

# Tests on ground of the Flight Model of the PHARAO Cold Atom Space Clock

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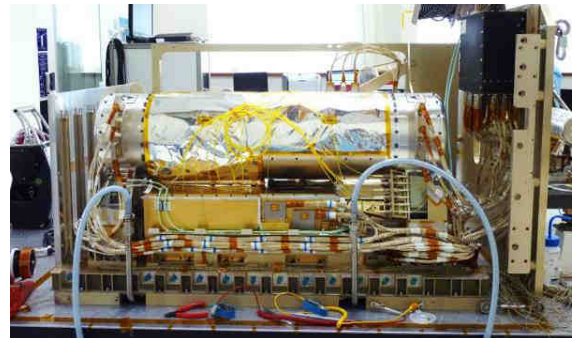
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The PHARAO (Projet d'Horloge Atomique par Refroidissement d'Atomes en Orbite) development entered in the last phase: All the Flight Model (FM) sub-systems have passed the qualification process and the whole FM of the cold cesium clock is now assembled. We start the functional and performance tests. PHARAO is a main instrument of the ESA mission ACES (Atomic Clock Ensemble in Space) [1]. The ACES payload will be installed on-board the International Space Station to perform fundamental space-time experiments with ground based clocks. PHARAO which is being developed by the French space agency CNES, is the first primary frequency standard specially designed for operation in space.

In this talk, we will present the main results obtained during the on ground characterization of the flight model: cold atoms manipulation, operation in the thermal and magnetism environment and metrological evaluation. Although the clock performances cannot be optimized during ground operation, these tests must assess the performances achievable during operation in space. These expected performances are frequency accuracy less than  $3 \cdot 10^{-16}$  and frequency stability of  $10^{-13} \tau^{-0.5}$ .

We also present the operation scenario during the flight. The launch of ACES is scheduled on the second half of 2016.

[1] L. Cacciapuoti and C. Salomon, "Space clocks and fundamental tests: The ACES experiment," *The European Physical Journal Special Topics*, vol. 172, no. 1, pp. 57–68, Jun. 2009



Picture of the PHARAO flight model assembled at CNES, Toulouse, on the ACES baseplate. The clock sub-systems are : Cesium Tube (top), Laser Source (underneath), Microwave Source (underneath on the right) and On-Board Computer (top on the right). Remaining ACES sub-systems (Maser, phase/frequency comparator, computer, links, power supply) will be assembled by Astrium in Germany.