

TWSTFT calibration campaign 2023

Mobile Station Operations

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Introduction: This work presents the operational aspects of the European two-way satellite time and frequency transfer (TWSTFT) calibration campaign 2023, which was initiated and coordinated by VSL, Delft. TimeTech GmbH was responsible for the planning and conduction of the calibration trip including the provision and operation of the Mobile Calibration Station (MOB) during a time period from mid August to mid November 2023. Detailed results of this campaign are in a companion paper, see Erik Dierikx, *TWSTFT calibration campaign 2023 – Analysis of results*, EFTF 2024.

Planning the trip: 11 European time laboratories have been visited, each for a nominal measurement duration of 3 full days. The MOB, which is mounted in a trailer, travelled on an agreed schedule, minimizing travel distances, meeting station availabilities and observing weather constraints.

Preparing the trip: Based on experiences with earlier calibrations, several new features had been implemented, incl hardware improvements, mainly to enhance the confidence in the station and to secure its operations under non-nominal conditions. An unattended, automated operation for 24/7 was implemented, together with a new remote-control capability, automated data generation and transmission. Data upload to the FTP server at the BIPM (Bureau International des Poids et Mesures) was automatic with a latency of 1 hr. These new features allowed the rather ambitious schedule, changing calibration sites on a weekly basis and validating its performance in near-real time. Total travel distance was approx. 15.000 km during 3 months, including 4 legs with ferries.

Performance: This campaign was the first large campaign after return to the 2.5MCh/s chip-rate, and a significant improvement was expected with respect to the 1 MCh/s modulation rate applied earlier. We used several established methods to determine the performance of MOB, in the short-term using common-clock operation to the site visited, and TWSTFT links to other stations using the direct connection to the local clock. The long-term performance has been verified using the closure method, where one station (i.e. PTB05, Braunschweig) has been visited at the beginning and at the end of the trip. An error budget has been established together with VSL. The estimated MOB performance, which is comparable to the most stable stations visited, will be reported.

Conclusions – The 2023 European calibration trip has been conducted as planned, with few exceptions well within the allocated time frame. The schedule was met despite some adverse conditions, incl outside temperatures from 40°C in August to -10°C in November and several extreme weather time periods. Technical problems including mains power outages and air conditioning failures have been managed with minimum impact. A concise set of operational parameters has been recorded. Key parameters from MOB operations during the whole trip will be presented together with valuable lessons learned.