



VLA Low Band Ionospheric and Transient Experiment (VLITE): Current Status and Future Plans

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VLA Low Band Ionospheric and Transient Experiment (VLITE)

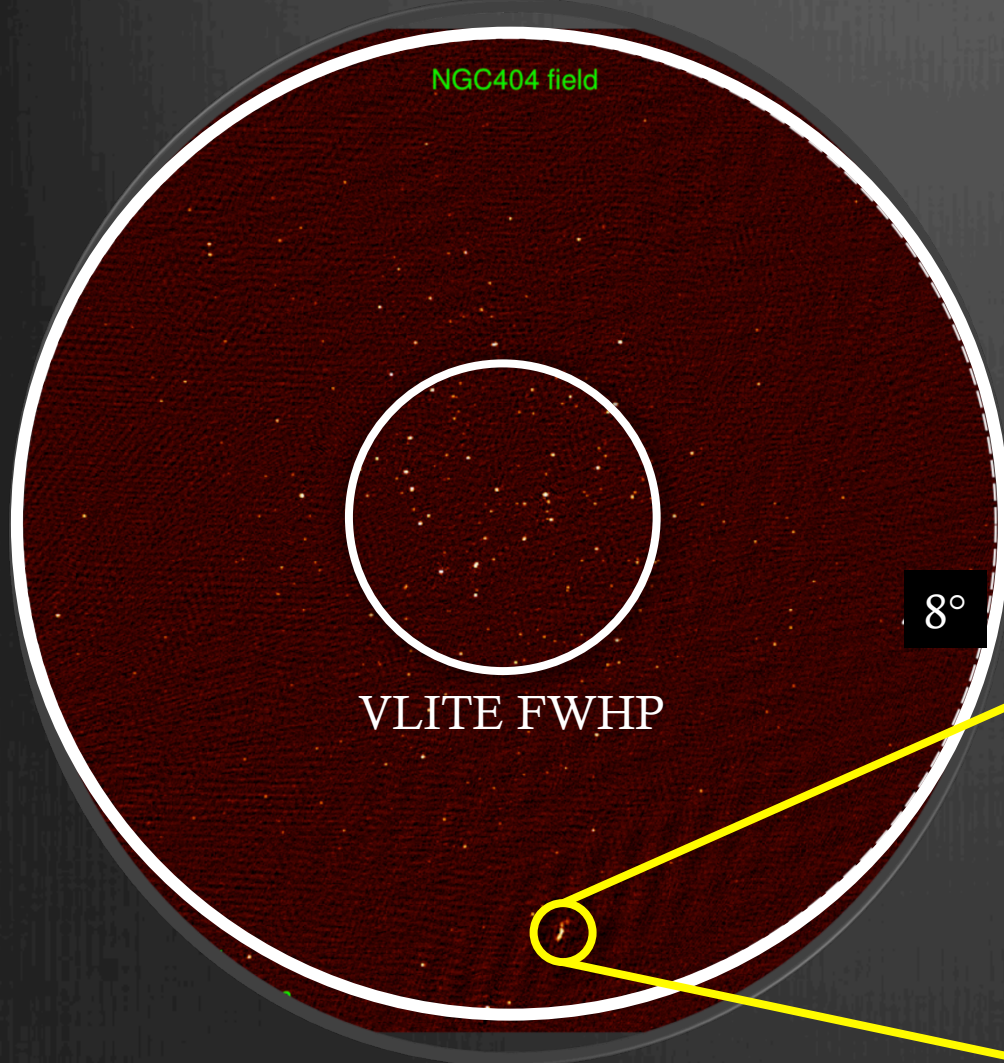
- Correlates 330 MHz band for 10 VLA antennas
 - Frequency range: 320 – 384 MHz
 - Channel width: 100 kHz
 - Integration time: 2s
 - Products: 4 polarizations (linears)
 - Field of view: > 5 square degrees
 - Resolution: 5'' – 3', large scale structure up to 1°
 - Data rate: 2GB/hour operating 24/7 for two full A and B configs
 - On-sky wall time: ~ 70% (actual)
 - Science operations started 11/25/2014. Just passed 1 year mark!
- Minimal impact on VLA infrastructure
- No impact on primary observer program resources
- **VLITE-FAST: see talk by Paul Ray Thursday pm**

The Power of a Commensal System: Field of View

VLITE 8°

- Low frequencies have a large field of view

NGC404 field

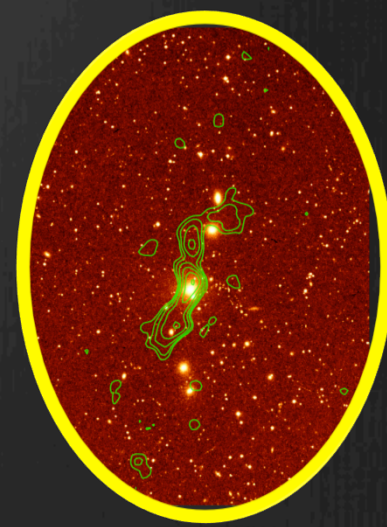
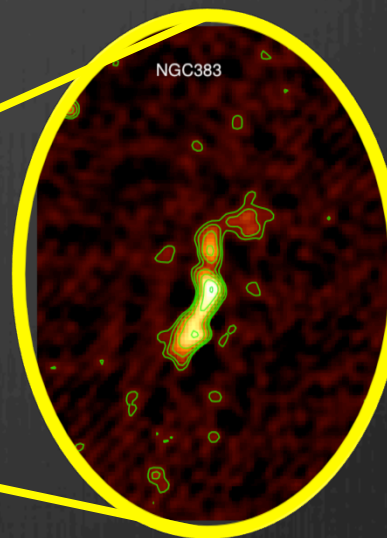


○ 1.5 GHz FWHP

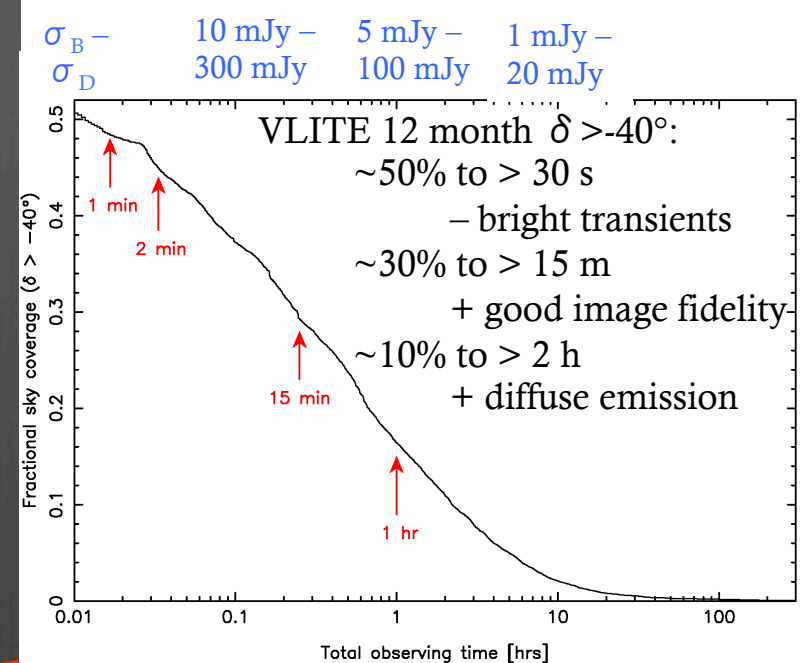
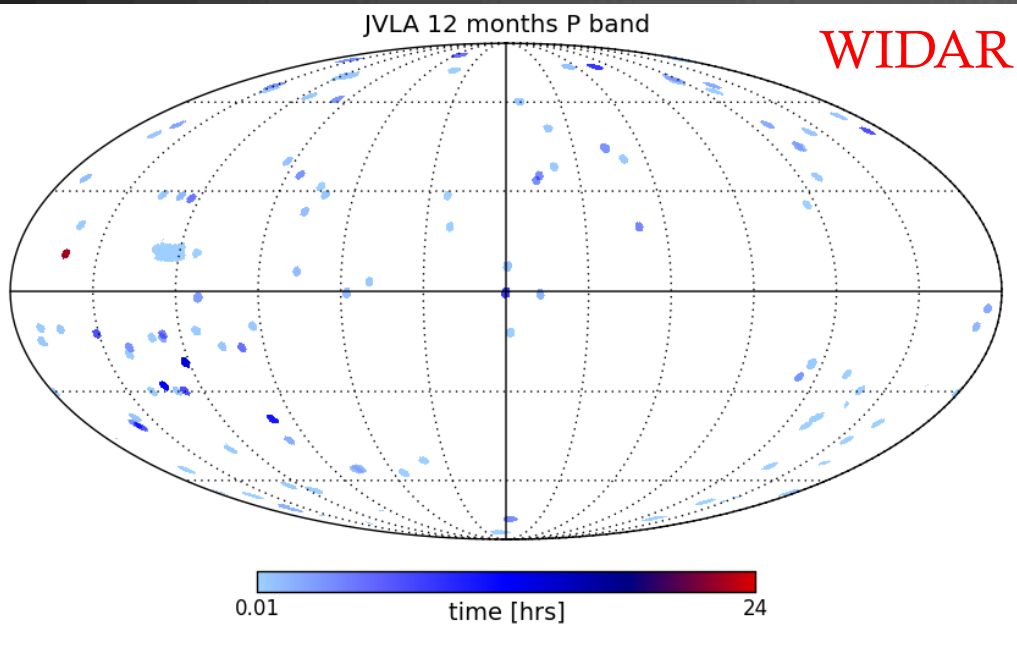
○ 3.0 GHz FWHP

○ 40 GHz FWHP

~3.5° from center



The Power of a Commensal System: Sky Coverage (Tile)

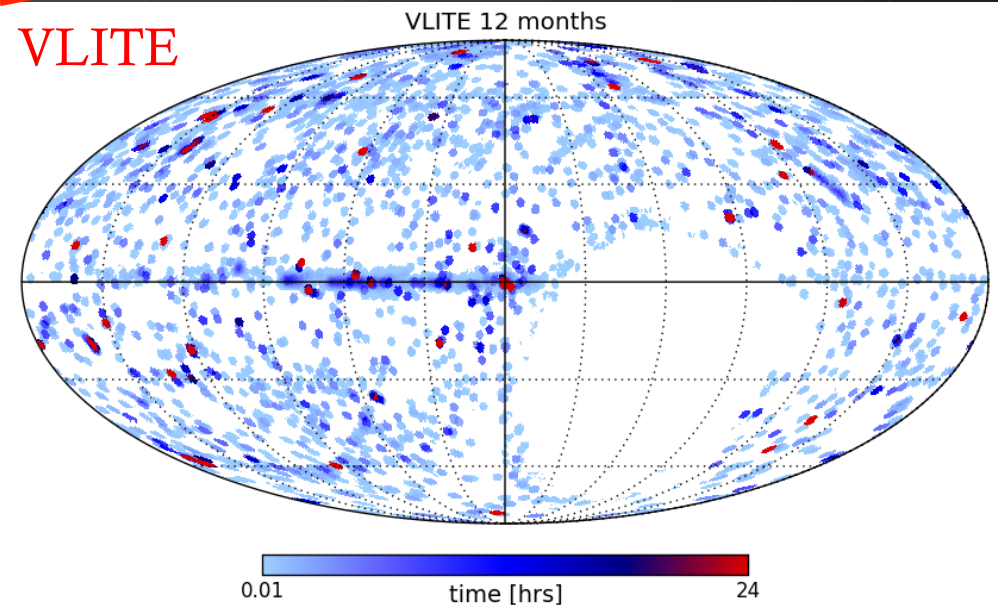


WIDAR 12 months:

- Deepest P band field is 22h

VLITE 12 month:

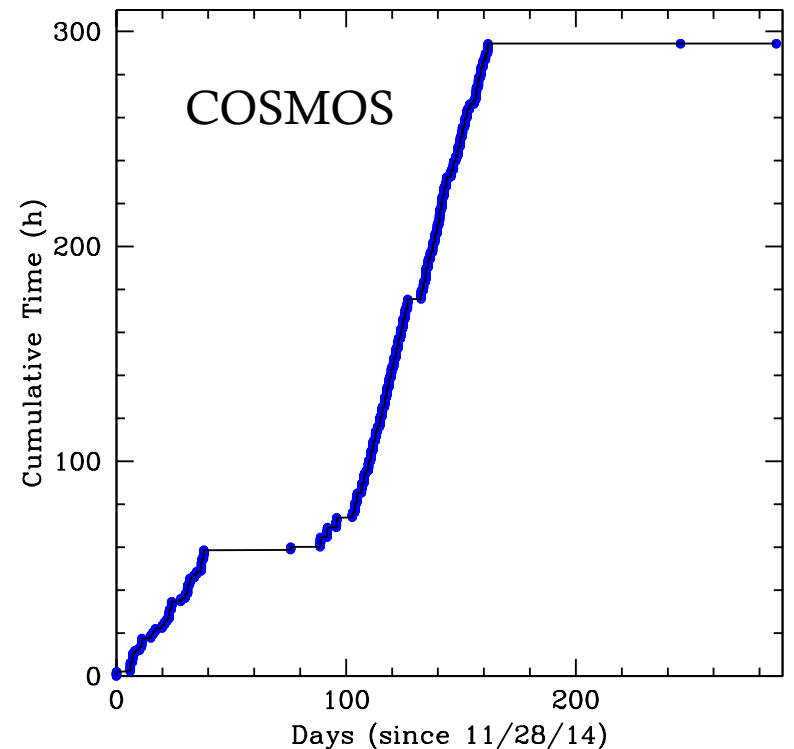
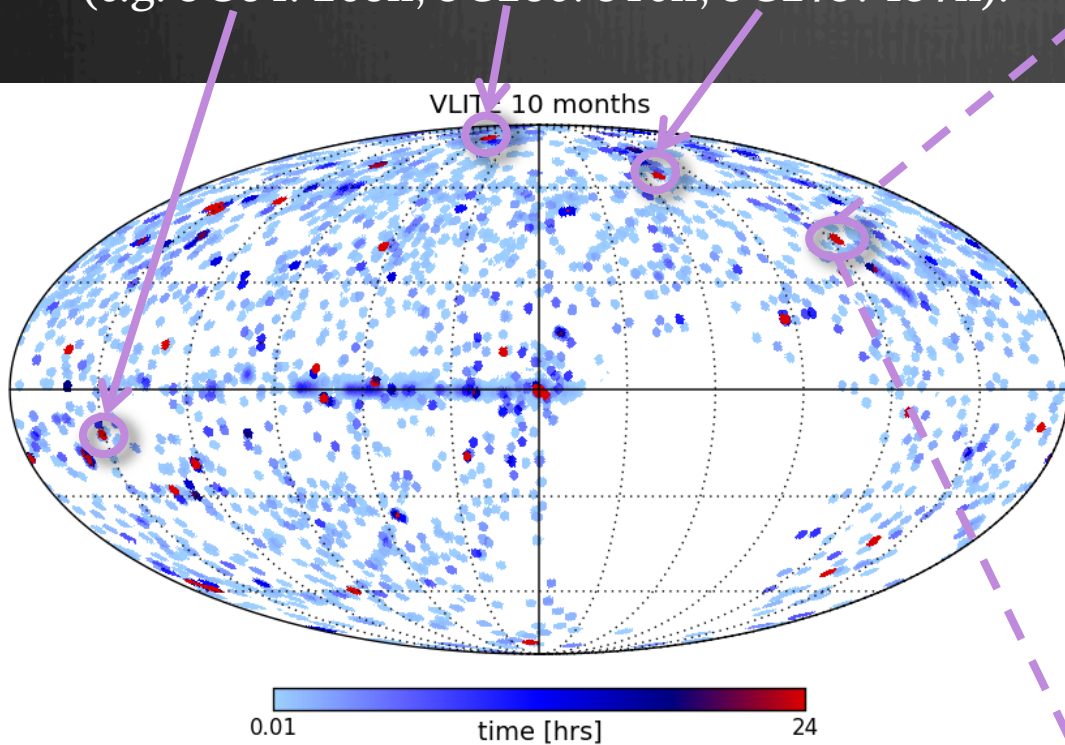
- VLITE recorded ~6300 h or 71% wall time
- Deepest P band PI field is > 290h (COSMOS)



The Power of a Commensal System: Depth (Stare)

Numerous areas of the sky are intrinsically interesting for many science cases (e.g. deep multi-wavelength survey fields). These fields are observed by the JVLA with a variety of instrumental configurations but appear homogeneous to VLITE!

VLITE has accumulated over 294 h of data on the COSMOS field. These data span a length of 287 days. Similarly calibrator fields accumulate similar depth (e.g. 3C84: 268h, 3C286: 310h, 3C273: 137h).



Why Build VLITE?

It is an experiment designed to demonstrate:

- 1) the power of a sensitive, continual ionospheric monitor that provides fluctuation spectra for analysis of climatological trends and rare events (talk by Joe Helmboldt Friday am).
- 2) the capabilities of a fully commensal low frequency system on a cm-wave instrument to expand the phase-space for radio transient phenomena.
- 3) the scientific payoff across a broad range of low frequency astrophysics using a cm-wave instrument in a piggy-back mode.

The ultimate goal of VLITE (beyond scientific productivity) is to demonstrate the power of a commensal system and obtain community support to develop the R&D path and secure funding to complete a new broadband user facility on 27 VLA antennas – the Low Band Observatory (LOBO) (Kassim and VLITE team poster).

Transients and Astrophysics with VLITE: The Power of 24/7 Operations

1) Value Added Science:

- PI studies at higher frequencies can use VLITE for morphological, spectral, and/or variability work.

2) Stand-alone Science:

- Large FoV expands opportunities to build large samples/deep images
- Areas of the sky are observed with different setups for independent science are equivalent in VLITE and increase depth.

3) Serendipity:

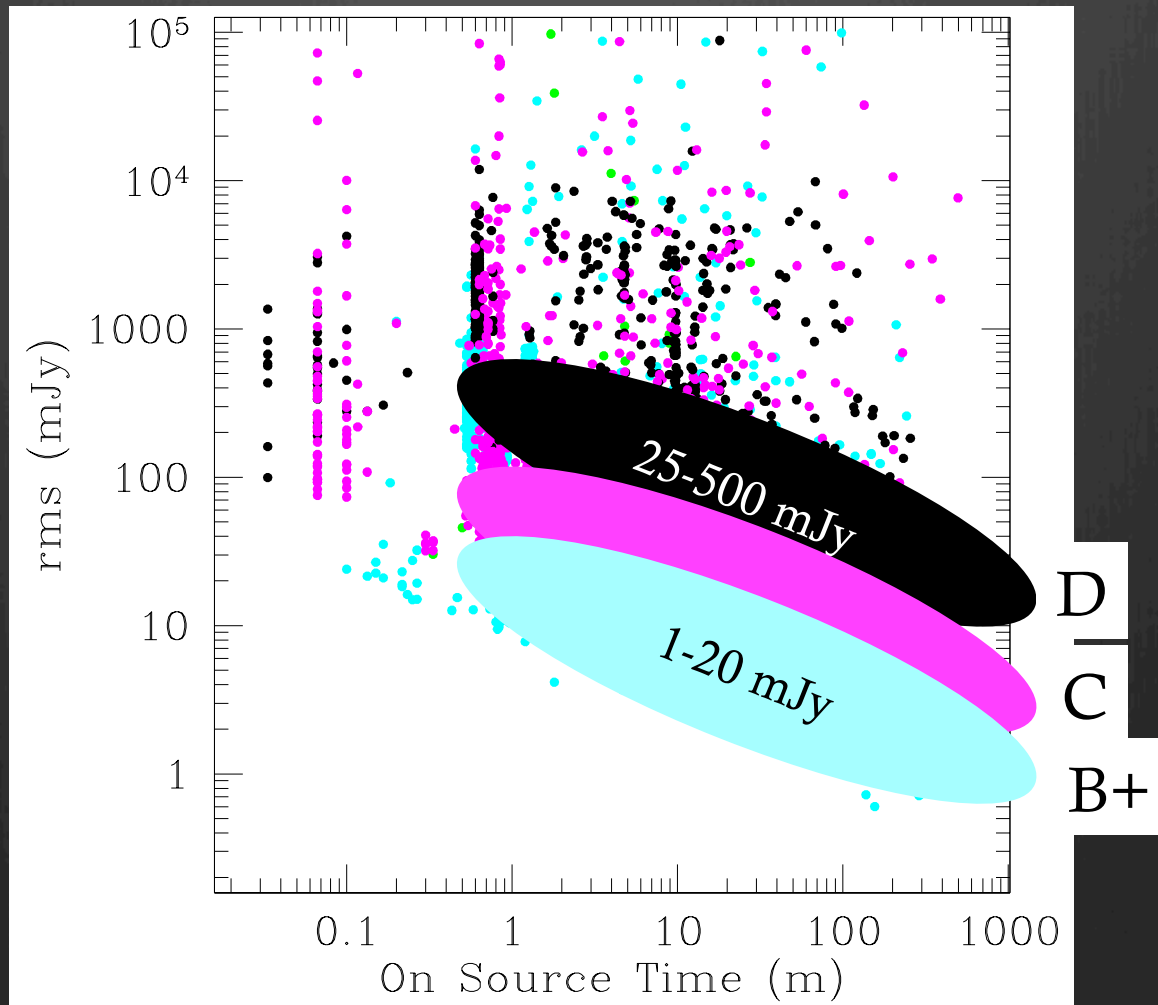
- Many sources lurk in large FoV – slow transient machine with large sky coverage and long-term monitoring.

4) Sky Catalog/Images:

- VLITE will provide a new sky catalog of fluxes and images for the sky above -45° .

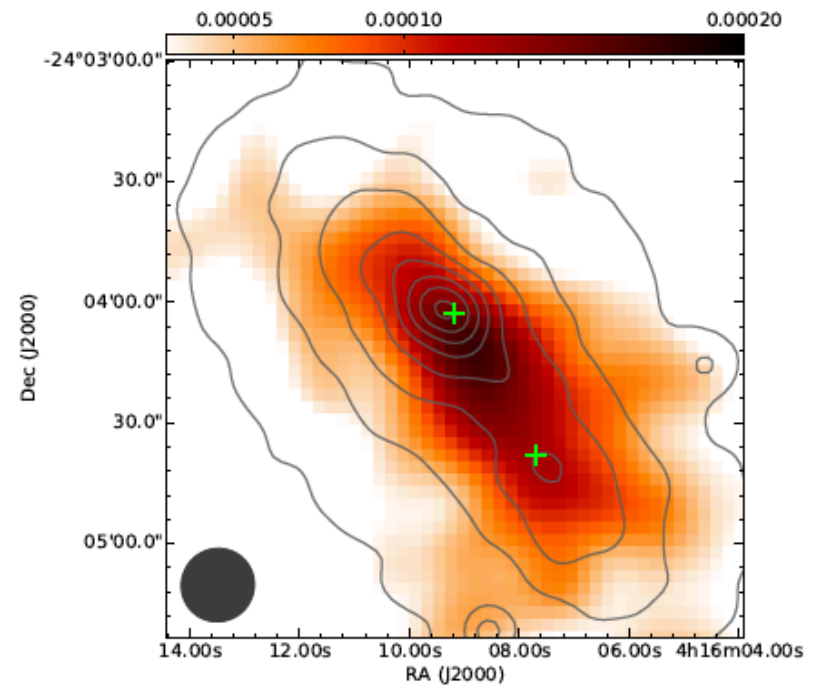
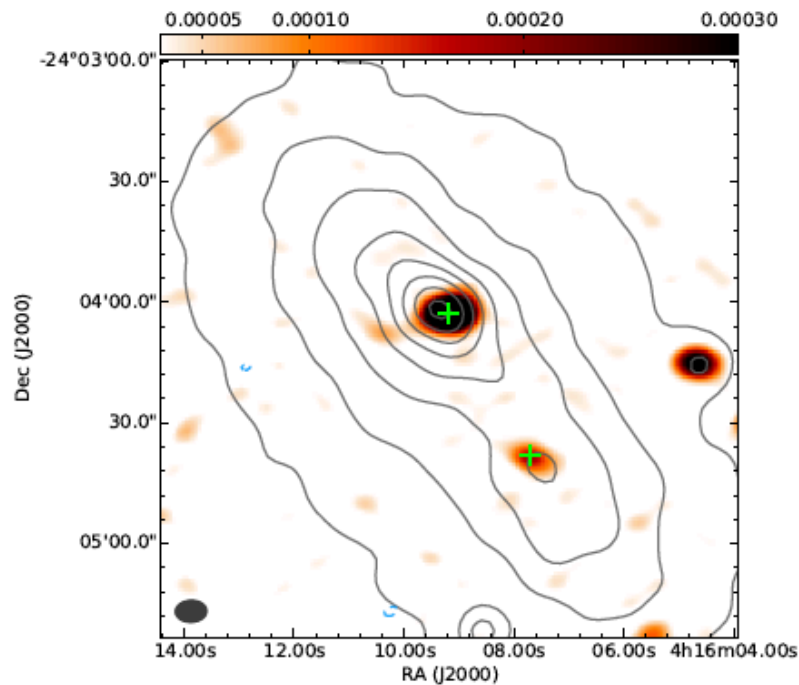
VLITE Imaging Performance:

Plot of rms vs on-source time for a fraction of the archival data pipeline images. Only images from single day runs.



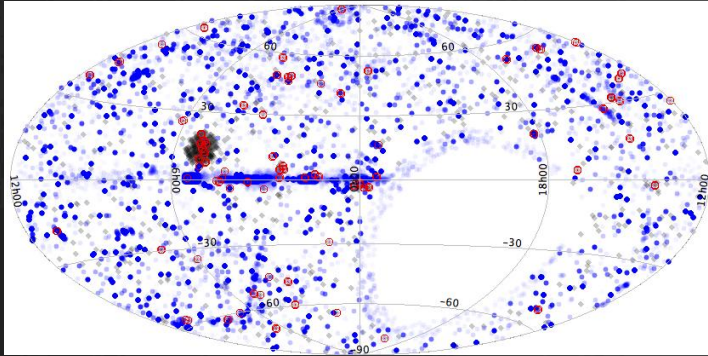
Astrophysics: First VLITE Paper

- Ogrean et al., 2015 ApJ, 812, 153:
 - PI study of HST Frontier Field Cluster use JVLA 1-2 GHz to detect diffuse emission co-incident with dynamically complex cluster.
 - VLITE data detects source at $\sim 3\sigma$, yields a spectral index of $\alpha \sim -1.4$.
 - Additional GMRT follow-up at 610 MHz confirms steep VLITE-JVLA spectral index

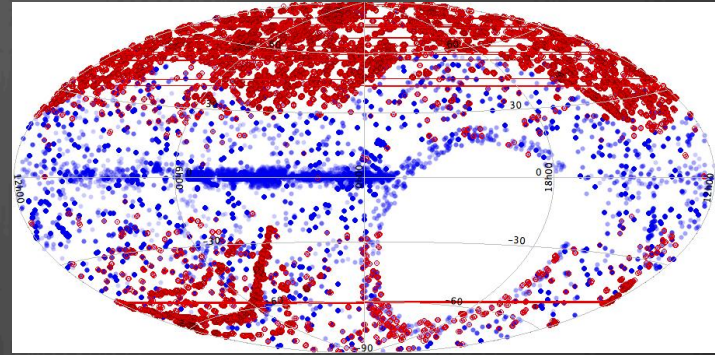


Stand-Alone Astrophysics: VLITE Programs

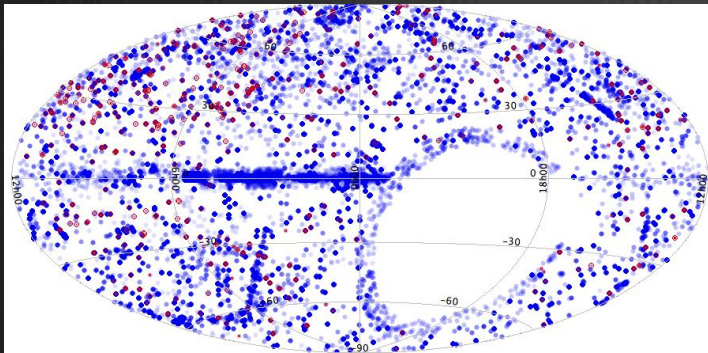
Extrasolar Planets (Turner) - 97



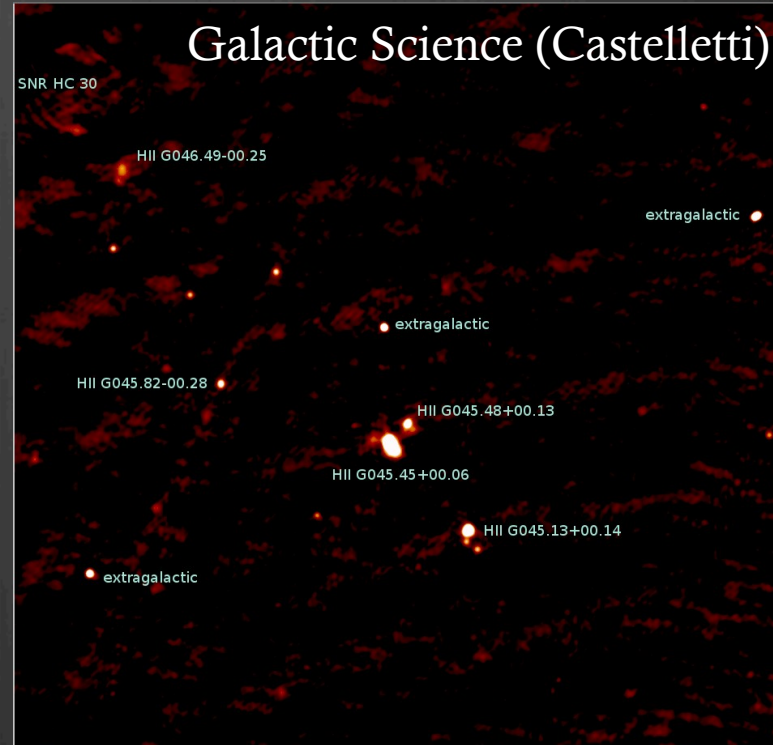
Galaxy Clusters (Clarke+) - 22300



Blazars and Jets (Meyer) - 519

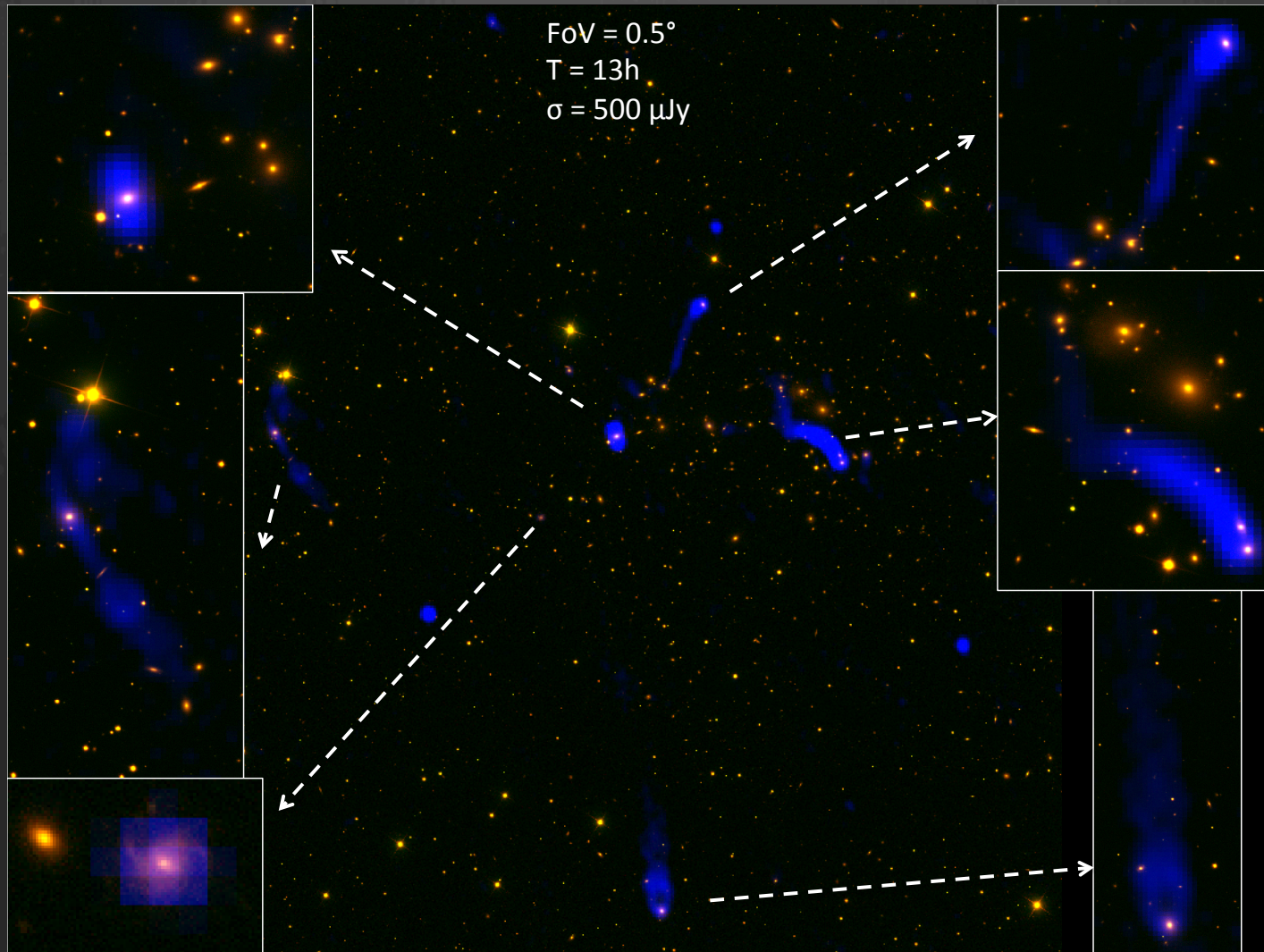


Galactic Science (Castelletti)



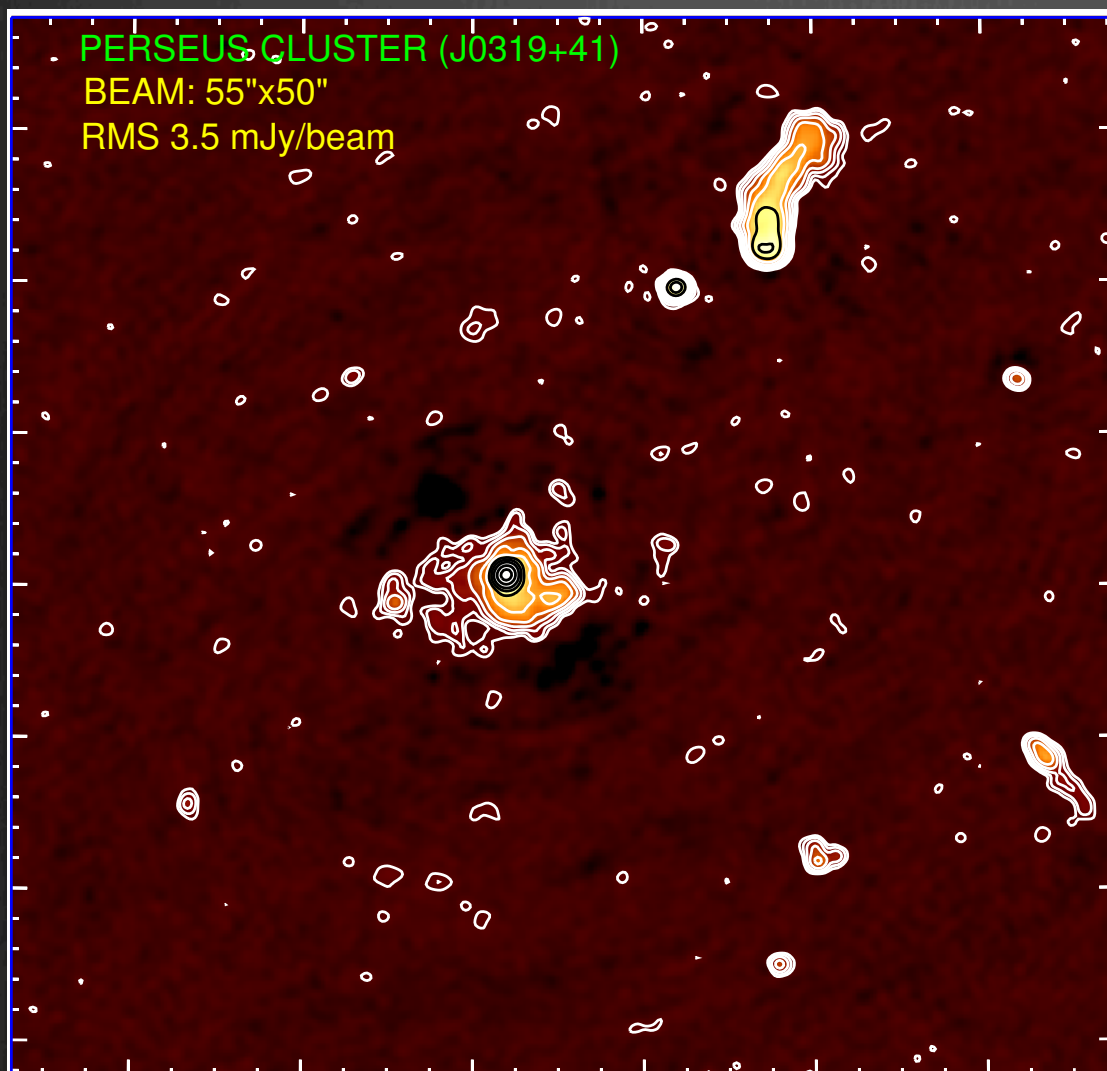
Galaxy Clusters

Abell 2255 (Rudnick B config. L band): VLITE detects radio galaxy components but misses diffuse emission in the system due to limited sampling.



Building Depth

Depth: Data from 3 days (C config., total < 1hr) on this 'calibrator'



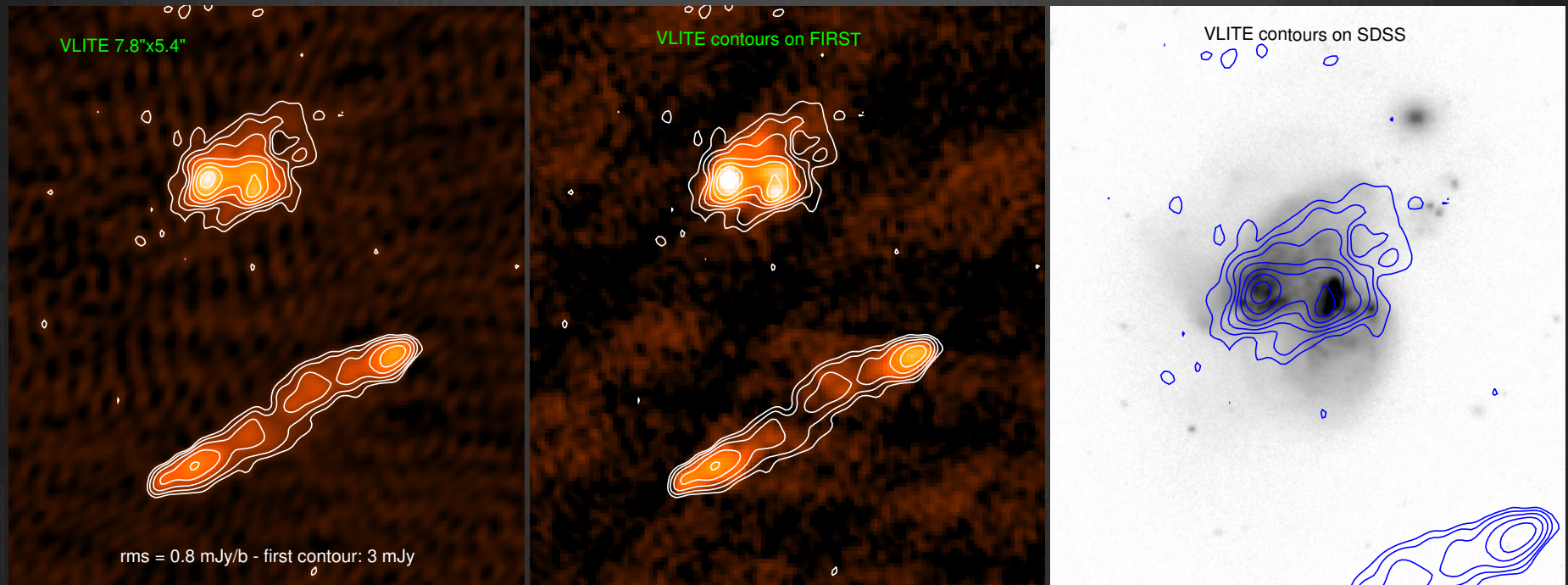
- Noise level is within a factor of a few of the noise in the 48 hr dedicated WSRT observations (Sijbring 1998).
- 12 month data set has 44,692 scans 268h on 3C84.

Astrophysics: A configuration is a Challenge!

- 45 baselines and short integrations are a potential nightmare for imaging multi-degree fields of view in A configuration (~8kx8k cells)!
- Fields with bright sources OK, others are failing so we designed a B+ configuration.

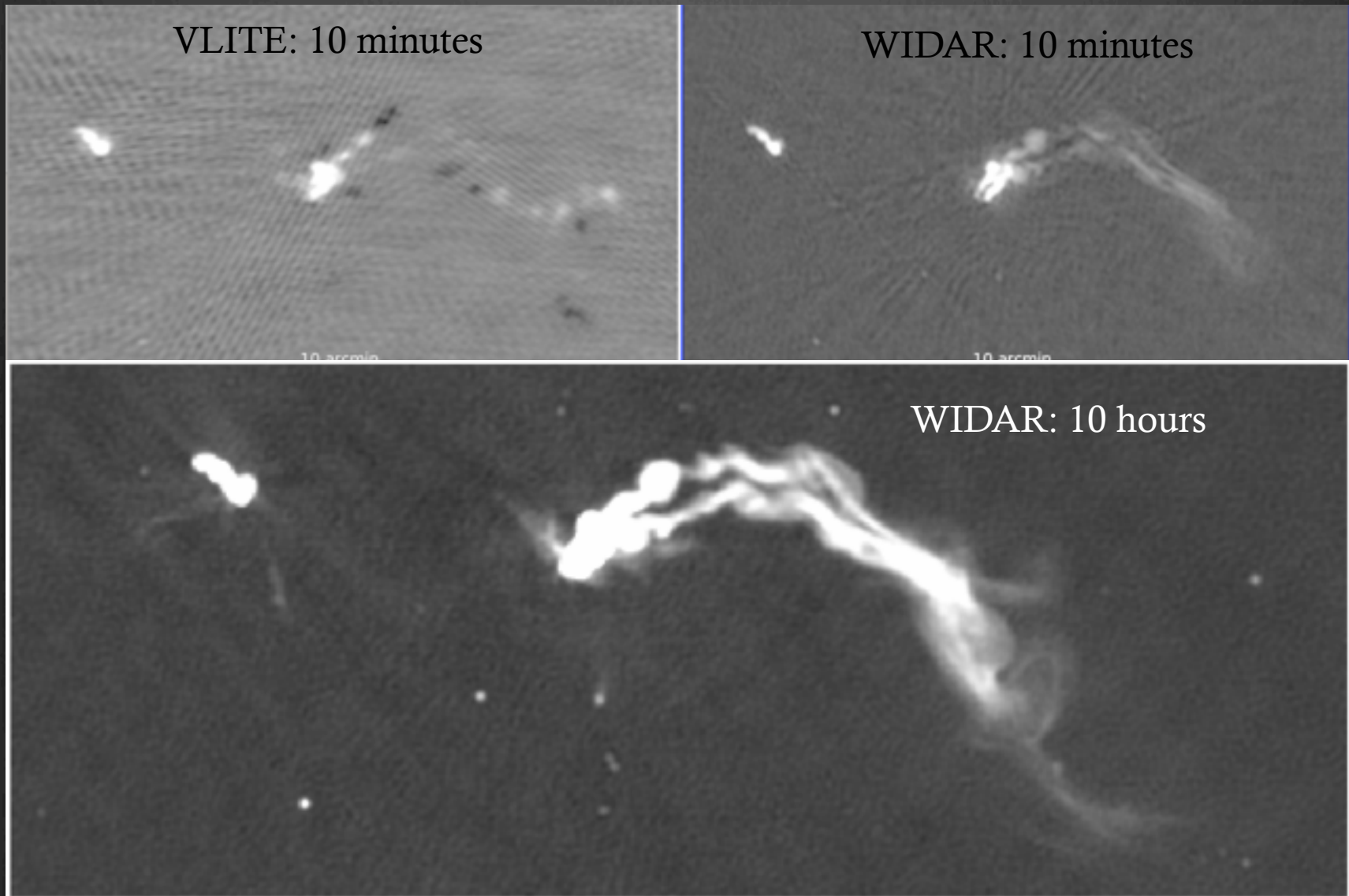
ARP 299 – interacting galaxies driving young starburst

Miguel Pérez-Torres – Global VLBI, L band, 6 hours



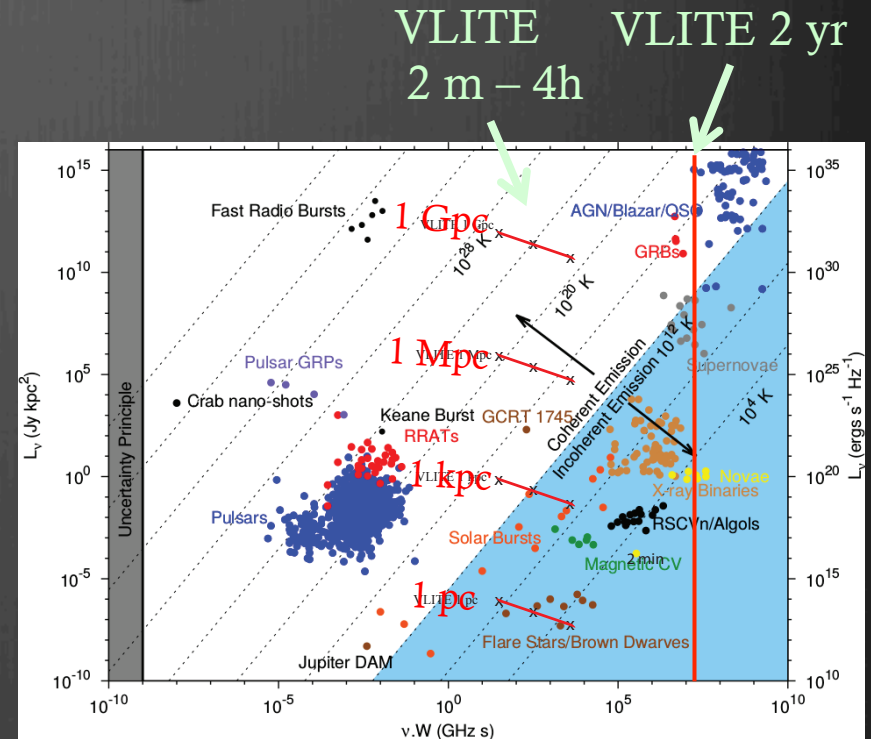
Why do we need more (i.e. LOBO)?

3C129: 15 minute VLITE and WIDAR images (B config).
Significant loss of large scale emission by VLITE.



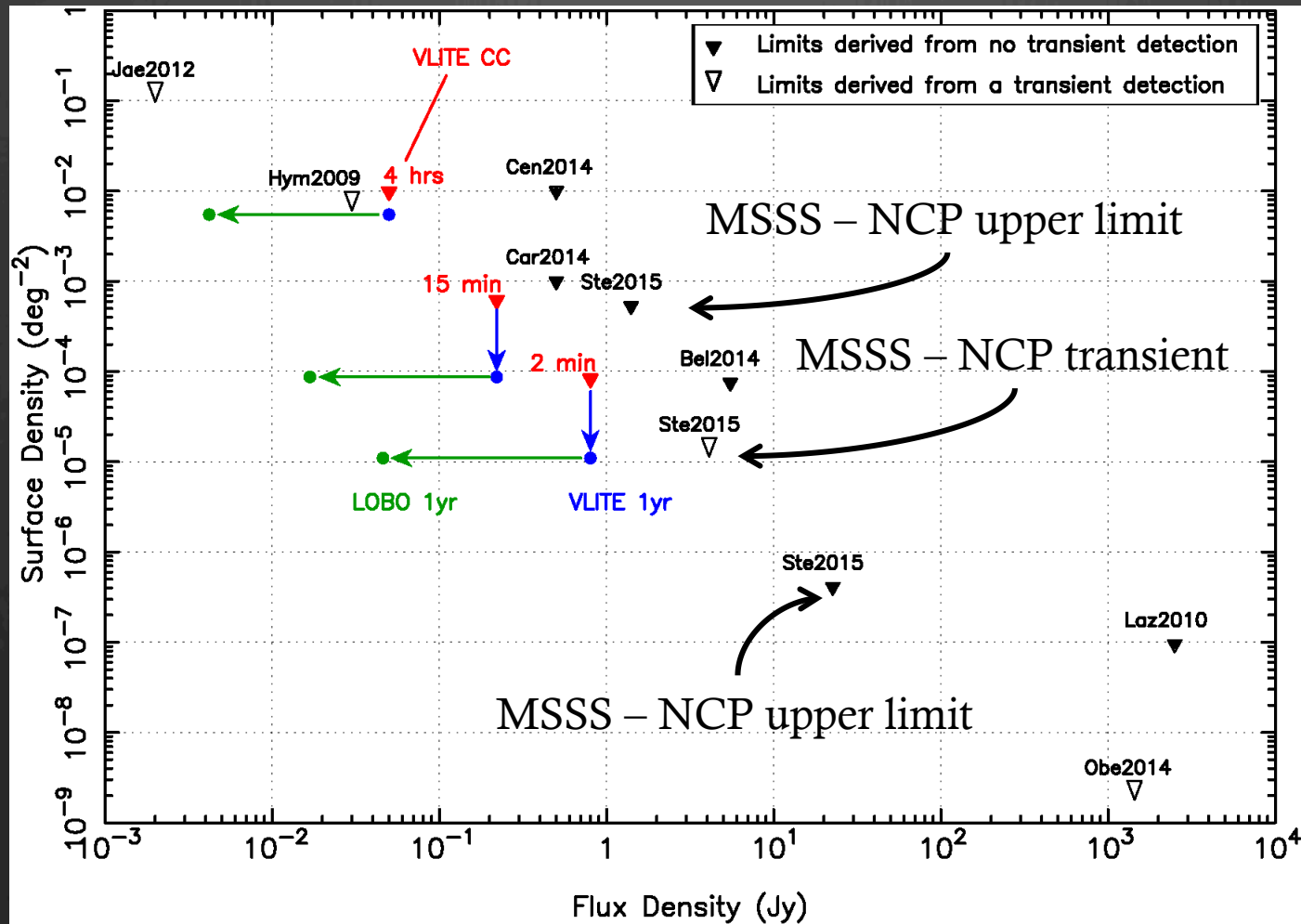
VLITE Transient Program

- Slow transient machine
- Cross-compare VLITE catalog to NVSS and to ID possible transients
- Refine sky catalog (variability studies, spectral studies, population studies, ...)
- Low frequencies are ideal for finding coherent emission from transients.
- With long operation time VLITE pushes into the incoherent regime.



Cordes plot: showing coherent and incoherent phase space for transients. VLITE sensitivity is shown for 2m to 4h from 1 pc (lower red line) to 1 Gpc (upper red line) while a multi-epoch 2 year baseline will extend into the incoherent regime to the vertical red line.

Transient Surface Density Limits at MHz Frequencies



Compilation of rates and upper limits for blind searches for radio transients in the MHz frequency range. Modified from Fender et al. (2015) to add VLITE and LOBO limits.

First VLITE Transient: ATel #7728

V404 Cyg – BH and star binary



$S = 186 \pm 6$ mJy (June 22, 2015)

$\sigma = 1.5$ mJy/bm

$\Theta = 10'' \times 4''$

$\Delta t \sim 4.5$ h

Outside
GCN
IAUCs

Other
ATel on Twitter and Facebook
ATELstream
ATel Community Site
MacOS: Dashboard Widget

The Astronomer's Telegram
Post | Search | Policies
Credential | Feeds | Email
6 Jul 2015; 17:57 UT

[Previous | Next]

VLITE meter-wavelength detection of V404 Cyg at 341 MHz

ATel #7728; *N. E. Kassim (NRL), S. Giacintucci (CPI), W. M. Lane-Peters (NRL), S. D. Hyman (SBC), T. E. Clarke (NRL), E. J. Polisenky (NRL), J. F. Helmboldt (NRL), P. S. Ray (NRL), J. S. Deneva (NRC)*
on 29 Jun 2015; 03:01 UT
Credential Certification: *Scott Hyman (shyman@sbc.edu)*

Subjects: Radio, Millimeter, Sub-Millimeter, Infra-Red, Optical, X-ray, Binary, Black Hole, Nova, Transient, Variables

Referred to by ATel #: **7740**

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We observed V404 Cyg with the Very Large Array Low Band Ionospheric and Transient Experiment (VLITE, <http://vlite.nrao.edu>) at 341 MHz (38 MHz bandwidth) between 2015 June 17 10:52 UTC (MJD 57190.45) and June 25 12:17 UTC (MJD 57198.51). The upper limit on the flux density for the 3 min, June 17 observation is ≤ 20 mJy (3 sigma). The source was detected at 186 ± 6 mJy on June 22 from ~11:30 to 14:30 UTC (centered on MJD 57195.54) and at 90 ± 7 mJy on a 3 min, June 25 observation. For these measurements we have applied the flux scale of Scaife & Heald (2012). Finer resolution time and frequency analysis of our data are underway and will be reported if significant. These VLITE meter-wavelength data are bracketed by higher (ATEL #7716) and lower (ATEL #7720) frequency radio detections, helping constrain the broadband, radio continuum spectrum and radio light curve. We note that the two VLITE detections bracketing the lower flux density LOFAR detection at 150 MHz may suggest a component of thermal absorption.

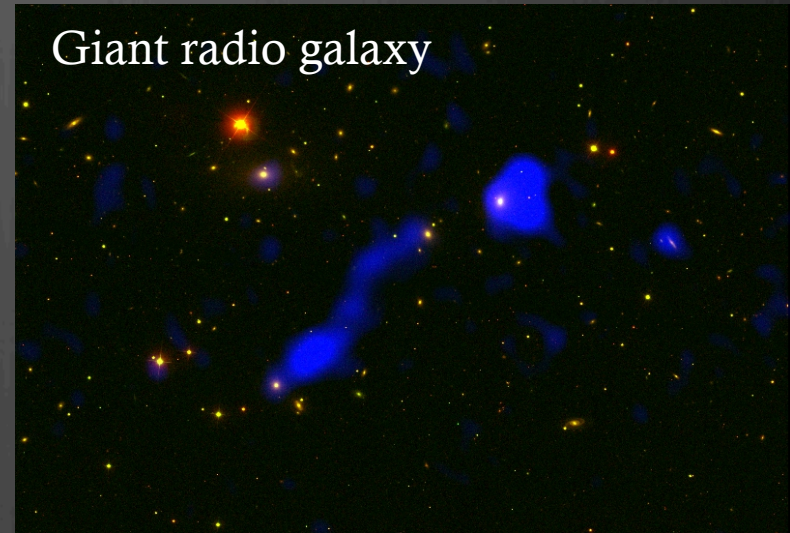
VLA Low Band Ionospheric and Transient Experiment

Cross-correlation of V404 Cyg with VLITE archive shows we have 1823 scans since December 6, 2014 where V404 Cyg is within 0.5 degrees of field center!

NRL VLITE Archive & Products

- Operations: NRL monitors health, archives raw data, pipeline calibrates and images data on a daily basis with NRAO support for hardware
- Pipeline: 1 day lag post processing
 - Add depth by combining images on bimonthly basis
 - *Future addition of polarization products?*
- VLITE products: wide-band full-field images (~2.5 degrees on a side), spectral index maps, spectral window images (narrow band), calibration tables, calibrated uv data, sky catalog, and light curves
- Process one day of data in 3-15 hrs, depending on VLA configuration and number of targets

Abell 1314

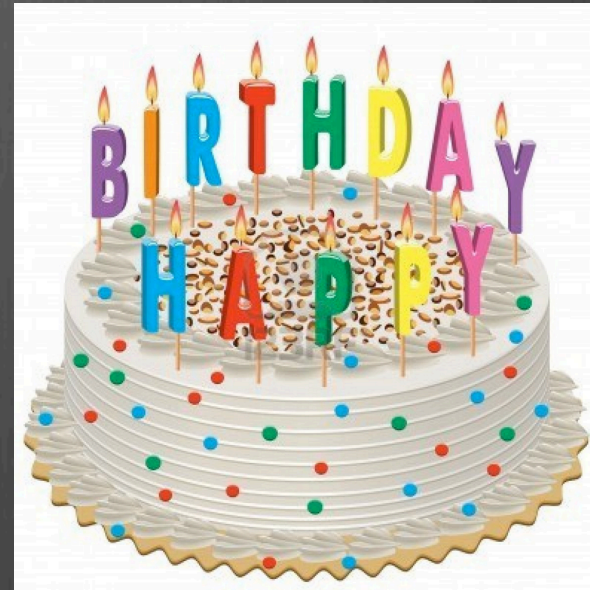


- In some cases, significant improvement is possible through minimal user flagging and re-imaging of pipeline products.

VLITE Summary

- Science observations commenced 11/25/2014, 3 year lifetime
- At 1yr VLITE observed 362,200 scans for a total of >6300 hours
- Catalog produces roughly 12000 unique sources each month (7 sigma)
- Enhances PI-driven science (encourage PI to contact NRL)
- Imaging across all VLA configurations but A config is a challenge!
- Contact NRL if interested in data/collaborations
- NRC postdoctoral positions at NRL open. Contact us!
- *VLITE transition to a full wideband 27 antennas Low Band Observatory (LOBO) will require evidence of scientific productivity and community interest (please see poster by Kassim and the VLITE team).*

Happy Birthday
VLITE!



We look forward
to you growing up
to LOBO!



Galaxy Clusters

Planck ESZ Sample (van Weeren):

