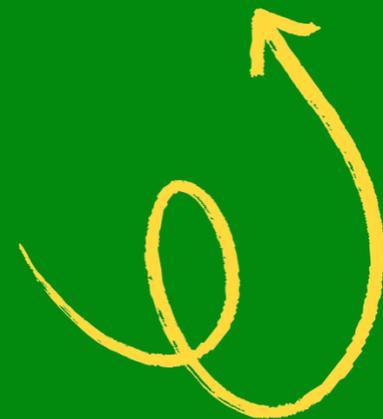


# Gone in 17,500 MPH- Catching Chaos & Saving Space

A Hands - On STEM + Arts Mission in  
Orbital Debris Defense



# The Bee or We ?

Who do you think is in danger ?



Object Type	Size Category	Estimated Count	Ratio (Debris : Active)
Operational Satellites	Intact & Functional	~14,300	1 : 1
Tracked Debris	> 10 cm (Softball size)	~40,500	~3 : 1
Lethal Debris	1 cm – 10 cm	~1,100,000	~77 : 1
Small Debris	1 mm – 1 cm	~130,000,000	~9,000 : 1

# Session Outcomes

Participants will be able to

Describe what space debris is and explain its risks using data and case studies.

Collaborate in designing functional prototypes.

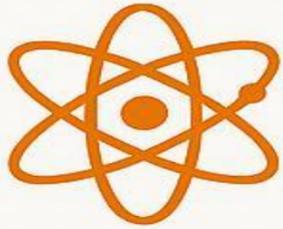
Apply physics and math concepts to real-world challenges.

Integrate ART and think critically about the sustainability of space exploration.

# Subjects Integration

## GONE IN 17500 MPH

### PHYSICS



- Speed
- Collision
- Relative motion
- Magnets, electromagnets

### SPACE



- Satellites
- Debris challenge and debris catcher
- Deorbit
- Reentry

### ENGINEERING



- Design
- Problem solving
- Design challenge



### MATHEMATICS



- Graphs and data
- Trajectory
- Collision safe distance

### ARTS

- Visual arts and storytelling to communicate

# Session Integration

## NEXT GEN OR TEKS STANDARDS USED



### Next Generation Science Standards (NGSS)

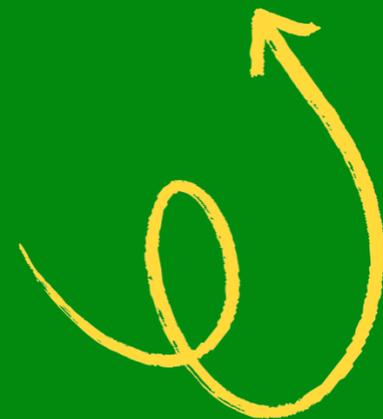
HS-PS2-1, HS-ESS1-4, HS-ETS1-2

### Texas Essential Knowledge and Skills (TEKS)

- Physics – §112.39(c)(4)((A, B)
- Engineering Design – §130.375
- Art – §117.315(c)(2(B)

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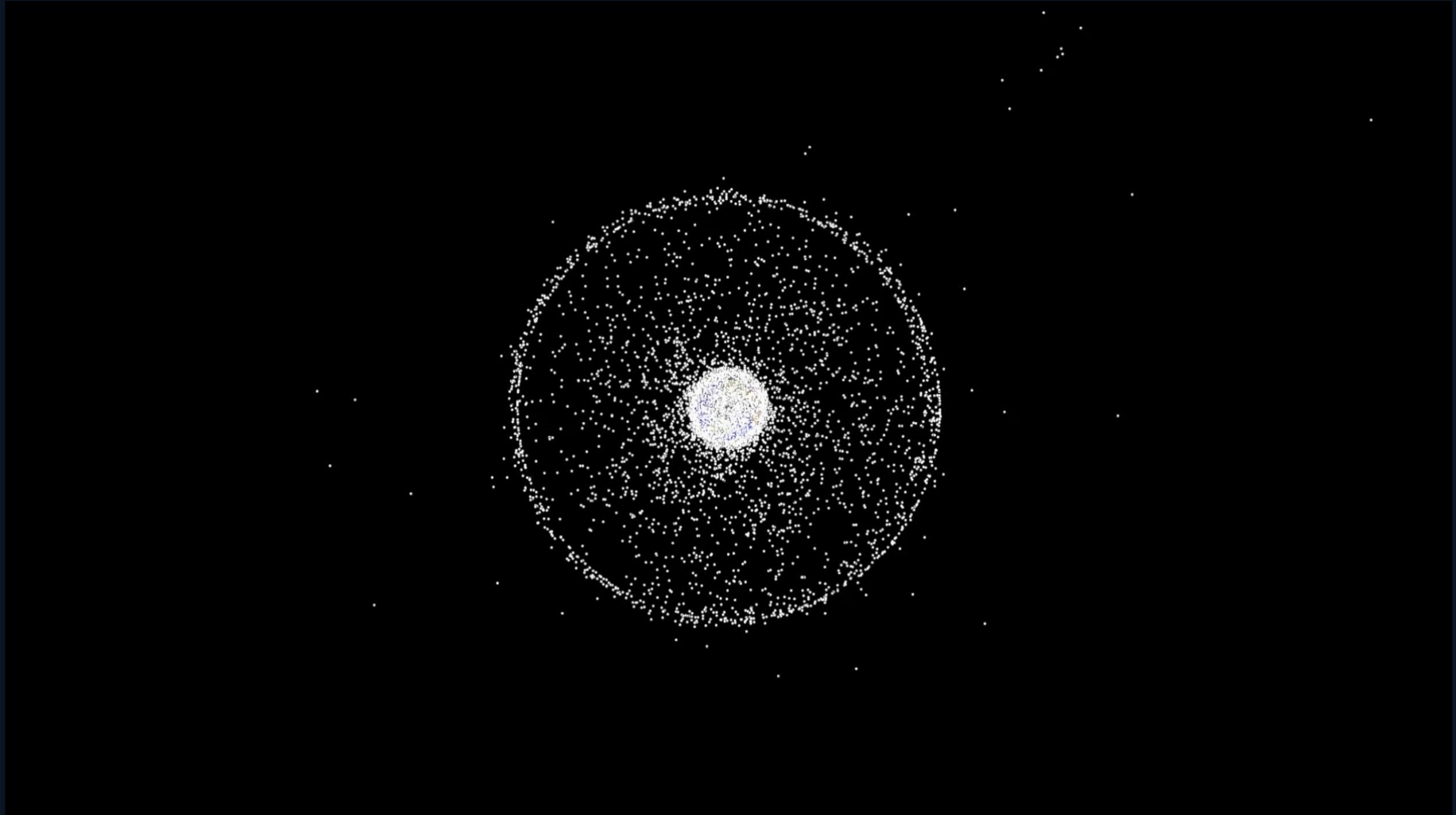
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## **Section 1** **What's the** **Challenge**



# Debris around Earth



# Space Debris: Hazards



**1. Destroy or Damage Operational Satellites**

**2. Threaten Human Spaceflight & Space Stations**

**3. Create More Debris via The Kessler Syndrome**

**4. Increase Mission Costs & Complexity**

**5. Limit Access to Space**

**6. Endanger People & Property on Earth**

**7. Pollute Orbits for Astronomy & Science**

**8. Trigger Political & Legal Conflicts**

**9. Hinder Future Space Exploration**

**10. Create Long-Term Environmental Harm**

**11. Economic Domino Effects**

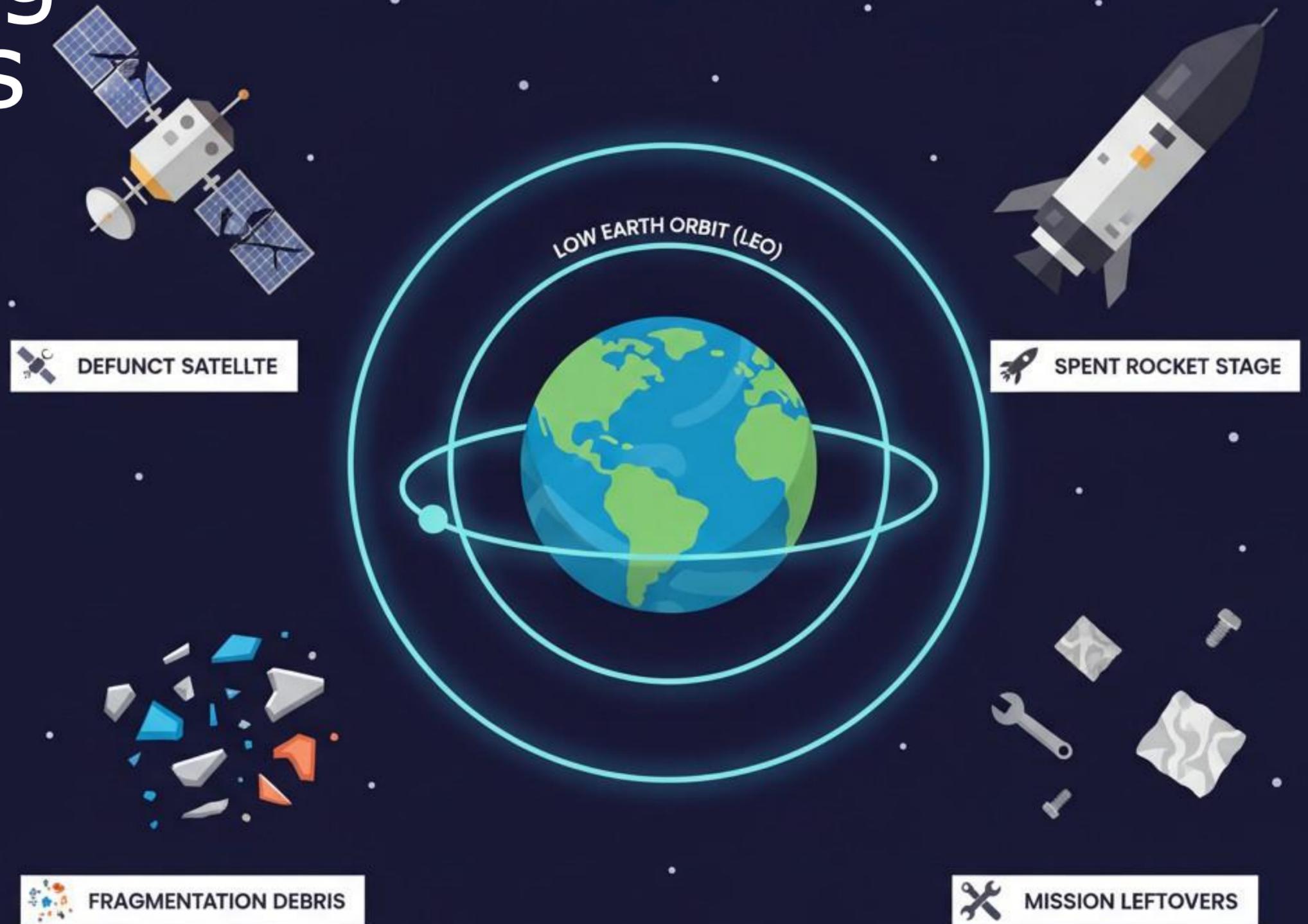
# Understanding Space Debris

Space debris encompasses various objects:

- **Defunct Satellite**
- **Spent Rocket Stage**
- **Fragmentation Debris**
- **Mission Leftovers**

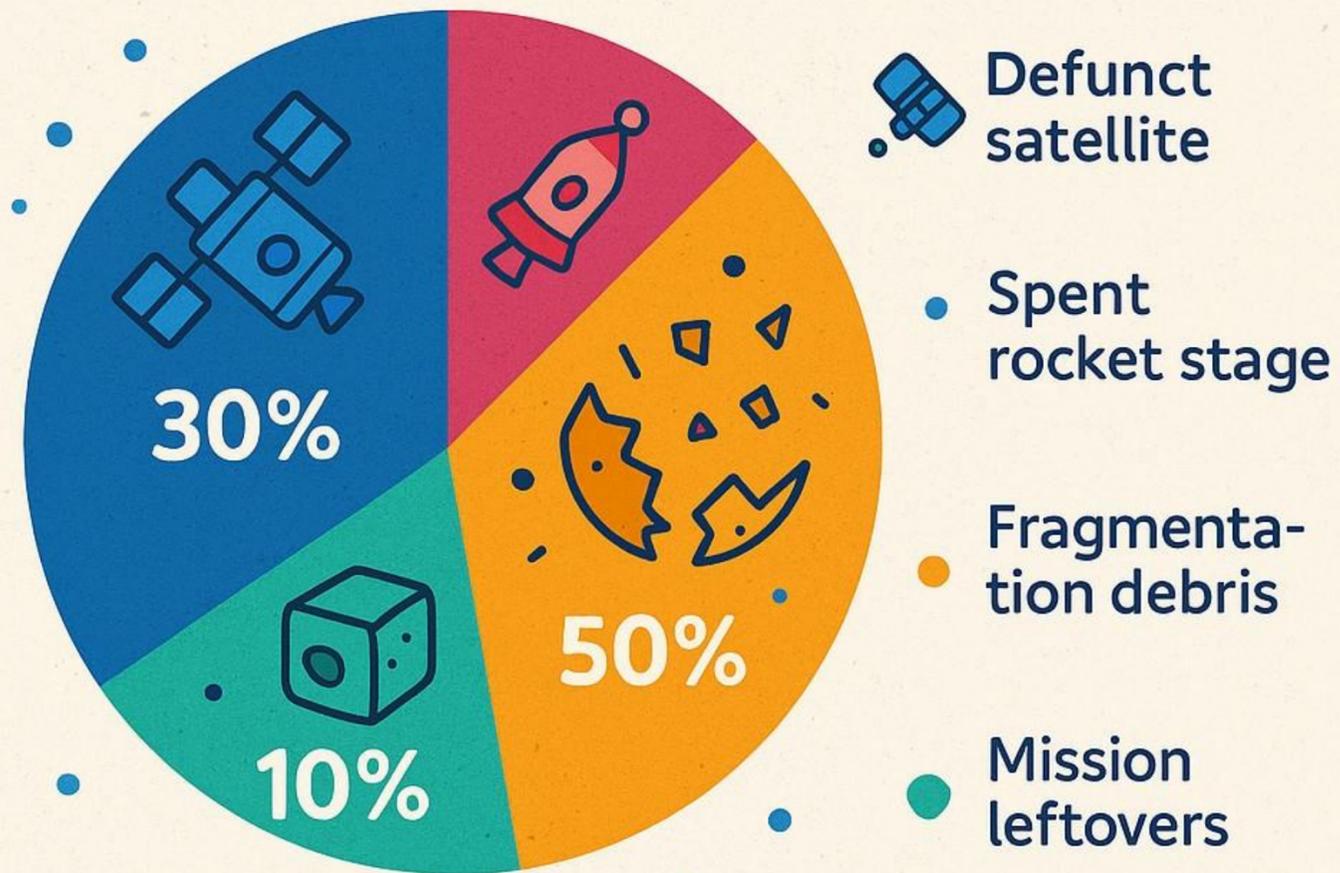
Each type poses significant risks to operational spacecraft and contributes to the growing concern of sustainability in space exploration.

## WHAT IS SPACE DEBRIS?



# Space Debris — Estimated Percentages

## Percentage Availability of Space Debris



Defunct satellites ( $\approx 23-34\%$ )

Spent Rocket Stage ( $\approx 10-11\%$ )

Fragmentation debris ( $\approx 47-56\%$ )

Mission Leftovers ( $= 10-12\%$ )

# Speed & Kinetic Energy

## ORBITAL SPEED COMPARISON

UNDERSTANDING SPACE DEBRIS VELOCITY



TYPICAL BULLET

~1,700-1,800 mph



FASTEST  
AIRPLANE: X-15

~4,520 mph



ORBITAL  
DEBRIS (LEO)

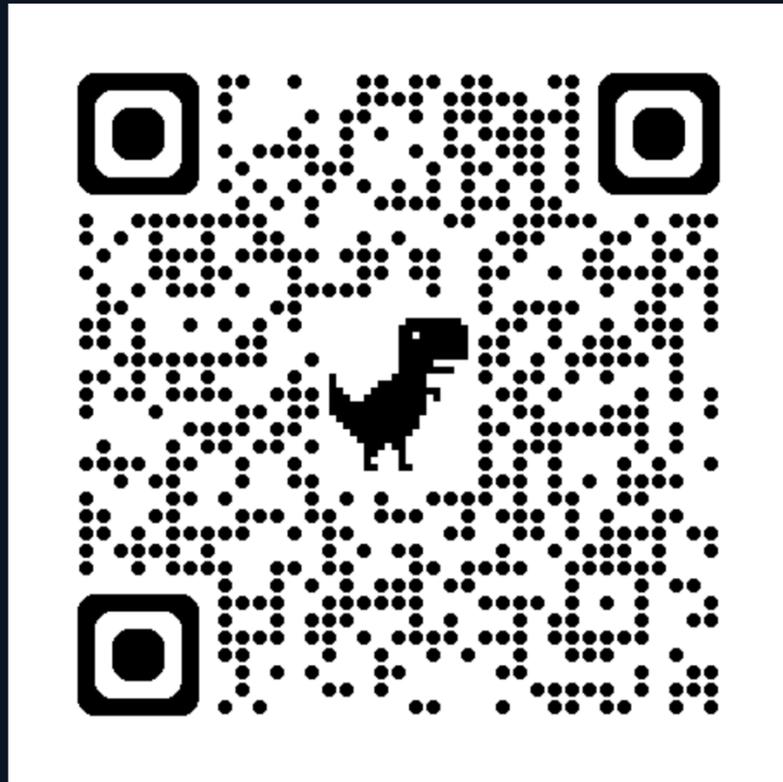
~17,500 mph

Space debris can travel at ~28,000 km/h (17,500 mph) nearly 10× faster than a bullet and ~4× faster than the fastest manned aircraft.

**Kinetic Energy-** Kinetic Objects in Low Earth Orbit (LEO) travel at roughly 7.8 km/s (over 17,500 mph). At these speeds, even a 1 cm piece of debris has the explosive energy of a hand grenade



# Live Debris Data



Scan and See

**Kessler Syndrome !**

A screenshot of the Leolabs space debris visualization interface. The interface is dark-themed and shows a 3D visualization of Earth surrounded by a dense field of space debris. The debris is color-coded by type: green for Payload, yellow for Rocket Body, red for Debris, and blue for Unknown. A control panel on the left side of the interface includes a search bar, a speed slider set to 25, and several checkboxes for 'Debris', 'Beams', 'Instruments', 'Follow Earth', and 'Auto Refresh'. Below these are sections for 'Views' (Object Type, Perigee, Period, Inclination, Country of Origin) and 'Filters' (Perigee range). At the bottom, there is a 'LEOLABS' logo, copyright information, and a timestamp '2026-01-07 21:04 UTC' with '25041 objects displayed'.

<https://platform.leolabs.space/visualizations/leo>

# The Real Challenge



SPACE DEBRIS COLLISION ANIMATION, CREDIT: ESA

# Challenges- On Earth



Pressure sphere recovered in South Africa.  
Photo: Argus/Enver Essop



The cylindrical object, found on Thursday in Kachin state, is 4.5m (15ft) long and 1.2m wide (11-11-2016 BBC)

Dec30, 2024- Ariane rocket (SYLDA Adapter )  
launched in 2008 – landed on the Kenyan  
village of Mukuku, after 16 years



Over 3 times a day in 2025- ESA

# Challenges- Metals in Atmosphere

United Nations Environment Program (UNEP) released "Safeguarding Space: Environmental Issues, Risks and Responsibilities."

The document dubbed a set of space debris woes as "emerging issues."

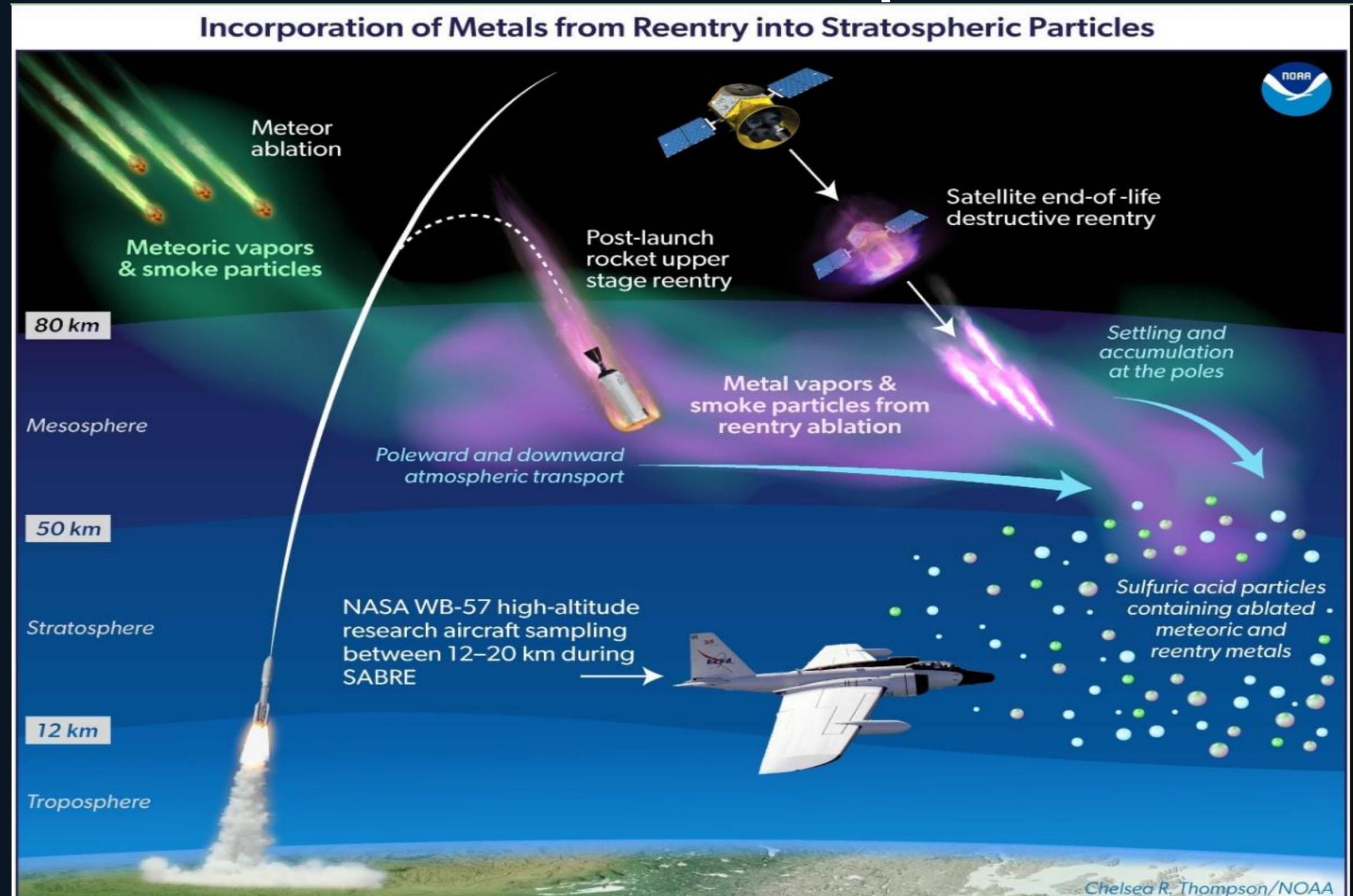


Image credit: Chelsea Thompson/NOAA)

Chelsea R. Thompson/NOAA

# Challenges – In Space

## Space debris may have hit a Chinese spacecraft, delaying return of Shenzhou 20 astronauts

**News** By Josh Dinner published November 5, 2025

The taikonaut trio had been scheduled to come home Wednesday (Nov. 5).



The Shenzhou 19 and newly arrived Shenzhou 20 astronauts pose for a photo on China's Tiangong space station on April 24, 2025. (Image credit: CCTV)

## Chinese astronauts inspect damaged Shenzhou 20 spacecraft during 8-hour spacewalk (video)

**News** By Mike Wall published December 9, 2025

The Shenzhou 20 vehicle was deemed unfit to carry astronauts back to Earth after suffering a space junk strike.

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Chinese astronauts just got an up-close look at the damage that space junk can cause.

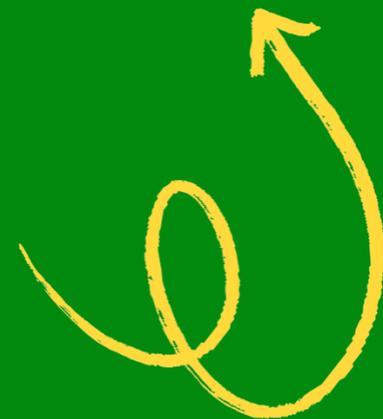
# Feel the Impact– Hands On Activity-1



This experiment can be further upgraded by changing the heights, changing different materials at different levels and the thickness' of materials.

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## **Section 2** **Facing the** **Challenge**



# Tackling Space Debris

## Tackling Space Debris



- **NASA Programs:**

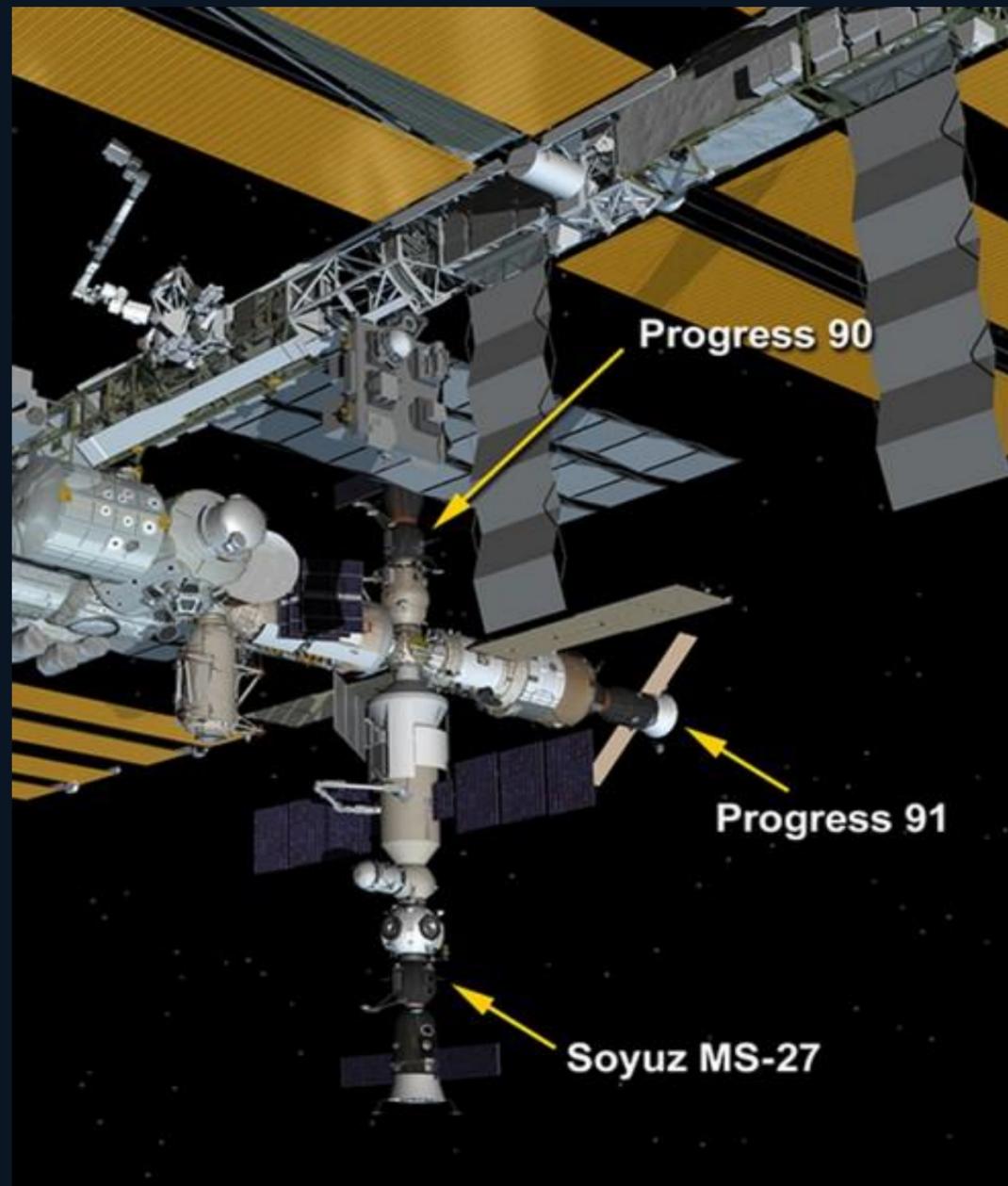
- Orbital Debris Program Office (NOPDO)
- RemoveDEBRIS
- Space Sustainability Strategy
- Debris Assessment Software (DAS)- 25 yrs Rule

- **ESA Programs:**

- Zero Debris Approach
- Zero Debris Charter (5 yrs Rule)
- CREAM (Collision Risk Estimation and Automated Mitigation)
- Active Debris Removal in Orbit Service (ADRIOS)

# ISS Avoid Orbital Debris

(Active Debris Avoidance Manoeuvres - DAMs)



April, 22, 2025- The Progress 91 thrusters were fired at 6:10 p.m. EDT Wednesday for 3 min, 33 sec, to raise the orbit of ISS

Resulting extra margin of distance from a piece of orbital debris from a fragment of a Chinese Long March rocket launched in 2005.

Without the maneuver, NASA estimated the fragment could have come within around 0.4 miles of the station.

To make sure U.S. spacewalk 93 on Thursday, May 1, with NASA astronauts Anne McClain and Nichole Ayers is not affected.

In 2024 alone, Starlink satellites moved nearly 50,000 times to avoid close passes.

# ISS Shielding Strategies (Whipple Shields)

You Remember Activity-1 .....

**Physical Shielding (Whipple Shields-** Multi-layer bumpers that break up debris)

- Concept:** These shields use multiple layers (a thin outer bumper and a thicker inner wall) with space in between, similar to spaced armor on tanks.
- Function:** The first layer shatters incoming debris into a harmless cloud of smaller particles, which are then absorbed by the inner layers before reaching the main hull.
- Capability:** Effective against small particles (up to about 1 cm) and most meteoroids, protecting critical areas like habitable modules.



Impact on Whipple shields. Image Credit: NASA

# NASA OSAM-1



## **NASA OSAM-1 On-orbit Servicing, Assembly, and Manufacturing 1 (OSAM-1)**

NASA's OSAM-1 mission is developing an unprecedented capability for a robust, cost-effective space infrastructure

**Currently On Hold**

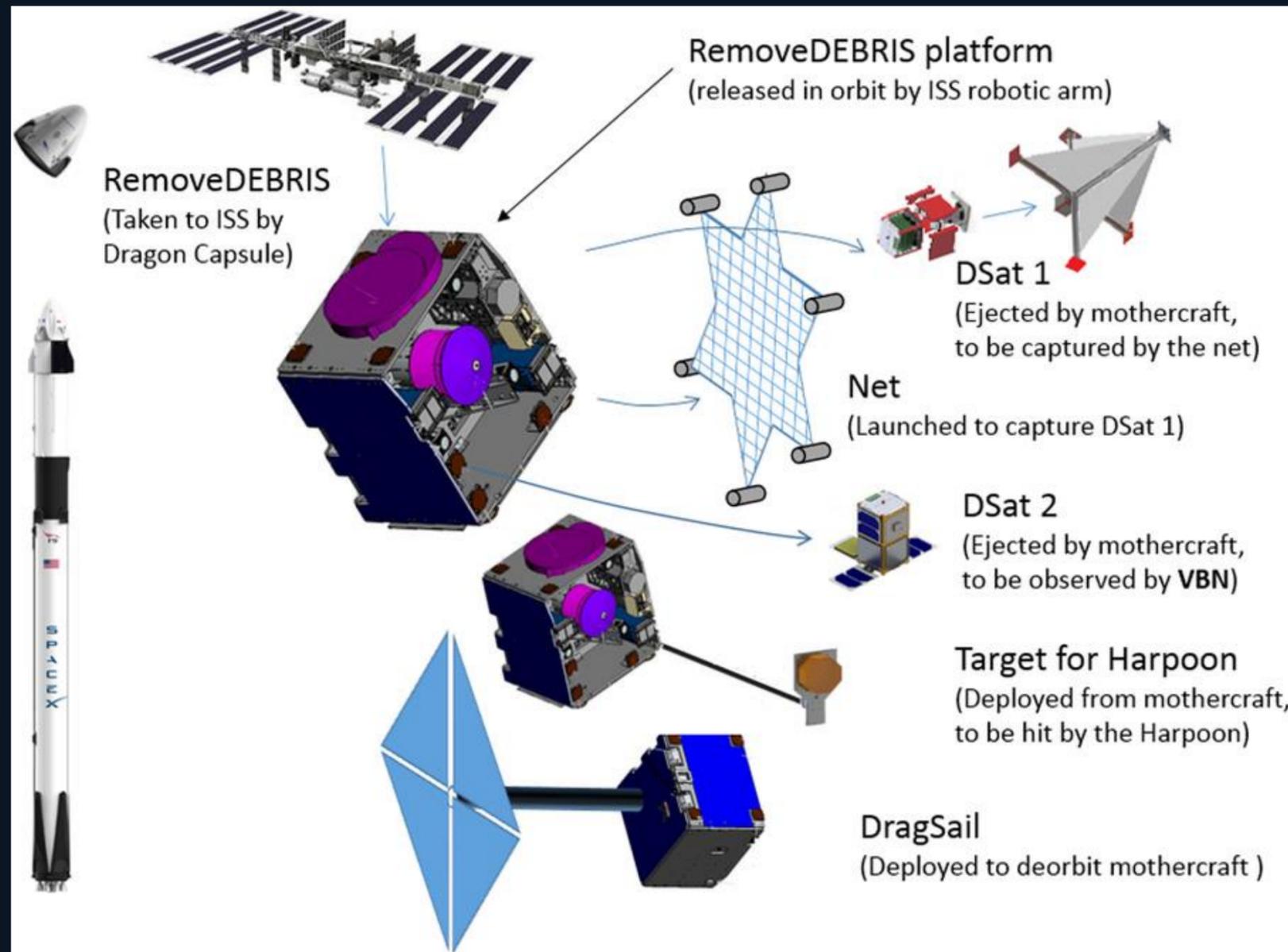
# RemoveDEBRIS Mission

Led by University of Surrey with ESA Support

Tested space debris removal technologies:

- 1 **Harpoon**,
- 2 **Net Capture**,
- 3 **Dragsail**, and
- 4 **Vision-Based Navigation (VBN)**

**NASA's role** - key launch provider, facilitating deployment from the ISS



<https://youtu.be/QUhCLTfXf0>

# ESA Missions - ClearSpace-1

→ THE EUROPEAN SPACE AGENCY



SPACE SAFETY

## clearspace-1

**Launch (planned):** 2029

**Industrial team:** Lead by OHB SE

**Target object:** ESA's PROBA-1 satellite

**Target dimensions:** 0.6 m × 0.6 m × 0.8 m

The first mission to remove a piece of space debris from orbit, ClearSpace-1 will rendezvous with, capture and safely bring down a satellite for a safe atmospheric reentry



# ClearSpace-1 : Mission

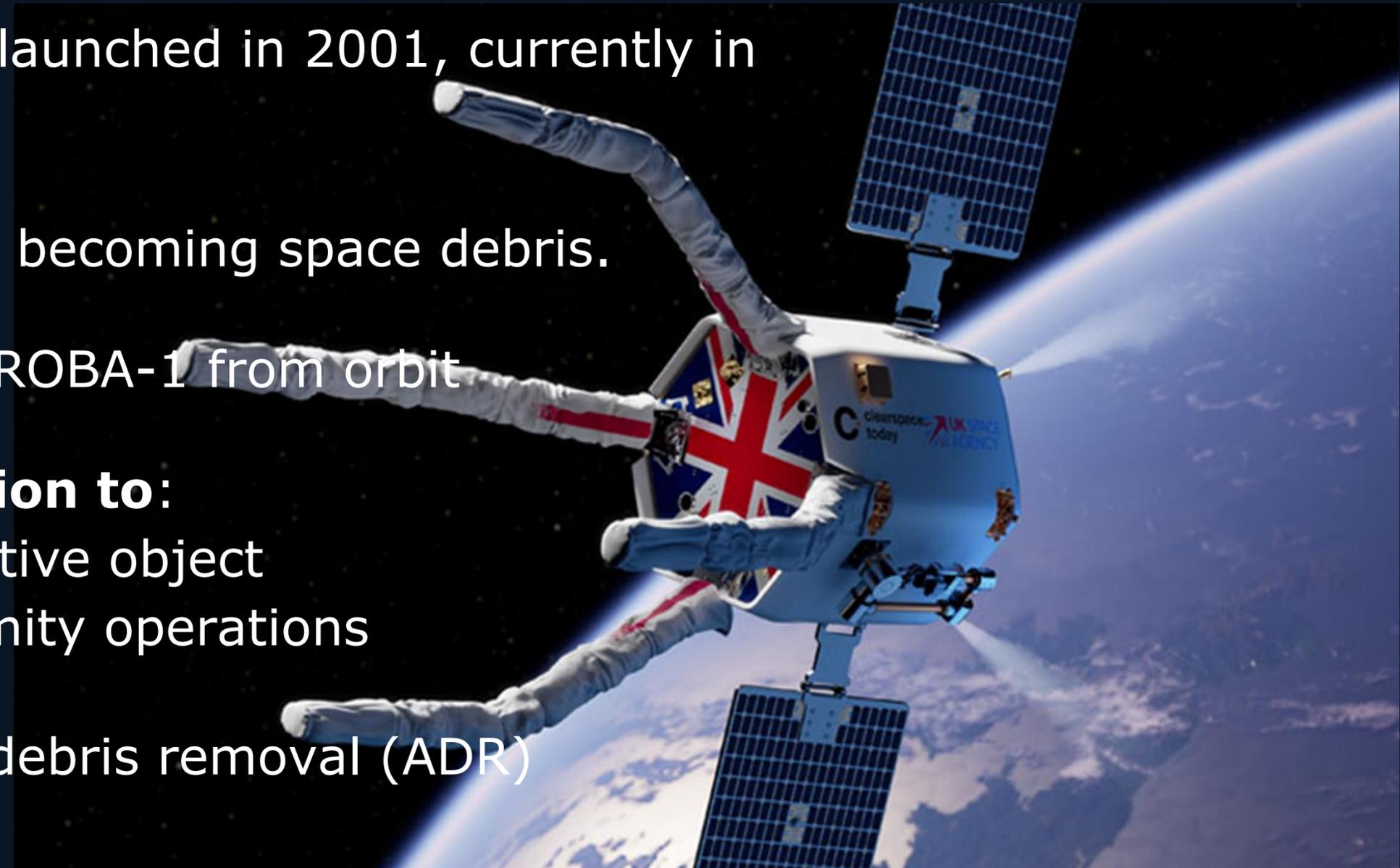
## ESA CleanSPACE Initiative



- PROBA-1 is a 95 kg ESA satellite, launched in 2001, currently in LEO
- PROBA-1 is now inactive and risks becoming space debris.
- ClearSpace-1 will safely remove PROBA-1 from orbit

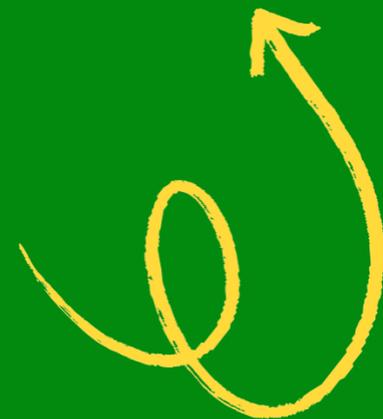
### **This will be the world's first mission to:**

- Capture and remove an uncooperative object
- Using a high-precision close-proximity operations
- The mission demonstrates active debris removal (ADR) technologies

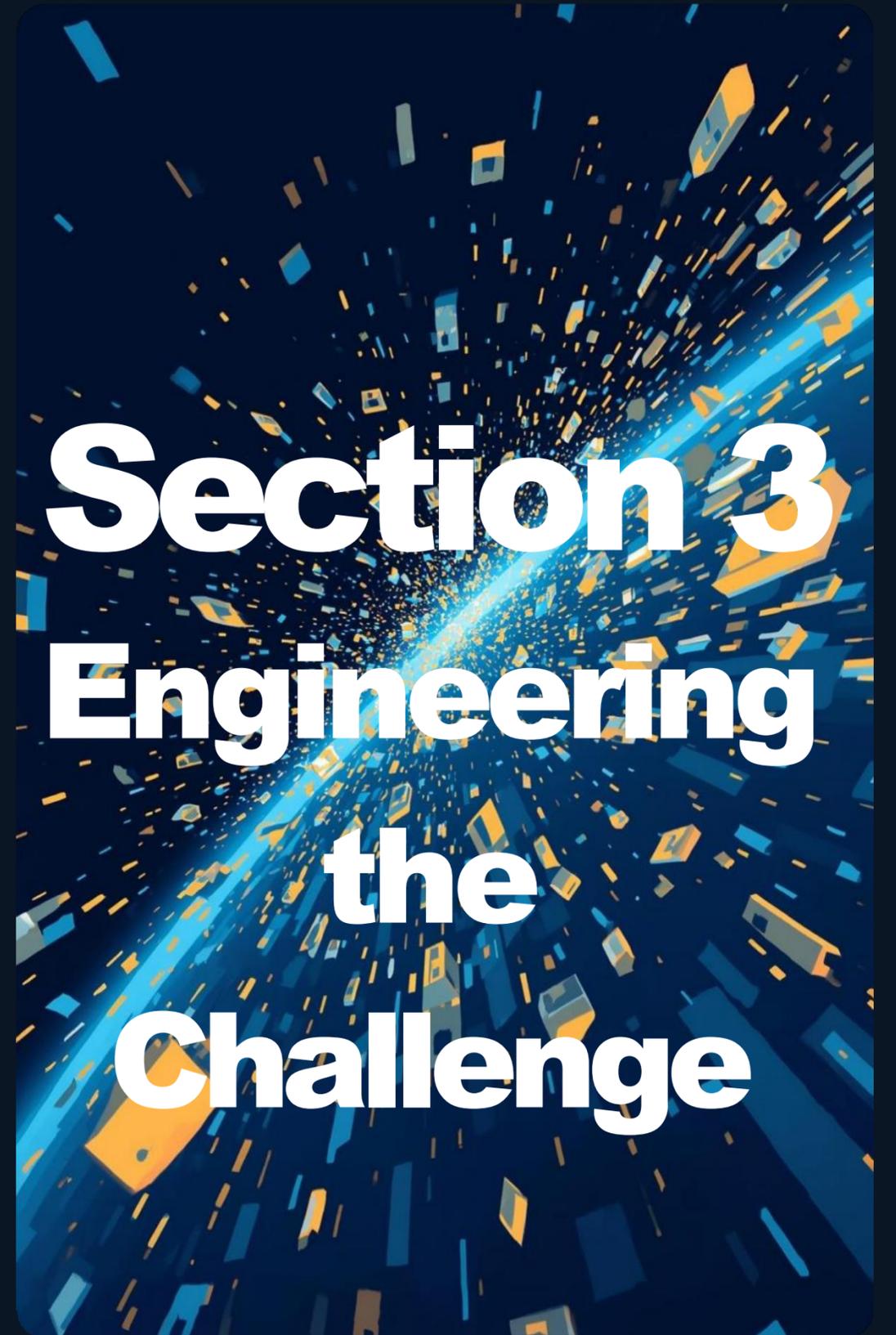


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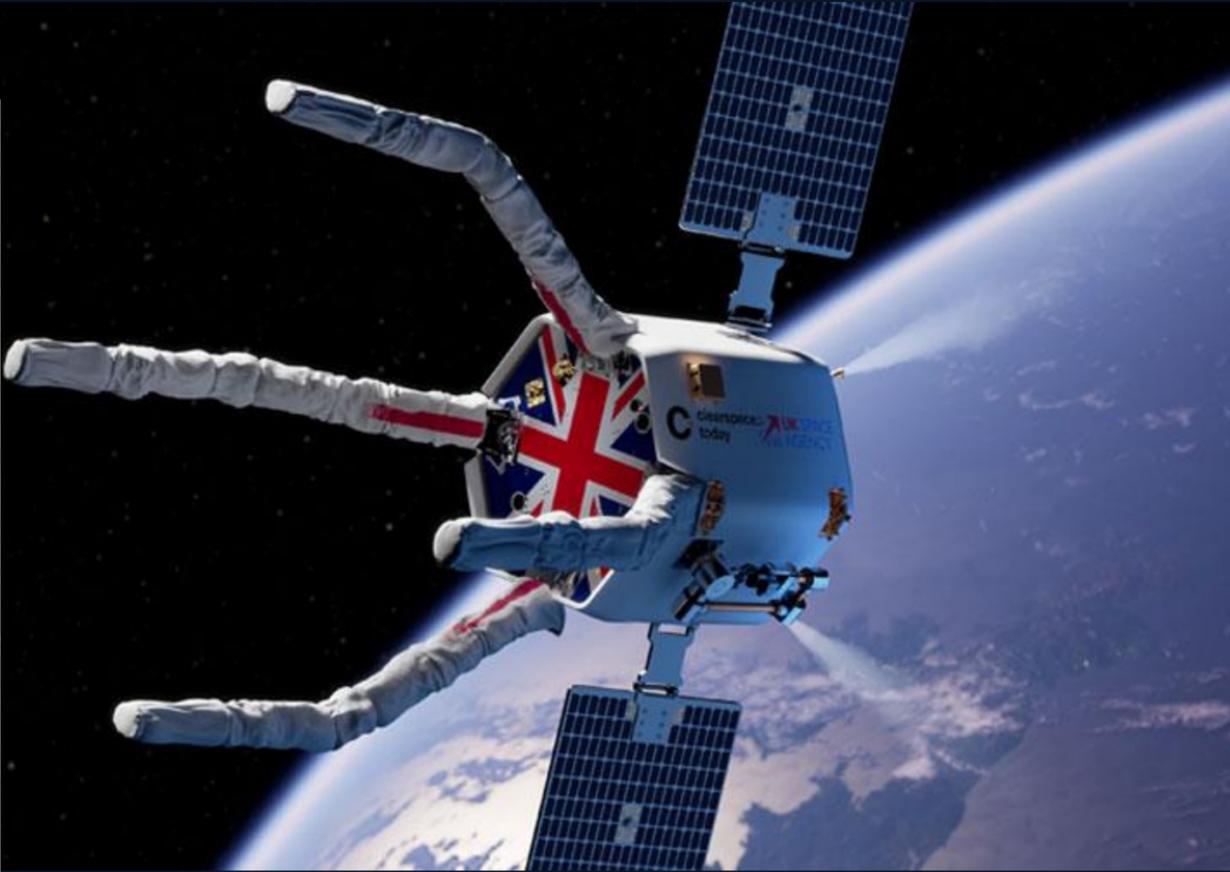
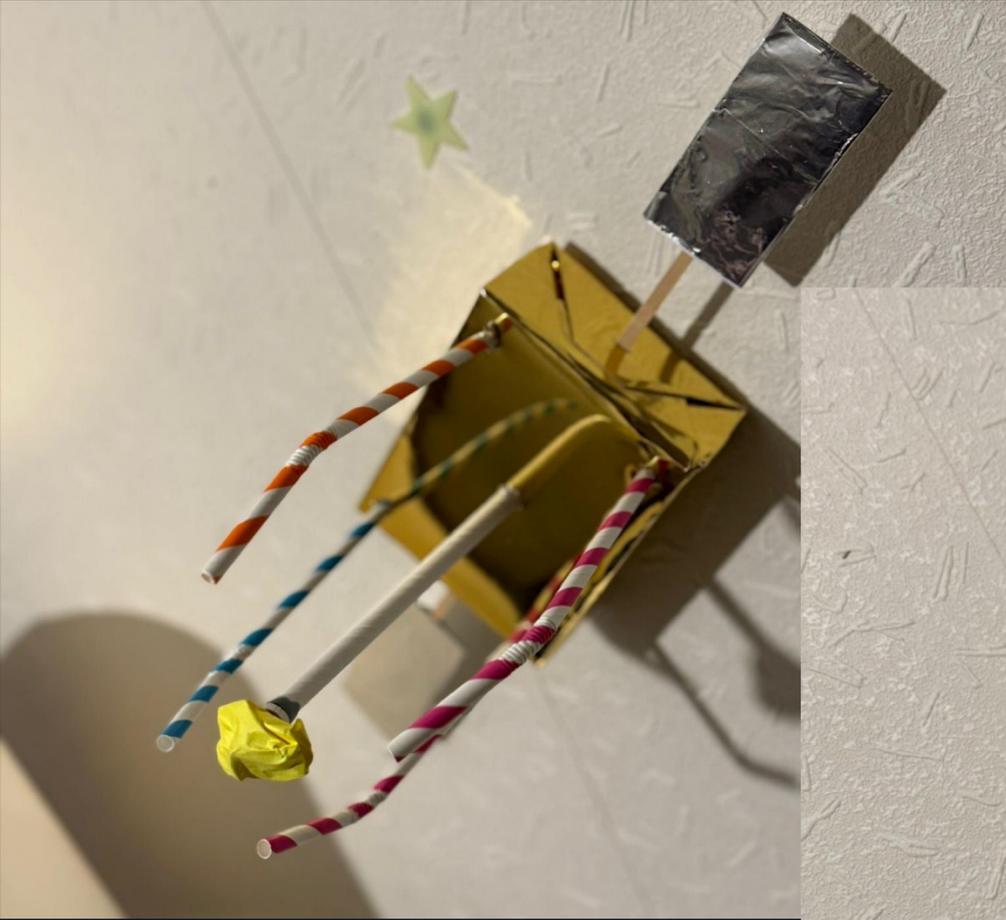
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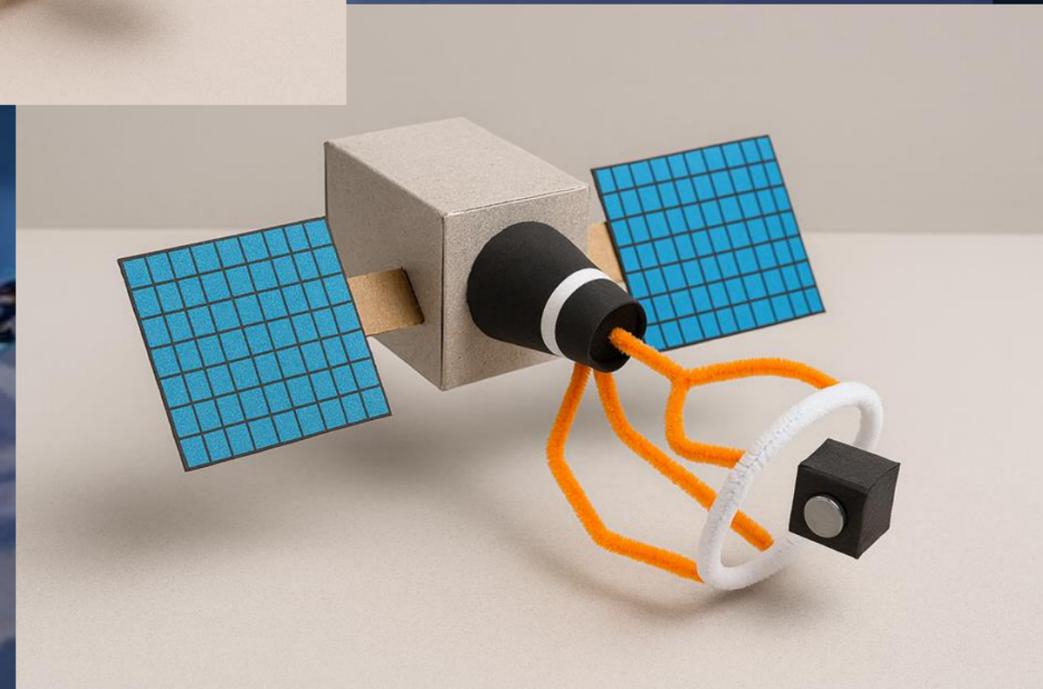
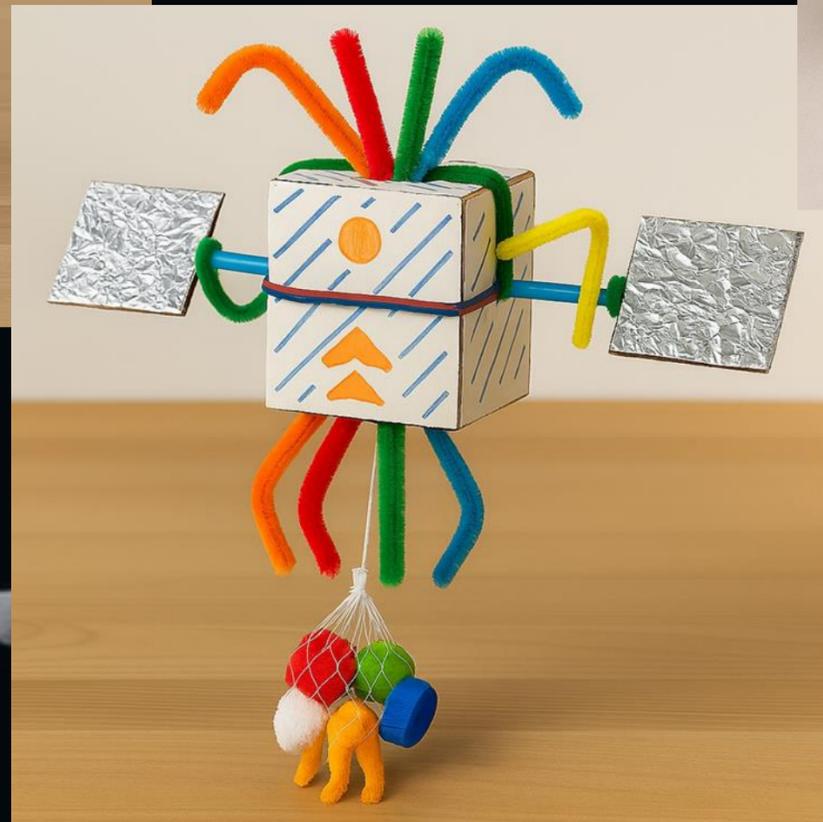
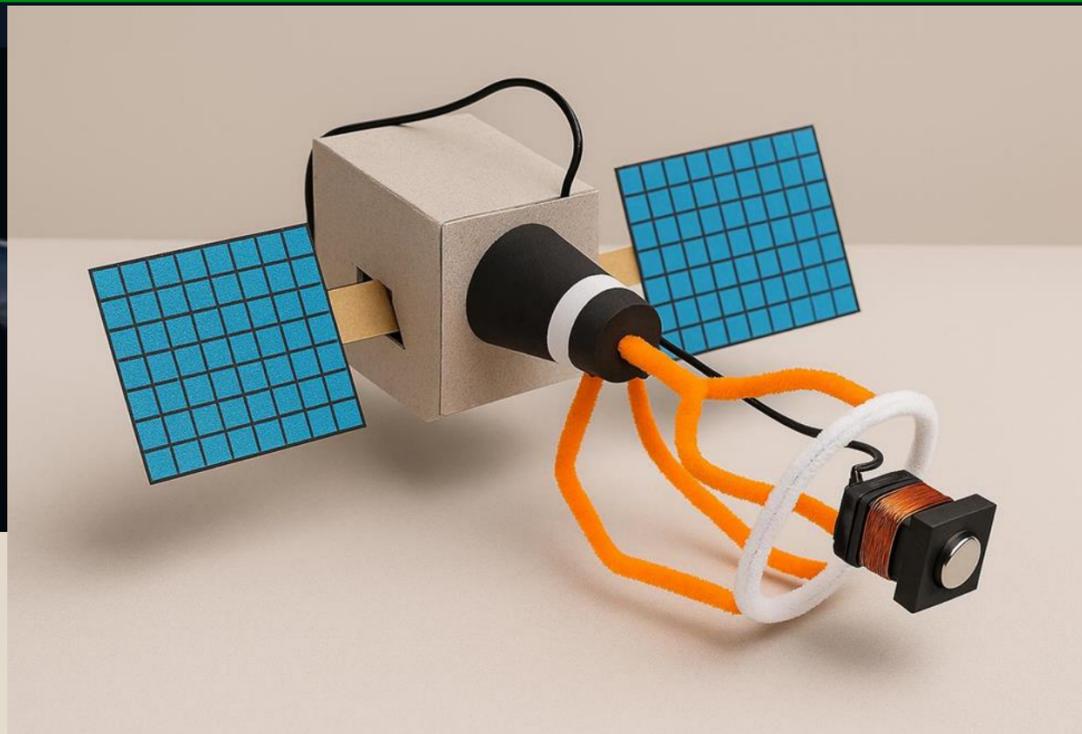
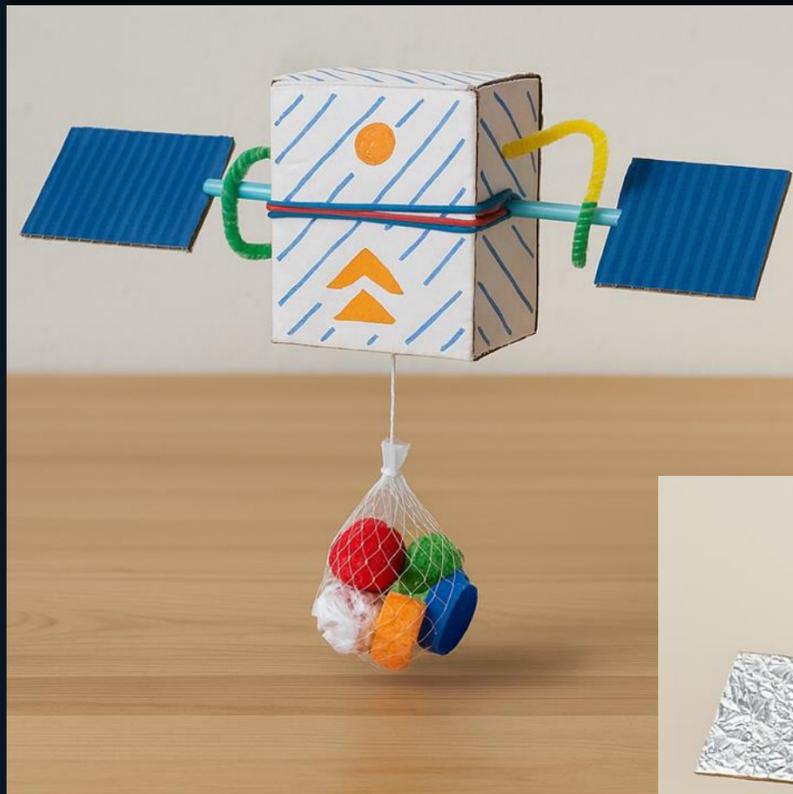
## **Section 3** **Engineering** **the** **Challenge**



# Hands-On : From Scratch to Debris Defense



# Design Challenge – ClearSPACE Model



# Thanks a Universe



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