Pressure Sensor Analysis of Interaction Between Occupant and Seatback

UNECE EqOP Task Force 2

September 9th, 2024

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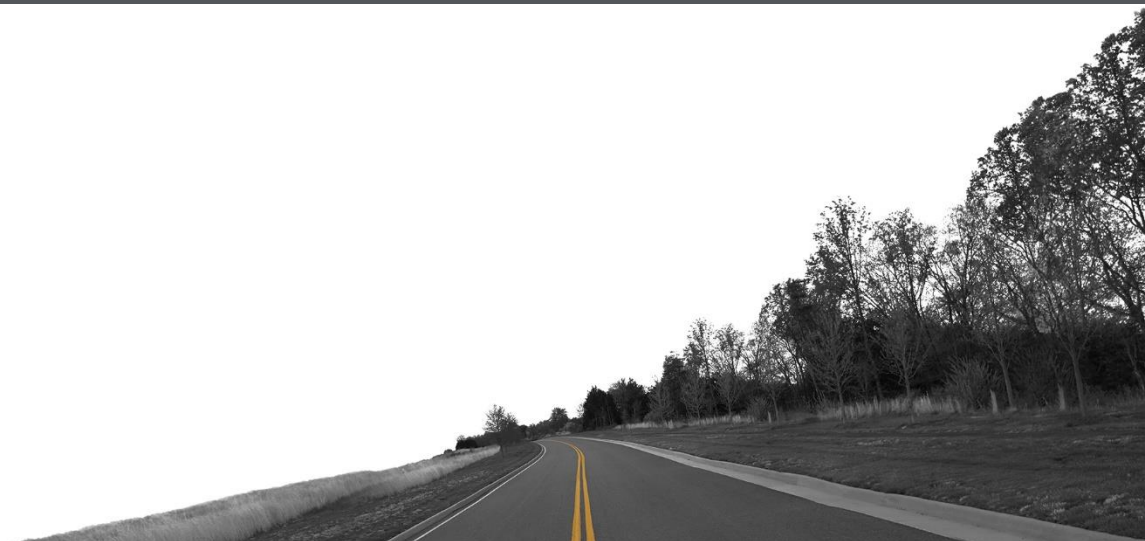
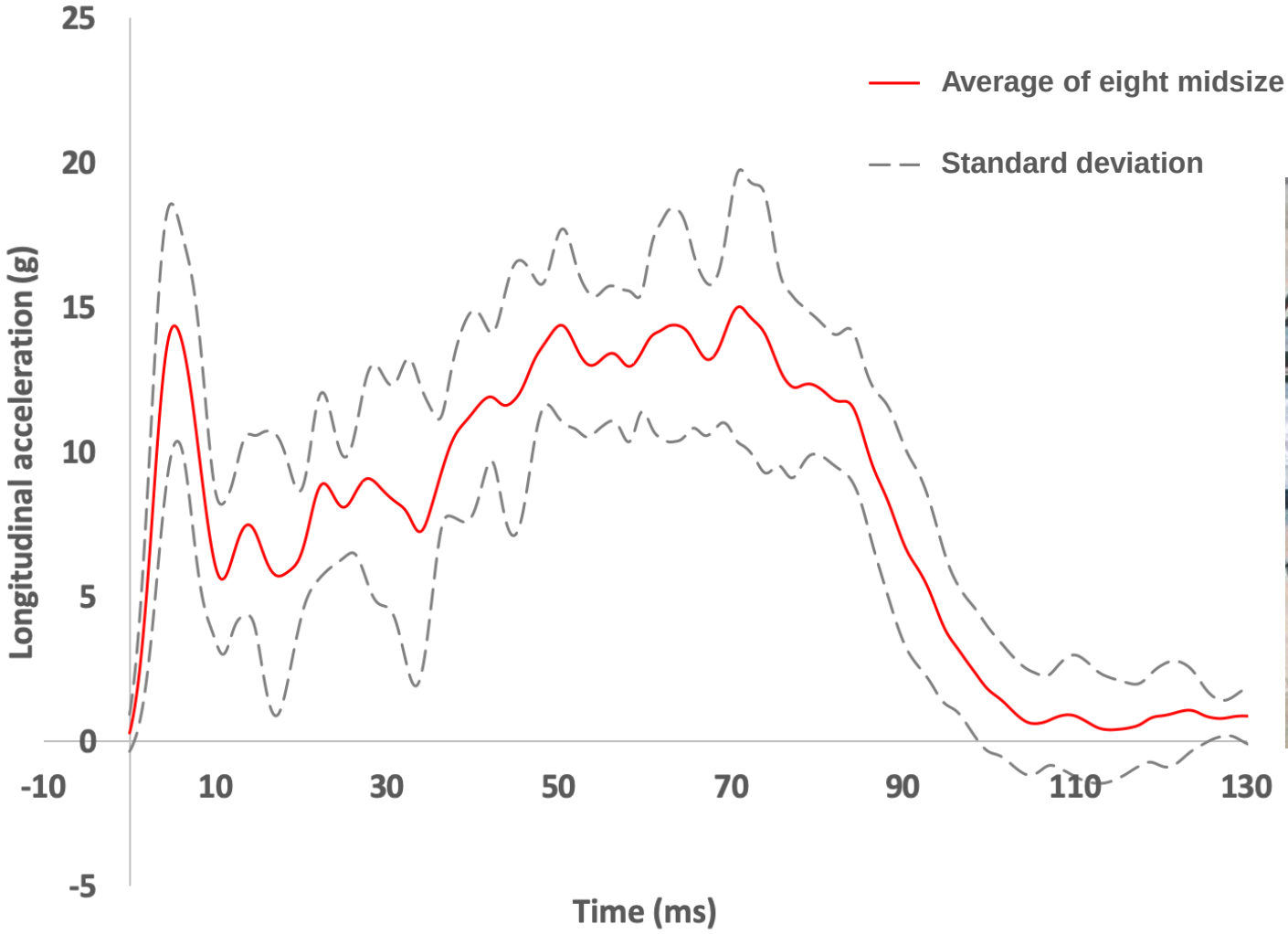
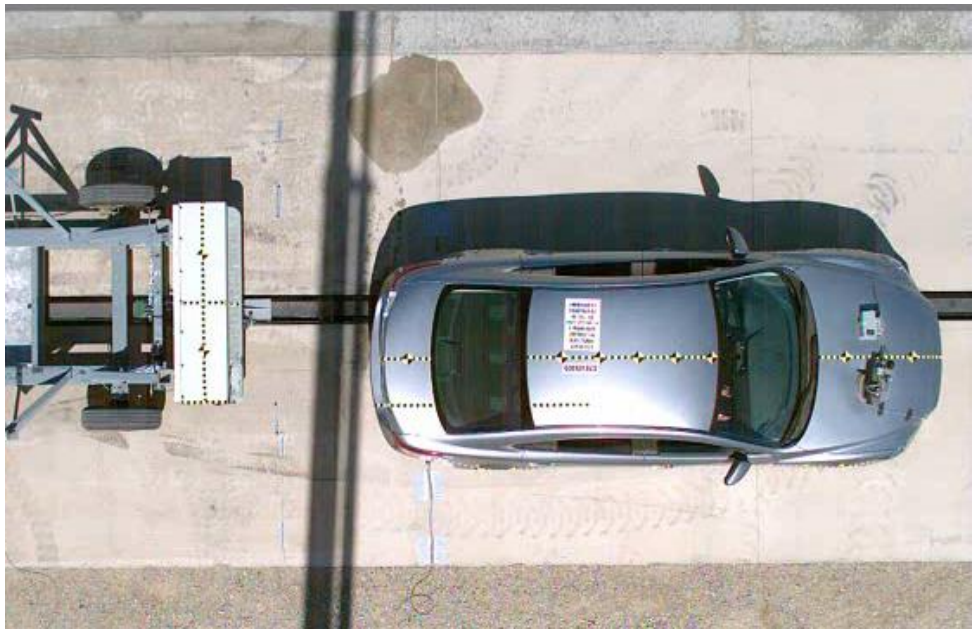
Senior Research Engineer



Background

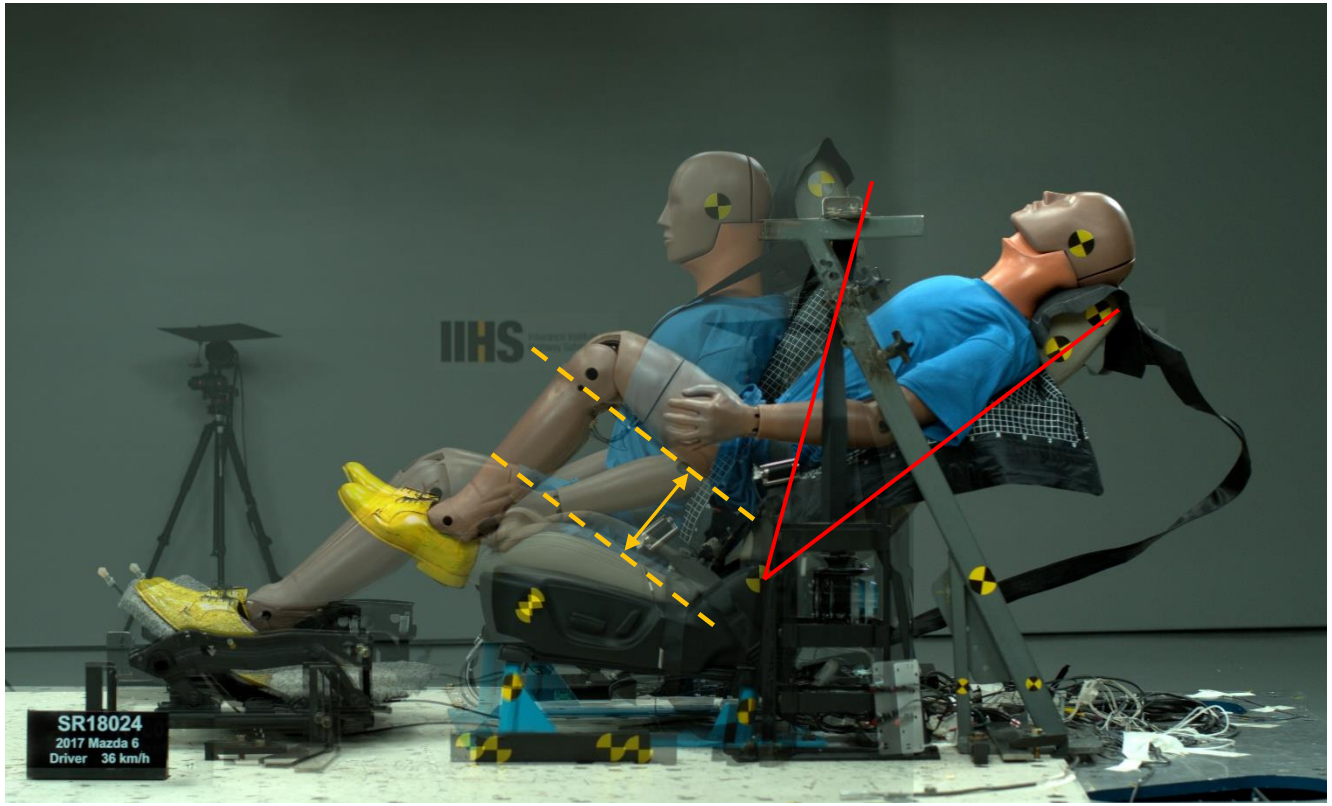
Sled test conditions FMVSS 301R test 36 km/h delta v



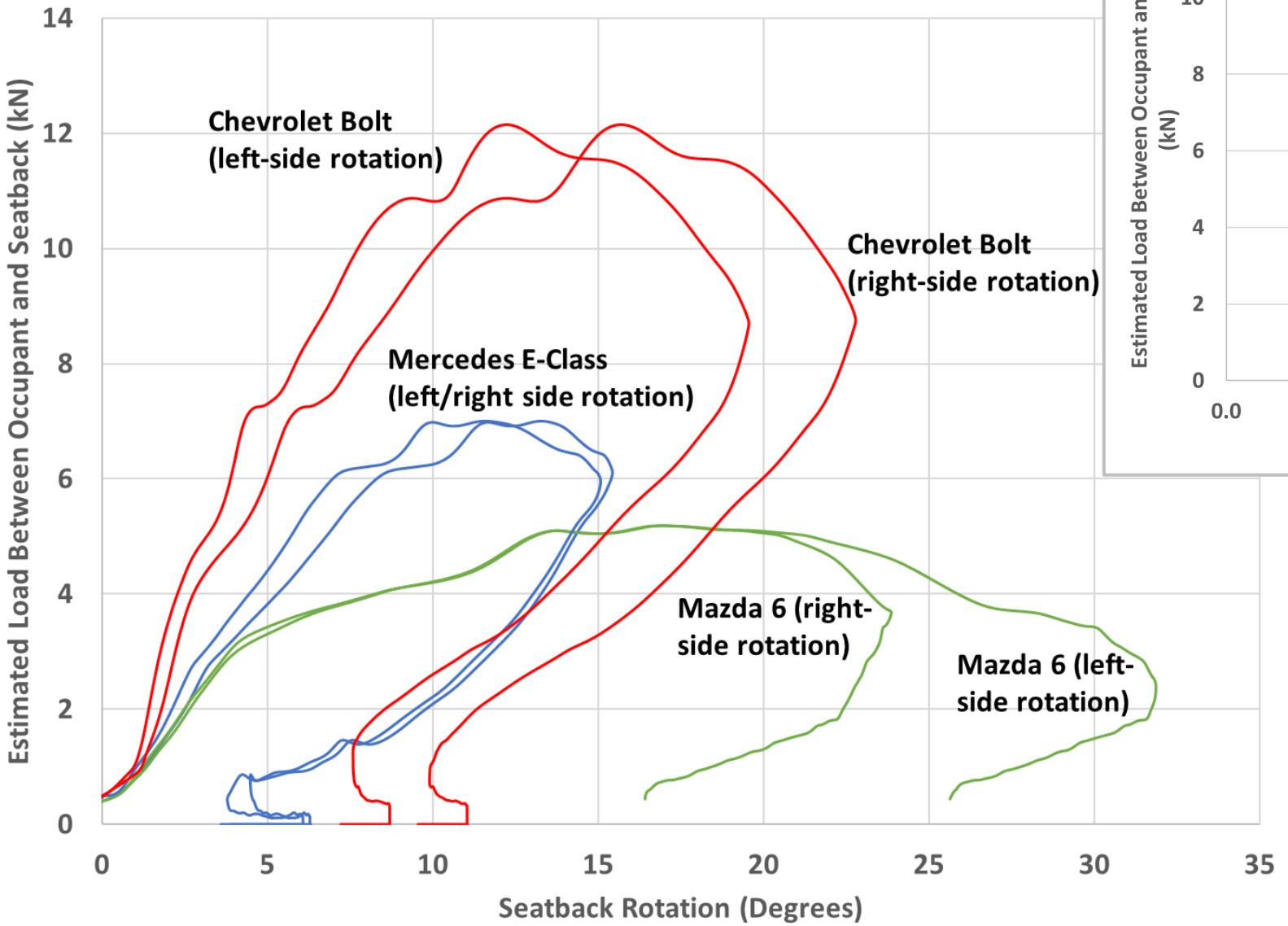


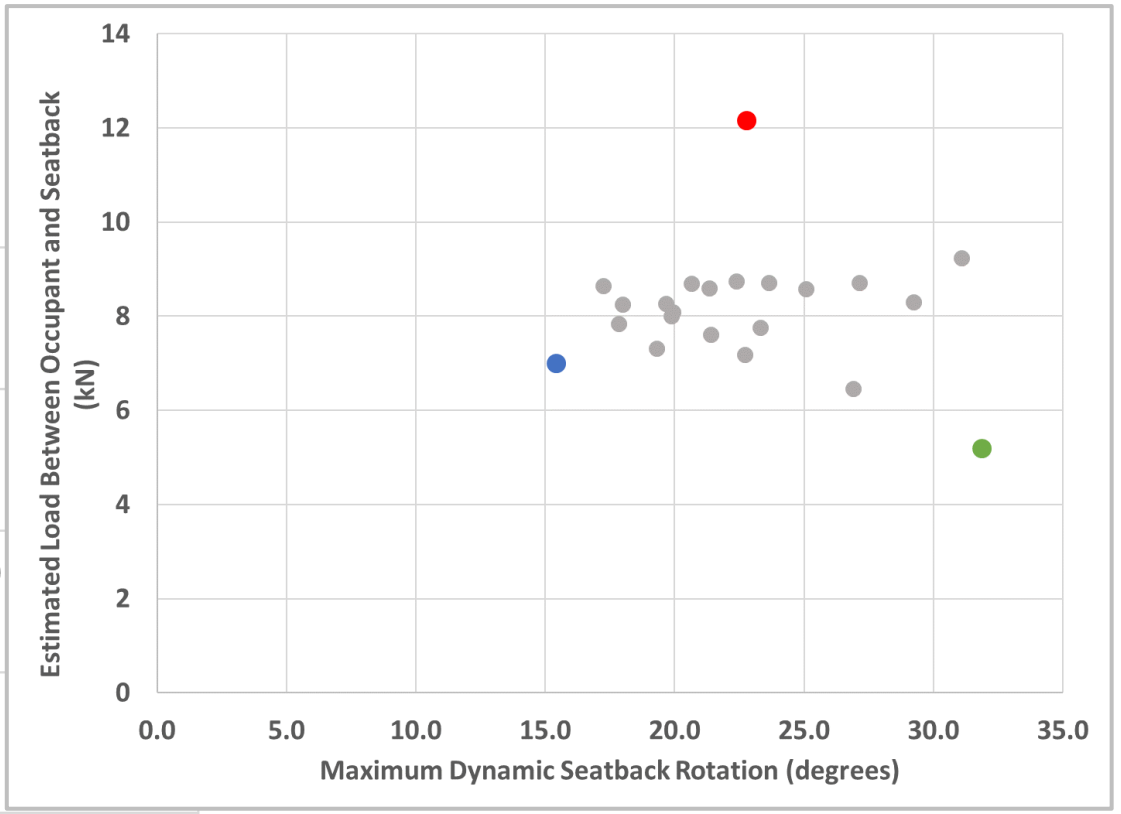
Data collection

- Occupant retention metrics
  - Maximum dynamic seatback rotation
  - Vertical pelvis displacement
- Dummy injury metrics
- XSensor pressure sensor mats

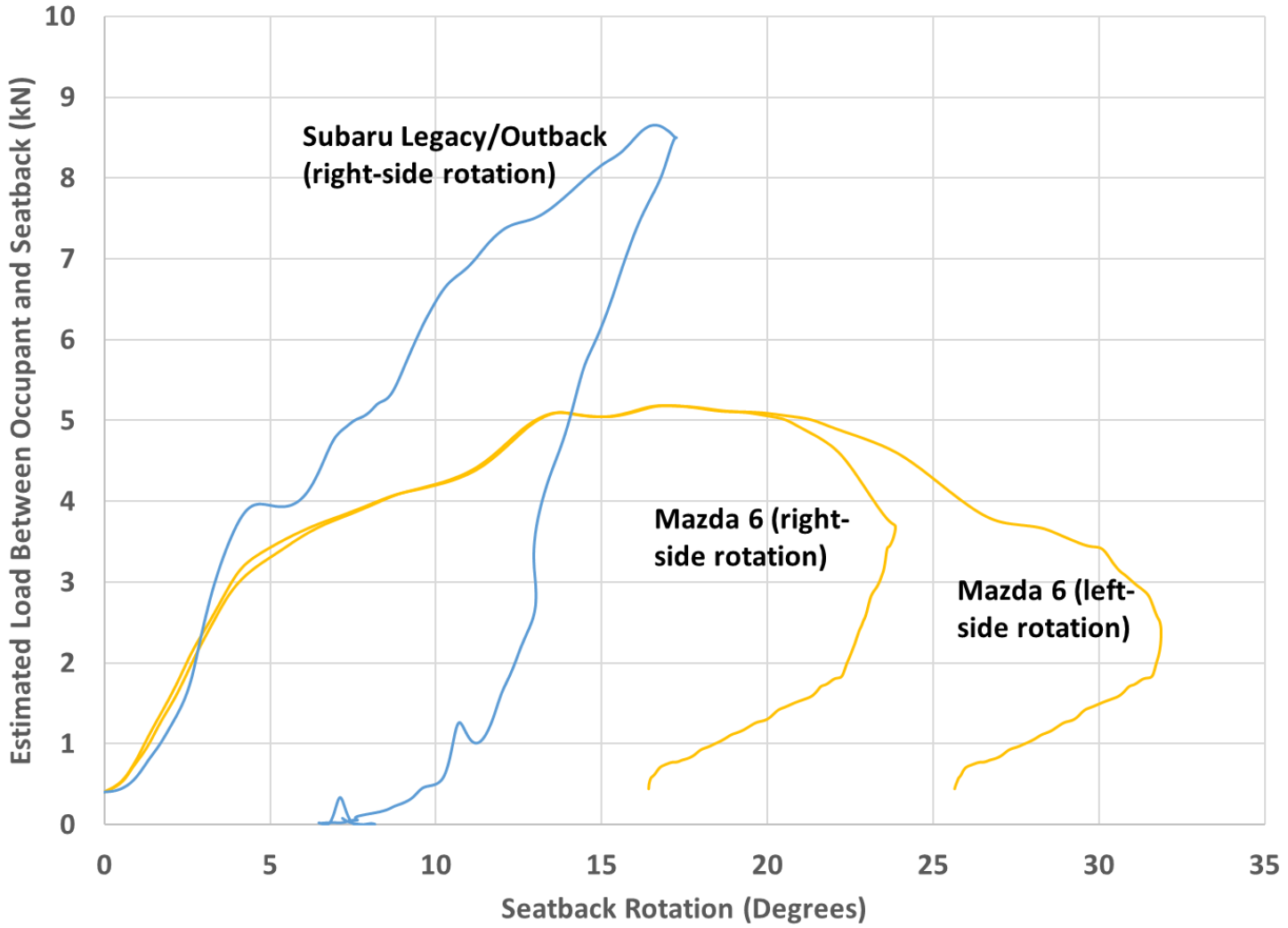


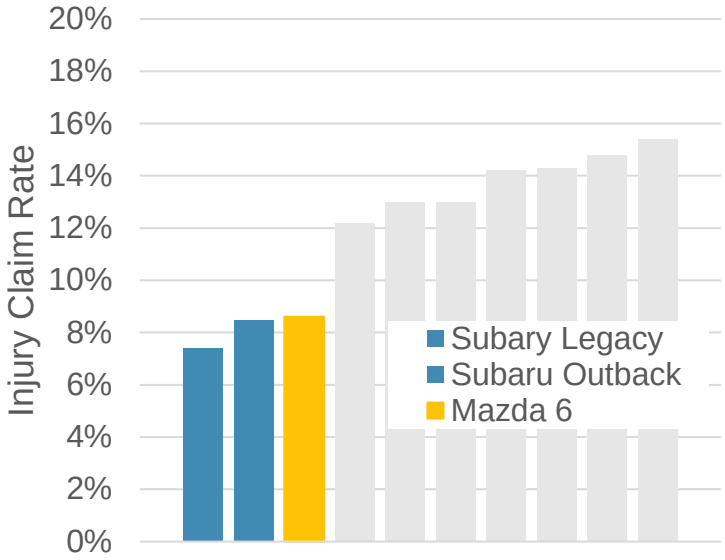
Pressure sensor results





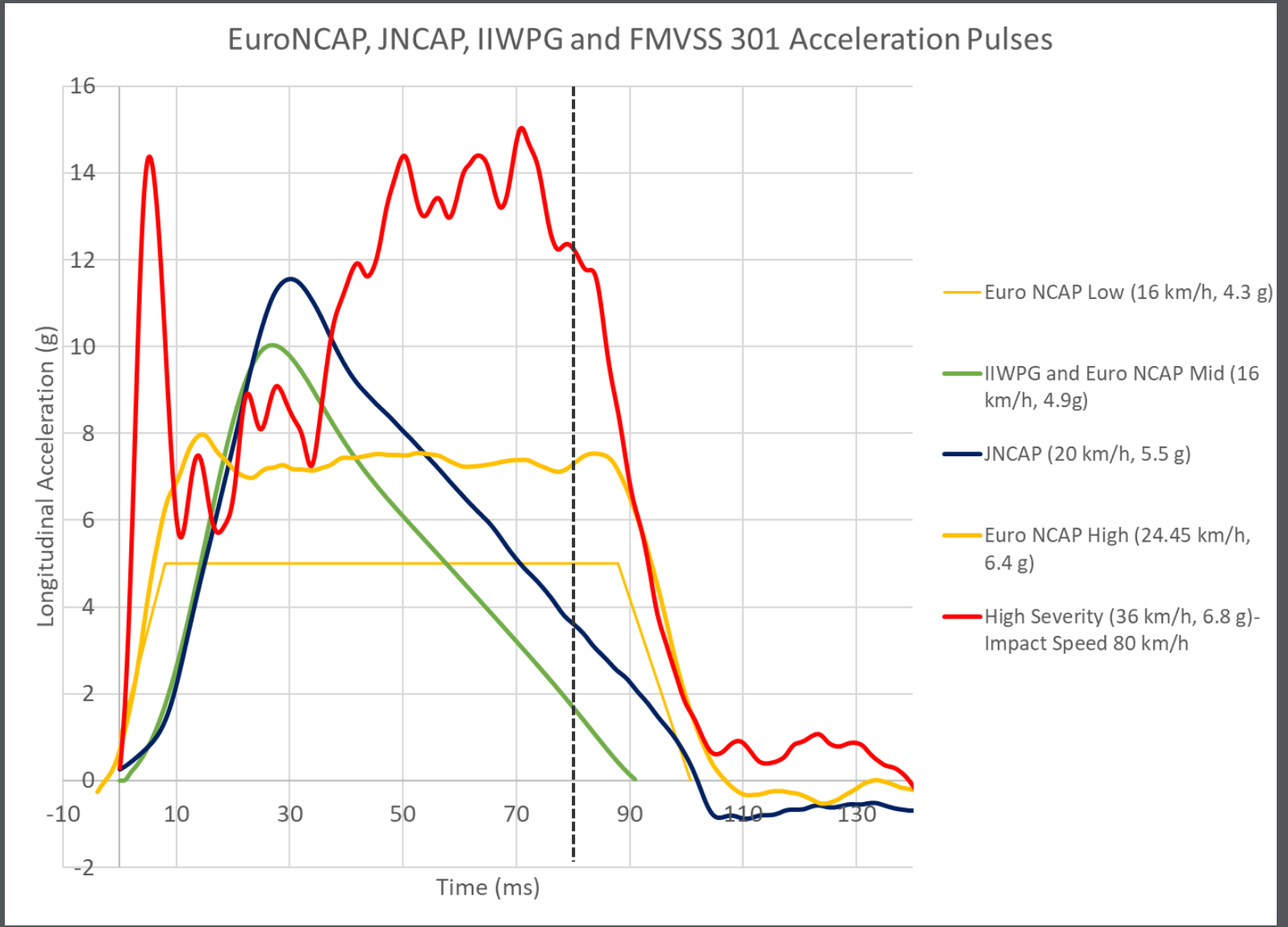
Optimizing Seat Designs for Low- and High-Severity Occupant Protection





Load distribution – pressure sensor

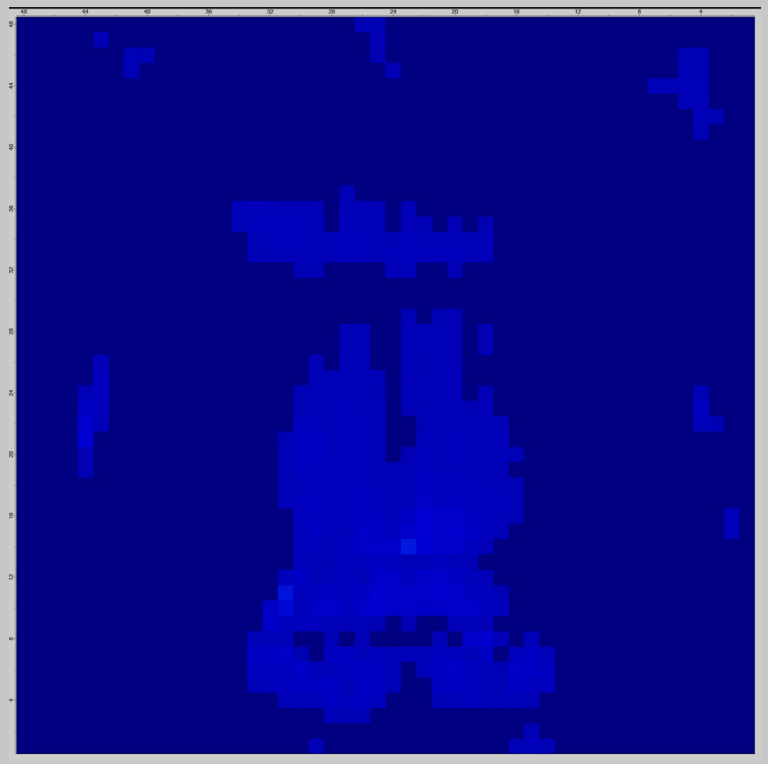
Crash pulse comparison



Subset of tests for analysis

	Test ID	Injury claim rate	Max seatback rotation
Industry benchmark	SR18034	-	26.9º
Midsize cars	SR18022	7.4%	17.3º
	SR18024	8.6%	31.9º
	SR18031	12.2%	29.2º
	SR18028	14.3%	22.7º
	SR18023	15.4%	23.3º

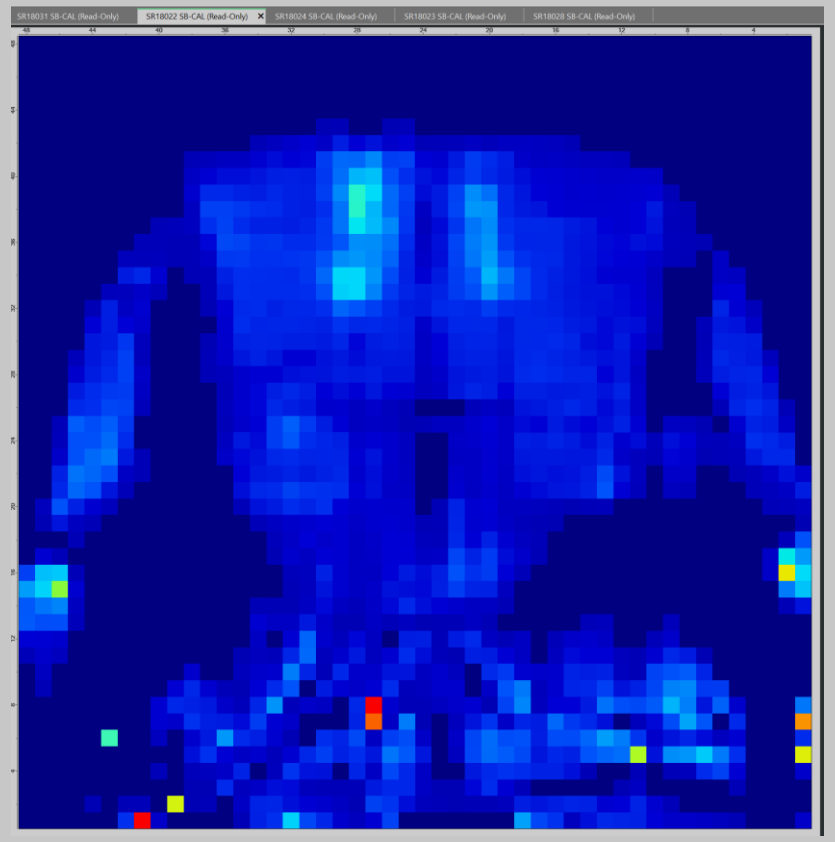
High severity seat testing and pressure mat



SR18022

Injury claim rate = 7.4% Max seatback rotation = 17.3 degrees

High severity seat testing and pressure mat



SR18022

Injury claim rate = 7.4% Max seatback rotation = 17.3 degrees


SER18022 – 7.4% ICR


SER18028 – 14.3% ICR

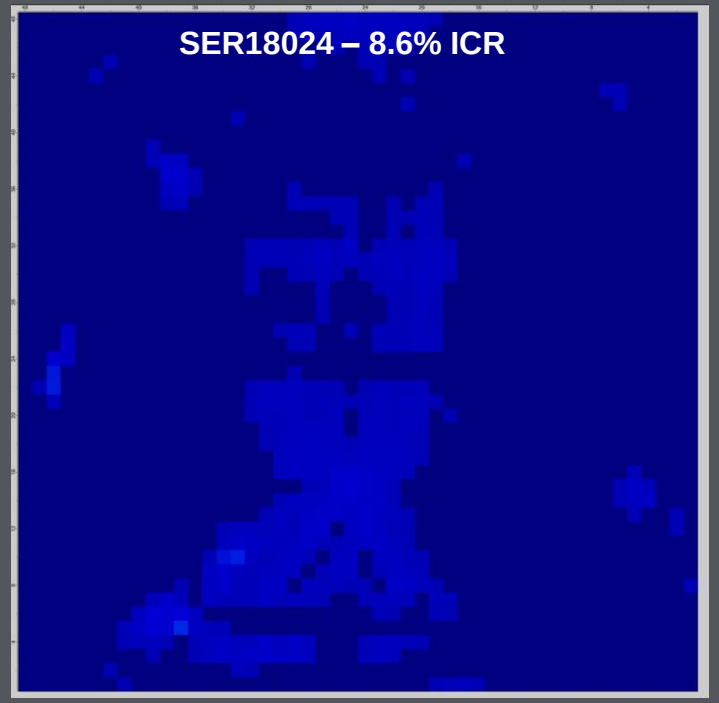

SER18024 – 8.6% ICR

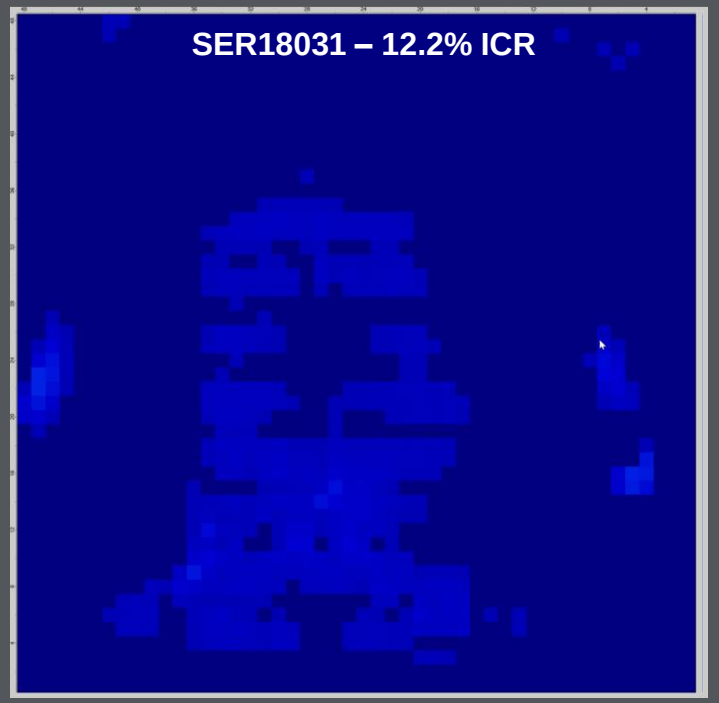

SER18023 – 15.4% ICR

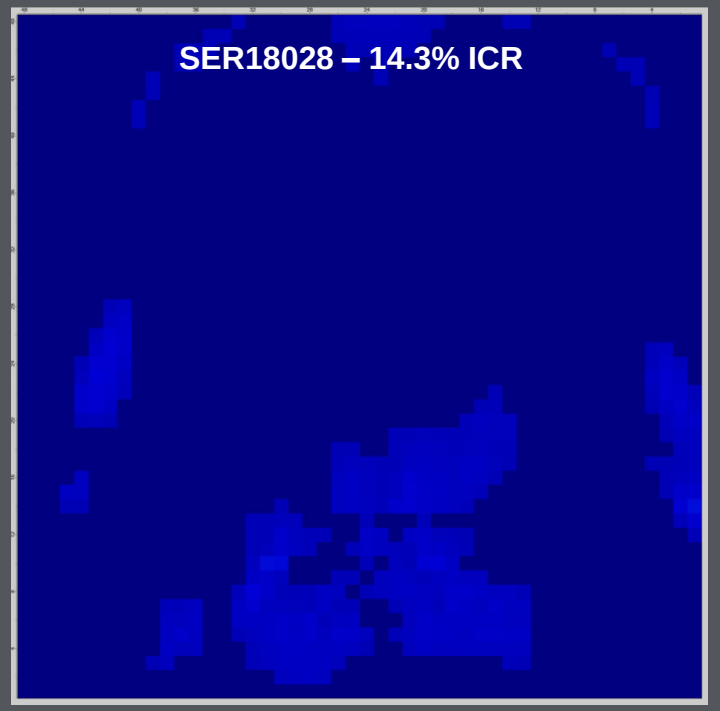

SER18031 – 12.2% ICR

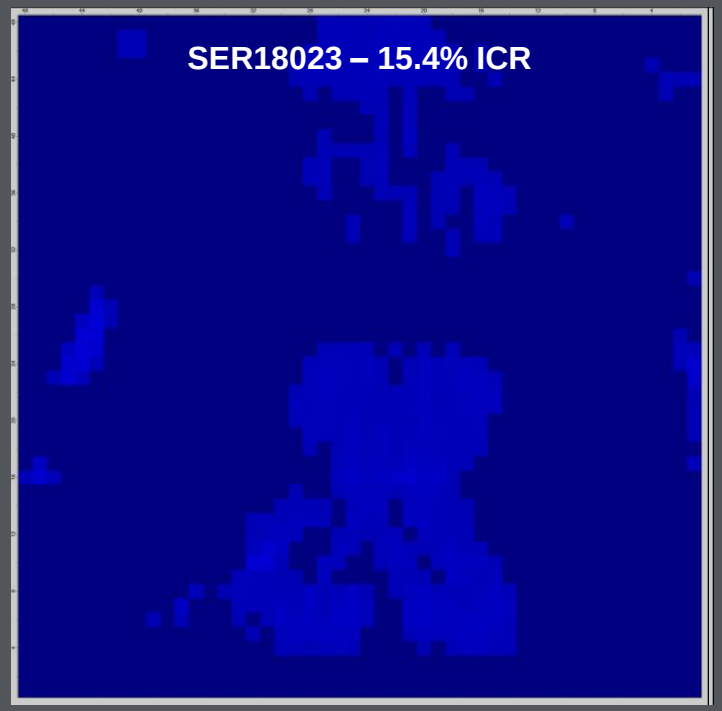

SER18034 – industry benchmark

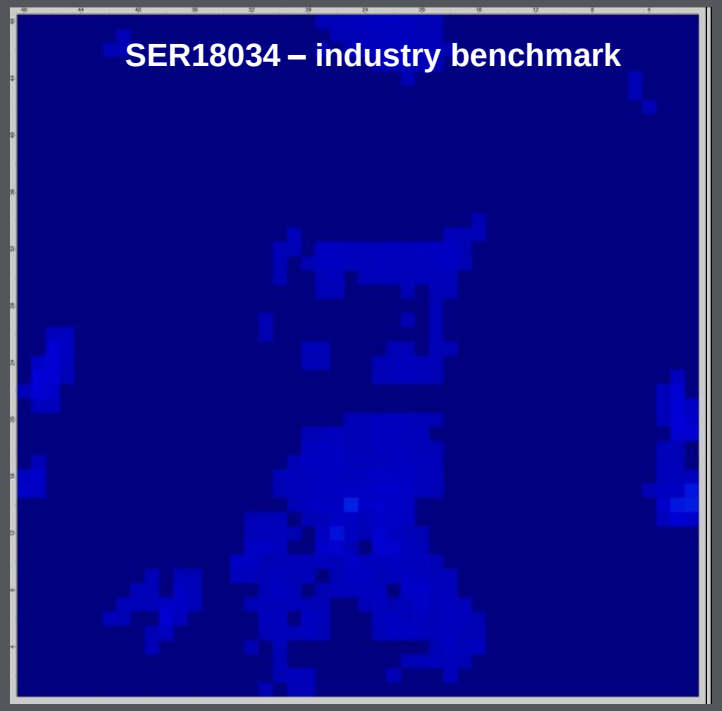

SER18022 – 7.4% ICR

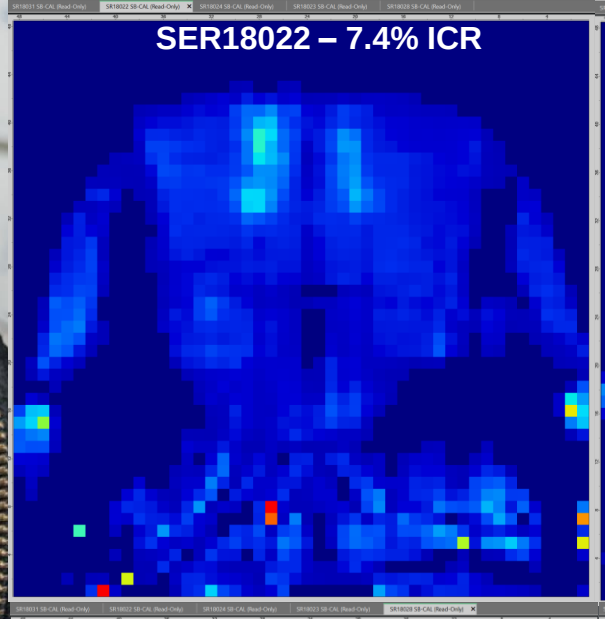

SER18024 – 8.6% ICR

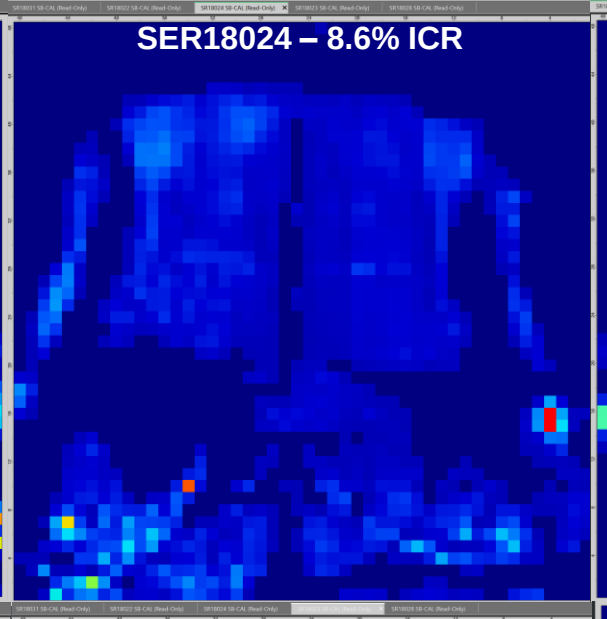

SER18031 – 12.2% ICR

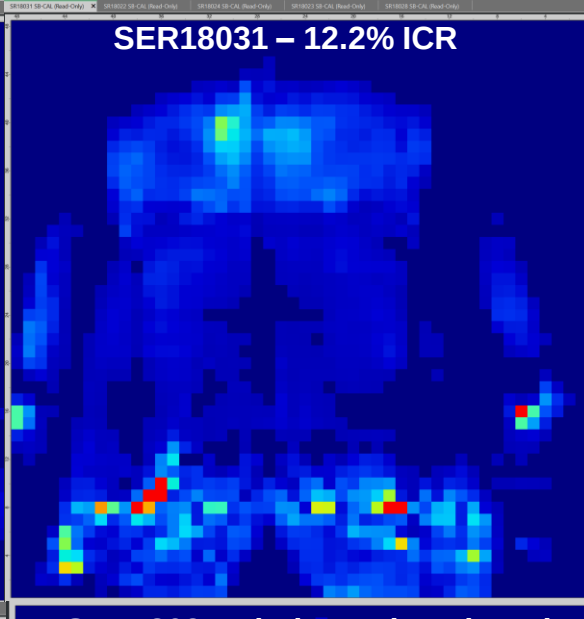

SER18028 – 14.3% ICR

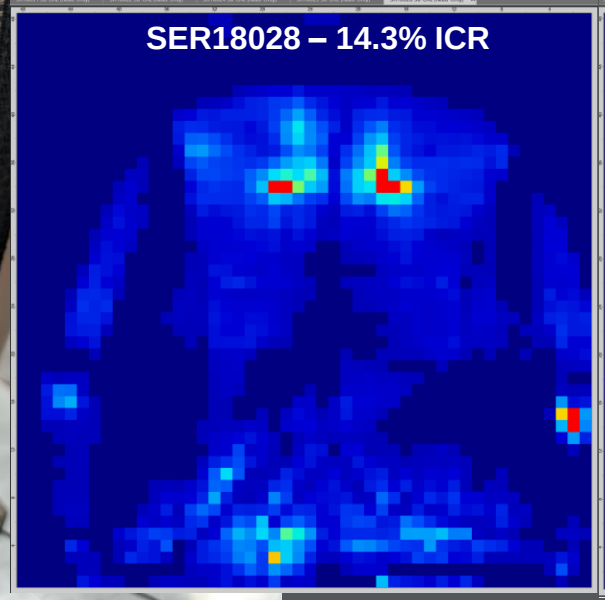

SER18023 – 15.4% ICR

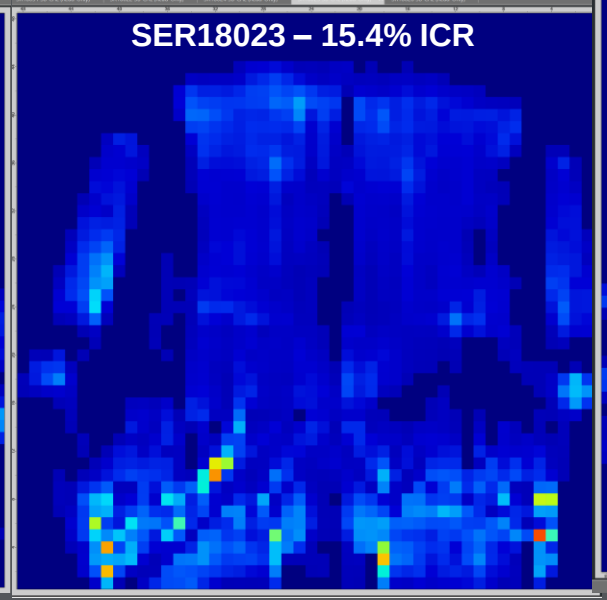

SER18034 – industry benchmark

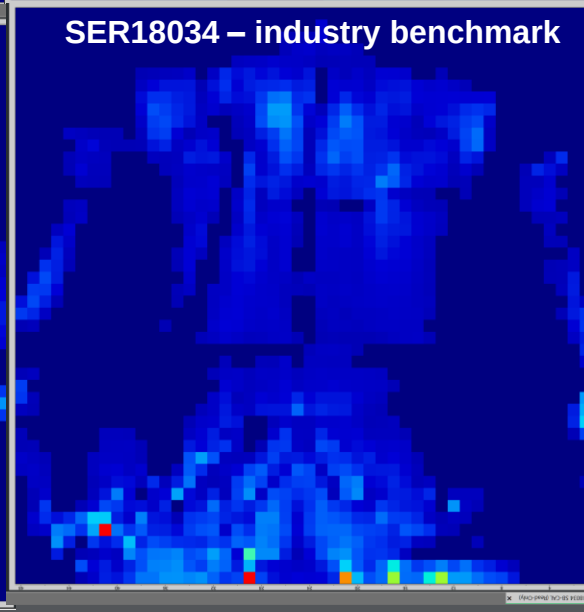








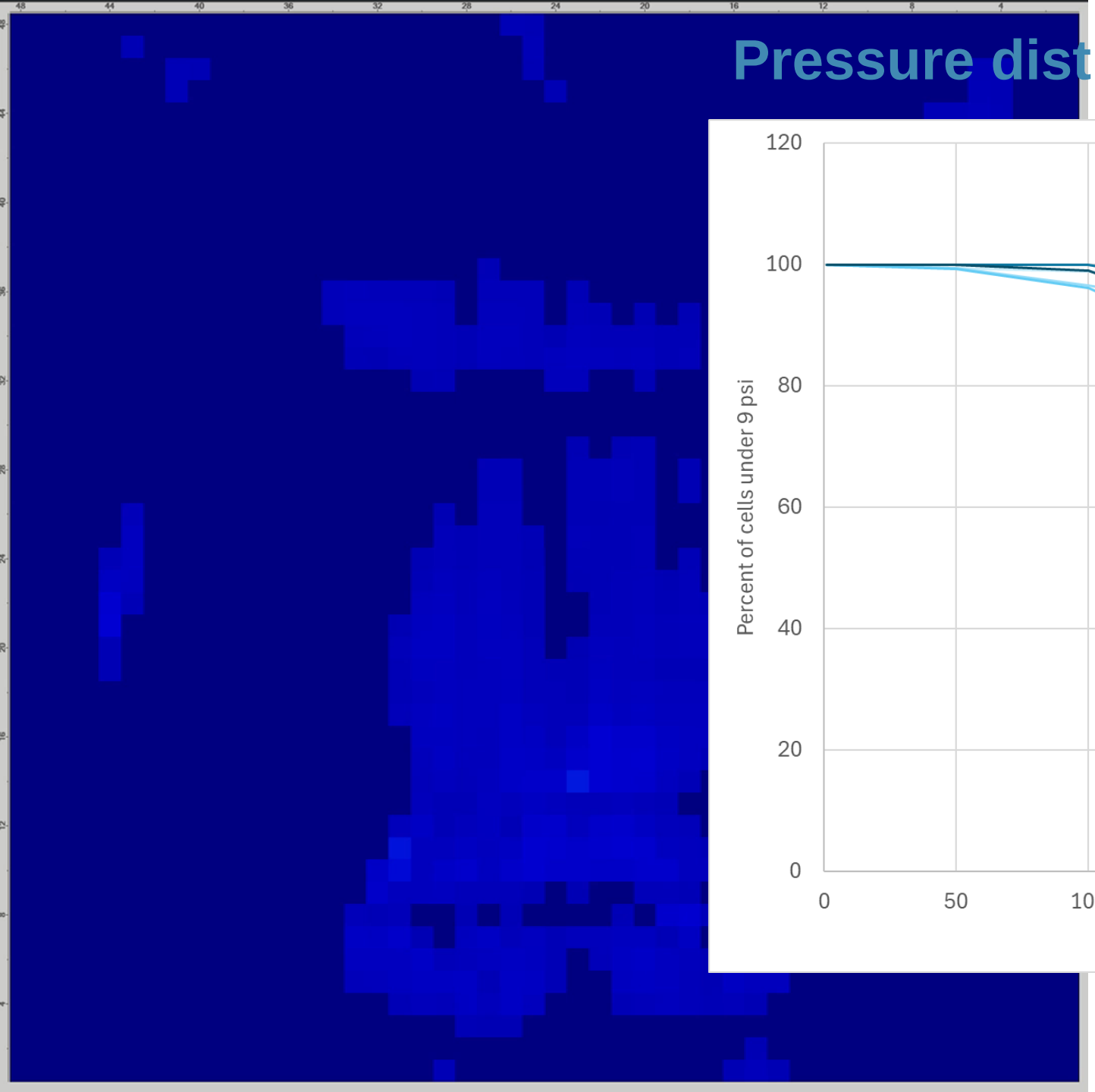


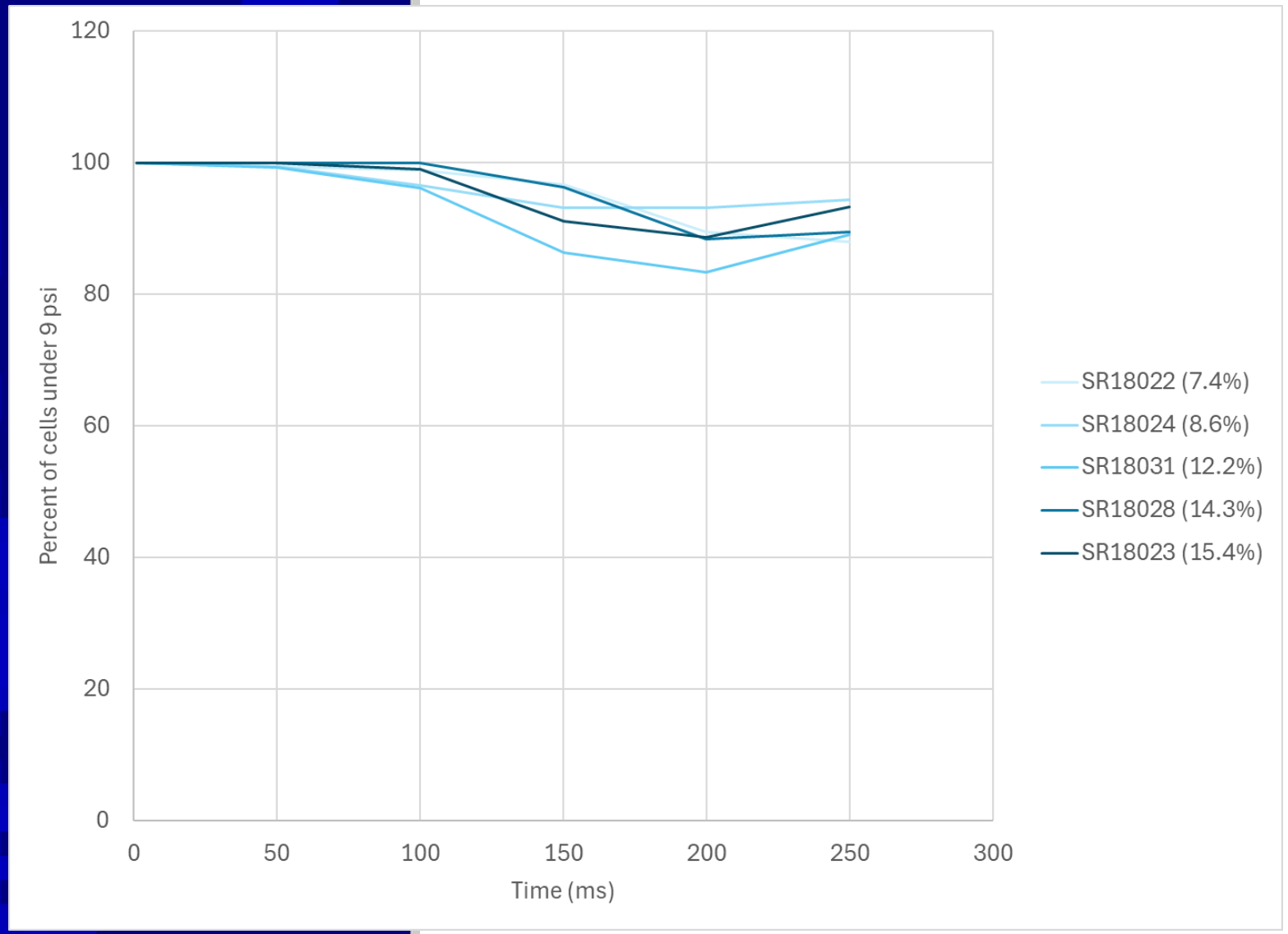


Snapshots taken at 80 ms

ICR = Injury claim rate

Pressure distribution



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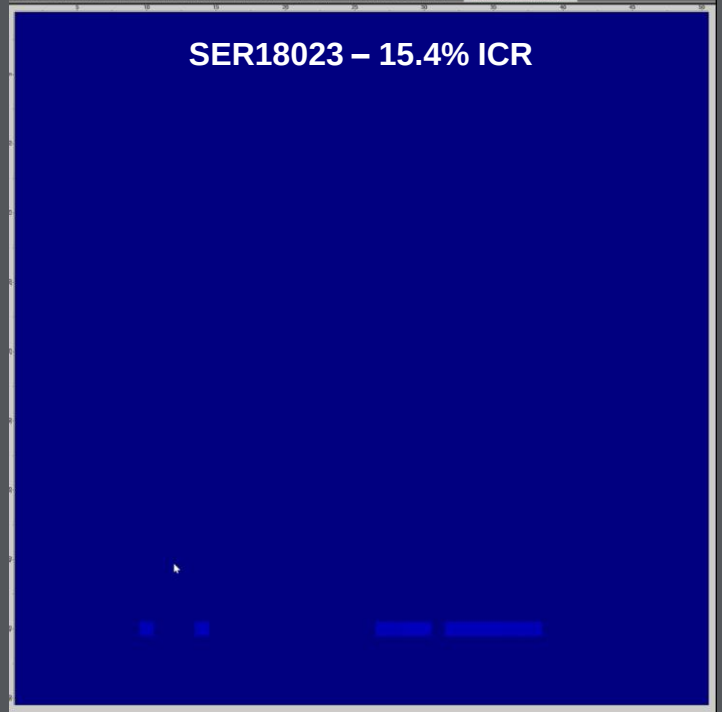
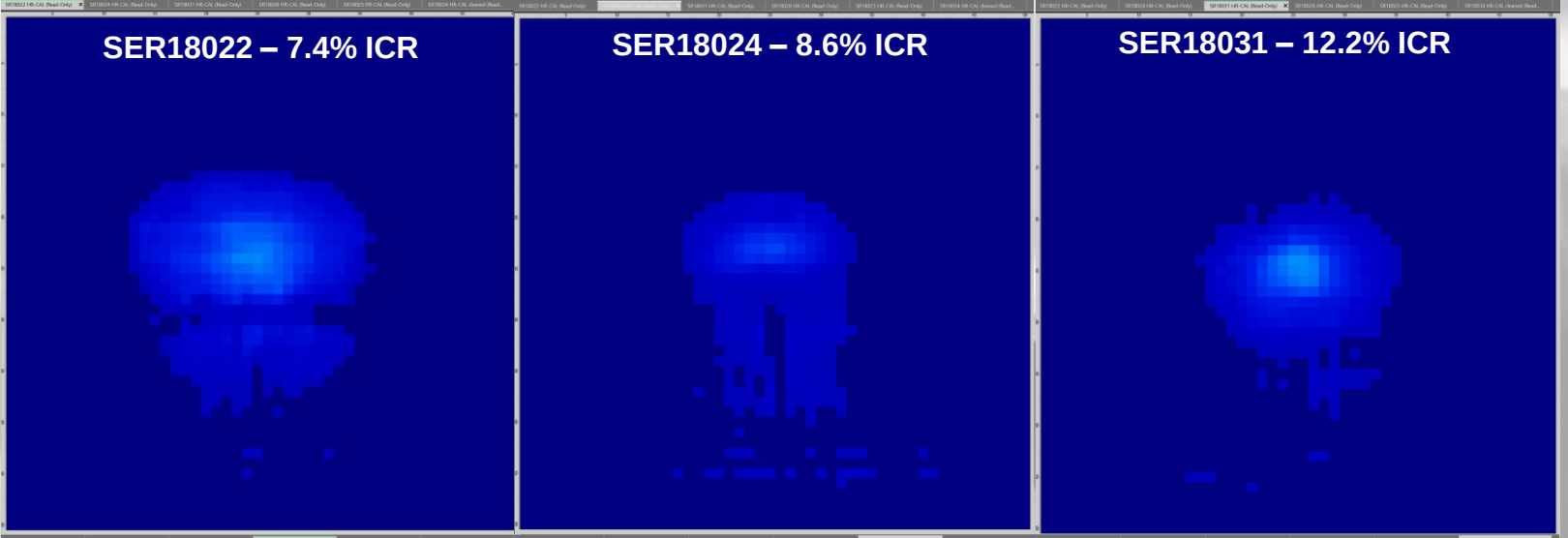
SER18031 – 12.2% ICR


SER18028 – 14.3% ICR


SER18023 – 15.4% ICR


SER18034 – industry benchmark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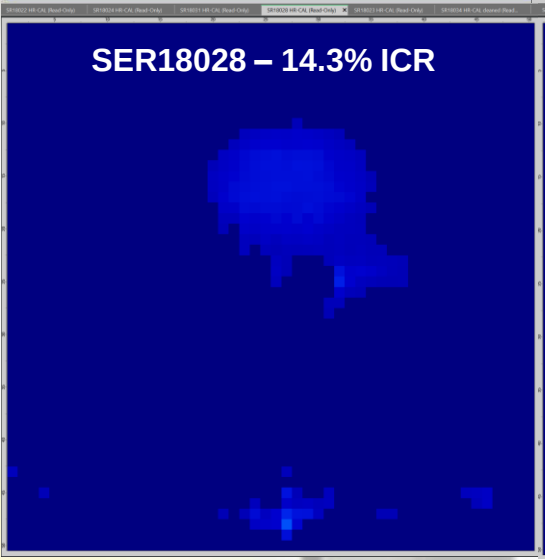
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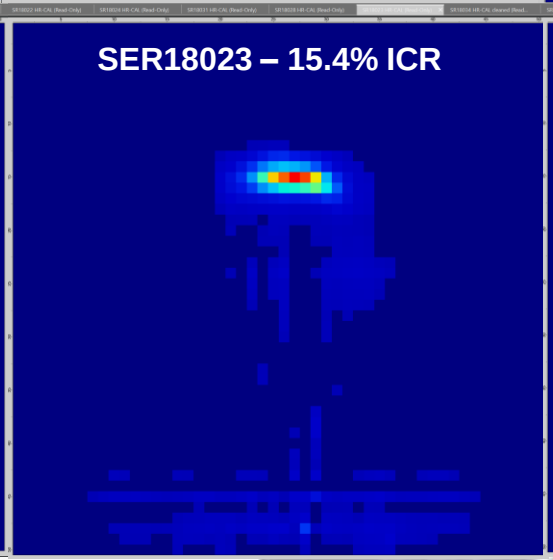
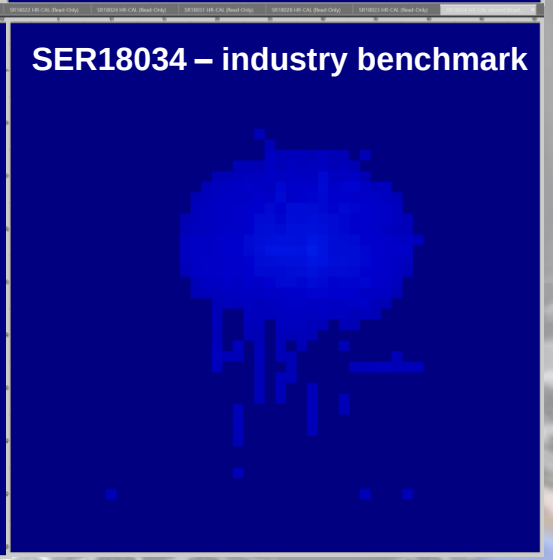

SER18023 – 15.4% ICR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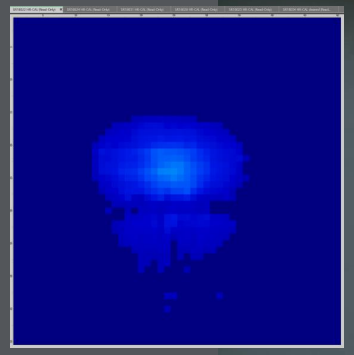

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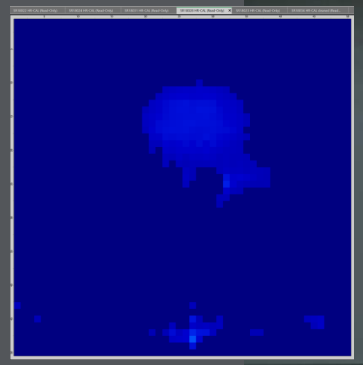

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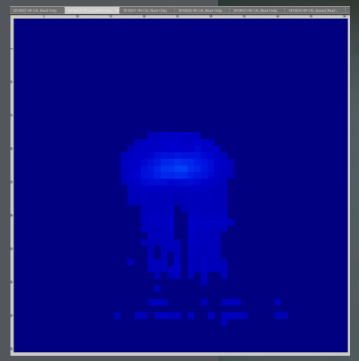

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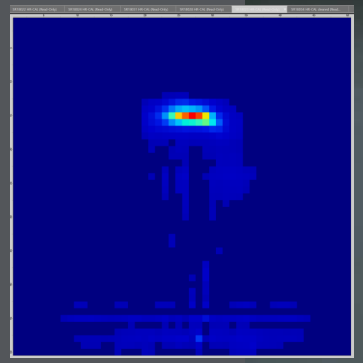
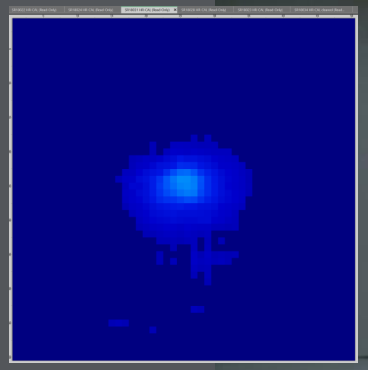
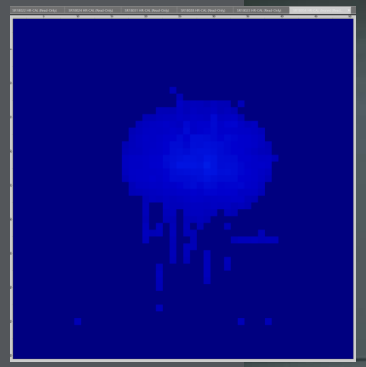


SER18031 – 12.2% ICR



SER18034 – industry benchmark



Takeaways

- Multiple factors affect injury claim rate outcomes for rear impacts
  - Crash speed
  - Pre-impact occupant position
  - Occupant kinematics
  - Vehicle mass
  - Vehicle energy absorption
  - Seat energy absorption
  - Distribution of force transferred to occupant
- Analysis of distribution of load may be one piece of the puzzle
  - Pressure sensors promising tool
- Human surrogate fidelity is very important for analysis of load distributions to be meaningful.

Future work

Continue to reduce whiplash injury in low-severity rear impacts

Active safety technology

- Automatic emergency braking

Integrated safety

- Pre-impact interventions for rear impacts

Robust seat and restraint design that protect many occupants

- Different crash severities
- Varied occupant positions
- Range of occupant sizes and sex

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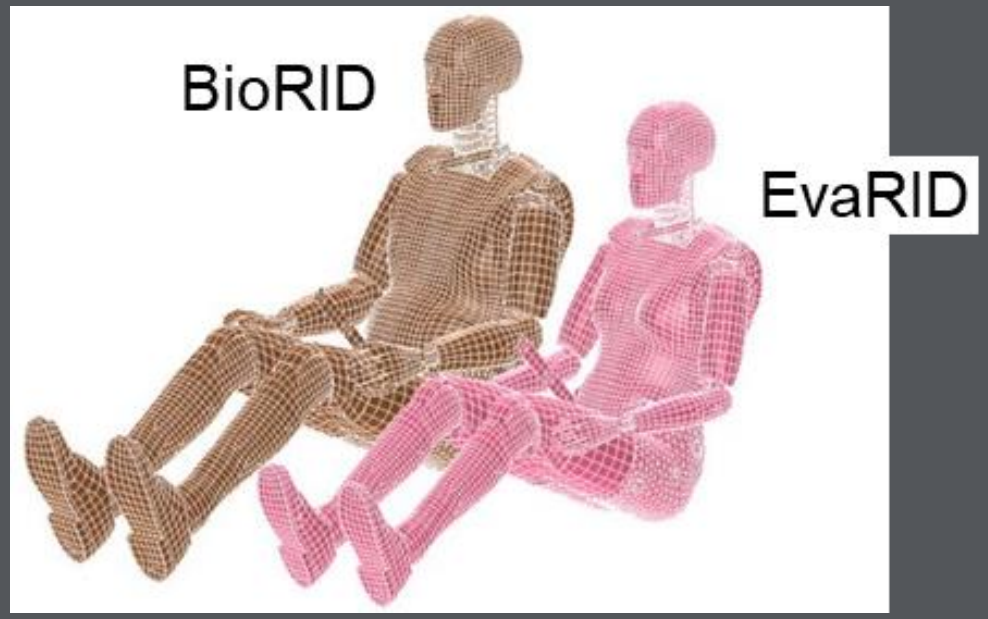
Rear impact parameter study



- 50th male and 50th female rear impact finite element ATDs

- Large scale parametric study on the occupant position, occupant anthropometry, seat construction and performance factors that influence dummy outcomes
- Project completion – Spring 2025

Parameter study progress

Identify study parameters and outputs

Inputs

Seat and head restraint characteristics (geometry, strength, material properties)

-

Pre-impact braking pulse

-

Crash pulse

-

Seatbelt tensioning

-

Occupant (BioRID and EvaRID)

Outputs

Injury metrics

-

Seat and occupant motion

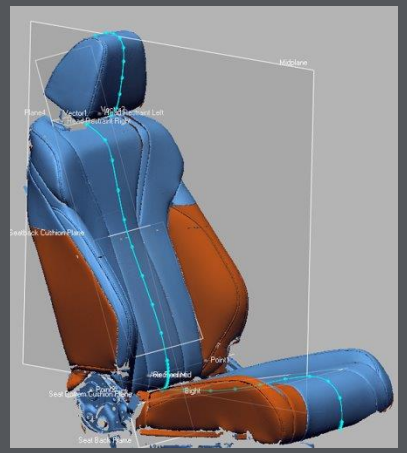
Parameter study progress

Identify study parameters and outputs

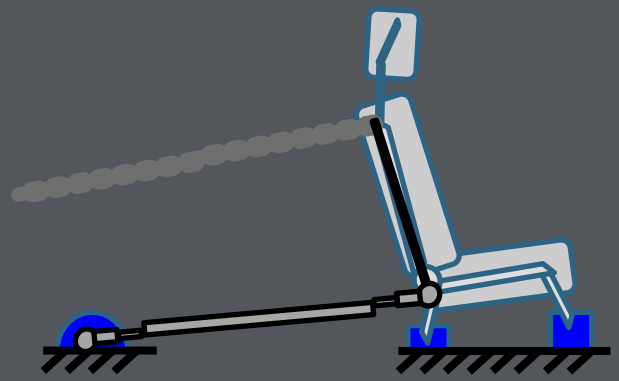
Seat parameter testing

75%

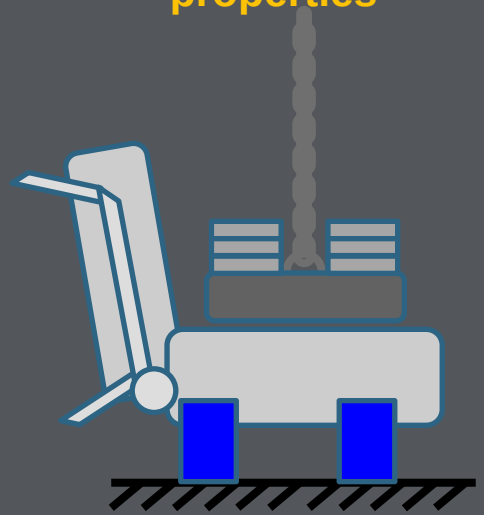
Seat geometry parameterization



Frame strength



Cushion/trim properties



Parameter study progress

Identify study parameters and outputs

Seat parameter testing

Generic seat model definition

✓

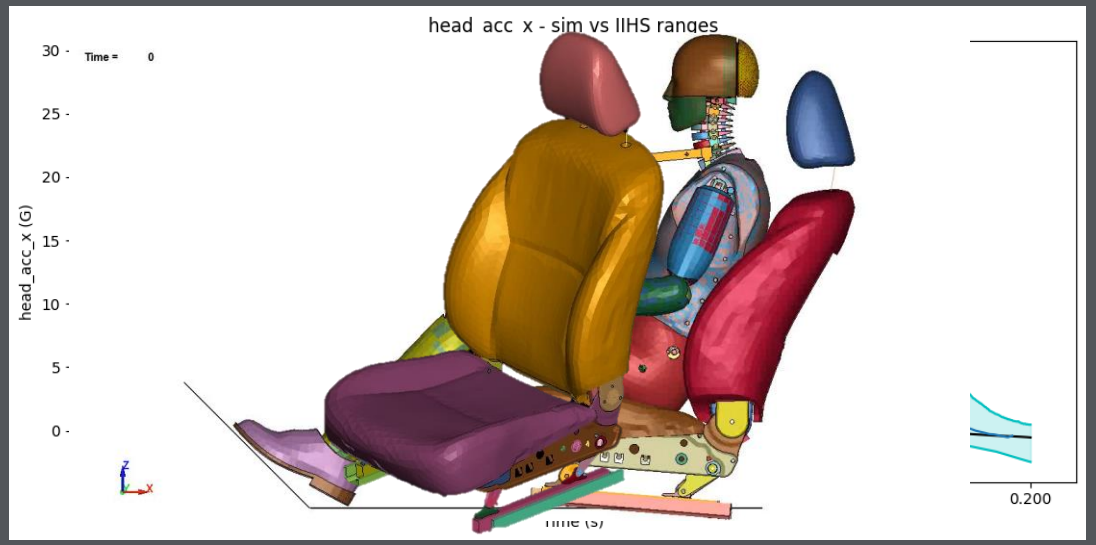
75%

75%

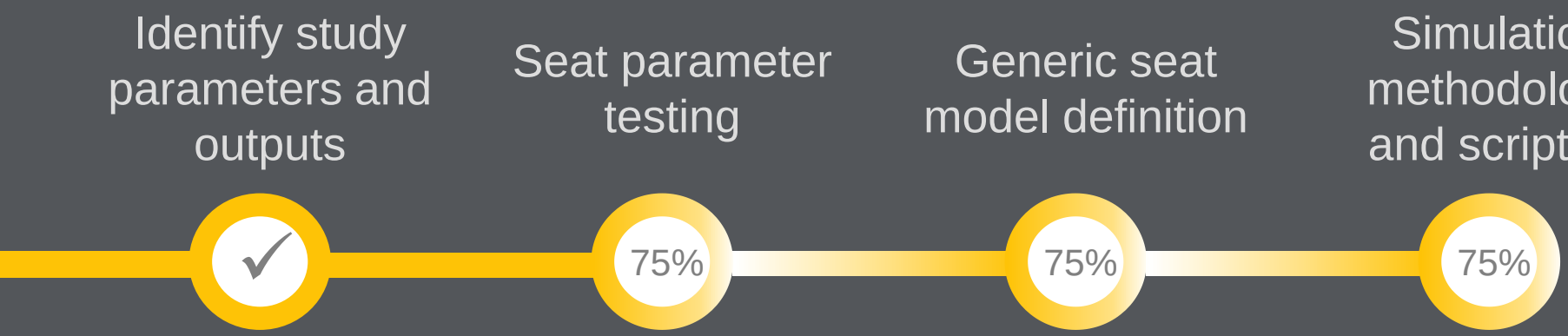
Validation against IIHS sled tests

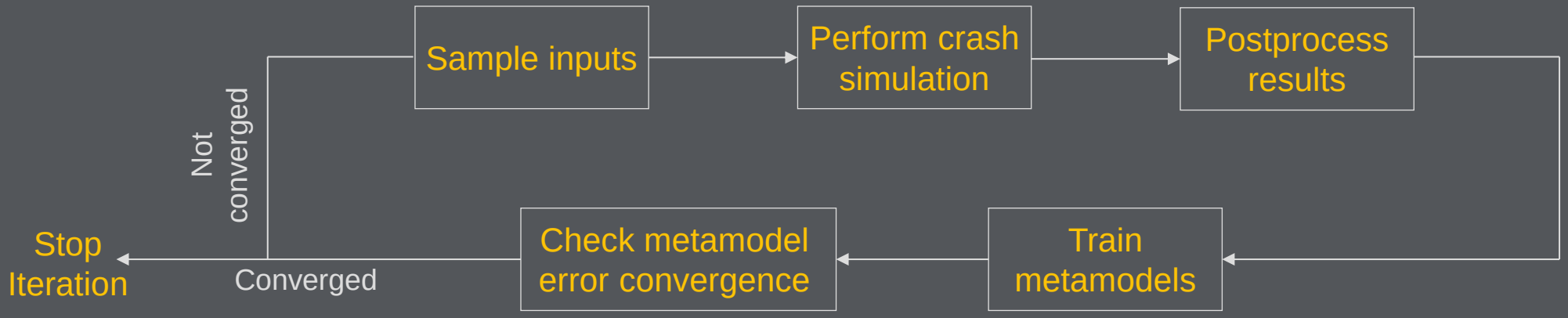
Parameterize Dummy seating process and seat parameter testing

Refine seat model

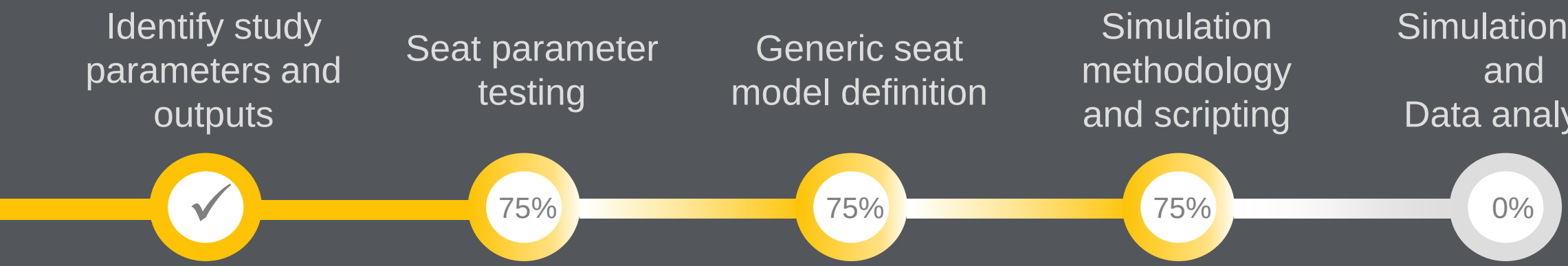


Parameter study progress





Parameter study progress



Outcomes

Correlation between input and outputs

-

Correlations between injury metrics

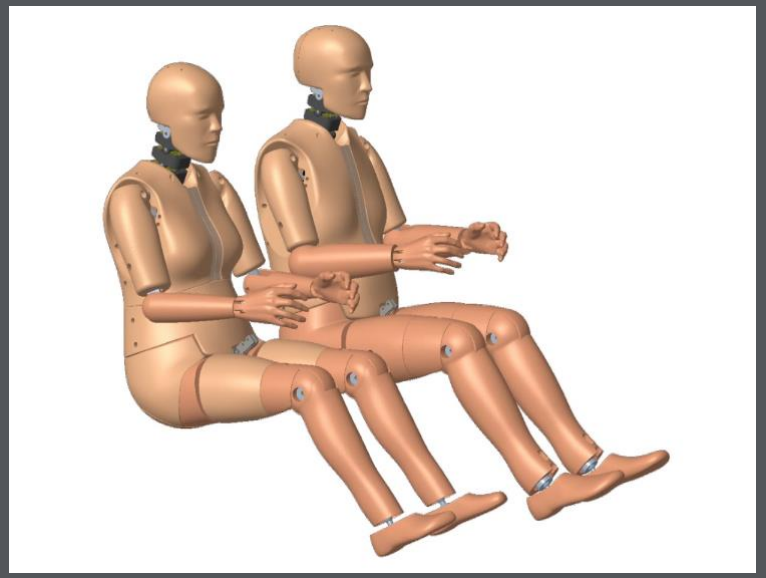
-

Sensitivity of injury metrics to change

-

Influence of impact conditions

Alternate rear impact tools



50th female and 50th male SET tools

- Evaluate physical seat evaluation tools (SET) tools to identify if the output metrics from these tools can help us set limits to further reduce rear impact injuries

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Highway Loss Data Institute

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THANK YOU

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