



BE BOLD. Shape the Future.
College of Engineering

Small Rocket Launch Rail Adapter

Justin Trujillo (MAE) & Demitri Barraza (MAE)

Spaceport America



Mission

Spaceport America is requesting the development of a launch rail adapter to enable the integration of small collegiate rockets with its existing launch rail system while ensuring reliable and repeatable launches.

The following parameters must be met:

- R&D of an adapter:
 - Securely attaches 1010 (1"x 1") and 1515 (1.5" x 1.5") aluminum T-slots
 - Non-destructive design and materials
- Ensure T-slot attachment is:
 - 1" x 1" Aluminum Railing
 - 1.5" x 1.5" Aluminum Railing
 - Easily connects to the launch rail
 - Easily removed from the launch rail
 - Seamlessly integrated
 - Perform clean launches
- Create a manual with instructions for use and assembly
- Conduct structural analysis to determine the maximum supported rocket weight and thrust

Research

Initial research was conducted on standards involved with model rocketry:

- Standard rail buttons for collegiate rockets
- Universal rail guides for collegiate rockets
- Standard launch procedures and codes involved for model rocketry launches

This was followed by finding common connections for 1010 and 1515 T-slot railings:

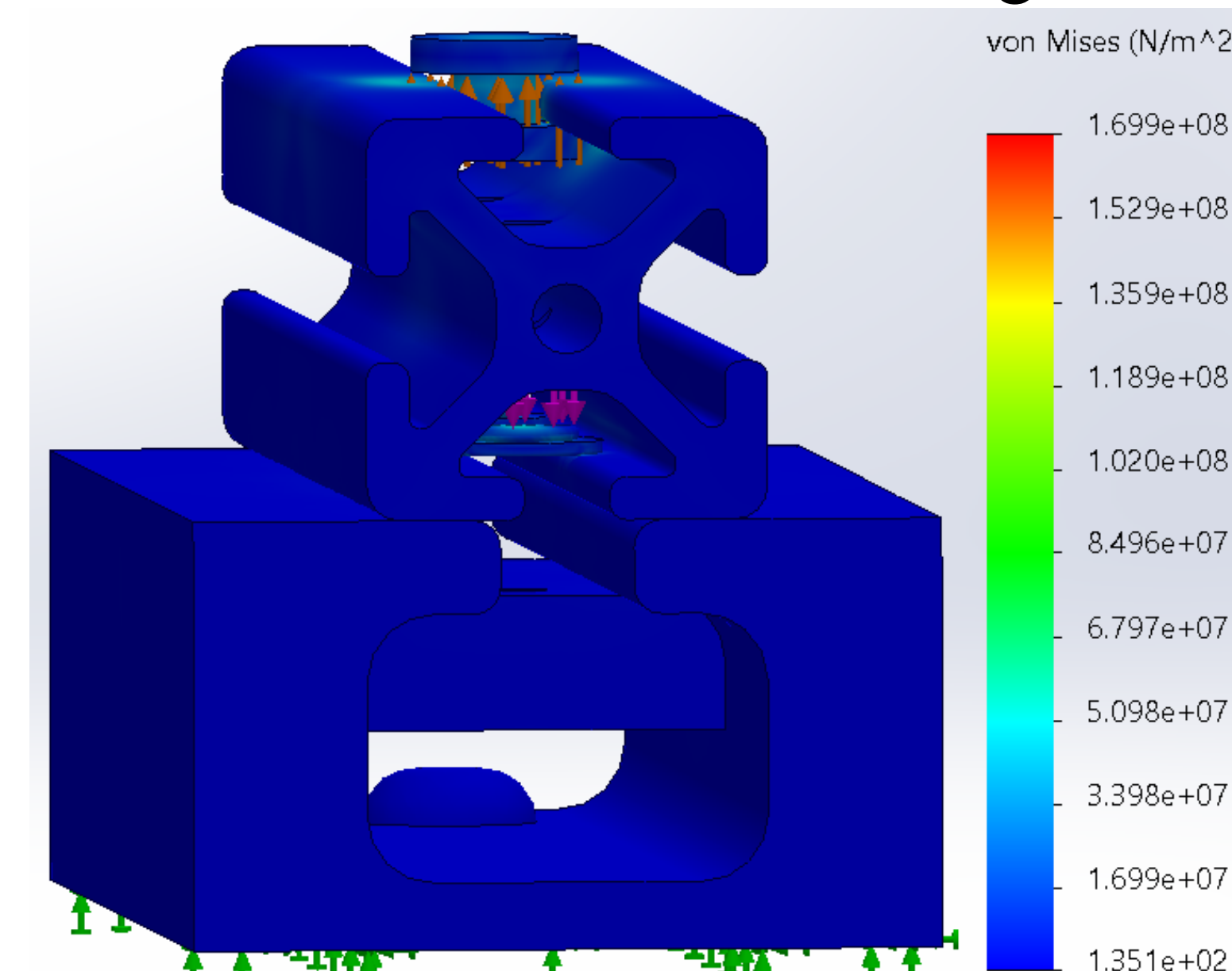
- Linear bar connections for parallel extensions
- Upon developing an initial conceptual design for a rail adapter to attach the 1010 and 1515 T-slot railing, research was conducted into developing Torque specifications for the selected screw type.

Then researched the proper fasteners and Helical Inserts for our purpose and for best fit of aluminum extrusions

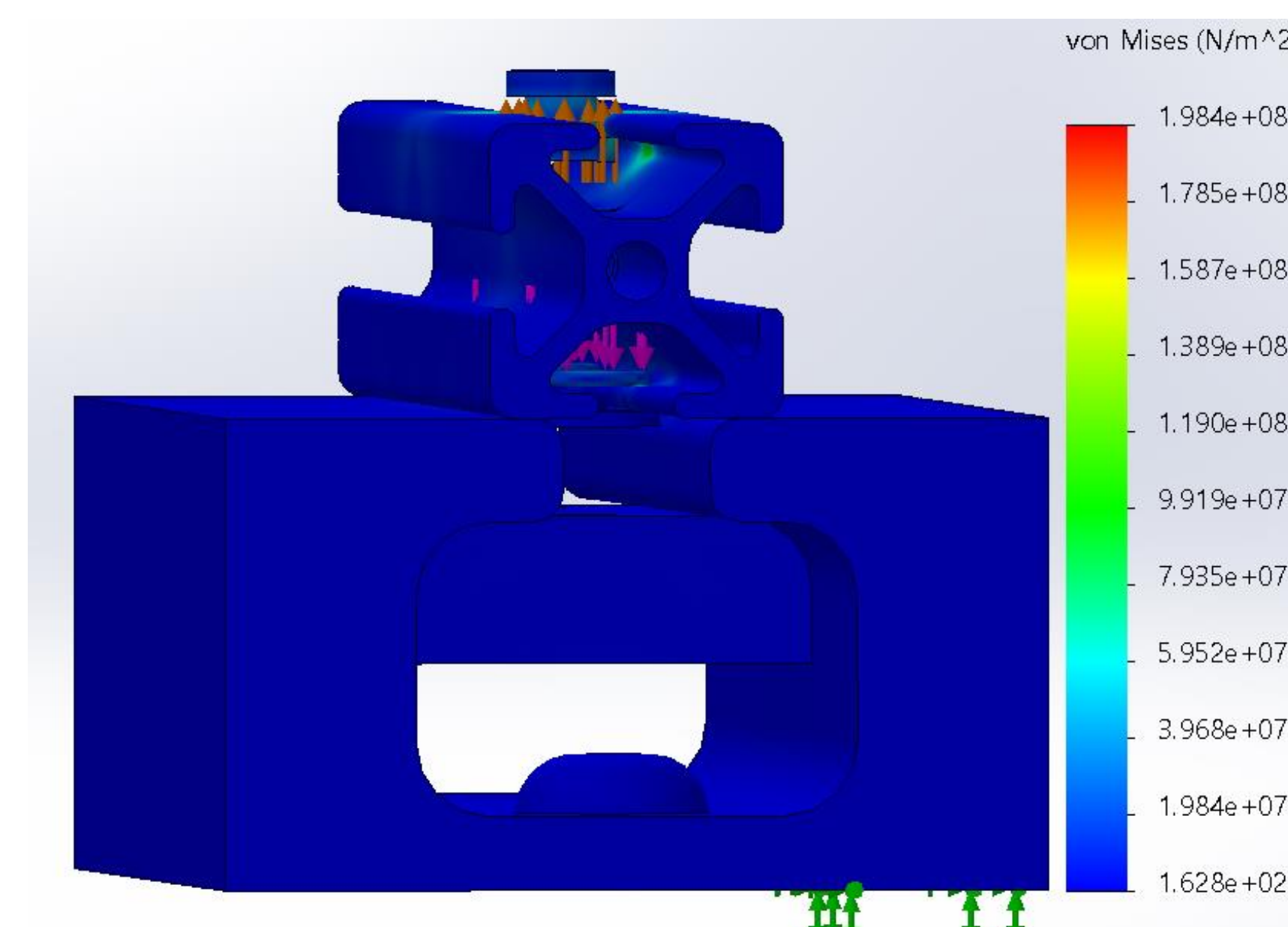
- 1/4-20 Black-oxide alloy steel button head Torx screw
 - Torx screw head prevents stripping of bolts and damage to the screwhead
- 18-8 Stainless Steel—Right-Hand 1/2" Threaded helical insert to prevent threading shear with dissimilar metals

Testing

- Our design process involved physical test fitting for the “internal nut” design and the physical Spaceport launch railing with 3D printed test parts
- A Finite Element Analysis study on a simplified 6-inch section of the SolidWorks models was completed to ensure stability while under torquing loads and forces through the rail buttons
 - A 6-inch section was used because the points of connection between the railings will be the main point of stress
 - The torquing load of the screw was set at 15 in-lbs. on the 1010 and 30 in-lbs. for the 1515 configuration
 - The forces exerted through the rail button were completed for a loading force of up to 150 lbs. on the 1010 and 285 lbs. on the 1515 configuration with no foreseeable damage to any part of the connection



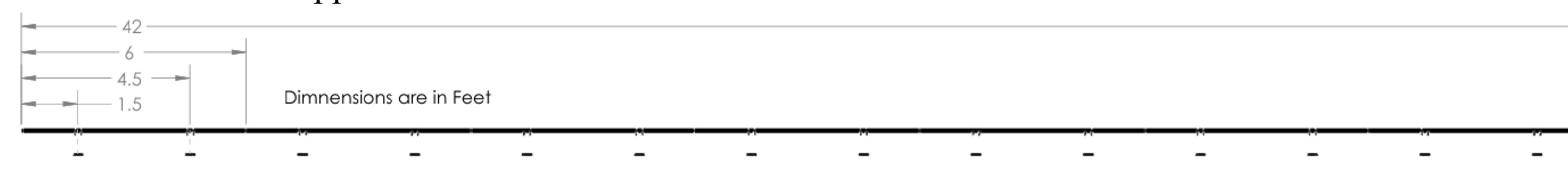
FEA on 6-inch 1515 Connection



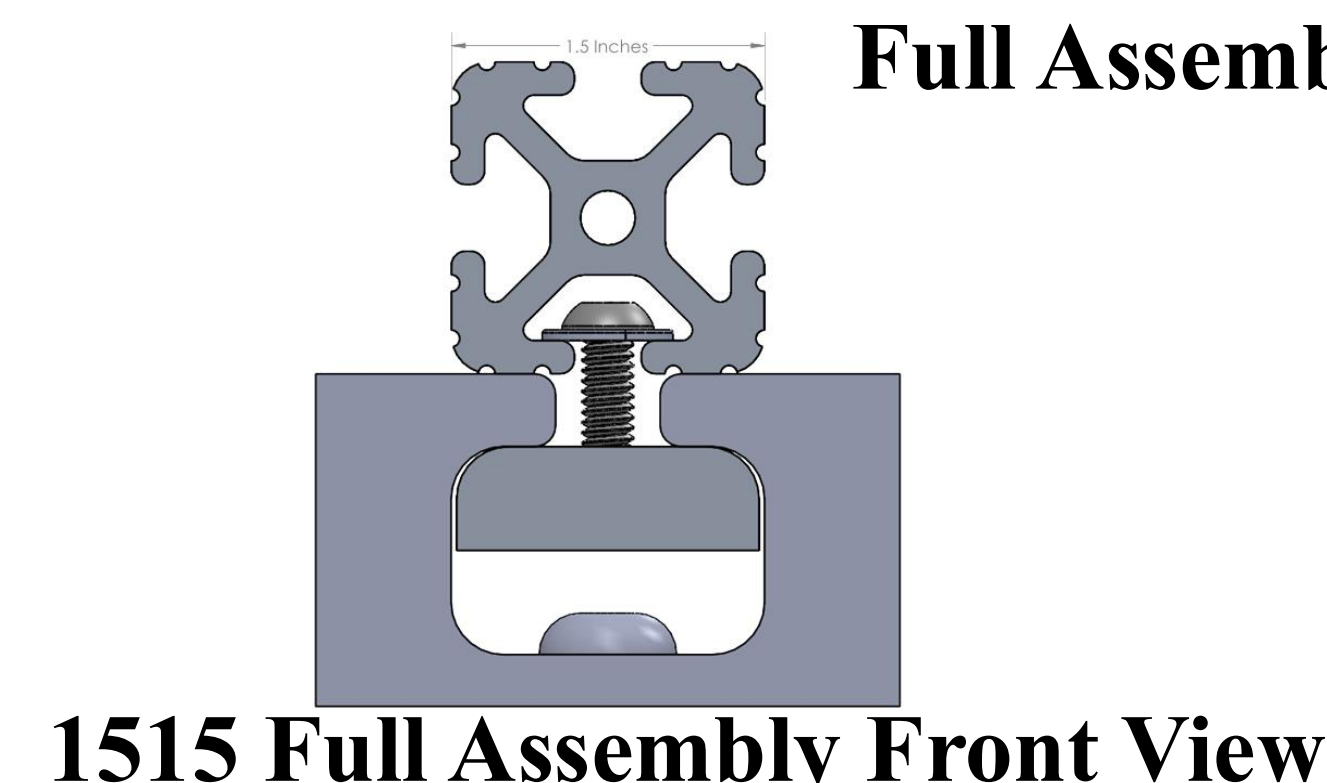
FEA on 6-inch 1010 Connection

Final Design

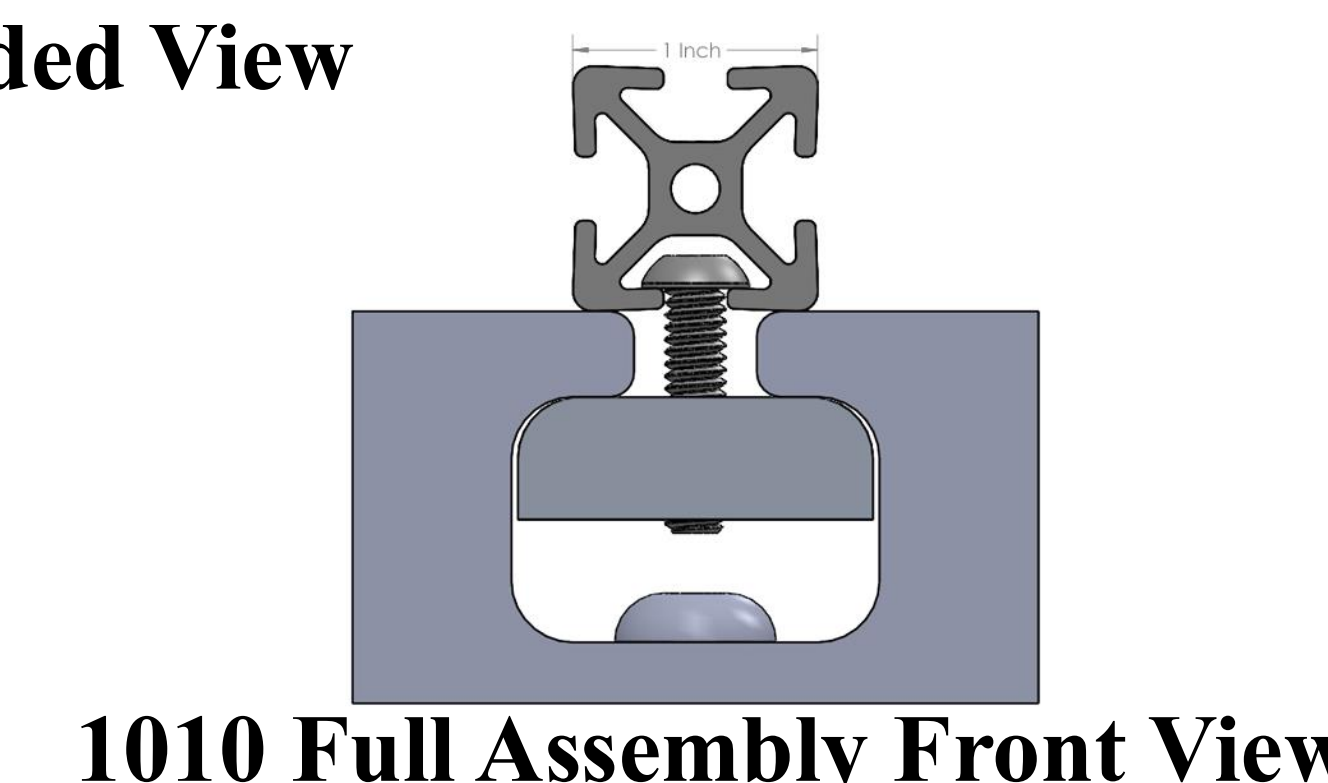
- The adapter must securely and non-destructively attach a 1" x 1" and 1.5" x 1.5" aluminum T-slot
- The internal machined nut will be placed inside the already existing rail and the smaller t-slot is fastened together using a 1/4-20 Black-oxide alloy steel button head Torx screw.
- This screw will need a washer added to change the size of T-slot rail from 1010 to 1515 making an easy adjustment to fit both sizes of T-slot rails.
- We will have 7 sections of 6-foot rails joined together with linear bar connections to ensure seamless guide surface
- The connections between railings will have rounded edges to account for misalignments
- This final design allows for a straightforward assembly and disassembly while maintaining structural integrity and alignment
- It accommodates both rail sizes with minimal modification
- Ensure a reliable support for the small-scale rocket launches at NMSA site



Full Assembly Side Exploded View



1515 Full Assembly Front View



1010 Full Assembly Front View

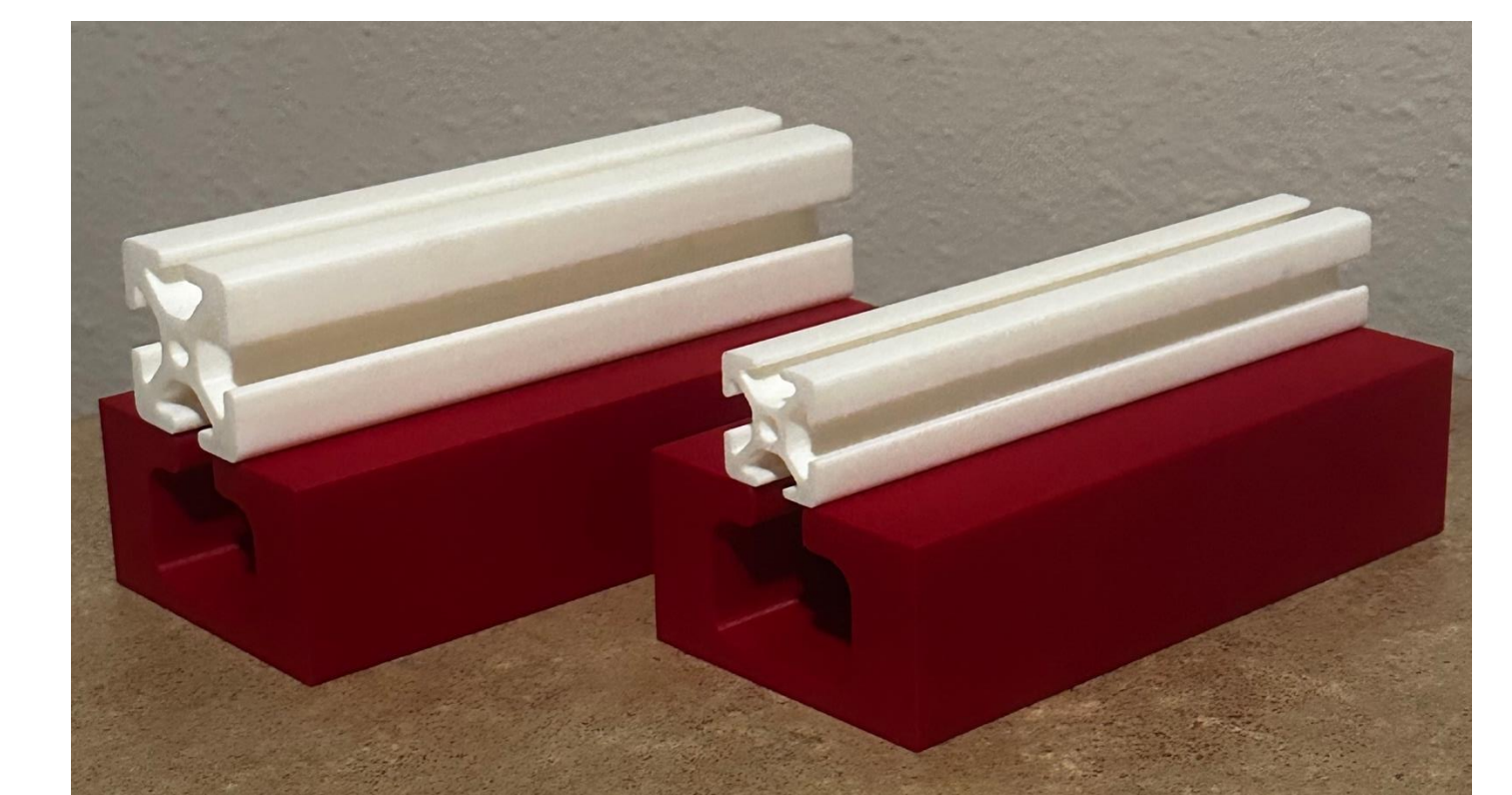
Concept Development

After going to the Spaceport facility and taking measurements on the guide railing, we completed the following tasks:

- 3D modeled the guide rail and T-slots extrusions
- Determined how to test assembly connection
- Brainstormed how to design with cost and safety in mind
- Design prototype of attachment mechanism
 - Own internal rail guide shoe
 - Full railing connection with many common off the shelf parts
- After completing the steps, we then selected, and purchased materials needed for machining and assembly



Screw Fit Live Fitting on 1010 (Left) & 1515 (Right) Railing



3D-Printed 6-inch section Assembly
1515 (Left) & 1010 (Right)

References

- <https://www.apogeerockets.com>
- https://www.phidgets.com/docs/T-Slot_Guide
- <https://8020.net>
- <https://rocketlabdelta.com/notes/rail-guides/>
- <https://www.mcmaster.com/>
- <https://www.mfsupply.com/Button-Head-Cap-Screws-p/bsc14cx1-fslash-2d.htm>
- <https://asm.matweb.com/search/specificmaterial.asp?bassnum=ma6061t6>
- <https://www.rocketryforum.com/threads/rail-button-dimensions.30354/>
- <https://www.nar.org/RocketMotorResources>