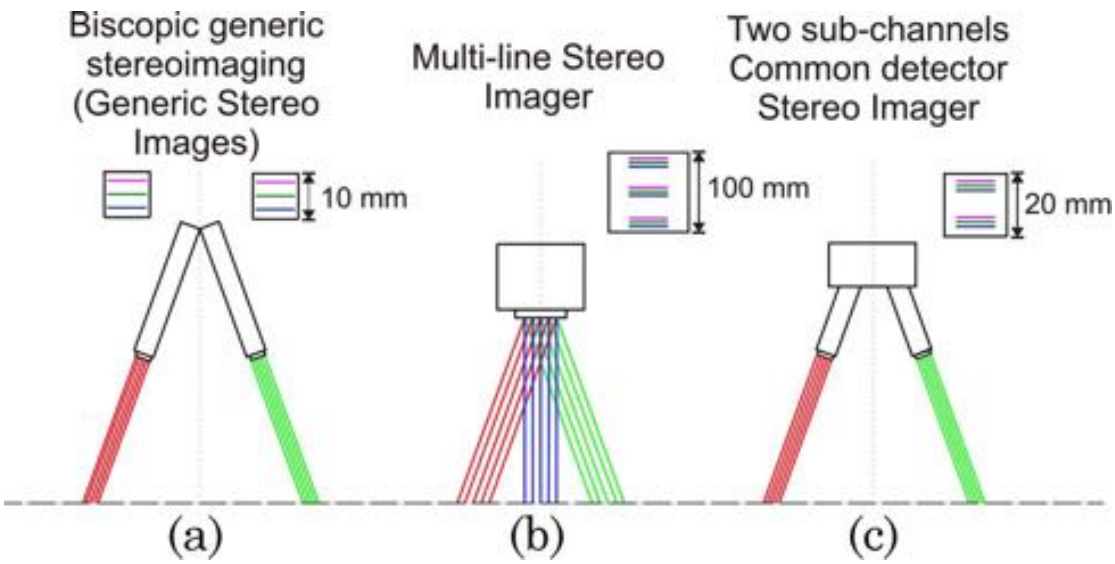
Stereo Camera (STC) for the BepiColombo mission

Scientific requirements

The main scientific requirements for the STC are to provide the global panchromatic coverage of the surface and, second, to study selected areas in predefined spectral bands. Both imaging tasks should be accomplished with a scale of 50 m per pixel at the equator, increasing with the latitude up to 110 m per pixel at the poles. The verticl accuracy of the Digital Terrain Models (DTM) has to be better that 84 m.
The spectral bands have been chosen with the aim of studying surface composition on large scale and defining the main geological units. The STC will allow analysis of the morphology of the tectonic features, the impact craters, and the volcanic edifices. It will also provide the context for HRIC investigation.

The STC is a double-wide-angle camera designed to image each portion of Mercury's surface from two different perspectives, providing panchromatic stereo image pairs required for reconstructing the DTM of the planet's surface. In addition, it has the capability of imaging some portion of the planet in four different spectral bands. It is composed by two channels with the orientation of +20° and −20° from the nadir direction and adopts a catadioptric optical design with common detector in order to save mass and power.

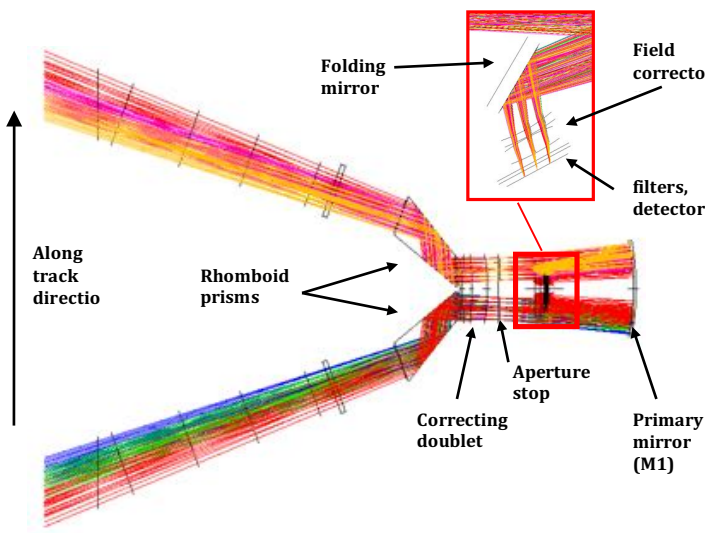


The figure shows the possible stereo imaging configurations:
(a) generic stereo imaging configuration: two independent cameras oriented along two slanted viewing directions;
(b) a single camera with large FoV simultaneously covering both stereo angles and also the nadir-looking direction, if needed;
(c) the stereo configuration proposed for STC, in which most of the optical elements and the detector are common to both subchannels.
They are not drawn to scale; the expected image aspect and size are reported as a square area placed near each configuration.

The adopted STC configuration is an intermediate solution between the "two cameras" and the "single camera" one. The proposed design can be considered as composed of two "sub-channels" looking at the desired stereo angles and that, thanks to the novel optical design, share the majority of the optical elements and the detector. With respect to classical two- or single-camera designs, this solution allows to reach good stereo performance with general compactness, saving of mass, volume and power resources.

STC scientific requirements.

Parameter	Value
Scale factor	50 m/px at periherm
Swath	40 km at periherm
Stereoscopic properties	±20° stereo angle with respect to nadir both images on the same detector
Vertical accuracy	80 m
EE	> 70% inside 1 pixel
MTF	> 60% at Nyquist frequency
Wavelength coverage	410-930 nm (5 filters)
Filters	Panchromatic (700 ± 100 nm) 420 ± 10 nm 550 ± 10 nm 750 ± 10 nm 920 ± 10 nm



STC overall optical design layout. The inset shows a different projection of the focal plane region.

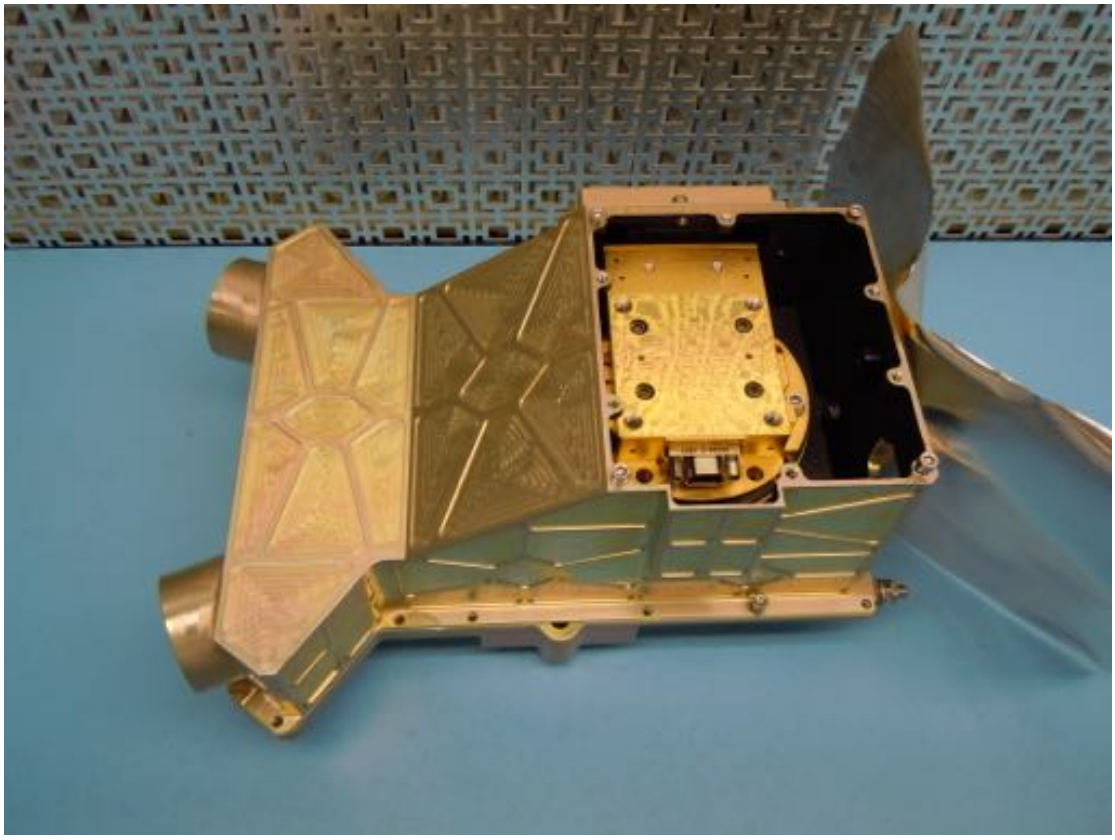
At periherm, each panchromatic strip corresponds to an area of about 40 × 19 km^2 on the Mercury surface, and each colored strip to an area of about 40 × 3 km^2.
Considering that the two sub-channels are projecting their images side by side on the same plane, the useful area on the system focal plane has a rectangular shape, which would obviously be optimally coupled with a rectangular sensor array. However, due to programmatic reasons, a squared 2048 × 2048 pixel array had to be adopted, with the result that large part of the detector will not be used. See the following figure for useful filter strip image position and distribution on the 2kx2k detector. The selected detector is a hybrid Si_PIN device; that kind of detector is particularly useful both in term of radiation hardness, given the hostile Mercury environment, both for the capability of snapshot image acquisition, which is less demanding in terms of S/C pointing and stability.

Position and size of useful filter strips image on the full 2kx2k detector area (in black).

STC optical characteristics.

Parameter	Characteristic
Optical concept	Catadioptric: modified Schmidt telescope with rhomboid prisms and field corrector
Stereo solution (concept)	2 identical optical sub-channels; Detector and most of the optical elements common to the two sub-channels
Focal length (on-axis)	90 mm
Pupil size (diameter)	15 mm
Focal ratio	*f*/6

Mean image scale	23 arcsec/px (111 µrad/px)
FoV (cross track)	5.3°
FoV (along track)	2.4° panchromatic 0.4° color filters
Detector	Si_PIN (format: 2048 × 2048; 10 µm squared pixel). 14 bits dynamic range



STC during the integration in Leonardo s.p.a.

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