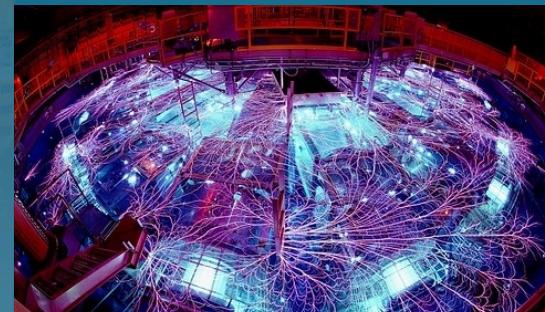




Sandia  
National  
Laboratories

# Fixture Design and Analysis for Multi-Axis Mechanical Shock Testing



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Sandia National Laboratories

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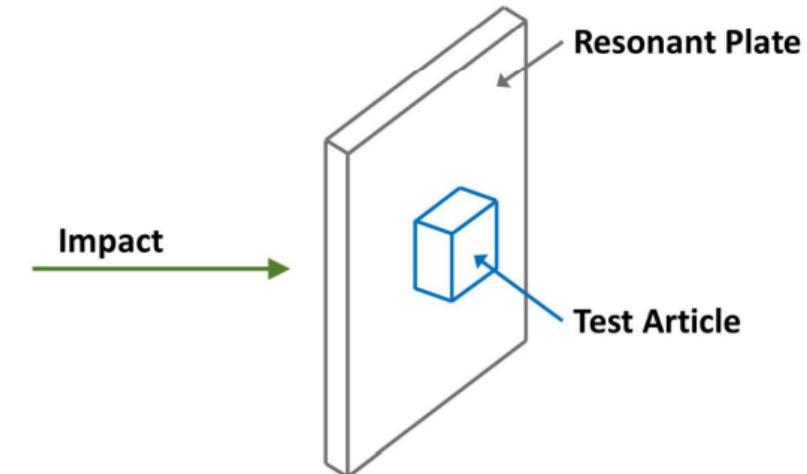
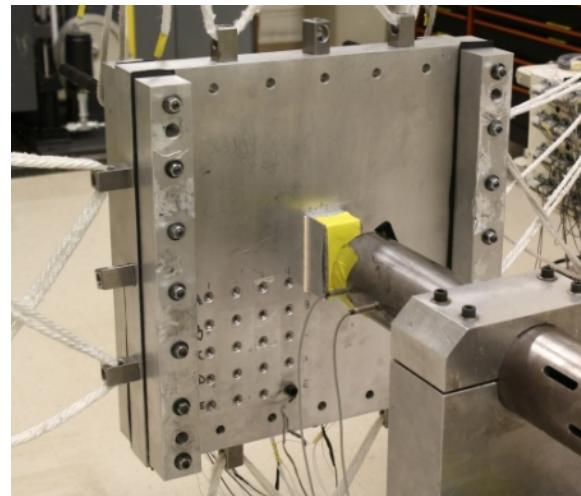
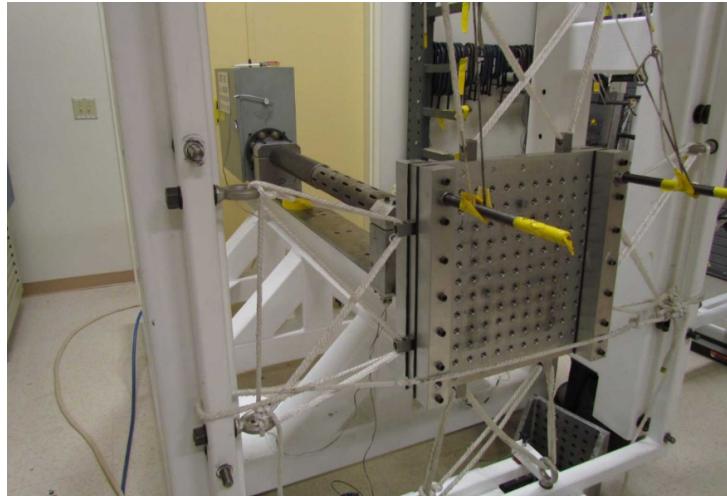
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# Introduction and Overview

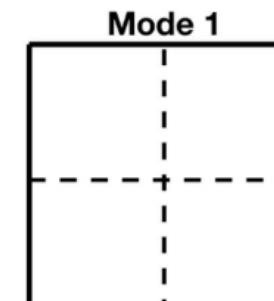


## Resonant Plate Shock Test

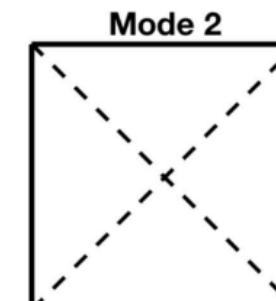
- Developed at Sandia for simulating high-frequency pyroshock environments
- Test article is typically attached to the front of the plate, and a projectile is used to strike the back of the plate and excite a response
- Goals: Simultaneous excitation in all axes and to better simulate field environments



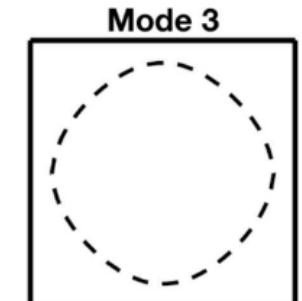
Hopkins and Sisemore, Design of a resonant plate shock test for simultaneous multi-axis excitation, 2019



“Twisting”



“Saddle”

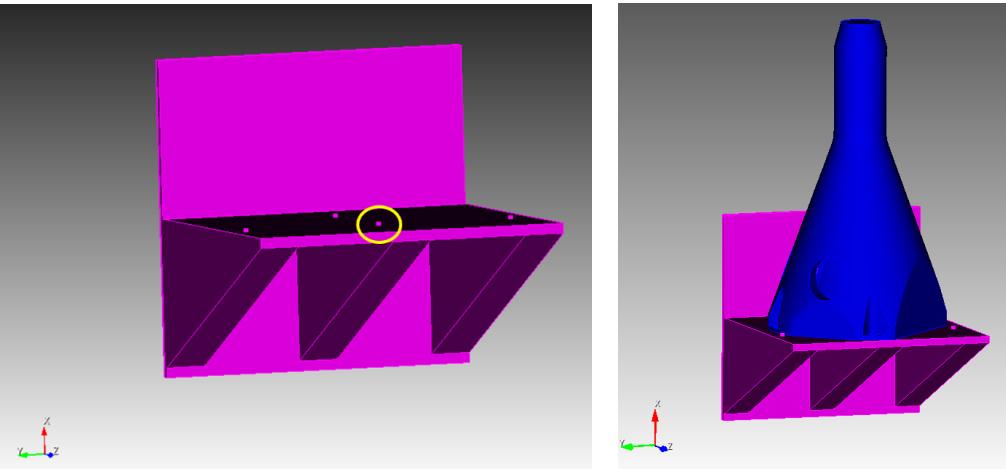
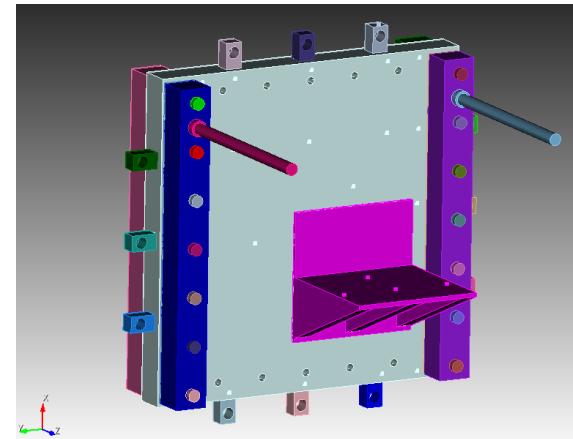
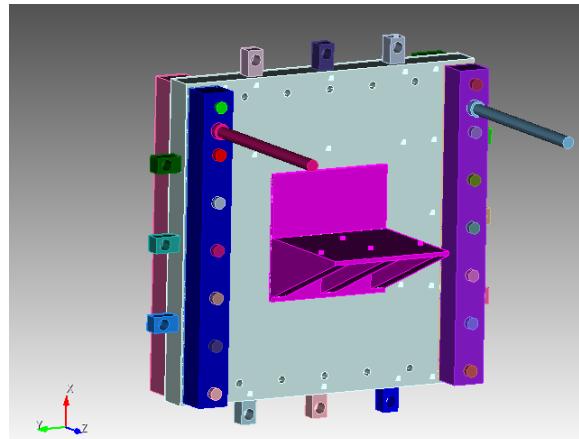
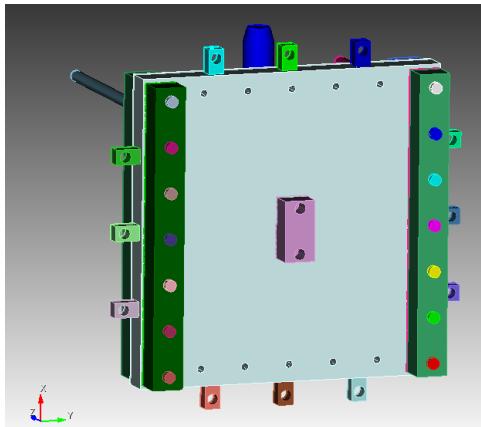
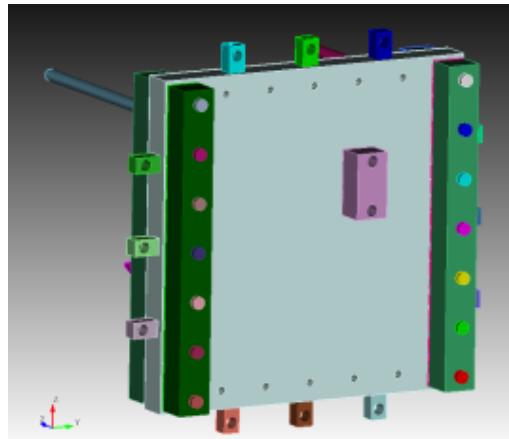


“Breathing”

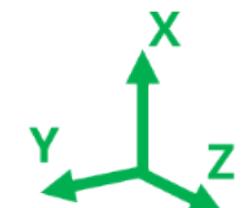
# Test Configurations



- Changing the impact location as well as the fixture location
  - Multi-axis response can be achieved
- Comparison with and without a test article
  - Adding a sizable test article significantly affects the response



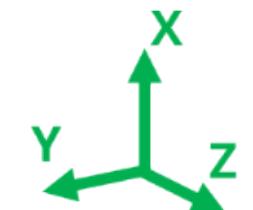
Configuration Type	Impact and fixture location (inches)	Case #
3 rib configuration	(0, 0) & (0, 0)	1
	(3.0, 3.0) & (0, 0)	2
	(3.0, 3.0) & (-3.0, -3.0)	3



# Case 1 – Center



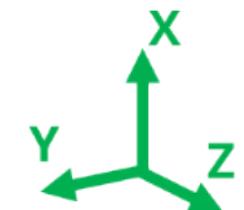
	Without test mass	With test mass
Impact Location	Center	Center
Fixture Location	Center	Center
Modes		
Plate Saddle (Hz)	713	
Plate Breathing (Hz)	829	
Angle Bracket "Diving Board" (Hz)	1365	
Angle Bracket "Twisting" (Hz)	1318	



# Case 2 – Off-center impact

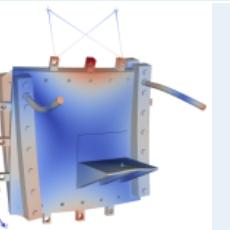
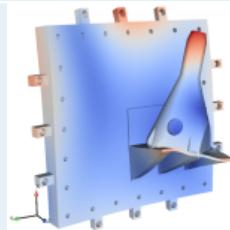
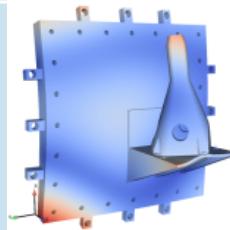
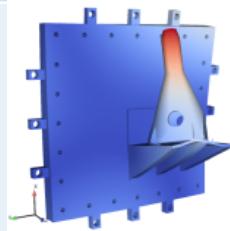
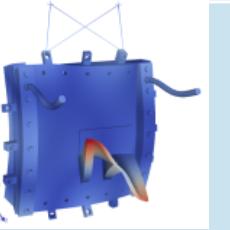
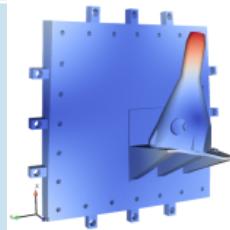


	Without test mass	With test mass
Impact Location	Off center (3.0", 3.0")	Off center (3.0", 3.0")
Fixture Location	Center	Center
Modes		
Plate Saddle (Hz)	711	
Plate Breathing (Hz)	829	
Angle Bracket "Diving Board" (Hz)	1365	
Angle Bracket "Twisting" (Hz)	1319	



# Case 3 – Off-center impact and fixture



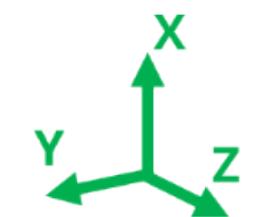
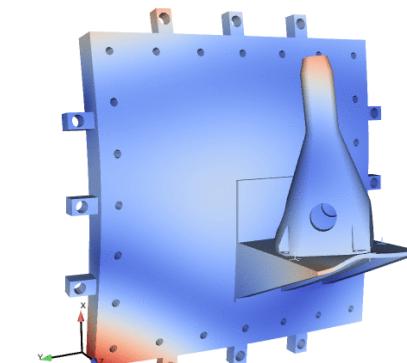
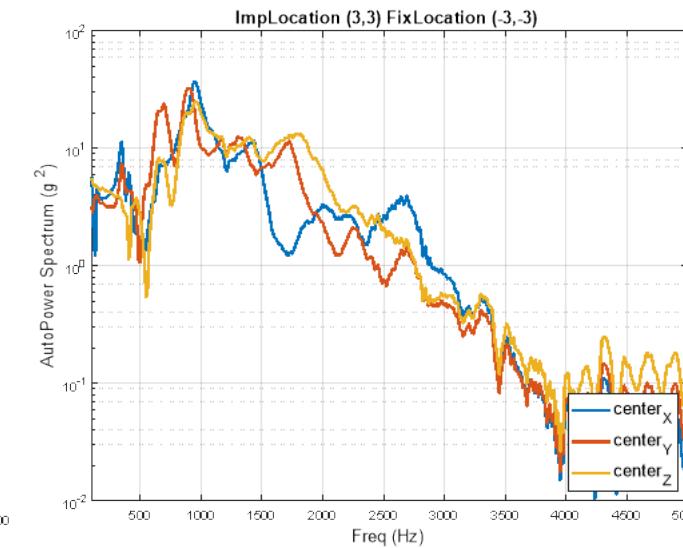
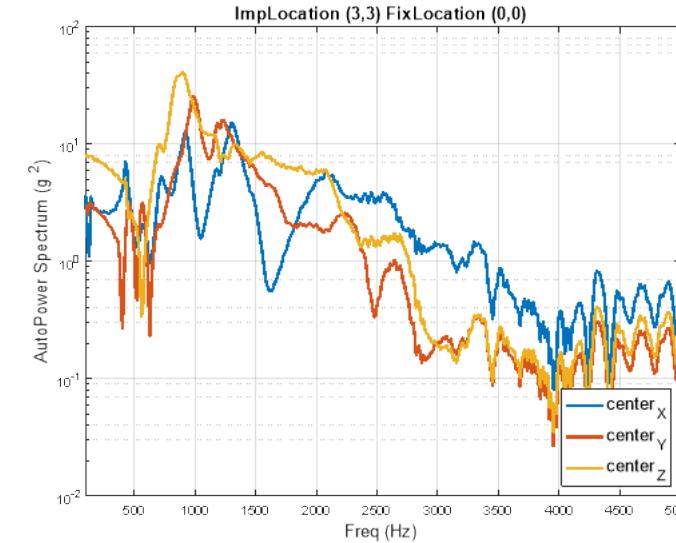
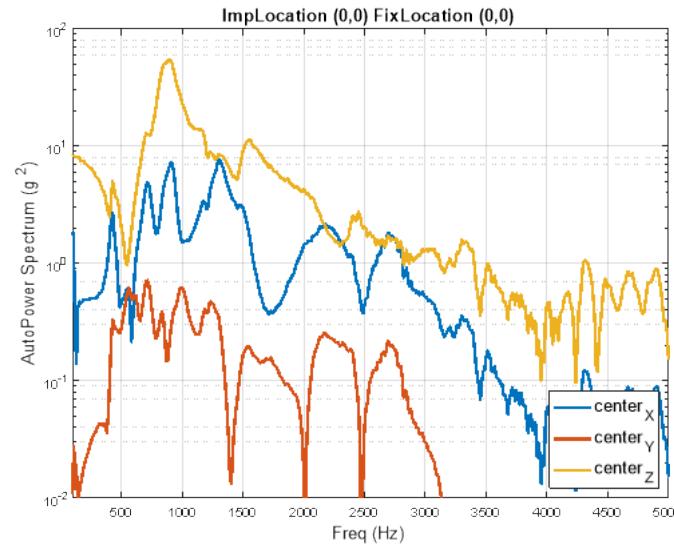
	Without test mass	With test mass
<b>Impact Location</b>	Off center (3.0", 3.0")	Off center (3.0", 3.0")
<b>Fixture Location</b>	Off center (-3.0", -3.0")	Off center (-3.0", -3.0")
<b>Modes</b>		
<b>Plate Saddle (Hz)</b>	668 	692 
<b>Plate Breathing (Hz)</b>	808 	857 
<b>Angle Bracket "Diving Board" (Hz)</b>	X	403 
<b>Angle Bracket "Twisting" (Hz)</b>	1372 	611 



# FFT Analysis



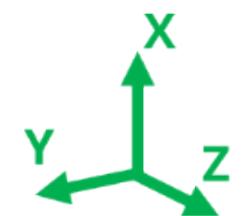
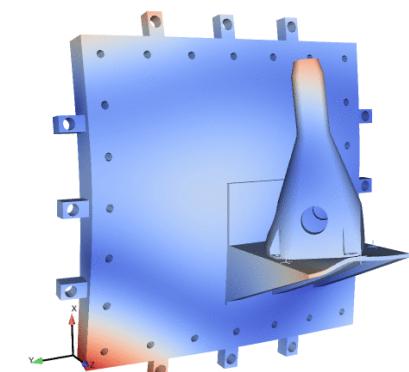
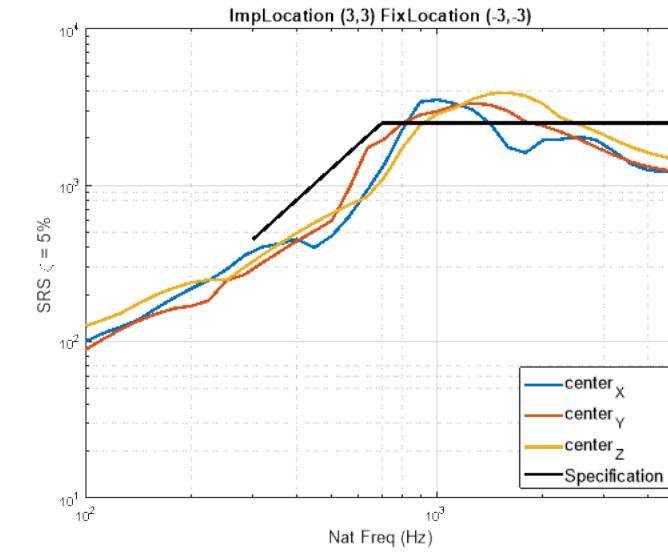
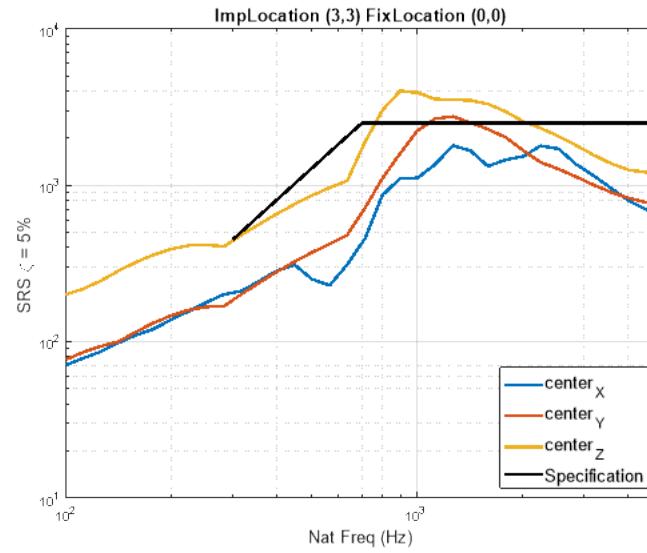
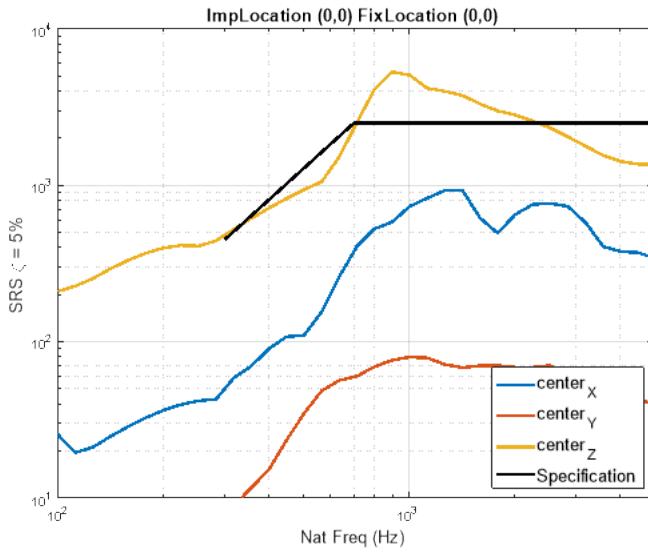
- Measurement location on the center of the angle bracket
- Frequencies shift for off-center impact and fixture configuration
- Max peak for all three configurations is at the breathing mode of the plate



# Shock Response



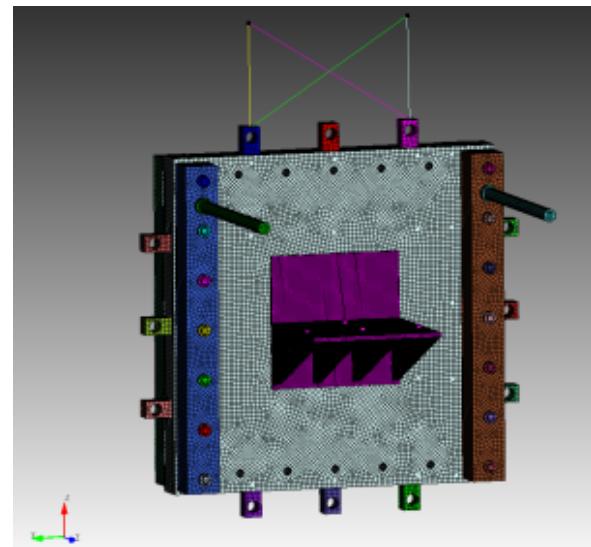
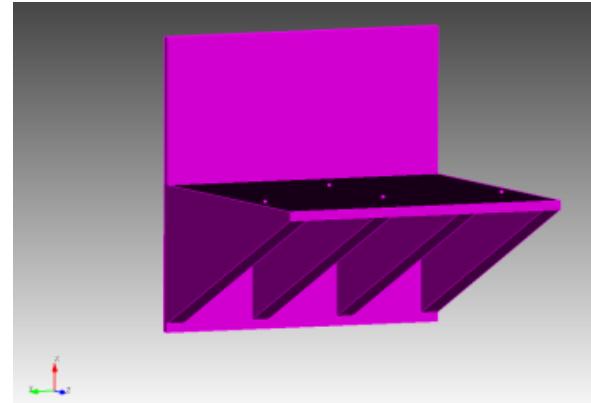
- SRS knee frequency is driven by the breathing mode frequency
- Response is coupled by adding a relatively heavy test article
- Multi-axis response seen with off-center impact and fixture configuration



# Conclusions and future work



- Moving fixture or impact locations allow the off-axis responses to increase to levels similar to the response normal to the plate
- Investigate other parameters that effect the response of the fixture
  - Modify rib/base thickness, number of ribs, or material
  - Different test articles
- Possible fabrication for testing





Questions?

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