

DEBRIS MANAGEMENT IN SPACE



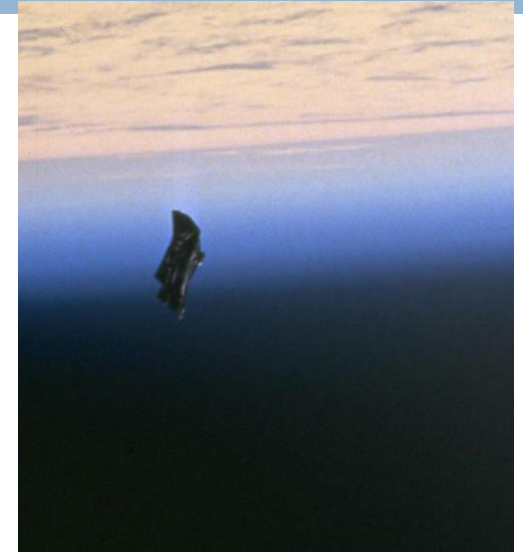
Dr. S V Sharma



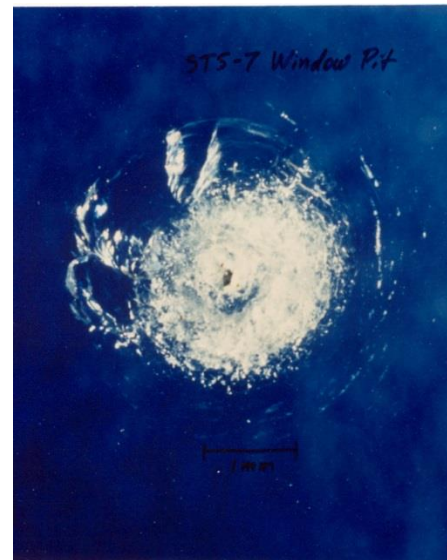
Is it a problem?

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□ Drifting of the thermal shield STS-98

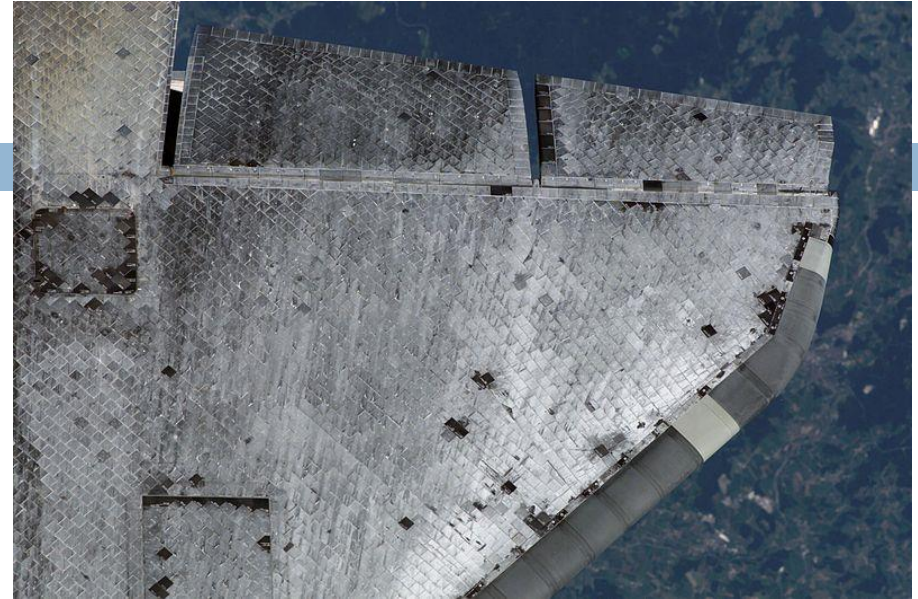


□ Challenger
Space Shuttle hit by
1 mm object

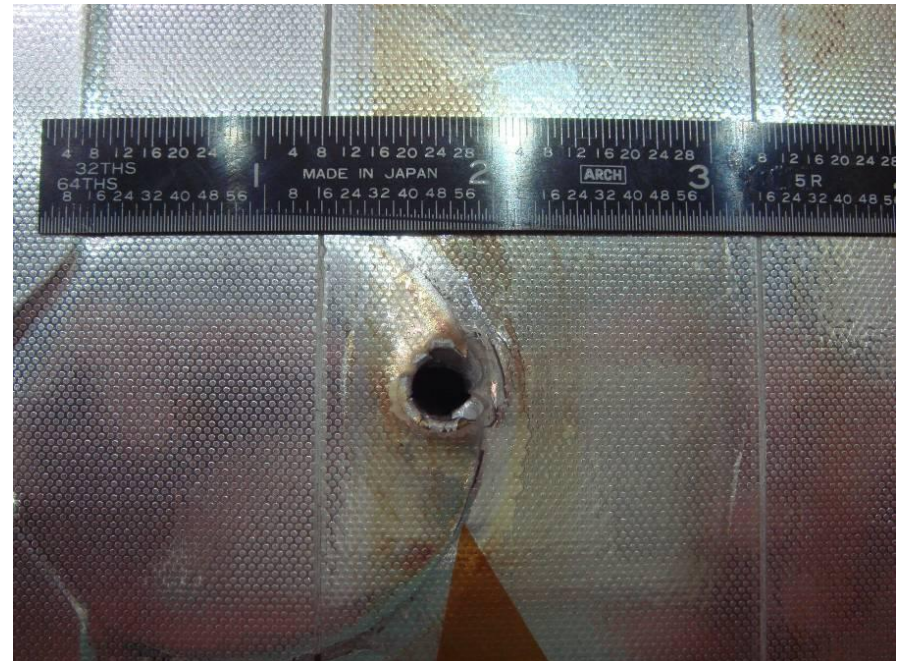


Problem??

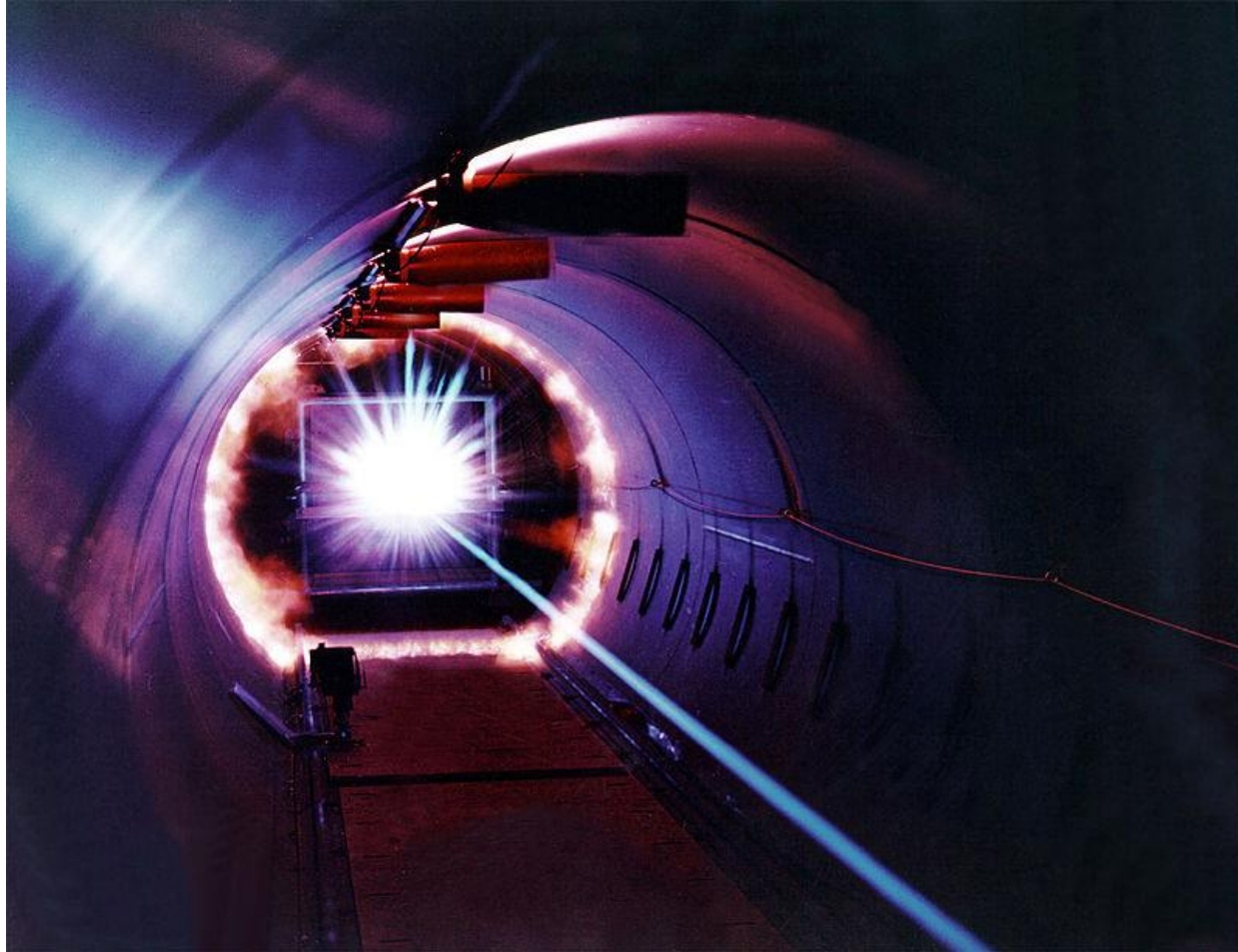
□ Discovery Thermal Shield



□ Challenger's agony!



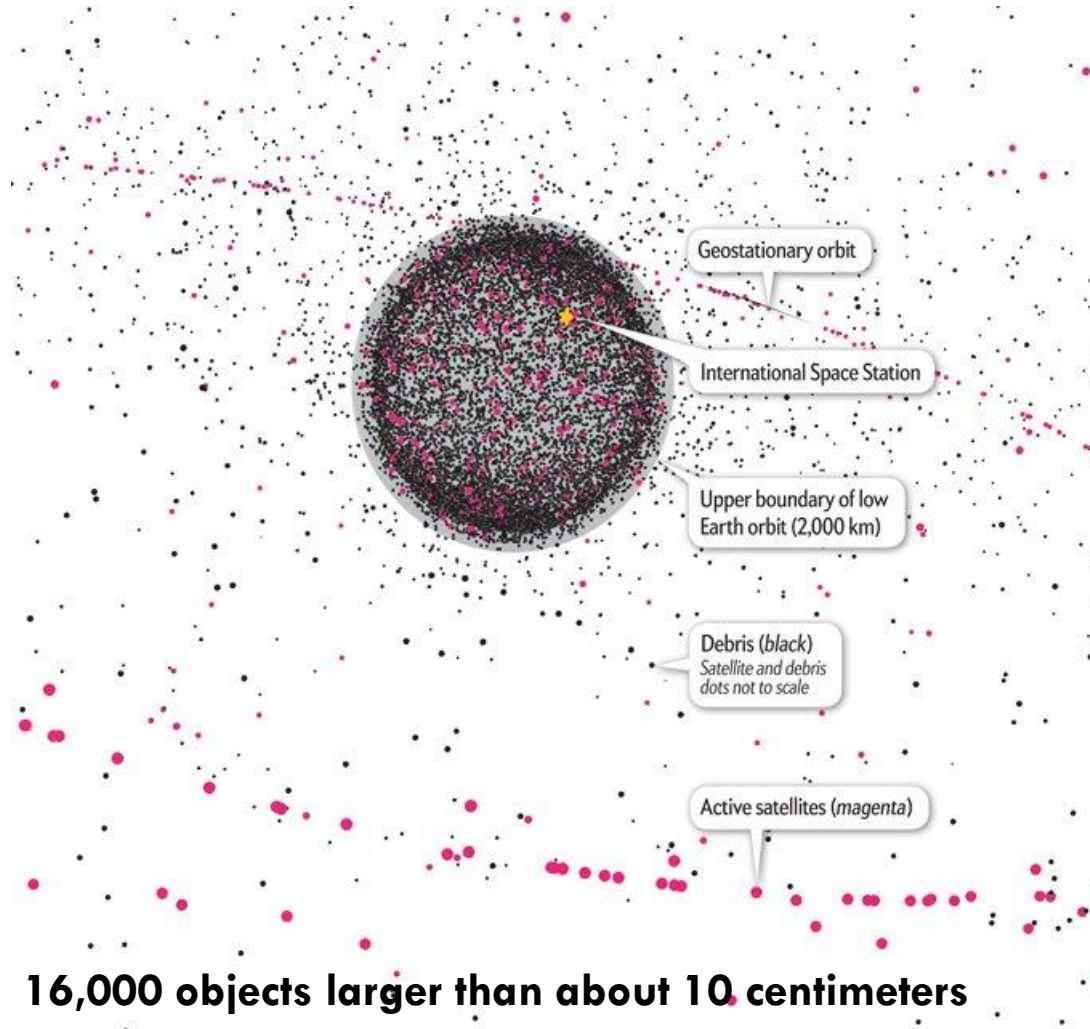
What happens when a 1 cm object hits a spacecraft?



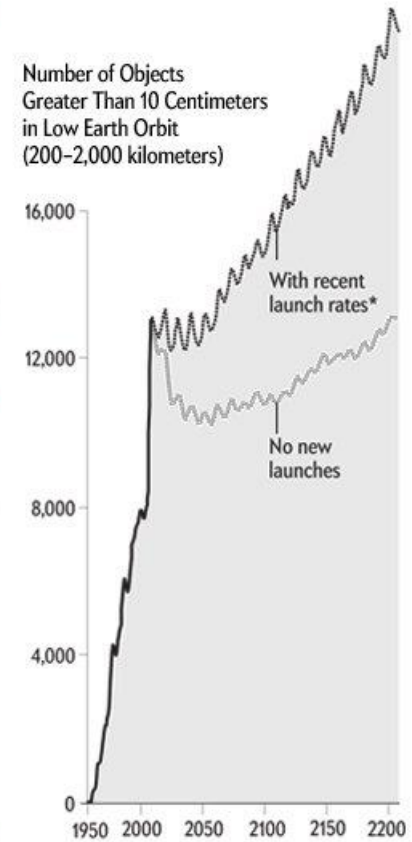
NASA Image of simulating Hypervelocity energy splash

Space Debris – A visualization

□ Is

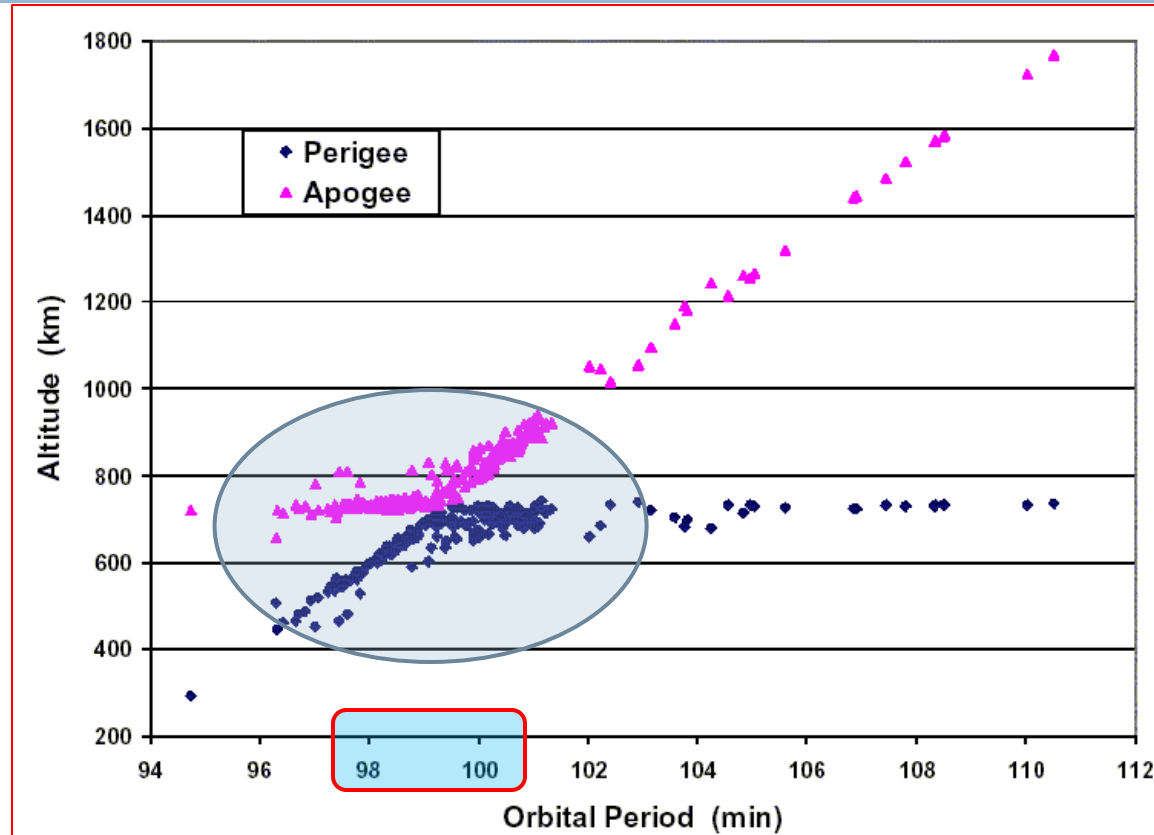


16,000 objects larger than about 10 centimeters



* Assumes 90 percent compliance with commonly adopted debris-mitigation policies

An example of Debris



- Gabbard diagram of almost 300 pieces of debris from the disintegration of the five-month-old third stage of the Chinese Long March 4 booster on 11 March 2000. **See the orbital period!!**



Numbers!

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- Number of rocket launches since the start of the space age in 1957: **About 5250**
- Number of satellites these rocket launches have placed into Earth orbit: **About 7500**
- Number of these still in space: **About 4300**
- Number of these still functioning: **About 1200**
- Number of debris objects regularly tracked by the US Space Surveillance Network and maintained in their catalogue: **About 23 000**
- Estimated number of break-ups, explosions and collision events resulting in fragmentation: **More than 290**
- Total mass of all space objects in Earth orbit: **About 7500 tonnes**
- Number of debris objects estimated by statistical models to be in orbit:
29 000 objects >10 cm
750 000 objects from 1 cm to 10 cm
166 million objects from 1 mm to 1 cm



A video

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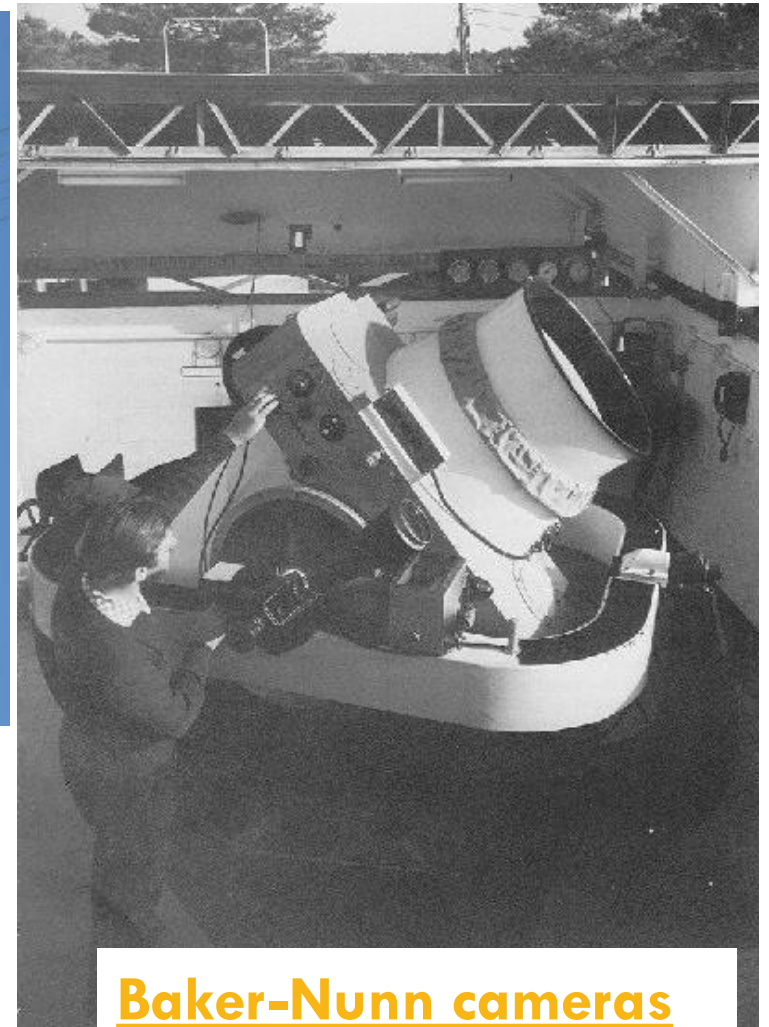
SKS sir I HAVE ESA VIDEO I CAN SHARE IT IF YOU WANT IT ON PEN DRIVE !!!

How to detect?

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ISRO's Multi Object Tracking Radar



Baker-Nunn cameras



Multi Object Tracking Radar (MOTR)

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- Rs. 240-crore multi-object tracking radar, operates from Sriharikota range can track nearly 10 objects simultaneously
 - Used to detect space debris approaching an Indian satellite
 - the path of satellite can be diverted to avoid collision and damage
 - a similar radar would cost around Rs 800 crore in the international markets and is mainly used for defence purposes.
 - The tracking data used for computing the Instantaneous Impact Points (IIPs) of the descending/separated objects of the launch vehicle, more accurately.
- MOTR will also provide the data related to close approach of space debris to the remote sensing satellites in Low Earth Orbit (LEO)
- Space debris data is mostly taken from the National Aeronautics Space Agency (NASA)
 - newly acquired technology will help in keeping a watch on ISRO space assets on a daily basis.
 - Unlike conventional radars, MOTR has a stationary antenna, which has electronic beam steering capability.
- The commissioning of MOTR would provide real-time data.



Multi Object Tracking Radar (MOTR)

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- ❑ MOTR is indigenous and domestically sourced.
- ❑ The new radar can track nearly 10 objects simultaneously.
 - ❑ 50 cm x 50 cm object size at a slant range of 1000 km
 - ❑ 30 cm x 30 cm size at a slant range of 800 km in LEO
- ❑ The phased array radar antenna is stationary
 - ❑ beam generated by 4,608 radiating elements can be steered.
 - ❑ operates in L-band frequency (1.3 to 1.4 GHz) with active phased array antenna
 - ❑ maximum peak power of 830 kW
- ❑ The radar weighing 35 ton, 12m long and 8m tall
 - ❑ could be turned in different directions
 - ❑ used to meet the range safety during a rocket launch



Challenges

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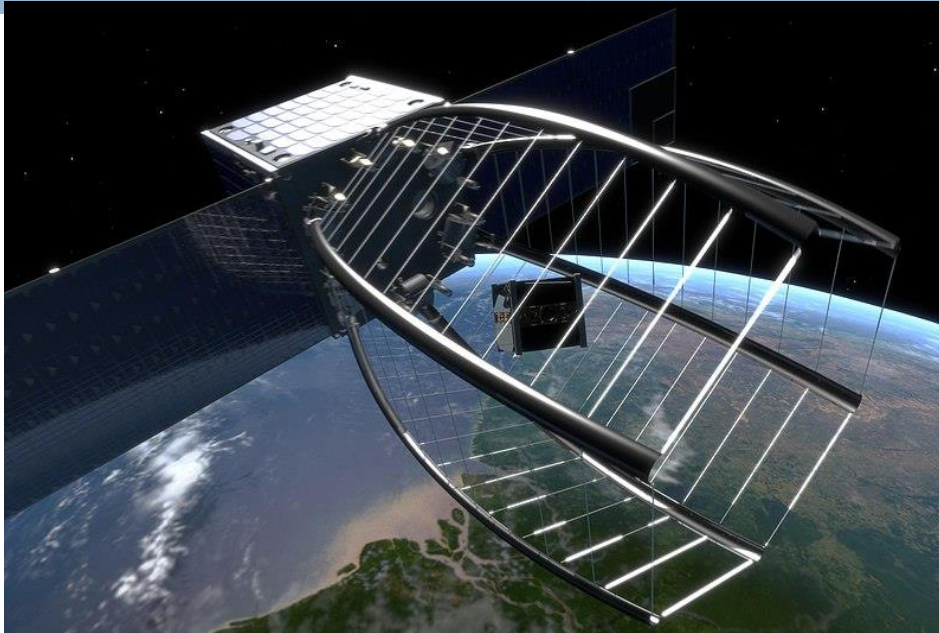
- ❑ Object size varies significantly.
- ❑ The orbital period may vary so that tracking the same object may not be easy.
- ❑ The shape or size of the objects vary thus the image footprint vary
 - ❑ Thus detection is highly difficult



Requirements

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- ❑ Radar and optical measurements and their simulation
- ❑ Development of space debris and meteoroid environment and risk assessment models
- ❑ Analysis of debris mitigation measures and their effectiveness for long-term environmental stability
- ❑ In-orbit collision risk assessments
- ❑ Re-entry safety analyses
- ❑ Space debris database issues



Debris Trapper

Sling-sat





Next Steps of ISRO

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- ❑ Capability building in tracking, orbit fixing, orbit determination, of Debris.
- ❑ Suitable communication with the space objects, both optical and radio frequency.
- ❑ Data linking with the space debris operations room.
- ❑ Information exchange through data links for spatial diversity.
- ❑ Probability estimation for a possible conjunction



Next Steps

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- Launch window analysis and orbit manoeuvres for collision avoidance
- Maintenance of the data records and data recording with geo sync missions
 - ▣ both normal and super synchronous
 - ▣ various software systems for analyses and associated interfaces