

OVERVIEW ON 2012 SPACE DEBRIS ACTIVITIES IN FRANCE

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COPUOS STSC
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CONTENT

- *End of life operations*
- *Collision risk monitoring*
- *Atmospheric reentries predictions*
- *R/D studies*
- *Regulatory activities*
- *National Register of Space Objects*
- *Workshops and meetings*

END OF LIFE OPERATIONS

LOW EARTH ORBIT:

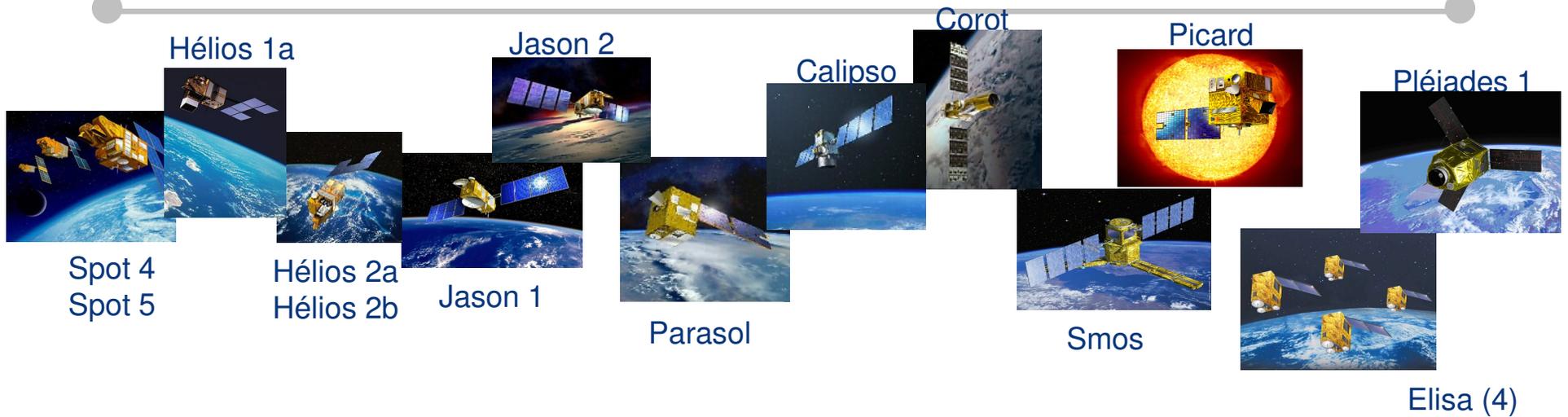
- **Helios 1A (18 February 2012)**
 - ◆ Remaining orbital lifetime about 18 years

GEOSTATIONARY ORBIT:

- **EUTELSAT 4A (23 February 2012)**
 - ◆ Graveyard orbit 500 km above GEO
- **Telecom 2D (18 November 2012)**
 - ◆ Graveyard orbit 450 km above GEO

➔ compliance with French law and international recommendations

COLLISION RISK MONITORING



- **Operational service called CAESAR (Conjunction Analysis and Evaluation, Assessment and Recommendations)**

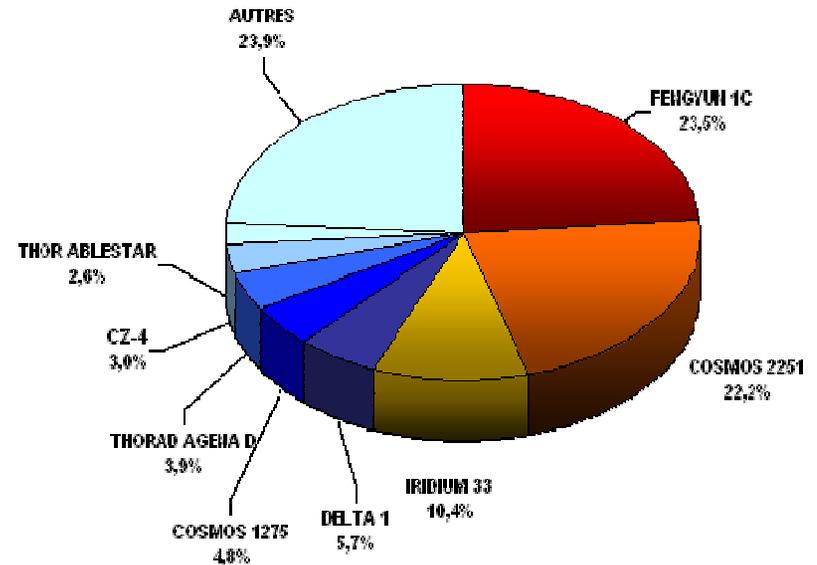
- ◆ Analysis of all CSMs available corresponding to a conjunction
- ◆ Risk evaluation and avoidance recommendations
- ◆ Use of tracking radars or telescopes when necessary

- **Open to:**

- ◆ Satellites controlled by CNES
- ◆ External customers (AstroTerra-Spot 6 for the time being)
- ◆ Additional customers expected in 2013

COLLISION RISK MONITORING

Most dangerous debris



2012 synthesis:

- 18 satellites monitored
- 114 risks identified by the automatic process (probability of collision $> 10^{-4}$)
- 163 risks identified by JSpOC
- 9 support requests: JSpOC or radar tracking (probability of collision $> 10^{-3}$)
- 13 avoidance manoeuvres

ATMOSPHERIC REENTRIES MONITORING

■ Objects monitored:

« French » objects that could fall on foreign countries (Launching State responsibility)

- satellites and launcher stages registered by France
- launcher stages registered by ESA

« foreign » objects that could fall on the national territory:

Potentially dangerous objects registered by other countries:

- Mass > 5T
- dangerous materials

■ Particular cases:

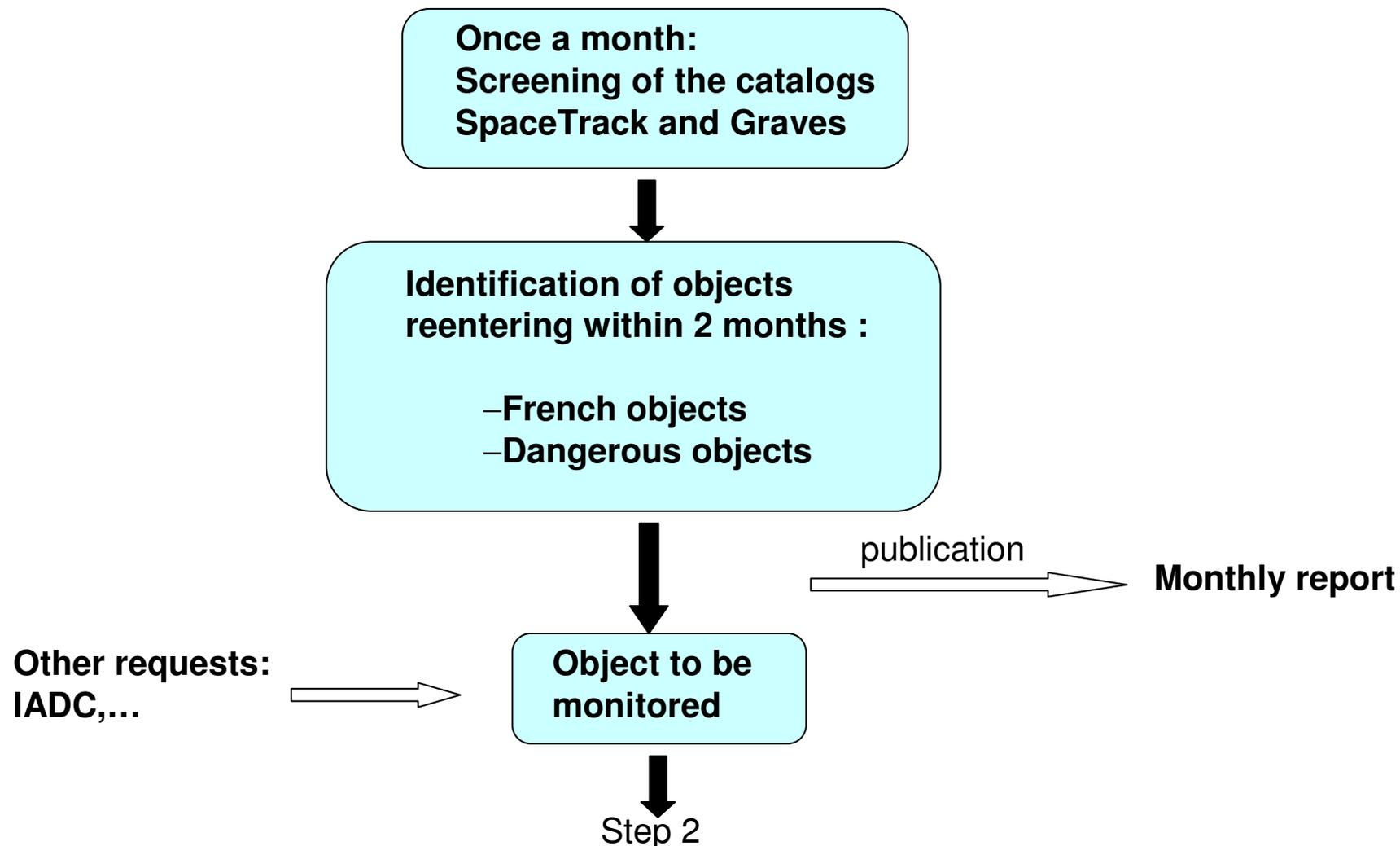
IADC or governmental requests

■ «debris » objects not considered



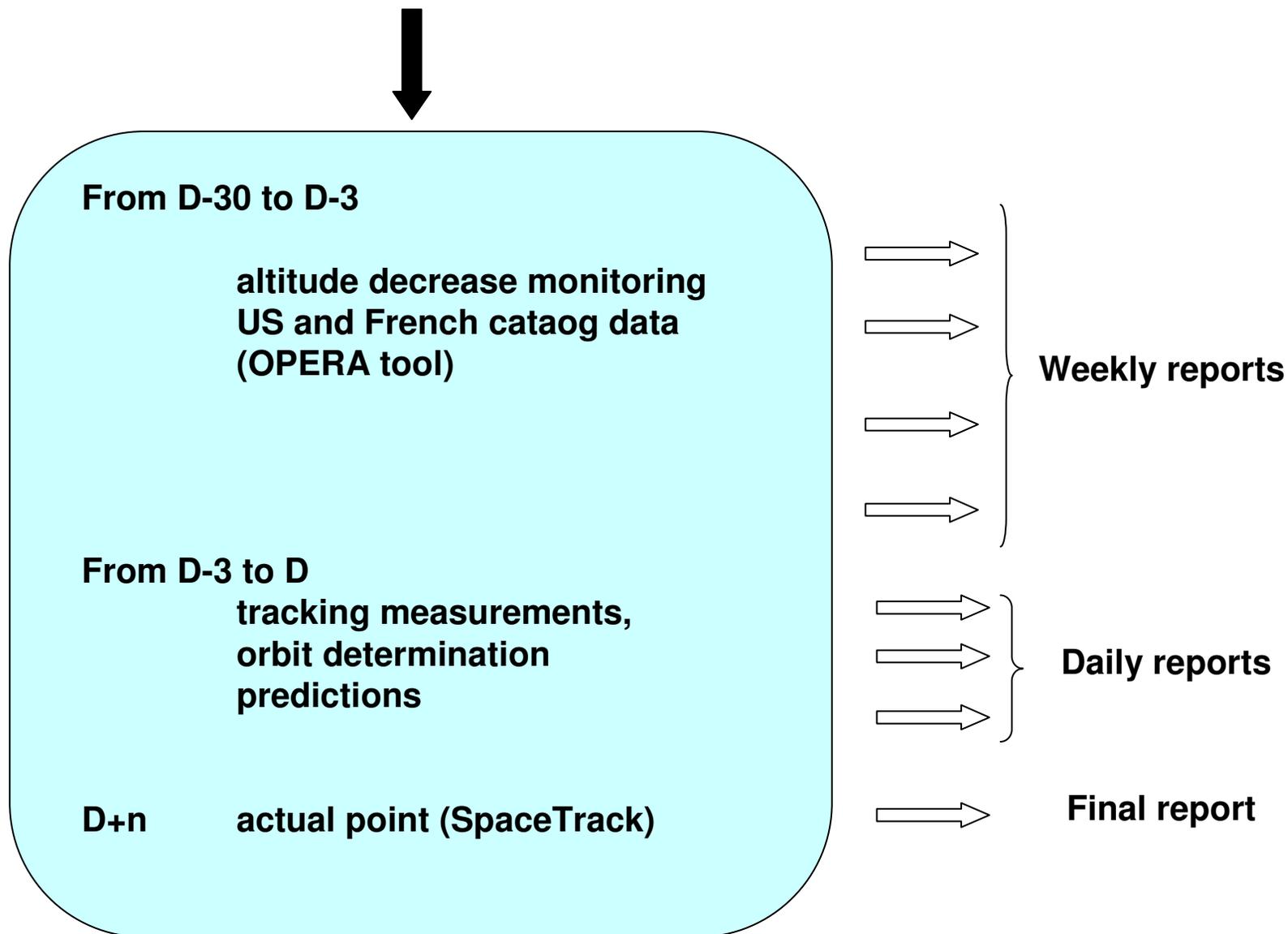
MONITORING PROCESS

Step 1: routine surveillance



MONITORING PROCESS

Step 2: monitoring of a particular object



CONTENT OF THE REPORTS

- number of French objects in the catalogs
- list of French objects with a perigee lower than 200 km,
- list of French objects reentering within 60 days,
- list of French objects that reentered in the last 30 days.

monthly

- name and number of the object, launch date,
- dimensions, mass, apogee, perigee and inclination
- predicted reentry date, uncertainty interval,
- latitude band, risk level.

weekly

- idem weekly reports +
- orbit ground track with begin and end indications,
- list of countries overflown, risk level.

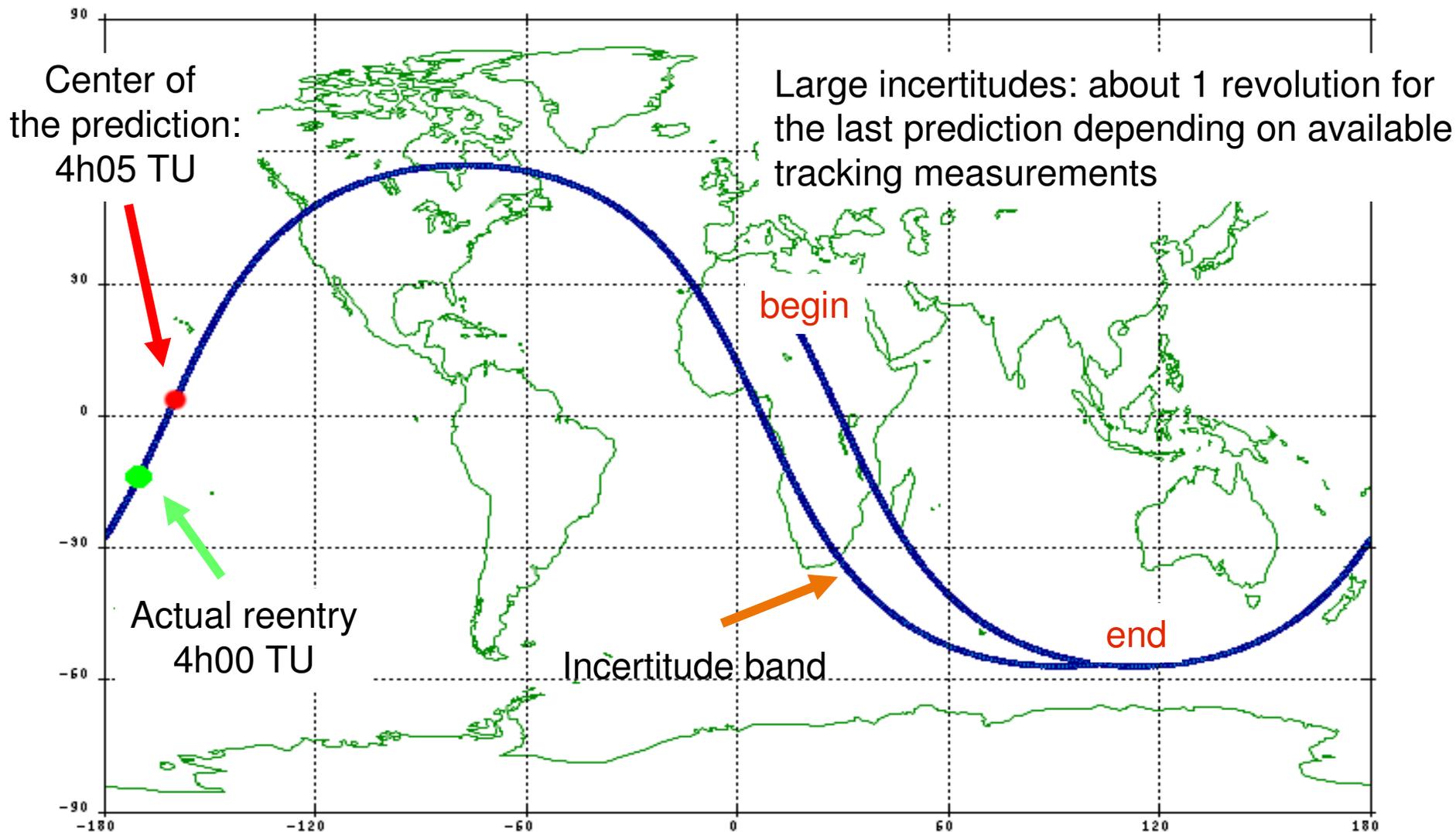
daily

- date and coordinates of the reentry point when available (US information)
- comparison with the last prediction,
- estimation of debris fallout zone

final

EXAMPLE

UARS REENTRY 24 SEPTEMBER 2011



SPACE DEBRIS R/D ACTIVITIES

● ON-ORBIT SITUATION:

- ◆ Debris observation from space and ground
- ◆ Catalog management

● PROTECTION:

- ◆ Effect of debris impacts on satellites, protection
- ◆ Aero-thermodynamics models for reentry

● MITIGATION:

- ◆ Electric and fluidic passivation
- ◆ Reentry survivability

● REMEDIATION:

- ◆ Long term evolution of the space debris population
- ◆ Optimal orbital transfer for active debris removal missions

REGULATORY ACTIVITIES

- **French Space Act applicable since December 2010**
- **Technical compliance is checked by CNES before launch or critical operations**
- **Methods and tools are developed and 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

NATIONAL REGISTER OF SPACE OBJECTS

● 5 French registered satellites launched in 2012

date	Name	Number	Launcher	Launch base
13 February	ROBUSTA	1	VEGA	Kourou
9 September	SPOT 6	1	PSLV	India (Sirharikota)
10 November	Eutelsat 21B	1	Ariane 5	Kourou
2 December	PLEIADES 1B	1	Soyuz	Kourou
3 December	Eutelsat 70B	1	Zenit 3	Sea Launch

NATIONAL REGISTER OF SPACE OBJECTS

- **13 French registered upper stages launched in 2012:**
 - ◆ 12 Ariane 5 (upper stages and launcher elements)
 - ◆ 1 Fregat
- **4 French registered objects reentered into the atmosphere in 2012**

Reentry date	Name	Launch date
4 January	Ariane 4 R/B	14 August 1991
22 February	Ariane 4 R/B	16 April 1997
8 July	Ariane 4 R/B	5 October 1998
22 November	Ariane 5 R/B	12 July 2001

NATIONAL REGISTER OF SPACE OBJECTS

305 space objects, end 2012, in the French Register

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

- **114** satellites:

operational satellites: **63**

LEO : 35

GEO: 28

inactive satellites: **51**

LEO : 24

GEO: 23

GTO: 4

MEETINGS AND WORKSHOPS

- **Meetings and workshops are regularly organized:**

- ◆ To inform all partners (industry, operators, research organizations, governmental bodies,...) on space debris activities at national and international levels
- ◆ To get their feedbacks and needs relative to mitigation rules and to research activities

- **Main meetings:**

- ◆ 24 January 2012: GEO satellites end of Life workshop (Paris)
- ◆ 18 and 19 June 2012: Active Debris Removal workshop (Paris)
- ◆ 11 July 2012: annual national meeting on space debris
Space Debris Synthesis Group (Toulouse)