In House Shock Prediction Tool

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Outline

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- Technical Approach
- SEA Case and Results
- Conclusions

Background

- For decades and still today the preferred tool for shock prediction at NASA GSFC is a semi empirical approach based originally in a study for NASA Goddard NAS5-15208: "Aerospace Systems Pyrotechnic Shock Data", Ground Test and Flight, March 1970, and subsequent empirical data.

- NASA also sponsored in the past Shock Prediction Technology, for example the TRANSTAR (TRansient ANalysis STorage And Retrieval) which is a database management and prediction system. We no longer use it at GSFC although it may still be used by the industry.

- The Mechanical Systems Analysis Branch (Code 542) has an AutoSEA2 license for vibroacoustic analysis. AutoSEA2 is currently owned by the ESI Group.

Background

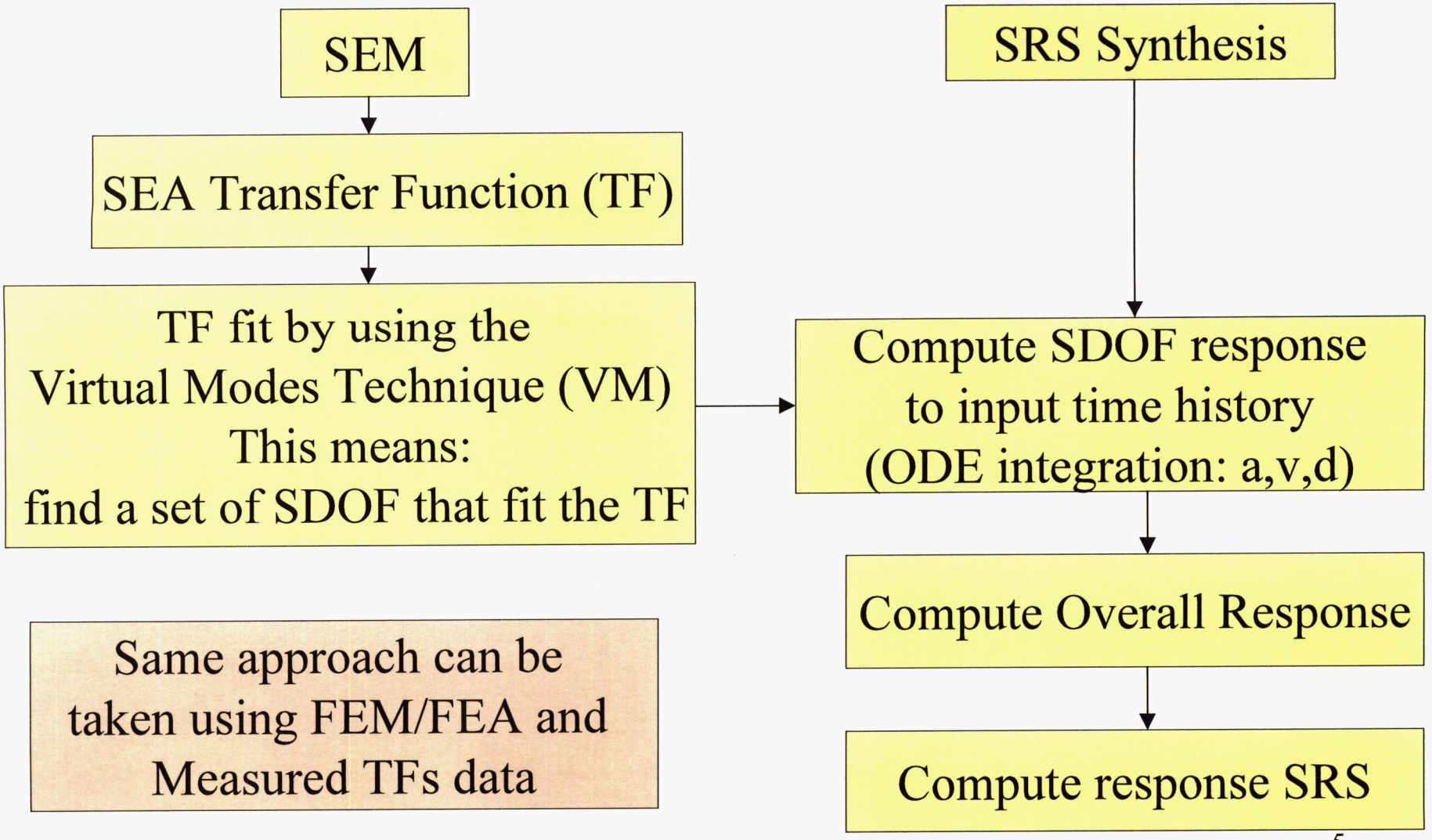
- The ESI Group has expanded the use of AutoSEA2 by integrating the PowerSurge code which was licensed under an agreement with Military Technology Inc.

- The Shock Module from ESI Group allows to extend the use of AutoSEA2 models to shock prediction.

- Code 542 does not have the Shock Module Expansion due to budget limitations. Swales Aerospace purchased the Module and used it in support of various shock problems at NASA.

- Code 542 decided to use existing in house routines and try to develop the technique. We asked and received from Swales data to benchmark our in house effort.

Technical Approach



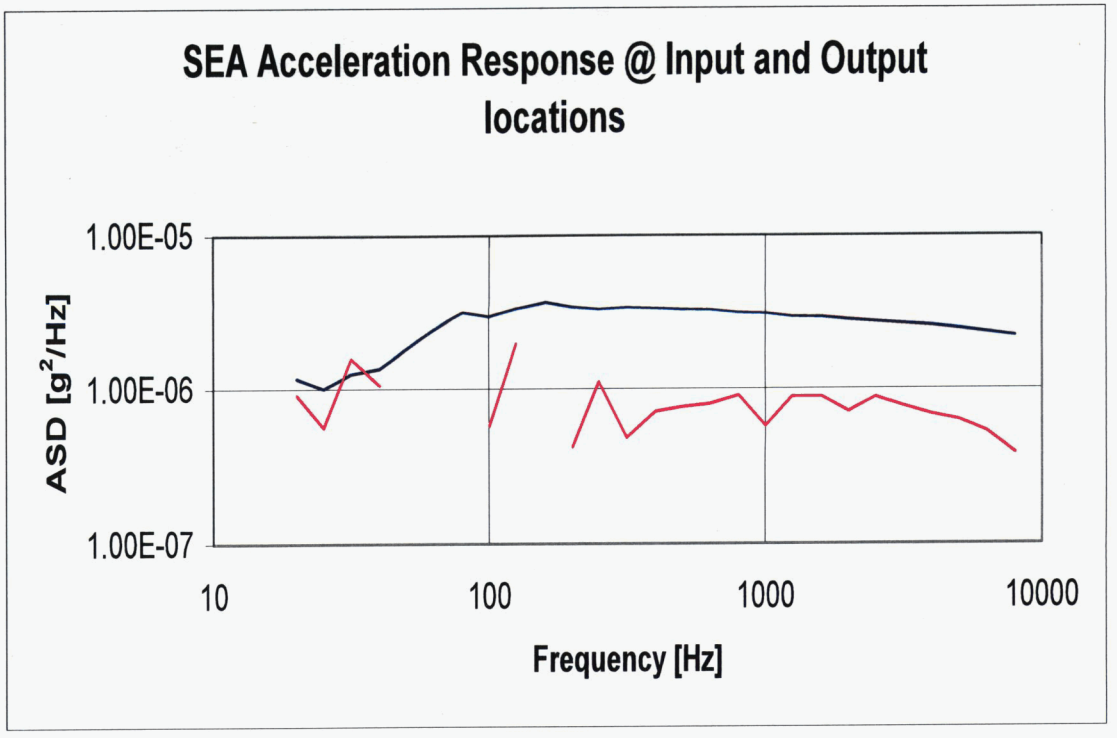
SEA Case

- Swales provided the necessary data to benchmark the problem. This is: Input SRS, SEM, input and output locations and SRS response.
- Code 542 took the SEM, identified input and output locations and computed a psd response (SC shear panel) due to an unitary force at the input location.
- An acceleration TF [g/g] was obtained by:

$$TF = SQRT(PSDout / PSDin)$$

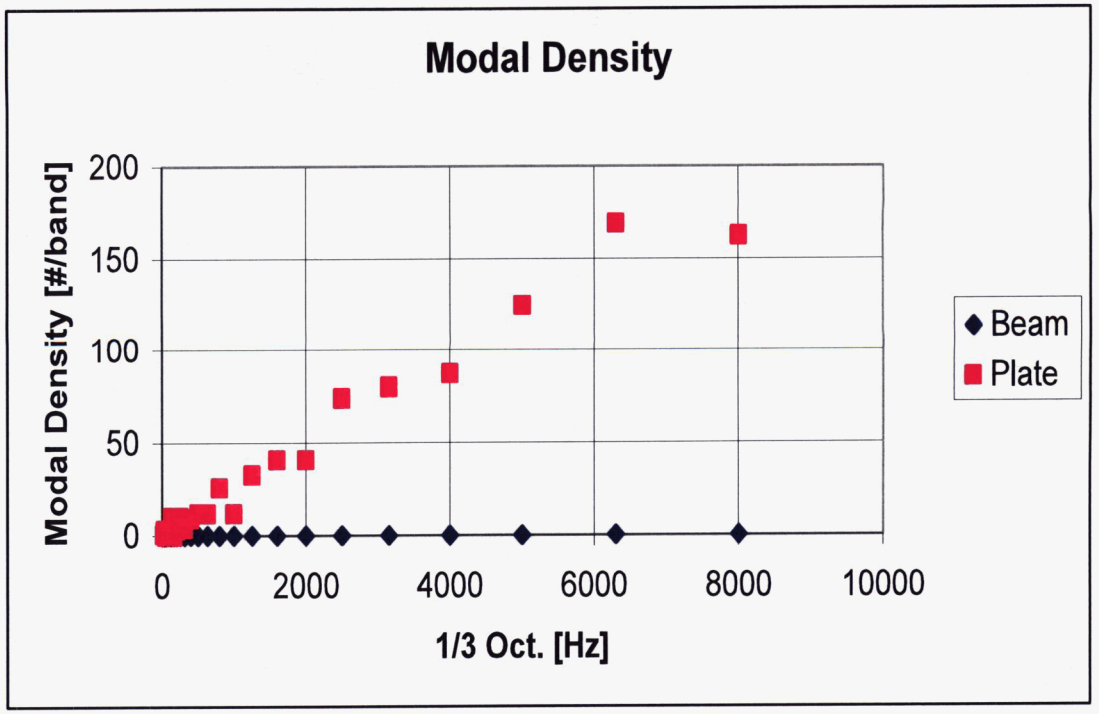
SEA Results

Frequency(Hz)	Beam 990 Extensional ASD(g^2/HZ)	Plate 936 Flexural ASD(g^2/Hz)
20	1.17E-06	9.11E-07
25	1.00E-06	5.66E-07
31.5	1.25E-06	1.56E-06
40	1.34E-06	1.06E-06
50	1.79E-06	0
63	2.39E-06	0
80	3.12E-06	0
100	2.89E-06	5.78E-07
125	3.32E-06	1.94E-06
160	3.71E-06	0
200	3.42E-06	4.22E-07
250	3.30E-06	1.11E-06
315	3.40E-06	4.84E-07
400	3.34E-06	7.13E-07
500	3.28E-06	7.64E-07
630	3.24E-06	7.93E-07
800	3.09E-06	8.98E-07
1000	3.04E-06	5.72E-07
1250	2.88E-06	8.84E-07
1600	2.84E-06	8.84E-07
2000	2.74E-06	7.08E-07
2500	2.65E-06	8.75E-07
3150	2.57E-06	7.68E-07
4000	2.51E-06	6.77E-07
5000	2.40E-06	6.25E-07
6300	2.28E-06	5.30E-07
8000	2.15E-06	3.84E-07

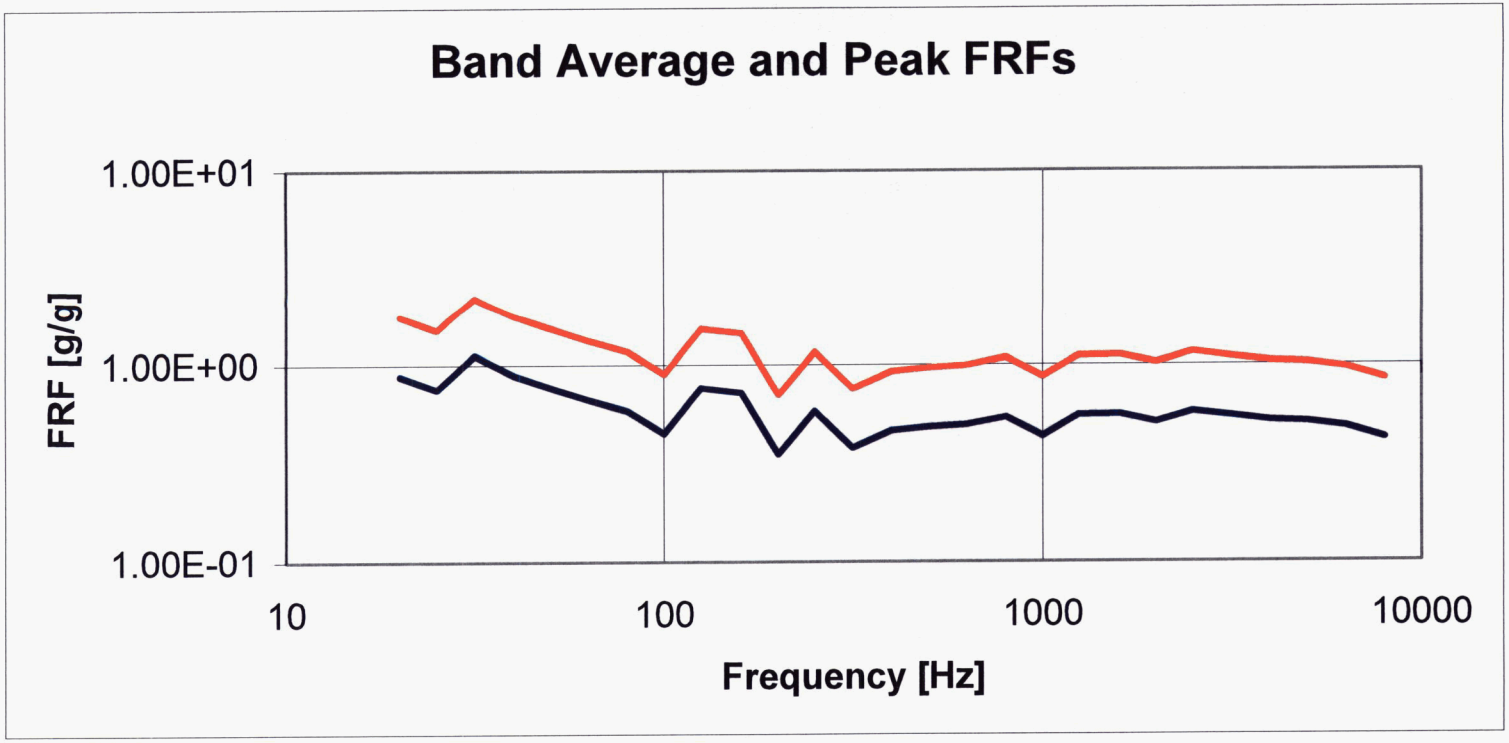


SEA Results

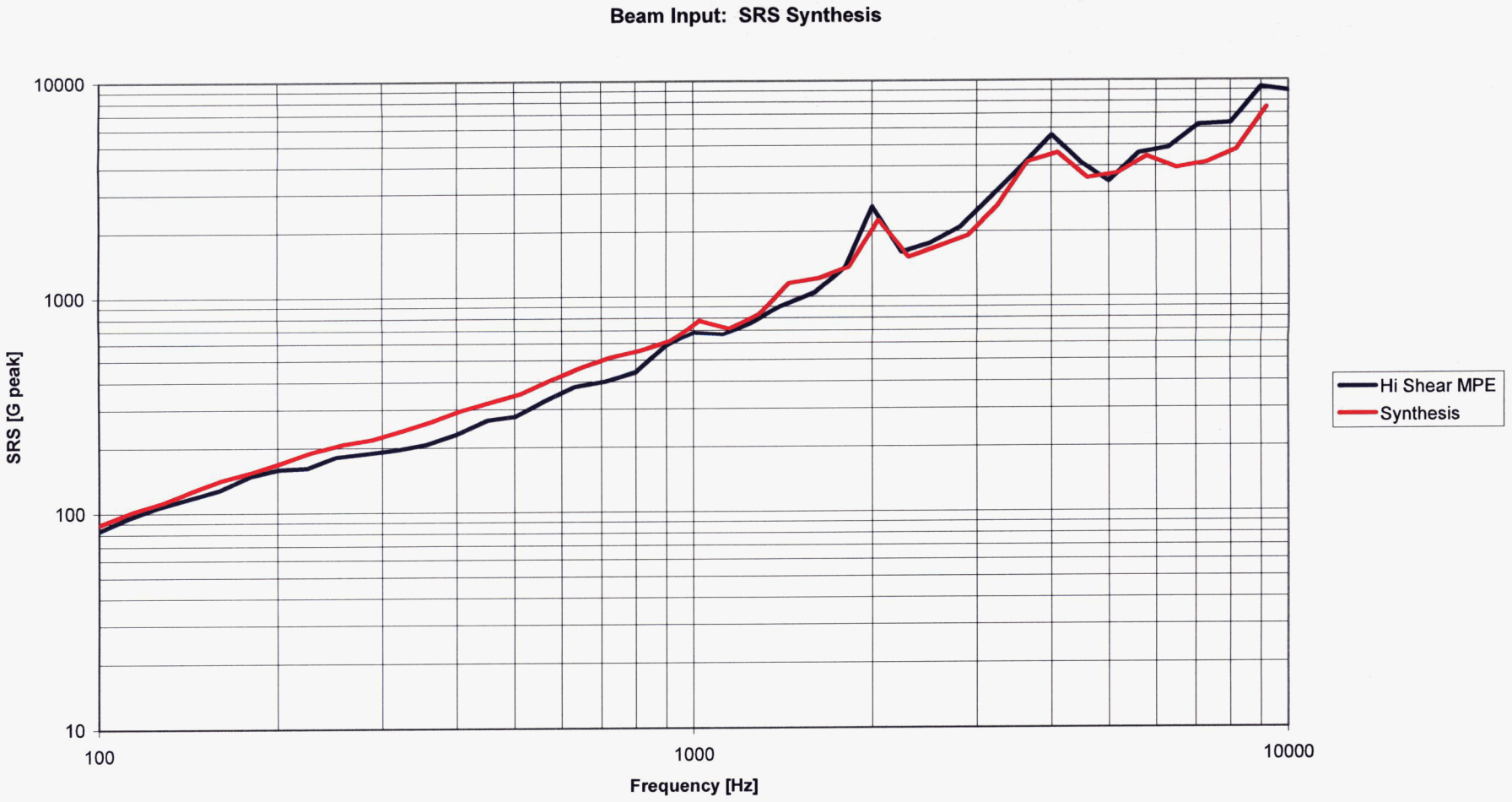
	Modal Density	
	Beam 990	Plate 936
	Extensional	Flexural
requency(H	Modes	Modes
20	0	1
25	0	1
32	0	3
40	0	3
50	0	0
63	0	0
80	0	0
100	0	2
125	0	10
160	0	0
200	0	3
250	0	10
315	0	4
400	0	9
500	0	12
630	0	12
800	0	26
1000	0	12
1250	0	33
1600	0	41
2000	0	41
2500	0	74
3150	0	80
4000	0	87
5000	0	125
6300	0	169
8000	0	163
	total # modes	921



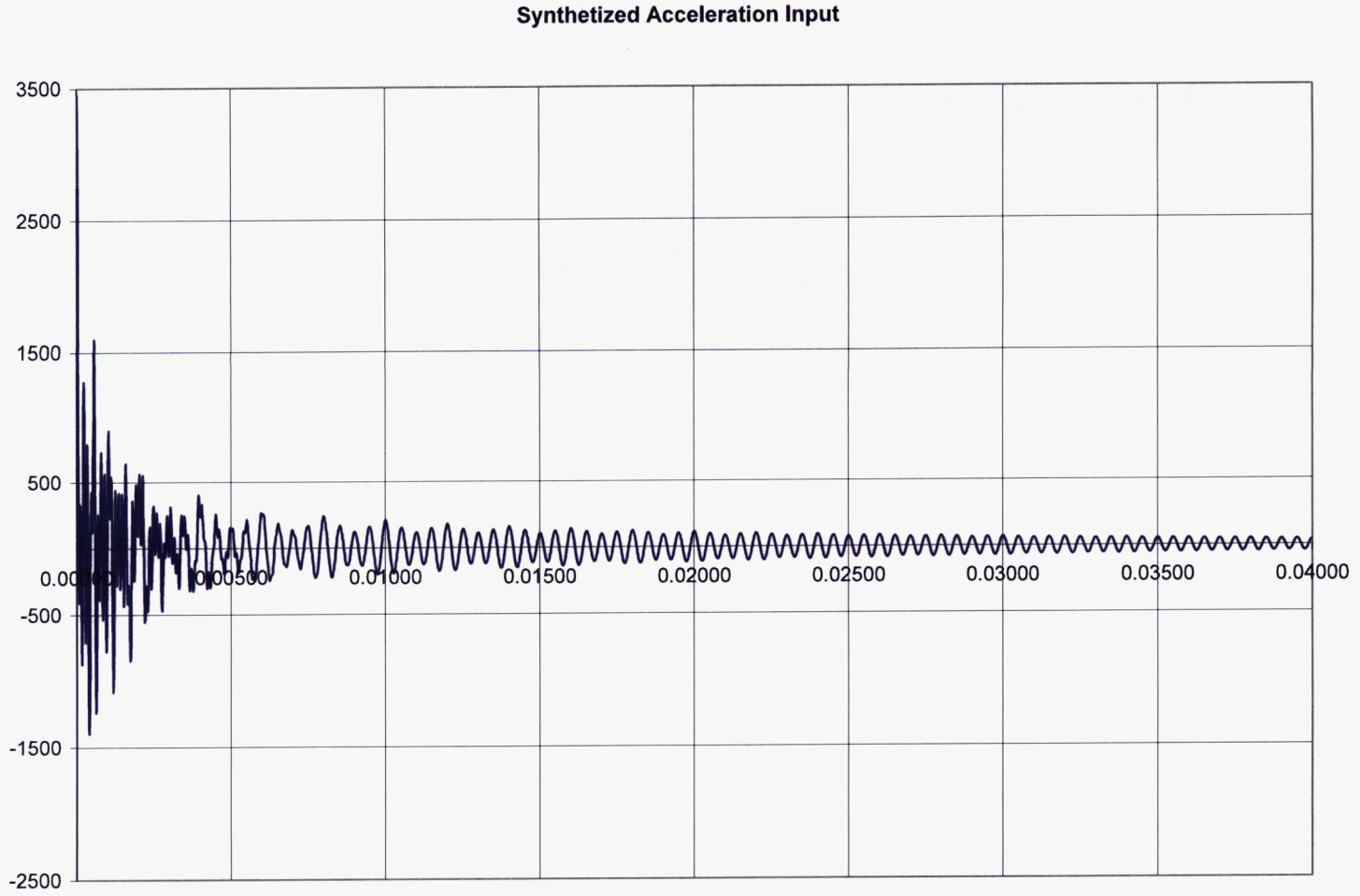
SEA Results


Band Average and Peak FRFs
1.00E+01
1.00E+00
1.00E-01
FRF [g/g]
10
100
1000
10000
Frequency [Hz]

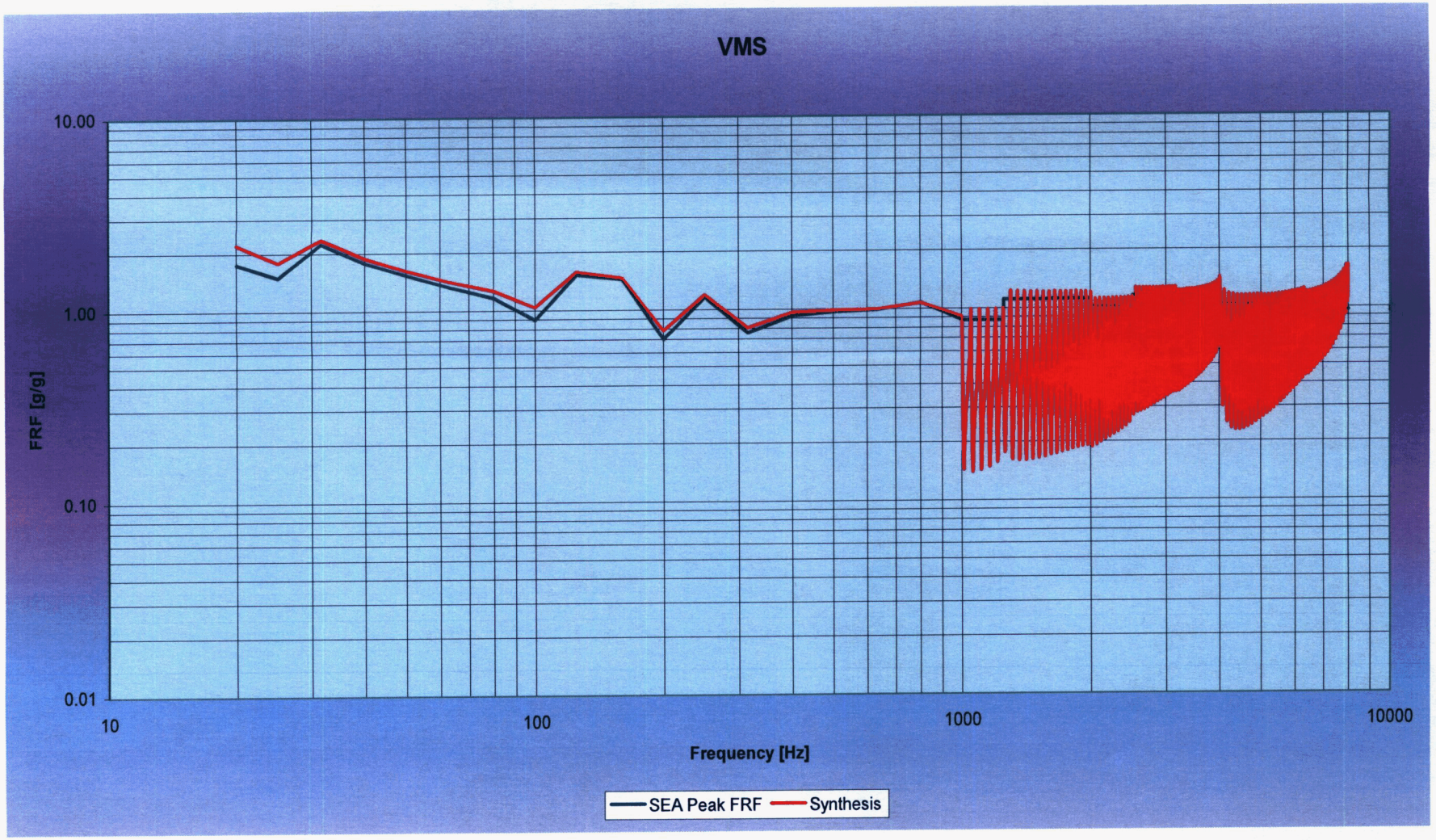
SEA Results


Beam Input: SRS Synthesis
10000
1000
100
10
SRS [G peak]
100
1000
10000
Frequency [Hz]
Hi Shear MPE
Synthesis

SEA Results


Synthetized Acceleration Input
3500
2500
1500
500
-500
-1500
-2500
0.01000
0.01500
0.02000
0.02500
0.03000
0.03500
0.04000

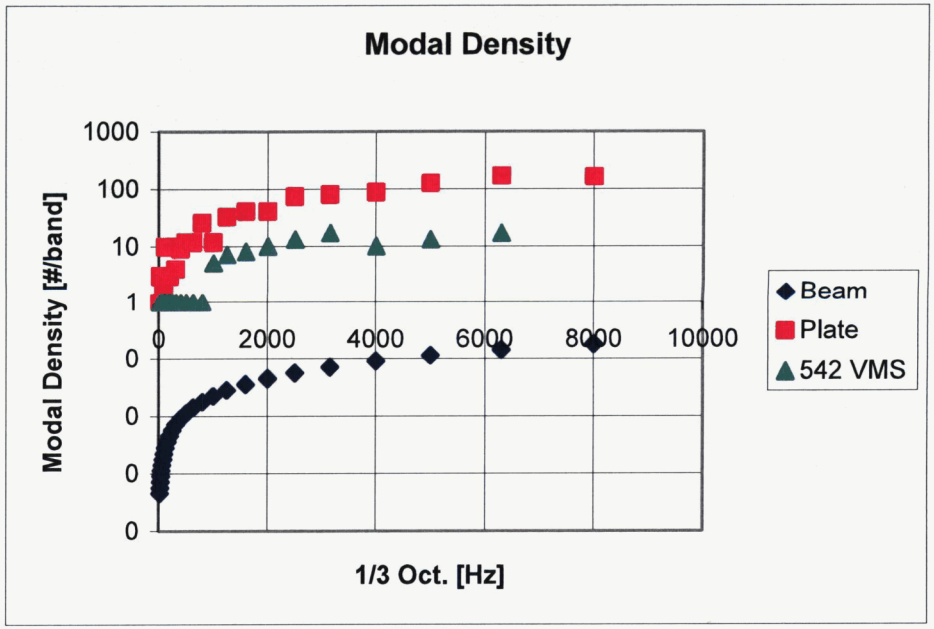
SEA Results


VMS
10.00
1.00
0.10
0.01
FRF [g/g]
10
100
1000
10000
Frequency [Hz]
SEA Peak FRF
Synthesis

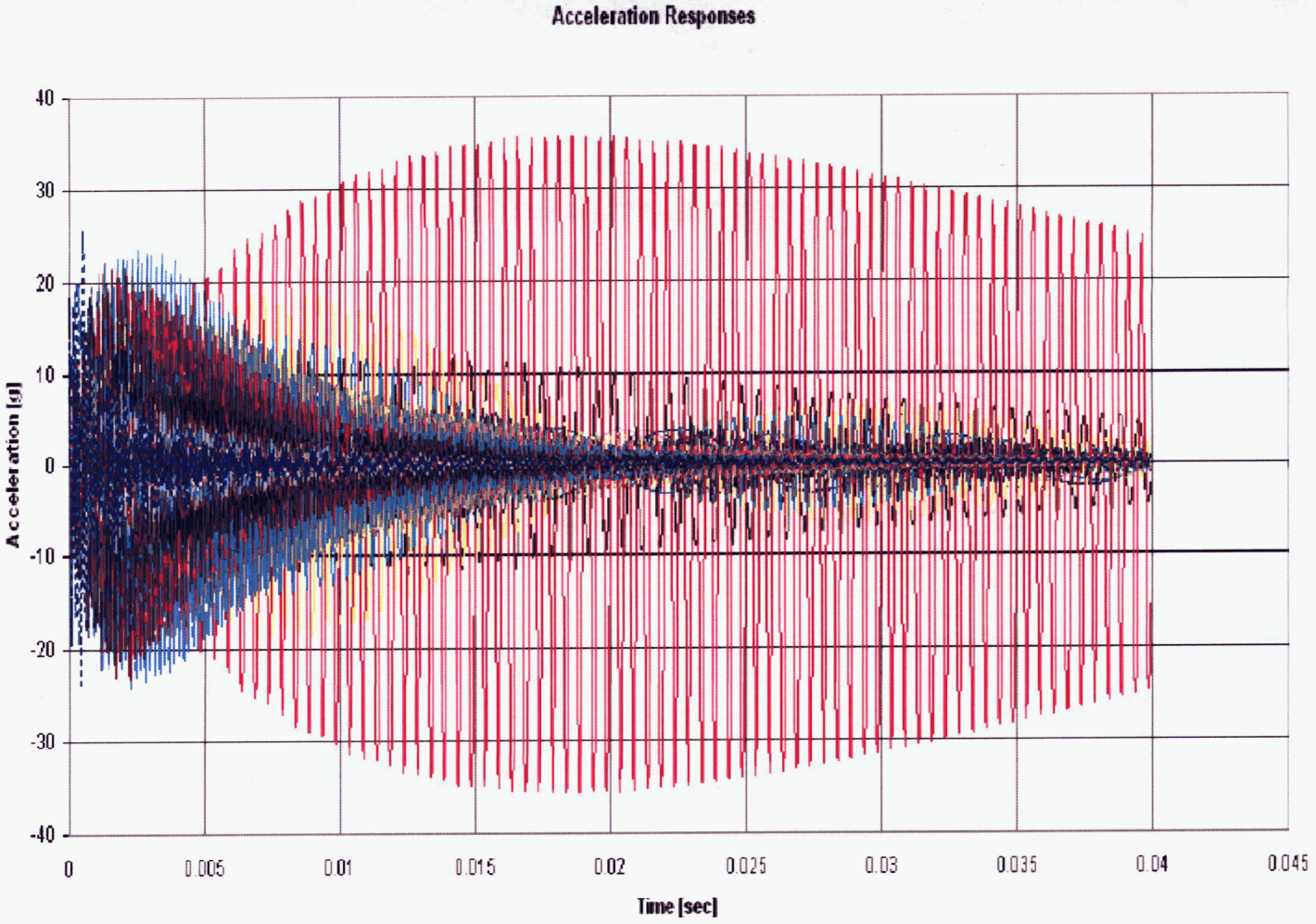
SEA Results

- # Modes Used=118
- Mass Normalized

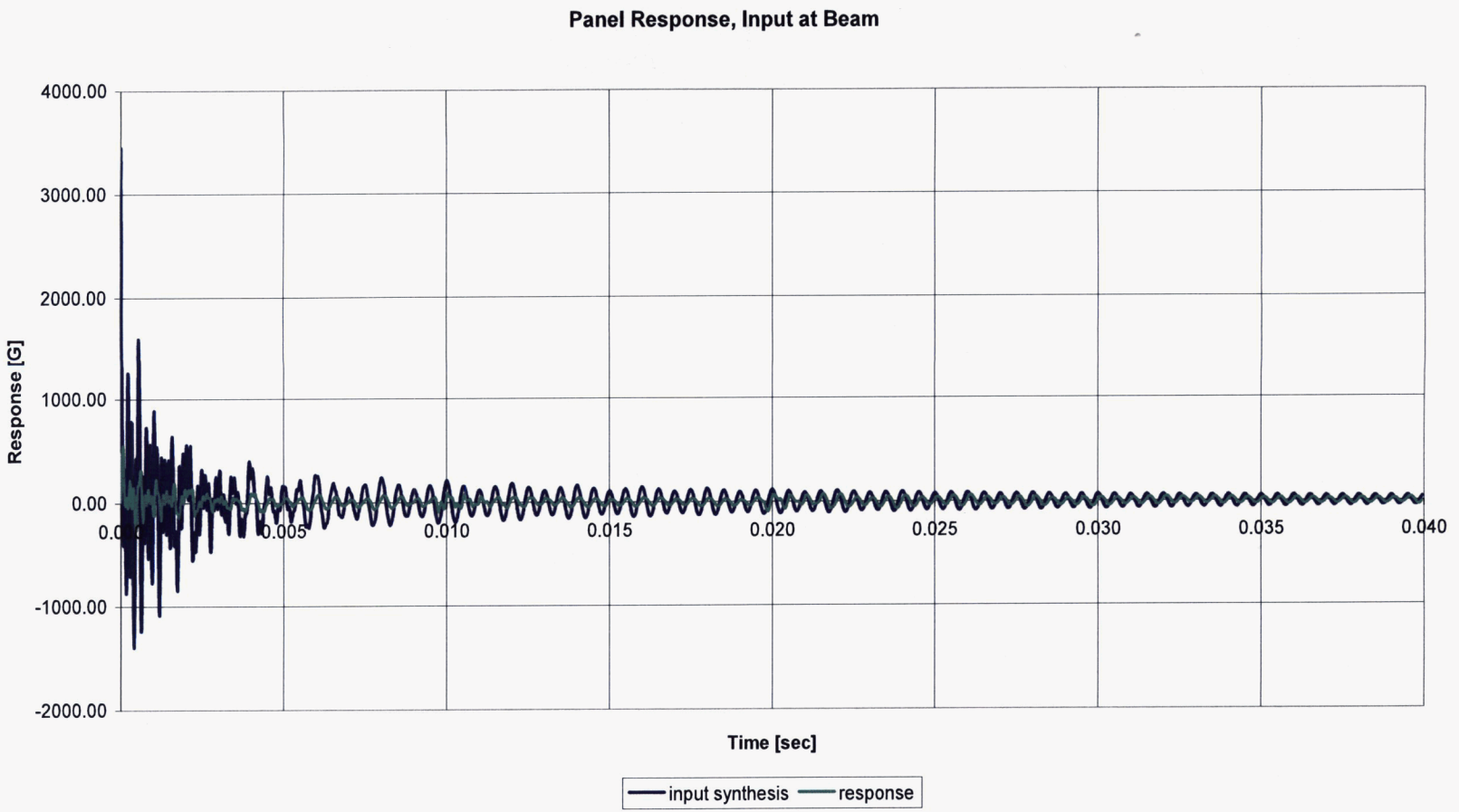
- Outputs are:
  - Mode#
  - Frequency
  - Damping
  - Effective Weight



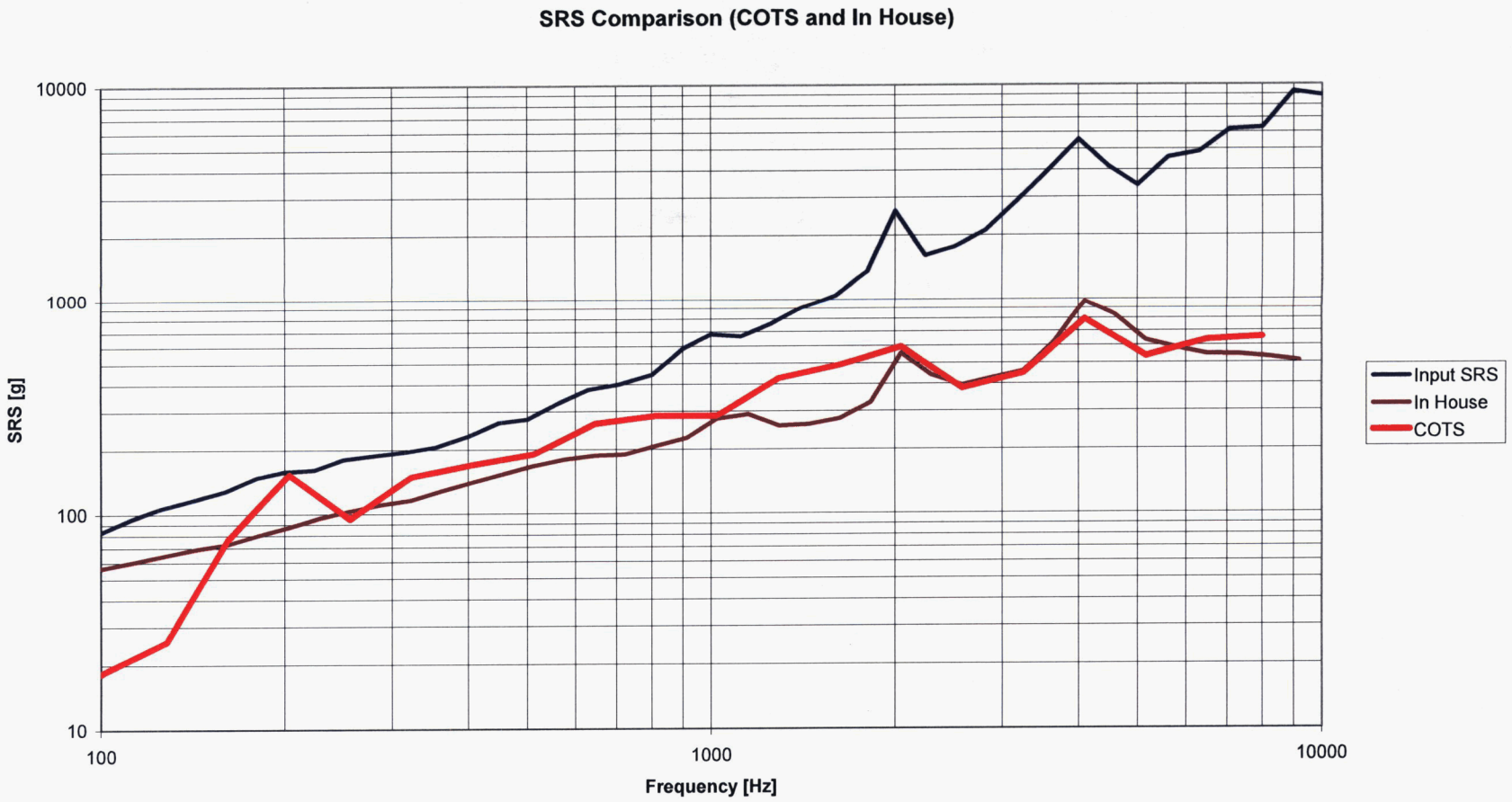
SEA Results


Acceleration Responses
Acceleration [g]
40
30
20
10
0
-10
-20
-30
-40
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
0.045
Time [sec]

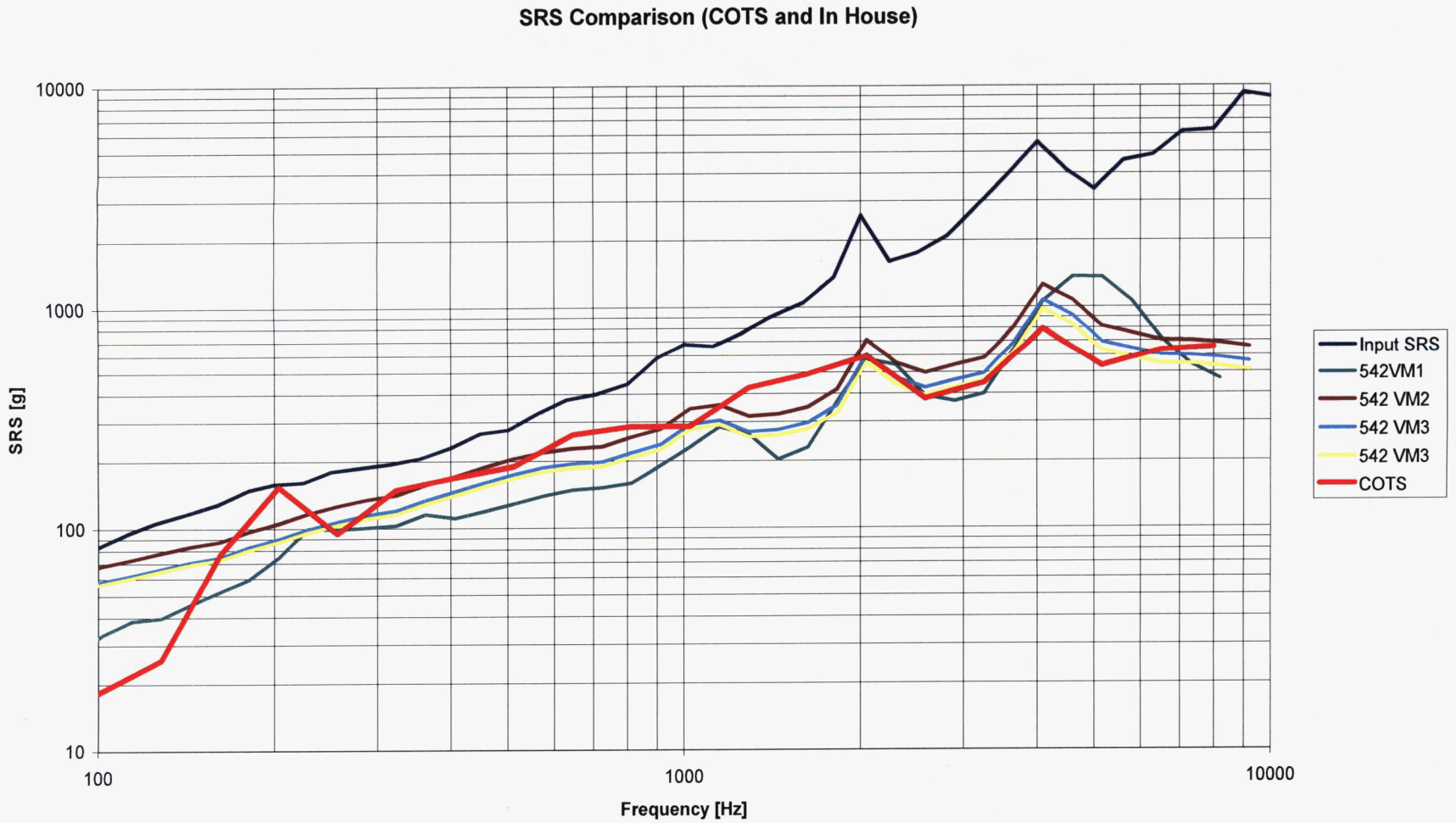
SEA Results


Panel Response, Input at Beam
4000.00
3000.00
2000.00
1000.00
0.00
-1000.00
-2000.00
Response [G]
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
Time [sec]
input synthesis
response

SEA Results


SRS Comparison (COTS and In House)
10000
1000
100
10
SRS [g]
100
1000
10000
Frequency [Hz]
Input SRS
In House
COTS

SEA Results


SRS Comparison (COTS and In House)
10000
1000
100
10
SRS [g]
100
1000
10000
Frequency [Hz]
Input SRS
542VM1
542 VM2
542 VM3
542 VM3
COTS

Conclusions

- Used existing GSFC in house routines to perform an equivalent solution to the COTS Shock Module.
- The results are very sensitive to the VMS process.
- Responses look good enough to justify the time investment in improving the code.
- The VMS process needs more work and further validation versus COTS code and/or test measurements.
- The in house routines still have to be integrated and automated.
- By applying the method to FEMs and SEMs, results can be combined to get an improved LF/HF solution.