

### **Paris Observatory Lunar Analysis Center: from LLR predictions to tests of fundamental Physics**

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POLAC (Paris Observatory Lunar Analysis Center) is an ILRS analysis centre founded by J. Chapront, M. Chapront-Touzé, and Gérard Francou in 1996. They developed in the 80’s a semianalytical solution of the lunar motion named ELP (Ephéméride lunaires Parisiennes). The original purpose of POLAC was the fitting of ELP to the lunar laser ranging observations (LLR) in order to improve the determination of fundamental astronomical parameters, such as the free modes of the lunar physical librations, the tidal secular acceleration of the lunar longitude, or the transformation between celestial reference systems. Since its beginning, POLAC worked in close collaboration with the laser ranging station at Grasse (MÉO) by providing a posteriori validation of their LLR normal points in order to avoid calibration and format issues. Since 2010, POLAC has evolved. Firstly, it additionally provides a priori predictions for laser ranging observations – mainly for the Moon tracking but also, in an experimental mode, for two ways LRO (Lunar Reconnaissance Orbiter) tracking. Secondly, with the elaboration of a new Lunar ephemeris called ELPN (Ephémérides lunaires Parisiennes numériques), POLAC also takes part to the long legacy of testing fundamental Physics with LLR observations. Indeed, even if ELPN was built originally in the framework of general relativity, it can also be used to test alternative theories of gravity. One of particular interest is the Standard Model Extension (SME) which parametrizes Lorentz Symmetry violations, in the pure gravity sector and also in the matter sector. By fitting ELPN in the pure gravity sector (including operators of mass dimension 4 and 5) and the matter sector of the SME framework to 50 years of collected data, we have been able to provide accurate realistic estimates on possible Lorentz symmetry violations arising at the level of the weak and the strong Einstein equivalence principles.