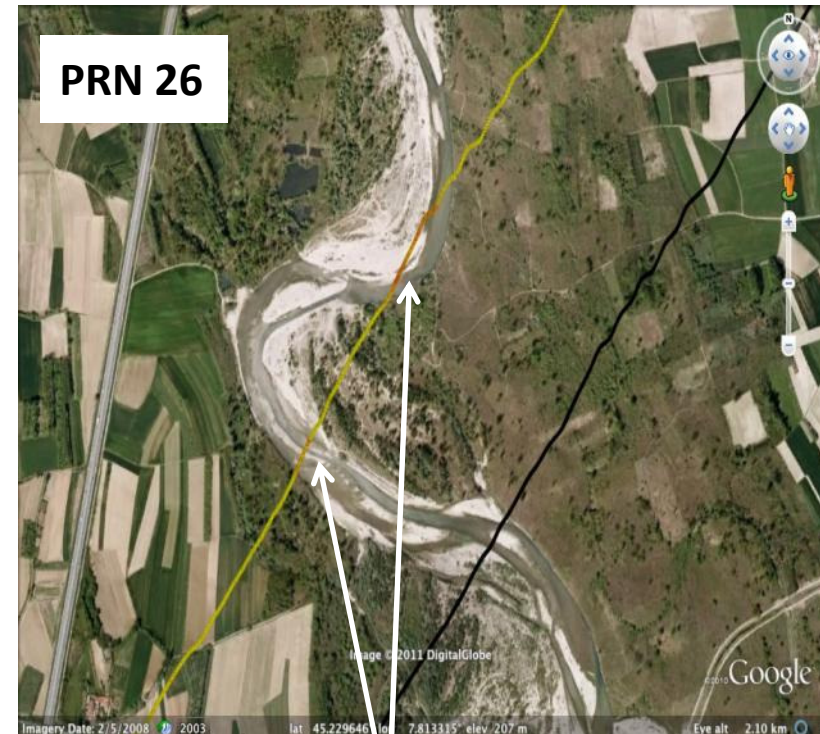


Flying over rivers



Satellite imagery indicates reflection power increase corresponds to specular point along, and crossing, rivers

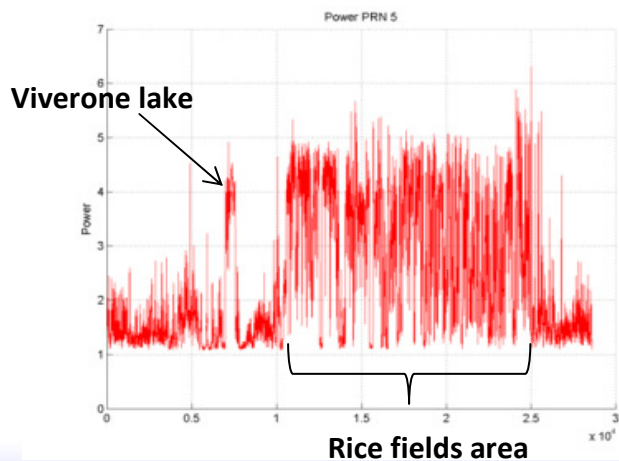
Flying over crops

During the flight over crops the reflected power fluctuates more than over lakes.



Satellite imagery indicates:

- reflection power increase over rice crops,
- reflection power decrease over fields not filled by water.



A short movie of the rice crops

**Remote Sensing Experiment using
Backscattered GPS Signals**

**Sensitivity to field
boundaries**

**Viverone, Piedmont - Italy
05/05/2011**

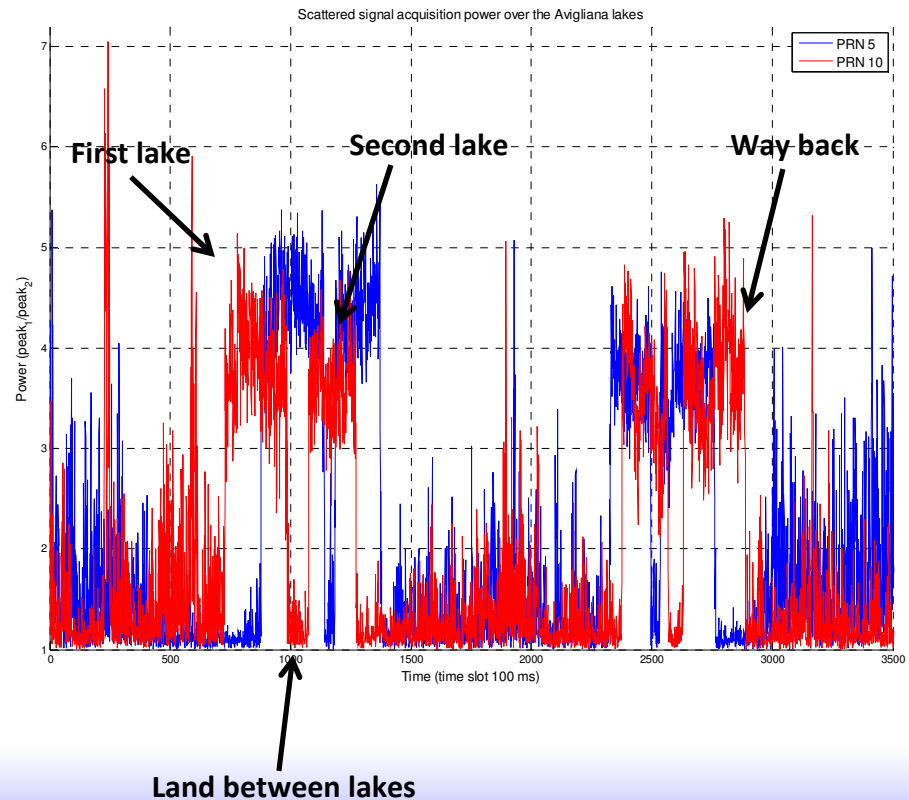
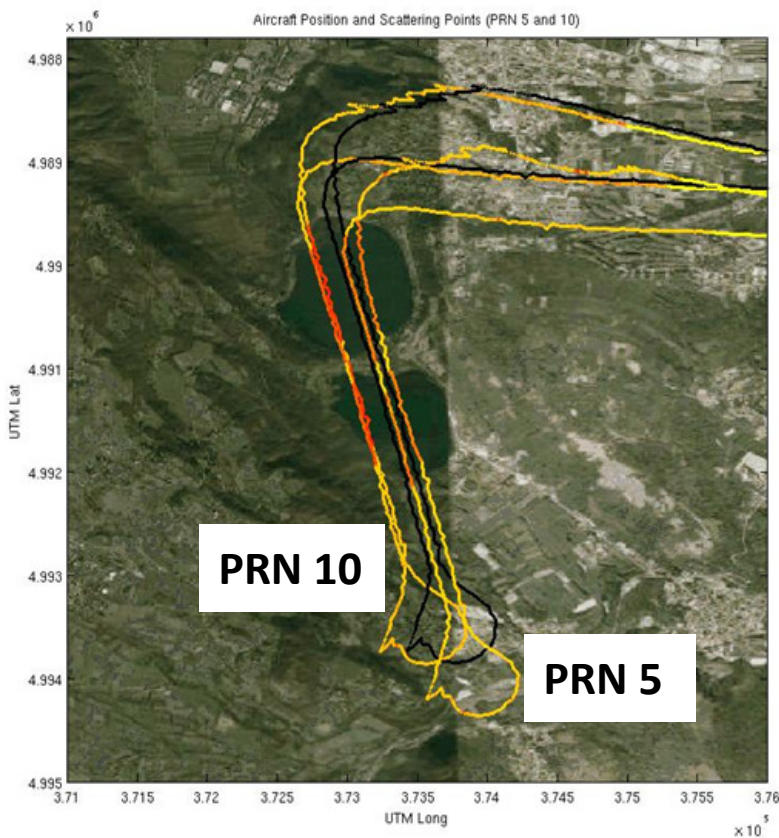
**Istituto Superiore Mario Boela
NavSAS**

Raul Hung 08/2011



Other results: Avigliana lakes

First results obtained processing the data set collected during a shorter test flight over Avigliana. The first test helped to refine the algorithms for the analysis of the data collected during the second flight.



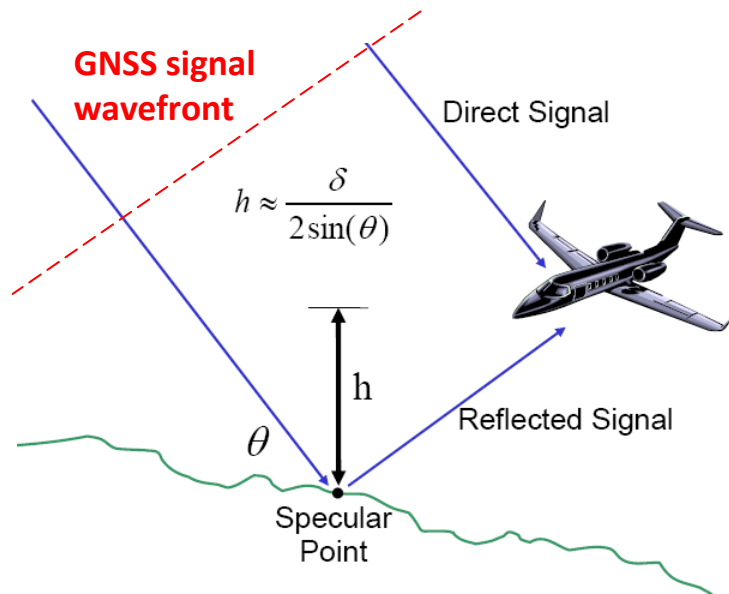
Outline

- The NavSAS research group at Istituto Superiore Mario Boella and overview of Global Navigation Satellite Systems (GNSS);
- Work performed in the framework of SMAT-F1 project:
 - A GPS/Galileo software radio receiver on board of a small aircraft
 - GPS/Galileo software radio receiver for remote sensing applications
 - GPS/Galileo software radio receiver as a precise and low cost altimetry system
- **Signal Processing analysis of:**
 - Signals collected on lake, rivers and rice crops for scatterometry purposes
 - GPS Signals collected on lakes for accurate altimetry estimation.
- Summary & Conclusions



Altimetry using direct and reflected signals

Objectives: *estimate the aircraft height through carrier phase measurements on the reflected signal (0.1 m level accuracy achievable)*



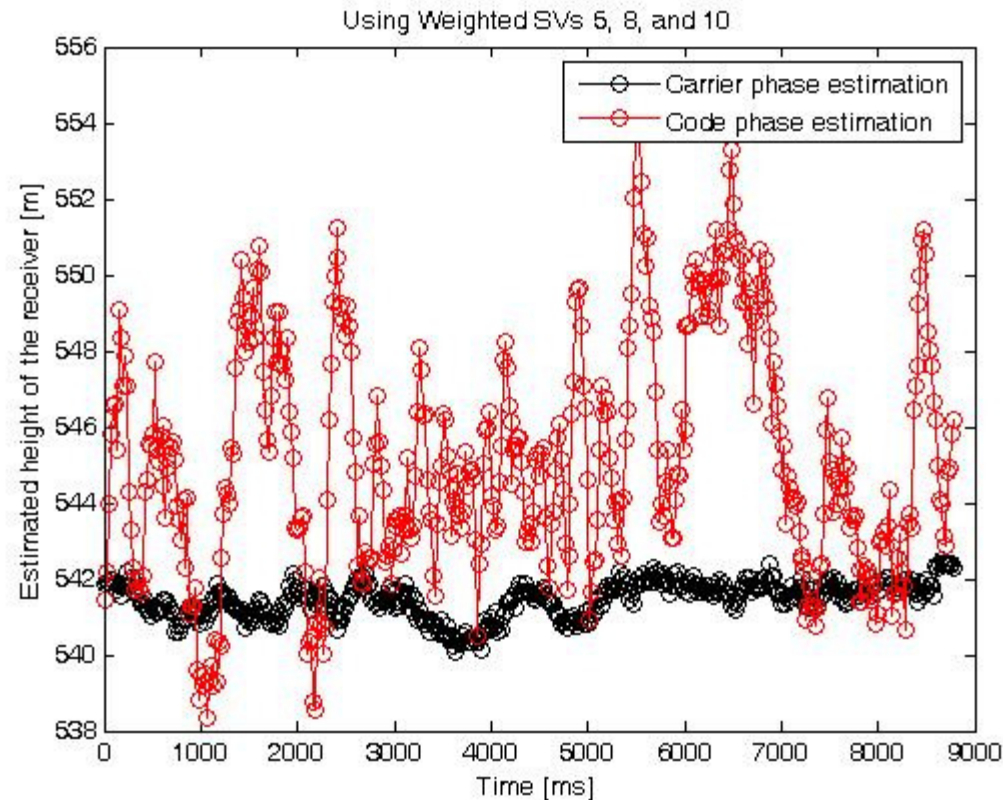
- Relative positioning concept applied to direct and reflected signals.
- Using both code and carrier phase measurements, apply the least squares algorithm to solve for phase ambiguity relative to each satellite and height between receiver and reflection point.

$$L_c(t) = c\Delta\tau(t) = 2h(t).\sin(\mathcal{E}(t)) + b$$

$$L_p(t) = 2h(t).\sin(\mathcal{E}(t)) + b + N_p\lambda$$

- Integer ambiguity resolution applying lambda method.
- Height re-estimation using only code or carrier phase measurements separately.

Height estimates (code vs carrier)



Variance of heights using carrier phase measurements is around 21 cm vs 3 meters using code phase measurements.

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Summary & Conclusions

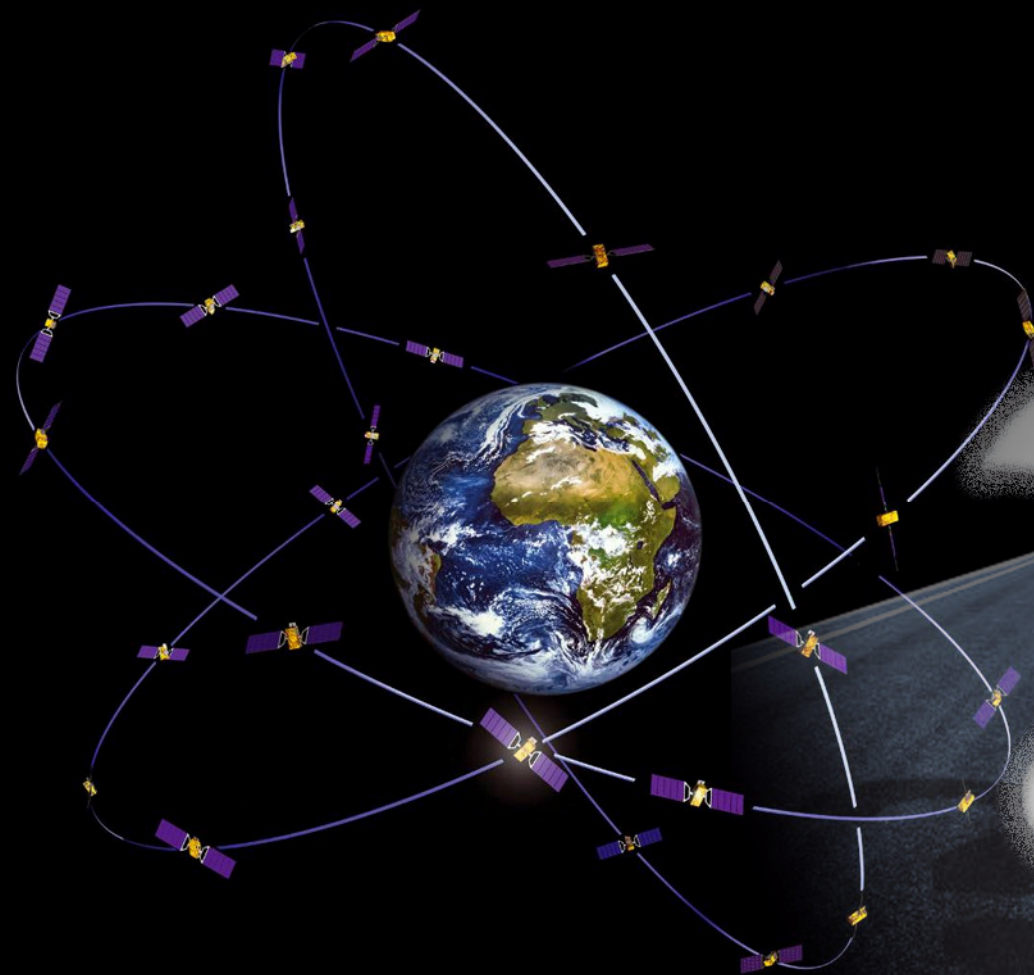
In this experiment the following results have been achieved:

- We have shown how a **SDR GPS receiver can be used also for remote sensing applications**
- We have demonstrated how a **low-cost setup can be more than sufficient to guarantee good performance/results** in the remote sensing field instead of the expensive instruments used by other Institutes
- In the field of **back-scattering** we were able to detect water surfaces even with a small size. **Such a capability could be exploited to monitor flooding or to enhance water management.**
- **The altimetry** method has been able to compute the altitude of the aircraft at cm-level accuracy. **Therefore, it could be used to evaluate the ice/snow thickness or to monitor the water level to avoid hazards.**



Thanks!

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www.ismb.it



Speaker: Gianluca Falco
falco@ismb.it

Questions?