



A GNSS-R MULTIROTOR UAV FOR SOIL MOISTURE DETECTION AND ALTIMETRY

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Hatchouelou Kant Williams Kouassi, Georges Stienne, Maximilian Semmling, Jean-Christophe Kucwaj, Serge Reboul, et al.. A GNSS-R MULTIROTOR UAV FOR SOIL MOISTURE DETECTION AND ALTIMETRY. Global Navigation Satellite System-Reflectometry (GNSS-R), May 2019, Bénévento, Italy. hal-03105898

HAL Id: hal-03105898

<https://hal.science/hal-03105898>

Submitted on 11 Jan 2021

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A GNSS-R MULTIROTOR UAV FOR SOIL MOISTURE DETECTION AND ALTIMETRY

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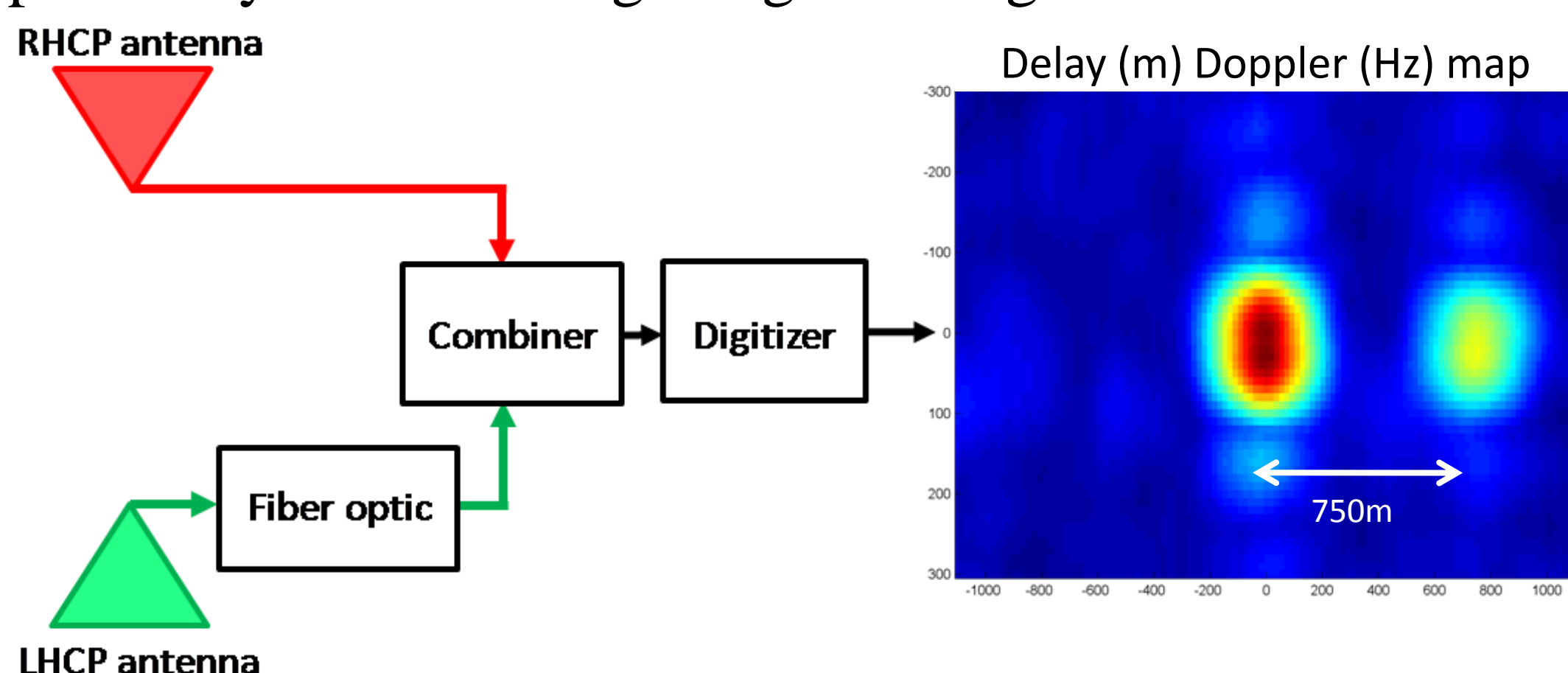


Context and objectives

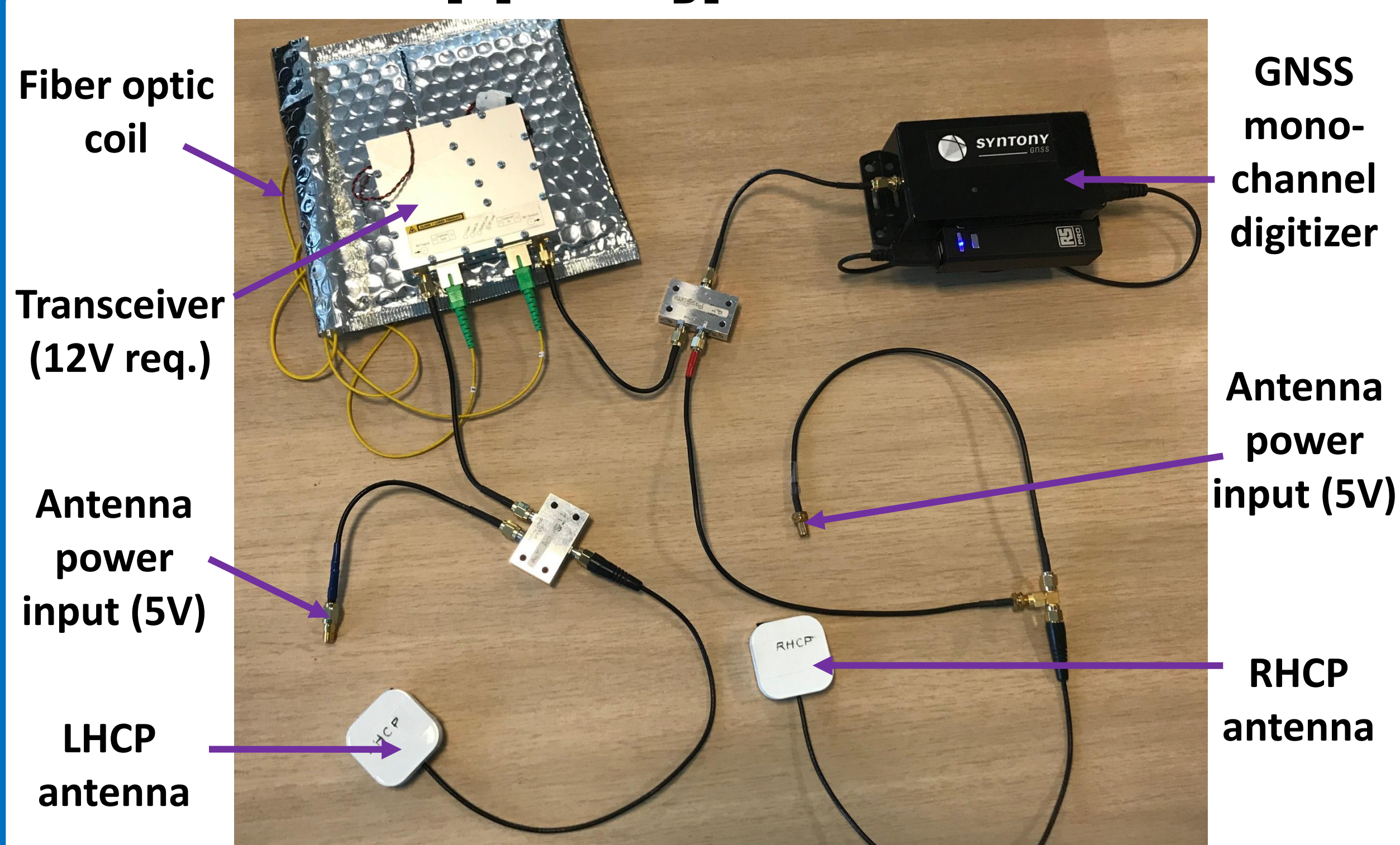
GNSS-Reflectometry studies in the framework of the MARCO (Marine Research at Côte d'Opale) project focus on techniques for inundation monitoring. In this context, it is important to fastly reach the area of interest where the soil moisture content [1] and the water level (e.g. of rivers and lakes) [2] shall be monitored. A GNSS-R setup onboard an Unmanned Aerial Vehicle (UAV) is expected to meet all these requirements. A GNSS-R setup of reduced size and weight has been developed for this application, allowing synchronously digitizing GNSS signals from two antennas on a single mono-channel bitgrabber.

GNSS-R setup principle

The GNSS-Reflectometer consists of an up-looking right hand (RHCP) and a down-looking left hand (LHCP) antenna, a light-weight one channel GNSS digitizer and a 750 meters fiber optic coil. The coil delays the LHCP antenna signal before it is combined with the RHCP antenna signal, effectively separating the two signals in the time delay domain so both can be analyzed independently from the single digitized signal.



GNSS-R setup prototype



Multirotor UAV

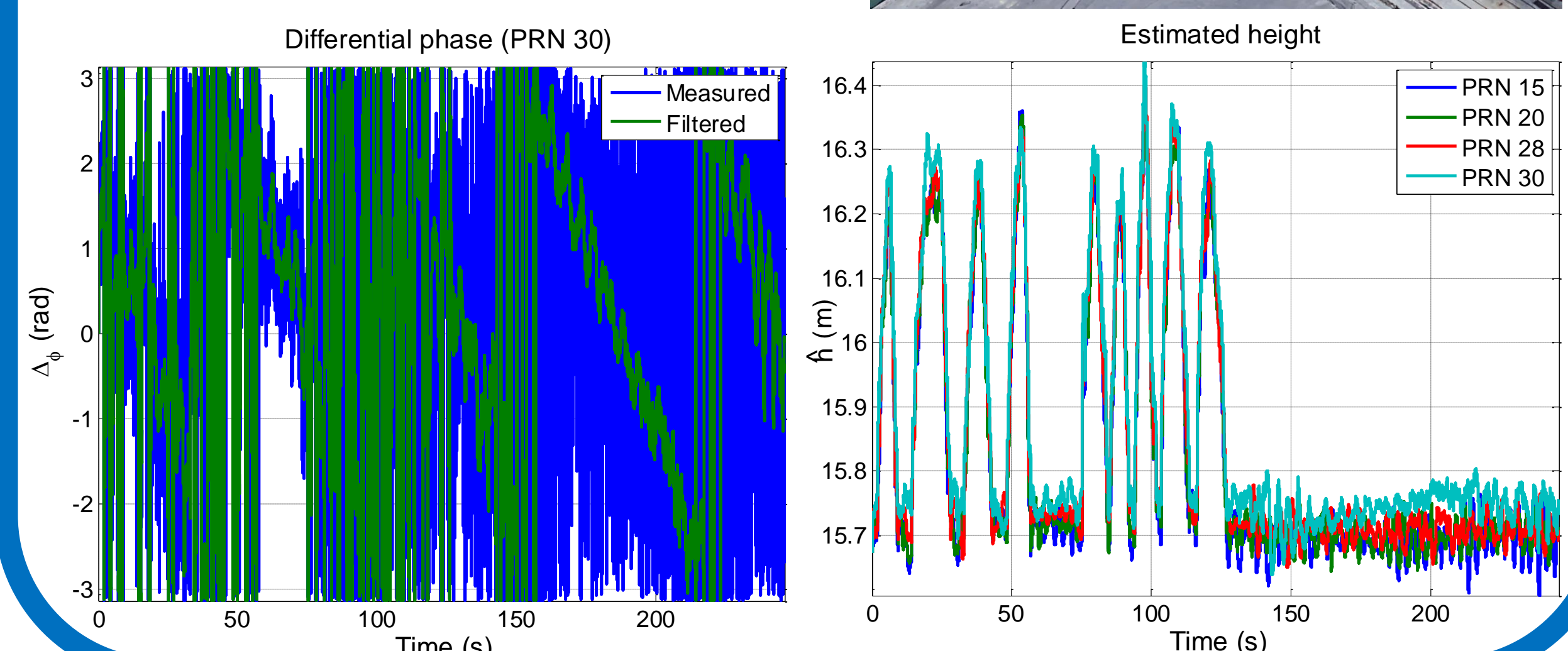
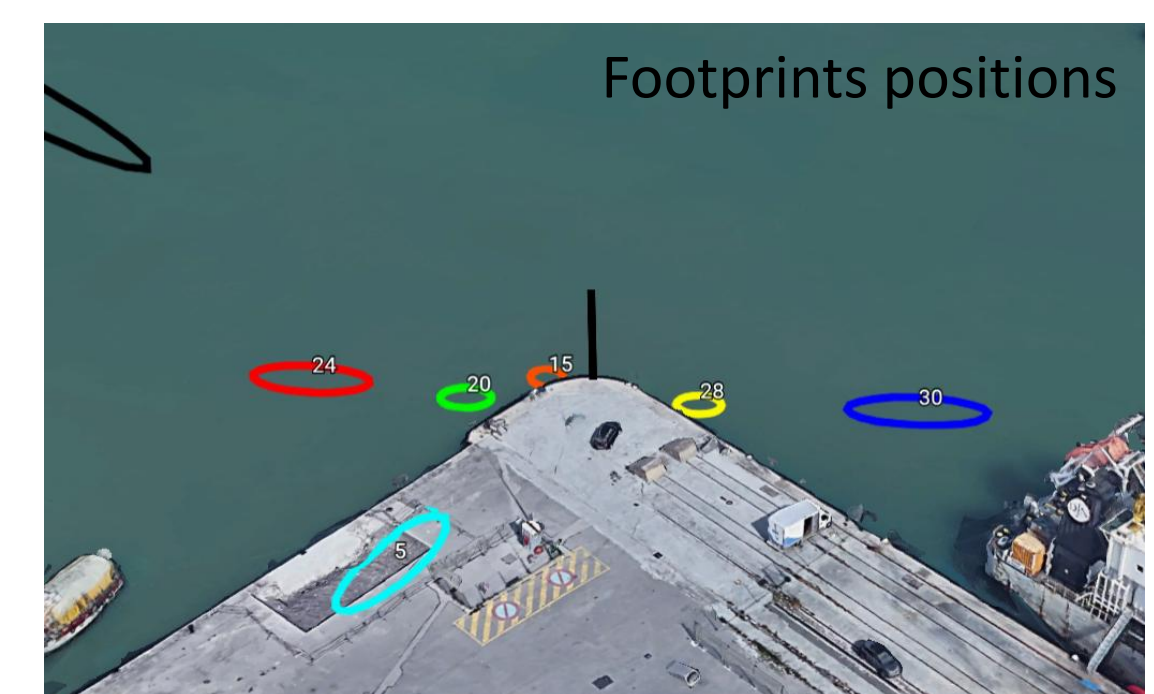
- Added payload up to 3kg
- Available power sources for the payload (5V, 12V)
- Autonomy: 40 minutes
- GPS RTK positioning
- Laser altimeter (120m range) for comparison
- Open, configurable auto-pilot (PixHawk)
- Configurable body frame
- Multi-rotor UAVs allow for high maneuverability



Preliminary results

Several experiments have been realized in order to assess and calibrate the GNSS-R setup prototype before its use onboard the UAV. A number of these experiments focused on amplitude estimation for soil moisture contents study [1]. Other experiments were realized over water and ground for phase altimetry.

A circular filter [3] was used in order to smooth the differential phase observations. A phase ambiguity technique was developed in order to provide absolute height estimates at a millisecond rate.



Conclusion

A GNSS-R multirotor UAV is being developed for inundation monitoring applications. A specific GNSS-R setup and the associated signal processing techniques have been developed and successfully tested through ground experiments with moving platforms. The project currently deals with compatibility issues between the GNSS-R setup and the UAV during flight.

This work has been financially supported by the European Union (ERDF), the French Government, the French Region Hauts-de-France and Ifremer, in the framework of the project CPER MARCO 2015-2020.

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 [2] J.C. Kucwaj, G. Stienne, S. Reboul, J.B. Choquel, M. Benjelloun. "Circular Regression Applied to GNSS-R Phase Altimetry". *Remote Sensing*, 9(7) : 651, 2017.
 [3] G. Stienne, S. Reboul, M. Azmani, J.B. Choquel, M. Benjelloun. "GNSS dataless signal tracking with a delay semi-open loop and a phase open loop". *Signal Processing*, 93(5), 2013.