Application Note
FREQUENCY COMB TECHNOLOGY

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Testing the Weak Equivalence Principle in Parabolic Flight on an Airbus

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Atom interferometers have demonstrated excellent performances in the field of high precision inertial measurements. Foreseen applications include terrain measurements (inertial navigation, geophysics, oil prospection...) and tests of fundamental physics. In this respect we are developing a dual species atom interferometer in order to carry out a test of the Universality of Free Fall (UFF) onboard an aircraft carrying out parabolic flights. We have already demonstrated that it was possible to operate an atom interferometer in an aircraft, reaching very high acceleration sensitivities (up to a few 10^{-5}g) by rejecting the plane's vibration noise. We are now turning to the double species (Rb-K) operation of the setup. A first step was the observation in May 2011 of the first dual-species magneto-optical trap in microgravity. The lasers that interrogate the atoms are stabilized on a fiber-based optical frequency comb, which allows for common-mode frequency noise rejection. More recently, in 2015, the team of Interférométrie atomique à sources Cohérentes pour l'Espace (Atom Interferometry for Space Applications, ICE) successfully operated two simultaneous interferometers of rubidium-87 and potassium-39 which enabled the first test of the weak equivalence principle in a free-falling vehicle. The comb was also successfully tested in flight in 2011 and in 2015 in a more compact version (Airocomb).

Figure 1: Left: The Zero-G-Airbus. Right: Preparations of the experiment before takeoff.

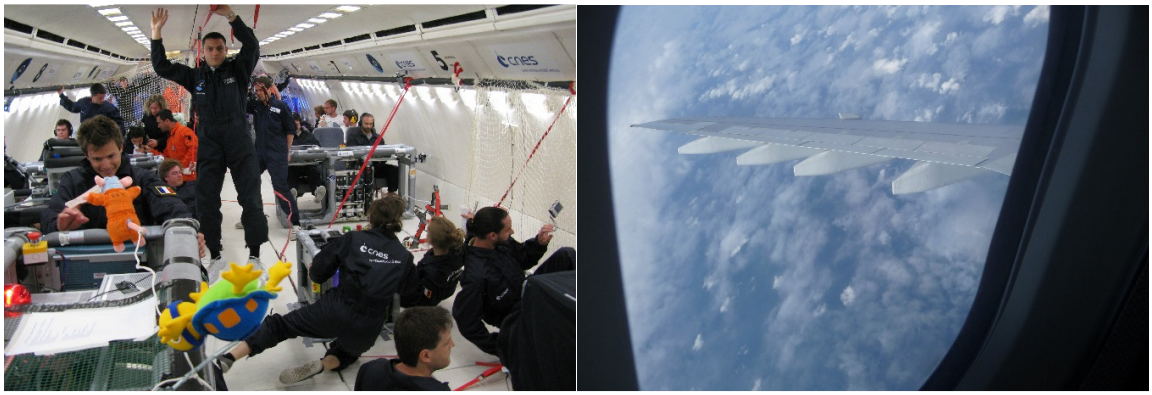

Figure 2: Left: Inside the aircraft during free fall. Right: View out the window during free fall

Videos available online:

- Impressions of the experimental setup mounted in the Airbus before takeoff
- Scientists and experiment floating in zero gravity - as the 2-g acceleration phase starts, the frequency comb remains phase locked
- Clouds through the window of the Airbus

Weblinks:

The Atomic interferometry project:
https://www.coldatomsbordeaux.org/ice

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