



Forum on Tracking Detector Mechanics Rock West Composites Inc. BTST Fabrication-

Purdue University, West Lafayette USA

John Marks

May 29-31, 2024

Rock West 

It took all of us to complete:

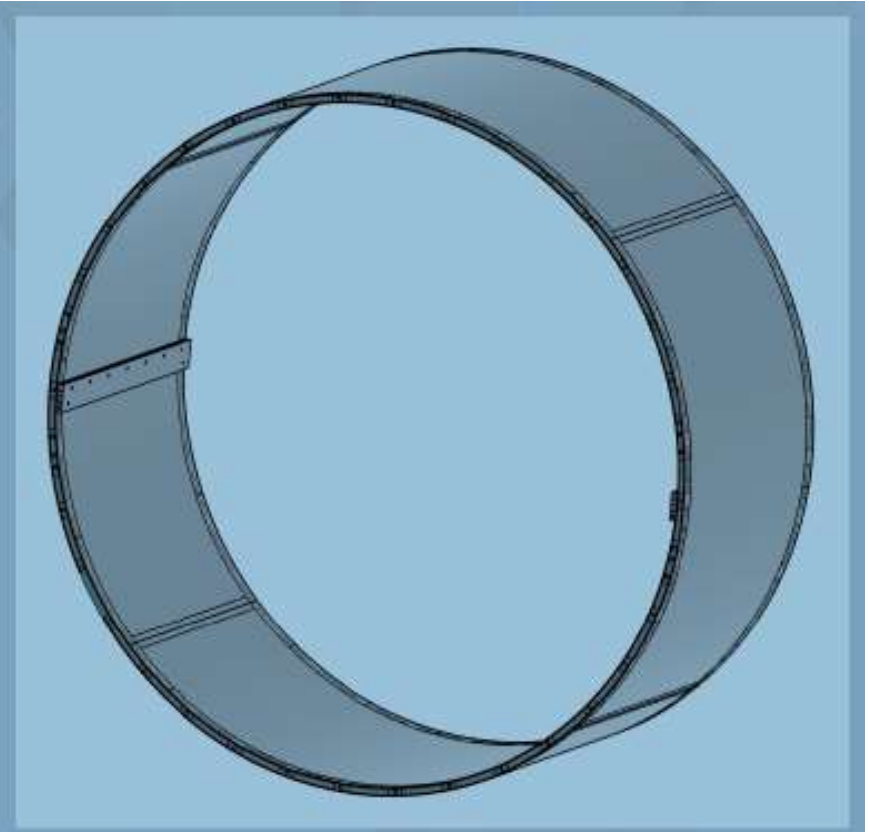
PM-Eng-QA-Layup-Machine shop- assembly- Purchasing, accounting and Sr Management



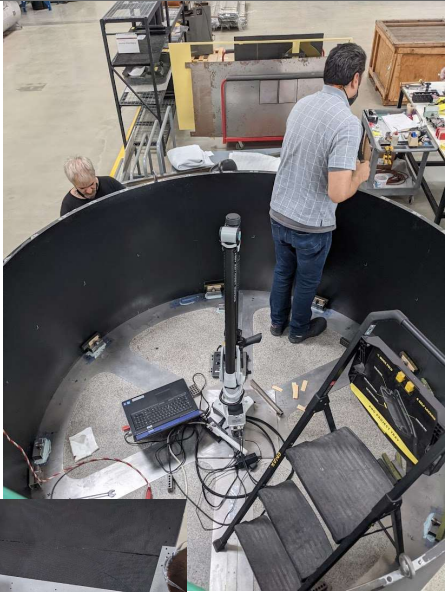
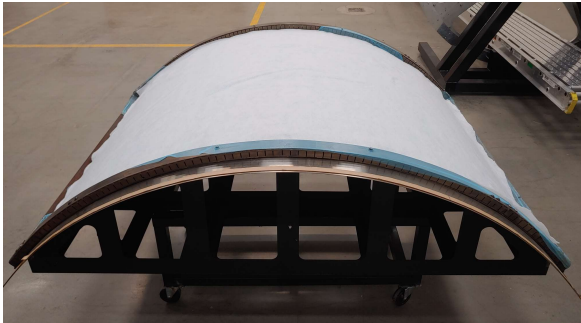
RWC-QA-139_E

Initial 1m Prototype V3

- (2) End Ring
 - (32) M16 Metallic Inserts, ~50x50x22mm
 - (4) Special Three-Hole Metallic inserts
 - Solid CFRP Connector Rods, ~180x25x22mm
 - (8) Special Connector Rods, shorter
 - (12) "Doubler", 30° arc
 - CFRP face sheets, 1.8mm thick
 - honeycomb core, ~22mm thick
- (4) Tube Quarter Shells, 90° arcs
 - CFRP face sheets, 2mm thick
 - Nomex honeycomb core, 26mm thick
 - (4) Joint panels/blocks, ~3° arc
 - CFRP face sheets, 2mm thick
 - Nomex honeycomb core, ~22mm thick
- (2) Rails, machine from solid CFRP plates
- (2) Rail Guide Rods and (18) Rail Pins provided by CERN (Ø10mm)

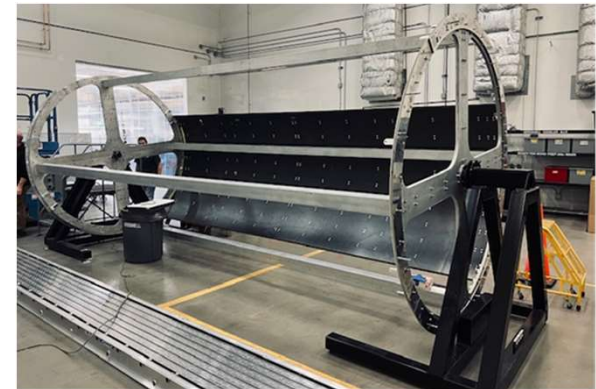


Prototype Proof of Concept



Manufacturing Build Plan summary

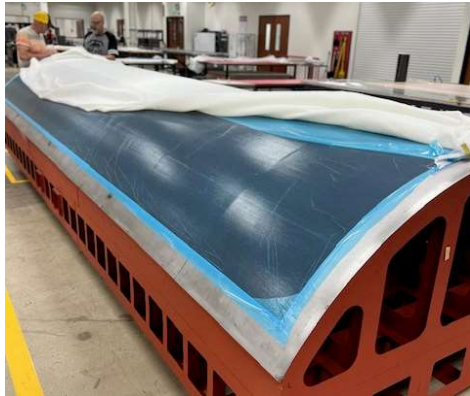
1. Tool design and fab- complete
2. Long lead Materials- purchased- still need Core, Adhesive and Fittings
3. Test Panel fabrication and test- awaiting core arrival
4. Fab test $\frac{1}{4}$ section to define Angle close-up from HM63-F6 skins -complete
5. Machine Composite end fittings sections By waterjet
6. Procure metal end fittings Ti 6Al-4V.- Complete
7. Co cure splice plates
8. Machine splice plates
9. Co-cure 4 $\frac{1}{4}$ sections
10. Machine $\frac{1}{4}$ sections
11. Assemble spools into quarter sections
12. Assemble $\frac{1}{4}$ sections into cylinder
13. Assemble end fittings
14. Verify completed cylinder
15. Ship to Purdue



Both Lay-up and assembly will be completed in the High Bay Pass-thru plan for a large curtain to minimize dust and debris and it would be better if there was some AC for lay-up

Materials- Co Cured sandwich Panel.

- **HM63/ F6- Skins 2.0 mm (0.079") 200 gsm- 12 plies 2mm**
 - Patz Materials
 - (0.079") skins (0/60/120/120/60/0)2
- **Nomex core- Euro Composites**
- **Tube made in Quarter section**
- **Edge laminate- Flat-Lam 2@1.0" X24" X24" each Made from 2@ ½"X24"X24"**
 - Off the shelf 437-1224 670 GSM 12k T700 (or equivalent)



Skin lay-up- 60° ply shown



Core Perforation- poly holds vacuumed core down thru perforation process

HexTow® HM63 carbon fiber is a continuous, high strength, high performance, high modulus, PAN based carbon fiber available in 12,000 (12K) filament count tows. This fiber has been surface treated and sized to improve its handling characteristics, interlaminar shear strength, compressive strength, and structural properties.

It is suggested for use in aerospace, space, premium sporting goods, and industrial applications.

The unique properties of HexTow® HM63 fiber, such as higher tensile strength and modulus.

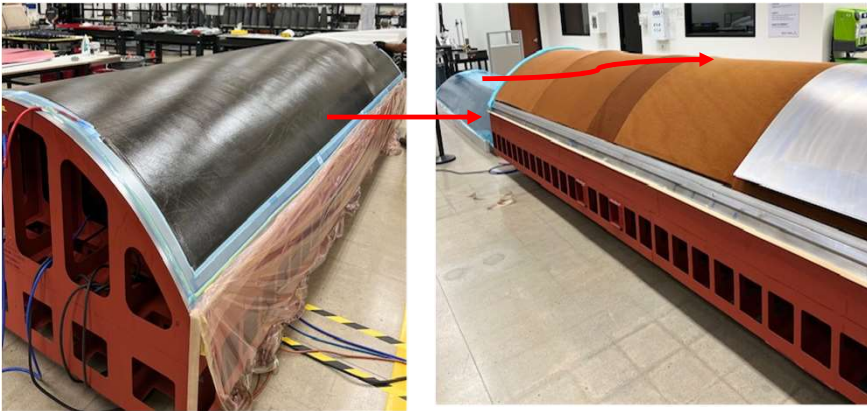
Typical Fiber Properties	U.S. Units	SI Units
Tensile Strength	700 ksi	4889 MPa
Tensile Modulus (Chord 6000-1000)	63.0 Msi	434 GPa
Tensile Modulus (Tangent 1/2 Load)	65.6 Msi	452 GPa
Ultimate Elongation at Failure	1.0%	1.0%
Density	0.0661 lb/in ³	1.83 g/cm ³
Weight/Length		
6K	11.8 x 10 ⁻⁶ lb/in	0.210 g/m
12K	23.6 x 10 ⁻⁶ lb/in	0.422 g/m
Approximate Yield		
6K	7088 ft/lb	4.76 mv/g
12K	3527 ft/lb	2.37 mv/g
Tow Cross-Sectional Area		
6K	1.8 x 10 ⁻⁴ in ²	0.12 mm ²
12K	3.57 x 10 ⁻⁴ in ²	0.23 mm ²
Filament Diameter	0.195 mil	4.9 microns
Carbon Content	99%	99%

Resin Properties

Property	Value
Density	1.19 g/cm ³
Outgassing (TML)	0.18%
Outgassing (VCM)	0.00%
Water absorption	< 1.2%
Dielectric Constant @ 3GHz	Dk/Df= 2.75/0.003
Toughness Kic	0.75 in-lb/in ²

Property	Value
Tg , standard cure	396 °F
Tg, 400°F Post Cure	435 °F
Tension Strength	8.23 Ksi
Tension Modulus	0.56 Msi
Compression Strength	21.5 Ksi
Compression Modulus	0.66 Msi

Quarter Section Co-cure Lay-up & Cure



Bag-Side Skin lay-up to be removed and placed back on core once it is assembled



Tool-Side Skin lay-up



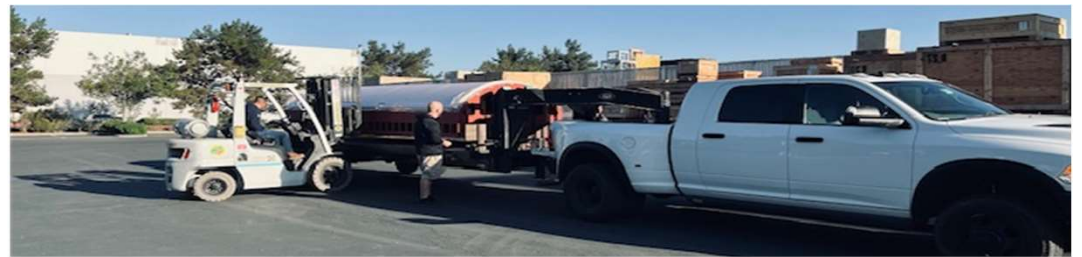
Core sheets bonded together with Arldite 2011 w phenolic micro ballons



Qtr section Bagged for cure held under Vacuum for minimum of 48 hrs prior to cure



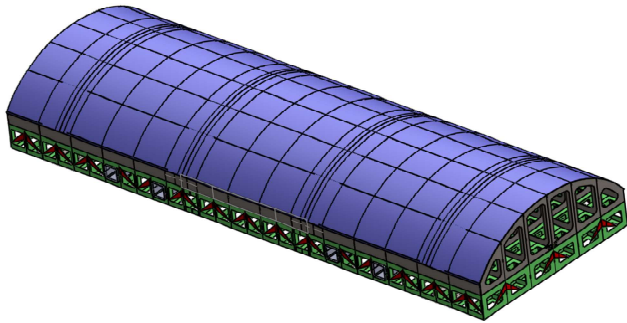
Transported to Rock West North for autoclave cure (a 5 min trip)



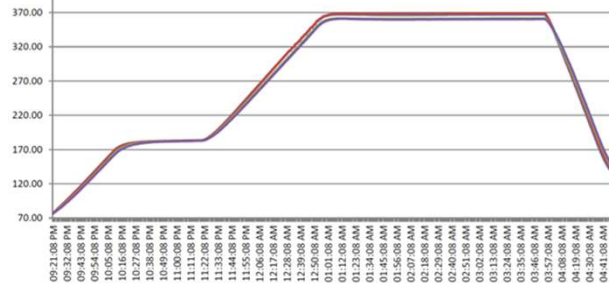
Curing- Tooling made In-House. Parts Cured at RWC North

Lay-up tooling:

1. The lay-up tool will be made from steel
2. tack welded to the iso-grid under structure



Section Bagged readied for 5 min trip to Rock west North



1. Apply 10 psi pressure
2. Heat to 180F
3. Increase pressure to 20 psi
4. Hold @ 180+/-5F for 1 hr & 20 psi
5. Heat to 350+/-10 F
6. Hold at 350+/-10 and 20psi for 4 hrs
7. Cool to RT dump pressure @ 150F



Section fits well in 20 ft autoclave



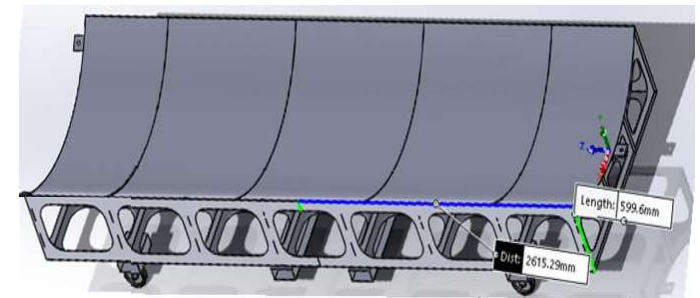
Section awaits pick up after cure

Machining Fixture

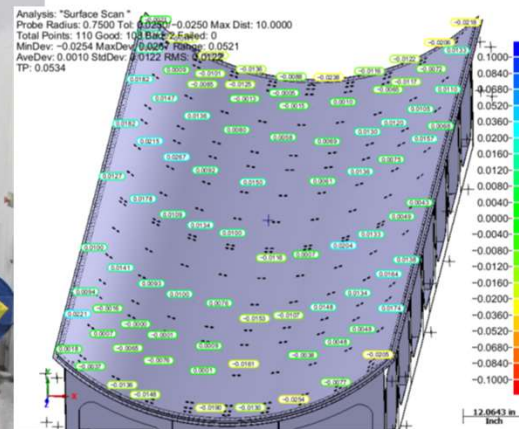
Tacked together sheet metal laser cut fixture offers support and positional controls to the quarter sections during the machining



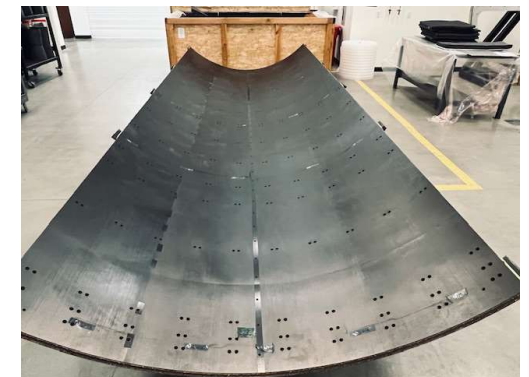
Strong Back Machining fixture holds the pre-machined qtr section to Radii during machining opp



Simple welded sheet metal fixture



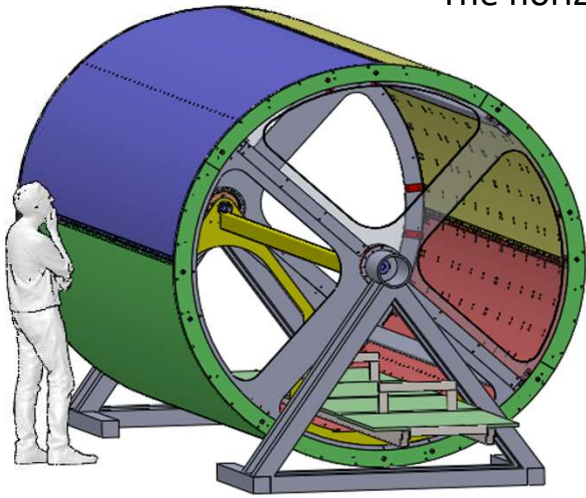
Machining vendor maps hole pattern



Qrt Section received – ready for assembly

Horizontal Rotisserie ASFX

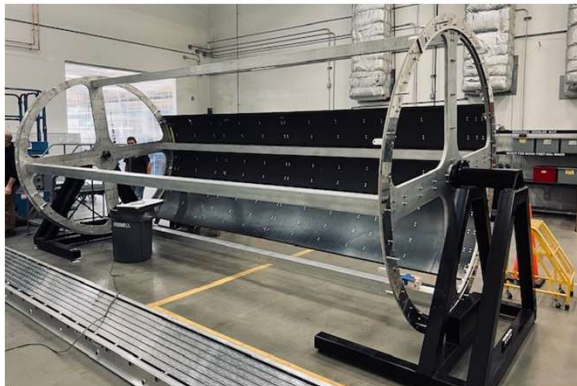
The horizontal fixture takes some risk out of the assembly process.



Rotisserie assembly fixture initial design



Rotisserie assembly with Tracker inside



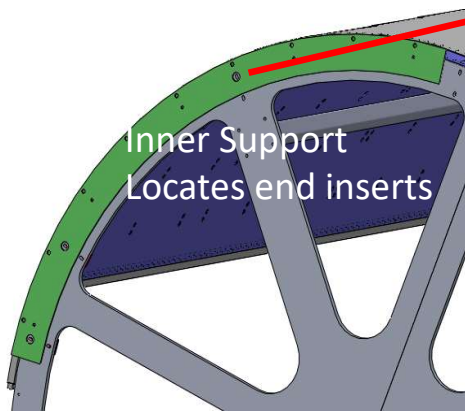
Rotisserie assembly fixture as built



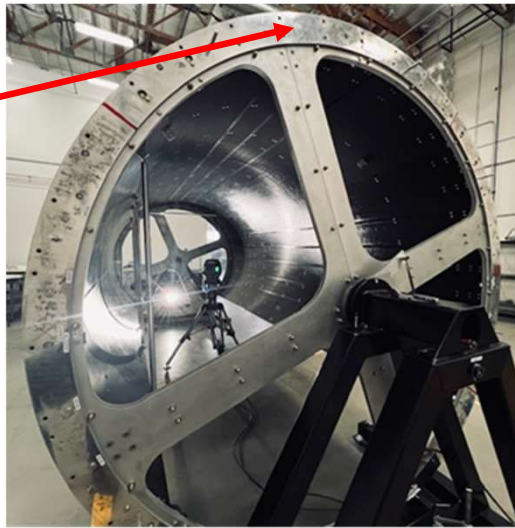
Note how thin this 1" thick sandwich looks on an 8ft dia cylinder

The assembly team

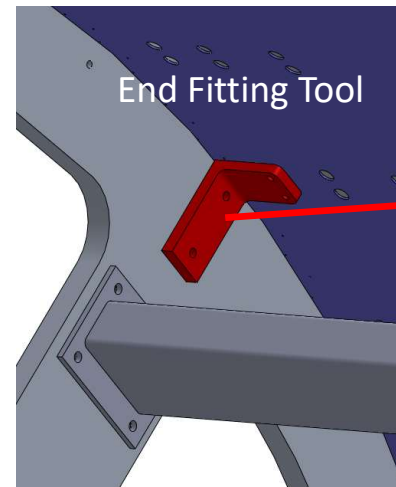
Keeping End Ring to Quarter Section Positions



End ring 30-degree sections are assembled and located as 90-degree arcs



Spreading bars were used to remove gravity sag in cylinder so hole pattern RMS could be best fit to end rings



Angle Plates used to tie end ring fixture to panel insert locations

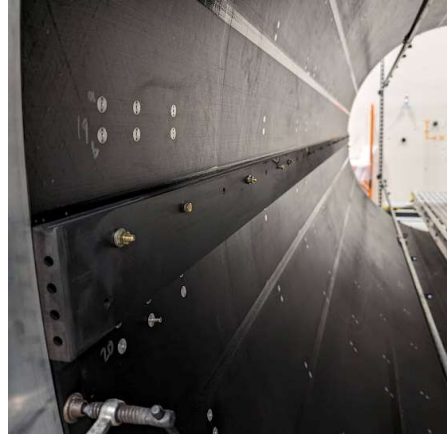


Angle Plates shown attached to inner skins by potted inserts

K13916/F6 isotropic Rails

Material

- K13916 Pitch fiber- 110 Msi- 435Ksi tension- 300gsm
 - Orientation (0/60/120/120/60/0)¹⁵ –
 - PREPREG, K13916/F6 PW, 300 GSM FAW, 0.0010" CPT
 - Estimated to be 30MSI



Quality Goals

1. Maintain as Manufactured design
2. Maintain actual Processes and variations to those processes
3. Retain Materials traceability
4. Inspect final assembly

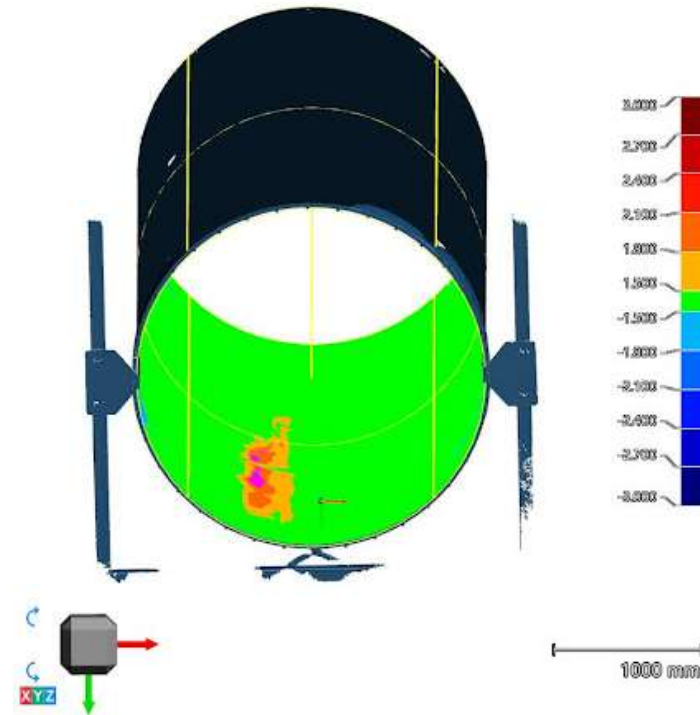
Verisurf Inspection Report

Serial Number: 001	Part Name: BTST Assembly		report_image	
Program #: 23-539-01	Inspector: X. Guerrero			
DWG #: BTST Full Assembly	Date: 2/12/24			

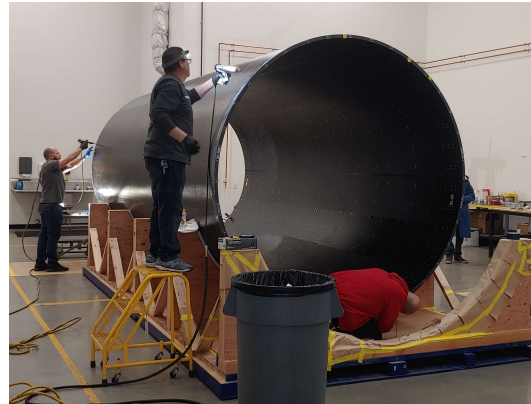
Measurements						
	Measured	Nominal	Tol +	Tol -	Dev	OOT
Inner Surface						
Radius	1190.8814	1191.0000	1.5000	-1.5000	-0.3186	Pass
Cylindricity	2.4453	2.0000			0.4453	Fail
Outer Surface						
Radius	1219.7484	1221.0000	1.5000	-1.5000	-1.2516	Pass
Overall Length / Using: Plane1 - Plane2						
DZ	5299.8967	5300.0000	1.5000	-1.5000	-0.1033	Pass
End to End Parallelism / Using: Plane1 - Plane2						
Calculated Deviation	0.1086	Nominal	0.2500			Pass

Screenshot

Analysis: Inner Surface-Reduced.vt
 Probe Radius: 18.055 To: MBD Max Dist: 25.200
 Total Points: 1147 Good: 533 Bad: 512 Filter: 0
 MinDev: -1.031 MaxDev: 1.388 Range: 2.419
 AreaDev: 0.288 StdDev: 0.505 RMS: 0.588
 TP: 2.776



Packing and Shipping





Rock West
COMPOSITES® 

Lightening Your Load
with Advanced Composites



Our Growth

SALES



Record 43% growth
in sales for 2023

27% 10 Year CAGR





Our People



Experienced and Educated Team of Employee-Owners

San Diego South – Prototype to Medium Batch Production



San Diego North – Fiberglass layup, Metal Forming, Build-to-Print Aerospace Sub-assemblies, Spares



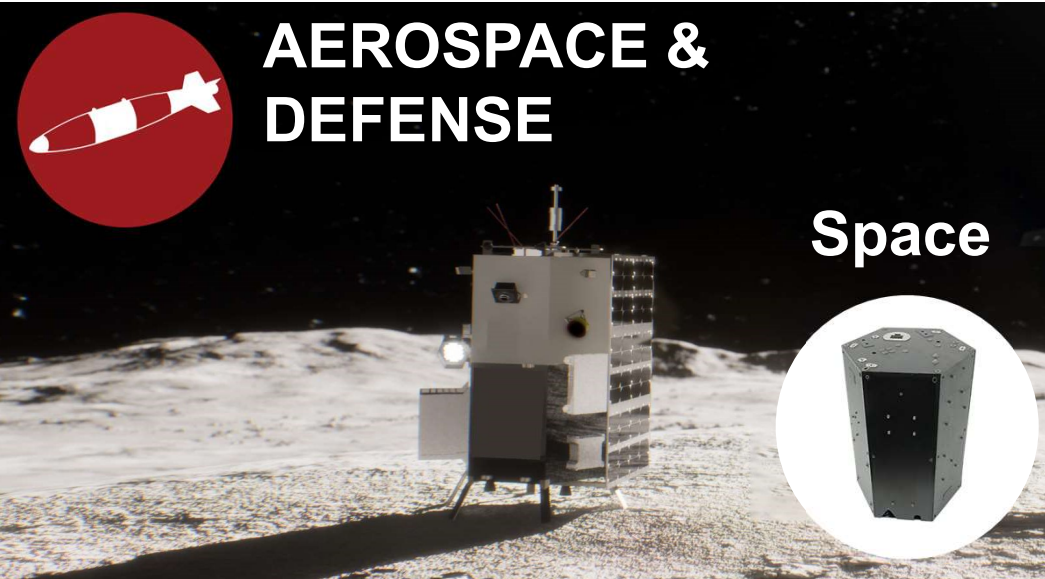
Salt Lake City – Ecommerce, Prototype to Medium Batch Production



Tijuana – High-Rate Production



AEROSPACE & DEFENSE



Space



Structures



Aircraft



Radomes





COMMERCIAL

Industrial



Medical



Sporting



Energy



ECOMMERCE

Thousands of Items

Machining Services Available

Tubes

Plates



STRATO

First Ever Off-the-Shelf selection of Space Ready Tubes, Plates, Panels & Solar Arrays

All the components and tools needed to build custom composite parts

Materials and Accessories

Manufacturing Methods

Lay Up / Molding

- Open mold wet lay up
- Prepreg
- Resin infusion
- Roll Wrap
- Filamented winding – wet
- Tape Wrap
- Bladder molding
- Compression molding
- Vacuum forming
- Metal Bonding



Manufacturing Methods

Curing

- Oven
- Autoclave
- Press

Assembly

- Bonding – inserts and fittings
- Precision assembly – optical structures

Trim and Paint

- Large grind and sanding booths
- Tube Sanding
- Large paint booths

Machining

- Conventional machining centers
- CNC
 - 3 axis
 - 4 axis
 - 5 axis

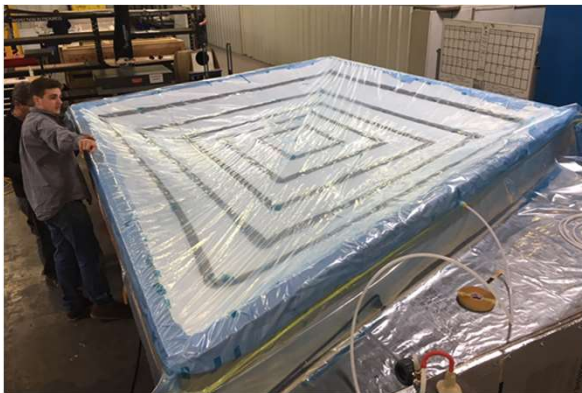


Large RF Test Body

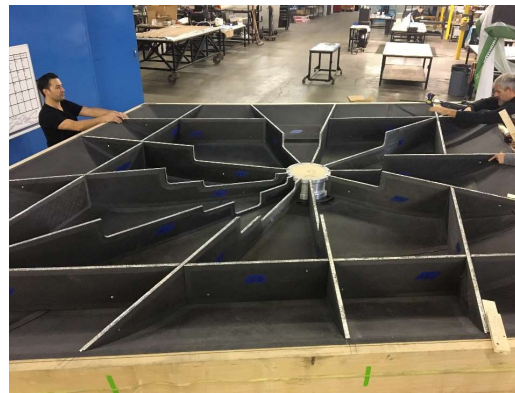
- Tooling – MDF In Five Sections
- Infused, High Mod Carbon Skins
- Aluminum Core Inner Ribs



Strategic coatings are used control FR absorption



20' - Tip To Tip- infusion bag being completed



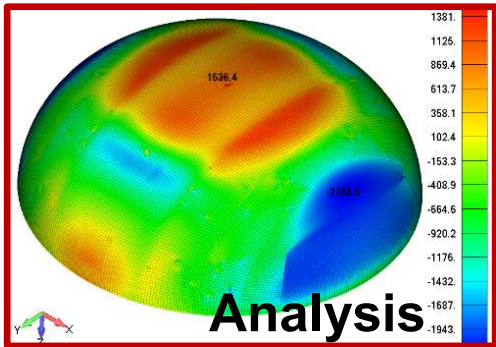
Sandwich ribs used to drive the loads to an off-center mounting hub



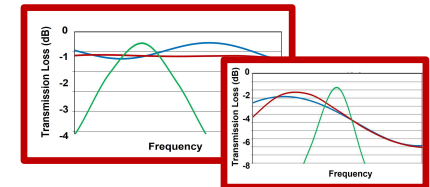
Top deck skin of the Test Body hand carried to final assembly. It's a dance

RF Structures

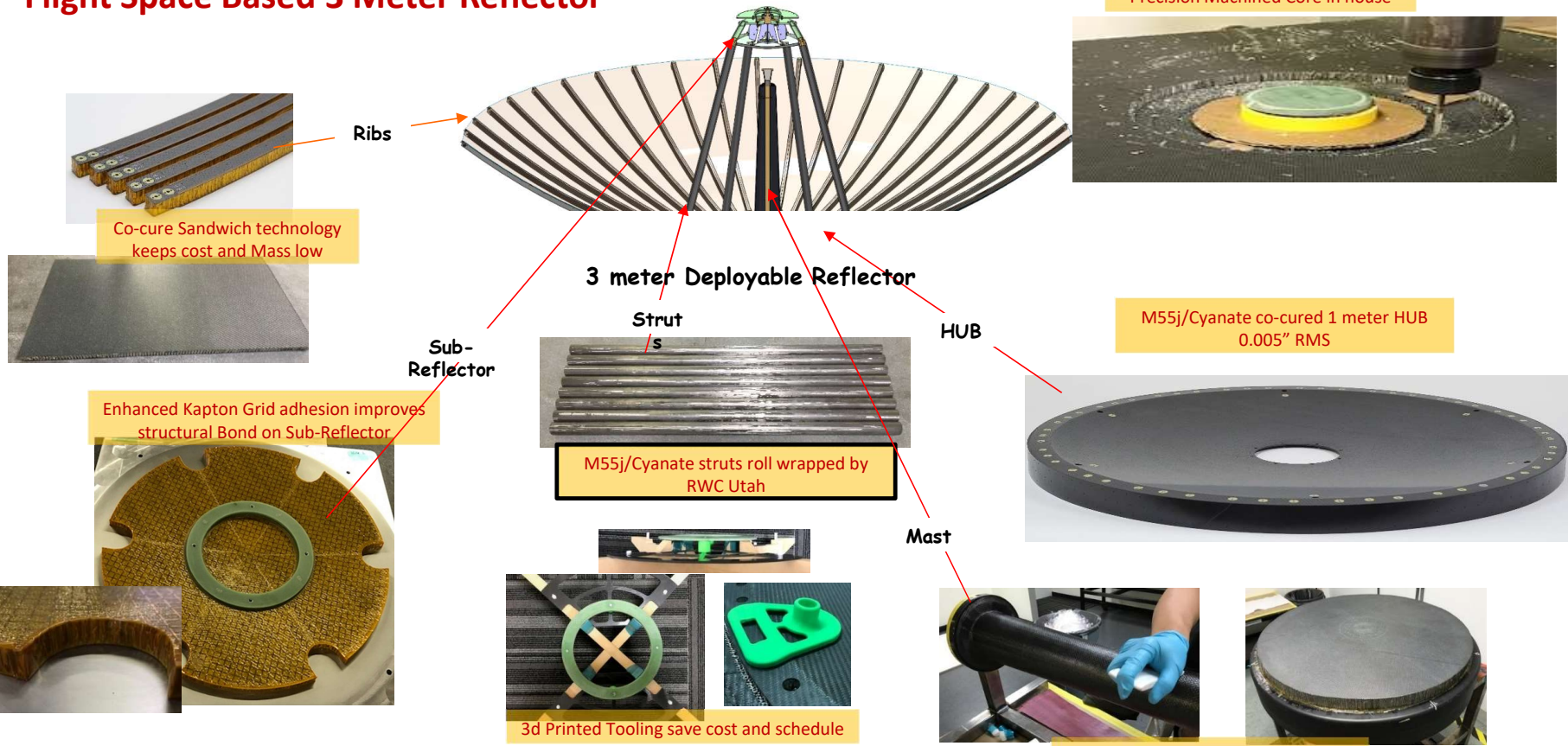
- RF and Structural Design & Analysis



- Testing
 - Structural
 - Radio Frequency



Flight Space Based 3 Meter Reflector



Reflector Program supplies State of the Art hardware at a fraction of the cost



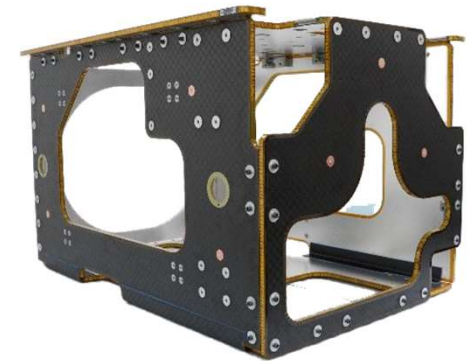
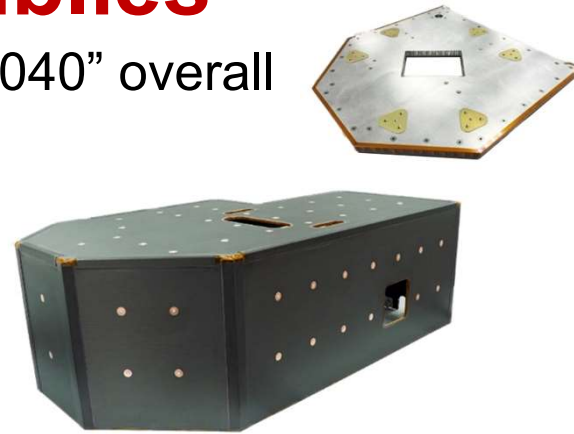
Reflectors

- Multiple materials available
- Egg-crated backup structure or other assembly method
- Tight RMS tolerances available, <math><0.005\text{''}</math> and better
- Monolithic graphite tool build process
- Multiple reflector geometries available



BUS Panel and Assemblies

- Up to 72"x170", flatness of 0.020"/m², 0.040" overall
- Aluminum and composite face sheets
- Wide range of core densities
- Adhesive film reticulation available
- Integrated heat pipe/wires
- Core potting
- Precision feature machining
- Precision insert and fittings potting/bonding
- Edge closeout (Kapton tape, potting, etc)
- Grounding
- Multi-panel assembly
- Thermal/Emissivity coatings



Rock West 

Solar Array Substrates and Wing assemblies

- Up to 72"x170", flatness of 0.020"/m², 0.040" overall
- Thin face sheets, down to 0.007"
- Low density core, down to 1.0 PCF
- Adhesive film reticulation available
- Co-cured Kapton
- Laminate and sandwich panel
- Core potting
- Precision feature machining
- Resistance verification
- Thermal/Emissivity coatings
- Precision insert/fitting potting/bonding
- Wing assembly



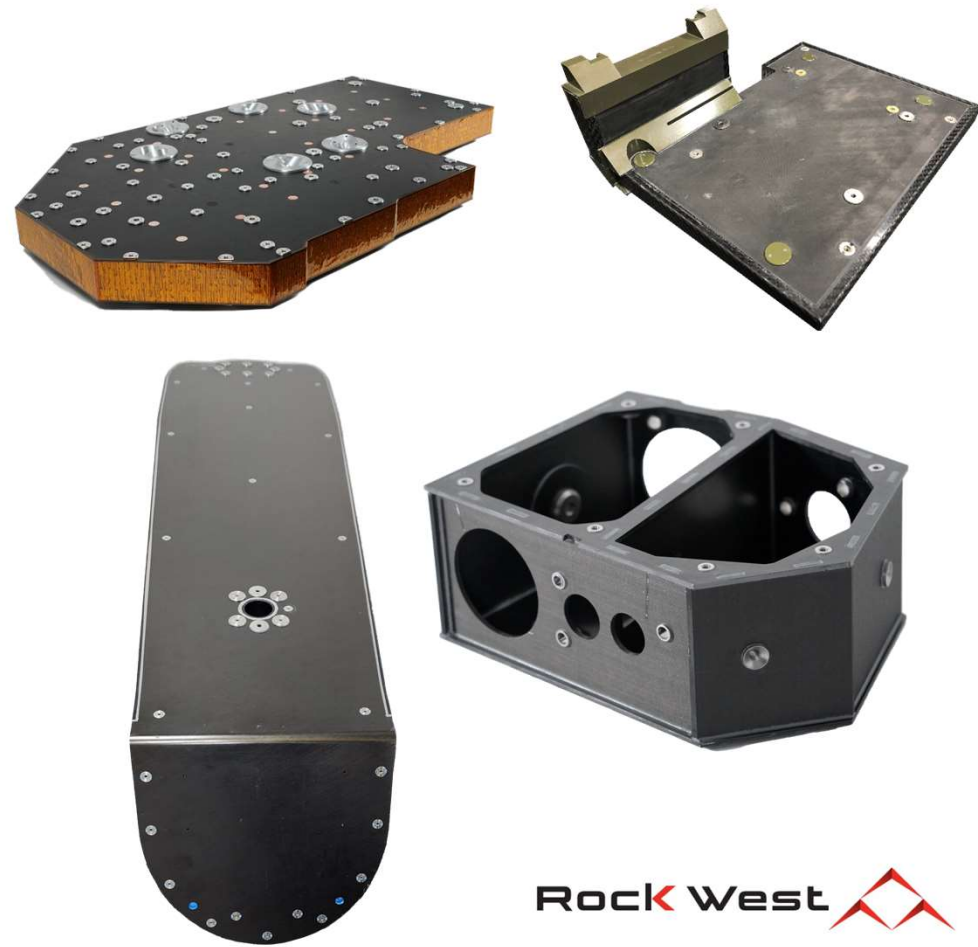
Struts and Assemblies

- Diameter range 0.100" to 4"+ diameter
- Thickness from a few plies to 0.5"+ thick
 - May require multiple cures
- Uni-direction and Fabric material
- Local buildups
- Precision machining for diameter, length, and features
- Tight tolerance fitting and structure bonding
- Grounding and secondary operations
- Structural testing
- Thermal/Emissivity coatings



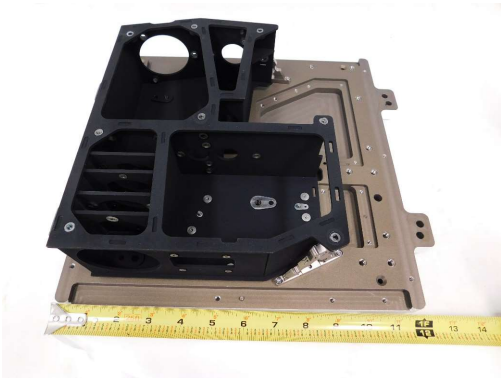
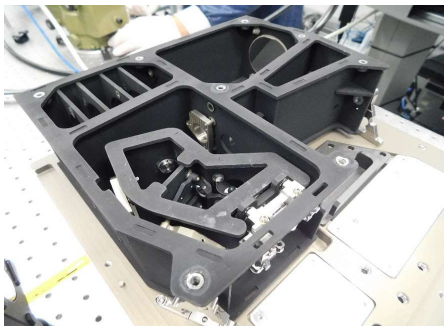
Optical Benches

- High modulus carbon fiber face sheets tuned for CTE
- Adhesive film reticulation available
- Wide range of core densities and core materials
- Laminate and sandwich panel
- Core potting
- Precision feature machining
- Precision insert and fitting potting/bonding
- Resistance verification
- Various coatings available (metal plating, foil, etc.)
- Thermal/Emissivity coatings



High Precision Optical Benches

- High modulus carbon fiber with low outgassing resin for NASA space application
- Low coefficient of thermal expansion (CTE) for very stable structure and precise optics
- Precision machined and assembled. Very tight tolerances on bench walls and placement of optics (less than $\pm 0.005''$)



Ground-based
Optical
Communication
System



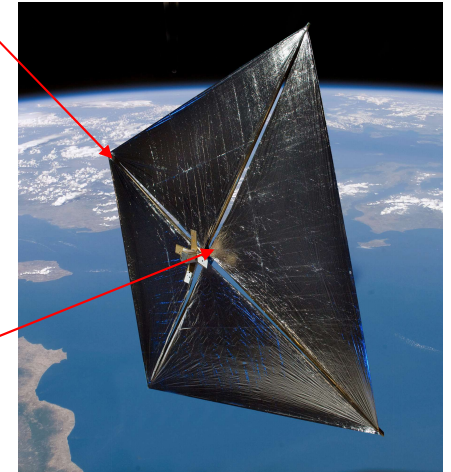
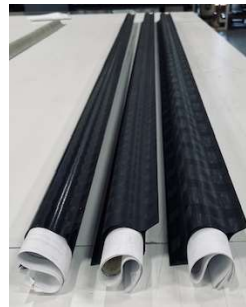
Optical Metering Tubes and Telescope Assemblies

- High modulus carbon fiber tuned for CTE
- Precision insert and fitting bonding
- Various coatings available (metal plating, co-cured foil, etc.)
- Thermal/Emissivity coatings
- Multi-Piece Bonding/Assembly
- Experience in <.2m up to 1m



Deployable Structures

- Telescoping tubes of circular or polygonal geometries
 - Tight IML and OML profiles
~0.010"
- High strain composite rollable deployable members
- Hinged panels
- Tight tolerance bonding assembly and integration
- Rollup solar sail booms 20 ft dev and 50 foot production.



16 section expandable truss extends
From each satellite

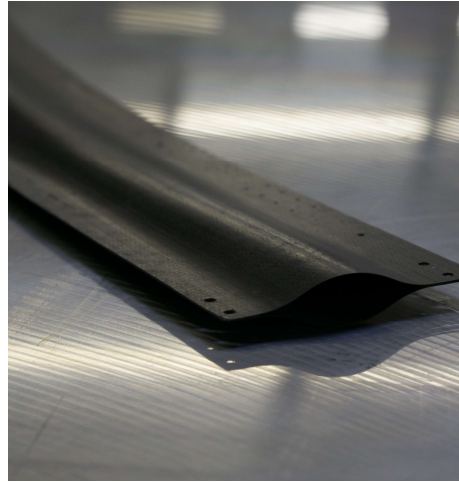
3000 low earth orbit satellites planned



Proof of Concept



Process Development



Verification



Delivery

Heritage Supplier of Deployed Omega Booms







STRATO™ Space Grade Products

- Inventoried Space Grade Material

Material Type	STRATO GEO	STRATO LEO
Prepreg - Uni	M55J/PMT-F33 Unidirectional High Modulus Carbon/Cyanate Ester 84 GSM, 32% RC (0.0028" CPT, 57% FV)	HR40/NB321 Unidirectional High Modulus Carbon/Epoxy 80 GSM, 40% RC (0.0034" CPT, 50% FV)
Prepreg - Fabric	T300 PW/PMT-F33 Fabric Standard Modulus Carbon/Cyanate Ester 80 GSM, 32% RC (0.0027" CPT, 57% FV)	AS4 PW/NB321 Fabric Standard Modulus Carbon/Epoxy 190 GSM, 45% RC (0.0093" CPT, 40% FV)
Film Adhesive	FM300-2U 0.030 PSF FM300U 0.030 PSF	NB301 0.030 PSF
Core Splice	FM410-1 0.050	NB51-301 0.050
Paste Adhesives	EA9394 EA9396 EA9396.6MD	



STRATO™ Space Grade Products

Product	Description	Standard Size
 STRATO Tube™	-Quasi-isotropic tubes from STRATO GEO and STRATO LEO unidirectional materials -Plain-Weave fabric available at ID and OD	72" Length
 STRATO Plate™	-Quasi-isotropic flat laminates from STRATO GEO and STRATO LEO unidirectional materials -Plain weave fabric available at top and bottom surfaces	48"x96" Area
 STRATO Panel™	-Sandwich panels with quasi-isotropic carbon face skins and film adhesive from STRATO GEO and STRATO LEO materials -Sandwich panels from aluminum face skins with a variety of coatings with film adhesive from STRATO GEO and STRATO LEO	48"x96" Area
 STRATO Substrate™	-Sandwich panels with quasi-isotropic carbon face skins, co-cured 0.002" HN Kapton and film adhesive from STRATO GEO and STRATO LEO materials	48"x96" Area

- Predicted properties provided, characterized properties in progress
- Full deliverable paperwork package available
 - Material certs, Cure data and out time logs as required, WIP testing as required, CTE testing as required
- Uses Rock West stocked materials for < 6-week lead time



Quality

Quality Policy

Rock West Composites is committed to deliver products and services that meet or exceed expectations, on-time, and at the best possible price to ensure customer satisfaction and company growth. Rock West Composites does this by promoting a culture of continuous improvement of the quality management system.

Quality Objectives

- ⤴ Achieve 95% or greater on-time delivery of products and services.
- ⤴ Achieve 97.5% or greater delivered product quality.
- ⤴ Achieve 90% or greater customer satisfaction.
- ⤴ Achieve 10% or greater company growth.

5s

SORT

STRAIGHTEN

SHINE

STANDARDIZE

SUSTAIN

+2

SAFETY

SENSE OF URGENCY

Rock West Composites has established, implemented, and maintains a quality management system certified to AS9100D including ISO 9001:2015



ITAR
REGISTERED



Rock West 




Support

- Competitive burdened labor rates
 - DCAA approved rates
- Robust **Supply Chain**
 - Long-term supply relationships
 - Commitment to inventory
 - Raw materials
 - Supplies
 - Finished Goods
 - Significant cold storage space
 - Multi-site shipping and receiving
 - Rapid ecommerce fulfillment



Our Customers



NORTHROP GRUMMAN

TOYON

Raytheon

ARMAMENT DIRECTORATE

CUBIC

MILLENNIUM SPACE SYSTEMS
A Boeing Company

BOEING

NASA JPL

BLUE ORIGIN

INTUITIVE MACHINES

LOCKHEED MARTIN

IS4S
Intelligence Solutions for Systems

GENERAL DYNAMICS
Ordnance and Tactical Systems

MIMA Design

SHIELD AI

amazon | project kuiper

amazon Prime Air

Skydio

SPIRIT AEROSYSTEMS

HEXAGON
MANUFACTURING INTELLIGENCE

LUTRON

TURNER IMAGING SYSTEMS

AURIS

GARRETT

Nine

SIMPSON


BPI OUTDOORS

SUBIOMED
suspension biomechanics for life

Deadlywind

RIFFE

CHRISTENSEN ARMS



LOWE'S

McMASTER-CARR


MSC | BUILT TO MAKE YOU BETTER

PANTHER

COLSA

★ Trustpilot
★★★★★

And thousands of very satisfied small businesses, entrepreneurs, and hobbyists



Why Rock West?



- Team of Educated and Experienced Employee-Owners



- Who are incentivized to produce innovative and high-quality products, on-time and on-budget



- Shipping over 175,000 products to more than 3,500 very satisfied customers last year alone



- Leading to sustained growth and projected sales of \$74MM+ this year

