

**IAA-BR-16-0S-0P****CubeSat Frame Design - Petal Model**

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This summary deals with the development of a modular structure with conceptual focus on the disposal of PCBs (printed circuit board) in a CubeSat, where instead of the traditional format in which the cards are stacked inside, the electronic boards are positioned in the hub side in order to achieve greater internal space for payloads, as well as facilitating the access of PCBs during assembly and testing. This concept was titled as "petal model." The proposed structure was created according to the needs of the various groups taking part in the project. The modeling of the structure was carried out through a graphical modeling software where we adapted our concept according to the international standard specification for CubeSats. The parameters verified were weight, dimensions and materials, amongst others. Throughout the development, several prototypes were built in order to verify the technical feasibility of the proposal, enabling improvements to be incorporated in the structure. Comparisons of design and payload volume between the model and the current model were held. From this study it becomes clear that it is an interesting model and very competitive in the conceptual aspect, but for the reliability of that there is the need for further studies such as vibration, thermal and efforts.

**Introduction**

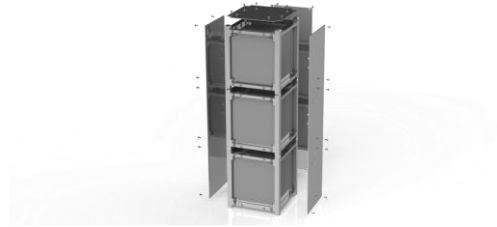
The objective of this project was to develop and build a structure of CubeSat to comply with the requirements of the international regulation of CubeSats [1], make better use of possible internal space, seek modularity which provides mounting of n-units (1U, 2U, ...), as shown on Fig. 1, which external fixation plates are responsible for unite the different units. The electronic boards (PCBs) were fixed in the faces of the cube and not stacked inside it, the idea arose from satellite COROT project analysis, aiming to facilitate the mounting and testing steps.

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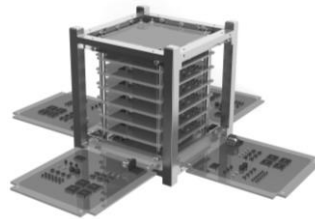
**Fig. 1 - IMTSat 3U**

## Development

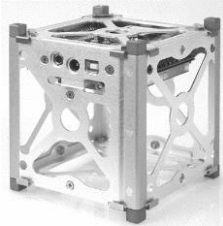
Aiming to meet the proposed objective and to demonstrate the advantages and disadvantages of the petal project, the characteristics of IMTSat (Fig. 2 and Fig. 3) were compared with two other commercial CubeSats, CubeSat Kit (Fig. 4) [2] and CubeSat Shop (Fig. 5) [3].



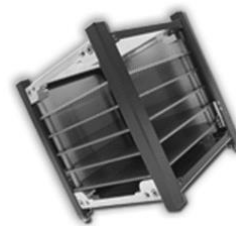
**Fig. 2 - Assembled IMTSat**



**Fig. 3 - IMTSat petal model**



**Fig. 4 - CubeSat Kit**



**Fig. 5 - CubeSat Shop**

Comparing the mass of the three analyzed cubes was observed that the IMTSat has the largest mass as listed on Tab. 1.

Mass [g]	IMTSat	CubeSat Shop	CubeSat Kit
PSM <sup>2</sup>	165	100	-
SSM <sup>3</sup>	340	200	243

**Tab. 1 – Comparison of masses**

<sup>2</sup> Primary Structure Mass (PSM) : Side frames, top frames

<sup>3</sup> Secondary Structure Mass (SSM) : Aluminium shear panels, PCB stacking elements, PCB side elements, PCB top elements

However, when comparing the usable area between the three analyzed cubes, it can be seen that the IMTSat has a larger area compared to the other (about 27% compared to the CubeSat Shop and 30% to the CubeSat Kit) as listed on Tab. 2.

	IMTSat	CubeSat Shop	CubeSat Kit	Unit
PCB stacking	73x73	94x94	96x90	[mm]
Stacking area	5329	8836	8640	[mm <sup>2</sup> ]
N° of stacking elements	5	5	5	-
PCB side	75x75	-	-	[mm]
Side area	5625	-	-	[mm <sup>2</sup> ]
N° of side elements	4	-	-	-
PCB top	60x60	-	-	[mm]
Top area	3600	-	-	[mm <sup>2</sup> ]
N° of top elements	2	-	-	-
<b>Total Area</b>	<b>56345</b>	<b>44180</b>	<b>43200</b>	[mm <sup>2</sup> ]

**Tab. 2 – Usable area 1U**

## Conclusion

Considering the comparisons was possible to conclude that the IMTSat structure petal model has a total usable area larger than the other compared models, and this way was possible to utilize the wasted area in the other models, leaving interior space to be used as payload. The proposed structure still new, but proves to be competitive in the market by allowing greater use of usable area, with only the necessity of mass optimizing the structure.

## Bibliography

- [1] Cal Poly, "CubeSat org," 20 02 2014. [Online]. Available: [http://www.cubesat.org/images/developers/cds\\_rev13\\_final.pdf](http://www.cubesat.org/images/developers/cds_rev13_final.pdf). [Accessed 01 2016].
- [2] "CubeSat Kit," 08 2007. [Online]. Available: <http://www.cubesatkit.com/docs/cubesatkitsystemchart.pdf>. [Accessed 01 2016].
- [3] "CubeSat Shop," ISIS, 2010. [Online]. Available: [http://www.isispace.nl/brochures/ISIS\\_CubeSat%20Structures\\_Brochure\\_v.7.11.pdf](http://www.isispace.nl/brochures/ISIS_CubeSat%20Structures_Brochure_v.7.11.pdf). [Accessed 01 2016].