VT ThickSat: A Scalable Chassis in the ThinSat Program

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I. Background

Virginia Tech was asked to extend a flexible carbon fiber boom structure in space and verify deployment. The mechanism seen in Figure 1 and the camera assembly occupied the space of roughly a 1U-sized cubesat, but the satellite only needed to operate for a day to complete the mission. This amplified the effect of cost on achieving mission success.

The ThinSat program was conceived to lower the cost of space access for K-12 classes, so students can send payloads on a high-altitude balloon and then to space for short-duration experiment missions.[1] The satellites are joined into a stack and deployed as a group. As can be seen in Figure 2, the vehicle chassis are approximately one sixth the thickness of a 1U cubesat. This unit is called a 1T.[2]

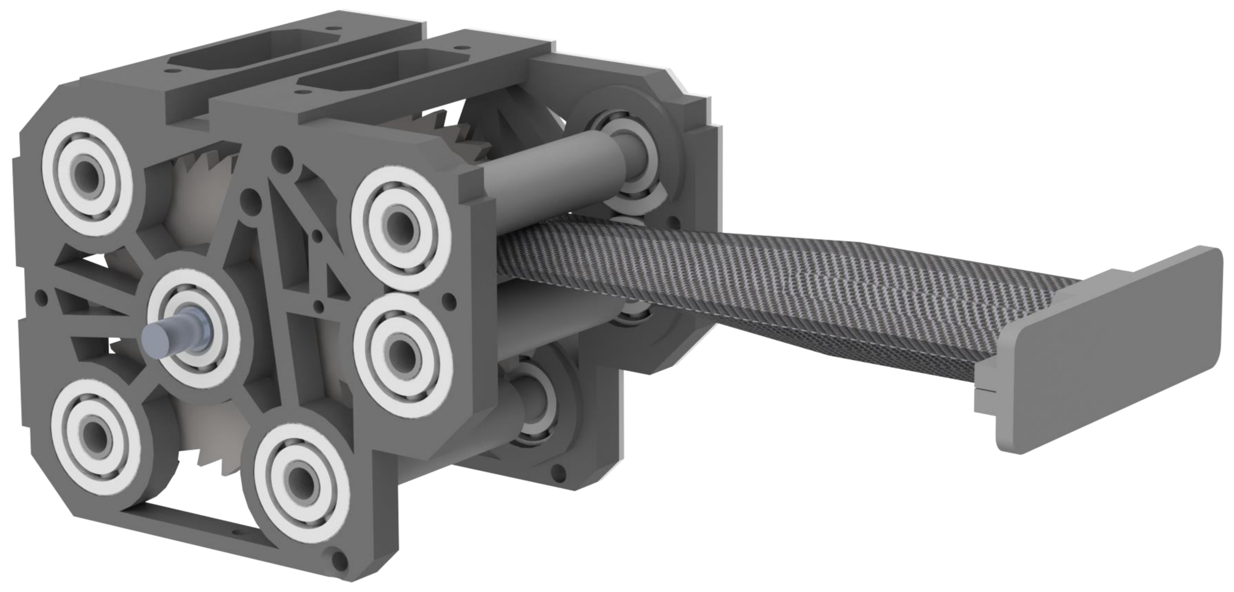

Figure 1: Flexible boom deployment mechanism

II. Requirements

The chassis was required to be constructed from billet aluminum, of either 6061-T6 or 7075-T6. Where the external requirements dictated the maximum allowable size, shape, and material, the internal requirements were purely focused on functionality and integration with the other subsystems. The use of the spool and rollers necessitated an entirely open center cavity.

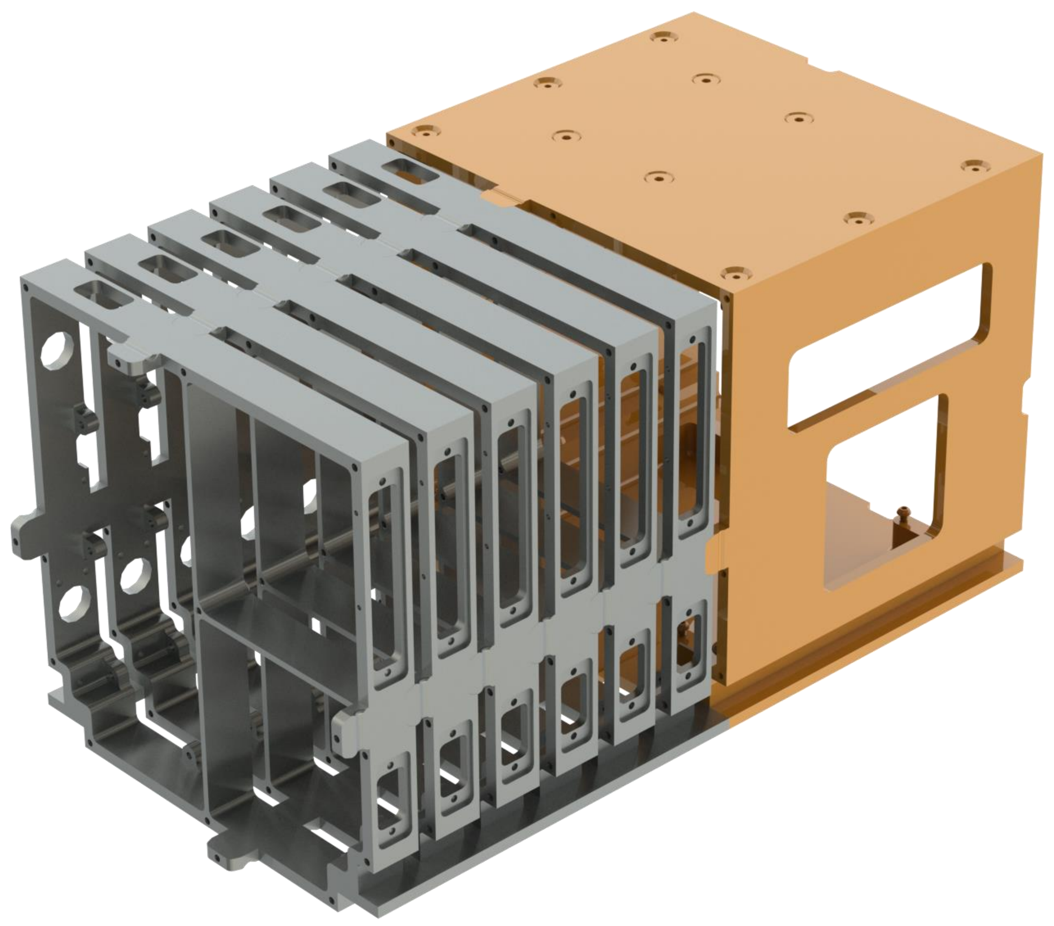

Figure 2: ThinSat stack in deployment configuration with normal 1T chassis (gray) and the Virginia Tech 6T chassis (orange)

III. Design and Manufacturing

Figure 3: Waterjet cutting failure with uneven dimensions

Initially, machining was attempted with a waterjet. This failed, as seen in Figure 3, when the jet deviated, cutting into the wall of the chassis.[3] This led to designing a multi-part assembly instead of attempting to build as a single piece. The move to multi-part also eliminated the original "5T+1T" architecture, allowing the team to start from a clean sheet 6T design.

Each chassis example machined cost $1490.00. This is more expensive than a 1U cubesat chassis from a company such as Pumpkin Space Systems, which sells a solid wall 1U for $925.00, but the custom chassis contains all the features needed to perform the mission, whereas the Pumpkin chassis needs further modification to integrate well with the other subsystems.[4]

Test assembly will be carried out prior to launch at Virginia Tech facilities, and final integration completed at Twiggs Space Lab and Northrop Grumman assembly labs. Having a test chassis will fulfill the education aspect of the program and serve as a future reference for engineering students.

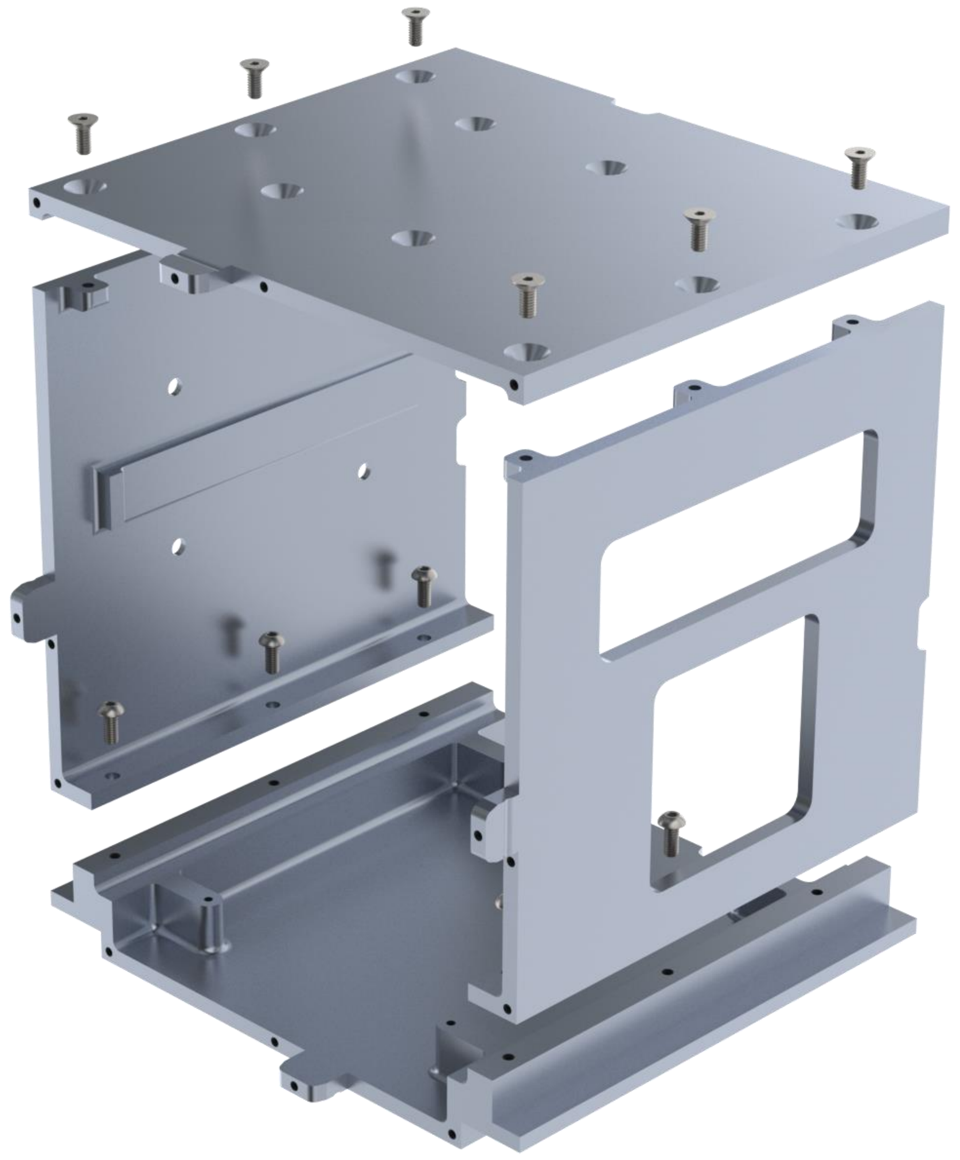

Figure 4: Exploded view of ThickSat chassis assembly

IV. Conclusions

The successful expansion of the ThinSat architecture has many useful applications. This represents a more flexible paradigm for small satellites, especially when testing components prior to flight on larger, more complex vehicles. Access to a low-cost, scalable platform that can rapidly return useful information is crucial to the rapid prototyping future of space.

The development of this flexible platform also has implications for educational institutions. A low-risk, low-cost option that can be turned from concept to completed vehicle in an academic year can pave the way for a robust development of talent in the industry at a young age.

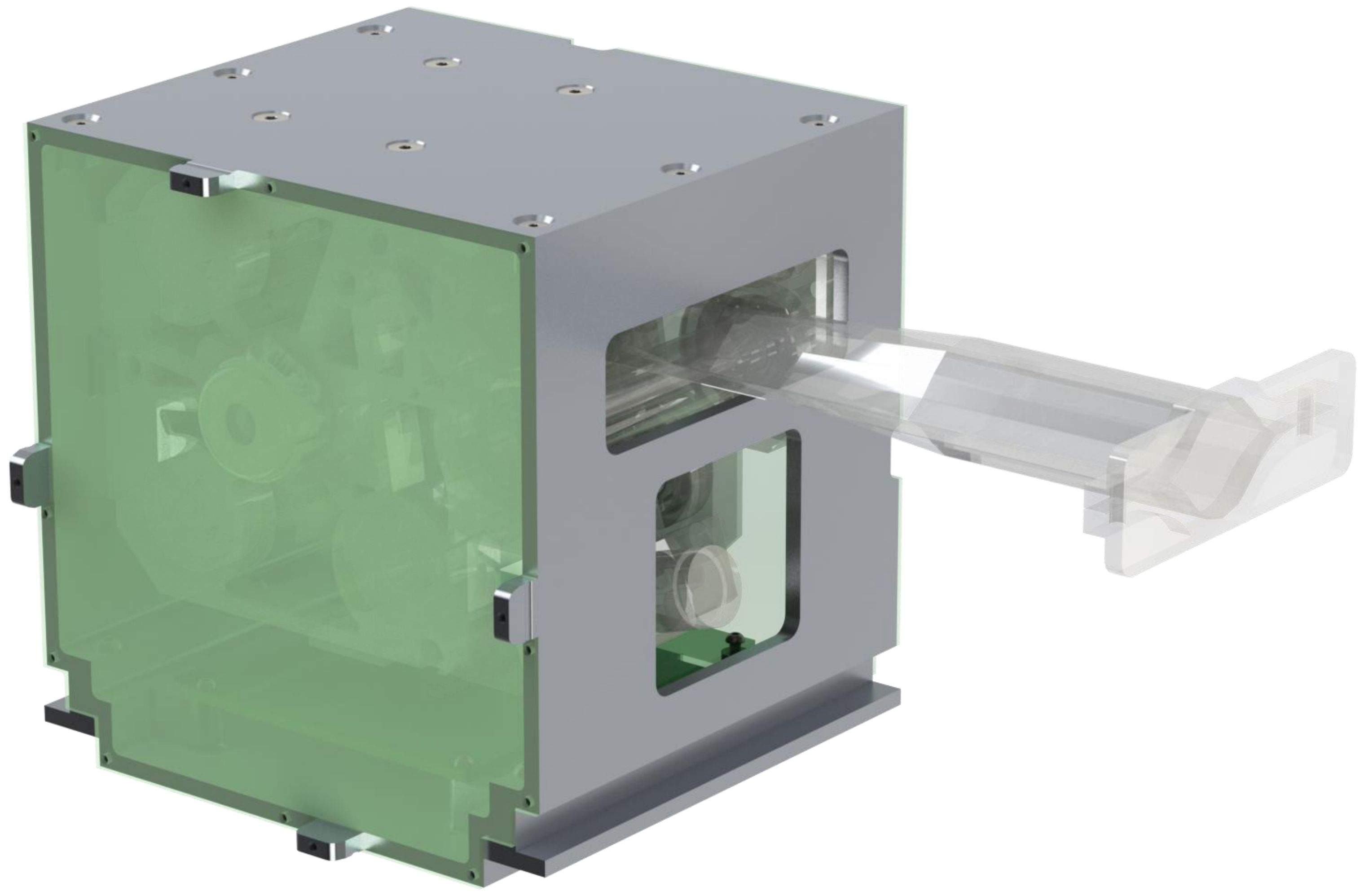

Figure 5: Full assembly of VT ThickSat

V. Acknowledgements

Manufacturing expertise and machining of the chassis components was carried out by Metal Processing Inc. of Radford, VA. Anodizing was completed by Global Metal Finishing of Roanoke, VA. Technical requirements and help navigating the design process provided by Matt Craft of Twiggs Space Lab, Matt Orvis of NearSpace Launch, and Zachary Campbell of Virginia Space.

VI. References

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