

Experimental Determination of Operational Pedal Cycle Frame Loads

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Objectives

- To build a database of verified load cases to be applied to vehicle design
- Finite Element Analysis models to be verified by actual load data
- Future: Failure modes or criteria may also be developed or verified

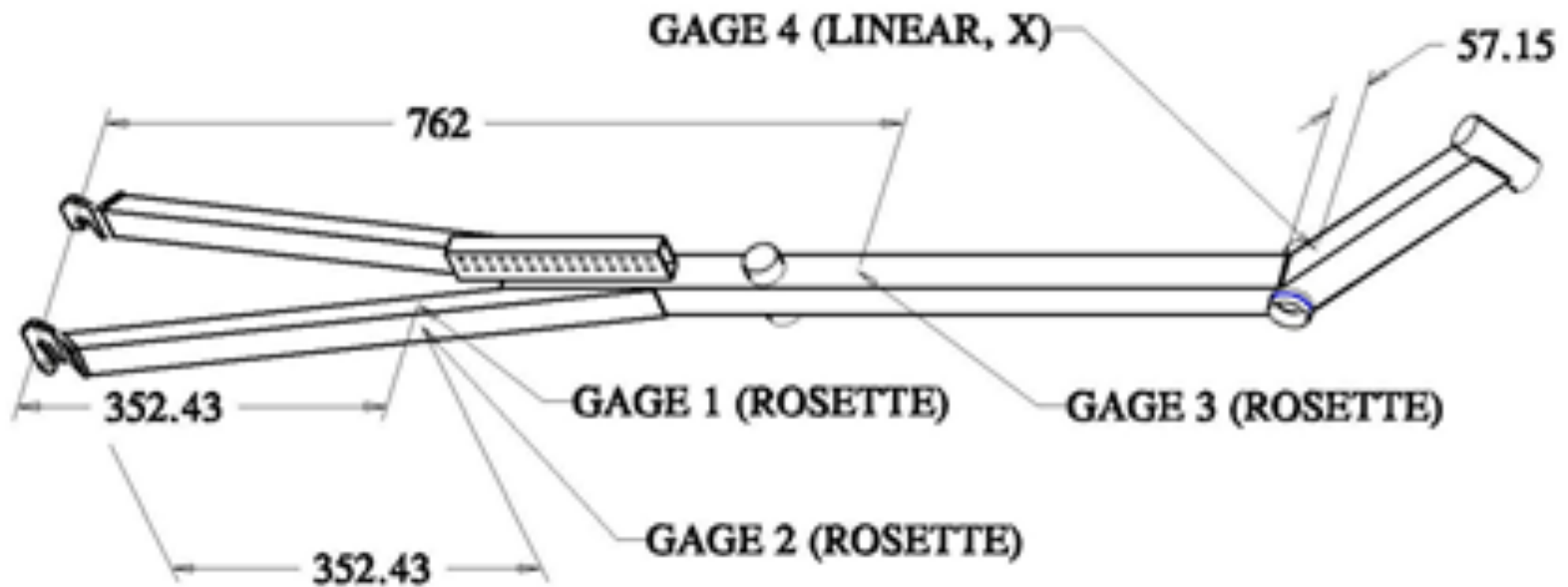
Long Wheel Base - Recumbent Bike



Experimental Methods

- Data was collected under 6 different loading conditions
 - Static
 - Steady riding
 - Smooth
 - Normal
 - Rough
 - Hard acceleration
 - Level
 - Uphill

Basic Frame with Strain Gauge Locations



Dimensions in millimeters

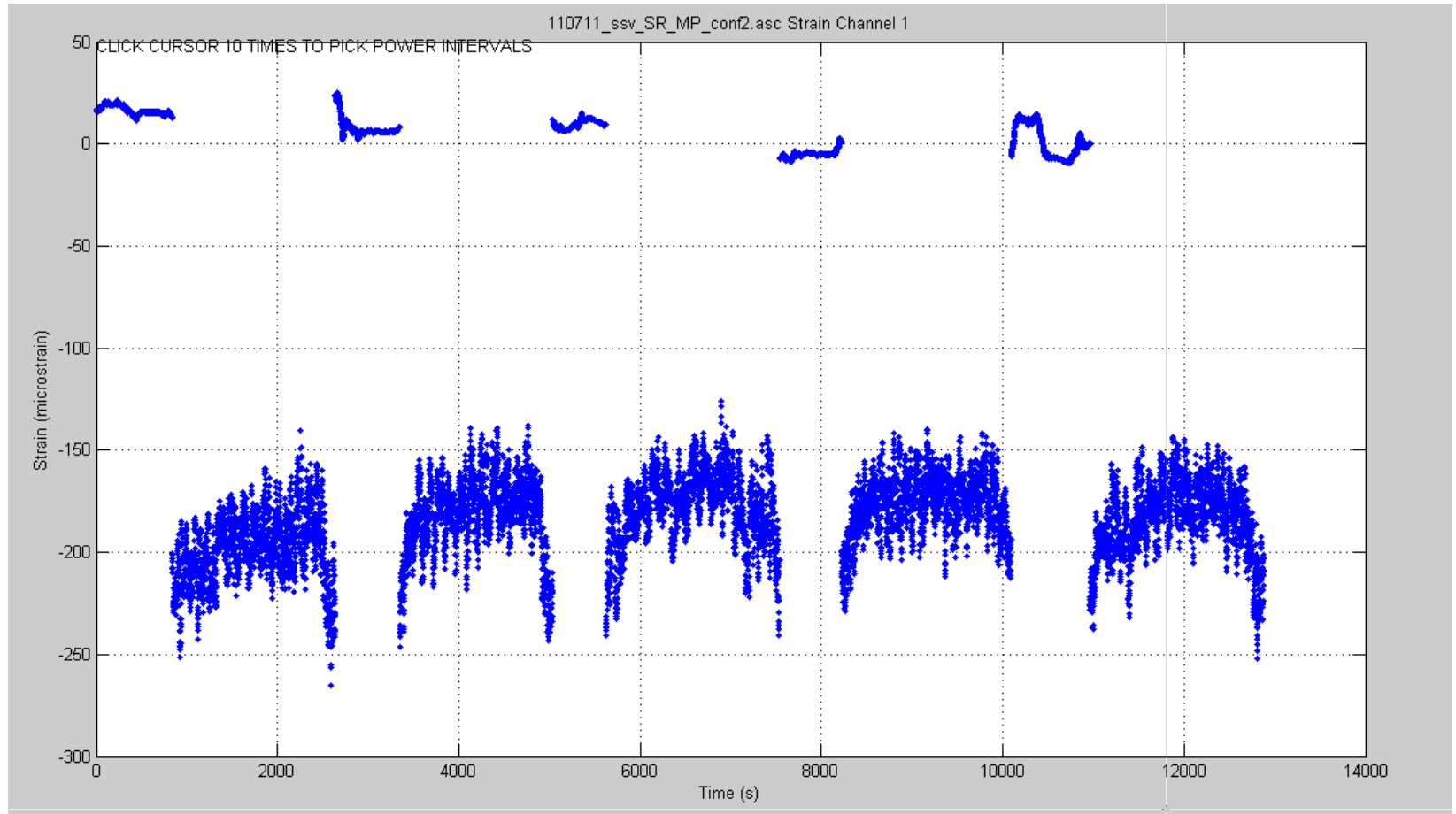
Data Analysis – Matlab Programming

- Stress calculations
 - Principal stresses were found using strain data from rosette gauges along with the modulus of elasticity and Poisson's ratio
 - Axial stresses were found using Hooke's Law

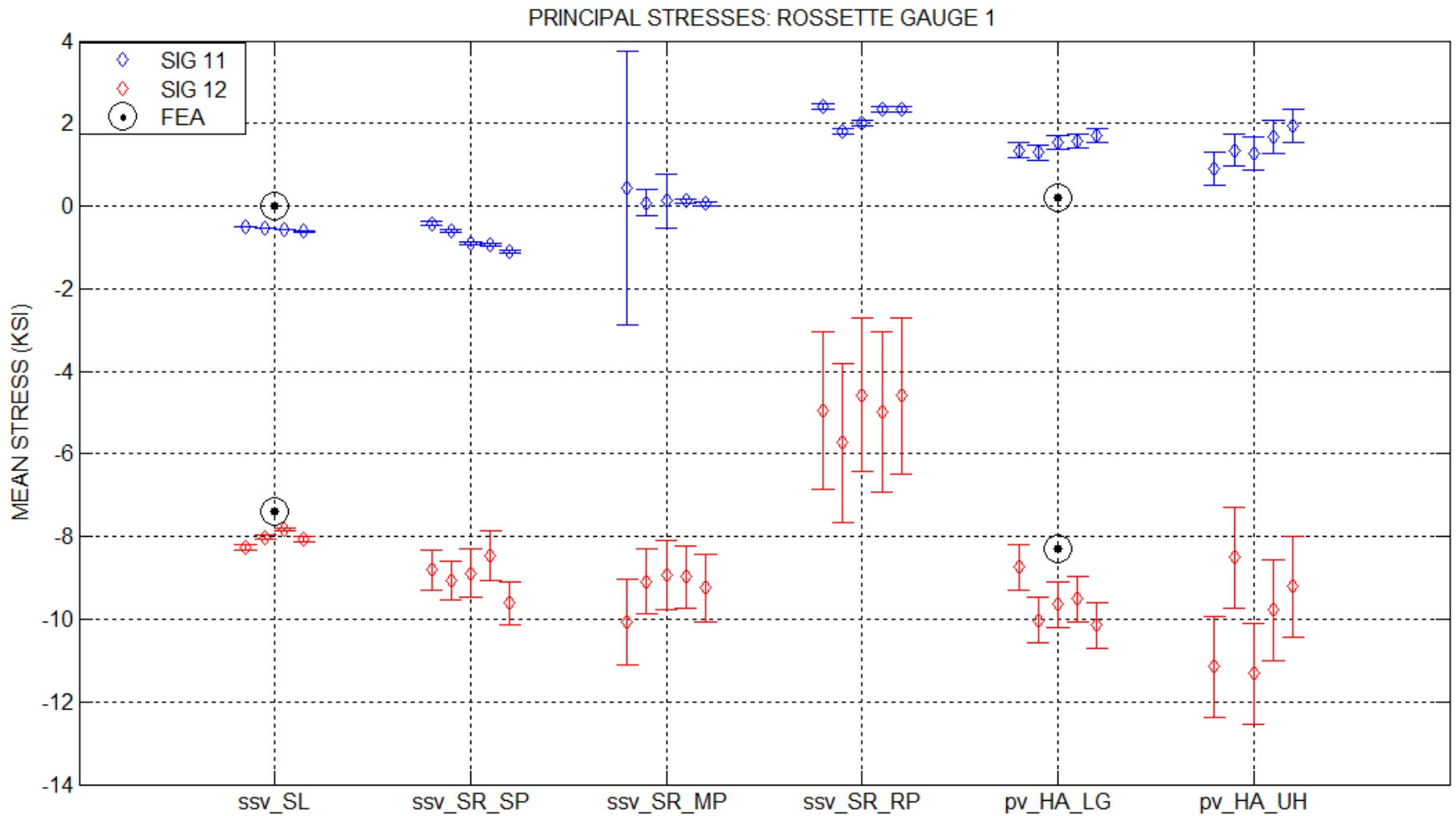
Matlab Programming

- 1 main code
 - Loads raw .txt/ .asc or saved .mat files
 - Saves data to .mat files
 - Creates matrix with mean, standard deviation, and case number
- Functions
 - Outputs state of stress at the different gauge locations based on strain data
 - stress_caseplot_QB_LWB.m
 - Menu to switch between different gauge locations
 - Graphs mean stress with standard deviation respective to each case

Raw Strain Data



Top of Chainstay – Principal Stress

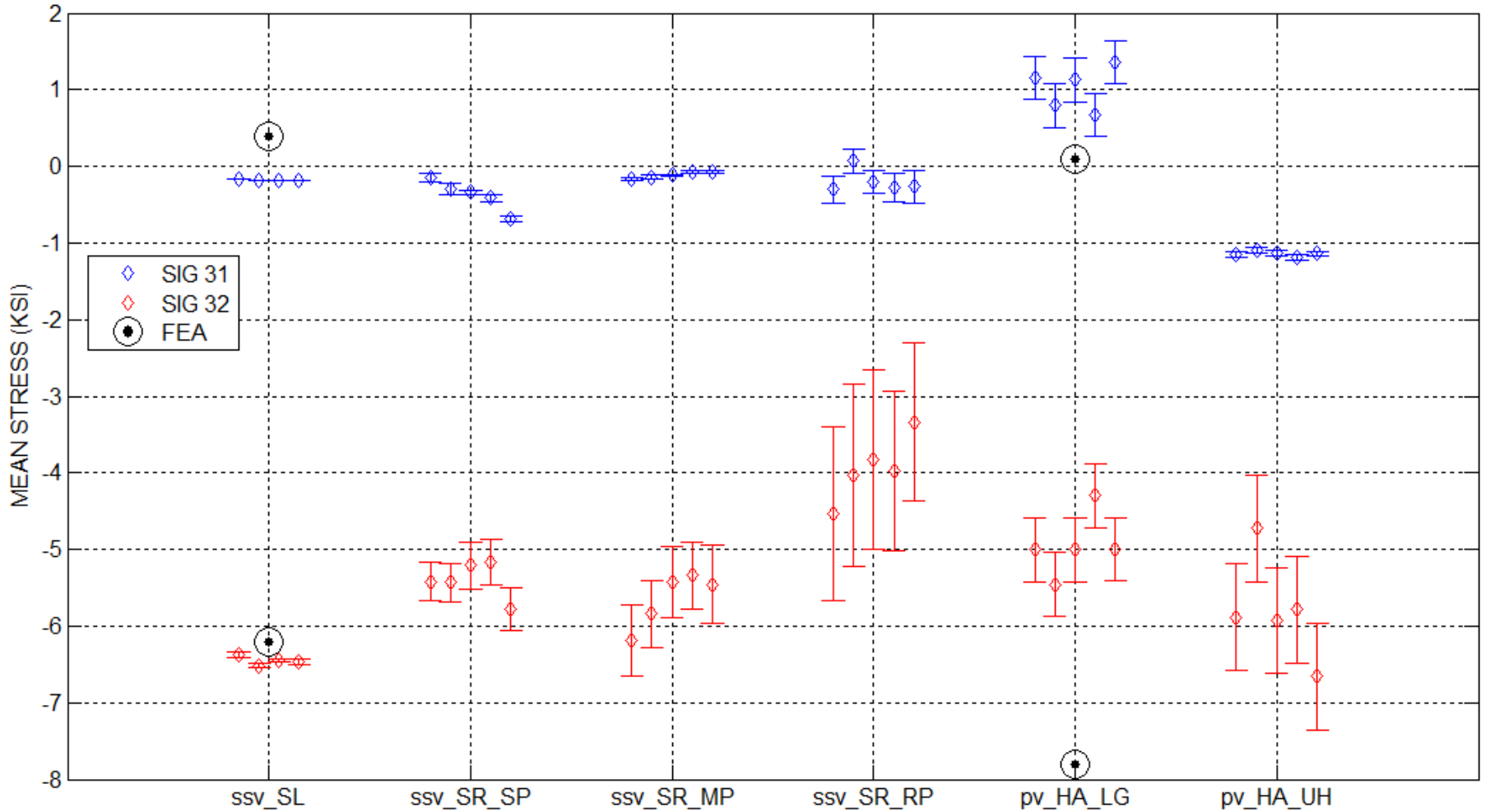


Distribution of Weight while Pedaling

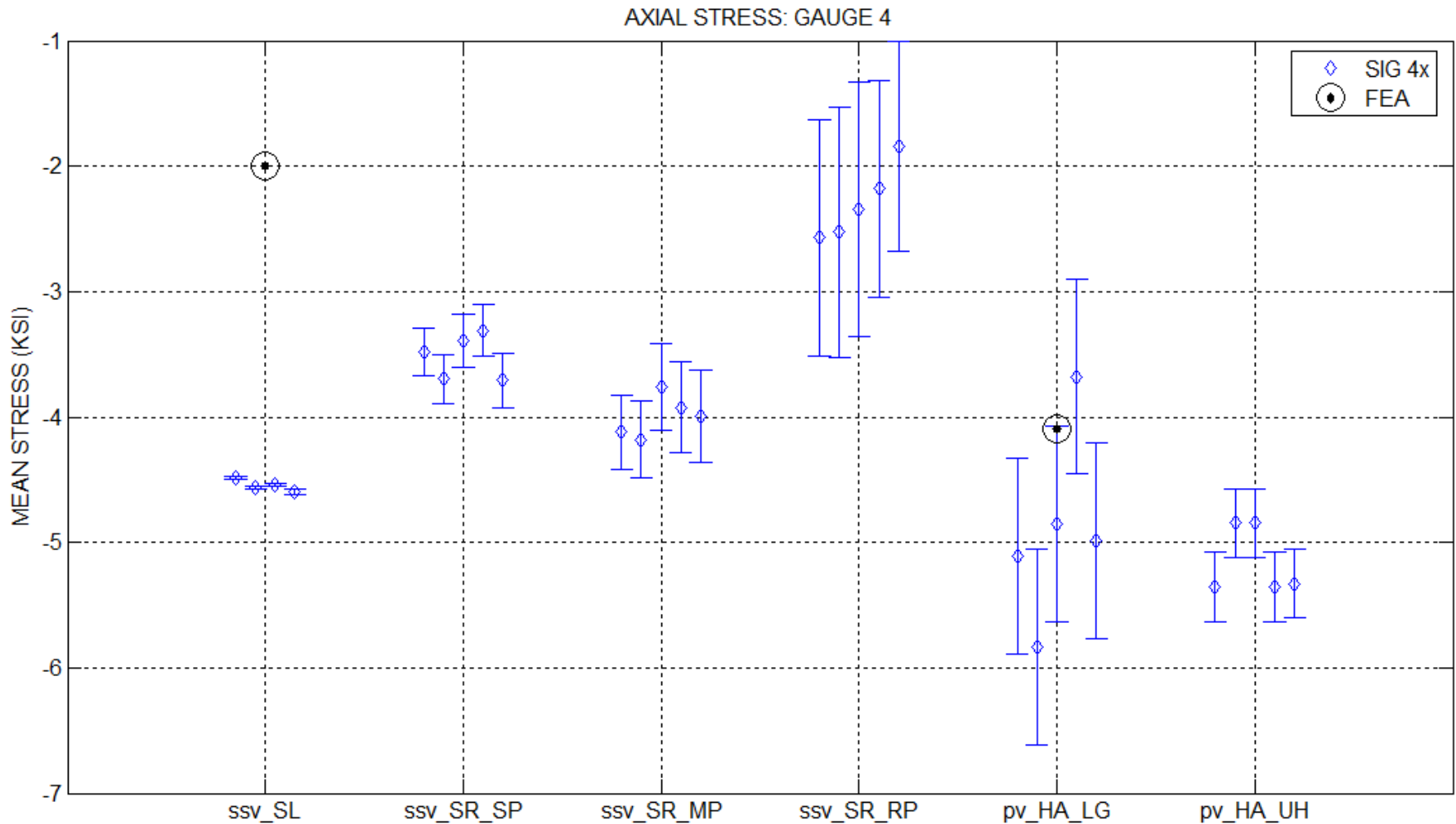


Top of Main Tube – Principal Stress

PRINCIPAL STRESSES: ROSSETTE GAUGE 3



Top of Down Tube in Front - Axial Stress



Comparing Experimental and FEA

FEA Comparison

	SL (ksi)	FEA 1G (ksi)	Absolute Difference (ksi)		HA_LG (ksi)	FEA HA- LP 3G (ksi)	Absolute Difference (ksi)
Sig11	-0.6	0.0	0.6		1.5	0.2	1.3
Sig12	-8.0	-7.4	0.6		-9.2	-8.3	0.9
Sig31	-0.2	0.4	0.6		0.9	0.1	0.8
Sig32	-6.4	-6.2	0.2		-4.7	-7.8	3.1
Sig4x	-4.5	-2.0	2.5		-4.7	-4.1	0.6

Conclusions

- State of stress within frame found successfully using experimental methods
- Use of FEA model in static and hard acceleration loading conditions verified