



## Acoustic Measurements for Small Solid Rocket Motors

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# Agenda

- Overview and Scope
- Small Solid Rocket Motor Parameters
- Test Setup and Microphone Layout
- Instrumentation
- Procedures
- Data Analysis
- Time Histories
- 1/3 Octave bands
- Summary and conclusions

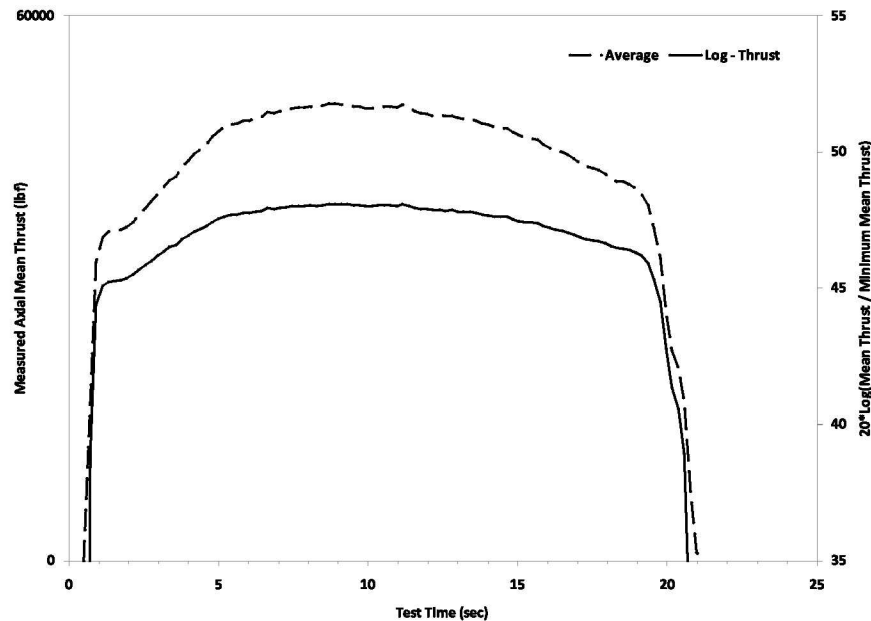


# Overview and scope

- Models have been developed to predict large solid rocket motor acoustic loads based on the scaling of small solid rocket motors
- MSFC has measured several small solid rocket motors in horizontal and launch configurations to anchor these models
- Solid Rocket Test Motor (SRTM) has ballistics similar to the Reusable Solid Rocket Motor (RSRM) therefore a good choice for acoustic scaling
- Acoustic measurements were collected during the test firing of the Insulation Configuration Extended Length (ICXL) 7,6, and 8 (in firing order) in order to compare to RSRM horizontal firing data
- The scope of this presentation includes:
  - Acoustic test procedures and instrumentation implemented during the three SRTM firings
  - Data analysis method and general trends observed in the data

# Parameters

Parameters	ICXL	RSRM
Thrust	50,000 lbf	300,000 lbf
Exit Diameter	0.97 ft	12 ft





# Test Setup

- Microphone layout based on nozzle diameters for scaling
- Sensors installed on uni-strut stands and leveled with the nozzle exit plane



- Uni-struts placed on 80 and 120 ND from the nozzle centerline

# Instrumentation

- PCB 106B50, 5 psi, 10 kHz, quartz microphone
- Several DAQs were used for the tests due to availability
  - VXI 1432 ICXL7 and 6
  - VXI 1436 ICXL8
- IRIG-B was provided by the test area
- Weather information was collected by the test area
- Microphone location determined using an infrared GPS





# Procedures

- Pre and Post-test calibration measured using a B&K pistonphone , 124 dB at 250 Hz
- System triggered remotely via ethernet using PCAnywhere software
- The system is started approximately 1 second before T-0, IRIG-B can be used to adjust the data to T-0



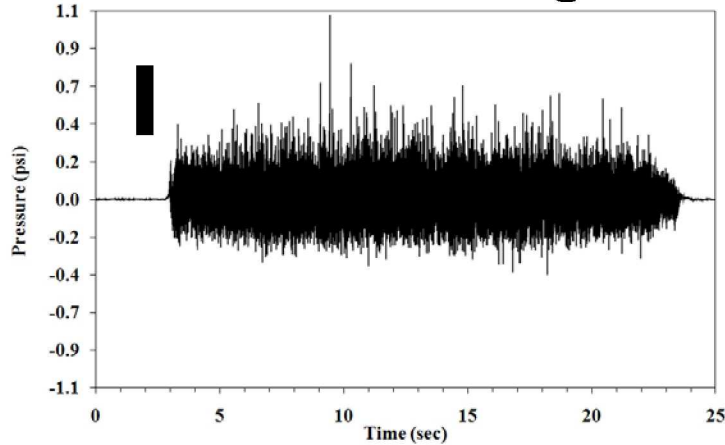
# Data Analysis

- Data analysis performed using PCSignal
- Sample rate varied from test to test due to different DAQ and channel numbers
- Time: 8 second interval with 80% overlap
- Frequency: 5 second interval, 1.3 Hz bandwidth with 80% overlap
  - The processing block size was selected according to the sample rate to best match the parameters
  - The time interval was selected to encompass the maximum thrust time period

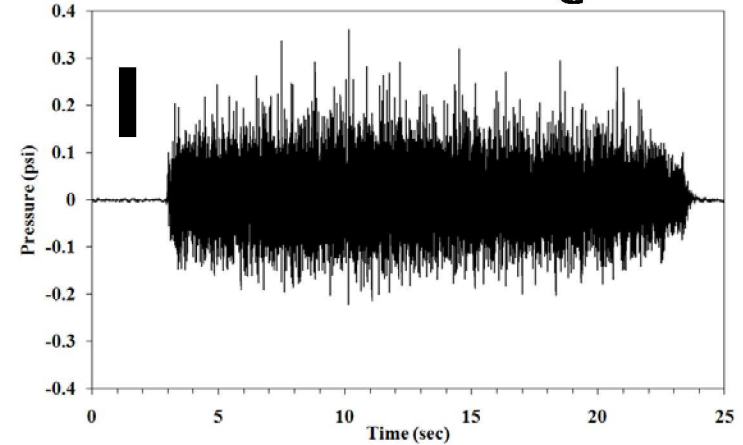


# Time Histories

80 Nozzle Diameters @ 30°

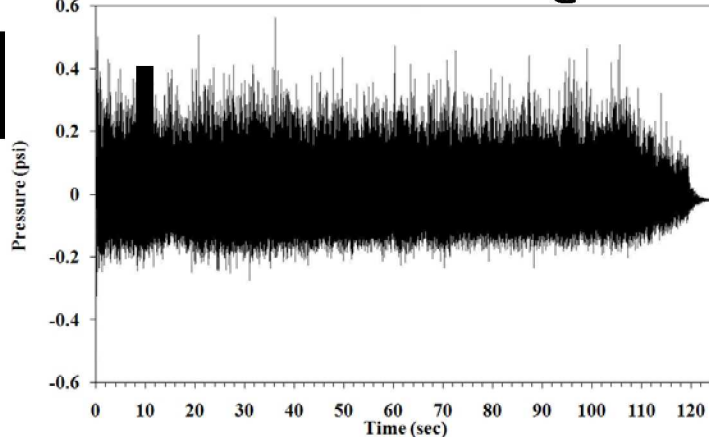


120 Nozzle Diameters @ 30°

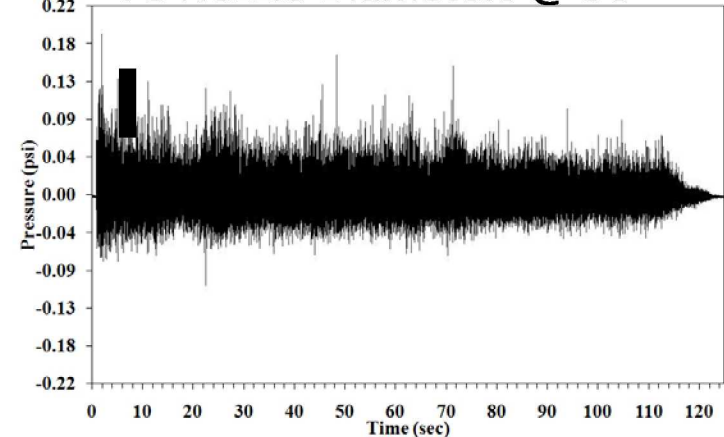


- Time histories show positively skewed data
- Similar behavior has been observed in RSRM data

17 Nozzle Diameters @ 90°

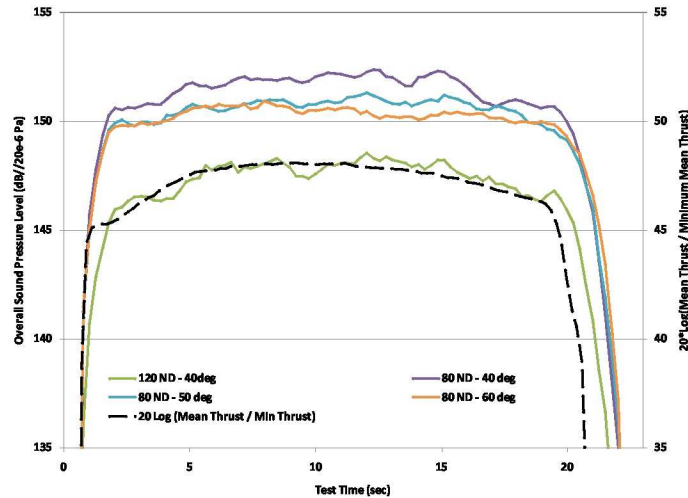


78 Nozzle Diameters @ 90°

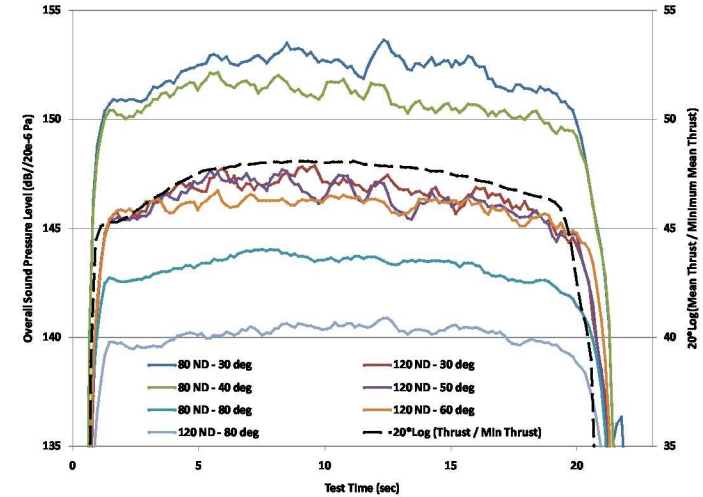


# Overall Sound Pressure Level

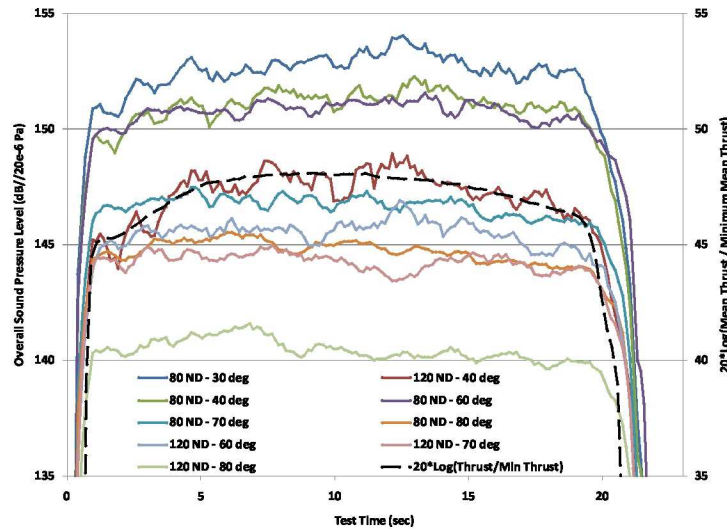
ICXL-7



ICXL-8

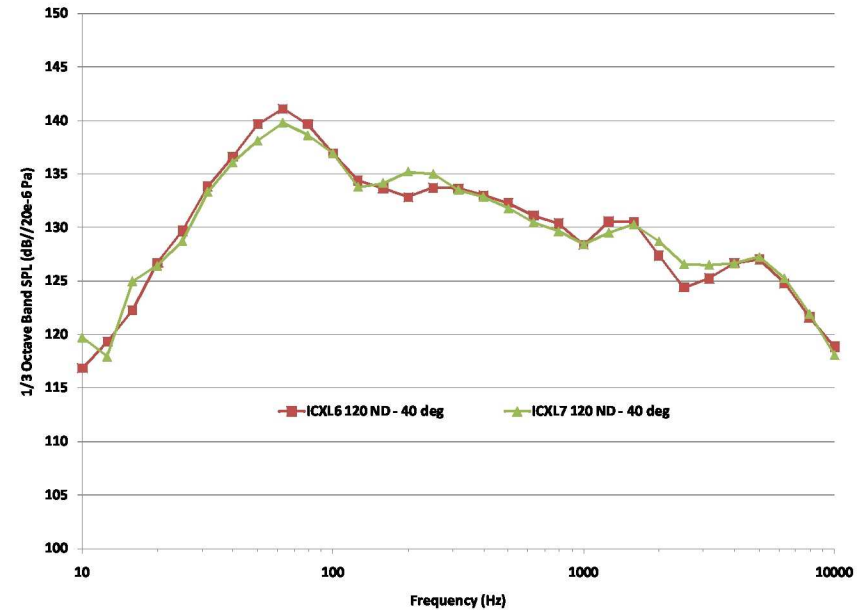
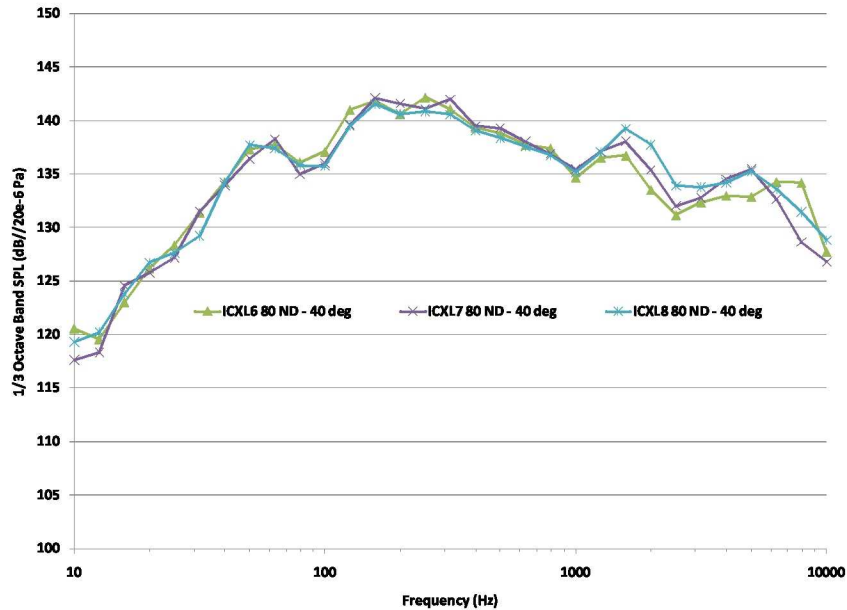


ICXL-6



- Acoustic data follows the thrust max
- 3 dB reduction with 50% distance increase

# 1/3 Octave Bands



- 1/3 Octaves shows repeatability of the measurements from test to test



# Summary and future work

- Measured acoustic data shows repeatability and trend similar to the ones shown in previous static firings
- One more SRTM will be measured in May
- Data will be collected to make the required corrections