Information Paper

O’Higgins Satellite Ground Station

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The O’Higgins Satellite Ground Station O’Higgins (OHG) is part of the global ground station network of DLR’s German Remote Sensing Data Center (DFD) (Fig. 1). In addition to antenna facilities at DFD in Neustrelitz and Oberpfaffenhofen in Germany, DFD operates two near-polar ground stations within this global network – one in Inuvik in the Canadian Arctic and the other at O’Higgins, Antarctica. Using these extremely high latitude stations has a major benefit: the number of stations can be kept low because they provide frequent daily contact with polar orbiting satellite.

***Fig. 1**. Ground Station Network of the German Remote Sensing Data Center (DFD) of DLR. The blue circles delineate the visibility circles of the receiving stations.*

The OHG station is able to work autonomously. At the core of OHG is a 9 m full motion tracking antenna for receiving and transmitting radio-frequency signals. In general, OHG provides receiving capacity in the S-band and X-band and transmitting capability in the S-band. For satellite systems S-band is normally used for dumping housekeeping data and commanding the satellite (TT&C, Telemetry, Tracking and Command). High data rate dumps are not possible in the S-band since the available frequency spectrum is limited. Therefore, earth observation data is normally dumped in the X-band, which allows data-rates up to 500Mbit/s per channel. It is thus essential for OHG to have X-band as well as S-band capability. Detailed technical specifications of the frequency range usable at OHG can be found in Table 2.

To convert radio signals received from satellites to data files a high-sensitivity demodulator in combination with a recording system is required. For demodulation of the radio signals state-of-the-art software configurable demodulators are used at OHG. This is necessary to provide the flexibility to support several satellite missions and therefore several downlink transmission schemes. For recording data, so-called direct archive systems and front-end processors are in use. At OHG parallel receiving chains provide the necessary availability.

Another important parameter of a tracking antenna which can point in almost any direction in space is the elevation mask. It defines the maximum field of view by providing the minimum possible elevation look angle as a function of azimuth angle: ground obstructions like buildings or hills increase the minimum elevation angle. The antenna field of view is directly related to the maximum possible contact time to a satellite. The location of OHG results in a very good elevation mask, shown in Fig. 2.

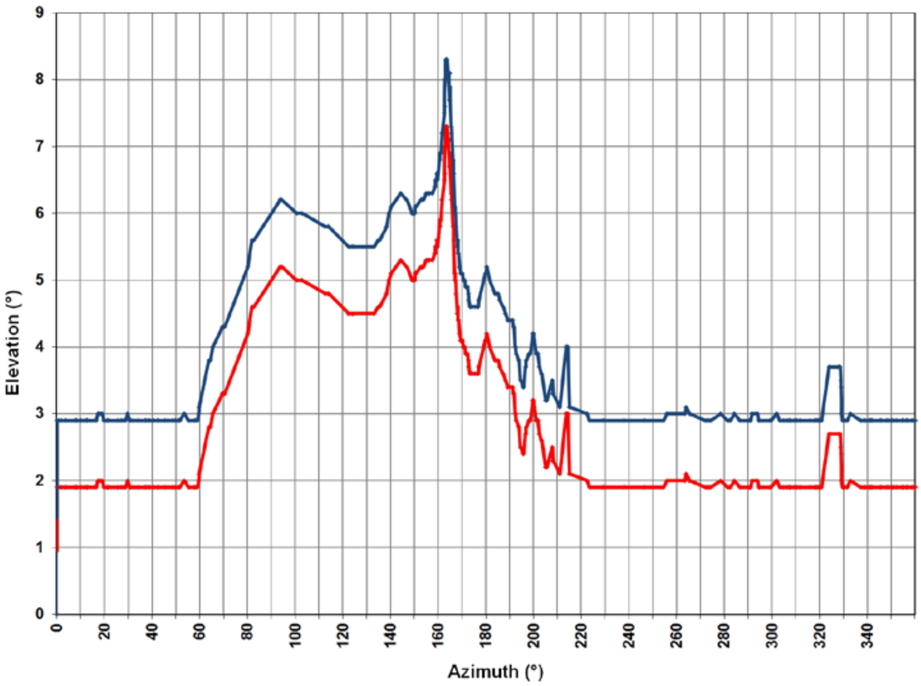

Fig. 2. *Currently used elevation mask of the OHG antenna for S-band (red) and X-band (blue), which guarantees good receiving quality.*

The different mission configurations, storage of received data, as well as the monitoring of all technical devices necessary for data reception are handled by a Station Monitoring and Control System (SMCS) that was developed and is maintained by DLR's International Ground Segment software engineering team in Oberpfaffenhofen, Germany. The SMCS is responsible for the fully automated operation of the system from antenna control to data reception to tape archiving. Furthermore, SMCS gathers comprehensive log and report information that can be accessed by both system engineers and station operators through HTML-based views.

OHG became operational in October 1991 and was operated on a campaign basis until 2010. During 28 campaigns basically in support of the ERS missions more than 5000 passes were acquired with a station availability of more than 99%. In 2010 the TanDEM-mission required a year-long high number of contacts above Antarctica. Therefore, the operations schedule of OHG was changed to a 24h/7d/365d continuous operation scheme. The development in the number of contacts over the years of operation can be seen in Fig. 3, which shows all contacts from 1991 to 2013 including payload data reception, TT&C support, and Launch and Early Orbit Phase (LEOP) support. Table 1 summarizes the missions supported at OHG.

In 2012 and 2013 more than 5000 successful contacts to the TerraSAR-X and TanDEM-X satellites were made. Even with the higher options load, the availability could be kept constant at around 98-99%. This consistently high level of performance was achieved through automation (using SMCS) and redundancy, and most importantly through the dedicated support of highly experienced system engineers working on site in order to ensure stable operations. OHG was awarded ISO 9001 certification in 2010.

In summary, OHG is an outstanding receiving facility optimized for automated, reliable payload data reception for earth observation missions. OHG also provides satellite contingency and emergency 24h/7d TT&C support.

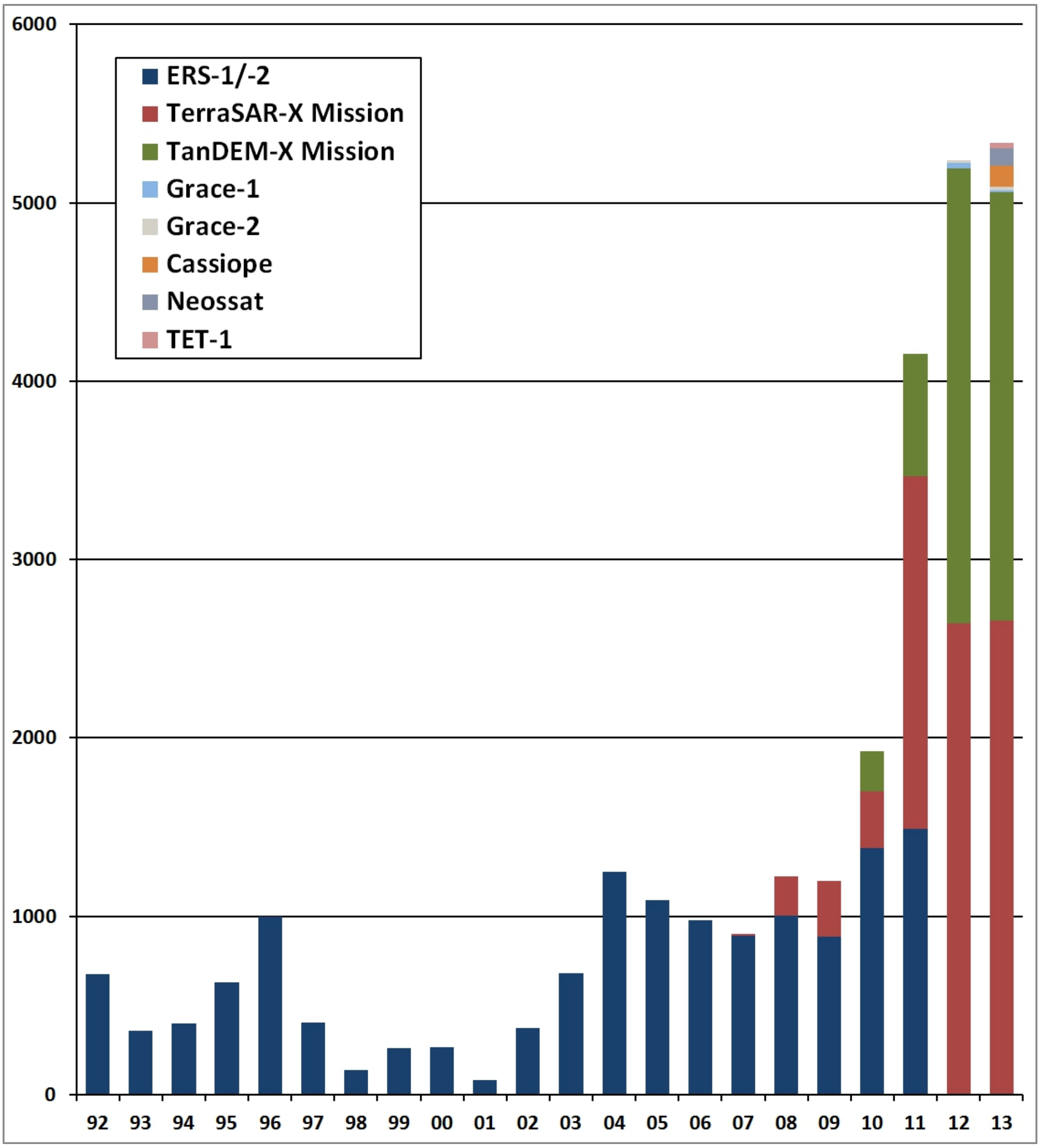

Fig. 3*. Data acquisition at GARS O'Higgins. All contacts from 1992 to 2013 are shown. They include payload data reception, TT&C and LEOP support. ERS-1/-2 contact only took place during defined campaigns during the Antarctic summer.*

Tab. 1: *Supported satellite missions at GARS O'Higgins.*

Supported missions	**Ground station service requested**				**Service requestor**	**Mission operator / partners**
	Payload data downlink	Comman-ding	House-keeping data downlink	LEOP support		
Historical missions:						
ERS (ERS-1, ERS-2)	x		x		ESA	ESA
CHAMP		x	x		DLR	DLR / GFZ
Missions supported in the past:						
Landsat-5	x				USGS	NASA / USGS
Current missions:						
TET-1		x	x		DLR	DLR
Terra/Aqua MODIS	x				DLR	NASA
GRACE (GRACE1, GRACE2)		x	x		DLR	DLR / NASA, GFZ, UTCSR
SCISAT-1		x	x		CSA	CSA
TerraSAR-X (TSX-1,TDX-1)	x	x	x		DLR	DLR / Astrium, GFZ
TanDEM-X (TSX-1, TDX-1)	x	x	x	x (TDX-1)	DLR	DLR / Astrium, GFZ
NEOSSAT		x	x	x	CSA	CSA / DRDC
CASSIOPE		x	x	x	SSC	MDA

Abbrevations: ESA - European Space Agency, GFZ - GeoForschungsZentrum, USGS - U.S. Geological Survey, NASA - National Aeronautics and Space Administration, UTCSR - University of Texas Center for Space Research, CSA – Canadian Space Agency, DRDC - Defence Research and Development Canada, SSC – Swedish Space Corporation.

Tab. 2: *Antenna system parameters*

Reflector system	
Type	Cassegrain
Main reflector size	9.0 m
Tracking & pointing	
Tracking modes	program-track auto-track: S-band, X-band or S/X-band auto-diversity
Pointing accuracy	0.01 deg rms
Slewing speed	11 deg/s (azimuth) 5 deg/s (elevation)
Environmental constraints	
Max wind speed average (operational)	150 km/h
Max wind speed in gusts (operational)	180 km/h
Max wind speed stow position	300 km/h
S-band performance	
Transmit frequency range	2025 – 2120 MHz
Transmit polarization	LHCP or RHCP
Transmit EIRP	59 dBW
Receive frequency range (sat. downlink)	2200 – 2300 MHz
Receive frequency range (VLBI)	2100 – 2400 MHz
Receive polarization	LHCP and/or RHCP
Receive gain to noise ratio (G/T)	19.5 dB/K
Ranging support	for S/C transponder coherent mode
Doppler measurements	2-way Doppler for S/C transponder coherent mode 1-way Doppler for S/C transponder non-coherent mode
X-band performance	
Receive frequency range (sat. downlink)	8025 – 8500 MHz
Receive frequency range (VLBI)	8100 – 8900 MHz
Receive polarization	RHCP
Receive gain to noise ratio (G/T)	32.0 dB/K