

AA421

System Test Plan

SPACE Lab

Part Name: _____

Part Number: _____

Date: _____ / _____ / _____
yyyy mm dd

Test Team:

Name	Initials

Introduction

This experiment is designed to verify the ability of the test stand assembly to resolve deflections such that impulse bits and steady-state thrusts of an operating pulsed plasma thruster (PPT) can be measured. Corresponding to system requirements 3 and 4, the test stand assembly must be able to resolve impulses between $10 \mu\text{N}\cdot\text{s}$ to $100 \text{mN}\cdot\text{s} \pm 5 \mu\text{N}\cdot\text{s}$ and steady-state thrusts between 0.1mN to $0.1 \text{N} \pm 0.05 \text{mN}$ respectively. This test plan is to accompany the test procedure for the system test.

Test Constraints

Constraint	Description	Value
$m_{p1,p2}$	Total mass of pendulum and shelf	1.37 kg - 1.78 kg +/-5%

Test Parameters

Variable	Description	Values / Range
T	Temperature of test environment	15-25°C
m_{p1}	Mass of pendulum configuration 1 (metal chamber configuration)	1.37kg+/-5%
m_{p2}	Mass of pendulum configuration 2 (crystal chamber configuration)	1.78kg +/-5%

Test Variables

Variable	Description	Range
m	Mass of test masses	0.2-10.1 kg, given mass +/-1%
F	Flexure selection	Impulse flexure sizing
C_1	Shelf configuration 1 (metal chamber configuration)	
C_2	Shelf configuration 2 (crystal chamber configuration)	

Measurements

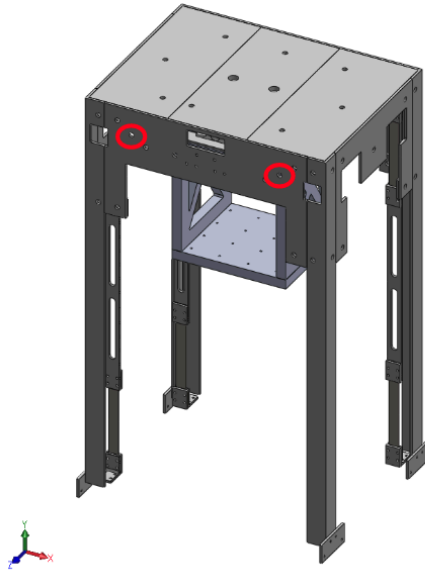
Variable	Description	Values / Range
d	Displacement of pendulum due to loading	Values must not diverge relative to previous measurements by greater than an order of magnitude
t_s	Pendulum settling time	
V_p	Peak voltage	
ω	Pendulum oscillation frequency	

Test Matrix

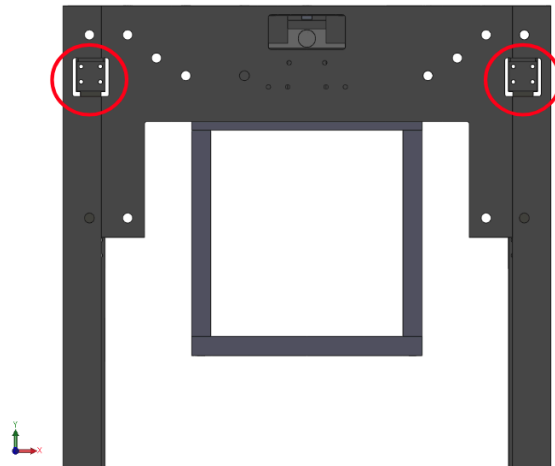
1.0 Impulse Testing

M.1.1 - Test Matrix

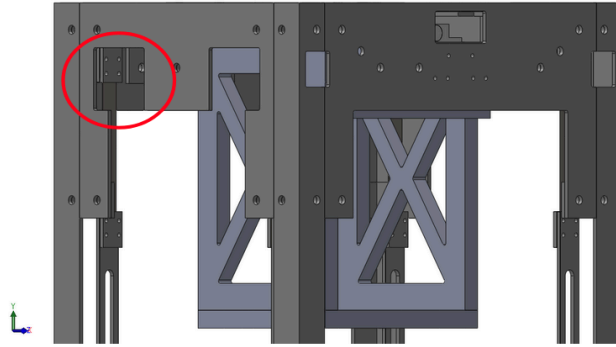
Flexure Set 1							
Shelf 1				Shelf 2			
Thruster + Shelf Mass		3.6 kg		Thruster + Shelf Mass		9.7 kg	
Test 1	Waterfall with Damper	Calibration Mass	50 g	Test 5	Waterfall with Damper	Calibration Mass	75 g
Test 2	Waterfall Without Damper	Calibration Mass	50 g	Test 6	Waterfall Without Damper	Calibration Mass	75 g
Test 3	Damping (No Waterfall)	Calibration Mass	50 g	Test 7	Damping (No Waterfall)	Calibration Mass	75 g
Test 4	No Damping, No Waterfall	Calibration Mass	50 g	Test 8	No Damping, No Waterfall	Calibration Mass	75 g
				Test 9	Waterfall with Damper	Calibration Mass	100 g
				Test 10	Waterfall Without Damper	Calibration Mass	100 g
				Test 11	Damping (No Waterfall)	Calibration Mass	100 g
				Test 12	No Damping, No Waterfall	Calibration Mass	100 g



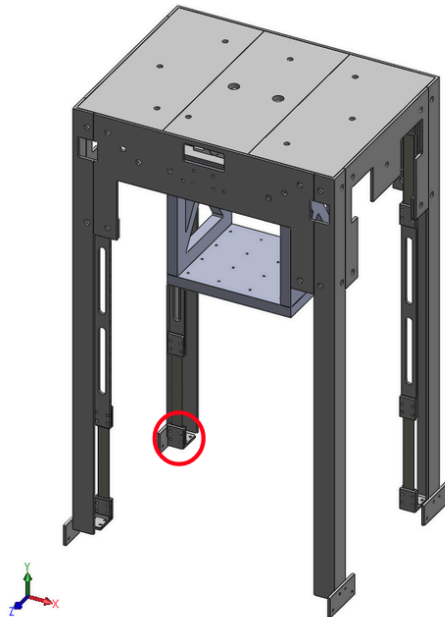
2. Once the pendulum top is supported, access bolts through cut out, indicated in red circles below, using a size PH1 phillips head screwdriver.



Access the nuts on the other side of the pendulum arm through the cut outs indicated with red circles below. Using a $\frac{1}{4}$ " box end wrench to counter hold the nuts, fully loosen each bolt using the screwdriver. Remove each nut, but leave bolts and the upper flat bracket in place to keep the pendulum arm supported.



3. At lower flexure access nuts and bolts on corner bracket indicated below in red circles



Using socket driver with 3/16" inch socket attached, loosen nuts on lower flexures while counter holding bolts using 1/4" box end wrench. Remove nuts, bolts, and the lower flat bracket from the pendulum arm.

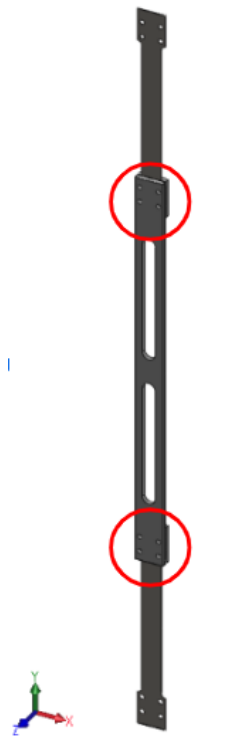
4. Remove the pendulum arm without corner brackets, shown below.



5. Repeat procedure for other 3 pendulum arms.

PRD 1.2 Flexure Removal

6. With pendulum arms removed from pendulum, remove nuts, brackets, and bolts from pendulum arms and remove flexures. Place removed flexures with flexures of the same thickness to avoid confusion.

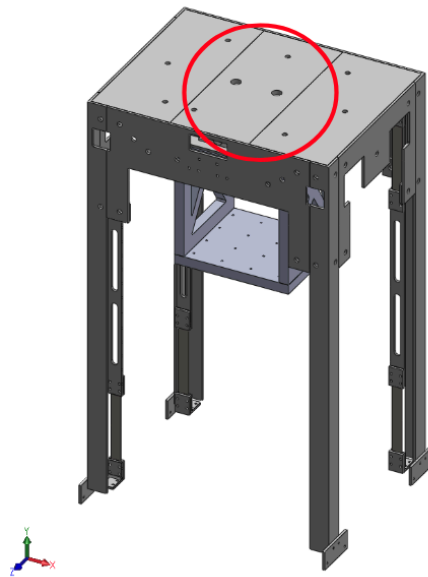


7. Install new flexure onto the pendulum arm by reversing PRD 1.2.
8. Install pendulum arms with new flexures by reversing PRD 1.1.
9. Remove 0.25" support bolts from the pendulum frame.

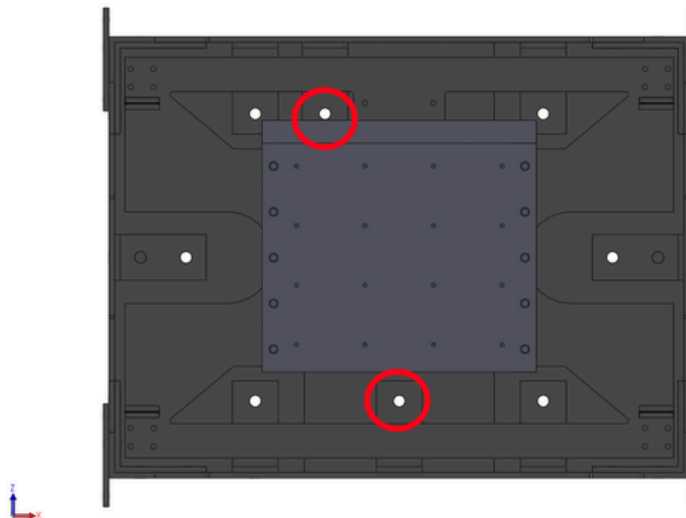
PRD 2 Thruster Shelf Change Procedure (~15 min)

PRD 2.1 Pendulum Frame Top Removal

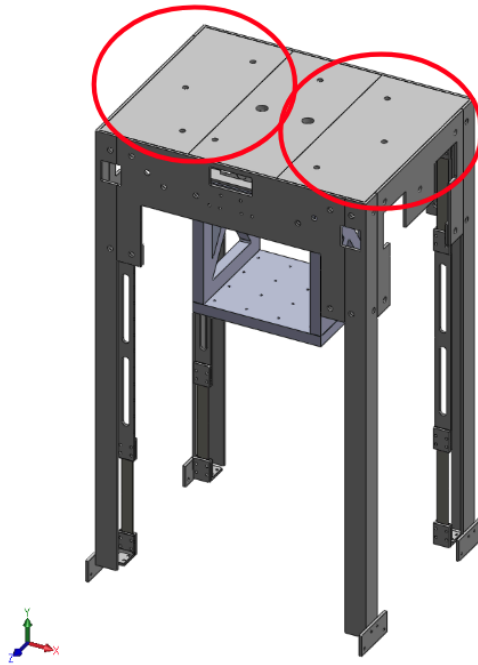
1. Remove center panel of top of pendulum frame, indicated in red circle below.



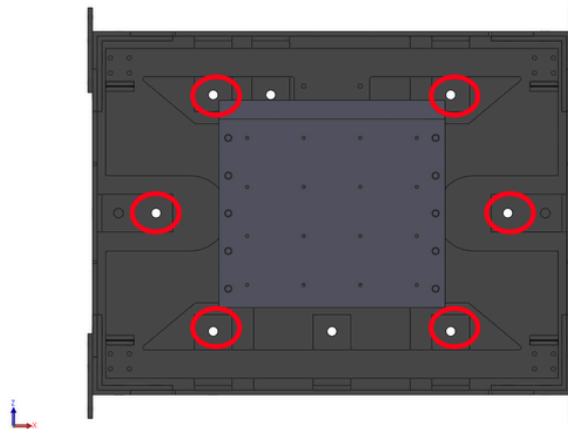
Bolts can be accessed from top using a $\frac{3}{8}$ " box end wrench. The nuts are accessed from below, indicated below, using a socket driver with a $\frac{7}{16}$ " socket attached. Using $\frac{1}{2}$ " holes in the center of the panel to remove the panel.



2. Remove side panels on top of pendulum frame, indicated in red circles below.



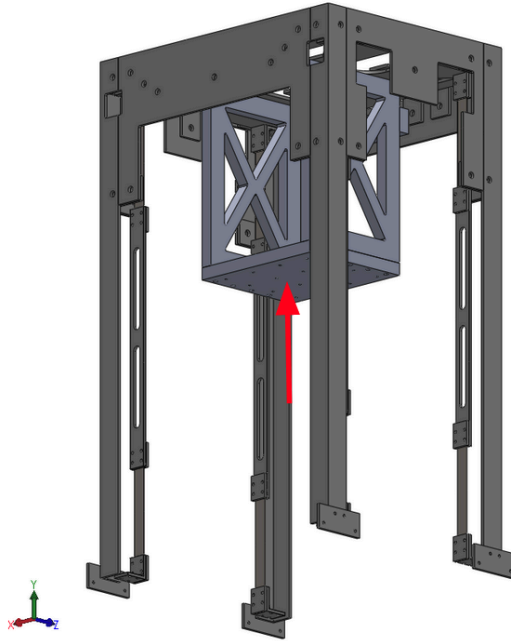
Bolts can be accessed from top using a $\frac{3}{8}$ " box end wrench. The nuts are accessed from below, indicated below, using a socket driver with a $\frac{7}{16}$ " socket attached.



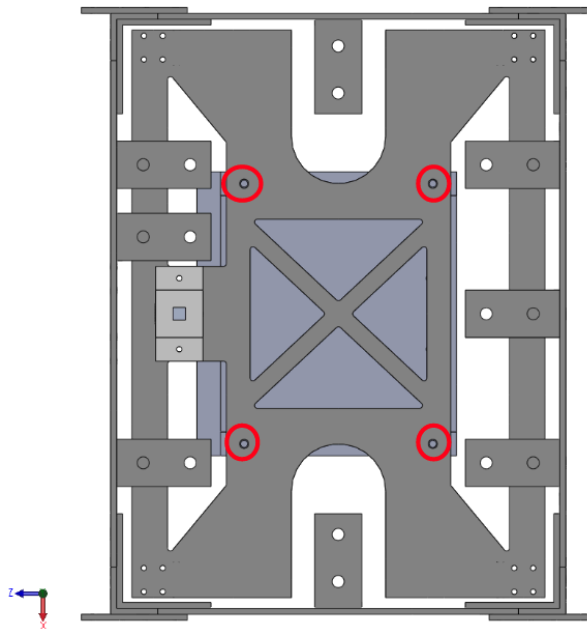
Remove panels from the pendulum frame.

PRD 2.2 Shelf Removal

3. Support thruster shelf from below with one hand, as indicated with red arrows below



4. While supporting the shelf from step 3, remove 4 bolts, indicated in red circles below, securing the thruster shelf to the pendulum using a socket driver with a 5/16" socket.

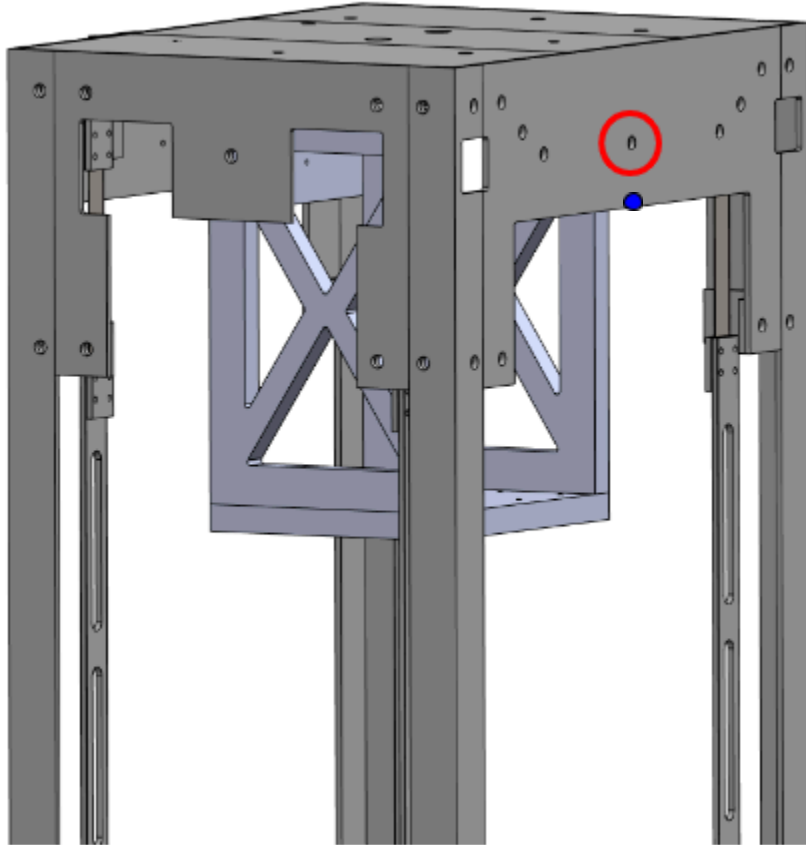


5. Remove thruster shelf from pendulum, store shelf in box.
6. Reinstall new thruster shelf by reversing PRD 2.2.

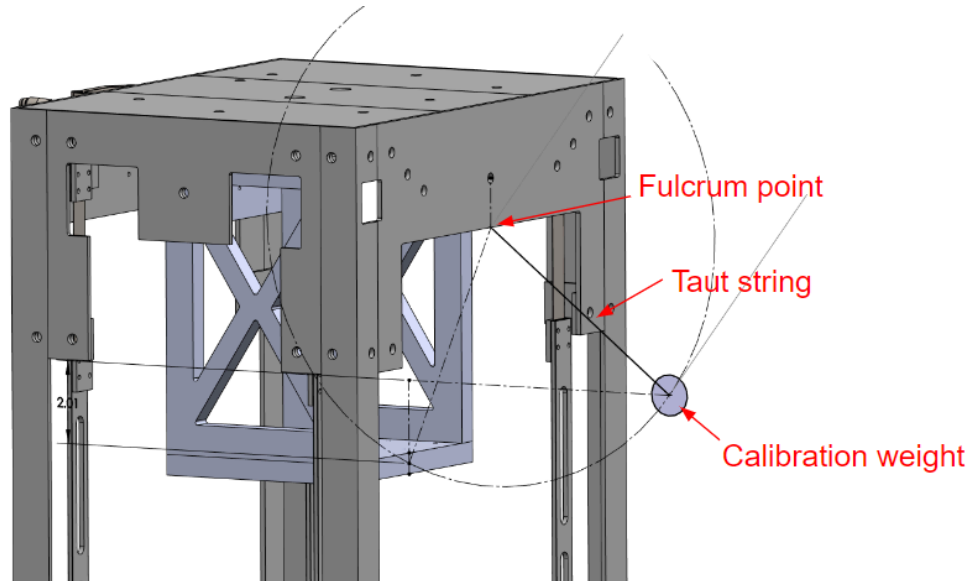
7. Reinstall pendulum frame top panels by reversing PRD 2.1.

PRD 3 Atmosphere Impulse Application Procedure (~1 hour)

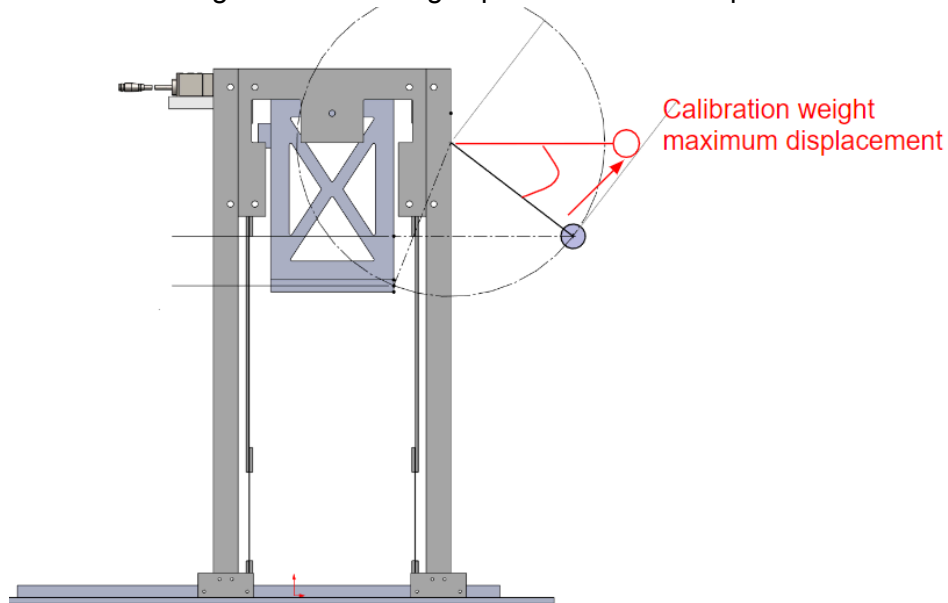
1. At the circled hole on the assembly, screw on a $\frac{1}{4}$ " bolt, leaving $\frac{1}{2}$ " of the bolt shaft exposed.



2. Using a string, tie a knot on the exposed bolt threads, leaving an ample length slack.
3. Tape down the length of string to the face of the frame, such that the swinging motion of the string is at the bottom of the face (blue dot).
4. Tie the calibration weight to the other end of the string, making sure to have a sufficient string length between the edge of the frame and weight such that the weight collides with the pendulum.



5. Immediately prior to the impulse test, raise the calibration weight, keeping the string taut.
6. Hold calibration weight until the string is parallel to the floor plane.



7. Release the weight, and ensure that the scope recorded the resultant oscillation of the test stand pendulum.
8. Save raw voltage data from the scope to a flash drive.
9. Repeat steps 5-8 for all trials.