

SPACE SYSTEMS SYMPOSIUM (D1)  
Innovative and Visionary Space Systems Concepts (1)

Author: Mr. Konstantinos Konstantinidis  
Universität der Bundeswehr München, Germany, k.konstantinidis@unibw.de

Prof.Dr. Roger Förstner  
Universität der Bundeswehr München, Germany, roger.foerstner@unibw.de

CUBALLUTE: A CUBESAT MISSION TO DEPLOY AN INFLATABLE HYPERSONIC DRAG BODY  
(BALLUTE) IN THE MARTIAN ATMOSPHERE

**Abstract**

Cuballute is an interplanetary Cubesat mission concept to probe the tenuous upper layers of the Martian atmosphere and high altitude landing sites on Mars such as Tharsis, by means of a hypersonic drag balloon, a device known as a “Ballute”. The Ballute itself and concepts to deploy it on Mars have been under active development for the past years by the Mars Society Germany and the Bundeswehr University Munich in the context of the ARCHIMEDES programme. MIRIAM-2, a technology demonstration mission scheduled for launch in 2014 will deploy a Ballute in the Earth’s upper atmosphere using a sounding rocket. Cuballute aims to fulfill part of the science goals of ARCHIMEDES at the lower costs associated with the Cubesat template. The Cuballute bus is based on that of the Interplanetary Cubesat template as developed at JPL by R.L. Staehle et al.: Cuballute is a 6U CubeSat with 2U taken up by the solar sail propulsion module based on the 6 x 6 m Planetary Society/Stellar Exploration LightSail, 1U by the Laser Telecommunications Module currently under development at JPL and 1U by satellite housekeeping based on the avionics of the Calpoly CP7 and JPL COVE Cubesat missions. The remaining 2U are reserved for the Cuballute payload: 1U for the Ballute and its inflation system and 1U for the scientific instrument suite that will be attached to the Ballute. The instruments will be selected and adapted from the instrument list considered for the QB50 cubesat atmospheric science mission. During this study several mission architectures were considered, including deploying the Ballute during a Mars flyby, capturing in a Mars orbit and deploying the Ballute, and using “piggyback” communications through spacecraft already in Mars orbit. The diameter of the Ballute and the weight of the scientific payload were traded-off with respect to the required deceleration profile in the Martian atmosphere. Solar sail trajectories were designed for various launch scenarios (launch to GEO, Earth escape) and sail sizes using the InTrance software developed in DLR. The trajectory of the Ballute in the Martian atmosphere was modeled using the MARSGRAM model. The results showed that Cuballute is a feasible, low-cost, high-science return mission, based on technologies that are heritage or currently under active development. A Ballute Cubesat payload according to this concept could potentially be repurposed for further applications in Cubesats, such as low Earth orbit recovery, passive deorbiting and aerobraking.