

# D4D Technos (eNOVA Consortium)

10 Years Activities & Legacy on D4D Technologies





No NewSpace without  
GreenSpace

# Experience & Legacy

2012

**Foundation ALTRAN Research** : MMOD (Mitigation Measures for Orbital Debris)

- MMOD : Micro Meteoroid Orbital Debris : Satellite Shielding and Robustness Assessment Altran Research



2014

**ESA CLEANSPACE (2014-2016) :** **Design for Demise for Satellite**

- European Space Agency (ESA) / Thales Alenia Space (TAS) Consortium:



2016

**ESA CLEANSAT**



- Nimesis: Design for Dismantlement
- Rockwell Collins : Reaction Wheels Demise



IFTH: Demise / Survive Fibers  
ALTRAN : Demise / Survive Blocks (D4C Technos)

2017

**ESA CLEANSPACE (2016-2017) : Design for Demise for Optical Payloads**

- European Space Agency (ESA) / Thales Alenia Space (TAS) Consortium :



2019

**Foundation of e.NOVA AeroSpace**

- CNES Study on DEBRISK v3 Software



2020

**ESA ITT with Consortium on Flexible Thermal Protection System (F-TPS)**

- Start of the BFS project (Back From Space : an Atmospheric Reentry Kit)
- H2020 ASTROPRENEUR Process: Selection of MAGNUS & BFS projects



2021

**ESA CLEANSPACE (2021-) :**

**Design for Containment**

- European Space Agency (ESA) / Thales Alenia Space (TAS) Consortium :
- AAP CNES IOD IOV Attempt (BFS Cubesat)

2022

**AAP CNES Innovative Technologies for NANOSATS / BFS Project\_F-TPS Techno**

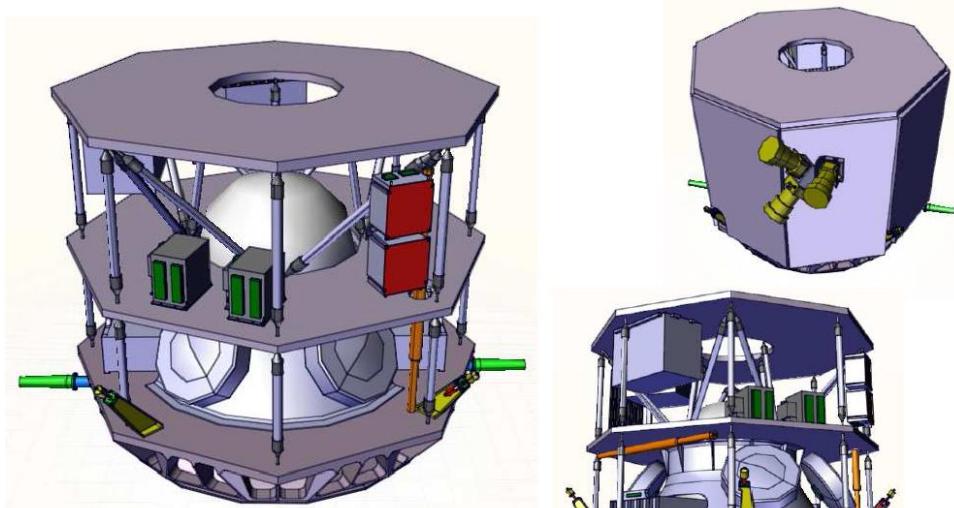
- CNES Study on D4D / D4C Technos



# 2. S/C Architecture

## 1. TOPIC : S/C Standard Architecture

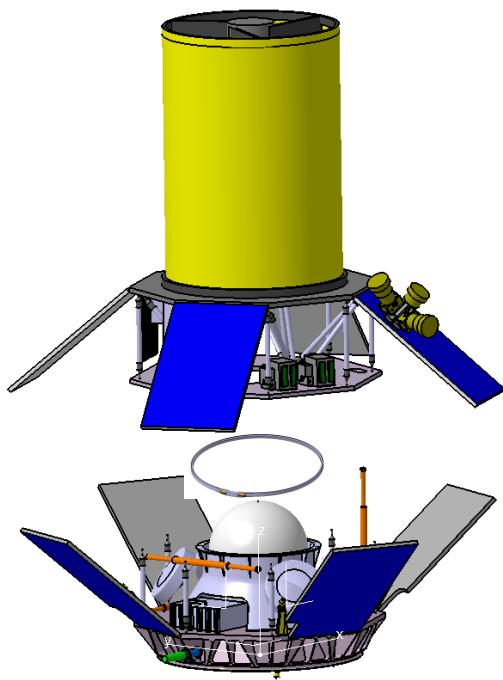
- Dense & Compact is problematic
- Internal units have shadowing effect to Flux



*Note: Solar Panels are not showed*

## 2. CONSEQUENCE: Concept AltranSat v1.0

- CYLINDRICAL Shape, Solar arrays on panels  
=> Better Shape , No Appendages, Better Ballistic Coeff ,
- INTERNAL Structural Frame (NO Eqt on panels)  
=> Later/lower dismantlement , later/higher Mass & Ballistic Coefficient
- SOFT External Panels (Plastic ? For Quicker demise)  
=> Earlier Flux exposure , Intial T° Increase, More energy received for ablation
- OPEN SPACE Architecture (No shear web panels / struts architecture)  
=> Less Shadowing , Less Cross Section, Earlier Flux exposure , Intial T° Increase
- LESS Structural I/Fs (easier dismantlement control)  
=> Clear Weakness, Struts I/F , Clamp



## 3. CONCLUSIONS :

**DEMISE Ranking:**

**SYSTEM Ranking:**

**TRL Ranking:**

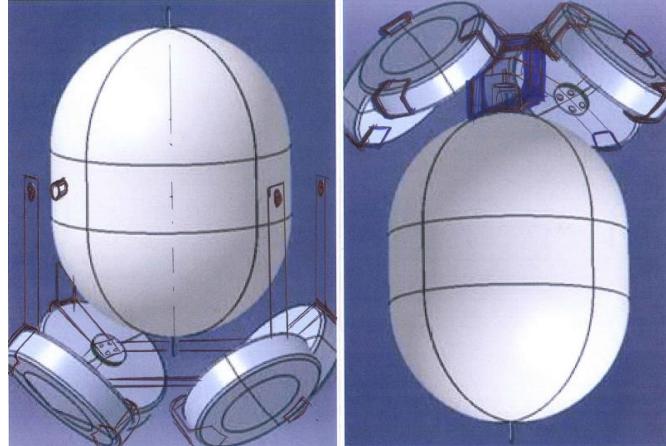
# 2. P/F Architecture

## TOPIC : Architectural Block

To achieve better Demise : (Better Ballistic Coeff & ablation)

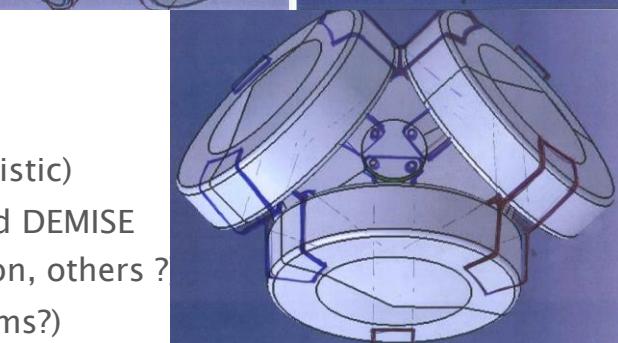
To achieve Ground Risk Mitigation : Regroup debris but Impact Energy > ?

D4D : DEMISE BLOCK / D4C : SURVIVE BLOCK



## STATUS :

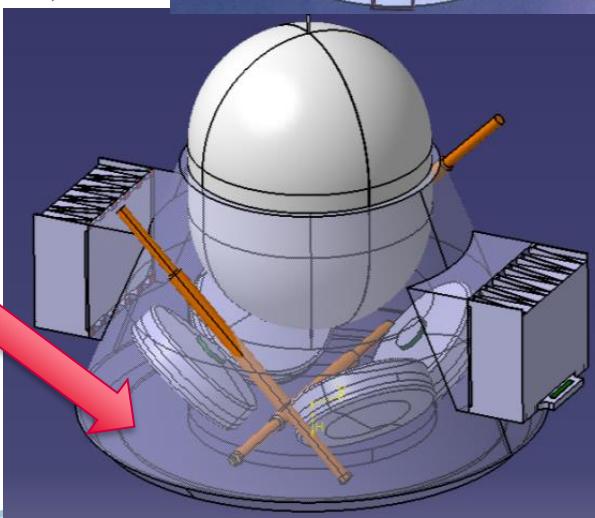
- “**BIRD CAGE**” : light structural frame to restrain debris grouped  
=> 1mm Thick - 30mm Width : should be enough for non-Ablating part (Bad C.Ballistic)
- “**THERMAL Protected System**” : Light & flexible thermal protection to avoid DEMISE  
=> Ablative material (liege) or insulating foam – HT flexible fibers ( NEXTEL, Carbon, others ?)
- **Optimised SURVIVE Block** (Aerodynamic stability, I/Fs Th-Protections, Foams?)  
=> Block attached to structure
- If not enough, Implement **CONFINEMENT BOX**  
=> Block providing structural Stiffness (C/C structural cone ?)  
=> Block thermally protected (as reentry body, Flexible TPS ?)



## CONCLUSIONS :

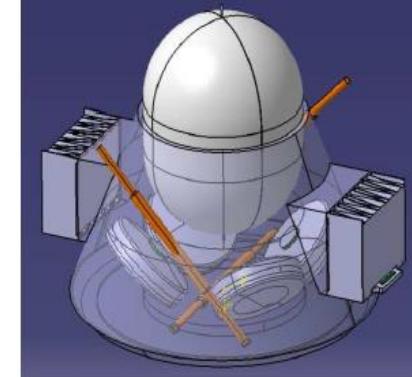
**Demise BLOCK to improve DEMISE (Cb>)**

**Survive BLOCK for Ground Risk Mitigation**



# 2. P/F Architecture

## Carbon-carbon impact



### STATUS :

**ALTRAN Research** activities (2012-2018)  
-> **e.NOVA Aerospace** (2019- )

The **central cone** of the Sentinel 3 satellite FEM were replaced by a **3.1mm NB41** carbon-carbon sheet with mechanical properties :  $E = 200 \text{ GPa}$  . / Density =  $1970 \text{ kg/m}^3$  / Yield limit = **169 MPa**  
**Mass = same** as original CFRP panels

### APPROACH & SOLUTION :

#### Containement Box :

SVM Central Cone made out **C/C**

#### SYSTEM Impact Analysis /

(S3 Analysis made @ iso-resistance S3 analysis)

### OUTCOMES & RESULTS: TRL3-9

**System Impact OK but (Cost)**

**High DCA Potential**

**Confidence**

**Simulability**

### OUTCOMES & RESULTS :

+1.0 Hz Lateral Modes

+ 1.5 Hz Axial Mode

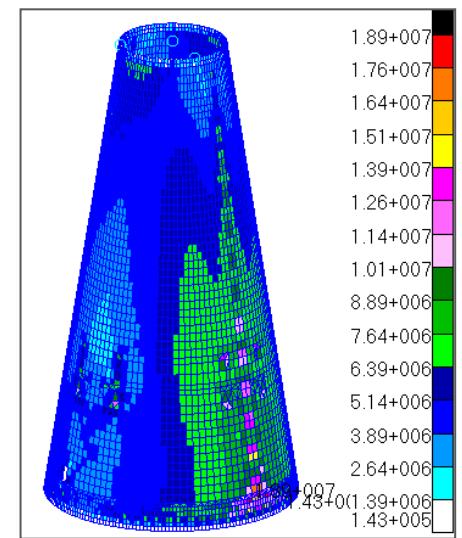
**Negligible Impact**

on Modal Analysis

**But More Stiffness**

#### Displacements under 1g

		1gY	1gZ
Disp X - HComb	<b>1.13 µm</b>	1.34 µm	7.96 µm
Disp Y - HComb	-250.98 µm	<b>14.71 µm</b>	24.63 µm
Disp Z - HComb	-13.36 µm	-245.70 µm	<b>1.51 µm</b>
Disp X - C/C	<b>1.70 µm</b>	1.26 µm	6.88 µm
Disp Y - C/C	-190.30 µm	<b>11.1 µm</b>	25.17 µm
Disp Z - C/C	-10.16 µm	-183.42 µm	<b>1.41 µm</b>



### 3. Building Block 11 :

#### CONTEXT & OBJECTIVES

Reaction Wheels are main Debris Casualty Area contributor for S/C (units with Steel Flywheels)

D4D improvements on this Equipment are a major priority for S/C D4D.

#### APPROACH & SOLUTION

- Option 1: Mechanical upgrade: Flywheel Material swapped from Steel to Aluminium

Mechanical and inertial optimisation to fit the current housing

⇒ AOCS Performances still compliant with design put DEMISE Compliant

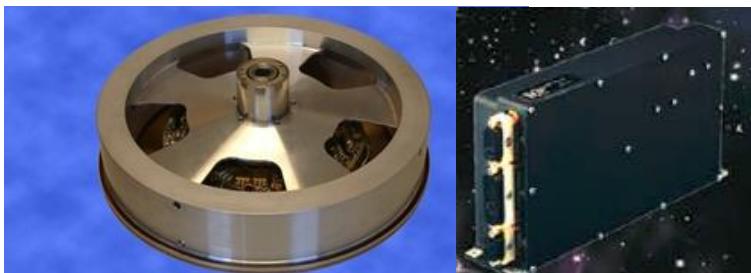
- Option 2 : Electronical upgrade: Mechanical Down sizing to Aluminium flywheel

Speed and torque increased capability via Electronics upgrade

⇒ DEMISE design with AOCS performances put COMPLIANT

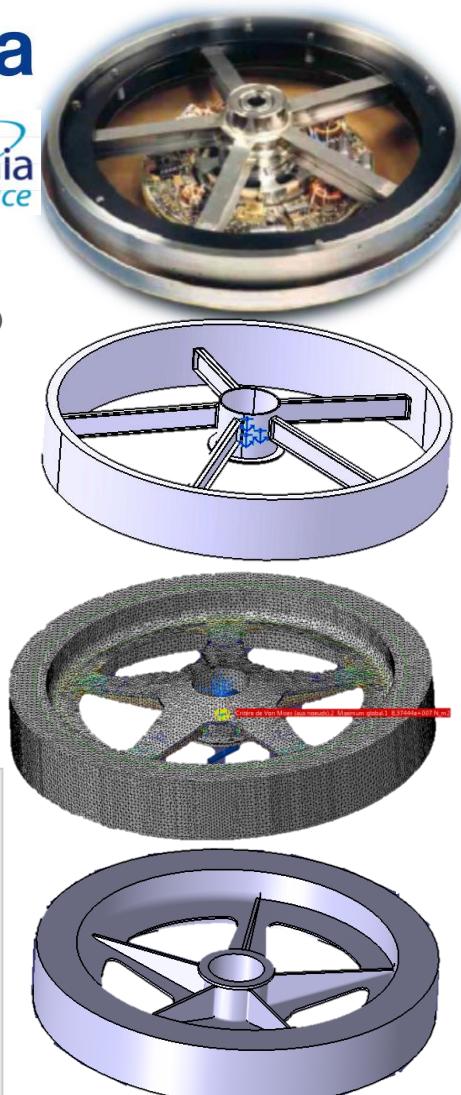
- Option 3 : Additional options :

D4D Techniques at S/C level , Unit Internal dismantlement ,  
Core D4D techniques , Innovative solutions (magnetic bearing)



#### RESULTS & ADDED VALUE

- Presentation at ESA Cleansat CDF sessions confirmed those options
- ALTRAN Cannes is investigating further collaboration with ROCKWELL COLLINS Germany :
  - Monobloc Flywheel designs
  - D4D Recommendations inside units
  - investigations on material swap



### ***3. Building Block 10 :***

#### **OUTCOMES**

In order to improve S/C dismantlement and aerothermal exposure during re-entry phase, mechanical **release devices** activated by temperature are investigated

#### **APPROACH & SOLUTION**

- |  |                        |
|--|------------------------|
| Concept 1 : SMA Washers (European Frangibolts)   | => TRL 3 (Back-up)     |
| Concept 2 : SMA Inserts (SMA Spring or Ring TBC) | => TRL 2-3 (Baselined) |
| Concept 3 : SMA Cutting Cords :                  | => TRL 1 (TBD)         |
| Concept 4 : SMA Sleeves                          | => TRL 2-3 (TBC)       |
| Concept 5 : SMA Hinges                           | => TRL 1 (Unselected)  |

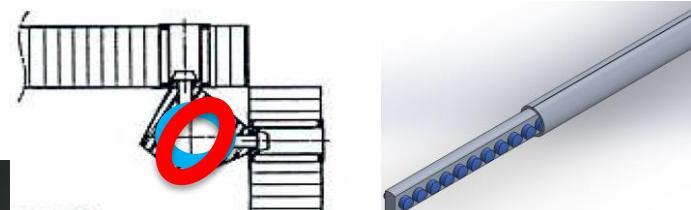
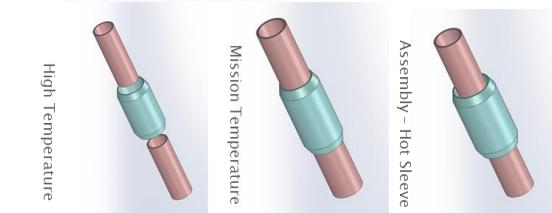
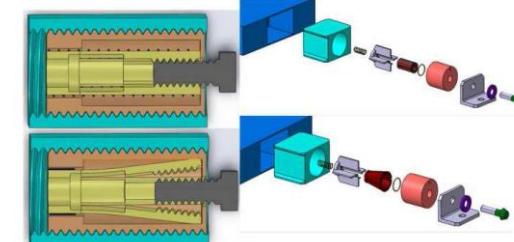
#### **OUTCOMES & RESULTS**

Concept 1 : SMA Washers => **Low NRC** , **More mass impact** : 12 Kg / 1m<sup>2</sup> Panel

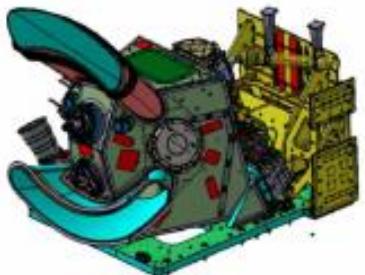
Concept 2 : SMA Inserts => **More NRC** , **Less Mass impact** 7Kg / 1m<sup>2</sup> Panel

Capacities of NIMESIS SMA Ti-Ni & CuAlNi

=> allows accurate / adjustable triggering T° in a large range of temperature (75-250°C)



## 4. Optical P/L D4D Techniques & Techn



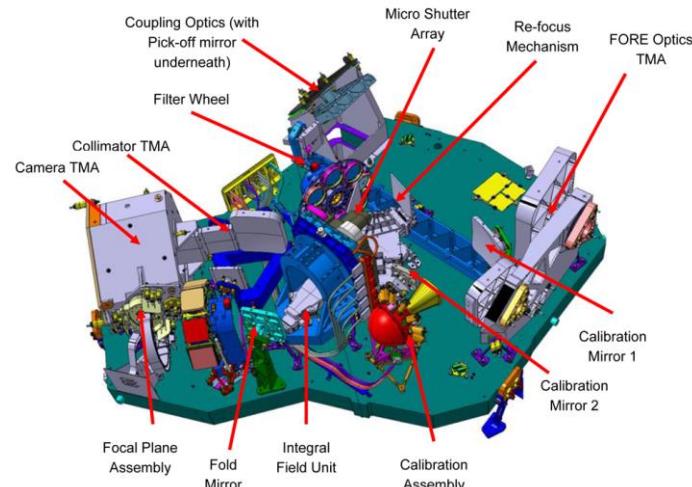
1. Did you know Space Agencies is investigating
2. Satellite Design for Demise (D4D) ?
3. A dedicated study was funding for optical payload D4D Techniques

### CONTEXT & OBJECTIVES

- Design for Demise (D4D) techniques are very challenging and requires evolutions & innovations
- Main techniques identified are system impacting and needs re-validation and qualification  
(Material Swap – innovative Process Selection – Innovative components Equipments Evolution – Mechanical & System Architecture )

### APPROACH & SOLUTION

- Mechanical & architectural concepts allowing easier dismantlement at re-entry
- Specific dismantlement devices such as (SMA) shape memory alloy mechanisms
- Specific modification of on spacecraft equipments , components



ESA Earth Observation Portal Website \_NIRSpec (JWST instrument)

### RESULTS & ADDED VALUE

- THALES consortium including ALTRAN won ESA contrat “ D4D Techniques for Optical P/L ”
- ALTRAN Research Cannes was involved (2016-2017) in ESA D4D activity inside THALES Consortium (Torino, Cannes & HTG Germany) 
- ALTRAN has proposed a complete panel of innovative D4D techniques for P/L improvement.
- Reentry analysis on 5 OP/Ls (OLCI, SLSTR, CarbonSat, PREMIER, DEVA )

# 5. S/C Components

TOPIC : OHB D4DBB \_ CSID 2021

STATUS : OHB\_INVENT\_SAUBREY\_ DEMISE Joint

CONCLUSIONS :

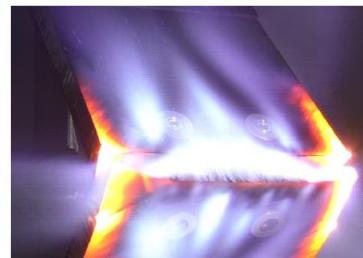
Demise insert

SMA Bolt (Nimesis Sample)

Bonded Cleat

• Highly effective concept:

- Destruction of inserts within trajectory and constant heat flux
- Consistent for the aluminium and CFRP faceskins
- Clear release of the panels visible
- Releases at approximately 140°C
- Correlates to the prediction



Re-entry Test Results - Bonded Cleats

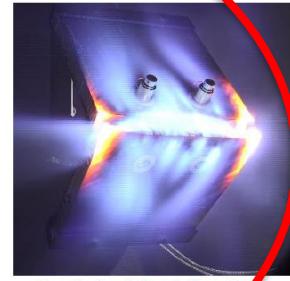
- Very promising result for one flange bonded to outer panel side
- Failure of panel-panel connection either through:
  - cleat bondline failure
  - loss of sandwich panel integrity
- In general, **limited demisability improvement** seen
  - Detachment between 300°C - 400°C



Outer cleat sample setup during wind tunnel testing

Re-entry Test Results - SMA Concept

- SMA bolts mounted externally for best exposure
- **Highly effective concept:**
  - Clear release of the panels
  - Actuation between 170°C - 210°C
  - Correlates to the prediction
  - Triggered the fastest of all demise tests
- Trajectory heat flux not tested

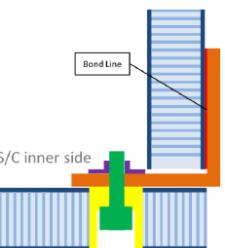


2-panel setups during wind tunnel testing

Demise Concepts

Bonding joint

- No form fit
- External placement



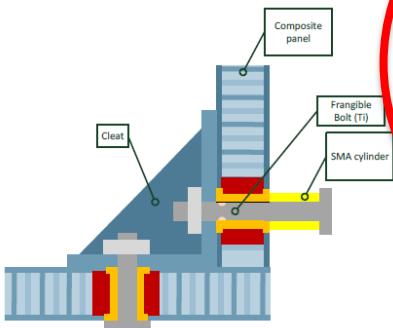
Demisable insert

- Temperature sensitive insert
- Different insert designs
- Minimal re-design of S/C needed
- Minimal increase of mass



SMA bolts

- Temperature sensitive bolt
- Placed externally
- Increase of cost & mass



# 6. Synthesis

**TOPIC :** D4C Technos

**STATUS :**

THALES Consortium  
(ESA Activity)



**CONCLUSIONS :**

Work under Progress

## CONTAINMENT METHODS

### ///Regroup

- / Architecture change
- / Adaptative change

### ///Protect

- / Protection Upgrade
- / Protection Addition
- / Heat Shield Implementation

### ///Attach

- / Specific attachment
- / Interface change
- / Design change

### ///Encapsulate

- / Partial Encapsulation
- / Total Encapsulation

N°ID	D4C : Design For Containment		Study Case	Study Case Applicability		Technos	H/W Technos	Simulability ?	Techno TRL		
	Techniques	Methods		Technos	H/W Technos						
1	REGROUP	Architecture Change (For Flight )	P/F	4 RWA	Equipements Block	By Standard Design or with implementation of below Technos : Titanium parts + TPS (below) Ablative Foam / Ceramic Coating ? Ceramic Textile + Aerogel	YES	3	3		
2			P/L	4 RWA+ TANK	Module Block			3	3		
3				All P/F Elements on Bench				9	9		
4				All OP/L Elements				9	9		
5			P/L + P/F	RWA+ OP/L	S/C Core Block			3	3		
6				Tank+ OP/L				9	9		
7				P/F + P/L				9	9		
8	ADAPTIVE	Adaptative Change (For Reentry)	P/L + P/F	RWA + OP/L ? (OP/L)	Foldables Frames ?	SMA Hinges + TPS EOL Activated Mechanisms	YES	1	1		
9			P/L	De/Deployable Telescope ?	Folding Mechanisms ?			1	1		
10				De/Deployable SAR Antenna ?				1	1		
11						EOL Activated Mechanisms					
12	ATTACH	Specific Attachment	P/F & P/L	OP/L Brackets	Magic Rope Magic SMA Spring	Wire Link (+ TPS ?)	YES (rigid)	5	5		
13		I/F Change		OP/L Elements		SMA Spring + TPS	YES (final&rigid)	4	4		
14						Ceramic I/Fs	YES (rigid)	8	8		
15		Design Change		RWA Ti Mounting Base	Housing Material Change	UHT Materials	YES	9	9		
16					Others TBD	Standard HT Materials	YES	3	3		
17											
18	PROTECT	Protection Upgrade (HT)	P/L	OP/L panel Protection	Titanium Envelope	Titanium Envelope	YES	7	7		
19		Protection Addition		OP/L Baffle	Ceramics materials TPS	Ceramics materials TPS	YES (no brittle)	7	7		
20					Added TPS	Ablative Materials	YES (TBC)	7	7		
21		Heat Shield Implementation			Flexibles TPS	Flexible TPS	YES (rigid)	5	5		
22				OP/L Baffle -> Reentry Cone	Inflatable Shield	SMA Mesh & mechanisms	NO	2	2		
23						EOL Activated inflation device					
24				OP/L Baffle -> Reentry Cone	Deployable Shield	SMA Hinge	YES	5	5		
25						EOL Activated Mechanisms	YES	5	5		
26	ENCAPSULATE	Partial Encapsulation	P/L	OP/L Tube Closure	Panel Closure	SMA Hinge	NO or Final Shape	5	5		
27				OP/L Encapsulation	Net	Wire Mesh	NO	7	7		
28				OP/L Encapsulation	Bird Cage	Retaining Strips	?	5	5		
29				OP/L Titanium Enveloppe		Foldable Shields / Panels	YES (rigid)	5	5		
30		Total Encapsulation		OP/L C/C Tube	Box	Titanium Aeroshell	YES	5	5		
31				OP/L Heatshield		C/C Central Tube / Ceramic Cone	YES	7	7		
32						Adapted mixed heatshield Nose (Ceramics) Lateral (F-TPS)	YES	5	5		
33											
34											
35											
36											
37											

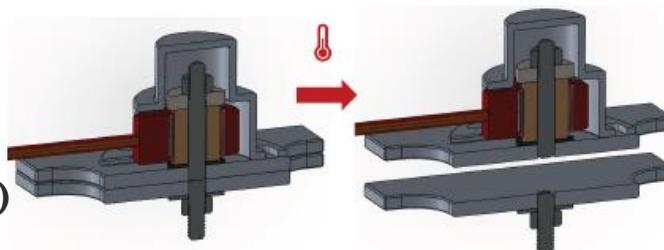
# 6. D4C "Design for Containment"

## Task 1



### STATUS :

#### SMA (Shape Memory Alloys)

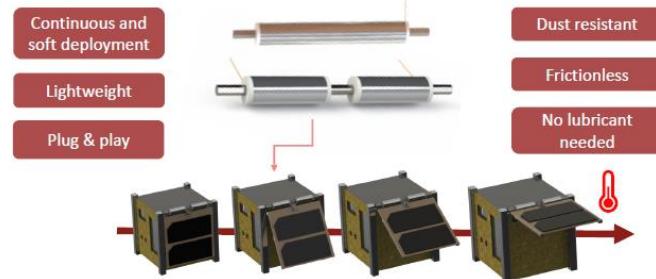


- ▶ Shockless: progressive deployment
- ▶ Wide operating temperature range (from -120°C to +80°C)
- ▶ Compatible with a broad range of satellites and spacecrafts
- ▶ 90° and 180° deployment
- ▶ High torque: up to 120 N.m

### APPROACH & SOLUTION :

#### Thermo activated Mechanisms

⇒ Need TPS (Max T°=600°TBC)



#### "SMA Washer / Screw Release" (TRL7)

⇒ "Adaptative Change" Mechanisms

#### "SMA Torque Hinge" (TRL5-6) -> TRL7@2023

=> Fold Baffle & Close Encapsulation Box

### OUTCOMES & RESULTS :

#### Moderate System Impact

#### Specific Application

Simulability OK (T° triggered)

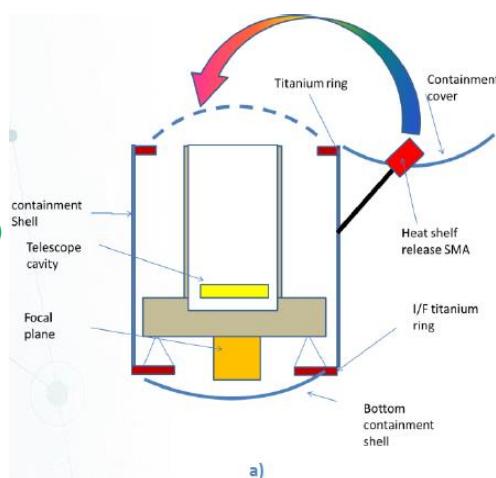


Figure 1-23 Example of (a) HR optical payload containment by a shell with close up cover and (b) Nimesis Self ignited SMA bolt release already qualified

	HECTOR® (SINGLE)		HES190	HES118	HES290	HES218	HES390	HES318
Dimensions	Total length (mm)	Fasteners length (mm)	90	180	270	220	110	220
Operational length (mm)	70	80	150	160	220	240		
Diameter (mm)	12.8	9.7	21.1	13.8	28.4	18.0		
Nominal deployment angle (°)	90	180	90	180	90	180		
Maximal deployment angle (°)	110	220	110	220	110	220		
Deployment accuracy <sup>1</sup> (°)	2	4	2	5	2	4		
Reproductibility (°)	1	2	1	2	1	2		
Maximal torque (N.m)	6	1	56	8	118	29		
Torsional stiffness (hot) (Nm/°)	1,7	0,2	17	1,2	53	4,3		
Torsional stiffness (cold) (Nm/°)	0,2-1,7	0,02-0,2	1,8-17	0,1-1,2	5,8-53	0,5-4,3		
Mass (g)	32	11	292	82	941	280		
Power (W)	32	11	145	41	469	140		
Nominal voltage <sup>2</sup> (V)	8	8	16	16	110	28		
Nominal current (A)	4	1,5	9	2,5	4,5	5		
Actuation duration (s)	300	300	600	600	600	600		

# 6. D4C "Design for Containment"

## Task 1

TOPIC: D4C Technos Devices

STATUS: SMA Springs

### 3.1 Spécimen d'essai

Réalisation ressort :

- D ext 46.5mm
- D int 42.5mm
- D fil 2 mm
- NiTi LM0441
- 5 spires



Etirement du ressort à son maximum à température ambiante.

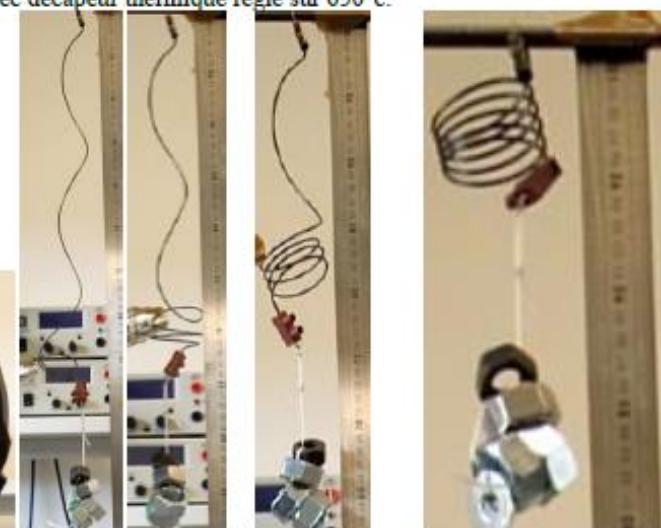


On utilisera une masse de 200 grammes pour simuler l'effort mécanique à fournir.

D'après la géométrie du ressort et la masse de 200 grammes on sera à une contrainte de von mises de 46 MPa en traction et 53 MPa en compression.

D'après le document DR1, on devrait avoir 330 MPa de limite élastique à 400°C et 68 MPa à 700°C.  
Donc théoriquement ce ressort pourrait supporter 200 grammes jusqu'à 700°C.

Réchauffage du ressort avec décapeur thermique réglé sur 650°C.



DANGER >600°C for SMA

⇒ Need F-TPS protection (NEXTEL Sleeve shape available)

### CONCLUSIONS:

Moderate System Impact / High DCA Potentiel

Several Applications / Low TRL3-4 (moderate confidence)

Simulability? (F-TPS & movements)



# 6. D4C "Design for Containment"

## Task 1

STATUS : F-TPS (Flexible Thermal Protection Systems)

Reentry Kit / Deployable Shield

### APPROACH & SOLUTION :

IAD: Inflatable Aerothermal Decelerator

DAD: Deployable Aerothermal Decelerator

"Light" Encapsulation Enclosure

### OUTCOMES & RESULTS :

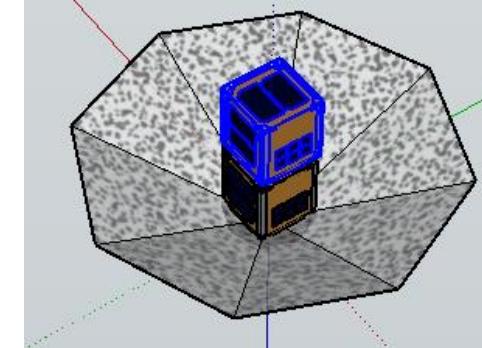
Moderate System Impact / **High DCA Potentiel**

Several Applications / **Low TRL4(FR) -7(EU)**

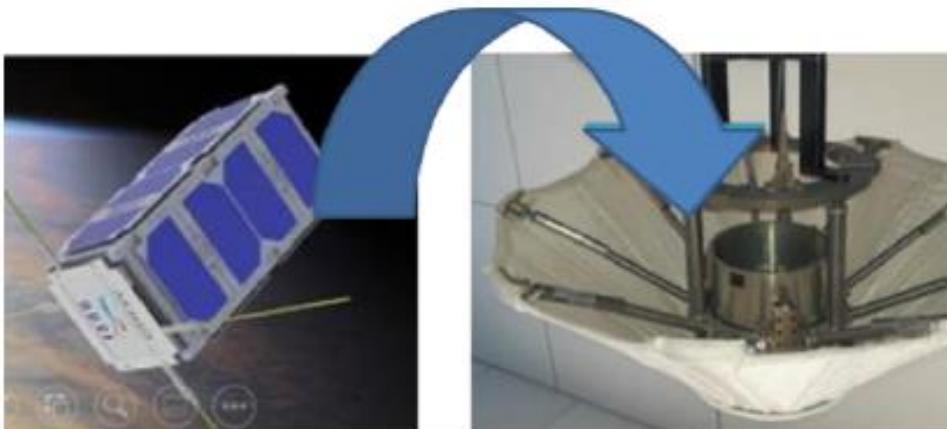
**Confidence <500KW/m<sup>2</sup> (Oxyde Ceramics)**

**Confidence >500KW/m<sup>2</sup> (Ceramics SiC / C-C)**

**Simulability**



- a) NASA inflatable heat shield surviving Mach 20 re-entry with temperature above 537°C.



**E.NOVA**

- b) deployable containment heat shield proposed by E.NOVA

Figure 1-9: Example of "full" containment solutions

# 7. Synthesis

## All Technos

**TOPIC:** ALL TECHNOS

D4D / D4B / D4C

**STATUS:**

INDUSTRIAL Developments

**CONCLUSIONS:**

Still Few Industrial Techno Available

UptoDate Status Unclear

⇒ Upgrade Industrial Survey

Dedicated Mailing Send

D4C : Design For Containment						Data	Techno TRL	System (0-5)	Confidence (0-5)		
N°ID	Techniques	Applicability	Supplier	H/W Technos							
1	D4D	P/F	Ariane Group_FR	Alu lined Prop Tank (HP)	BB02	CLEANSAT 2016	6	2	4		
2			Ariane Group_FR	PEEK Prop Tank	BB03	CLEANSAT 2016	2	4	2		
3			Ariane Group_DE	Alu Prop Tank	BB05	CLEANSAT 2016	4	2	4		
4			MT_Aero_DE	Alu Prop Tank	BB19	CLEANSAT 2016	7	2	4		
5		P/L	OHB	Demise OP/L_1	BB09_1. Mirror Segmentation	CLEANSAT 2016	2	4	4		
6				Demise OP/L_2	BB09_2. Pyro Bolts	CLEANSAT 2016	3	3	4		
7				Demise OP/L_3	BB09_3. Structure Brittle Break-up	CLEANSAT 2016	2	4	1		
8		P/F	ALTRAN_FR / RCD_DE	Demise RWA	BB11_1. Alu Large Flywheel	CLEANSAT 2016	5	2	2		
9				Demise RWA	BB11_2. MECH DownSizing/ELEC Upgrade	CLEANSAT 2016	5	2	2		
10				Demise RWA	BB11_3. Core Demise Options	CLEANSAT 2016	2	2	2		
11			ESA / RCD / HTG	Demise RWA	GSTP	CSID 2018	3	5	2		
12				Demise RWA_Thermites	GSTP	CSID 2018	5	2	5		
13			LUSOSPACE_PT	Demise MTB ?	BB18	CSID 2017	3	1	4		
14			KONGSBERG_NO	Demise MTB ?	GSTP	CSID 2017	5	1	3		
15			PZL_PL	Demise TANK? Drivers	GSTP	CSID2021	4	1	3		
16			MT Aerospace_DE	Demise TANK			3	2	4		
17			PEAK_AT	Demisable HP Tanks_LEO Satcoms			6	3	4		
18		P/L	Polito/Reactive	Thermites	ESA SPADEOXO	FAR2022_s03.02.02	5	2	4		
19			D4B	Belstead	Demisibility Structural Joint	BB12.Bolted Joints	CLEANSAT 2016	5	3	4	
20						BB12.Riveted Joints	CLEANSAT 2016	5	3	4	
21						BB12.Brazed Joints	CLEANSAT 2016	5	3	4	
22						BB12.Welded Joints	CLEANSAT 2016	5	3	4	
23				Ariane Group_DE		BB12.Soldered Joints	CLEANSAT 2017	5	3	4	
24						BB12.Bonded Joints	CLEANSAT 2016	5	3	4	
25				P/F & P/L		BB12.Inserts	CLEANSAT 2016	5	3	4	
26						BB06.Release Screw	CLEANSAT 2016	3	2	4	
27						BB06. Release Anchor Nut	CLEANSAT 2016	3	3	4	
28				ALTRAN / NIMESIS	BB10_1. SMA Washer_Screw Brk-up	CLEANSAT 2016	7	3	4		
29					BB10_2. SMA Inserts_Screw Release	CLEANSAT 2016	3	2	2		
30					BB10_3. SMA Cutting Cord	CLEANSAT 2016	1	4	1		
31					BB10_4. SMA Sleeves	CLEANSAT 2016	1	4	1		
32					BB10_5. SMA Hinges	CLEANSAT 2016	5	2	4		
33				D4C	NIMESIS	SMA Washer_Screw Brk-up	NIMESIS Datasheet	4	4	3	
34						SMA Hinge_D4D Hinges ?	NIMESIS Datasheet	7	4	4	
35					TAS-I	GSTP_E1.Washer EZAC	CSID 2018	5	2	2	
36						GSTP_E1_Washer BABBIT	CSID 2018	5	2	2	
37					OHB/INVENT	D4BB_1. SMA Cylinder (NIMESIS)	CSID2021	8	3	4	
38						D4BB_2. Inserts 2 parts (Bonded/solder)	CSID2021	5	3	4	
39						D4BB_3. Composite Insert	CSID2021	5	3	3	
40						D4BB_4. Bonded Cleats	CSID2021	9	1	3	
41				D4C	EPFL	CF-PEEK Demise Fasteners	FAR2022_S03.02.04	4	3	2	
42					DLR	3DP_CF-PEEK	FAR2022_S03.02.03	3	2	2	
43					NIMESIS	Release Insert	NIMESIS		4	3	
44					ADS_FR	Monolith OP/L Bench		9	3	4	
45					OHB_DE	Un-Demisable Tether, "Magic Wire"	D4BB / D4C	CSID 2018	3	3	
46						Thermal Container	D4BB / D4C	CSID 2018	6	4	
47						Non-Demisable Mount	D4BB / D4C	CSID 2018	9	2	
48						Net / Cage	D4BB / D4C	CSID 2018	3	2	
49				TAS_FR	Non Demisable Tether "Magic Wire"	ESA D4C_Design for Containment	FAR2022_s03.02.01	3	3	3	
50					Encapsulation	ESA D4C_Design for Containment	FAR2022_s03.02.01	6	4		
51					Non-Demisable I/F	ESA D4C_Design for Containment	FAR2022_s03.02.01	9	2		
52					Net / Cage Enveloppe	ESA D4C_Design for Containment	FAR2022_s03.02.01	3	3		
53					Other TBD	ESA D4C_Design for Containment	FAR2022_s03.02.01				
54					Other TBD	ESA D4C_Design for Containment	FAR2022_s03.02.01				
55					NIMESIS	SMA Torque Hinge	Hector (Internal Devt + R&T CNES)	NIMESIS Datasheet	6		
56			eNOVA/NIMESIS		SMA" Magic Spring" _ Regroup Link	eNOVA/NIMESIS		4	3		
57			NIMESIS		4DPrint Mechanism Parts	GSTP_E1_A09894_4DPrint	EUCASS 2021	6	4		
58											
59											

# *H/W INNOVATIVE Project Initiative*

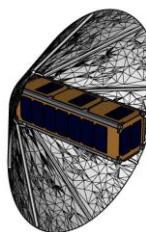
## *"BFS : Fly your stuff BACK From SPACE"*

### STATUS

A lot of scientific experiments need human intervention in ISS facility

NEWSPACE Market to get experiments in space and **back to Earth**

=> Experiments on Cubesats & recovered on Earth with Reentry Kits



### APPROACH & SOLUTION

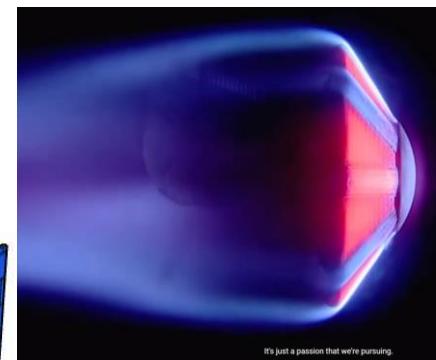
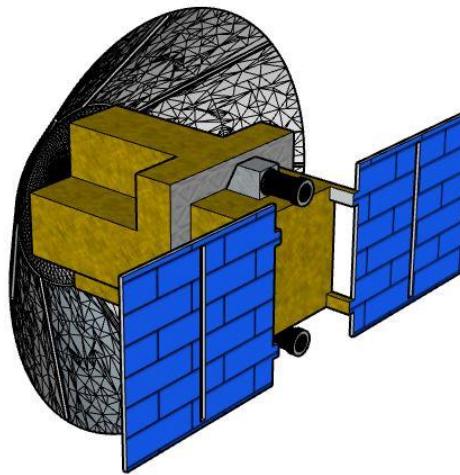
Tech DEMO Experiment (aging, HRAD°, ATOX or MMOD Flux exposure)

Science & exploration (Asteroid mining, Extra-terrestrial samples recovery)

Production High-Tech or added-value (ABIS, Fibre Optics Assy & Build in Space)

Space Environment qualification (Material, Process, EEE, demonstrator)

Solar Cell samples calibration/recovery for flasher tests



### OUTCOMES & RESULTS

Reentry Kits Solutions / Market Survey (Bio & Pharma)

Potential applications: science & technological P/L



*ifth* Institut Français du  
Textile et de l'Habillement



BFS "Back From Space"

# F-TPS Consortium (2022)



French « Plan de Relance »  
« Innovative Technologies for  
NANOSAT »  
**18months Activity** with Collaborative  
Funding



**IFTH : Textile Expertise**  
(Flexible Thermal  
Protections)  
**Material & Process**  
Expertise  
Production & Tests



**RTech: Computed Fluid  
Dynamics (CFD)**  
AerothermoDynamics



**Management, Aerospace  
Network**  
**Mission & System  
Engineering**  
**Consortium Coordination**



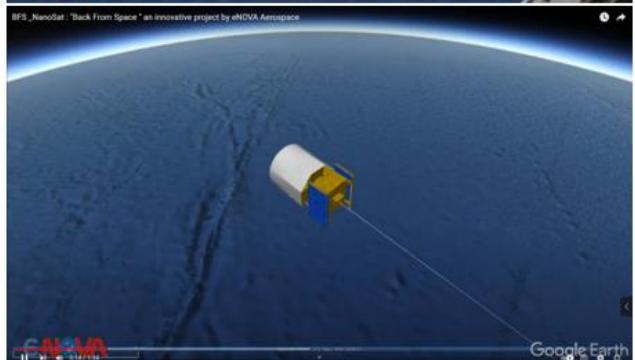
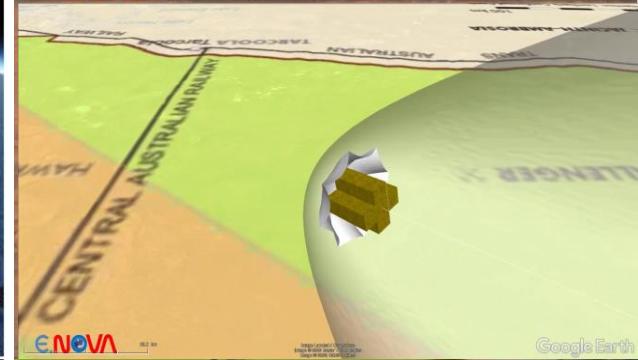
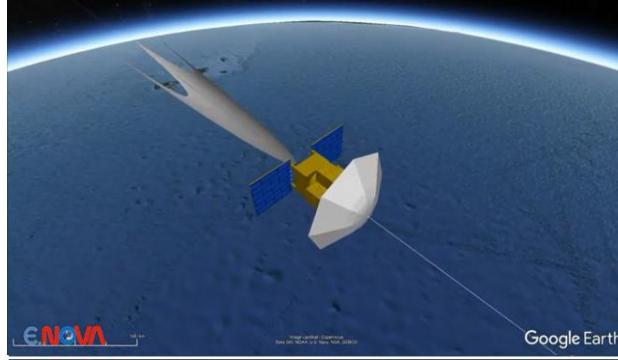
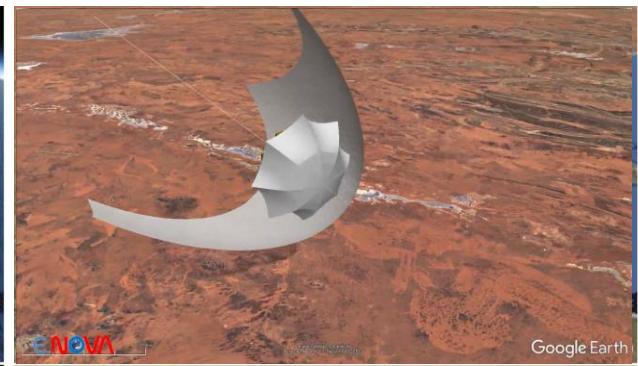
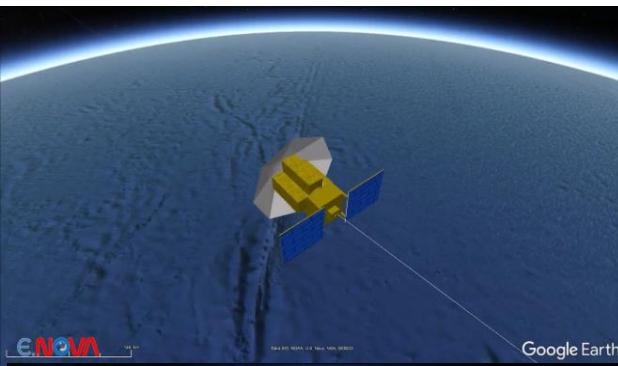
**CNRS-INSIS : Aerothermal  
Tests**

**PHEDRA** (*Soufflerie à Plasma Hors  
Equilibre De Rentrées Atmosphériques*).

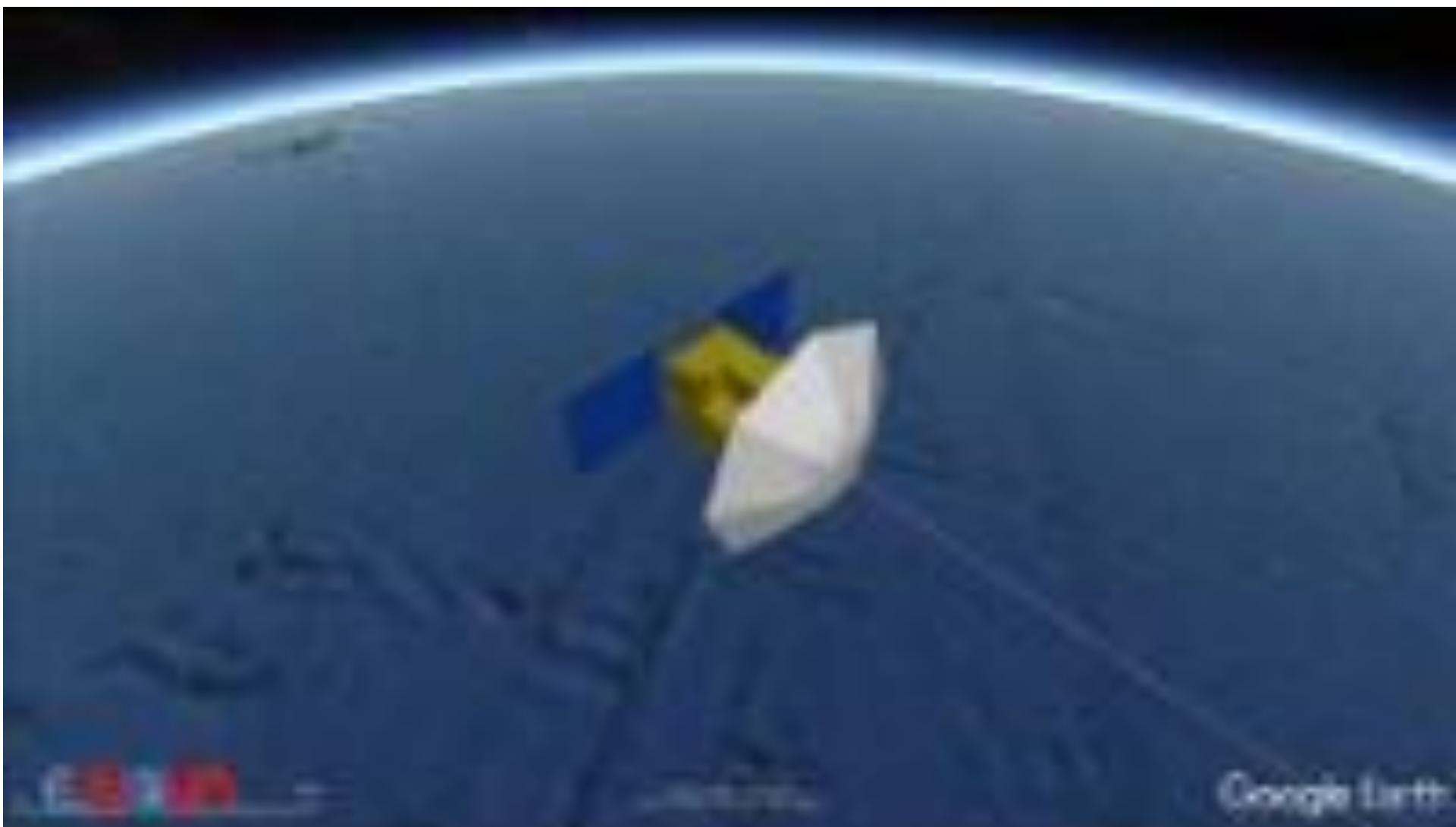


BFS\_NanoSat - "Back From Space" an innovative project by eNOVA Aerospace

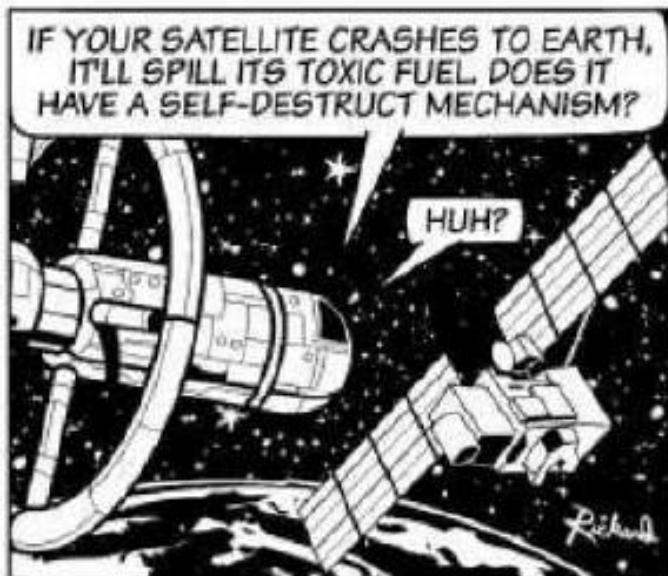
[https://youtu.be/m5\\_PHDM7azg](https://youtu.be/m5_PHDM7azg)



**e.NOVA**  
AeroSpace



**E.NOVA**  
AeroSpace



Another D4D Techno ?  
No, Just Kidding !!