Targeted section:

Session E: Instrumentation and technologies for interplanetary missions

Session Chairs:
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Abstract Title: Development of a ruggedized rubidium CPT clock platform

Abstract Text: Since their introduction to the commercial market in 2009, microwave atomic clocks using a Coherent Population Trapping (CPT) approach have provided a smaller size, lower power alternate to Rb lamp clocks. By eliminating several complex assemblies, specifically the lamp and microwave resonator, CPT clocks have been able to leverage economies-of-scale and provide a board-mountable, low-cost atomic clock to applications like handheld test equipment and telecom infrastructure.

More recent iterations of CPT clocks have addressed early technical challenges, such as a reliable and rapid lock acquisition time, as well as integration of low noise electronics to improve overall stability metrics such as Allan Deviation (ADEV), phase noise and temperature stability (TempCo). CPT clock performance now approaches the performance of commercially available lamp technology.

Now, CPT clocks have turned towards ruggedization to meet the demanding environmental and performance requirements of aerospace and defense applications.

This paper discusses the challenges and development of a low-profile Rb oscillator platform that leverages CPT cost, size and power reductions into a ruggedized design. This design is intended to offer a wider temperature range compared to commercial variants by employing a novel approach of integrating a thermo-electric-cooler (TEC) into the Rb cell assembly, with a goal of surpassing a range of -40 to +85°C. The design is also intended to accommodate several options including improved short-term stability (ADEV and phase noise) and radiation tolerance. The latter to be addressed in subsequent projects with an approach similar to products such as the space Chip-Scale Atomic Clock (CSAC), which minimally modifies and screens by lot to achieve radiation goals while maintaining a low cost. The improved short-term stability variant is to be addressed by leveraging the latest in low-power evacuated miniature crystal oscillator (EMXO) technology and integrating it into the control loop. The baseline ADEV performance is anticipated to meet 2E-11 @ $\tau = 1s$, while the low noise variant has a goal of 5E-12 @ $\tau = 1s$ with a phase noise of -95dBc/Hz @ 1Hz. Experimental results and progress will be shared.