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The ALMA Wideband Sensitivity Upgrade: Preliminary System Design

Theodoros Nakos*[(1)(2)], Juande Santander-Vela[(1)], Tzu-Chiang Shen[(1)(2)], John Carpenter[(1)(2)], Carla Crovari[(1)], Robert Kurowski[(3)], Enrique Macías[(3)], Brian Mason[(2)], Takeshi Okuda[(1)(4)], Tomás Staig[(1)], Eric Villard[(3)], Catherine Vlahakis[(2)].

(1) Joint ALMA Observatory, Santiago, Chile
(2) National Radio Astronomy Observatory, Charlottesville, USA
(3) European Southern Observatory, Garching, Germany
(4) National Astronomical Observatory of Japan, Tokyo, Japan

1 Extended Abstract

The Atacama Large Millimeter/Submillimeter Array (ALMA) is the world's largest ground-based facility for observations at millimeter and submillimeter wavelengths. Inaugurated in March 2013, ALMA has achieved more than a decade of steady-state operations. It consists of 66 antennas located at approximately 5000 meters at the Chajnantor Plateau in the Atacama Desert in northern Chile.

The Wideband Sensitivity Upgrade (WSU) is the top priority initiative of the ALMA 2030 Development Roadmap [1]. The WSU will be rolled out in a staged approach, starting towards the end of this decade. It will eventually provide up to 4× increased intermediate frequency bandwidth, and one to two orders of magnitude increase in the correlated bandwidth at high spectral resolution (up to ≈ 0.1 km/s) in most receiver bands, which will constitute a significant enhancement on ALMA's capabilities. The WSU will also provide improved sensitivity due to lower receiver noise and increased digital efficiency, in both digitization and correlation. For continuum observations, the extended bandwidth will further enhance the sensitivity of ALMA. These upgrades will significantly improve all future ALMA observations and expand the range of scientific programs that the community can pursue [2].

The WSU is now well into its design phase, having already passed Preliminary Design Reviews (PDRs) for all the components on the critical path to provide the signal chain for the WSU, and being on the verge to undergo its own System PDR in July 2025.

This talk will present the progress made in the development of the WSU System Design Description (SDD) towards this System PDR since its Delta System Requirements Review [3]. The SDD defines the architecture of the WSU, covering the beginning of the signal chain to processing, as well as monitoring, control, and other essential functions. Of particular importance is the ability of the ALMA Observatory to switch from its current signal chain (now called the *legacy signal chain*) to the WSU signal chain, which allows for the *Parallel Deployment* of the WSU. We will also outline the key capabilities of ALMA with the WSU and clarify the scope of the WSU Program, highlighting what is included and what remains beyond its objectives.

References

[1] J. Carpenter, D. Iono, L. Testi, et al., "The ALMA2030 Development Roadmap" *ALMA Memo Series*, **612**, June 2018, doi:10.48550/arXiv.1902.02856.

[2] J. Carpenter, C. Brogan, D. Iono, and T. Mroczkowski, "The ALMA 2030 Wideband Sensitivity Upgrade" *ALMA Memo Series*, **621**, November 2022, doi:10.48550/arXiv.2211.00195.doi:10.48550/arXiv.2211.00195.

[3] J. Santander-Vela et al., "The ALMA Wideband Sensitivity Upgrade: status update on the first ALMA 2030 project" *AT-RASC 2024, Gran Canaria*, May 2024, doi:10.46620/URSIATRASC24/MVGQ6188.