NTSB | National Transportation Safety Board

NTSB Investigations Addressing ADAS Technologies

August 10, 2022

What is the NTSB?

- Independent Federal agency established in 1967
  - To investigate and determine the causes of accidents in all modes of transportation
  - 1974 – separate agency from US DOT
- Conduct safety studies in significant areas of concern
- 5 Board Members appointed by the President
- Over 400 staff in various areas of expertise
- Non-regulatory agency

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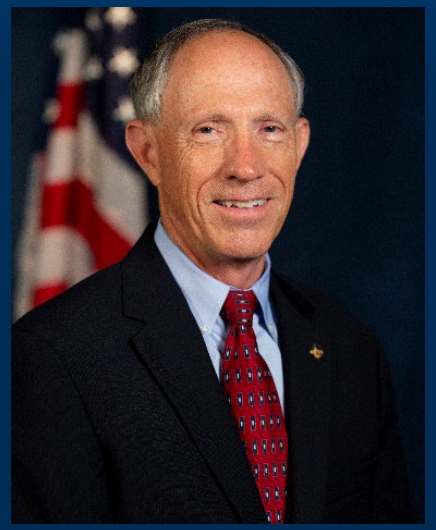
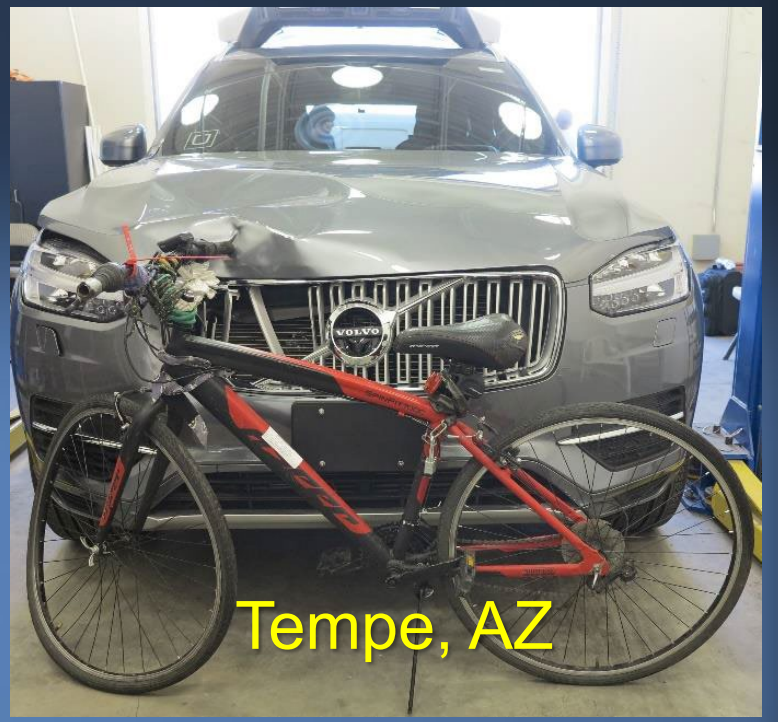
NTSB Board Members

- 5 presidentially-appointed Members — by and with the advice and consent of the Senate

ADAS/ADS Crashes

Williston, FL



Culver City, CA

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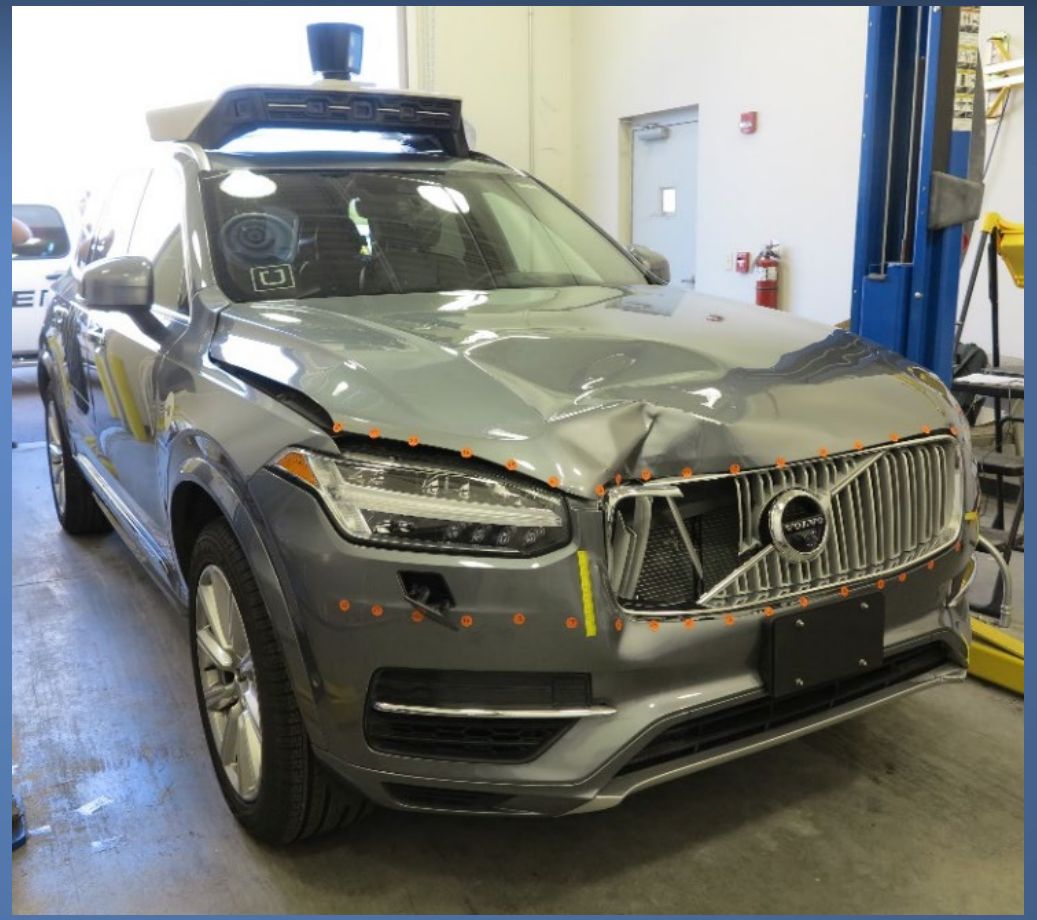
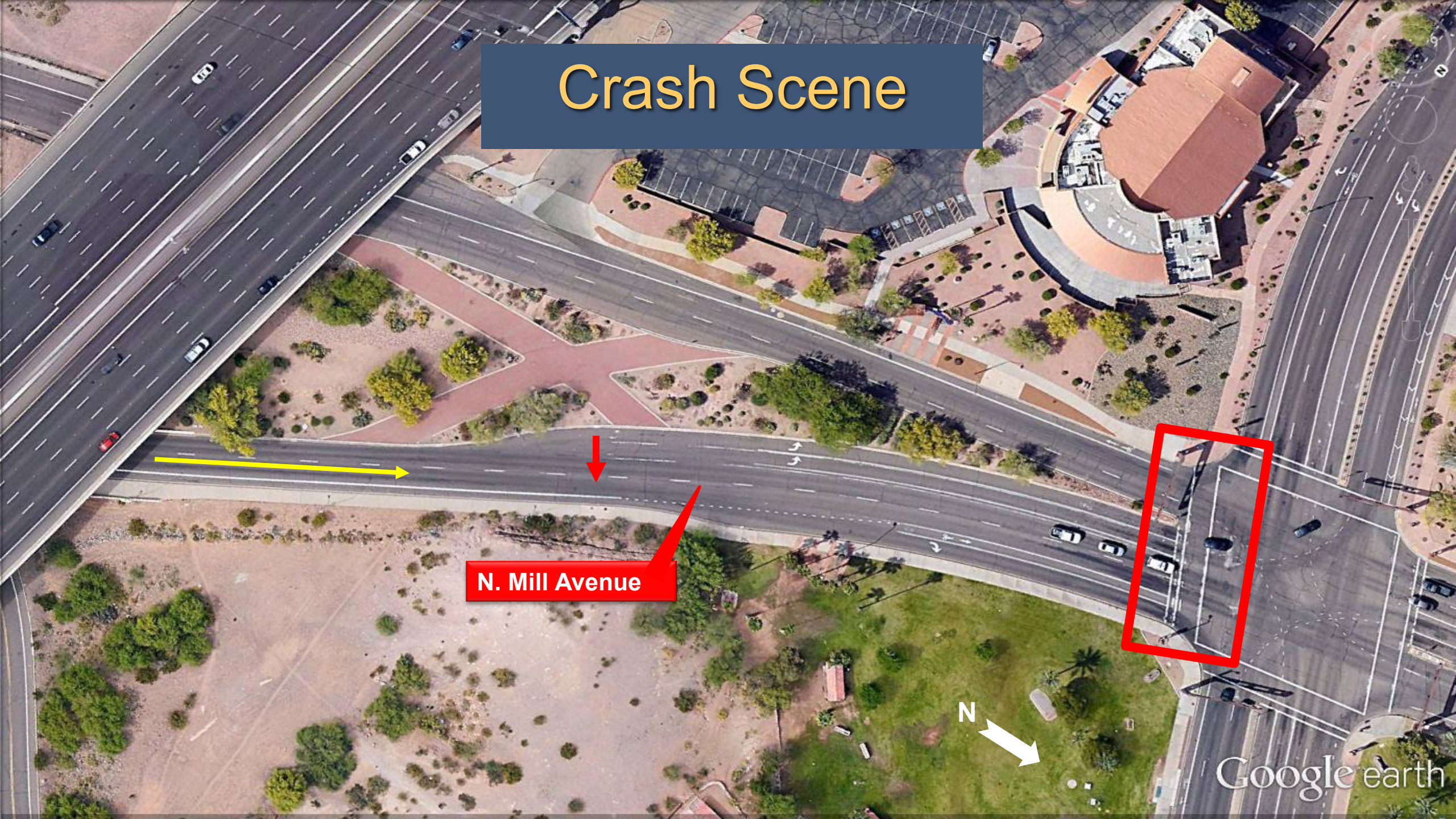
Tempe, AZ (March 18, 2018)

- Uber test vehicle based on 2017 Volvo XC90
- Uber ATG automated driving system (ADS)
- Female operator occupied the driver's seat
- Vehicle was being controlled by the ADS
- Struck pedestrian pushing a bicycle across roadway
- Pedestrian fatality

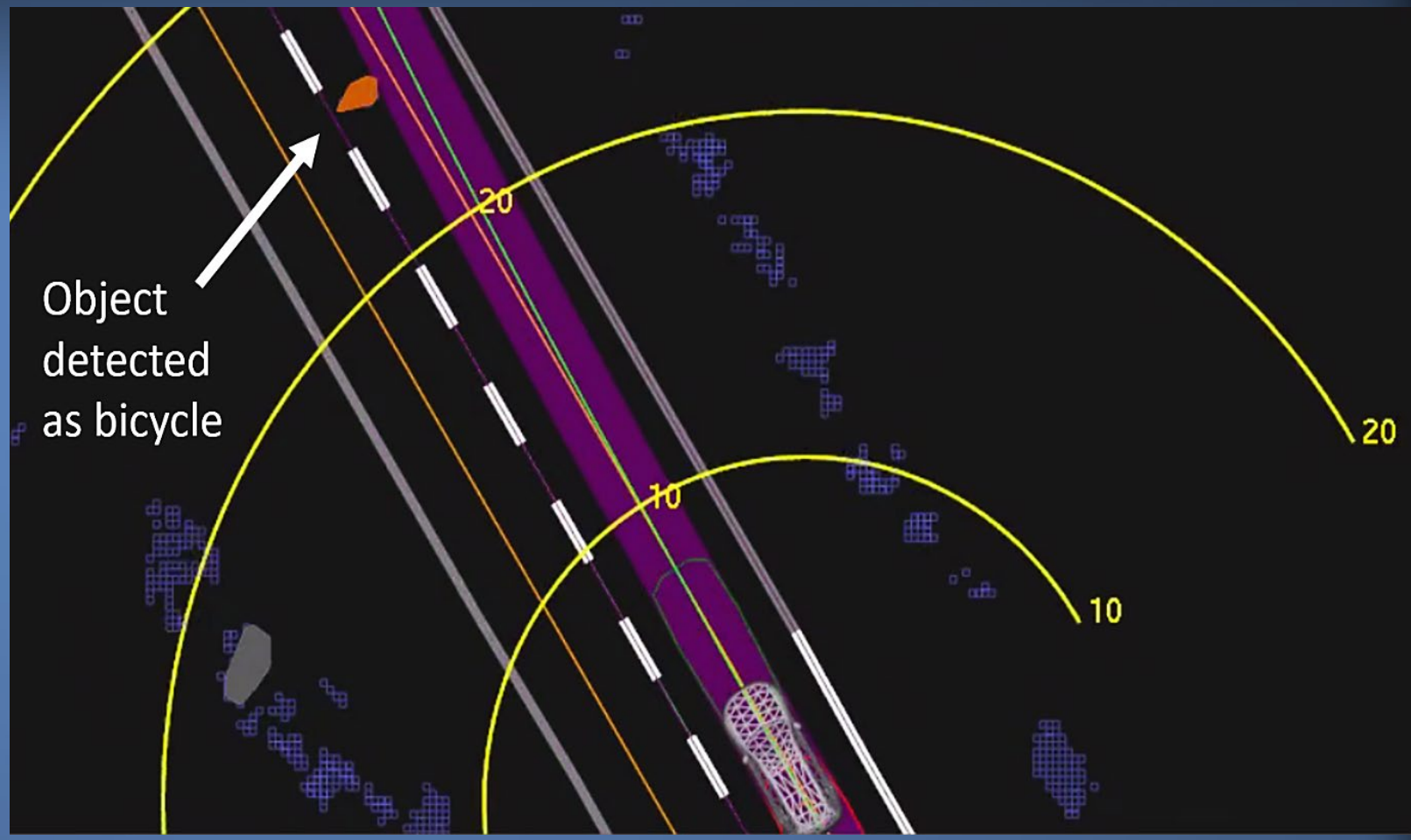


Crash Scene



Crash Detection Sequence

- A hazard (pedestrian) detected 6 sec before impact
- Speed of 43 mph
- The hazard changed to an unknown object, a vehicle, and then a bicycle
- Emergency braking needed 1.3 s before impact
- Driver steered < 1 s
- Impact speed 39 mph



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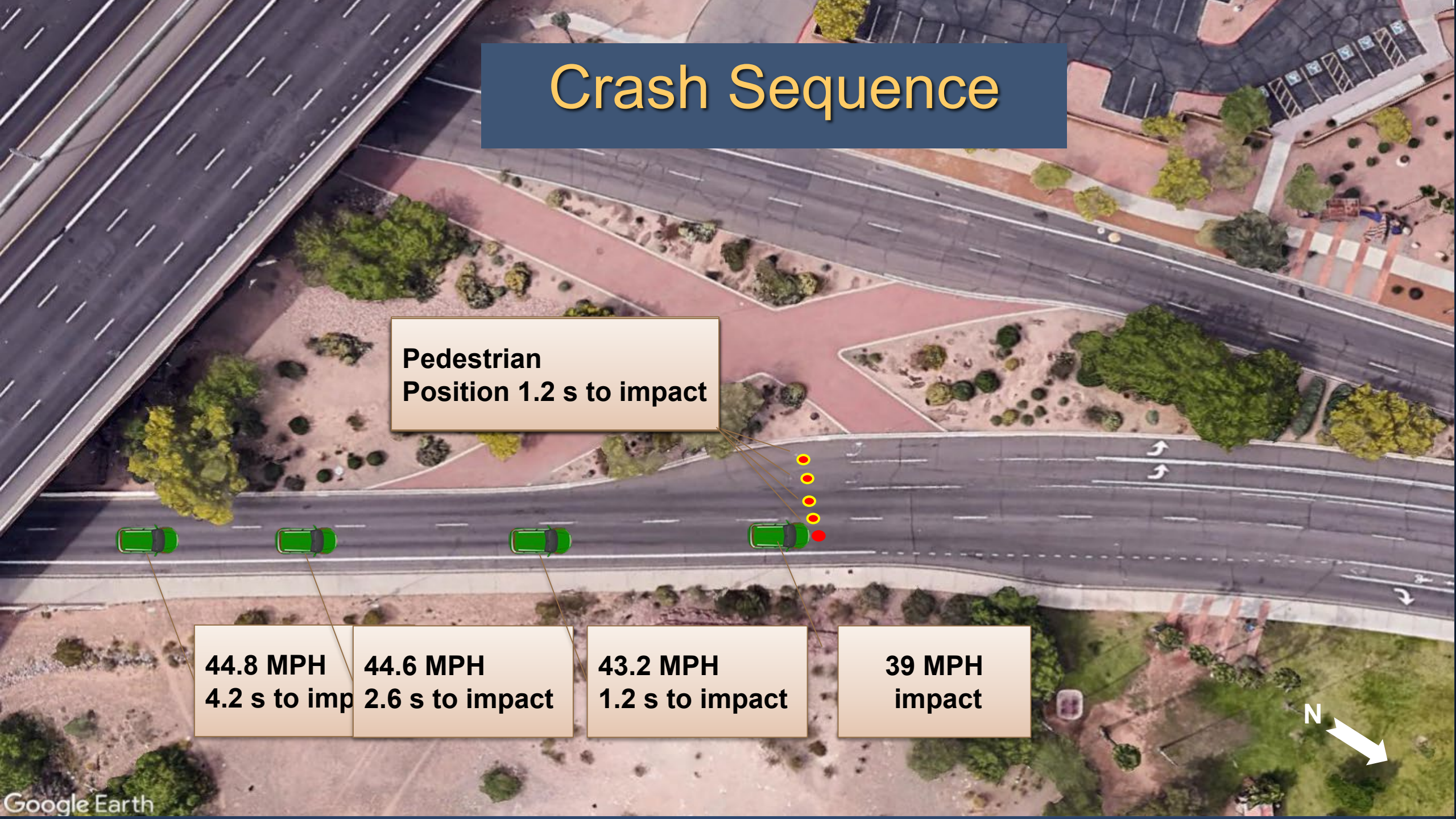
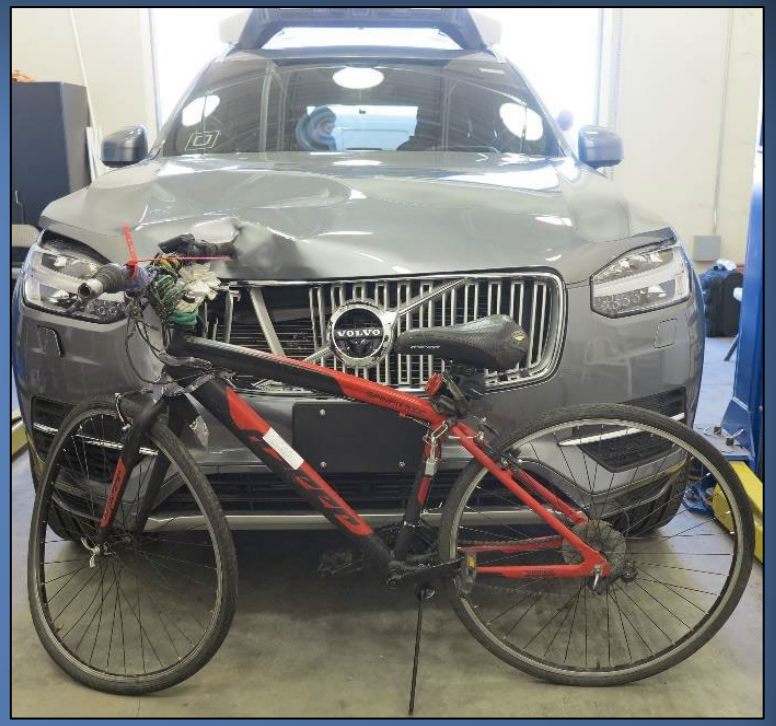
Crash Sequence



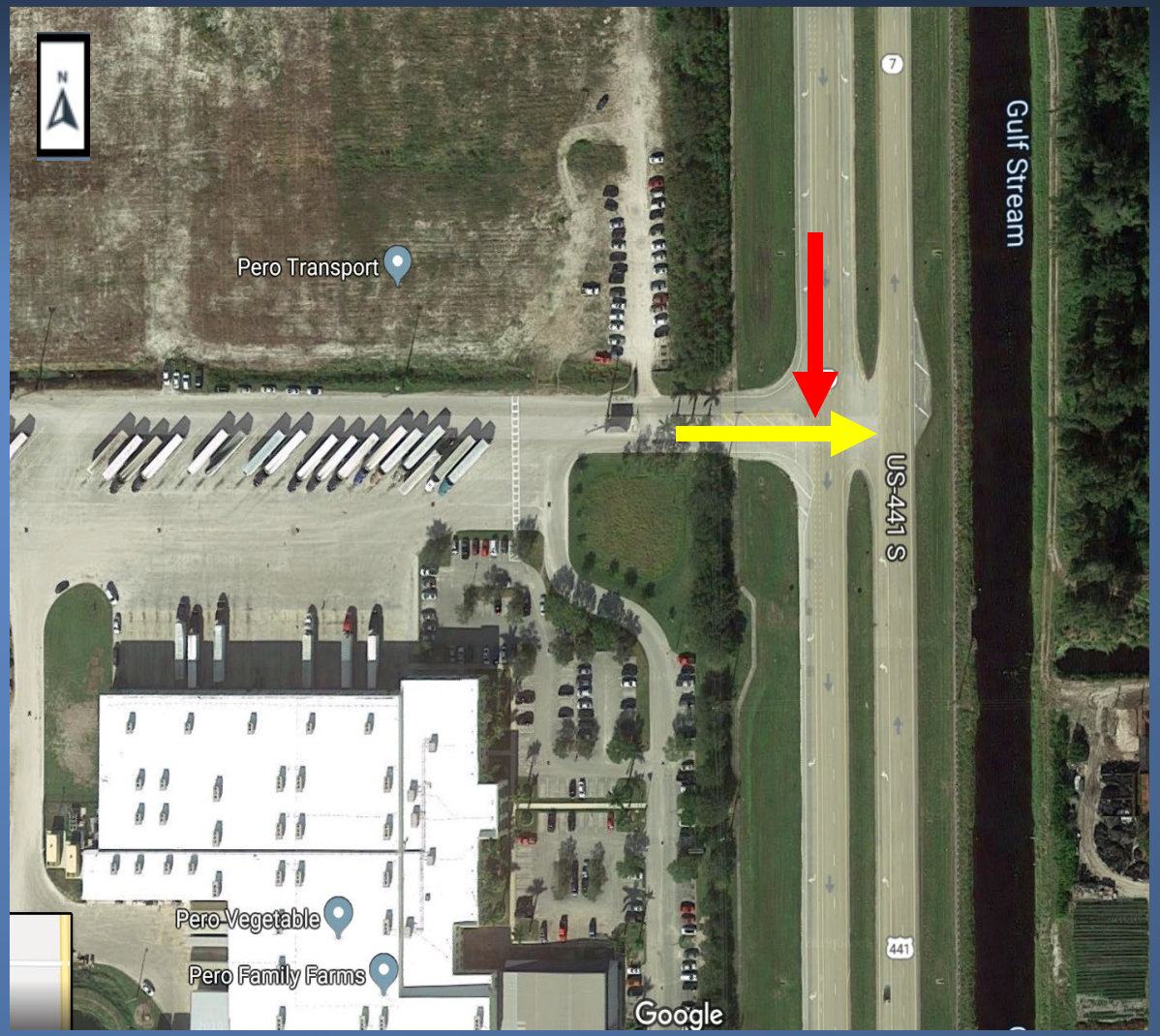
Sensor and System Challenges

- Inability to properly classify the pedestrian pushing a bicycle
- Greater dependence on classification for object's direction of travel than the previous position of object
- System programming did not have a pedestrian classification for a person crossing the road outside of a marked crosswalk
- Emergency braking was delayed due to potential for "false positives", instead depended on the backup driver for proper action



Delray Beach, Florida (March 1, 2019)

- 6:17 a.m. (EST)
- 2018 Tesla Model 3
- 2019 International truck-tractor in combination with a semi-trailer
- Posted speed limit 55 mph
- Tesla speed = 69 mph
- Autopilot activated 9.9 s before impact
- 1 Fatal



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Delray Beach, Florida (March 1, 2019)

Delray Beach - Impact Damage

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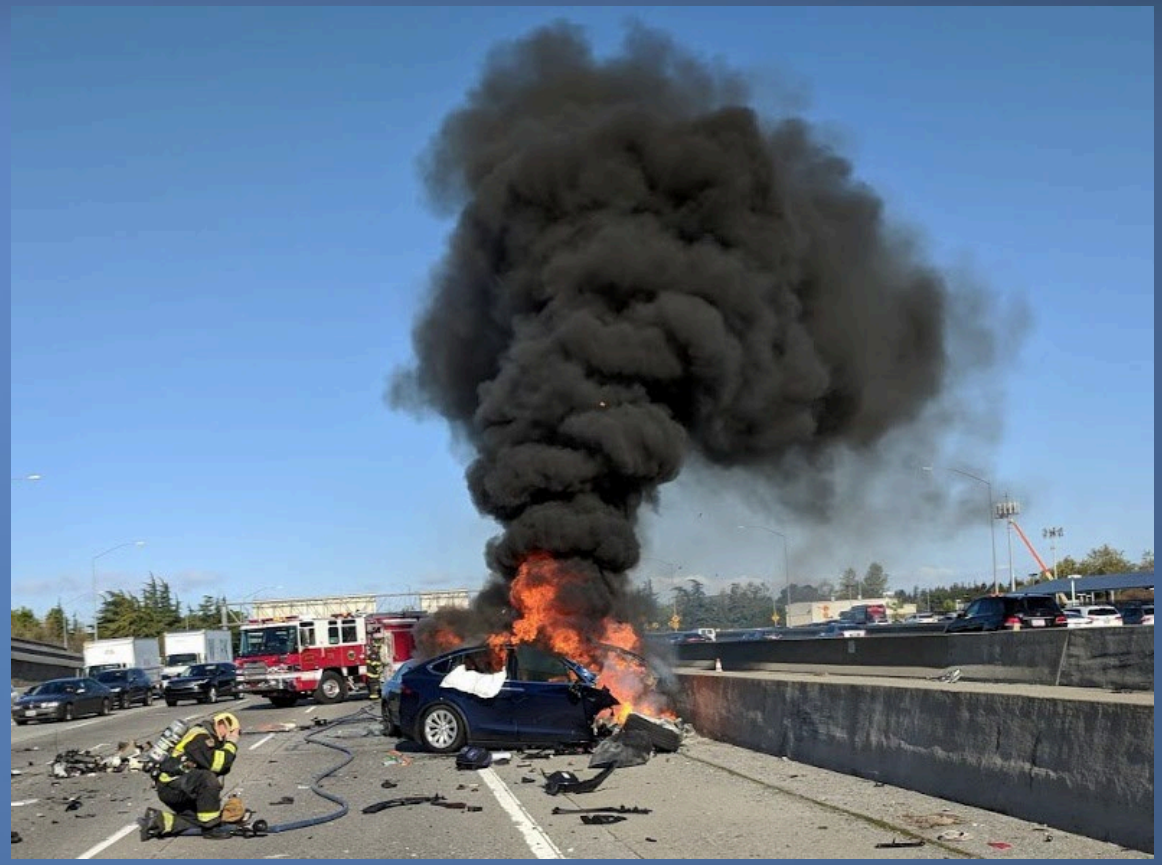
Challenges

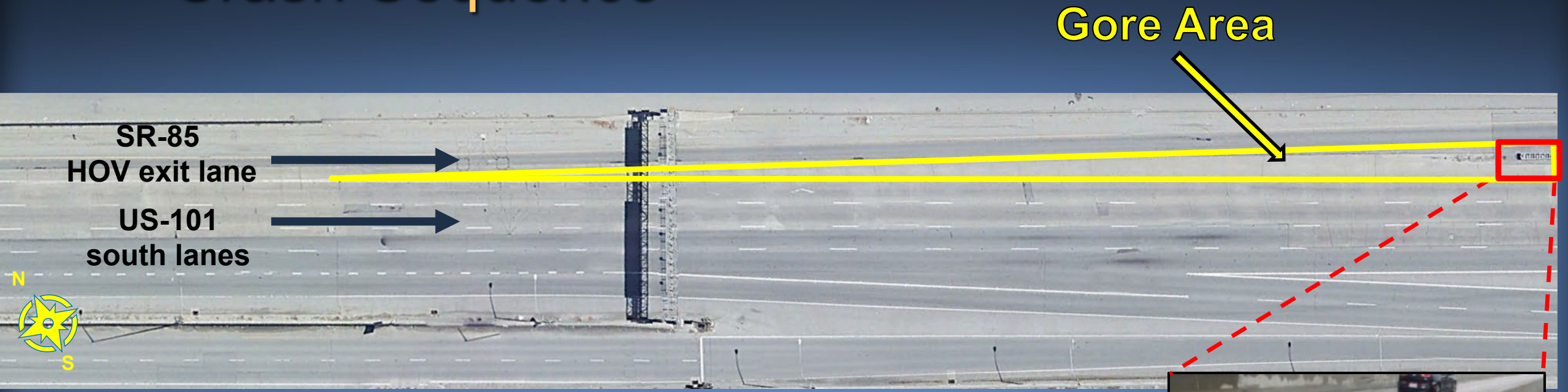
- Inability of the vehicle sensors to detect the crossing trailer
  - Sufficient “free space” under the trailer for vehicle to pass
- Insufficient driver monitoring system to determine driver disengagement prior to the crash

Mountain View, CA (March 23, 2018)

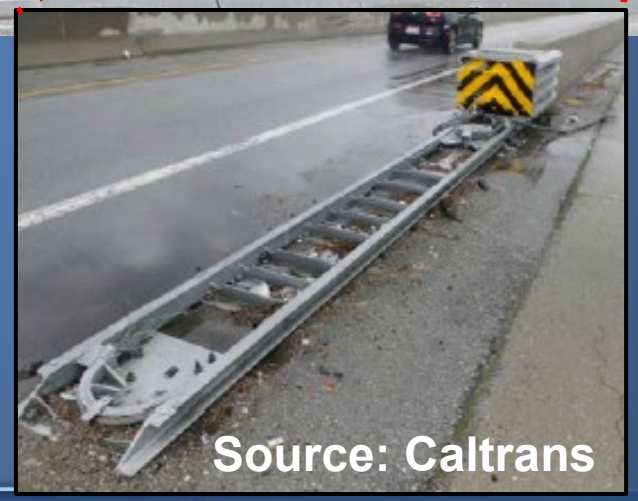
- 2017 Tesla Model X
- Struck previously damaged highway attenuator with Autopilot engaged
- Tesla high voltage battery fire, reignition
- Driver fatality



Crash Sequence



Crash attenuator was collapsed and nonoperational prior to the crash



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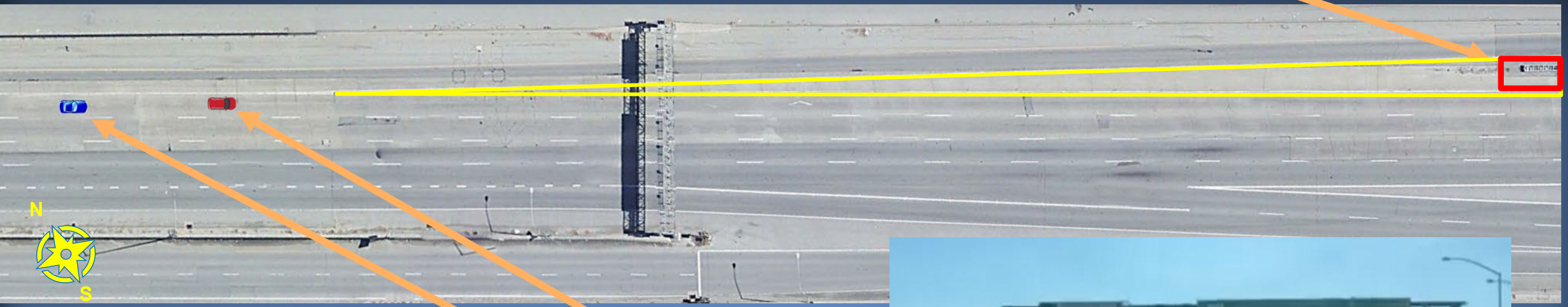
Crash Sequence



Tesla

Lead vehicle

Time to crash:	7.9 seconds
Speed:	64.3 mph
Lead vehicle:	83.7 feet
Distance to crash:	748 feet

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Crash Sequence

Time to crash:	**5.9 seconds**
Steering:	**5.6 degrees left**
Speed:	**64.1 mph**
Lead vehicle:	**82 feet**
Distance to crash:	**560 feet**
Indication:	**Hands-off steering wheel**

Crash Sequence

Time to crash:	3.9 seconds
Speed:	61.9 mph
Lead vehicle:	None detected
Distance to crash:	375 feet

Vehicle begins to accelerate
Hands-off steering wheel indicated

Lead vehicle
(no longer followed)

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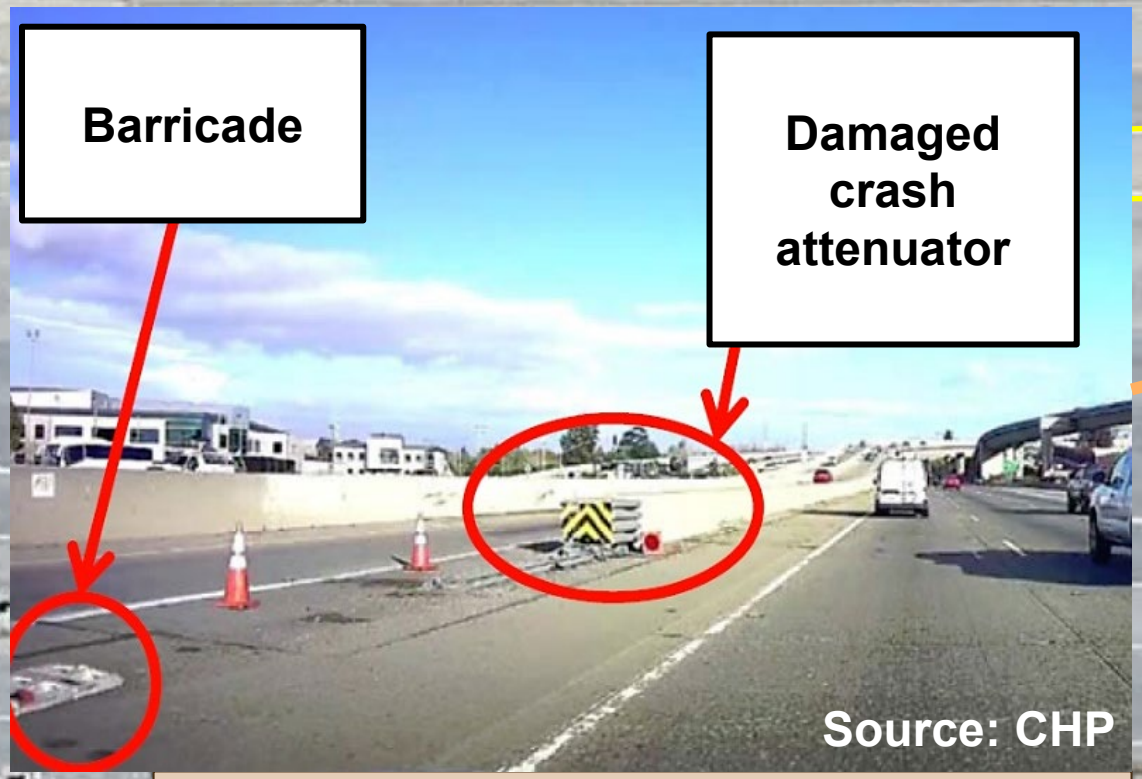
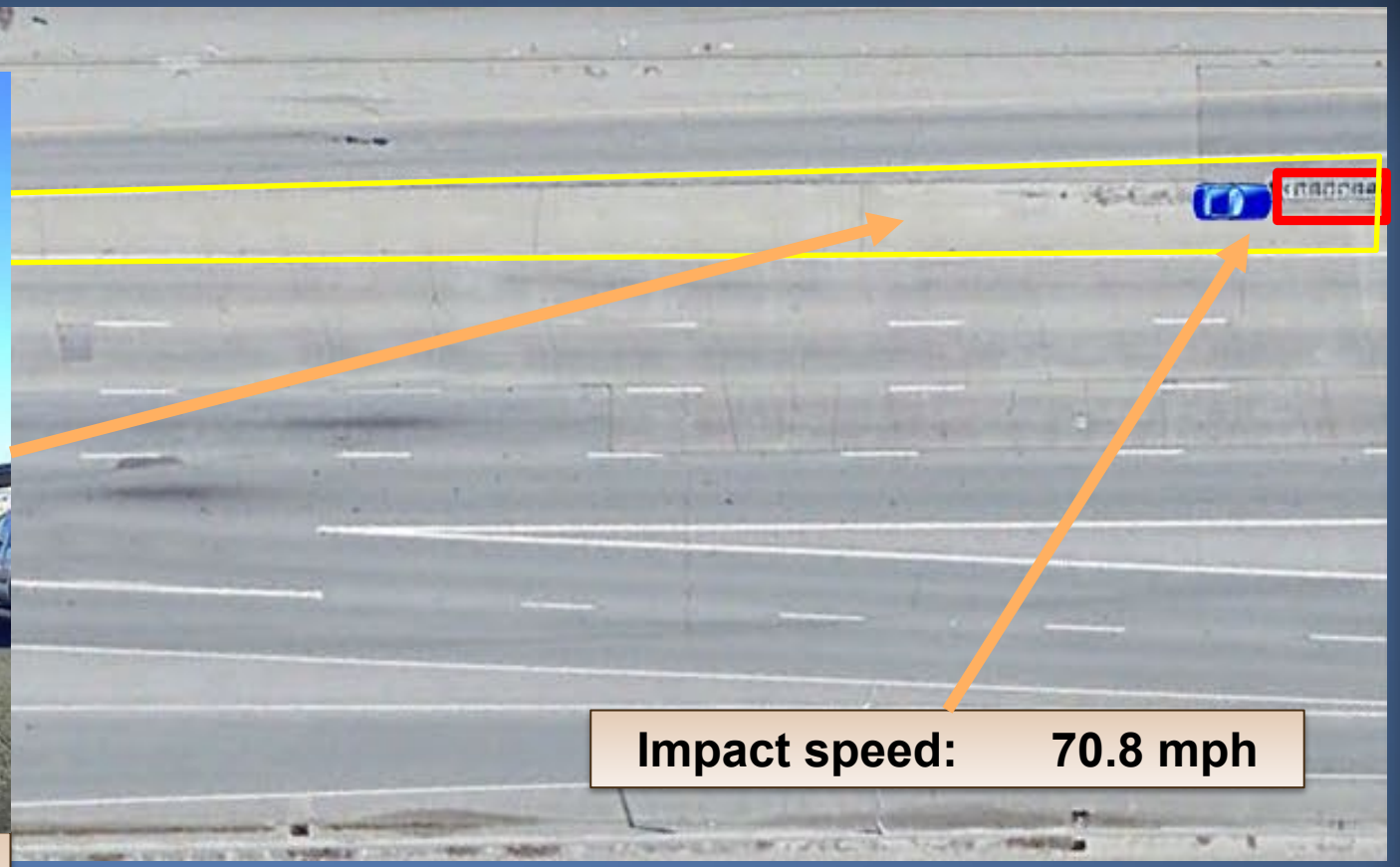
Crash Sequence



Barricade and cones placed in advance of attenuator prior to crash



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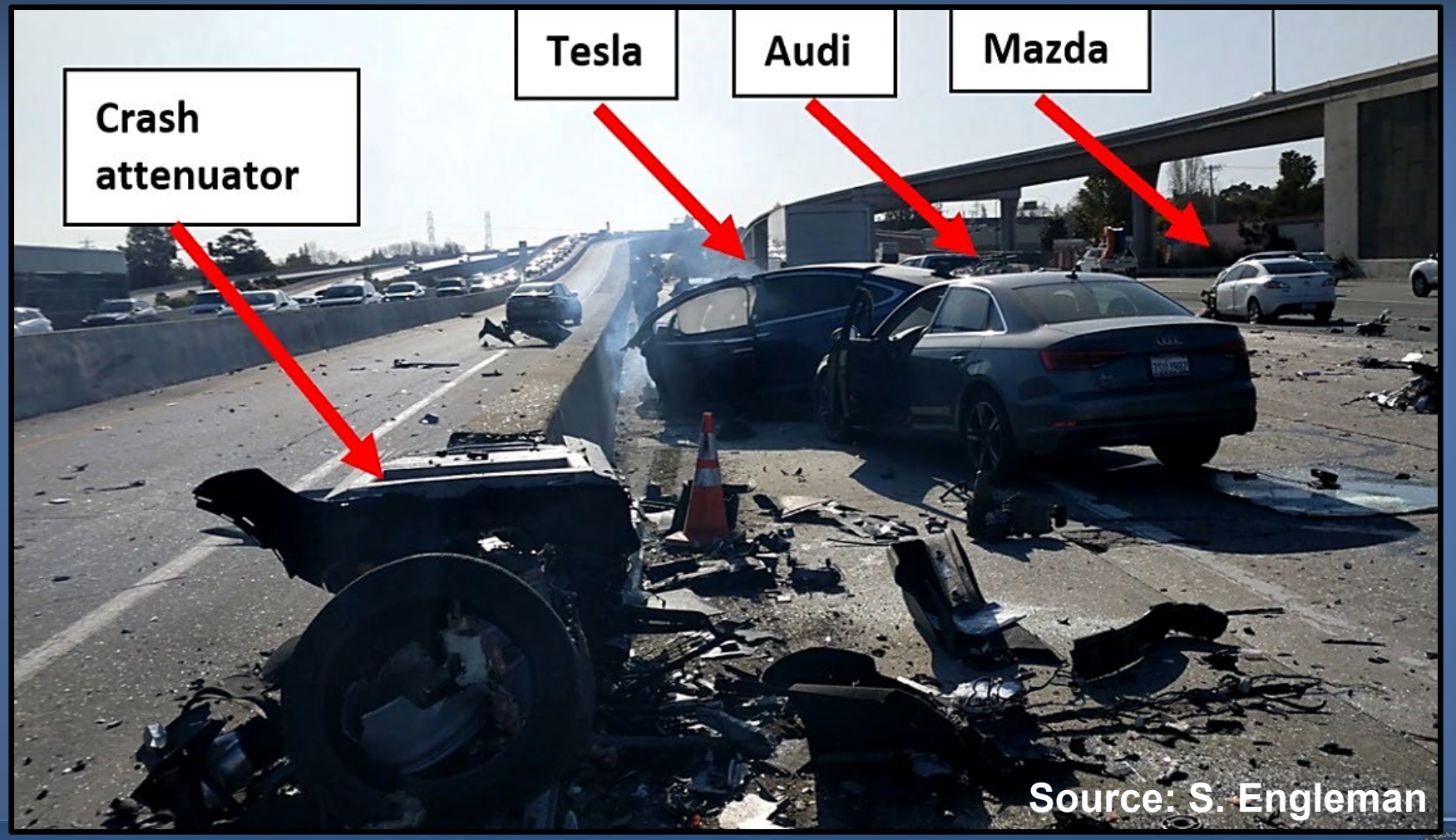
Crash Sequence



Mountain View Challenges

- Inability of the vehicle sensors to recognize poor lane markings on right side of gore
- Accelerated to preset cruise speed once the lead vehicle was not present (vehicle fully in gore area)
- Inability to recognize the damaged energy attenuator
- Insufficient driver monitoring system to determine driver disengagement prior to the crash

Mt. Pleasant, Pennsylvania

- January 5, 2020, 3:30am
- Multi-vehicle crash on Interstate 70/76
- Motorcoach departed roadway, impacted right side embankment, overturned, and came to rest blocking all westbound lanes
- 70 mph speed limit with a 55 mph curve advisory speed for the crash location

Overturned Motorcoach

Source: FedEx forward-facing video, annotated by NTSB

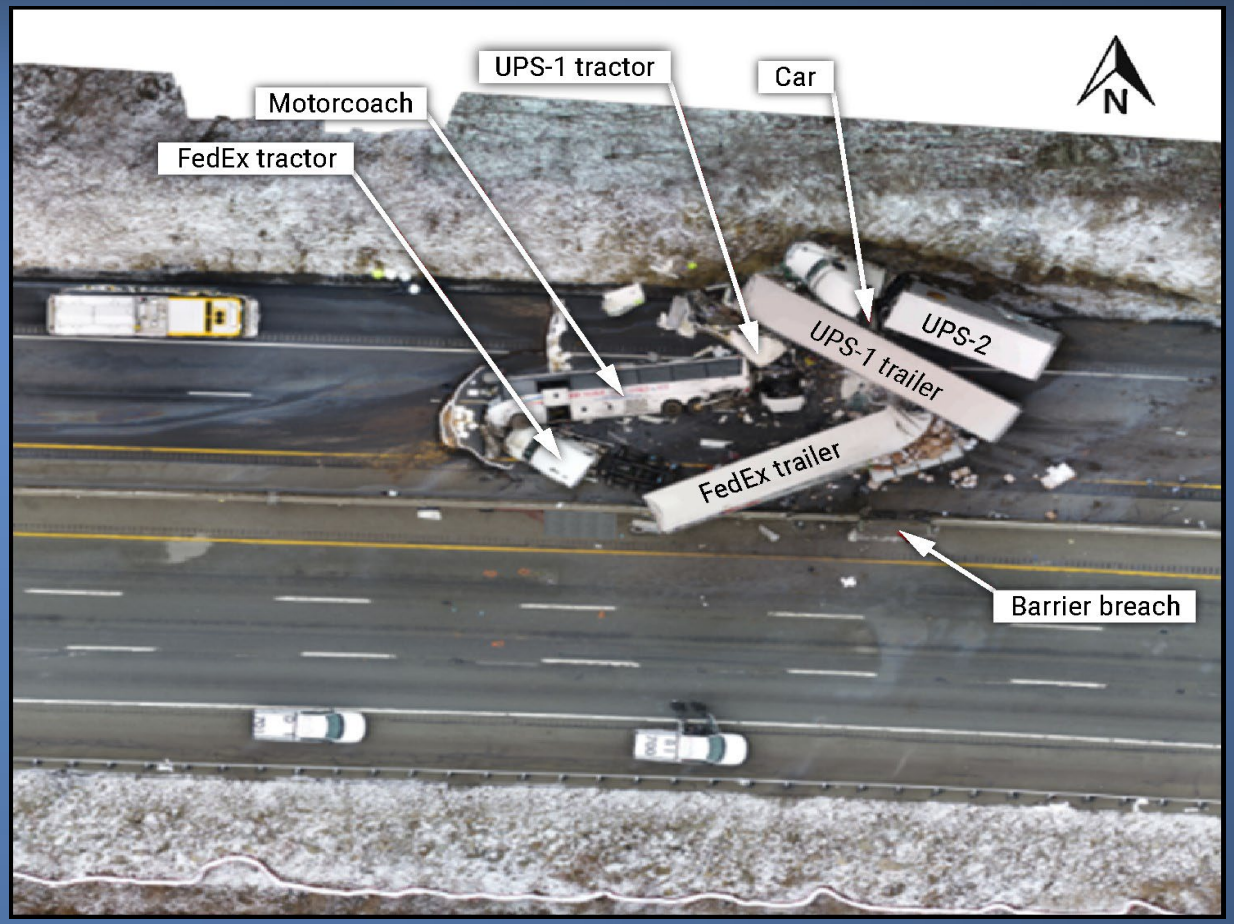
- Initial position of rest was blocking both travel lanes and shoulders
- Entered curve at 77 mph
- Light braking upon entering curve decreased speed to 70 mph
- After brakes released vehicle speed changes not associated with braking or throttle occurred
- Speed changes consistent with vehicle yawing from excessive steering inputs
- Sufficient roadway traction existed for normal travel

Crash Scene

- Vehicles at final rest
- Left-hand curve
- East and westbound lanes
- 55-mph warning sign

Mt. Pleasant, PA – January 5, 2020

- Final rest positions of vehicles
  - Motorcoach
  - FedEx tractor & trailer
  - UPS-1 tractor & trailer
  - Passenger car
  - UPS-2 tractor & trailer



Forward Collision Avoidance Systems (CAS)

- Three Freightliner truck-tractors were equipped with forward CAS
  - Not functioning on UPS-1
  - FedEx and UPS-2 did not activate precrash
- CAS: audible warning, automatic emergency braking (AEB)
- Designed to mitigate or prevent rear-end crashes
- Performance affected by
  - Generational capabilities
  - Roadway and crash parameters

NTSB Vehicle Automation page: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