



Graphical Performance Measures for Practitioners to Triage Split Failure Trouble Calls

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Paper No. 14-0301



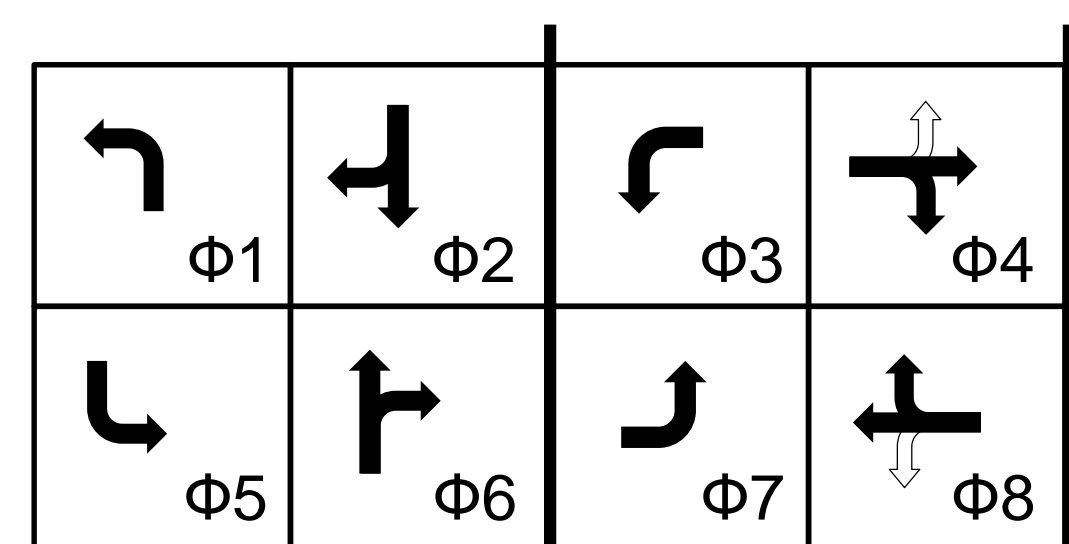
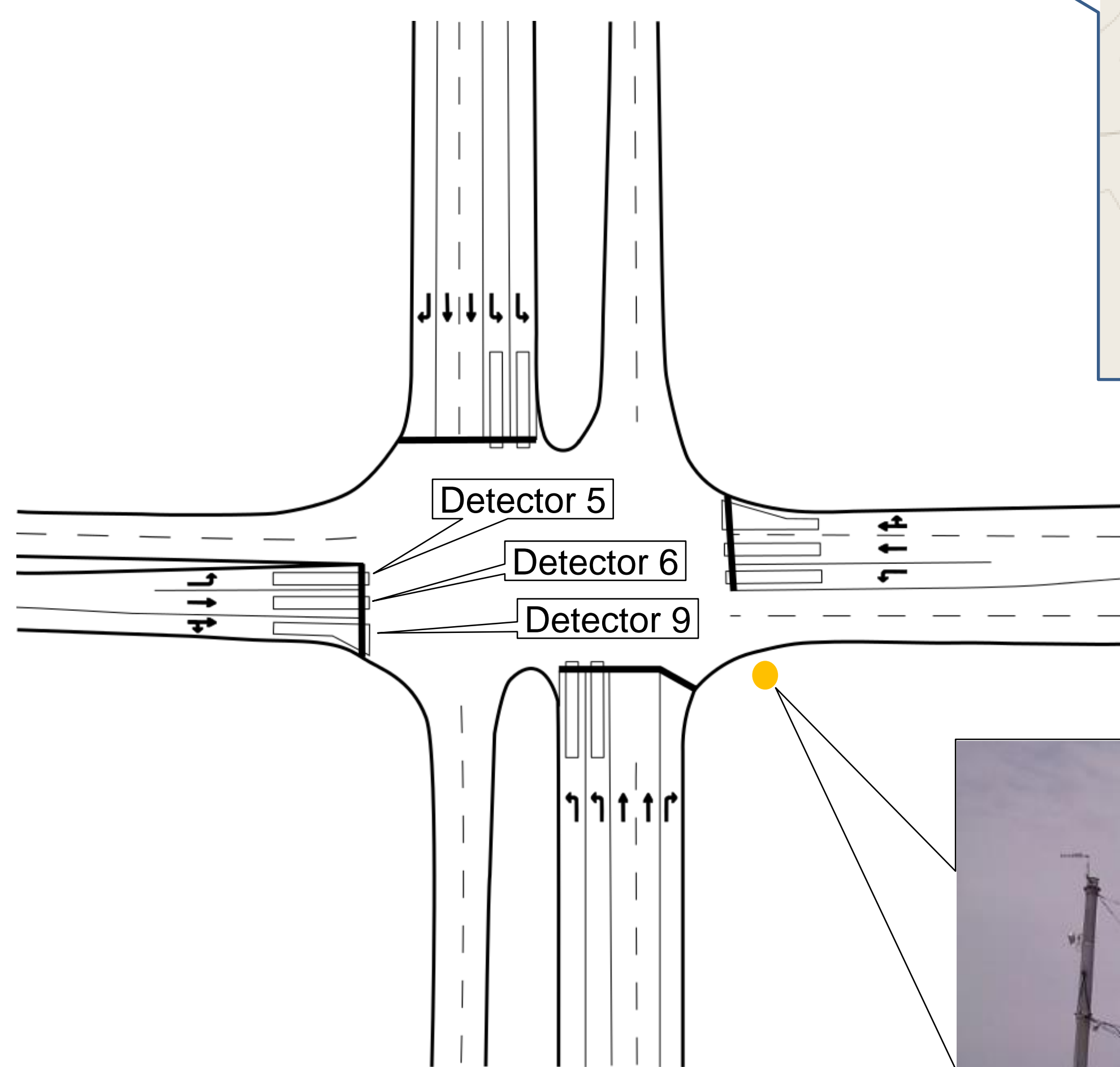
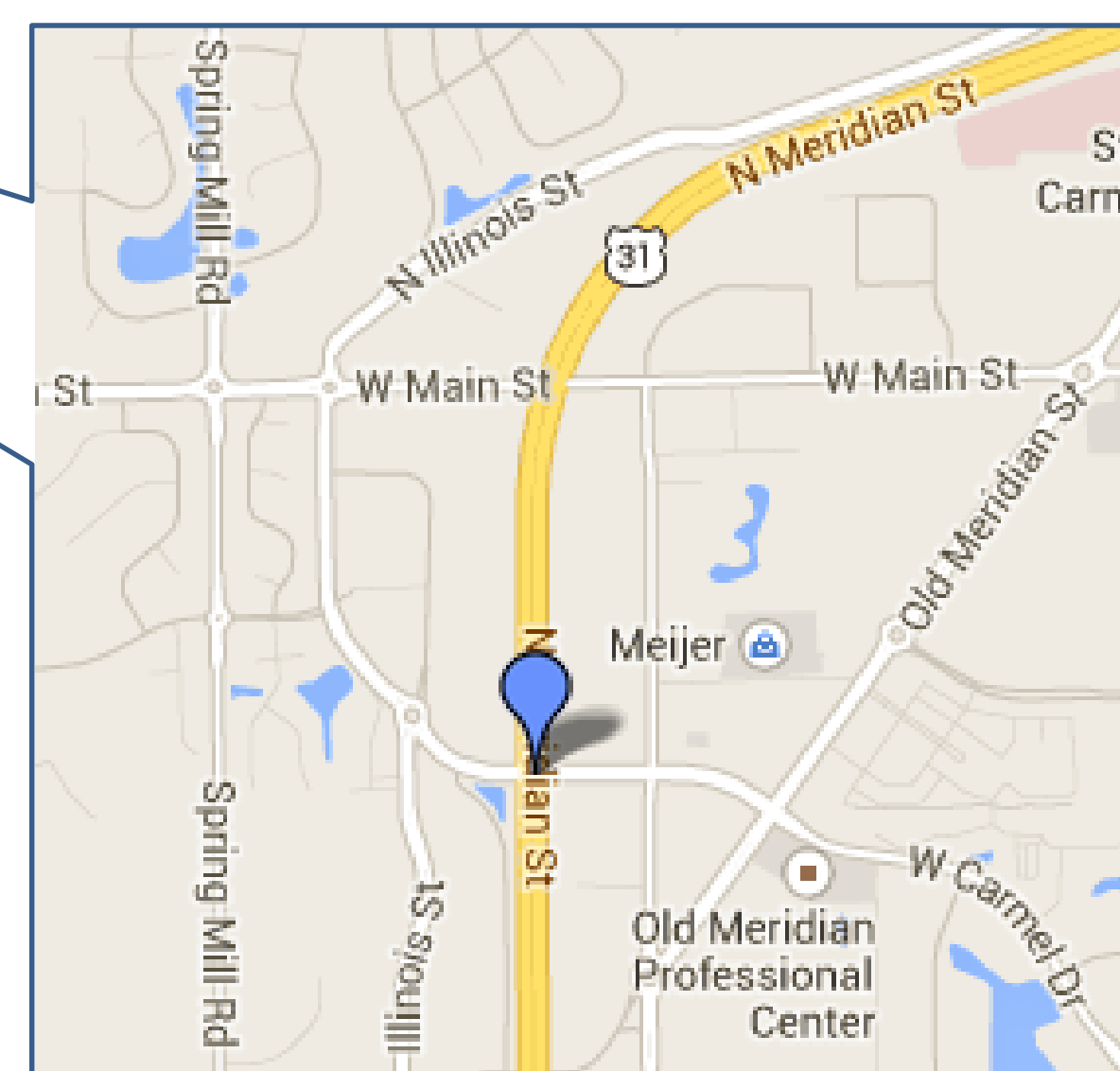
Abstract

Detector occupancy is commonly used to measure traffic signal performance. Despite improvements in controller computational power, there have been relatively few innovations in occupancy-based performance measures or integration with other data. This paper introduces and demonstrates the use of graphical performance measures based on detector occupancy ratios to verify potential split failures and other signal timing shortcomings reported to practitioners by the public. The proposed performance measures combine detector occupancy during the green phase, detector occupancy during the first five seconds of the red phase, and phase termination cause (gap out or force off). These are summarized by time of day to indicate whether the phase is undersaturated, nearly saturated, or oversaturated. These graphical performance measures and related quantitative summaries provide a first-level screening and triaging tool for practitioners to assess user concerns regarding whether sufficient green times are being provided to avoid split failures. They can also provide outcome-based feedback to staff after making split adjustments to determine whether operation improved or worsened. The paper concludes by demonstrating how the information was used to make an operational decision to re-allocate green time that reduced the number of oversaturated cycles on minor movements from 304 to 222 during a Thursday 0900-1500 timing plan and from 240 to 180 during a Friday 0900-1500 timing plan.

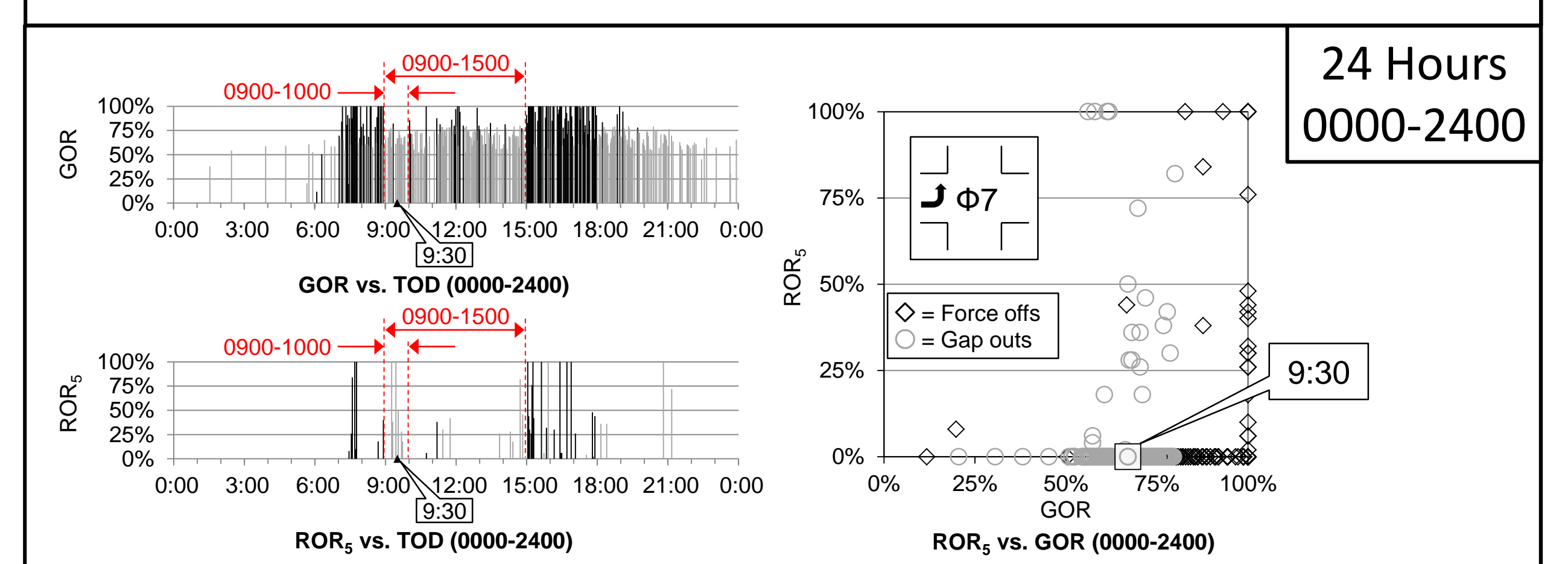
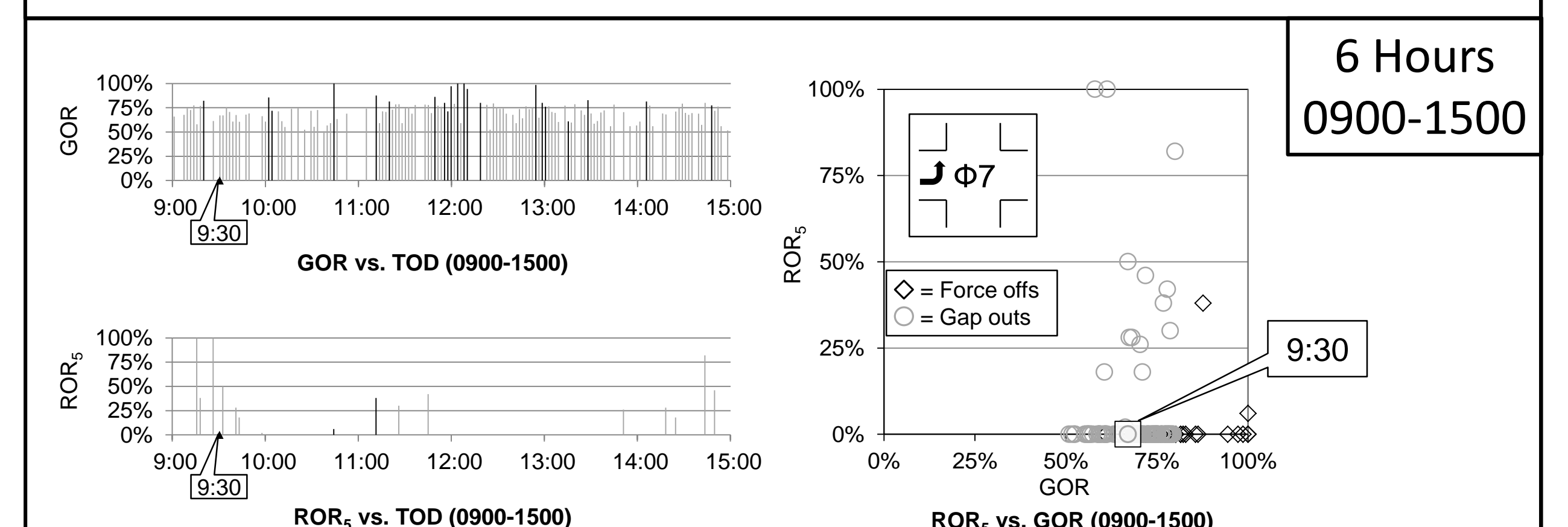
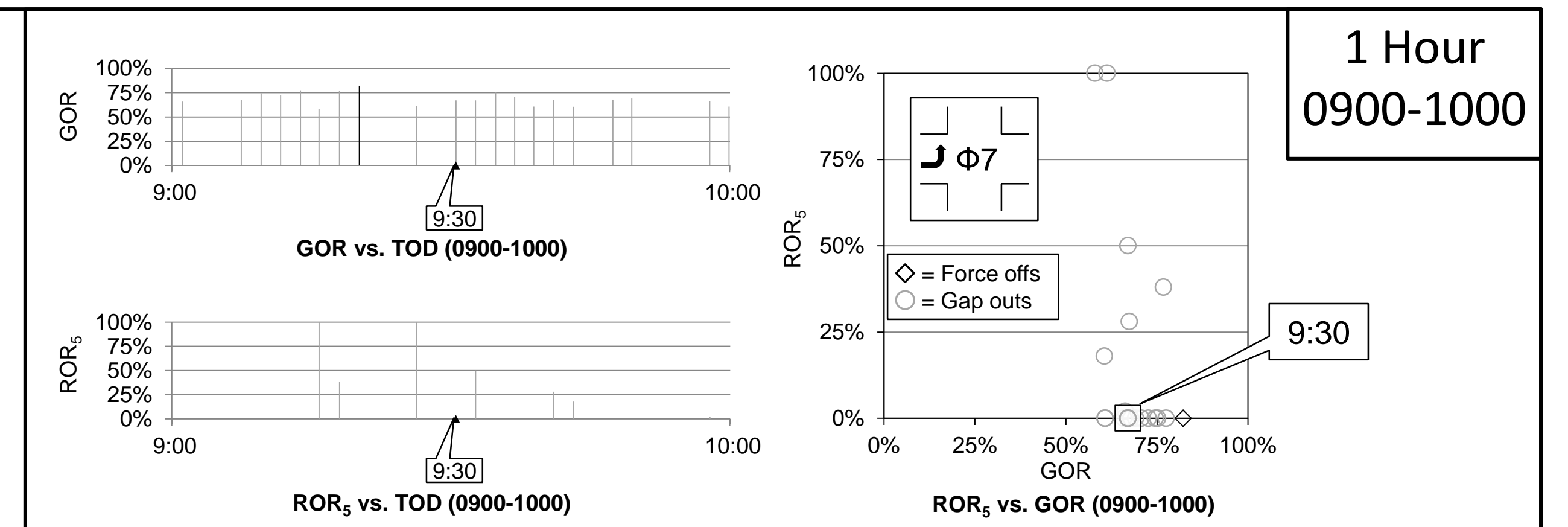
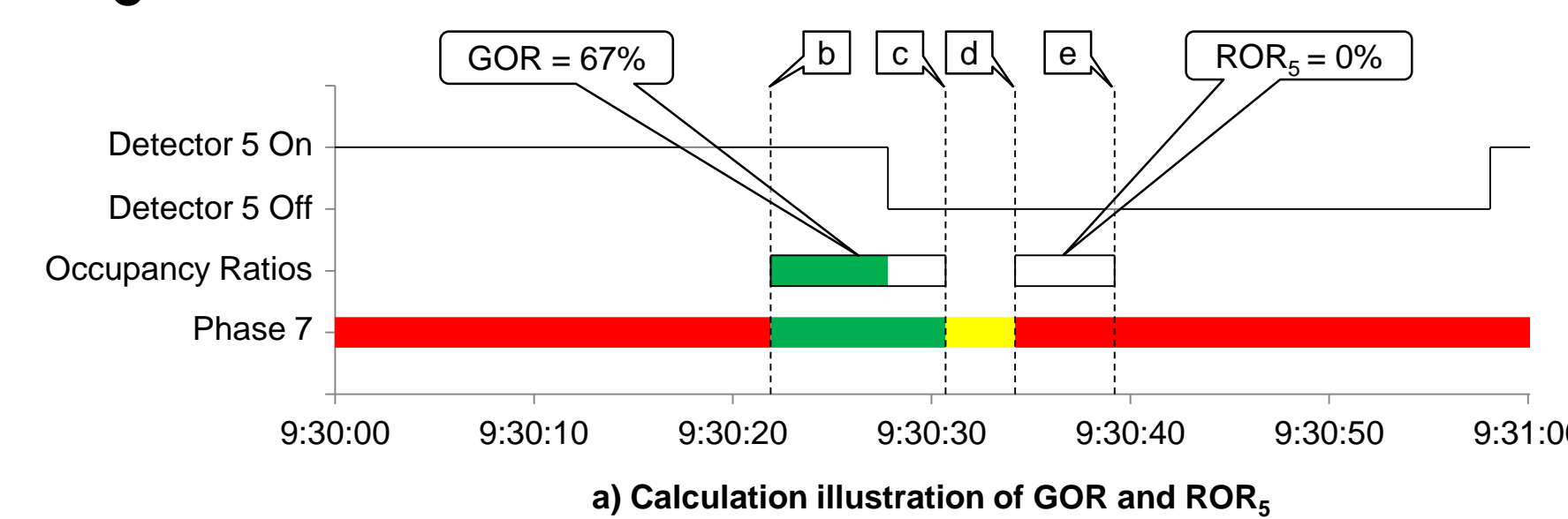
Overview of Study Location



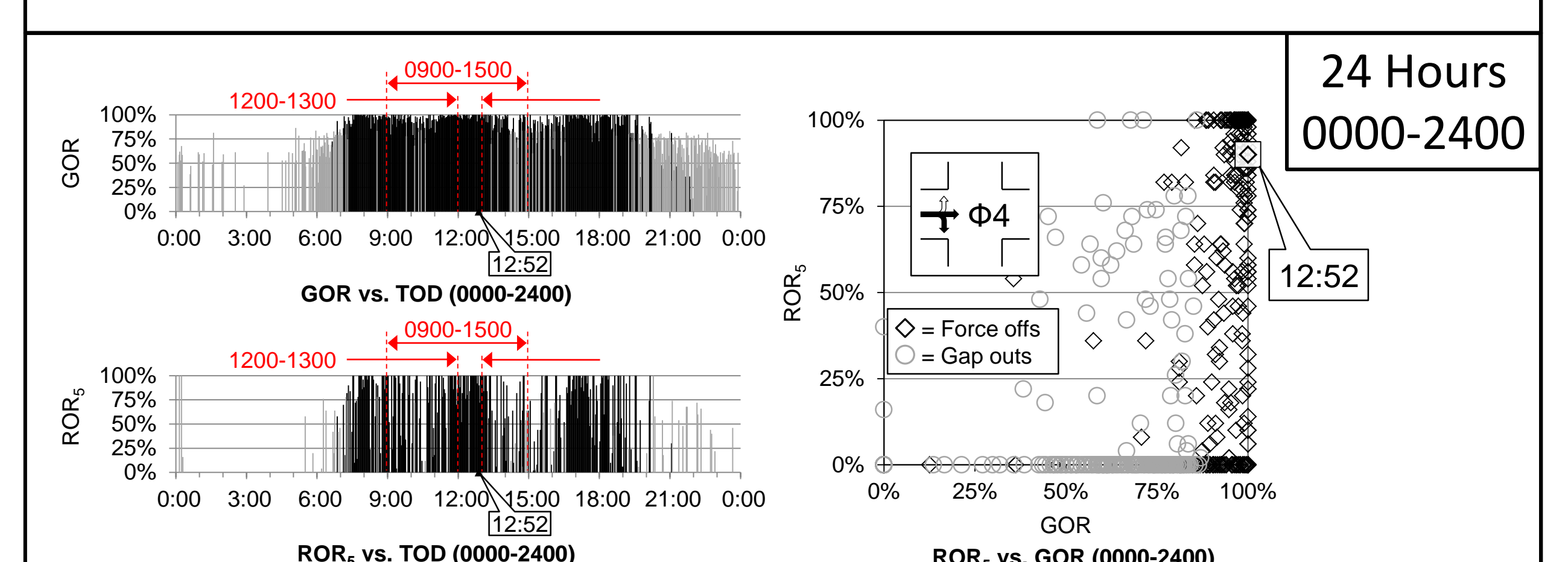
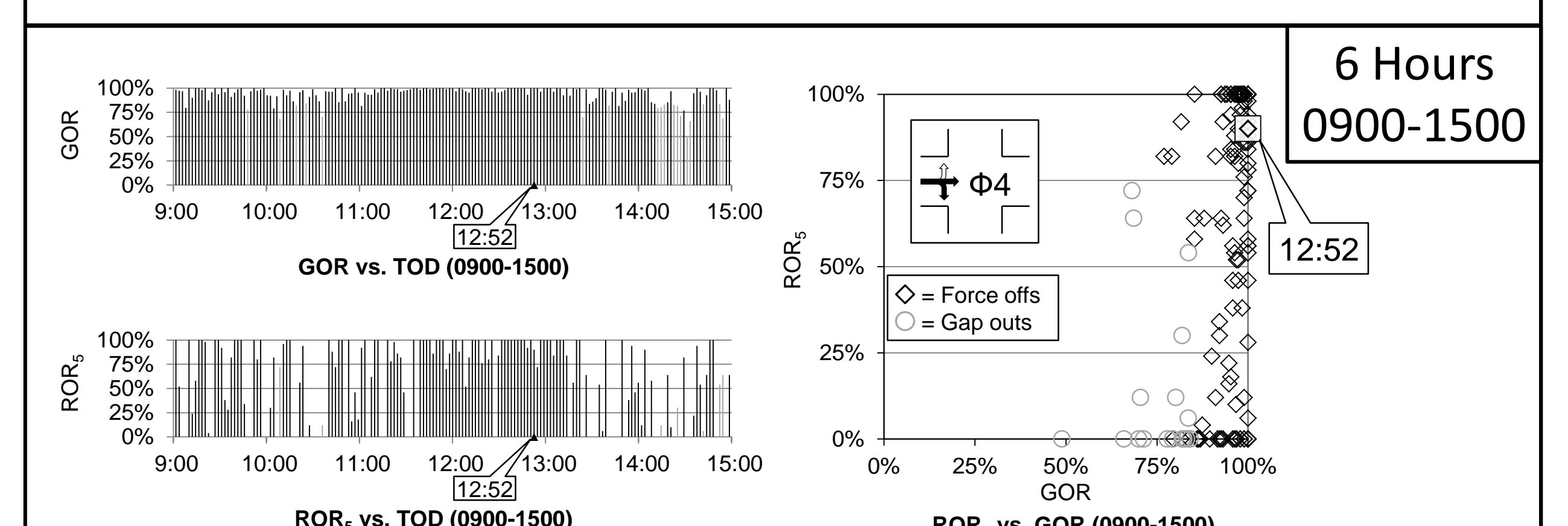
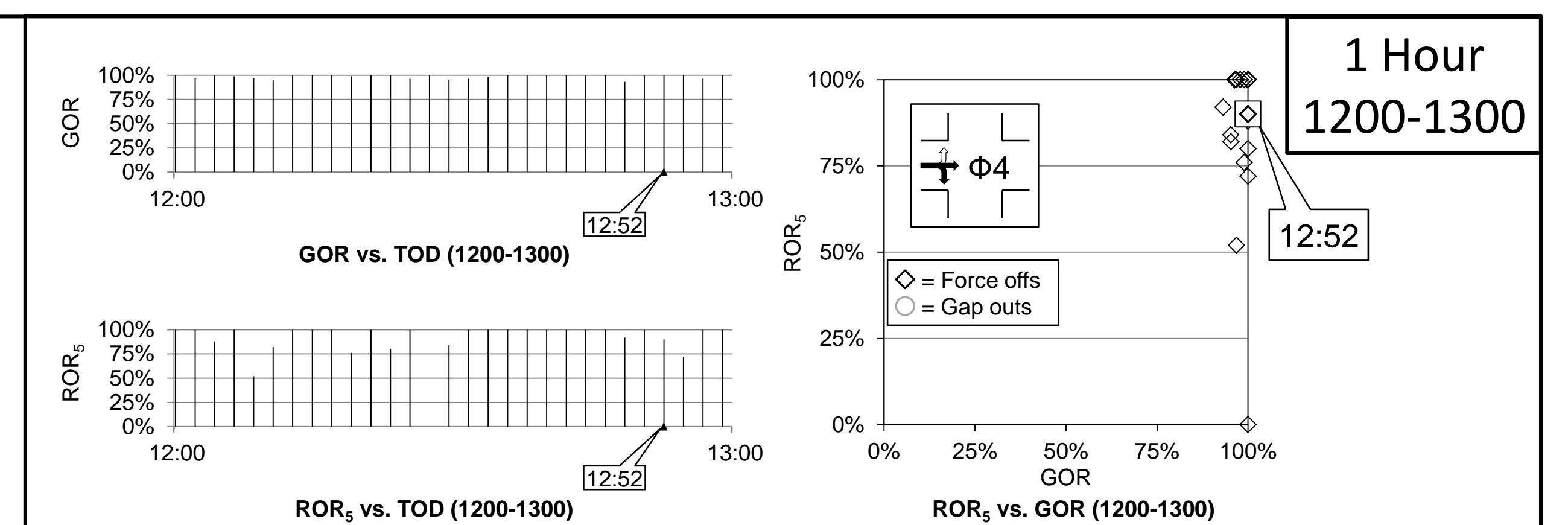
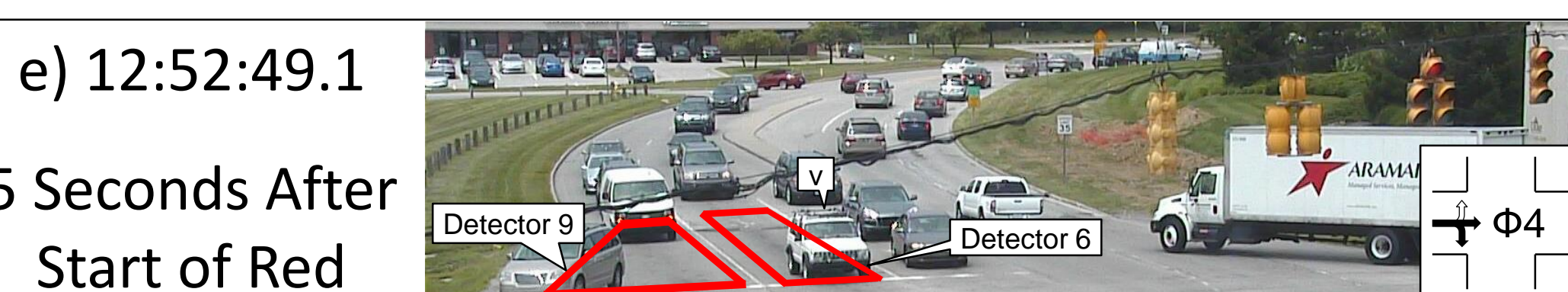
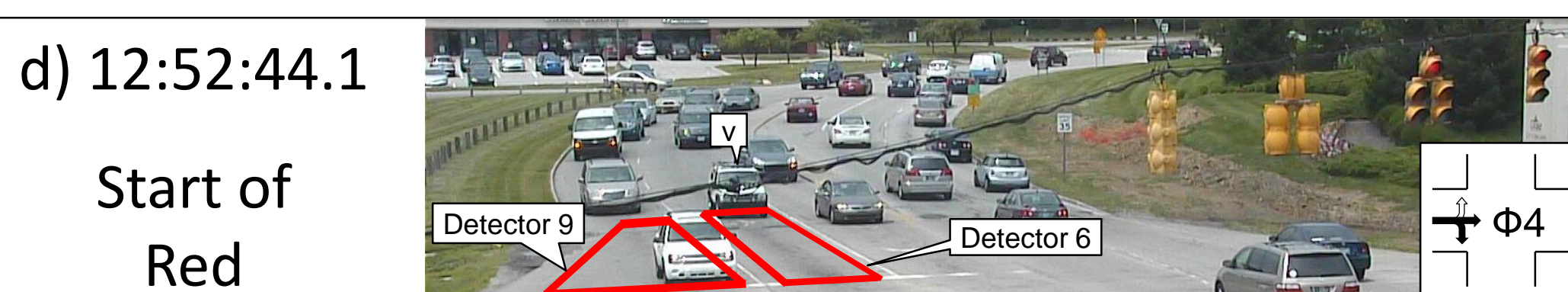
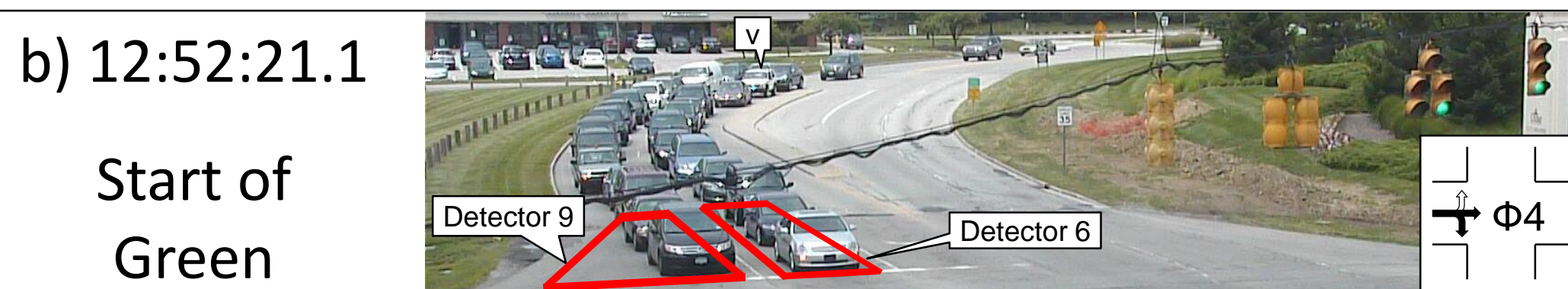
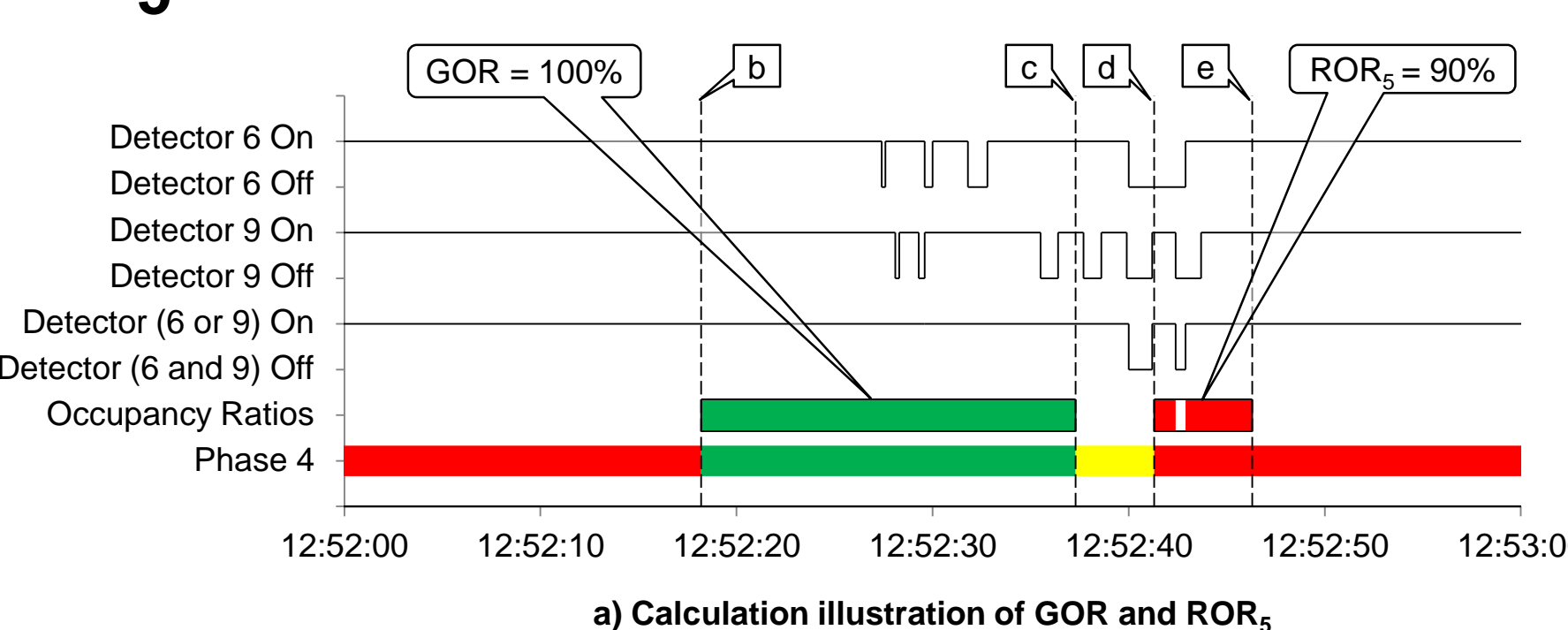
The location used to demonstrate the use of the graphical performance measures is the intersection of US-31 (Meridian St.) and 126th St. (W. Carmel Dr.), which is located north of Indianapolis. The detector mappings of the EB approach are shown in the diagram of the intersection geometry.



ROR₅ vs. GOR for One Undersaturated Cycle



ROR₅ vs. GOR for One Oversaturated Cycle





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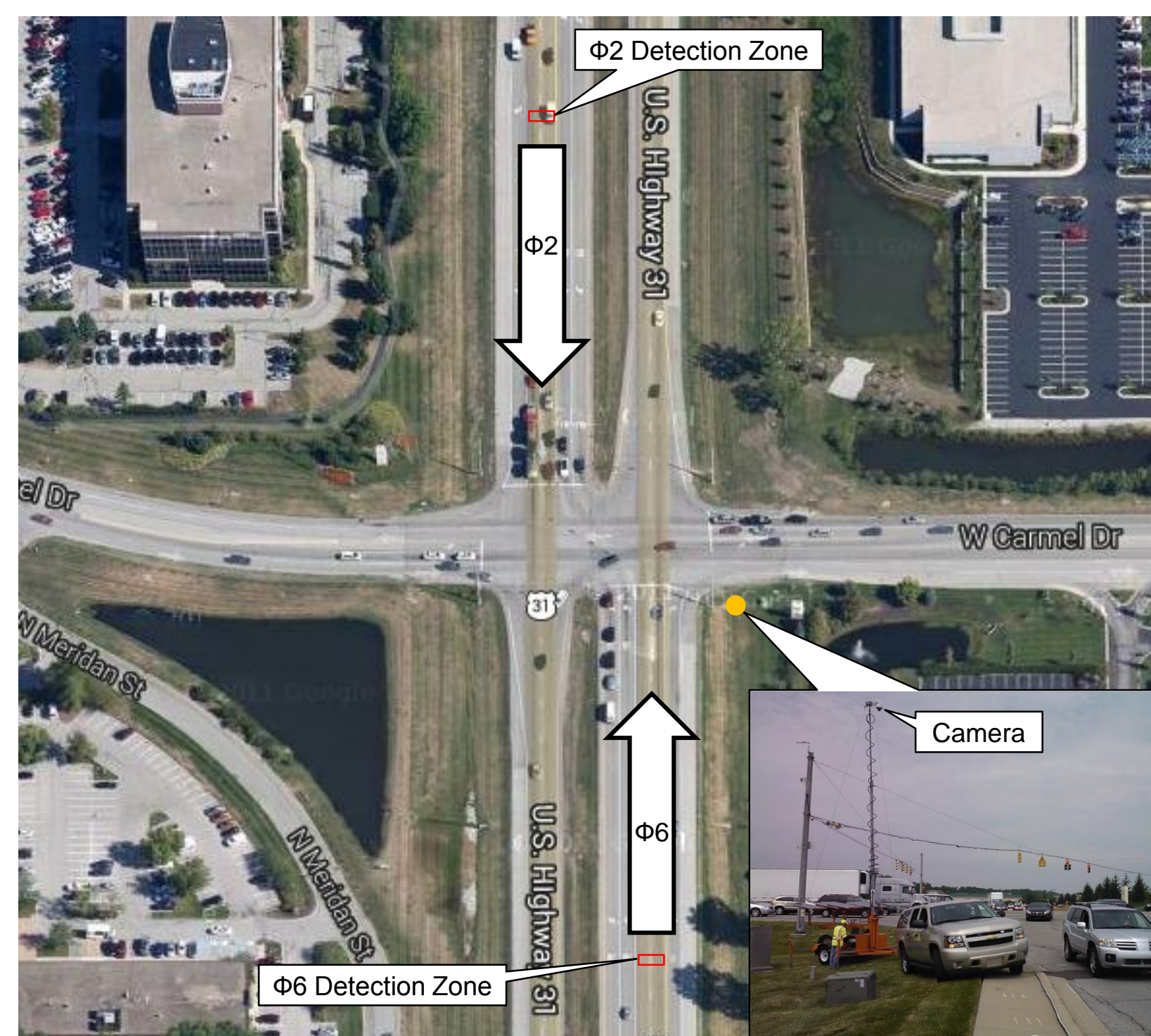
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Detector Occupancy vs. V/C Ratios for Advanced Detectors



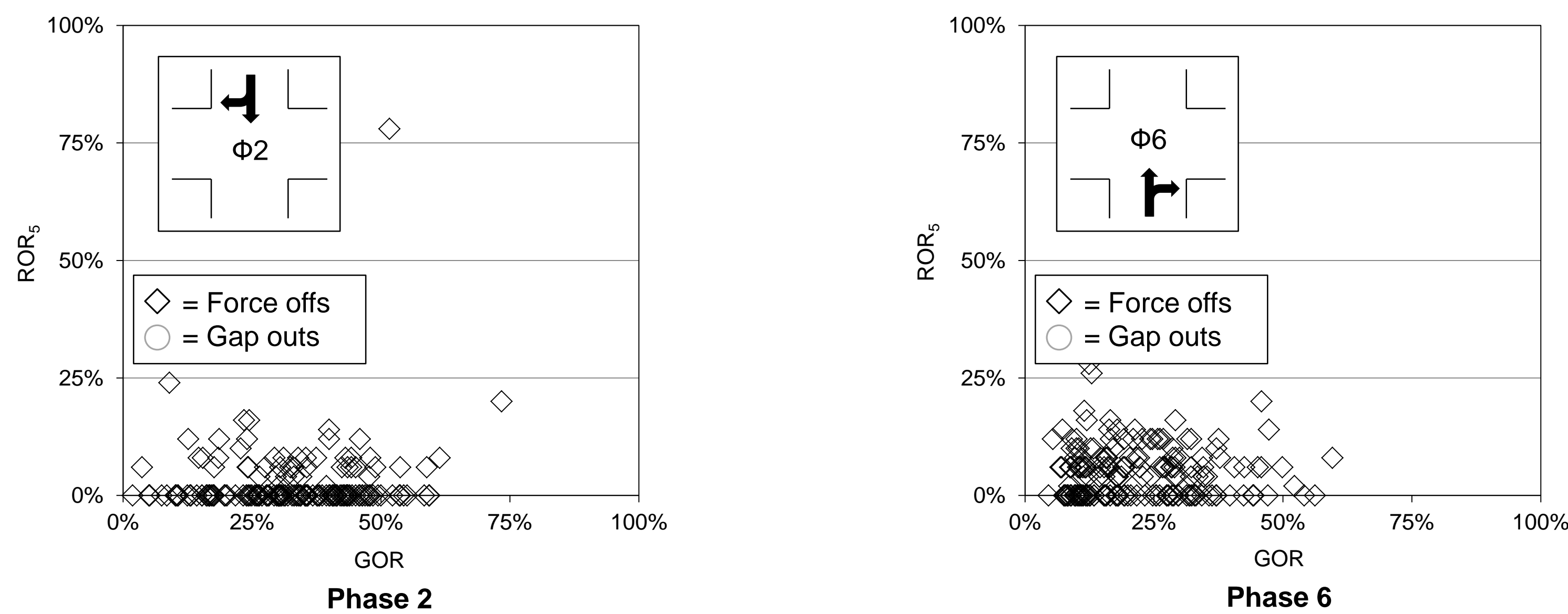
Calendar of Data Collection Before and After Split Adjustment

JULY 2013						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

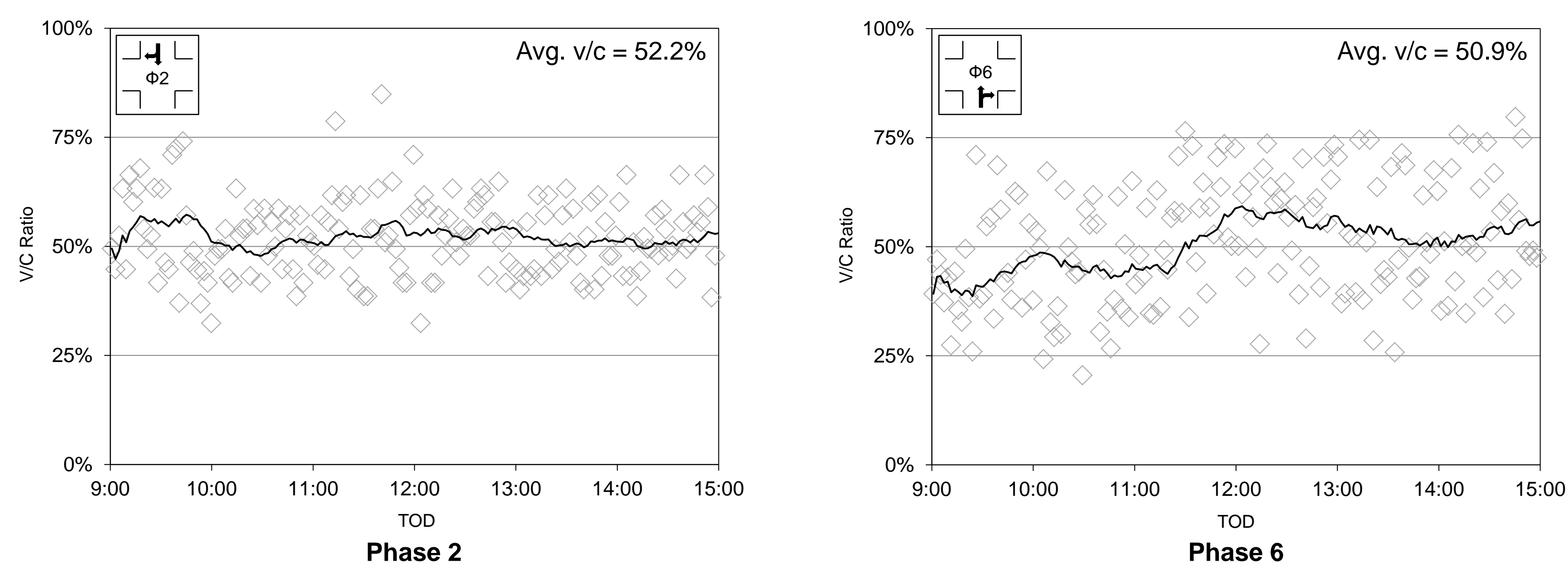
■ = Before Split Adjustment
■ = After Split Adjustment

The ROR vs. GOR plots for Phases 2 and 6 appear substantially different from the others because these phases have only setback detectors (located 405 ft upstream of the intersection), and not stop bar detectors. To characterize the degree of saturation on these movements, it is more appropriate to use the volume-to-capacity (v/c) ratio. On Wednesday, June 26th, 2013, the average v/c ratios of Phase 2 and Phase 6 during the 0900-1500 timing plan were 52.2% and 50.9%, respectively, which means that they were undersaturated and could afford to yield some split time to other phases.

✗ Phases 2 and 6 ROR vs. GOR Scatter Plots (Wed. 6/26/13)



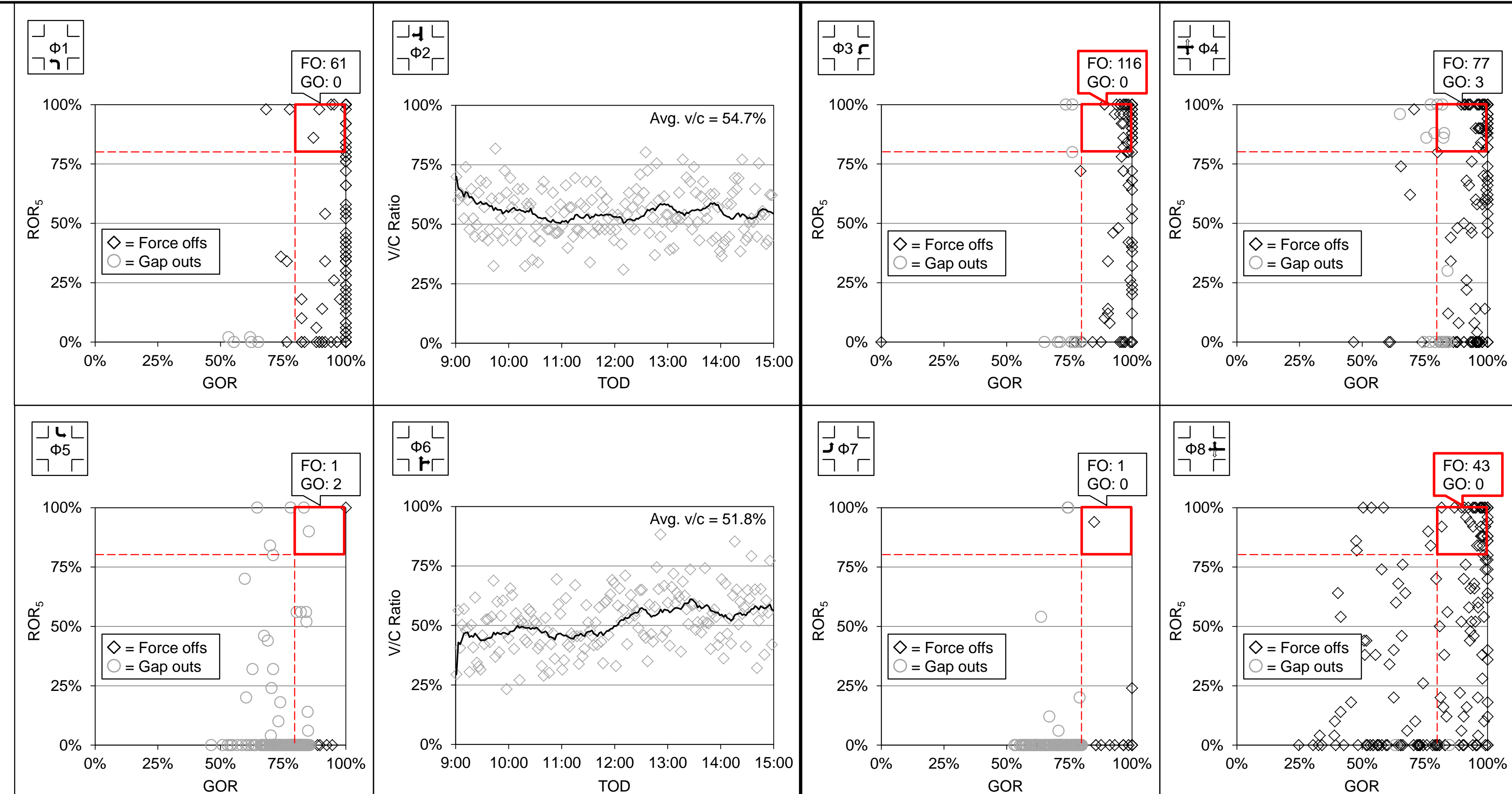
✓ Phases 2 and 6 Cycle by Cycle V/C Ratios (Wed. 6/26/13)



Split Adjustment (0900-1500)

Before (Thurs. 7/18/13)

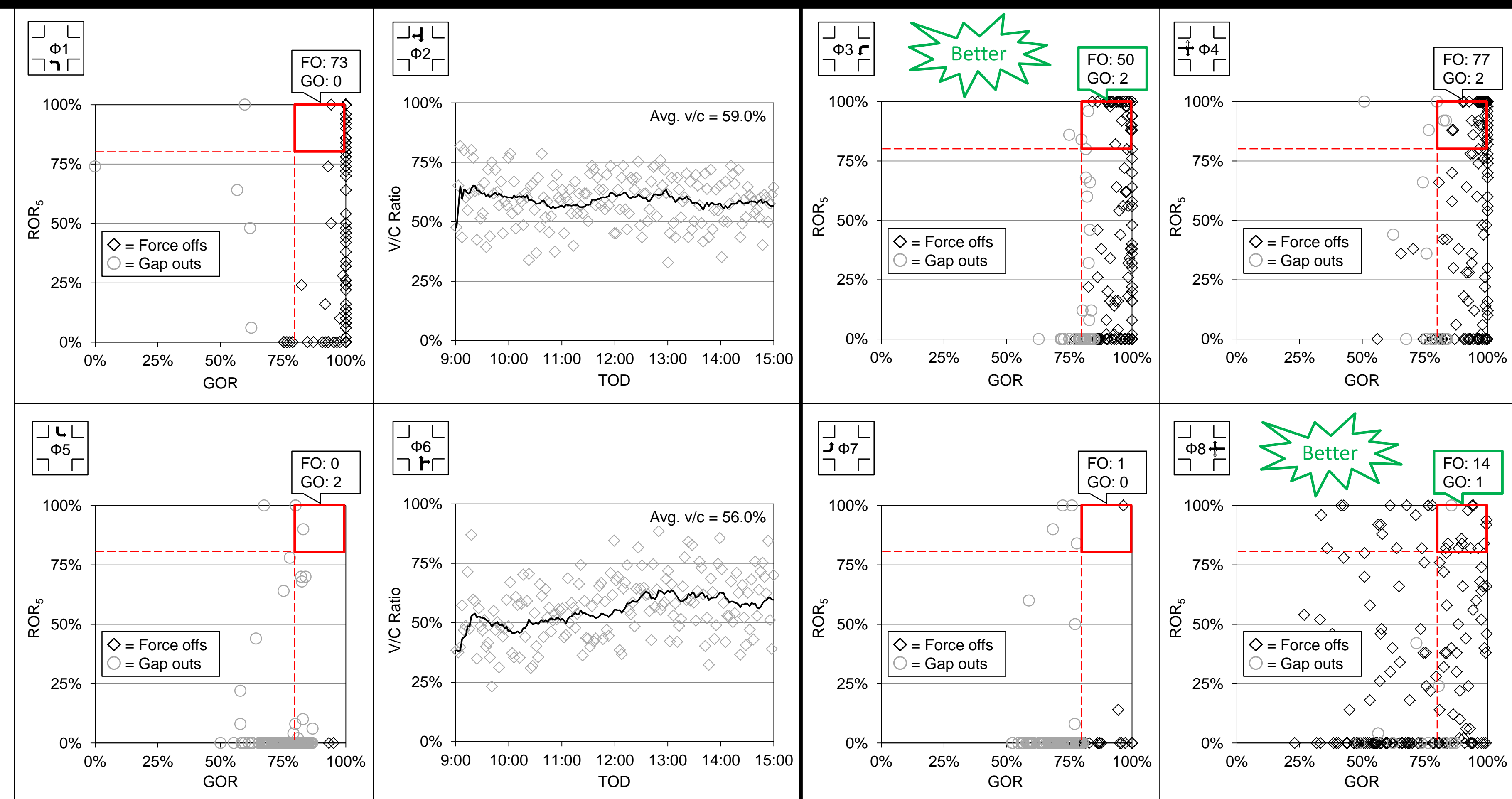
Φ1	Φ2	Φ3	Φ4
11%	53%	16%	20%
Φ5	Φ6	Φ7	Φ8
22%	42%	16%	20%



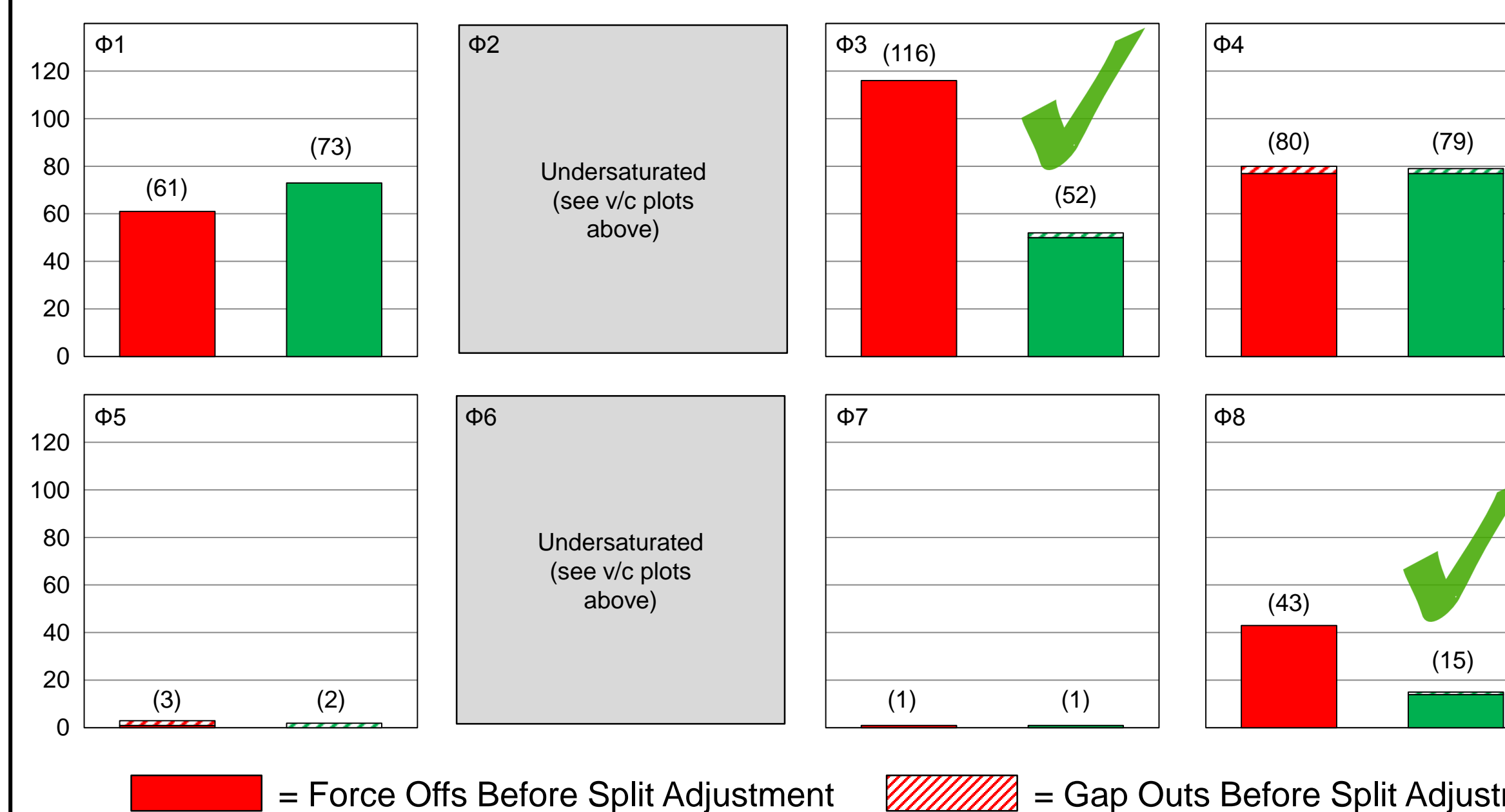
Φ1	Φ2	Φ3	Φ4
11%	49%	20%	20%
Φ5	Φ6	Φ7	Φ8
22%	38%	16%	24%

-4% +4%
-4% +4%

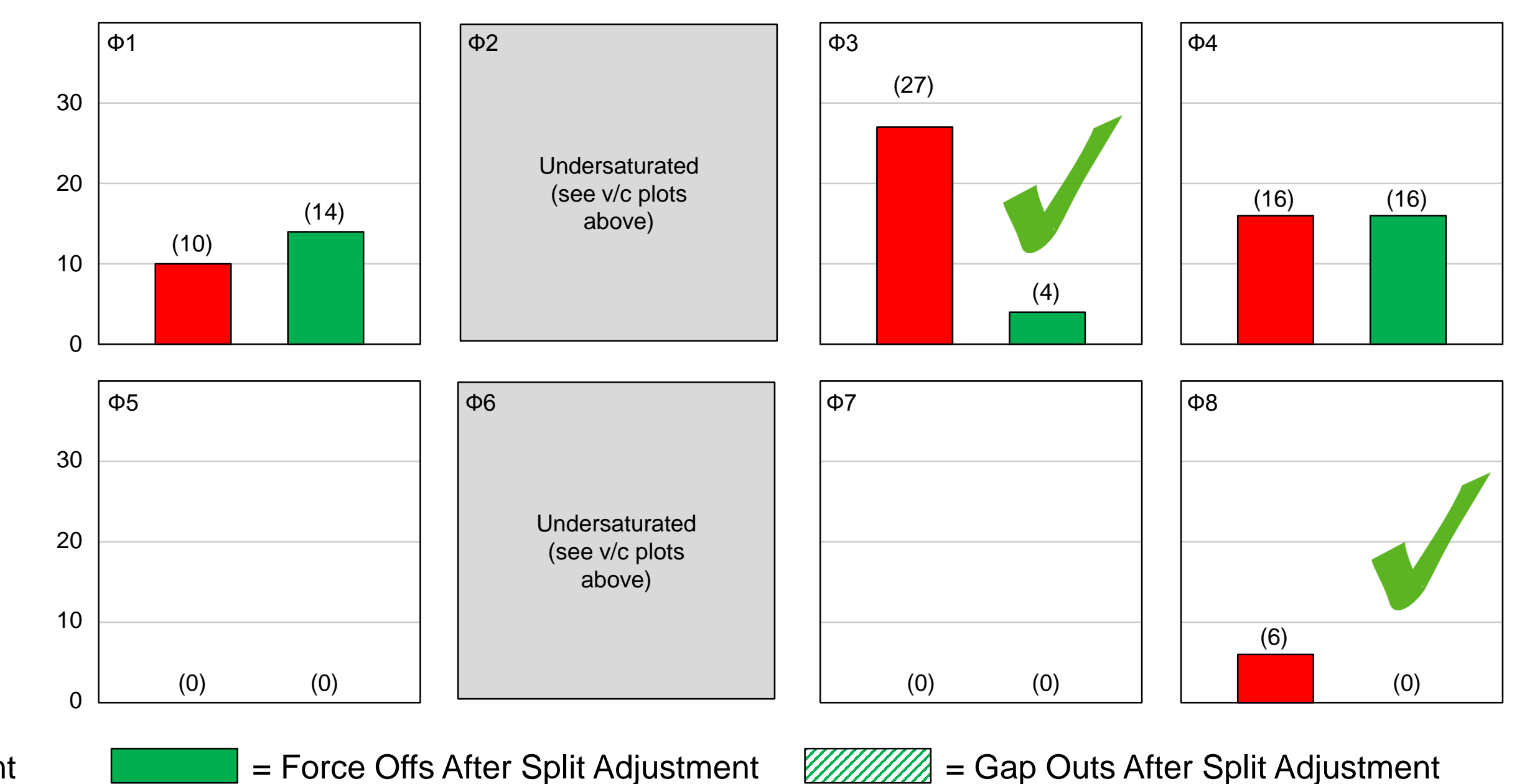
After (Thurs. 7/25/13)



Number of Oversaturated Cycles (GOR ≥ 80%, ROR₅ ≥ 80%) from 0900 to 1500



Number of Three Consecutive Oversaturated Cycles (3 FO, GOR ≥ 80%, ROR₅ ≥ 80%) from 0900 to 1500



■ = Force Offs Before Split Adjustment ■ = Gap Outs Before Split Adjustment ■ = Force Offs After Split Adjustment ■ = Gap Outs After Split Adjustment