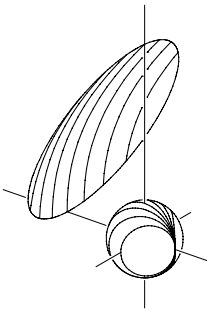

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Ref.: P:\MADS\letter_2000_03_31.doc

2000, March 31

Dansk Rumforskningsinstitut
Juliane Maries Vej 30
2100 København Ø

att.: Hans Ulrik Nørgaard-Nielsen

subject: PLANCK project, ellipsoid axis accuracy

Dear Hans Ulrik,

The RF degradation of a remaining inaccuracy of the primary mirror ellipsoid rotational symmetry after a best-fit determination is investigated in this letter.

The RF performance of the antenna system is calculated with the GRASP8 program at the frequency 353 GHz and for the horn, HFI353-6.

Distortions on primary mirror

The inaccuracy of the primary mirror ellipsoid rotational symmetry is defined by a change of the ellipsoid axis in the y-direction (out of antenna symmetry plane) related to the ellipsoid axis in the x-direction. The ellipsoid axes in the x-direction and the y-direction are specified to 3984.916 mm.

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This investigation considers a reduction of .5 mm and 1.0 mm of the ellipsoid axis in the y-direction. The phase degradation of the primary mirror aperture field at 353 GHz and with 1 mm inaccuracy is shown in Figure 1.

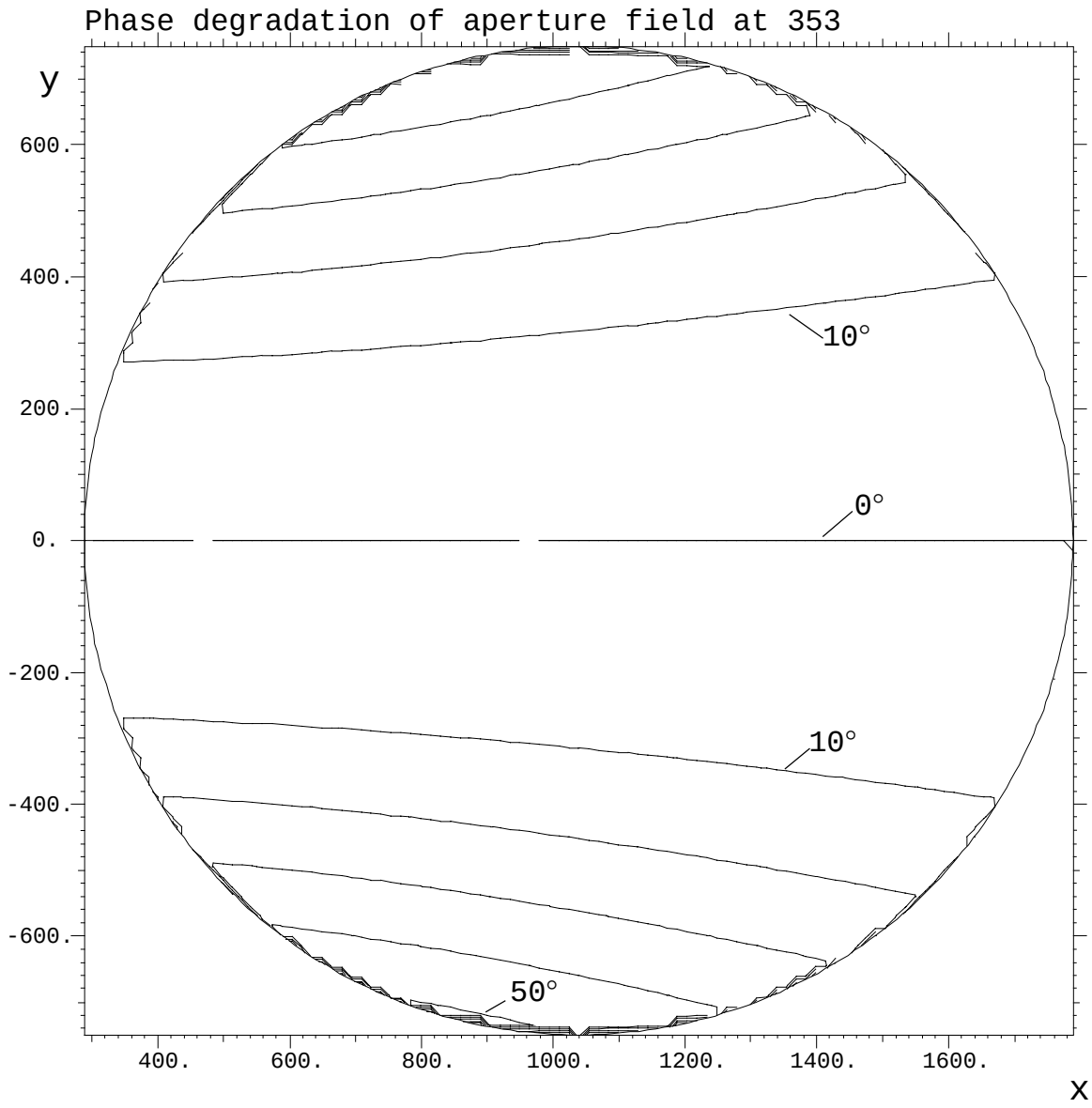


Figure 1 Aperture field phase error created by 1mm axis inaccuracy on primary mirror.

The contour curves are drawn for phase degradation intervals of 10°. The maximum level is about 50°.

RF performance.

The main parameters of the RF performance are given in Table 1.

The elliptic inaccuracy of 1 mm gives a peak gain loss of .26 dB and this power is transferred to the region around the main beam. The maximum angular distance from the beam peak to 20 dB below is increased from 5.92° to 6.22°, and the half power ellipticity is increased by 4%.

353 GHz horn, HFI353-6	nominal	Ellipse y-axis reduction	
		0.5mm	1mm
Peak [dBi]	69.25	69.12	68.99
Gain loss [dB]		0.12	0.26
Half power Ellipticity	1.16	1.18	1.21
Distance from peak to 3 dB contour			
Min [arcmin]	1.81	1.82	1,84
Max [arcmin]	2.14	2.17	2.23
Distance from peak to 20 dB contour			
Min [arcmin]	4.60	4.65	4.70
Max [arcmin]	5.92	6.06	6.22
Power [%]			
inside 3 dB	49.05	48.87	48.75
inside 10 dB	89.25	89.19	89.18
inside 20 dB	98.73	98.73	98.74
Solid angle in steradians*10^{-6}			
Inside 3dB	1.02	1.04	1.07
Inside 10 dB	3.44	3.55	3.67
Inside 20 dB	7.13	7.36	7.61
Angular resolution arcmin	3.91	3.96	4.02

Table 1 RF characteristics of PLANCK antenna

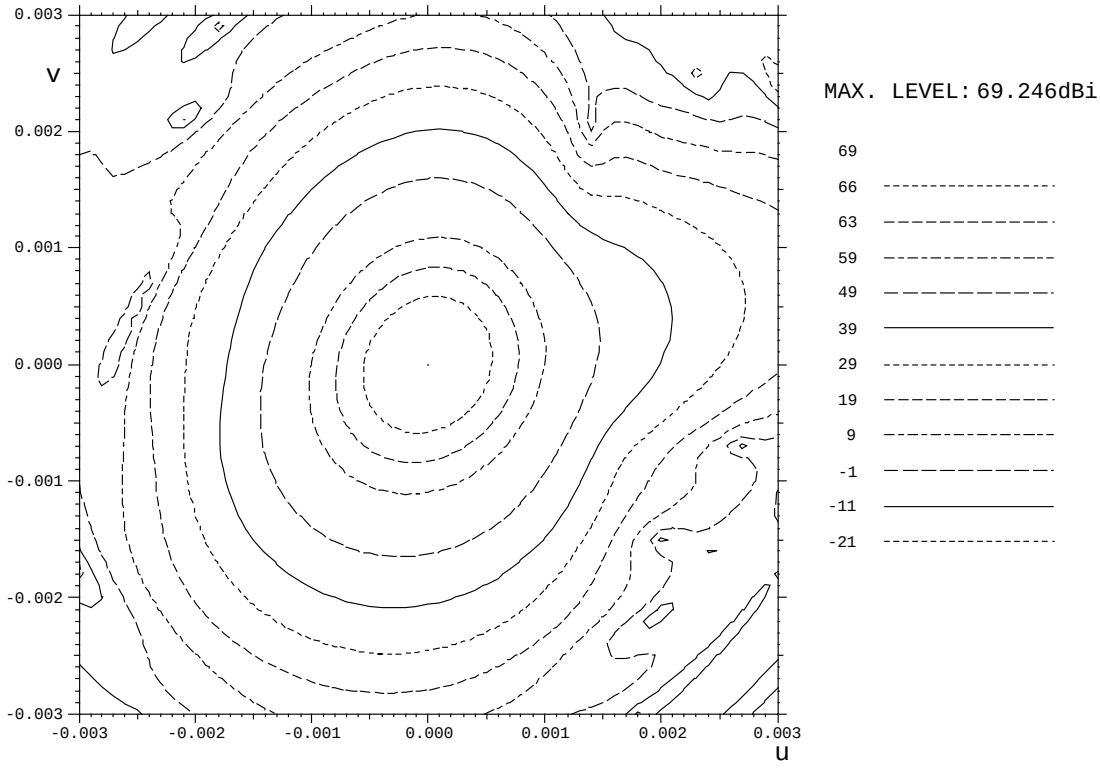
The far fields are shown in a region of 0.17° around the main beam in a u,v grid with contour curves at 3dB, 6dB, 10dB, …, 100 dB below peak and in 2 pattern cuts for ϕ=0° and ϕ=90° and $-0.3° \leq \theta \leq 0.3°$. The θ,ϕ direction is referenced to an output co-ordinate system in the direction of the nominal main beam, and with the ϕ=0° plane in the antenna symmetry plane. The pattern degradation around the main beam is most evident in Figure 3b in the far field region up to θ = .25°.

Frequency dependency.

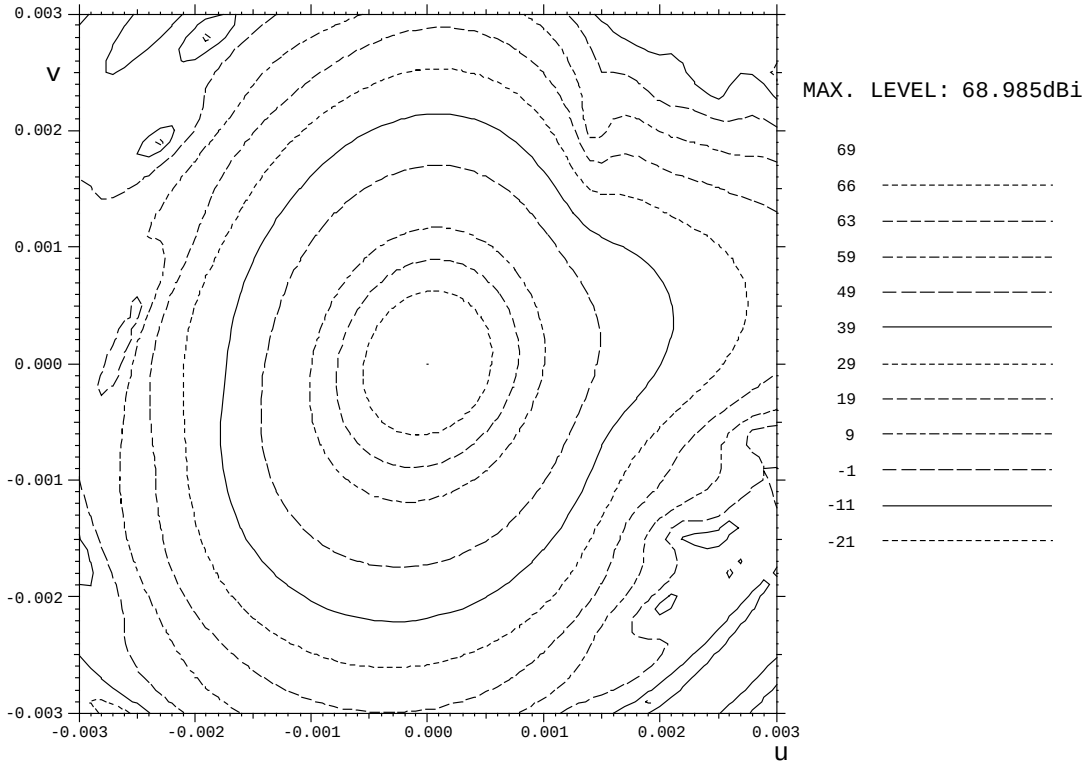
The RF degradation is increased for higher frequencies, but remains near the main beam giving larger gain loss, beamwidth and ellipticity.

With regards

Per Nielsen

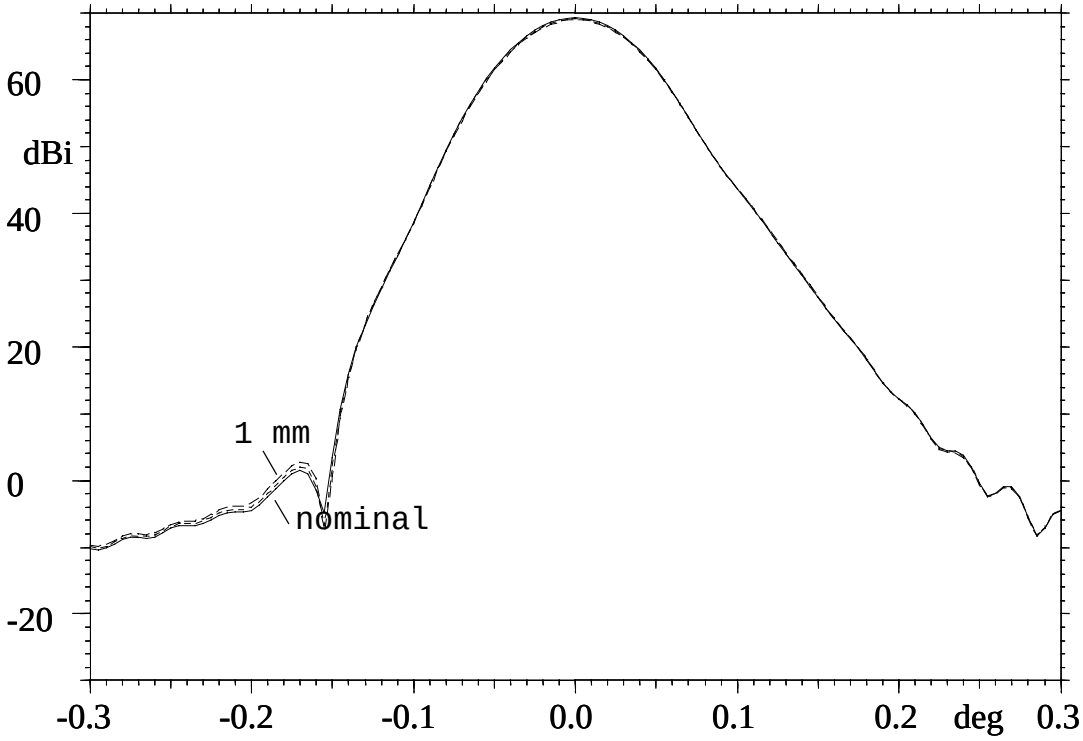


a) nominal

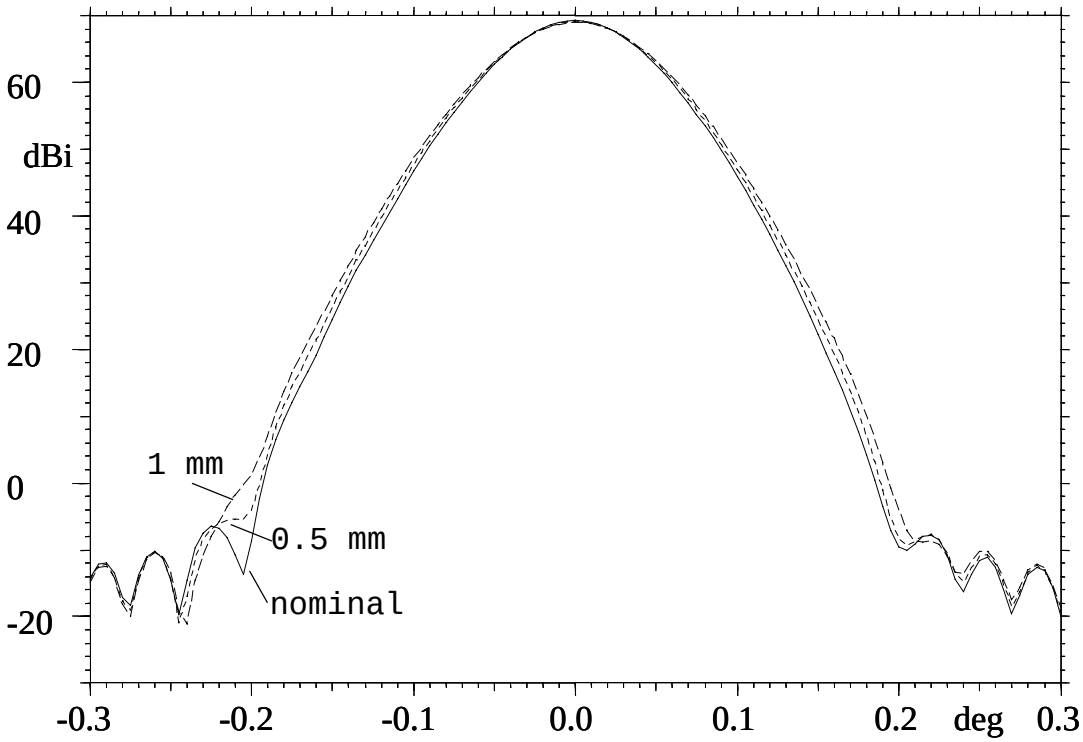


b) 1 mm inaccuracy

Figure 2 Far field in UV-grid.



a) ϕ = 0°



b) ϕ = 90°

Figure 3 Far field in main cuts, ϕ = 0°, 90°.