



Fixture Design and Analysis for Multi-Axis Mechanical Shock Testing



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IMAC-XLI

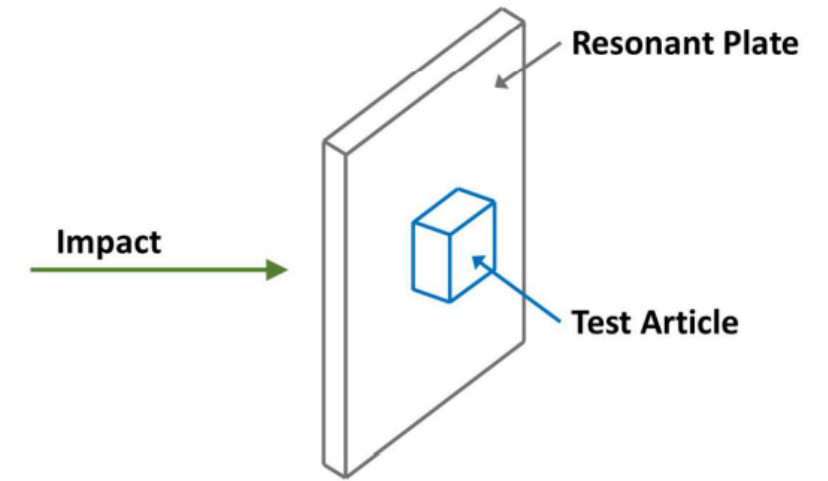
Submission #14554

Introduction and Overview

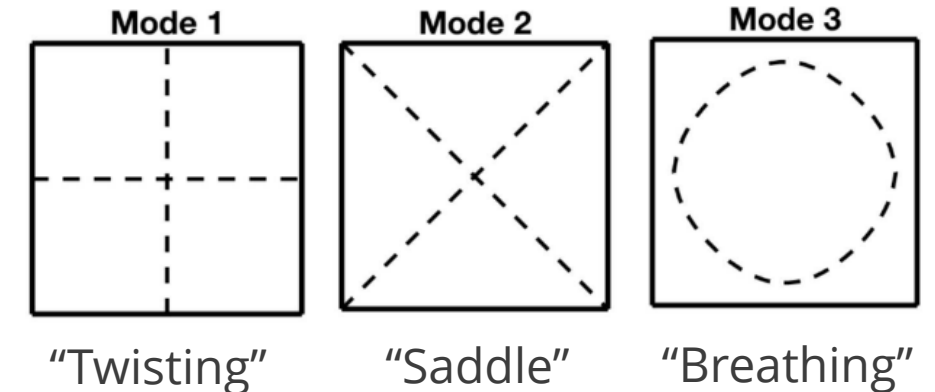
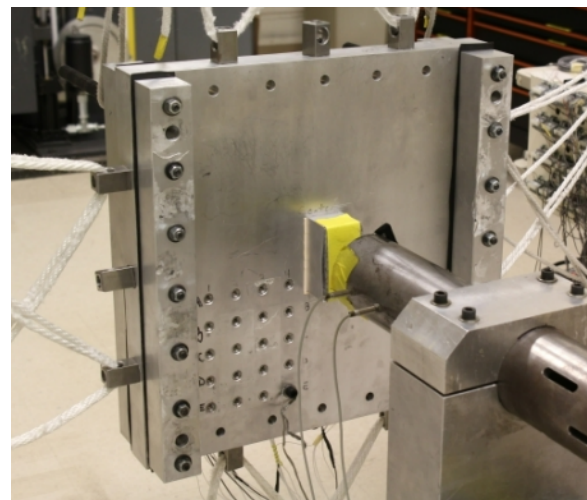
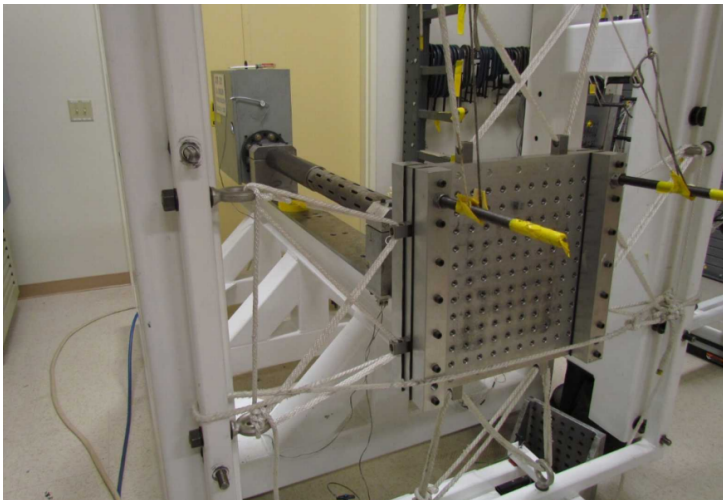


Resonant Plate Shock Test

- 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



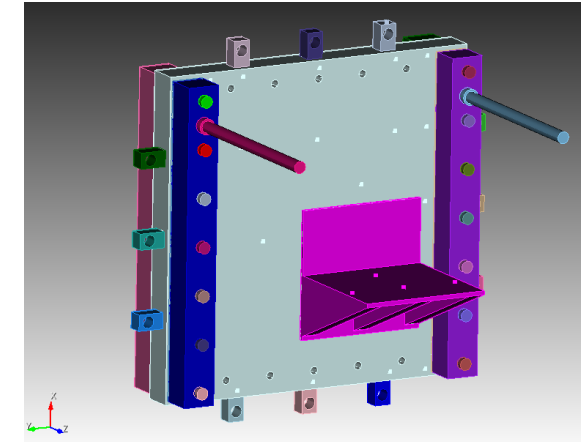
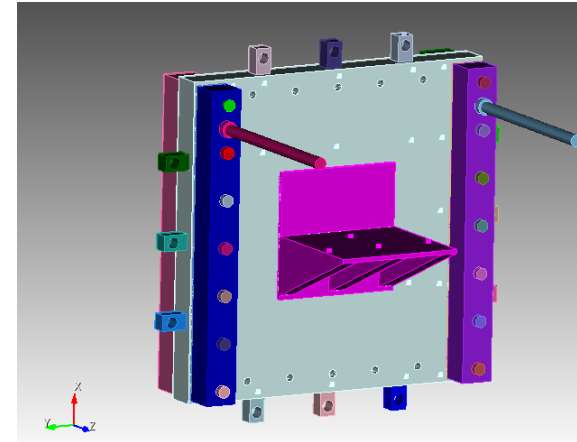
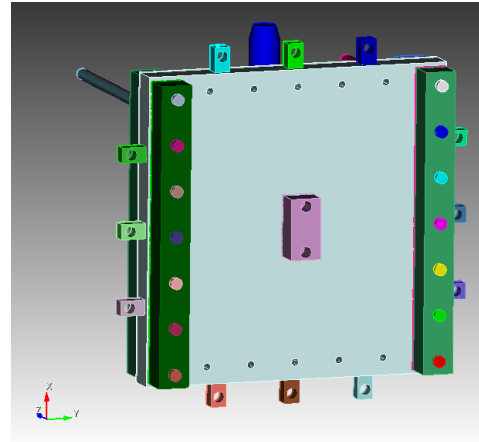
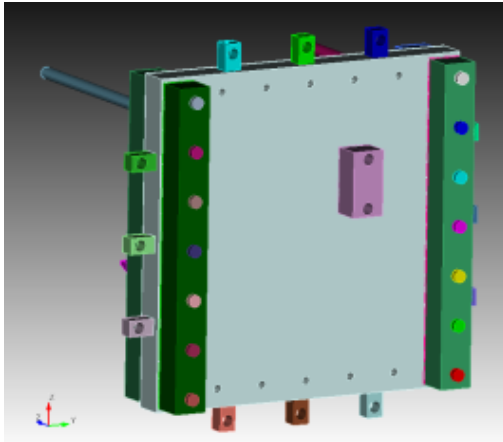
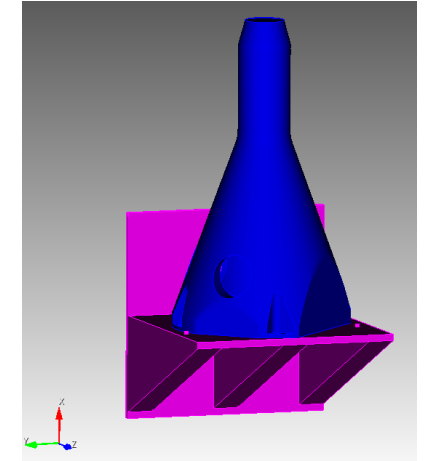
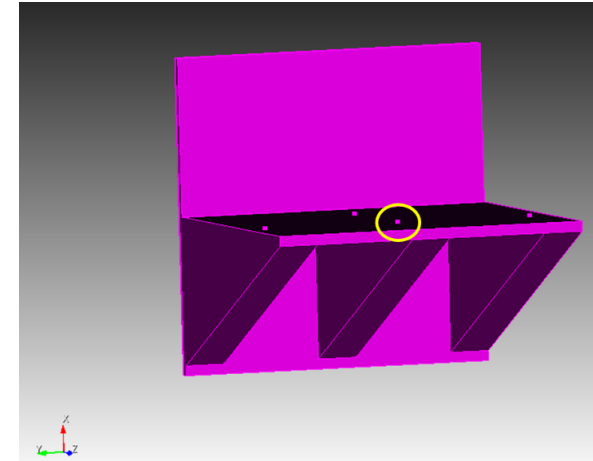
Hopkins and Sisemore, Design of a resonant plate shock test for simultaneous multi-axis excitation, 2019



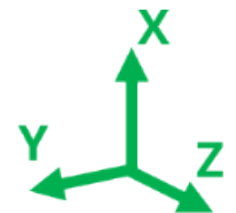
Test Configurations



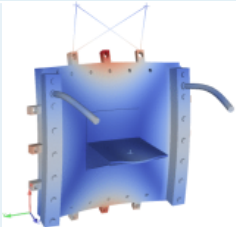
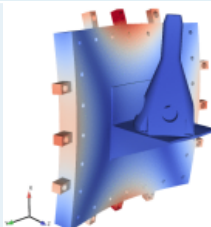
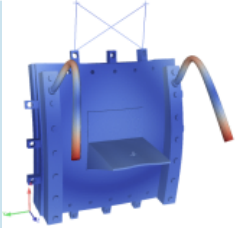
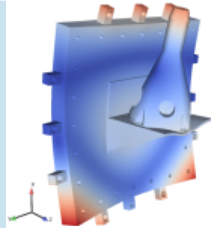
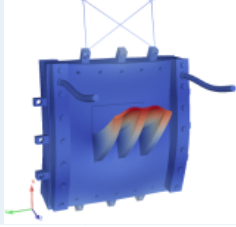
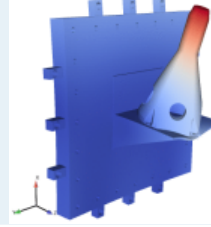
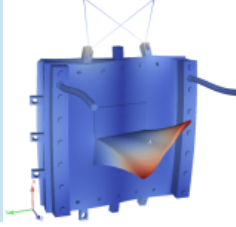
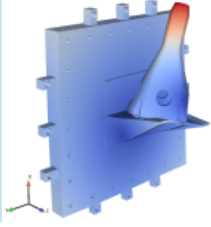
- Changing the impact location as well as the fixture location
 - Multi-axis response can be achieved
- Comparison with and without a test article
 - Adding a sizable test article significantly affects the response

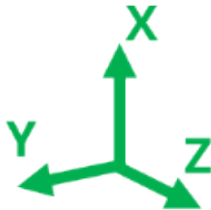


Configuration Type	Impact and fixture location (inches)	Case #
3 rib configuration	(0, 0) & (0, 0)	1
	(3.0, 3.0) & (0, 0)	2
	(3.0, 3.0) & (-3.0, -3.0)	3



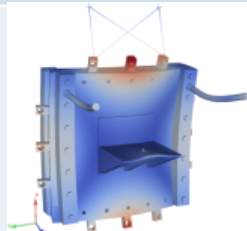
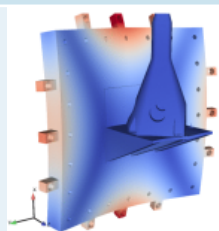
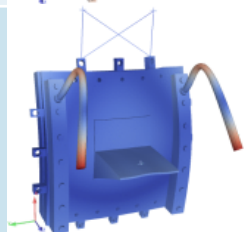
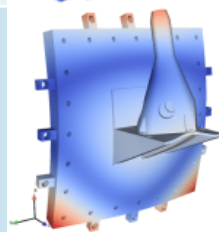
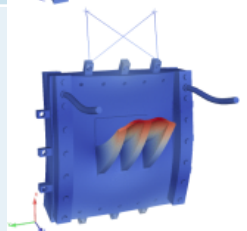
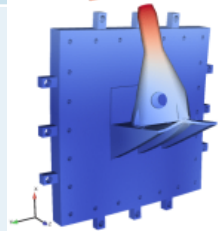
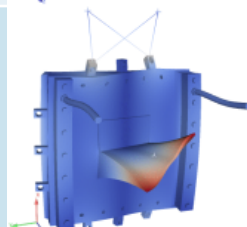
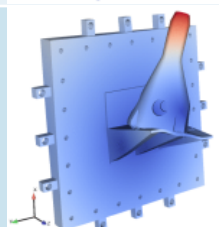


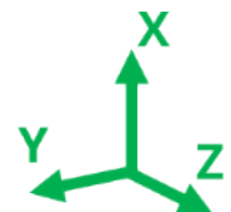
	Without test mass		With test mass	
Impact Location	Center		Center	
Fixture Location	Center		Center	
Modes				
Plate Saddle (Hz)	713		715	
Plate Breathing (Hz)	829		894	
Angle Bracket "Diving Board" (Hz)	1365		436	
Angle Bracket "Twisting" (Hz)	1318		700	



Case 2 – Off-center impact

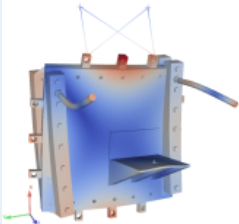
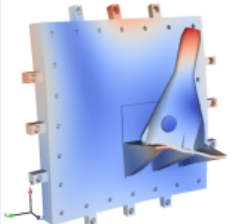
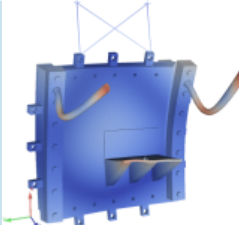
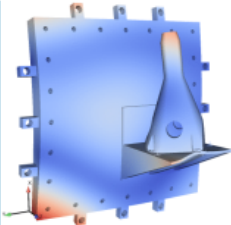

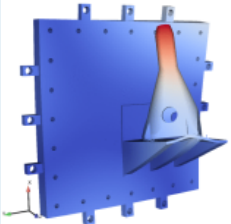
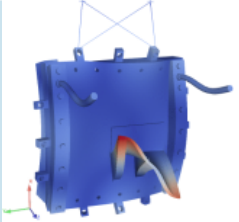
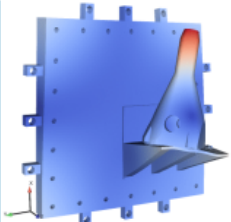


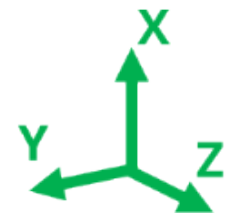
	Without test mass		With test mass	
Impact Location	Off center (3.0", 3.0")		Off center (3.0", 3.0")	
Fixture Location	Center		Center	
Modes				
Plate Saddle (Hz)	711		714	
Plate Breathing (Hz)	829		895	
Angle Bracket "Diving Board" (Hz)	1365		435	
Angle Bracket "Twisting" (Hz)	1319		700	



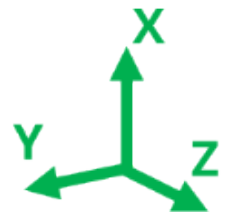
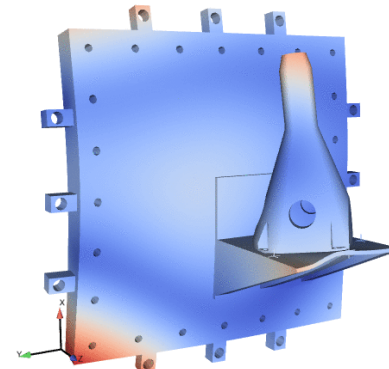
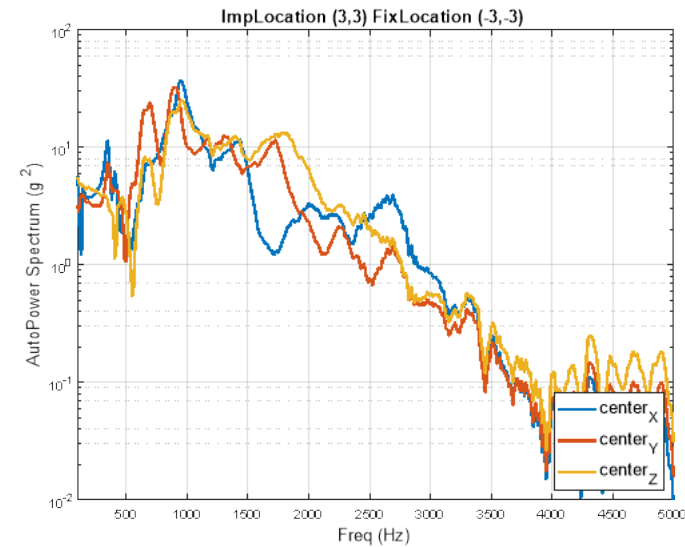
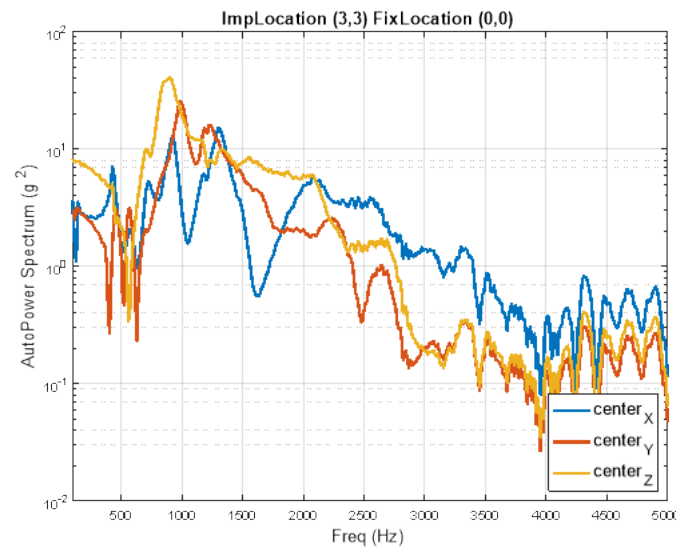
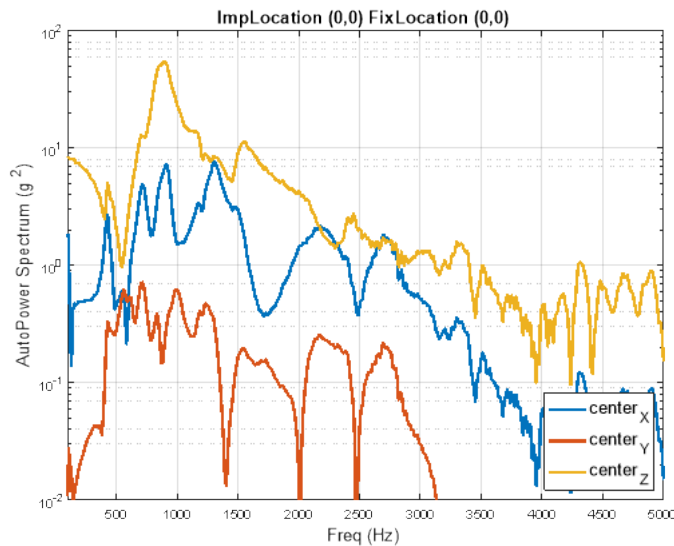
Case 3 – Off-center impact and fixture



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



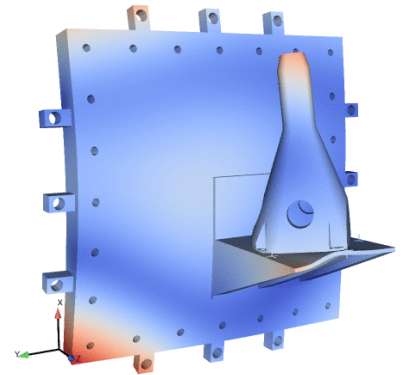
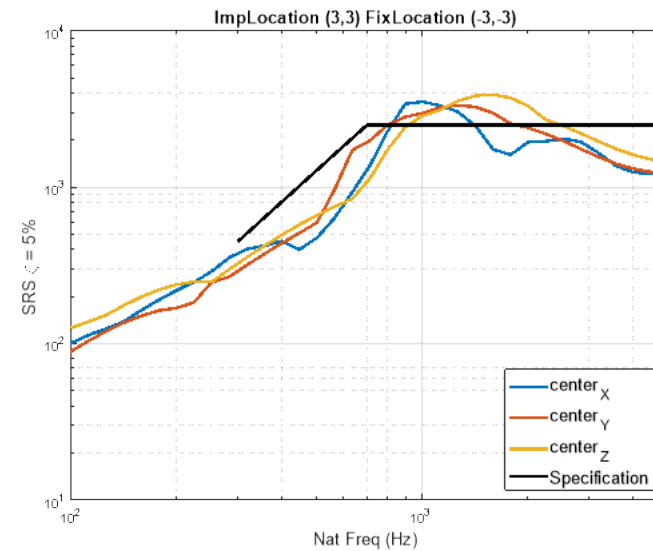
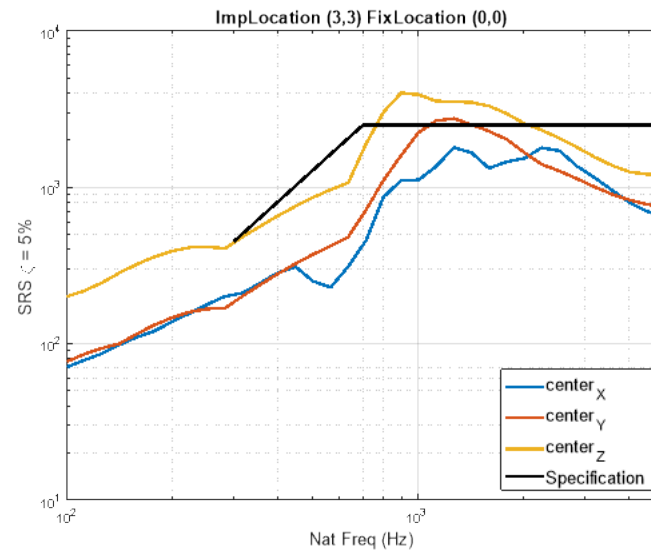
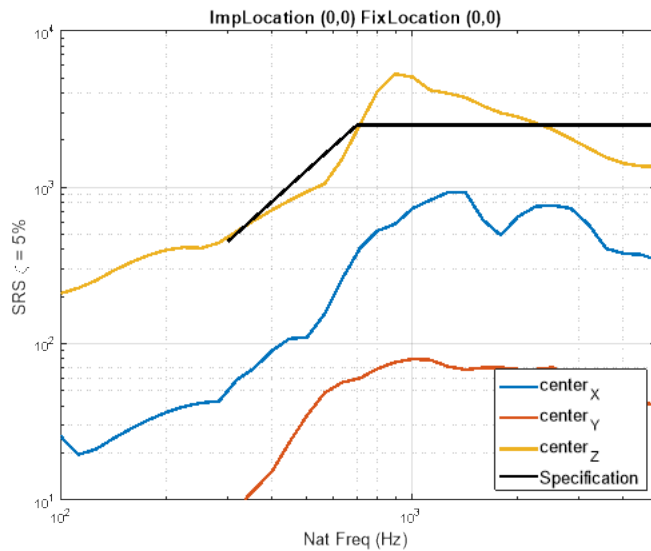
- Measurement location on the center of the angle bracket
- Frequencies shift for off-center impact and fixture configuration
- Max peak for all three configurations is at the breathing mode of the plate



Shock Response



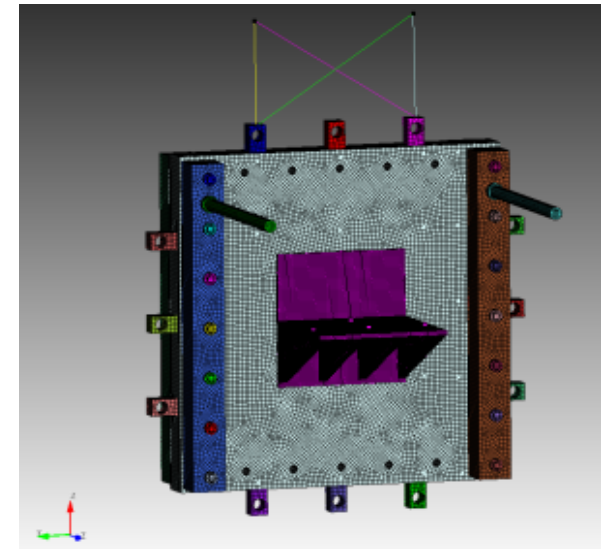
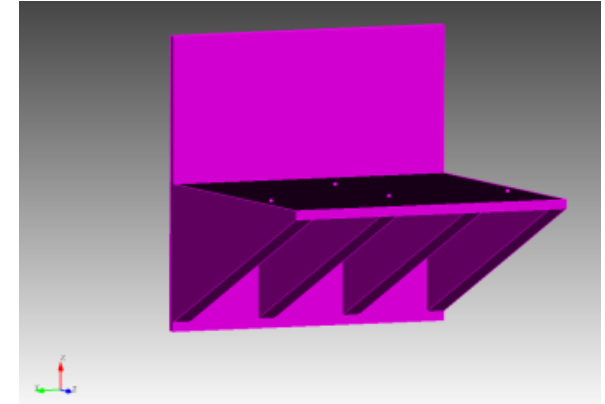
- SRS knee frequency is driven by the breathing mode frequency
- Response is coupled by adding a relatively heavy test article
- Multi-axis response seen with off-center impact and fixture configuration



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?

