



On-Orbit Results of ISS ROSA (iROSA) and Double Asteroid Redirect Test (DART) ROSA Missions

Space Power Workshop 2023

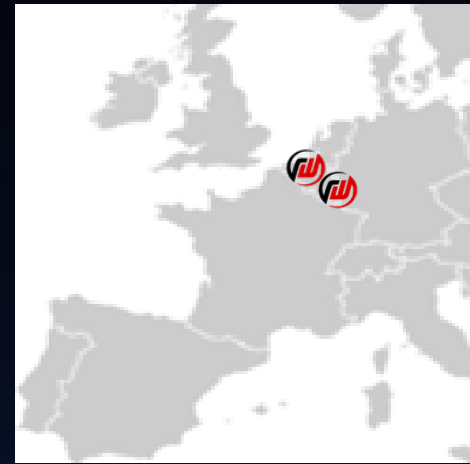
Matt LaPointe

Advanced Programs Engineering Lead

Redwire Space Systems - Goleta

Redwire Space Employs Over 750 Jobs in U.S. and Europe

Redwire Space Provides 50+ Years of Space Flight Heritage and Innovative Capabilities for Civil Space and National Security Missions!



COLORADO (Littleton and Longmont)

- 102,000 sq. ft total in CO
- Clean Rooms
- RF & Antenna Systems
- Deployable and Retractable Space Structures
- Solar Arrays, Batteries, Thermal Products
- Space Systems Engineering Services
- Camera Systems
- Flight Avionics
- Data Recovery Systems
- In-House Testing Capabilities
- Digital Engineering
- Modeling & Simulation

CALIFORNIA

- Collaborating with JPL
- 80,000 sq. ft. office & manufacturing area
- 3-Story High Bay
- Deployables IA&T
- ISS & PPE Large ROSA IA&T
- High Power Solar Array R&D

NEW MEXICO

- 14,000 sq. ft facility
- Operate and Maintain AFRL testing facility
- Design and Analysis Services
- Structural & Thermal Testing
- Launch Accommodation Hardware
- Thermal Control Hardware
- Deployable Technologies

ALABAMA

- Strong partnerships with NASA MSFC

FLORIDA

- Redwire Corporate Headquarters in Jacksonville
- 37,247 sq. ft facility
- Clean rooms
- Advanced In-Space Manufacturing Technology
- Large In-Space Manufacturing Project – OSAM-2/Archinaut One
- ISS Payload Development

INDIANA

- 22,000 sq. ft facility
- In-space Research
- ISS Payload Development
- Advanced Space Manufacturing Technology
- Biotechnology, bioprinting, on-orbit manufacturing
- ISS/CASIS

MASSACHUSETTS

- 18,000 sq. ft. facility
- Clean Rooms
- Sun Sensors & Star Trackers
- Integrated Camera Systems
- ADACS Systems
- Satellite Systems

LUXEMBOURG

- Redwire Engineering & Sales Center in Europe
- 2,500 sq. ft facility
- Robotic Systems
- Avionics

BELGIUM

- QinetiQ Space NV
- 19,000 sq. ft. facility
- Hi-Ref SmallSats, Berthing & Docking Mechanisms, Avionics

DC/VA/MD

- Engaging NASA GSFC in MD
- 8,000 sq. ft. facility under construction (2/3 SCIF)
- SCIF, Classified Systems Access
- Digital Engineering Lab

Merritt Island, FL (near KSC)

- 2,377 sq. ft. facility
- Strong partnership with NASA KSC
- Prelaunch processing laboratory and support
- Commercial partnership with Tupperware Brands
- In-space plant biology research
- ISS and lunar Payload Development



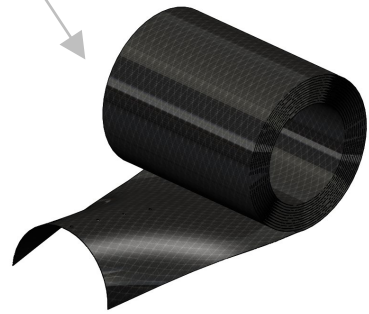
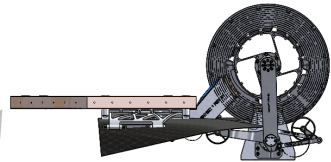
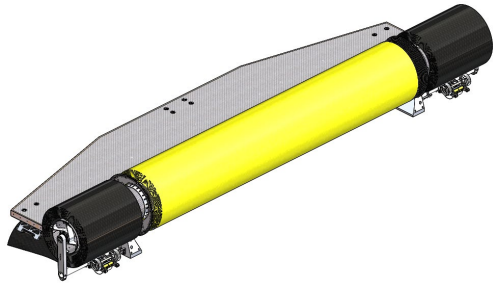
 Cleared Personnel



BUILD ABOVE

Roll-Out Solar Array (ROSA) Nomenclature

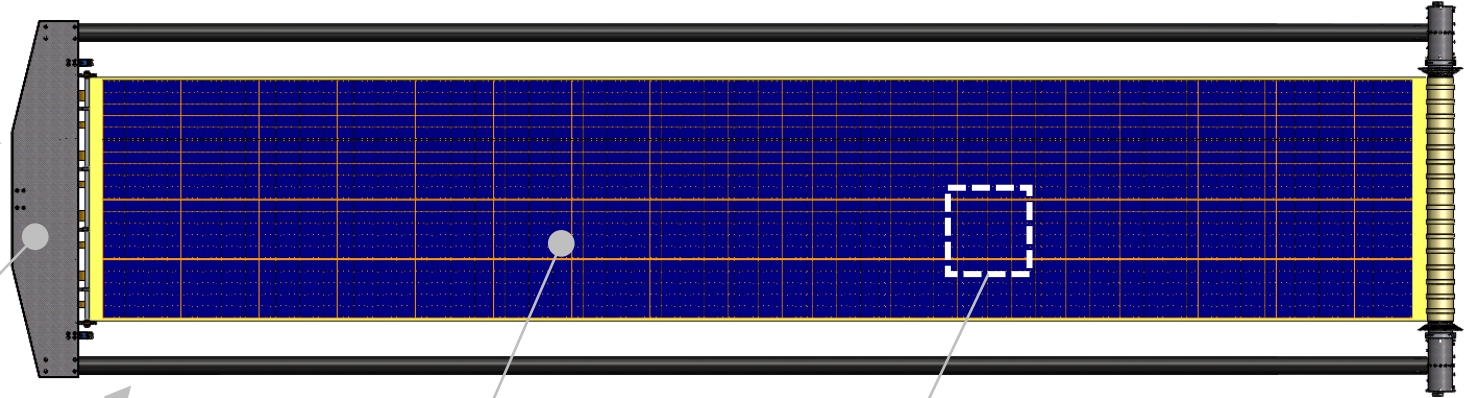
Stowed Wing | **Deployed Wing**



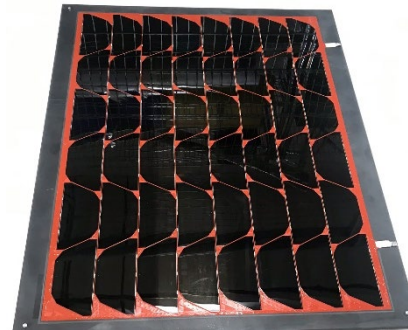
Composite Boom (Stowed)

Offset or Yoke Structure

Diode Boards (backside)



Integrated Modular Blanket Assembly (IMBA)

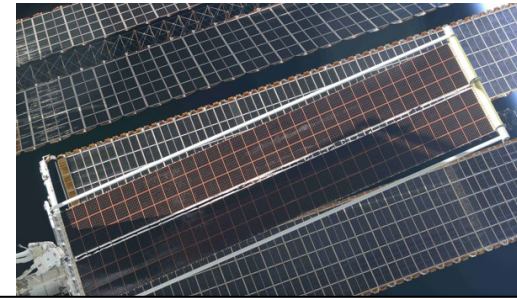


Standard Power Module (SPM)



Mandrel Tube Assembly

ROSA Heritage & Qualification Summary



ISS ROSA (iROSA) 28kW Wings

- Deployed Dimensions: 240.4" [6.11 m] wide x 763.6" [19.40 m] long
- Modular IMBA blanket with Spectrolab XTE multijunction solar cells

- **International Space Station ROSAs (iROSA) for NASA/Boeing, 28 kW BOL per wing [TRL 9]**

- Wings 1 & 2 deployed in June 2021
- Wings 3 & 4 deployed in December 2022
- Wings 5 & 6 delivered and launching in June 2023

- **Double Asteroid Redirect Test (DART) ROSA for APL/JHU, 3.4 kW BOL per wing [TRL 9]**

- Two wings were successfully deployed in November 2021

- **Ovzon 3 Commercial GEO ROSA for Maxar, 5.3 kW BOL per wing [currently TRL 8]**

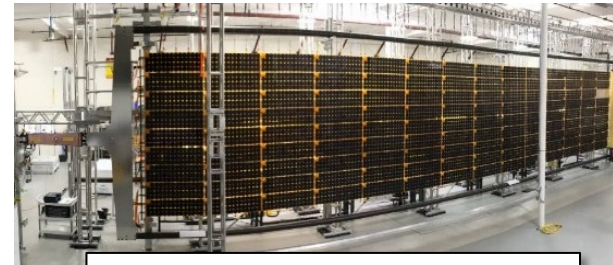
- Fully tested and delivered to the customer, launching in 2023

- **GEO Qualification ROSA for Maxar, 15+ kW class wing [TRL 7/8]**

- Fully qualified GEO bus ROSA, completed 2020

- **ISS ROSA Flight Demonstration (funded by AFRL), 2-3 kW class wing [TRL 7/8]**

- Deployed and retracted on-orbit June 2017



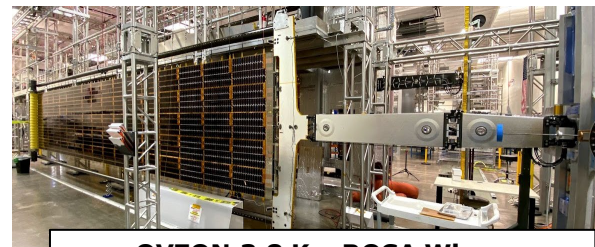
Maxar 15kW ROSA Qual Wing

- 5.5-in DIA 4-ply booms
- SolAero solar cells



DART 3.3 kW ROSA Wings

- 91.4" [2.3 m] wide x 337.5" [8.57 m] long
- SolAero cells



OVZON 3.8 Kw ROSA Wings

- 105.18" [2.67 m] wide x 494.55" [12.56 m] long
- SolAero cells



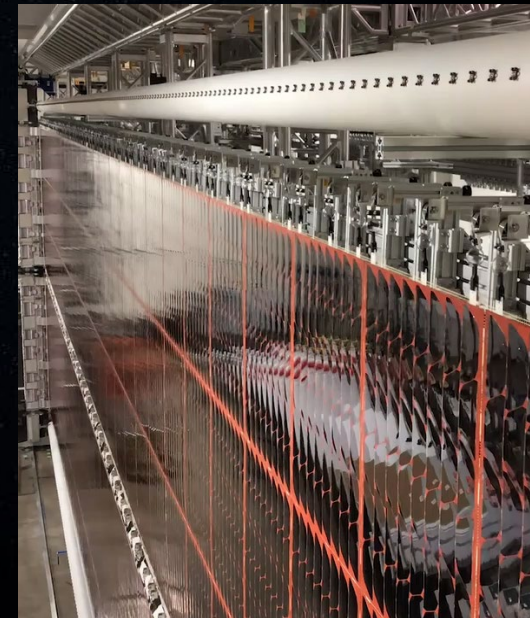
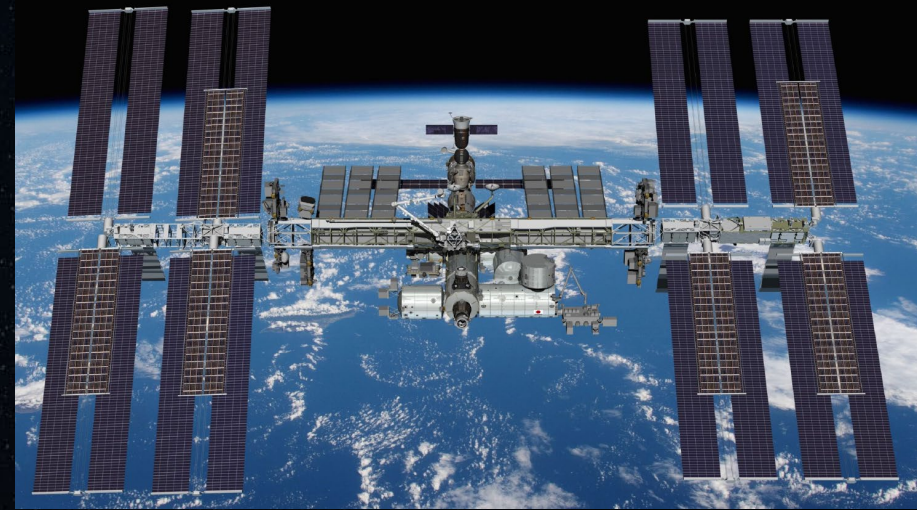
ISS ROSA Flight Demonstration

- 66.4" [1.69 m] wide x 211.0" [5.36 m] long
- Spectrolab & SolAero cells

ISS Power Augmentation Program Overview

Powering ISS for the next decade and beyond

- Six new ROSA Solar Arrays designed for ISS, called iROSA, provided by Redwire
 - Flight Support Equipment (FSE) and Mast Canister Modification hardware (Mod Kit) provided by Boeing
- Pairs of iROSA wings delivered to ISS via three SpaceX Dragon CRS missions
- Wings installed and deployed by EVA



iROSA Solar Arrays

- Features:
 - Folded Mandrel ROSA design – Maximized Stowed Volume
 - 6.5" Diameter Boom – Massive Torque Margin
 - 28 kW BOL Flex Blanket featuring Spectrolab XTJ Cells
 - Designed for complete EVA operation
- Wings 1 & 2 successfully deployed in June 2021
- Wings 3 & 4 successfully deployed in December 2022
- Wings 5 & 6 delivered and launching June 2023



esa

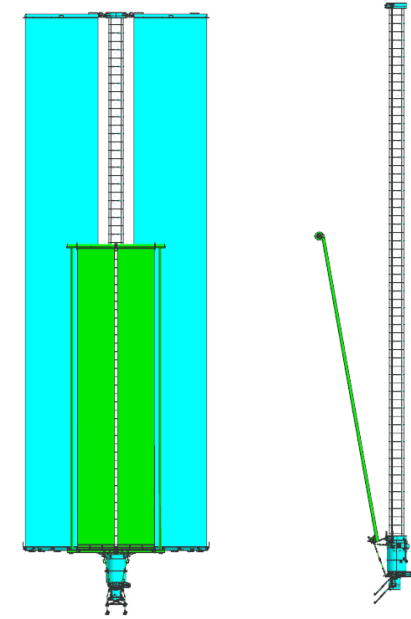


iROSA On-Orbit Performance

- Deployment durations consistent for all four wings (within 5%)
 - Ground deployment average from 7:30 (ambient) to 12:30 (cold)
 - Deployment speeds consistent with post-eclipse predictions

Wing #	EVA	Channel	Date	T+ Eclipse	Deploy Time
Wing 1	US EVA 75	2B	6/20/2022	0:08:23	0:09:43
Wing 2	US EVA 76	4B	6/25/2022	0:03:49	0:09:51
Wing 3	US EVA 82	3A	12/3/2022	0:01:37	0:09:28
Wing 4	US EVA 83	4A	12/22/2022	0:03:58	0:10:24

- Power Production:
 - 100% of iROSA strings performing as-expected
 - Total channel power is aggregate of legacy arrays (partially shadowed) and new iROSA arrays (canted at 10°)

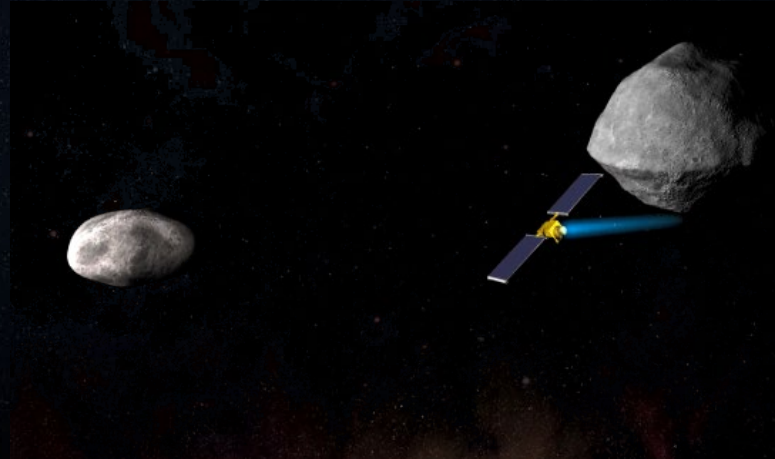
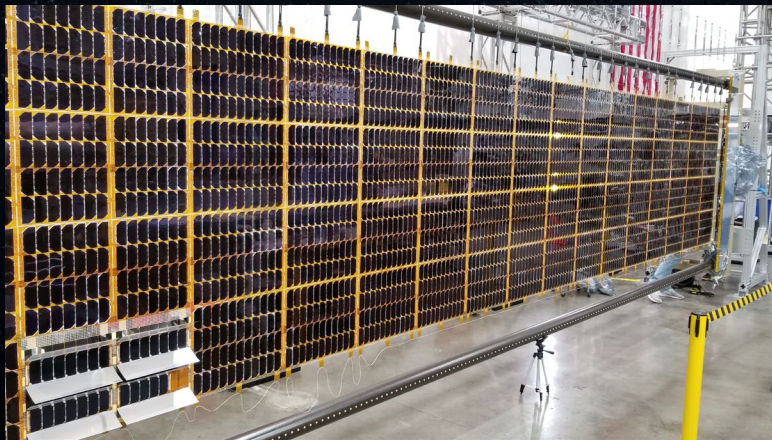
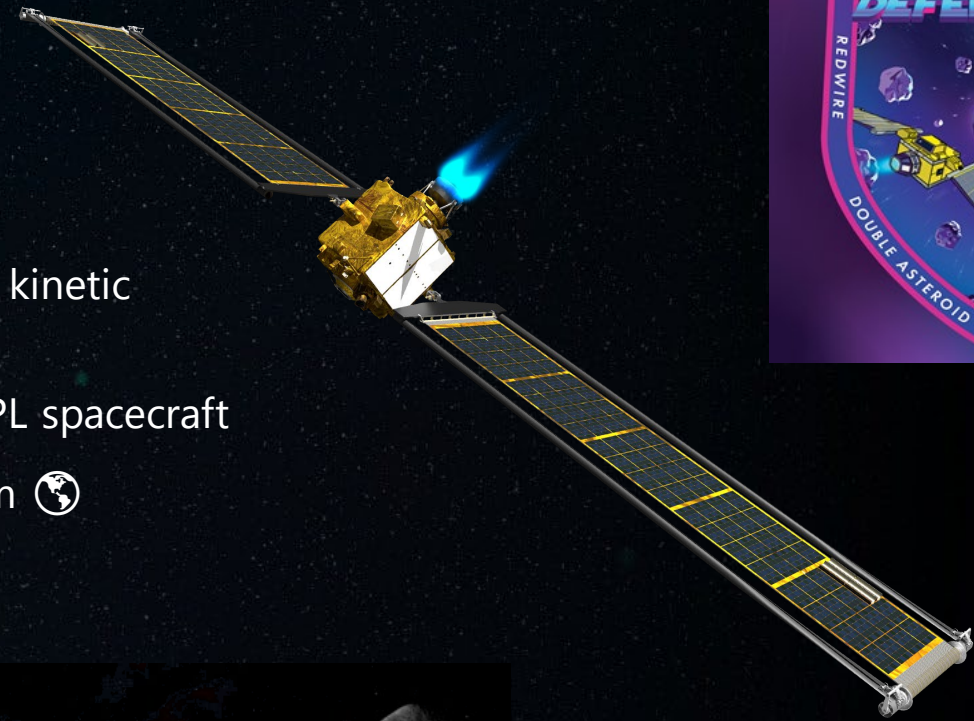


Measured Power of Combined Legacy and iROSA Wings under Operating Conditions			
Channel	Before kW	After kW	Delta kW
2B	17	26	9
4B	18	26	8
4A	21	28	7
3A	19	28	9
		Total:	33

DART Mission Overview

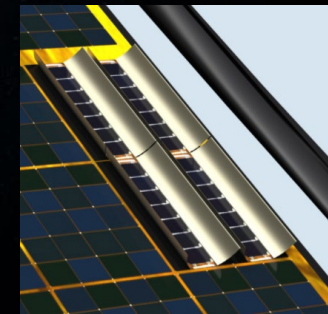
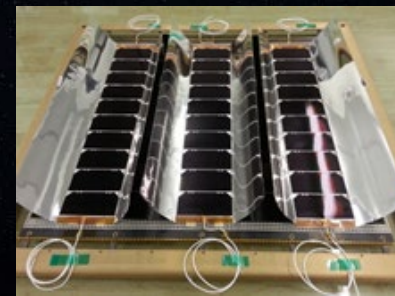
NASA Double Asteroid Redirect Test (DART) Mission

- First-ever spacecraft to demonstrate asteroid deflection by kinetic impactor on asteroid target
- Redwire delivered two 3.3 kW BOL ROSA arrays for JHU/APL spacecraft
- 🌐 Designed and built by Redwire's Planetary Defense Team 🌐
- Both arrays successfully deployed in November 2021!

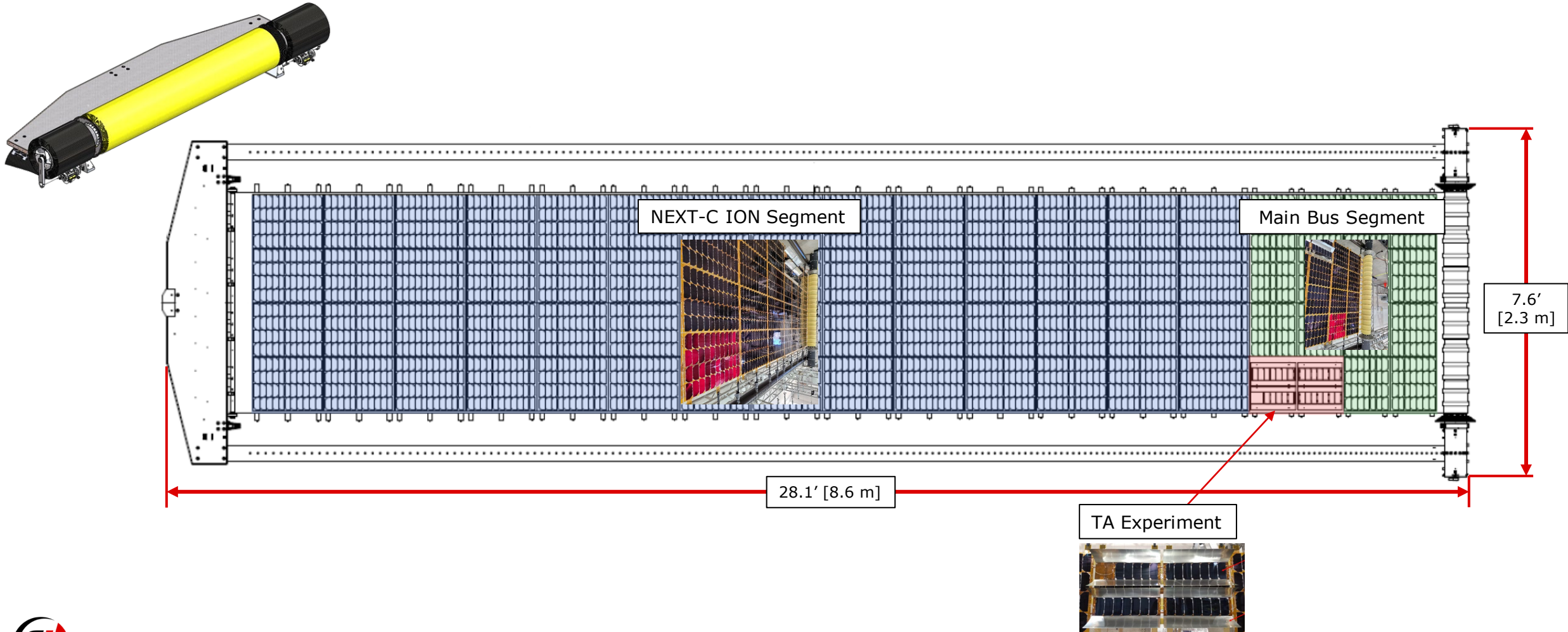


DART ROSA Summary

- Key Requirements:
 - Power: > 6.6 kW Total (3.3 per Wing)
 - Mass: > 100 W/kg
 - Stiffness: > 0.25 Hz Deployed and > 50 Hz Stowed
- Two segments using SolAero ZTJ 30.5 cm² CICs:
 - Main Bus Segment (60 V) – QTY 14 4x7 CIC SPM
 - NEXT-C Ion Segment (100V) - QTY 56 4x11 CIC SPM
- Transformational Solar Array (TA) Experiment:
 - Two SPMs used Redwire's FACT Concentrators with SolAero IMM CICs to evaluate performance for future extreme missions



DART Power Segment Layout

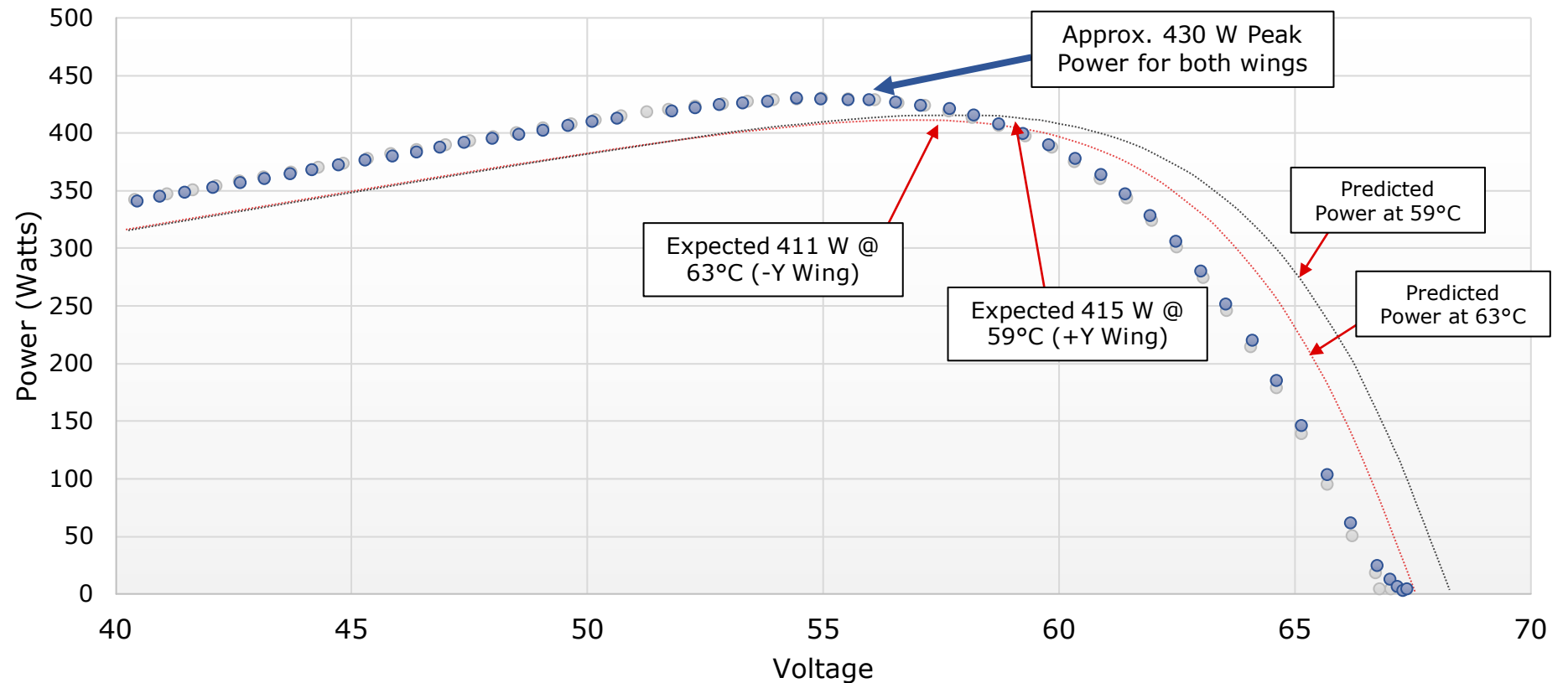
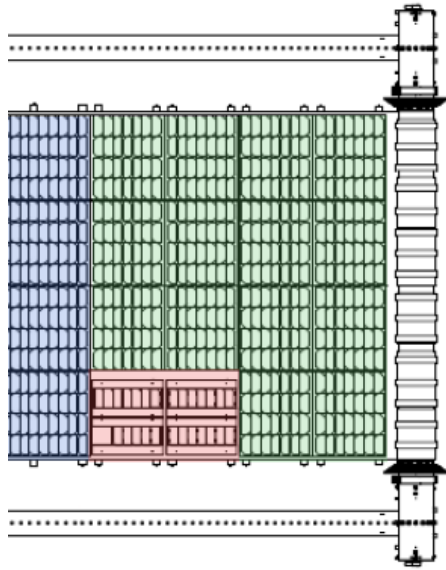


DART On-Orbit Results

- **Deployment Results:**
 - Both ROSAs deployed within nominal deployment time
- **Power Results:**
 - Power measured for all segments during initial ROSA deployment on 11/24/21
 - I-V Sweep performed on Main Bus and TA segments on 12/18/2021
 - Due to NEXT-C anomaly, no additional sweeps were measured
 - Results:
 - Main Bus Segments performed as expected for entire mission
 - Ion Segment also produced power as expected, but only operated for short duration prior to ion thruster issues

DART Main Bus Power Measurement

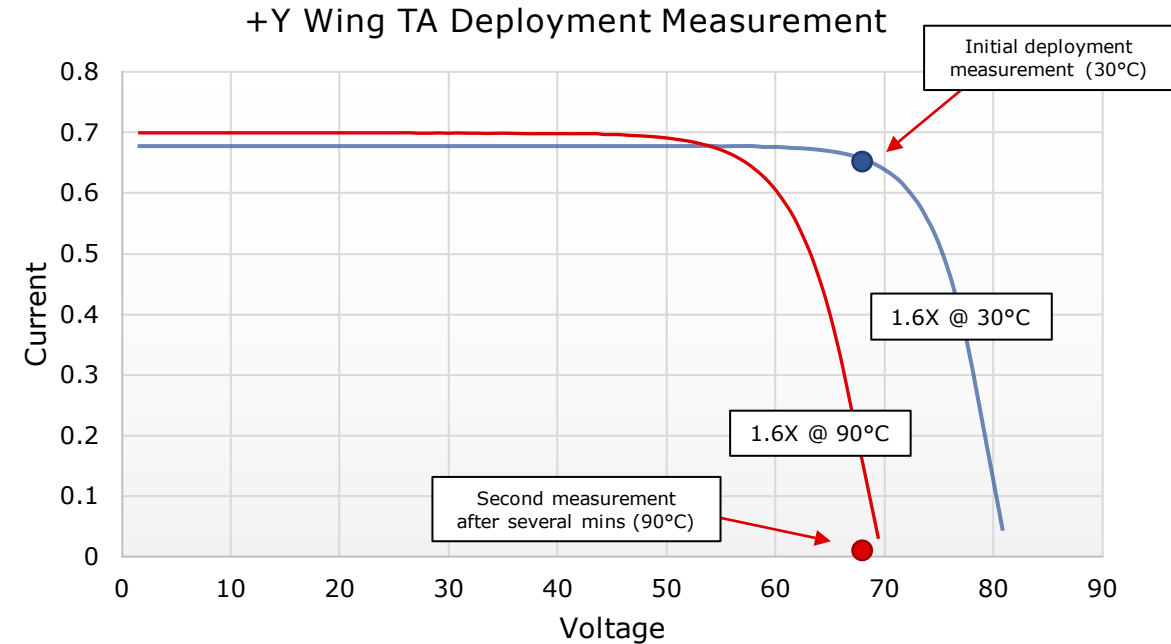
Main Bus Power vs. Voltage (Measured 12/18/2021)



Wing likely operating hotter than temperature sensor measurements (sensors located on backside)

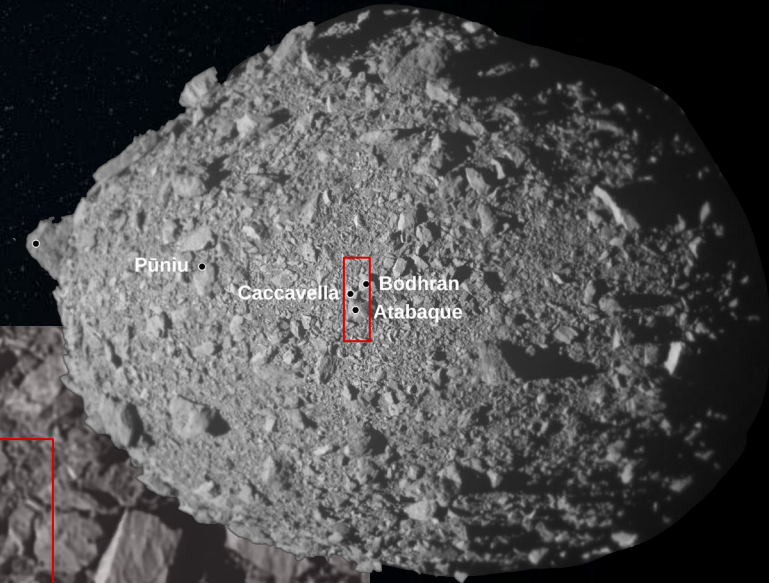
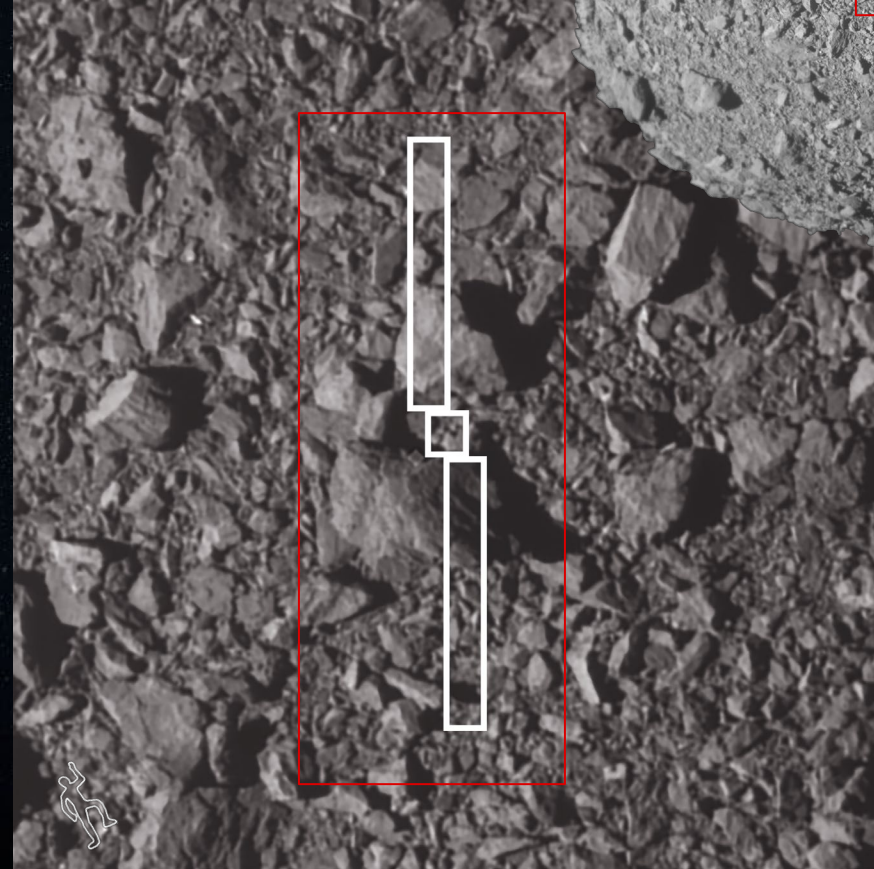
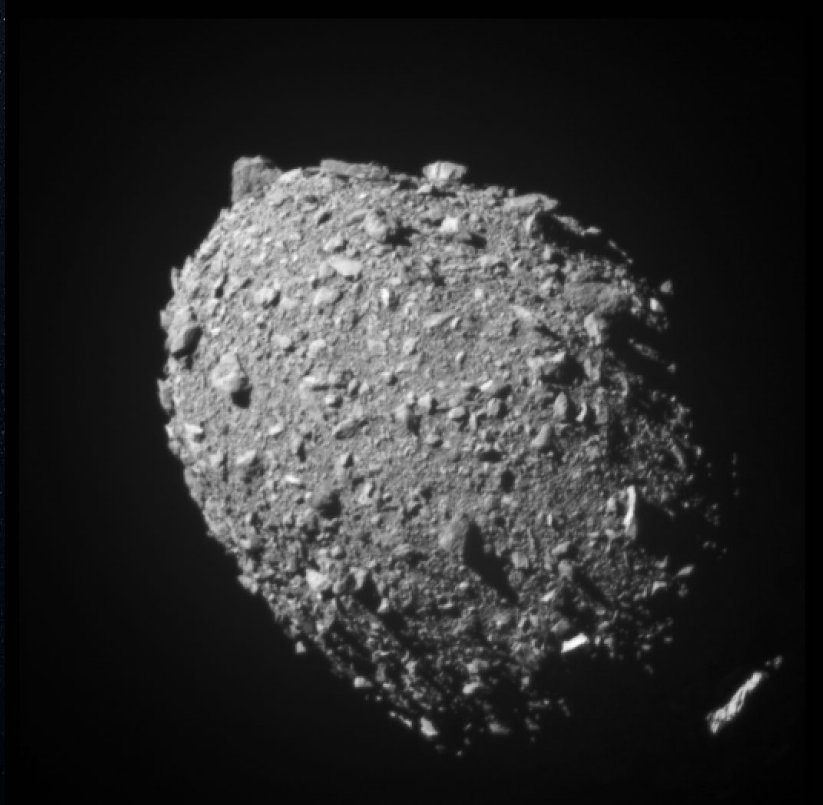
DART TA Results

- Experiment results inconclusive
- What we know:
 - FACT concentrators deployed
 - Approx. 1.6X concentration predicted (rough sun-pointing at deployment)
 - Voltage as expected at deployment
 - I-V sweep after 24-day OC showed lower than expected voltage
 - Unable to perform additional I-V sweeps due to NEXT-C issues

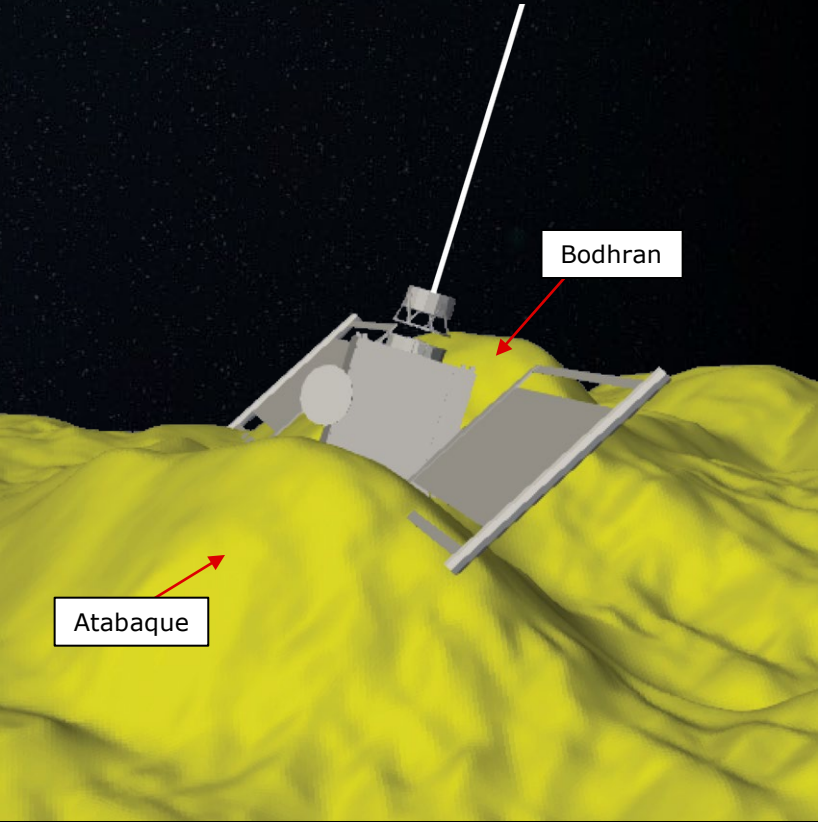
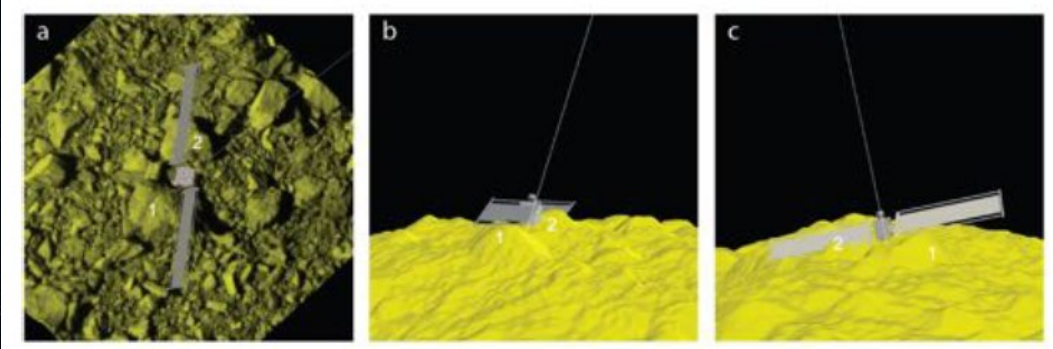
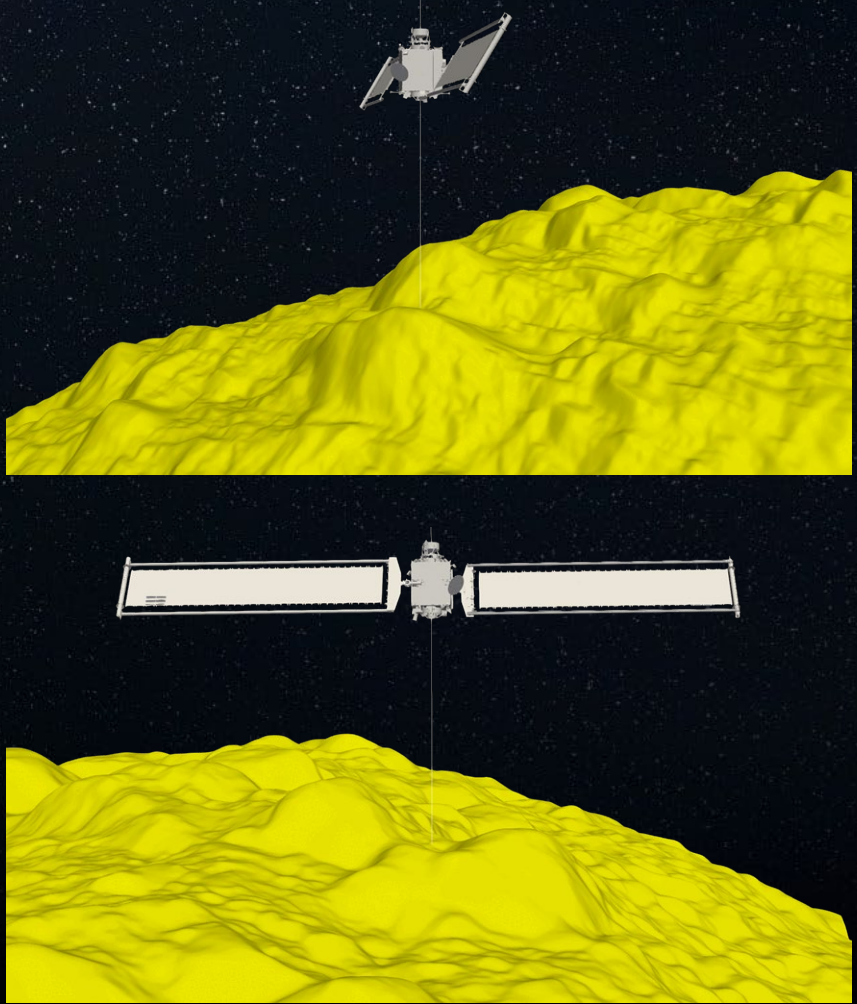


DART Ending-of-Life

DART spacecraft impacted Dimorphos at 6.6 km/s on September 26, 2022



DART ROSA Impact





Questions

Thank you for your time and consideration!

Questions or More Info: matt.lapointe@redwirespace.com

