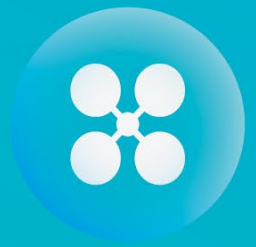


sindri

PROSPERITY PARTNERSHIP

EDF

University of BRISTOL

MANCHESTER 1824
The University of Manchester

UKRI Science and Technology Facilities Council

Imperial College London

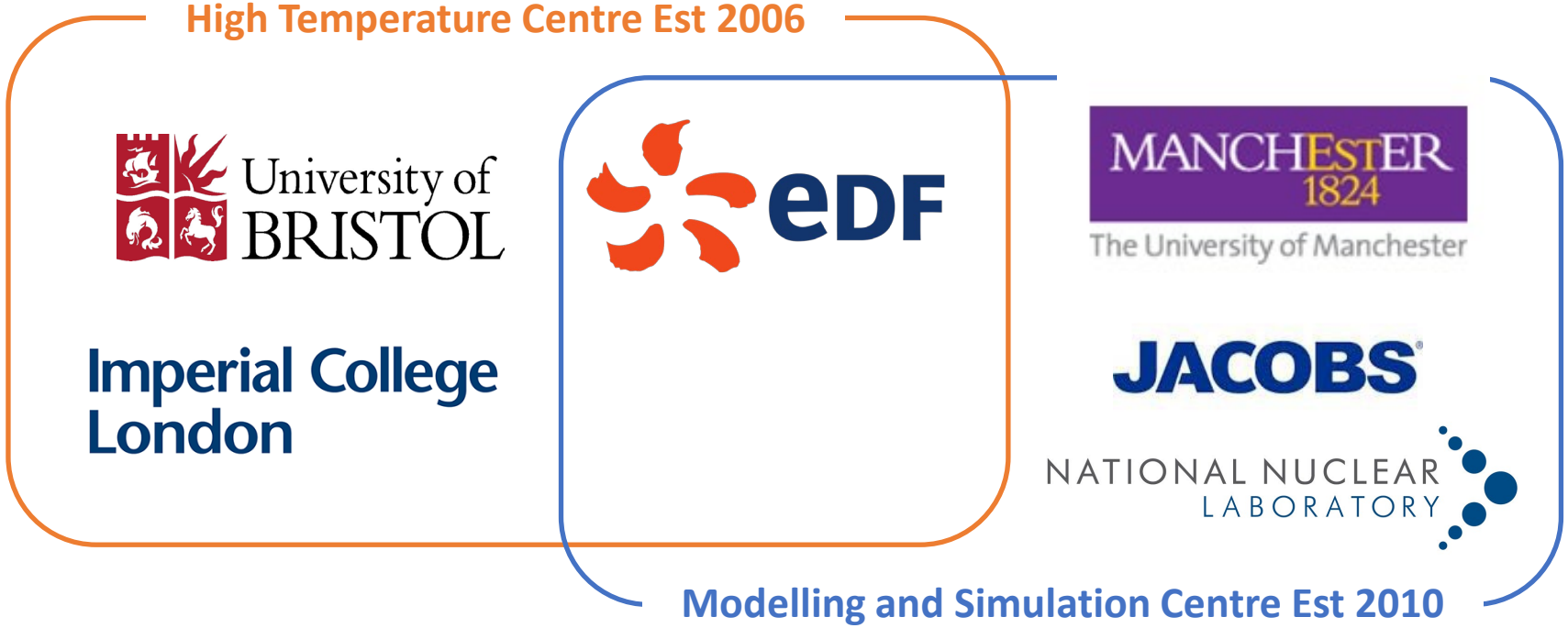
Synergistic utilisation of INformatics and Data centRic Integrity engineering

Chris Truman

(on behalf of PI David Knowles)

Nuclear Academics Meeting 2024

Who?



UKRI Science and Technology Facilities Council

UKRI Engineering and Physical Sciences Research Council

UK Atomic Energy Authority

HENRY ROYCE INSTITUTE

The Alan Turing Institute

ROLLS ROYCE

NUCLEAR AMRC

Investigators

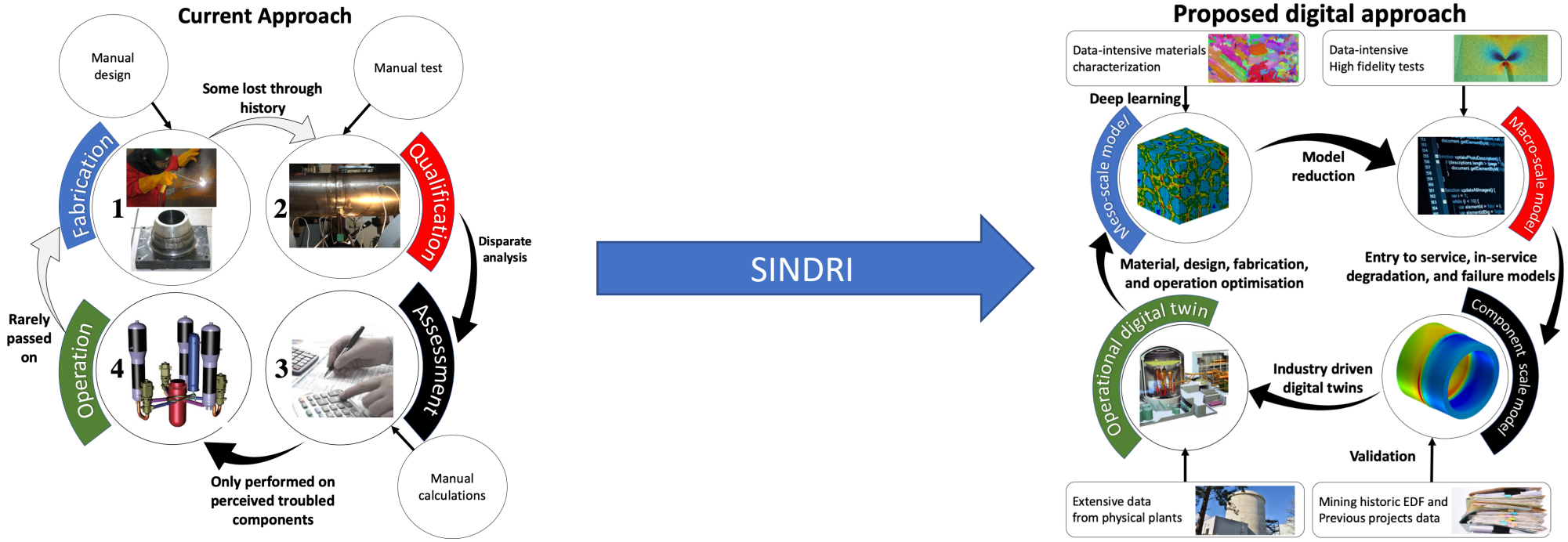
- David Knowles (Bristol)
- Chris Truman (Bristol)
- Burcu Tasdemir (Bristol)
- Mahmoud Mostafavi (Bristol)
- Paul Wilcox (Bristol)
- Nicolo Grilli (Bristol)

- Catrin Davies (Imperial)
- Jun Jiang (Imperial)
- Mark Wenman (Imperial)
- Emilio Martinez-Paneda (Oxford)

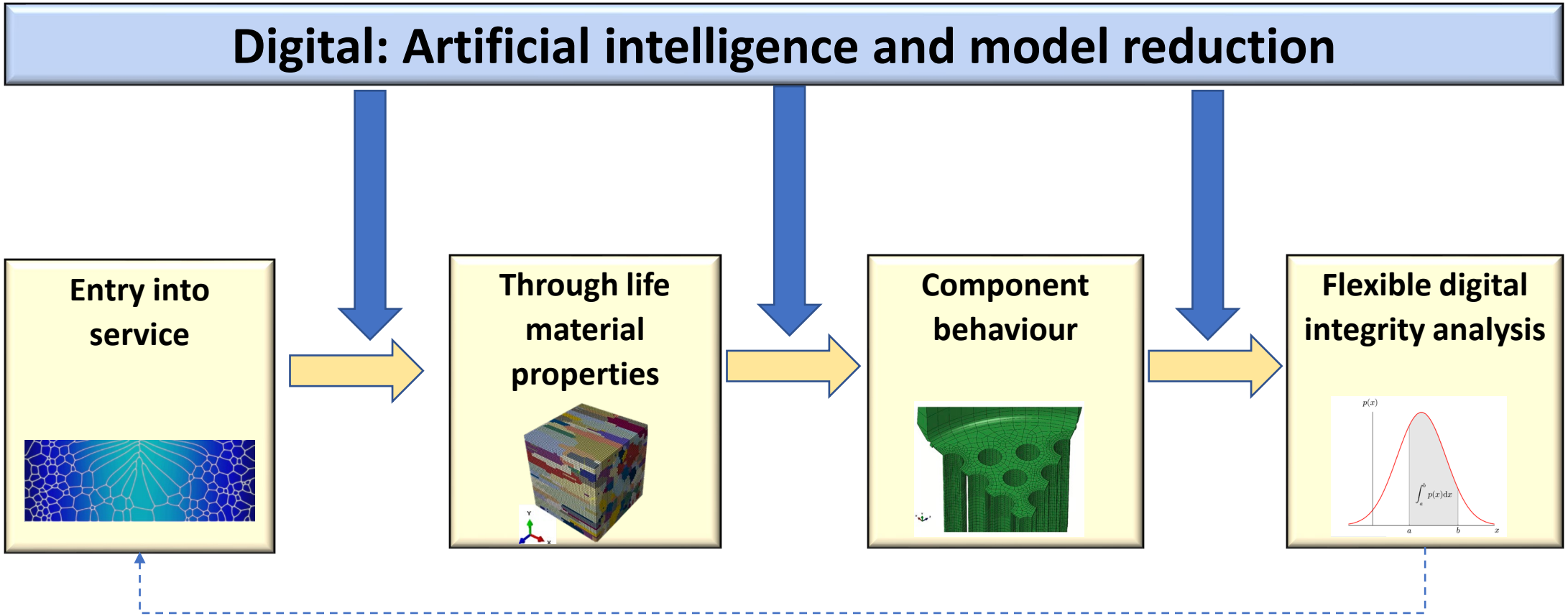
- Mike Smith (Manchester)
- Anastasia Vasileiou (Manchester)
- Mat Roy (Manchester)
- John Francis (Manchester)
- Brian Connolly (Manchester)
- Ed Pickering (Manchester)

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**



Workflow Concept

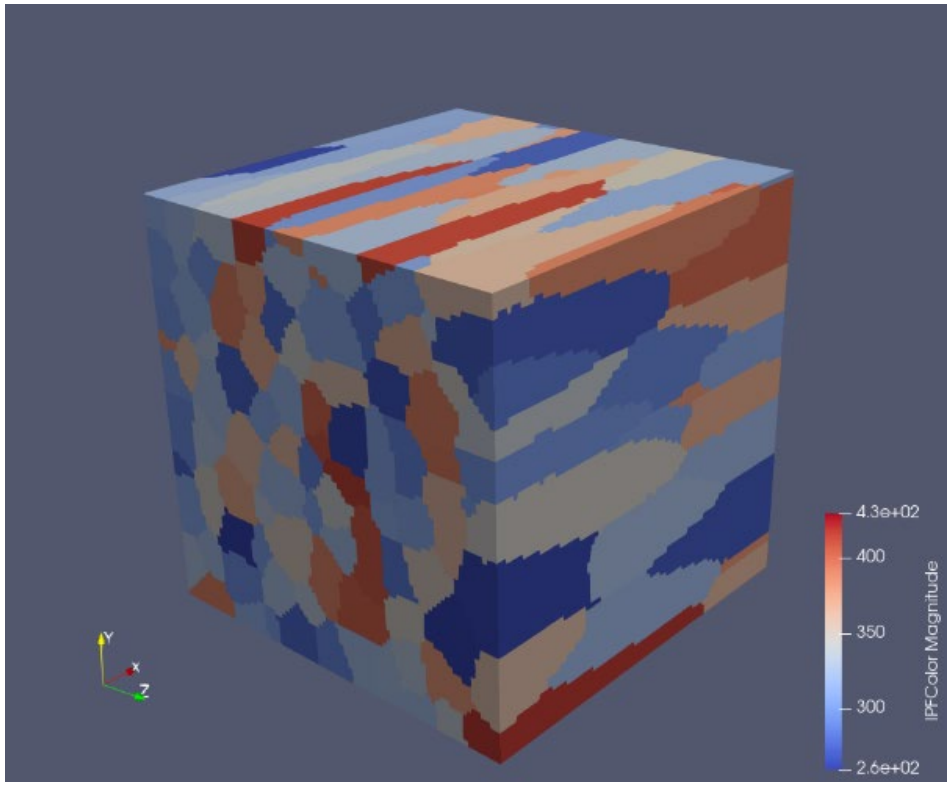


Example of a Complex Model

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

$$\tau_c^{\alpha} \cong \tau_{c\,0}^{\alpha} + a\, G\, b \left(\sqrt{H_{\beta}^{\alpha}\, \varrho^{\beta}} + \frac{c}{L^{\alpha}} \right)$$

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

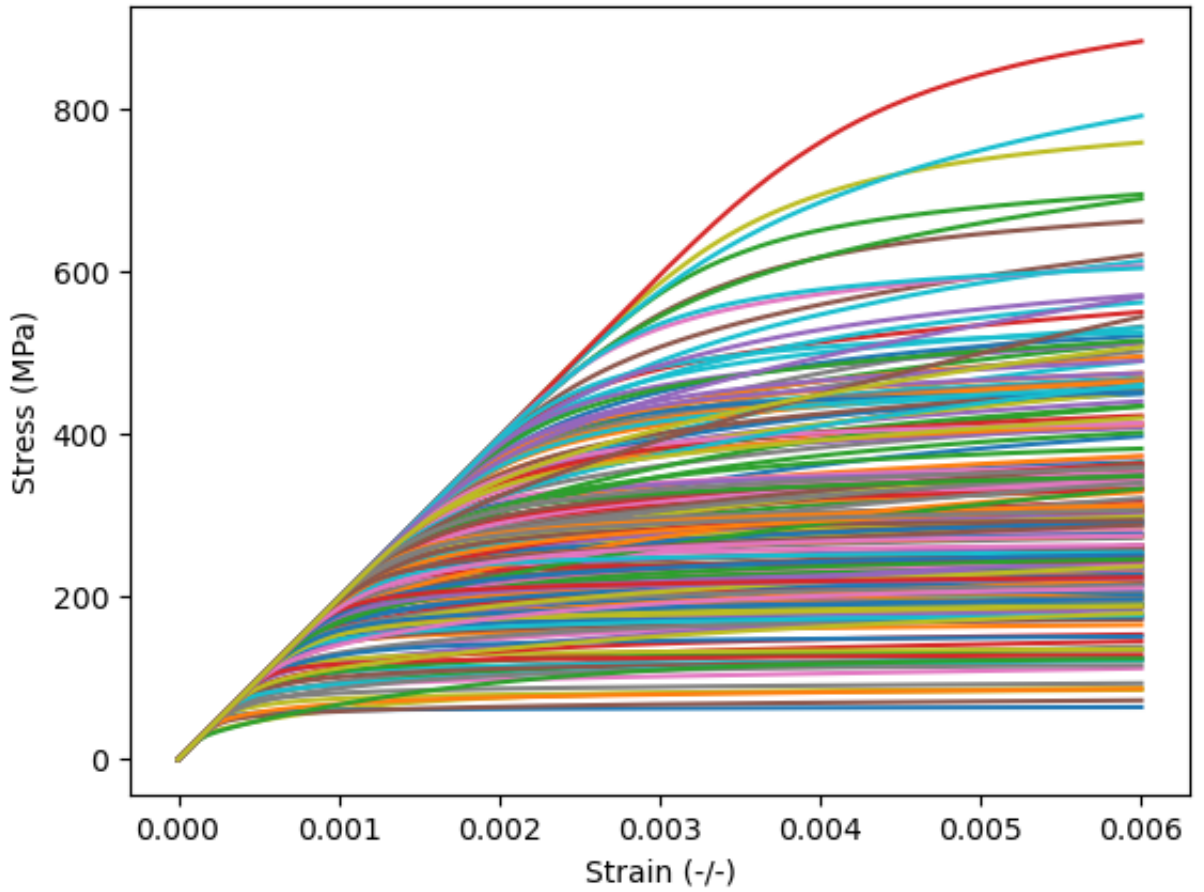


Eralp Demir et al J. Mech and Phys Solids 2023

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

New Inputs

$\dot{\gamma}_0$
m
$\tau_{c,0}$
$\vdots$

Gaussian Process Surrogate Model

$y = \hat{f}(\boldsymbol{X})$

Predicted Outputs

Functional principal component scores:
α_1
$\vdots$
α_4

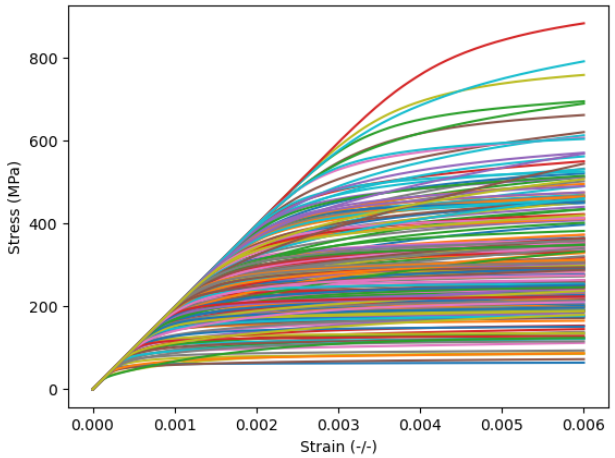
Predicted Stress Strain Response

Training Data

CPFE Parameters

$\dot{\gamma}_0$
m
$\tau_{c,0}$
$\vdots$

CPFE Model

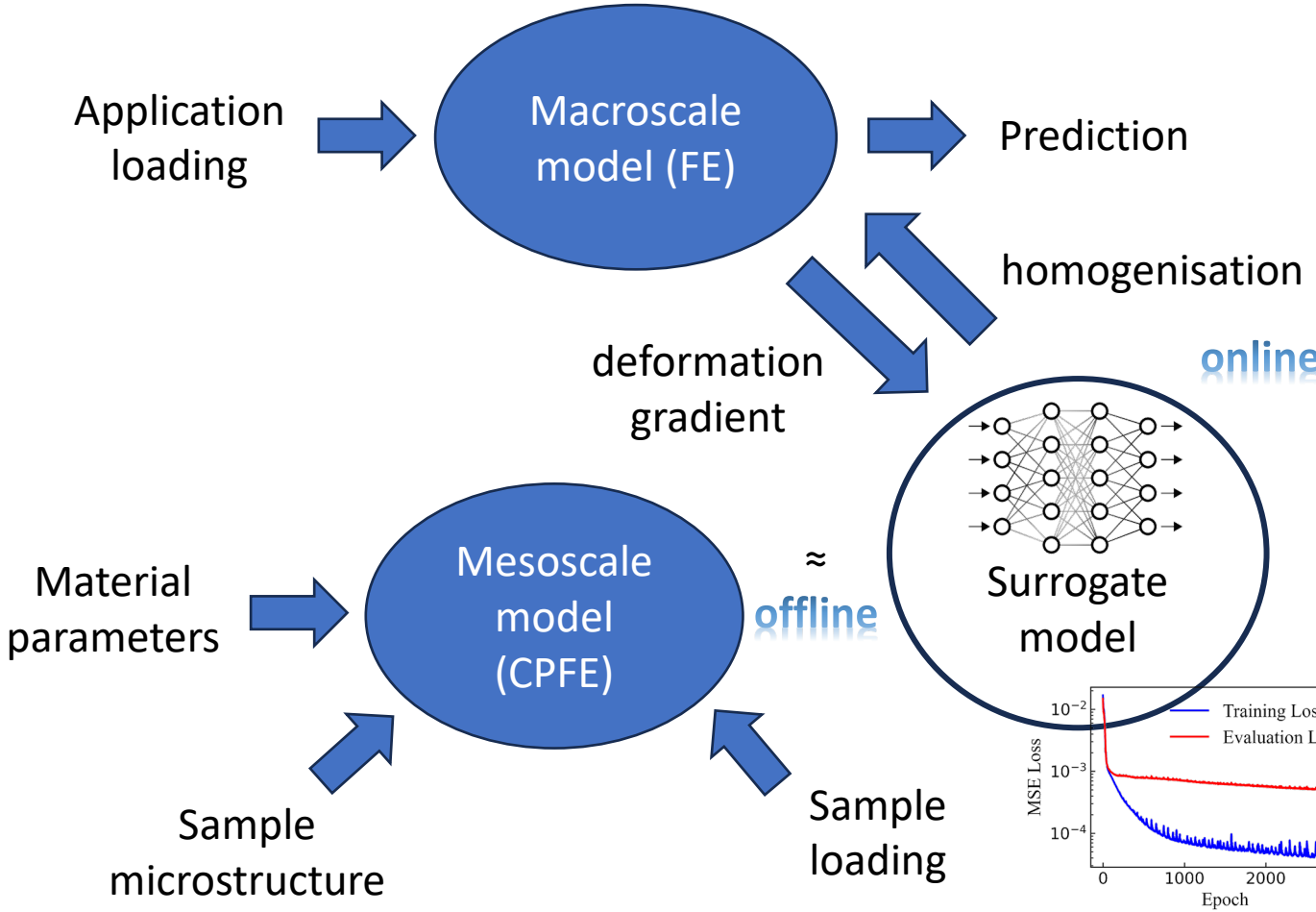


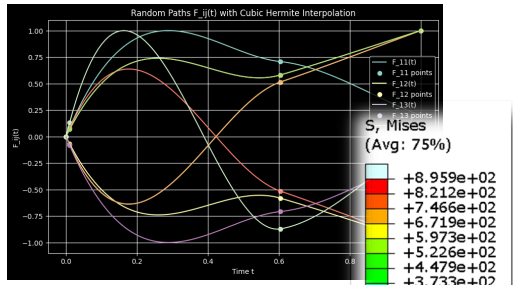
Functional Principal Component Analysis

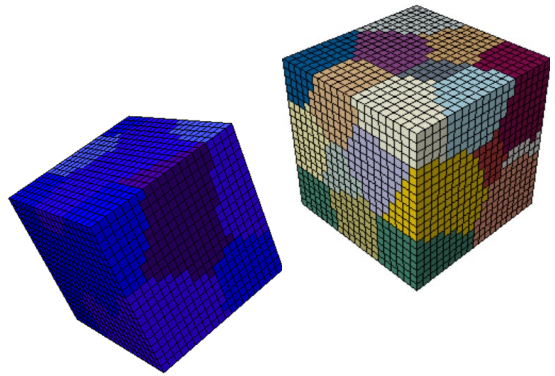
fPCA Representation

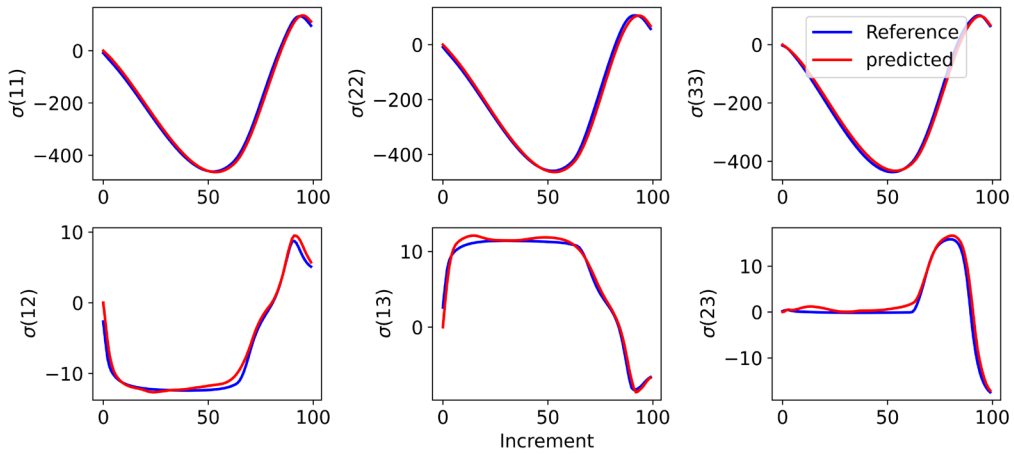
Functional principal component scores:
α_1
$\vdots$
α_4

Microstructure based multiscale modelling









Priorities

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