Development of a Common Dataset for Electronic Component Survivability Under Repeated Shock

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Outline:

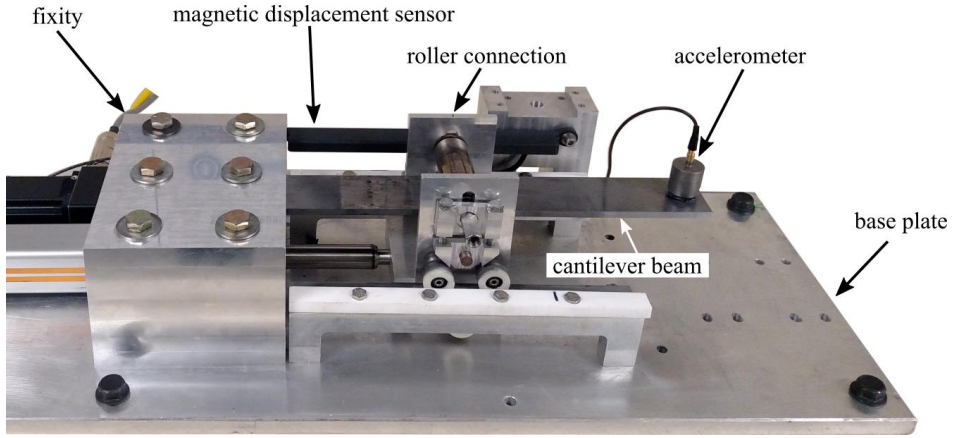
Methodology
- dataset development
- PCB health state estimation

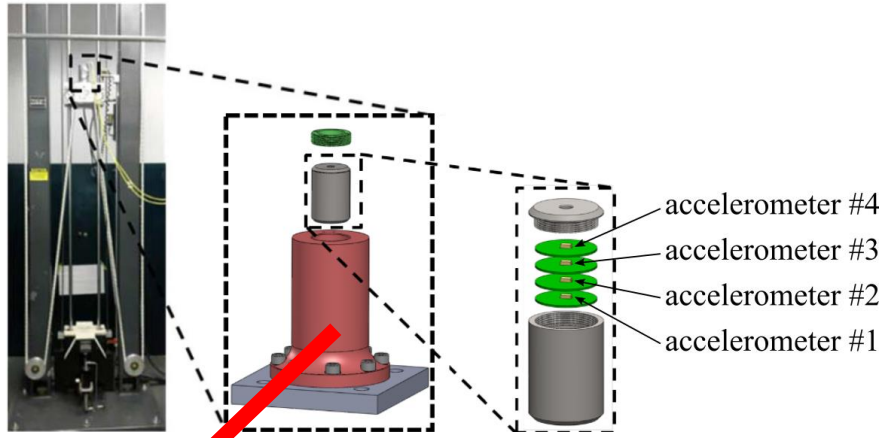
Experimentation
- experimental setup
- daisy chain PCB impedance

Results and discussion
- time and frequency domain
- feature extraction
- impedance vs. number of impacts

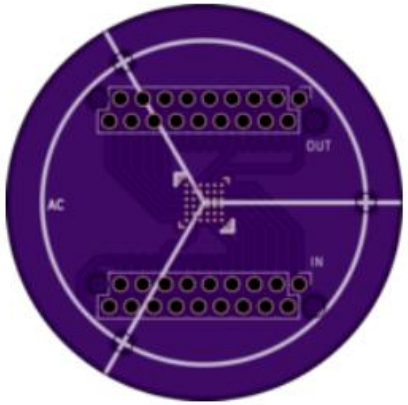
Future work
- multi-connection impedance measurement
- raise sampling rate and impact magnitude

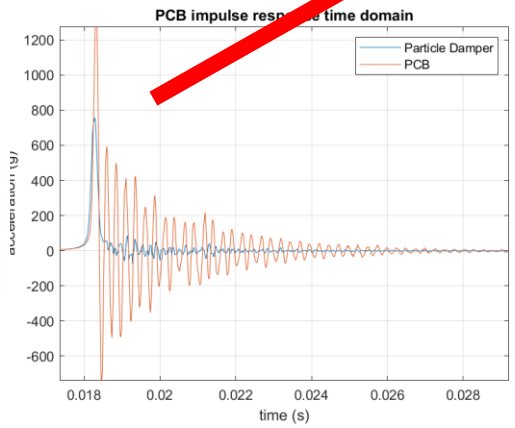
Datasets of Varying Complexity

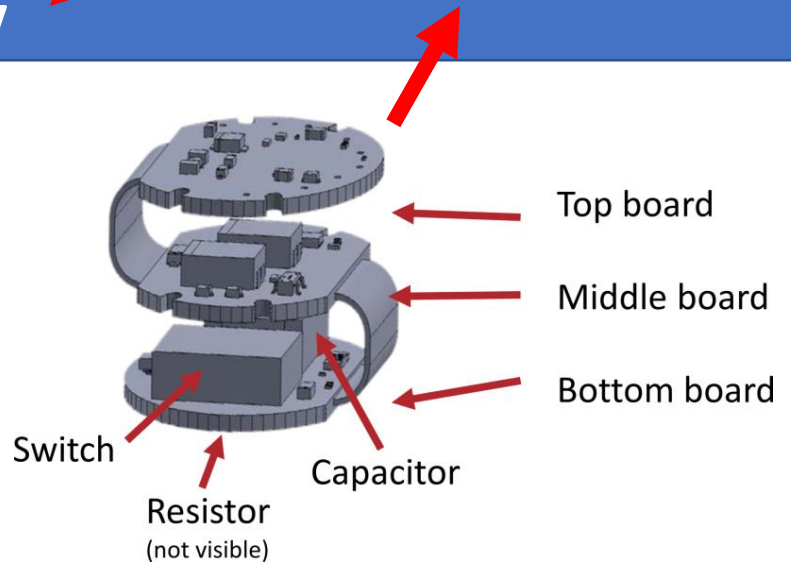




Complexity







Common Datasets - a Method for Collaboration

https://github.com/High-Rate-SHM-Working-Group

Dataset-1-High-Rate-Drop-Tower-Data-set Public
A data set focused on quad PCBs under shock.
Python 0 0 0 0 Updated on Jun 23, 2021

Dataset-1a-Shock-Test-GAN-model Public
Generating model trained on Dataset 3
Python CC-BY-SA-4.0 0 0 0 0 Updated on Jun 24, 2022

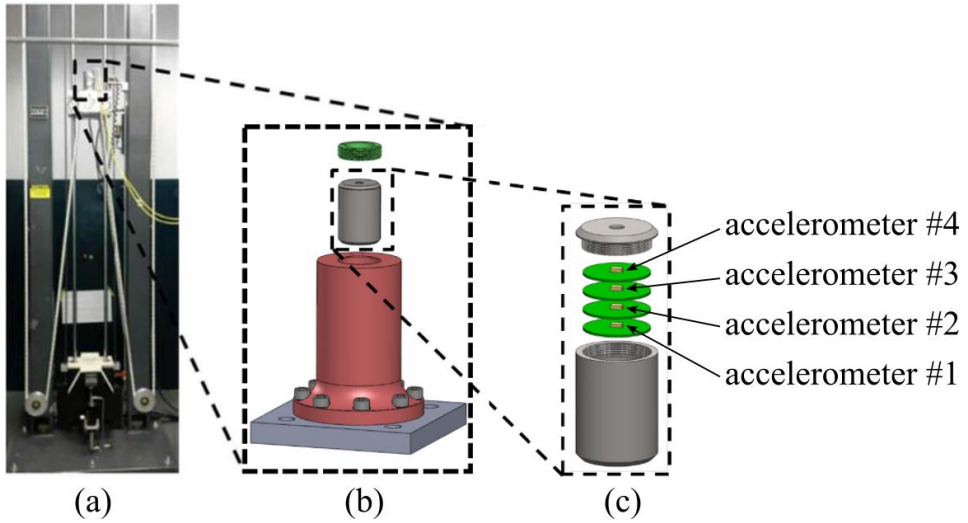
Dataset-2-DROPBEAR-Acceleration-vs-Roller-Displacement Public
Acceleration-vs-Roller-Displacement Dataset for DROPBEAR
Python CC-BY-SA-4.0 1 1 0 0 Updated on Nov 23, 2022

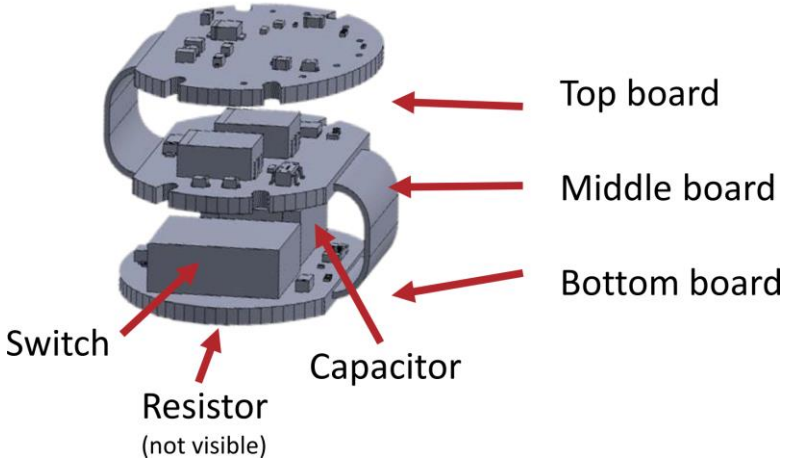
Dataset-3-High-Rate-In-Situ-Damage-of-Electronics-Packages Public
Drop Tower shock tests of highly-instrumented electronics package
0 0 0 0 Updated on Jun 24, 2021

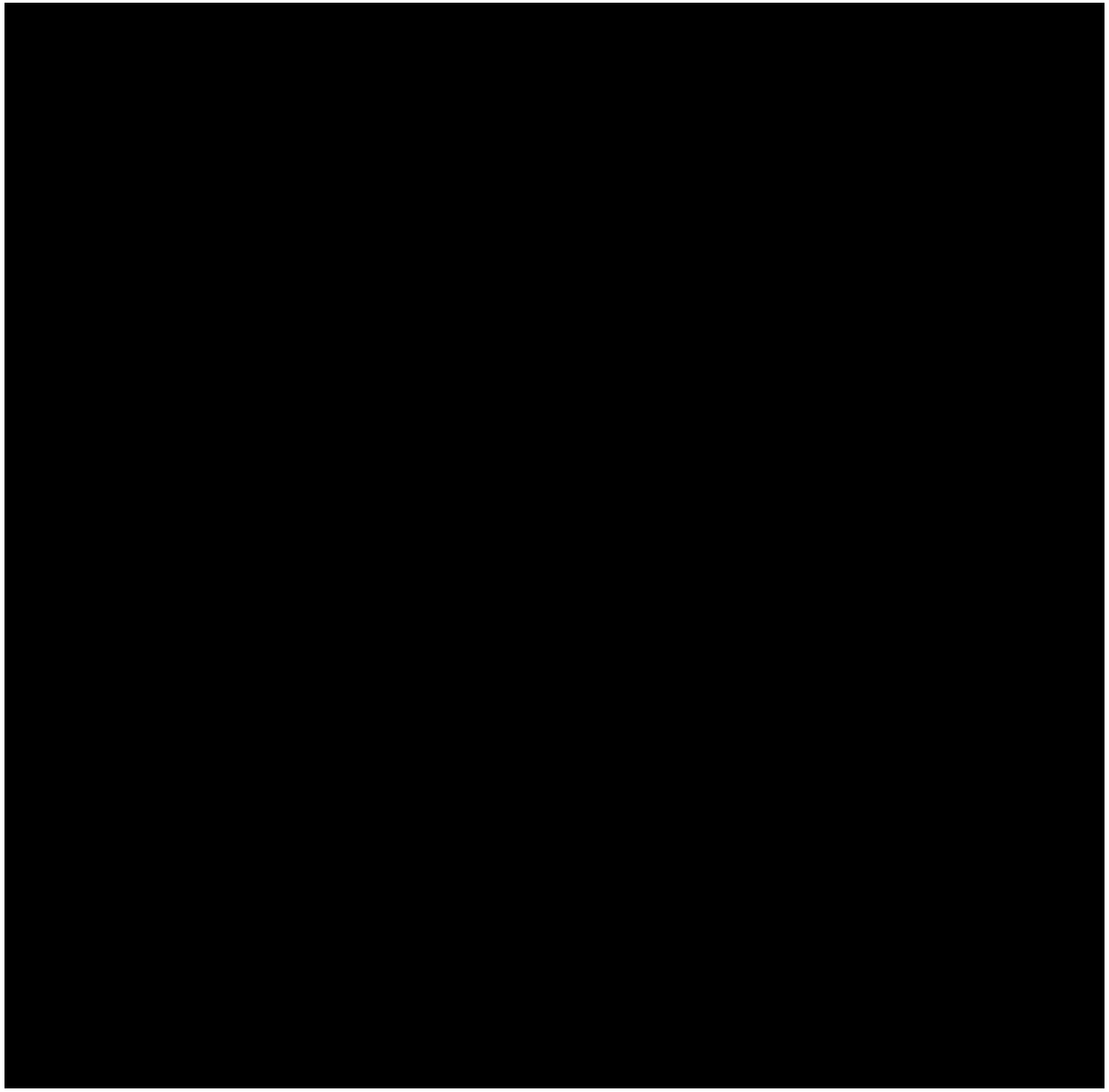
Dataset-4-Univariate-signal-with-non-stationarity Public
univariate signal with varying levels of non-stationarities
Python CC-BY-SA-4.0 0 0 0 0 Updated on Sep 27, 2022

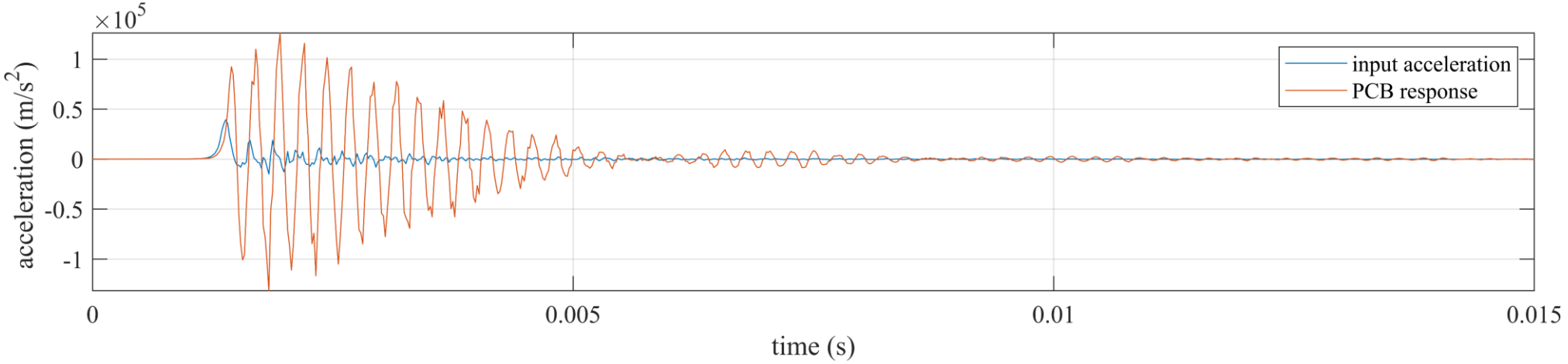
Dataset-5-Extended-Impact-Testing Public
Roff CC-BY-SA-4.0 0 0 0 0 Updated on Sep 30, 2022

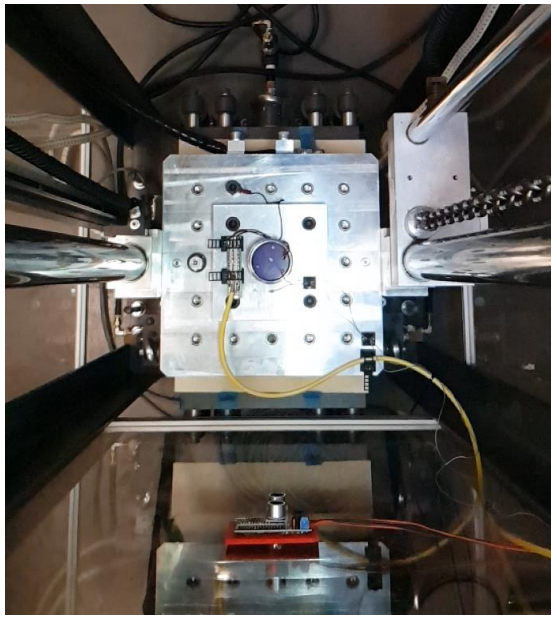
Dataset-6-DROPBEAR_data Public
Data for the paper Generated datasets from dynamic reproduction of projectiles in ballistic environments for advanced research (DROPBEAR)
0 0 0 7 Updated on Jul 24, 2022

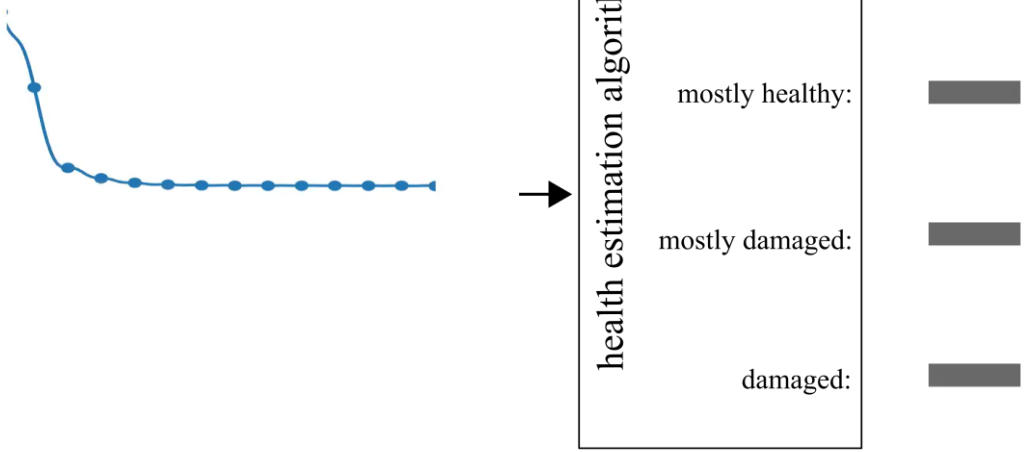


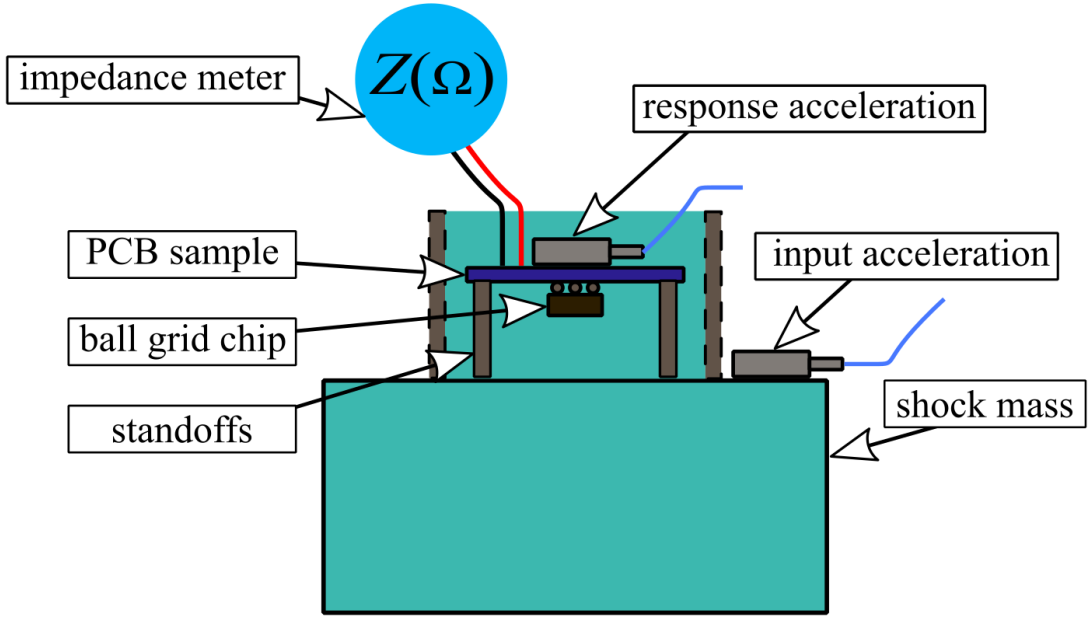


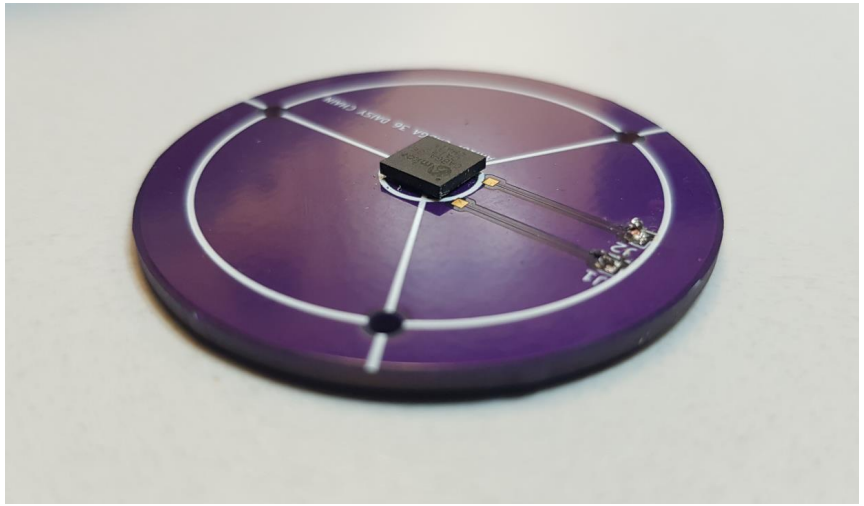


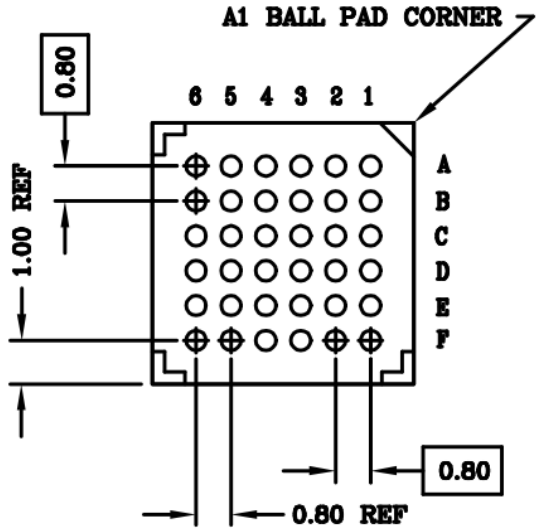

×10^5
1
0.5
0
-0.5
-1
acceleration (m/s^2)
0
0.005
0.01
0.015
time (s)
input acceleration
PCB response

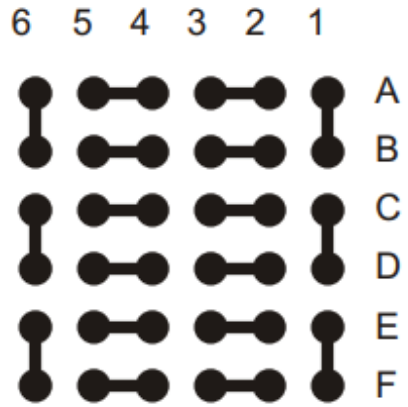



health estimation algorithm
healthy:
mostly healthy:
mostly damaged:
damaged:



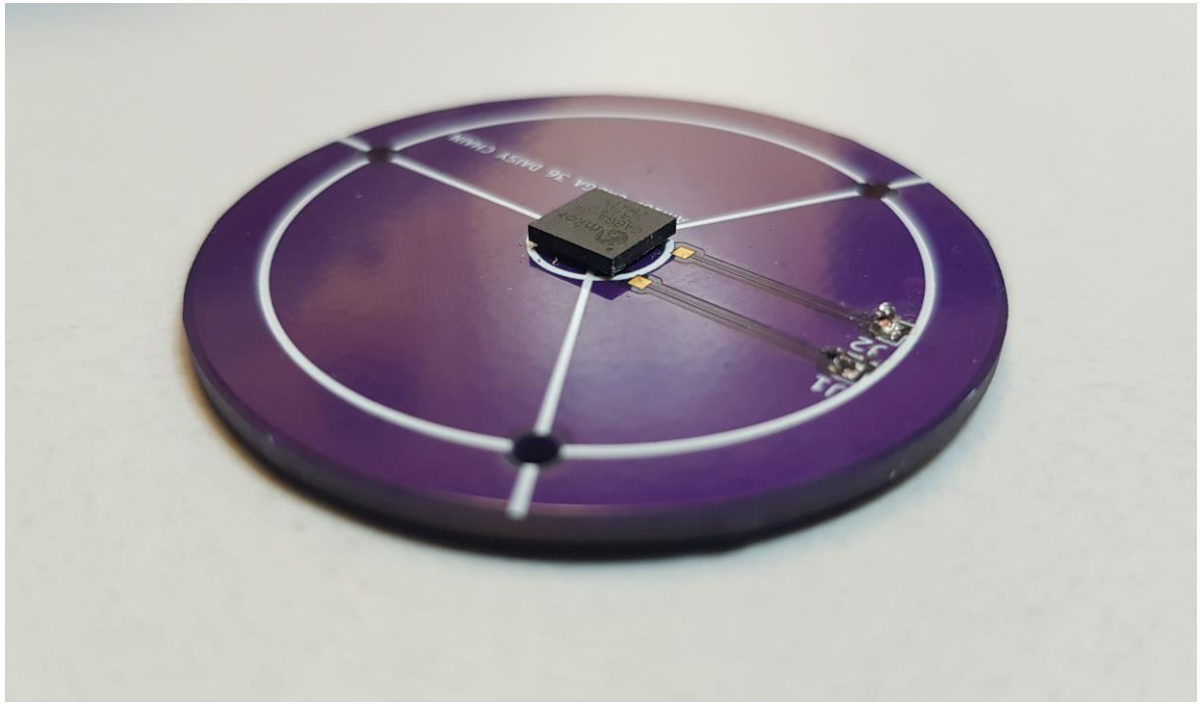


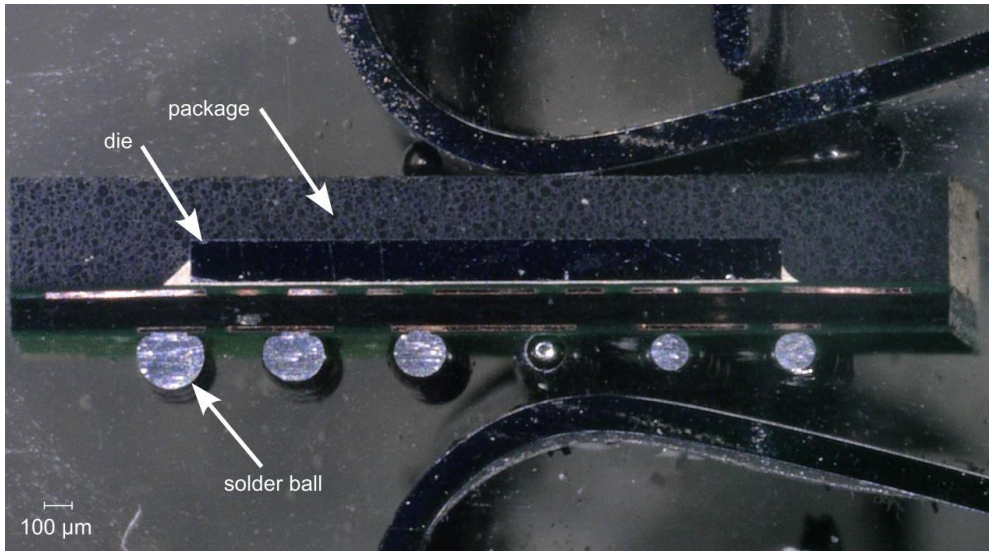


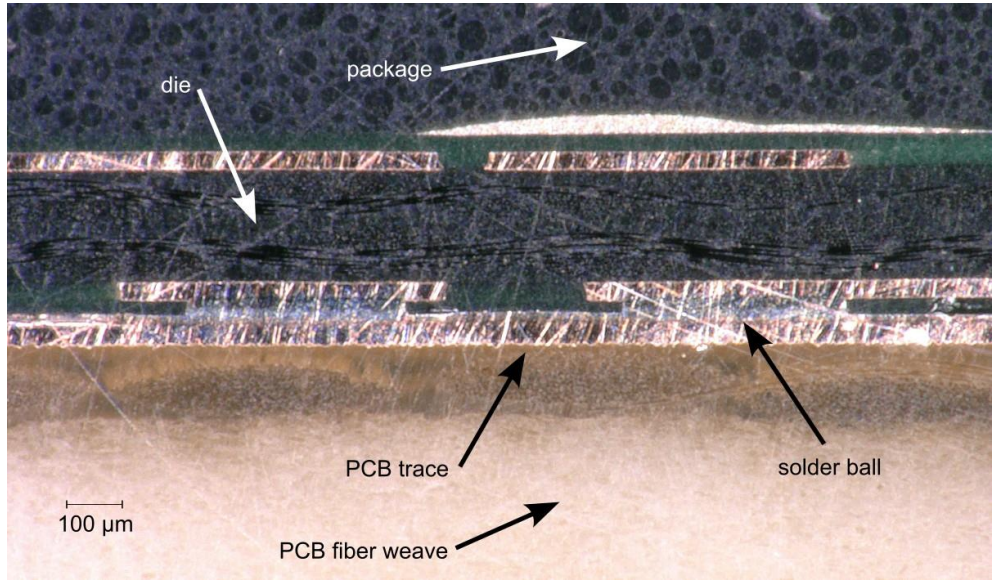


A-CABGA36-.8mm-6mm-DC

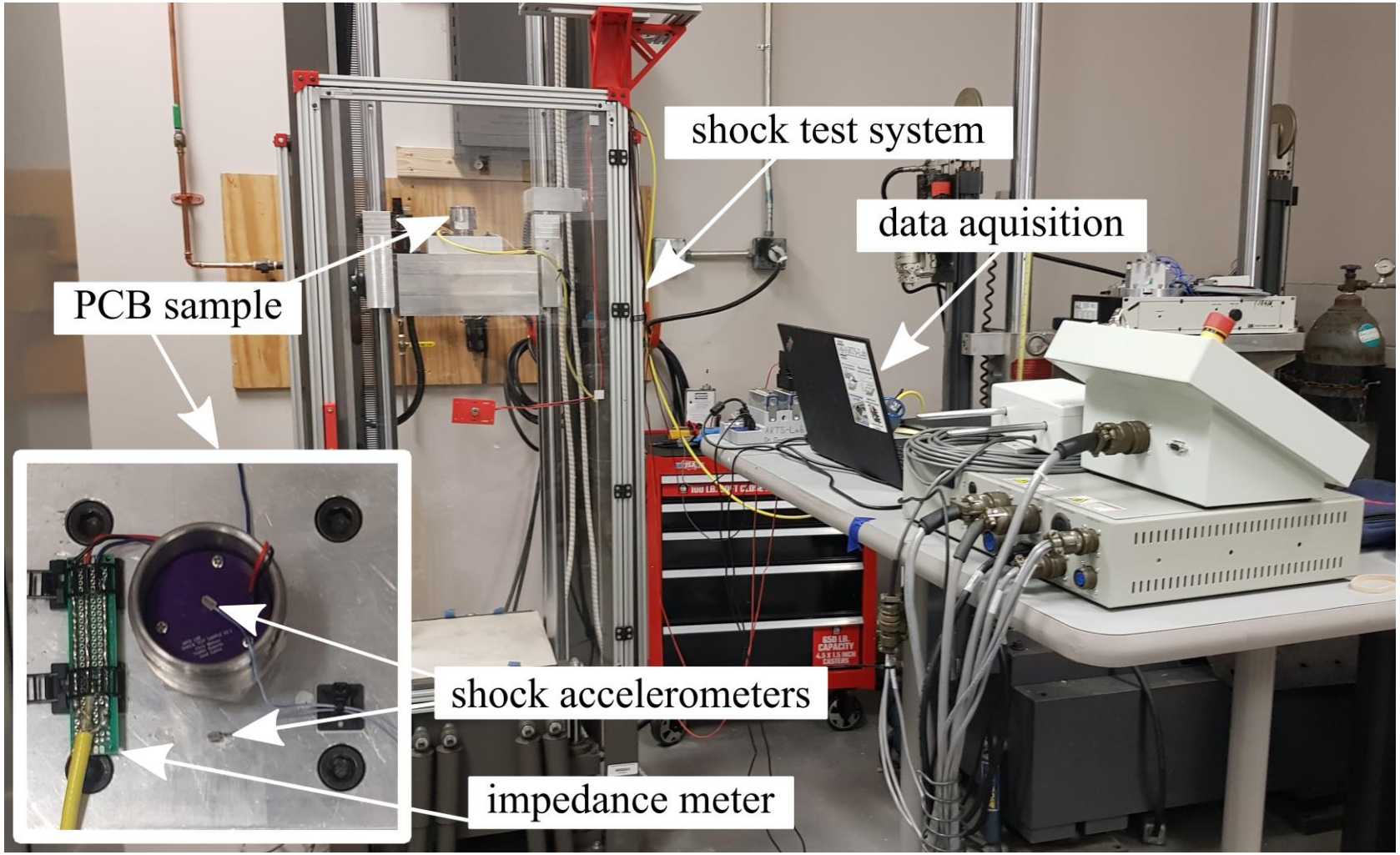
Ball View



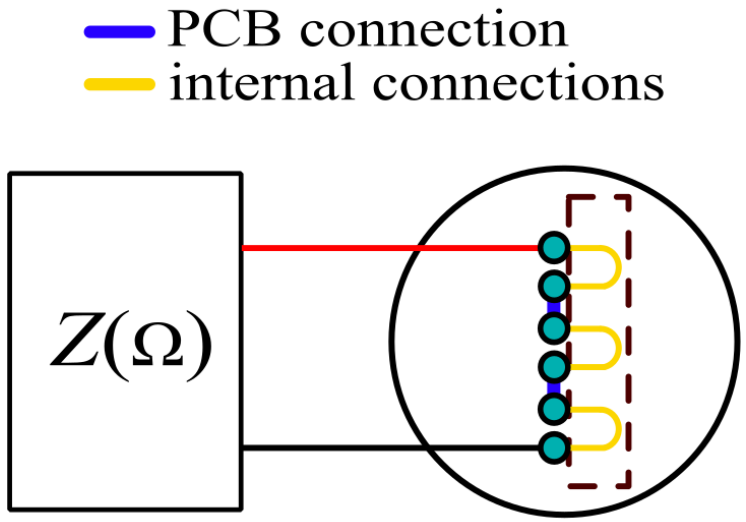

package
die
solder ball
100 µm

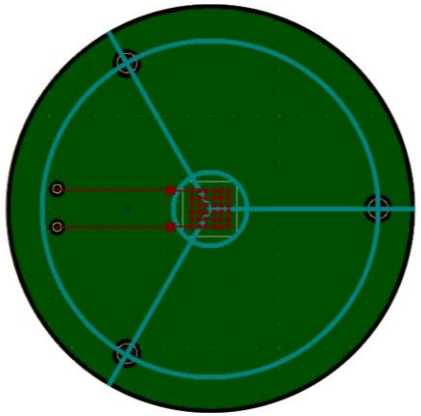

die
package
PCB trace
solder ball
100 µm
PCB fiber weave

Experimental setup

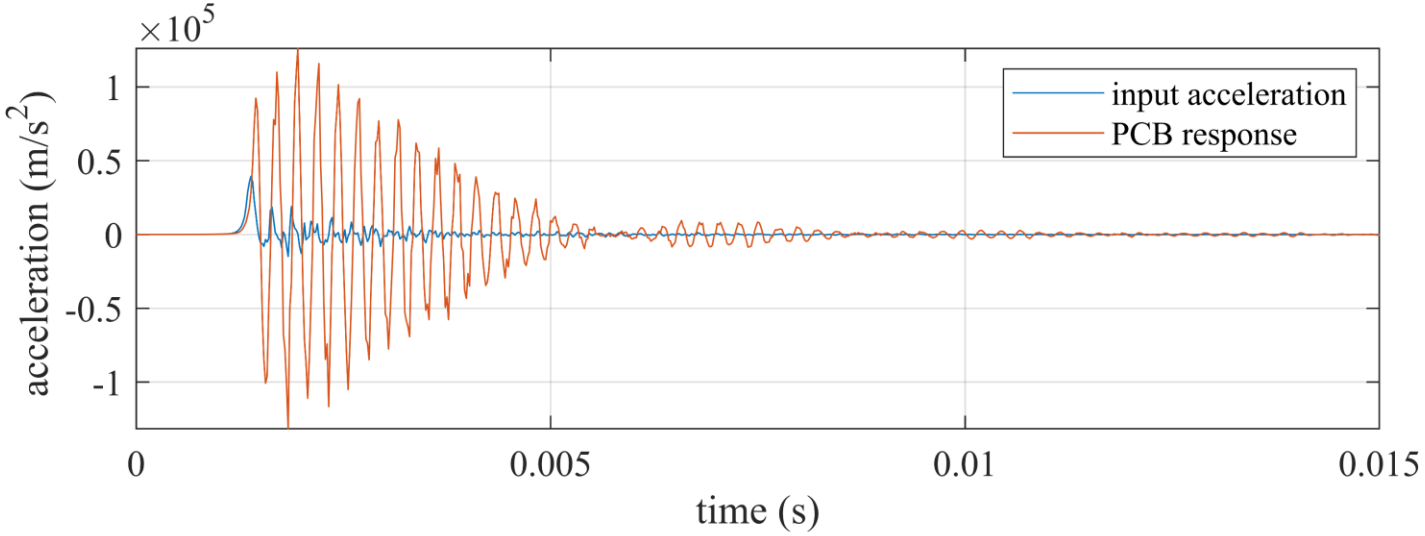


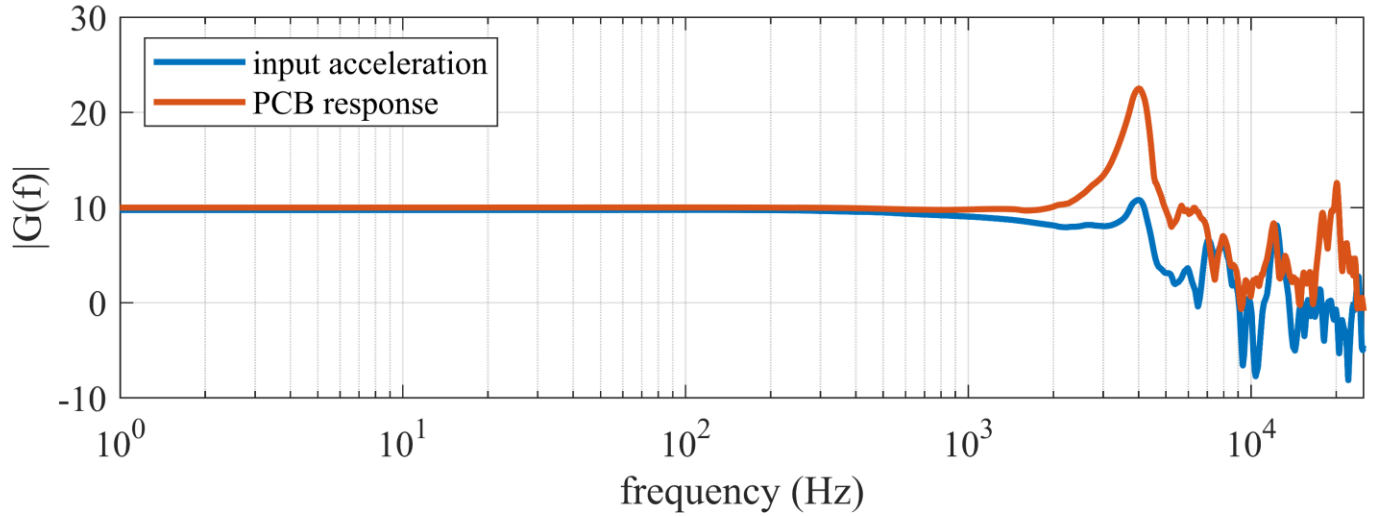
Current test sample





Time and frequency domain response





Dataset Layout

https://github.com/High-Rate-SHM-Working-Group/Dataset-5-Extended-Impact-Testing/tree/main/data/dataset-2

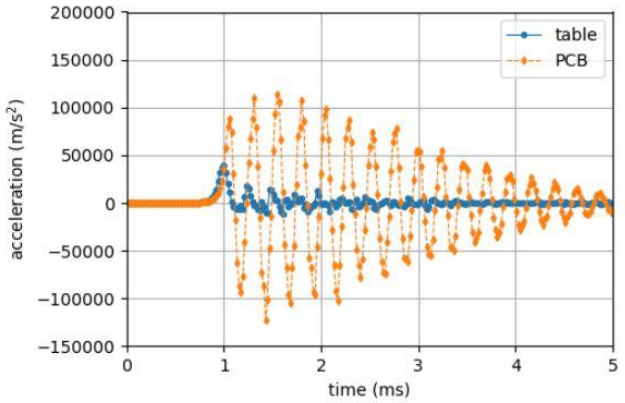
Dataset-5-Extended-Impact-Testing / data / dataset-2 /

Name	Last commit message
..	
data-1	Delete README.md
media/initial_microscope_images	added image annotation file
README.md	Update README.md

README.md

Dataset 2

Dataset 2 consists of 32 tests performed May 5 2023. Tests were performed consecutively on the same PCB. Following each impact test, impedance was measured at five LCR excitation frequencies. The folder also contains a python file with a demonstration for extracting data from the .lvm files and plotting, and figures plotting the acceleration and measured impedance.



Dataset Layout

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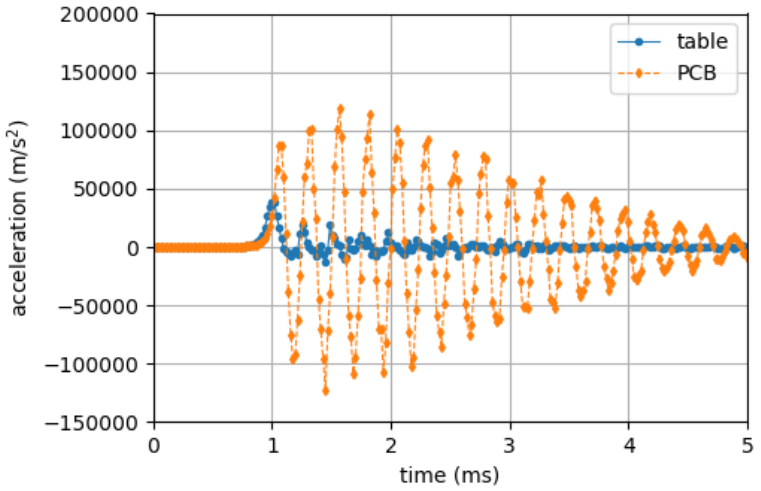
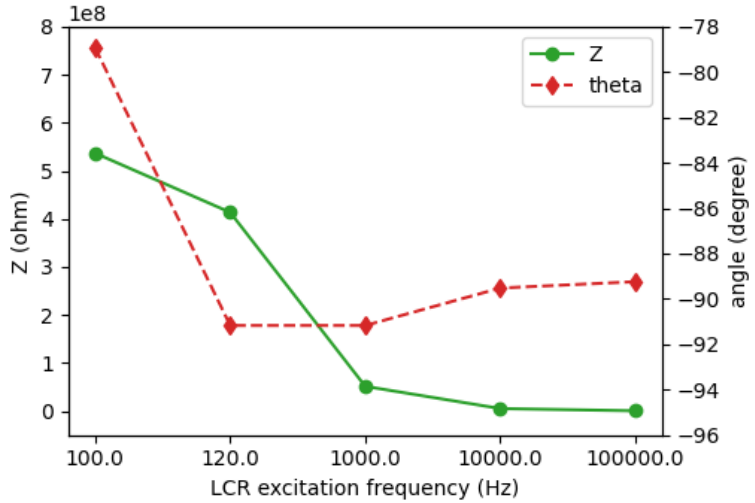




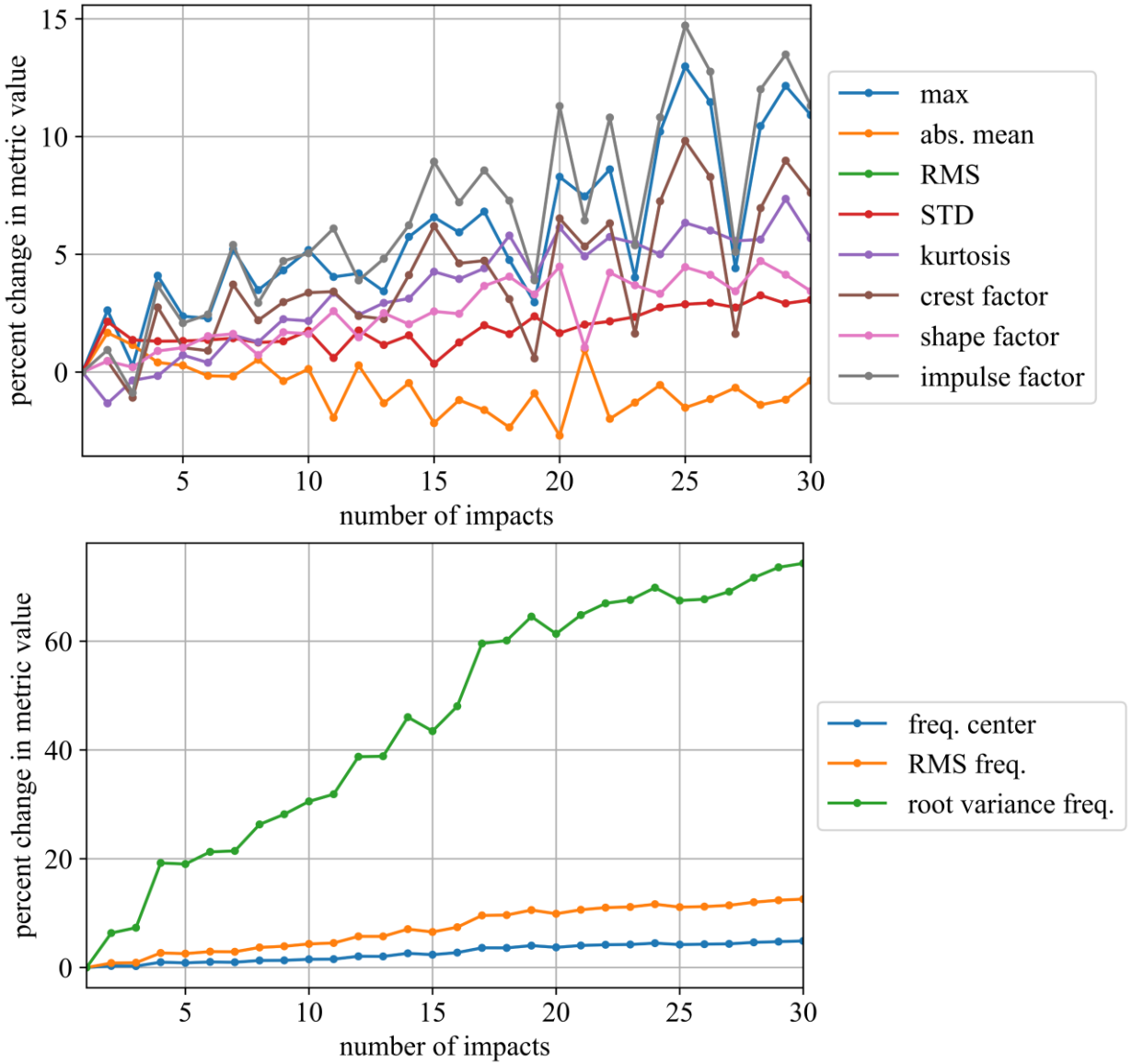
Acceleration feature extraction (X)

Table 1 Time-domain features

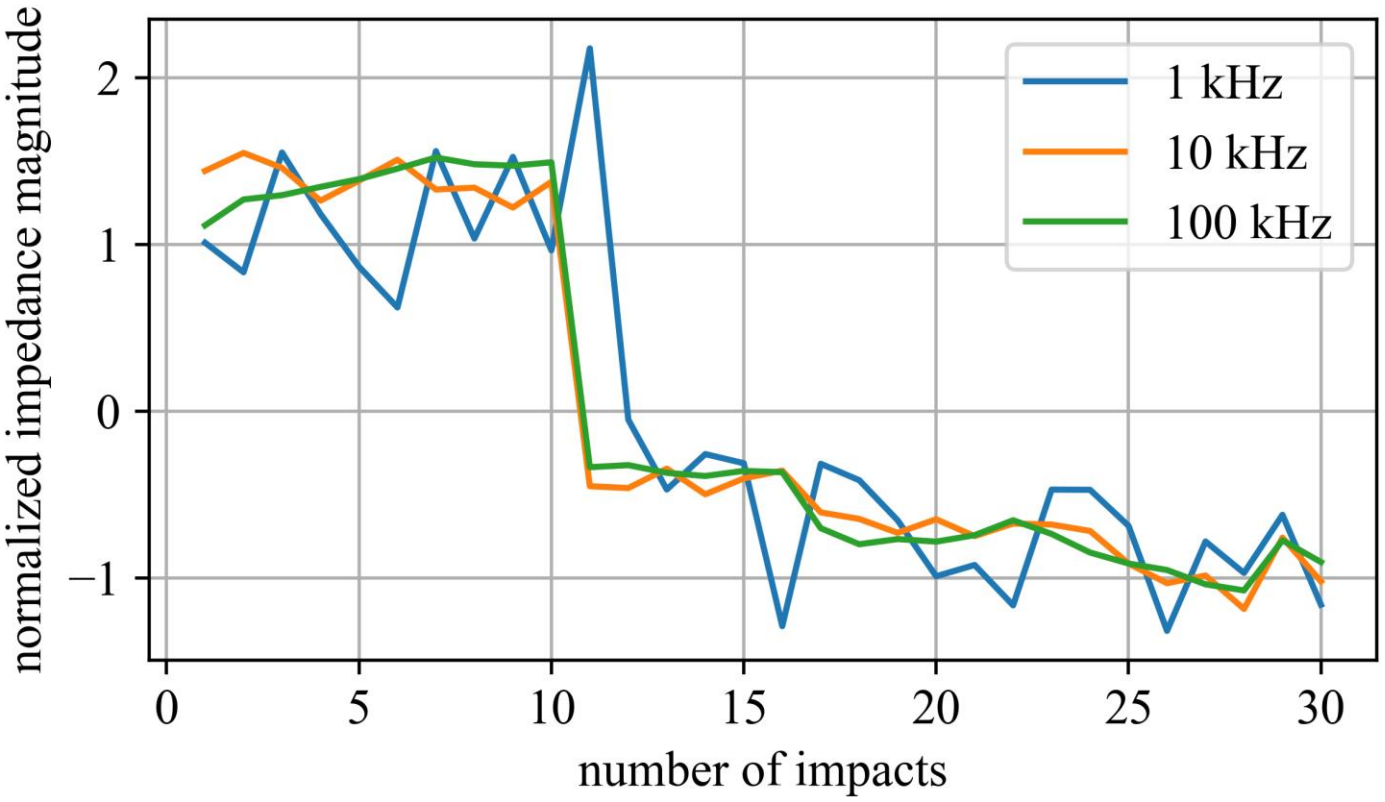
No.	Features	Description	Physical interpretation
T1	Maximum	$\mathrm{Max}(X_i)$	Kinetic energy related
T2	Absolute Mean	$\mathrm{Mean}(\lvert X_i \rvert)$	
T3	RMS	$\sqrt{\frac{\sum X_i^2}{N}}$	
T4	Skewness	$\frac{\sum (X_i - \bar{X})^3}{(N-1)s^3}$	Data statistics related
T5	Kurtosis	$\frac{\sum (X_i - \bar{X})^4}{(N-1)s^4}$	
T6	Crest Factor	$\frac{\mathrm{Max}(X_i)}{X_{rms}}$	Sinusoidal wave shape related
T7	Shape Factor	$\frac{X_{rms}}{\mathrm{Mean}(\lvert X_i \rvert)}$	
T8	Impulse Factor	$\frac{\mathrm{Max}(X_i)}{\mathrm{Mean}(\lvert X_i \rvert)}$	

Table 2 Frequency-domain features

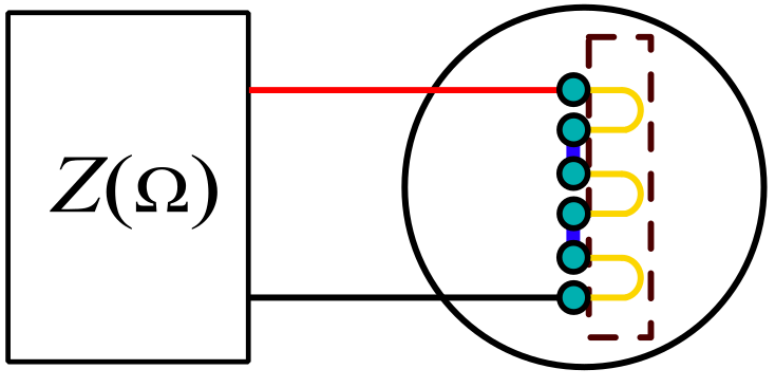
No.	Features	Description	Physical interpretation
F1	FC	$\frac{\int f \times s(f) df}{\int s(f) df}$	Position change of main frequencies
F2	RMSF	$\left[\frac{\int f^2 \times s(f) df}{\int s(f) df}\right]^{1/2}$	

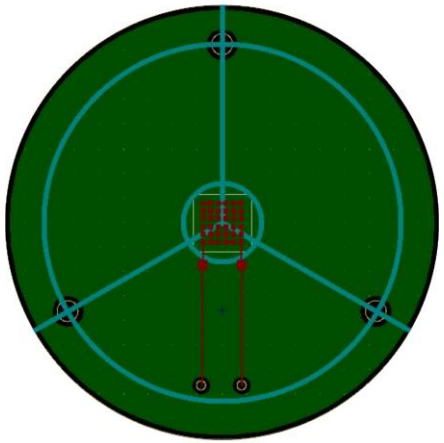


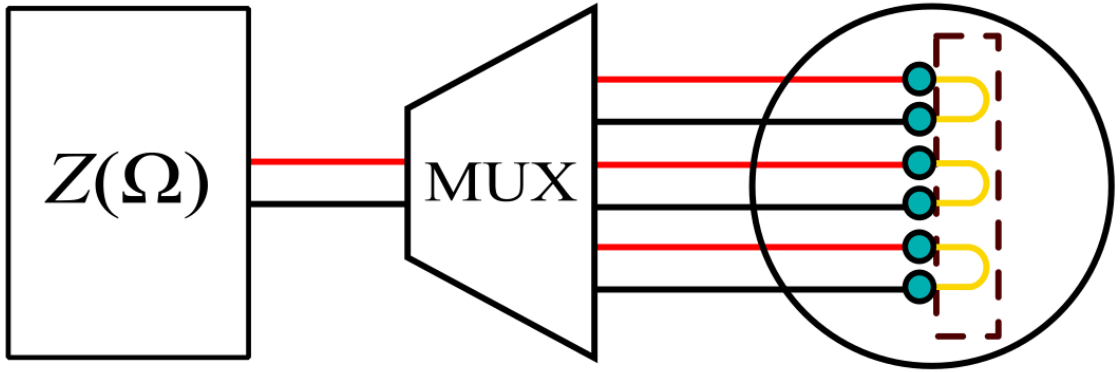
Electrical feature extraction (*y*)

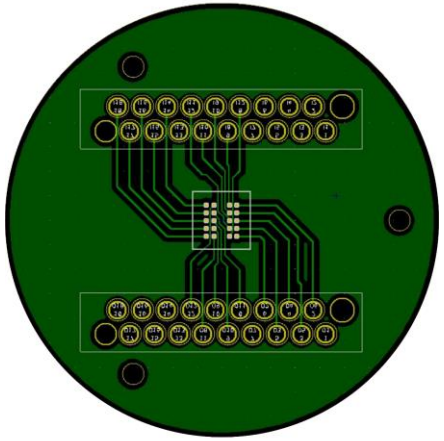


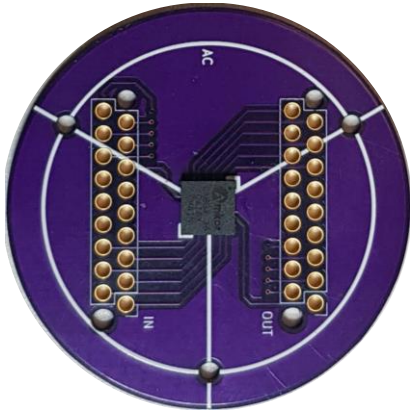
PCB connection
internal connections





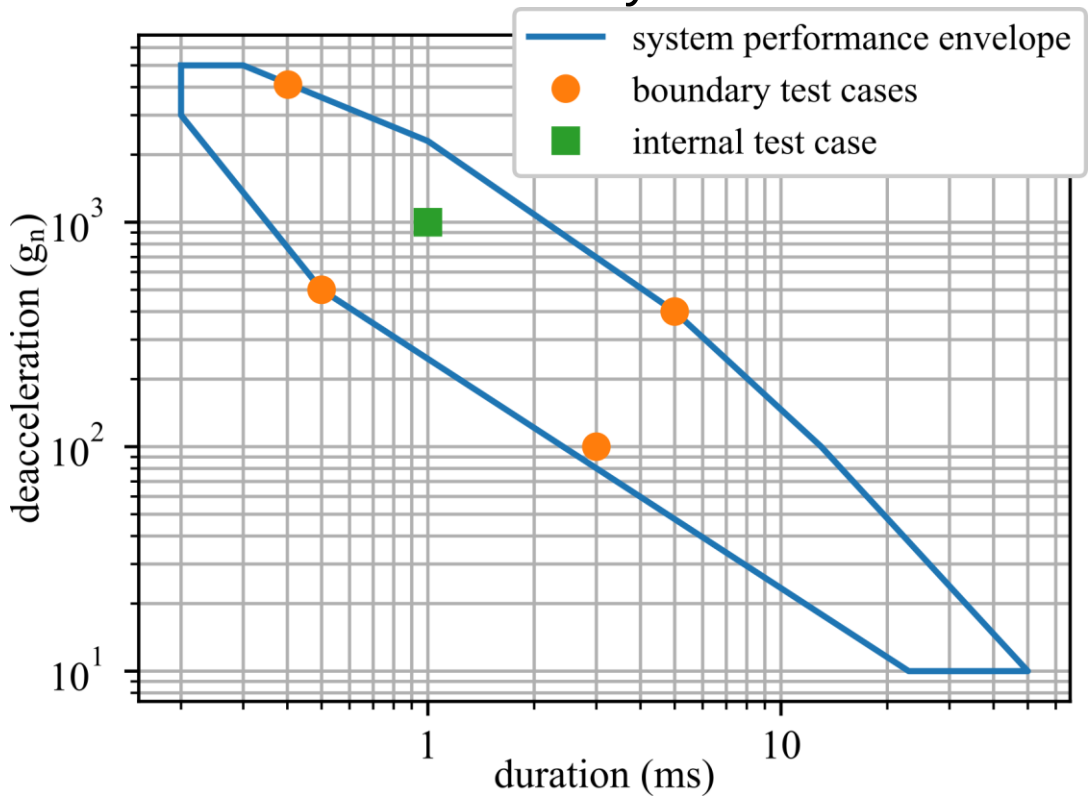




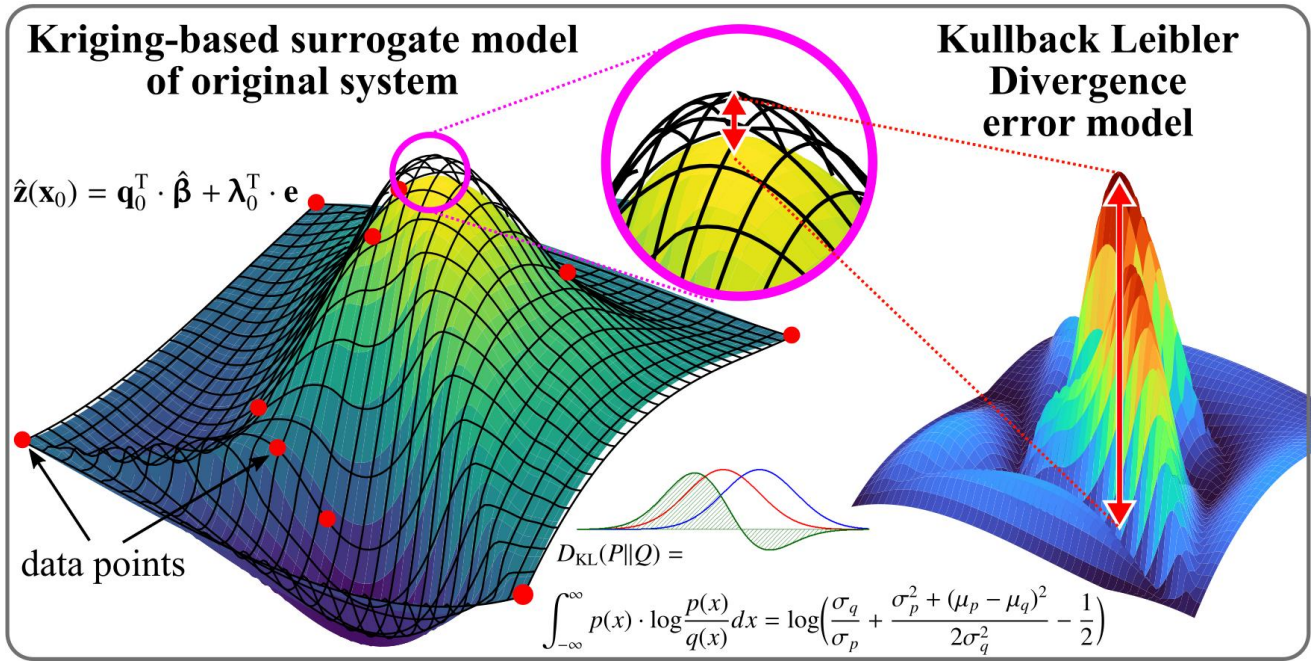


Develop Test-to-failure Data and Surrogate Performance Model

Shock test system



Kriging model for identifying test locations



Thank you

Questions?

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Email: austindowney@sc.edu