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Detector Data Simulation and Filtering Strategy for the European Laser Timing (ELT) Experiment On-board ACES

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Due to the rapid progress of frequency standards in the optical domain and increasingly demanding applications in metrology and fundamental physics studies, accuracy requirements on frequency and time transfer are continuously increasing. Most present satellite based clock comparison systems work in the microwave domain and are based on GPS and TWSTFT (Two-Way Satellite Time and Frequency Transfer). Recently, systems such as LASSO (LAser Synchronization from a Stationary Orbit) and T2L2 (Time Transfer by Laser Link) promised even better performance in the optical domain. In 2016 the ESA mission ACES (Atomic Clock Ensemble in Space) will bring a new generation of atomic clocks into the microgravity environment of the ISS, which will distribute a stable and accurate time base. In the frame of this mission an optical link called ELT (European Laser Timing) is presently under study, which is subject of our work. The on-board hardware of ELT consists of a corner cube retro-reflector (CCR), a single-photon avalanche diode (SPAD), and an event timer connected to the ACES time scale. The SPAD detects laser pulses fired towards the payload and the CCR reflects these pulses back to the ground station. The detection dates are recorded in the ACES time scale, while the two-way time of flight can be used for precise ranging. Consequently, time transfer and clock analysis can be performed based on data triplets comprising the time of transmission of a laser pulse, its time of reception at the ELT-detector and its time of reception back at the station-detector.

We present simulations of these triplets based on simple ISS orbits including preset attitude and accurate Earth orientation data. In addition, we consider experimentally derived detector, reflector, and background noise characteristics as well as simulations of the ACES clocks. The ELT data center, which will be hosted by our institution, will have to extract the data triplets from the large amount of noisy detector dates. Thus, we developed a data filtering scheme, which is described in the second part of this poster. Our filtering approach is validated using the simulated data as well as real data from the T2L2 experiment.