



2018 SPACE DEBRIS ACTIVITIES IN FRANCE : HIGHLIGHTS

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Space Debris : a CNES top priority



COOPERATION

- France actively supports international groups in charge of establishing best practices, guidelines and standards :
 - ❖ ECSS
 - ❖ ISO
 - ❖ UN COPUOS
 - ❖ IADC
 - ❖ ...
- France advises states which aim to promote a space law by sharing its experience and feedback
- Cooperation frameworks on surveillance and technology blocks

SURVEILLANCE : collision risk monitoring

- ❖ CNES operational service called **CAESAR** (Conjunction Analysis and Evaluation, Assessment and Recommendations) :
 - 106 satellites worldwide use CAESAR through EU-SST services

	LEO 2018	MEO 2018	GEO 2018
Satellites monitored	26	30	50
Close approach alert	25	2	8
Additional tracking request	10	0	5
Effective collision avoidance maneuvers	15	0	2



- ❖ Improving conjunction analysis methods
 - Improvement of collision probability algorithms
 - Improvement of cataloguing algorithms
 - Developpement of new planning/scheduling algorithms

SURVEILLANCE : 2018 Re-entries followed by France

French objects

Re-entry date	Norad	International	Name	Launch	Incl. (deg.)	Radius (m) / Mass (t)
03/02/2018	N33753	2009-008E	Ariane 5 Deb (Sylda)*	12/02/2009	1.89	5.6 / 0.4
27/02/2018	N37395	2011-016D	Ariane 5 Deb (Sylda)*	22/04/2011	5.49	5.6 / 0.4
05/03/2018	N24754	1979-104C	Ariane 1 Deb	24/12/1979	17.57	NC / NC
03/04/2018	N31309	2007-016D	Ariane 5 Deb (Sylda)	04/05/2007	5.74	5.6 / 0.4
28/10/2018	N37267	2010-070D	Ariane 5 Deb (Sylda)	29/12/2010	3.07	5.6 / 0.4
06/11/2018	N27674	1991-075K	Ariane 44L Deb	29/10/1991	7.37	NC / NC

Foreign objects

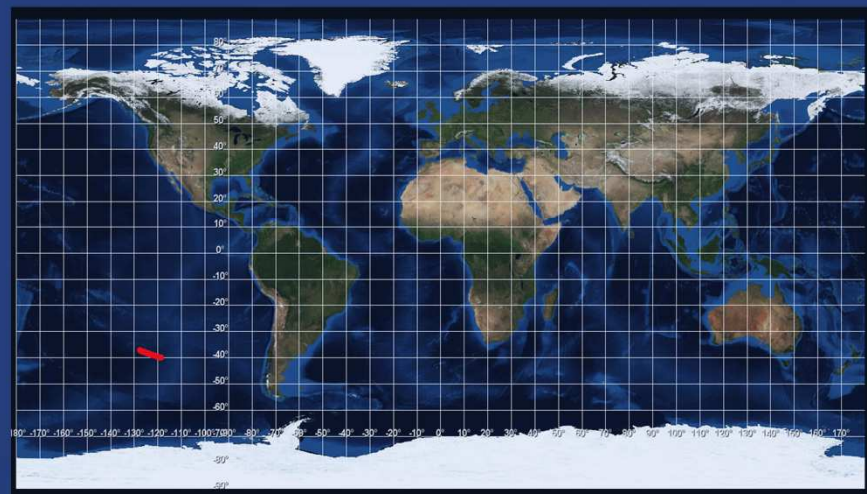
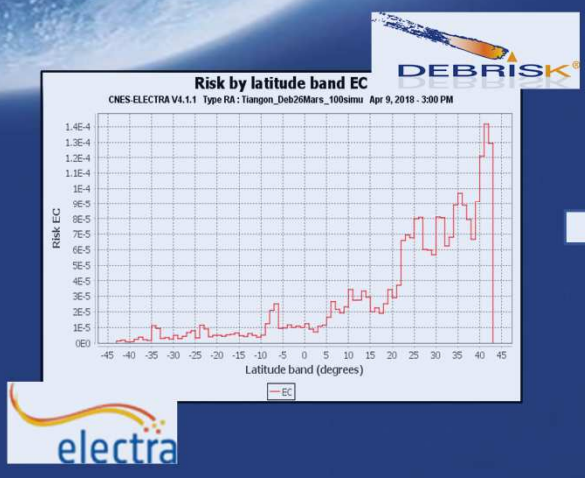
Re-entry date	Norad	International	Name	Launch	Incl. (deg.)	Radius (m) / Mass (t)
11/02/2018	N25039	1997-069A	Iridium 43 (US)*	09/11/1997	86.35	4.7 / 0.7
02/04/2018	N37820	2011-053A	Tiangong-1 (PRC)*	29/09/2011	42.74	8.5 / 6.6

SURVEILLANCE : TIANGONG Re-entry IADC Campaign

ANALYSING

SAFETY

TRACKING



SPACE-TRACK



Inter-Agency Space Debris Coordination Committee



TECHNOLOGY : Tech4SpaceCare

Tech4SpaceCare Initiative aiming to develop technological elements to ensure the **sustainable** use of space and the **safety** of space operations in synergy with **CleanSpace** ESA activities

Re-entry Safety

Modeling

Fragmentation, Mechanical stress, Wind tunnel, tools

Design for Demise

Testing, Advanced Studies, materials

Reentry Observation

GSTP support, advanced studies, International cooperation for reentry observation

Impact on environment

Toxicity, hazardous materials

Space Sustainability

End of Life

Post Mission Disposal , Reliability, Autonomous desorbitation, ADR Compatibility & Maturity, Passivation Systems, tools

Mission extension

Health Monitoring & Machine Learning, EOL decision

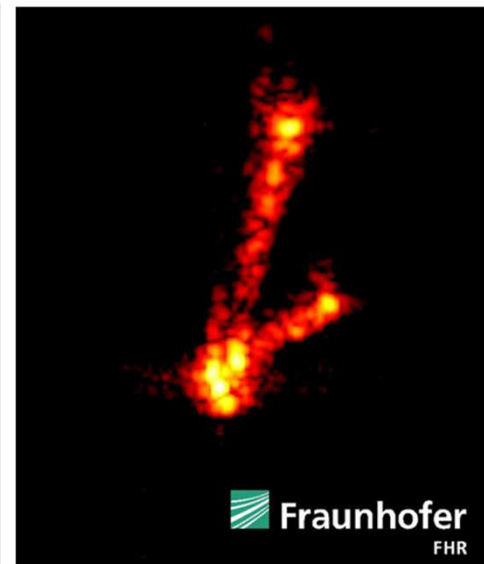
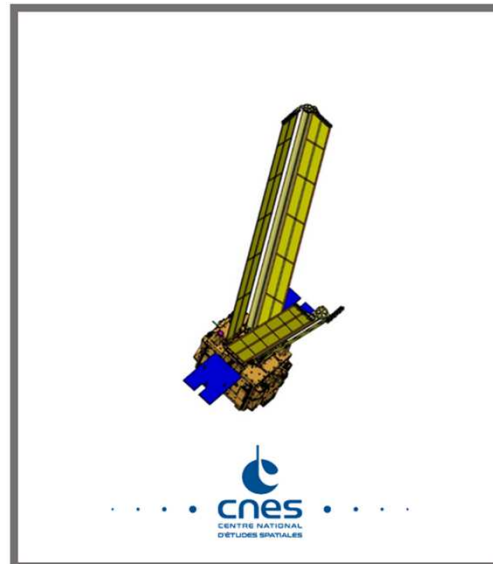
Protection/Vulnerability

Hypervelocity impact, debris generation, MMOD protection, pressurized tanks, Battery

TECHNOLOGY : MICROSCOPE DRAG SAIL DEPLOYMENT in Oct 2018

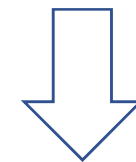
IDEAS : Innovation DEorbiting Aerobraking System:

- 2 inflatable beams (4m70, $\text{Ø} = 0,16 \text{ m}$)
- 4 sails providing 9 m^2 additional surface
- Total mass : 17 kg



Natural decay

70 yrs



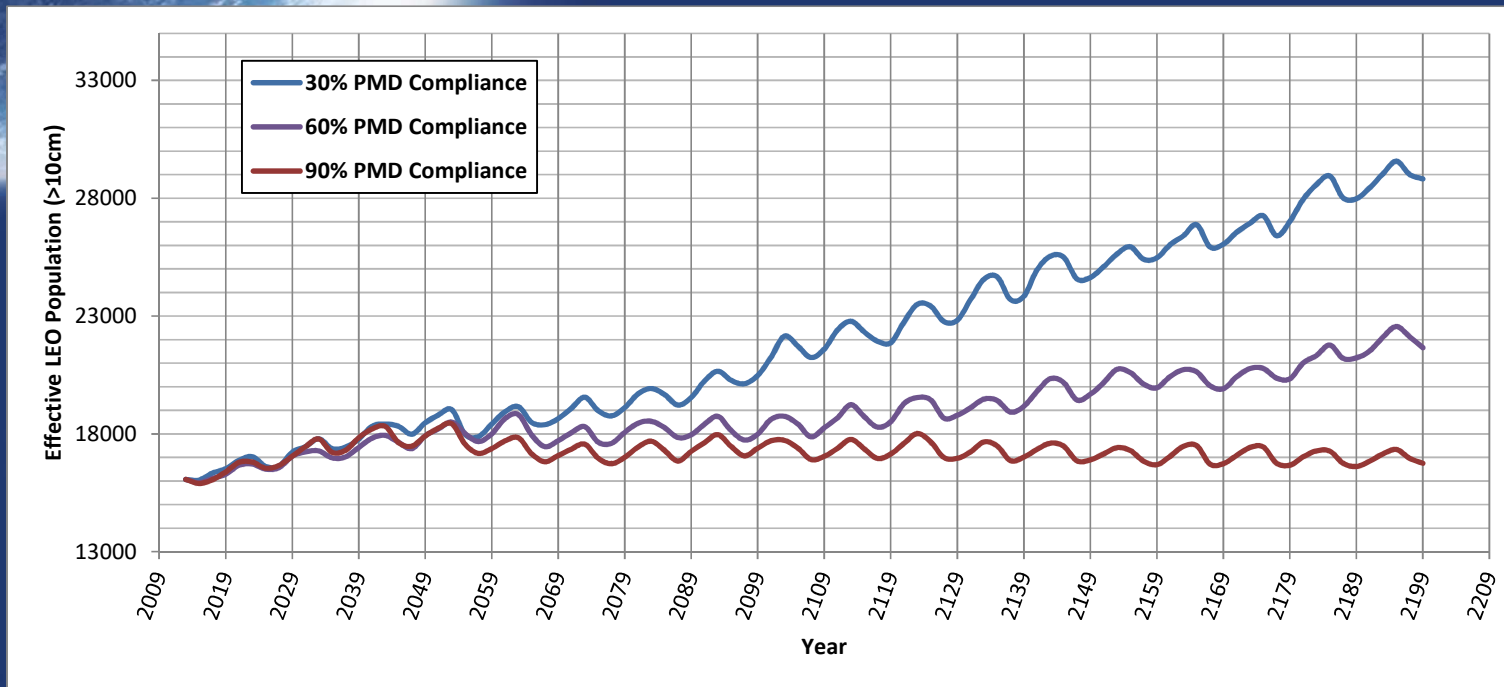
25 yrs

Satellite MICROSCOPE du CNES avec ses 2 ailes de désorbitation déployées (17/10/2018)
Modèle CAO (à gauche) et image radar capturée par le système TIRA du Fraunhofer Institute (à droite)

MITIGATION : Licences under French Space Law



MITIGATION: to invert debris increase trend

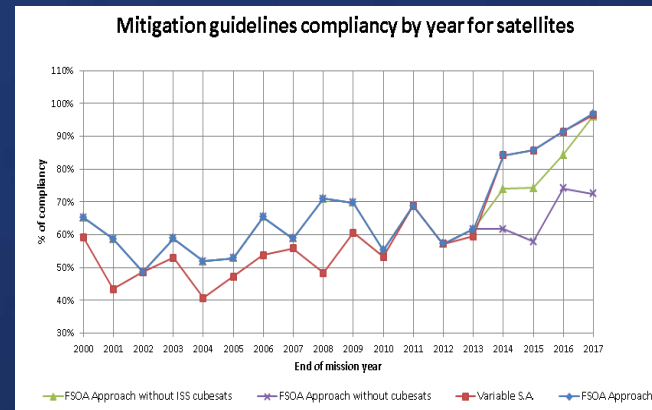
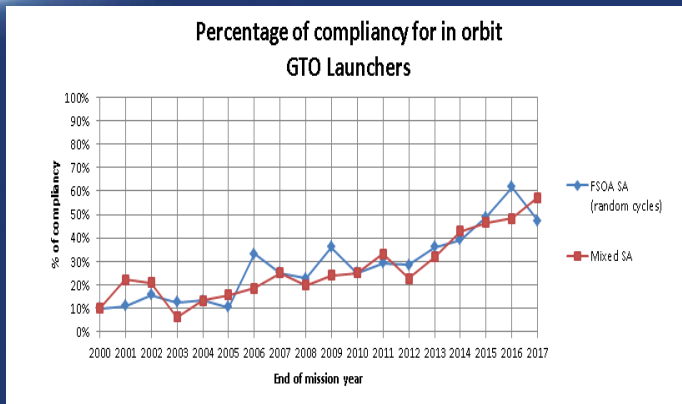


90 % of satellite and rocket bodies should perform Post Mission Disposal

Space debris evolution for the next 200 years vs Post mission disposal compliance

MITIGATION : deorbitation compliancy

- French law technical regulation criteria
 - Leave LEO protected zone in less than 25 years after EOL
 - Free GEO protected zone during 100 Yrs after EOL



50 % worldwide launchers compliant in 2017

72 % worldwide LEO satellite EOL compliant in 2017 (cubesat excepted)

MITIGATION : Need of new space traffic rules

“2019 paradigm is not anymore 2008 paradigm”



international guidelines, best practices, national regulatory acts to be updated

WORKSHOPS

- 7th Workshop on Satellite End Of Life - CNES HQ - Paris, Jan 25, 2018
- 5th European Workshop on Space Debris Modeling and Remediation - CNES HQ - Paris, June 25-27, 2018

Coming soon

- International Conjunction Assessment Workshop, CNES HQ – Paris, June 26-28, 2019

38th IADC Meeting – June 2020 - Toulouse

