20 Meter Antenna Bochum

https://amsat-dl.org/20-meter-antenna/

General

- Operated by AMSAT-DL in cooperation with Sternwarte Bochum
- Diameter: 20m
- Weight: 140t
- a 40m high air dome serves as weather protection
- built in 1965
- ground support for the Apollo missions
- drive systems and RF equipment renovated in 2003 (AMSAT-DL)
- motor control system accuracy: 10”
- maximum rotational speed: Azimuth 1.25 deg/s, Elevation 0.8 deg/s
- precise location of Bochum antenna: N51.426990, E7.192566, 159.65m ASL (elevation axis centre)
- knowledge of phase center: 50mm (estimated)

Performance

- RX: 2.2-2.45 GHz, 8.4 GHz, 10 GHz
- TX: 2.45 GHz (license limited)
- complete RF chain phase locked to Rb reference or GPSDO:
- Allan Deviation <1E-11@100 sec

Frequency [GHz]	G/T [1/K]	3dB beamwidth [deg]
2.4	32.6 dB	0.43
8.4	41.0 dB	0.124
10.4	42.0 dB	0.10 deg (estimated)

Receive

- phase-locked receivers for:
  - 2.3 GHz (DSN/ham-radio)
  - 5.8 GHz (ham-radio)
  - 8.4 GHz (DSN X-Band)
  - 10.4 GHz (ham-radio X-Band)
- reference oscillator: 10 MHz Rb-Normal, HP Z3801 (GPS-locked)
- Allan-Deviation ca. 1E-11(tau=100 sec)
- complete RX chain down to baseband phase locked
- Reception of VOYAGER 1 (2006-03-31) at ~14.7 Billion km (~99AU)
- Regular (daily) operations of STEREO-A/B space weather beacon since 2009 (upgraded Turbo Coding by AMSAT-DL in 2013) for NASA/NOAA including demodulation and decoding the data before forwarding TLM frames to a central server in US.
- Reception of deep space probes (residual carrier):
  - 2001 Mars Odyssey
  - Mars Surveyor 98
  - New Horizons
  - Rosetta
  - Mars Express
  - Ulysses
  - Akatsuki (Venus Express, Cassini) and IKAROS
  - Spitzer space telescope
  - Venus Climate Orbiter
  - MRO
  - Voyager 1

Transmitter

- Coherent transmitter on 2.4 GHz (Magnetron, Pout = 6kW PEP, Rb locked phase)
- S-Band transmitter (hamradio): 250W PEP
- Planetary radar echoes on 2.45 GHz at Venus conjunction in 2009 at 42 Million Km distance
- First detection of ISEE-3 carrier on March 2014, primary downlink for ISEE-3 recovery operations

Digitizers at IF:

- USRP (max. 50 MS/s)
- HPSDR (max. 384 kS/s)
- Soundcard (48 kS/s)
- 8.4 GHz frequency control ADC 166 kS/s
- CCSDS standard decoder: work in progress
- Internet connectivity: 10Mbit/s upstream, 100 Mbit/s downstream

Control Room