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The Optical Subsystem of the SOFIA Telescope

H. Bittner, M. Erdmann, M. Erhard, P. Haberler
Kayser-Threde GmbH, Munich

Abstract: The poster presents Kayser-Threde's major contribution to the Stratospheric Observatory for Infrared Astronomy (SOFIA) which are the telescope optics and the tracking cameras. SOFIA accommodates a Cassegrain telescope with an effective aperture of 2.5 m. The central optical part of the telescope is the 2.7-m monolithic lightweight Zerodur primary mirror mounted in a stiff CFRP mirror cell. The Focal Plane Imager uses the visible focus of the main telescope allowing high-precision pointing of the star field under observation in the sub-arcsecond range (up to 0.2 arcsec rms). The two other cameras, the Wide Field Imager and the Fine Field Imager, are boresighted to the main telescope and will be used for acquisition of the star field as well as for pointing and tracking of the telescope.

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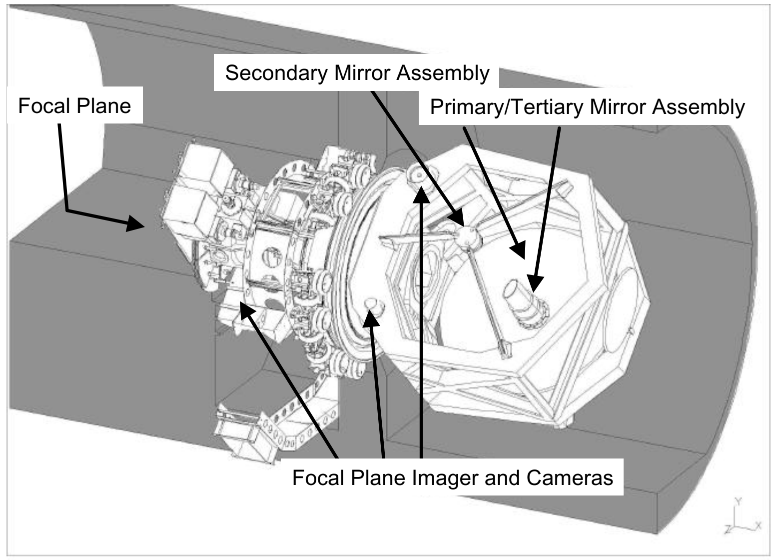

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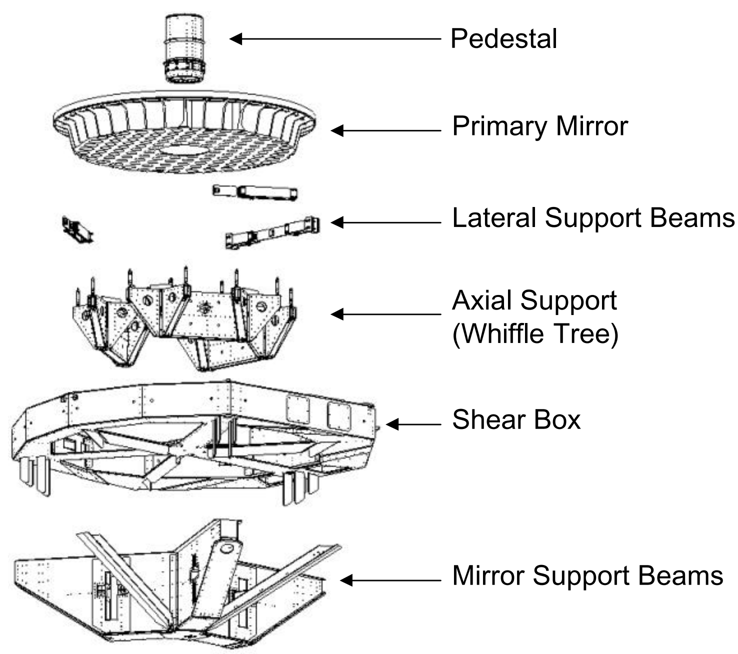
Primary / Tertiary Mirror Assembly

- extremely stiff CFRP structure for mounting of the primary mirror
- 1st eigenfrequency of mirror in structure approx. 80 Hz



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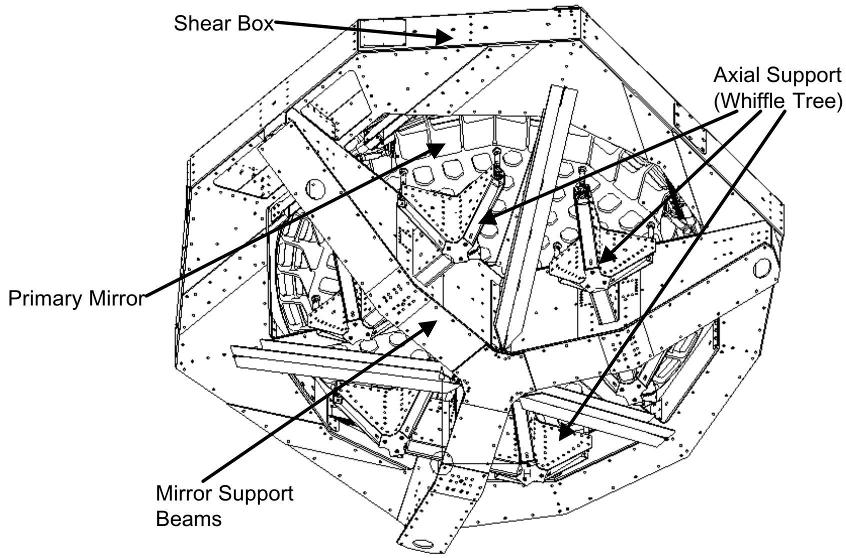
Primary Mirror Assembly: Bottom View



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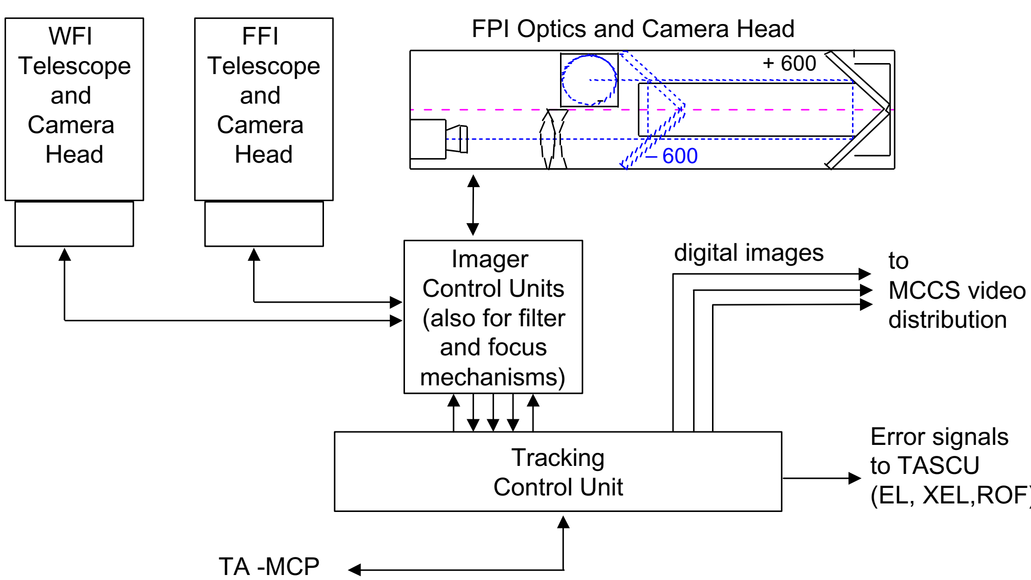
Tracking Subsystem Overview



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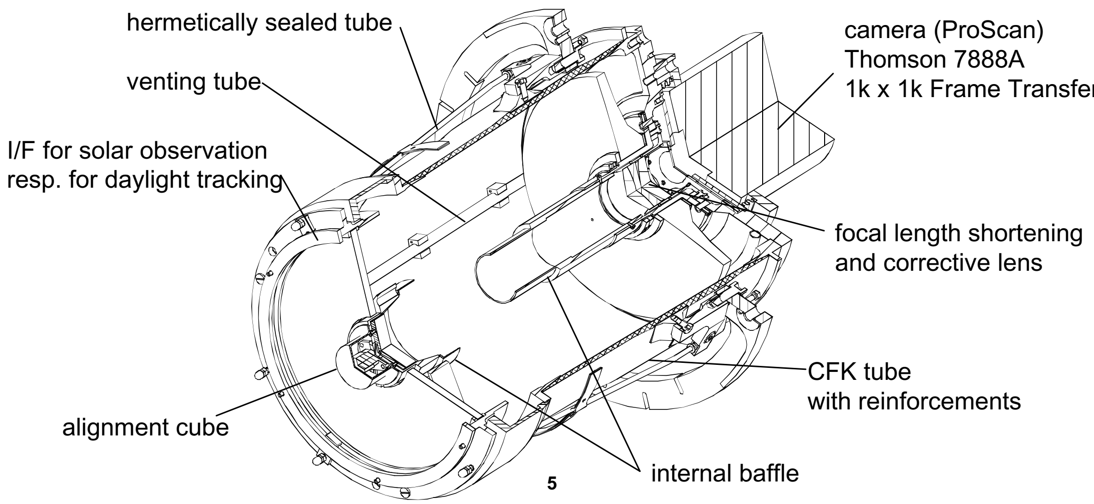
Fine Field Imager (Schmidt-Cassegrain, 2.8/700 mm, 70‘FOV)

- astrometric precision: 0.4 arcsec @ m_v = 13 and 3 sec. integration time



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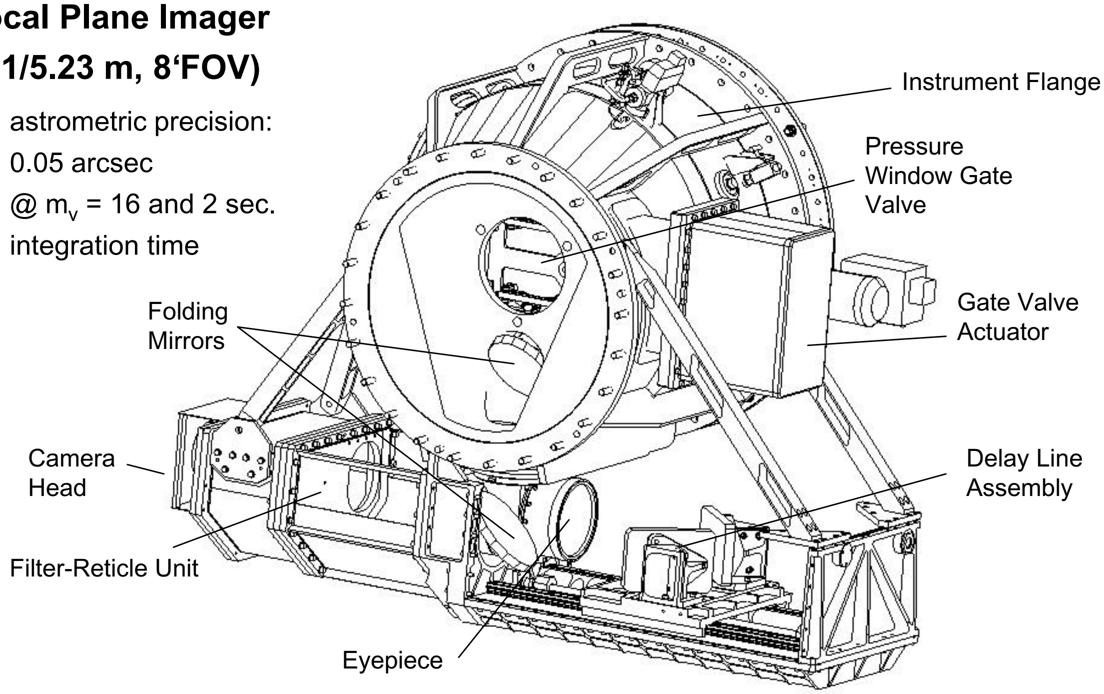
Focal Plane Imager (2.1/5.23 m, 8‘FOV)

- astrometric precision: 0.05 arcsec @ m_v = 16 and 2 sec. integration time



The Brazilian Near Infrared Camera

Cássio Leandro Dal Ri Barbosa
Instituto Astronômico e Geofísico - USP

Francisco J. Jablonski
Divisão de Astrofísica - INPE

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Abstract

We present the Brazilian Near Infrared (CamIV) photometric system from the best estimates for the characteristics of the Pico dos Dias Observatory, at Laboratório Nacional de Astrofísica (OPD/LNA), as well as the manufacturer's instrumental data for both the filter sets and detector. We used the synthetic photometric system method to describe and characterize the CamIV photometric system.

We show the two set of filters (the J,H broad bands and a narrow band set "inside" the K band) and the difficulties in using the K band. We also present the camera early results and the strategies to access longer wavelengths such as 2.16 μm.

1 Introduction

The OPD/LNA is located in a pleasant site at the summit of the Dias' Peak (1860 m above the sea level) at Minas Gerais, Brazil. The facilities at the Observatory include three telescopes: a 1.6 m Perkin-Elmer, a 60 cm Boller & Chivens and a 60 cm Zeiss.

The LNA's office is also coordinating two recent key projects: the Brazilian participation on Gemini project and the SOAR project. The both are projects specially designed for the infrared. On this basis, the Brazilian astronomical community would prepare themselves for the new techniques. And this is the goal of the CamIV's project: to make the infrared observational strategies familiar.

Fully operating since July 1999, the CamIV has, as we present below, a HAWAII HgCdTe detector and two filter sets: one containing two "near-Johnson" J,H broad band and the other containing five narrow band filters "inside" the K broad band. The major problem of the OPD's site is, as we will see later, the high thermal background, and this make the K band unable to use.

2 The Photometric System

The CamIV's photometric system is divide, as well all photometric systems, in their major components:

2.1 Atmosphere

The atmosphere transmission at the OPD site is dominated by the column of water vapour, as we see in Fig.1. This transmission curve adopts a column of 10 mm of water vapour. The Fig.2 shows the site's major problem: the high thermal background, specially in longer wavelengths as the K band. This high background makes the use of the K band almost impossible, even adopting a K_{short}, i.e. a K band significatively narrower.

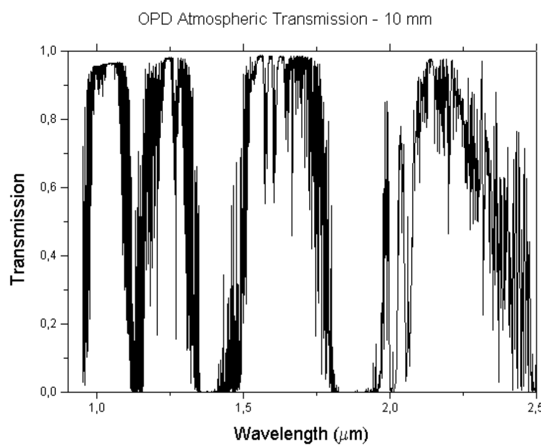

Figure 1: Atmospheric transmission calculated for a column of 10 mm of water vapour

2.2 Filters

The CamIV's filter wheel has eight positions: two for the broad band filter set (the J and H filters), five for the narrow band filter set and a "dark"

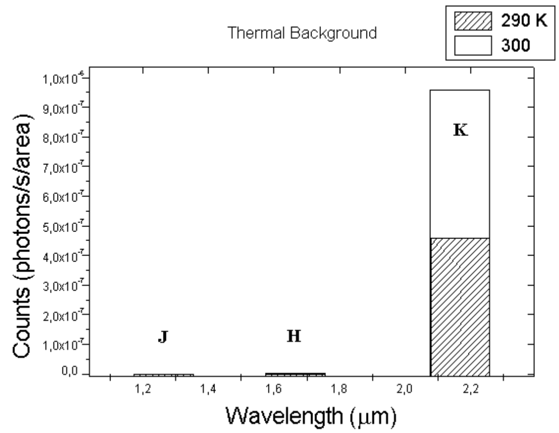

Figure 2: Thermal background for the broad band from two blackbodies

Filter	Pivotal λ [μm]	FWHM [μm]	Max. Trans.
J	1.2632	0.2102	0.848
H	1.6651	0.2082	0.847
HeI	2.0695	0.0161	0.744
C1	2.1384	0.0178	0.690
Brγ	2.1813	0.0292	0.736
C2	2.2494	0.0633	0.713
CO	2.3629	0.0656	0.599

Table 1: The filter sets main characteristics.

filter. The Fig.3 and 4 show the filter characteristic curves, including the original, but not used K band. The narrow band filters are: the "line" filters HeI and Brγ, the "molecular band" filter CO and two "continuum" filters, C1 and C2.

The Table 1 summarizes the most important filter characteristics calculated from the manufacturer's data.

2.3 Detector

The CamIV is based on a HAWAII 1024×1024 pixels (each pixel is 18.5μm wide) HgCdTe detector, sensitive in the 0.8-2.5 μm range. When it is

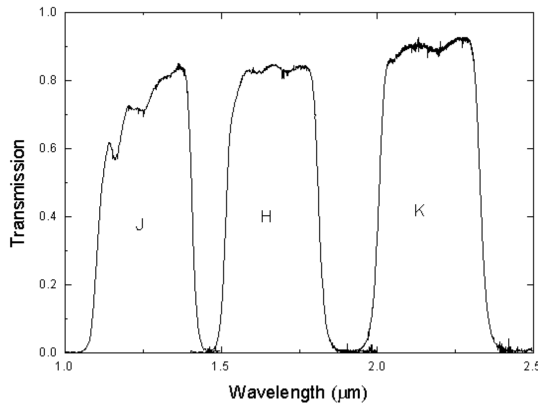

Figure 3: Transmission curves for the broad band set of filters

mounted on the 1.6 m telescope, the field of view is about 4×4 arcminutes (plate scale of ∼ 0.234 arcsec/pixel) and in the 60 cm telesopes is 8×8 arcminutes (plate scale of ∼ 0.47 arcsec) suitable for small surveys.

Finally, using the synthetic photometry we can construct the total eficiency curve for the OPD photometric system, combining the curves presented above. The result is shown in the Fig. 5.

3 The Early Results

As discussed above, the K broad band showed to be inaccessible due to the high thermal background. The first attempt to solve this problem was build a filter narrower than the usual, but it was not enough. The solution, a paliative one, is to use the narrow filter C1, which is centered almost at the K central wavelength and is a continuun filter. The next attempt is to reduce the minimum integration time to 0.5 second and *accumulate* several images.

The Table 2 sumarizes the early observations results for the filters zero point calibrations.

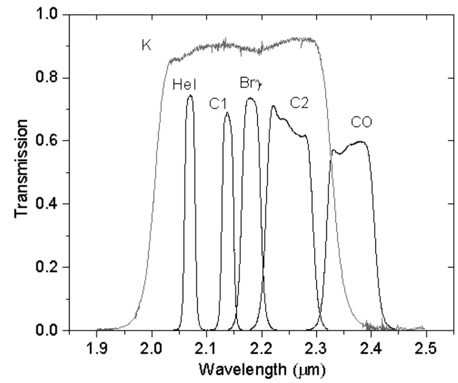

Figure 4: Transmission curves for the narrow band set of filters

J	**H**	**HeI**	**C1**	**Brγ**	**C2**
19.42 ($\pm$0.26)	19.37 ($\pm$0.25)	16 ($\pm$0.62)	16.12 ($\pm$0.39)	17.99 ($\pm$0.02)	19.69 ($\pm$0.27)

Table 2: The early calibrations: the filter zero points.

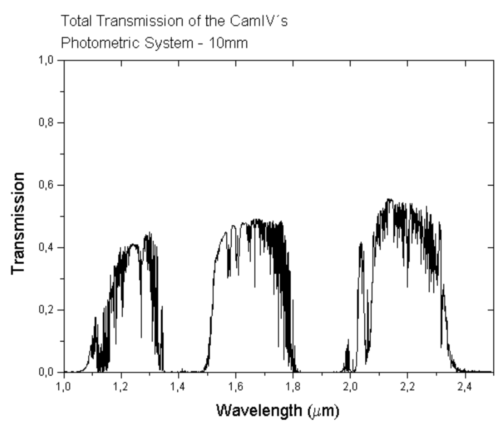

Figure 5: The total photometric system transmission calculated for a column of 10 mm of water vapour