Microwave Vehicle Detection

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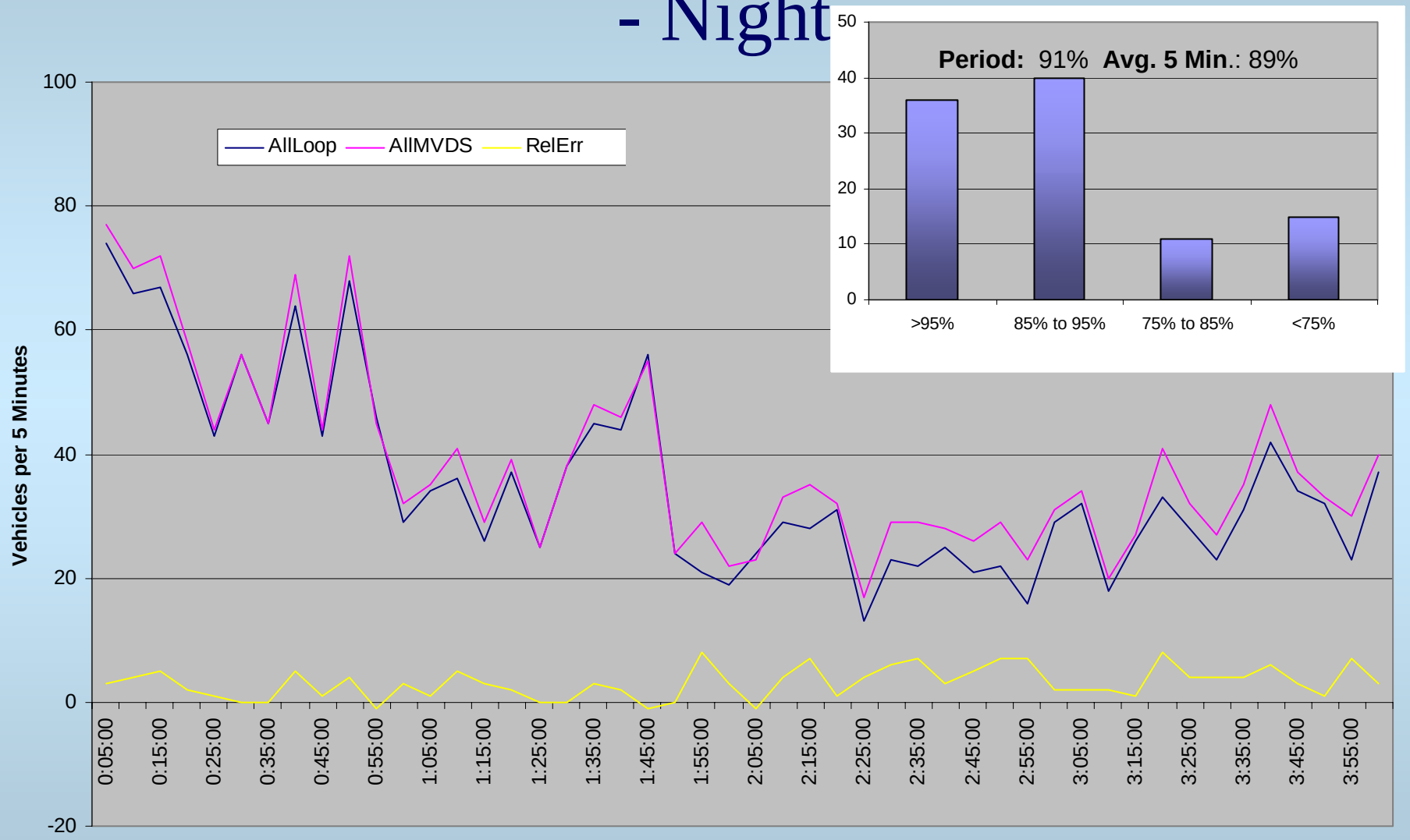
Caltrans

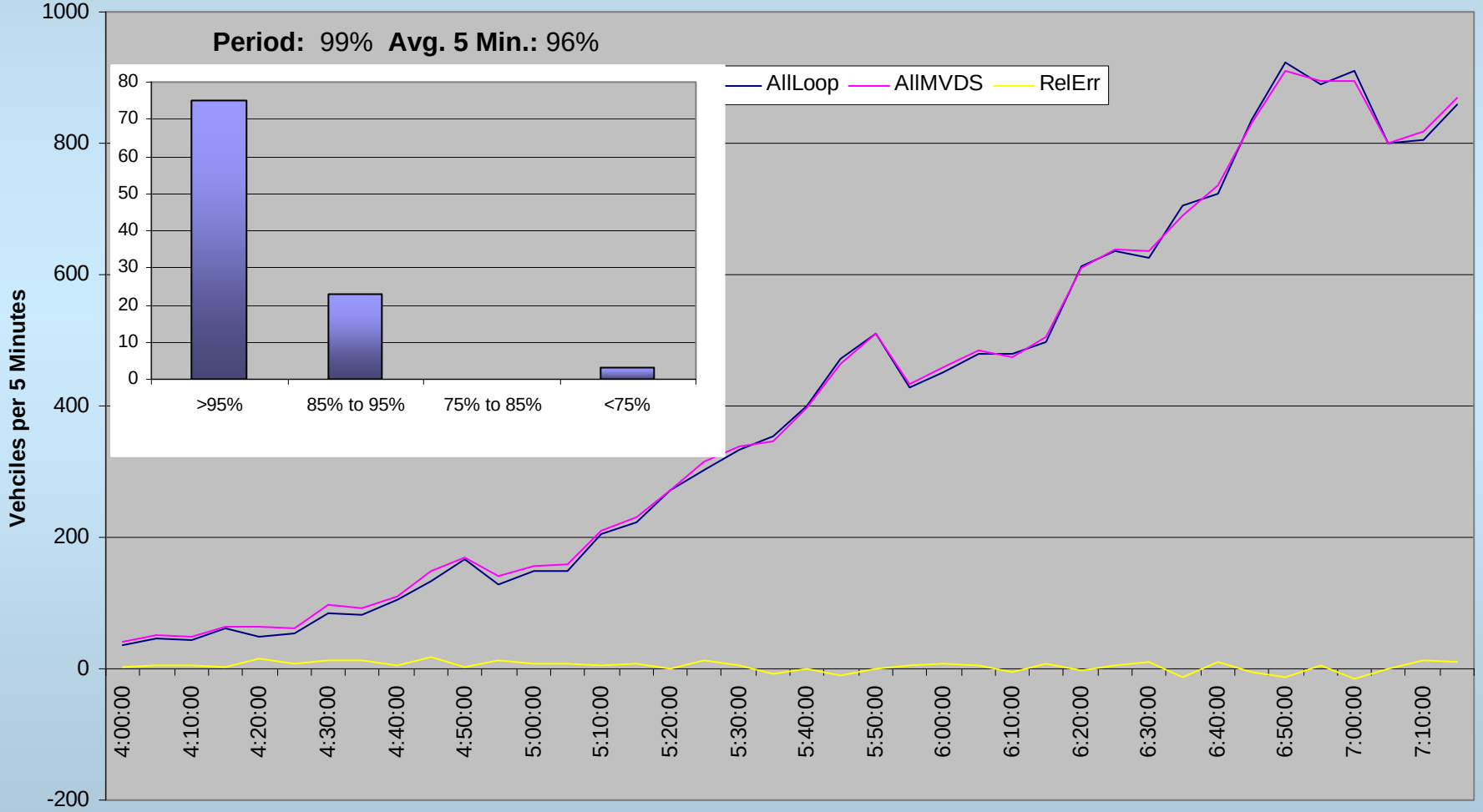
Microwave Vehicle Detection

- Inductive Loops
  - Simple
  - Versatile
  - Many problems
- Need non-intrusive alternative

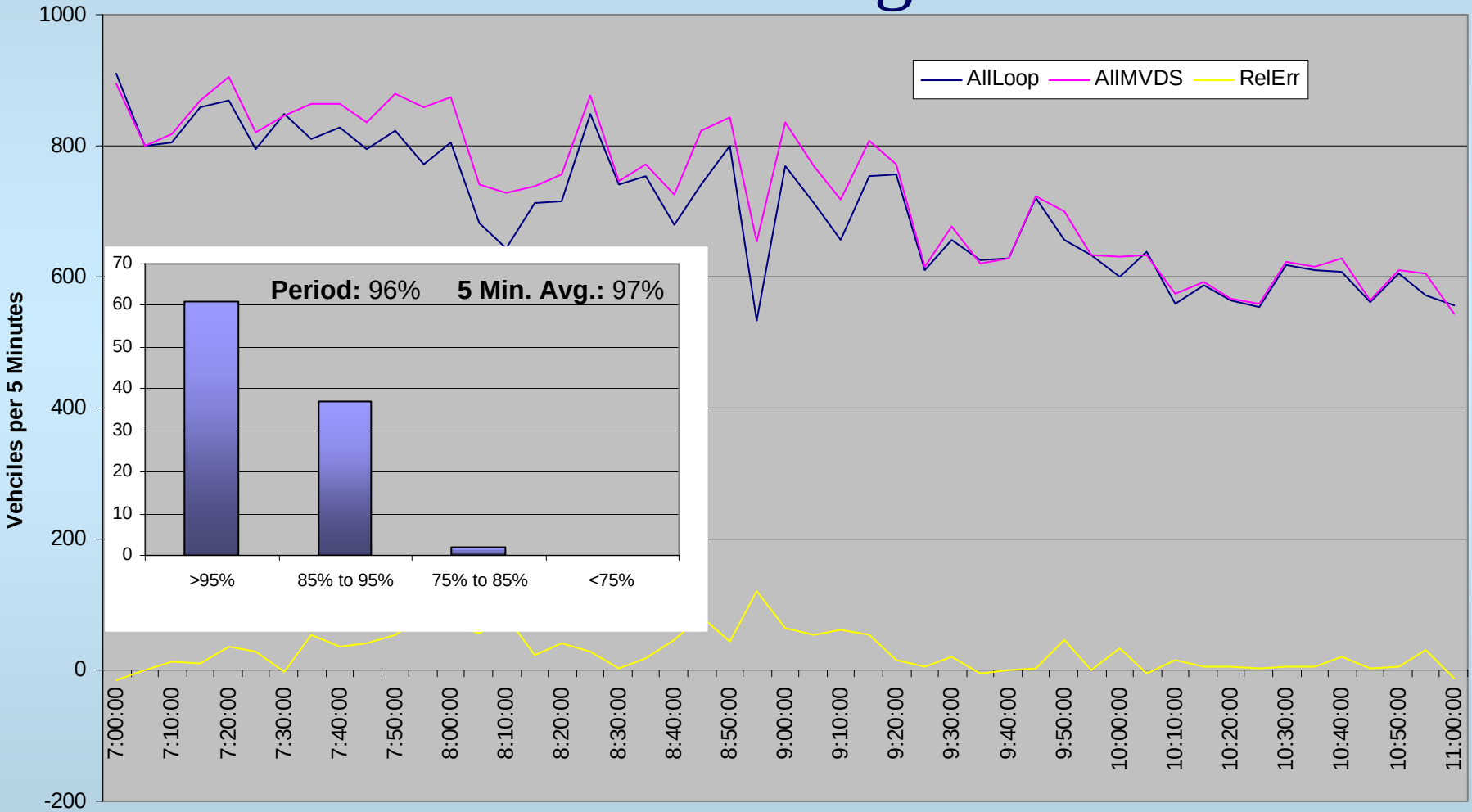
Comparing MVDS & Loop Performance - Night



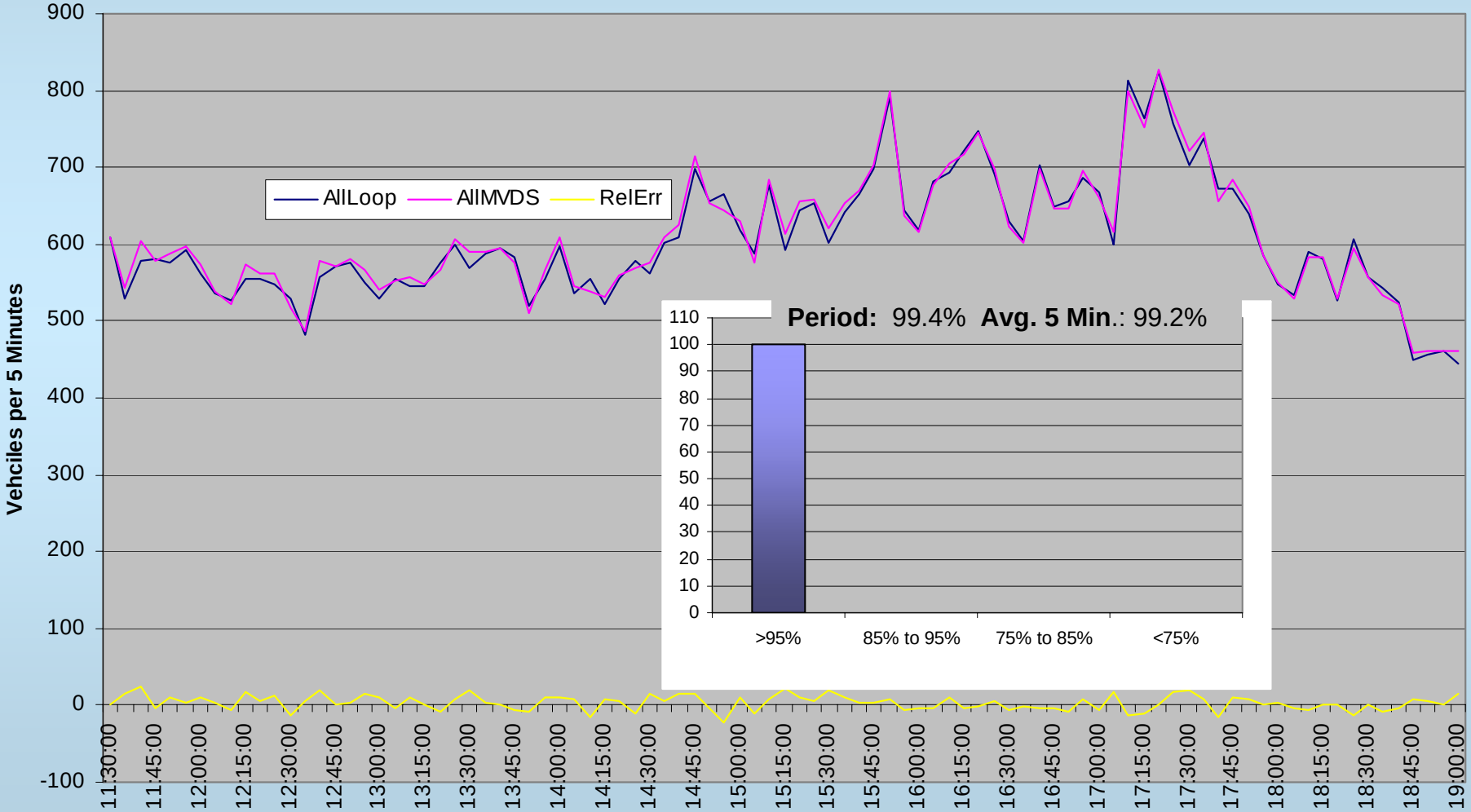
Comparing MVDS & Loop Performance - Early Morning



Comparing MVDS & Loop Performance - Morning



Comparing MVDS & Loop Performance - Afternoon



One Week 5 Minute Data Results

Wavetronix Model SS-105 Five Minute Data Trial Results (Nov 12 – Dec 12, 2002)

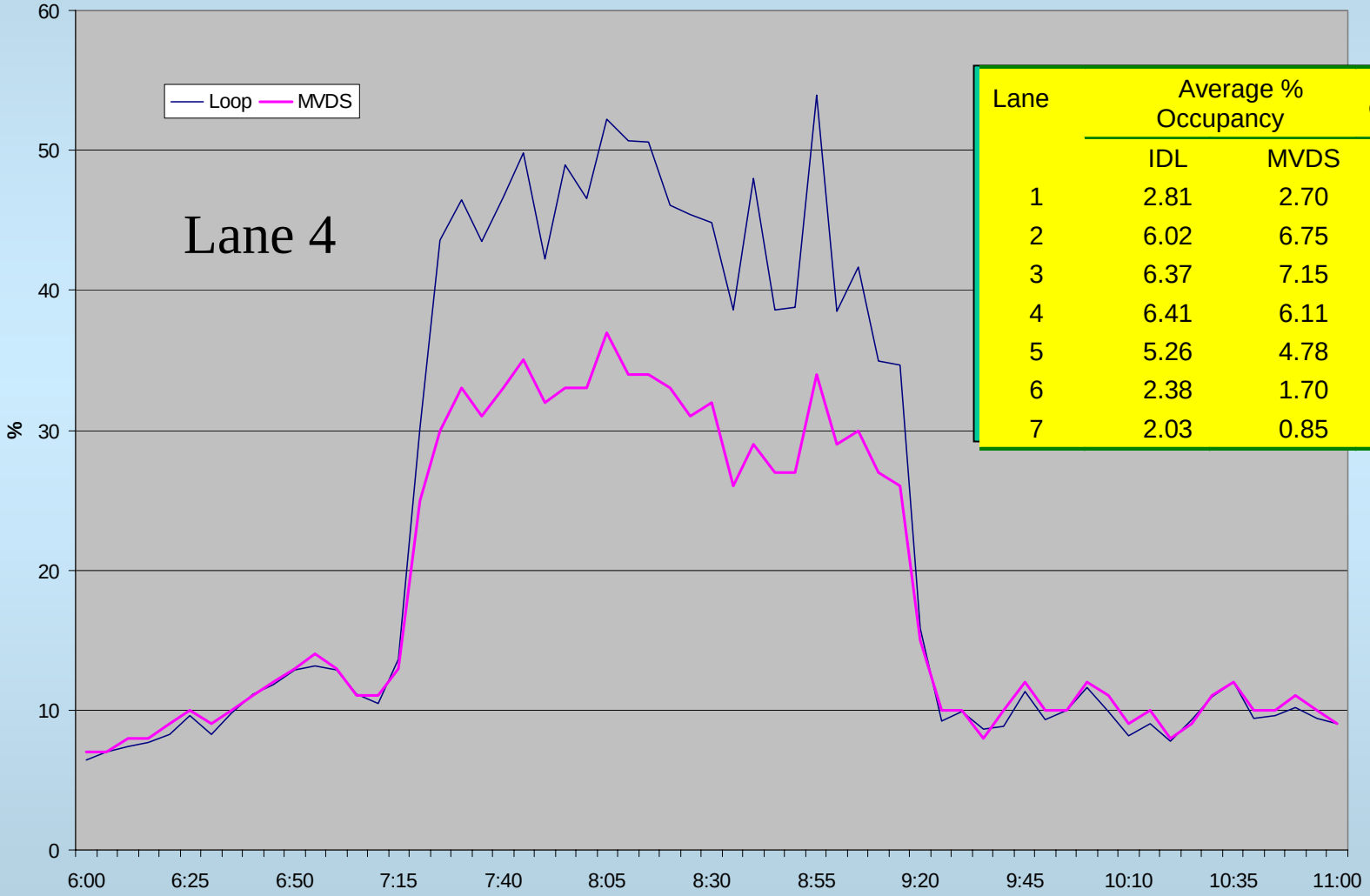
Volume (No of vehicles per week)

Lane	Loop	Sensor	Consistency
1	96196	101506	94.5%
2	181662	179602	98.9%
3	186123	183641	98.7%
4	151856	152596	99.5%
5	108895	109830	99.1%
2-5	628536	625669	99.5%
6	48578	53152	90.6%
7	39342	40473	97.1%
6-7	87920	93625	93.5%
1-7	812652	820800	99.0%

Speed (miles per hour)

Lane	Loop	Sensor	Consistency
1	75.8	79.9	94.7%
2	74.8	79.8	93.3%
3	72.6	77.6	93.2%
4	70.7	73.3	96.3%
5	68.4	71.1	95.9%
2-5	71.6	75.5	94.6%
6	66.5	68.5	96.9%
7	65.9	61.8	93.9%
6-7	66.2	65.2	98.5%
1-7	70.7	73.1	96.5%

Occupancy



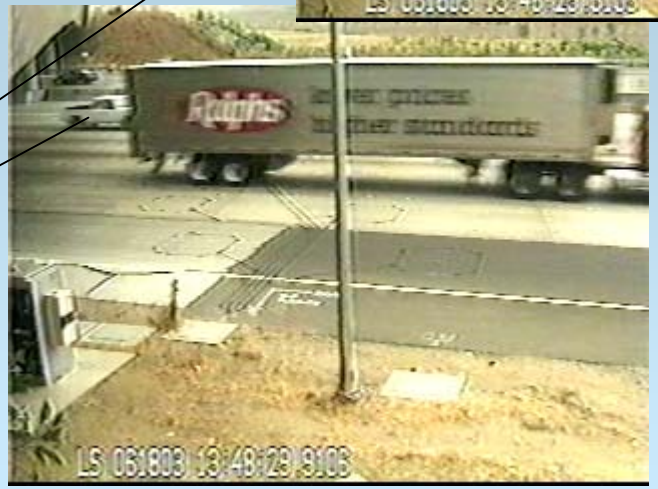
Lane	Average % Occupancy		Concurrence
	IDL	MVDS	%
1	2.81	2.70	96.1
2	6.02	6.75	87.9
3	6.37	7.15	87.8
4	6.41	6.11	95.3
5	5.26	4.78	90.9
6	2.38	1.70	71.4
7	2.03	0.85	41.9

Early MVDS Findings

- Full roadway 5 minute results:
  - Counts Compared > 95%
  - Speed better than 95%
- Five minute by lane results:
  - Accurate in center lanes
  - Occupancy understated
- Needed 30 second performance

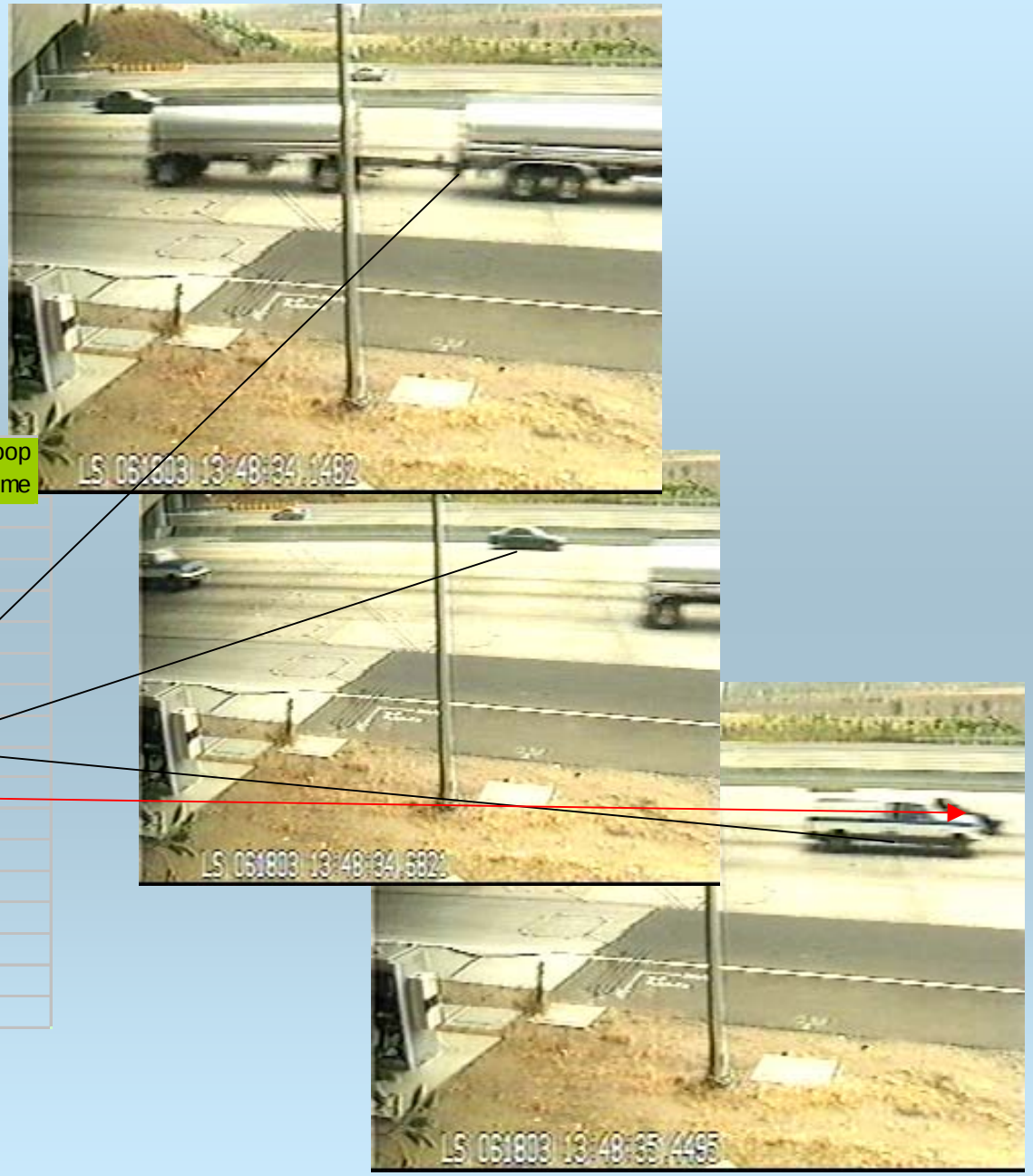
Splash & Occlusion

	MVDS		IST Loop		
	Lane	Time	Lane	Time	
	3	13:48:22.559	3	13:48:21.673	
	4	13:48:22.669	4	13:48:21.783	
	2	13:48:22.719	2	13:48:21.813	
	3	13:48:23.070	3	13:48:22.179	
	6	13:48:23.310	6	13:48:22.624	
	2	13:48:23.981	2	13:48:23.034	
	4	13:48:23.901	4	13:48:23.145	
	7	13:48:25.483	7	13:48:24.917	
	6		6	13:48:27.160	+LC
	7	13:48:27.837	7	13:48:27.271	
	2	13:48:29.639	2	13:48:28.783	
+1	6	13:48:30.220	6		
T	5	13:48:30.591	5	13:48:29.133	
Missed	3		3	13:48:29.544	
	2	13:48:30.681	2	13:48:29.854	



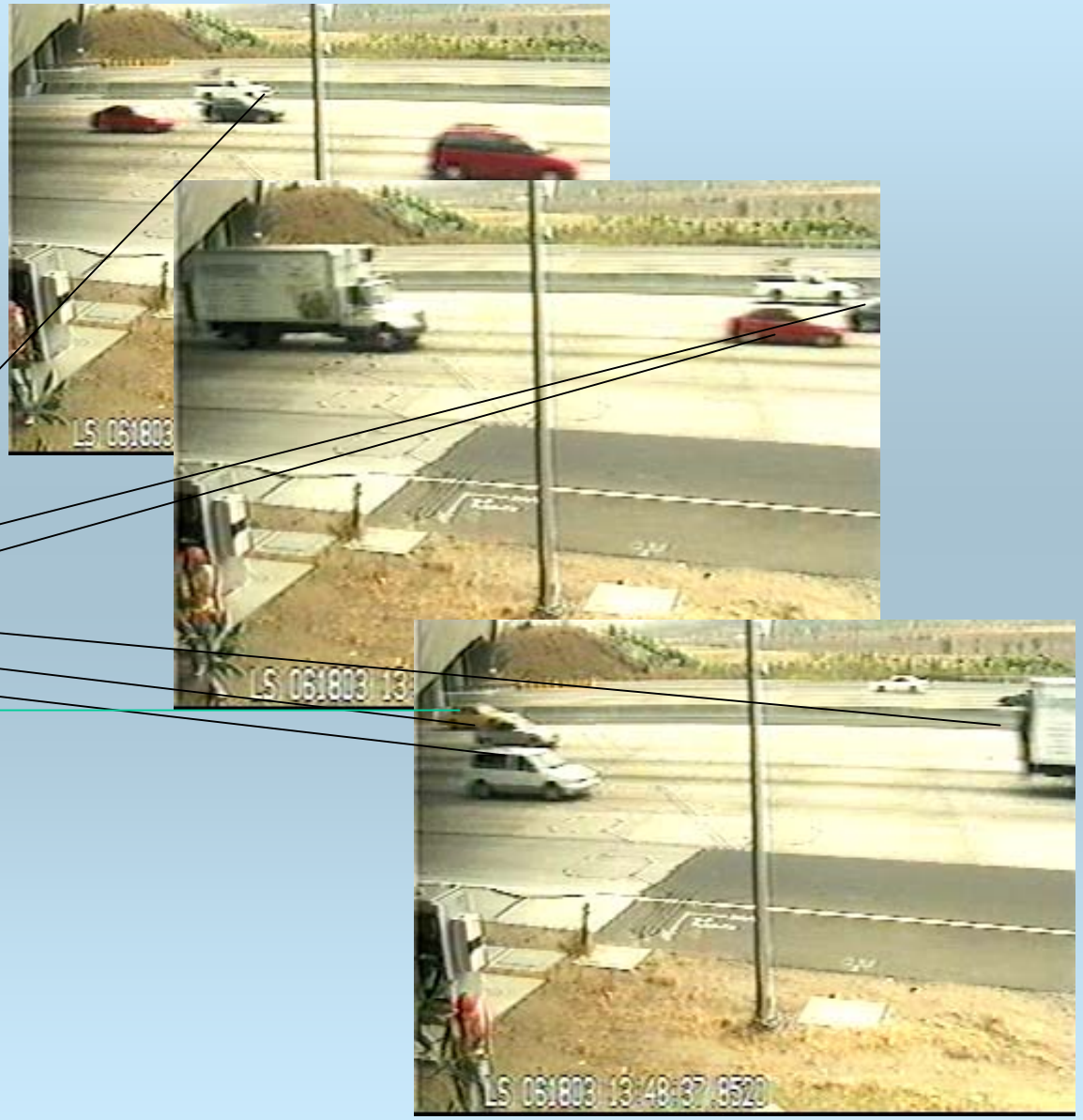
More Occlusion

	MVDS		IST Loop		
	Lane	Time	Lane	Time	
	2	13:48:31.882	2	13:48:31.046	
	3	13:48:33.194	3	13:48:32.378	
	4	13:48:33.565	4	13:48:32.748	
	3	13:48:33.755	3	13:48:32.989	
TT	5	13:48:34.827	5	13:48:33.349	
Missed	4		4	13:48:33.510	
Missed	4		4	13:48:33.954	
	1	13:48:35.077	1	13:48:34.020	
	4	13:48:35.708	4	13:48:34.771	
-OCC	3		3	13:48:34.821	
	5	13:48:36.709	5	13:48:35.943	
	2	13:48:37.100	1	13:48:36.183	
	1	13:48:37.230	2	13:48:36.213	
Missed	3		3	13:48:36.414	
	4	13:48:37.901	4	13:48:36.874	
	2	13:48:38.682	2	13:48:37.786	
	5	13:48:38.602	5	13:48:37.816	



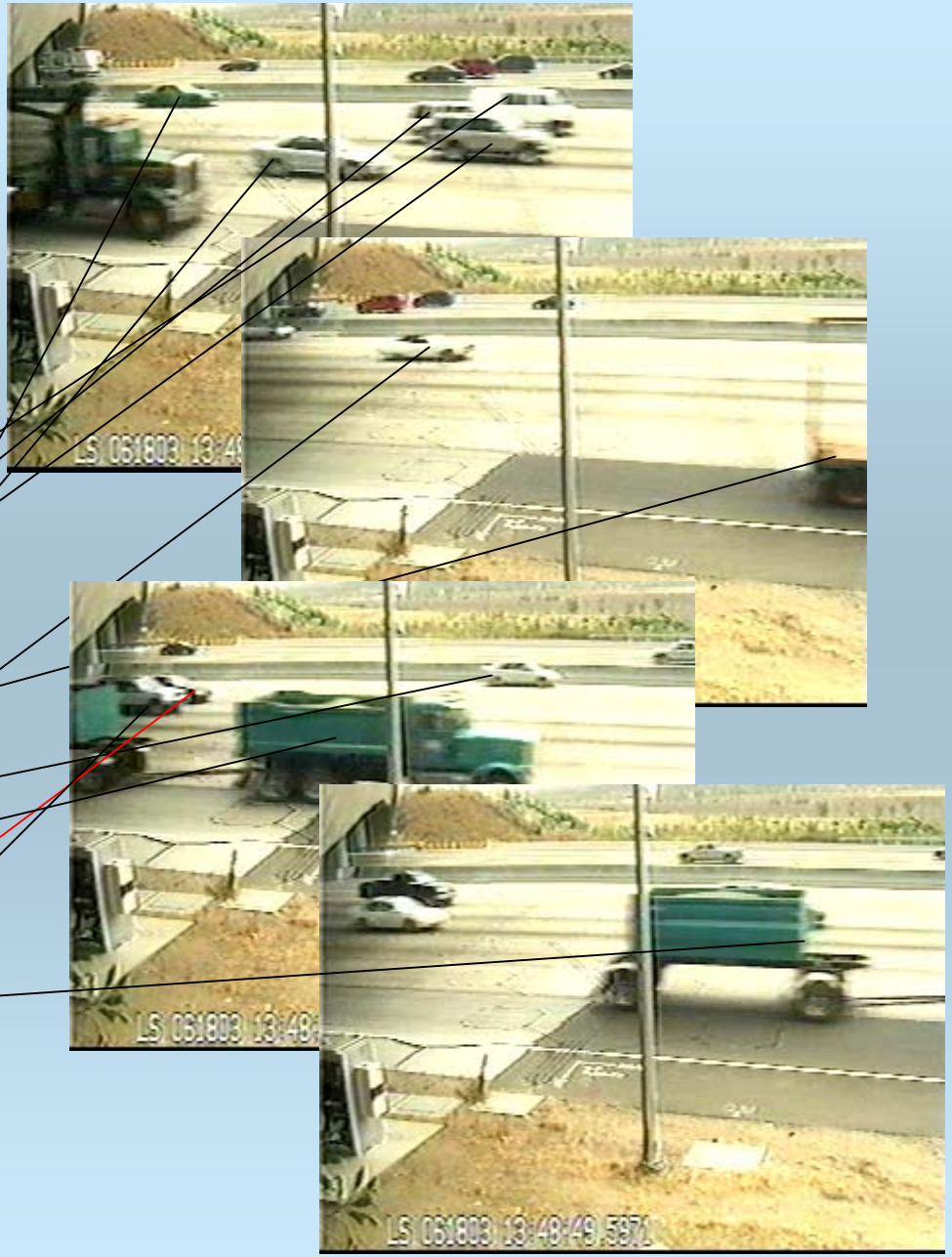
Missed Counts & Occlusion

	MVDS		IST Loop	
	Lane	Time	Lane	Time
-OCC	3		3	13:48:34.821
	5	13:48:36.709	5	13:48:35.943
	2	13:48:37.100	1	13:48:36.183
	1	13:48:37.230	2	13:48:36.213
Mis -1	3		3	13:48:36.414
	4	13:48:37.901	4	13:48:36.874
	2	13:48:38.682	2	13:48:37.786
	5	13:48:38.602	5	13:48:37.816
	1	13:48:40.204	1	13:48:37.846



Lane Changes & Occlusion

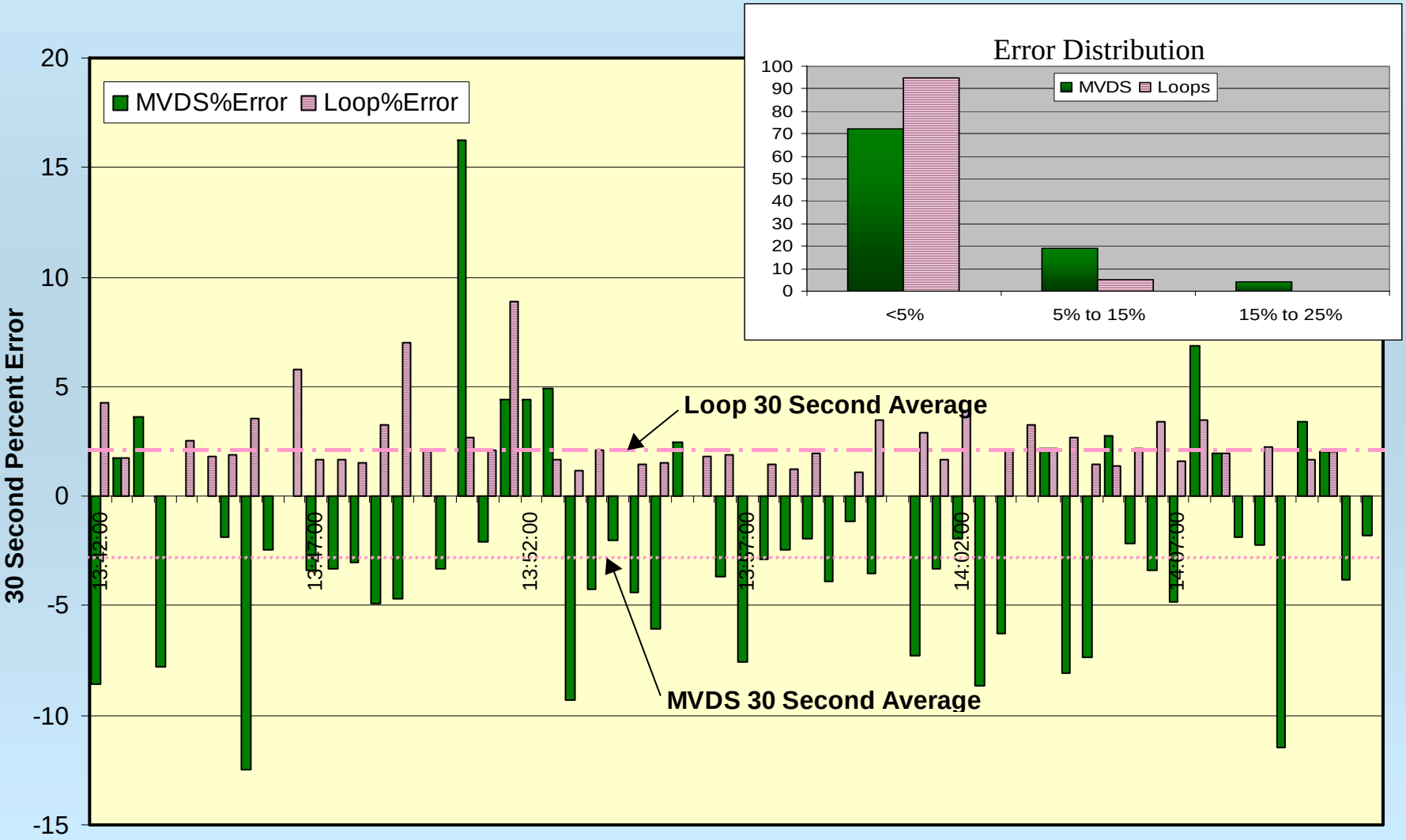
	MVDS		IST Loop		
	Lane	Time	Lane	Time	
TT	5	13:48:46.473	5	13:48:45.266	
	2	13:48:47.305	2	13:48:46.488	
	3	13:48:47.435	3	13:48:46.588	
	4	13:48:47.385	4	13:48:46.588	
	5	13:48:47.575	5	13:48:46.859	
	1	13:48:47.976	1	13:48:46.879	
T	7	13:48:48.216	7	13:48:47.059	
	2	13:48:48.857	2	13:48:47.970	
	1	13:48:49.418	1	13:48:48.321	
TT	6	13:48:49.458	6	13:48:48.661	
+LC	7	13:48:49.398	7	13:48:48.791	+LC
Miss-	2		2	13:48:48.992	
	3	13:48:49.848	3	13:48:49.062	
	6	13:48:49.878	6	13:48:49.124	
+LC	7	13:48:49.858	7	13:48:49.179	+LC



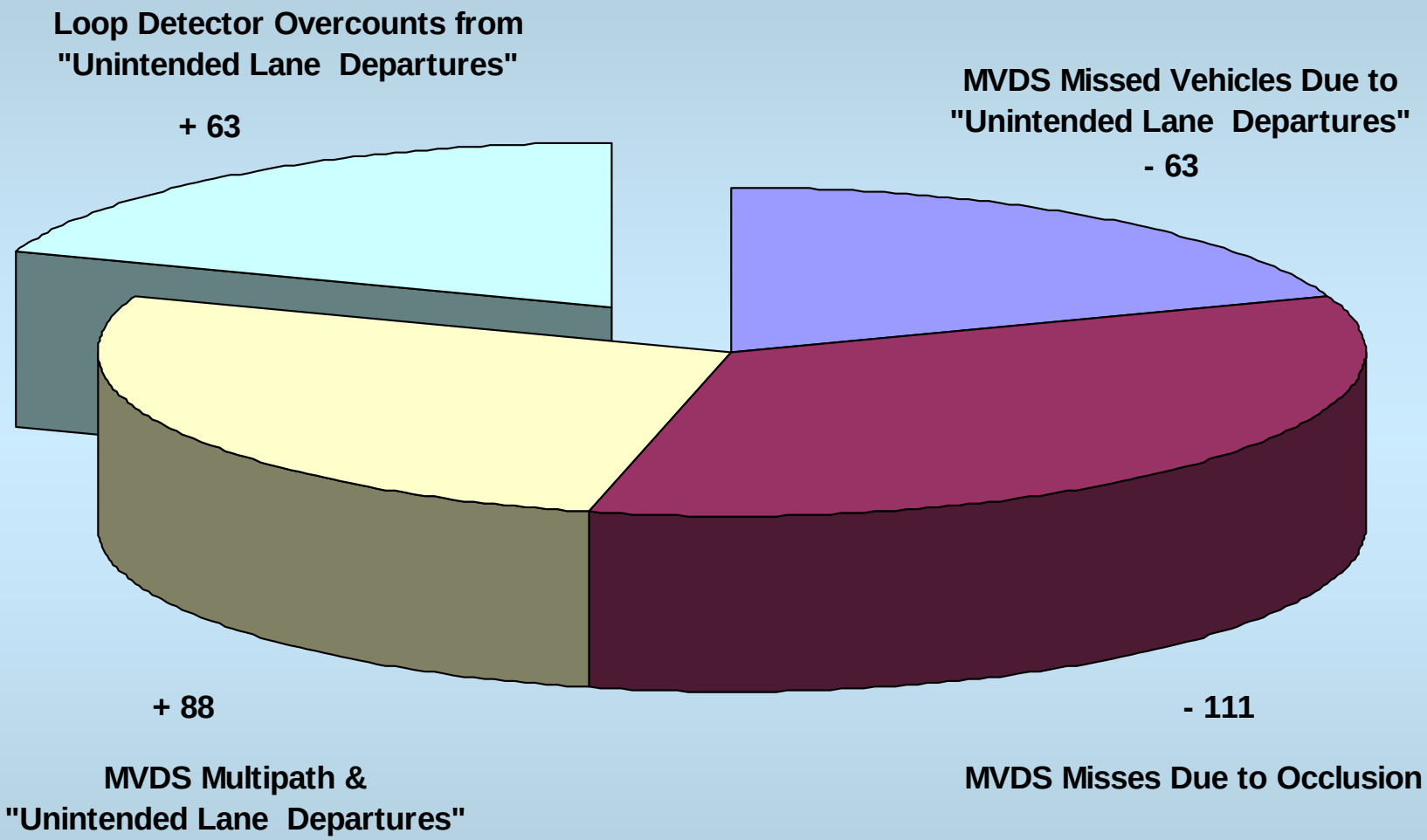
Transport should count for how many vehicles?

		MVDS		IST Loop	
	Lane	Time	Lane	Time	
+1	4	13:49:09.537	4		
TT	5	13:49:09.587	5	13:49:08.209	
	1	13:49:10.007	1	13:49:08.940	
	7	13:49:09.907	7	13:49:09.111	
	6		6	13:49:09.371	+LC

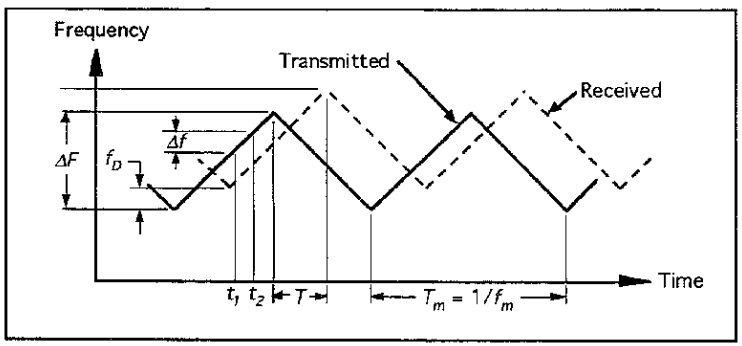
MVDS & Loop 30 Second Results



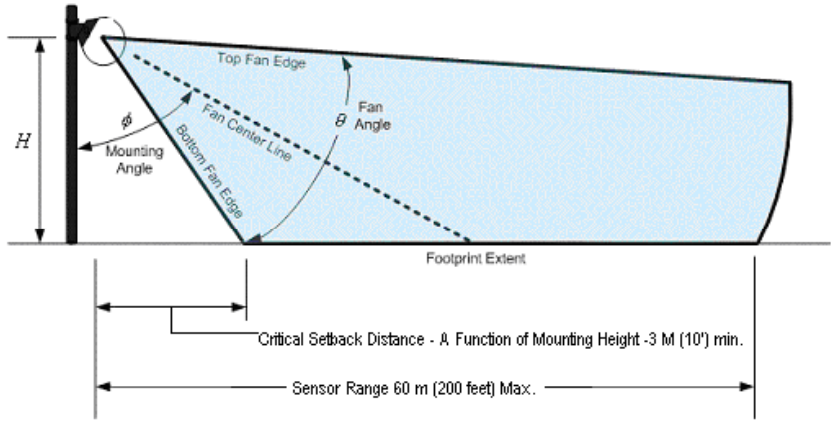
Sources of Detection Error



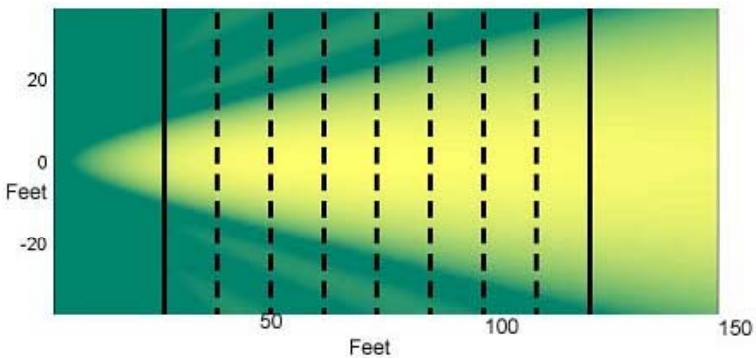
MVDS Operation

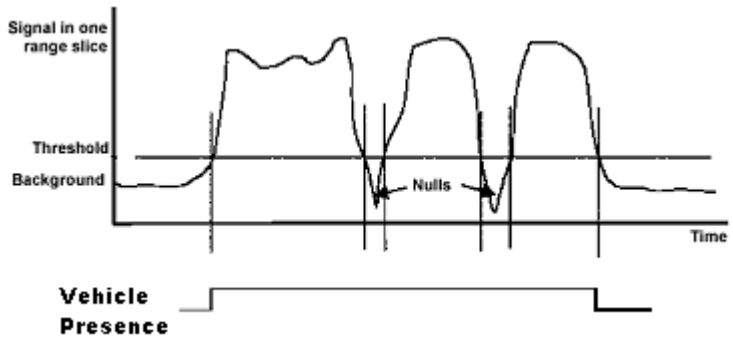


MVDS Signal



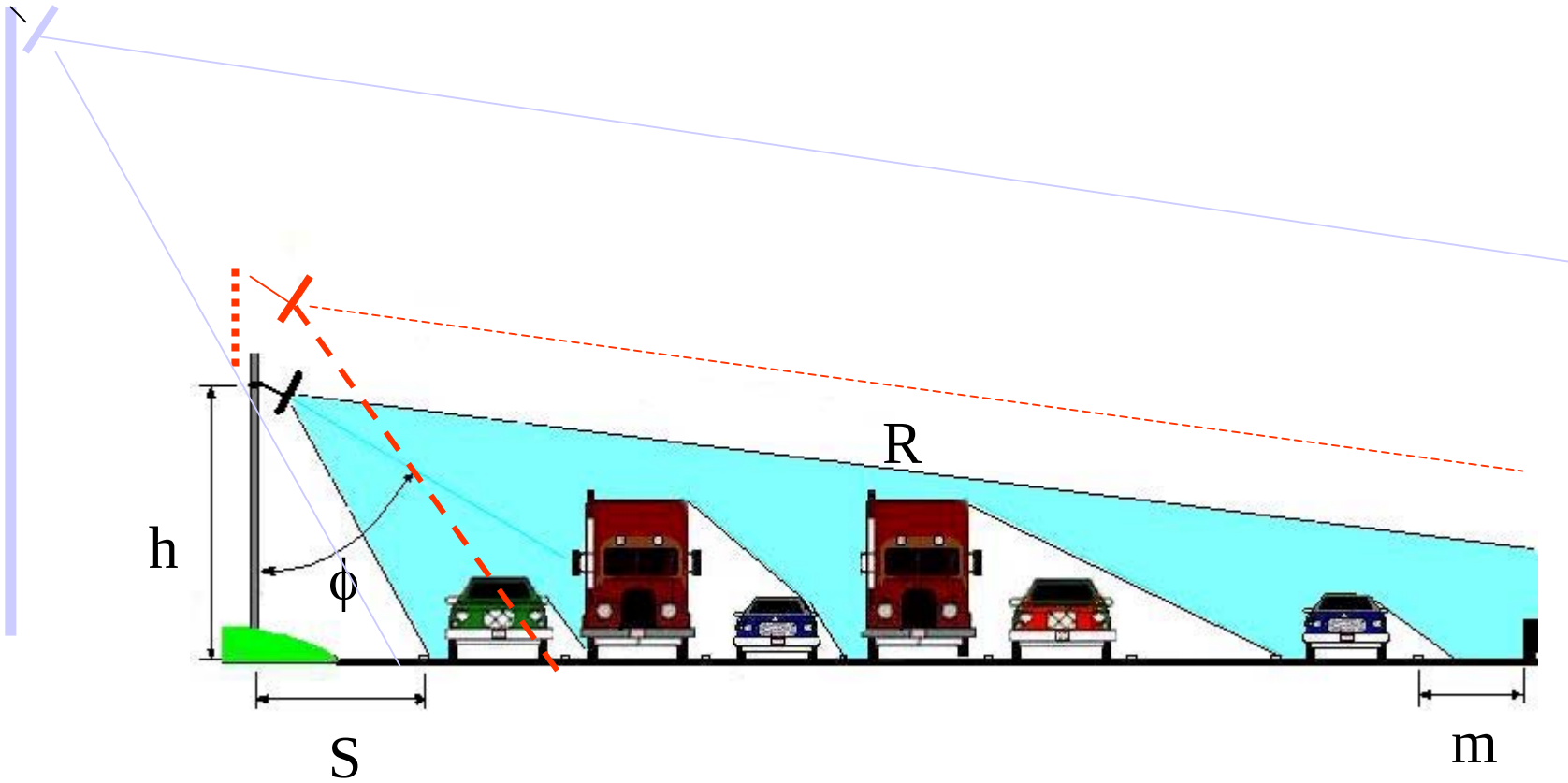
Orientation





Sensitivity Threshold

Critical MVDS Requirements



$h > 17$ ft $S > 15$ ft $m > 9$ ft $R < 200$ ft $\phi = 42^0$

Observations

When MVDS is properly installed & calibrated:

- Will tend to under count
  - Can be very accurate in center lanes
  - Will undercount far lanes (truck occlusion)
  - Will over count in near lanes (RF splash)

MVDS Performance affected by:

- Pole placement, mounting height, detector orientation, distance to median
- Lane configuration, calibration are critical

When ILD installed correctly:

- Will tend to over count due to “unintended lane departures”

When to Consider MVDS

	Inductive Loop Detectors (ILD)	Microwave Detection (MVDS)
Strength	• Have a wealth of experience, know-how • Able to detect / derive many parameters • Acceptable accuracy • Affordable	• Best available "Side-Fire" solution • Reduced need for road closure • Low power, viable for solar / wireless operation • Affordable
Weakness	• Safety concerns in working on roadway • Cost of lane closures • Subject to road wear and tear/service • Tend to over-count lane changers	• Occlusion from trucks in remote lanes • Strict installation requirements • Tricky set-up and calibration • Don't know what you have w/o TRUTH • Will not reliably hold presence

Possible Use		• Option for some freeway data applications
		  • Count Stations
		  • Speed Maps
		  • Quick expansion of data collection into rural areas
		  • Fill missing data points
		  • Temporary Construction

Where Not to Use		• Un-proven for controlling Signals • Not acceptable for some Ramp Metering

Test report available at:

http://www.dot.ca.gov/hq/traffops/elecsys/reports/FinalMVDS104.pdf

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