SPACE MIND

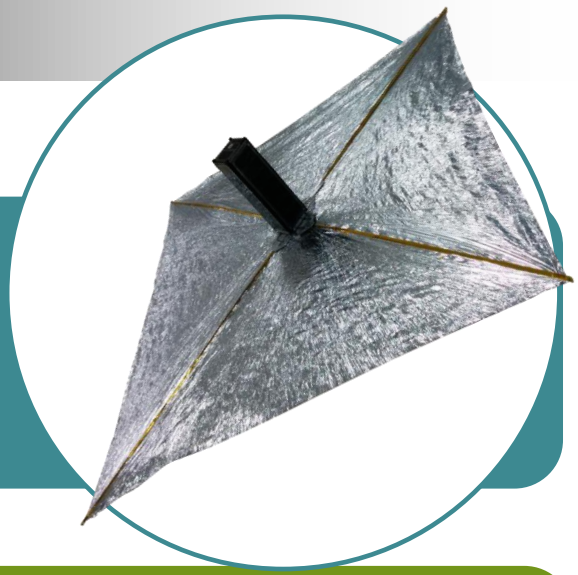
NPC Spacemind

Solution provider for the aerospace sector

NPC
new production concept

Activities and experiences

Products and services

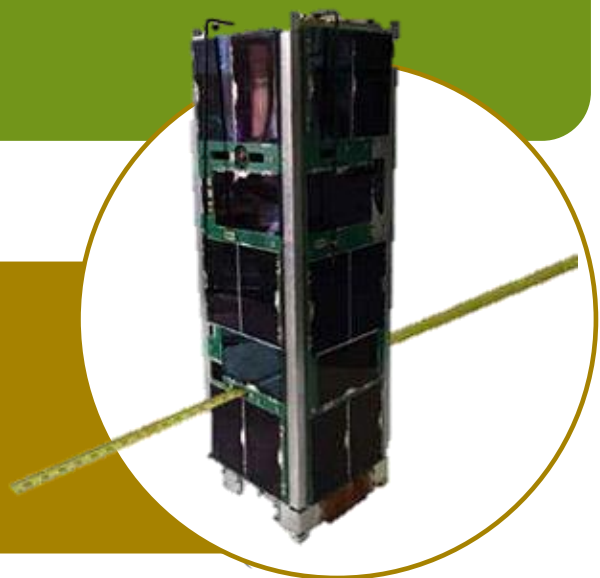


Design and production of nanosatellite hardware:

- System for the mitigation of space debris
- Microsat/Nanosat structures

Professional pointing systems:

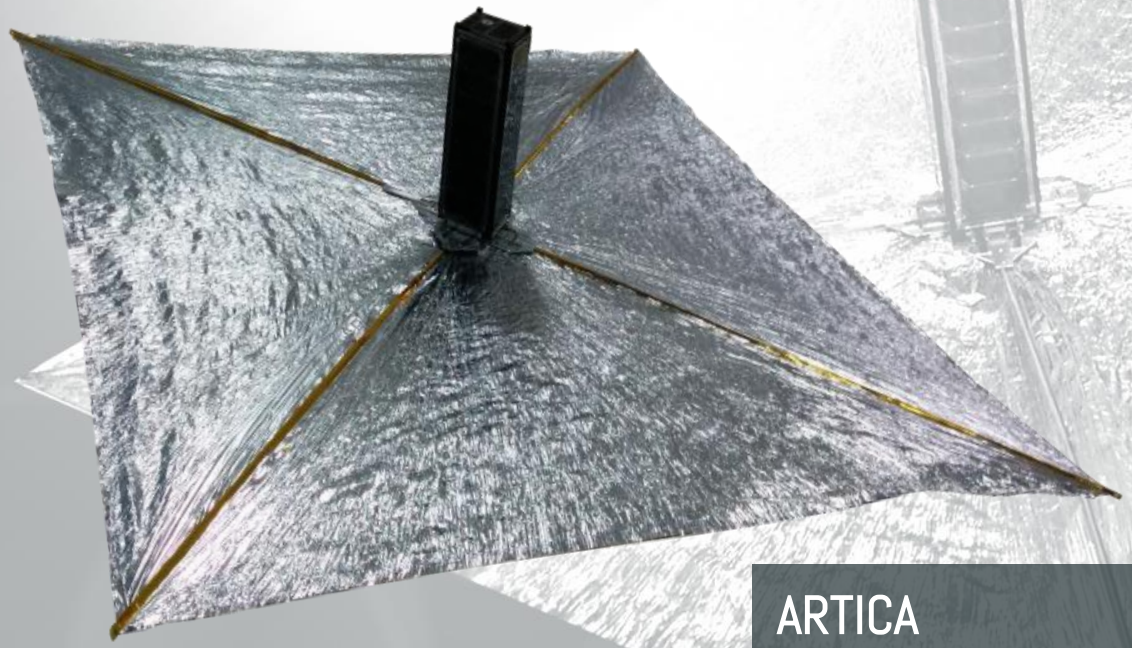
- ALTAZ mount for space debris tracking (SSA activities)
- Laser ranging and radar applications
- Astronomy



Space mission design and nanosatellite integration:

- Involvement in 4 nanosatellite cubesat missions
- Design of nanosatellite missions for monitoring applications

ARTICA



ARTICA

Aerodynamic **R**eentry **T**echnology **I**n **C**ubesat **A**pplication

It's an autonomous deorbiting system based on the deployment of a thin aerobrake sail

ARTICA Deorbiting system

Project requirements

- **ARTICA** is a **passive deorbiting** system specifically designed for Cubesat.
- The system consists in a deployable drag sail of **2,1 sqm**
- The project started in 2012 with the aim to provide solution for space debris mitigation.
- The period was characterized by the imminent explosion of the nanosatellite market in terms of numbers and future services offered, indicating thus a future drastic amount of object in LEO orbit.
- Parallel it was observed also an increase of attention towards the environmental and safety problems related to space debris both by media and society and both from scientific community.
- In this contest the project ARTICA borne with the aim to simultaneously embrace two contrasting but strongly interrelated aspects of the space sector: on one hand the explosive growth of the nanosatellite cubesat market, on the other the need to reduce the consequent overcrowding of orbits and increase of space debris

ARTICA Deorbiting system

Project requirements

Commercial needs

- Avoid mass budget «waste» on-board spacecraft
- Avoid mission cost budget «waste»
- Avoid increasing spacecraft complexity
- Avoid environmental operational limitation

COMPACT VOLUME AND SIZE
INDEPENDENT & STAND ALONE
PASSIVE SYSTEM AND SIMPLE
EFFICIENT IN COMMERCIAL ORBIT (IADC GUIDELINES)

Environmental needs

- Mitigate the increase of space debris population
- Reduce the expected overcrowding of most commercial orbits
- Ensure efficiency and reliability
- Guarantee operation even in case of satellite loss

DEORBITING CAPABILITIES
EFFICIENT IN COMMERCIAL ORBIT
PASSIVE SYSTEM AND SIMPLE
INDEPENDENT & STAND ALONE

ARTICA Deorbiting system

Project requirements

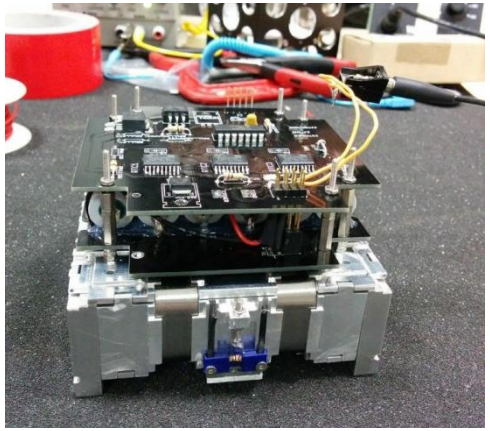
Low volume and size	• Applicable on board 1U cubesat → Total system size <0,3 U
Passive and simple system	• Avoid the presence of pressurized tank for structures inflating • Efficient without attitude control system
Efficient to de-orbit a 3U Cubesat	• Within 25 Years for high LEO • Well below 25 year for low LEO
Independent from the satellite	• Fully functional as a satellite itself

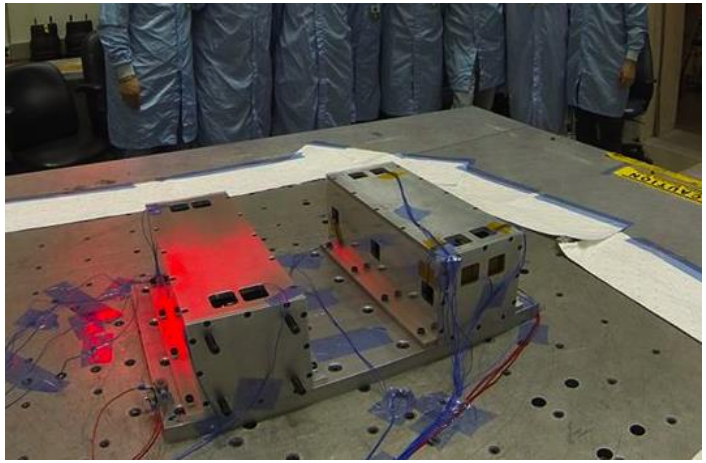
- Self deployable drag sail
- Stored size of 0,3 U
- Area of the sail < 1,2 sqm
- DT<25 yr up to 700 km orbit (3U)

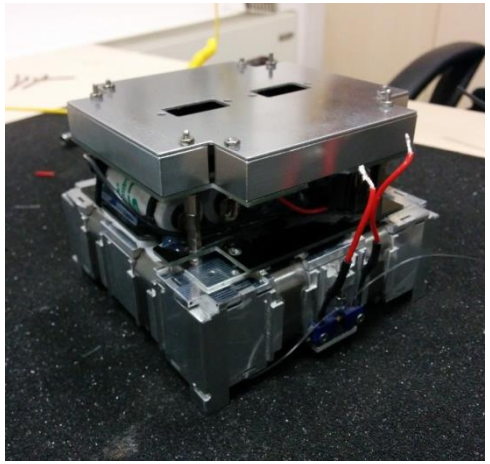
System evolution

ARTICA 0

- **Year:** 2013
- **Size:** 0, 4U
- **Sail size:** 1 sqm
- **Heritage:** Integrated and ground tested on board ELEONORA 3U Cubesat
- **Status:** Not launched



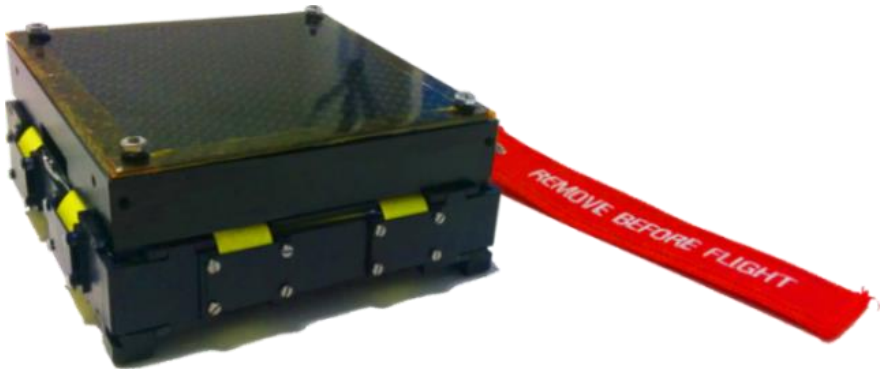




System evolution

ARTICA 1.0

- **Year:** 2016
- **Size:** 0, 33U
- **Sail size:** 2 sqm
- **Heritage:** In orbit on board Cubesat URSAMAIOR
  Launched 23 July 2017
- **Status:** active -waiting for deployment



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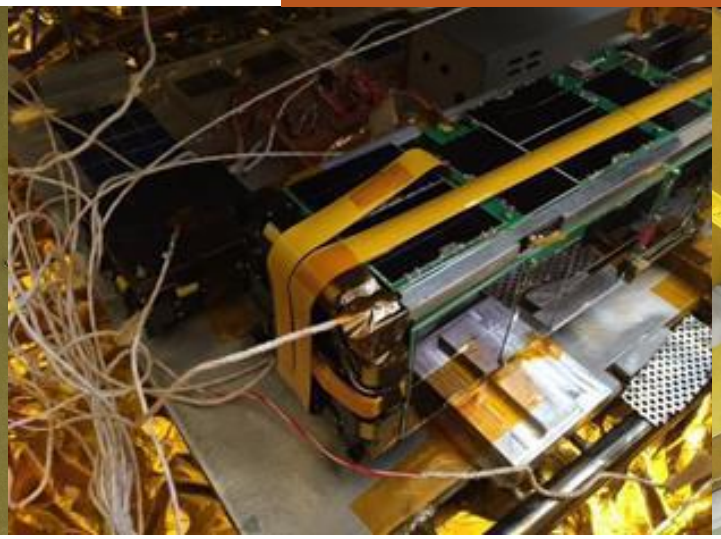
Enviromental qualification campaign


System evolution

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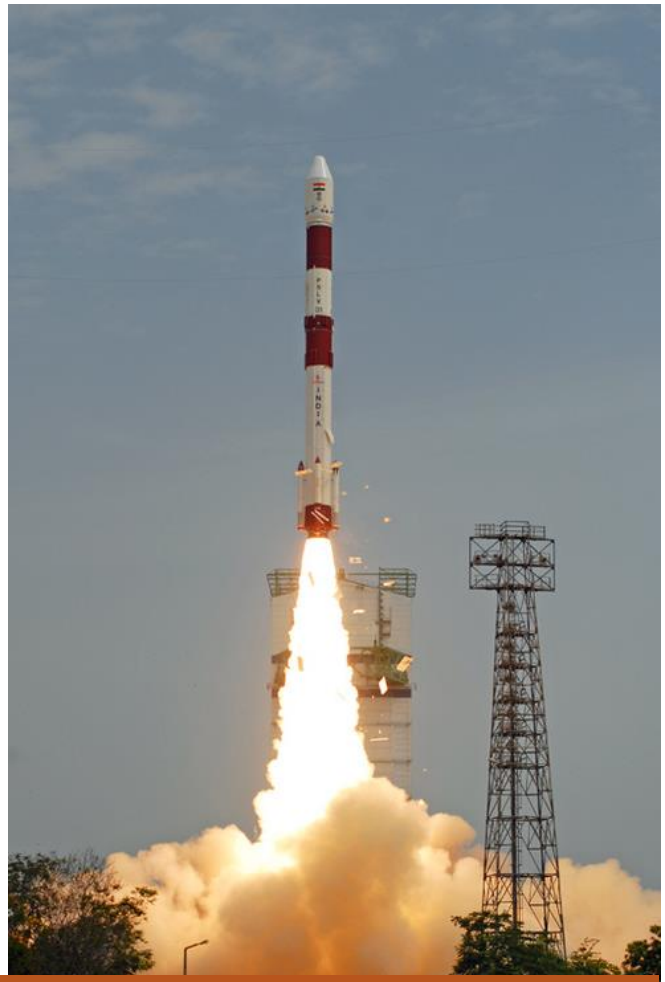

Launch:– PSLV C-38

System evolution

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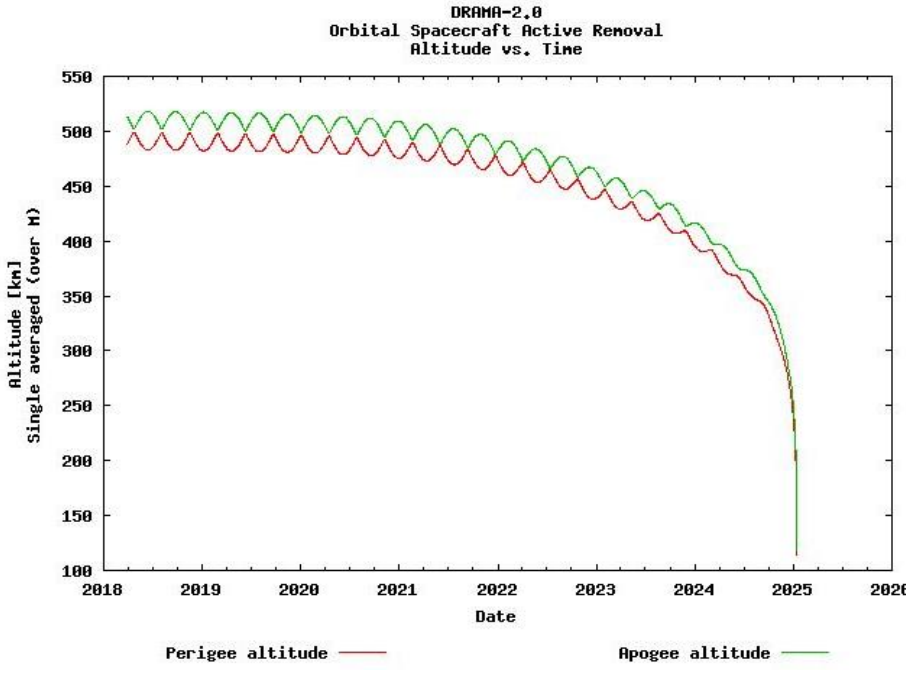
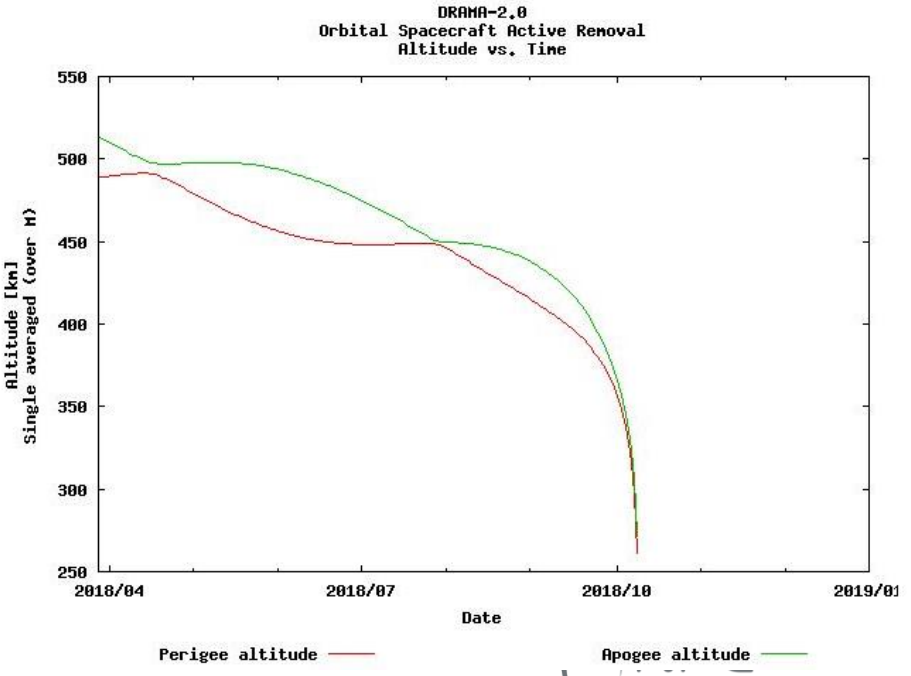




System evolution

ARTICA 2.0

- **Year:** 2018
- **Size:** 0, 25U Size
- **Sail size:** 2,1 sqm
- **Heritage:** none
- **Status:** ground tested

ARTICA

Spacemind Cubesat structure SM01

- More compact;
- Lightweight;
- **Compatible with 6U and 12 U standards**
- Compatible with Spacemind class of structuresand with PC104 standard
- Efficient even in case of tumbling satellite (average cross sectional area)

Current status

New application scenario

THE SCENARIO HAS CHANGED!

2012 ... **2018**

Project begin
Definition of requirements

Novel platforms
Novel needs

Evolution of scenario

New application scenario

With respect to 2012 scenario has notably changed:

1. Spacecrafts became much more reliable and evolved (the probability of failure of the satellite is reduced)

2. Due to the amount of future constellation of satellties in orbit (thousands in next couple years), deorbiting requirement shall become more strict:

   - ✓ Need of controlled deorbiting for collision avoidance
   - ✓ Need of faster and safer deorbiting

Current status

Modular device approach

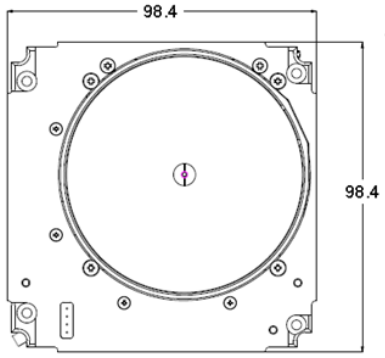
1. Spacecrafts became much more reliable and evolved

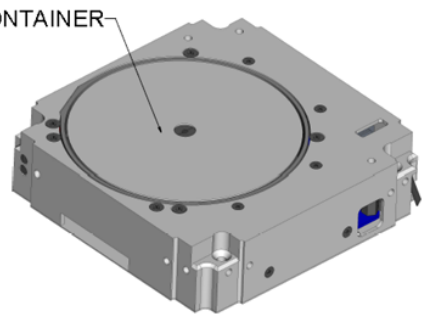
- ARTICA has been conceived as modular in order to allow the system to be controlled by the host satellite
- This reduce further reduce masses, volumes and complexity of the device
- The scope is to encourage the use of the system by the user dealing with an extremely more compact device.

Operative mode	ID	Description	Electrical interface	Remarks
Commanded release	CR	Satellite bus acts directly on ARTICA releasing system to trigger the deployment of the sail.	Electrical interface between S/C and ARTICA releasing system	Nominal: > 3V DC unregulated - I>2 Amps - @ t>30s Min PWR required: 3W
Commanded activation	CA	Sail deployment command is issued by the hosting satellite.	Electrical connection to ARTICA control circuit	High level signal: 3,3 V to 5 VDC
Stand-alone	SA	ARTICA acts as a completely autonomous device:	No electrical interface with S/C required	ARTICA has its own control board and exploits its own power system

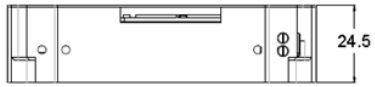
Current status

Modular device approach

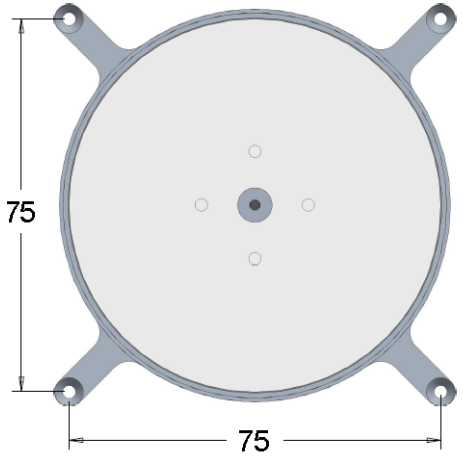


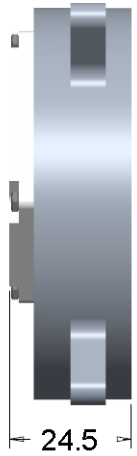


Fully standalone



Minimum configuration





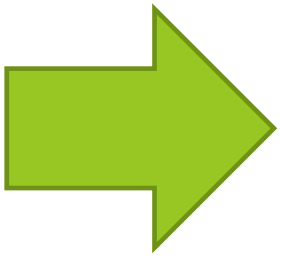
Current status

Different application approaches

2. Deorbiting requirement shall become more strict:

- In the new scenario, active deorbiting devices (engines) could result more suitable, especially for higher orbits.
- In order to obtain the same performance of an active deorbiting device it would be necessary to greatly increase the sail area:
  - The system could hardly be enogh compact to be compliant with a cubesat class spacecraft
  - The deployed sail would increase the risk of collision.

Make your weakness your strenght!



- For LEO<400km ARTICA could result a valuable primary deorbiting device (high efficiency due to higher drag effect)
- For higher LEO orbit, thanks to its compact size, a standalone ARTICA could result in a good backup deorbiting device in case of failure of the primary deorbiting system (active)

Next steps

Project status and development

- **Looking for possibilities of IOD of the new versione of the system**
- Under study a novel concept of activation targeted to remove the possibility of failure (demisable actuator)
- Re-engineering of system hardware as a solar sail (possibility to orient the sail surface)

Other activities in space debris field

MORAL tracking mount

- **MORAL** (**MO**unt **R**obotic **AL**tazimuth) is a project started in 2015 leading to the realization of high perforomance telescope mount for 1m class telescope for space debris tracking and SSA ans SST activities.

- The system has been exploited for a full tracking of *Tiangong-1* orbiting at 190Km (~6 minutes continued tracking)

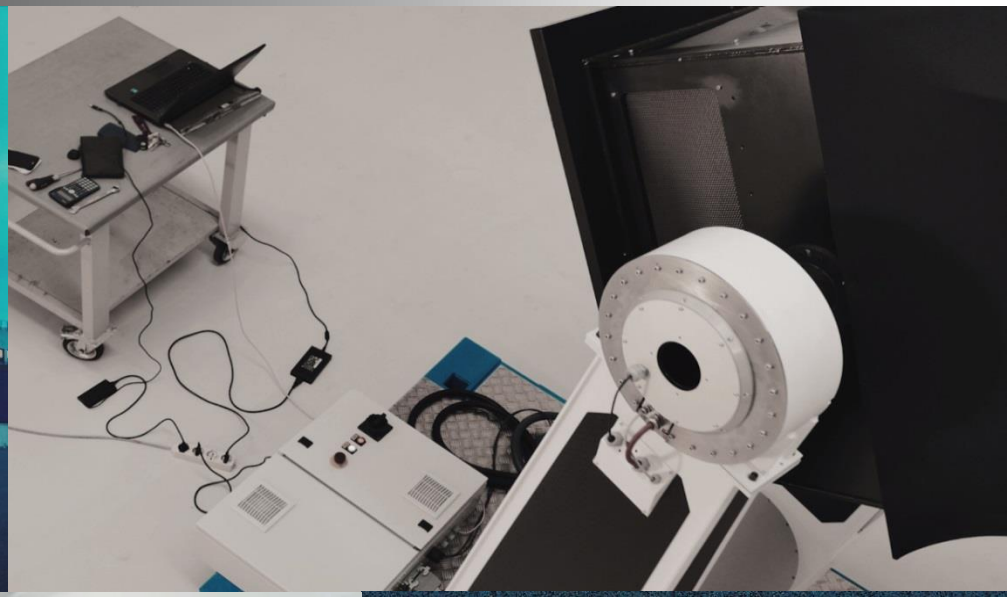
- MORAL mount has been currently rescaled for SSA network to operate 500mm optical paylaod and mainteining the same level of performances.

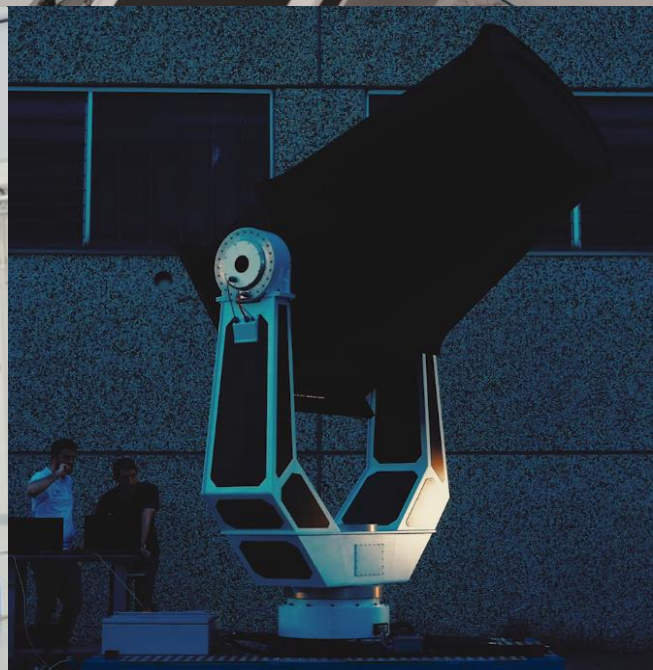
MO.R.AL
ACCURACY VELOCITY CONTROL

Other activities in space debris field

MORAL tracking mount

Other activities in space debris field





Thanks for the attention!

N.P.C. New Production Concept S.r.l.
Via Errico Malatesta 29
Imola (BO)

www.npcspacemind.com

Ing. Niccolò Bellini - n.bellini@npcitaly.com
Ing. Davide Rastelli - d.rastelli@npcitaly.com

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