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# VLITE-Fast: High Time Resolution, Commensal 350 MHz Observations with the VLA

M. Kerr, S. Bethapudi, T. Clarke, N. Kassim, F. Janet, P.S. Ray, J. Deneva, E. Posilensky

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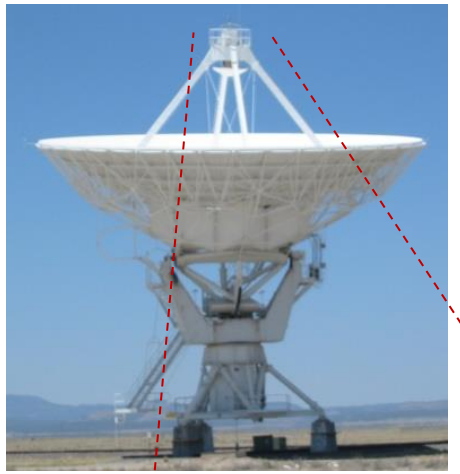
# VLITE in a nutshell (see Clarke et al. 2016)

(VLA Low-frequency Ionosphere and Transient Experiment)

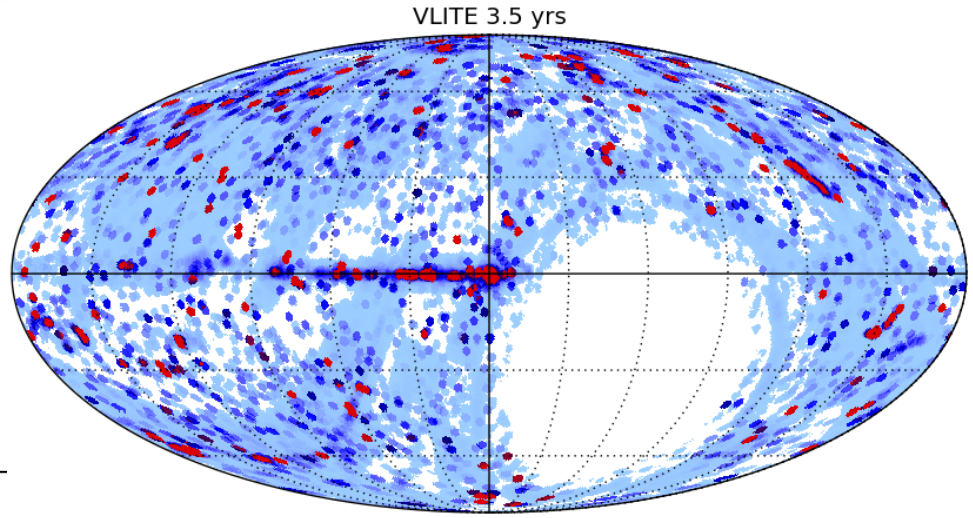


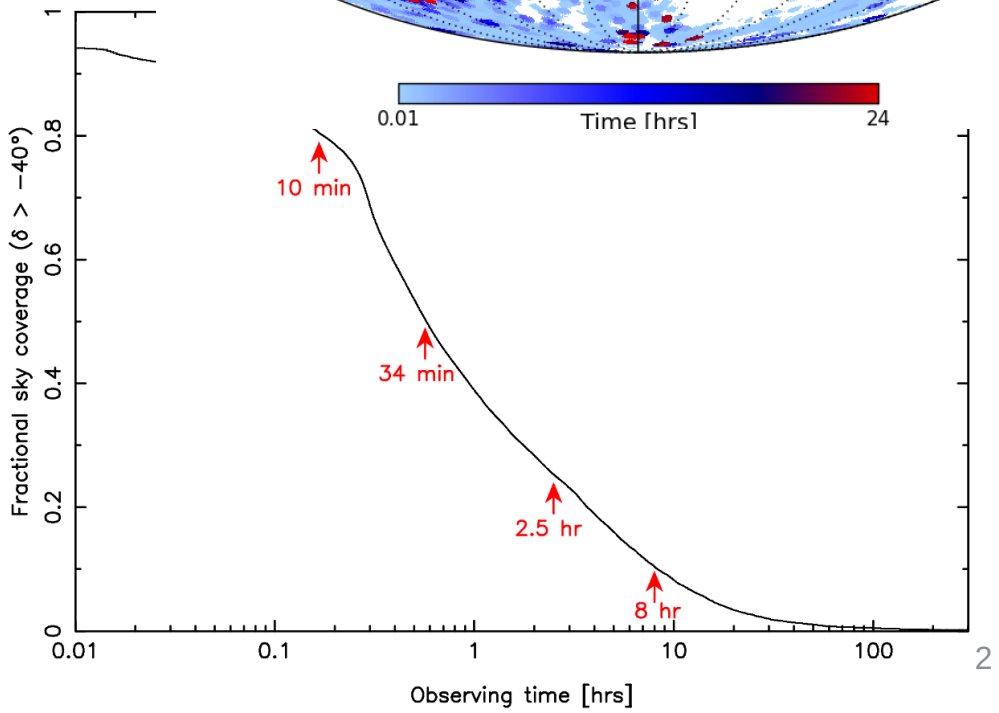
- Uses the VLA P-band dipoles installed at the primary focus
- Independent optical path, samplers, and correlator

(minimal impact on primary observer program)

~~16~~ 18 antennas in 350 MHz band

- 320 – 384 MHz, $\Delta\nu$ = 100 kHz
- $\Delta\tau$ = 2s (2 GB/hr data rate)
- Full polarization (linear)
- Field of view: > 5 deg$^2$
- 5” – 3’ resolution, up to 1° largest angular scale
- CPU correlator (DiFX)
- Lose 360-384 MHz to MUOS



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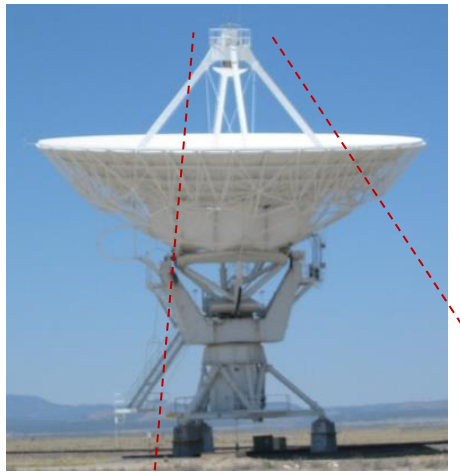

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**If VLITE data would be helpful for your science, please let us know!**

- **Archival data**
- **Upcoming observations**


Tracy Clarke
Namir Kassim
Simona Giacintucci
Wendy Peters
Emil Polisensky
Jason Kooi

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# VLA Configurations: Uniquely Identify Host Galaxy

D Configuration (Now): 1.0 km / 200”

C Configuration (Nov 19): 3.4 km / 60”

**B Configuration (Feb 20, 2019)**
**11.1 km / 18.5”**

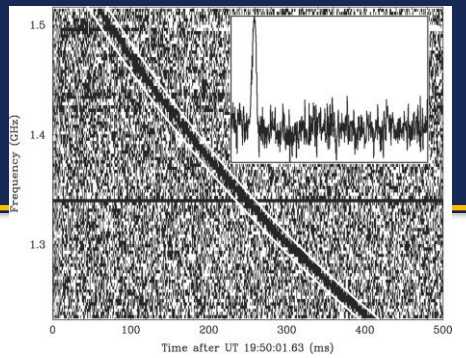
A Configuration (Aug 2, 2019)
36.4 km / 5.6”

With just a bit of luck, VLITE could uniquely identify host galaxies in B configuration. (S/N of beamformed image is huge.)

VLITE will definitely uniquely identify host galaxies of FRBs detected in A configuration.

VLA in A Configuration
Credit T. Burchell, NRAO/AUI/NSF

# VLITE-Fast: a commensal commensal system




**Network Interface**

**Ring Buffer (60s of baseband voltages)**

**Local SSD (on trigger)**
Offline FRB localization

**GPU**
- Channelization
- RFI Filtering
- Detection
- Bandpass normalization
- Polarization summing
- Time averaging

**Ring Buffer (dynamic spectra)**

**Disk (NFS)**
- Offline FRB search
- Pulsar/RRAT search
- RFI/Data Quality

**GPU**
Transient Search in pulse width and dispersion

**Candidates**

**CPU**
- RFI monitoring
- Coincidencer
- Trigger

**8.5s** will elapse between the arrival of an FRB with a DM of 1000 at 360 MHz and the arrival at 320 MHz

Different technique compared to **realfast**, which is an imaging-based search.

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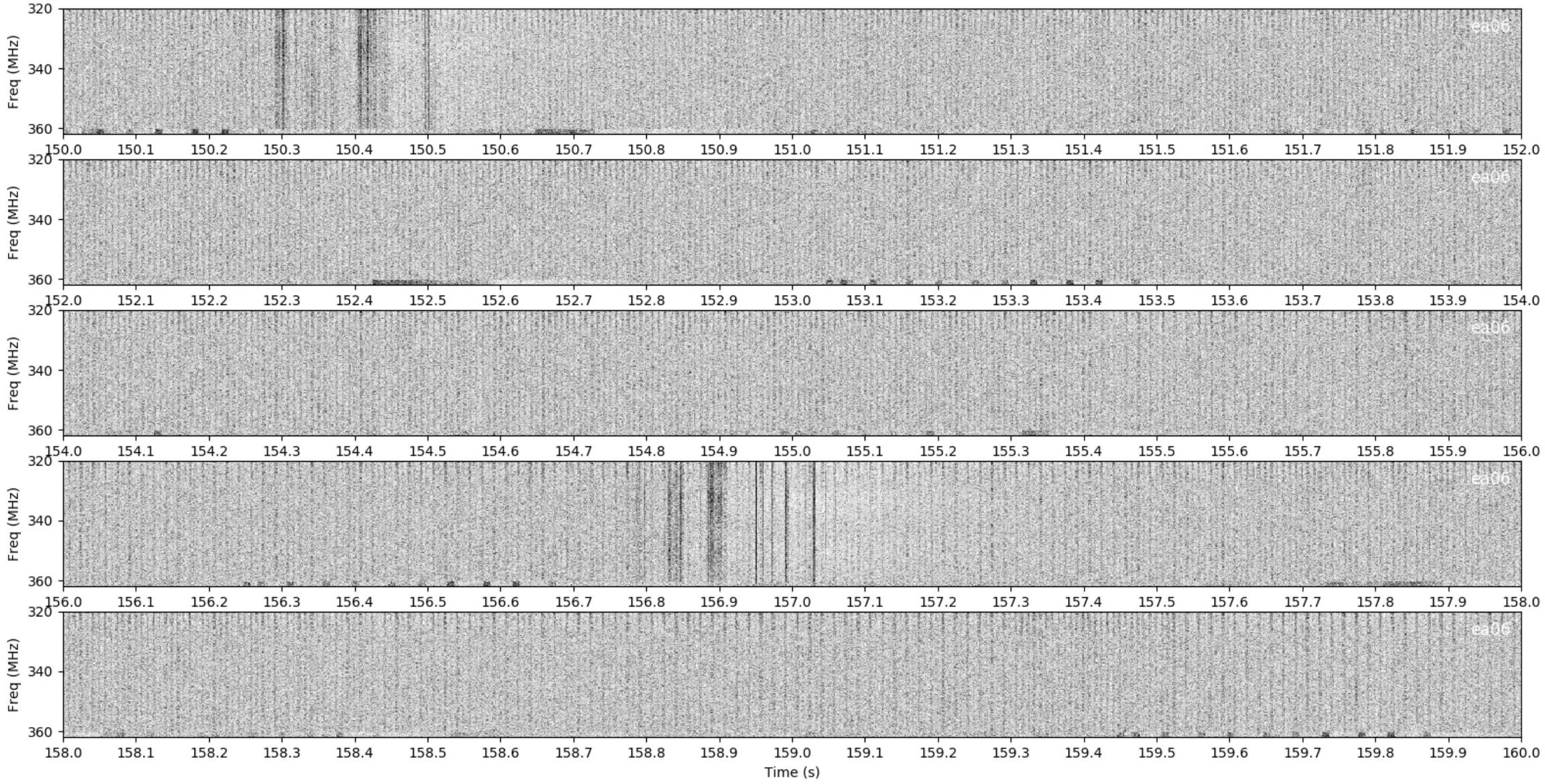
# Typical VLITE-Fast data: “White noise”



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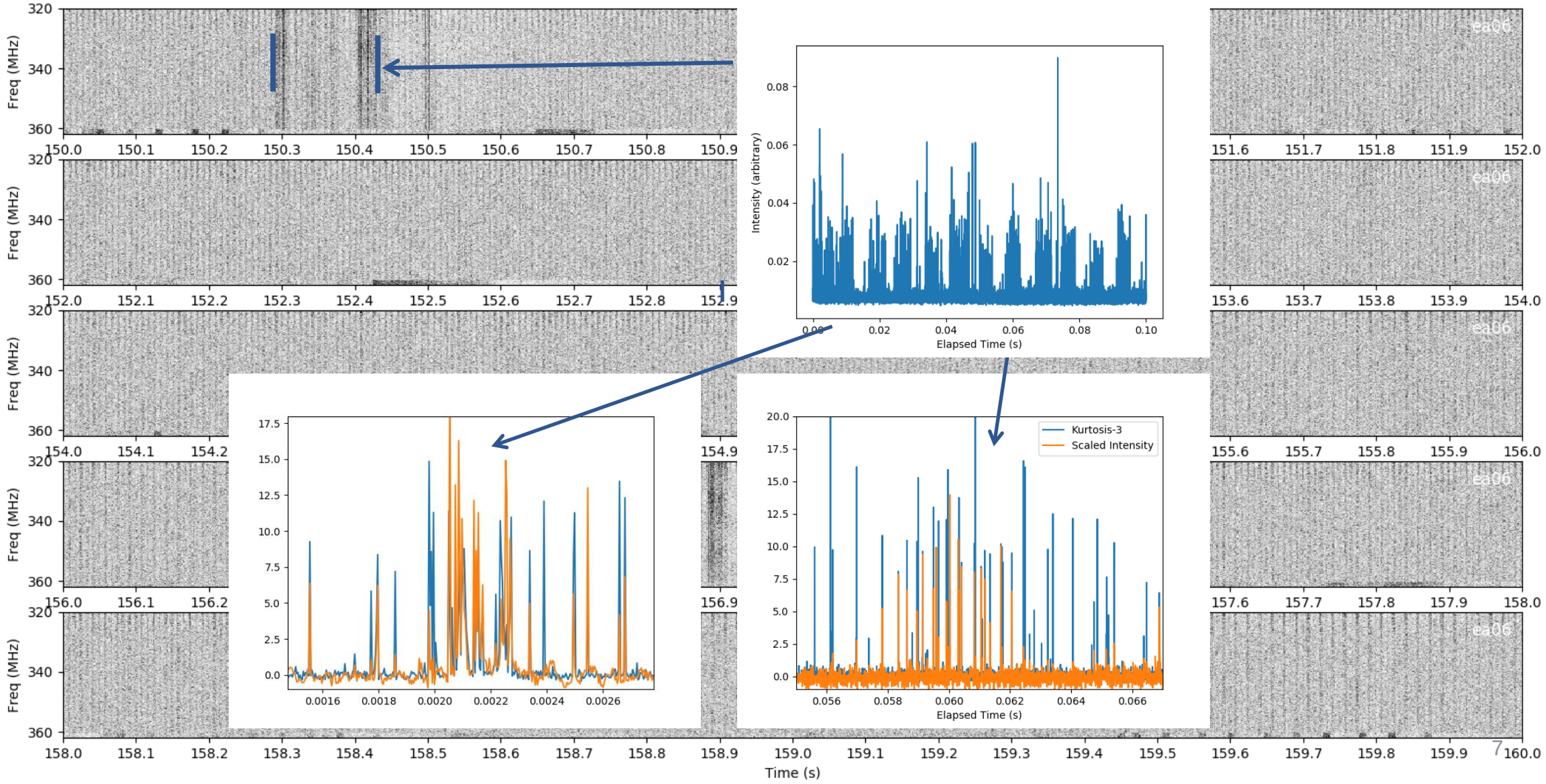
# Typical VLITE-Fast data: Kurtosis analysis



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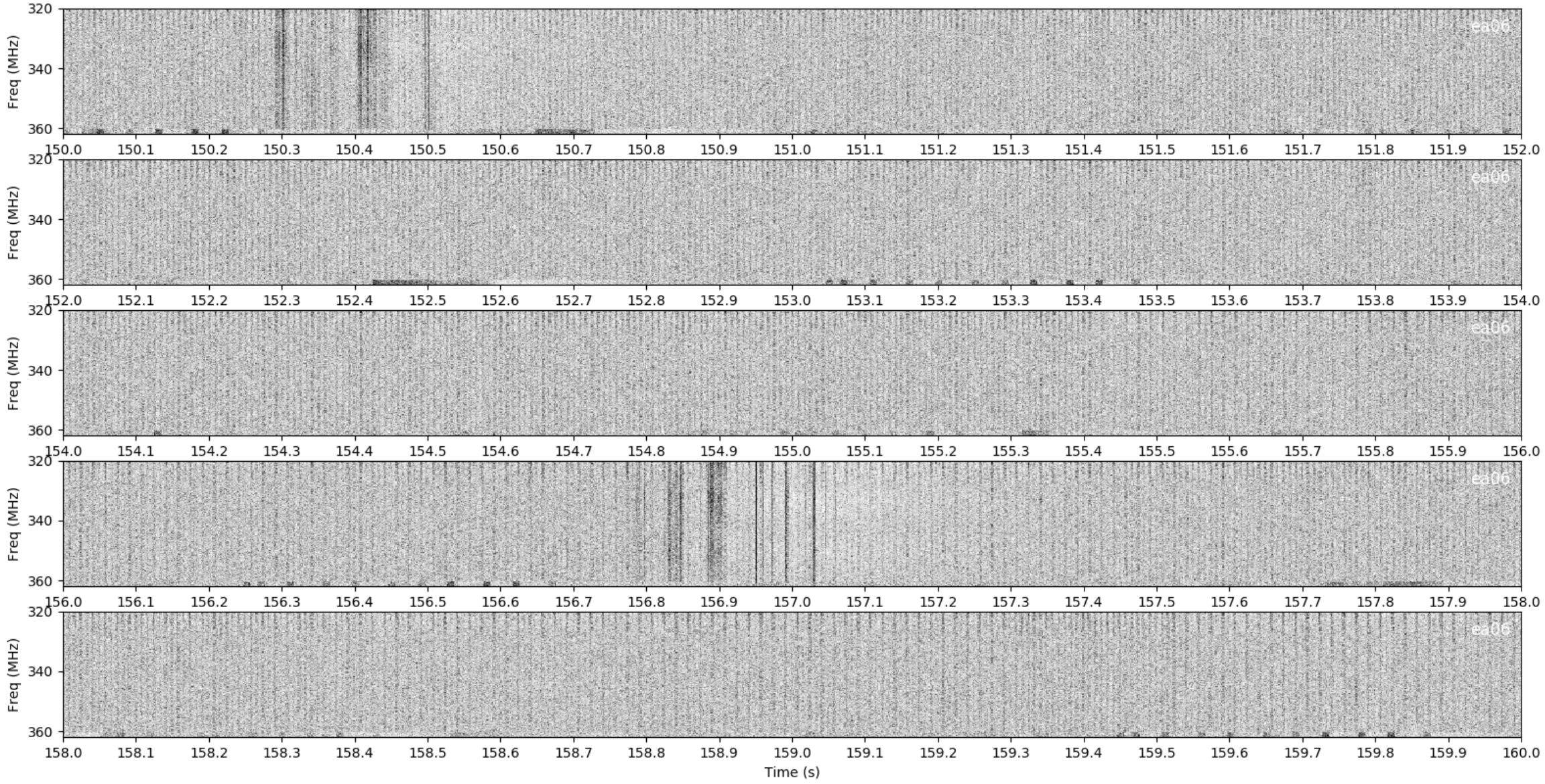

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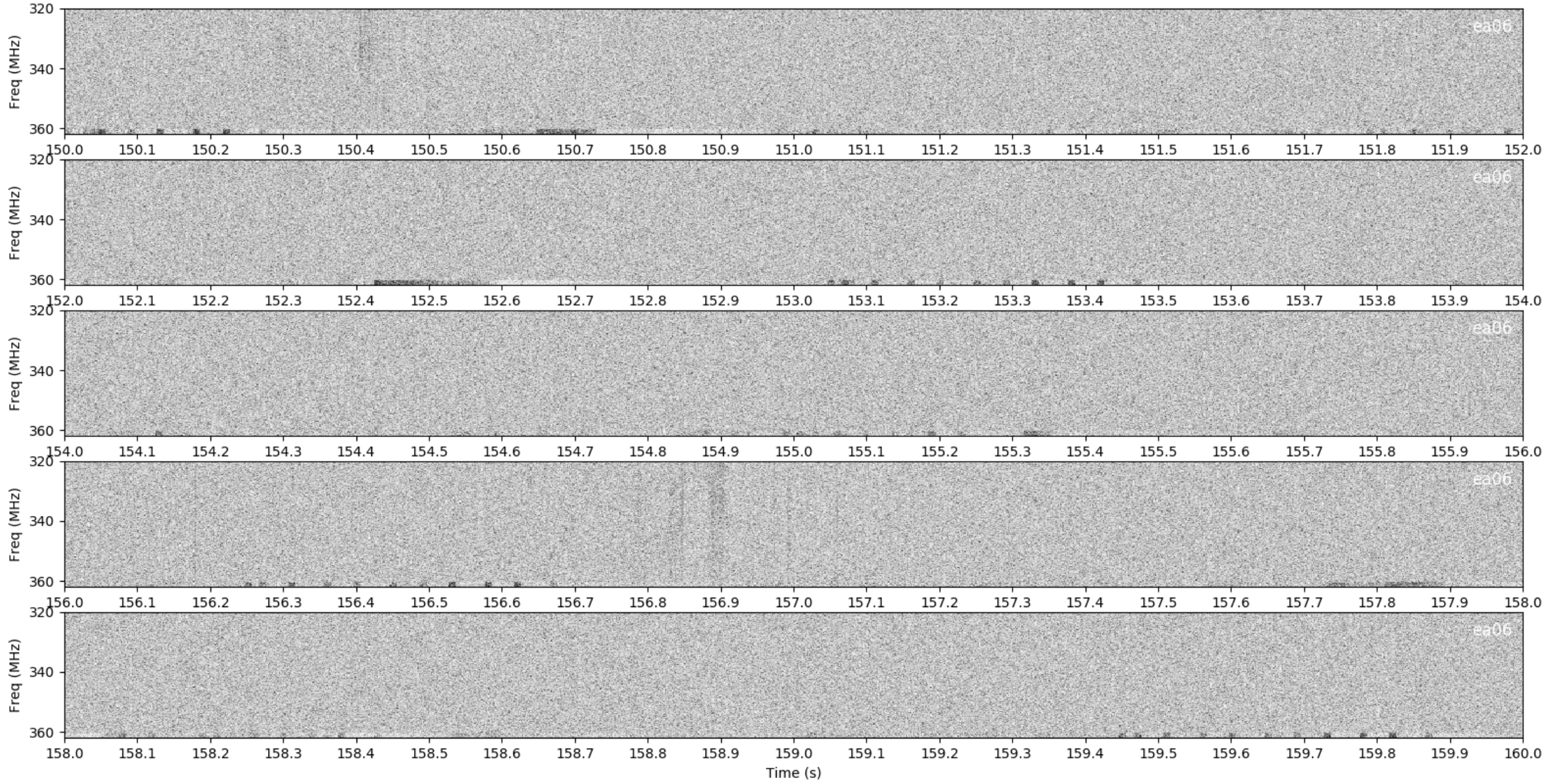

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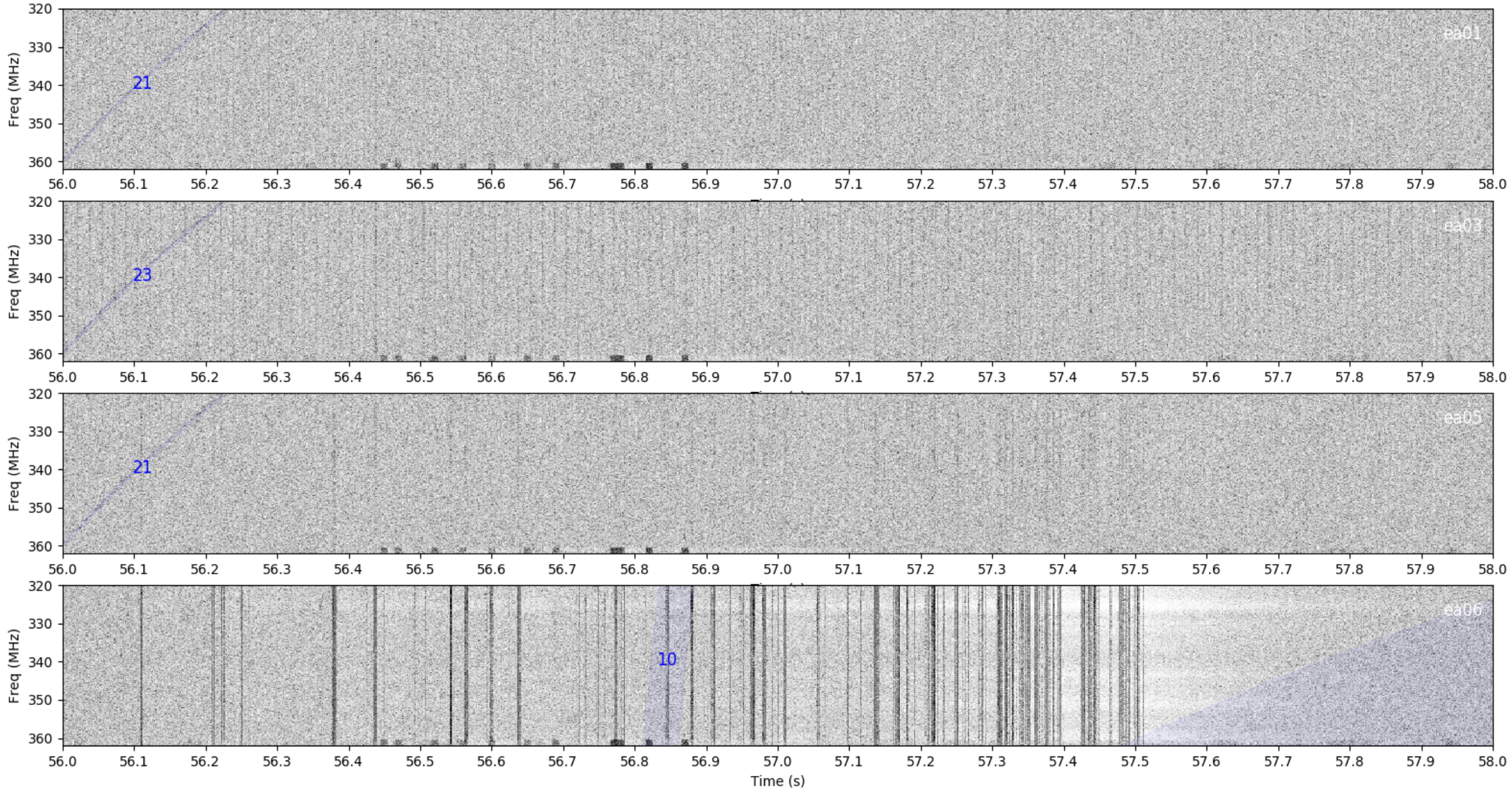
# Typical VLITE-Fast data: PSR B0329+54



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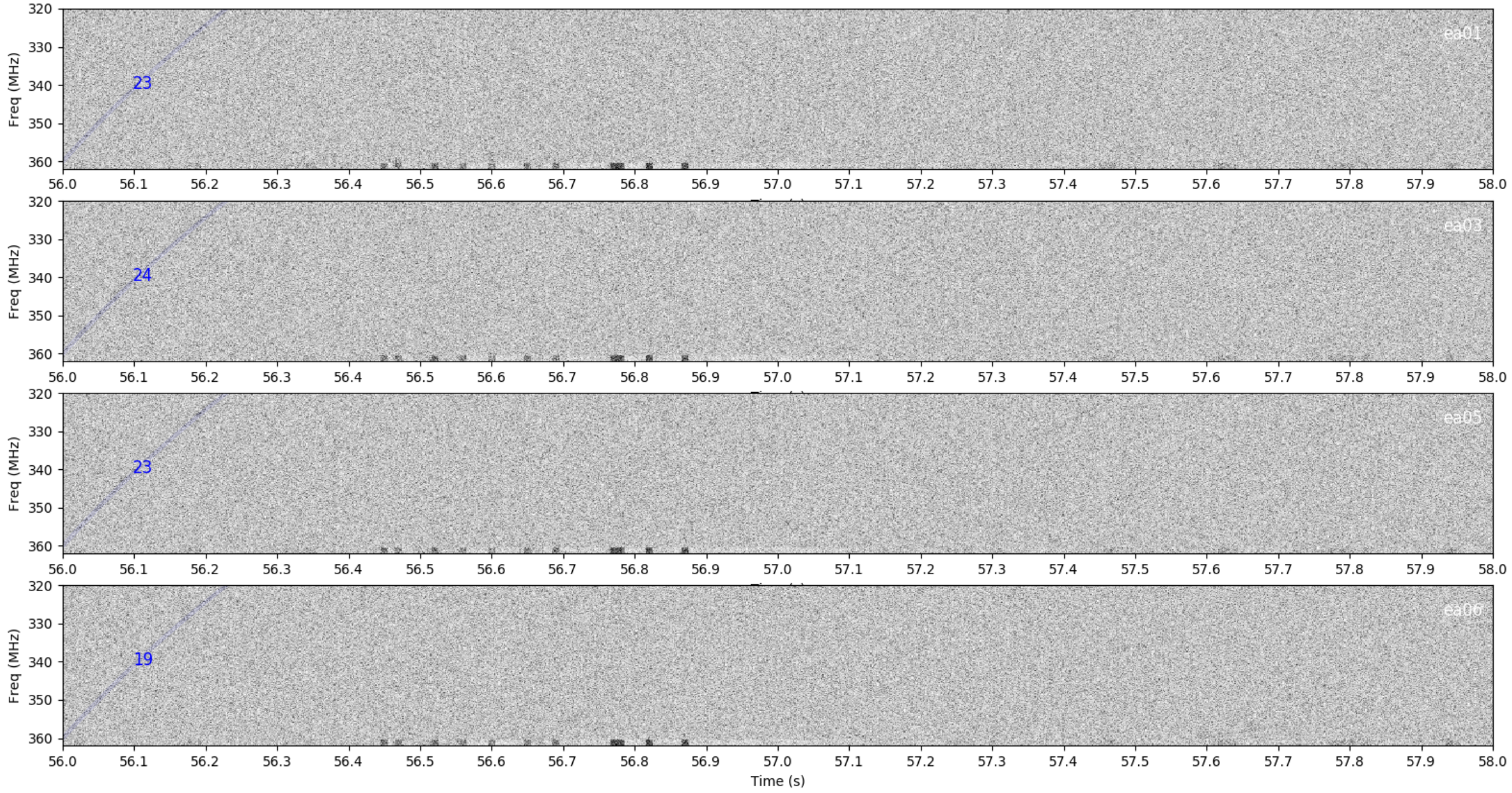

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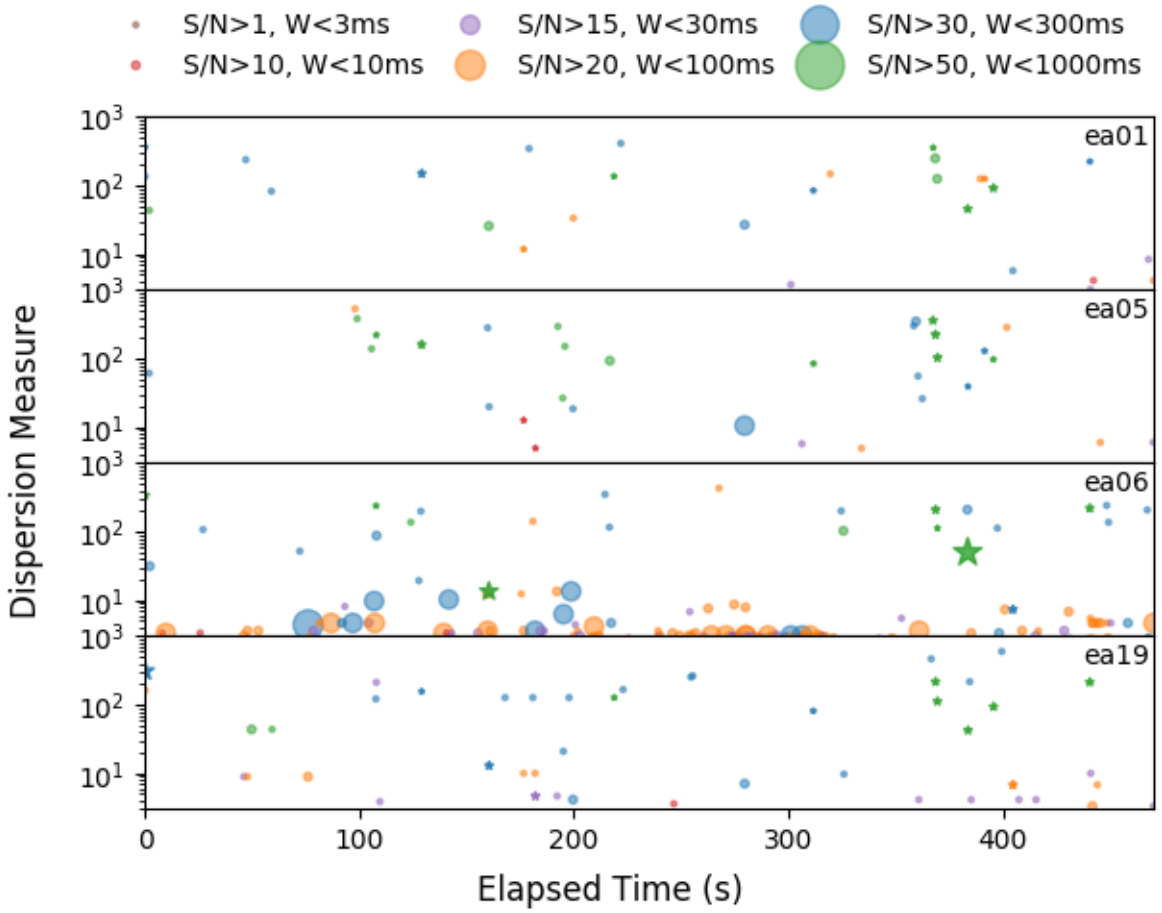
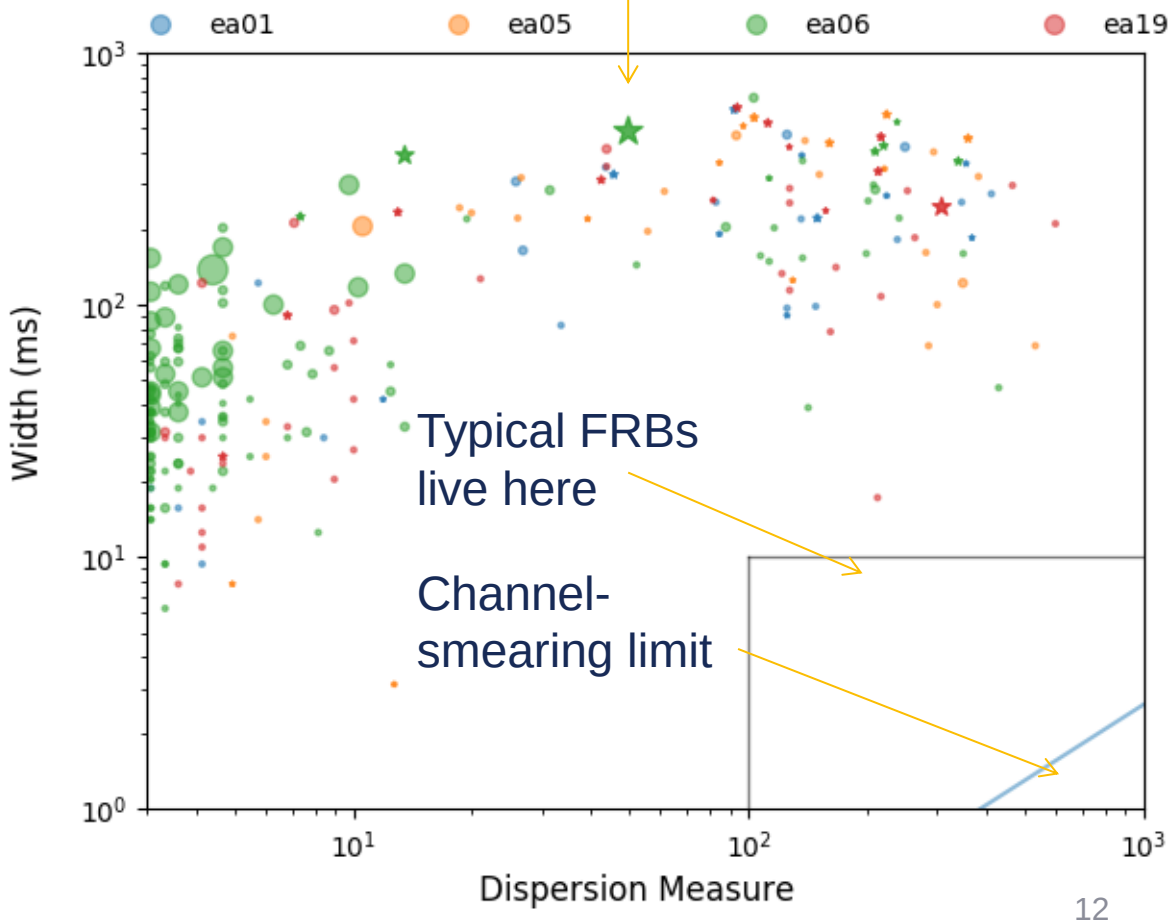
# Same data, now looking at transient candidates




Stars indicate candidates with common time + DM



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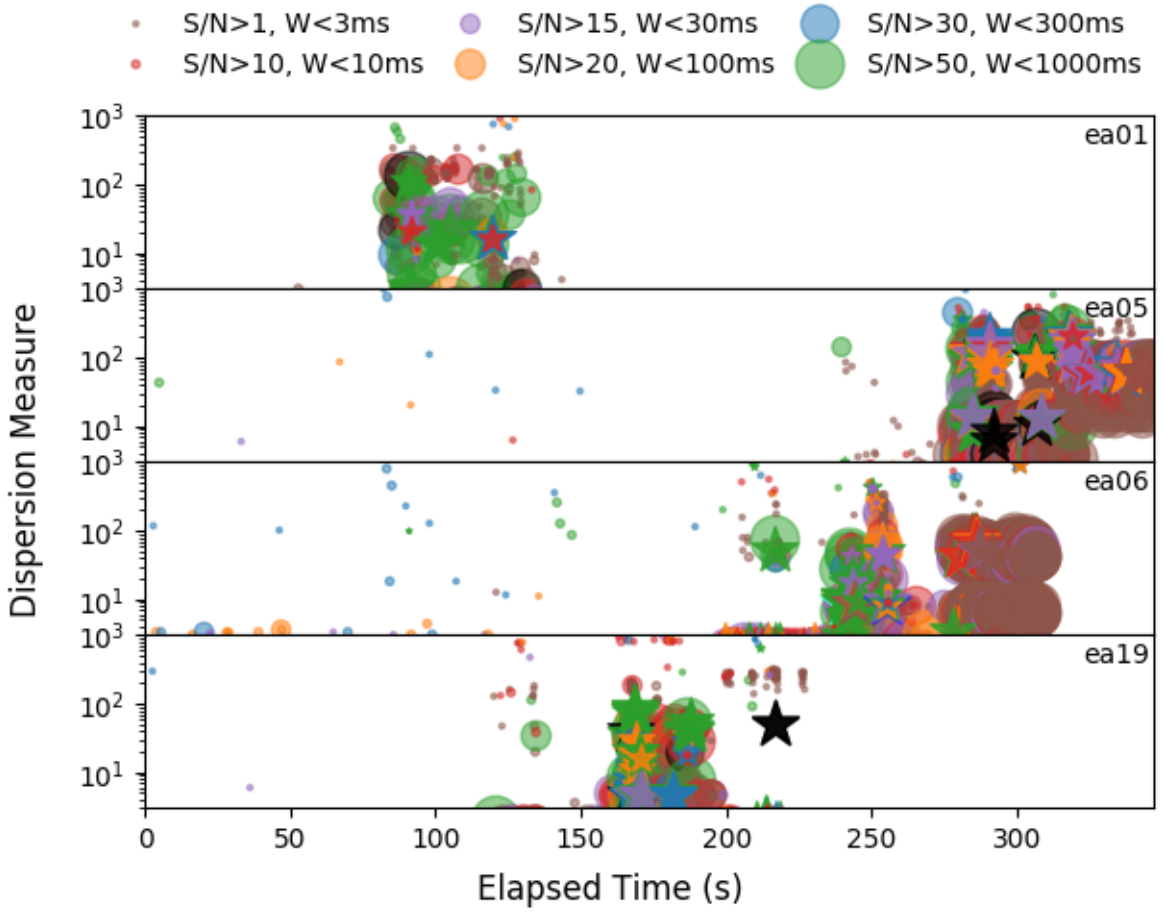
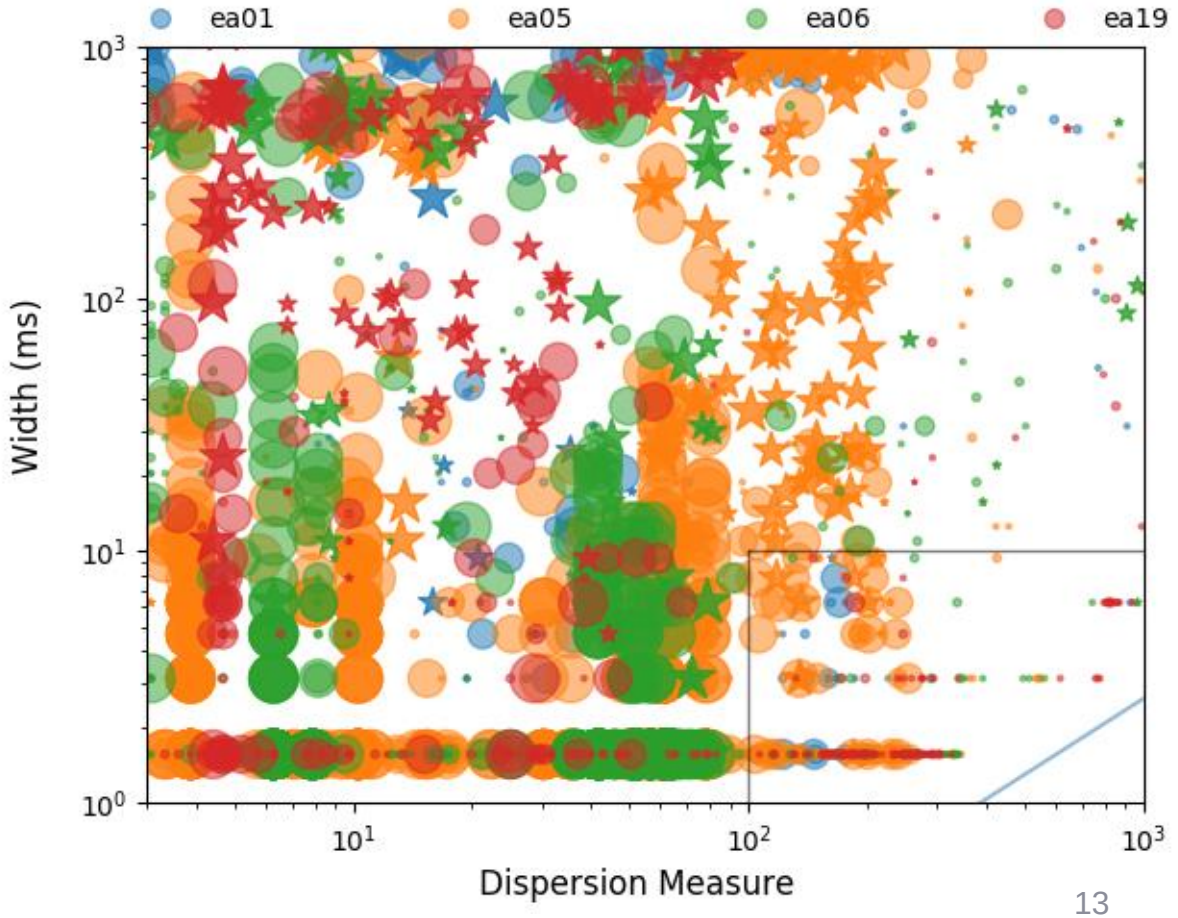
# RFI Strikes

This is the big push now, to become robust to this RFI to avoid filling up disks with false positives.



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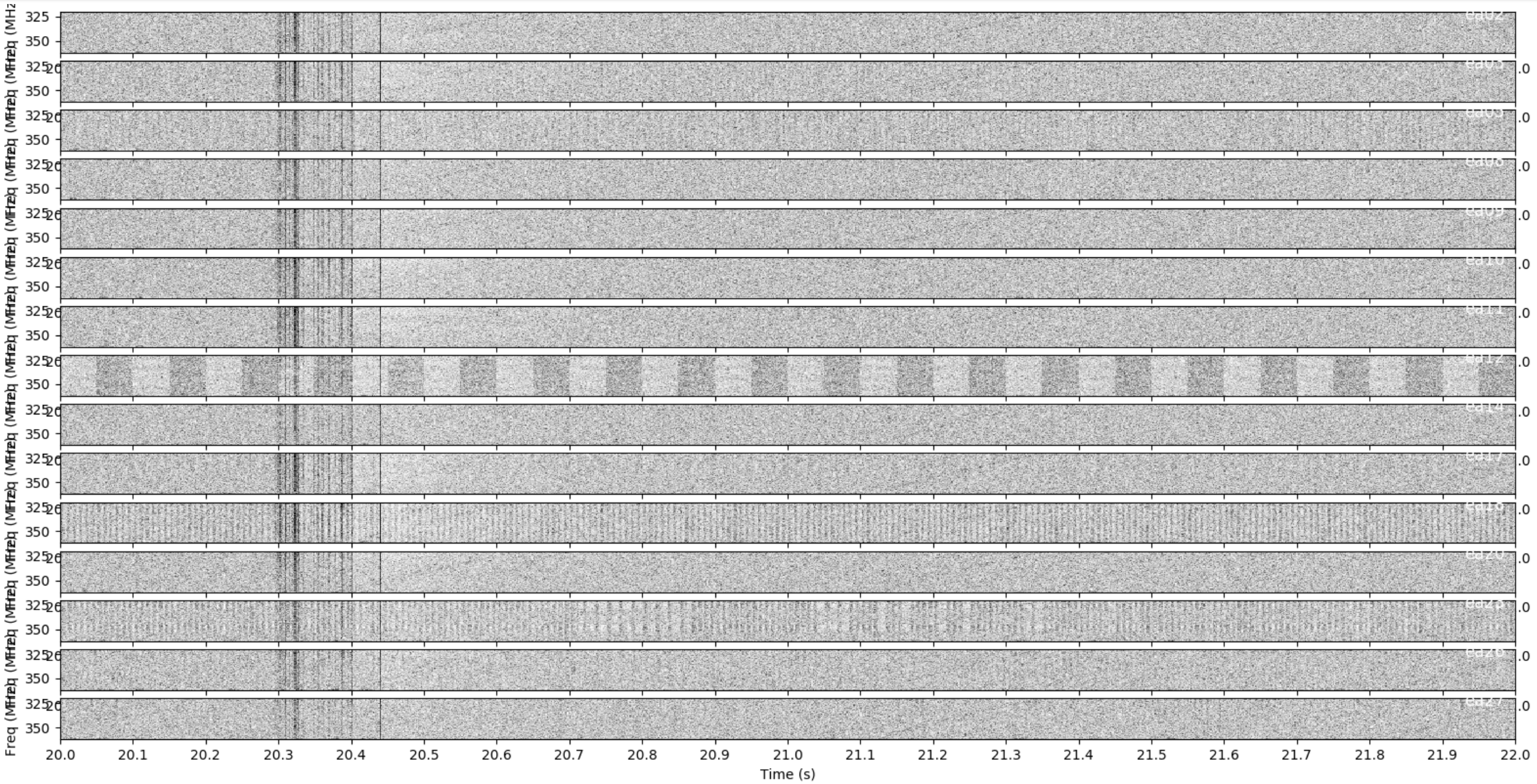
# Recent Data – 15 antennas!



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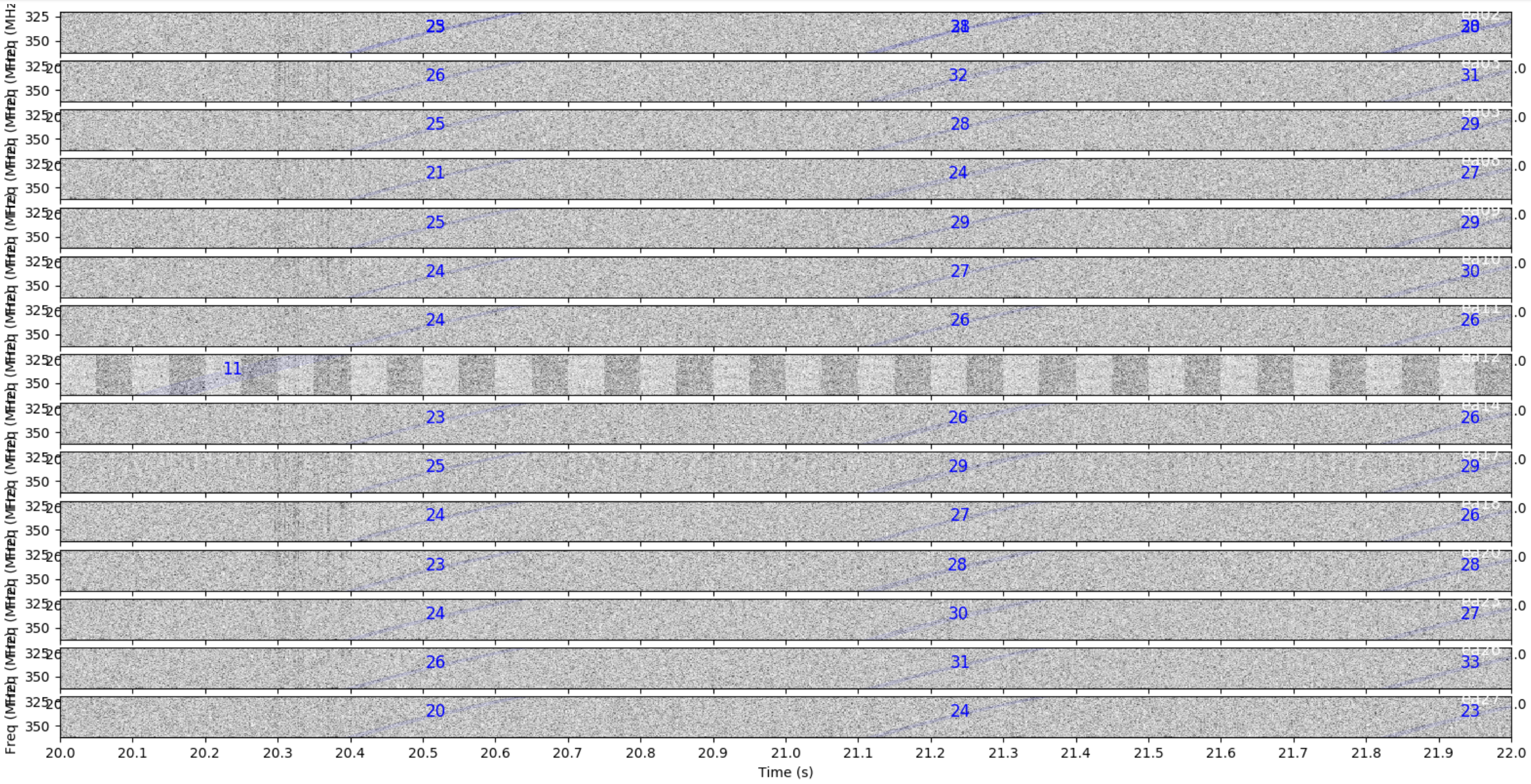

# VLITE-Fast Detection Rate (1)

$$S_{min} = \frac{\sigma_{min}\left(T_{sys} + T_{sky}\right)}{G\sqrt{N_{ant}\ N_{pol}\ \Delta f\ W_{obs}}}$$

Single VLITE Antenna:

$$S_{min} = 18.6\ \sigma_{min}/\sqrt{W_{obs}}\ \mathrm{Jy}$$

Contains intrinsic pulse width, scattering physics (uncertain host galaxy, distance); offset by flexibility in the threshold because we have 16 antennas to use in coincidence.
(I think Tsys/G is also too high based on pulsar observations. But…)

$$F_{min} \approx 100\ \mathrm{Jy\ ms}$$

# VLITE-Fast Detection Rate (2)

ASKAP Mean Spectral Shape: $S(\nu) \propto \nu^{-1.8}$ (Macquart et al. 2018)

ASKAP LogN-LogS: $N(F > 42\ \mathrm{Jy\ ms}) = \frac{17}{\mathrm{sky\ day}} F^{-2.1}$ (James et al. 2018)

ASKAP LogN-LogS: $N(F > 510\ \mathrm{Jy\ ms}) = \frac{17}{\mathrm{sky\ day}} F^{-2.1}$@ 350 MHz

ASKAP LogN-LogS: $N(F > 100\ \mathrm{Jy\ ms}) = \frac{510}{\mathrm{sky\ day}} F^{-2.1}$@ 350 MHz

VLITE-FAST sees ~1/10000 of the sky.

- 1 FRB every 20 days (single antenna mode)

Factor of 4 from incoherent addition:

- 1 FRB every 4 days!

# VLITE-Fast Summary / Timeline

**Reach full operations in current B array (started Feb 20).**

**Major software overalls close to enabling co-addition mode.**

**New package “asgard”!**

**Expect 6 to 30 FRB hosts in B configuration, and nearly same for A configuration.**

**VLITE now operating in 18-antenna mode (2/3 of VLA!).**

Longer term: storage for offline data products

- pulsar search
- RRAT search
- low-frequency commensal NANOGrav observations
- signal processing/RFI excision test bed.