



Overview of Thales Alenia Space Italia GNSS Products & Activities

7th Multi-GNSS Asia (MGA) Industry Seminar

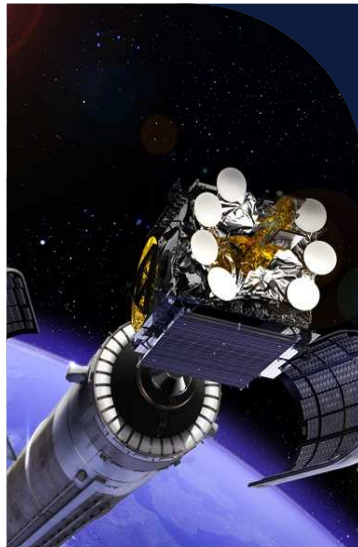
LIVIO MARRADI | Thales Alenia Space Italia



HORIZON 2020



AEROSPACE



SPACE



GROUND
TRANSPORTATION



DEFENCE



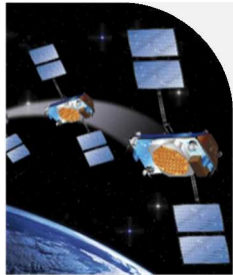
SECURITY

**EACH OF THE MARKETS
THAT THALES SERVES
PLAYS A VITAL ROLE
IN SOCIETY.**

Thales operates as a **single organisation**, drawing on the talent and technologies of the entire Group to act as prime contractor, systems integrator, equipment supplier and value-added service provider on both civil and military programmes.

Thales plays a major role in space systems through two joint ventures with Finmeccanica: **Thales Alenia Space and Telespazio serving satellite operators,** space agencies and defence customers

- **Helping them to design, develop and deploy orbital infrastructure, systems, ground segments and services**
- **For telecommunications, Earth observation, navigation and scientific missions**



Telecommunications

Thales Alenia Space is prime contractor for all telecommunication satellite constellations, including Iridium Next, Globalstar, O3b



Orbital infrastructure

Thales Alenia Space has supplied 50% of the pressurised volume of the International Space Station



Science

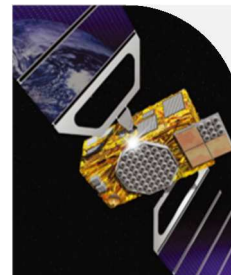
Thales Alenia Space is prime contractor for ExoMars, Europe's first mission to land on Mars



Earth observation

Civil, military, dual-use

Meteosat 1st, 2nd & 3rd generations, Helios, CSO, Pleiades, Cosmo SkyMed, Sentinels



Navigation

Space and Ground Segments
EGNOS, Galileo
Equipment & Infrastructures

Space and Ground GNSS Product Lines



GNSS Ground Reference Receivers

- EGNOS V2/V3 RIMS
- GALILEO GRCN IOV/FOC
- IONO MONITORING RECEIVERS



GNSS Spaceborne Receivers

- LAGRANGE-2G REAL-TIME NAVIGATION LEO/GEO/GTO
- GNSS RADIO OCCULTATION INSTRUMENT
- GNSS REFLECTOMETRY



GNSS User Applications

- TEST USER RECEIVER
- RAIL USER TERMINAL
- SW RADIO RECEIVER



GALILEO NSGU Navigation P/L

- NSGU IOV/FOC
- ENSGU / LNSGU new generation



Ground Reference Receiver Products

EGNOS RIMS-B



Key features:

- 16 channels GPS L1/L2
- 12 channels GLONASS L1
- 6 channels GEO L1
- All in view acquisition and tracking;
- Provides Raw Data, Navigation Message, Signal Quality and Signal Status Indicators, Health Status;
- Provides Timing Synchronisation (PPS);
- 19", 3 PU (133 mm height) sub-rack plus antenna;
- Provides raw data to the EGNOS processing chain

Domains for application:

- Reference receiver for EGNOS SBAS Ground Segment

Maturity on the market :

- > 40 recurrent units operational on EGNOS sites worldwide

GALILEO GRCN Rx for IOV/FOC



Key features:

- Galileo receiver for OD&TS, IPF and PTF chains
- Processing of 16 GALILEO satellites L1, E5, E6 except PRS, 12 channels GPS L1/L2
- Raw measurements generation (code, carrier phase, C/No, Doppler, code-carrier coherency indicators) and validity flags from the E5a-b, E5 (AltBOC), E6 and L1 signals, for each Galileo satellite in view;
- Galileo PTF station receiver and automatic calibration mode
- Interference mitigation through pulse blanking
- Navigation Data Messages output
- PPS signal generation

Domains for application:

- Reference Rx for Galileo Ground Mission Segment

Maturity on the market:

- 40 GRCN Units delivered and operational
- 4 new generation GRCN-NG Rx delivered
- 4 PTF-C Calibrators

Ground Reference Receiver Products

RIMS-E/V3 New Generation Rx



Key features:

- RIMS New Generation Rx capable of providing raw data on the following signals:
 - Baseline provision
 - GPS L1C/A, L2P(Y), L2CM/L2CL, L5
 - GALILEO E1, E5a
 - GEO L1, L5
 - Expandability provision
 - GPS L1C
 - HEO L1, L5
 - GLONASS L10C, L50C
 - BeiDou B1C, B2a
- Antenna: interface to COTS geodetic reference antennas or dedicated Dual-Tracking Antenna (DTA) for increased performance in MP and Interference

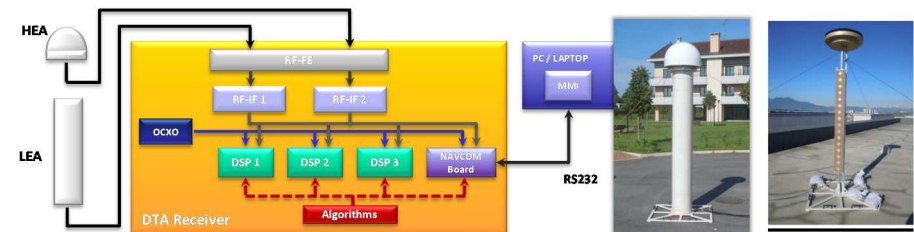
Domains for application:

- Reference receiver for Ground Stations Infrastructure

Maturity on the market:

- Qualified unit Q2 2016

DUAL TRACKING ANTENNA Rx (DTA)



Key features:

- Based on TAS-I receiver platform
- The DTA concept is based on the tracking/acquisition of the GNSS satellites at any elevation angle dividing the field of view in two different sides (Low Elevation Antenna - LEA, High Elevation Antenna - HEA)
- Dedicated measurement chains and appropriate combination algorithms allow to mitigate the errors affecting the measurements for multipath and interferences and minimizing their impact

Domains for application:

- Reference receiver of ground reference stations
- Antenna/Receiver system for Airport GBAS Stations

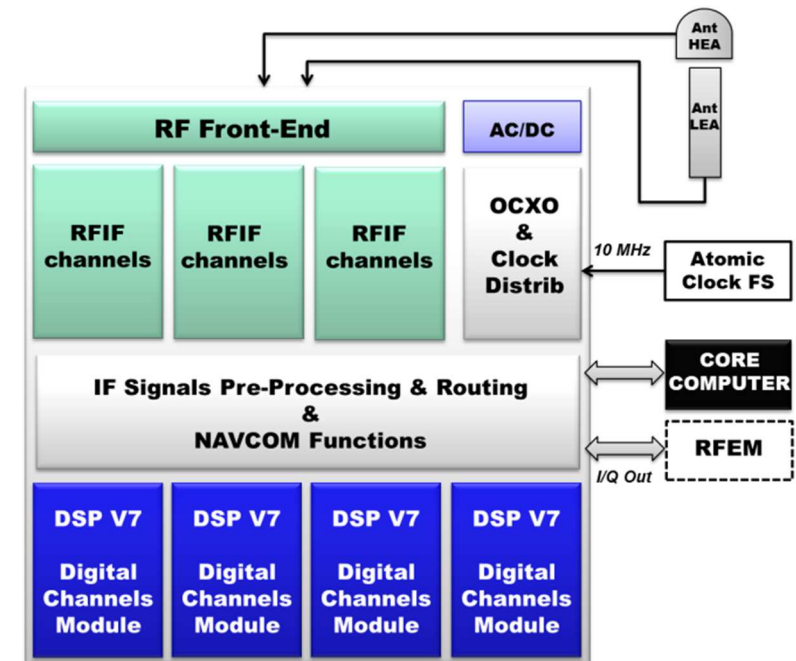
Maturity on the market:

- Demo Proto available
- Qualified Unit Q2 2016

Multi-Constellation / Multi-Frequency Ground Receivers

COMMON PLATFORM SCALABLE ARCHITECTURE

- Designed for Ground Station Infrastructures & GNSS Networks
- Expandable to All-constellation / All-signals (GPS/GAL/GEO/GLO/BEI)
- State-of-Art Performance
- Robustness to environment for usage in harsh sites
 - Interference: NB, WB, Pulse, Extreme
 - Multipath: up to 6dB D/U
 - Scintillation: extension to Equatorial/Polar Regions
- 11+1 Multicorr/Channel for EWF function (local / central)
- Digital I/Q samples output for RF Env Monitoring (RFEM)
- Interface to COTS geodetic antenna or DTA technology
- Adaptable external data interface
- Security Features
- Qualified to DO-254/278 standards
- TAS-I commitment to continuous Rx technology evolution



GISMO Ionospheric Monitoring Receiver

FLEXIBILITY & CONFIGURABILITY

- **Dual Frequency, Dual Constellation Signal Tracking**
 - GPS/GAL: L1CA, L2c, L5/E5a
 - Tracking Loops Configurability (DLL/PLL BW, code/phase discriminators)
- **Expandability:** Channels expandability by adding boards in the Rx

ROBUSTNESS

- **Tracking Loops:** PLL, FLL-aided-PLL, Kalman Filter PLL
- **Bit grabbing capability:** Storage capability and post-processing I/Q data

OBSERVABILITY

- **Rate:** Meas Rate configurable: 50, 20, 1 Hz (SNR and Carrier Phase)
- **Clock:** Ultra stable OCXO: spectral purity (phase noise) and short term (Allan deviation)
- **Ionospheric Products:** S4, Sigma-Phi, TEC, Δ TEC, Iono Flag
- **Environmental Products:** CCC Iono Free, Cycle Slip Flag, Interf. & MP Flags
- **Data Output:** Rinex, ISMR, Binary High Rate Files

EQUATORIAL REGIONS AFFECTED BY IONO

IONO MONITORING STATIONS FOR MODELING & FORECAST TO USERS

GISMO Reference Receiver

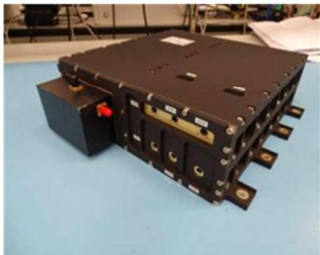


MISW, MONITOR, BELS Stations



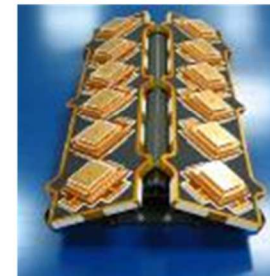
DUAL-FREQ GPS POD (LAGRANGE & LAGRANGE-2G)

- 12 GPS / GLO L1+L2 channels
- Precise Orbit Determination (POD by ground post processing)
- MIL-STD 1553B data I/F
- Mass 5 kg Power: 30 Watt
- Dimensions: 250 x 164 x 190 mm
- Navigation output states:
 - Position @ 1 Hz- Velocity @ 1 Hz
 - Time @ 1 Hz
 - Raw Data L1/L2 measurements @ 1Hz
- Maturity: 18 units produced for several missions
- NEW LAGRANGE-2G SDR: ready Q3 2016
 - SW Defined Radio based on FPGA
 - In-Flight reconfiguration capability
 - GPS L1/L2P(Y)/L2C, GAL E1



GNSS RADIO OCCULTATION INSTRUMENT (ROSA)

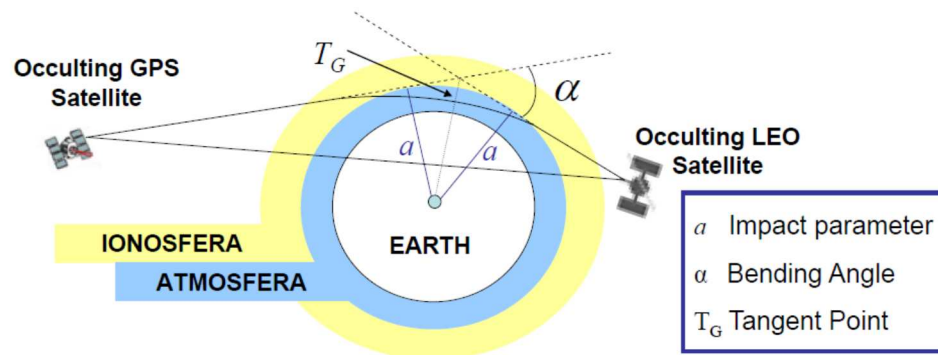
- Spaceborne Instrument to sound the Atmosphere
- Real-time NAV and OBS measurements for meteorology and climatology science
- GNSS signals on L1 and L2
- MIL-STD-1553 communication interface
- Up to Two (velocity, anti-velocity) Radio Occultation Antenna with maximum gain at atmosphere layer from 0 to 100 km
- NAVIGATION MODE: real-time navigation
- OBSERVATION MODE: occultation measurements
 - 16 DFC Navigation Mode
 - 8 Navigation DFC + 8 DFC Observation
- OUTPUT:
 - Pseudorange, carrier phase, SNR @ 1-10-50 Hz (Closed Loop)
 - I/Q samples and Doppler Model @ 100 Hz (Open Loop)
- 3 missions (ISRO / ASI / CONAE)



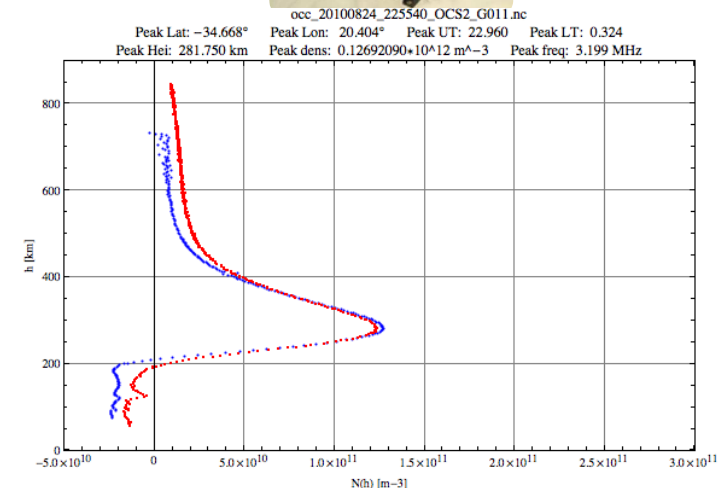
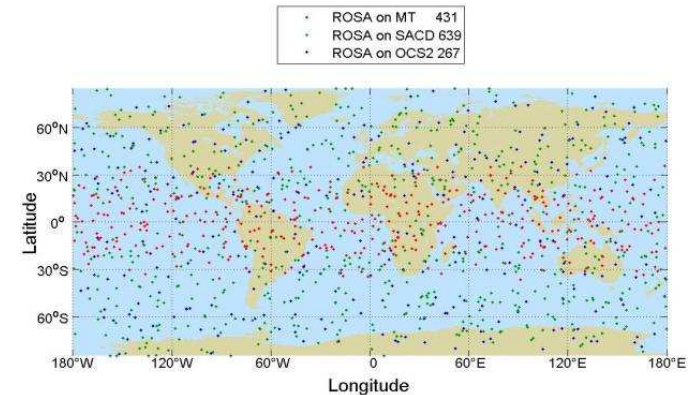
Combined Ground/Space Iono Monitoring

GNSS-RO FROM SPACE A HIGH ACCURACY PROFILING TECHNIQUE

- Long Term Stability
- All-weather operation, Global 3D coverage
- High Vertical Resolution
- Exploit “co-located ground/space” observations
- Relative strengths of different measurements
- Space RO provides good vertical resolution combined with ground based ionospheric tomography
- Physical modeling of neutral atmosphere using ground-based and radio-occultation space data



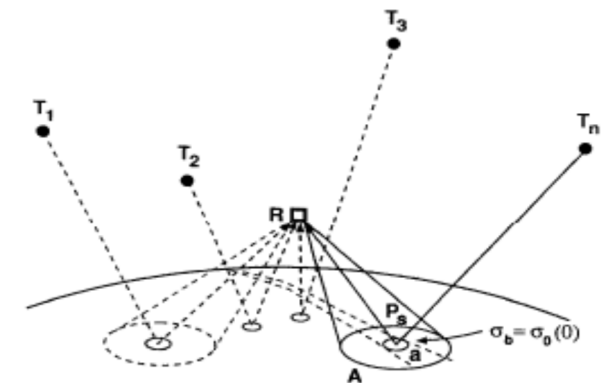
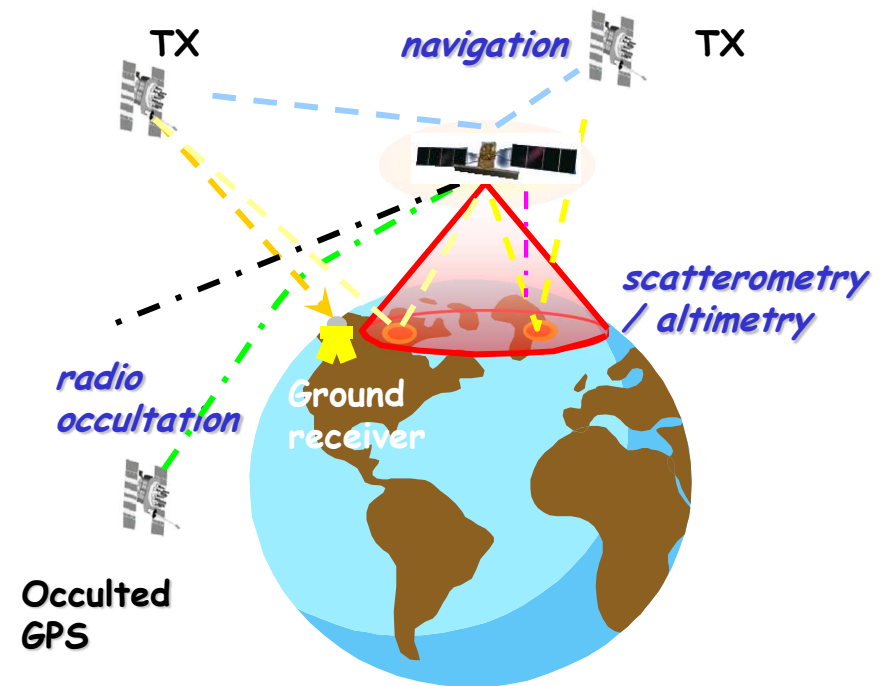
ROSA Occultation Geolocation Distribution on 24h of 12/07/2012



Earth Observation by GNSS Reflectometry

EARTH OBSERVATION FROM SPACE FOR AGRICULTURE

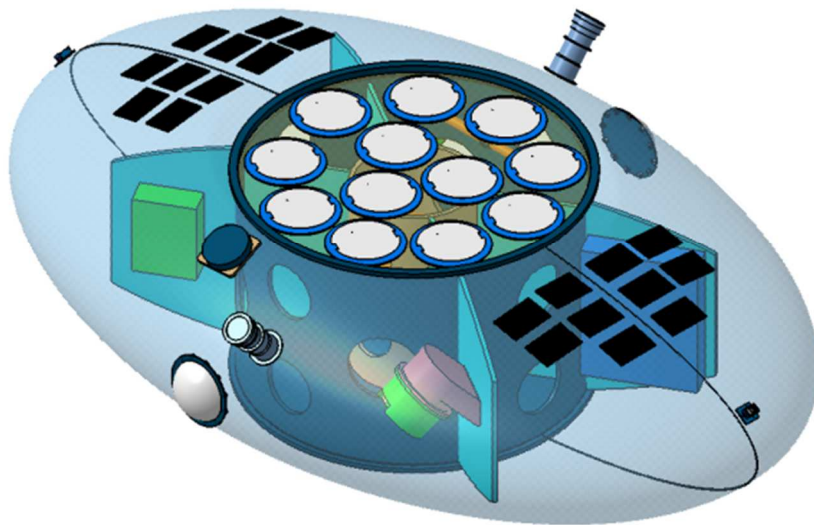
- Measure from satellite bio-geophysical quantities: soil moisture, soil roughness and plant water content
- GNSS Reflectometry based on interferometric measurement of the reflected signal .vs. the direct signal
- Allow retrieval of arrival time delay and of properties of the reflecting surface
- GNSS-R implements a bistatic observation at L band
- Low cost, increasing number of GNSS transmitters, many specular points on earth (high coverage), L-band penetrates into vegetation and soil



MicroSatellite R&D for GNSS Remote Sensing

GNSS Remote Sensing Application (internal R&D):

- **GNSS RADIO OCCULTATION**: global meteorological predictions & space weather studies
- **GNSS REFLECTOMETRY**: land, vegetation and ocean studies



MICROSATELLITE BY ADDITIVE MANUFACTURING TECHNOLOGY (1.6m x 1m, 100Kg)

RAIL Safety-Critical GNSS User Terminal

- RAIL User Terminal based on GNSS Rx + IMU
 - Virtual Balise
 - Enhanced Odometry
 - Train Integrity (Train Head-Tail)

IMU



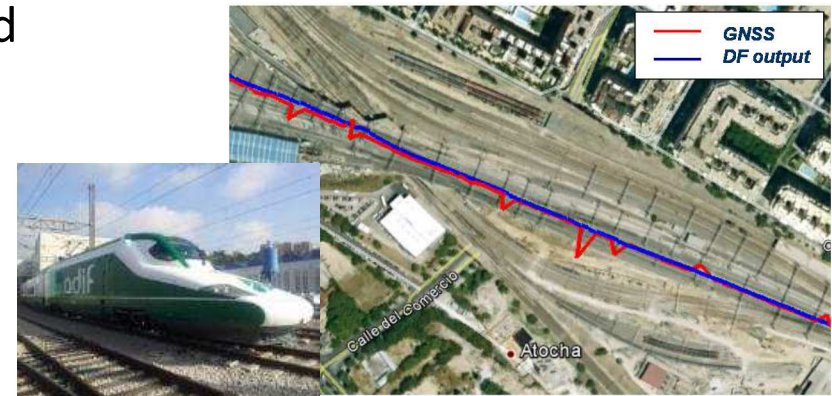
GNSS TERMINAL



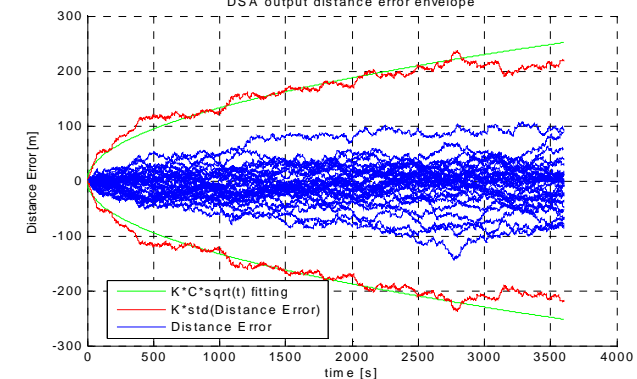
PEGASUS Rx



- Output Traveled Distance + Speed to Train On-Board Guidance System
- CENELEC Safety-Integrity-Level: SIL-2 (THR $1e-7$ / hr)
- Confidence level with TAS-I “Along-Track Protection Level” algorithm provides error over-bound
- The confidence level is the range around the provided distance (velocity) within which the true distance (velocity) lays with a probability of 5σ



DSA output distance error envelope



FIELD TESTS ON HIGH-SPEED LINES
IN SPAIN (MADRID-BARCELONA)

TAS-I GRAIL USER TERMINAL AND PEGASUS RECEIVER

GNSS Receivers

Reference



Safety Critical



Space



Needs

1. **Multi-constellation
Multi-Frequency
scalable architecture**
2. **Robustness to RF
environments**
3. **Performance**
4. **Integrity & Continuity**

Technologies

- **Advanced Antennas (simple DBF)**
- **RF Direct Sampling & DDC**
- **GNSS waveforms (SCA-like architectures)**
- **Algorithms for robust tracking, adaptive filtering, hybridization, confidence bounds**
- **GNSS Remote Sensing techniques**

- **TESTS IN NAVIS HUST CENTER (HANOI) IN THE FRAME OF BELS PROGRAM:**
 - TASI will install a GISMO Iono Receiver in Hanoi to perform measurements and analyse performance in presence of scintillation within this region
- **TAS-I READY TO COLLABORATE WITH SOUTH EAST ASIA INSTITUTIONS** in the fields of GNSS Equipment, Technologies and Applications related to:
 - GNSS Ground Infrastructures
 - Ionospheric Monitoring Networks
 - Remote Sensing by use of GNSS signals
 - Rail Safety-Critical Applications
- **TAS-I READY TO HOST RESEARCH STUDENTS FOR STAGE PERIODS IN ITALIAN SITES**

CONTACT

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