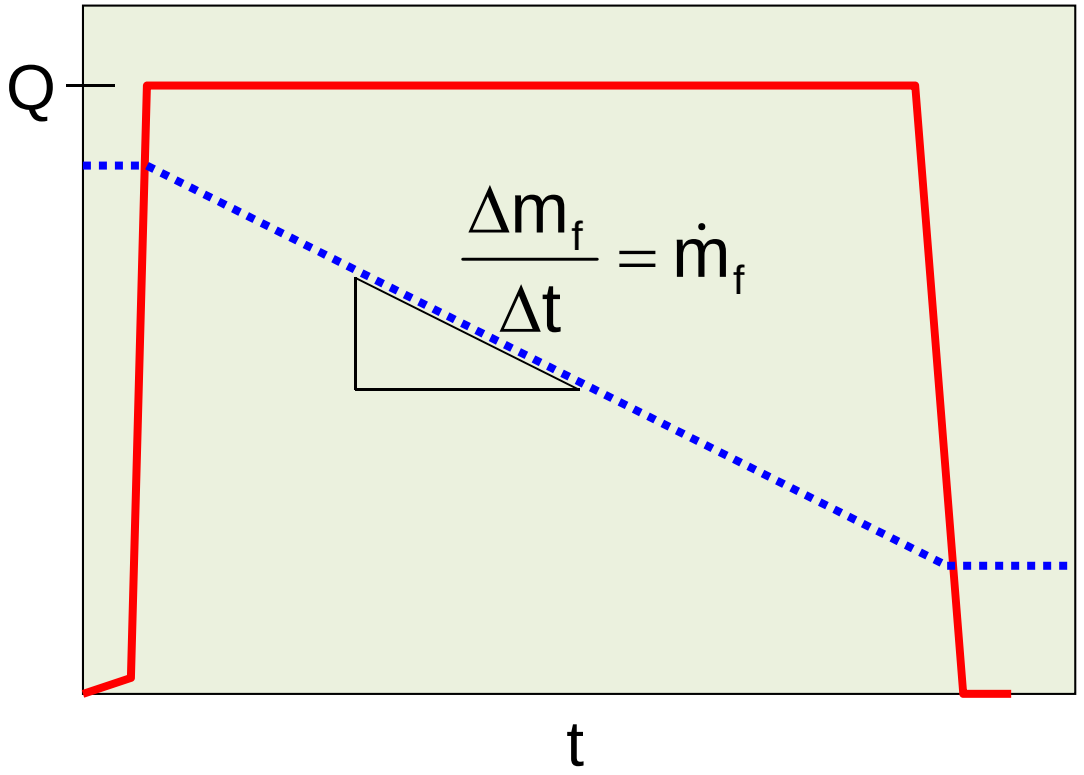
# Calculations

The energy release rate can be calculated as:

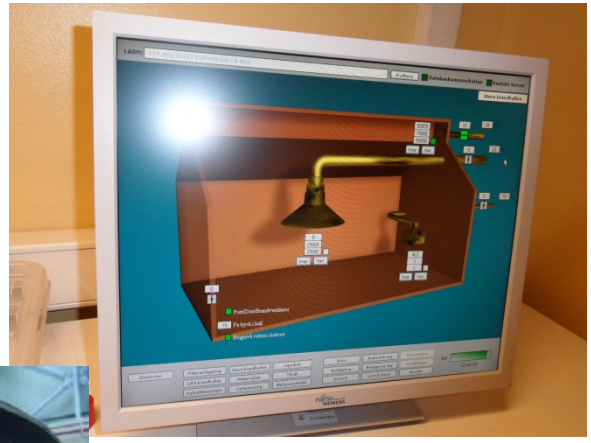
$$Q = 13.1 \, \Delta \dot{m}_{O_2} \quad [MJ]$$

# Experimental Results

- Ideal Scenario:



# The Real Scale Application- Large Scale Calorimeter



# Aim is

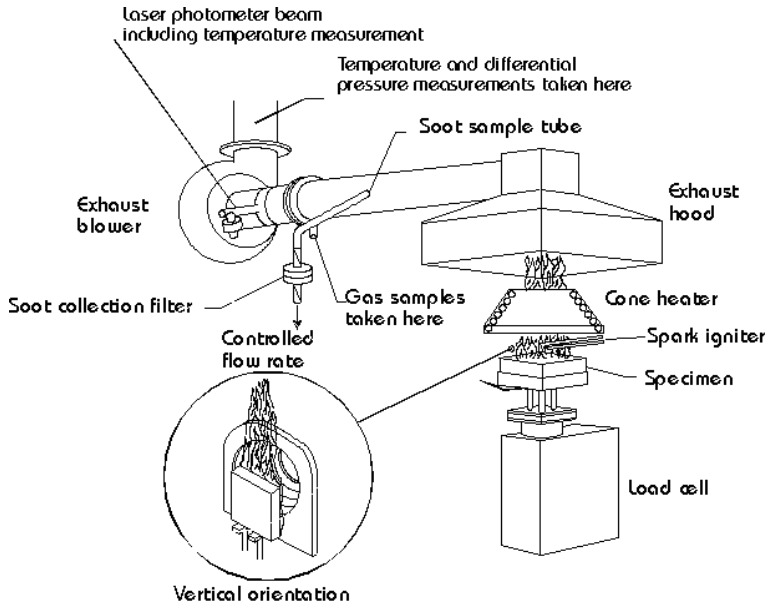
- To introduce the cone calorimeter for determining of
  - **the burning rate**
  - **Heat Release Rate**
  - **time to ignition**

# Aim is

- To get a better understanding of
  - **How Heat Release Rate is measured**
  - **Use of the measured data for calculation**

# Laboratory work – Cone Calorimeter

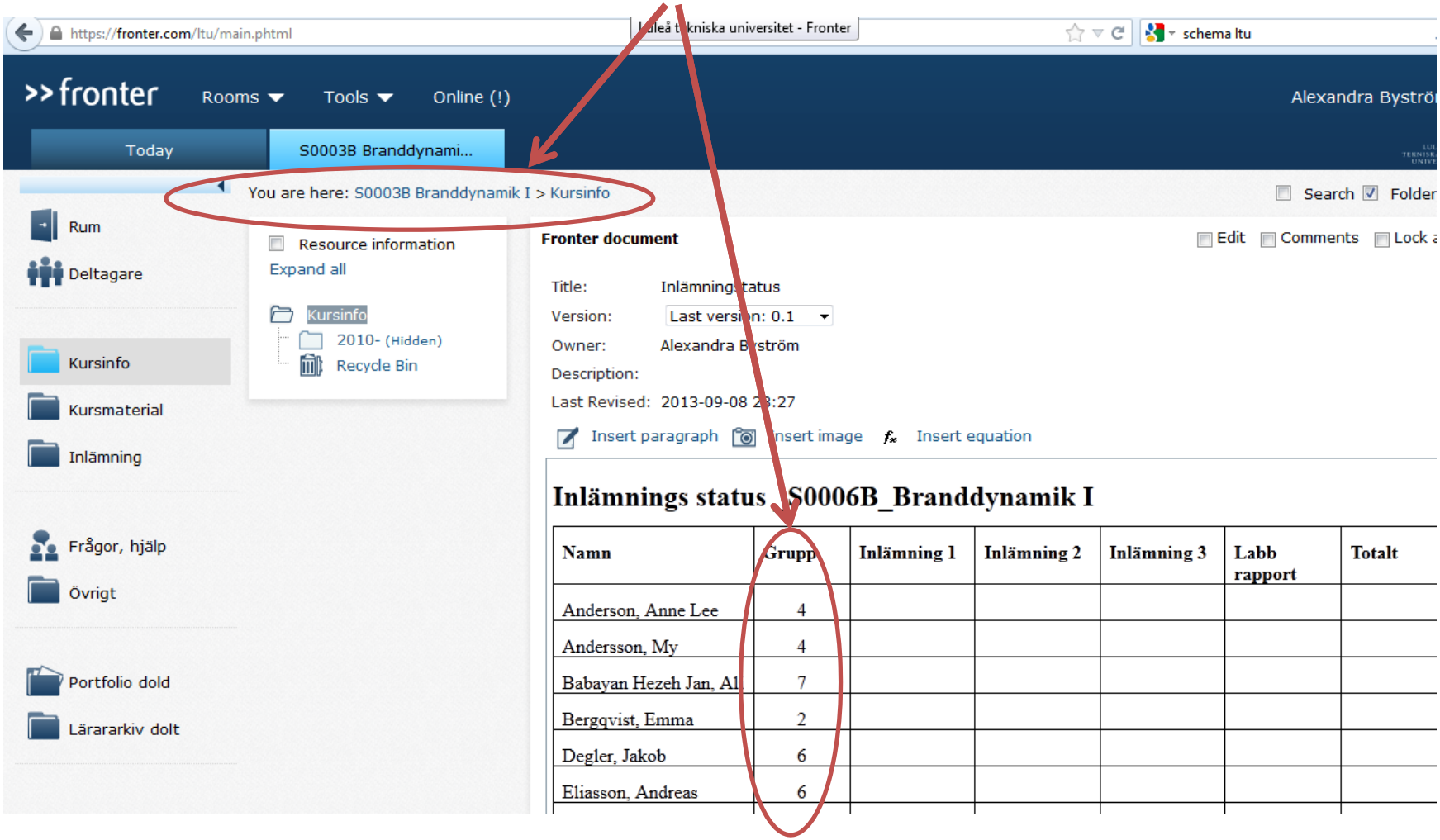
- Heat Release Rate
- Ignition Temperature
- Partical board (PB) and porous fiberboard (PF)
- Different effect of the incident radiation



# Lab 1. Important information

- *Date – **2nd and 3rd of October***
- Place – *Complab.* Fire corner.
- Groups of 3-4 people
- Lab report should be written in **ENGLISH** and handed in on the course Fronter page.
- Deadline - Wednesday the 10th of October
- Approved report will award to group of students 1.5 point.

# Groups


https://fronter.com/ltu/main.phtml
schema ltu
>>fronter
Rooms
Tools
Online (!)
Alexandra Byström
Today
S0003B Branddynami...
You are here: S0003B Branddynamik I > Kursinfo
Search
Folder
Rum
Deltagare
Kursinfo
Kursmaterial
Inlämning
Frågor, hjälp
Övrigt
Portfolio dold
Lärararkiv dolt
Resource information
Expand all
Kursinfo
2010- (Hidden)
Recycle Bin
Fronter document
Edit
Comments
Title: Inlämning status
Version: Last version: 0.1
Owner: Alexandra Byström
Description:
Last Revised: 2013-09-08 23:27
Insert paragraph
Insert image
Insert equation
Inlämnings status _S0006B_Branddynamik I
Namn
Grupp
Inlämning 1
Inlämning 2
Inlämning 3
Labb rapport
Totalt
Anderson, Anne Lee 4
Andersson, My 4
Babayan Hezeh Jan, Al 7
Bergqvist, Emma 2
Degler, Jakob 6
Eliasson, Andreas 6

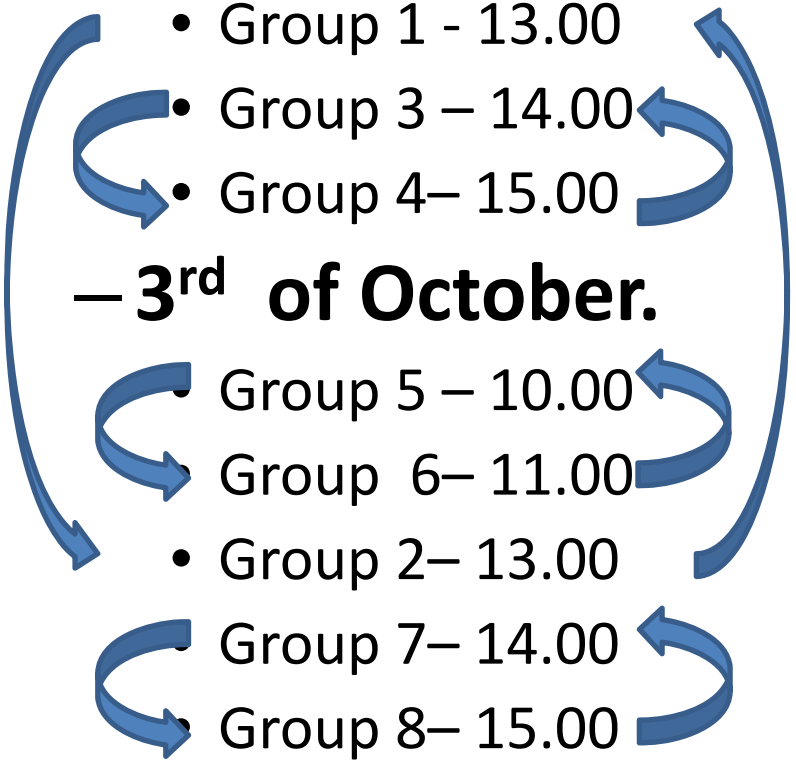
# Schedule

– **2nd of October.**

- Group 1 - 13.00
- Group 3 – 14.00
- Group 4– 15.00

– **3rd of October.**

- Group 5 – 10.00
- Group 6– 11.00
- Group 2– 13.00
- Group 7– 14.00
- Group 8– 15.00



# Questions

- What temperature should be set on the cone to get the incident radiation effect at
  - 20 $kW/m^2$
  - 40 $kW/m^2$?

  (According to the calibration data).

# Recordings

| | | |
|---|---|---|
| Time to ignition | $t_{ign\ PB}$<br>$t_{ign\ PF}$ | sec<br>sec |
| Samples dimensions (PB and FB) | L*B*H | m |
| Weight of samples | m | kg |
| Time of extinguished (PB and FB) | $t_{ext,\ PF}$<br>$t_{ext,\ FB}$ | sec |
| Heat release rate as a function of time | $\dot{Q}$ | $W/m^2$ |
| Peak rates of heat release (PHRR) | $\dot{Q}_{max}$ | $W/m^2$ |
| Time of maximum HRR (PHRR) | $t_{max\ HRR}$ | sec |
| Average effective heat of combustion | $\Delta H_{eff,\ average}$ | MJ/kg |
| Mass burning rate | $\dot{m}$ | g/sec |

# Ignition theory

- **piloted ignition** - the surface temperature of 250 ºC to 450 ºC.

- **auto ignition** - temperature exceeds normally 500 ºC.

# Questions

## Heat release rate??

Hint: Tsantaridis, L. Reaction to the fire performance of wood and other building products. Doctoral thesis. KTH. 2003

# Report

Short and clear

# Use in your report

- Diagrams
  - Temperature
  - Heat release rate
  - Burning rate on your choice
- Picture from experiment (take a camera)
- Tables
- Ets