

Expected Performance of Mid-infrared Camera and Spectrometer (MCS)

"MCS" is a temporary name, a nickname for this instrument is wanted!

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Mid-infrared Camera and Spectrometer (MCS) has imaging and spectroscopic capabilities at wavelengths of 5–38 μm . This instrument consists of Wide Field Camera (WFC) with 5x5 arcminutes field of view, Low Resolution Spectrometer (LRS), Mid Resolution Spectrometer (MRS) with an integral field unit by an image slicer, and High Resolution Spectrometer (HRS). WFC, LRS, MRS, and HRS have two channels ("–S" and "–L" indicate channels for short and long wavelengths) to cover a wide range of wavelengths.

We present expected performances of the instruments. Specifications and assumptions that used for the estimation are shown in order to clarify the validity.

Specifications: Specifications of instruments and detector arrays are summarized in the following tables.

Table 1: Specifications of instruments

Instrument	Imaging		Spectroscopy					
	WFC		LRS		MRS		HRS	
Channel	S	L	S	L	S	L	S	L
Array format	Si:As (2k x 2k)	Si:Sb (1k x 1k)	Si:As (2k x 2k)	Si:Sb (1k x 1k)	Si:As (2k x 2k)	Si:Sb (1k x 1k)	Si:As (2k x 2k)	Si:As (2k x 2k)
Wavelength coverage (μm)	5-25	20-38	5-26	20-38 (option 25-48)	10-20	19.5-36.1	4-8	12-18
Filter bands	5-25 μm , R=5	20-38, R=10						
Spectral resolution ($\lambda/\Delta\lambda$)			50-100	50-100	1460 @ 13 μm	680 @ 27.8 μm	30,000	20,000-30,000
FOV size	5' x 5'	5' x 5'			12" x 6"	12" x 12".5		
Slit length x width			2'.5 x 1".40	2'.5 x 2".66	12" x 1".2 (x 5 slices)	12" x 2".5 (x 5 slices)	3".0 x 0".72	6".0 x 1".2
Pixel scale ("/pix)	0".146/pix	0".293/pix	0".146/pix	0".293/pix	0".403/pix	0".485/pix	0".288/pix	0".48/pix
Main disperser			Prism	Grating or Prism	Grating	Grating	Immersion grating	immersion grating

Table 2: Specifications of detectors

	Si:As	Si:Ab
Supplier	Raytheon	DRS
Format	2048 x 2048	1024 x 1024
Wavelength	1-26 μm	1-38 μm
Average quantum efficiency	> 40% (Goal > 80%)	> 50% (for 20-38 μm , incl. refl.)
Peak quantum efficiency	-	> 60% (for 20-38 μm , incl. refl.)
Readout noise*	20 e-	100 e-
Dark current	< 0.5 e-/s/pix < 0.2 e-/s/pix (Goal)	< 2 e-/s/pix for 1024 x 1024 area < 0.2 e-/s/pix for 1024 x 900 area < 0.1 e-/s/pix (Goal)
Pixel size	25 μm	18 μm

*Noise in CDS readout. The noise will be reduced up to 1/4 in Fowler-16 sampling.

Assumptions: Following assumptions are used for sensitivity estimations.

Brightness of the background

The main brightness source is the zodiacal emission, which varies with the line of sight. Two cases, low- and high-background, are assumed (e.g., Leinert et al. 1998, Reach et al. 2003).

low (ecliptic latitude $\sim 90^\circ$): 274K blackbody, 15.5MJy/sr @ 25 μm
 high (ecliptic latitude $\sim 0^\circ$): 268.5K blackbody, 80MJy/sr @ 25 μm

Performances of arrays

Specifications of detector arrays are shown in Table 2. For sensitivity estimation, following values are used.

	Si:As	Si:Ab
quantum efficiency	50% @ all wavelengths	50% @ all wavelengths
Readout noise	5 e-	25 e-
Dark current	0.5 e-/s/pix	2 e-/s/pix

Other parameters

Telescope diameter: 3.0 m
 Effective area of the telescope: $\pi \times (3.0/2)^2 \times 0.875 \text{ m}^2$
 Integration time of one frame: 600 sec.

For each instrument

HRS

HRS uses simple assumptions for the optical system.
 optical efficiency (lens and immersion grating): 0.15
 slit efficiency for a point source: 0.6 for HRS-S, 0.3 for HRS-L

LRS, MRS

LRS and MRS take into account wavelength dependencies of the optical and the slit.

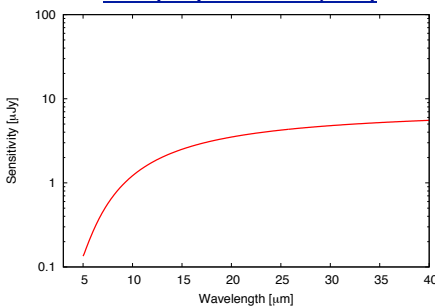
WFC

WFC uses slightly different assumptions as; readout noise of 20e-, dark current of 1e-/s/pix, optical efficiency of 0.35 (including telescope), background of 216K blackbody with 18MJy/sr @ 25 μm .

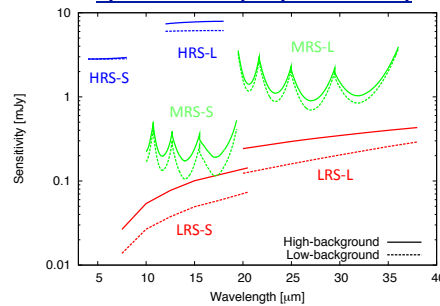
Sensitivity estimation (5 σ , 1hr) Estimated sensitivities are shown in the following figures.

Note: This estimation is slightly different from that in the fact sheet or the proposal because assumptions are changed.

WFC (for point source, R=5)



Spectrometer (for point source)



Spectrometer (for diffuse source)

