SPACE2CONNECT CONFERENCE

SHAPING THE FUTURE TOGETHER

VALUES

SESSION 8

How can we ensure responsible, safe and sustainable use of space?

DAY 2

THURSDAY 8th JUNE 2023

VALUES

SESSION 8

RESPONSIBLE USE OF SPACE

Protection of Space Assets

SPEAKER

Holger Krag

Head of Space Safety Programme, ESA

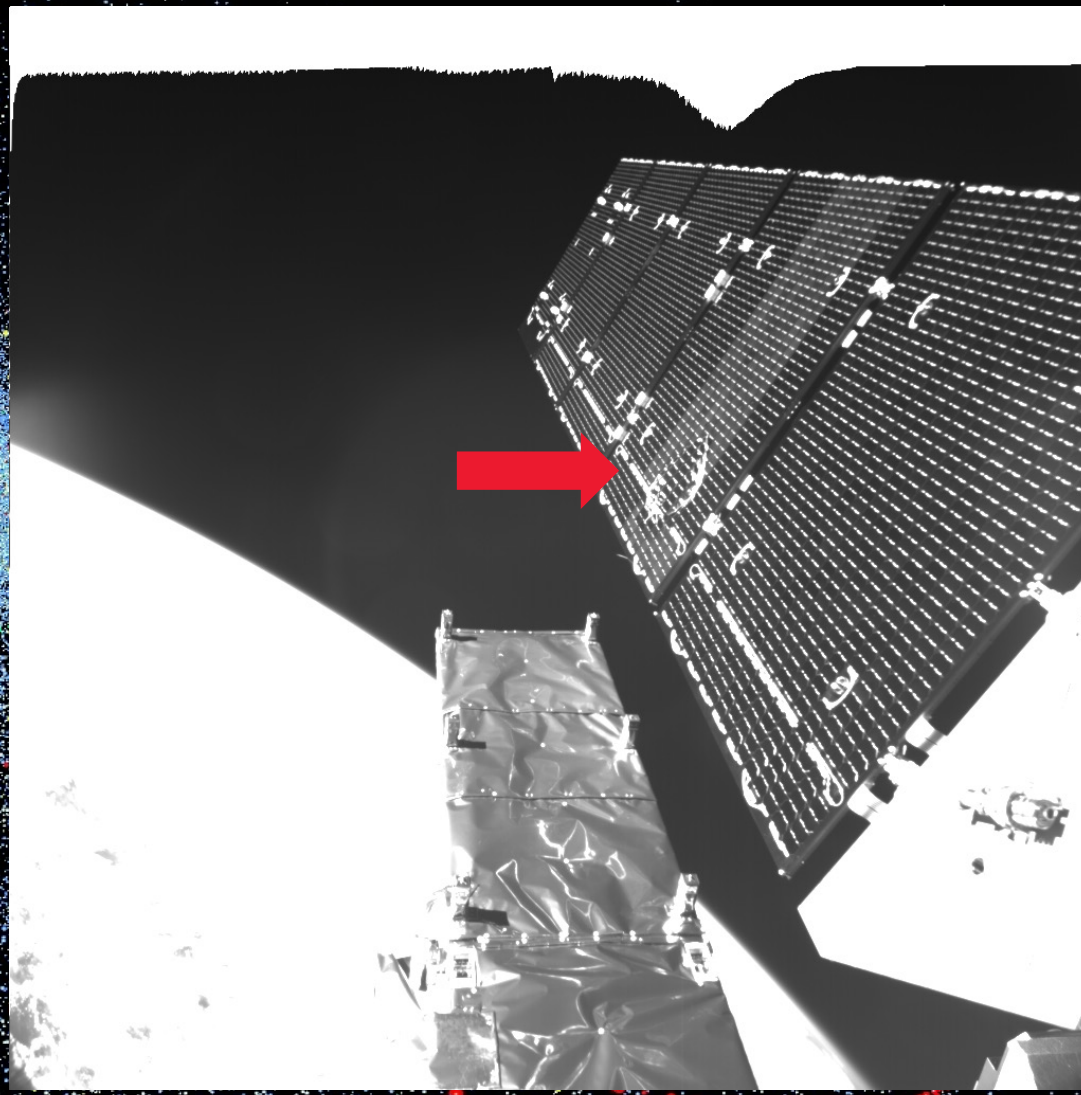
Protection of Space Assets

Holger Krag

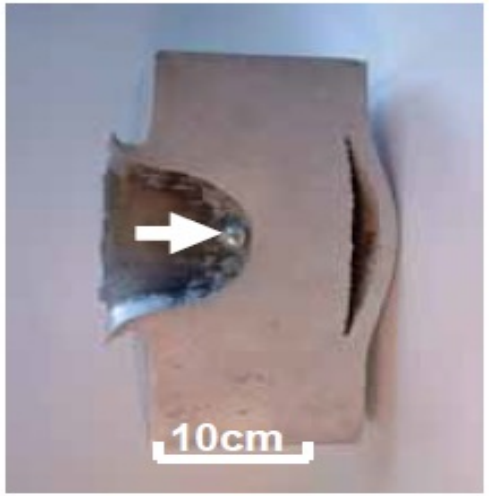
Space2Connect,

08.06.2023

>1mm



Energy equivalent



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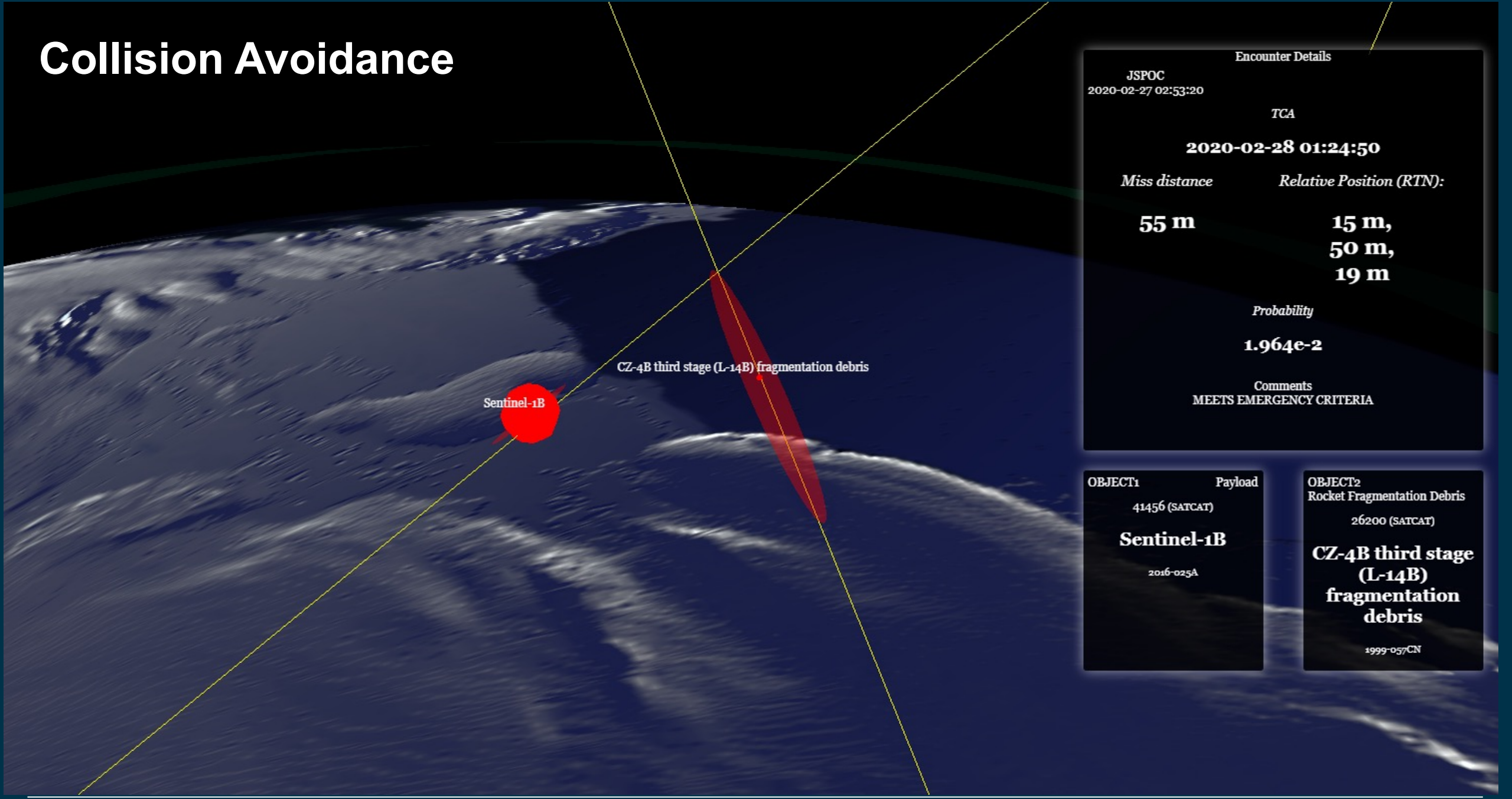
Collision Avoidance



Encounter Details

JSPOC
2020-02-27 02:53:20

TCA

2020-02-28 01:24:50

Miss distance

55 m

Relative Position (RTN):

15 m,
50 m,
19 m

Probability

1.964e-2

Comments
MEETS EMERGENCY CRITERIA

OBJECT1 Payload

41456 (SATCAT)

Sentinel-1B

2016-025A

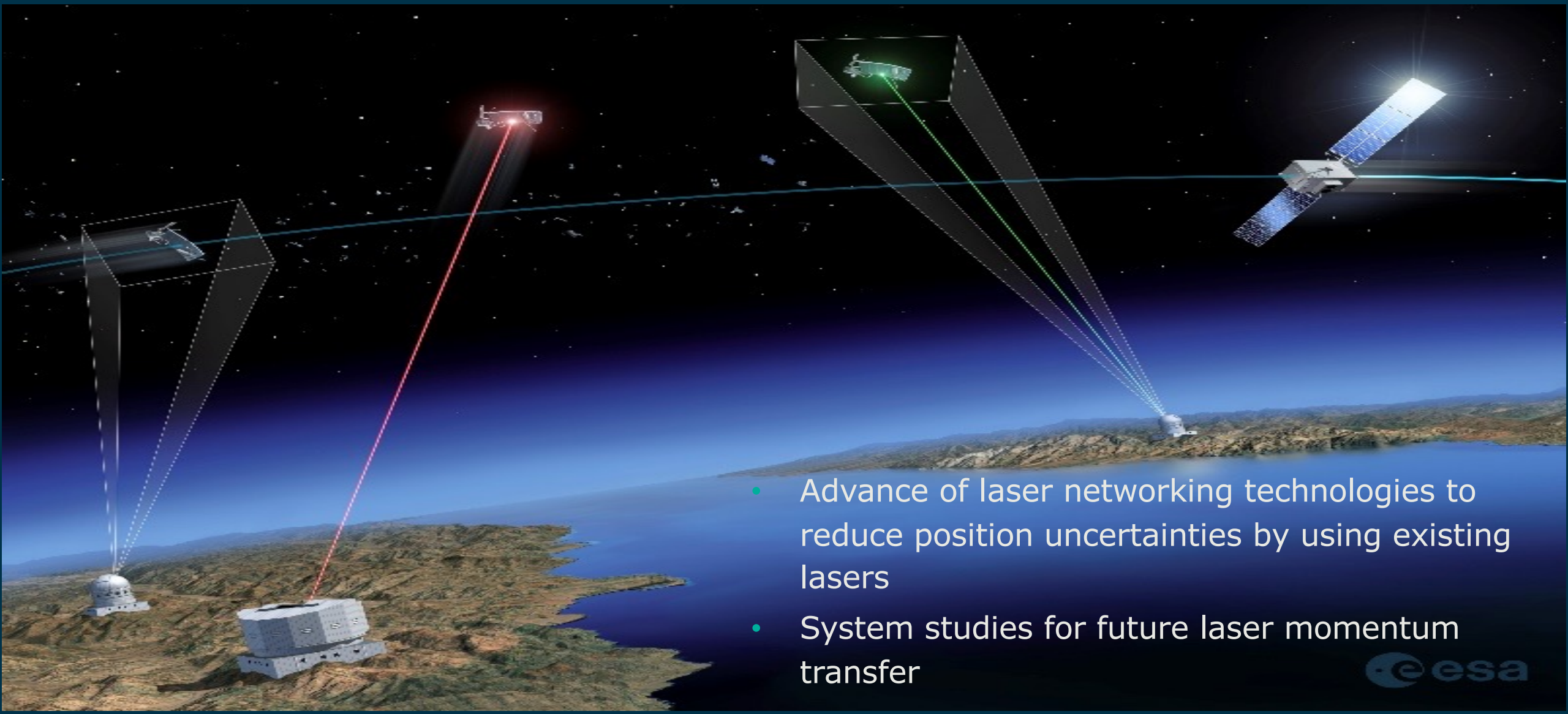
OBJECT2
Rocket Fragmentation Debris

26200 (SATCAT)

CZ-4B third stage (L-14B) fragmentation debris

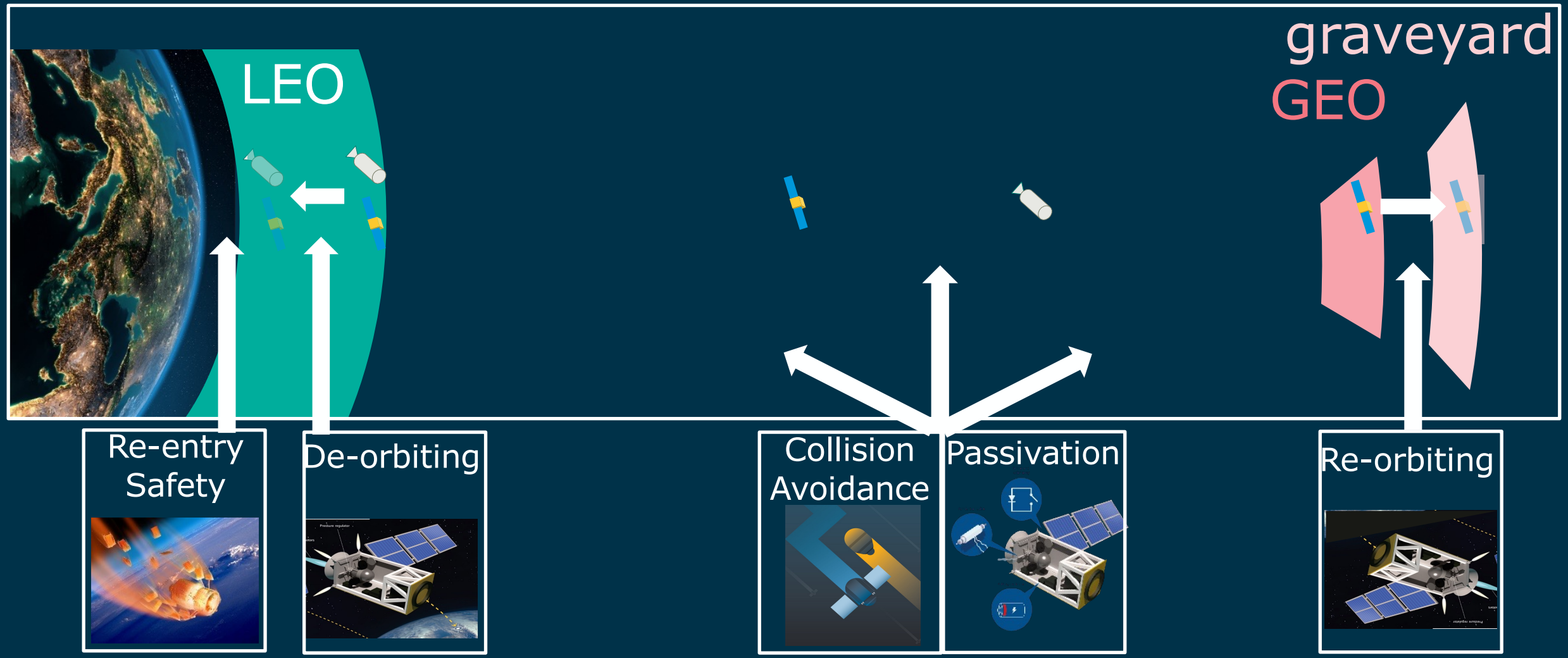
1999-057CN

COSMIC Laser Technology



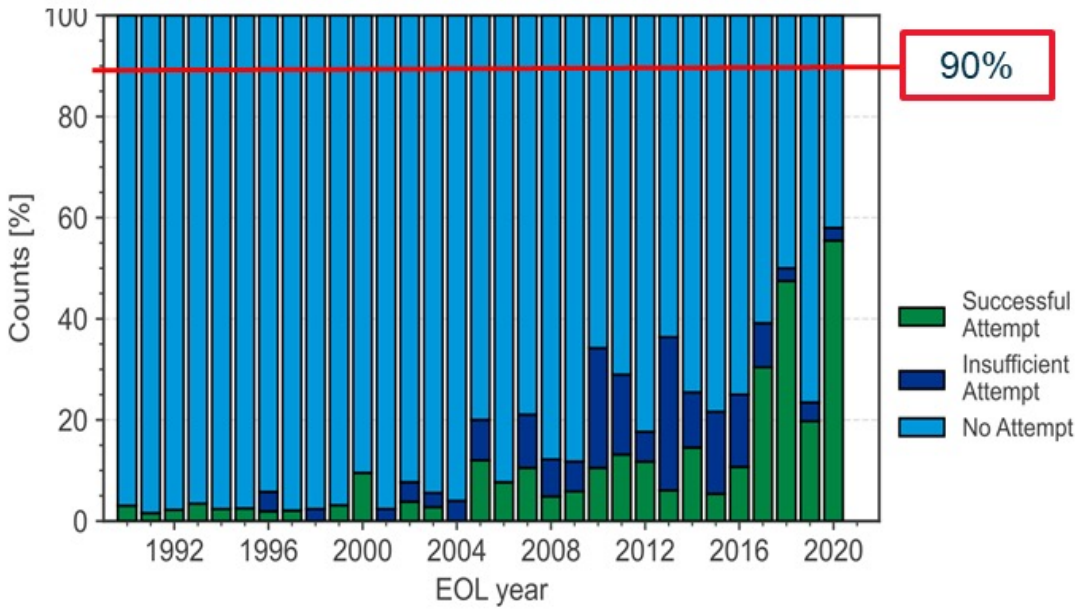
- Advance of laser networking technologies to reduce position uncertainties by using existing lasers
- System studies for future laser momentum transfer

Mitigation of Space Debris

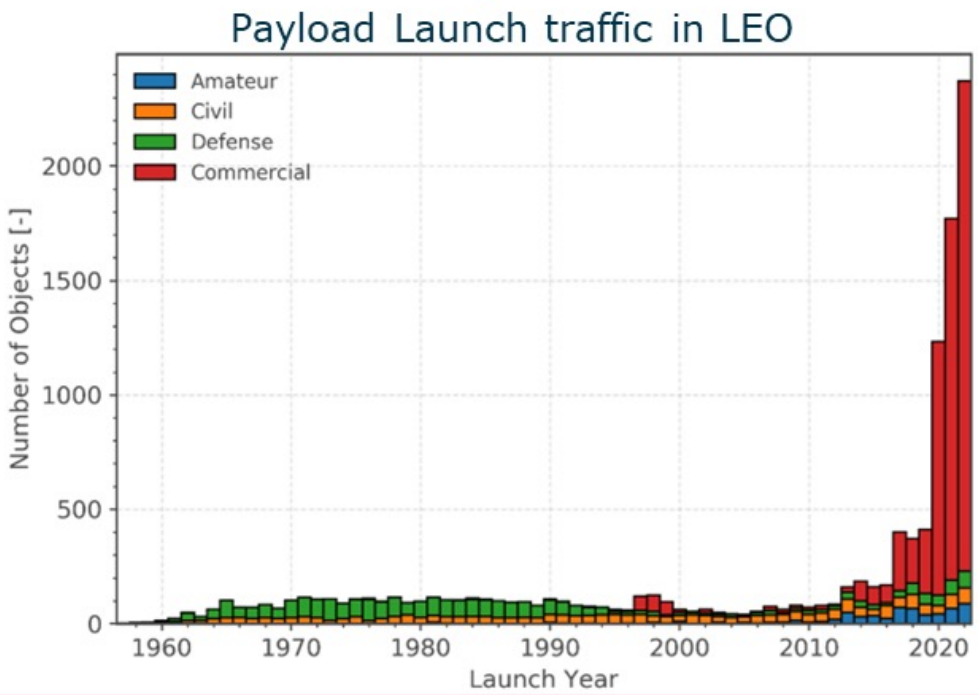


The orbital environment is changing

Successful disposal in LEO significantly below 90%



In 3 years more satellites launched than in the 60 years before



Source: ESA's Annual Space Environment Report. Issue 6, released: 22 April 2022
https://www.sdo.esoc.esa.int/environment_report/Space_Environment_Report_latest.pdf

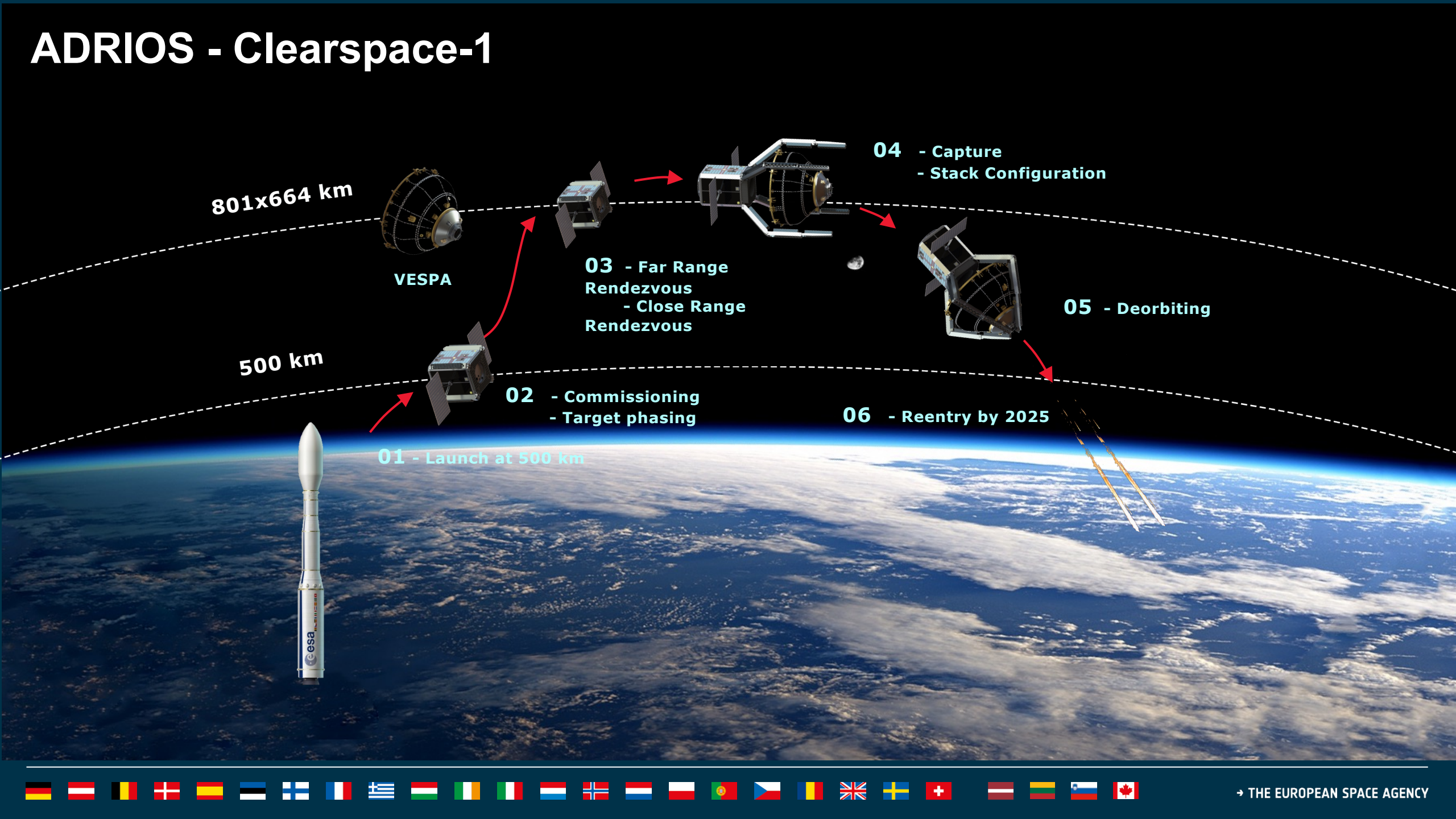
ESA's Zero Debris Approach

"In
we
sp
for
they

by 2030

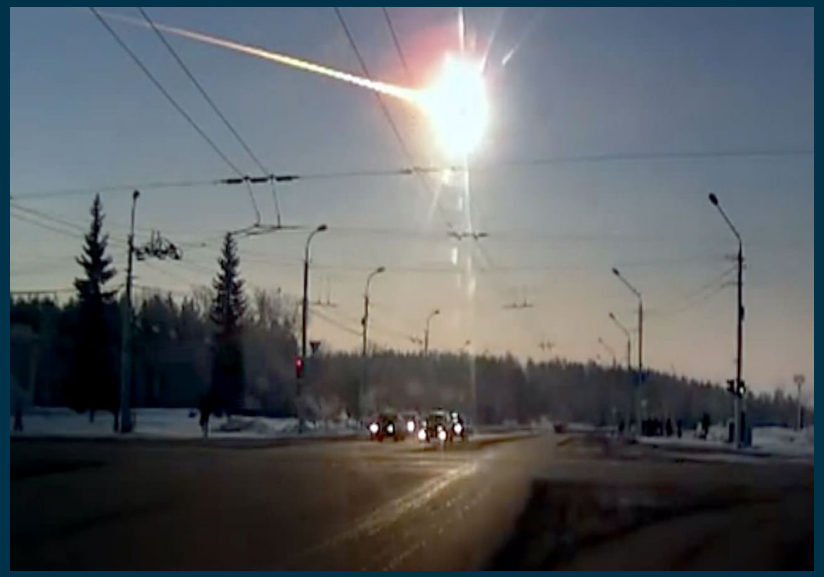
- Compliance with Post Mission Disposal much higher than 90%
- Removal missions for remaining debris

ADRIOS - Clearspace-1

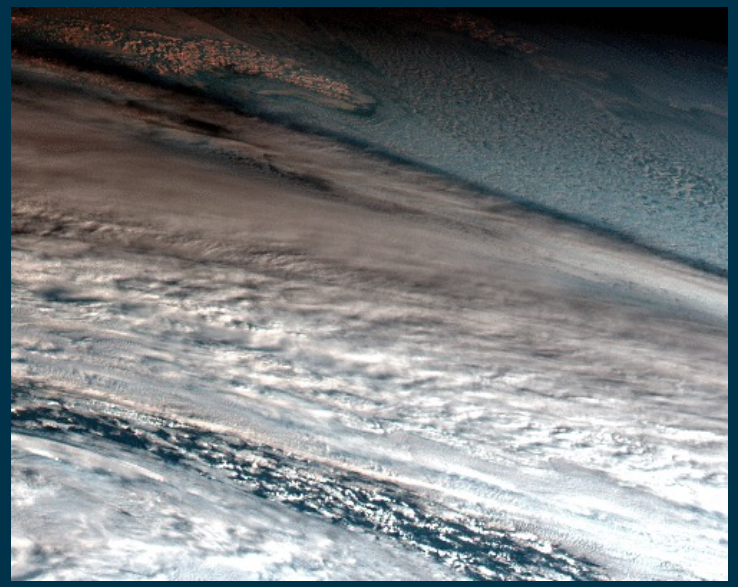


NEO Airbursts

(30m diam)
February 2013
Chelyabinsk

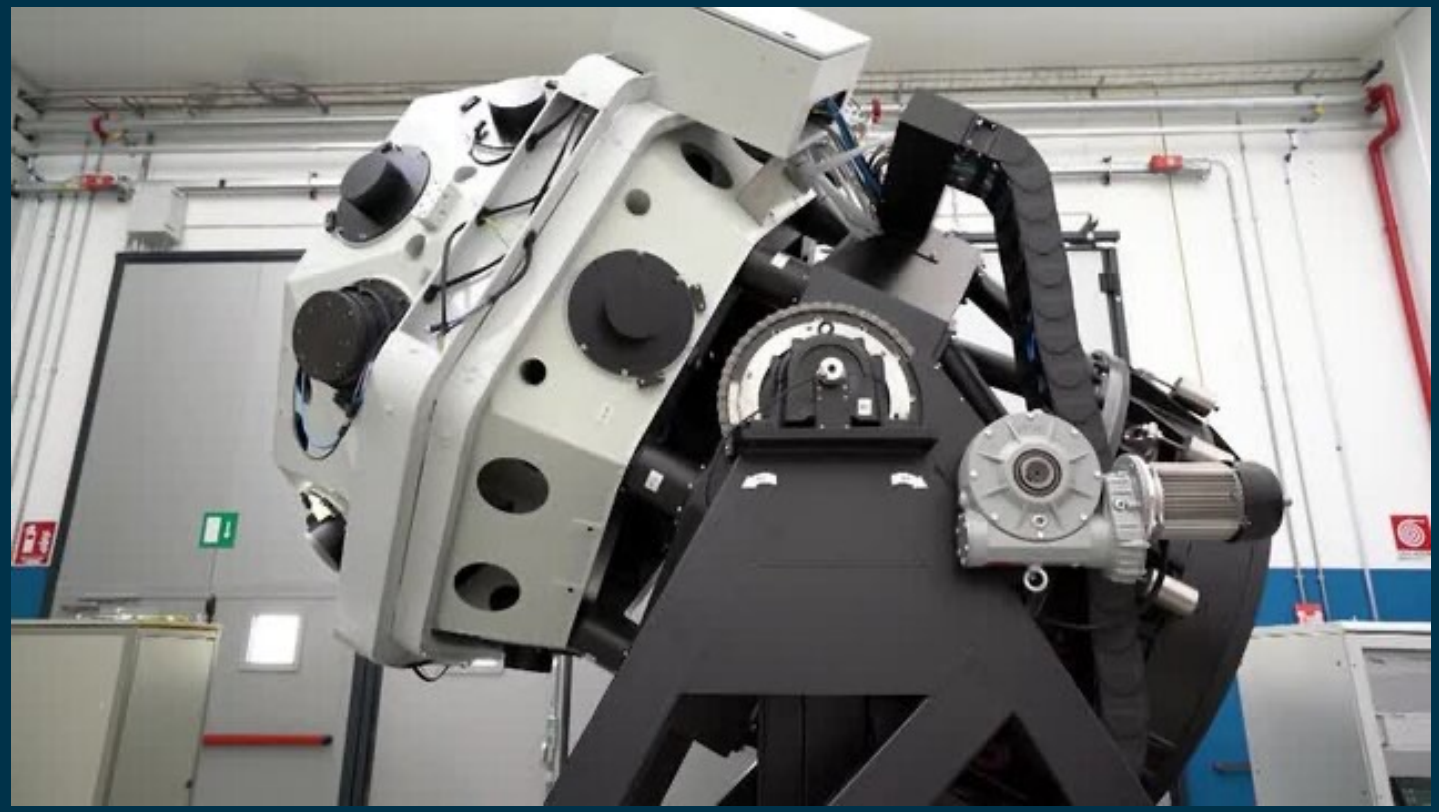


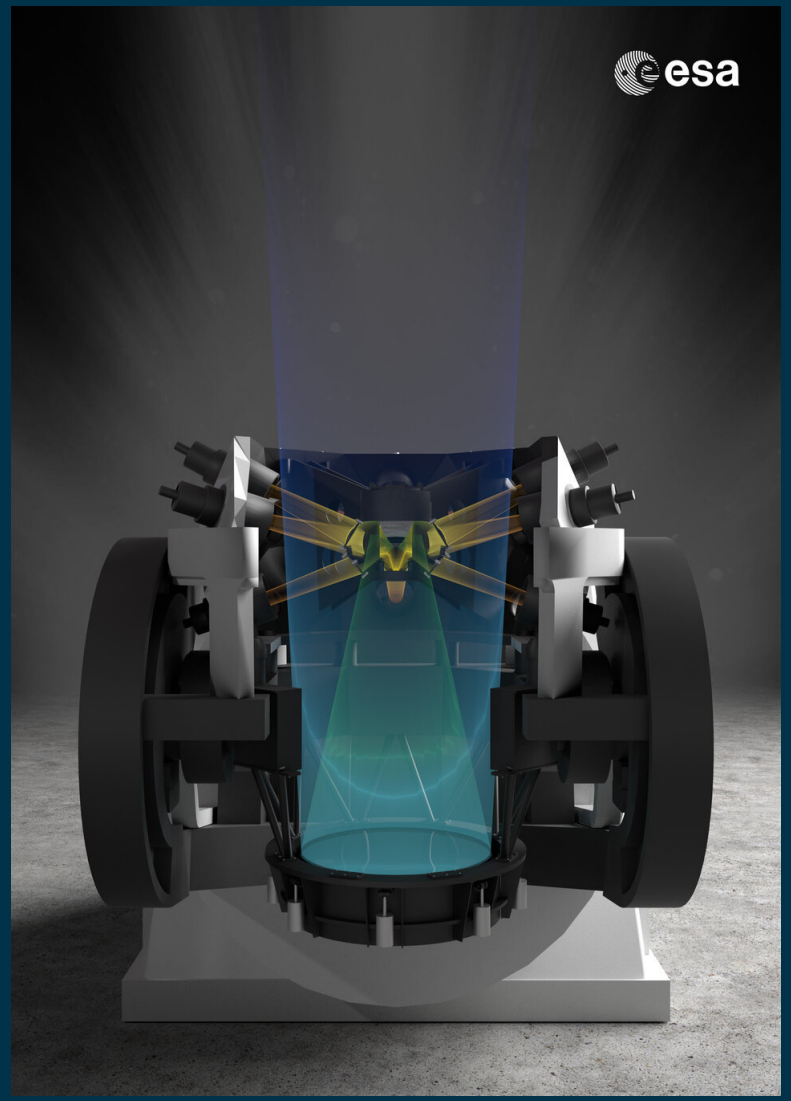
(10m diam)
December 2018 –
Bering Sea



(0.1m diam)
May 2019 Fireball
Adelaide, Australia)

FlyEye Telescope tests in Matera






Thank You !

DAY 2

THURSDAY 8th JUNE 2023

VALUES

SESSION 8

RESPONSIBLE USE OF SPACE

Spectrum Scarcity

SPEAKER

Sergio Buonomo

Chief of the Study Group Department
at the Radiocommunication Bureau, ITU

Space2Connect Conference
MATERA
ITALY
7-9 JUNE 2023

Spectrum Scarcity

Mr. Sergio Buonomo
Chief, Radiocommunication Study Groups Department
International Telecommunication Union (ITU)

ITU WRC DUBAI 2023

A bit of relevant history...

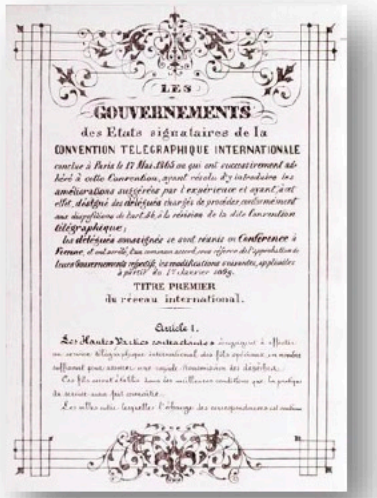
Space race of the 50-60's created the need to allocate and coordinate radio spectrum for space communications

1865
(Paris)

The International Telegraph Union:
Founded on 17 May 1865 by 20 nations

1906
(Berlin)

International Radiotelegraph Convention
(1st Radio Regulations – binding rules)


LES
GOUVERNEMENTS
des Etats signataires de la
CONVENTION TELEGRAPHIQUE INTERNATIONALE
TITRE PREMIER
du réseau international.
Article 1.

1959
(Geneva)

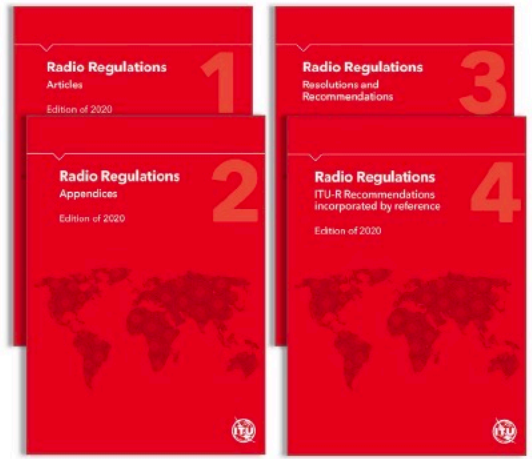
WARC-59:
Included of the definition of space service and allocated frequencies for space research purposes only

1963
(Geneva)

EARC-63 and the first allocations to satellite communications

1971
(Geneva)

WARC-71 for Space Telecommunications



Over **110 years** of **Radio Regulations**

ITUWRC DUBAI 2023

Radio Regulations

The **Radio Regulations (RR)** are the **international treaty governing** the use of the radio-frequency spectrum and the geostationary-satellite and non-geostationary-satellite orbits.

It is elaborated and revised by administrations and membership, during **World Radio Conferences (WRC)**.

WRCs are held every 3-4 years.

RR have a **binding nature for ITU Member States**.

ITU acts as depositary of the RR.

Last version: RR-20 (as revised during WRC-19).

The RR can be downloaded, free of charge, for the general public, in the 6 UN Languages, at: https://www.itu.int/pub/R-REG-RR-2020.

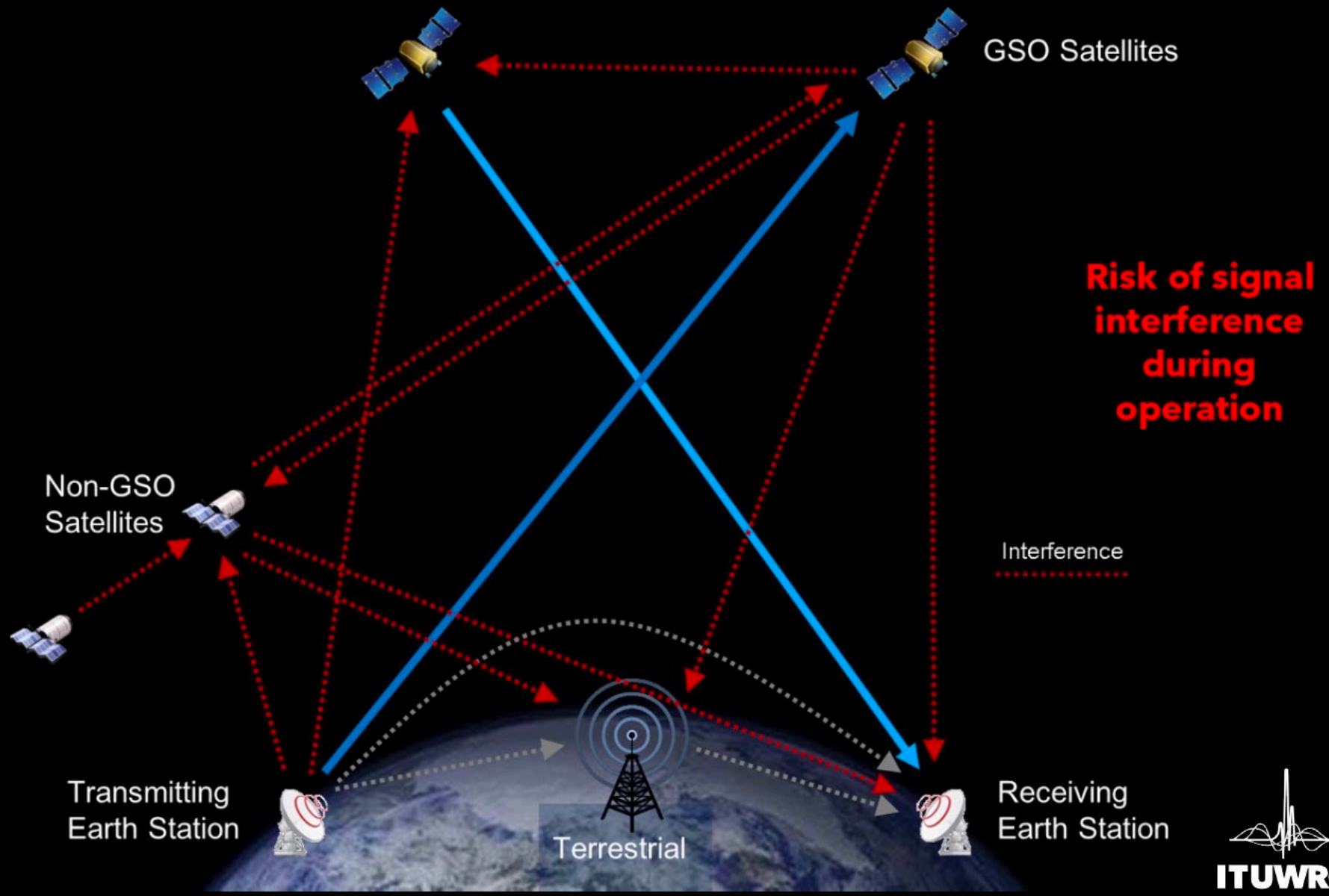
ITUWRC DUBAI 2023

Interference scenarios

Several degrees of service degradation and tolerance.

The global nature of coverage of space radiocommunications require mechanisms for interference prevention.

WRC-97 and **WRC-2000** established **sustainable principles** which enabled **protection of GSO** by the means of hard-limits and provided **coordination procedures between non-GSO systems**.



ITU PP-22

New and updated regulatory measures adopted by PP-22

Space Sustainability

Resolution 219 (Bucharest, 2022)
Sustainability of the radio-frequency spectrum and associated satellite-orbit resources used by space services

ITU-R Study Groups to carry out studies on:

- *the increasing use of spectrum and associated orbital resources in non-GSO orbits;*
- *the **long-term sustainability** of these resources; and*
- *the equitable access to the GSO and non-GSO orbit and spectrum.*

Space2030 Agenda

Resolution 218 (Bucharest, 2022)
ITU's role in the implementation of the "Space2030" Agenda: space as a driver of sustainable development, and its follow-up and review process

*Value of space technology and applications, as well as of space-derived data and information to support the achievement of the **Sustainable Development Goals**.*

Outer Space

Resolution 186 (Rev. Bucharest, 2022)
Strengthening the role of ITU with regard to transparency and confidence-building measures in outer space activities

Need to make available to administrations information related to satellite-monitoring facilities.

*ITU has signed many cooperation agreements on **Space Radio Monitoring Facilities** to have the detailed technical and administrative information online.*

Debris and the Radio Regulations

Satellite debris

Debris management
It is **not in the core mandate of the Radio Regulations**.
This is becoming an urgent issue.

ITU Master Register (MFIR)
ITU has a record in the Master Register of the satellites which are no longer in operation.

Radio frequency spectrum allocation
The allocation of radio frequency spectrum to radar systems to monitor the debris or the telecontrol to de-orbit the satellites is an ITU core activity.

Astronomy

Astronomers
Astronomers are another user community of the space.

ITU and radio astronomy
- ITU is working on the level of interference from the aggregate out-of-band emissions from large constellations.
- ITU is establishing radio quiet zones in locations with astronomy installations.

Thank you!

https://www.itu.int/
https://www.itu.int/en/ITU-R/Pages/default.aspx

sergio.buonomo@itu.int

ITUWRC

DAY 2

THURSDAY 8th JUNE 2023

VALUES

SESSION 8

RESPONSIBLE USE OF SPACE

Impact in Astronomy

SPEAKER

Piero Benvenuti

Director of the Protection of Dark and Quiet Skies from Satellite Constellations Interference, IAU

RESPONSIBLE USE OF SPACE

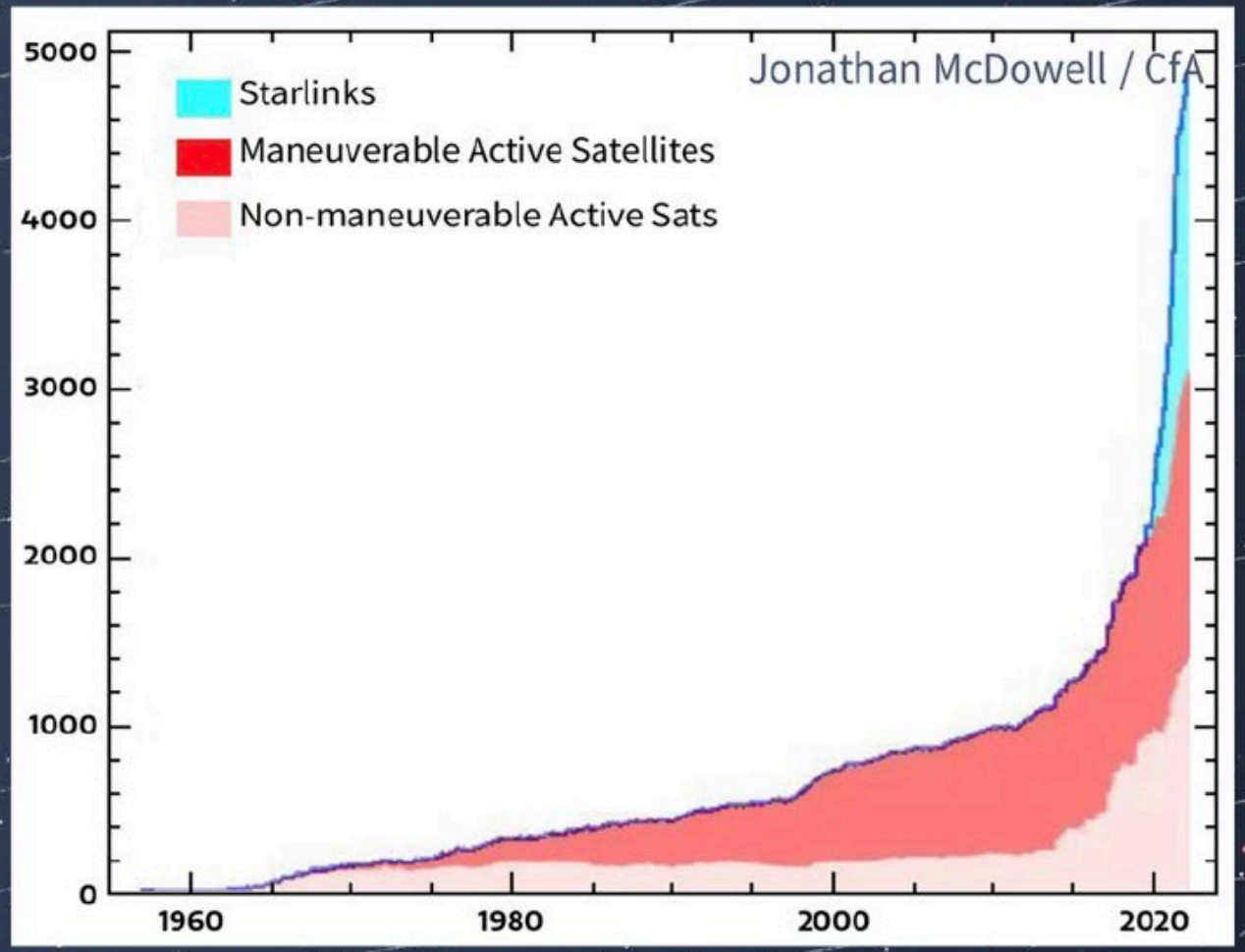
The impact on astronomy

Piero Benvenuti – IAU CPS

New Space Economy and a new Space era

- We are witnessing the beginning of a new era in the utilization of the space environment, especially of the Low Earth Orbits
- Private companies have reached the same, if not superior capabilities of the Space Agencies
- Differently from the latter, their objectives are not only technological progress, but mainly their profit.
- The most impacting (in positive and negative sense) of their programmes is the deployment of large constellations of communication satellites
- Great benefits for the society, but a threat to science and cultural heritage in the absence of adequate mitigation measures

The issue: the exponential increase in LEO satellites



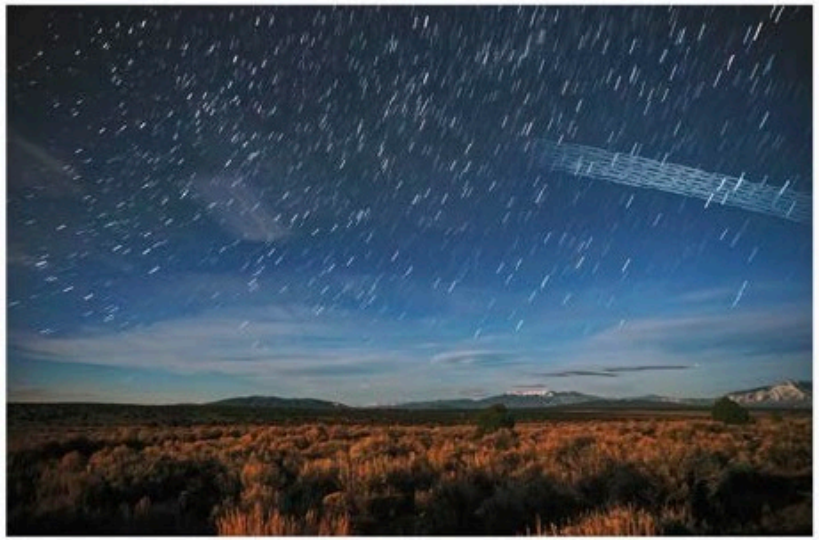
Satellite constellations

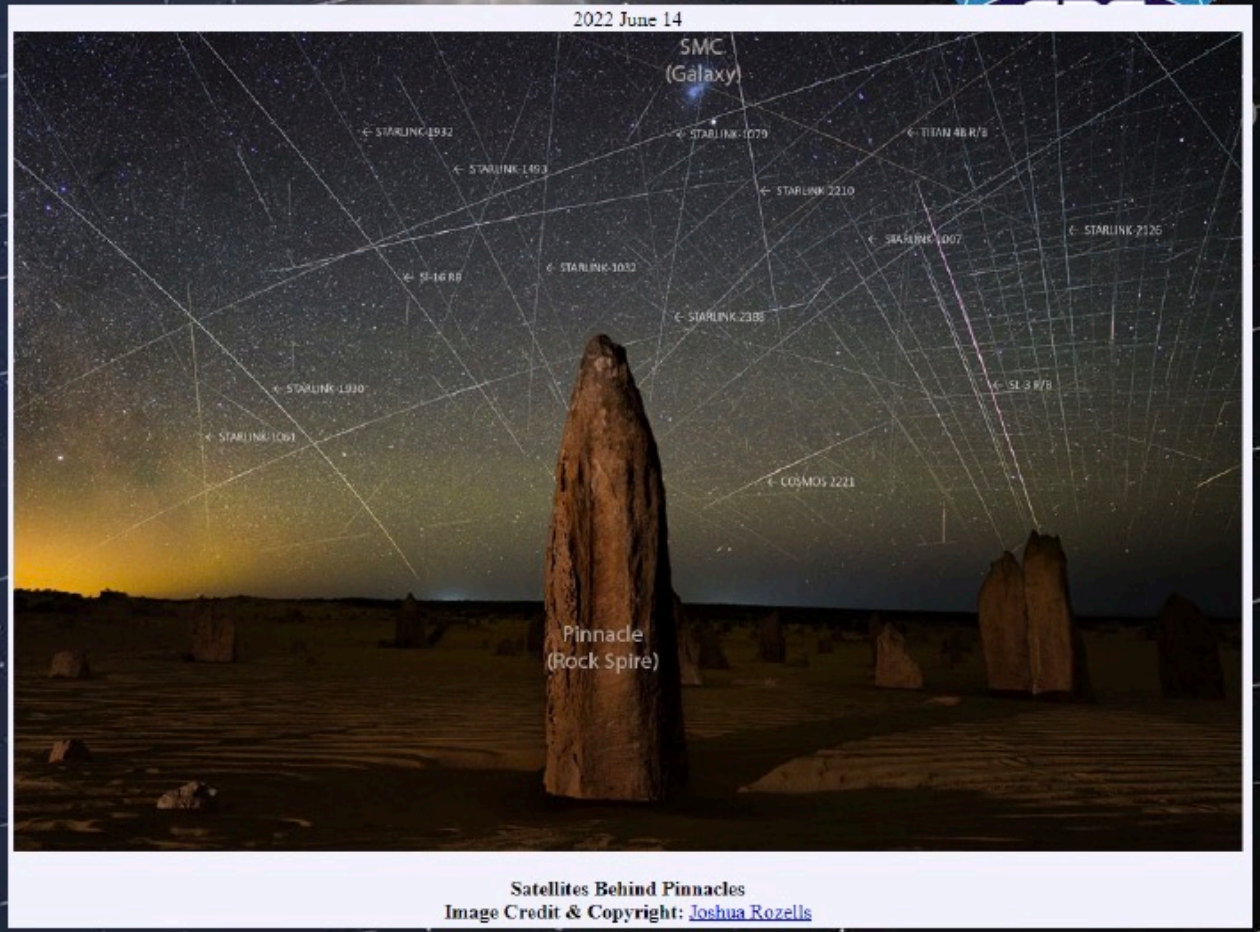
Constellation	Altitude (km)	Number of Sats Planned	Number Sats Operational
Starlink (SpaceX) Gen1, Apr2020 FCC Filing	540 - 570	4408	3508
Starlink (SpaceX) Gen2, Aug2021 FCC Filing	340 - 614	29988	0
OneWeb, Phase 1, 2021 revision	1200	716	612
OneWeb, Phase 2, 2021 revision	1200	6372	0
Amazon Kuiper	590 - 650	7774	0
Chinese Guangwang, 2021 revision	590 - 1145	12992	0
Galaxy Space (Yinhe)	500	1000	0
Hanwha Systems	500	2000	0
Lynk Global cellphone service constellation	500	2000	0
Astra (2021 V-band proposal)	380 - 700	13620	0
~~Boeing (2021 V-band proposal)~~	~~670 - 10000~~	~~132~~	~~0~~
Telesat Lightspeed (Canada) (2021 V-band proposal; reduced by 100 in 2022)	1015 -1325	1969	0
Hughes Network Systems HVNET (2021 V-band proposal)	1150	1440	0
Spin Launch/SN Space Systems (UK)	830	1190	0
Globalstar (Germany)	485-700	3080	0
E-SPACE Cinnamon-937 (Rwanda/G. Wyler)	528-638	337323	0
Total		**426004**	**4092**

- **Today**
  - 3000+ pre-const. LEO sat.
  - 4100 constellation satellites x2
  - Green: launched/in construction
- **In ~10 yr:**
  - ~70k-400k LEO Sat ?? x30-100
  - ~30+ constellations
- **Caveat**
  - Many file, few launch
  - Many changes…

Illuminated satellites can affect Optical Astronomy and the Night Sky

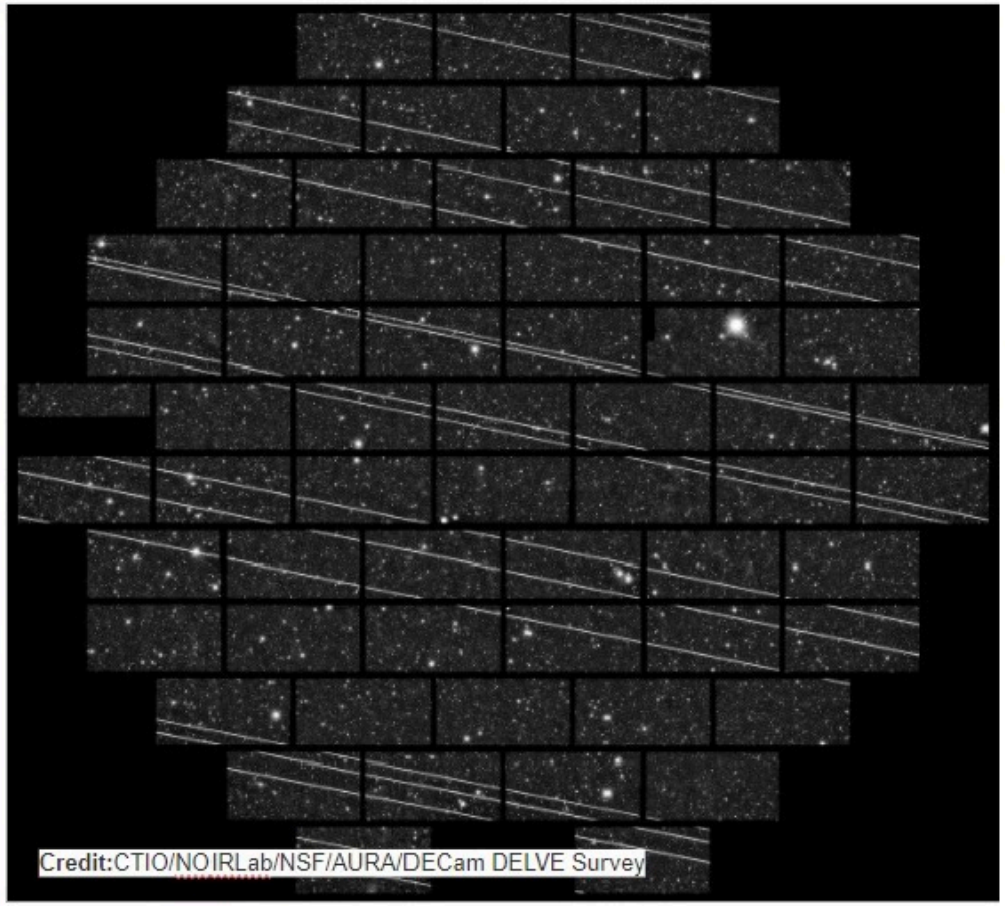
- Professional Astronomy
- Amateur Astronomy
- Stargazers
- Cultural heritage
- Nature
- Tourism

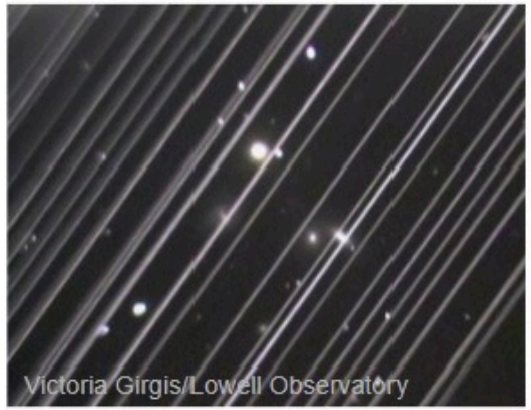


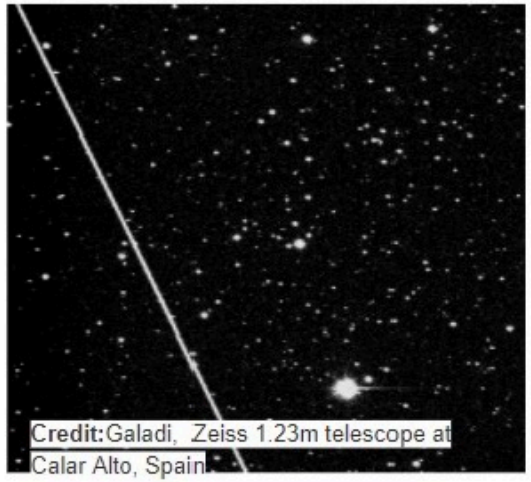


Satellites Behind Pinnacles
Image Credit & Copyright: Joshua Rozells

The impact on optical astronomy



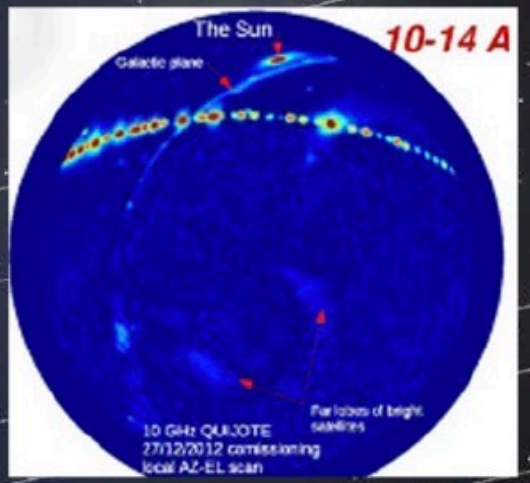


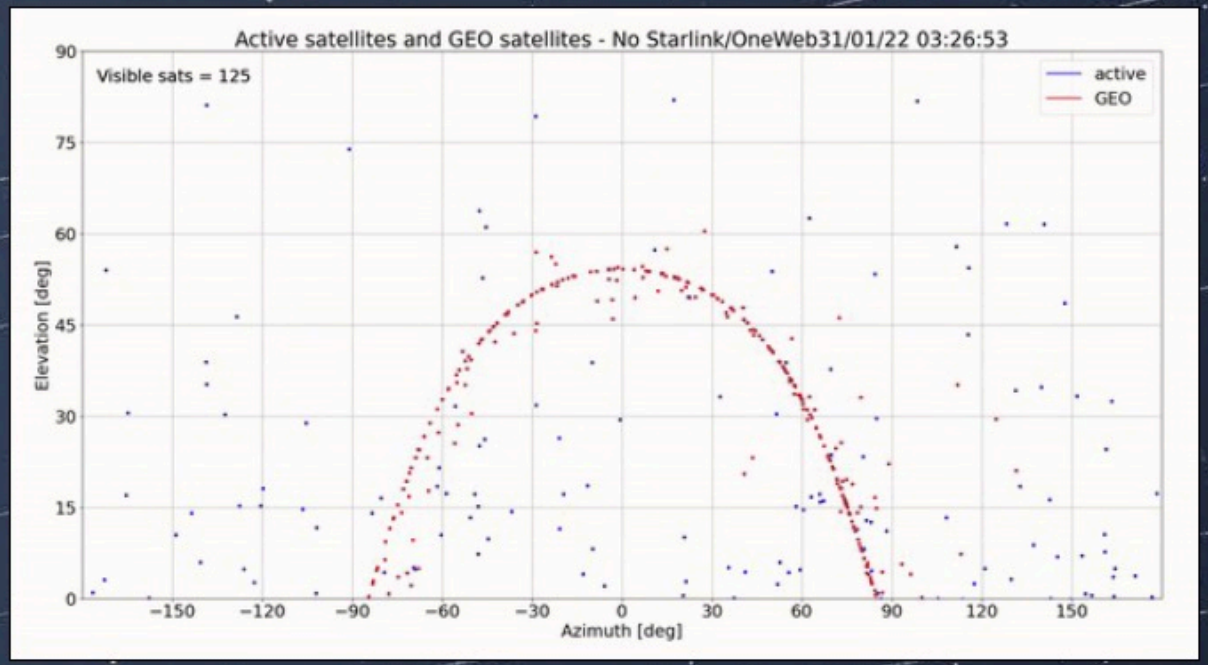


- Narrow field : ~% - ~10% frames affected at twilight
- Wide-field: 50% of frames - *several satellites per frame* at twilight
- Super-Wide-field on large telescope: Vera Rubin Observatory
  - all frames affected at twilight (tens of trails),
  - many frames affected during whole summer night by high-altitude satellites.
  - many frames **ruined** at twilight

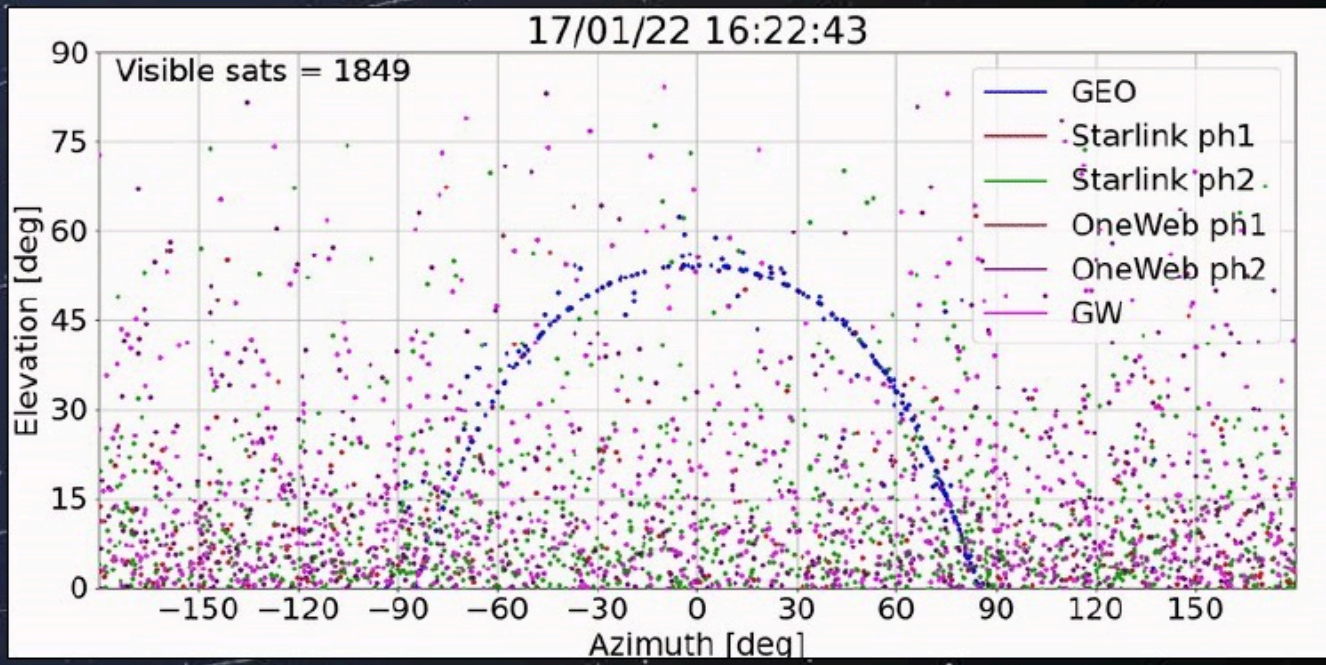
The impact on radio astronomy

- Satellites are not a new thing
- Before there were not many in LEO and many located in the GEO orbit
- Situation is drastically changing!





Before megaconstellations



Megaconstellations deployed

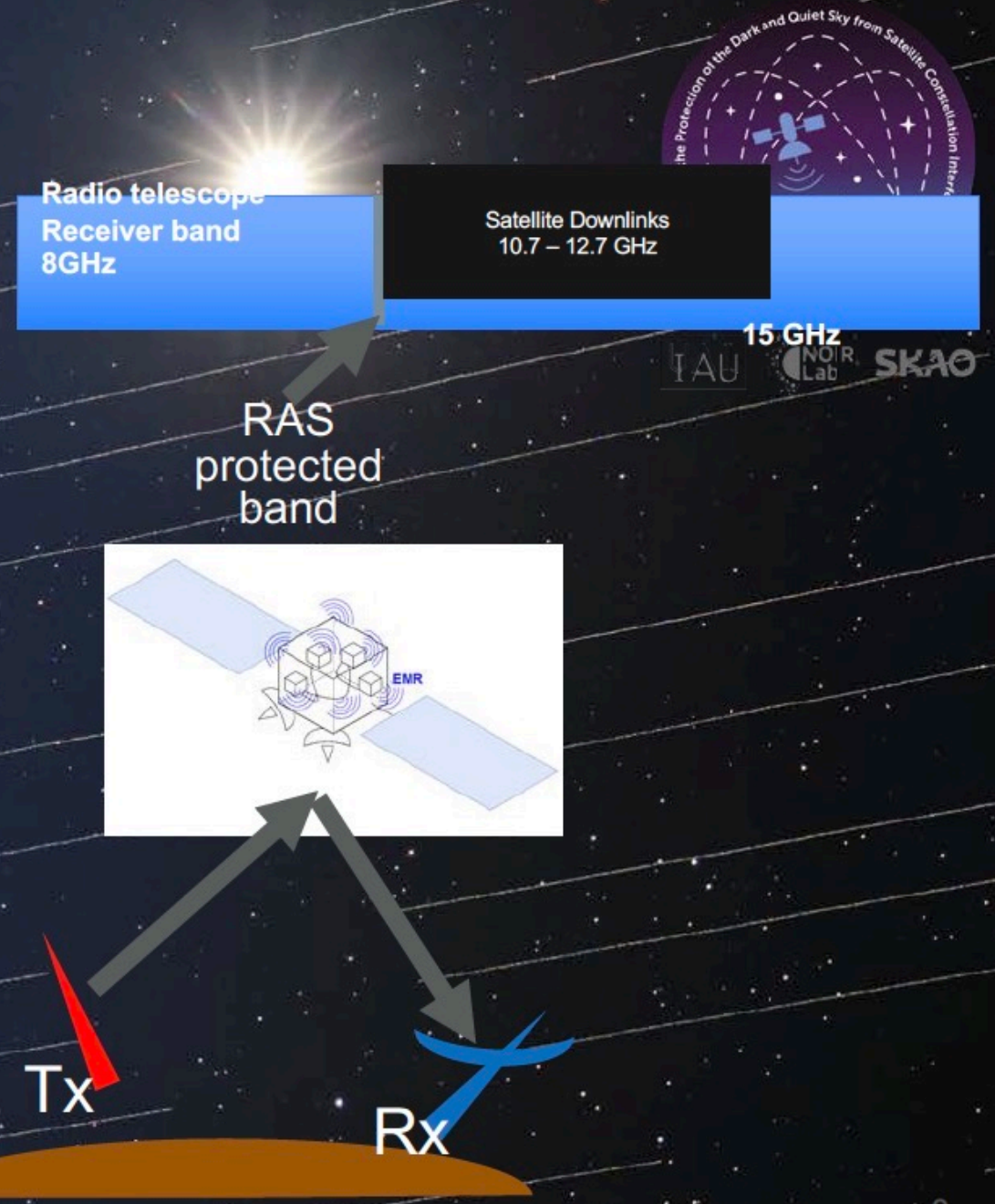
Types of radio interference

I. Interference into wideband observations

II. Interference into RAS protected bands

III. Unintentional electromagnetic radiation from satellites

IV. Reflections of ground transmissions



Is mitigation possible?

The answer is yes, if at least the following 3 goals are met:

1. The apparent luminosity of the satellites is reduced so that only a small fraction of the constellation is visible to the naked eye (technologically quite challenging)

2. The accurate real-time position of **all the satellites** is made available (possible with the agreement/cooperation of the operating companies)

3. The radio emission by the satellites is switched off in the proximity of the large radio-astronomical observatories (possible with the agreement/cooperation of the operating companies)

The IAU Center (CPS) is pursuing these goals in close cooperation with all stakeholders, but the UN COPUOS and the ITU would be instrumental in promoting them at international level as voluntary actions

Dark & Quiet Sky has reached high visibility

"We recognize the importance of continued discussion, in the UN COPUOS and International Telecommunications Union (ITU) frameworks, as well as with the International Astronomical Union (IAU) on the impact of large constellations of satellites on astronomy for the protection of the dark and quiet sky."

Summit of the G7 Science and Technology Ministers

"Acknowledges that the effects of light pollution and electromagnetic interference in particular from satellite constellations must be taken into consideration and mitigation measures put in place to minimise negative impacts on astronomical observations and research worldwide; Welcomes the efforts of the United Nations Committee on the Peaceful Use of Outer Space (UN COPUOS) in this regard;"

European Council on "Fair and sustainable use of space" Document

STSC & COPUOS

- 59th STSC (2022): WP (Austria, Chile, Dominican Republic, Slovakia, Spain, IAU, ESO, SKAO
  - Astronomy was declared instrumental to all space activities, its protection is within the COPUOS remit
  - The constellations' impact is serious and requires the cooperation of all stakeholders
- 60th STSC (2023): CRP (Chile, Spain, Slovakia, Bulgaria, Dominican Republic, Peru, South Africa, IAU, ESO and SKAO)
  - Keeping the D&Q_S Agenda Item for a minimum of 3 more years
  - Creation of a COPUOS Expert Group on D&Q_S
- 66Th COPUOS (2023): Decision TBC
- Independently of the final decision, the CPS will continue its actions and the IAU will regularly report its achievements and difficulties to the STSC and COPUOS

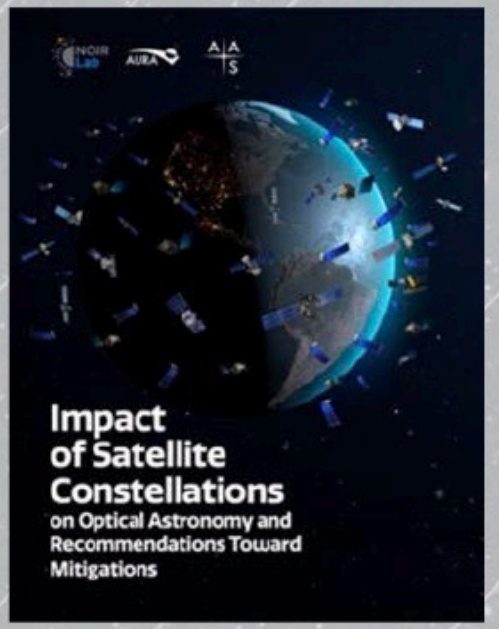
Available documentation

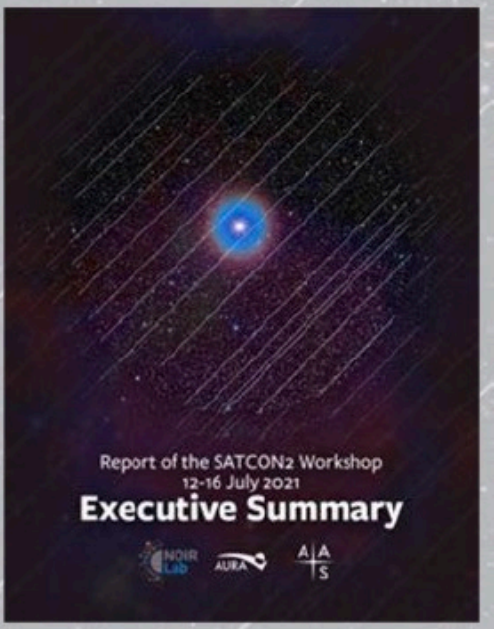
https://cps.iau.org/further-reading/

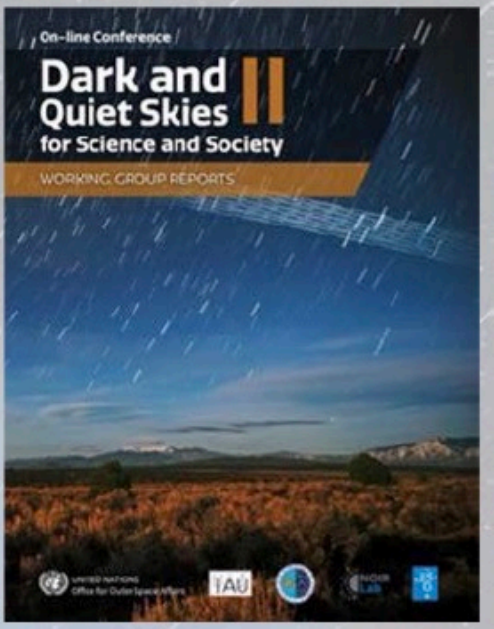
2020: Identify the issues; formulate recommendations for mitigation: SATCON1, Dark & Quiet Skies I

2021: Identify the pathways to implement recommendations: SATCON2, Dark & Quiet Skies II

2022: *IAU Centre on the Protection of the Dark & Quiet Sky from Satellite Constellation Interference* (IAU CPS)
https://cps.iau.org







DAY 2

THURSDAY 8th JUNE 2023

VALUES

SESSION 8

RESPONSIBLE USE OF SPACE

Sustainable Space Systems

INTERVIEWEE

Greg Wyler

Founder & CEO, E-Space

DAY 2

THURSDAY 8th JUNE 2023

VALUES

SESSION 8

RESPONSIBLE USE OF SPACE

Ethics orbiting Near-Earth Space Environment

SPEAKER

Jacques Arnould

Expert éthique, CNES

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