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# HVM17 GNM17 Conference, 2-3 Nov 17

## How 2-D & Nano-materials and HVM could help AeroSpace/Space fly better

Martin Agnew, R&T Management (DISCON), AD&S Central Engineering,  
Airbus\_HVMandGraphene\_to\_help\_fly\_better\_MJA\_Is0\_1\_1Nov17.pptx,  
Issue 0.11, 1Nov17

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## Introduction

Abstract, Introduction - Help us 'make things fly' better,  
Requirements Summary Table – Martin's selection...

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# Abstract

HVM17 GNM17 Conf - How 2-D & Nano-materials and HVM could help AeroSpace/Space fly better

"The recent advances in 2-D & Nano-materials (eg. Graphene, MX-ene's, CNT's...) and the continuing advances in High Value Manufacturing (eg. Ultra-Precision and ALM/3D Printing, ...) allow unique opportunities for early application in Space & Aerospace platforms for secondary structures and payloads where mission criticality will not be compromised. The author will outline his personal view of the possibilities and the drivers/barriers-to-adoption for a range of platforms and applications; both from Airbus & other suppliers."

# Introduction - Help us 'make things fly' better

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- **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,  $\approx 0\text{eV}$  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)
- **HVM Opportunities:**
  - Via breakages
  - Wheel bearings - Vibration, Lifetime
  - Propellant Injectors
  - Mirror finishes
  - Stiction
  - Dendrite Growth (Temp Cycling -> Moisture Ingress -> Dendrites -> Shorts -> Pulses)
  - Dust > precision => Cost
  - Alignment vs Precision finish
  - ....

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# Requirements Summary Table – Martin's selection...

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- **Vibration**
- **Shock**
- **Temperature:** Absolute temp extremes, #Cycles, thermo-elastic distortion
- **Radiation:** Van-Allen, Solar Storms (CME), Solar-Wind...
- **Solar aging (UV)**
- **Interference & Jamming**
- **Cryo & Toxic Materials/Fuels**
- **Hypersonic Drag, Thermals...**
- **COST(NRE/RE)!**

## Remember the foundations of (Aero-)Space:

- **Reliability** eg. Lessons learnt from Aramide PCB's
- **Safety/Certification**
- **Manufacturing, Assembly & Test**
- **Lightning/RFI/EMI**
- **Time-to-market (TTM)**
- **Route-to-market (RTM)**
- **RISK/Reward**
- **Maintenance & Support = HUMS**
- **Services!!**

# Platforms & Networks

## (Aero)-Space, Sea & Ground Challenge Opportunities

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

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A400M Capability Development Sep2015

4:35 24x 1T Parachute Delivery

RAF Voyager air-to-air refuelling

**Propellers/Rotors**

Stresses  
Vibrations..

**Shielding**

RFI/EMI  
Lightning  
RCS  
Stones/Objects

**Batteries/Supercapacitors**

Energy Storage  
Thermal management

**Structures**

Advanced Composites

**Ice Prevent/De-Ice**

Thermal  
E-Mechanical...

**Displays**

Tactile  
Strength  
Contrast...

**Optics  
/Opto-Electronics**

Lasers  
Receivers  
Modulators  
Lens/Mirrors

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

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## Solar Arrays

Efficiency >28%?  
Thermal management

## Structures

Advanced Composites

## Batteries/Supercapacitors

Energy Storage  
Thermal management

## Payload

Function/Mass/Power

[150907 AirbusDS Zephyr Update.wmv](#)  
[SDHforUAVs AirbuDS Febr2014.wmv](#)  
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# Launchers

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Structures

Advanced Composites

Sky5B Launch 8/Feb/2008

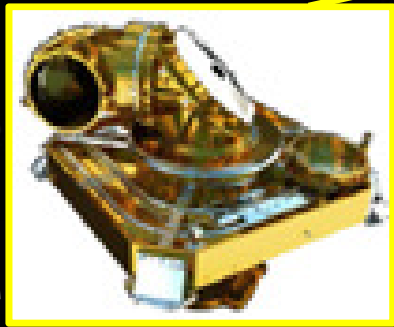
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# HEO/MEO/GEO – ‘Fight the Radiation’ -> Live for >15yrs! High Altitude

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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



**Laser Comm's**

Airbus D&S Clip VFS Full.wmv  
4:30-5:51 Laser Comm's  
EDRS General Movie  
EDRS ESA Tesat.wmv  
4:30-5:30 Laser Comm's

- Solar Arrays**
- Efficiency >28%?  
Thermal management  
Cover Glass?

- e-Thrusters**
- Clever Cathodic Tech's  
Thermal Management

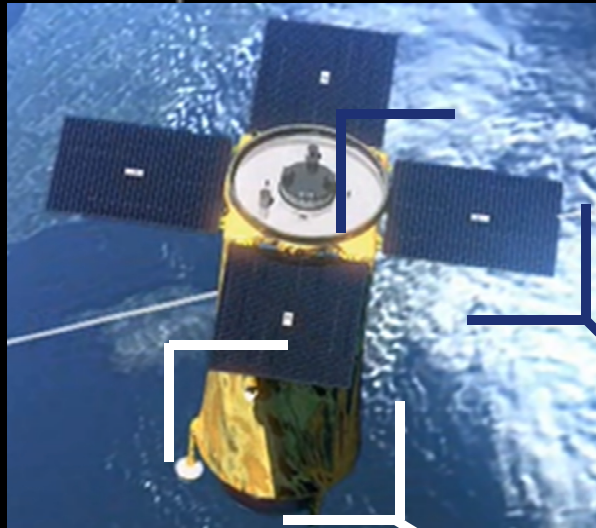
- Radiators**
- Mirrors  
Cover Glass?

- Multi-Layer Insulation (MLI)**
- Thermal Shield

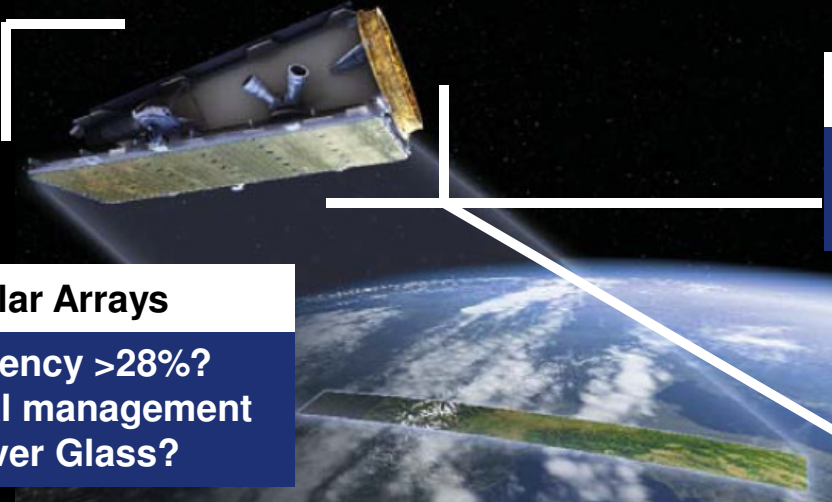
- Structures**
- Advanced  
Composites

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

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

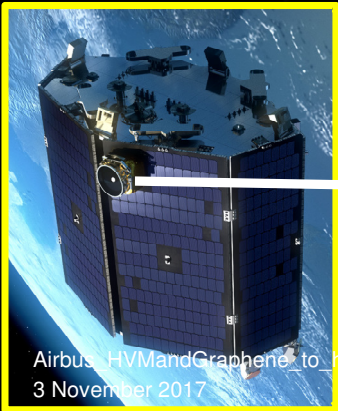


**Structures**  
Advanced Composites

**Batteries/Supercapacitors**  
Energy Storage  
Thermal management

**Multi-Layer Insulation (MLI)**  
Thermal Shield

**Optics /Opto-Elect.**  
Lasers  
Receivers  
Modulators  
Lens/Mirrors



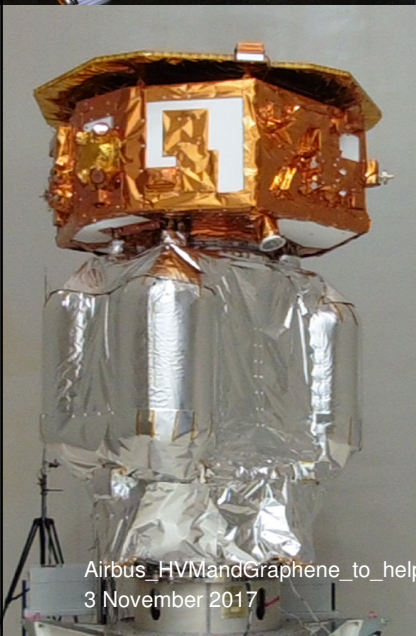
Airbus HVMandGraphene to help fly  
3 November 2017

Airbus D&S Clip VFS Full.wmv  
2:40-3:10 Constellations  
4:30-5:51 Comm's via GEO Data Relay

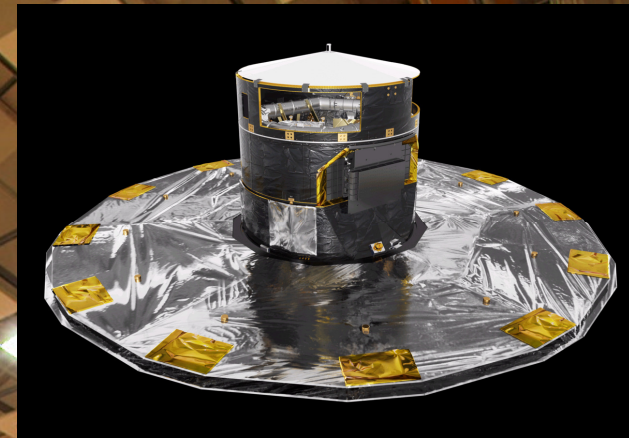
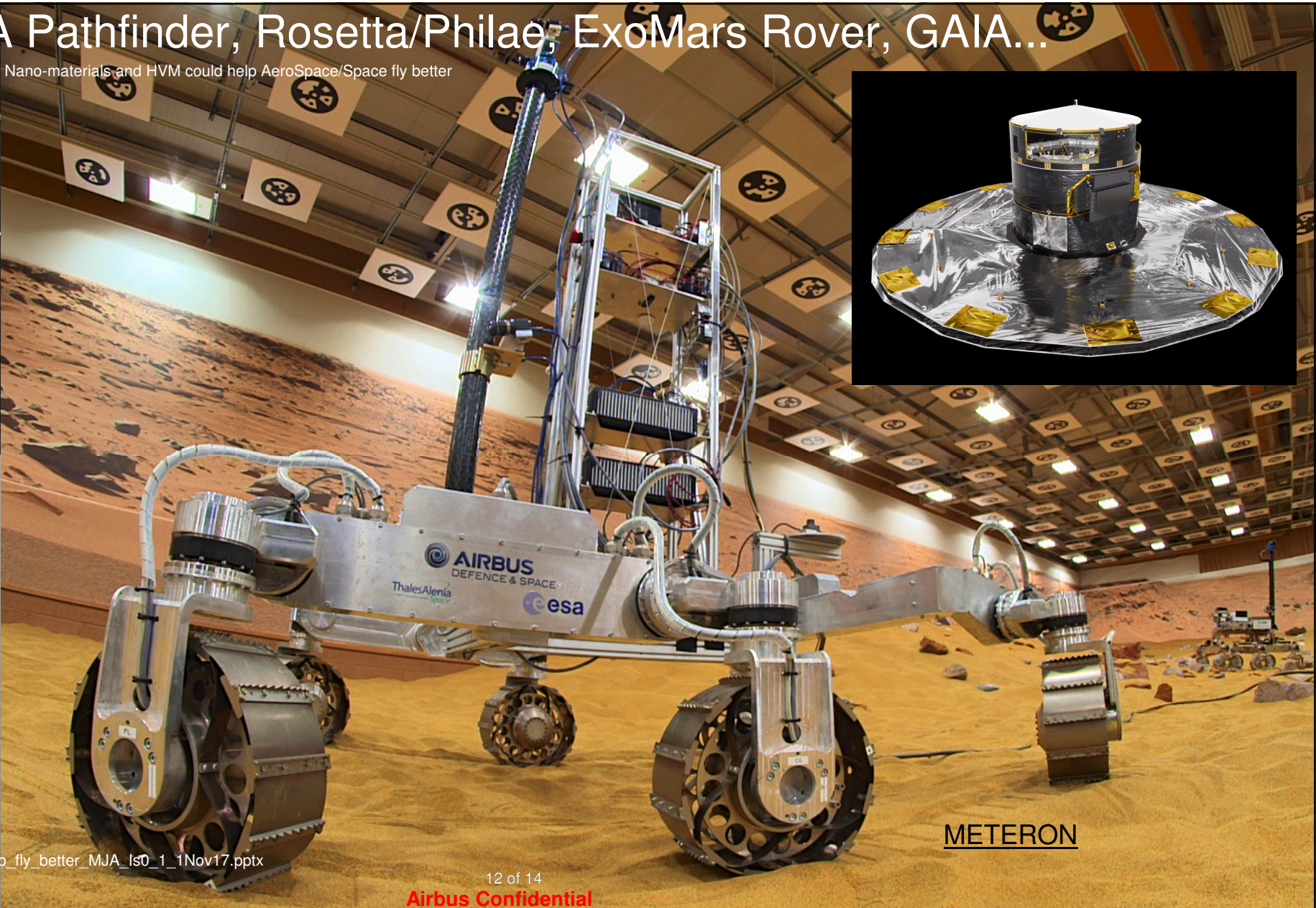
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# Science – LISA Pathfinder, Rosetta/Philae, ExoMars Rover, GAIA...

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METERON

# Conclusions

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- **Justin asked me to take the User's perspective, I could have talked about:**
  - Commercial Aircraft ...
  - Helicopters - even more of a 'Gravity challenge'!
  - ...
- **Timescales in Aerospace & Space for mission critical systems & primary structures can be very long (>10yrs) - we don't want another Comet window issue!**
- **But opportunities exist much nearer term:**
  - **Medium term (3-5yrs) on secondary structures lacking redundancy**
  - **Short term (1-2yrs) on payloads, and ancillaries & secondary structures with redundancy**
- **The Big Q: Can a monolayer (2-D) enhance (Aero)-Space Platforms & Payloads?**
- **Manufacturability, Safety, Reliability & Certifiability...are the Barriers-of-Entry... & Opportunities**
- **The Big Opportunity: What Disruptive/New Capabilities do these Materials & HVM offer?**
- **Last (Personal) Thoughts:**
  - Consider all 2-D materials, not just G+ eg. MX-ene's?
  - No-one is yet properly exploiting anisotropy
  - HVM is producing 'New Industrial Revolution's eg. ALM, Digitisation
  - **SERVICES (SeRL!) are the future (PaaS, GaaS, ...) - HVM & 2D Materials are key enablers**

Contributions from: various ABG RM, Airbus Defence & Space team members



# THANK YOU

Eur Ing **Martin Agnew** CEng MIET MIEEE  
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