

An Overview of the TVC1 Desktop Vacuum Chamber

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Some Available Vacuum Chambers



Johns Hopkins Applied Space Technology Center - From Sargent Welch
For Sale on eBay, \$1 Million
Pumpkin Space Systems Spang Power Chamber A

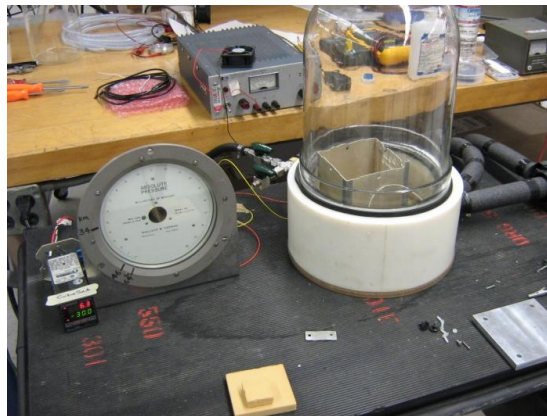
Why are we making one?

- Need for vacuum testing of systems and components
- Traditional testing inefficient
 - Giant chamber – long cycle times, expensive, etc.
 - Limited access to internal payloads
- Need low-cost COTS solution
- Desire an easily accessible solution
 - Transportable
 - Easy to connect to
 - Standard ports
 - Standard consumables



CTEC by SRI

- SRI developed an in-house chamber
 - Ultra High Molecular Weight Polyethylene ring
 - Bell jar
 - Cooling plate, chiller, Swagelok connections
 - Electrical Passthroughs
 - Reached 0.2 Torr
- Presented April 2009
- http://www.klofas.com/papers/7_Klofas-CTEC.pdf

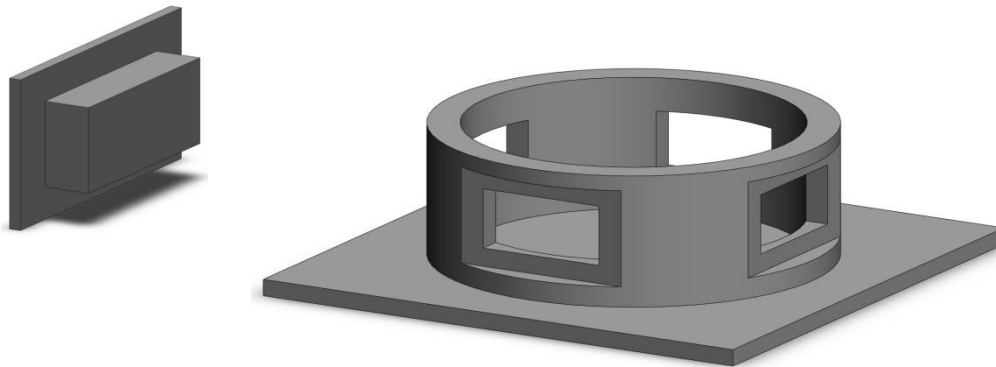


Product Goals

- Micron-level vacuum
- Accommodate 3U CubeSat with sensors, cabling, etc.
- Allow electrical communication with CubeSat system
- Allow of fluid transport (cooling, etc)
- Allow flexibility in choice for vacuum, cooling, etc.

Chamber Design Concept

- Monolithic Base
 - Annular Ring
 - Ports for inside access
- Sealed with plates
- Plates with passthrough holes for vacuum & cooling
- Electrical Passthrough PCB
- Bell Jar Enclosure



Mechanical/Electrical Design

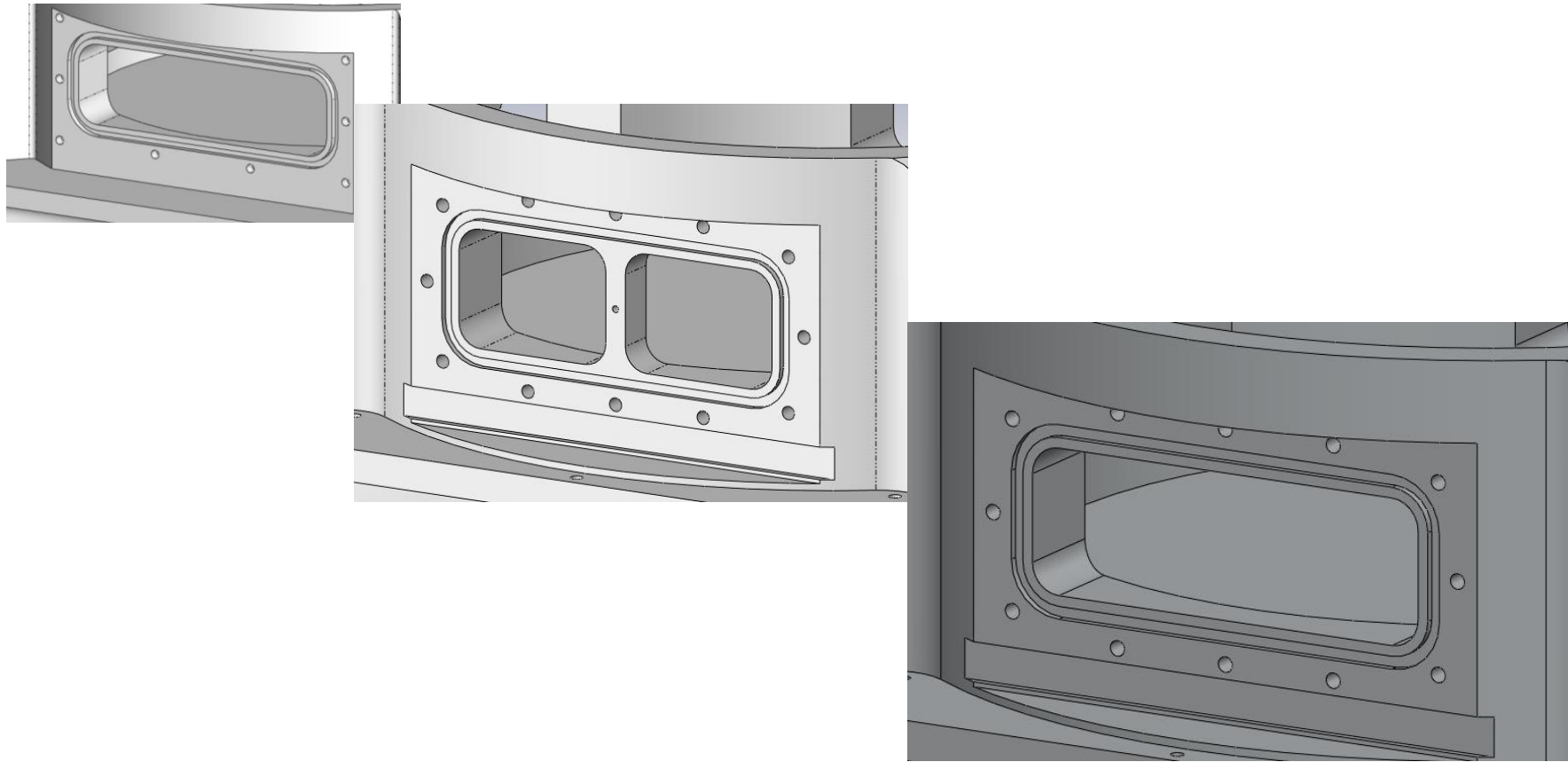
- CAD Modeling in SolidWorks
- Drawing release and interaction with various machinists
 - Special thanks to Clay Allen and Bill Hoffman
- Source electrical components from Samtec, Digi-Key
- Iterate, iterate, iterate! (within your constraints)
 - Alter port size to accommodate:
 - ♦ Electrical connectors: USB, Ethernet, Headers, Terminal Block
 - ♦ NPT Connectors (vacuum & cooling lines)
 - Bell Jar size
 - Use standard-size O-rings
 - ♦ Referenced Parker O-ring Handbook:
http://www.parker.com/literature/ORD%205700%20Parker_O-Ring_Handbook.pdf

Materials Considerations

- Desired Characteristics
 - Strong
 - Light
 - Resilient
 - **Low Outgassing**
- Monolithic Base
 - Aluminum – Bare or Type III, Class 1 Hard Anodized
 - UHMW Polyethylene – Great for Thermal Insulation
 - 316 Stainless Steel
- Sealing Plate: 316 Stainless Steel
- Electrical Passthrough PCB: FR4
- Sealing O-rings: Viton ® and EPDM

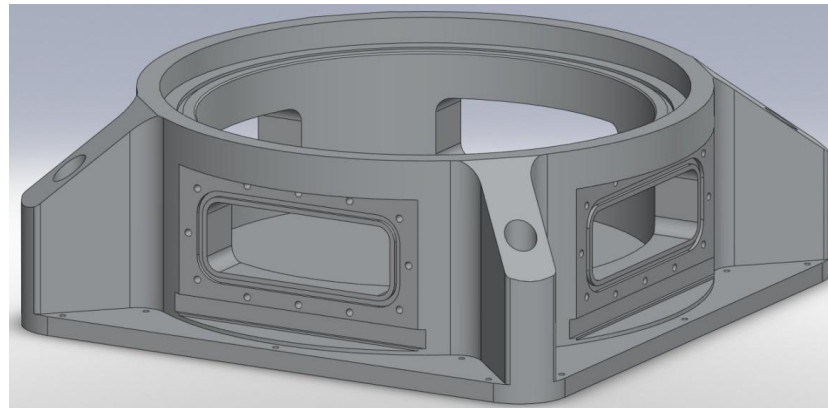
Case Study: Port Cut-out Evolution

- Design evolved over several iterations

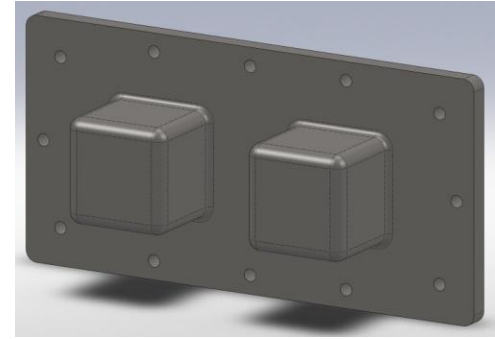
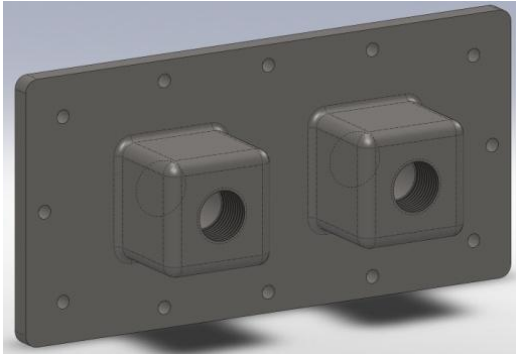


Monolithic Base

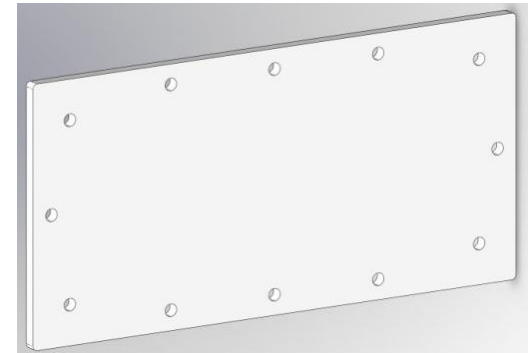
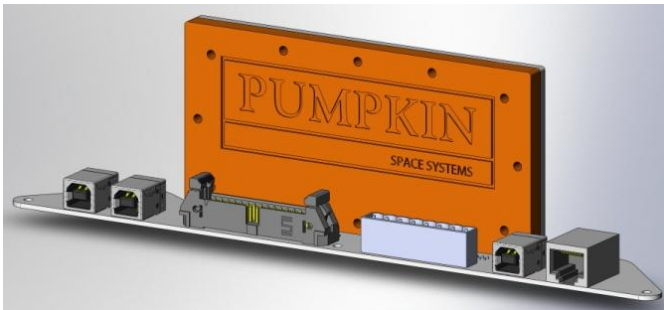
- Large interior volume for sensors, wiring and cabling, thermal components, etc.
- UHMW PE Base allows good thermal insulation
- 4 ports allow modular access to interior
- Support securing to
 - ◆ Rubber Isolators
 - ◆ Inch- and Metric-pattern Optical tables



Sealing Plates

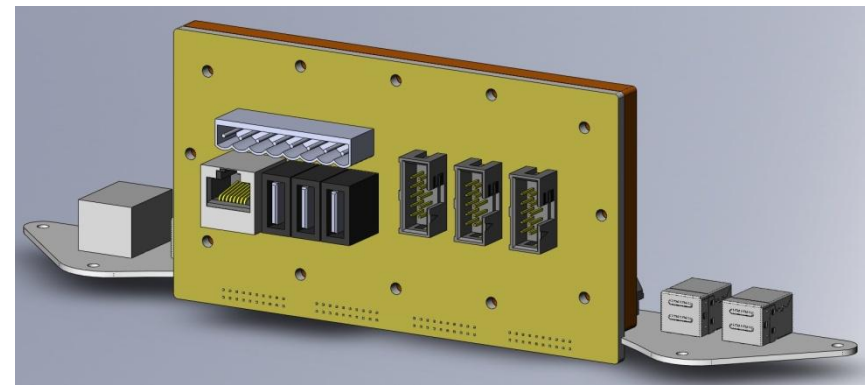
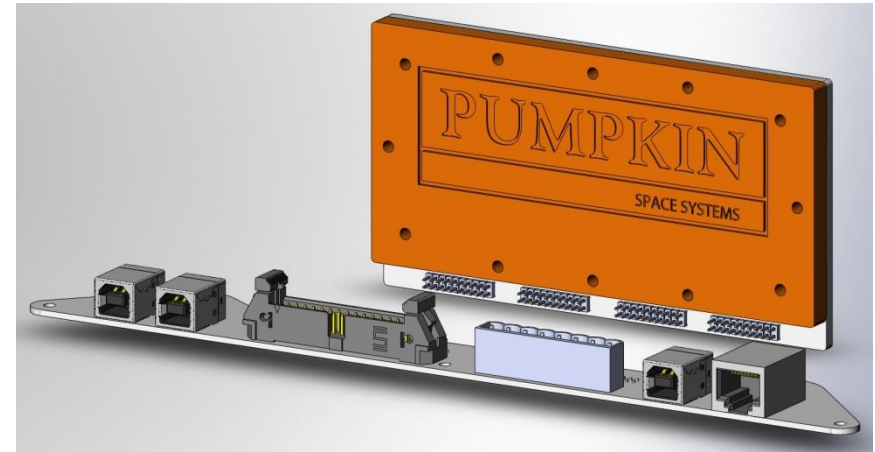


- Plate with ¼ in NPTF Threaded Holes
- Unthreaded Plate for Custom holes
- Electrical Passthrough Plate
- Blank Plate



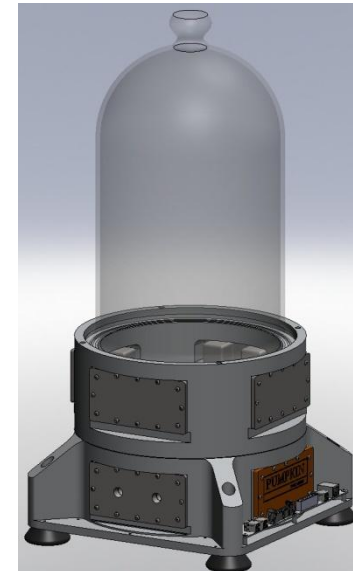
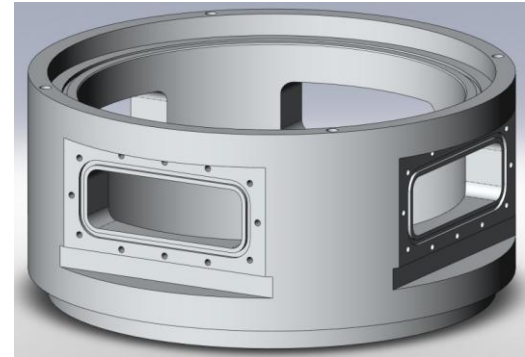
Electrical Passthrough

- One 10-BaseT Interconnect (RJ45)
- Three USB 2.0 Interconnects
- One 8-pin high-power screw terminal connector
- Fifteen pairs of low-power signal connectors (3 groups of 5 pairs)

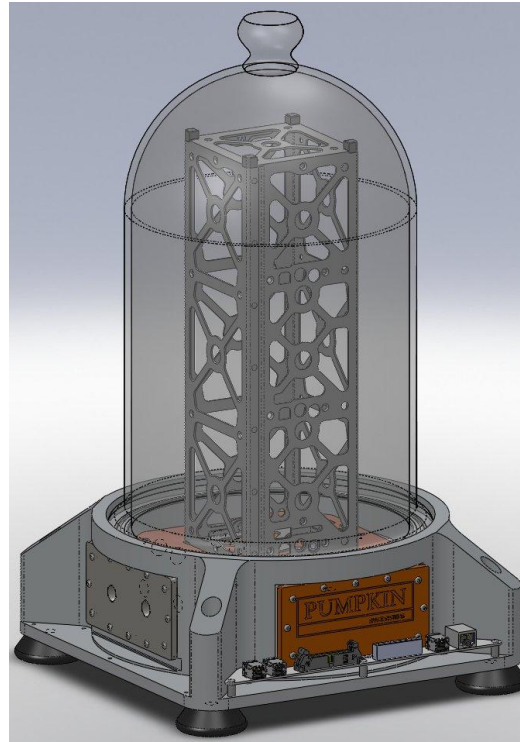


Chamber Extender

- Derived from the base central cylinder
- Allows user to scale chamber length as desired
- Adds more ports to chamber



Final Product



Pumpkin

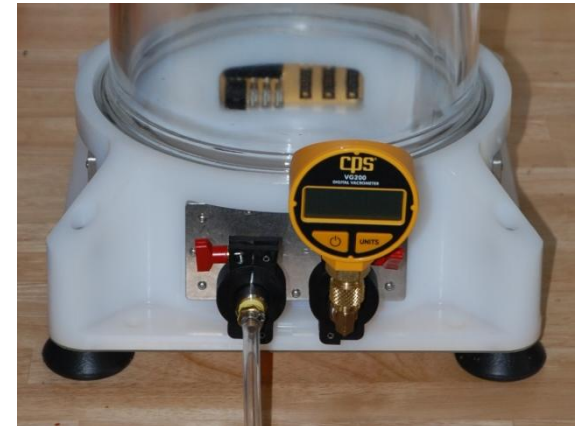
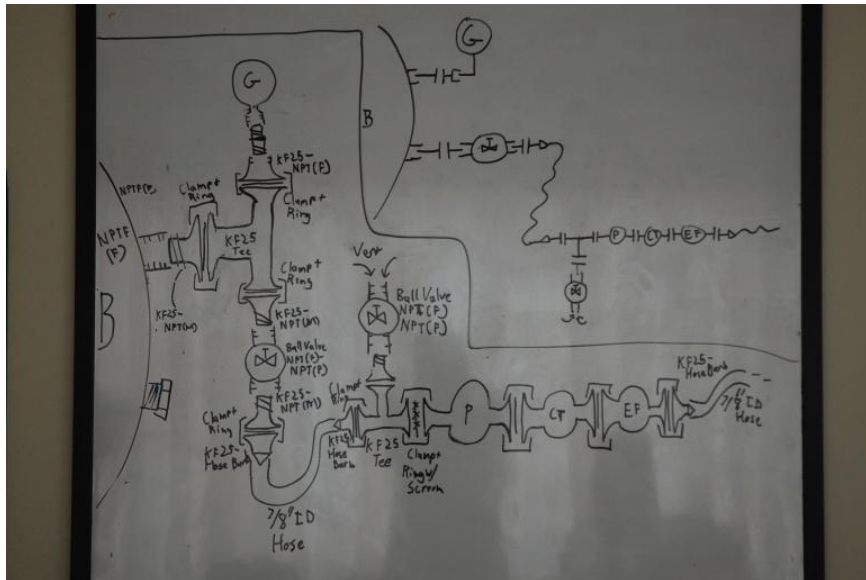
Vacuum Systems

- Researched vacuum system components for in-house testing
- Industry Standard: KF & CF Flanges
- Swagelok
 - Compression Fitting
 - Quick Disconnect
 - KF, CF
 - Ultra-Torr
- Pumps
- Gauges
 - Thermistor
 - Residual Gas Analyzers



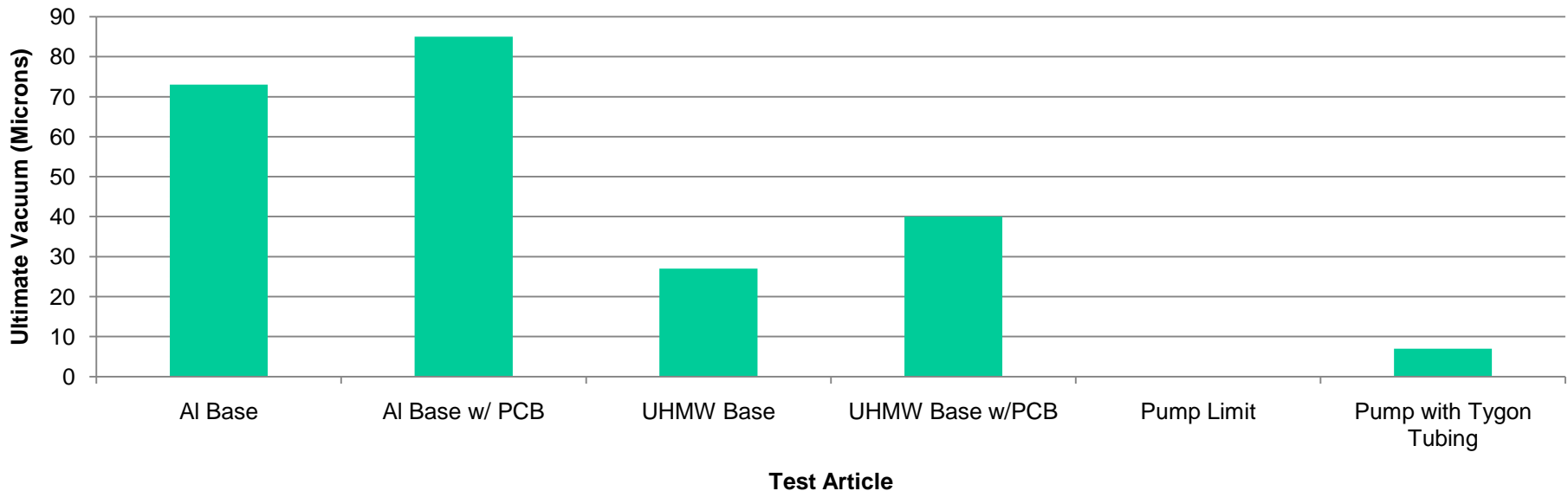
Test Set-Up

- Oerlikon-Leybold Rotary Vane Pump
- CPS VG-200 Digital Vacrometer
- Tygon Tubing Hoses
- KF-16 and KF-25 Flanges and Tees



Some Test Results

Various Test Results



- Results suggest Al must be baked
- Tygon tubing outgasses

SUCCESS!

- Replaced Tygon Tubing with Stainless Steel Coupler
- Bottomed out gauge (0 +/- 1 micron) in ~10 minutes



Product goals... ACCOMPLISHED

- Micron-level Vacuum
- Electrical, Vacuum, and Fluid Connections
- Standard consumables
- Modular Panel Architecture
- Scalable size with Extenders
- Customizable Interfaces
- Easily accessible

Come by our booth and see it in action!



Q&A Session

Thank you for attending this Pumpkin presentation at the 2010 CubeSat Summer Developers Workshop!

Notice

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www.pumpkininc.com/content/doc/press/Pumpkin_CSDWLU_2010-1.ppt

and:

www.pumpkininc.com/content/doc/press/Pumpkin_CSDWLU_2010-1.pdf

Appendix

• Speaker information

- Mr. Truong-Cao is a systems engineer and mechanical designer at Pumpkin. He earned his Bachelor of Science in Mechanical Engineering from the California Institute of Technology in 2007 and earned his Master of Science in Aeronautics & Astronautics from Stanford University in 2010. In addition to his projects at Pumpkin, He is also the Mechanical Systems lead in the Space & Systems Development Laboratory (SSDL) in the Department of Aeronautics & Astronautics at Stanford University, where he oversaw the mechanical design of several different CubeSat mission projects. Contact Mr. Truong-Cao at eddie@pumpkininc.com.

• Acknowledgements

- Pumpkin's Salvo and CubeSat Kit customers, whose real-world experience with our products helps us improve and innovate.

• CubeSat Kit information

- More information on Pumpkin's CubeSat Kit can be found at <http://www.cubesatkit.com/>.

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