An overview of deployers used in CubeSats missions

Erica Generoso Lima[1], Silvio Manea[2] and Willer Gomes dos Santos[3]

1. Graduate student, Space Engineering and Technology, National Space Research Institute, São José dos Campos, São Paulo, Brazil
2. Professor, Space Engineering and Technology, National Space Research Institute, São José dos Campos, São Paulo, Brazil
3. Professor, Aerospace Systems Department, Aeronautics Institute of Technology, São José dos Campos, São Paulo, Brazil

Abstract — The deployer is an electromechanical device whose main objective is jettisoning the CubeSats of different configurations. This device was developed to meet the need for academic projects, which aims to manufacture them at low cost and complexity. Over time, several types of deployers have been developed, making it possible to eject CubeSats from launch vehicles and also by the International Space Station. Given the importance of its use, this article presents an overview of CubeSats launches and deployers in space missions until the year 2020, in order to identify the technology adopted in the most used deployers.

I. INTRODUCTION

In a global context, with the advancement of space exploration, the introduction of satellite miniaturization has become essential for reducing the costs of space missions [1]. With this proposal of decreasing the dimensions and mass of the satellite, the California Polytechnic State University (Cal-Poly), the San Luis Obispo University in partnership with the Stanford University's Space Systems Development Laboratory (SSDL) developed, in 1999, a standard design model for the class of picosatellites, in the order of 0.01-1 kilograms and with dimensions of a cube of 10 x 10 x 10 cm, denominated as CubeSat [2]. The CubeSat standard is composed of a cubic unit with a 1U CubeSat notation, enabling formation with fewer or more components, ranging from 0.5U to 16U, and can be included in the class of nanosatellites, in the order of 1-10 kilograms, according to the Refs. [3], as illustrated in Fig. 1.

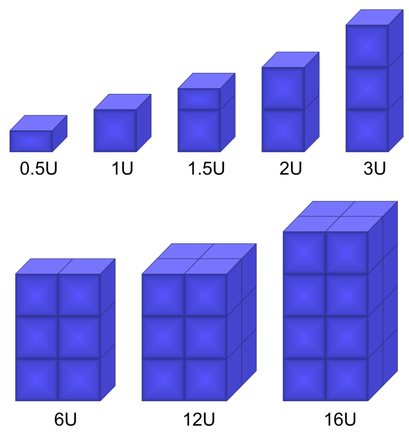

Fig. 1. The standard of size and shape of CubeSats. Adapted from [3].

This new satellite configuration allows the accessibility of studies in the aerospace sector, providing the interest of public, private, and academic institutions, the opportunity to experience the conception of a full cycle of the space mission that meets the needs of a space research [4].

As described in [5], CubeSats are launched, generally, as a secondary payload, that is, together with one or more satellites of greater volume that make up the primary payload in a launch vehicle and released into space, by a process called jettisoning. To place the CubeSat in its orbit, it is essential to use an electromechanical device, called deployer [6], which acts as an interface between the satellite and the launch vehicle. Another alternative for orbitalization is through the Japanese experimental module JEM (Japanese Experimental Module), known as "Kibo", which is integrated into the International Space Station (ISS).

Problem Definition

In view of this perspective, a general analysis of deployers applied in the CubeSats missions has been described in this paper. An additional objective was to gather and present the models of deployers available on the market, observing the difference in technologies between them.

II. CUBESAT DATABASE

The database for the realization of this work contains information on the space missions, launched from 2000 to 2019, that have succeeded with the application of CubeSats and their respective deployers. This collection has been used for the processing of statistical data that were extracted from several references [7], [8], [9], [10] and [11].

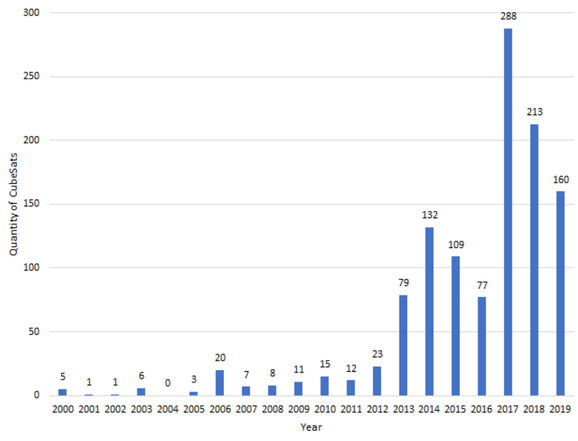

Fig. 2. Distribution of CubeSats per year.

IV. ANALYSIS OF DEPLOYERS

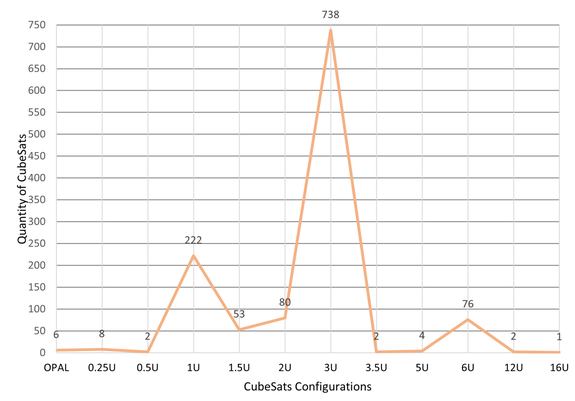

Fig. 3. Distribution of the CubeSats configurations by deployer.

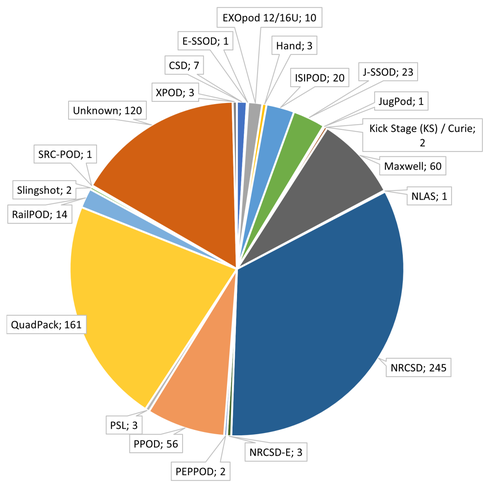

Fig. 4. Deployers in 3U CubeSats configuration.

V. TECHNOLOGY DIFFERENCE BETWEEN THE MOST USED DEPLOYERS

TABLE I
DEPLOYERS IN 3U CUBESATS CONFIGURATIONS.

3U CubeSats Configurations				
CSD	0,95%		NRCSD-E	0,41%
E-SSOD	0,14%		PEPOD	0,27%
EXOpod 12/16U	1,36%		PPOD	7,59%
Hand	0,41%		PSL	0,41%
ISIPOD	2,71%		QuadPack	21,82%
J-SSOD	3,12%		RailPOD	1,90%
JugPod	0,14%		Slingshot	0,27%
Kick Stage (KS) / Curie	0,27%		SRC-POD	0,14%
Maxwell	8,13%		Unknown	16,26%
NLAS	0,14%		XPOD	0,41%
NRCSD	33,20%			

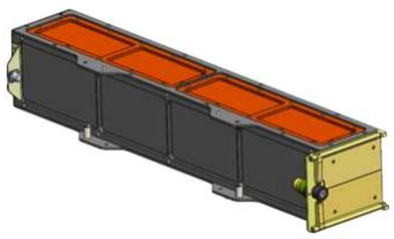

Fig. 5. Deployer NRCSD [12].

VI. CONCLUSION

Given the importance of using deployers to perform the CubeSats ejection into orbit elements according to each project and mission, the present work presented an overview of all the deployers used in the CubeSats missions, from the year 2000 to 2019 and the technology difference of the most used deployers. There was an increase in CubeSats missions that adopted the 3U configuration, as well as the most used model was the NRCSD model. Therefore, this work presents consistent theoretical basis that allows an overview of the projects of deployers that aim to meet the same objectives.

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