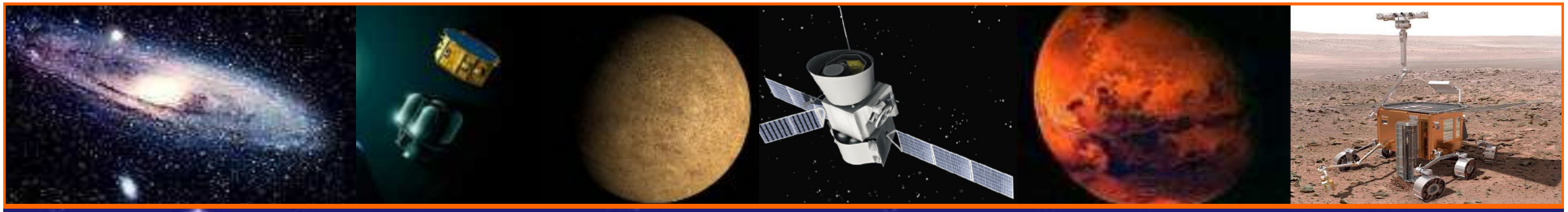

Science missions from an industrial view

Matthew Stuttard

Science and Exploration, Future Programmes, UK

9th Dec 2010

All the space you need

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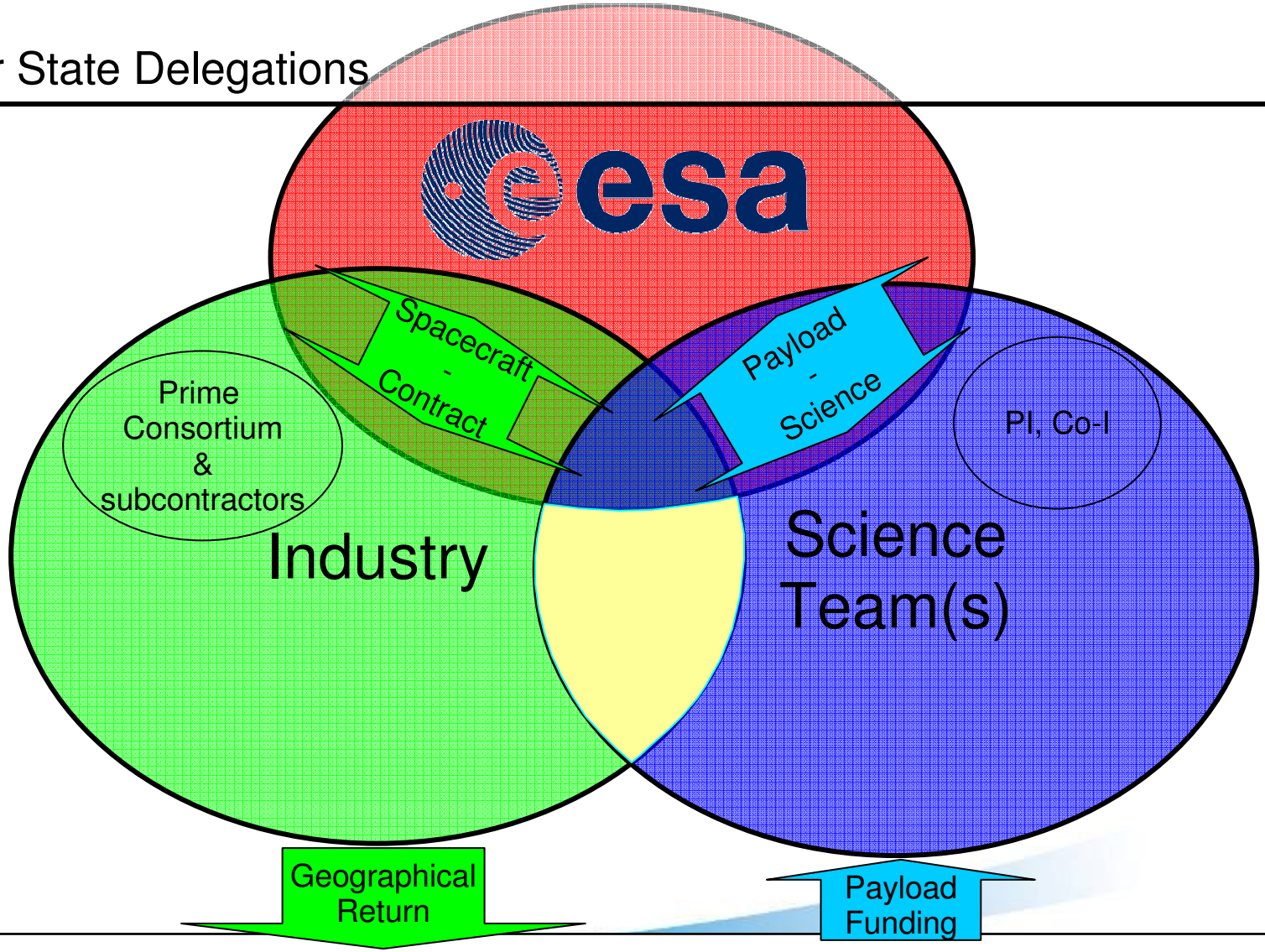
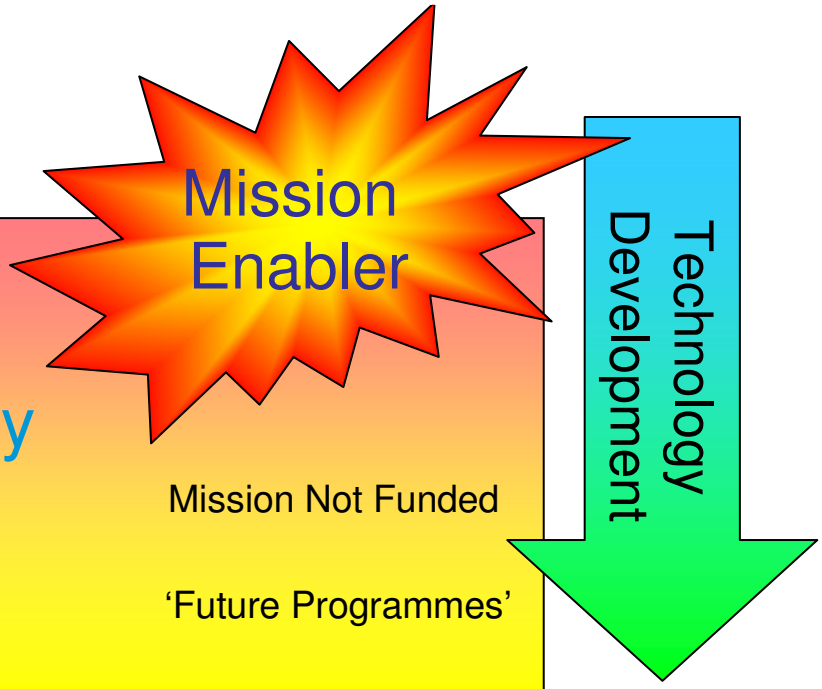
AN EADS COMPANY

Member State Delegations



ESA Mission Phases



- Pre-Phase A, Conceptual Study
- Phase A, Preliminary Analysis
- Phase B, Definition

Mission Not Funded

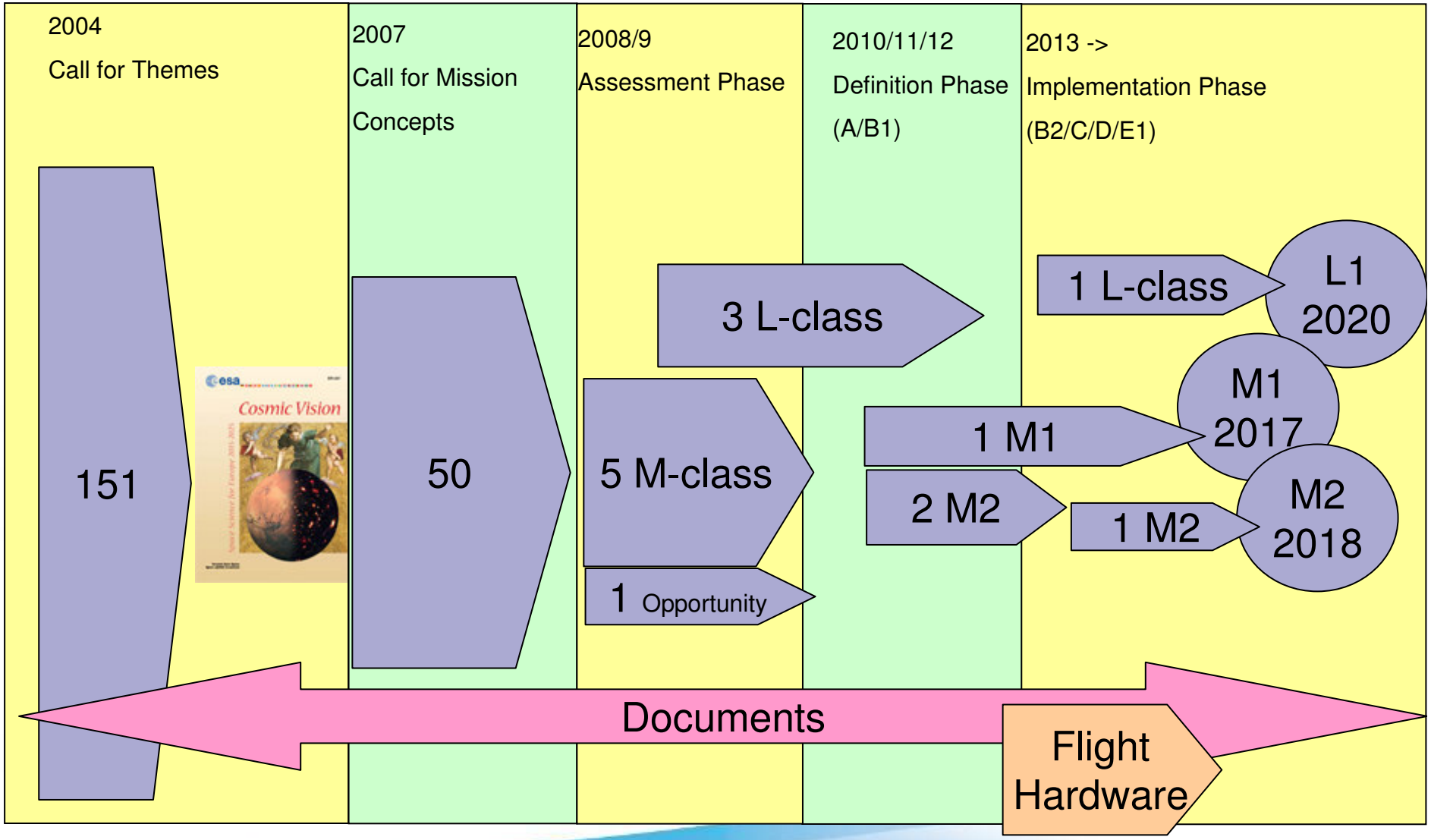
'Future Programmes'

Mission "Funded"

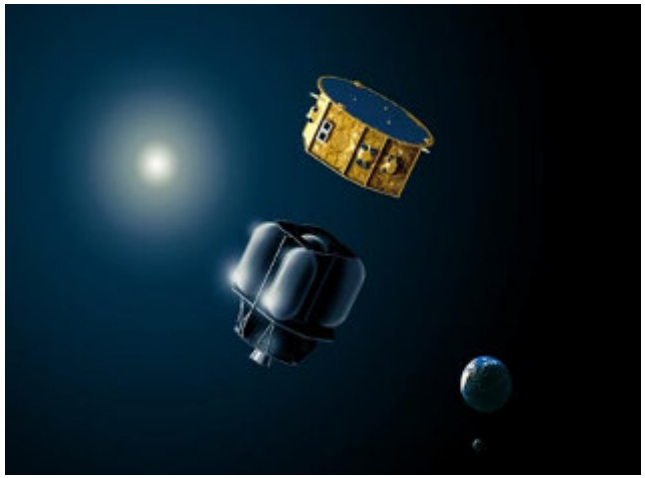
'Projects'

- Phase C/D, Design and Development
- Phase E, Operations Phase
  - E1: Launch and Commissioning
  - E2: Science Operations

ESA – ‘Cosmic Vision’ - Mission Selection Process



LISA Pathfinder - from Artists Impression to Hardware

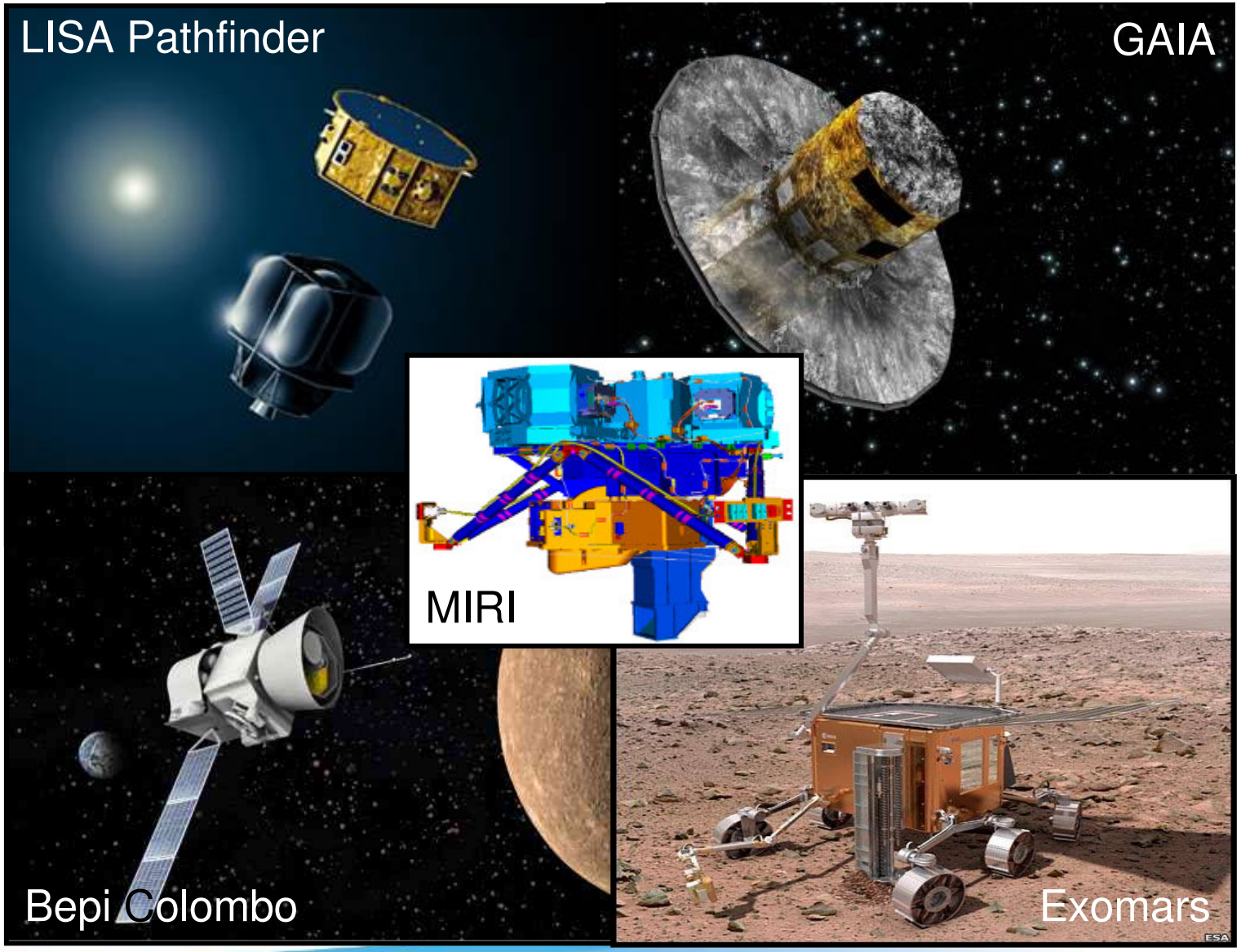


Propulsion Module without blankets

Structural Test and Flight Models

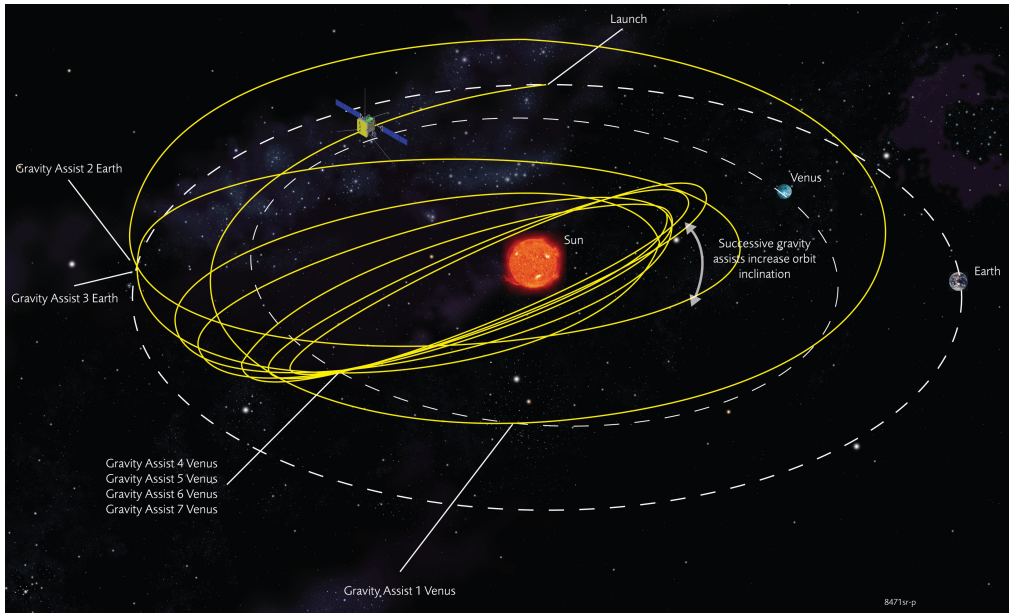
Transfer Orbit Thermal Test in Solar Simulator

Science & Exploration Missions in Implementation

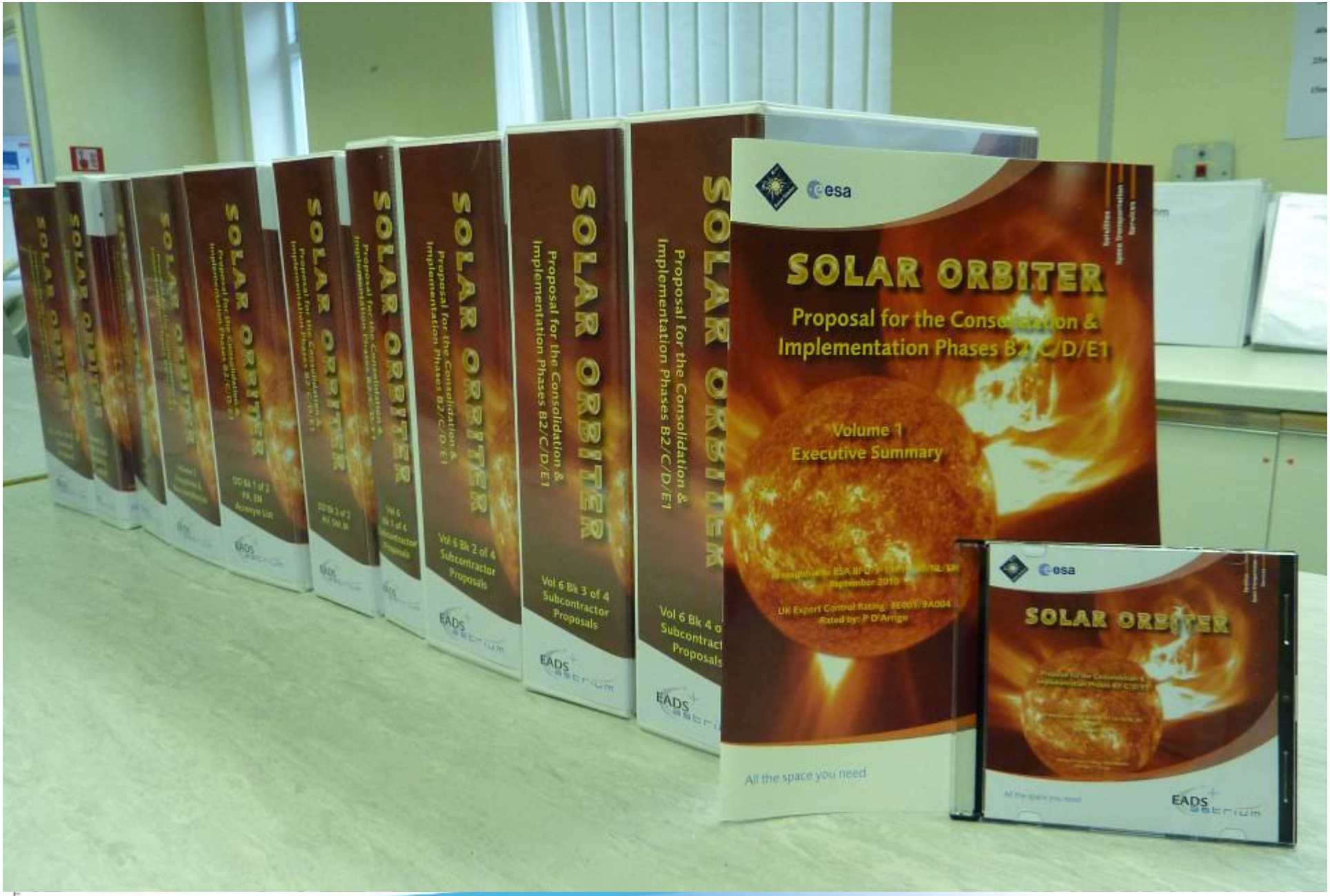


Solar Orbiter – entering implementation

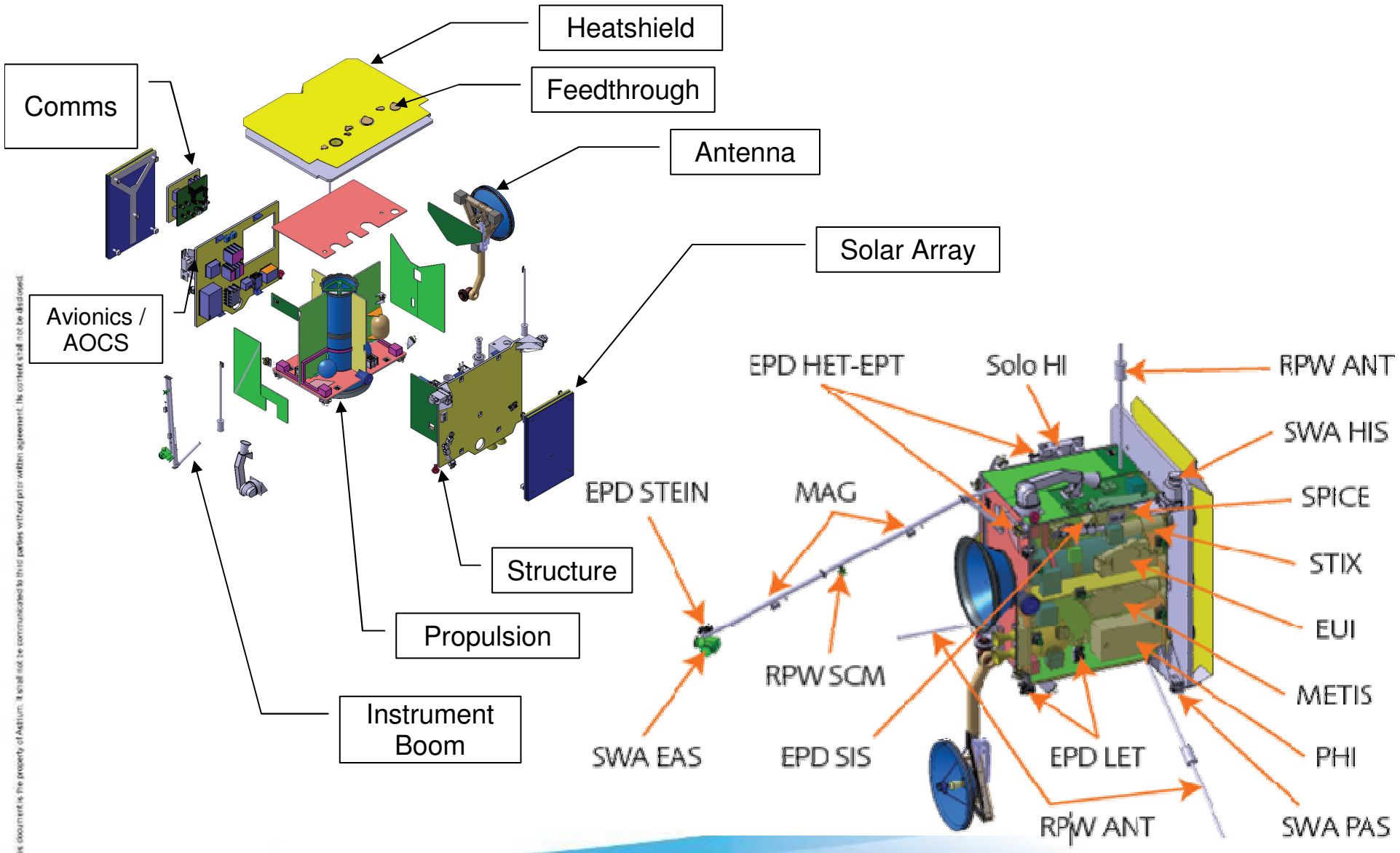
- Astrium UK leads Phase B1X
  - May 2008 – Dec 2010
  - System design, Payloads
  - Electrical architecture
  - Mech & Thermal architecture
  - Feedthroughs, doors, mech
  - Propulsion system
  - Technologies, Costing …



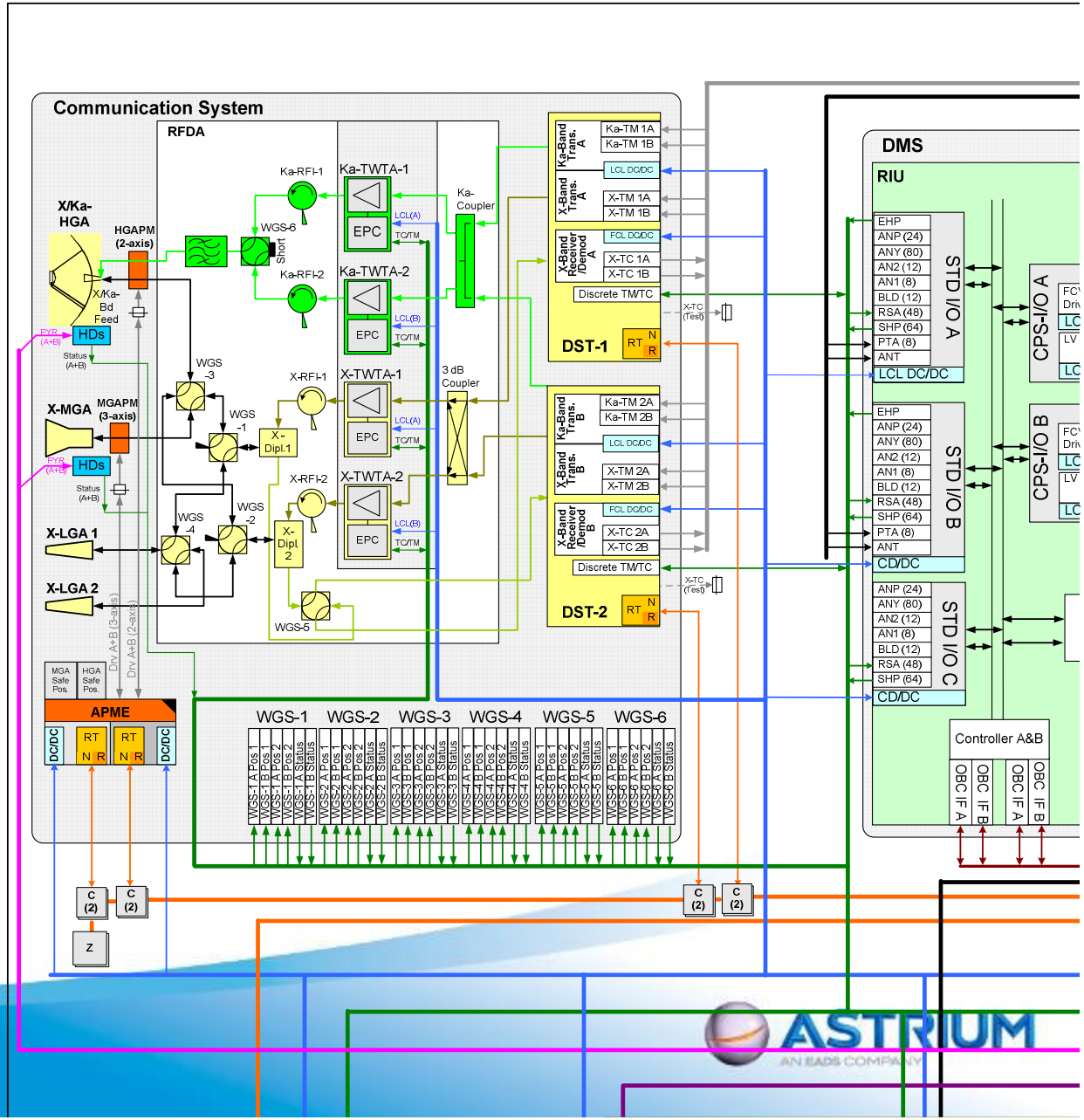
- Phase B2/C/D Prime Proposal
  - Submitted Sept 2010


SOLAR ORBITER
Proposal for the Consolidation & Implementation Phases B2/C/D/E1
Volume 1
Executive Summary
esa
All the space you need
EADS astrium

ESA Science Missions - Organisation



Solar Orbiter Design Overview



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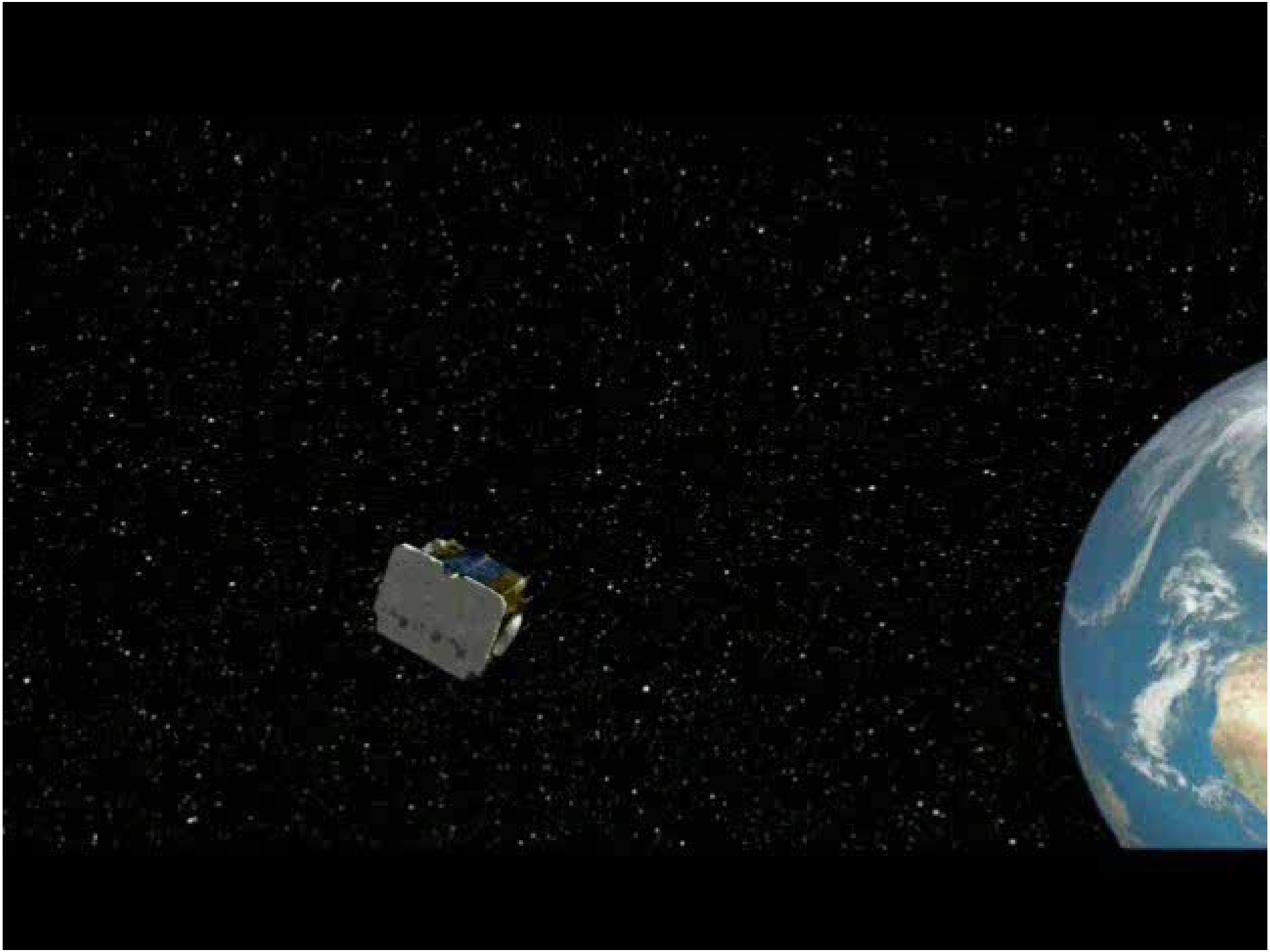
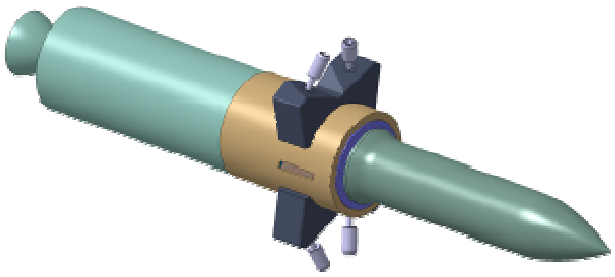


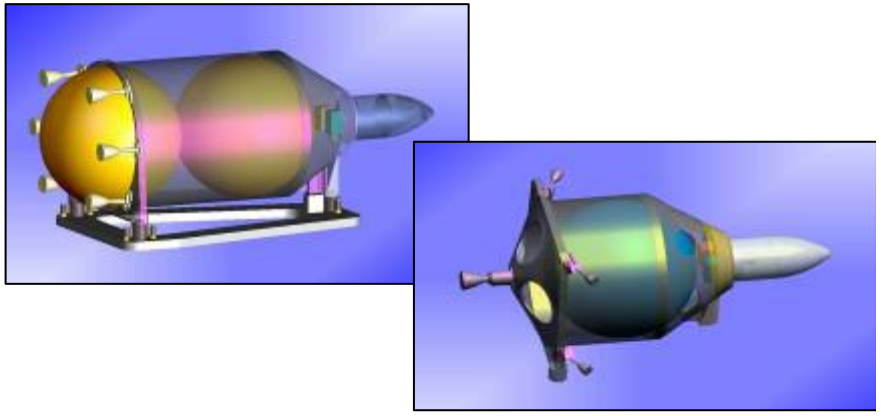
Technology Development – Roadmaps, Enablers

Penetrators

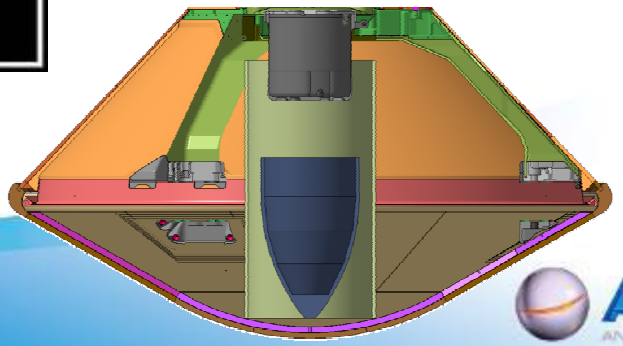


- UK niche from MoonLITE
  - Multi-disciplinary community formed by MSSL
  - Instrumented penetrators (4)
    - Seismics, heatflow, volatiles
  - 51kg, solid rocket for de-orbit

- Jovian Moon penetrator
  - Ganymede 86kg, bi-propellant
  - Europa 62kg mono-propellant



- Mars penetrators
  - Mars 25kg aerodynamic entry




MoonLITE
Descent Module

Therefore, the horizontal displacement between the Penetrator and PDS on impact is given by:

$$\therefore \Delta s_{1,2,\Delta t} \equiv s_{1,2}(t_{f,1}) - s_{2,2}(t_{f,2}) =$$

$$(v_{x,0} + \Gamma_1 g_m \tan\theta)\left(\sqrt{\left(\frac{v_{z,0}}{g_m} + \Gamma_1\right)^2 + 2\Gamma_1\left(t_1 + \frac{\Delta t}{2}\right) + \frac{2H_0}{g_m}} - \left(\frac{v_{z,0}}{g_m} + \Gamma_1\right)\right) - \Gamma_1 g_m \tan\theta\left(t_1 + \frac{\Delta t}{2}\right)$$

$$-(v_{x,0} - \Gamma_2 g_m \tan\theta)\left(-\left(\frac{v_{z,0}}{g_m} - \Gamma_2\right) + \sqrt{\left(\frac{v_{z,0}}{g_m} - \Gamma_2\right)^2 - 2\Gamma_2\left(t_1 + \frac{\Delta t}{2}\right) + \frac{2H_0}{g_m}}\right) - \Gamma_2 g_m \tan\theta\left(t_1 + \frac{\Delta t}{2}\right) =$$

$$(v_{x,0} + \Gamma_1 g_m \tan\theta)\left(\sqrt{\left(\frac{v_{z,0}}{g_m} + \Gamma_1\right)^2 + 2\Gamma_1\left(t_1 + \frac{\Delta t}{2}\right) + \frac{2H_0}{g_m}} - \left(\frac{v_{z,0}}{g_m} + \Gamma_1\right)\right) - (v_{x,0} - \Gamma_2 g_m \tan\theta)\left(-\left(\frac{v_{z,0}}{g_m} - \Gamma_2\right) + \sqrt{\left(\frac{v_{z,0}}{g_m} - \Gamma_2\right)^2 - 2\Gamma_2\left(t_1 + \frac{\Delta t}{2}\right) + \frac{2H_0}{g_m}}\right)$$

$$-(\Gamma_1 + \Gamma_2) g_m \tan\theta\left(t_1 + \frac{\Delta t}{2}\right)$$

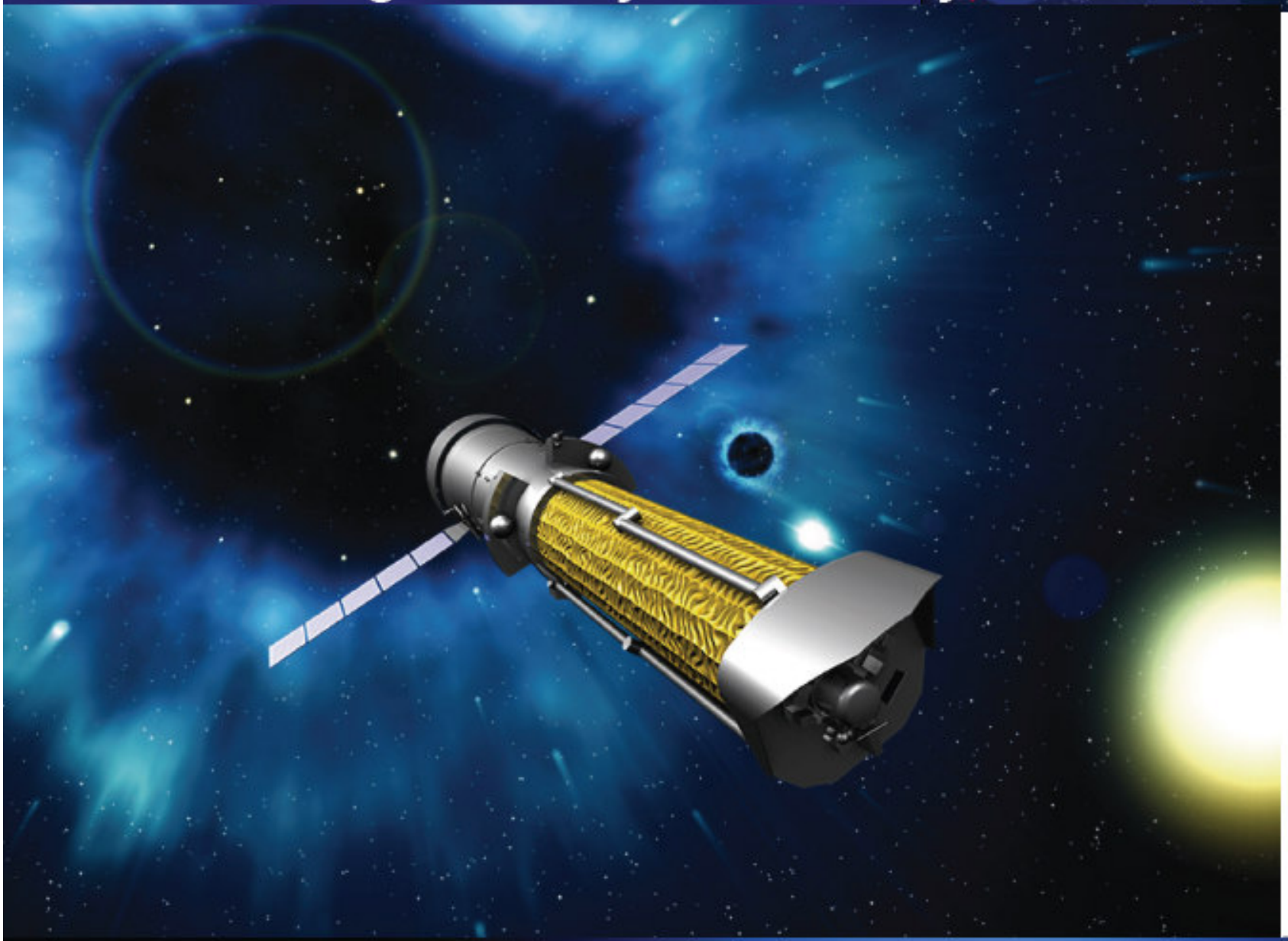
(Eq-B11)

and the time between the Penetrator impact and the PDS impact is given by:

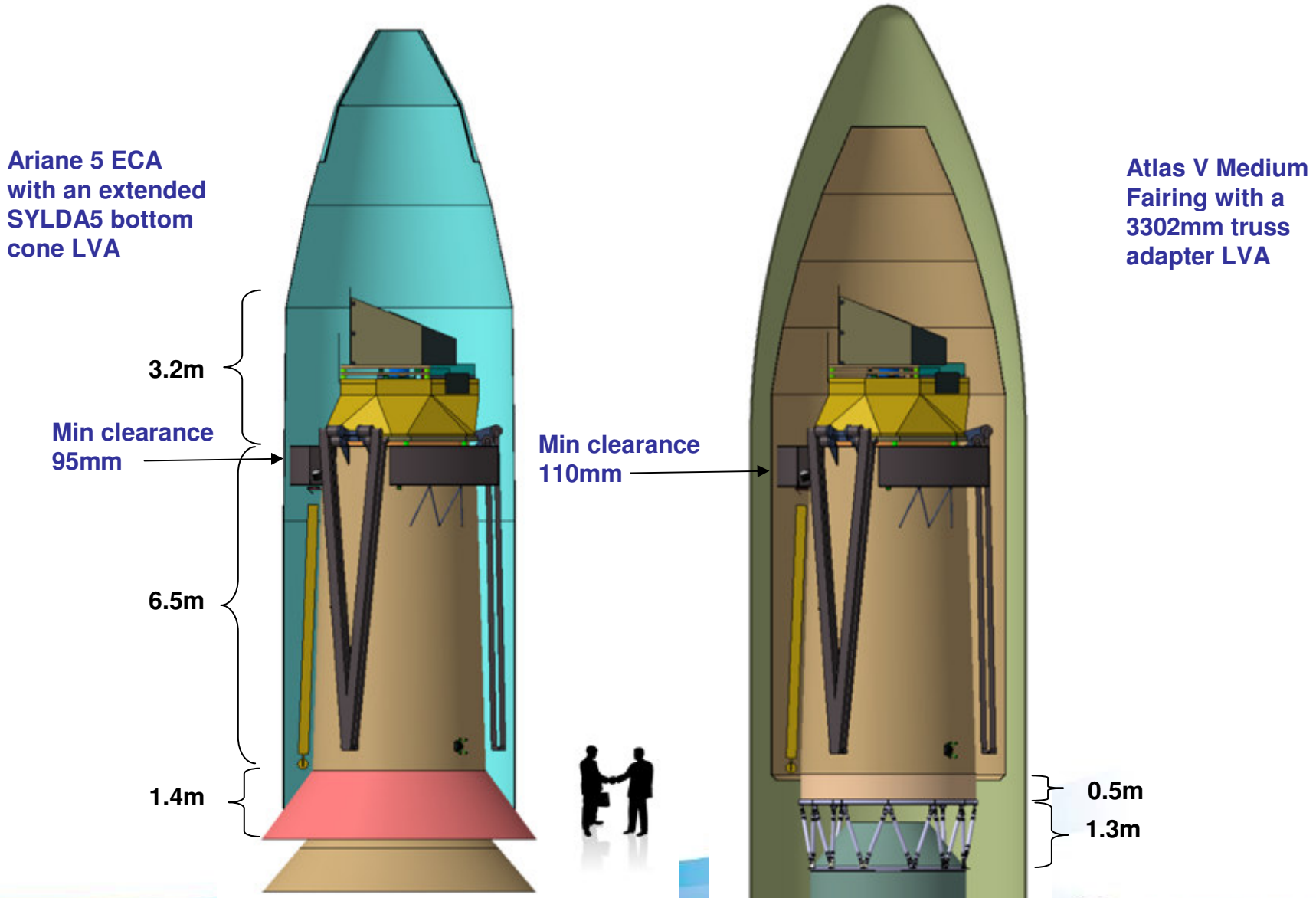
$$\therefore \Delta t_{f,1,2} = \Delta t_{f,1} - \Delta t_{f,2} = \sqrt{\left(\frac{v_{z,0}}{g_m} + \Gamma_1\right)^2 + 2\Gamma_1\left(t_1 + \frac{\Delta t}{2}\right) + \frac{2H_0}{g_m}} - \sqrt{\left(\frac{v_{z,0}}{g_m} - \Gamma_2\right)^2 - 2\Gamma_2\left(t_1 + \frac{\Delta t}{2}\right) + \frac{2H_0}{g_m}} - (\Gamma_1 + \Gamma_2)$$

(Eq-B12)

IXO: The next great X-ray observatory



S/C Mechanical Design – IXO Launch Configuration



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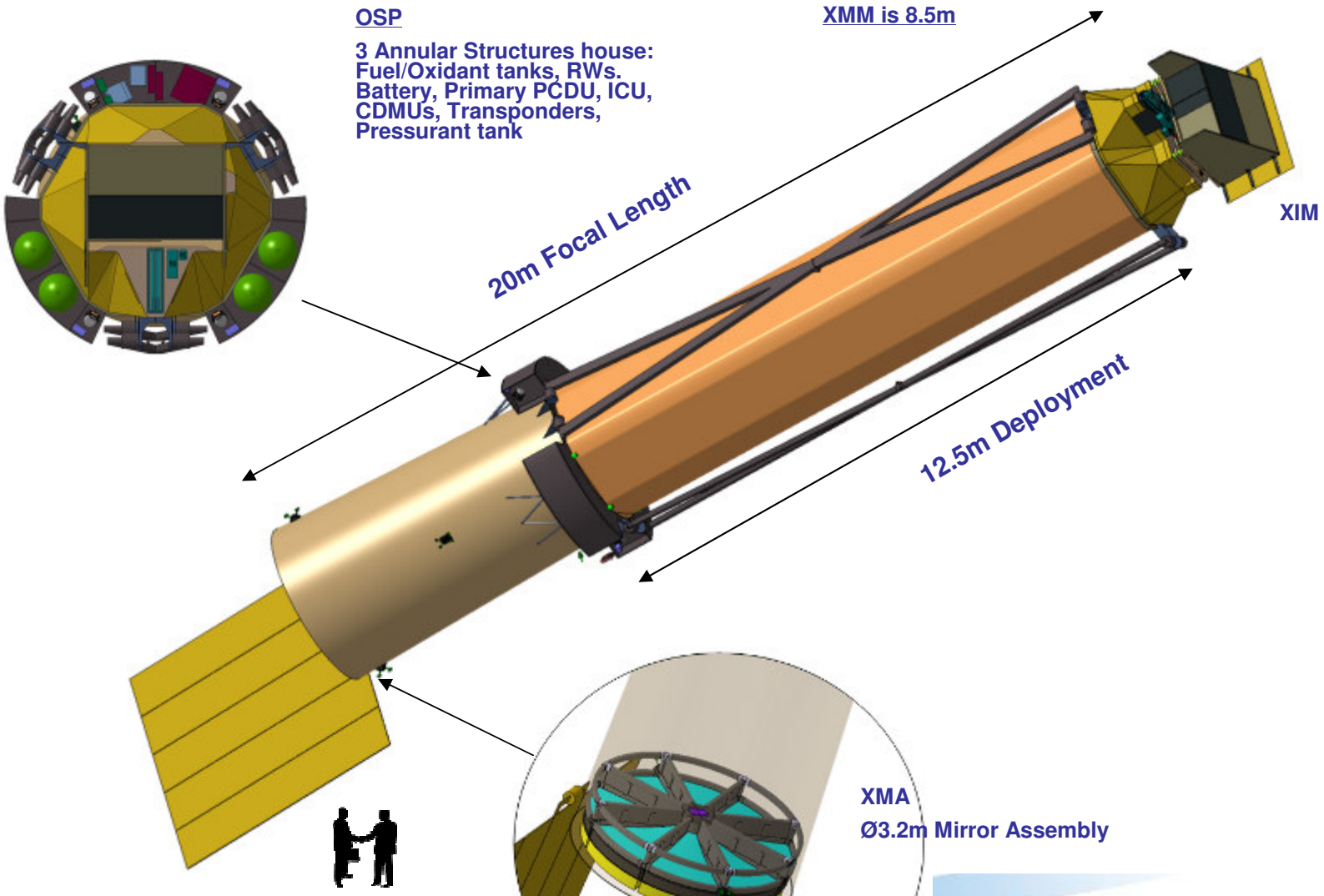
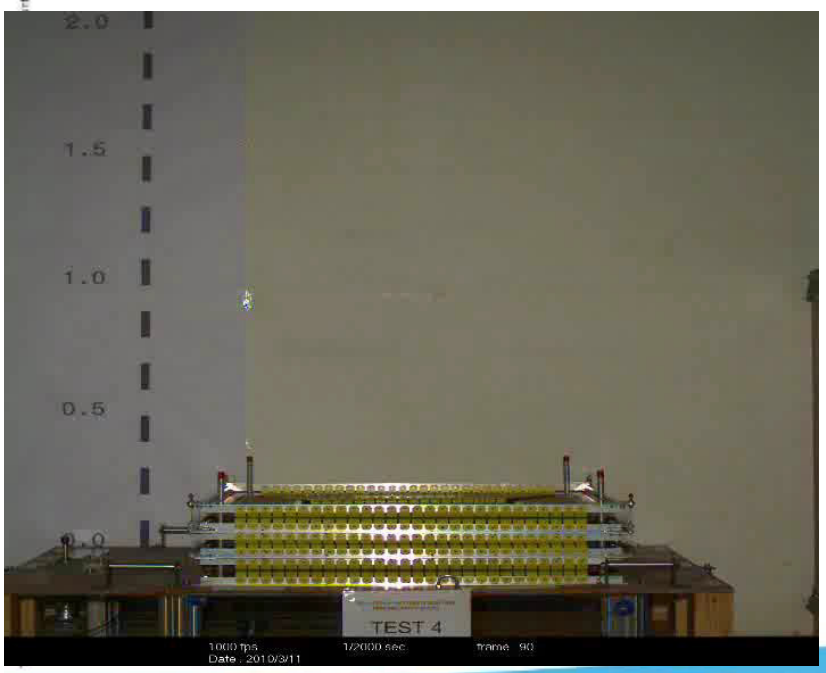
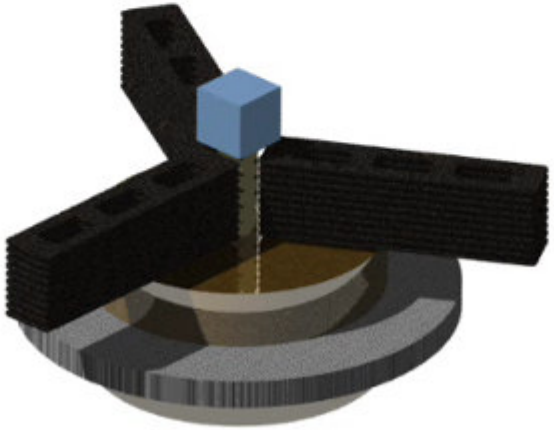
S/C Mechanical Design – IXO Deployed



Extendable Optical Bench





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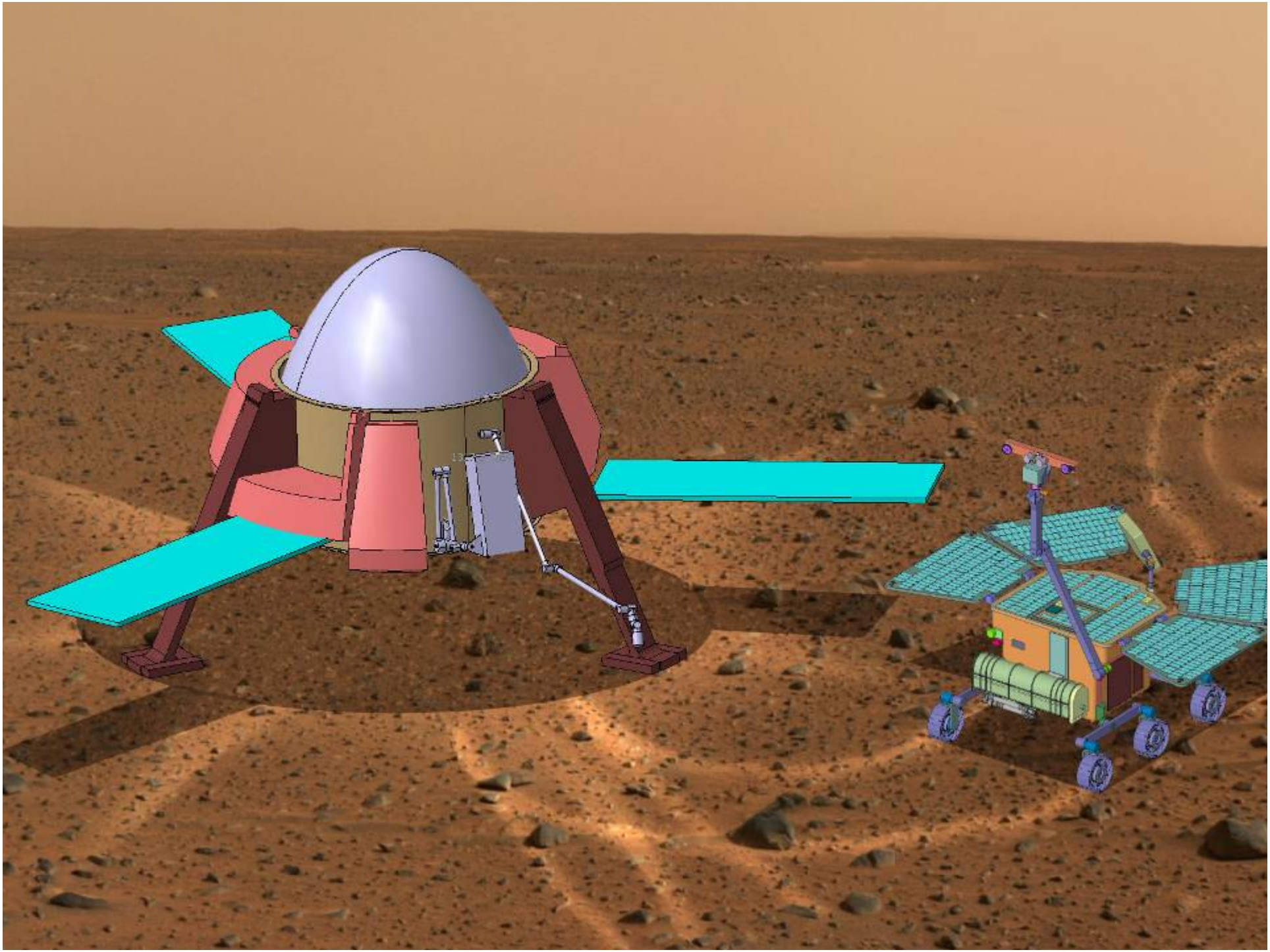
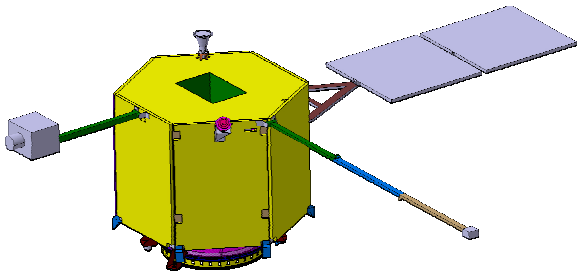
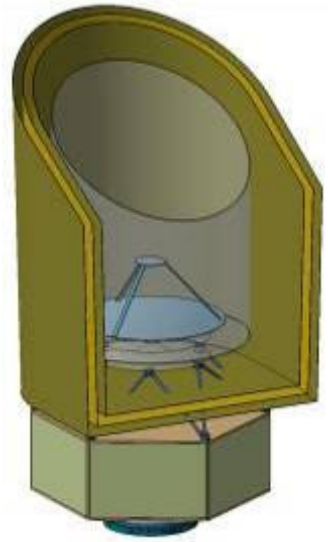


New Science Mission Concepts 2010: for Cosmic Vision



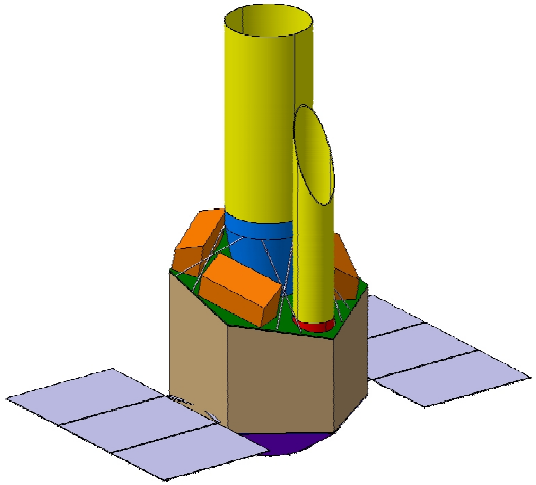
AXIOM

Magnetosphere and Auroral plasma



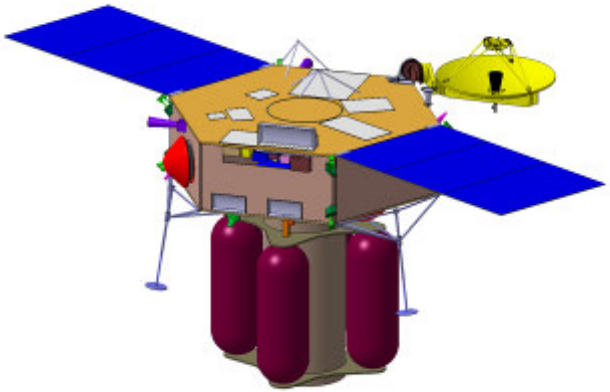
ECHO

Exoplanet characterisation



ORIGIN

Gamma Ray Burst + X-Rays



Asteroid Sample Return

… and also

- LunarNet - penetrators
- SAGE – EUV and soft X-ray
- Envision – Venus InSAR
- MICE – Magnetosphere
- DUAL – Gamma Ray
- Uranus Pathfinder

Form
Fit
Function
Feasibility

Spacecraft Industry and Science Missions

- Maintains and develops national core capability in design, manufacture and test of innovative spacecraft
  - Science missions always push new limits in engineering
  - Developing and managing complex supply chains
- Promotes achievement of national goals
  - Active in Civil Space
  - World Class Science -> industry has a role in positioning
  - Leading Technology
  - World Class Engineering
  - Inspiring careers in high tech -> STEM
- Technology demonstrated in operation – spins across to more risk averse commercial missions (e.g. telecoms)
  - Past: Carbon fibre, Attitude control, Electric propulsion, Highly Integrated Design
  - Future: Large low mass structures, large telecoms antennas, amplifiers for high frequency comms, autonomous systems, Space Weather service

All the space you need

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