MICROGRAVITY SCIENCES AND PROCESSES (A2)
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THE ACES MISSION: SYSTEM DEVELOPMENT AND TEST STATUS

Abstract

Atomic Clock Ensemble in Space (ACES) is a mission of the European Space Agency (ESA) developed by an industrial consortium led by EADS Astrium Space Transportation. ACES will be testing fundamental laws of physics with high-performance atomic clocks. Operated on-board the International Space Station, the ACES payload will distribute a clock signal with fractional frequency instability and inaccuracy of $1*10^{16}$.

This frequency reference is resulting from the medium-term stability of an active hydrogen maser (SHM) and the long-term stability and accuracy of a primary standard based on samples of laser cooled Cs atoms (PHARAO, developed by the French space agency CNES). The ACES clocks are combined by two servo-loops, the first stabilizing the PHARAO local oscillator on SHM, the second controlling the long-term instabilities of SHM using the error signal generated by the PHARAO Cesium resonator. A link in the microwave domain (MWL) and an optical link (ELT) will make the ACES clock signal available to ground laboratories equipped with atomic clocks, connecting them in a worldwide network. Space-to-ground and ground-to-ground comparisons of atomic frequency standards will be used to test Einstein's theory of general relativity including a precision measurement of the gravitational red-shift, a search for time variations of fundamental constants, and Lorentz Invariance tests. Applications in geodesy, optical time transfer, and ranging will also be supported.

The ACES main instruments and subsystems have now reached an advanced status of development, demonstrated by the completion and the successful test of their engineering models. In particular, a dedicated test campaign has recently verified the performance of the ACES system, where PHARAO and SHM, locked together via the ACES servo loops, are operated as a unique oscillator to generate the ACES frequency reference. The test campaign conducted at CNES premises in Toulouse between July and November 2009 concluded the engineering models phase, releasing the manufacturing of the ACES flight models. The first prototype of the ACES MWL ground terminal is being assembled. The ACES ground segment architecture has been defined. Based on an extension of the standard Columbus USOC (User Support and Operations Center) located in CADMOSToulouse, the ACES USOC will remotely control the network of MWL ground terminals, and provide the necessary interfaces with the Columbus Control Center and the ACES users' community.

The current development status of the ACES mission elements will be presented and discussed.

An overview of future planning will be given.