Archival study to examine StarLink impacts on VLA data

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Satellite Constellations and the VLA

The rapid growth of satellite constellations, especially SpaceX's Starlink, has raised new concerns for radio astronomy due to radio frequency interference (RFI). These satellites transmit used by radio telescopes, potentially affecting calibration and imaging quality.

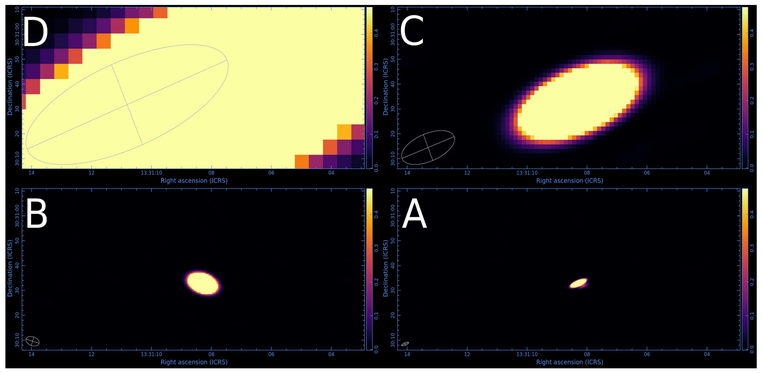
In 2024, StarLink's Direct-to-Cell (DtC) service introduced new downlink frequencies within the VLA's L band. To mitigate interference, Operational Data Sharing (ODS) framework become fully active early 2025, enabling coordination between SpaceX and the NRAO, allowing satellites to adjust transmissions during observations.

This project analyzes archival VLA continuum data to evaluate whether increasing Starlink activity has measurably impacted data quality across X, Ku, and L bands.

Methods

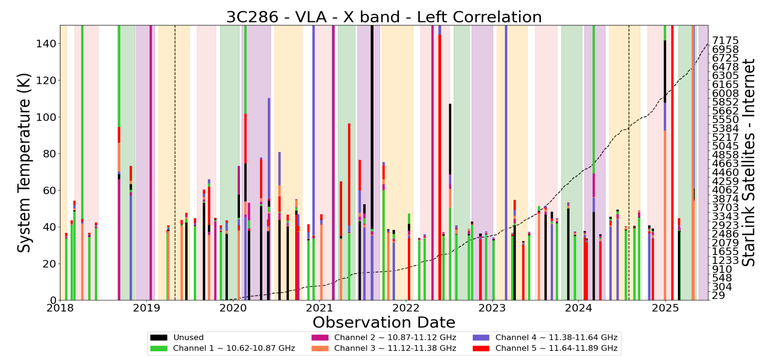
Archival VLA continuum observations of calibrator 3C286 were selected monthly across X, Ku, and L bands. Data was processed using the standard NRAO calibration and imaging pipeline in CASA.

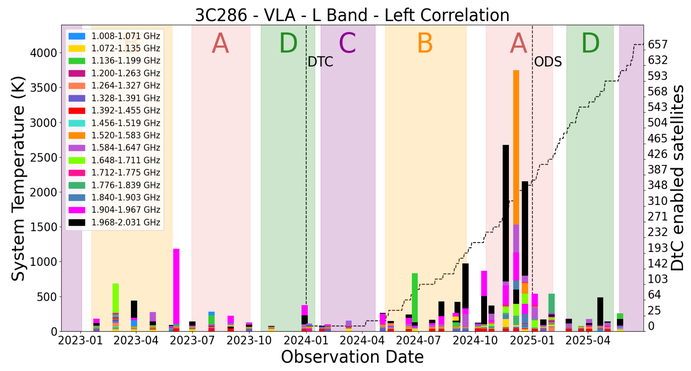
For each dataset, key performance metrics flagged data percentage, measured RMS, and system temperature (Tsys) were extracted to assess potential data degradation. Observations were grouped by frequency band, configuration, and date to track trends alongside the growing number of Starlink satellites.



Results

X and Ku Bands: Had stable flagged data, RMS, and Tsys across configurations and time. No measurable degradation correlated with Starlink satellite count.
Pre-ODS L BAND: Rise in left-hand Tsys within DtC spectral window.
Post-ODS L BAND: Tsys returned to normal levels





Conclusions and Future Work

Across X, Ku, and L bands, Starlink's presence has not significantly degraded VLA calibration or imaging performance. An increase in L-band Tsys associated with DtC transmissions reduced once the ODS framework became active, demonstrating the effectiveness of real-time coordination between industry and observatories.

Future Work:

- Repeat analysis using narrower bandwidths to see if this influences RFI.
- Conduct targeted observations aligning spectral windows with Starlink downlink frequencies.
- Increase observation frequency to monitor RFI.

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