

## What is this data?

The data shown in this project is the experimental testing performed on the starboard wing for the BAE T1A Hawk aircraft that is hosted at the Laboratory for Verification and Validation at the University of Sheffield. Most of the sensors used for this test are accelerometers apart from the excitation force sensor that measures the force. This testing was funded by the Alan Turing Institute project *Digital Twins for High-Value Engineering Systems (DTHIVE)*. Continuation of this testing is being performed by the EPSRC funded project *Digital Twins for Improved Dynamic Design (DigiTwin)*.

## What tests were Performed?

The naming convention of the file will identify the excitation type and test suite performed for that excitation type. The possibilities are:

- Burst Random (BR) – This excitation applies a pseudo-random excitation in bursts that allow for transient decay. Using this excitation doesn't require the use of windowing and allows for nonlinearity to be averaged across the multiple bursts.
- Forward Sine Sweep (FSS) or Reverse Sine Sweep (RSS) – This excitation applies a single frequency sine excitation to the system with the frequency varying through time. In the forward sine sweep, the frequency starts low and increases while the reverse sine sweep starts high and decreases. This is one common method of identifying nonlinearity in a system since many sources of nonlinearity are hysteretic. The change in frequency for these tests are done linearly.
- Forward Log Sweep (FLS) or Reverse Log Sweep (RLS) – This excitation is identical to FSS and RSS respectively with one major difference, the change in frequency is done logarithmically instead of linearly.
- Damage Simulation (DS) – While this is not an excitation type, the nomenclature includes this scenario. For these tests, a few locations are selected, and an additional mass is added to the system to simulate a decrease in stiffness. This mimicking can represent local degradation or damage such as crack initiation. The data produced from this scenario can be used for structural health monitoring techniques to identify the location and/or the severity of the damage.

In addition to the excitation type, there are multiple test suites performed with these excitations. This is identified as the second part of the name. The possibilities are:

- Amplitude Ramp (AR) – This suite performs the same testing with varied excitations levels. In general, this excitation is applied in an open loop, thus only the output voltage to the modal shaker is specified. The force gauge attached to the shaker can give physical context to the voltage by showing the force in Newtons.
- Damage Location (TLE, RLE, CTE) – These suites of tests are only for the DS tests and are typically excited using the BR excitation

For each combination of excitation and test suite, multiple repetitions are performed to gauge the experimental variability. Most of the testing used 10 repetitions while some only used 3. This was decided at the time of testing to accommodate the specified testing schedule.

## How do I access this data?

This data is stored in python objects (Pickles) that utilise the data structure within python (free programming language). Each .zip file has multiple pickle files, one containing the meta-data associated with the test and one for each sensor recorded. To access this data, download the .zip file

and extract it into a specified folder. Then within python, run this simple 3 lines of code to load the data into the dictionary “data”. In this script the “path/filename.pickle” identifies while file/sensor you want to read in, and the “path” is the computational path from the current working directory to the file. If the working directory is the same folder that the pickle files are stored in, the path can be ignored since the path is empty.

```
import pickle
with open("path/filename.pickle", 'rb') as file:
    data = pickle.load(file)
```

### **What is contained within the data files?**

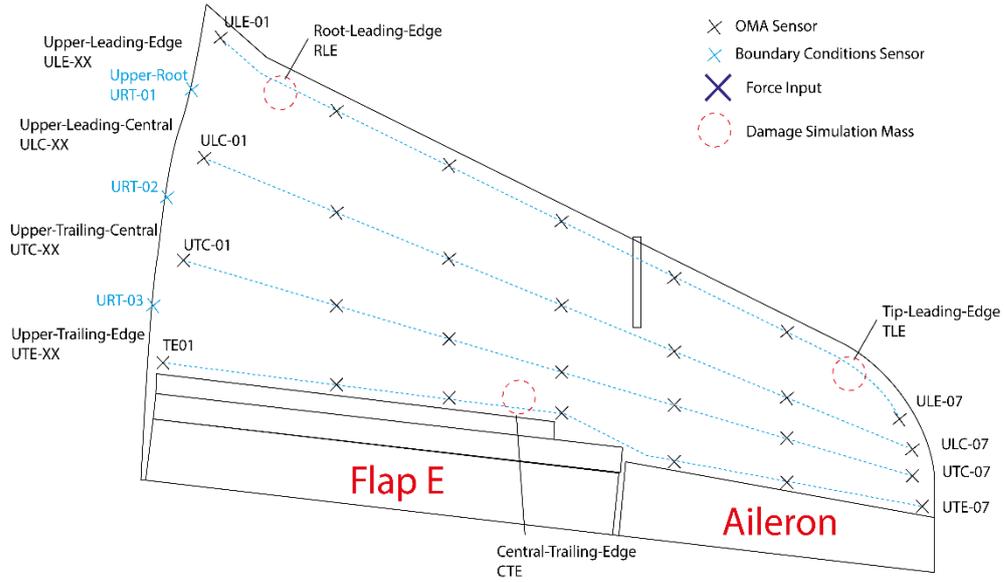
For the meta-data file, information about the test is included in the file. This includes the excitation type, test name, sensors used, the physical location of the sensors in the local coordinate system, test output voltage, and other parameters used in the data acquisition such as frequency averages, spectral lines, etc. The sensor data is stored in the filename of the sensor. These sensor names and approximate locations can be seen in Figure 1. Additionally, the damage locations and excitation location are also denoted. The data associated with these files include the test name for cross-referencing purposes, the sensor name, and 5 pieces of data. These pieces of data include the averaged time history, the auto-power spectrum, the dynamic stiffness, coherence spectrum, and spectra. Primarily, the time history and auto-power spectrum are the main pieces of data used, however these additional pieces of data are available if need for future techniques.

### **Can I use this data?**

ABSOLUTELY. This data is presented for open-source collaborations with a variety of researchers. We only ask for proper citation for this data and the associated paper.

### Upper Side

Total sensors: 54



### Lower Side

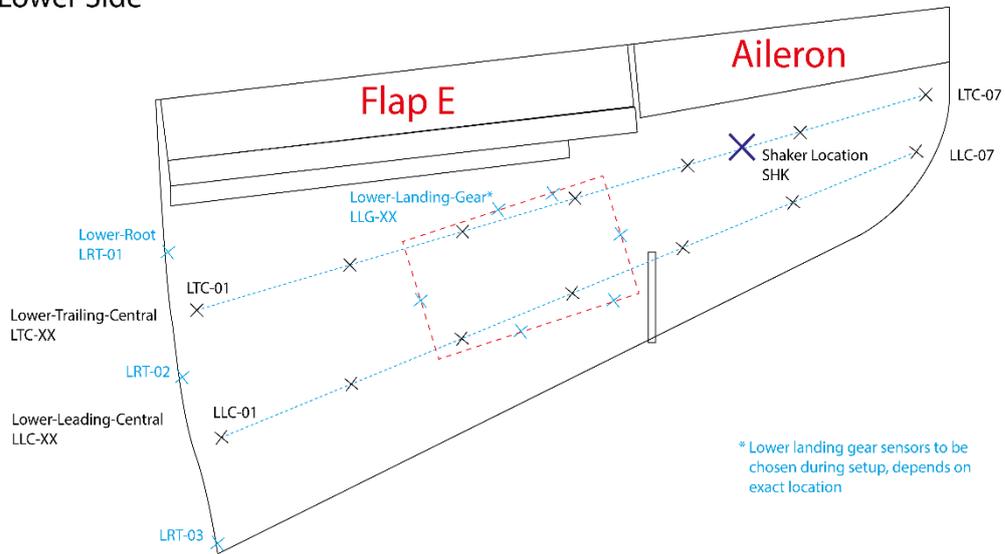


Figure 1: Sensor Layout of testing