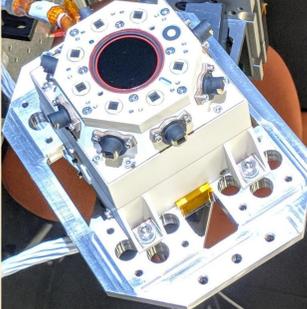


Skycam: The Mars Environmental Dynamics Analyzer camera on the Mars 2020 rover, Perseverance

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MEDA, the Mars Environmental Dynamics Analyzer
MEDA [1] is a meteorological suite for the Mars 2020 rover with heritage from the Mars Science Laboratory (MSL) Rover Environmental Monitoring Station (REMS, [2]). It includes capability to measure pressure, surface and atmospheric temperature, winds, and humidity. The REMS ultraviolet sensors [3] have been replaced with the **Radiation and Dust Sensor**.

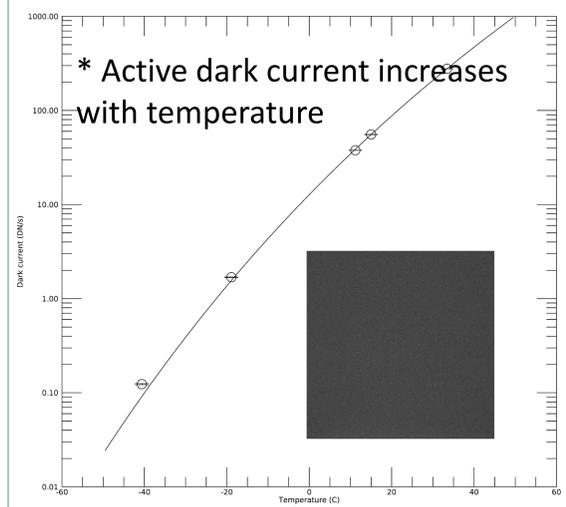
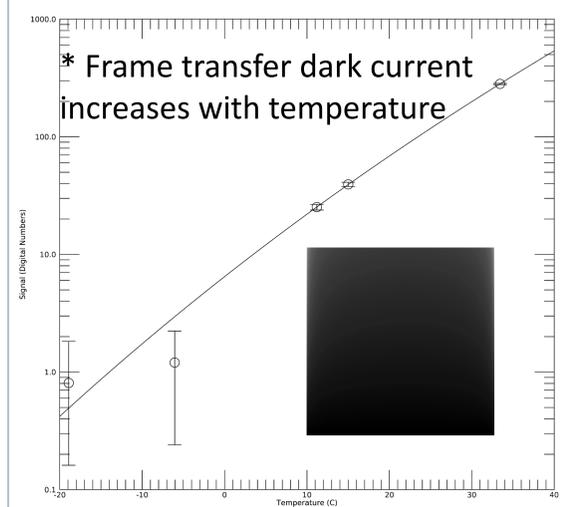
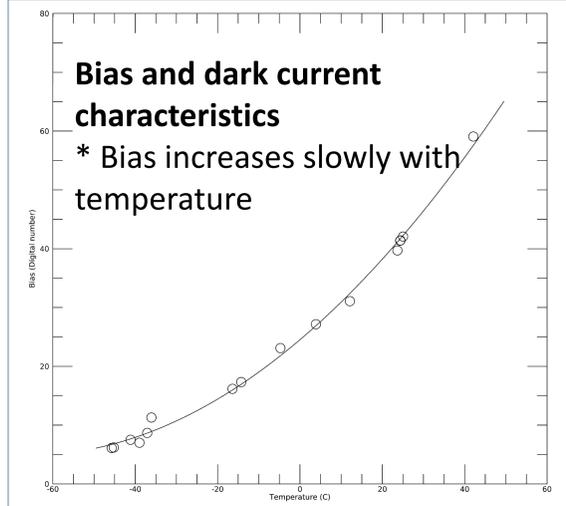
MEDA Radiation and Dust Sensor (RDS)



The RDS assembly is mounted on the rover deck. The **Skycam** window is the dark circle in the center of the top plate. Turrets around the RDS and sensors visible on the top plate are *photodiodes* of various wavelengths to study solar and thermal radiation and atmospheric aerosols.

Skycam is a modified, spare Hazcam [4] from MSL that is mounted within the RDS in an upward-looking geometry. Its two-fold purpose is to *determine aerosol optical depth over time*, and to *determine aerosol physical properties* and their time variation. Skycam will provide a pan-sky view in order to provide instantaneous cross-sky radiance surveys to provide the data from which physical properties studies may be performed. In addition, Skycam will include a partial ND coating—when the Sun is within the coated region, flux measurements may be made. The annular ND coating will provide two times per day (approximately 9h and 15h local true solar time) when solar flux, and thus aerosol optical depth, may be retrieved.

Skycam characteristics
Detector: 1024x1024 active area; 12-bit analog to digital conversion; linear to 3000 DN; exposure duration of 0 s to 5 minutes in 5.2 ms steps
Optics: 124° field of view; 8.3 pixels/degree; 0.3-0.4° optical resolution; 127° baffle; neutral density 5 annulus 36-52° from center; effective wavelength 691 nm (bandpass 594-777 nm).

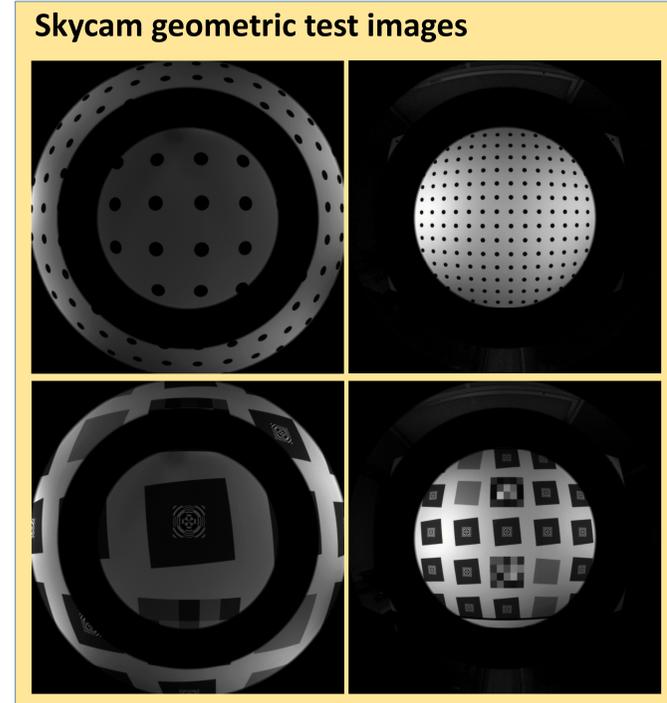


Skycam requirements
The CCD window shall have a spectral filter band between 400-880 nm.
The CCD sensor shall have a field of view of at least ±60 degrees around RDS Z axis.
The RDS CCD shall have a baffle with a field of view of 120 degrees full cone that rejects direct light outside of a 160 degrees cone.
The CCD window shall have an annular ring to attenuate direct solar light at least 5 orders of magnitude for at least 60 minutes every day.
RDS SkyCam has to have at least a 75% of it not obstructed by the rover on the surface.
MEDA's measurements of solar aureole with the CCD shall have a range of 0.005 to 0.8 W/m²/nm in a dust-free environment providing clean optical surfaces at a temperature of 23°C.
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MEDA's measurements of solar aureole with the CCD shall have a precision of ±0.005 W/m²/nm in a dust-free environment providing clean optical surfaces at a temperature of 23°C.
MEDA's irradiance measurements with the CCD shall have an accuracy of ±10% in a dust-free environment providing clean optical surfaces.
MEDA's measurements with the CCD shall have a resolution of at least 1 deg/pixel in a dust-free environment providing clean optical surfaces.
MEDA shall be able to acquire images from the CCD at a rate of one image per minute.

Skycam optical field

±63.5° Baffle
ND5 annulus: 5 order of magnitude attenuation for solar imaging
±32° sky
52-63° sky
Flat field image
Optical mask image
±63.5° Baffle

Solar observations: Twice per sol, the Sun transits the ND5 annulus; solar flux measurements at these times permit optical depth measurement; dust on optics will be monitored by comparison with Mastcam-Z [5].
Sky observations: when the Sun is low, sky images constrain aerosol scattering properties and can be used to observe and track clouds or for astronomical imaging such as retrieving optical depth from stellar fluxes.



Skycam test images

Engineering model outdoor test

Cloud
Bleeding artifact
Sun
Cloud

Crop from rover test
Remote sensing mast head

References: [1] Rodríguez-Manfredi, J. A., et al. (2019), *AGU Fall Meeting 2019*, P41B-3423. [2] Gómez-Elvira, J., et al. (2012), *Space Sci. Rev.*, 170, 583-640. [3] Smith, M.D., et al. (2016), *Icarus*, 280, 234-248. [4] Maki, J., et al. (2012), *Space Sci. Rev.*, 170, 77-93. [5] Bell et al. (2020), *LPSC 51* (this issue).