

Subject: Vertex Antenna

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Dear Bob,

The following is a statement summarizing the status of the North American Vertex prototype antenna for the ALMA project:

The Vertex prototype antenna for the ALMA Project is for the purposes (1) of demonstrating that the antenna is capable of meeting the very stringent ALMA specifications and (2) for the contractor to understand the technical challenges and processes involved in building the antenna in order to provide a fixed price bid for the production of 64 antennas for ALMA.

Delivery of the Vertex prototype antenna for the ALMA Project has been delayed from 3 September 2002 until no later than 30 March 2003. While the antenna is completely assembled, formal acceptance of the antenna by NRAO has been delayed.

The original plan for antenna evaluation was based on testing in parallel two prototype antennas with similar delivery schedules. The second prototype antenna will be provided by our European partner. Evaluation of the two antennas was to take approximately eighteen months for both antennas. Unfortunately, the prototype antenna from Europe, supplied by Alcatel, has experienced greater delays and will not be available for test until late this calendar year.

Of the more than 400 specifications to be verified during acceptance testing, a single specification remains to be verified before the antenna can be accepted and the milestone completed. The remaining specification to be verified is blind pointing performance. The planned test procedure for this specification has been found to be insufficiently accurate to verify the performance. A new procedure is under review and will be implemented immediately.

While antenna acceptance has been delayed, the project has taken several steps to mitigate the impact on the entire project. The contractor has cooperated with NRAO in allowing shared access to the antenna during erection and prior to completion of acceptance. This access has allowed NRAO to accomplish significant work on the antenna that was originally scheduled for after acceptance. All hardware required for antenna evaluation has already been installed on the antenna. This includes all cabling, the evaluation receiver and cryogenics, the nutator and the holography receiver. Significantly, software integration with the antenna is already very advanced. The ALMA software system is now fully capable of controlling all modes of the antenna. Successful observations of the moon have already been completed in the 3mm and 1mm bands. In all, approximately ten weeks of schedule have been recovered in this way.

As a result of the delay of the European prototype, antenna evaluation has been replanned to accommodate testing a single antenna. The current evaluation plan for the Vertex antenna extends for approximately ten months, completing in January 2004. A contract for production antennas could be signed as early as the third quarter of FY2004 pending negotiations with our European partner. While this is later than our original schedule, it will meet the current project Level One milestones.

In a review of the prototype antenna schedule, we find that delays during the fabrication phase occurred in two major areas. The

major steel structural elements of the antenna were delayed by approximately a month due to a roof collapse caused by snow at a subcontractor steel fabricator. This delayed shipment of the steel structure to the VLA site, and thus delayed the start of antenna erection. A second month of delay occurred in the precision machining of the 250 aluminum reflector panels. The contractor initially selected a single subcontractor to machine all of the panels to the required accuracy of less than ten micrometers RMS. The subcontractor encountered a number of technical problems developing the appropriate tooling and procedures to produce the panels reliably to the required accuracy. A second subcontractor was engaged late in the program and was able to complete the necessary production.

Delays during the erection phase were caused primarily by several technical difficulties found during erection. The longest of these delays was due to a fit problem with the thermal insulation that covers the antenna structure. The insulation is formed from layers of sheets cut to fit each complex surface. The manufacturing tolerances of this purchased material was larger than anticipated and the resulting thickness too great to accommodate the exterior cladding that covered the insulation. New material had to be procured to solve this problem. Other erection delays were related to longer than anticipated field assembly of the cladding attachments, the glycol circulation loops in the receiver cabin and a malfunctioning motor. In addition, some delays occurred due to weather at the VLA site. Erection of the antenna required approximately two months longer than was originally scheduled.

Finally, acceptance testing will take approximately two months longer than originally scheduled. A major performance related problem was identified during acceptance testing. The tracking performance was compromised by a servo oscillation. This required detailed analysis by the contractor using the contractor's factory simulator and software models. This problem has now been solved, but has delayed the completion of the acceptance tests. The remaining specification to be verified is blind pointing performance.

The delays that have occurred stem from the challenging specifications posed by the ALMA science requirements. The combination of the stringent surface accuracy and pointing stability required the use of a number of new technologies that had to be developed and tested prior to use. The contractor underestimated the time required to develop these technologies, put them into production and integrate them into a system. The experience gained by the contractor and NRAO during the erection of the prototype should allow more accurate predictions for antenna production, as part of the original intent of building the prototype antenna.