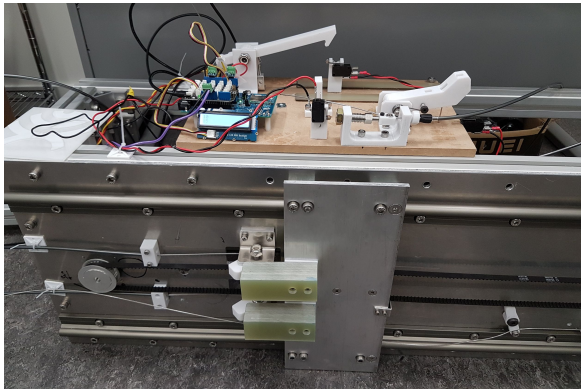
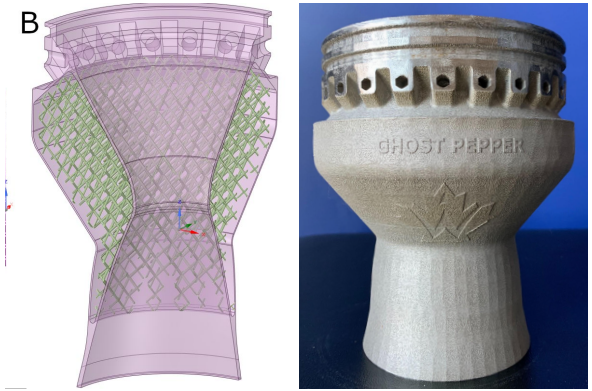
Stefan Martin

Personal Project Portfolio

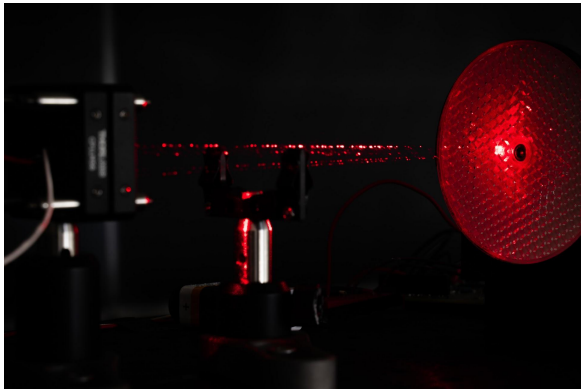
14/08/2020



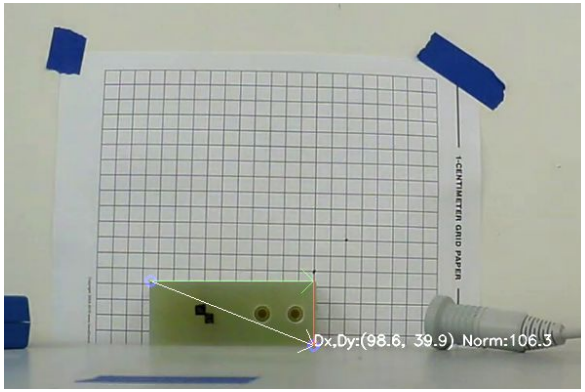
Automated Test Rig



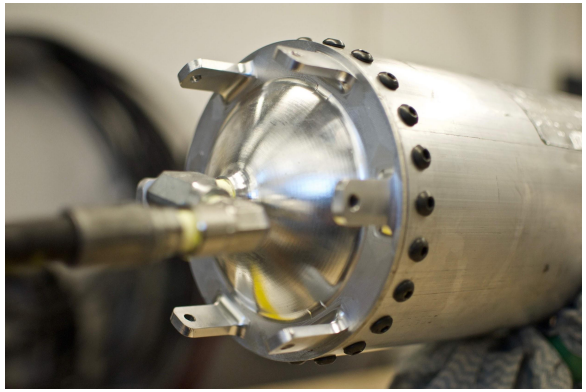
Printed Rocket Nozzle



Self-Mixing Laser Interferometer



CV Visual Displacement



Rocket Oxidizer Systems

More Projects:
stefan-martin.github.io/Website/

Hybrid Rocket

Nitrous-oxide HTPB engine delivering >40,000Ns of total impulse.

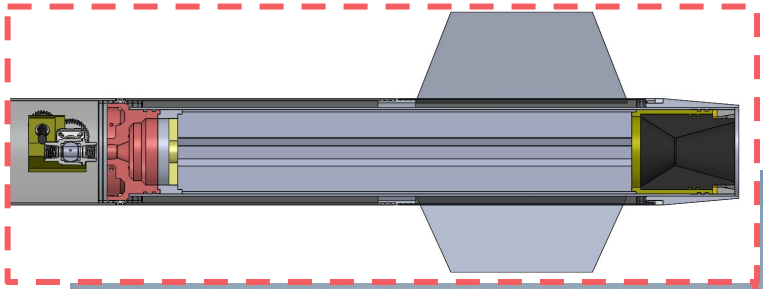
Advised in design reviews for safety and system integration. Involved in simulation of the flight and engine dynamics.

Ground tests of engines and fuel systems.

Results:

Launched to **15,500ft** at IREC 2019

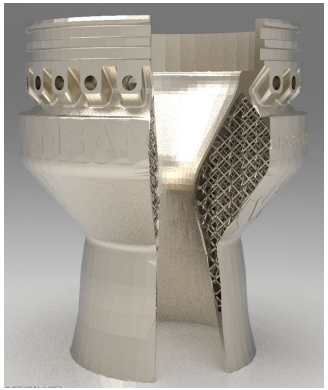
At **5.5m** it is the largest rocket ever (successfully) flown by the team

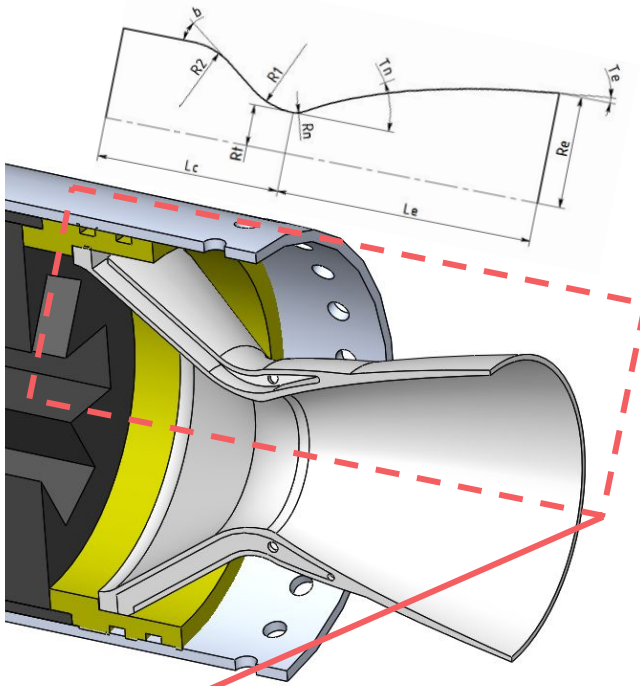


Rocketry: 3D Printed Inconel Rocket Nozzle

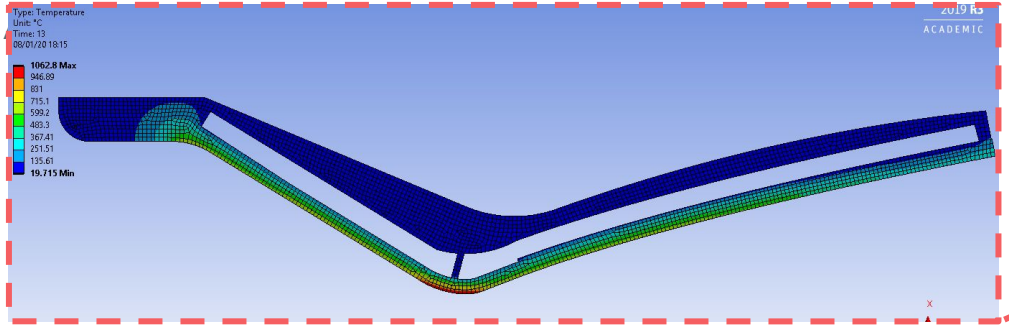
Thrust-optimized parabolic nozzle geometry printed out of Inconel 625 gains 3% performance over previous conical design while weighing 30% less.

Water **phase-change cooling** system designed using ANSYS transient thermal. Used lattice **topology optimization** to minimize weight of the internal structure.





Engine combustion simulation in Rocket Propulsion



Project Sponsors:

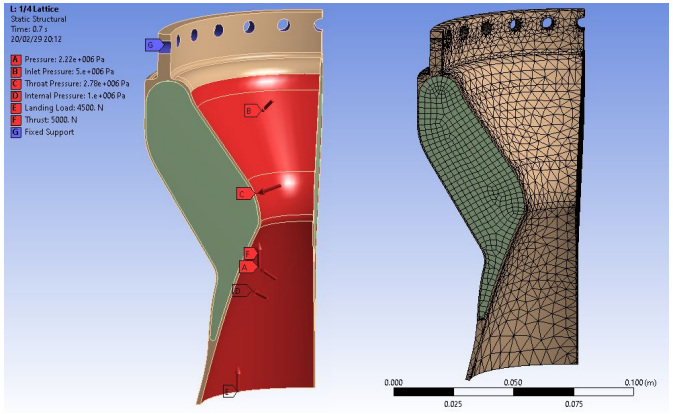
ANSYS

MSAM

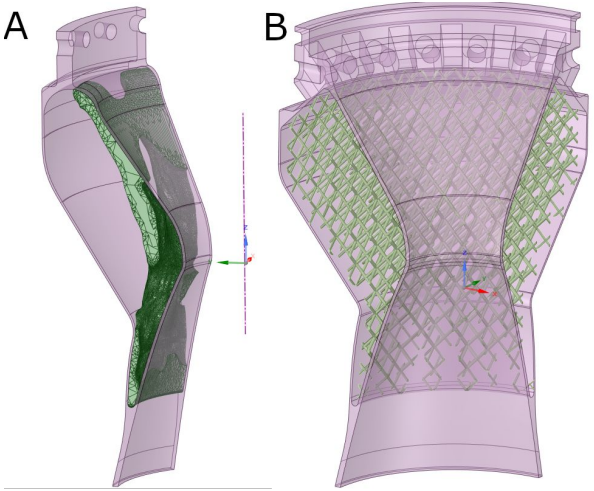
Rocket Nozzle Topology Optimization

AM-constrained optimization for combined thermal and pressure loading. Designed to optimally carry inlet pressure of **5MPa** at a peak gas **temperature of 2600K**

Read the full paper on my website



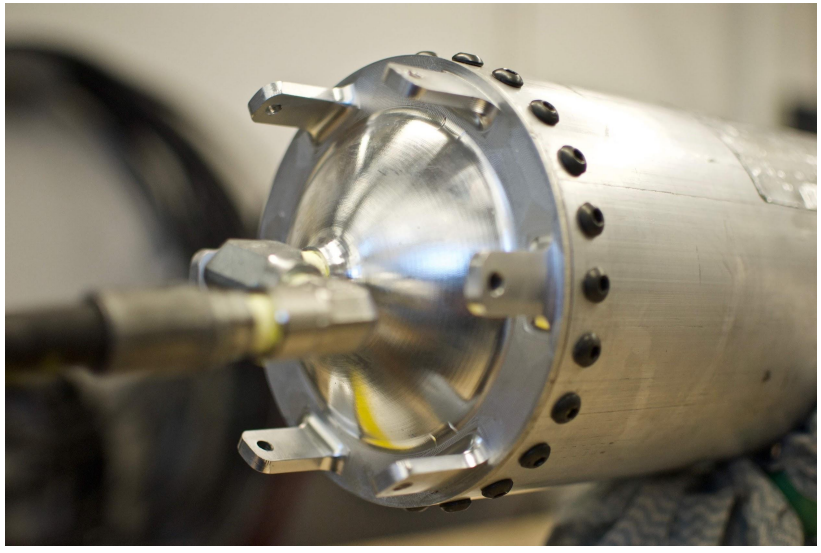
Modelling and simulation



Topology optimization

Completed Print

Rocketry: NOS Pressure Vessel



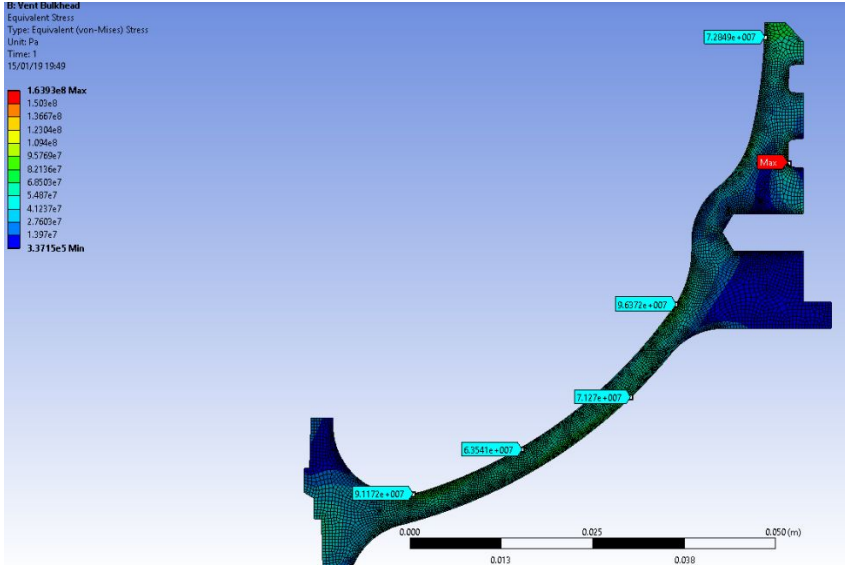
Designed to hold liquid nitrous oxide at up to **1000psi**.

Axisymmetric ANSYS simulation was run to validate calculations for yield safety factor.

Bearing stresses on the tank walls are limiting.

Results: Successfully hydrostatic tested to 1500psi with no leaks.

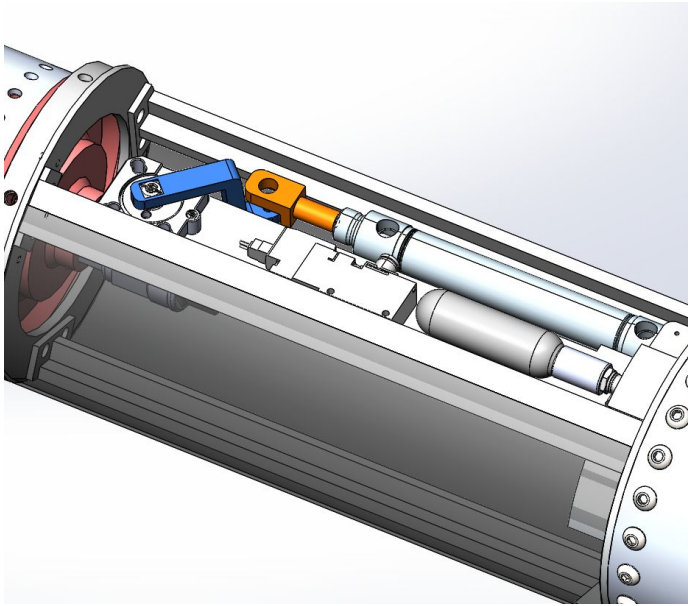
Hemispherical bulkheads were CNC machined and **weighed 50% less** than the previous year's design.

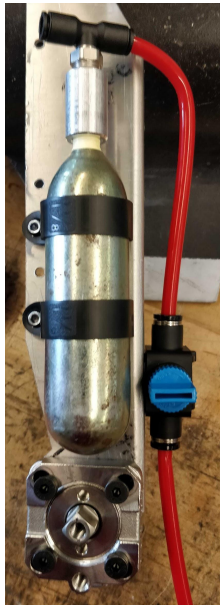


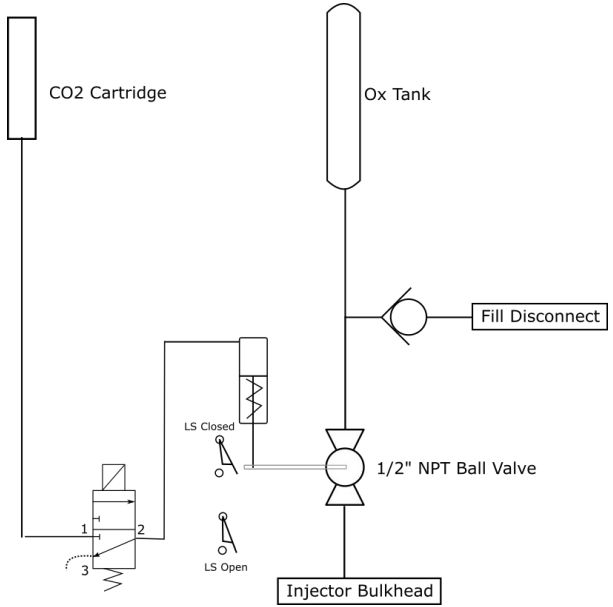
Rocketry: Pneumatic Injector Valve

Pneumatic and mechanical design for a compact valve actuation mechanism.

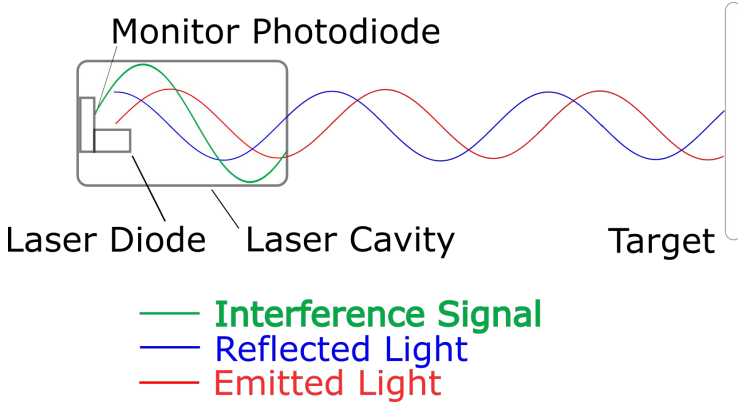
Using a lightweight CO2 cartridge to power the system and open the valve in under 0.5 seconds.







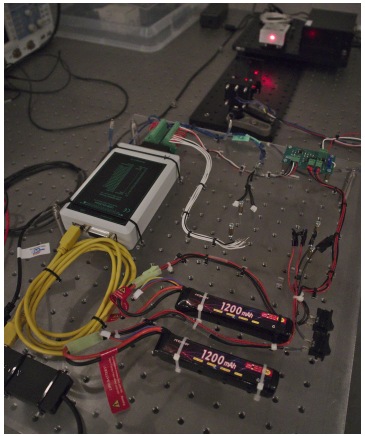
Capstone: Self-Mixing Laser Interferometer

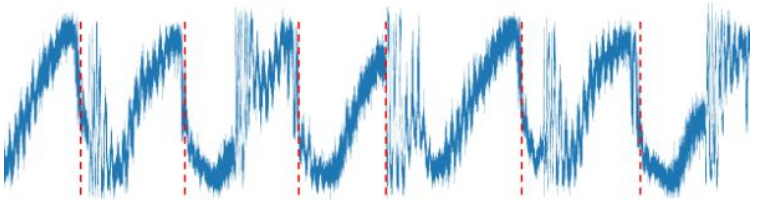


Quantum sensing on a **classical** budget

Optical feedback configuration for an inexpensive interferometer to do precision displacement measurements.

Achieved **50nm resolution** (λ/12) at a BOM cost of only $400 including the necessary environmental calibrations.



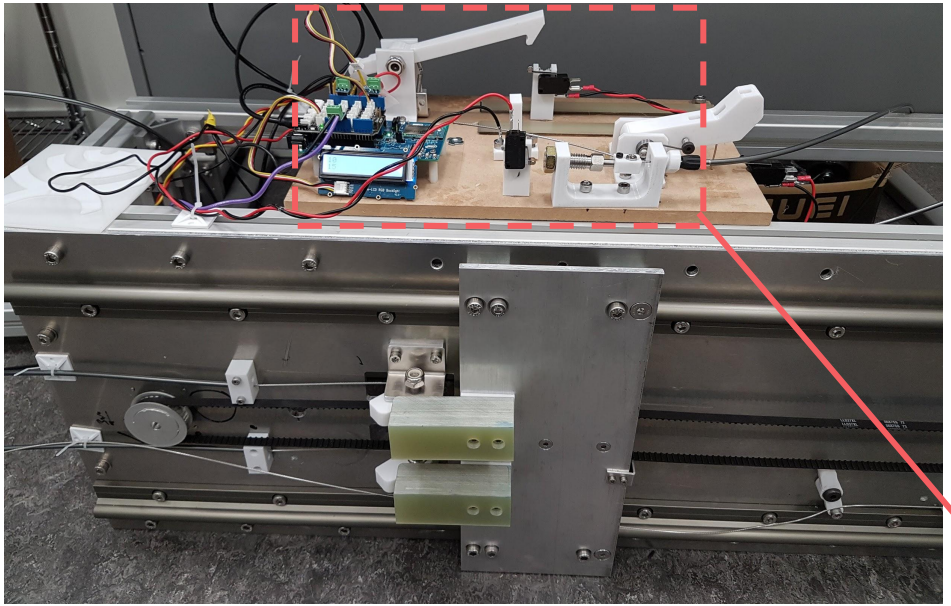


$$\phi_{nom} - \phi_{feedback} = C \sin\left(\phi_{feedback} + tan^{-1}\alpha\right)$$

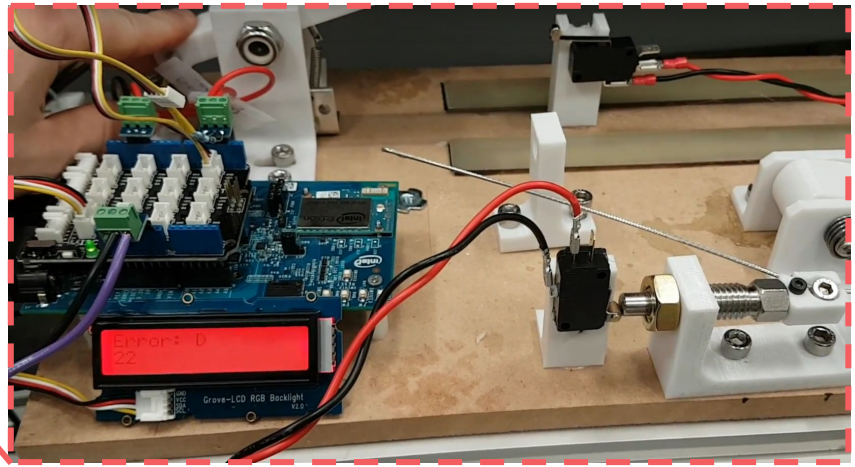
Recovered Interference Fringe Signal

Read the full project report

Automated Test Rig



Limit switches for error detection in SUT



Designed and assembled a linear motion system driven using a programmable brushless servo.

Results:

Ran **>20,000 cycles** of fully automated testing using an Arduino to provide error logging and diagnostics

Flight Control Ground Station

Manual override commands and physical user interface.

Implements custom radio packets to communicate with the flight computer.

Visual Displacement Tracker

OpenCV point tracking as a tool to measure displacements.

1. Contrast enhancement and lens distortion pre-processing.
2. Optimal tracking points are computed in the image.
3. Track using LK flow.
4. Compute displacement using camera FOV and distance.
5. For lost or obscured points, reattachment is done using template matching based on capture of point when first created.

Results:

Validated to achieved **millimeter resolution** and accuracy based on calibration tests.

Used in observing loading tests to measure maximal deflection.