Precision Timing for Space-Based Applications – Utilisation Study

Scoping compact, high accuracy clocks for use on small satellites

Mission Goal: To develop new technologies and capabilities that leverages a timing solution that is highly accurate, stable and independent of GNSS.

Precision timing is a key capability underpinning the operational efficiency of society's most critical infrastructure and is making new applications possible. Global Navigation Satellite System (GNSS) satellites carrying atomic clocks have contributed to delivering a global timing capability with high levels of accuracy and stability. The increasing demand for GNSS independent timing solutions, as well as the potential for optical clocks offering higher levels of timing accuracy and stability demands a study to address the potential applications and technologies required for success in these areas.

This project is investigating the new opportunities and resilience that a compact, high accuracy clock for use on small satellites would enable for a broad range of precision timing applications.

The long-term objective is to develop new technologies and capabilities that leverage a timing solution that is highly accurate, stable and independent of GNSS. This project is interlinked with the University of Adelaide-led project called Compact Clock for Small Satellite Applications, which is aimed at developing a compact optical clock for small satellites with a target stability being an order of magnitude better than the current hydrogen maser clocks used by the Galileo satellites.

This project will deliver a scoping study highlighting new opportunities for a broad range of precision timing applications both in space and on the ground.

The challenge is to investigate applications in relevant industry sectors that could potentially make use of this enhanced timing capacity.

The specific deliverables are case study analysis and system modelling to identify opportunities and trade-offs based on several use cases, including, but not limited to, one or more of the following:

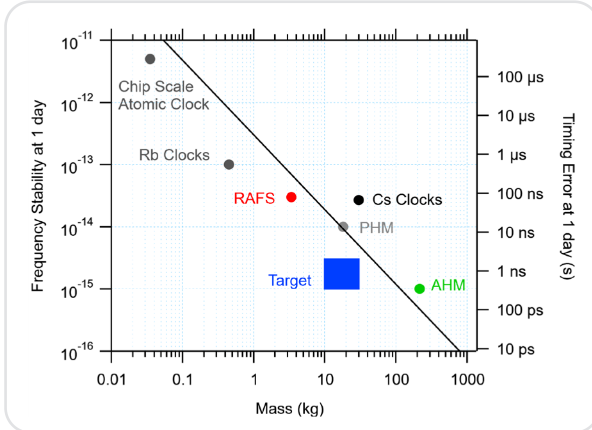
- Smart Cities/Agriculture/Mining where automation requires precise time and position. Can time reference an order of magnitude better than GNSS systems, enable new end user automated applications?
- Electronic Warfare, particularly from distributed systems, where a common time reference enables precise comparison of signals collected at different locations.

IN COLLABORATION WITH:

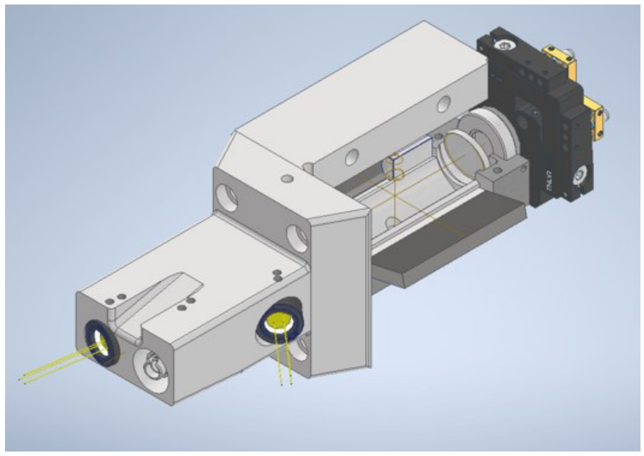
- Resilient timing distribution as a backup to current systems including GNSS PNT. For example, can small low weight accurate clocks support secondary payloads on satellite constellations for backup-wide area time distribution? Technical questions will cover the performance of such a system as a function of the number of independent clocks, novel technologies for synchronising the constellation time reference, and for distributing the time to end-users.
- Solar system navigation for one-way navigation signals leveraging a common time base. In current solar system navigation, it is common for the spacecraft to echo back a navigation signal transmitted from Earth to accurately measure the spacecraft's distance.

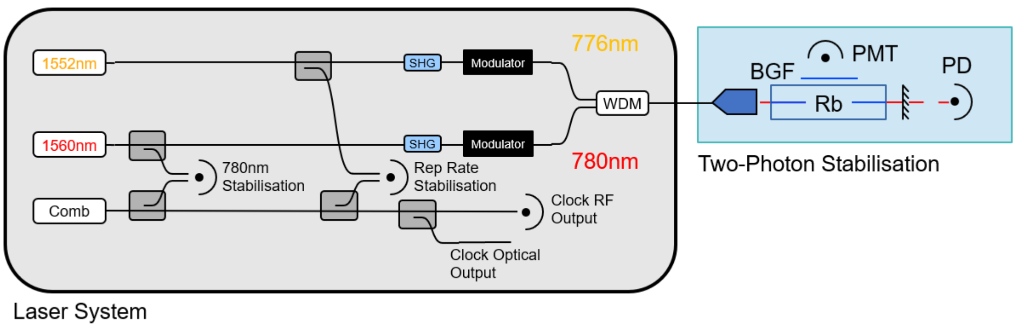
If both the Earth and spacecraft have an accurate common time reference, then only a one-way signal from the Earth is required for measuring distance. This is important for critical spacecraft operations, such as planetary orbit insertion/atmospheric entry.

Scientific space experiments requiring accurate timing. The deliverables of this study will include a detailed market analysis, examining growth sectors and application areas of precision timing as well as a simulation-based analysis to analytically assess whether a more stable space-based clock can meet the demands of the identified applications. The outcome of the simulated results will be a model predicting the performance of the new compact clock when deployed on navigation satellites



Graph of the Allan Deviation showing target stability.





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