

Head Contacts in Pedestrian Crashes

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Field Data Study

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NHTSA Non-Motorist Data Collection

- CIREN Pedestrian Pilot Study
 - (2019-2020) – 9 cases, 2 CIREN sites
- Vulnerable Road User In-Depth Crash Investigation Study (VICIS)
 - (2022) – 90 Cases, 4 CISS PSUs
- CISS Non-Motorist
 - (2024) – 404 cases, 37 CISS PSUs
 - Sample design, case weights, nationally representative data



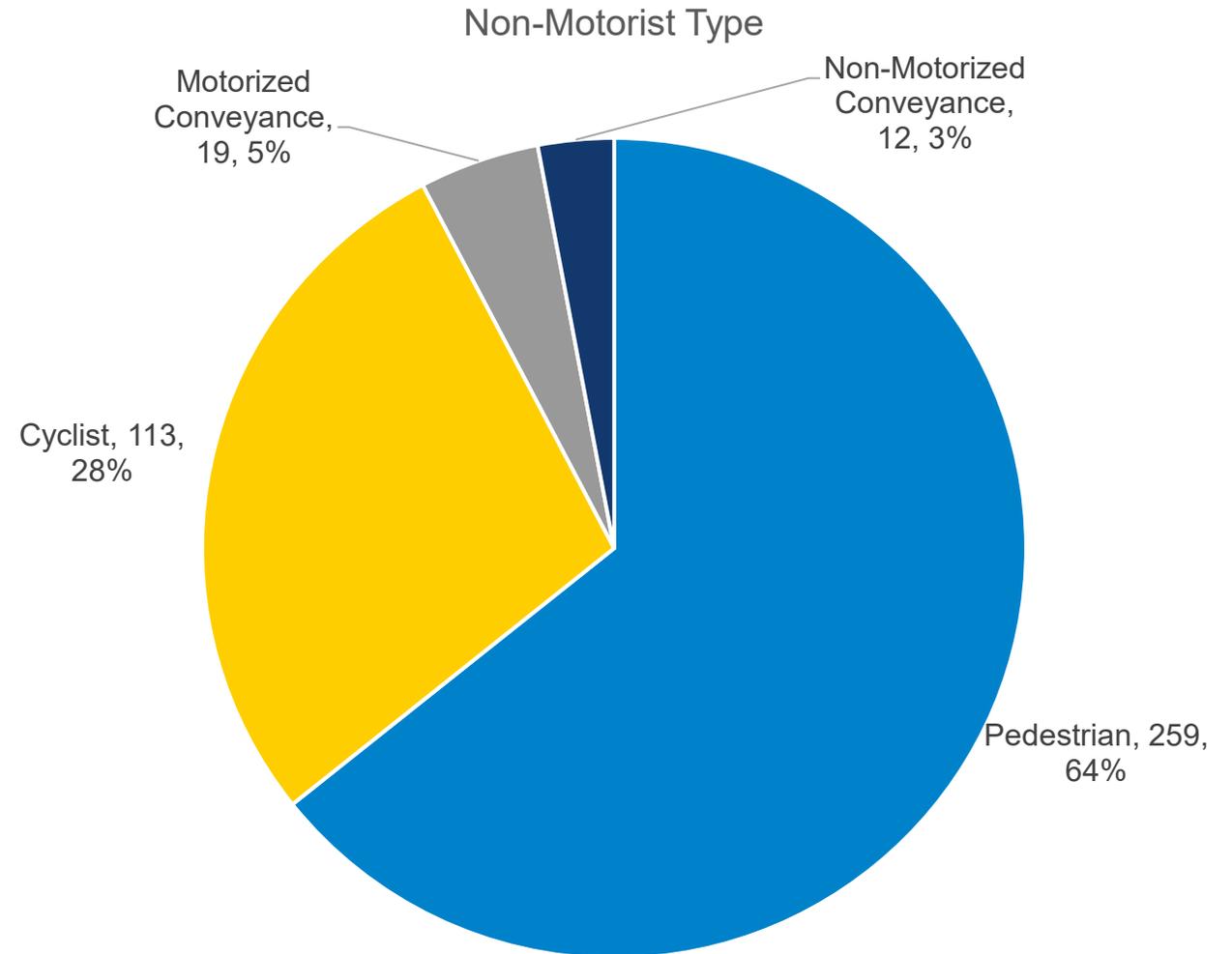
2013 Volkswagen Passat



2021 Chevrolet Silverado

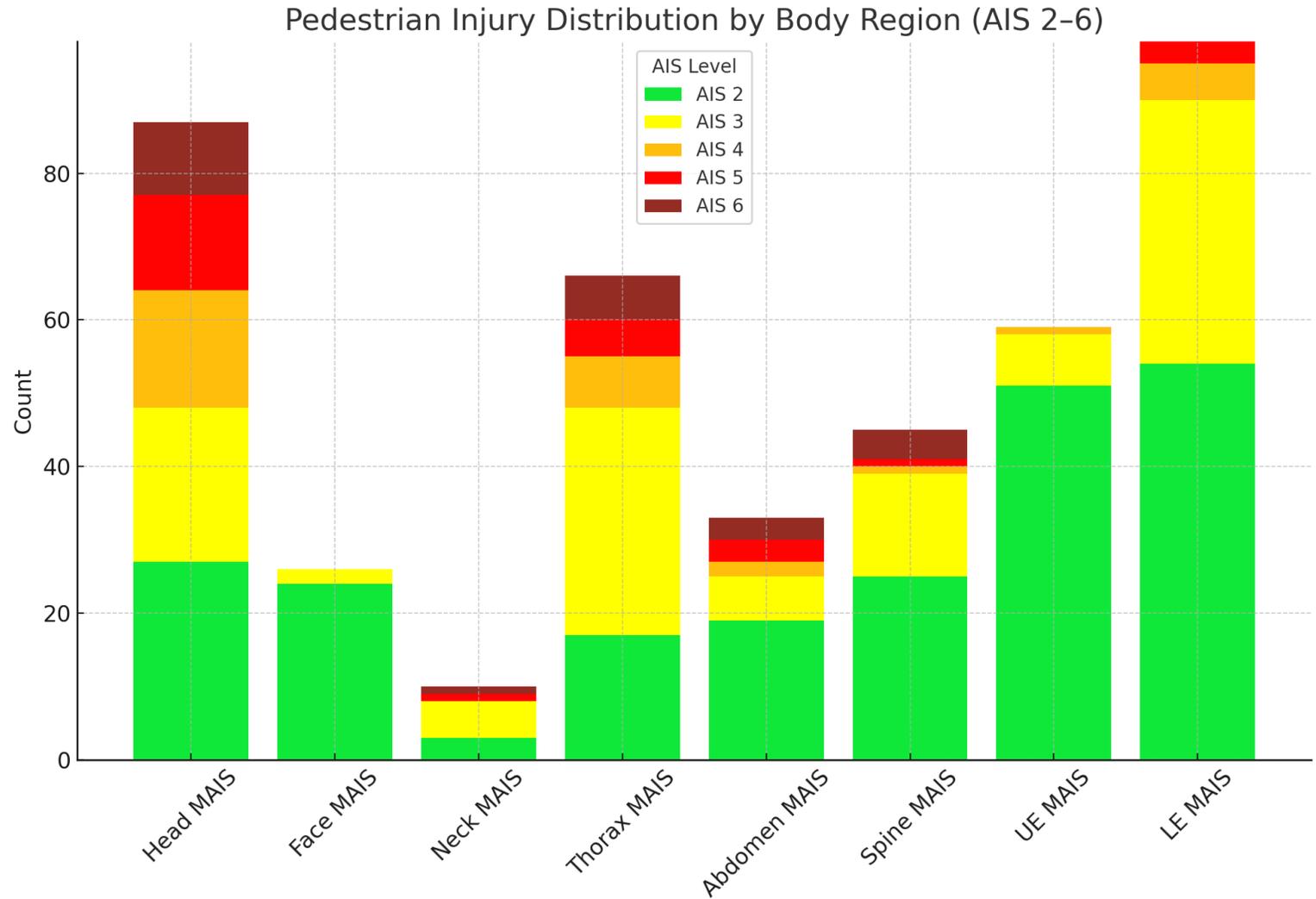
CISS 2024 Non-Motorist Crash Data

- 404 total Non-Motorist cases
 - 259 pedestrians
 - 113 cyclist
 - 31 on personal conveyance
 - 19 motorized
 - 12 non-motorized / unknown



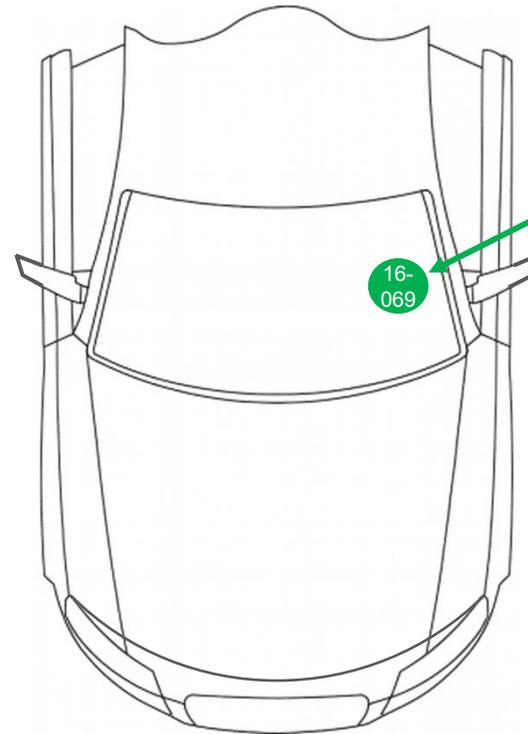
CISS 2024 Pedestrian Injury Distribution

- 259 pedestrian cases
- MAIS 2+
 - Lower Extremity, 98
 - Head, 87
 - Thorax, 66
- MAIS 3+
 - Head, 60
 - Thorax, 49
 - Lower Extremity, 44



Study Objectives

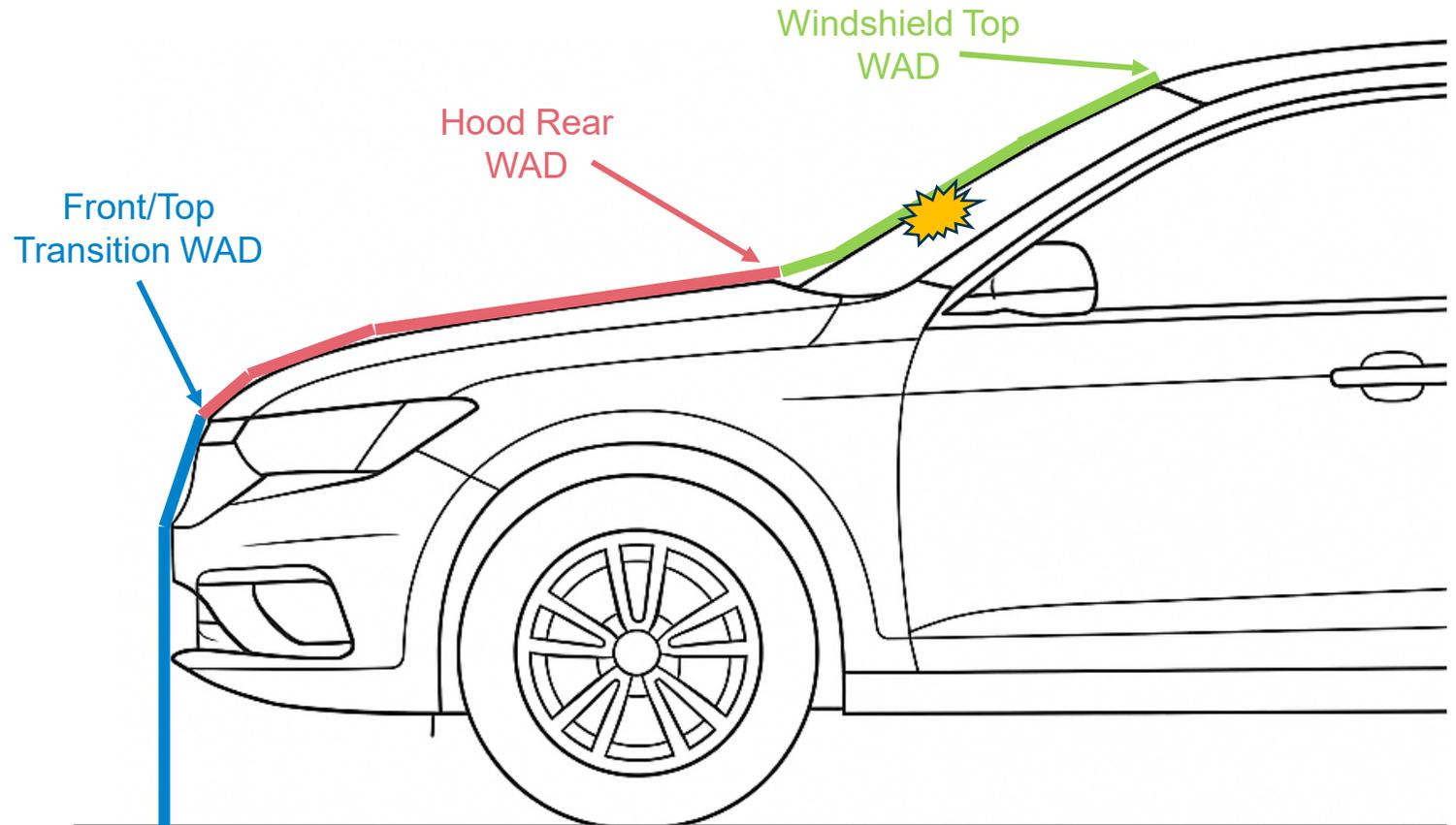
- Case-by-case review to plot head contact locations on simplified vehicle wireframe
- Visualize patterns of involved vehicle components and geometry
- Compare with proposed head form testing zones



2023 Tesla Model 3

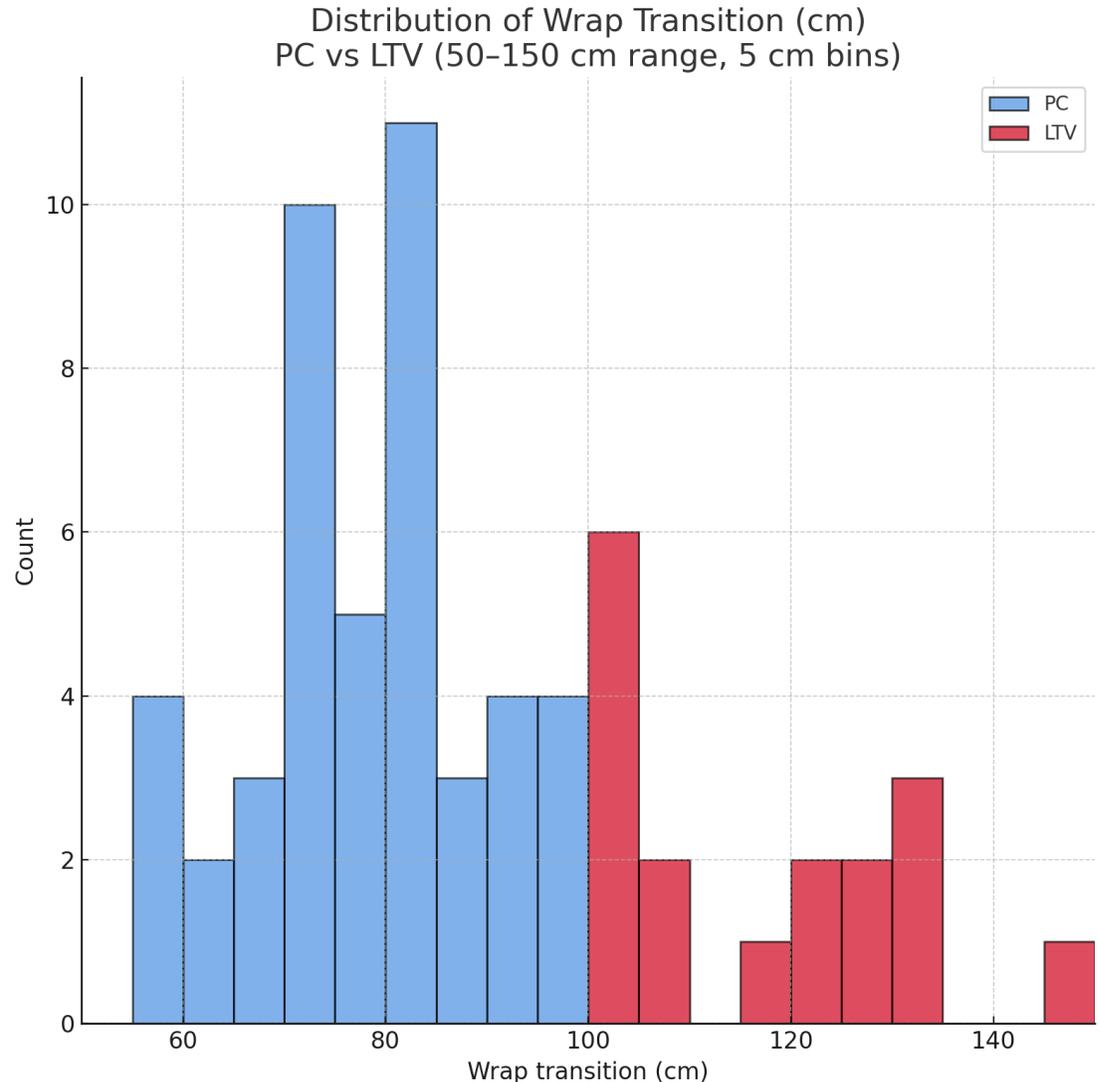
Wrap Around Distance (WAD)

- Crash Investigators measured front end geometry WADs with flexible tape
 - Front/Top Transition
 - Hood Rear
 - Windshield Top
 - Head Contact



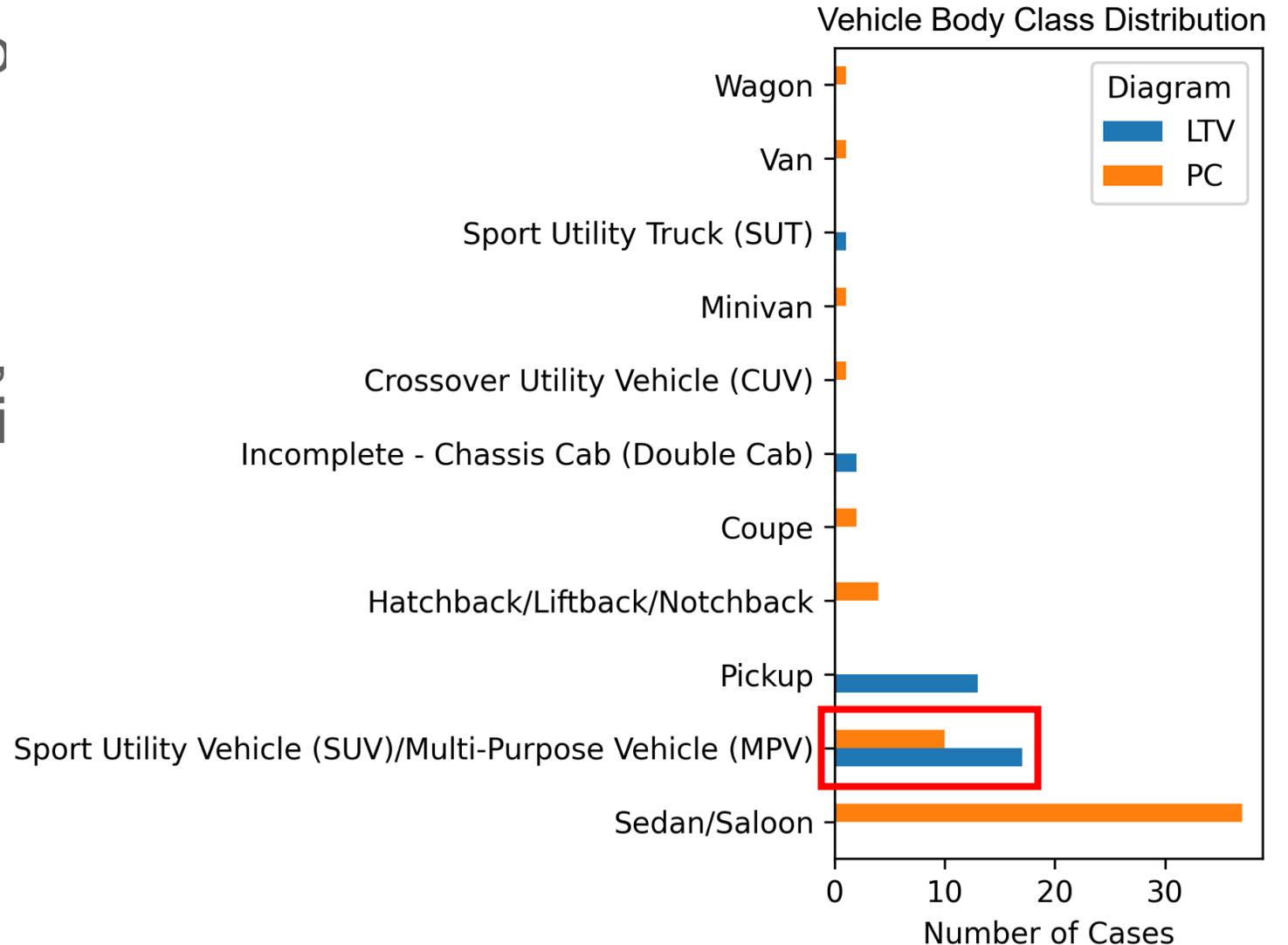
Front / Top Transition

- Group vehicles by Front/Top transition WAD 1000
 - Passenger Cars (PC) with transition WAD <100 cm, 63%
 - Light Truck Vehicles (LTVs) with transition \geq 100 cm, 37%



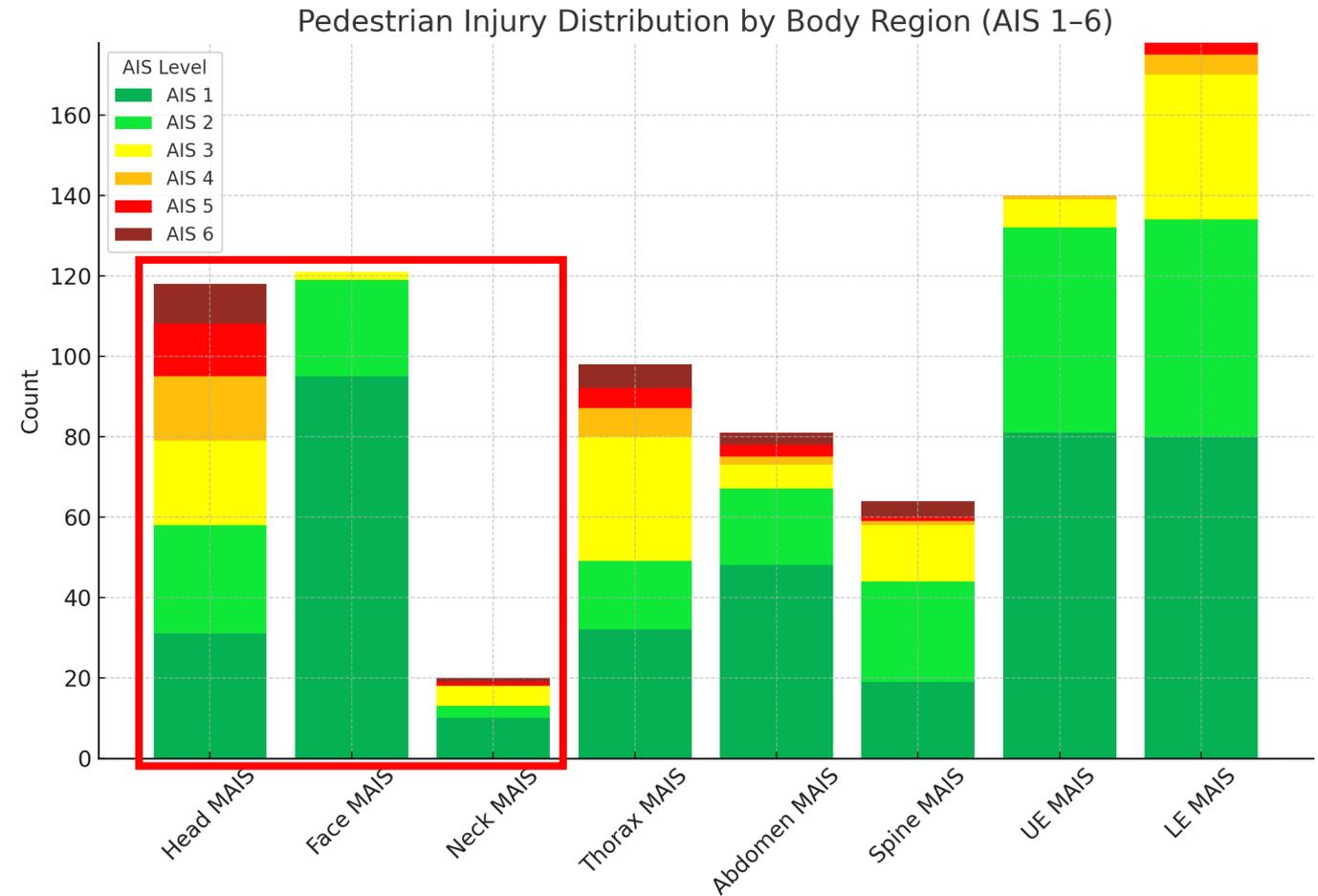
Front / Top Transition

- 100 cm is comparable to IIHS “tall” category used recent studies
- 50th male CG at ~98 cm, wrap vs. forward projecti kinematics threshold



Head / Face / Neck (HFN) Injuries

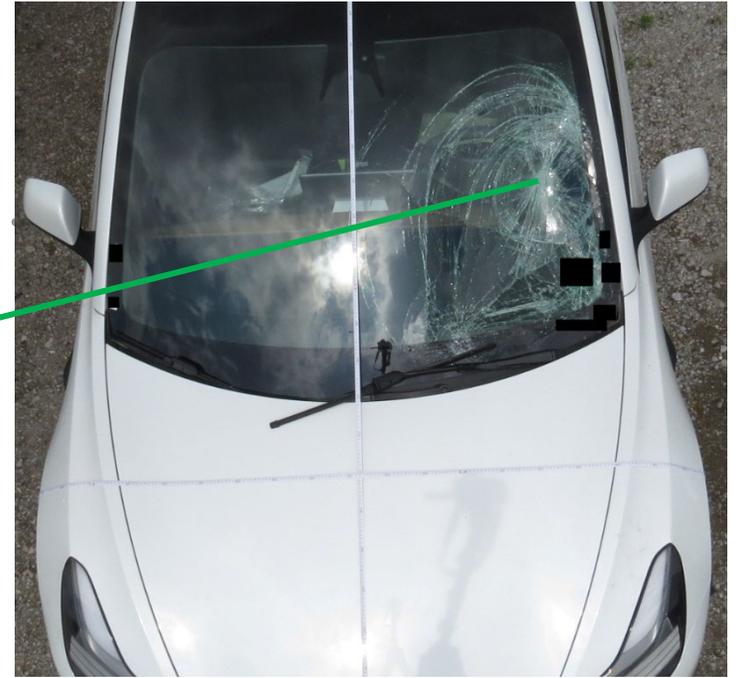
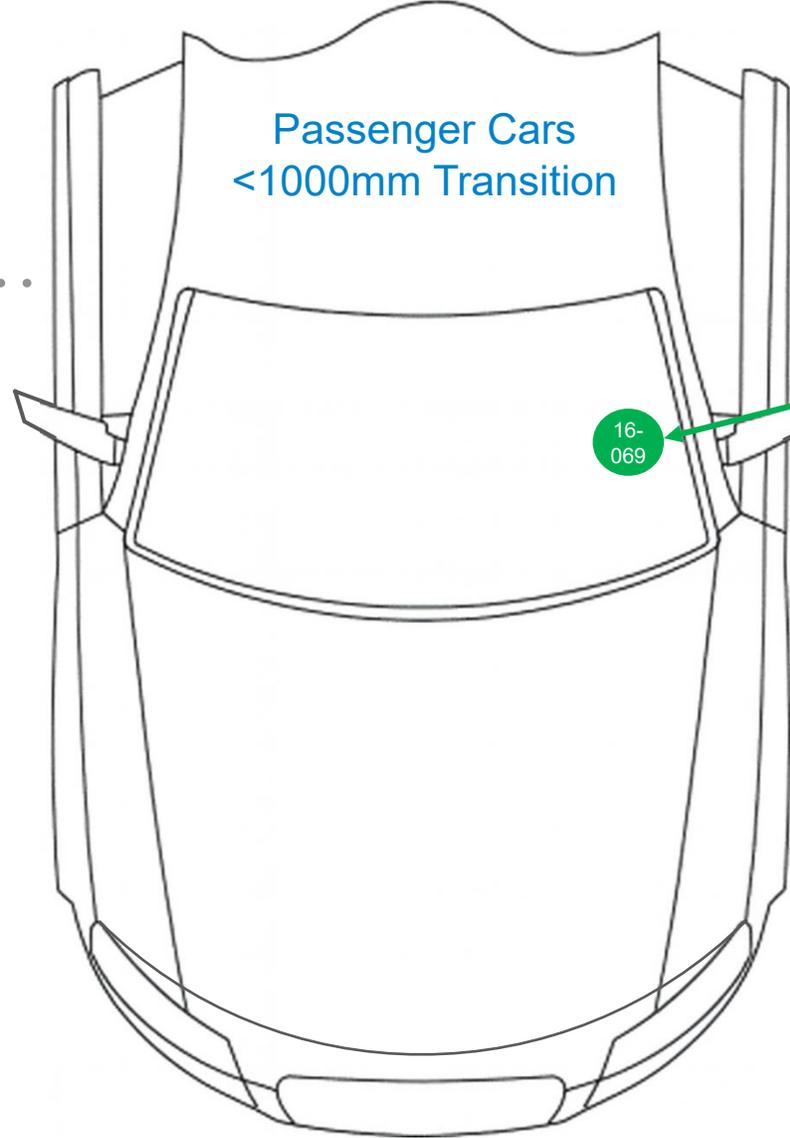
- CISS 2024: 156 pedestrians with HFN AIS 1+
 - 57 passenger car
 - 33 LTVs
 - 66 N/A – no photos, unknown ICS, multiple vehicles, overlapping damage, etc
- CIREN/VICIS: 60 pedestrians with HFN AIS 1+
 - 34 passenger car
 - 23 LTV
 - 3 N/A



Head Contacts

Head/Face/Neck (HFN)
Maximum AIS (MAIS)

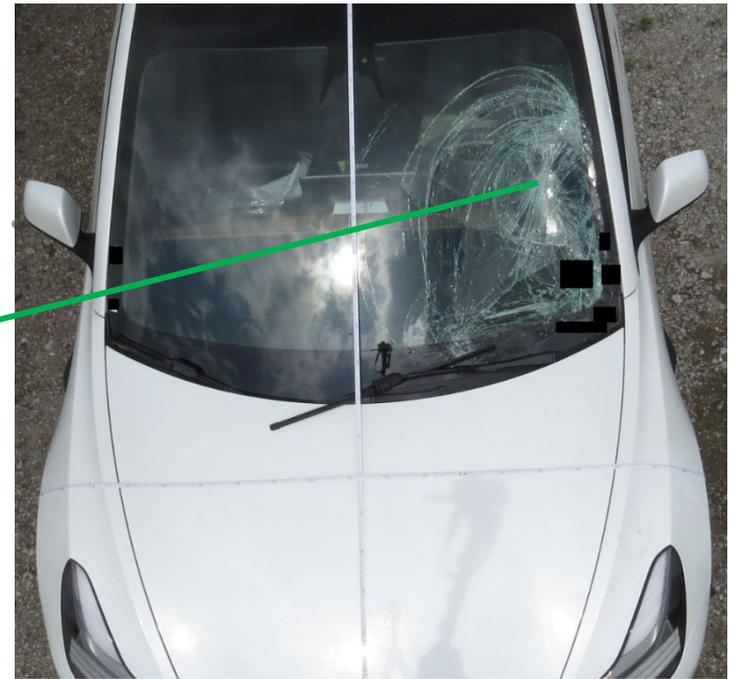
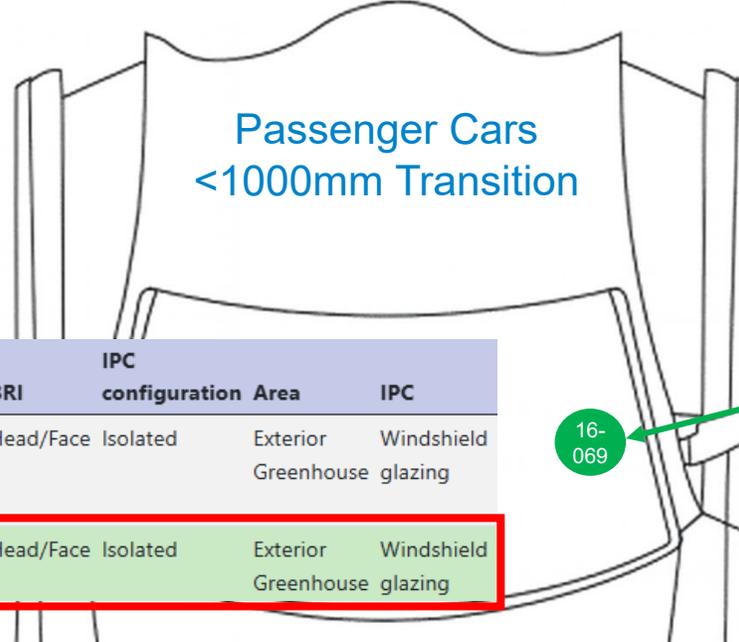
- 1 AIS 1 - Minor
- 2 AIS 2 - Moderate
- 3 AIS 3 - Serious
- 4 AIS 4 - Severe
- 5 AIS 5 - Critical
- 6 AIS 6 - Maximal
- 9 Unknown Severity



51 yo female
160 cm height
~40 kph speed

2023 Tesla Model 3

Head Contacts



Injury #	Rank	AIS ICS #	Code	Severity	AIS Description	Localizer	BRI	IPC configuration	Area	IPC
1	1	110402.1	1 - Minor	Scalp contusion; subgaleal hematoma, individual >6 months old	Left	Head/Face	Isolated	Exterior	Windshield Greenhouse glazing	
2	1	110600.1	1 - Minor	Scalp laceration NFS	Left	Head/Face	Isolated	Exterior	Windshield Greenhouse glazing	

Contact Area	Area	Component	NM #	X cm	Y cm	Crush-CM	Body Region	Evidence	Confidence
A	Front	Front bumper	1	60	-40	0	Thigh - Right	Combination (specify): Video evidence	Certain
B	Top	Hood surface	1	73	-24	0	Buttock - Right	Scuffed	Certain
C	Top	Front fender top surface	1	120	-70	0	Buttock - Left	Scuffed	Certain
D	Greenhouse	Windshield glazing	1	228	-62	6	Head	Hair	Certain
E	Top	Wiper blades and mountings	1	175	-22	Not Applicable	Unknown	Bent	Probable
F	Greenhouse	Windshield glazing	1	185	-50	Unknown	Elbow - Right	Cracked	Probable
G	Other object	Ground	1	Not Applicable	Not Applicable	Not Applicable	Unknown	Combination (specify): Ground contact	Probable



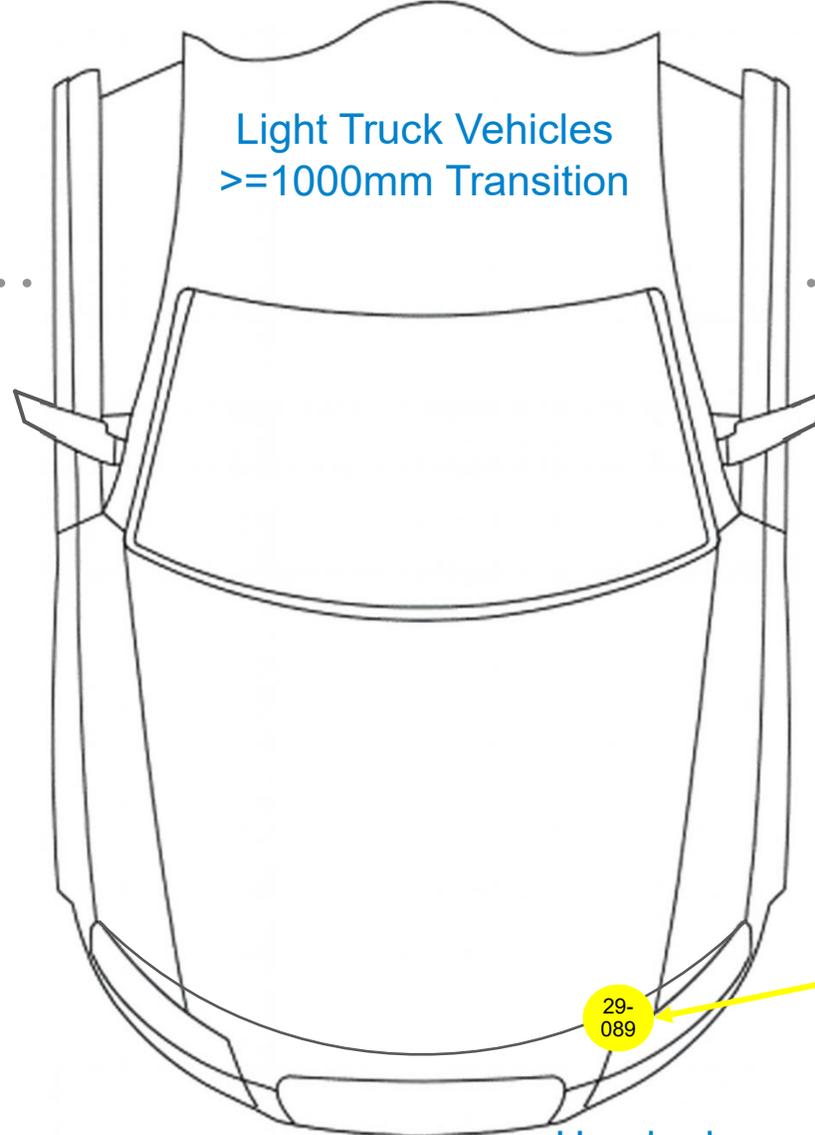
51 yo female
160 cm height
~40 kph speed

2023 Tesla Model 3

Head Contacts

Head/Face/Neck (HFN)
Maximum AIS (MAIS)

- 1 AIS 1 - Minor
- 2 AIS 2 - Moderate
- 3 AIS 3 - Serious
- 4 AIS 4 - Severe
- 5 AIS 5 - Critical
- 6 AIS 6 - Maximal
- 9 Unknown Severity



14 yo female
Unknown height
~50 kph speed

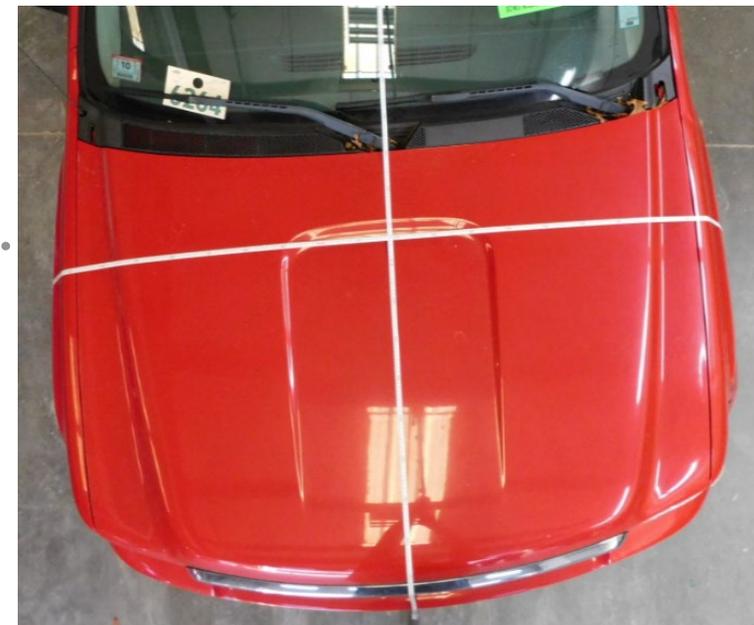
Hood edge
or ground?



2009 GMC Sierra

Head Contacts

Light Truck Vehicles
 >=1000mm Transition

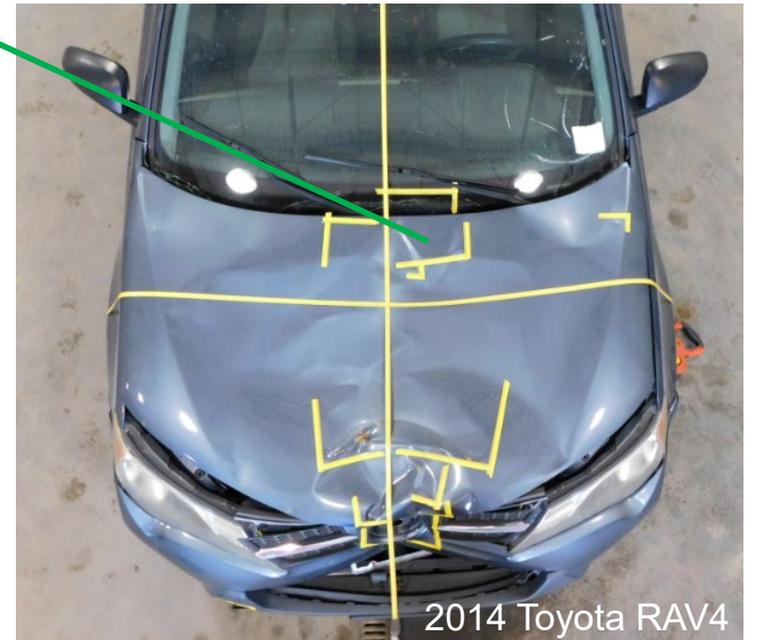
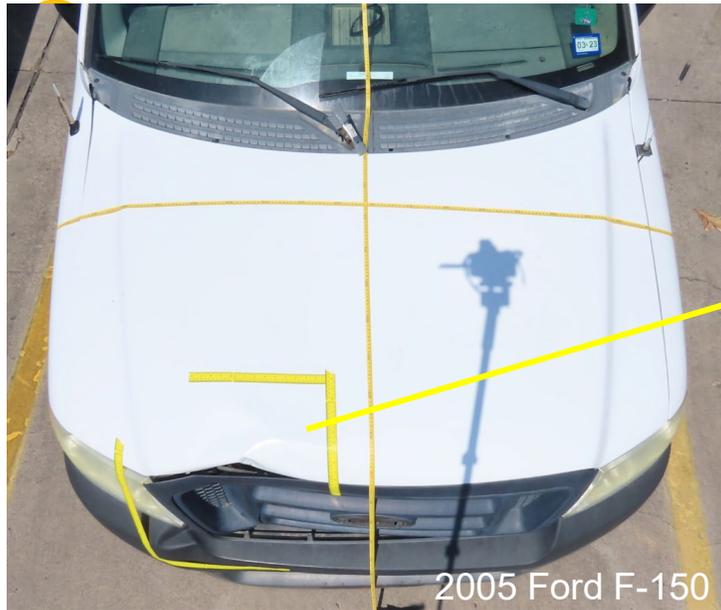
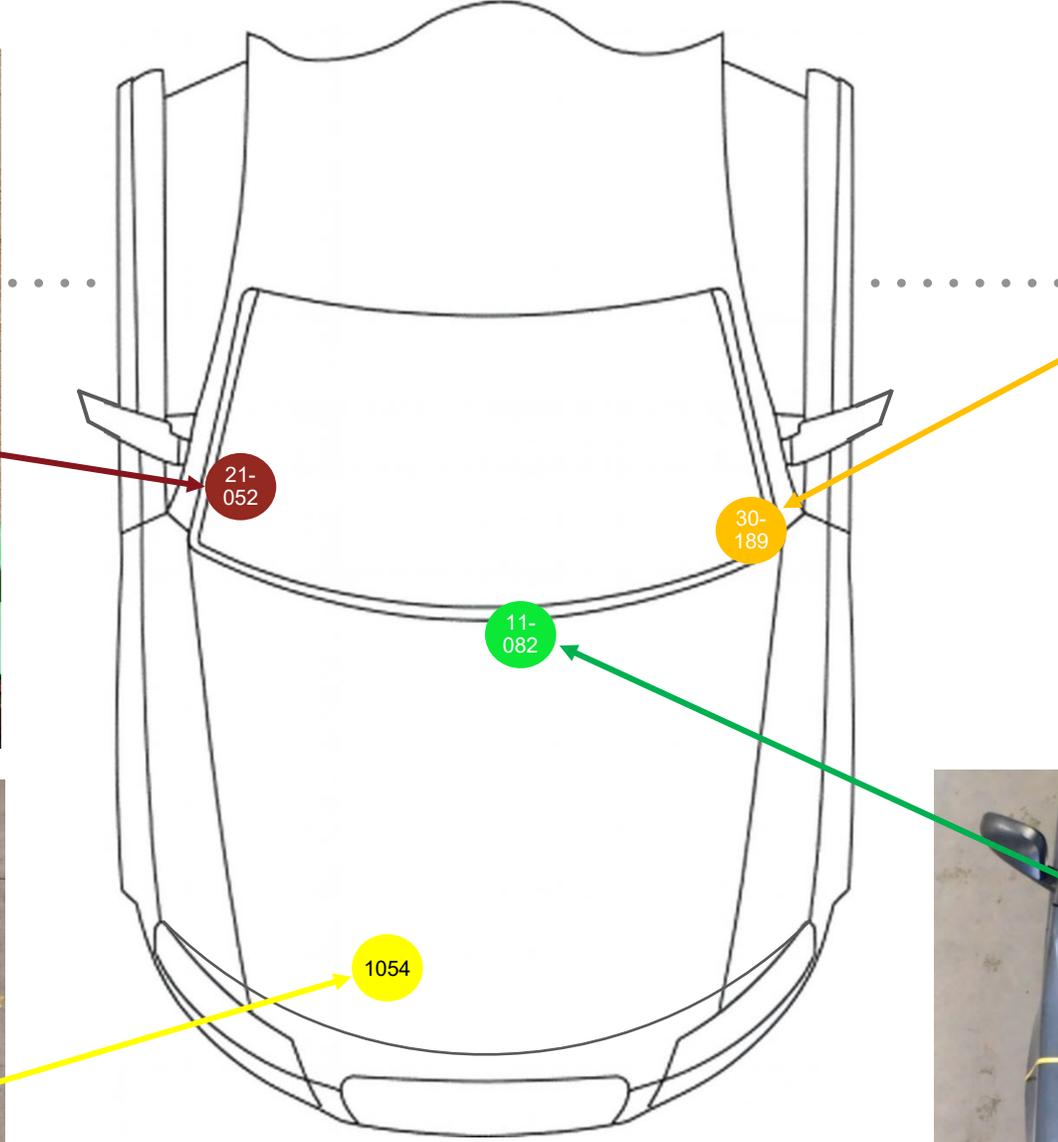
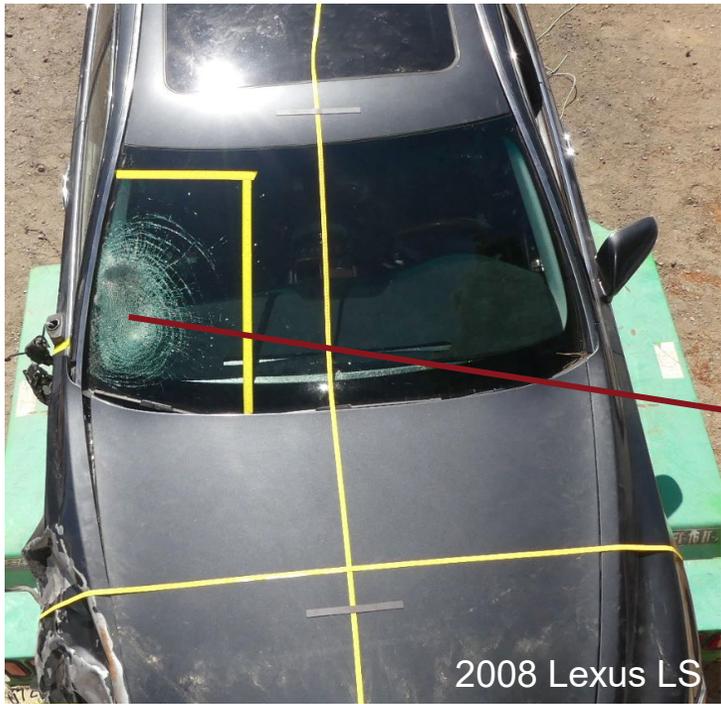


2009 GMC Sierra

Injury #	Rank	ICs #	AIS Code	Severity	AIS Description	Localizer	BRI	IPC configuration	Area	IPC
5	1	140638.3	3 -	3 - Serious	Cerebrum hematoma (hemorrhage)-> intracerebral NFS [include perilesional edema for size]	Right	Head/Face	Isolated IPC	Other Exterior Object	Ground
								possible		
5	2	140638.3	3 -	3 - Serious	Cerebrum hematoma (hemorrhage)-> intracerebral NFS [include perilesional edema for size]	Right	Head/Face	Isolated IPC	Exterior Hood Front Exterior and/or Front trim Headlight	
								probable		

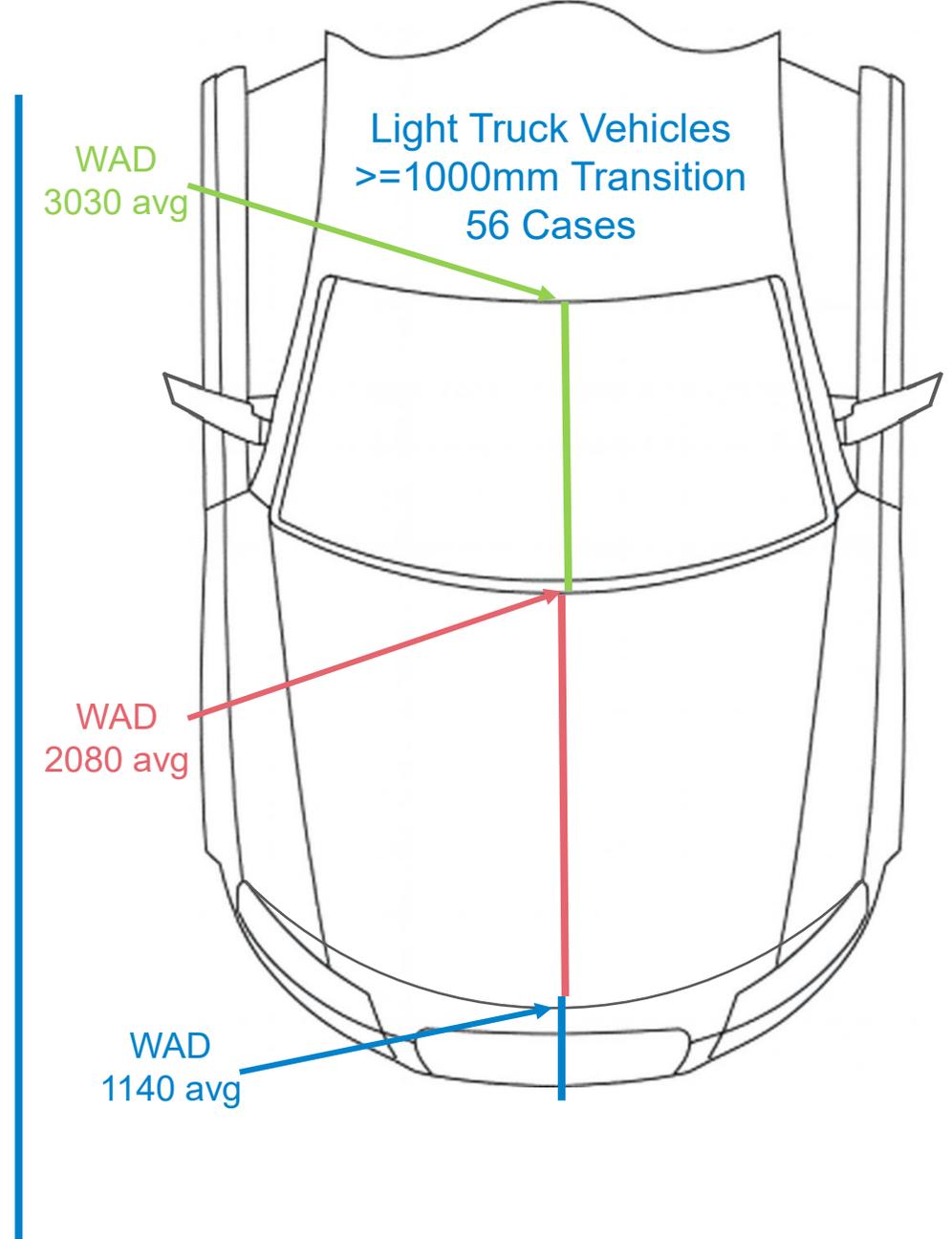
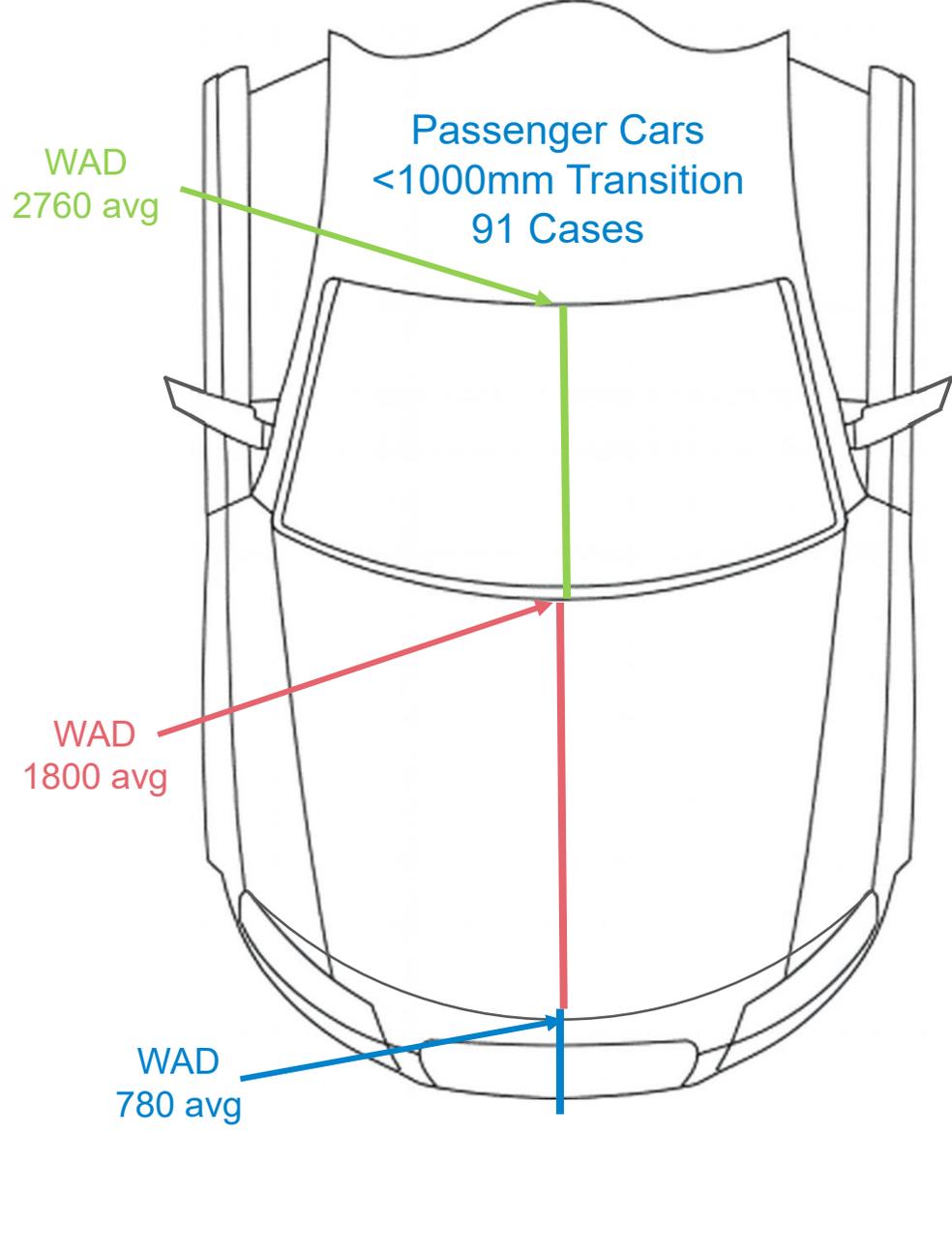
Contact Area	Component	NM #	X cm	Y cm	Crush-CM	Body Region	Evidence	Confidence
A	Front bumper	1	75	-90	0	Flank - Right	Deformed	Probable
B	Headlight	1	100	-90	Unknown	Unknown	Cracked	Certain
C	Hood edge and/or trim	1	110	-95	1	Unknown	Deformed	Probable
D	Other object	1	Not Applicable	Not Applicable	Not Applicable	Unknown	Other (specify): ground contact	Certain

14 yo female
 Unknown height
 ~50 kph speed



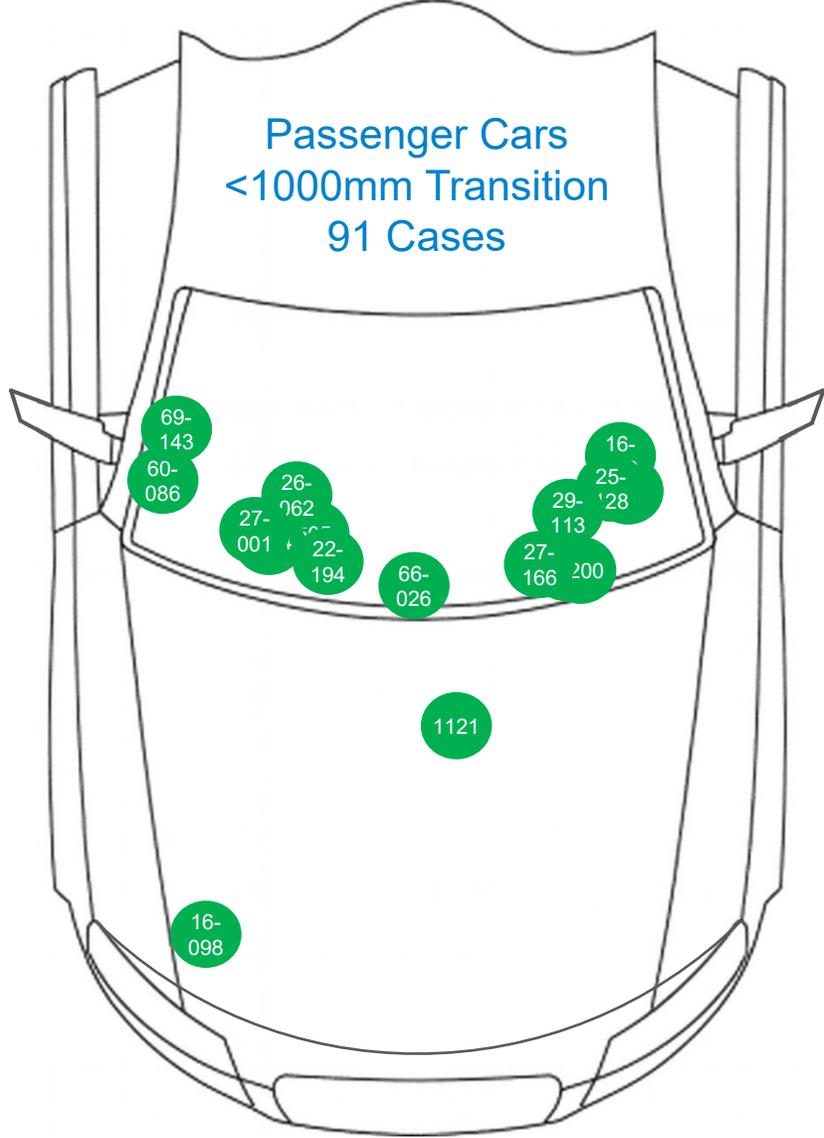
H/F/N
MAIS

- 1
- 2
- 3
- 4
- 5
- 6
- 9

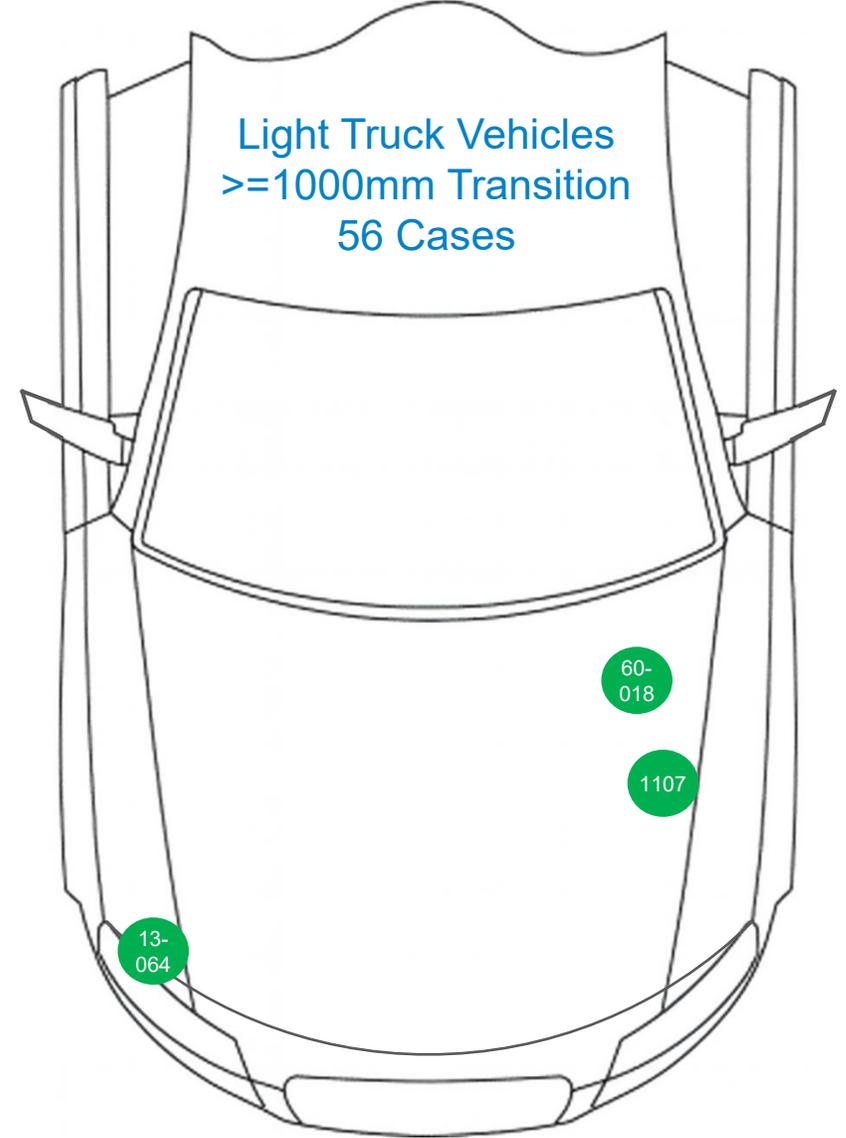


H/F/N
MAIS

- 1
- 2
- 3
- 4
- 5
- 6
- 9



- 1138
- 1116
- 1126
- 77-027
- 57-009
- 1020

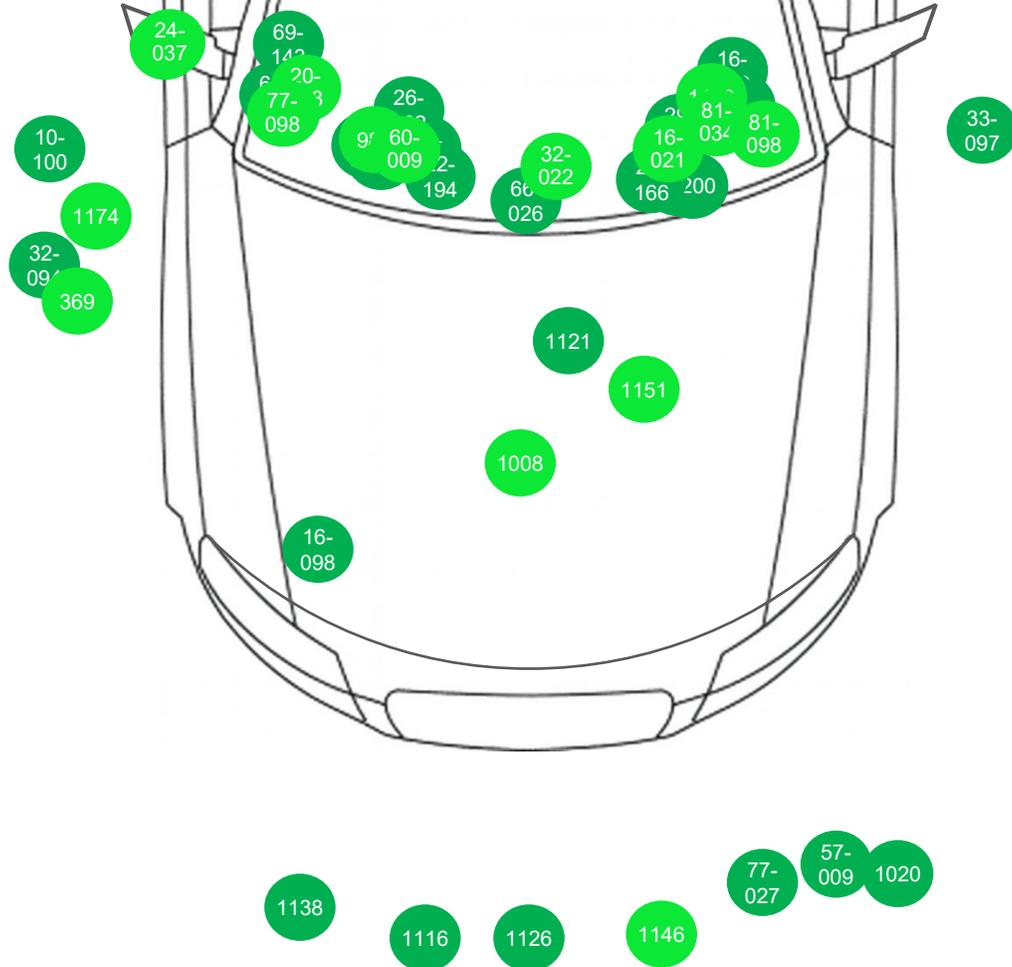


- 1086
- 1012
- 28-042
- 532
- 1084
- 360
- 1166
- 15-242
- 28-042

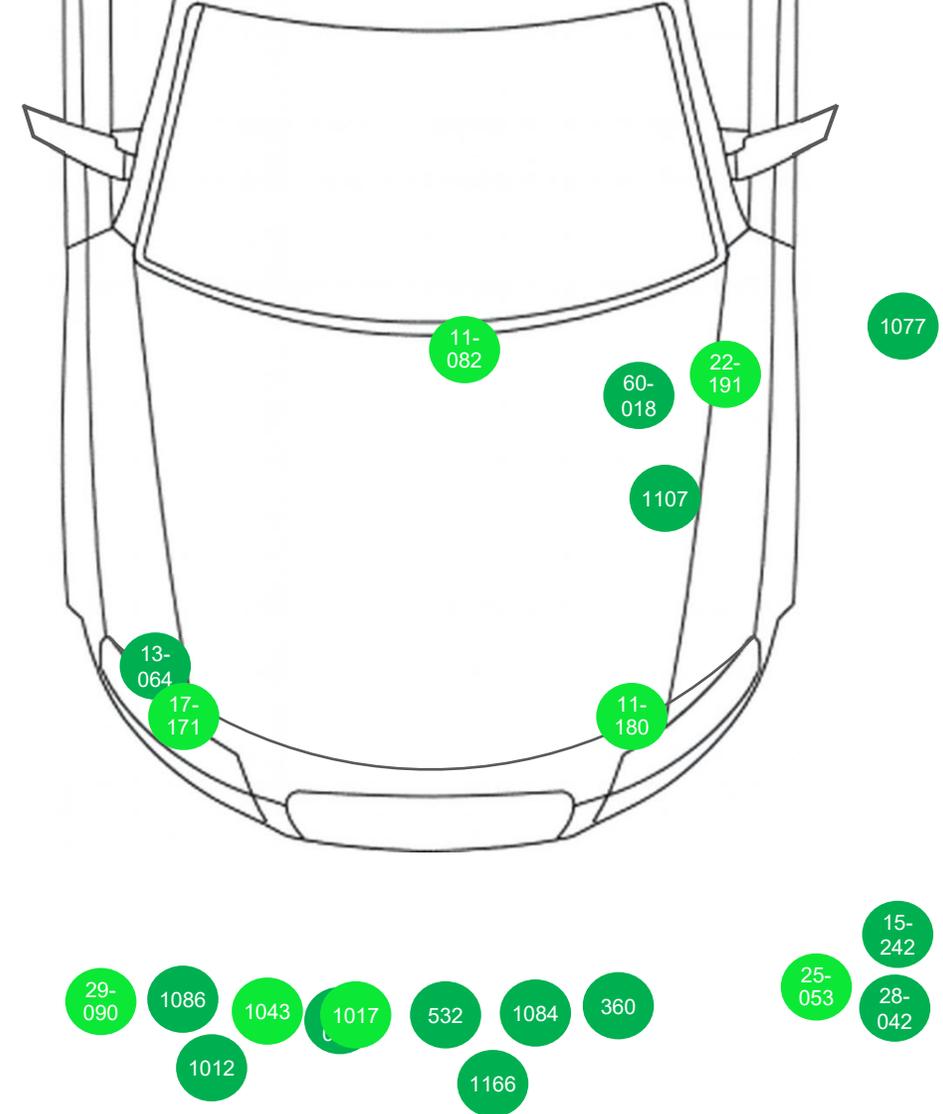
H/F/N
MAIS

- 1
- 2
- 3
- 4
- 5
- 6
- 9

Passenger Cars
<1000mm Transition
91 Cases

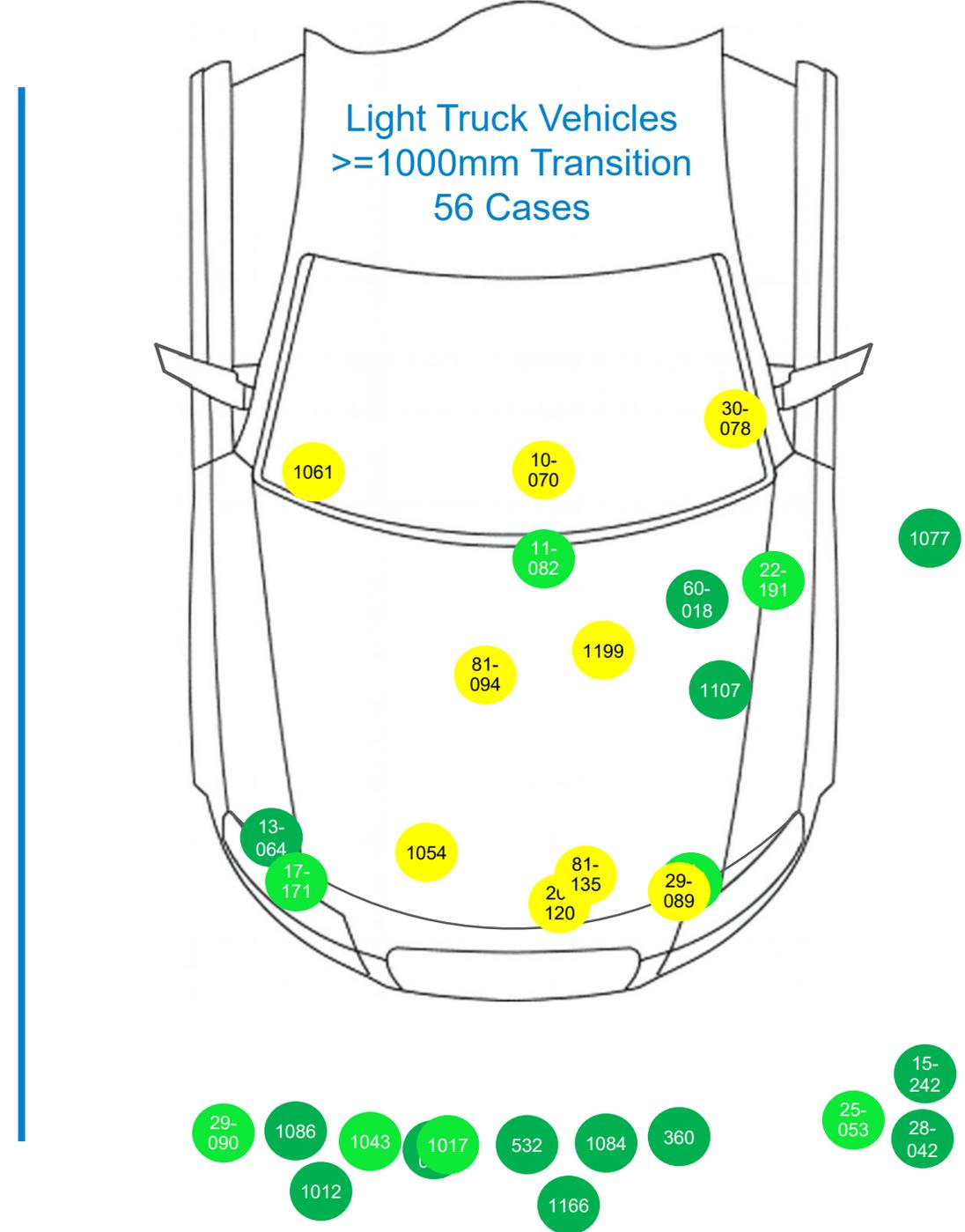
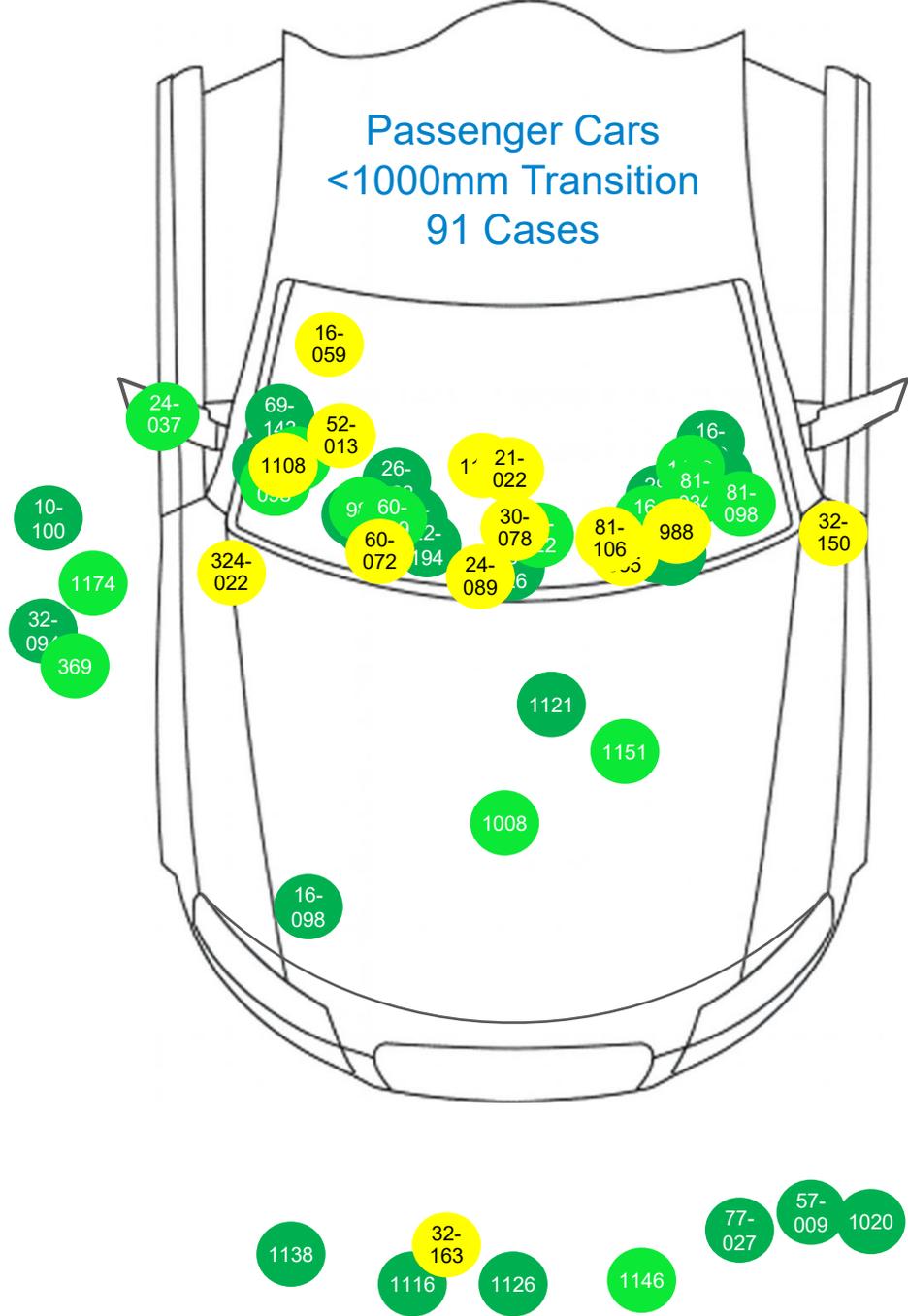


Light Truck Vehicles
>=1000mm Transition
56 Cases



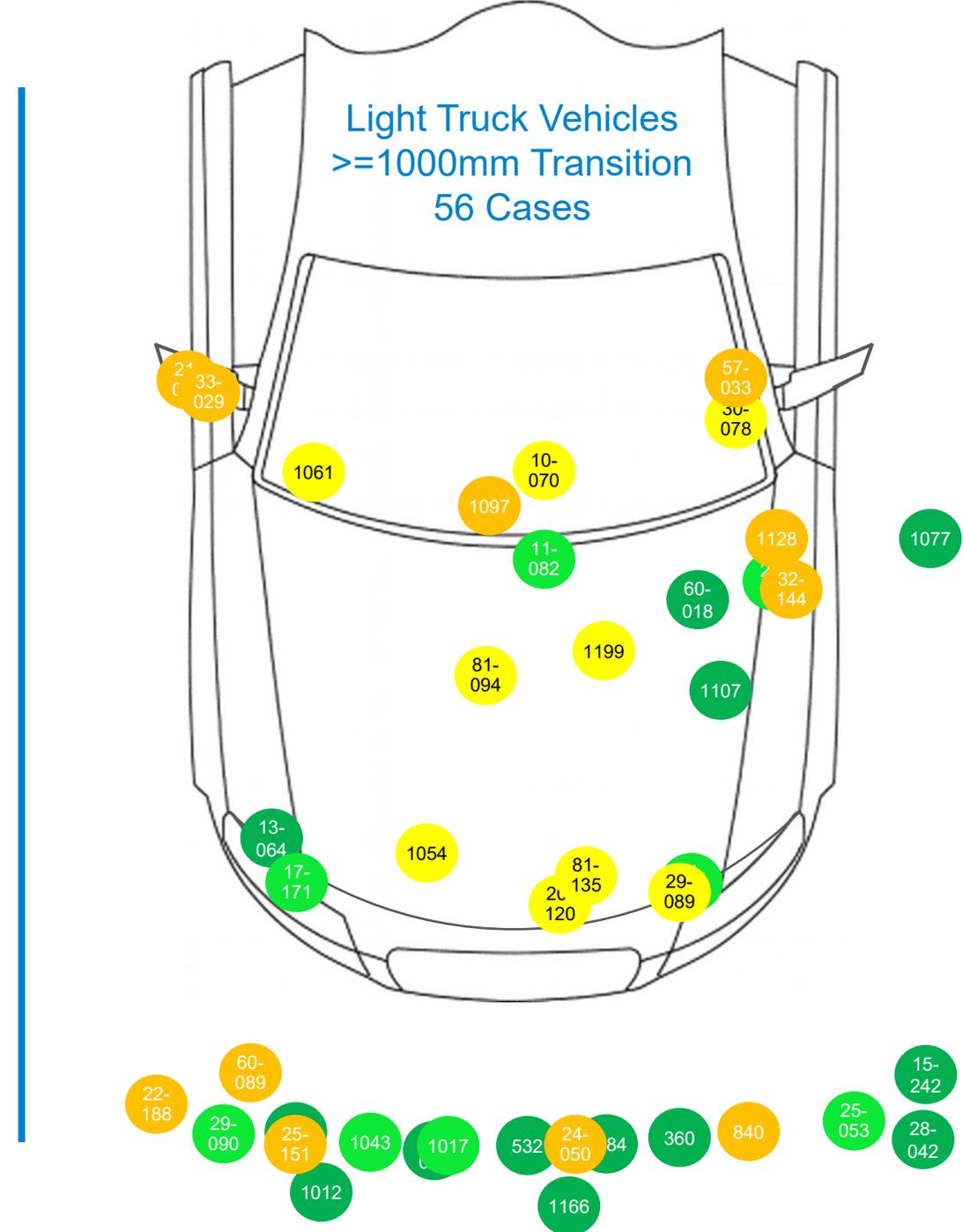
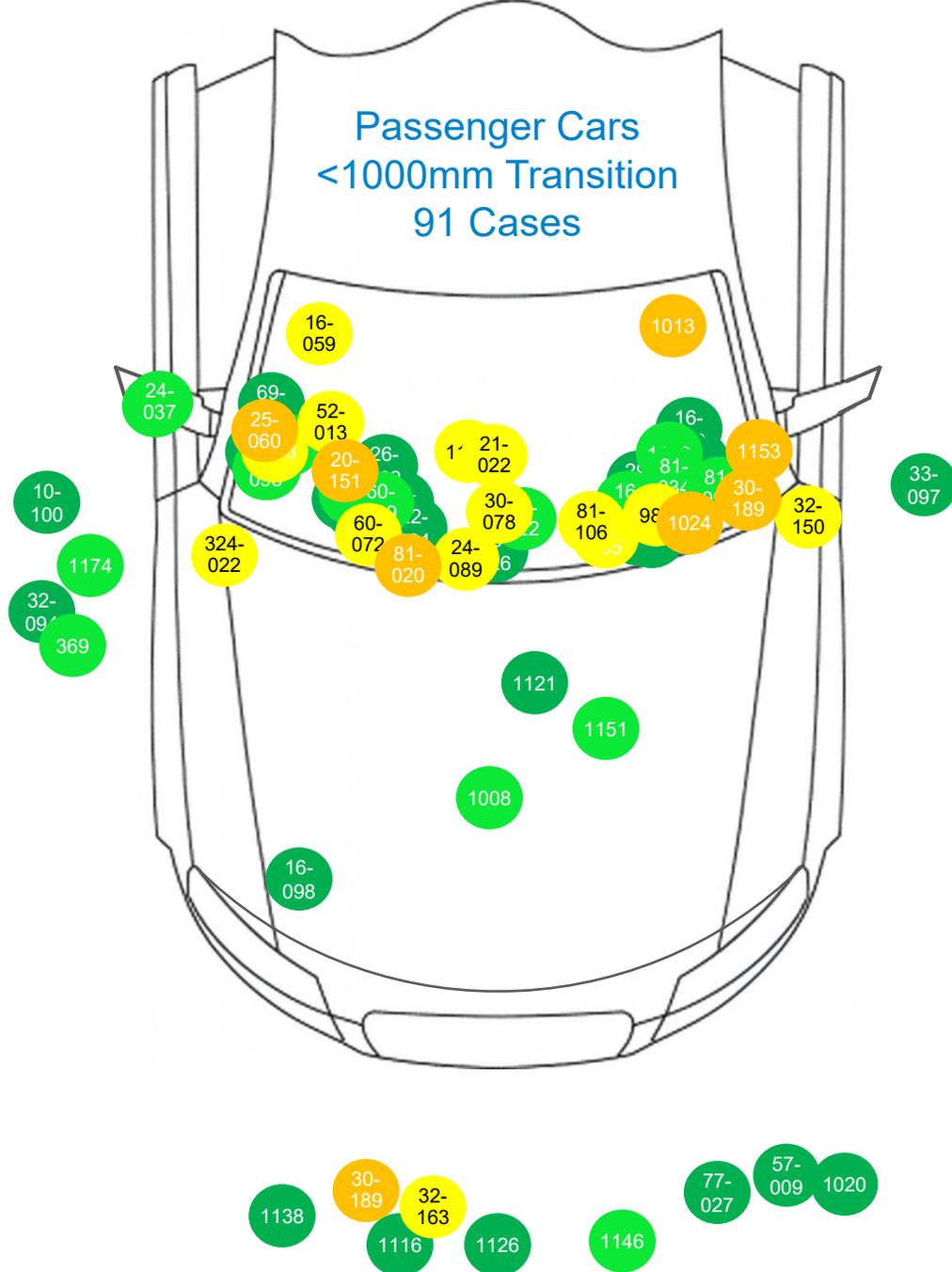
H/F/N
MAIS

- 1
- 2
- 3
- 4
- 5
- 6
- 9



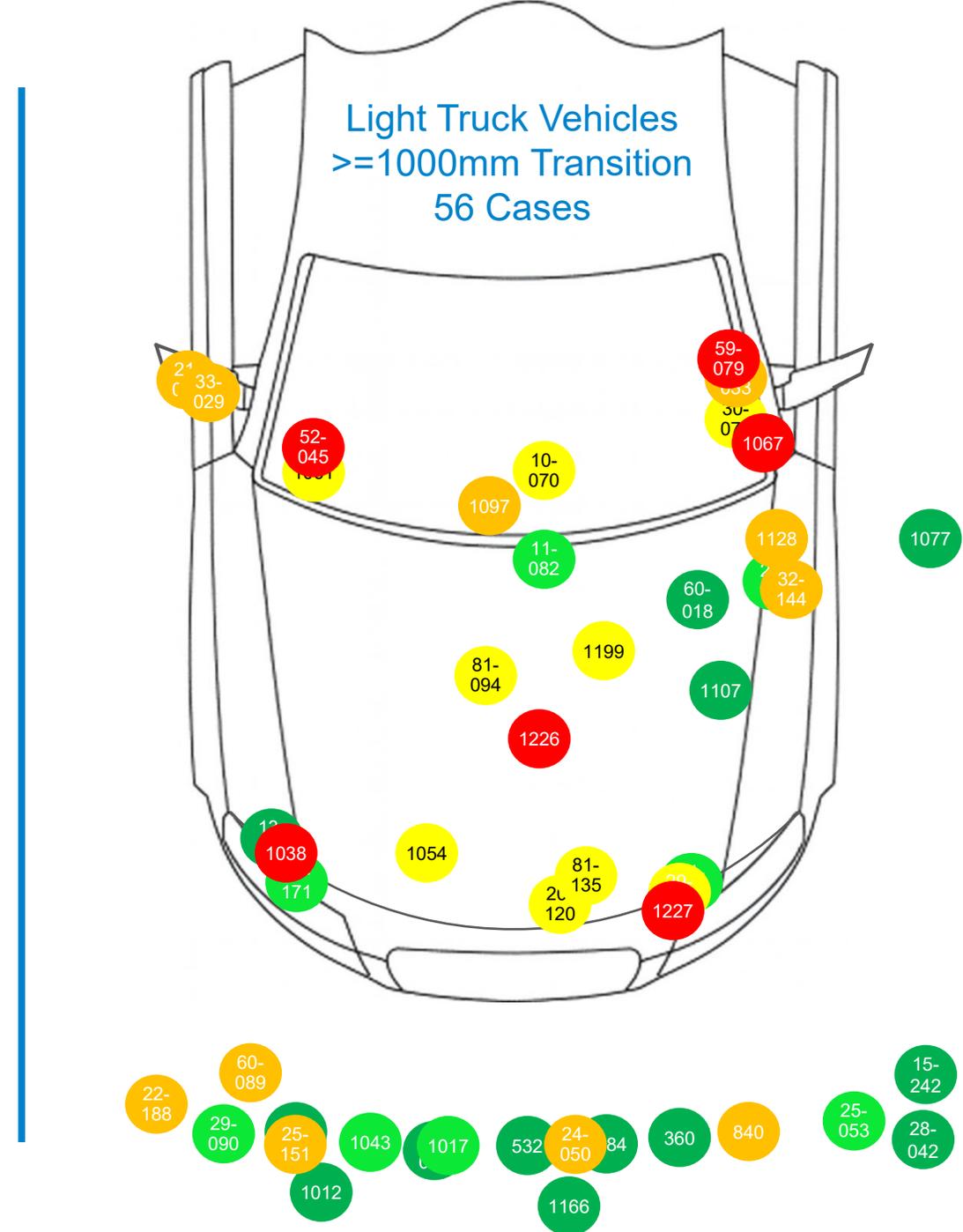
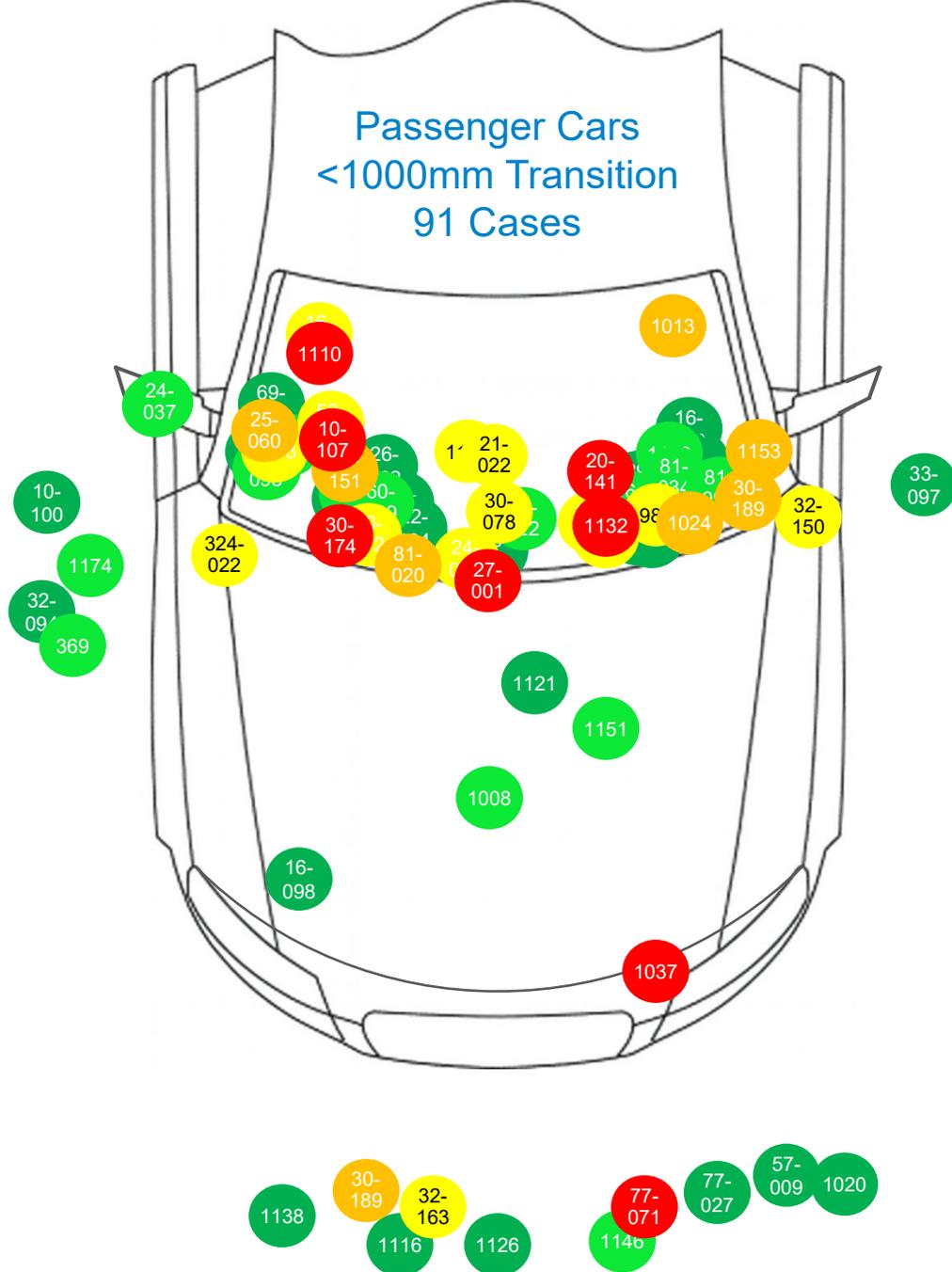
H/F/N
MAIS

- 1
- 2
- 3
- 4
- 5
- 6
- 9



H/F/N
MAIS

- 1
- 2
- 3
- 4
- 5
- 6
- 9

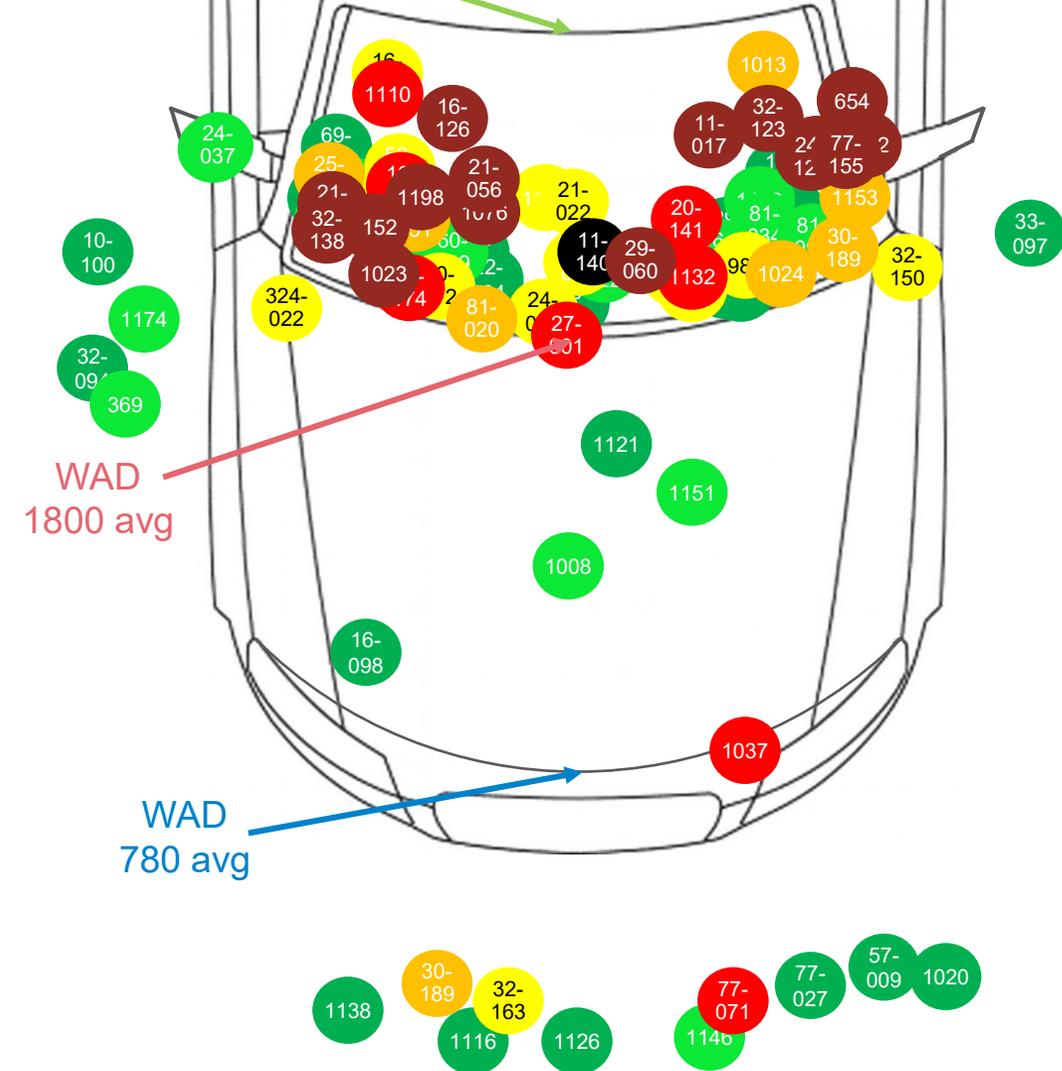


H/F/N
MAIS

- 1
- 2
- 3
- 4
- 5
- 6
- 9

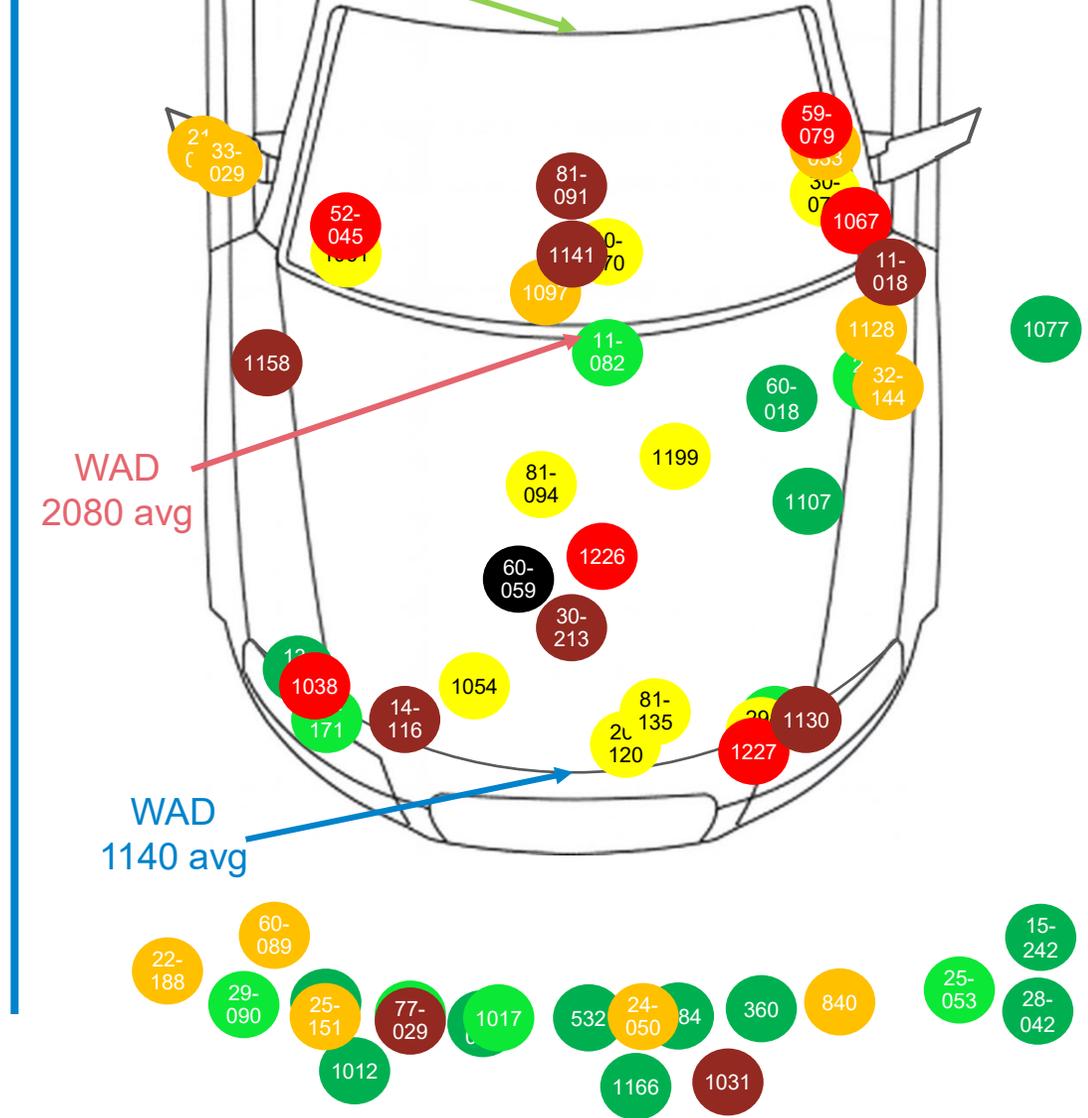
WAD
2760 avg

Passenger Cars
<1000mm Transition
91 Cases



WAD
3030 avg

Light Truck Vehicles
≥1000mm Transition
56 Cases

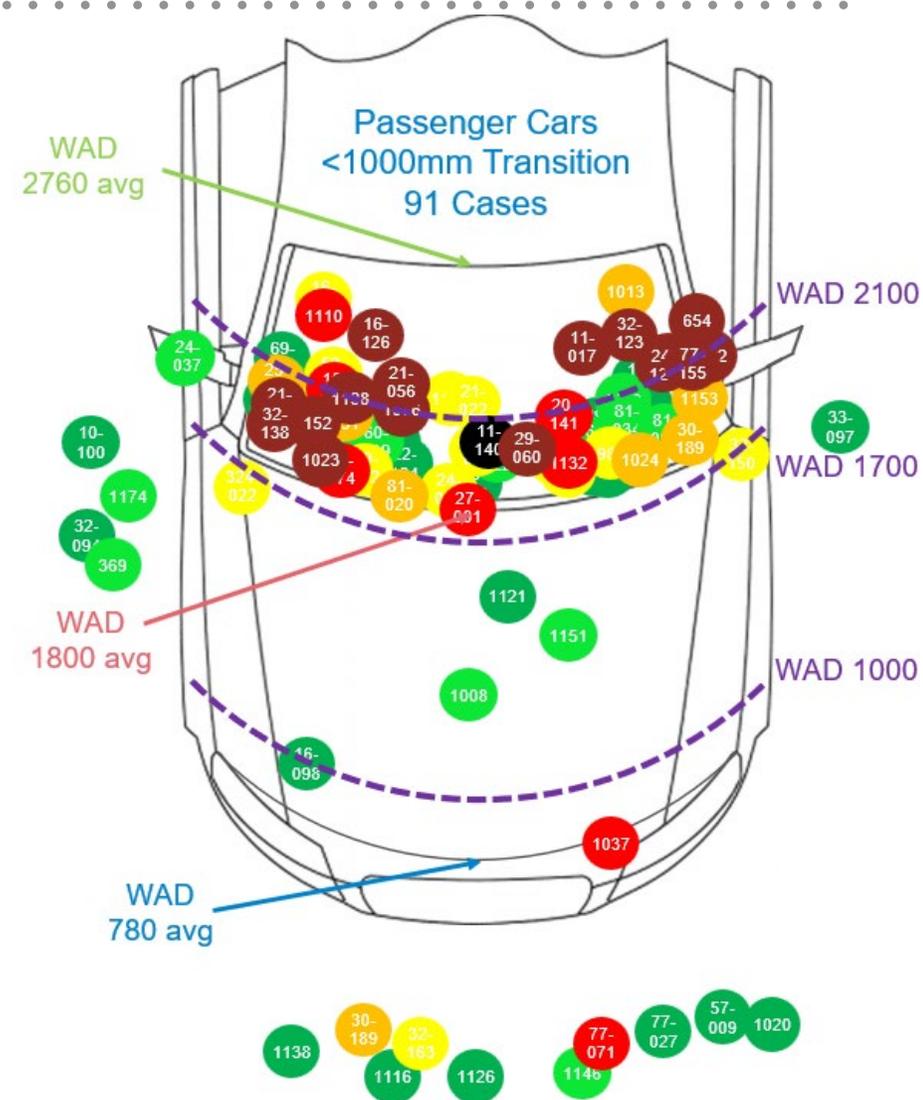


Limitations

- Potential head contacts with no documented AIS 1+ injury were not captured
- Secondary impacts with the ground/environment
 - Many head injuries coded with alternate injury causation scenarios (ICS) for ground impacts
- Hood contacts can be harder to identify based on photos compared to glazing contacts
 - Crash investigators documented hair/skin in windshield glazing contacts when present to increase confidence
- Few children (n=11 for 12 yo and under) in dataset

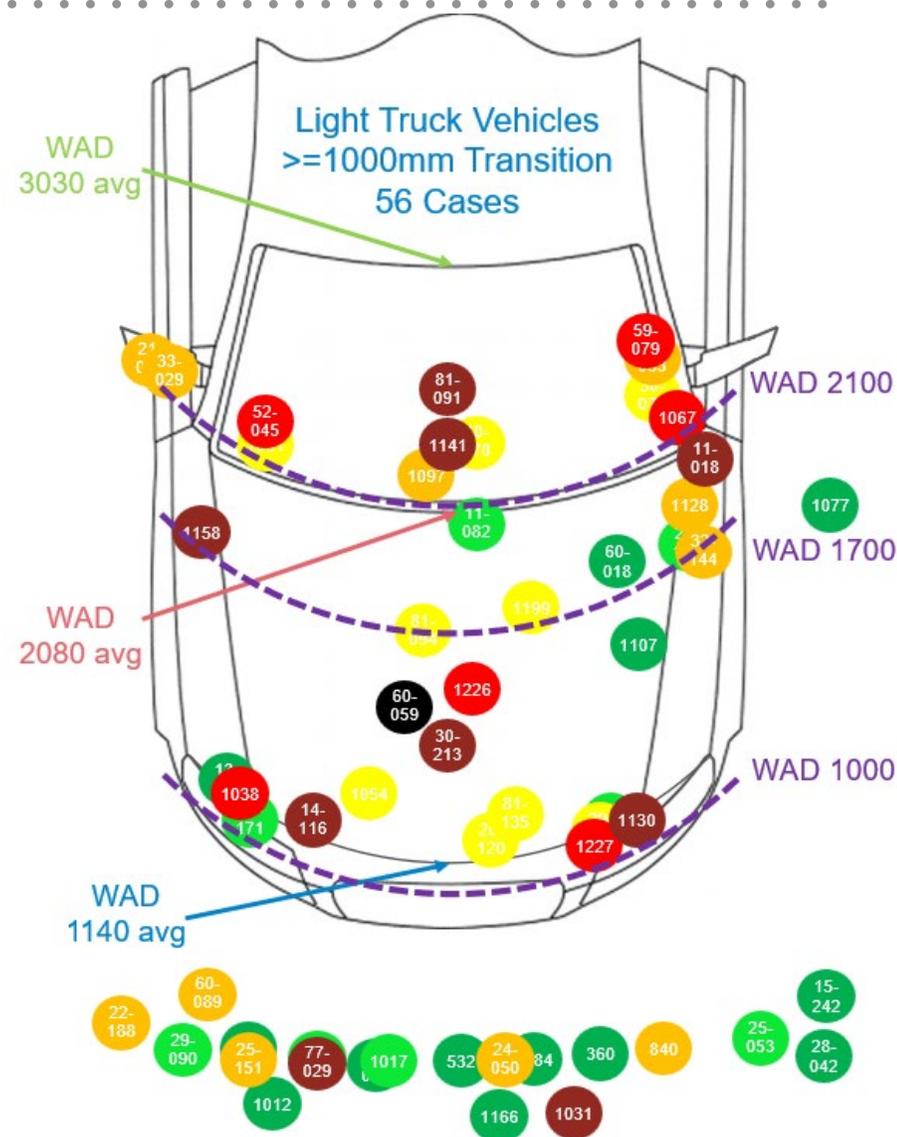
Conclusions

- Passenger Cars
 - Hood contacts appear to be less common, with less severe injury outcomes
 - Windshield glazing, cowl, and a-pillars common contacts with more severe outcomes
 - Wrap kinematics common with sliding along the hood
 - ~75% of head-to-vehicle contacts between WAD 1000 and WAD 2100
 - ~25% of head-to-vehicle contacts above WAD 2100



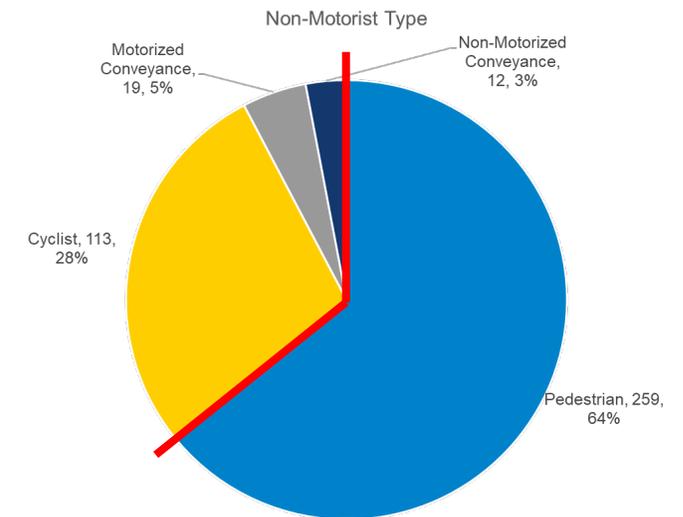
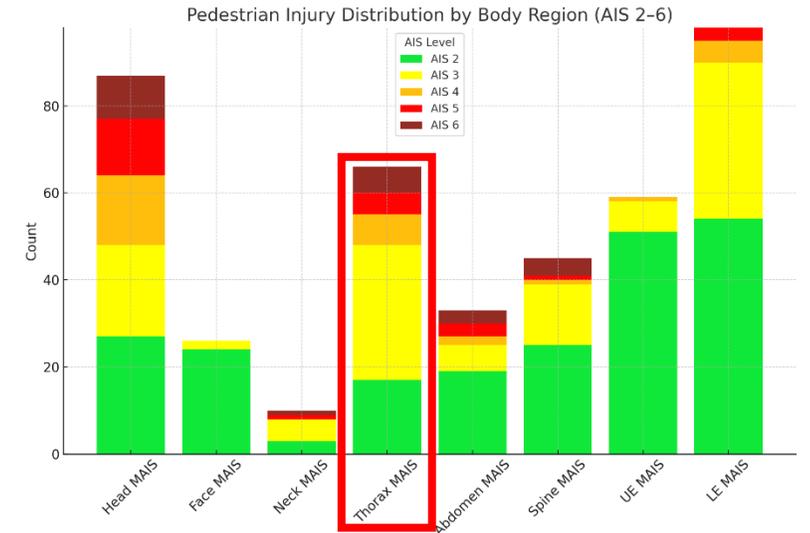
Conclusions

- Light Truck Vehicles
 - Hood contacts more common than windshield, cowl, a-pillars
 - Cluster of head contacts at hood leading edge and headlight junction areas just above WAD 1000
 - Forward projection kinematics common with increased number of ground contact ICS
 - ~70% of head-to-vehicle contacts between WAD 1000 and WAD 2100
 - ~30% of head-to-vehicle contacts above WAD 2100



Next Steps

- Mapping thorax-to-vehicle contacts and injury outcomes for pedestrians
- Head contact locations for cyclists and personal conveyance crashes
- Statistical modeling for injury outcomes by body region
 - Vehicle impact speed
 - Vehicle front end height



Thank you!

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