



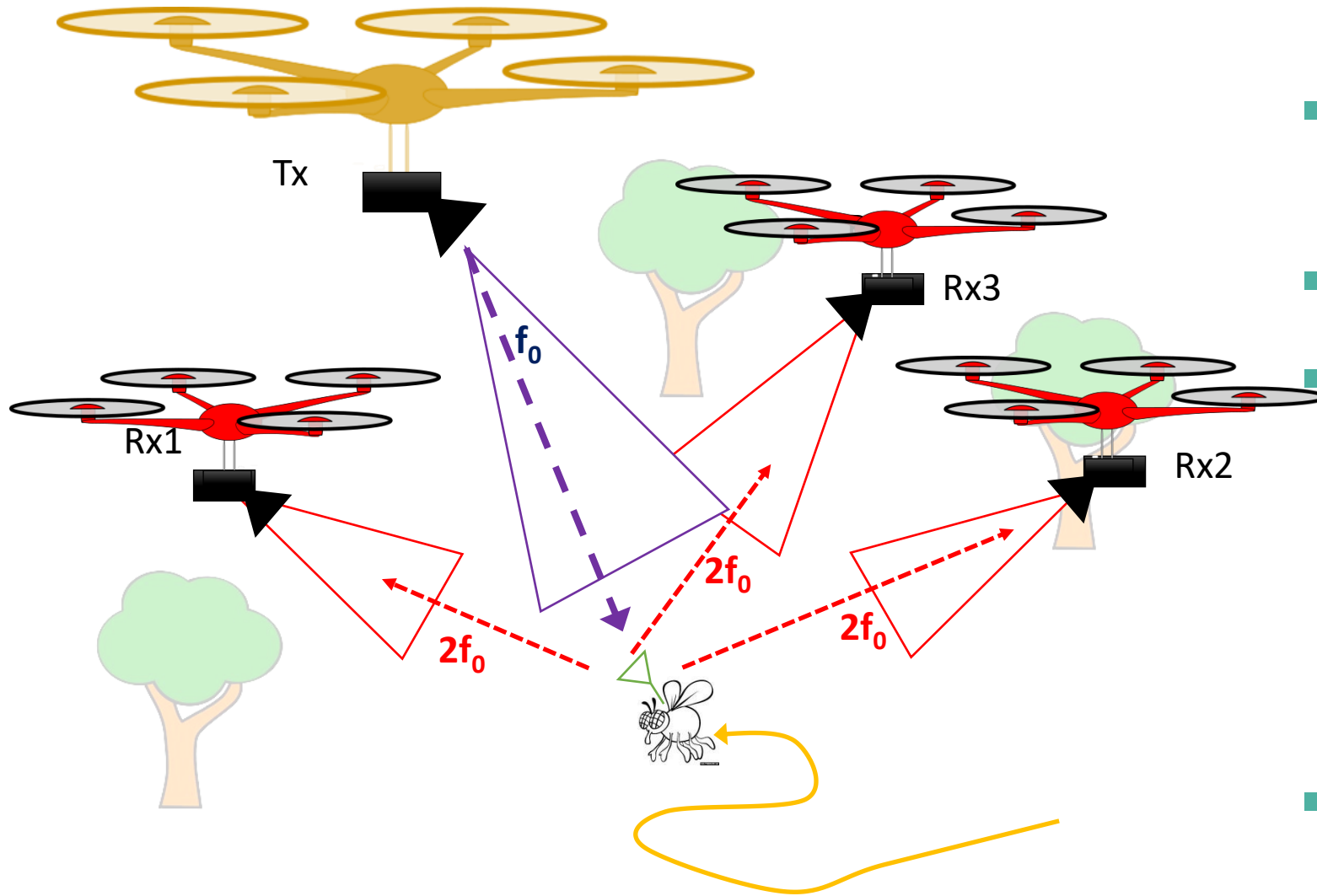
Research Highlights 2021-22 Wireless Research Centre University of Canterbury

Dr Graeme Woodward

Outline

- Radio localisation of insects from drone swarms
- Antarctic sea-ice measurement
- Race Ranger
- mmWave channels
- Postgrads

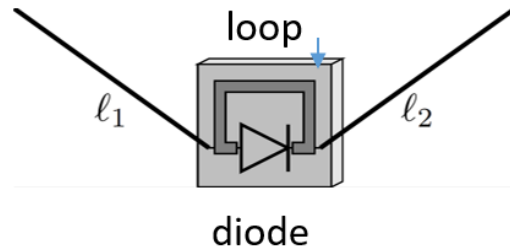
Multi-static harmonic radar on UAV swarm platform



- One high-power tx @ f_0
- Tag converts f_0 to $2f_0$
- Multiple receivers @ $2f_0$, target position by time difference of arrival + triangulation.
- UAV swarm “moves” with the target

Tag Design [K.Eccleston, Lincoln Agritech]

The basic principle of the tag circuit:

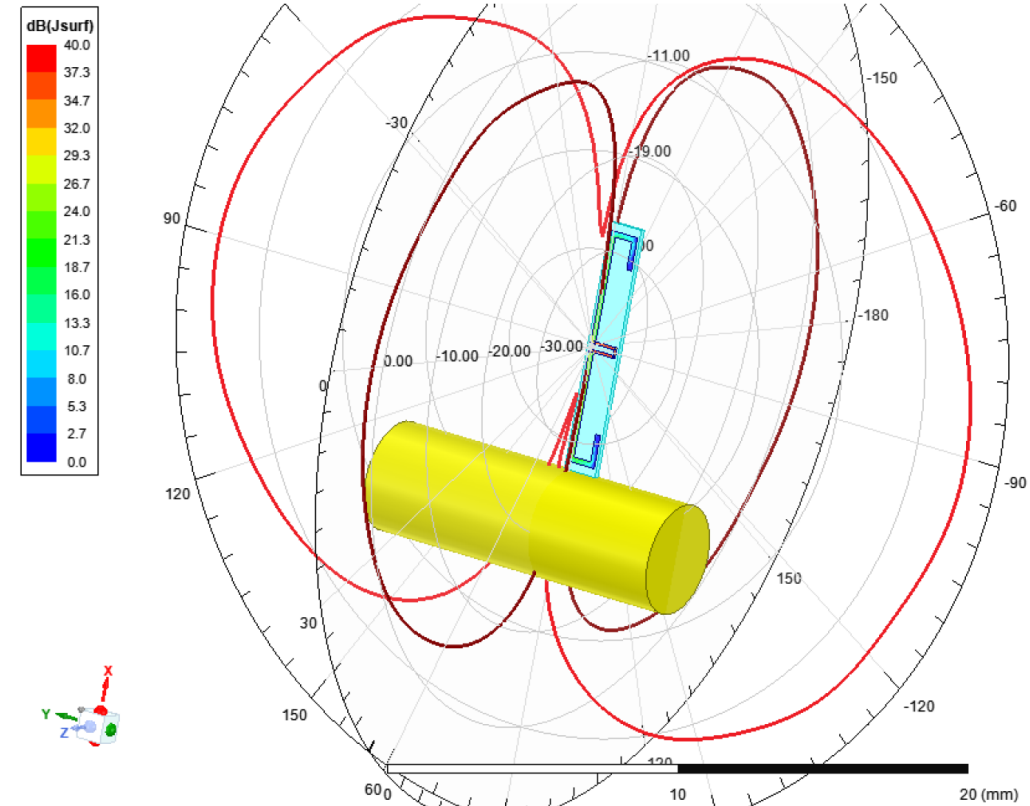


- Use photolithography to fabricate tag on 100micron glass.
- Unpackaged beam-lead diode
- Model Ansys HFSS, with model of insect body.

Meandered Dipole and Stub

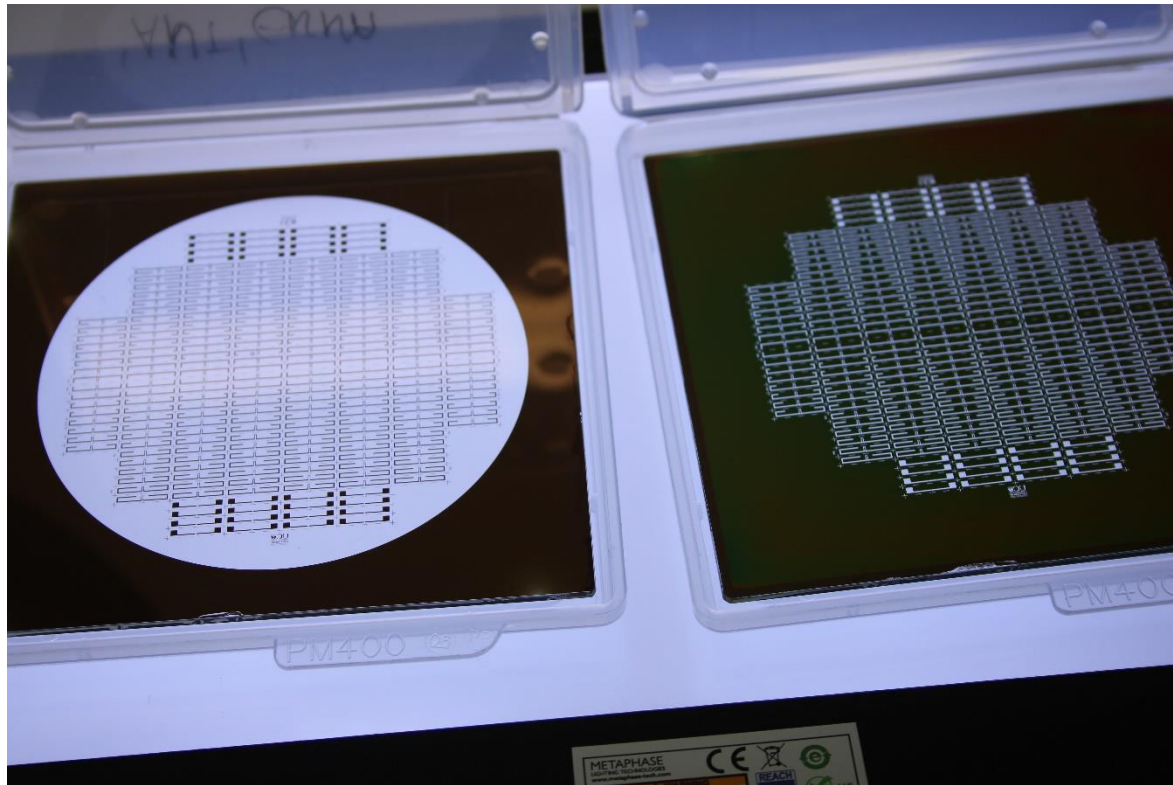
Radiation pattern is omni-directional in horizontal plane.

Stub has negligible impact on radiation pattern and this is to be expected as the two line currents cancel in the far-field.



Tag Fab – [UC nano-fab lab]

Mask



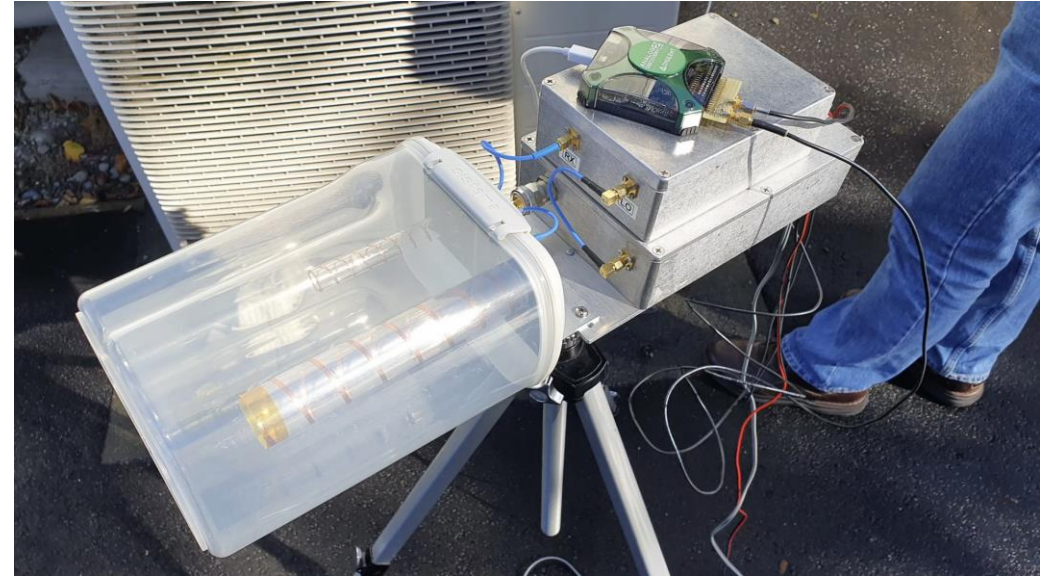
Test slide:



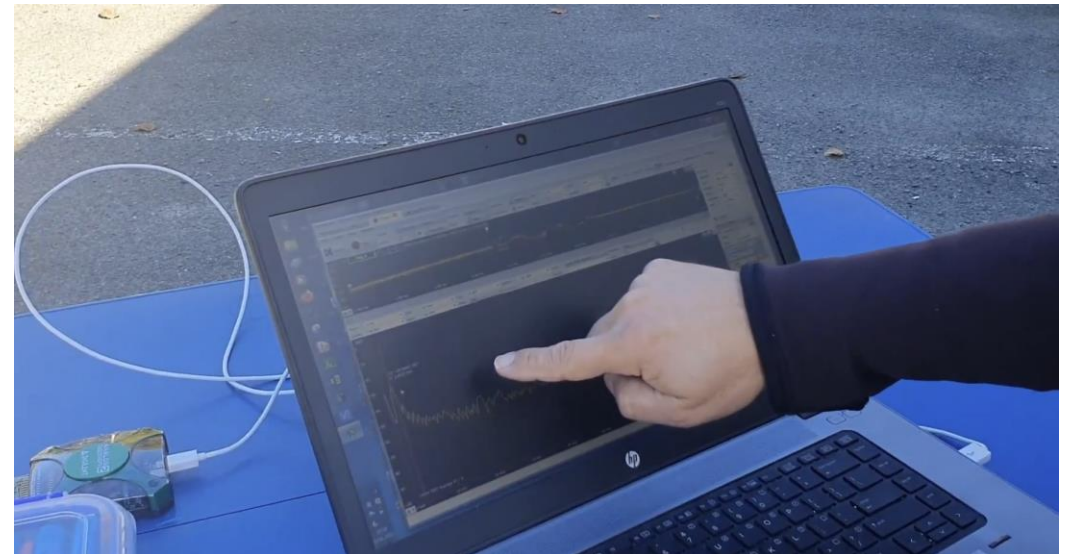
- Next challenges:
 - Resolution, fragile, placing small diodes

RADAR Design. Subcontract [Greg Storz (Consultant, AKL)]

Prototype testing

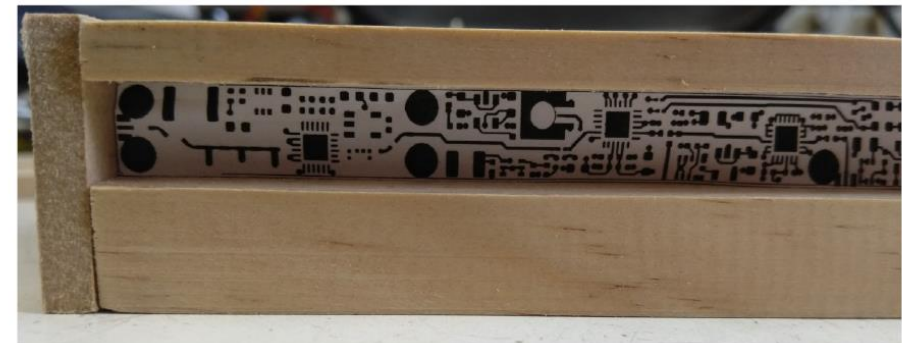
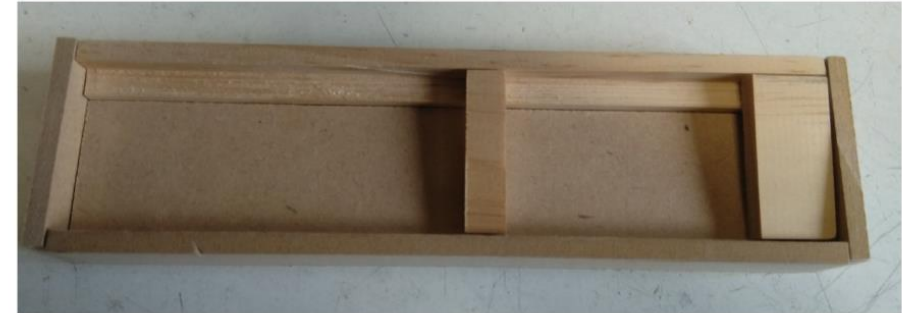


Car-park
test, April
2022



UC
UNIVERSITY OF
CANTERBURY
Te Whare Wānanga o Waitaha

A photograph of a rectangular wooden box with a lid, made of light-colored wood, resting on a white surface. The box is shown from a top-down perspective, slightly angled. The lid is closed, and the box appears to be empty. The wood grain is visible on the sides and the lid. The background is a plain, light-colored surface.



9.3GHz SWEEPER
80mm x 37mm, FR47, 4 Layer

9.5GHz HELPER RECEIVER AND DRIVER
46mm x 37mm, FR47, 4 Layer

18GHz RECEIVER
150mm x 9mm, FR47, 4 Layer

CONTROL, IF, ADC PCB
180mm x 31mm, 4 Layer FR4
max. height 13.0mm

ESTIMATED MODULE SIZE 200mm x 50mm x 30mm

Table 1: Estimated Module Size

Module	Size (mm)	Material	Layer	Height (mm)
9.3GHz SWEEPER	80 x 37	FR47	4	7.0
9.5GHz HELPER RECEIVER AND DRIVER	46 x 37	FR47	4	7.0
18GHz RECEIVER	150 x 9	FR47	4	6.0
CONTROL, IF, ADC PCB	180 x 31	FR4	4	13.0

Table 2: Radar Module System Diagram Options

Option	Size (mm)	Material	Layer	Height (mm)
Option A3	200 x 50	FR4	4	13.0
Option B3A	200 x 50	FR4	4	13.0
Option B3B	200 x 50	FR4	4	13.0
Option B3C	200 x 50	FR4	4	13.0
Option B3D	200 x 50	FR4	4	13.0
Option B3E	200 x 50	FR4	4	13.0
Option B3F	200 x 50	FR4	4	13.0
Option B3G	200 x 50	FR4	4	13.0
Option B3H	200 x 50	FR4	4	13.0
Option B3I	200 x 50	FR4	4	13.0
Option B3J	200 x 50	FR4	4	13.0
Option B3K	200 x 50	FR4	4	13.0
Option B3L	200 x 50	FR4	4	13.0
Option B3M	200 x 50	FR4	4	13.0
Option B3N	200 x 50	FR4	4	13.0
Option B3O	200 x 50	FR4	4	13.0
Option B3P	200 x 50	FR4	4	13.0
Option B3Q	200 x 50	FR4	4	13.0
Option B3R	200 x 50	FR4	4	13.0
Option B3S	200 x 50	FR4	4	13.0
Option B3T	200 x 50	FR4	4	13.0
Option B3U	200 x 50	FR4	4	13.0
Option B3V	200 x 50	FR4	4	13.0
Option B3W	200 x 50	FR4	4	13.0
Option B3X	200 x 50	FR4	4	13.0
Option B3Y	200 x 50	FR4	4	13.0
Option B3Z	200 x 50	FR4	4	13.0

Table 3: Radar Module System Diagram Options

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Option A3	200 x 50	FR4	4	13.0
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RaceRanger: Draft busting in triathlon



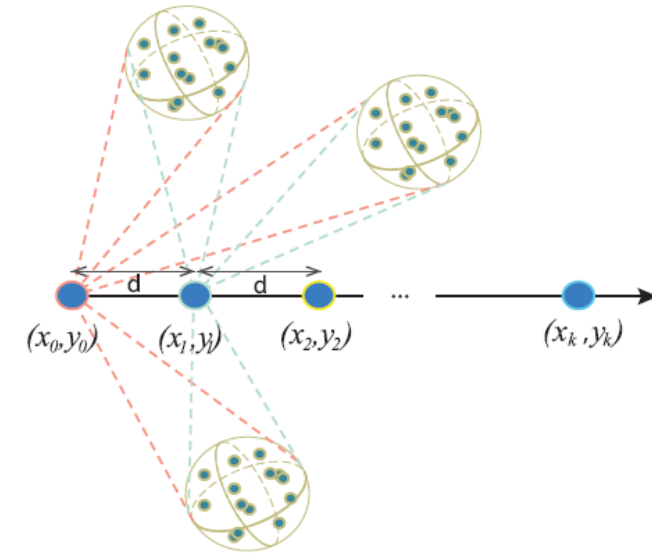
- Start-up: RaceRanger.
- Athletes have limited time to overtake others, or face time penalties.
- This technology gives visual display of time within overtaking box
- Combination of wireless technologies
 - BT beacons to detect bikes in proximity to each other
 - UWB ranging to accurately measure range
- Technology field tested. Limited production run. First race Sept., Spain.



New mmWave channel models with spatial consistency

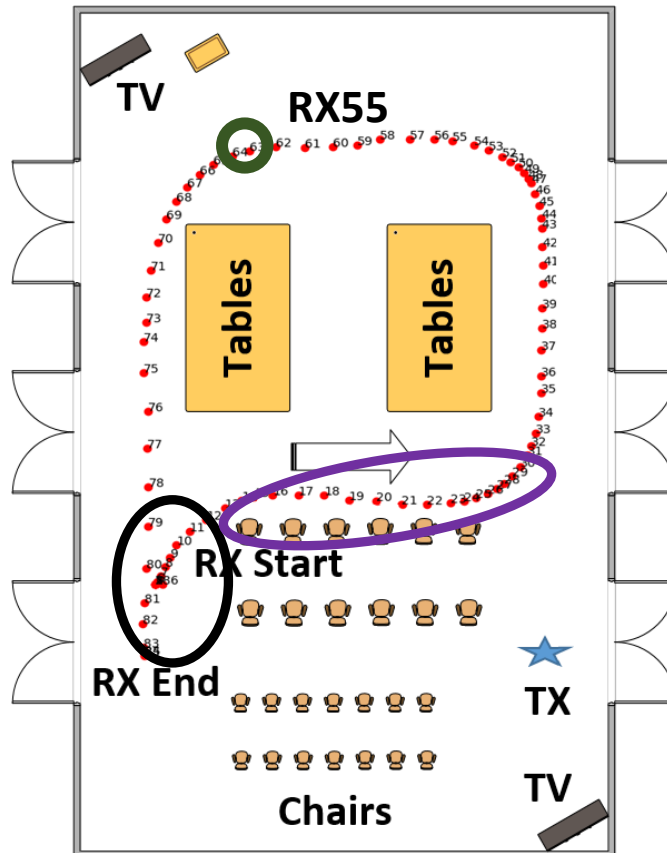
Will Sloane (PhD student). Internship at NIST (USA)

- Need a model where parameters continuously evolve, for beamsteering and tracking.
- As users move, channel parameters are correlated to previous positions.
- Represent the channel with clusters of reflectors. Model path evolution as the receiver moves by the clusters.
- Utilise 60GHz 3D channel measurements, National Institution of Standards & Technology (NIST)

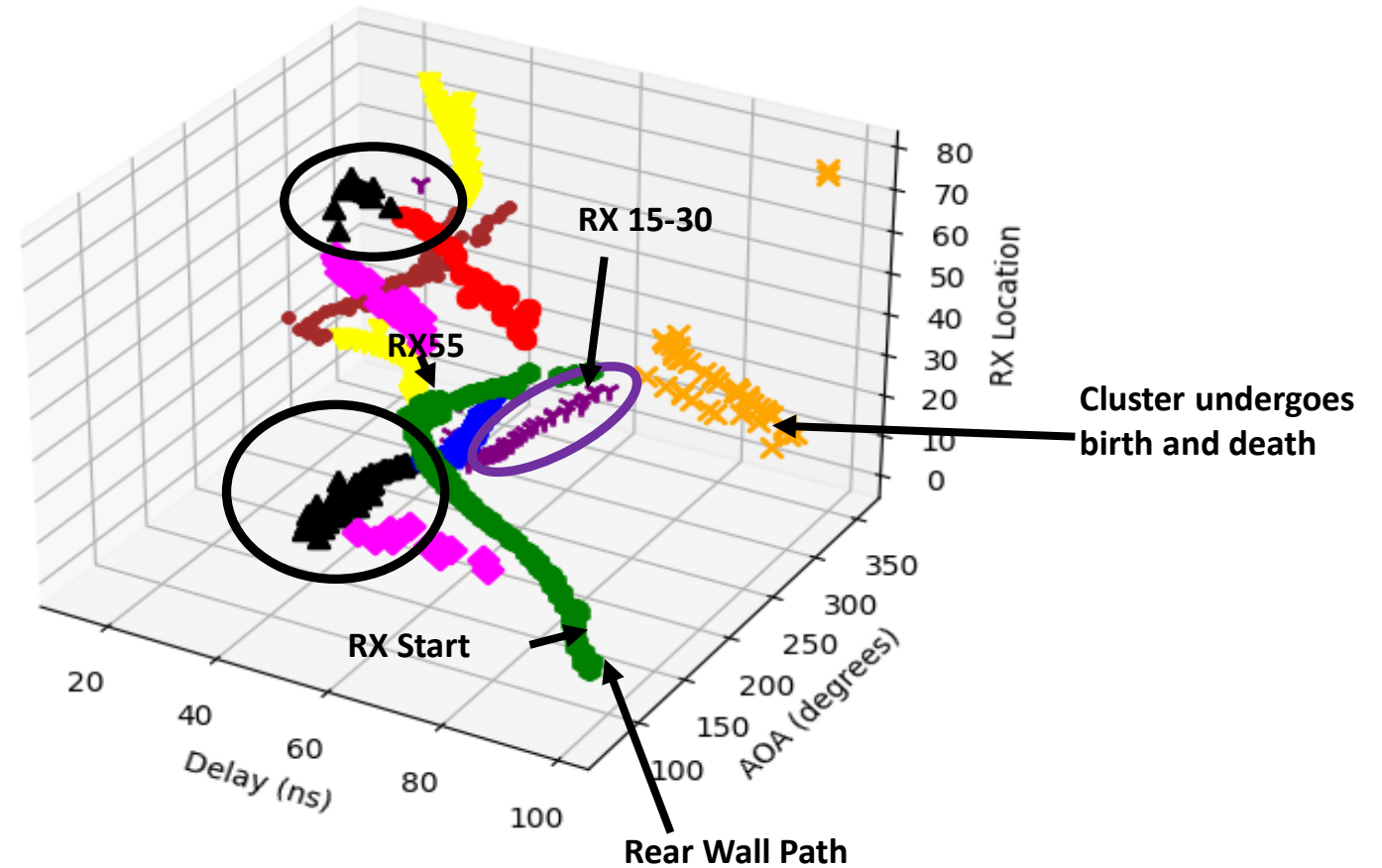


Model development using mmWave Channel Measurements at 60GHz (NIST)

Lecture Room (10x19m)



RX track
33m



Joint **delay-angle-location** clustering

Other postgraduate student research

- **Aston Taylor** (Masters): mmWave radar: sensing & tracking
- **Zubia Ishrat** (PhD): High sectorisation & frequency re-use for narrowband utility field area networks.
- **Amy Inwood** (PhD): Massive MU-MIMO/RIS