International Satellite Imaging Spectroscopy Technical Committee

Alex Held + Karl Staenz
Co-Chairs

ISIS Technical Committee Meeting

Vancouver, July 27, 2011

Vision

"..Hyperspectral remote sensing has the potential to leapfrog multispectral r.s. in many future applications, especially where higher levels of physics-based remote sensing, subtle target detection and quantitative information is needed by global operational programs…"

What needs to happen to realise the Vision

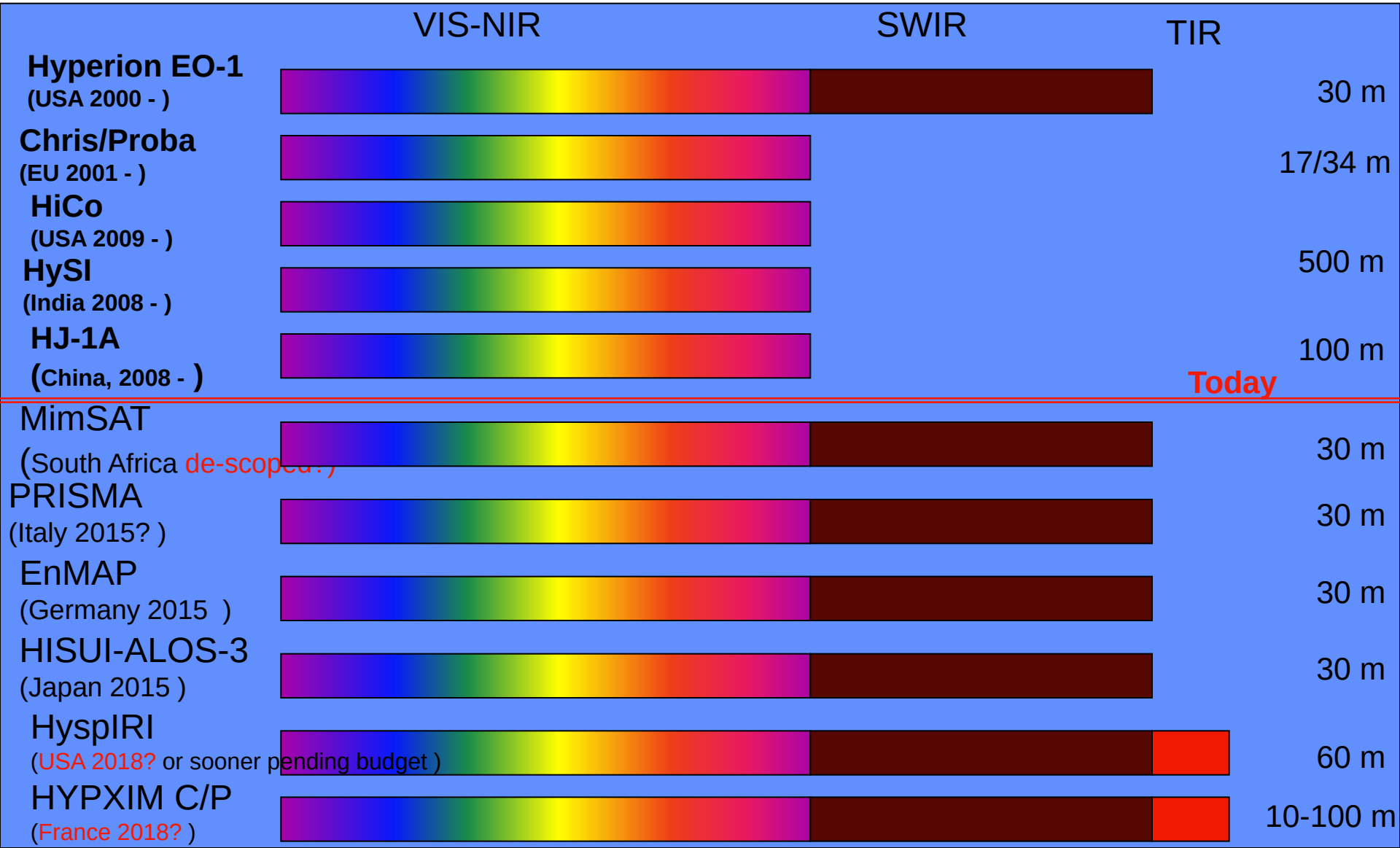
Transition the technology from a primarily R&D activity (today), towards operational data acquisition, standard products and efficient delivery (ideally public-good to all countries) by 2016, via:

- Coordination among key space agencies to establish data acquisition strategies involving a “virtual satellite constellation”
- Production of a small number of core public-good hyperspectral satellite data streams
  - Improved Signal:Noise (e.g. SWIR 50 -> 150+)
  - Sensor stability
- Efficient data delivery to processing facilities (at key global centres or to in-country institutions)
- Agreed data analysis protocols and a small set of “core products”.
- Coordinated vicarious calibration and product validation activities; linkages to airborne remote sensing community
- Robust, underpinning R&D program for continuous improvement.

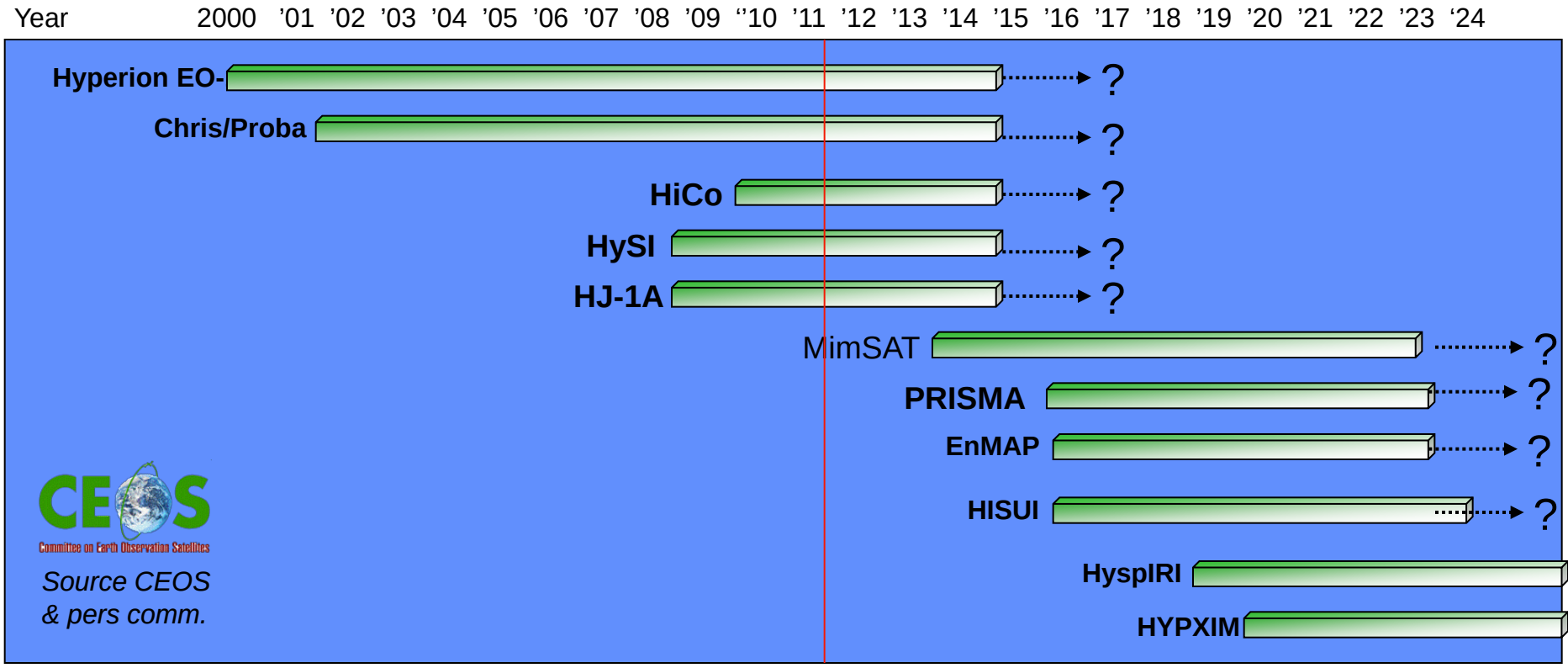
A role for GRSS, WHISPERS and ISIS

Current and Planned Civilian Hyperspectral Satellite Missions

(Updated Feb. 2011)



A ”Virtual Constellation” of Spaceborne Imaging Spectrometers



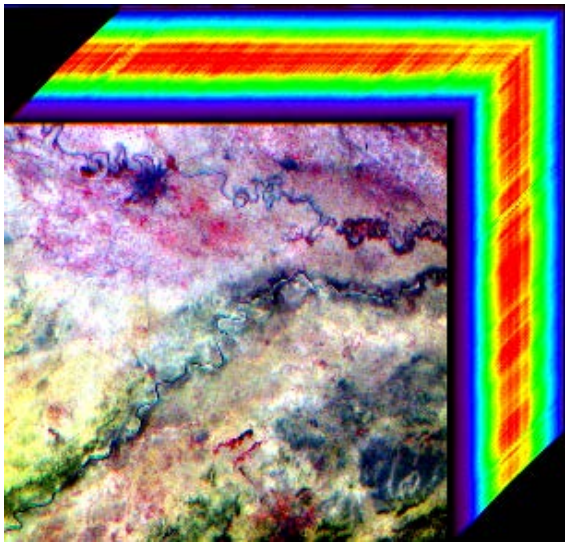
- Proceeded by unsuccessful proposals for e.g. ARIES, NEMO, Hydice, SPECTRA, etc.
- Supported by high Signal:Noise Airborne HSI systems
- Wide data access and data policies still are a key challenge
- Technical comparison of systems is difficult

IEEE

Current Indian Hyperspectral Imaging Sensors

Spaceborne

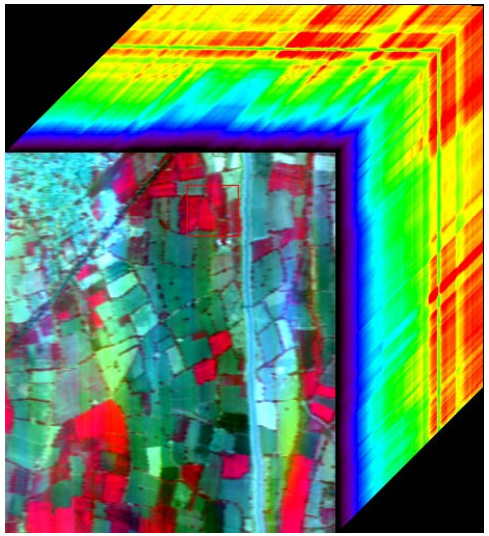
IMS-1 / HySi
(Hyperspectral Imager)



64 bands; 400-950 nm range;
Spectral separation 8 nm;
Spatial Resol. 505.6 m; Swath 129.5 km

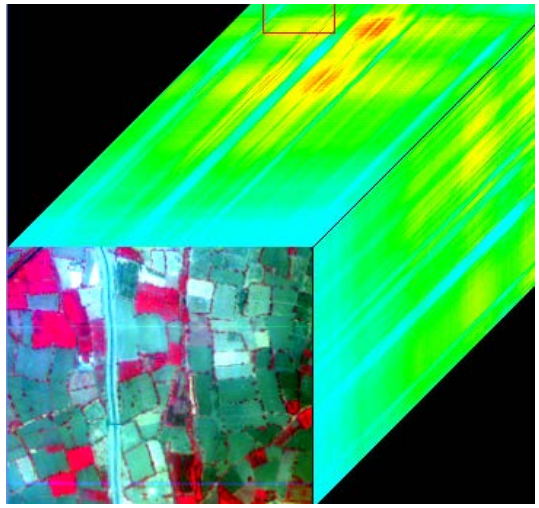
Airborne

AIMS
(Airborne Imaging Spectrometer)



Spatial Resolution: 4.4 m
Spectral Range: 456-889 nm
Number of Bands: 143
Band Width: 3.3-4.1 nm

AHYSI
(Airborne Hyperspectral Imager)



Spatial Resolution : 3.5 m
Spectral Range : 420-950 nm
Number of Bands: 512
Spectral sampling interval: 1.2 nm

Introduction for HJ HSI

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Introduction for HJ HSI

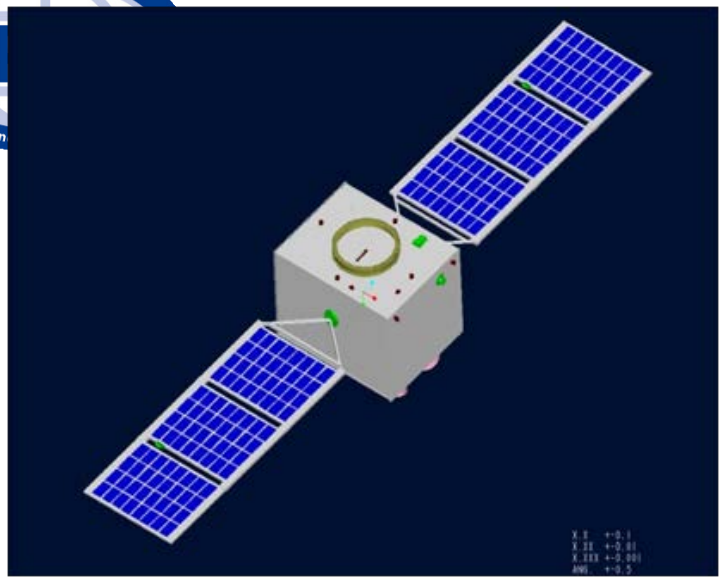
- **HSI (Hyper Spectral Imager) is Chinese first spaceborne hyperspectrum sensor, which is loaded on HJ-1A satellite. HJ is the Chinese abbreviation of “Environment”.**
- **HSI sensor is a Fourier transform imaging spectrometer, which is designed by Xi’an Institute of Optics and Precision Mechanics of Chinese Academy Sciences.**

Orbit

- Type: Sun-Synchronous
- Altitude（km）: 649.093
- Inclination（°）: 97.9486
- Period（min）:97.5605
- Repeat Cycle(day):31
- descending time:10：30AM±30min
- Orbital velocity（km/s）:7.535

HSI Sensors

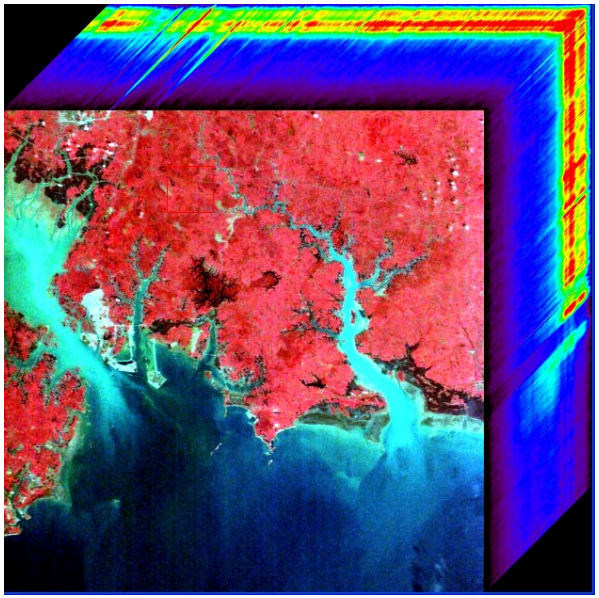
- **Spatial Resolution 100 m**
- **Swath Width 50km**
- **Spectral Channels 115unique channels.**
- **Spectral Bandwidth 2-8nm (nominal)**
- **Digitization 12 bits**
- **Signal-to-Noise Ratio (SNR) >50**
- **Weight 50.78kg**



HJ-1A Satellite

HSI Image

HSI Sensor



HSI Image

CENTRE NATIONAL D'ÉTUDES SPATIALES

HYPXIM – SATELLITE HYPERSPECTRAL DUAL

Résultats préliminaires des études

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HYPXIM : 2 concepts satellites différents

- Pour satisfaire ces besoins, 2 concepts de satellite sont étudiés avec le support industriel de Thales Alenia Space et d'EADS-Astrium :
  - HYPXIM-Challenging (HYPXIM-C), et
  - HYPXIM-Performance (HYPXIM-P).

- HYPXIM-Challenging
  - Le défi pour la conception d'HYPXIM-C est de respecter deux contraintes quasiment antinomiques : un microsatellite (< 200 kg) et un instrument hyperspectral de haute résolution (15 mètres).
  - Les études préliminaires menées par le CNES (avec supports des industriels) montrent qu'une mission HYPXIM-C "Advanced" (HYPXIM-CA) pourrait être mise en orbite d'ici 2020, et qu'une mission HYPXIM-C "Basic" (HYPXIM-CB) - encore à l'étude - pourrait suivre un calendrier plus proche encore.

- HYPXIM-Performance
  - Le challenge de la mission HYPXIM-P est de concevoir et d'aménager un instrument hyperspectral à très haute résolution (8 mètres) ainsi qu'un spectromètre IRT sur un mini-satellite (500 kg – 1 t).
  - Les études préliminaires montrent qu'une mission HYPXIM-P pourrait être mise en orbite d'ici 2020.

HYPXIM : spécifications de mission (1/2)

Domaine	Spectre (nm)	Rés. spectrale dλ (nm)	Rapport Signal-à-Bruit
VIS	400-700	10	≥ 250:1
NIR	700-1100	10	≥ 200:1
SWIR	1100-2500	10	≥ 100:1
PAN	400-800	400	≥ 90:1
IRT	8000-12000	100	≥ 100:1

@ L2 (cf. + loin)

- Le continuum spectral est requis en VIS et en SWIR, avec une résolution spectrale de 10 nanomètres.
- Le continuum spectral est aussi requis pour l'IRT, avec dλ de 100 nm.
- L'image hyperspectrale peut être « combinée » avec l'image panchromatique.

HYPXIM : spécifications de mission (2/2)

- Résolution spatiale : 3 classes de besoin sont identifiées pour le domaine VNIR-SWIR (0.4 - 2.5 μm) :
  - 30 mètres => sera couvert par les missions EnMAP et PRISMA.
  - 15-20 mètres
  - 5-10 mètres

  } => Cibles pour HYPXIM

- Résolution spatiale de 100 mètres requise pour l'IRT (8 - 12 μm).

- Champ : 15 km (minimum).

- Période de revisite du satellite :
  - Revisite journalière requise pour certaines applications Sécurité & Défense, mais revisite à 3 jours acceptable.
  - Non critique pour un certain nombre d'applications (exemple : géosciences, environnement urbain).

ISIS TC Activities

- **Attended and presented Keynote at WHISPERS – June 6-9, Lisbon 2011**

Proposed Activities 2011-2012

- Workshop on development of ‘Global Hyperspectral Products’ (proposed April 18-19, TBC)
- IGARSS2012 Special Session/Workshop on data management, data policy, processing and distribution of spaceborne imaging spectroscopy missions
  - IEEE GRSS TGARSS Special Issue on High-Volume IS Data Processing Approaches” – 2012 ??
- Develop archive of HSI datasets and simulated satellite data for product development – (Coordinated by DLR & NASA ?)
- Development of “Best-Practice” hyperspectral sensor development and data analysis” – SPIE Paper?
- IEEE GRSS Proposal to CEOS Hyperspectral Cal/Val Sub-program – Lead ??
  - IEEE GRSS JSTARS Special Issue on “Field Methodologies for Hyperspectral CAL/VAL” – 2012 ??
- Establish ISIS wiki site for discussion and documents

Next full Technical Committee Meeting

Planned for IGARSS 2012

July 22-27 2011

Munich, Germany

http://www.grss-ieee.org/Resources/TechCommittees