FLUXPYR ACTIVITIES AT THE INSTITUTE OF GEOMATICS

Aerial image acquisition and processing

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CONTENTS OF THE PRESENTATION

Photogrammetric workflow

IG Technologies

Flight plan

Flight results: from flight plan to Aerial images acquisition

Data processing

- Trajectory determination
- Image processing

Conclusions

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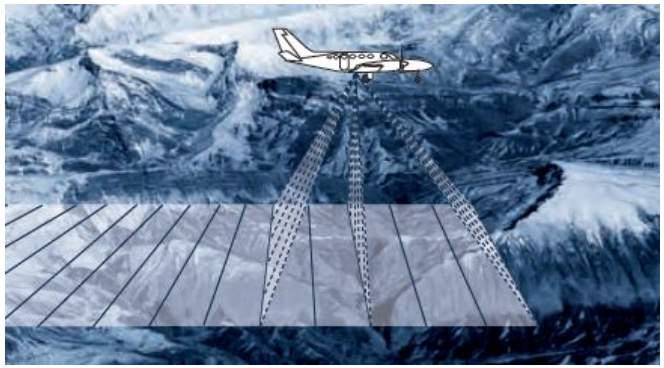
IG WORKFLOW

REQUIRED TECHNOLOGIES

- tPVA determination system
- Image acquisition system
- Post processing & analysis of results

FLIGHT PLAN → **FLIGHT** → **DATA ACQUISITION** → **DATA PROCESSING**



DATA FROM:

- GPS
- IMU
- CAMERA
- OTHER SENSORS...

IG WORKFLOW

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FLIGHT PLAN → **FLIGHT** → **DATA ACQUISITION** → **DATA PROCESSING** → **FINAL RESULT**

- tPVA precise determination
- Georeferenced image block (RGB & NIR)

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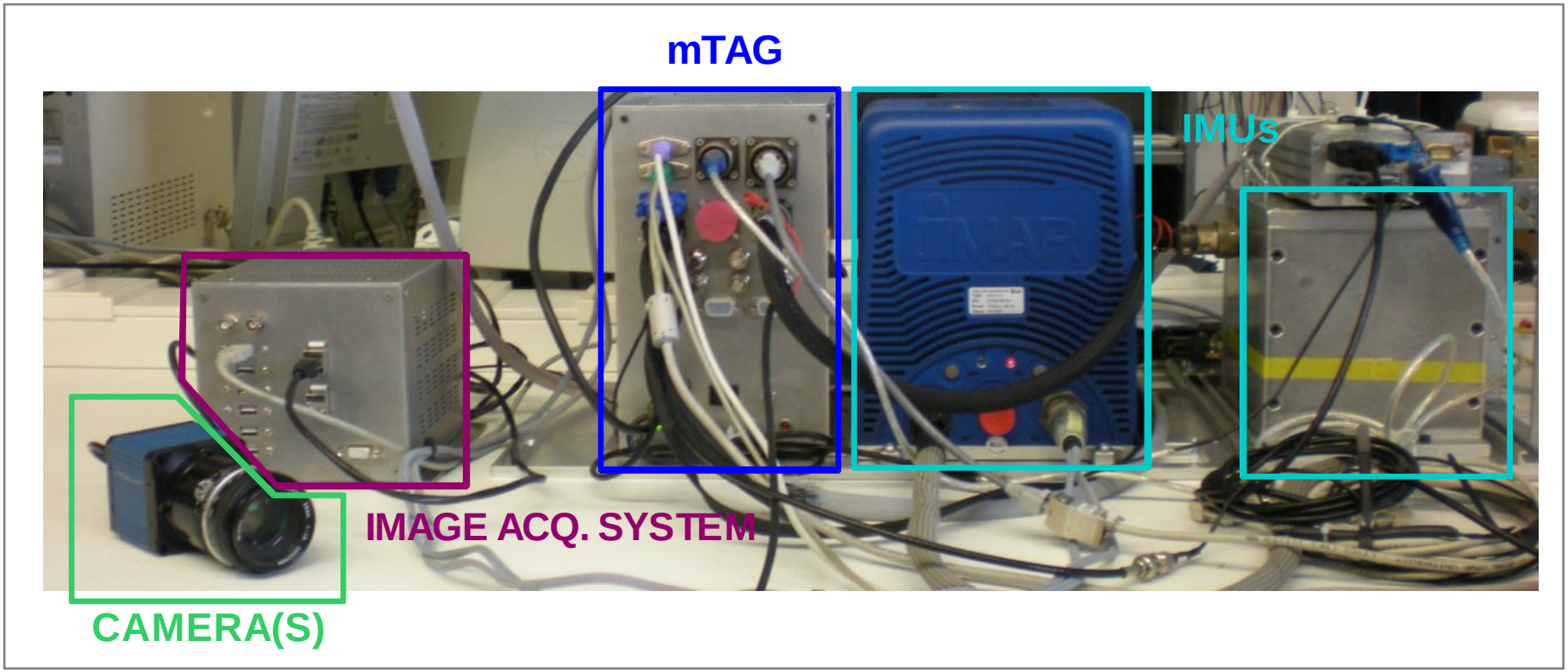
mTAG + IMUs + Image acquisition system + Cameras



IG TECHNOLOGIES

CAMERA SPECIFICATIONS

- **RGB 16 MP CCD Camera.** *Prosilica GE4900C*
- High resolution 4872 x 3248 pixels
- Pixel size 7.4 x 7.4 µm
- 3 frames per second

- **Monochrome 5MP CCD Camera.** *Prosilica GC2450*
- High resolution 2448 x 2050 pixels
- Pixel size 3.45 x 3.45 µm
- 15 frames per second

NIR FILTERS

- LP780 IR Longpass filter – wavelength 780nm
- LP830 IR Longpass filter – wavelength 830nm
- BP880 IR Bandpass Filter – wavelength 880nm

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FLIGHT PLAN

FLIGHT

- Carried out by *GRUP AIR-MED* (Girona's Airport)
- Light aircraft: *Partenavia P68 C*
- In collaboration with Agustin Lobo (ICTJA-CSIC)

PREVIOUS TEST FLIGHTS

- July 27, 2010
- October 22, 2010

Objective: To test the overall system performance before the flight, for further development and improvements and to evaluate data quality.

FIRST RESULTS

- Continuous and processable set of data from different sensors
- RGB and NIR image block

GRUP AIR-MED Light aircraft


RGB Image Prosilica GE4900C

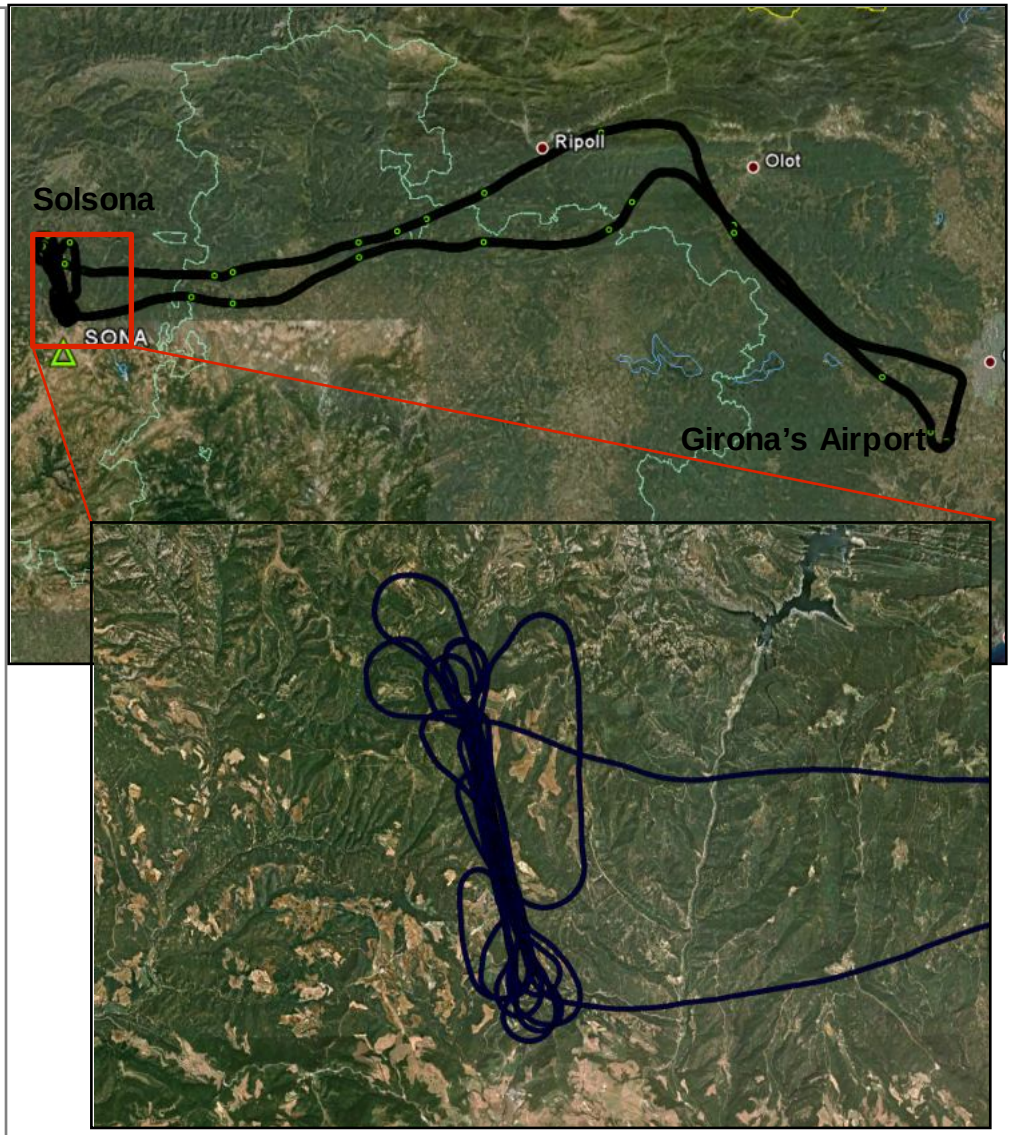
FLIGHT PLAN

FLIGHT

- July 1, 2011 16:00h
- Flight plan:
  - Flight defined by waypoints
  - 3 different flight heights 500, 700 and 900 meters (above ground)
  - considering the image acquisition rate, a constant flight speed, the image size and its footprint at ground, the flight height, etc.

DATA FROM SENSORS

- GNSS, IMU and barometer
- RGB Images (From: Prosilica GE4900c)
- NIR Images (Prosilica GC2450 + IR 880nm)
- Lever arm measurements



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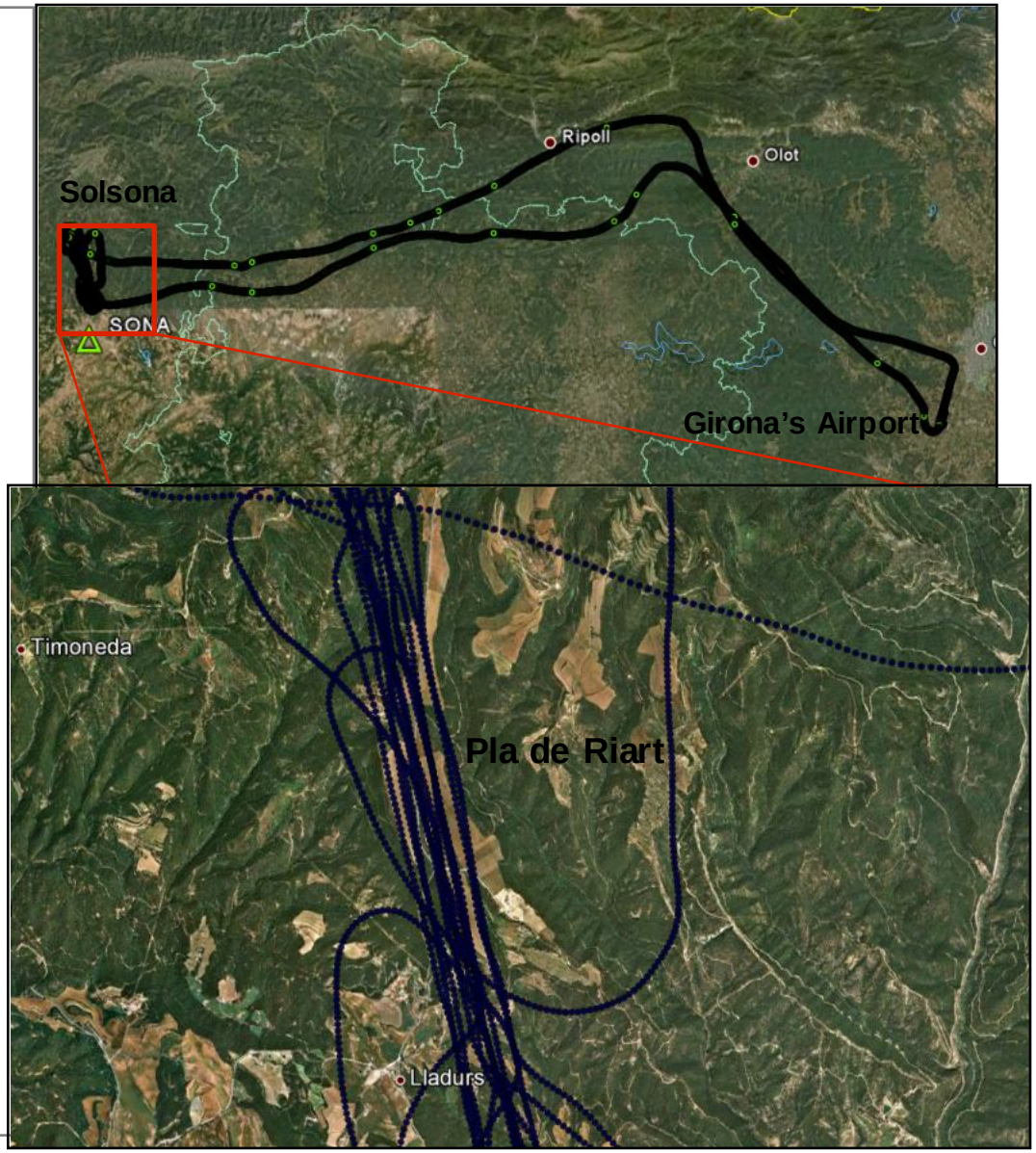

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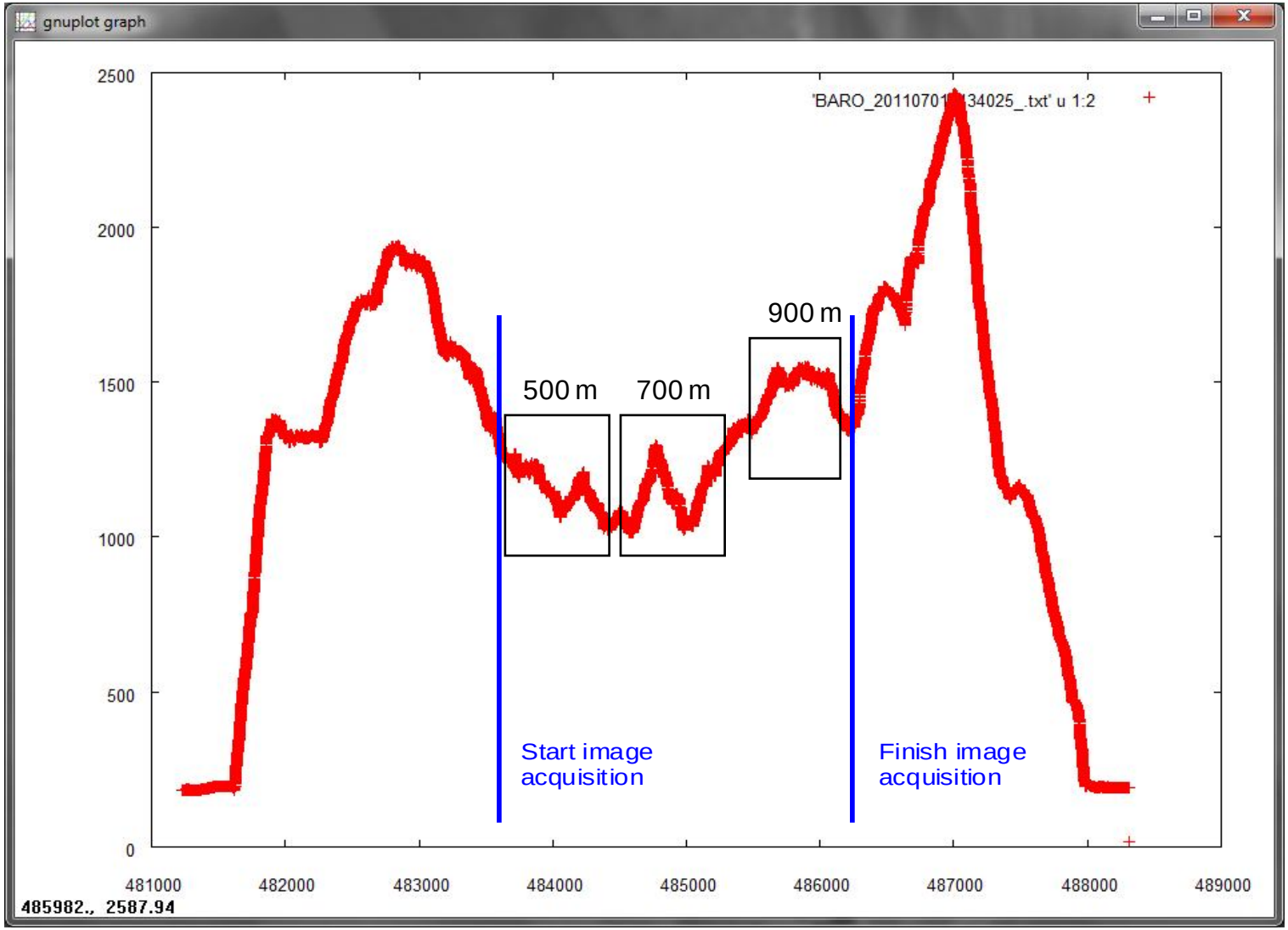
FLIGHT RESULTS

Height profile



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DATA PROCESSING – Trajectory determination

GNSS/INS data processing

PROCESSING SUMMARY INFORMATION (GNSS/INS)

Program: Inertial Explorer
Version: 8.40.1330
Project: G:\Vols FLUXPYR\3_vol_FLUXPYR_2011.07.01\procesamiento_2\inertial_explorer8.40\fluxpyr_20120420.cfg

Solution Type: Combined

Number of Epochs:

Total in GPB file:	7087
No processed position:	5
Missing Fwd or Rev:	229
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0249 (m)
C/A Code:	1.33 (m)
L1 Doppler:	0.000 (m/s)

Fwd/Rev Separation RMS Values:

East:	0.042 (m)
North:	0.037 (m)
Height:	0.044 (m)

Fwd/Rev Sep. RMS for dual FWD/REV fixes (6812 occurances):

East:	0.036 (m)
North:	0.033 (m)
Height:	0.038 (m)

Quality Number Percentages:

Q 1:	55.3 %
Q 2:	35.3 %
Q 3:	8.7 %
Q 4:	0.6 %
Q 5:	0.1 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	98.1 %
0.10 - 0.30 m:	1.9 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Standard Deviation: 10 cm

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol:	3.3 %

Baseline Distances:

Maximum:	108.896 (km)
Minimum:	0.001 (km)
Average:	66.604 (km)
First Epoch:	0.036 (km)

Input files

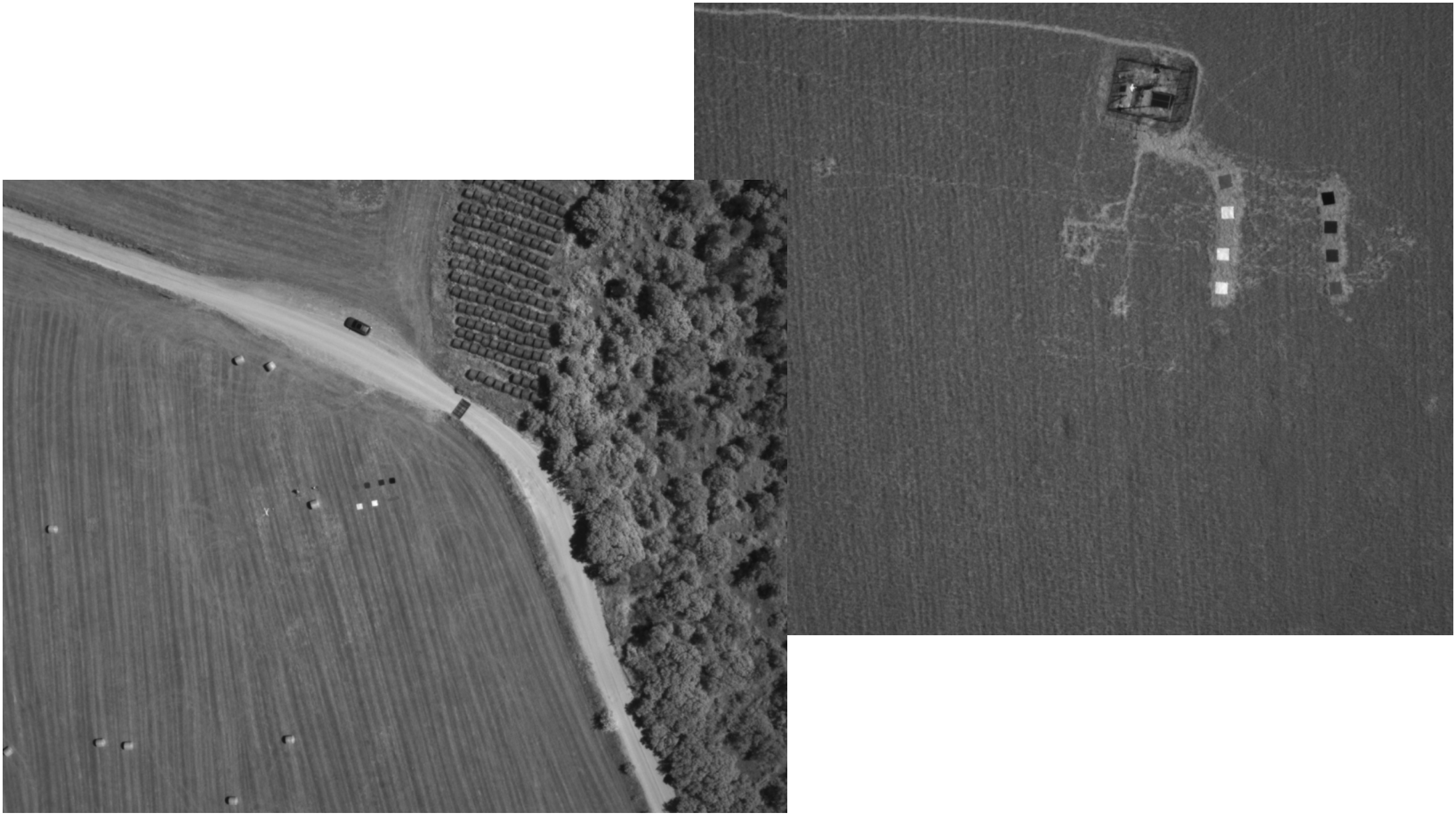
- GNSS
- IMU
- Time tag file
- Lever arm measurements

Output file

- Image id
- Image acquisition time
- Easting, Northing, H-Ell (SD)
- Roll, Pitch, Heading (SD) and/or Omega,Phi, Kappa (SD)
- …

RGB Images

NIR Images



DATA PROCESSING – Image processing

Image processing (Match-AT INPHO SW)

Input files

- RGB and NIR images (~ 3500 images)
- GNSS/INS processed trajectory output file
- Ground control points (GCPs) measurements
  - Field measurement campaign (Solsona)
  - Input file with the points coordinates

Image processing workflow

- Image measurement of GCPs
- Tie Point extraction (automatic process)
- Block adjustment
- Analysis of results

GCP measurement campaign

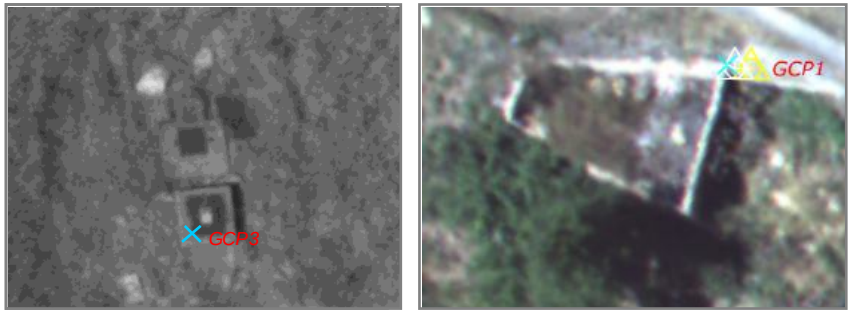
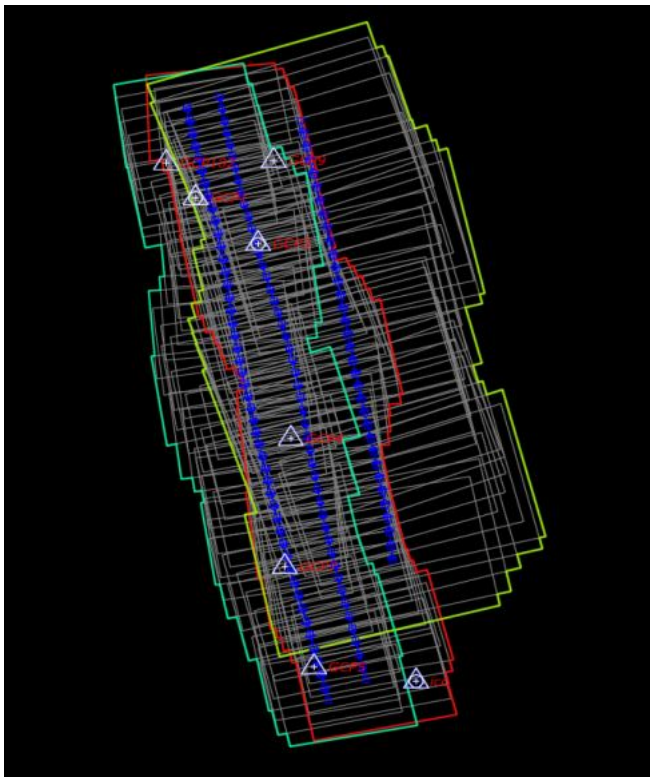


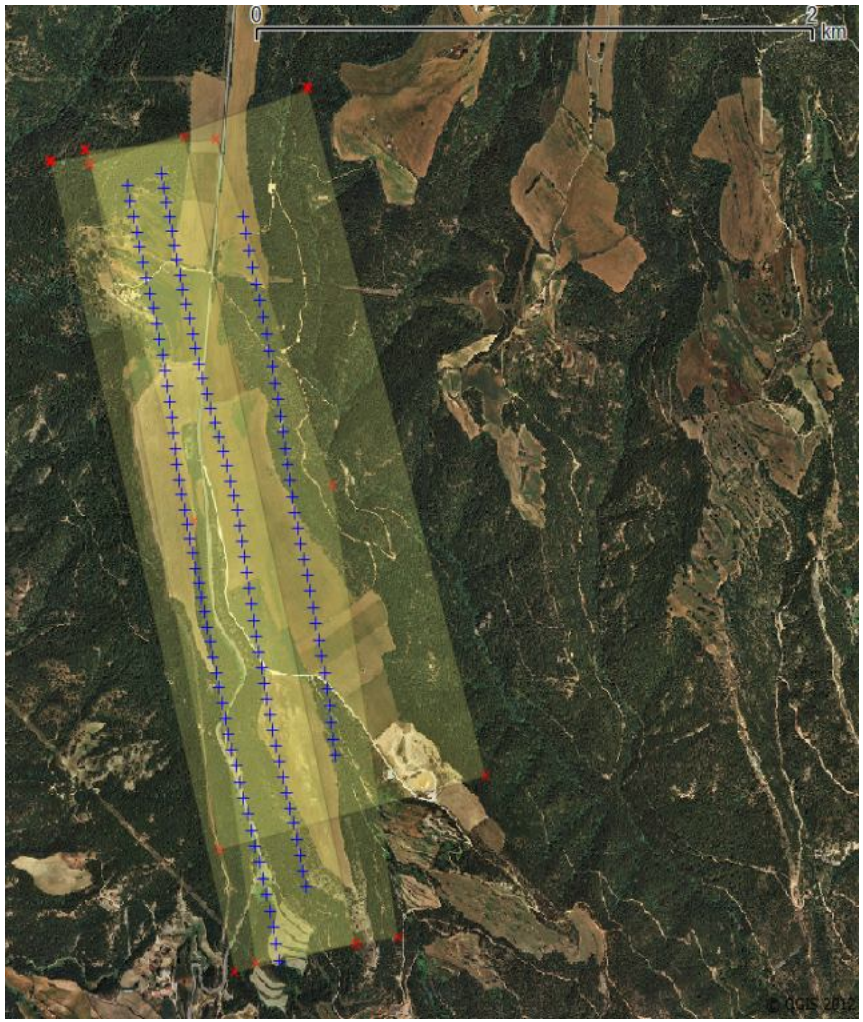
Image measurement of GCPs

DATA PROCESSING – Image processing

RGB Images

- 130 images in 3 different strips
- 900 x 3000 m study area
- images acquired at 350-550 m above ground
- GSD (Ground Sample Distance) 8.5-15 cm
- 8 GCP



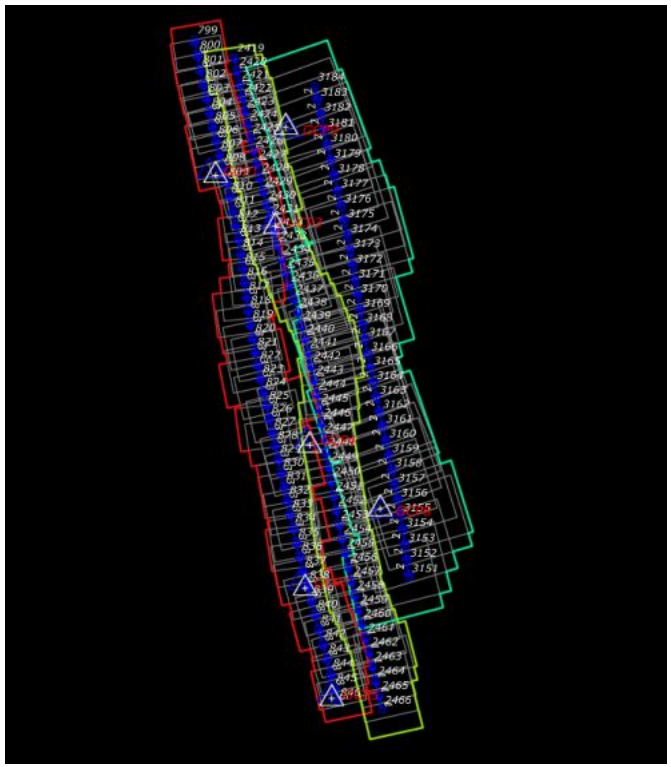


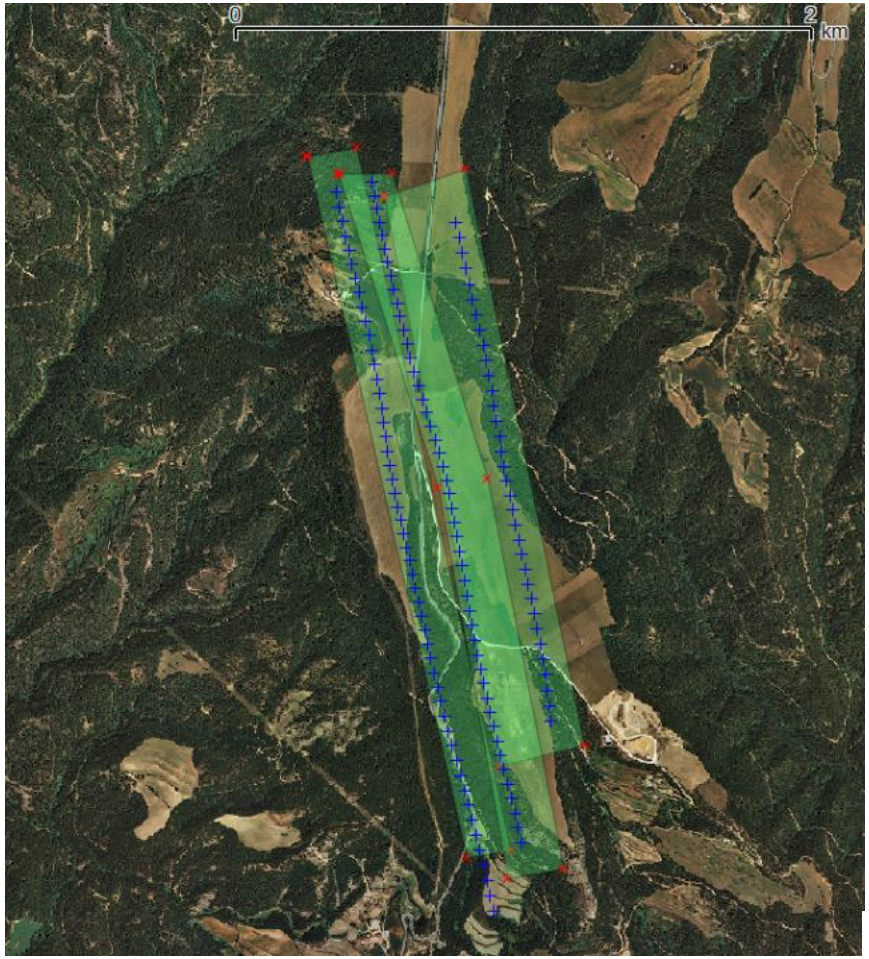
RGB images block. Approximated covered area

DATA PROCESSING – Image processing

NIR Images

- 130 images in 3 different strips
- 500 x 2500 m study area
- images acquired at 350-550 m above ground
- GSD (Ground Sample Distance) 6.5-10cm
- 7 GCP





NIR images block. Approximated covered area

DATA PROCESSING – Image processing

Preliminary results

- pixel size: 7.4 µm
- RMS image points in photo x= 1.5 µm y= 2.3 µ
- RMS control points in photo x= 20.8 µm y= 13.4 µ
- RMS control points in terrain x= 0.038 m y= 0.036 m z= 0.189 m
- Mean standard deviation of adjusted photo orientation x= 0.09 m y= 0.08 m z= 0.23 m

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CONCLUSIONS (1/2)

- Aerial Remote Sensing using light manned airplanes can be used to provide time series of high resolution RGB and NIR images. However, navigation can be difficult in the absence of autopilots and this can lead to weak block geometry or impossible block geometry.
- To deal with different scales, height changes, unstable platforms, insufficient overlap, etc. investment in further research and development is required.

CONCLUSIONS (2/2)

- Broad-resolution but frequent satellite imagery proves that remotely-sensed multi-spectral measurements are essential for understanding surface dynamics related to CO2 fluxes through its capability to estimate key variables to model GPP.
- Current satellites providing Multi-temporal information are too coarse, and there is a significant gain when using higher resolution as demonstrated with the time series of Landsat images.
- Light Aerial Remote Sensing can provide time series of very high resolution NIR and multi-spectral images at reasonable costs.
- UAVs and RC AVs have achieved a notorious operational efficiency, but rough landing is a significant limitation for embarking costly sensors
- Geometric processing of Light Aerial Remote Sensing images is complex and below the current (extremely high) standards of conventional (very expensive) aerial photography, but sufficient to provide:

  - Multi-temporal registration with errors < 1 m (which is enough for very detailed GPP maps)

  - Sub-meter resolution for very detailed vegetation maps. These maps will have distortions, but they can be warped to a better geometry as a post-processing.

THANKS FOR YOUR ATTENTION