SPIM on the 3.6m DOT

The 3.6-m DOT has three instrument ports, one axial main and two on the sides. Currently, the main port and only one side-port (where NIR instrument TIRCAM-2 is mounted) are engaged in the scientific observations. Instruments available on the main-port mounting are TANSPEC (NIR imager and spectroscopy), ADFOSC (optical imaging and spectroscopy), and 4Kx4K optical Imager. Therefore, the side-port Imager (SPIM) is critical, especially when TANSPEC is mounted on the main-port of the 3.6-m DOT. To address the lack of an optical imaging instrument on the other side-port, a SPIM with an in-house design is designed which is mounted on one of the side-port of the 3.6m telescope. The SPIM can capture observations using both broad-band and narrow-band filters. Its filter wheel has the capacity to hold up to 16 filters at a time.

One of the most exciting features of the SPIM is the ability to accommodate two CCDs on a rotating plate simultaneously. Currently, a new 4K×4K CCD from ANDOR is installed on the SPIM, which was procured in January 2023. The CCD can be thermo-electrically cooled. With a pixel size of 15 μ, the CCD offers a field of view of approximately 6.5 × 6.5 arcmin^2. Given its coverage of wavelengths from 350 nm to 1000 nm and its ability to perform both broadband and narrowband imaging, the SPIM is well-suited for studying star-forming regions, star clusters, transient sources, active galactic nuclei, variable stars, and more.
The median seeing of Devasthal site is 1.1 arc-sec and occasionally seeing as low as 0.7 arc-sec (~ 10% of the observing time) as seen during ground level seeing measurements.

Camera Specifications:
The iKon-XL 230 model uses the Teledyne e2v CCD230-84 back-illuminated sensor, offering a very large 61.4 x 61.4 mm^2 imaging area from a 4096 x 4108 array format and 15 μm pixel size, ideal for applications in Astronomy .

Read-out speed (noise in e^-)	100 kHz (3.8), 1 MHz(8.5), 2 MHz (12), 4 MHz (23)
Binning	User definable
Dark Current	0.0009 electrons at -60 C
Quantum efficiency	>95%

Linearity	Better than 99%
Outputs	Quad or single port
Blemish specification	Grade 1 sensor from supplier
Minimum temperatures	-75 ºC (@ coolant temperature of 16ºC) -60 ºC (air cooled (@20°C ambient)

For this CCD camera, images could be saved in fits format. It is also possible to read-out the chip in a single mode using only one amplifier or a "quad" mode reading all the four quadrants separately. However, while opting for a "quad" mode for some of the science cases, one should be careful about the pre-processing of the image files before further processing/calibrations.

Shutter and Filters:

The camera has an extended range shutter which can be used in the temperature range -30 to +30 C.

The filter wheel contains a set of Bessel UBVRI filters and a set of SDSS ugriz filters with one clear. The time taken to change the consecutive filters is about 15 sec.

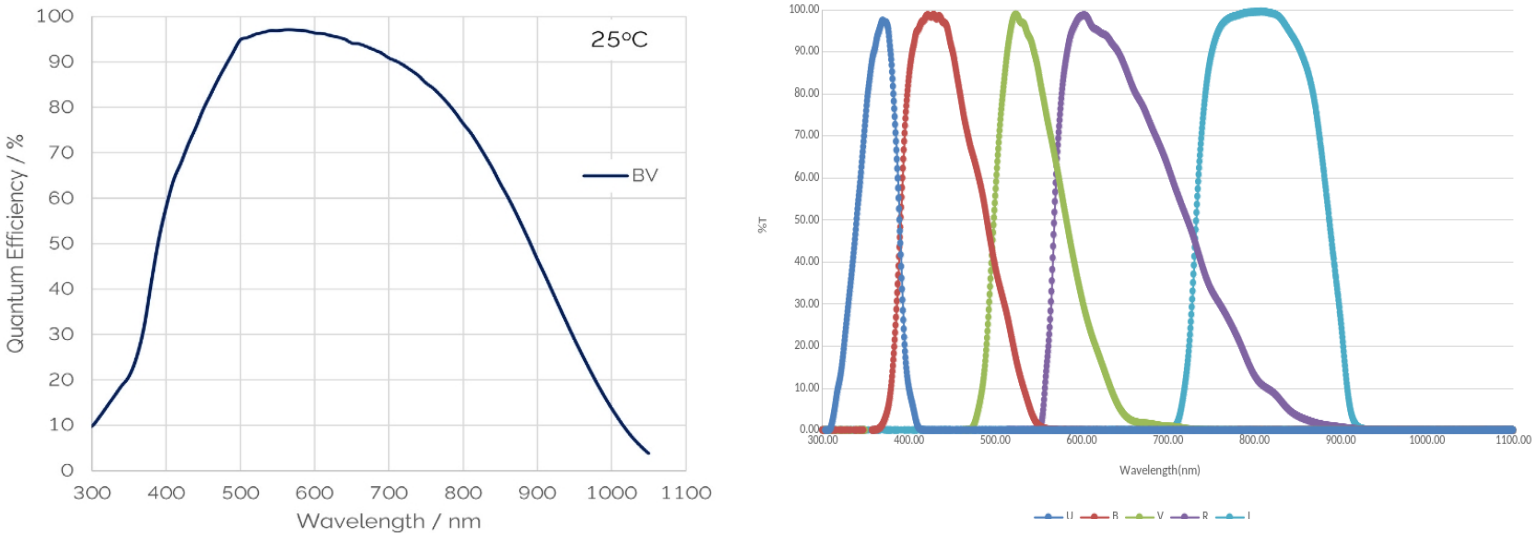

Figure 1: Quantum efficiency curve for the ANDOR CCD (left). Transmission of the Bessel filters used with the SPIM (right)

Throughput of the CCD Imager was calculated using the the standard specifications of the 3.6m DOT and using the published values of the extinction coefficients, sky-brightness (Kumar A. et al. 2022) for an assumed value of 1 arc-sec FWHM at zenith.

The simulated results of the signal to noise ratio at different brightness levels for the given quantum efficiencies of the CCD at a read-out speed of 1 MHz show that for the present M1 reflectivity, for a value of SNR=10, 1 hr exposure can reach up to 23.5 mag and 22 mag in V and I bands, respectively.

Using sky flats in several filters and bias frames, photon transfer curves were generated to verify gain and read-out noise values at different speeds. Parameters like linearly, bias stability were verified in single output mode.

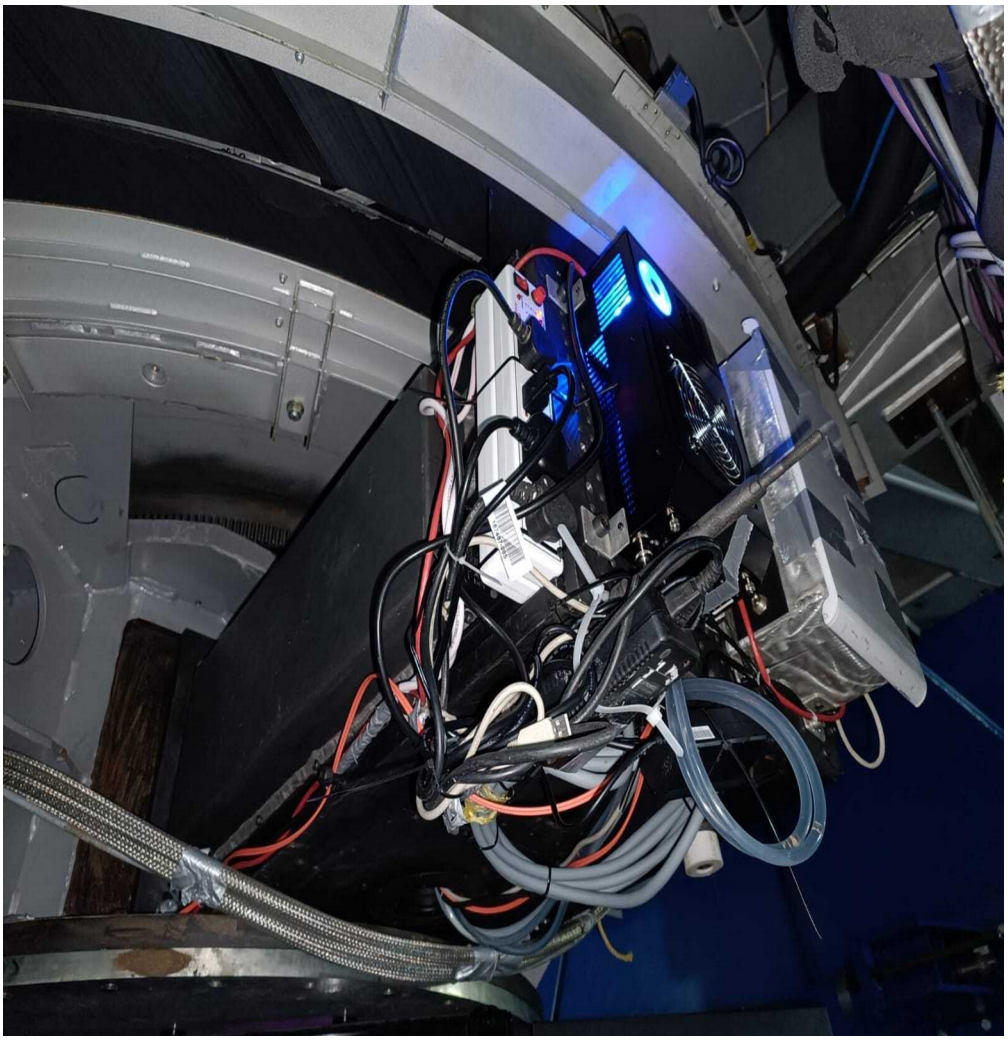

Figure 2: The 4Kx4K CCD camera along with the automated filter wheel mounted at the side-port of the 3.6m DOT.

Exposure time in a given filter and other CCD parameters could be set as per the science requirements. The Telescope could be operated both in open and closed loop modes using the auto-guiding unit through the Telescope Control Software. The details about making the telescope ready for observations and using the auto guiding units etc.

will be provided through a separate set of documents/manuals. On site observing assistance will be provided. The user manuals of the CCD camera will also be provided separately to the observers.

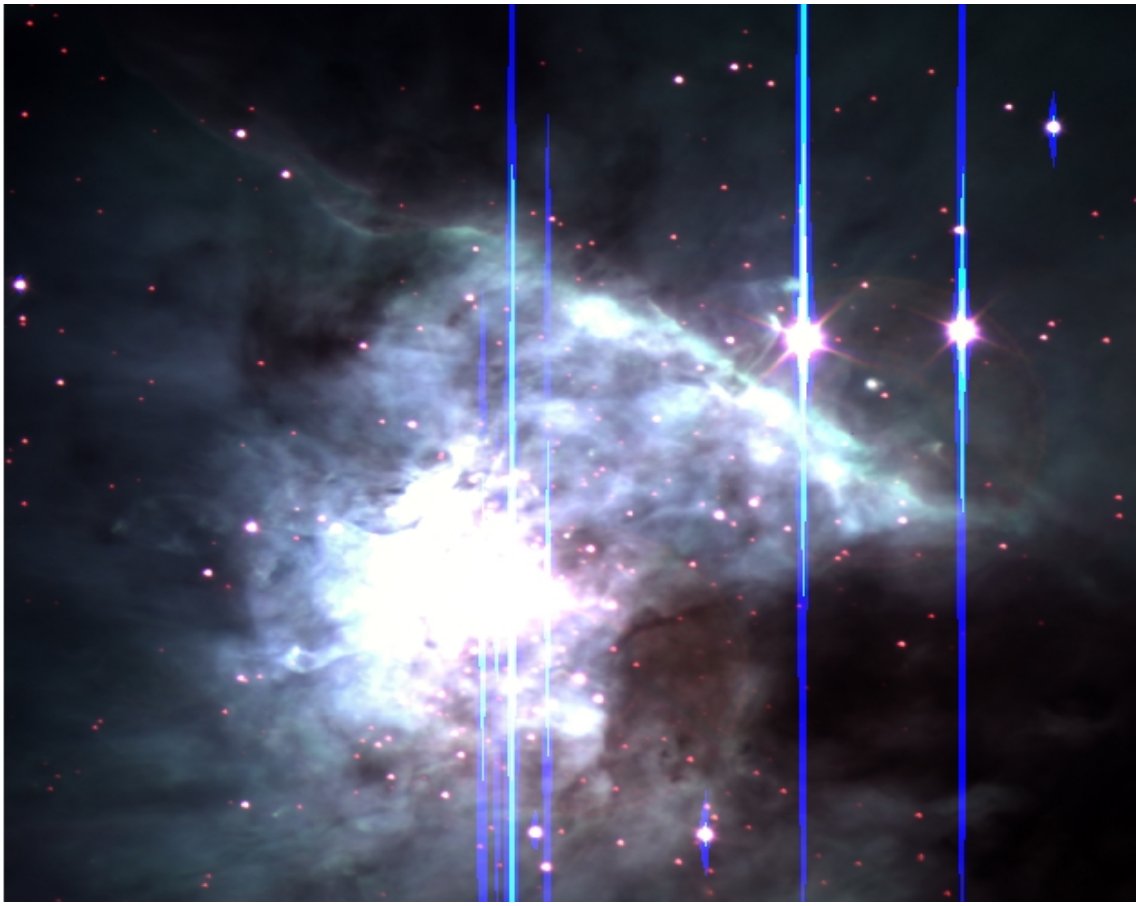

Figure 3: BVR colour-composite RGB images of Orion Nebula (150 sec) observed with the SPIM mounted at the side-port of the 3.6m DOT.

Acknowledgements: Contributions from the side-port Imager team is thankfully acknowledged to get the instrument working well within time limits as an in-house developmental activity. A detailed report on the Imager development and calibration will soon be made available to users and published by the team.