Parameter Study - Objective

- **To investigate the individual effect of a number of parameters:**
  - **Impact Conditions**
  - **Material Properties**
  - **Software Control**
  - **Processing Power**

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Base Line (Reference) Model Run

- **Vehicle Model: GM_R4**
- **Barrier Model: ESP-N2**
- **Number of CPUs: 4**
- **LS-DYNA Version: V970rev.5434a**
- **Vehicle Mass: 893kg**
- **Impact Speed: 100km/h**
- **Impact Angle: 20deg**

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Base Line Results

- **ASI: 0.80**
- **THIV: 23.7kph**
- **PHD: 12.86g**
- **Dynamic Deflection: 666mm**
- **Working Width: 748mm**
- **Exit Speed: 81.49kph**
- **Exit Angle: 7.57deg**

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Changes in Impact Conditions

Weight/Speed/Angle	ASI	THIV	PHD	DD	WW	Exit Speed	Exit Angle
893/100/20	0.80	23.70	12.86	666	748	81.49	7.57
893/107/20	0.89	23.12	13.04	719	813	84.60	6.29
893/100/21.5	0.90	25.18	12.00	723	807	78.23	8.22
893/105/21.5	0.88	24.30	10.54	812	894	82.79	5.98
893/102/19	0.76	21.60	12.16	649	740	81.34	6.08

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Changes in Impact Conditions (%ages)

Weight/Speed/ Angle	ASI	THIV	PHD	DD	WW	Exit Speed	Exit Angle
893/100/20	0.80	23.70	12.86	666	748	81.49	7.57
893/107/20	+11.3	-2.4	+1.4	+8.0	+8.7	+3.8	-16.9
893/100/21.5	+12.5	+6.2	-6.7	+8.6	+7.8	-4.0	+8.6
893/105/21.5	+10.0	+2.5	-18.0	+21.9	+19.5	+1.6	-21.0
893/102/19	-5.0	-8.9	-5.4	-2.6	-1.1	-0.2	-19.7

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Changes in Impact Conditions (%ages)

Weight/Speed/Angle	ASI	THIV	PHD	DD	WW	Exit Speed	Exit Angle
893/100/20	0.80	23.70	12.86	666	748	81.49	7.57
893/107/20	+11.3	-2.4	+1.4	+8.0	+8.7	+3.8	-16.9
893/100/21.5	+12.5	+6.2	-6.7	+8.6	+7.8	-4.0	+8.6
893/105/21.5	+10.0	+2.5	-18.0	+21.9	+19.5	+1.6	-21.0
893/102/19	-5.0	-8.9	-5.4	-2.6	-1.1	-0.2	-19.7

Changes in Material Properties

Change in Properties	ASI	THIV	PHD	DD	WW	Exit Speed	Exit Angle
Baseline	0.80	23.70	12.86	666	748	81.49	7.57
E: +2%	0.79	23.60	12.58	678	765	78.59	6.06
E: -2%	0.78	23.90	14.01	658	744	79.73	8.13
Yield Stress: -21%	0.76	22.60	10.68	763	852	78.29	7.50
UTS: -24%	0.82	23.40	12.72	682	766	80.25	7.67
Rail & Post thick.: +5%	0.82	23.50	10.57	615	712	79.16	9.06
Rail & Post thick.: -5%	0.82	24.00	9.83	695	782	75.92	1.47

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Changes in Material Properties (%ages)

Change in Properties	ASI	THIV	PHD	DD	WW	Exit Speed	Exit Angle
Baseline	0.80	23.70	12.86	666	748	81.49	7.57
E: +2%	-1.3	-0.4	-2.2	+1.8	+2.3	-3.6	-19.9
E: -2%	-2.5	+0.8	+8.9	-1.2	-0.5	-2.2	+7.4
Yield Stress: -21%	-5.0	-4.6	-17.0	+14.6	+13.9	-3.9	-0.9
UTS: -24%	+2.5	-1.3	-1.1	+2.4	+2.4	-1.5	+1.3
Rail & Post thick.: +5%	+2.5	-0.8	-17.8	-7.7	-4.8	-2.9	+19.7
Rail & Post thick.: -5%	+2.5	+1.3	-23.6	+4.4	+4.5	-6.8	-80.6

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Changes in Material Properties (%ages)

Change in Properties	ASI	THIV	PHD	DD	WW	Exit Speed	Exit Angle
Baseline	0.80	23.70	12.86	666	748	81.49	7.57
E: +2%	-1.3	-0.4	-2.2	+1.8	+2.3	-3.6	-19.9
E: -2%	-2.5	+0.8	+8.9	-1.2	-0.5	-2.2	+7.4
Yield Stress: -21%	-5.0	-4.6	-17.0	+14.6	+13.9	-3.9	-0.9
UTS: -24%	+2.5	-1.3	-1.1	+2.4	+2.4	-1.5	+1.3
Rail & Post thick.: +5%	+2.5	-0.8	-17.8	-7.7	-4.8	-2.9	+19.7
Rail & Post thick.: -5%	+2.5	+1.3	-23.6	+4.4	+4.5	-6.8	-80.6

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Changes in Processing Procedure

Change in Properties	ASI	THIV	PHD	DD	WW	Exit Speed	Exit Angle
Baseline	0.80	23.70	12.86	666	748	81.49	7.57
Software change (backwards)	0.81	23.30	11.36	660	748	76.26	5.93
One Processor (19hrs, 23mins 18sec) *	0.78	22.90	9.70	685	783	72.92	10.41
Two Processors (13hrs, 43mins 4sec) *	0.78	22.90	9.70	685	783	72.92	10.41

* Added mass changed: causing the differences to the baseline

Changes in Processing Procedure (%ages)

Change in Properties	ASI	THIV	PHD	DD	WW	Exit Speed	Exit Angle
Baseline	0.80	23.70	12.86	666	748	81.49	7.57
Software change (backwards)	+1.3	-1.7	-11.7	-0.9	0	-6.4	-21.7

RESULTS

- **All of the factors examined have had an effect on the final results to different levels (with the exception of the number of processors).**

- **In particular:**
  - **Increases to the impact speed**
  - **Changes to the material Yield Stress**
  - **Increases to the rail and post thicknesses**

- **The records kept of model runs should be detailed and record as much information as possible, including aspects such as:**
  - **Impact Conditions**
  - **Material Properties**
  - **Software used**

- **Although there are many more factors which we have not been able to examine to date.**

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