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G/T at 243 GHz for the ALMA Telescope

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Introduction

A (limited) student version of GRASP [1] was used to analyze the gain/system temperature (G/T) at 243 GHz for the ALMA telescope. It shows an optimum edge taper of between -12 dB and -14 dB at the secondary mirror, with the telescope pointing at the zenith, for the Band 6 receiver.

Description and Results

GRASP8.2.5-SE, version 1.1.2, was used to analyze G/T at 243 GHz for the ALMA telescope. The software utilizes a Gaussian feed pattern at the telescope focal point, and the secondary and primary mirrors as given in Tham and Withington [2]. The blockage effects of the secondary mirror and the support legs could not be included with the limited capabilities of the software used (the full software package has the capacity to calculate blockage effects). The beam of the telescope and the amount of power incident on each of the mirrors (assuming normalized input power in the Gaussian beam) were calculated. From these calculations, the gain (G) and the spillover past each mirror could then be computed. Assuming (i) the spillover past the secondary "sees" the cold sky at 6.9 K [2], (ii) the spillover past the primary "sees" ground at 300 K and (iii) with a receiver noise temperature of 50.1 K past the internal optics [2], the receiver temperature (T) was determined. Figure 1 shows the forward gain (dBi) and the power on each of the mirrors (normalized to the input power). Figure 2 shows the G/T derived from the results in Figure 1. It also shows the calculated G/T extracted from the figures in [2].

Discussion

From Figure 2, it is clear that the G/T at 243 GHz, with the telescope pointing at zenith, has an optimum edge taper of between –12 dB and -14 dB. This is not expected to change if a real horn pattern is used as input, or vary much with elevation angle [3]. The Band 6 receiver optics should be optimized to generate this edge taper for maximum G/T. Calculations should be made for other bands, especially at higher frequencies as the optimum could move to more severe (*i.e.*, towards -16 dB) edge tapers.

References

[1] GRASP8, TICRA engineering consultants of Copenhagen, Denmark.
[2] C. Y. Tham and S. Withington, "Receiver Optics Design Electromagnetic Analysis," second report 2003-01-13.
[3] S. Srikanth, private communication.

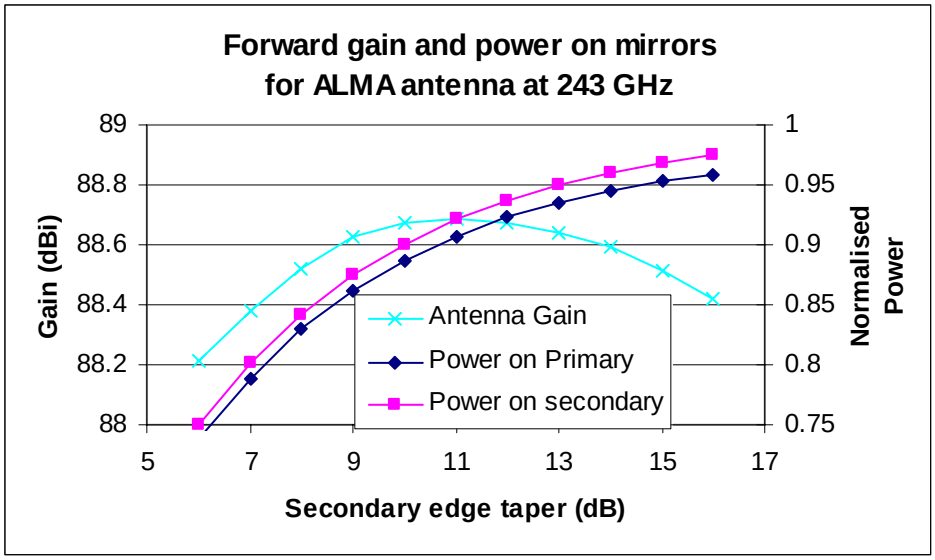

Figure 1.

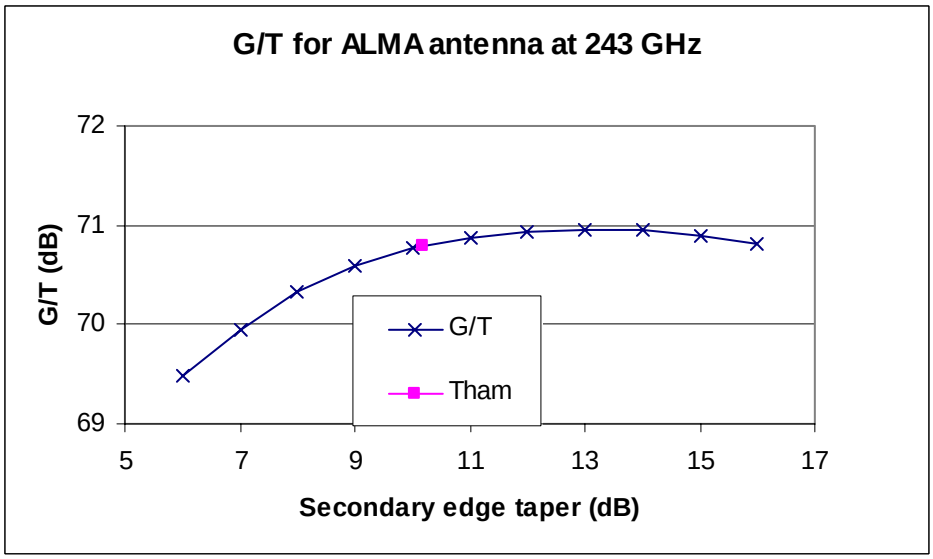

Figure 2.