# A STUDY ON THE INFLATABLE ANTENNA FOR MUSES-B SPACECRAFT

T. OBUCHI, Y. SHIBAYAMA, K. SEKINE
NEC Corporation
4035 Ikebe-cho, Midori-ku, Yokohama, 226 JAPAN

S. SAKAI S. KATO
KAWASAKI HEAVY Industries, LTD
1 Kawasaki-cho, Kakamigahara-city, Gifu, 504 JAPAN

M. NATORI
Institute of Space and Astronoutical Science
Yoshinodai, Sagamihara, 229 JAPAN

## Abstract

This paper describes a study on the 10m in diameter inflatable antenna system for MUSES-B satellite with analysis and some typical test results of a partial bread board model.

MUSES-B will be the first space VLBI (Very Long Baseline Interferometry) satellite in Japan. The features, antenna configuration, deployment sequence, and problems to be solved are discussed.

## 1. Introduction

The Japanese scientific satellite MUSES-B is a mission of the Institute of Space and Astronoutical Science (ISAS). The VLBI targets are to observe unresolved quasars, energetic cores of radio galaxies and compact components of star forming regions. (1)

The satellite will be estimated the weight within 760kg, and also the size within 2.2m in diameter by M-3S-V rocket's fairling capability. However, a large deployable antenna (10m in diameter) is required to meet MUSES-B space VLBI mission.

Keys of this antenna development are to realize the precision surface of large deployable reflector and simple and compact deployment truss. In order to attain a high precision accuracy reflector surface, easy transpotation and collapsible efficiency, a space inflatable rigidized cassegrain antenna has been studied as a candidate of MUSES-B's spaceborn antenna. It is found that the surface accuracy has better than 0.5mm rms and the radiation efficiency has about 40 ~ 50% in the observing frequency of 22GHz, 5GHz, 1.6GHz.

## 2. System Requirements

The system requirements for antenna are shown in Table 1.

As shown in Table 1, frequency range is very wide from K band to L band, and it needs high efficiency and also light-weight, better folding stiffness, and precision surface (0.5mm rms).

## 3. Configuration of Antenna

The deployable antenna is a symmetrical cassegrein type and consists of an inflatable regidized reflector, a rigid subreflector, common use feed system and support truss as shown in Fig.1.

The inflatable reflector adopts modularized use of inflatable elements with back up truss structure. It is possible to keep the best fit parabola with the above elements.

The dimensions of inflatable antenna are shown in Fig.2.

The feed system block diagram is shown in Fig.3. As shown in this figure, C and K band horn consists of a common use conical horn and L band four horn's multi-feeeds. To reduce the system thermal noise, it adopts a cooling device to K and C band low noise amplifiers.

Table 1. System Requirements

| | |
|---|---|
| I. Electrical Performance | |
| Observing Freq. | 22, 5, 1.6GHz |
| Frequency band width | 50MHz |
| Radiating efficiency | ≧ 40 ~ 50% |
| Side lobe level | ≦ -20dB |
| II. Structure Performance | |
| Weight | ≦ 250kg |
| Feature | ·folded within M-3S-V fairling<br>·10mφ in diameter deployable in orbit |
| Stiffness | |
| folded | ≧ 20Hz |
| deployment | ≧ 0.5Hz |
| Surface accuracy | ≦ 0.5mm rms |

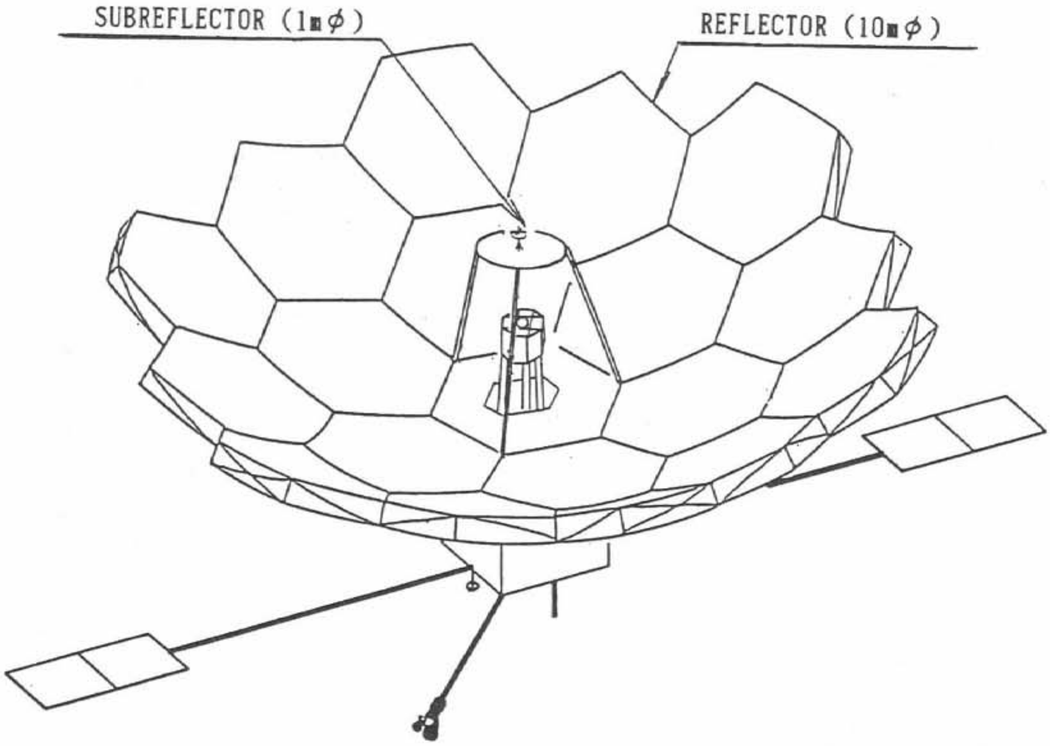


Fig.1 MUSES-B in orbital configuration

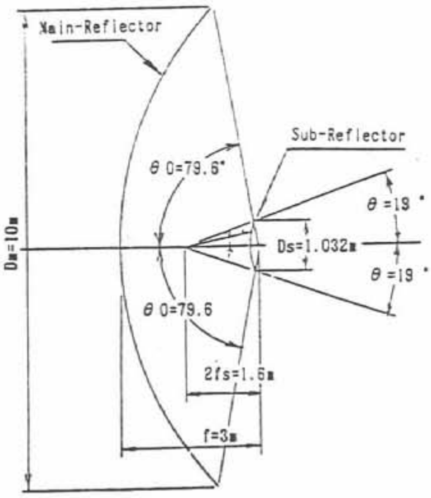


Fig.2 Antenna dimensions

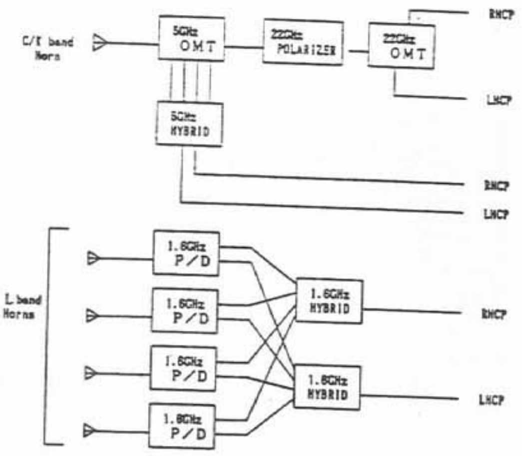


Fig.3 Antenna System Block Diagram

## 4. Description of the inflatable structure

The inflatable surface reflector structure consists of modularized inflatable elements and back-up truss structure. The hexagonal inflatable elements have good compatibility with deployable back-up truss. In launch phase, the inflatable element is stowed in a prepregged state. In orbit it is deployed from the stowed configuration, and appropriate internal pressure are applied to the inflatable elements to control the surface accuracy during rigidization of membrane materials After rigidization has finished, the internal pressure is removed.

Various tests were conducted on the hexagonal one cell model of back-up truss structure as shown in Fig.4 to evaluate the feasibility of this concept. (2)

It has been cleared on these test results that the concept of inflatalbe modularized surface reflector has the potential for high precision space reflector mission.

## 5. Pattern Analysis

The radiation patterns of using Fig.2 parameters were analyzed for all observing frequencies by the physical optics method.

It was found that the computed values for the gain patterns have satisfied the requirements.

Theses analyzed patterns are shown in Figs. 5 ~ 7.

## 6. Conclusions

In MUSES-B spaceborne deployable antenna technology, it is found that an inflatable rigidized reflector which consists of modularized elements with back-up truss can attain better than 0.5mm rms surface accuracy, and also gained simple deployability and compact collapsiblity. In next development phase it would be conirmed that the antenna can be inflated to the right dimensions by full scale engineering test model.

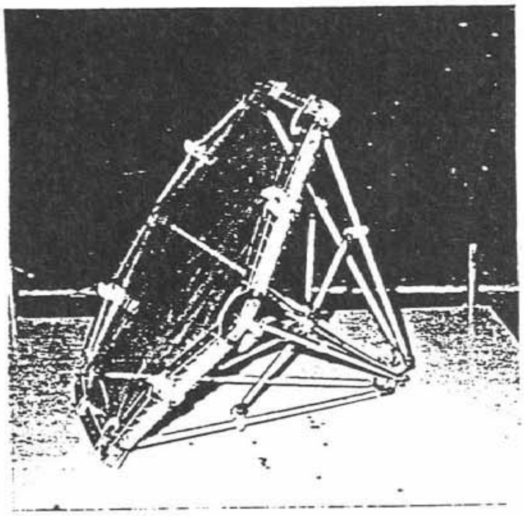

FIG.4 ONE CELL MODEL

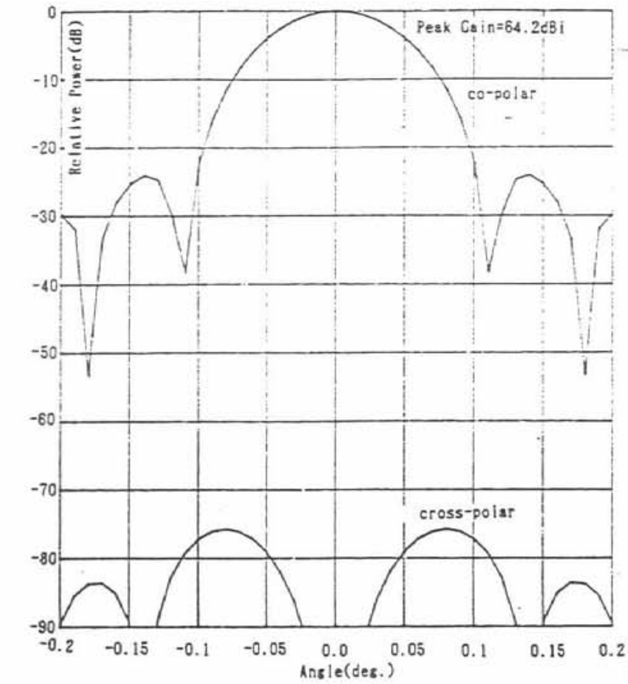


Fig.5 22GHz Pattern

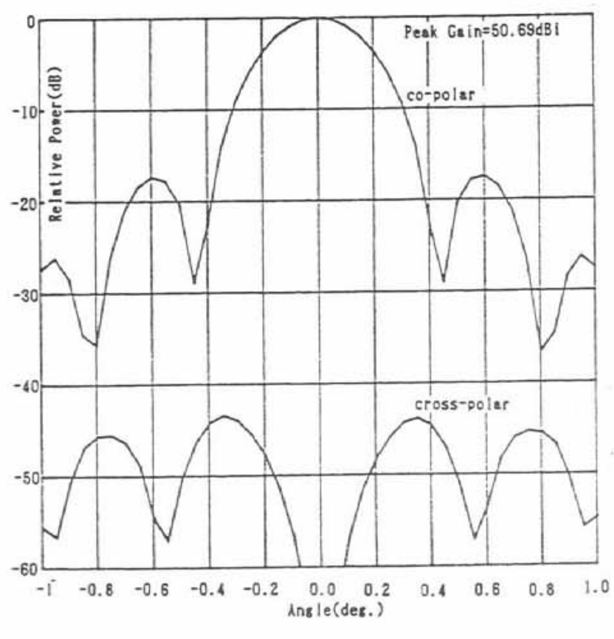


Fig.6 5GHz Pattern

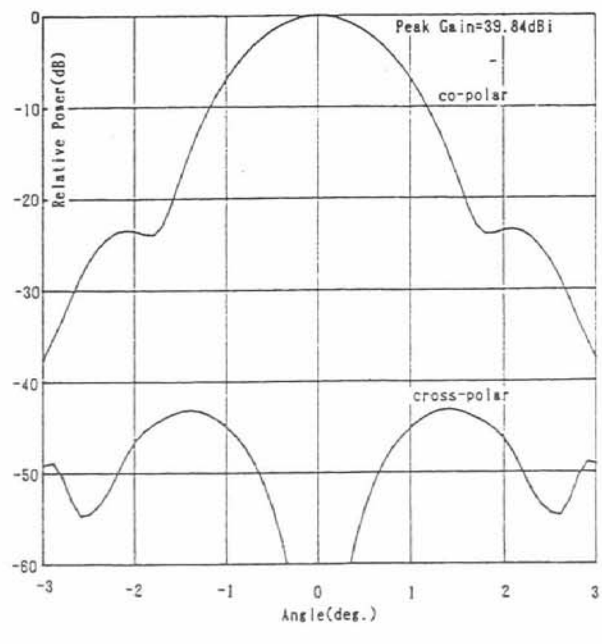


Fig.7 1.6GHz Pattern

## 7. References


(1) Masaki Morimoto, Hisashi Hirabayashi, Makoto Inoue, Toshimitsu Nishimura NRO Report No. 183 "VSOP-Japan's Space VLBI Program".

(2) S. Kato, Y. Takeshita, Y. sakai, O. Muragishi, Y. Shibayama, M.Natori, "CONCEPT OF INFLATABLE ELEMENTS SUPPORTED BY TRUSS STRUCTURE FOR REFLECTOR APPLICATION". IAF-88-274