Hot topic presentation

ACES in orbit

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Atomic Clock Ensemble in Space (ACES) is an ESA (European Space Agency) mission that uses high performance clocks and links to test Einstein's theory of general relativity. From the International Space Station (ISS), the ACES payload will distribute a clock signal with fractional frequency instability and inaccuracy of 1-2×10^{-16} establishing a global network to compare clocks in space and on ground.
On 21 April 2025, ACES was launched to the ISS by a SpaceX Falcon 9 rocket and installed at the external payload facility of the Columbus module (see Fig. 1) using the robotic arm. From the ACES payload, the PHARAO clock, which uses laser cooled cesium atoms, and the active H-maser SHM will be compared to atomic clocks on ground using two time and frequency transfer systems, a link in the microwave domain (MWL) and a pulsed optical link (ELT). Connected to the ground terminals of the ACES MWL, the atomic clocks operated by LTE in France, PTB and Wettzell in Germany, NPL in the United Kingdom, JPL and NIST in the United States, and NICT in Japan are contributing to the ACES clock network. The ACES ground segment is then completed by satellite laser ranging stations (Wettzell, Graz, Herstmonceaux, Potsdam, Zimmerwald, etc.), which connect their clocks to ACES via the ELT optical link.

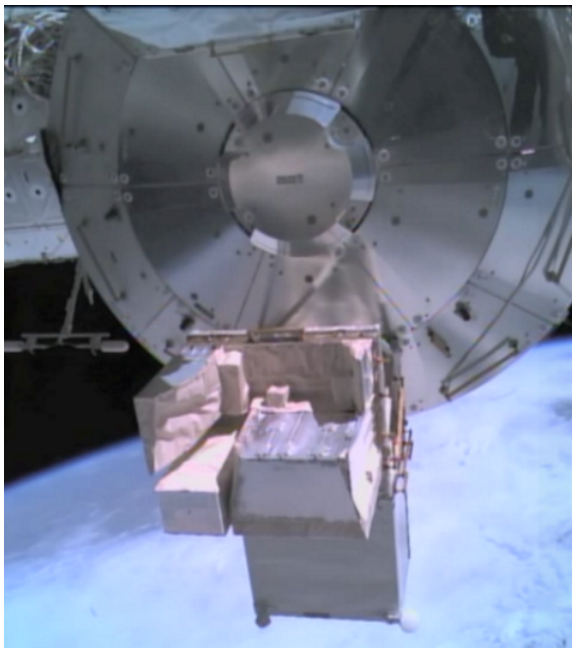

Figure 1: Figure 1: ACES installed at the external payload facility of the Columbus module and pointing towards the Earth (Credits: @ESA-NASA).

With a time instability of a few ps, the ACES microwave link will allow comparing clocks to 1×10^{-17}, opening unique opportunities to test general relativity and constrain dark matter models, but also to develop applications in relativistic geodesy, time & frequency metrology, and timescales distribution.
In this presentation, we will describe the progress on the ACES qualification and preliminary results in orbit.