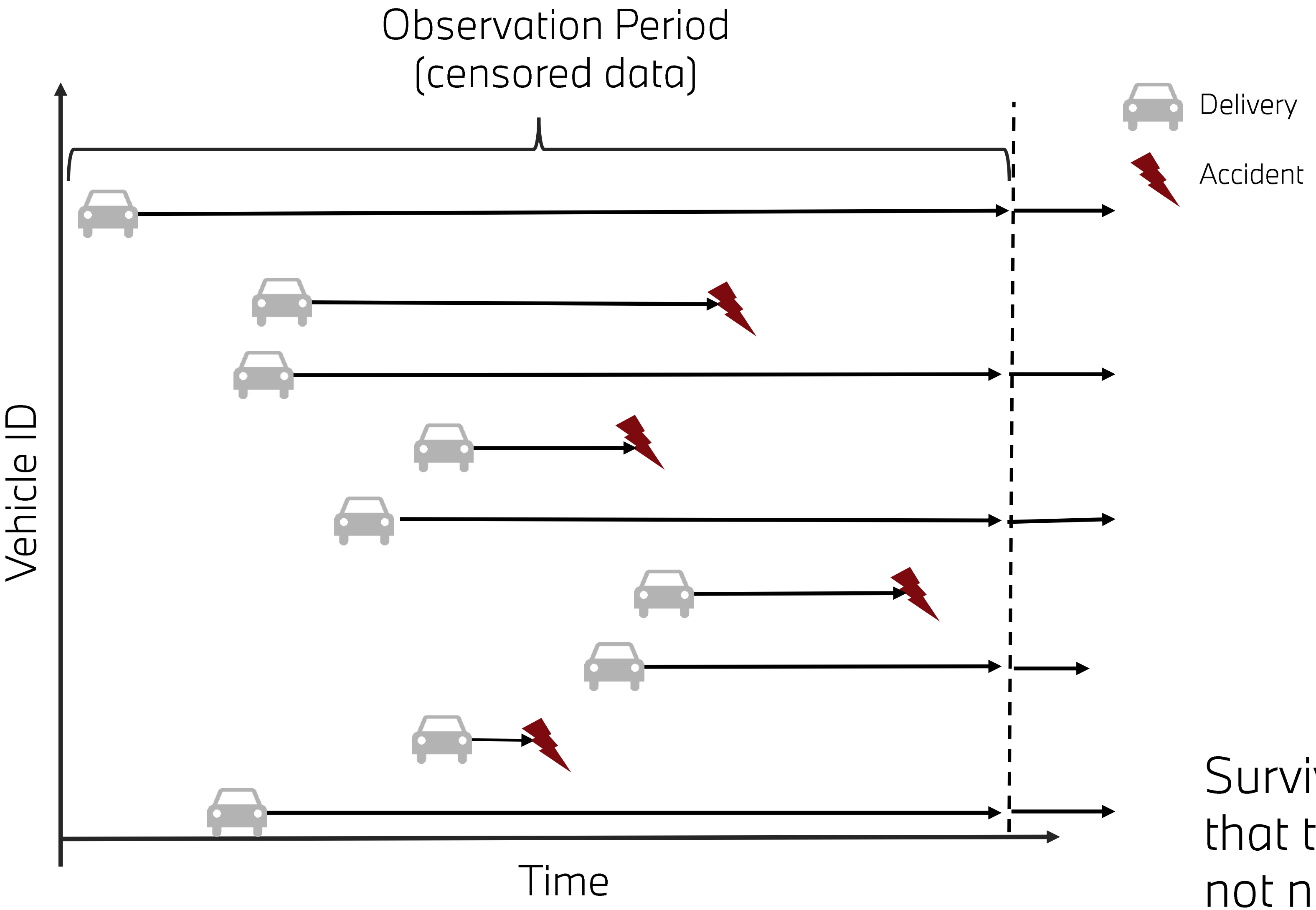
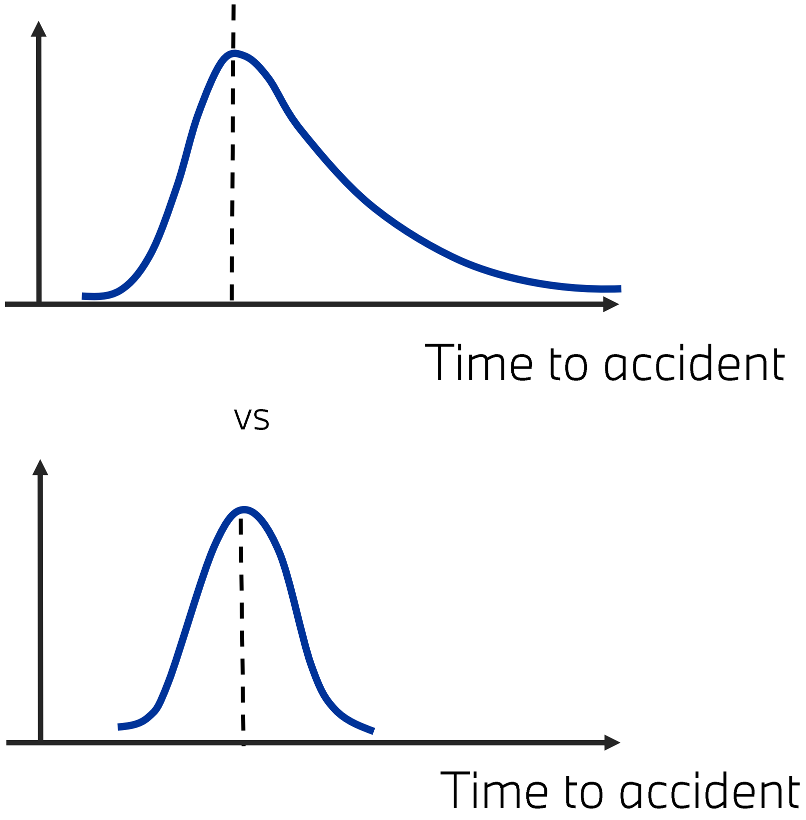
QUANTIFIZIERUNG DER FELDEFFEKTIVITÄT VON FAHRERASSISTENZSYSTEMEN MITTELS UNFALLDATEN

LUDWIG DREES, BMW GROUP

BMW X5. ADAS FEATURES EXAMPLES. CAN WE SEE A REAL-WORLD BENEFIT?

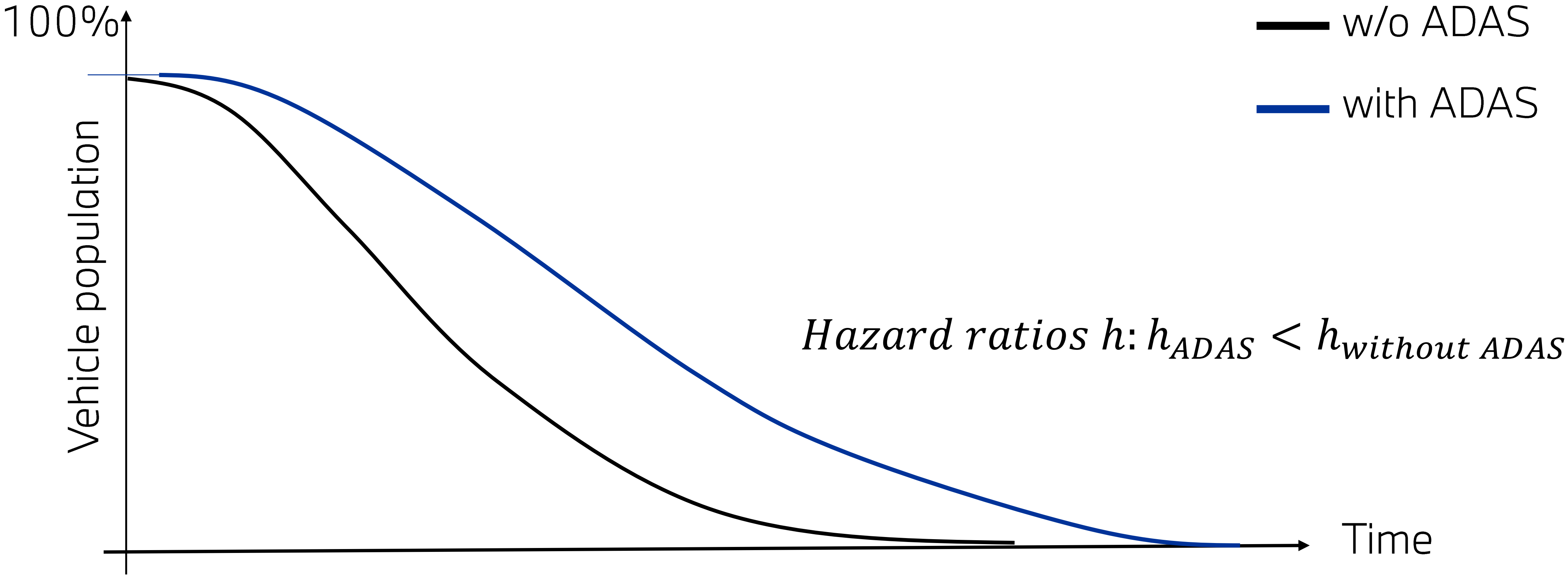
QUANTIFYING THE EFFECTIVENESS OF ADAS USING A SURVIVAL ANALYSIS.





Survival analysis takes into account that the time to accident is typically not normal distributed.

SURVIVAL ANALYSIS.



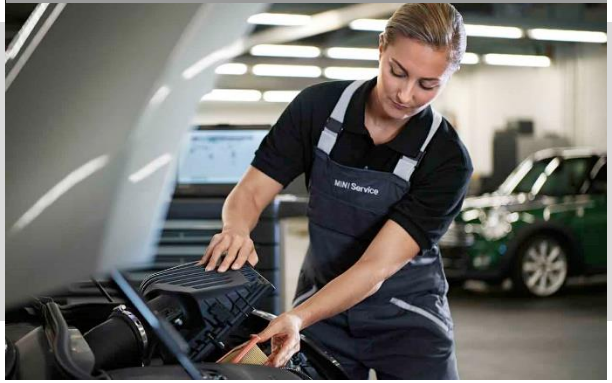
Hazard ratio of the hazard rates quantifies the field effectiveness of ADAS.

STUDY #1: A POPULATION-BASED STUDY. EVALUATION OF US MARKET/ACCIDENT DATA.

Sales data.

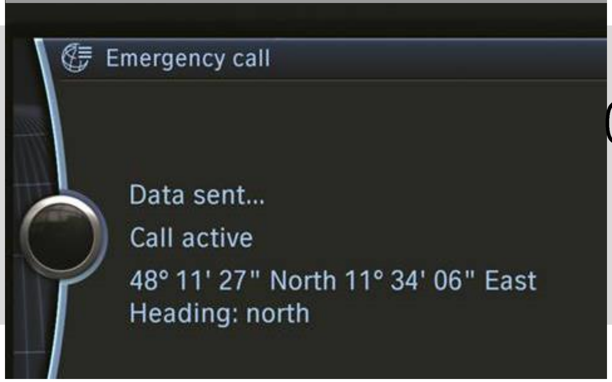
~ 1,4 Mio. vehicles

Workshop data.



Mileage information

Accident data.



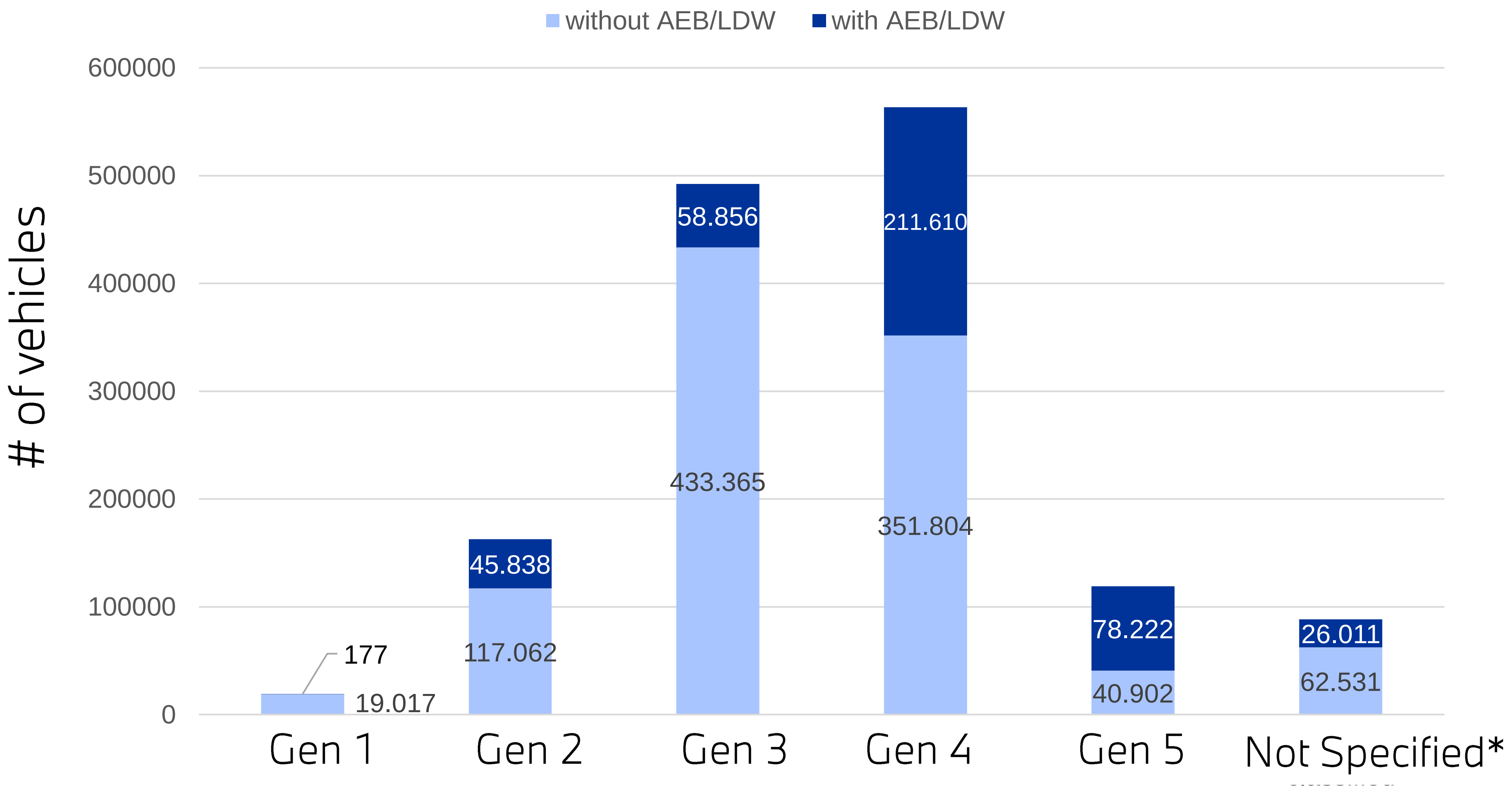
~24,000 crashes

Correlating via VIN

Study period: Jan 2014 – July 2018
- Vehicle configuration
- Sales date
- Model year 2014 and newer

Automatic Emergency Calls between Jan 2014 und Dec 2018
- Accident date
- Severity
- Accident characteristics

SALES DATA.
GROUPING VEHICLES INTO TECHNOLOGY GENERATIONS.



Technology Evolution

- Gen 1: Monocamera
- Gen 2: Monocamera
- Gen 3: Radar with Monocamera (no fusion)
- Gen 4: Radar with Monocamera Fusion
- Gen 5: Radar with Stereocamera Fusion

AEB/LDW = Frontal Collision Warning with Automatic Emergency Braking and Lane Departure Warning
* Not specified vehicles are M-Series vehicles.

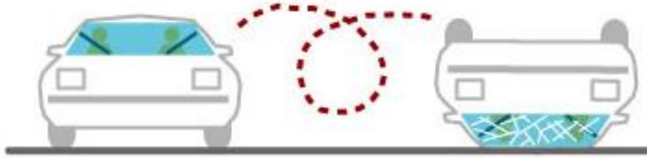
ACCIDENT DATA.
DISTRIBUTION OF CRASHES BY FIRST IMPACT LOCATION.

Front: 62.2%
n=15,012

Driver Side: 12.8%
n=3,104

Passenger Side: 8.9%
n=2,157

Rear: 11.2%,
n=2,704

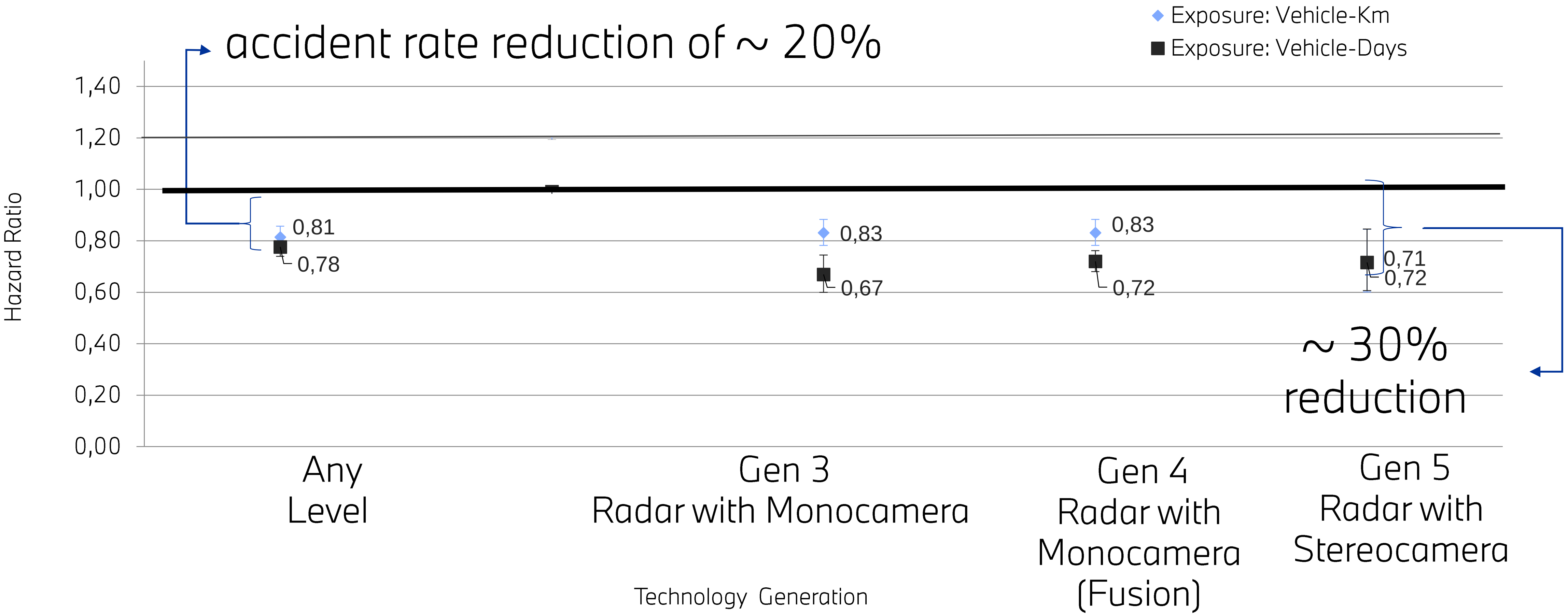


Rollover: 4.4%,
n=1063

Impact location could not be determined:
0.5%, n=111

Crashes between January 1, 2014 and December 28, 2018. First impact location determined based on impact direction of maximum delta V of first impact measured by the eCall System system. For the 1,667 cases where delta V was missing, impact location was determined based on the impact location detected by the eCall system.

HAZARD RATIOS FOR FRONTAL CRASHES BY TECHNOLOGY GENERATION AND EXPOSURE MEASURE.



AEB/LDW = Frontal Collision Warning with Automatic Emergency Braking and Lane Departure Warning
Regression models controlled for model year and model.

STRENGTHS AND LIMITATIONS.

Strengths

- Large sample size (n)
- Population-based
- Census of eCall-triggered crashes
- Able to evaluate different levels of ADAS technology
- Strong exposure measure (Vehicle-Km)

Limitations

- eCall crashes do not include minor crashes (→ question remains: are crashes avoided or or mitigated below eCall threshold?)
- eCall system does not provide information on crash type (e.g. front-to-rear, side swipe)
- Usage of ADAS is not taken into account

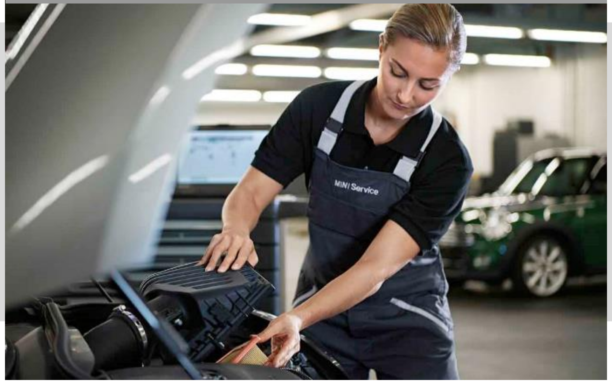
STUDY #2 - EVALUATION OF SELECTED US MARKET/ACCIDENT DATA.

Sales data.

~ 300k vehicles

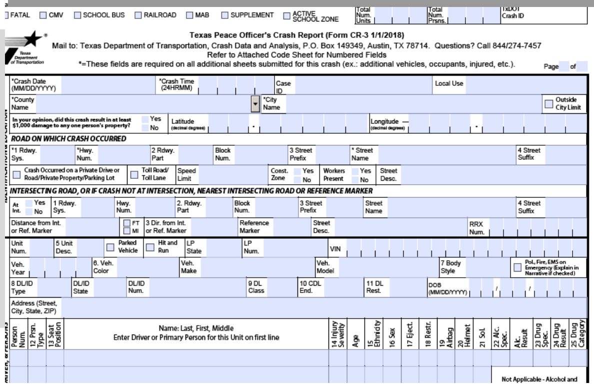
- Vehicle configuration
- Sales date
- Model year 2014 and newer

Workshop data.



Mileage information

Accident data.


FATAL CMV SCHOOL BUS RAILROAD MAB SUPPLEMENT ACTIVE SCHOOL ZONE Total Num. Units Total Num. Prsns. TxDOT Crash ID

Texas Department of Transportation

Texas Peace Officer's Crash Report (Form CR-3 1/1/2018)

Mail to: Texas Department of Transportation, Crash Data and Analysis, P.O. Box 149349, Austin, TX 78714. Questions? Call 844/274-7457

Refer to Attached Code Sheet for Numbered Fields

*=These fields are required on all additional sheets submitted for this crash (ex.: additional vehicles, occupants, injured, etc.). Page of

*Crash Date (MM/DD/YYYY) *Crash Time (24HRMM) Case ID Local Use

*County Name *City Name Outside City Limit

In your opinion, did this crash result in at least $1,000 damage to any one person's property? Yes No Latitude (decimal degrees) Longitude (decimal degrees)

ROAD ON WHICH CRASH OCCURRED

~16,000 crashes

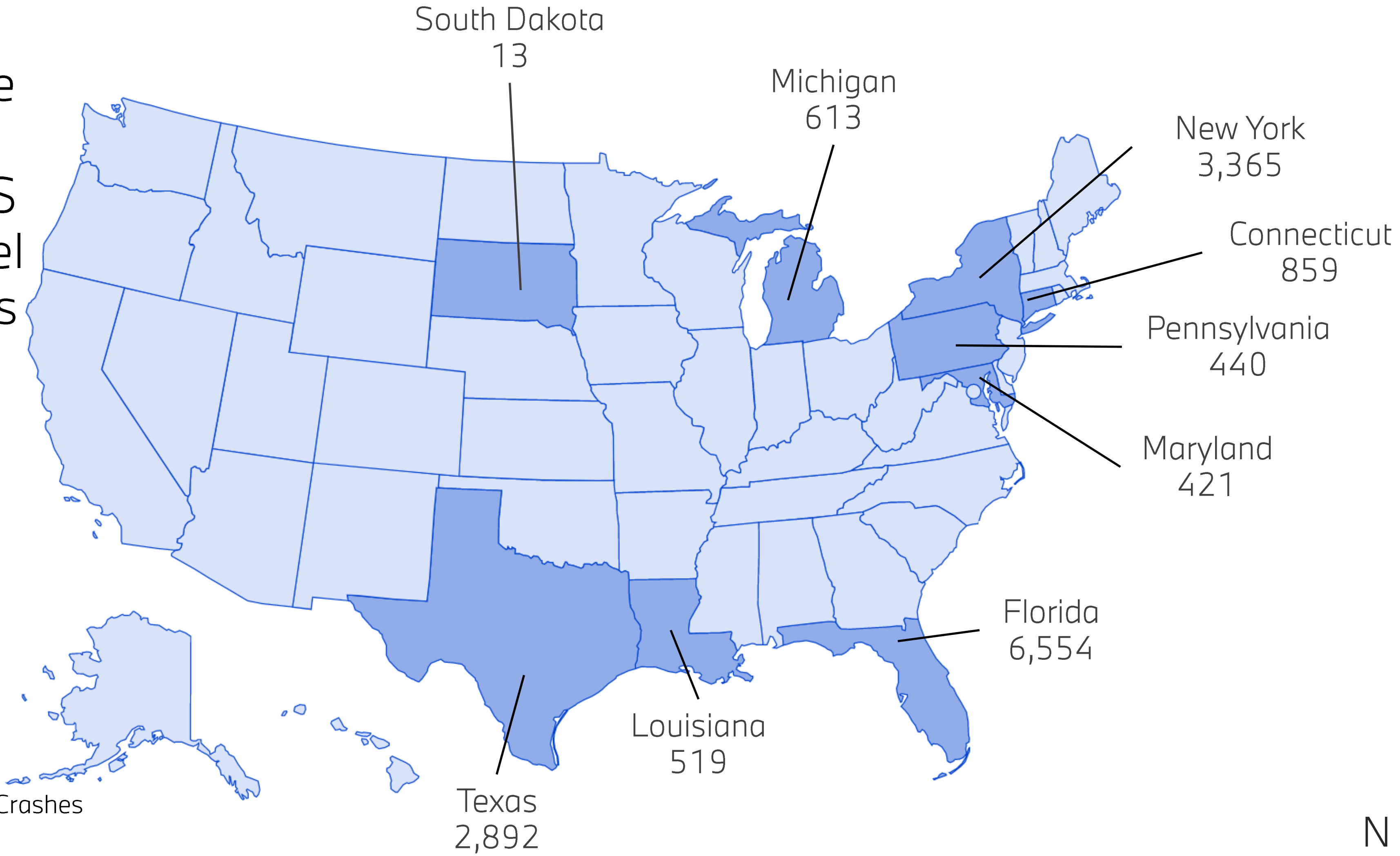
Police Reports between Jan 2015 and Dec 2017

- Accident date
- Severity
- Accident characteristics

Correlating via VIN

POLICE REPORTED CRASH-INVOLVED BMWS IN THE 9 STUDY STATES.

Identified police reported crashes in 9 US states for model and crash years 2015-2017

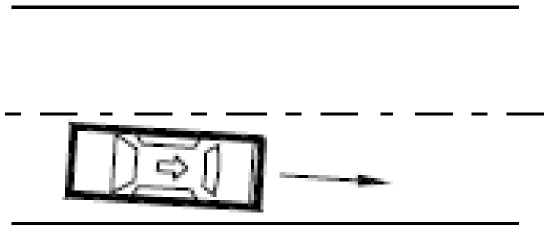


Source: State Police Reported Crashes
Crash Year 2015-2017

N = 16,533

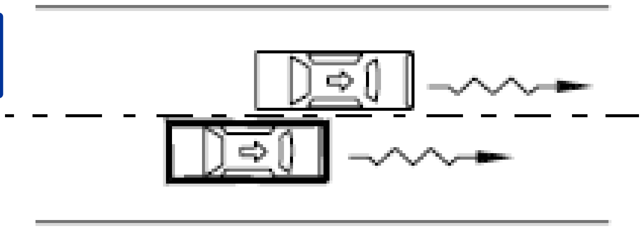
CRASH CONFIGURATIONS TARGETED BY LANE KEEP ASSIST AND LANE DEPARTURE WARNING.

1



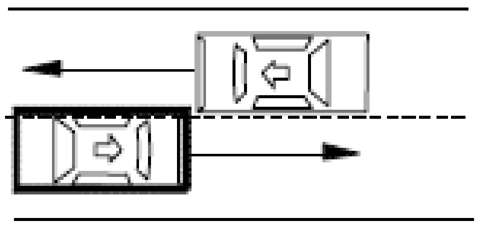
Running Off Road

2



Drifting into other lanes
in the same direction (side swipe)

3

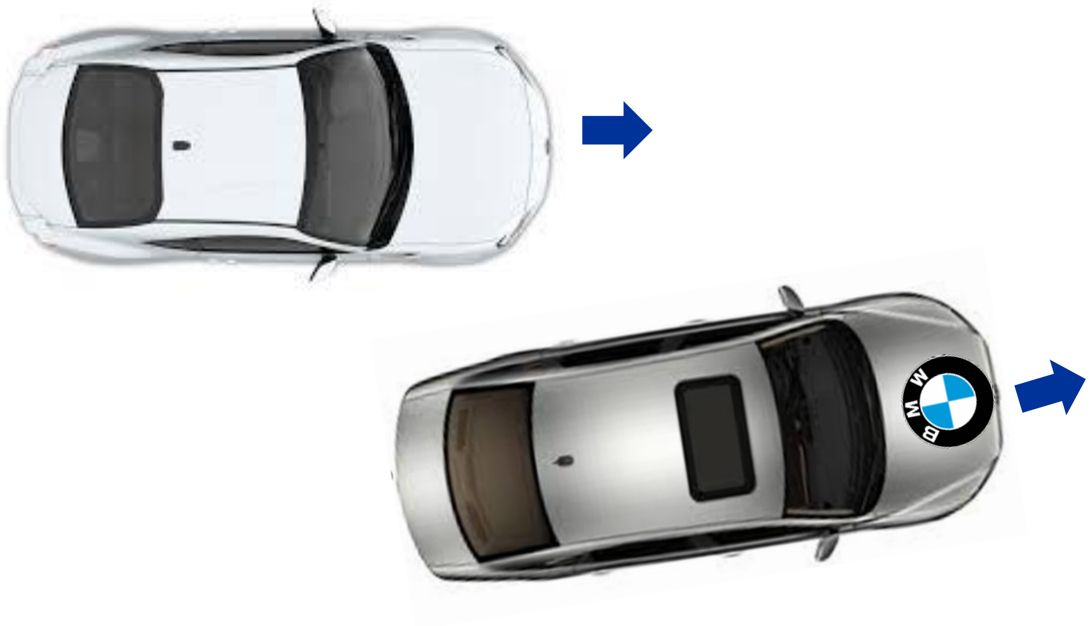


Drifting into lanes of oncoming traffic

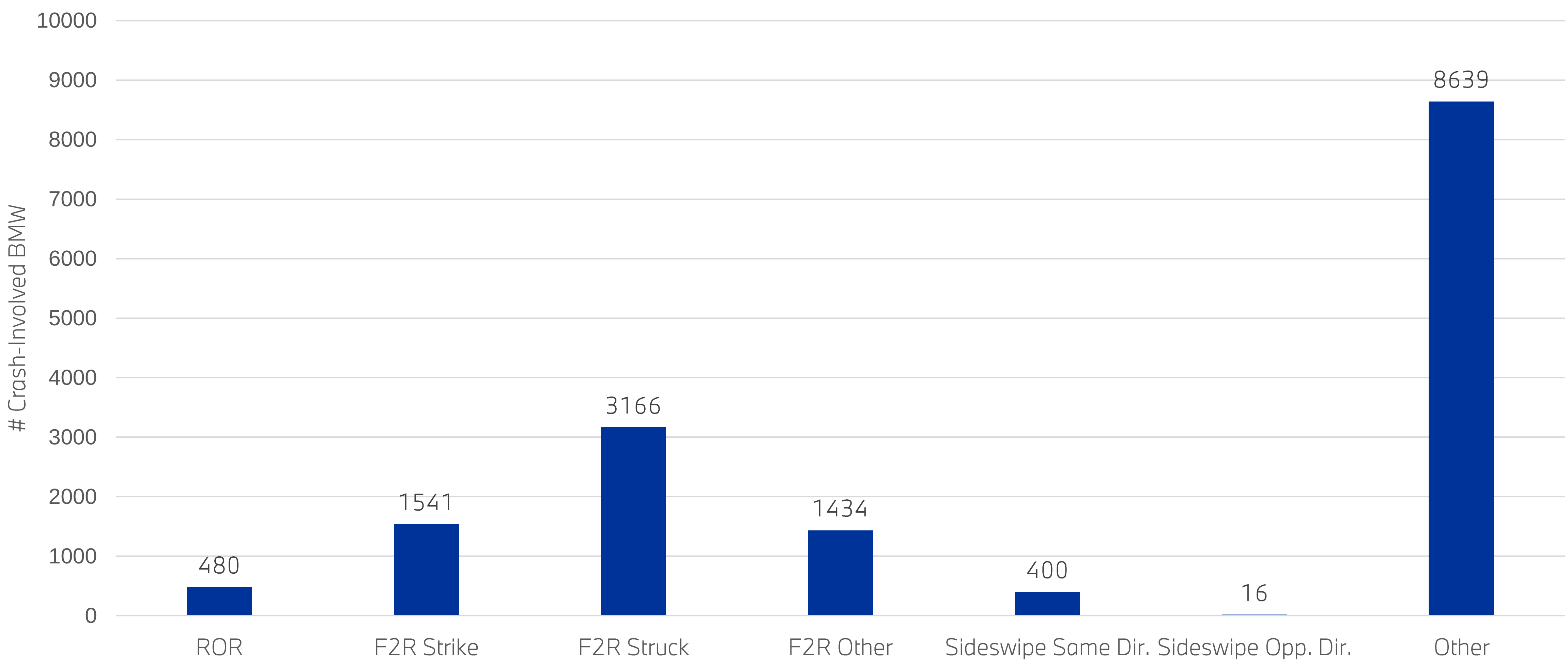
LKA: Lane Keep Assist
LDW: Lande Departure Warning

USING POLICE REPORTS TO IDENTIFY SIDE-SWIPE CRASHES (SAME AND OPPOSITE DIRECTION).

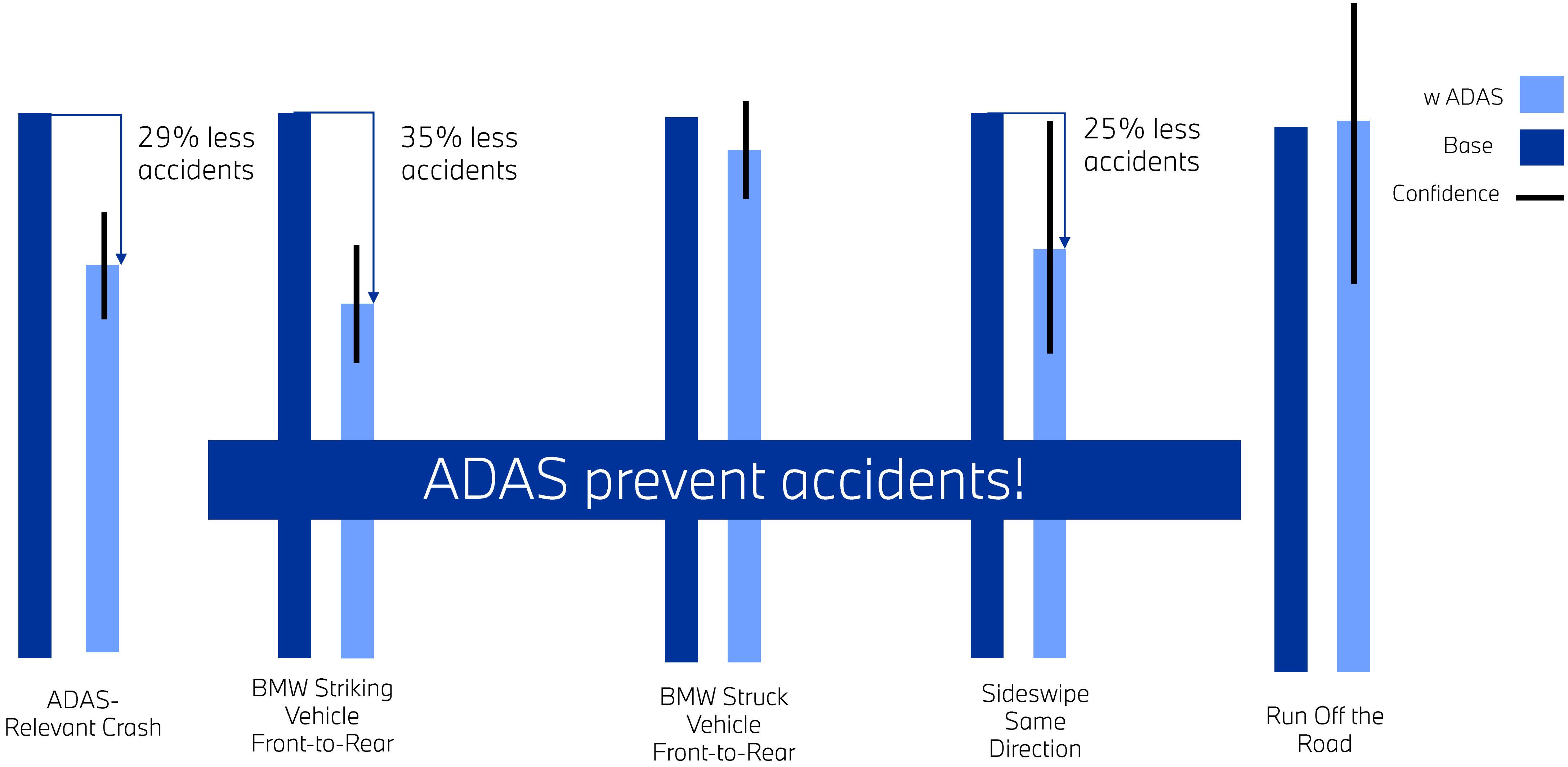
- 2 or more reported vehicles involved
- Collision-type:
  - “Side Swipe – same direction”
  - “Side Swipe – opposite direction”
- Driver Action
  - “Changing lanes”
  - “Merging”



CRASH-INVOLVED VEHICLES BY CRASH TYPE.



HAZARD RATIOS FOR CRASHING (BY SURVIVAL ANALYSIS).



Note: Survival models controlled for model year, model

KEY FINDINGS.

- ADAS-equipped vehicles are less likely to crash compared to non-equipped
- ADAS effectiveness was enhanced for crash scenarios targeted by the technologies
  - 35% less likely involved in a front-to-rear crash as the striking vehicle
  - 25% less likely involved in a sideswipe crash with a vehicle going in the same direction
  - 29% less likely involved in an ADAS-targeted crash scenario
- There was no effect of ADAS on risk of a non-ADAS-relevant crash (struck vehicle in a front-to-rear crash)

THANK YOU!

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