

# Cast iron containers

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Multiscale Material Modeling – Cenaero

# Introduction

## Objective

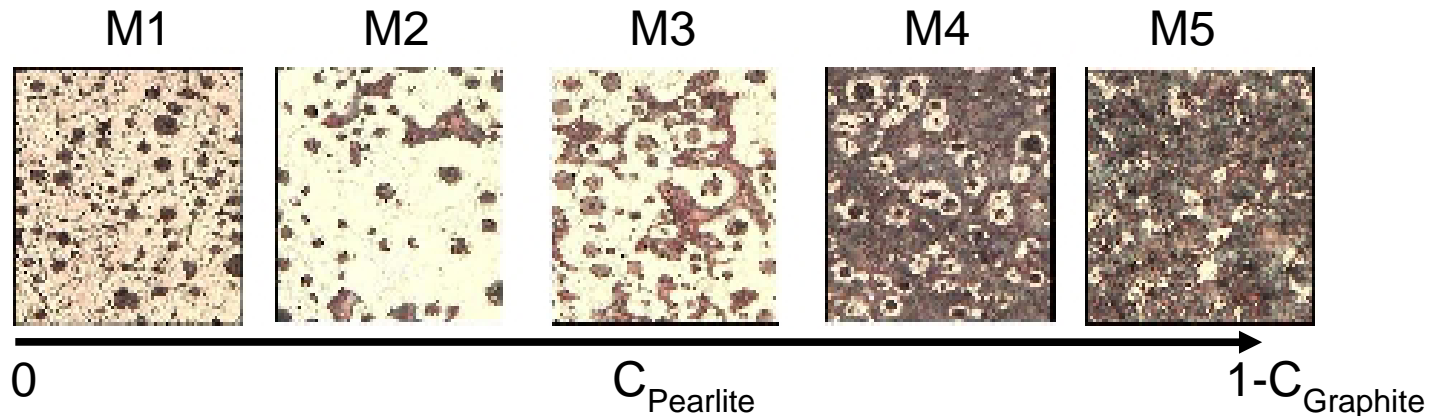
*To build up a flexible micro-macro model for the mechanical behaviour of spheroidal cast iron*

## Model requirement

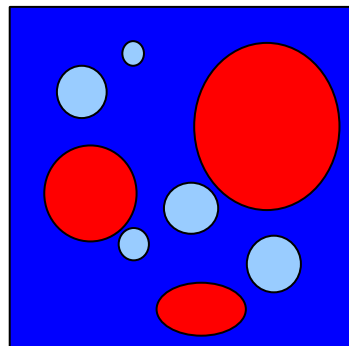
- good **overall** composite description
- good **phases** descriptions
- **fast** computation

→ Analytical model

## Real $\mu$ -structures



## Model $\mu$ -structures

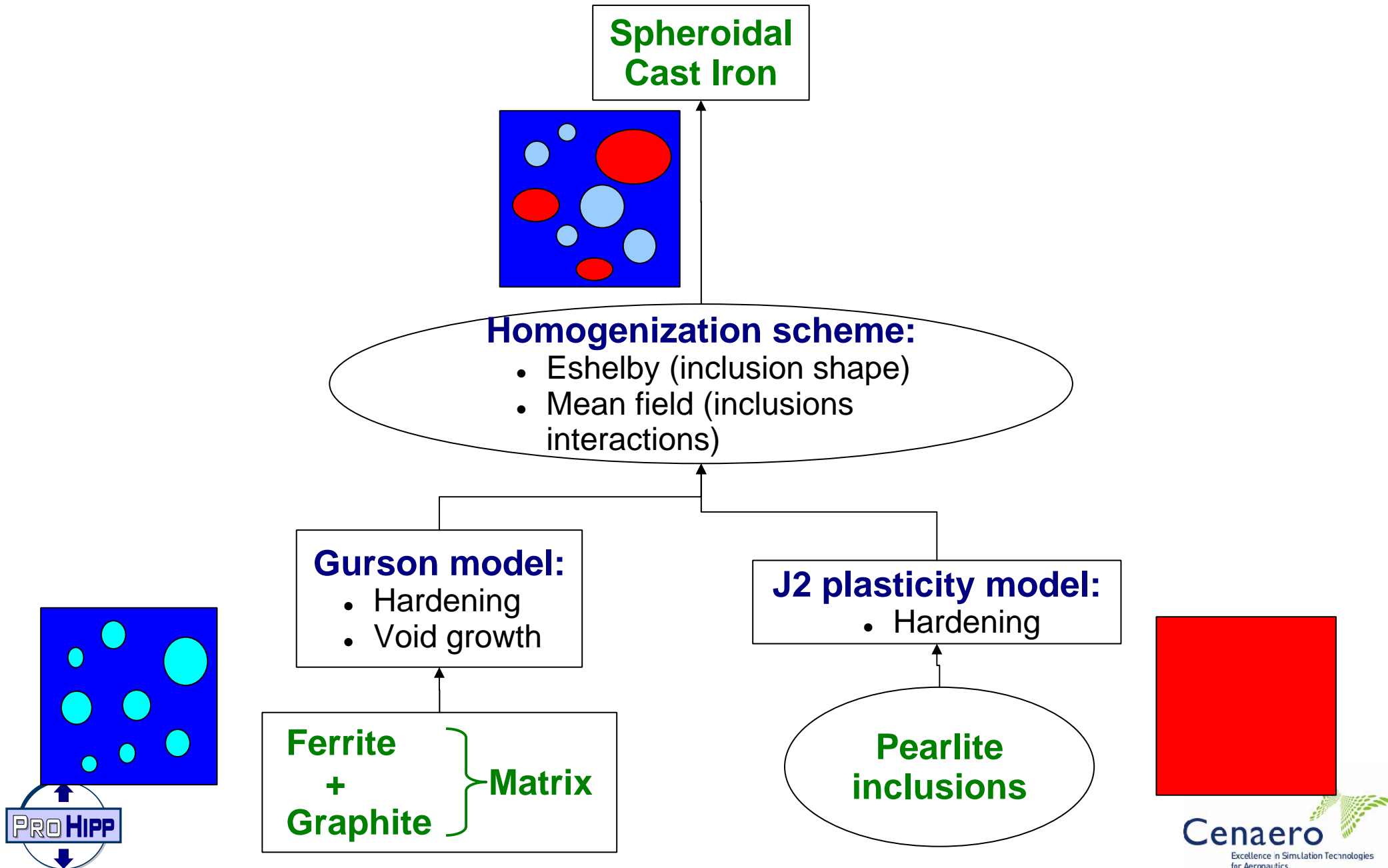


Ferrite = Matrix

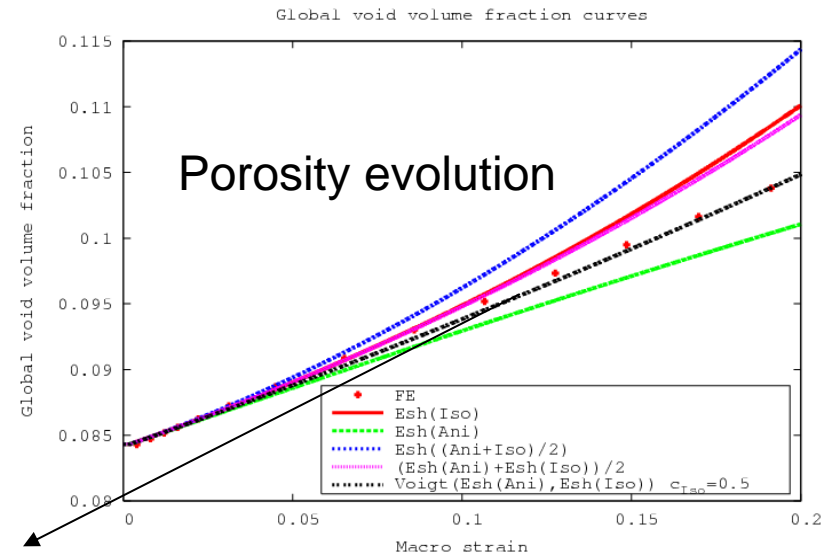
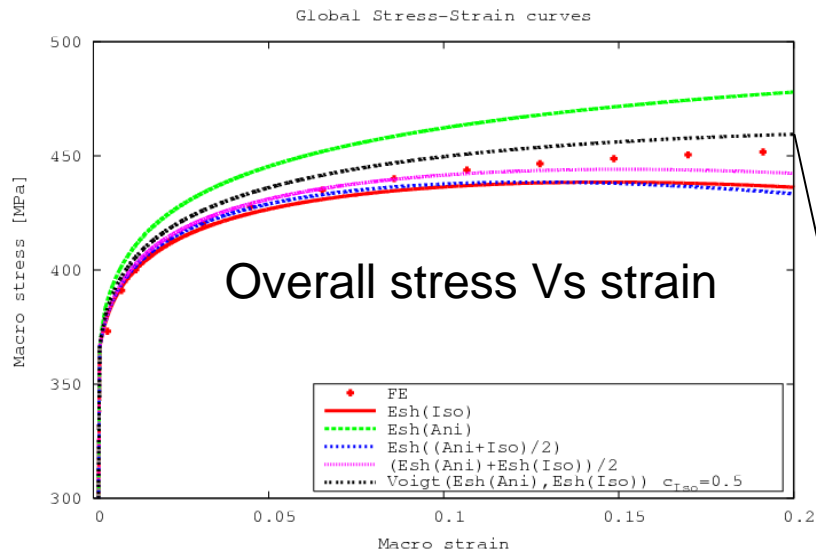
Pearlite = Hard ellipsoidal Inclusion

Graphite = Spherical Voids  
!!! observed weakly bound to the matrix !!!

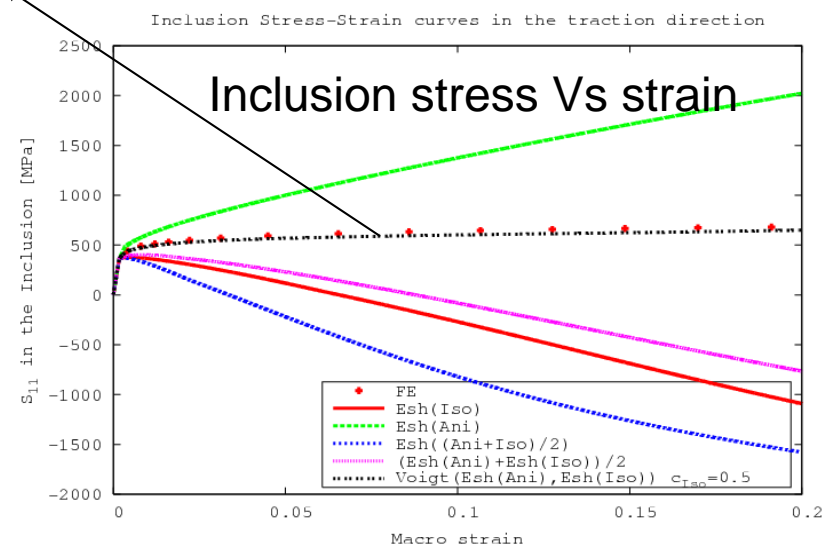
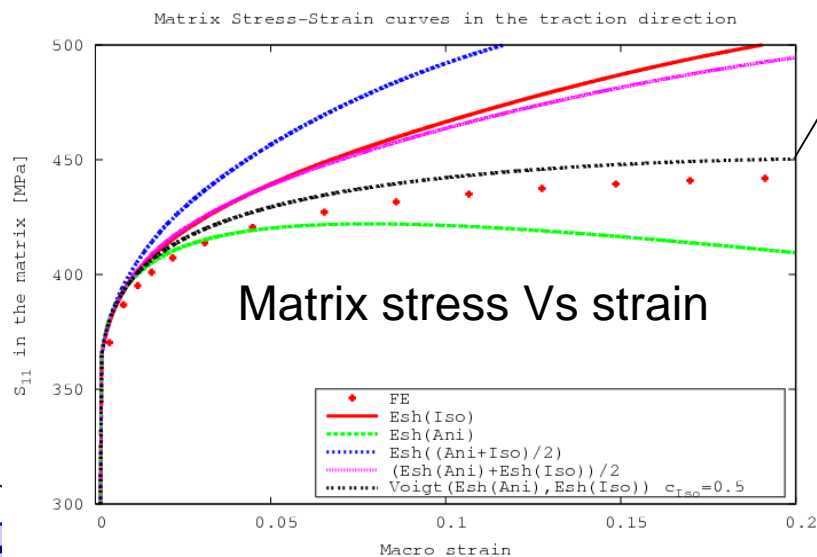
# Analytical Model Scheme



# Comparison with 3D FE unit cells



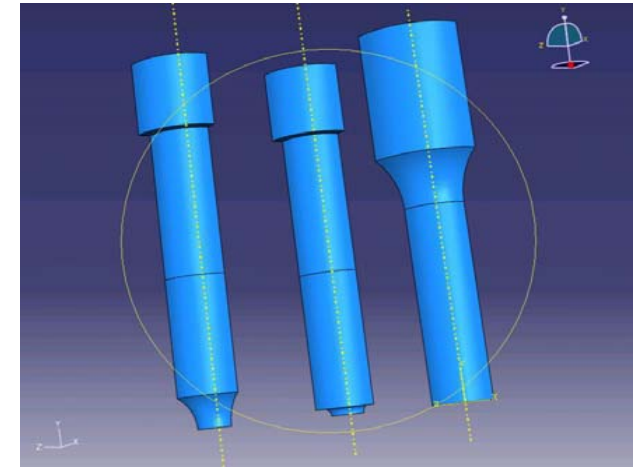
OK with the home build  
multi-level homogenization scheme



# Experimental characterisation

## Samples

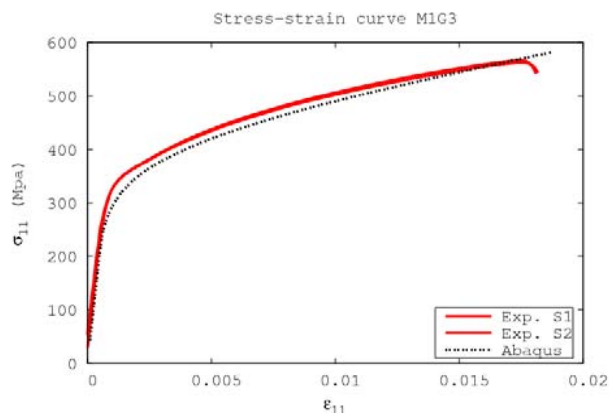
- **Three samples geometries**  
=> 3 different triaxiality ratios
- **Five microstructures [M1->M5]**  
=> from fully ferritic to fully pearlitic matrix



G3 G2 G1

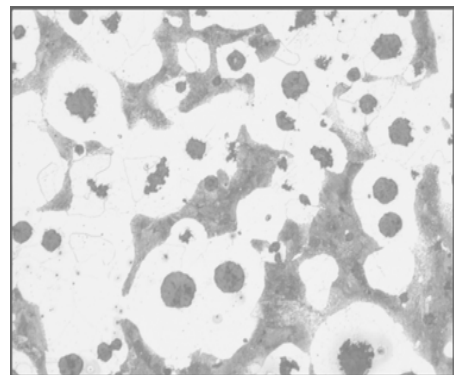
## Experiments

### Tensile tests



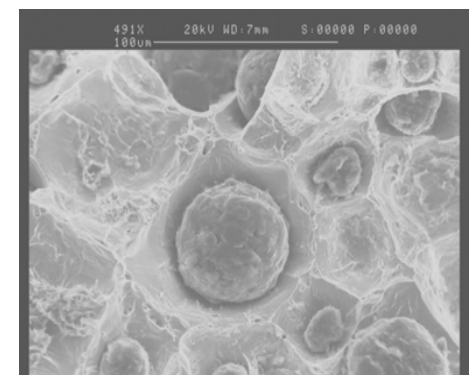
- Mechanical properties

### Optical microscopy



- Phases volumes fractions
- Microstructure

### Electron microscopy

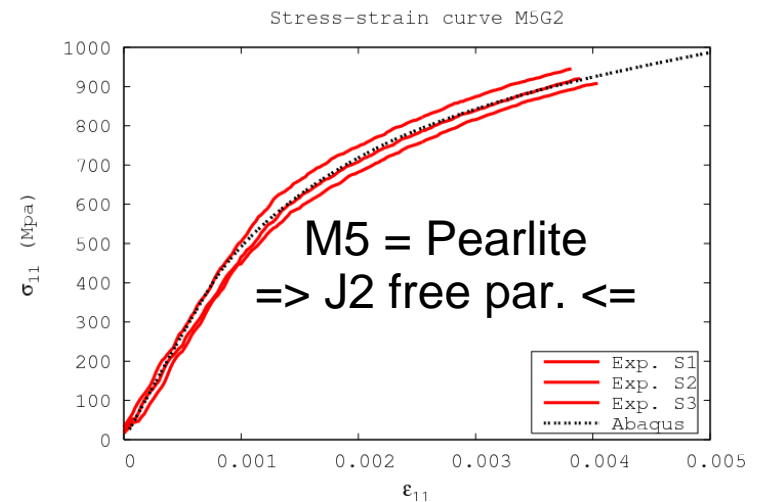
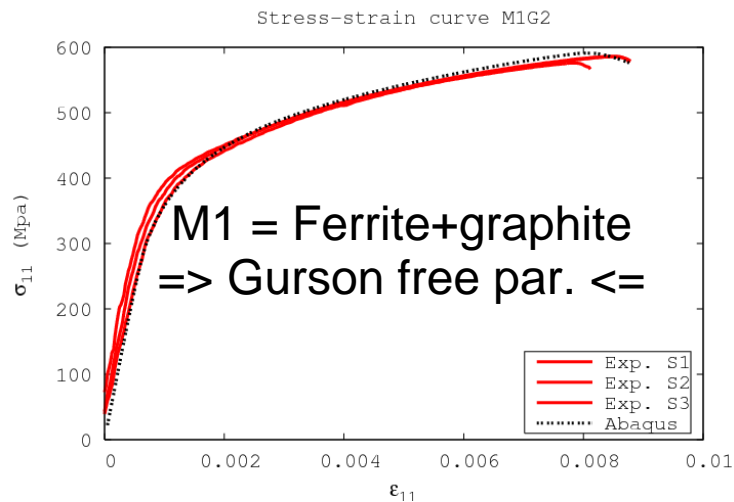


- Rupture mechanism
- Interface properties

# Model Vs Experiment

## 1. Inverse analysis => Adjust the free parameters

- FE models of the traction tests (ABAQUS with UMAT containing the model)
- Optimisation loop based on Genetic Algorithm + Surrogate models

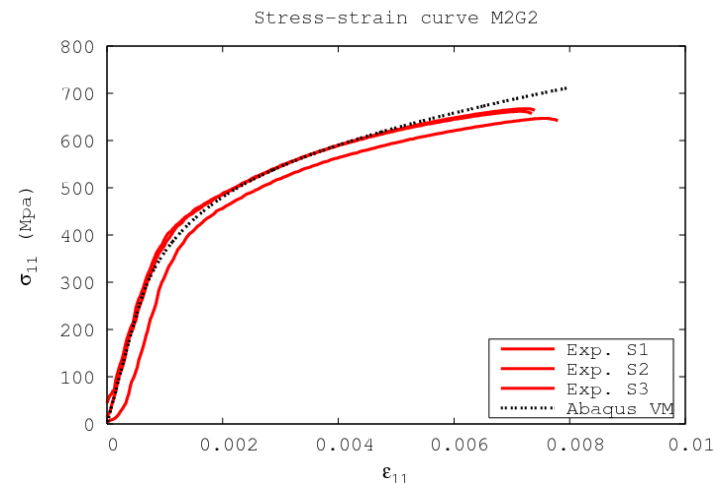


## 2. Model predictions Vs Experimental measures

M2 = Ferrite + graphite + pearlite

Vs

Full Micro-Macro Model



OK !!!!