

An Automated Image Processing Workflow for Air/Spaceborne (Hyperspectral) Remote Sensing

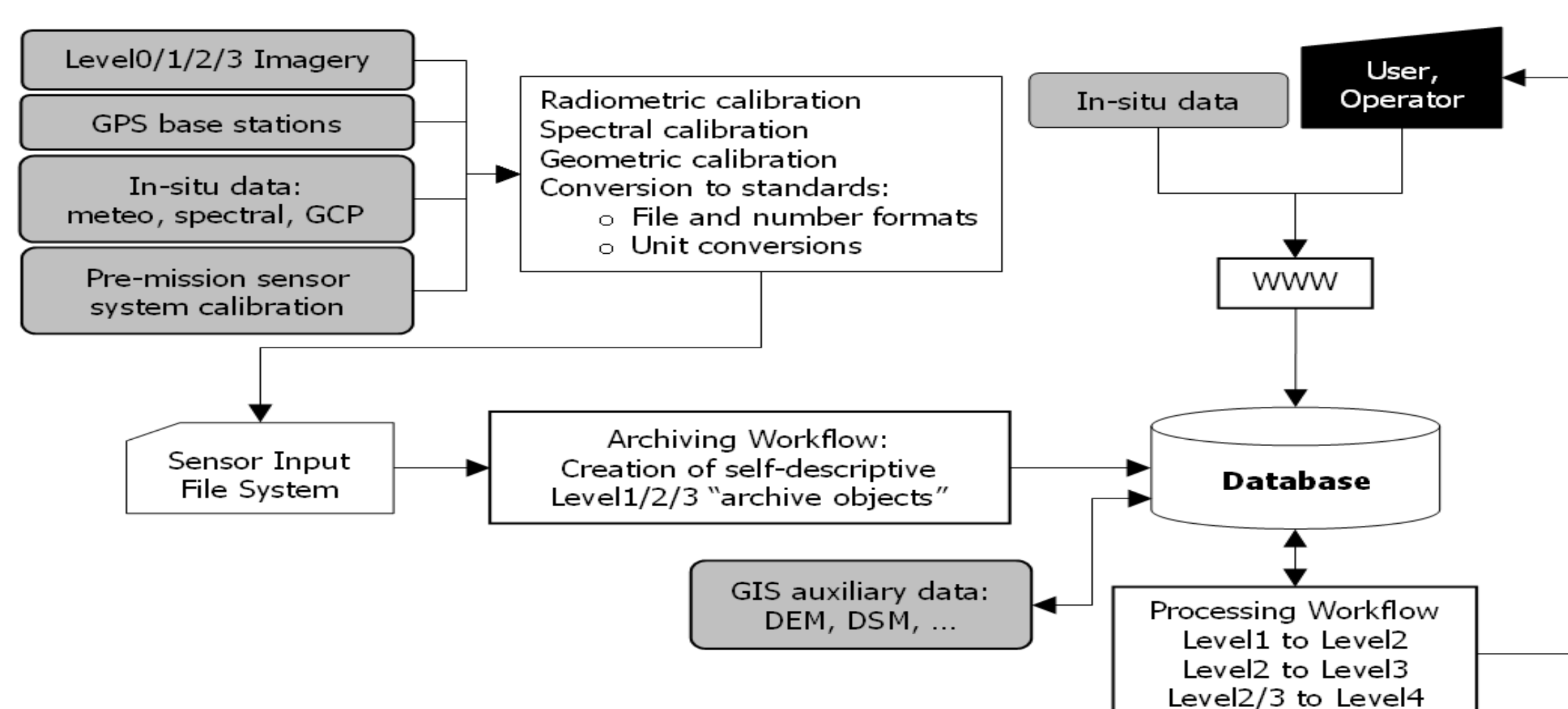
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Motivation

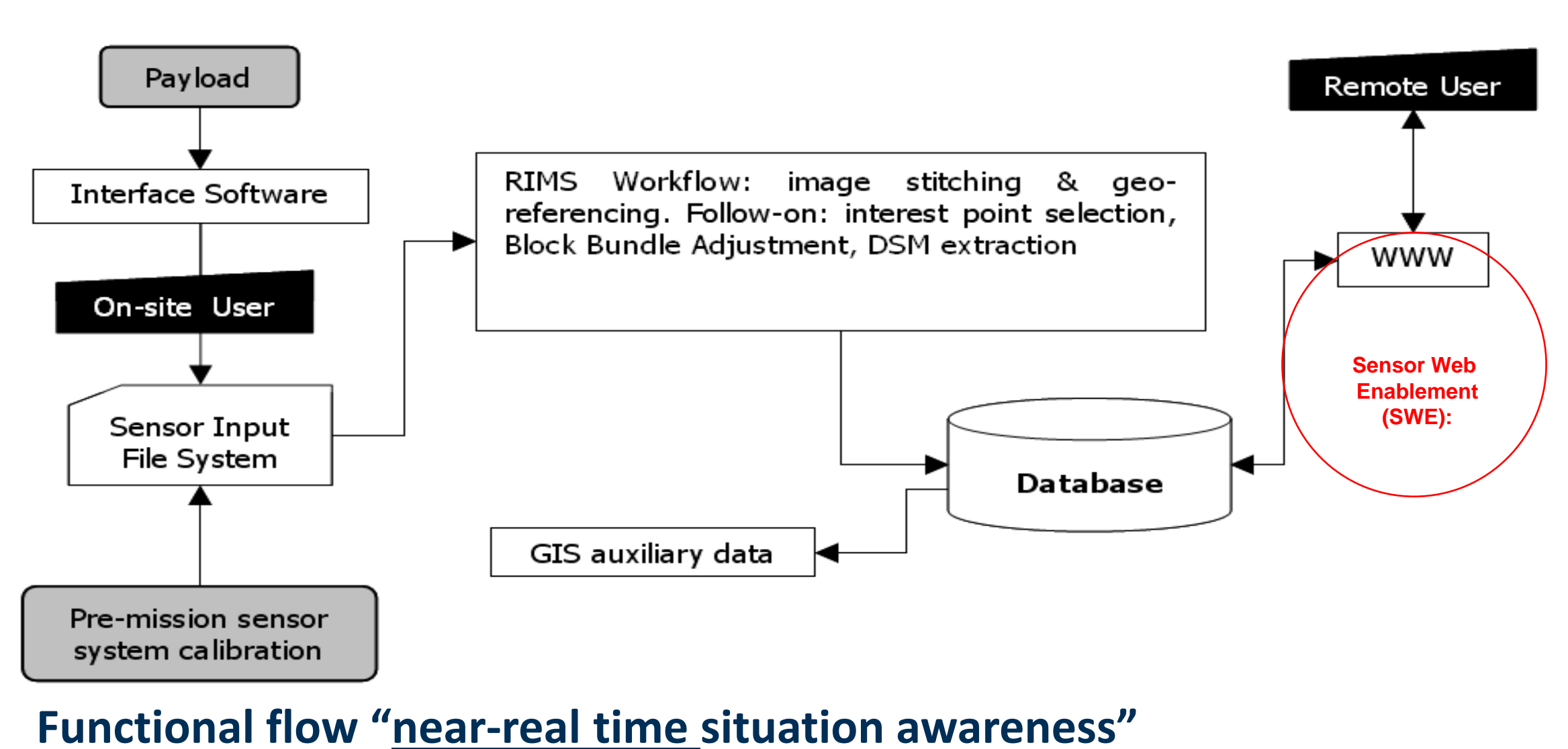
The software development process of the processing workflows for airborne remote sensing started at July 2004 and was triggered by several research projects and airborne image campaigns **both with frame sensors, push- and whiskbroom (hyperspectral) sensors and video cameras**. As no available software could handle all this sensor types within the same framework, the development started of a generic, tunable processing workflow able to handle all of the above mentioned sensor types

Two Generic Processing Workflows

Two functional workflows have been developed:



Functional flow "Classical air/spaceborne missions"



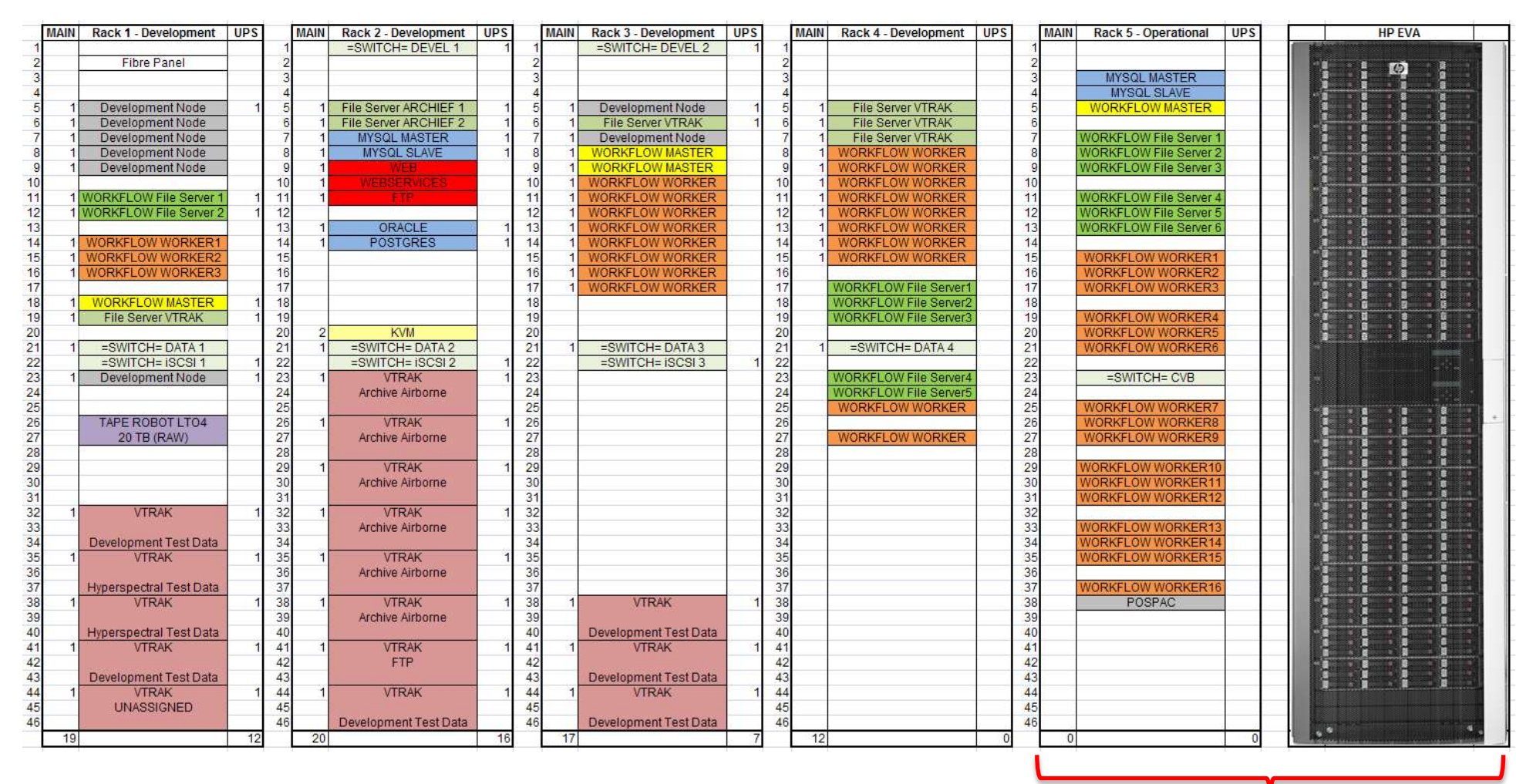
Functional flow "near-real time situation awareness"

Middleware for cluster/distributed computing developed by VITO

- Middleware is computer software that connects software components or applications. The software consists of a set of enabling services that allow **multiple processes running on one or more machines** to interact across a network.
- **Airborne missions generate thousands of images** → need for distributed computing → need to chose patterns for parallelism:
 - **Master/Worker**: Master application constructs a job-list and maintains the job-dependency. Worker applications ask the master for a job and execute this job.
 - **Task/Data Decomposition**: algorithmic module is executed on smaller subsets of data. Master applications implements the task and data decomposition.
- **Parallelism is implemented in the middleware, NOT in the applications** (this keeps the C++/C/Fortran/Java/IDL code of the applications as simple as possible)

Hardware setup

Development and Research platform separated from Operational Platform



Operational Platform, currently 180 cores on 20 machines

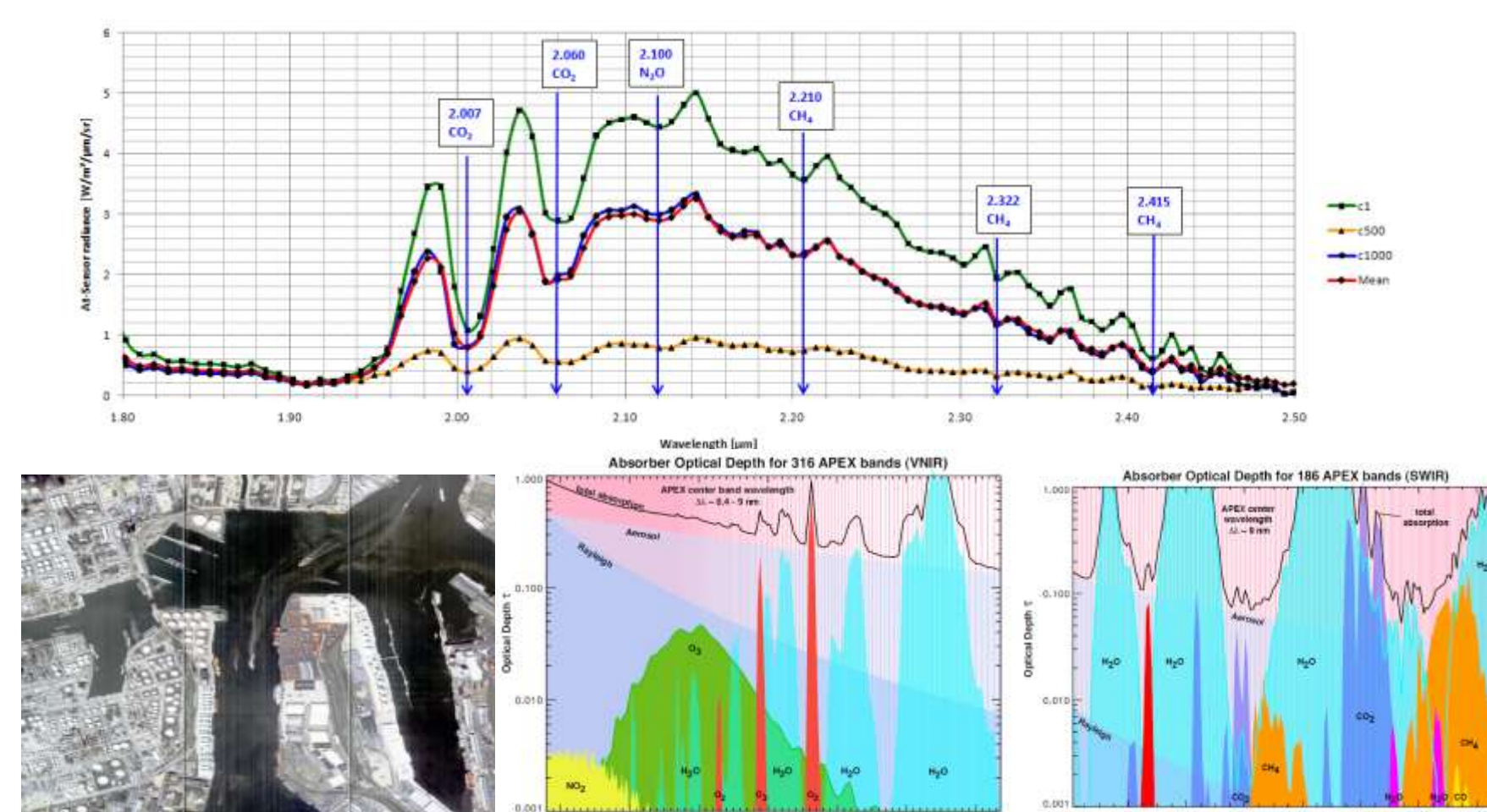
Hyperspectral Processing

Hyperspectral data from many different sensors (CASI, AHS, AISA, HySpex,, HyMap,...) were successfully processed . Currently, the Processing and Archiving Facility (PAF) of the airborne hyperspectral sensor **APEX** (www.apex-esa.org) is hosted.

1) Archiving workflow for file format and unit standardization

Function: (a) the packaging of image data and image metadata in one single "archive object", i.e. (a) **Level1 HDF5 file**, (b) the production of an orthorectified quicklook

Other features include: Geometric (Bore-sight) Calibration, Radiometric calibration and an automated **Spectral calibration** i.e. smile detection and correction



2) Processing workflows Level 1 → Level 2/3/4

Subdivided in 3 workflows grouped in one single WWW interface:

- Level 1 → Level 2 : Geometric and Atmospheric correction of the images
- Level 2 → Level 3: Mosaics of Level 2
- Level 3 → Level 4: e.g. change detection and classifiers

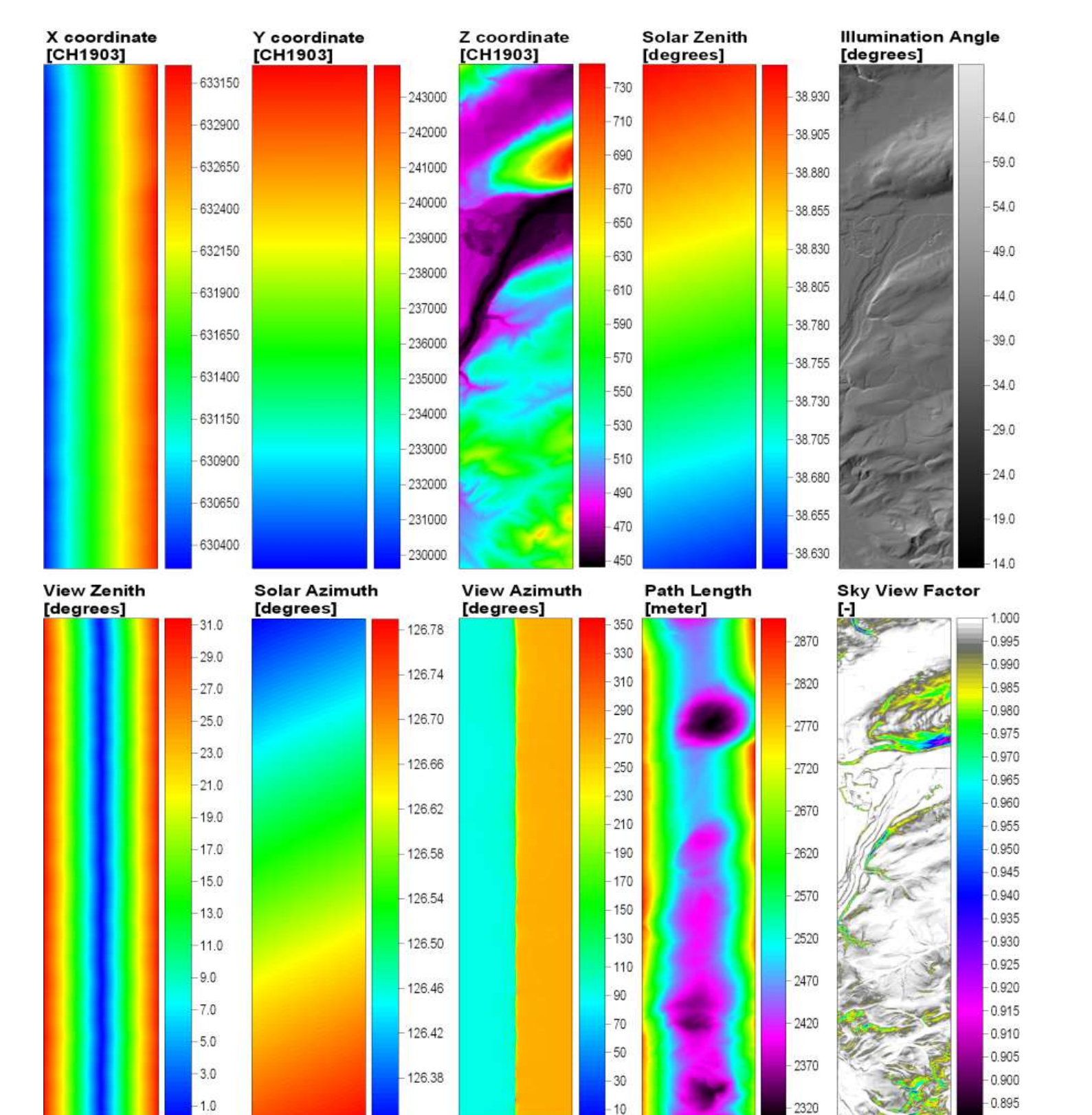
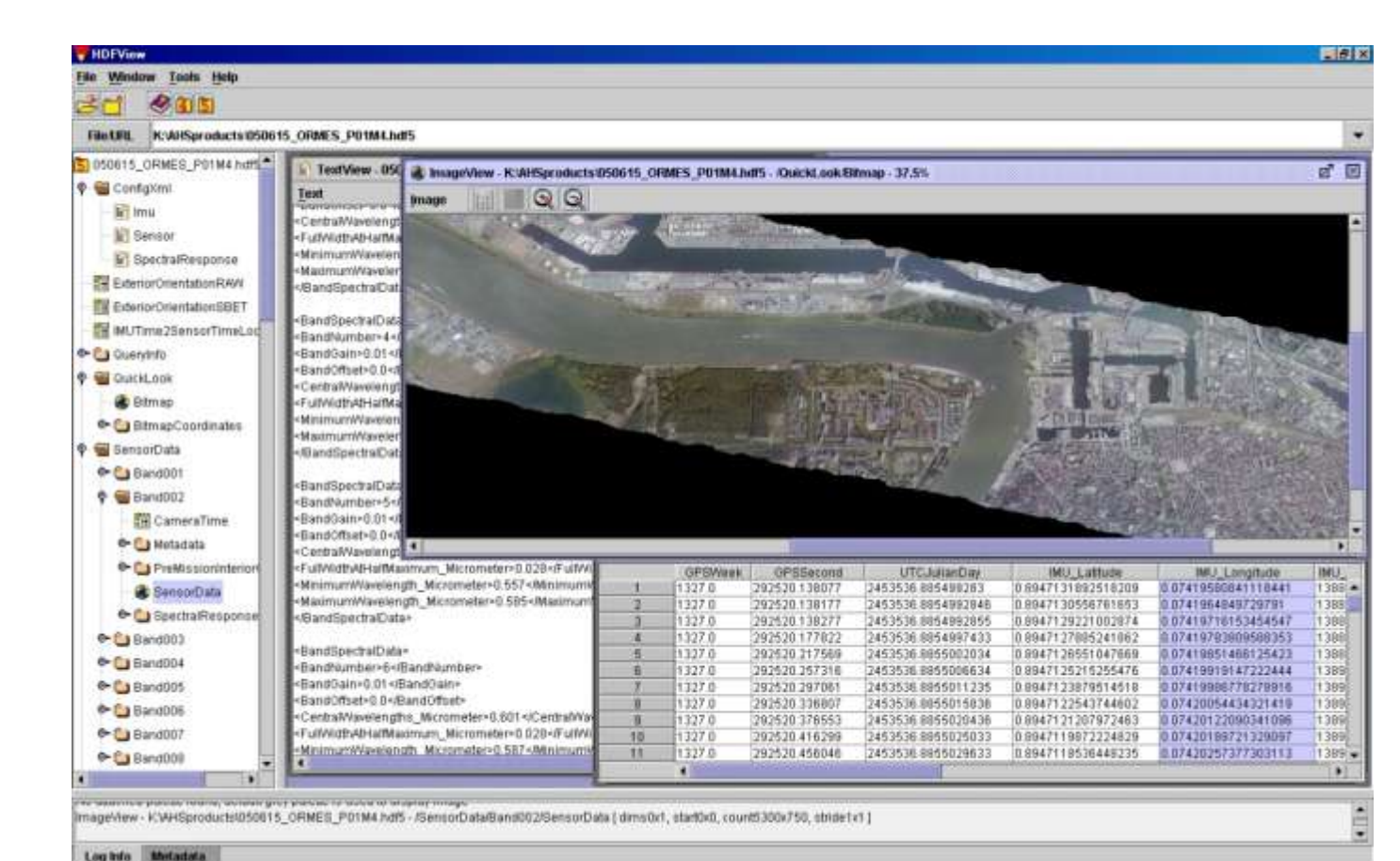
a) Level 1 → Level 2 Ortho-rectification : in house developed C++ module

- For better interfacing with Modtran and given the requirement that all Level 2 algorithms have to work on the raw sensor geometry and resampling is done at the end.
- To be able to support frame sensors and wishbroom and pushbroom line sensors

b) Level → Level 2 Atmospheric correction

Modtran 4/5 is implemented in such a way all 176 parameters are freely configurable, as such no pre-calculated look-up tables are used and Modtrans is configured:

- 1) Through an XML configuration file
- 2) Image based parameter retrieval (water vapour, visibility, ...)
- 3) Through web-interface



Output data generated by the Ortho-rectification module

Outlook

Besides being used for the processing of all airborne missions at VITO and the **operational APEX processing**, the workflow and middleware have been used for the development of **Proba-V** space mission processing chain. Further the system is being tuned for the operational processing of the **Hyplant airborne sensor (FZ Juelich)** and the airborne thermal hyperspectral **Hyper-Cam sensor (CRP G. Lippmann)**. Furthermore, the processing flow will be prepared for the **processing and calibration of the VNREDSat-1b hyperspectral mission**, due for launch in 2017.