THE FRENCH EARTH OBSERVATION SCIENCE/DEFENCE MISSION HYPXIM – A SECOND GENERATION HIGH SPECTRAL AND SPATIAL RESOLUTION IMAGING SPECTROMETER

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ABSTRACT

Spaceborne sensors such as Hyperion [1] have opened the way to new studies of surface diversity and chemistry. Future programs like EnMAP [2], PRISMA [3] and HyspIRI [4] prove that the interest of the scientific community has increased, extending the range of applications using hyperspectral data.

In France, CNES took the initiative to gather a group of Science and Defense users of imaging spectrometry data (Groupe de Synthèse sur l'Hyperspectral, GSH [5]) to address several objectives: establish an up-to-date review of possible applications and specify spectral, spatial, and temporal sampling characteristics as well as signal-to-noise ratio and revisit time necessary for accurate, quantitative retrieval of diagnostic parameters. Six fields of application where imaging spectrometry is a major contribution were selected: vegetation, coastal and inland waters, geosciences, urban environment, atmospheric sciences and Defence. Following the GSH report, a pre-phase A study for an hyperspectral mission concept

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was decided, called HYPXIM (HYPerspectral-X IMagery). This pre-phase A focused on studies supported by Defense devoted to specific applications and on a more accurate definition of reference radiances, simulated using radiative transfer and surface reflectances of natural targets [6]. Definition of scientific issues that could not be accurately addressed by first generation hyperspectral sensors due to their spatial resolution (30 m) and how to complement observations at a bigger scale like HyspIRI was also considered. Results pointed to applications where high spatial resolution was necessary. For example, in the case of ecosystem studies, it is generally agreed that many model variables and processes are not accurately represented and that upcoming sensors with improved spatial and spectral capabilities, such as higher resolution imaging spectrometers, are needed to further improve the quality and accuracy of model variables. Short revisit time is also an issue for security and Defense as well as crisis monitoring.

Based on these specifications, instrument technical designs proposed by the industry (EADS-Astrium and Thales Alenia Space) provided two different scenarios: HYPXIM-Challenging, on a micro-satellite platform, with a 15 m pixel and HYPXIM-Performance, on a mini-satellite platform, with a 8 m pixel, and possible TIR hyperspectral capabilities. Both scenarios include a PAN camera with a 1.85 m pixel. Platform agility would allow for "on-event mode" with a 3-day revisit time.

The HYPXIM phase A was recently decided by CNES and should end in 2015. The most performing concept, HYPXIM-P (8 m pixel but without TIR capabilities, considered not enough "mature" by the board), was selected. Instrument requirements are summarized below:

Spatial Resolution	Hyperspectral 8m Panchromatic 1.85 m
Spectral range	0.4 – 2.5 µm
Spectral resolution	10 nm
SNR at L2	VIS > 250:1 NIR > 208:1 SWIR > 133:1
Image size	16 x 16 km
Revisit period	19 days (nadir); 3 days (+/- 35°)

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Preliminary studies with industrial support show that this challenge can be taken to space around 2020/2021 depending on the development of critical technologies (like specific detectors). Expected lifetime in orbit is 10 years, including end-of-life operations.

This paper gives an update on the status of the HYPXIM mission, summarizes the results from pre-phase A [7, 8], and describes the choices made for phase A studies with targeted applications that will help refine requirements that will be key drivers for instrument design.

References:

[1] J.S. Pearlman, P.S. Barry, C.C. Segal, J.Shepanski, D. Beiro, and S.L. Carman, 2003 – Hyperion, a space based imaging spectrometer. *IEEE Trans. Geosci. Remote Sensing, 41 (6), pp. 1160-1173.*

[2] H. Kaufmann, K. Segl, S. chabrillat, S. Hofer, T. Stuffler, A. Müller et al., 2006 – EnMAP hyperspectral sensor for environmental mapping and analysis. *IGARSS, Denver, pp. 1617-1619.*

[3] C. Galeazzi, G. Varacalli, F. Longo, E. Lopinto, L. Garramone, and R. Capentiero, 2009 – Overview of the PRISMA mission. *Proc. 6th EARSeL SIG Workshop on Imaging Spectroscopy, Tel Aviv, Israel*.

[4] R.O. Green, 2007 – Overview of the HyspIRI Mission. *International Spaceborne Imaging Spectroscopy Working Group, 16 November 2007*.

[5] Groupe de Synthèse sur l'Hyperspectral, 2008 – Synthèse sur l'imagerie hyperspectrale. *CNES strategic documentation*.

[6] Simulations de luminances en entrée de l'instrument HYPXIM (phase 0.2), *Rapport du Groupe Mission pour l'avant-projet HYPXIM du CNES, October 2010 (Project internal report).*

[7] X. Briottet, R. Marion, V. Carrère, S. Chevrel, P. Prastault, M. D'Oria, P. Gilouppe, S. Hosford, S. Jacquemoud, B. Lubac, A. Bourguignon, 2011 – HYPXIM: A new hyperspectral sensor combining science/defence applications. *3rd WHISPERS, Lisbon*.

[8] M.J. Lefèvre-Fonollosa, P. Gamet, S. Michel, 2012 – HYPXIM, an advanced hyperspectral satellite for environment, security and defence, *XIIth ISPRS Congress, 25 August – 1 September 2012, Melbourne, Australia, http://www.isprs2012.org/abstract/1770.asp*.

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