Educational tools for GNSS

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NavSAS research group

NavSAS is a joint research group of ***ISMB*** and ***Politecnico di Torino*** University operating in the satellite navigation and localization sectors.

- NavSAS staff consists of 28 researchers.
- Research is focused specifically on advanced technologies for GPS / EGNOS / Galileo receivers and applications.
- NavSAS cooperates with major industrial and institutional players operating in the field.
- See http://www.navsas.eu & http://www.galileoblog.eu

Outline

1 – Master on Navigation

2 – NAVKIT

3 – Signal Generator / Analysis

4 – Software receiver

5 – SAT SURF / SAT SURFER

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Master on Navigation and related applications

The one-year Master is a joint initiative of

with the cooperation of

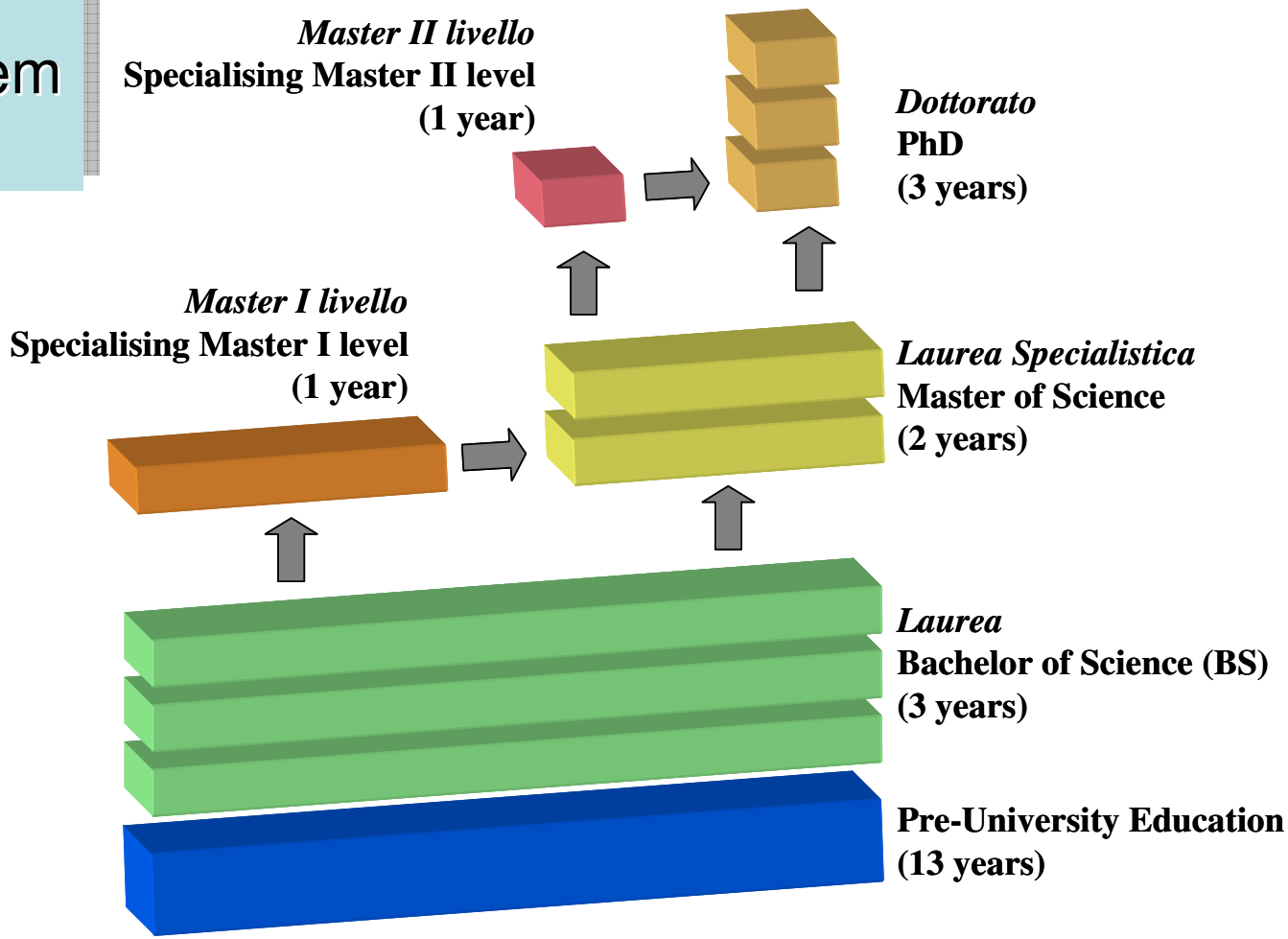
INRIM Galileo Ferraris and UN OOSA

United Nations

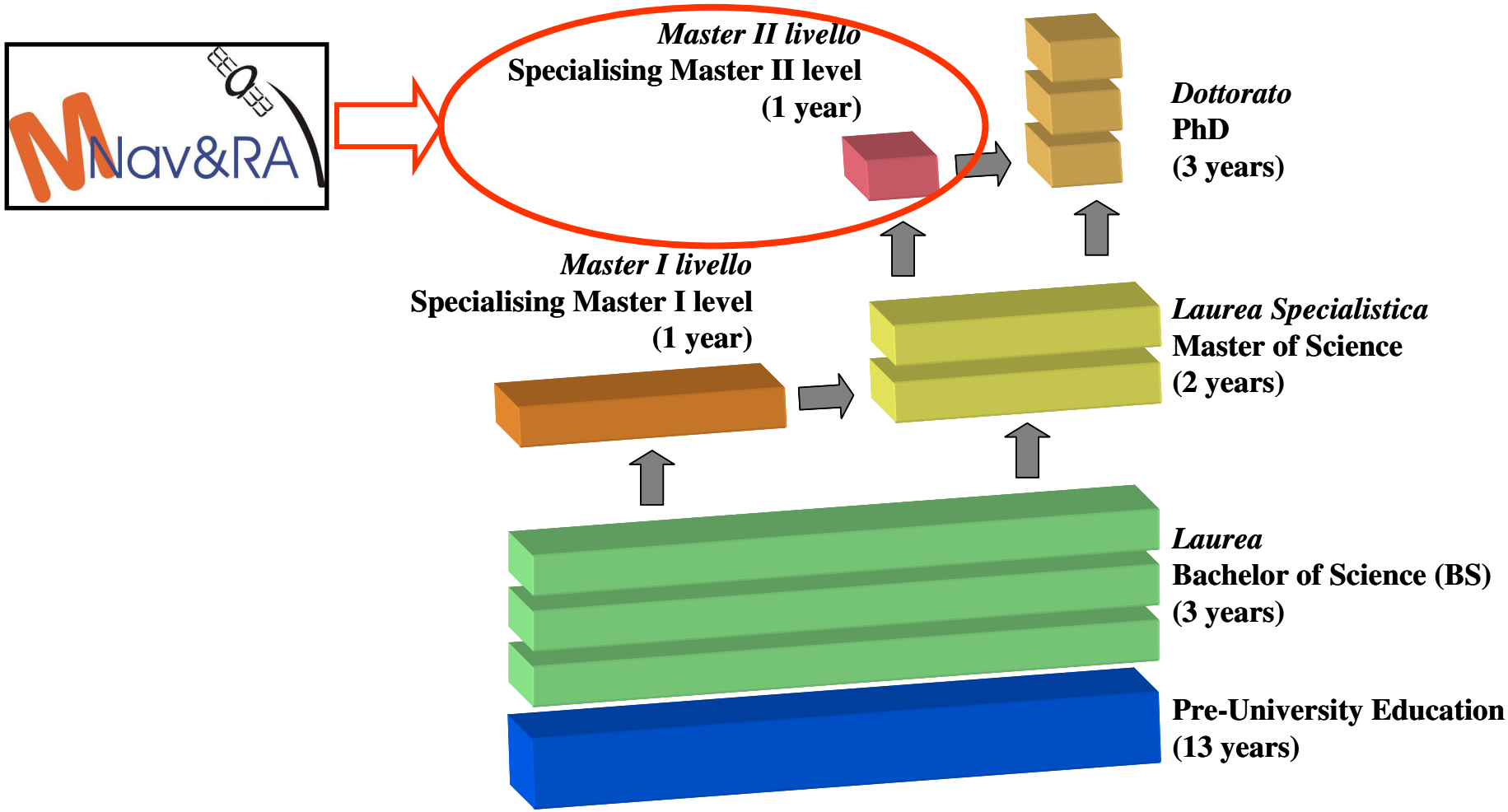
Office for Outer Space Affairs

Structure of Education in Italy

The Italian University system after 1999



Specializing Master



The first five editions

UN/ISMB Project

Country - Students	
Algeria - 1	Madagascar - 1
Egypt - 1	Mexico - 1
Georgia - 1	Mongolia - 1
Ghana - 1	Nigeria - 2
Haiti - 1	Pakistan - 3
Iran - 1	Sri Lanka - 1
Jordan - 1	Vietnam - 2

ALPIP-Meftia Projects

Country	
Argentina - 4	Ecuador – 2
Brazil - 2	Mexico – 1
Colombia - 1	Peru - 1

JEAGAL

Country
China - 6
Vietnam - 4

National funds

Country	
Bangladesh - 1	France - 2
China - 1	Italy - 16
Colombia - 2	Lebanon – 1
Ecuador – 2	Pakistan – 3

ASIAN-Zhong Guò Projects

Country
China - 3
Indonesia - 1
Vietnam - 1

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What is NavKIT

- NAVKIT is a tool for autonomous training on satellite navigation subjects
- NAVKIT has been developed by professors and researchers of the NavSAS Group
- NAVKIT has been developed as a task of the ERIG project “Education Research and Innovation in GNSS” funded by the GNSS Supervisory Authority within the VI FP

European GNSS Supervisory Authority

ERIG

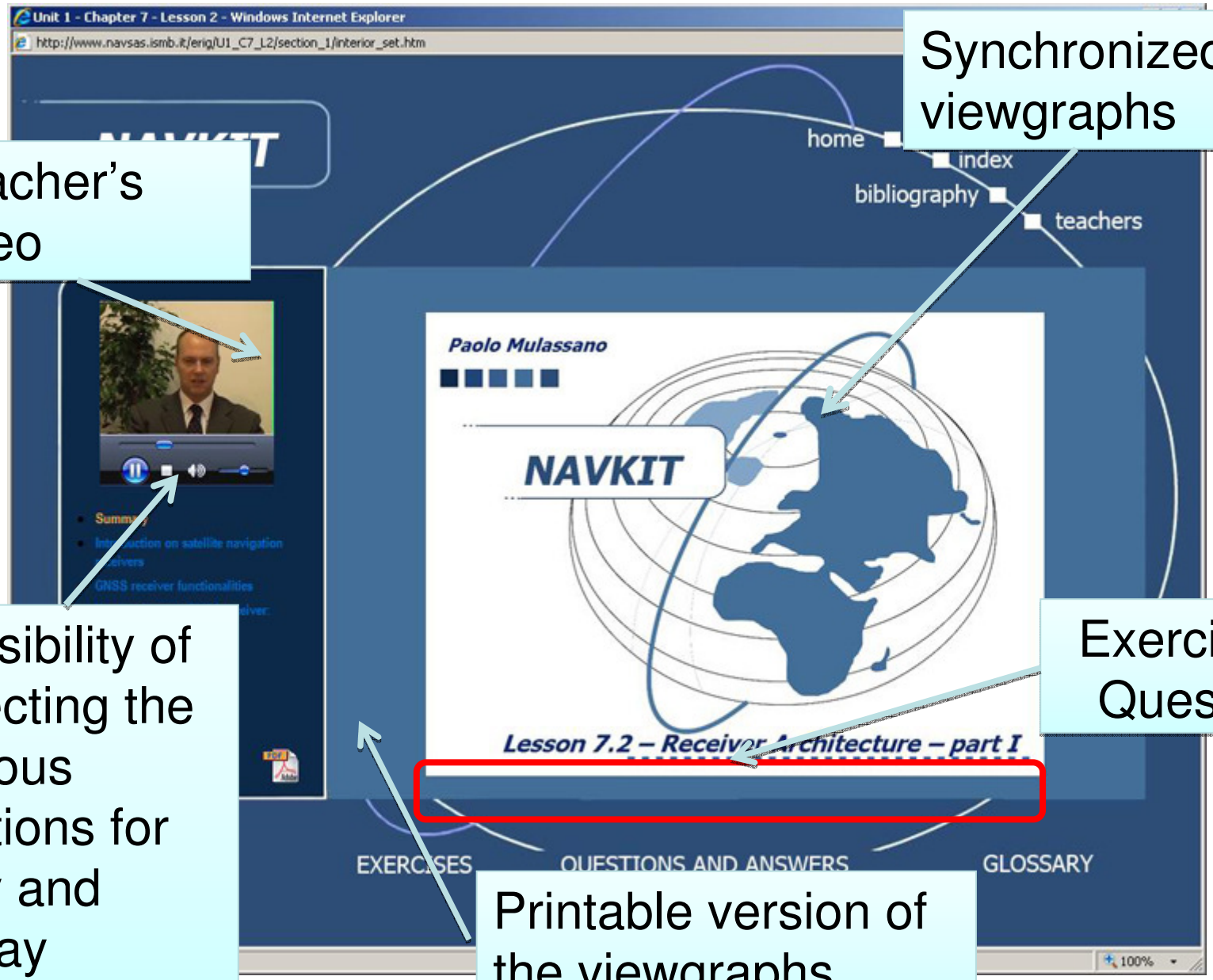
Education, Research & Innovation in GNSS

What is NavKIT

- The tool can be accessed via Web (www.navsas.eu) or can be installed as an application on your own PC
- It allows to learn the basic concepts of satellite navigation by means of a multimedia approach
  - ✓ Videos (lectures)
  - ✓ Exercises fully solved step by step
  - ✓ Self evaluation tests
  - ✓ Frequently asked questions

The Target Audience

- The content of the lesson is organized in order to provide technical concepts also to non specialists
- The tool is designed for students but also for technicians and professionals in need of a starting training in the field



Synchronized viewgraphs

Teacher's video

Possibility of selecting the various sections for play and replay

Exercises & Questions

Printable version of the viewgraphs

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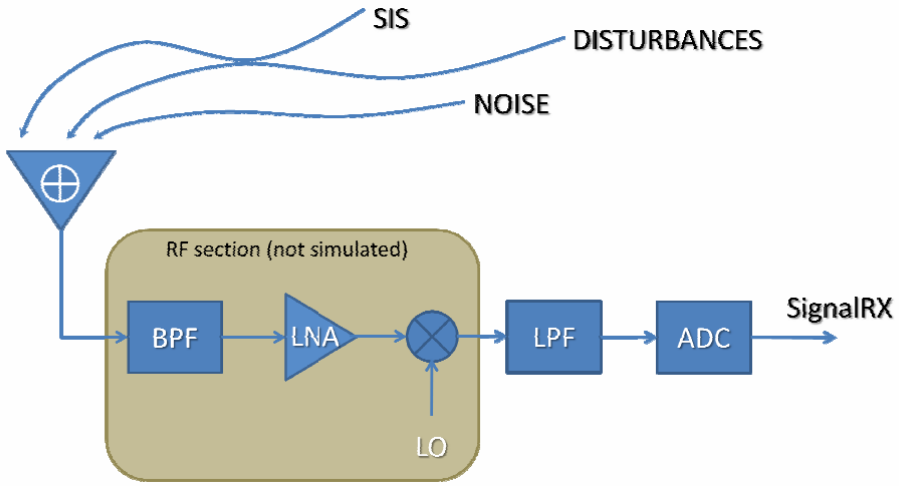
N-FUELS: GNSS signal generator



N-FUELS (FUll Educational Library of Signals for Navigation) is a **MATLAB®-based** GNSS signal generator;

It allows the simulation of **physical layer** signal structu for GPS, Galileo and EGNOS systems in all the current and future bands.

N-FUELS has been created both for **research** and **educational** use.

First of all, the study of signals and systems innovation generates the need of manipulating all the different GNSS signals.

This helps in comparatively analyzing signals performance and testing novel processing algorithms.

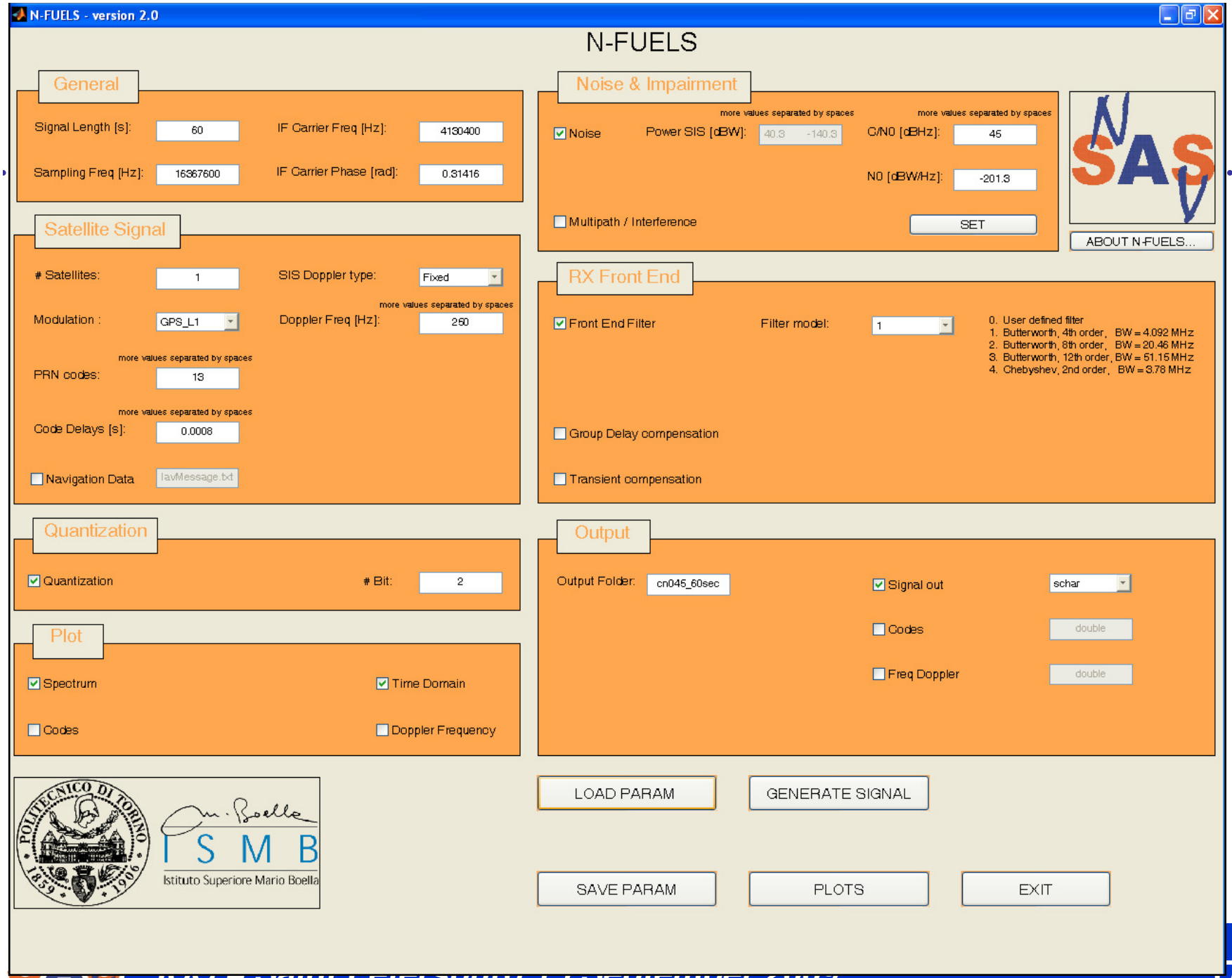
SIS Modulations

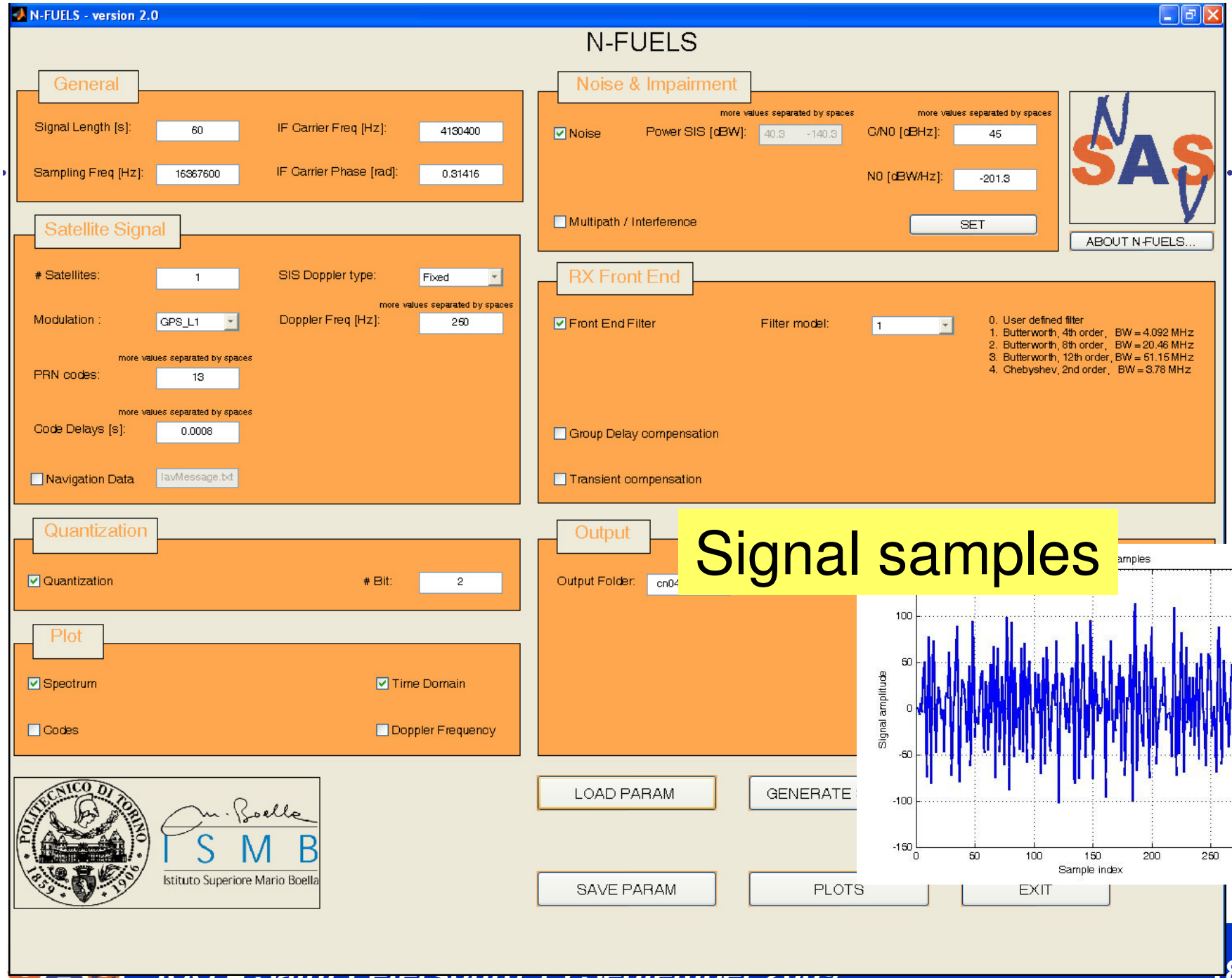
N-FUELS: SISGEN & JAMGEN

- GPS
  - L1
  - L2
  - L5
  - L1C
  - L2C
- Galileo
  - E1-BOC
  - E1-MBOC
  - E5
  - E6
- EGNOS

Interference

- Intra/Inter-system interference (IS): one ore more signals among GPS, Galileo, and EGNOS;
- Multipath (MP): one ore more attenuated and delayed versions of the SIS;
- Narrowband interference (CW): continuous wave (CW) signal;
- Wideband interference (WB): wideband signal modeled as filtered white noise.


N-FUELS - version 2.0
N-FUELS
General
Signal Length [s]: 60
IF Carrier Freq [Hz]: 4130400
Sampling Freq [Hz]: 16367600
IF Carrier Phase [rad]: 0.31416
Satellite Signal
Satellites: 1
SIS Doppler type: Fixed
Modulation : GPS_L1
more values separated by spaces
Doppler Freq [Hz]: 250
more values separated by spaces
PRN codes: 13
more values separated by spaces
Code Delays [s]: 0.0008
Navigation Data
NavMessage.txt
Quantization
Quantization
Bit: 2
Plot
Spectrum
Time Domain
Codes
Doppler Frequency
Noise & Impairment
more values separated by spaces
Noise
Power SIS [dBW]: 40.3 -140.3
more values separated by spaces
C/N0 [dBHz]: 45
N0 [dBW/Hz]: -201.3
Multipath / Interference
SET
ABOUT N-FUELS...
RX Front End
Front End Filter
Filter model: 1
0. User defined filter
1. Butterworth, 4th order, BW = 4.092 MHz
2. Butterworth, 8th order, BW = 20.46 MHz
3. Butterworth, 12th order, BW = 51.15 MHz
4. Chebyshev, 2nd order, BW = 3.78 MHz
Group Delay compensation
Transient compensation
Output
Output Folder: cn045_60sec
Signal out
schar
Codes
double
Freq Doppler
double
POLITECNICO DI TORINO
1859
1906
ISMB
Istituto Superiore Mario Boella
LOAD PARAM
GENERATE SIGNAL
SAVE PARAM
PLOTS
EXIT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Group Delay compensation
Transient compensation
Output
Output Folder:
LOAD PARAM
GENERATE
SAVE PARAM
PLOTS
EXIT
Signal samples
Signal amplitude
Sample index

N-FUELS - version 2.0

N-FUELS

General

Signal Length [s]: 60
IF Carrier Freq [Hz]: 4130400
Sampling Freq [Hz]: 16367600
IF Carrier Phase [rad]: 0.31416

Satellite Signal

Satellites: 1
SIS Doppler type: Fixed
Modulation : GPS_L1
Doppler Freq [Hz]: 250 (more values separated by spaces)
PRN codes: 13 (more values separated by spaces)
Code Delays [s]: 0.0008 (more values separated by spaces)
Navigation Data: lavMessage.txt

Noise & Impairment

Noise
Power SIS [dBW]: 40.3 -140.3 (more values separated by spaces)
C/N0 [dBHz]: 45 (more values separated by spaces)
N0 [dBW/Hz]: -201.3
Multipath / Interference
SET

ABOUT N-FUELS...

RX Front End

Front End Filter
Filter model: 1

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Group Delay compensation
Transient compensation

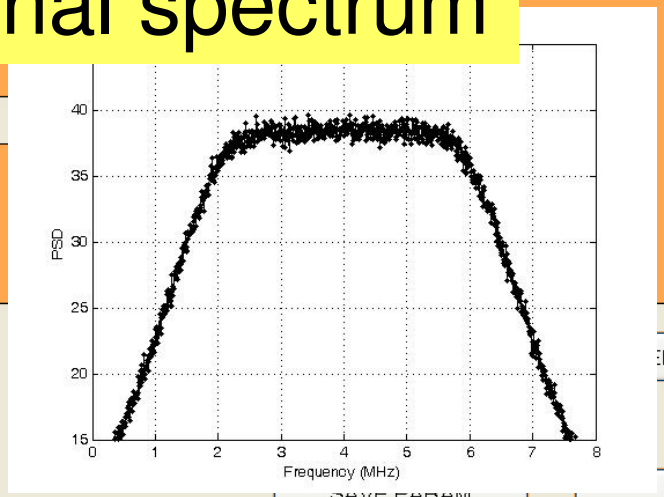
Quantization

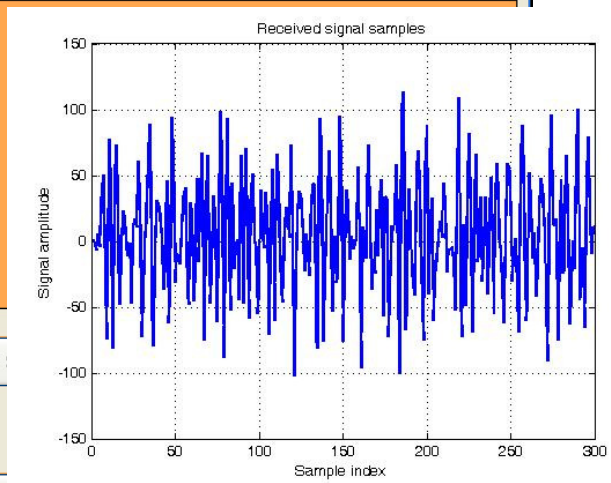
Quantization

Plot

Spectrum
Codes

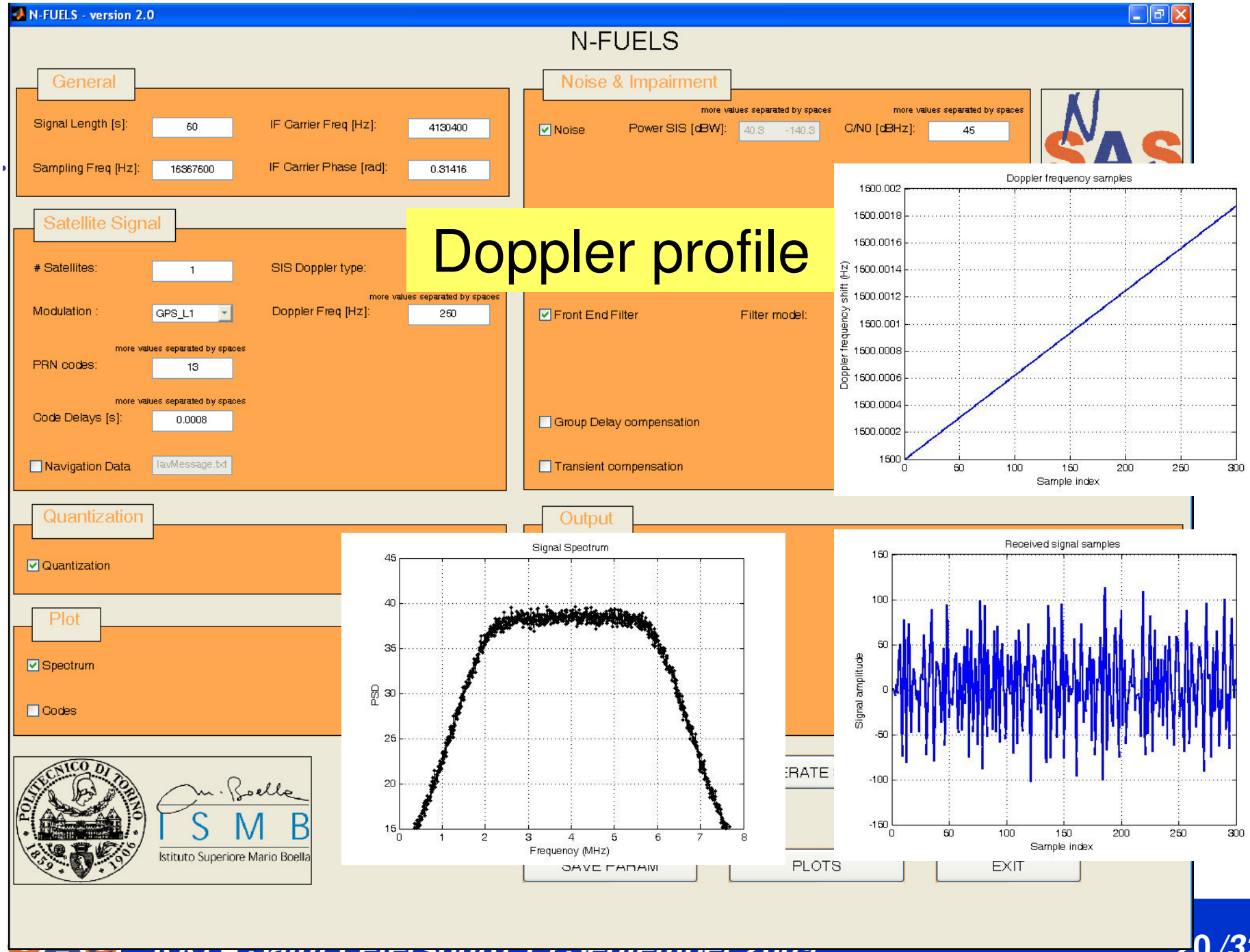
Signal spectrum





Politecnico di Torino 1859 1906
ISMB Istituto Superiore Mario Boella

SAVE PARAM
PLOTS
EXIT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Navigation Data
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Front End Filter
Filter model:
Group Delay compensation
Transient compensation
Quantization
Quantization
Output
Plot
Spectrum
Codes
Doppler profile
Doppler frequency samples
Doppler frequency shift (Hz)
Sample index
Signal Spectrum
PSD
Frequency (MHz)
Received signal samples
Signal amplitude
Sample index
PLOTS
EXIT
POLITECNICO DI TORINO
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N-FUELS – Student Version

N-FULES – Student Version

The folder contains both the software and the user's manual
In order to run the generator, MATLAB© has to be pre-installed (or at least the MATLAB Component Runtime library)
All the instructions to get starting are included in the user's manual

Click N-FUELS link and download the software

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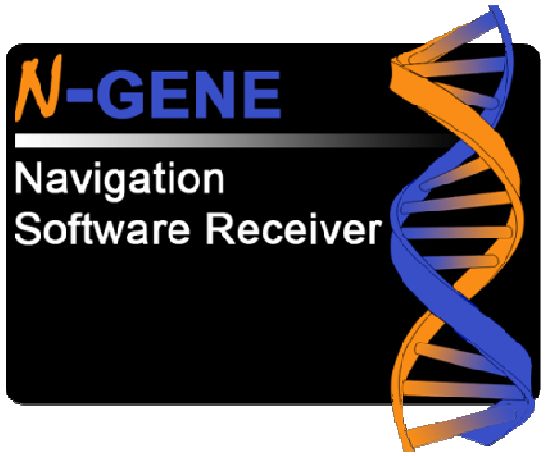
Research on GPS/Galileo Receivers

NavSAS started its R&D activities applying advanced signal processing strategies to Galileo and GPS receivers

TODAY on Galileo receiver

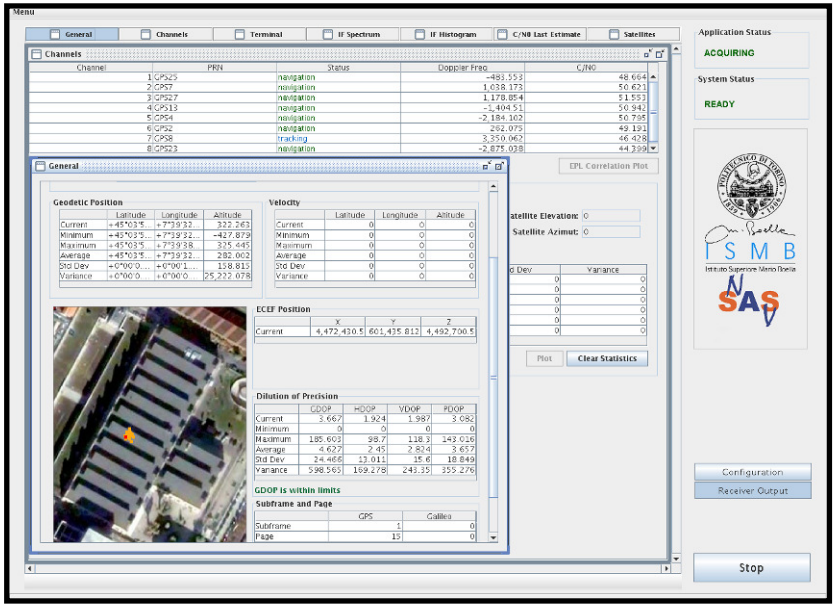
The first release of the **N-GENE** fully SW receiver is ready!



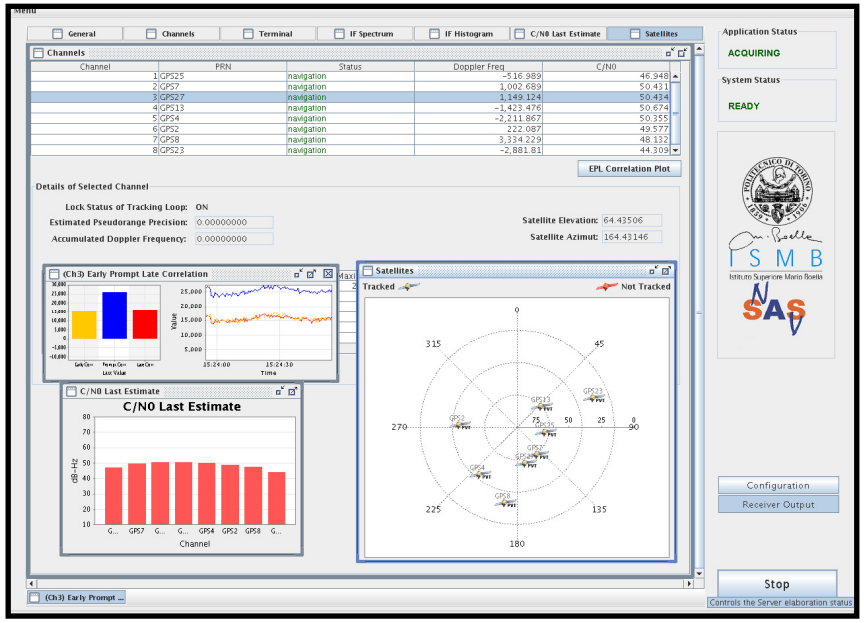
R&D Activities:

- Receiver core technologies
- Fully SW and SDR implementations
- NAV/COM integration and data fusion
- Interference detection and mitigation
- Quality Control

N-GENE Software Receiver: Performance



- Position Accuracy: r.m.s<10 m using code-based measurements and without applying carrier smoothing techniques
- Time to First Fix in Cold Start mode lower than 45 seconds
- Up to 20 channels



- **GPS L1 8 bits quantization at a sampling rate of** 17.5103 MHz
- **Galileo E1, GIOVE-A & GIOVE-B** signals, upgradable to Multiplexed Binary Offset Code (MBOC) easily
- **EGNOS, WAAS &A-GPS**

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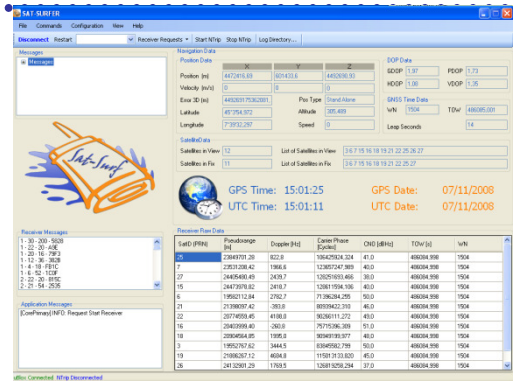
SAT-SURF & SAT-SURFER

A Tool for Practical Training on
Satellite Navigation

SAT-SURFER Software Architecture



Graphical User Interface

File Logs

Settings

Data Logger Matlab, Text, Rinex, KML

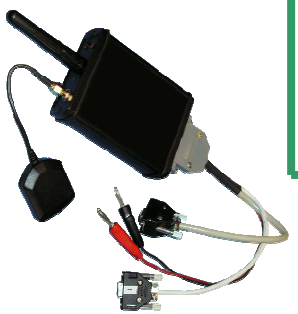
Core Application

Driver SiRF

Driver uBlox

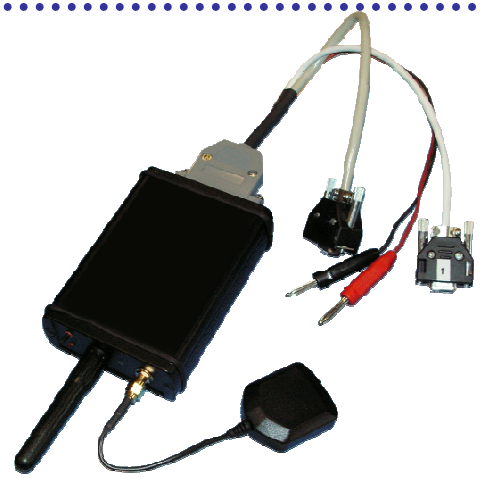
Driver GSM Modem

Driver NTrip DGPS



SAT-SURF HARDWARE

SAT-SURF & SURFER Features



1 – Allows to log all the raw GPS and GSM data (both binary and NMEA Protocols)

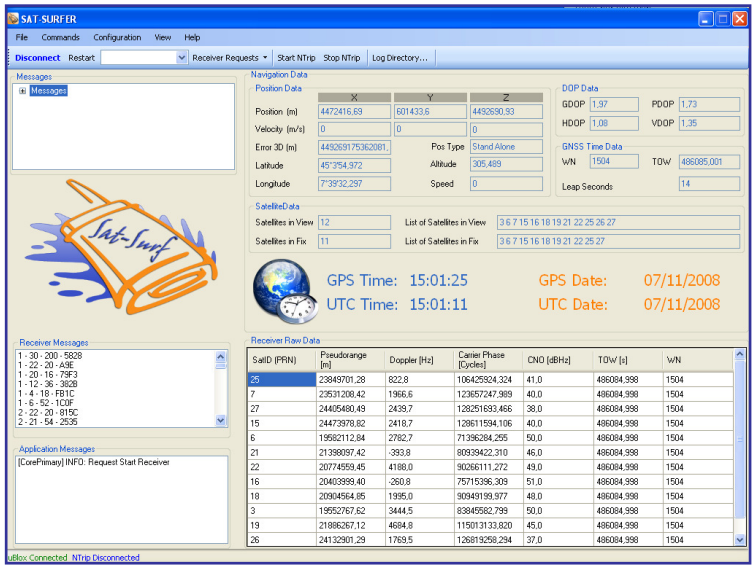
2 – Embeds different GPS modules depending on the user needs:

- uBlox Modules
- SiRF Modules

3 – Equipped with a quad-band GSM/GPRS modem (worldwide coverage) for NAV/COM integration

4 – Raw data storage in the various file formats for an easy post-processing:

- ASCII, Excel® & MATLAB® files
- RINEX 2/3 Log



SAT-SURF & SURFER Features

NAV/COM Integration Capabilities

SAT-SURF is made of components of the shelf. The HW + SW tool is an innovative and complete GPS+GSM evaluation kit. It can be effectively used to test all the receiver features, Assisted-GPS strategies (OMA-SULP compliant) and/or Differential GPS techniques.

Specific Educational Tool

SAT-SURF & SAT-SURFER is a complete educational tool. It includes several exercises with solutions for students. This is then a perfect tool for a lab dedicated to ICT technologies.

A Ready to Use Tool

SAT-SURF & SAT-SURFER is a ready-to-use tool. The tool has already been delivered to many education institutions such as Hanoi University of Technology (Vietnam), Asia Institute of Technology (Thailand) and Politecnico di Torino (Italy).

Partnership

- SAT-SURF and SAT-SURFER have been designed and developed by the NavSAS Group and represents a technology transfer example;
- SAT-SURF is manufactured and distributed by SAET s.r.l., a high-tech Italian SME;
- SAT-SURFER has been written by the NavSAS Group.

www.navsas.eu

www.saetsrl.com

Contact Information

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Tel.: +39 011 2276200

Our web site: *http://www.navsas.eu*


Thank you for attention