Low Frequency Commensal Systems: from VLITE to LOBO to ngLOBO

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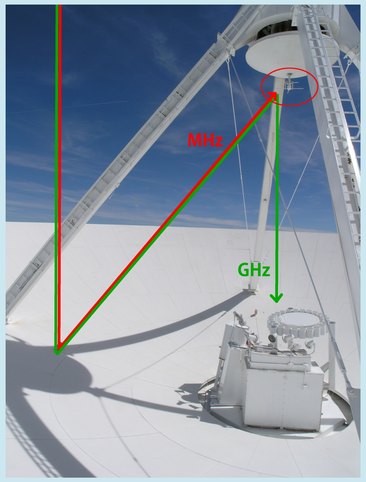
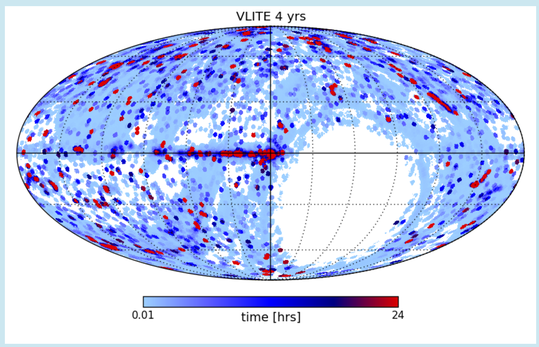
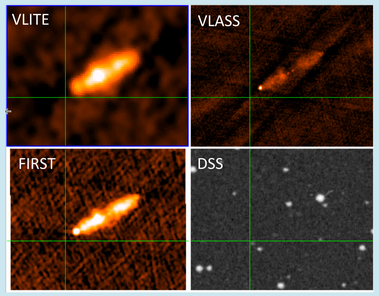
Commensal Now -- VLITE

- The VLA Low-band Ionosphere and Transient Experiment is a commensal system which uses the VLA 330 MHz feeds and receivers and dedicated real-time DiFX software correlator to observe during most regular GHz-frequency observations:
  - 320<v<364 MHz,
  - Δv_{ch}=100 kHz,
  - FOV = 2^o
- Currently operates on up to 18 antennas; typically 15-16
- Minimal impact on VLA infrastructure
- Real-time ionosphere pipeline and astrophysics/transient pipeline on 24 hour delay.
- Archive: raw data, final self-calibrated visibilities, images, source catalog and light curves.
- Data are currently made available through NRL.



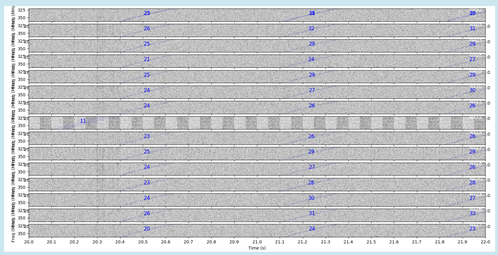


After 4 years of operations, VLITE has observed nearly the entire visible sky; most of the red patches are calibrators, test objects, and deep fields. Just over 80% of the sky has been observed for at least 10 minutes.



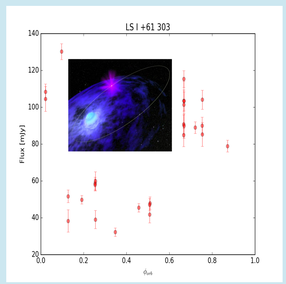
4C +58.15 imaged at wavelengths of 90 cm (VLITE), 20 cm (FIRST), and 10 cm (VLASS). This comparison illustrates the potential VLITE offers for spectral studies of radio galaxies.

VLITE-Fast Transient Search:



Sample VLITE-Fast data showing a known pulsar observed with 15 antennas. The system uses a GPU search in pulse width and which is sensitive on 1-32 ms scales and dispersions up to 1000 pc cm^{-3} . It will run 24/7 with a 60 second buffer. A candidate trigger dumps the buffer for off-line verification. Simultaneous VLITE imaging can be used to localize the host galaxy.

VLITE-Slow Transient Search:



A sample VLITE light curve, folded to the orbital period, for a bursting neutron star in a 26.496 day elliptical orbit around a Be star. There are 27 VLITE detections included. The inset shows an artist's conception of the system.

VLITE-Slow is an ongoing search in all daily images for transients on scales of seconds to years. It has found known transients and variable sources (eg. SS443, V404 Cyg) but no new transients. After 4 years, the detection limits are approaching predictions for several populations of known variable sources.

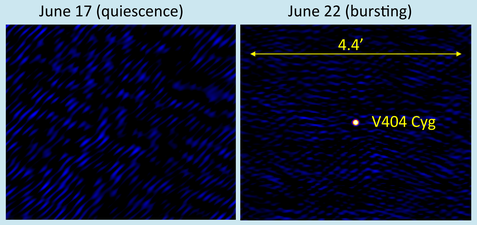
. . . in the near future

LOBO: the LOw-Band Observatory

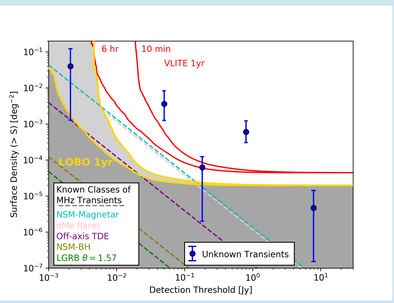
Expand VLITE to all 27 VLA antennas with broadband frequency coverage

Transients with VLITE

June 17 (quiescence) June 22 (bursting)

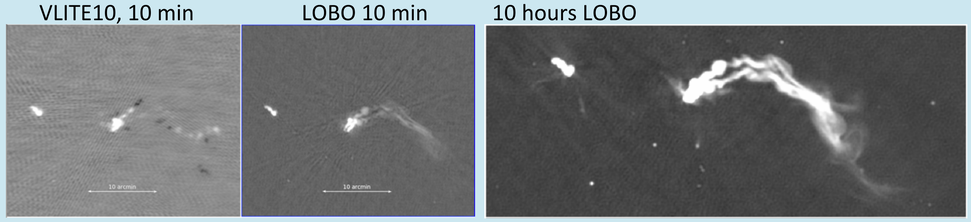


Transients with LOBO



VLITE is able to detect occasional bursting sources, but its one year sensitivity to transients is well outside the detection threshold of known transient types. In the same time on-sky, LOBO should be sensitive to known transient classes such as Magnetars and TDEs.

VLITE10, 10 min LOBO 10 min 10 hours LOBO



Imaging with VLITE vs. LOBO: 3C129.1 (left) & 3C129 (right): LOBO will have improved sensitivity to faint and extended structures. The broad band will also provide instantaneous spectra for bright sources.

. . . and in the ngVLA era

ngLOBO Low

Standalone aperture array

- 50 stations, 256 dipoles per 100 m station, $B_{max} \geq$ = 400 km
- BW: . . . . . 5 – 150 MHz
- FoV: . . . . . 120' @ 80 MHz
- FWHM: . . 1.4" @ 80 MHz
- σ = 0.5 mJy @ 80 MHz [1 hr, 4 MHz]
- 1 beam commensal with ngVLA
- 3+ Independent beams for ionosphere, solar, space science & applications

Pathfinder: LWA

- 4 independent beams + all-sky

ngLOBO High

Fully commensal array

- Prime focus feed(s) near ngVLA antennas prime focus
- BW: . . . . . 150 – 1500 MHz
- FoV: . . . . . 193' @ 300 MHz
- FWHM: . . 0.6" @ 300 MHz
- σ < 7.15 μJy @ 300 MHz [1 hr, 500 MHz]
- Single beam commensal with ngVLA

Pathfinder: VLITE

- VLA antennas, prime focus commensal
- >6000 hours per year

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