Filtering and flashing through cycleways

Presentation to
SNUG 2018 Workshop

ViaStrada Ltd

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TRANSPORT PLANNING AND DESIGN

Setting the scene

- Separated cycleways at signalised intersections
  - left turning motorists vs through cyclists
- Typical treatment = full protection
  - Is this *really* the most safe and efficient way?
  - Are there other options?
- Let's talk…

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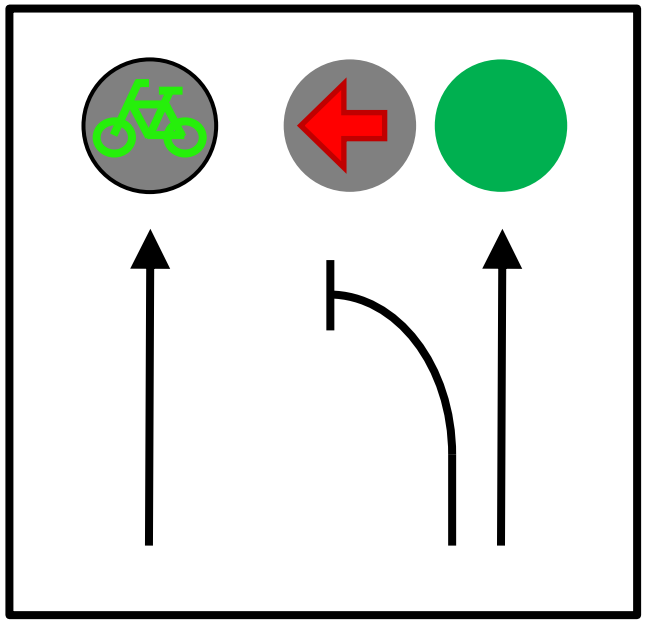
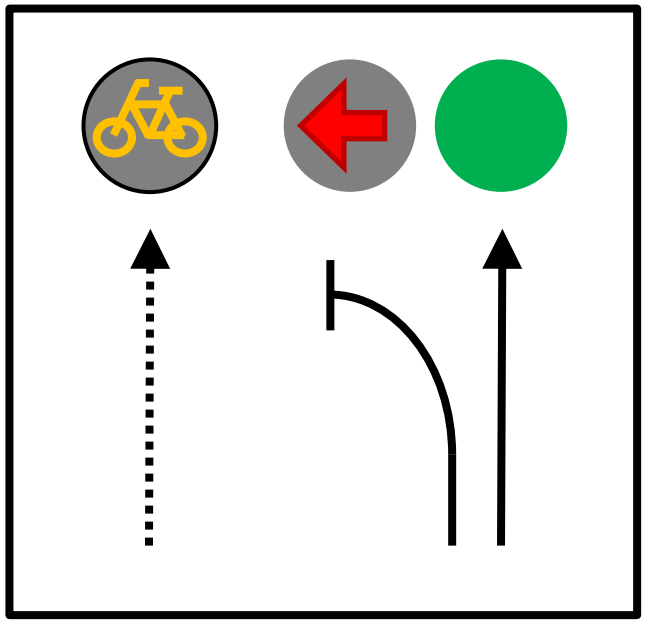
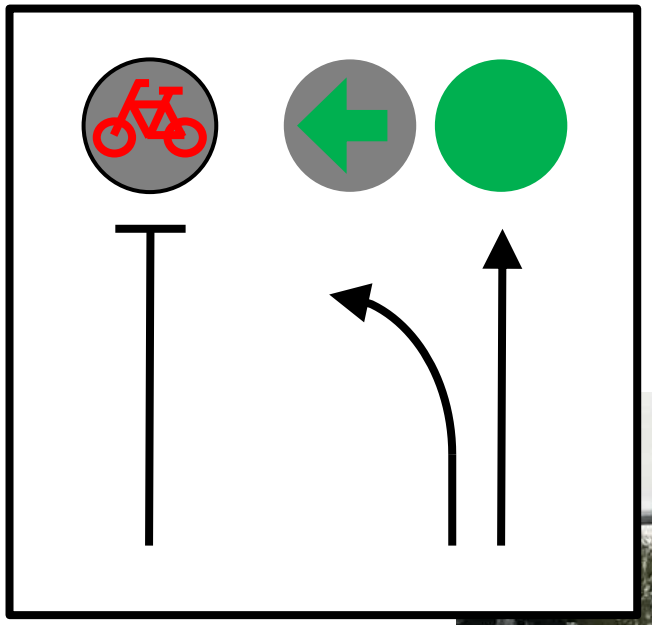
Fully protected cycleway at intersection







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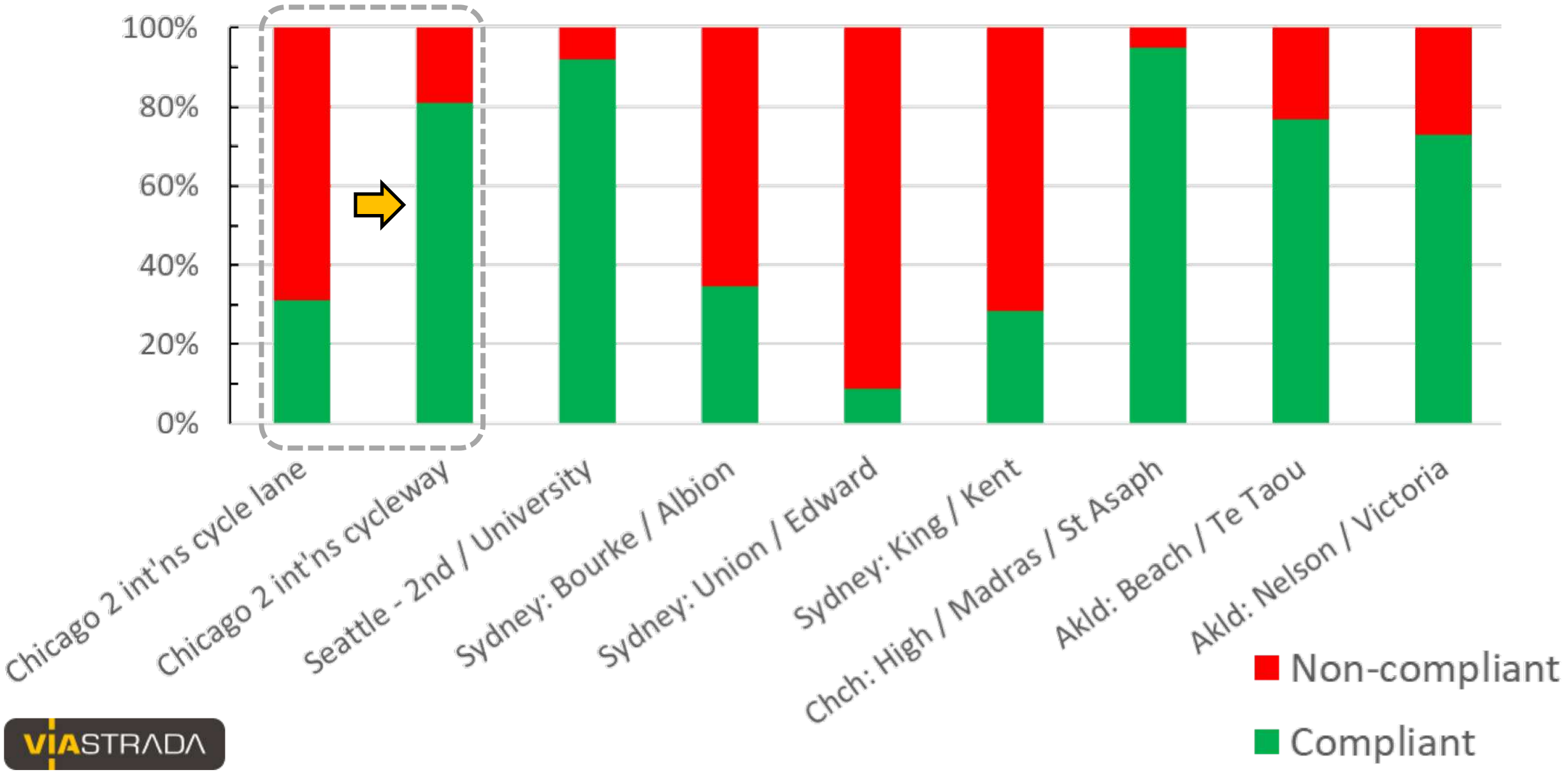
Cycle compliance studies – full protection



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Factors in cyclist compliance at full protection

- Opportunity to infringe
  - Depends on cycle signal state on arrival

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- Risk of conflict

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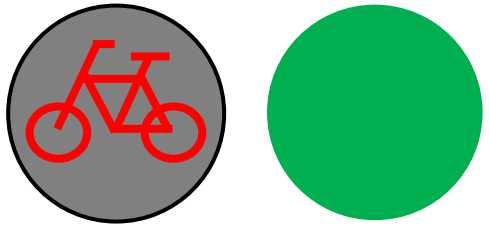
Factors in cyclist compliance at full protection

- Opportunity to infringe
  - Depends on cycle signal state on arrival
  - Timing of cycle movement within phase is important
  - Relates to coordination along corridor
- Risk of conflict
- Comparison with parallel through traffic

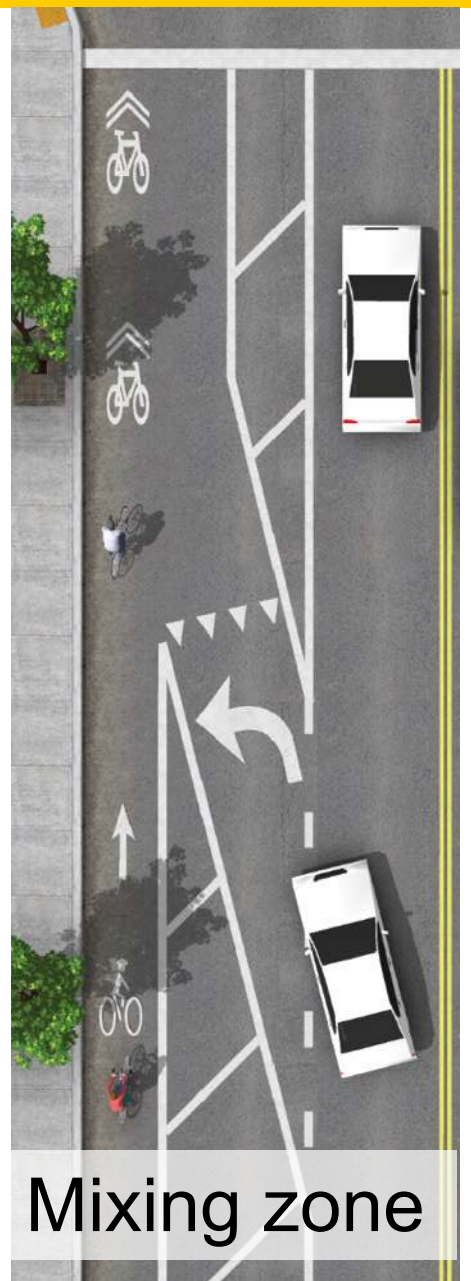


$$Cyclist\ compliance \sim \frac{cyclist\ green\ time}{parallel\ traffic\ green\ time}$$

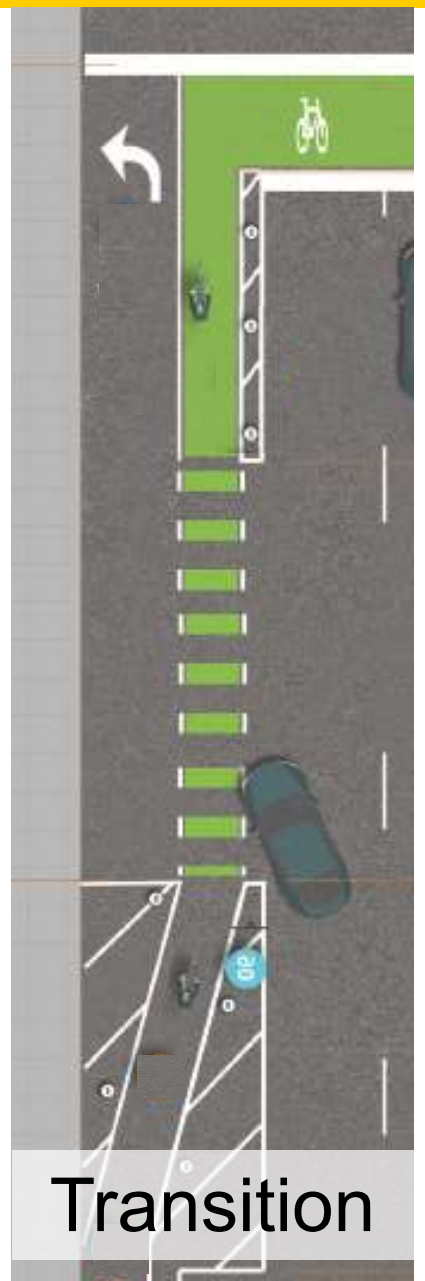
Alrutz et al (1996)

Other ways to tackle the problem?

Filter turning

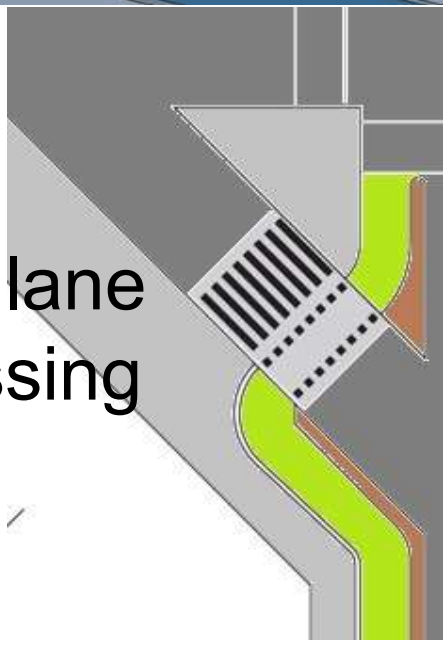


Mixing zone



Transition

Protected intersection



Slip lane crossing

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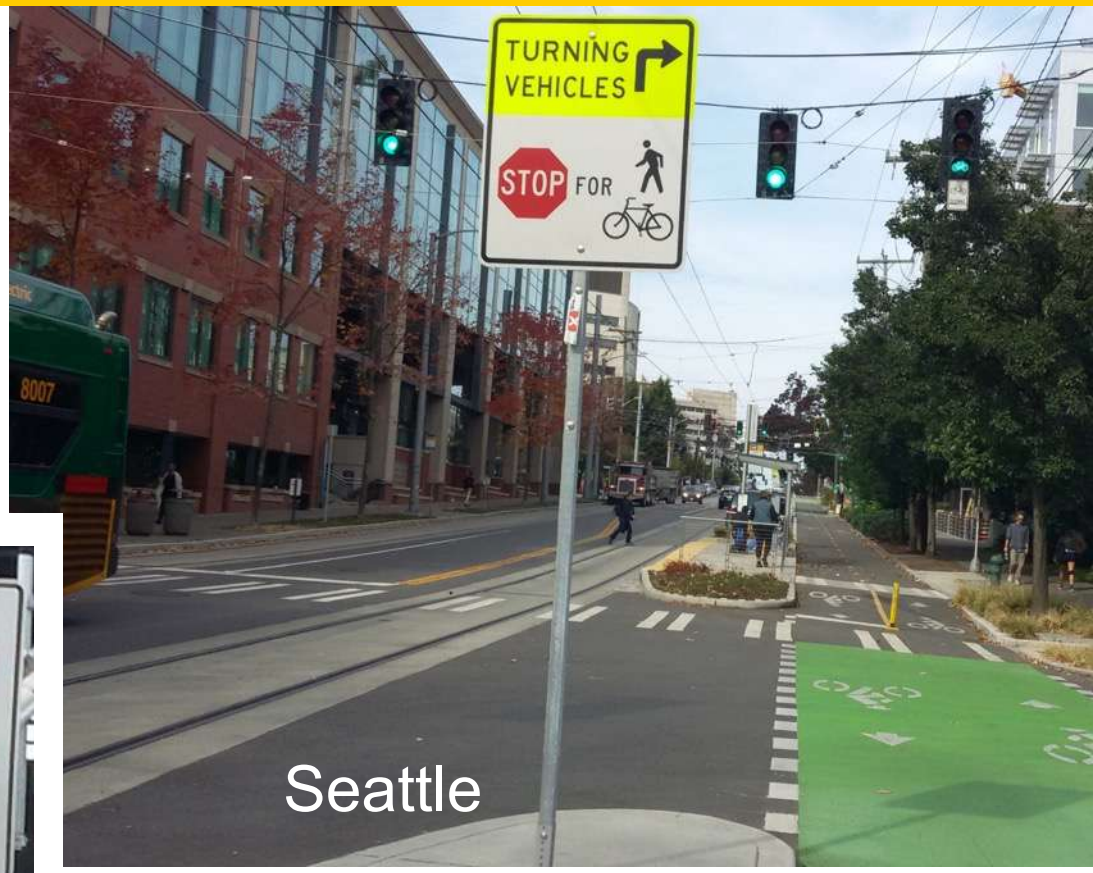
Filter turning – New York example

New York City

Filter turning aids – signs & markings

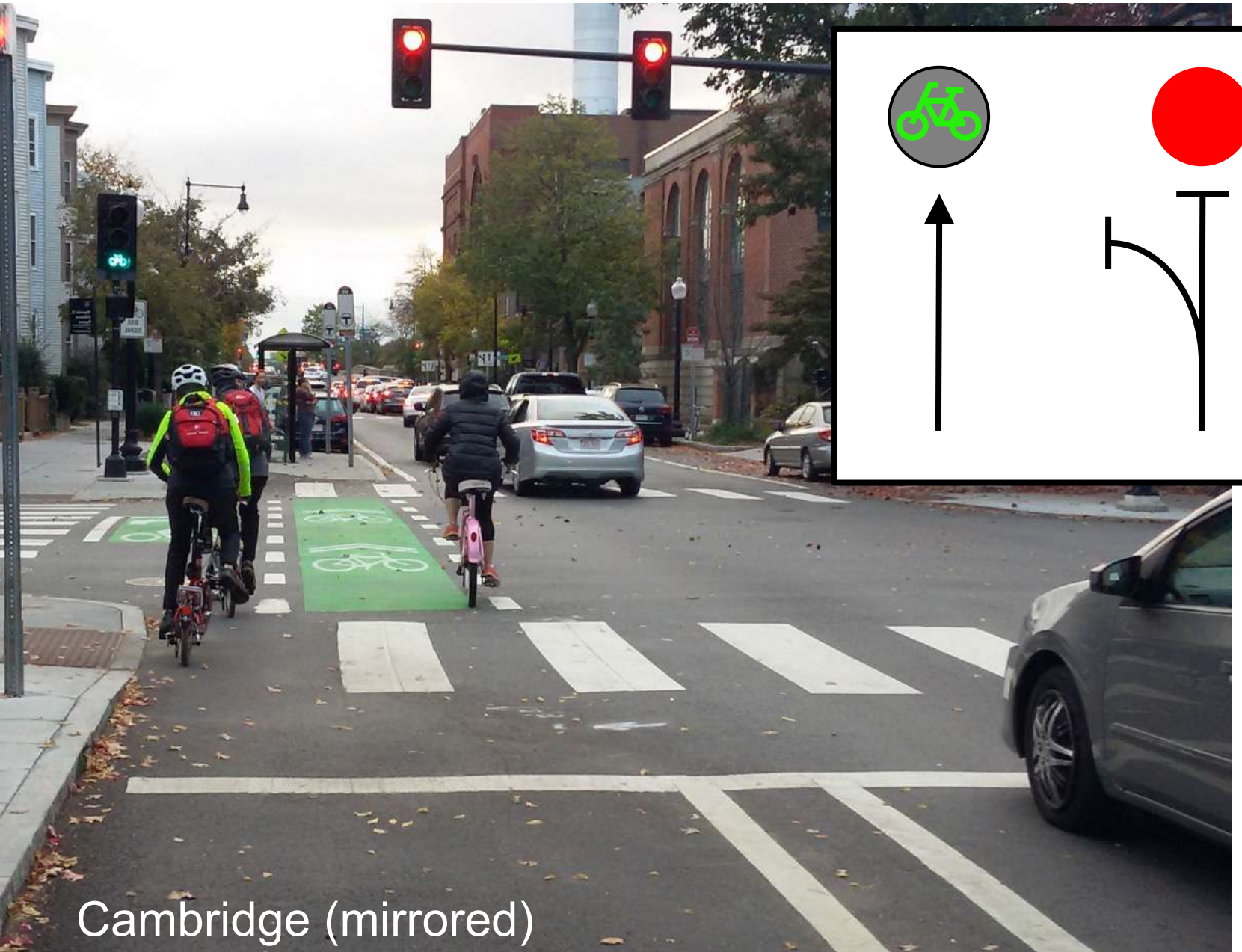
Cambridge


Toronto

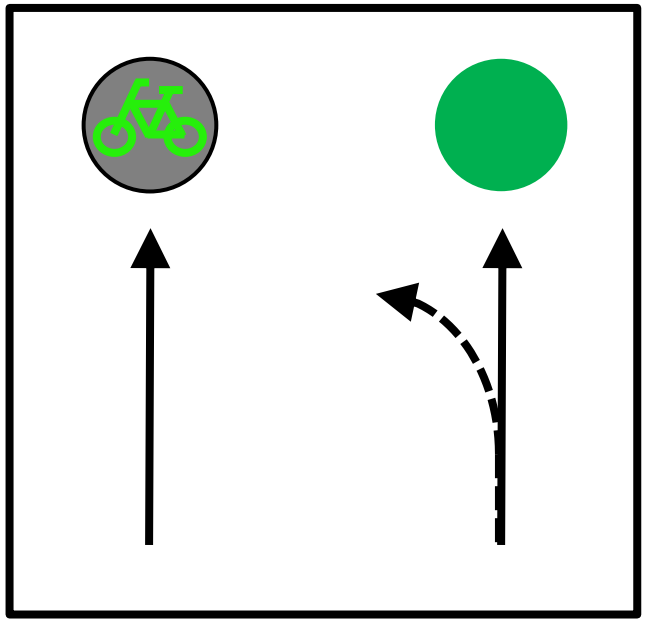


Seattle

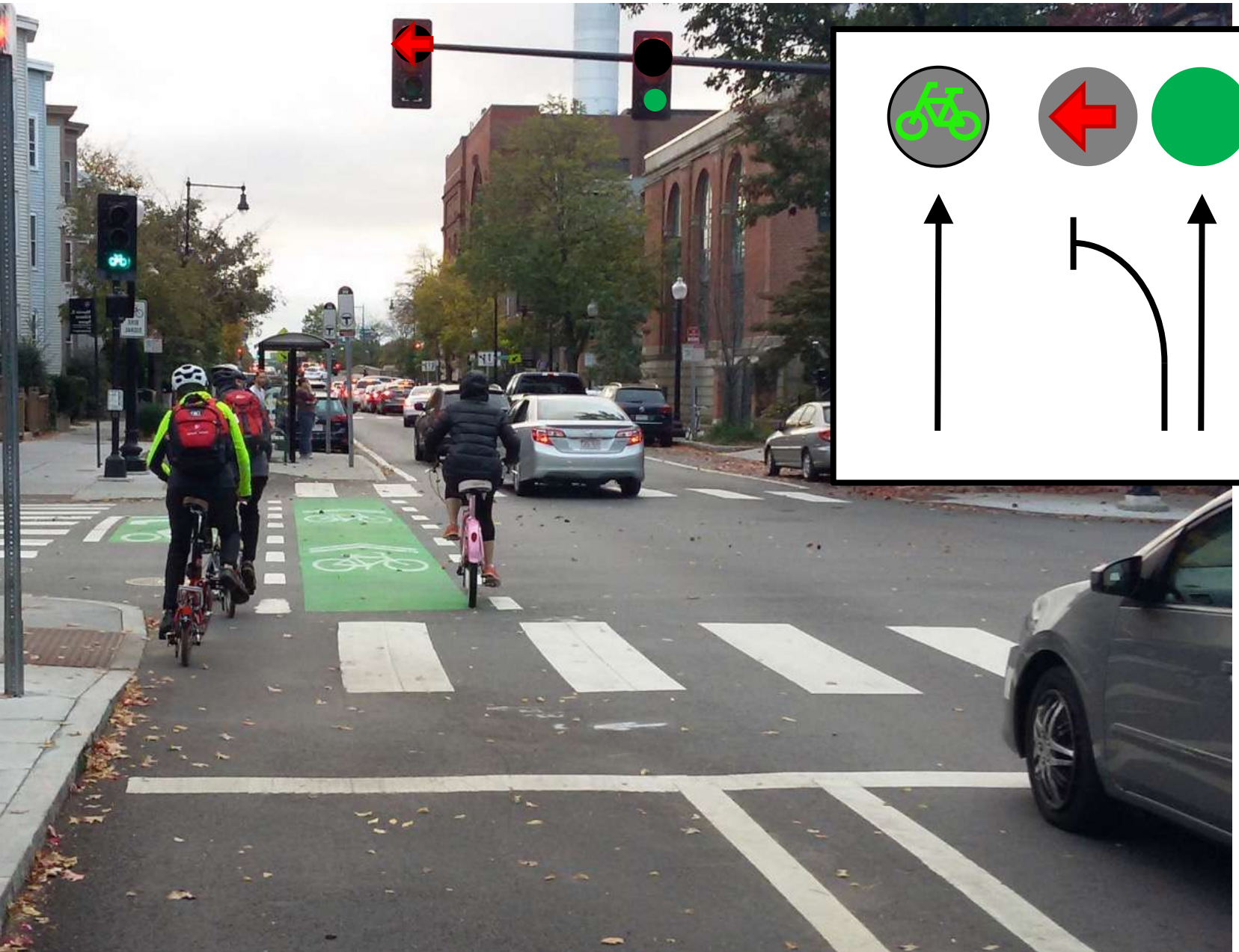
Filter turning aids – cycle head starts

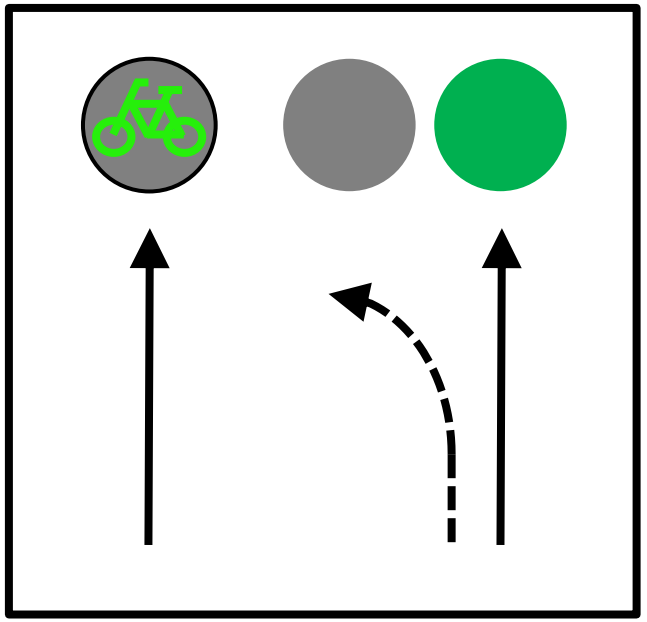


Cambridge (mirrored)



Filter turning aids – partial protection





Filter turning aids – flashing yellow arrows

New York City

Filter turning aids – flashing yellow arrows

New York City

Filter turning in NZ?

- Legal implications
  - Might still be a few grey areas (as seen at SNUG 2014)
    - **Ambiguous definition of "roadway" (Road User Rule)**
    - Limited definition of cycle aspect (Traffic Control Devices Rule)
  - Flashing yellow arrows would require an official TCD trial
    - *Might* also be a way around problems with above definitions
- Concerns
  - Already have a problem with filter turning through pedestrians – why extend this to cyclists?
  - Will drivers understand the flashing yellow arrow?

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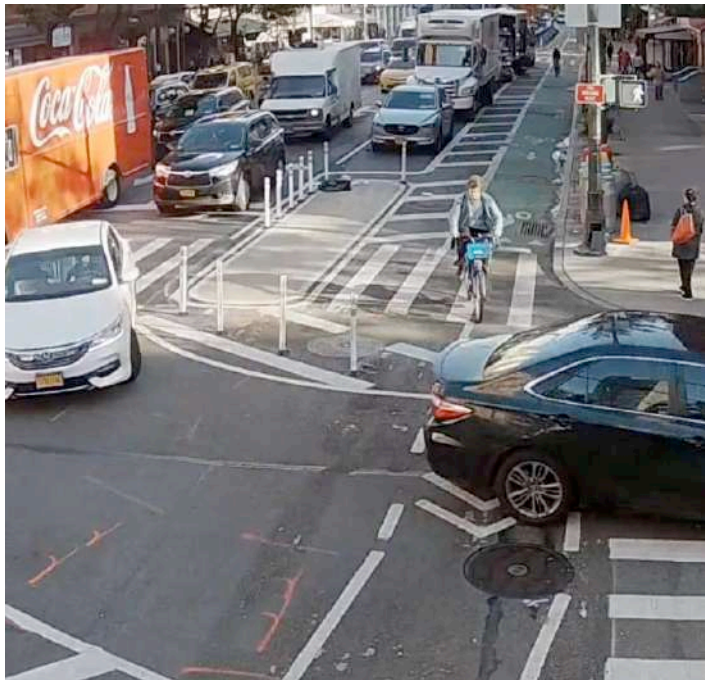
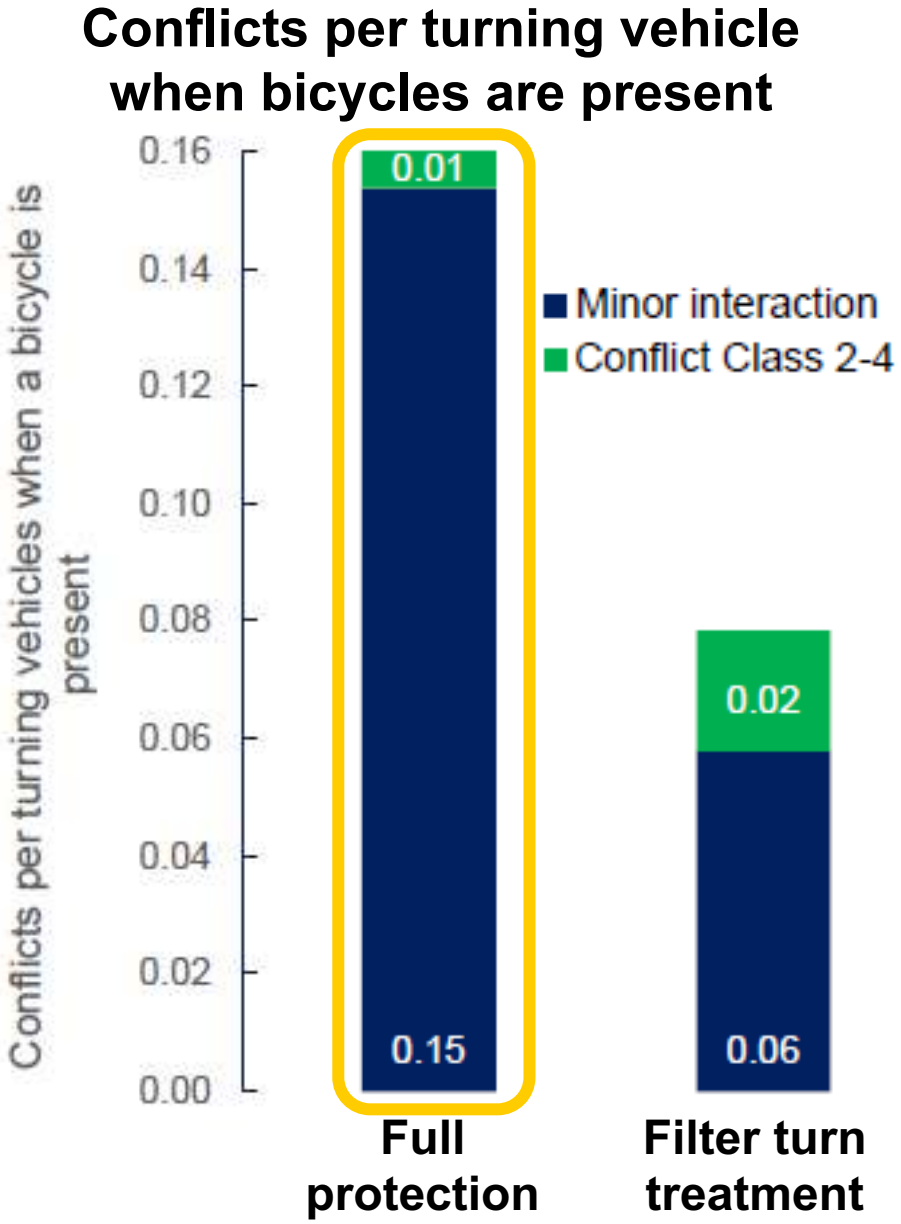
NYC study: protection vs filtering

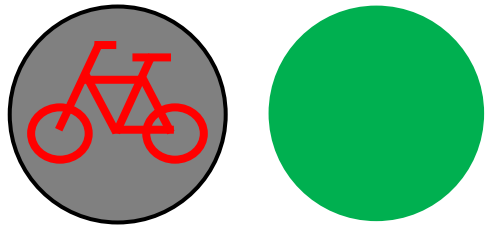
- 4 signalised intersection treatments for separated cycleways:
  - Mixing zones
  - Full protection
  - Filter turning (with partial protection + flashing yellow arrow)
  - Offset crossing (“Dutch intersection” design)



NYC study: protection vs filtering



- Fewer conflicts for filter turn treatment!
- Conflicts at fully protected sites:
  - Red light running (mainly cyclists)



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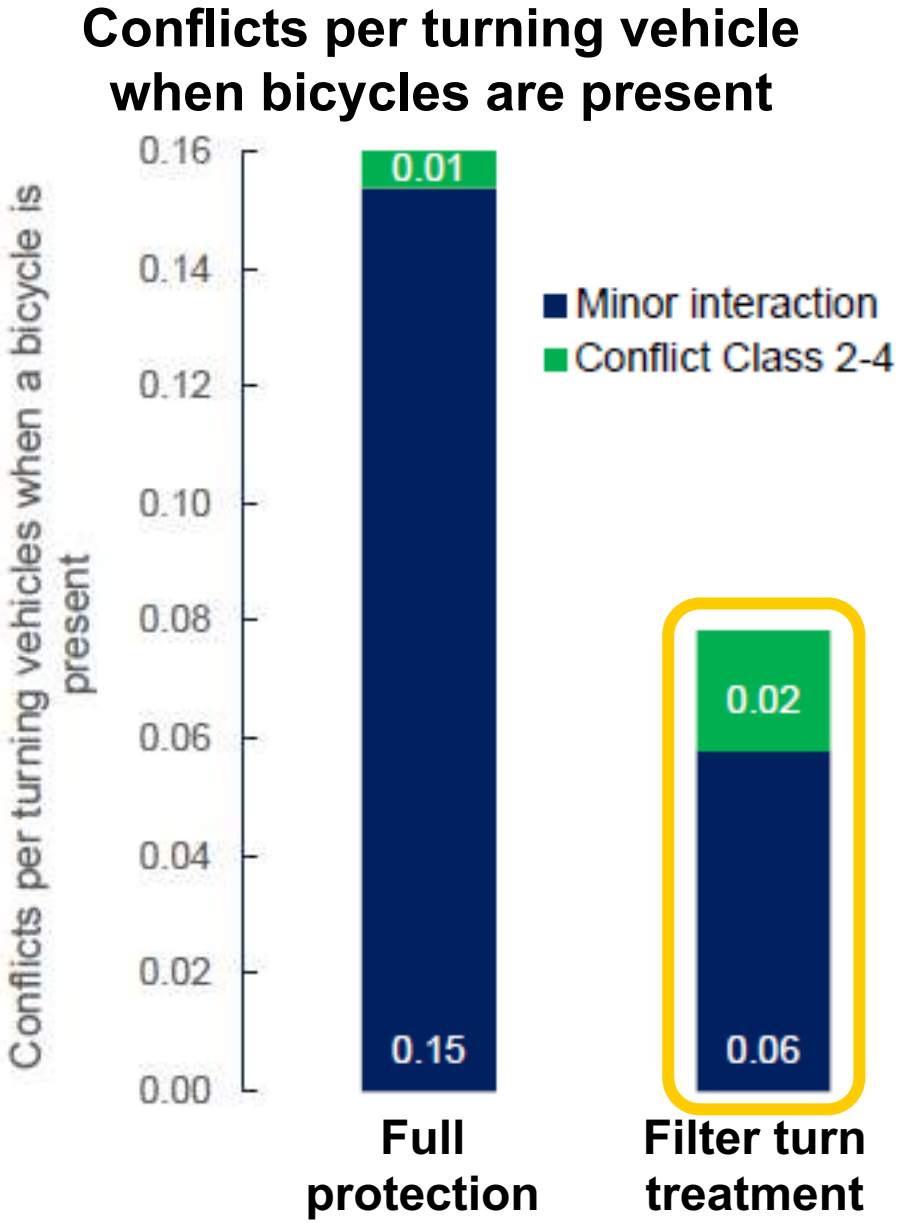
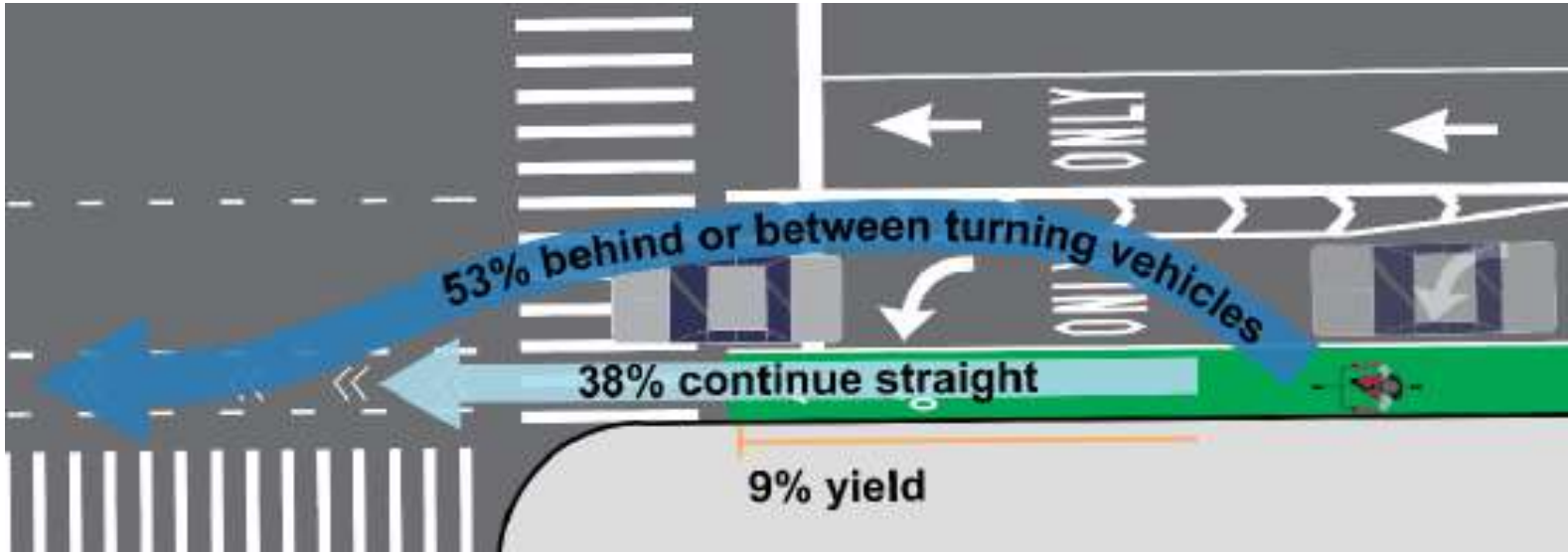
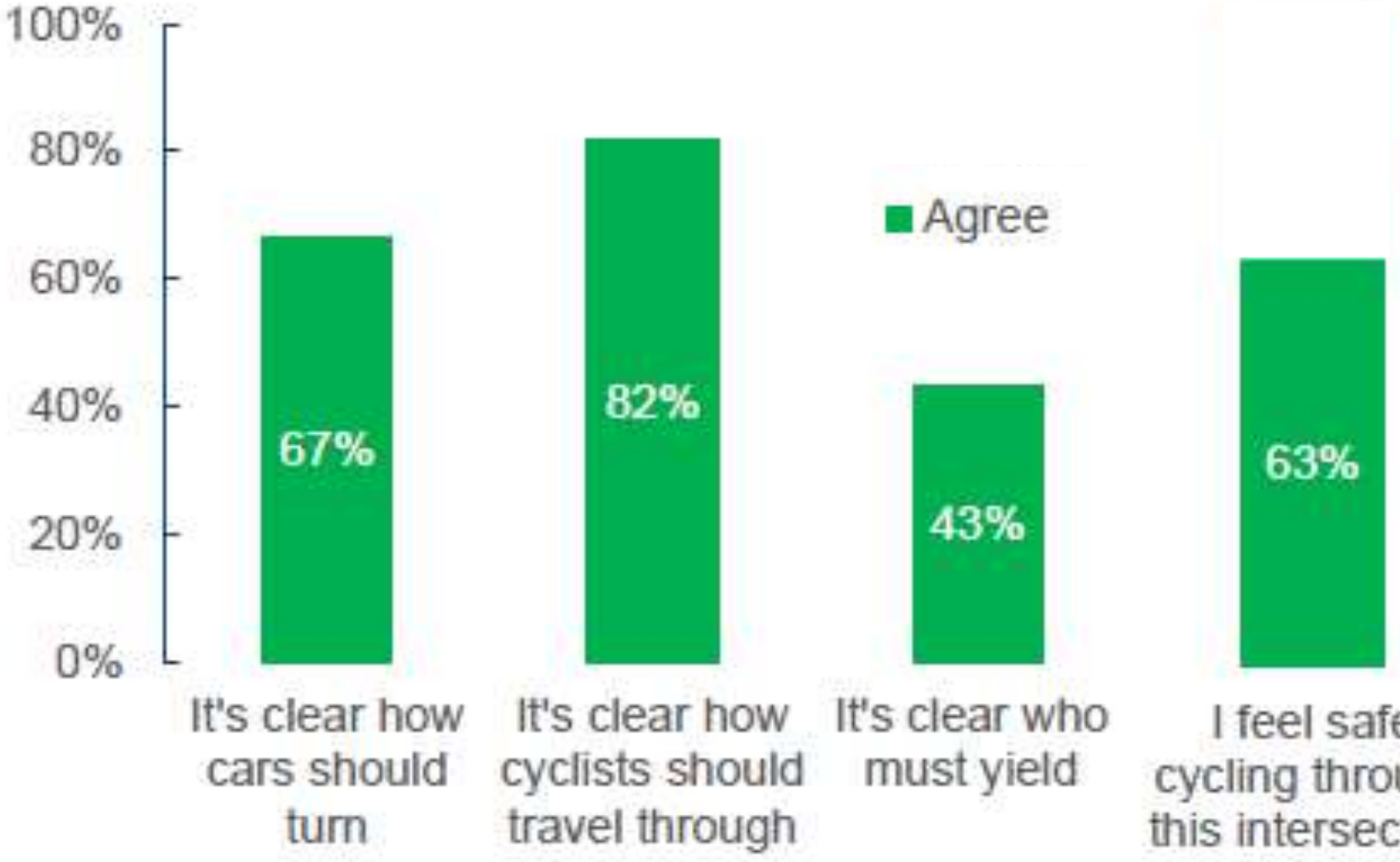


- Fewer conflicts for filter turn treatment!
- Conflicts at filter turn sites:
  - Cyclists treating it as a mixing zone
  - Drivers turning at start of flashing yellow arrow, without checking for cyclists
  - Drivers bypassing overflowing LT queue



NYC study: cyclist opinions at filter turn sites

Intercept survey, 222 cyclists:



A few ideas on thresholds

			Parallel street volumes (vehicles / hour)			
			One-way	Two-way		
					Right turn	
Separated cycleway direction	**Cross street** direction	**Cross street** # lanes	Left turn OR right turn	Left turn	Across 1 opposing traffic lane	Across 2 opposing traffic lanes
One-way	One-way	1	**150**	150	100/50+	**50**
		2+	60			
	Two-way		150			
Two-way			100	100	50	0

MassDOT and NYC
MassDOT (2015)
NYC (2018)
Not specified

- CROW: 2-way cycleways – ALWAYS apply full protection!
  - Risk to cyclists in contra-flow direction much greater.

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Summary – what we think

- Filter turning can be safer than full protection
  - In some cases, just need to reconsider when to run cycle movement during phase
- Should consider trialling filter turning
  - + partial protection + flashing yellow arrows
  - Start with thresholds from previous slide?
  - NOT across 2-way cycleways
- Need to clear up some legal definitions

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What do YOU think?

- Filter turning can be safer than full protection
  - In some cases, just need to reconsider when to run cycle movement during phase
- Should consider trialling filter turning
  - + partial protection + flashing yellow arrows
  - Start with thresholds from previous slide?
  - NOT across 2-way cycleways
- Need to clear up some legal definitions

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Thank you!
Questions and discussions

Megan Gregory & Axel Wilke

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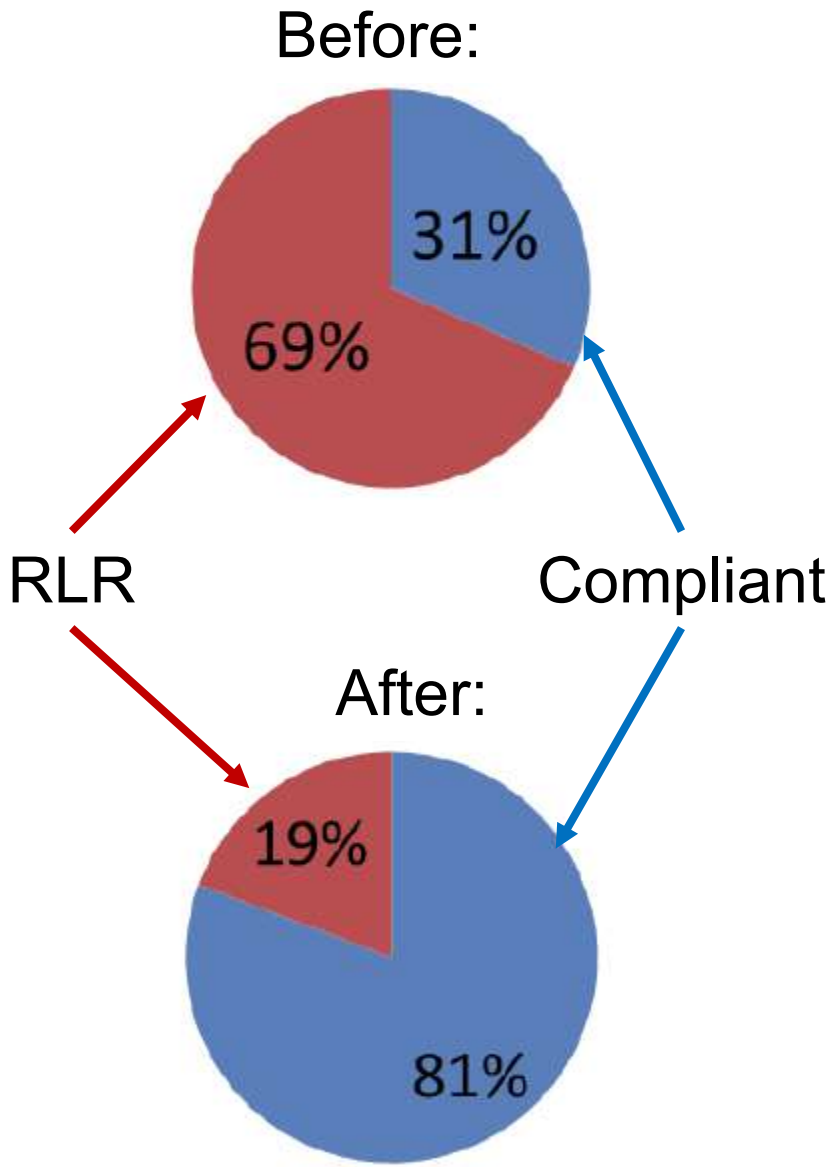
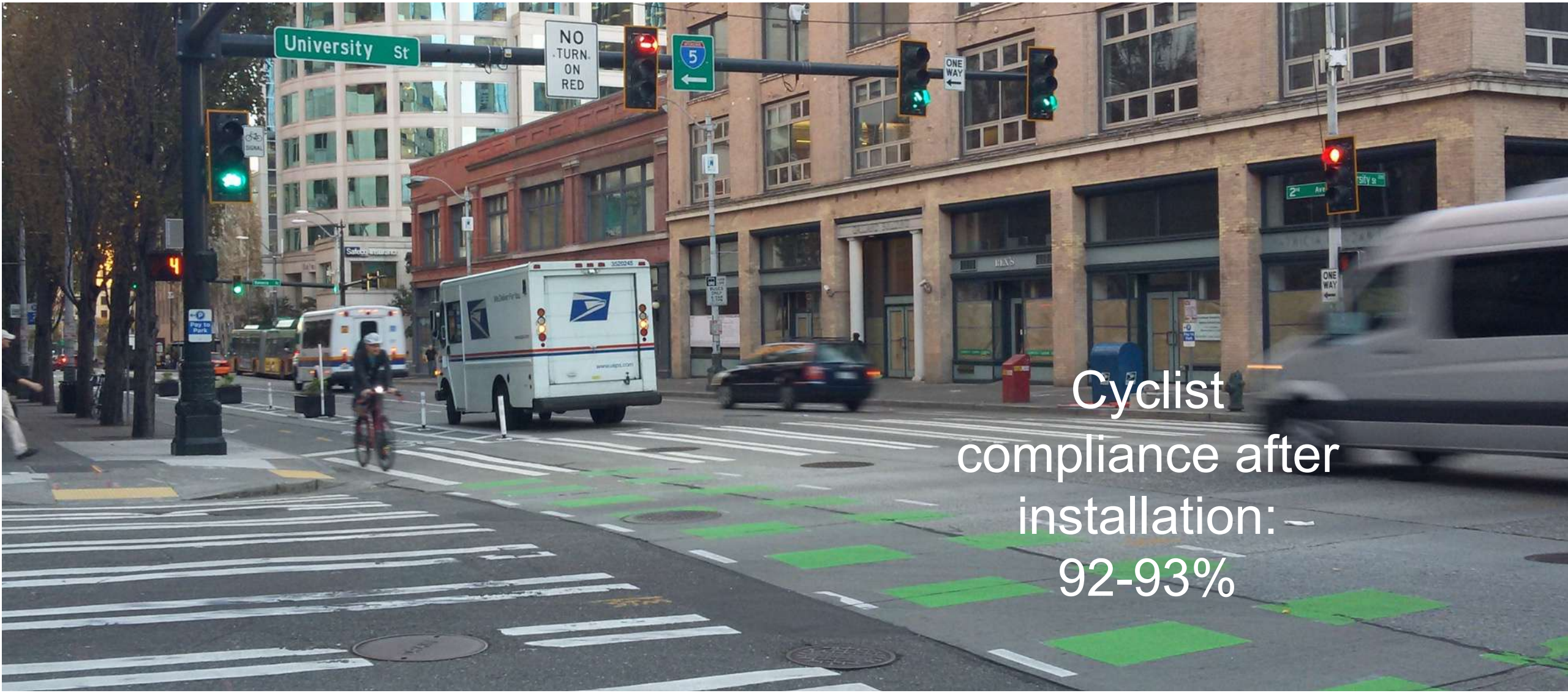
Just in case more detail is required…

Full protection – cyclist compliance, Chicago

Klein (2013)



Full protection – cyclist compliance, Seattle



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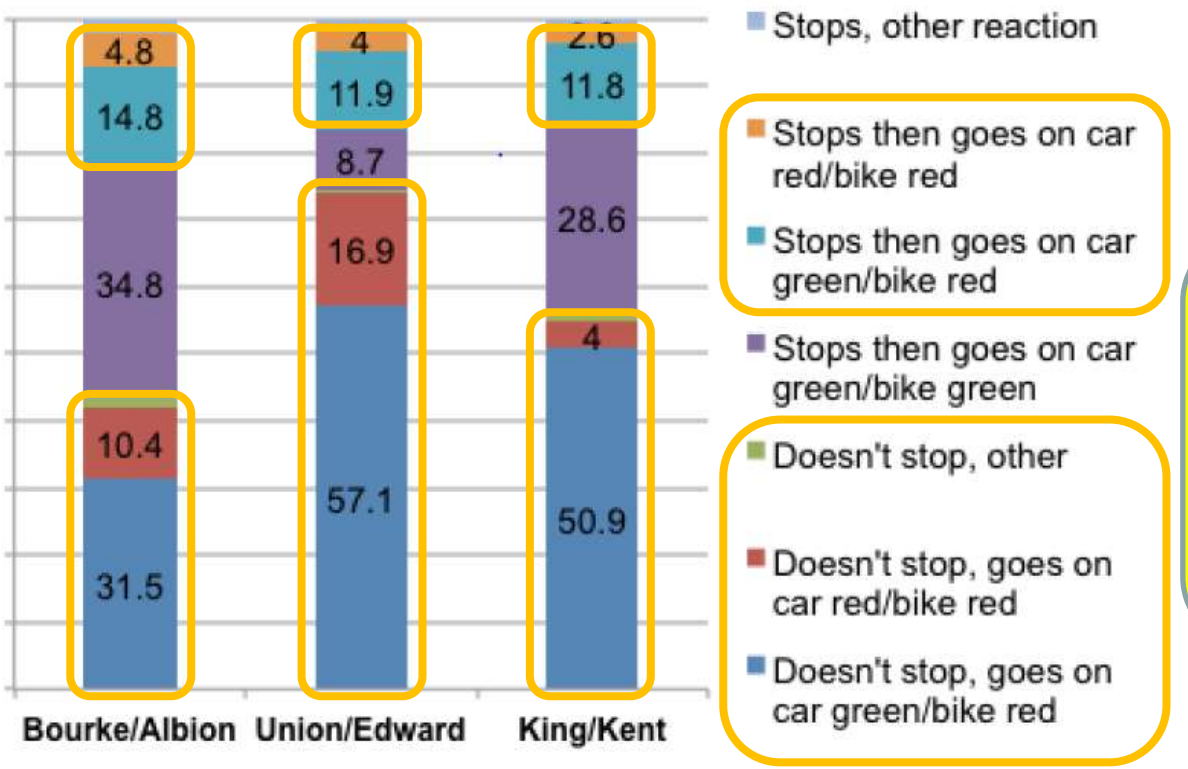
Chang (2016)

Full protection – cyclist compliance, Sydney

Cyclists' reactions to red signal:



"in the vast majority of cases cyclists are following the directions of the car traffic signals as they would when riding on a non-cycleway road"

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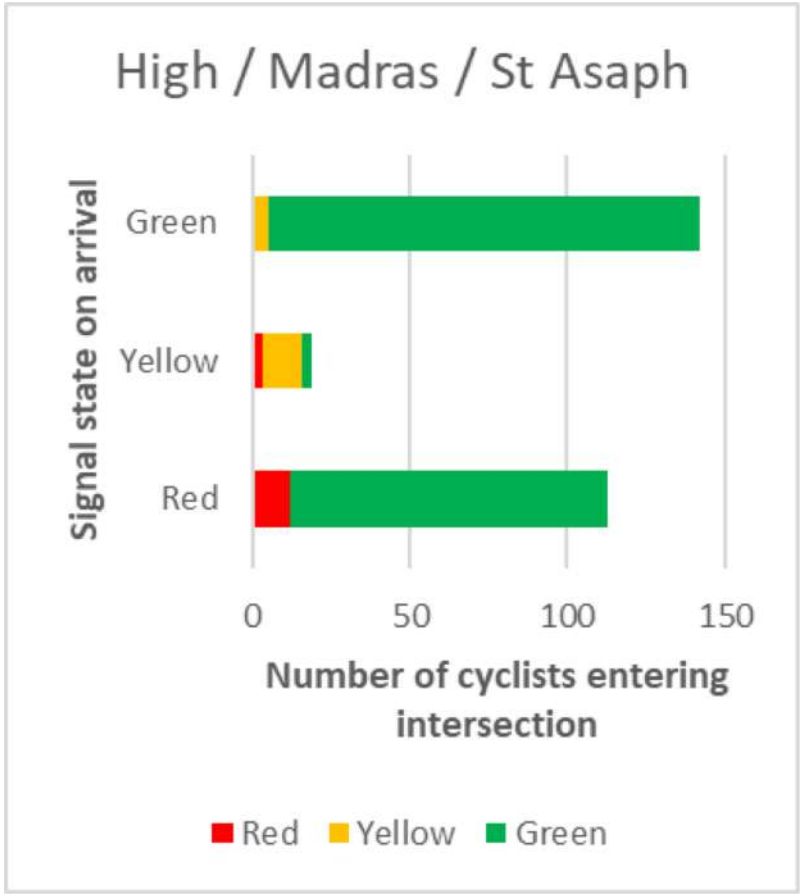
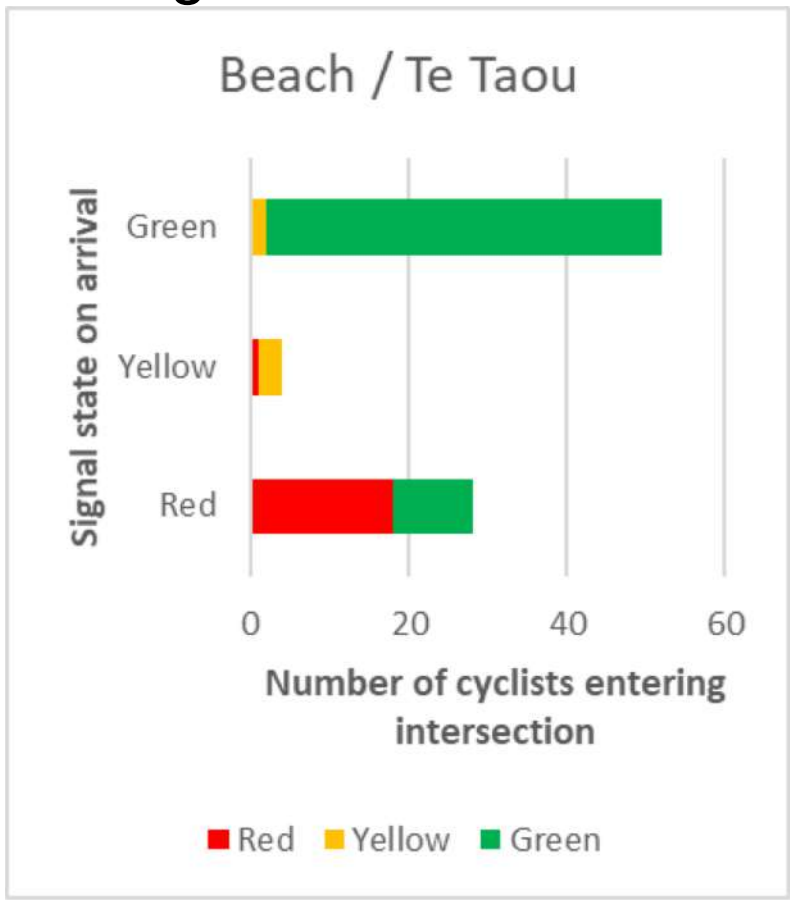
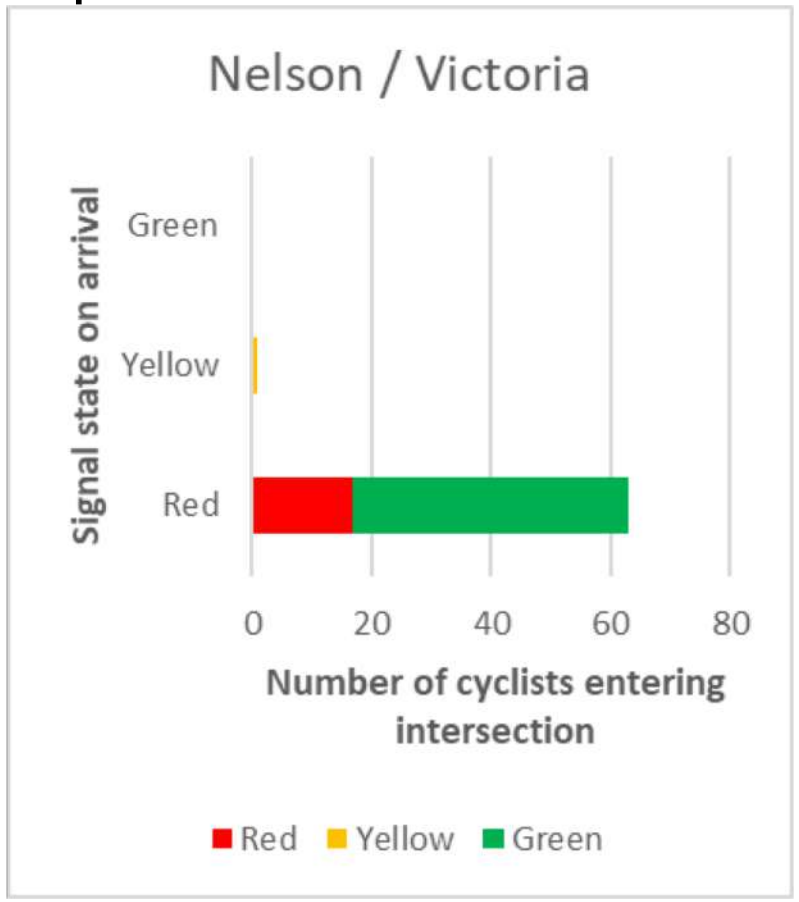
Full protection – cyclist compliance, NZ

Through cyclists' signal state on arrival vs departure:



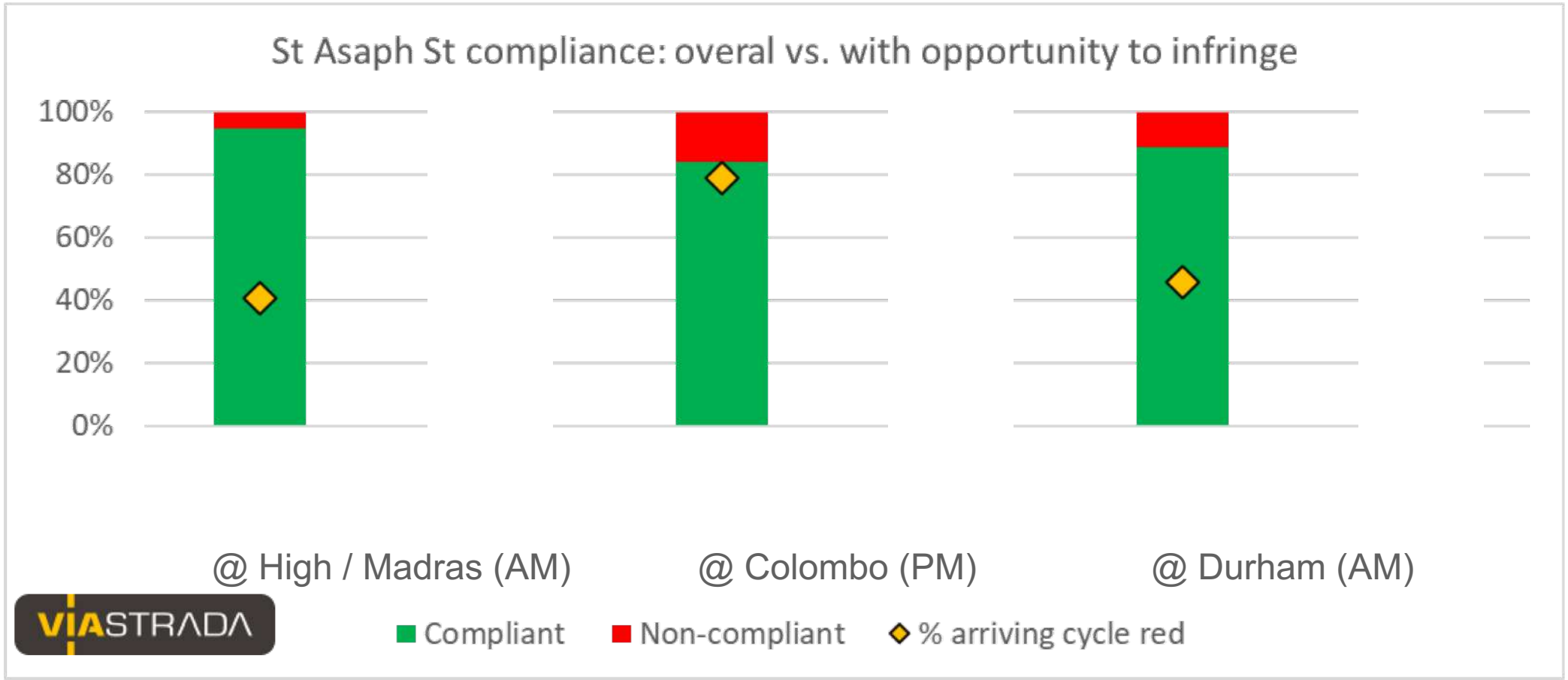




Overall compliance:	95%	77%	73%
Opportunity to infringe, but compliance:	89%	36%	73%

Factors in cyclist compliance at full protection

- Opportunity to infringe
  - Depends on cycle signal state on arrival
  - Coordination along corridor is key



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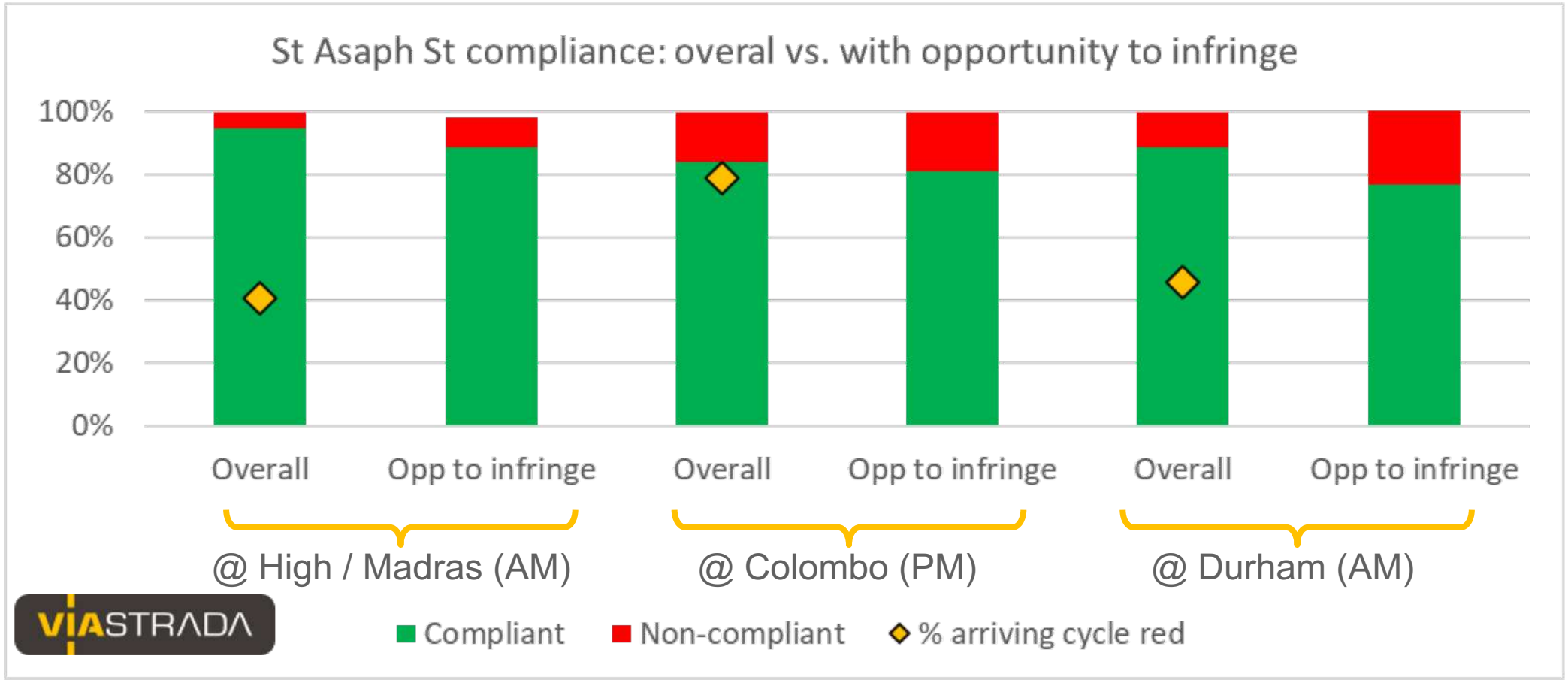

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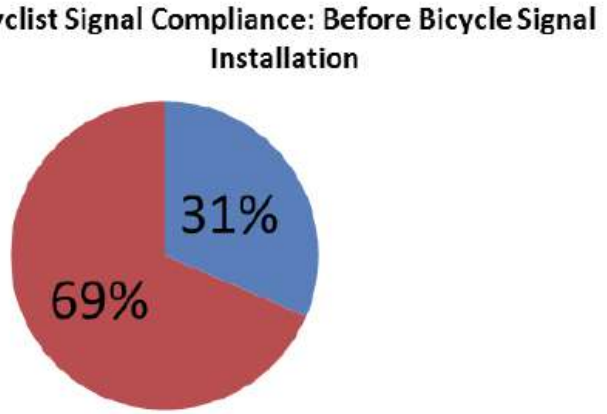
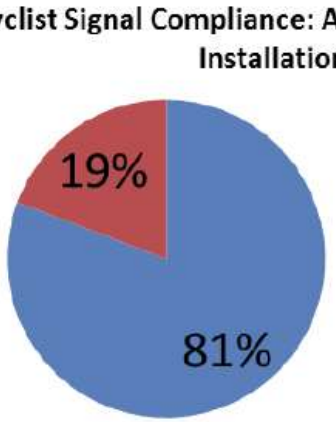
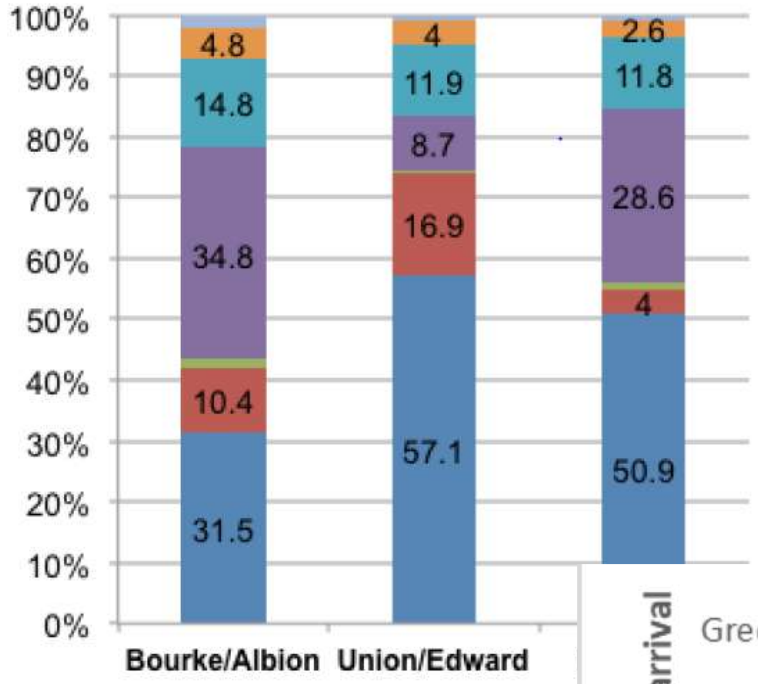
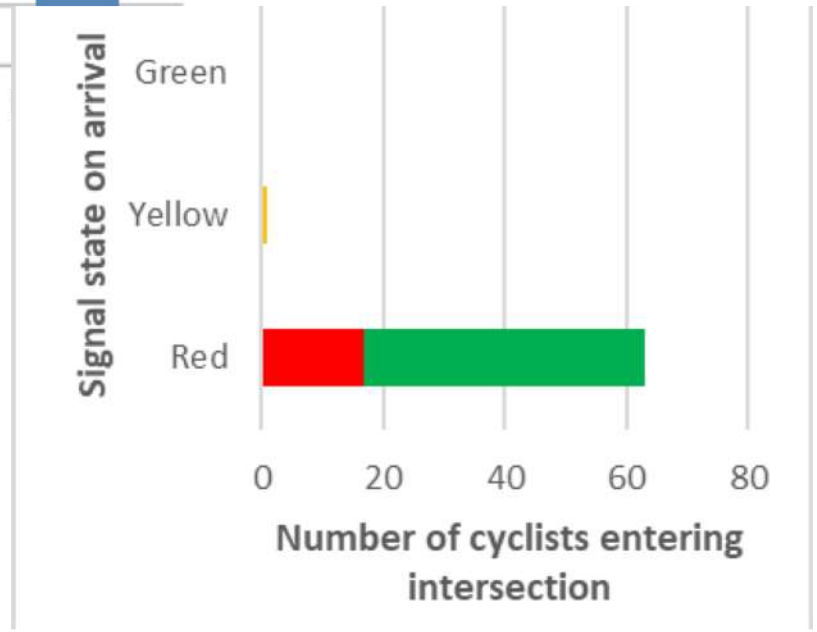
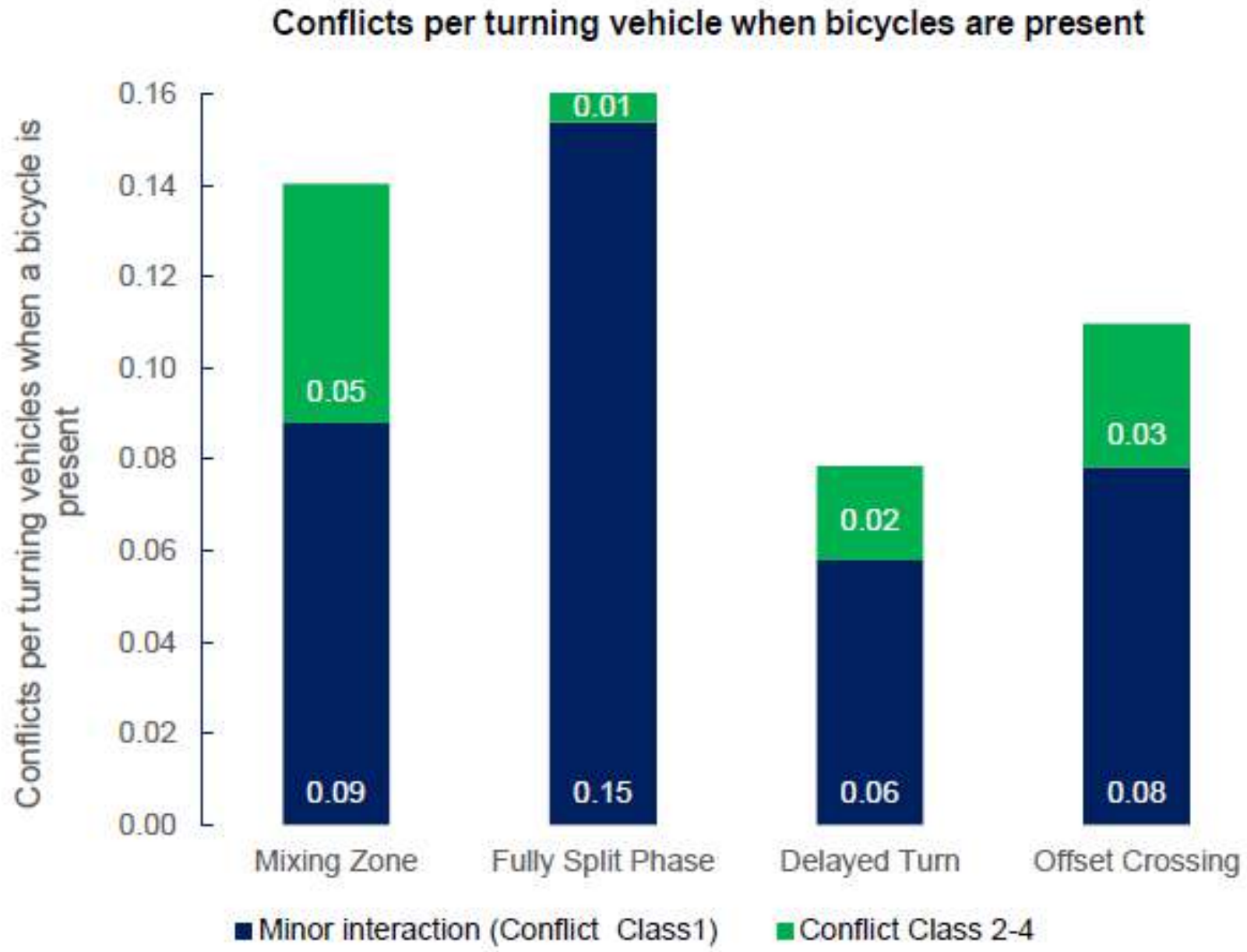








NYC study – all treatment types



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MassDOT guide: filter turn thresholds

Separated Bike Lane Operation	Motor Vehicles per Hour Turning across Separated Bike Lane			
	Two-way Street			One-way Street
	Right Turn	Left Turn across One Lane	Left Turn across Two Lanes	Right or Left Turn
One-way	150	100	50	150
Two-way	100	50	0	100

EXHIBIT 6A: Considerations for Time-separated Bicycle Movements

- Note: USA guide – RT = short turn, LT = long turn

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NYC matrix for 1-way separated cycleways

i.e. partial protection + filter turn + FYA

Application Considerations[1]		Delayed Turn (AKA Split LBI) Continue with limited use under specific conditions
Along a one-way street with cross-street lanes:	1	Possible for turn volumes <150/hr where a LPI is needed
	2+	Possible with turn volumes <60/hr where a LPI is needed
Cross-street is two-way		Possible with turn volumes <150/hr and LTTC
PBL is along a two-way street[2]		Consider when left turns <50/hr[3]
Leading Pedestrian Interval		Possible
Curb space needed (parking/loading loss)		Typically 110 ft
Speed limit ≥30mph		Not recommended

Other considerations

- **Continue with limited use when a LPI without delaying through traffic is needed – must meet conditions in this table**
- **Preferred installation is at a two-way cross-street w/ LTTC due to additional maneuvering space before conflict**
- **Not recommended at downhill locations where cyclist speed may be higher**
- Moderate turning volumes, but minimal storage space for turning lane/bay
- High through volumes that would be delayed by a standard LPI
- A turn lane or bay is required

INTERSECTION DESIGN MATRIX FOR ONE-WAY PBLS

Application Considerations[1]		Mixing Zone	Fully Split Phase	**Delayed Turn** (AKA Split LBI) Continue with limited use under specific conditions	Offset Crossing
Along a one-way street with cross-street lanes:	**1**	Preferred for higher turn volumes	Preferred when a gap in ped traffic is required to process traffic	Possible for turn volumes <150/hr where a LPI is needed	Preferred for turn volumes <120/hr
	2+	Possible with turn volumes <60/hr	Preferred	Possible with turn volumes <60/hr where a LPI is needed	Possible with turn volumes <60/hr
Cross-street is two-way		Possible with turn volumes <80/hr and LTTC	Preferred	Possible with turn volumes <150/hr and LTTC	Possible with turn volumes <80/hr and Left Turn Traffic Calming (LTTC)
PBL is along a two-way street[2]		Consider when left turns <50/hr[3]	Consider when left turns >50/hr	Consider when left turns <50/hr[3]	Consider when left turns <50/hr[3]
Leading Pedestrian Interval		Possible with sign: 'Bikes May Use Ped Signal'	Possible	Possible	Possible with bike signal or sign: 'Bikes May Use Ped Signal'
Curb space needed (parking/loading loss)		Typically 90 ft	Typically 130 ft - Based on 85th percentile queue	Typically 110 ft	Typically 25 ft on mainline and 20 ft on narrow cross-streets
Speed limit ≥30mph		Not recommended	Preferred	Not recommended	Not recommended
Other considerations		• The current, shorter design should be used • If used at multilane cross-streets, traffic calming and visibility measures should be included • Consider context (e.g. schools, paths, etc.) where more comfortable designs with the tradeoffs such as higher delay may be desirable	• Turn lane/bay is req'd, of a length that can store all turning vehicles • Consider where a lower stress connection is preferable • Where multiple turn lanes/turning movements cross the impacted crosswalk/bike facility • No gap for turning vehicles due to high pedestrian and bike volumes • If several split phases are used along a corridor, a progression speed for bicyclists should be considered	• **Continue with limited use when a LPI without delaying through traffic is needed – must meet conditions in this table** • **Preferred installation is at a two-way cross-street w/ LTTC due to additional maneuvering space before conflict** • **Not recommended at downhill locations where cyclist speed may be higher** • Moderate turning volumes, but minimal storage space for turning lane/bay • High through volumes that would be delayed by a standard LPI • A turn lane or bay is required	• A 15 ft offset requires approximately 17 ft from curb to edge of travel lane • If used at multilane cross-streets, traffic calming and visibility measures should be included (i.e. high visibility markings, LTTC) • If a turn lane is provided, the full 15 ft offset may be reduced • Operationally not recommended on streets with >300 through veh/lane/hour • Truck and bus routes require additional care • Requires 40 ft of clear distance on approach to the Point of Curvature

1. This table provides planning guidance for typical intersection conditions, site specific conditions may require different design approaches
2. This threshold may be increased if there is only one opposing lane
3. On a two-way street, the right turn treatment should be selected separately

NOTE: As the knowledge base is always evolving, the design matrix will be updated periodically to reflect new information and best practices.

Flashing yellow arrows – considerations

- Concerns
  - What will drivers understand?
    - Time's running out – better go faster
    - If I have an arrow, I have right of way
    - If it's yellow, and I can stop safely, I shouldn't go
  - "Disco effect"
  - Already have a problem with filter turning
- Trial

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