

Field Evaluation of Red Light Running Evaluation Methods



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Purdue University

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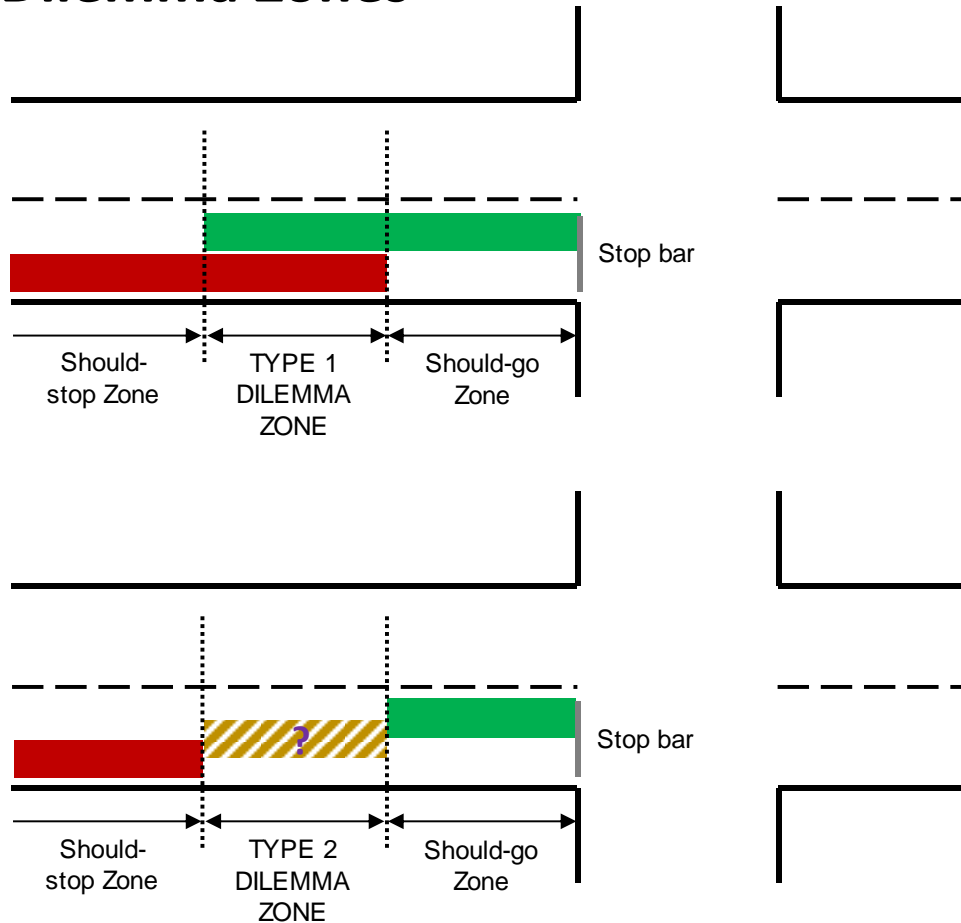
PURDUE
UNIVERSITY

Existing Red Light Running Research

- Countermeasure effectiveness vs. site selection
- Bonneson (2003): Video detection & automated camera enforcement to track red light runners
- Papaioannou (2007), Sharma et al. (2007), Lavrenz et al. (2014): Factors influencing driver behavior in dilemma zones
- Lu et al. (2015): Yellow Light Running Identification with Loop Detectors

Factors Behind Red Light Runners (RLRs)

Dilemma Zones



Distracted Driving

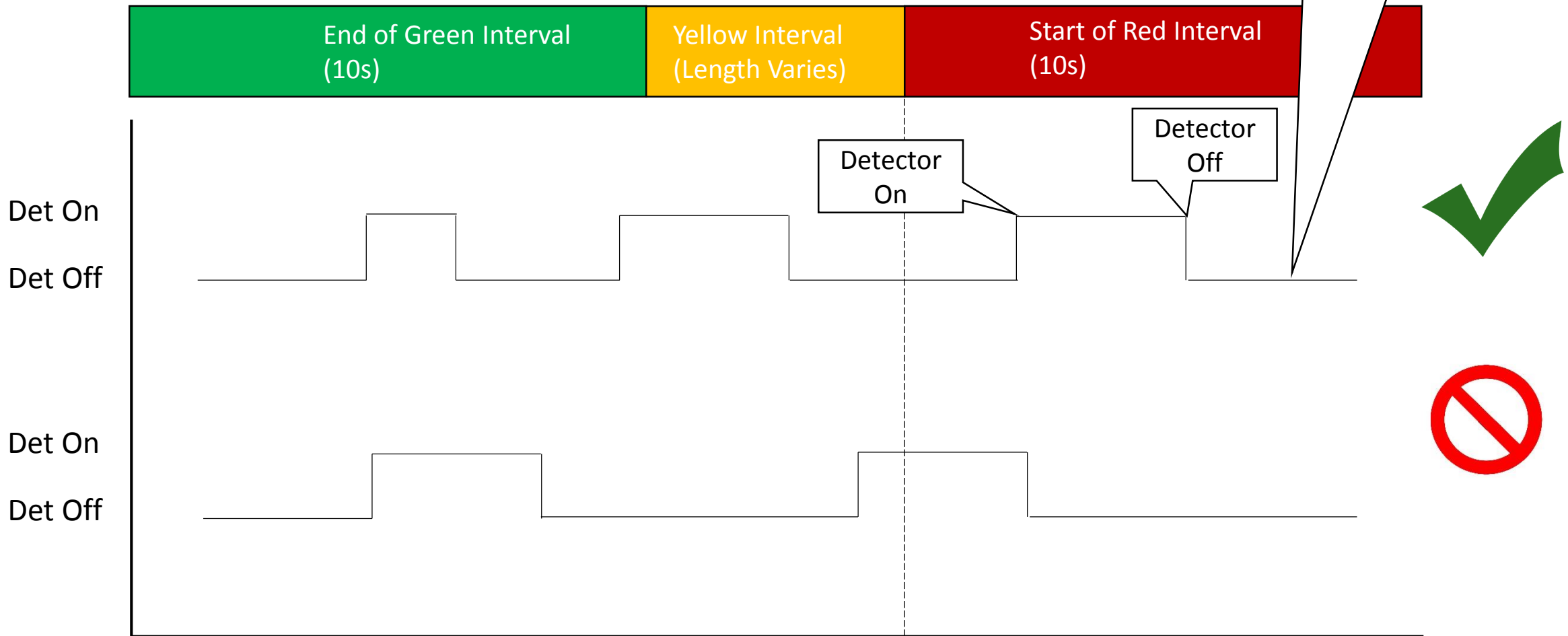
Split Failures & Other Congestion



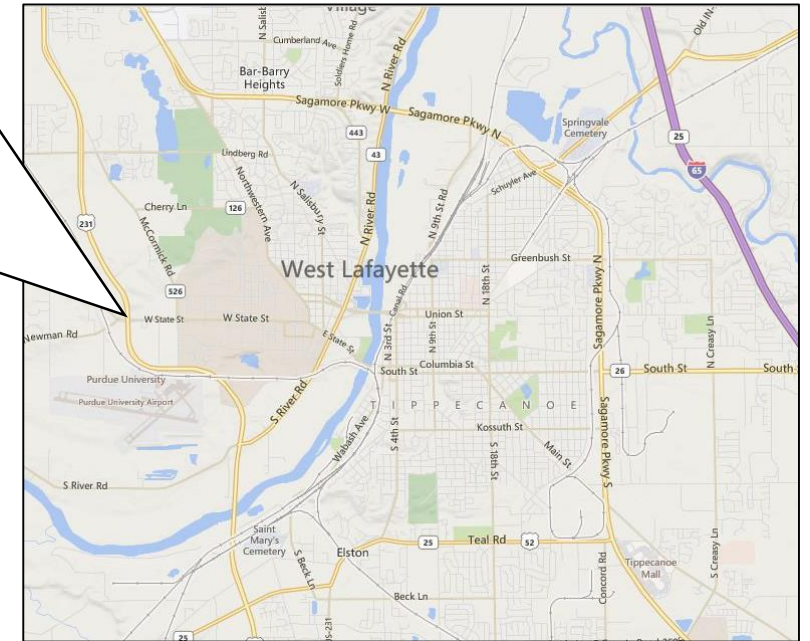
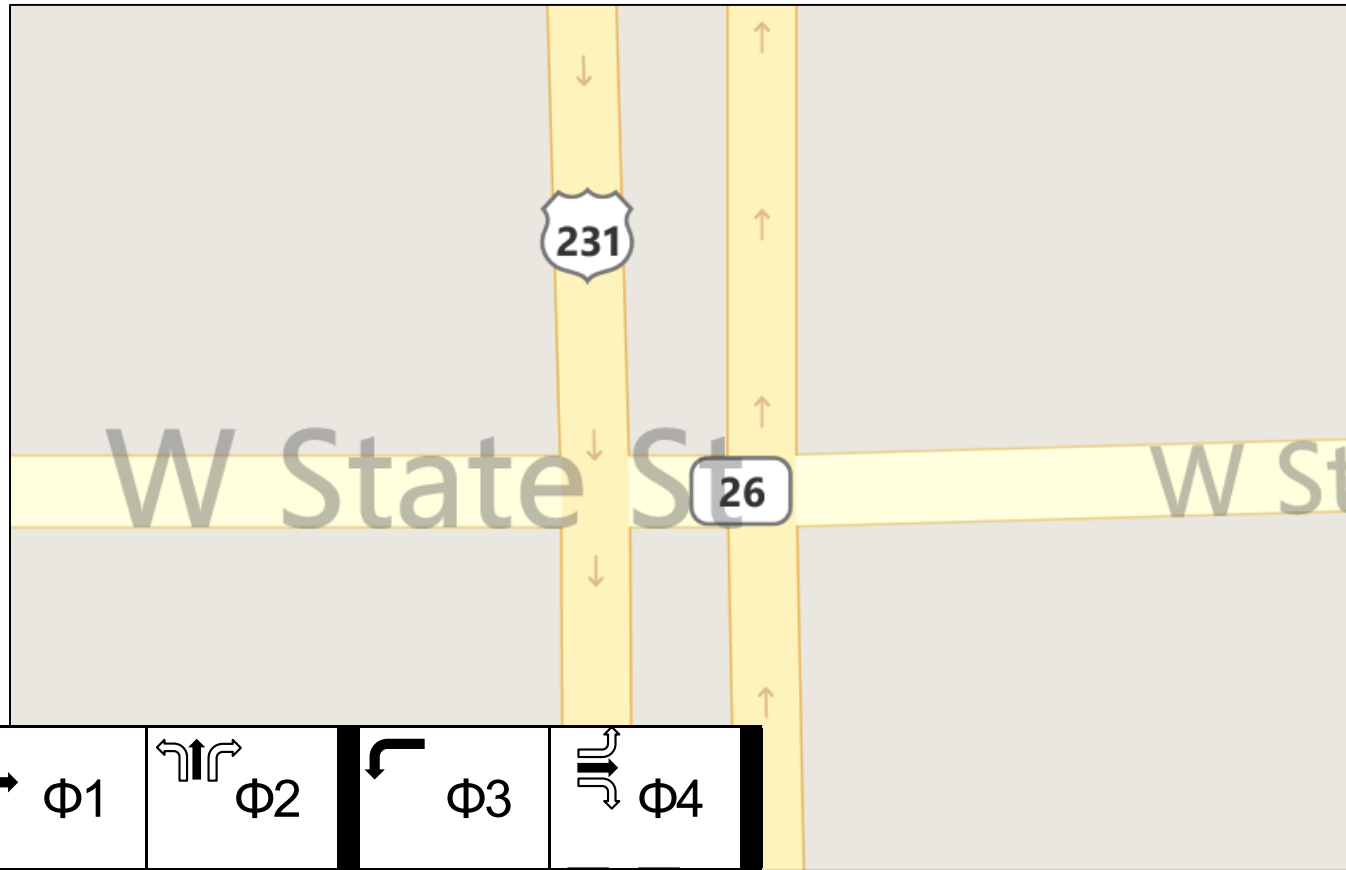
Conceptual Overview

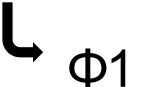
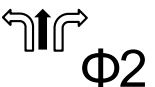

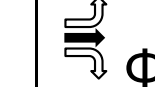



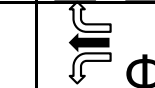
Field Evaluation of Red Light Running Evaluation Methods

Concept: How is a Red Light Runner Defined?

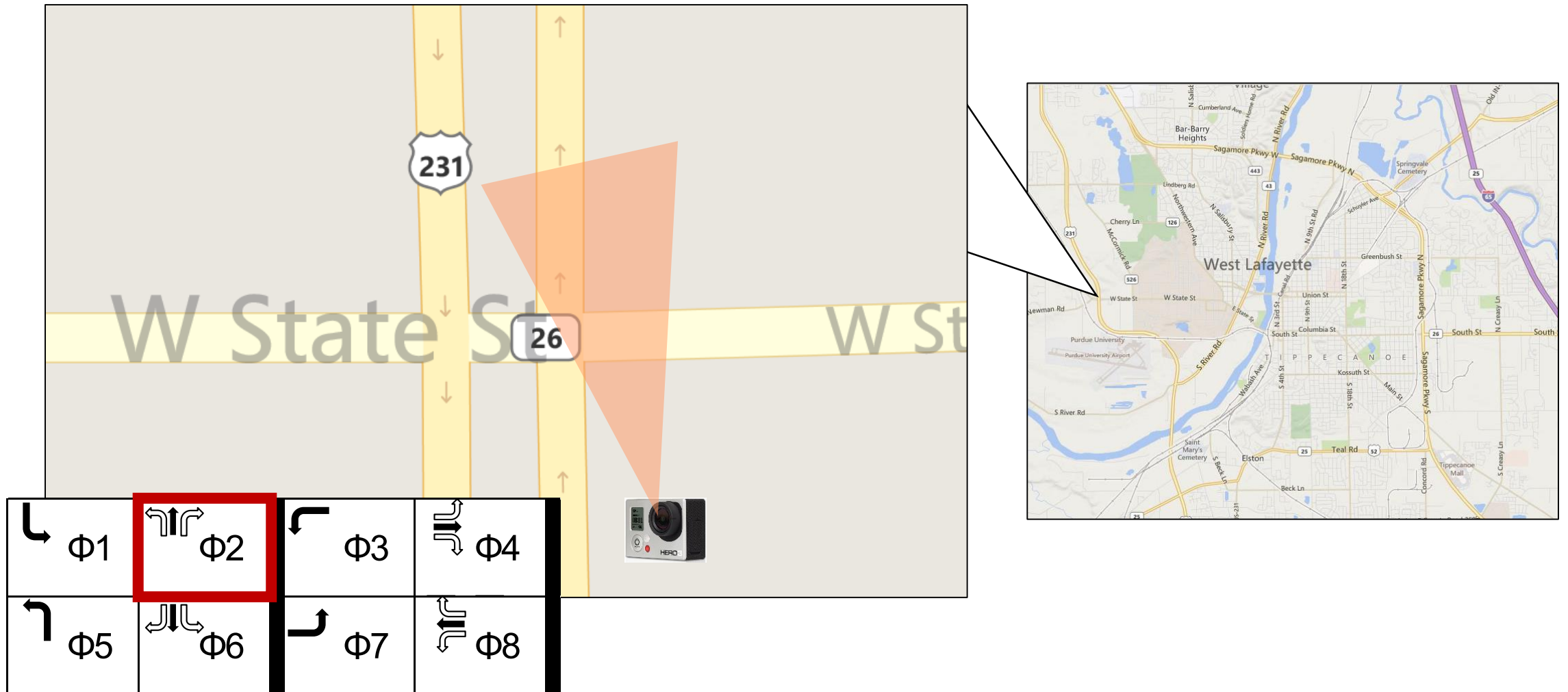


Conceptual Example: US231 & State St.



 $\Phi 1$	 $\Phi 2$	 $\Phi 3$	 $\Phi 4$
 $\Phi 5$	 $\Phi 6$	 $\Phi 7$	 $\Phi 8$

Conceptual Example: US231 & State St.



Field mounting of cameras for video recording

US231 & State St



US231 & River Rd





DET
ON

DET
OFF

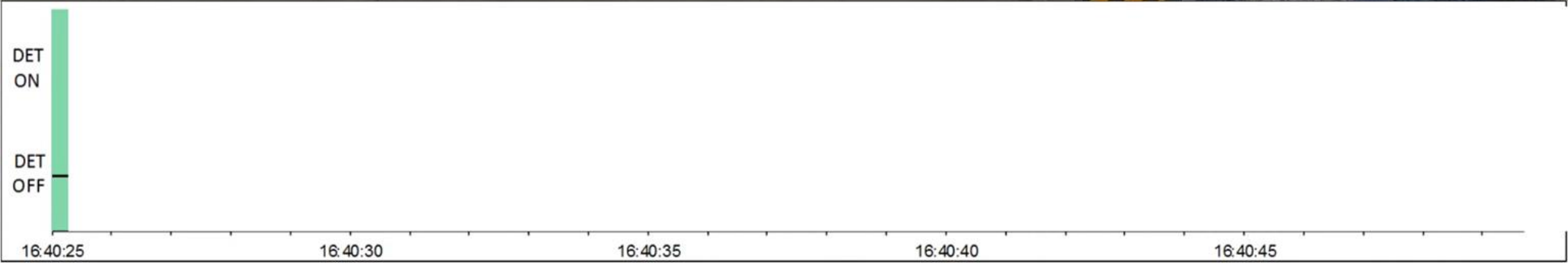
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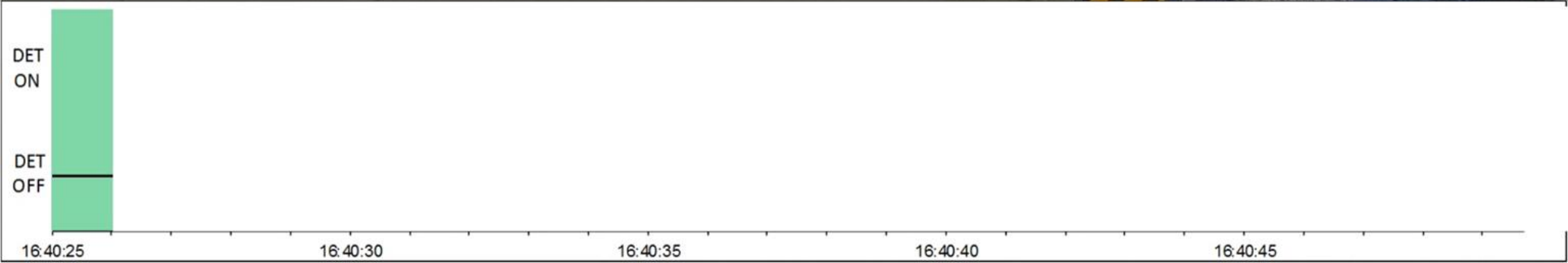
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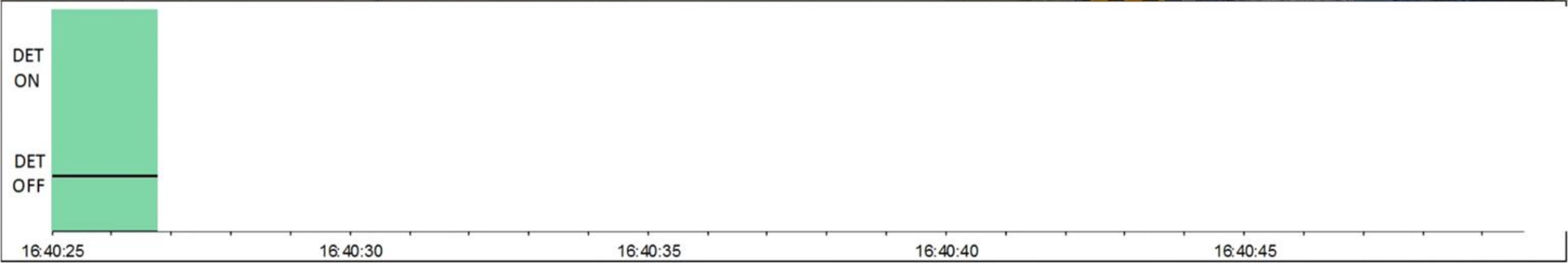
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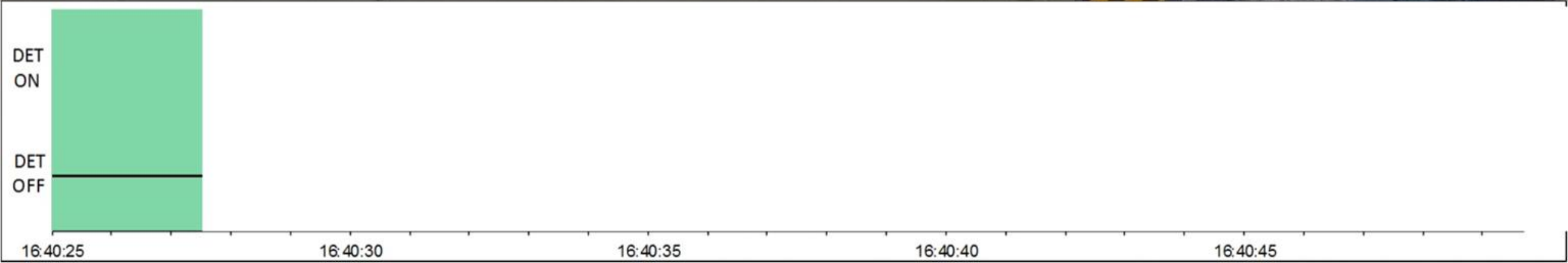
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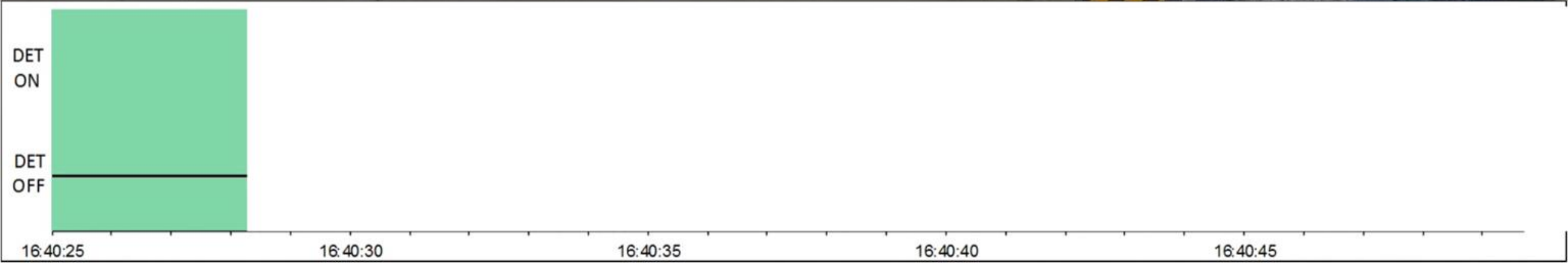
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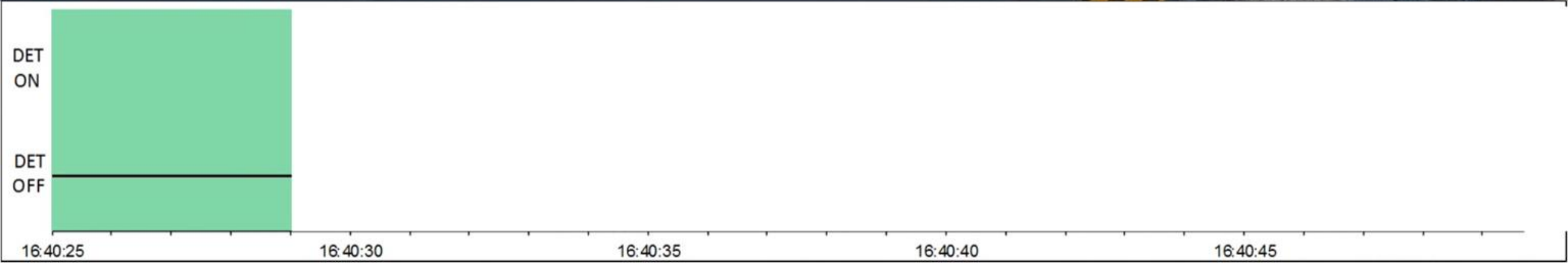






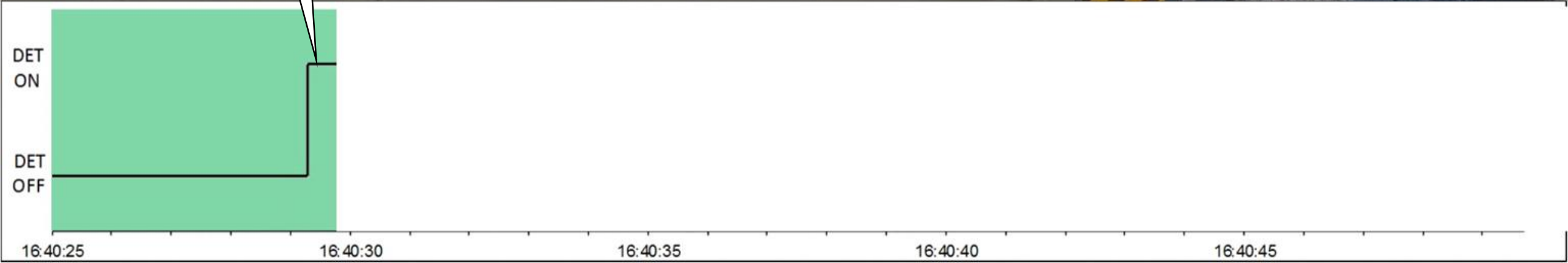


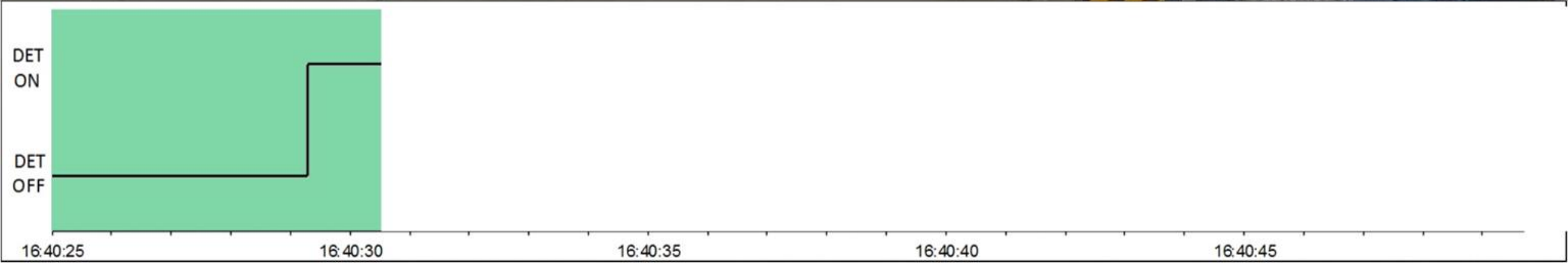






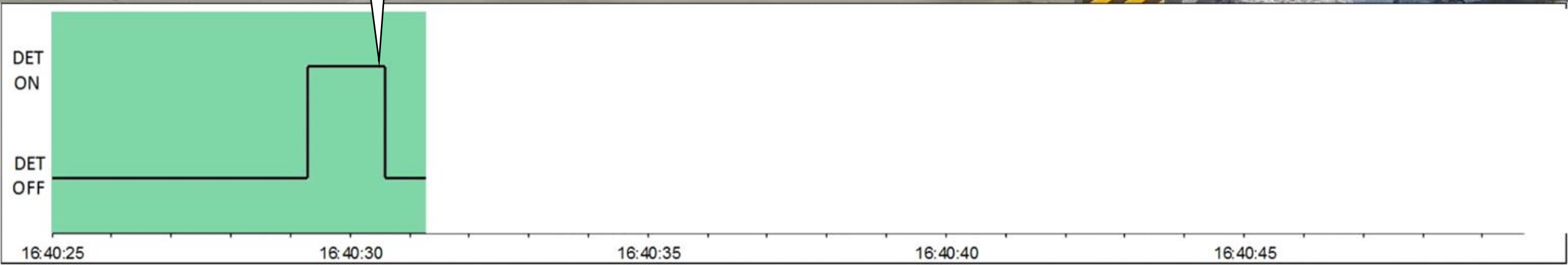
Detector Zone
Occupied

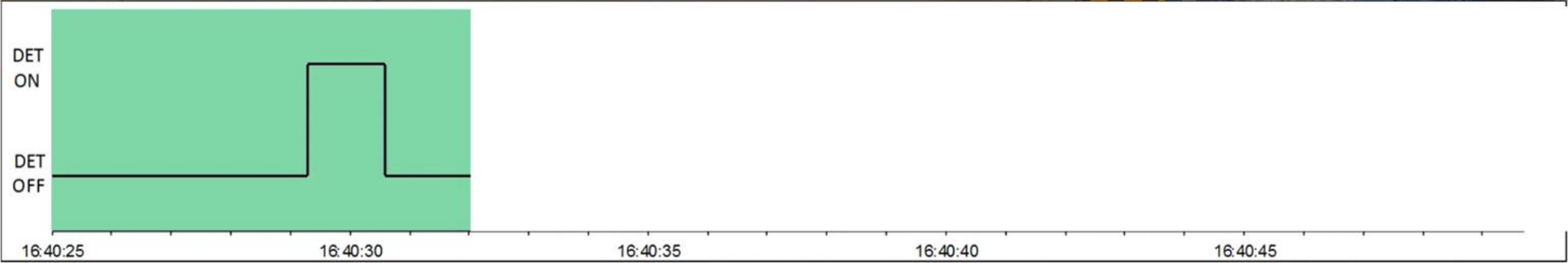


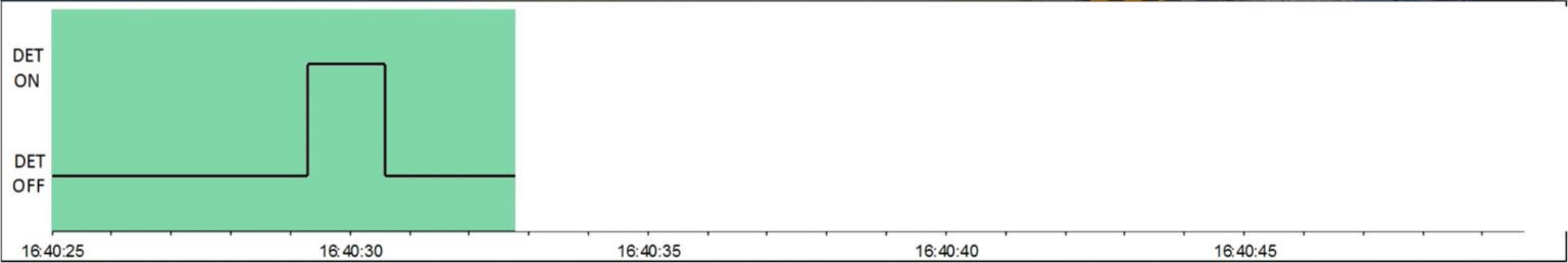


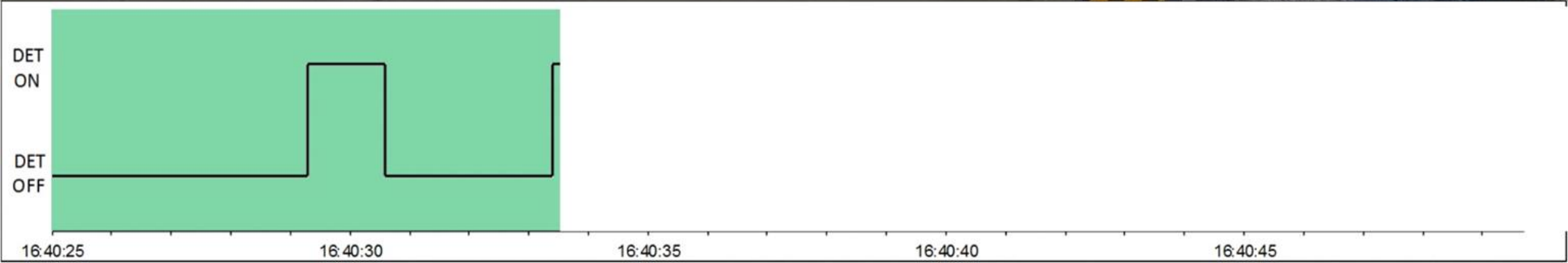


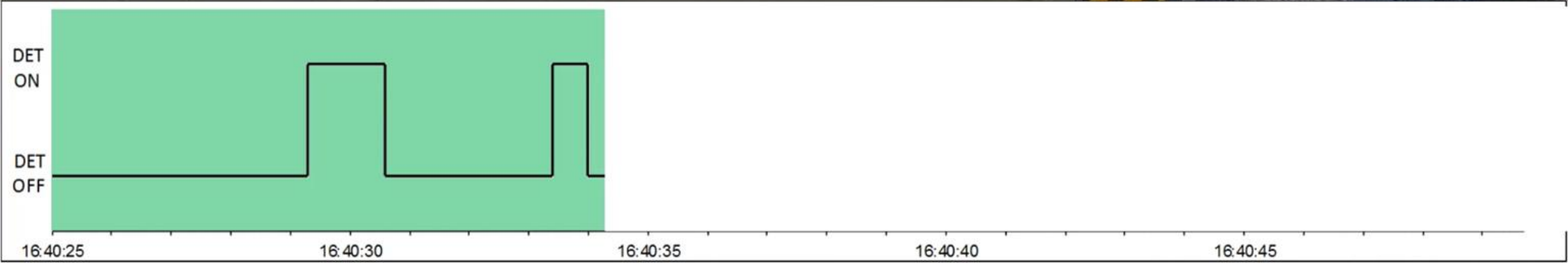
Detector Zone
Unoccupied

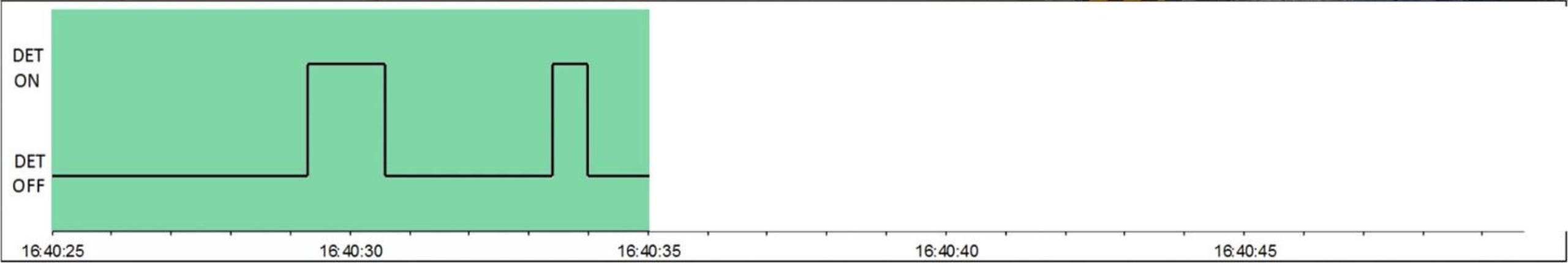






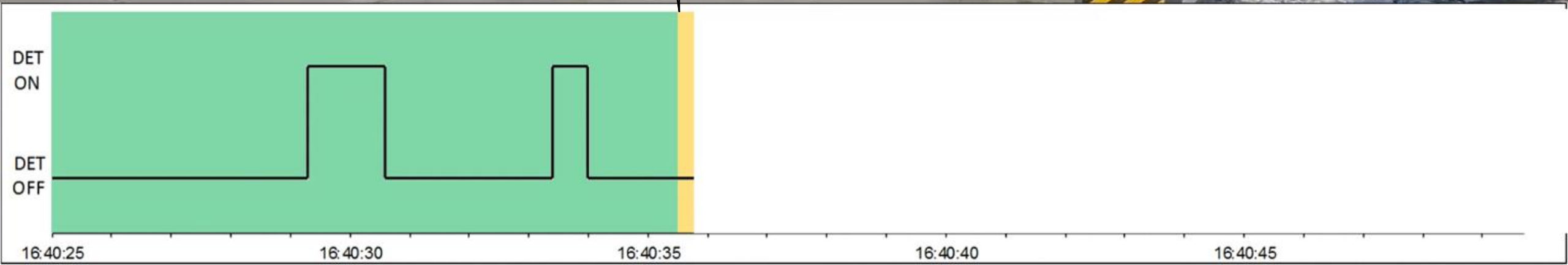


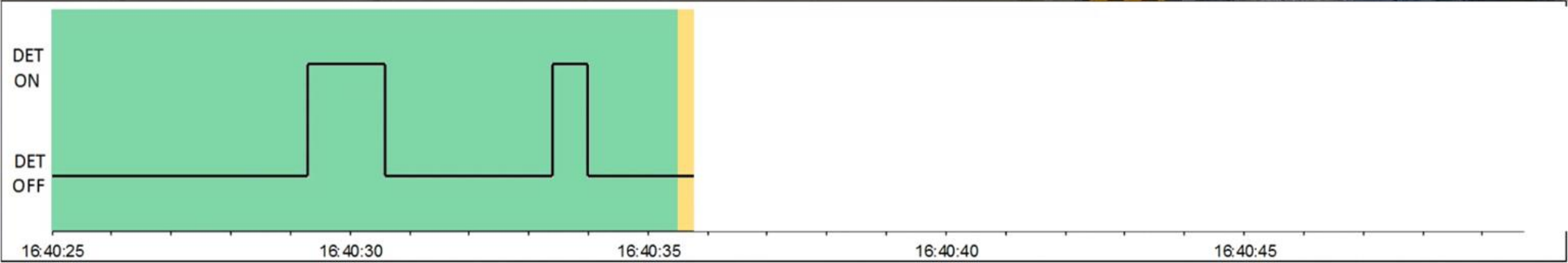


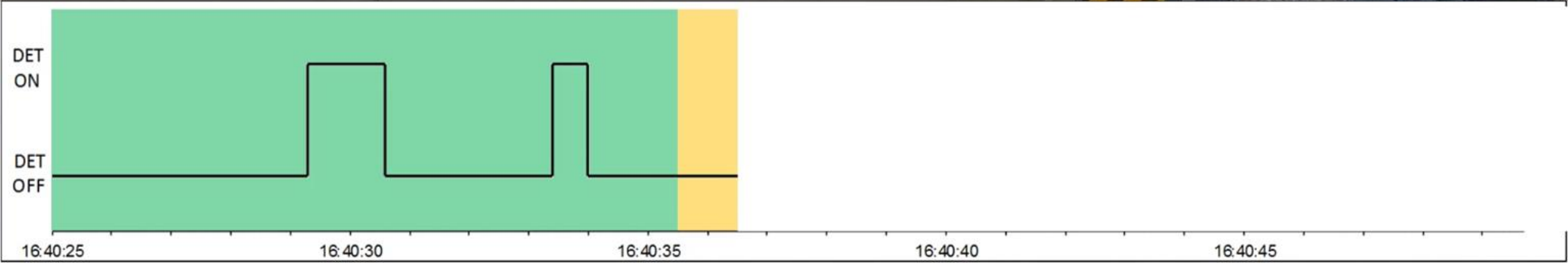


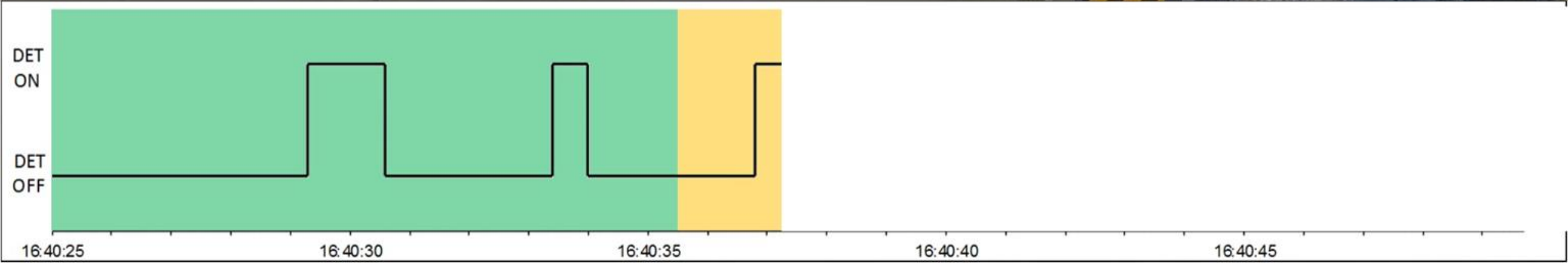
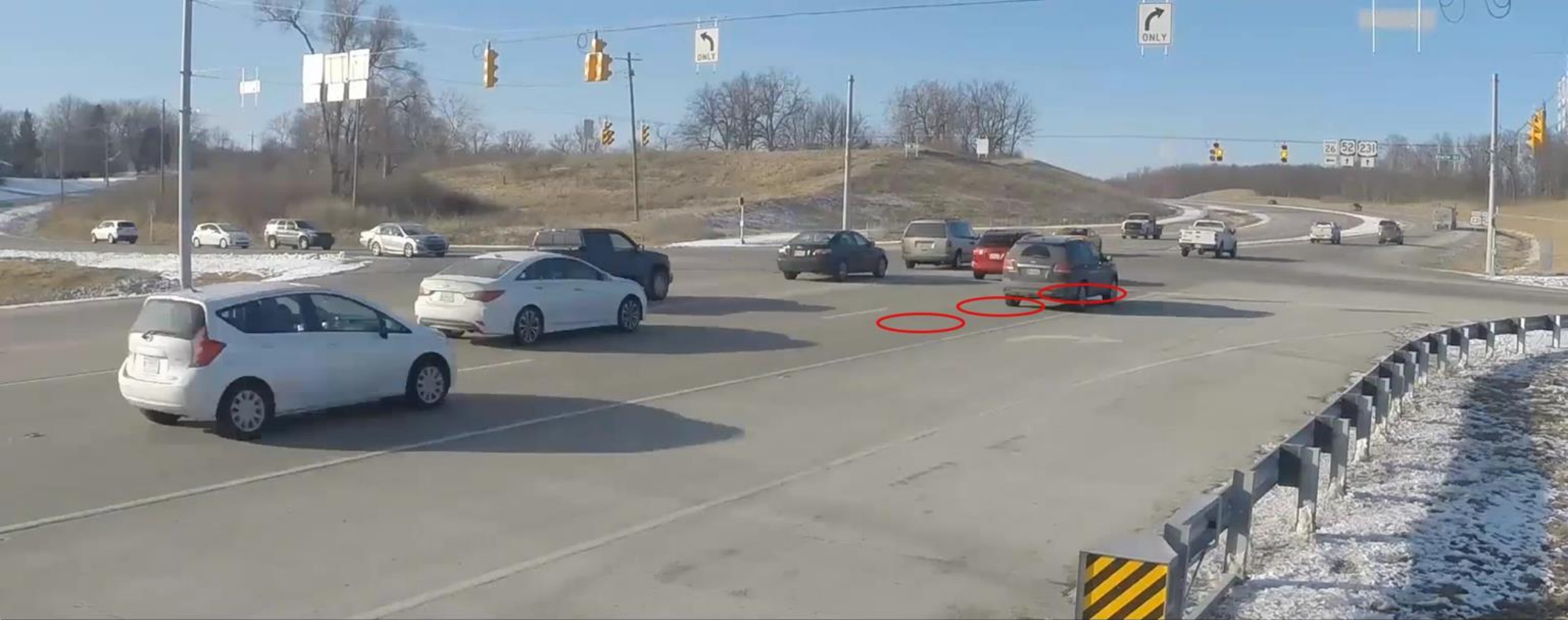


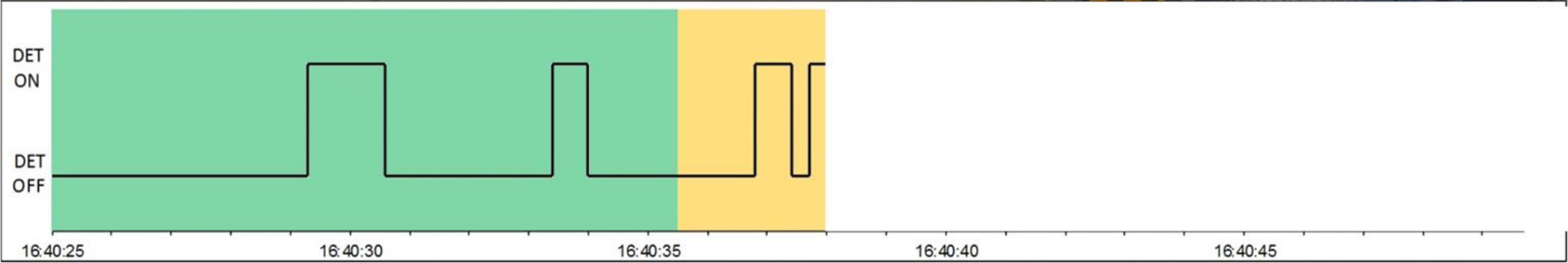
Start of Yellow

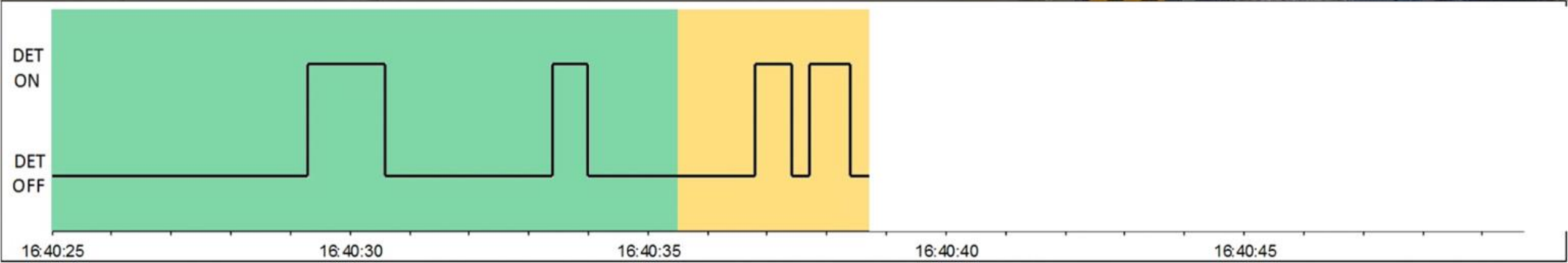


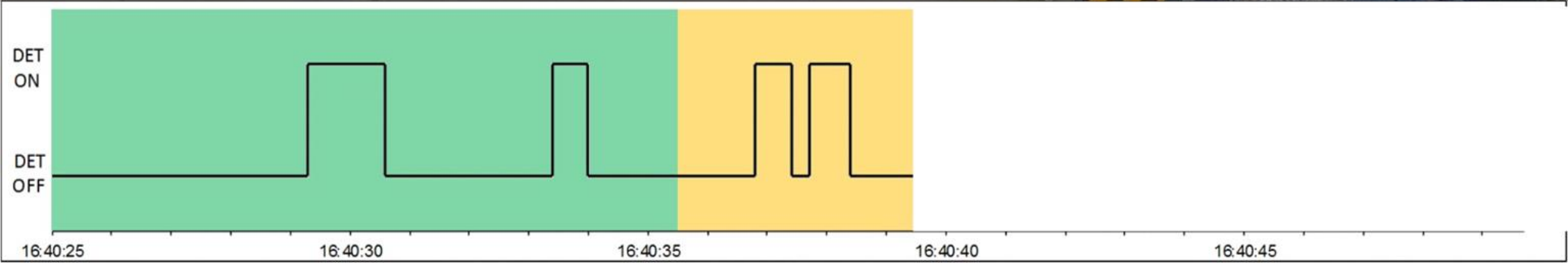


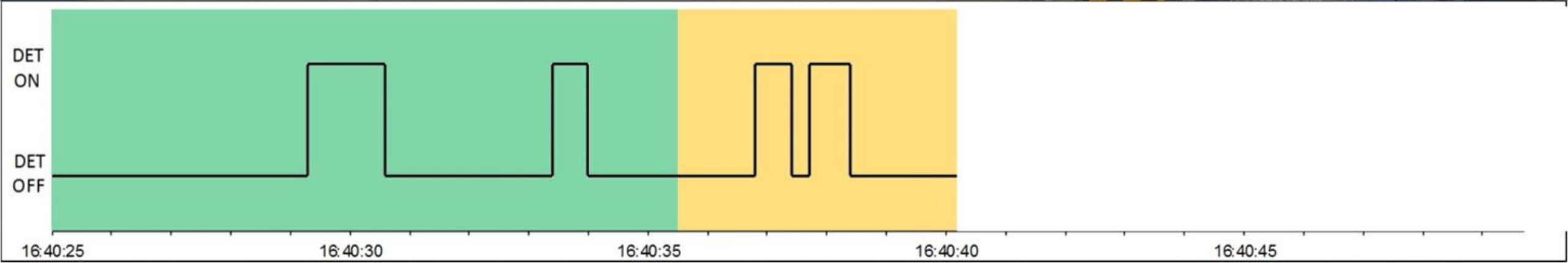


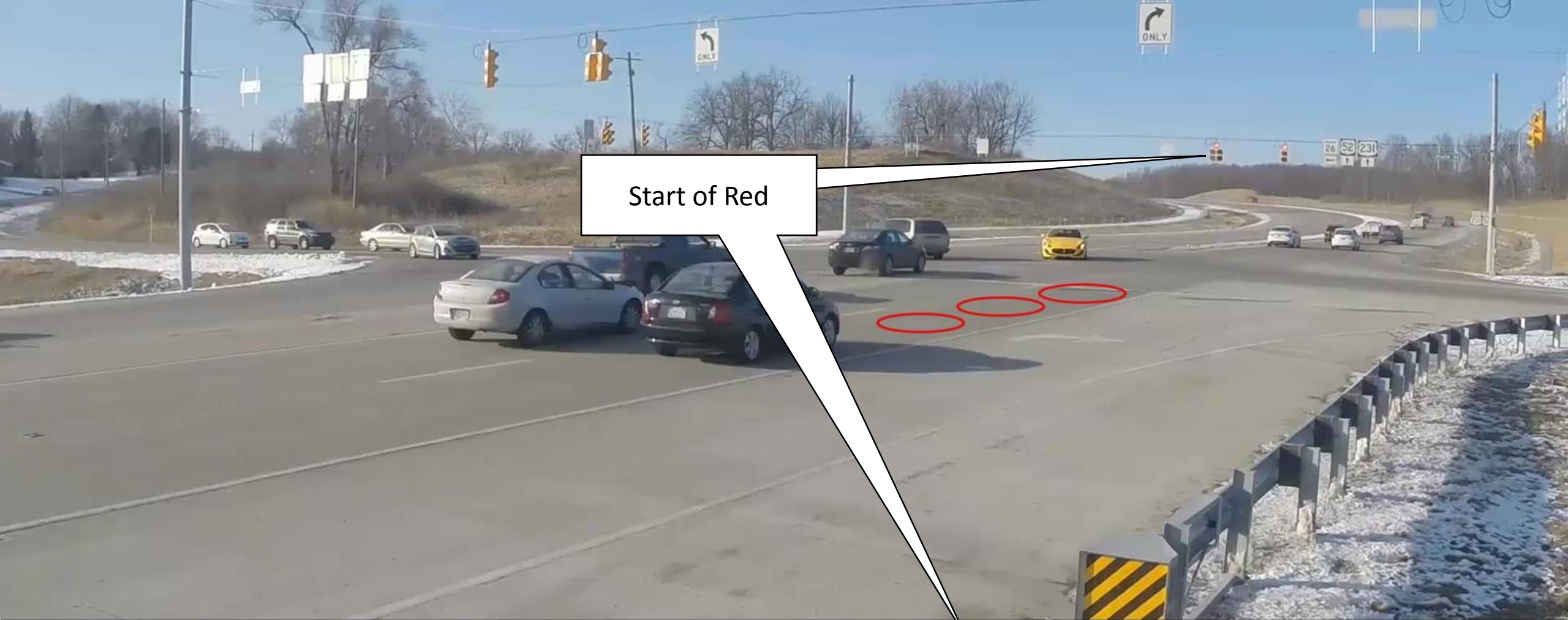




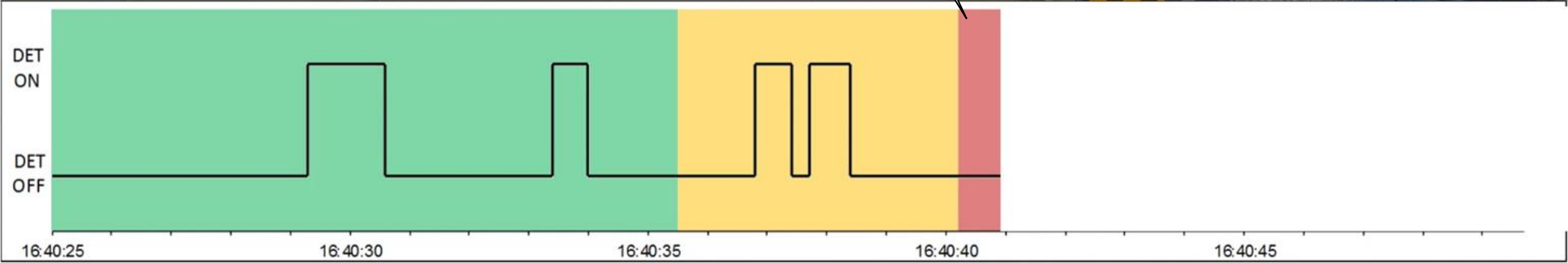


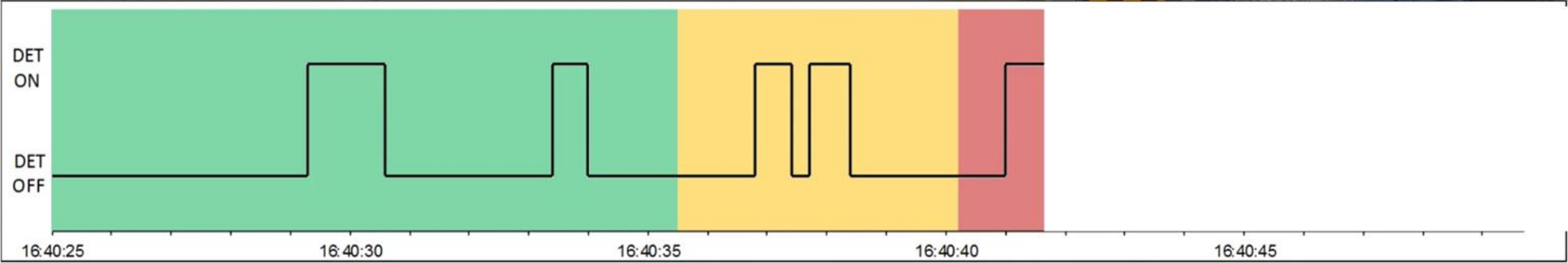


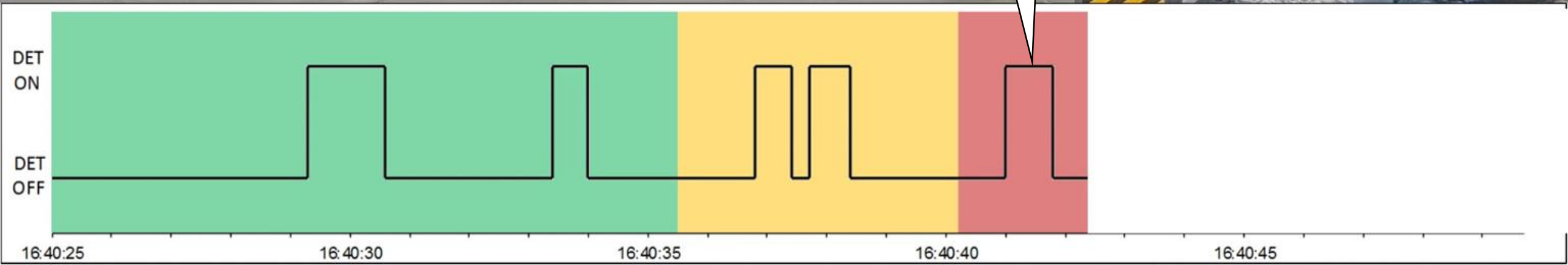


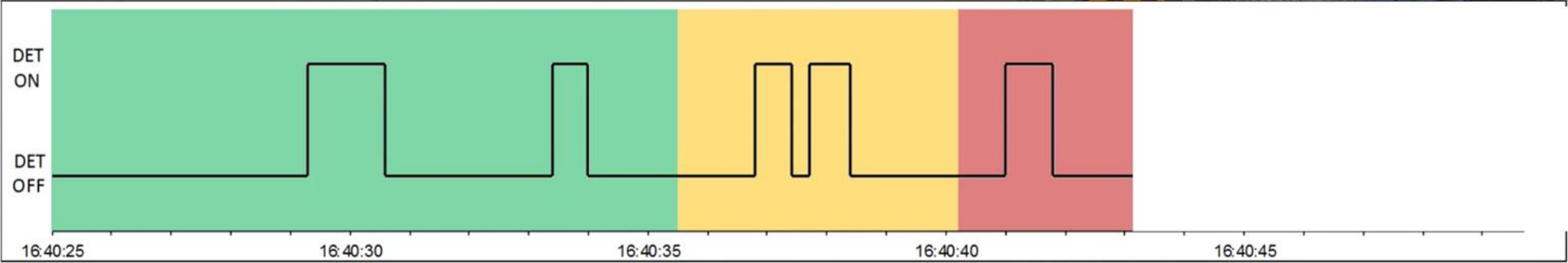


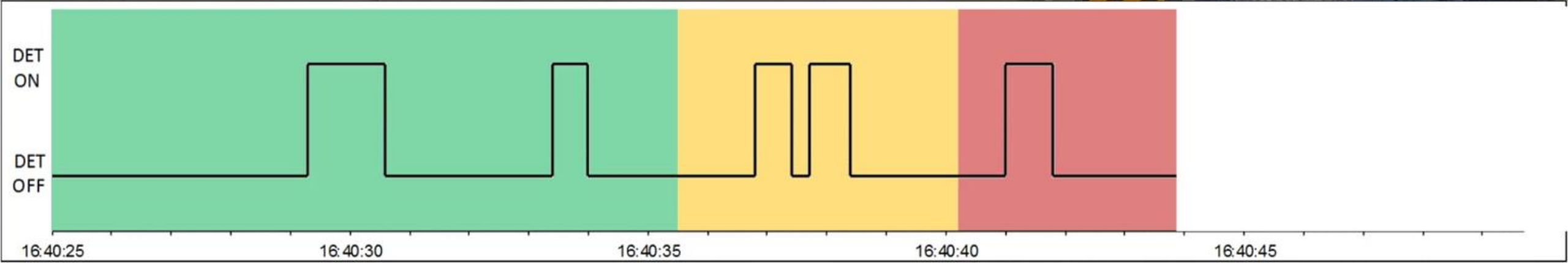
Start of Red

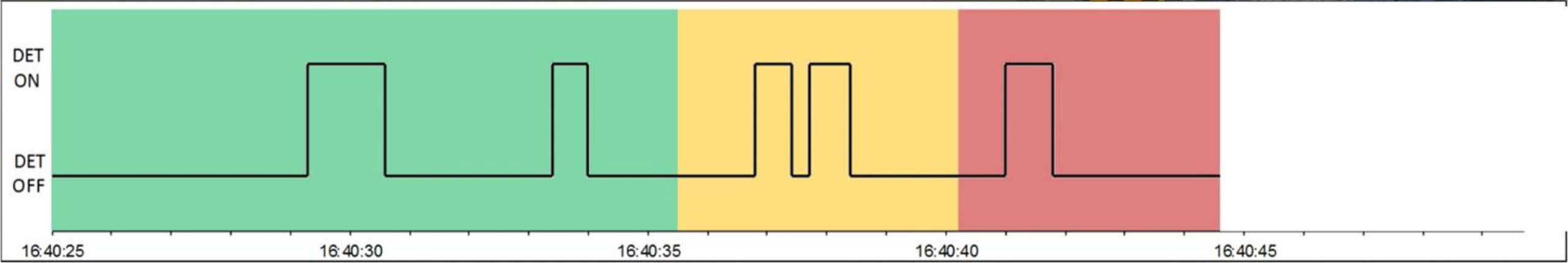


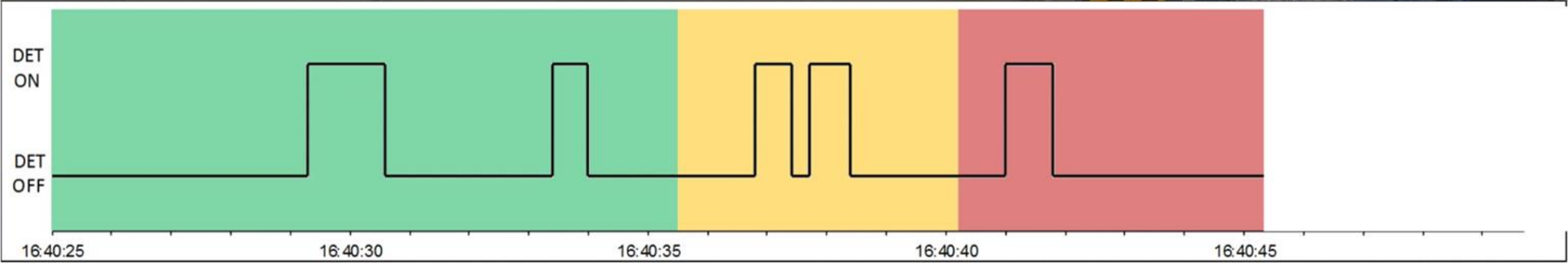


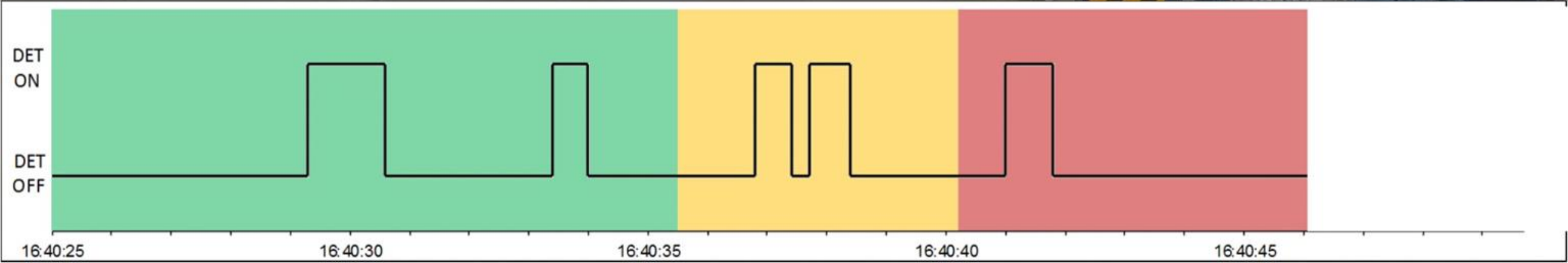


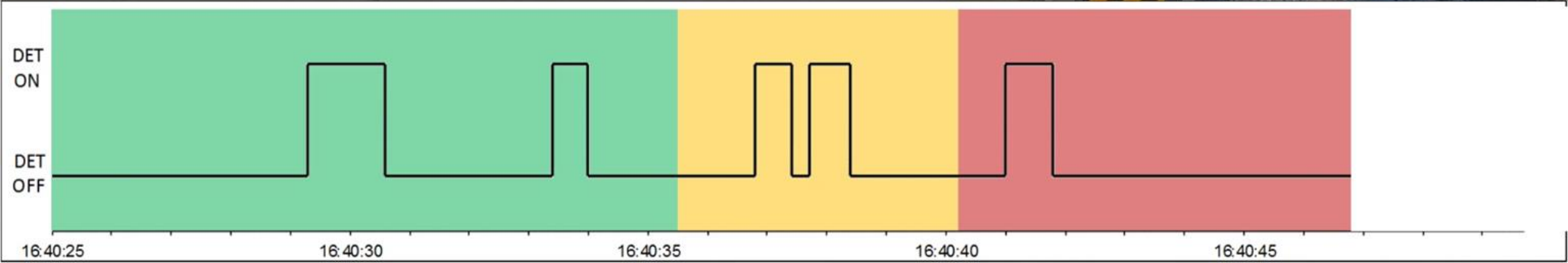


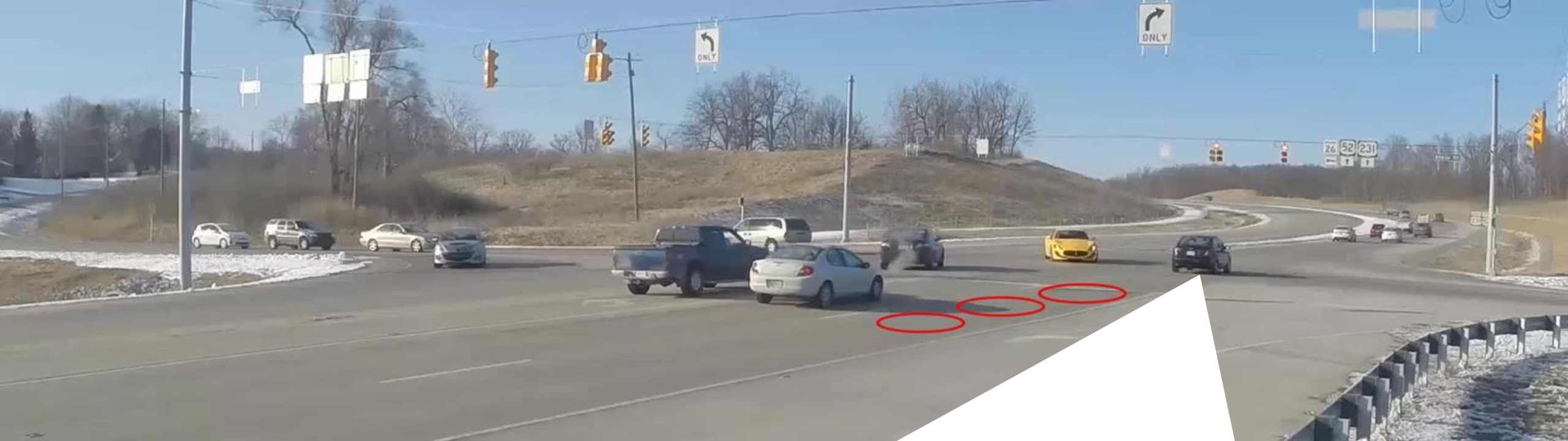




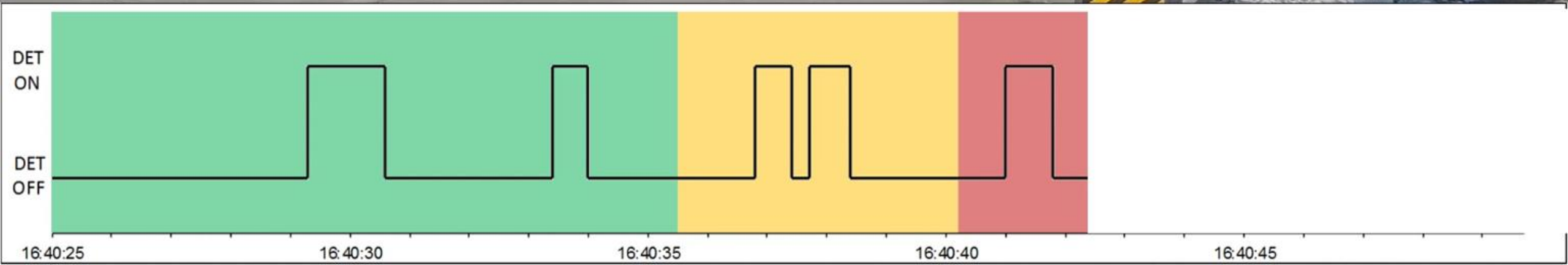




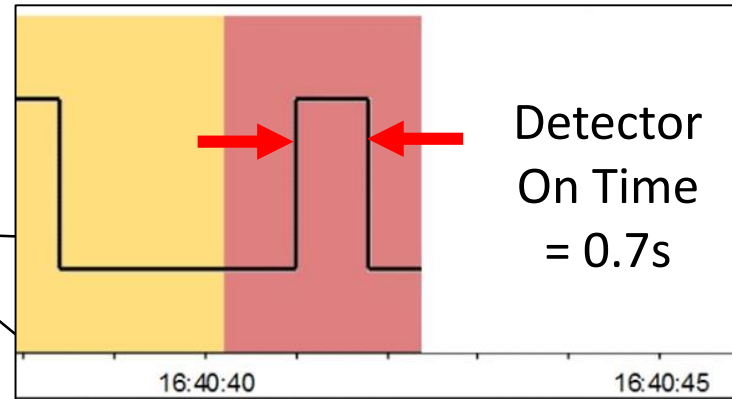
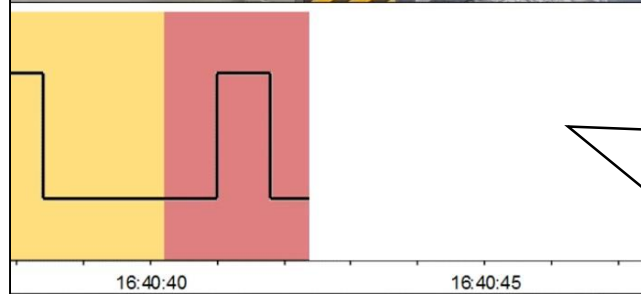
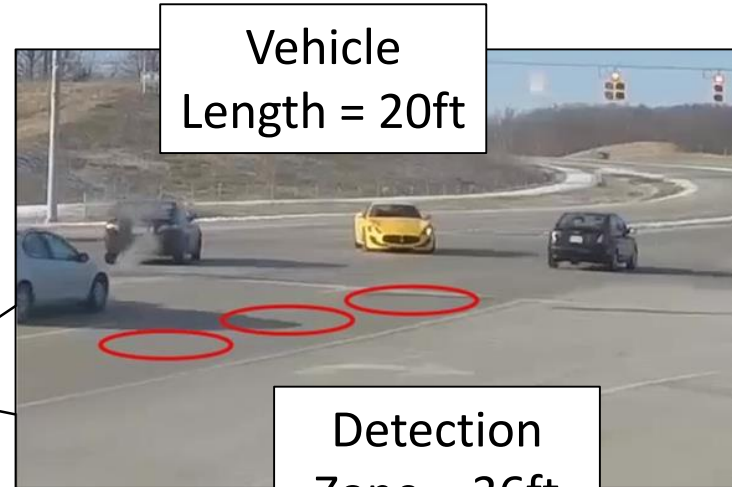




Estimating RLR Driver Speed through the Intersection



Estimating RLR Vehicle Speed through the Intersection

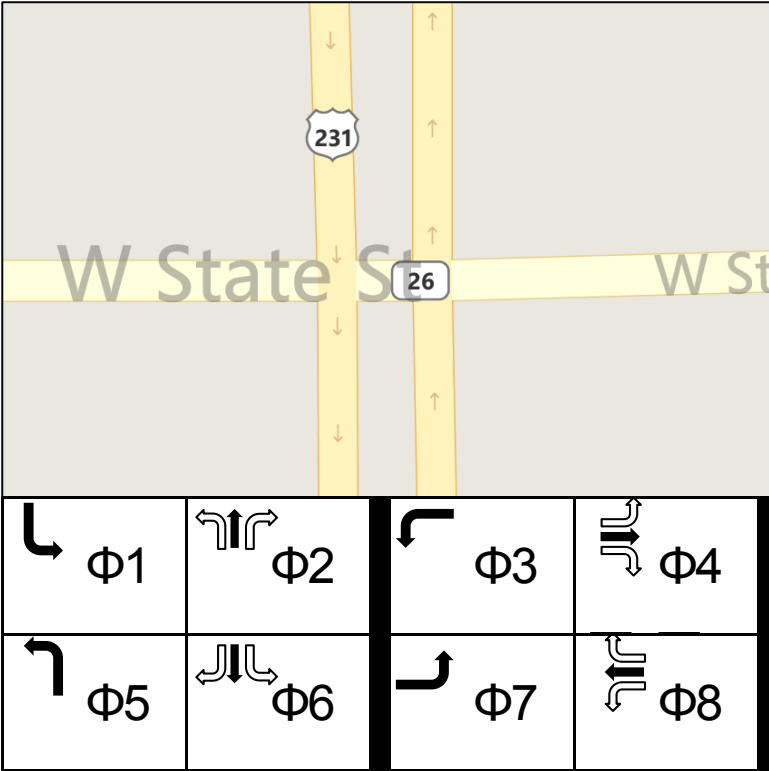
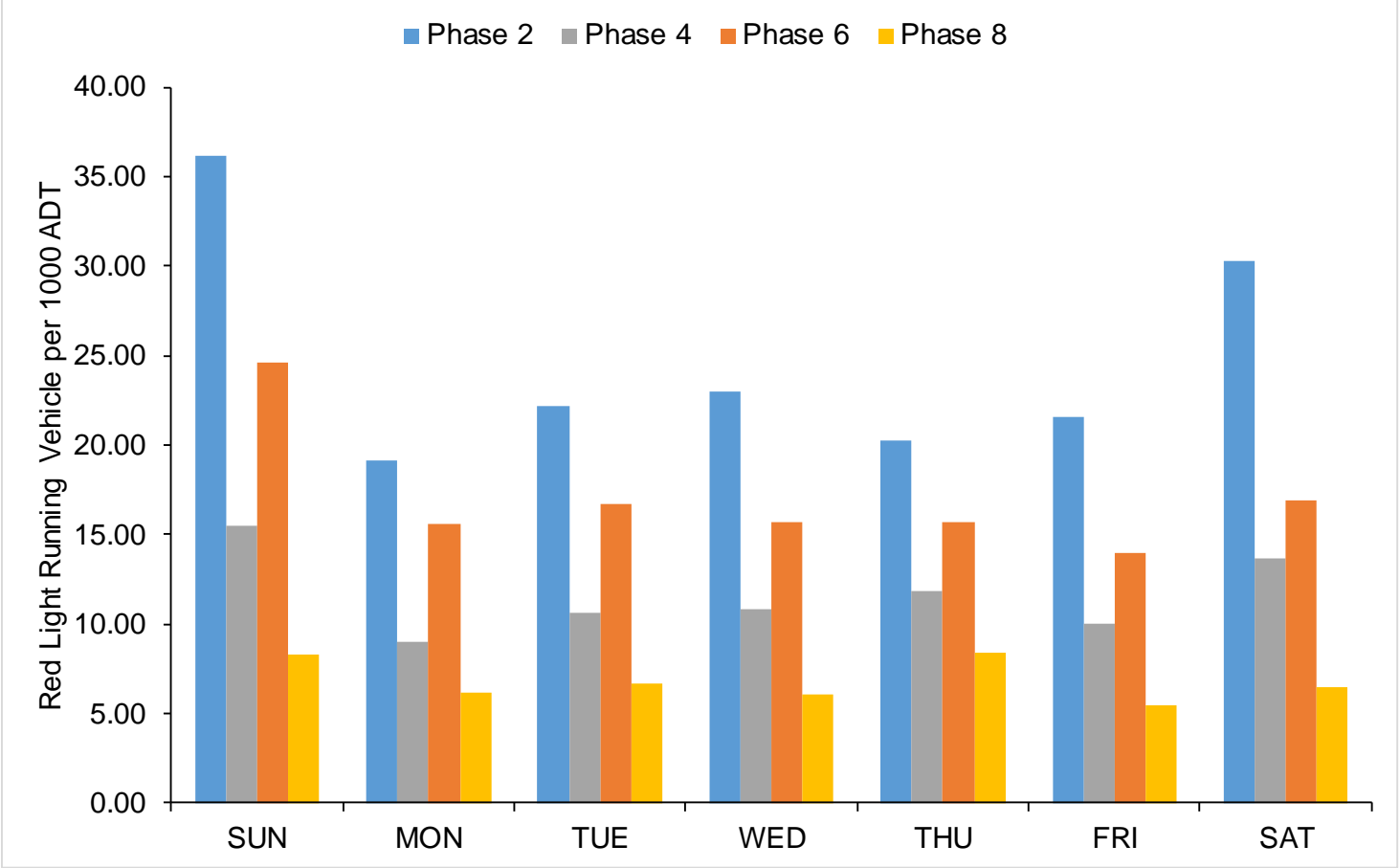


$$\begin{aligned} \text{RLR Vehicle Speed} &= \frac{\text{Distance}_{\text{Det On}}}{\text{Time}_{\text{Det On}}} \\ &= \frac{(20\text{ft} + 36\text{ft}) * \frac{1 \text{ mile}}{5,280\text{ft}}}{(0.7\text{s}) * \frac{1 \text{ hr}}{3,600\text{s}}} \\ &= \mathbf{54.5 \text{ mph}} \end{aligned}$$

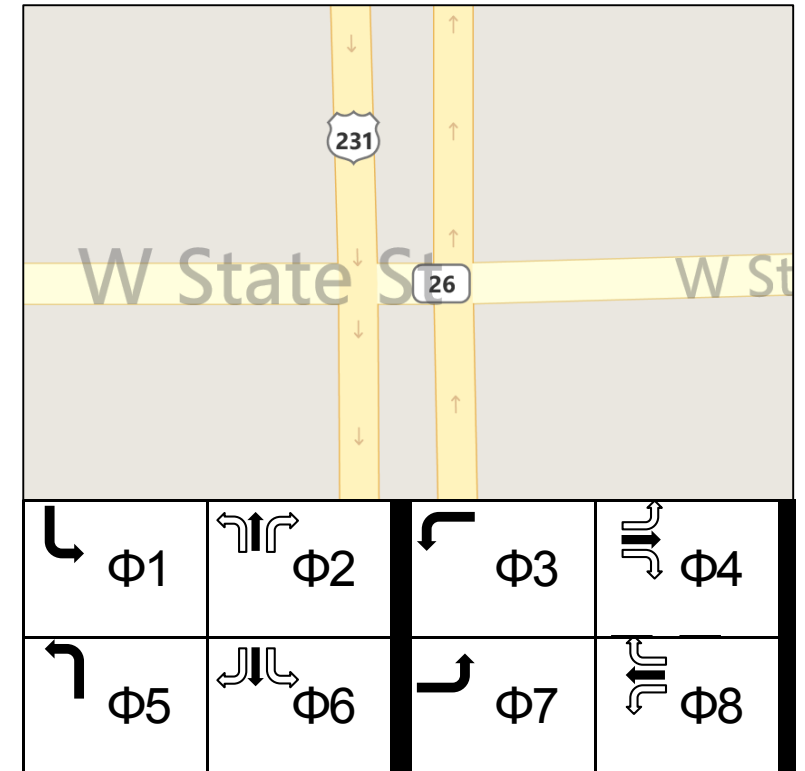
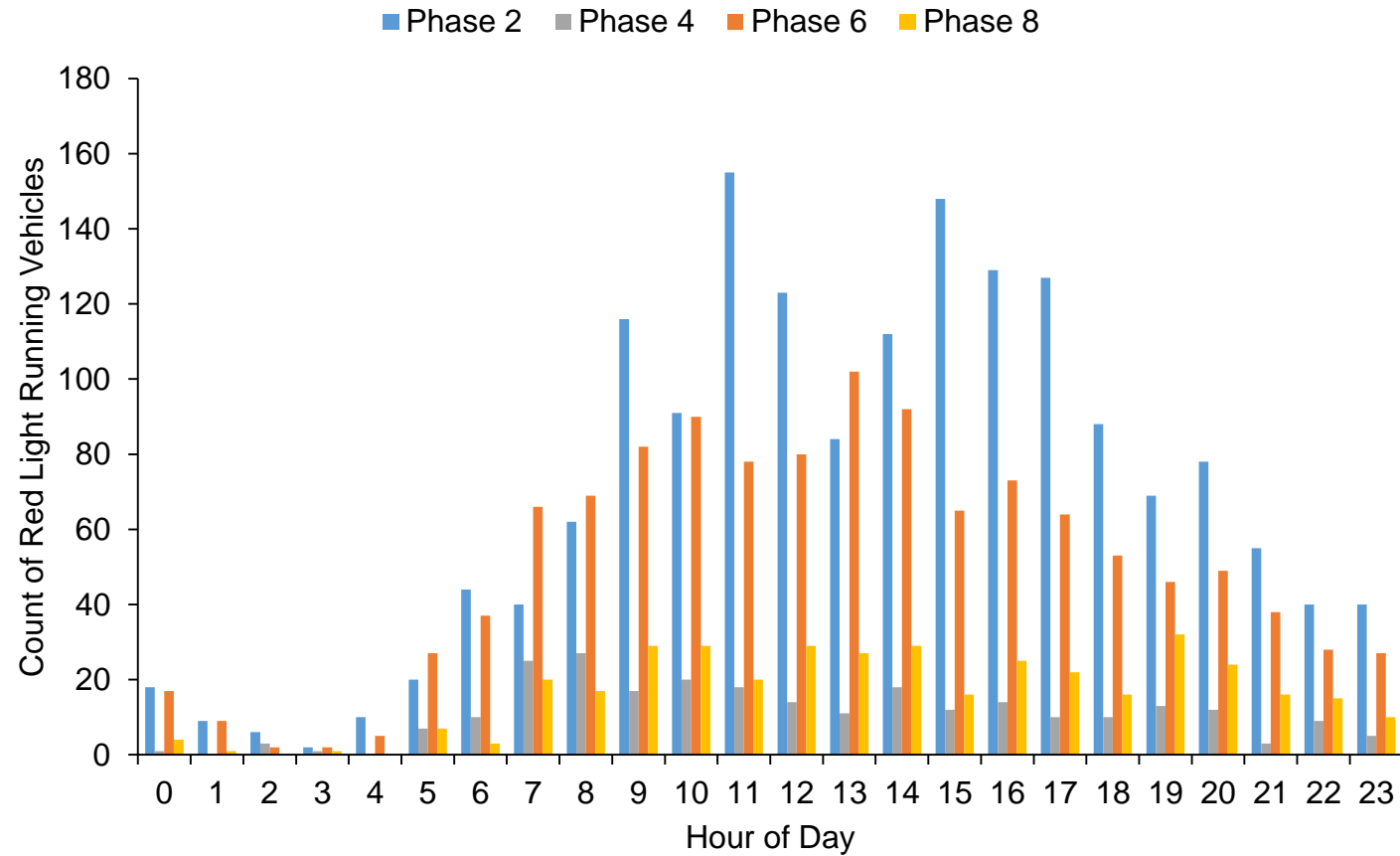
US 231 & State St. Patterns & Trends

Field Evaluation of Red Light Running Evaluation Methods

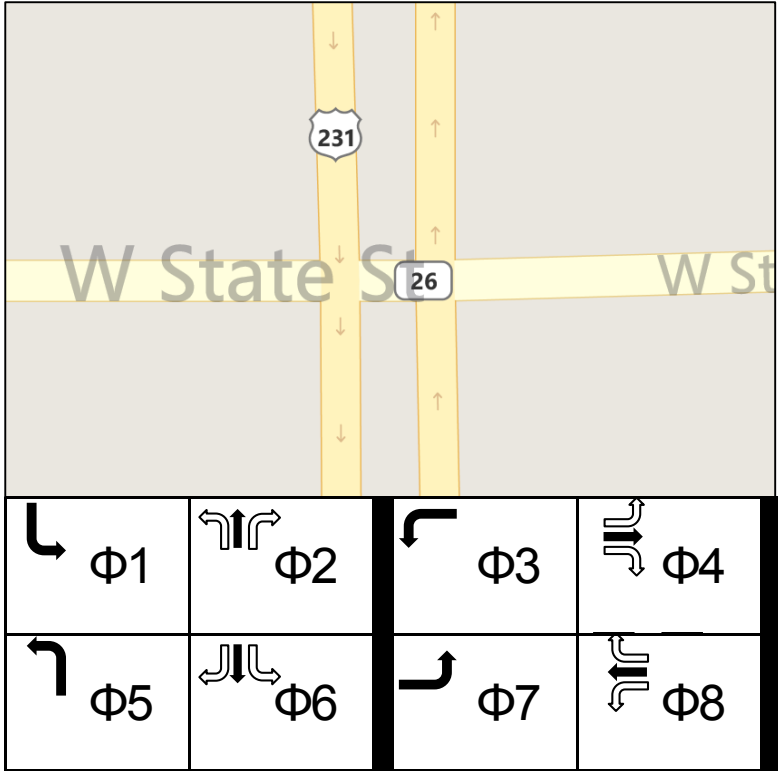
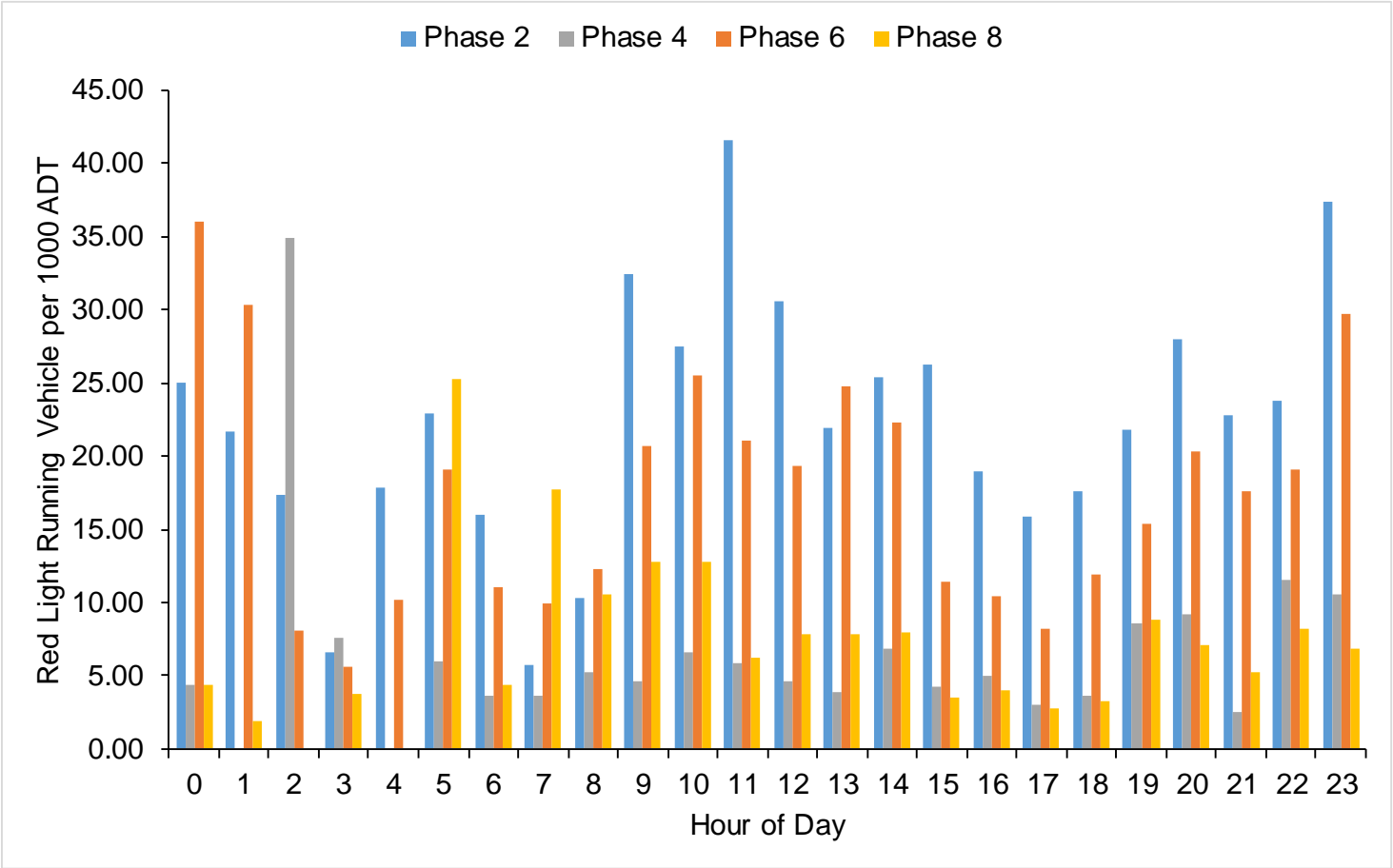
Normalized RLR Distribution by Day of Week



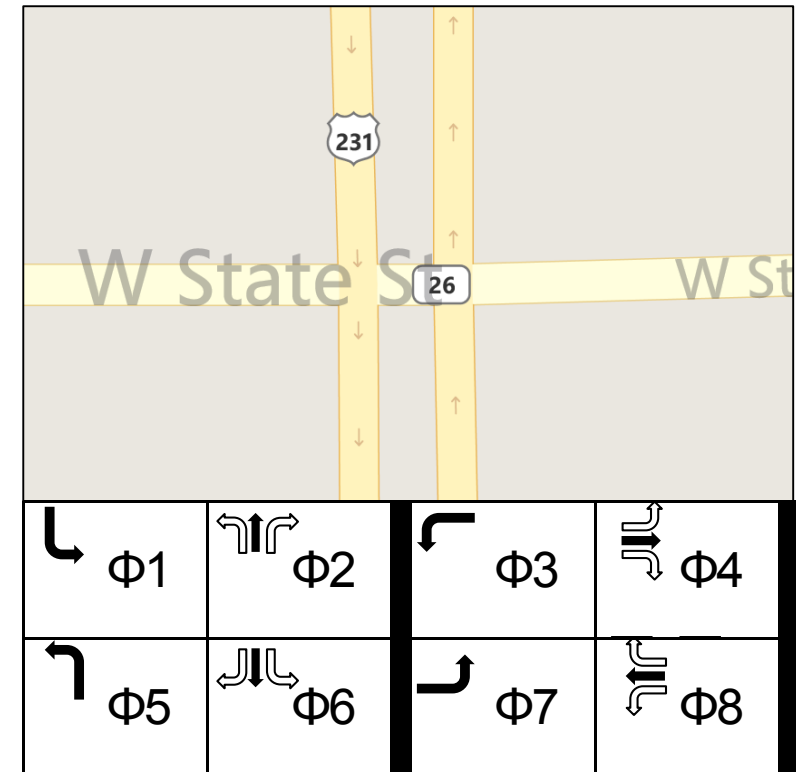
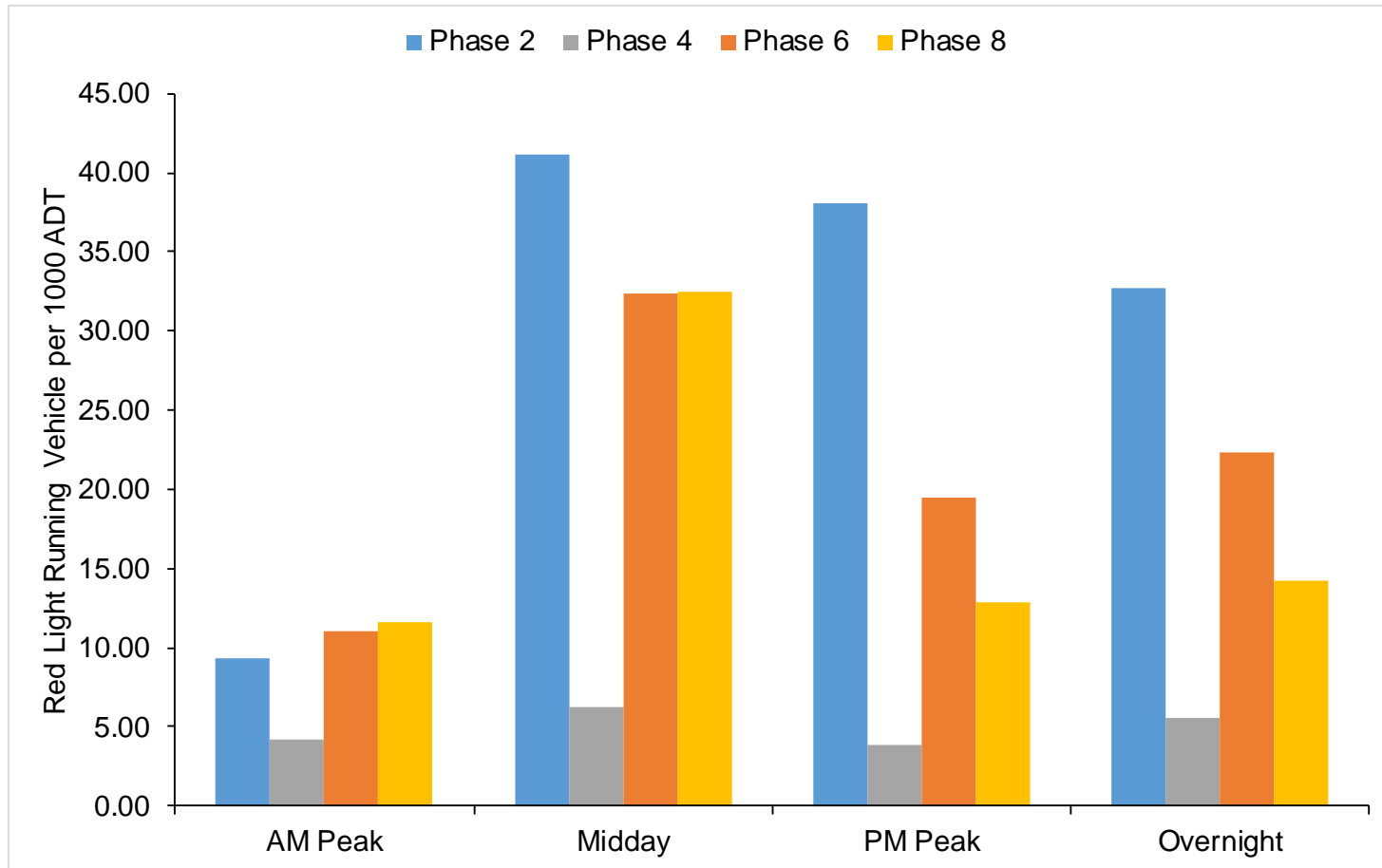
RLR Distribution by Hour of Day



Normalized RLR Distribution by Hour of Day



Normalized RLR Distribution by Timing Plan



Benefits & Case Study Uses

Field Evaluation of Red Light Running Evaluation Methods

Statewide High Resolution Signal Ranking



- Approximately 140 signals in Indiana with hi-res data
- Opportunities for targeted law enforcement
- Safety countermeasure screening

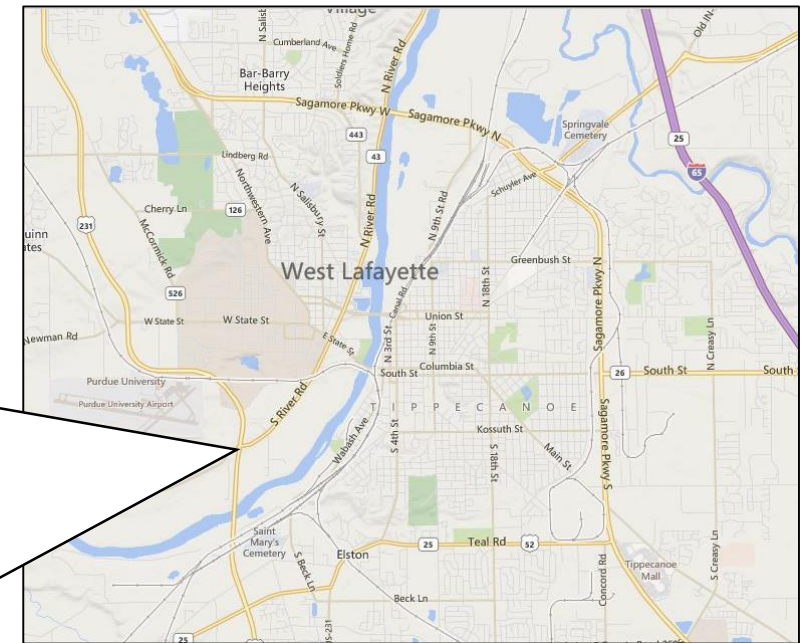
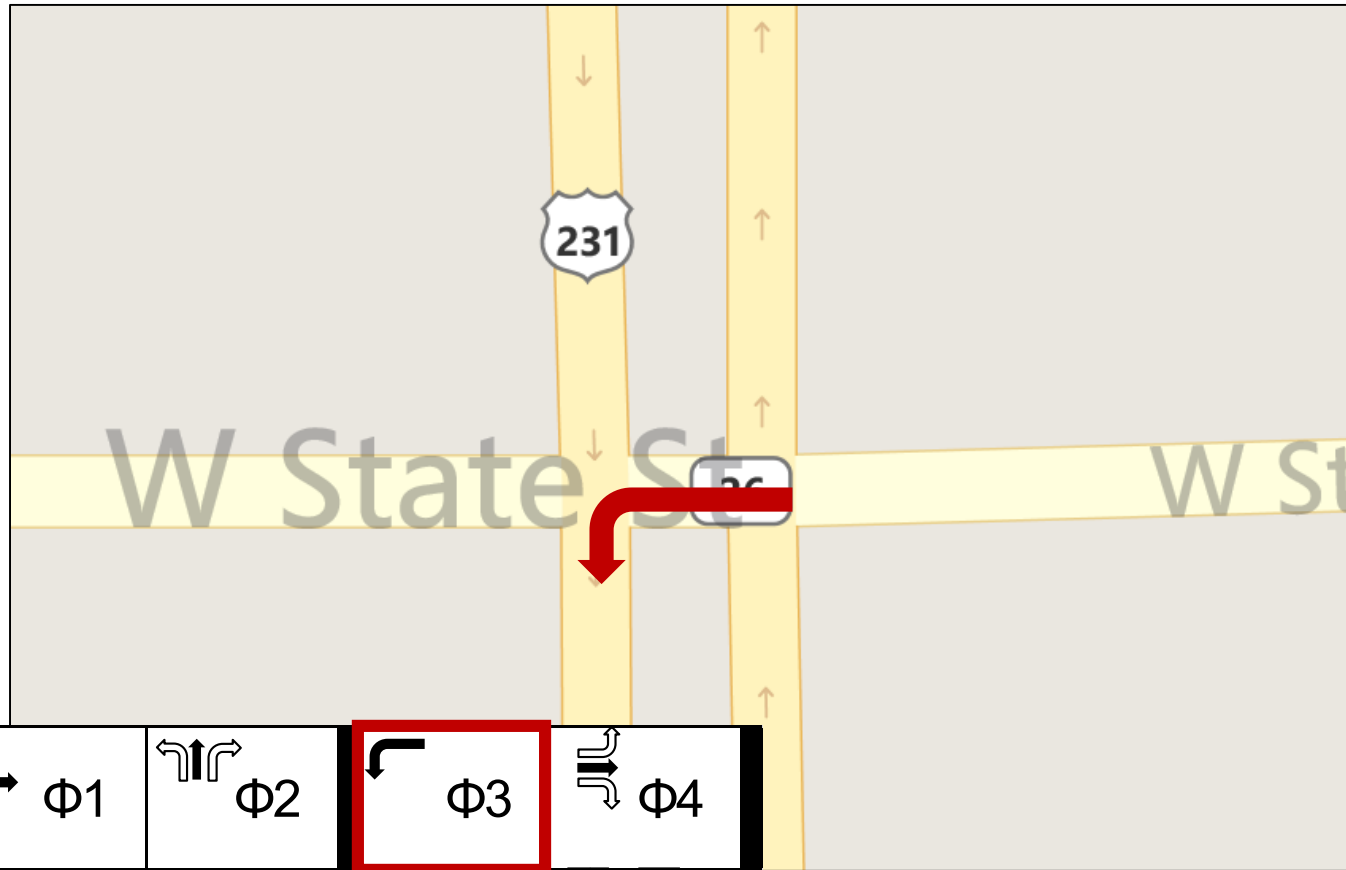
Phase 2/6 Top 20 Intersections

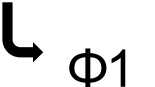
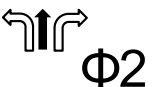





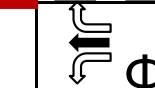


Conceptual Ranking

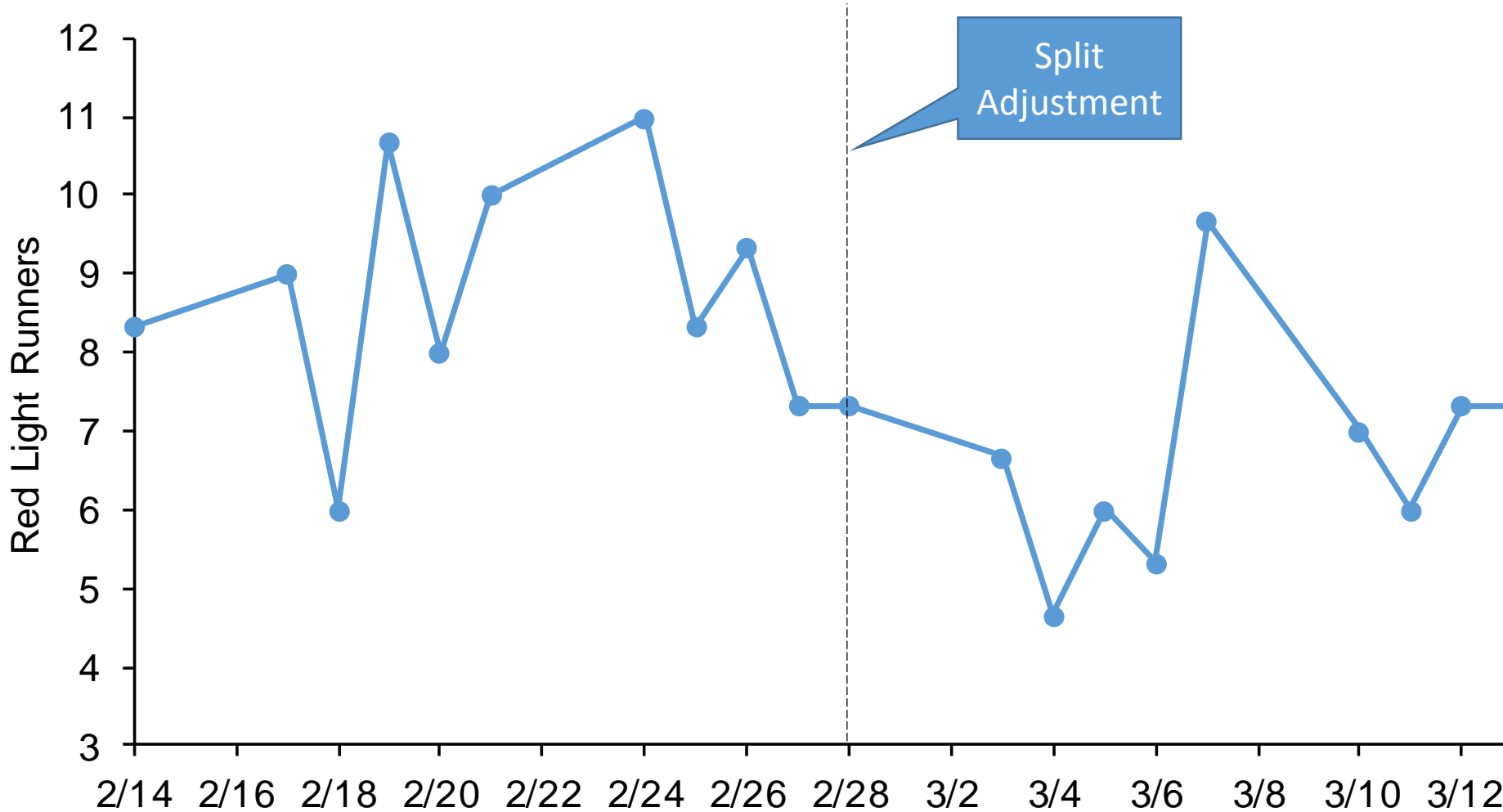
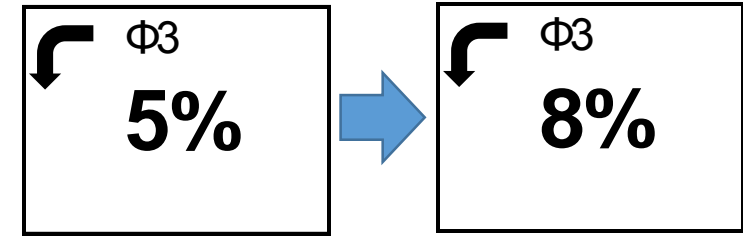


Left Turn Split Extension: US231 & River Rd



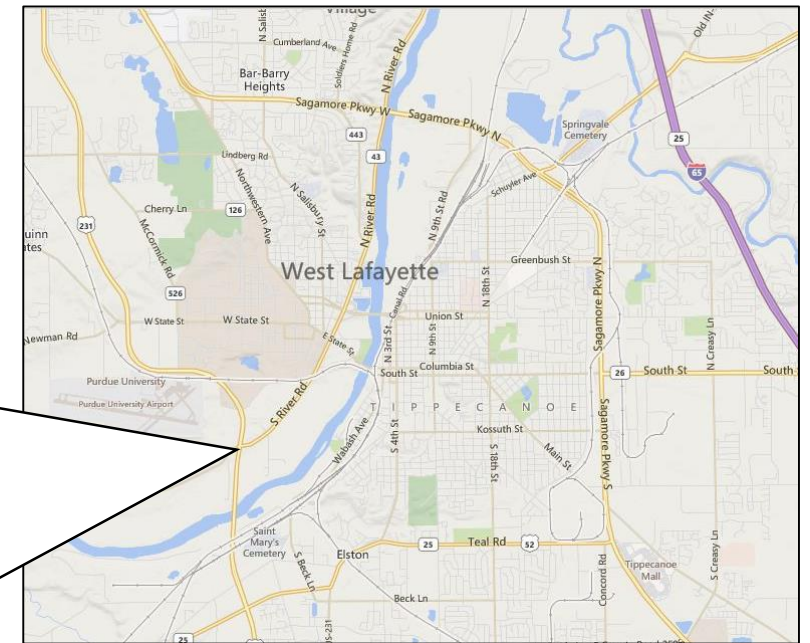
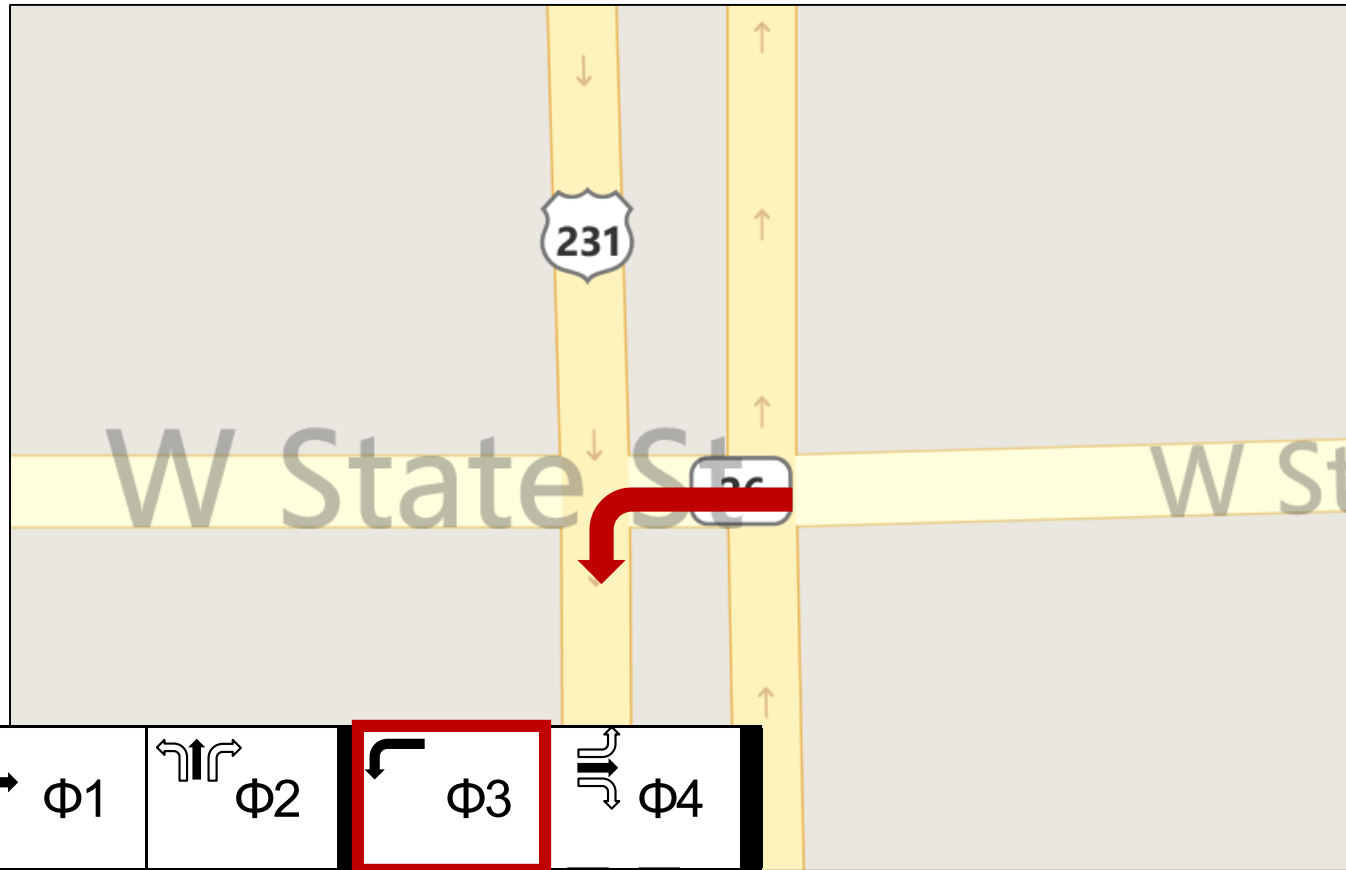
 $\Phi 1$	 $\Phi 2$	 $\Phi 3$	 $\Phi 4$
 $\Phi 5$	 $\Phi 6$	 $\Phi 7$	 $\Phi 8$

EB Left: 1500-1900 Split Increase



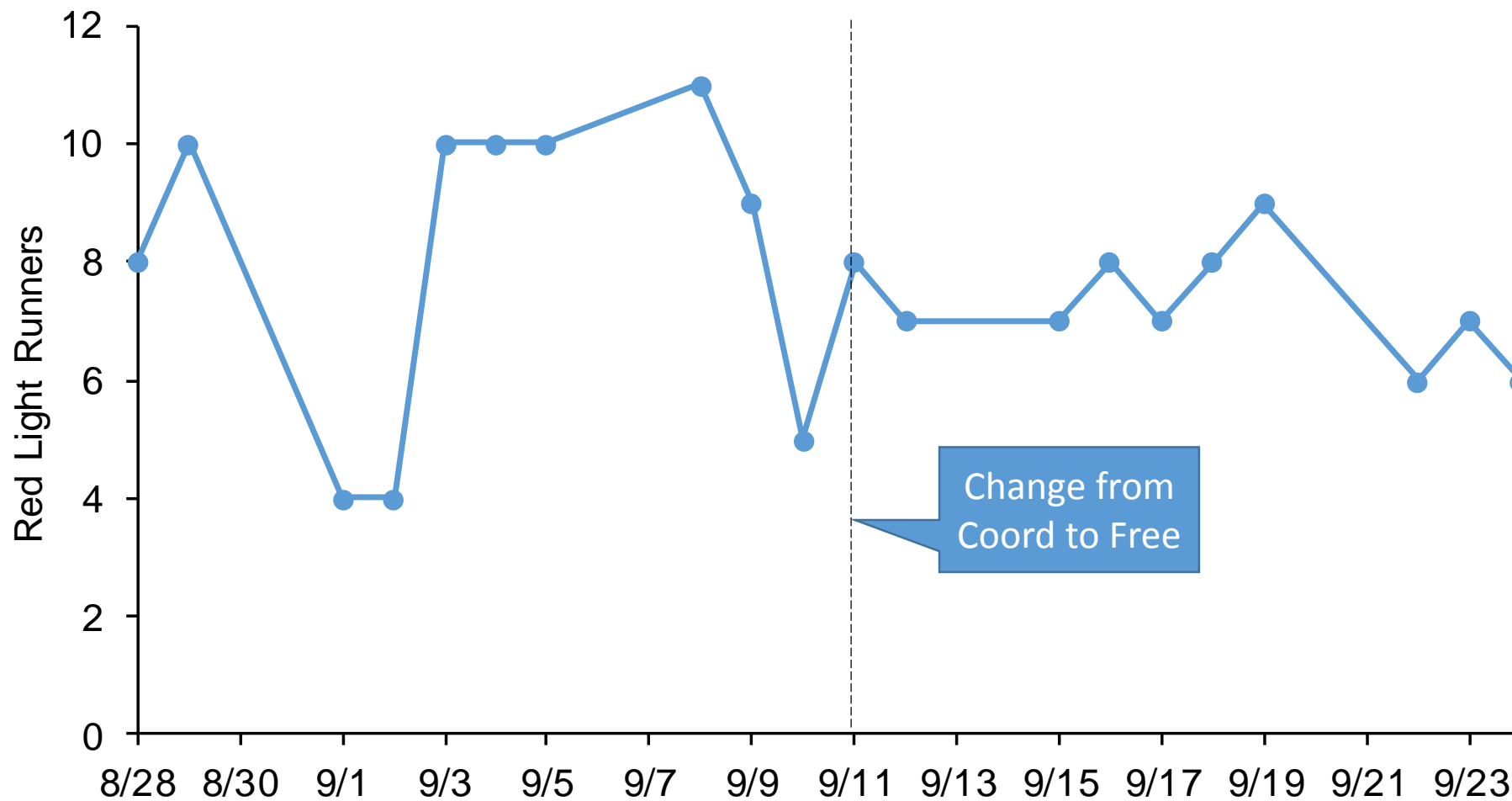
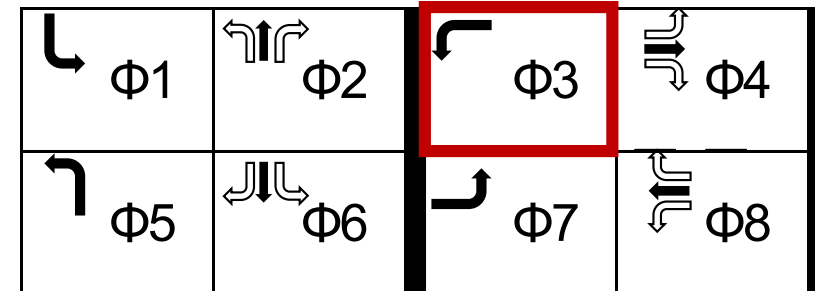
	<i>Before</i>	<i>After</i>
Mean	4.4	3.2
Variance	0.7	0.4
Observations	11	9
Pooled Variance	0.6	
Hypothesized Diff.	0	
Degrees Freedom	18	
t Statistic	3.39	
P(T<=t) one-tail	0.002	
t Critical one-tail	1.73	

Going from Actuated-Coordinated to Fully Actuated Operation: US231 & River Rd



 $\Phi 1$	 $\Phi 2$	 $\Phi 3$	 $\Phi 4$
 $\Phi 5$	 $\Phi 6$	 $\Phi 7$	 $\Phi 8$

EB Left: Coordinated \rightarrow Free



	<i>Before</i>	<i>After</i>
Mean	8.1	7.2
Variance	6.7	0.9
Observations	11	9
Pooled Variance	4.1	
Hypothesized Diff.	0	
Degrees Freedom	18	
t Statistic	0.95	
P(T<=t) one-tail	0.177	
t Critical one-tail	1.73	

Conclusions

- Intersection safety measures using in-place signal infrastructure
- Proper signal database maintenance is crucial
 - Proper phasing, clearance intervals
 - Identification of detector channels, lane movements, etc.
- Evaluation of Countermeasures
- Targeted Law Enforcement Opportunities