

AISA data processing chain

Lucie Homolova, Katja Alanko-Huotari

3rd Hyper-I-Net summer school, Pavia, Italy, 8-11 Sept 2009



ENHANCE YOUR PERCEPTION

Outline

- AISA sensor family
- Data acquisition
- Overview of AISA data processing chain
- Radiometric corrections
- Geometric corrections
- Demo

AISA sensor family



Coming soon!

	AisaEAGLET	AisaEAGLE	AisaHAWK	AisaDUAL	AisaOWL
	Lightweight VNIR	VNIR sensor	SWIR sensor	VNIR + SWIR (Eagle+Hawk)	LWIR sensor
Spectral range	400-1000 nm	400-970 nm	970-2500 nm	400-2500 nm	8-12 μ m
Spectral bands	Up to 410	Up to 488	Up to 254	Up to 244 + 254	84
FWHM	3.3 nm	3.3 nm	12 nm		100 nm
Spatial px. (max.)	1600	1024	320	320	384
Spatial res. @1km	0.33 m	0.52 m	0.97 m		1.1 m
Camera & output	CCD & 12 bits	CCD & 12 bits	MCT & 14 bits		MCT & 14 bits
Sensor weight	3.5 kg	6.5 kg	18 kg	50 kg (mount)	8.5 kg

AISA system properties

	AisaEAGLET	AisaEAGLE	AisaHAWK	AisaOWL
	Lightweight VNIR	VNIR sensor	SWIR sensor	LWIR sensor
SNR	120:1 - 280:1	350:1 - 500:1	800:1	450 at 8 um 580 at 10 um 230 at 12 um

AISA system components



Hyperspectral sensor head



Data acquisition and storage system in a rugged compact PC



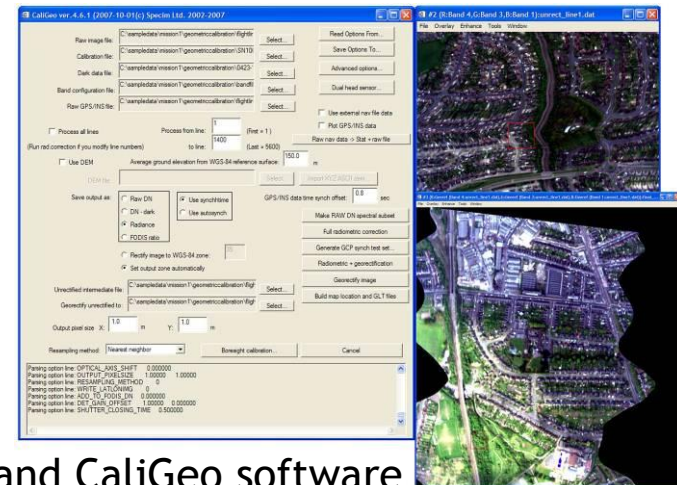
Daylight readable LCD Display



GPS/INS unit



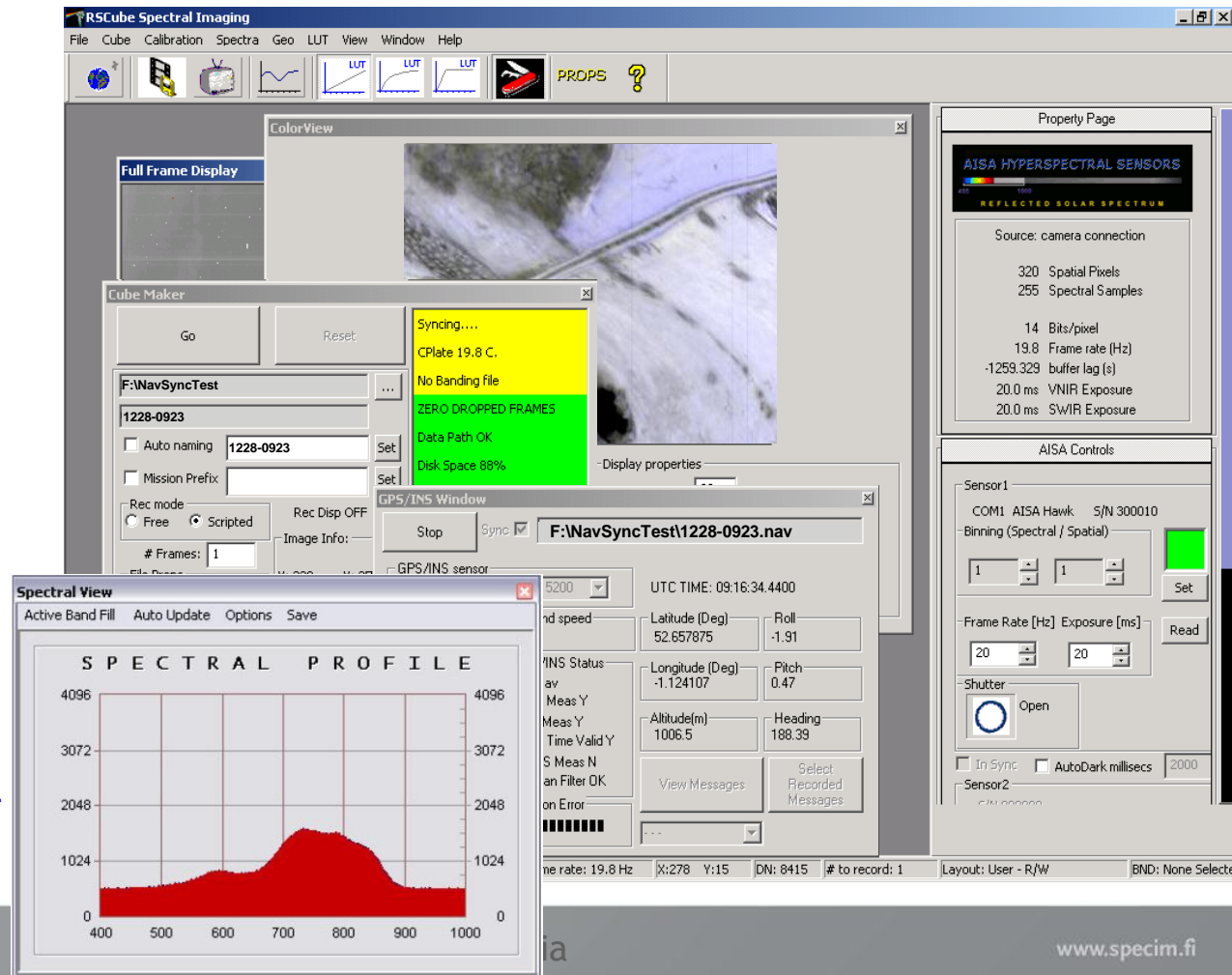
FODIS irradiance sensor



RSCube and CaliGeo software

AISA Operating Software - RSCube

- Windows-based software
- Control hardware
 - Frame rate
 - Exposure time
 - Binning
- Display images, GPS/INS status
- Monitoring of data collection



The screenshot displays the RSCube Spectral Imaging software interface. The main window shows a 'ColorView' of a landscape. Overlaid windows include:

- Cube Maker:** A control panel with 'Go' and 'Reset' buttons. It shows 'Syncing...' status, 'CPlate 19.8 C.', 'No Banding file', 'ZERO DROPPED FRAMES', 'Data Path OK', and 'Disk Space 88%'. It also has fields for 'F:\NavSyncTest\1228-0923', 'Auto naming', 'Mission Prefix', 'Rec mode' (Free/Scripted), 'Rec Disp OFF', and '# Frames: 1'.
- Property Page:** Displays sensor information: 'AISA HYPERSPECTRAL SENSORS', 'REFLECTED SOLAR SPECTRUM', 'Source: camera connection', '320 Spatial Pixels', '255 Spectral Samples', '14 Bits/pixel', '19.8 Frame rate (Hz)', '-1259.329 buffer lag (s)', '20.0 ms VNIR Exposure', and '20.0 ms SWIR Exposure'.
- AISA Controls:** Shows 'Sensor 1' settings: 'COM1 AISA Hawk S/N 300010', 'Binning (Spectral / Spatial)' set to 1x1, 'Frame Rate [Hz]' set to 20, and 'Exposure [ms]' set to 20. It includes a 'Shutter' control and 'In Sync'/'AutoDark' checkboxes.
- Spectral View:** A 'SPECTRAL PROFILE' graph showing intensity vs. wavelength (400-1000 nm). The y-axis ranges from 0 to 4096. A red shaded area under the curve indicates the spectral data.
- GPS/INS Window:** Displays real-time location and orientation data: 'Latitude (Deg) 52.657875', 'Longitude (Deg) -1.124107', 'Altitude(m) 1006.5', 'Roll -1.91', 'Pitch 0.47', 'Heading 188.39', and 'Time Valid Y 1006.5'. It also includes 'View Messages' and 'Select Recorded Messages' buttons.

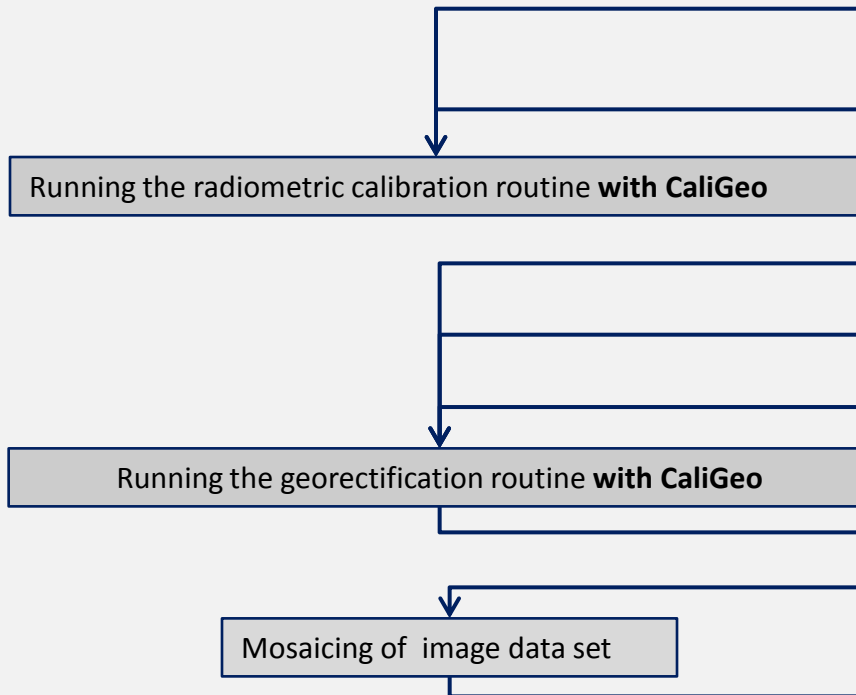
The status bar at the bottom shows: 'Frame rate: 19.8 Hz', 'X:278 Y:15', 'DN: 8415', '# to record: 1', 'Layout: User - R/W', and 'BND: None Selected'.

Acquired data

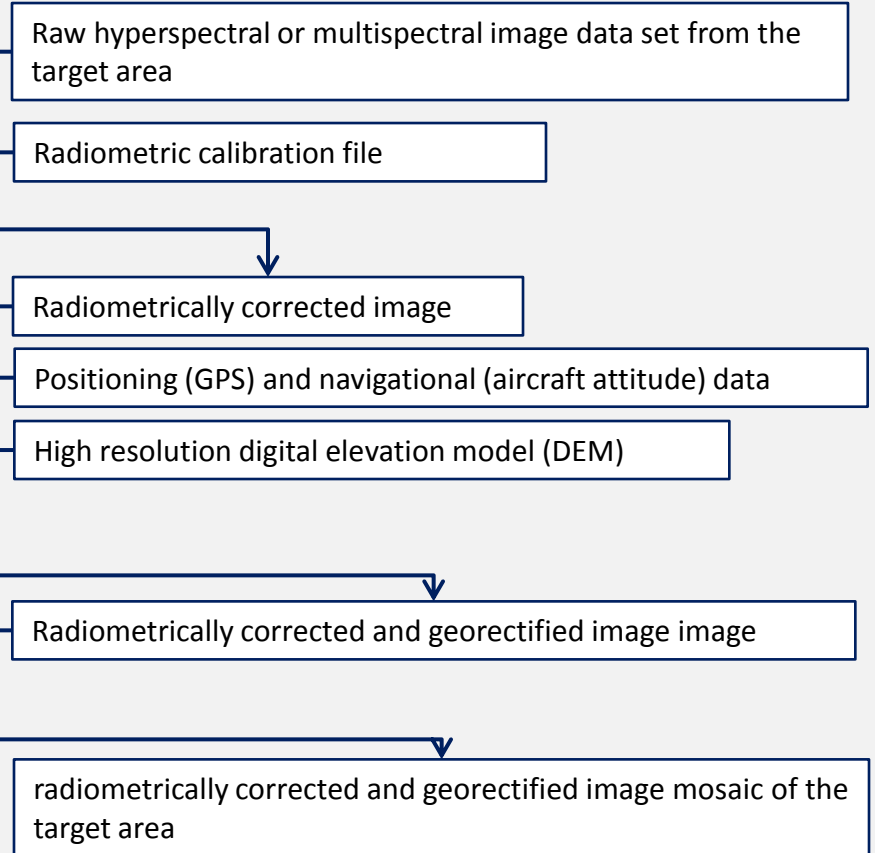
- AISA operating software - RSCube
 - full hyperspectral mode
 - multispectral mode with programmable bands
- Raw image data and header file
- Dark image data -> recorded and stored together with raw image file
- Navigation GPS/INS data
- Log file recording dropped frames

AISA processing chain - flowchart

Work flow



Data flow



AISA processing software - CaliGeo

- Interactive GUI running as an ENVI/IDL plug-in
- Designed for all AISA data processing
- Radiometric corrections and georeferencing
- Co-alignment of AisaDUAL sensor data
- Boresight calibration (sensor head vs. GPS/INS)
- Use of DEM data

CaliGeo ver. 4.5 (2007-07-30) (c) Specim Ltd. 2002-2007

Raw image file: D:\CaliGeo1\demosetti\geometric_caline1\0423-1 Select... Read Options From...

Calibration file: D:\CaliGeo1\demosetti\geometric_cal\N100005_ Select... Save Options To...

Dark data file: D:\CaliGeo1\demosetti\geometric_cal\0423-1436.ra Select... Advanced options...

Band configuration file: D:\CaliGeo1\demosetti\geometric_cal\bandfile.bnd Select... Dual head sensor...

Raw GPS/INS file: D:\CaliGeo1\demosetti\geometric_cal\line1\042303 Select... Use external nav file data

Process all lines Process from line: 1 (First = 1) Plot GPS/INS data

(Run rad.correction if you modify line numbers) to line: 1000 (Last = 5600) Raw nav data -> Stat + raw file

Use DEM Average ground elevation from WGS-84 reference surface: 127.0 m

DEM file: Select... Import XYZ ASCII dem...

Save output as: Raw DN Use synchhime Use autosynch GPS/INS data time synch offset: 0.500 sec

DN - dark Radiance FODIS ratio

Rectify image to WGS-84 zone: 35 Set output zone automatically

Unrectified intermediate file: E:\CaliGeo1\out\demo_out\geometric_cal\unrect_ Select...

Georectify unrectified to: D:\CaliGeo1\demosetti\geometric_cal\line1\final Select...

Output pixel size X: 1.0 m Y: 1.0 m

Resampling method: Nearest neighbor Boresight calibration... Cancel

Make RAW DN spectral subset

Full radiometric correction

Generate GCP synch test set...

Radiometric + georectification

Georectify image

Build map location and GLT files

```

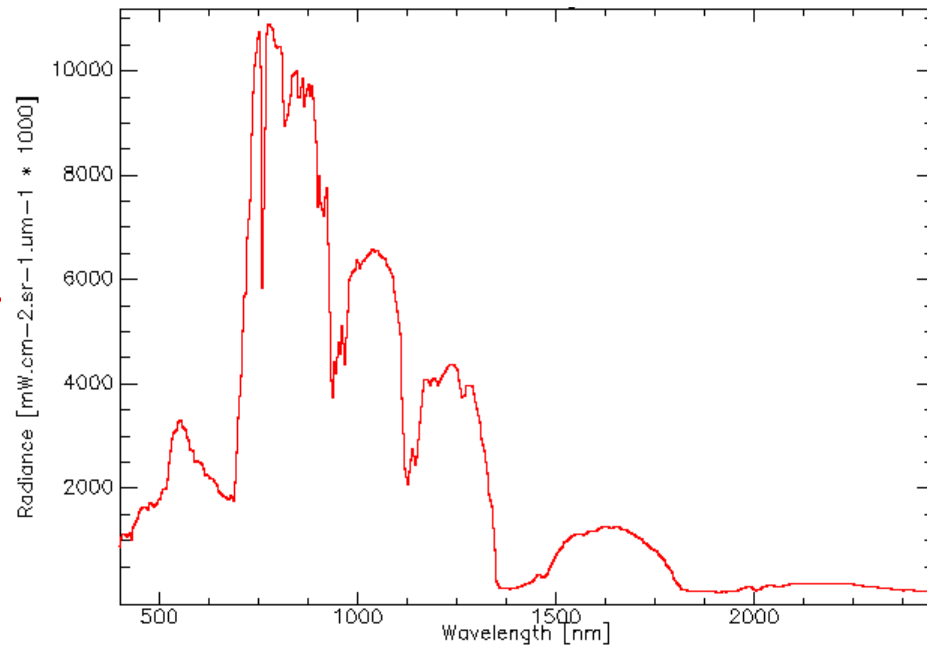
Parsing option line: OPTICAL_AXIS_SHIFT 0.000000
Parsing option line: OUTPUT_PIXELSIZE 1.00000 1.00000
Parsing option line: RESAMPLING_METHOD 0
Parsing option line: WRITE_LATLONIMG 0
Parsing option line: ADD_TO_FODIS_DN 0.000000
Parsing option line: DET_GAIN_OFFSET 1.00000 0.000000
Parsing option line: SHUTTER_CLOSING_TIME 0.500000
    
```

Radiometric correction

- Conversion of raw DN values to radiance
- Radiance units: $\text{mW cm}^{-2} \text{sr}^{-1} \mu\text{m}^{-1}$ * scaling constant
- Linear response -> only one radiometric calibration file required
- Batch processing of larger number of files
- Radiometric calibration of sensors
 - Calibrated integrating sphere
 - Recommended once a year

Radiometric calibration - example of AisaDUAL

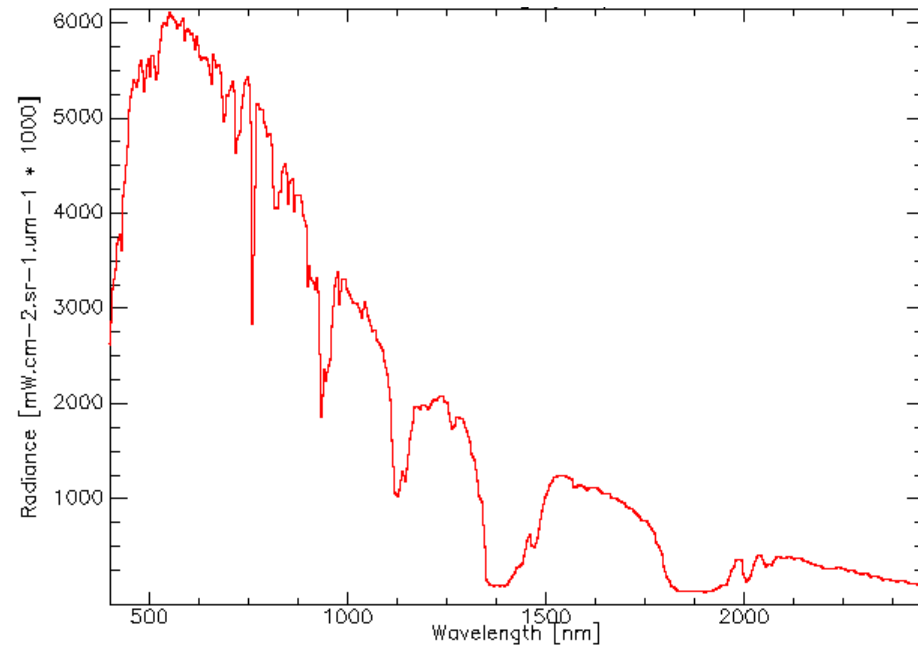
Vegetation - radiance



Radiometric calibration - example of AisaDUAL



Grey asphalt - radiance

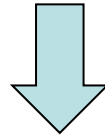
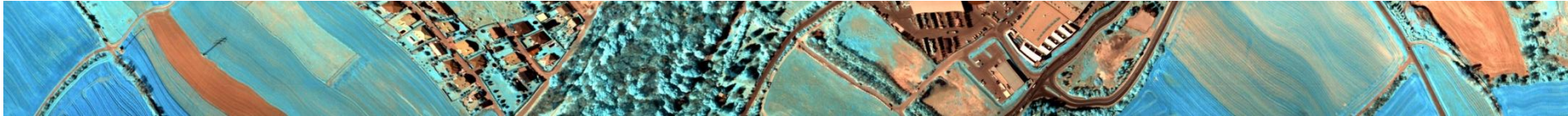


Subset of EcoChange 2008 AISA Dual data, French Alps. True color composite R(640) G(551) B(462), spatial resolution 1m. Courtesy of Wageningen University.

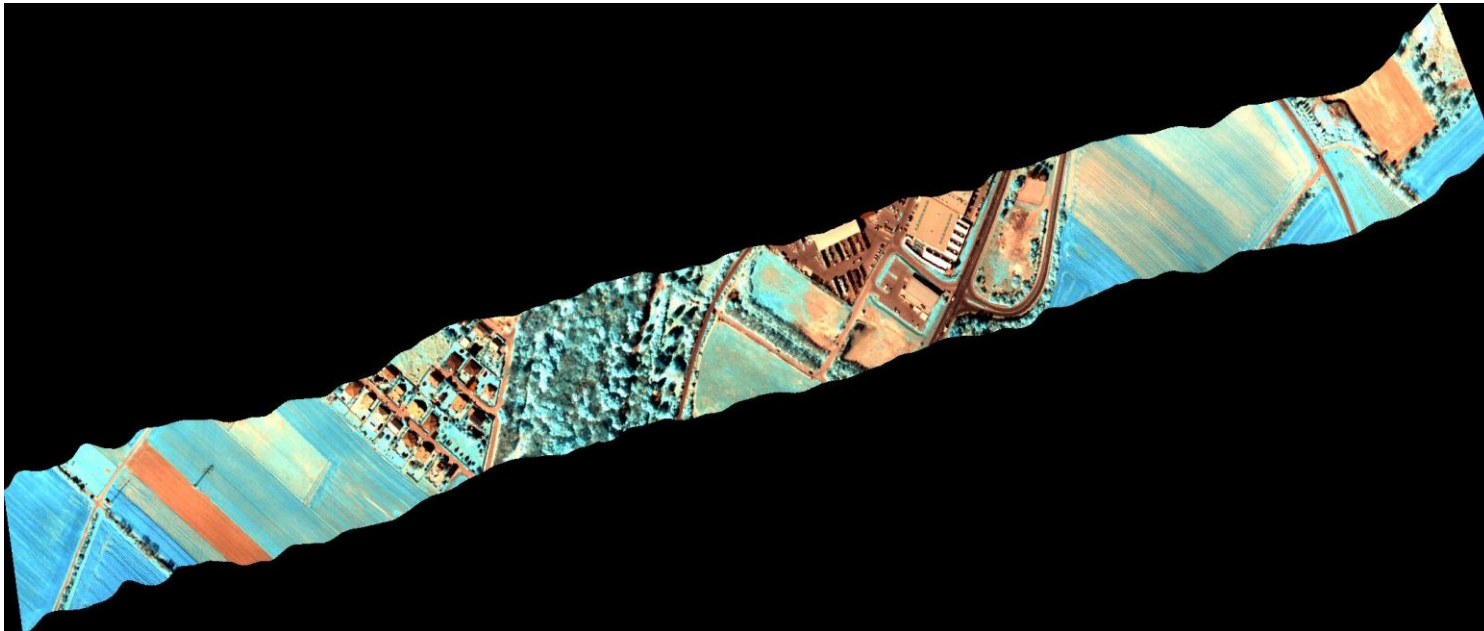
Geometric correction

- Synchronization of navigation and image data
 - roll, pitch, heading, flight altitude for each data line
- Build GLT (Geographic Look-up Tables) and map location files
 - Information about long/lat of each pixel
 - ENVI -> georeference image from GLT
- DEM orthorectification
- Georeferencing to UTM WGS-84
- All the above steps are combined in one georectification step

Radiance data

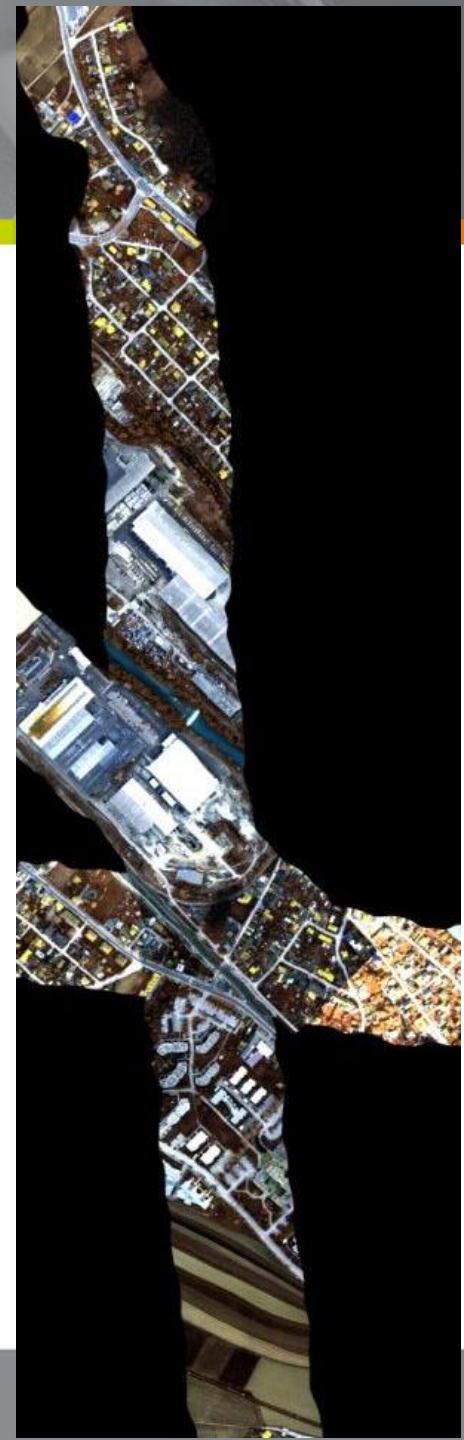


Georectified data



Boresight calibration

- Roll, pitch and yaw angle differences between sensor and navigation unit->
 - Boresight calibration flight - 3 lines crossing
 - Calculation done by using ground control points of image pairs
 - To provide optimal georectification accuracy
 - Everytime when sensor is mounted to the GPS/INS



Atmospheric corrections

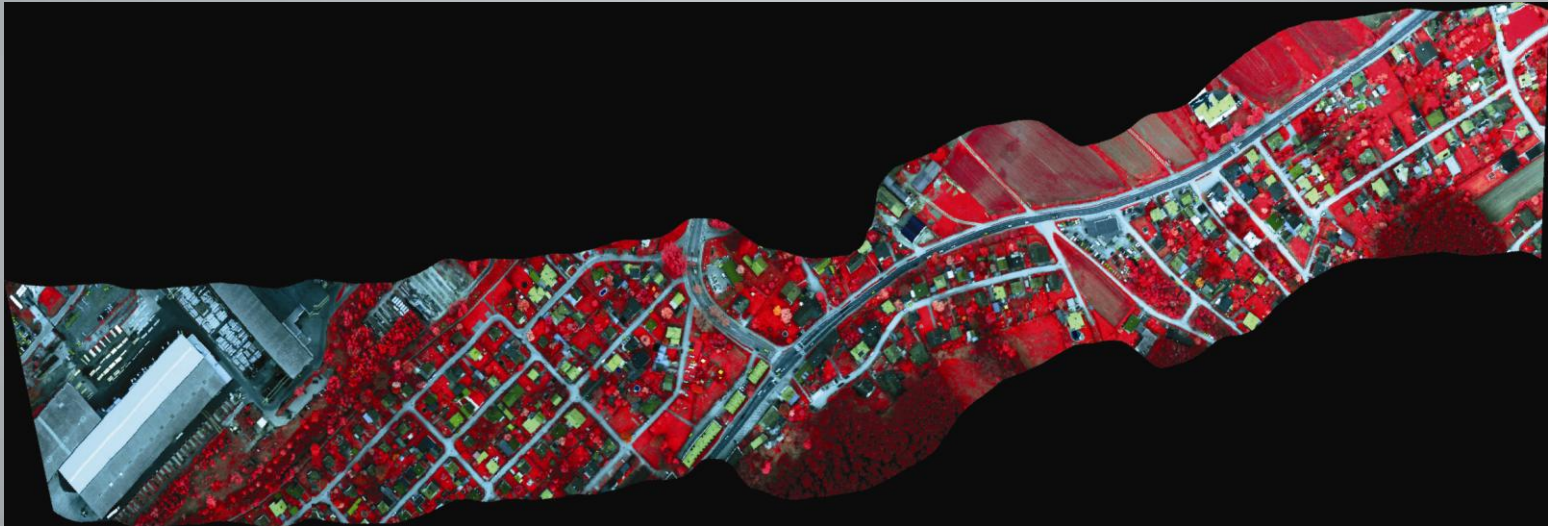
- Not part of ALSA data processing chain ensured by Specim
- Customer dependent
- Available atmospheric correction packages has been used
 - Atcor-4 (ReSe)
 - ENVI Flaash

Thank you for the attention.

Contacts and further questions:

<http://www.specim.fi>
info@specim.fi

lucie.homolova@specim.fi
katja.alanko-huotari@specim.fi



ENHANCE YOUR PERCEPTION