SPICA / SMI Fact Sheet

SPICA Mid-infrared Instrument (SMI) covers the wavelength range of 12–36 μm with four channels: spectroscopy (SMI/LR, /MR, /HR) and imaging (/CAM).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SMI /LR</th>
<th>/CAM</th>
<th>/MR</th>
<th>/HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band centre - μm</td>
<td>27</td>
<td>34</td>
<td>27</td>
<td>15</td>
</tr>
<tr>
<td>Wavelength - μm</td>
<td>17 – 36</td>
<td>18 – 36</td>
<td>12 – 18 (a)</td>
<td>15 – 18 (a)</td>
</tr>
<tr>
<td>Spectral resolution R</td>
<td>50 – 150 (b)</td>
<td>1300 – 2300 (b)</td>
<td>33000 (c)</td>
<td></td>
</tr>
<tr>
<td>(diffuse source)</td>
<td>(20 – 110)</td>
<td>(1100-1400)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field of view</td>
<td>600&quot; x 3.7&quot;</td>
<td>600&quot; x 720&quot;</td>
<td>60&quot; x 3.7&quot;</td>
<td>4&quot; x 1.7&quot;</td>
</tr>
<tr>
<td>Band centre FWHM</td>
<td>2.7&quot;</td>
<td>3.5&quot;</td>
<td>2.7&quot;</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Pixel scale</td>
<td>0.7&quot; x 0.7&quot;</td>
<td>0.7&quot; x 0.7&quot;</td>
<td>0.7&quot;</td>
<td>0.7&quot;</td>
</tr>
<tr>
<td>Detector 1K x 1K</td>
<td>Si:Sb</td>
<td>Si:Sb</td>
<td>Si:Sb</td>
<td>Si:As</td>
</tr>
<tr>
<td>Point source sensitivity (5σ/1 hr)</td>
<td>25 (e)</td>
<td>13</td>
<td>280 (e)</td>
<td>1400 (e)</td>
</tr>
<tr>
<td>Continuum - μJy</td>
<td>5</td>
<td>13</td>
<td>28</td>
<td>1400</td>
</tr>
<tr>
<td>Line - 10⁻²⁰ W/m²</td>
<td>~28</td>
<td>~4500</td>
<td>~1.8</td>
<td>~1000</td>
</tr>
<tr>
<td>Survey speed - arcmin²/hr</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diffuse source sensitivity (5σ/1 hr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuum - MJy/sr</td>
<td>0.04</td>
<td>0.05</td>
<td>0.6</td>
<td>1.5</td>
</tr>
<tr>
<td>Line - 10⁻¹⁰ W/m²/sr</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturation limit – Jy</td>
<td>~20</td>
<td>~1</td>
<td>~1000</td>
<td>~20000</td>
</tr>
</tbody>
</table>

(a) continuous coverage up to 18.1 μm + partial coverage for H₂O 18.66 μm.
(b) λ/Δλ = 150 (SMI/LR) and 1300 (/MR) at λ = 36 μm.
(c) designed for λ20 μm diffraction limited PSF.
(d) sensitivity estimated with Fowler-16 sampling for SMI/LR and /CAM (0.5 Hz), and with ramp curve sampling for /MR (0.5 Hz) and /HR (1 Hz sampling).
(e) continuum sensitivity rescaled with R = 50, R = 1300, and R = 25000 for SMI/LR, /MR and /HR, respectively.
(f) sensitivity for an unresolved line.

SMI Factsheet v12 - 16 May 2019
How to make spectral mapping with SMI

- Slit length
  - LR: 10 arcmin (very long) x 4 slits, MR: 1 arcmin (long), HR: 4 arcsec (short)
- Stepwise scan perpendicular to the slit direction
- Recommendation for the step size:
  - overlap of each FoV by half a slit width.
  - 1.9 arcsec for LR, MR. 0.9 arcsec for HR.
- In order to estimate the total time required for mapping, the observational efficiency of 70% should be considered, which accounts for time losses due to maneuver (+ telescope stabilization), Fowler sampling (only applicable to LR, CAM), thermal annealing (+ detector warming-up) before starting each SMI campaign, calibration, and so on.

LR spectral mapping

- CAM needs to be operated simultaneously, which works as a slit viewer for LR. (CAM data are valuable not only technically for LR spectral image reconstruction, but also scientifically.)
- Telescope (spacecraft) scan with 95 steps is needed (i.e., inter-slit 3 arcmin divided by half a slit width 1.9 arcsec) to cover 10 x 12 arcmin² area.

• Example: 12 x 10 arcmin² in 2 hrs
  - LR on-source time: 2 hrs/95 x 1.5 (50% overlap) = 114 sec
  - sensitivity: 260 μJy (see the last slide)
  - CAM on-source time: 2 hrs, sensitivity: 9 μJy
MR spectral mapping

- 1-D Beam Steering Mirror (BSM) is used.
- BSM scan with 32 steps is needed to cover 1 x 1 arcmin\(^2\) area.
  BSM full stroke: ±0.5 arcmin (nominal), ±1 arcmin (goal)

- Example: 1 x 1 arcmin\(^2\) in 1 hr
  MR on-source time: 1 hr/32 x 1.5 (50% overlap) = 169 sec
  sensitivity: 2 \times 10^{-19} \text{ Wm}^{-2} (see the last slide)

- Example: 1 x 1 arcmin\(^2\) in 10 min
  MR on-source time: 10 min/32 x 1.5 = 28 sec (3 \times 10^{-18} \text{ Wm}^{-2})

HR spectral mapping

- 1-D Beam Steering Mirror (BSM) is used. Due to the short slit, only 1-D spectral mapping is obtained with BSM.

### Sensitivity as a function of time

**LR CAM**

![LR CAM sensitivity graph]

**CAM**

![CAM sensitivity graph]

**MR**

![MR sensitivity graph]

**HR**

![HR sensitivity graph]