28. May 2024

VAT no. 38980076

SCSDK HERITAGE

Launch – Launched - Deployed

Any estimates stated in this document might be subject of change when the final quote is given. This document does not constitute any obligation on behalf of Space Composite Structures DENMARK (SCSDK) or subsidiaries nor will SCSDK be liable for any expenses incurred by the third parties unless the written agreement hereto is available at the time of consideration

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Annex 1: Space Composite Structures DENMARK

Quality

TÜV NORD

CERTIFICATE

Management system as per
BS EN ISO 9001:2015

In accordance with TÜV UK Ltd procedures, it is hereby certified that

Space Composite Structures Denmark ApS
Hestehaven 21J,
DK-5260
Odense S
Denmark

applies a management system in line with the above standard for the following scope:

Design, development, production, verification, assembly and sales of structures for space and ground applications.

Certificate No:	GB01895
Annex No:	n/a
Audit Report No:	2022

UKAS MANAGEMENT SYSTEMS
0065

Valid until:	04/09/2025
Initial Certification:	05/09/2022
Effective Date:	16/12/2022

Signed for and on behalf of TÜV UK Ltd, the Certification Body

This certificate, which remains the property of TÜV UK Ltd, was issued in accordance with the TÜV UK Ltd auditing and certification procedures as amended from time to time and its validity is subject to regular surveillance audits

TÜV UK Ltd. AMP House, Suites 27 – 29, Fifth Floor, Dingwall Road, Croydon, CR0 2LX www.tuv-uk.com

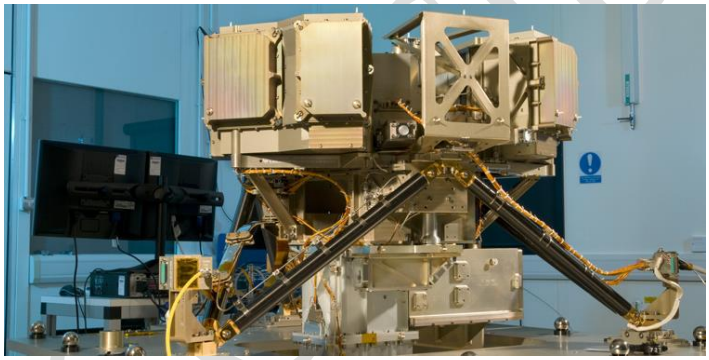
Annex 2:
Relevant heritage

COMPOSITES & BONDING – THE HIGHLIGHTES

Customer: RAL University (ESA/NASA)
Mission: James Webb Space Telescope
Task: design, manufacturing, bonding, testing.
Year: 2013 - 2016
Status: deployed

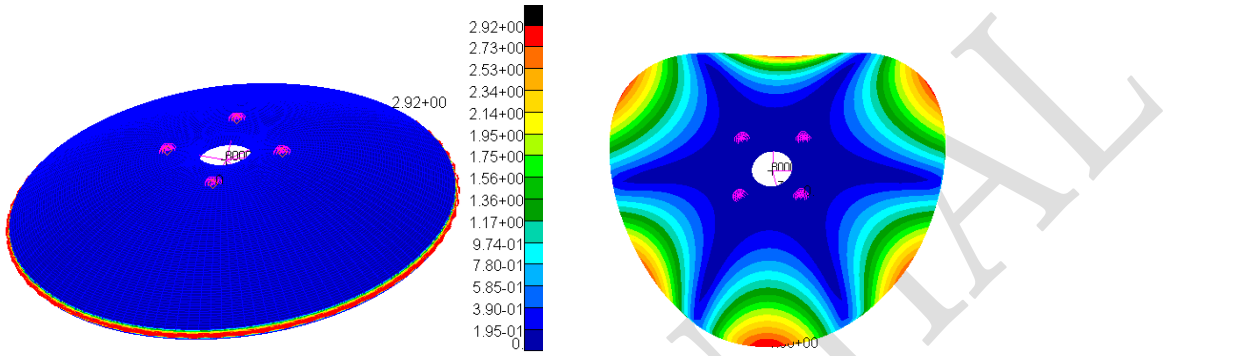
Invar/CFRP CTE=0 struts for hexapod structure on Mid Infrared Sensor on JWST, ESA contribution. The contract extended to thermal shroud struts


Hexapod struts shipped in formation


SCSDK struts integrated on the instrument


Threaded fitting struts for Thermal Shroud

Customer: AIRBUS DEFENCE & SPACE – GERMANY
Mission: AYAP 1
Task: Design, Calculations, FINITE ELEMENT ANALYSIS, **CFRP/Honeycomb antenna parabola** manufacturing, bonding,
Year: 2023 and on
Status: Scheduled for launch 2024



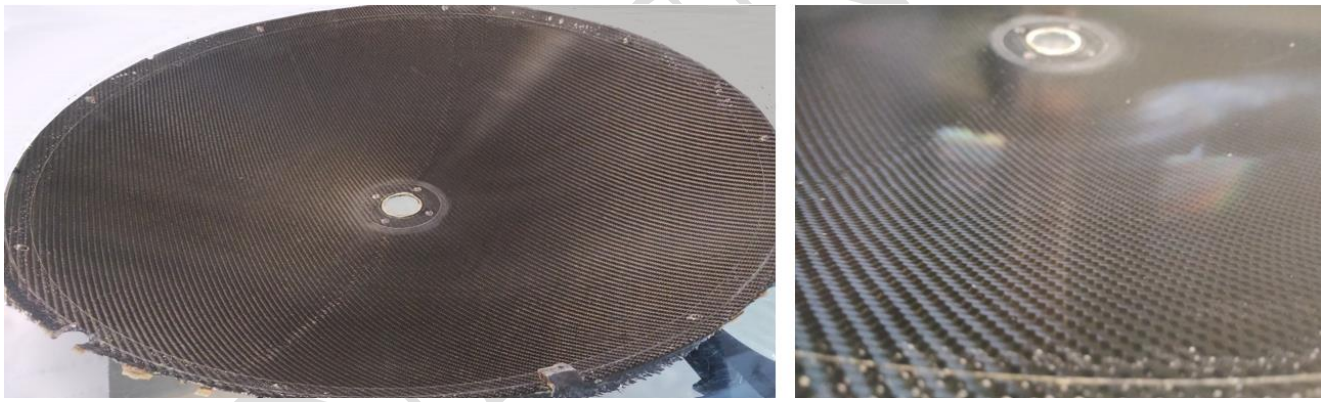


Figure 1 CFRP Skins for CFRP/honeycomb sandwich parabola

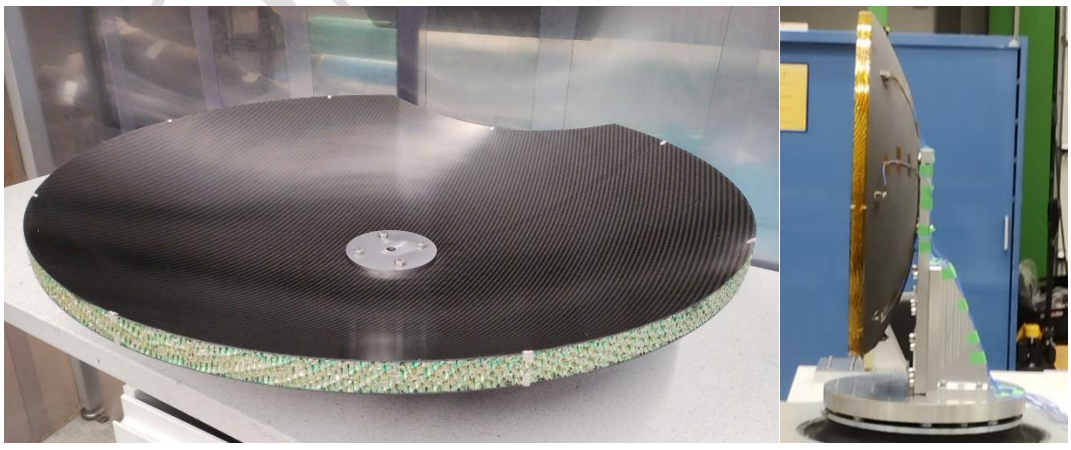


Figure 2 Sandwich antenna

Customer: AIRBUS DEFENCE & SPACE – UNITED KINGDOM
Mission: ROSALIND FRANKLIN (ESA/NASA)
Task: Design, Calculations, FINITE ELEMENT ANALYSIS, manufacturing, bonding, tests
Year: 2024 and on
Status: Scheduled for launch 2026

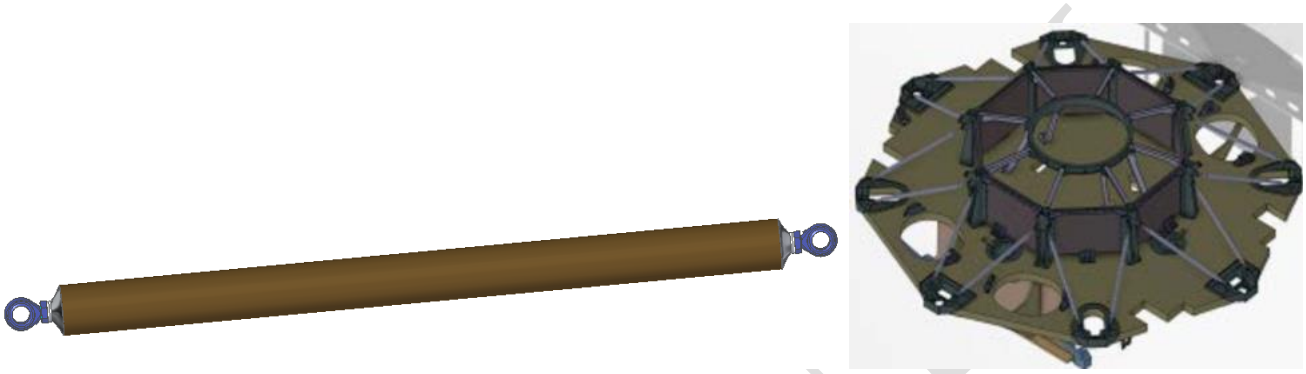


Figure 3 CFRP/Titanium support struts for Landing Platform

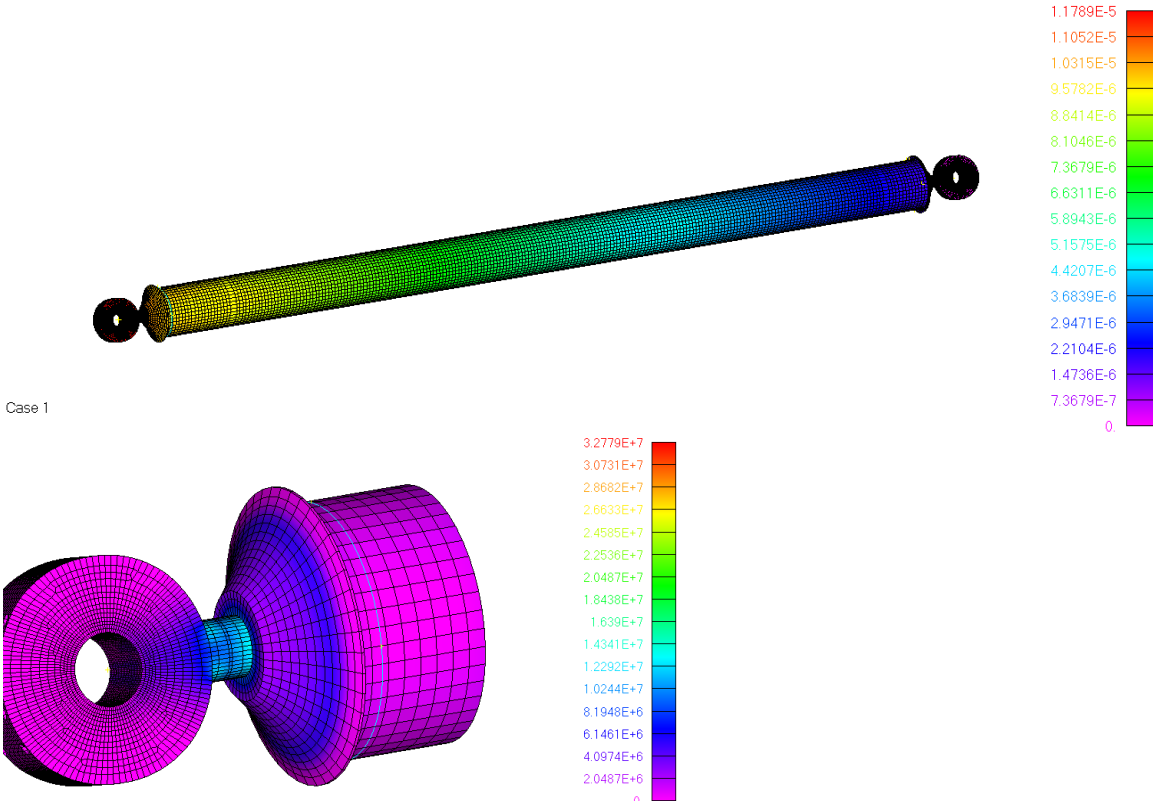


Figure 4 Finite Element Analysis is details

Customer: DTU Space, RAL University, ESA
Mission: ARIEL
Task: Filament winding, bonding, coating, test of instrument bi-pods.
Year: 2019 and on
Status: Scheduled for launch 2025

On-going. SCSDK is support to development and manufacturing of instrument bi-pods. The solution is based on SCSDK product BLACK STRUTS, 100% CFRP solution (see elsewhere in this document)

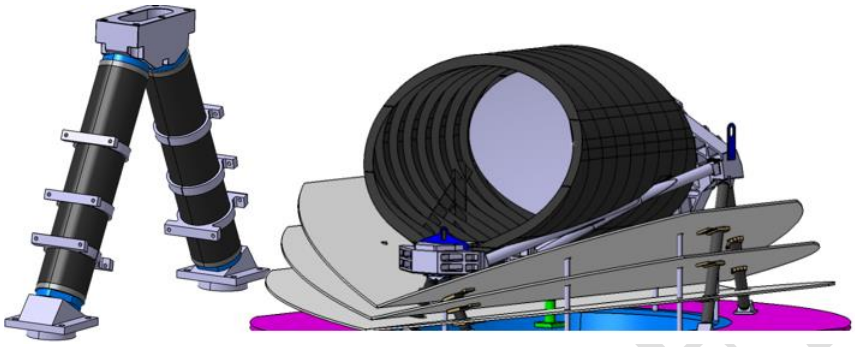


Figure 5 ARIEL Instrument Alu/Alu panels and Bi-pods. Bi-pod struts are SCSDK unique product Black Struts

Figure 6 First test model

Customer: THALES ALENIA SPACE - FRANCE
Mission: COPERNICUS CO2M
Task: Design, Calculations, filament winding, bonding, coating, test of instrument bi-pods.
Year: 2020 and on
Status: Scheduled for launch 2025

On-going. SCSDK is contracted for design, development and manufacturing of instrument bi-pods

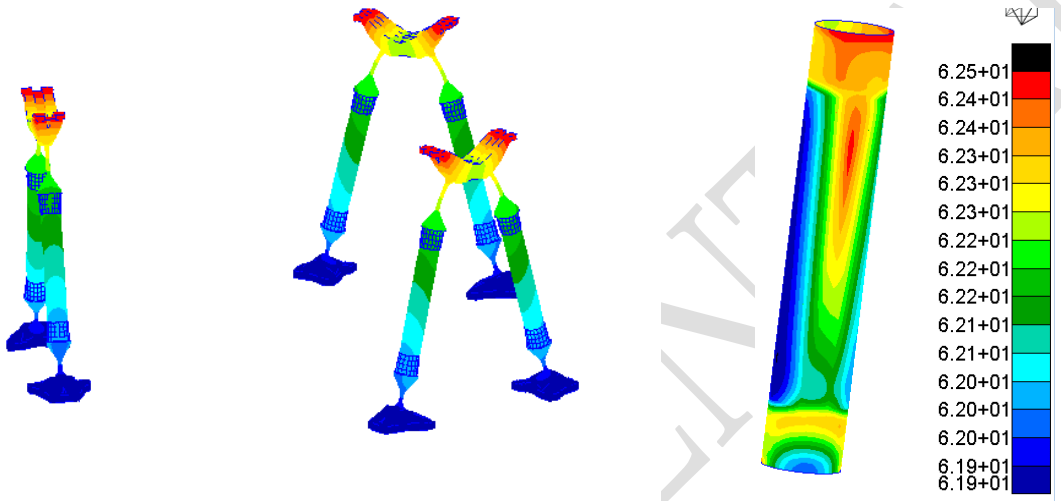
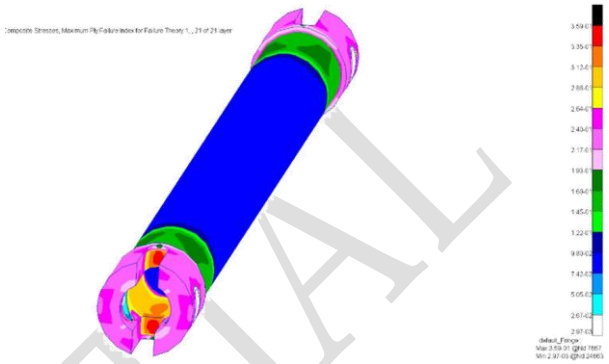


Figure 7 Deformation of the first axial mode + Thermal load on CFR Tube, cold

Figure 8 Bipods in Final configuration

Customer: ESA
Mission: ESA study HIGH PERFORMANCE CFRP STRUTS – **BLACK STRUTS**, CORE TECHNOLOGY PROGRAM (Threaded version for ARIEL)
Task: Design, Filament winding, bonding, no-cut-fibers-hole winding, verification
Year: 2019 and on



TRL6 delivered. TRL7 on-going. **Showcasing filament winding of no-cut-fiber-hole**

- Struts have following components:
  - CFRP tube
  - Metallic fittings
- Fittings bonded to tube using epoxy adhesive
- Fittings are typically aluminum, titanium or steel
- Fittings represent up to 90% of the strut's overall mass

Goal of the project: develop, manufacture and test 100% CFRP strut, no metal, affordable, very low CTE/CME, no broken fibers, and save more than 30% of mass

Results achieved, new struts, Black Struts beats the reference struts in all performance aspects and achieve +50% mass savings

Figure 9 Close up on pin holes: no-cut-fibers

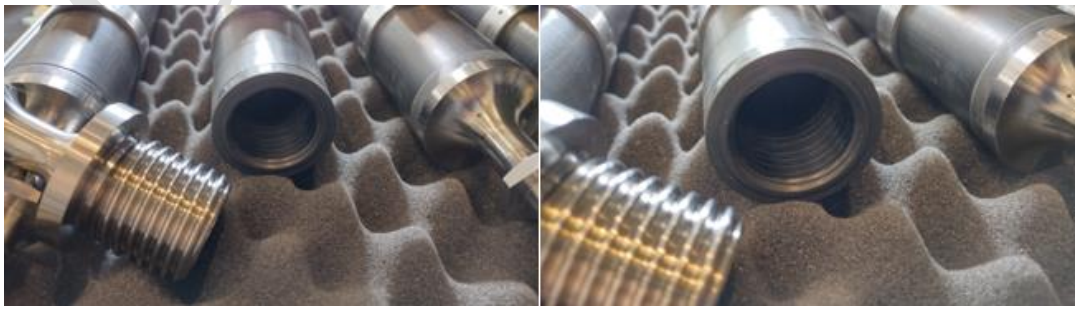


Figure 10 BLACK STRUTS, size Ø47, threaded fitting in action for ARIEL mission

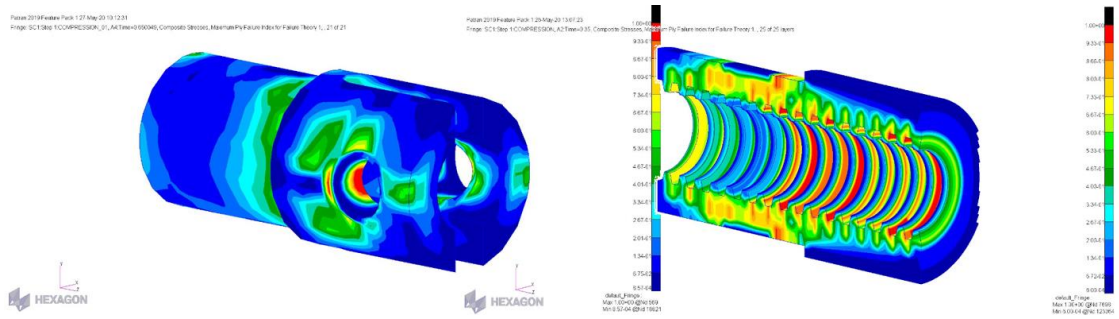


Figure 11 The whole strut has a mass of one equivalent INVAR metallic fitting

Figure 12 Black Struts series

Customer: WEIBEL Scientific
Mission: Ground Defence Radar
Task: design, manufacturing, bonding, coating, test of Radar axle.
Year: 2016
Status: deployed
Delivered. Examples of large diameter precision CFRP structures catering for filament winding & adhesive bonding with large metallic rings: here shown radar elevation axle with bonded metallic interfaces and after-machining of interface holes for tight tolerances. Estimated TRL6 (current temperature spec is in line with MIL-810G requirements)

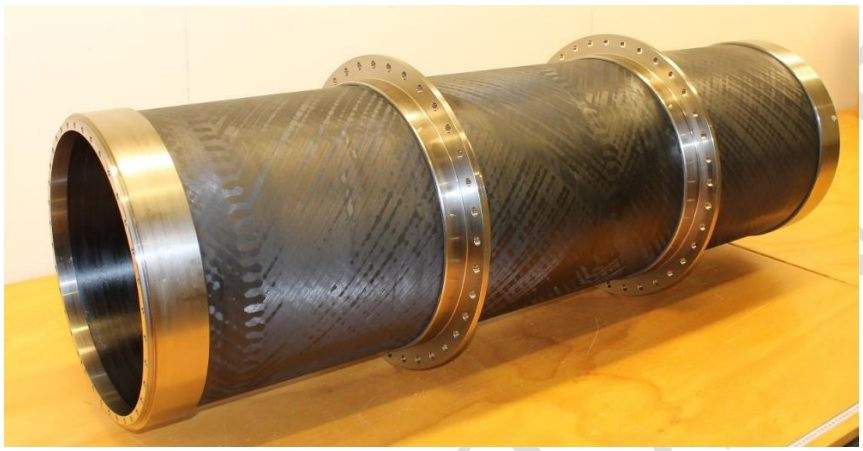
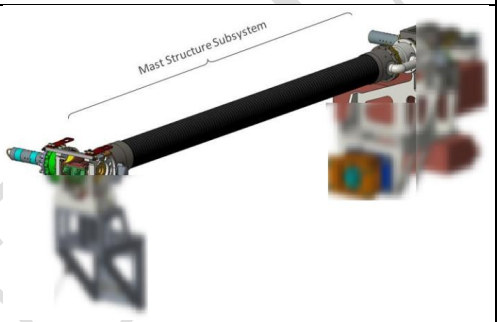
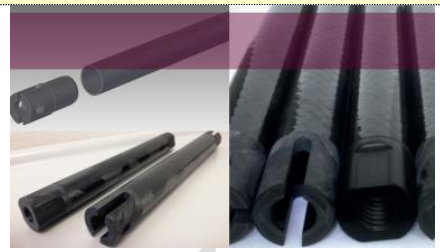
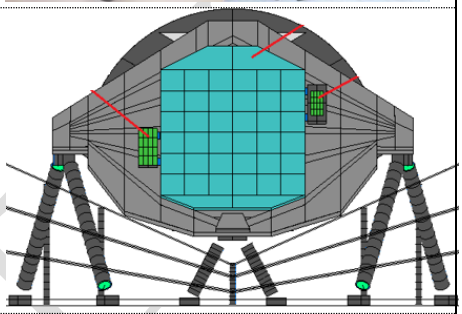
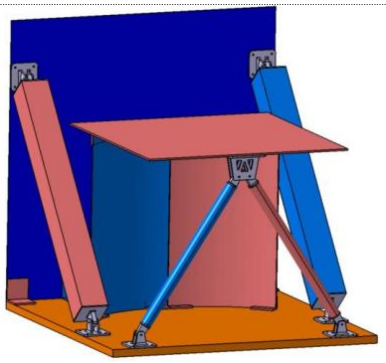
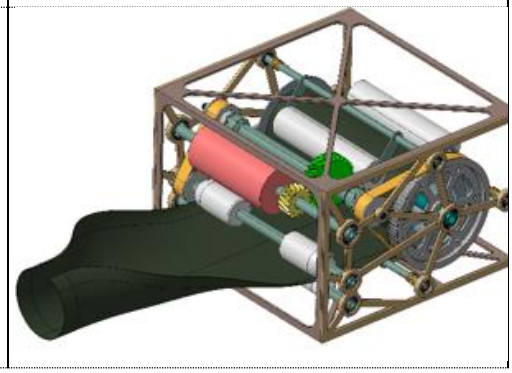


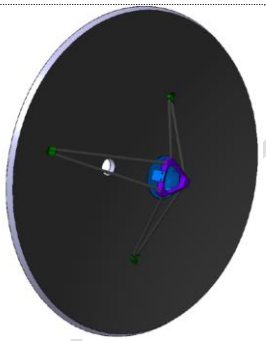
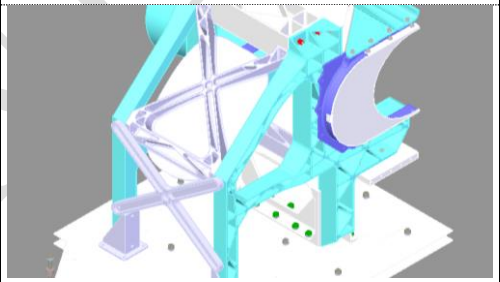
Figure 13 BASELINE: Monolith filament wound cylinder, example of Central tube similar size item

Figure 14 After-machining of bonded structure to achieve tight tolerances

The List

Contract Name *(Role)*	Description	Year	Funding	Results (Direct & Indirect), and Lessons Learned	Illustrations
Instrument struts, manufacturing	CFRP/Invar struts, manufacturing, **James Webb Space Telescope** mission TRL9	2013	**NASA**	CTE = 0 struts, tested to -256C Launched 2021	
Mast Structure Subsystem	**Mars** Sample Fetch Rover **Robotic Arm**, CFRP/Titanium	On-going	**ESA**	Heritage design and manufacturing (Solar Orbiter & JUICE booms) Launch 2024	
Instrument boom, manufacturing	CFRP/Titanium **boom** sections for **Solar Orbiter** mission, manufacturing TRL9	2015	**ESA**	Delivered according to the spec Launched 2020	
Central Tube struts, design & manufacturing	Alu/C(G)FRP struts, design and manufacturing TRL9	2010 - 2017	**IAI**	Delivered according to the spec Launched since 1991	
Instrument Struts, design & manufacturing	Titanium/CFRP **struts**, design and manufacturing, **ExoMars** mission TRL8	2014-2017	**ESA**	Delivered according to the spec, very demanding manufacturing Launch postponed	
Anisogrid structure, design & manufacturing	Low cost manufacturing of Anisogrid structure TRL3	On-going	**ESA**	Several prototypes in different pattern/size	

Contract Name *(Role)*	Description	Year	Funding	Results (Direct & Indirect), and Lessons Learned	Illustrations
High performance struts, design & manufacturing	CFRP/CFRP struts, design and manufacturing TRL6	Ongoing	**ESA**	100 % CFRP struts, CTE=0, CME=0, 60% mass savings	
Instrument Bi-pods, design & manufacturing	CTE=0 **Bipods**, design and manufacturing for **ARIEL mission** TRL6	Ongoing	**ESA**	Low CTE, shall survive 50 Kelvin, high thermal conductivity Launch 2025	
Mars Wind Turbine	CFRP Wind Turbine vertical wing design, manufacturing & assembly	Delivered	**ESA**	Successful delivery of demanding hardware	 
Novelty techniques for CFRP Structures NDI – Manufacturing & testing	CFRP/CFRP/Metallic struts, design and manufacturing, void placement & Ultrasonic NDI	Delivered	**ESA**	Correlation between voids & NDI	
HF.VHF Tubular Deployable Antenna, design and manufacturing	Development, manufacturing and test of deployable compact flexible tubular antenna arm	Delivered	**ESA**	Proven manufacturability for Titanium and CFRP solution	

Contract Name *(Role)*	Description	Year	Funding	Results (Direct & Indirect), and Lessons Learned	Illustrations
Instrument BiPods, Mechanical & Thermal	CFRP/GFRP/Metallic struts, design and manufacturing for COPERNICUS CO2M mission TRL6	Ongoing	**ESA**	Mechanical & Thermal Capabilities	
AYAP-1	CFRP/Honeycomb Sandwich parabolic antenna with titanium interfaces. Design, manufacturing & test	Ongoing	**AIRBUS**	Mechanical & Thermal Capabilities	
Instrument Structure Complete	Detailed design on component level and all manufacturing & test of entire instrument	Ongoing	**ESA**	Mechanical & Thermal Capabilities CFRP panel, alu structure, assembly, test	

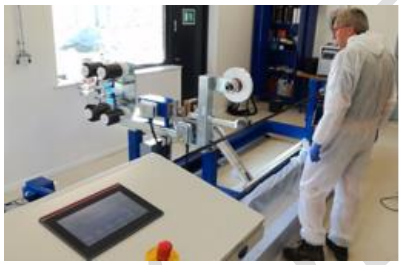


Figure 15 Inhouse manufacturing from left: Filament winding of CFRP tube, digital controlled CNC, struts in bonding jig

Figure 16 ISO 8 soft wall cleanroom (installed in October 2018), mainly for bonding, cleaning & contamination control purposes

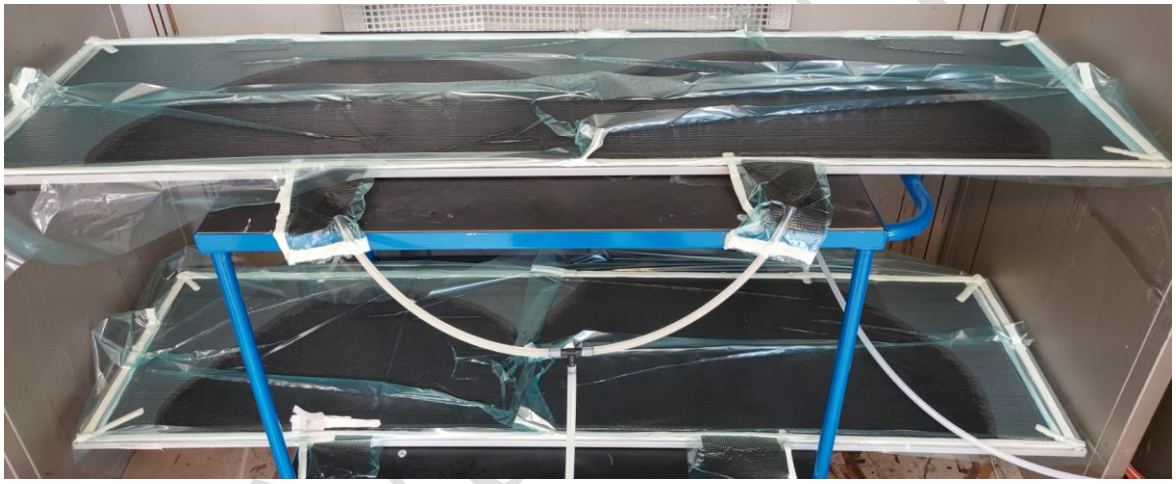


Figure 17 Thin flat CFRP panels vacuum infusion

Machined parts in aluminum

Customer: AIRBUS (France)
Mission: METOP SG
Task: design, manufacturing 123 assemblies, coating (Black Paint & Kapton tape), heaters bonding, test.
Year: DELIVERED 2017 / 2018
Status: deployed

Delivered. STM Units mimic METOPSG scientific instruments in mass, centre of gravity and thermal behavior meaning that SCSDK has designed, manufactured, verified by test and delivered a high number of flight-spec components and assemblies without rejects. Solutions used: high precision machining of 7075 Aluminium components ordered and controlled supplier in Slovenia, Kapton tape & Aeroglaze Black paint ordered and controlled supplier in Denmark, implementation of thermal control (bonding of heaters), final assembly, test & inspection done in-house @ SCSDK

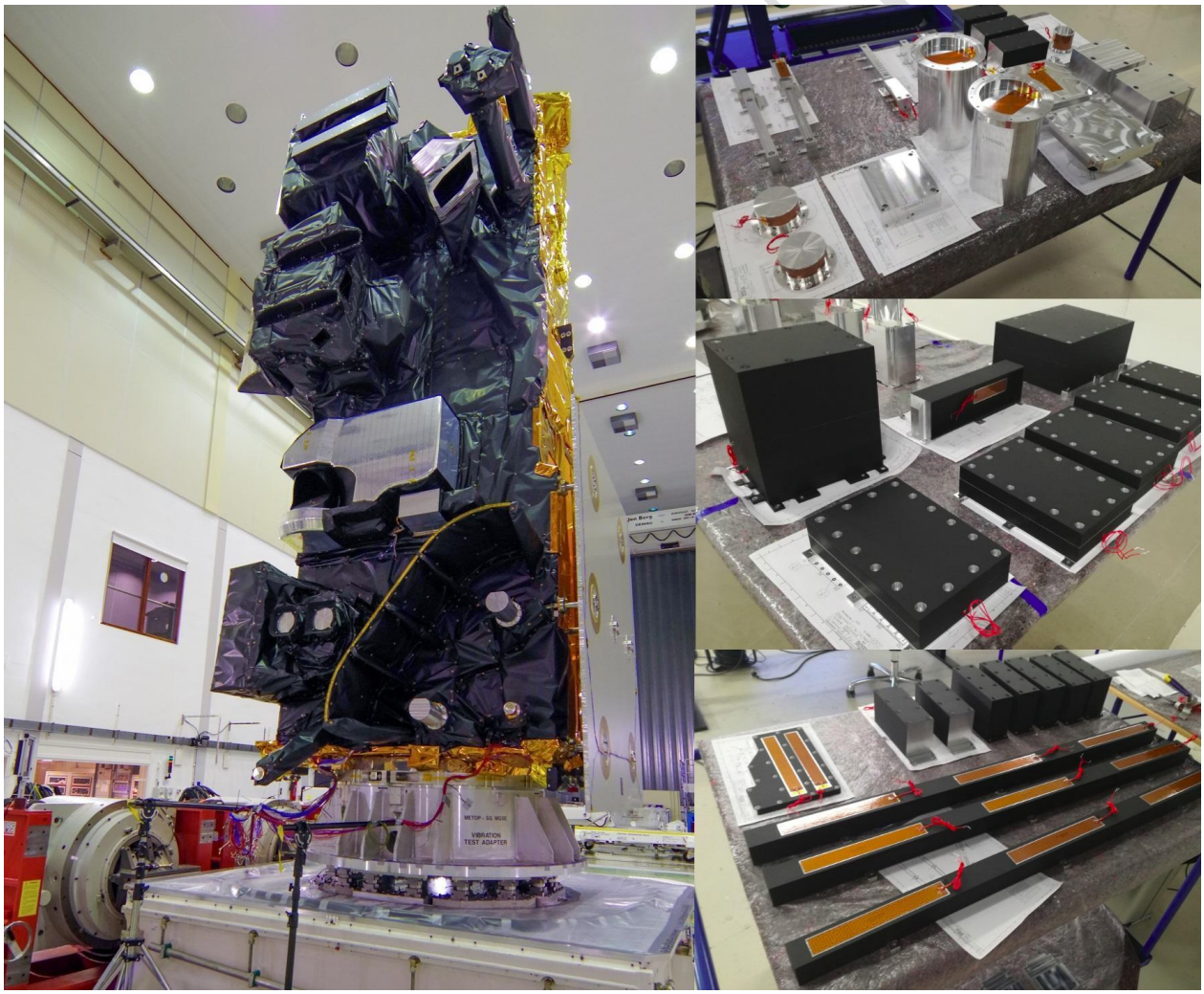


Figure 18 STM Units mimics real Scientifics instruments (Photo: European Test Services B.V & SCSDK)

Customer: Omnisys Instruments
Mission: ARCTIC WEATHER SATELLITE
Task: Design, manufacturing, test of entire instrument structure
Year: 2021 - 2023
Status: Scheduled for launch 2024

SCSDK is responsible for detailed design on component level and all manufacturing & test of entire instrument for Arctic Weather Satellite. Aluminum 7075 + helicoil installation

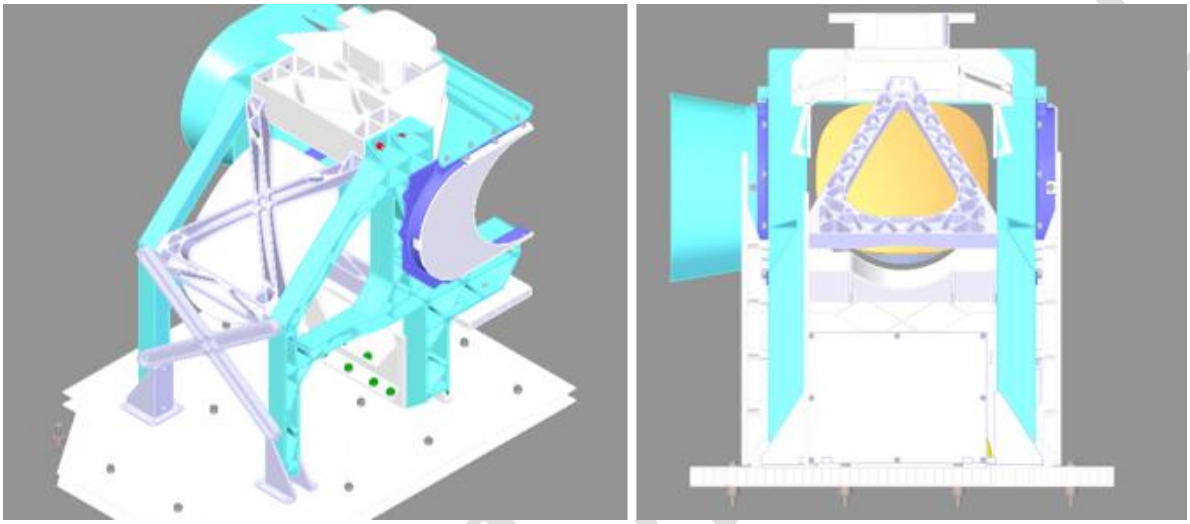


Figure 19 Arctic Weather Satellite Structure

Mechanical Ground Support Equipment

Customer: LUSOSPACE (Portugal)

Mission: SENTINEL 5

Task: design, manufacturing, coating, assembly, test.

Year: DELIVERED 2021

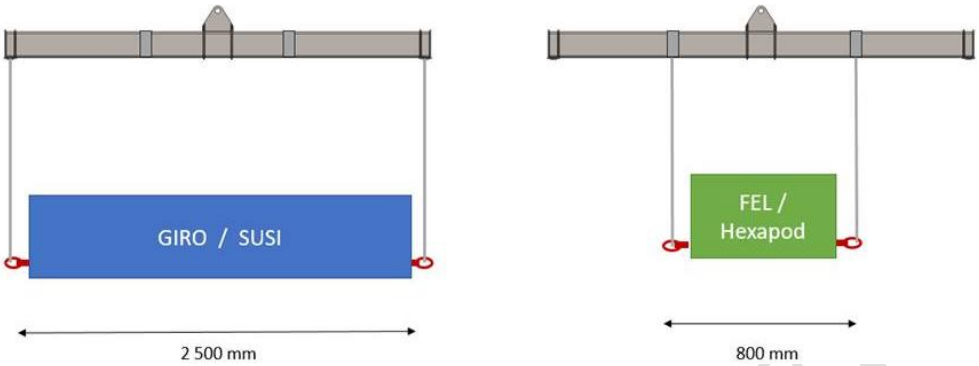


Figure 20 Lifting device, adjustable load width, for hoisting various types of Sentinel 5 Optical Equipment with weights up to 500 kg

Figure 21 Dolly for transporting 800 kg radiance equipment for Sentinel 5

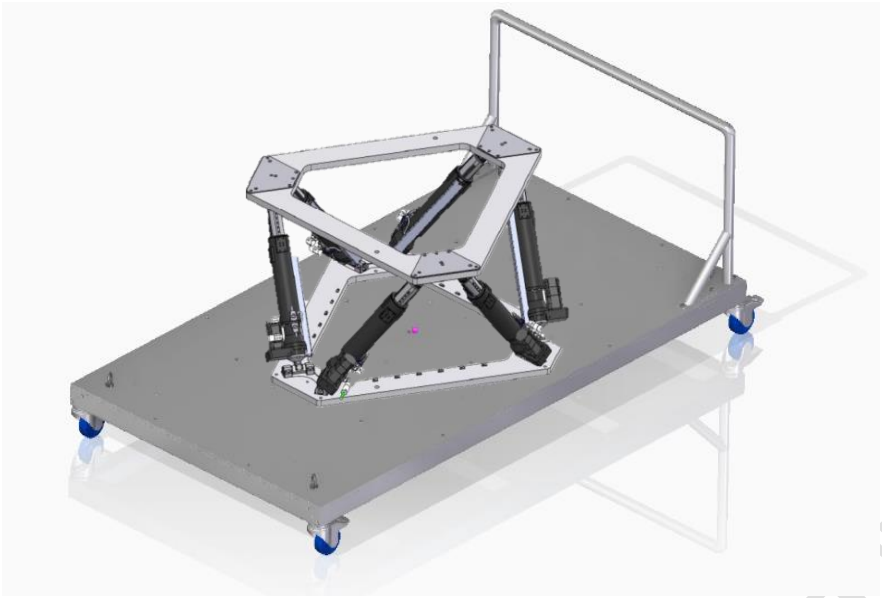


Figure 22 Multipurpose dolly for transporting Sentinel 5 equipment of up to 500 kg

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Customer: AIRBUS (France)
Mission: Solar Orbiter
Task: (Design only)
Year: 2012

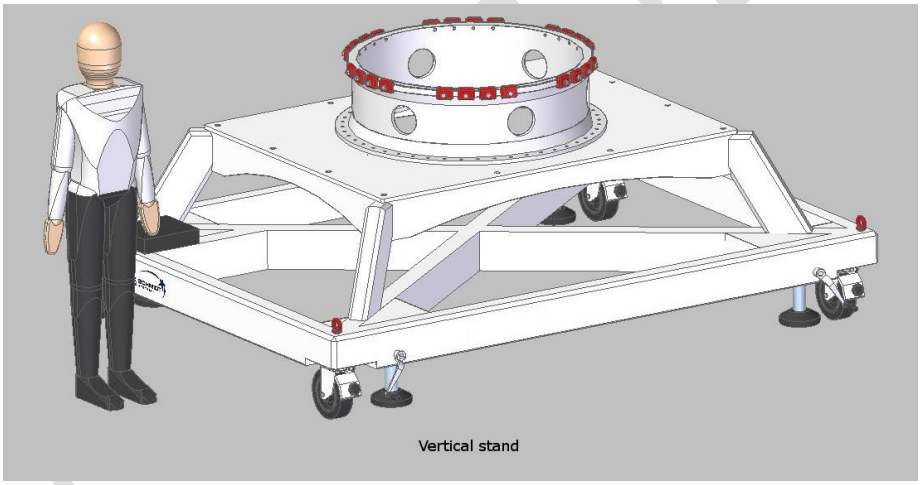

Figure 23 Vertical stand: lateral movement only

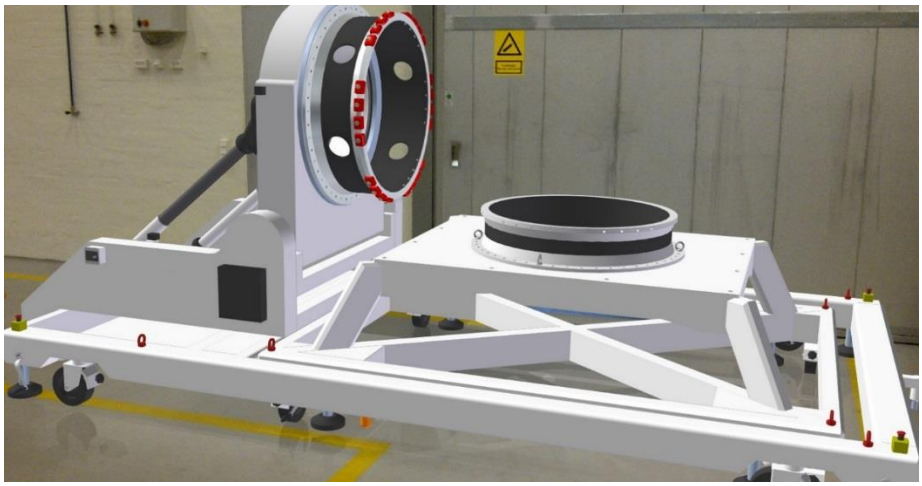

Figure 24 Multi-Purpose trolley with corresponding Vertical Stand