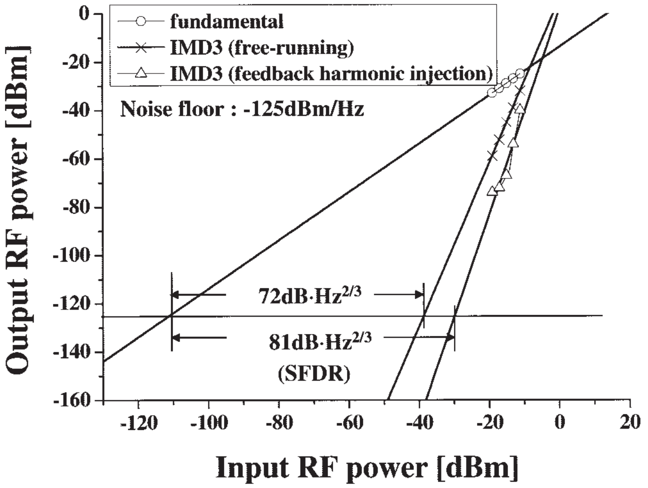

Figure 4 SFDR of the link for free-running and linearized DFB LD (fundamental: 1.2 GHz, IMD3: 1.3 GHz)

ω_2) should be the same as that ($a_2A_2A_3$) of lower injected-generation term ($2\omega_1 - \omega_2$). The phases between lower IMD3 and lower injected-generation term need to be out-of-phase. The phase of harmonic signal was adjusted and optimized by using RF phase shifter. The same logic was applied to reduce upper IMD3 ($2\omega_2 - \omega_1$: 1.3 GHz) with the magnitude/phase control of harmonic (2.4 GHz) in the feedback loop.

As shown in Figure 3(b), intermodulation distortion products were significantly reduced in 1 GHz bands. The experimental result showed that the CNR enhancement of 12 dB when compared with free-running operation was achieved by optimization of RF magnitude and phase. Figure 4 shows the received RF power of the fundamental signal (1.2 GHz) and IMD3 (1.3 GHz) with variation of input RF power for both free-running and the proposed schemes. As expected, the SFDR was improved from 72 to 81 dB $Hz^{2/3}$ by 9 dB with the proposed scheme.

4. CONCLUSION

A novel technique of intermodulation products reduction using the feedback harmonic injection in DFB LD for RoF link was proposed. The proposed scheme is mainly composed of a photodiode, two BPF, and RF phase shifter/amplifier. This scheme is capable of suppressing IMD up to 12 dB when compared with that of free-running DFB LD for RoF transmission link.

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ERROR CORRECTION IN THE GAUSSIAN BEAM TELESCOPE APPLICATED TO THE NEW 40 m RADIOTELESCOPE OF CENTRO ASTRONÓMICO DE YEBES

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ABSTRACT: *In this article, an elegant methodology to correct the positioning errors of the focalization system in a radiotelescope is presented. Two different solutions are presented in two bands. In one case the solution is highly stable with tolerance positioning. In the other solution, the tolerance in the positioning and the focal distances of the lenses are very low. But a method to correct these tolerance problems and getting the accurate focalization parameters of the radiotelescope is proposed. New 40 m radiotelescope of the National Observatory (Spain) is used to validate results.* © 2006 Wiley Periodicals, Inc. Microwave Opt Technol Lett 48: 2074–2077, 2006; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.21849

Key words: *radiotelescope; Gaussian beams; quasioptical systems; radiostronomy; beam mode expansion*

1. INTRODUCTION

A radiotelescope is one of the most powerful instrument on the earth to know more and more about the cosmos, our evolution, our origin, and, maybe, our future. Quasioptical theory has been commonly used in the design of the different parts of these devices. The reason is the possibilities that the Gaussian beam mode expansion permits to focalize the instruments.

At present, a new radiotelescope is being built in Yebes, Spain. This new device, whose features are listed in Table 1 [1], will be capable of observing star radiation in nine frequency bands, from 2.1 to 120 GHz. The main objective of the design of the different bands is to focalize the radiotelescope, in quasioptic-terms; thus, determinate curvature radius and a beam radius of the beam in the subreflector were obtained [2].

The target searched in this case is finding a taper at the subreflector of −12 dB. This aim for a subreflector diameter of

TABLE 1 Features of the 40 m Radiotelescope of Yebes

Main reflector diameter	40 m
Ratio Focus-Diameter (F_m/D_m)	0.375
Main focus (F_m)	15 m
Half-angle from the primary (Φ_v)	67.38°
Depth of the primary (h_p)	6.667 m
Vortex hole diameter	3.170 m
Ratio focus-diameter of the Cassegrain (FED)	7.909
Equivalent focus (F_e)	316,379 m
Magnification (M)	21.0919
Subreflector diamater (D_s)	3.28 m
Hole diameter at the subreflector (D_{vs})	0.2635 m

3.28 m, applying Eq. (1), guides to get a beam radius at the subreflector border of

$$T\,(\mathrm{dB}) = -\frac{20\,\frac{r^2}{w^2}}{\ln(10)} = -8.69\frac{r^2}{w^2} \Rightarrow w = 1.395\ \mathrm{mm}. \qquad (1)$$

This value is calculated to determine the distance of the beam radius of the feeder of 25,916.6 mm, corresponding to the distance of the vertex of the subreflector (25,396 mm) plus the depth of the subreflector (520.6 mm).

To obtain these values, a Gaussian telescope structure in the focalization has been used (see Fig. 1), which allows us to establish the focus of the radiotelescope at the point of interest.

In this article, a solution for the focalization of the radiotelescope is presented, when it is working at two different bands: 27–33 GHz and 92–120 GHz [3, 4]. It is to study the taper obtained by observing that it satisfies the specifications. The tolerance of the different part of the system to errors will be analyzed, and an elegant solution will be developed for the errors [3].

2. SOLUTION PROPOSED FOR 27–33 GHz BAND

In this band, the lens are at the horn aperture as illustrated in Figure 2, and the distance d_1 is 0. Other parameters of the solution are shown in Table 2. Figure 3 presents the radiation pattern of the set horn and lens with respect to the perpendicular distance to the propagation axis. The taper obtained at the subreflector of the system is equal to −12 dB over the entire band.

The next step is introducing errors in the system parameters. Moving $d_2 \pm 3$ mm is absolutely insensible with the focalization of the radiotelescope. A variation is obtained while moving *d*3 and the value is also very stable in the radiotelescope focalization. Taper obtained by varying the focal distance of $f_1 \pm 3$ mm is presented in Figure 4. These errors could be presented, for example, as positioning errors of the elements.

Figure 2 Horn plus lens at 30 GHz

From the figures it can be concluded that the system with this configuration has high tolerance to errors for other parameters, being only slightly significant to the tolerance to variations in f_1. Moreover, the variations are frequency independent.

3. SOLUTION PROPOSED FOR 92–120 GHz BAND

The parameters of the solution are shown in Table 3. The radiation pattern of the feed is shown in Figure 5 for the both planes H and E. The taper and the beam radius obtained for all the band is perfectly focalized with these parameters. The obtained results show a good focalization, with a taper of −12 dB and a beam radius of 1395 mm in the entire band when the system is exactly designed. But it is interesting to know how tolerant is the system with errors in its parameters.

In this sense, Figure 6 shows the taper obtained while moving d_1 ±3 mm. The same holds good for Figures 7 and 8 that is by

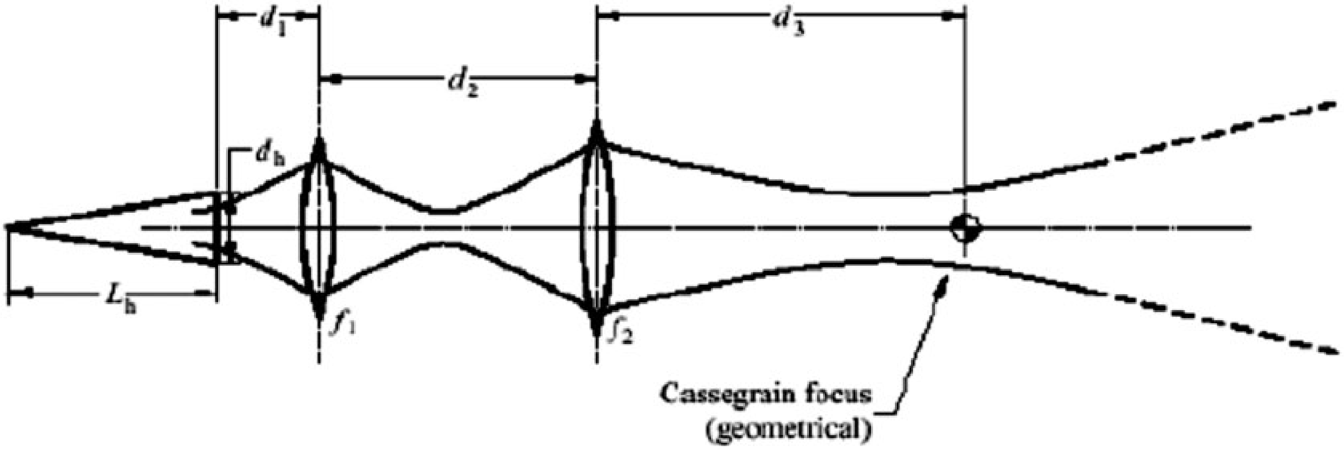

Figure 1 Gaussian telescope

TABLE 2 Parameters of the Gaussian Telescope at 30 GHz

d_1 (mm)	0
d_2 (mm)	544.8
d_3 (mm)	533.5
f_1 (mm)	140.4
f_2 (mm)	533.5

moving d_2 and d_3, respectively. Figure 9 presents the tolerance for the taper when a focal distance of $f_1 \pm 2$ mm is considered; however, Figure 10 depicts the same parameter but considering variations in $f_2 \pm 3$ mm.

As it can be observed from Figures 6–10, the system is not tolerant to variations in d_1, d_2, f_1, or f_2, being especially significant to the error introduced by variations in f_1 and f_2. So it is important to watch these parameters in the implementation, but if it is not possible to obtain good values, a correction method is needed, which is developed and discussed in the next section.

4. ERROR CORRECTION METHODOLOGY

If there is an error positioning d_1, it is possible to make an elegant correction of the system by moving d_2. For instance, if there is a

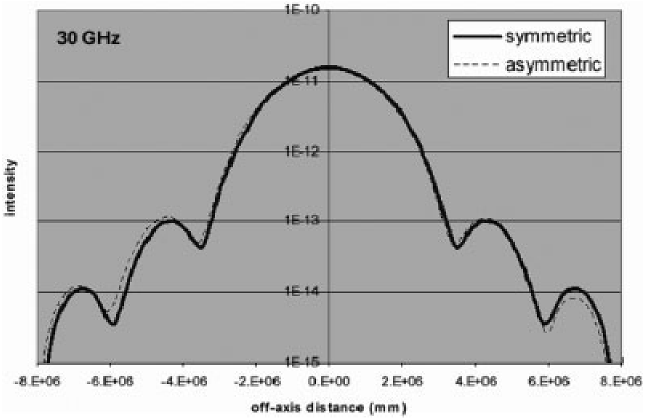

Figure 3 Radiation pattern in both planes E and H with respect to the perpendicular distance to the propagation axis

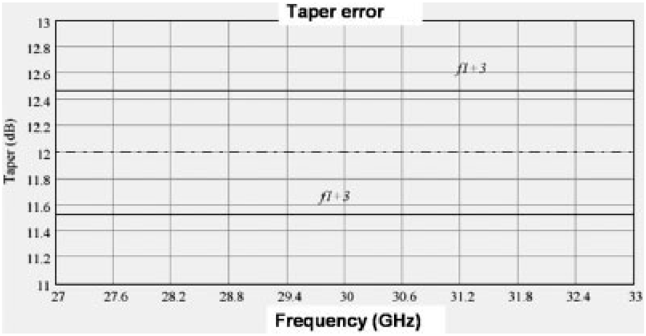

Figure 4 Taper error while varying f_1

TABLE 3 Parameters of the Gaussian Telescope at 100 GHz

d_1 (mm)	58.8
d_2 (mm)	557.9
d_3 (mm)	1010
f_1 (mm)	47.3
f_2 (mm)	312.1

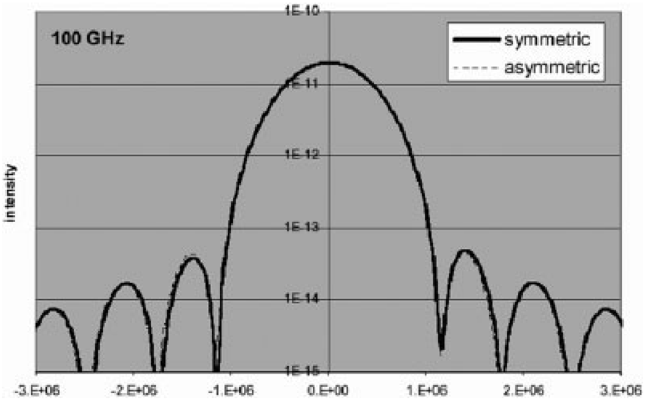

Figure 5 Radiation pattern in both planes E and H with respect to the perpendicular distance to the propagation axis for the fed horn at 100 GHz

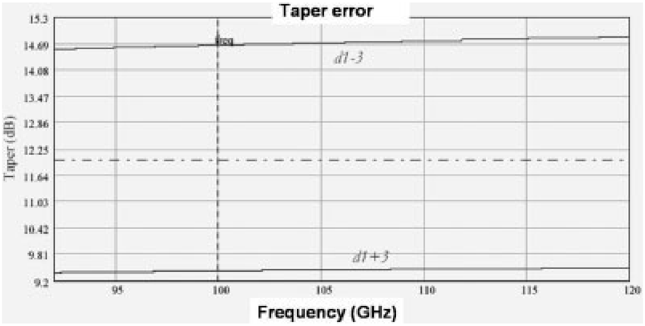

Figure 6 Taper error while moving d_1

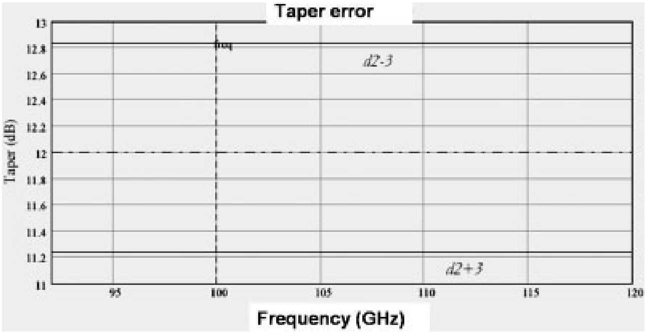

Figure 7 Taper error while moving d_2

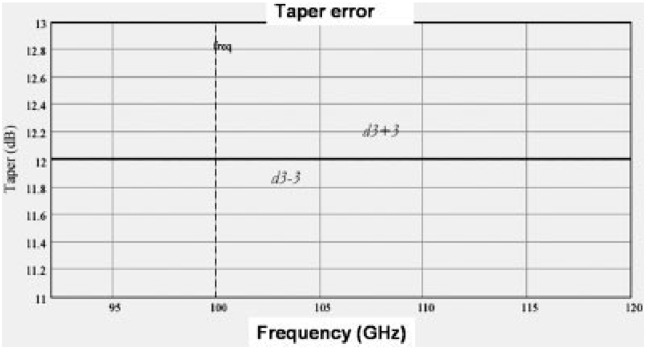

Figure 8 Taper error while moving d_3

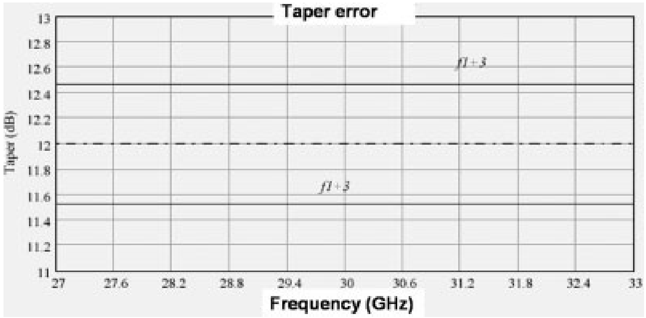

Figure 9 Taper error while moving f_1

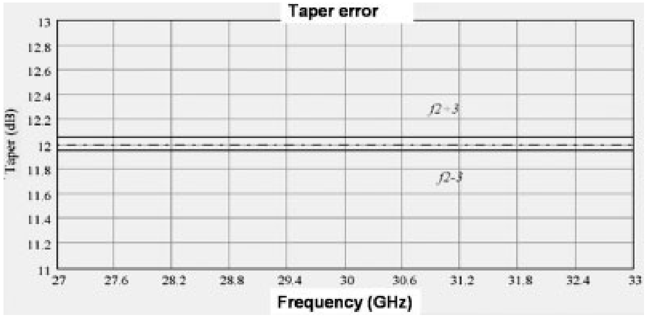

Figure 10 Taper error while moving f_2

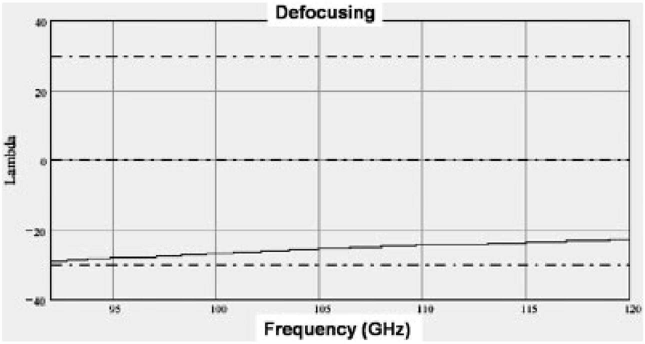

Figure 11 Taper error while moving $d_1 - 3$ mm and $d_2 - 7.5$ mm

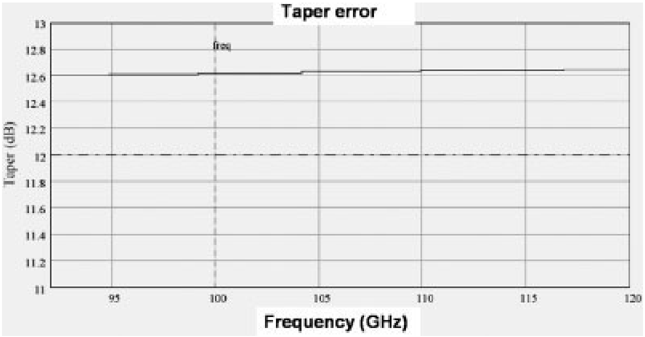

Figure 12 Taper error while moving $d_2 + 3$ mm and $d_1 + 1$ mm

variation in the taper at the subreflector of ±1 dB, an error of $d_1 -$ 3 mm is corrected by moving $d_3 - 7.5$ mm (see Fig. 11) or an error of $d_1 + 3$ by moving $d_2 + 8$ mm. At an error of −3 mm positioning, d_2 may be corrected by moving $d_1 + 1$ mm, the taper being obtained in the specifications limits. The same thing holds good for an error of +3 mm in d_2 with a shift of −1.6 mm in d_1. Figure 12 confirms these results. As is shown in Figure 13, an error of 1 mm in f_1 may by solved moving d_2, + 9 mm for the case of +1 mm and −8,1 for the case of −1 mm.

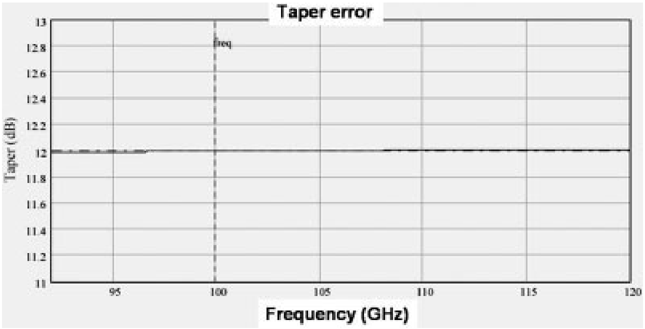

Figure 13 Taper error while $f_1 + 1$ mm and $d_2 + 9$ mm

5. CONCLUSIONS

The design of two bands of the radiotelescope has been developed for verifying the taper specification. The stability of the solution proposed while varying the system parameters for both bands has been study. In this sense it has been proved that the system with the first lens in the horn aperture is much more stable than the other one. For this case, when the stability is lower, an elegant and straightforward way of solution to this problem is proposed in this article.

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DISPLACEMENT SENSING OF ENHANCED SENSITIVITY AND NOISE SUPPRESSION WITH TWIN-FIBER ALGORITHM

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ABSTRACT: *A novel fiber sensing algorithm is proposed and demonstrated, where two single-mode fibers is used to sense the same signal with different sign so that sensitivity is doubly enhanced and common noise is eliminated. High sensing resolution and high sensing dynamic may be achievable when the high encircling number and high-speed power detector are applied.* © 2006 Wiley Periodicals, Inc. Microwave Opt Technol Lett 48: 2077–2080, 2006; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.21879

Key words: *fiber sensing; interferometers; single-mode fibers*