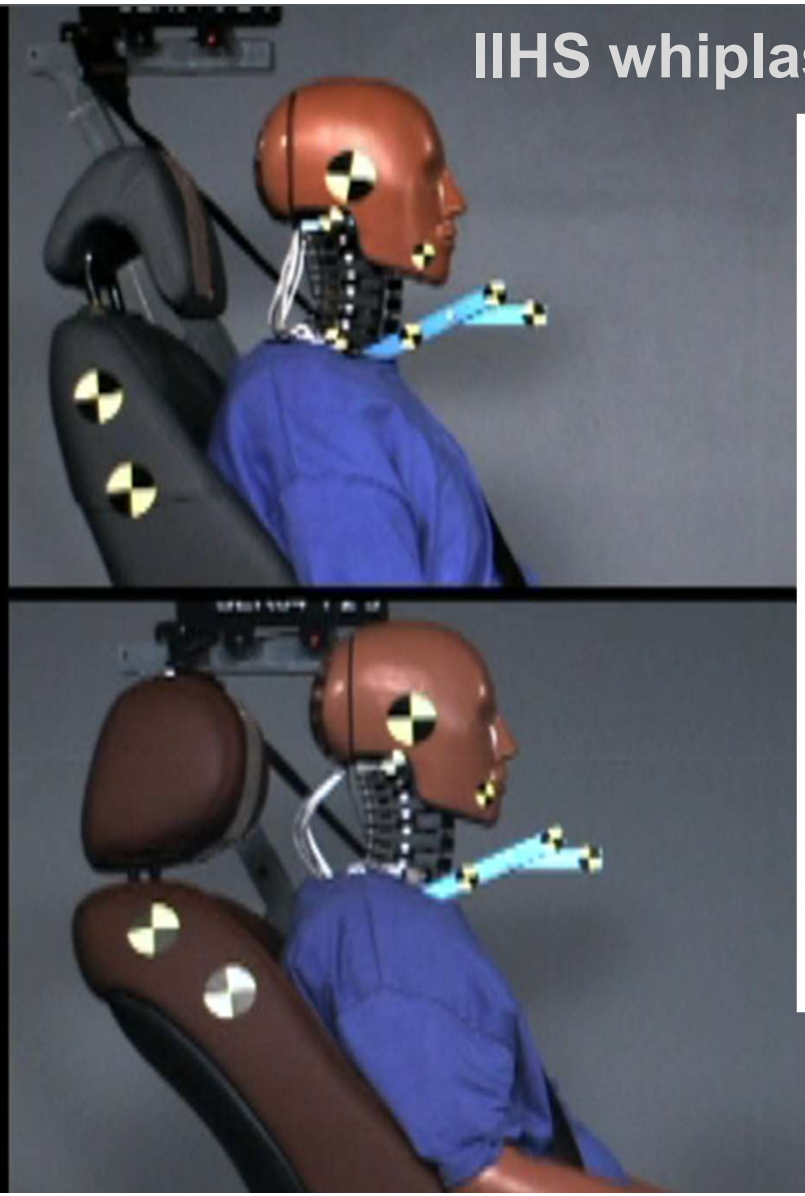
Rear impact research and program updates

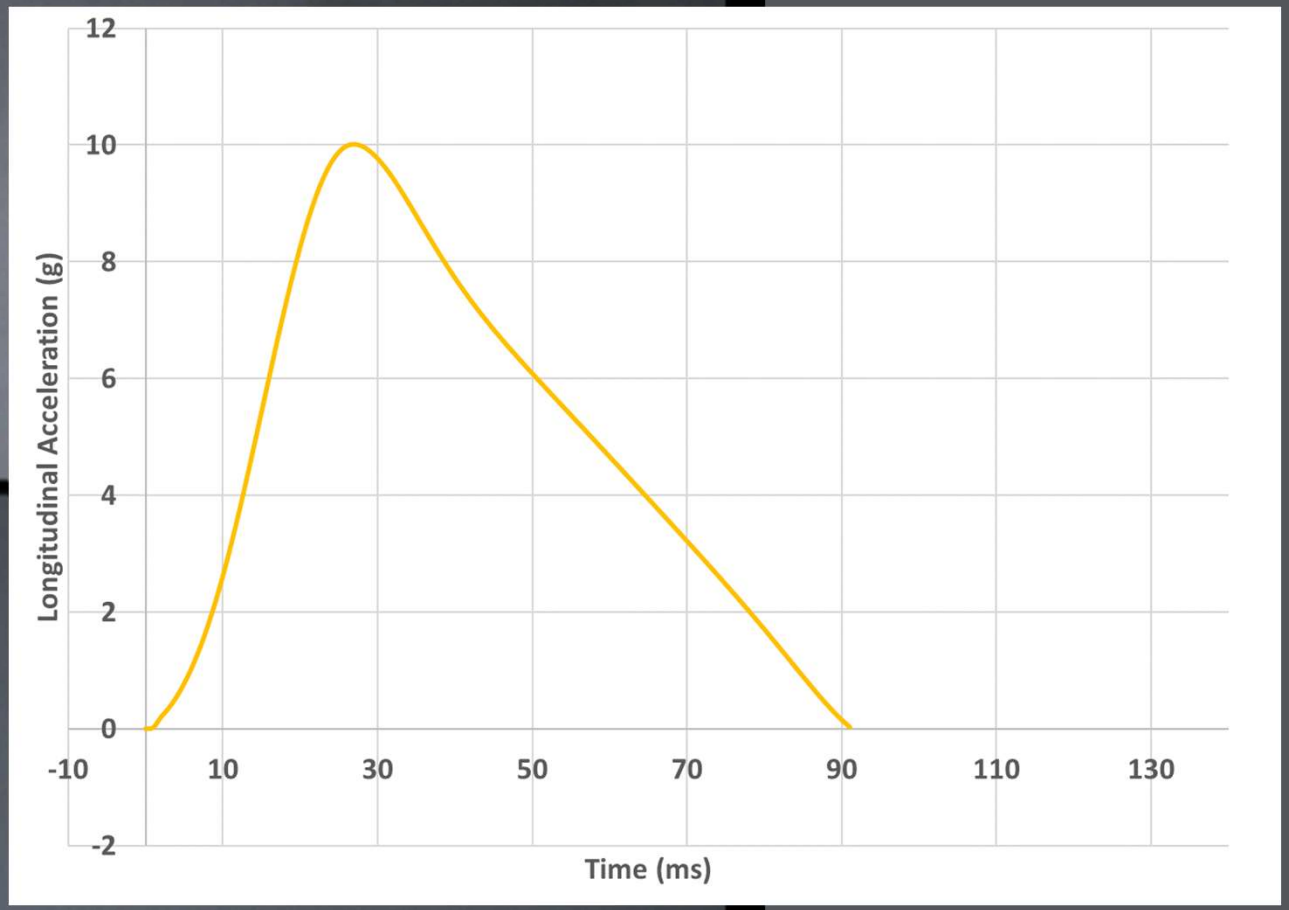
September 2023

Marcy Edwards
Senior research Engineer

Background

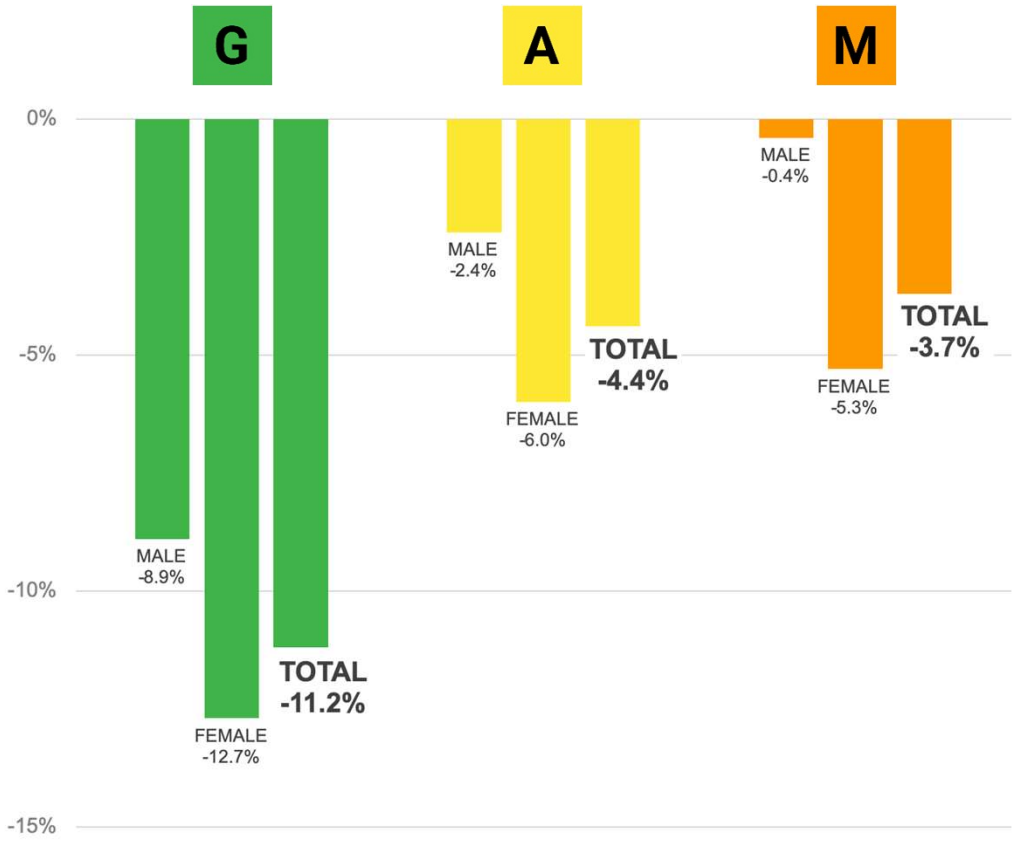
IIHS whiplash evaluation 2004-2022





IIHS whiplash evaluation

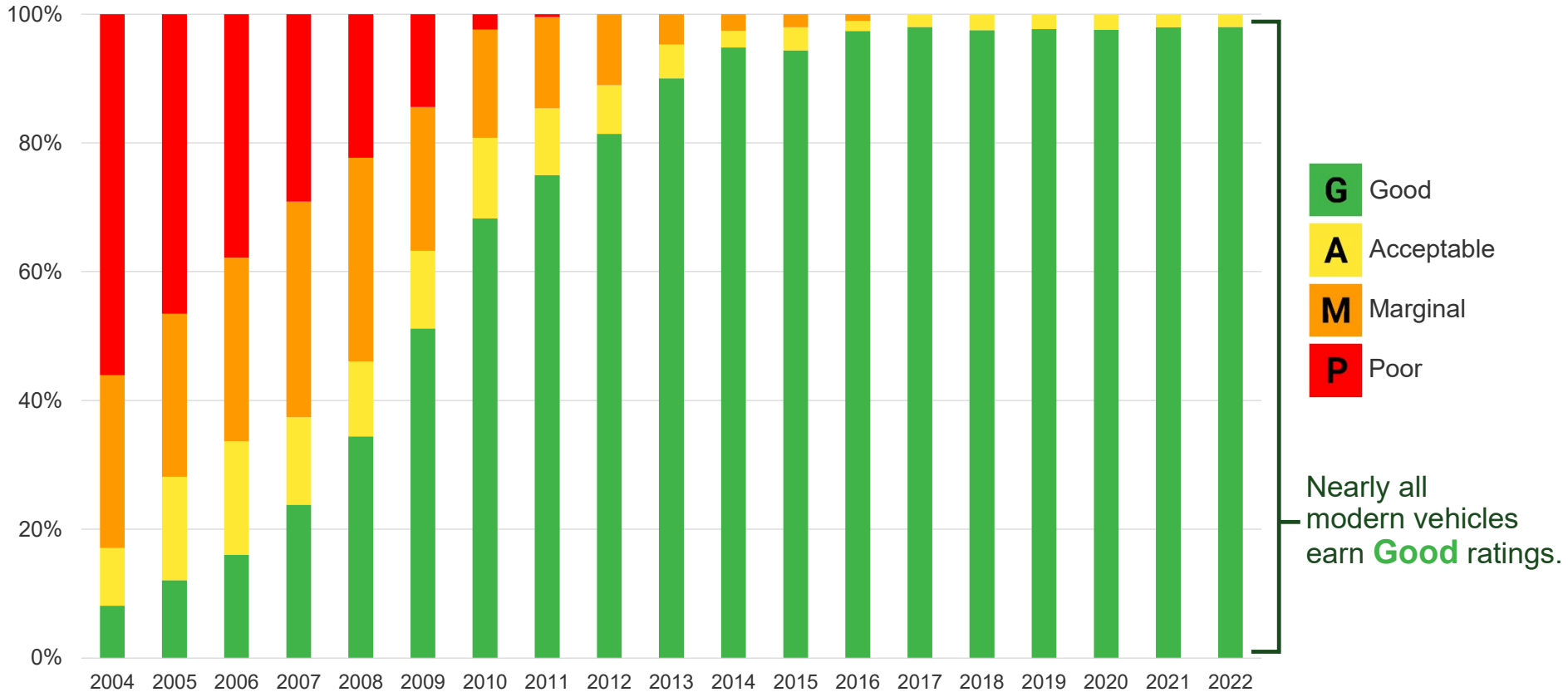
Percent reduction in injury claim rates vs. poor-rated seats



IIHS HLDI

Head restraint ratings by model year

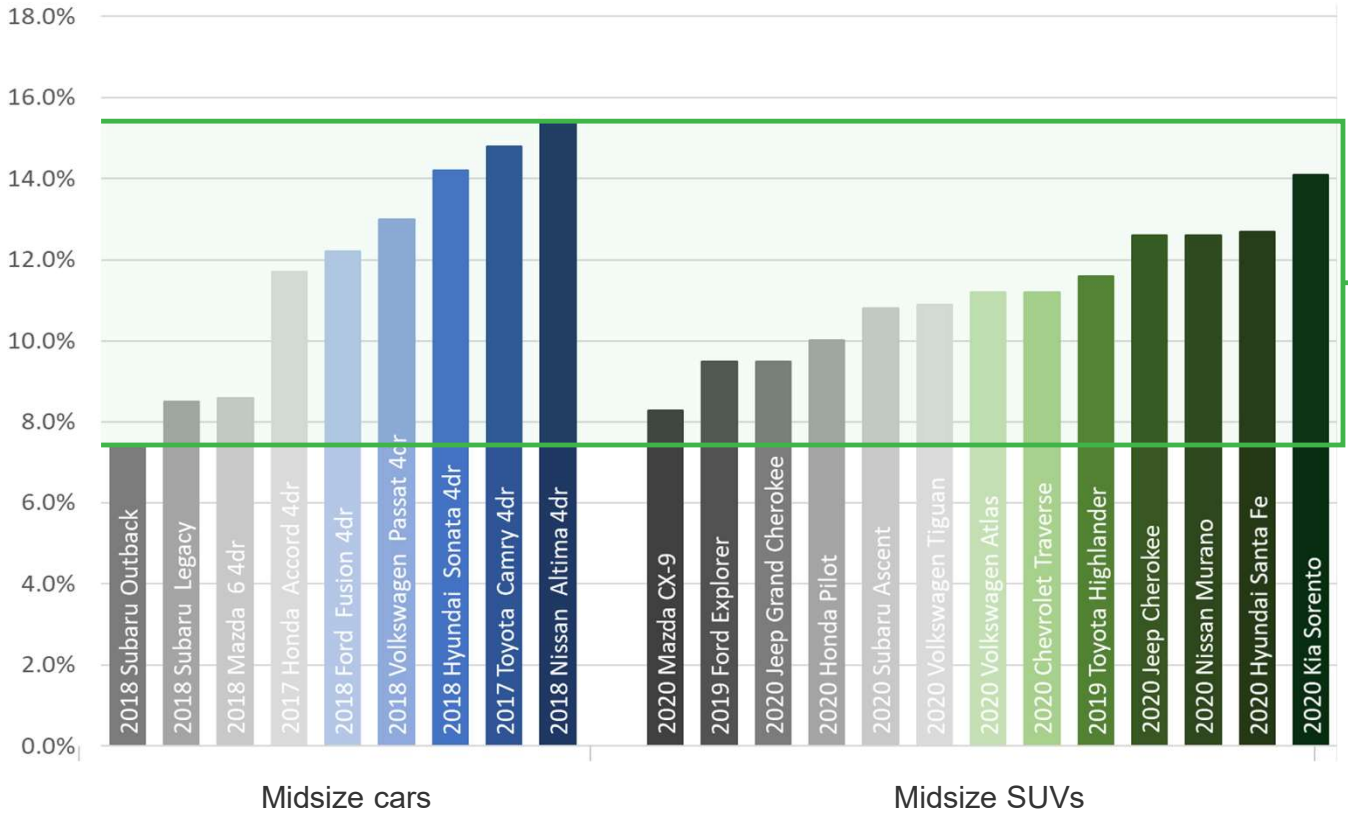
As of August 15, 2022



IIHS HLDI

Current IIHS ratings vs. real-world data

Insurance injury claim rates (PIP/PDL by class and vehicle)



IIHS HLDI

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

IIHS HLDI

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IIHS HLDI

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IIHS HLDI

Integrated safety demonstrations and insurer data analysis

Integrated safety demonstrations

Windsor Machine Group prototype for an active head restraint that deploys prior to impact

Volvo production reversible pretensioning activated prior to rear impact crash

IIHS HLDI

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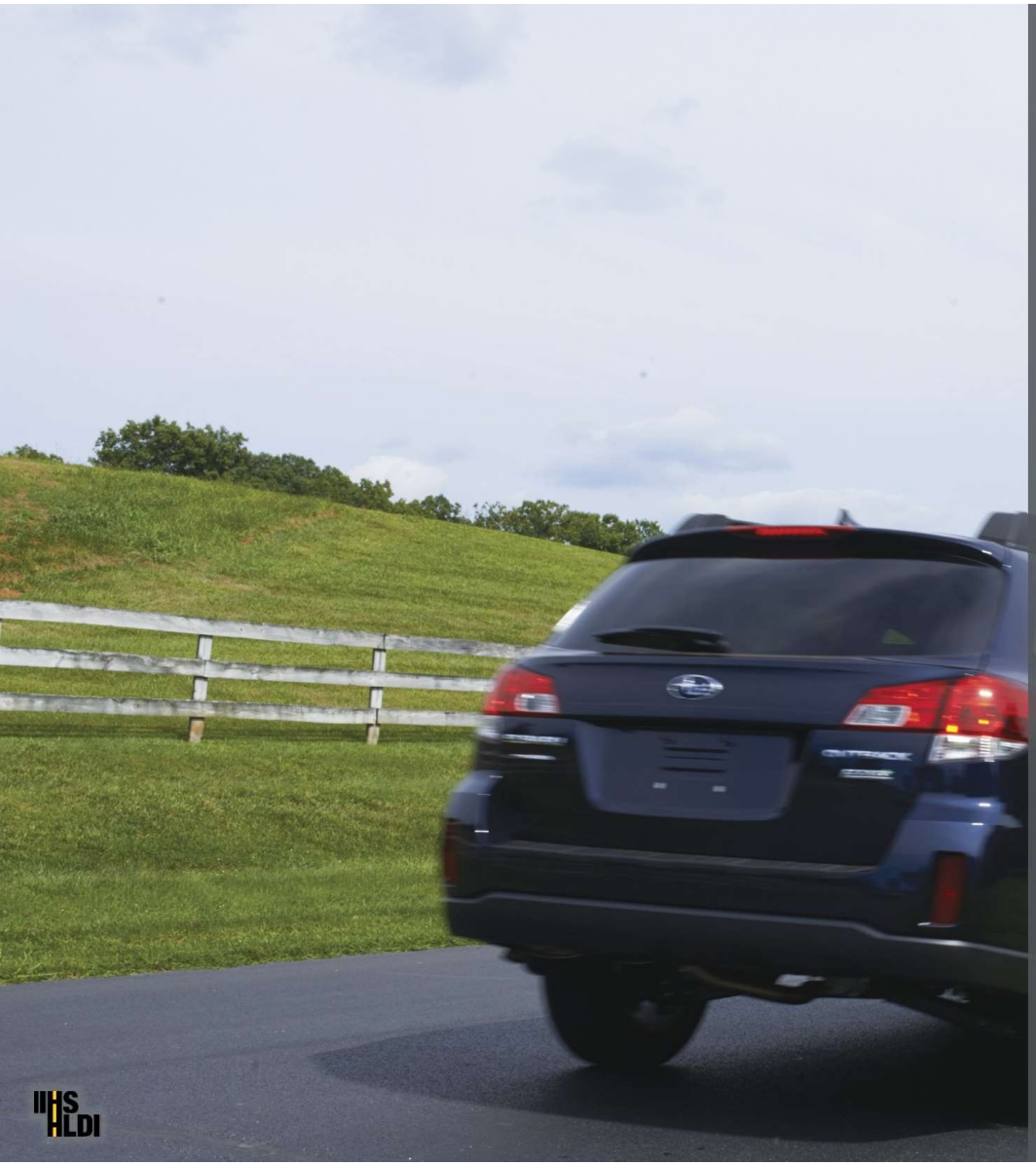
EDR analysis of NASS-CISS rear crashes

Crash severity



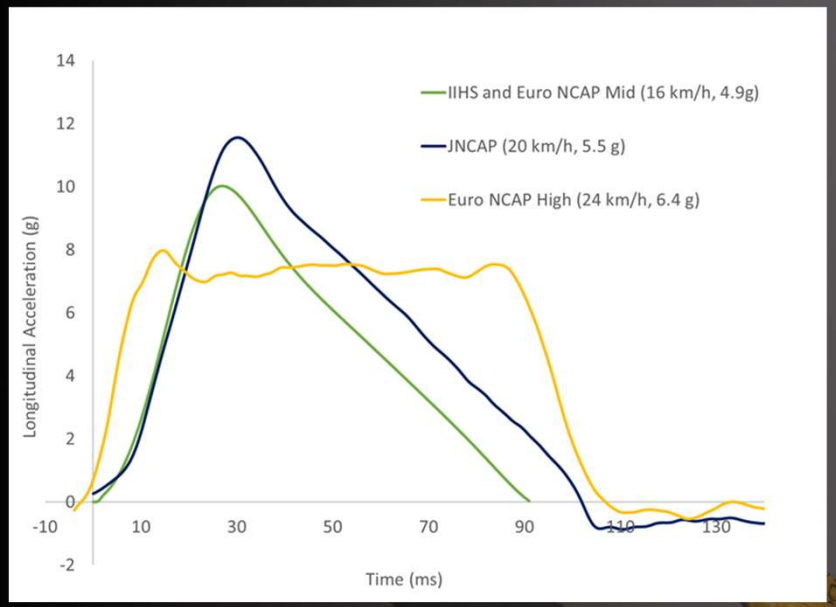
Goals, methods, preliminary findings

- Identify the most relevant pre-impact scenarios and post-impact crash severities and pulses for rear impact crashes
  - NASS-CISS rear impact crashes with EDR data for struck vehicle
  - Pre-crash and post-crash data collected
  - Braking, Delta V and acceleration analyzed
    - Initial analysis that over half of the crashes had a crash delta V between 10-25 km/h, which is a range currently addressed in NCAP evaluations

NCAP pulse investigation

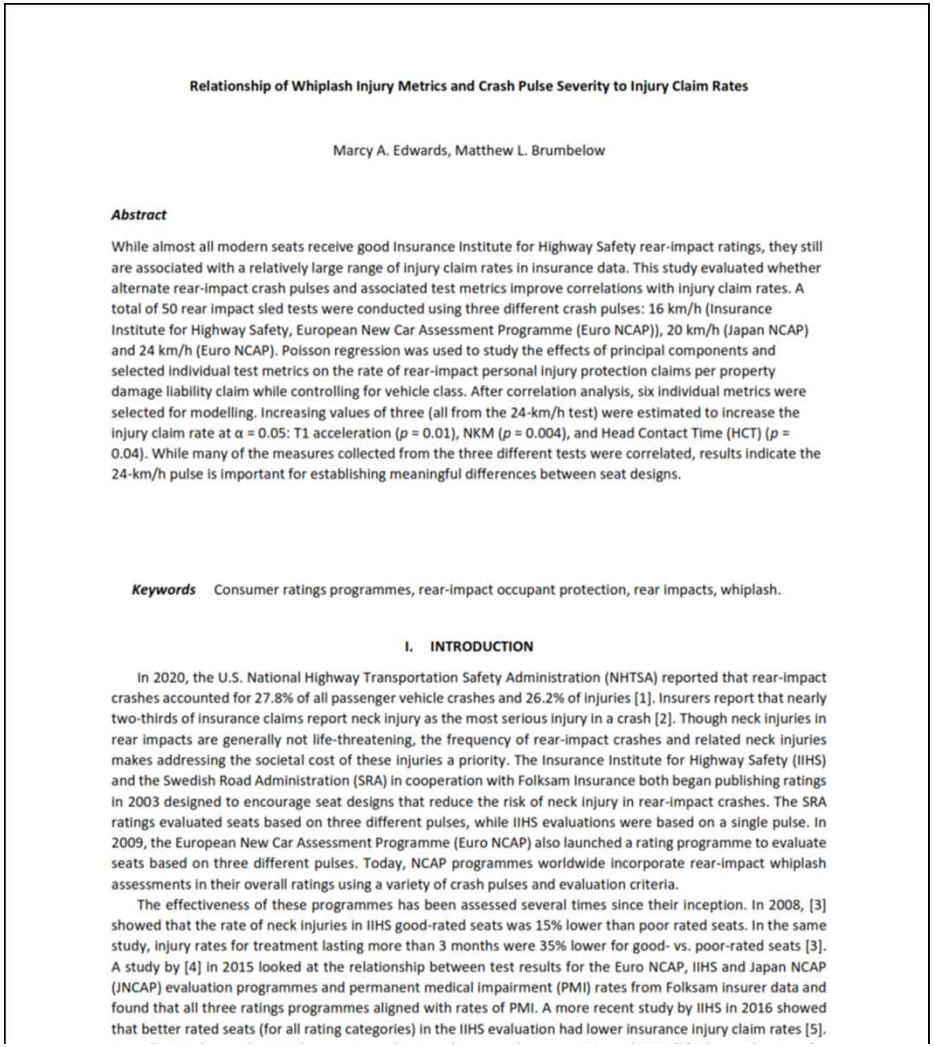
Crash severity

Rear Impact Research



- The BioRID dummy was used to compare the performance of seats on an acceleration sled using the IIHS and Euro NCAP mid (16 km/h), JNCAP (20 km/h) and Euro NCAP high (24 km/h) crash pulses

Relationship of Whiplash Injury Metrics and Crash Pulse Severity to Injury Claim Rates



Relationship of Whiplash Injury Metrics and Crash Pulse Severity to Injury Claim Rates

Marcy A. Edwards, Matthew L. Brumbelow

Abstract

While almost all modern seats receive good Insurance Institute for Highway Safety rear-impact ratings, they still are associated with a relatively large range of injury claim rates in insurance data. This study evaluated whether alternate rear-impact crash pulses and associated test metrics improve correlations with injury claim rates. A total of 50 rear impact sled tests were conducted using three different crash pulses: 16 km/h (Insurance Institute for Highway Safety, European New Car Assessment Programme (Euro NCAP)), 20 km/h (Japan NCAP) and 24 km/h (Euro NCAP). Poisson regression was used to study the effects of principal components and selected individual test metrics on the rate of rear-impact personal injury protection claims per property damage liability claim while controlling for vehicle class. After correlation analysis, six individual metrics were selected for modelling. Increasing values of three (all from the 24-km/h test) were estimated to increase the injury claim rate at $\alpha = 0.05$: T1 acceleration ($p = 0.01$), NKM ($p = 0.004$), and Head Contact Time (HCT) ($p = 0.04$). While many of the measures collected from the three different tests were correlated, results indicate the 24-km/h pulse is important for establishing meaningful differences between seat designs.

Keywords Consumer ratings programmes, rear-impact occupant protection, rear impacts, whiplash.

I. INTRODUCTION

In 2020, the U.S. National Highway Transportation Safety Administration (NHTSA) reported that rear-impact crashes accounted for 27.8% of all passenger vehicle crashes and 26.2% of injuries [1]. Insurers report that nearly two-thirds of insurance claims report neck injury as the most serious injury in a crash [2]. Though neck injuries in rear impacts are generally not life-threatening, the frequency of rear-impact crashes and related neck injuries makes addressing the societal cost of these injuries a priority. The Insurance Institute for Highway Safety (IIHS) and the Swedish Road Administration (SRA) in cooperation with Folksam Insurance both began publishing ratings in 2003 designed to encourage seat designs that reduce the risk of neck injury in rear-impact crashes. The SRA ratings evaluated seats based on three different pulses, while IIHS evaluations were based on a single pulse. In 2009, the European New Car Assessment Programme (Euro NCAP) also launched a rating programme to evaluate seats based on three different pulses. Today, NCAP programmes worldwide incorporate rear-impact whiplash assessments in their overall ratings using a variety of crash pulses and evaluation criteria.

The effectiveness of these programmes has been assessed several times since their inception. In 2008, [3] showed that the rate of neck injuries in IIHS good-rated seats was 15% lower than poor rated seats. In the same study, injury rates for treatment lasting more than 3 months were 35% lower for good- vs. poor-rated seats [3]. A study by [4] in 2015 looked at the relationship between test results for the Euro NCAP, IIHS and Japan NCAP (JNCAP) evaluation programmes and permanent medical impairment (PMI) rates from Folksam insurer data and found that all three ratings programmes aligned with rates of PMI. A more recent study by IIHS in 2016 showed that better rated seats (for all rating categories) in the IIHS evaluation had lower insurance injury claim rates [5].

- Will be presented at 2023 IRCOBI Conference
- 24 km/h pulse may be best suited for distinguishing meaningful difference in modern seat designs
  - Head contact time (HCT), Max NKM and T1 X acceleration were significant predictors of injury claim rate
- Interaction with head restraint differs across pulses suggesting multiple pulses should be considered

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Next steps

- Conduct a pilot series of vehicles from the small SUV class for the 24 km/h pulse (and 16 km/h if not already conducted)
- Use these results to establish ratings guidelines for update to rear impact protocol

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
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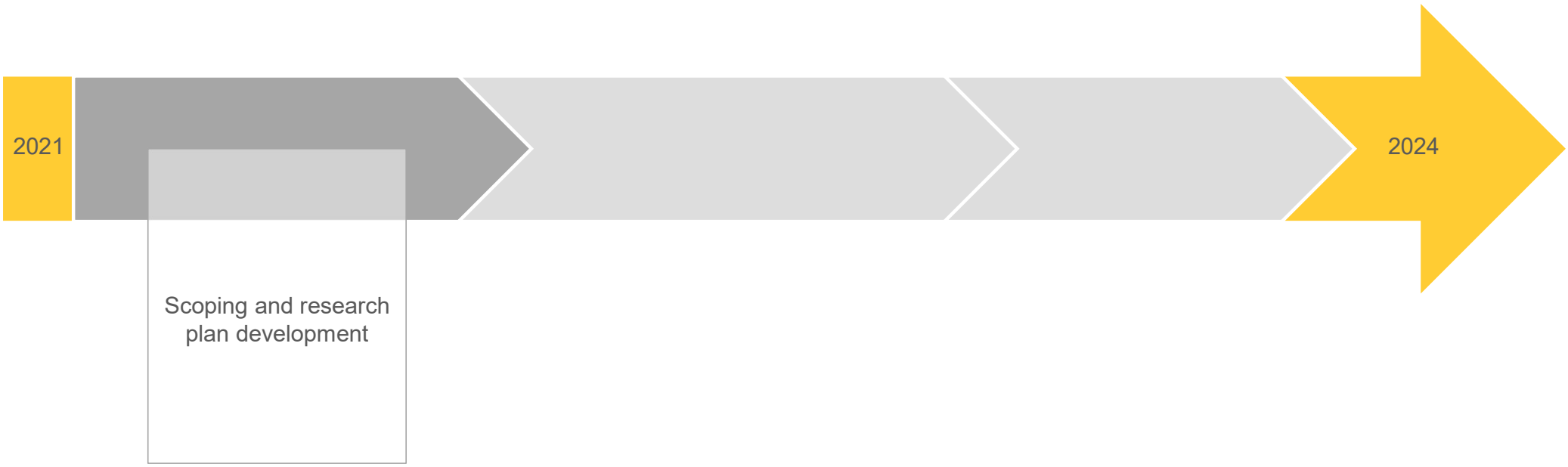
IIHS HLDI

Virtual testing

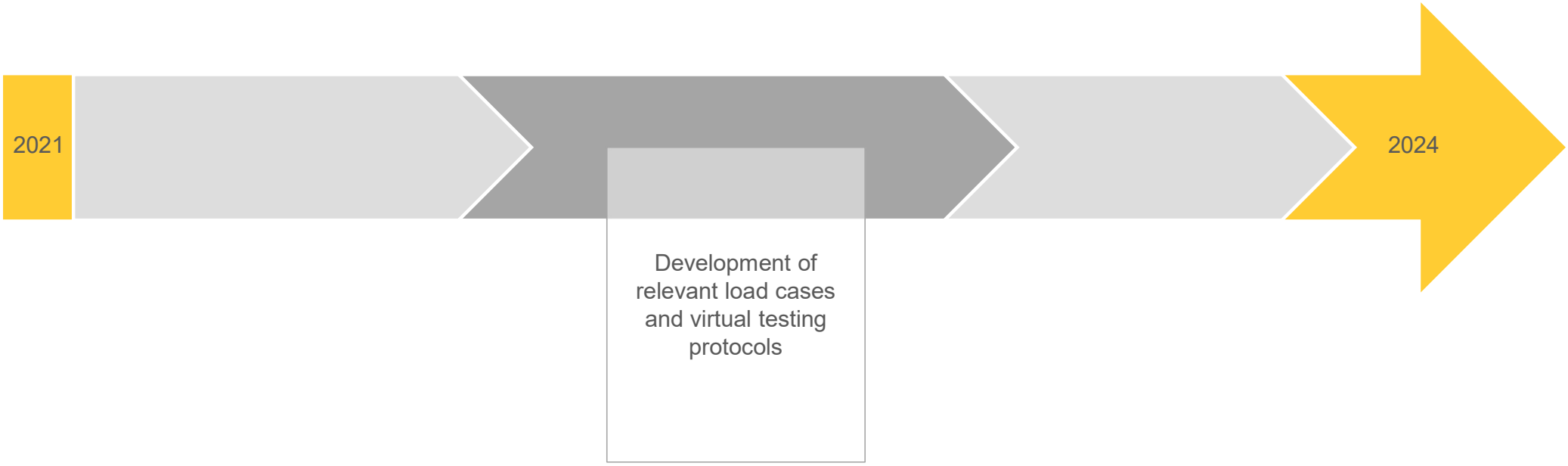
Research motivations

- Develop a virtual testing framework that can be used to promote seat safety robustness for a range of occupant size, sex, and seating position
- Lay groundwork for the possible use of human body models to evaluate rear impact whiplash
- Gain organizational experience with virtual testing and explore opportunities where virtual testing could be feasible and beneficial
- Develop a framework for the certification and validation of automaker seat models and/or automaker simulation results, data sharing with automakers and a workflow for virtual testing

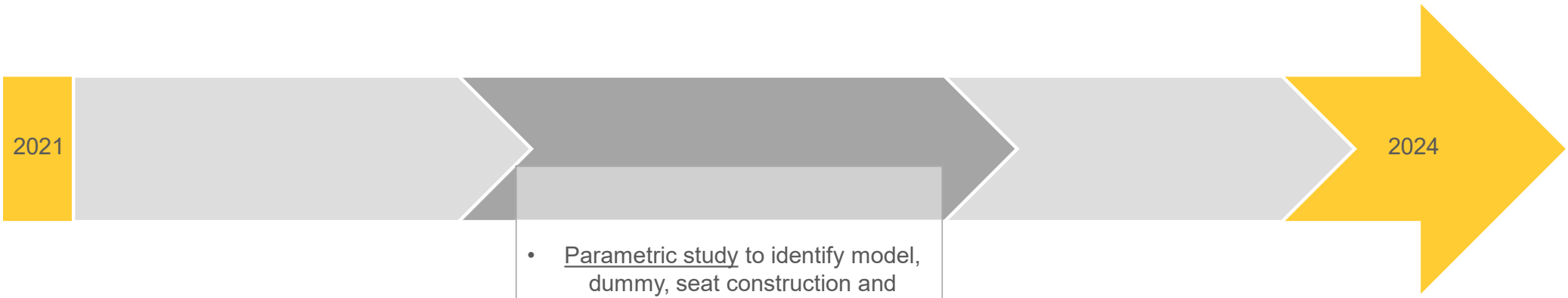
Virtual testing research plan



Virtual testing research plan



Virtual testing research plan



- Parametric study to identify model, dummy, seat construction and performance factors of importance
- Traceability protocols for ensuring trust in virtual test results while also maintaining the integrity of OEM intellectual property
- Identify out-of-position rear impact scenarios using SHRP2 dataset

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Research Project Updates

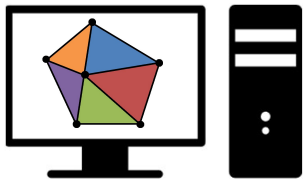
- Parameter Study
- Traceability Study
- Out of position scenario study

Parametric study

What affects rear impact responses?

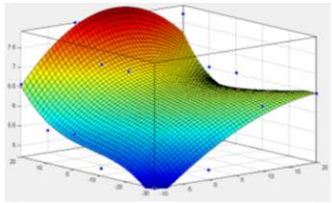
Parameter exploration

Seat and restraint



Modeling factors

Automated simulations



Response models
Data analysis

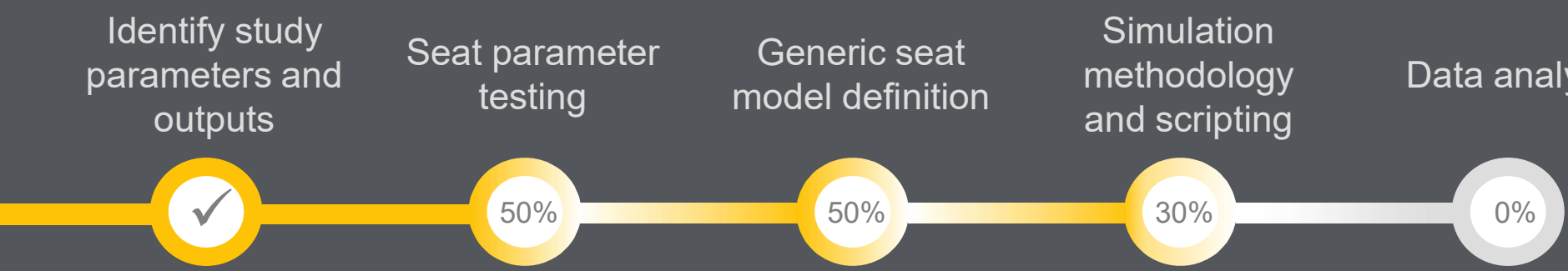
Outcomes

Factors that influence response

Inform future validation cases

Recommendations on injury metrics

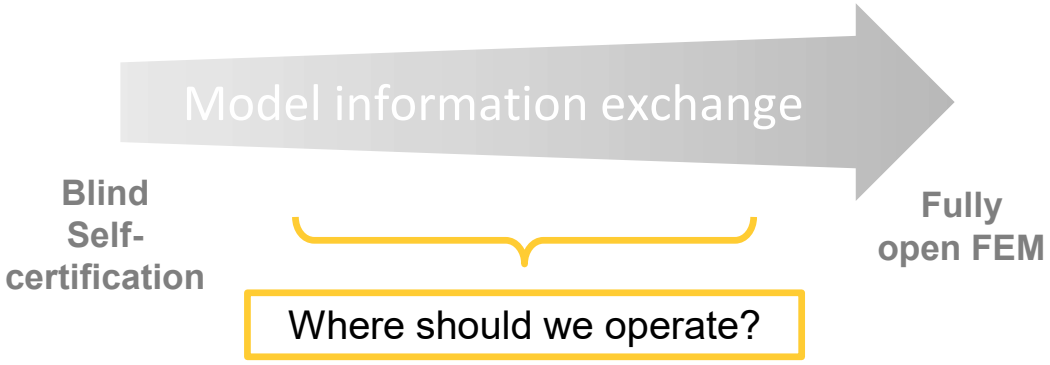
Parameter study progress



Model traceability

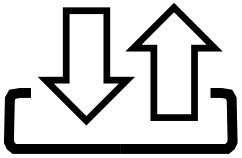
Sharing information without compromising IP concerns

How much information needs to be exchanged?



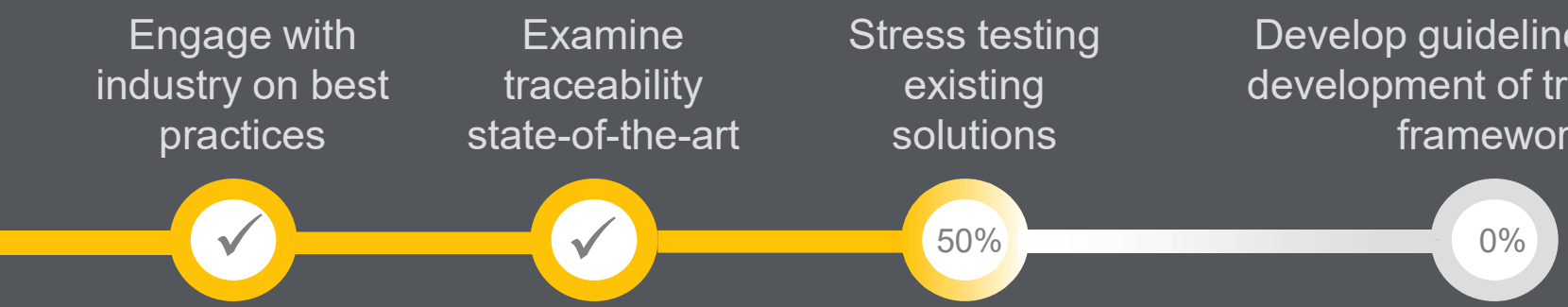
How do we protect IP concerns?

Fingerprinting



Input-output
checker report

Traceability study progress



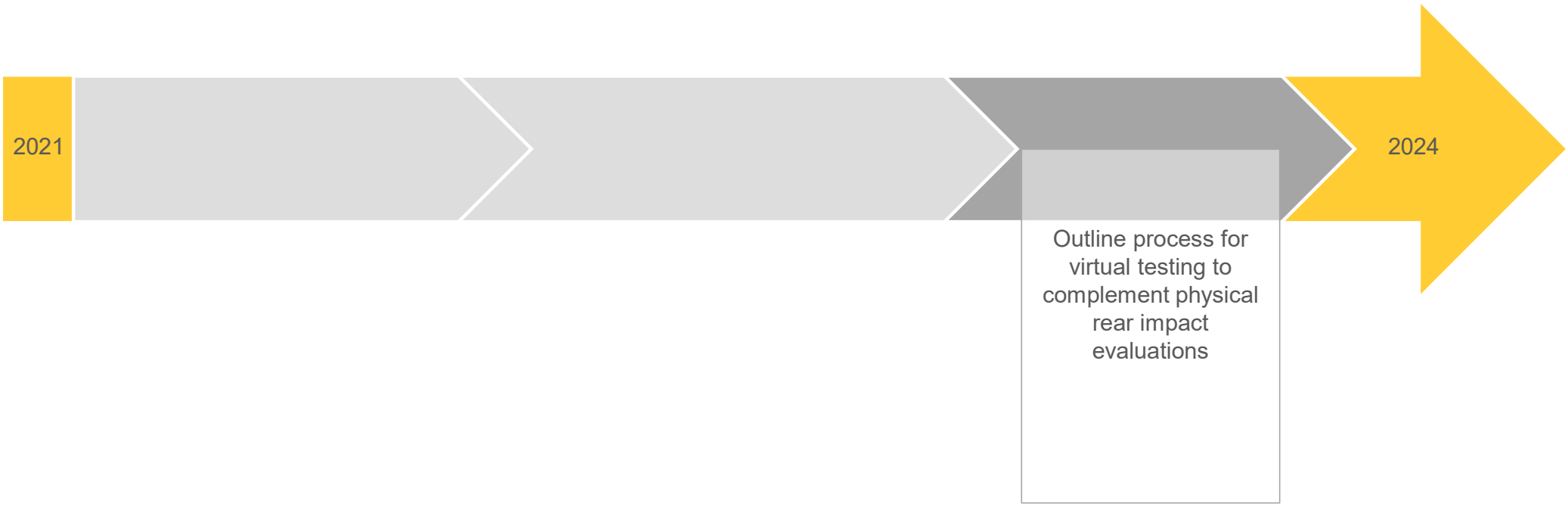
Out of position research

SHRP2 dataset

SHRP2 test sample data - Original and masked video.
Videos must be masked to access outside of secure enclave sites.

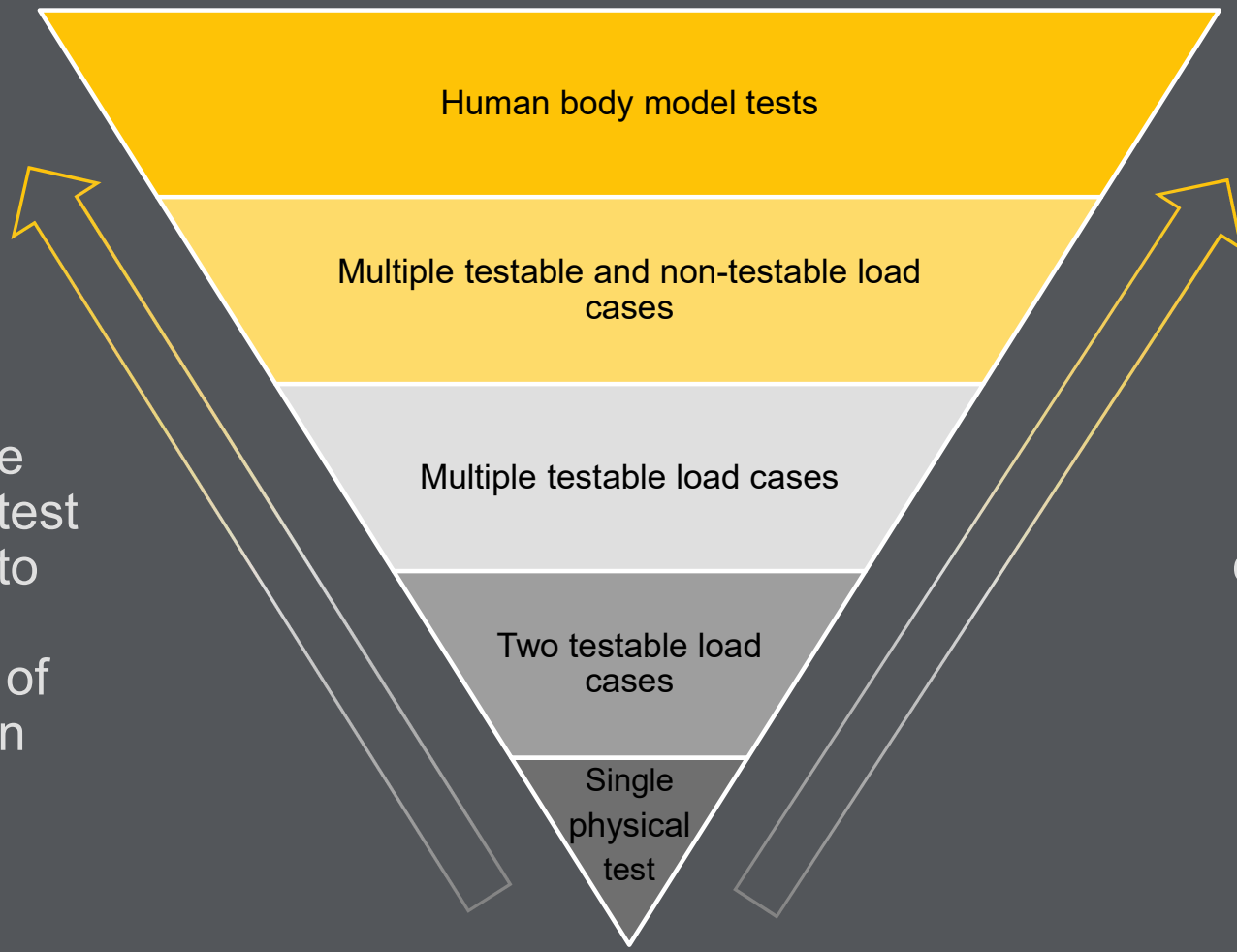
- Videos will provide high level information on occupant position and actions at the time of a rear impact crash. (e.g., looking left, looking down, head greater than 7 cm from head restraint)

Virtual testing research plan



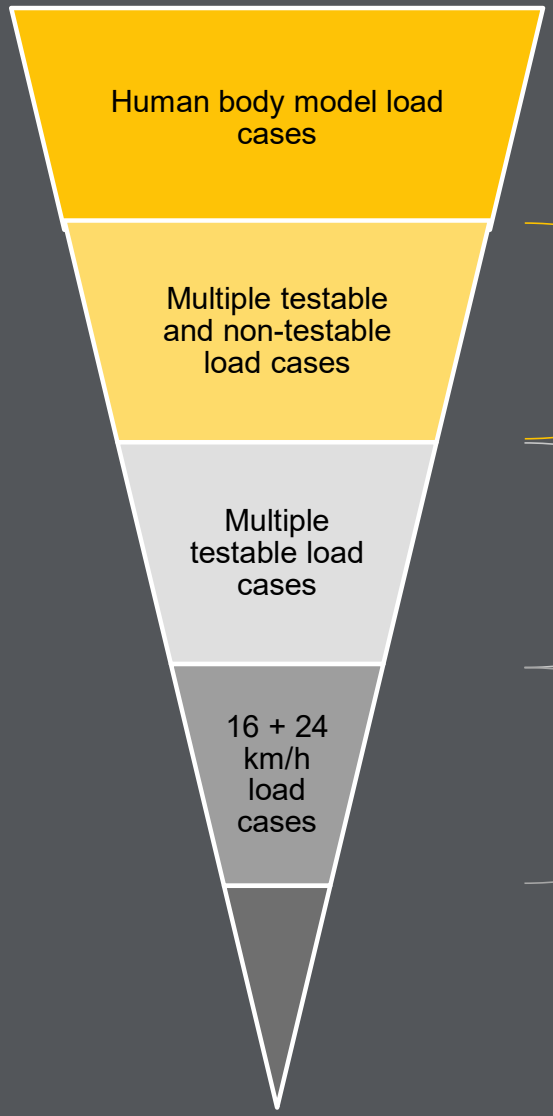
Preliminary Implementation Plan for Virtual Testing for Rear Impacts

Long term virtual testing goal



Expand the variability of test conditions to improve robustness of seat design

Increase complexity of oversight



Use traceability safeguards to allow models validated with a physically testable case to be used for untestable cases

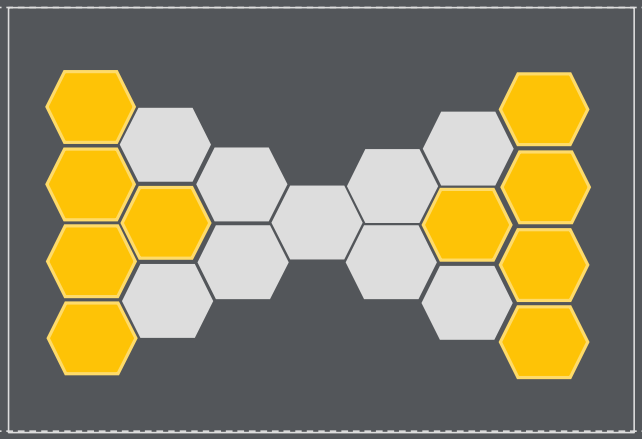
Expand load cases and the tools for assessment without sophisticated oversight

Introduce simulation in evaluation in a way that does not require sophisticated oversight

Virtual testing strategy

Validate many load cases with few physical tests

Physically testable cases

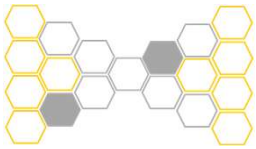


Untestable cases

IIHS Rear Impact Concept Assessment Matrix

Virtual testing workflow

Automaker conducts physical or simulated rear impact tests and provides results to IIHS



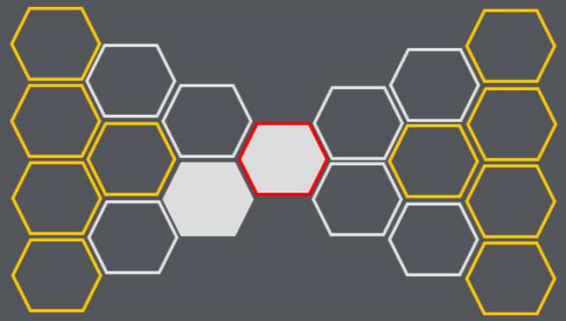
IIHS physically audits select loads cases to validate all results

After comparison analysis and correction rear impact rating is applied

G A M P

Auditing and validation

1.0 Targeted auditing concept



Assessed load cases

Future load cases

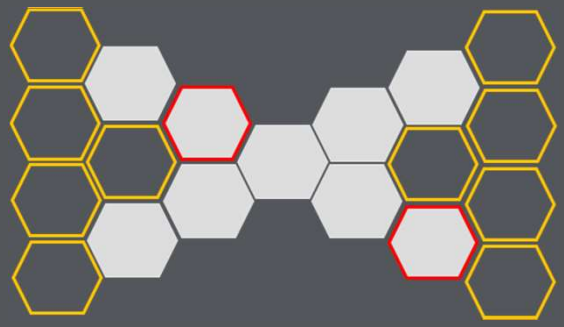
Audited tests

Physically testable

Physically untestable

Auditing and validation

2.0 Random auditing concept



Assessed load cases

Future load cases

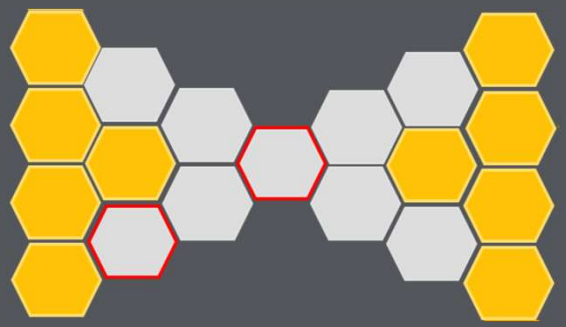
Audited tests

Physically testable

Physically untestable

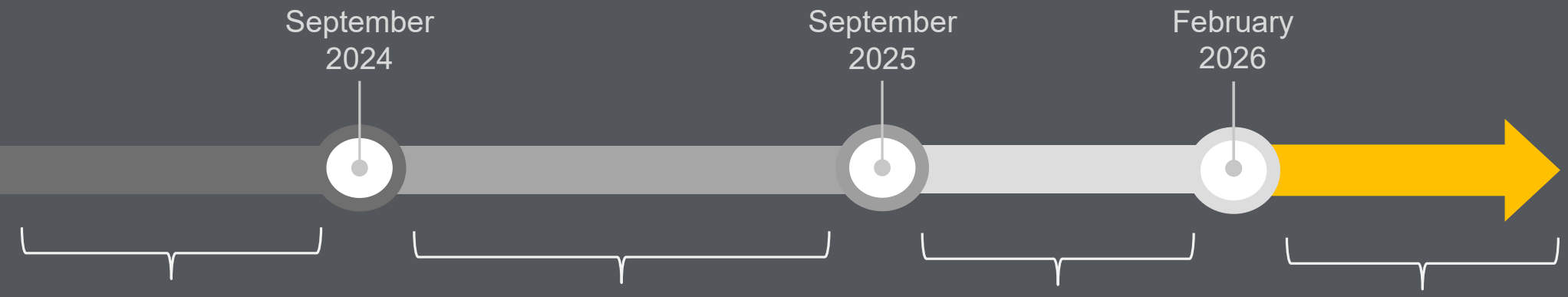
Auditing and validation for untestable load cases

3.0 Traceability safeguards concept



	Physically testable	Physically untestable
Assessed load cases		
Future load cases		
Audited tests		

Rear Impact research and evaluations



Finalize protocols

- Testing variation
- Simulation error
- Protocols for testing and assessment of 16 km/h and 24 km/h pulses
- Protocols for acceptance of verification submission (physical or simulation)

Initiate evaluation program

- Request verification data (physical or simulation) for 16 km/h and 24 km/h tests
- Conduct 1 physical audit/validation test in-house

Update rear impact ratings

- Targeting 2026 TSP

Expand evaluations

- Occupant size
- Seating positions
- Development of software and/or hardware tools needed to move beyond BioRID in standard seating position

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Insurance Institute for Highway Safety
Highway Loss Data Institute

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THANK YOU

Marcy Edwards
Senior research engineer
medwards@iihs.org