Bundesamt für
Kartographie und Geodäsie

Geodetic Observatory Wettzell

bkg FGS FESG

Tasks and duties

The Geodetic Observatory Wettzell is jointly operated by the Bundesamt für Kartographie und Geodäsie (BKG) and the Forschungseinrichtung Satellitengeodäsie (FESG) (Research Facility Satellite Geodesy) within the frame of the Forschungsgruppe Satellitengeodäsie (Research Group Satellite Geodesy) of the Technical University of Munich. Within the scope of international activities the Geodetic Observatory Wettzell makes a significant contribution to the realization and maintenance of global reference systems, which include a reference system co-rotating with the earth for the definition of positions on the earth's surface, the ITRF (International Terrestrial Reference System) and a space-fixed reference system not rotating with the earth for the definition of positions in space (e.g. satellite positions, planets, stars, quasars, …), that is, the ICRF (International Celestial Reference Frame). Both systems are connected by the earth's rotation, which is described by a set of earth orientation parameters (EOPs). Due to permanent mass shifts occurring within the system earth influencing permanently the earth's torque, the EOPs must be observed continuously.

Reference systems constitute the basis for precise position determinations that in turn are most essential for numerous high-precision tasks in the field of research, which means above all research work in the geosciences (continental drift, sea level variations, …), in space flight, but also in many sectors of everyday life (surveying, navigation …).

The duties of the Geodetic Observatory Wettzell include besides operation of the station's metrological facilities in particular

- the operation of a radio telescope for the determination of intercontinental baselines (distances between the radio telescopes) and their timely variations,
- and of a laser ranging system for measuring distances to artificial earth satellites and to the moon,

and also operation of a "Transportable Integrated Geodetic Observatory".

(TIGO), in Concepcion/Chile, as well as participation in the work of the Antarctic Station O'Higgins and in a large

number of other GPS receivers installed worldwide on a permanent basis. Besides further development of the space techniques new measurement technologies are established, as e.g. a local rotation sensor (ring laser “G”). Further measuring systems provide local data which are needed in addition to the spatial methods. These systems comprise

- a superconducting gravimeter for the acquisition of gravity variations,
- a meteorological station for the acquisition of the necessary weather parameters,
- a time and frequency system consisting of a multitude of atomic clocks, which contributes to the generation of the UTC World Time Scale by the BIPM (Bureau International des Poids et Mesures), as well as a seismometer for recording earthquake events.

WLRS, 75cm telescope

SOS-W, 50cm telescope

The Space Measurement Techniques

The **20m Radio Telescope Wettzell** (RTW) is used for Very Long Baseline Interferometry (VLBI) and makes essential contributions to the realization and maintenance of the global reference systems:

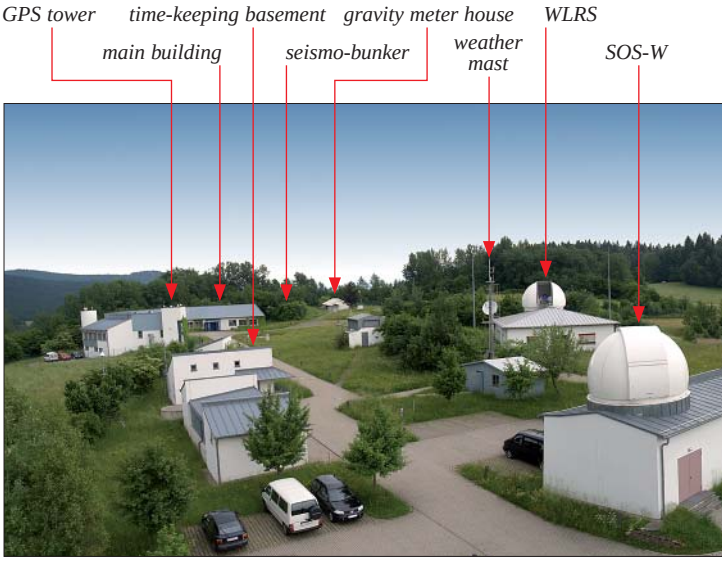
- ICRF: quasar positions and timely variation
- ITRF: station coordinates and motion vectors
- EOP: polar coordinates (. . .), angular velocity, (UTI-UTC), celestial pole (dψ, dε).

The basic technical specifications of the radio telescope are as follows:

- 20m diameter of the main mirror,
- S/X-band receiving system,
- MK IV, MK V and K4 recording systems,
- e-VLBI.

The **Wettzell Laser Ranging System** (WLRS) allows distance measurement to artificial earth satellites and to the moon and provides contributions for

- ITRF: derivation of station coordinates, motion vectors, variations of the Geocentre,

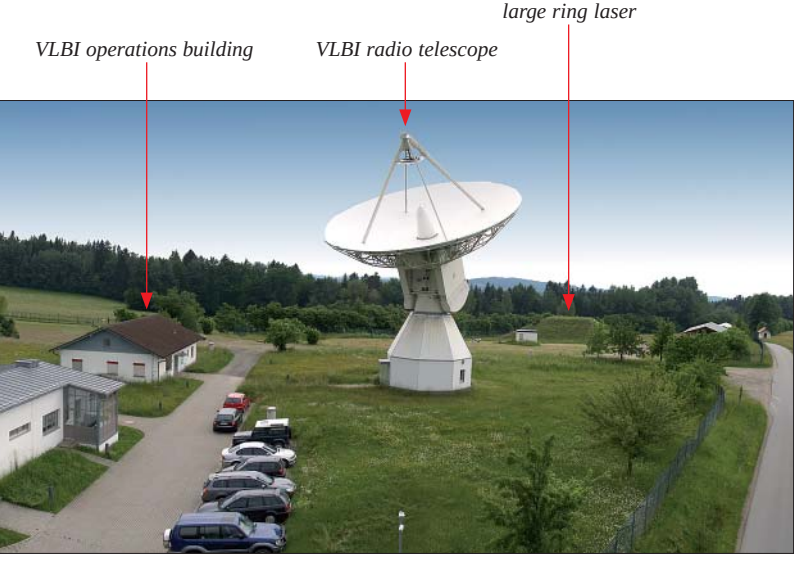


- Satellite orbit determinations by means of reflectors
- EOP: polar coordinates (x_p, y_p)

The basic technical specifications of the WLRS are as follows:

- 75 cm diameter of the transmitting and receiving telescope,
- Nd:YAG pulse laser (performance 150mJ, infrared and green light pulse, 80 ps impulse length),
- 4 photodetectors (MCP, APD),
- Event timer device with picosecond precision.

The new Satellite Observing System Wettzell (SOS-W) for laser satellite observations is presently being developed and is expected to take up operation as from 2009. This system has been designed in particular for observing fast low-flying satellites. Similar to WLRS it is a two-colour SLRS system with a 1000 Hz repetition rate (850nm, 425nm). It allows a largely autonomous, remotely controllable 24h-operation (all-day and night operation) which lets expect a measuring accuracy of better than 10mm (LAGEOS).



At Wettzell a **GPS/GLONASS Operation Center** is maintained for the operation of ca. 45 GPS/GLONASS stations established globally on a permanent basis, the data of which are retrieved in a one-hour and 24-hour cycle, respectively, for the purpose of contributing to

- ITRF: derivation of station coordinates and motion vectors, densification of the ITRF in order to provide it on the national level for the tasks of, e.g. the National Survey,
- Determination of the orbits of the GPS satellites,
- Determination of atmosphere and ionosphere parameters,
- EOP: polar coordinates (x_p, y_p).

The space measurement techniques contribute to:

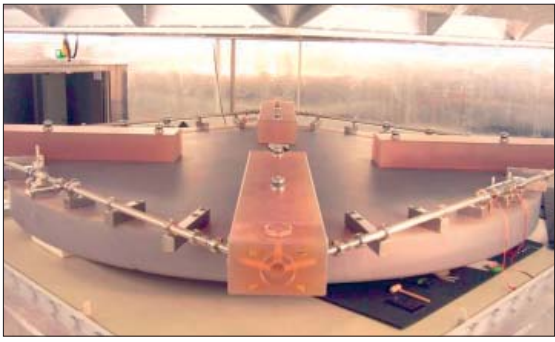
- Orbit determination of satellites,
- ITRF: station coordinates and motion vectors,
- EOP: polar coordinates (x_p, y_p).

International Services of the IAG (International Association of Geodesy) and of the IAU (International Astronomic Union) coordinate the international activities performed by means of the different space measurement techniques:

- IVS: International VLBI Service for Geodesy and Astronomy,
- ILRS: International Laser Ranging Service,
- IGS: International GPS Service,
- IDS: International DORIS Service,
- IERS: International Earth Rotation Service

The Ringlaser “G”

The technical field “Development of New Measuring Methods” comprises the operation of a local rotation sensor, which means the ring laser “G”. It serves the acquisition of the earth’s angular velocity by taking advantage of the Sagnac effect. The primary aim is to detect variations of the angular velocity in the course of a day.



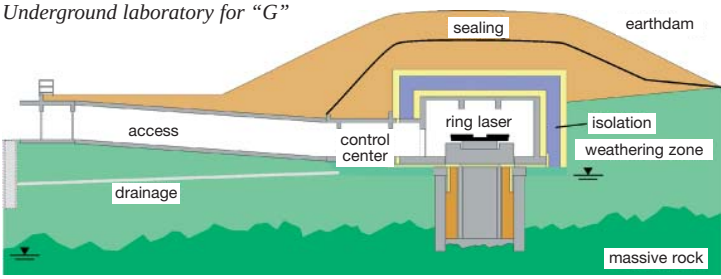
Ringlaser “G”

Its basic technical specifications are as follows:

- Size: 16m^2,
- Carrier material: zerodur glass-ceramics because of its low thermal expansion,
- He-Ne laser (ring oscillator of utmost quality),
- Present relative resolution 10^{-8} of the earth rotation.

The ring laser is accommodated in an underground laboratory for the purpose of thermal stabilization and shielding from external disturbances. Integrated tilt meters are needed in addition for the detection of local influences.

Underground laboratory for “G”



The Geodetic Antarctic Station O'Higgins

On the northern tip of the Antarctic Peninsula BKG operates together with the DLR (Deutsches Zentrum für Luft- und Raumfahrt/ German Aerospace Center) the Antarctic Station O'Higgins. It is equipped with a 9m radio telescope for VLBI as main system, which since 1991 is each year put into operation in the Antarctic summer and autumn and each time takes part in 4-6 VLBI campaigns.

Its basic technical specifications are as follows:

- 3 axes (in particular to enable zenith pass tracking)
- S/X band receiver
- MK IV, MK V data recording

In collocation with the radio telescope are on this station additionally operated:

- Two GPS/GLONASS receivers,
- One gauging station.

Antarctic Station O'Higgins

TIGO in Concepcion/Chile

TIGO – the Transportable Integrated Geodetic Observatory

TIGO provides contributions to IVS, ILRS and IGS and is employed on the Southern Hemisphere in Concepcion/Chile. Operation of this system is supported by:

- The Universidad de Concepcion (consortium leader),
- The Universidad del Bio Bio,
- The Universidad Catolica de la Santisima Concepcion,
- The Istituto Geografico Militar.

The **TIGO VLBI Module** has carried out observations since April 2002. The basic technical specifications are as follows:

- 6m offset antenna,
- S/X band receiver,
- MK IV, MK V and S2 data recording systems.

The **TIGO SLR Module** has carried out observations since April 2002. The basic technical data are as follows:

- 50cm telescope (type: Galilei, folded),
- Titan-sapphire impulse laser (performance 100mJ, 80ps impulse length, infrared and blue light pulse),
- 3 single photon avalanche photodetectors,
- 5 picosecond event timer.

The **TIGO Basic Module** consists of:

- GPS/GLONASS permanent stations,
- A Superconducting Gravimeter,
- A time and frequency system, integrated into the BIPM's service of UTC determination,
- A meteorological data acquisition system (water vapour radiometer),
- Power generators and a solar plant.