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Chen, Kangkang; Meindl, Michael; Rothacher, Markus; Kreiliger, Flavio; Styger, Erich; Joss, Marcel; De Florio, Sergio; López Gilabert, Lola

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## **A GNSS PAYLOAD WITH COMMERCIAL-OFF-THE-SHELF RECEIVERS FOR CUBESAT PRECISE ORBIT DETERMINATION**

Kangkang Chen<sup>1</sup>, Michael Meindl<sup>1</sup>, Markus Rothacher<sup>1</sup>, Flavio Kreiliger<sup>2</sup>, Erich Styger<sup>2</sup>, Marcel Joss<sup>2</sup>, Sergio De Florio<sup>3</sup>, López Gilabert<sup>3</sup>

<sup>1</sup> *ETH Zurich, Institute of Geodesy and Photogrammetry, Switzerland*

<sup>2</sup> *Lucerne University of Applied Sciences and Arts, Switzerland*

<sup>3</sup> *Astrocast, Switzerland*

Global Navigation Satellite Systems (GNSS) have been used as a key technology for satellite orbit determination since many years ago. In view of the increasing popularity of miniaturized satellites (e.g. CubeSats), we developed a small-sized versatile GNSS payload board for orbit determination using commercial-off-the-shelf single-frequency GNSS receivers with extremely small weight, size and power consumption. The board features two separate antenna connectors and four GNSS receivers—two per antenna. This redundancy lowers the risk of total payload failure in case one receiver malfunctions.

Two prototypes of the GNSS positioning board have been successfully launched onboard the Astrocast-01 and -02 3-unit cube satellites with altitudes of 575 and 505 km, respectively. The multi-GNSS receivers are capable of tracking the GNSS satellites from four major systems, i.e., GPS, GLONASS, BeiDou and Galileo. In addition, both satellites are equipped with an array of three laser retroreflectors enabling orbit validation with satellite laser ranging (SLR).

First real-time orbit results using GPS only indicate that the receivers perform very well on both satellites. The RMS of the 1-day orbit fits is at the level of 2-5 meters after removing a few outliers despite errors caused by the ionosphere and the orbit model. In the next few months, we will compare the accuracy of the real-time orbits derived using different GNSS, download raw code and phase measurements for a post-processing using the graphics linear combination (sub-meter accuracy expected) and validate the orbits with SLR. The results achieved in these experiments will be shown.