



International
Centre for
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Astronomy
Research

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Aperture Arrays And Its Quirks

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THE UNIVERSITY OF
WESTERN
AUSTRALIA



Government of Western Australia
Department of the Premier and Cabinet
Office of Science



Recap

- Aperture array are necessary to perform high resolution radio imaging at low frequencies (tens to hundreds of MHz)
- Several ideal characteristic assumptions have been made about aperture arrays
- Beam shape (*Primary Beam*) important for calibration



Murchison Widefield Array





Engineering Development Array



- **The benefits of high resolution radio imaging using sparse elements does come at a cost**
- **Some of the additional considerations includes:**
 - Changing beam patterns
 - Changing receiver noise temperature
 - Correlation within the array due to mutual coupling



Quirk #1: Changing Beam Patterns

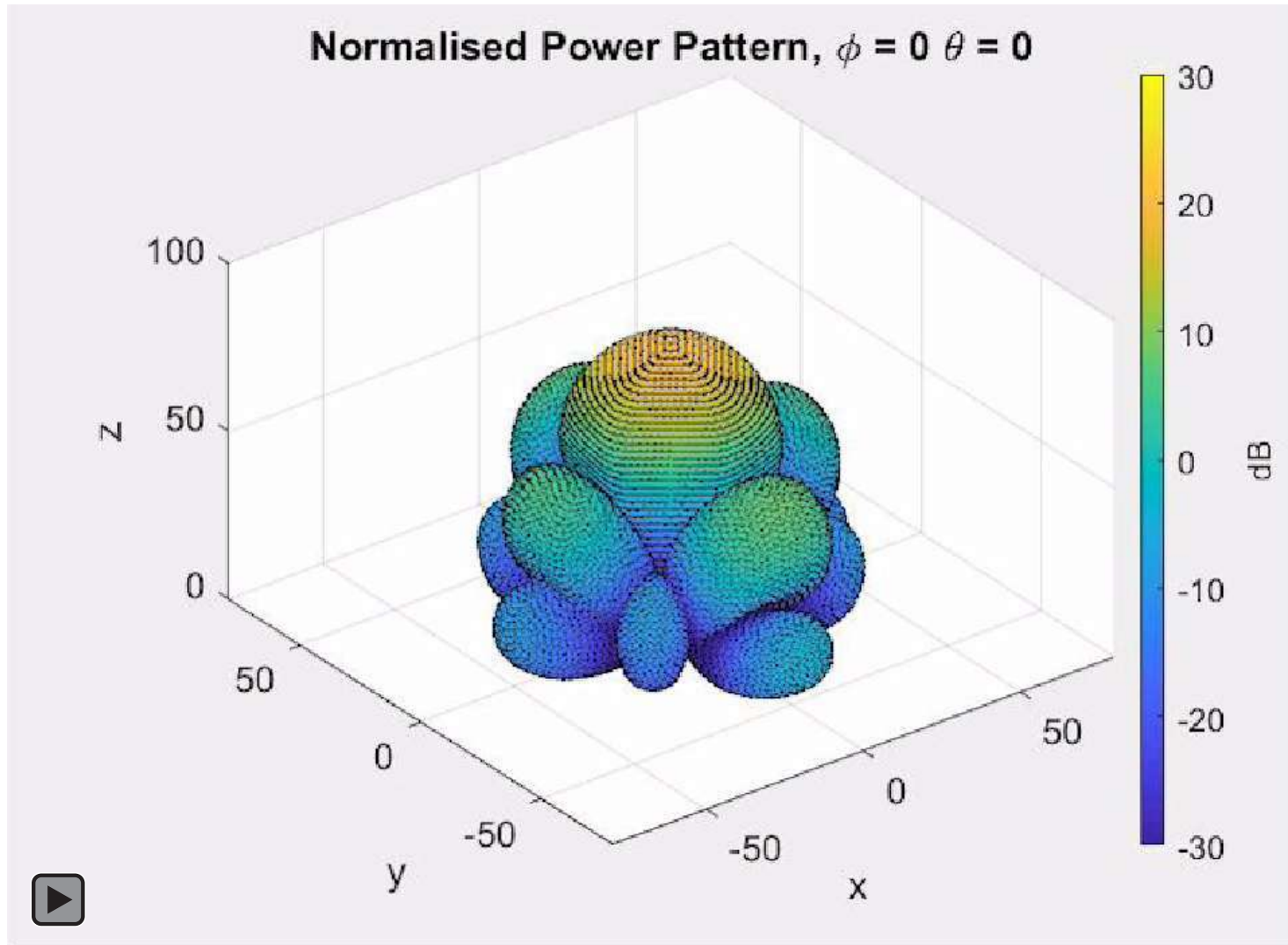
- To steer the telescope, we introduce appropriate time delays to all elements. For MWA, we achieve this by switching in longer physical track via the beamformer
- It is not hard to imagine that this process will change the beam pattern
- Beam also changes with frequency. This is not quirks of aperture arrays but characteristics of antennas
- So we have changing beams due to changing pointings and frequencies



MWA frequency response



MWA pointing response @ 160 MHz

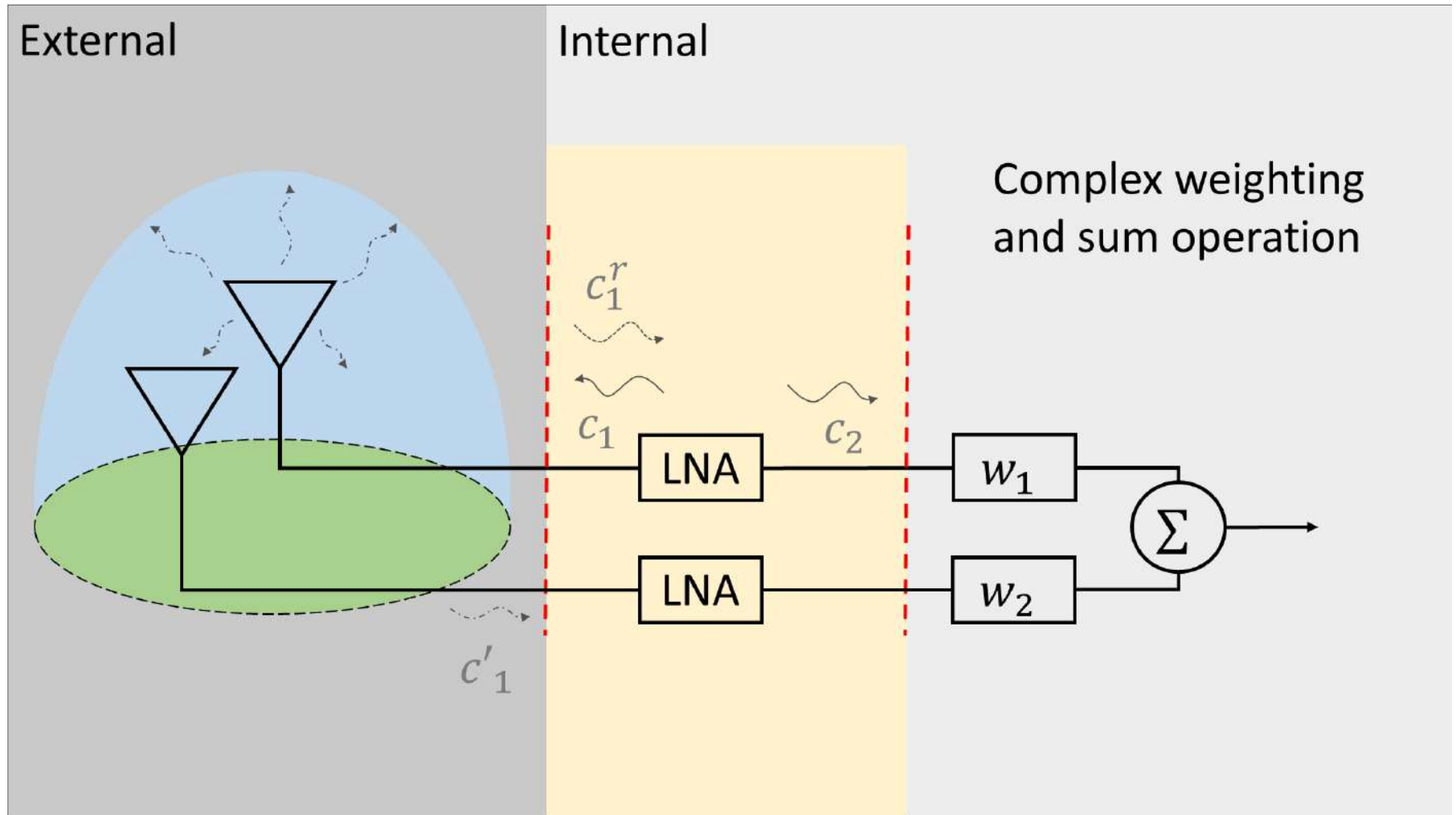




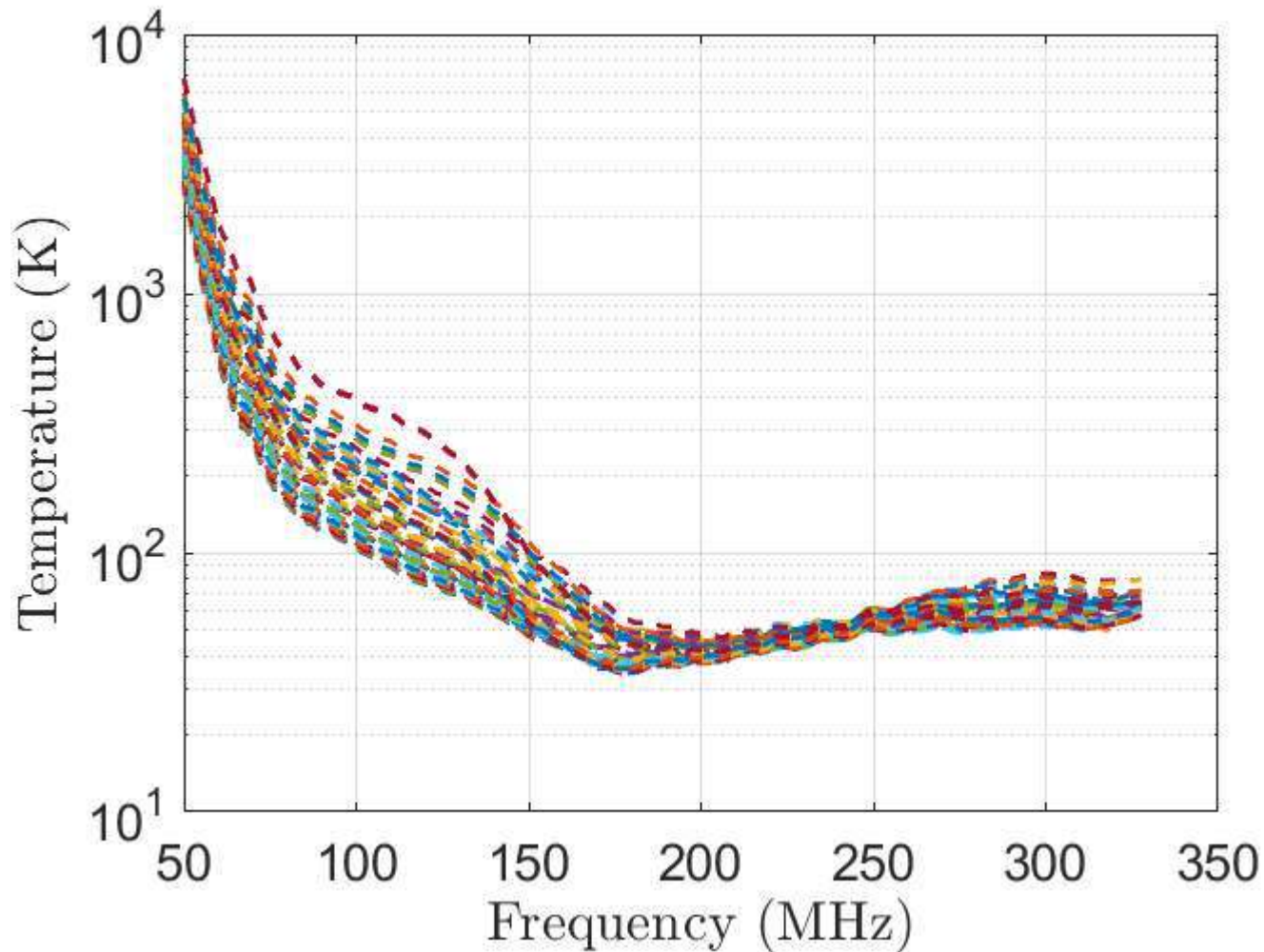
Quirk #2: Receiver Noise Temperature

- **Using the same arguments, we can see why the receiver noise temperature would change**

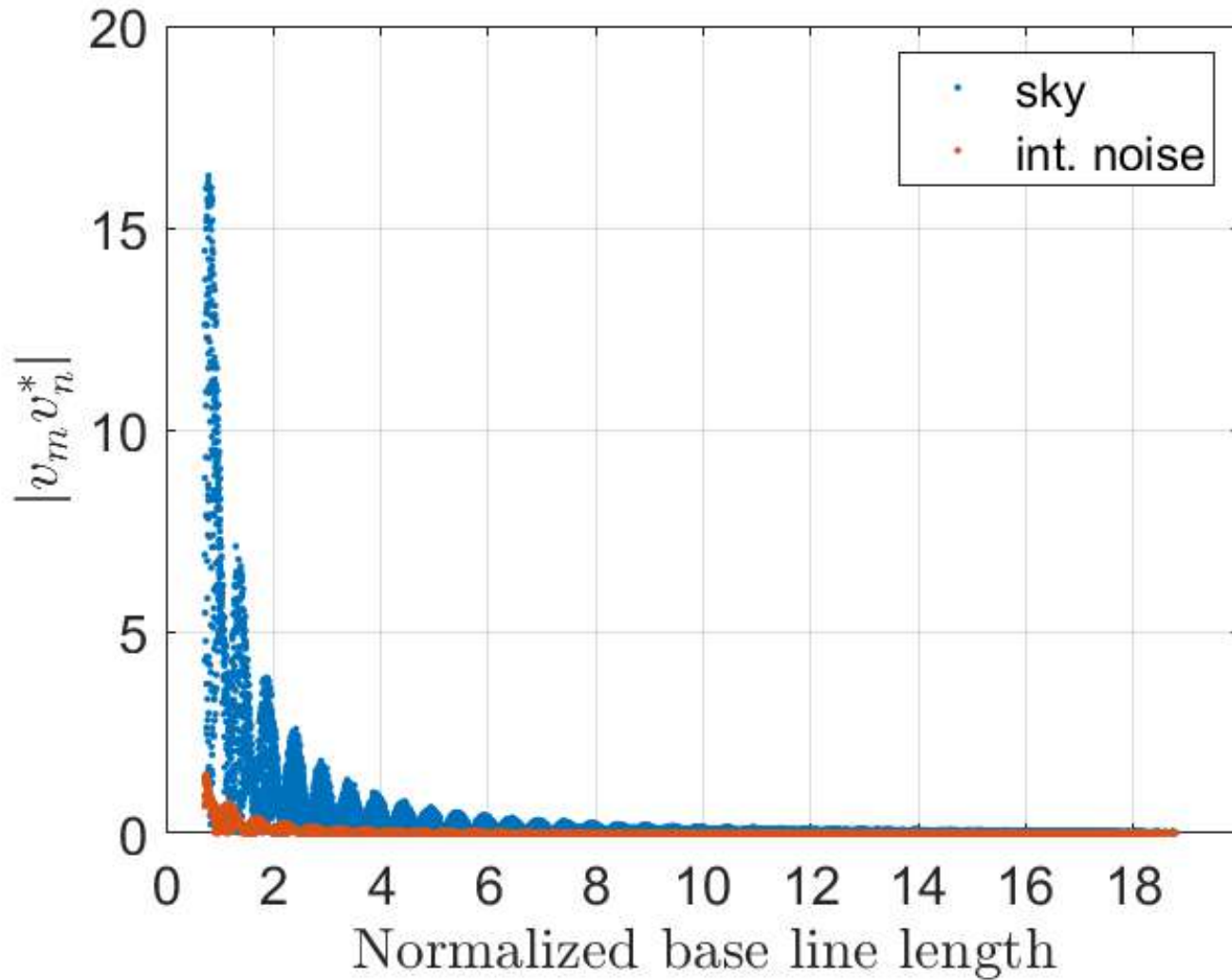
Coupling Model Example

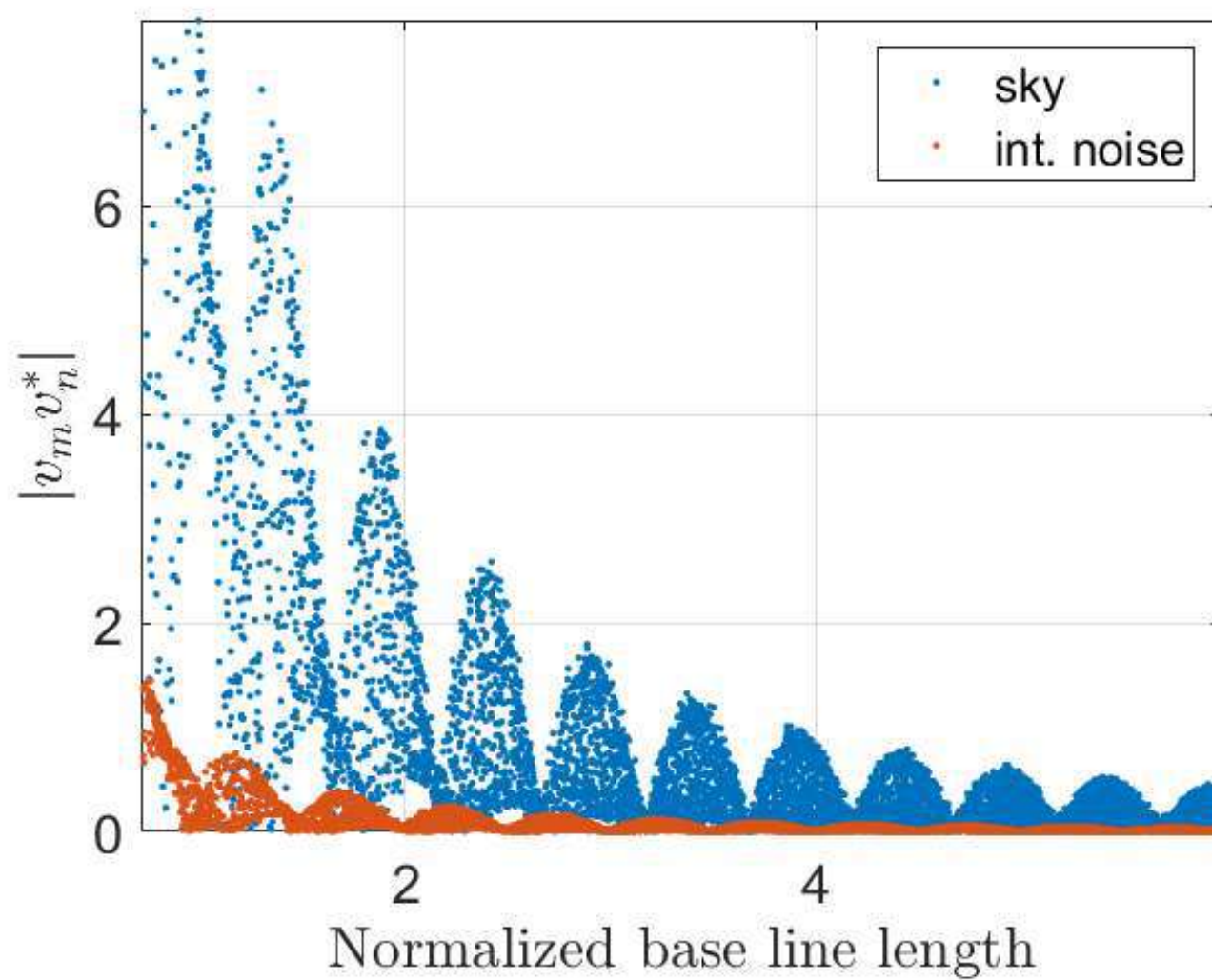


MWA Noise Receiver Temperature



Quirk #3: Correlation Due To Mutual Coupling







Implications for SKA

- **Calibration of receiver gain in dense array**
 - Effects of embedded beams
 - Correlation due to mutual coupling
- **Correction of raw visibilities?**



Thank you!

QUESTIONS?