

The CoMP-S instrument at the Lomnický Peak Observatory - status report

J. Koza¹, J. Ambróz¹, P. Gömöry¹, P. Habaj¹, J. Kavka¹, M. Kozák¹, A. Kučera¹, J. Rybák¹, P. Schwartz¹, S. Tomczyk², S. Sewell², P. Aumiller², R. Summers², L. Sutherland², A. Watt²



1 – Astronomical Institute, SAS, Tatranska Lomnica (Slovakia)
2 – High Altitude Observatory, NCAR, Boulder (USA)



Abstract: The Coronal Multi-channel Polarimeter for Slovakia (CoMP-S) has been installed at the high-altitude Lomnický Peak Observatory of the AISAS (2633 m a.s.l.) in 2011. The instrument was designed and manufactured by HAO/NCAR (Boulder, USA) with a tunable Lyot filter and polarimeter for visible and near IR spectral regions. This instrument is proposed for coronagraphic observations of magnetic and velocity fields in the solar corona and in prominences. A fundamental upgrade of this instrument has been prepared with a pair of cameras sensitive in the near IR spectral region in a new camera module. This upgrade is being incorporated to the instrument in course of the year 2014. In this contribution the technical parameters of the final configuration the CoMP-S instrument containing four cameras, covering both visible and near IR spectral regions, are described. We also present a potential of the CoMP-S instrument for coronagraphic spectro-polarimetric observations of the solar corona and prominences with a capability for sequential measurements of the spectral profiles of all prominent emission lines in the spectral region from 500 to 1100 nm.

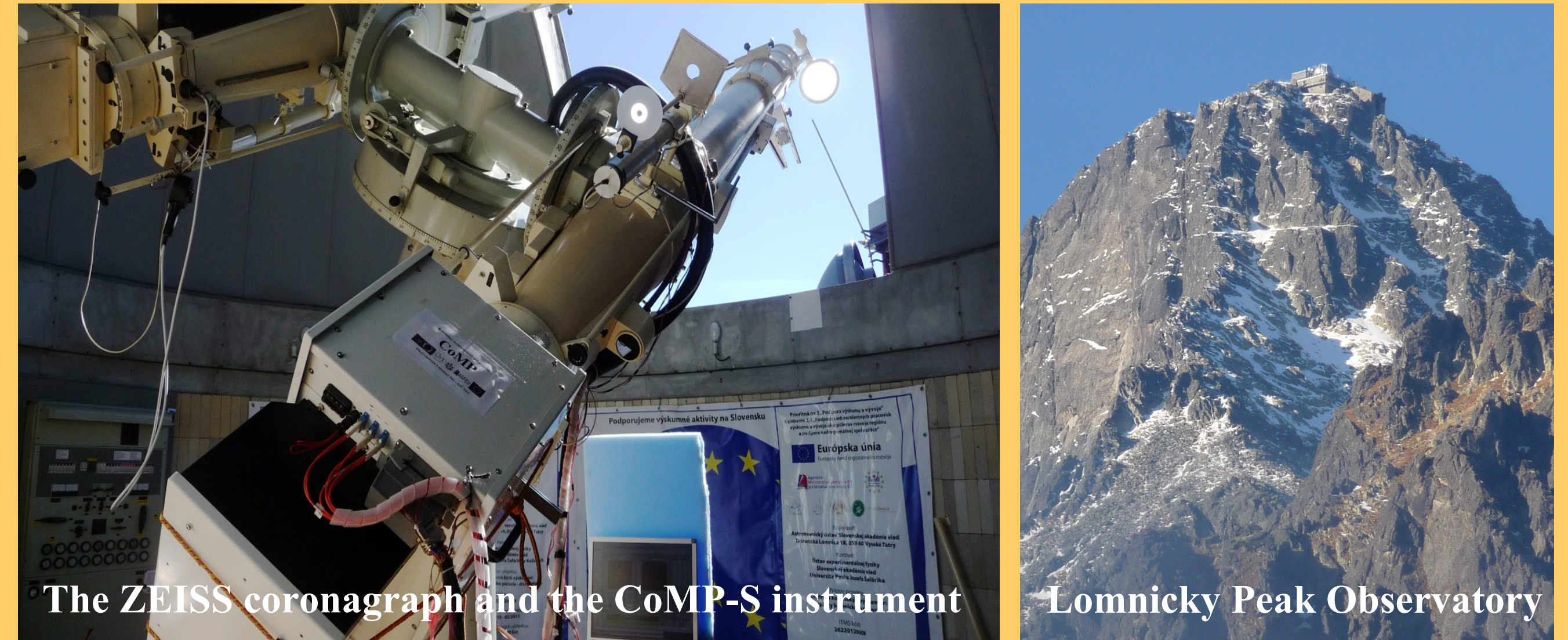
Observatory & coronagraph

Lomnický Peak Observatory:

- location & altitude: the High Tatras mountain range - 20°13' E, + 49°11' N, 2633 m a.s.l.
- operation & astroclimate: on duty all year round, ~120 observing days per year (Rybák *et al.*, 2010)
- access to the observatory exclusively by a cable car

Zeiss coronagraphs:

- 200/3000 ZEISS Jena coronagraph - a Lyot type instrument with ZEISS inventions (Lexa, 1963)
- single objective lens: BK7, aperture = 19.6 cm, focus = ~3 m
- secondary optics with a Lyot stop, final diameter of the solar image ~4 cm
- diffraction limited from 530 to 1100 nm by changing position of the objective lens
- spatial resolution: 0.67arcsec@530nm, 0.82arcsec@656nm, 1.36arcsec@1083nm
- field-of-view (FoV): ~1.02-1.84 of the solar radius
- on-line photoelectric pointing of the coronagraph



The ZEISS coronagraph and the CoMP-S instrument

Lomnický Peak Observatory



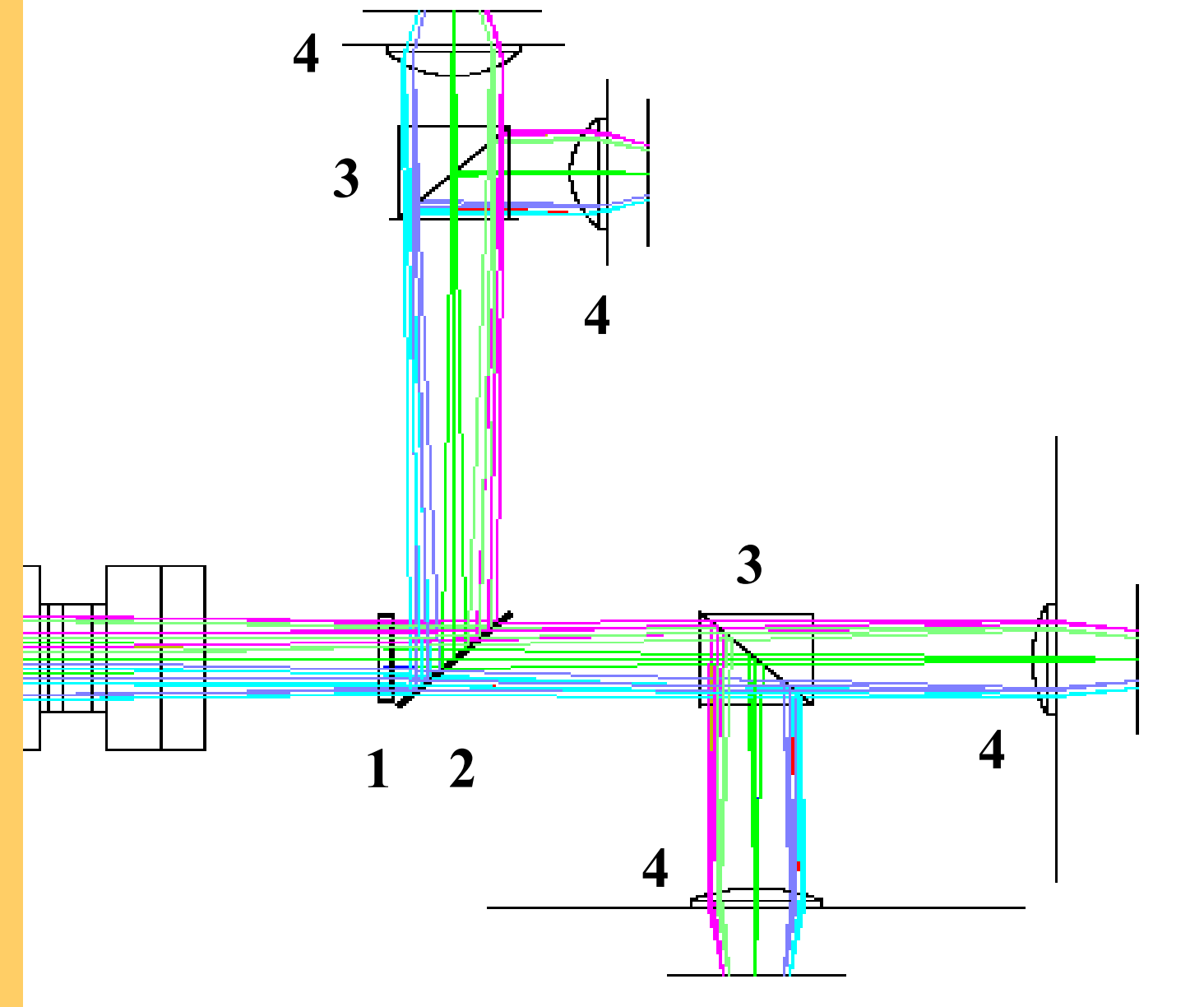
CoMP-S instrument – current status

- based on the CoMP instrument concept (Tomczyk *et al.*, 2008, Kučera *et al.*, 2011)
- a tunable 4-stage Lyot filter and Stokes polarimeter: diameter 30 mm
- optimized for visible and near IR wavelength ranges from 500 to 1100 nm
- polarizer material: VIS700BC4 by CODIXX, more than ~70 % transmission
- super-achromatic APSAW $\lambda/2$ plates by ASTROPRIBOR (range: 0.7- 1.5 λ nominal)
- the selected emission lines: corona: Fe XIV 530.3nm, Ca XV 569.5nm, Fe X 637.5nm, Fe XI 789.2nm, Fe XIII 1074.7 and 1079.8 nm; prominences: He I 587.6nm, H I 656.3nm, Ca II 854.2nm, He I 1083.0 nm
- bandpass width (FWHM): 0.028 - 0.13 nm, free spectral range: 0.50 – 2.5 nm (500–1100 nm)
- strategy: 2 orthogonal polarization states acquired simultaneously in two bandpasses shifted in wavelength by two separate detectors for a subtraction of scattered light
- polarization modulation: 2 ferroelectric liquid crystals (FLC): fixed retarder followed by linear polarizer (analyzer) – a scheme from the HAO PromMag instrument (Tomczyk *et al.*, 2010)
- actually installed detectors for the visible light: pco.edge sCMOS detector by PCO, 2560x2160 pixels, 60 % QE (500nm), 6.5 μ m pixels, readout: 16bit, 50 frames per second, 2 e⁻ readout noise
- final image sampling: 0.33 arcsec/pixel @ 656.3 nm, the final FoV: ~860 x ~680 arcsecs
- web page: <http://www.astro.sk/LSO/COMP-S/>

CoMP-S instrument – upgrade: optics

- an upgrade of the instrument was inevitable in order to incorporate to the instrument, besides the visible light detectors, also detectors for the near-IR spectral range up to 1100 nm
- an extension of the light beam by an negative achromatic lens system (1) is added in order to create space for all required optical elements
- a dichroic cube (2) is here for separation of the visible and the near-IR spectral ranges at ~1000 nm into two independent light channels
- in each channel an optimized polarizing cube splitter (3) is used to separate two orthogonal polarization with bandpasses shifted in wavelength
- positive achromatic lenses (4) placed in front of each camera are used to reverse the beam to the original f/20 configuration to keep the same FoV

An optical sketch of the new camera module

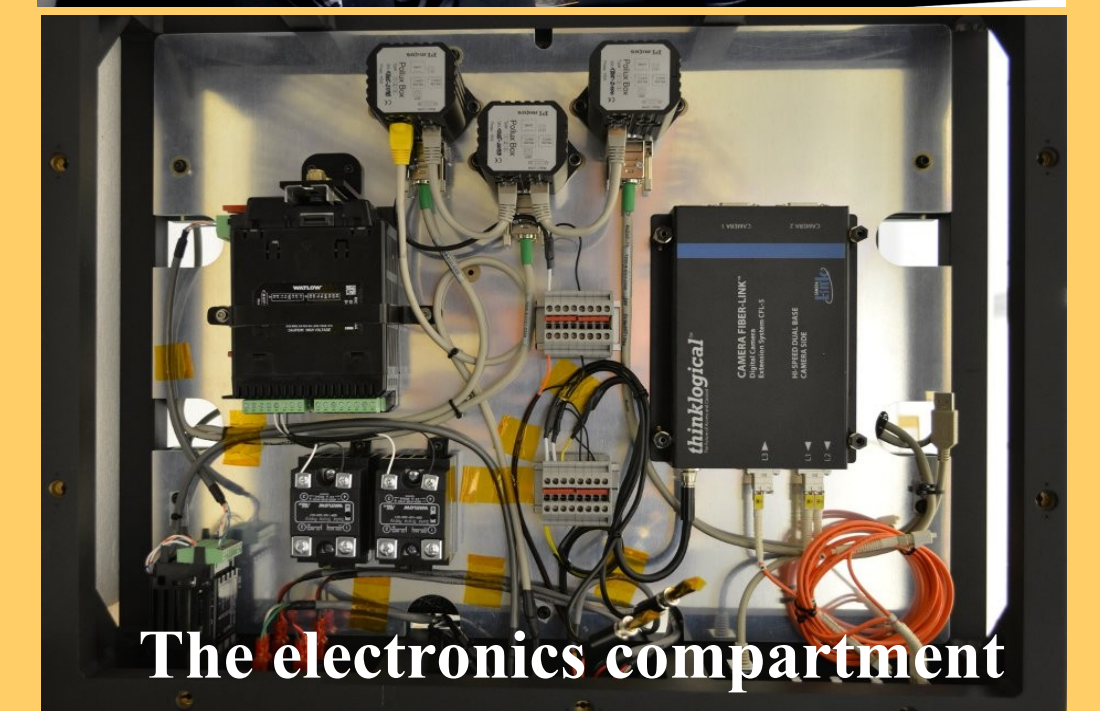


The CoMP-S – update: camera module

- a new frame structure will be connected to the original CoMP-S Lyot filter modul
- it will contain a thermal insulation and a heating/cooling system to maintain the nominal operation temperature of the pre-filters and the Lyot filter
- The structure will be divided to an optical and electronics compartments
- The optical compartment: all relay optics, an dichroic beam splitter, the polarizing beam splitters, the positioning devices, two ANDOR NEO sCMOS cameras, two Goodrich GA1280J cameras
- electronics compartment: electronics for operation of positioning devices, the temperature control, data signal conversion



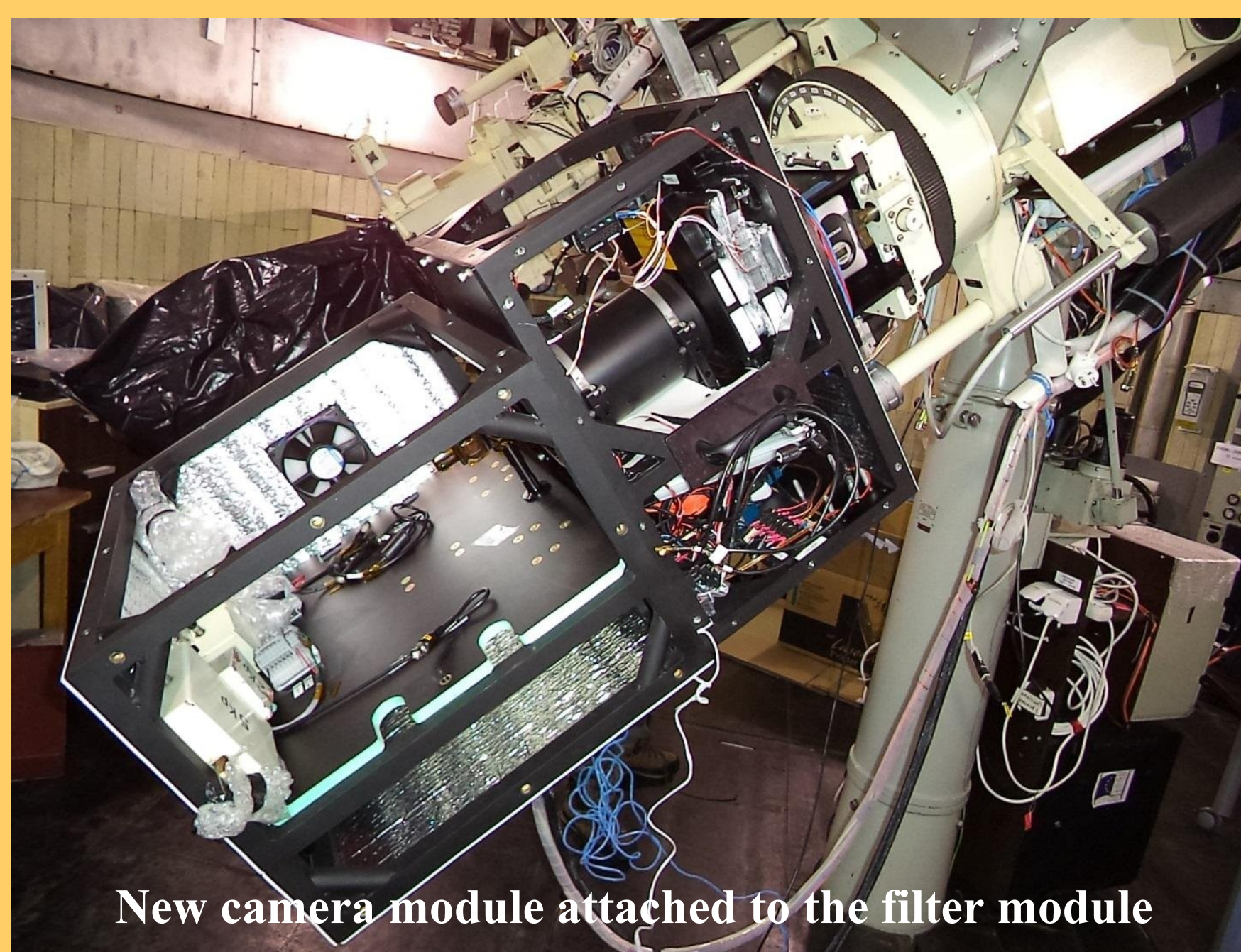
The optical compartment



The electronics compartment

CoMP-S instrument – upgrade: mechanical tests in the dome

- the very first mechanical and optical tests of the new camera module were made in June 2014
- combination of the modules has been found sufficiently stiff under full weight load for all nominal positions of the coronagraph & CoMP-S instrument
- minor changes of the interface between the filter and the camera modules were required
- tests with the adapted interface in the dome are expected in September 2014
- performance tests of the electronics will done till November 2014



New camera module attached to the filter module

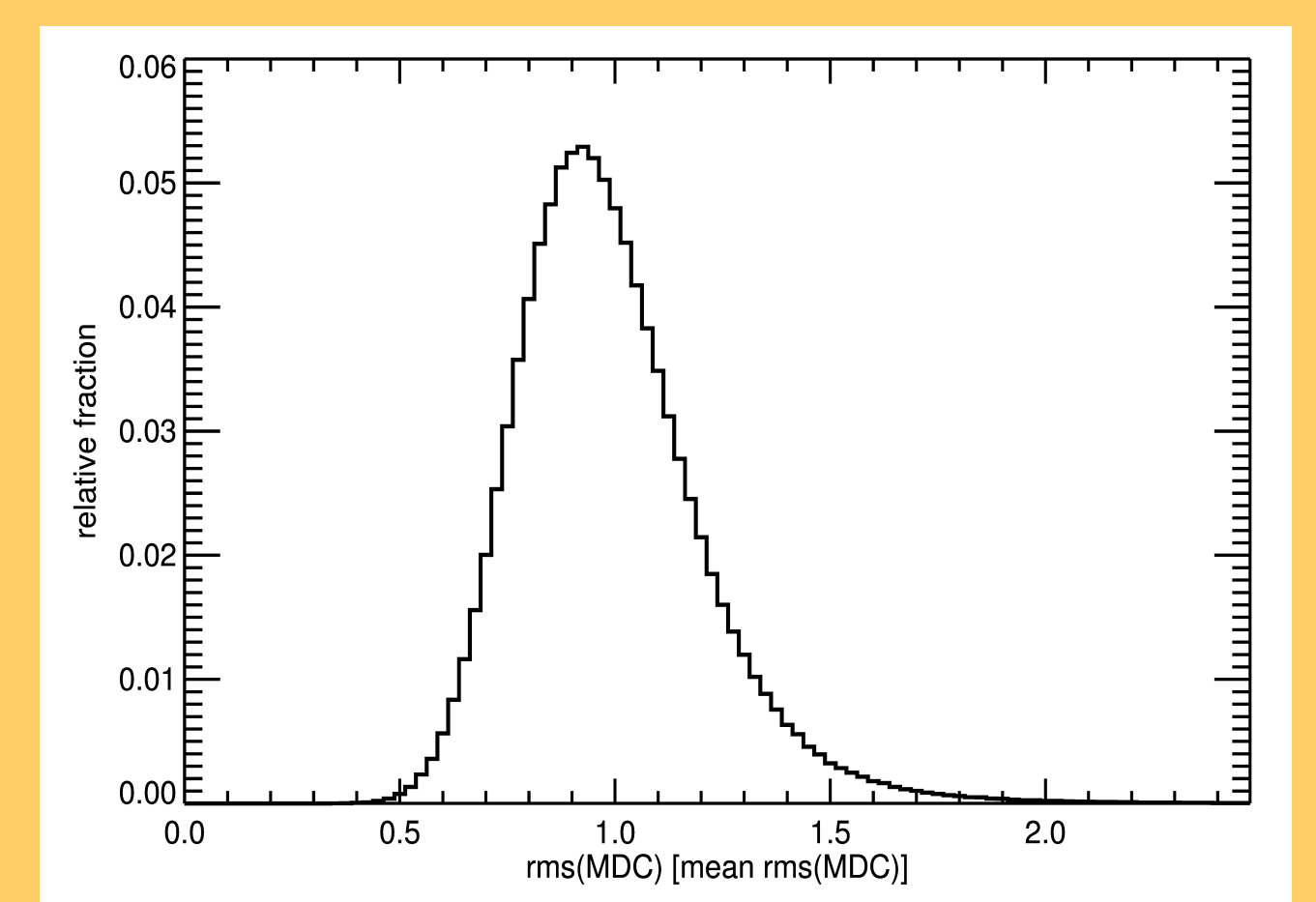
The CoMP-S near-IR detectors

- the Goodrich GA1280J cameras have been selected as the near-IR detectors for the CoMP-S upgrade. Their main parameters are listed as: InGaAs imager, 1280 x 1024 15 μ m pixels, sensitivity 950-1650 nm, 12bit output, 30 Hz full frame rate, quantum efficiency > 65 %, dynamic range up to 900:1.

dark current (DC) tests:

- conditions: chip temperature +30 °C, exp. time 32 ms, low gain, 24 frames
- results: mean DC value 641.7 counts, mean DC 1-sigma 14.2 counts, normalized DC 1-sigma 2.25 ± 0.526 %, hot pixels fraction 0.22 % (>2.0 rms)

- figure: histogram of the normalized standard deviations from the mean DC values derived from performed tests.



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