

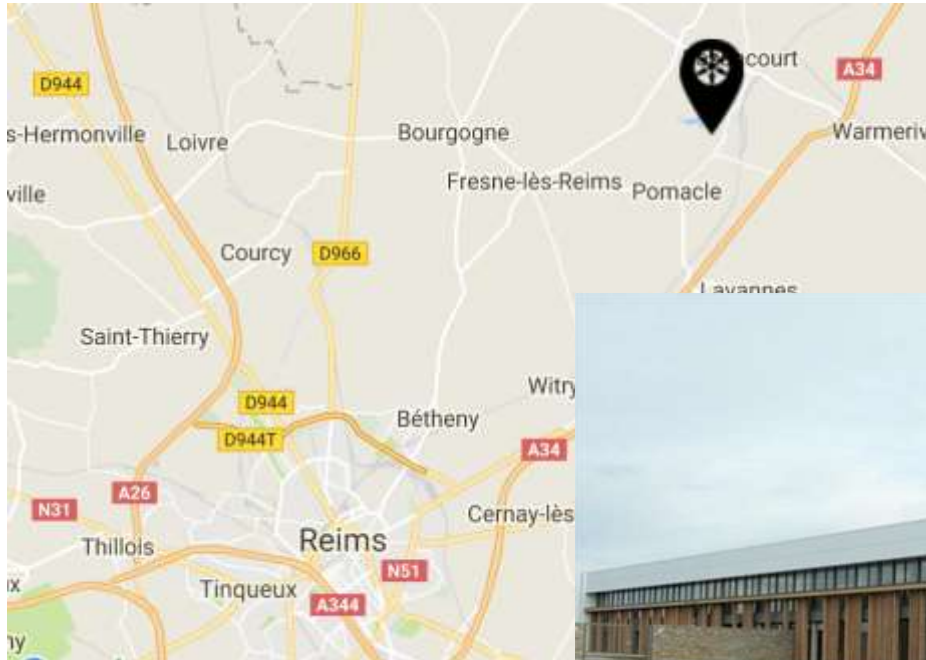
Upscaling/downscaling en bioprocédés : synergie
entre expérimentation et modélisation

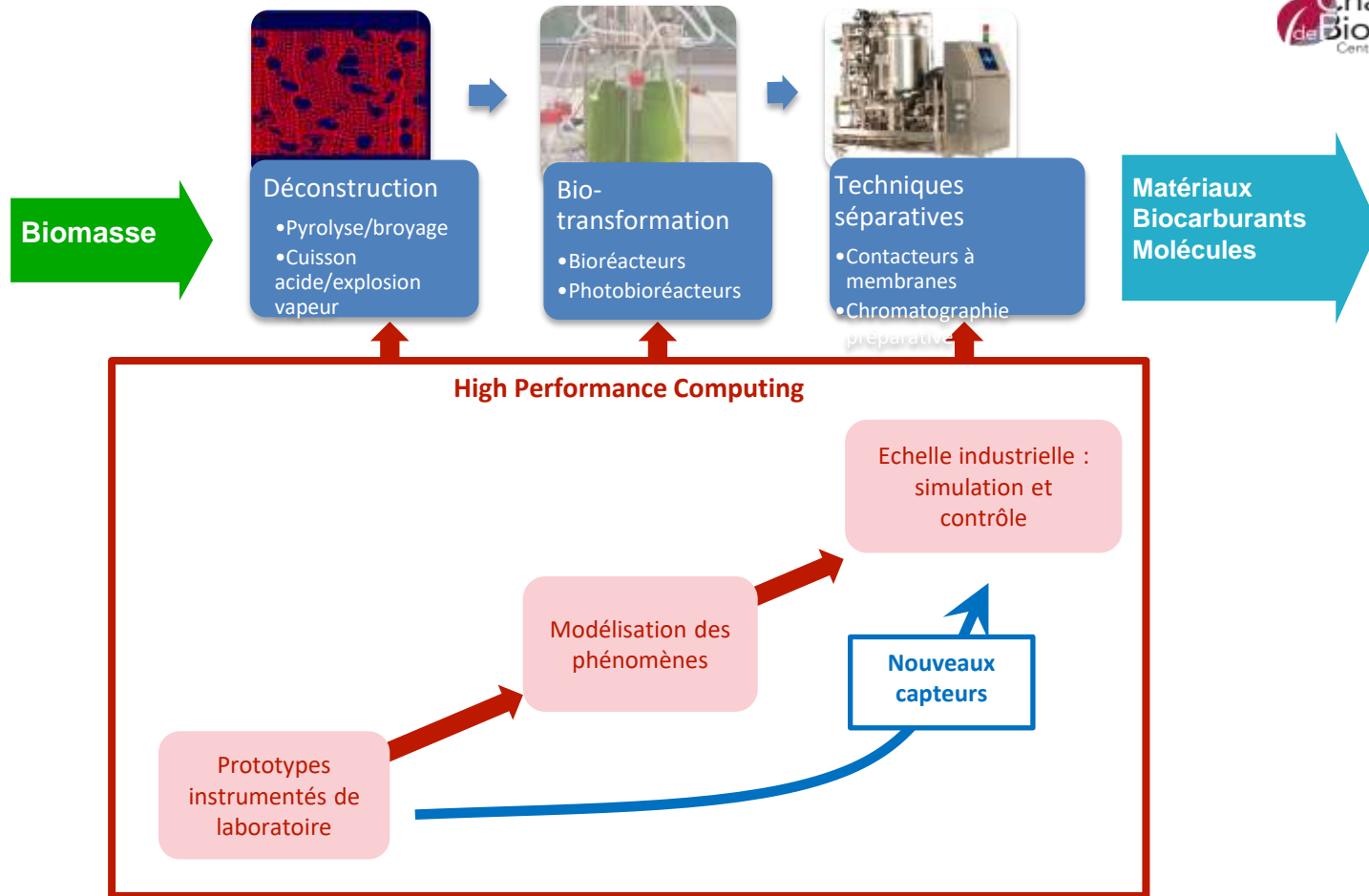
Prof. Patrick Perré

Plan

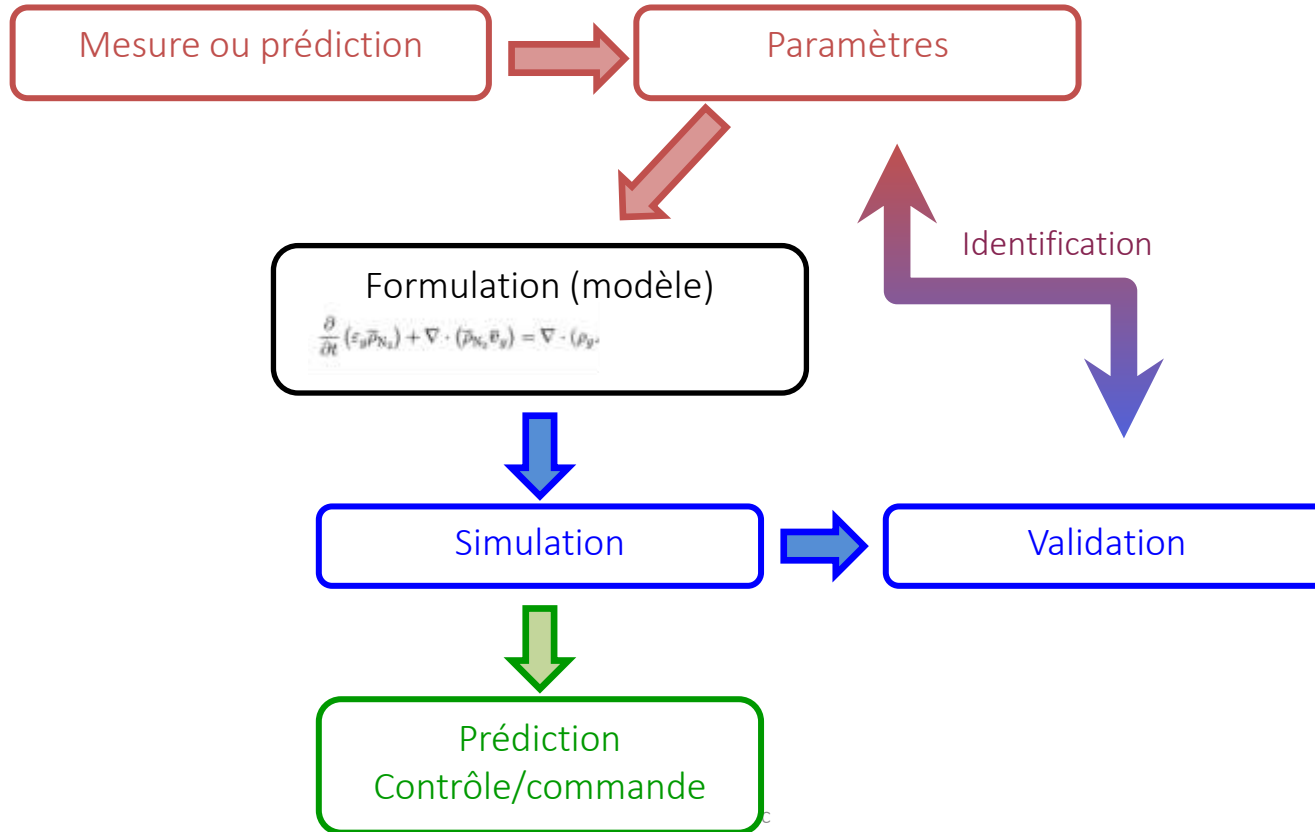
- Quelques mots sur CEBB et chaire biotechnologie de CS
- Modélisation prédictive et changement d'échelle
- Quelques exemples d'application
 - Séchage bois énergie
 - Fermentation
 - Bio-matériaux
- Perspectives

Le CEBB à Pomacle

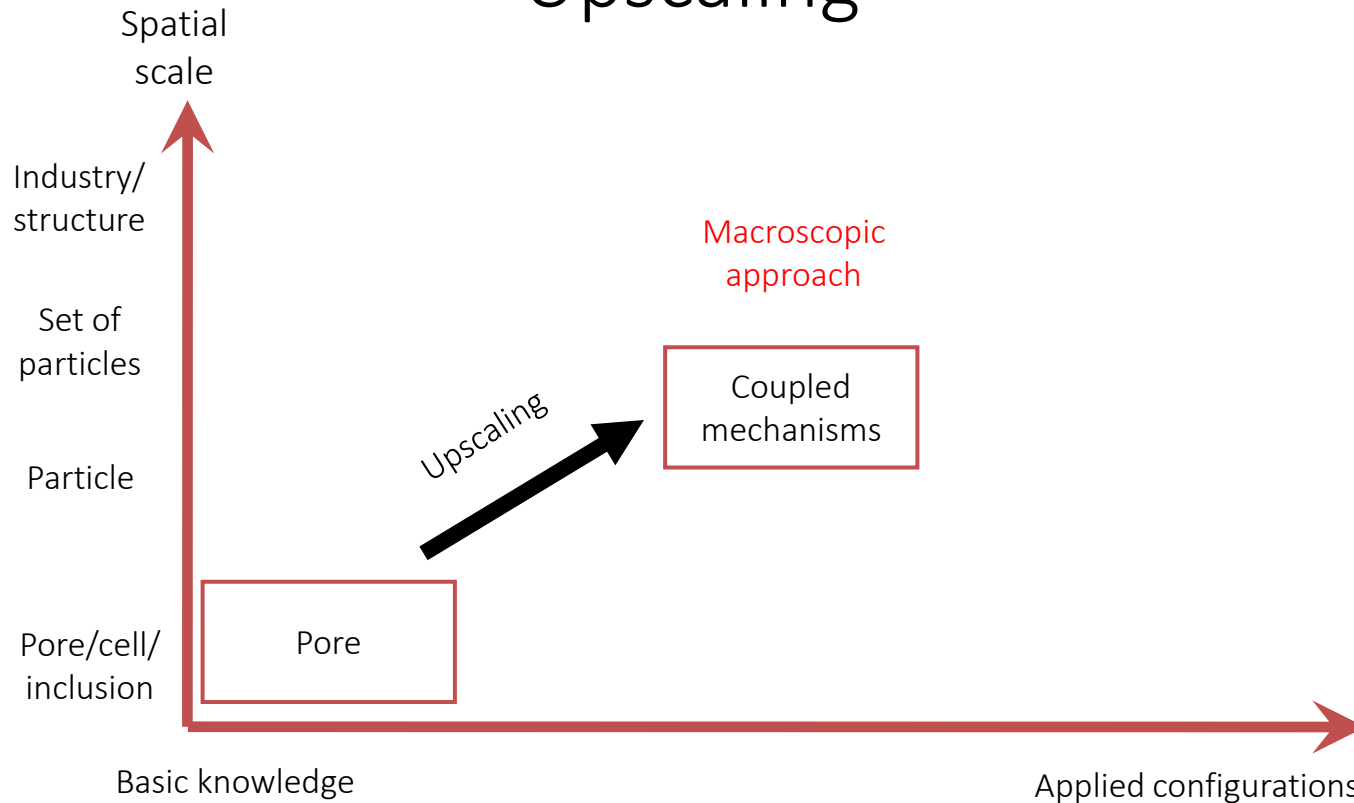




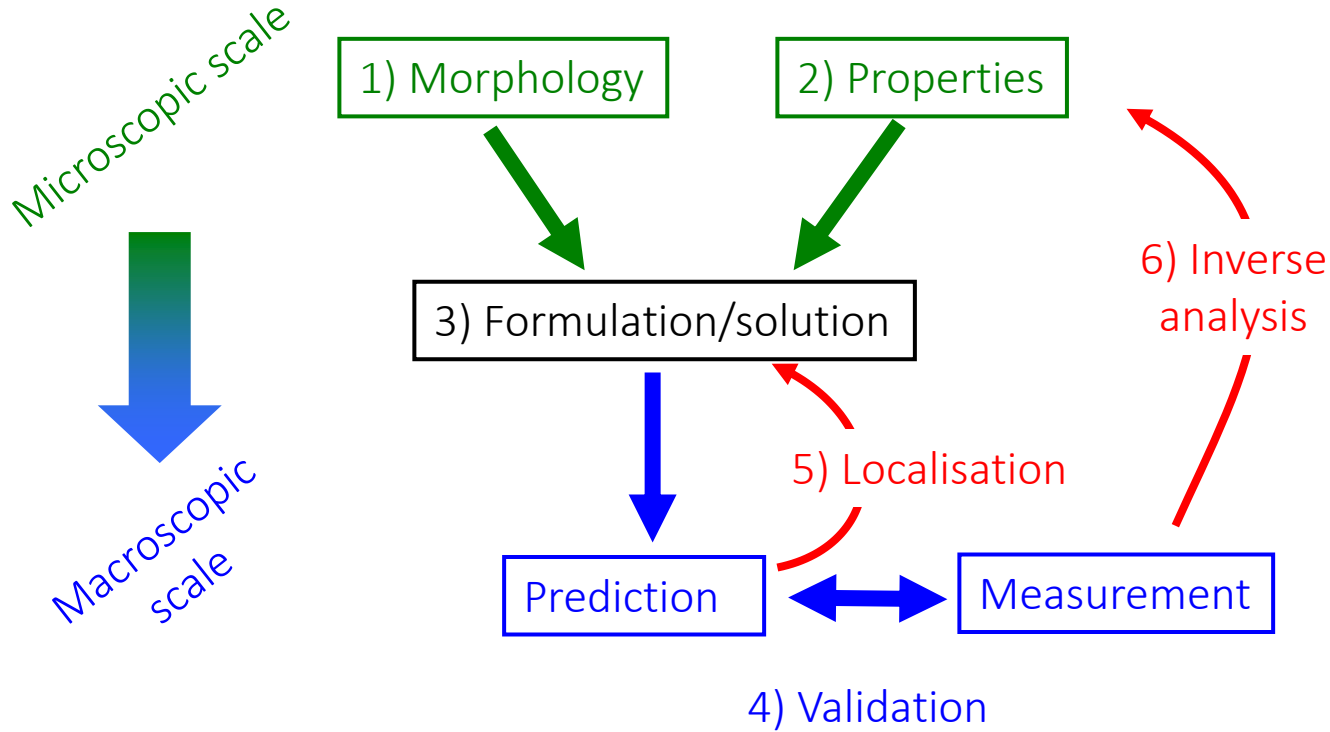
La simulation prédictive



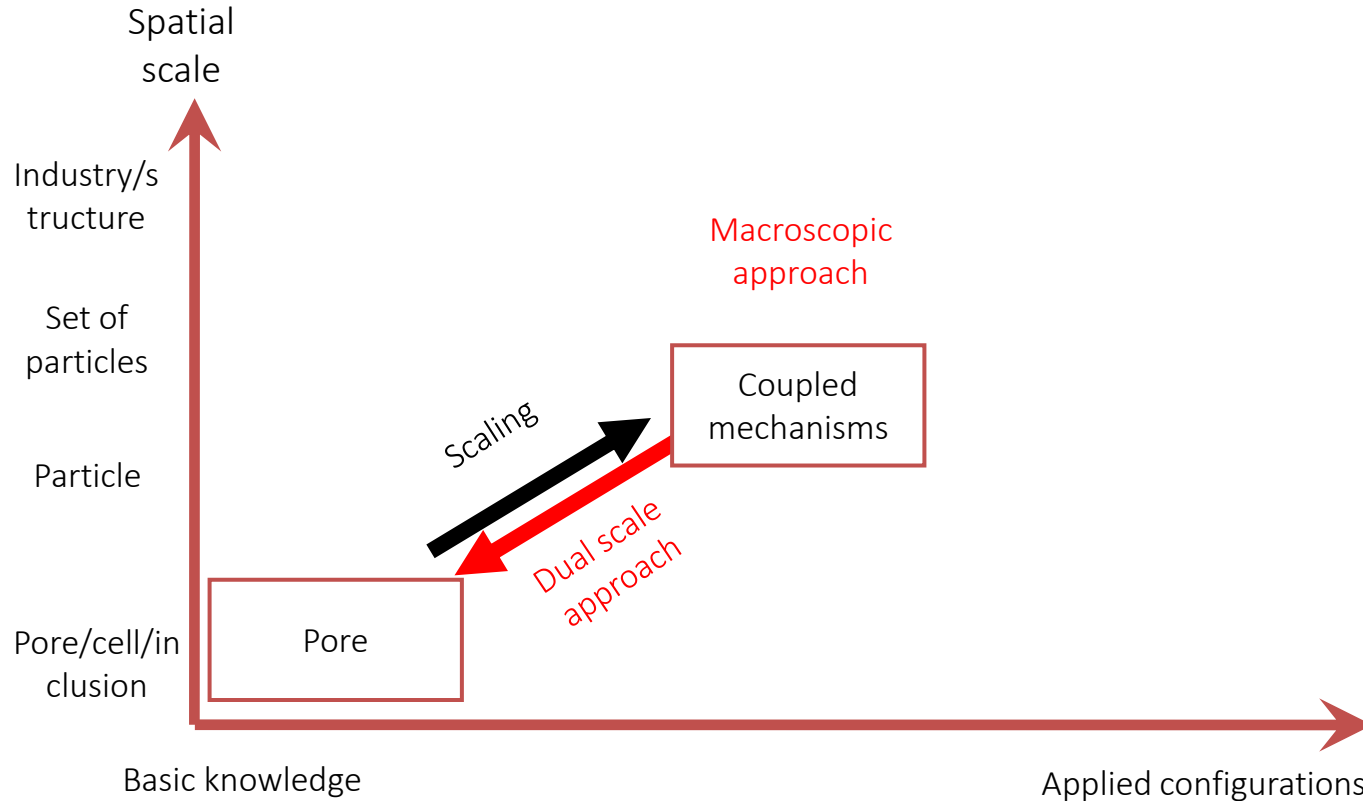
Upscaling



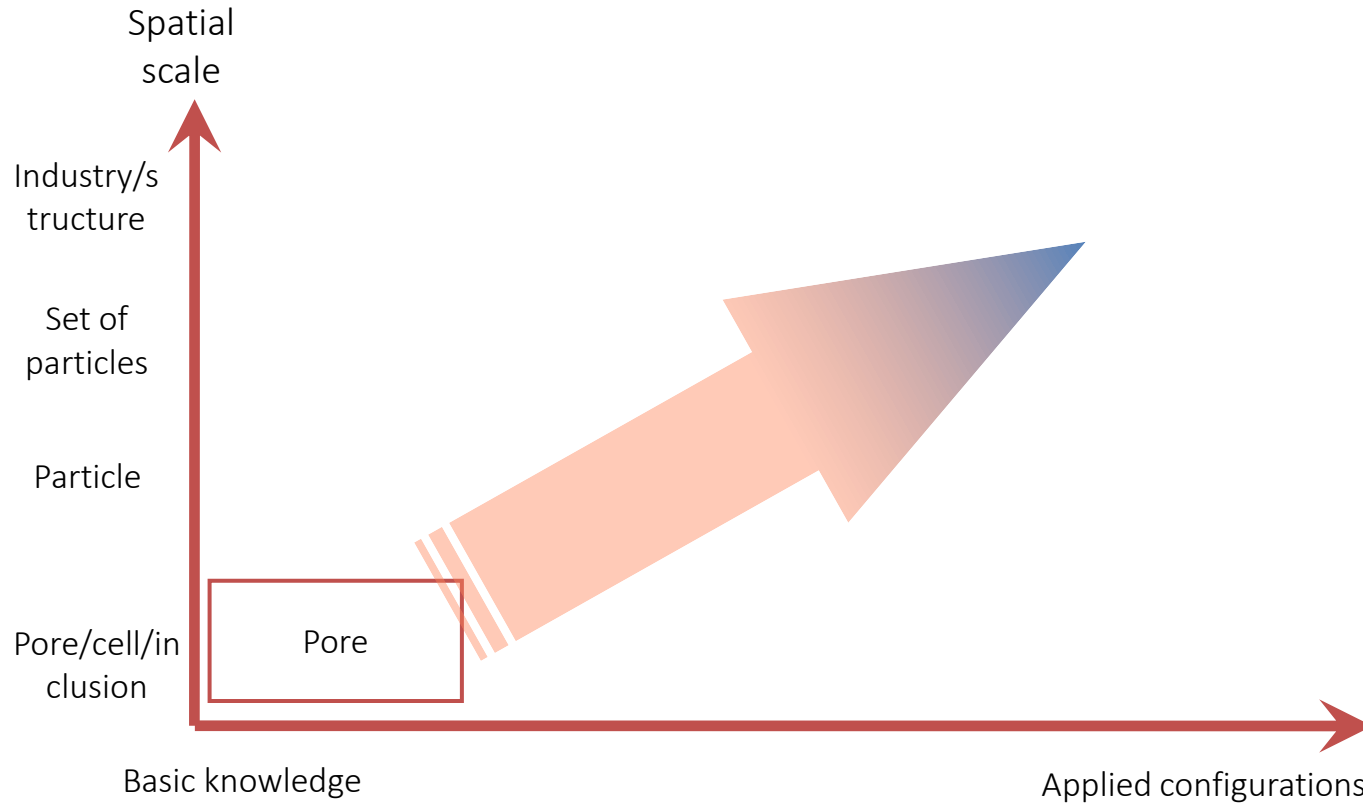
Principle of upscaling



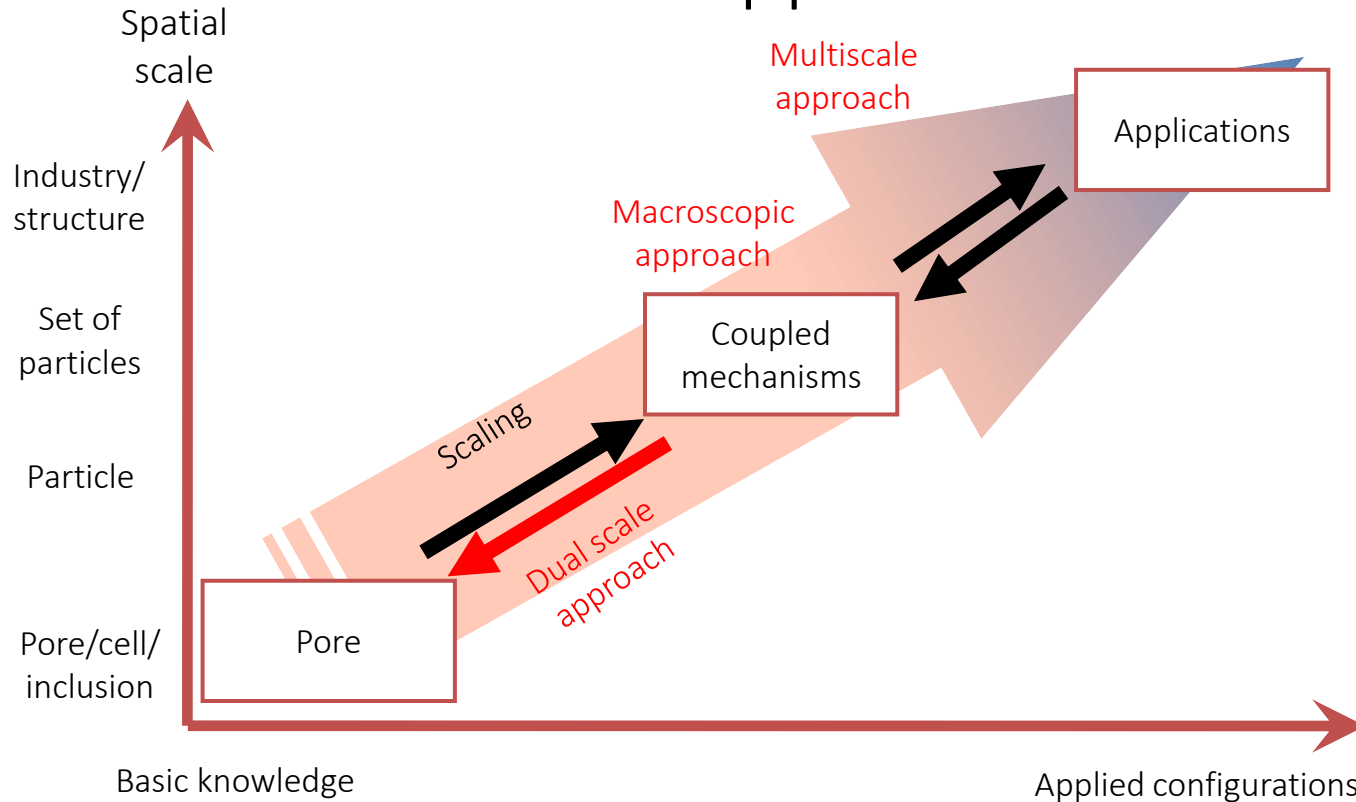
Multiscale approach



Downscaling ?



Towards applications

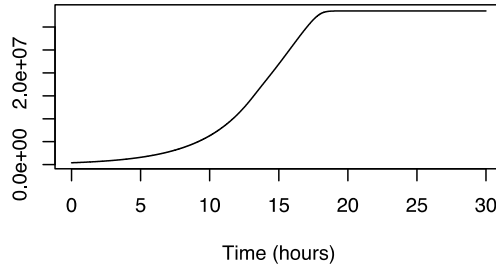


Quelques exemples d'application

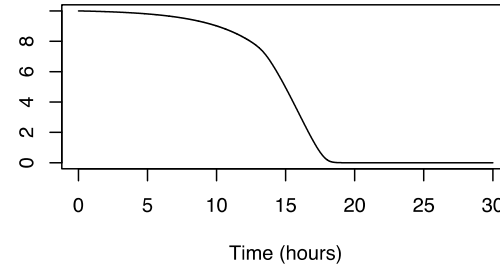
Exemple sur levure (respiration → fermentation)

Modèle bioréacteur

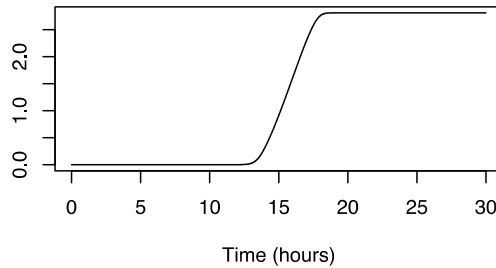
Levure



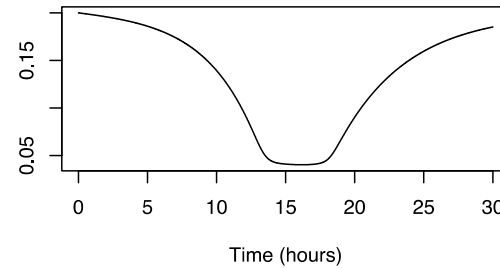
Glucose



Ethanol



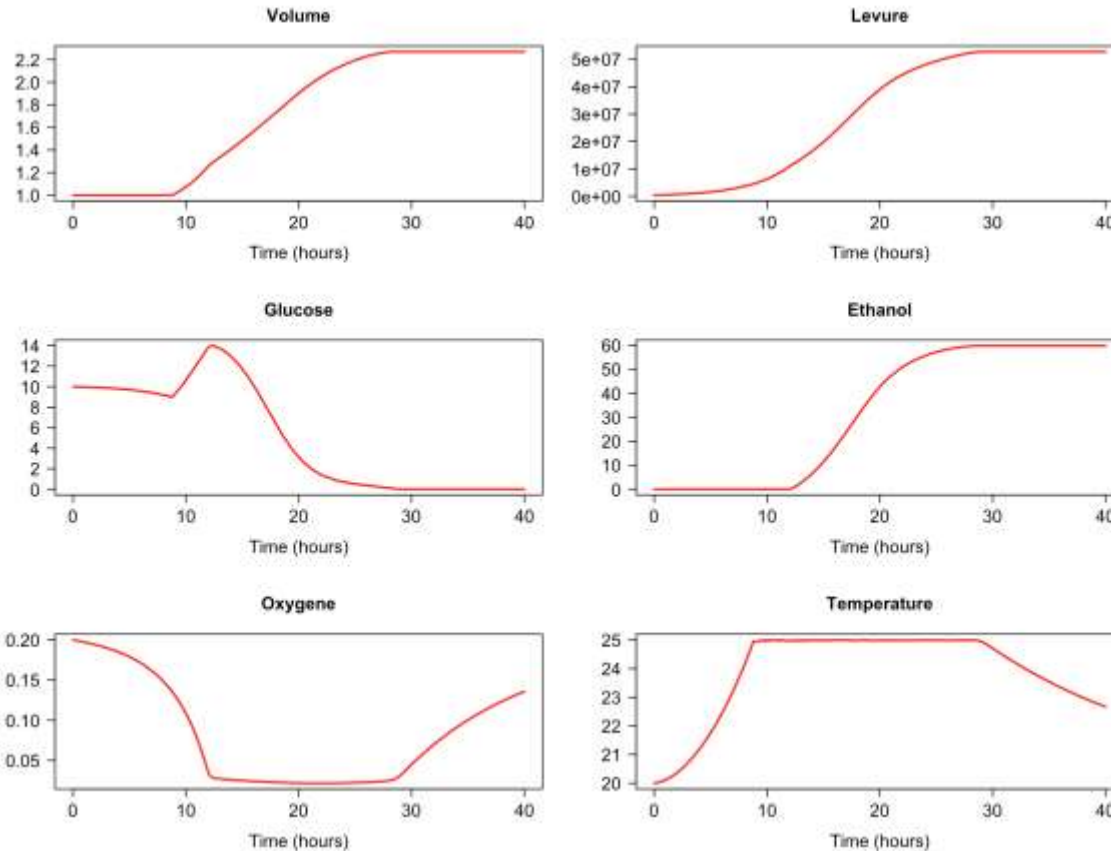
Oxygene



Contrôle d'un fermenteur par T

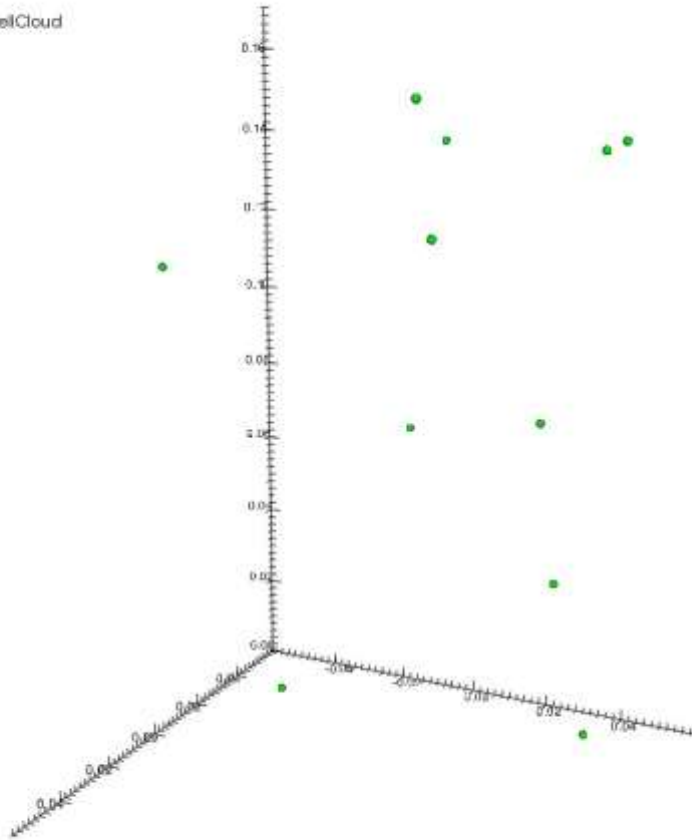


Contrôle d'un fermenteur par T



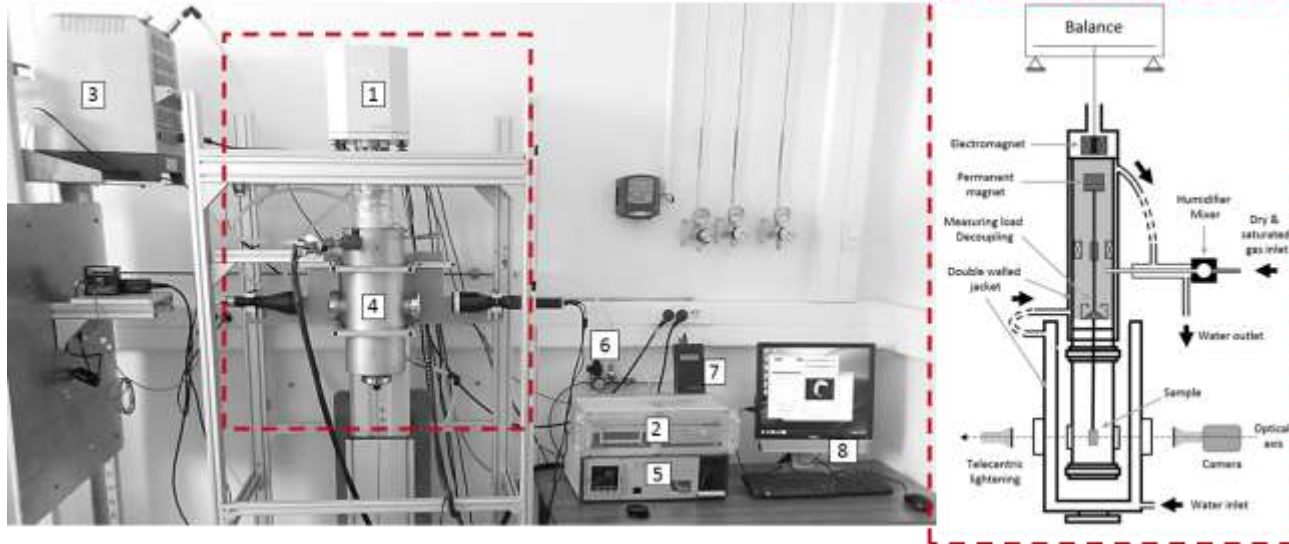
DB: T
Time:0

Mesh
Var: lagrangian/cellCloud

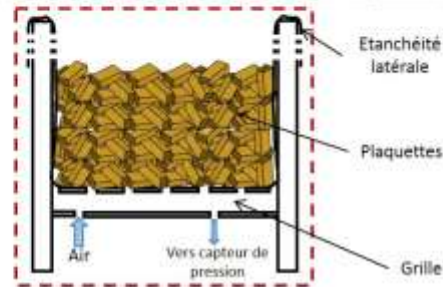
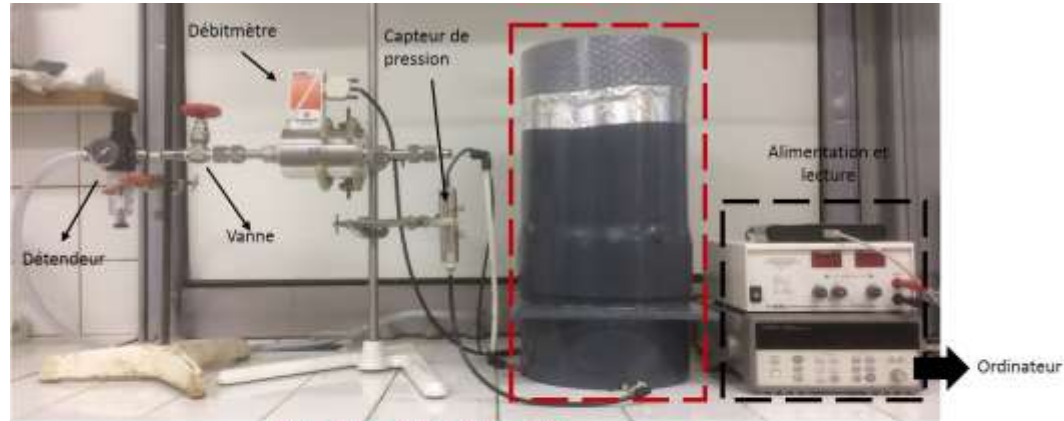


Victor Pozzobon, 2016

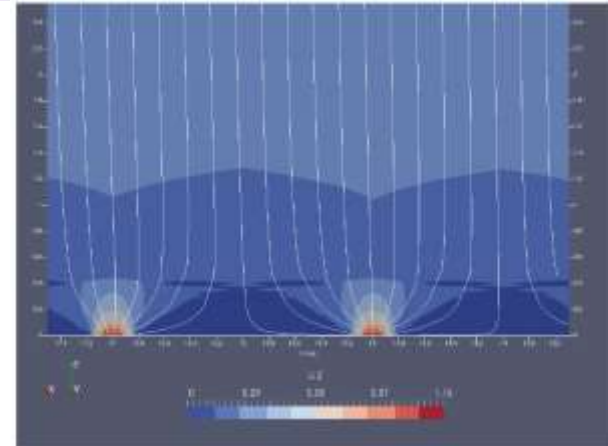
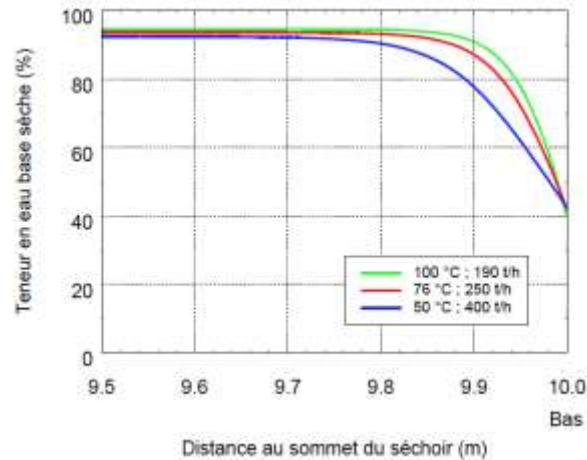
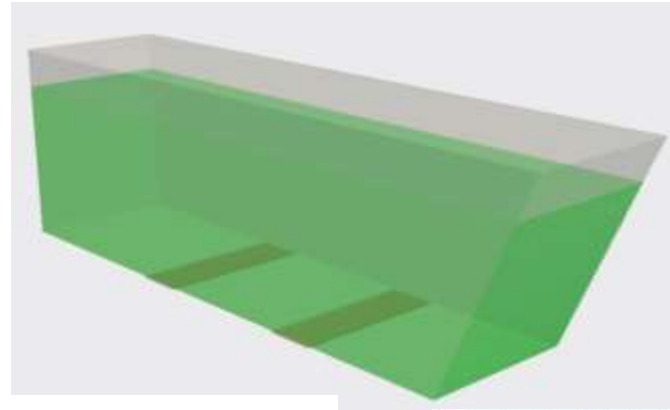
Préséchage bois énergie



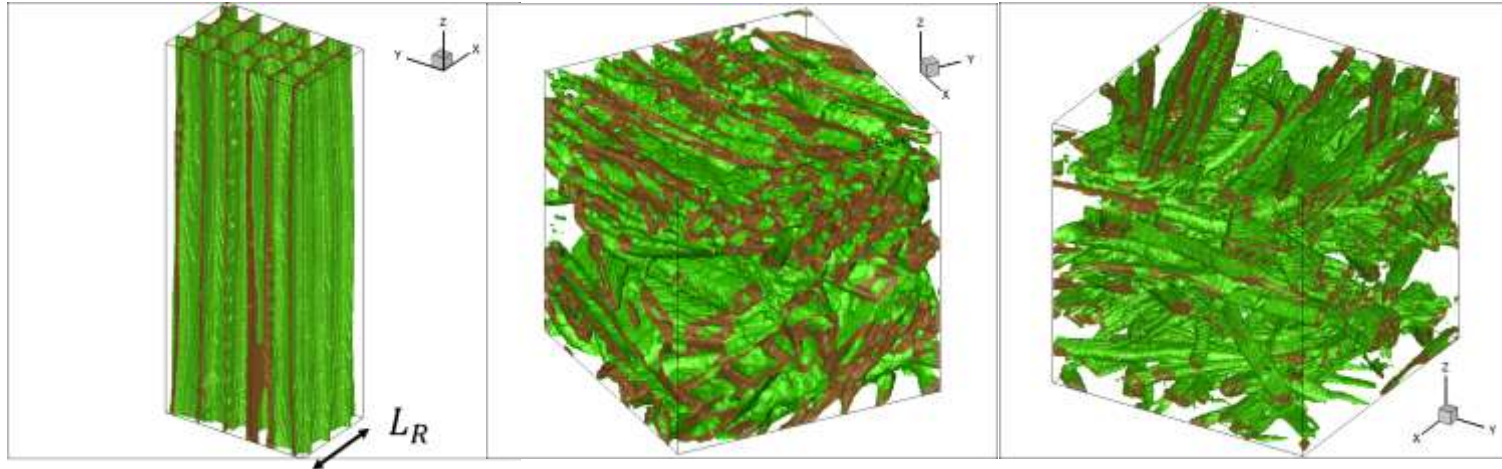
Préséchage bois énergie



Préséchage bois énergie



Matériaux biosourcés

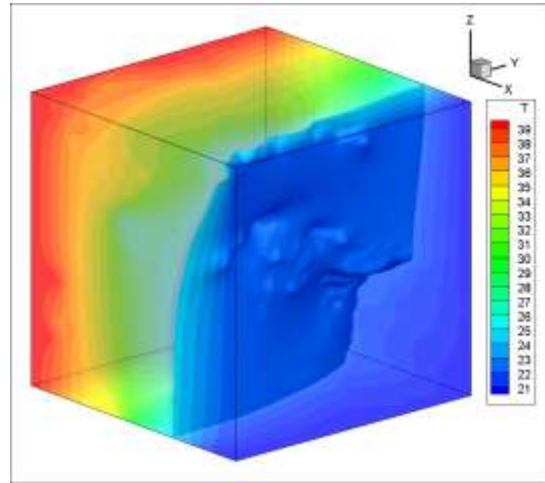


Spruce, earlywood
($435 \text{ kg} \cdot \text{m}^{-3}$)

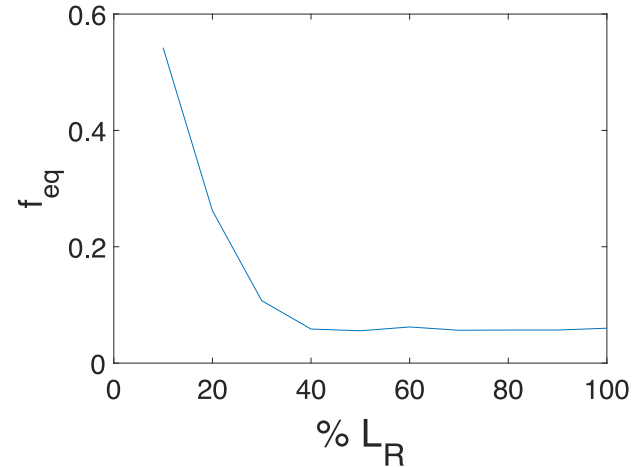
MDF
($645 \text{ kg} \cdot \text{m}^{-3}$)

LDF
($270 \text{ kg} \cdot \text{m}^{-3}$)

LB modelling (parallelised with OpenMP)



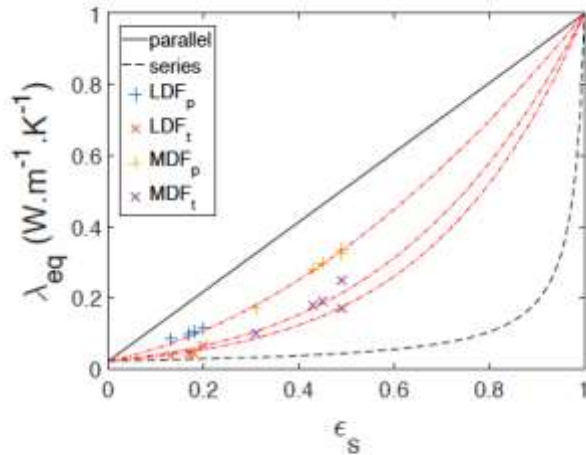
Isovalues (LDF, thermal problem)



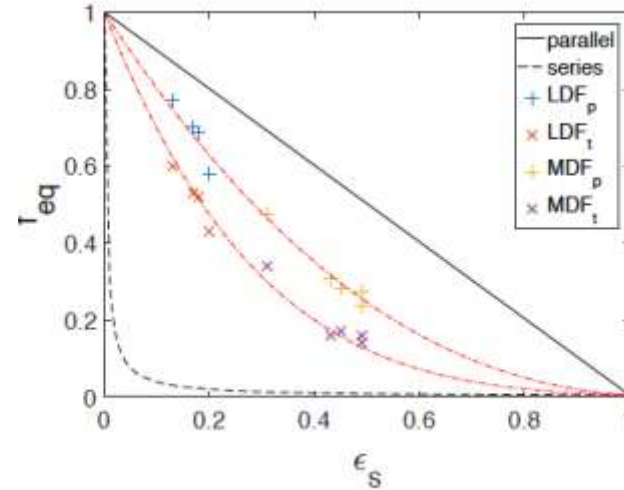
Convergence with the size of the unit cell

Property predictions

$$\Gamma_{\mu} = (\epsilon_g \Gamma_g^{\mu} + \epsilon_s \Gamma_s^{\mu})^{1/\mu}.$$



(a) Thermal diffusion: $\mu(\text{LDF}_t) = 0.11$; $\mu(\text{MDF}_t) = 0.22$
; $\mu_p = 0.53$



(b) Mass diffusion: $\mu_t = 0.18$; $\mu_p = 0.43$

Louërat, Ayouz, Perré, submitted

Un nanotomographe au CEBB



400 nm spatial resolution, \approx 5-hour scan time

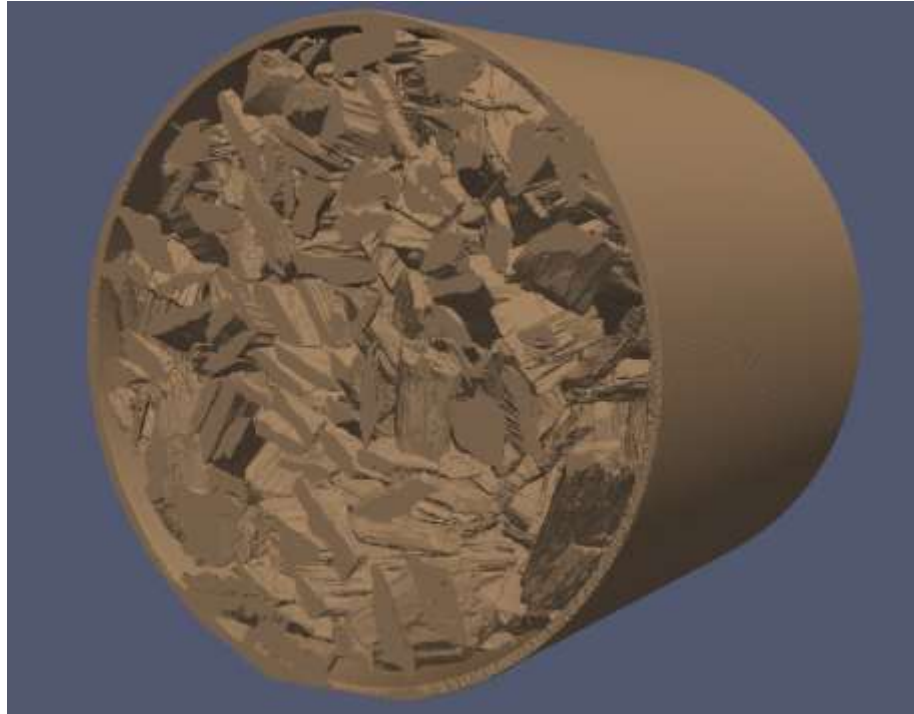
Exemple : composite EcotechLin



Exemple : composite EcotechLin



Ecoulement en milieux fragmentés



Quelques perspectives

- Ensemble de bioréacteurs et photobioréacteurs instrumentés
 - Données pour modèles biologiques
 - Downsizing
- Techniques séparatives
- Nouveaux capteurs
 - Chaire photonics de CentraleSupélec Metz
- Développement d'outils numériques spécifiques