IIHS includes motorcycles in front crash prevention testing program

SMSA annual meeting

September 15, 2023

Eric Teoh
Director of Statistical Services

Saving lives. Preventing harm.

IIHS-HLDI mission:

To reduce deaths, injuries and property damage from motor vehicle crashes through **research and evaluation** and through **education** of consumers, policymakers and safety professionals.

Crash tests

Research

IIHS-HLDI reducing harm

Track tests

Communication

WTHR — August 19, 2021
Yes, Carmel's roundabouts have a huge impact in reducing crashes

STREETS BLOG USA — August 10, 2021
Study: Protected Bike Paths Saved Lives During COVID

DETROIT FREE PRESS — May 3, 2021
2021 Bronco Sport crushes its crash tests, reaches Mt. Everest of safety ratings

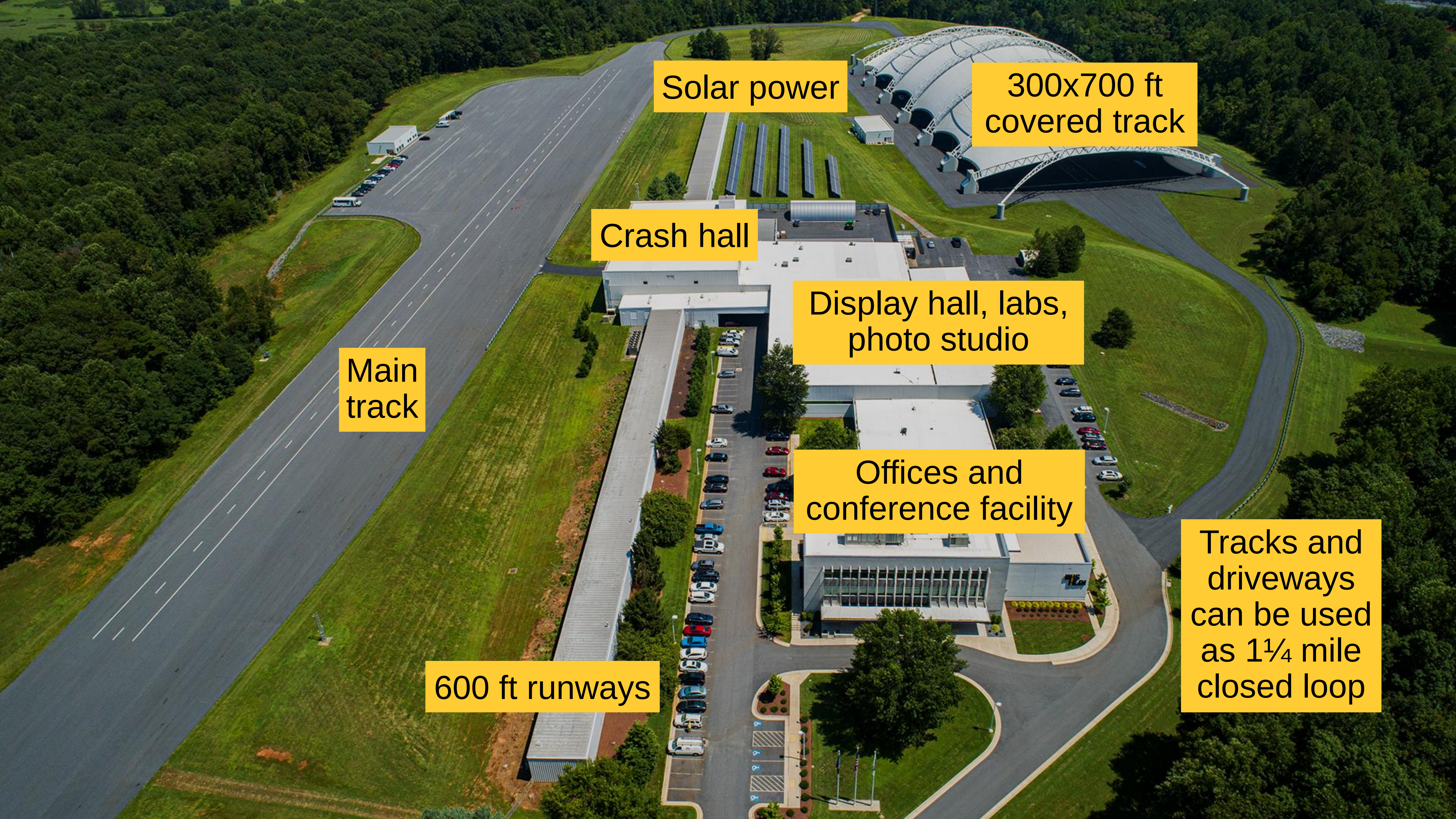
IIHS: Adaptive cruise control, Level 2 Pilot Assist ADAS often inactive on sharp curves

THE BRAKE REPORT — September 1, 2021
Study by IIHS Shows Motorcycle ABS Saves Lives

ROAD SHOW (CNET) — September 21, 2021
Volkswagen ID 4 nabs coveted IIHS Top Safety Pick Plus award

CLAIMS JOURNAL — September 13, 2021
Advanced Safety Equipment Slashes Young Driver Claim Rates More Than Half


117 employees
Washington, DC
Arlington, VA
Ruckersville, VA
4121 WILSON
42 staff members
75 staff members



Solar power
300x700 ft
covered track
Crash hall
Display hall, labs,
photo studio
Main
track
Offices and
conference facility
Tracks and
driveways
can be used
as 1¼ mile
closed loop
600 ft runways

Front crash prevention technology

- AEB, FCW, often focusing on AEB
- IIHS testing, 2013-present
- Automakers' voluntary commitment, 2016-2022
- USDOT proposed mandates, 2023
- No requirement for motorcyclist detection…

Automatic emergency braking

- ⬇ 50% Front-to-rear crashes
- ⬇ 56% Front-to-rear crashes with injuries
- ⬇ 14% Claim rates for damage to other vehicles
- ⬇ 24% Claim rates for injuries to people in other vehicles
- ⬇ 41% Large truck front-to-rear crashes

Automatic emergency braking with pedestrian detection

- ⬇ 27% Pedestrian crashes
- ⬇ 30% Pedestrian injury crashes

Front crash prevention technology needs to detect motorcyclists

- Failure to see/perceive motorcyclist is a common factor in crashes
- Technology can help, if it works
- Incremental improvement

Motorcycle crashes avoidable annually if all passenger vehicles had AEB systems that detect them

- 70 fatal rear-end crashes (2-vehicle)
- 4,900 police-reported rear-end crashes (2-vehicle)
- Some crashes involving 3+ vehicles

SMSA 2018

IIHS HLDI

TRAFFIC INJURY PREVENTION
2018, VOL. 19, NO. 5, 513–517
https://doi.org/10.1080/15389588.2018.1440082

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Motorcycle crashes potentially preventable by three crash avoidance technologies on passenger vehicles

Eric R. Teoh

Insurance Institute for Highway Safety, Arlington, Virginia

ABSTRACT

Objective: The objective of this study was to identify and quantify the motorcycle crash population that would be potential beneficiaries of 3 crash avoidance technologies recently available on passenger vehicles.

Methods: Two-vehicle crashes between a motorcycle and a passenger vehicle that occurred in the United States during 2011–2015 were classified by type, with consideration of the functionality of 3 classes of passenger vehicle crash avoidance technologies: frontal crash prevention, lane maintenance, and blind spot detection. Results were expressed as the percentage of crashes potentially preventable by each type of technology, based on all known types of 2-vehicle crashes and based on all crashes involving motorcycles.

Results: Frontal crash prevention had the largest potential to prevent 2-vehicle motorcycle crashes with passenger vehicles. The 3 technologies in sum had the potential to prevent 10% of fatal 2-vehicle crashes and 23% of police-reported crashes. However, because 2-vehicle crashes with a passenger vehicle represent fewer than half of all motorcycle crashes, these technologies represent a potential to avoid 4% of all fatal motorcycle crashes and 10% of all police-reported motorcycle crashes.

Discussion: Refining the ability of passenger vehicle crash avoidance systems to detect motorcycles represents an opportunity to improve motorcycle safety. Expanding the capabilities of these technologies represents an even greater opportunity. However, even fully realizing these opportunities can affect only a minority of motorcycle crashes and does not change the need for other motorcycle safety countermeasures such as helmets, universal helmet laws, and antilock braking systems.

ARTICLE HISTORY
Received 13 September 2017
Accepted 8 February 2018

KEYWORDS
Motorcycle crashes; crash avoidance technology; crash type; motorcycle safety; highway safety; forward collision warning; automatic emergency braking; blind spot detection; lane departure warning; lane-keeping assist

Introduction

Motorcycles present their riders with substantial risks in terms of highway safety. They lack structures necessary to protect their occupants in crashes, and their small size makes them harder for other road users to see. Moreover, it is especially challenging to judge the speed of oncoming motorcycles because of their narrow width and because they typically have only one headlamp (Gould et al. 2012). Per mile traveled, motorcyclists are nearly 5 times more likely than passenger car occupants to be injured in traffic crashes and nearly 29 times more likely to be killed (NHTSA 2017).

Efforts to improve motorcycle safety often have focused on helmets and helmet use laws, which have been shown many times over to reduce the risk of dying in crashes (Houston and Richardson 2008; Liu et al. 2009). However, helmets do not prevent all deaths and injuries, so crash prevention is also crucial. Antilock braking systems help motorcyclists avoid many crashes (Basch et al. 2015; Rizzi et al. 2015, 2016; Teoh 2013) but do not directly address the problem that motorcycles are not as visible to other road users. Rider training courses typically teach riders to position themselves in more visible locations (Motorcycle Safety Foundation 2014), but this does not change the physical characteristics of motorcycles, limiting potential benefits.

The proliferation of crash avoidance technologies on passenger vehicles represents an opportunity to reduce the conspicuity problem that motorcyclists face. These technologies, which exist under a wide variety of brand names and functionality specifics, use advanced sensors to monitor some aspects of the driving environment and warn the driver or intervene when they detect a possible collision. There are 3 primary classes of such systems that potentially could prevent crashes in which a passenger vehicle strikes a motorcycle: Front crash prevention, lane maintenance, and blind spot detection.

Front crash prevention systems use radar, laser, or video camera sensors (or some combination thereof) to monitor the road environment ahead. Forward collision warning (FCW) systems warn the driver if a collision is likely, and automatic emergency braking (AEB) systems apply the vehicle's service brakes to prevent or mitigate a forward impact if the driver does not take corrective action. A vehicle may be equipped with FCW, AEB, or both, but typically AEB systems include FCW. These systems focus on vehicles traveling in the same direction and are thus most relevant to rear-end crashes. Among current systems, there is much variation in whether AEB functions at all speeds and whether it brings the vehicle to a complete stop, whether FCW/AEB detects stationary vehicles, and whether these systems detect smaller road users like motorcyclists, bicyclists, pedestrians, or animals. Front crash prevention systems, especially those with both FCW and AEB, have been shown to reduce rear-end crash rates in the passenger vehicle fleet

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Associate Editor Giovanni Savino oversaw the review of this article.
Supplemental data for this article can be accessed on the publisher's website.

Left turn oncoming crashes avoided annually if all vehicles had left turn assist that detects them

- 750 fatal crashes (2-vehicle)
- 8,400 police-reported crashes (2-vehicle)
- Some crashes involving 3+ vehicles

TRAFFIC INJURY PREVENTION
2023, VOL. 24, NO. 6, 511–512
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Left-turn crashes and motorcycle safety

Eric R. Teoh

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ABSTRACT

Objective: To provide updated statistics on crashes in which another vehicle turns left in front of an oncoming motorcycle and discuss the potential of left turn assist technology.
Methods: Motorcycle driver involvements in 2-vehicle fatal and police-reported crashes during 2017-2021 were tabulated by crash type, with a focus on crash types involving vehicles turning.
Results: Crashes in which another vehicle turned left in front of an oncoming motorcycle were, by far, the most frequent type of fatal 2-vehicle motorcycle crash, at 26%.
Conclusion: There is a large opportunity to reduce harm by specifically addressing crashes in which another vehicle turns left in front of an oncoming motorcycle – ideally using a variety of countermeasures simultaneously.

ARTICLE HISTORY
Received 14 October 2022
Accepted 3 June 2023

KEYWORDS
Motorcycle safety; crash avoidance technology; left turns; left turn assist; crash avoidance; motorcycle

Introduction

While much progress has been made in reducing passenger-vehicle-occupant crash deaths, motorcyclists remain overrepresented in fatal crashes. One important countermeasure is motorcycle antilock braking systems (ABS), which have been proliferating in the motorcycle fleet and have been shown to reduce rider fatal crash rates by nearly a quarter (Teoh 2022). There are other motorcycle active safety systems under development or not yet widely available that show promise as well (Savino et al. 2020). Another promising countermeasure is the increasingly available crash avoidance technologies available on passenger vehicles, which have the potential to prevent 4-8% of fatal (and 9-10% of police-reported) motorcycle driver crash involvements in the United States (Teoh 2018; Dean et al. 2021). A study from France also estimated strong benefits for crash types deemed relevant to automatic emergency braking that detects motorcyclists (Saadé et al. 2022). Teoh (2018) discussed crashes in which a passenger vehicle turns left in front of an oncoming motorcycle as a particular area of concern. It was not the first study to identify this crash type as an area of concern, but the study did note that the emerging technology left-turn assist (LTA) on passenger vehicles as a huge opportunity to improve motorcyclist safety. The purpose of the current technical note is to provide updated statistics on this crash type and discuss the potential of LTA on improving rider safety.

Methods

Data on motorcycle driver involvements in 2-vehicle crashes during 2017-2021 were obtained from two sources. Fatal crash data were extracted from the Fatality Analysis Reporting System (FARS), which is a census of crashes in the United States that resulted in death within 30 days. Data on police-reported crashes were from the Crash Report Sampling System (CRSS), which is a nationally representative sample of police crash reports; CRSS weights were used to provide national crash count estimates. Both FARS and CRSS are maintained by the National Highway Traffic Safety Administration and have largely similar coding of data elements. For both datasets, drivers were defined as person type 1, motorcycles as body type 80–89, and crash types were categorized based on the acc_type variable, which codes the roles of both vehicles in the crash. The crash type coding in the current report is largely identical to that of Teoh (2018), except that some categories have been collapsed since specific crash avoidance technologies, aside from LTA, are not being discussed. In the Teoh (2018) study, crash type distribution was largely similar for driver involvements in crashes that resulted in injury and involvements in all police-reported crashes, so only the latter is presented in the current report. The analysis was repeated for crash involvements of passenger-vehicle (defined as 0 < bodytype < 50) drivers, and a few of the numbers are presented.

Results

Crashes in which another vehicle turned left in front of an oncoming motorcycle were, by far, the most frequent type of fatal 2-vehicle motorcycle crash, accounting for 26% of motorcycle driver involvements in 2-vehicle fatal crashes (Table 1). While still eclipsed by single-vehicle crashes (38% of motorcycle drivers involved in fatal crashes), this presents

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Associate Editor David Viano oversaw the review of this article.

Left turn oncoming crashes avoided annually if all vehicles had left turn assist that detects them

- 750 fatal crashes (2-vehicle)
- 8,400 police-reported crashes (2-vehicle)
- Some crashes involving 3+ vehicles

For LTA to detect motorcyclists, AEB must detect them

IIHS HLDI

TRAFFIC INJURY PREVENTION
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Left-turn crashes and motorcycle safety

Eric R. Teoh

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Associate Editor David Viano oversaw the review of this article.

Overrepresented crash scenarios for passenger vehicles with AEB

- Striking vehicle was turning vs. moving straight
- Struck vehicle was turning vs. slowing or stopped
- Struck vehicle was not a passenger vehicle or was special use vs. car
- Snowy/icy roads vs. dry
- Speed limit 70+ mph vs. 40-45
- Rear corner was struck vs. center

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2019, VOL. 20, NO. S1, S112–S118
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Characteristics of rear-end crashes involving passenger vehicles with automatic emergency braking

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Insurance Institute for Highway Safety, Arlington, Virginia

ABSTRACT

Objectives: Automatic emergency braking (AEB) is a proven effective countermeasure for preventing front-to-rear crashes, but it has not yet fully lived up to its estimated potential. This study identified the types of rear-end crashes in which striking vehicles with AEB are overrepresented to determine whether the system is more effective in some situations than in others, so that additional opportunities for increasing AEB effectiveness might be explored.

Methods: Rear-end crash involvements were extracted from 23 U.S. states during 2009–2016 for striking passenger vehicles with and without AEB among models where the system was optional. Logistic regression was used to examine the odds that rear-end crashes with various characteristics involved a striking vehicle with AEB, controlling for driver and vehicle features.

Results: Striking vehicles were significantly more likely to have AEB in crashes where the striking vehicle was turning relative to when it was moving straight (odds ratio [OR] = 2.35; 95% confidence interval [CI], 1.76, 3.13); when the struck vehicle was turning (OR = 1.66; 95% CI, 1.25, 2.21) or changing lanes (OR = 2.05; 95% CI, 1.13, 3.72) relative to when it was slowing or stopped; when the struck vehicle was not a passenger vehicle or was a special use vehicle relative to a car (OR = 1.61; 95% CI, 1.01, 2.55); on snowy or icy roads relative to dry roads (OR = 1.83; 95% CI, 1.16, 2.86); or on roads with speed limits of 70+ mph relative to those with 40 to 45 mph speed limits (OR = 1.49; 95% CI, 1.10, 2.03). Overall, 25.3% of crashes where the striking vehicle had AEB had at least one of these overrepresented characteristics, compared with 15.9% of strikes by vehicles without AEB.

Conclusions: The typical rear-end crash occurs when 2 passenger vehicles are proceeding in line, on a dry road, and at lower speeds. Because atypical crash circumstances are overrepresented among rear-end crashes by striking vehicles with AEB, it appears that the system is doing a better job of preventing the more typical crash scenario. Consumer information testing programs of AEB use a test configuration that models the typical rear-end crash type. Testing programs promoting good AEB performance in crash circumstances where vehicles with AEB are overrepresented could guide future development of AEB systems that perform well in these additional rear-end collision scenarios.

ARTICLE HISTORY
Received 9 November 2018
Accepted 27 January 2019

KEYWORDS
Crash avoidance; collision warning; autonomous emergency braking; AEB testing

Introduction

About one third of crashes reported to police in the United States in 2016 were rear-end crashes (Insurance Institute for Highway Safety [IIHS] 2018). It has been estimated that forward collision warning systems, which warn drivers when a rear-end crash may be imminent, and automatic emergency braking (AEB), which may brake automatically if drivers do not respond to the potential collision, could potentially prevent up to 70% of front-to-rear crashes involving passenger vehicles as striking vehicles and 20% of all passenger vehicle crashes reported to police (Jermakian 2011).

Evaluations of the real-world experiences of vehicles with AEB have demonstrated that the system is very effective in preventing front-to-rear crashes. AEB has been shown to reduce rates of front impact crashes by 27%, rear-end crashes by 27–50%, and rear-end injury crashes by 35–56% (Cicchino 2017; Fildes et al. 2015; Isaksson-Hellman and Lindman 2015a, 2015b, 2016; Rizzi et al. 2014; Spicer et al. 2018). Additionally, AEB has been associated with reductions of 8–20% in rates of insurance claims covering damage to other vehicles inflicted by an at-fault driver and reductions of 23–45% in those covering third-party injuries (Doyle et al. 2015; Highway Loss Data Institute 2018; Sari et al. 2017).

Although the size of crash reductions attributed to AEB is impressive, the technology has thus far not fully lived up to its estimated potential. Multiple factors could diminish the effectiveness of crash avoidance technologies. Use of

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Supplemental material for this article can be accessed on the publisher's website.

IIHS HLDI

Frequent crash types future AEB systems can address

- Subject vehicle turning / head-on crashes
- Low-light conditions
- Partner vehicle was motorcycle or medium/heavy truck
- Higher speeds than original IIHS tests
- 7,300 fatal 2-vehicle crashes annually, 216,000 police-reported ones, some 3+ vehicle crashes

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How can front crash prevention systems address more police-reported crashes in the United States?

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ARTICLE INFO

Keywords:
Front crash prevention
Automatic emergency braking
Forward collision warning
Police-reported crashes
CRSS
FARS

ABSTRACT

Government and consumer-information organizations can motivate automakers to address additional crash types through front crash prevention (FCP) testing programs. This study examined the current state of crashes potentially relevant to current and future FCP systems to provide a roadmap for the next crash types that vehicle testing programs in the United States should evaluate.

Crash records from 2016 to 2020 were extracted from the Crash Report Sampling System (CRSS) and the Fatality Analysis Reporting System (FARS). Crashes were restricted to ones involving no more than two vehicles where the striking or path-intruding vehicle was a passenger vehicle and a vehicle defect was not coded. Percentages of police-reported crashes, nonfatal-injury crashes, and fatal crashes were computed for different crash types and circumstances.

Rear-end and pedestrian crashes evaluated in existing FCP testing programs accounted for 27% of all police-reported crashes, 19% of nonfatal-injury crashes, and 18% of fatal crashes. The remaining crash types relevant to FCP accounted for 25% of police-reported crashes, 31% of nonfatal-injury crashes, and 23% of fatal crashes. A turning passenger vehicle crossing the path of an oncoming vehicle accounted for the largest proportion of the remaining police-reported (8%) and nonfatal-injury crashes (13%). Head-on crashes accounted for the largest proportion of remaining fatal crashes (9%). Most FCP-relevant police-reported crashes occurred on roads with a posted speed limit between 30 and 50 mph. Medium/heavy trucks were the crash partner in a disproportionate number of fatal head-on and rear-end crashes and motorcycles in a disproportionate number of fatal rear-end and turning crossing-path crashes. Fatal bicyclist and pedestrian crashes were overrepresented at night.

The findings from this study indicate that testing organizations should evaluate FCP performance at higher speeds; with non-passenger vehicles and vulnerable road users; during the night; and in more complex head-on and turning crash scenarios to reduce crashes of all severities. Some of these conditions are currently assessed by other testing organizations and can be readily adopted by U.S. programs or possibly addressed with new approaches like virtual testing.

1. Introduction

Front crash prevention (FCP) technologies like forward collision warning (FCW), which notifies the driver of a potential collision threat ahead, and automatic emergency braking (AEB) which automatically applies the brakes to mitigate a collision (and typically includes FCW functionality as well), are preventing crashes (e.g., Fildes et al., 2015; Spicer et al. 2021). Cicchino (2017) examined rear-end crash involvements for vehicles with and without FCW from six manufacturers. Rear-end crash rates were reduced by 27% for vehicles with FCW and reduced by 50% for vehicles with AEB. Leslie et al. (2021) examined the crash involvement of 2013–2019 General Motors vehicles with various crash avoidance features. Vehicles with only a FCW system had a 20% reduction in relevant police-reported crashes while vehicles with camera-based AEB or camera-radar fusion-based AEB had a 38% and 43% reduction, respectively. The Highway Loss Data Institute (HLDI) (2020) compared insurance losses for vehicles from various manufacturers with FCW or AEB relative to the same vehicles without the systems. The presence of FCW was associated with a significant 9% reduction in property damage liability claim frequency, which covers damage to a third-party vehicle or property, and AEB was associated with a 14% reduction.

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IIHS HLDI

Previous IIHS FCP testing

Previous vehicle-to-vehicle front crash prevention tests

20 km/h and **40 km/h**

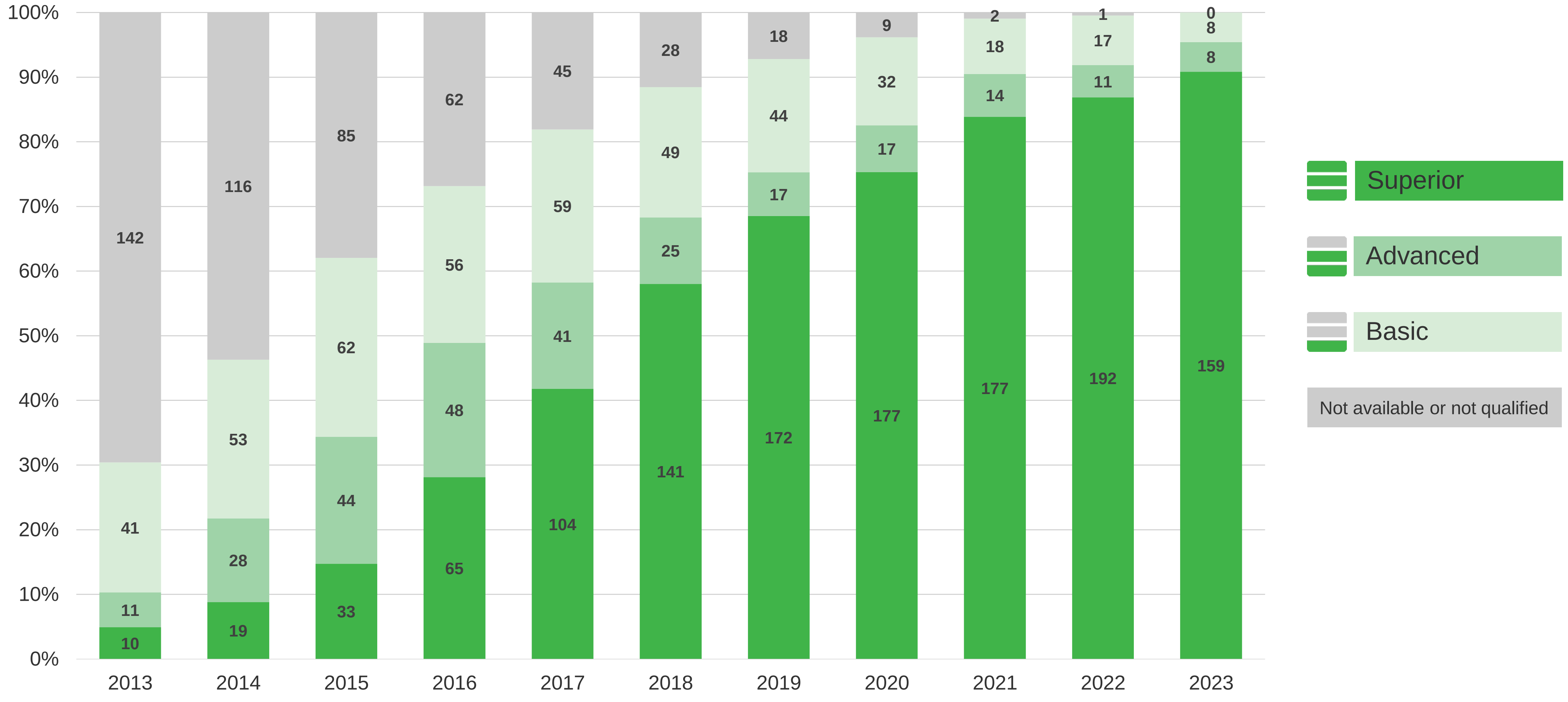
Superior

Advanced

Basic

IIHS front crash prevention ratings

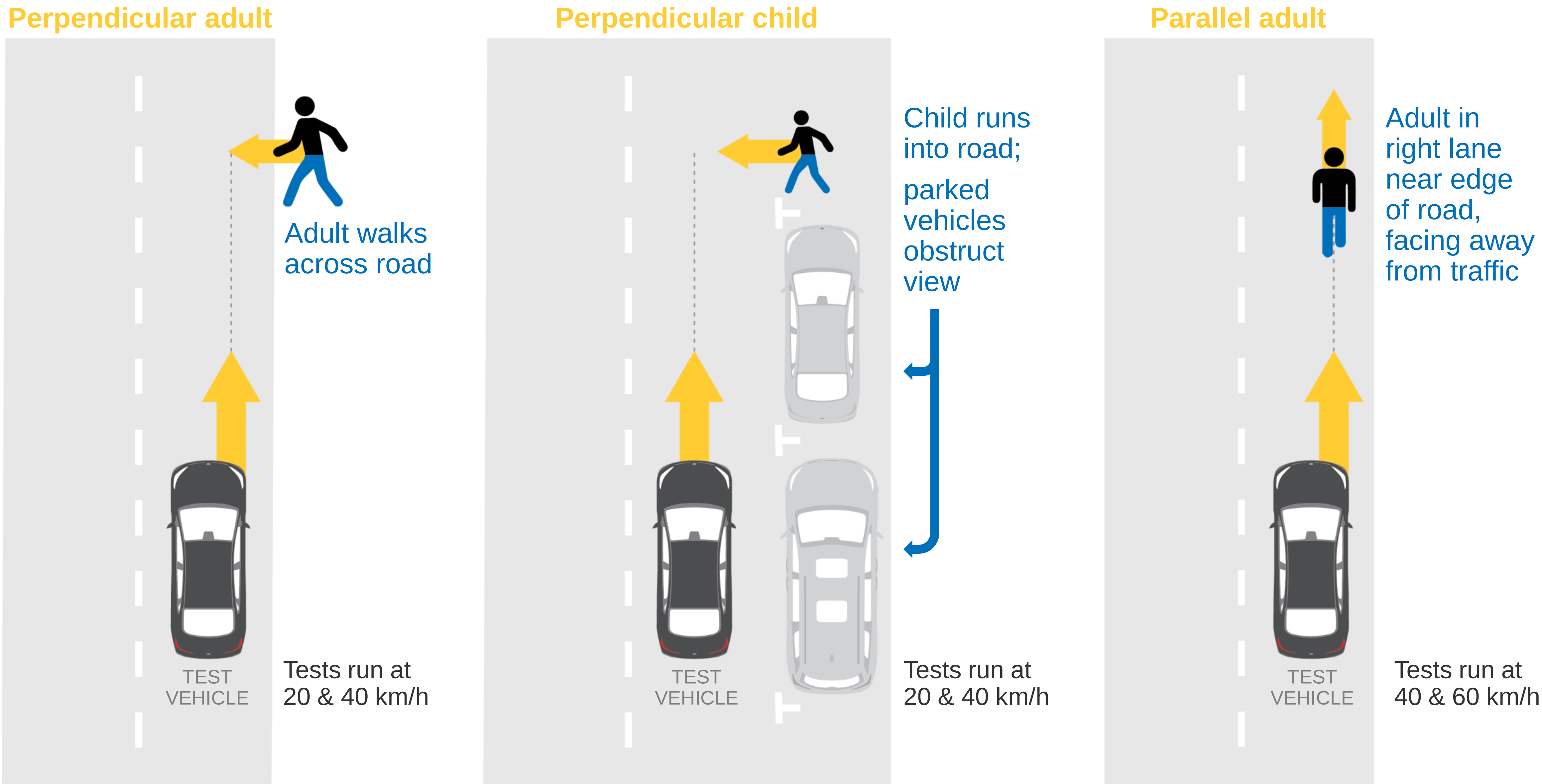
2013-23 models



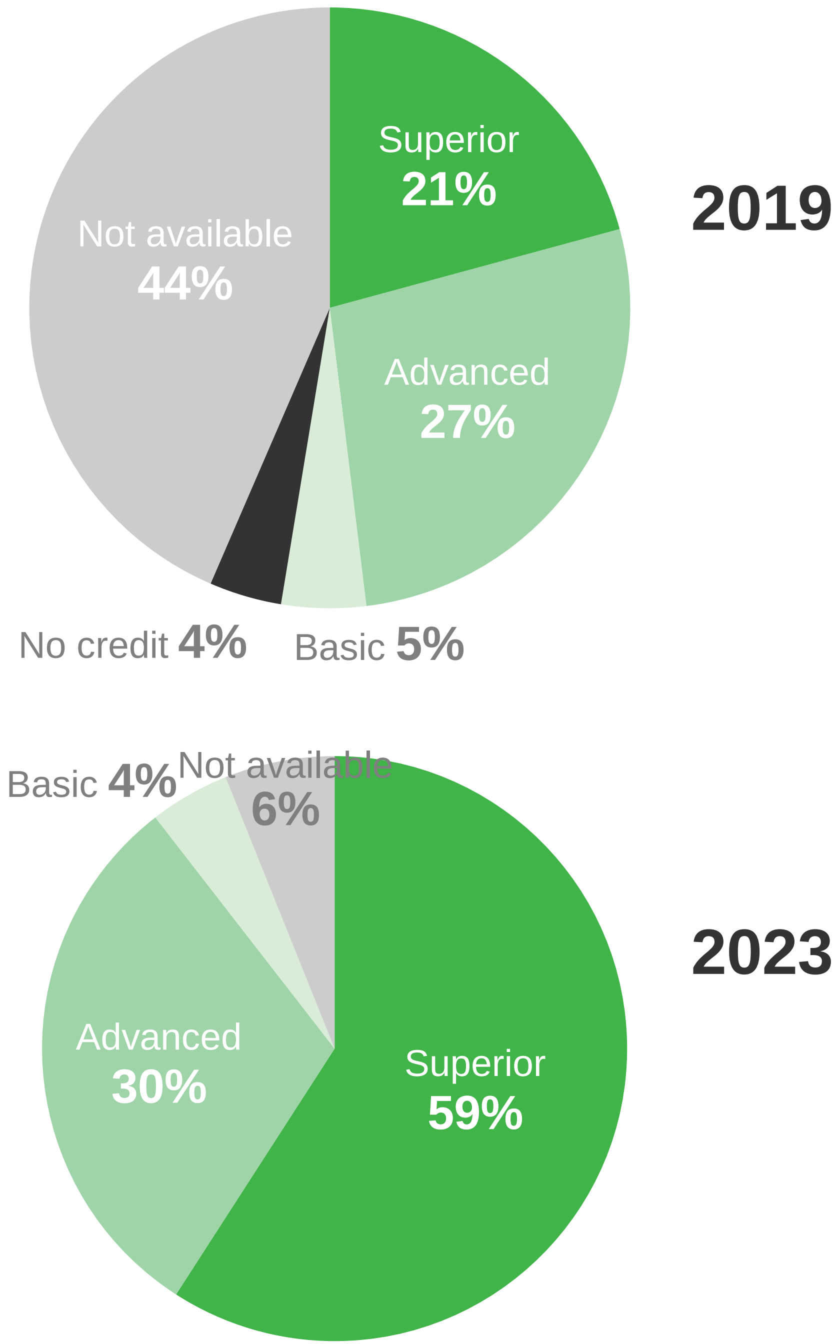
IIHS HLDI

Pedestrian test scenarios beginning in 2018

Pedestrian test scenarios

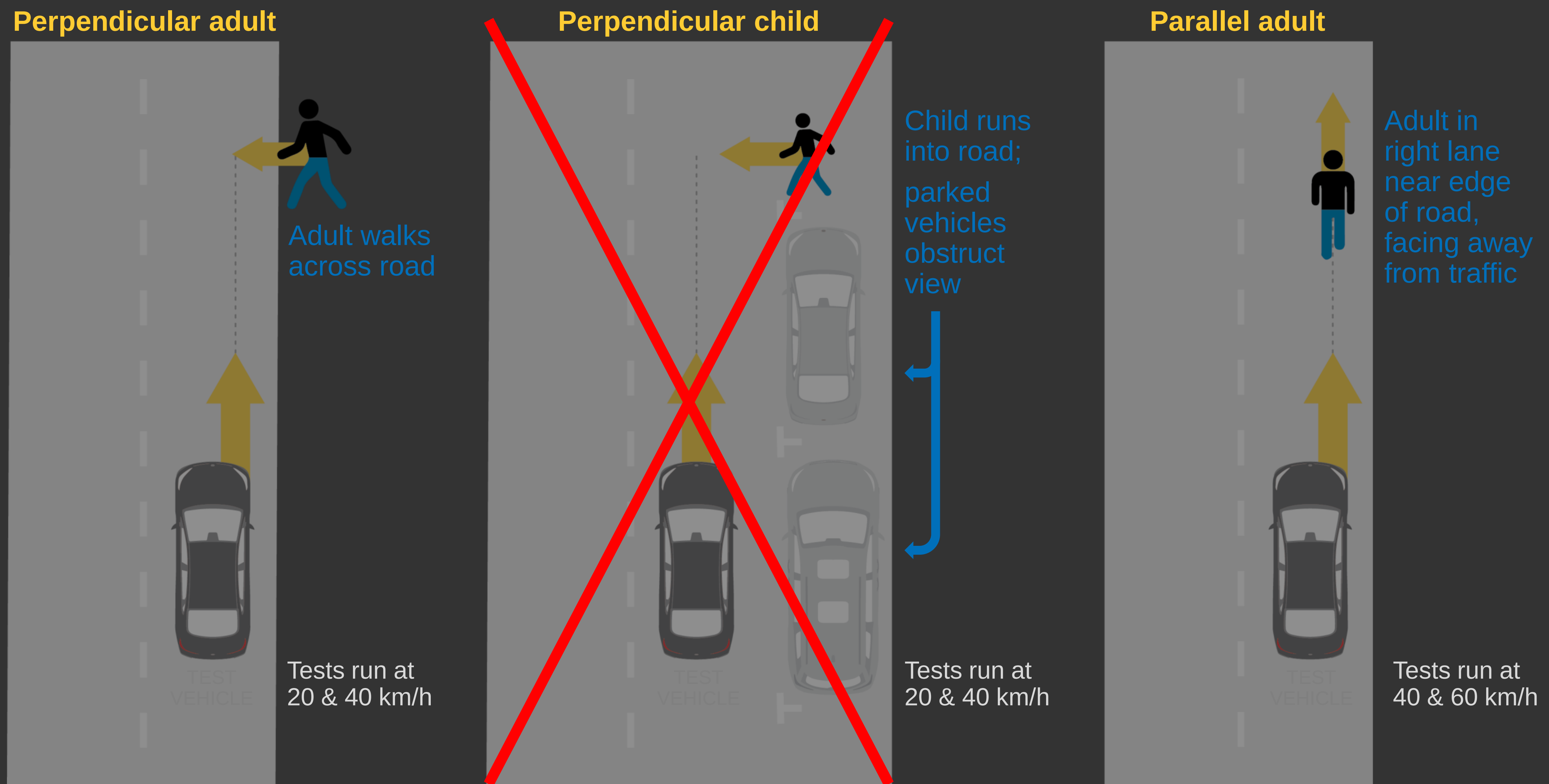


Pedestrian crash prevention ratings by model year



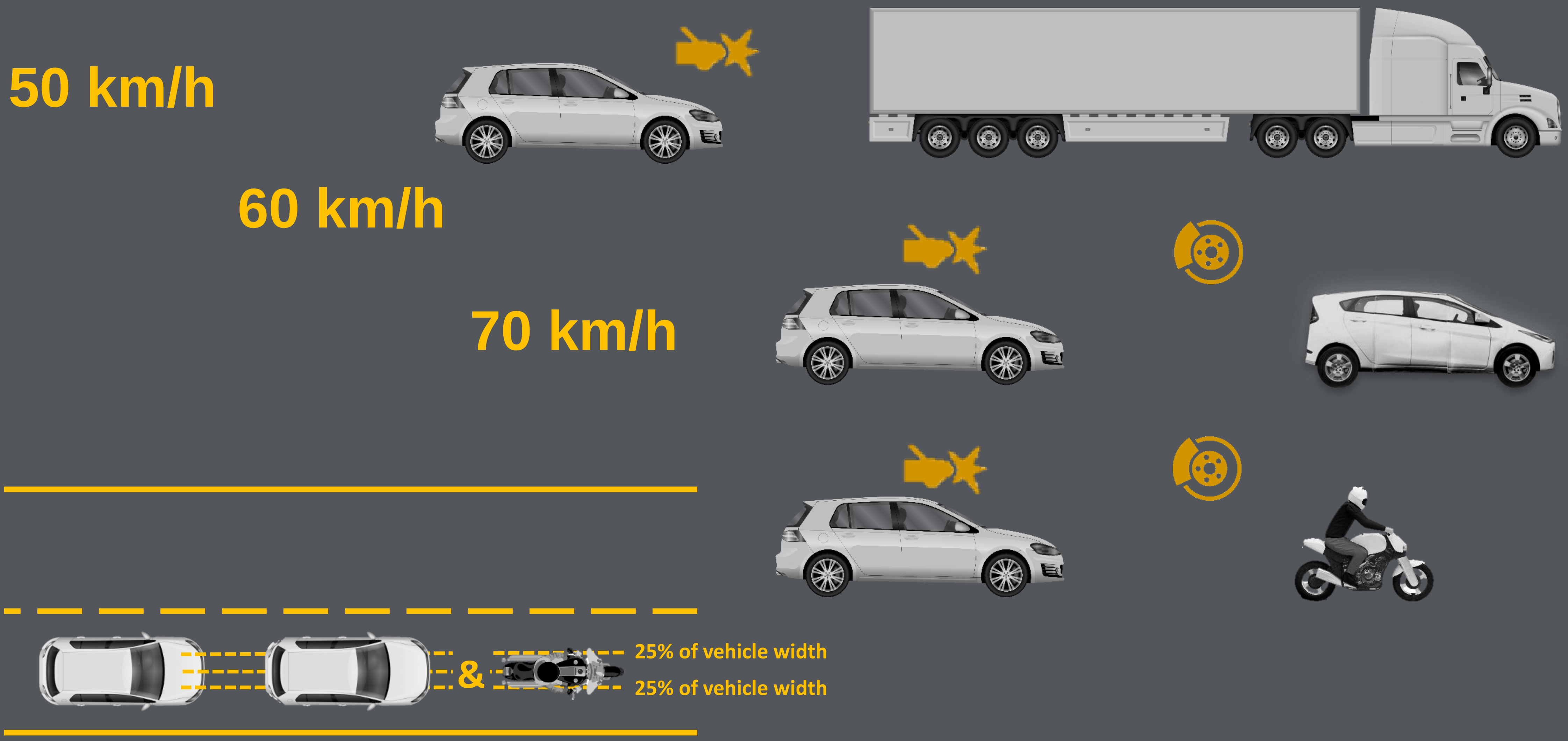
Night pedestrian front crash prevention test scenarios

Test conducted with both low and high beams

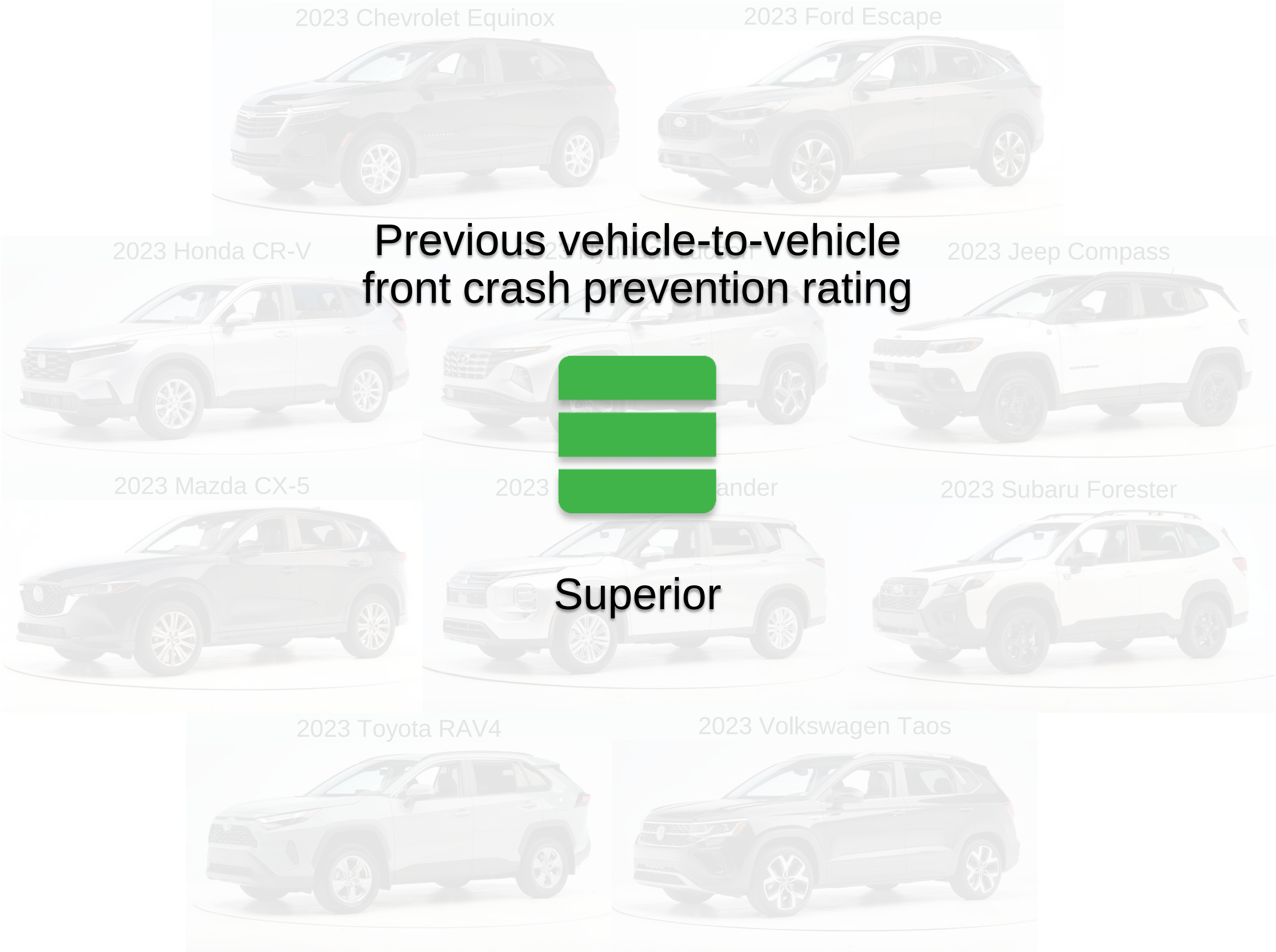


IIHS FCP 2.0 testing

Updated front crash prevention system evaluation



Small SUVs



Previous vehicle-to-vehicle front crash prevention rating

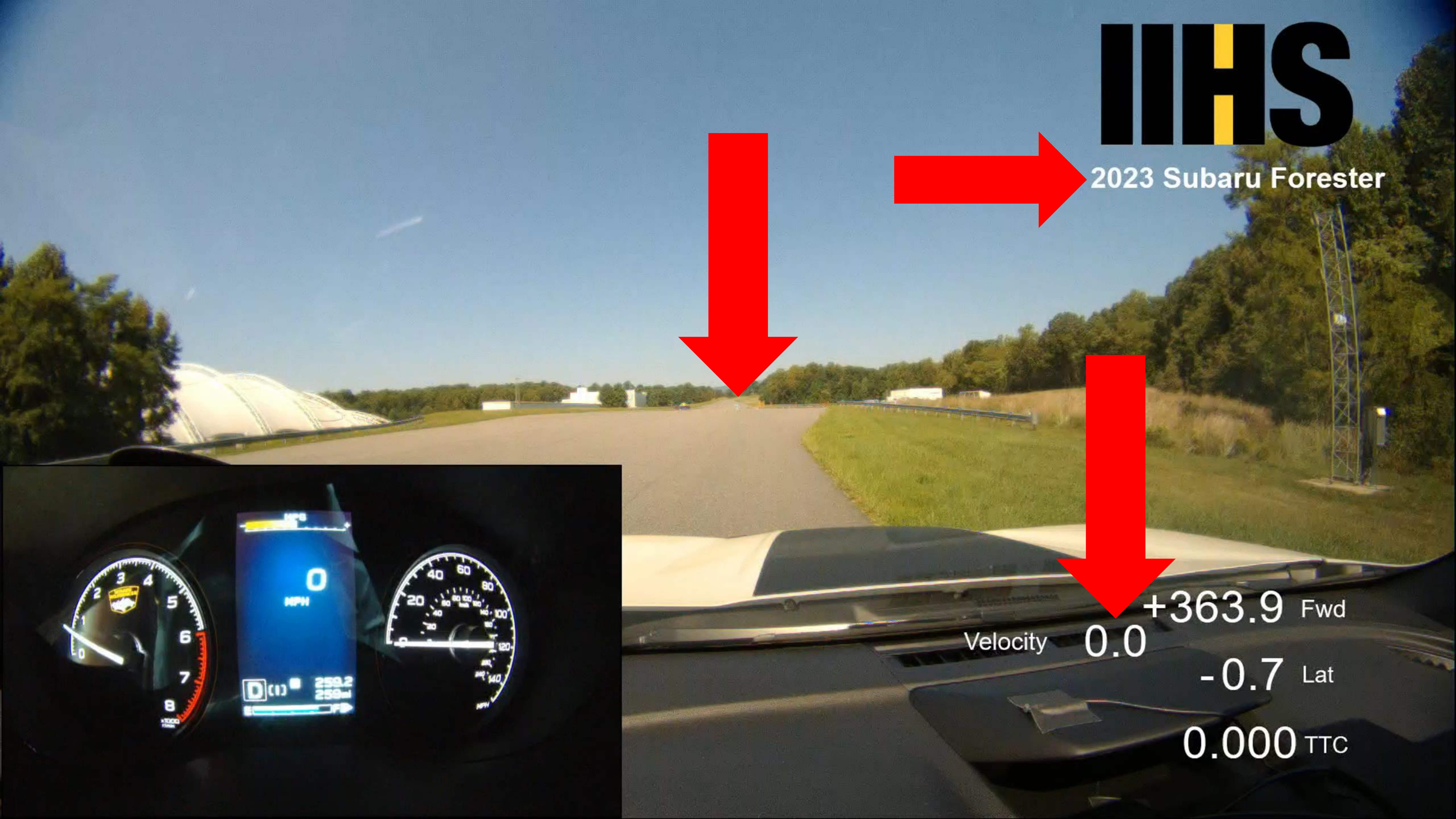
Superior

4activeMC soft target

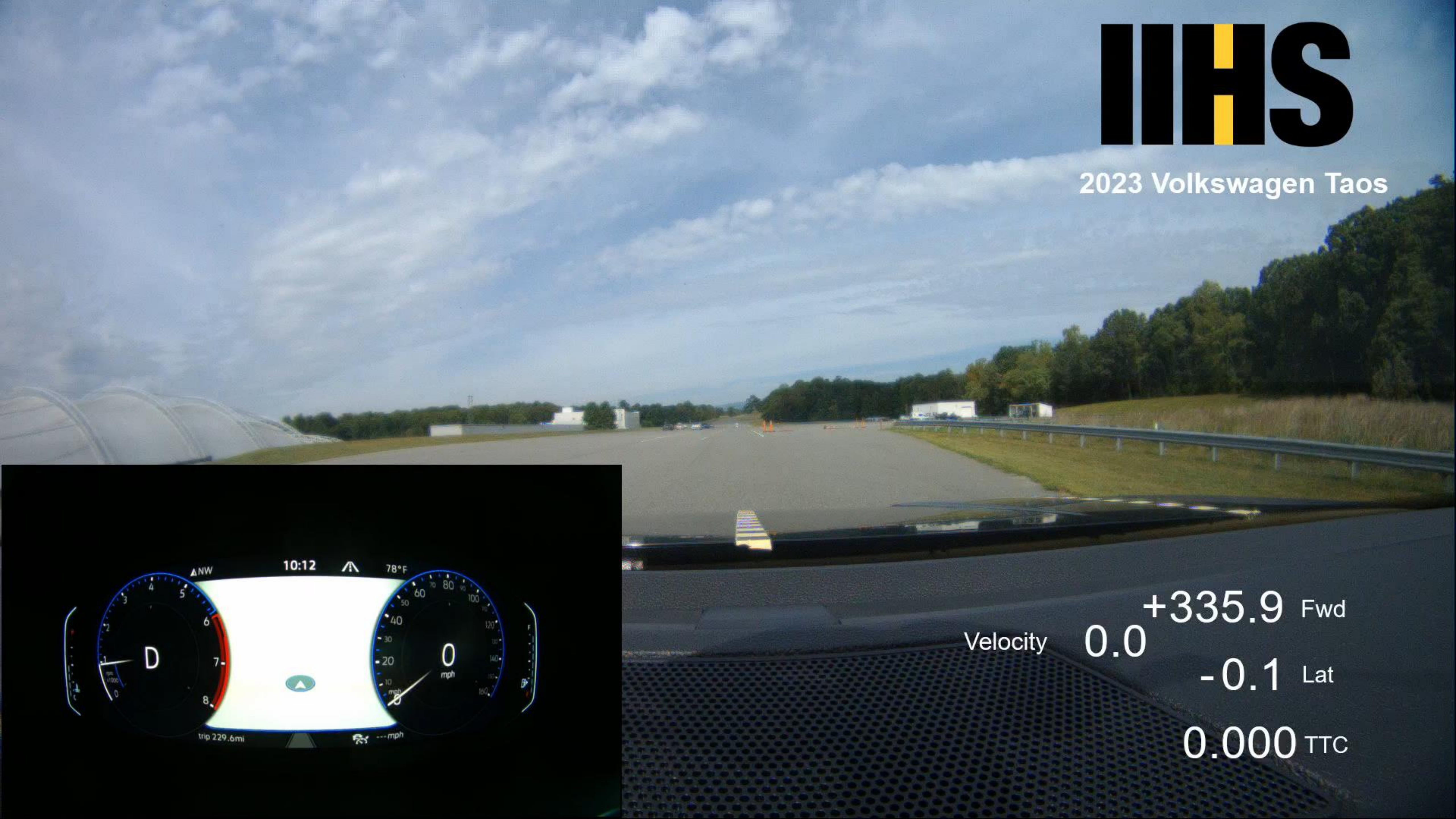
Average FCW time-to-collision

By surrogate target, lane position, and speed

Vehicle	Vanguard trailer			Passenger car, lane center			Passenger car, offset left			Motorcycle, lane center			Motorcycle, offset right		
	50 km/h	60 km/h	70 km/h	50 km/h	60 km/h	70 km/h	50 km/h	60 km/h	70 km/h	50 km/h	60 km/h	70 km/h	50 km/h	60 km/h	70 km/h
2023 Volkswagen Taos															
2023 Toyota RAV4															
2023 Subaru Forester															
2023 Mitsubishi Outlander															
2023 Mazda CX-5															
2023 Jeep Compass															
2023 Hyundai Tucson															
2023 Honda CR-V															
2023 Ford Escape															
2023 Chevrolet Equinox															


2023 Subaru Forester
+363.9 Fwd
Velocity 0.0
-0.7 Lat
0.000 TTC


2023 Subaru Forester
+363.9 Fwd
Velocity 0.0
-0.7 Lat
0.000 TTC


IIHS
2023 Volkswagen Taos
+335.9 Fwd
Velocity 0.0
-0.1 Lat
0.000 TTC
10:12
78°F
D
0
mph
trip 229.6mi


IIHS
2023 Honda CR-V
+366.4 Fwd
Velocity 0.0
-2.3 Lat
0.000 TTC
0
mph
NORMAL
000259 miles
D
12:23


IIHS
2023 Hyundai Tucson
+284.3 Fwd
Velocity 0.0
-0.2 Lat
0.000 TTC


IIHS
2023 Honda CR-V
+368.9 Fwd
Velocity 0.0
-2.5 Lat
0.000 TTC

Average speed reduction

By surrogate target, lane position, and speed

Vehicle	Passenger car, lane center			Passenger car, offset left			Motorcycle, lane center			Motorcycle, offset right		
	50 km/h	60 km/h	70 km/h	50 km/h	60 km/h	70 km/h	50 km/h	60 km/h	70 km/h	50 km/h	60 km/h	70 km/h
2023 Volkswagen Taos												
2023 Toyota RAV4												
2023 Subaru Forester												
2023 Mitsubishi Outlander												
2023 Mazda CX-5												
2023 Jeep Compass												
2023 Hyundai Tucson												
2023 Honda CR-V												
2023 Ford Escape												
2023 Chevrolet Equinox												

Upcoming consumer information and vehicle ratings

Insurance Institute for Highway Safety
Highway Loss Data Institute

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THANK YOU

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