

Innovation in meteorology for maritime navigation

GNSS-R Instrument for measurement of SWH

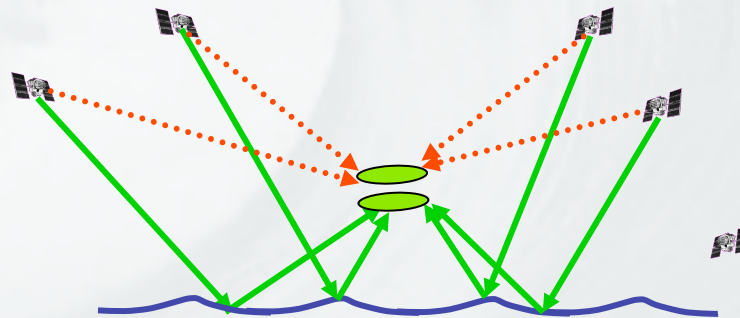


Outline

- Starlab presentation
- GNSS-R concept
- The Oceanpal instrument
- Planned improvements in the frame of Cosmemos
- Corresponding Upgrades
- Installation on the Mega Express II
- Preliminary results
- Validation
- Conclusions

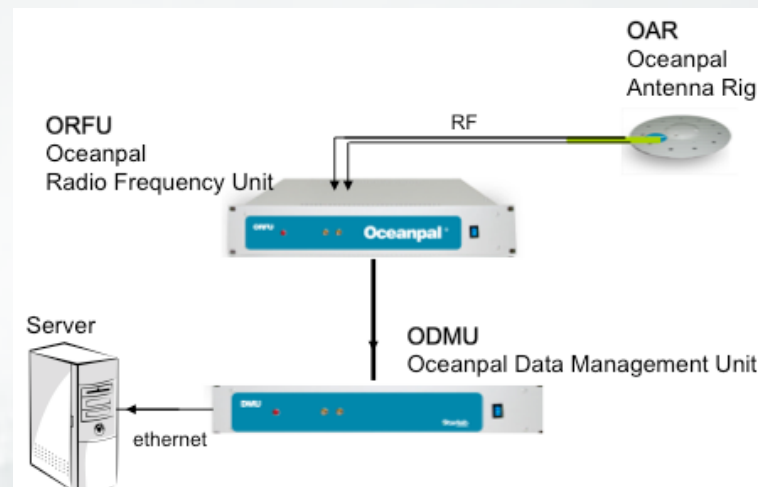
- **Company activities**
 - Technological R&D Studies (instrument concepts)
 - High added value services
- **Sectors**
 - Space technologies (SAR, GNSS-R)
 - Environment (Oceanography, Water Resources)
 - Agriculture
 - Neuroscience
- **30 collaborators**
- **Located in Barcelona, Spain**
- More information on www.starlab.es

- Global Navigation Satellite System-Reflections
 - ▶ A bistatic (multistatic) radar technique to monitor a reflective surface
- A passive receiver picks up simultaneously direct and the reflected signals emitted by several GNSS satellites at the same time (opportunity sources)
- Sources are: GPS + Augmentation Systems + Galileo IOVs (now), and Galileo operational (future)



Oceanpal *pre-Cosmemos*

- RF front-end 4 channels
- Multi-band (L1, L2, L5)
- BW up to 50 MHz (4 MHz used)
- Gigabit Ethernet link to send data



CStarlight processing Software

- GPS L1 band (BPSK modulation)
- Giove A E1 (BOC Modulation)
- Monoprocessor/thread



From the Cosmemos requirements

- **Retrieval of Significant Wave Height (SWH) information from moving platform**
 - Instrument shall go from a coast installation to a ship installation
- **Simultaneous GPS and Galileo/EGNOS E1/ E5 capability**
 - The increase of satellite should improve the precision of the measurements (in the end using more than 50 satellites).
- **Near real time processing**
 - Data needed in real time to feed the meteorological model
- **Interfacing with the rest of the COSMEMOS system**
 - Standardization of the output files to be processed easily by the rest of the system

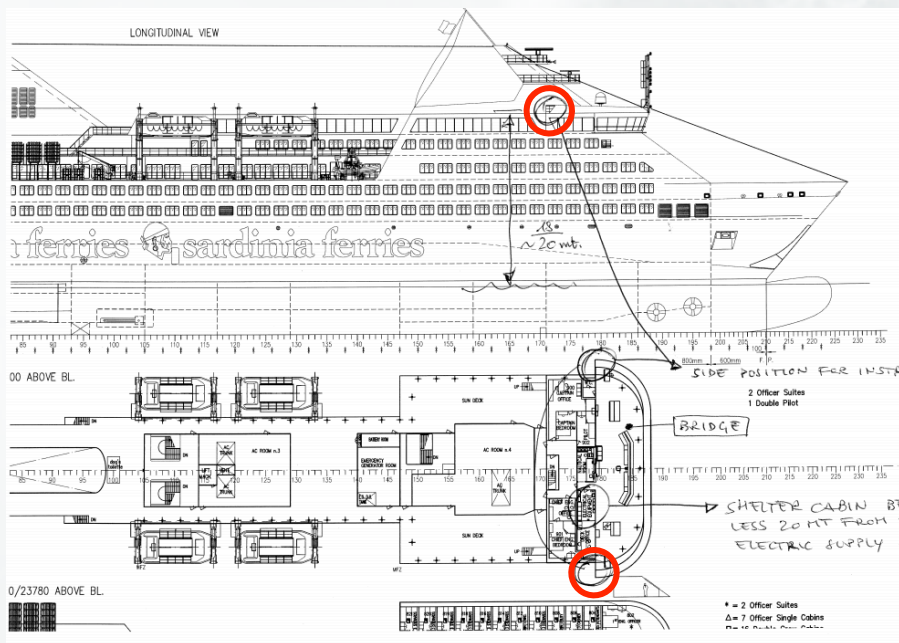
Hardware

- **Wideband RHCP and LHCP antennas** and RF Filters suitable for GPS L1 and Galileo E1 and E5 (1175 to 1580 MHz)
- RF Front-End set up for **simultaneous acquisition of L1 / E1 and E5**.
- **High speed USB 3.0 data interface** to account for the higher bandwidth and the higher channel count (up to 600 Mbits/s).

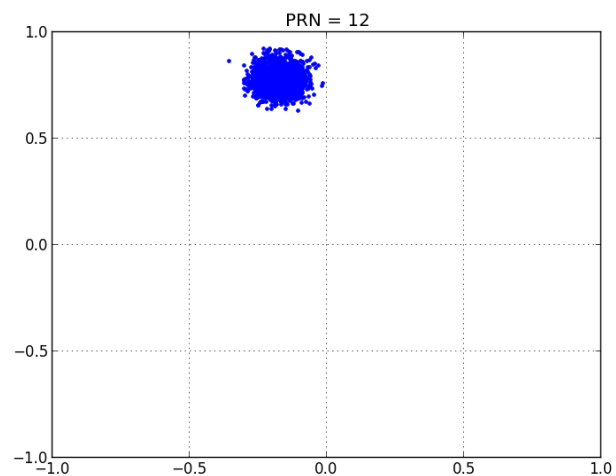
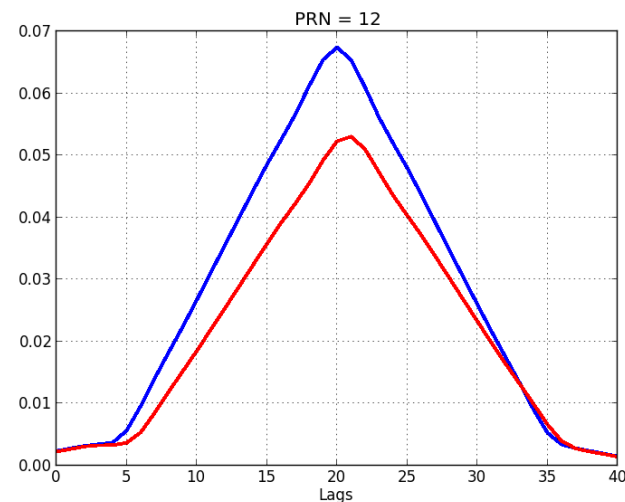
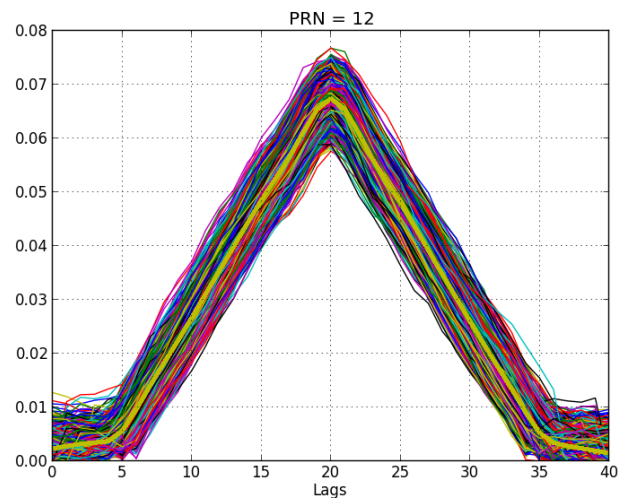
Software

- Implement **Galileo constellation and signals**
- **Update the estimation procedures** to account for the effects of a moving platform
- **Optimize the processing** for near real time processing of high bandwidth signals
- Instrument output format compatible **with the rest of the system**

Successfully performed beginning of August 2013
Thanks to all the crew for the precious support!



Preliminary results (1)

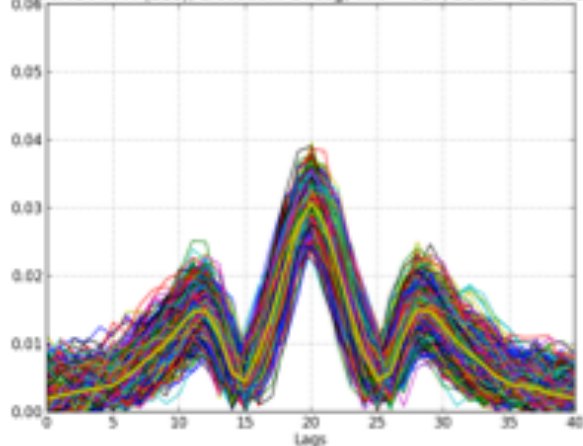


Estimated altimetric precision
20cm

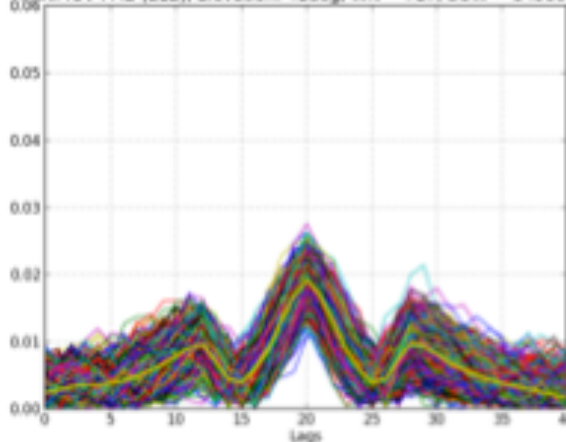
Interferometric field phase
SNR = 30dB.

Preliminary results (2)

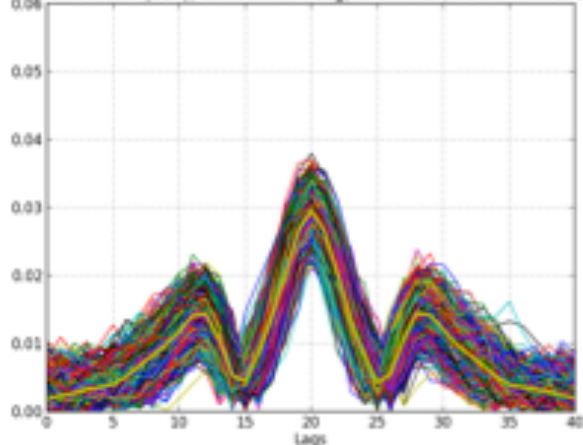
PRN: IOV PFM (E11), Elevation: 84deg, WN = 717, SOW = 345600.0



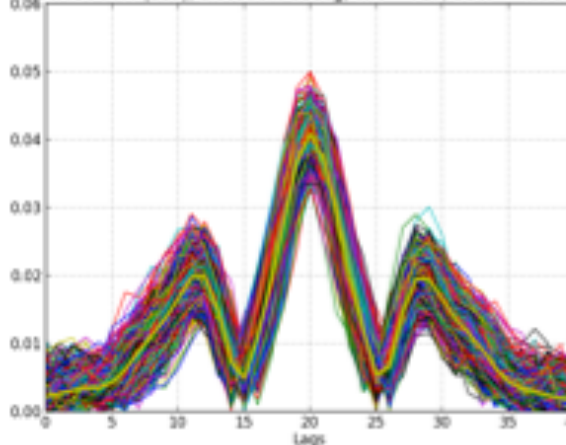
PRN: IOV FM2 (E12), Elevation: 41deg, WN = 717, SOW = 345600.0



PRN: IOV FM3 (E19), Elevation: 44deg, WN = 717, SOW = 435600.0

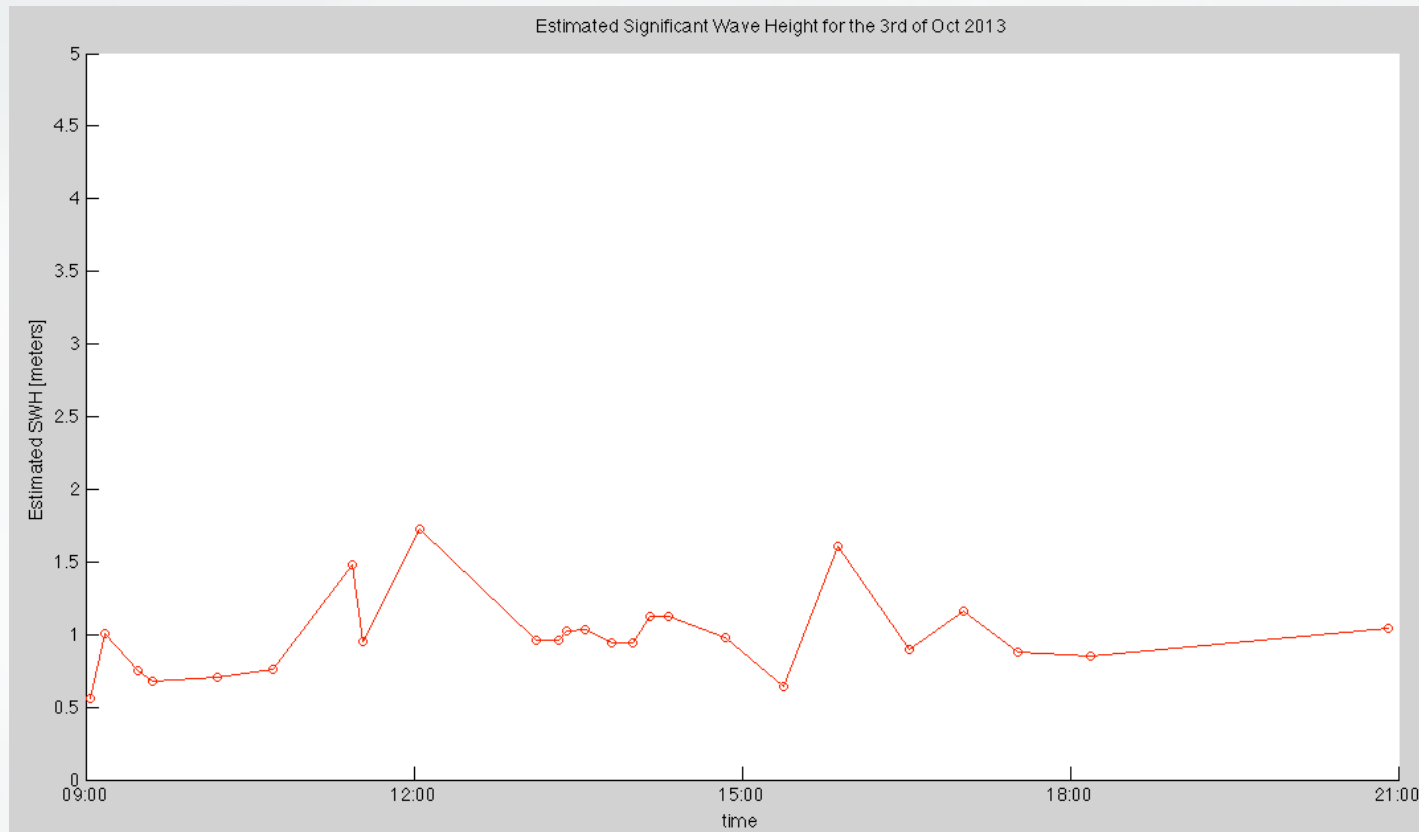


PRN: IOV FM4 (E19), Elevation: 81deg, WN = 717, SOW = 435600.0



- CBOC modulation tracking validated
- Signals from the 4 IOV tracked
- **All 4 Signals stable enough to be used for improvement of SWH estimation**

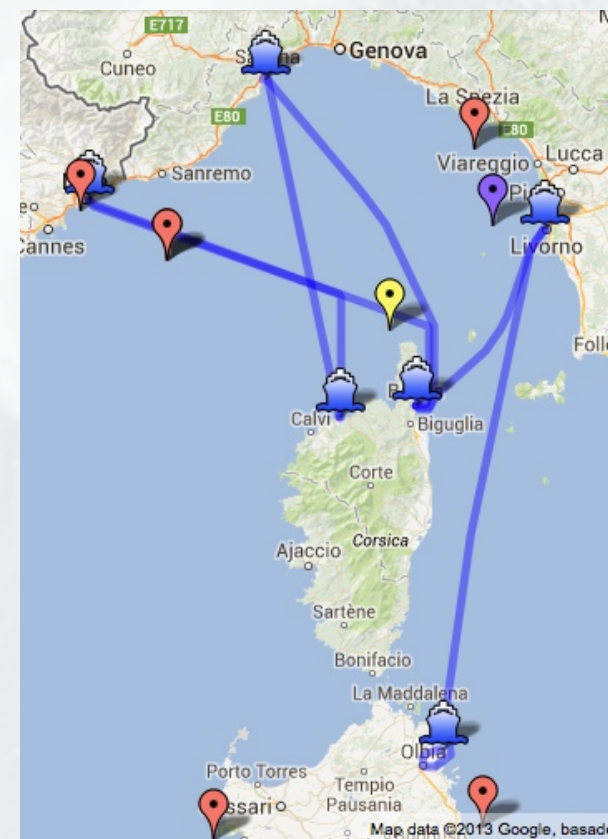
Preliminary results (3)



- Very preliminary processing of the data
- Example of SWH retrieval for the day of 3rd of October 2013

To calibrate and validate the SWH Estimation

- Independent information of sea state is required
- Available data source (ground truth) on the area:
 - Nice Buoy
 - French Riviera Buoy
 - Gorgona Buoy
 - Space Altimeters measurements
- Limitations
 - Only 3 buoys
 - Buoys Far away (min 12 km) from the boat
 - No automatic access to all the data
 - Satellite track narrow



- Starlab has developed and deployed the **first ever Galileo GNSS-R instrument on a moving platform**
- **Preliminary measurement** show the great capabilities of the instrument
- **Calibration** and **validation** of the measurements with respect to ground truth are under work
- Almost ready to be **integrated as an operational instrument** in the COSMEMOS service platform

Erwan Motte

erwan.motte@stalab.es