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Experimental study of biomass fast pyrolysis

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Experimental study of biomass fast pyrolysis

GREENER group
20 persons on biomass valorization
Laboratory of Reactions and Processes Engineering (LRGP)
CNRS, University de Lorraine
Nancy, France

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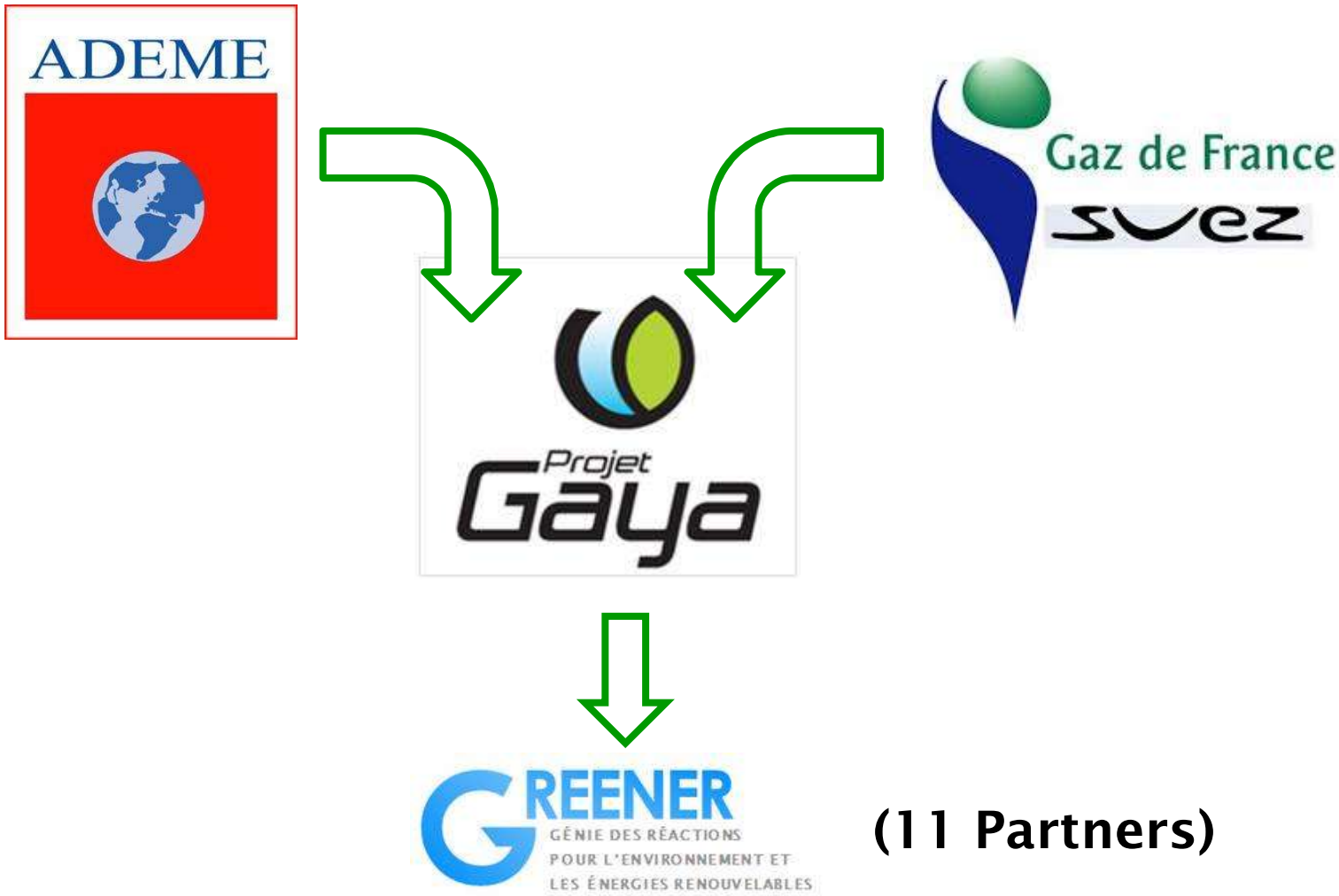
Biorefinery I : Chemical and Materials from Thermo-Chemical Biomass Conversion and Related Processes

September 27-october 02, 2015
Chania (Crete) , Greece



(11 Partners)

Dual Fluidized Bed Gasifier

Detailed modeling of dense and dual fluidised beds
(collaboration with EDF)

Freeboard model:

Kinetics of:

Water Gas Shift,

Methane reforming

Gas-phase and catalytic tar conversion

+ enthalpy balance

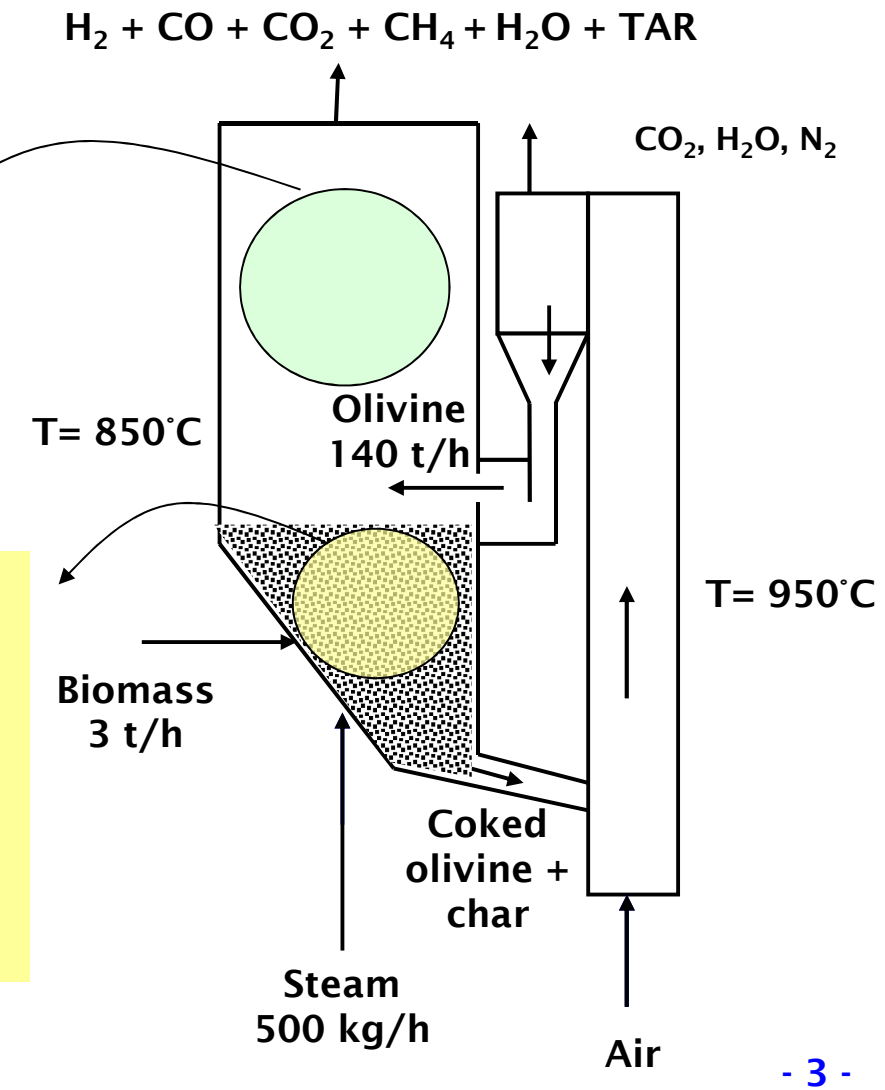
Dense bed model:

Fluidised bed hydrodynamics

Steam and heat transfer to biomass particles

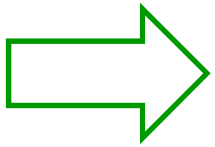
Particle model (internal heat transfer, drying, pyrolysis, char gasification)

Gas-phase reactions



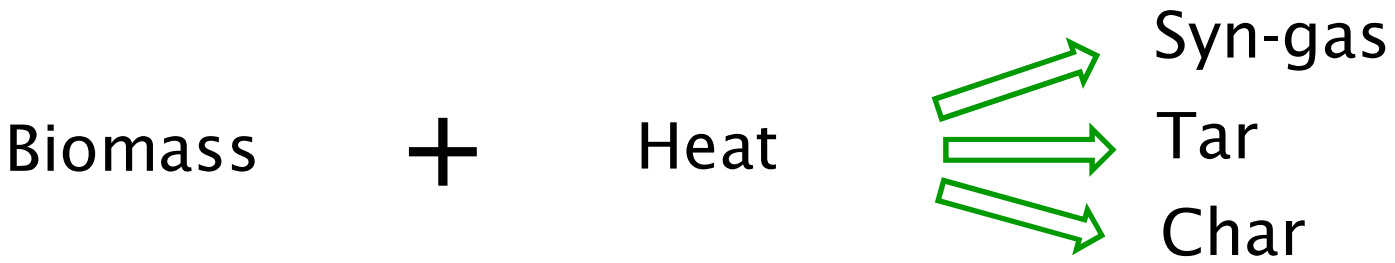
Objectives

Experiments of pyrolysis in the image furnace



Dual fluidized bed gasifier

Understand the phenomenon of fast pyrolysis of the biomass



Biomass nature

Powdered biomass:

(54 types of biomass)

Wood pellets:

- beech
- spruce

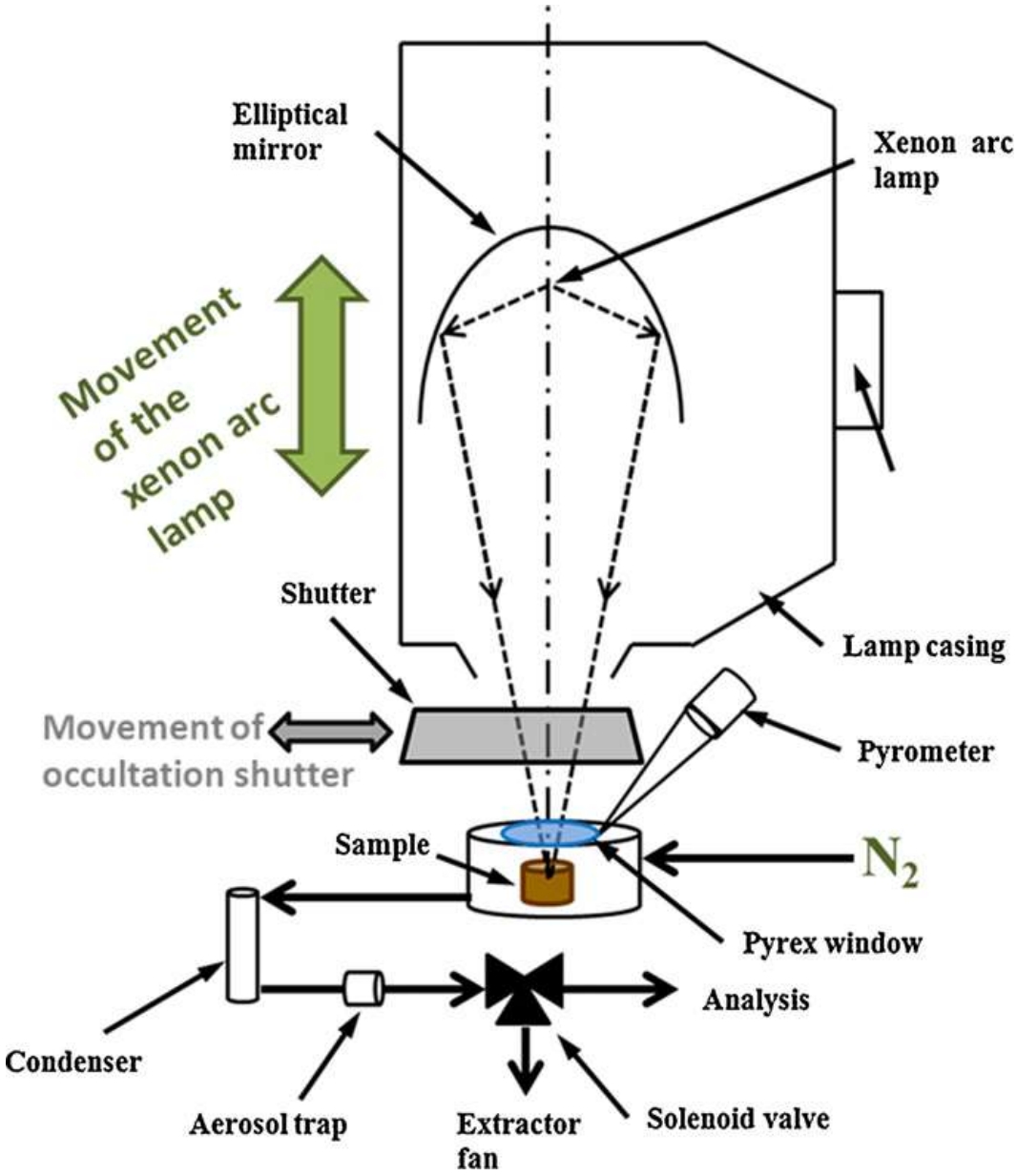
Samples

$$Lc = \frac{V}{S}$$

Diameter=6 mm
Length=20 mm

thickness=1.3 mm

Experiments on primary pyrolysis are conducted in an image furnace.



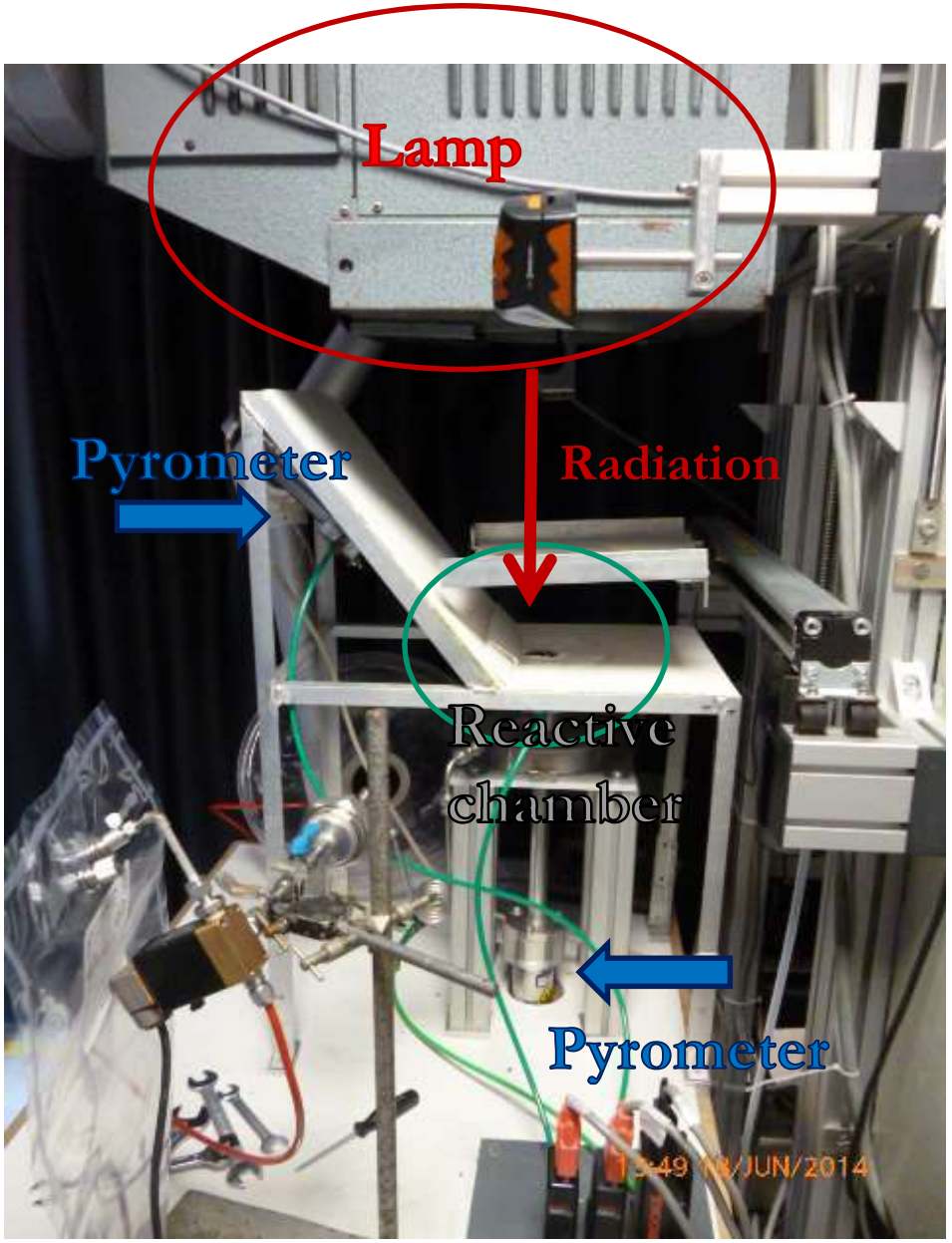
Christodoulou et al.

J. Anal. Ap. Pyrol. 2013

Image furnace

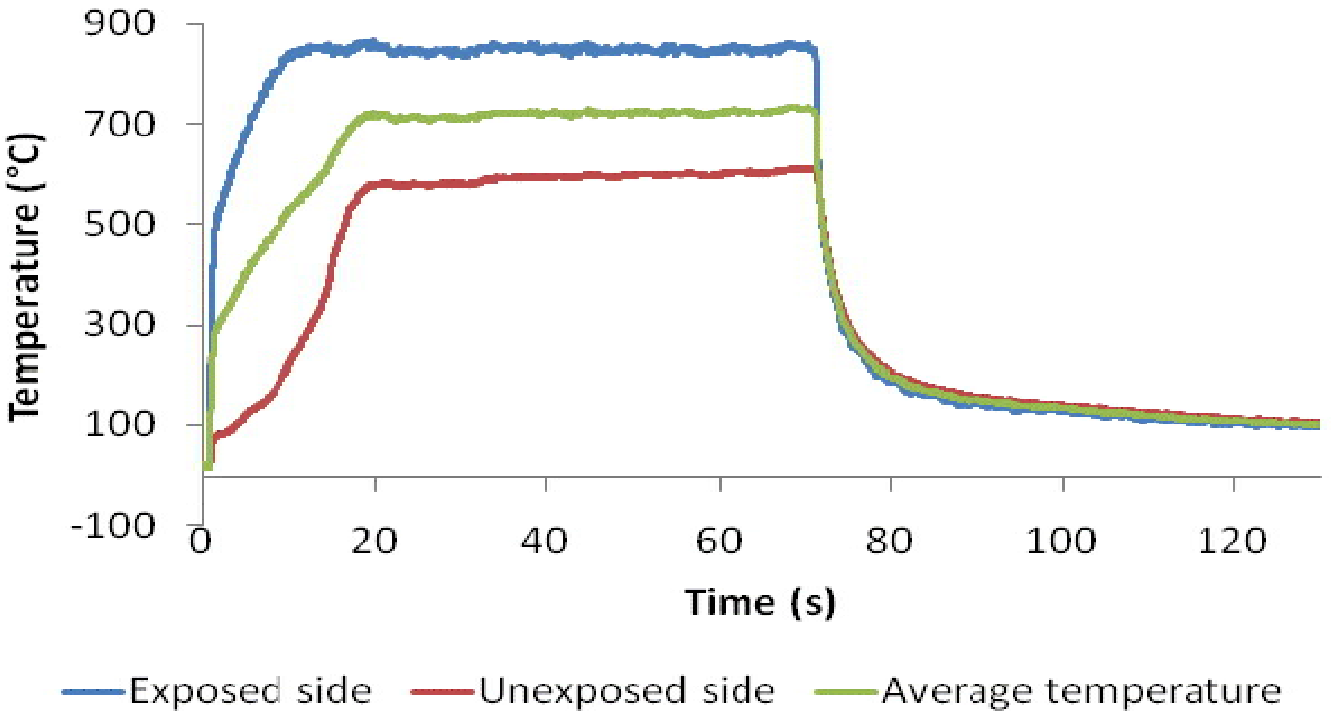
Xenon arc lamp

- Reactive chamber: Nitrogen Atmosphere
- temperature profile measured on both sides of the sample.



Evolution of Temperature

To reproduce the dual fluidized bed gasifier conditions of GAYA project



Experimental results

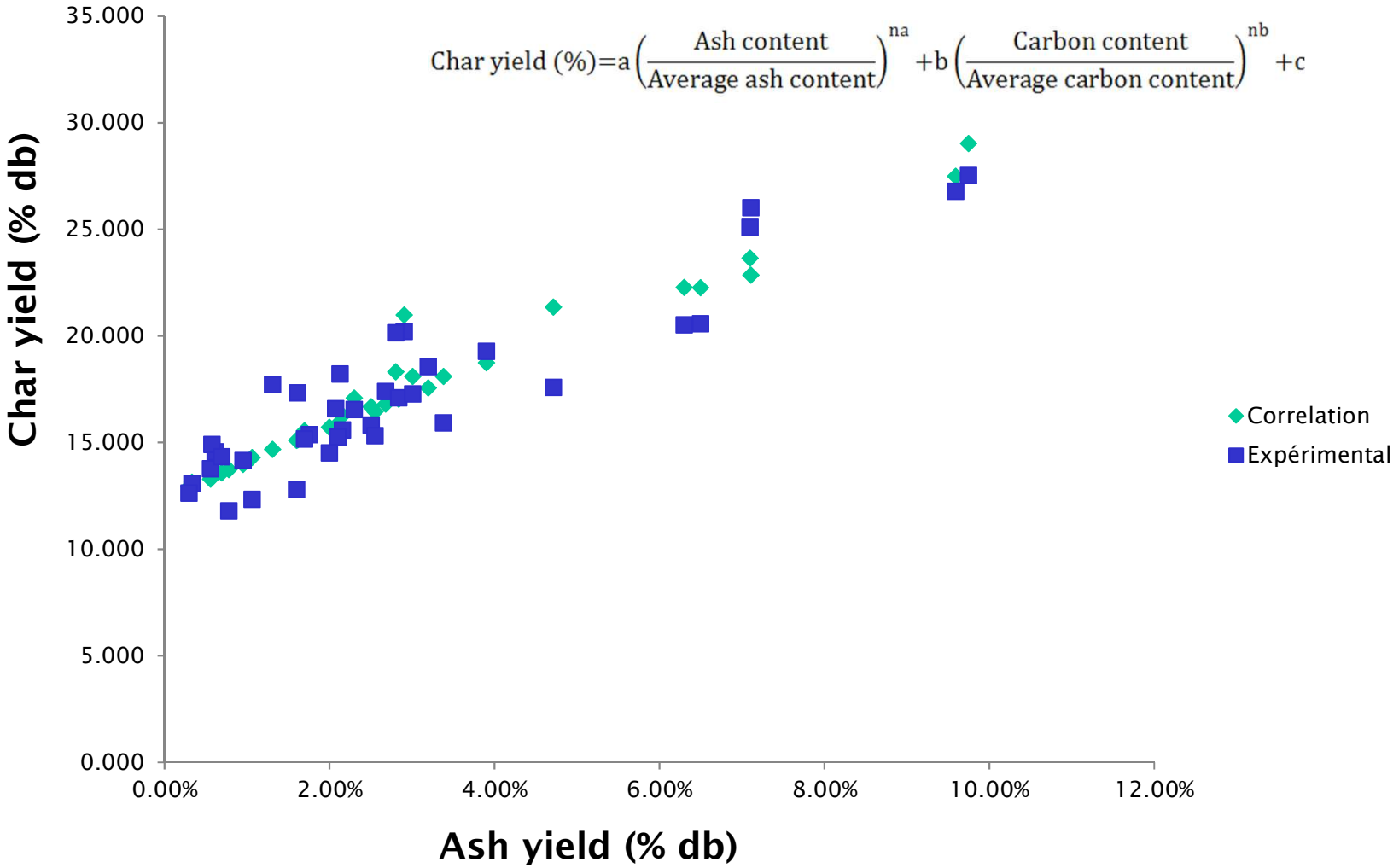
- Char yield for 54 kinds of biomass
  - Recovery of solid residues

- Mass balance for 3 kinds of biomass
  - Recovery of solid and gaseous products
  - Gas Composition

Char yields
on 54 kinds of Biomass

Species	Biomass category	Char yield (% db)	Average temperature (°C)
beech	roundwood	12,8	696
spruce	roundwood	14,6	700
spruce	Residuals	20,1	713
Douglas	Residuals	20,2	678
Miscanthus	energy crop	17,3	568
Sweet chestnut tree & Locust tree & Oak	Wood wastes from sawmill	15,6	695
Switchgrass	energy crop	17,3	657
Wheat straw	straw	26,0	616

Correlation

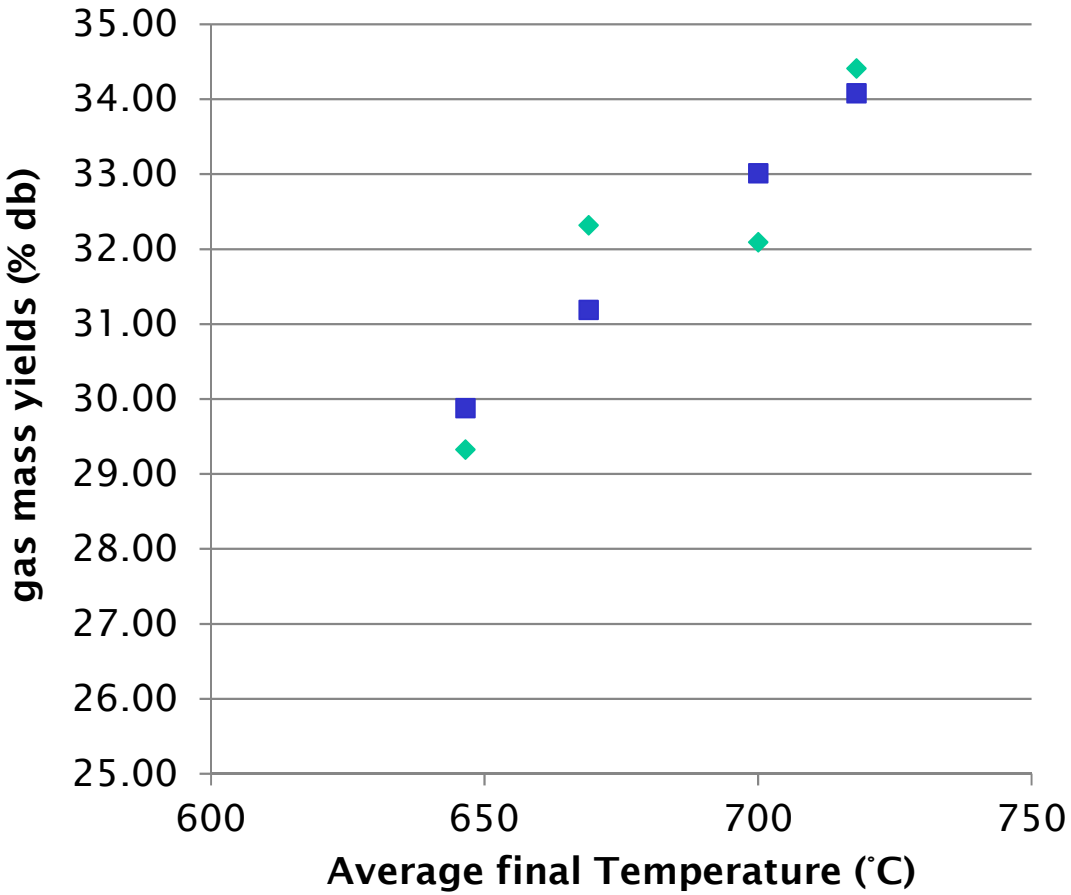


Full balances on 3 Biomasses

Species	% Char (db)	% oil (db)	% Gas (db)	Average Temperature (°C)	Thickness (mm)
Beech	14,5	60,5	29,1	606	1,80
Beech	14,5	56,2	30,6	619	1,91
Triticale	20,4	50,2	29,3	646	2,01
Triticale	21,8	45,9	32,3	669	1,96
straw	26	41,5	32,5	640	1,95
straw	25,7	39,5	34,8	651	2,05

Correlation - Triticale

$$\%\ \text{mass of gas} = a\left(\frac{\text{Average final temperature}}{\text{Mean of average final temperatures}}\right)^{b}$$



Parameters	Values
a	32
b	1,2

◆ Experimental
■ Correlation

Gas Composition

Pyrolysis gas

Micro-GC 490 Varian

- Hydrogen
- Carbon monoxide
- Carbon dioxide
- Methane
- Acetylene
- Ethylene
- Ethane
- Propene

Conclusion

- Coal: average yields between 11 and 32%
- Excellent reproducibility
- Influence of the temperature:
  - Char yield : weak
  - Gas yield and composition : strong
- Correlations were established for the influence of several properties on the yields

Stanislas place

▪Laboratoire Réactions et Génie Chimique, CNRS, Université de Lorraine

Thanks for your attention !!

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