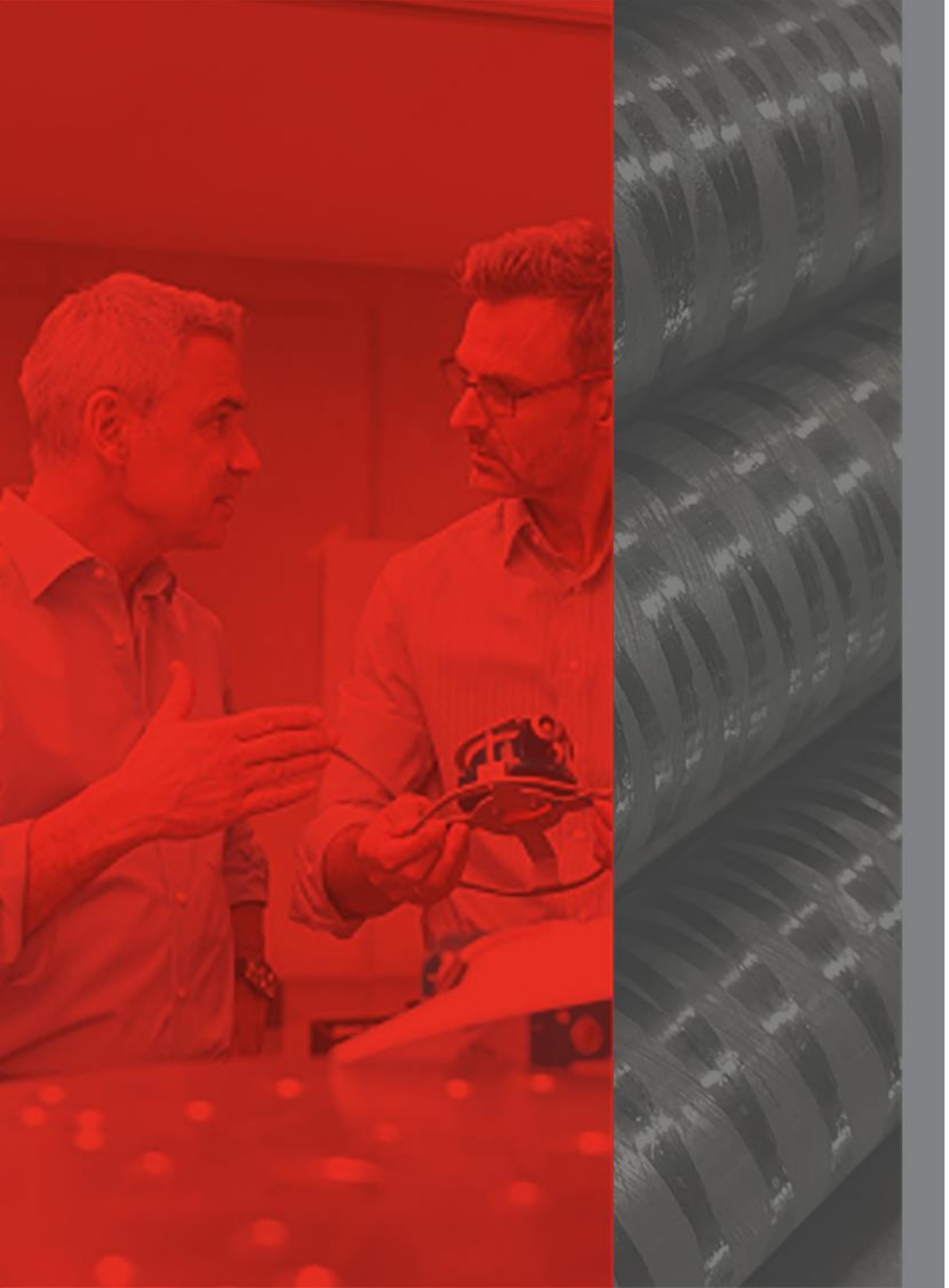


Forum on Tracking Detector Mechanics
Rock West Composites Inc.
BTST Fabrication-

Purdue University, West Lafayette USA

John Marks

May 29-31, 2024

Rock West

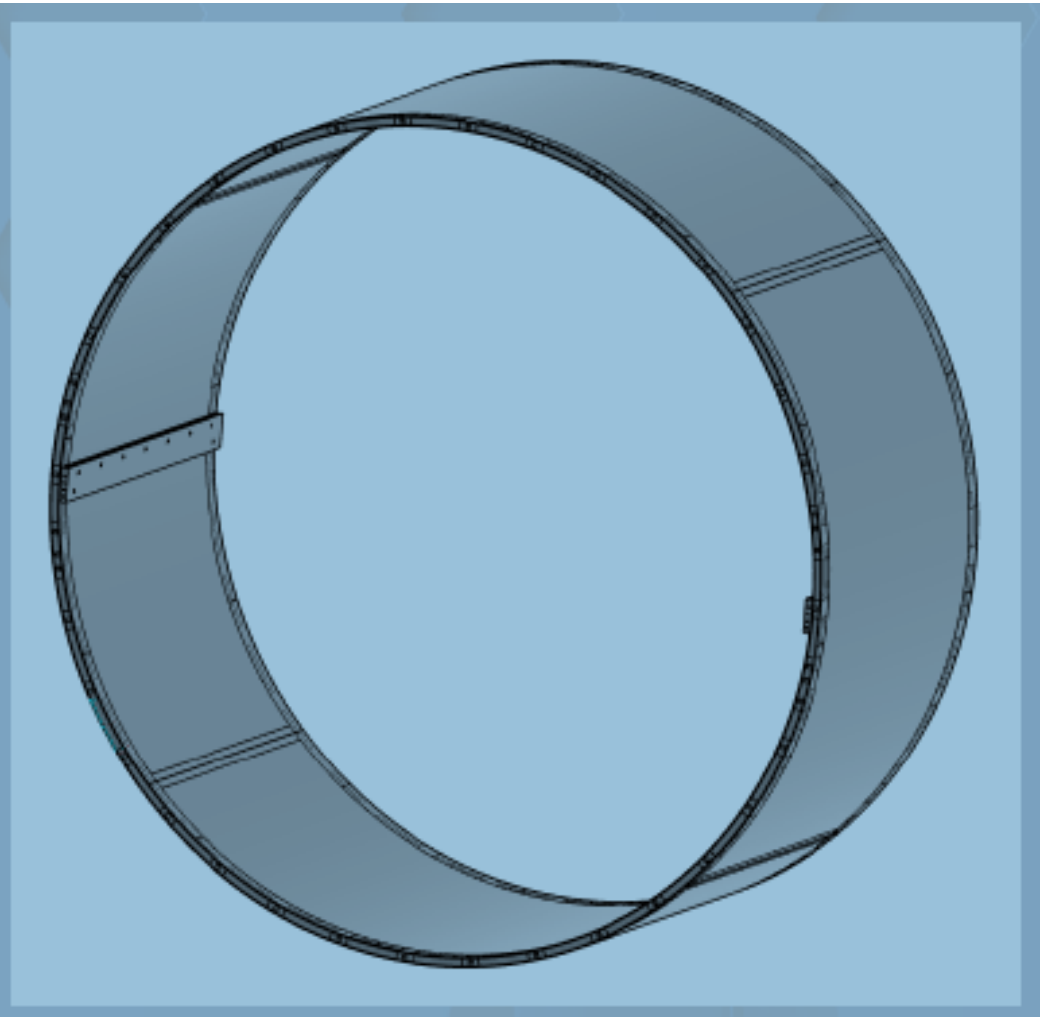
It took all of us to complete:

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

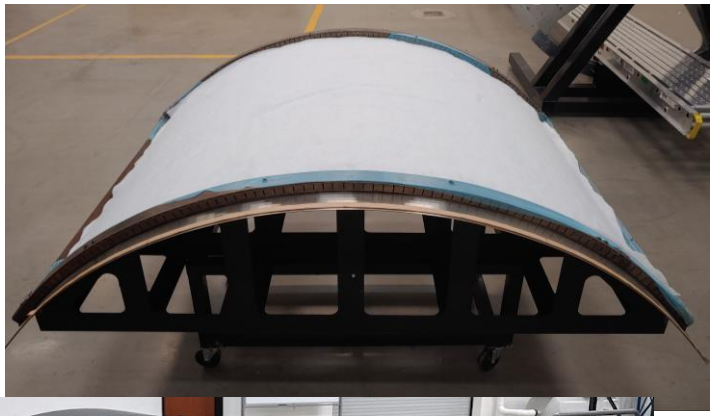
Rock West

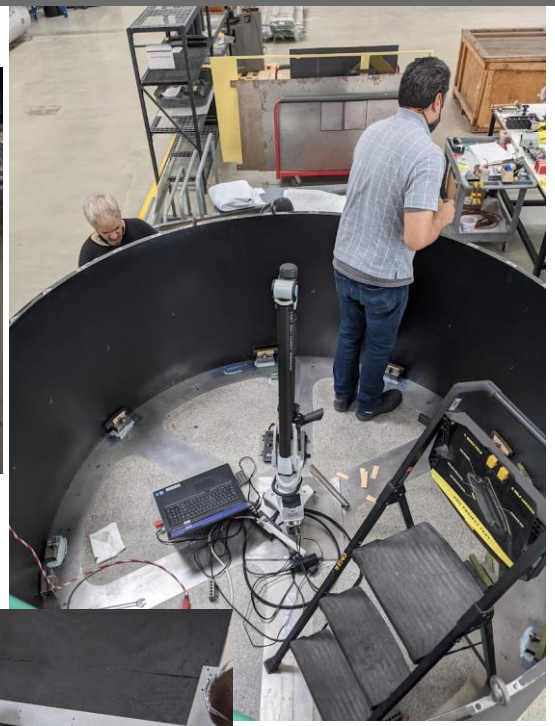
Initial 1m Prototype V3

- (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

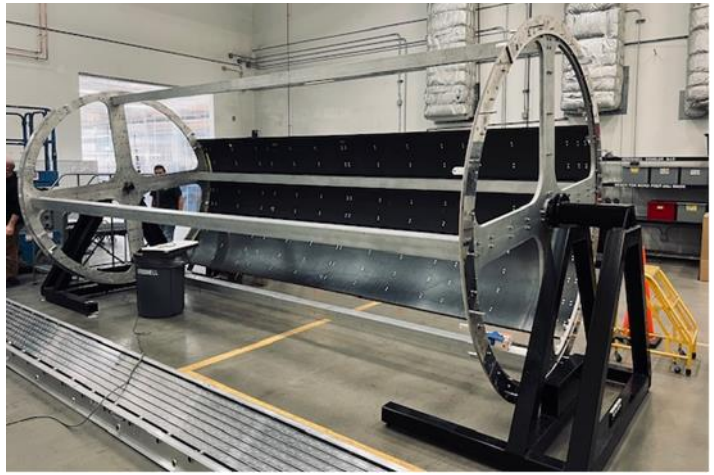




Rock West

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 ¼ 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 ¼ sections
10. Machine ¼ sections
11. Assemble spools into quarter sections
12. Assemble ¼ 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 plies2mm**
  - **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- 60º 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/in³	1.83 g/cm³
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 m/g
12K	3527 ft/lb	2.37 m/g
Tow Cross-Sectional Area		
6K	1.8 x 10^{-4} in²	0.12 mm²
12K	3.57 x 10^{-4} in²	0.23 mm²
Filament Diameter	0.195 mil	4.9 microns
Carbon Content	99%	99%

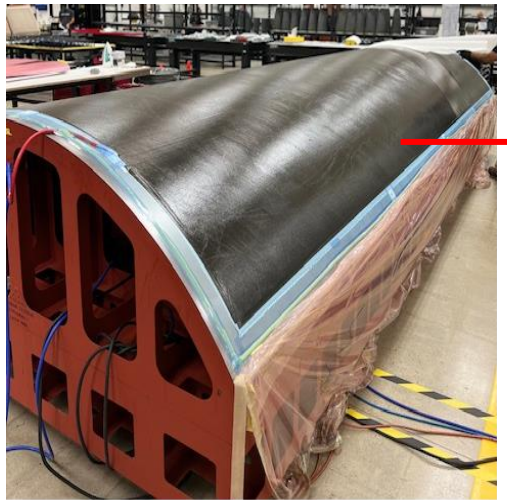
Resin Properties

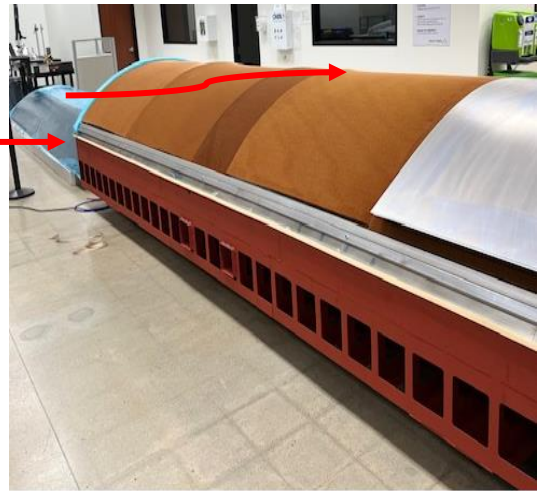
Property	Value
Density	1.19 g/cm³
Outgassing (TML)	0.18%
Outgassing (VCM)	0.00%
Water absorption	< 1.2%
Dielectric Constant @ 3GHz	Dk/Df= 2.75/0.003
Toughness Kic	0.75 in-lb/in²

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

Rock West

Quarter Section Co-cure Lay-up & Cure





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

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)

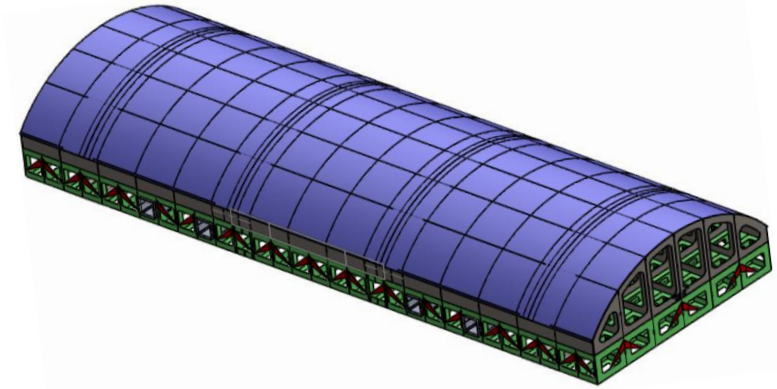
Tool-Side Skin lay-up

Rock West

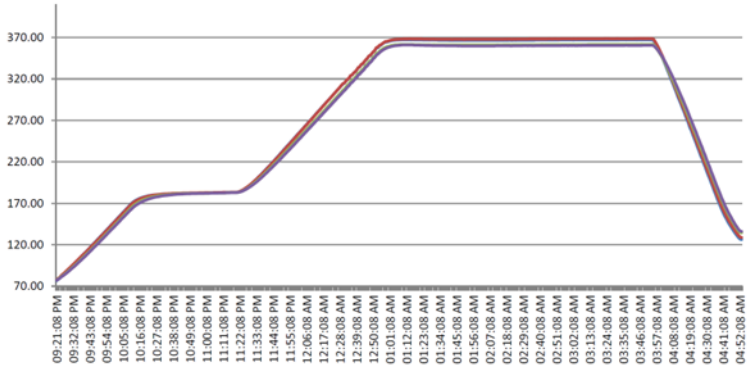
Curing- Tooling made In-House. Parts Cured at RWC North

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



Section fits well in 20 ft autoclave

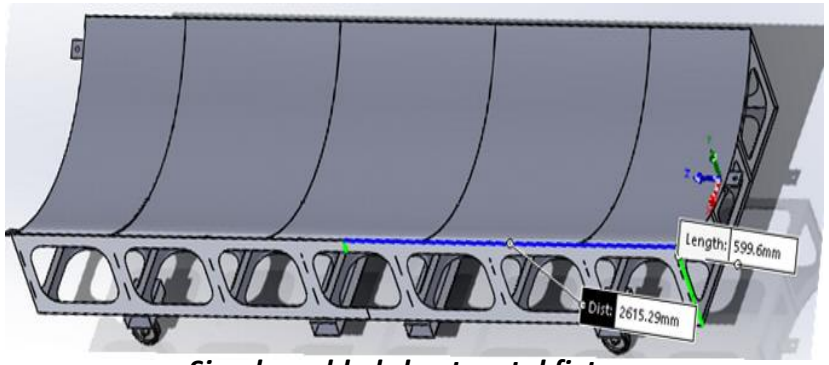
1. Apply 10 psi pressure
2. Heat to 180F
3. Increase pressure to 20 psi
4. Hold @ 180+-5F for 1 hr & 20 psi
5. Heat to 350+-10 F
6. Hold at 350+-10 and 20psi for 4 hrs
7. Cool to RT dump pressure @ 150F

Section awaits pick up after cure

Rock West

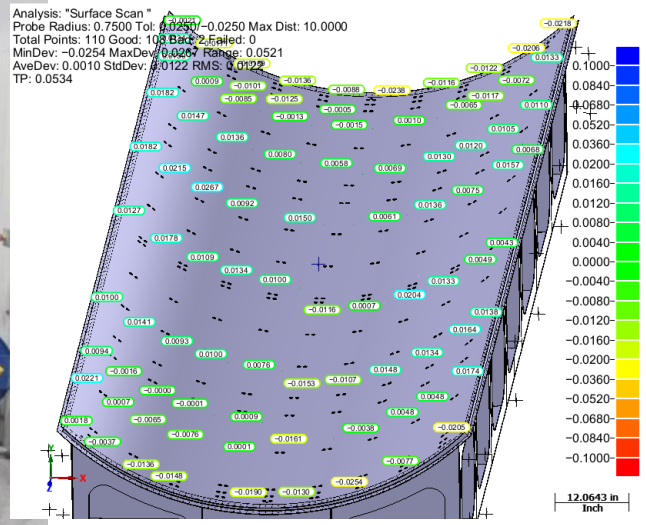
Machining Fixture

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



Simple welded sheet metal fixture

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

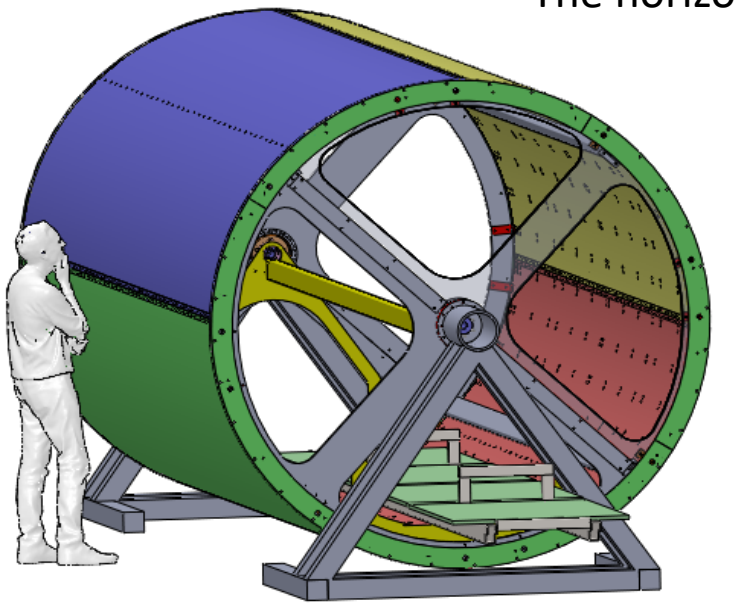


Machining vendor maps hole pattern

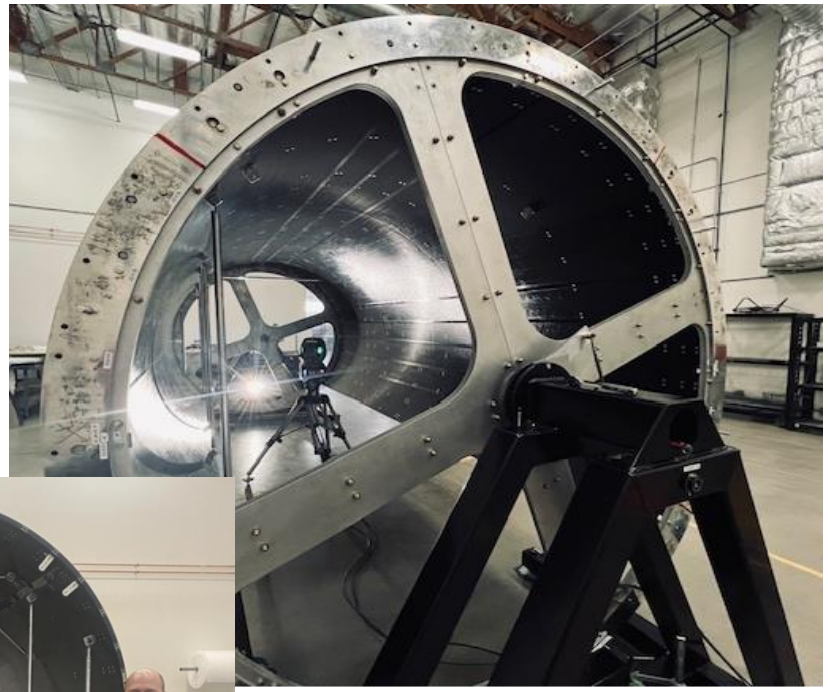
Qrt Section received – ready for assembly

Horizontal Rotisserie ASFX

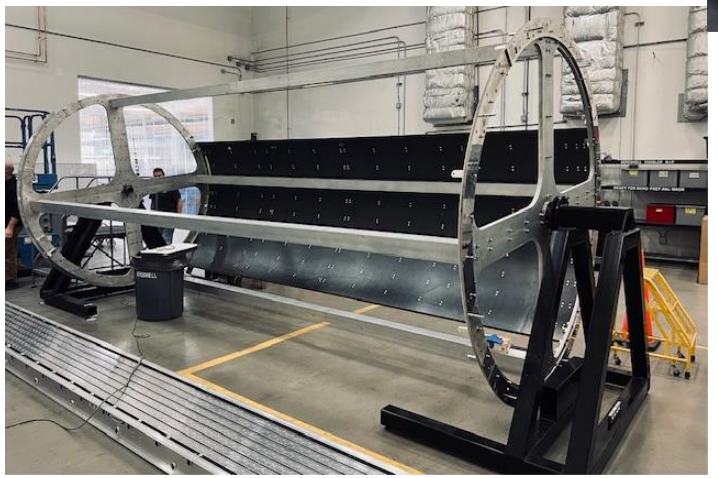
The horizontal fixture takes some risk out of the assembly process.



Rotisserie assembly fixture initial design



Rotisserie assembly with Tracker inside

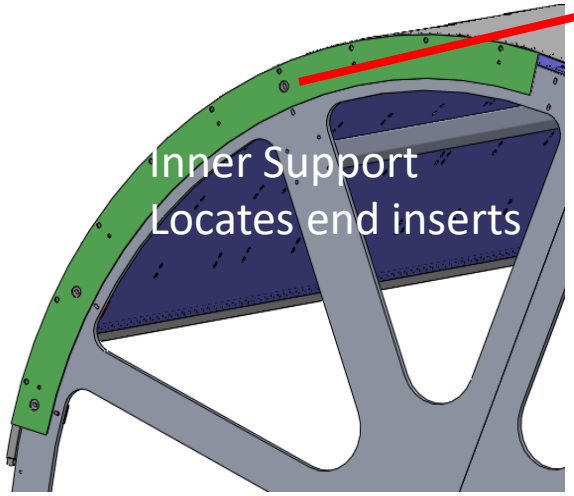


Rotisserie assembly fixture as built

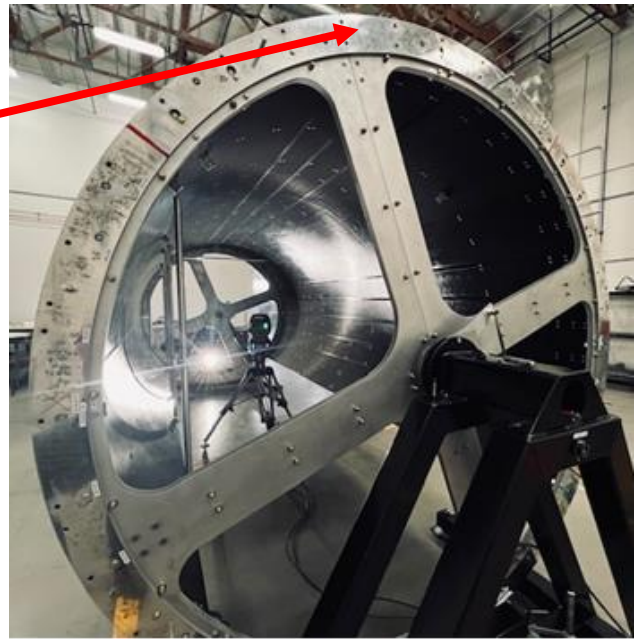
The assembly team

Rock West

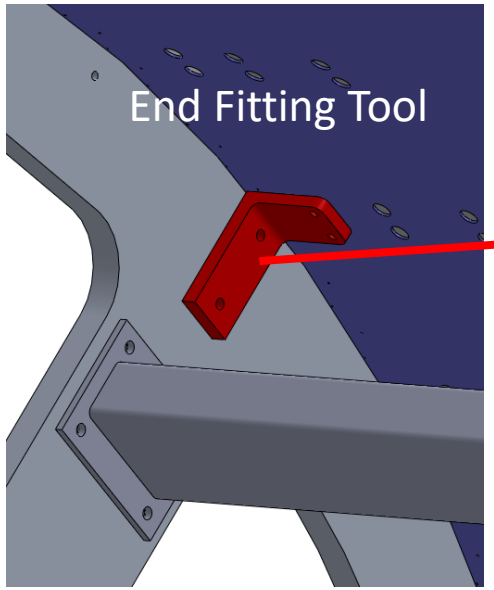
Keeping End Ring to Quarter Section Positions



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

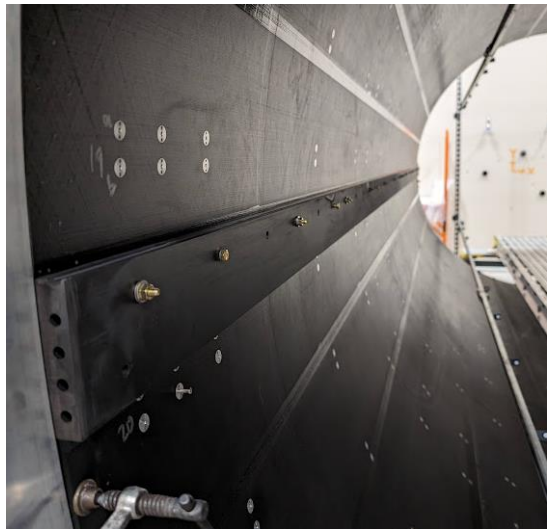
Angle Plates shown attached to inner skins by potted inserts

Rock West

K13916/F6 isotropic Rails

Material

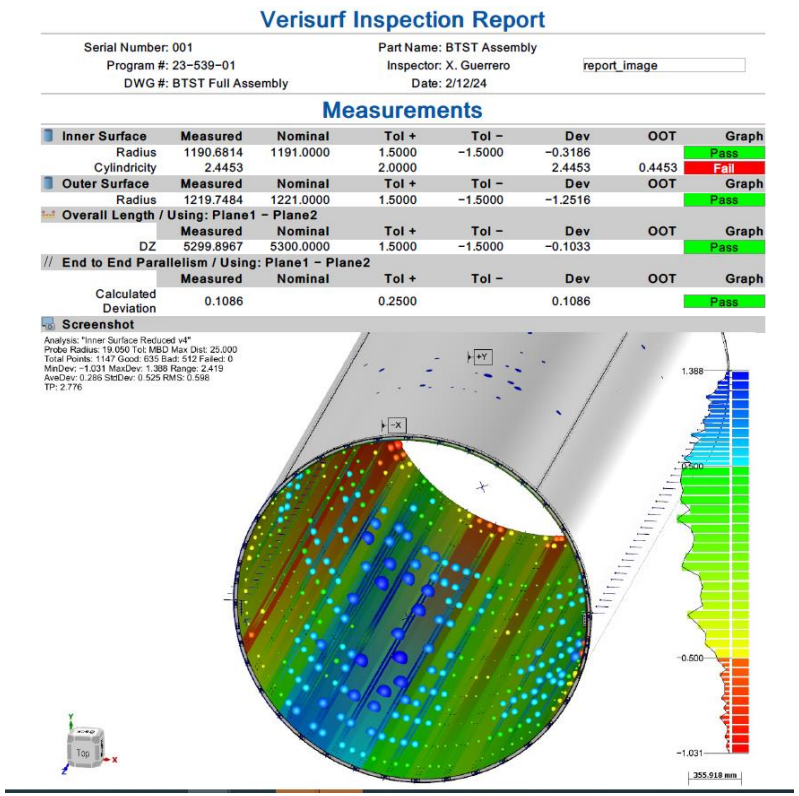
- **K13916 Pitch fiber- 110 Msi- 435Ksi tension- 300gsm**
  - **Orientation $(0/60/120/120/60/0)^{15}$ –**
  - **PREPREG, K13916/F6 PW, 300 GSM FAW, 0.0010" CPT**
  - **Estimated to be 30MSI**



Rock West

Quality Goals

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



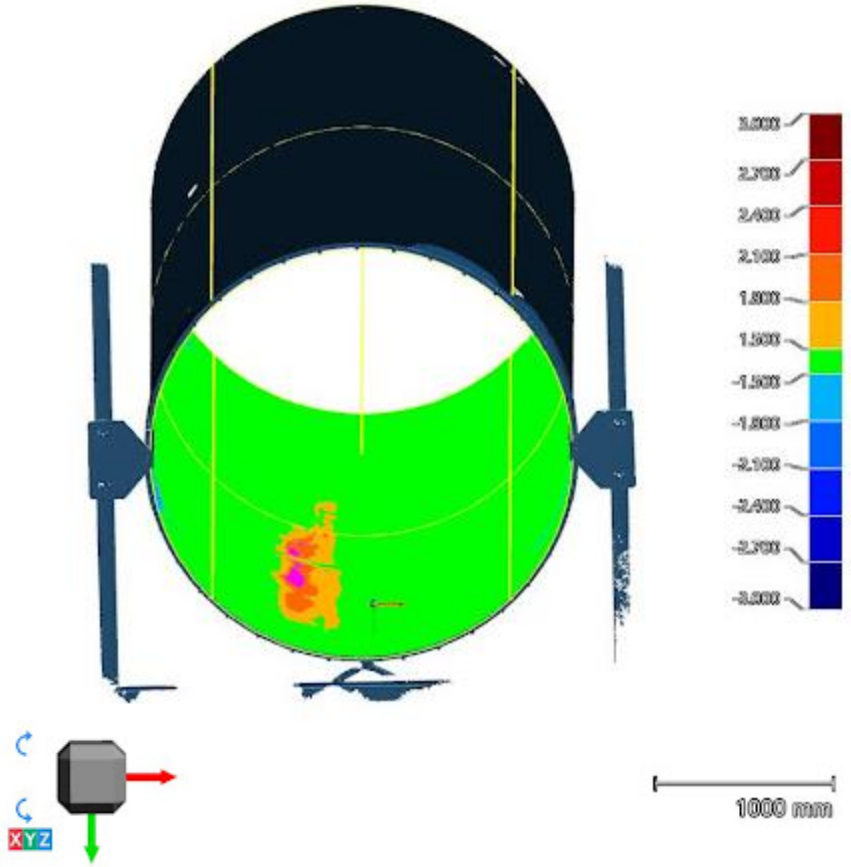
Verisurf Inspection Report

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

Measurements

Inner Surface	Measured	Nominal	Tol +	Tol −	Dev	OOT	Graph
Radius	1190.6814	1191.0000	1.5000	−1.5000	−0.3186		Pass
Cylindricity	2.4453		2.0000		2.4453	0.4453	Fail
Outer Surface	**Measured**	**Nominal**	**Tol +**	**Tol −**	**Dev**	**OOT**	**Graph**
Radius	1219.7484	1221.0000	1.5000	−1.5000	−1.2516		Pass
Overall Length / Using: Plane1 − Plane2							
	Measured	**Nominal**	**Tol +**	**Tol −**	**Dev**	**OOT**	**Graph**
DZ	5299.8967	5300.0000	1.5000	−1.5000	−0.1033		Pass
// End to End Parallelism / Using: Plane1 − Plane2							
	Measured	**Nominal**	**Tol +**	**Tol −**	**Dev**	**OOT**	**Graph**
Calculated Deviation	0.1086		0.2500		0.1086		Pass

Screenshot

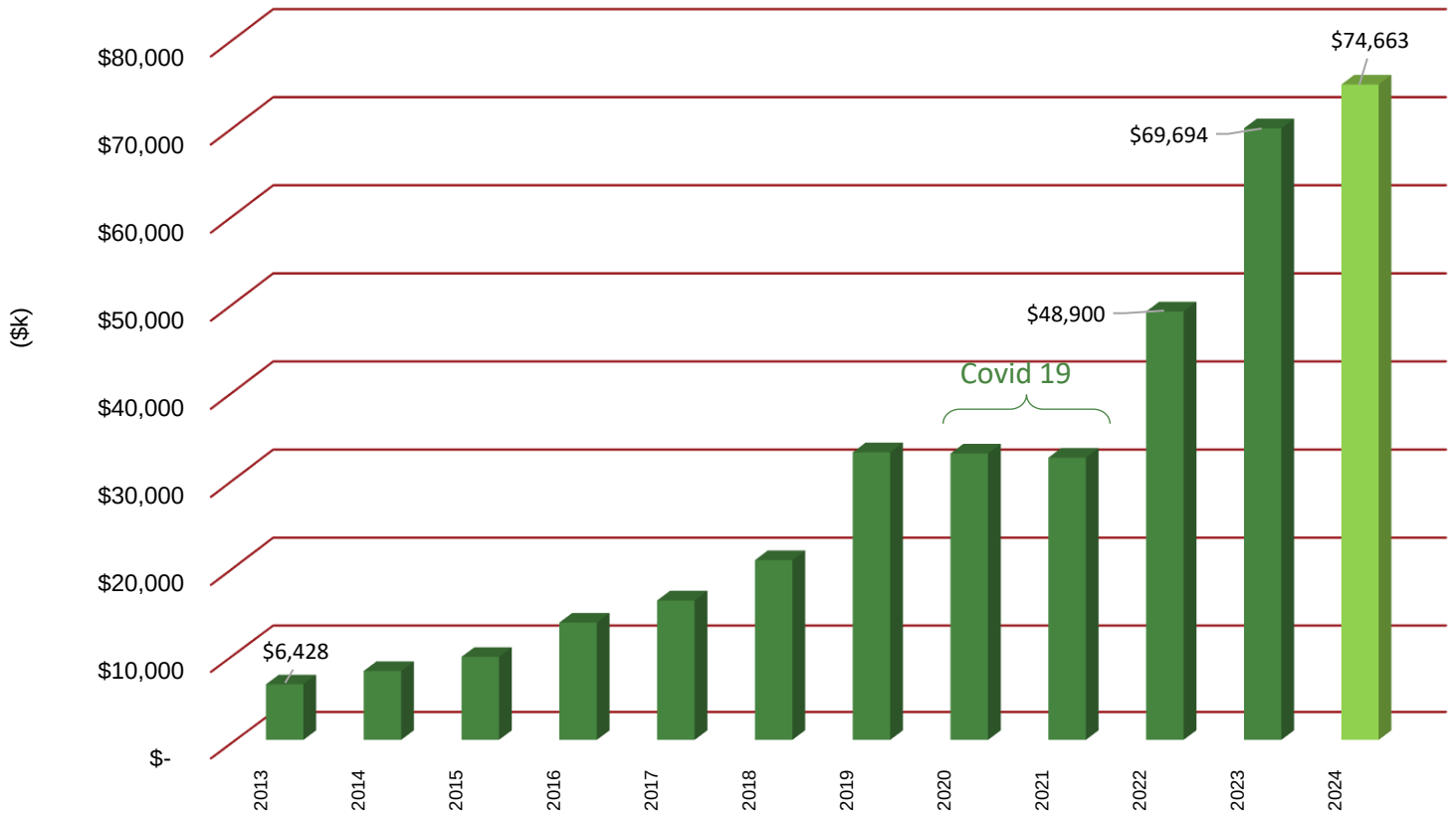


Packing and Shipping


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

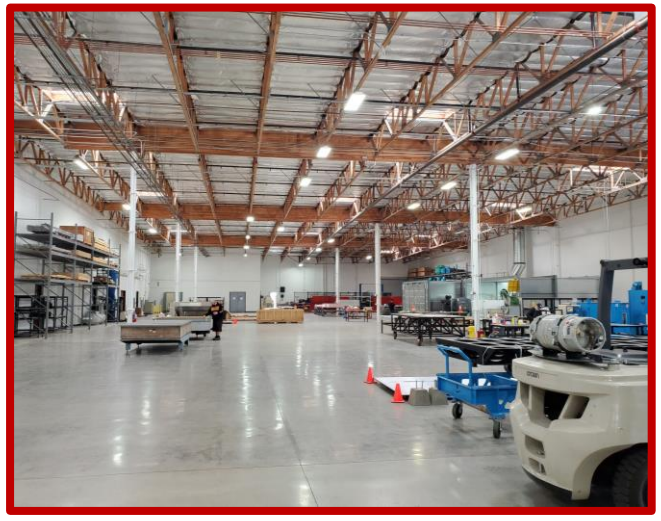
TOP WORK PLACES 2021 — The Salt Lake Tribune
TOP WORK PLACES 2021 — The San Diego Union-Tribune
TOP WORK PLACES 2022 — The Salt Lake Tribune
TOP WORK PLACES 2022 — The San Diego Union-Tribune
TOP WORK PLACES 2023 — The Salt Lake Tribune
TOP WORK PLACES 2023 — The San Diego Union-Tribune

TOP WORK PLACES 2022 USA

TOP WORK PLACES 2023 USA

Experienced and Educated Team of Employee-Owners

San Diego South – Prototype to Medium Batch Production



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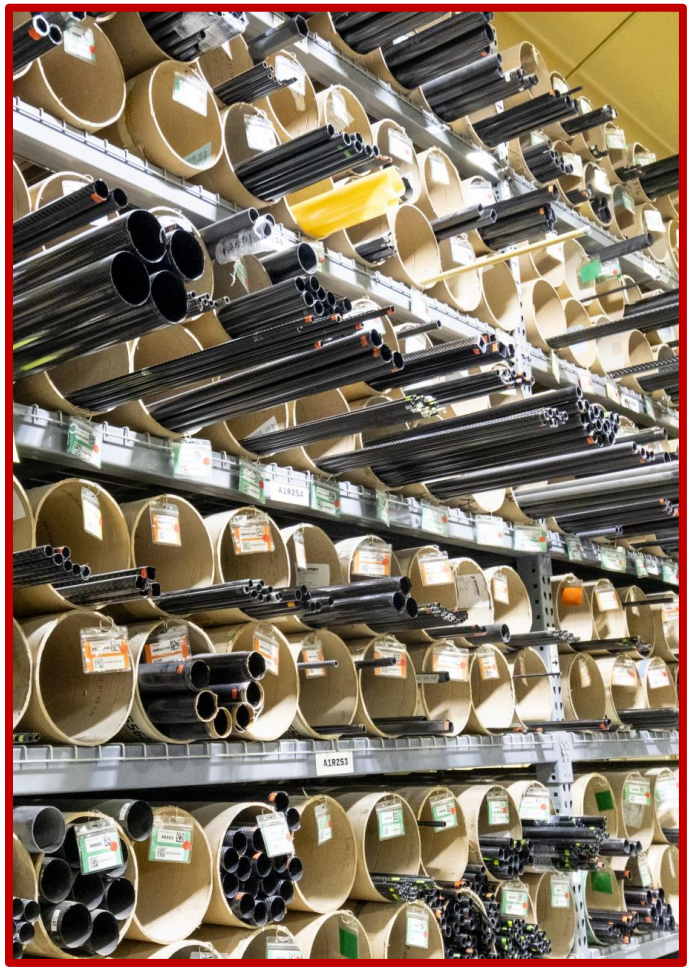
San Diego North – Fiberglass layup, Metal Forming, Build-to-Print Aerospace Sub-assemblies, Spares

Rock West

Salt Lake City – Ecommerce, Prototype to Medium Batch Production



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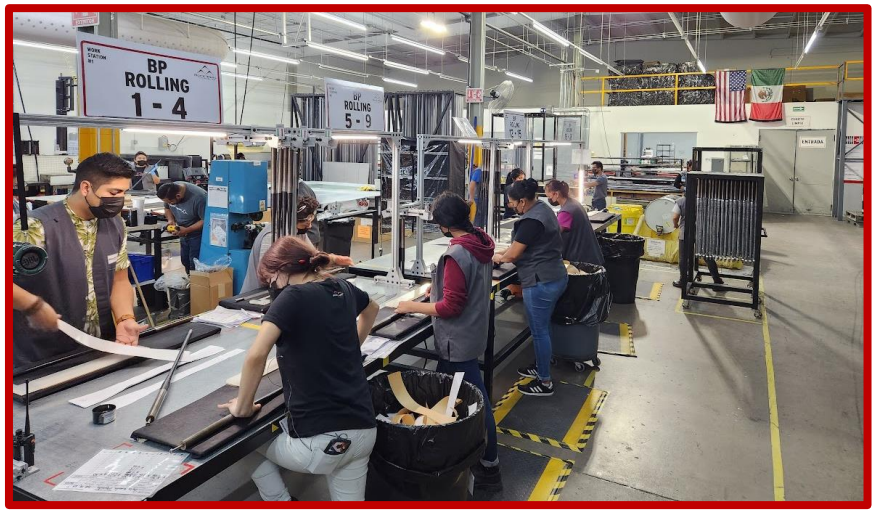
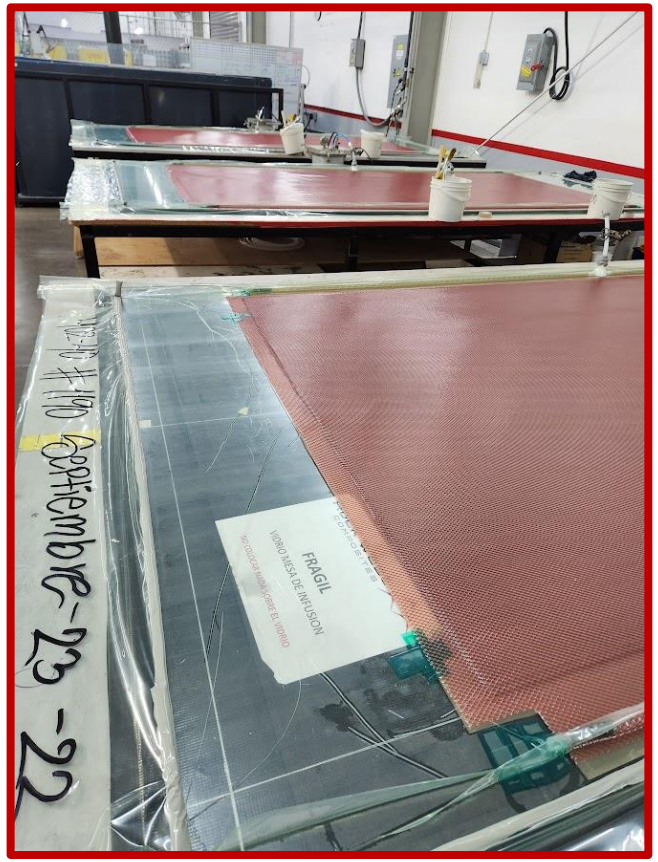
Tijuana – High-Rate Production





Rock West

AEROSPACE & DEFENSE

Space

Structures

Aircraft

Radomes

COMMERCIAL

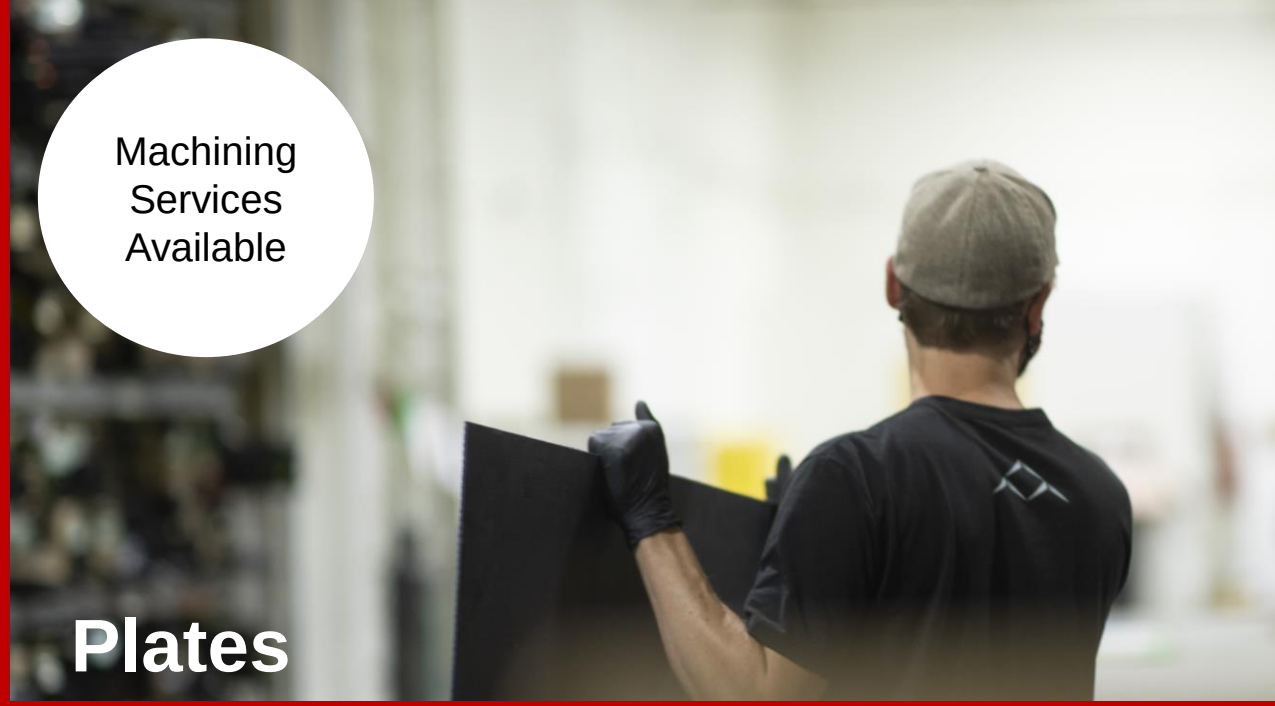
Industrial

Medical

Sporting

Energy


ECOMMERCE
Thousands of Items
Tubes


Machining Services Available
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

Rock West

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

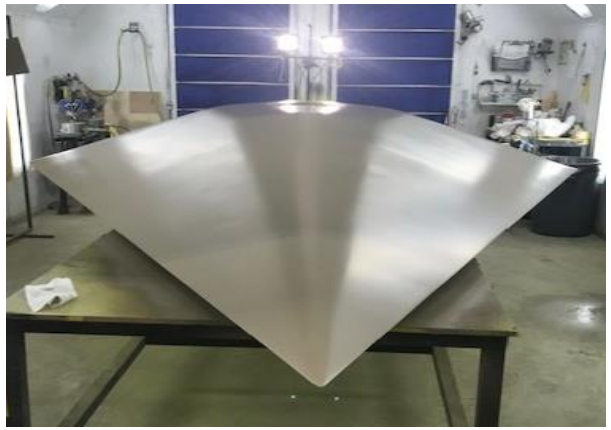
Machining

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

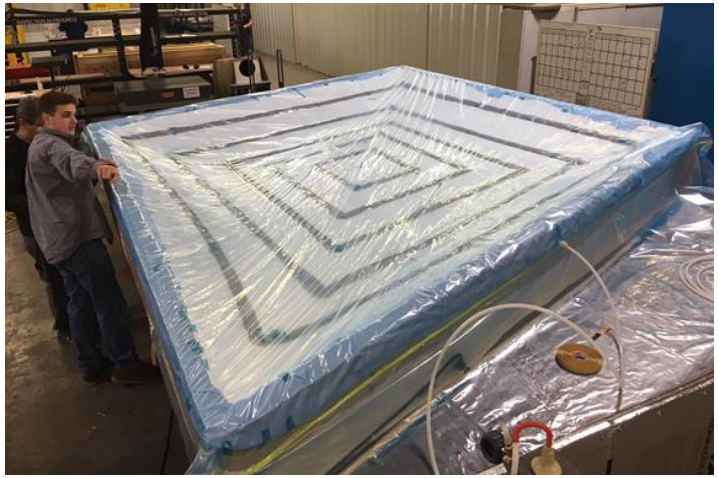
Rock West

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

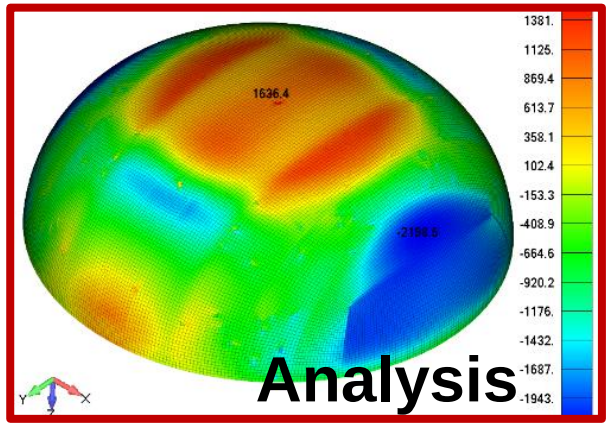
Sandwich ribs used to drive the loads to an off-center mounting hub

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

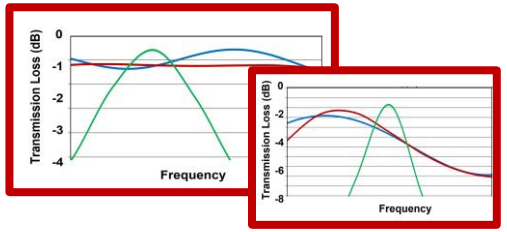
Rock West

RF Structures

- RF and Structural Design & Analysis



- Testing
  - Structural
  - Radio Frequency



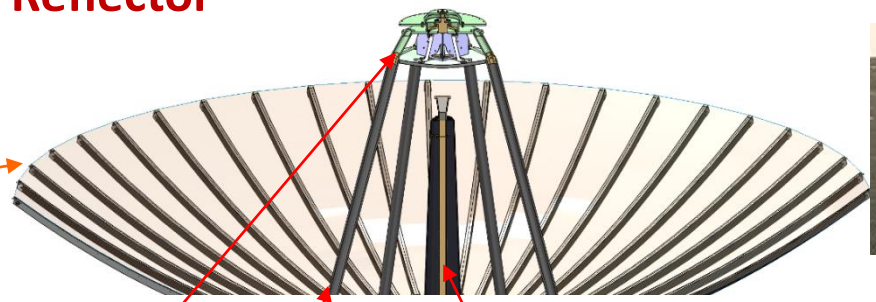
Rock West

Ku-Band Belly Radome Broadband on NRL's P-3

Flight Space Based 3 Meter Reflector

Ribs

Co-cure Sandwich technology keeps cost and Mass low



3 meter Deployable Reflector

Precision Machined Core in house

Sub-Reflector

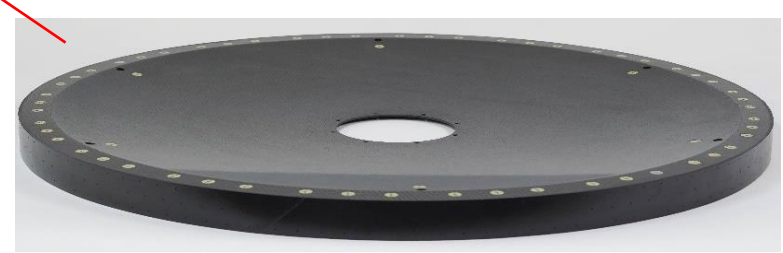
Enhanced Kapton Grid adhesion improves structural Bond on Sub-Reflector

Struts

M55j/Cyanate struts roll wrapped by RWC Utah

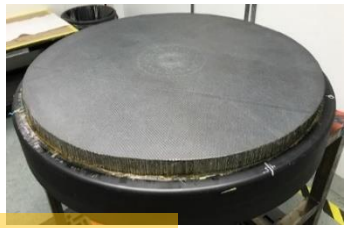
HUB

M55j/Cyanate co-cured 1 meter HUB 0.005” RMS



3d Printed Tooling save cost and schedule

Mast



Monolithic Carbon Low CTE Tooling

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

Rock West

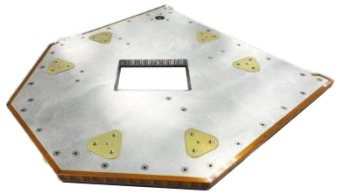
Reflectors

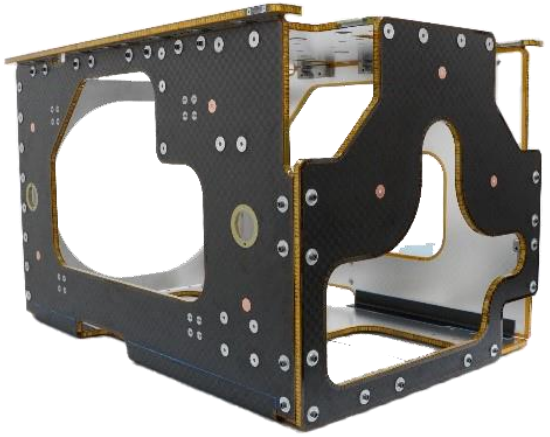
- Multiple materials available
- Egg-crated backup structure or other assembly method
- Tight RMS tolerances available, <0.005” and better
- Monolithic graphite tool build process
- Multiple reflector geometries available

Rock West

BUS Panel and Assemblies

- Up to 72”x170”, flatness of 0.020”/m^2, 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

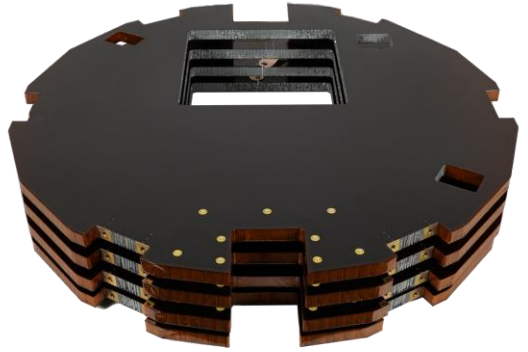


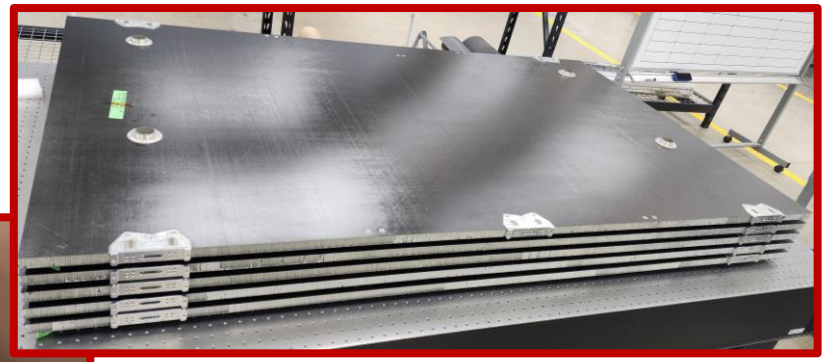


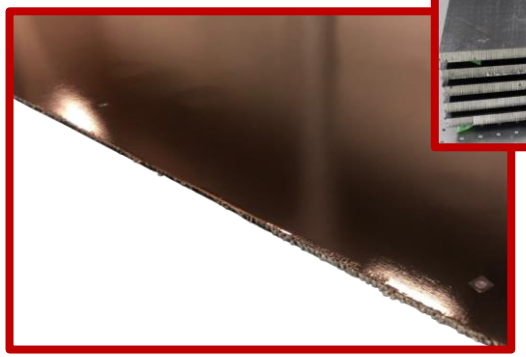
Rock West

Solar Array Substrates and Wing assemblies

- Up to 72”x170”, flatness of 0.020”/m^2, 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







Rock West

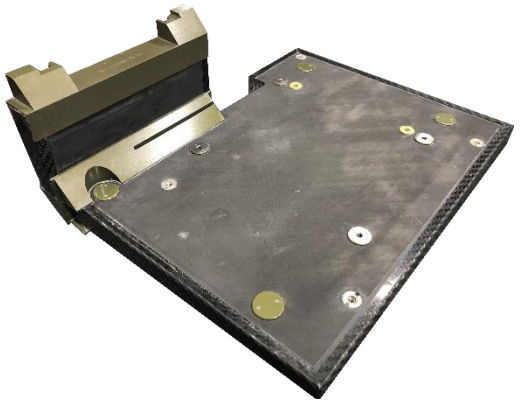
Struts and Assemblies

- 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

Rock West

Optical Benches

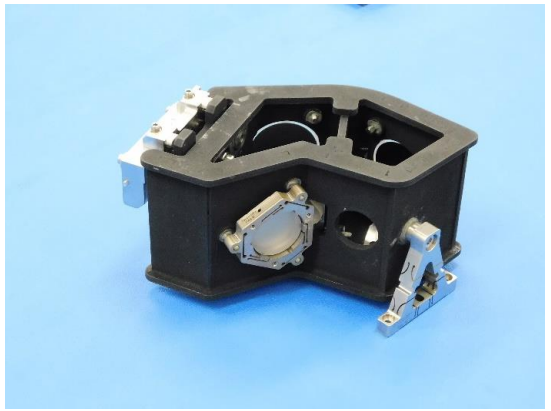
- High modulus carbon fiber face sheets tuned for CTE
- Adhesive film reticulation available
- Wide range of core densities and core materials
- Laminate and sandwich panel
- Core potting
- Precision feature machining
- Precision insert and fitting potting/bonding
- Resistance verification
- Various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

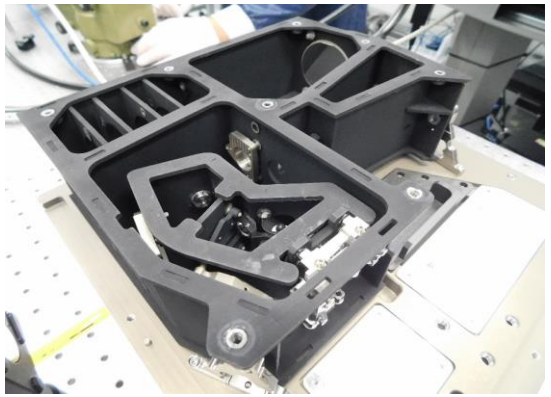


Rock West

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 +/- 0.005”)

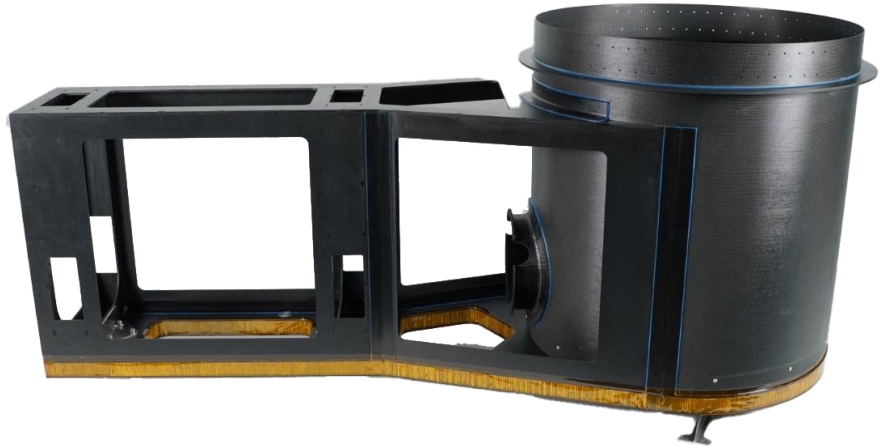




Ground-based Optical Communication System

Optical Metering Tubes and Telescope Assemblies

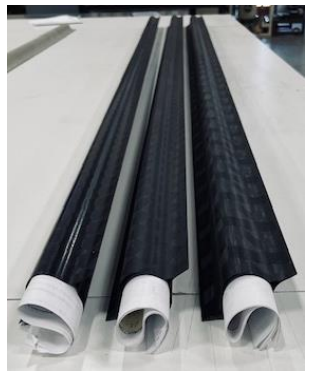
- High modulus carbon fiber tuned for CTE
- Precision insert and fitting bonding
- Various coatings available (metal plating, co-cured foil, etc.)
- Thermal/Emissivity coatings
- Multi-Piece Bonding/Assembly
- Experience in <.2m up to 1m

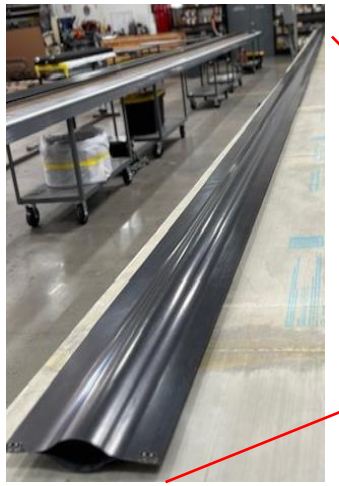


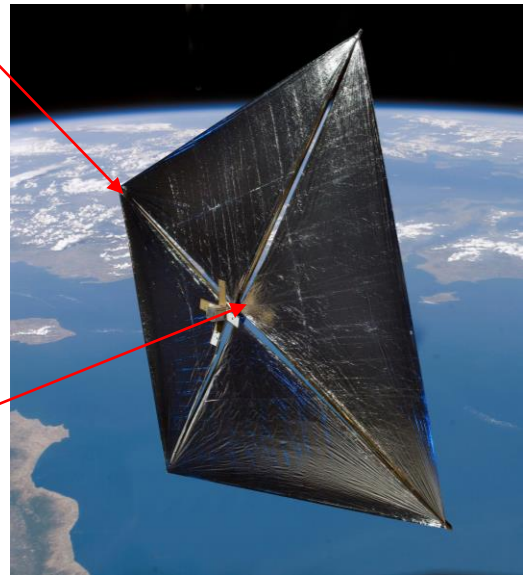
Rock West

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.







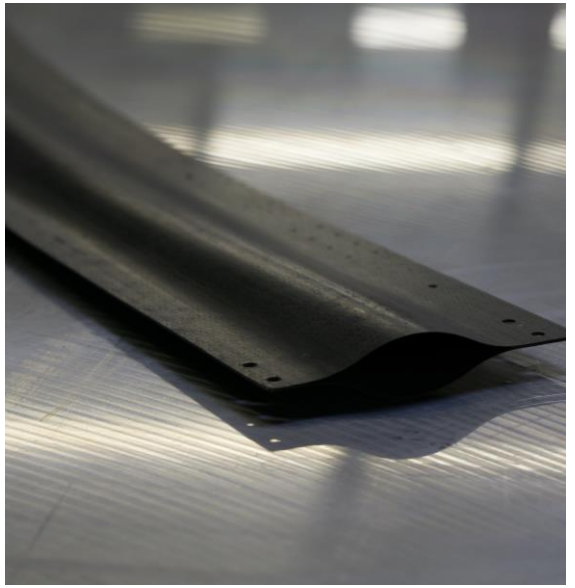
16 section expandable truss extends
From each satellite

3000 low earth orbit satellites planned

Rock West

Proof of Concept

Process Development



Verification

Delivery

Heritage Supplier of Deployed Omega Booms

Rock West

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**	

Rock West

STRATO™ Space Grade Products

Product	Description	Standard Size
STRATOTube™	-Quasi-isotropic tubes from STRATO GEO and STRATO LEO unidirectional materials -Plain-Weave fabric available at ID and OD	72" Length
STRATOPlate™	-Quasi-isotropic flat laminates from STRATO GEO and STRATO LEO unidirectional materials -Plain weave fabric available at top and bottom surfaces	48"x96" Area
STRATOPanel™	-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
STRATOSubstrate™	-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

Rock West

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.

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

ITAR REGISTERED

Nadcap

COST PERFORMANCE SCHEDULE

5s SORT STRAIGHTEN SHINE STANDARDIZE SUSTAIN +2 SAFETY SENSE OF URGENCY

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

DCAA
DEFENSE CONTRACT AUDIT AGENCY

Rock West

Our Customers

NORTHROP GRUMMAN

NASA JPL

Toyon

BLUE ORIGIN

INTUITIVE MACHINES

Raytheon

LOCKHEED MARTIN

ARMAMENT DIRECTORATE

IS4S
Integrated Solutions for Systems

GENERAL DYNAMICS
Ordnance and Tactical Systems

MMA Design

SHIELD AI

CUBIC

amazon | project kuiper

MILLENNIUM SPACE SYSTEMS
A Boeing Company

amazon Prime Air

BOEING

Skydio

SPIRIT AEROSYSTEMS

HEXAGON
MANUFACTURING INTELLIGENCE

LUTRON

AURIS

TURNER IMAGING SYSTEMS

GARRETT

Tidland
A Maxcess International Company

GEODynamics

Nine

SIMPSON

BPi OUTDOORS

SUBIOMED
suspension biomechanics for life

deadlywind

RIFFE

CHRISTENSEN ARMS

LOWE'S

McMASTER-CARR

COLSA

MSC | BUILT TO MAKE YOU BETTER

PANTHER

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

Rock West