I3C – Space Encase: Space Debris Mitigation

Suki Kushwaha

This material is based upon work supported by the Department of the Air Force under Air Force Contract No. FA8702-15-D-0001. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Department of the Air Force.

CNBC

Russian satellite blasts debris in space, forces ISS astronauts to shelter

PUBLISHED THU, JUN 27 2024•10:03 AM EDT

REUTERS

SMART NEWS

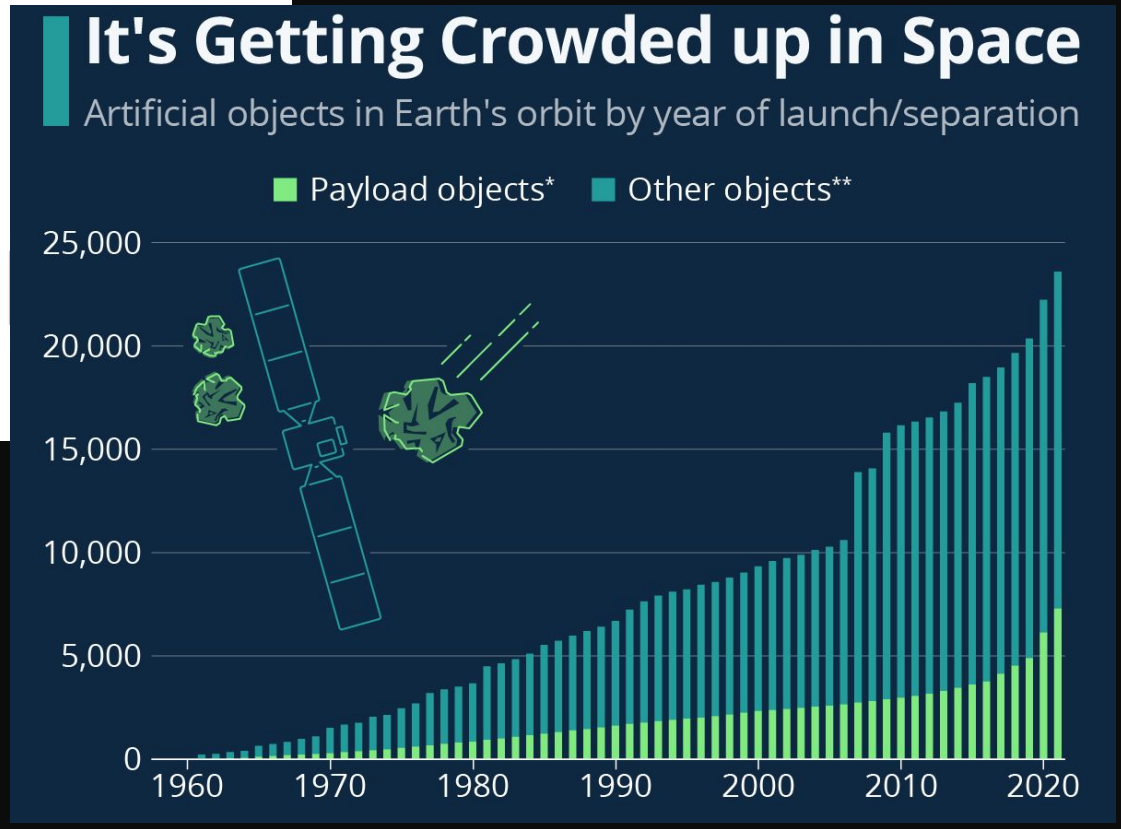
ISS Astronauts Forced to Briefly Take Shelter as Russian Satellite Suddenly Breaks Up in Orbit

Officials are unsure why the satellite fractured unexpectedly, splintering into nearly 200 pieces

Christian Thorsberg

Daily Correspondent

June 28, 2024



Meanwhile in Russia…

SPACE ENCASE

Space Debris Mitigation

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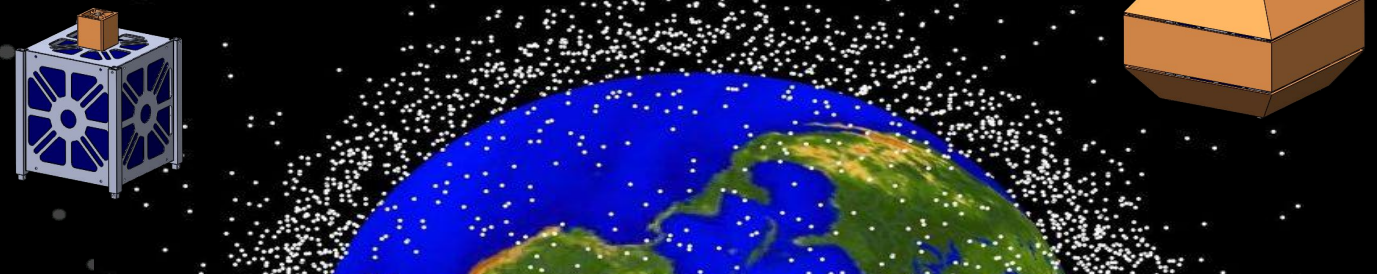
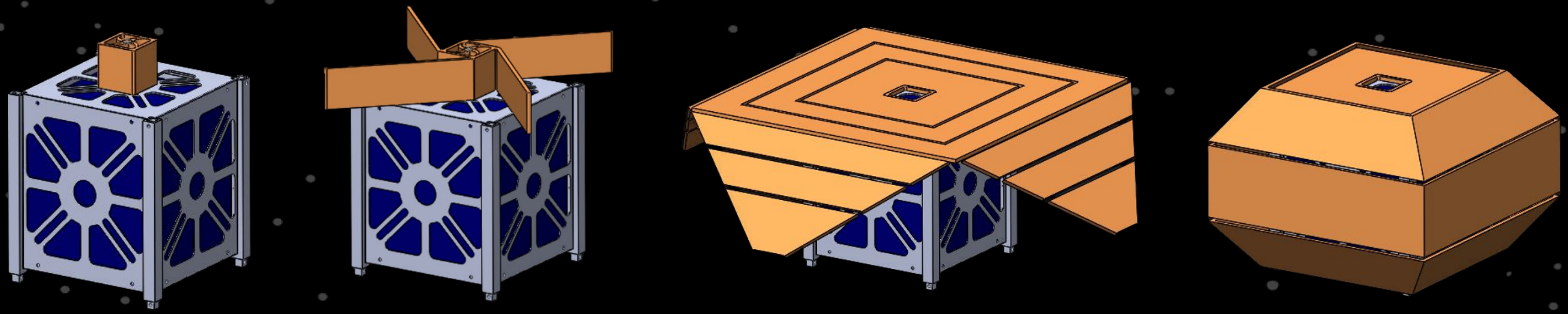


LINCOLN LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Introducing… SPACE ENCASE



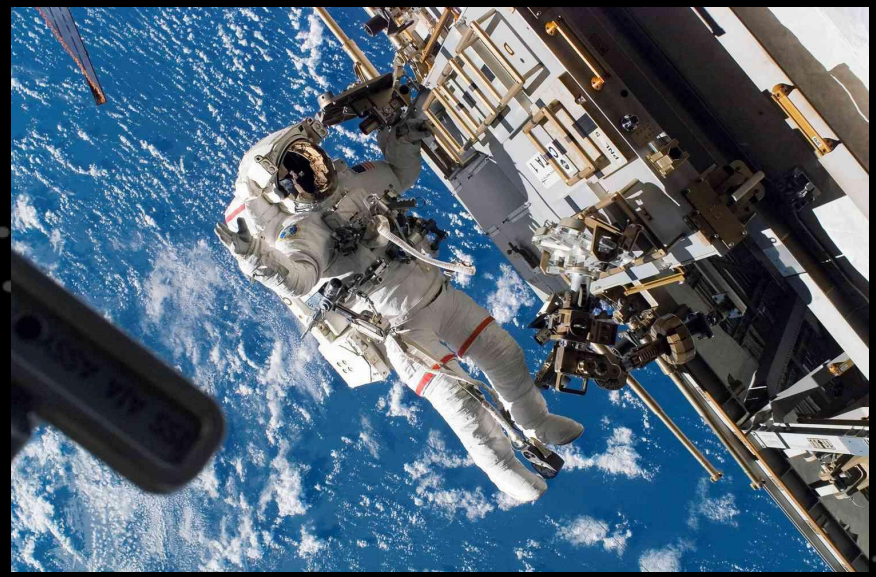
Stowable satellite encapsulation device deployed *at end of life* to mitigate space debris and promote “good neighbor” space policy

Motivation

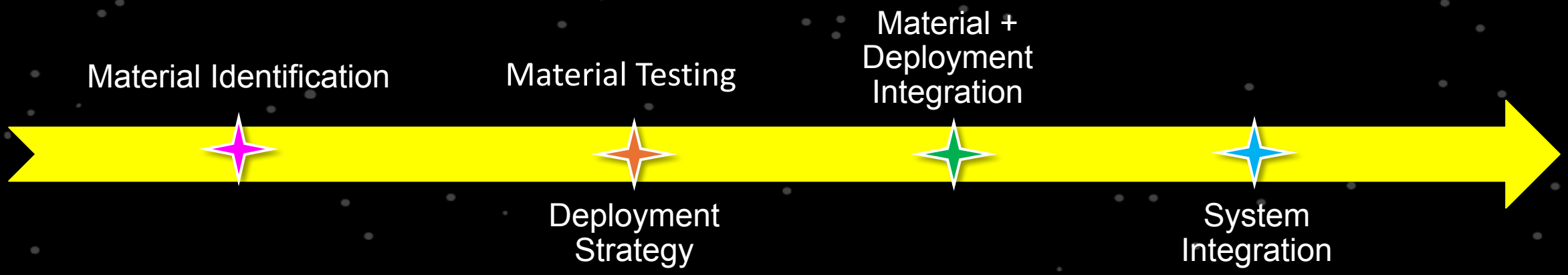
- ***Focus***
  - Mitigate creation of small, untrackable MMOD (Micrometeoroid & Orbital Debris)
  - Contain, NOT SHIELD, spacecraft breakup

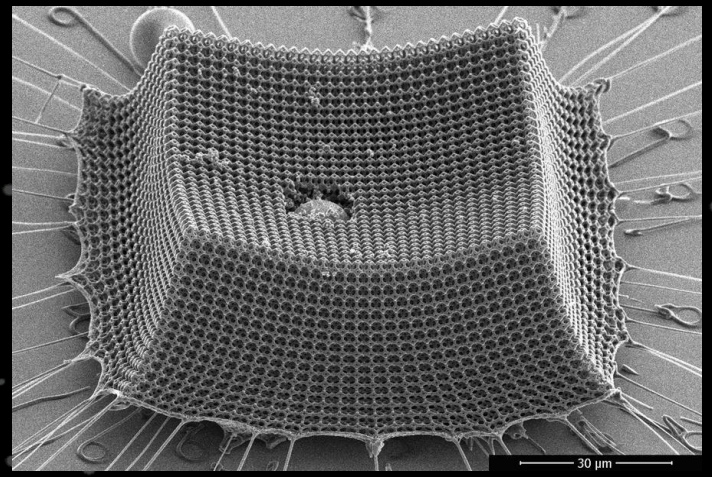
MMOD damage to ISS robotic arm

- ***Incentive***
  - Maintain safe human spaceflight missions
  - Promote sustainable space policy, "good neighbor"
  - Qualification for streamlined FCC launch licensing

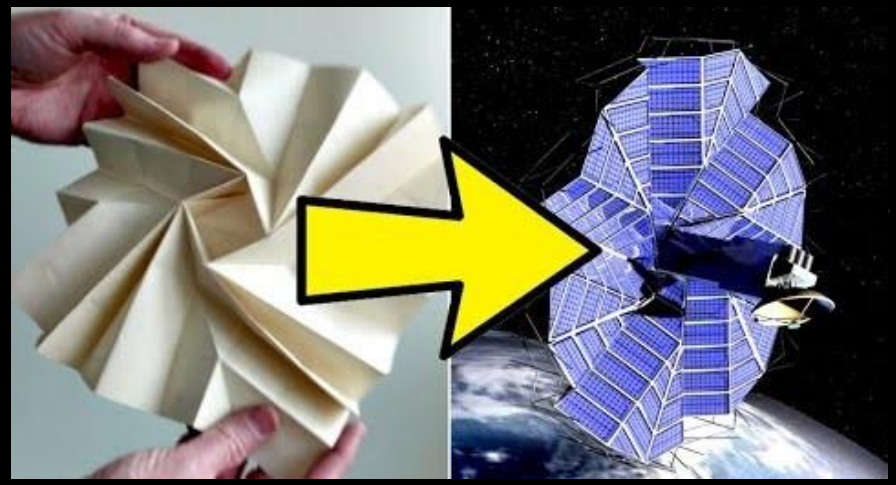


Project Progression





Nanostructured carbon material (Portela-MIT)



Origami inspired deployment mechanism (Pelligrino-Caltech)

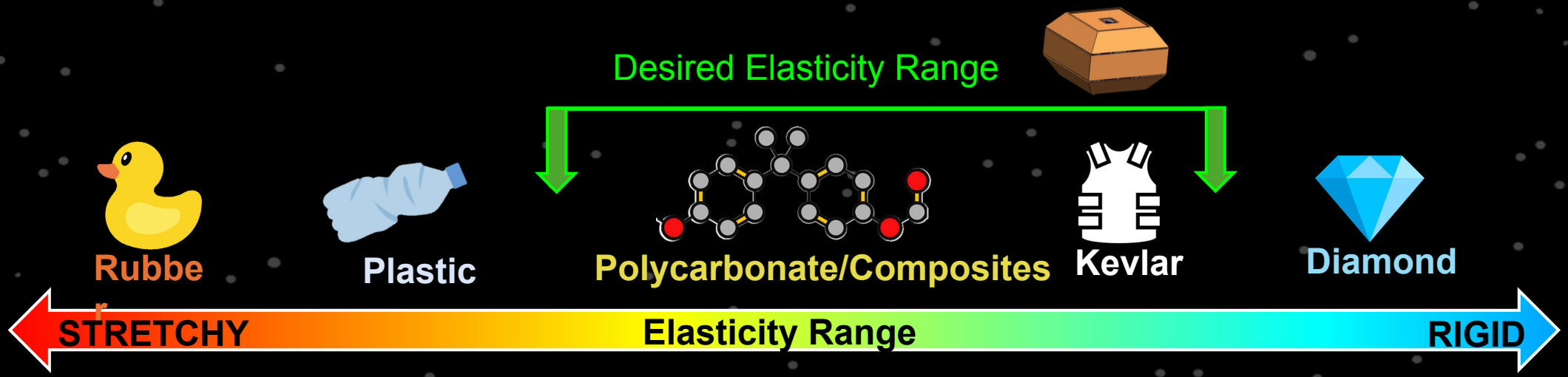
Materials

Necessary Characteristics

- Abrasion resistance
- Impact/debris absorption
- Light weight, foldable
- Elastic properties

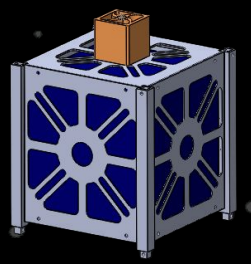
Possible Solutions

- Kevlar/Aluminum Composite Fiber
  - Woven and layered structures
  - Laminated
  - Polycarbonates
  - Composites



Deployment

- Current research exists on deployable structures (Pellegrino-CalTech)
- Compact, ultra-light stowable system
- Eventual development to smart shape sensing guidance



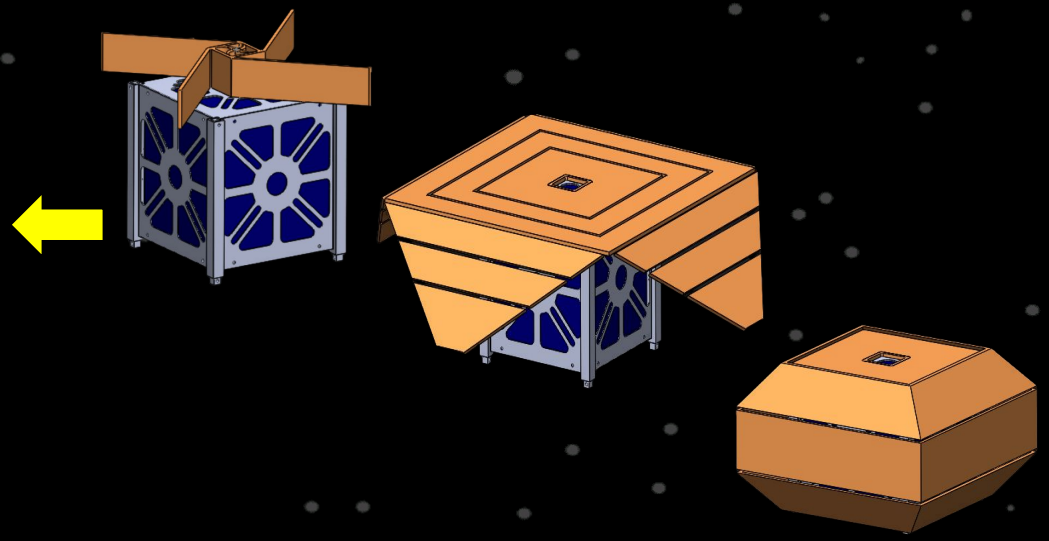
Space Encase + Spacecraft Integration

PRODUCTION: Attached to customer spacecraft

LAUNCH/MISSION: Encasement stays stowed

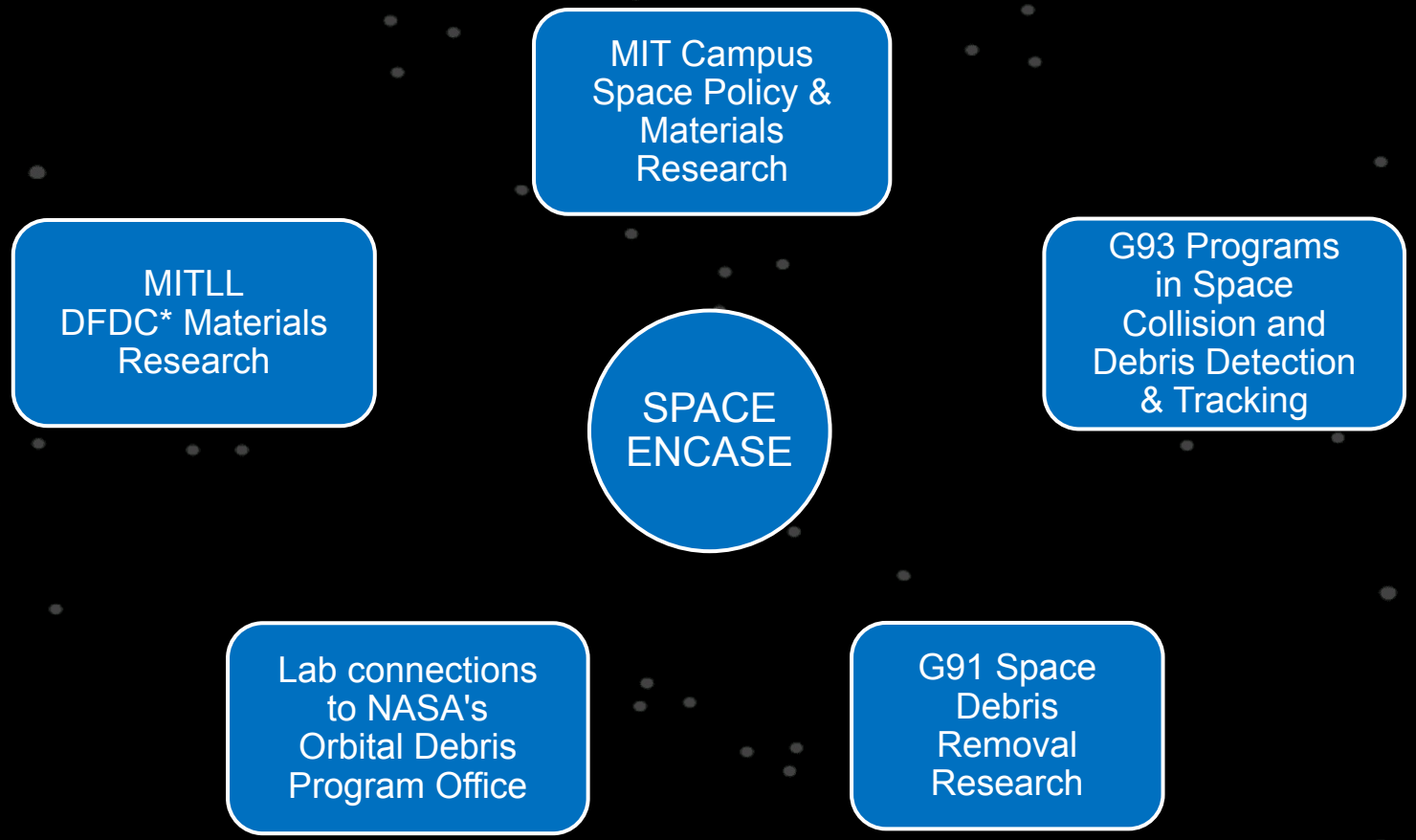
END OF LIFE: *DEPLOYMENT OF SPACE ENCASE*

DISPOSAL: Retrieval by future ADR* technology



*Active Debris Removal

Why Lincoln Laboratory?



Lincoln Laboratory network can be leveraged to research and develop Space Encase

*Defense Fabric Discovery Center

Thank you!

Mentors
Ryan Bohler (G93)
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Lori Milligan (G75)
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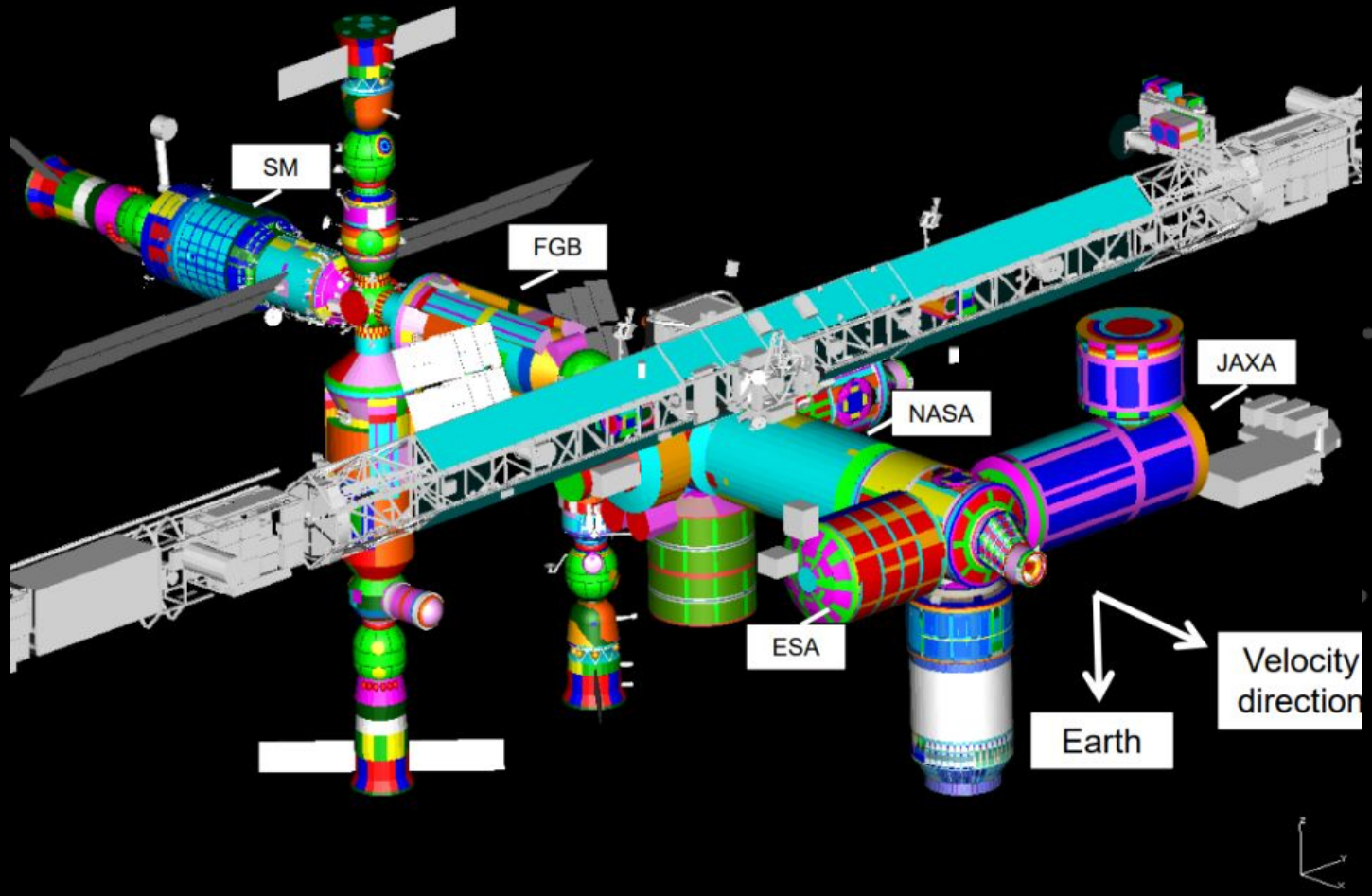
Ari Sandberg (G96)
Mark Polking (G81)
Kevin Tibbetts (G81)

Questions?

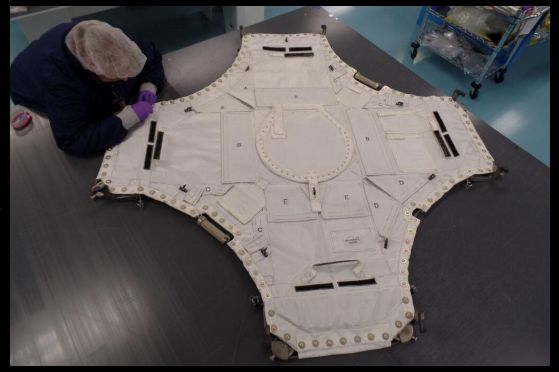
NASA ISS MMOD Shielding

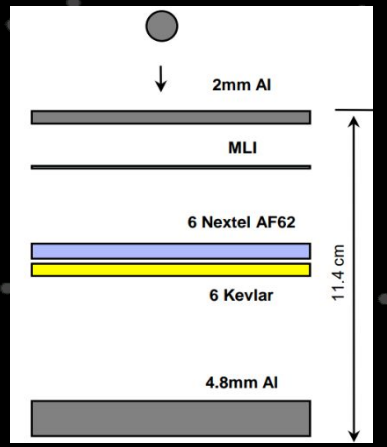


Each color represents a different MMOD shield configuration

Existing MMOD Work: Aerospace Fabrication

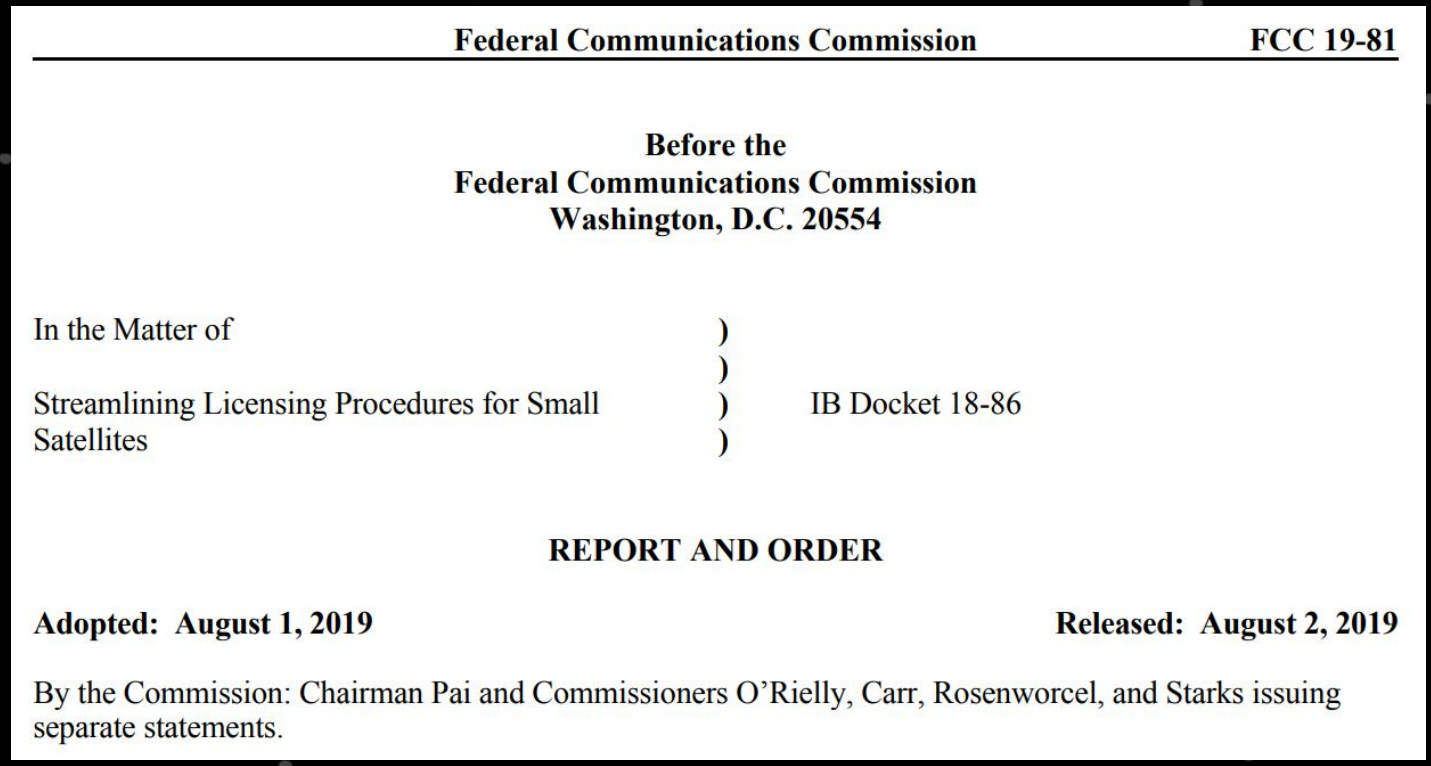
- Aerospace Fabrication MMOD Shield
  - Custom-designed armor blankets
  - Safeguard vulnerable surfaces
  - Offer passive thermal control
- NASA Whipple Shield
  - Multi-layer hypervelocity shield
  - effective for 1.3cm diameter debris impacting at typical impact conditions





FCC Streamlined Launch License

- Part 25 streamlined satellite license process
  - Granted earlier launch
  - Cuts down on cost
- For small satellites with orbital debris mitigation capability
- For commercial or non-commercial applications



Federal Communications Commission FCC 19-81

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Streamlining Licensing Procedures for Small Satellites	)	IB Docket 18-86
	)	

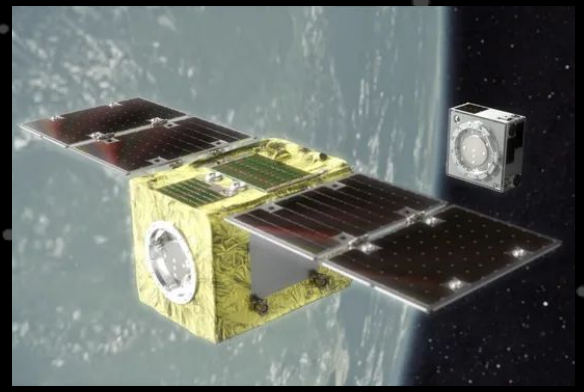
REPORT AND ORDER

Adopted: August 1, 2019 **Released: August 2, 2019**

By the Commission: Chairman Pai and Commissioners O'Rielly, Carr, Rosenworcel, and Starks issuing separate statements.

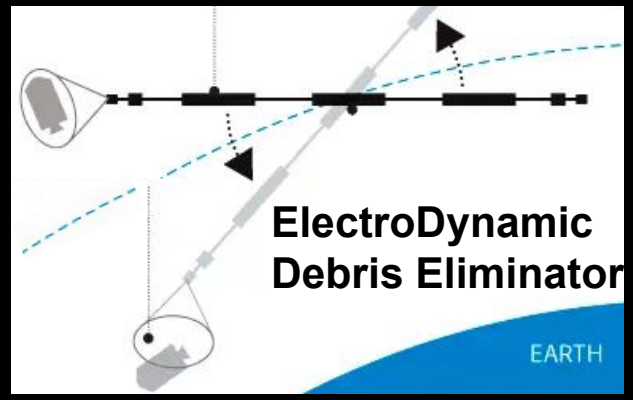
Future Active Debris Removal Technology

Astroscale



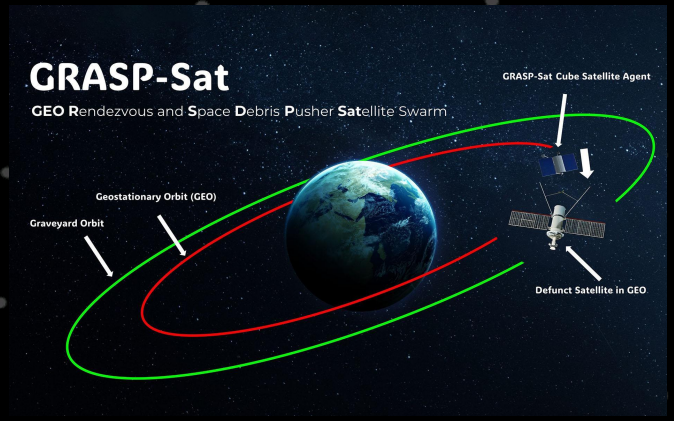
- Magnetic retrieval ADR
- $80 Million
- Currently testing

EDDE



- Tether pushing system
- $18 Million
- Conceptual

GRASP-Sat



- GEO pusher
- $ TBD
- Conceptual

Areas of Focus

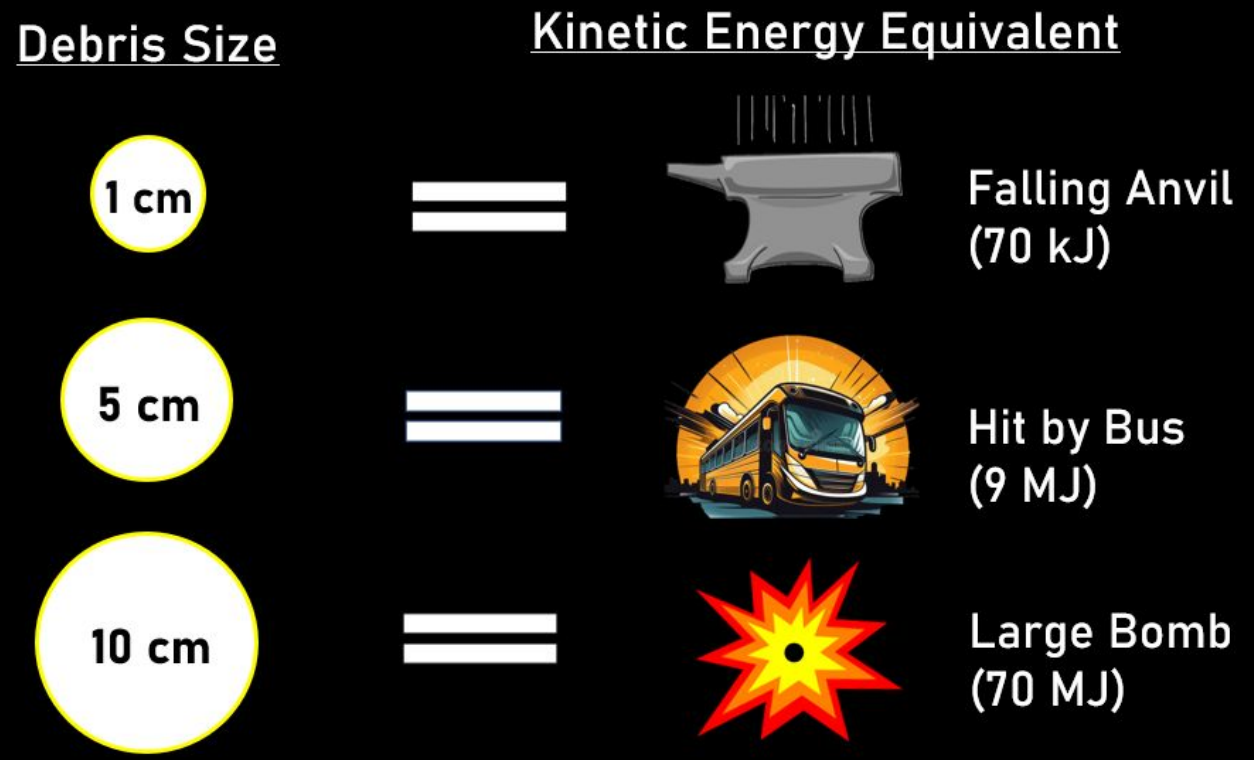
Altitude					
GEO (~3 km/s)					
MEO (4-7 km/s)					
LEO (~7 km/s)					
	Flecks/Dust (10^{-3})	Chips (10-1	Chunks (10^{0})	Satellites (10^{2})	Debris size (m)
	130,000	1,000	36	~10	Quantity (Thousands)

- Lower altitudes: faster orbital decay (drag)
- Larger debris: too much energy (and lots of debris)

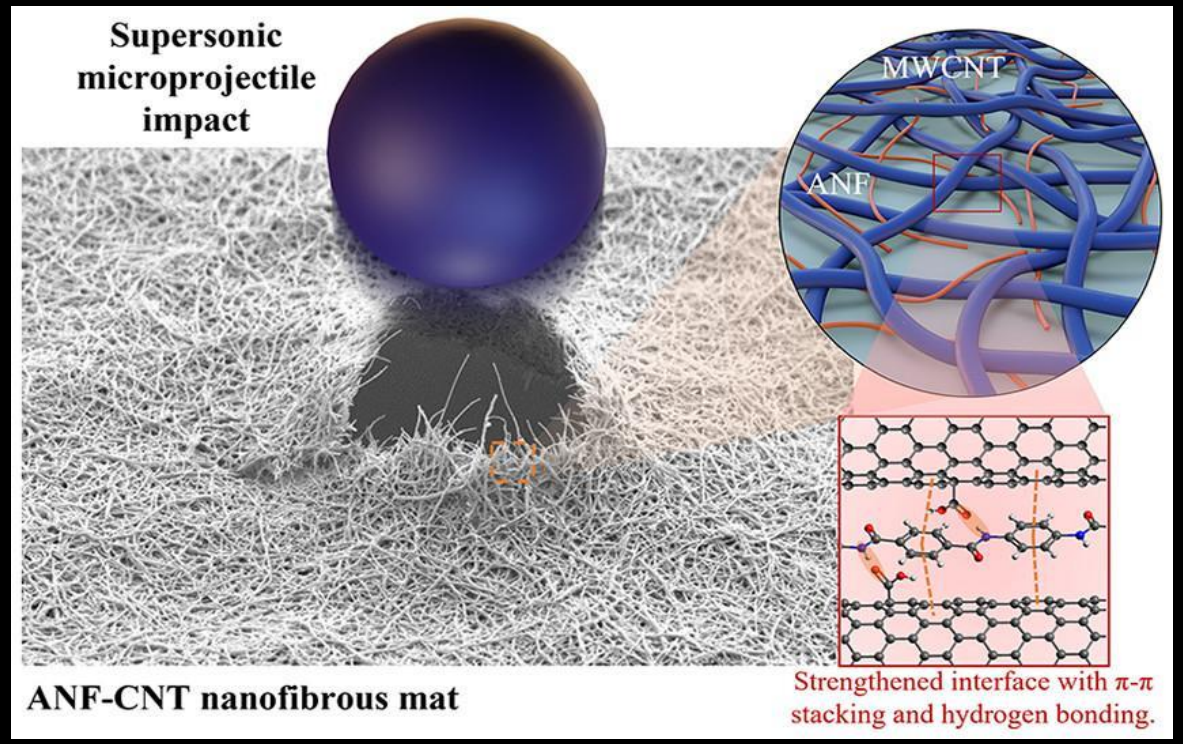
Space Encase would allow for debris mitigation across many different collision scenarios

Orbital Debris Impact Comparison

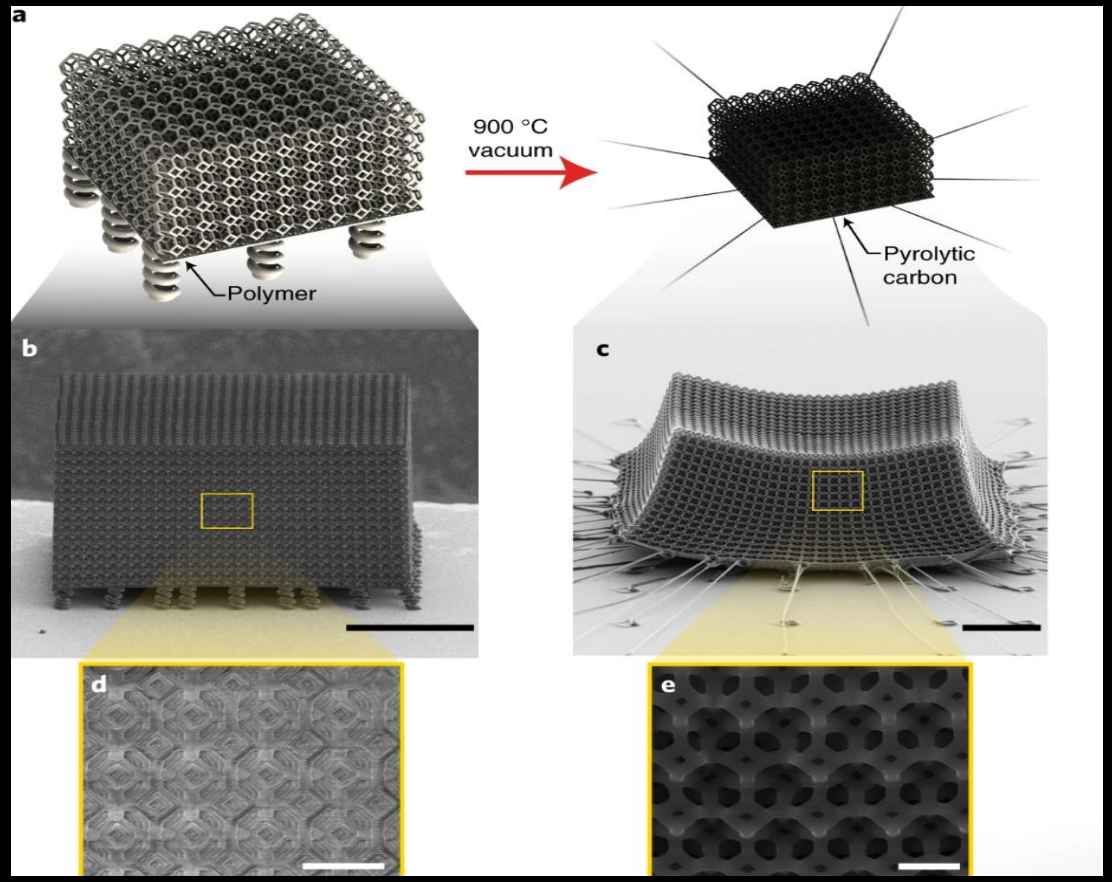
- At conjunction in LEO, 2 space objects have relative average velocities of 4 km/s, or ~5 times the speed of a rifle bullet



Existing Materials Research



- Nano Fiber Mats using hydrogen bonds



- 3D nanoarchitecture carbon

ISS Tweet: Space Debris Prevents Space Walk