

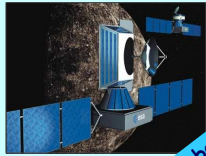
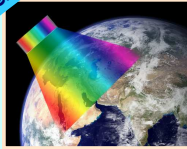
Optical transmission filters for space spectrometers

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Abstract

Small-dimension optical filters, with variable spatial performance, are useful for constructing compact instruments. The variation of their transmission along the surface allows the reduction of the number of optical components and the improvement of the instrument overall performance. Filter design and manufacturing are described and results reported.

Earth observation

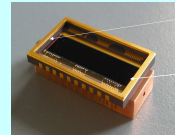


Bepi-Colombo mission to Mercury

Spectrometers are widely used for observation of Earth and planets from Space. Traditional instruments are based of push-broom methods while compact instruments, without moving parts, are presently under study.

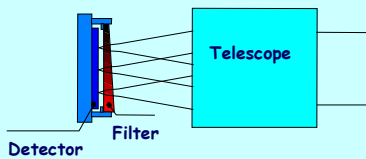
Special optical filters with non uniform performance, attached to a CCD detector, allow the construction of a compact spectrometer that offers great advantages because of its reduced weight and dimensions.

These filters show a narrow transmission band which peak wavelength is displaced along the surface of the filter itself. In this way the image of the observed object will be completely detected while the CCD is moved with respect to the object surface.



CCD detector

Graded filter

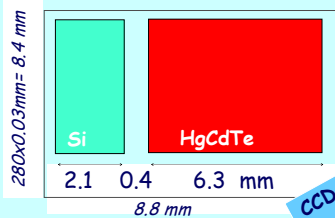


The variable filters are able to work from ultraviolet to infrared and are obtained by depositing a graded coating either on a quartz substrate or directly on the CCD surface.

Depending on the spectrum of interest, different materials are employed. Silicon oxide, tantalum oxide and silver have been chosen for the range 400-2500nm. The filter dimensions are of the order of few millimeters.

FILTER SPECIFICATIONS

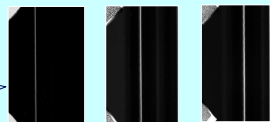
- Transmission wavelength range: 400 + 2500nm
- Transmission bandwidth $\Delta\lambda/\lambda$: 1-2%
- Lateral dimension: 2 - 6 mm
- Transmission peak linear gradient: 250nm/mm
- Outband rejection: < 0.5%



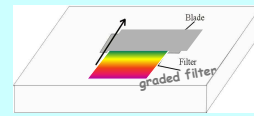
CCD dual hybrid detector

- Two adjacent filters are needed for the two detectors, in both cases a 21-layer metal-dielectric coating is used
- A blocking filter is deposited on the substrate back side, in this case a 40-layer dielectric coating is needed

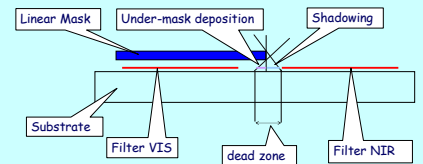
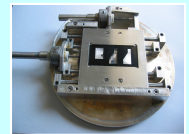
Image of a graded filter on the CCD, when illuminated at different wavelengths



DEPOSITION SYSTEM

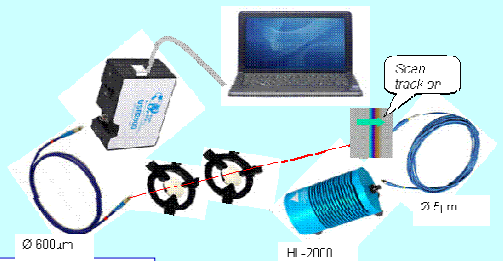
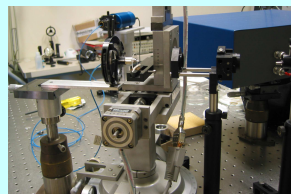


Linear translation mask



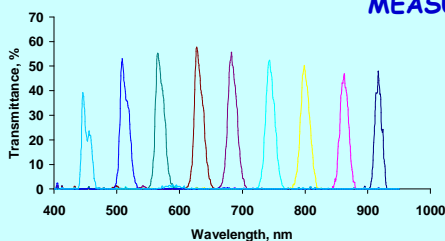
Distance between mask and sample ~100µm

MEASUREMENT SYSTEM

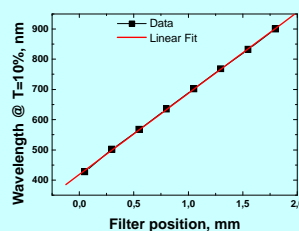


- Actual characterization range range: 400 + 1000nm
- 2-D translation micrometric system: min step 25µm
- Spectral resolution: < 2nm
- Spatial resolution: < 20 µm

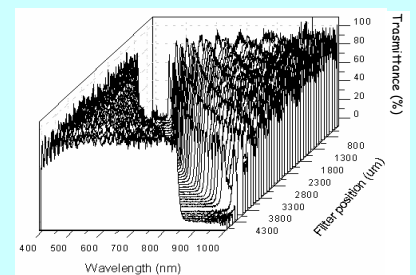
MEASURED FILTER TRANSMITTANCE



Measured transmittance at different positions along the surface of the graded Narrow-band filter



Graded filter linearity and gradient



Transmittance at different positions along the surface of a graded Blocking filter