**Experimental & Computational studies of nominally similar structures**

**Data-based SHM**
Data gathered on a structure in normal and abnormal states. Feature extraction & classification used to map between features

**Population-based SHM**
Common features of normal cases are identified from a population of similar structures

To this end, we aim to **experimentally test a population of structures**, build a Finite Element (FE) model, understand the variation between normal states in nominally similar structures, and test the potential of pseudo-damage.

**Experimental testing**
Population of 6 aircraft tailplane structures tested on both surfaces with and without two masses of pseudo-damage (total of 36 result cases). Structures hung on springs and excited (0-1000Hz white noise) on rear surface. Data captured by Scanning Laser Doppler Vibrometer over 400 surface points

**Pseudo-damage results**
Experimental Frequency Response Functions (FRFs) show close correlation between undamaged and pseudo-damage cases. Damage appears to decrease modal frequencies:

- Modal Assurance Criterion (MAC) allows comparison of modes between experiments and FE models, or between structures. For modal vectors \((\phi_n)\) and \((\psi_n)\):
  - MAC = 0 → Full correspondence
  - MAC = 1 → Zero correspondence
  - MAC = \((\phi^T_n \psi_n)/(\phi^T_n \phi_n)\)

**Population results**
Significant variation in nominally identical structure FRFs at high frequency (sample of 3 undamaged structures):

**Conclusions**
FE / Experimental correlation is currently low due to a lack of material properties and internal structure data. By incrementally damaging a structure we hope to collect this data:

- Damage structure
- Measure internal structure
- Material samples for testing
- FE model
- Agreement?
- Model updating
- Population-based SHM trial
- Undamaged case data

Incremental damage tests will also allow validation of pseudo-damage results. Damaged, undamaged and pseudo-damaged data will ultimately be used to test the population-based SHM concept.