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ACES OPERATIONS: AN ISS EXTERNAL SCIENTIFIC PAYLOAD LOOKING FOR
EXPERIMENTAL CONFIRMATIONS ON THE GENERAL RELATIVITY THEORY**Abstract**

Aces (Atomic Clock Ensemble in Space) is an ESA mission in fundamental physics based on a new generation of clocks operated in the microgravity environment of the International Space Station. ACES will be launched and installed on the international station Columbus external platform facility in 2020.

The ACES frequency reference is distributed on ground by a microwave link and used to compare distant clocks. These comparisons will allow ACES to perform tests of the Einstein's theory of general relativity including an accurate measurement of the gravitational red-shift, a search for time variations of fundamental constants and tests of the Standard Model Extension. ACES also develops applications in different areas of research including geodesy and Earth observation.

The flight segment, installed on-board the ISS, comprises two atomic clocks: PHARAO, a primary frequency standard developed by CNES and based on laser cooled caesium atoms, and SHM, an active hydrogen maser for space applications. The two clocks are compared and locked one to the other. The on-board time and frequency reference is distributed via a dual-frequency Microwave Link to ground sites situated all over the world.

The ground segment consists of a set of Microwave Link Ground Terminals (MWL GT) installed at ground sites and linked to a local time reference generated by different types of atomic clocks. In addition, an optical laser link between the flight segment and the ground allows performing time and frequency comparisons between the on-board time reference and various Satellite Laser Ranging stations that are coordinated by the European Laser Timing Data Centre.

Currently 8 MWL GT are provided. Six terminals are located at universities or institutes: three in Europe, one in Japan and two in the United States. In addition, 2 mobile terminals are provided to allow fine calibration or some specific experiments.

The planned mission duration is 18 months with the possibility to double it. During the first 6 months, the performances of the PHARAO and SHM clocks in space will be established. The PHARAO target performance is $7 \cdot 10^{-14} \cdot \tau^{-1/2}$ for the frequency stability and 10^{-16} for the frequency accuracy.

CADMOS, the ISS operational control Centre USOC owned by CNES and located in Toulouse, France, is the ACES Mission Control Centre and carries out ACES operations under ESA contract.

This paper presents the detailed operational concept that introduces ACES into the ISS operational process and operates the ACES flight and ground segments.