

MUSEO STORICO DELLA FISICA E CENTRO STUDI E RICERCHE ENRICO FERMI A CONTROL CALLA FISICA La Scienza nelle Scuole

Metrological Characterization of the EEE timing system

First Outcomes









INRIM-EEE Call Conference: 2019 October 15th

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INRIM Septentrio PolaRx5-TR dual frequency GNSS geodetic receiver

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Scope of the measurements at INRIM

- Performing the metrological characterization of the EEE timing system;
- Characterizing the EEE telescopes GPS 1PPS driving signals, in terms of stability and accuracy;
- Representative set of actually installed EEE GPS receivers (i.e. Spectracom Tsync and Trimble SMT360) had been considered;
- Dual frequency geodetic INRIM GNSS receiver for timing applications (i.e. Septentrio PolaRx5-TR, internally known as GR03) considered as potential transportable calibration device (with MESIT GTR50) and candidate receiver for improving EEE telescopes GPS timing system;
- UTC(IT) atomic Italian Standard Time considered as timing reference for the proposed metrological characterization.



Calibrated measurement setup (1/3)



Measurement Setup General Scheme



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Calibrated measurement setup (2/3)





TIC Based Measurement System



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Calibrated measurement setup (3/3)





INR5 (i.e. Septentrio PolaRx4-TR)

MESIT GTR50 (formerly DICOM)



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Septentrio PolaRx5-TR (1/3)





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Septentrio PolaRx5-TR (2/3)





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Septentrio PolaRx5-TR (3/3)





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Possible transportable calibration system (1/2)





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Possible transportable calibration system (2/2)





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Future Perspectives (1/2)

- Further and more exhaustive measurements campaigns, to consolidate results and methodologies for the metrological characterization and for the definition of a proper transportable calibration system;
- Possible "on-site" calibration of (all?) EEE currently deployed GPS receivers and future ones;
- Possible replacement of part of the currently installed EEE GPS single frequency receivers, with dual frequency receivers for timing applications (e.g. Septentrio PolaRx5-TR);
- Possible installation of (at least one) a EEE telescope at INRIM, synchronizing it (them) directly with UTC(IT) via coaxial cables and/or optical fibers (depending on the distance among telescopes and INRIM Time Laboratory);
- Possible UTC(IT) synchronization of already deployed EEE telescopes, via White Rabbit tecnique, over Optical Fiber.



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Future Perspectives (2/2)

ITALIAN QUANTUM BACKBONE, 1800 km



- Quantum Technologies
- T/F dissemination
- Radioastronomy
- High accuracy spectroscopy
- Space Galileo
- Finance
- 7 Research Institutes linked among: CNR – National Research Council ASI – Italian Space Agency INAF – Italian Astrophysics Institute
- 5 Industrial Users Consortium Top-IX Leonardo; Telespazio; Telsy; Thales Alenia Space Italy



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Preliminary Conclusions

- Preliminary evaluation of the stability and accuracy of the 1PPS signal (sync. with GPST) generated by two EEE representative GPS single frequency receivers has been performed, to be compared with the one of an INRIM calibrated geodetic dual frequency receiver (typically used for the remote comparison of atomic clocks and time scales);
- For the calibrated INRIM receiver ($u_B = 2 \text{ ns} \mid 2\sigma$), the 1PPS signal stability is around 4-5 ns 2σ , while for the two EEE (not calibrated receivers), this parameter ranges around 18-25 ns (2σ) \rightarrow calibration required. IONO effect evident for SMT360 (TBC);
- Possible strategies for the calibration of already deployed EEE GPS receivers had been presented, as well as a receiver to be potentially considered as "candidate" to replace some currently operated GPS receiver;
- The possibility to host at INRIM at least one telescope (sync. with UTC(IT)), together with the possibility to synchronize with UTC(IT) already installed EEE telescopes, will be envisaged.

