John Cruickshank Telescope Imaging Technology

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The John Cruickshank Telescope is a professional level telescope for observing the night sky in high resolution using the latest imaging technology with the following instruments:

A. Optical Tube Assembly (OTA)

The OTA of JCT is a premium StellaLyra Ritchey-Chrétien Telescope OTA [A] manufactured by Guan Sheng Optical (GSO) in Taiwan. Its high-performance Ritchey-Chrétien (RC) optics is designed to completely eliminate common off-axis optical errors found in more traditional telescope configurations and is today's standard for most large ground-based and space-borne professional research telescopes. This RC OTA has precise hyperbolic primary [A.1] and secondary [A.2] mirrors made of quartz, offering exceptional 95% reflectivity.

With its 16" aperture (the primary mirror having 16 inch in diameter), the JCT's RC OTA has a remarkable intrinsic optical resolution of 0.29 arcsec set by Dawes' limit. Combined with the focal length 3250mm, the focal ratio (focal length/aperture) of JCT is 8, i.e. f/8, ideal for high-resolution imaging with magnification up to 800x. On occasion, the focal length may be reduced, for example, by 20% to obtain f/6.4 for brighter images with shorter exposure times.

JCT's OTA features the same Serrurier truss configuration [A.3] as the 200" Hale telescope at the Palomar Observatory famously used by Nobel Laureate Astronomer Edwin Hubble to accelerate our understanding of the Universe's expansion he previously discovered. This truss design effects an equal amount of flexure, allowing the optics to stay on a common optical axis and keeping the optical elements parallel to each other regardless of the telescope's orientation so that optical collimation remains precisely intact. In addition, the trusses in JCT are made of a carbon fibre-reinforced composite material with virtually zero thermal expansion ensuring maximum thermal stability of the OTA.

B. Computerised GoTo Mount

JCT's OTA is secured rigidly on a computer-controlled observatory-class German Equatorial Mount [B] that provides exceptionally precise tracking of celestial and orbital objects and supports their high-resolution photography.

As an equatorial mount, it rotates through two primary axes corresponding to the two angles in the celestial coordinate system. The first, Right Ascension (RA), axis also known as the Polar axis is aligned with the Celestial North. The second, Declination (Dec), axis is perpendicular to the RA axis and allows the telescope to change the angle between its viewing direction and the Celestial North. When observing a star 'fixed' on the Celestial Sphere, JCT compensates for Earth's rotation by counter-rotating around the RA axis at the precise sidereal rate, allowing JCT to track deep-space objects as they move across the sky. For planetary observations, precisely controlled variable rotations around both RA and Dec axes are performed, which also applies to tracking a satellite that JCT is capable of.

The computerised GoTo mount enables the automated operation and astronomical data taking of JCT which can be remotely controlled and monitored using the international ASCOM Standards for Astronomy via high-speed internet.

C. Off-Axis Guider (OAG)

The observation resolution of ground-based telescopes at sea-level locations are typically limited to be approximately 1.5 arcsec due to seeing caused by atmospheric turbulences. At this resolution, many fine details on small solar system bodies appear blurry. Additionally, deviations in microns from perfect polar alignment, flexure of telescope optics and mechanics, and other factors cause small discrepancies to spoil the perfect tracking process. To obtain shape images with a resolution closer to JCT's intrinsic optical resolution of 0.29 arcsec, not only the motion of night sky needs to be tracked perfectly as the Earth rotates, but also errors in the tracking rate due to seeing and other factors must be corrected.

JCT is fitted with an Off-Axis Guider (OAG) [C], widely considered the most accurate autoguider technology for high-resolution astrophotography. The OAG uses a small prism as a diagonal mirror to deflect tiny part of the light arriving from the telescope near the edge of the imaging field to a separate guide camera. [C.1] An off-axis guider provides far more accurate tracking than a conventional guidescope, as it is attached firmly right adjacent to the imaging camera to entirely remove flexure between the two. The OAG is compact with low weight and has the full resolution of the main telescope by using the same optics. The OAG corrects for tracking errors to get sharper data capture by providing guiding feedback signals to JCT's GoTo Mount and indirectly to Electronic Automatic Focuser with error-compensating controls.

D. Imaging Camera

JCT's main imaging camera [D] is a top-tier CMOS camera for advanced deep-sky astrophotography. The camera features the professional-grade Sony IMX455 full-frame monochrome sensor, with a large chip size 36mm x 24mm and a phenomenal 61-megapixel resolution (9576 x 6388, greater than a 10K display pixel size) and an outstanding 16-bit colour depth per pixel of size 3.76micron. The camera has a superior light and near infrared sensitivity with a cutting-edge peak 91% quantum efficiency and is cooled so that the sensor temperature is up to 35°C lower than the surrounding temperature to minimise thermal noise for further enhanced imaging quality.

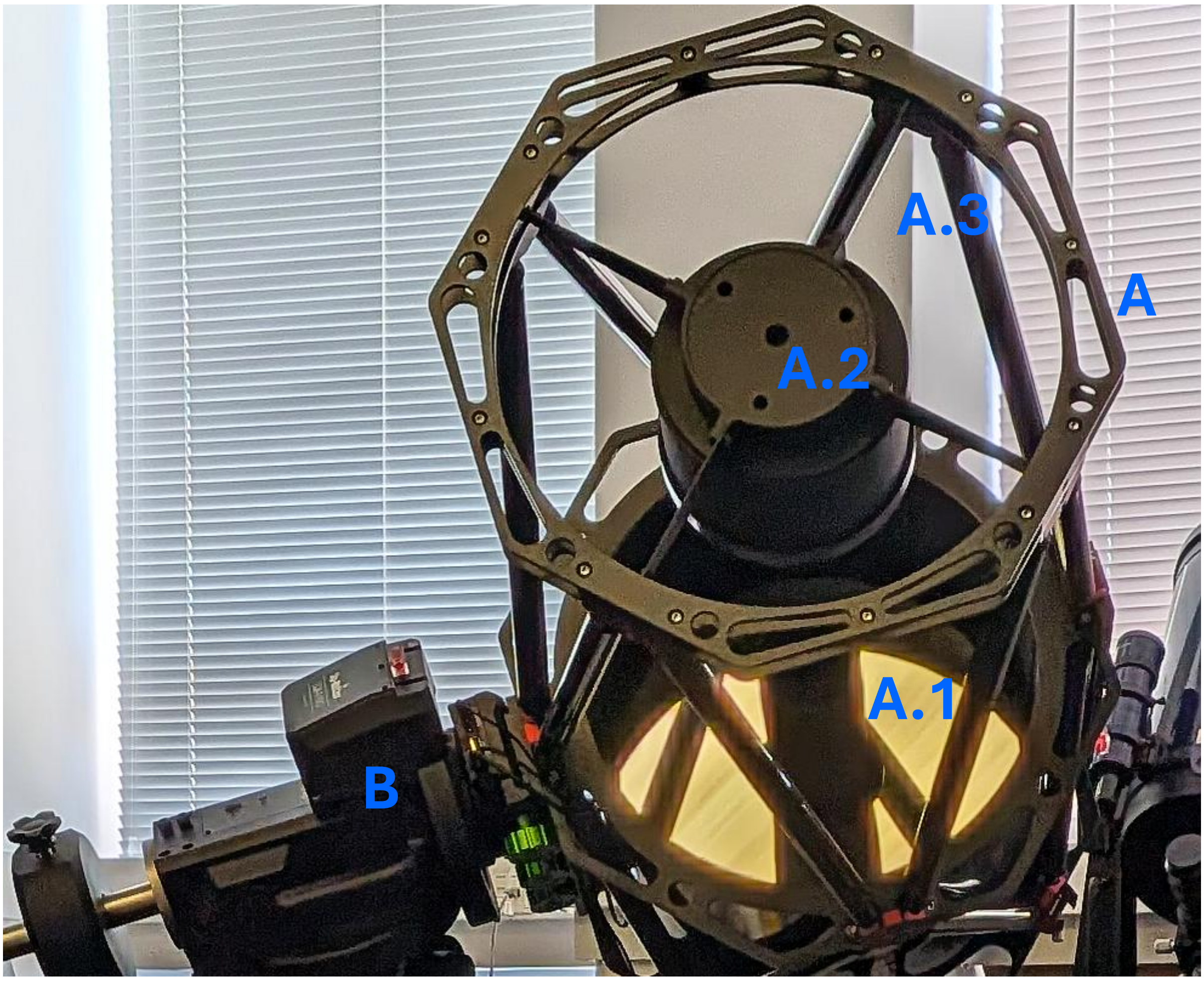
E. Electronic Automatic Focuser (EAF)

JCT is fitted with a state-of-the-art Electronic Automatic Focuser (EAF) [E]. It provides precise, micron-level focus control and automated focusing, significantly reducing the need for manual adjustments and improving image quality in combination with OAG by correcting focus drift.

F. Electronic Filter Wheel (EFW)

JCT uses a top-quality Electronic Filter Wheel [F], a motorised device used to switch between different optical filters in the imaging system as part of the computer/remote control of the telescope. It is primarily used to automate spectral selection, allowing to capture images in different wavelengths or control light intensity remotely.

See images on next page.


A.3
A
A.2
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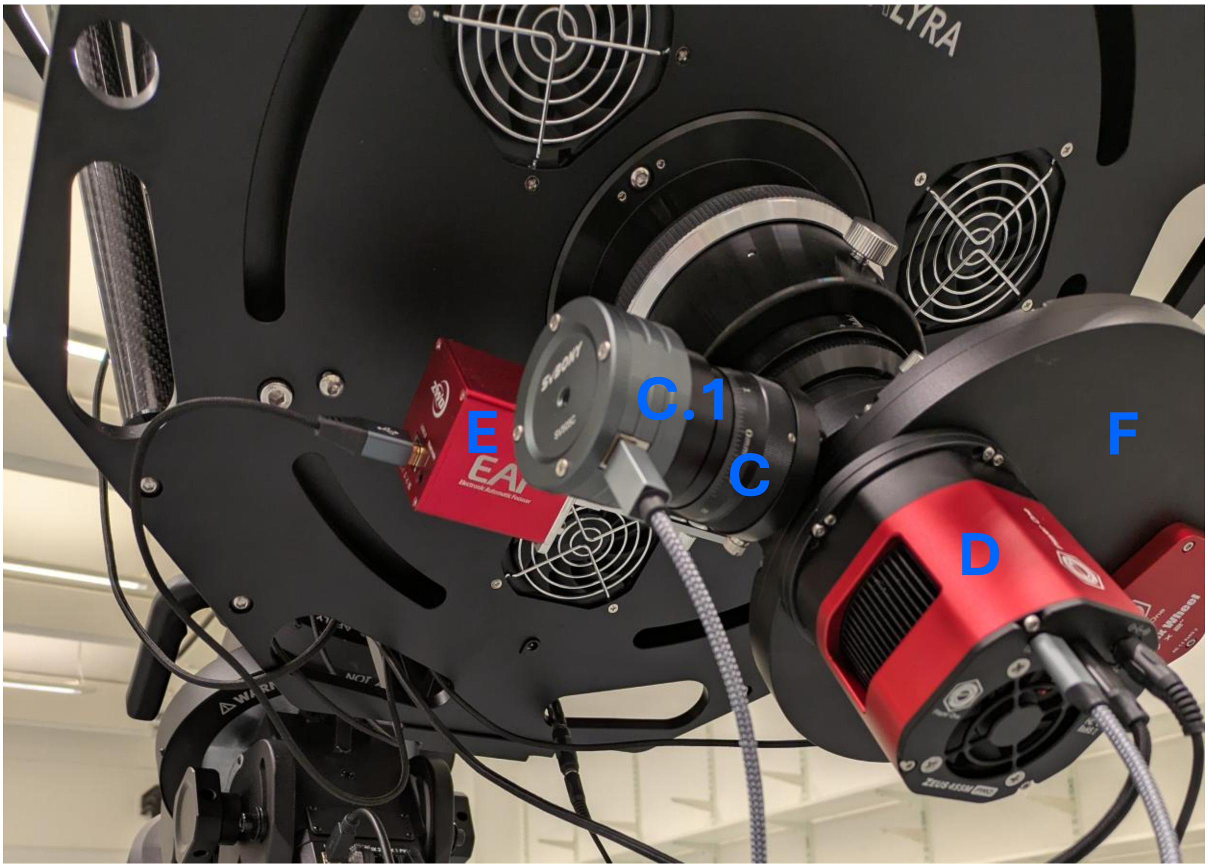
B


LYRA
C.1
E
EAF
C
F
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