CENTRE NATIONAL D'ÉTUDES SPATIALES

OVERVIEW ON 2010 SPACE DEBRIS ACTIVITIES IN FRANCE

F.ALBY

SUMMARY

- Atmospheric reentries
- End of life operations
- Collision risk monitoring
- French Space Act
- Space debris measurements
- Important meetings

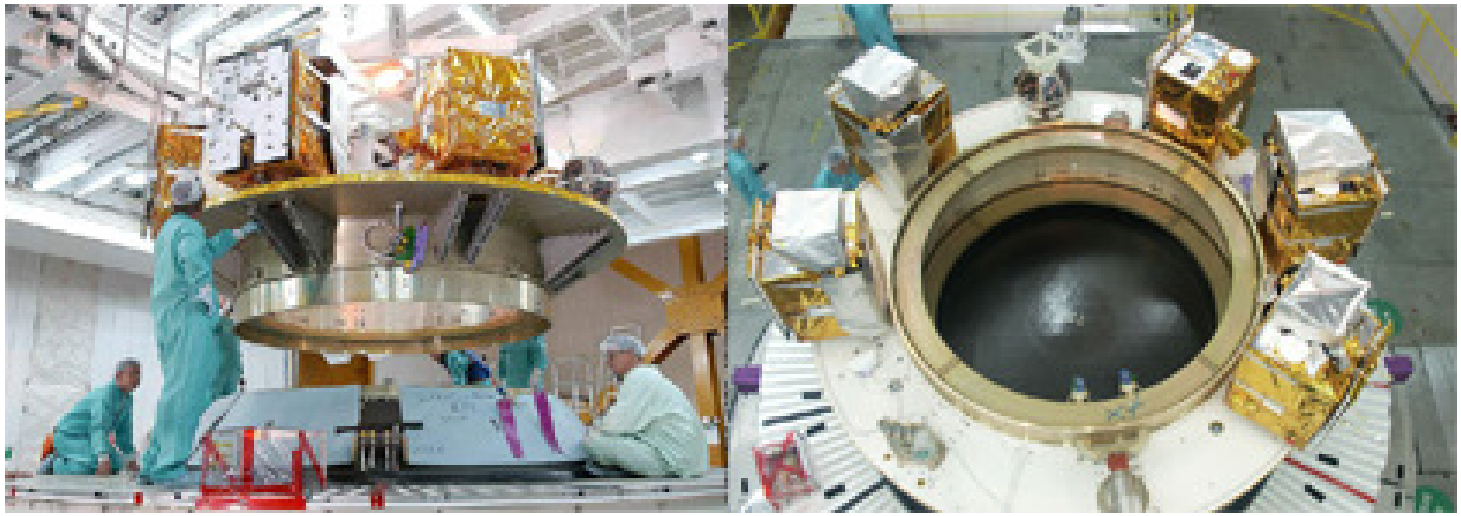
1-ATMOSPHERIC REENTRIES

- **2 French registered objects reentered into the atmosphere in 2010:**

Identification	Launch date	Description	Reentry date
2009-058-D	29 Oct 2009	Ariane 5 (V192) SYLDA	9 Sept 2010
2001-029-D	12 July 2001	Ariane 5 (V142) SYLDA	6 Oct 2010

2-END OF LIFE OPERATIONS (1/3)

- 4 « ESSAIM » satellites launched December 18, 2004, Ariane 5
- « Myriade » platform: ~120 kg, formation flying
- Quasi heliosynchroneous orbit around 700 km altitude
- Mission: characterization of the electromagnetic environment
- Development ASTRIUM + CNES
- Operated by CNES on behalf of DGA



2-END OF LIFE OPERATIONS (2/3)

- Essaim end of life operations in September and October 2010
- 1st step: altitude lowering in order to:
  - reduce the orbital lifetime
  - empty the tanks
  - manage the collision risks between the 4 satellites
- 2nd step: electrical passivation
  - Battery discharge
  - Satellites swith-off
- Final orbit: the 4 satellites are compliant with the 25-year rule

2-END OF LIFE OPERATIONS (3/3)

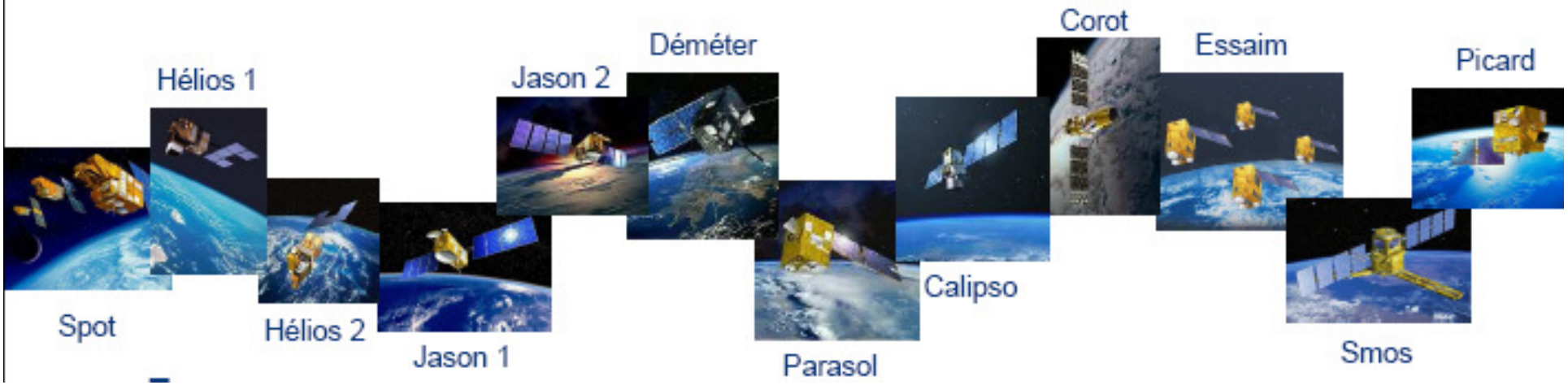
- EUTELSAT W2 built by Alcatel Space
- Platform Spacebus 3000: 3t
- Launched October 1998 by Eutelsat IGO
- Decommissioned in March 2010 by Eutelsat SA

- Final orbit:
  - Perigee 281 km above GEO
  - Apogee 290 km above GEO

- Will not reenter into the GEO protected region

- Compliant with UN space debris guidelines (2007) and with IADC Mitigation Guidelines

3-COLLISION RISK MONITORING (1/4)



- 17 LEO satellites and 1 GEO satellite controlled by CNES
- Permanent collision risk monitoring and avoidance maneuvers when necessary
- Improvements of the procedure:
  - Use of Conjunction Summary Messages received from US Joint Space Operations Center
  - Use of the Graves catalogue and measurements

3-COLLISION RISK MONITORING (2/4)

JSpOC

(For A-Train)

CNES

ORBIT COMPUTATION CENTER

Screening

Risk assessment

Support request

Maneuver proposal

Alert

risk analysis

CONTROL CENTER

One team per mission :

Mission coordination

Station-keeping

Vehicle

Ground segment

Le Monge

TIRA (Germany)

Military radars

Tracking facilities

3-COLLISION RISK MONITORING (3/4)

Stage 1 –Screening (7 days) => computation of maximum Probability of Collision (PoC)

JSpOC Alerts

PoC>10^{-4}

Stage 2 - manual risk assessment : computation of an Operational PoC (geometrical and statistical analysis)

Stage 3 - request for radar measurements, fine assessment:

Real alert = { **JSpOC or NASA (Aqua-Train)** ; **PoC > 10^{-3}** }

PoC>10^{-3}

Real Alert

Stage 4 - conjunction mitigation

- **Avoidance maneuver**
- **Return maneuver**

Stage 5 : end of alert

data archiving, report

Data

3-COLLISION RISK MONITORING (4/4)

■2010 synthesis:

- 17-18 satellites monitored
- 353 risks identified by the automated process (probability of collision > 10-4)
- 92 risk alerts received from US JSpOC
- 21 requests for radar measurements or support to JSpOC (probability of collision > 10-3)
- 13 avoidance maneuvers

4-SPACE OPERATIONS ACT (1/3)

- 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

4-SPACE OPERATIONS ACT (2/3)

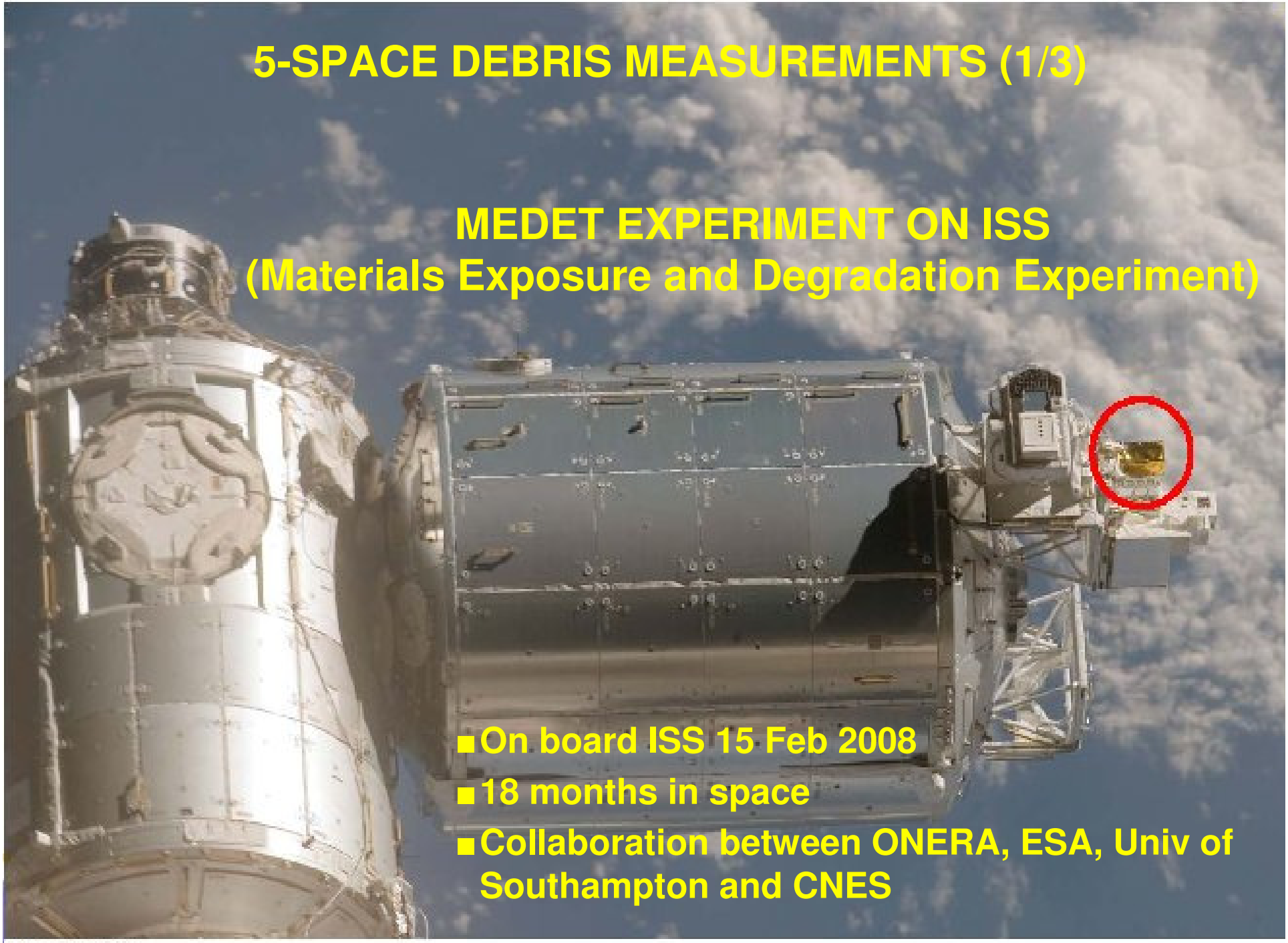
- Associated Technical Regulations prepared by CNES in 2009 and 2010 with participation of industry and operators
- In line with the UN-COPUOS and IADC Mitigation Guidelines
- Content:
  - Ground safety requirements (controlled and uncontrolled reentry)
  - Space debris limitation
  - End of life operations
  - Collision risk reduction
  - Planetary protection
  - Nuclear safety

4-SPACE OPERATIONS ACT (3/3)

- **Methods and tools are proposed to support the implementation of the Technical Regulations:**
  - **Fragmentation modelling during reentry**
  - **Estimation of ground risk in case of reentry**
  - **Determination of compliance with the 25-year rule**
  - **Long term stability of the GEO graveyard orbit**
  - **Collision risk during launch phase**

5-SPACE DEBRIS MEASUREMENTS (1/3)

MEDET EXPERIMENT ON ISS
(Materials Exposure and Degradation Experiment)



- On board ISS 15 Feb 2008
- 18 months in space
- Collaboration between ONERA, ESA, Univ of Southampton and CNES

S122E009992

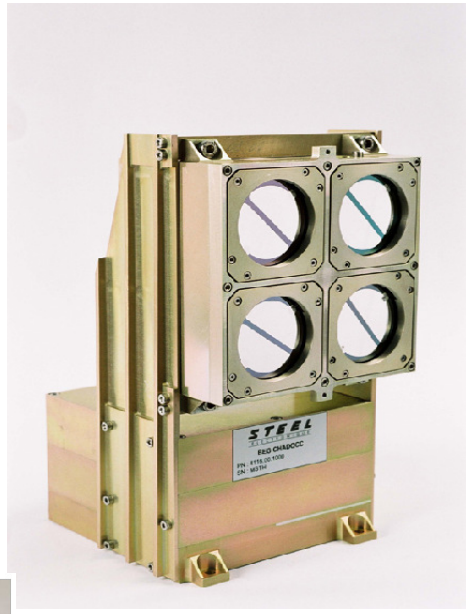
5-SPACE DEBRIS MEASUREMENTS (2/3)

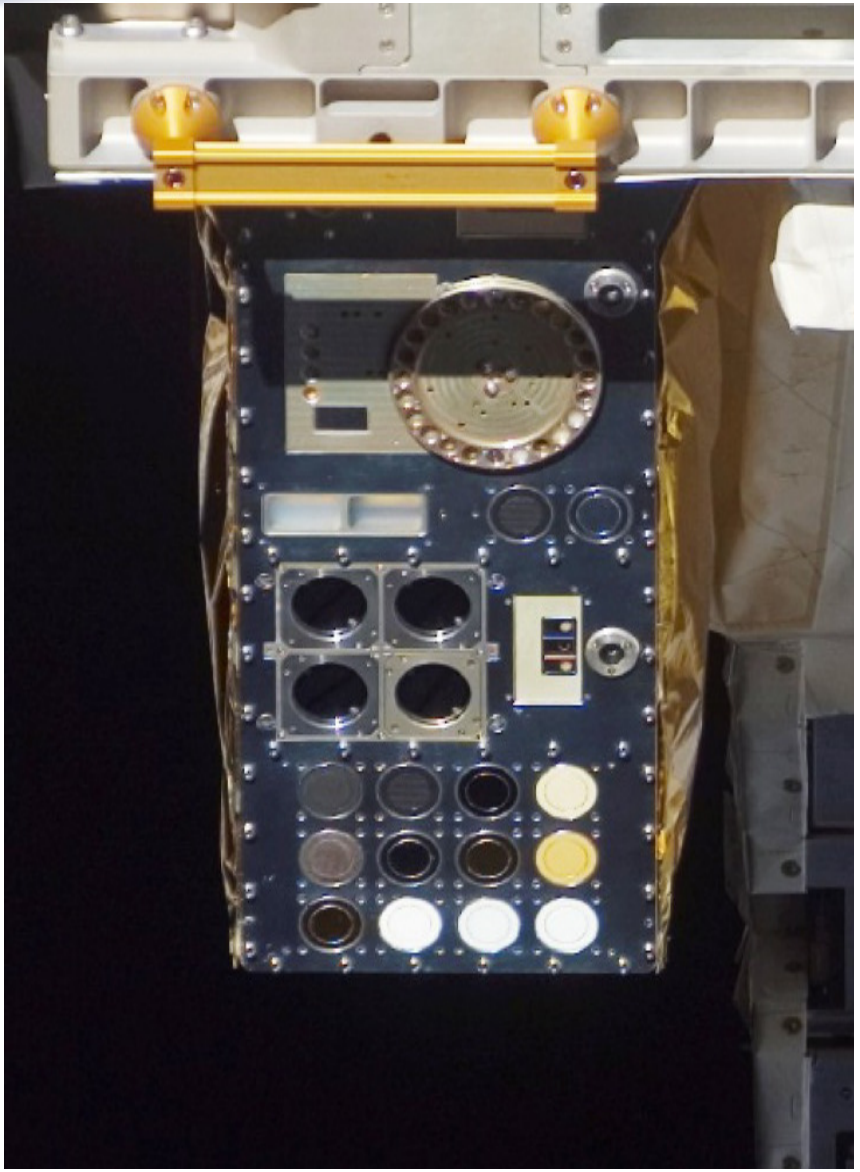
- Payload dedicated to space debris: SODAD (Système Orbital de Détection Active des Débris)
- Collaboration between CNES and ONERA
- Real time monitoring of space debris impacts
- Main objectives:
  - Debris clouds analysis
  - comparison with laboratory tests and numerical simulations, models calibration
  - new orbit population and evolution ?
  - environment around satellites and space station (docking)?
  - surface damage effect on satellites
- On-going analysis

5-SPACE DEBRIS MEASUREMENTS (3/3)

SODAD

- MOS active surface 5.1 x 8 = 40.8 cm^2
- AEROGEL passive surface 4 x 2 x 2 = 16 cm^2
- Other surface exposed (RAM plate)





6-WORKSHOPS

- GEO end of life workshop (27 January 2010, Paris)
  - Information of operators on regulatory issues under preparation
  - feed-back from operators having performed end of life operations
- Active Debris Removal workshop (22 June 2010, Paris)
  - Confirmation of the need for debris removal
  - Review of possible solutions
  - Discussion
- Space debris synthesis group (24 June, Toulouse)
  - General information on the in-orbit situation and space debris activities