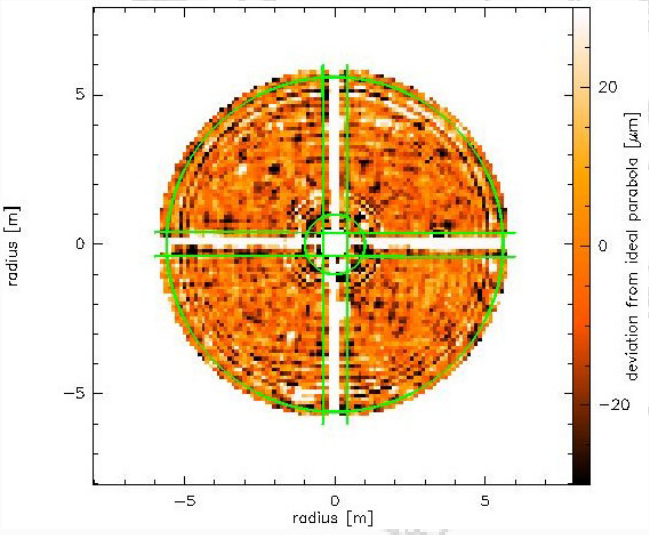
APEX
- the telescope -

After four months of intense commissioning the APEX telescope has passed final acceptance on June 28: the performance of the telescope complies with all critical contractual requirements with the contractor (VERTEX Antennentechnik GmbH, Duisburg). For the basic telescope parameters, see our sheet “APEX Key Facts”.

We summarize the prime features of the telescope.

Adjustment of the Surface

The surface of the main dish had been pre-adjusted to ca. 40 µm rms by means of optical photogrammetry. Adjustment to specification (“better than 20 µm”) was performed by MPIfR using near-field holography measurements (the transmitter is operated at 92 GHz, on nearby Cerro Chajnantor, at 14 deg elevation).
In May this year, a final series of adjustments provided an outstandingly good surface accuracy: over the 12m diameter of the antenna, towards the transmitter, the deviation from the perfect parabola is now less than 15µm (under stable night time conditions).This is smaller than one fifth of the average thickness of a human hair!

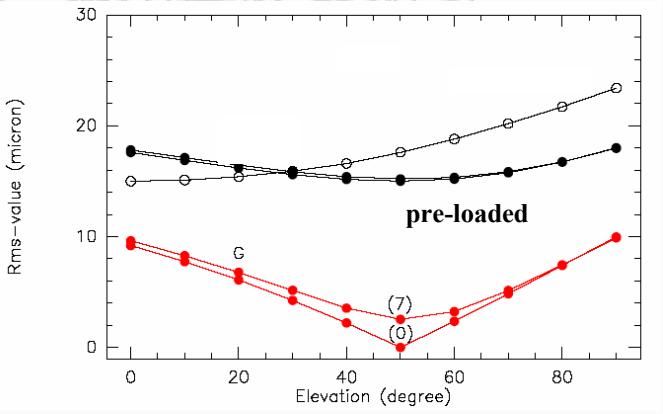


The surface error pattern of the APEX after completion of the surface adjustments (the projection of the feed legs has been masked). The untapered rms is 15µm. The repeatability of our holography (during stable night time conditions) has been excellent 5.5 µm!

Because astronomical observations will be performed at significantly higher elevations than the line-of-sight toward the transmitter, we corrected (“pre-loaded”) the surface settings to account for the gravitational deformation of the structure (following VA’s structural model of the antenna).

APEX during late sunset. The reflections on the antenna outline the positions of the adjustments screws (five for each of the 264 aluminium panels) that had to be adjusted with a few µm accuracy. The rms surface accuracy of the individual panel is 5µm.

In the graph below, we demonstrate that by pre-loading, the antenna performance has been optimized to the elevation range 30-80 deg (with rms surface <17µm).



Surface precision vs. elevation after pre-loading against gravitational deformations (all deviations in excess of 7µm have been adjusted). The “unloaded” case (when the antenna was adjusted toward the transmitter at 14 deg elevation is shown for reference).

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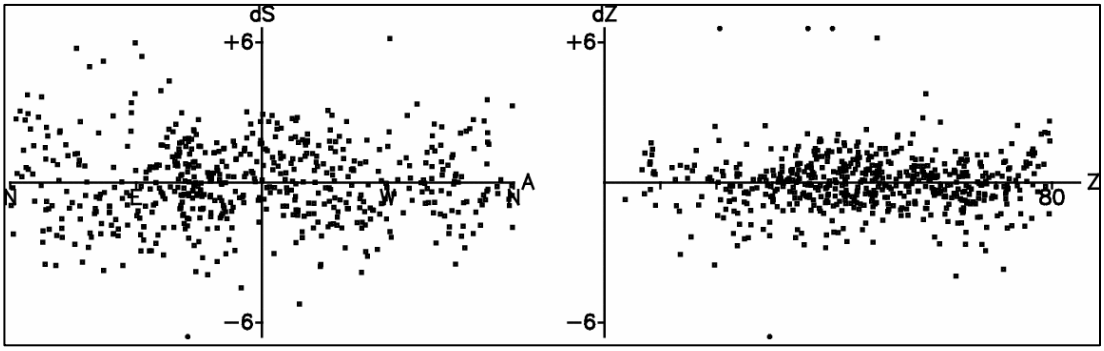
Pointing the Telescope

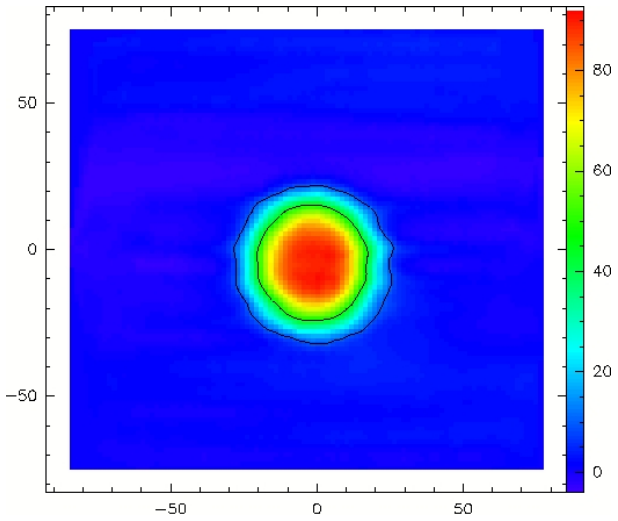
The pointing performance of the telescope as determined by frequent optical pointing runs on stars is ca. 2” (total rms, across the sky). Currently, with the first heterodyne receivers in commissioning, we are still optimizing the radio pointing models (for the Nasmyth Cabin A). The graph below displays the deviations (in arcsec) during one of the latest optical pointing runs (left: in azimuth, right panel: in elevation). Tracking a single star shows tracking accuracies better than 0.5’’ (rms).



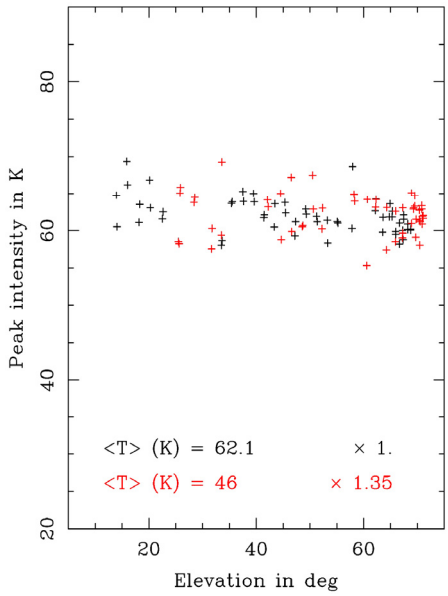
Performance verification “on sky”

The performance of an antenna “on sky” is best verified by studying well-known sources like planets. The map of Jupiter, measured at 812 GHz, reveals – within the dynamic range of the measurement – an absolutely clean antenna pattern with no hint of side lobes.

The system optics (telescope incl. guiding optics to the receivers) is diffraction limited (means, the angular resolving power of the telescope is exactly what is predicted for optimal optics and coupling).



Jupiter measured with FLASH at 812 GHz.



The coupling efficiencies of the APEX to the planets, as determined in carefully calibrated measurements, is consistent with a surface precision of ≤20µm (Ruze). A good antenna is characterized by elevation-independent coupling efficiencies. For APEX the “gain curve” as determined on Jupiter & Mars at the highest available frequency (812 GHz) is – within the uncertainty of the measurements – absolutely flat!

“We have a great telescope!“

Acknowledgement: the holography project team was supported by T.Sridharan & N.Patel (CfA) and A.Greve & D.Morris, whose contributions have been invaluable to our successful telescope commissioning.