



# ESA Reaches Out into Deep Space from Spain

– The New Cebreros Station

*Valeriano Claros*

ESA Directorate for Operations and Infrastructure, ESAC,  
Madrid, Spain

*Gisela Süß*

ESA Directorate of Resources Management, Paris, France

*Manfred Warhaut*

ESA Directorate for Operations and Infrastructure, ESOC,  
Darmstadt, Germany

### Why a Second ESA Deep-Space Ground Station?

Ground-station support for the early ESA deep-space missions Giotto and Ulysses was, and in Ulysses' case still is being, provided by the NASA Deep Space Network (DSN). To ensure independent access to its next generation of deep-space planetary exploration missions – Mars Express, Rosetta, Venus Express and Bepi Colombo – ESA, through its Technical and Operational Support (ESOC) and Science Directorates, embarked on the development of the New Norcia ground station in Western Australia. This station became operational in November 2002, and since June 2003 has been supporting the Mars Express mission on a daily basis.

With its 35 m-diameter antenna, New Norcia will not only provide tracking, data acquisition and command support to ESA's planetary exploration missions going out into deep space, which requires reliable communication at distances of up to 6.3 AU from Earth (1 AU is the distance from the Earth to the Sun), but also to the Agency's astronomy and survey missions going to the L2 Lagrangian point, namely Herschel/Planck and Gaia. Communicating with these missions will require large dish antennas in order to meet their high data-rate demands (in excess of 1.5 Mbits/sec). Consequently, in September 2001 the Technical and Operational Support and Science Directorates acknowledged that ESA needed a second deep-space ground station in order to support its future missions adequately. This opinion was strengthened by



*The Cebreros site, unrenovated and still with its old antenna, about 90 km northwest of Madrid (E)*

findings of the Inter-Agency Consultative Group for Space Science (IACG), comprising members from NASA, ESA, JAXA (Japan) and RASA (Russia), which show that the future demand for world-wide deep-space ground stations will greatly exceed availability. In the wider European context, therefore, the initiative to establish a European Deep-Space Network, particularly for the future planetary missions, is seen as vital.

### Why Choose Cebreros?

To complement the visibility and coverage provided from New Norcia, the second station has to be located either 120 deg East or West of it. Consequently, the ESA Satellite Tracking Station (VILSPA), recently renamed the European Space Astronomy Centre (ESAC), at Villafranca near Madrid, could have been a perfect site. However, contacts with the telecommunications authorities managing the Spanish frequency spectrum (Secretaría de Estado de Telecomunicaciones y la Sociedad de la Información, SETSI) indicated that the use of deep-space

frequencies from there would be problematic as third-generation mobile-telephone repeater towers were scheduled to be installed in the area in the near future and there could be interference problems. The growing number of constructions in the area was also deemed to be incompatible with a deep-space ground station.

Consequently, Cebreros in the province of Avila, about 90 km northwest of Madrid and about 60 km from ESAC, became the site of choice. In addition to complying perfectly with all of the technical selection criteria, it also enjoys particularly favorable weather conditions, which also influence station performance (rain attenuation, wind speed). For this site also, the most stringent requirement was to get the required radio-frequency clearance for data transmission and reception in the relevant frequency bands from the Spanish authorities.

The proximity of Cebreros to ESAC helps to meet the need for cost-efficient operations and maintenance, by allowing the existing contract provisions for

Villafranca to be extended to include the new station. Equally importantly, the Cebreros site also has the medium/long-term potential to host the existing antenna dishes at ESAC, should the need arise due to the encroaching urbanization around that site. The operational and science operations facilities could still be maintained at ESAC.

The Cebreros site is owned by the Instituto Nacional de Técnica Aeroespacial (INTA) and formerly hosted a NASA station, which was primarily used in the sixties and seventies for tracking, data acquisition and commanding of lunar and interplanetary NASA/JPL missions. The station also provided support to ESA's Giotto mission during its fly-by of comet Halley in 1986, but since then NASA has consolidated its DSN station assets at its Robledo site.

### Agreement between the Kingdom of Spain and ESA

Negotiations for an Agreement between Spain and ESA were initiated in April 2002. As the second 35 m deep-space

*The Agreement between the Kingdom of Spain and ESA for the Cebreros deep-space ground station*



Deep Space Antenna at the Cebreros (Avila) Site' was duly signed on 22 July 2003.

The terms of the Cebreros Agreement are similar to those governing ESA's activities at Villafranca, which was signed in 1974 and still remains in force today. It has the classical structure of a Host Agreement with provisions specifying the rights and obligations of both parties, and in particular the immunities afforded to ESA with respect to the facilities to be set up and operated on the Cebreros site.

### Station Completion and First Users

Industrial activities began in February 2003, with the start of work on the antenna front-end. In September, the on-site activities started with the construction of the antenna-tower access road and the

ground station constitutes a strategic asset for its future programmes, the Agency had three prerequisites:

- ESA management authority for the site,
- an international agreement similar to that concluded with respect to the Villafranca station,
- guaranteed growth potential for the new site.

Between April 2002 and May 2003, several meetings took place between ESA and representatives of the Spanish authorities: Centro para el Desarrollo Tecnológico Industrial (CDTI), the Ministry of Foreign Affairs, the Ministry of Defence, INTA and SETSI. The negotiations, which were held in a very constructive atmosphere, focused on the guaranteed growth potential that the Agency had asked for, exemption from indirect taxes, and the radio-frequency clearances. A satisfactory consensus was reached on all of these issues, and the 'Agreement between the Kingdom of Spain and the European Space Agency for the Establishment of Ground Tracking and Data Acquisition Facilities, including a

### Technical Features of the Cebreros Station

The proposed antenna system will enable X-band data uplinking (7.145 – 7.235 MHz) and downlinking (8.400 – 8.500 MHz) and will provide a Ka-band receive capability (31.800 – 33.200 MHz), with the possibility of adding Ka-band transmission at a later date if needed.

The design of the antenna installation is very similar to that at New Norcia, in terms of the antenna front- and back-ends, the high-precision frequency and timing system based on hydrogen masers, and the site infrastructure. The 35 m dish sits on a full-motion turning-head pedestal incorporating a beam-waveguide feed system. The radio-frequency signals are transmitted/received by means of mirrors, cryogenically cooled X-band and Ka-band low-noise amplifiers, and X-band transmitters (20 kW, 2 kW and 400 kW).

The antenna is close to 40 m high and the structure and the equipment mounted on the pedestal weigh approximately 630 t. The smooth motion provided by the antenna servo subsystem and the stiffness of the mechanical structure under typical environmental conditions provide excellent performance ratings: namely a main reflector surface accuracy of 0.3 mm, with a tracking error as small as 0.006 deg at Ka-band.

Advanced, mostly digital technology is applied for the receivers, demodulators and ranging equipment, which is needed to determine the position/orbit of the spacecraft. As at all other ESA ground stations, the Cebreros antenna will be remotely controlled and operated from ESOC in Darmstadt (D). This avoids permanent manning of the station and limits visits by maintenance staff to occasional checks on a weekly basis.



*Artist's impression of the completed 35 m Cebros deep-space antenna*

antenna pedestal. The majority of the site-preparation activities were completed by INTA (Spain) in December. The actual hand-over of the site to ESA took place in March 2004 and refurbishment of the site infrastructure and installation of a new power plant are already underway. Overall system acceptance testing is planned to start in August, with operational readiness of the new ground station foreseen for 30 September 2005.

The first user of the Cebros station will be the Venus Express mission, in late 2005/early 2006, to be followed by Smart-2 in November 2007, Gaia in 2010, and Bepi Colombo in 2012. Possible use of Cebros for the Herschel/Planck mission in 2007 is also being investigated. It is subsequently planned to use the station for the Rosetta mission's near-comet operations and lander delivery in 2014.

### Acknowledgements

The timely and successful conclusion of the Cebros Agreement was made possible by the support and dedication of Angel Orenes (Spanish Ministry of Defence), Juan Luis Muñoz de Laborde (Spanish Foreign Ministry), Ignacio Yurrita and José M. Leceta (CDTI), Moisés Fernández (INTA), Ricardo Alvariño and Angel Díez (SETSI), and Chris de Cooker, Marco Ferrazzani, Werner Frank, Immi Tallgren and Enrico Vassallo (ESA).



### The Industrial Consortium

The industrial team for the construction of the new deep-space antenna at Cebros includes the following companies:

- SED Systems (Canada): Prime Contractor (antenna front-end), with Vertex Antennentechnik, Germany (mechanical and servo system), MIRAD, Switzerland (radio-frequency components), ESTEYCO and NECSO, Spain (antenna tower infrastructure)
- LV Salamanca (Spain): site infrastructure and building remodelling
- S&C (Germany): power plant
- ND SatCom AG (Germany): antenna back-end and communications infrastructure
- Timetech (Germany): frequency and timing system; with Observatoire de Neuchatel (Switzerland): maser
- Alcatel Bell Space NV (Belgium): Ka-band down-converters
- IN-SNEC (France): L- and X-band converters
- BAE Systems (UK): modem and ranging system
- CS (France) : telemetry and telecommand system.