



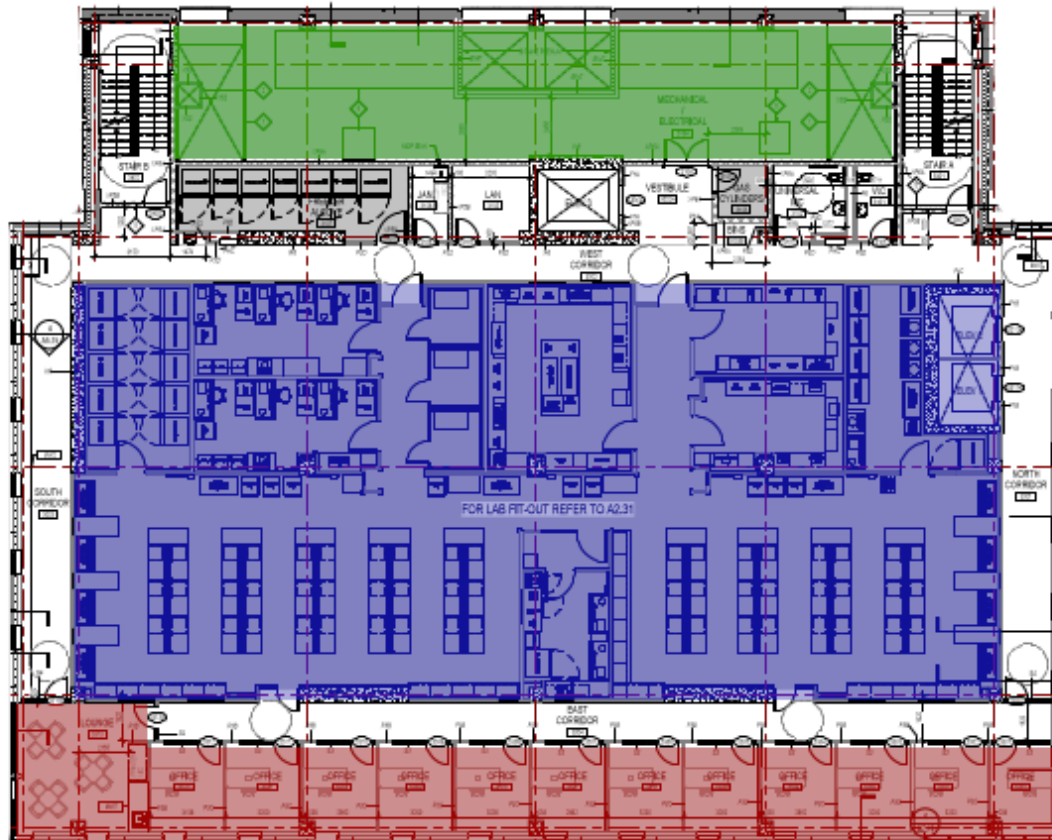
Carleton
UNIVERSITY



Health Science Building Audit

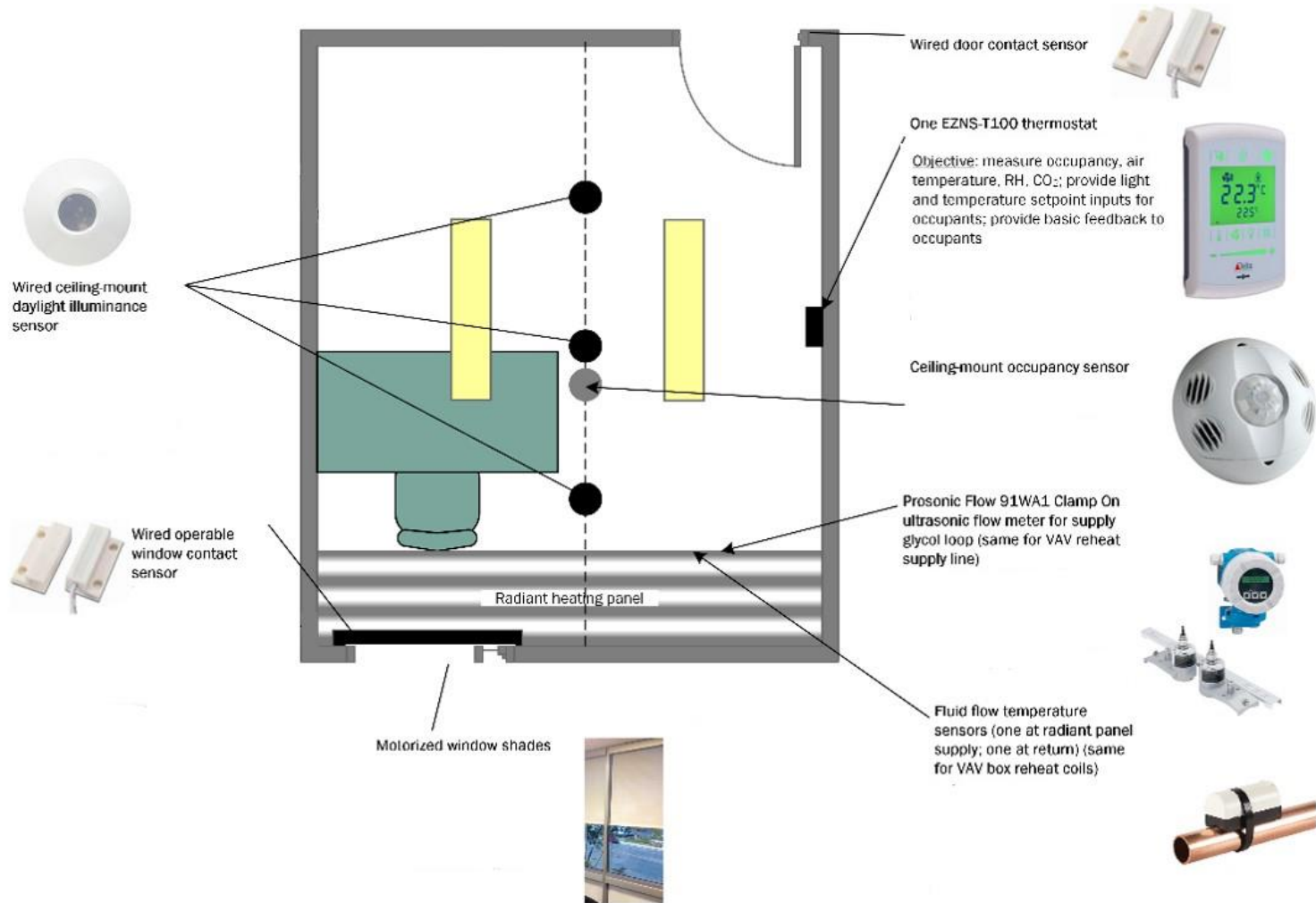
By: Ava Bebbington & Manav Shah | Supervisors: Prof. Gunay &
Prof. O'Brien

Health Science Layout



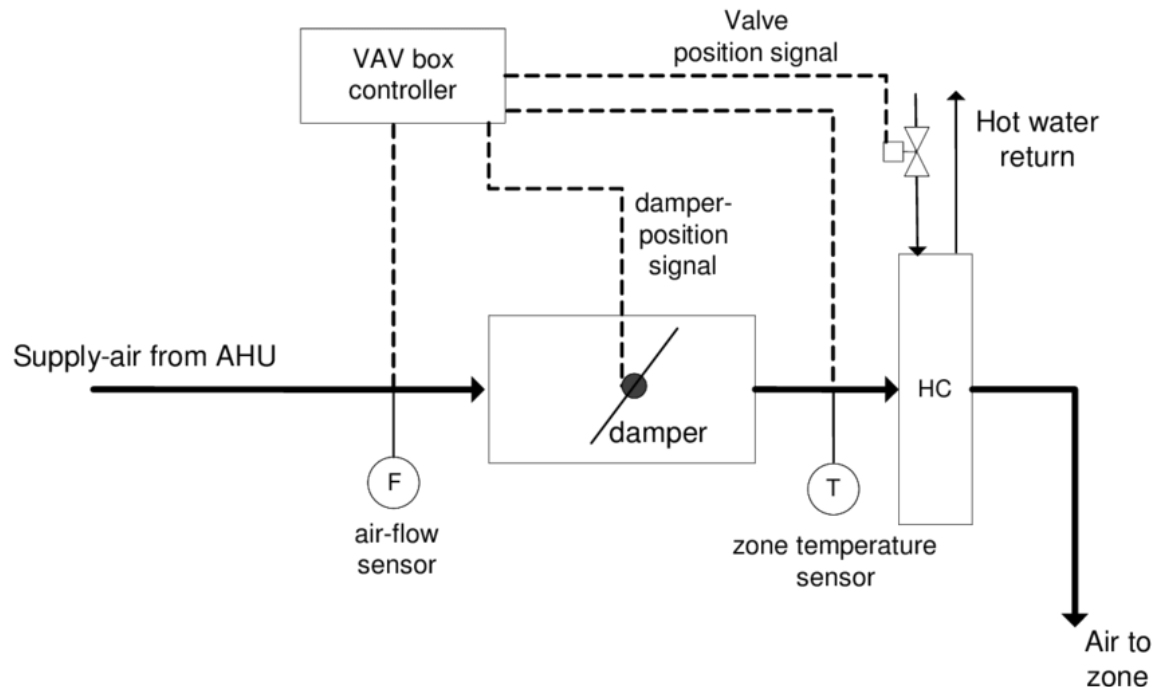
- Air Handling Unit
- Lab Area
- Offices and Lounge

Inside the Office



Background – Ventilation/VAVs

- Variable Air Volume boxes
- Serving multiple diffusers across rooms
- Changes air flow via damper position



Background - Objectives



- Audit the offices and other rooms equipped with the sensors.
- Test the aforementioned systems to ensure they are operating.
- Check sensor readings for bias.
- Highlight any significant issues.

Due to the annual FMP Switchover from heating to cooling, we could not test:

- Reheat Coils in VAV boxes
- Radiant heating panels

Background – Enteliweb

- Obtain reported values from sensors
- Change and override setpoints

HS_RM3303_TYPE_3B (490407)

Objects				
Command		Manage		Search
<input type="checkbox"/>		Object ↑	Name	Value
– Inputs (11 Items)				
<input type="checkbox"/>		AI1101	HS_RM3303_LUX1	44.8 lx
<input type="checkbox"/>		AI1102	HS_RM3303_LUX2	26.1 lx
<input type="checkbox"/>		AI1103	HS_RM3303_LUX3	25.1 lx
<input type="checkbox"/>		AI1304	HS_RM3303_RAT	22.1 °C
<input type="checkbox"/>		AI1305	HS_RM3303_LIGHT_AMP	0.0 A
<input type="checkbox"/>		AI201001	HS_RM3303_RMT	22.4 °C
<input type="checkbox"/>		AI201003	HS_RM3303_RMH	54.6 %RH
<input type="checkbox"/>		AI201004	HS_RM3303_CO2	418.6 ppm
<input type="checkbox"/>		BI1104	HS_RM3303_CMD	None
<input type="checkbox"/>		BI1202	HS_RM3303_DC	Close
<input type="checkbox"/>		BI201005	HS_RM3303_WMD	None
– Outputs (5 Items)				
<input type="checkbox"/>		AO1105	HS_RM3303_RAD_MOD	0.0 %
<input type="checkbox"/>		AO1207	HS_RM3303_LIGHT_DIM	0 %
<input type="checkbox"/>		BO1	PWR_OUT_1	On
<input type="checkbox"/>		BO1205	HS_RM3303_LIGHT_ON	Off
<input type="checkbox"/>		BO1206	HS_RM3303_LIGHT_OFF	On
– Values (69 Items)				
<input type="checkbox"/>		AV1	HS_RM3303_RMT_SP	21.0 °C
<input type="checkbox"/>		AV2	HS_RM3303_VAV_RMT_MIN_SP	18.0 °C

291 Objects | 0 Selected | Auto Refresh: 5 Seconds

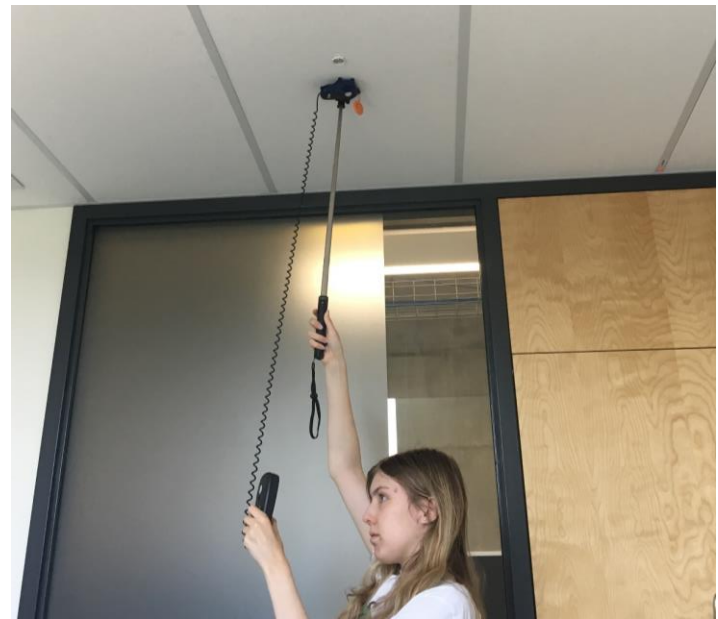
Procedure – Temperature, Humidity, Carbon Dioxide

- Three readings at separate times
- Recorded observed value (device) at same time as reported (Enteliweb)



Procedure - Illuminance

- Lux meter attached to selfie stick
- Held downwards at each sensor with blinds open, closed, and in between



Procedure – Air Flow

- Capture hood sealed over square diffusers
- Measured at 6 different setpoints: closed dampers, and minimum to maximum flow in increments of 25%



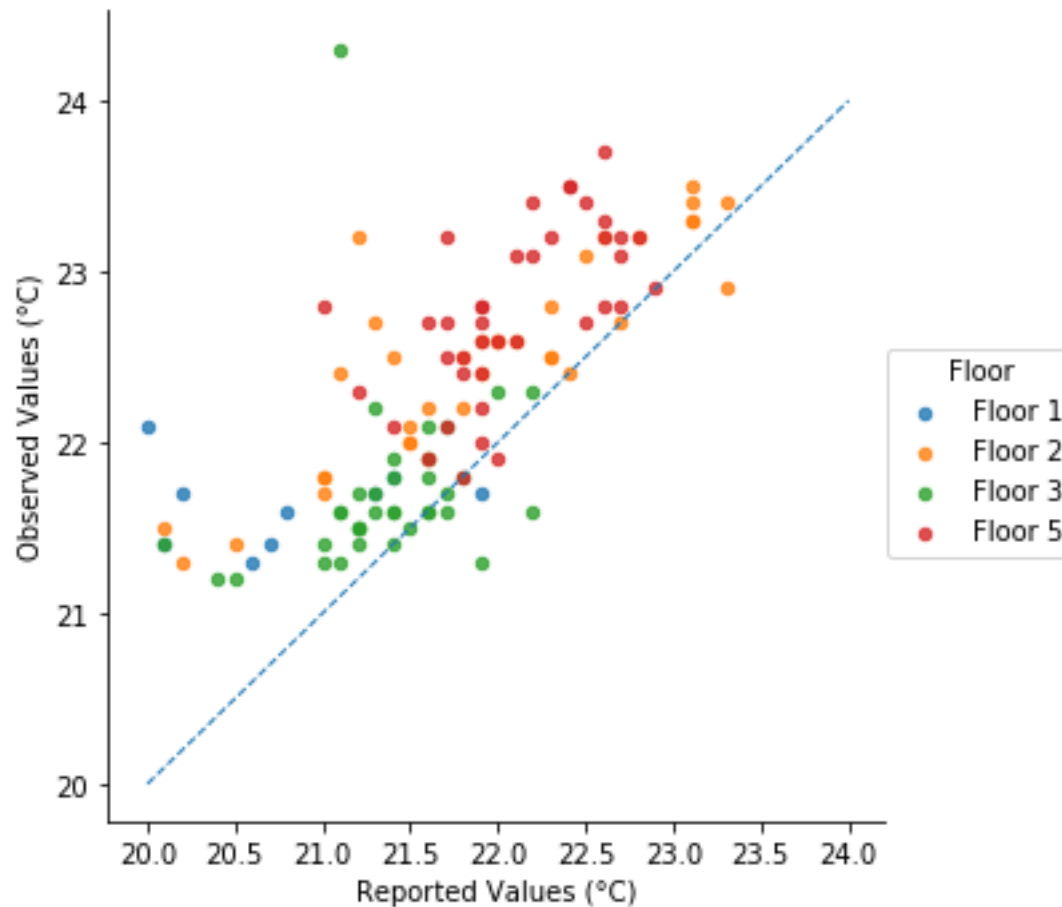
Procedure – Motion Detectors, Contact Sensors, Controls

- Moved and stayed still, checked motion detector response in Enteliweb
- Tried shades, light switches, and thermostats to ensure functionality
- Opened and closed windows and doors, checked reported state of contact sensors.



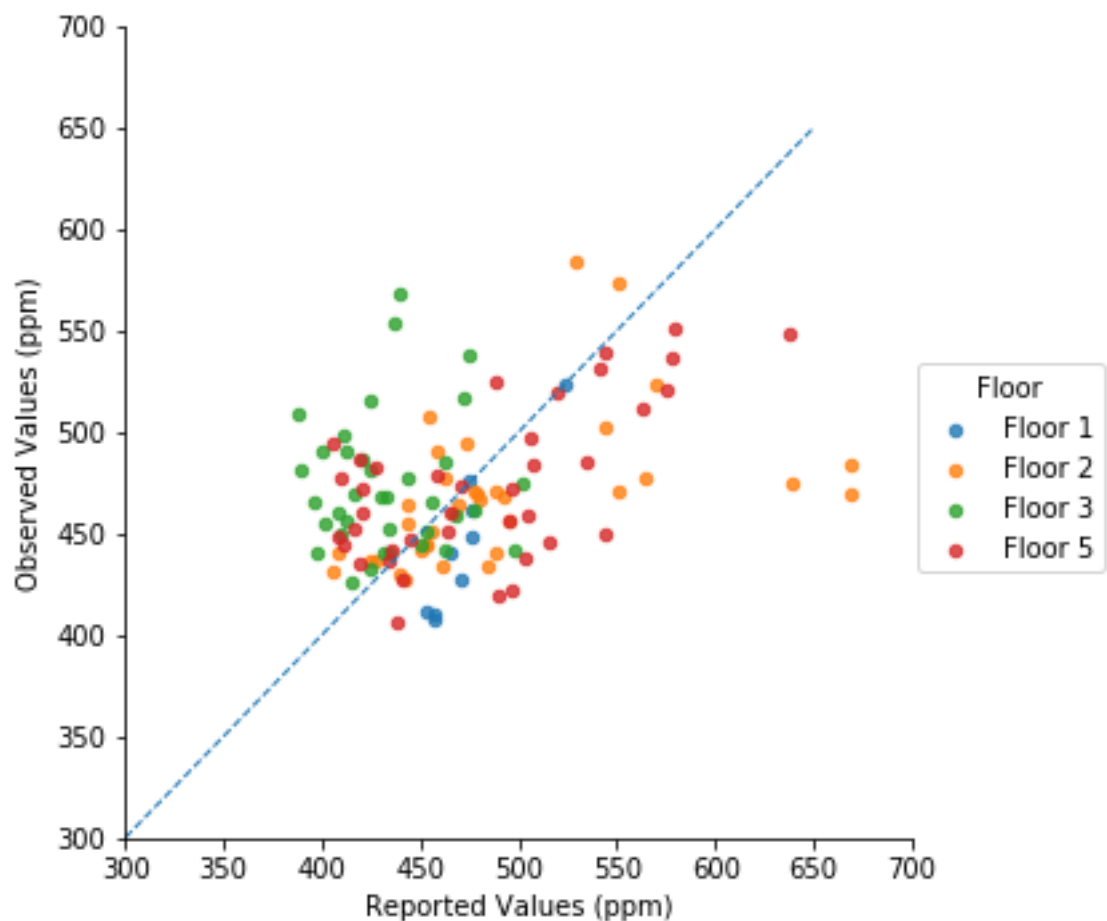
Results – Temperature

- Mean Absolute Bias: 0.657°C



Results – Carbon Dioxide Concentration

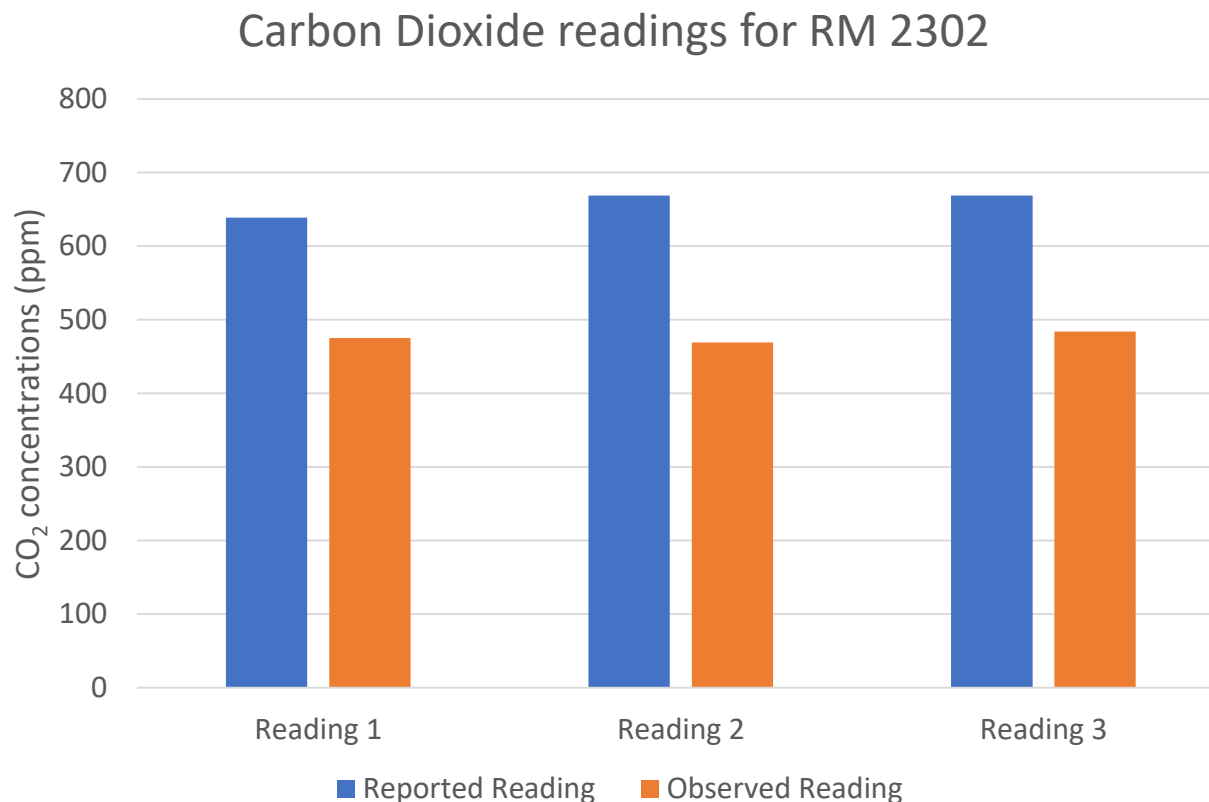
- Mean Absolute Bias: 38.2 ppm



Results – Carbon Dioxide Concentration

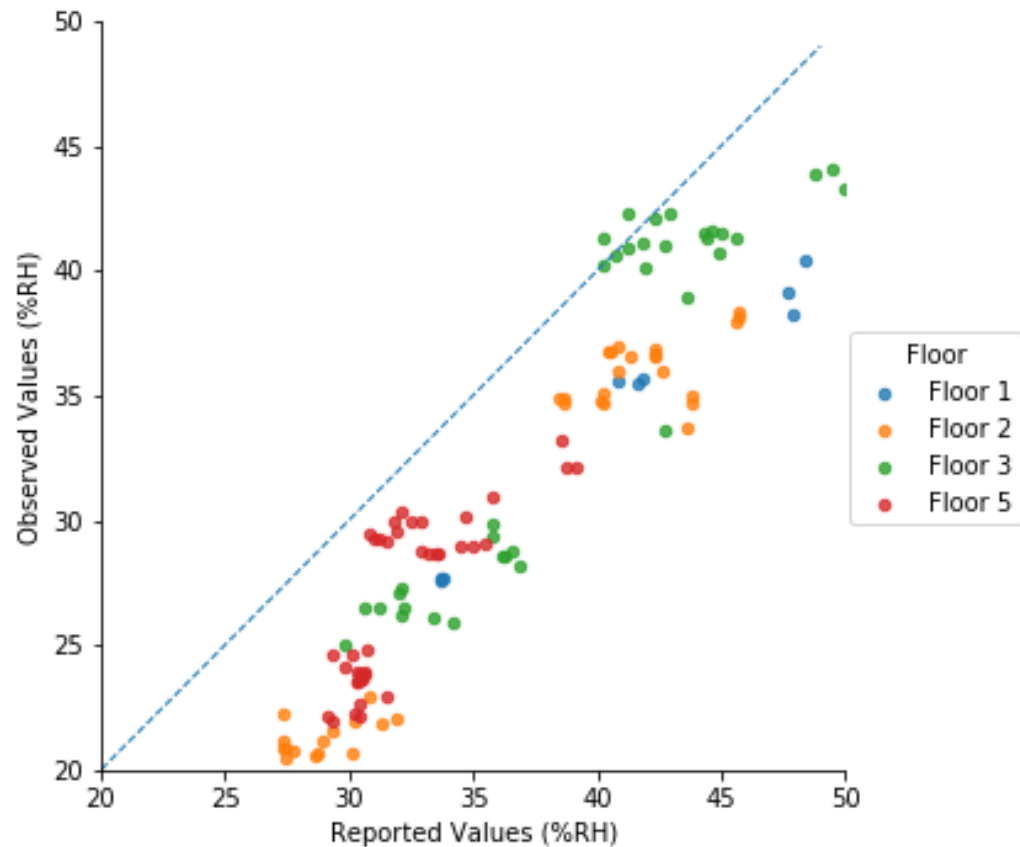
Anomaly: Room 2302

- Larger bias: reported values 183 ppm higher



Results – Relative Humidity

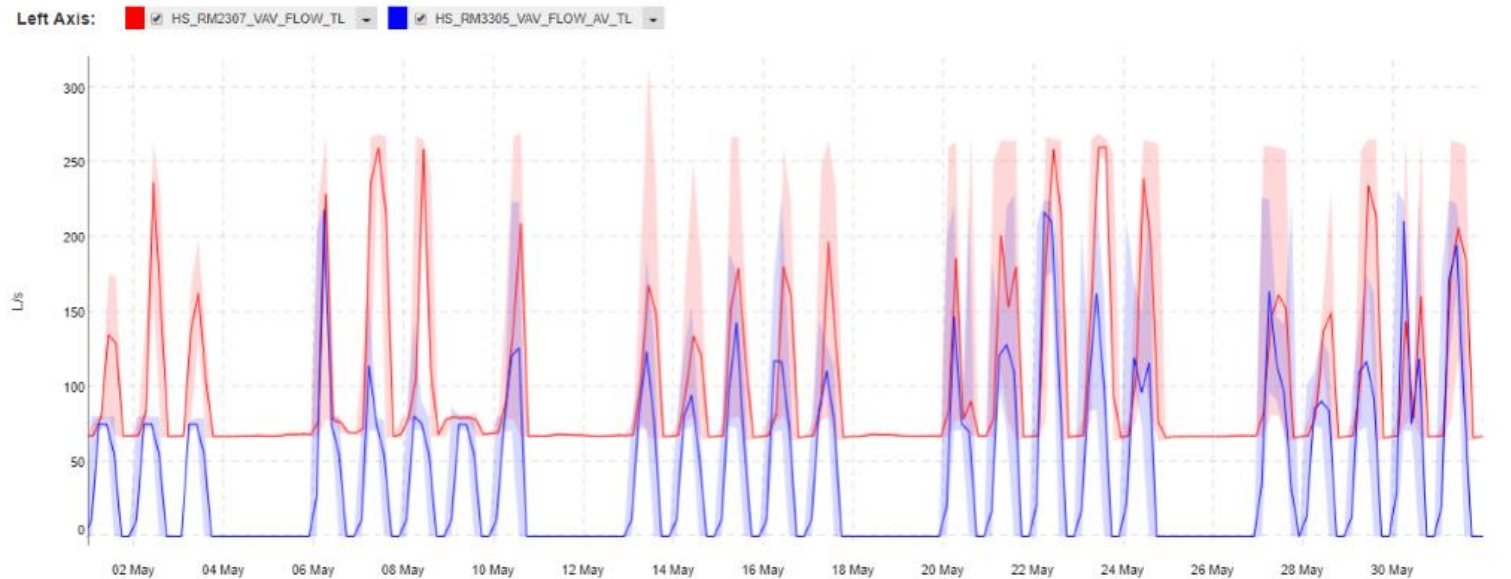
- Mean Absolute Bias: 5.74%RH
- Consistent bias across rooms



Results – Air Flow

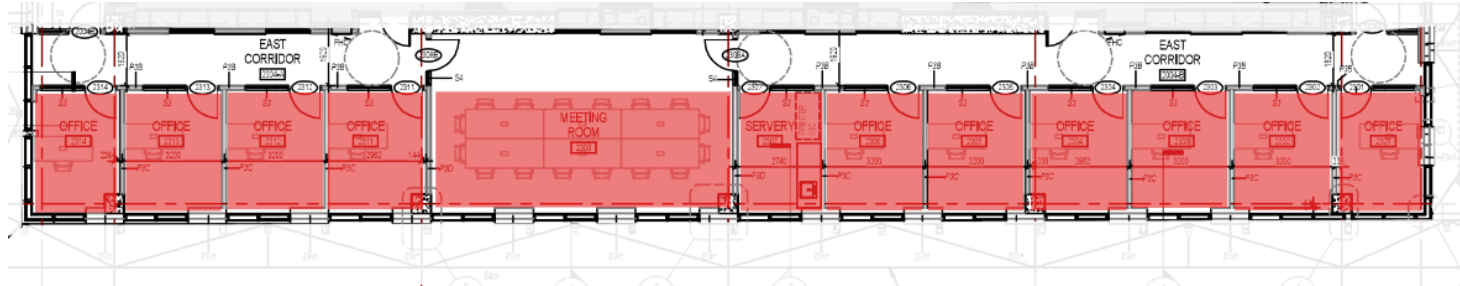
Key Issue

- Reported flow when VAV dampers are closed.
- No flow observed by capture hood, but enteliWEB reports non-zero flow.
- Reported flow ranged from 30 – 80 L/s

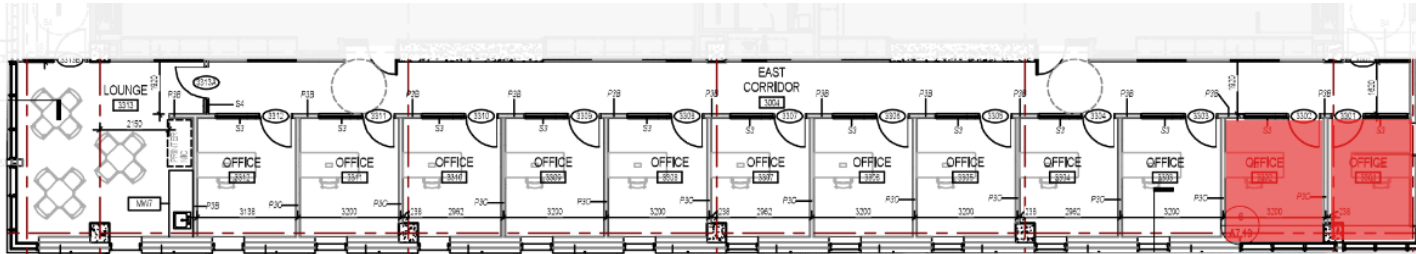


Affected Rooms

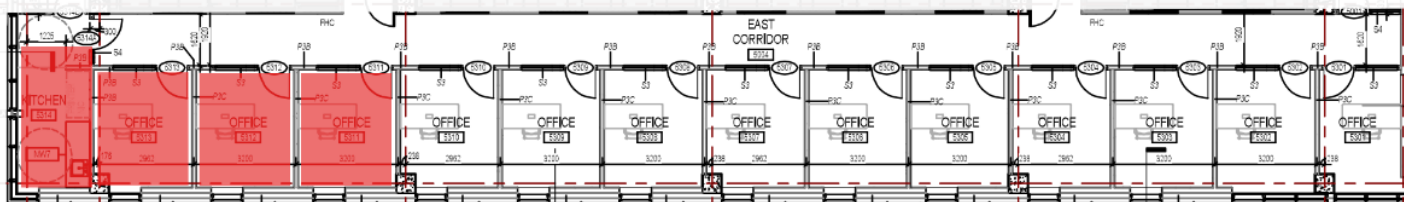
Floor 2



Floor 3



Floor 5



Results – Air Flow

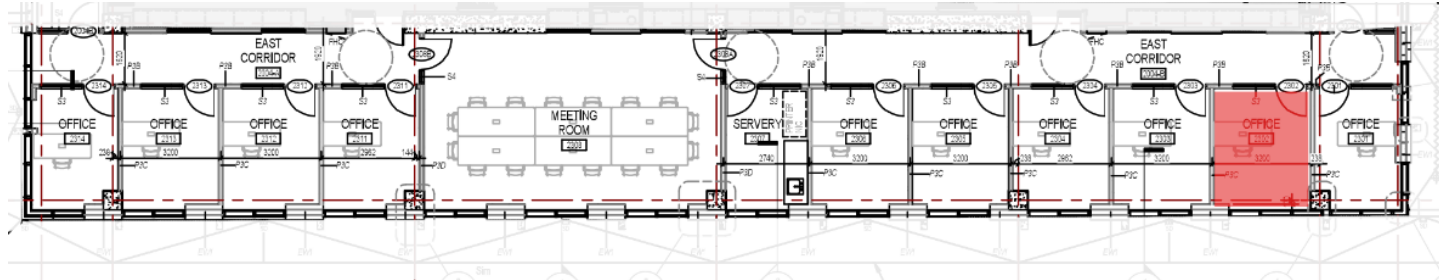
Key Issue #2: Leaky Dampers

- Observed flow when dampers are closed.
- Dampers are not fully closing.
- Only affects two rooms, leaking 4.0 – 6.5 L/s.
- For comparison, this issue affected all rooms in Canal, and amount of air leaking went upwards of 100 L/s in some cases.

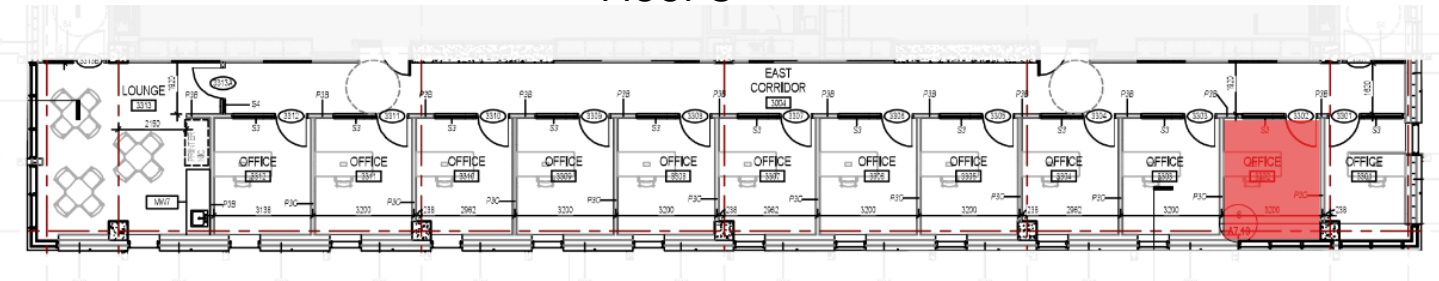


Affected rooms

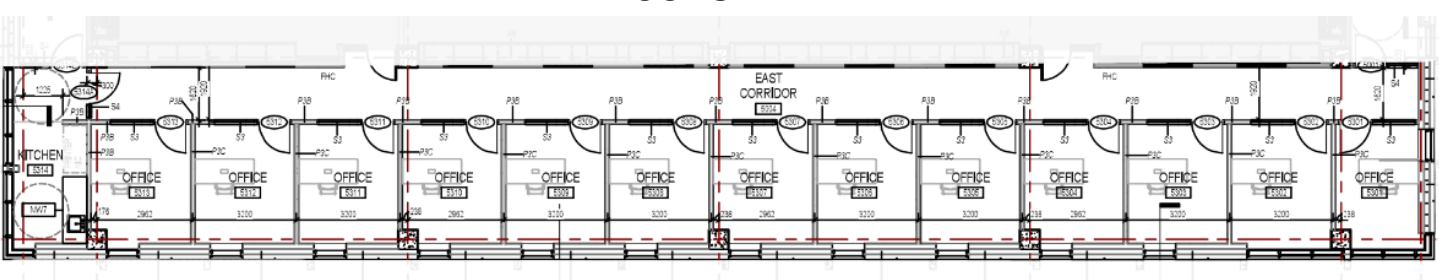
Floor 2



Floor 3



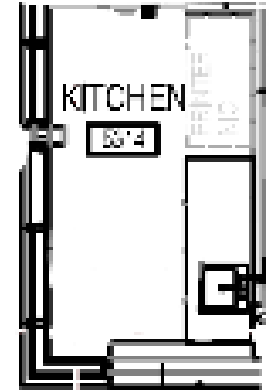
Floor 5



Results – Air Flow

Anomaly: Room 5314

- Fifth Floor Kitchen
- Measured flow was $\sim 1.8x$ higher than the reported flow.



Mislabeled flow reading

- Flow reading for VAV serving rooms 2301 and 2302, mislabelled as flow for room 2303

HS_RM2301_2302_CORR_2309_TYPE_1A (490305)

Objects

Command Manage flow

Object	Name	Value ↑
AV9	HS_RM2303_VAV_FLOW	0.0 L/s

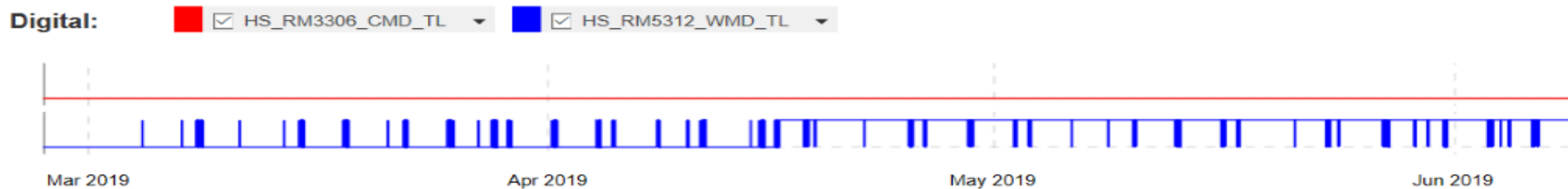
Results - Illuminance

- Difficulty in finding exact bias due to light changes from windows, lux meter obstructing sensor, etc
- Approximate bias: 27.5 lux
- Very large variance, observed from 3 lux - 819 lux



Results – Motion Detectors, Contact Sensors, Controls

- Broken window contact sensors: Rooms 5305, 5307, 5310, 5313
- Broken motion detectors: WMD in 5312, CMD in 3306





Thank You

Questions?

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