Insurance Institute for Highway Safety
Highway Loss Data Institute

Welcome

CAS Crash Course
July 19, 2018

David Harkey, President

IIHS is an independent, nonprofit scientific and educational organization dedicated to reducing the losses — deaths, injuries and property damage — from crashes on the nation's roads.

HLDI shares this mission by analyzing insurance data representing human and economic losses from crashes and other events related to vehicle ownership.

Both organizations are wholly supported by auto insurers.

IIHS – HLDI supporting groups

AAA Carolinas
Acceptance Insurance
Alfa Alliance Insurance Corporation
Alfa Insurance
Allstate Insurance Group
American Agricultural Insurance Company
American Family Mutual Insurance Company
American National
Ameriprise Auto & Home
Amica Mutual Insurance Company
Auto Club Enterprises
Auto Club Group
Auto-Owners Insurance
Bitco Insurance Companies
California Casualty Group
Celina Insurance Group
Censtat Casualty Company
CHUBB
Colorado Farm Bureau Mutual Insurance Company
Concord Group Insurance Companies
COUNTRY Financial
CSAA Insurance Group
Desjardins Insurance
ECM Insurance Company
Elephant Insurance Company
EMC Insurance Companies
Erie Insurance Group
Esurance
Farm Bureau Financial Services
Farm Bureau Insurance of Michigan
Farm Bureau Mutual Insurance Company of Idaho
Farmers Insurance Group
Farmers Mutual of Nebraska
Florida Farm Bureau Insurance Companies
Frankenmuth Insurance
Gainsco Insurance
GEICO Corporation
The General Insurance
Georgia Farm Bureau Mutual Insurance Company
Goodville Mutual Casualty Company
Grange Insurance
Grinnell Mutual
Hallmark Financial Services
Hanover Insurance Group
The Hartford
Haulers Insurance Company, Inc.
Horace Mann Insurance Companies
Imperial Fire & Casualty Insurance Company
Indiana Farm Bureau Insurance
Indiana Farmers Insurance
Infinity Property & Casualty
Kemper Corporation
Kentucky Farm Bureau Mutual Insurance Companies
Liberty Mutual Insurance Company
Louisiana Farm Bureau Mutual Insurance Company
The Main Street America Group
Mercury Insurance Group
MetLife Auto & Home
Mississippi Farm Bureau Casualty Insurance Company
MMG Insurance
Munich Reinsurance America, Inc.
Mutual Benefit Group
Mutual of Enumclaw Insurance Company
Nationwide
New Jersey Manufacturers Insurance Group
Nodak Mutual Insurance Company
Norfolk & Dedham Group
North Carolina Farm Bureau Mutual Insurance Company
Northern Neck Insurance Company
Ohio Mutual Insurance Group
Old American Indemnity Company
Oregon Mutual Insurance Company
Paramount Insurance Company
Pekin Insurance
PEMCO Insurance
Plymouth Rock Assurance
Progressive Insurance
PURE Insurance
Qualitas Insurance Company
Redpoint County Mutual Insurance Company
The Responsive Auto Insurance Company
Rider Insurance
Rockingham Group
RSA Canada
Safe Auto Insurance Company
Safeco Insurance
Samsung Fire & Marine Insurance Company
SECURA Insurance
Selective Insurance Company of America
Sentry Insurance
Shelter Insurance Companies
Sompo America
South Carolina Farm Bureau Mutual Insurance Company
Southern Farm Bureau Casualty Insurance Company
State Farm Insurance Companies
Stillwater Insurance Group
Tennessee Farmers Mutual Insurance Company
Texas Farm Bureau Insurance Companies
The Travelers Companies
United Educators
USAA
Utica National Insurance Group
Virginia Farm Bureau Mutual Insurance
West Bend Mutual Insurance Company
Western National Insurance Group
Westfield Insurance

Funding associations

American Insurance Association
National Association of Mutual Insurance Companies
Property Casualty Insurers Association of America

Haddon matrix

Recognizing opportunities to make a difference

	pre-crash	during crash	after crash
people	graduated licensing impaired driving laws automated enforcement	safety belts helmets	medical bracelets general health
vehicles	crash avoidance technology	airbags crashworthiness truck underride guards	automatic collision notification fuel system integrity
environment	roundabouts rumble strips	roadside barriers breakaway poles	emergency medical services long-term rehabilitation


CBS Evening News
55 MPH
MAXIMUM

Insurance Institute for Highway Safety
Highway Loss Data Institute

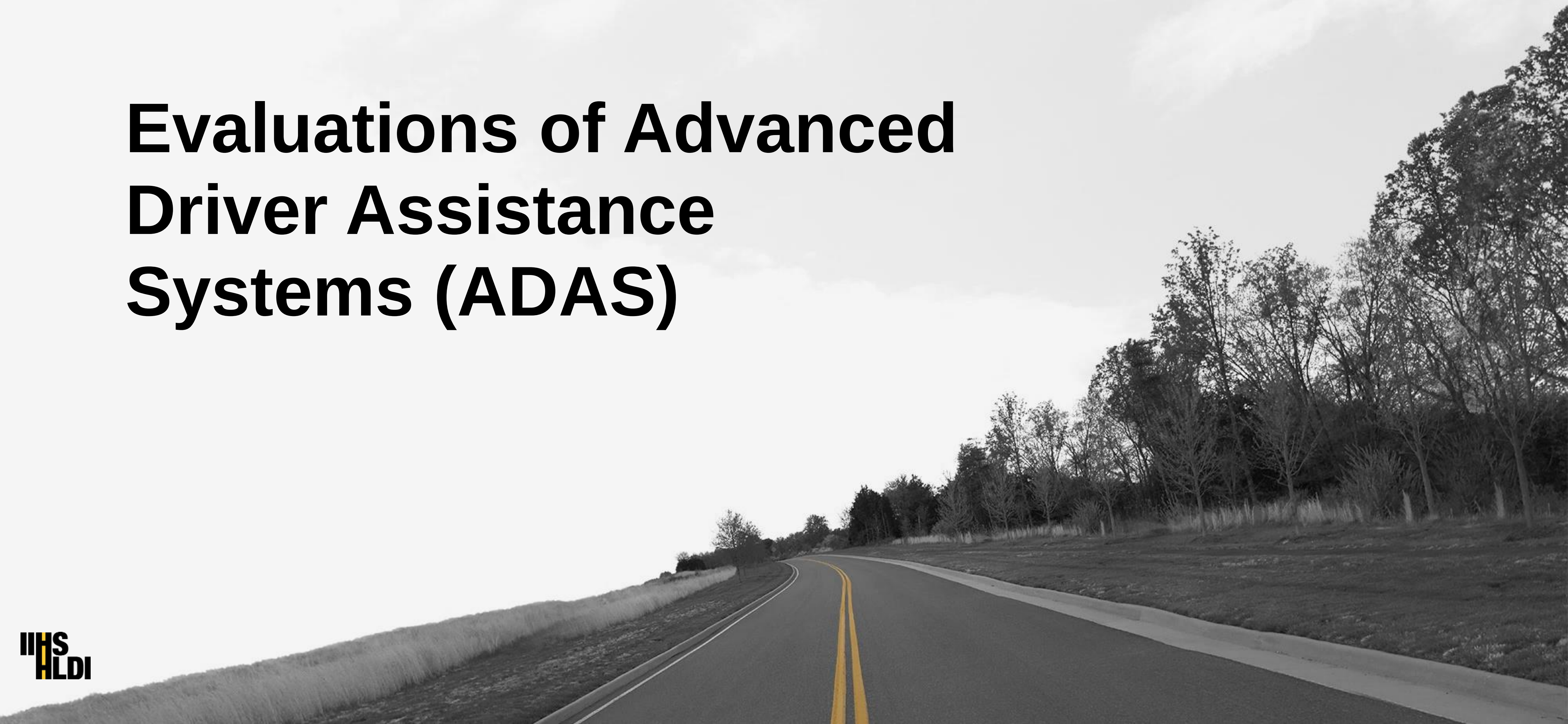
Advanced Driver Assistance Technology: The Latest Insights

CAS Crash Course
July 19, 2018

David Zuby, EVP and Chief Research Officer
David Aylor, Manager of Active Safety Testing
Jessica Cicchino, VP of Research
Matt Moore, SVP of HLDI

iihs.org

Evaluations of Advanced Driver Assistance Systems (ADAS)

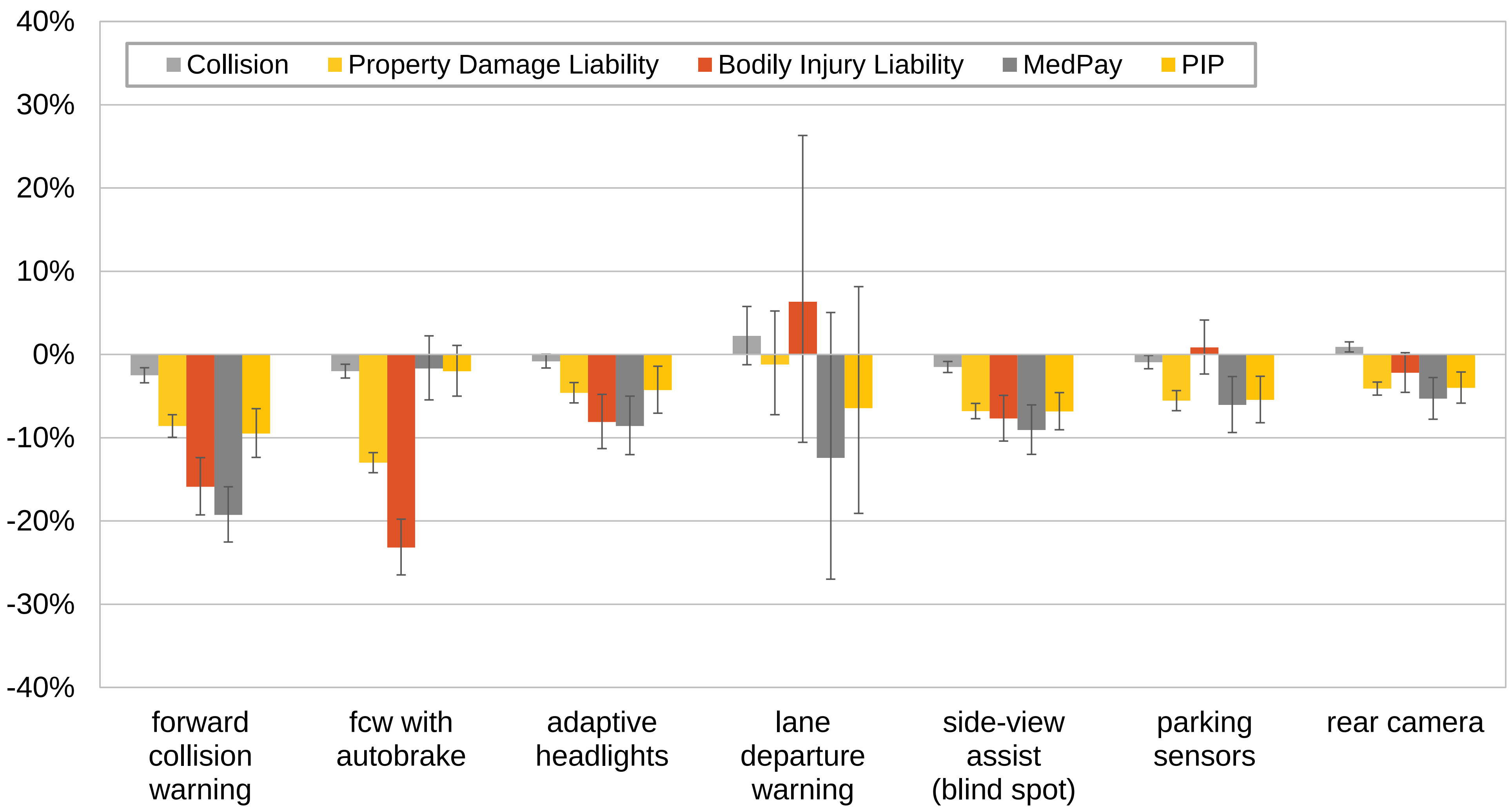


HLDI collision avoidance analysis

- The HLDI database includes data from companies that represent 85% of private passenger auto insurance in the U.S.
- On a monthly basis, HLDI processes 320 million insurance data transactions
- The insurance data includes the garaging zip code and rated driver demographics
- Manufacturers shared with us 17 digit VINs and information about collision avoidance systems fitted to those vehicles
- Our collision avoidance analysis used the manufacturer supplied feature data along with our geographic and demographic data
- Large amount of timely data
- Limited information on crash circumstances

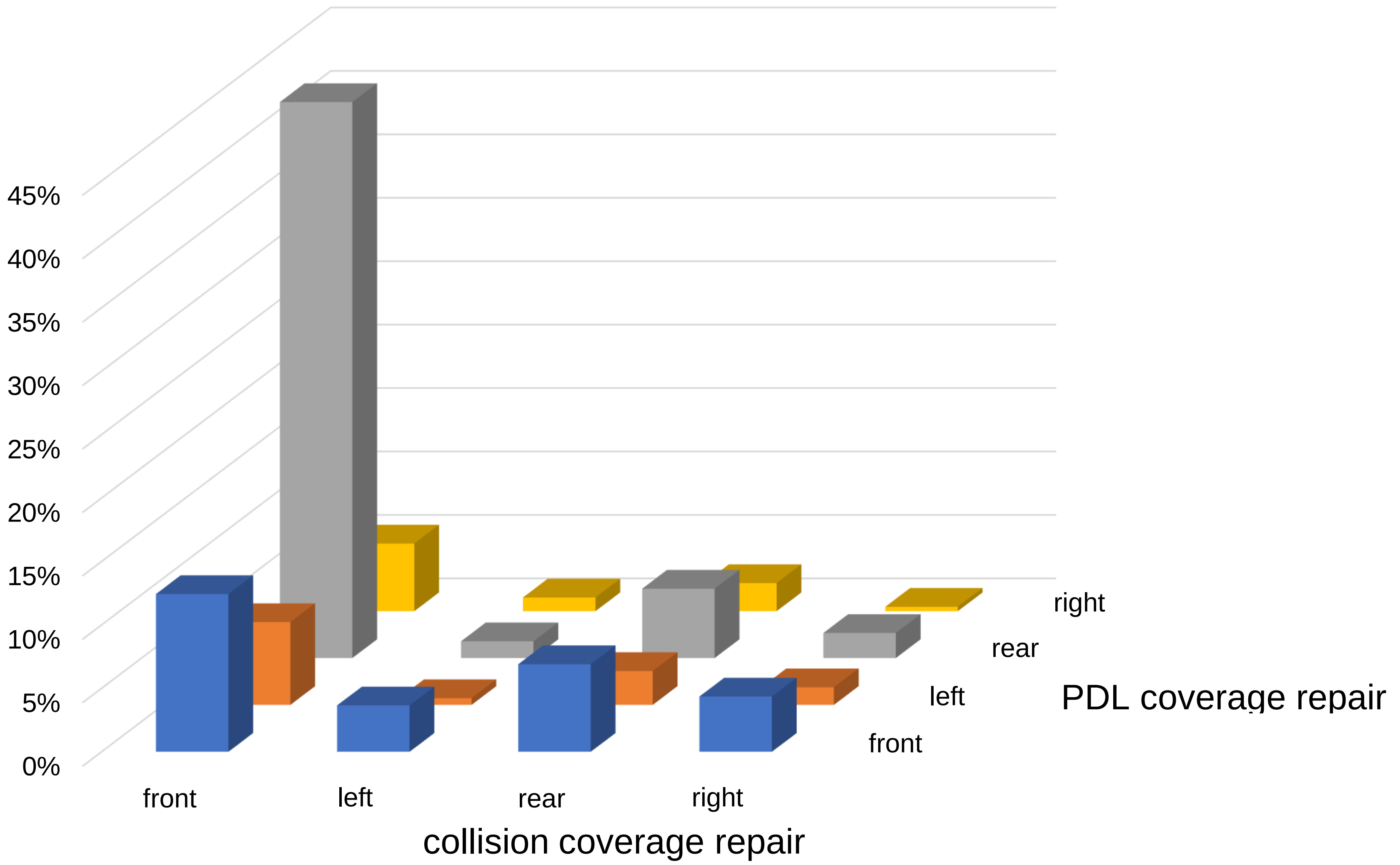
Summary of technology effects on insurance claim frequency

Results pooled across automakers



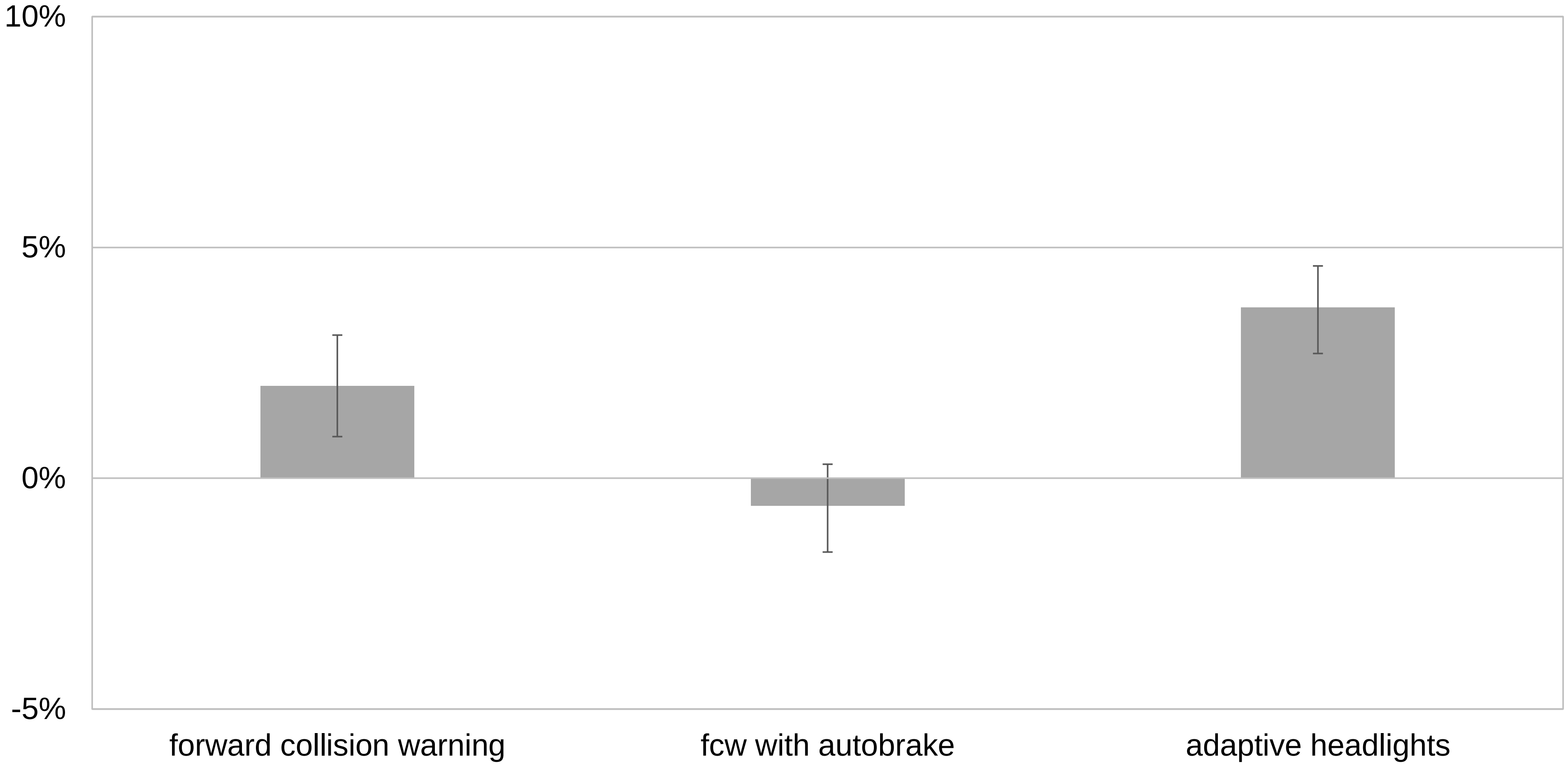
Percent distribution of matched pairs of collision & PDL estimates by point of impact

1981-2017 models, 2016 calendar year



Summary of technology effects on collision claim severity

Results pooled across automakers



HLDI and police-reported crash data

Insurance data

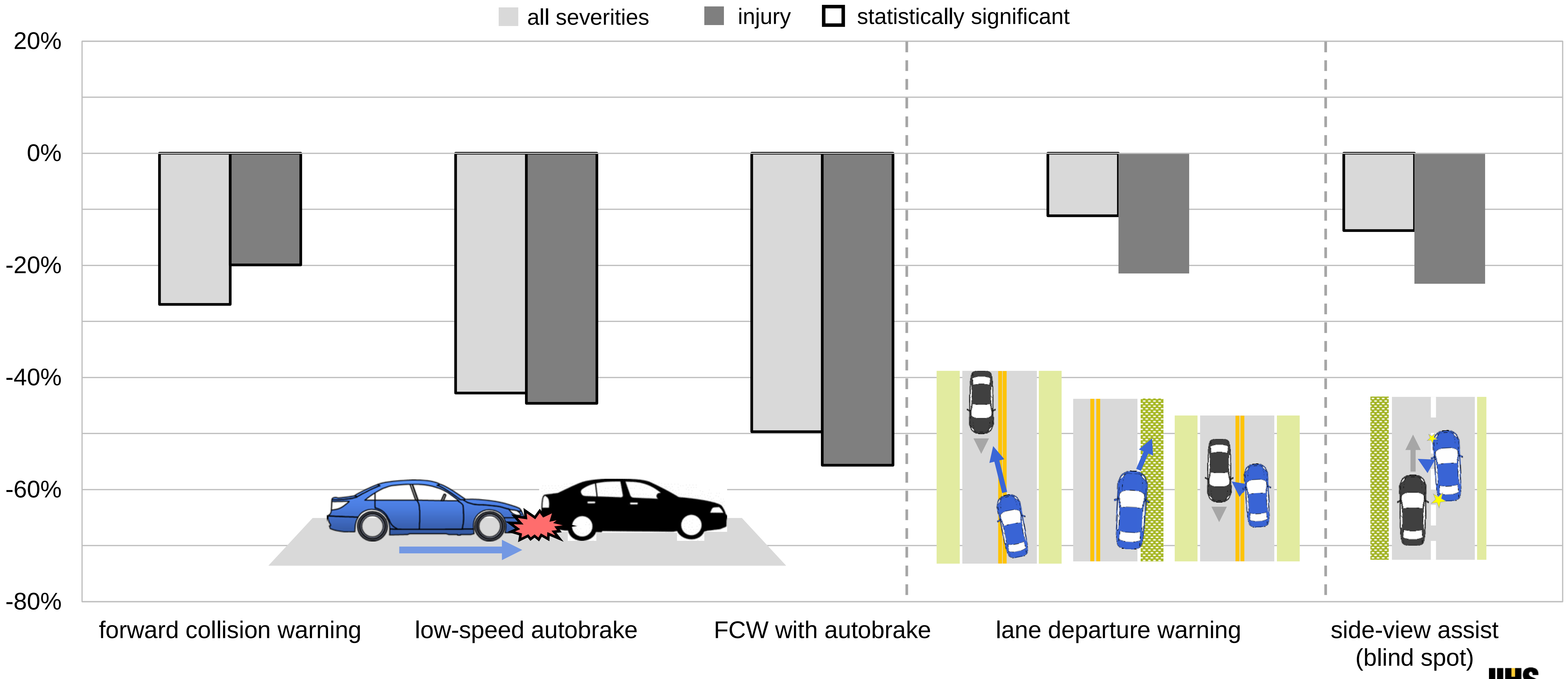
- Large amount of timely data
- Limited information on crash circumstances

Police-reported crash data

- More detailed information on crash type
- Limitations
  - Some crashes not reported to police
  - Delay in obtaining data
  - Data collected not uniform among states, and not all states have information to determine crash types

Most crash avoidance technologies are living up to expectations

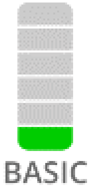
Effects on relevant police-reported crash types



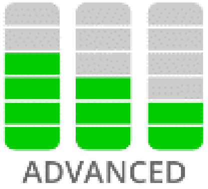
Front crash prevention testing and rating

Front crash prevention ratings

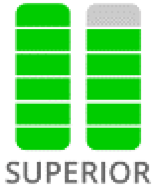
vehicles without forward collision warning or autobrake; or vehicles equipped with a system that doesn't meet NHTSA or IIHS criteria



vehicles earning 1 point for forward collision warning or 1 point in either 12 or 25 mph test



vehicles with autobrake that achieve 2-4 points for forward collision warning and/or performance in autobraking tests



vehicles with autobrake that achieve 5-6 points for forward collision warning and/or performance in autobraking tests

25 mph

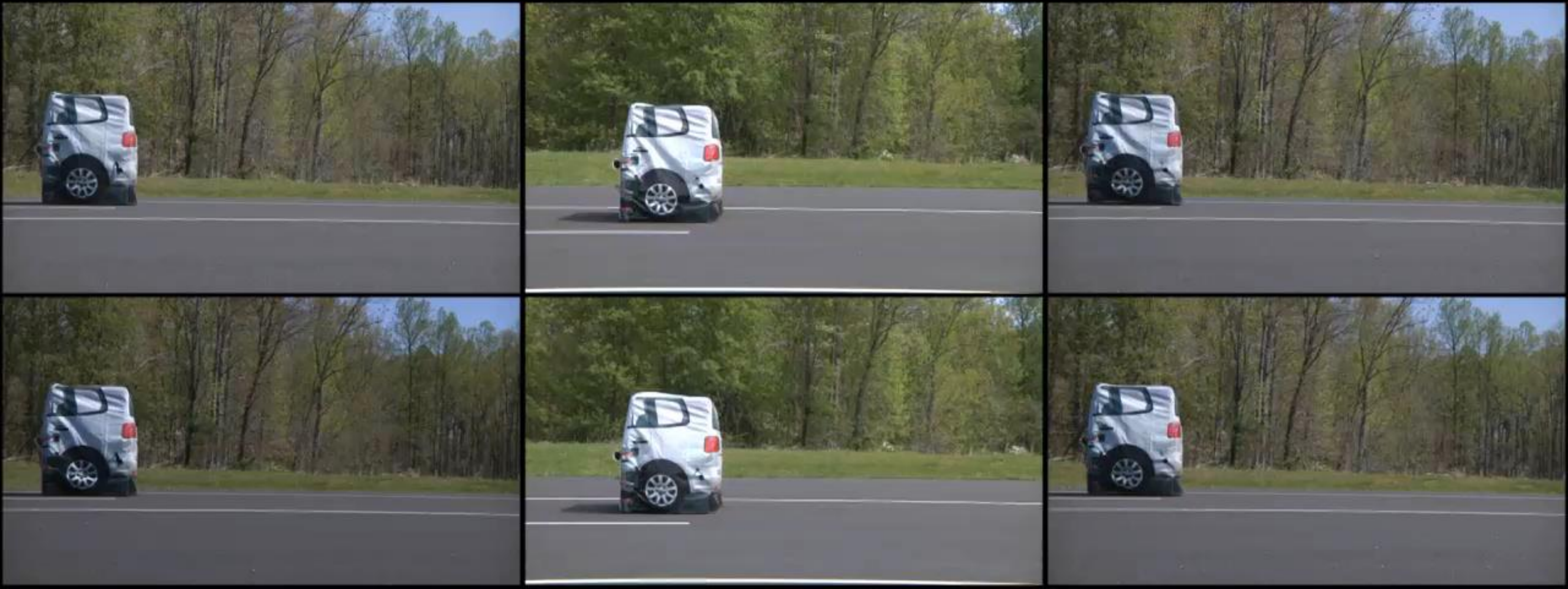
$28,131

12 mph

$5,715

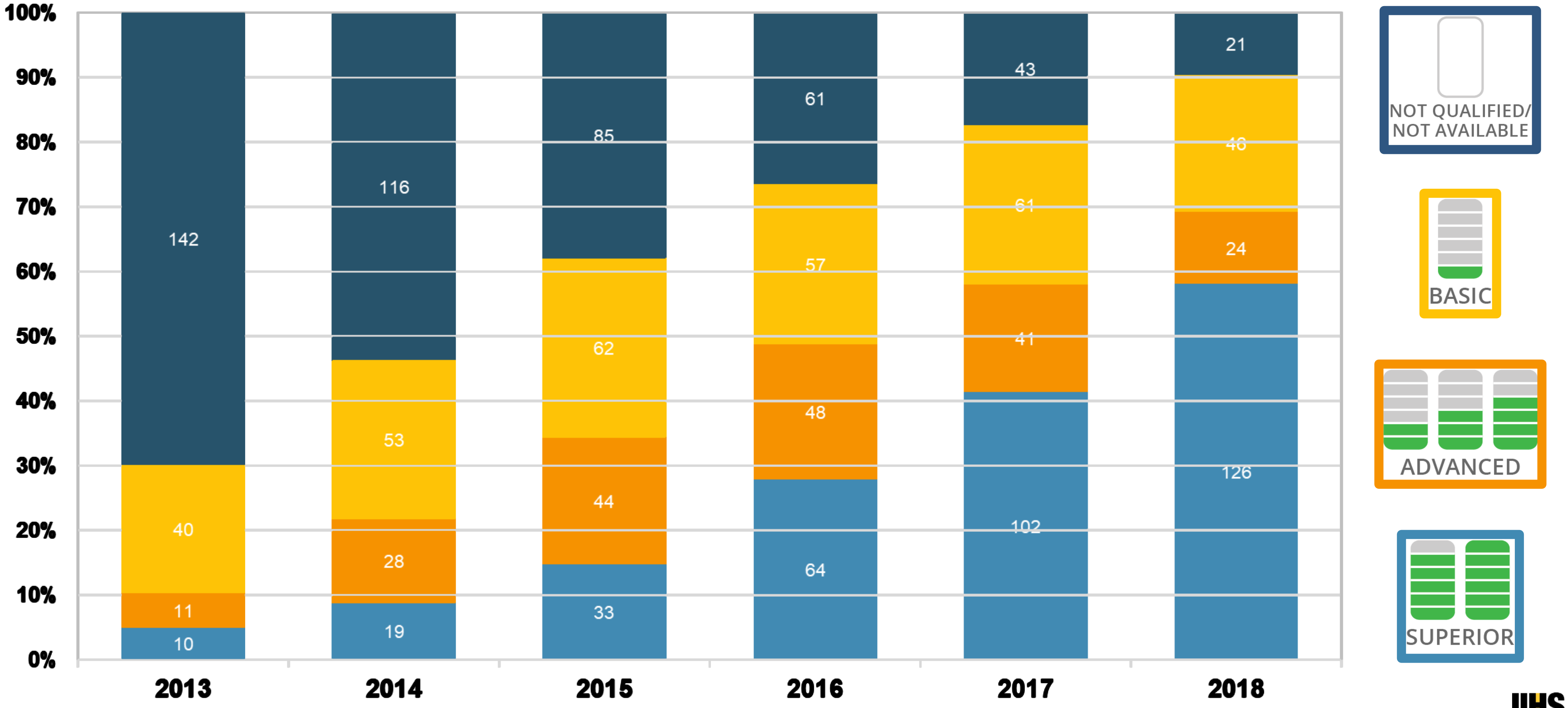
Speed reduction in 12 and 24 mph tests

Volvo S60	Dodge Durango	Subaru Outback
2 point advanced	3 point advanced	6 point superior



Front crash prevention ratings

2013-18 models, as of July 13, 2018



20 automakers have committed to make AEB a standard feature by September 2022

99+% of
U.S. market


Hyundai
advertisement

What kinds of front-to-rear crashes are vehicles with autobrake still involved in?

Not all rear-end crashes are the same

Not all rear-end crashes are the same

		Speed reduction
2014 Infiniti Q50		7 mph
2015 Subaru Legacy		6 mph
2014 Volvo S80		4 mph

Headlight testing and ratings

Motivation for headlight evaluation program

- 19,310 annual crash deaths in dark, dawn, dusk light conditions

  (2016 FARS)

- HLDI analyses point to benefits for curve-adaptive headlights

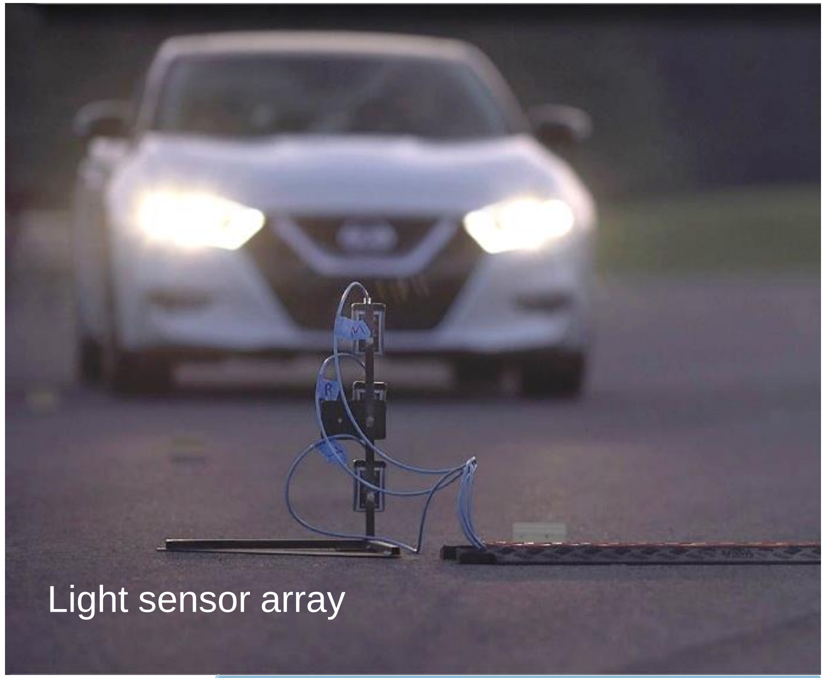
  (2012 HLDI analyses of Mazda, Acura, Mercedes-Benz, Volvo claims)

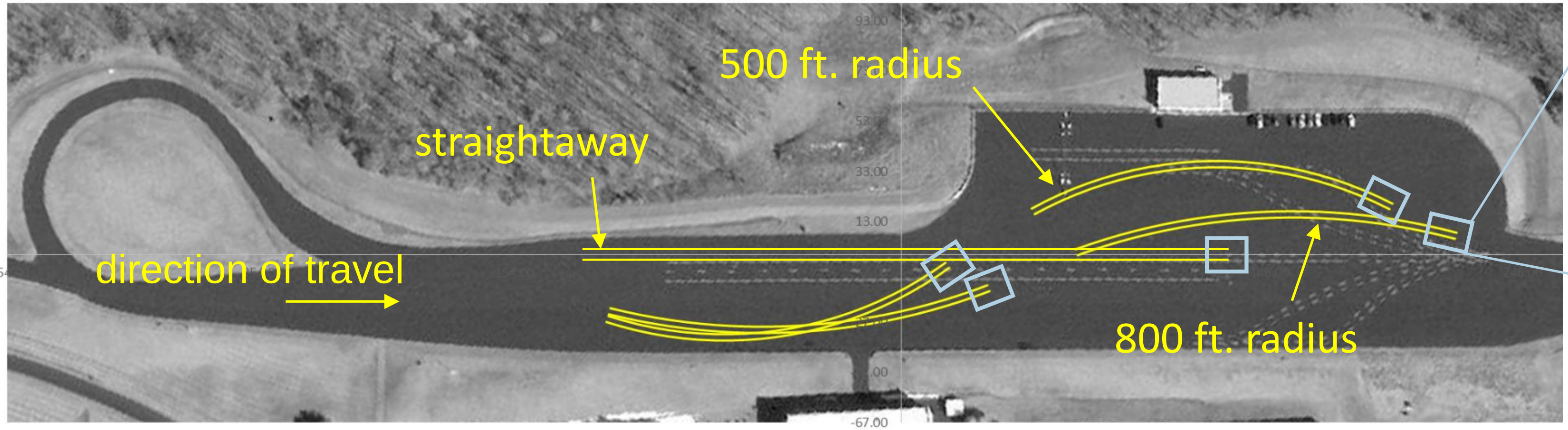
- Human factors experiments have established link between detection performance and improved lighting

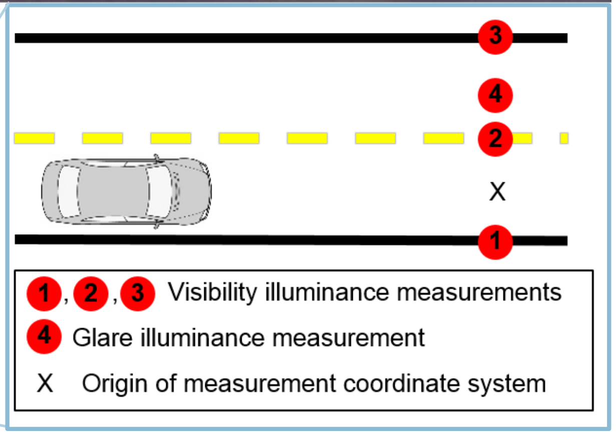
- FMVSS 108 produces wide range of on-road visibility
  - Large variation in allowable intensity
  - Performance is not measured when installed, so factors like lamp height and spread are not captured
  - Aim is not regulated

Dynamic headlight test setup

- Vehicle approaches:
  - 500 ft. radius left and right curves at 40 mph
  - 800 ft. radius left and right curves at 50 mph
  - Straightaway at 40 mph
- Record illuminance readings for:
  - Visibility – edges of road at 10 in. above ground
  - Glare – center of oncoming lane (3 ft. 7 in.)



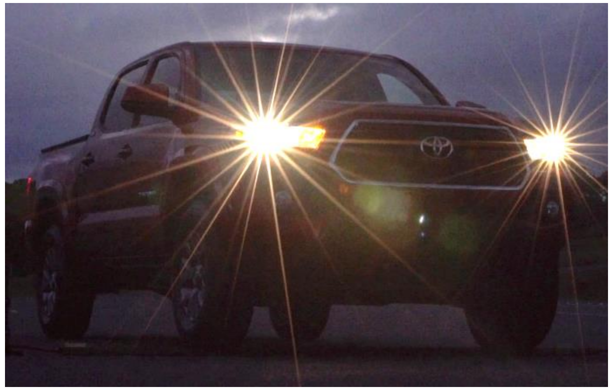




Headlight releases

Midsize car ratings – March 2016
31 models – 82 headlight combinations
65.7 million viewers

Small SUV ratings – July 2016
21 models – 47 headlight combinations
67.5 million viewers



Pickup truck ratings – October 2016
11 models – 23 headlight combinations
54.5 million viewers

Midsize SUV ratings – June 2017
37 models – 79 headlight combinations
72.2 million viewers

Consumer comments on headlight ratings

I wanted to thank IIHS for the headlight ratings report that you released last week.

-EH (Medford, New Jersey)

I own a 2013 Ford Edge. It should have come with a Seeing Eye Dog. For the first time in my life, I am afraid to drive at night.

-AM (Buckingham, Virginia)

Thank you for proving to my friends that I'm not crazy or blind.

-RW (Mentor, Ohio)

Thanks for the great work!

-RV (Tiverton, Rhode Island)

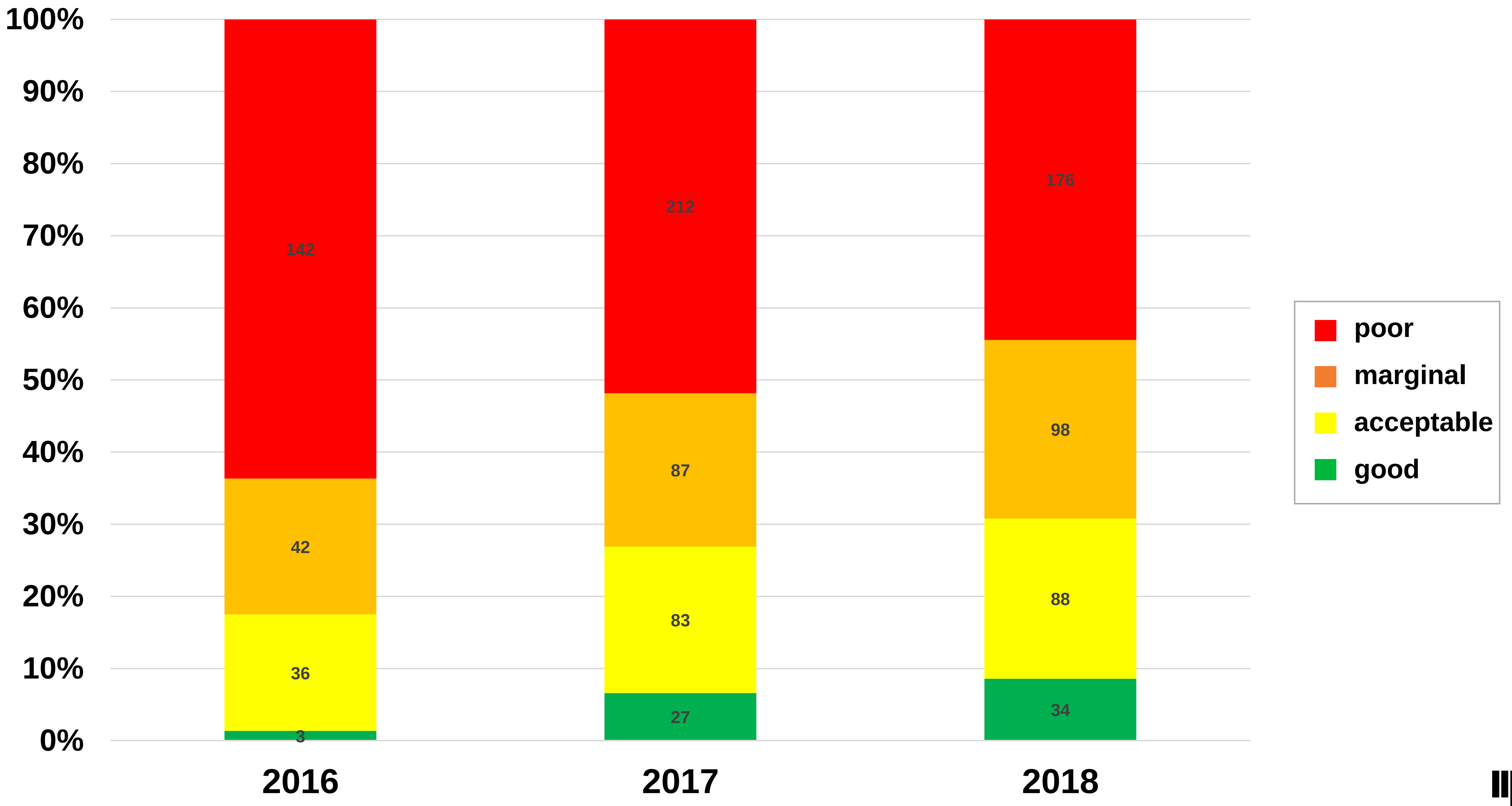
Toyota Prius v LED and BMW 3 series halogen

On-road comparison

IIHS HLDI

Headlight ratings (as of 7/13/18)

2016-2018 model years – all headlight variants

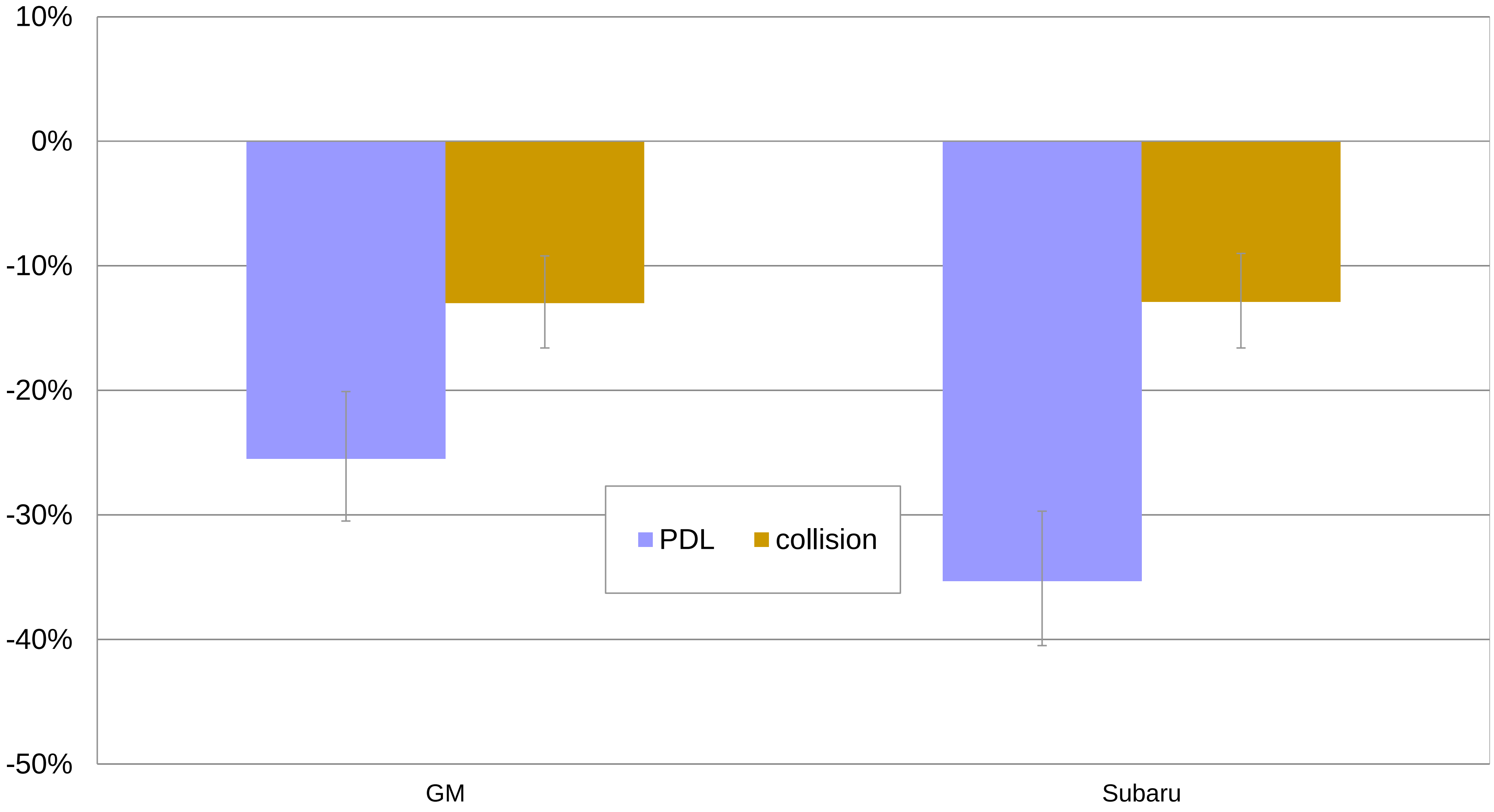


Rear crash prevention real world results

IIHS HLDI

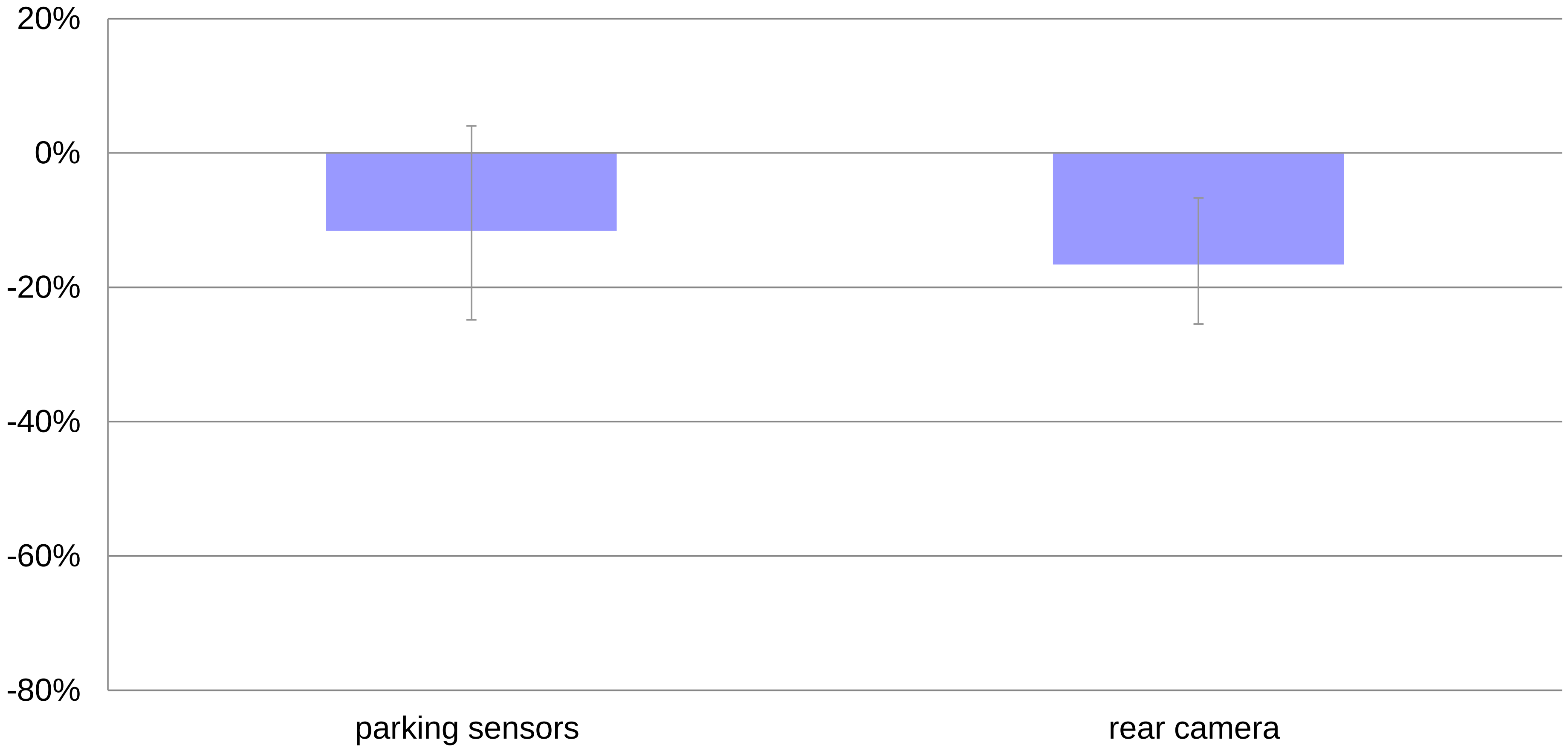
Rear automatic braking

Change in claim frequency



Rear camera and parking sensors have modest effects on backing crashes

Percent difference in police-reported backing crash rates

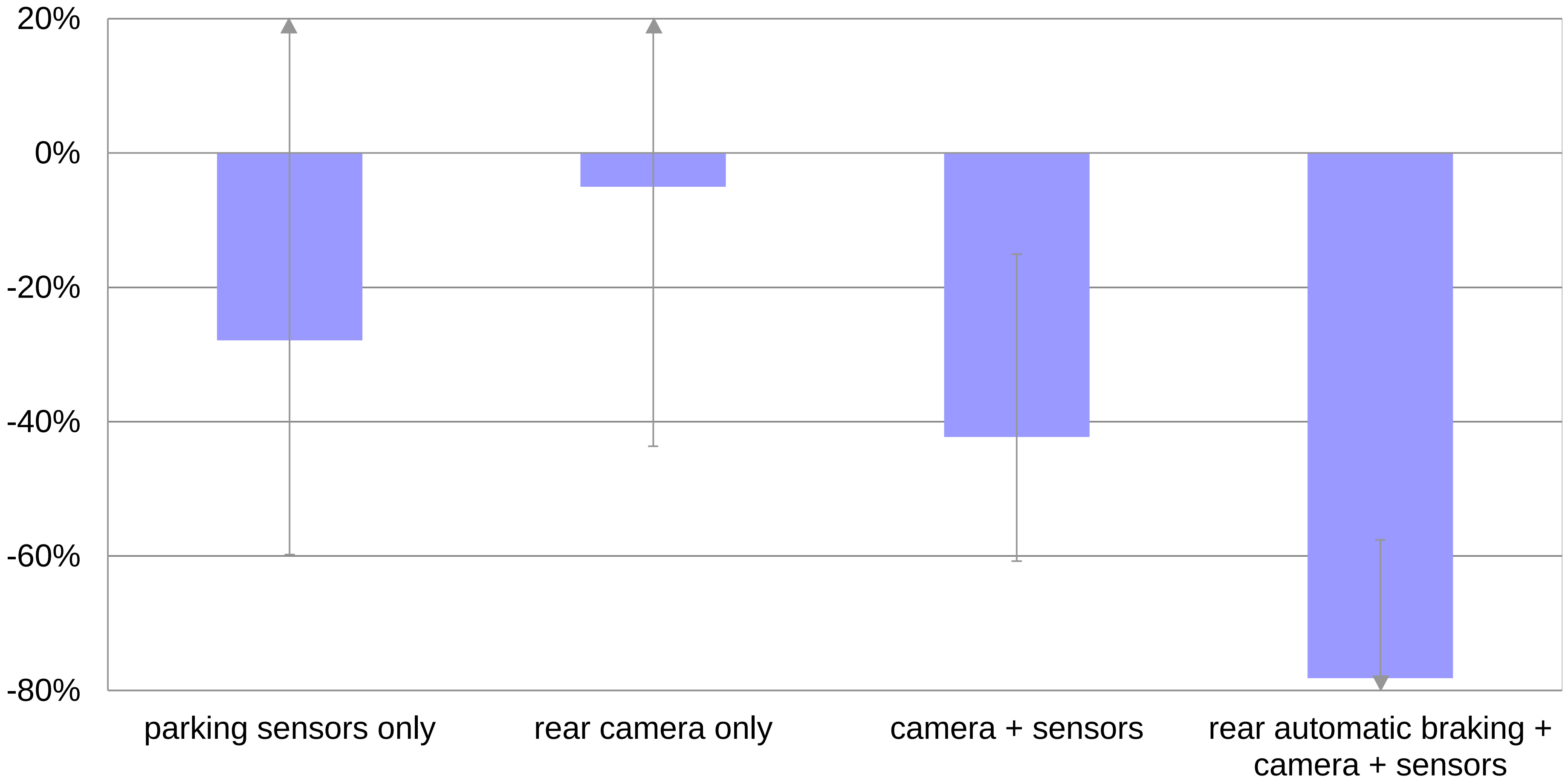


Drivers must respond to sensors for them to work

Objects are not always easy to see in the camera display

Rear automatic braking increases effectiveness

Percent difference in police-reported backing crash rates for General Motors vehicles

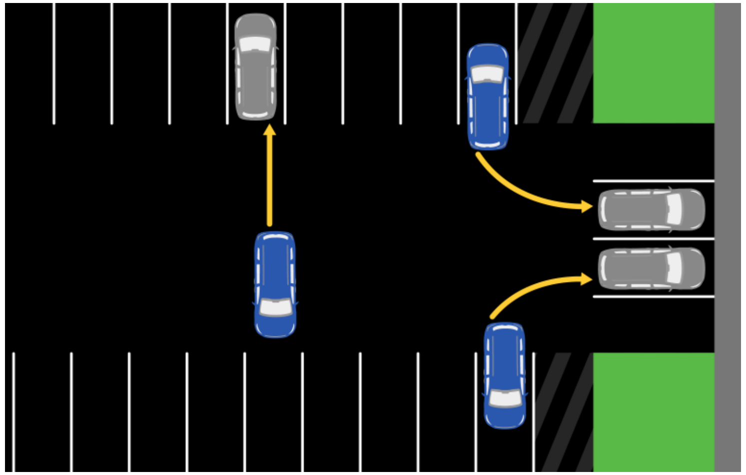


Rear crash prevention testing and ratings

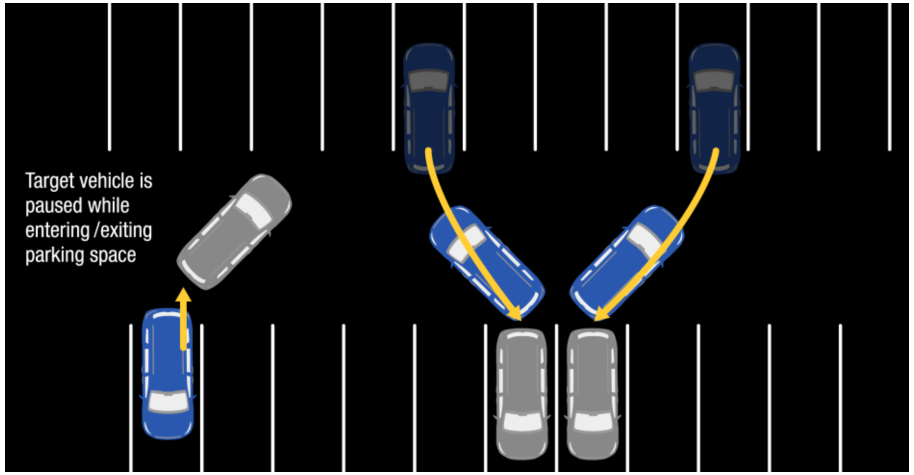
IIHS HLDI

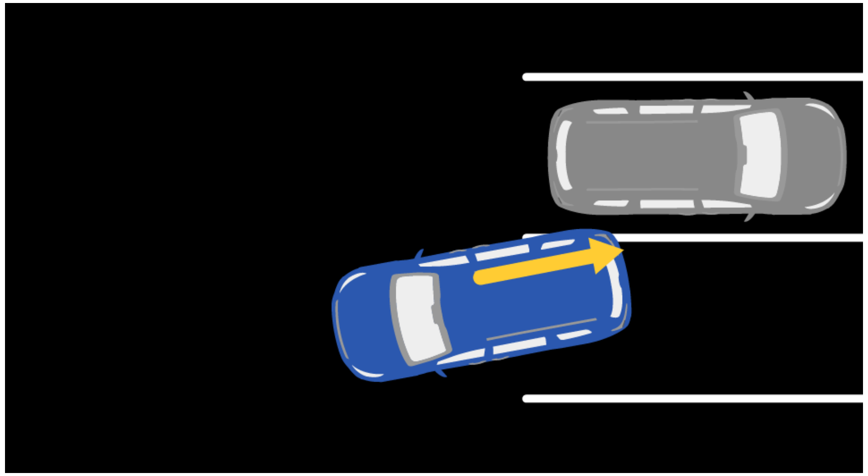
Rear crash prevention test scenarios

reversing car-to-car, 16” overlap

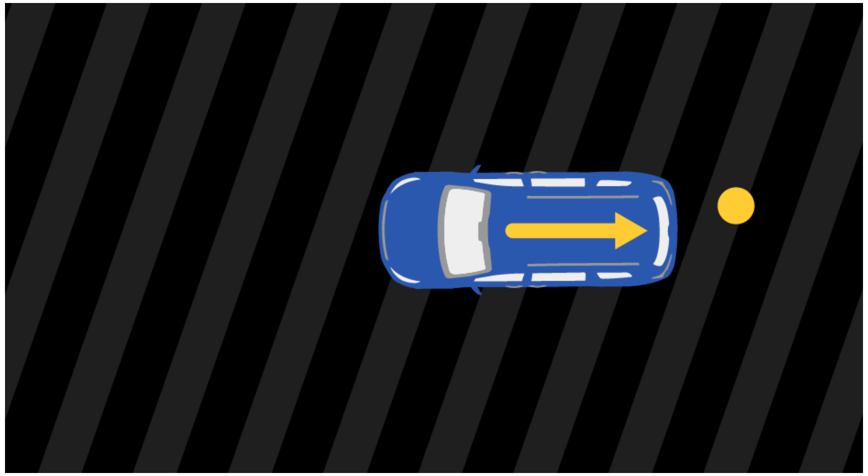


reversing car-to-car, 45° angle





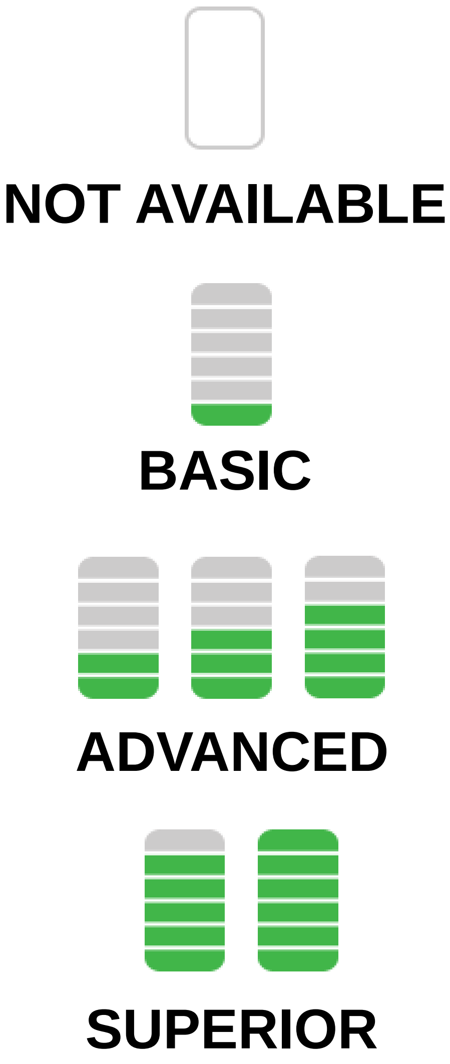
reversing car-to-car, 10° angle



reversing toward fixed pole

Rear crash prevention ratings

- Unavailable
  - Vehicles without rear parking sensors, rear cross traffic alert, or rear autobrake rear cross traffic alert
- Basic
  - Vehicles with rear cross traffic alert only
  - Vehicles with parking sensors only
  - Vehicles with cross traffic alert and parking sensors
  - Vehicles with parking sensors and/or RCTA and minimal rear autobrake performance
- Advanced
  - Vehicles with rear parking sensors, rear cross traffic alert, and more capable rear autobrake system
- Superior
  - Vehicles with rear parking sensors, rear cross traffic alert, and the best performing rear autobrake systems



IIHS HLDI

How vehicles rate for rear crash prevention, 2017 models

ADVANCED


BMW 5 series


Infiniti QX60


Jeep Cherokee


Toyota Prius

SUPERIOR


Cadillac XT5


Subaru Outback

Benefit of rear autobrake

Cadillac

SUPERIOR CONFIDENCE

The 2018 Cadillac XT5 has received an IIHS rating of Superior for rear crash prevention.

The Insurance Institute for Highway Safety has launched a rear crash prevention ratings program that can help consumers identify vehicles with the technology that can prevent or mitigate low-speed backing crashes. The 2018 Cadillac XT5 has earned the highest rating of Superior when equipped with optional Driver Assist Package. The Driver Assist Package includes Reverse Automatic Braking and is only available on vehicles equipped with Rear Cross Traffic Alert and Rear Park Assist.

IIHS SUPERIOR REAR CRASH PREVENTION

IIHS HLDI

Lane departure prevention performance

On-off status of front crash prevention systems

By manufacturer

	percent with system on	number observed
Cadillac	92	206
Chevrolet	87	142
Honda	98	239
Mazda	95	20
Volvo	94	52
total	93	659

Low use is likely limiting effectiveness of lane maintenance systems

2016 IIHS observations at dealership service centers

	percent with system on	number observed
Ford/Lincoln	23	93
Honda	36	239
Chevrolet	50	147
Cadillac	56	204
Lexus/Toyota	68	147
Volvo	75	105
Mazda	77	26
total	**52**	**961**

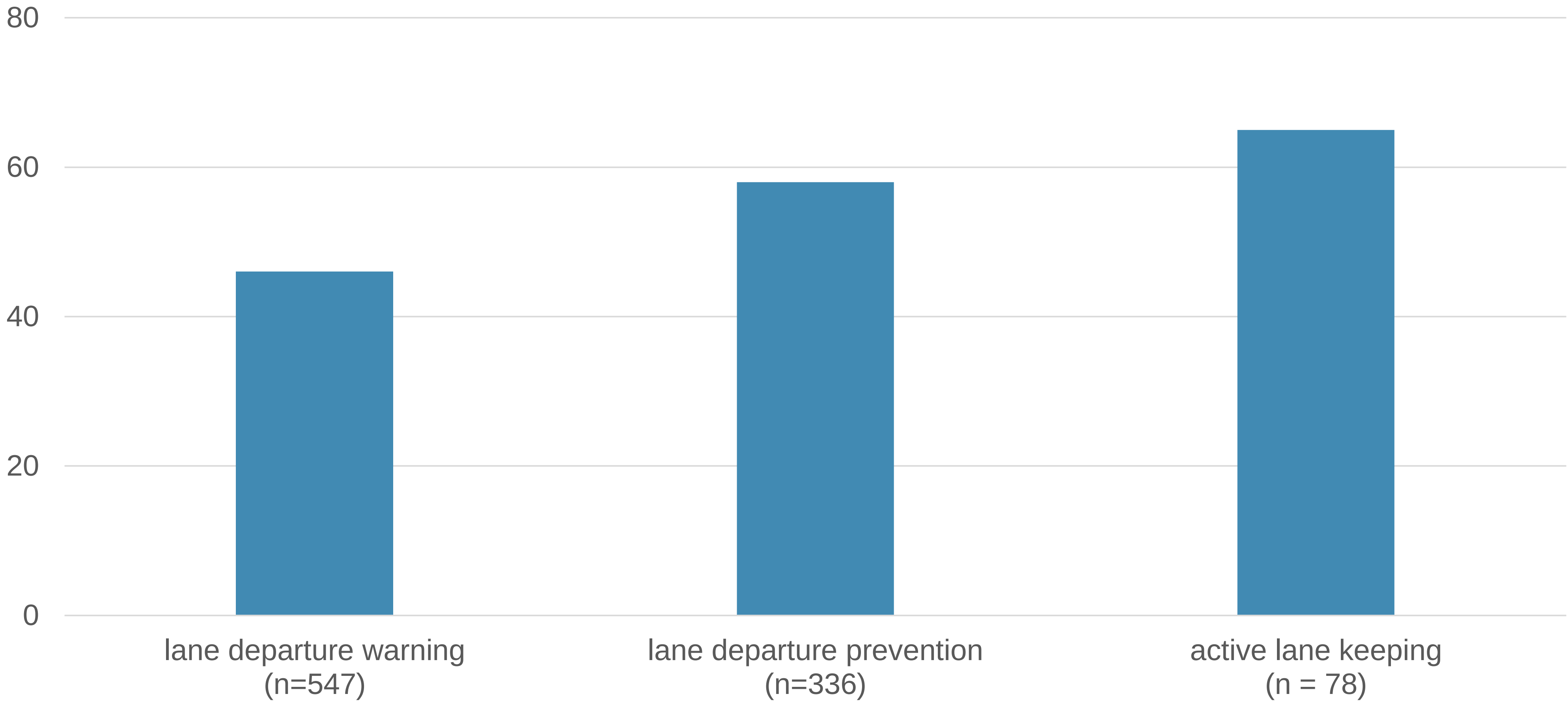
IIHS HLDI

GM lane departure warning on-off status by warning modality

		percent with system on	number observed
beep	Cadillac	33	18
	Chevrolet	39	66
	total	38	84
vibrating seat	Cadillac	58	142
	Chevrolet	49	49
	total	56	191

On-off status by maximum observable lane-maintenance intervention level

Percent with system on




Advertisement:
Lane valet

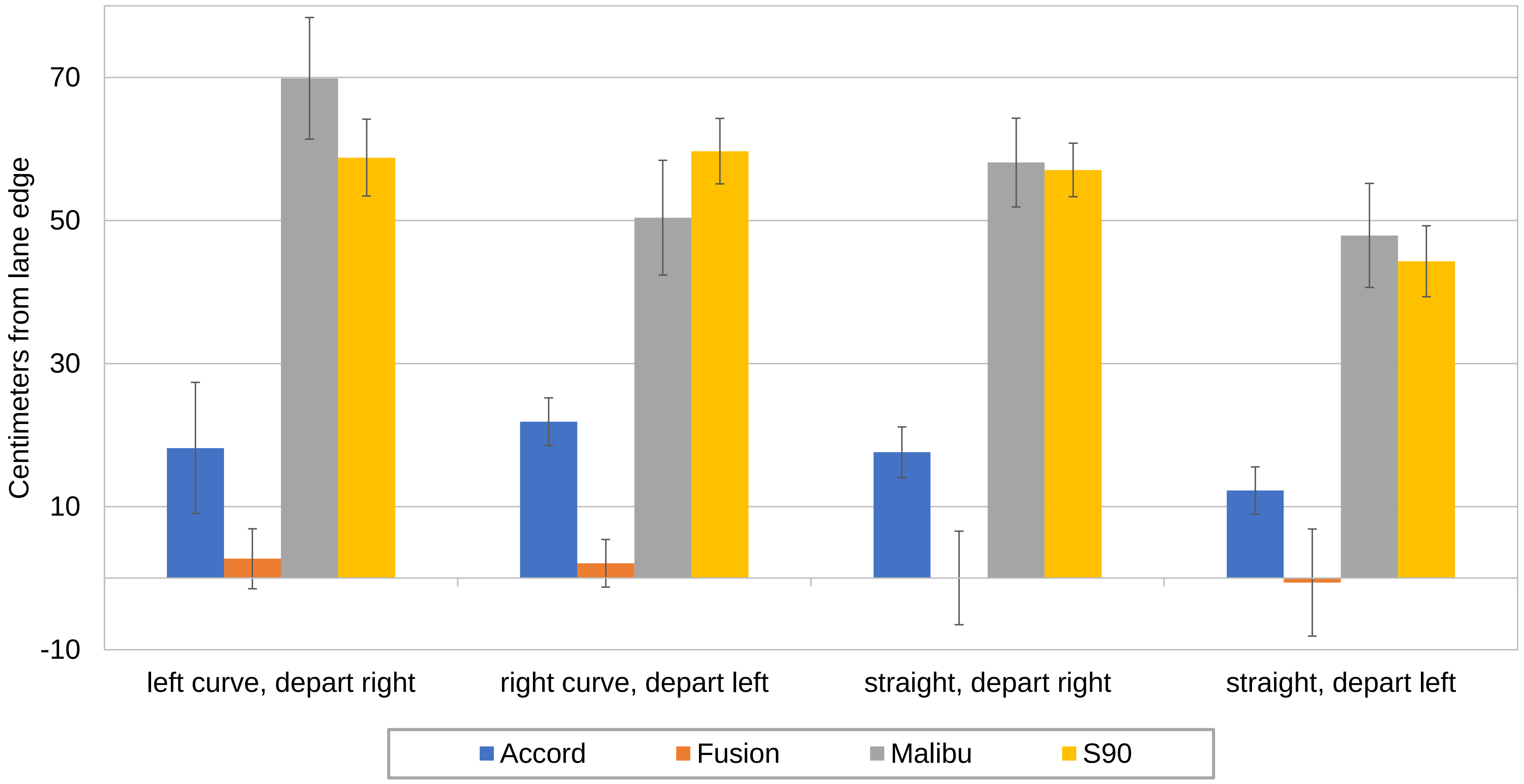
Method for testing lane departure prevention performance

- 80 lane drifts on four-lane divided highway
  - 40 departures in 1,000-meter-radius curve, departed opposite direction of curve
    - Drive straight into curve to induce departure in opposite direction
  - 40 departures on straightaway
    - Slight steering input by driver to induce departure
  - Departures balanced between left/right and dashed/solid lines
  - 50 mph test speed

IIHS HLDI

Video fed to datalogger to code and measure performance

Mean distance to inside lane edge when steering input first occurred

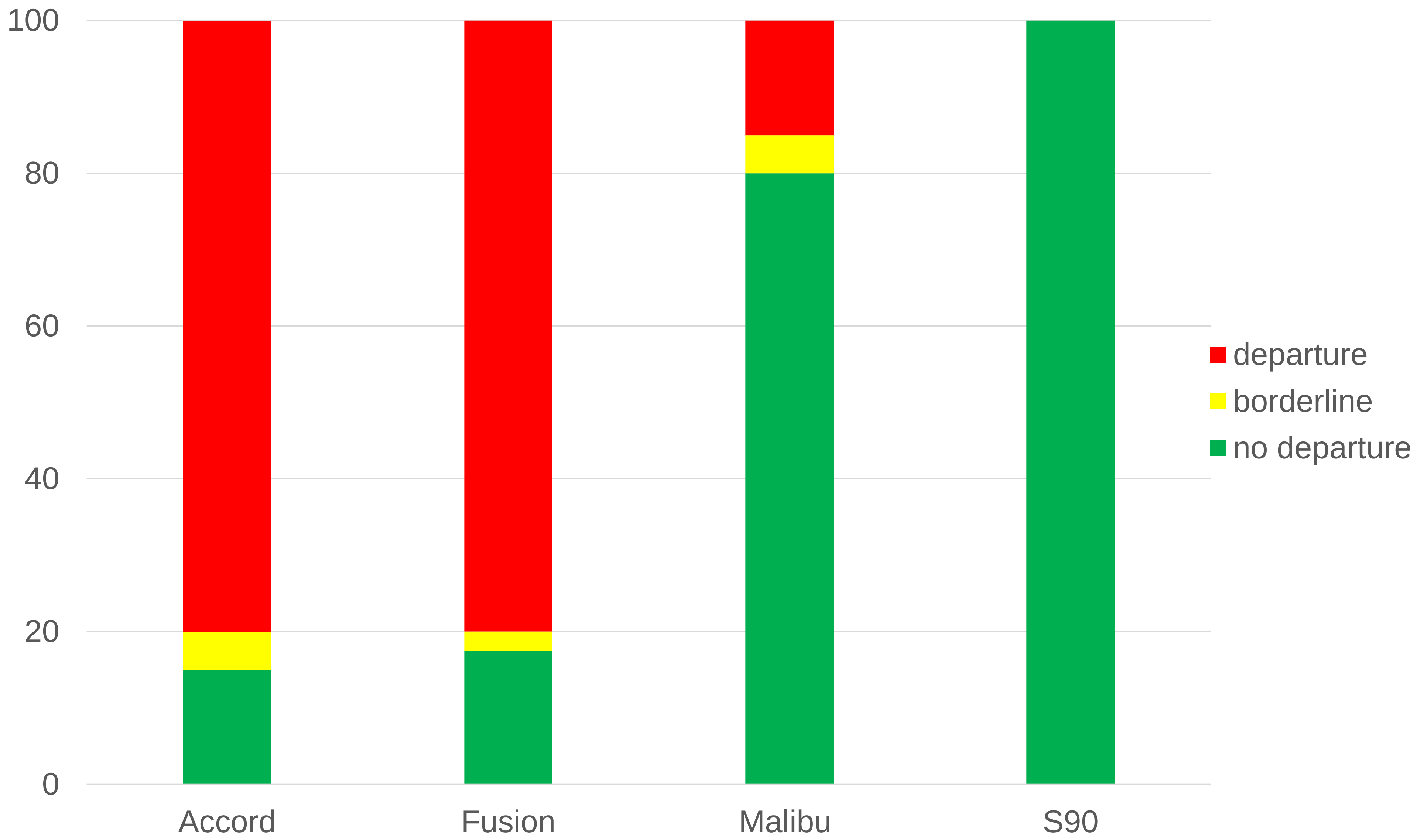


Judgements of whether departure greater than 35 cm occurred

Departure example

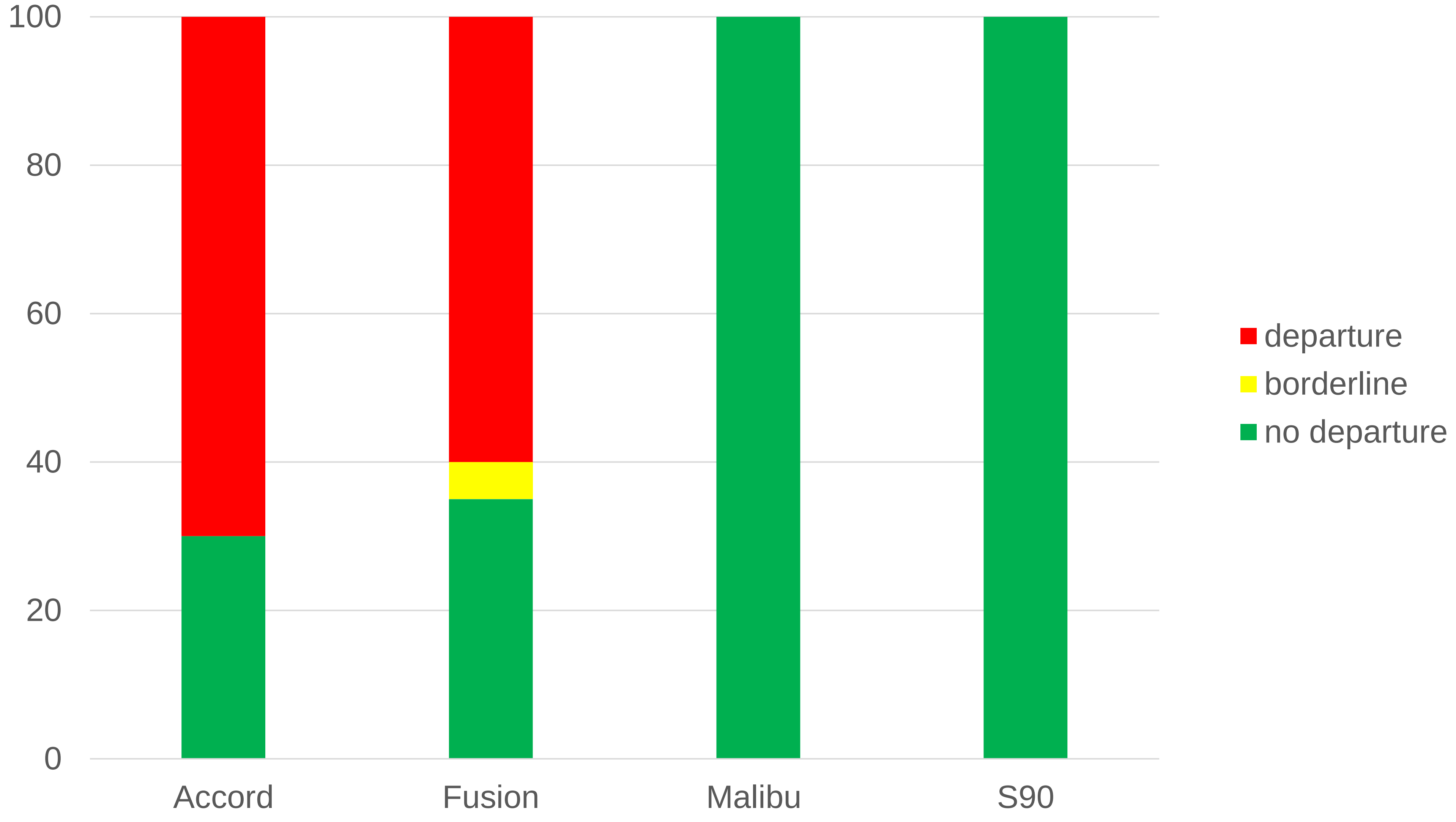
Did car depart lane by more than 35 cm?

Percentage of trial outcomes across all scenarios with a solid lane marker

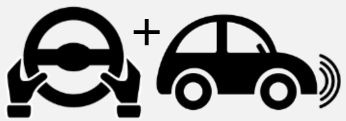


Did car depart lane by more than 35 cm?

Percentage of trial outcomes in curve scenarios with a solid lane marker

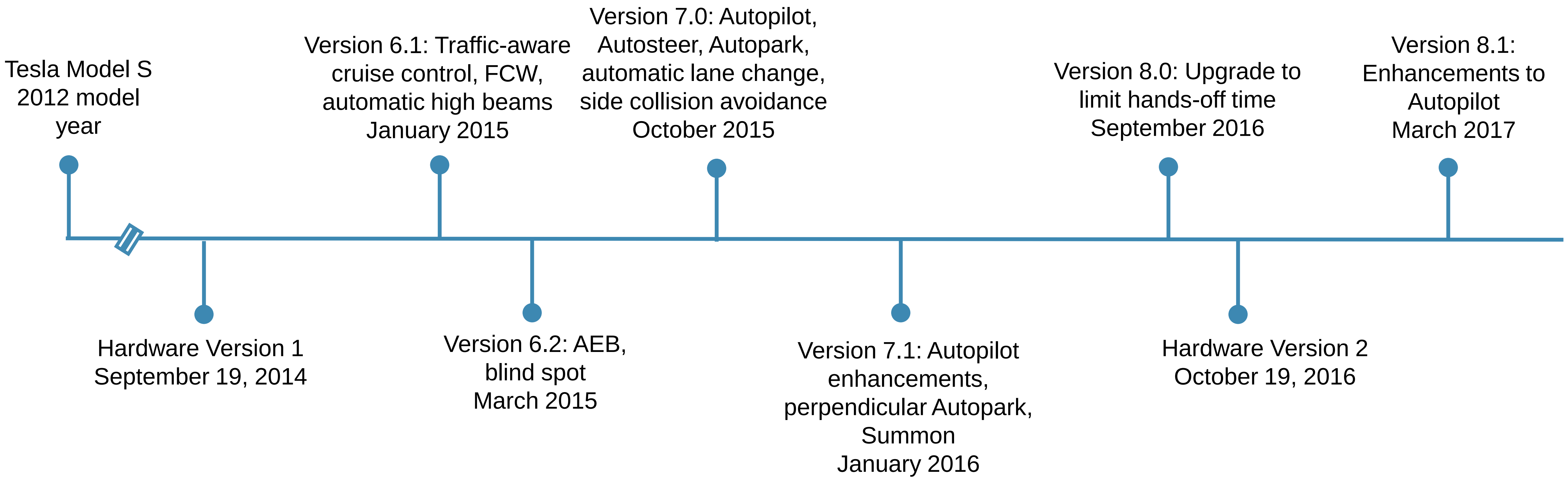


SAE International’s automation levels

	Who or what is driving?		Fallback	Where and when does it operate?
	Sustained control	Detection & response		
Level 0: none			none	n/a
Level 1: assistance				limited
Level 2: partial				limited
Level 3: conditional				limited
Level 4: high				limited
Level 5: full				unlimited

Tesla Model S driver assistance technologies

Tesla timeline



Tesla Model S insurance losses by model year

Methods

collision exposure (in years)	3,271,318
model years	2012-16
covariates	model year, calendar year, state, vehicle density, rated driver age, gender, and marital status, deductible, risk, drive type (4WD vs. 2WD), miles per day, model year * Tesla
control group	large luxury vehicles

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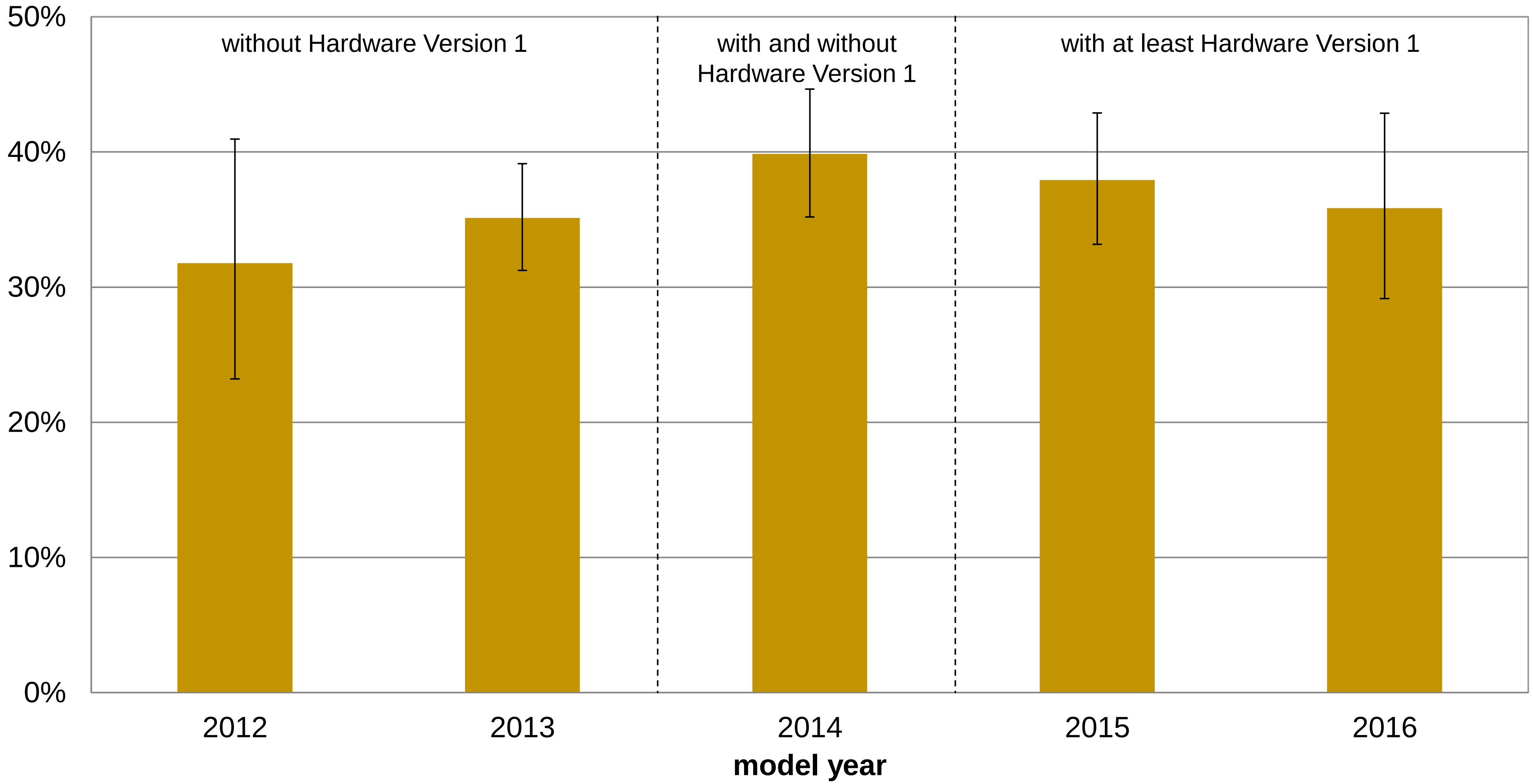
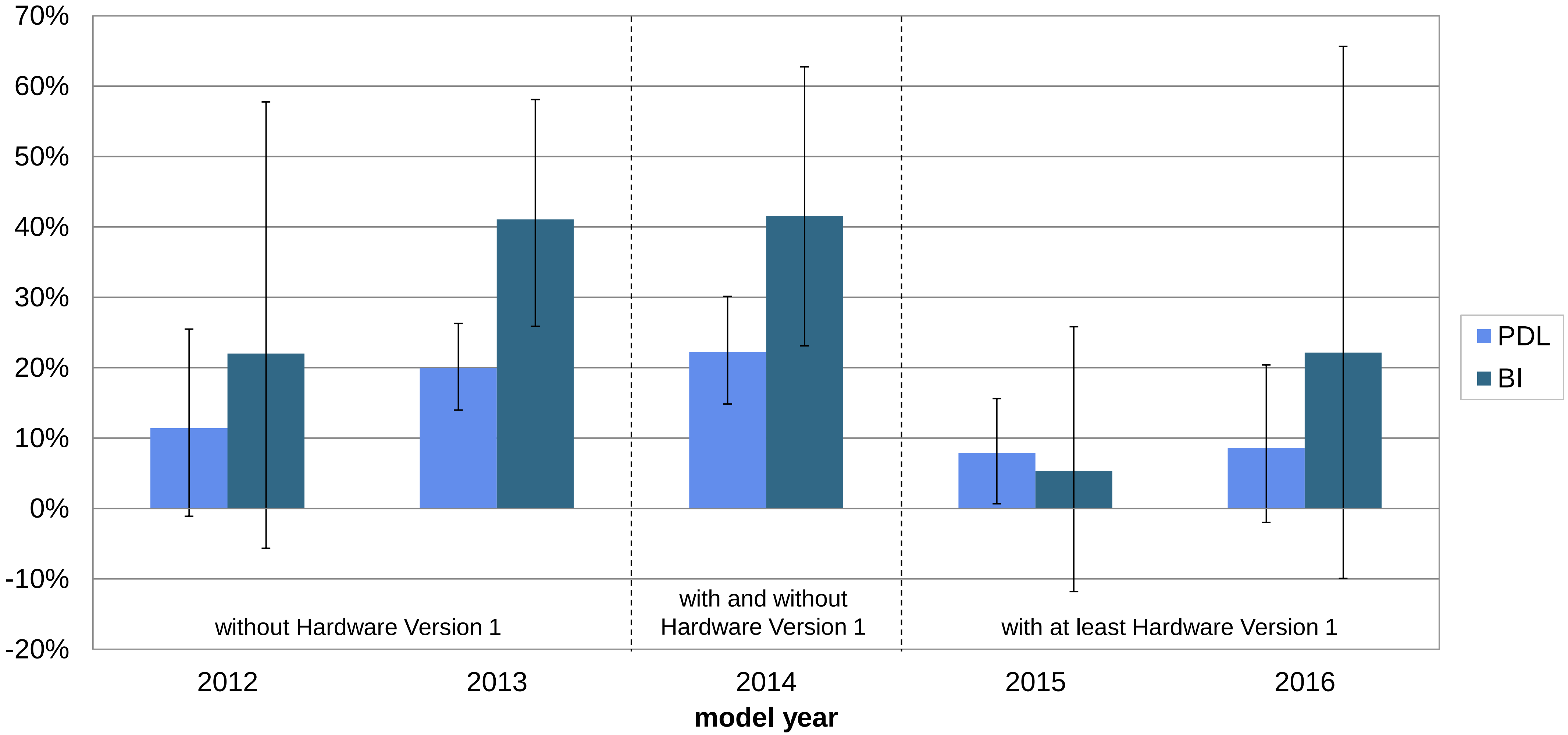
Tesla Model S versus large luxury vehicles

Collision claim frequency, by model year



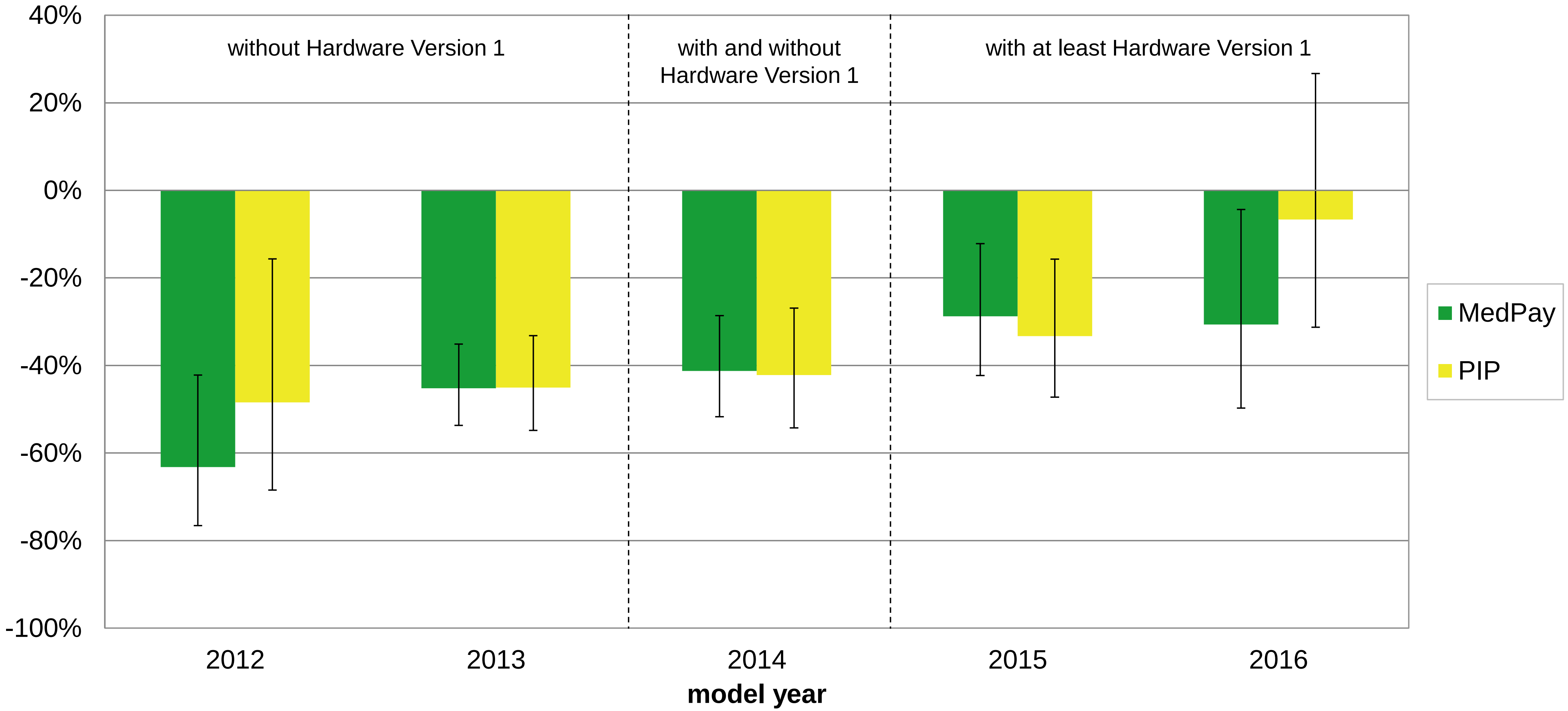
Tesla Model S versus large luxury vehicles

PDL and BI claim frequencies, by model year



Tesla Model S versus large luxury vehicles

MedPay and PIP claim frequencies, by model year



Estimating effect of driver assistance technology enabled by Tesla Model S Hardware Version 1

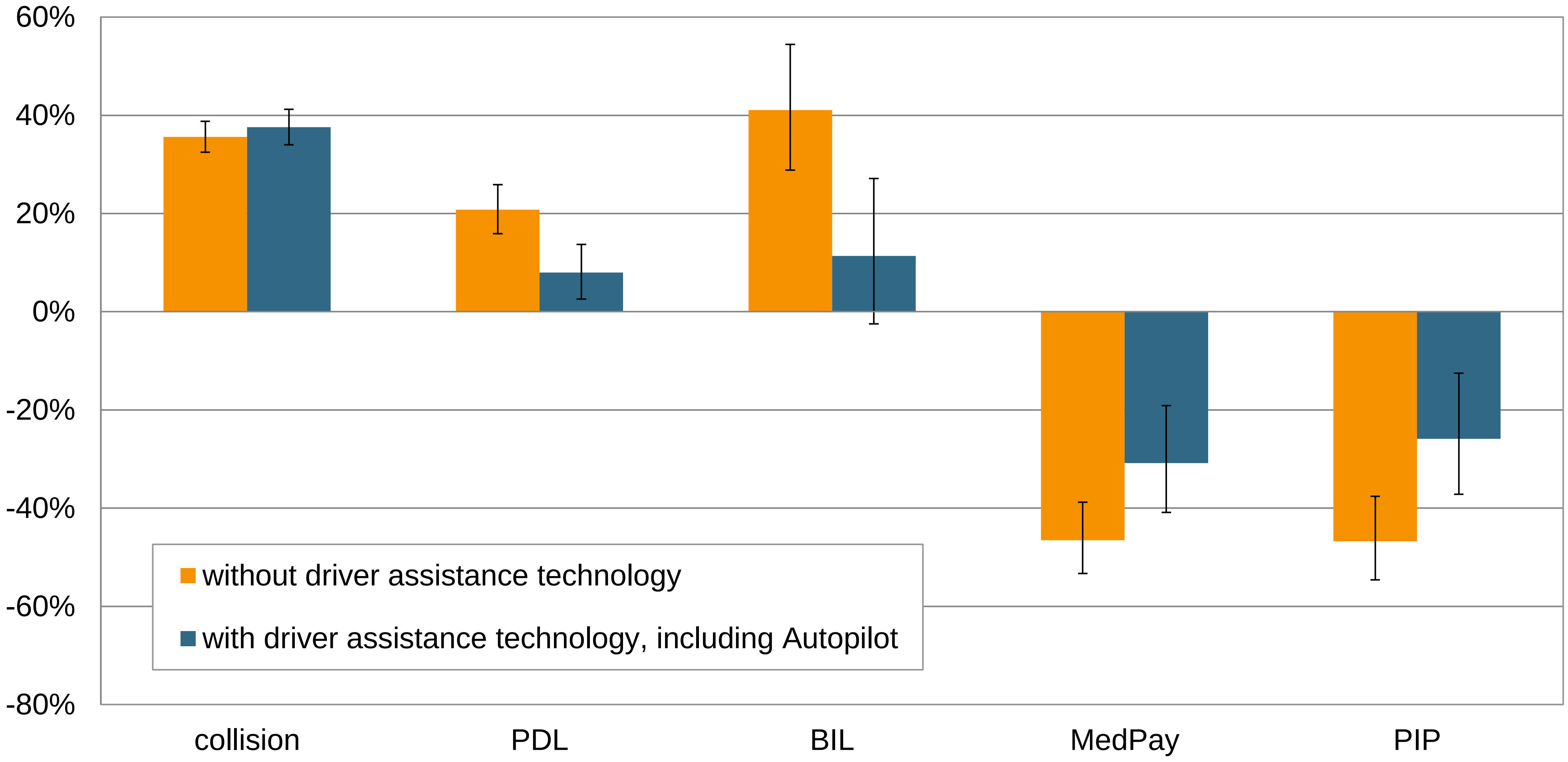
- Use “difference-in-differences” approach to compare the loss experience of Tesla Model S vehicles with and without driver assistance technology (including Autopilot) enabled to same aged large luxury vehicles
- With driver assistance technology: 2015-16 Tesla Model S vs 2015-16 conventional large luxury
- Without driver assistance technology: 2012-14 Tesla Model S vs 2012-14 conventional large luxury
- Adjustments made to account for:
  - Some 2014 MY had Hardware Version 1
  - Software update 6.1 in January 2015
  - 2016 MY vehicles with Hardware Version 2 did not have AEB enabled initially

Driver assistance technology enabled by Hardware Version 1

- Version 6.1 (January 2015)
  - Traffic-aware cruise control, forward collision warning, automatic high beams
- Version 6.2 (March 2015)
  - Automatic emergency braking, blind spot warning
- Version 7.0 (October 2015)
  - Autopark, Autosteer (enabling Tesla Autopilot), automated lane change, side collision avoidance
- Version 7.1 (January 2016)
  - Summon, perpendicular Autopark

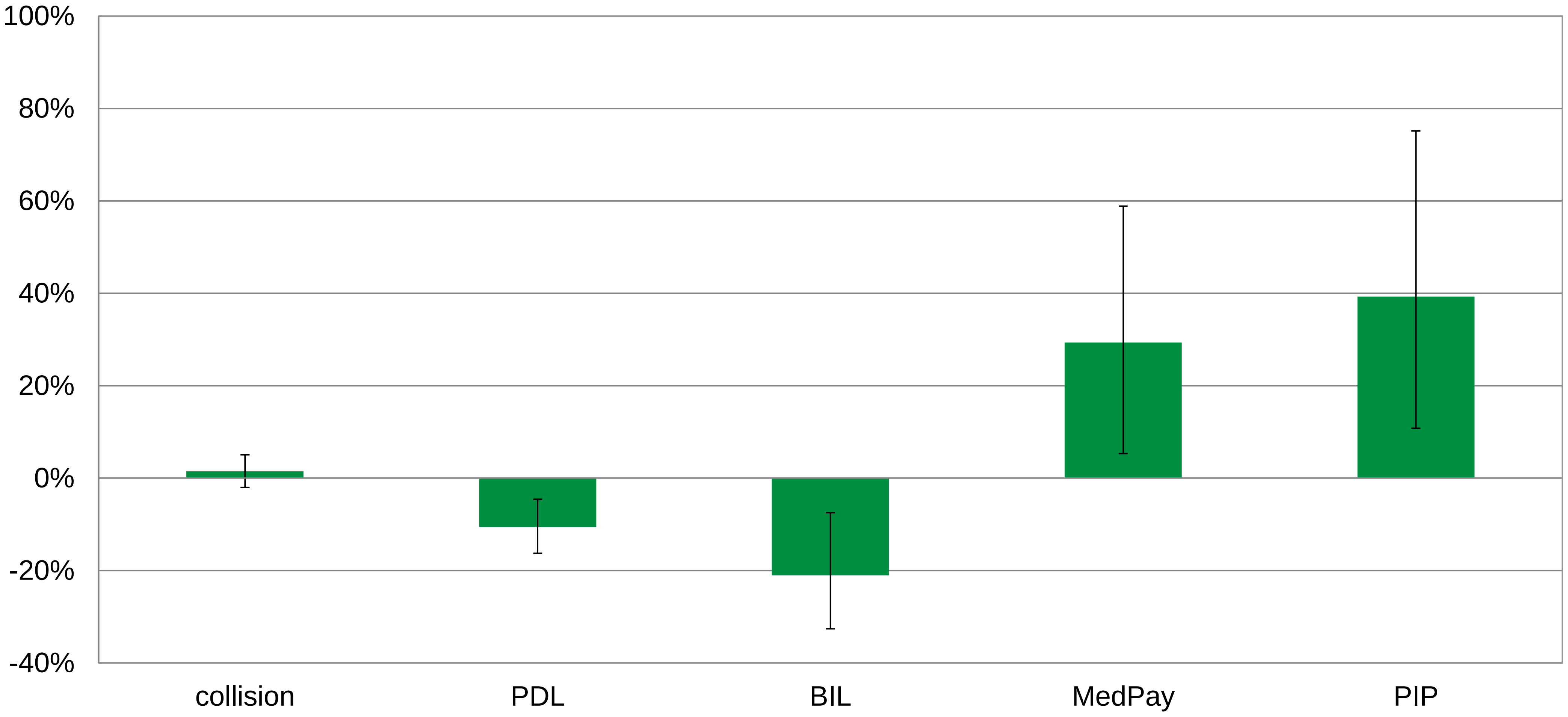
Tesla Model S claim frequencies with and without driver assistance technology versus large luxury vehicles

Effect of driver assistance technology, including Autopilot



Estimated effect of Tesla Model S driver assistance technology enabled by Hardware Version 1 on claim frequency

Effect of driver assistance technology, including Autopilot



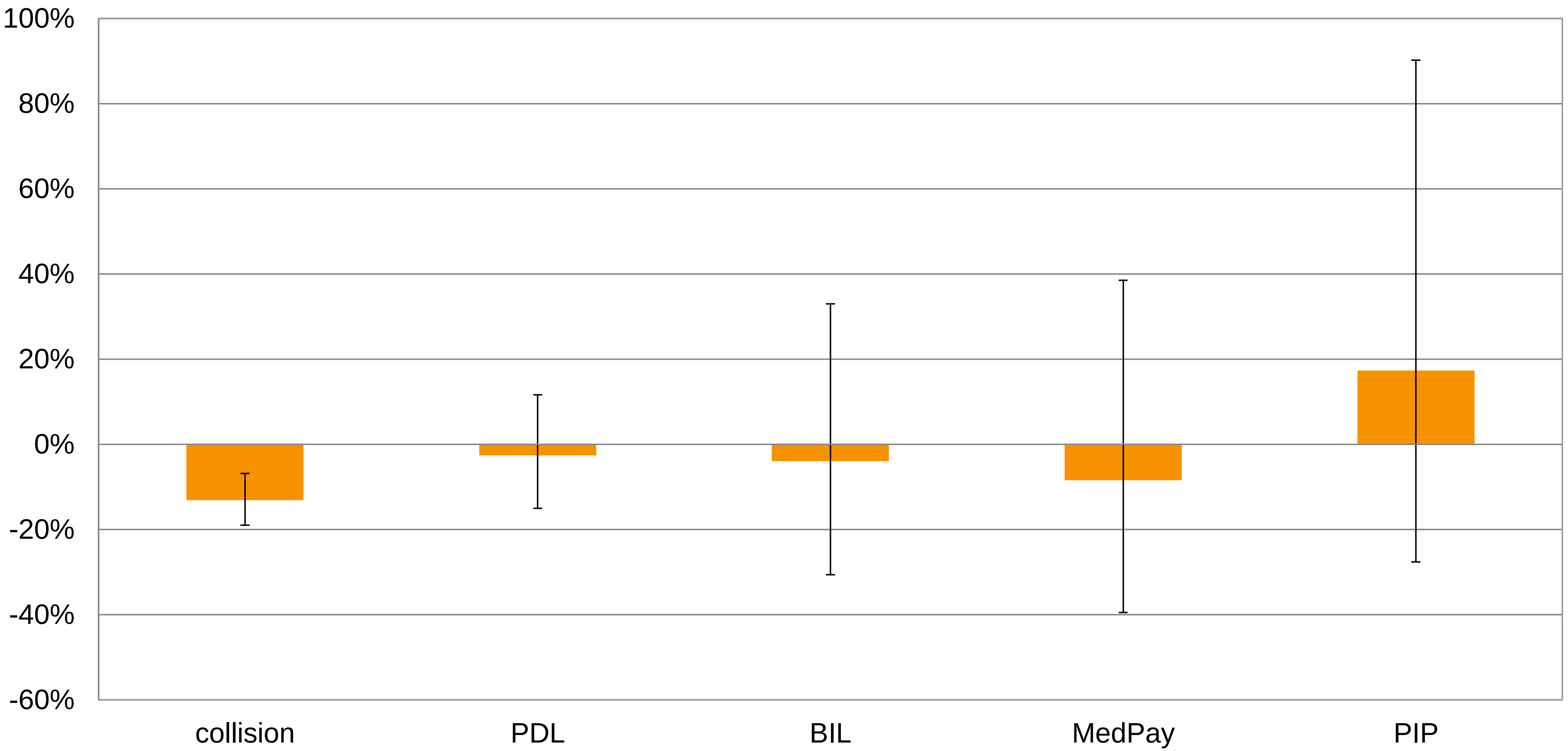
Estimated incremental effect of Tesla Model S Autopilot system

Methods

- Assume that all Tesla Model S with Hardware Version 1 had Autopilot enabled after the software version 7.0 update in October, 2015
- Exclude loss experience for Tesla Model S without driver assistance technology
- Use “difference-in-differences” approach to compare the loss experience of Tesla Model S vehicles with and without Autopilot enabled to large luxury vehicles of the same age
- Note that the vehicles with Autopilot also had following features enabled during the same period and their effect is included:
  - Autopark
  - Automated lane change
  - Side collision avoidance
  - Perpendicular Autopark
  - Summon

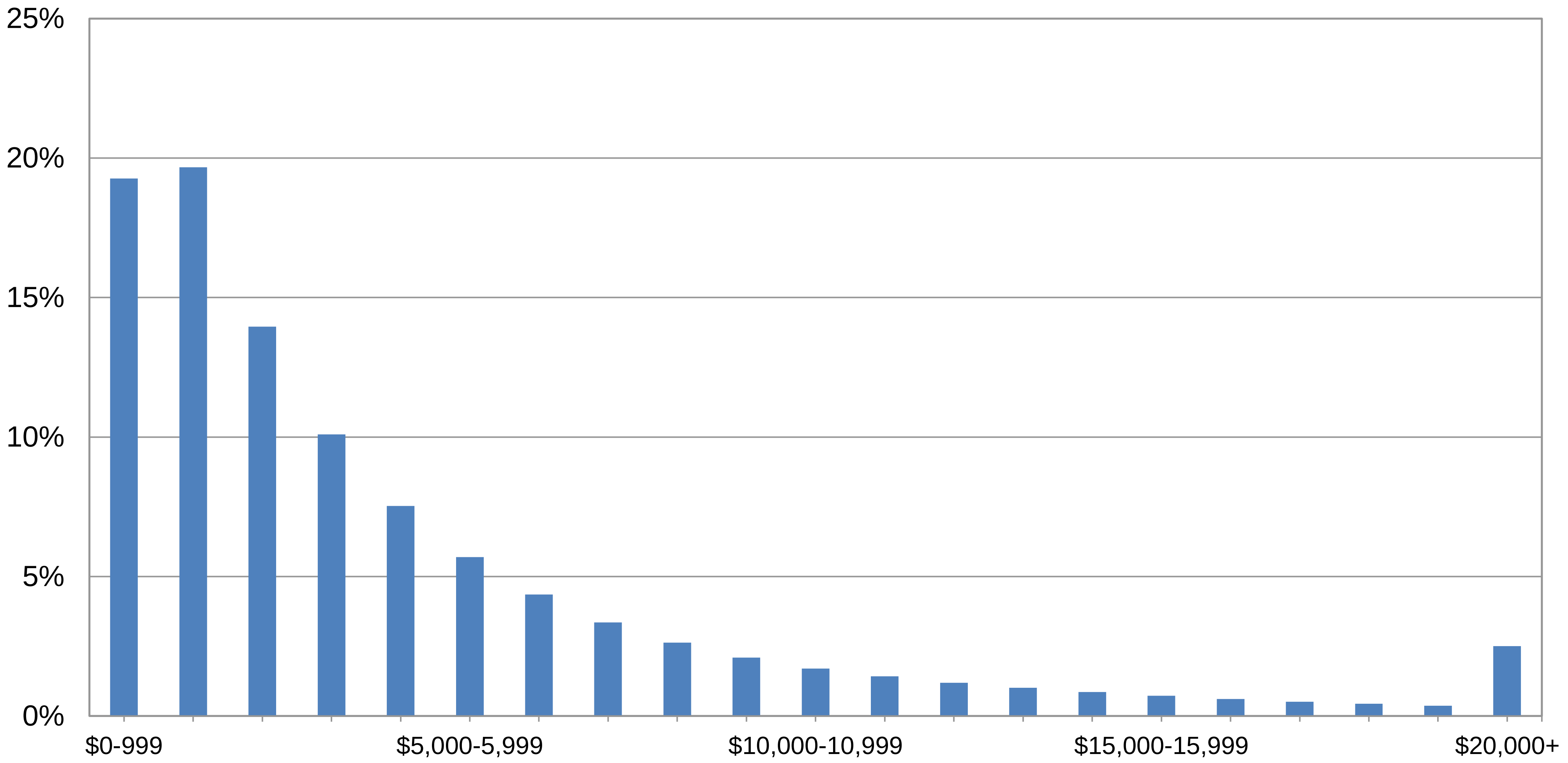
Estimated effect of Tesla Model S Autopilot on claim frequency

Driver assistance technology plus Autopilot vs. early driver assistance technology alone



Distribution of collision claims, 2016 calendar year

By claim size, 1981-2017 models




ROAD TRIP! TESLA MODEL S COAST TO COAST
CAR AND DRIVER
APR/2017
INTELLIGENCE. INDEPENDENCE. IRREVERENCE.
25 Cars Worth Waiting For
Alfa Romeo Stelvio
Kia Stinger
Chevrolet Corvette ZR1

April 2017

Model S effortlessly covered our staff's day-to-day demands with plenty of juice to spare. It wasn't off-limits to staffers with long commutes, nor did we ever feel uneasy taking the car for a weekend, when charging was less convenient or assured. There's good reason newer EVs are targeting the 200-mile threshold that Tesla cracked.

We charged at our office every weekday, initially using a 240-volt, 40-amp circuit that required more than 10 hours to replenish the depleted pack. We soon upgraded to a 100-amp line that could push 58 miles' worth of electricity into the car every hour. Those who charge overnight at home can make do with 30- or 40-amp circuits, but we became convinced some form of 240-volt service is required for Tesla ownership, especially in cold-weather climates. Over the course of a 20-degree weekend with minimal charging, one editor saw 134 miles of driving range disappear to warming the battery, heating the cabin, and reduced efficiency. Our Model S rarely enjoyed the warmth of a garage, whether it was plugged in or not, which would have increased the vehicle's overall efficiency and reduced the winter range losses we experienced.

The quiet, smooth Model S is a prolific

The 21-inch black wheels wore summer tires. The silver 19s wore all-seasons or

ered 3647 miles in four days, spending 57 hours behind the wheel and another 15 hours, 22 minutes plugged in (not including

Time certainly made our Tesla smarter. A software update in October 2015 enabled Autopilot, which combines adaptive cruise control, a self-steering lane-keeping program, and automated lane changes (activated by triggering the turn signal). Autopilot can cover scores of highway miles without driver involvement, and yet it occasionally yanked – suddenly and alarmingly – at the steering wheel when it lost the scent of lane markers, causing the vehicle to swerve out of its lane.

a nuclear reactor, but the onboard batteries can only send enough power to generate 463 ponies. While correcting the record didn't make the Model S any slower, Tesla's own software did. In January 2017, Tesla admitted that its software limits maximum output after a car exceeds a predetermined number of launches and hard accelerations in order to protect the powertrain. We have no doubt that our adolescent drivers crossed that threshold. The company also said it will remove this protection with the next software update, probably to ward off lawsuits as much as to appease customers. Between its initial and final performance tests, our P85D slowed from a 3.3-second zero-to-60-mph sprint to 3.7 seconds. The quarter-mile stretched another half-second beyond the first run of 11.8 seconds.

Time certainly made our Tesla smarter. A software update in October 2015 enabled Autopilot, which combines adaptive cruise control, a self-steering lane-keeping program, and automated lane changes (activated by triggering the turn signal). Autopilot can cover scores of highway miles without driver involvement, and yet it occasionally yanked—suddenly and alarmingly—at the steering wheel when it lost the scent of lane markers, causing the vehicle to swerve out of its lane.

Tesla's blind-spot monitor relies on the ultrasonic sensors that most automakers use only as parking-lot spotters. CEO Elon Musk says Tesla prefers this approach because, compared with the radar-based alternative, the sensors work at lower speeds and better detect "soft" objects, such as humans. But ultrasonic sensors have less range than radar, so they can't spot a fast-closing car in the next lane. That makes the automatic lane change a dicey proposition. New Teslas wear eight cameras that provide a 360-degree view around the car, upgrading their lane-changing capabilities.

While the instrument cluster implores the driver to keep their hands on the wheel during Autopilot use, the system's seeming competence easily lulls you into false confidence and dumb behavior such as texting or, in the case of our drivers, writing notes in the car's logbook. There's no doubt that Tesla's Autopilot is more capable than the nervous, lawyer-handicapped systems offered by every other automaker, but it's far from finished. Autopilot's inability to handle all scenarios was highlighted in the May 2016 fatal accident in which a Model S operating on Autopilot broadsided a semi-trailer that crossed the Tesla's path.

We've been promised that EVs will reduce operating costs, but Tesla's service prices don't reflect its vehicles' simplicity. The 12,500-mile maintenance stop involves replacing the cabin air

HOW TO TRAVEL FAST AND EAT WELL IN A TESLA

The Model S's embedded trip planner keeps a conservative store of electricity in reserve and favors frequent but short charging. As we crossed middle America, the nav system recommended stopping at almost every Supercharger along our route. But because the charging rate slows as the battery fills, we found it quicker to ignore Tesla's recommendations, drive the car to near empty, and plug it in for only slightly longer charges. Our routine: Drive between 120 and 200 miles at roughly 5 mph over the speed limit, charge for 20 to 45 minutes to a predicted range 50 miles greater than what was needed for the next stint, then get back on the road. We typically arrived at the subsequent stop with 20 to 30 miles of remaining range, although uphill stints caused us to slash our speed or tuck in behind semis on a couple occasions. Starting with 247 miles of range and climbing a little more than 1000 feet over 190 miles into Weatherford, Oklahoma, we rolled to the plug with just two miles of indicated range.

Traveling in this manner requires some advanced planning to know which chargers to visit and which to bypass. We used Google Maps and plugged in our chosen charging stops knowing that we wouldn't risk a run longer than 200 miles.

In hindsight, we would have added one preplanning task: Noting the nearby amenities that are listed on Tesla's Supercharger web page. You can't escape mediocre megachain dining along the Supercharger network, but you can prevent the disappointment of pulling up to a charger at dinner time only to discover that it's located at a secluded hotel. And even the best-planned trip requires a good pair of walking shoes. It often takes a decent hike—sometimes across lawns, through landscaping berms, or along busy roads—to refuel the passengers. —ET

July 28, 2016
31,018 miles: Car trucked to Tesla's Cleveland service center where they replace the driver's front lower control arm to address a clunking noise and clean out the sunroof drain lines to stop the leaking that persists. $0

August 8, 2016
31,387 miles: Discover both front wheels are bent; replace worn front tires. $805

August 17, 2016
32,287 miles: Straighten one front wheel and learn that the other is damaged beyond repair. $135

August 25, 2016
32,698 miles: Driver's seat replaced at our office. $0

Service ranger also delivers a new front wheel. $1188

September 27, 2016
34,174 miles: Repair rock chip in windshield. $50

November 16, 2016
34,549 miles: Car retrieved by the Cleveland service center to address a clunking front suspension. Technicians replace the right-front anti-roll-bar end link and the chrome tailgate trim, which is allowing water in the taillights. $0

December 5, 2016
40,000 miles: Model S finishes its long-term tour

TOTAL COSTS

MAINTENANCE	$1188
NORMAL WEAR	$805
REPAIR	$0
DAMAGE AND DESTRUCTION	$3180
ELECTRICITY (@ $0.13 PER KWH)	$2477

SERVICE

DEALER VISITS (SCHEDULED/UNSCHEDULED)	2/5
DAYS OUT OF SERVICE	25

Experiences with driving automation

Opinions of level 2 driving automation technology after brief use

- 17-20 employees drove each vehicle on a 20-mile route while using level 2 driving automation the entire drive
- Completed a survey about their experience after the drive

2017 BMW 5 series with “Driving Assistant Plus”

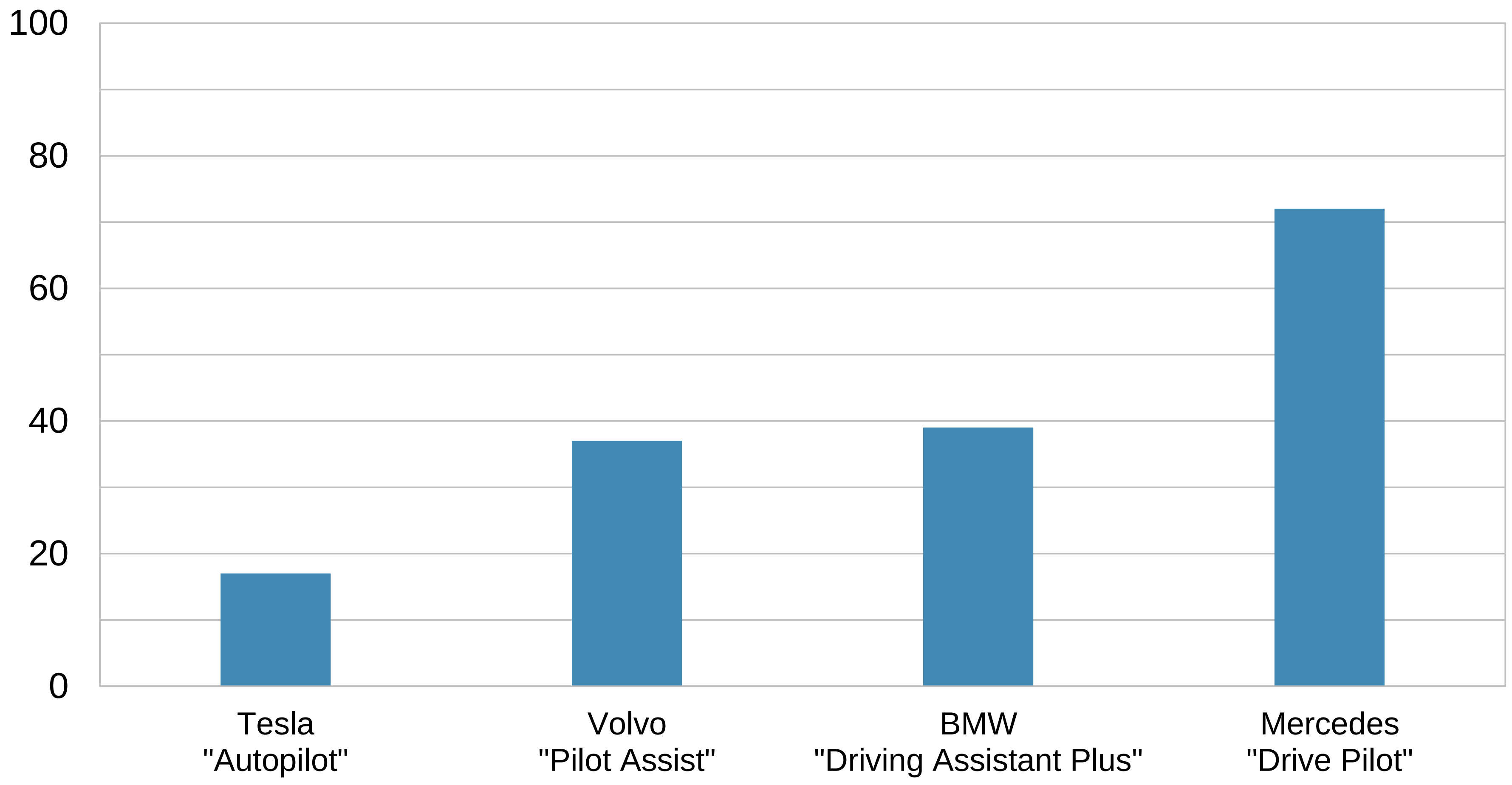
2017 Mercedes E-Class with “Drive Pilot”

2016 Tesla Model S with “Autopilot”

2018 Volvo S90 with “Pilot Assist”

Overall, I felt the automation improved my driving experience

Percentage of drivers who agreed or strongly agreed

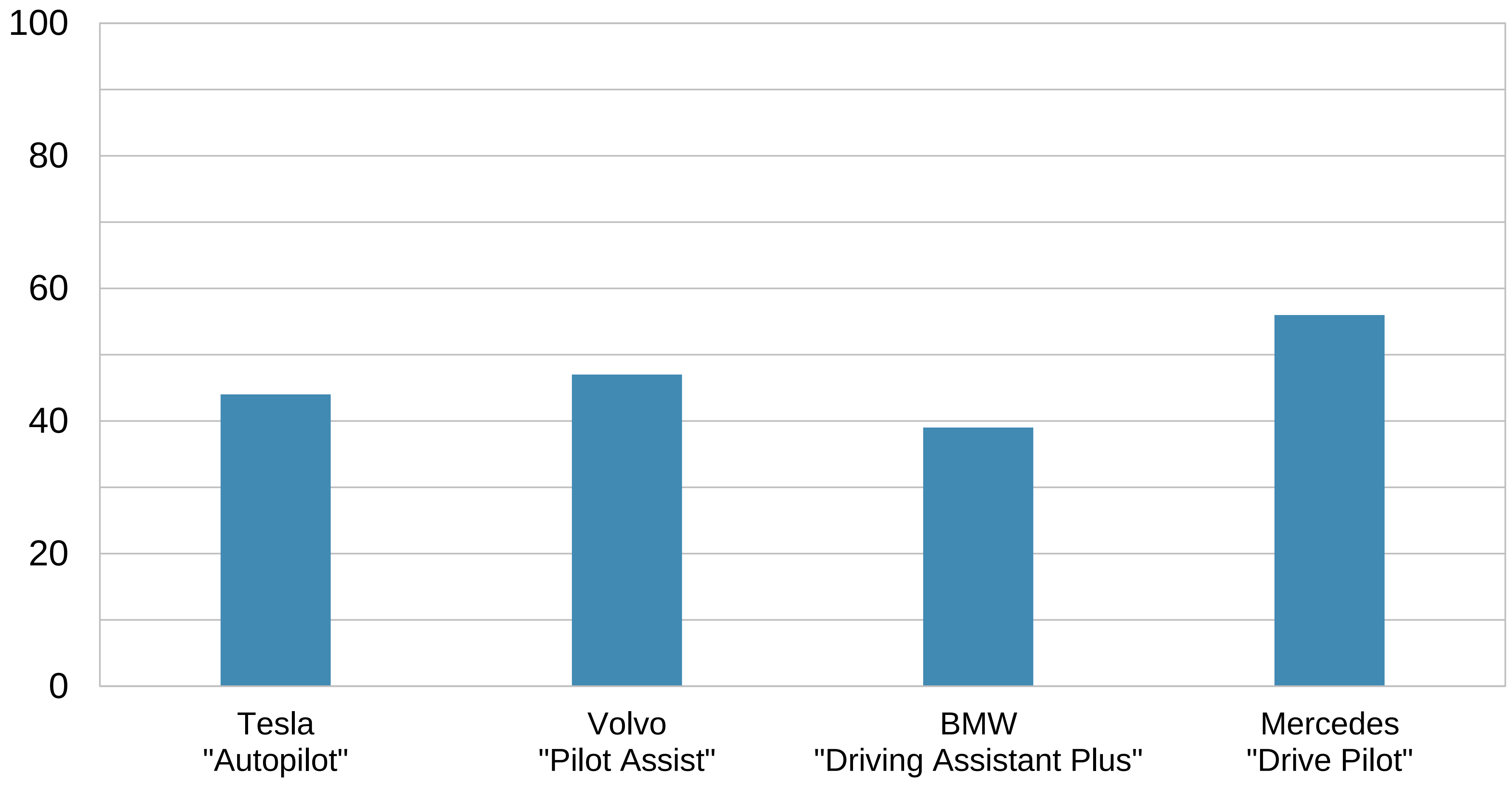


What did drivers think the systems did well and poorly?

- Drivers reported their level of agreement with statements about the automation:
  - Accelerated and decelerated the vehicle smoothly
  - Made smooth, gentle steering corrections
  - Made infrequent steering corrections
  - Always knew whether the vehicle ahead was detected
  - Always knew whether the lane markings were detected
  - Consistently detected lane markings
  - Detected moving vehicles ahead
  - Detected stopped vehicles ahead

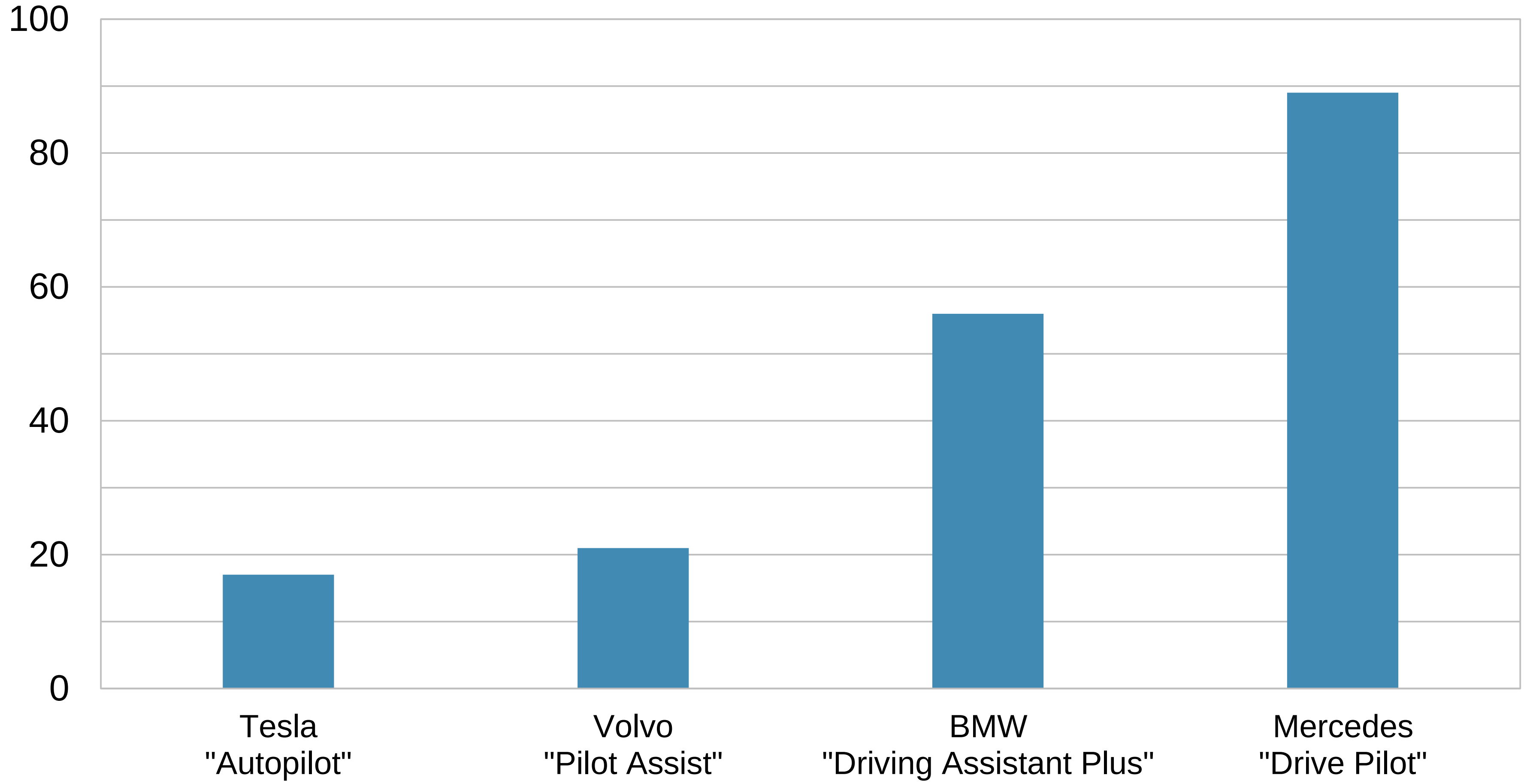
The automation detected stopped vehicles ahead in my lane

Percentage of drivers who agreed or strongly agreed



The automation made smooth, gentle steering corrections

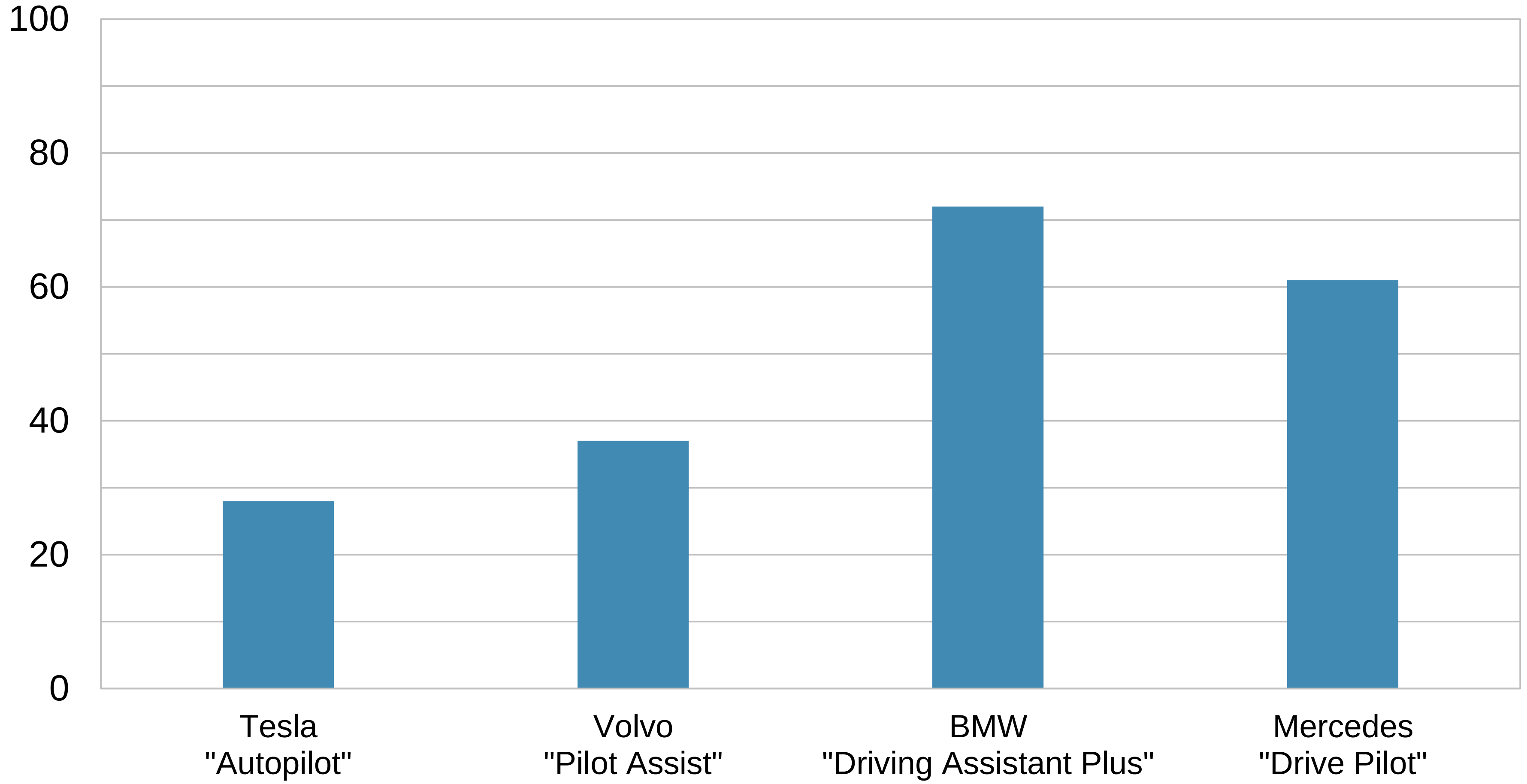
Percentage of drivers who agreed or strongly agreed



IIHS HLDI

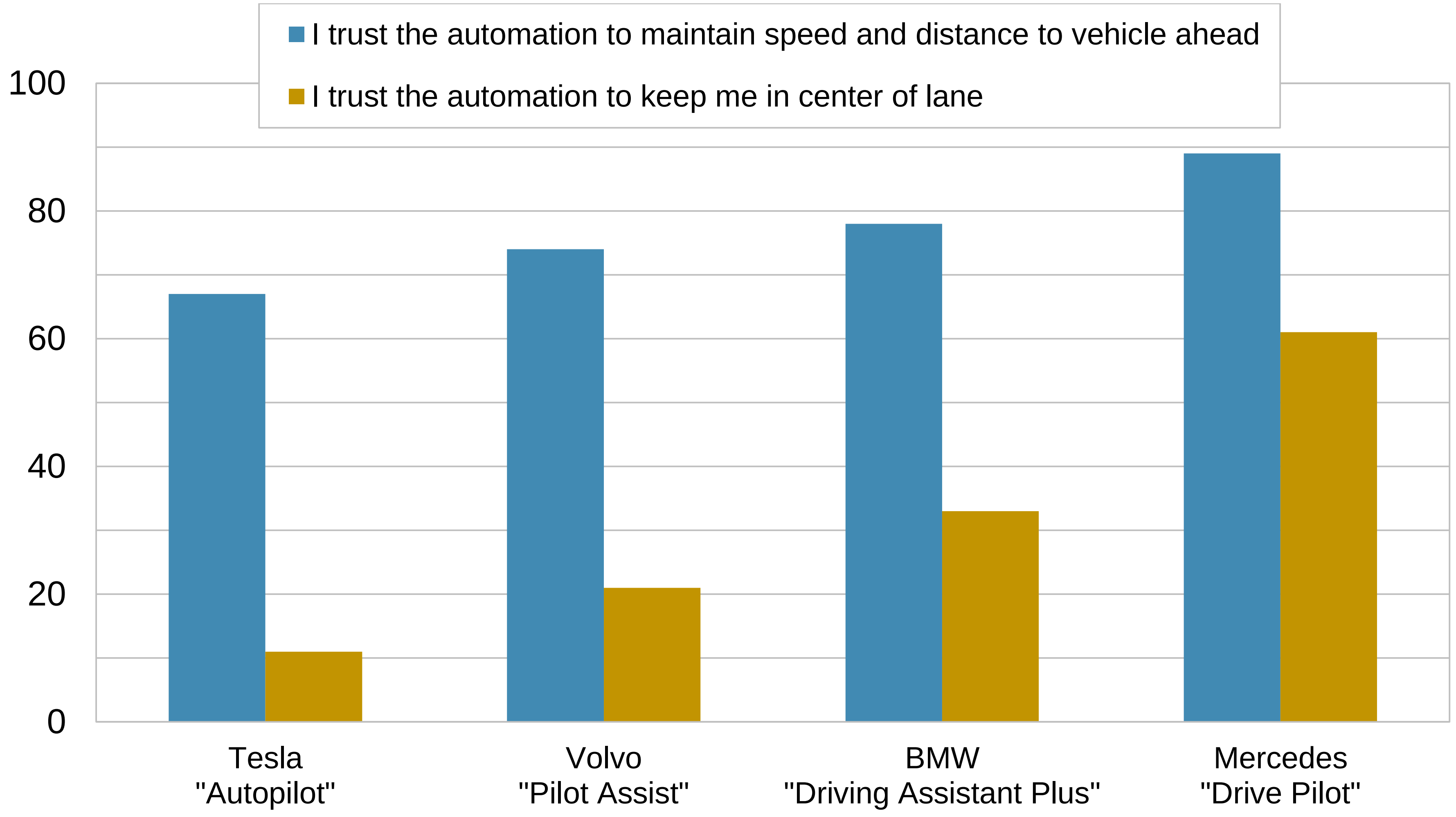
The automation made steering corrections infrequently

Percentage of drivers who agreed or strongly agreed



Adaptive cruise control trusted more than active lane keeping

Percentage of drivers who agreed or strongly agreed



Functional performance of adaptive cruise control and active lane-keeping systems

Functional performance testing of adaptive cruise control and lane-keeping systems

- Combination of track and on-road tests designed to discriminate differences seen in our driver experience study
- Scenarios based on driver experience study
  - Adaptive cruise control
    stopped lead vehicle, vehicle exiting lane, acceleration/deceleration profiles
  - Active lane keeping
    lane tracking, steady-state lane position, curve handling and hill capability

2017 BMW 5 series with “Driving Assistant Plus”

2017 Mercedes E-Class with “Drive Pilot”

2016 Tesla Model S with “Autopilot”

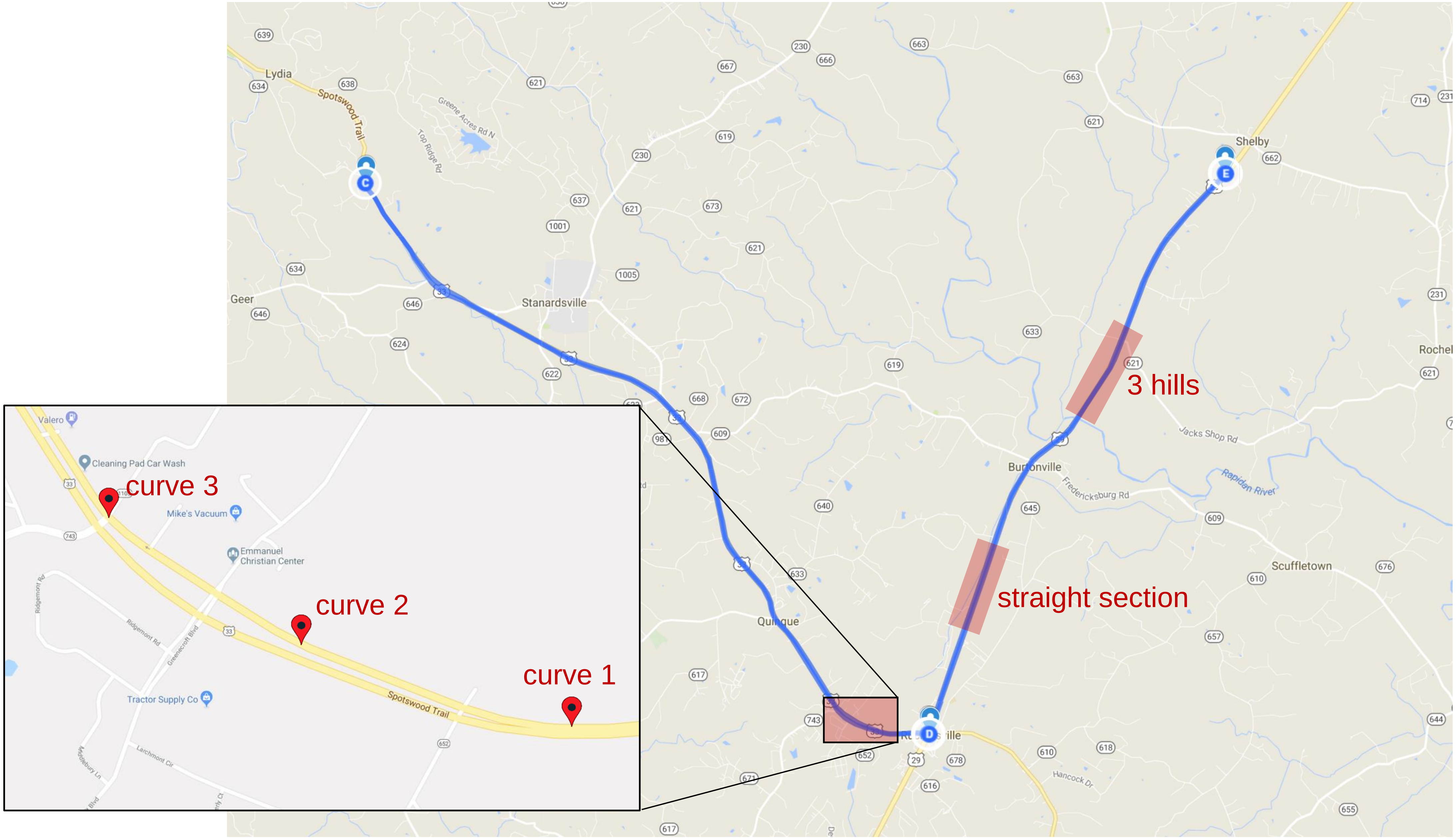
2017 Volvo XC90 with “Pilot Assist”

Approach stationary target with ACC on

ACC acceleration from stop

Revealed stationary vehicle

On-road testing



Lane keeping in curves - Tesla

IIHS HLDI

Lane keeping in curves - BMW

Lane keeping on hills - Mercedes

Lane keeping on hills - Volvo

SAE Level 4 / Level 5 Systems

IIHS HLDI

New York Times, November 20, 2017

Uber Strikes Deal With Volvo to Bring Self-Driving Cars to Its Network

CNET, December 4, 2017

Nissan Begins Public Robo-taxi Trials Next Year

The Verge, December 6, 2017

Lyft is Now Offering Self-driving Car Trips in Boston

Wired, April 4, 2017

Mercedes promises self-driving taxis in just three years

CleanTechnica, November 11, 2017

Self-driving taxi service from Waymo set to begin shortly

Wall Street Journal, November 30, 2017

GM Aims for Self-Driving Taxi Fleet by 2019

Industry Week, December 6, 2017

Final Countdown: Nissan Introducing Fully Autonomous Cars in 2022

CarAdvice, December 4, 2017

BMW autonomous vehicles coming in 2021

How do experimental self-driving vehicles compare to human drivers?

Google self-driving car program

2009-present

- Testing on public roads in Mountain View, Calif., and later expanded to Austin, Texas; Kirkland, Wash.; and metro Phoenix, Ariz.
- Self-driving technology includes detailed mapping, variety of sensors and advanced software
- Designed to operate free of active driver control in most situations
- Testing monitored by Google employees who will take over vehicle control when necessary

modified Toyota Prius

modified Lexus RX450h

Google prototype low-speed vehicle

IIHS HLDI

Two studies comparing Google-car to human drivers

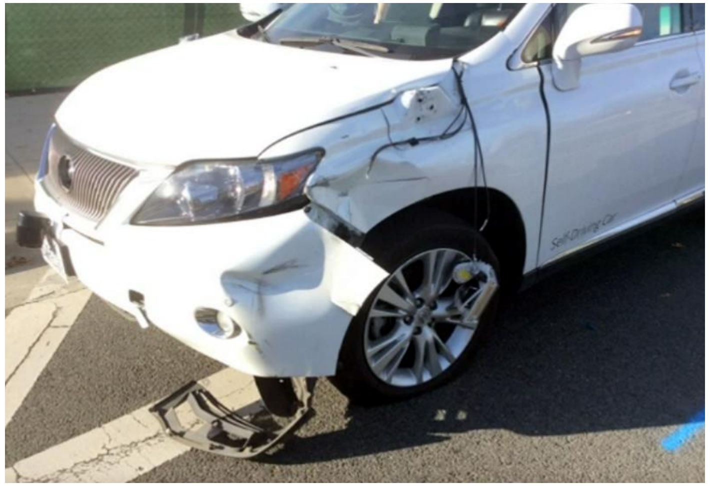
Two different conclusions

- University of Michigan Transportation Research Institute
  - Used estimates of underreporting to police to inflate General Estimates System crash count estimates
  - Found Google-car crash rate was higher than humans
- Virginia Tech Transportation Institute
  - Compared safety-related events in naturalistic driving studies to incidents reported by Google to California
  - Found Google-car had lower rate of such incidents than humans

Crash involvements in autonomous operation

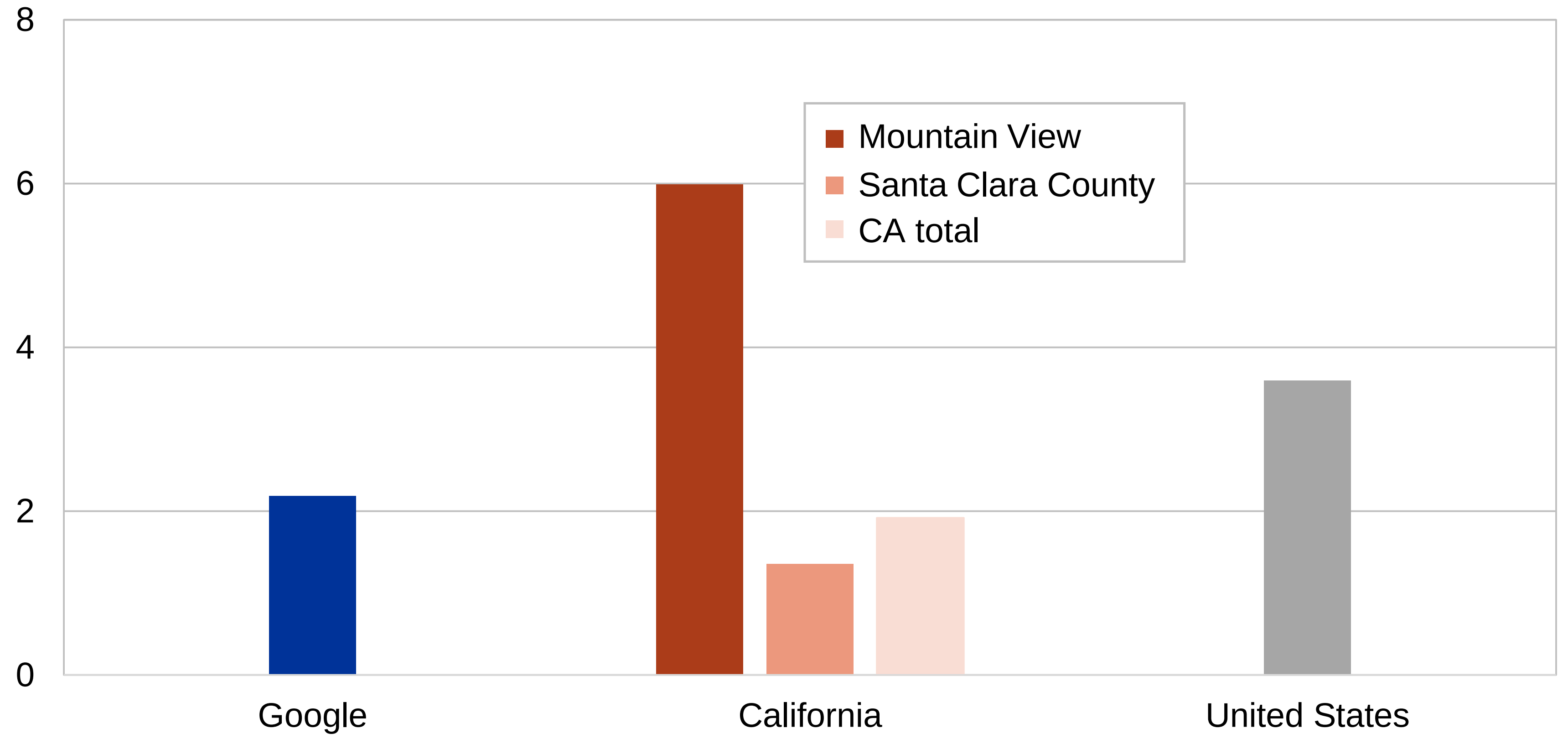
2009 – August 31, 2016

- 19 crash incidents reported by Google
  - 9 deemed possibly police-reportable by IIHS
  - 12 where the Google car was stopped or traveling < 2 mph
  - 2 involved contact with only the side mirror
- Crash rates and types were compared with those of conventionally-driven passenger vehicles



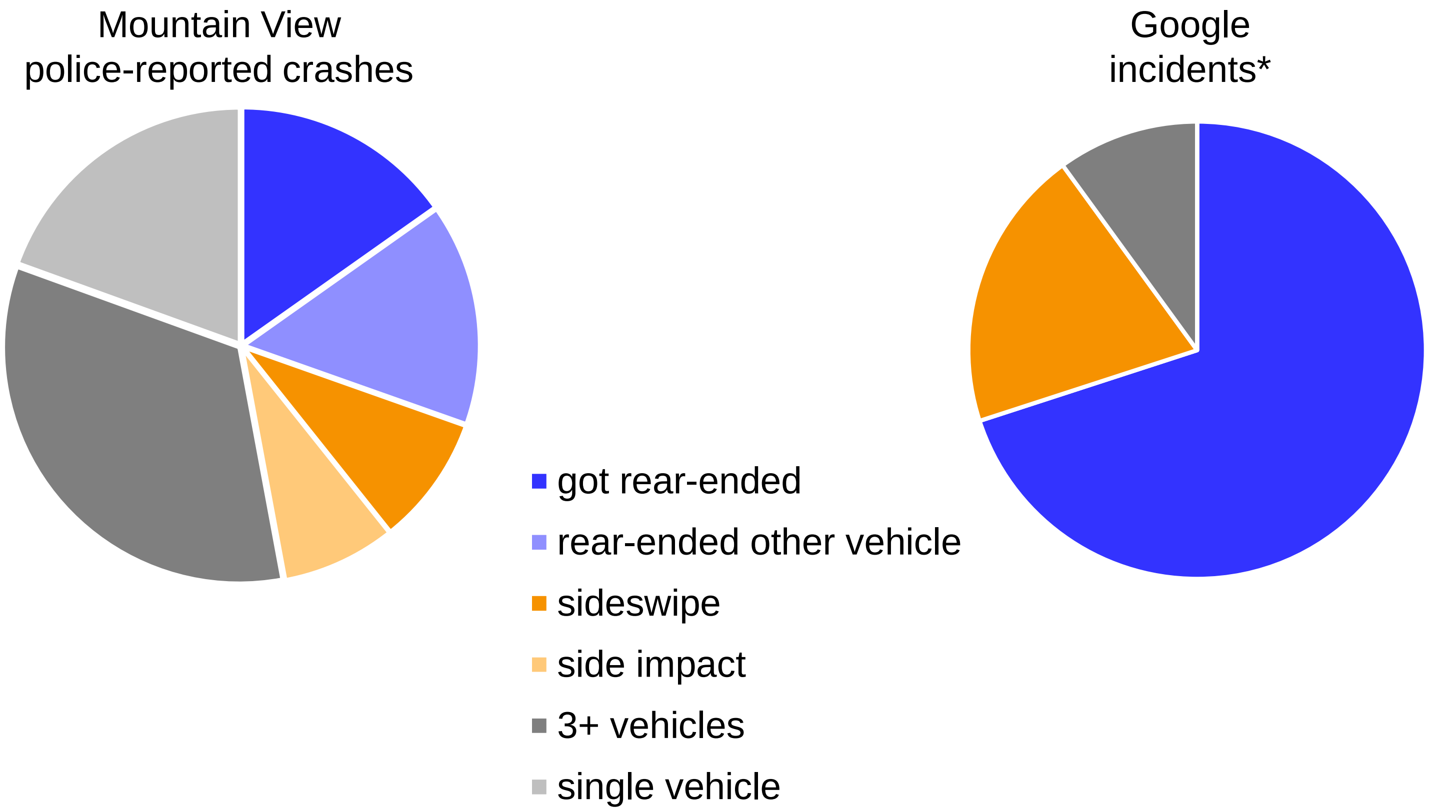
Police-reportable crashes per million vehicle miles traveled

2009-15



Crash types

2009-15



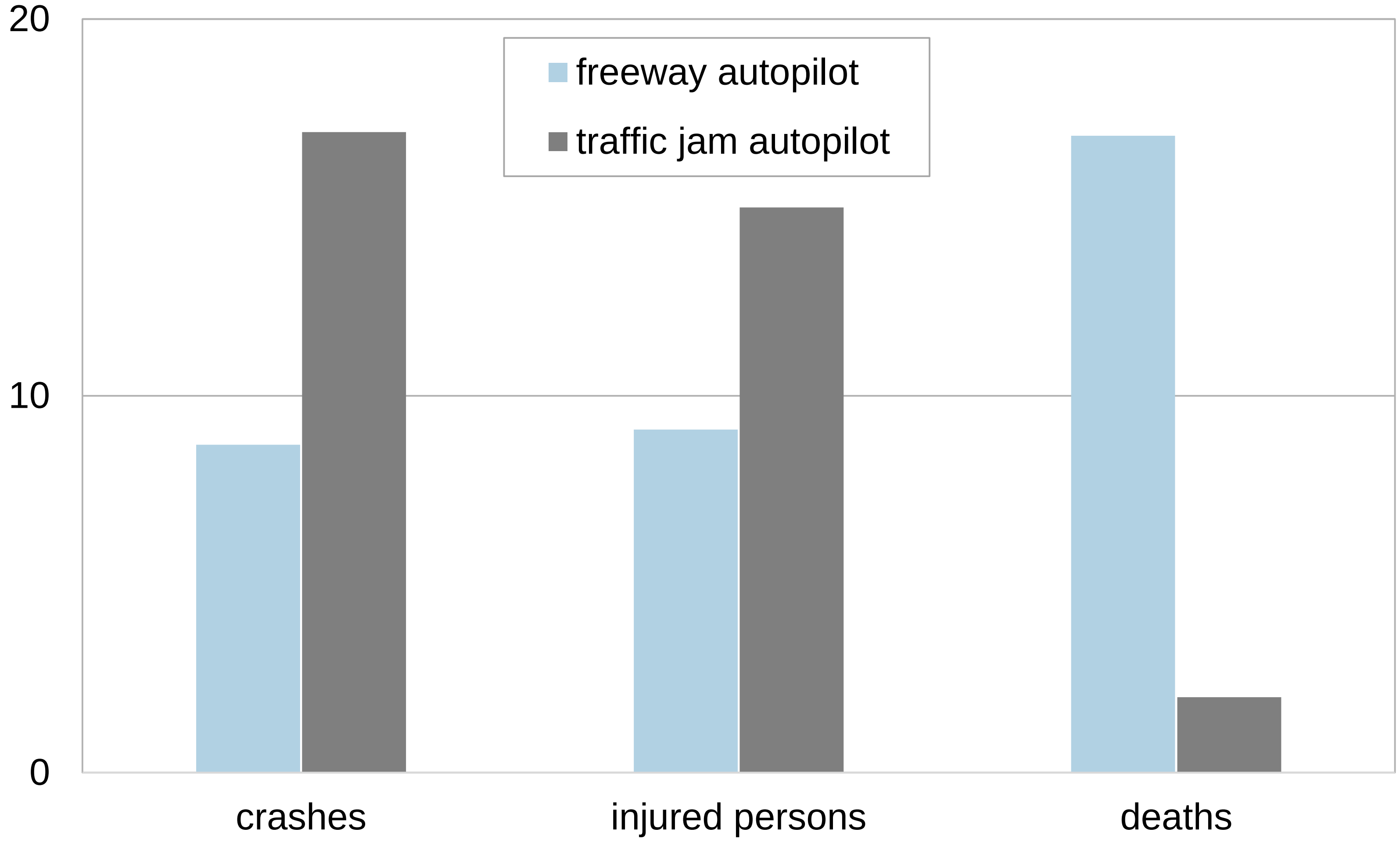
■ Google car rear-ended by another vehicle that was also rear-ended

* Includes all incidents, not just those possibly police-reportable

What crash reductions can we expect from limited automated driving systems?

Crash prevention potential of two domain restricted automated driving systems

Percent of crashes



What if NYC Taxicabs were replaced by robo-taxis that didn’t crash?

2015

- 13,587 in operation
- 13,282 crashes
- 0.98 crashes/cab/year
- 5 fatal crashes

- Assuming crash rates similar to Google car
  - 8,400 crashes prevented
  - About 3 fatal crashes prevented
- 29 taxicabs in fatal crashes in the U.S. in 2015

IIHS HLDI

Automated driving system policy and legislation

IIHS HLDI

Policy and legislation will not collect data to evaluate SAE level 3 and higher automated driving systems

September 12, 2017

July 25, 2017

115TH CONGRESS
1ST SESSION

H. R. 3388

IN THE SENATE OF THE UNITED STATES
SEPTEMBER 7, 2017

Received; read twice and referred to the Committee on Commerce, Science, and Transportation

AN ACT

To amend title 49, United States Code, regarding the authority of the National Highway Traffic Safety Administration over highly automated vehicles, to provide safety measures for such vehicles, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "Safely Ensuring Lives Future Deployment and Research In Vehicle Evolution Act" or the "SELF DRIVE Act".

September 28, 2017

115TH CONGRESS
1ST SESSION

S. 1885

To support the development of highly automated vehicle safety technologies, and for other purposes.

IN THE SENATE OF THE UNITED STATES
SEPTEMBER 28, 2017

Mr. THUNE (for himself, Mr. PETERS, Mr. BLUNT, and Ms. STABENOW) introduced the following bill; which was read twice and referred to the Committee on Commerce, Science, and Transportation

A BILL

To support the development of highly automated vehicle safety technologies, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "American Vision for Safer Transportation through Advancement of Revolutionary Technologies Act" or the "AV START Act".

Public VIN database would support safety assessments

- IIHS and HLDI linked crash and exposure data using VINs supplied by OEMs
- Database at a minimum would include:
  - VINs of vehicles with SAE level 3 or higher systems
  - Level of automation of each equipped system
  - Operational Design Domain of each equipped system
  - Exemptions from Federal Motor Vehicle Safety Standards
- VIN would be submitted at time of manufacture

States, law enforcement and insurers would benefit

- VIN-indexed database would support:
  - Motor vehicle registration
  - Vehicle safety inspection
  - Crash reporting and investigation
  - Insurance underwriting and claim processing
- More robust database would include:
  - Level 2 driving automation systems by VIN
  - Crash avoidance technologies by VIN
  - Marketing names of crash avoidance and automation technologies
  - Current software version of each technology and software version history

Event data recorders would help determine the role of automation in a crash

- Event data recorders are not required — only the data elements they must record
- Required data elements do not include information about crash avoidance or driving automation systems
- IIHS developed a list of data elements to describe the status of crash avoidance and automation in a crash

Event and exposure data are critical for understanding whether new vehicle technology improves safety

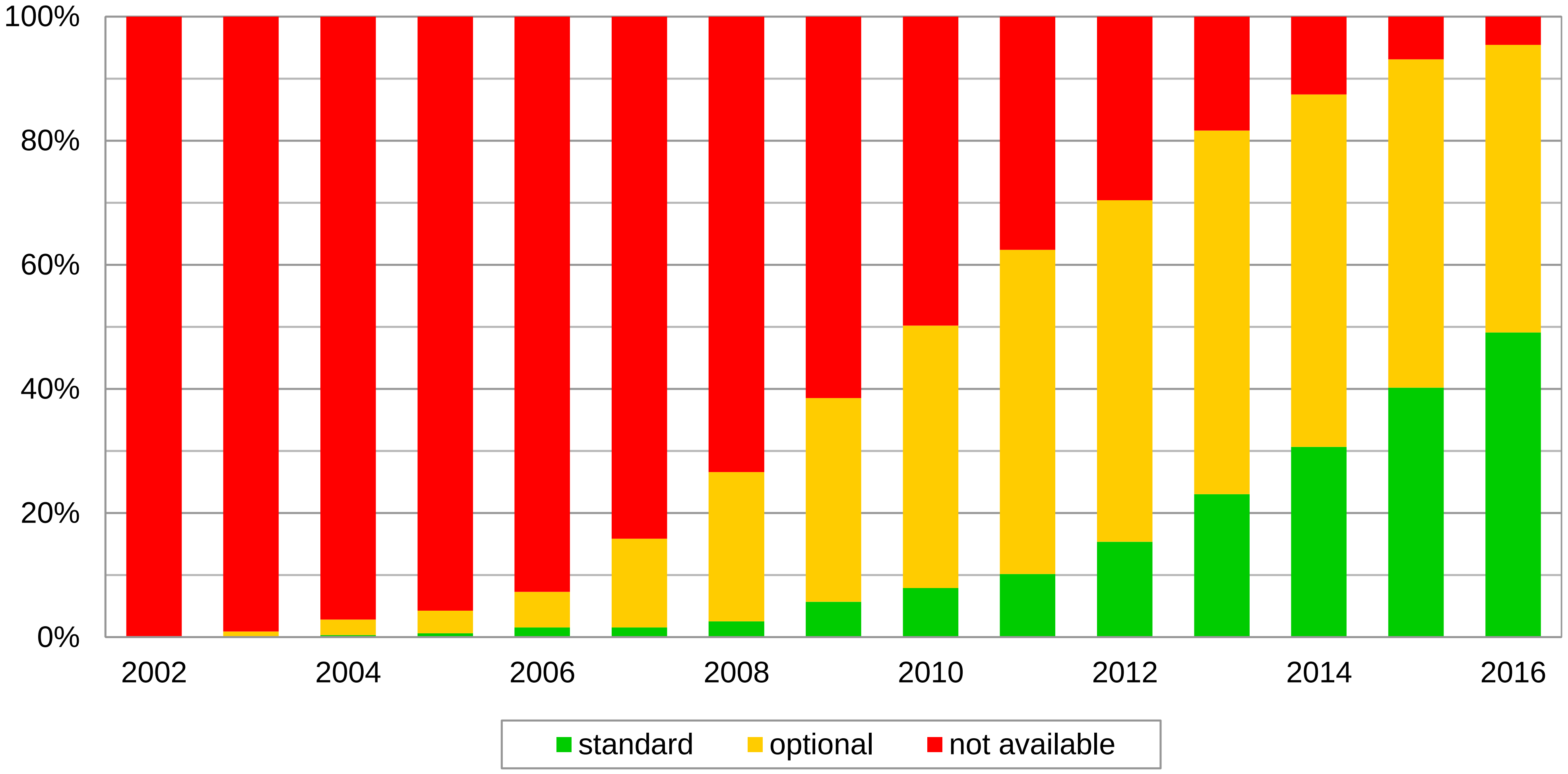
- Measuring the effect of a vehicle feature on safety requires:
  - Knowing how the feature works and under what conditions
  - Identifying vehicles with and without the feature
- Information about the feature’s status in a crash improves precision
- NHTSA voluntary guidance and proposed congressional legislation will gather incomplete information for assessing the real-world safety of automation
- Public database listing vehicles with automated driving systems by VIN will support proven methods for measuring safety benefits

Phase in of collision avoidance systems

IIHS HLDI

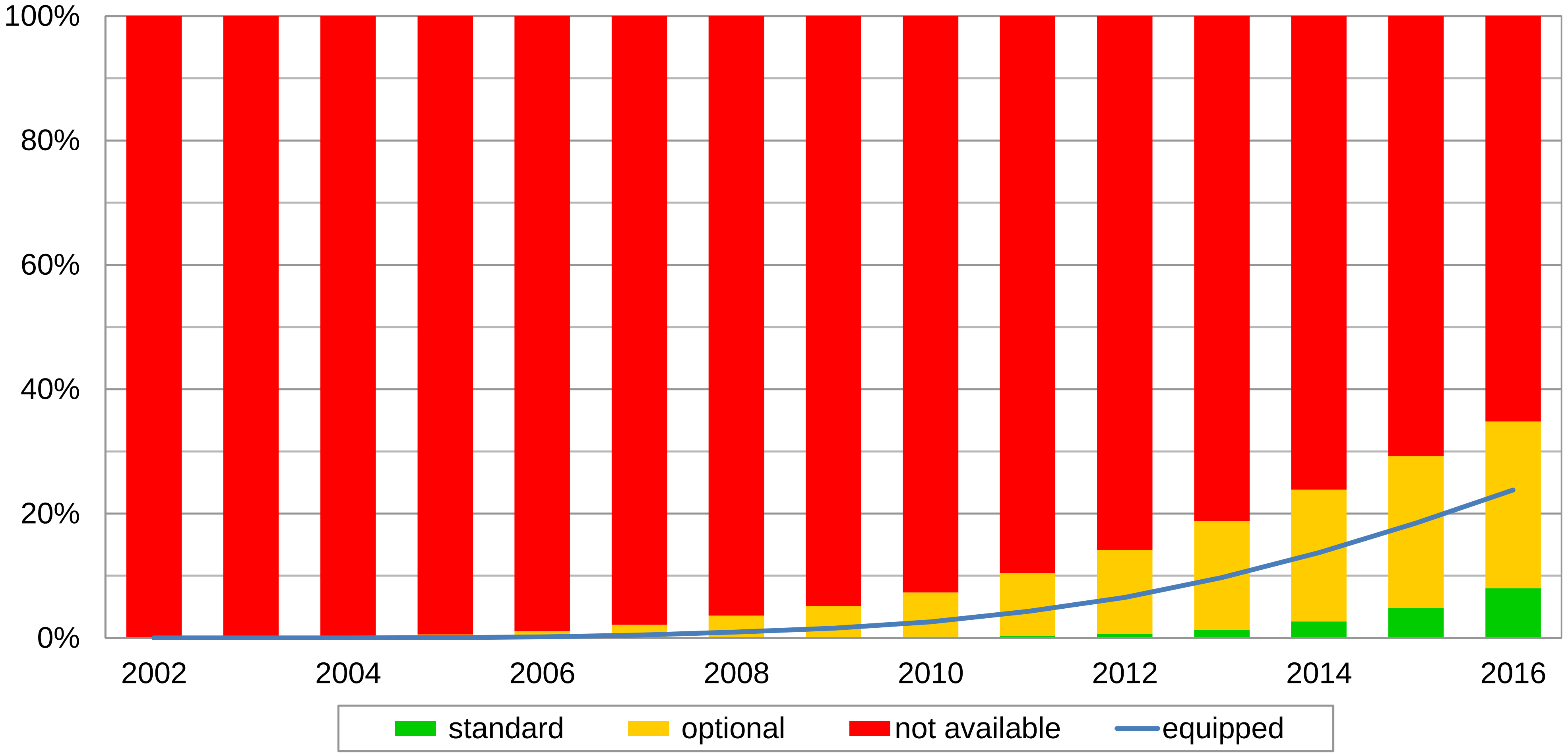
New vehicle series with rear camera

By model year



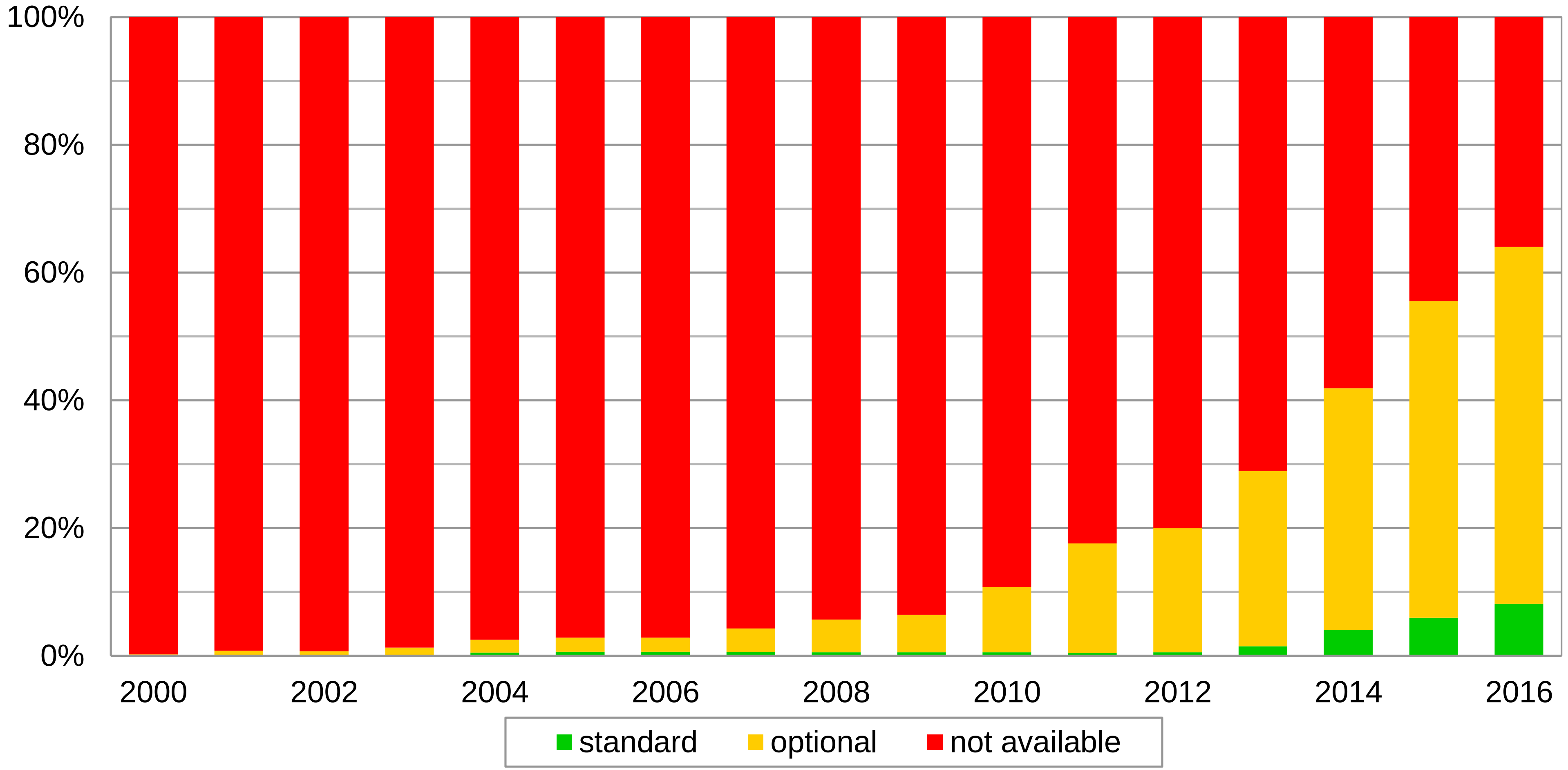
Registered vehicles with rear camera

By calendar year



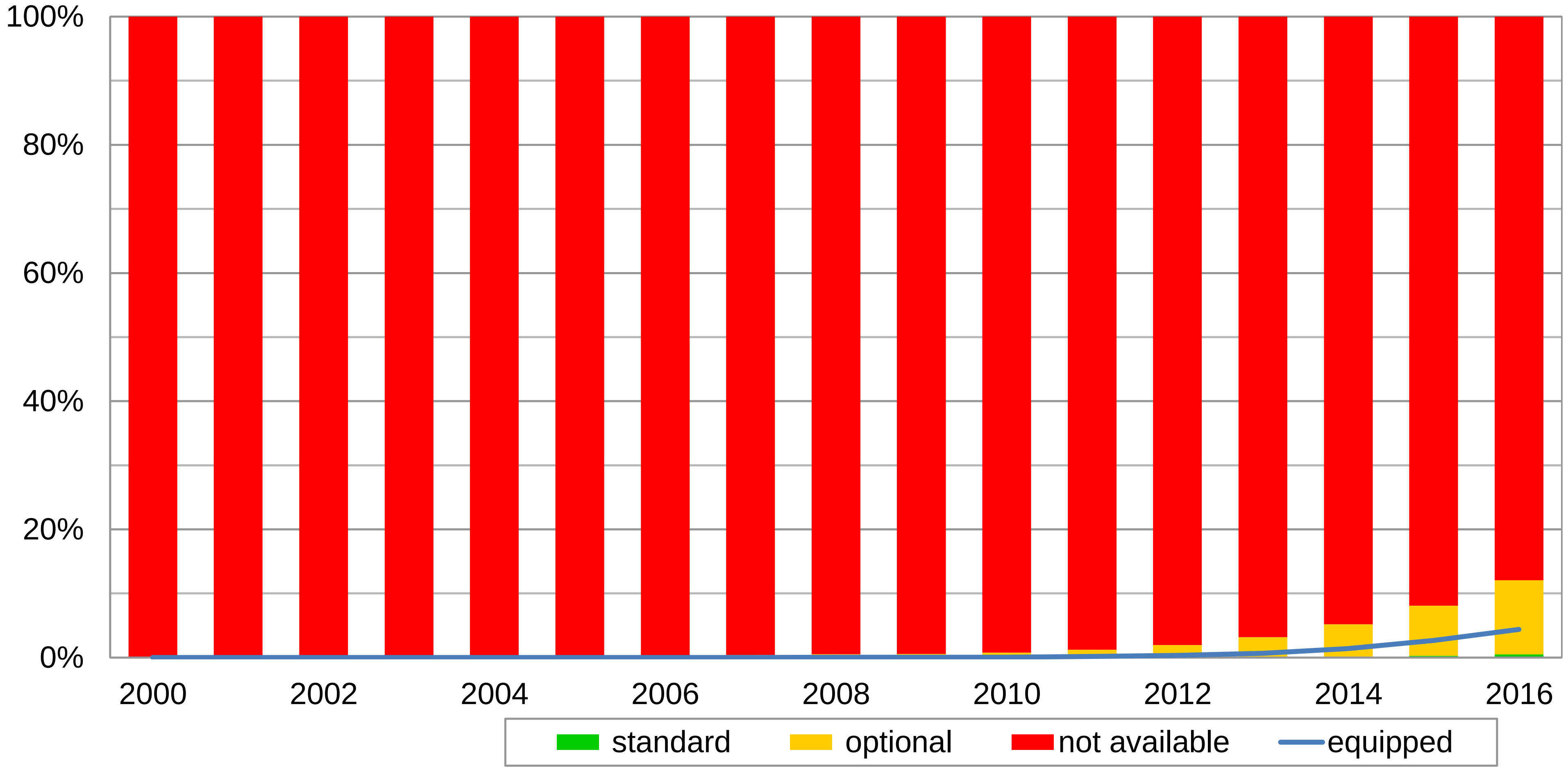
New vehicle series with forward collision warning

By model year



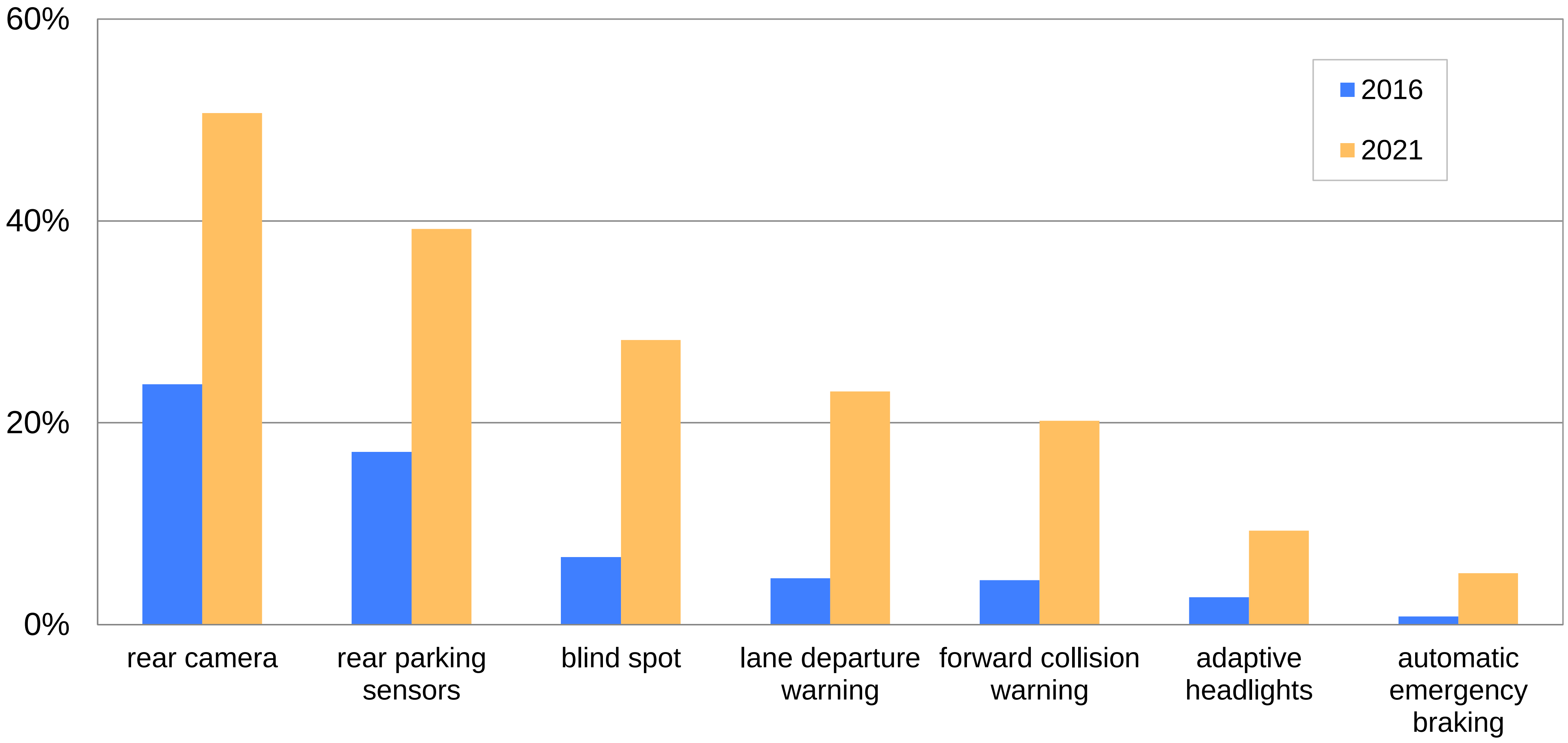
Registered vehicles with forward collision warning

By calendar year



Estimated registered vehicles by feature

Calendar years 2016 and 2021



Insurance Institute for Highway Safety
Highway Loss Data Institute

More information at iihs.org and on our social channels:

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