Deorbit Kit – modular solution for standardized satellite deorbit

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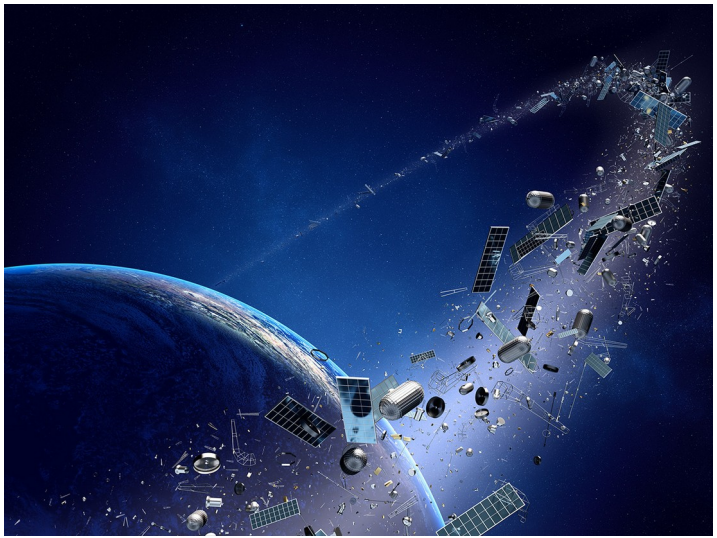
The Deorbit Kit concept

- Outline of talk
  - Introduction of speaker and company
  - The space debris issue
  - Deorbit Kit high level concept
  - Plasma brake
  - System outline
  - Scalability and modularity

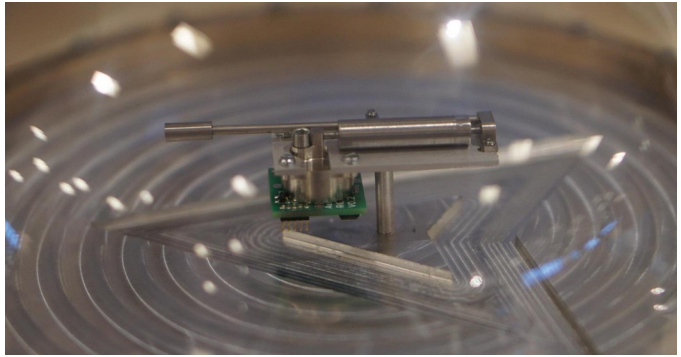


Introductions 1/2

- Hello I am Pyry Peitso from Aurora Propulsion Technologies, I work as a Research Engineer specializing in Deorbit Simulations
- I have a background in Space Weather and Space Climate studies, as well as CubeSat engineering

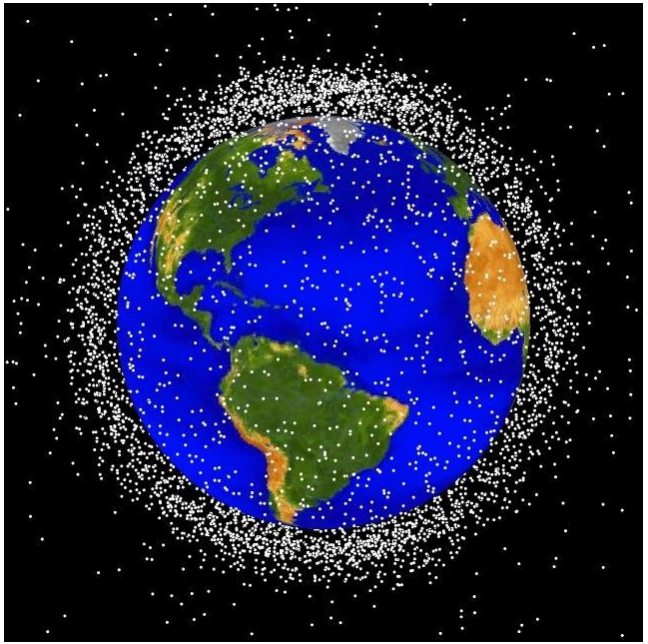
Introductions 2/2

- Aurora Propulsion Technologies is a Finnish space technology startup located in Espoo, Finland
- We manufacture attitude and orbit control solutions for CubeSats and small satellites
- Our ARM resistojet is the worlds smallest resistojet



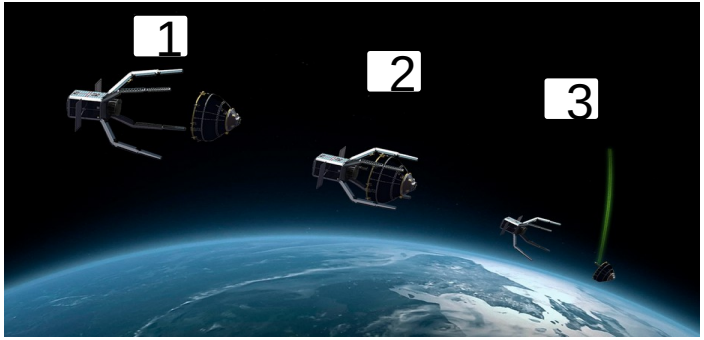
The space debris issue

- Space debris a growing concern, preventative as well as active debris removal action is need
- 25 year space debris removal rule de jure in place
- A standardized solution for debris mitigation would be highly useful



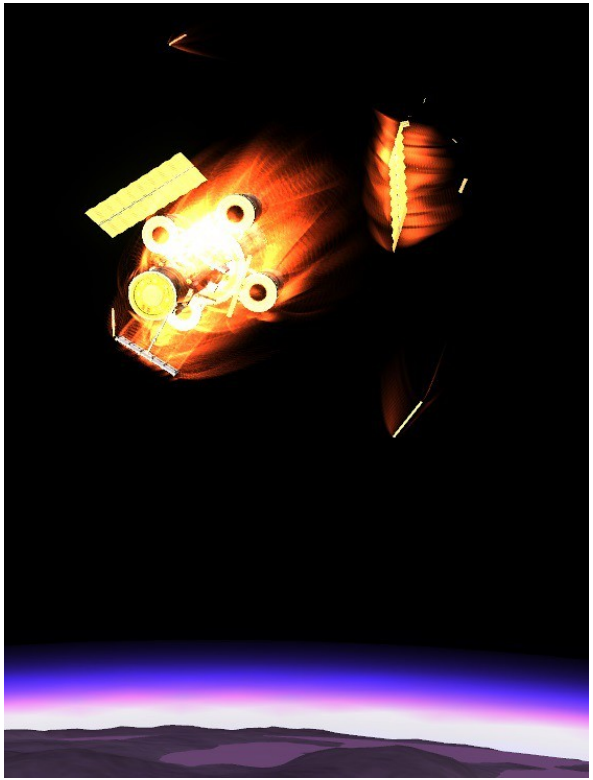
Space debris mitigation

- Designed 4 Demise (D4D), have all space assets come integrated with a solution for deorbiting
- Active debris removal, in situ removal of especially larger pieces of space debris



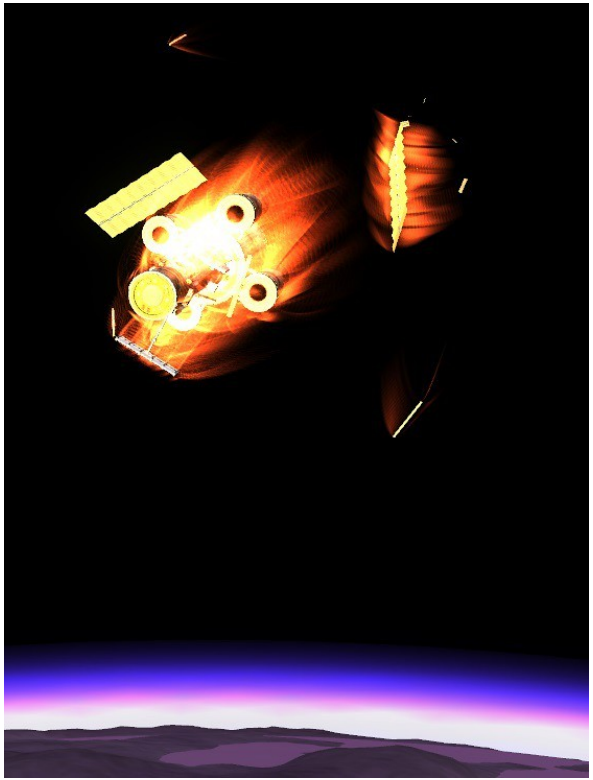
The Deorbit Kit concept 1/3

- The Deorbit Kit would be a ground-installed standalone, modular and scalable solution to enable any space asset to deorbit itself reliably within safety margins



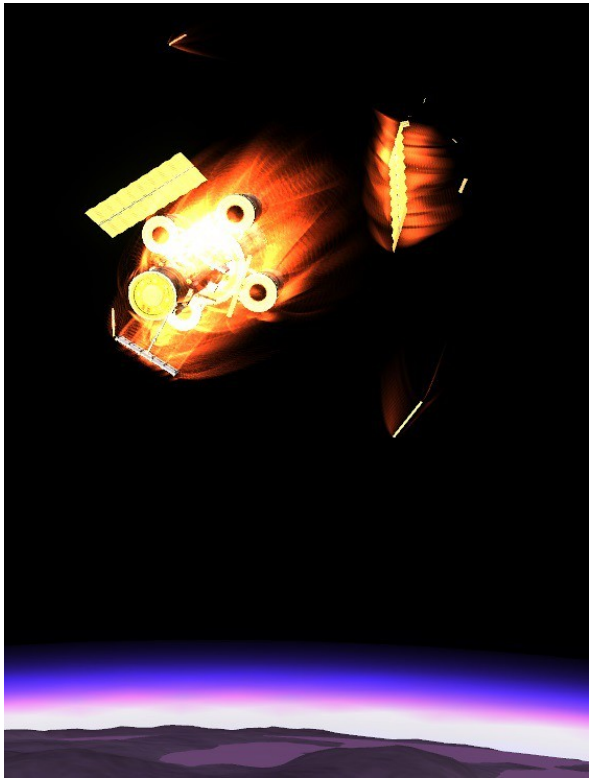
The Deorbit Kit concept 2/3

- Designed in several types, depending on system size, target altitude, availability of power
  - Initial distribution of 500 to 2500 kg satellites, 100 to 250 kg and less than 100 kg
- Dead man's switch option to deorbit even disabled targets



The Deorbit Kit concept 3/3

- Plasma brake microtether system would be key enabler of deorbiting force, though a chemical propulsion unit could also be added to the Kit

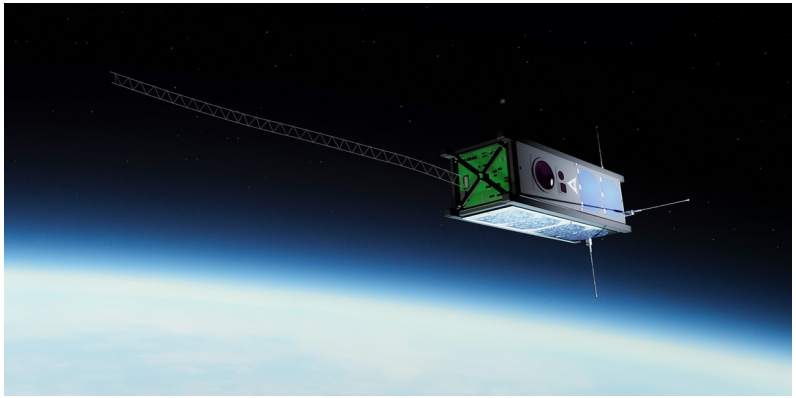


Physical system introduction

- System size in the range of 10 kg
- Scalable according to use case, availability of power, etc
- Would conserve mass budget on the carrying spacecraft due to reduced need for end-of-life propulsion

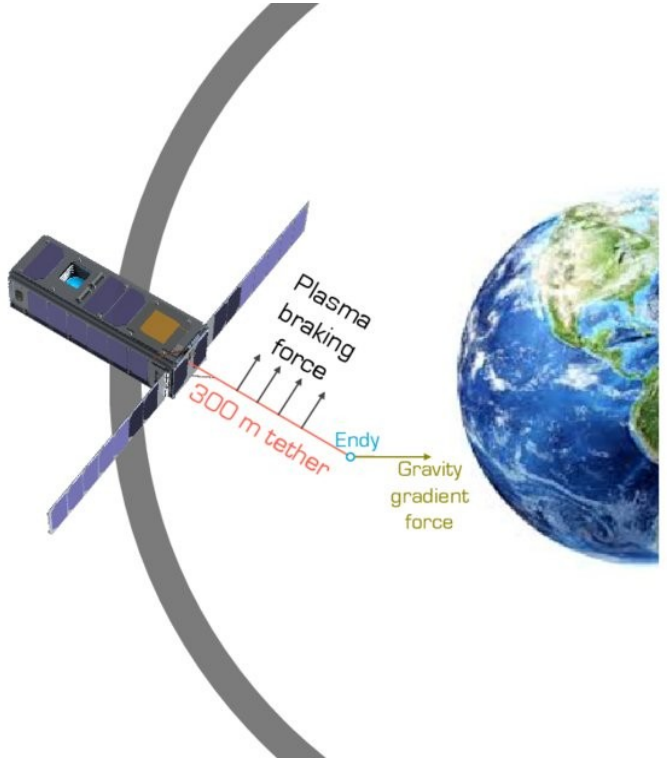
Plasma brake technology introduction

- Plasma brake is a novel, emerging deorbiting technology utilizing charged particles to provide thrust
- A spin-off from the electric solar wind sail research
- Microtether system allows for propellantless thrust to deorbit a satellite



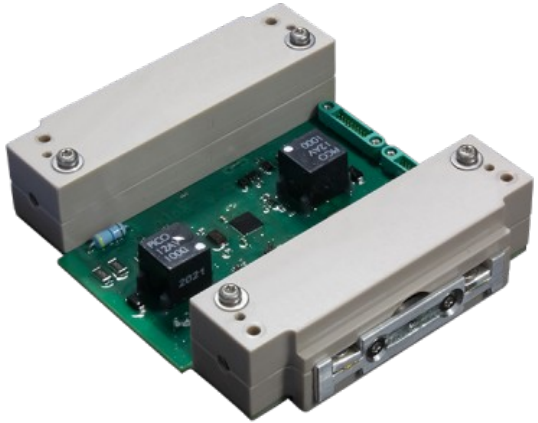
Plasma brake physics

- The plasma brake utilizes Coulomb Drag, to generate a deorbiting force from charged particles hitting a long charged tether deployed outward from the satellite
- Electrostatic tether, not be confused with electromagnetic tether



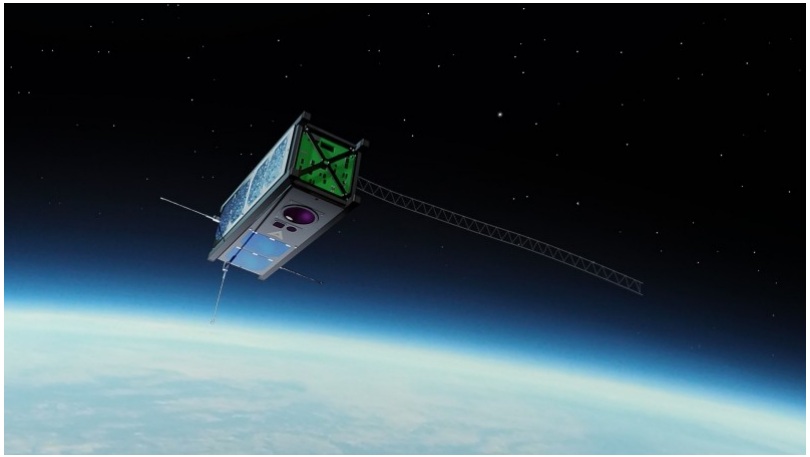
Plasma brake pros and cons

- Propellantless, highly efficient thrust to mass ratio
- Safe system due to microtether structure having very low mass
- Long deorbit times
- Challenging deployment of tether



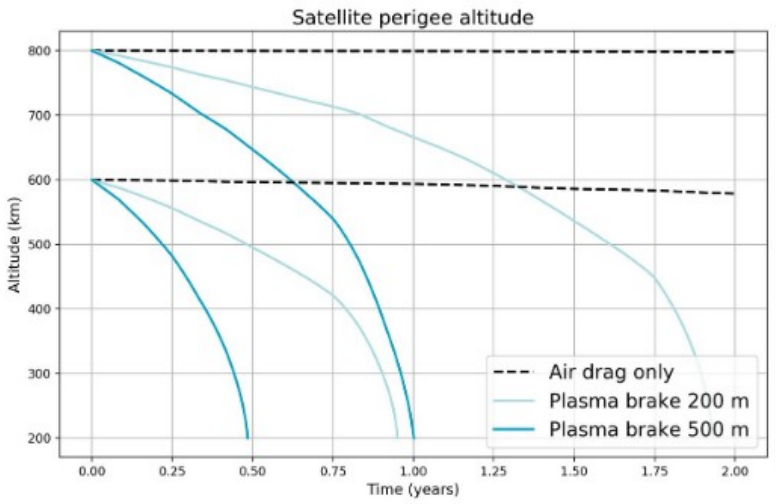
Plasma brake in Deorbit Kit

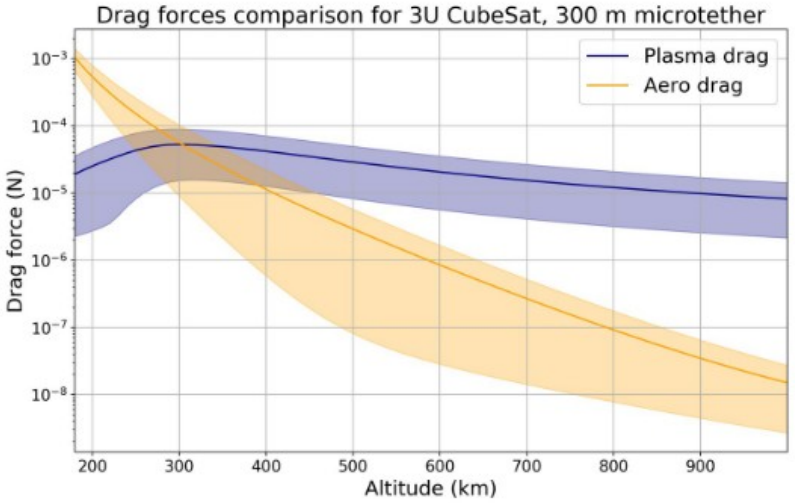
- Plasma brake would be highly useful option for Deorbit Kit
- Ideal for end-of-life deorbit
- Though it cannot perform controlled deorbiting, can perform majority of the deorbit maneouvre
  - Significantly decresed the required delta-v from the chemical propulsion system for the final controlled deorbit burn



Example of plasma brake deorbit capability

- Significantly more effective than aerodrag at altitudes above 400 km
- Deorbiting force scales with tether length



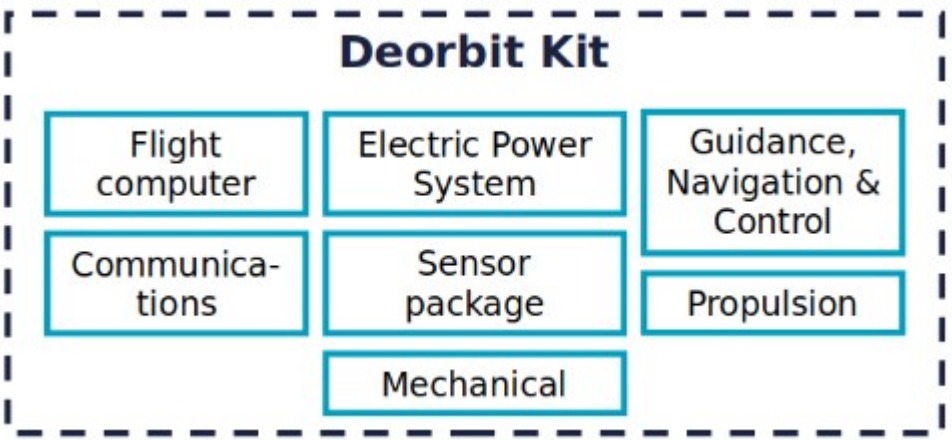


Microtether safety

- Microtether is very safe to other space assets due to the low mass of the system
- The triple-wire arrangement is very robust to micrometeoroid impacts
- Even if tether severed, the detached part will burn up in the atmosphere without any collateral damage

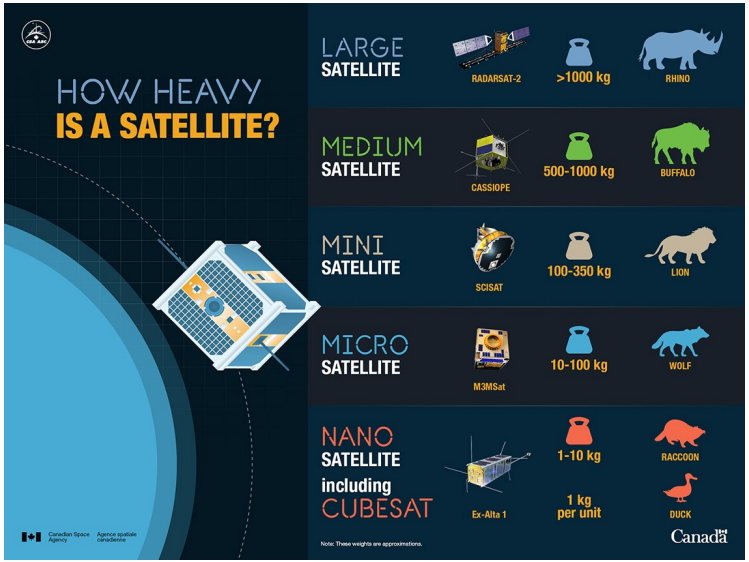
Basic system structure

- Initial system architecture



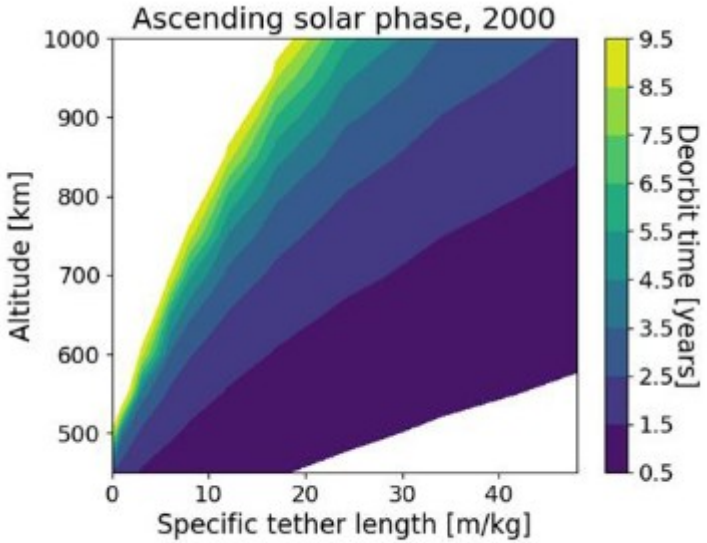
Applicable targets

- Targeted for 50 to 300 kg satellite size, but could be utilized even for 1000 kg class
- Orbits in LEO



Modularity

- System to be sized according to satellite size, orbit height
- Several ready-made size to be manufactured
- Especially in case a controlled deorbit is needed, a chemical thruster could be added



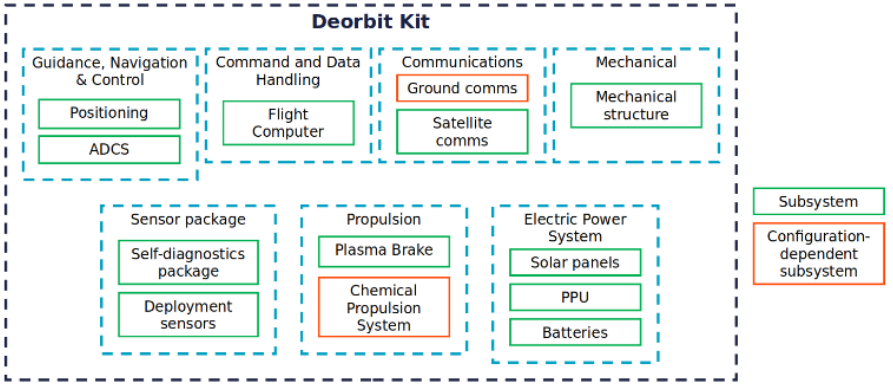
Plasma Brake deorbiting times.

Scalability

- Once the basic operations of the system have been verified, the system could be conceivably scaled to even higher orbits and satellite sizes

Fully autonomous or integrated solution

- Current plan envisions both fully autonomous or integrated solutions for the Deorbit Kit
- Fully autonomous system would allow deorbit of non-functional satellites in case of mission failure, but the system itself will have to be more sophisticated

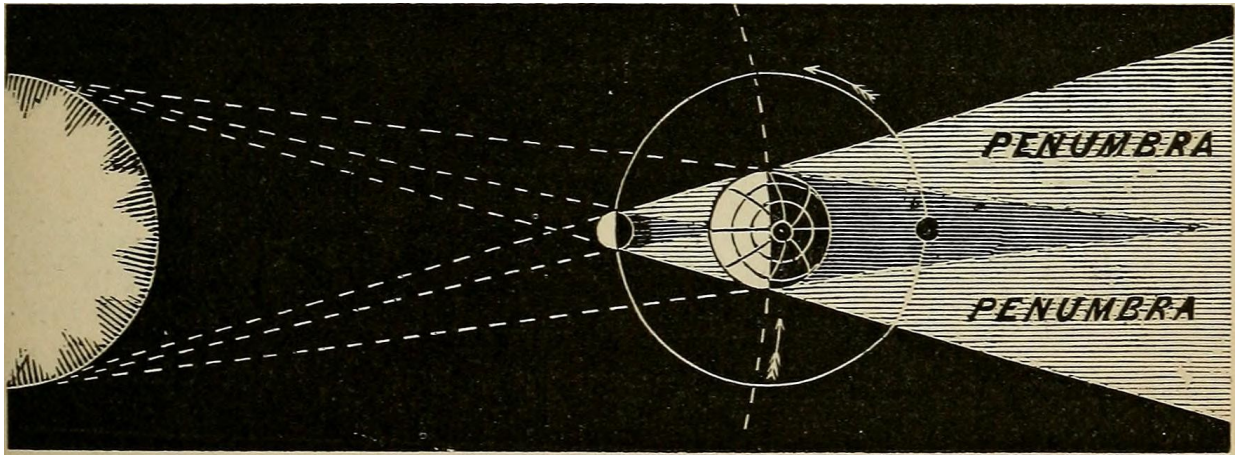


Benefits

- Standardized and easy to manufacture solution would greatly help with the growing space debris problem
- Deorbit Kit concept is modular and scalable
- Plasma brake is highly effective deorbiting solution due to it’s safety and low mass

Project status

- The project is in early concept stages, having undergone several revisions
- Currently looking for pilot customers



Conclusions

- Space debris is a challenging problem requiring both active and passive solutions
- Deorbit Kit is a scalable deorbit solution that would serve most space assets well
- Plasma brake is an emerging deorbiting technology utilizing microtethers and Coulomb drag