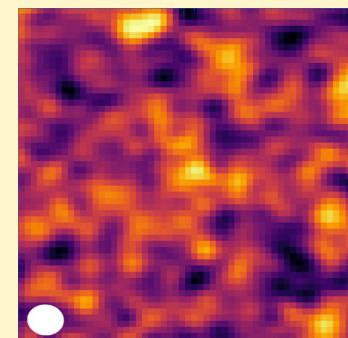


The transformational gain in continuum mapping speed directly translates in improved ability to efficiently detect and map fainter and farther sources, from asteroids to forming planets and dusty galaxies at high redshifts.



As a demonstration of the continuum sensitivity enhancement of the WSU, for a small Near-Earth Asteroid such as (99942) Apophis (~370 m diameter), a detection by ALMA at the time of its close approach to Earth will allow one to determine the surface's temperature and thermal properties, as illustrated in the simulations below. Such observations would provide a major contribution to coordinated multi-wavelengths campaigns preparing for dedicated space missions.

ALMA Now

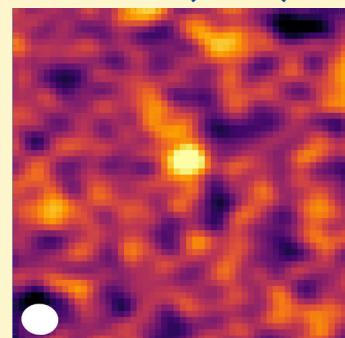


Simulated continuum observation of Apophis during a close approach with the current ALMA system (1 hr observation, Band 6, frequency coverage 223-227/239-243 GHz. SNR is ~4).

The 30 μ Jy target is not detected.

Rendering of (99942) Apophis shape model (Pravec et al., 2014). www.3d-asteroids.space

ALMA WSU (BWx2)



Simulated continuum observation of Apophis during a close approach with the ALMA WSU BWx2 (1 hr observation, Band 6v2, frequency coverage 219-227/239-247 GHz. SNR is ~6).

The target is detected.

ALMA-WSU Timeline

The goal is for WSU first science (full signal chain and all Band 2 receivers) to be on sky by the end of this decade. Next planned implementation stages include upgraded receivers for bands 6, 7, and 8, and eventually deployment of the BWx4 correlator mode. Additional receiver bands may follow. Regular ALMA science operations will continue with some adjustments during WSU commissioning.

WSU Status
(December 2025)

Completed Preliminary Design Reviews

ATAC Correlator
OSF Correlator Room
Data Transmission System
Wideband IF Processor (Digitizer)
Fiber Optics System

Completed Conceptual Design Reviews

Total Power GPU Spectrometer (TPGS)

Receivers in production

Band 2 (67-116 GHz)

Receivers in development

Band 6v2 (209-281 GHz);
Band 8v2 (385-500 GHz)

Receiver in Study:

Band 7v2 (275-373 GHz)

ALMA Observatory WSU project page:

www.almaobservatory.org/en/scientists/alma-2030-wsu

ALMA Memo 621:

Carpenter et al., 2023, arXiv:2211.00195



National Radio Astronomy Observatory



JAN 2026

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For more information please contact ALMA Help Desk:
<https://help.almascience.org>
Or visit:
science.nrao.edu/facilities/alma



TRANSFORMING ALMA SCIENCE: The Wideband Sensitivity Upgrade

A partnership-wide initiative enabling the next decade of discoveries

The ALMA Wideband Sensitivity Upgrade (WSU) is an ALMA partnership-wide initiative that will dramatically increase the system's observing efficiency across ALMA's entire wavelength range. These gains will result from a transformational increase of the instantaneously correlated bandwidth, up to at least 16 GHz per polarization, combined with significantly improved receiver and digital path efficiency.

Dramatic Increase in Correlated Bandwidth for Each Receiver Band

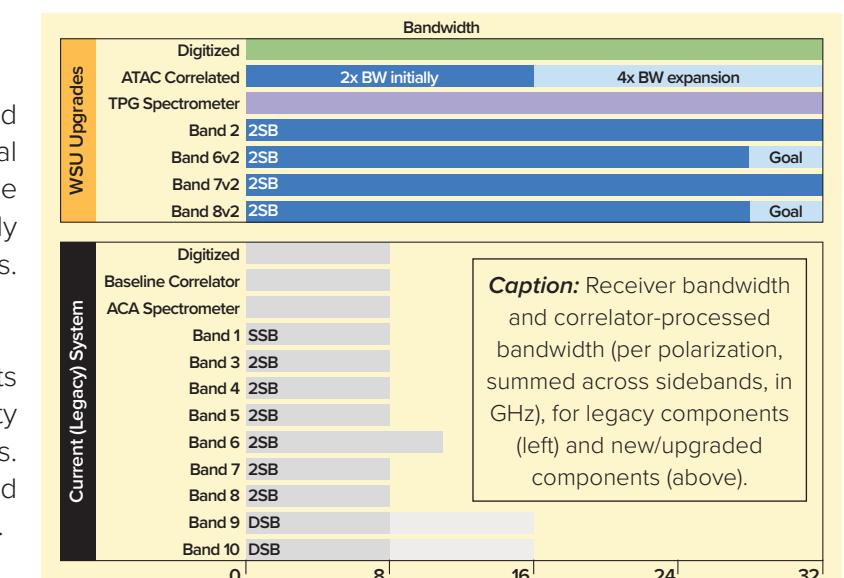
The entire instantaneously correlated bandwidth is available at any spectral resolution – eliminating the need to trade bandwidth for resolution, and significantly increasing the efficiency of spectral scans.

Improved Observing Speed

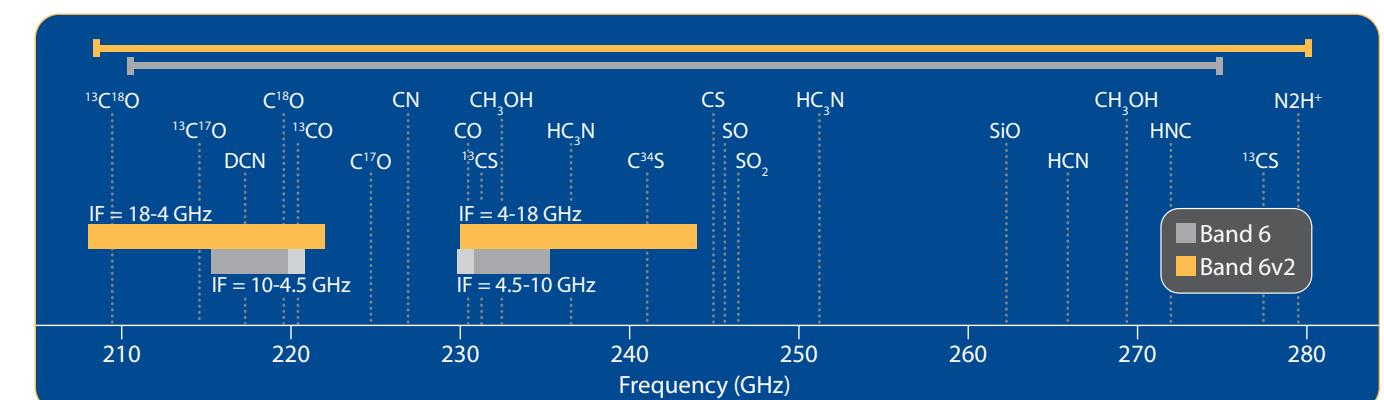
Better digital efficiency (20%) impacts all observations, with further sensitivity improvements for updated receivers. Continuum sensitivity is directly boosted by the increase in correlated bandwidth.

Other WSU benefits include:

- Spectral resolution down to 10 m/s at all bands
- Improved instantaneous Fourier-plane coverage
- Flexible correlator modes



Caption: Receiver bandwidth and correlator-processed bandwidth (per polarization, summed across sidebands, in GHz), for legacy components (left) and new/upgraded components (above).



Above: Total spectral coverage for Band 6 (gray) and Band 6v2 (yellow); a selection of molecular transitions is overlaid. The intermediate frequency coverage (IF) of each is also shown, indicating the current and improved instantaneous spectral coverage. Note that the 4.5-5.5 GHz portion of the Band 6 IF (highlighted in light gray), which is required for simultaneous observations of the $^{12}\text{CO}(2-1)$ and $^{13}\text{CO}(2-1)$ transitions, features excess noise. The increased IF of Band 6v2 will translate to a factor of 3 improvement in observing time for this popular spectral tuning compared to Band 6.

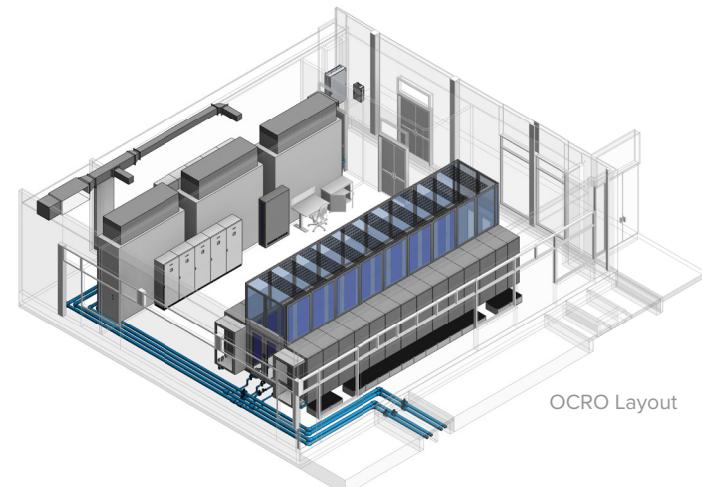
Components of the ALMA-WSU

Most of the observatory's hardware elements are being replaced or upgraded, including key receivers, the Advanced Technology ALMA Correlator (ATAC), and other signal chain components. Most online and offline software will be upgraded to accommodate the new components and expanded throughput.



ATAC: Advanced Technology ALMA Correlator

- Initially doubling maximum correlated bandwidth (BWx2), expandable to BWx4
- Up to 1.2 million spectral channels available
- Flexible subarrays to process 12m and 7m arrays concurrently
- 13.4% improvement in correlation efficiency
- Hosted in a new Correlator Room (OCRO) at the Operations Support Facility



WSU components are provided by members of the ALMA partnership:



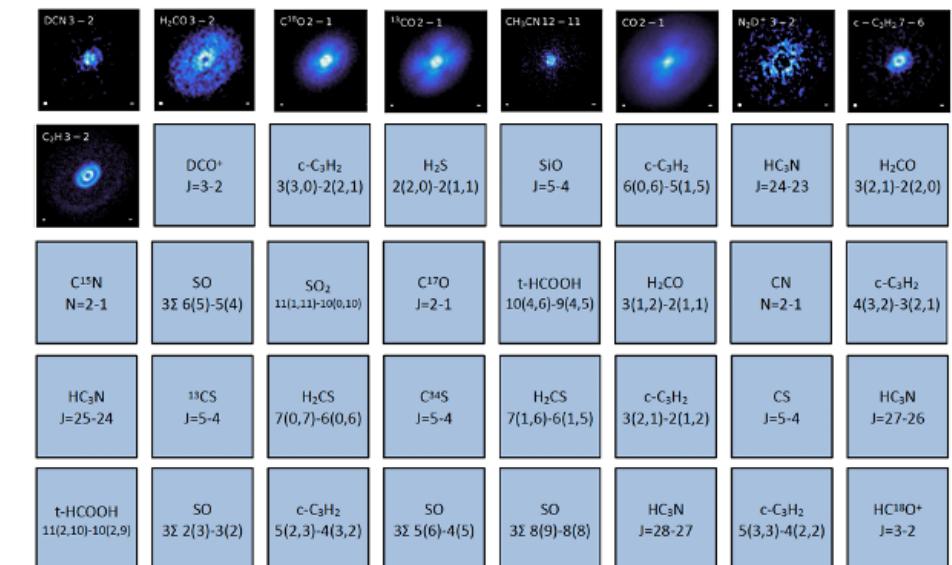
- New Correlator Room (OCRO): NRAO
- Wideband IF Switch, IF Conditioner, and Digitizer: ESO
- Data Transmission System: NAOJ, NRAO
- ATAC: NRC, NRAO
- New Total Power GPU Spectrometer: KASI, NAOJ
- Fiber Optics System: ESO, NRAO

First sets of receivers:

- Band 2: ESO, NAOJ, NRAO
- Band 6v2: NRAO, NAOJ
- Band 7v2: ESO
- Band 8v2: NAOJ

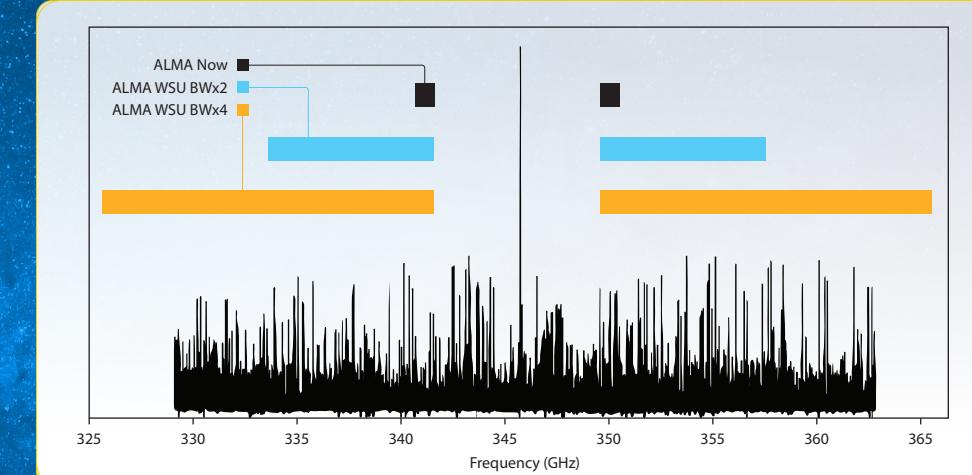
The scientific impact of ALMA-WSU

The WSU will **dramatically increase the efficiency of high spectral resolution spectral surveys**. For chemical characterization of Galactic sources, spectral scanning efficiency will increase by a factor 10 or more, multiplying opportunities for serendipitous detections.



Nine spectral images of protoplanetary disk HD 163296, observable simultaneously in Band 6 with the current system (~ 0.1 km/s spectral resolution). The empty squares show additional lines that can be observed simultaneously with ALMA-WSU BWx2 and Band 6v2 upgrade (Carpenter et al. 2023).

Subscribe to NRAO e-news for WSU updates.



Composite spectrum of Class 0 protostellar binary IRAS 16293-2422 (Jorgensen et al., 2016). A contiguous Band 7v2 34 GHz-wide spectral survey with 0.2 km/s spectral resolution would require only 2 distinct spectral setups with ALMA WSU, as opposed to 18 currently.

