SUNDAI'S 75CM ALT-AZ TELESCOPE WITH AN E6 HONEYCOMB MIRROR

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Abstract

A 75cm alt-az telescope with a primary mirror made from the Ohara E6 glass was completed in December, 1983, at Kitakaruizawa, Japan. We describe the surface accuracy of mirror during its polishing and in a telescope cell, and also discuss some new technical points developed for this telescope.

Keywords: Telescope, Honeycomb mirror, Alt-az mounting.

<u>1. Introduction.</u> It is an essential matter to develop new technology in construction to materialize very large optical telescopes. As shown in this proceedings and others (e.g., Proceedings of SPIE, Volume 444, Advanced Technology Optical Telescope II, 1983), many engineers in astronomy are trying to do this. One of the authors (S.I.) originaly had the intention of developing some new technology, while the Sundai Senior High School wanted to build a telescope for its 50 years anniversary. So, we jointly build a new telescope with a 75cm primary mirror of honeycomb structure, a computer-control alt-az mounting, a TV guide system, and a flip-flop top ring between the primary and Nasmyth foci (figure 1). Here, we describe the performance of this telescope, especially that of the primary honeycomb mirror made from the Ohara E6 glass.

<u>2. The primary mirror with honeycomb structure.</u> The primary mirror

Proceedings of the IAU Colloquium No. 79: "Very Large Telescopes, their Instrumentation and Programs", Garching, April 9–12, 1984.

has honeycomb structure and weighs 60kg which is about a half of that for a solid mirror blank of the same size. This mirror was produced by Dr. R. Angel at the Steward Observatory, the University of Arizona and was made from the Ohara E6 glass. This is the first honeycomb mirror in use for actual observations.

The mirror blank was polished by Mr. K. Ikeya from July to September, 1983 (figure 2). Before polishing, the back-surface of the ribs was polished to make a good fit between the mirror and the polishing platform. During the polishing period, the mirror blank was continuously settled on this platform and was fixed by side stoppers at 3 points. A knife edge

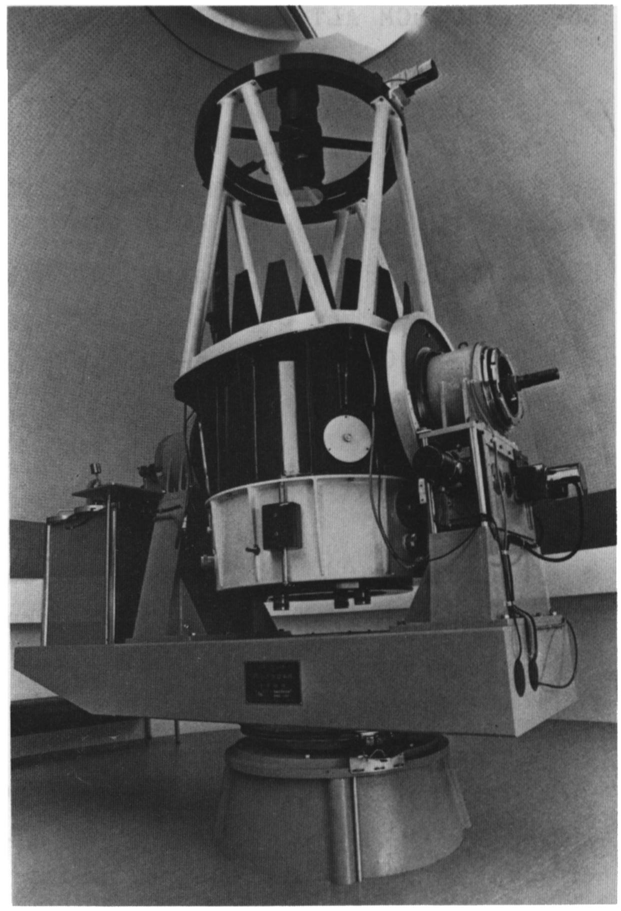

Figure 1. An overview of the Sundai's 75cm alt-az telescope.

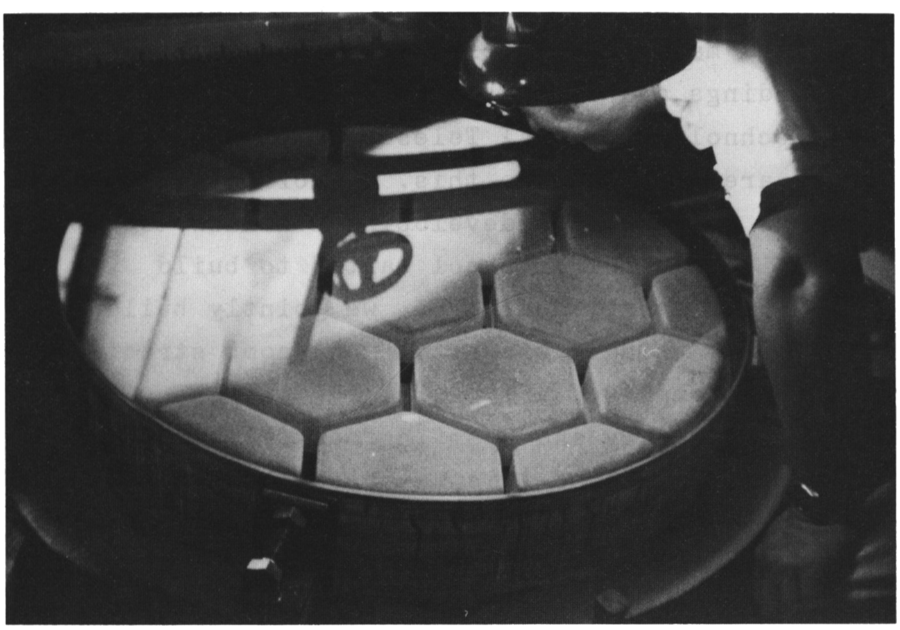

Figure 2. A 75cm honeycomb mirror during polishing at the platform by Mr. K. Ikeya.

https://doi.org/10.1017/S0252921100108358 Published online by Cambridge University Press

test was carried out by tilting the platform perpendicularly. As shown in table 1, the accuracy of the mirror surface in the laboratory were 0".3 or better. On the telescope, we introduced 3 x 2 pneumatic supports for axial support and a half circle

Table 1. A result of the knife edge test.

y mm	$y^2/2R$ mm	Nomalized value at y = 350mm	Measured value	Difference
50	0.278	13.35	14.40	-0.05
100	1.113	12.52	12.48	+0.04
150	2.503	11.13	11.10	+0.03
200	4.450	9.18	9.15	+0.03
250	6.954	6.68	6.67	+0.01
300	10.629	3.62	3.62	0.00
350	13.629	0.00	0.00	0.00
382	16.278	-2.65	-2.59	-0.06

Diameter of mirror : 767mm
Radius of curvature: 4494mm
Focal length : 2247mm
Weighs : 60kg
Thickness : 131mm

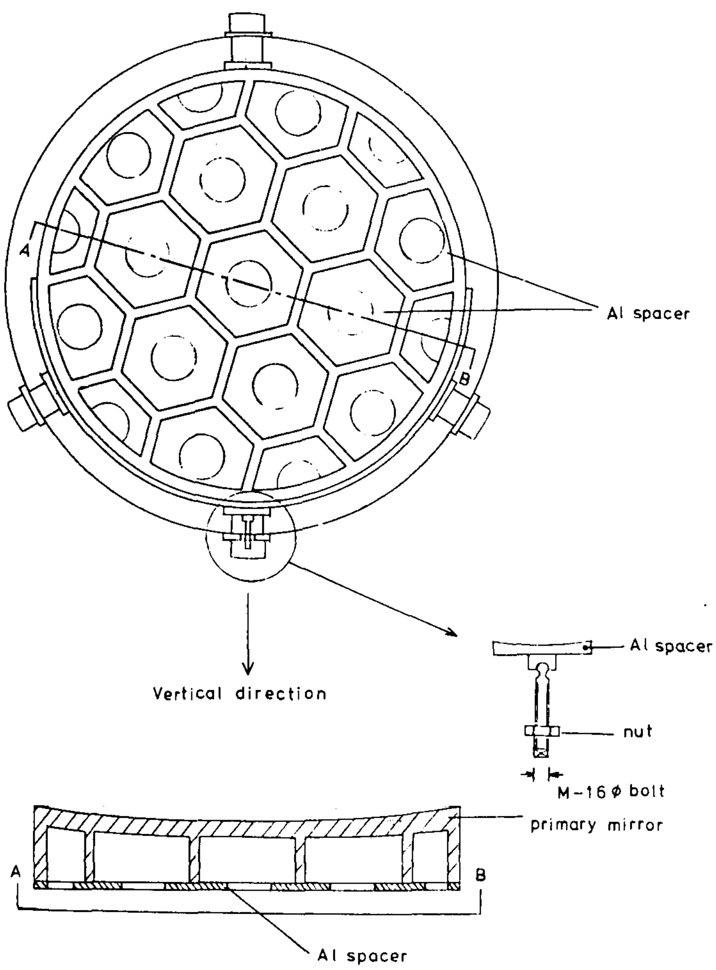

Figure 3. Configuration of honeycomb mirror and its support system. The mirror sits on a Al spacer.

belt for radial support (figures 3 and 4). When a star near the zenith was seen at the Nasmyth focus, we found that the image size of the star was defined by its seeing size of 2". However, when a star was located far from the zenith, the belt supported by soft touch pads was needed to get a good imege.

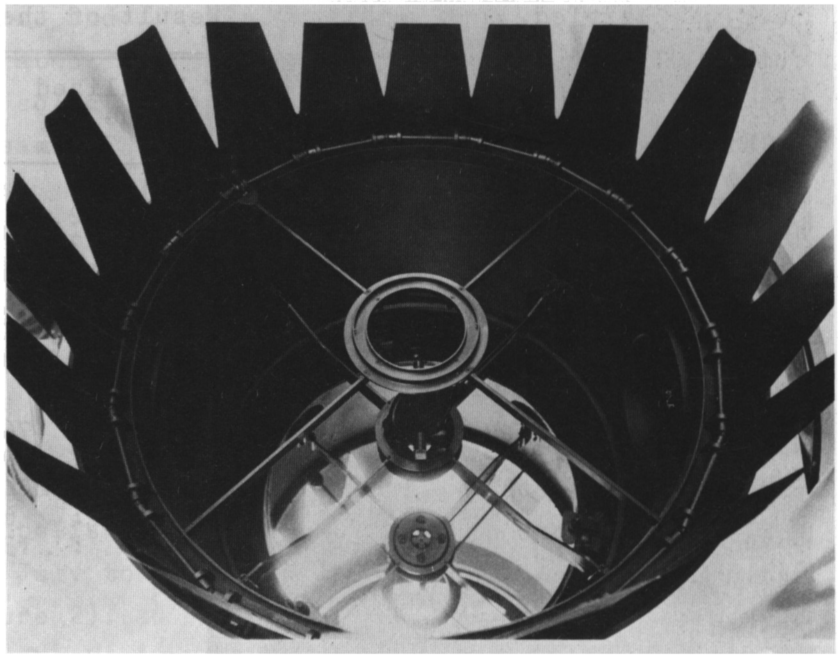

Figure 4. A 75cm honeycomb mirror in the mirror cell. A tertiary mirror for both Nasmyth foci is seen.

The primary mirror has a focal ratio of F3 and the combined focal ratio at the Nasmyth focus is F12 which is an optimized value to make a turn-over of the top-ring possible. An image of the Orion Rigel is shown in figure 5.

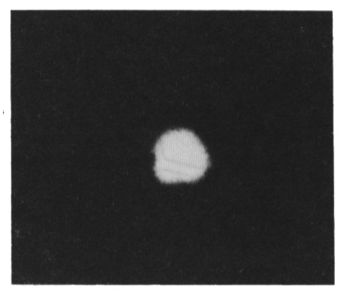

Figure 5. An image of the Orion Rigel with an image size of 3" defined by its seeing size.

3. Focal system and control system.

A flip-flop top ring with the primary and Nasmyth foci is introduced. The primary focus is only used for photographic observations. An Olympus OM1 camera with a roll film and a remote shutter and winding system is set at the primary focus to reduce lost time during the exchange of films from one exposure to another. There are two Nasmyth foci. By tilting a tertiary flat mirror in 90°, one can get either Nasmyth focus in a few seconds. Reproducibility of the stellar position at the same focus before and after the movement of the tertiary mirror is good enough in less than the seeing size of a star.

One Nasmyth focus is used only for eye observations, because some

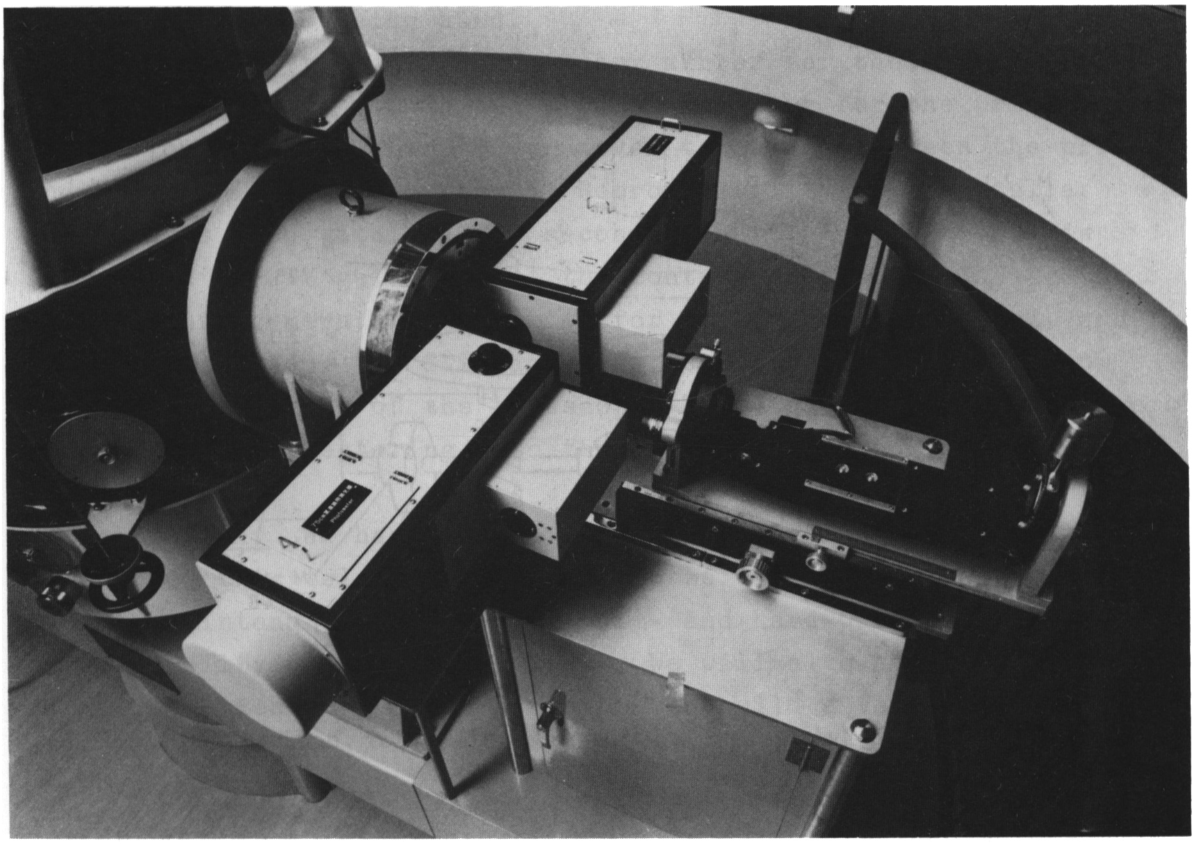

Figure 6. A layout of the photometer, the spectrometr, and the holder of the SIT TV camera at the Nasmyth focus.

parts of the telescope time are allocated for public education.
At the other focus, there are three observational instruments: an SIT TV camera, a photometer, and a spectrometer, which are used for astronomical observations. These three instruments are fixed on the Nasmyth platform. In front of the Nasmyth focus, a dichroic mirror is inserted and is able to tilt in 90°. Therefore, one part of the light beam goes directly to the SIT TV camera and the other part goes to either the photometer or the spectrometer by tilting the dichroic mirror (figure 6).
An alt-az mounting is introduced. Therefore, a computer control system is needed to point the telescope to an observing field, to track it at the fixed field, and to rotate the observational instruments for compensation of the field rotation. The dome motion is also controlled by the computer.
Since the primary encoder at each axis has only 16 bits because of the limited amount of the total budget, an additional sub-encoder with 11 bits is added as shown in figure 7. Thus, we may

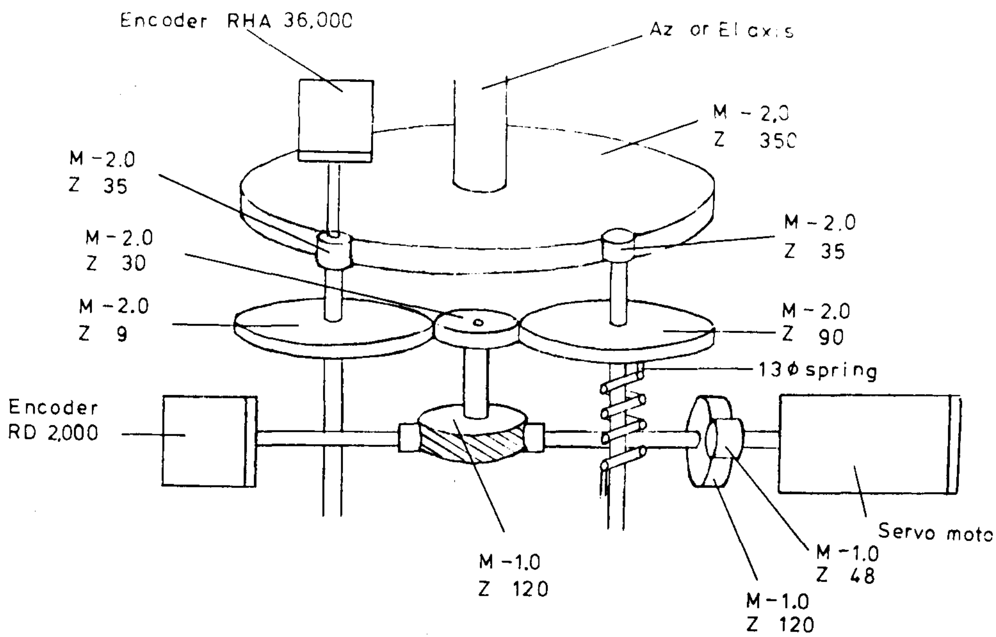

Figure 7. Driving and encoding system for both azimuth and elevation axis.

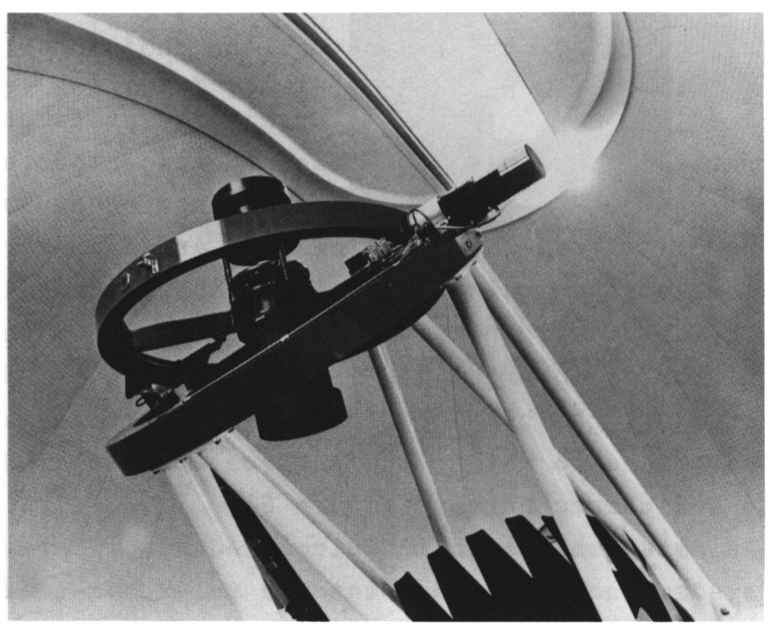

Figure 8. A flip-flop top ring between the primary and Nasmyth foci.

read the telescope position to a sub-arc second in principle, but the gear system makes worse the position accuracy. A spring coil is used to reduce the back-rash of the driving gear. The diameter of the main gear is 75cm. Although we are still developing a soft-ware program for the pointing and tracking of the telescope, by April 30 the amount of drifting motion of a stellar image at the focus is $\sim 1''$ per one minute of time. This is not perfectly acceptable but does not give much difficulty in practical use because an SIT TV

https://doi.org/10.1017/S0252921100108358 Published online by Cambridge University Press

guiding system is being used.
On the top ring there is a secondary mirror for the Nasmyth focus and a photographic camera and a guiding system for the primary focus. This ring is able to turn over to change between the primary and Nasmyth foci in one minute. Reproducibility of the stellar position is good within a few seconds of arc. An SIT camera is introduced for TV guiding. All the control systems including the photographic camera, the computer for the telescope control, and the moniter TV for the SIT camera is located in a separate room under the dome room of the telescope. Therefore, observers can work without actually entering into the dome room.

4. Conclusion. We have almost completed our 75cm alt-az telescope. Therefore, this telescope is ready to be used for actual observations. We intend to develop our soft- and hard-ware system to allow a high quality of the observations. We will also study what kind of difficulties are in its structure to build a very large optical telescope in future.

The authors would like to express their sincere thanks to Mr. K. Ikeya for good polishing, to the staffs of Norizuki Technical Factory, to the staffs of the Tokyo Astronomical Observatory, especially Mr. K. Tomita and Mr. M. Shimizu for their helpful comments on the telescope design, and Mr. K. Ohtani, the Vice-director of the Sundai Senior High School, for his continuous encouragement during this project.