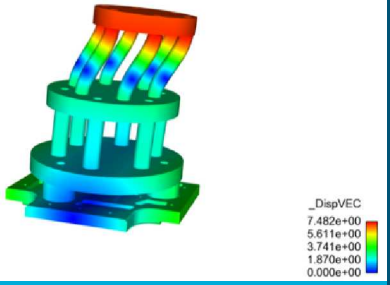
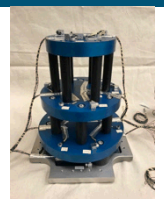
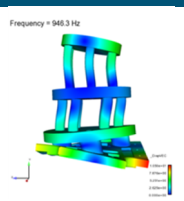
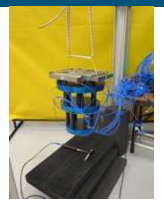
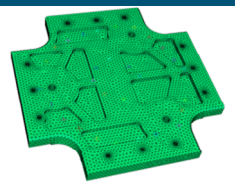
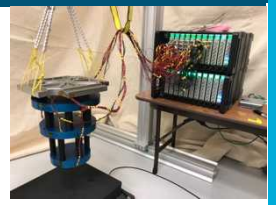
SAND2018-2018PE

Modal Validation Experiment (Wedding Cake)



PRESENTED BY

Brandon R. Zwink

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Outline

Motivation

Approach

Hardware Selection

Testing

Results

Conclusions

Future Work

Questions

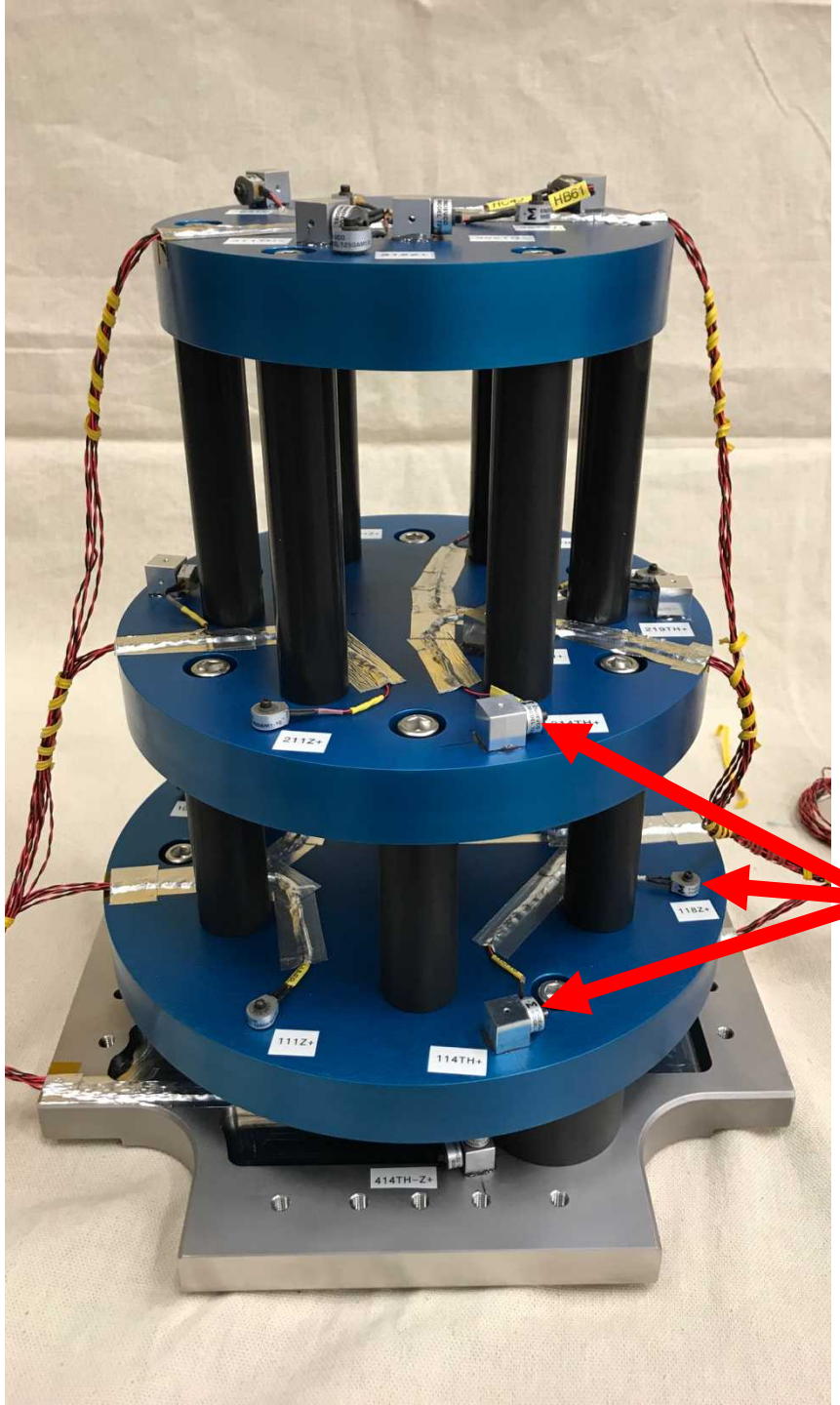
Motivation

What we are trying to do:

- Prediction of flight environment responses at un-instrumented locations

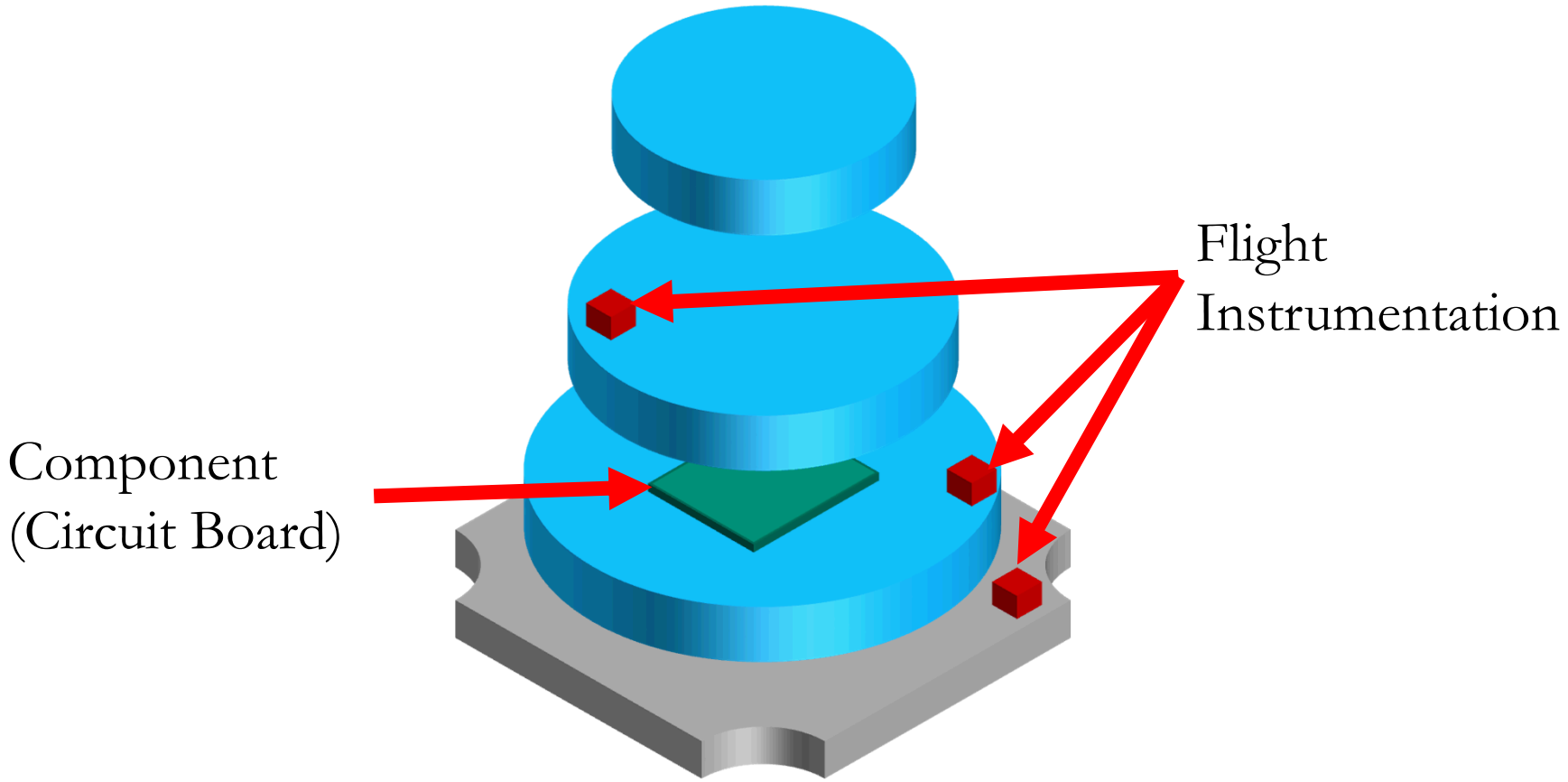
Why is this important?:

- Telemetry data is typically sparse (location and direction)
- Reduce environment uncertainty
- Over/under-designing of components
- Over/under testing of components

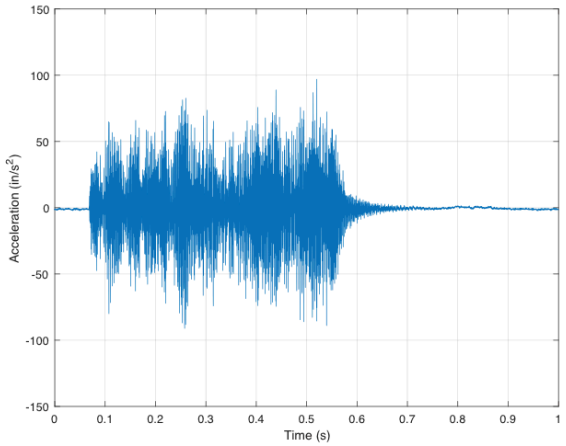


Sparse Measurement Locations

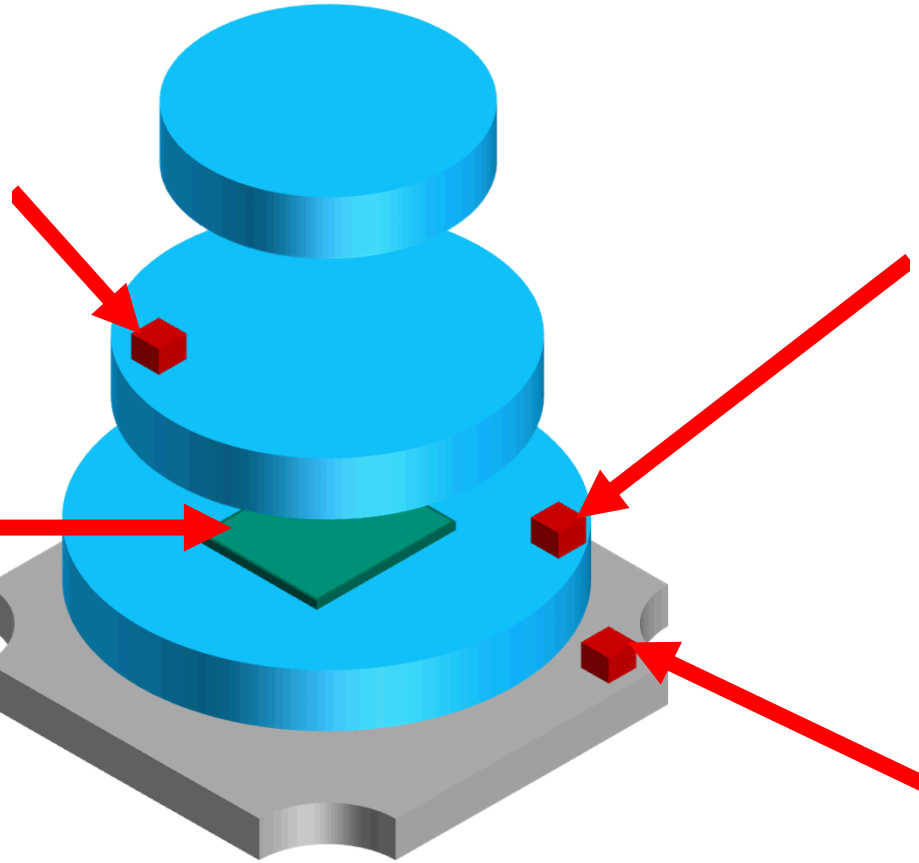
Motivation

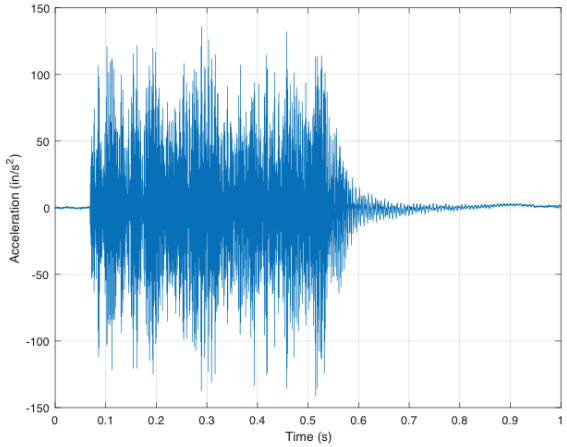


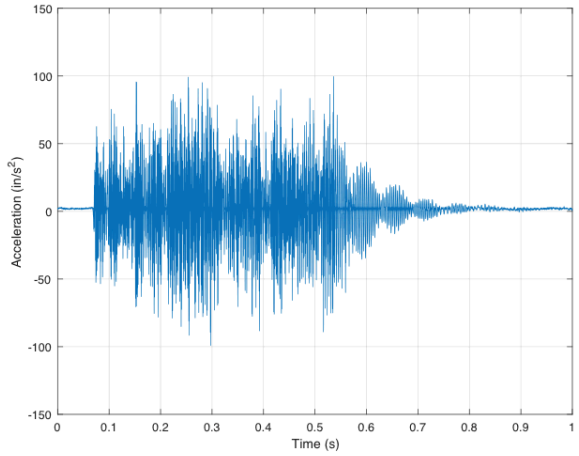
Motivation



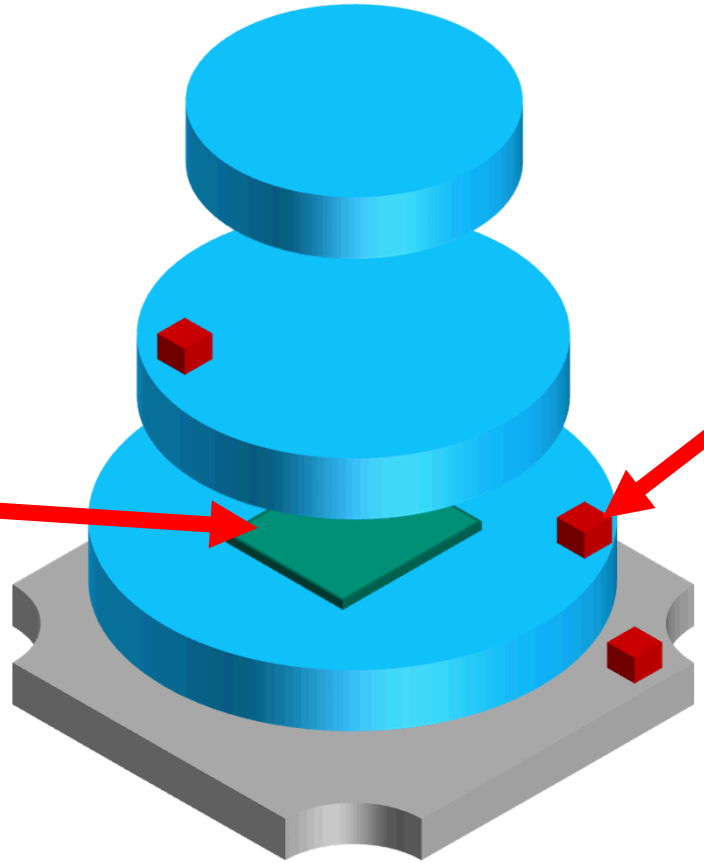
Response = ?

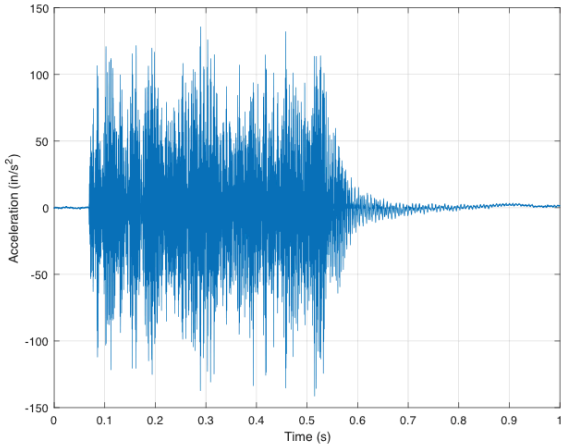




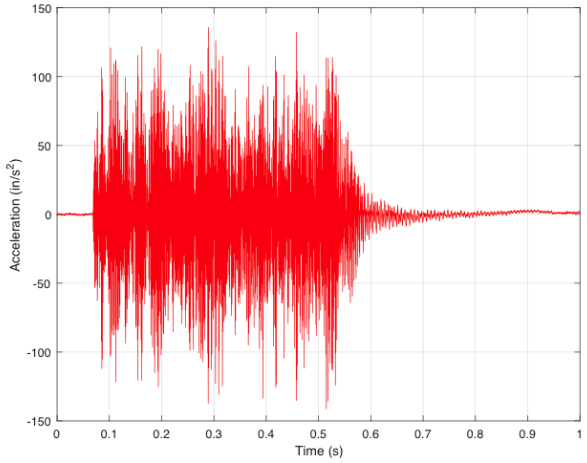


Motivation





Response = ?

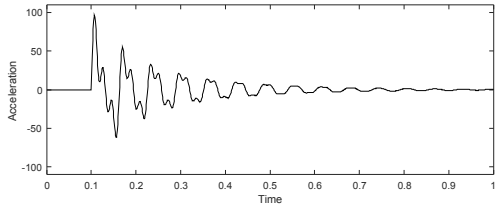


Can we do better?

Approach

Modal Superposition

System Response



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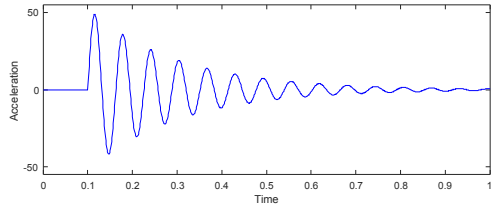
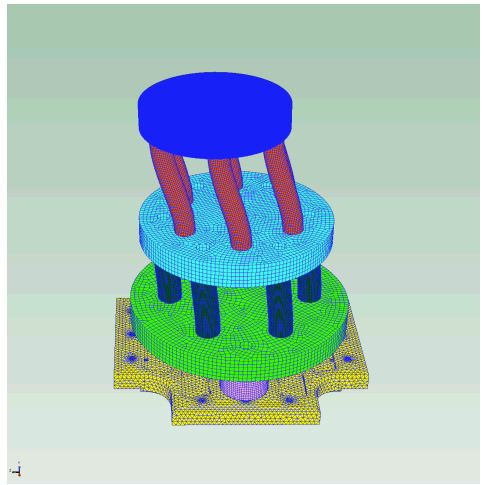
Mode 1





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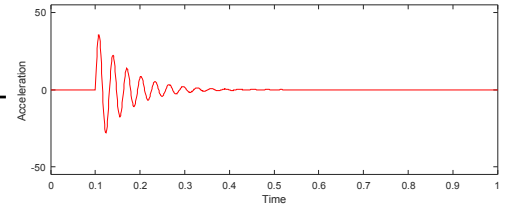
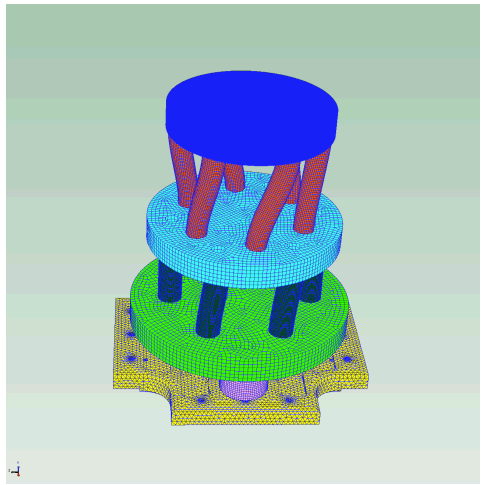
Mode 2





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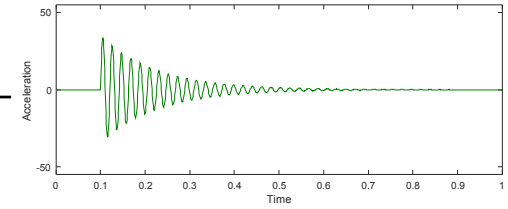
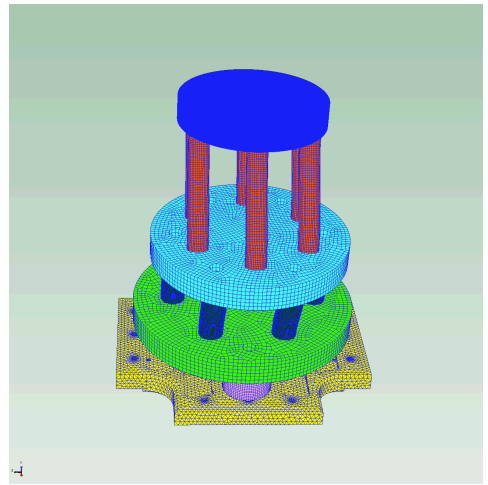
Mode 3





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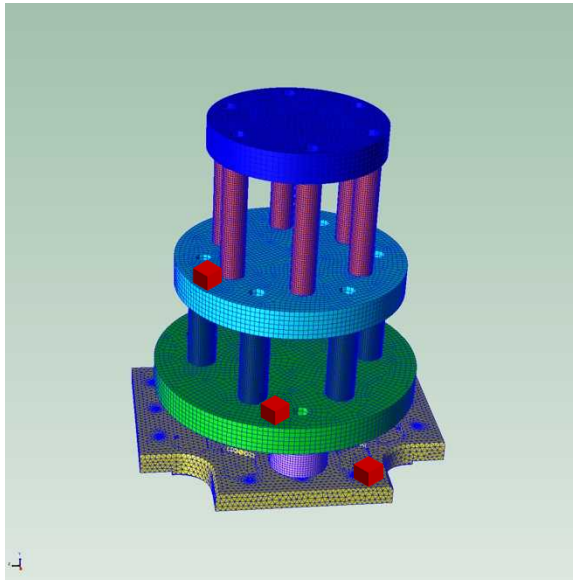
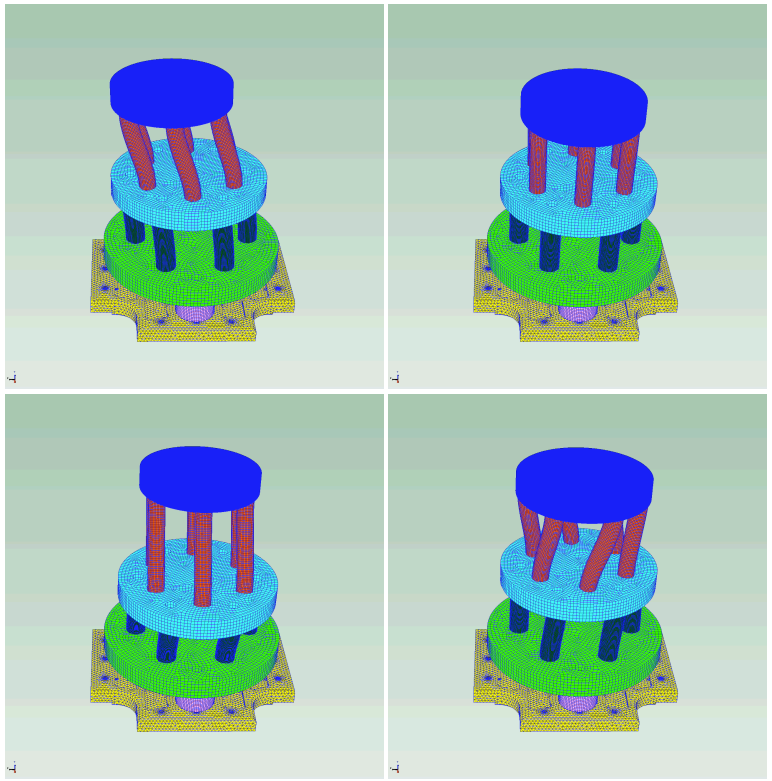
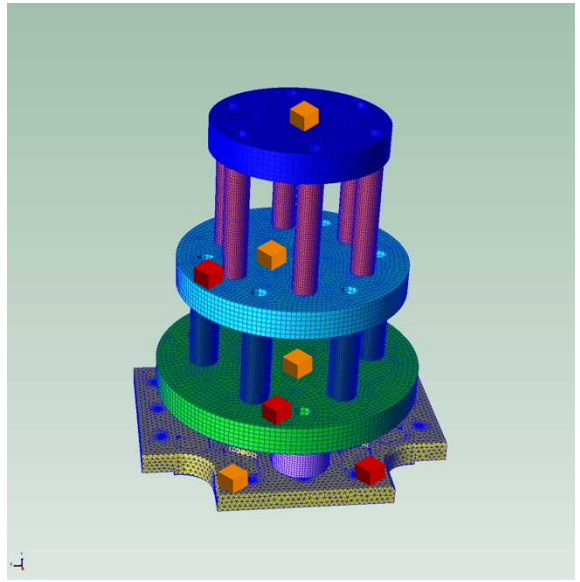
Approach

Response at Measured Locations → Modal Response (From FEM) → Response at Unmeasured Locations (Virtual Accelerometers)





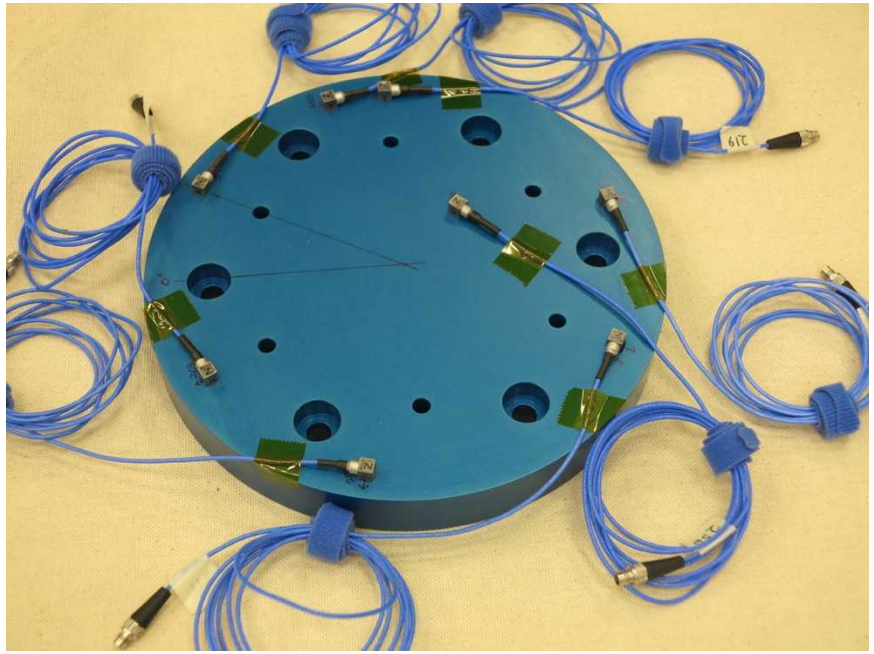


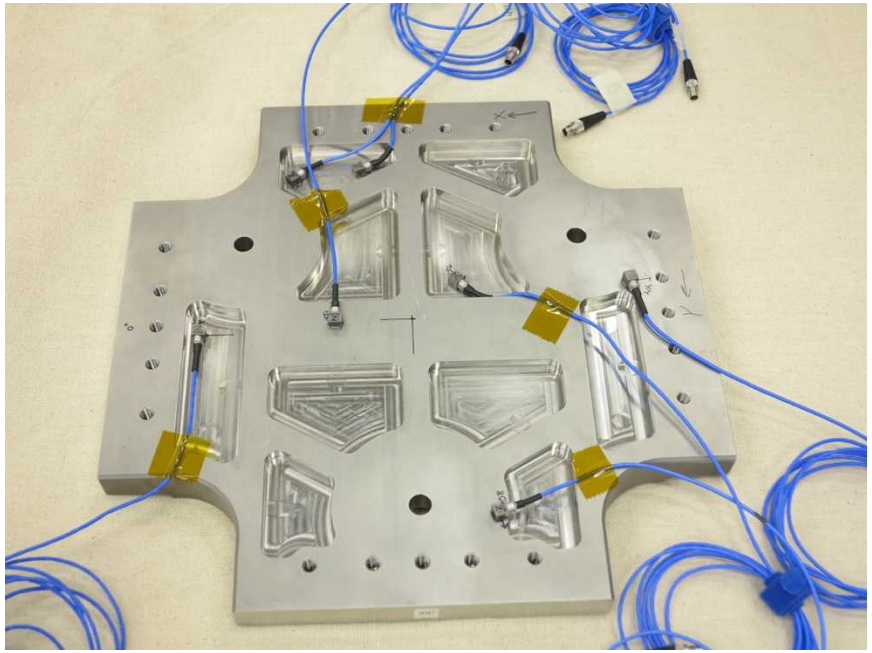
- Measurement Location
- Predicted Response Location

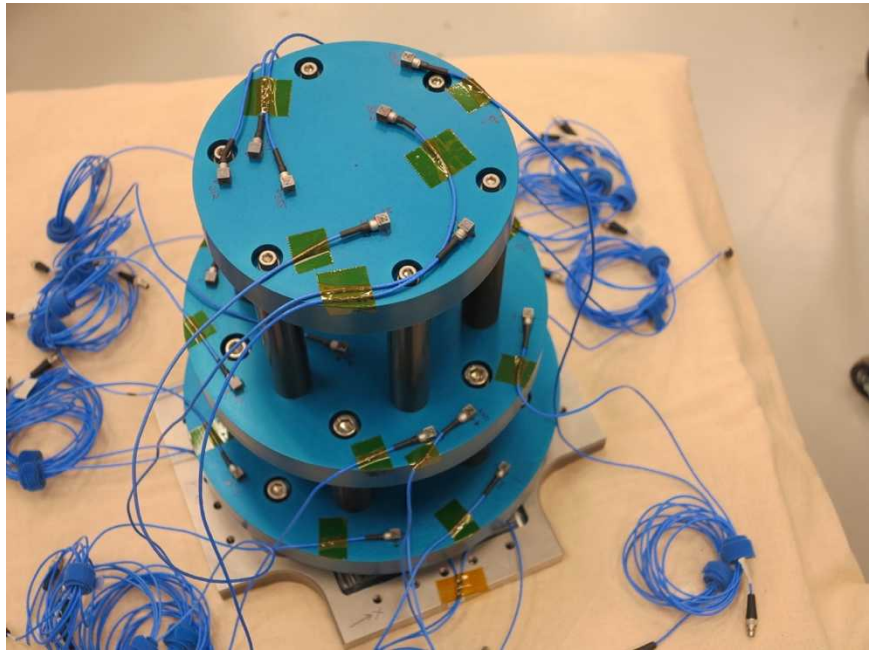
Hardware Selection

Design Criteria:

- Active modes in excitation bandwidth
- Linear response
- Durable
- Reasonable amount of damping
- Easy to build and test



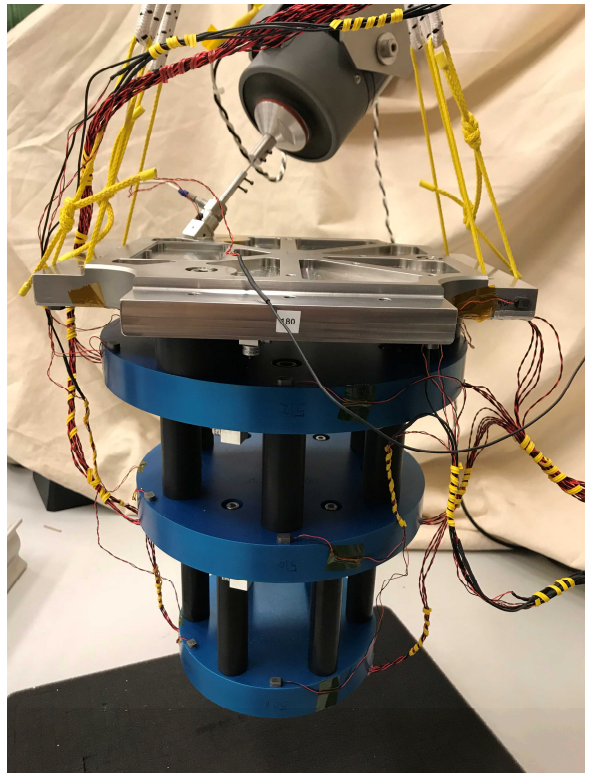


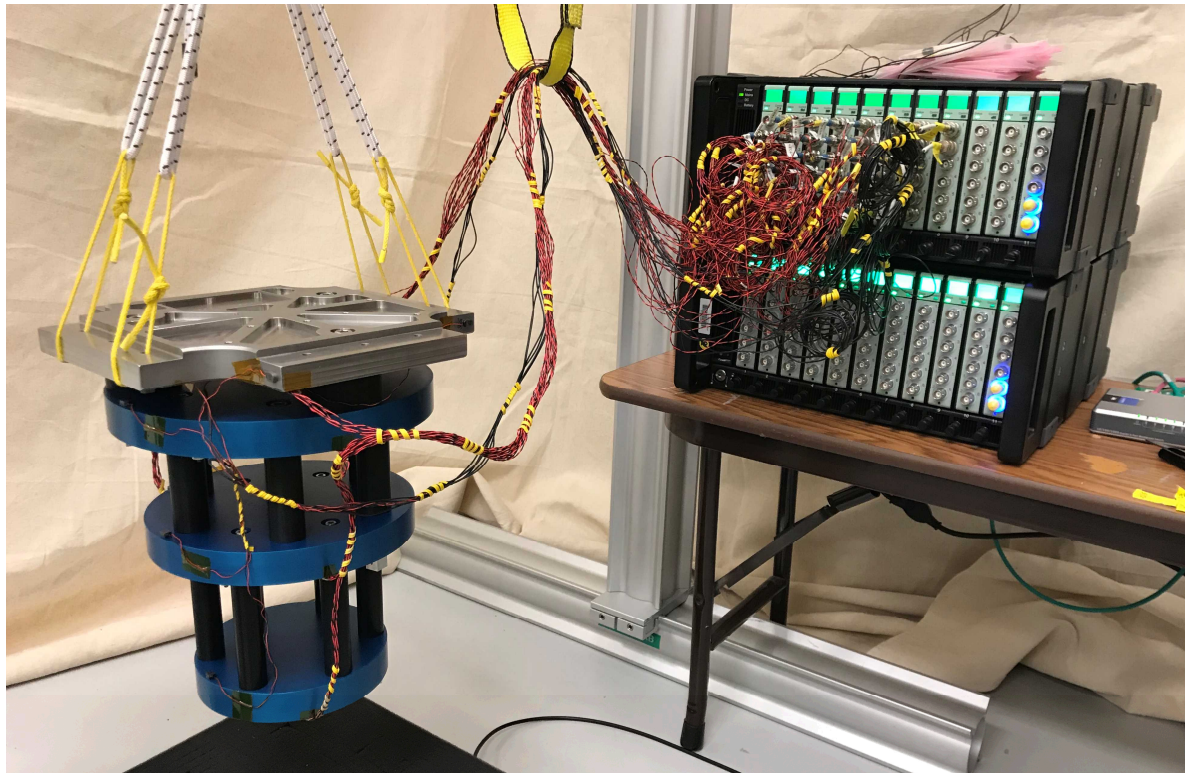


Testing

We need good mode shapes for unmeasured locations

- Can come from experimental or Finite Element Model
- Require all modes active within excitation bandwidth



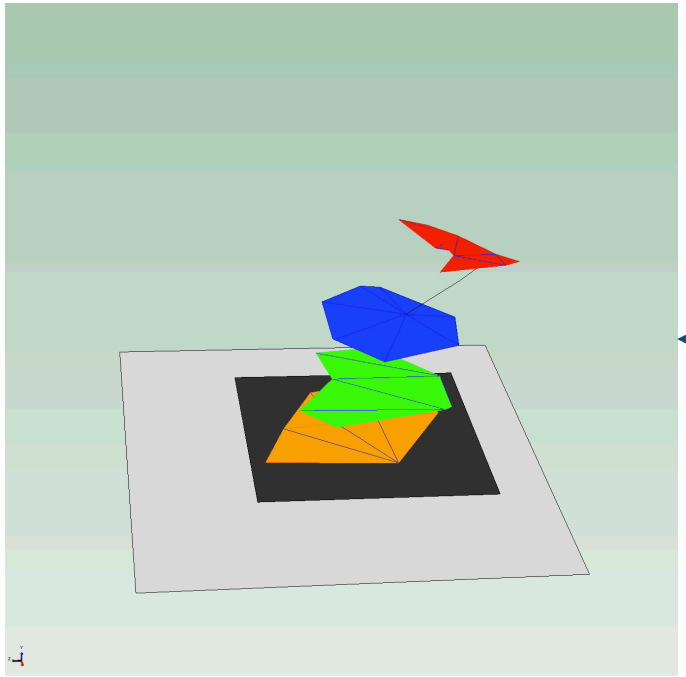


Testing

Finite Element Model Correlation

- Modal Impact Testing/Shaker Testing
- Mode Extraction
- Finite Element Model Updating

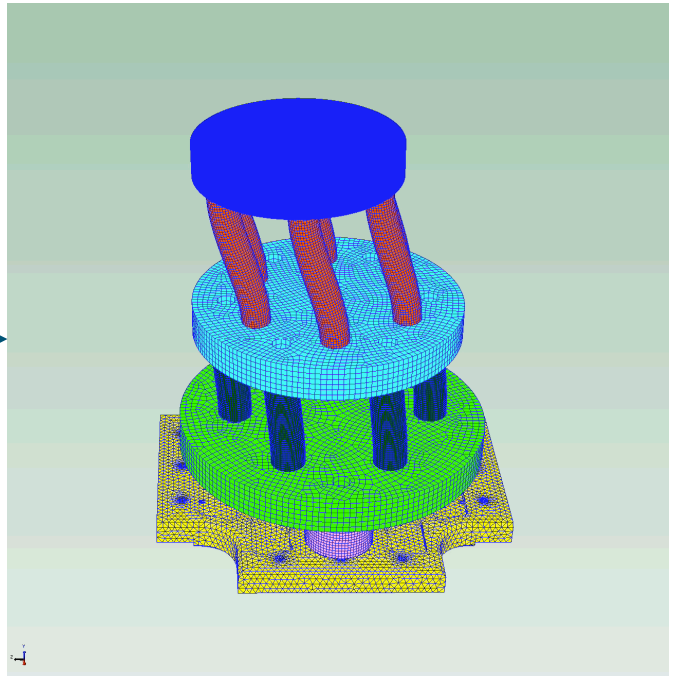
Experimental Model



Compare

Update FEM

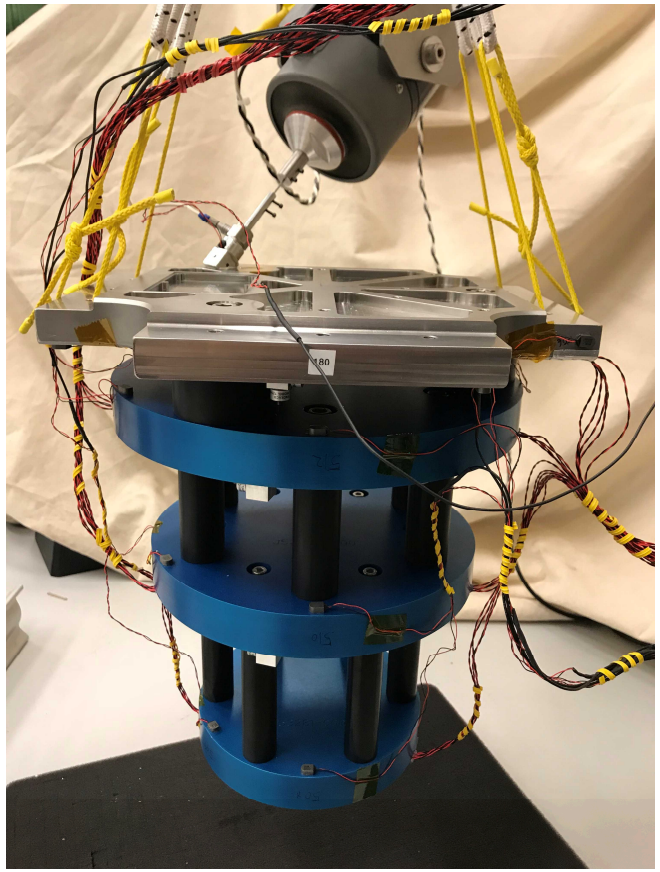
Finite Element Model

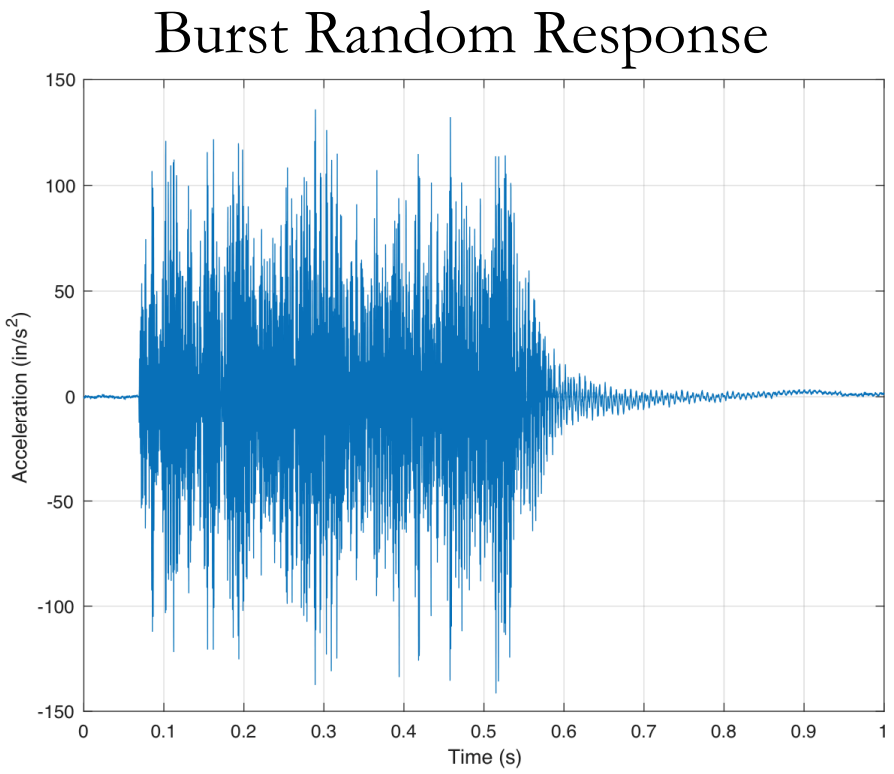


Results

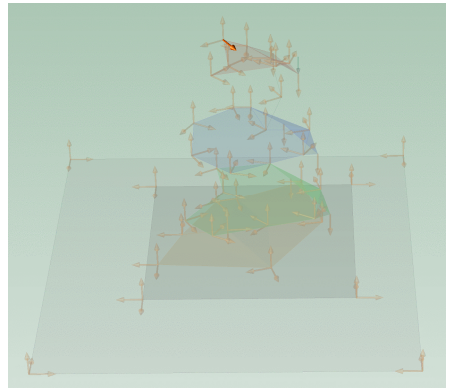
Response Prediction at Unmeasured Locations

- Shaker used to create "pseudo environmental data"

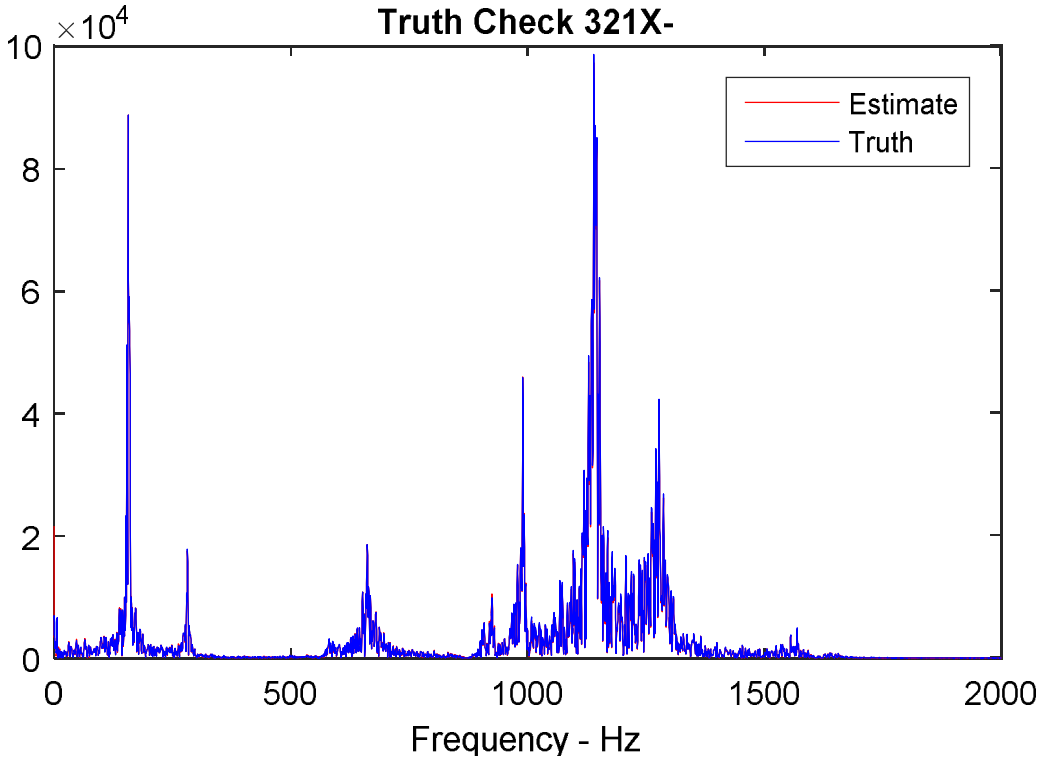


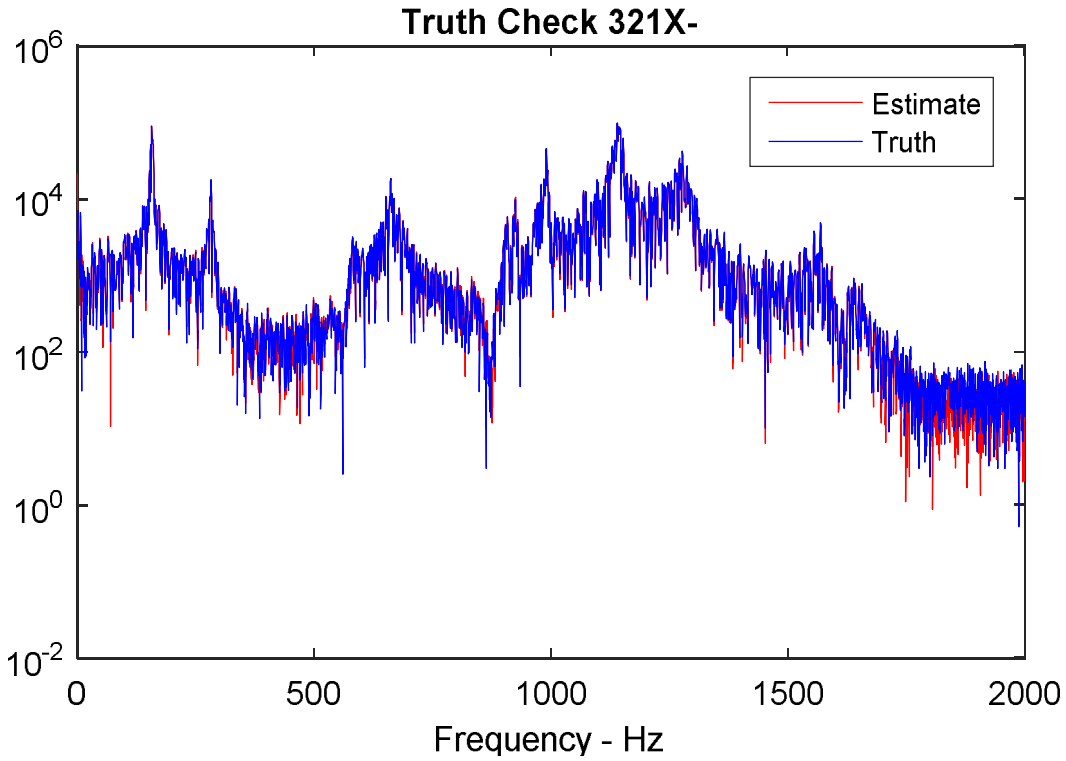


Results

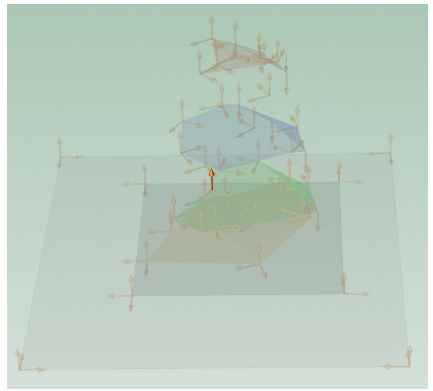


Response Prediction at Unmeasured Locations (That we actually measured)

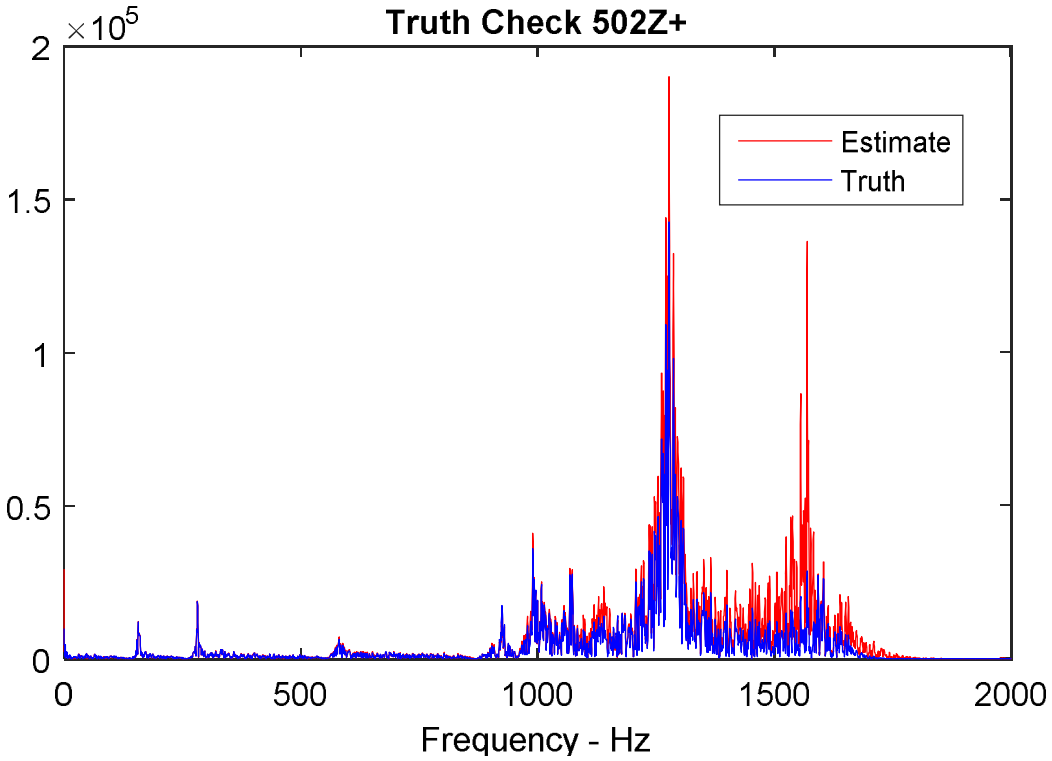


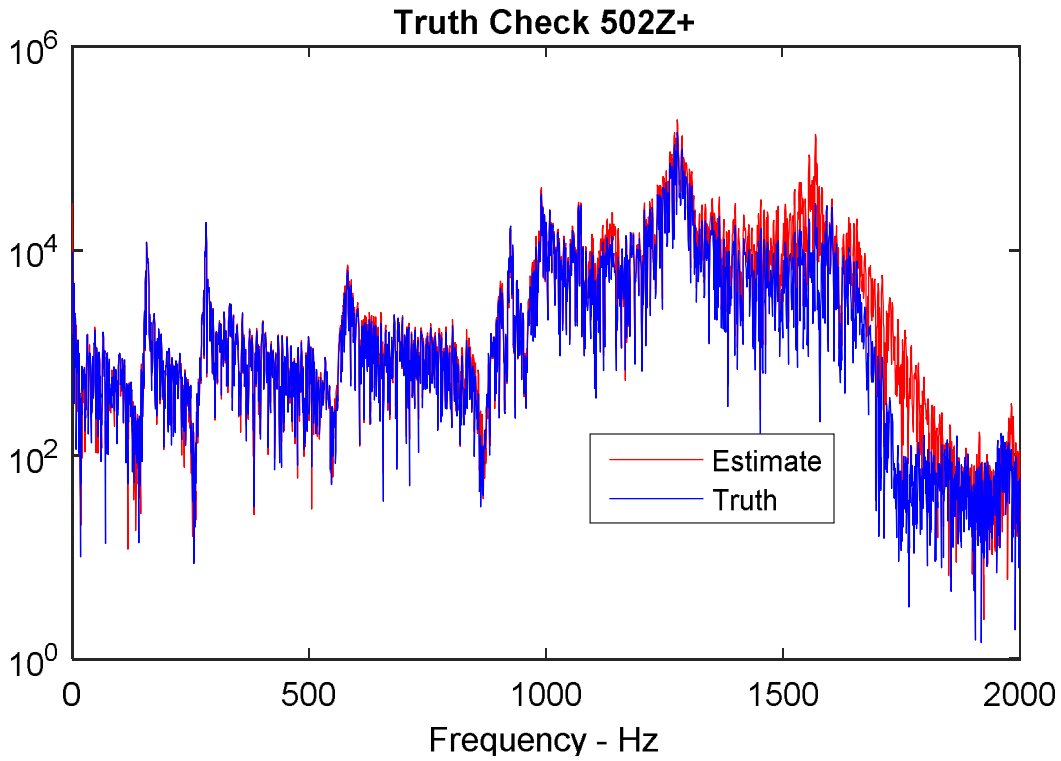


Results

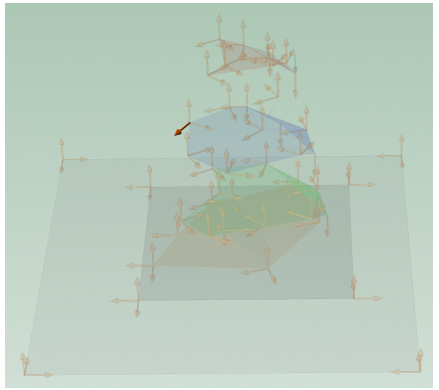


Response Prediction at Unmeasured Locations
(That we actually measured)

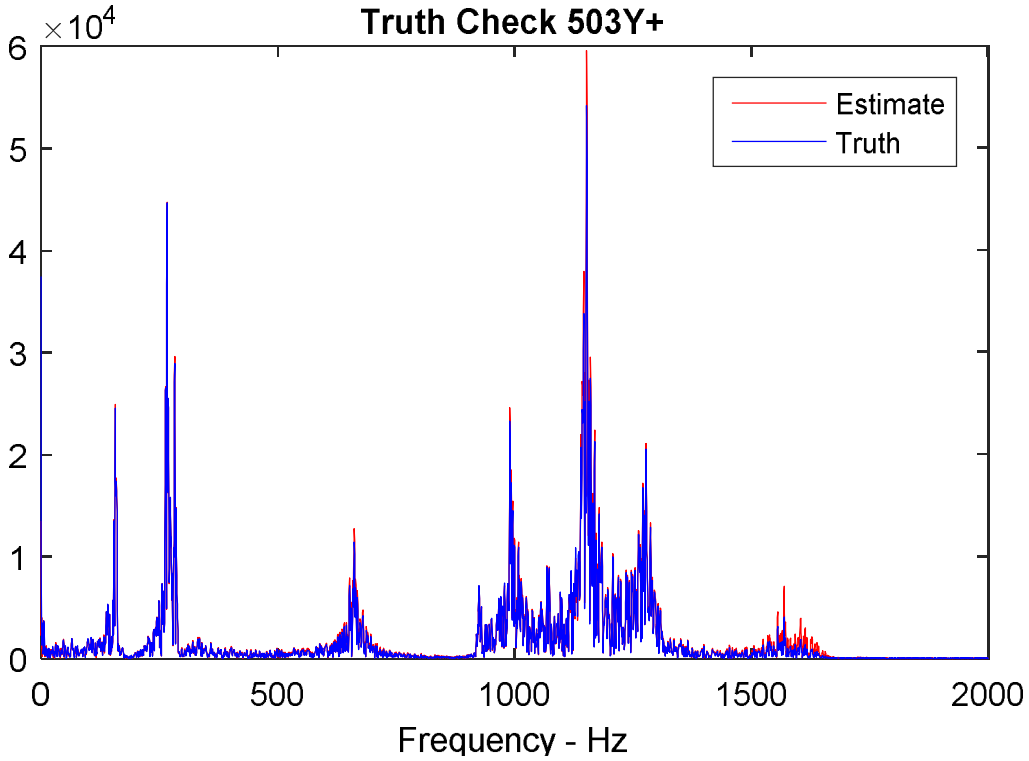


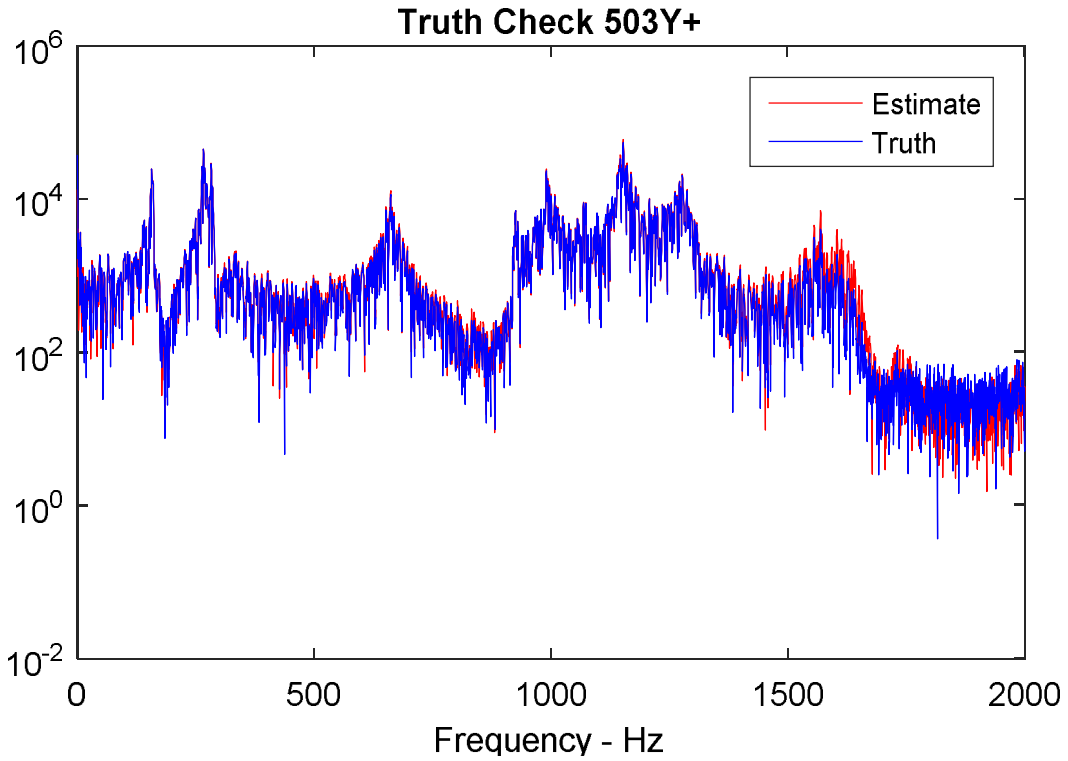


Results



Response Prediction at Unmeasured Locations (That we actually measured)





Conclusions

- Response predictions could be improved by improving finite element model correlation
- Experimental modal extraction needs to be high quality for good results
- Collaboration/communication between analysis group and modal group was improved as a result of this study

Future Work

6DOF Environment Definition

6DOF Testing

Compensation for Boundary Conditions

- Additive Manufacturing
- Modal Substructuring

Apply to Real Environmental Data

Thanks

Randy Mayes

Brian Owens

Greg Tipton

Questions