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Relativistic corrections in the European Laser Timing (ELT) experiment

The European Laser Timing (ELT) experiment, which is part of the ESA mission ACES (Atomic Clock Ensemble in Space), aims at enabling picosecond time transfer between ground based clocks and the ultra-stable time scale of the ACES module aboard the International Space Station. To this end, both a classical two-way and an additional one-way optical link shall be established, both of which are based on timing via ultra-short laser pulses. For maximum timing precision, the space based ELT hardware will be equipped with a novel single photon avalanche diode (SPAD), which needs to be gated to reduce the signal-to-noise ratio to an acceptable level. To synchronize pulse transmission dates with the gating of the ELT detector, space and ground clocks shall be referred to a common time scale like UTC. Hence, the ELT data center is required to compute the relativistic drift of the ACES clock with respect to UTC, as the payload has no access to a sufficiently accurate approximation of UTC, for example through GNSS. We briefly present the underlying relativistic effects and our approach to compute the associated clock correction products. In doing so, we discuss the impact of the resolution of the employed gravity model as well as the effects of the tidal potentials of Sun, Moon, and planets. In addition, we suggest how these clock correction products could efficiently be delivered to the SLR stations that contribute to ELT. Finally, we further address relativistic pulse delay corrections, namely the standard Shapiro time delay and first and second-order Sagnac corrections.