UPGRADE TO THE 64-ANTENNA ALMA CORRELATOR

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An upgrade to the 64-antenna ALMA correlator is described here which will double the instantaneous bandwidth and increase the number of spectral points by a factor of 8, making ALMA a significantly more efficient instrument at all bands.

The strategy behind this upgrade is to provide the enhancements above with a minimum of cost, effort, disruption, risk, and software rework. The idea is to retain the correlator system infrastructure (racks, cables, power supplies, microprocessor control system, etc.) and swap out old logic cards with newly designed cards using modern technology.

Doubling the bandwidth of the system requires doubling the operating clock frequency from the current 125 MHz to 250 MHz. Also, existing motherboard and signal cable data paths will be required to operate at twice the current data rate.

A study project (PMD-365), funded by the North American ALMA Development Program, was conducted largely in 2016 to investigate the feasibility of such an upgrade. Cost and schedule estimates were made and some of the critical features, such as using existing motherboard and cable interfaces at the new data rate, were tested to demonstrate adequate capability for use in the upgrade. The study project also produced detailed designs of almost all of the new logic cards and the custom ASIC necessary for the upgrade, thus reducing the time required to bring the new system to operation if funding is approved.

An additional advantage of the increased frequency resolution is that observations not requiring the highest frequency resolution will have the option to trade frequency resolution for sensitivity by, for example, selecting 4-bit correlation or twice Nyquist sampling modes with lower but still high resolution.

A prime objective of the upgrade will be to keep system software modifications to a minimum. This is accomplished by retaining the same control system with minor modification to control protocols, and by upgrading the existing modes to similar ones with wider bandwidth and greater resolution. Still, the software effort is significant. In particular, the correlator data processor backend will process 8 times more data than today.

In order to take advantage of the new correlator capacity, changes to other parts of the ALMA system must be implemented. The principal modification required is new digitizers, some rework of the optical data transmission system from the antennas and the design of new flexible digital filters. A group at the Observatoire de Bordeaux is currently working on an upgrade to these systems.

Existing ancillary operating support of the correlator, such as for VLBI support, will be retained and support for a future high time resolution system to observe transient phenomena will be incorporated into the upgraded system.