# THE ALCATEL/EIE ALMA ANTENNA PROTOTYPE APPROACHES COMPLETION IN NEW MEXICO

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AT THE TIME OF WRITING the French-Italian Consortium responsible for one of the two ALMA Antenna prototypes is completing the assembly phase of the antenna at the ALMA test facility (ATF) located at the site of the Very Large Array (VLA) in New Mexico.

*The ALCATEL/EIE antenna in the final phase of assembly at the ATF.*

The assembly activities are performed by a team led by ALCATEL Space of France, including engineers of European Industrial Engineering (EIE) of Italy, the other member of the Consortium, and responsible for the antenna design.

ALCATEL Space Industries joined the original Italian Consortium, formed by EIE and Costamasnaga in December 2001, when an amendment to the original Contract was signed by ESO allowing the enlargement of the Consortium. With the amendment ALCATEL Space became the Consortium leader.

In the months following the signature of the Contract amendment, the existing antenna design was brought to the manufacturing stage. This process was the occasion for further optimising a design that had been considered to be very promising since the beginning of the project. Direct drives (similar to those used on the VLT main structure) are used on both elevation and azimuth axes. The receiver cabin is entirely manufactured of Carbon Fiber Reinforced Plastic (CFRP). This allows considerable mass saving compared to a steel cabin. Together with the primary reflector backup structure (BUS), also made of CFRP, it provides a thermally stable elevation structure. Both the direct drives and the CFRP cabin are expected to be advantageous for the dynamical performance demanded of the ALMA antennas.

Another new design feature was the use for the reflector surface of replicated Nickel panels developed by Media Lario under a Contract from the European Space Agency (ESA) and ESO. The replica technique has allowed a fast production process and may prove to be advantageous for the serial production of the 64 ALMA antennas.

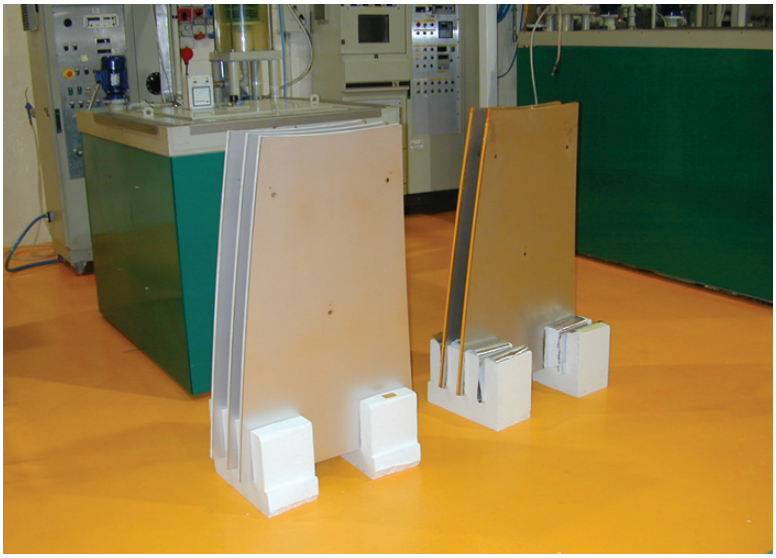
The replicated panels are Rhodium coated for protection against the harsh Chajnantor environment. The performance of these panels for the ALMA antenna has been the object of extensive studies and tests. One major test has made use of a setup constituted by one panel, mounted by its adjusters on a CFRP slice of the BUS in a climatic chamber to prove some elements of the surface stability budget of the reflecting surface.

In the tradition of ESO all new design characteristics were subjected to a formal review process by the team in charge of the follow-up of the Contract[1]. This re-

[1]The "core" team is composed of J. Baars, F. Biancat Marchet, C. Dichirico, B. Gustafsson, F. Koch, M. Kraus, J. Strasser, A. van Kesteren and the author.

*The machining of the CFRP cabin interfaces at the Galbiati factory. The machining head is working on the elevation motor attachment point.*

*The BUS being assembled at the Galbiati factory.*



*View of the replicated Nickel Panel at the Media Lario factory. The panels at the left have been coated with Rhodium and have a brighter appearance than those on the right (bare Nickel).*

view process was also applied to the new design of the internal metrology system of the antenna. Such a system will be used to guarantee the very demanding pointing and stability performances in the open conditions of the Chajnantor site, characterized by strong winds, significant temperature gradients, and strong solar radiation.

The pre-erection activities in Europe were limited by the short time available to the Consortium and by the default, in May 2002, of one of the Consortium members (Costamasnaga), whose original scope of work within the Consortium had been the mechanical manufacturing and pre-assembly. A replacement mechanical shop (Galbiati) was found for those activities, and EIE took over the tasks linked to the antenna mount manufacturing (antenna base, yoke, motors, electrical subsystems etc.). At the Galbiati assembly hall the major parts of the antenna mount were installed and checked in November 2002, to be finally shipped to the ATF in January 2003.

The assembly of the CFRP cabin and BUS, performed in parallel, and extending up to spring 2003, proved to be a delicate task, given the dimensions of the parts to be joined together and the strict dimensional tolerances on the final assemblies. The cabin and BUS were manufactured by two specialized Italian CFRP manufacturers (Plyform and ATR) based on the EIE design, under contract from ALCATEL. The various sub-assemblies had to be glued and bolted together under dimensional control by means of a laser tracker. For this task ALCATEL made use of a French subcontractor (SETAT) specialized in the measurement of large structures[2]. A setback was encountered when two of the sixteen sectors of the BUS structure were damaged in a road accident while being transported from ATR to the Galbiati integration hall. Nevertheless in April 2003 the cabin and BUS were finished, painted, specially packed and shipped by air cargo to the testing site. (See *ESO Messenger* No. 112. p. 2) .

In the meantime, in order to be able to work in the difficult conditions of the ATF (strong winds in late spring, burning sun and thunderstorms in summer) the Consortium had erected a temporary shelter for the assembly of the antenna. This shelter has proven valuable for the

[2]The company is known to ESO for having performed the dimensional measurement of the primary mirror cells of the VLT.

delicate task of mounting and aligning the antenna. All major mounting operations were performed under control of the laser tracker. In June the cabin was positioned and aligned onto the antenna mount, and on 11 July the important operation of mounting the BUS on the antenna was performed without major difficulties. All major interfaces, although not tested at the factory, mated correctly.

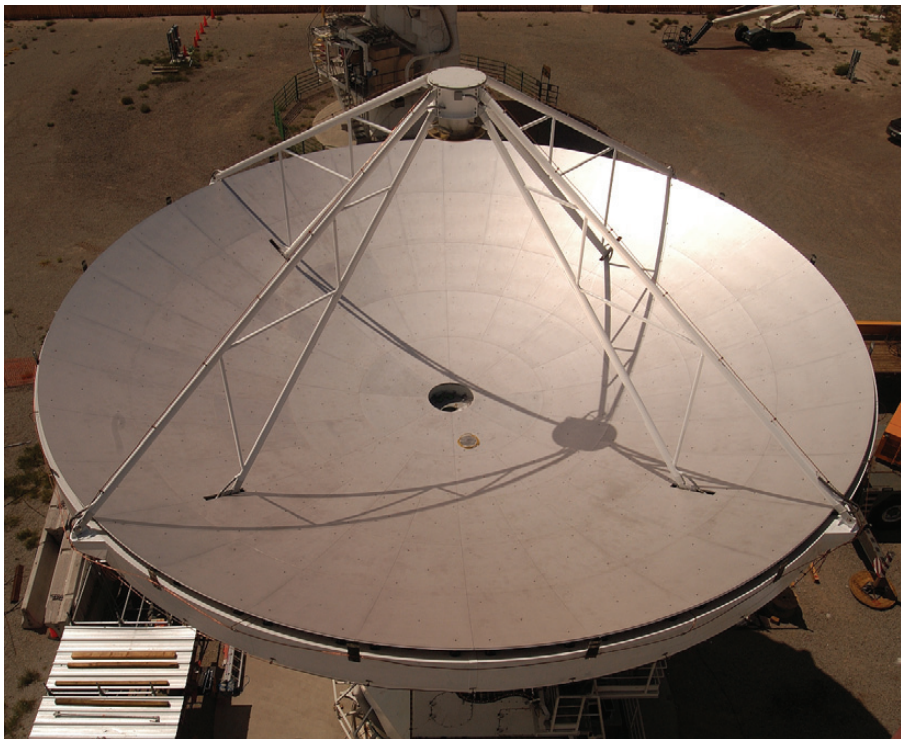
In the following weeks the 600 panels adjusters and the 120 replicated panels were mounted and aligned on the BUS. A verification of the surface accuracy with the laser tracker has resulted in a panel map with the excellent accuracy of 40 micrometers. (It will be a later task of the joint ESO-NRAO Antenna Evaluation Group (AEG) to obtain the final specified accuracy of 25 micrometers.)

On 18 August the roof of the shelter was removed and the quadrupod with the sub-reflector and its mechanism were installed. A branch of a tree (later removed) had been put on top of the antenna to respect an old French building tradition. The long-awaited dismounting of the shelter walls revealed for the first time the antenna in its entirety and final configuration.

In the entire manufacturing and assembly process the close collaboration between the ALCATEL integration team, and the EIE engineering team, author of the ALMA antenna design, has been fundamental for solving the unexpected problems and various glitches typical of a prototype. At the ATF site even minor problems can impact the schedule due to the transport and import time. Close communication between the site team and the design office is essential.

At the time of writing the technical commissioning of the antenna has started, in parallel with the finishing activities. The team on site is working round the clock to give the final touches to the antenna and to start the verification phase with ESO. Part of the verification activities is linked to the commissioning of the metrology system, involving a set of delicate performance measurements, some of which will be performed on the sky. Following acceptance of the antenna by ESO, the final evaluation of the antenna characteristics will be done by the Antenna Evaluation Group of the ALMA project after equipping the antenna with a receiver.

*The mounting of the BUS onto the antenna at the ATF site.*



*View of the top of the antenna, after completion of the reflecting surface and installation of quadripod and subreflector.*