



CambU Graphene Conference 6Nov15: 2D Material -> 'Help make things fly better'

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Airbus Defence & Space, 4 November 2015

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Introduction

(Aero)-Space 2D Materials Challenge Scope

Introduction - Help us 'make things fly' better

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Proprietary

Graphene/2-D Material System User Challenges:

- **All our Platforms are 'Fighting Gravity'!** (even GEO Satellites N/S Station Keeping)
Particularly Helicopters, Launchers...
- **Key Performance Indicators (KPI's)...**
 - Function/Mass = Fuel saved = Environment impact reduced = Opex Money ...
 - Performance affected by Temperature, Vibration (eg. Imager), Pressure/Aero-load...
- **G+/2-D Material Opportunities:**
 - Anisotropy
 - New/disruptive properties eg. Conductivity, Tensile strength, ≈ 0 eV BandGap s/c....
 - Mid-life Upgrades
 - New Industry Trends (Exploit?) eg. e-Plane/e-Sat..., ALM/3D,...
 - Obsolescence (eg. Look at 3D printing lessons learnt)
- **Remember the foundations of (Aero-)Space:**
 - Reliability eg. Lessons learnt from Aramide PCB's
 - Cost (NRE/RE)
 - Safety/Certification
 - Manufacturing, Assembly & Test
 - Lightning/RFI/EMI
 - TTM
 - RTM
 - RISK/Reward
 - Maintenance & Support = HUMS
 - Services!!

Platforms

(Aero)-Space 2D Materials Challenge Opportunities

Aircraft – S/M/L Transport, Multi-Role Tanker Transporters, Combat..

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A400M Capability Development Sep2015

4:35 24x 1T Parachute Delivery



Propellors/Rotors

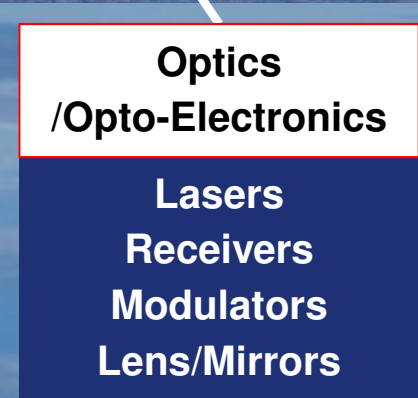
**Stresses
Vibrations..**



Displays

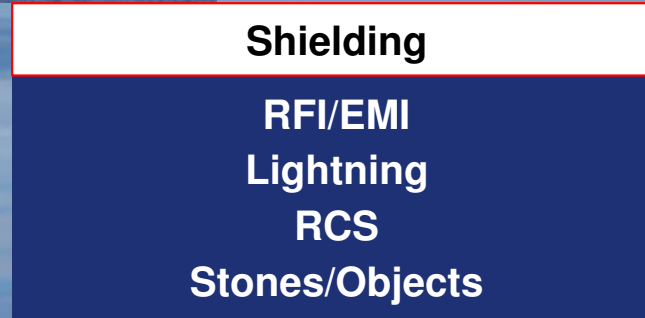
**Tactile
Strength
Contrast...**

RAF Voyager air-to-air refuelling



**Optics
/Opto-Electronics**

**Lasers
Receivers
Modulators
Lens/Mirrors**



Shielding

**RFI/EMI
Lightning
RCS
Stones/Objects**



Ice Prevent/De-Ice

**Thermal
E-Mechanical...**



Structures

Advanced Composites

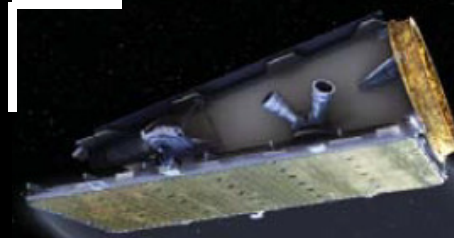
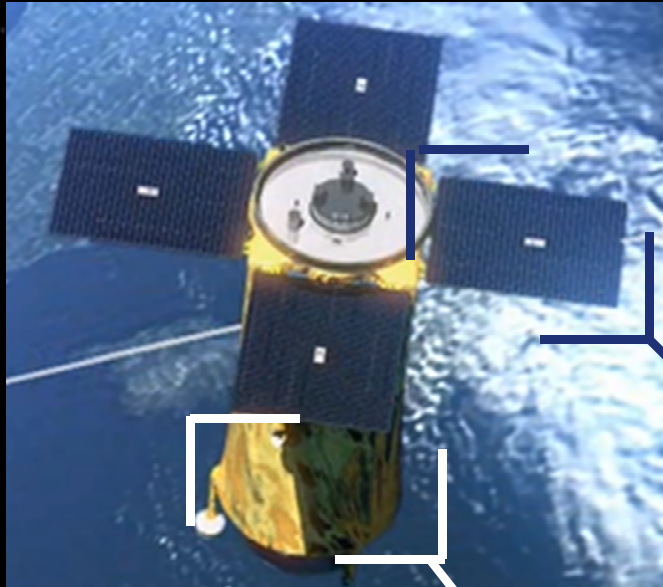
Batteries/Supercapacitors

**Energy Storage
Thermal management**

LEO Satellites – Major Industry Trend to Constellations...VHR...SAR/AIS

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Structures

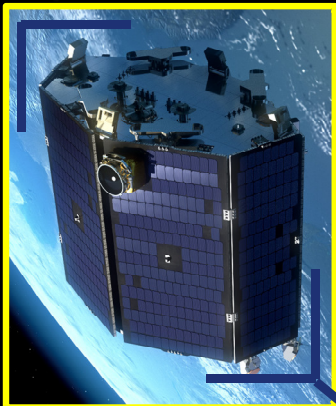
Advanced Composites

Solar Arrays

**Efficiency >28%?
Thermal management
Cover Glass?**

Multi-Layer Insulation (MLI)

Thermal Shield



Batteries/Supercapacitors

**Energy Storage
Thermal management**

[Airbus D&S Clip VFS Full.wmv](#)

2:40-3:10 Constellations

4:30-5:51 Comm's via GEO Data Relay

HEO/MEO/GEO – ‘Fight the Radiation’ -> Live for >15yrs!

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Antennas & Mechanisms

Structural Integrity
Conductivity

Shielding

(Selective) Radiation
RFI/EMI

Batteries/Supercapacitors

Energy Storage
Thermal management

Optics /Opto-Electronics

Lasers
Receivers
Modulators
Lens/Mirrors

Structures

Advanced Composites

Solar Arrays

Efficiency >28%?
Thermal management
Cover Glass?

e-Thrusters

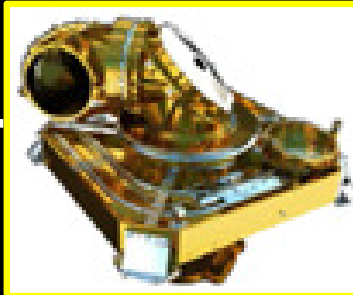
Clever Cathodic Tech's
Thermal Management

Radiators

Mirrors
Cover Glass?

Multi-Layer Insulation (MLI)

Thermal Shield



Laser Comm's

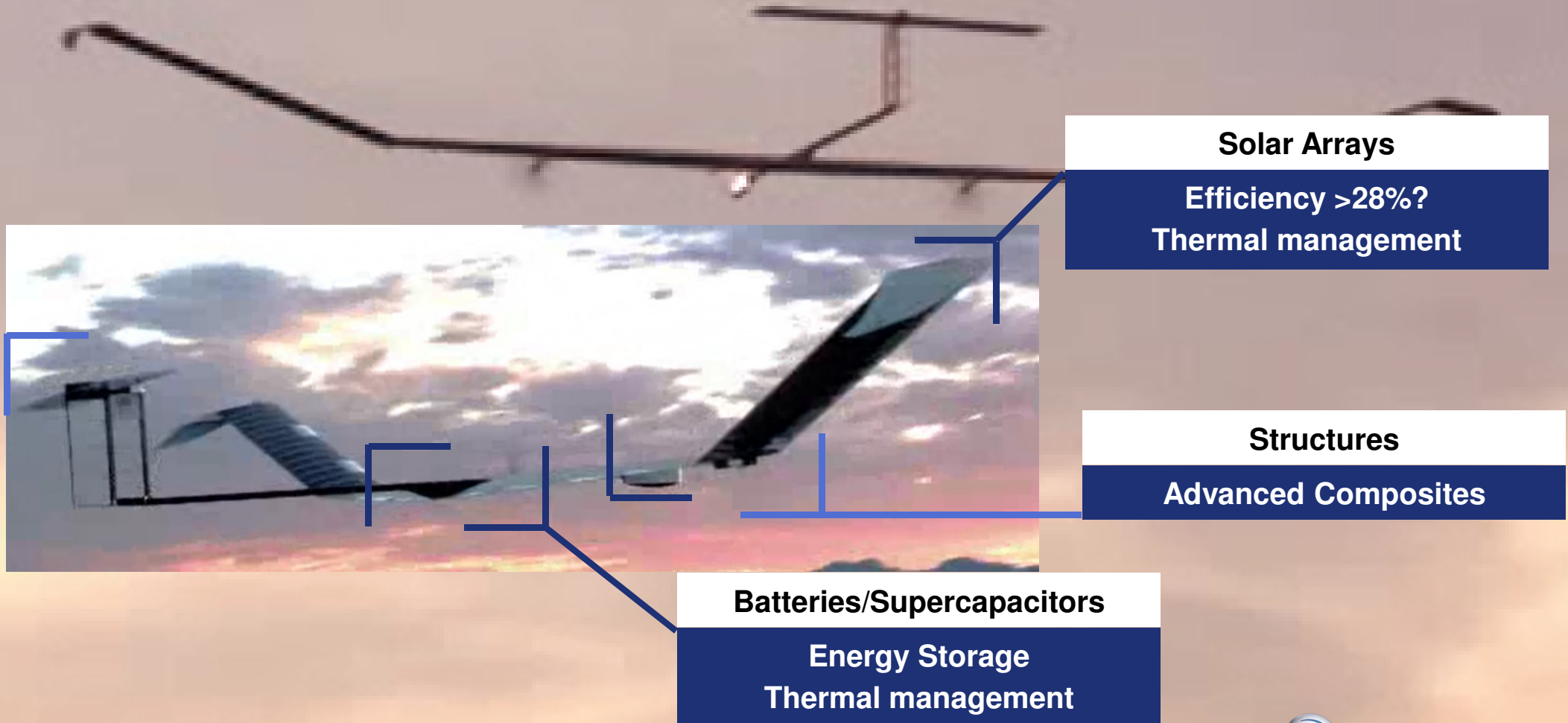
Airbus D&S Clip VFS Full
4:30-5:51 Laser Comm

High Altitude Pseudo Satellites (HAPS) – is it a plane or a satellite?!

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150907 AirbusDS Zephyr Update.wmv



Conclusions

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- **Could have talked about:**
 - Communications – tamper proof modules, portable SatCom...
 - Helicopters – even more of a 'Gravity challenge'!
 - Launchers – Hypersonic stresses, Cryo-structures, Vibration...G-forces
 - ...
- **The Big Q:** Can a monolayer (2-D) enhance (Aero)-Space Platforms & Payloads?
- Manufacturability, Safety, Reliability & Certifiability...are the Barriers-of-Entry
- **The Big Opportunity:** What Disruptive/New Capabilities do these Materials offer?
- **Last (Personal) Thoughts:**
 - Consider all 2-D materials, not just G+ eg. Phosporene,SiC?
 - No-one is yet properly exploiting anisotropy
 - ...SERVICES (SeRL!)

Contributions from: various EDRS, Airbus Defence & Space, SSTL and TESAT team members

THANK YOU

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