JOINT EUROPA MISSION (JEM). A MULTISCALE STUDY OF EUROPA TO CHARACTERIZE ITS HABITABILITY AND SEARCH FOR EXTANT LIFE. O. Prieto-Ballesteros[1], M. Blanc[2], N. André[2], J. Gómez-Elvira[1], G. Jones[3], V. Sterken[4], D. Mimoun[5], A. Masters[6], Z. Martins[6], E. Bunce[7], W. Desprats[2], P. Garnier[2], G. Choblet[8], V. Lainey[9], F. Westall[10], T. van Hoolst[11], A. Jäggi[12], L. Iess[13], A. Longobardo[14], F. Tosi[14], P. Hartogh[15], K. Stephan[16], R. Wagner[16], N. Krupp[15], J. Cooper[17], B. Bills[18], K. Hand[18], S. Vance[18], R. Lorenz[19], K. Khurana[20], S. Kempf[21], G. Colins[22], E. C. Sittler[17], K. Szegő[23], M. Wolwrck[24] and the JEM team. [1]CAB-CSIC-INTA, Spain (prietobo@cab.inta-csic.es). [2]IRAP, France (michel.blanc@irap.omp.eu). [3]MSSL/UCL, UK. [4]ISSI, Switzerland, [5]ISAE, France. [6]Imperial College, UK. [7]U. Leicester, UK. [8]U. Nantes, UK. [9]IMCCE, France. [10]CBM, France. [11]ROB, Belgium. [12]AIUB, Switzerland. [13]Univ. Roma La Sapienza, Italy. [14]IAPS, Italy. [15]MPS, Germany. [16]DLR, Germany [17]Goddard Space Flight Center, USA. [18]Jet Propulsion Laboratory, USA. [19]APL/JHU, USA. [20]UCLA, USA. [21]LASP, Univ. Colorado, USA. [22]Wheaton Colleage, USA. [23]WIGNER, Hungary. [24]IWF, Austria.

Introduction: We propose that ESA works with NASA, which presently leads the way towards in situ exploration of Europa, to design and fly jointly an ambitious and exciting planetary mission to search for signatures of life in Europa. In this sense, the Joint Europa Mission (JEM) proposal was submitted to the ESA M5 call last October 2016, and is now under study.

Scientific goals of JEM: Overarching goal of JEM is "Understand Europa as a complex system responding to Jupiter system forcing, characterize the habitability of its potential biosphere, and search for life in its surface, sub-surface and exosphere."

We suggest to address these goals by a combination of five Priority Scientific Objectives (PSOs):
PSO#1: Characterize the Europan magnetic field and plasma environment; PSO#2: Determine the global structure of the solid body and potential biosphere of Europa, and their response to Jupiter System tidal forcing; PSO#3: Understand the exchange and transformation processes at the interface between the ice-shell surface/subsurface and the exosphere/ionosphere including potential plume characterization; PSO#4: Understand the exchange processes between the ice-shell surface/subsurface and the potential habitable zone; PSO#5: Search for biosignatures at the surface / subsurface. It is primary focused on local scale studies on a landing site where fresh and young material will be expected, coming from the near surface or even from the plumes, if they are detected. In near-surface investigations, direct sampling and contact analysis instruments are absolutely necessary since the concentration of bio-signatures is assumed to be very low. JEM will equiped to analyse chemical biosignatures in the solid or liquid phase if any. The necessary state of the sample is conditioned by the biosignature typology and the technique used for its recognition. Besides near-surface science, JEM also foresees the possibility of detecting bio-signatures of extant life in the exosphere and potentially in plumes, whose several occurrences have recently been reported.

We derived from our science objectives a carefully selected science payload for the lander and for the orbiter (see abstract by Gomez-Elvira et al. for details about instruments related to Astrobiology).

Mission strategy: Our observation strategy to address them will combine three types of scientific measurement sequences: I) measurements on a high-latitude, low-latitude Europan orbit providing a continuous and global mapping of planetary fields (magnetic and gravity) and of the neutral and charged environment during a period of three months; II) in-situ measurements to be performed at the surface, using a soft lander focusing on the search for bio-signatures at the surface and sub-surface by analytical techniques in the solid and liquid phases, and on the operation of a surface geophysical station whose measurements will ideally complement those of the orbiter; III) and measurements of the chemical composition of the very low exosphere in search for biomolecules originating from the surface or sub-surface, to be performed near the end of the mission during the final descent phase.

The implementation of these three observation sequences will rest entirely on the combination of two science platforms equipped with the most advanced instrumentation: a soft lander to perform all scientific measurements at the surface and sub-surface at a selected landing site, and an orbiter to perform the orbital survey and descent sequences. In this concept, the orbiter will also provide for the lander the vital functions of carrier, with the objective of carrying the lander stack from the Earth to a Europan orbit on which it will release it before its descent, and of data relay during the lander operations. Using its own instrument platform, it will perform science operations during the relay phase on a carefully optimized halo orbit of the Europa-Jupiter system, before moving to its final Europan science orbit for three months.