



NASA's Measurement Activities

Radar, Optical, Laboratory Measurement Activities

Inter-Agency Space Debris Coordination Committee



IADC Working Group 1
June 12-15, 2023



Radar Measurements Status



Credit: NASA JPL,
<https://deepspace.jpl.nasa.gov/galleries/goldstone/#gallery>



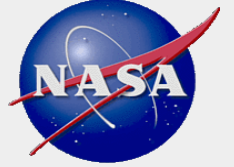
Credit: Reprinted with permission Courtesy of MIT Lincoln Laboratory,
Lexington, Massachusetts

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NASA Radar Measurements Status (1/2)

- **HUSIR hours of orbital debris (OD) data collected: ~420 in 2022, 99 in 2023 as of April**
 - HUSIR transmitter ~100 kW in CY22, currently ~180 kW
 - Current sensitivity of ~60 dB
 - Continue debris collections at 10.1 GHz, no RFI seen with new operating frequency
 - Approximately 2/3 of data at 75° elevation, 90° azimuth
 - Approximately 1/3 split between 20° and 10° elevation, 180° azimuth
- **Goldstone Radar OD hours collected: ~109 in 2022, 45 in 2023 as of April**
 - Planning for approximately twice as many hours collected in 2023 as in previous years
 - Goldstone transmitter ~434 kW in CY22, currently ~430 kW
 - New observation plan implemented to sample 700 km – 1000 km
 - Use four different pointings that overlap in coverage within the altitude range of interest
 - Minimum completeness size is now approximately 2.2 mm at 1000 km altitude
 - Most sensitive ground-based radar measurements at these altitudes to date
 - New sawtooth waveform in development



NASA Radar Measurements Status (2/2)

- **Space Fence data**

- Collaborating with U.S. Space Force to obtain 2 weeks of data from 2022 to assess usage for orbital debris detections

- **Publications**

- HUSIR Radar Measurements of the Orbital Debris Environment: 2021, September 2022
 - <https://orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnv26i3.pdf>
- Goldstone Orbital Debris Radar Measurements of the Orbital Debris Environment: 2020 to 2021, March 2023
 - <https://orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnv27i1.pdf>



ES-MCAT

Eugene Stansbery-Meter Class Autonomous Telescope
(7° 58' S; 14° 24' W) ~350' Elevation

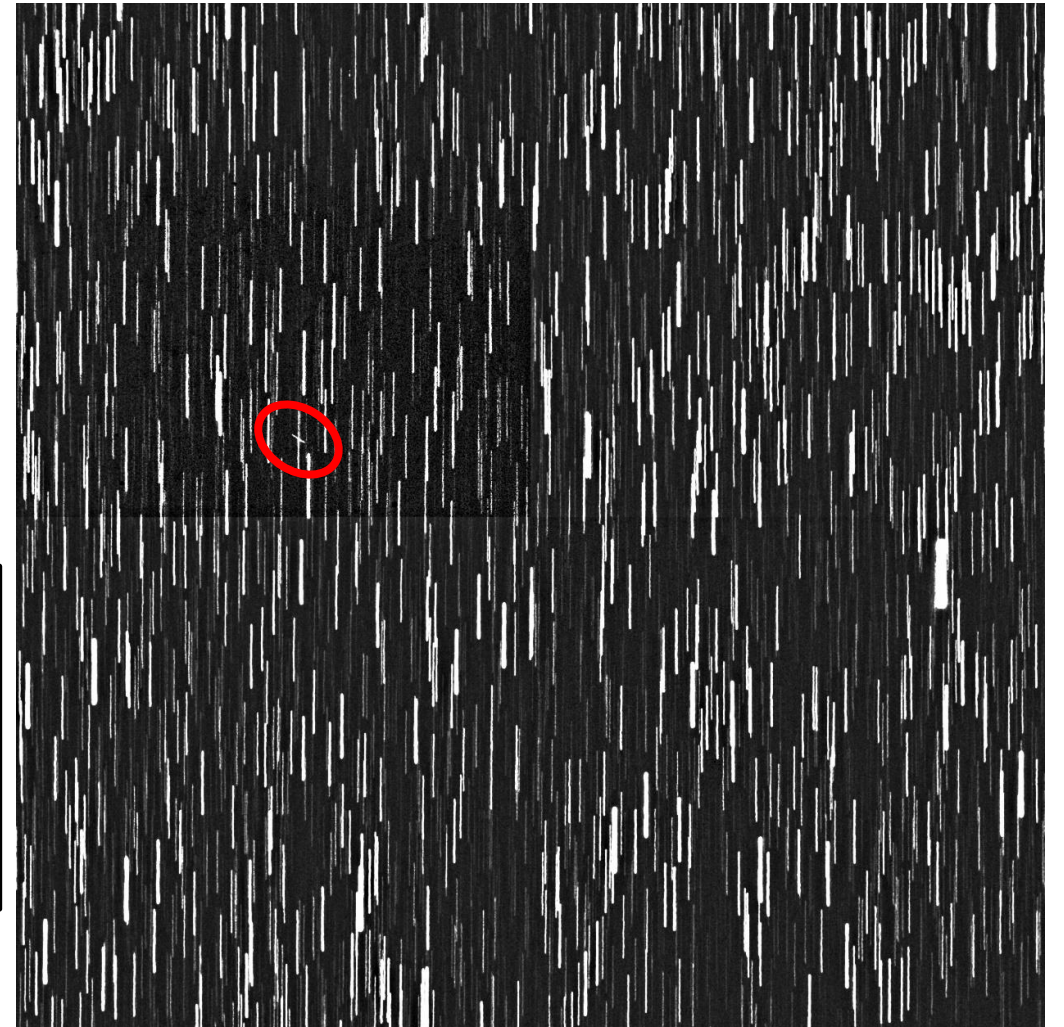


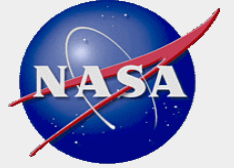
ODQN Publication:

- Updates of the Eugene Stansbery-Meter Class Autonomous Telescope for Geosynchronous Orbit Survey Operations, March 2023

<https://orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnv27i1.pdf>

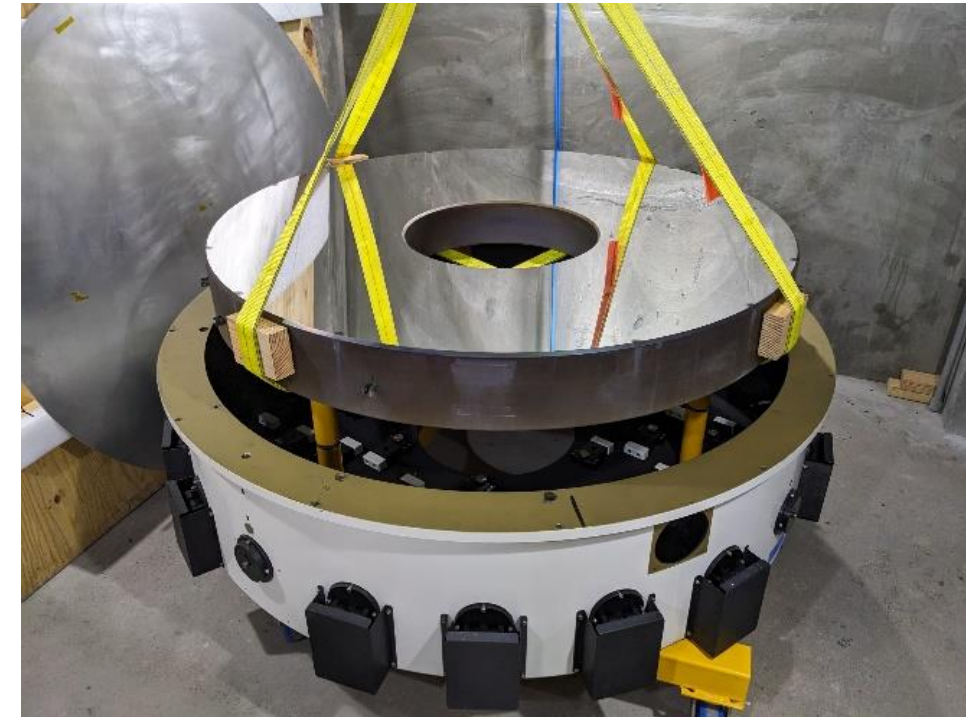
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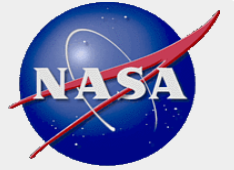




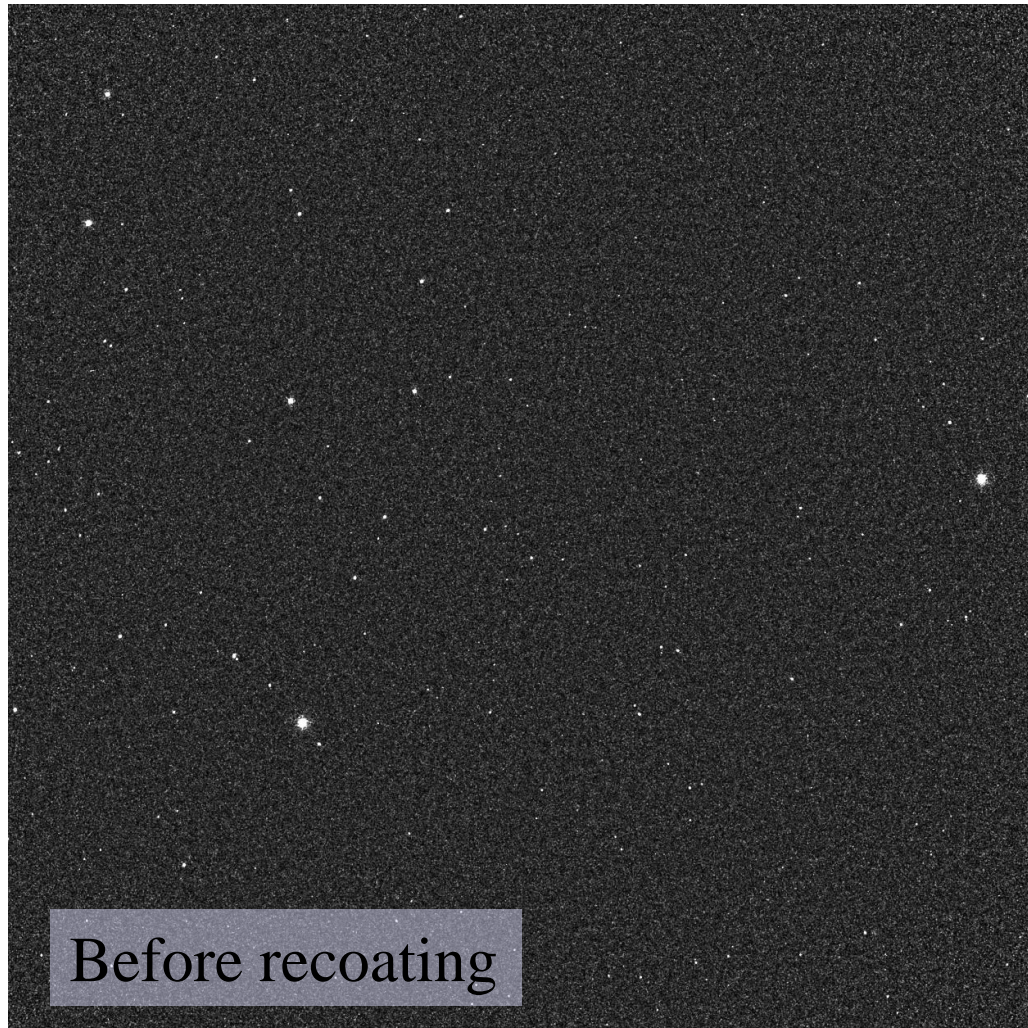
ES-MCAT Status

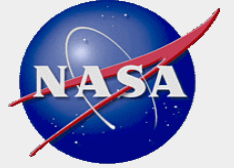
- **First GEO survey completed**
 - Covers 14 April 2020 – 22 Feb 2022
- **Primary mirror recoated and replaced**
 - Degradation of mirror coating was seen due to COVID-induced travel restrictions and limited cleaning from 2020-2021
 - New coating developed to achieve a minimum 90% reflectivity
 - Mirror removed in May 2022, replaced in January 2023
- **Second GEO survey began in January 2023**
 - Planned to continue until January 2025
 - Observations currently on hold while addressing dome repairs





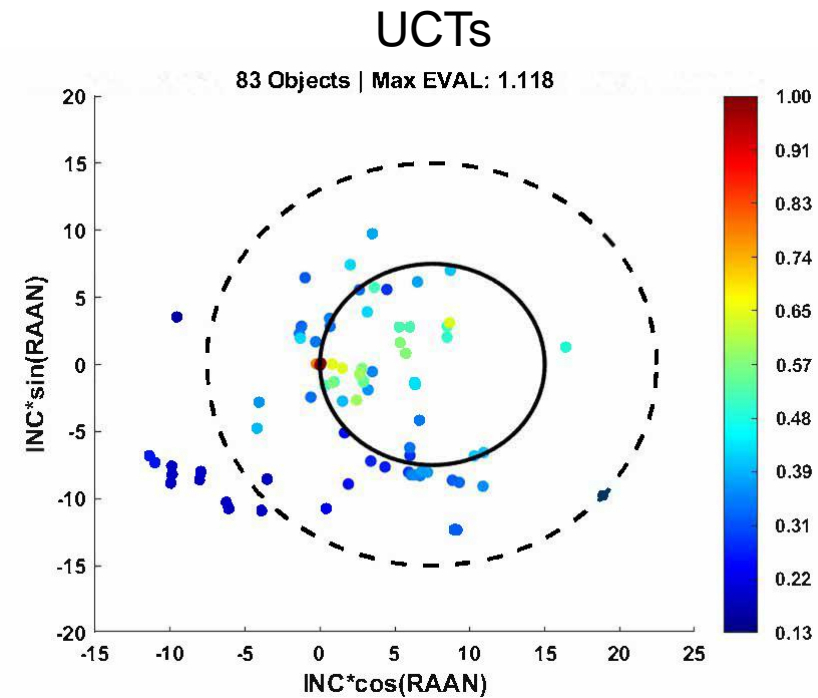
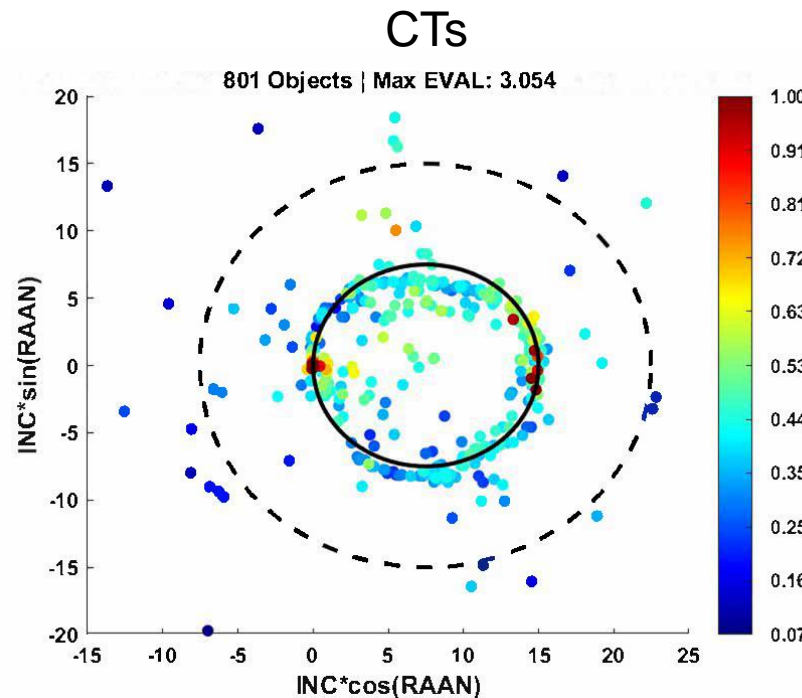
ES-MCAT New Mirror Coating





ES-MCAT GEO Survey 2020-2022

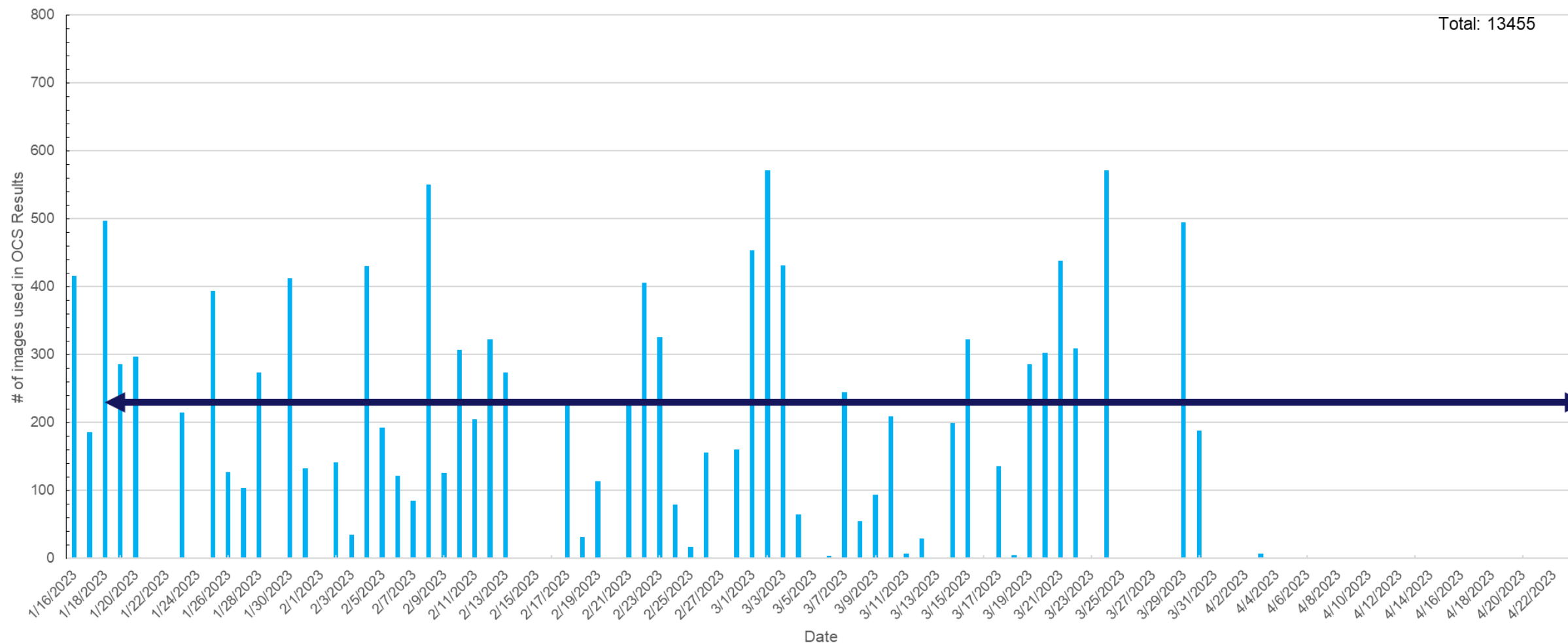
- **GEO survey focused on covering region of interest**
 - Area in Cartesian coordinates ($\text{INC} \cdot \cos(\text{RAAN})$, $\text{INC} \cdot \sin(\text{RAAN})$), centered at $(7.5^\circ, 0^\circ)$ with a radius of 15°
 - Goal is to cover this region with an expectation value (probability of detection) ≥ 0.3



UpTime of GEO Survey: 16 Jan 2023-6 April 2023



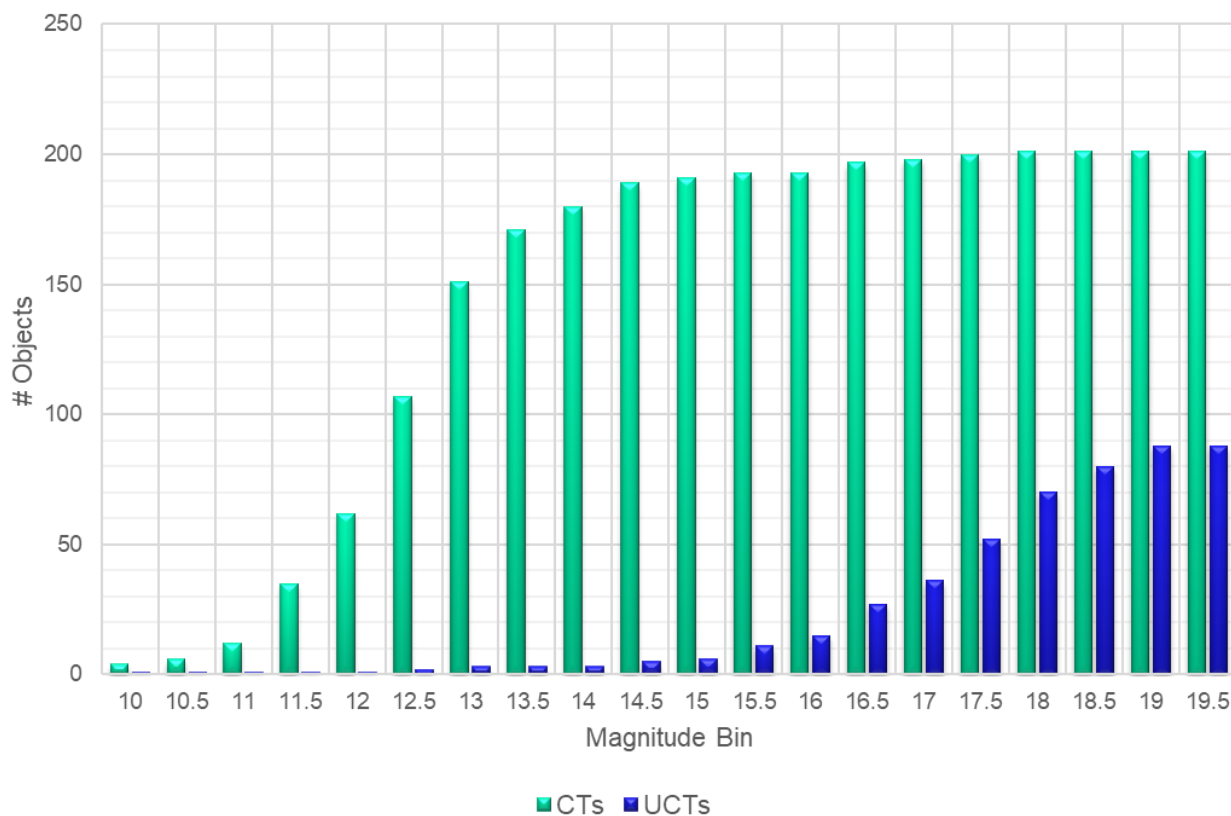
Hours of Data Taken on a Given Date



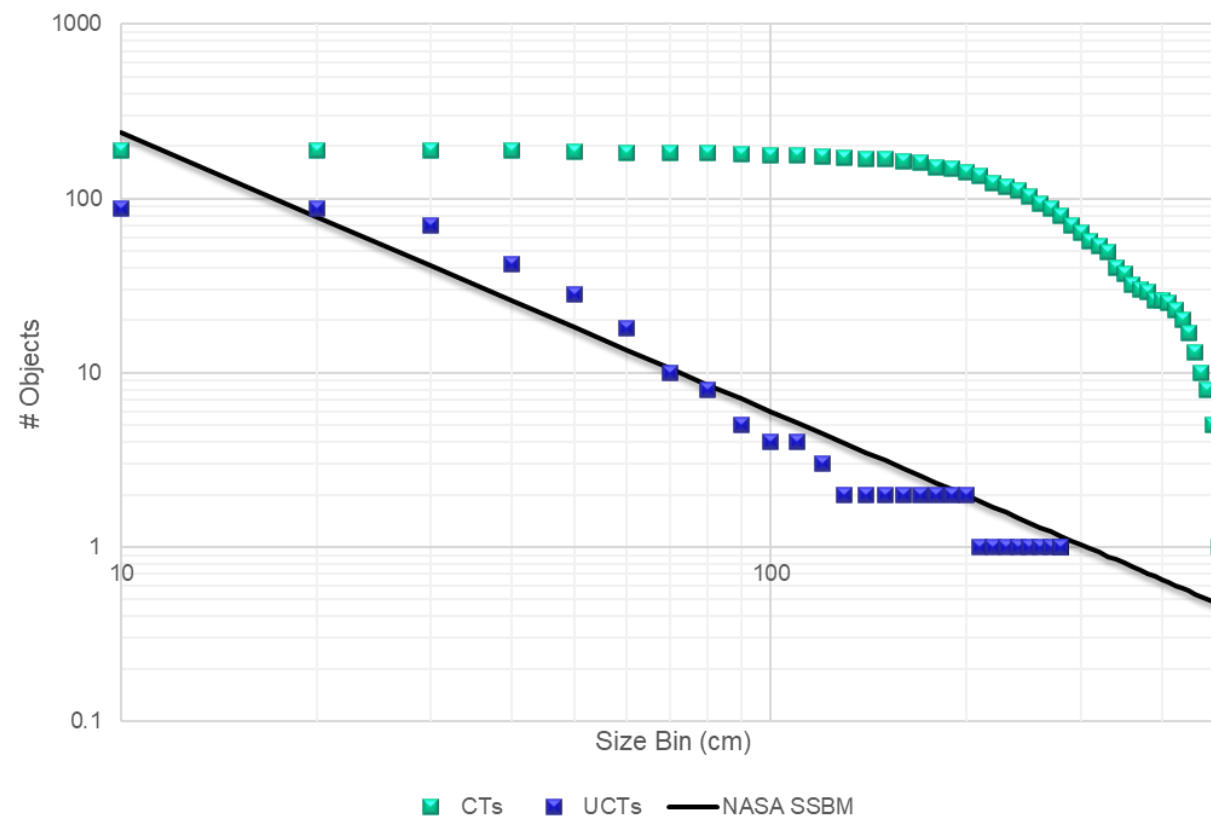


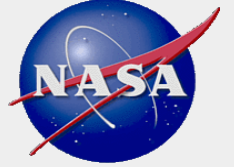
Current Detection Distributions

2023-2025 GEO Survey: CTs and UCTs Cumulative Magnitudes
01/18/2023 - 03/30/2023



2023-2025 GEO Survey: CTs and UCTs Cumulative Sizes
01/18/2023 - 03/30/2023





DebrisSat Project Status



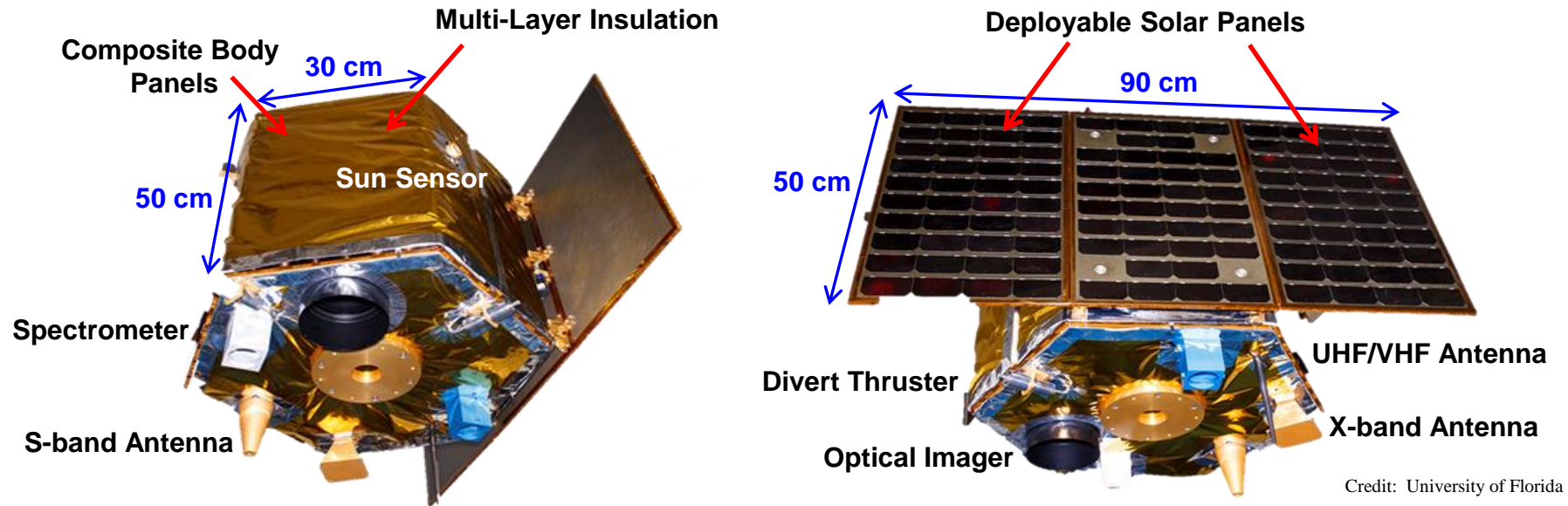
Credit: University of Florida

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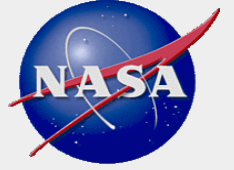


Brief Intro

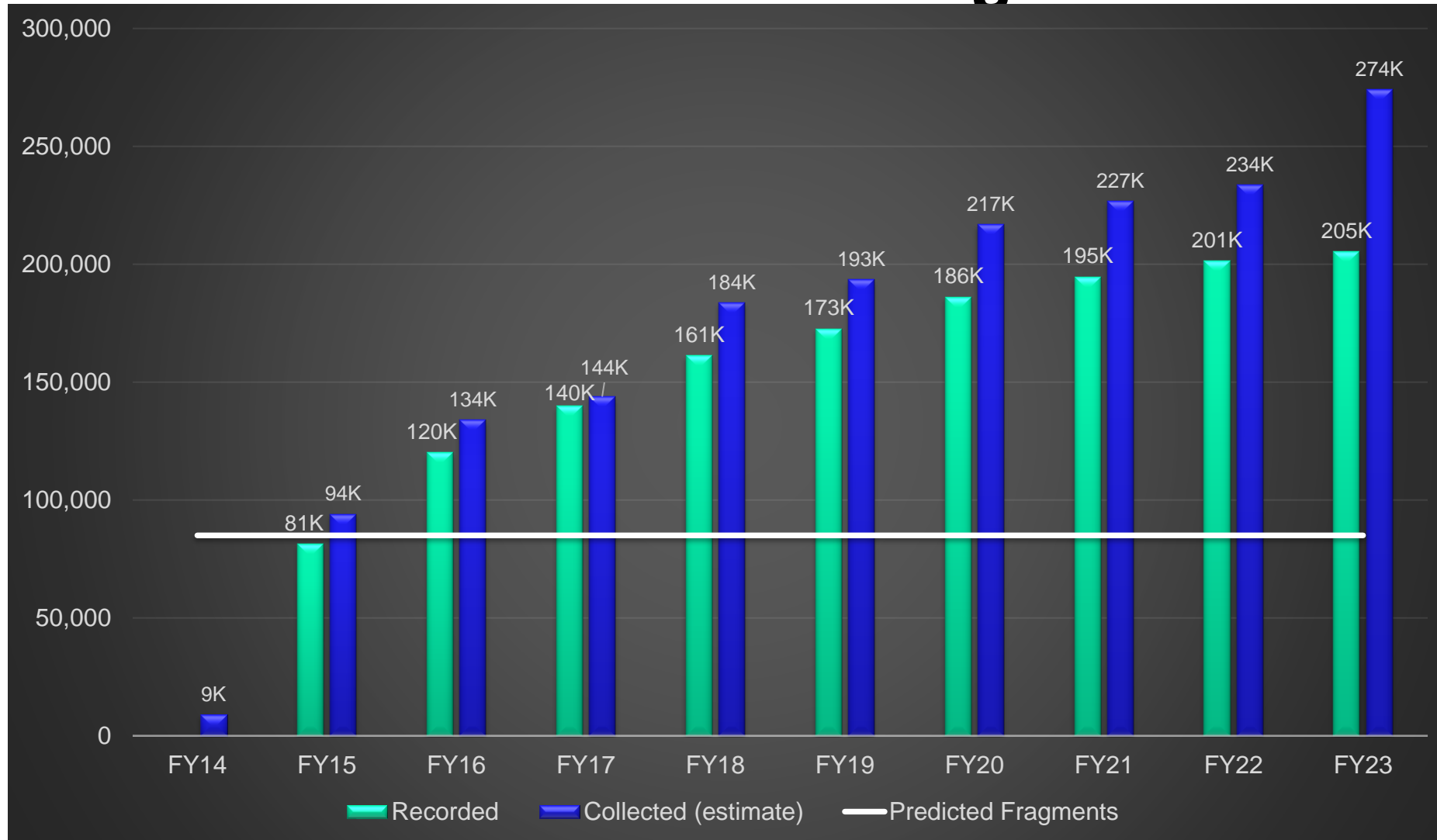
The purpose of the DebrisSat project is to replicate a hyper-velocity fragmentation event using modern-day spacecraft materials and construction techniques to better improve the existing DoD and NASA breakup models

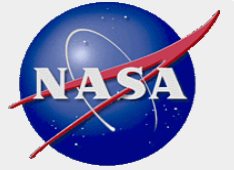


570 g projectile @ 6.8 km/sec

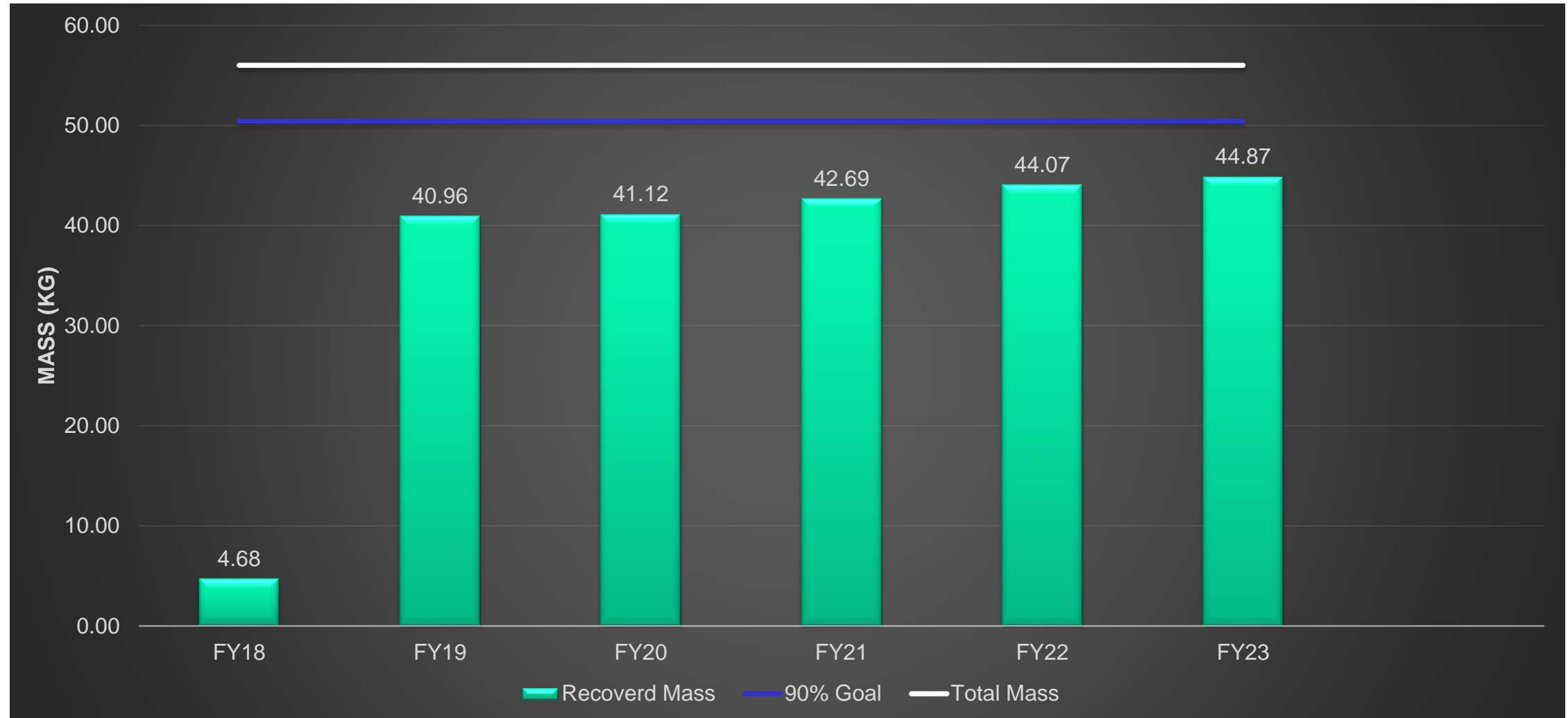


Historical progression of recorded/collected fragments





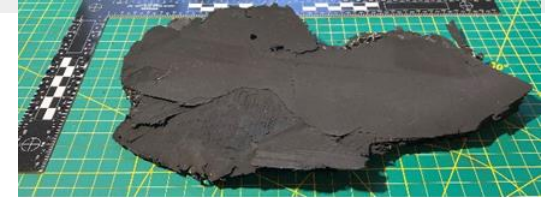
Recovered Mass to date





Characterizing Non-spherical Shapes

- Flat Plate
- Bent Plate
- Straight Needle/Rod/Cylinder
- Bent Needle/Rod/Cylinder
- Parallelepiped/Nugget/Spheroid
- Flexible/MLI



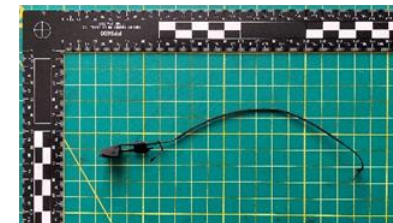
- Straight Needle/Rod/Cylinder



- Bent Needle/Rod/Cylinder



- Parallelepiped/Nugget/Spheroid



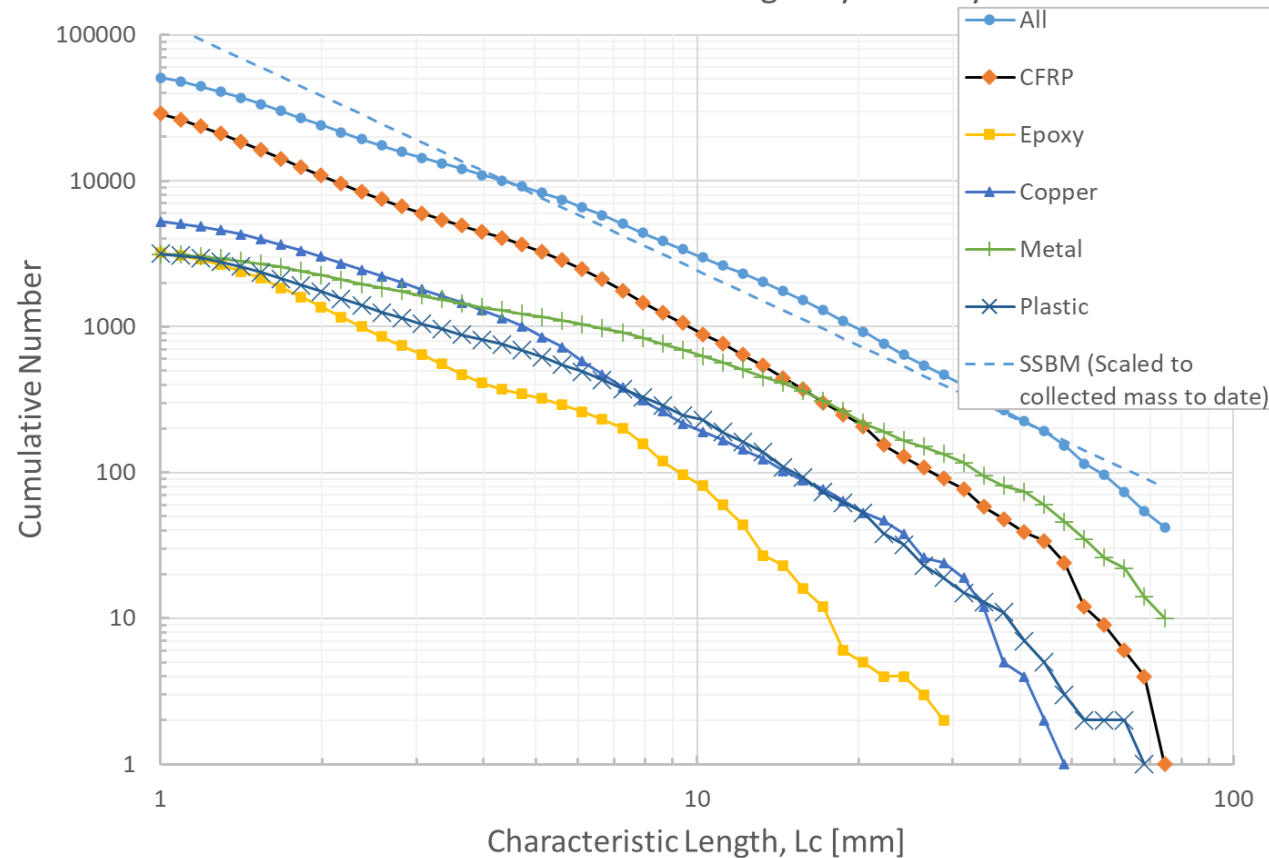
- Flexible/MLI

Cumulative number vs L_c (materials and shape)

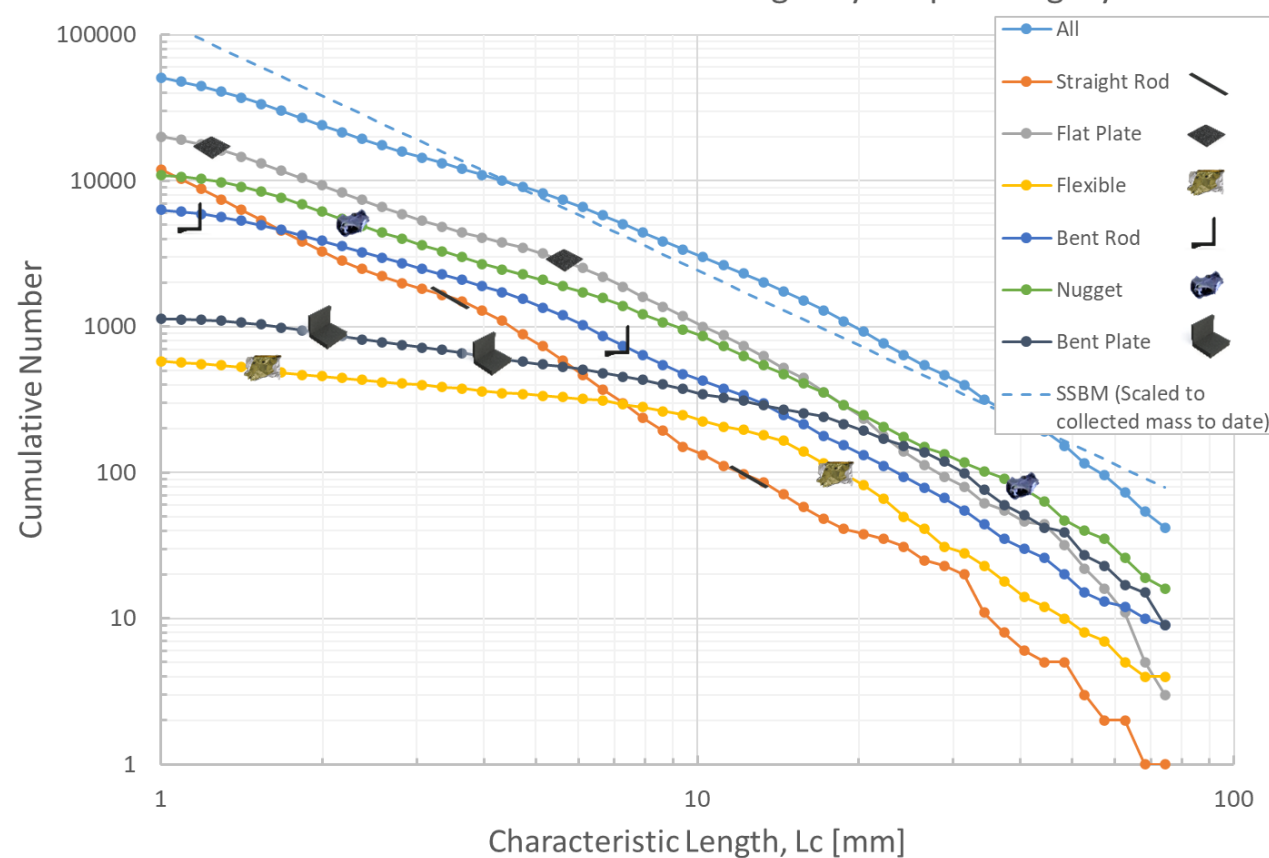


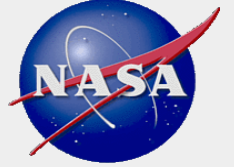
Current as of 01 January 2023

Cumulative Number V. Characteristic Length by Primary Material



Cumulative Number V. Characteristic Length by Shape Category





RCC approximation for L:D distributions

