

FLASHING RED ARROW: LEFT-TURN INDICATION AND INTERSECTION SAFETY

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PRESENTATION OUTLINE

1. Background
2. Locations
3. Before-After Study
4. Conclusion

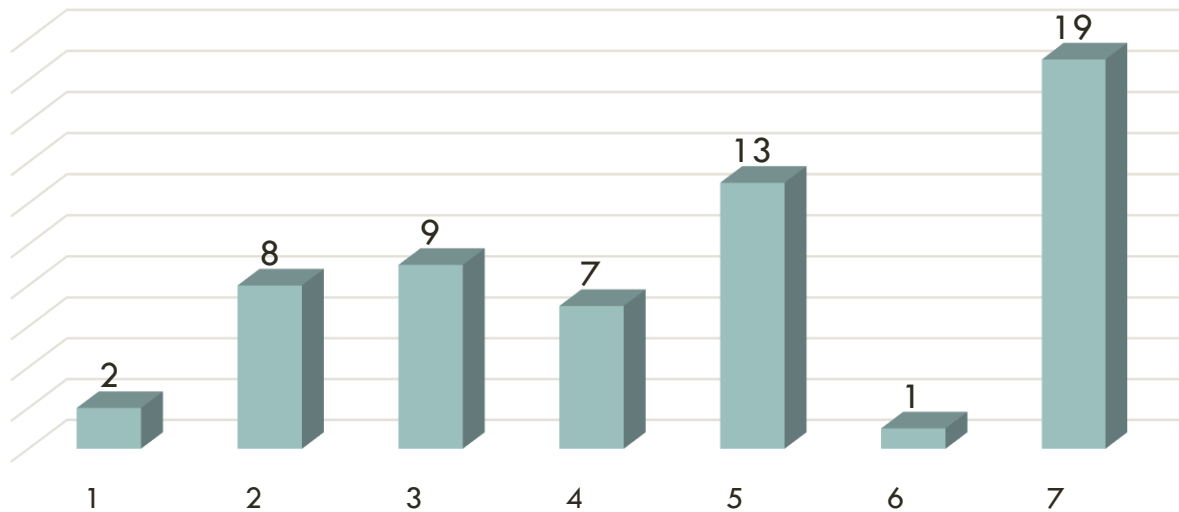
BACKGROUND

- Only Maryland and Delaware use flashing red arrow (FRA) display; most states utilize flashing yellow arrow
- Deployed by SHA since 1989
- Typical reasoning for FRA installations on SHA roads:
 - Crash pattern on an EP controlled LT movement (existing signals)
 - Original equipment for newly designed signals
- Temporary or permanent solution
- Can work part-, or full time, depending on the need and conditions. Uses standard LT signal heads and controller

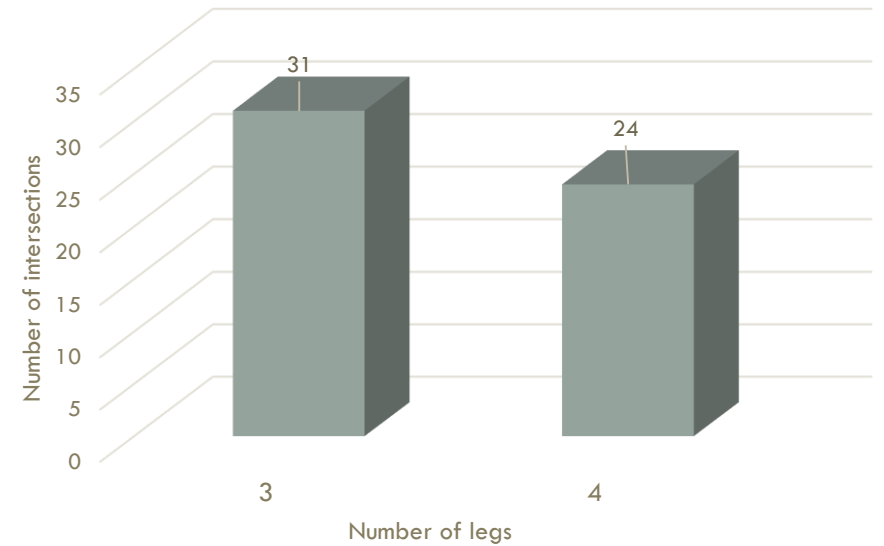
LOCATIONS

To date, TDSD/TOD identified 60
Intersections with FRA

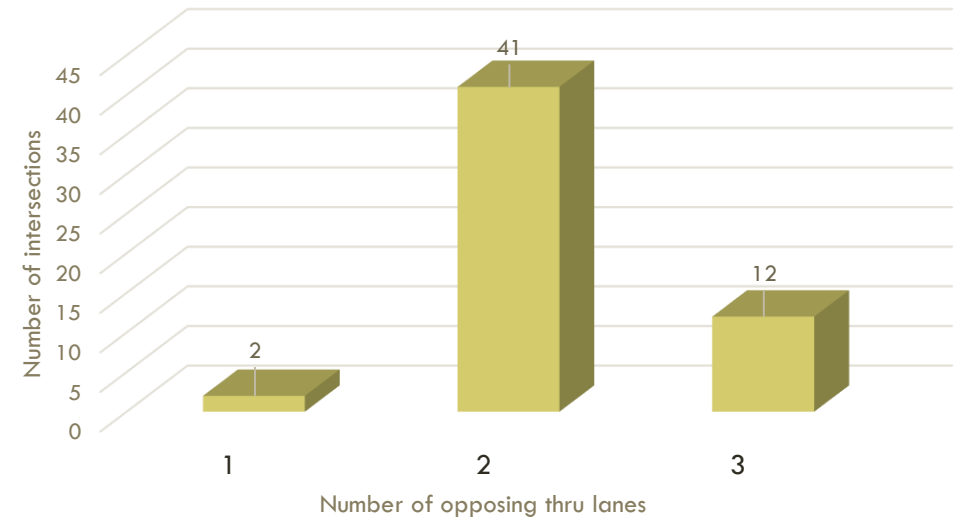
Known FRA Locations by District



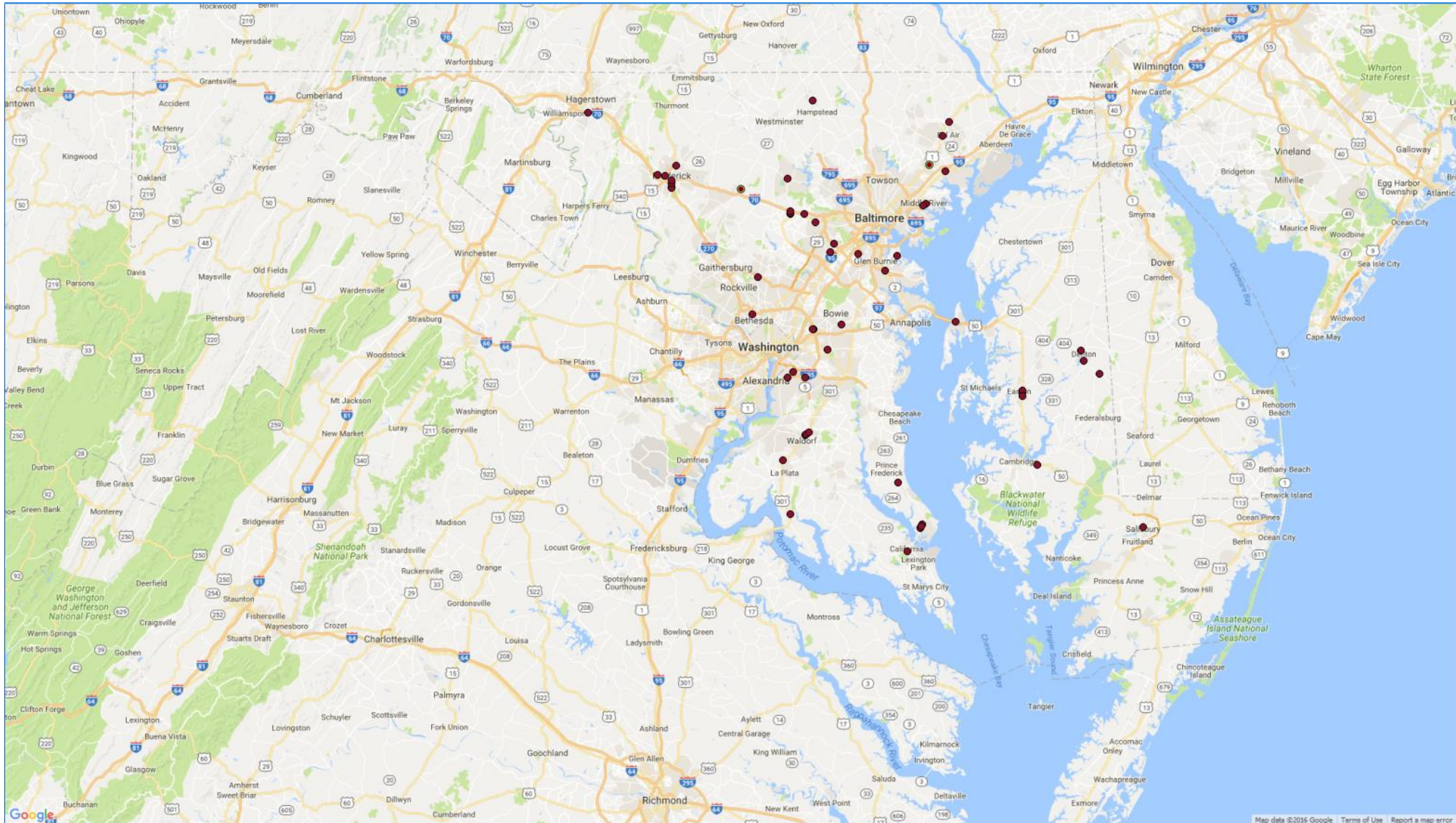
Distribution by # of legs



Distribution by # of opposing thru lanes



LOCATIONS



RESEARCH OBJECTIVES

What is the effect of Flashing Red Arrow on crashes?

Can FRA improve one crash pattern but have a negative impact elsewhere?

How can we control for the effect of just the LT display?

BEFORE-AFTER STUDY SELECTION CRITERIA

- **SATISFY THE MAIN RESEARCH OBJECTIVE**
 - Accept locations where FRA was the sole improvement at the time of deployment (replacement for 5-head EP display)
 - Accept all intersection layouts (half-signal, T or 4-leg; 1-,2-, or 3 opposing lanes)
 - Accept temporary or permanent installations
 - Reject previously unsignalized intersections
 - Generally, reject part-time FRA's (However, possible inclusion after careful time-of-day filtering of the crash data)
- **CRASH DATA RELIABILITY**
 - 3 calendar years of crash data for both 'before', and 'after' condition
 - Reject 'too old' installations (before 2000) due to potentially unreliable 'before' crash data.
 - Reject 'too new' installations (after 2013) due to insufficient 'after' data.

FINAL LIST

| Location | District | Leg | Opposing thru lane | Date of approval | Date of installation |
|---------------------------|----------|-----|--------------------|------------------|----------------------|
| MD 8 @ MD 18 | 2 | 4 | 2 | 3/1/2009 | 3/25/2009 |
| US 50 @ Dutchmanns | 2 | 4 | 2 | 10/1/2012 | 9/30/2013 |
| US 50 @ MD328 | 2 | 4 | 3 | 10/1/2012 | 12/11/2012 |
| US 50 @ MD 331 | 2 | 4 | 3 | 10/1/2012 | 12/11/2012 |
| MD 450 @ I 495 | 3 | 3 | 3 | 2/1/2003 | 7/19/2003 |
| MD 26 @ Johnsville | 7 | 4 | 2 | 3/14/2012 | 6/14/2012 |
| MD 85 @ Guilford Dr | 7 | 4 | 2 | 11/16/2007 | 04/11/2008 |
| MD 103 @ Brightfield Rd | 7 | 4 | 1 | 1/7/2010 | 5/14/2010 |
| MD 108 @ Lark Brown Rd | 7 | 4 | 2 | 4/1/2012 | 10/23/2012 |
| MD 150 @ Kingston Rd | 4 | 3 | 2 | 1/3/2012 | 7/13/2012 |
| US 40 @ Marriottsville Rd | 7 | 4 | 2 | 12/1/2008 | 2/26/2009 |

RESULTS

Before After

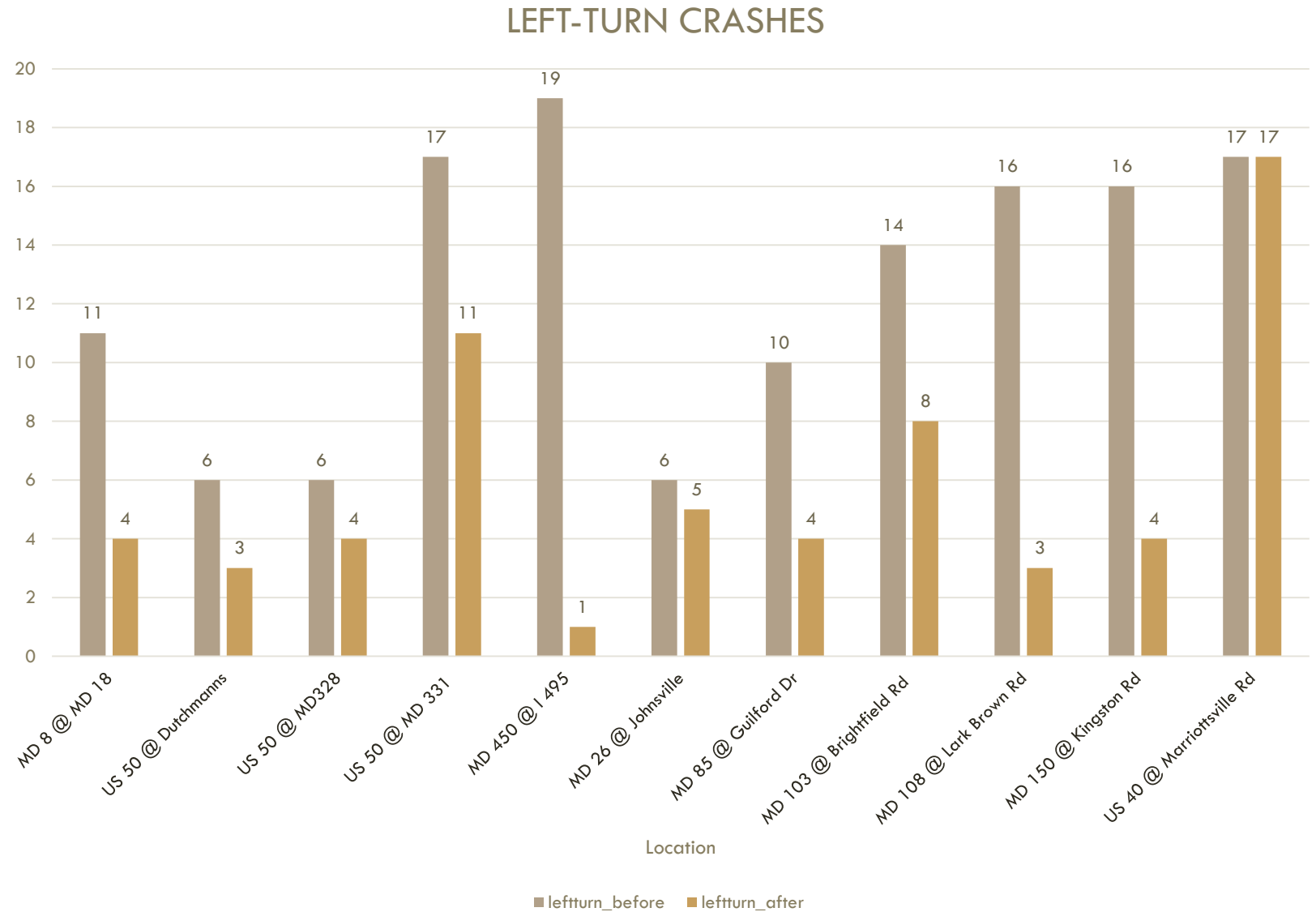
Mean 12.55 5.82

Diff 6.73

t 4.006

P-value 0.0025

95% conf inv [2.99, 10.47]

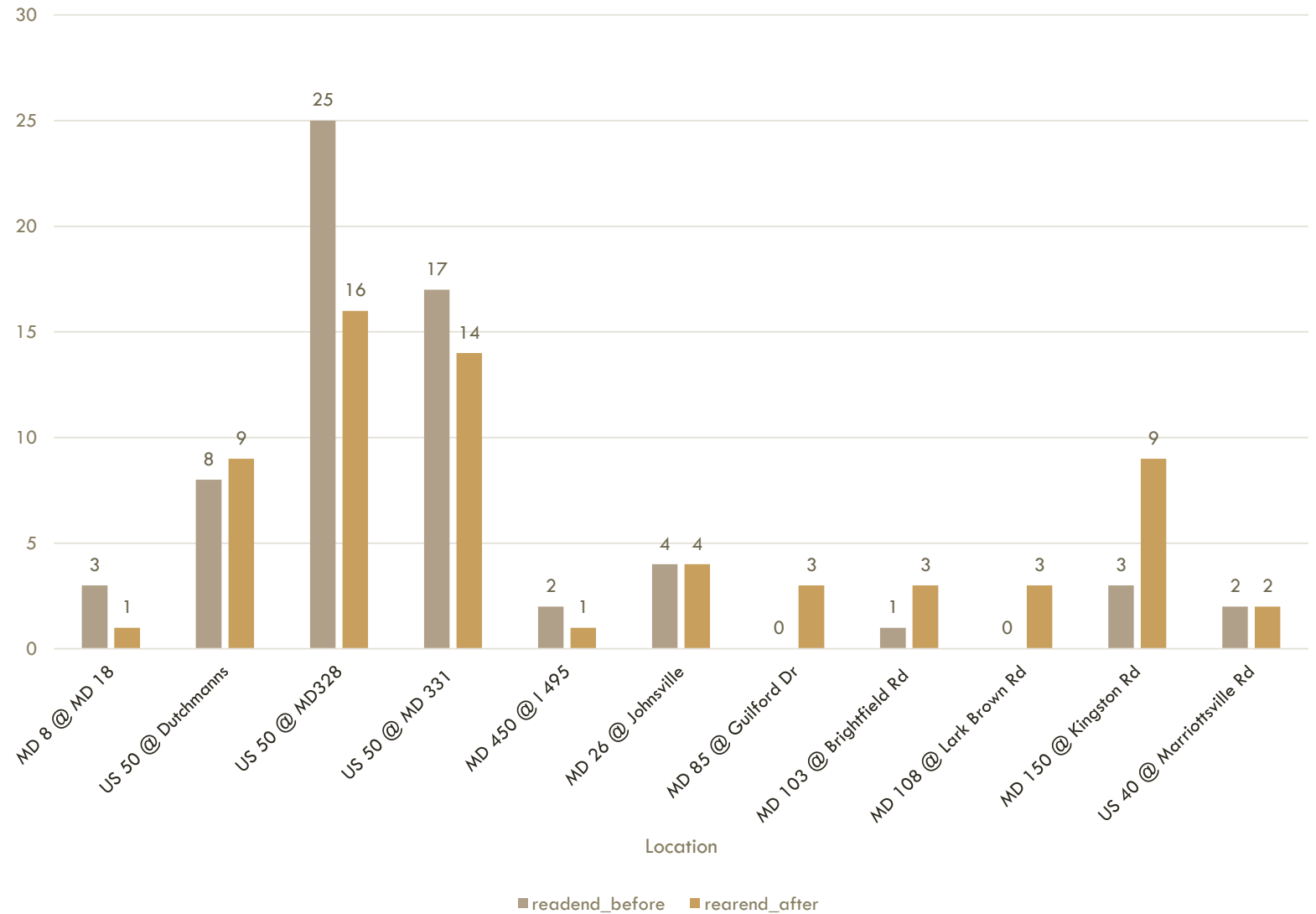


RESULTS

| | Before | After |
|--------------|---------------|-------|
| Mean | 5.91 | 5.91 |
| Diff | 0.00 | |
| t | 0.00 | |
| P-value | 1.00 | |
| 95% conf inv | [-2.64, 2.64] | |

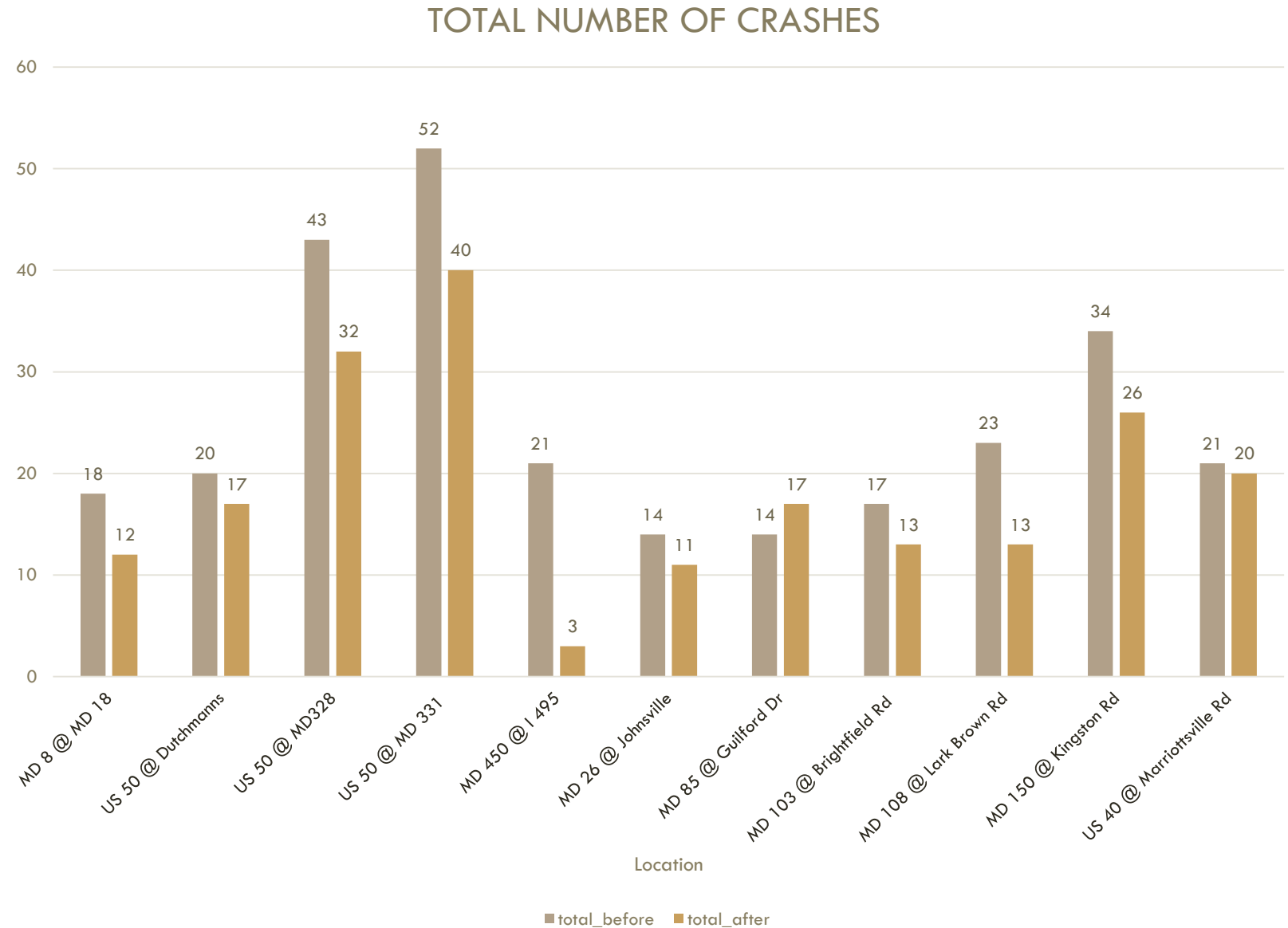
NOT significantly different

REAR-END CRASHES



RESULTS

| | Before | After |
|--------------|---------------|-------|
| Mean | 25.18 | 18.55 |
| Diff | 6.64 | |
| t | 3.73 | |
| P-value | 0.0039 | |
| 95% conf inv | [2.67, 10.60] | |



CONCLUSIONS

- Left-turn related and total number of crashes decreased after the FRA treatment
- No change in the number of rear-end crashes
- Gathering a larger sample expected to yield a more statistically convincing argument and allow for CMF development

FUTURE DIRECTIONS

- The Crash Modification Factors for FRA will be developed to systematically model the effect on safety
- As the sample increases, consider expanding the study onto more strictly defined sub-groups of intersections (e.g. previously unsignalized, T-only, effect of number of opposing lanes, etc.)

What to look forward to in 2017:

- OOTS Application Guideline on FRA Signal Display (TDSD)
- Research paper documenting this study in detail (TDSD/UMD)

QUESTIONS?

