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Envisaging a world with greener cities

LSBU field study September 2019

Anna Schroeder

October 2019

UNIVERSITY OF CAMBRIDGE

Imperial College London

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The beginning

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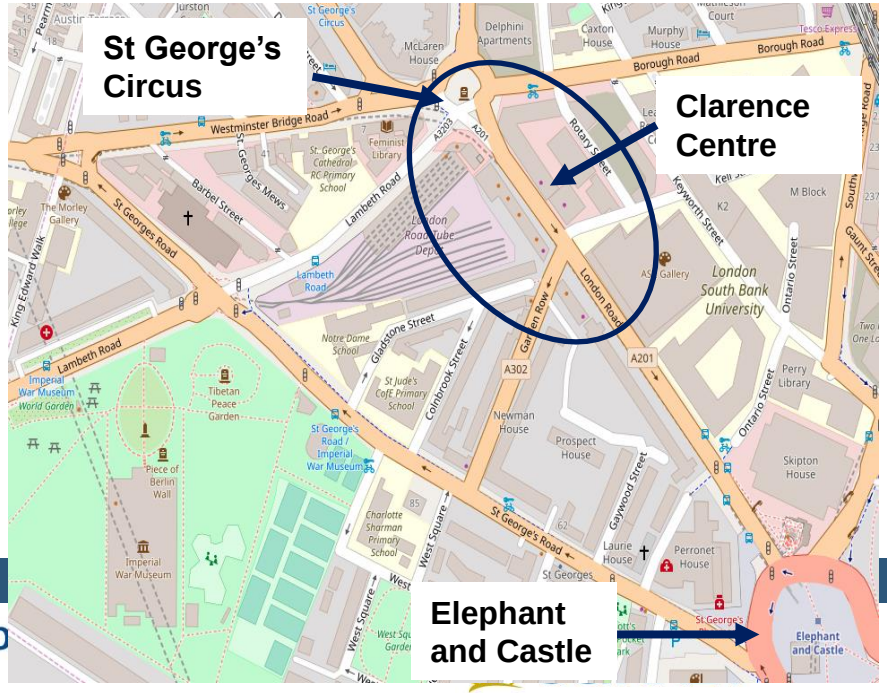
- Repeat 2017 field study using Shiwei's sensors outdoors and indoors
- Add camera to understand traffic patterns



How it developed

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- Cambustion (GPS and tailpipe emissions)
- TfL junction study:
  - Improved traffic flow -> reduced emissions?
  - Compare two traffic light cycles

- Need high resolution sensors!
- Need cameras to capture number plates

How it developed cont.

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Initial idea:

- put camera on top of LSBU sports centre
- Not possible

→ Need to put cameras on lampposts

Things to consider:

- Height of camera (double-decker buses)
- Memory space
- Battery capacities
- How to see what camera is seeing?
- What sort of camera?
- How to attach camera to lamppost?

Cameras

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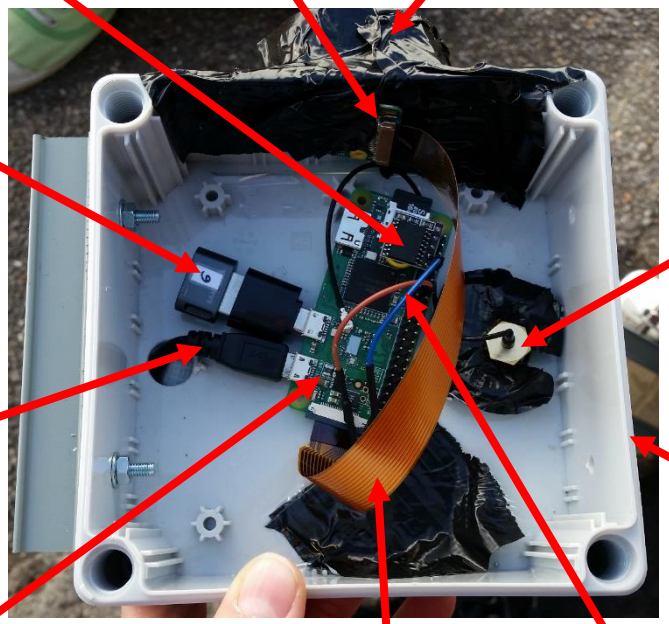
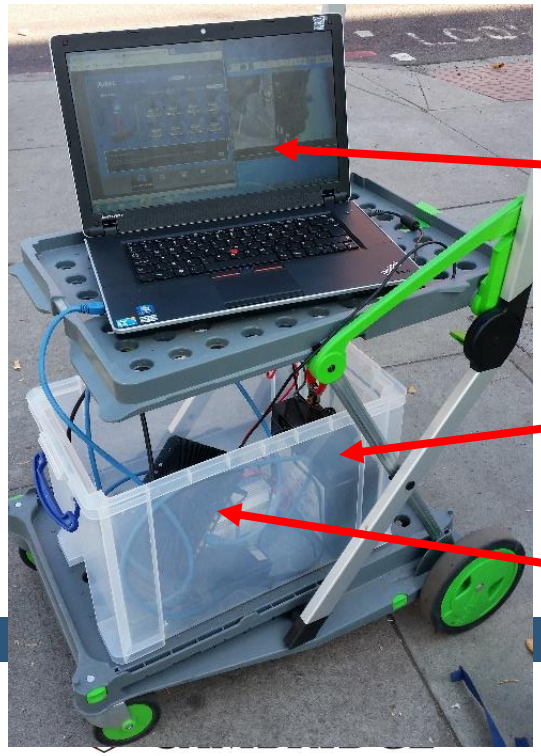
- Raspberry Pi mini computers
- Power bank
- External memory space

- Extendable pole



Cameras cont.

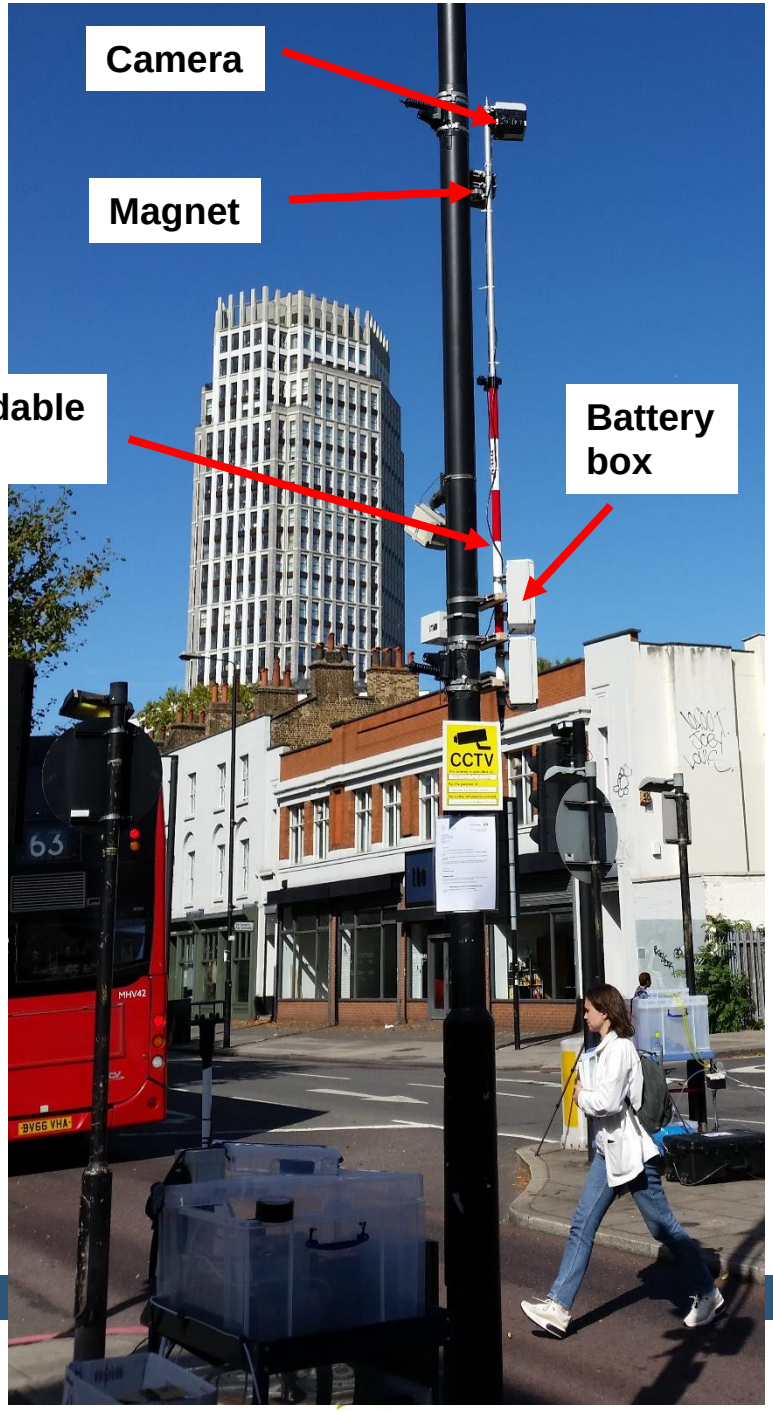
Tripods for number plate information



Laptop to communicate with camera

Battery for router

Router



Final set of equipment

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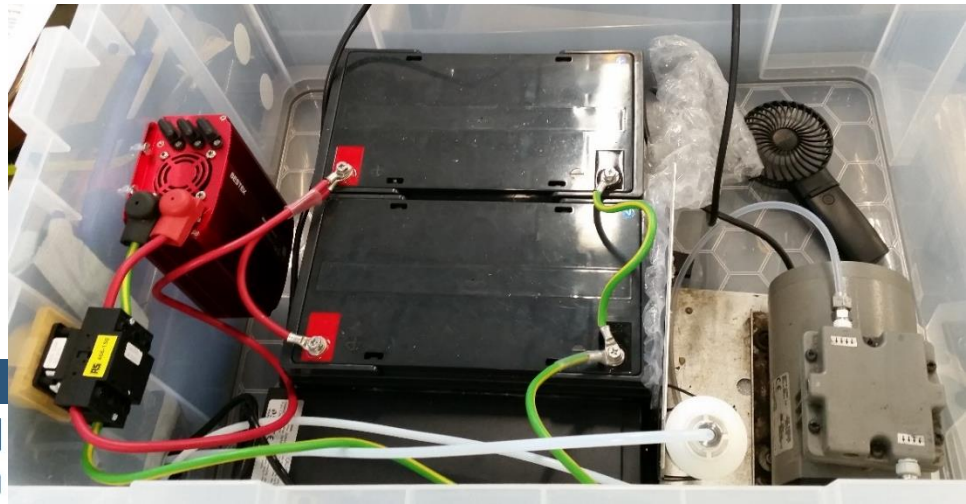
- 17 x **Shiwei's sensors** outdoors
- 5 x Shiwei's sensors indoors
- 3 x high resolution **NO2/NO/NOx** sensors
- 1 x high resolution **CO2** sensor
- 2 x aethalometers (**black carbon**)
- 1 x partector (**ultrafine particles**)
- 7 x **cameras** on lampposts
- 3 x cameras on tripods
- 3 x **anemometers**
- LOTS of **batteries**



Start of field study – moving equipment to LSBU

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15th of September 2019

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Lab space at LSBU

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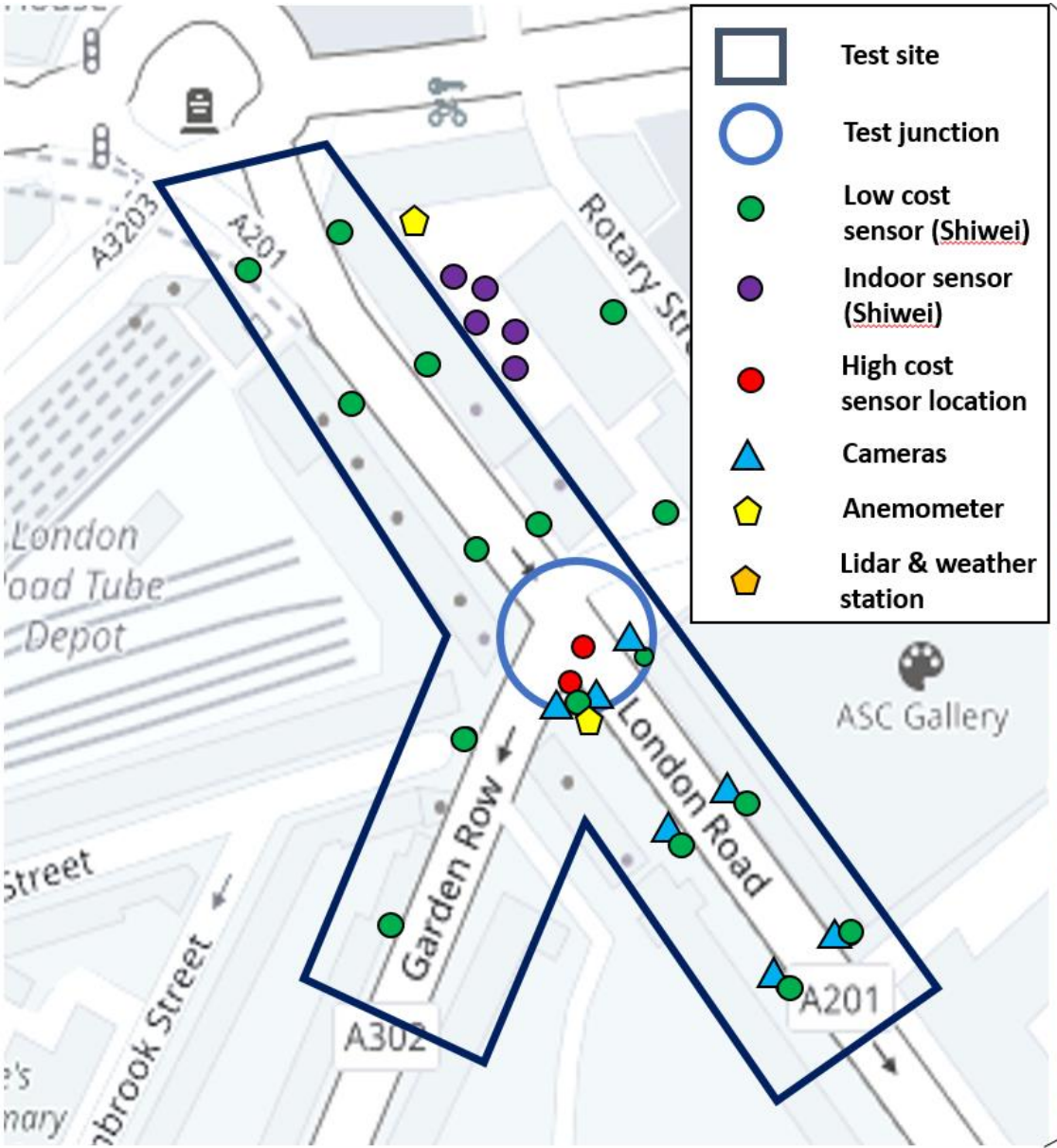
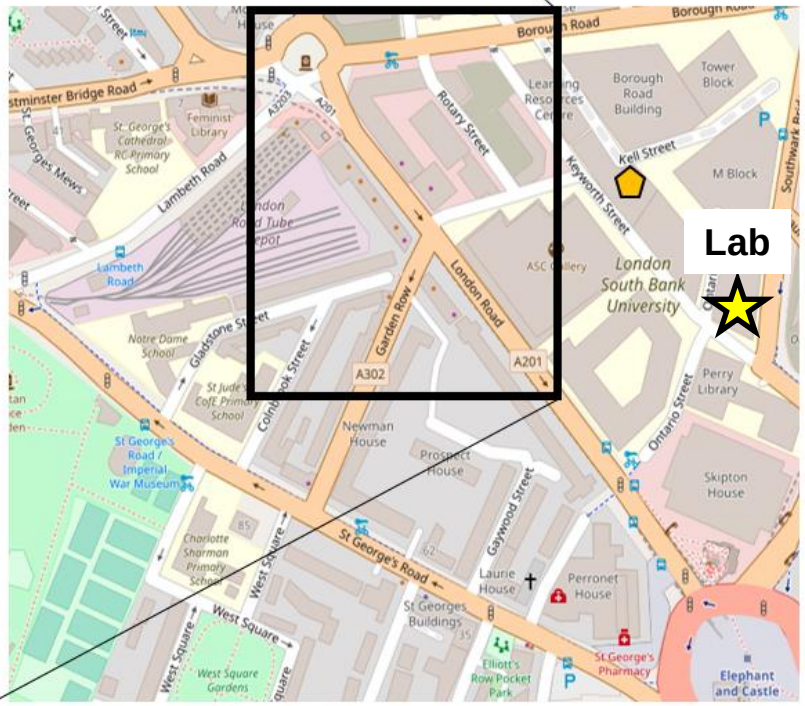
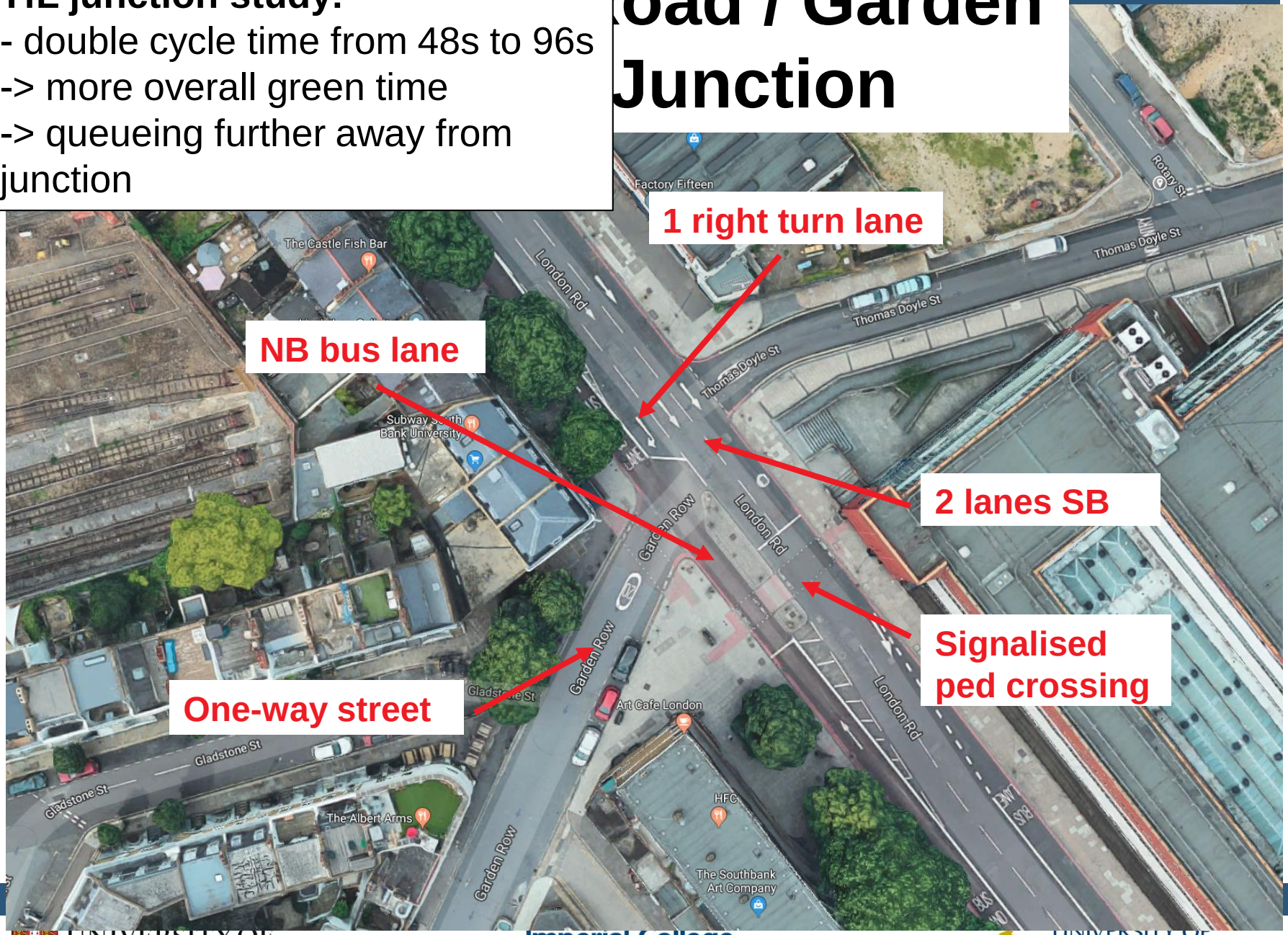
Test location





oad / Garden Junction

TfL junction study:
- double cycle time from 48s to 96s
-> more overall green time
-> queueing further away from junction



High resolution sensors

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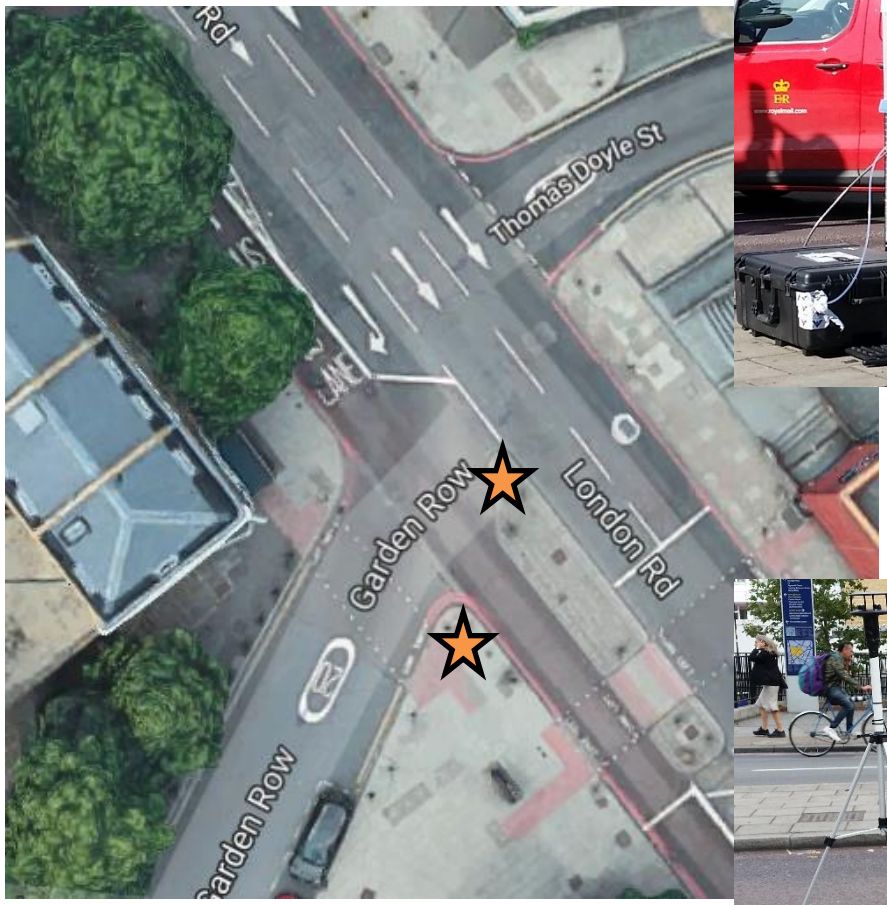
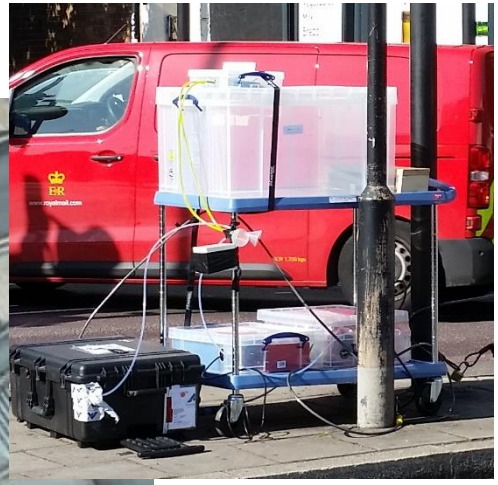
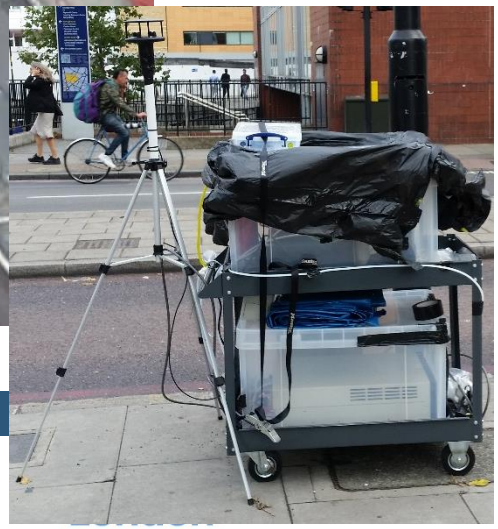




Sensors on central island:

- CAPS (NO2, 1s)
- 2BTech 405 (NO/NOx/NO2, 5s)
- Partector (LDSA, 1s)
- Aethalometer (black carbon, 1s)
- LICOR (CO2, 1s)
- Shiwei's sensor



Sensors next to bus lane:

- Chemiluminescence (NO/NOx/NO2, 1min)
- Aethalometer (black carbon, 1s)
- Anemometer (wind speed and direction)
- Shiwei's sensor

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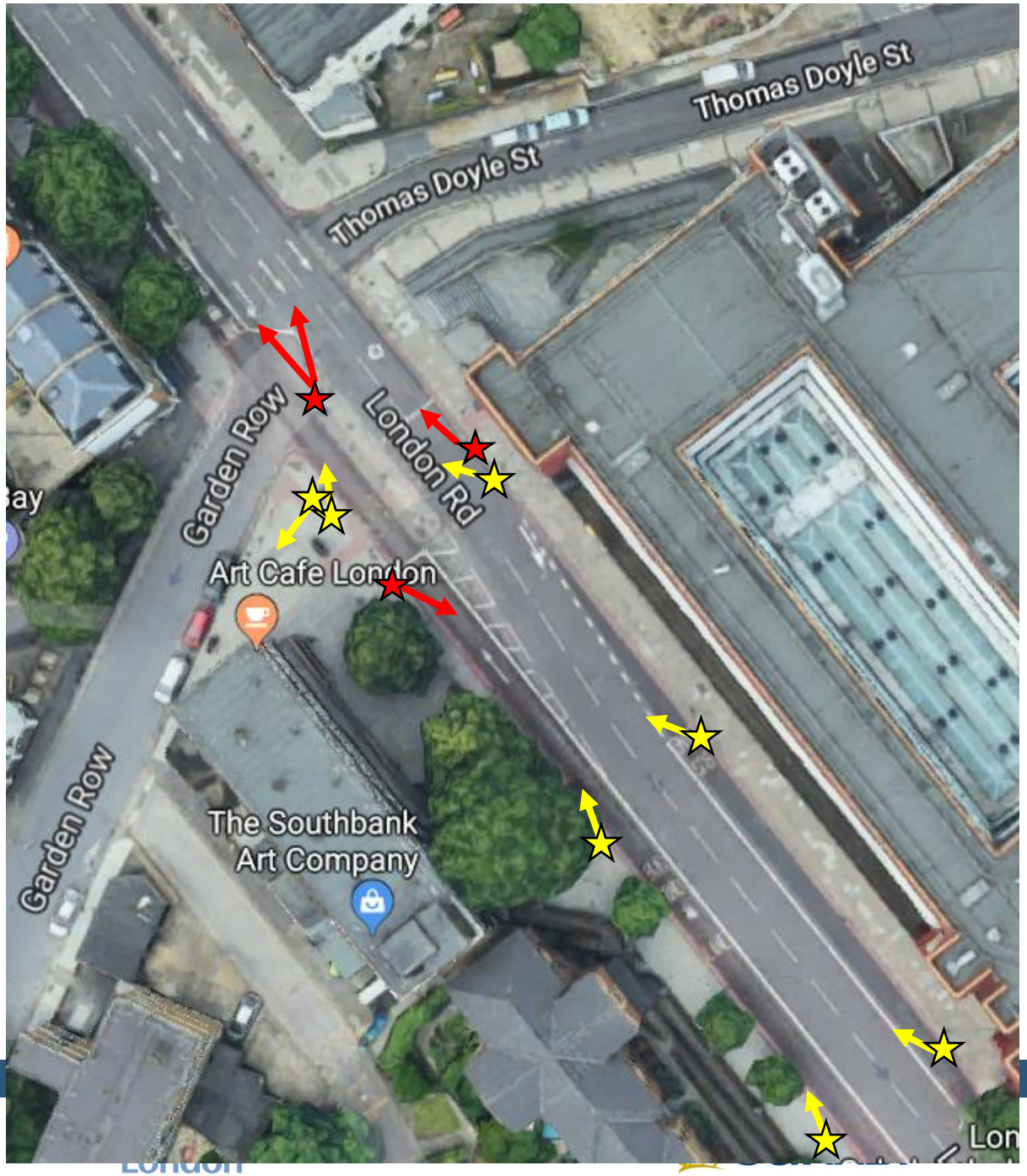
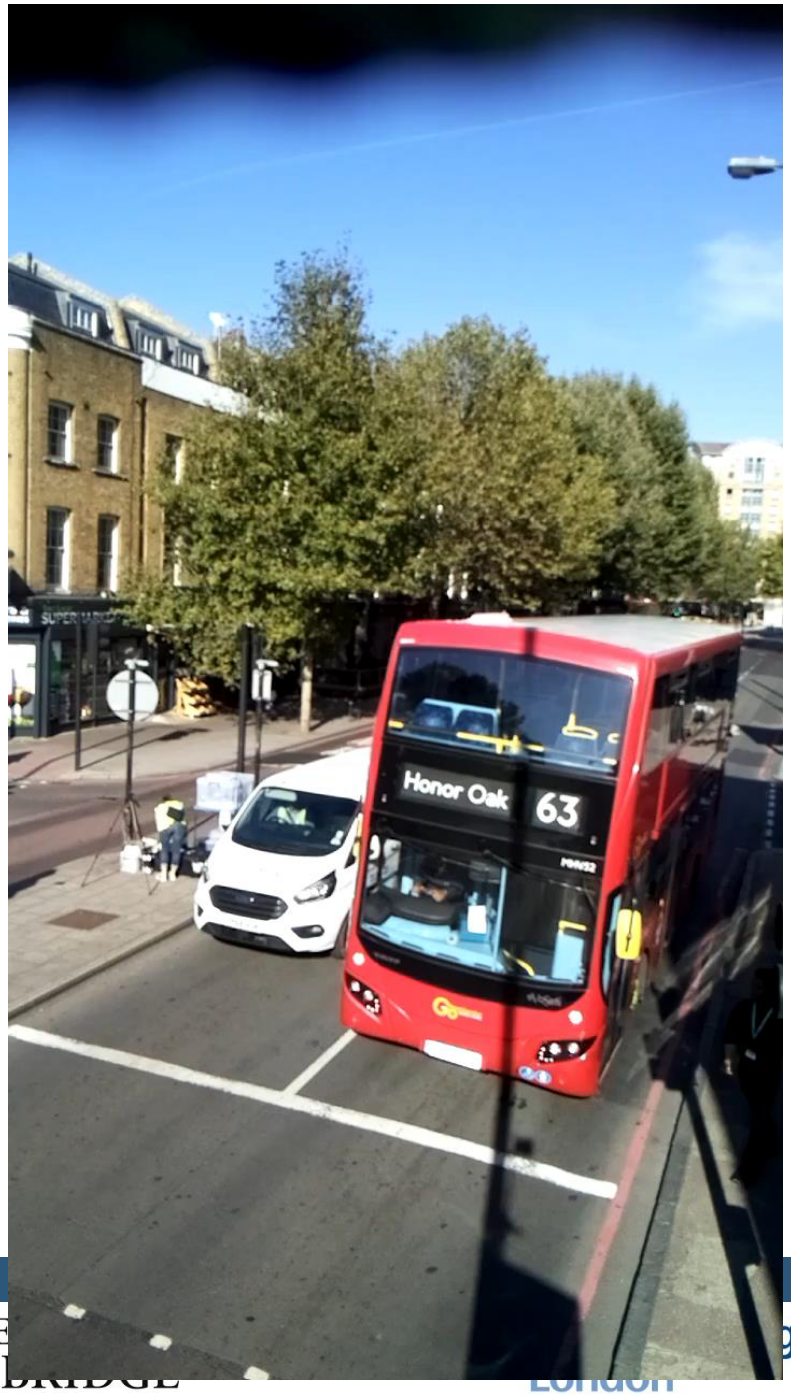
Map of Cameras

Lamppost cameras and direction

Tripod cameras and lanes covered





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Cambustion

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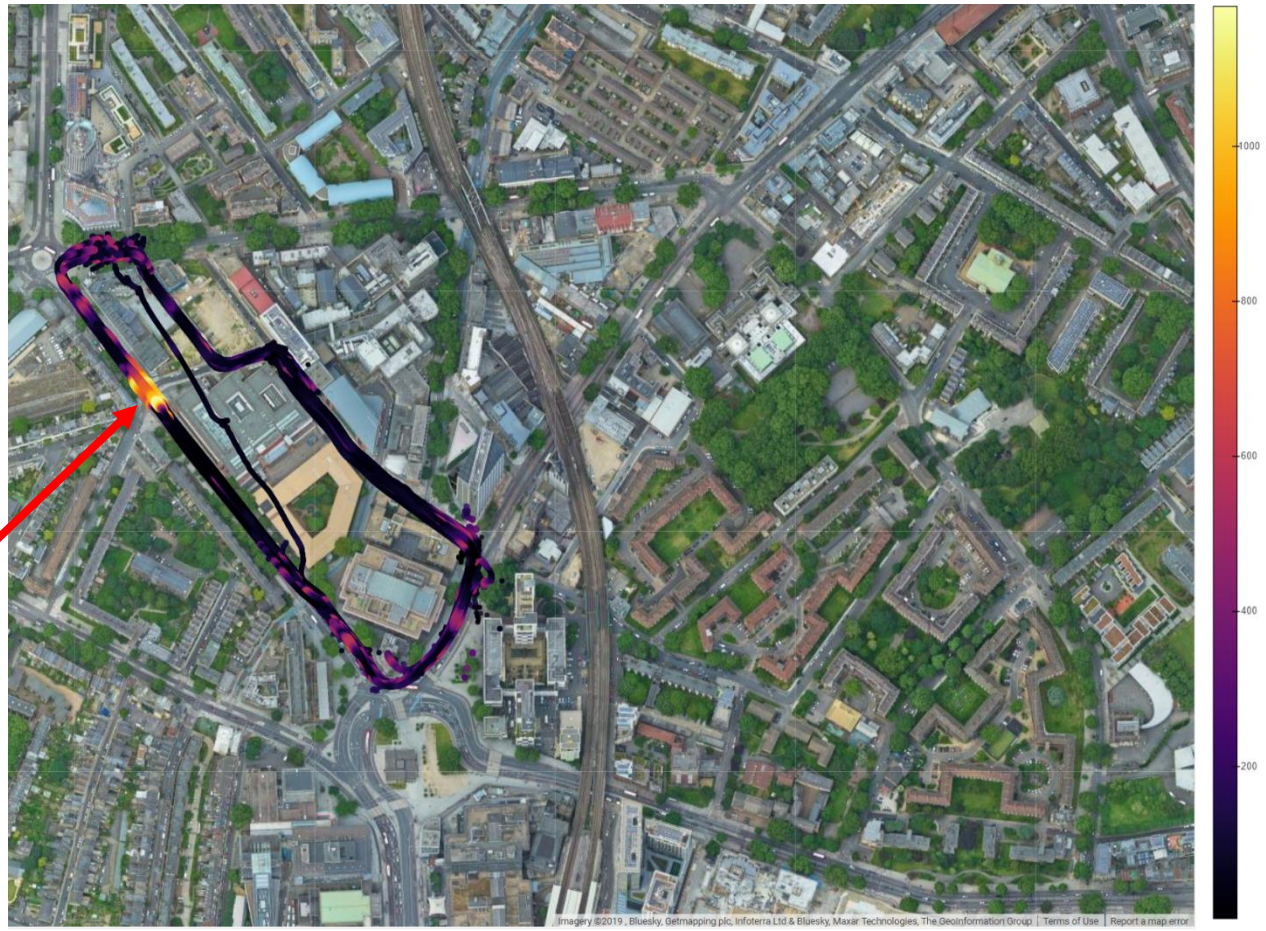
- GPS data
- Tailpipe emissions (NO, NOx, CO2)



NO tailpipe emissions

Two weeks later…

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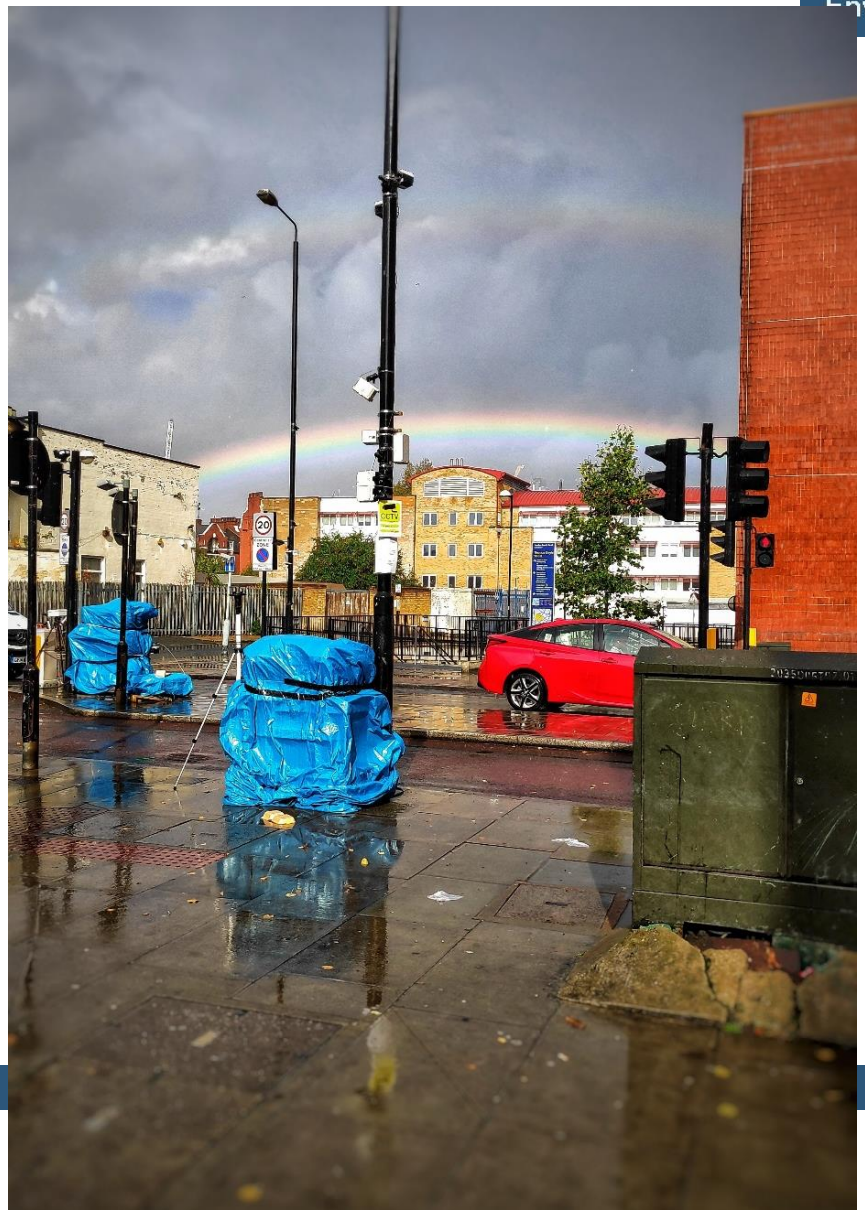

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Paper 1: Raspberry Pi cameras

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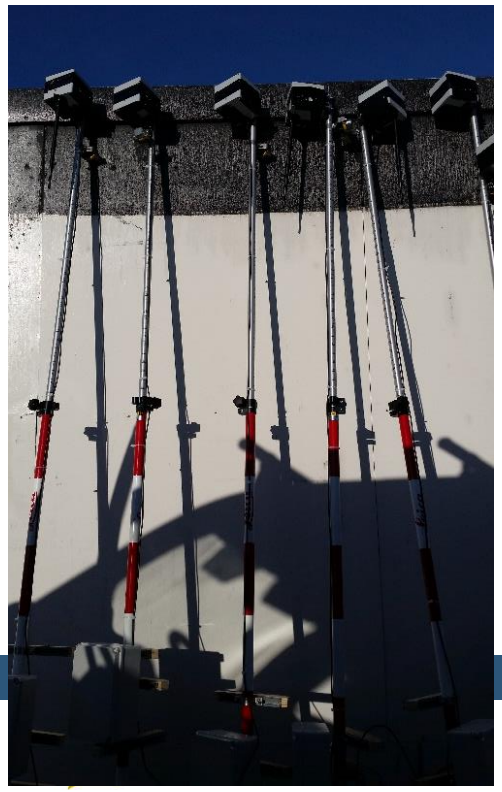
- Usage of Raspberry Pi cameras
- Develop computer vision algorithm to get vehicle classification and trajectories
- How to combine footage from different cameras (including tripods)
- (use Cambustion for validation)



Paper 2:
TfL signal time study

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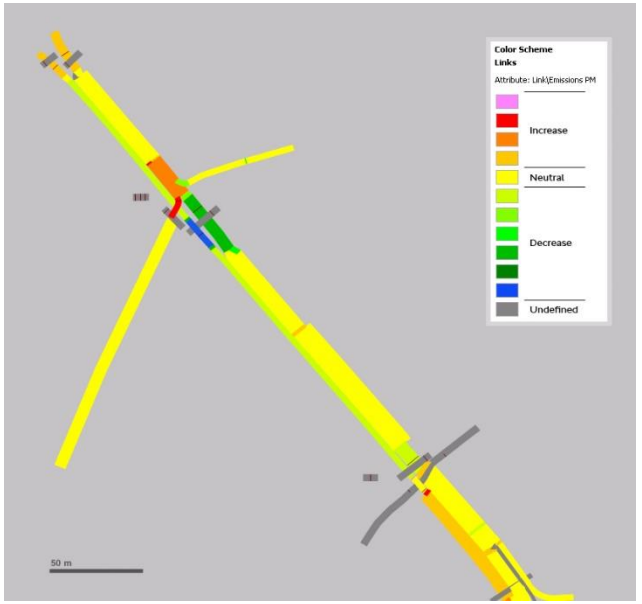
- Does a change in signal timings affect emissions?
- Model effects
- Look at on-road measurements
- Might have to factor in vehicle counts, classification, weather, etc.



Paper 3:
Effects of high emitters

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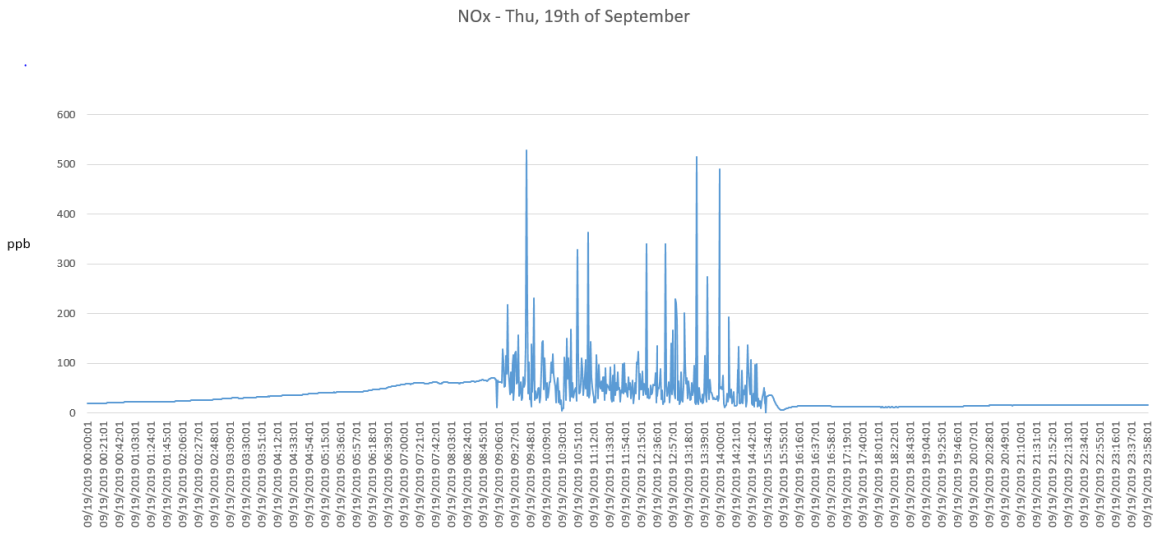
- Model effect of high emitting events
- Calculate emission factors based on data; find outliers
- Look at effect of Cambustion high emitting events on sensors
- Can we link peaks in sensors with high emitting vehicles ?



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Paper 4: MAGIC data

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- Get vehicle trajectories
- Estimate instantaneous tailpipe emissions
- Fluidity
- How do results compare to on-road measurements?

Other questions

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- Capture individual vehicle plumes / bus emissions
- Central island compared to side of road pollution
- Low cost versus high cost sensors
- Personal exposure study (Singapore)
- Acoustic study