Baseline Analysis of Driver Performance for Intersection Crossing and Crash Avoidance Applications

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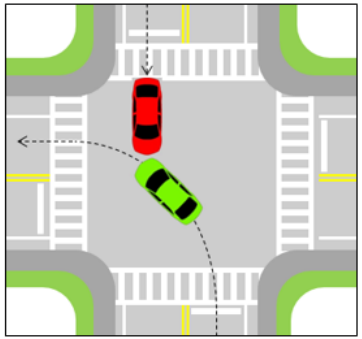
NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

SCENARIOS

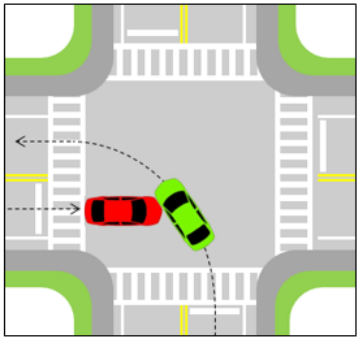
Left Turn Assist (LTA)

Intersection Movement Assist (IMA)

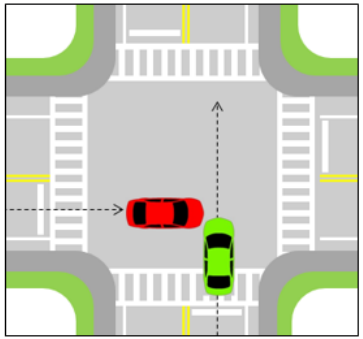
LTAP-OD
Left Turn Across Path – Opp. Dir.



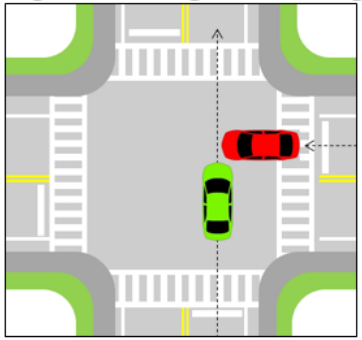
LTAP-LD
Left Turn Across Path – Left Dir.



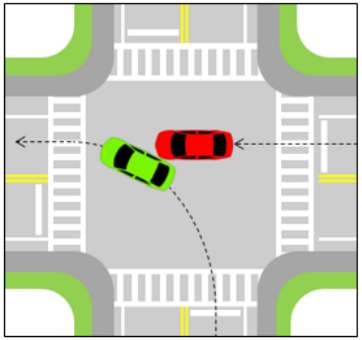
SCP-L
Straight Crossing Paths - Left



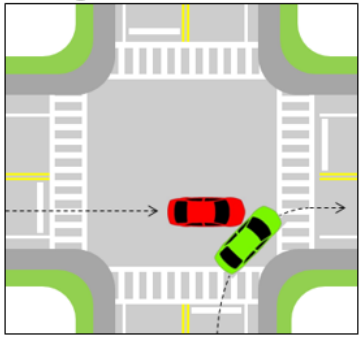
SCP-R
Straight Crossing Paths - Right



LTIP
Left Turn Into Path



RTIP
Right Turn Into Path



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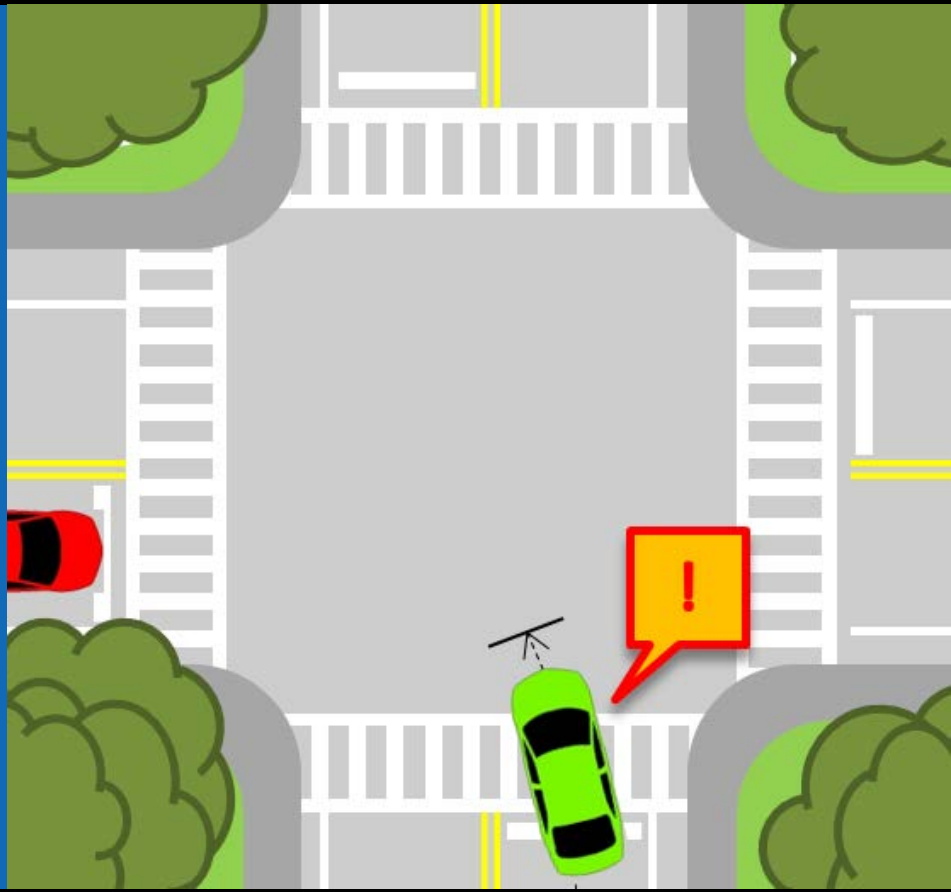
NUISANCE ALERTS

Difficult to identify because:

1. What constitutes a nuisance varies from driver to driver
2. Driver intentions are difficult to anticipate

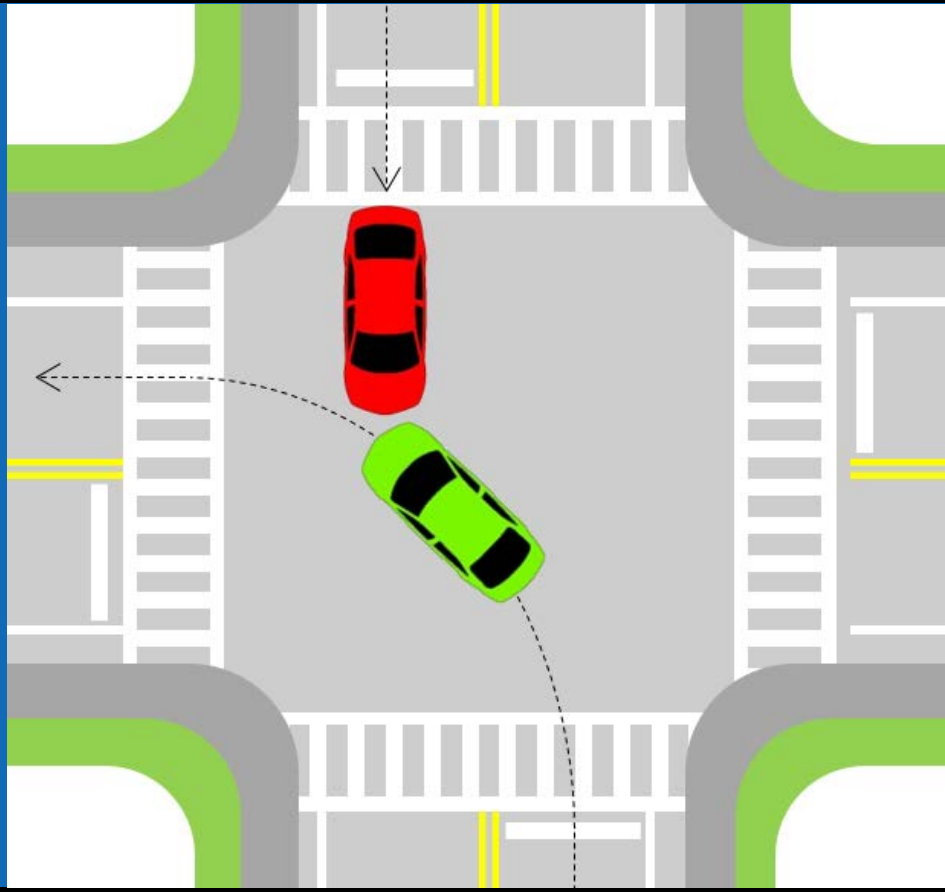
Improved understanding of driver behavior at intersections is needed.



STUDY GOALS: LEARNING THE BASELINE

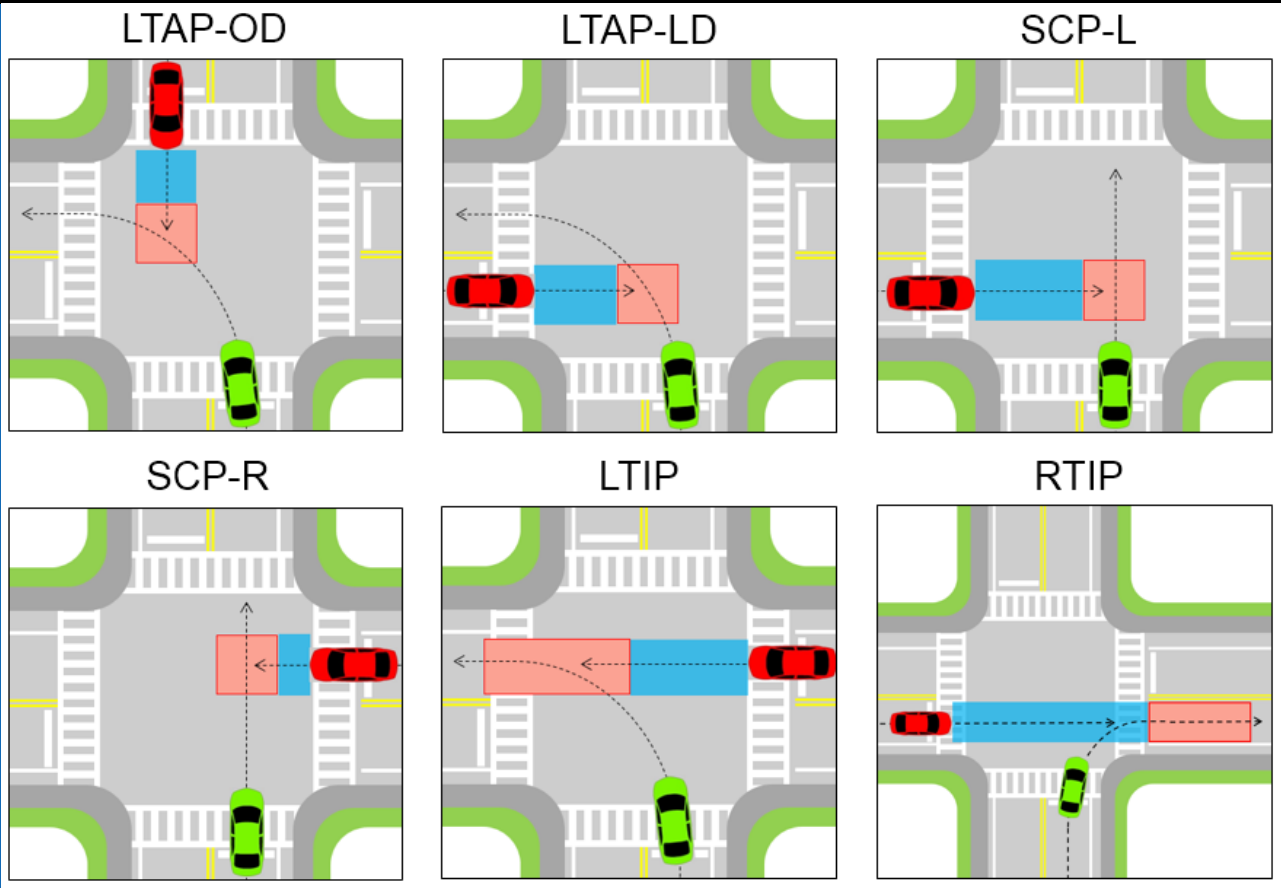
1. Provide information on typical or “baseline” driving for refining crash alert or avoidance criteria

2. Provide performance data for practical test procedures



DEFINING GAPS

(Key Intersection Crossing Metric)



BACKGROUND

Gap choice is not solely a function of length.

Drivers accept shorter gaps, the…

- More untaken gaps pass (Mahmassani and Sheffi 1981, Tupper et al 2011)
- Time spent queueing (Kittelson and Vandehy 1991)
- Longer the total waiting time (Toledo 2007, Zohdy et al. 2010, Tupper et al. 2011)
- Longer the anticipated time until the next gap (Pollatschek et al. 2002)
- Faster the oncoming vehicle's speed (Spek et al. 2006—simulator study)

BACKGROUND (Cont.)

- Gaps vary by intersection (strong evidence)
- Age effects exist for gap size, with teens being more aggressive and older drivers more willing to wait (not seen for all variables)
- Mixed results for gender (weak evidence)

Models of driver behavior must include an array of variables to accurately predict driver behavior.

BASELINE DATA SOURCES

Large-scale, naturalistic driving studies of collision-warning systems

Safety Pilot Model Deployment

- 127 volunteers
- 6 months
- Ann Arbor, Michigan

Driver Adaptation

- 37 volunteers
- 3, 9, or 12 months
- Washington, DC

LTA BASELINE METHODOLOGY
(LTAP-OD Scenario)

1. Queried left turns with steering-wheel rotation and vehicle yaw

2. Excluded events without oncoming traffic using video review

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Events were rare:

- Protected left-turn lights → no gaps
- Low traffic, waited until no oncoming vehicle → no gaps

IMA BASELINE METHODOLOGY
(SCP, LTIP, LTAP-LD, and RTIP Scenarios)

1. Queried events with verified alerts
2. Subset to unsignalized intersections
3. Selected return visits to intersections without alerts
4. Excluded events without oncoming traffic using review

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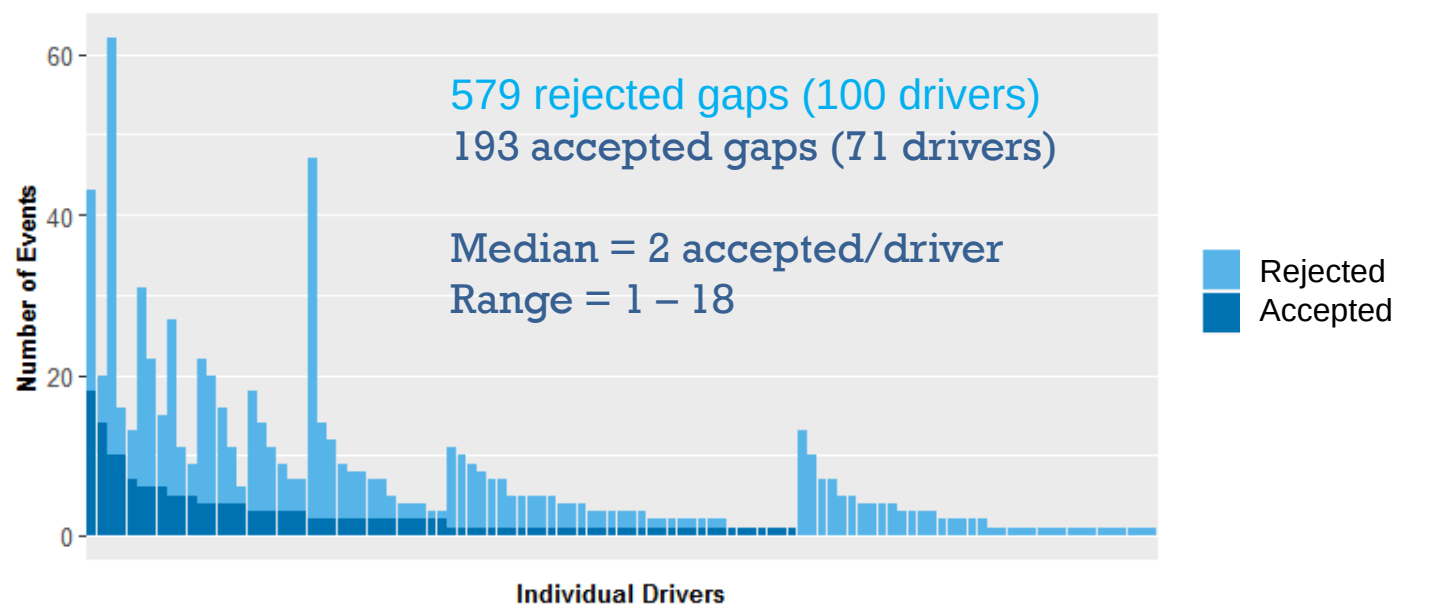
ANALYSIS METRICS

Gap x	Age Gender Speed Number of lanes Intersection geometry Traffic control device Lighting/weather Road condition Distraction
Speed	
Acceleration	
Steering wheel angle	
Turn signal use	

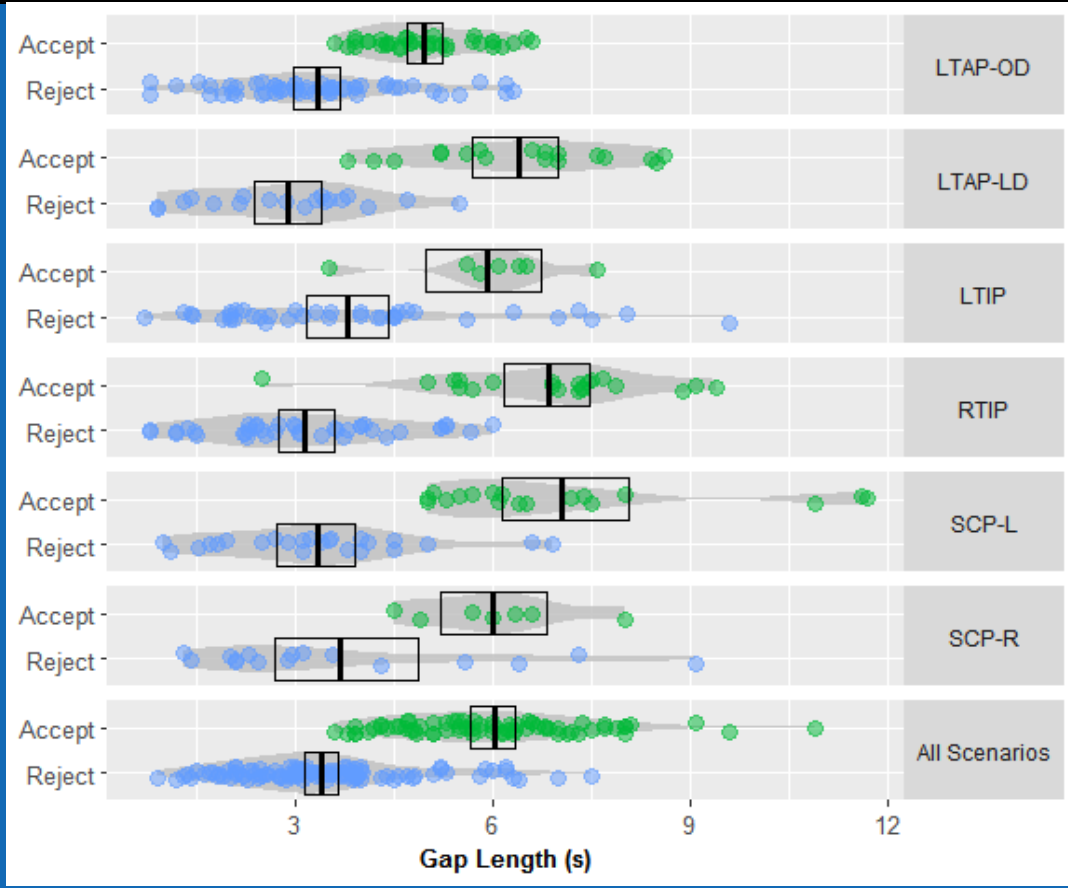
RESULTS: EVENTS PER DRIVER

Unit of analysis = the driver (averaged multiple gaps)



RESULTS: GAP LENGTHS

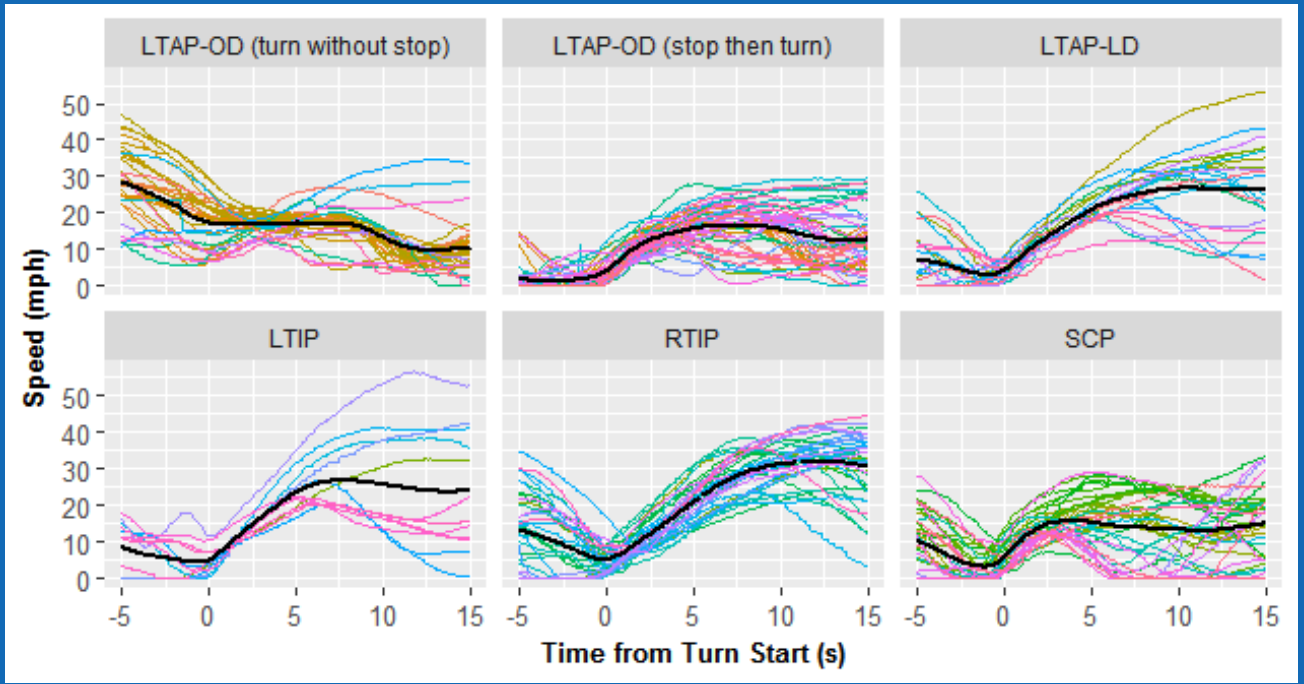
Large difference between accept/reject for all scenarios



RESULTS: SPEED THROUGH INTERSECTION

Can be cut by driver, intersection, environmental condition, etc.

Also have steering-wheel angle.



RESULTS: AGE, GENDER, & TURN SIGNAL USE

- No consistent age effects
- Men turned into smaller gaps than women (medium effect)
- Turn signal use:

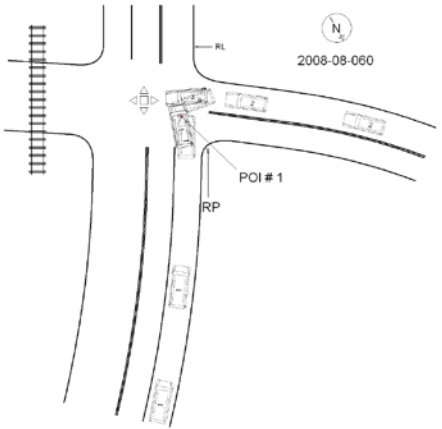
Scenario	Percentage
LTAP-OD	96 %
LTAP-LD	75 %
LTIP	50 %
RTIP	58 %
All turning scenarios	81 %

CRASH DATABASE ANALYSIS

Estimated gaps for crashes:

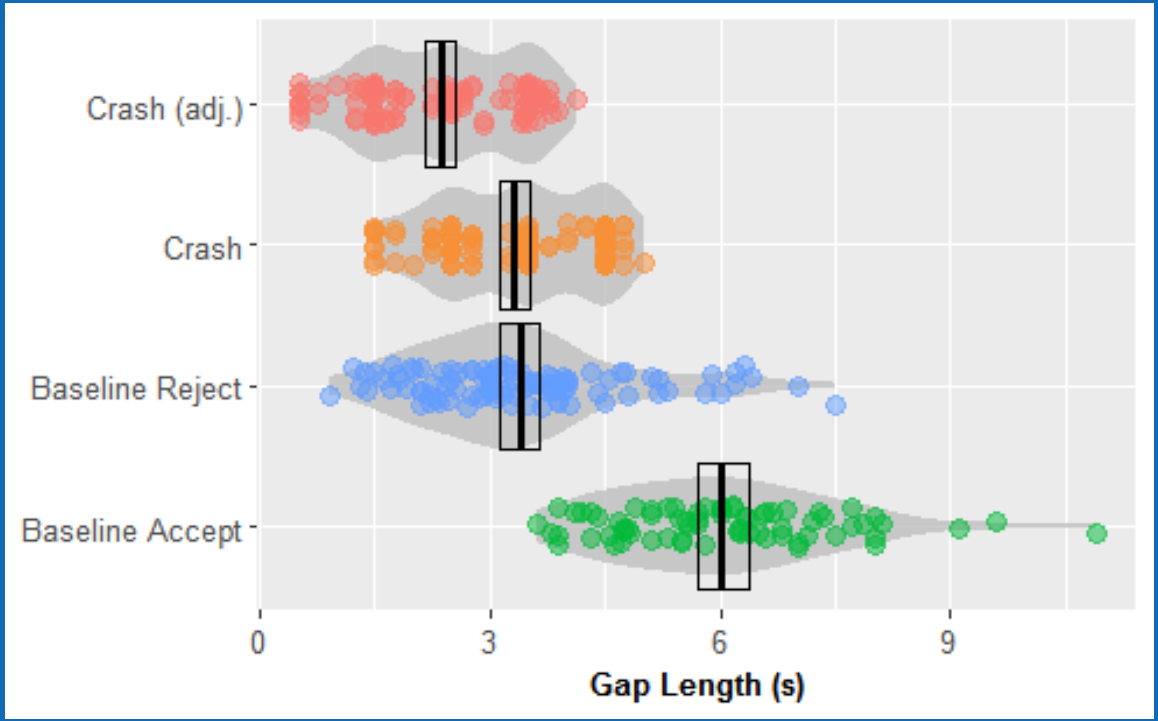
- Start = sudden throttle increase (esp. with brake release)
- End = collision / time zero

- Subtracted baseline median throttle-to-gap delay



RESULTS: GAP LENGTHS

105 crashes
(45 were LTAP-OD)



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Thank you!

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