Finnish Centre of Excellence in Research of Sustainable Space

FORESAIL (2018 – 2025)

Director: Prof. Minna Palmroth, University of Helsinki

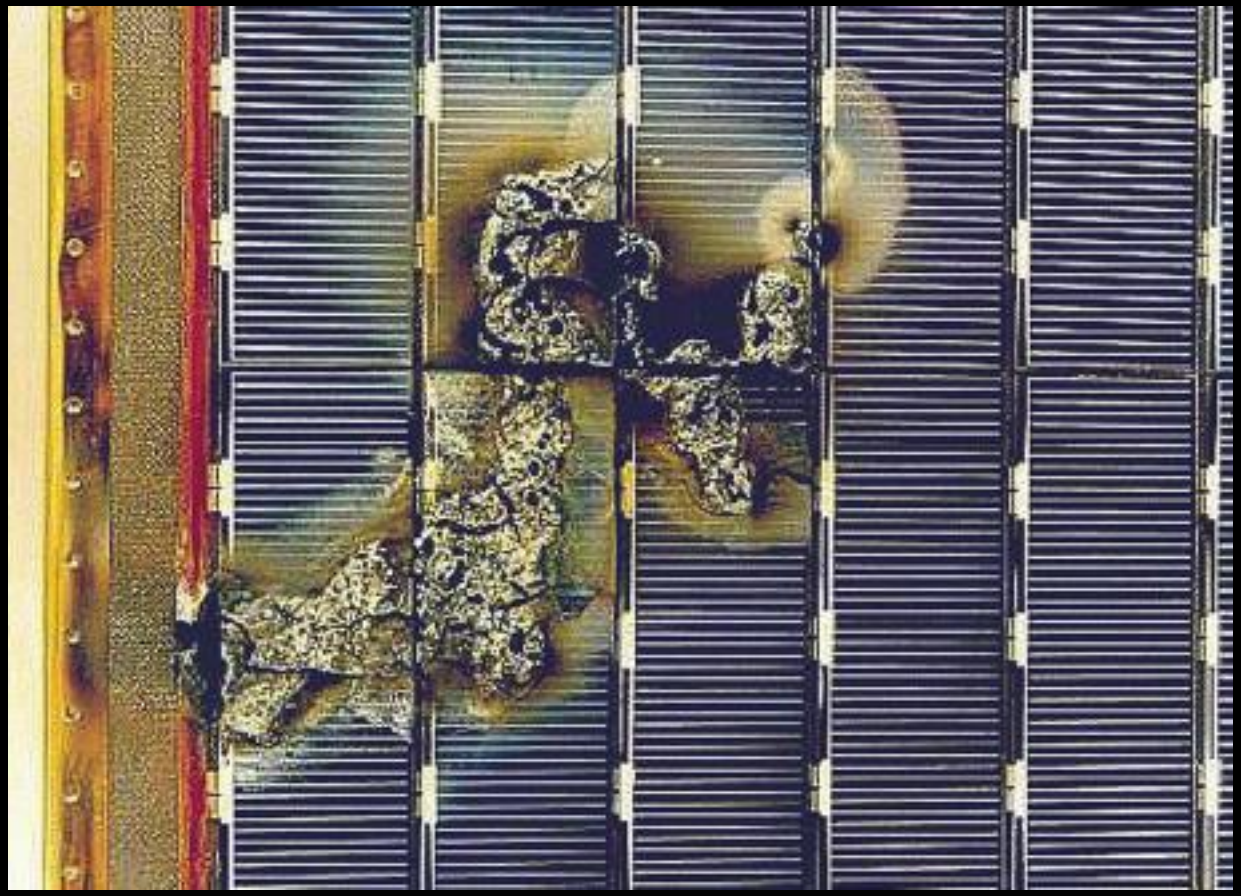
Consortium: Rami Vainio, University of Turku
Emilia Kilpua, University of Helsinki
Jaan Praks, Aalto University
Pekka Janhunen, Finnish Meteorological Institute

Background

Image: NASA

Image: ESA/ Nasa

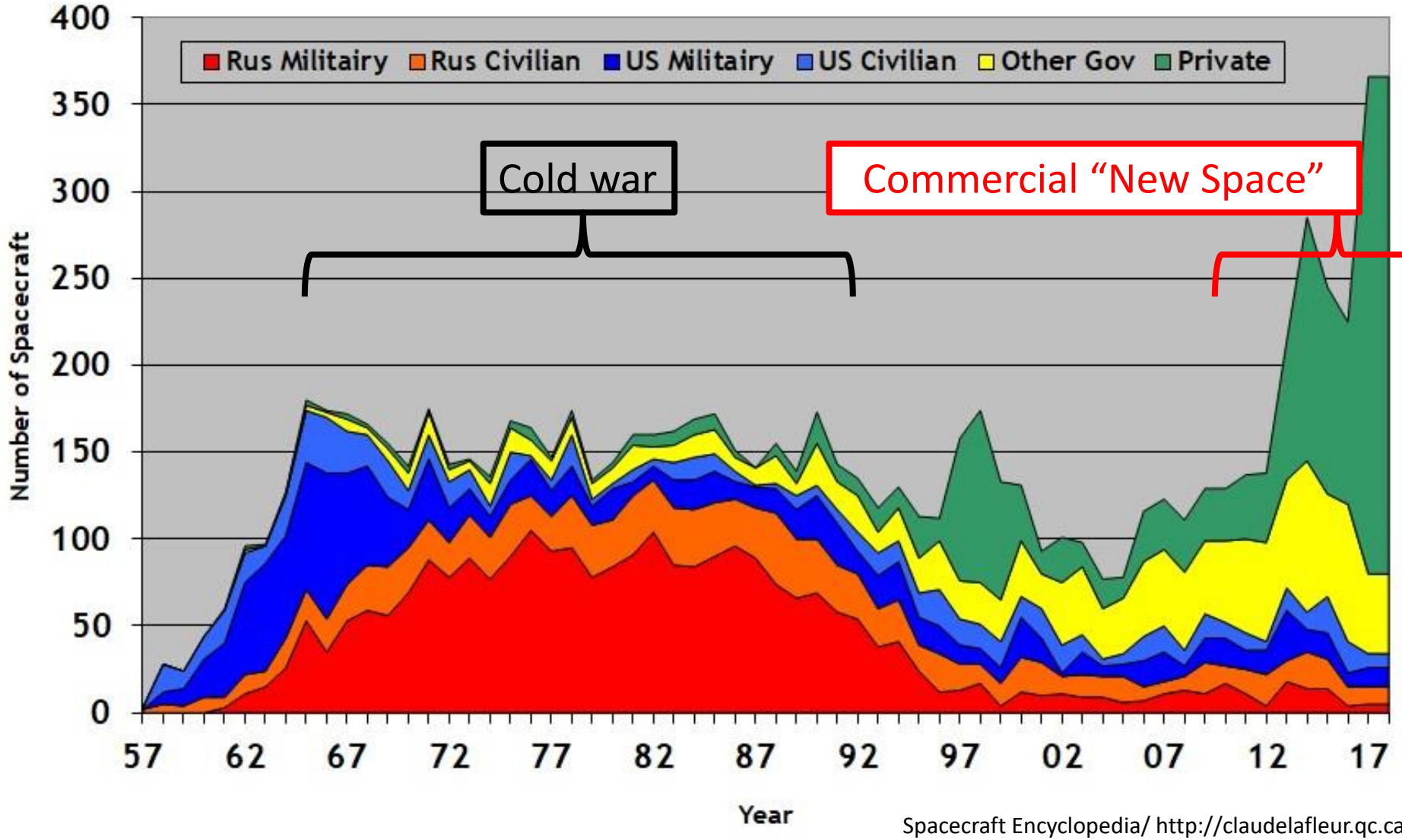
Space is a harsh radiation environment



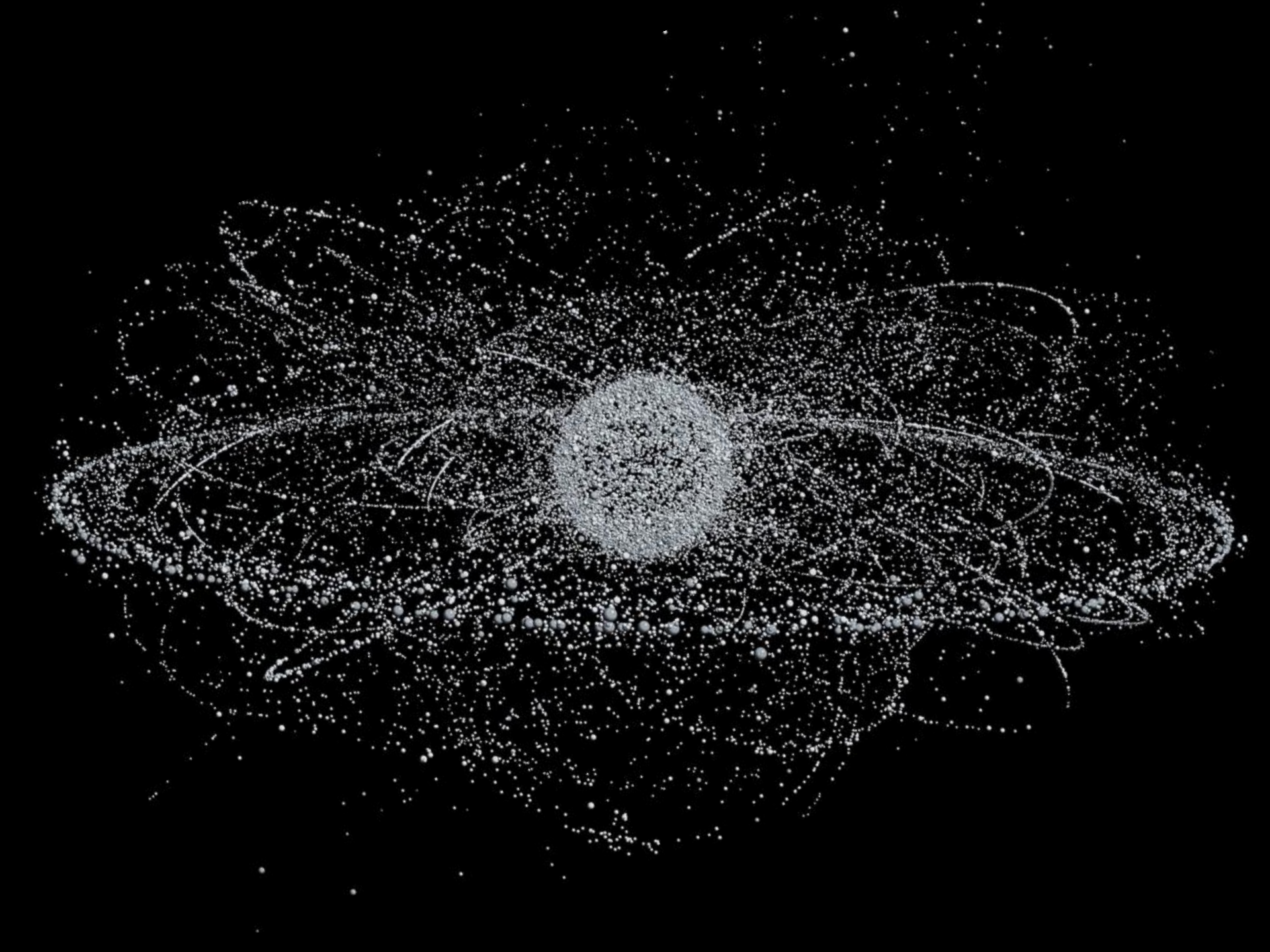
ESA EURECA satellite solar array sustained arc damage.
Credits: ESA

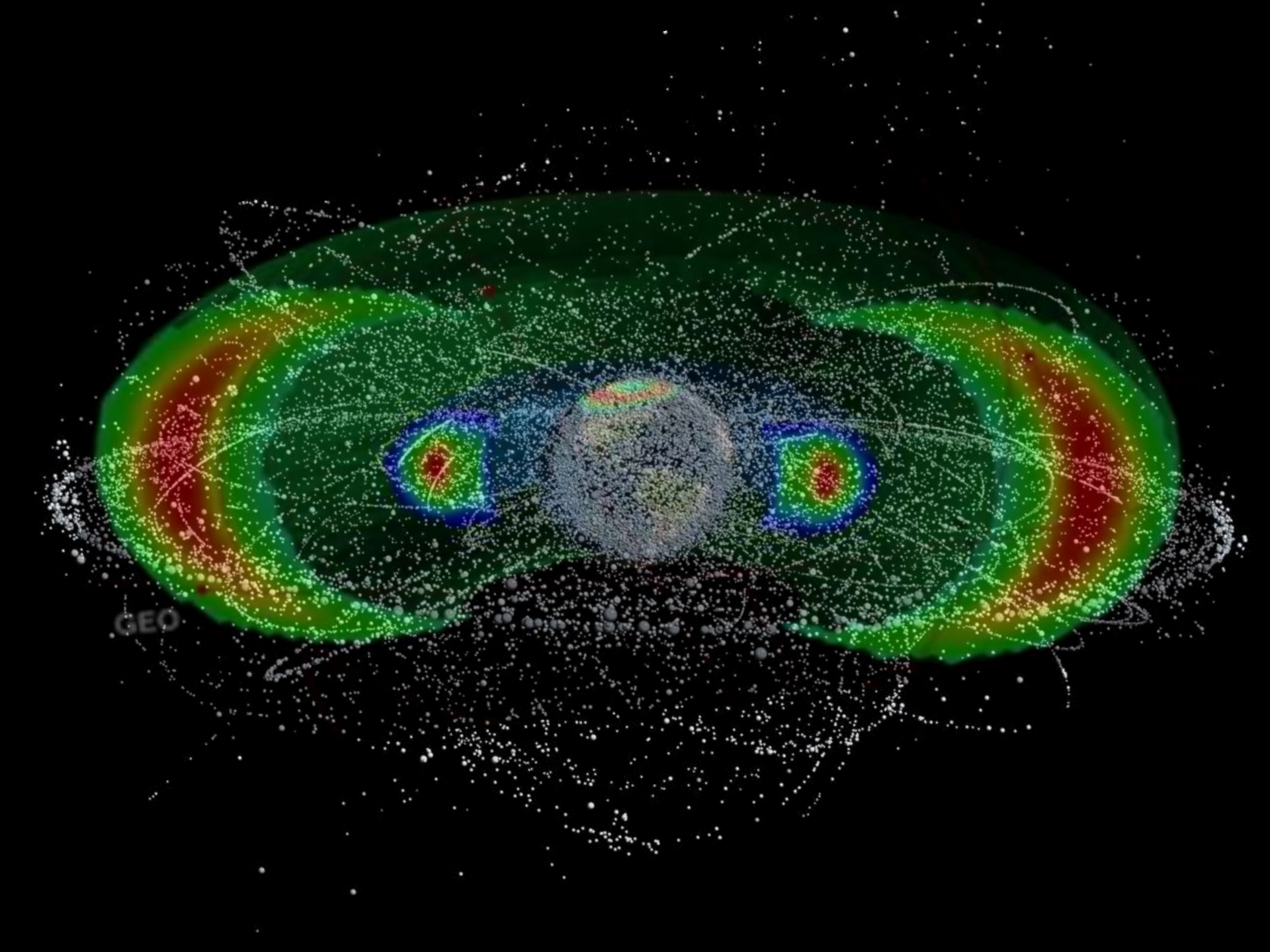
Emerging megatrend

Number of all spacecraft launches



Spacecraft Encyclopedia/ http://claudelafleur.qc.ca




GEO

Genes behind embryonic aneuploidy *pp. 180 & 235*

Closing the Central American Seaway early *pp. 186 & 226*

Chemical imaging of membrane lipids *p. 211*

Science

$10
10 APRIL 2015
sciencemag.org

AAAS

CubeSats take flight

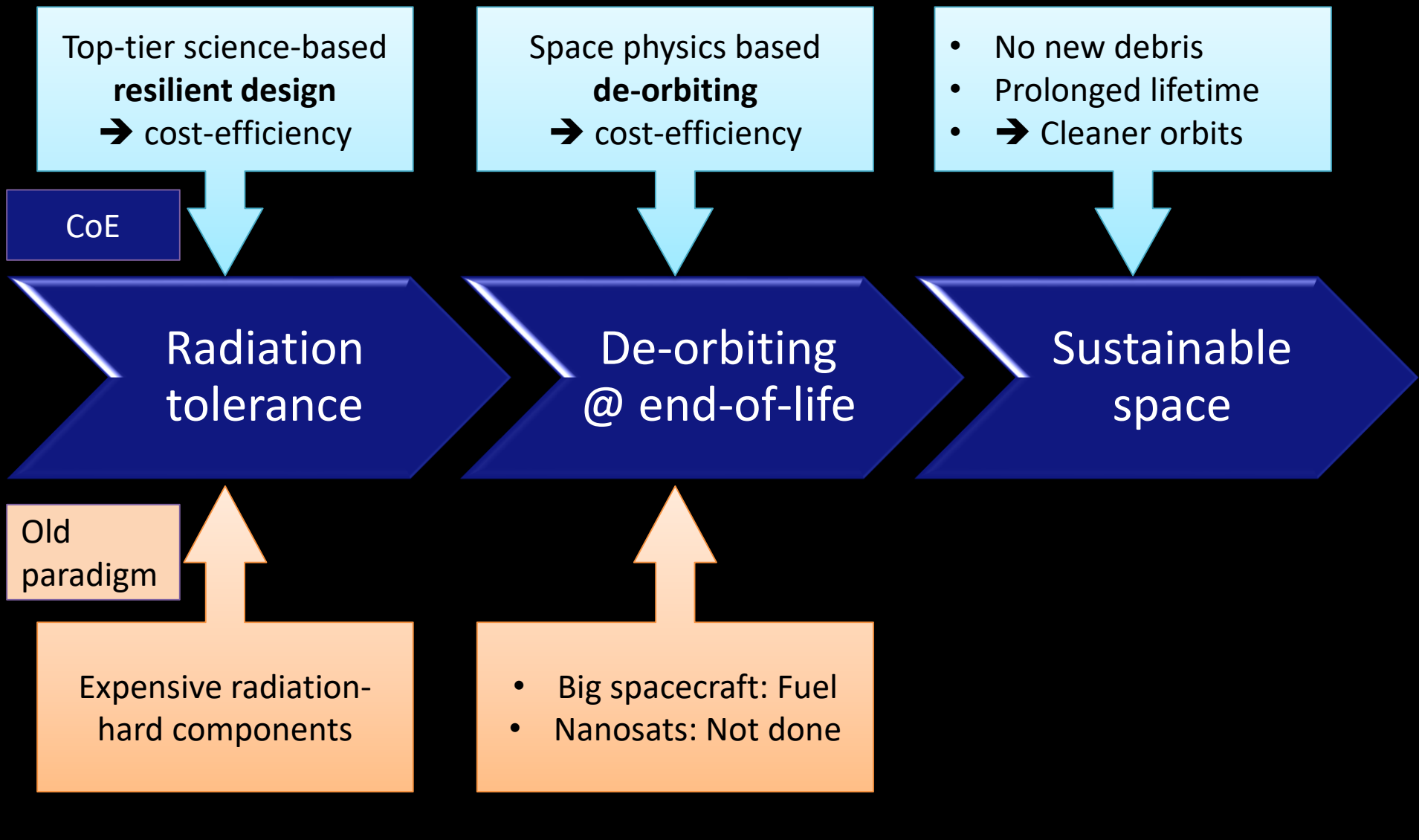
Cheap, miniature satellites democratize space *p. 172*

Finnish Centre of Excellence in Research of Sustainable Space – our strategy

Number of space objects 1957 - 2015

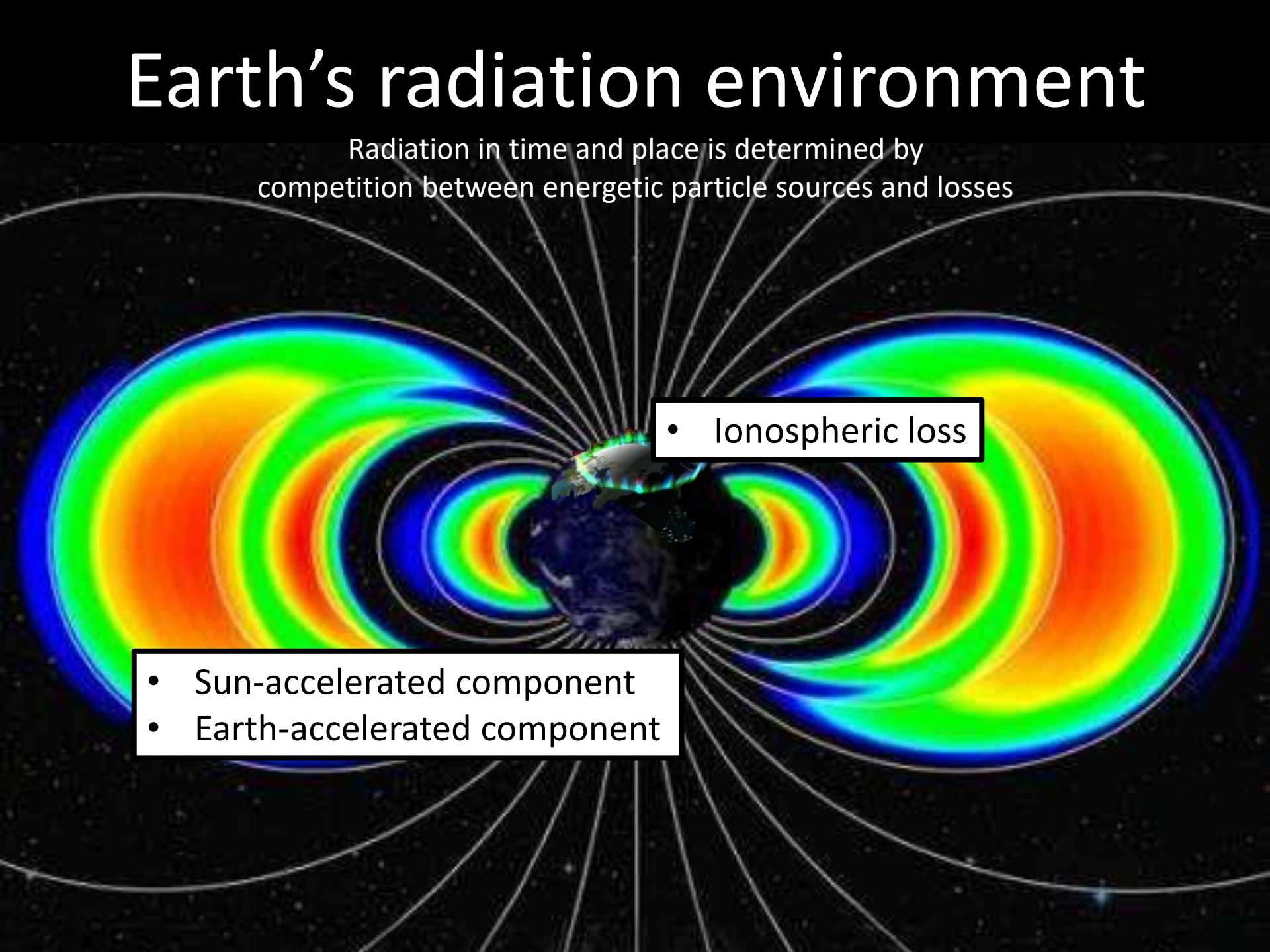
Courtesy: Stuart Grey, YouTube

Our Strategy



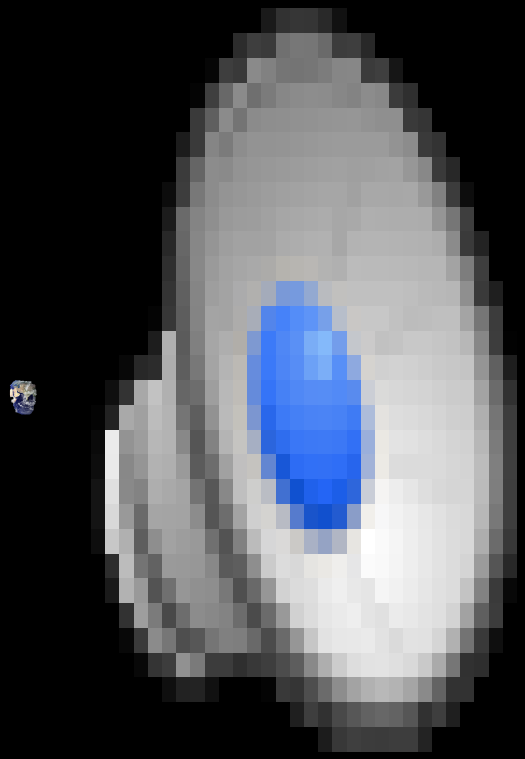
Earth's radiation environment

Radiation in time and place is determined by
competition between energetic particle sources and losses



- Ionospheric loss

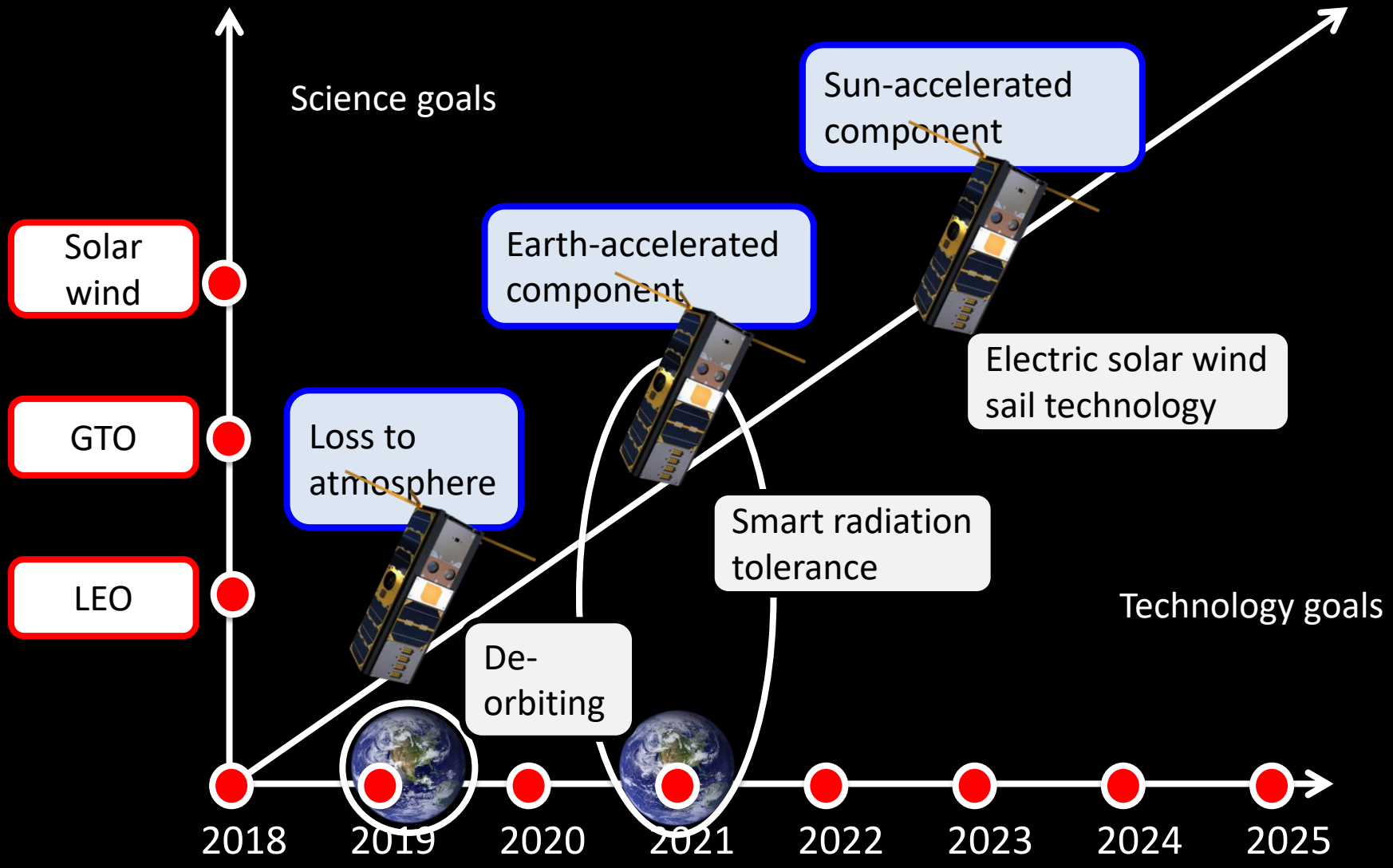
- Sun-accelerated component
- Earth-accelerated component



VLASIATOR

*E.g., Mann [*Nature* 2016]; Breneman [*Nature* 2015]; Su [*Nature* 2015]; Brito [GRL 2012]

Our Programme



Technology

Technology

Aalto nanosatellite laboratory

Platforms

RADMON instrument UT space lab

Instruments

Tether close-up FMI space lab

Propulsion

Intelligent radiation shielding

We have previously developed expertise in terrestrial IoT and safety applications

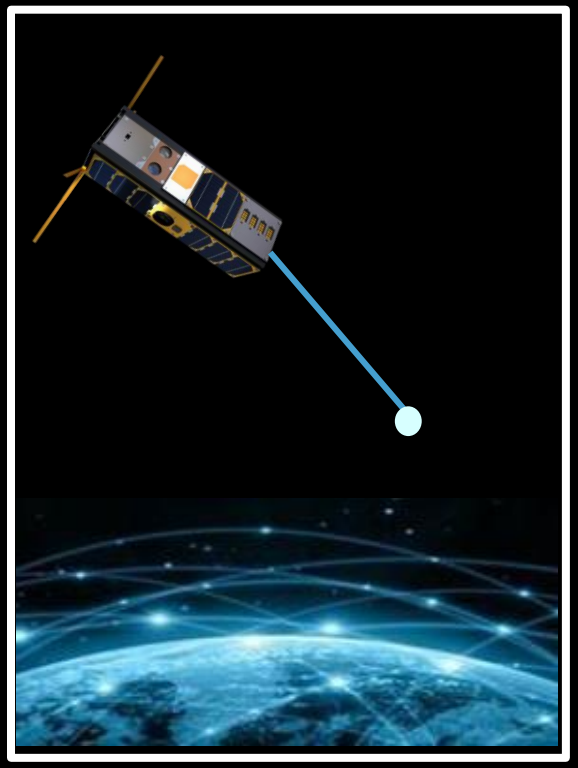
➔ We will apply to space hardware (spin-in)

Currently widely used "*radiation hard"* hardware requires special engineering and is largely not carried out in Europe

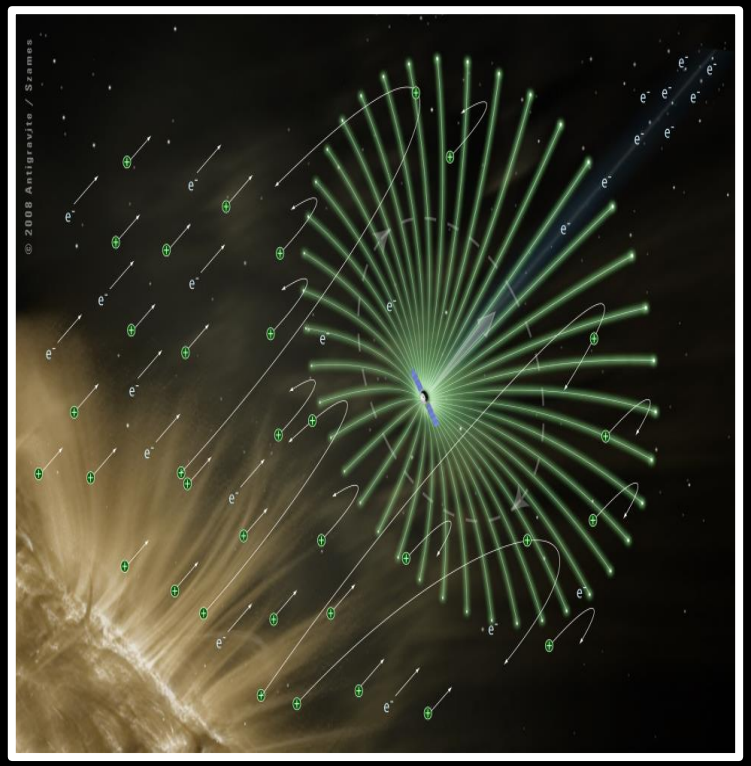
➔ We enable European new technology development in cost-efficient software-based resilience

New debris removal

Coulomb drag devices



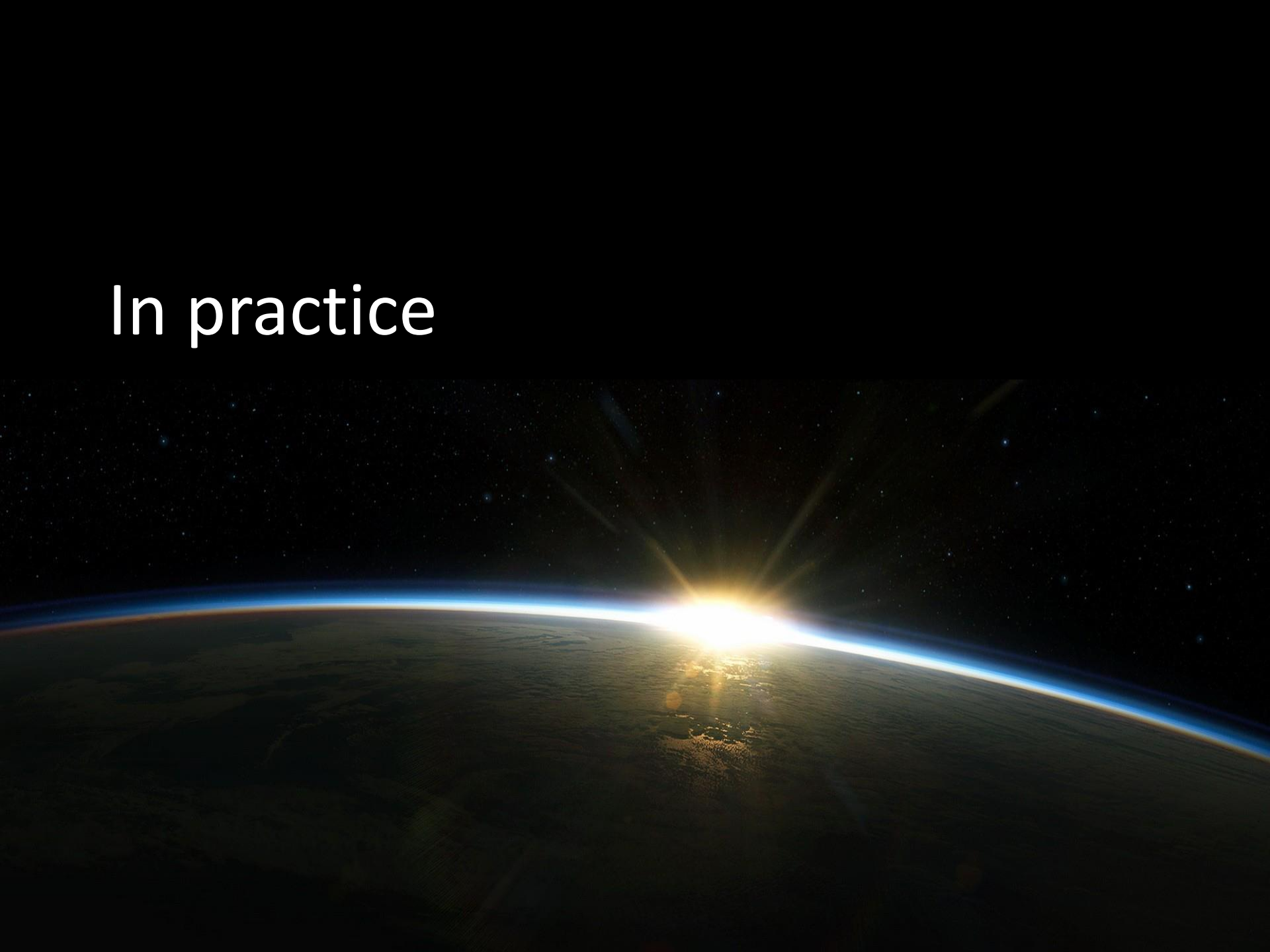
Plasma brake for satellite deorbiting



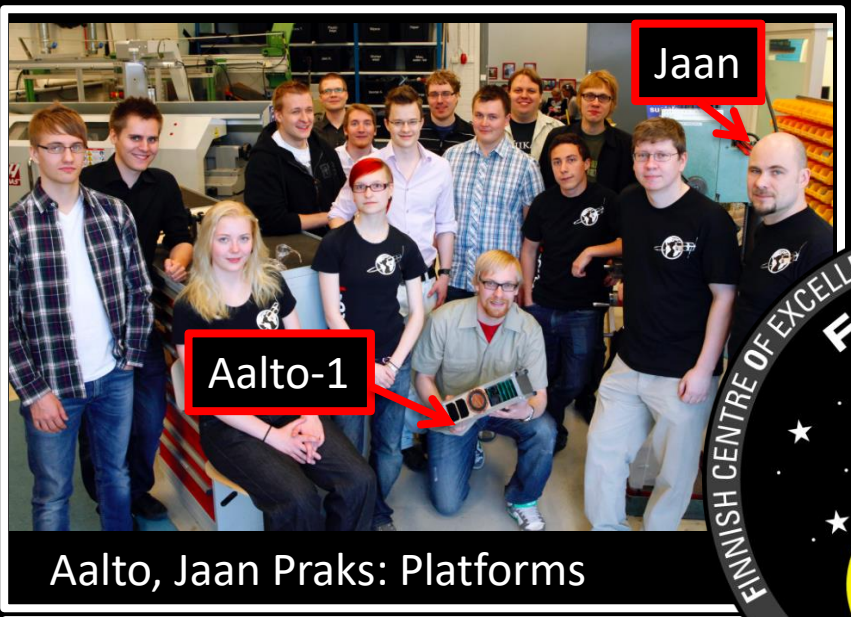
Electric solar wind sail (E-sail): Spacecraft thrust from solar wind momentum

http://www.electric-sailing.fi

In practice

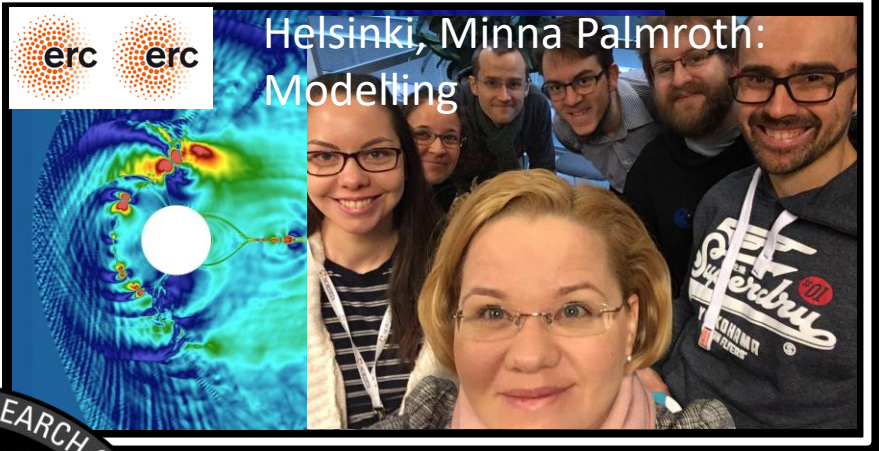


Who we are



Aalto, Jaan Praks: Platforms

FINNISH CENTRE OF EXCELLENCE IN RESEARCH OF SUSTAINABLE SPACE
FORESAIL
TECHNOLOGY
SCIENCE
SOCIETY



Helsinki, Minna Palmroth: Modelling

Helsinki, Emilia Kilpua: Observations

Turku, Rami Vainio: Instruments

Finnish Met. Inst.Pekka Janhunen: Propulsion

Centre as a whole

Sustainable science

VLASIATOR

Sustainable technologies

Aalto-1

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FORESAIL

TECHNOLOGY

SCIENCE

SOCIETY

Sustainable applications

Impact

Science

- Holistic understanding of radiation environment
- Science based on nanosatellites

Economy

- Competitive advantage
- New industry sector
- New market potential

Society

- Orbit safety
- Space weather
- Education meeting new market demands