DESIGN CONSIDERATION FOR HIGH STABILITY TELESCOPE STRUCTURE

Deoggyu Lee, Hongsul, Jang, Eungshik, Lee, Daejun, Jung, Seunghoon, Lee

Optical Payload Department, KOMPSAT-3 Program Office,
Korea Aerospace Research Institute, Taejon 305-333, Korea
Phone: 042-860-2095, Fax: 042-860-2603
dglee@kari.re.kr

ABSTRACT:

Telescope structure based on Korsch type optical layout was suggested for a large aperture optical system. Korsch type optical layout is regarded as providing wide field of view and no color aberration for which high resolution space cameras greatly demand. For the suggested Korsch type telescope structure, two folding mirrors are adopted, firstly to provide for the refocusing device mounting plane on the second fold mirror assembly, secondly by double folding the light path to concisely confine focal plane assembly within the perimeter of the tube. Optical layput design and corresponding support structure design were attained.

KEY WORDS: Korsch, Telescope, Electro-Optical System(EOS), Optical Module(OM)

1. INTRODUCTION

It is great importance for an Electro-Optical Ssystem(EOS), specially purposed for space operation to have a robust optical design to produce high quality images and dimensionally stable supporting structures against structural and thermal environments.

There exist several types of optical design for space camera such as Cassegrean type and Korsch type, etc.. Each system has advantages and disadvantages over one another and optical design has to be carefully selected to meet the mission requirements.

As end users demand high resolution and image quality along with wider field of view, optical designs have been evolved to more sophisticated ones, which often require new fabrication methods, new materials and fine tuning in assembly, integration and test.

Currently, a high resolution space camera with capability of producing submeter images has been under a intensive research in Korea Aerospace Research Institute. System requirements such as submeter image product, wide field of view and installment of refocusing mechanism were attributed to a Korsch type optical design with two fold mirrors. Optical layput design and corresponding support structure design were conducted and presented in this paper.

2. OPTICAL DESIGN

An optical conceptual design(Layout) for the telescope structure with the system requirements described in Table 1 was suggested with Korsch type with two fold mirrors, depicted in Fig. 1. The envelope of focal plane assembly for the suggested optical design was significantly reduced by double folding the light path, within the perimeter of the tube. The refocusing device was mounted on the 2nd fold mirror assembly.

Table 1. System requirements for an optical layout.

Requirement		Related Optical parameters
Parameters	Values	
Ground Sampling Distance	0.7m Pan, 2.8m Ms	Aperture dia., EFL
Altitude, Swath width	685km, 15km	FOV, optical configuration
Spectral Band	0.5μm~0.9μm 1 Pan 0.45μm~0.9μm 4 MS	Wave length, Off-axis angle, Focal Plane configuration, optical configuration
MTF	0.12 Pan, 0.2 MS	MTF
SNR	100 (PAN, MS)	Aperture dia., Transmittance, Obscuration..
Dimension	PM dia. : < 820mm Bezel dia. : < 1050mm Length : < 1950mm Sun shield : ~ 350mm	Dimension, Distance between mirror, Folding mirror position
Operational Temperature	20 ° +/- 2°	Performance Tolerance
CCD size	13□m PAN(TBD) 52□m MS(TBD)	EFL
Detector Block configuration	TBD	Beam splitter/ folding mirror
Dimensional Stability (Despace between SM and PM)	TBD	CTE, CME

Fig. 1 shows the suggested Korsch type light path. The focal length of primary mirror gets long enough to alleviate the sensitivity for the secondary mirror position error. Positions for a tertiary, 1st fold and 2nd fold mirrors were manipulated to provide space for the supporting structures without degrading the optical performance. Fig.

2 depicts 3-D view of the suggested Korsch type light path.

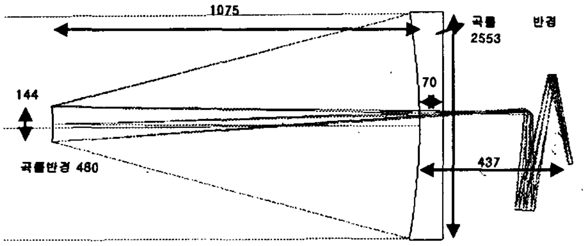

Figure 1. Korsch type light path with two fold mirrors.

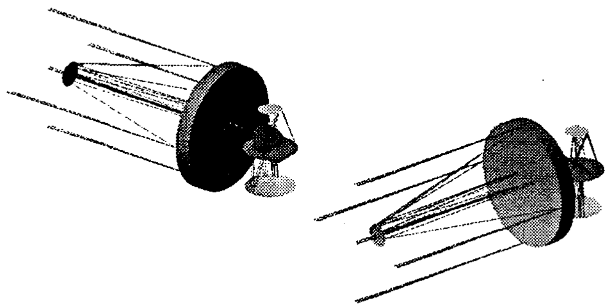

Figure 2. type light path with two fold mirrors(3D view).

Focal plane design for PAN and MS is shown in Fig. 3. Spectral bands were divided into PAN focal plane block and MS focal plane block. MS block needs another fold mirror to guide light source into beam splitter and detector units.

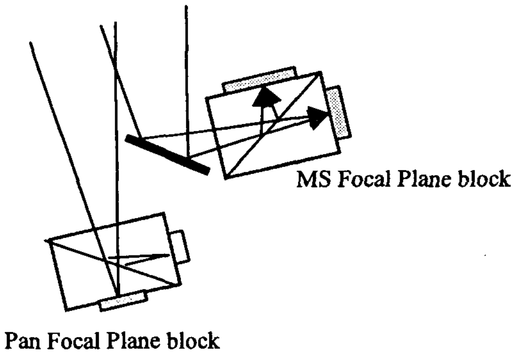

Figure 3. Focal plane design concept: Pan focal plane and MS focal plane.

3. TELESCOPE STRUCTURE DESIGN

Telescope structure has to be designed to support the suggested optical system with structural and thermal dimensional stability. In fig. 4, secondary mirror, primary mirror, tertiary mirror, 1st fold mirror, 2nd fold mirror and PAN and MS detector blocks were located properly on the positions according to the suggested Korsch type optical design.

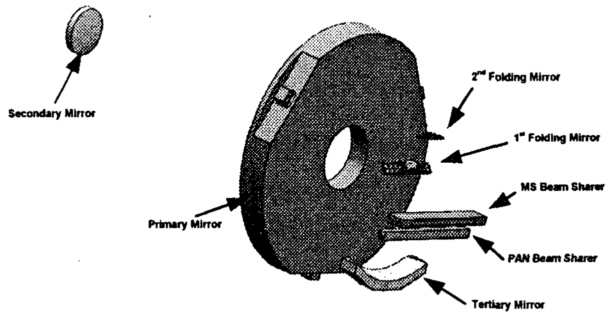

Figure 4. Suggested optical layout of SM, PM, TM, FM1, FM2 and DFA.

Fig. 5 shows the secondary mirror assembly. Baseplate is in the shape of mushroom and supported by three blades giving bending stiffness in the circumferential direction and three V-shape blades on top of them, giving bending stiffness in the radial direction. Baseplate was glued to the secondary mirror.

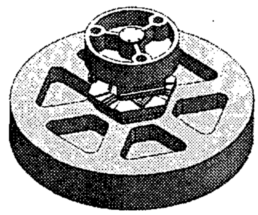

Figure 5. Secondary mirror and baseplate.

Fig. 6 illustrates the primary mirror assembly. A-shape mounts were glued to three bosses located in the position of zero astigmatism. A-mount is designed to provide the bending stiffness in the circumferential and radial directions.

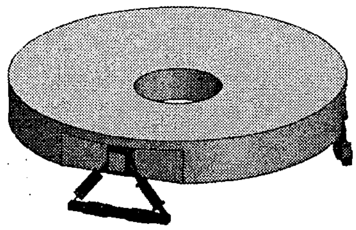

Figure 6. Primary mirror and mounting structure.

Tertiary mirror assembly is depicted in fig. 7. Mushroom type support was adopted and glued to the mirror. Tertiary mirror is in the shape of ellipse.

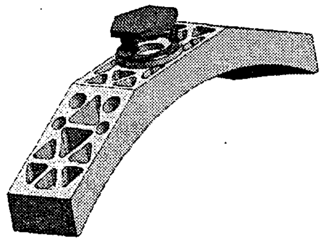

Figure 7. Tertiary mirror and mounting structure.

Fig. 8 shows 1st fold mirror assembly. 1st fold mirror has 45° angle with the line of axis. Mushroom type baseplate was adopted for 1st fold mirror.

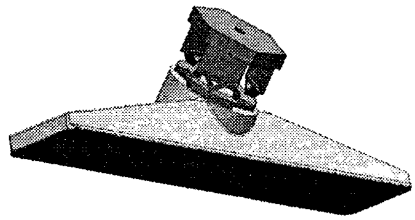

Figure 8. 1st fold mirror and mounting structure.

Fig. 9 shows 2nd fold mirror assembly. 2nd fold mirror has a right angle with the line of axis. Mushroom type baseplate was adopted for 2nd fold mirror.

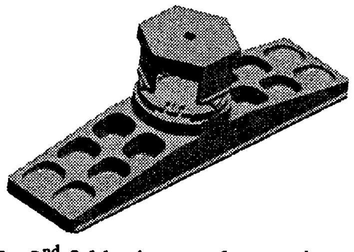

Figure 9. 2nd fold mirror and mounting structure.

Fig. 10 shows the primary mirror baseplate. Startrackers were mounted on the same plane as the primary mirror and the tube to minimize the distortion angle between the Line of Sight(LOS) for the optical system and the line of sight for the startracker.

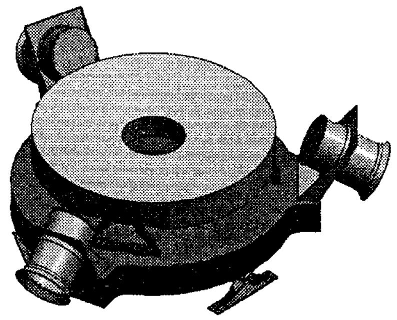

Figure 10. Primary mirror baseplate and startrackers.

Fig. 11 shows the external flexure providing interface between the Electro Optical System(EOS) and the BUS. X-shape flexure has double blades providing the stiffness in the circumferential and radial directions. X-flexure is mounted vertically, which gives easy mounting and high stiffness.

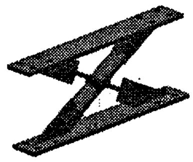

Figure 11. External flexure.

Fig. 12 shows the assembled Optical Module(OM) for the suggested Korsch type optical design with two fold mirrors. The rear view of OM is depicted in fig. 13 and all optical system including the focal plane are confined inside the perimeter of the primary baseplate. Section view for the OM is shown in fig. 14.

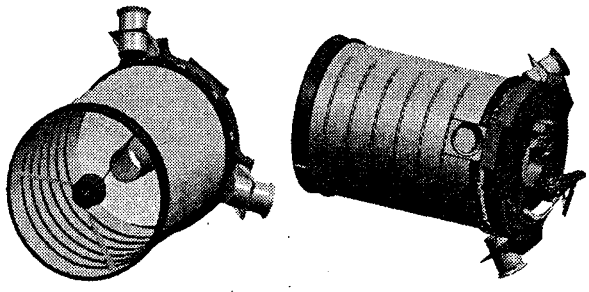

Figure 12. Suggested Optical Module.

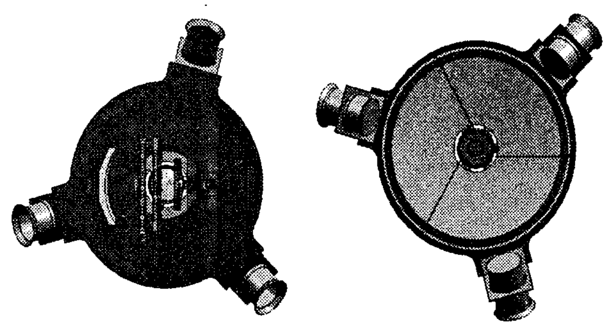

Figure 13. Suggested Optical Module(Rear view).

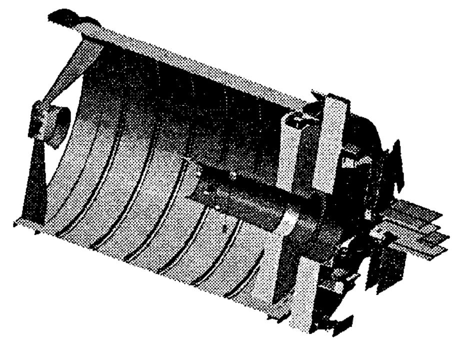

Figure 14. Suggested Optical Module(Section view).

Physical envelope for the suggested Optical Module was shown in fig. 15: ~ L(1883mm) x D(1475mm).

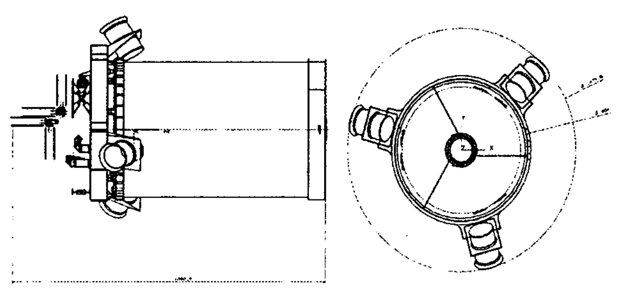

Figure 15. Physical envelope for the suggested Optical Module.

4. SUMMARY

Conceptual optical/structural design for a high resolution space camera with capability of producing submeter images has been suggested in this work. System requirements such as submeter image product, wide field of view and installment of refocusing mechanism were consider for optical/structural design and correspondingly, a Korsch type optical/structuraldesign with two fold mirrors was attained.

REFERENCES

K-3 Camera OM Conceptual Design, *KARI internal report.*