**HYPXIM – a hyperspectral satellite designed for science, security and defence users**

Sylvain Michal, Philippe Gamet, Marie-José Lefèvre-Fonollosa, Centre National d’Études Spatiales, Toulouse, France ([@cnes.fr](mailto:))

---

**Introduction**

Based on sound mission technical requirements provided by a group of national experts in hyperspectral imagery, CNES has been conducting pre-phase A studies with the support of Astrium and Thales Alenia Space, in non-concurrent engineering. Two mission scenarios were defined:

1) HYPXIM-Challenging aims at finding out the highest possible performance level achievable using a microsatellite platform, with a Basic (HYPXIM-CB) and an Advanced (HYPXIM-CA) option.

2) HYPXIM-Performance goal is to reach a higher spatial resolution and to provide a TIR hyperspectral capability.

---

**HYPXIM mission objectives**

Radiometry

Spectral continuum is required from VIS to SWIR optical domain with a spectral resolution of 10 nanometers. Spectral continuum is also required for TIR with a spectral resolution of 100 nm.

The panchromatic image can be combined with the hyperspectral image so as to enhance spatial resolution.

Ground Spatial Resolution (GSR)

3 classes of needs are identified for VNIR-SWIR domain (0.4 - 2.5 μm) : - 20 meters and larger => covered by EnMAP and PRISMA missions, - 10 to 15 meters, - 5 to 10 meters. GSR : 50 to 100 meters is required for TIR (8 to 12 μm).

Swath

15 km minimum, up to 30 km.

Revisit period

Daily revisit required for applications (e.g. security & defence) but 3-day revisit period acceptable. Non critical for many applications (geosciences, urban environment, …).

At-sensor radiances

At-sensor radiances are defined by the scientific and defence mission group [1]. For a better understanding, the at-sensor radiances specifications are converted into observable ground reflectances, according to the observation latitude and the sun-zenith angle. For instance, at 400 nm, a pre-defined at-sensor radiance (defined L2 favorable) is reached on June, 23rd for a ground reflectance of 0.1 at 40°N latitude (fig. 1).

![Image](image)

Figure 1 : Ground reflectance providing an at-sensor radiance of L2 favorable, for a site located at 40°N latitude, at 2 dates on June, 23rd and December, 21st

---

**HYPXIM-Performance**

<table>
<thead>
<tr>
<th>Domain</th>
<th>Spectrum (nm)</th>
<th>Bandwidth / resolution (μm)</th>
<th>SNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIS</td>
<td>400-700</td>
<td>10</td>
<td>2500</td>
</tr>
<tr>
<td>NIR</td>
<td>700-1100</td>
<td>10</td>
<td>2000</td>
</tr>
<tr>
<td>SWIR</td>
<td>1100-2500</td>
<td>10</td>
<td>900</td>
</tr>
<tr>
<td>PAN</td>
<td>400-800</td>
<td>400</td>
<td>900</td>
</tr>
<tr>
<td>TIR</td>
<td>8000-12000</td>
<td>100</td>
<td>1000</td>
</tr>
</tbody>
</table>

Spectral requirements for HYPXIM mission

- SNR = Signal-to-Noise Ratio

---

**HYPXIM-CA : 2020 timeframe.**

- **Altitude**
  - 650 km

- **Payload**
  - TMA telescope ø150 mm with dedicated panchromatic channel, prism-based spectrometer
  - Detector VNIR-SWIR 2000 x 360 pixels (to be developed)

- **Spatial resolution / Swath**
  - 15 m / 30 km

- **Spectral bandwidth / resolution**
  - 400 - 2500 nm / 10 nm

- **Payload budget**
  - Mass 65 kg, Power (imaging) 55 W
  - Dimensions : 670 x 790 x 650 mm

- **Satellite**
  - Mynade NG 195 kg (incl. 17% margin)
  - Dim. 620 x 600 x 1327 mm
  - Mass <150 kg, Power (imaging) <350 W
  - Satellite
    - 1-ton range

- **Revisit period**
  - With +/-20° across-track imaging : 15 days
  - With +/-40° across-track imaging : 3 days

- **Imaging capacity**
  - 125 square images per day

- **Ground-to-space link**
  - X-band link at 150 Mbps (with ground or mobile stations)

- **Launch compatibility**
  - Soyuz, Vega

- **Expected lifetime**
  - 5 years (incl. end-of-life operations)

---

**Synthesis**

The HYPXIM concept introduces the next hyperspectral space sensors generation with :

- enhanced spatial resolution from 15 m to 8 m
- higher revisit frequency available for Security and Defence actors
- miniaturization allowing to design a microsatellite to achieve a high-resolution hyperspectral low cost demonstration mission by 2018
- a new TIR Hyperspectral capability,
- multi-sensors fusion products using on board PAN and TIR data.

HYPXIM missions meet the needs of a wide community of users currently using in situ and high-resolution hyperspectral images (Airborne, UAV, etc.).

---

**References**