Development of Hammer Blow Test to Simulate Pyrotechnic Shock

Interim Design Review

Team 15

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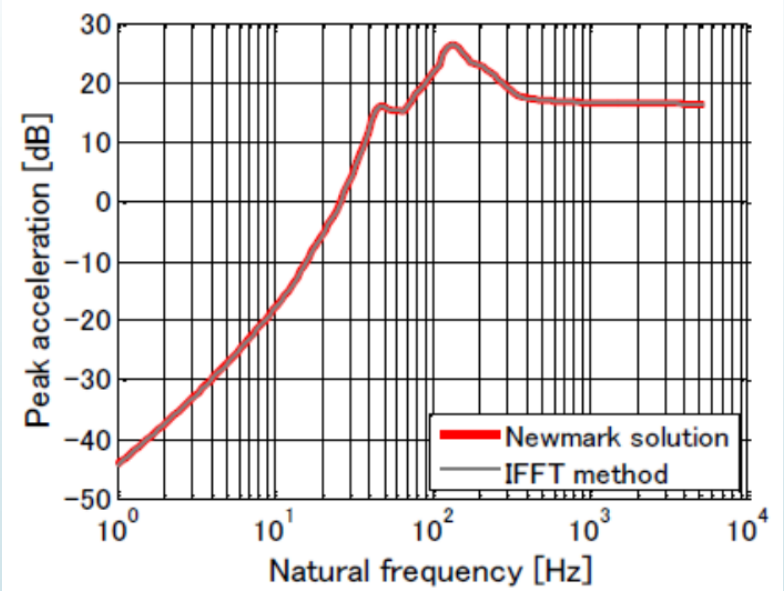
Background

- Explosive components commonly used in satellite systems
  - Stage separation, antenna deployment
- High acceleration, high frequency transient shockwaves
  - Damage or disable sensitive equipment
  - Characterized with SRS Curves due to complex nature

- Include more information about using kinetic impact to model what a pyrotechnic device causes.

Theory

- High acceleration, high frequency, transient nature
  - Difficult to specify or recreate
- SRS – Shock Response Spectrum
  - From time domain to frequency domain
  - Provide quantitative measure
- Effects captured by Accelerometer & DAQ system
- Acceleration time history processed into SRS Curve



Project Overview

- Harris Testing: Harris Corp. seeking system level approach to modeling pyrotechnic shock.
- Needs Statement:

The current shock testing method lacks adaptability, requiring too much trial and error and expenditure of resources.

- Goal Statement:

Design and Develop a Tunable Resonant Fixture Plate and Test Modeling/Analysis software to examine trends in varying test parameters.

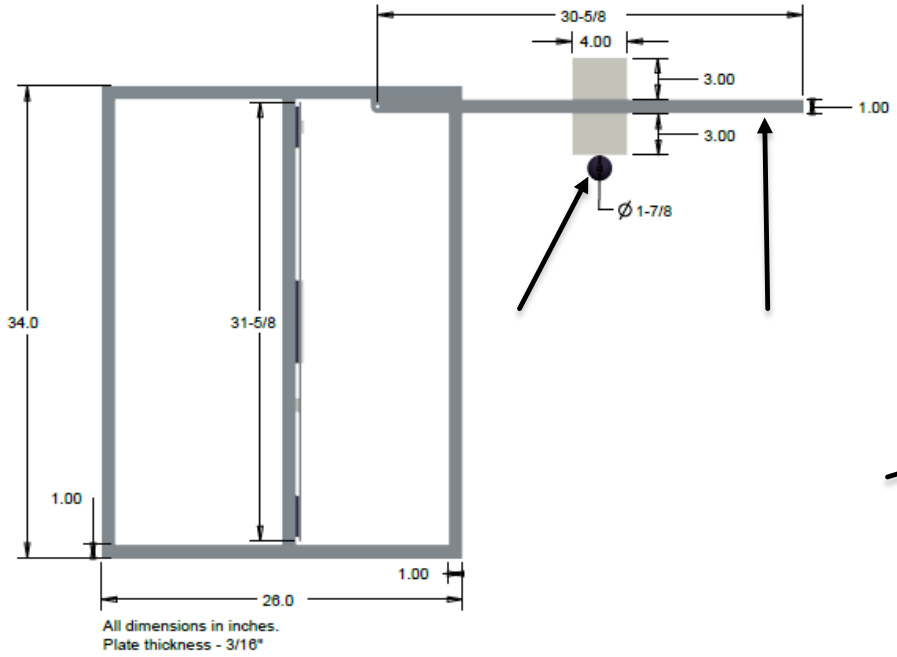
Project Scope

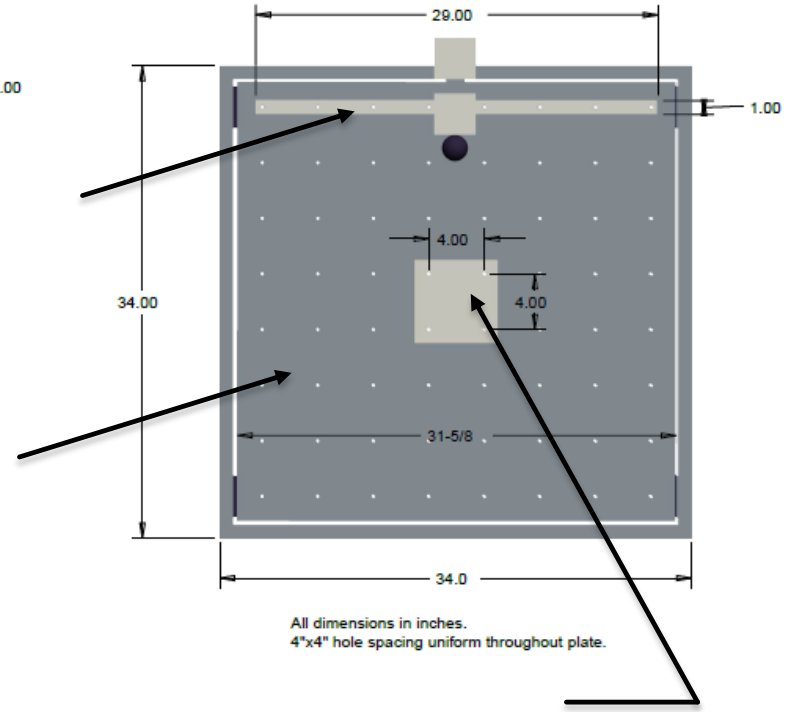
- Two year project
  - Year 1 – Proof of concept, small scale testing
  - Year 2 – Full scale testing
- Design & build a capable test rig
  - CAD Model & Simulations
  - Manufacture actual test rig
- Develop software to convert test data to graphical plot
  - Swallwood Recursive Method
- Compile catalogue of experimental data and variables
  - Matlab, Excel
- Budget: $4000

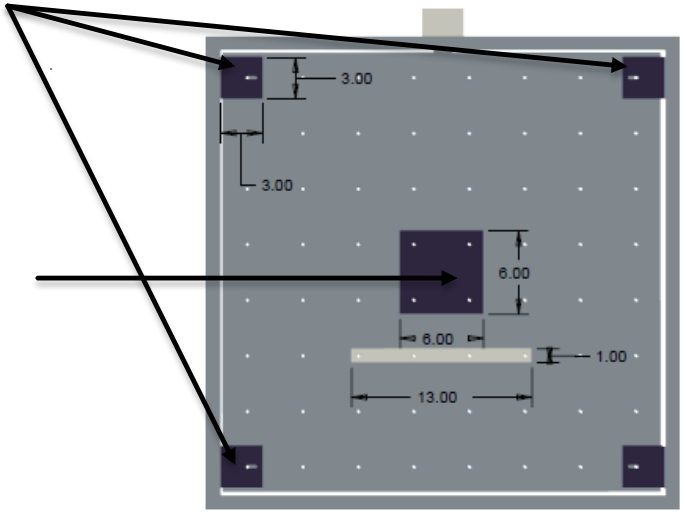
Constraints & Specifications

- Test article size - up to 8 x 8 x 6 inches
  - **Selected article: 6” x 6” x 0.5” low carbon steel**
- Test article weight - up to 10 lbs
  - **Article weight: 5.1 lbs**
- SRS response up to 500g acceleration and 10 kHz
  - Stay within tolerances set by MIL-STD-810 G, Method 517.2, Proc III
  - **Anticipated Maximum Force Generated: Abaqus → 396g’s Max (Weight of hammer?- Roughly 10.5 lbs: 0.975lb hammer tip, 9.37lb weights)**
- Project expenses must stay within allotted budget ($4000)
  - **Funds Used: $2116.94**
- Acceleration data acquisition that covers generated force ranges
- Software conversion for raw data to usable SRS curves
  - **Smallwood Recursive Matlab script**

Creo Model

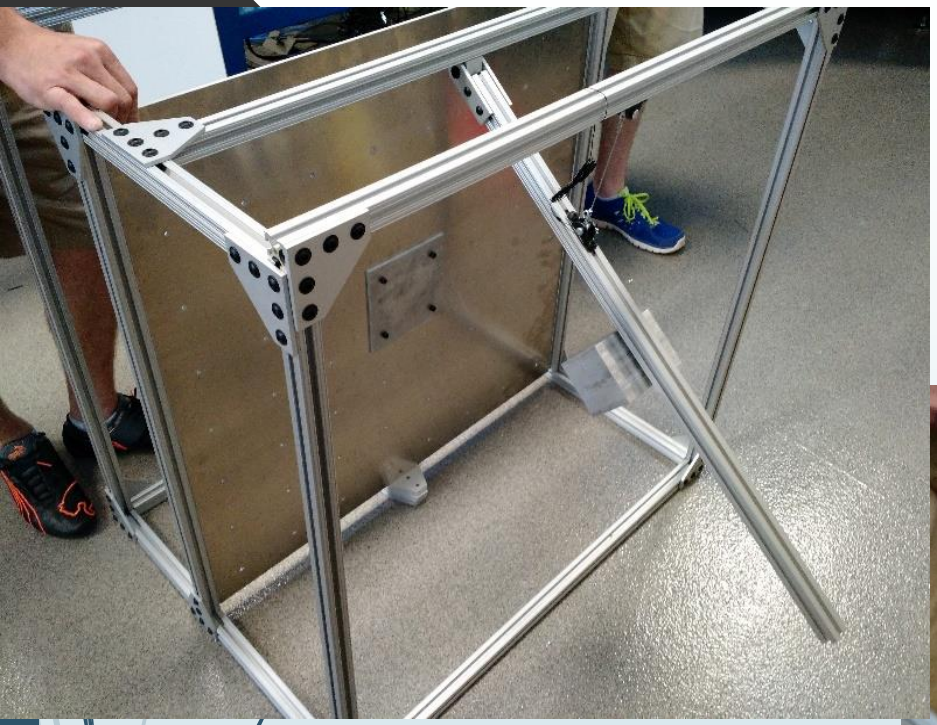






*All Dimensions in Inches

Testing Apparatus



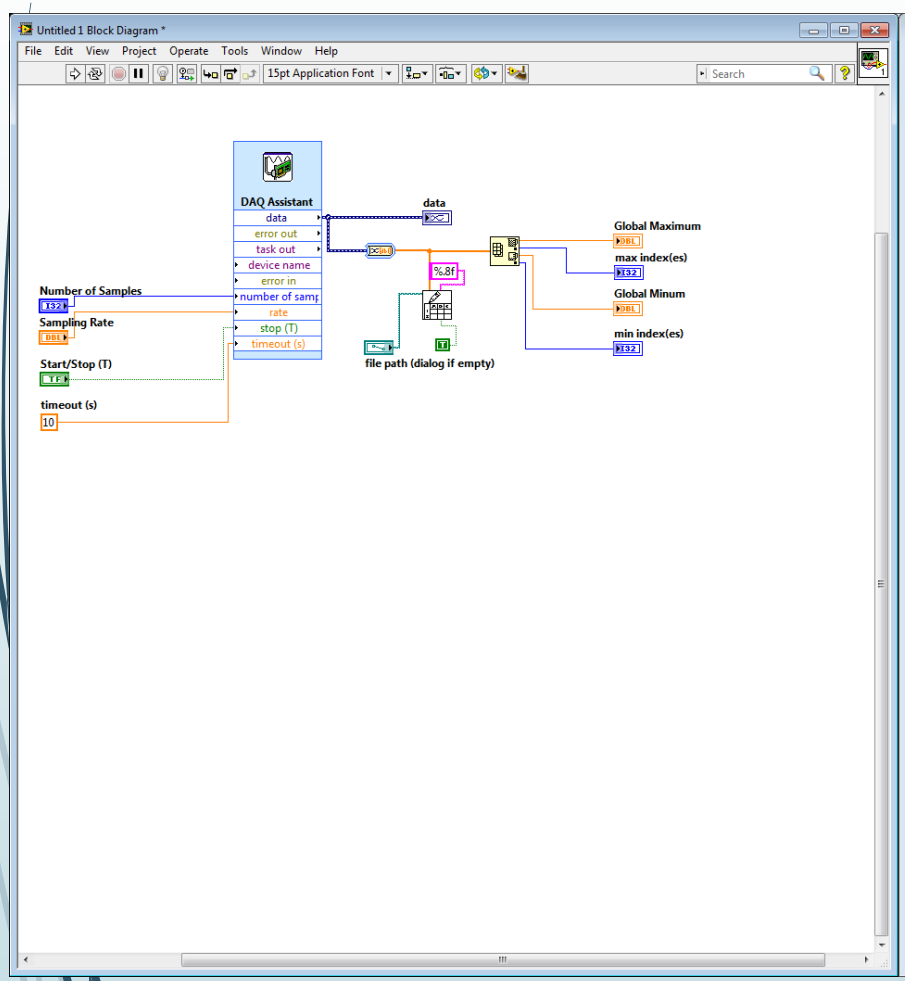
Testing Apparatus – Quick Release

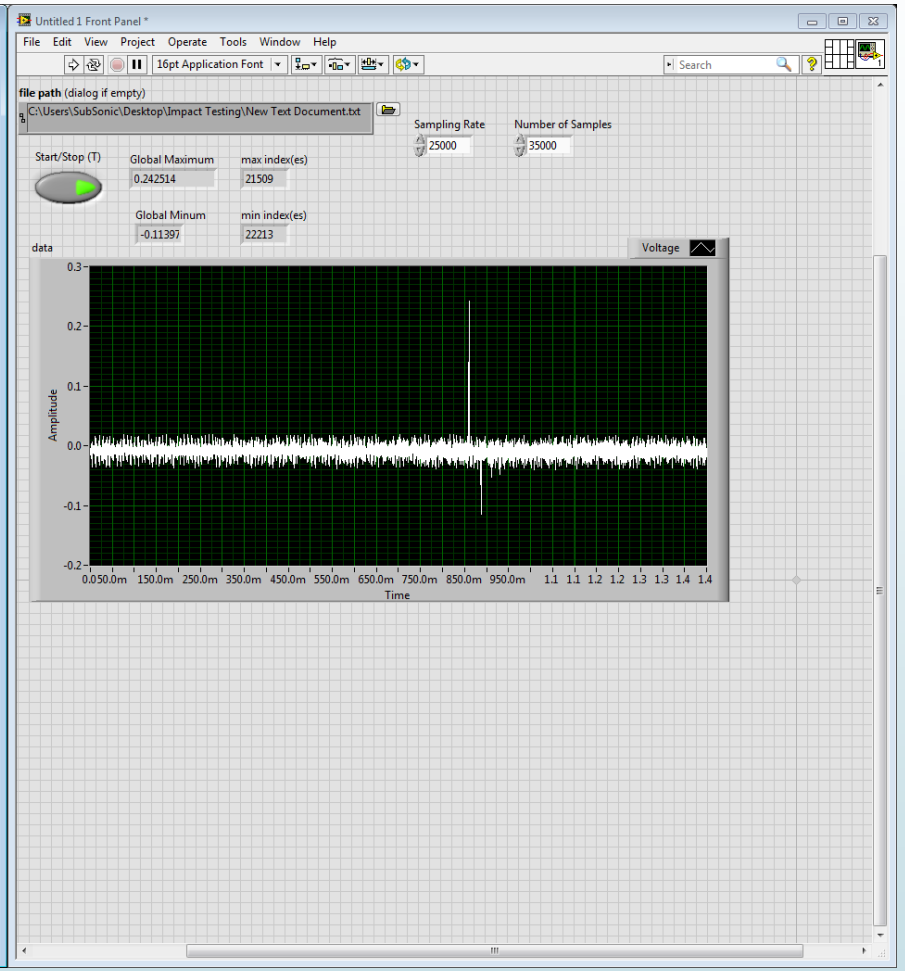
DAQ Setup


NATIONAL INSTRUMENTS
BNC-2110
DIGITAL AND TIMING I/O
TRIGGER/COUNTER
PFI 0 / P1.0
PFI 12 / P2.4
USER-DEFINED SIGNALS
USER 1
USER 2
D GND
NAME
NAME
Electrostatic Sensitive Connectors


4110C
CURRENT SOURCE
SENSOR BIAS VDC

LabView Virtual Interface





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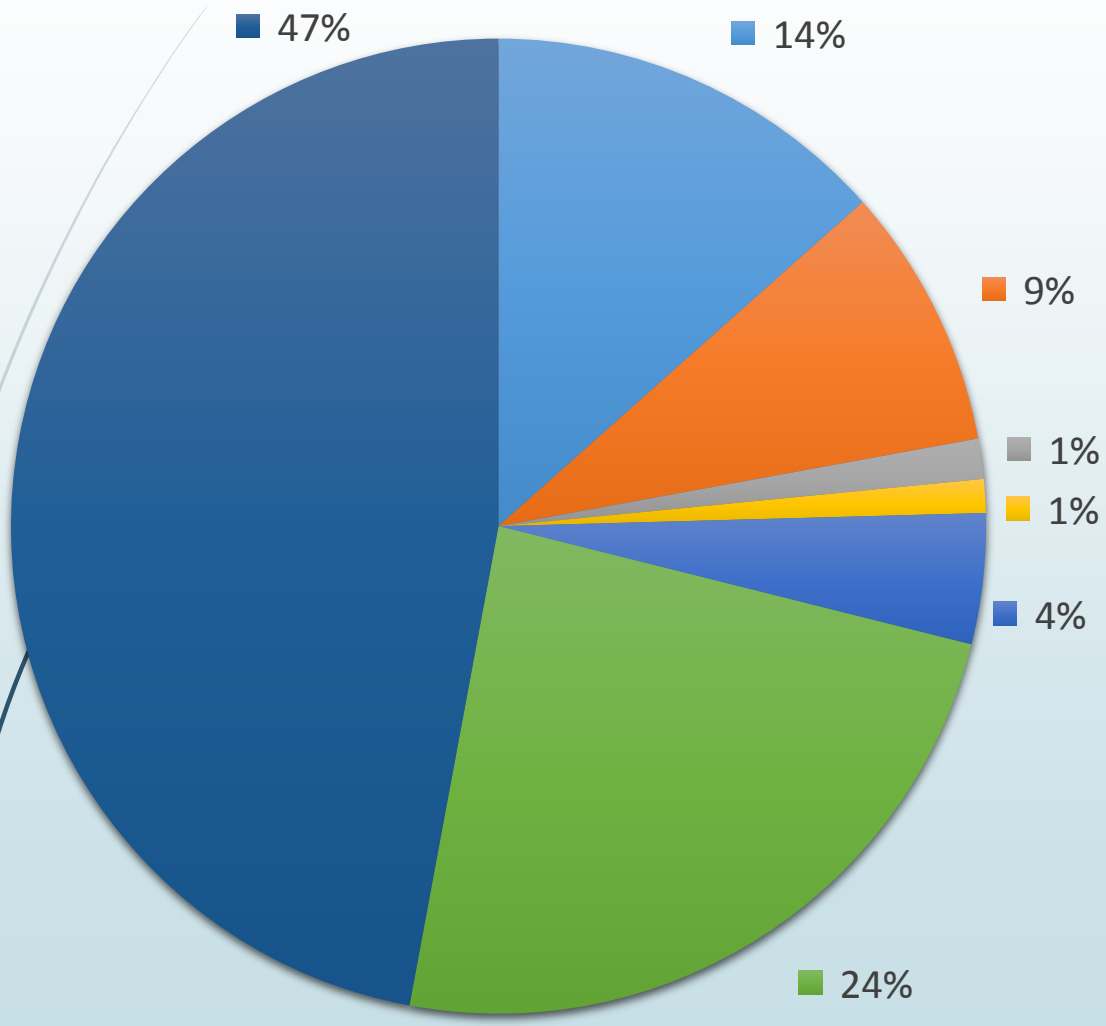
Budget



Budget Allocation
Total - $4,000

Frame	$537.00
Fixture	$324.21
Hardware	$53.14
Test Article	$44.76
Hammer	$173.24
DAQ	$960.80
Remaining	$1,883.06

Challenges

- Complexities of FEA modeling
- Large amount of documentation
- Plastic deformation of sacrificial plates from specific hammer tip sizes
- Ensure rigid boundary conditions of the frame
- Machine shop turn around times delaying final assembly
- No reference for anticipated results
- Refining DAQ to overcome noisy signals employing signal conditioner

Schedule

ID	Task Name
1	**Prototyping**
2	**Reporting**
32	**Procurement**
33	Submit Purchase Orders
34	Inventory Orders
35	Submit Addt'l Orders (if necessary)
36	Submit Addt'l Orders 2 (if necessary)
37	**Manufacturing / Assembly**
38	Submit CAD Drawings for Machining
39	Assemble Chassis
40	Assemble Striking Hammer
41	Mate Chassis & Hammer
42	Test Fit Full Assembly
43	**Analytical Modeling**
44	Obtain & Verify Smallwood Code
45	Verify CAD Models & Simulations
46	Build MATLab SRS Processing Program
47	Test SRS Processing with CAD Sims
48	Submit MATLab Code to Mr. Wells for Verification
49	Continuous Simulations and Refinement
50	**D.A.Q.**
51	Build Lab View Module
52	Test Equipment
53	**Experimental Modeling**
54	Final Assembly: Chassis & Hammer
55	Baseline Testing
56	Test Parameter 1 (Article Location)
57	Test Parameter 2 (Strike Location)
58	Test Parameter 3 (Plate Boundary Conditions)
59	Test Parameter 4 (Hammer Tip Shape)
60	Test Parameter 5 (Stiffining plates)
61	**Documentation**
62	Track MATLab Modifications
63	Record D.A.Q. Setup and Calibration Procedure
64	Record Testing Results (1)
65	Record Testing Results (2)
66	Record Testing Results (3)
67	Record Testing Results (4)
68	Record Testing Results (5)
69	Assemble Database of Results
70	***Final Product***

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Summary

- Harris Corp. seeking system level approach to modeling pyrotechnic shock
- Damage potential of shock gauged by acceleration in the frequency domain (SRS curve)
- Team 15 proposed a swinging hammer to simulate pyrotechnic with limited variable parameters to adjust
- Goal: Use tunable test rig to correlate input parameters to output SRS curve to highlight any trends in test results
- Testing will begin as soon as final shop parts are ready

References

- [1] Robert, Wells. "University Capstone Development of Hammer Blow Test Device to Simulate Pyrotechnic Shock 2 Year Project." 6 Jan. 2015. Web. 7 Jan. 2015.

http://eng.fsu.edu/me/senior_design/2015/team15/