THE ALMA PROTOTYPE ANTENNAS - DESIGN FEATURES, EVALUATION METHODS AND MEASURED PERFORMANCE

Baars Jacob, J. Mangum, A. Greve, R. Lucas, R.Snel, P. Wallace
ALMA, ESO, Tannenstrasse 6, Swisttal, NRW, Gemany 53913

The Atacama Large Millimeter Array (ALMA) is planned to comprise 64 high accuracy submillimeter antennas of 12 m diameter. Two prototypes antennas erected next to each other at the VLA site in New Mexico have been subjected to an evaluation program. The first antenna was delivered by VertexRSI to NRAO, the other by the Alcatel-EIEConsortium (AEC) to ESO. The identical specifications are extremely demanding: 25 µm surface accuracy (with a goal of 20 µm), 0.6" pointing accuracy and 15 µm path length stability, all under the extreme conditions of the 5000 m high site in Chile. The antennas will be moved by a special transporter between some 200 stations over distances of up to 10 km. They must also be able to very fast position switching at typically 10 seconds interval between points on the sky about 1.5 degrees apart. The development of new testing procedures was necessary to check these specifications. The designs incorporate interesting features to meet the specifications; both apply carbon-fiber reinforced-plastic (CFRP) as material for the reflector structure. On the AEC antenna the receiver cabin is also entirely of CFRP. This design uses direct drives and a new panel technology, based on electroformed nickel surface skins, deposited on a steel form and bonded to aluminium honeycomb cores. We shall present the major design features shortly and then describe the test program for the evaluation of the performance. We measured and set the reflector panels with the aid of a near-field radio-holography system at 3 mm wavelength and a transmitter at 300 m distance. The pointing model was determined with an optical telescope mounted on the reflector structure and further checked with radiometer measurements at 3 mm. The radiometer was also used for a check on the tracking stability and changes in focus as function of elevation angle and ambient temperature. We used optical measuring devices to study path length changes and structural deformations, also with a goal to check the predictions of the Finite Element Model of the antenna. Here we applied sets of quadrant detectors and also an API laser instrument, which allows the measurement of the movement of a point in 5 degrees of freedom.

Highly interesting results were obtained from a set of accelerometers mounted on the structure, on the subject of dynamical behaviour of the structure, in particular under the influence of varying wind forces. The major performance parameters of the two antennas will be summarised. Both antennas are meeting the specification for most performance requirements, but will need some improvement in certain areas to be acceptable for the series production. The features of the design, selected for the ALMA series production will be highlighted.