Baseline Design of the SUNRISE Telescope

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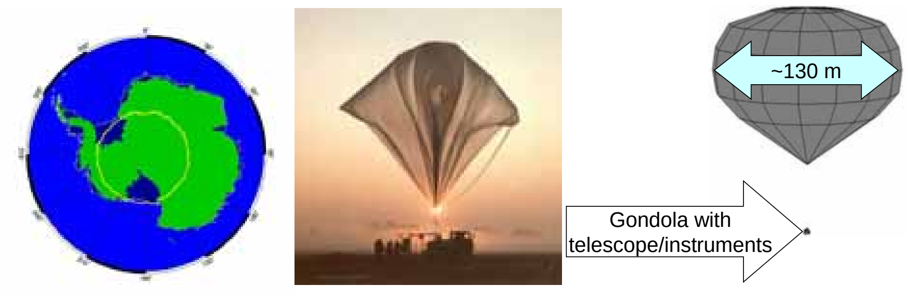
Abstract

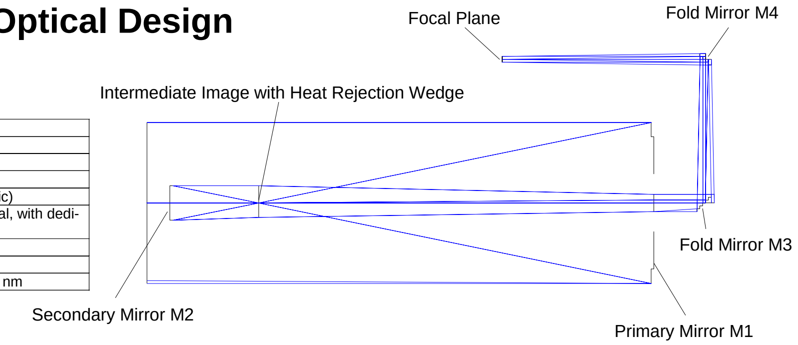
The SUNRISE telescope is part of a balloon-borne instrument for spectro-polarimetric high-resolution observations of the solar atmosphere, to be flown 2007/2008 in the Antarctic summer stratosphere. It is a 1-m UV-VIS Gregory type telescope, operating close to the VIS diffraction limit. The telescope has a steel central frame and a lightweight CFRP trusswork structure with Serrurier properties, providing proper alignment of the optical elements over the varying elevation angle. Mechanisms allow a fine adjustment of the optics. Aberrations caused by residual deformations of the stiff silicon carbide (Cesic®) primary mirror are lowered by a dedicated offset in the secondary mirror polish (imprint). The telescope is subjected to the changing heat loads caused by the Sun and Earth radiations, necessitating measures to provide thermal conditions suitable for high-performance observations. Appropriate solutions for an effective mirror/gondola baffling are outlined.

Balloon/Mission



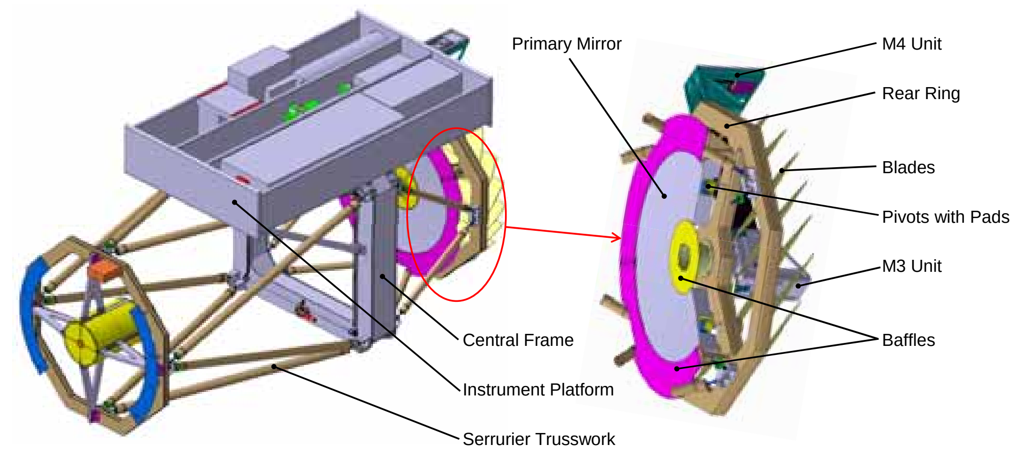
Optical Design

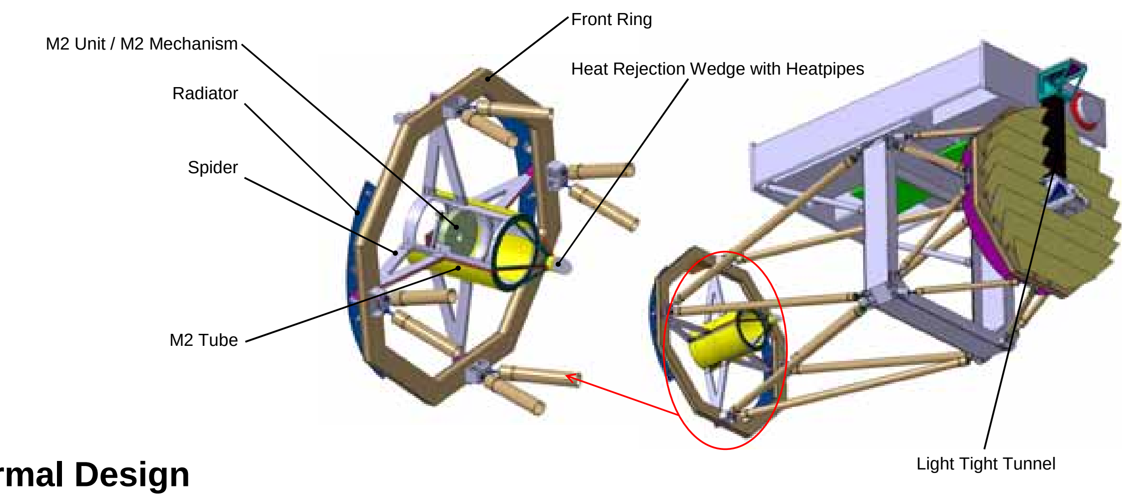
Optical parameters	Value
Telescope	Gregory type
Entrance Pupil Diameter	1 m
Effective focal length	25 m
Primary focal length	2.5 m (concave, parabolic)
Secondary focal length	0.55 m (concave, elliptical, with dedicated imprint)
Field-of-view	+/- 125 arcsec
Wavelength range	200-800 nm
Image quality (on-axis, zone and edge)	Diffraction-limited at 633 nm



Mechanical Design

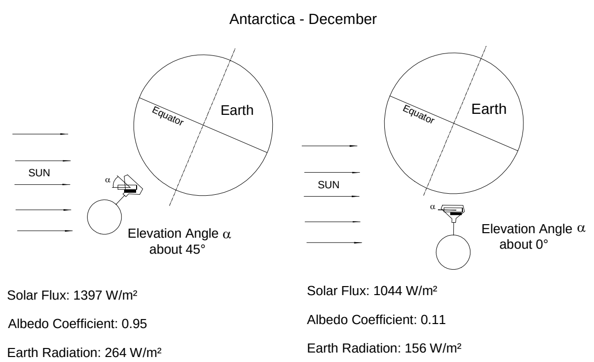
- Overall geometrical dimensions: length 4 m, width 1.4 m, height 2 m (instruments included)
- Total estimated (most probable) mass of 330 kg for telescope and mounting struts
- 1-m diameter Cesic® primary mirror
- 3 mirror adjustment mechanisms: M2 (3 linear axes), M3 (1 linear axis), M4 (1 linear axis)
- Front ring from CFRP plates and profiles, bonded and riveted
- Back ring / mirror cell from CFRP plated and profiles, bonded and riveted
- Central frame of stainless steel (riveted construction)
- Struts from filament-wound CFRP tubes



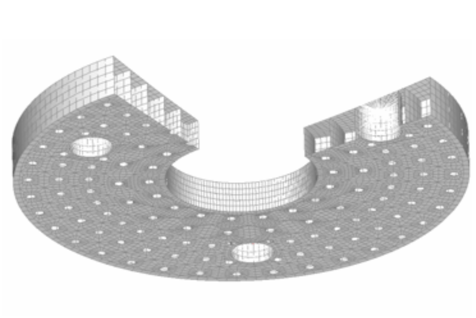


Thermal Design

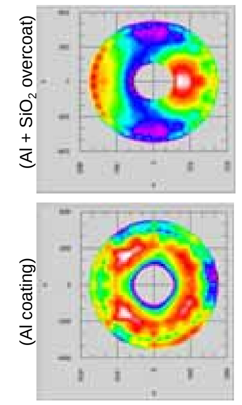
- Unavoidable CTE mismatch between mirror material and materials of support (pads, joints, cell) as well as possible Schlieren effects call for small temperature excursions around integration and ambient temperatures: goal is 20 °C ± 25 °C
- Primary mirror is subjected to several radiation sources and sinks: Sun, Earth (thermal and albedo), cold sky, gondola surfaces
- Worst case WFE shall be less than 40 nm rms for diffraction-limited observations
- Highly reflective mirror coating / mirror backside coating with defined emissivity
- MLI wrapping of the mirror surrounding
- Reflective surfaces of the other telescope parts on the rear side of the mirror
- M1 radiation shielding / deflection baffles
- Appropriate gondola design / baffling / surface properties



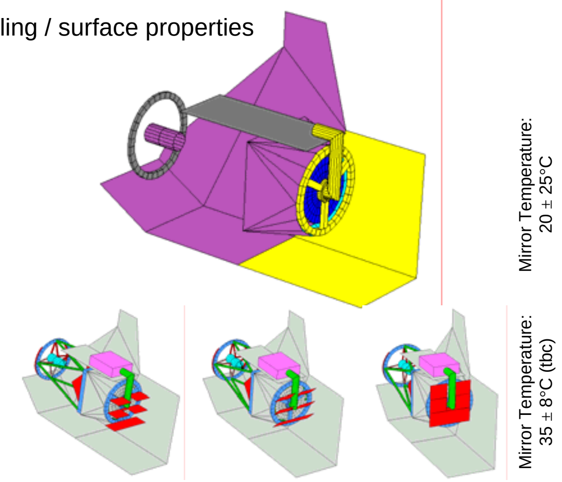
Extreme cases of the thermal boundary conditions, left: hot case, right: cold case



Primary Mirror structure with mounting interfaces



Typical wavefront error results from thermo-elastic calculations



Potential thermal baffling (bottom configurations require dedicated control)