

HiFFUT – A New Class of Transducer

Project Meeting

26th September 2018

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DYNOPTIC



WARWICK



EPSRC

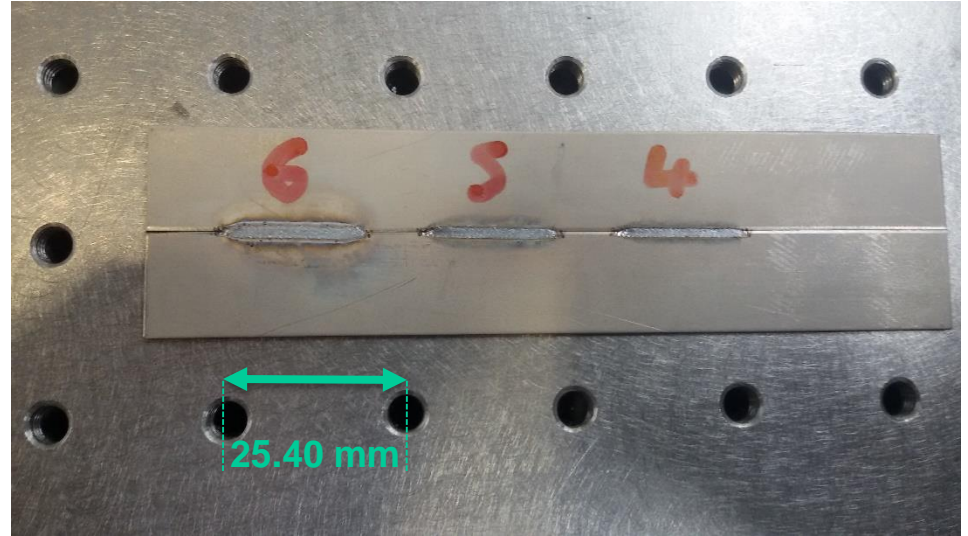
Engineering and Physical Sciences
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EP/N025393/1



FUT Fabrication by Laser Welding

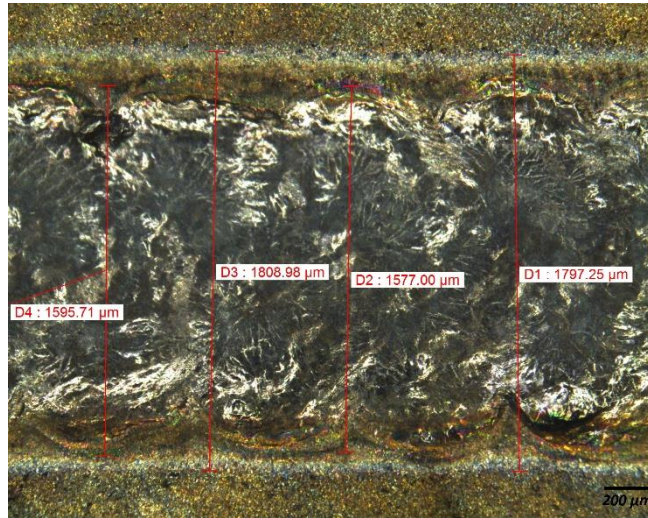
- The laser welding of different metals is being investigated for manufacture of FUTs.
- Cap membranes and supports have been fabricated from titanium, stainless steel, and aluminium.
- All parts are being laser welded in collaboration with WMG.
- Laser spot size is around 0.30 mm.
- HAZ results in a convex profile which can be modified to form a flat surface.
- Weld testing has been conducted to assess optimum welding parameters.



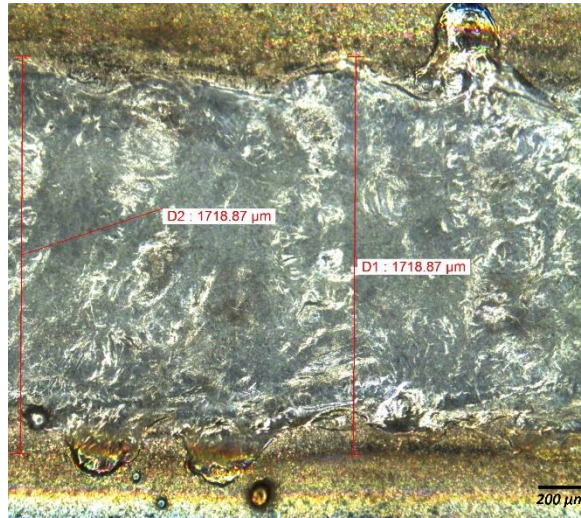
Test Welds on Titanium

FUT Fabrication by Laser Welding

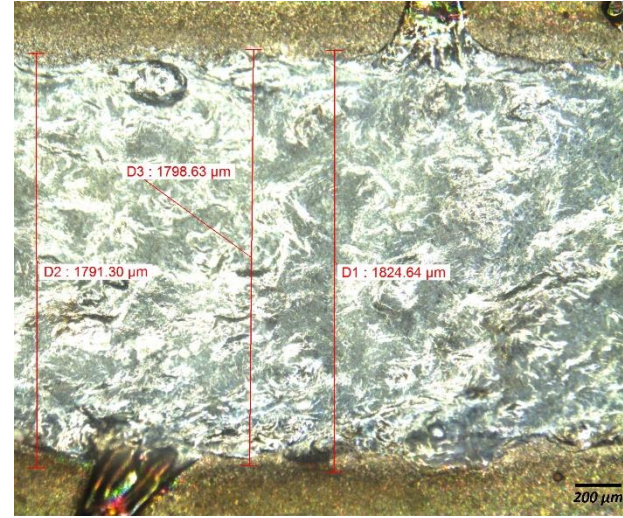
- The HAZ for each titanium sample is shown below, with approximate widths in the order of **1.50 – 1.80 mm**.
- Each membrane has a diameter of 11.46 mm.
- The characteristics of the HAZ can be investigated.



Sample 4



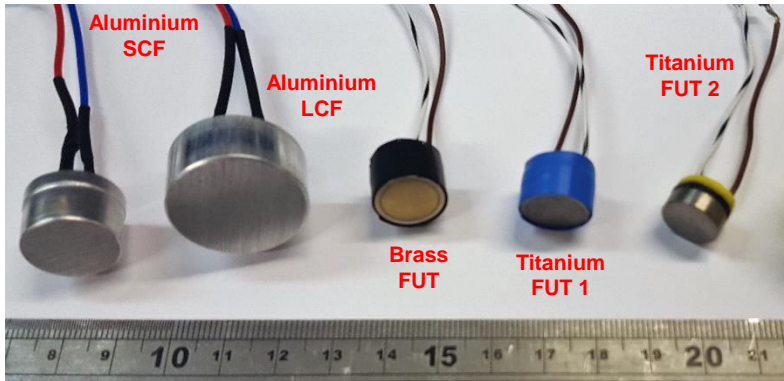
Sample 5



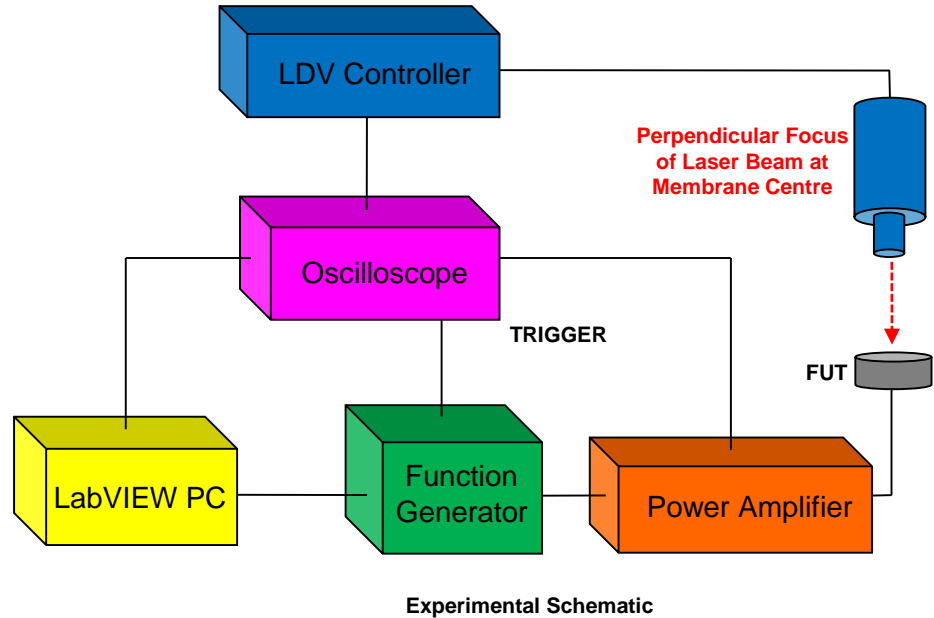
Sample 6

Dynamic Nonlinearity in Piezoelectric FUTs

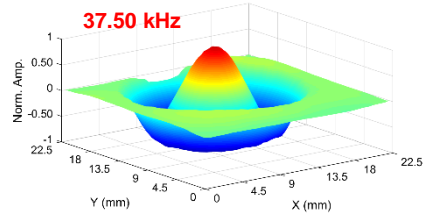
- Continuation of the studies into dynamic nonlinearity published in IEEE Sensors Letters.
- A selection of FUTs, a combination of commercial and custom fabricated, used to investigate origins of nonlinearity.
- Excitation up to 40 V_{p-p}, with LabVIEW control.
- Continuous-wave, sinusoidal signal.



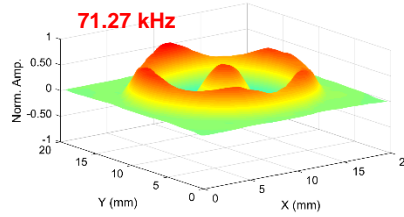
FUTs



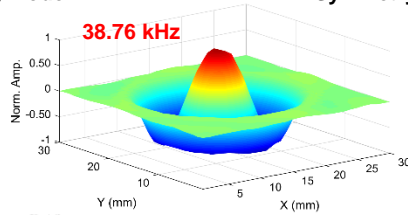
Dynamic Nonlinearity in Piezoelectric FUTs



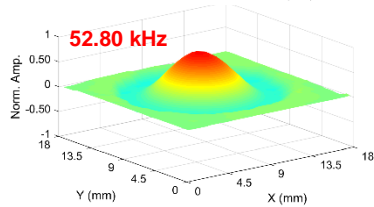
Aluminium SCF,
(1,0) Mode



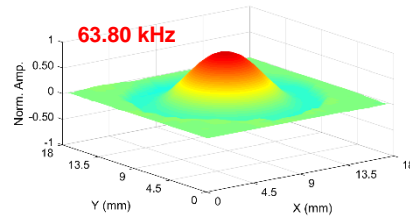
Aluminium SCF, Five-Fold
Symmetry (FFS) Mode



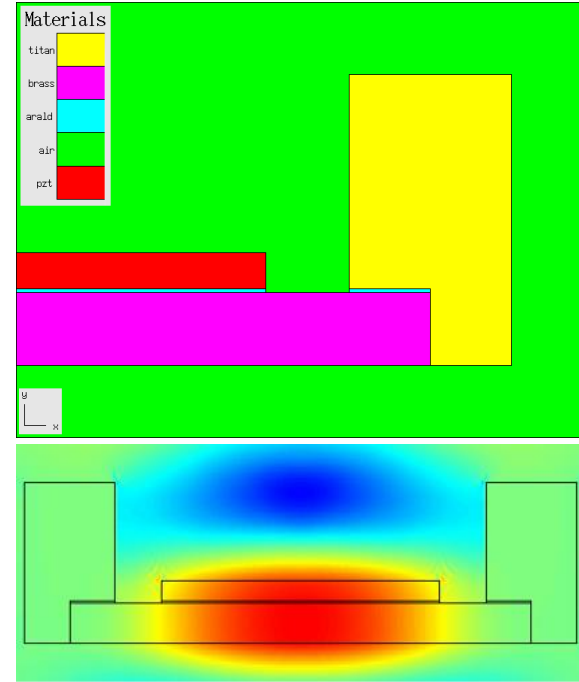
Aluminium LCF,
(1,0) Mode



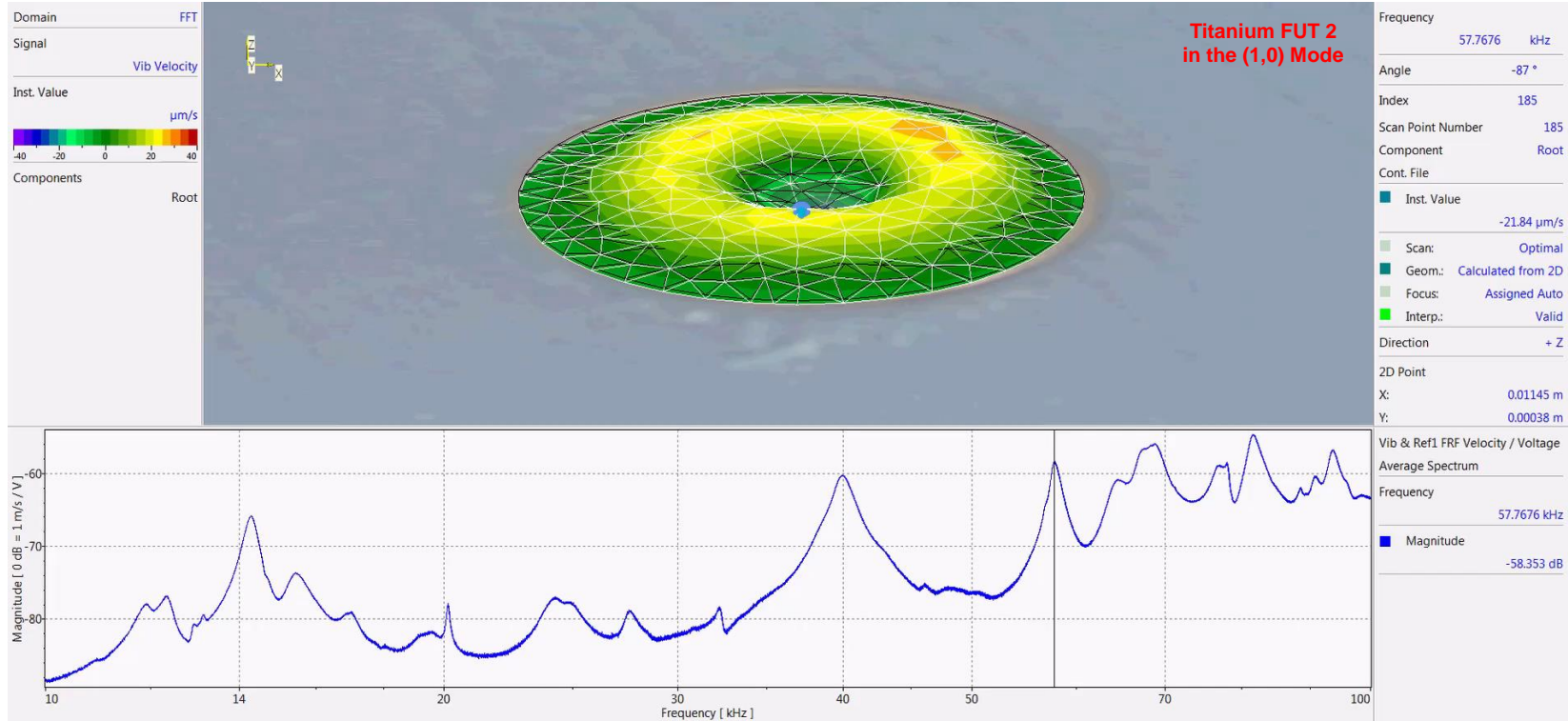
Brass FUT, (0,0)
Mode



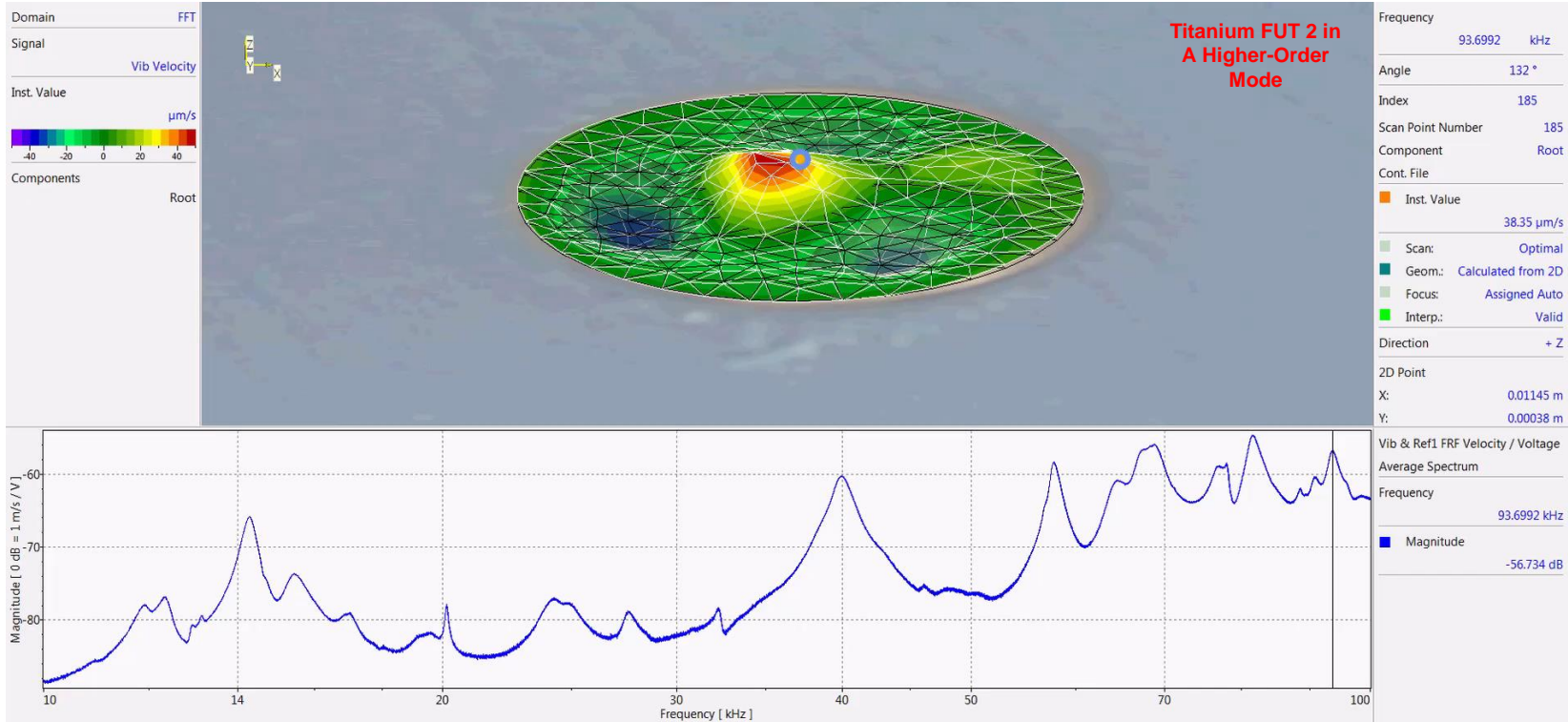
Titanium FUT 1,
(0,0) Mode



Dynamic Nonlinearity in Piezoelectric FUTs



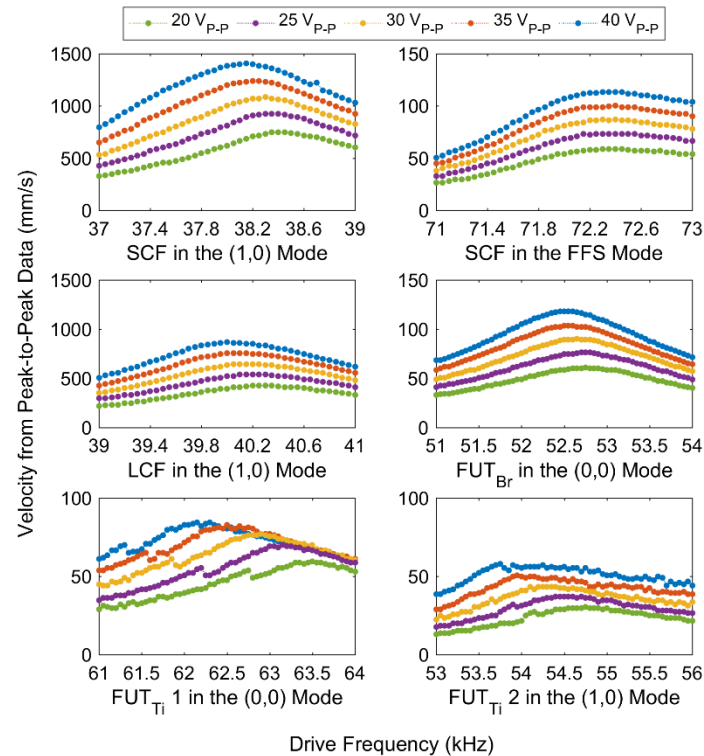
Dynamic Nonlinearity in Piezoelectric FUTs



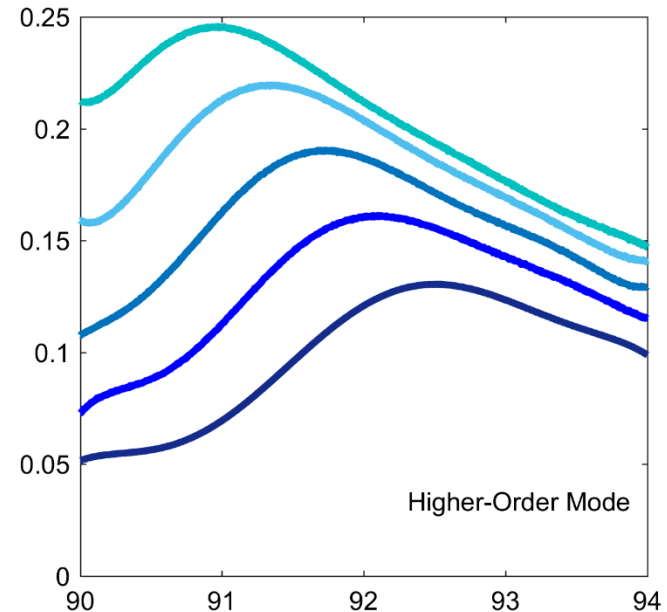
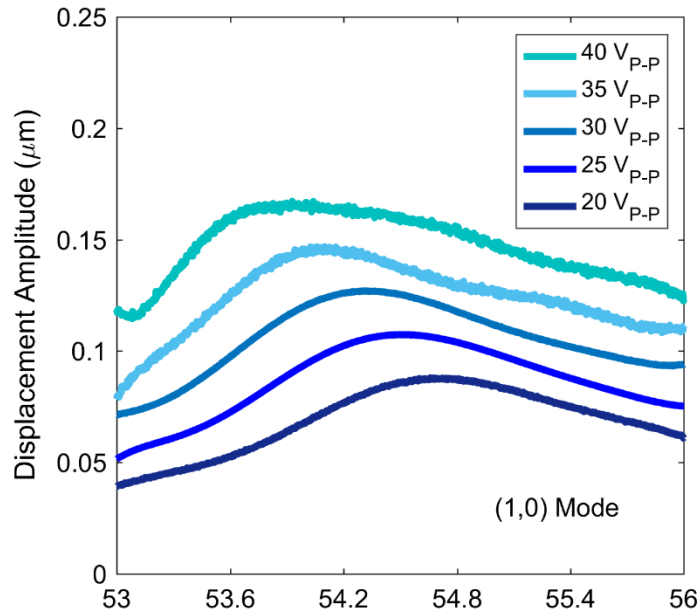
Dynamic Nonlinearity in Piezoelectric FUTs

- Using LabVIEW, the drive frequency is automatically switched, and the peak-to-peak amplitude recorded.
- The drive frequency is swept around resonance, indicated by the mode shape measurement.
- The voltage measurements are converted to velocity, using the mm/s/V sensitivity on the LDV system.

Transducer	Frequency Reduction (Hz)
Aluminium SCF: (1,0) Mode	200
Aluminium SCF: FFS Mode	0
Aluminium LCF: (1,0) Mode	200
Brass FUT: (0,0) Mode	300
Titanium FUT 1: (0,0) Mode	1350
Titanium FUT 2: (1,0) Mode	1000



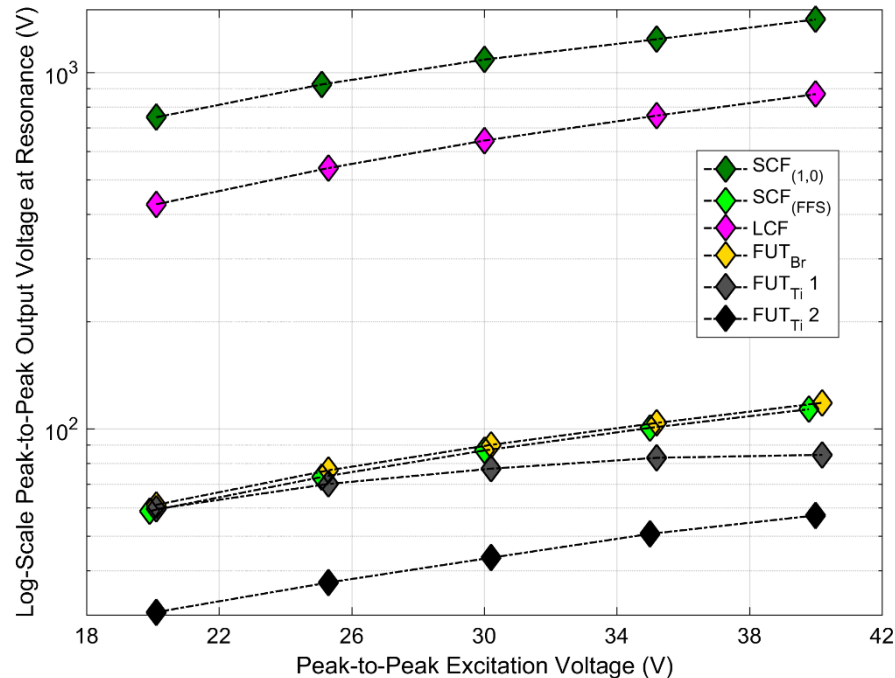
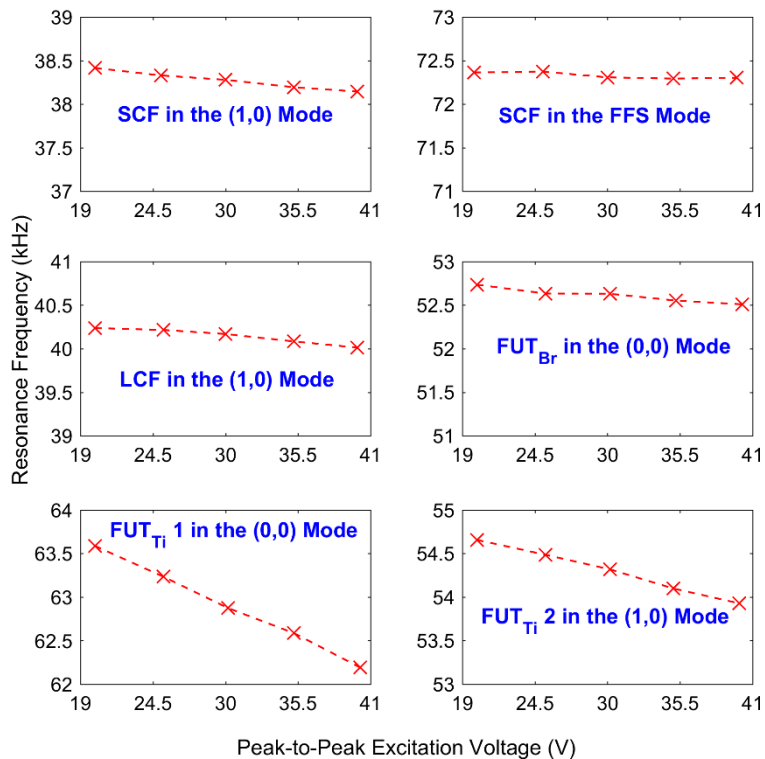
Dynamic Nonlinearity in Piezoelectric FUTs



Drive Frequency (kHz)

Amplitude-frequency Polynomial Fits for Two Operating Modes of Titanium FUT 2

Dynamic Nonlinearity in Piezoelectric FUTs



Next Steps

- Complete the fabrication and subsequently characterise the laser welded transducers.
- High pressure HiFFUTs have been designed for pressures upwards of 200 bar. Testing of these transducers will be undertaken in 2019.
- Optimisation of the transducer fabrication process and of HiFFUT performance.
- Continue patenting of new devices, and publishing of new results.

Acknowledgements

- Dr Pasquale Franciosa, WMG, for assistance with laser welding.
- Jonathan Harrington and Mareike Herrmann, for fabrication of select transducer components.
- Polytec GmbH, for assistance with scanning laser Doppler vibrometry.

Project Gantt Chart

