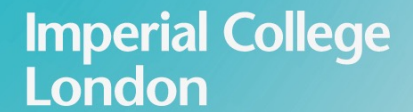


 **sindri**  
PROSPERITY PARTNERSHIP





# Synergistic utilisation of INformatics and Data centRic Integrity engineering

Mahmoud Mostafavi  
(on behalf of PI David Knowles)

Nuclear Academics Meeting  
2023

# Who?



High Temperature Centre Est 2006



Imperial College London



JACOBS



Modelling and Simulation Centre Est 2010

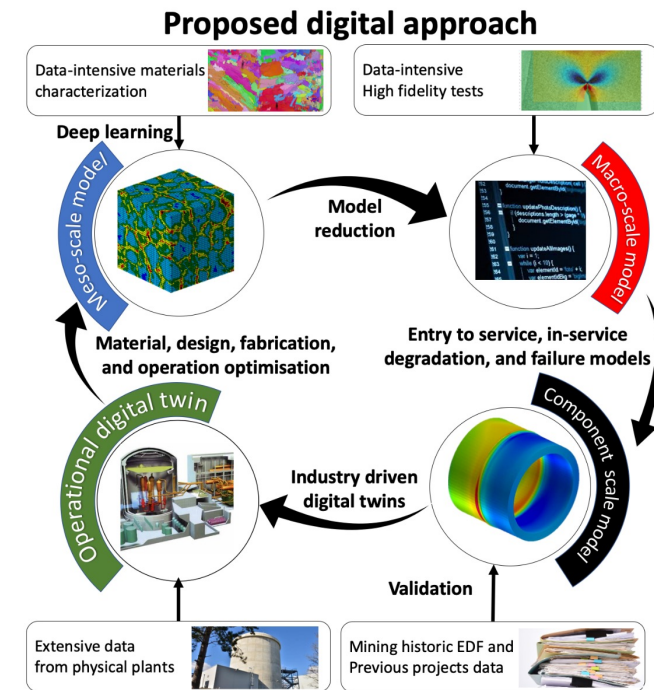
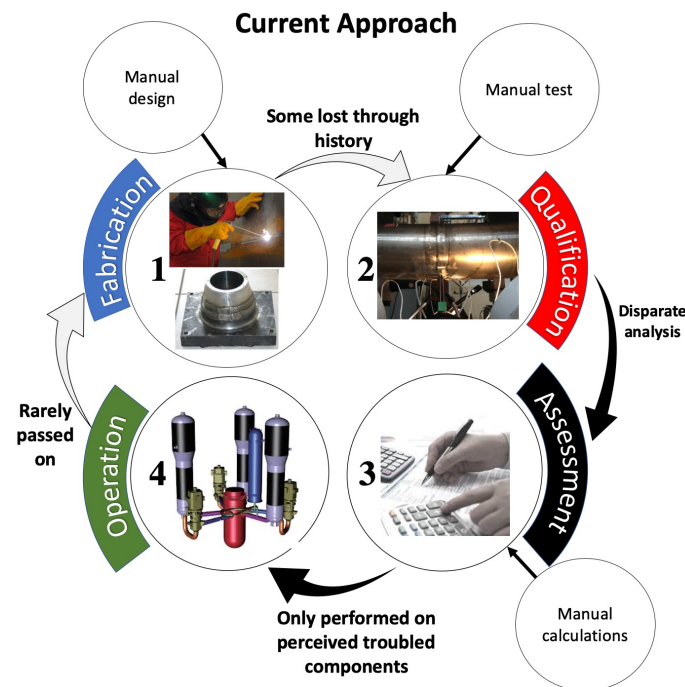


# Investigators

- David Knowles (Bristol)
- Mahmoud Mostafavi (Bristol)
- Chris Truman (Bristol)
- Harry Coules (Bristol)
- Nicolo Grilli (Bristol)
  
- Catrin Davies (Imperial)
- Jun Jiang (Imperial)
  
- Mark Wenman (Imperial)
- Emilio Martinez-Paneda (Oxford)
  
- Mike Smith (Manchester)
- Anastasia Vasileiou (Manchester)
- Mat Roy (Manchester)
- John Francis (Manchester)
- Brian Connolly (Manchester)
- Ed Pickering (Manchester)

# Aim

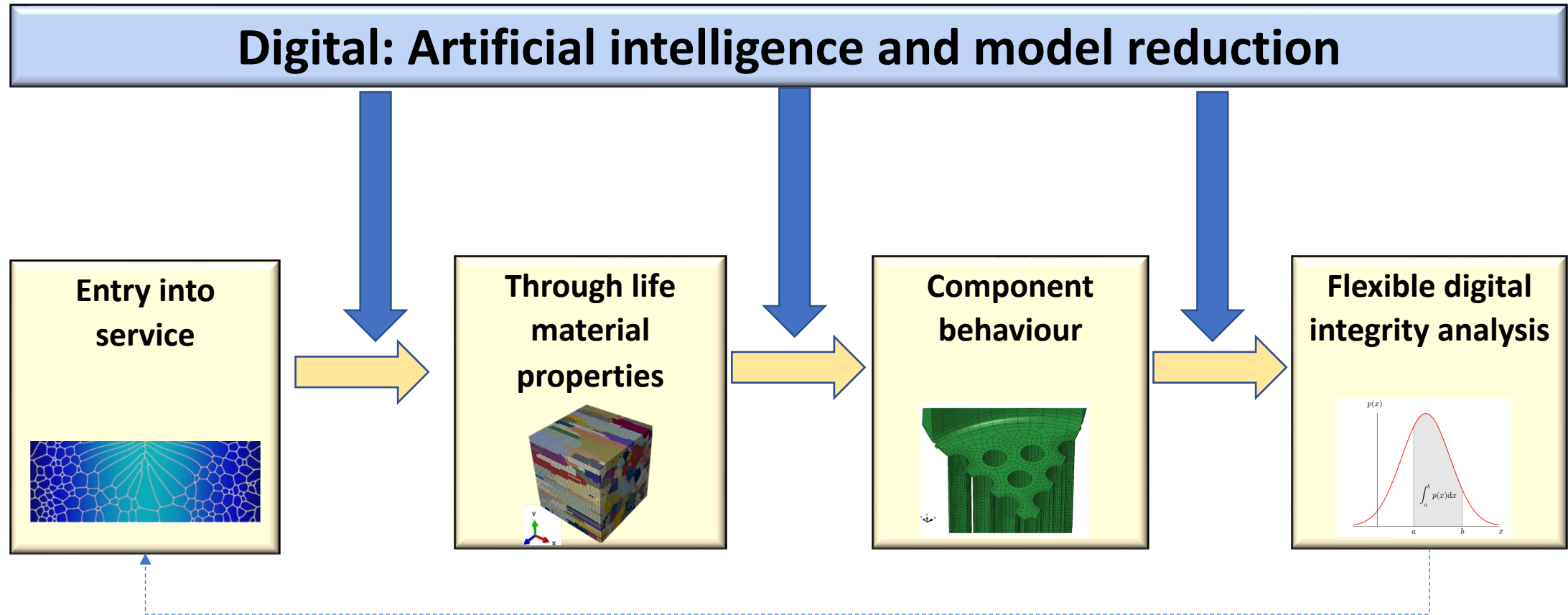
- Create a **coherent digital framework**, populated by **modular** multi-physics, multi-scale models. This will replace time consuming and extensive physical testing associated with traditional approaches; **enhance speed and efficiency**



# SINDRI is NOT a welding Project!

But we are using welds as case studies!

# Workflow Concept

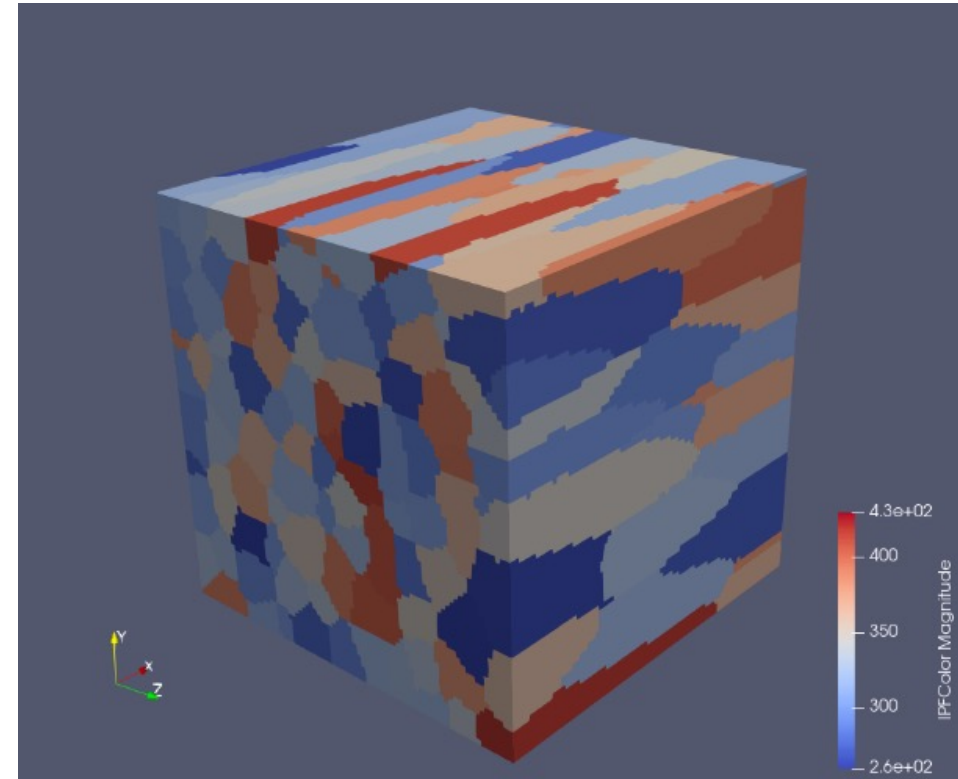


# Example of a Complex Model

$$\dot{\gamma}^{\alpha} = \dot{\gamma}_0^{\alpha} \left( \frac{\tau^{\alpha} - X^{\alpha}}{\tau_c^{\alpha}} \right)^{\frac{1}{m}}$$

$$\tau_c^{\alpha} \cong \tau_{c_0}^{\alpha} + a G b \left( \sqrt{H_{\beta}^{\alpha} \rho^{\beta}} + \frac{c}{L^{\alpha}} \right)$$

$$\dot{\rho}^{\alpha} \cong \left[ K \left( \sqrt{\rho^{\alpha}} + \frac{c}{L^{\alpha}} \right) - 2 y_c \rho^{\alpha} \right] \frac{|\dot{\gamma}^{\alpha}|}{b}$$

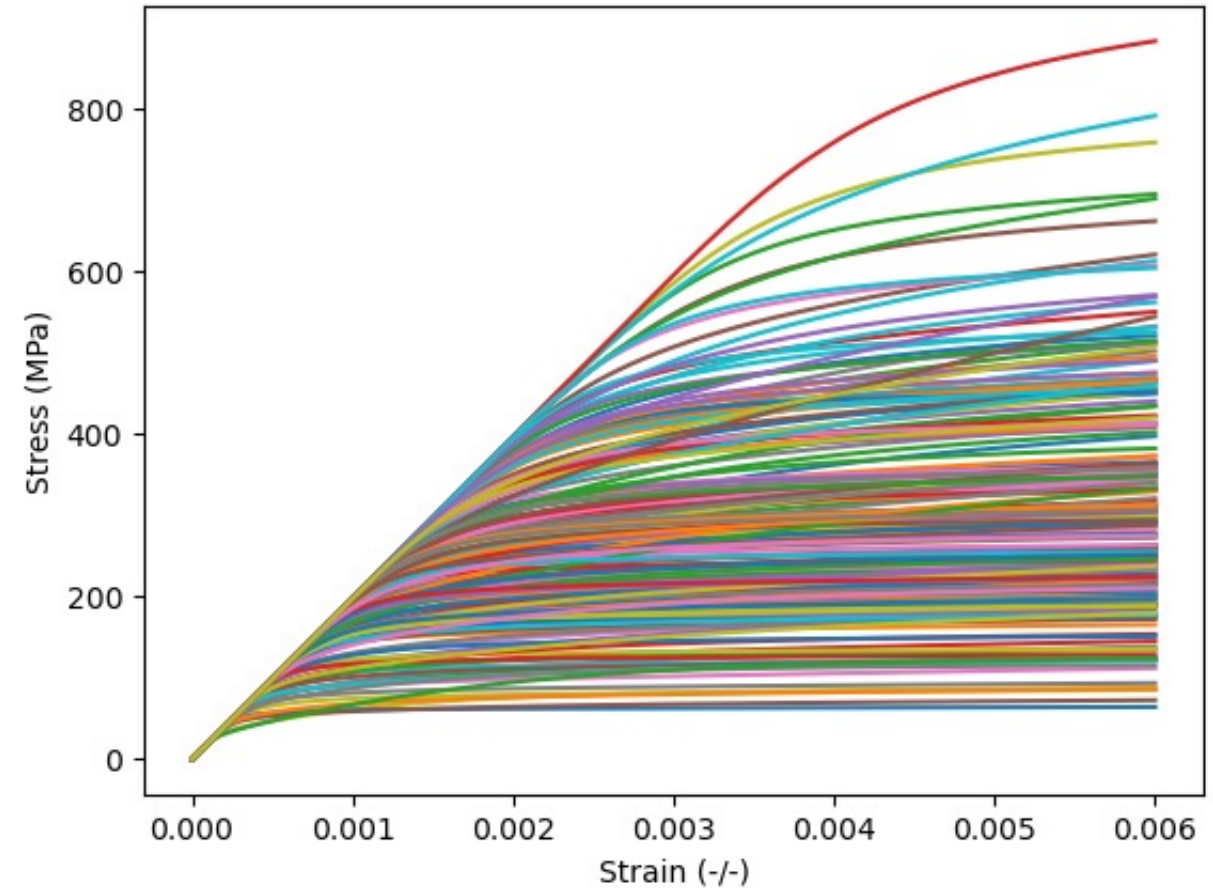




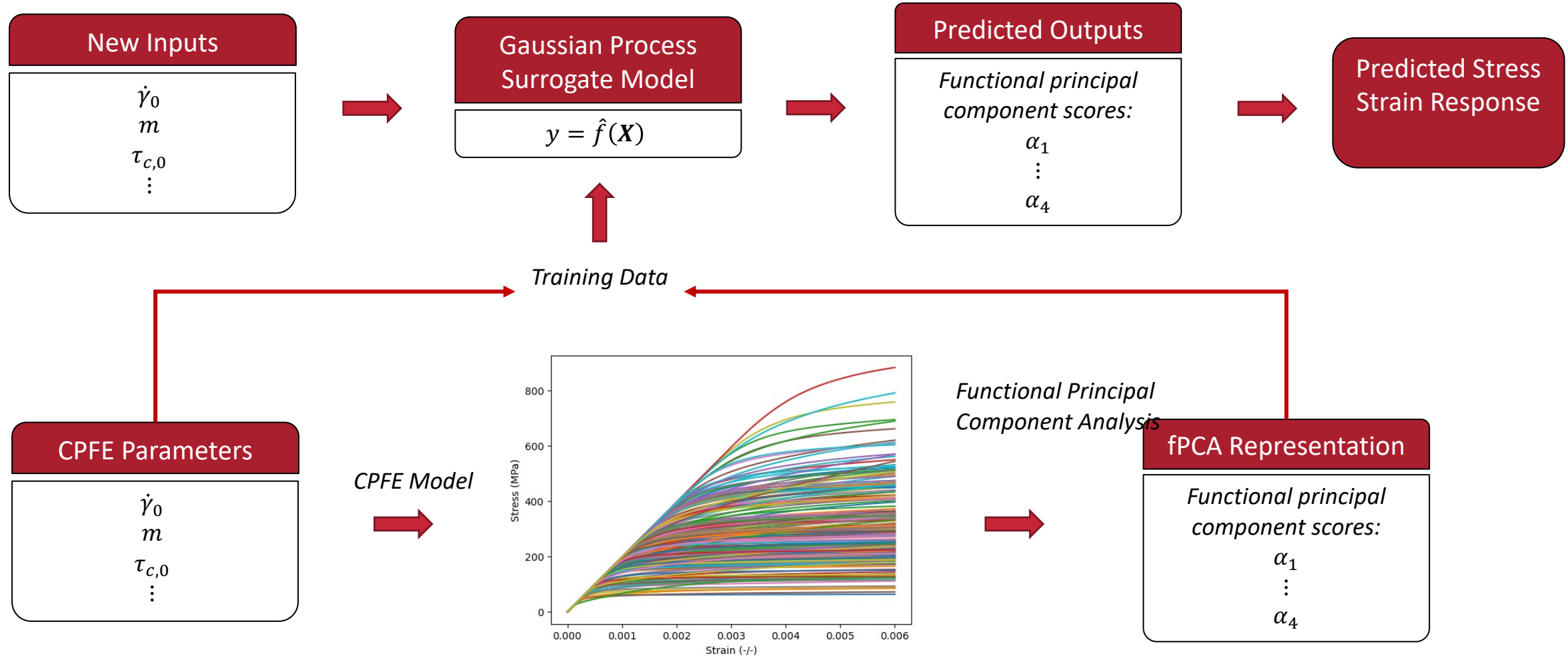
## Simplify the Model

- Example of 200 tensile curves created using a crystal plasticity model.
- Each curve presented in fPCA series:

$$\sigma(\varepsilon) \approx \sum_{i=1}^{n_c} \alpha_i \phi_i(\varepsilon)$$



# Surrogate Model



# Priorities

- Probabilistic analysis
- Current focus on HTGR (AGRs as starting point)
- Include in open source SINDRI toolbox (developed by EDF)
- Engage more with the regulator