International Centre for Radio Astronomy Research

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Aperture Arrays And Its Quirks

Daniel Ung

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Curtin University

THE UNIVERSITY OF WESTERN AUSTRALIA

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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

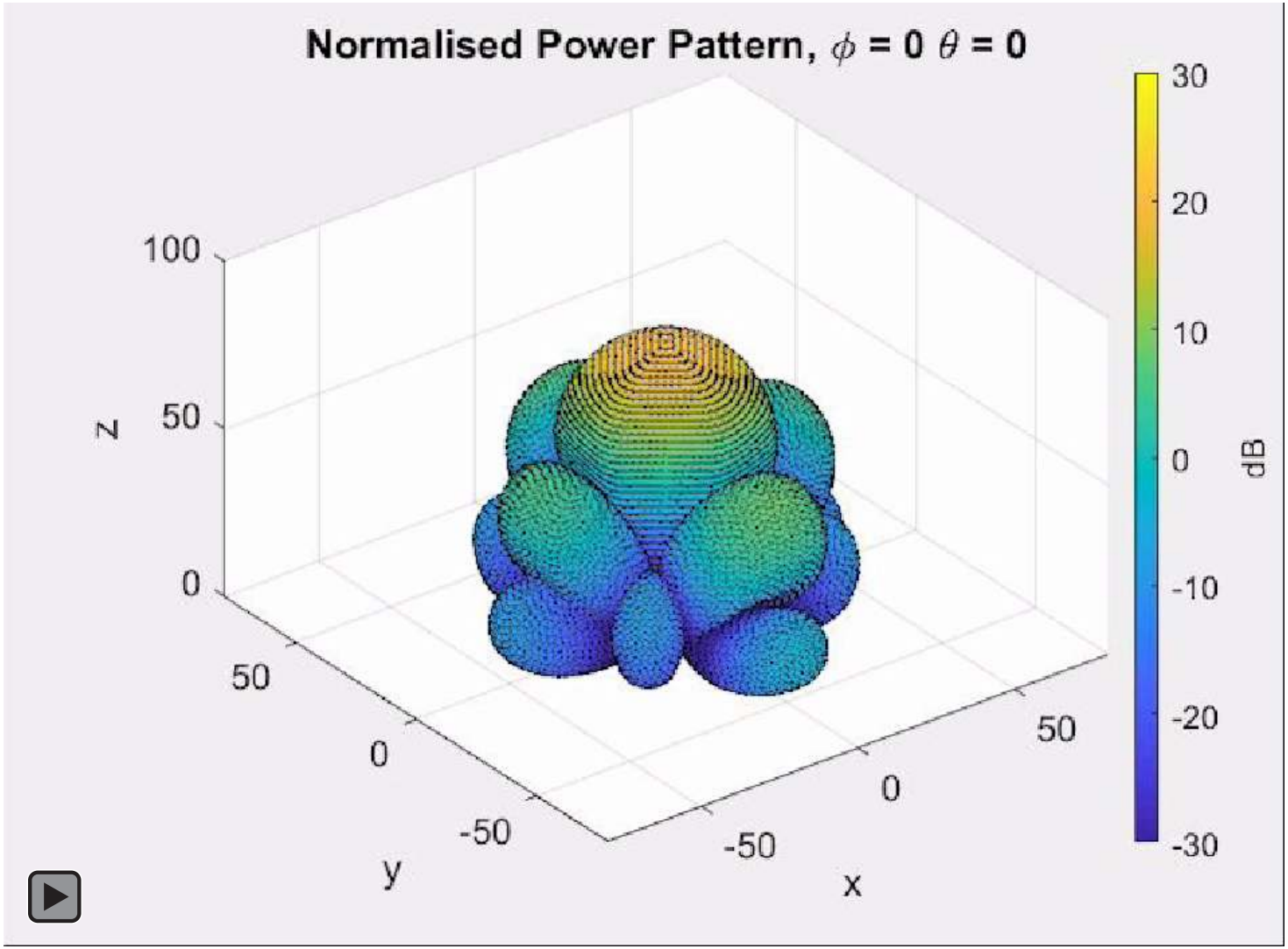
- **The benefits of high resolution radio imaging using sparse elements does come at a cost**
- **Some of the additional considerations includes:**
  - Changing beam patterns
  - Changing receiver noise temperature
  - Correlation within the array due to mutual coupling

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

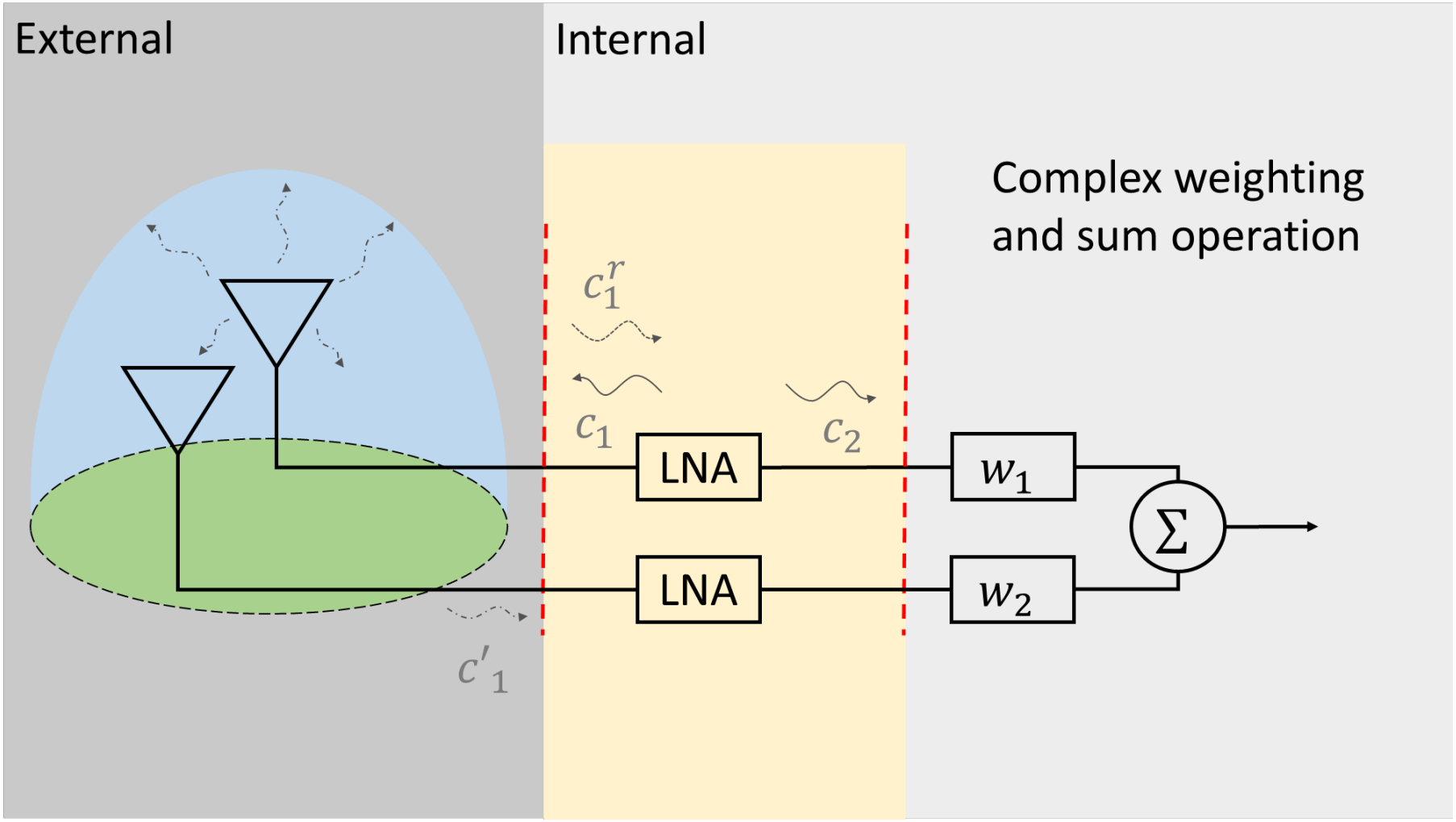
MWA pointing response @ 160 MHz



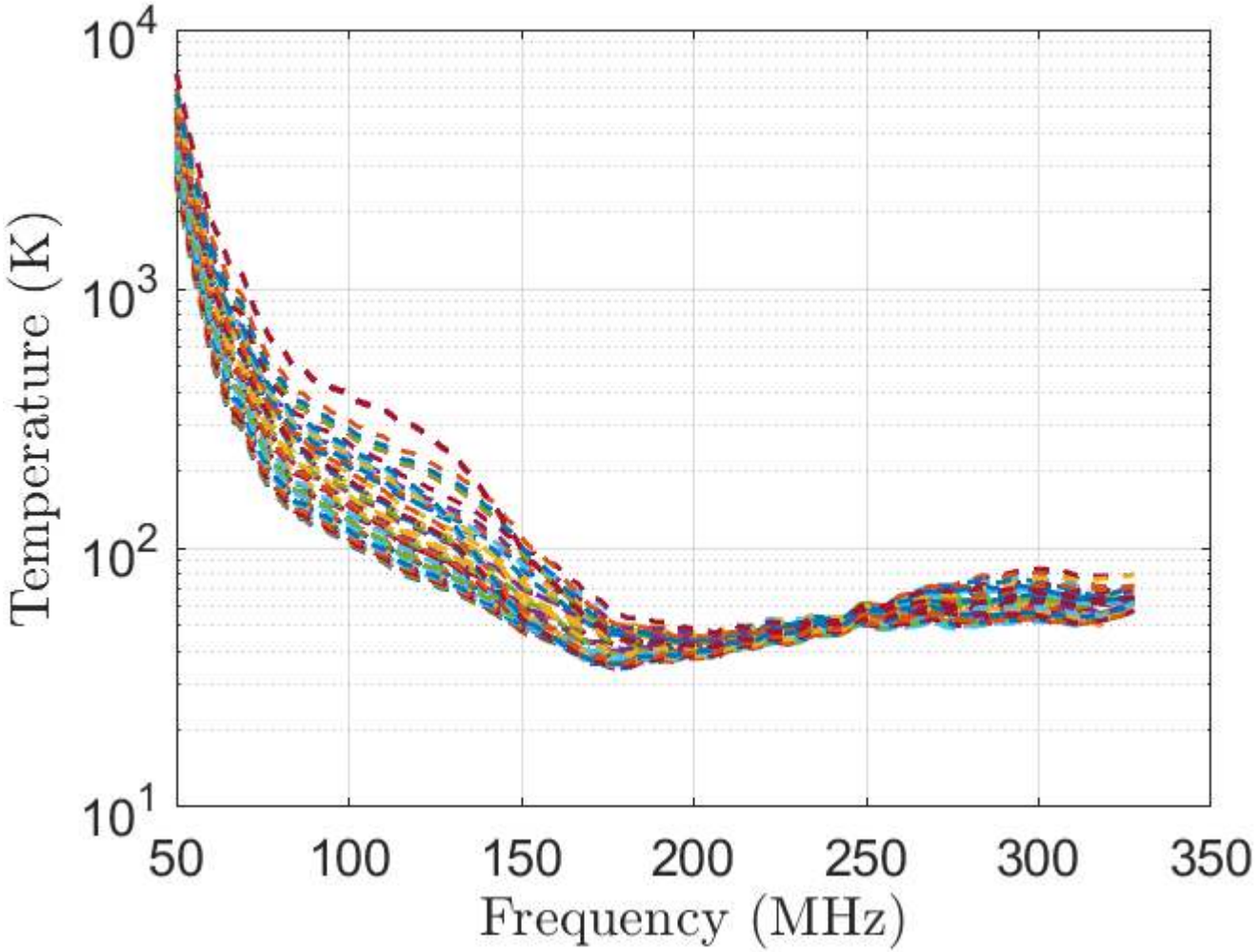
Quirk #2: Receiver Noise Temperature

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

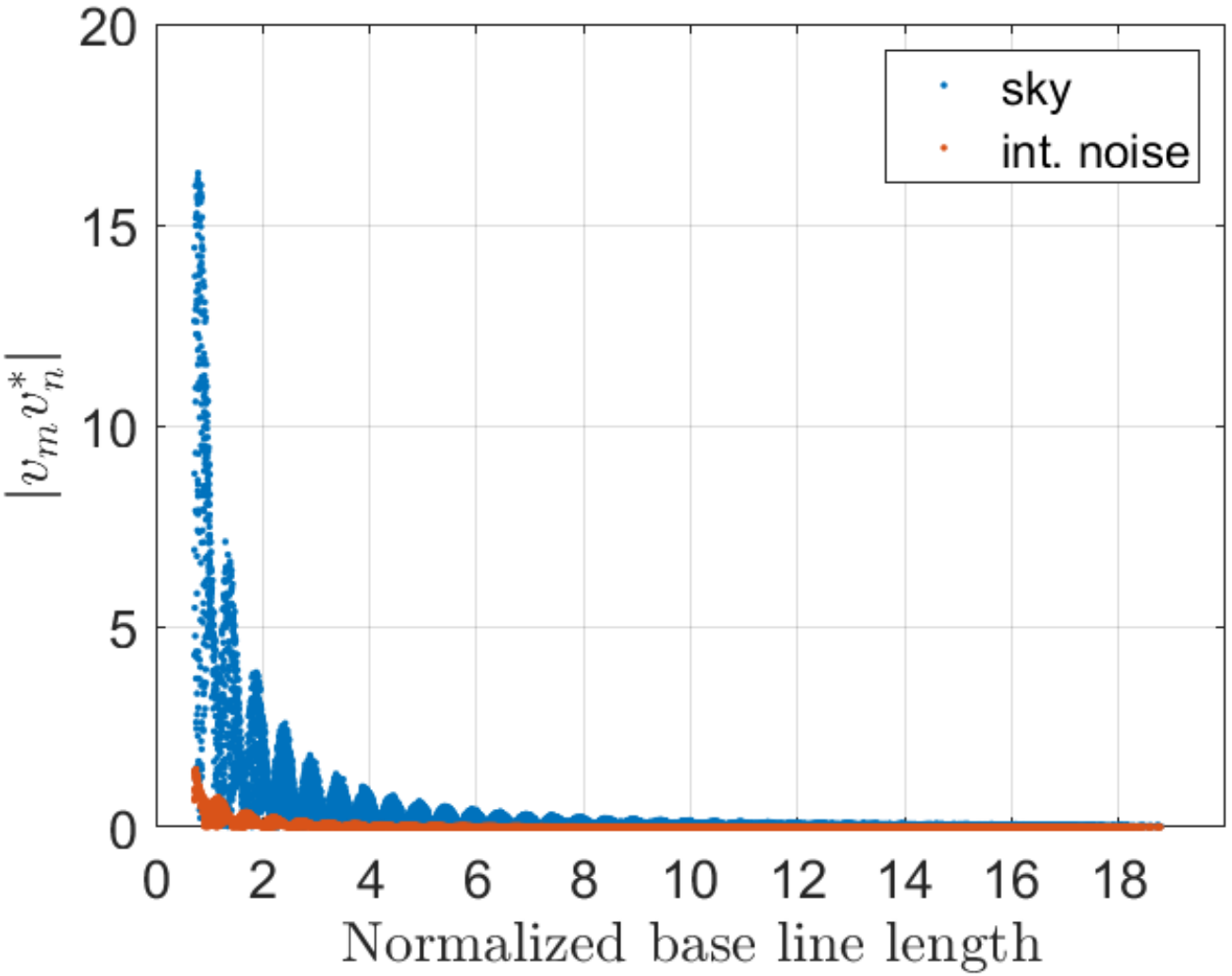
Coupling Model Example

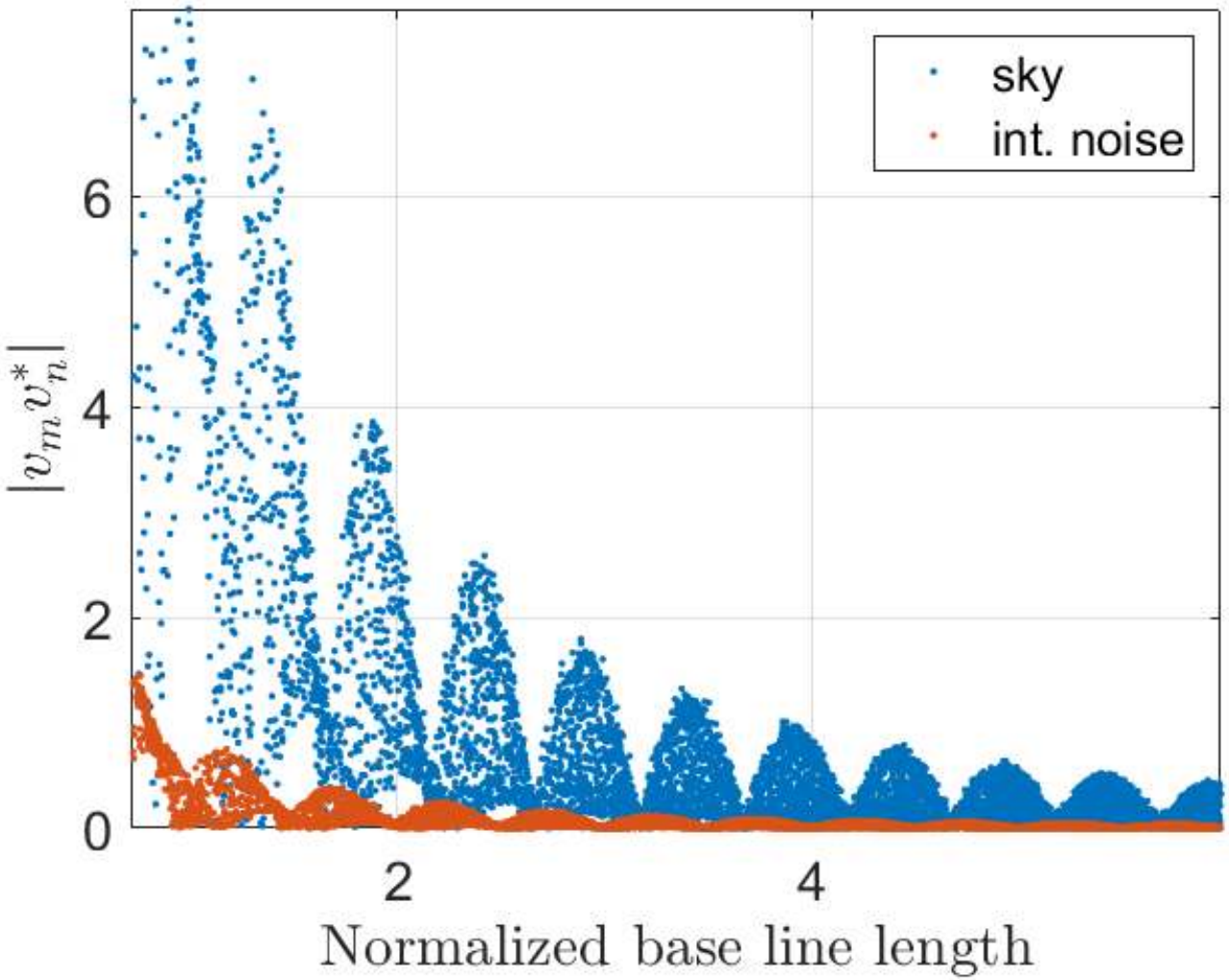


MWA Noise Receiver Temperature



Quirk #3: Correlation Due To Mutual Coupling




sky
int. noise
6
4
2
0
2
4
$|v_m v_n^*|$
Normalized base line length

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?