

Correction to the near-field holography

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An error was found in the mathematics of the near field holography data reduction.

After the panel setting (december 2004) on the VertexRSI antenna, two panels (8-53 and 8-54) have been intentionally displaced by $100\mu\text{m}$ towards the focus in order to check the amplitude and sign of the measurement of the different antenna surface measurement methods.

The maps obtained after the panels were displaced showed the right direction of motion, a slightly smaller displacement ($\sim 86\mu\text{m}$), but the panel edges (inner and outer) appeared displaced on the map, by about 2 cm from the nominal panel limits, away from the center of the dish.

This displacement was caused by a wrong scaling factor in the radial coordinate. The complex map is obtained by a Fourier transform, followed by a near-field correction on the phases:

$$F(\xi, \eta) = \frac{i}{\lambda} \frac{e^{-ikR}}{R} e^{-ik\delta p_1(\xi, \eta)} \int f(u, v) e^{ik(u\xi + v\eta)} e^{-ik\epsilon} dudv. \quad (1)$$

In this equation u, v are the direction cosines of the direction to the transmitter seen from the aperture plane. However as the aperture plane is offset from the antenna rotation axis by a distance d , there is a parallax effect which causes u, v to be slightly larger than the antenna scanning coordinates, which we may call u', v' (Figure 1):

$$u = u' \left(1 + \frac{d}{R}\right) ; \quad v = v' \left(1 + \frac{d}{R}\right) \quad (2)$$

If u, v are approximated to u', v' the scale of the map image is wrong: it is overestimated by a factor $\left(1 + \frac{d}{R}\right)$.

As a result the near-field correction is not evaluated at the proper radius for each pixel. This causes a pathlength error proportional to the derivative of the near-field correction with respect to the radial coordinate (Figure 2). For d we take the distance between the elevation axis and the mid-plane of the reflector ($d = 2.18 + 1.85/2 = 3.105\text{m}$). The weighted r.m.s. error is $18\mu\text{m}$. This error needs to be added in quadrature to the previous surface RMS estimates to get the true surface accuracy.

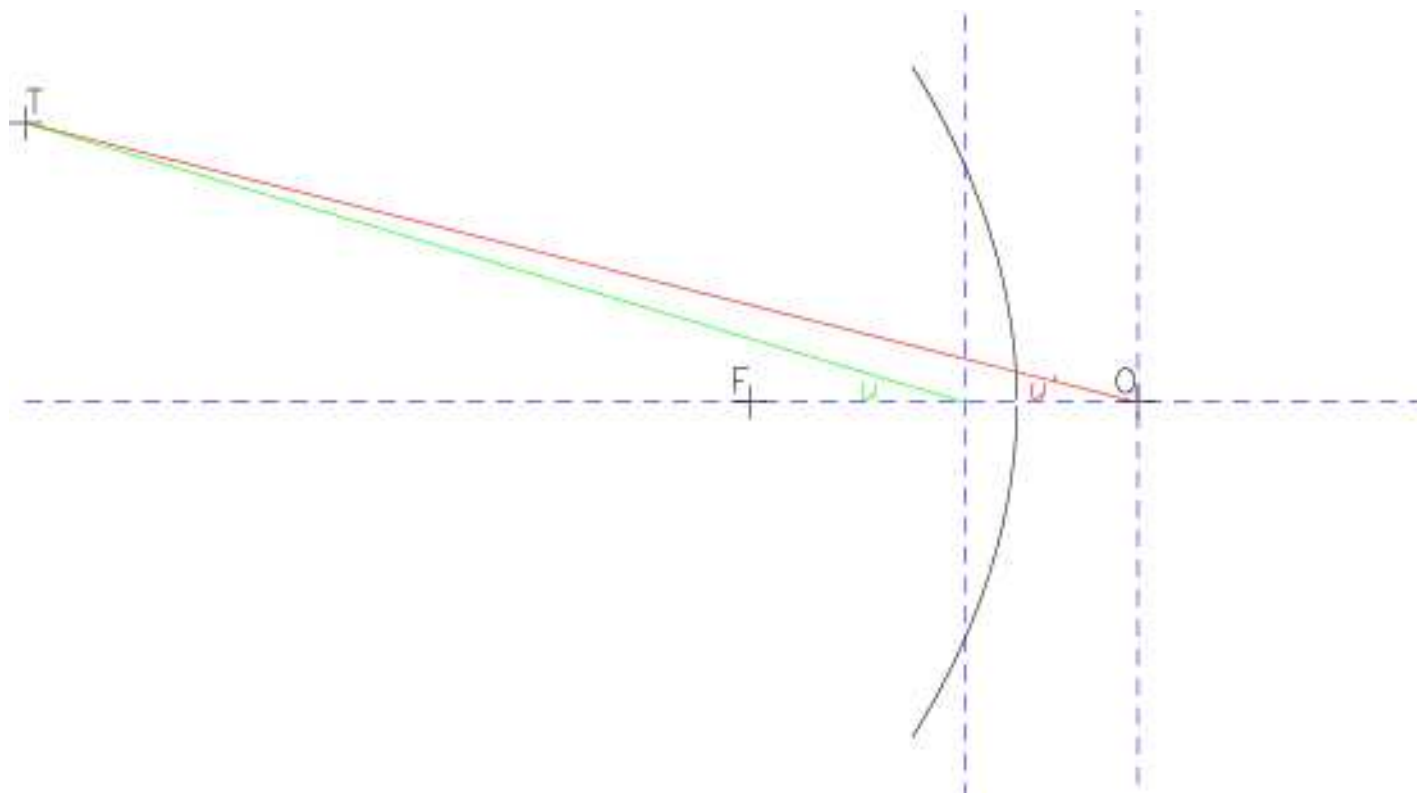


Figure 1: The angles u and u' referred to in the text. T is the position of the transmitter while scanning the antenna.

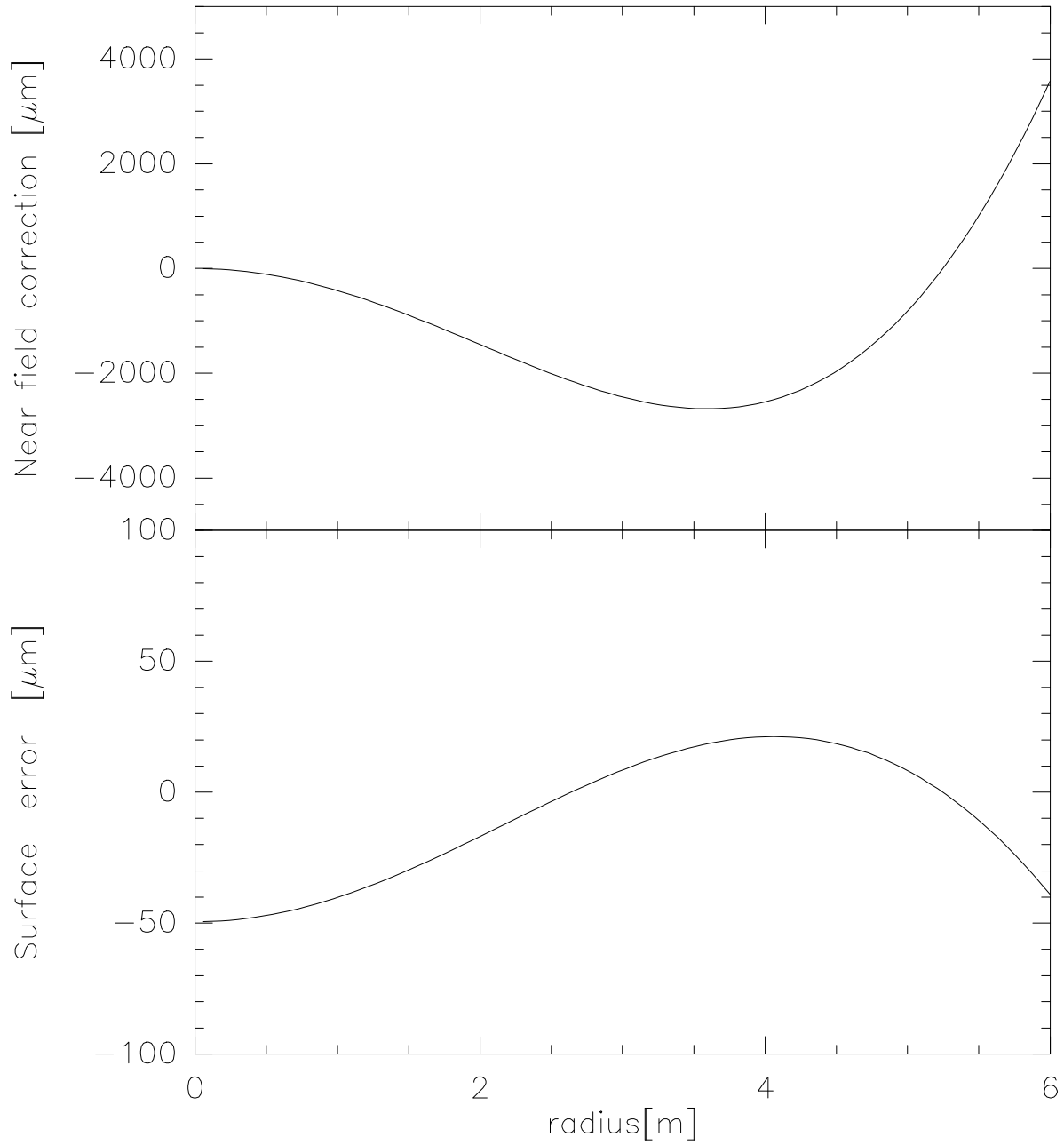


Figure 2: Top: the near field pathlength correction as a function of radius. Bottom: the surface error resulting of the misregistering of the radial coordinate. The best fit parabola has been removed.