SETI Institute announces Breakthrough Listen funding

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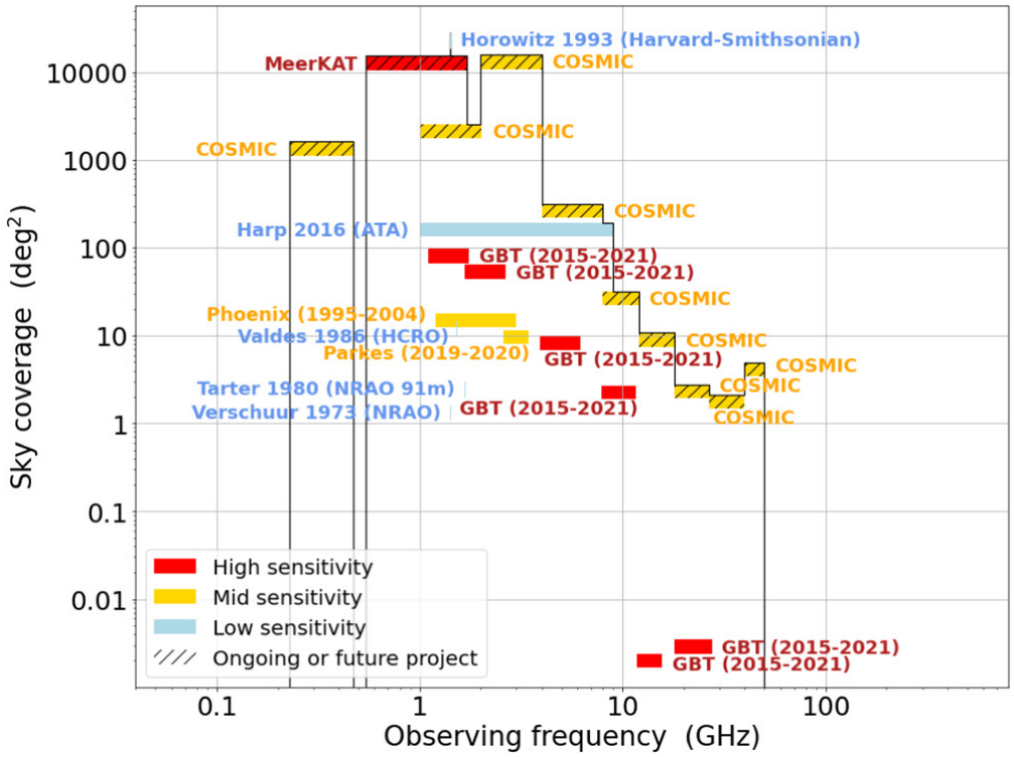
In *COSMIC: The SETI Institute is Unlocking the Mysteries of the Universe with Breakthrough Technology at the Karl G Jansky Very Large Array* [1], the SETI Institute announces a major initiative in the search for extra-terrestrial intelligence. The Commensal Open-Source Multimode Interferometer Cluster (COSMIC) is supported by the US National Radio Astronomy Observatory (NRAO) and Breakthrough Listen.

A paper in The Astronomical Journal [2] explains how the new Commensal Open-Source Multimode Interferometer Cluster (COSMIC) digital backend on the Karl G Jansky Very Large Array (VLA) will expand SETI with a new hardware system design, its current software pipeline, and plans for its future development.

The paper lists the instruments currently involved in this SETI effort and shows how they cover both sky and frequencies.

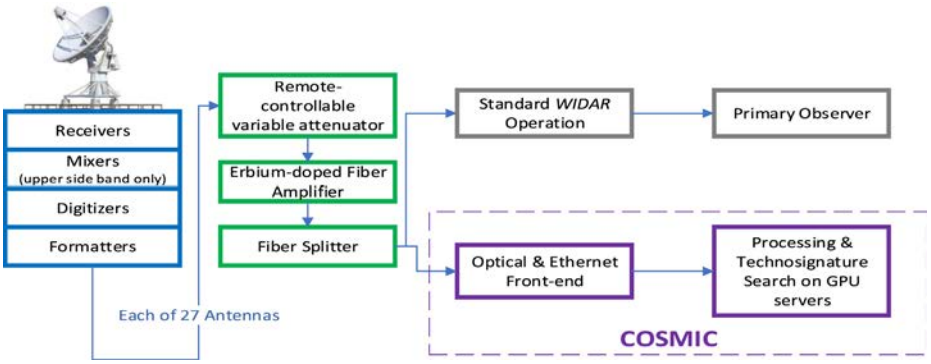


Sky coverage vs observation frequency for key SETI projects conducted to date (modified from Figure 5 of Ng et al 2022 [3]. The colour scale represents three levels of detectability for a 10^{13} W Arecibo-like transmitter emitting a 1 Hz wide technosignature. Blue represents low sensitivity, in which the transmitter must be within 5 pc from Earth; yellow represents medium sensitivity, corresponding to a transmitter 25 pc away; and red represents high sensitivity, enabling detection of a source at a distance of 75 pc.
Credit (image and caption): Tremblay et al, Figure 1.

[1] www.seti.org/press-release/cosmic-seti-institute-unlocking-mysteries-universe-breakthrough-technology-karl-g-jansky-very-large
[2] *COSMIC: An Ethernet-based Commensal, Multimode Digital Backend on the Karl G Jansky Very Large Array for the Search for Extraterrestrial Intelligence*, C D Tremblay et al, December 2023 iopscience.iop.org/article/10.3847/1538-3881/ad0fe0
[3] *Search for Extraterrestrial Intelligence with the ngVLA*, iopscience.iop.org/article/10.3847/1538-3881/ac92e7/meta

COSMIC enhances SETI at the Karl G Jansky Very Large Array by "piggybacking" on normal VLA processing ahead of the standard VLA processing pipeline and without impacting the standard scientist-driven programmes and processing. It will cover potentially tens of millions of stars in a frequency range of 0.074–50 GHz. It aims to exceed the capacity of other systems including even the giant MeerKAT array in South Africa.

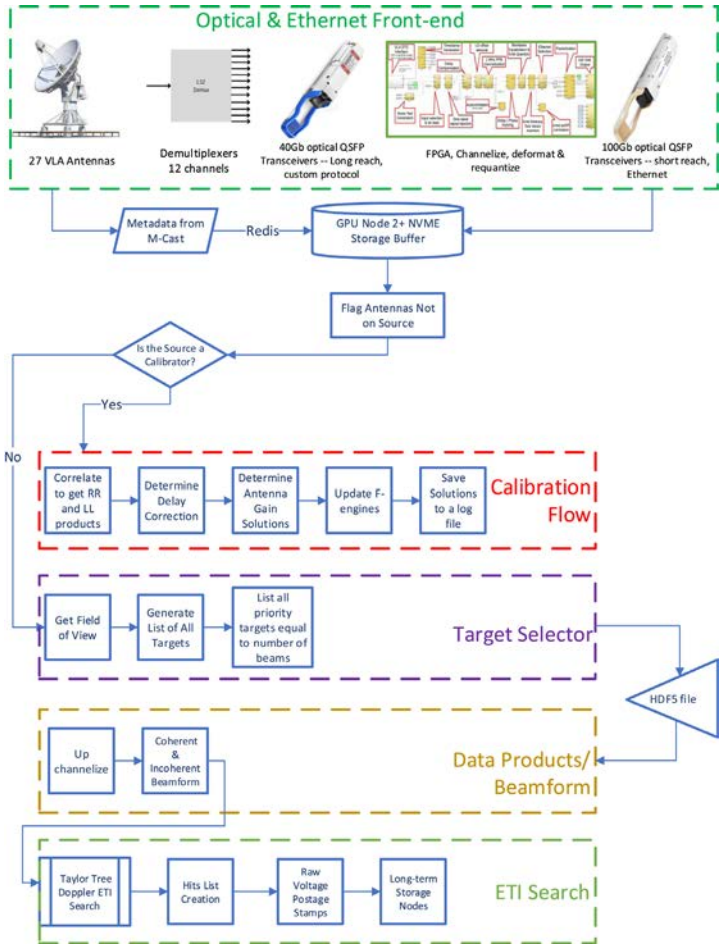
The VLA digitises its received signals at each of the 27 operational antennas in the array so the data feed to COSMIC cannot degrade the standard astronomical data feed. Each antenna has a field-programmable gate array (FPGA) module, 100 Gb/second Ethernet switches handle the multiple data streams and CPU and GPU array processors analyse each narrowband channel, for each polarisation, from all antennas in the VLA. The overall architecture of the VLA with the COSMIC back end is -



A high-level diagram of the data flow from the VLA antennas in the context of COSMIC. The signals from each antenna pass through the receivers, and in the 8 bit mode (the VLA can operate in both a 3 bit and an 8 bit mode), all received frequencies are shifted to the X band (8–10 GHz; upper sideband). COSMIC receives one copy of the digitized signals after they are amplified through an EDFA. The other copy is processed through the WIDAR correlator for standard VLA processing.
Credit (image and caption): Tremblay et al, Figure 3

The per-antenna front end uses FPGAs to implement a protocol for onward transmission which includes the usual checksums and embeds timing and synchronisation to allow both the digitisation sampling clock and the relative timing from each antenna to be recovered for processing.

In the current incarnation of COSMIC, the GPU compute cluster consists of 22 GPU servers. The data processing pipeline is shown right.



Schematic showing an overview of the COSMIC data processing pipeline. There are two data streams: one for real-time system calibration and the other for recording and searching the data for potential technosignatures. The beamformer is designed to create a flexible number of coherent beams, depending on computing resources and workflow. Additionally, the channelization step (Upchannelizer) can be modified to account for different frequency and time resolutions.
Credit (image and caption): Tremblay et al, Figure 8

It is notable that COSMIC, in common with other SETI systems, has to take special measures to combat radio frequency interference which (in the SETI case) has the additional hazard of false positives of ETI signals. The researchers aim to build a database of RFI for the site to combat this.

This paper is a detailed open access description of one of the major systems involved in the Search for Extraterrestrial Intelligence (about 13,000 words) and this news report has merely skimmed over a few points of interest. The paper may be of interest not only in the SETI field but as an example of how current digital systems technology can tackle the ancient question - Are we alone?