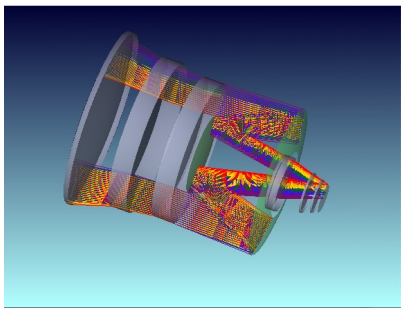
Wide-field Houghton-Terebizh telescope



Model: TEC-VT 300mm/7deg

Brief description

This telescope was designed by Dr. V.Yu.Terebizh (Moscow University) to have a very wide angular field of view, 7 degrees, with an aperture of 300 mm in diameter.
By contrast, the field of view of a classical Cassegrain telescope is only a few minutes of arc, the field of a known Ritchey-Chretien system attains approximately 20 arc minutes, correctable to as much as a degree or two with a three-element Wynne corrector.
Thus, the TEC-VT telescope, with 20 times the solid angle, increases dramatically the speed that the sky can be surveyed in search of new comets and asteroids, space tracking, aerial surveillance, etc.

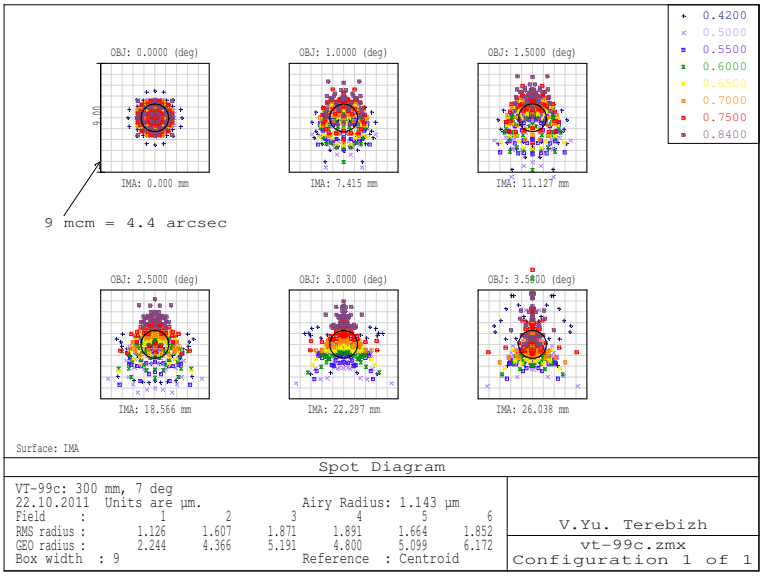


Fig. 1. Spot diagram of the TEC-VT telescope in the integral light 0.42 – 0.84 µm.
Images are given for the field angles: 0, 1°.0, 1°.5, 2°.0, 2°.5, 3°.0, and 3°.5;
respective linear off-axis shifts (in mm) are shown at bottom of each box.
The box size is 9 µm (4″.4); the circles correspond to the Airy disc.

The optics of the telescope consists of five lenses and two mirrors. It is remarkably fast, f/1.44, which matches the field of view to a 52-mm detector, and the focal surface is flat. Achievement of good images in the integral light of the full optical spectral waveband 0.42 – 0.84 µm was also an important condition. Even with such stringent requirements, the optical system provides the stars images of less than 5 µm RMS diameter across the entire field of view (Fig. 1). The fraction of light vignetted is typical of wide-field astrographs. All surfaces are spherical, an important aspect for manufacturing and tolerancing.

Optical design specifications

Table 1

Optical layout	Houghton-Terebizh
Entrance pupil diameter	300 mm
Effective focal length	425 mm
Working focal ratio	1.44
Scale in the focal plane	2.06 μm/arcsec
Primary spectral waveband	0.42 – 0.84 μm
Angular field of view	7°.0
Field curvature	Flat
Linear diameter of the field	52.1 mm
Fraction of unvignetted light	
Optical axis	0.70
Edge of field	0.57
Linear obscuration coefficient	
Optical axis	0.54
Edge of field	0.65
Effective aperture diameter	
Optical axis	250 mm
Edge of field	227 mm
Back focal length (last lens surface – detector)	70 mm
RMS spot diameter (D_{rms}) in the integral spectral range center – edge	2.3 – 3.8 μm (1″.1 – 1″.8)
Diameter of circle that contains 80% of energy in a star image (D_{80}), integral light, center – edge	5.5 – 7.1 μm (2″.7 – 3″.5)
Distortion	< 0.20%
Harmful ghosts	Absent
Axial length of the system	
First – last surface	373 mm
First surface – detector	443 mm

The diameter of the flat field corresponds well to a diagonal of commonly available CCDs. In particular, a FLI PL16803 camera includes the TrueSense (formerly Kodak) KAF-16803 chip with the 4096 × 4096 pixels of 9 μm size (36.9 × 36.9 mm; diagonal 52.1 mm). Another known detector, FLI PL09000, includes the KAF-09000 chip with the 3056 × 3056 pixels of 12 μm size (36.67 × 36.67 mm; diagonal 51.9 mm).

The optical images are relatively less compared to the pixels of these detectors, and so the optics is not the limiting factor in attaining high signal-to-noise ratio for faint objects against the sky background.

Optical tube assembly

Table 2

Weight, including FLI PL camera with CFW-9-5 filter wheel	41 kg
Full length (baffle entrance – rear side of FLI)	1030 mm

Mechanical design of the OTA features:

A-thermal Titanium cells;

Invar rods assembly for thermal stability of the focus;

Orthogonal tip-tilt adjustment of the camera focal plane with micrometer adjustment (0.25 degree range);

45 degree camera axial rotation;
Belt-driven helical focusing mechanism with focusing range of 5 mm;
Front baffle (410 mm OD × 550 mm long) is easily removable for transportation.

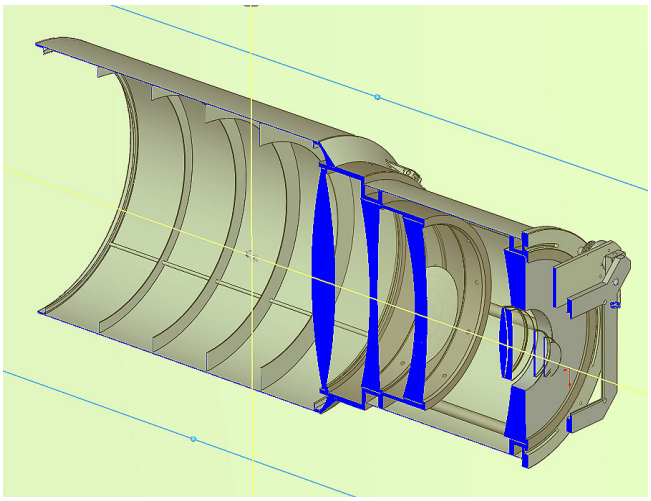


Fig.2. Optical tube assembly of the TEC-VT telescope

Imaging equipment

The following Finger Lakes Instrumentation components are very suitable matches for this telescope:

ProLine camera of choice – PL16803 (any grade), or PL09000;
Filter wheel – CFW-9-5 (5 positions for 65 mm square filters).

Fig. 3. TEC-VT telescope at the North-East Astronomy Forum
(NEAF, April 28th-29th, 2012)

Relevant Information

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Publication:
V.Yu.Terebizh, "New Designs of Survey Telescopes",
Astronomical Notes/Astronomische Nachrichten, Vol. **332**, No. 7, 714 – 742, 2011

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