Development of the optical system for VSOP-2 offset Cassegrain antenna

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Abstract

We are developing the satellite(ASTRO-G) for the space VLBI mission, called VSOP-2 [1]. This system has a large offset Cassegrain antenna. This telescope is equipped with three receivers(8.4 GHz, 22 GHz, 43 GHz bands). Three multi mode feed horns are set to Cassegrain focus position. We are designing antenna optics of three band receivers with good low cross-polarization and high antenna efficiency. We calculated these optical performances used in physical optics method. The result of these simulations shows low cross-polarization level (< -25 dB) against the co-polarization level, and antenna efficiencies have 63--68 percent in these bands without surface errors.
In this paper, we present these results of simulation of ASTRO-G antenna optics.

1. Introduction

In order to increase angular resolution and sensitivity in comparison to VSOP, VSOP-2 satellite has a larger antenna for higher frequency. The antenna is a deployable reflector (LDR) with a diameter of 9 m with surface accuracy of 0.4mm rms [2]. To improve the aperture efficiency, we adopted the off-set Cassegrain antenna, which has no blocking with sub-reflector. The main-reflector is consisting of 7 hexagonal modules. And three band feed horns are juxtaposed at the Cassegrain focus (Figure.1). We examined the arrangement of three feed horns with good antenna efficiency.

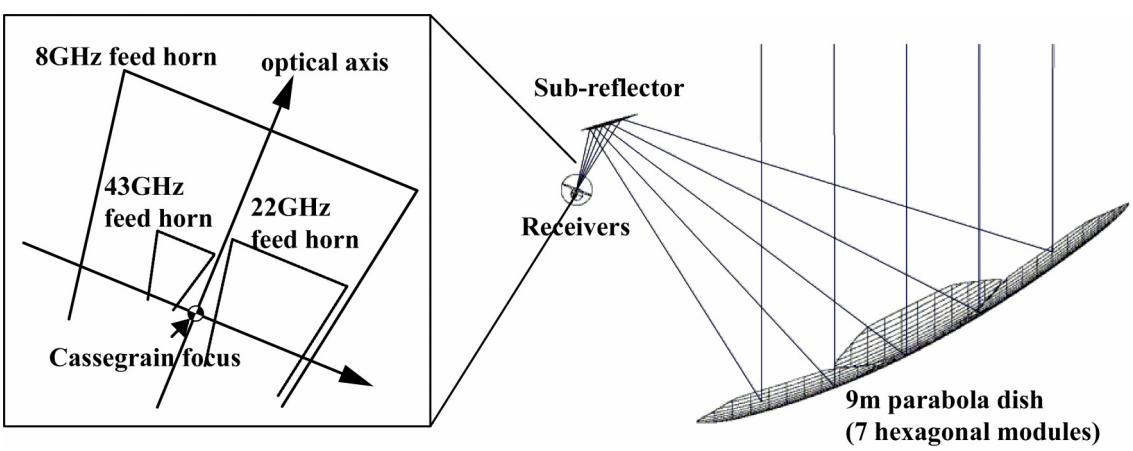

Figure.1 VSOP-2 offset Cassegrain antenna
This figure shows configuration of a VSOP-2 telescope. This telescope has a classical offset Cassegrain antenna. Main reflector is consisted 7 hexagonal modules that have a mesh surface. 43 GHz and 22 GHz band receivers are installed in the cryostat dewar and 8.4 GHz receiver is installed on the cryostat dewar side.

2. Simulation of the optical system

We calculated the antenna optics used by GRASP software in physical optics method. We adopted the multi-mode feed horn. This is good symmetry and low cross polarization more than conical horn, and this is able to reduce the size and weight more than corrugated horn. The antenna performance was pursued repeating the horn design. Because 43GHz band has best priority, the optics is designed to optimize to the efficiency and the cross polarization at 43 GHz. This telescope will operate in dual circular polarization (RH,LH). However, radiated polarizations are defined as liner polarizations in these simulations. Figure.2 shows the result of the antenna beam pattern at 43 GHz.

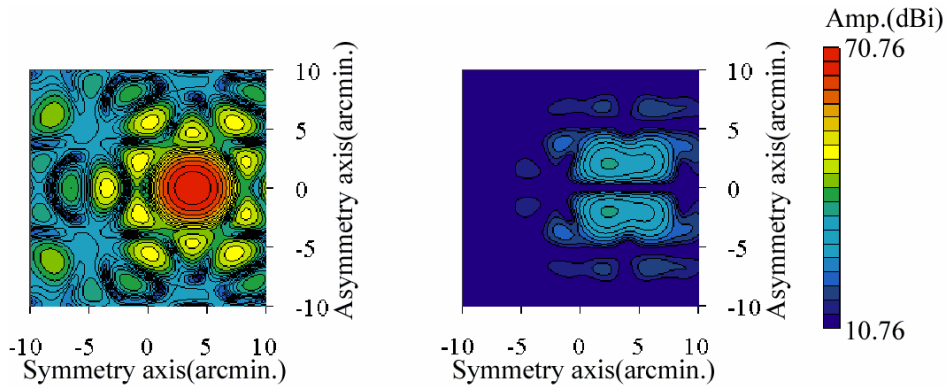

Figure.2 Simulation results of antenna beam patterns at 43 GHz.
Left graph shows the co polarization beam pattern and right graph show the cross polarization beam pattern. Maximum cross polarization level shows -35 dB at peak level of co polarization.

3. Conclusion

We are now developing the offset Cassegrain antenna with the 9-m, high accuracy LDR for the VSOP-2 mission. As simulation results that used the physical optics without degradation by main-reflector, they showed the antenna efficiency of 68 percent at 43 GHz band. The simulation results are listed in Table 1. We designed the offset Cassegrain antenna optics that have good efficiency at 43GHz band.

Table.1 Results of antenna beam pattern simulations

				Pointing offset		Beam half size	
Freq. (GHz)	Gain (dBi)	efficiency	Cross-pol max.level (dB)	Az. (deg)	El. (deg)	Min. (deg)	Max. (deg)
8.40	56.27	0.64	-27.79	0.02	0.55	0.123	0.134
22.24	64.91	0.67	-29.75	-0.12	0.00	0.046	0.051
43.00	70.76	0.68	-35.46	0.06	0.00	0.023	0.026

4. References

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