

OVERVIEW ON 2011 SPACE DEBRIS ACTIVITIES IN FRANCE

Fernand Alby
CNES Toulouse

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CONTENT

- *End of life operations*
- *Collision risk monitoring*
- *Regulatory activities*
- *Vulnerability studies*
- *National Register of Space Objects*

END OF LIFE OPERATIONS DEMETER

- **Detection of Electro Magnetic Emissions Transmitted from Earthquake Regions**
- **Main characteristics:**
 - ◆ Size: about 1 m x 1 m x 1 m
 - ◆ Mass 120 kg
 - ◆ Power 190 W at Beginning of Life
- **Launched in June 2004**
- **Initial orbit 700 km SSO, local hour 22h**
- **Orbit lowered in 2006 following solar panel anomaly**



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END OF LIFE OPERATIONS DEMETER

- **Disposal operations:**

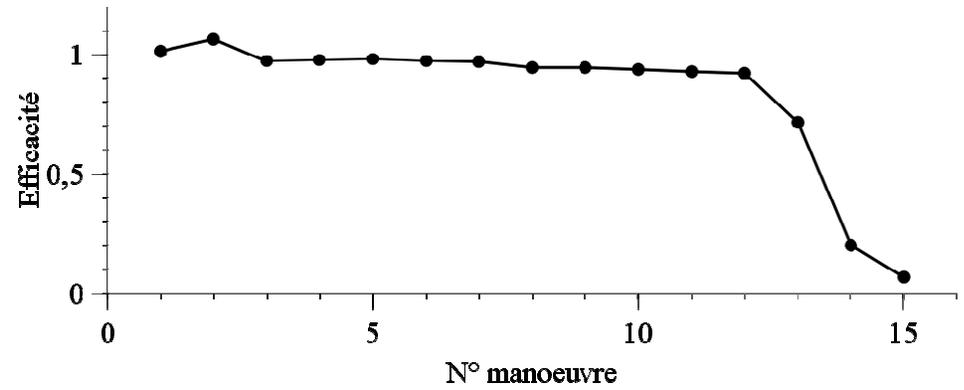
- ◆ 15 burns (January 4 - February 8, 2011)
- ◆ Fuel exhausted during 13th burn
- ◆ Burn #14 and #15 with lower pressure

- **Final orbit 650 km x 650 km**

- **Passivation:**

- ◆ Batteries discharged
- ◆ Solar panel power shunted
- ◆ S band transmitters off

- **Atmospheric re-entry expected in less than 25 years**



END OF LIFE OPERATIONS SPIRALE

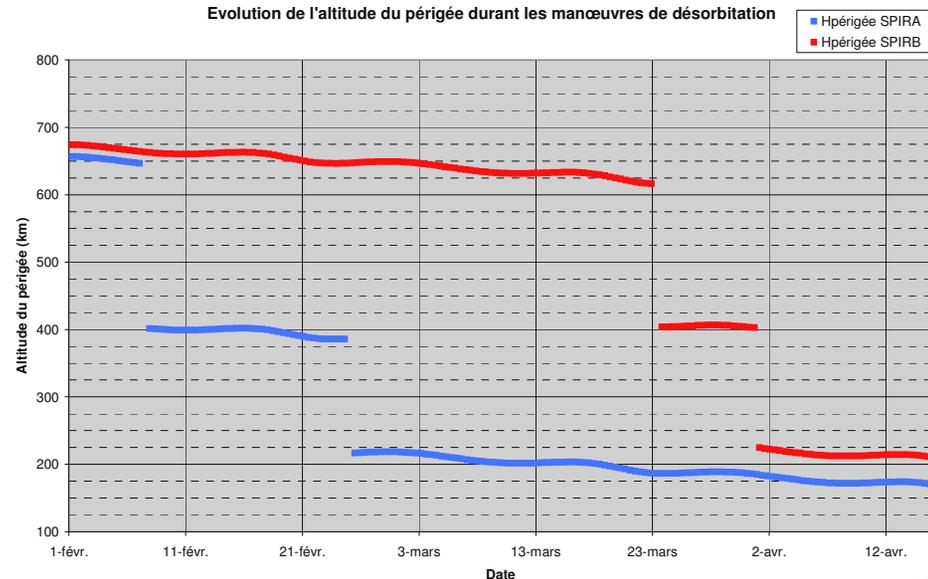
Spirale : *Système Préparatoire Infra-Rouge pour l'ALerte*

- **2 micro satellites launched with Ariane 5 ECA on 12 February 2009**
- **Geostationary Transfer Orbit 600 km x 35720 km**
- **Controlled by ASTRIUM Toulouse**
- **End of life operations in February and March 2011**



END OF LIFE OPERATIONS SPIRALE

- Perigee altitude lowered to 200 km
- 2 maneuvers per satellite
- No collision risk with GEO satellites and with ISS due to orientation of the orbital plane
- Remaining orbital lifetime estimation very sensitive to:
 - ◆ S/m ratio
 - ◆ Sun and Moon attraction
- Simulations show compliance with the 25-year rule



END OF LIFE OPERATIONS EUTELSAT W75

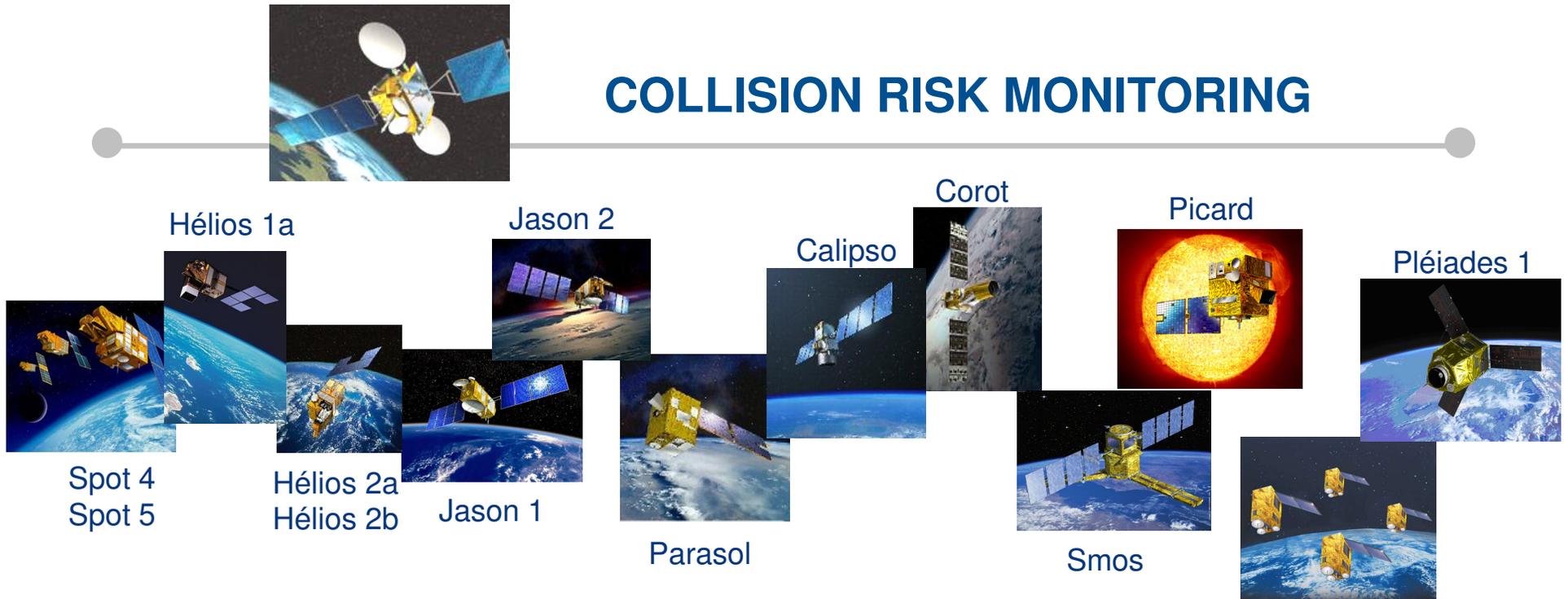


- **EUTELSAT W75 (ex HB3) launched on November 2, 1997**
- **Thrusters anomaly => satellite disposal decided by Eutelsat**
- **Nominal strategy: due to reduced efficiency the perigee would have been raised by less than 100 km**
- **Alternative strategy: reorbiting below GEO arc**

- **Passivation:**
 - ◆ **Fuel exhausted**
 - ◆ **Batteries configured to permanently discharge.**
 - ◆ **Switch-off on July 5, 2011**

- **Final Orbit:**
 - ◆ **Apogee radius: ~41655 km (~508 km below GEO)**
 - ◆ **Perigee radius: ~41448 km (~716 km below GEO)**

COLLISION RISK MONITORING



=> 17 LEO satellites and 1 GEO satellite controlled by CNES

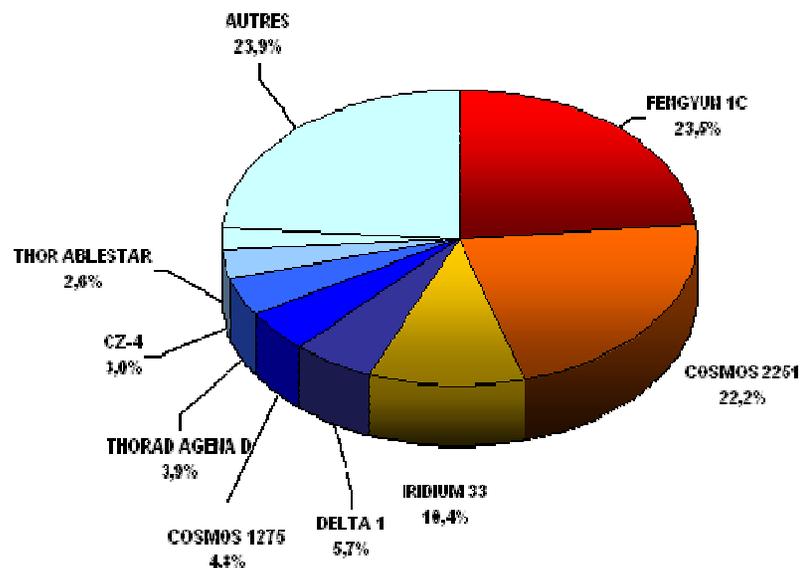
Elisa (4)

Permanent collision risk monitoring and avoidance maneuvers when necessary:

- **Use of Conjunction Summary Messages received from US Joint Space Operations Center (JSpOC)**
- **Use of the Graves (French radar system) catalogue and measurements**

COLLISION RISK MONITORING

Familles les plus dangereuses



2011 synthesis:

- 122 risks identified by the automated process (probability of collision $> 10^{-4}$)
- 89 risk alerts received from US JSpOC
- 15 requests for radar measurements or support to JSpOC (probability of collision $> 10^{-3}$)
- 5 avoidance maneuvers

REGULATORY ACTIVITIES



- Space Operations Act voted by the Parliament in June 2008
- Law entered into force on December 10, 2010
- Objectives: protection of people, property, public health and environment (including on orbit)
- Applicable to:
 - ◆ Operators carrying out operations from French territory
 - ◆ French operators anywhere in the world
- Operators shall demonstrate compliance w.r.t. Technical Regulations
- Authorizations are granted by the Ministry of Research after analysis of technical aspects by CNES

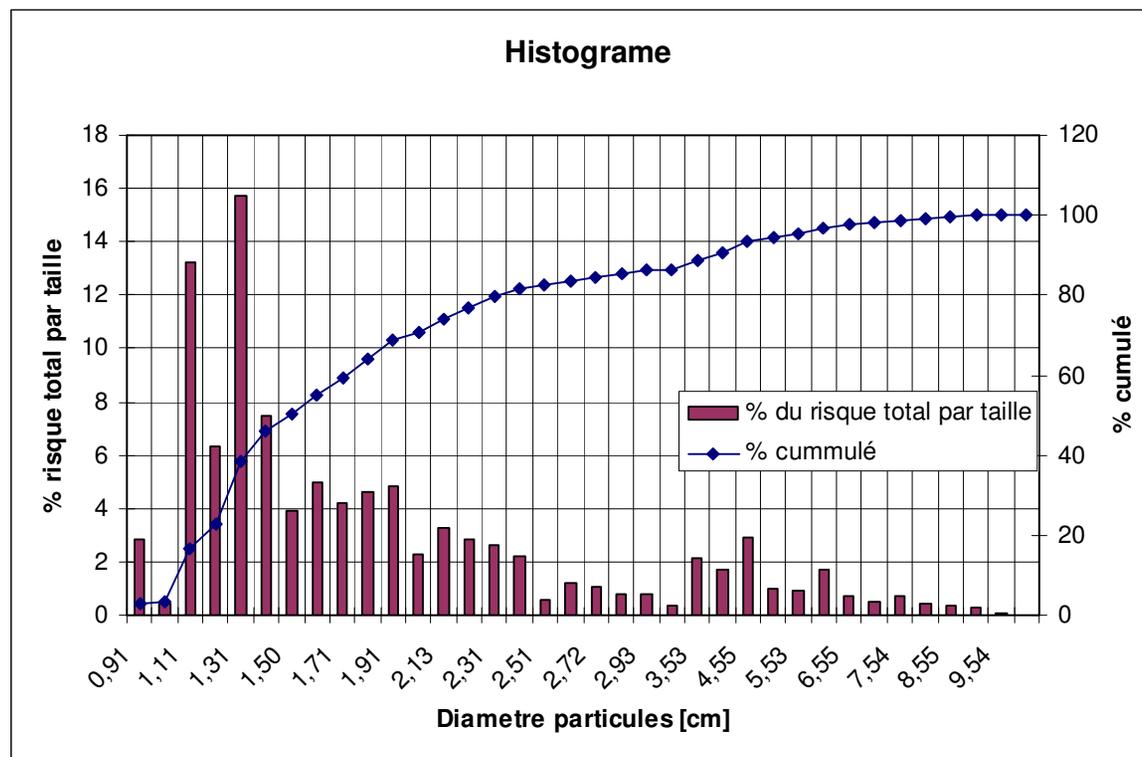
REGULATORY ACTIVITIES

- Conformity verification office has been set up
- Technical compliance is checked by CNES before launch or critical operations
- Methods and tools are proposed to support the implementation of the Technical Regulations:
 - ◆ Fragmentation modeling during reentry: DEBRISK
 - ◆ Estimation of ground risk in case of reentry: ELECTRA
 - ◆ Determination of compliance with the 25-year rule: STELA
 - ◆ Long term stability of the GEO graveyard orbit
 - ◆ Collision risk during launch phase: ARCL

STUDIES

SATELLITE VULNERABILITY

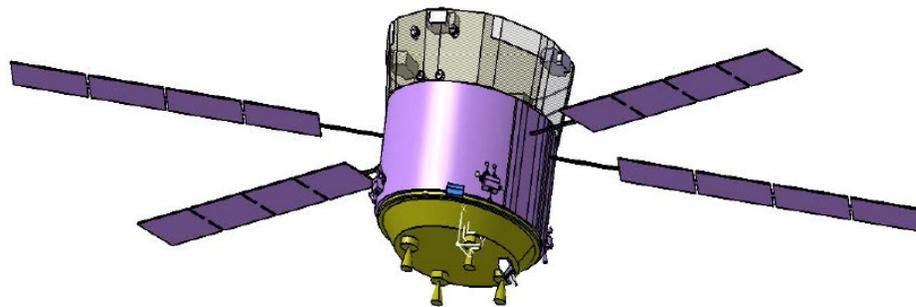
- Objective: estimation of probability to lose a satellite in case of collision with small size debris
- Main results:
 - ◆ Lethal collisions: most of the risk comes from particles < 4 cm
 - ◆ Catastrophic collision: should occur every 5 years in average



STUDIES

ACTIVE DEBRIS REMOVAL

- Increasing risk to operational satellite
- Mitigation measures will not be sufficient
- Active debris removal will be necessary
- Complex issue: technical, economical and legal difficulties
- Strong cooperation between countries is necessary



STUDIES

ACTIVE DEBRIS REMOVAL

- Several on-going studies at CNES, ASTRIUM, THALES ALENIA SPACE and BERTIN
- Objective to identify technical difficulties and critical technologies:
 - ◆ *Rendez-vous* with non cooperative target
 - ◆ Capture of a tumbling object
 - ◆ De-orbiting solutions: propulsion, tethers, inflatable devices,...
- Development of a debris population model to analyze:
 - ◆ Future evolution
 - ◆ Influence of mitigation options
 - ◆ Risk level evaluation
 - ◆ Target selection
- 2nd European workshop on Active Debris Removal: 18-19 June 2012

NATIONAL REGISTER OF SPACE OBJECTS

● 19 French registered satellites launched in 2011

date	Name	Number	Launcher	Launch base
13 July	Globalstar 2	6	Soyuz	Baïkonour
24 September	Atlantic Bird 7 (Eutelsat)	1	Zenit 3SL	Sea launch
7 October	Eutelsat W3C	1	Long March 3B	Xi Chang
17 December	Elisa	4	Soyuz	Kourou
17 December	Pleiades 1	1	Soyuz	Kourou
28 December	Globalstar 2	6	Soyuz	Baïkonour

NATIONAL REGISTER OF SPACE OBJECTS

- **3** French registered objects reentered into the atmosphere in 2011

Reentry date	Name	Launch date
17 February 2011	Ariane 5 EPS (ATV2)	16 February 2011
21 June 2011	Sylda Ariane 5-ECA	26 November 2010
21 October 2011	Spelda Ariane 4	3 June 1997

NATIONAL REGISTER OF SPACE OBJECTS

- **290** space objects, beginning 2012, in the French Register

- **181** launcher elements (LEO, MEO, GTO)

- **109** satellites:

- operational satellites: **62**

- LEO : 34

- GEO: 28

- inactive satellites: **47**

- LEO : 22

- GEO: 21

- GTO : 4

- *Details will be given at the Legal Sub-Committee (03/2012)*