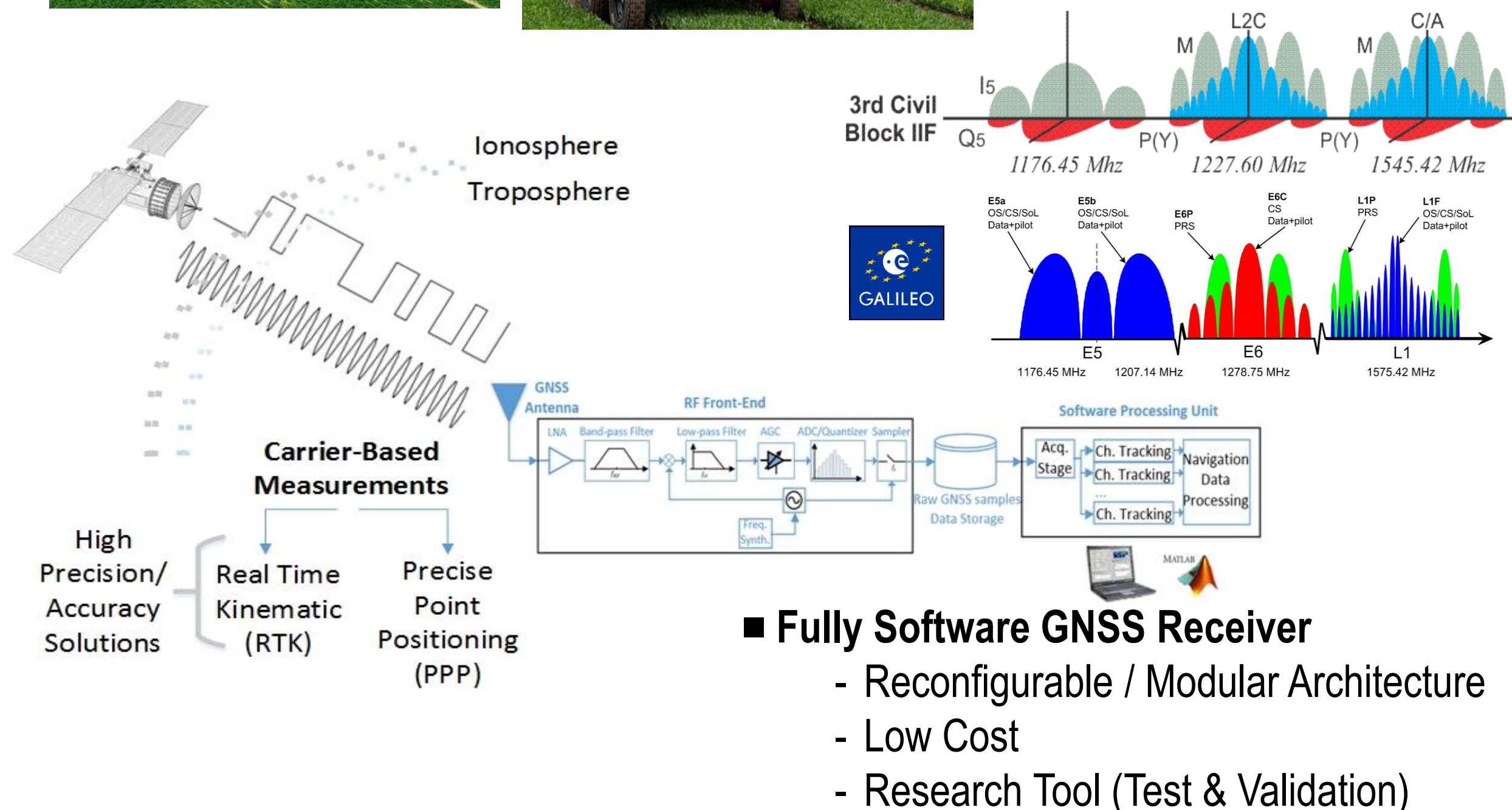
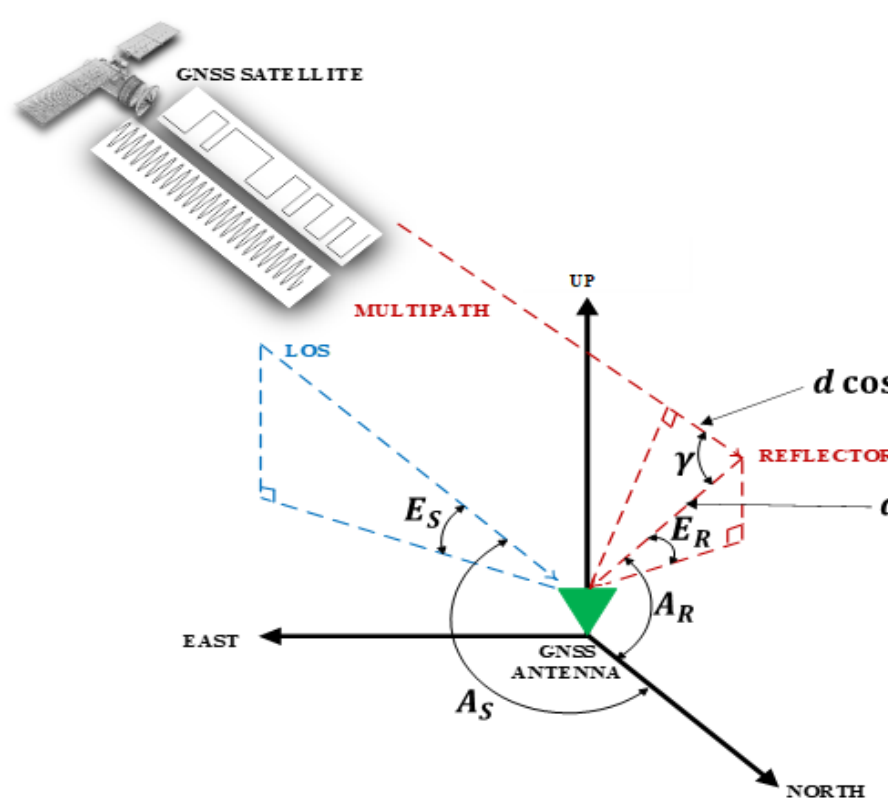


Research context and motivation



Addressed research questions/problems

- The receiver serves as a **research tool** for testing **robust architectures** able to cope with **harsh ionospheric scintillation** and **multipath** environment.



$$s(t) = \underbrace{Ap(t - \tau_0) \cos(\omega_0 t + \theta_0)}_{\text{DIRECT SIGNAL (LOS)}} + \underbrace{A \sum_{k=1}^N \alpha_k p(t - \tau_0 - \tau_k) \cos[\omega_0 t + \theta_0 + \Delta\phi_{M,k} + (\Delta\omega_k - \Delta\omega_0)t]}_{\text{MULTIPATH SIGNAL}}$$

- Multipath** leads to **carrier amplitude**, **pseudorange**, and **carrier phase errors** that **degrade** the navigation performance.

- Fluctuations** in the signal **amplitude** and **phase** caused by while signal is propagating through the **ionosphere** are **challenging** problems for signal processing.

External Training and Other Activities

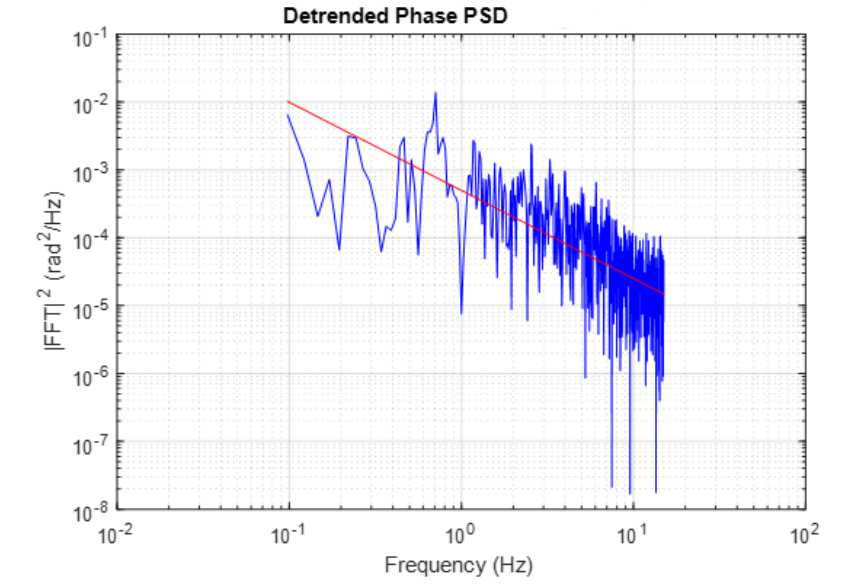
- TREASURE Workshop, April 17-18, 2018, INGV, Rome
- Natural and Artificial Threats to GNSS Seminar, May 7-9, 2018, ISMB-Politecnico di Torino, Torino
- International Project Management in CFRP Development Programs course – June 21, 2018, Torino
- ESA/JRC International Summer School on GNSS 2018 – July 16-27, 2018, Loipersdorf, Austria
- TREASURE Autumn School, November 19-22, 2018, Bath, United Kingdom
- TREASURE Secondment, March 18 – April 19, 2019, UNESP, Presidente Prudente, SP, Brazil

Submitted and published works

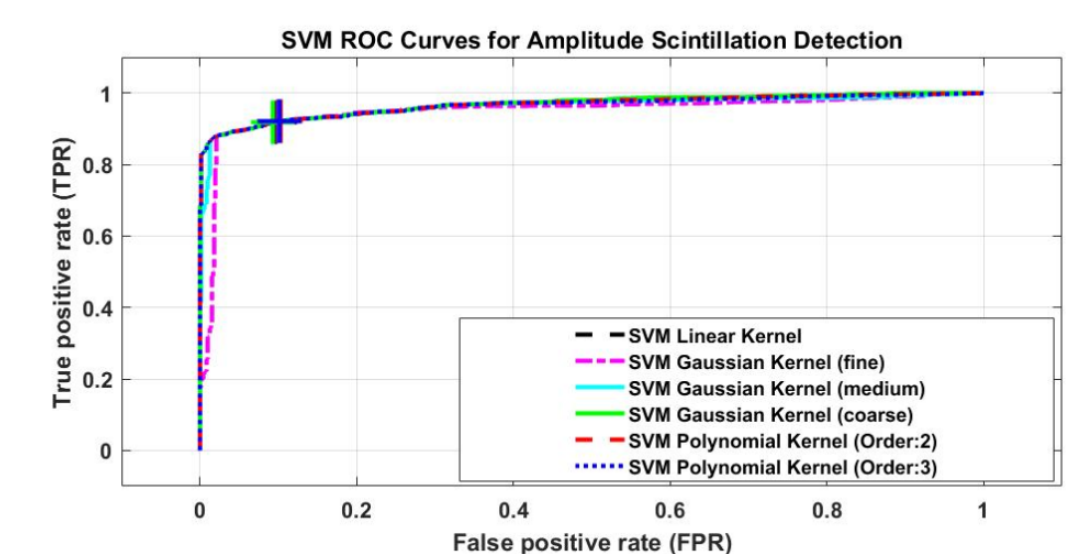
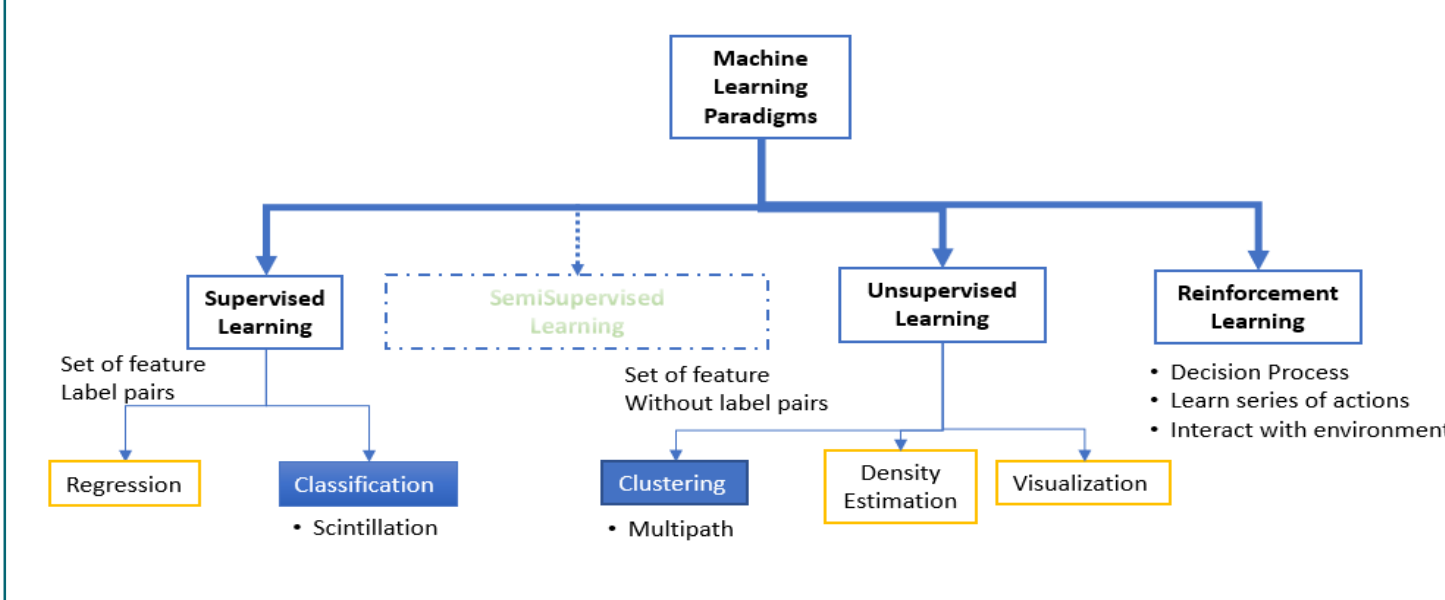
- Savas, C., Dovis, F., and Falco, G., "Performance Evaluation and Comparison of GPS L5 Acquisition Methods under Scintillations", *International Technical Meeting of The Satellite Division of the Institute of Navigation (ION GNSS+ 2018)*, Miami, Florida, September 2018, pp.3596-3610.
- Savas, C., Falco, G., and Dovis, F., "A Comparative Analysis of Polar and Equatorial Scintillation Effects on GPS L1 and L5 Tracking Loops", *Institute of Navigation International Technical Meeting (ITM 2019)*, Reston, Virginia, January 2019, pp.632-646.
- Savas, C. and Dovis, F., "Comparative Performance Study of Linear and Gaussian Kernel SVM Implementations for Phase Scintillation Detection", *International Conference on Localization and GNSS (ICL-GNSS 2019)*, Nuremberg, Germany, June 2019.
- Savas, C. and Dovis, F., "Multipath Detection Based on K-means Clustering", *International Technical Meeting of The Satellite Division of the Institute of Navigation (ION GNSS+ 2019)*, Miami, Florida, September 2019.
- Savas, C., Falco, G., and Dovis, F., "A Comparative Performance Analysis of GPS L1 C/A, L5 Acquisition and Tracking Stages under Polar and Equatorial Scintillations", *IEEE Transactions on Aerospace and Electronic Systems*, [Submitted on January 2019, Under Review].

Novel contributions

- Implementation of a **multi-frequency, carrier based** (high accuracy) software GNSS receiver and related GUI
- Implementation of **spectral analysis** tools for the **scintillated data**



- Test and performance comparison of different **acquisition** and **tracking** schemes under **clean** and **scintillated (amplitude & phase)** signal environment for **robustness**
- Comparative assessment of different **phase detrending** algorithms
- Linear, Gaussian and Polynomial kernel **SVM** methods for **scintillation** detection
- Multipath** detection based on **K-means clustering** algorithm



Adopted methodologies

- Data collections by using the GNSS antenna & front-ends and processing the sampled IF data through the software GNSS receiver in MATLAB environment
- Design and implementation of different acquisition, tracking algorithms and machine learning based implementations at MATLAB GNSS receiver
- Test, performance evaluation and comparison of the algorithms under different scenarios

Future work

- Extending the receiver structure to the Galileo signals
- Interface design for the external precise orbit and clock corrections
- Study of alternative architectures and algorithms for the software receiver (e.g. machine learning based techniques)
- Implementation of carrier-phase measurement algorithms on MATLAB for multi-frequency

List of attended classes

- 03LPXBG – Satellite Navigation Systems (10/09/2018, 8 CFU)
- 01RGWGN – Carrier Phase Positioning (01/06/2018, 4 CFU)
- 04JURGN – Time Scale and Timing in GPS and Galileo (30/05/2018, 3 CFU)
- 01QPRPRV – Satellite Navigation Signal Exploitation for Atmospheric and Environmental Monitoring (13/09/2018, 3 CFU)
- 01SHCRV – Unsupervised Neural Networks (09/04/2018, 6 CFU)
- 01SCSIU – Machine Learning for Pattern Recognition (03/05/2018, 4 CFU)
- 02LWHRV – Communication (04/09/2018, 1 CFU)
- 01SHMRV – Entrepreneurial Finance (06/08/2019, 1 CFU)
- 01NDLRV – Lingua Italiana I Livello (05/07/2019, 1 CFU)
- 08IXTRV – Project Management (04/09/2018, 1 CFU)
- 01RISRV – Public Speaking (21/08/2018, 1 CFU)
- 01SYBRV – Research Integrity (06/08/2019, 1 CFU)
- 01SWQRV – Responsible Research and Innovation, The Impact on Social Challenges (13/09/2018, 1 CFU)
- 02RHORV – The New Internet Society: Entering the Black-Box of Digital Innovations (13/09/2018, 1 CFU)
- 01SWPRV – Time Management (13/09/2018, 1 CFU)