A NEW SIMULATION CHAMBER FOR STUDYING PLANETARY ENVIRONMENTS. J. A. Martín-Gago[1, 2], E. Mateo-Martí[1], O. Prieto-Ballesteros[1], C. Atienza[3], J. M. Sobrado[1] and J. Gómez-Elvira[1]. [1]Centro de Astrobiología. INTA-CSIC. Torrejón de Ardoz, 28850 Madrid. Spain. (gago@icmm.csic.es). Instituto de Ciencia de Materiales de Madrid (CSIC), Cantoblanco 28049 Madrid, Spain. [3]Tecnovac, 28760 Tres Cantos, Madrid, Spain

Introduction: Nowadays, the study of planetary environments with astrobiological interest has become a major challenge. Planetary objects like Mars and the Europa satellite are among the priority targets for searching biosignatures in our solar system. This is mainly due to the presence of water in any of their phases during the past or present of their geological histories [1,2,3,4]. However, the effect of the environmental parameters at the planet surface, such as radiation, gas pressure or temperature, is critical either for microorganism survival or the preservation of biosignatures [4, 5].

Due to the obvious technical limitations for *in-situ* planetary exploration, laboratory simulations are one of the most feasible research options to get further both in planetary science and in a consistent description of the origin of life. Furthermore, new and updated data arrive constantly from space missions. With this aim in mind, we have built a versatile planetary simulation chamber able to computer-control gas composition in the atmosphere and sample temperature for most of the solar system planets. Our equipment has been especially developed to make feasible *in-situ* irradiation and characterization of the sample. Therefore it allows for recording chemical changes in a given sample upon gas environment, temperature and radiation dose. For this purpose we include irradiation sources as UV-photons, ions and electrons, and the implementation of analytical techniques like IR and UV spectroscopy.

Technical description: To fully achieve this ambitious objective we had to overcome some technical difficulties. The system we have built consists of an ultra-high vacuum (UHV) chamber 500 mm long by 400 mm diameter with standard CF flanges and fittings (see figure 1). Several flanges have been left available for future developments. The desired gases are mixed in a many-fold to the required proportion, controlled each by individual fluxmeters. Gas composition is constantly monitorized by a residual gas analyzer spectrometer, which fixes the desired partial pressure of a particular gas by acting on its corresponding fluxmeter. Temperature at the sample is regulated by a Helium cooling system connected to the sample holder. Irradiation by different sources can be performed at Mars pressures (mbar range) by means of a performante differential pumping stage, which assure the correct working conditions at the irradiation source. A water partial pressure can be also set and regulated. Samples are mounted horizontally in order to allow the study of low cohesive material. Crystals, soils, rocks and minerals are among the possible samples that can be introduced.

Summary of the technical specifications:

- Total pressure range from 5 mbar to $5x10^{-9}$ mbar. Partial pressure of the gasses can be set with this precision.
- Temperature range from 4K to 325K
- Gas composition is regulated via a residual gas analyzer with ca ppm precision
- Sample size range from 5 to 35mm
- Available irradiation sources: up to 5 KV-ions (ions) 5 KV-electrons, Deuterium UV lamp and noble-gas discharge UV.
- Analysis techniques: UV spectroscopy, infrared spectroscopy

At this moment, the experimental system has been optimized and tested for three standard planetary environments:

a) Mars surface: 7 mbars are used as the average atmospheric pressure of the planet, temperature cycles are programmed from 150 to 280K, and a composition of the atmosphere of 95%CO_2, 2,7% N_2, 1.6% Ar and 0.6% H_2O. UV radiation environment is taken from the deuterium lamp from 200 to 400 nm.

b) For studies on the surface of the satellite Europa, 10^{-8} mbar just from O_2 in the atmosphere and temperature ranging from 86 to 146 K are being used. The radiation environment is reproduced including ion and electron sources.

c) Triton conditions have also been developed as one technically extreme environment because the circumstance of relative low pressure (10^{-2} mbar, from 93% N_2, 4%CO and 3% CH_4) and very low temperatures. Although Triton does not have any evident interest for astrobiology, it deserves attention from a geological point of view.

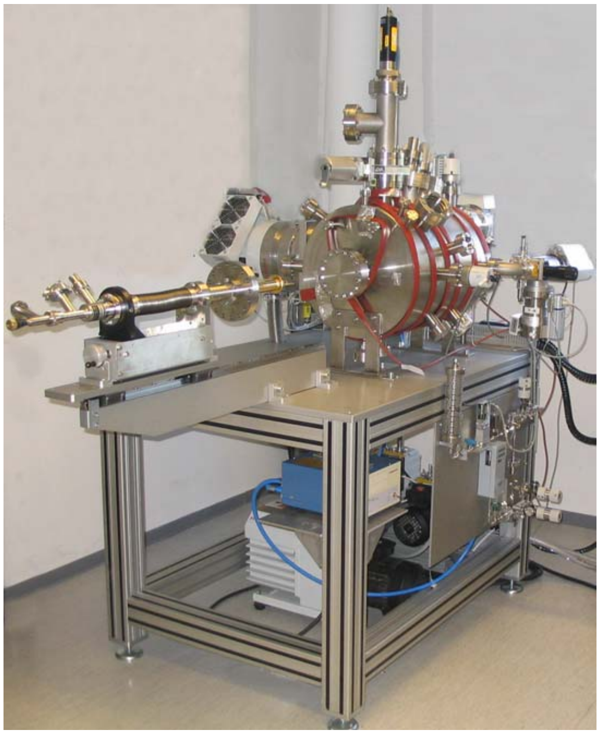

Figure 1: Photograph of the experimental system for planetary environmental studies.

Future Perspectives: The flexibility of this experimental set-up makes feasible many different types of experiments, both from geological and astrobiologycal point of view. Particularly, phisico-chemical changes induced in astro-materials and in microorganisms imbibed on it, and the behavior of bio-products in extreme planetary environments would be among the more suitable investigations.

Summary: The flexibility of this simulation chamber to reach different planetary conditions (partial pressure and temperature) and the possibility to adapt different in-situ irradiation and analytical techniques results in a unique instrument for Astrobiological and Planetary studies, that will be open for applications to the whole scientific community.

References:

[1] Horneck, G (2000). *Planet. and Space Sci.* 48 (11), 1053-1063. [2] McKay, C. P (1997). The search for life on Mars. *Orig. Life Evo. Bioph*. 27, 263-289. [3] Marion, G. M. et al. (2003) *Astrobiology,* 3 (4) 785-811. [4] Chyba, F. C. and Phillips, C. B. (2001) *PNAS, 98,* 801-804. [5] Patel, M. R. et al. (2004). *Adv. Space Res.* 33 (8), 1247-1252.