VLA Capabilities and Observing

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National Radio Astronomy Observatory

Atacama Large Millimeter/submillimeter Array

Expanded Very Large Array

Robert C. Byrd Green Bank Telescope

Very Long Baseline Array

NRAO

The EVLA – Upgrading the VLA

The VLA was the world's most powerful radio-wavelength interferometer, but was designed and built in the 1960's/70's, and completed in 1980 - the dark ages relative to "modern" electronics! But the infrastructure (antennas, rails, buildings, etc…) were sound. The EVLA was a ~10-year construction project to upgrade the VLA, which is now complete.

The EVLA upgraded:

- Front Ends (feeds + Rx)
- Local Oscillator
- Data transmission
- Correlator (WIDAR)
- Software

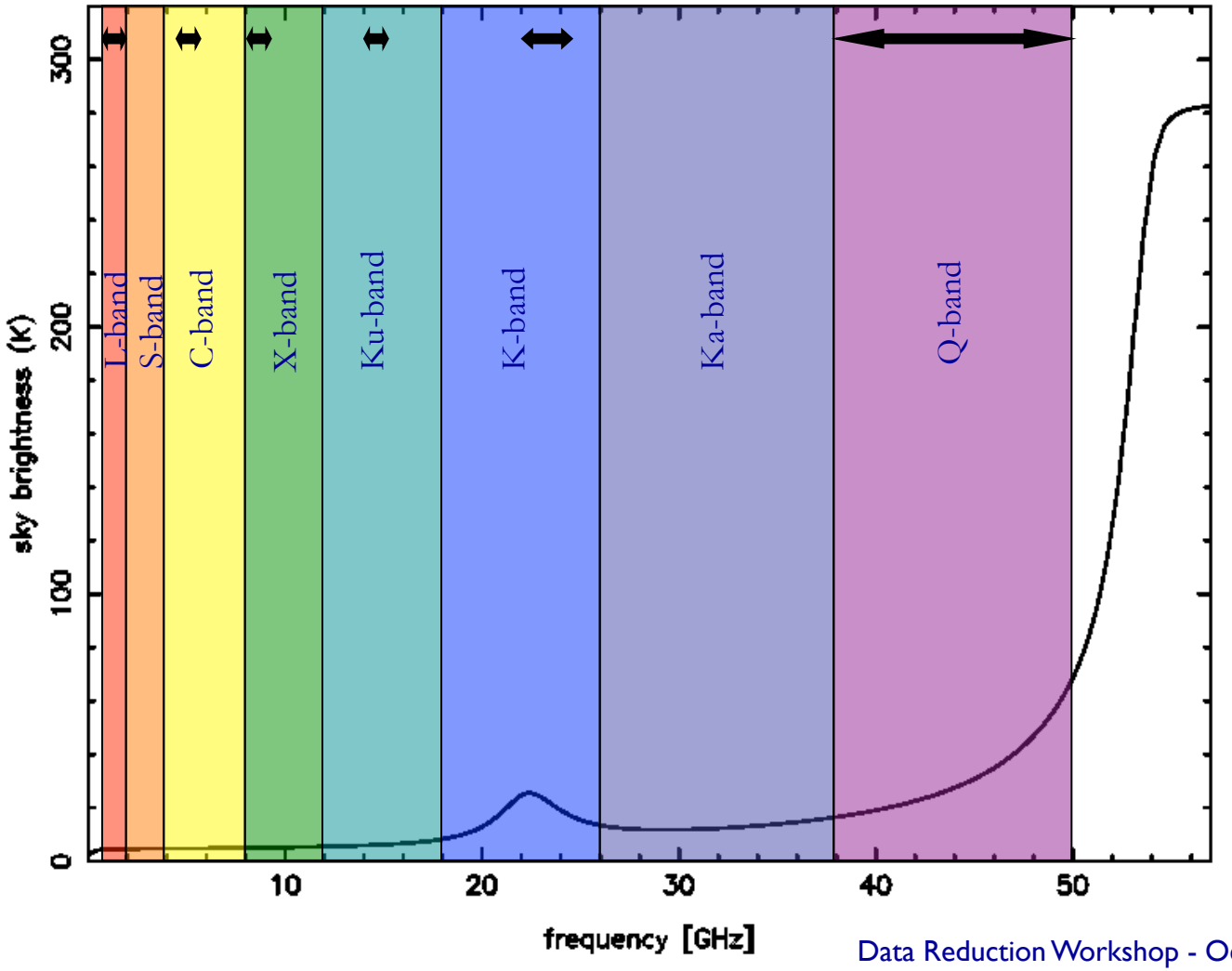
Main result is increased sensitivity (a few microJy in a few hours)

Current VLA

What are the primary things that determine how you can use the VLA (and how to do it)?

1. frequencies (observing bands/receivers)
2. Samplers
3. Configurations
4. WIDAR setup (including dump time)

Front Ends


sky brightness (K)
0
100
200
300
10
20
30
40
50
frequency [GHz]
L-band
S-band
C-band
X-band
Ku-band
K-band
Ka-band
Q-band

Samplers

The VLA electronics system allows users to observe with either 2X1 GHz samplers (with 8 bits), or 4X2 GHz samplers (with 3 bits). The 8-bit samplers are most useful for low frequencies (P-, L-, and S-band), where they can cover the entire bandwidth and provide more dynamic range to deal with RFI. The 3-bit samplers are most useful for higher frequencies, where the bandwidths are wider and RFI not as problematic. Mixing 3- and 8-bit samplers is possible.

However, the noise in the 3-bit samplers is ~15% higher than with the 8-bit samplers, so in some cases, observers prefer to use the 8-bit samplers even at high frequencies. See EVLA memo 166 for details.

Configurations

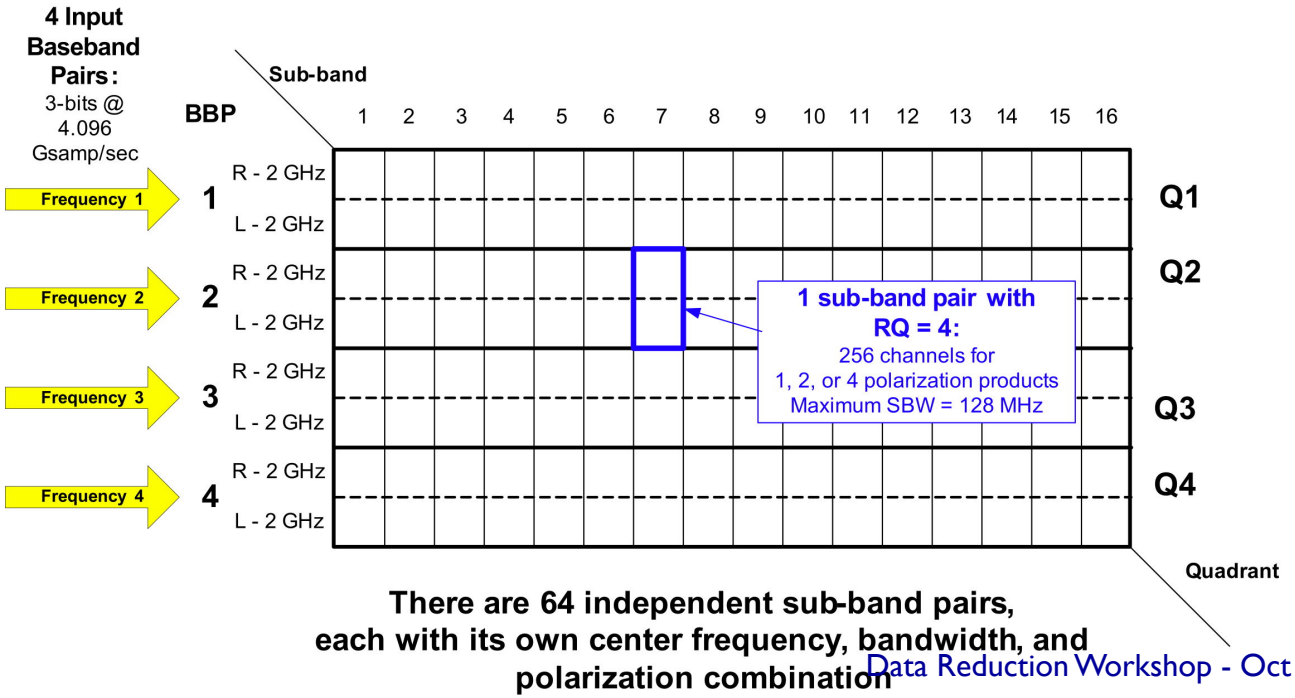
Array antenna configurations are unchanged from the original VLA:

- A configuration – maximum baseline ~36 km
- B configuration – maximum baseline ~ 11 km
- C configuration – maximum baseline ~ 3 km
- D configuration – maximum basline ~ 1 km

The configuration, combined with your observing frequency, determines resolution and largest angular scale.

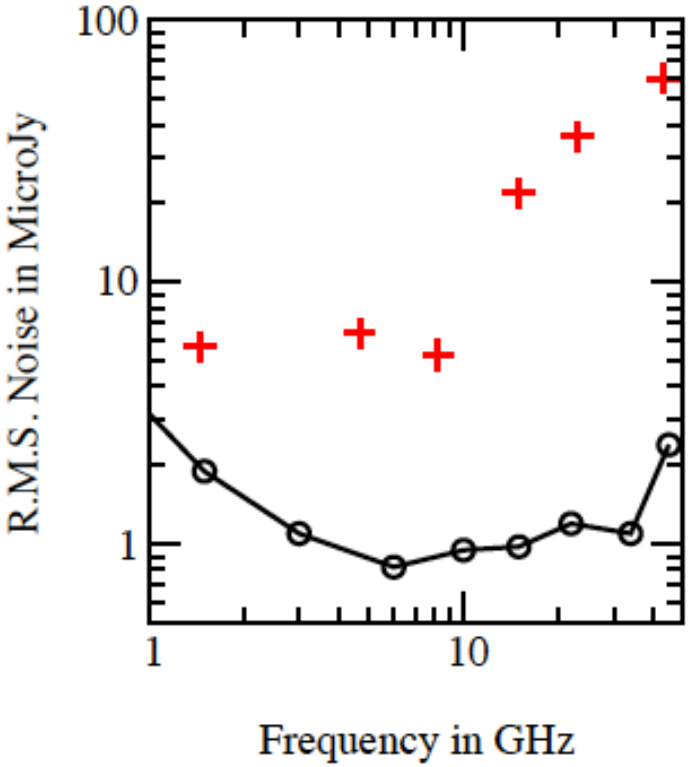
Correlator (WIDAR)

- Built by DRAO in Canada - 10 POP/s special-purpose computer
- 8 GHz maximum instantaneous bandwidth, full polarization
- 16384 spectral channels minimum, 4.2 million maximum
- 64 almost entirely independently tunable spectral windows

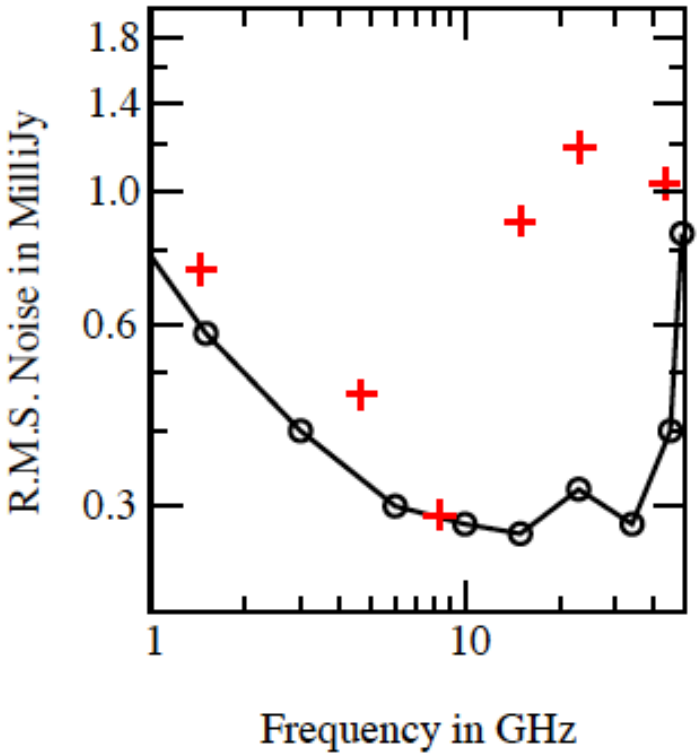


Sensitivity

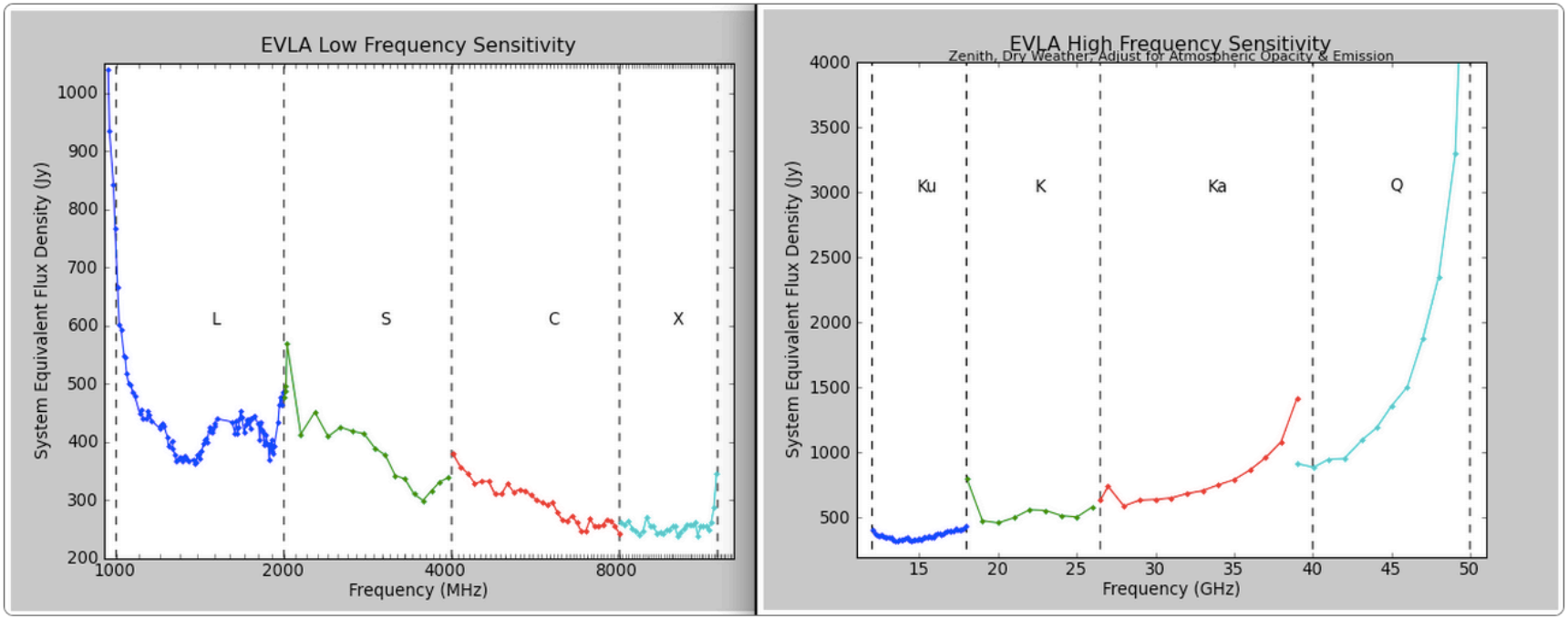
Continuum Sensitivity



Spectral Line Sensitivity



Sensitivity



VLA Observing Programs

Despite the EVLA construction project being complete, we continue to make new modes of observing available to users. For this reason, we separate VLA observing into three programs:

1. **General Observing (GO)** – fully tested and commissioned observing modes.
2. **Shared-Risk Observing (SRO)** – tested and commissioned observing modes, which can be set up with our standard software, but might need a short example observation to verify.
3. **Resident Shared-Risk Observing (RSRO)** – observing modes which have not been well-tested (possibly not at all), and might not be able to be set up with standard software.

See: https://science.nrao.edu/facilities/vla/docs/manuals/oss/proposing

Shared-Risk Observing (SRO)

Types of observing that are SRO:

- On The Fly Mosaicing (OTFM)
- Up to 32 sub-bands per baseband with 8-bit samplers
- Recirculation of up to a factor of 64
- 8-stream recording with the phased VLA for VLBA observing

Resident Shared-Risk Observing (RSRO)

Types of observing that are RSRO:

- Dump times < 50 msec (up to 5 msec)
- Pulsar observations
- Data rates > 60 MB/s
- Recirculation > factor of 64
- P-band polarimetry and spectroscopy
- More than 3 subarrays, or 3-bit subarrays

There is more; basically anything we can't do currently, or don't offer currently.

What are we working on now?

- Automation of:
  - Subarrays
  - Planetary and solar observing
- VLITE
- Pulsars
- Frequency averaging in correlator
- TIP scans
- 4-band receivers
- Triggered observations
- Commensal fast-transient system (pending funding)
- Water Vapor Radiometry (WVR) (pending funding)
- VLA-PT link (pending funding)

How do I actually observe?

1. Write a proposal, using the Proposal Submission Tool (PST).
2. If approved, set up Scheduling Blocks (SBs) in the Observation Preparation Tool (OPT).
3. Wait for observations to occur (most are dynamically scheduled!).
4. Download either raw data, or pipeline-calibrated data.
5. Use CASA for further reduction.
6. For all steps, if you need help, use the helpdesk.