EPA Office of Research and Development

HOMELAND SECURITY RESEARCH

Preliminary Results
LA Metro Field Study using Puro Lighting Xe UVC Light for Disinfection of Surfaces

August 2020

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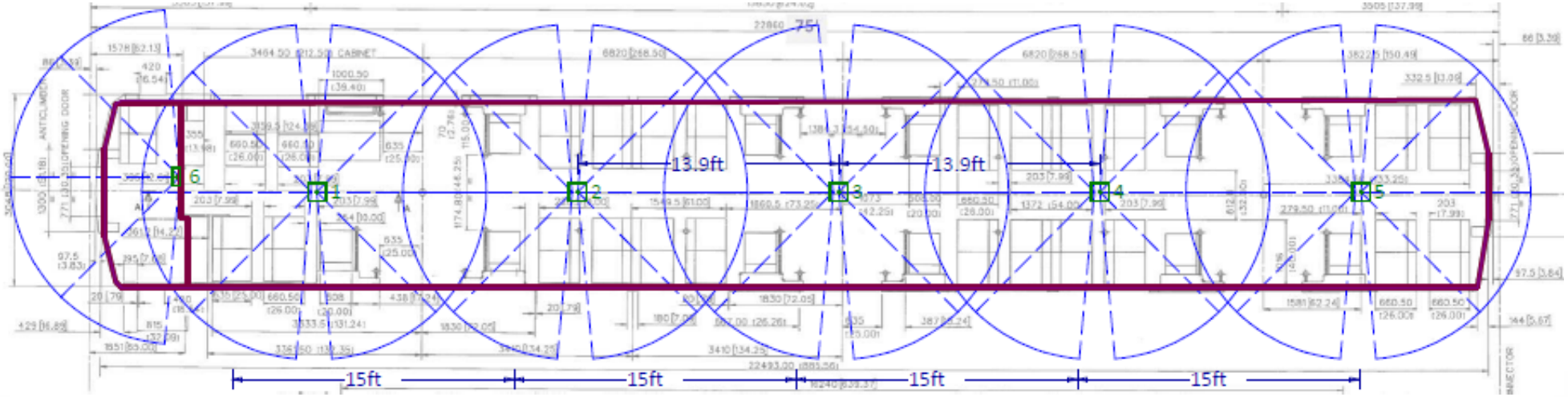
LA Metro Field Study - Puro Lighting

- Los Angeles County Metropolitan Transportation Authority (LA Metro) is considering including UV-C technology in routine disinfection practices
- Field study purpose: Evaluate practicality of UV-C units (ease of use, setup time, durability, electrical load, functionality) and disinfection efficacy
- Unit tested: Puro Lighting Sentry M1
  - Generates pulsed light, including UV-C
  - One flash (milliseconds) every six seconds
  - Broad wavelength emission from UVC to visible

https://purolighting.com/products/#sentrymobile

LA Metro Field Study - Puro Lighting

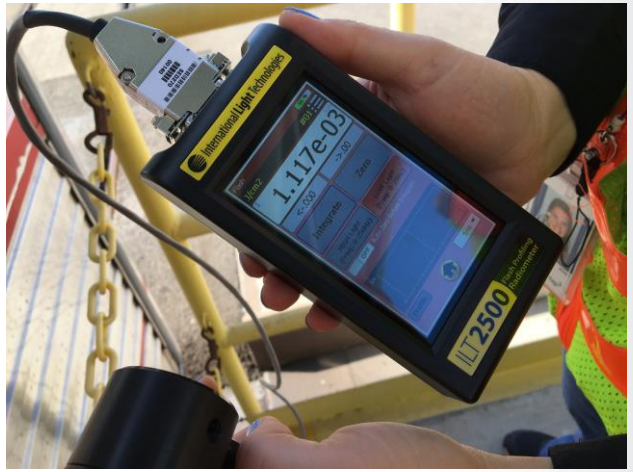
- Testing conducted in Breda A650 Heavy Rail Vehicle
- Recommended setup from UVC vendor: 6 tripods (5 dual light, one single light in operator cab) with a 30 min runtime



- Can runtime be reduced while still achieving an effective disinfection dose by including additional tripods/lights?

LA Metro Field Study - Puro Lighting

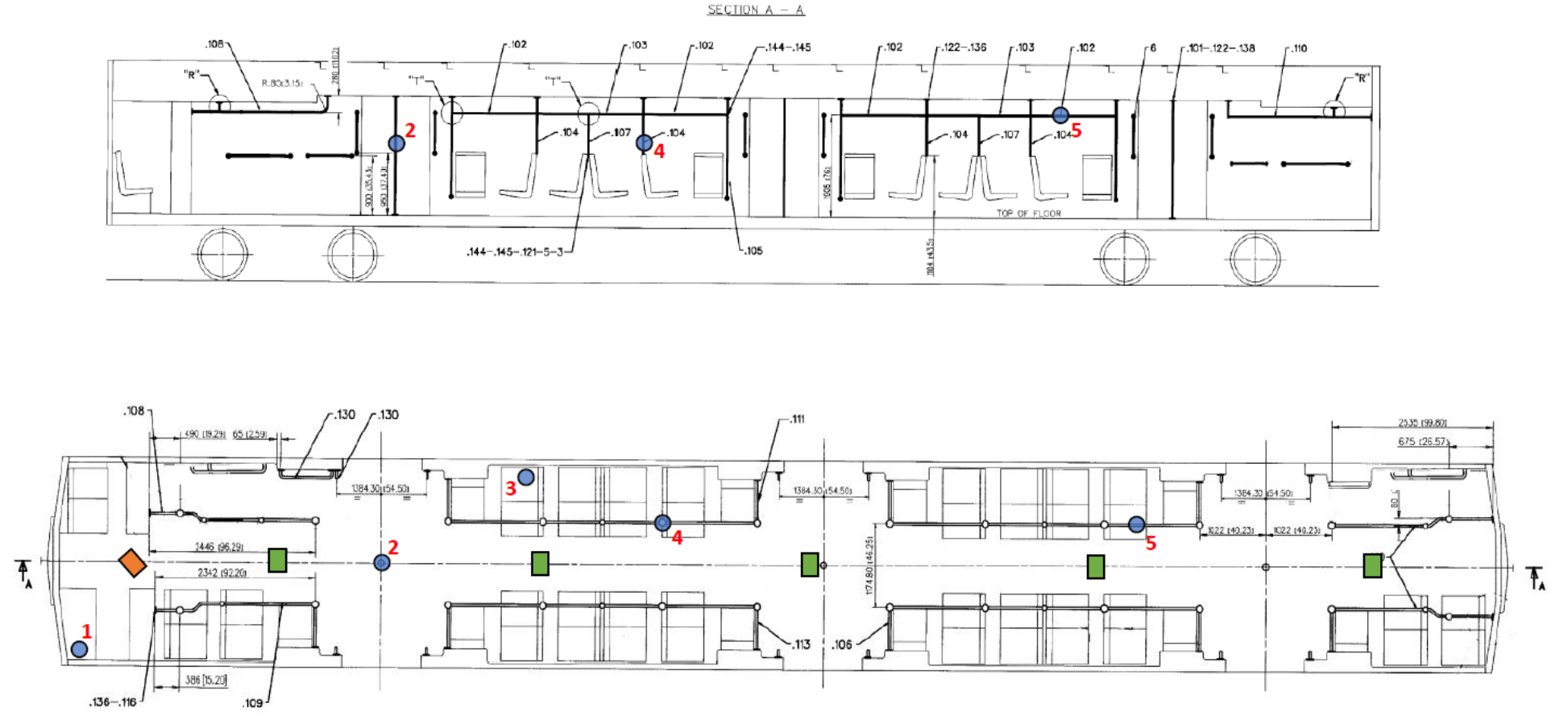
- Initial round of UV-C measurements on July 30, 2020
  - Two light configurations
    - **A**: 5x2 + 1 lights (five double light tripods and one single in cab)
      - 30 min and 15 min test duration
    - **B**: 9x2 + 1 lights (nine double light tripods and one single in cab)
      - 15, 10, and 5 min test duration
- UV-C Light measurements in presence of EPA coupons* were conducted on August 5, 2020
- Coupon locations selected by LA Metro; represent areas inside and outside of the direct line-of-sight from UV-C light



Light intensity measurement with ITL-2500

* EPA coupons: Stainless steel material coupons (2 cm x 4 cm) inoculated with ~1.0 x 10^7 MS2 (bacteriophage) virions in phosphate buffered saline amended with a stabilizer (5% Fetal Bovine Serum).

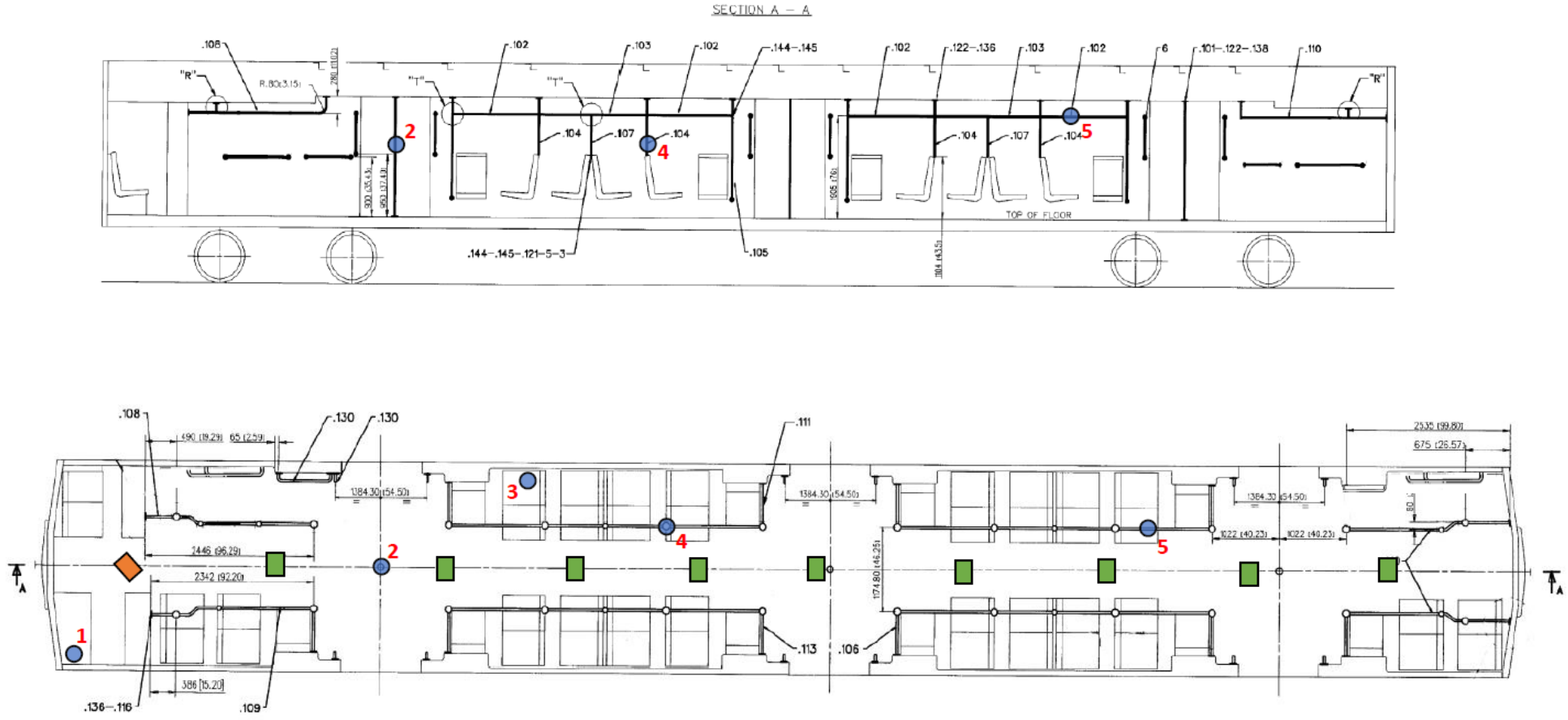
Configuration A – 6 tripods



Note:

1. Location (3) in shadow areas
2. Location (5) on top of maximum height of tripod

Configuration B – 10 tripods

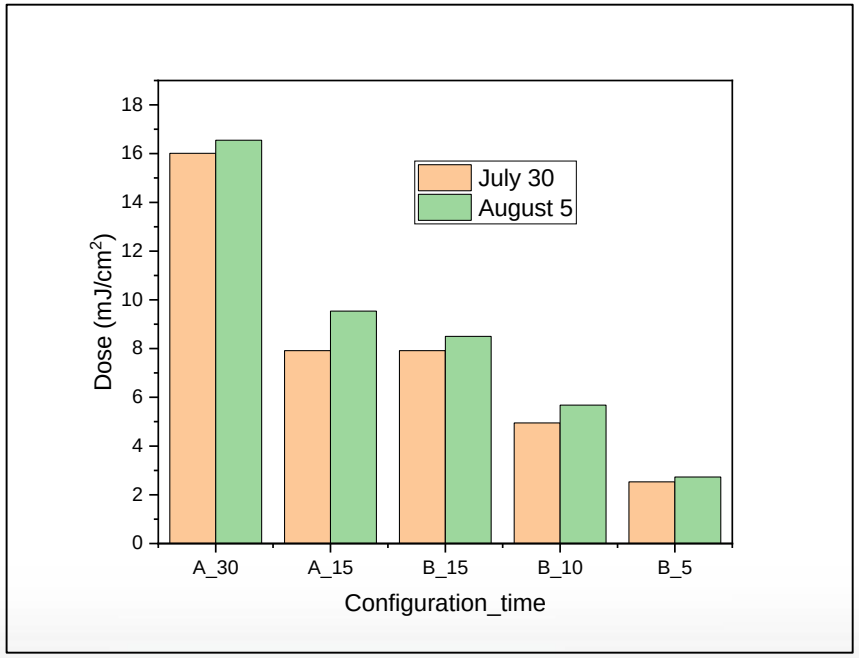


Note:

1. Location (3) in shadow areas
2. Location (5) on top of maximum height of tripod

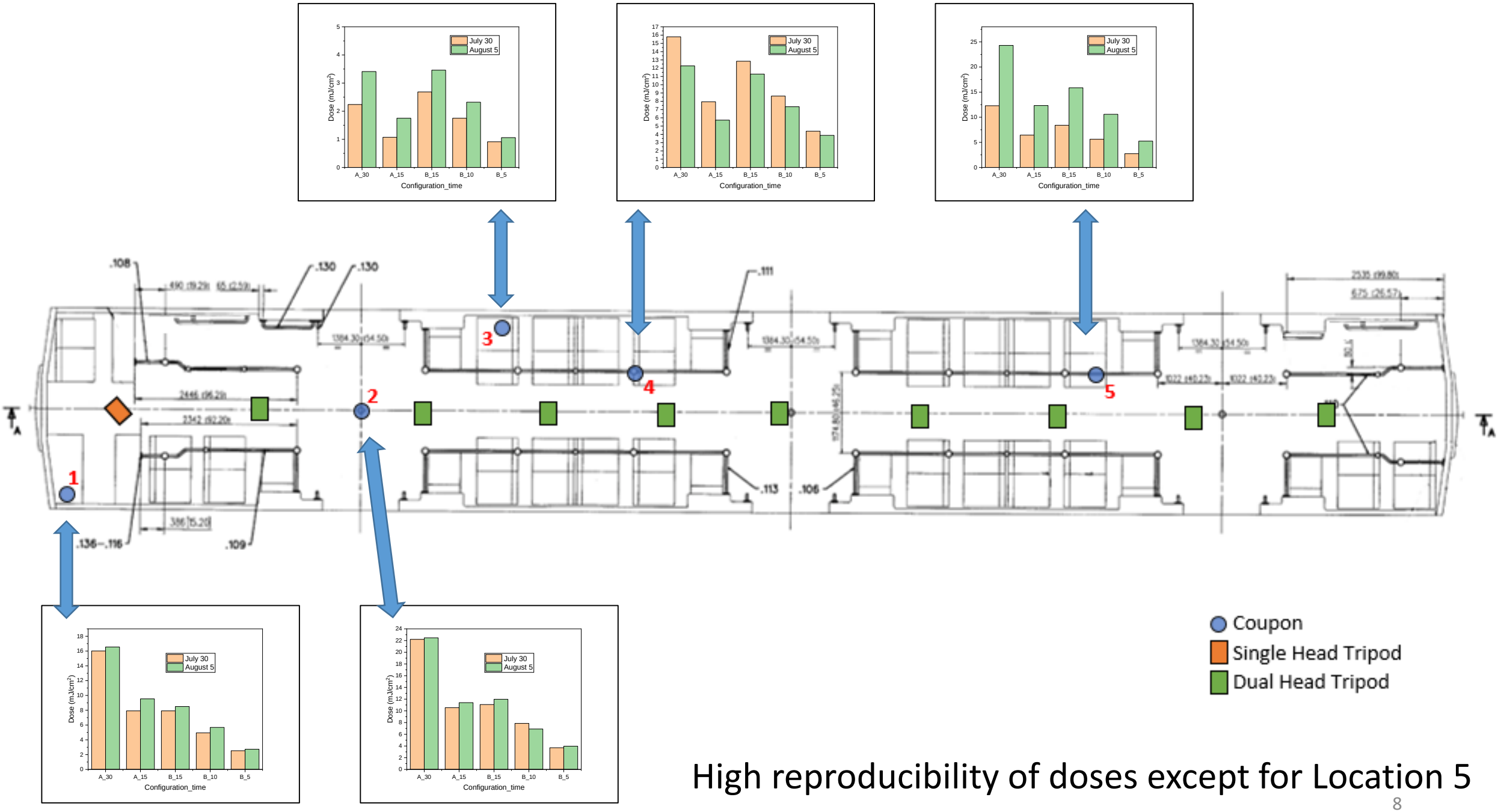
UVC Light Doses

- Measurement of UVC dose* (in mJ/cm^2) at five locations for each test condition (5 total) on two days (July 30 and August 5) in order to:
  - Determine reproducibility of measured UVC dose
  - Determine dose as function of configuration and duration
- Example: Location 1

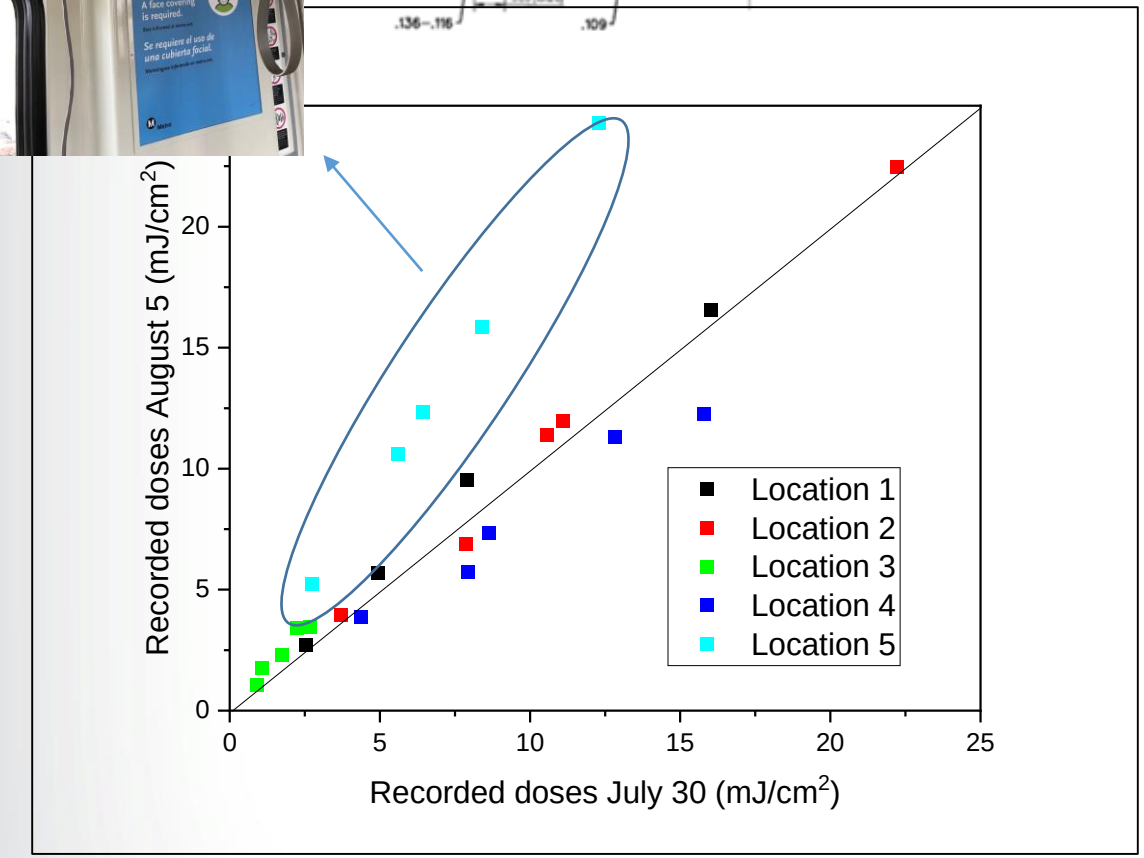


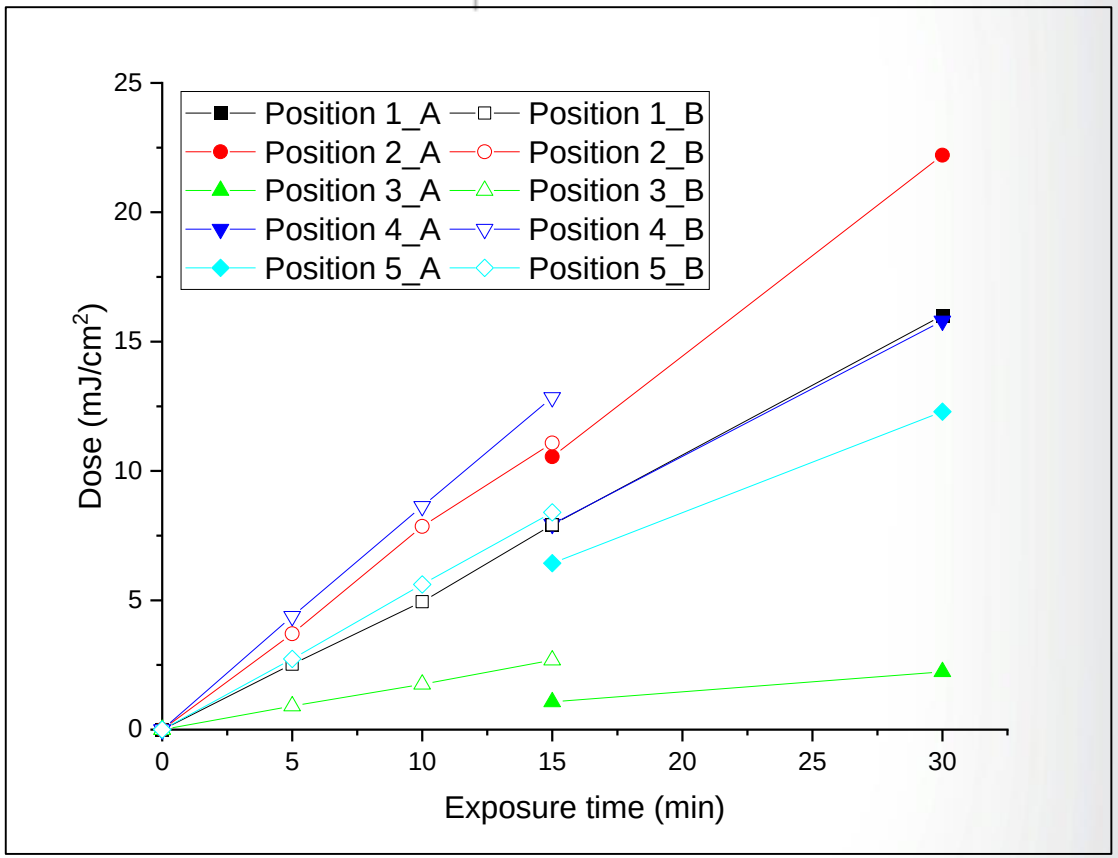
A_30: Config A, 30 min
A_15: Config A, 15 min
B_15: Config B, 15 min
B_10: Config B, 10 min
B_5: Config B, 5 min

*: Dose = intensity x time; ITL 2500 meter and sensor collects measured intensity over time and displays as acquired dose



High reproducibility of doses except for Location 5





- High reproducibility of doses at four out of five locations
- Sensor location 5 mounted on railing which may have been at different angle

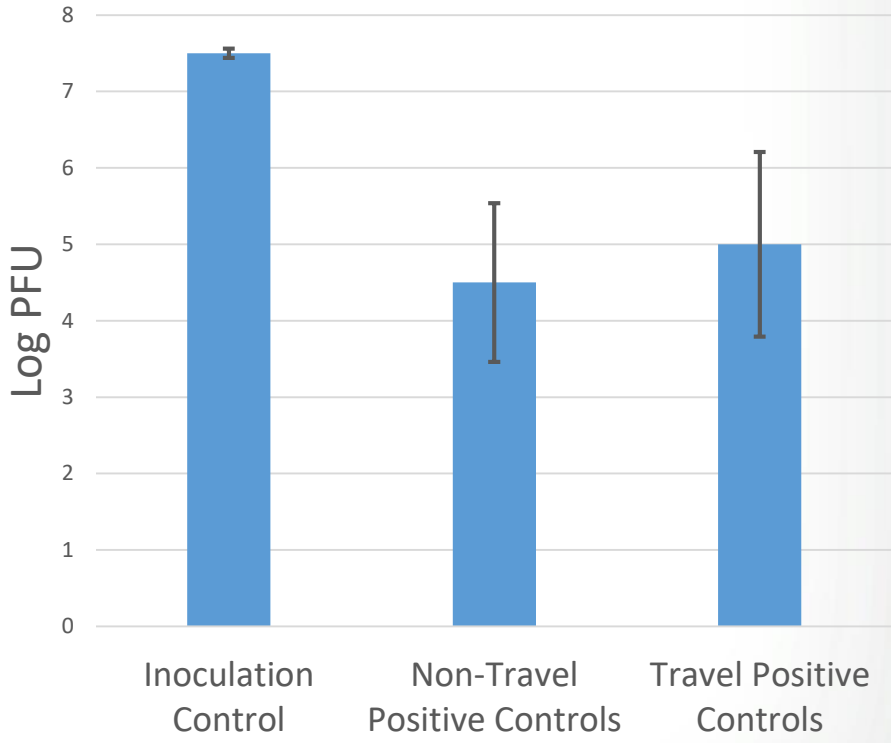
- (Near) linear increase of dose with exposure time at all locations

LA Metro Field Study – Virus Data

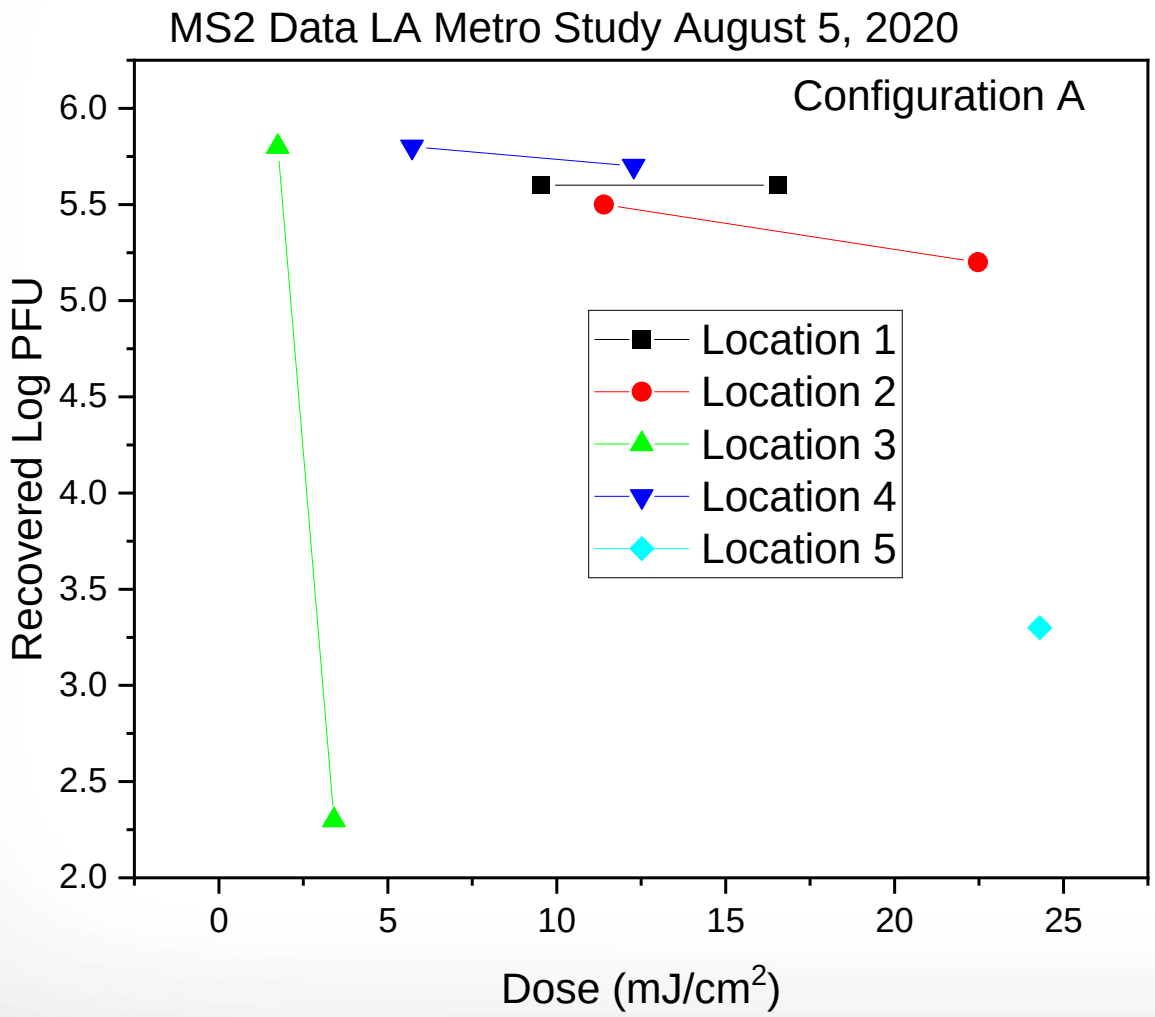
- Recoveries of MS2 Controls:

Type	Log PFU	StDev	Range Log PFU
Inoculation Control	7.5	0.06	
Non-Travel Positive Controls* (n=3)	4.5	1.04	3.4 - 5.4
Travel Positive Controls* (n=3)	5.0	1.21	3.8 - 6.4

*: Extracted and enumerated at same time together with test coupons

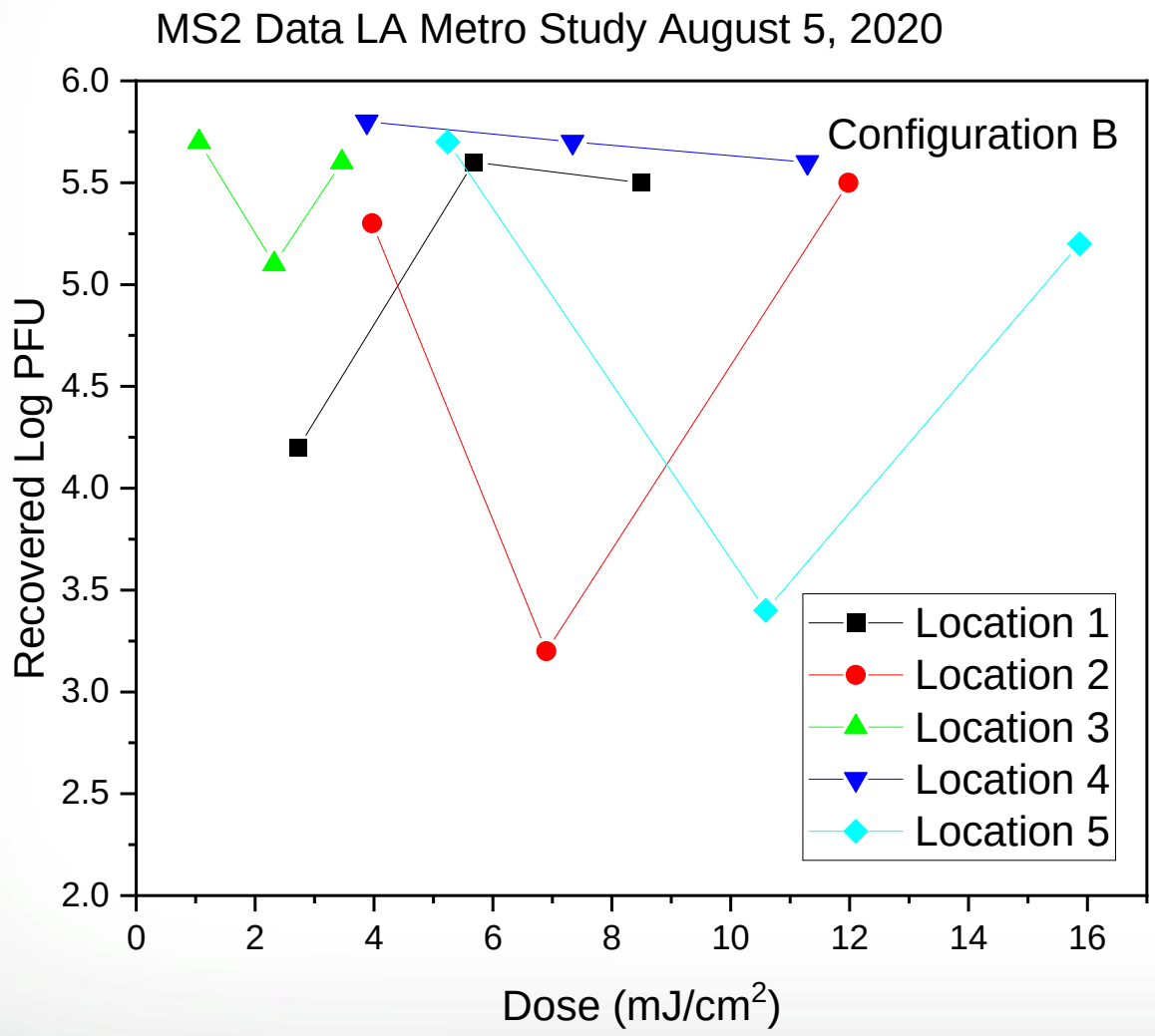


MS2 Virus Data – Configuration A



- Travel Coupons (unexposed) had 5.0 Log PFU
- No appreciable losses at locations 1,2, and 4
- Location 3's 3 log reduction for double dose is inconsistent with other data
- Location 5 sample, 15 min not received; unlabeled sample had 1 log PFU recovered (not shown)

MS2 Virus Data – Configuration B



- Travel Coupons (unexposed) had 5.0 Log PFU
- No appreciable losses at locations 3, 4, and 5
- Inconsistent recoveries for locations 1 and 2 as function of measured dose

MS2 Virus Data – Interpretation of Results

UVC Dose Measurements

- Measured range 1 – 24 mJ/cm^2
- Consistent doses for different configurations and exposure times

Coupon Results

- Lack of reduction in MS2 virus may be attributed to the hardiness of this non-enveloped virus

- Literature show a one (1) log reduction in MS2 for 20 mJ/cm^2 and 35 mJ/cm^2 (different UVC light sources, different conditions) dose
  - SARS-CoV-2 dose to reach 1 log reduction is expected to be ~ 4 mJ/cm^2 with an upper limit of ~11 mJ/cm^2 [1]

(1): Ultraviolet irradiation doses for coronavirus inactivation – review and analysis of coronavirus photoinactivation studies Hessling et al., GMS Hygiene and Infection Control 2020, Vol. 15

MS2 Virus Data – Interpretation of Results

Justification for use of MS2 in this field study

- Selection of bacteriophage MS2 virus was made based on
  - Need to have limited losses during the one week of inoculation, transport to LA, testing and transfer back to Durham, NC
  - Capability to extract, process and enumerate in EPA RTP biolab
  - Short preparation time

Field Study Conclusions

Conclusions:

- Real UVC dose measurements in a metro car are very valuable!
- Occasional MS2 low recoveries do not seem to be indicative of deactivation by UVC light during tests and are more likely due to other factors (still somewhat unexplained)
- More research to be done on variability of this virus or other surrogate viruses
  - Only one coupon per test condition makes interpretation more difficult

Next Steps

EPA/ORD Research with SARS-CoV-2

- Conducting tests with virus in biosafety level 3 lab in September
- Inactivation dose-response curve will be evaluated with same pulsed xenon light
  - Testing also planned with UVC LED lights

EPA/ORD Research with additional surrogate virus, Phi6

- Conduct side-by-side UV tests with the Puro Sentry M1 unit (provided by LA Metro) with the bacteriophages Phi6 and MS2 in EPA RTP labs
  - Phi6 is an enveloped virus, like SARS-CoV-2 (expected to be more sensitive to UVC)
- Determine inactivation dose-response curves for both Phi6 and MS2 with UVC unit
  - Collective data will allow correlation of field results

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