POSSIBLE CONCEPTS FOR AN *IN SITU* SATURN PROBE MISSION. A. Coustenis[1], J.-P. Lebreton[2], O. Mousis[3], D. H. Atkinson[4,5], J. I. Lunine[6], K. Reh[5], L. Fletcher[7], A. Simon-Miller[8], S. Atreya[9], W. Brinckerhoff[8], T. Cavalié[10], A. Colaprete[11], D. Gautier[1], T. Guillot[12], P. Mahaffy[8], B. Marty[13], A. D. Morse[14], J. Sims[5], T. Spilker[15], L. Spilker[5], C. Webster[5], J. H. Waite[16], P. Wurz[17], [1] LESIA, Observatoire de Paris, CNRS, UPMC, Univ. Paris-Diderot, 5, place Jules Janssen, F-92195 Meudon Cedex, France, athena.coustenis@obspm.fr, [2] LPC2E, CNRS-Université d'Orléans, 45071 Orléans Cedex 2, France, [3] UTINAM, Université de Franche-Comté, Observ. Besançon, France, [4]University of Idaho, Moscow ID 83844-1023, USA, [5]NASA Jet Propulsion Lab / California Institute of Technology, Pasadena, CA 91109, USA, [6]Cornell University, Ithaca, NY 14853, USA, [7] AOPS, University of Oxford, Oxford OX1 3PU, UK, [8]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA, [9]University of Michigan, Ann Arbor, MI 48109-2143, USA, [10] Max-Planck-IfS, 37191 Katlenburg-Lindau, Germany, [11]NASA Ames Research Center, Mountain View, USA, [12]Observatoire de la Côte d'Azur, France, [13]RPG-CNRS, Nancy-Université, 54501 Vandoeuvre-ls-Nancy, France, [14]PSS, The Open University, Milton Keynes MK7 6AA, UK, [15]Solar System Science & Exploration, Monrovia, USA, [16]SwRI, San Antonio, TX 78228, USA, [17] SSP, University of Bern, 3012 Bern, Switzerland.

Introduction : *In situ* exploration of Saturn's atmosphere would bring insights in two broad themes: the formation history of our solar system and the processes at play in planetary atmospheres. The science case for *in situ* measurements at Saturn are developed in [1] and two companion abstracts (see Mousis et al., and Atkinson et al.). They are summarized here. Measurements of Saturn's bulk elemental and isotopic composition would place important constraints on the volatile reservoirs in the protosolar nebula and hence on the formation mechanisms. An *in situ* probe, penetrating from the upper atmosphere (µbar level) into the convective weather layer to a minimum depth of 10 bar, would also contribute to our knowledge of Saturn's atmospheric structure, dynamics, composition, chemistry and cloud-forming processes.

Mission concepts : Different mission architectures are envisaged, all based on an entry probe that would descend through Saturn's stratosphere and troposphere under parachute down to a minimum of 10 bars [1]. Future studies will focus on the trade-offs between science return and the added design complexity of a probe that could operate at pressures greater than 10 bars. Accelerometry measurements may also be performed during the entry phase in the higher part of the stratosphere prior to starting measurements under parachute. A carrier system would be required to deliver the probe along its interplanetary trajectory to the desired atmospheric entry point at Saturn. The entry site would be carefully selected.

Three possible mission configurations are currently under study (with different risk/cost trades):

• *Configuration 1*: Probe + Carrier. After probe delivery, the carrier would follow its path and be destroyed during atmospheric entry, but could perform pre-entry science. The carrier would not be used as a radio relay, but the probe would transmit its data to the ground system via a direct-to-Earth (DTE) RF link;

• *Configuration 2*: Probe + Carrier/Relay. The probe would detach from the carrier several months prior to probe entry. The carrier trajectory would be designed to enable probe data relay during over-flight as well as performing approach and flyby science;

• *Configuration 3*: Probe + Orbiter (similar to the Galileo Orbiter/Probe). As for Configuration 2, but after probe relay during over-flight, the orbiter would transition to a Saturn orbit and continue to perform orbital science.

In all three configurations, the carrier/orbiter would be equipped with a combination of solar panels, secondary batteries and possibly a set of primary batteries for phases that require a high power demand, for example during the probe entry phase. Nuclear power would be considered for the carrier or the orbiter only if available solar power technology would be found to be infeasible.

Payload: To match the measurement requirements, a model payload could include a mass spectrometer, a tunable laser system, a helium abundance detector, an atmospheric structure instrument, accelerometers, temperature sensors, pressure profile, Doppler wind and nephelometer instruments, etc.

Such a mission would greatly benefit from strong international collaborations.

References

[1] Mousis, O., et al. 2014, "Scientific Rationale of Saturn's in situ exploration", submitted to *Plan. Space Sci.* (and references therein).