Developmental Tests of the Deployable Mesh Antenna for MUSES-B Satellite

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Introduction

This paper describes the development status of the deployable mesh antenna of 10 m maximum diameter, which will be carried on MUSES-B satellite for space VLBI (Very Long Baseline Interferometry) mission,[1] as shown in Figure 1. As the cargo room is very limited, the antenna structure should be folded compact in launch phase. For this requirement, a novel deployment concept of a tension truss main reflector[2] is proposed and realized.[3]

Antenna Configuration

Figure 2 shows the detailed configuration of the deployable mesh antenna. A displaced axis Cassegrain antenna[4] is applied in order to reduce the gain degradation due to sub-reflector blockage. The tension truss, cable net and mesh system form the main reflector surface. The deployment mechanism including six extensible masts which radially extend, support the peripheries of the tension truss and cable net system. A link extension system is applied to the sub-reflector.[5] The sub-reflector is stowed by folding up the links which can be extended by the motor driven wires. For the purpose of VLBI observation, three frequency bands of 1.66GHz, 4.85GHz and 22.15GHz are required. A long conical horn is used as a primary radiator and fed in the three frequency bands in common.[6]

Test Sequence

The developmental tests for the flight model antenna was carried out according to the test sequence shown in Figure 3. Prior to the antenna assembly, the main reflector, the sub-reflector and the feed were tested individually. After the antenna assembly, a thermal vaccum test and a vibration test were performed for antenna assembled configuration. The deployment test was performed for the main reflector and the sub-reflector individually.

Electrical Test

The electrical performance of the primary radiator with feed system was measured prior to the antenna assembly, and verified that the performance satisfy the requirement.[7] The measured performance is summarized in Table 1, and the radiation pattern for 4.85GHz is shown in Figure 4 as an example.

Usually, the RF performance of an onboard antenna are verified by measuring the field distribution on a reflector aperture and converting it to the far field. In the case of the MUSES-B antenna, however, a different way is adopted as described below.

The electric field which is radiated from the primary radiator and scattered from the sub-reflector has been measured around the main reflector surface by a spherical near-field measurement system. Figure 5 shows the test configuration. The secondary radiation performance will be estimated using these data together with the measured mechanical data of the reflector surface on the basis of the ray tracing and diffraction theory. This expedient method is adopted because the near field measurement needs a large-scaled facility and also because the validity of the estimation method in the case of a polyhedron-approximated reflector has been verified using the electrical model antenna.[8]

Mecanical Test

The environmental tests such as a thermal vacuum test and a vibration test have been performed to verify that the hardware withstands under the specified environmental condition.

To verify the stability and repeatability of the deployment structures, deployment tests have been performed both for the main reflector and the sub-reflector, and successfully completed. The deployment test configurations for the main reflector and the sub-reflector are shown in Figure 6 and Figure 7, respectively. The final surface adjustment of the main reflector is in progress.

Conclusion

Through the developmental tests of the flight model antenna, good compromise of precise accuracy and compact packaging have been realized. The successful deployment and precision surface formation in space are expected for this program.

References

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(7) T. Takano et al., "Development of the Primary Radiator for the MUSES-B Large Deployable Antenna", B-140, Proceedings of 1995 IEICE.
(8) E. Hanayama and T. Takano, "Analysis of radiation Characteristics of a Polyhedron Approximated Reflector Antenna using the Aperture Integration Method and the Current Distribution Method", Trans. of IEICE, vol.77, no.1, Jan.1994.

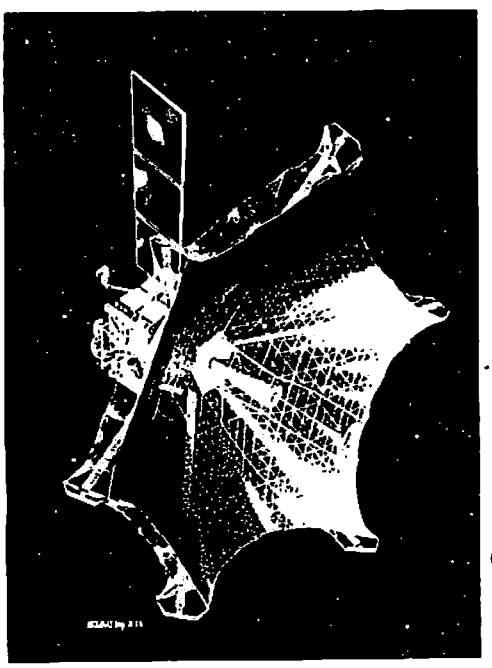


Figure 1 Deployed Antenna Configuration in Orbit

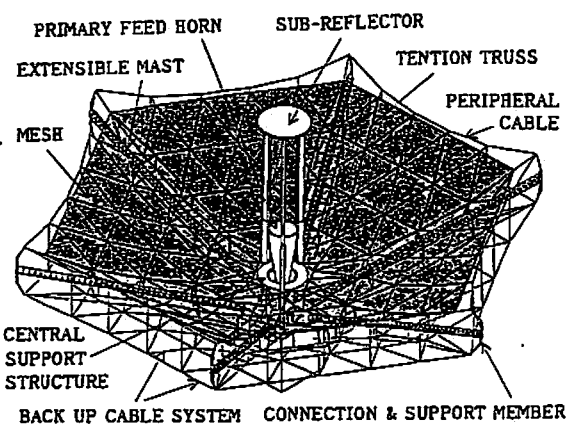


Figure 2 Antenna Configuration

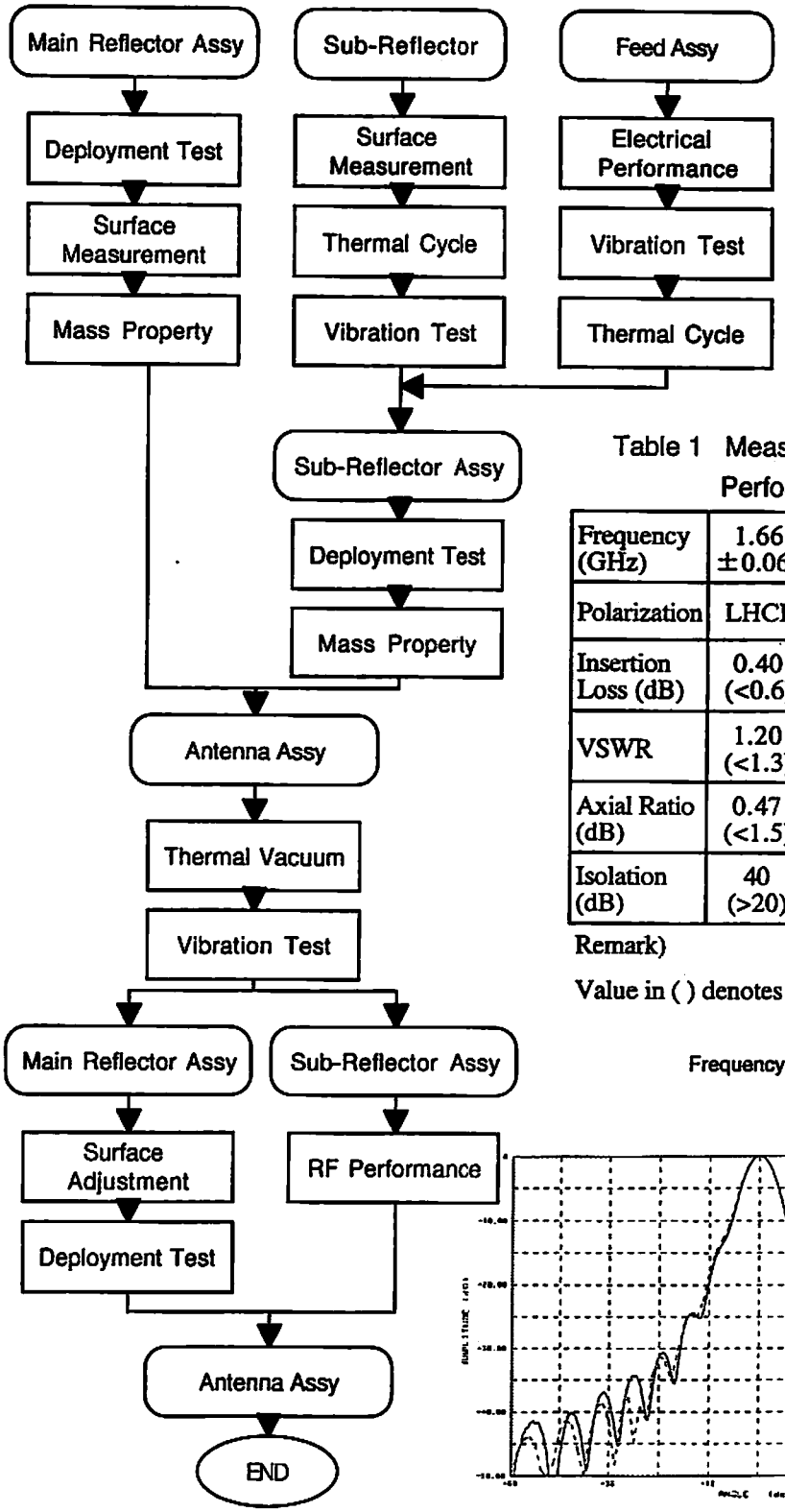


Figure 3 Antenna Test Flowchart

Table 1 Measured Feed Performance Summary

Frequency (GHz)	1.66 ±0.065	4.85 ±0.15	22.15 ±0.15
Polarization	LHCP	LHCP	LHCP
Insertion Loss (dB)	0.40 (<0.6)	0.70 (<0.9)	0.34 (<0.5)
VSWR	1.20 (<1.3)	1.17 (<1.3)	1.03 (<1.2)
Axial Ratio (dB)	0.47 (<1.5)	0.82 (<1.5)	0.51 (<1.0)
Isolation (dB)	40 (>20)	30 (>20)	N/A

Remark)

Value in ( ) denotes designed one.

Figure 4 Radiation Pattern of Primary Radiator

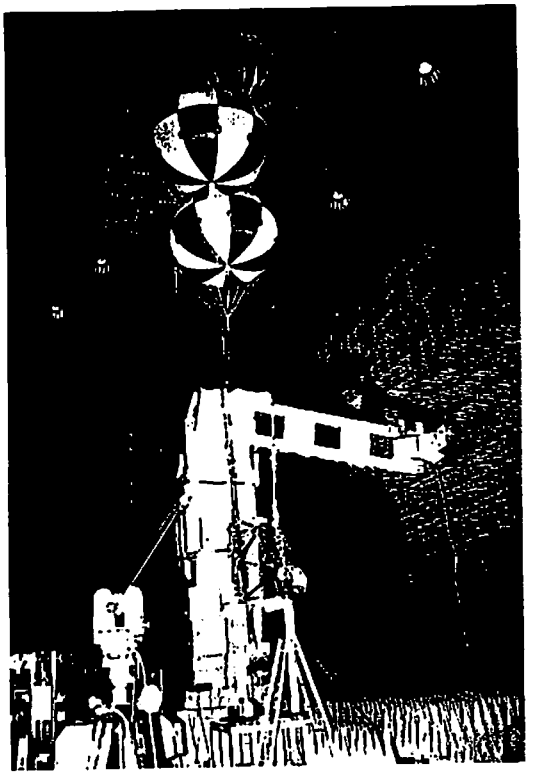


Figure 5 RF Test Configuration

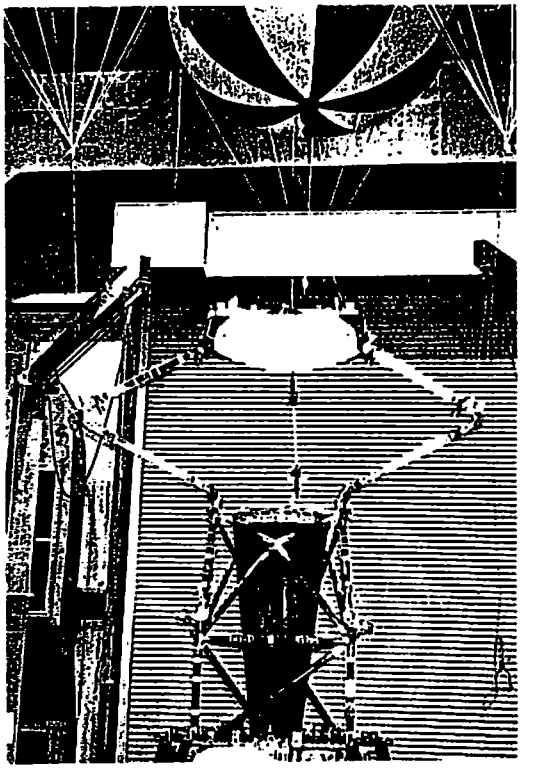
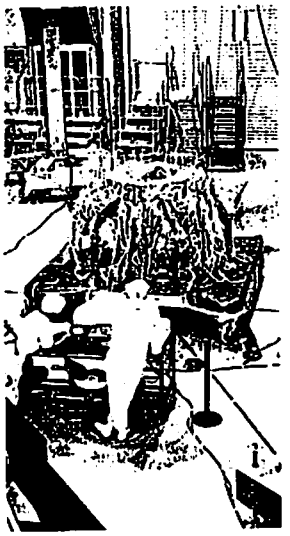
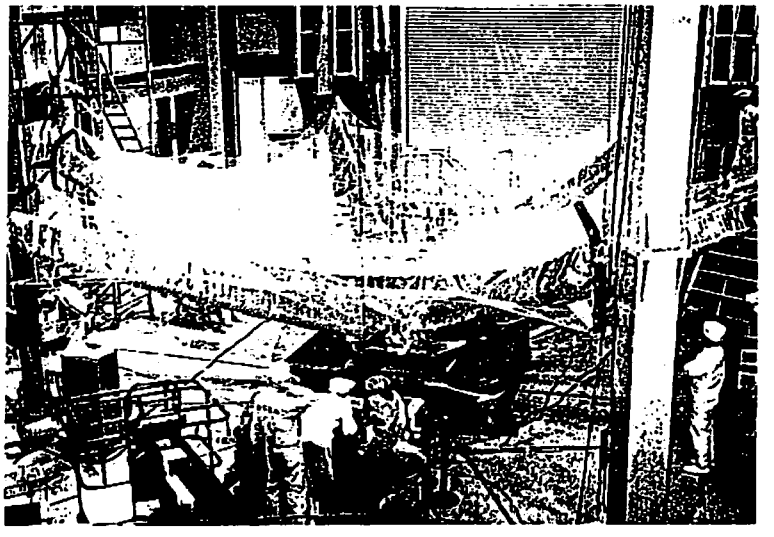


Figure 7 Sub-reflector Deployment Test Configuration



(a) Stowed Cofiguration



(b) Deployed Configuration

Figure 6 Main Reflector Deployment Test Configuration