Differential accelerometer for equivalence principle tests: the common mode rejection factor and separation of signal from noise

V. Iafolla (1), D.M. Lucchesi (1), S. Nozzoli (1), F. Santoli (1), E.C. Lorenzini (2), I.I. Shapiro (2), J. Ashenberg (2), C. Bombardelli (2), S. Glashow (3)

(1) Istituto di Fisica dello Spazio Interplanetario (IFSI/INAF), Rome, Italy; (2) Harvard Smithsonian Center for Astrophysics, Cambridge, MA, USA; (3) Boston University, Boston, MA, USA

Testing the Equivalence Principle (EP) with an accuracy higher than the present state of the art requires to detect a very small signal out of the instrument's intrinsic noise and to the quite high common mode signals acting on the pair of test masses constituting the differential accelerometer. Usually the rotation of the experiment permits to modulate the violation signal at a frequency separated from other signals with frequencies associated with the motion (orbital or not) of the instrument, carrier and gravity gradients. The possibility to detect the very small violation signal is related with a very high value for the Common Mode Rejection Factor (CMRF) and the separation of the differential signal due to a possible EP violation from the differential signal due to the gravity gradients. Will be presented an experiment, under development by our team (TEPEE/GReAT), to test for a violation of the EP in an Einstein Elevator. Particular emphasis on the experimental activity concerning the implementation of the differential accelerometer, to its CMRF and the indication on the algorithm to separate the signal from noise sources will be given. A numerical simulation of the detector's dynamics in the presence of relevant perturbations, having assumed realistic errors and construction imperfections, will be also presented. In the experiment the detector spins about a horizontal axis while free falling for about 25 s in vacuum inside a comoving capsule released from a stratospheric balloon. A possible EP violation signal of a few parts in 10ˆ15 needs to be extracted from the effects associated with the detector's motion and gravity gradients. The characteristics of the instrument package and the configuration of the detector itself play a key role in the possibility to extract an EP signal at the desired threshold level.