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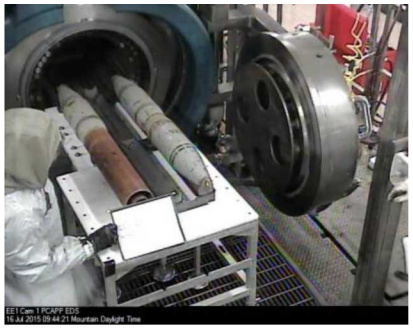

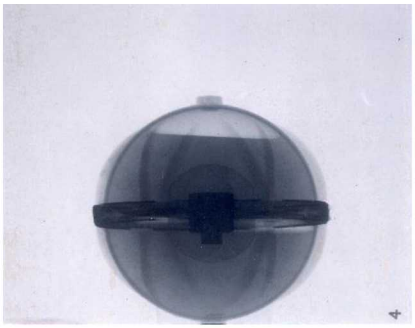

ANALYSIS OF EDS VESSEL CLAMPING SYSTEM AND DOOR SEAL

Jerome Stofleth, Robert Crocker, John Ludwigsen, Megan Tribble

ASME 2019 PVP | July 14-19, San Antonio, Texas, USA

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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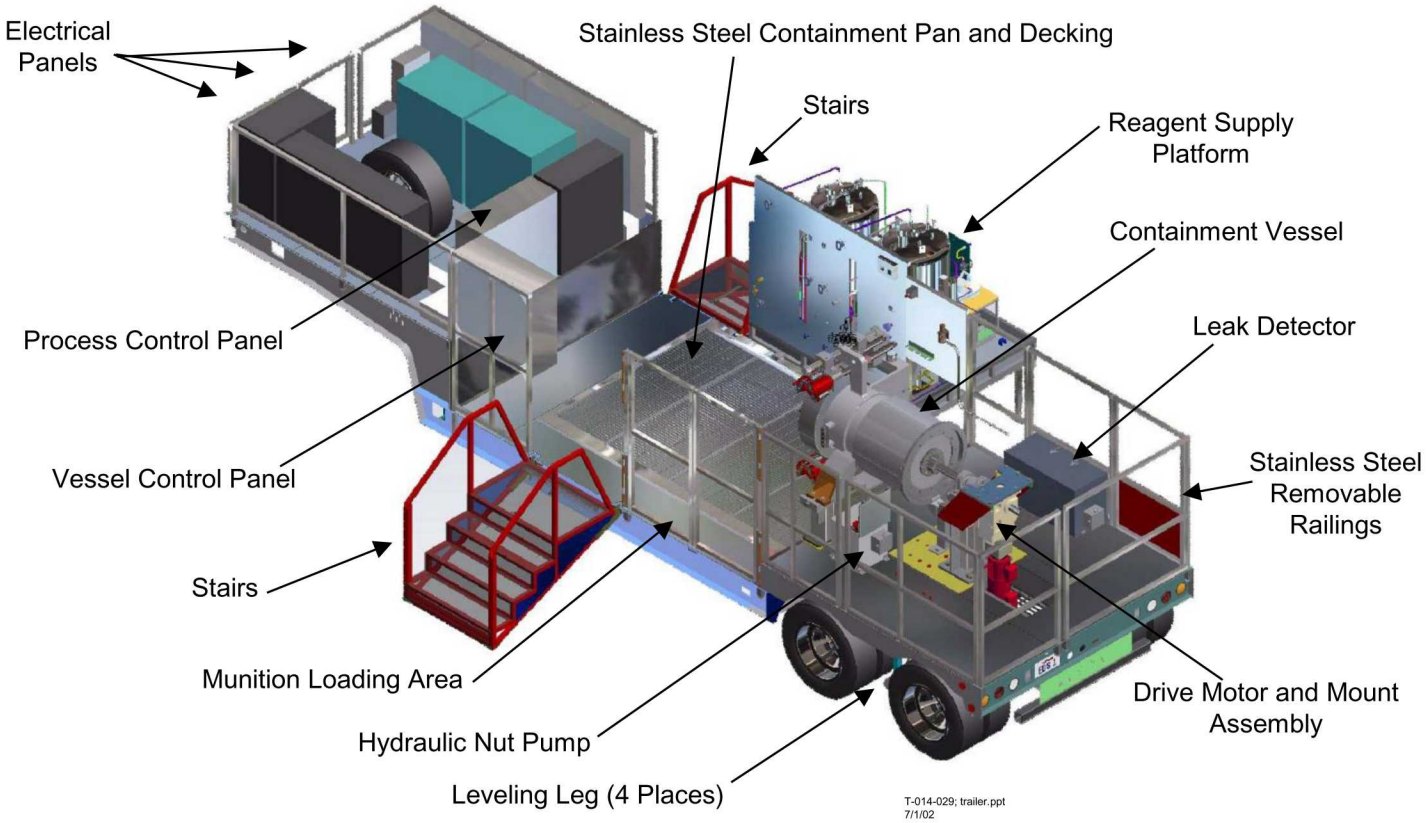
DISCUSSION TOPIC

ANALYSIS OF DOOR SEAL AND CLAMPING SYSTEM INTEGRITY UNDER AN EXPLOSIVE DRIVEN IMPULSIVE LOAD IN THE EXPLOSIVES DESTRUCTION SYSTEM (EDS) CONTAINMENT VESSEL

EDS SYSTEM OVERVIEW

EDS is a trailer-mounted chemical munition treatment system with a rotating explosive containment vessel

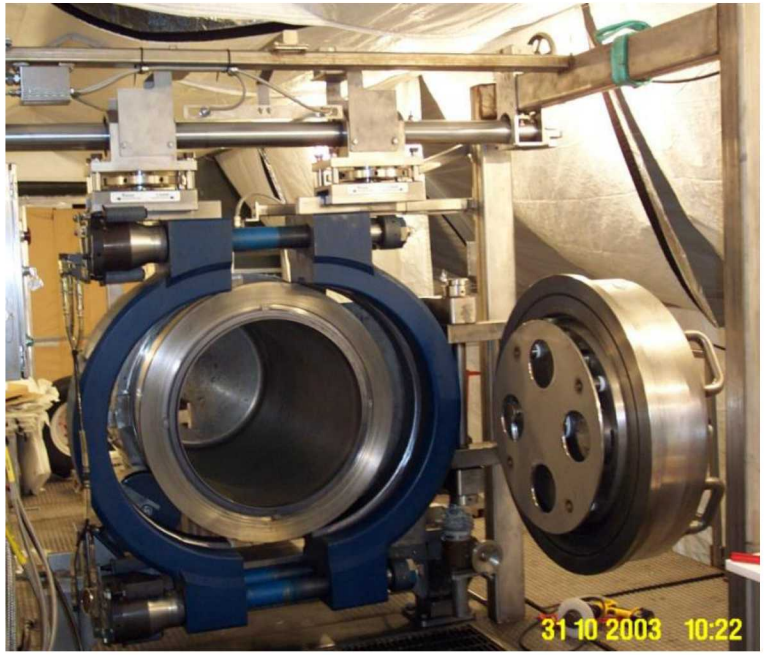


Phase 2 System

- 40-foot single drop trailer
- 11 foot shipping height
- 8.5 feet wide
- 55,000 pounds total

EDS VESSEL DESCRIPTION

- Cylindrical cup
- Flat door
- 316 stainless steel
- Grayloc™ metal gasket
- 4140 steel clamps
- Vessel volume is 620 liters
- Rated for ~500 uses at 9 pounds TNT equivalent unitary charge, centrally located



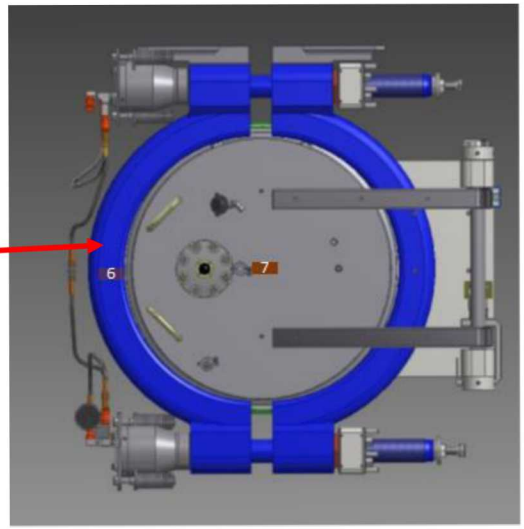
ASME stamped for Static and Impulsive loadings

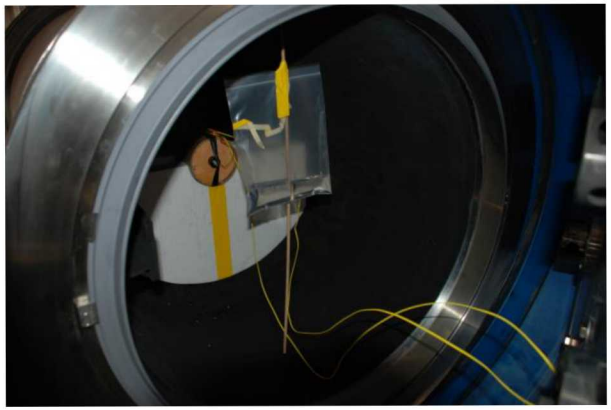
SEALING SYSTEM DESIGN

2-Piece clamping system

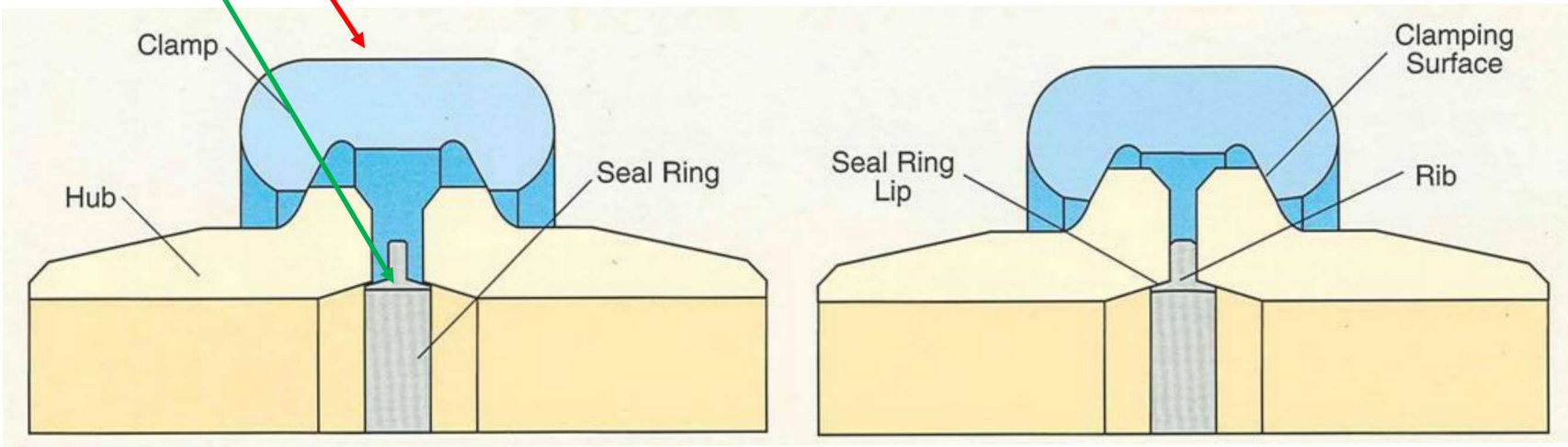
Clamp

Seal ring





Seal ring on vessel



INSTRUMENTATION
Strain Gages

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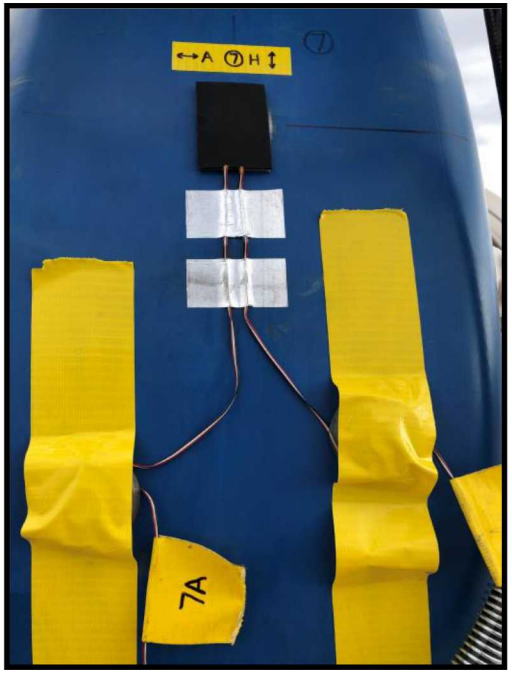
Some strain gage locations:

Vessel body

Clamp exterior



Clamp interior

INSTRUMENTATION
Digital Image Correlation (DIC)

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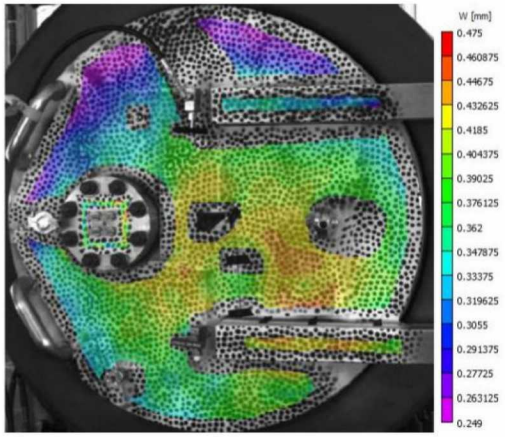
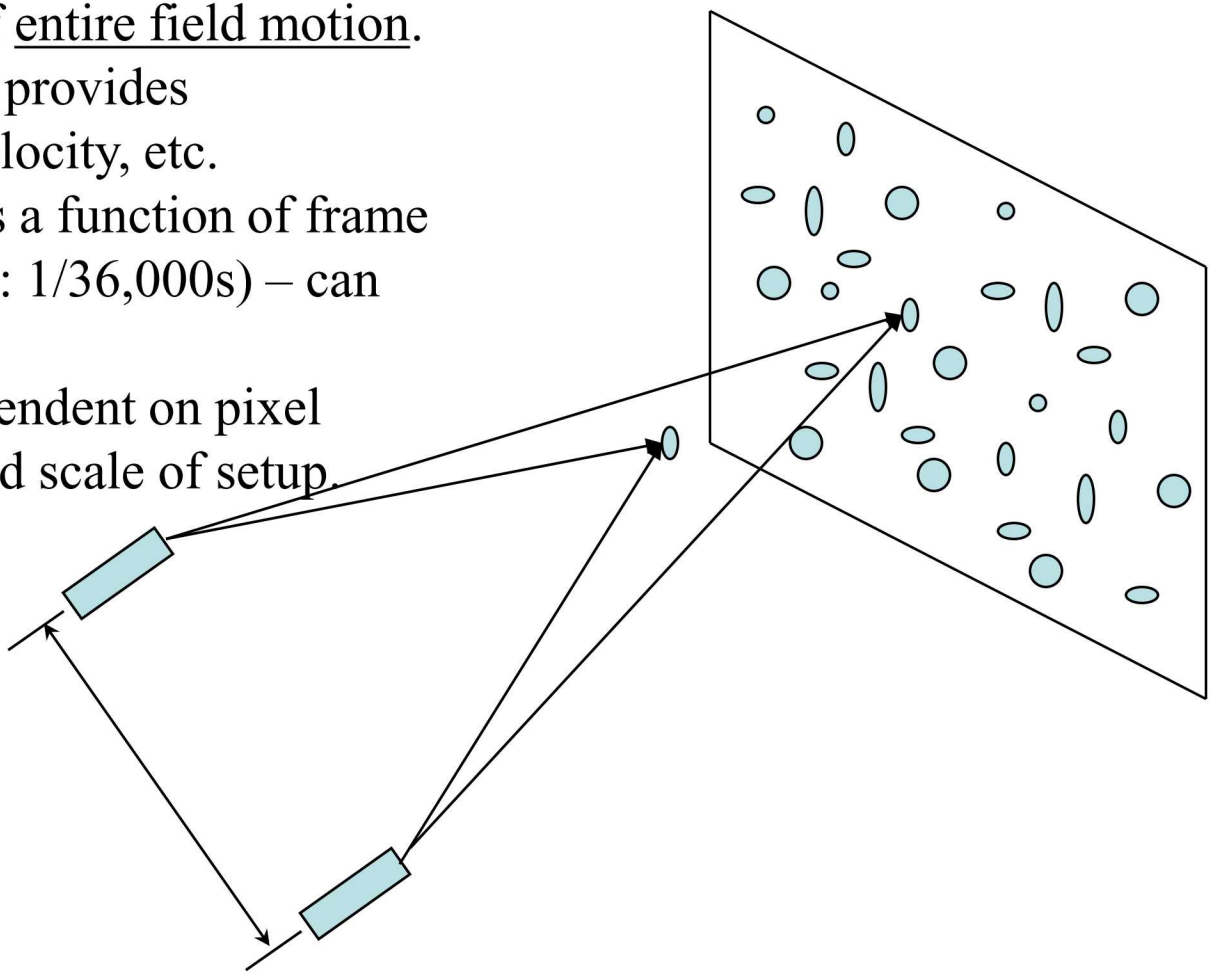
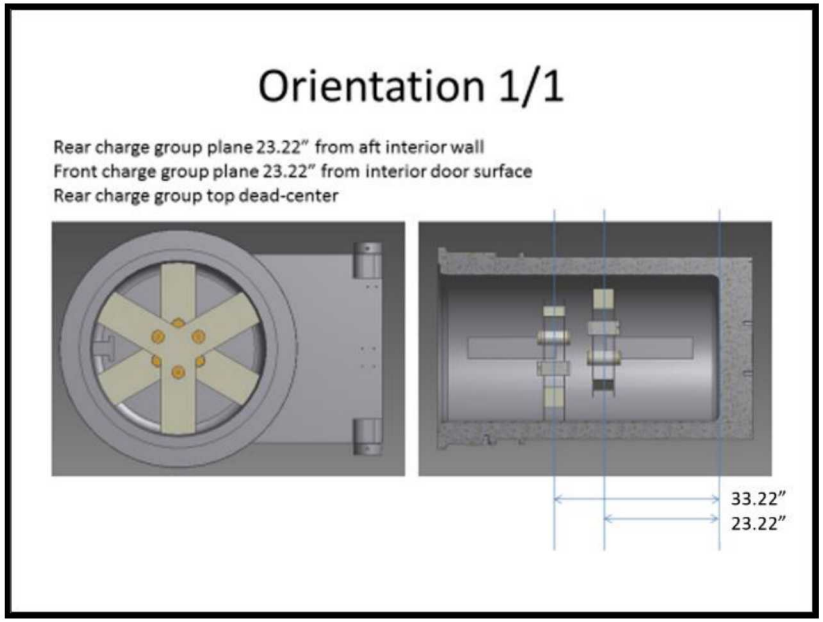
- Pseudo-random speckle pattern provides for stereo correlation of entire field motion.
- Correlation algorithm provides displacement, strain, velocity, etc.
- Temporal resolution is a function of frame rate of cameras (typical: 1/36,000s) – can be up to 1/500,000s
- Spatial resolution dependent on pixel resolution of camera and scale of setup.



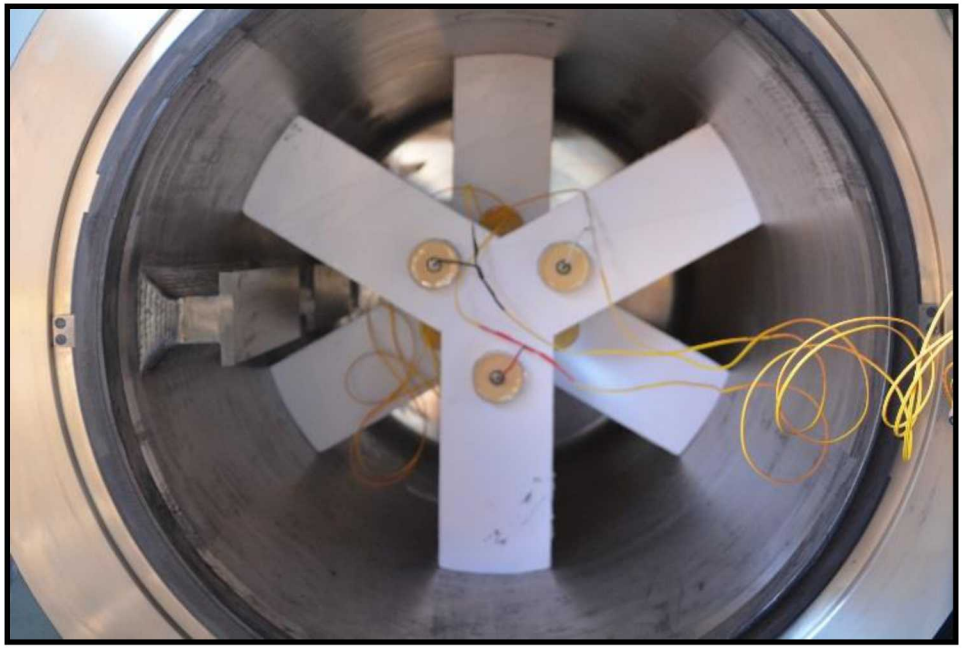


EXPLOSIVE TEST LOAD
9lbs Composition C-4 (11lbs TNT)

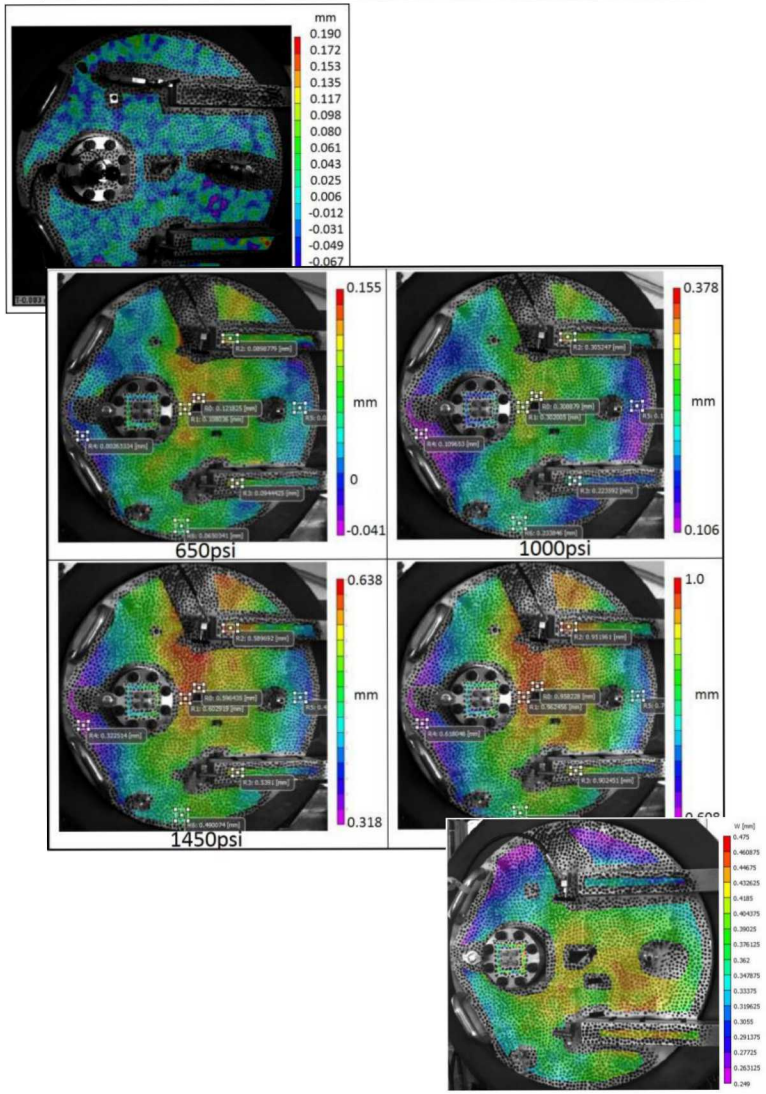


Individual 1.5 lbs C-4 charges

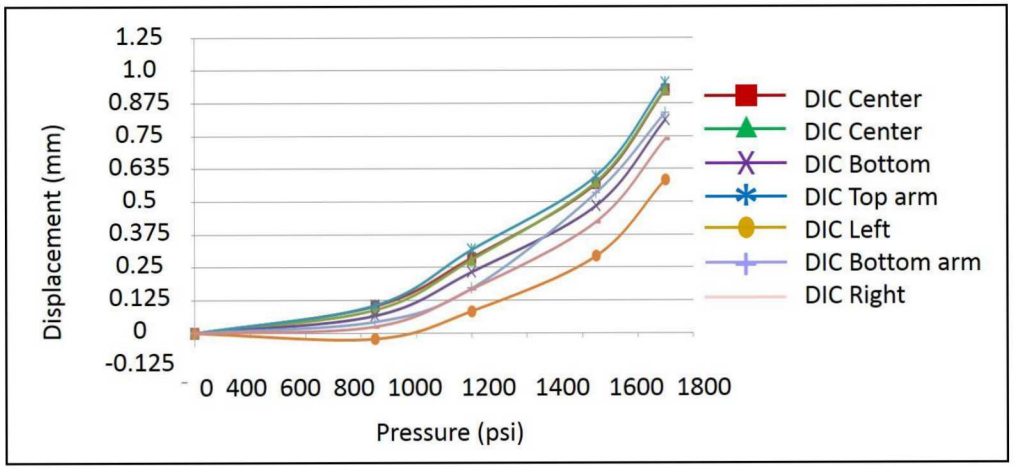
6 charges in orientation 1/1



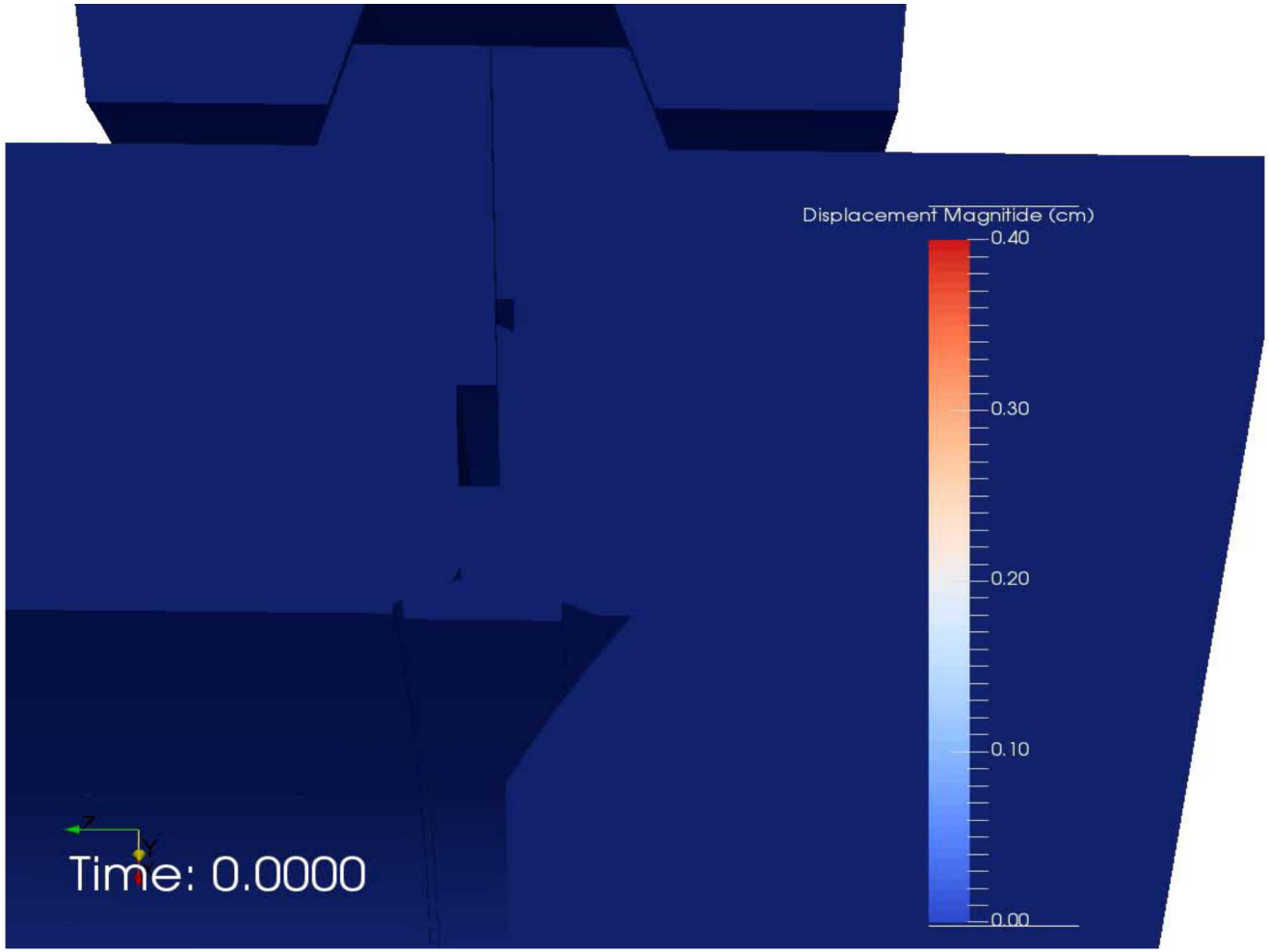
HYDROSTATIC TEST RESULTS



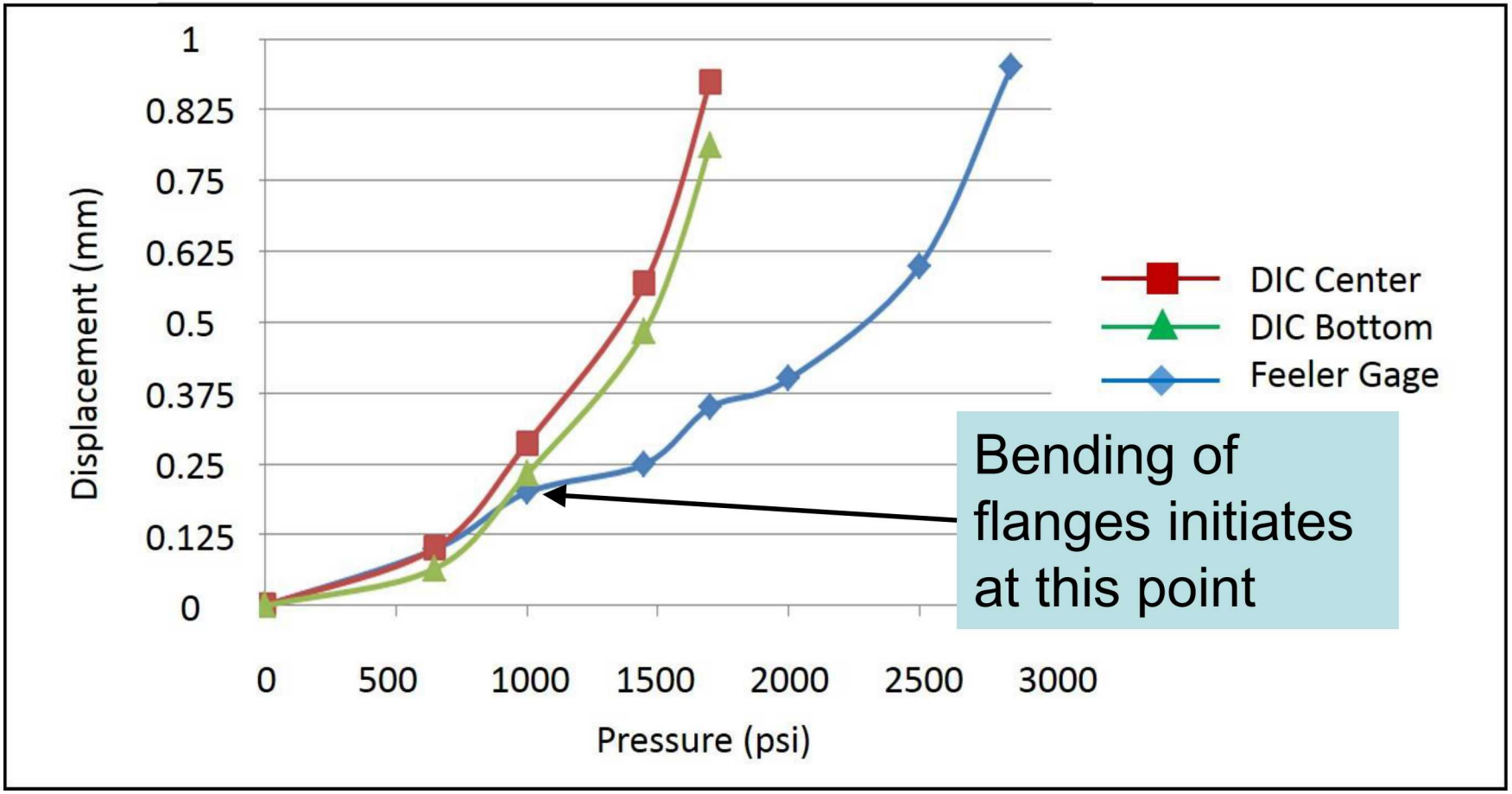
Pressure (psi)	Feeler gage	DIC center	DIC bottom	DIC left side	DIC right side
0	0	0	0	0	0
650	0.102	0.104	0.067	-0.022	0.025
1000	0.203	0.291	0.236	0.085	0.170
1450	0.254	0.578	0.492	0.298	0.430
1700	0.356	0.940	0.824	0.593	0.750
2000	0.269				
2500	0.610				
2850	0.965				
0	0.058				



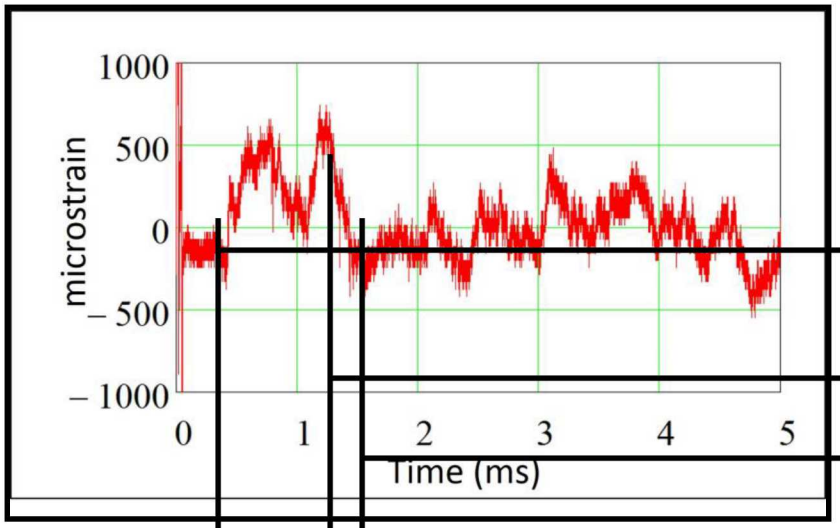
COUPLED HYDROCODE / FINITE ELEMENT MODEL OF CLAMP GAP



DOOR/BODY GAP COMPARISON (feeler gage versus DIC)



DYNAMIC TEST RESULTS (Strain)

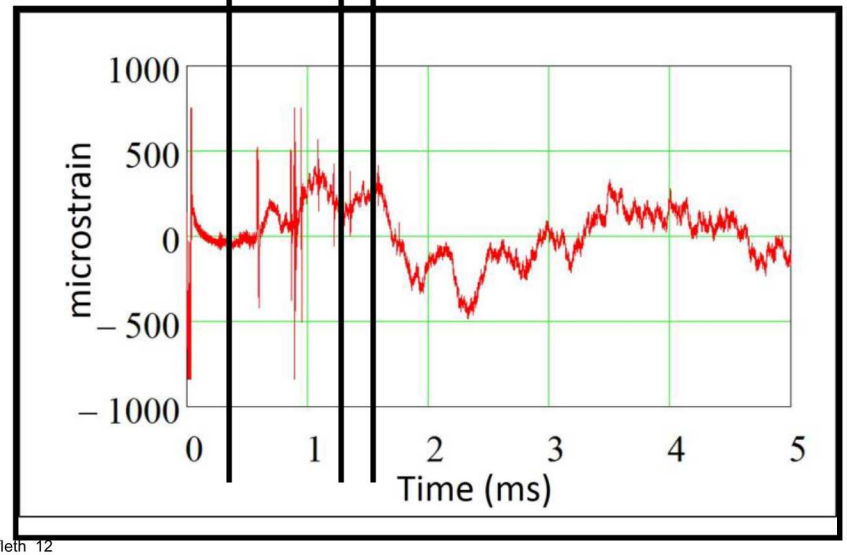


Strain at door center point

0.2μs – begging of bending

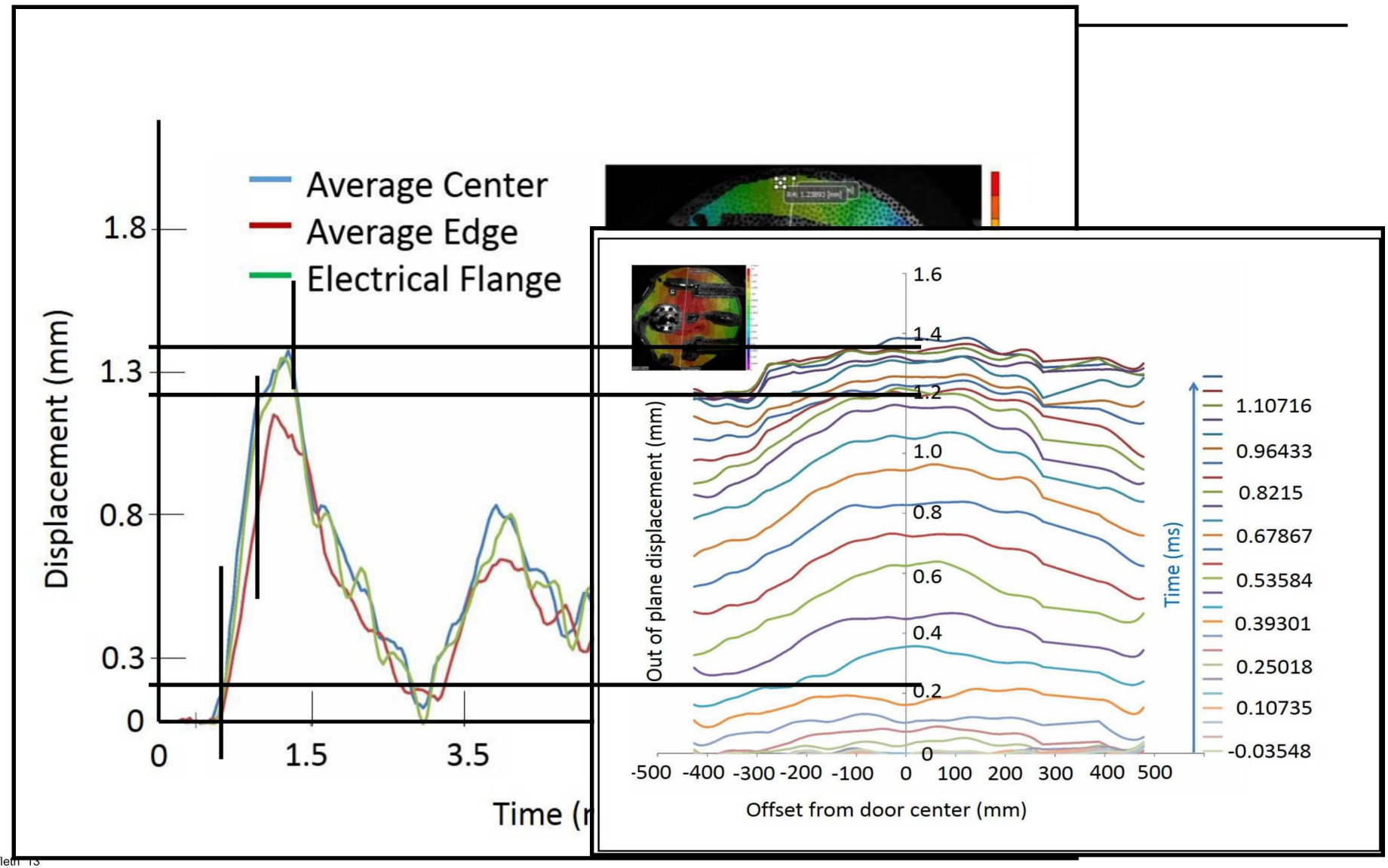
1.2μs – peak bending

1.4μs – bending stops

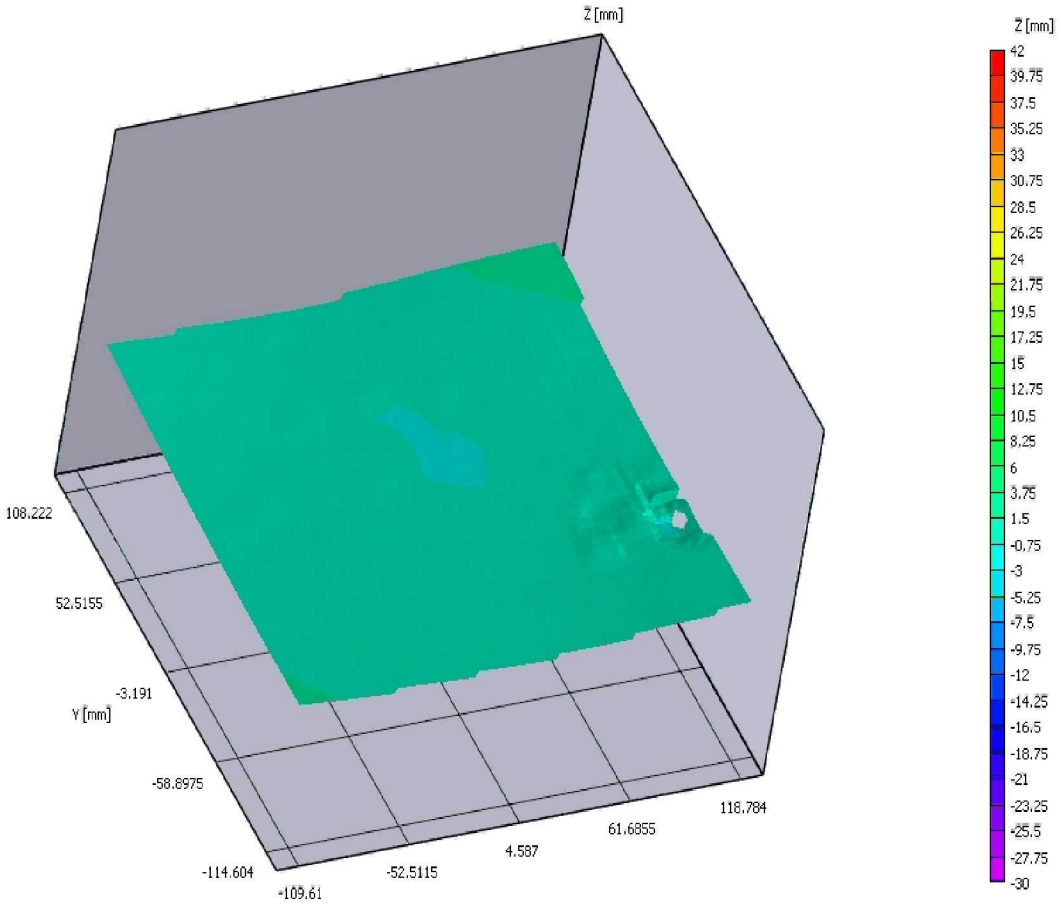


Hoop strain on clamp interior

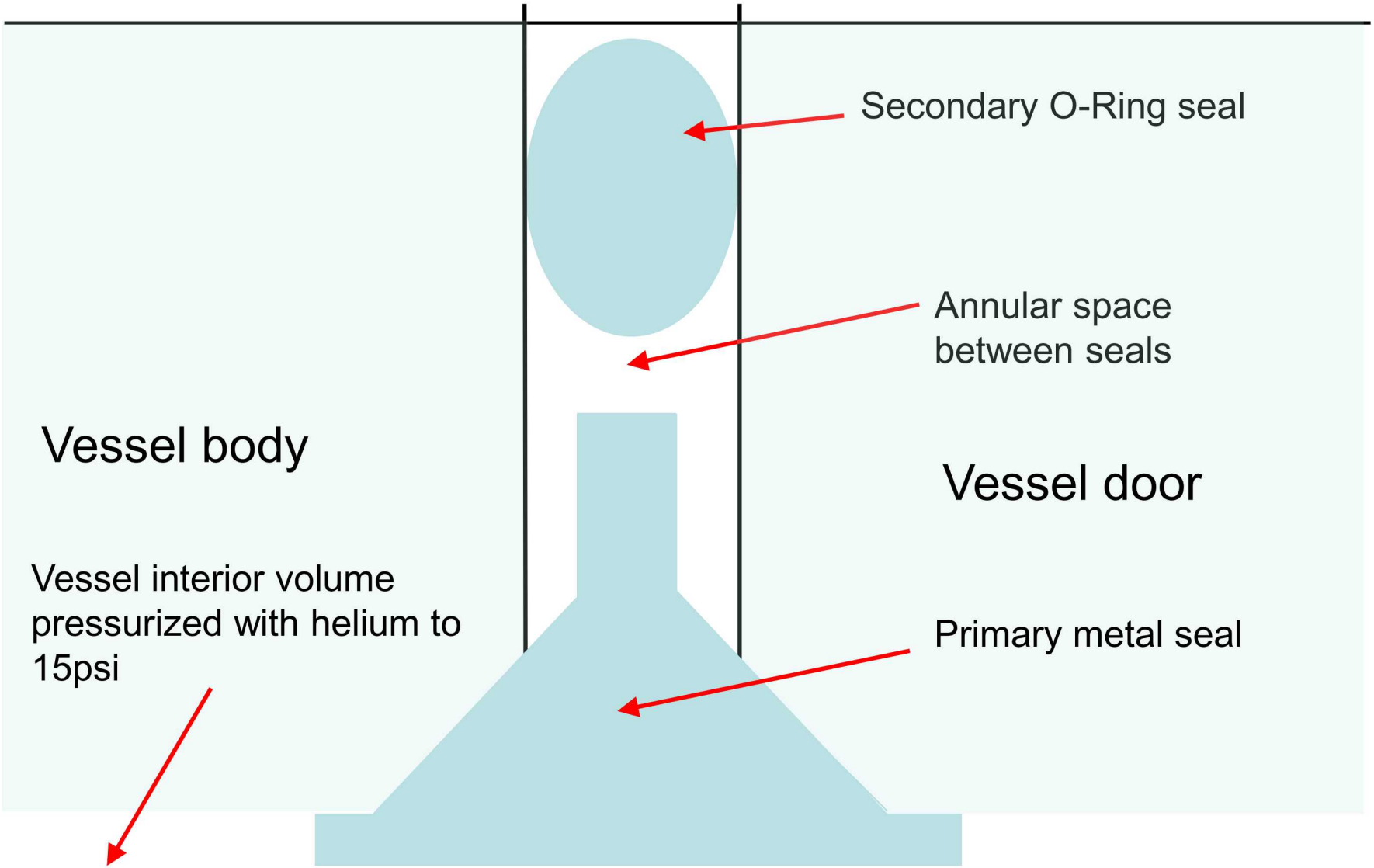
DIC RESULTS
Center point and line cut motion



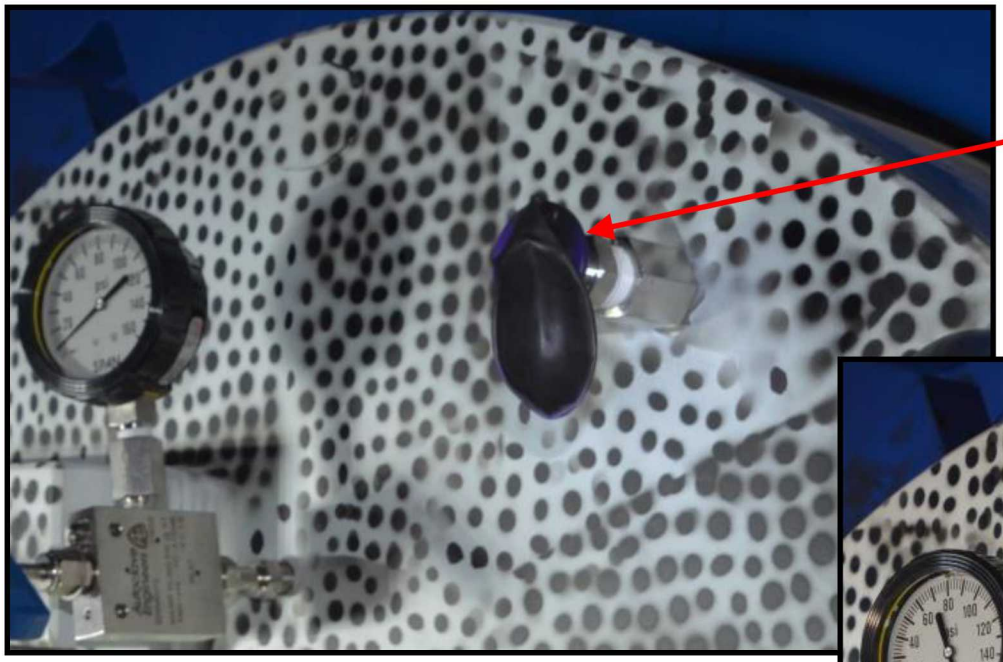
DIC EXAMPLE


Z [mm]
108.222
52.5155
-3.191
Y [mm]
-58.8975
-114.604
-109.61
-52.5115
4.587
61.6855
118.784
Z [mm]
42
39.75
37.5
35.25
33
30.75
28.5
26.25
24
21.75
19.5
17.25
15
12.75
10.5
8.25
6
3.75
1.5
-0.75
-3
-5.25
-7.5
-9.75
-12
-14.25
-16.5
-18.75
-21
-23.25
-25.5
-27.75
-30

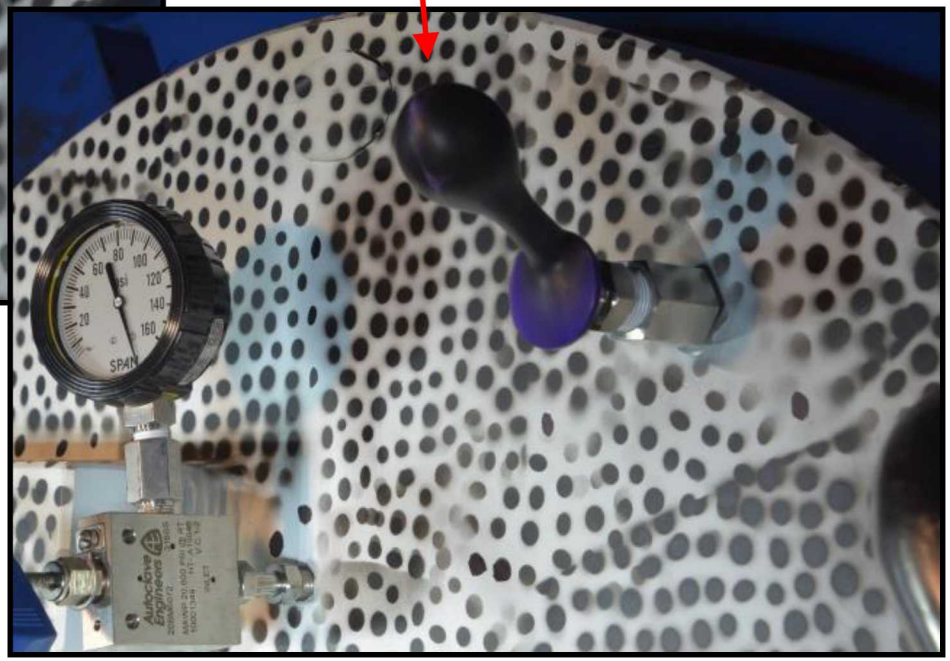
VESSEL BURP MEASUREMENT



VESSEL “BURP”



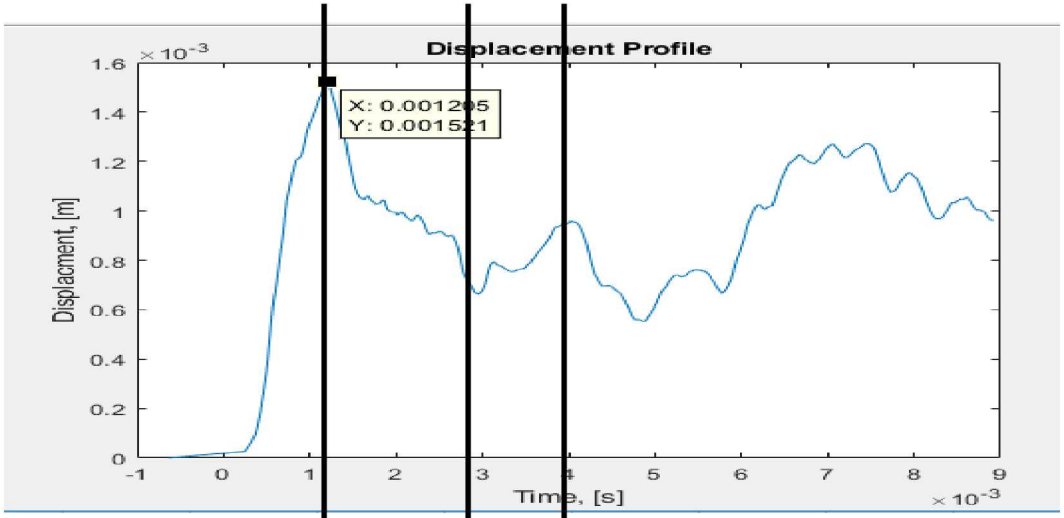
Pre-shot (deflated)
Post-shot (inflated)



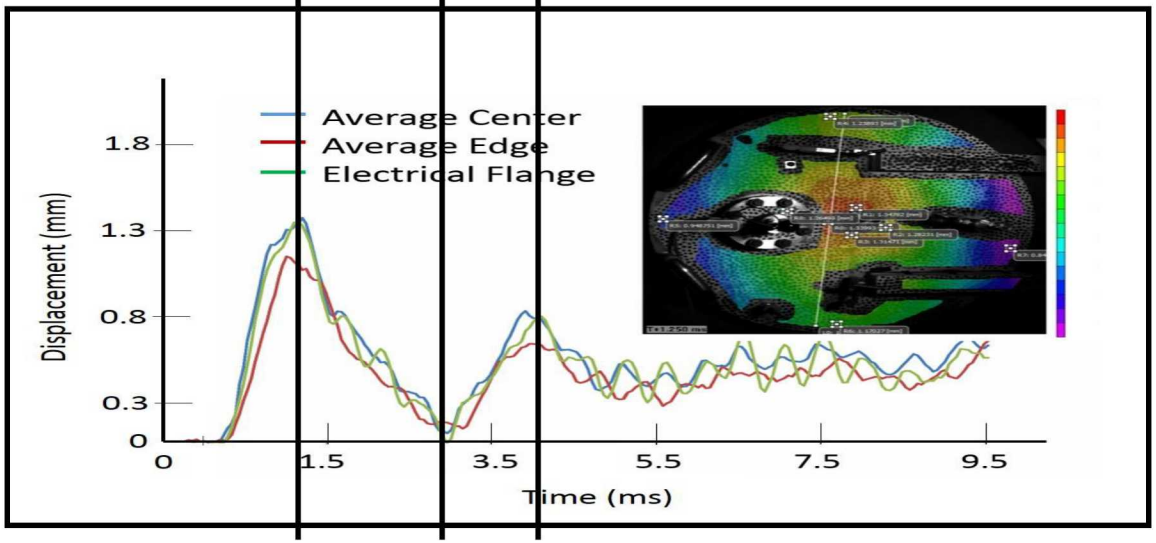
No helium detected in inflated balloon volume – must be air from exterior

Recent Photonic Doppler Velocimetry (PDV) compared to old DIC

PDV 2019



DIC 2013



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