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PHARAO'S LASER SOURCE AND CESIUM TUBE FLIGHT MODELS ACHIEVEMENT

Abstract

PHARAO (Projet d'Horloge Atomique à Refroidissement d'Atomes en Orbite), a scientific project funded by the French space agency CNES, and a Hydrogen Maser, are two atomic clocks on board ESA's ACES (Atomic Clock Ensemble in Space) platform which will dock on the International Space Station in 2016.

PHARAO will be the first space atomic clock to use the physical principle of atoms cooling, and thus it will be one of the most accurate and stable clock ever built.

Sodern designed, integrated and tested two main clock equipments, namely the Cesium Tube and the Laser Source.

The Cesium Tube is mainly made of:

- an Ultra-High Vacuum Tube, where the Cs atoms are manipulated
- a magnetic subsystem made of three concentric cylindrical magnetic shields and an active compensation coil

- an optical subsystem with 10 collimators attached to the Ultra-High Vacuum tube and equipped with optical fibres for laser injection towards the Cs atoms.

The Laser Source is composed of:

- a stable optical bench to produce 14 laser beams which are injected into 10 optical fibers
- a set of 14 electronic boards to monitor and control the optical bench.

The flight model of the Cesium Tube was delivered to CNES in February 2013 and the Laser Source was delivered in January 2014. CNES is now integrating and testing the PHARAO clock.

This paper emphasizes some of the challenges encountered during the development of the Cesium Tube and Laser Source flight models. It also gives the main magnetic, optical or thermal performances measured on both equipment during their final acceptance tests.