# LISA Pathfinder, STEP and Astrium

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# Astrium and STEP
# Background

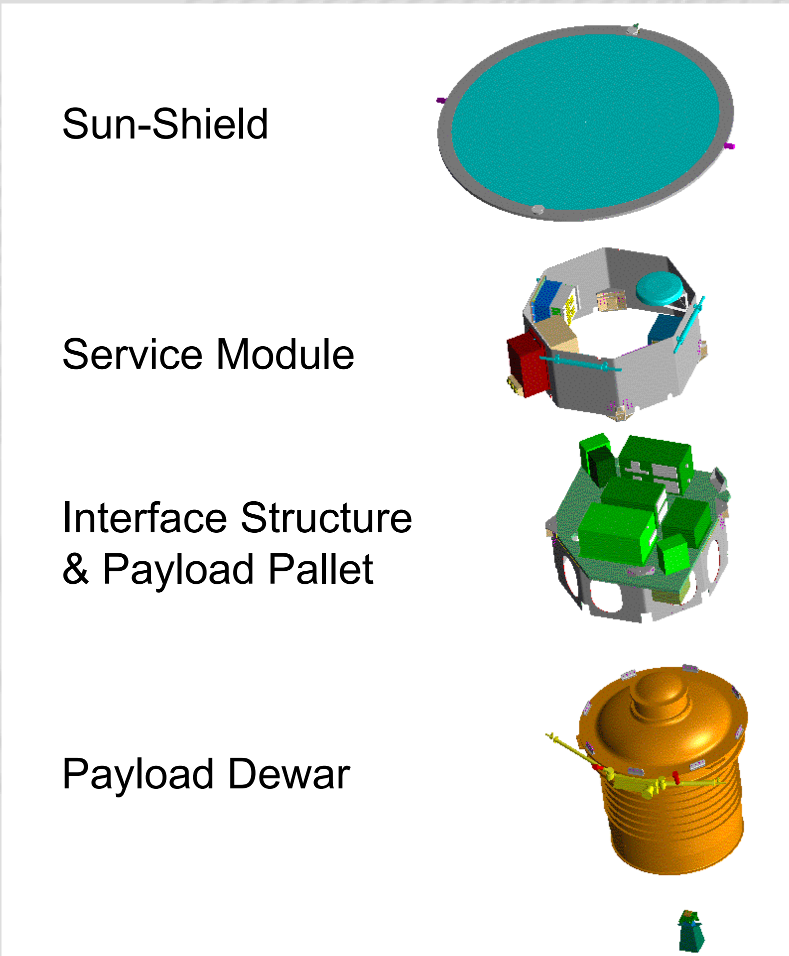
- Satellite Test of the Equivalence Principle has been studied in different forms over nearly 30 years
- Joint ESA/NASA mission with joint US/European science team
  – Baseline for ESA to contribute Service Module
  – 1999: ESA study by Matra Marconi Space for provision of Service Module based on commercial EO platform
    - Outputs of study formed part of inputs to SMEX proposal
  – 2001: STEP proposed as candidate for the NASA SMall EXplorer programme - Selected for Phase A study which resulted in submission of an implementation proposal
    - Astrium supported compilation of SMEX proposal under internal funding
  – ESA support for STEP continued with the DFACS study
  – 2002: ESA Pre-Phase B study (led by Astrium) to consolidate Phase A design with updated payload information, dewar interfaces, revised redundancy philosophy etc.
- Experience from STEP applied to LISA Pathfinder

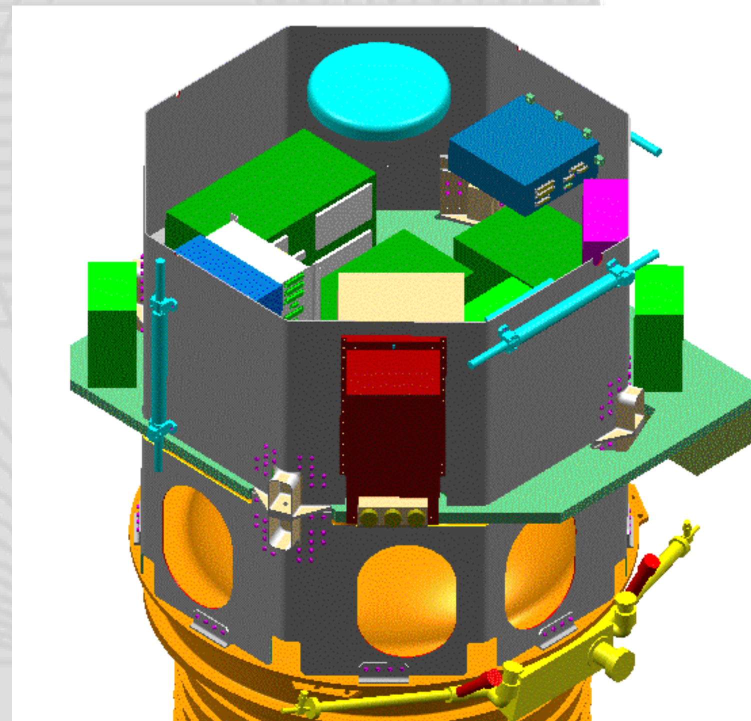
# Astrium and STEP
# Pre-Phase B Study Objectives/Requirements

- Study Objectives
  - Update/Define interface between Service Module and Payload
  - Consolidate Service Module design
  - Plan systems integration
  - Cost technical baseline

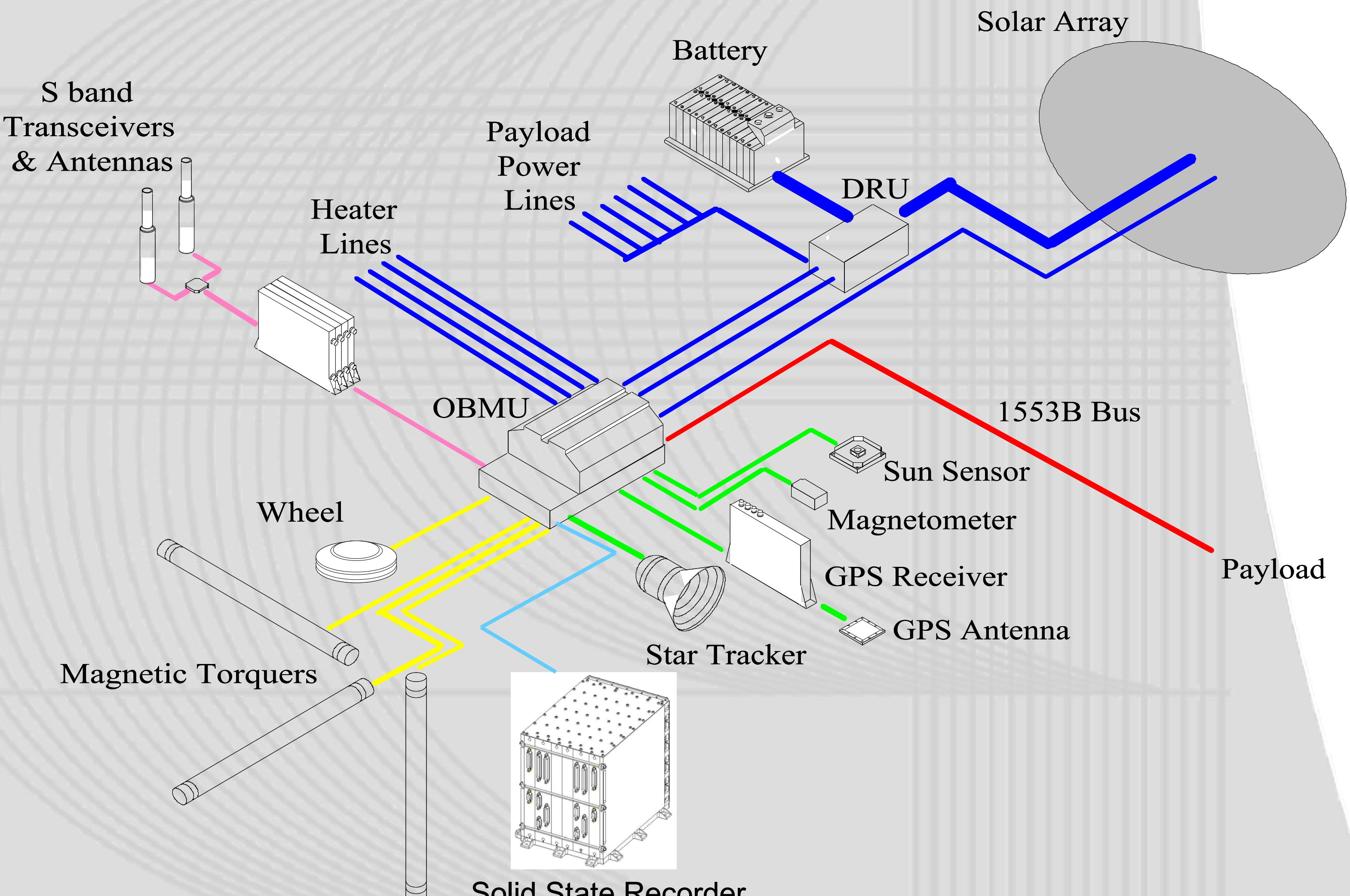
- Key Requirements
  - Provide power, accommodation, communications and thermal stability for the payload
  - Provide navigation data (GPS and star tracker), safe mode and coarse pointing mode
  - Don’t disturb the science: no moving parts, minimised thermal distortion
  - Sun-synchronous dawn-dusk 400-600 km altitude orbit
  - 16 hours autonomous operation - 60 hours of data storage

# Astrium and STEP
# Mechanical Configuration

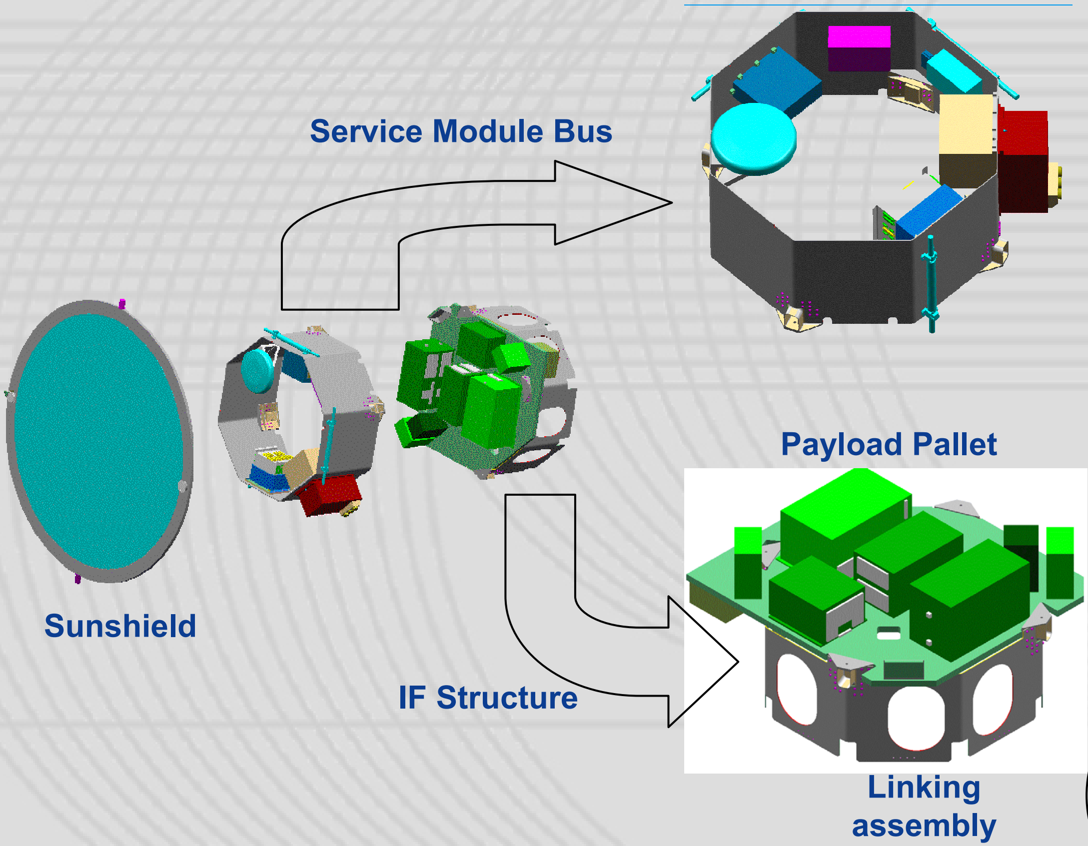


# Astrium and STEP
# System Electrical Architecture - Leostar



# Astrium and STEP Baseline Architecture



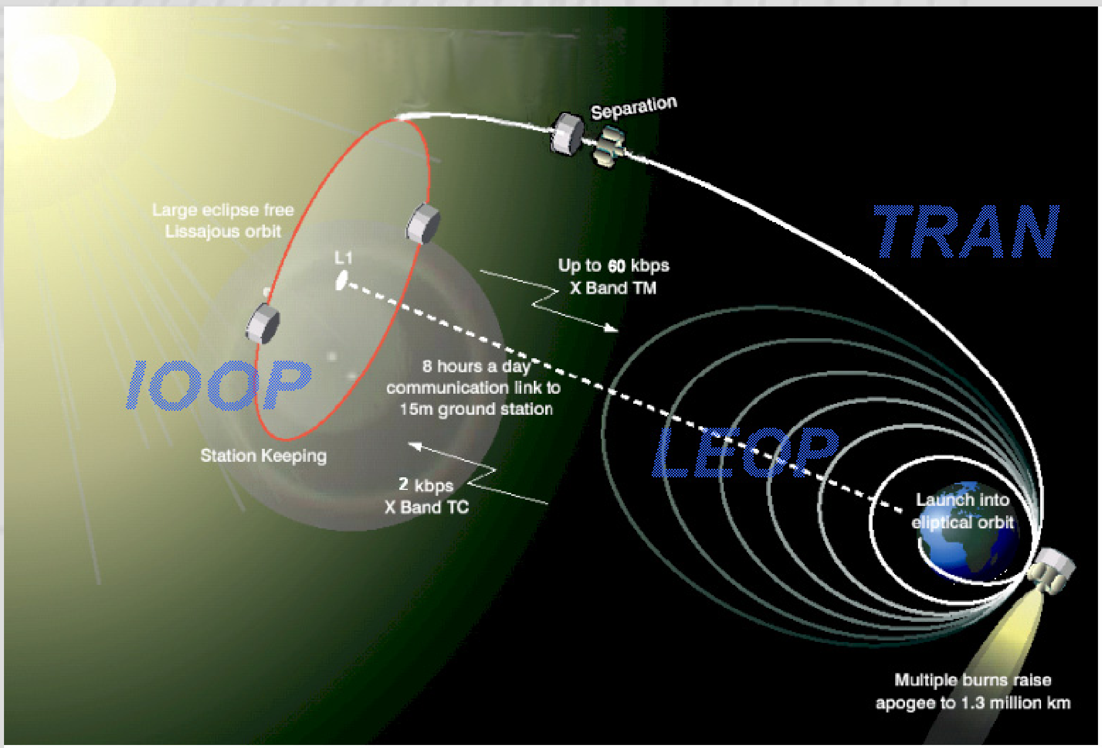

- Astrium LEOSTAR Commercial platform
- Designed for quiet operation w.r.t. science

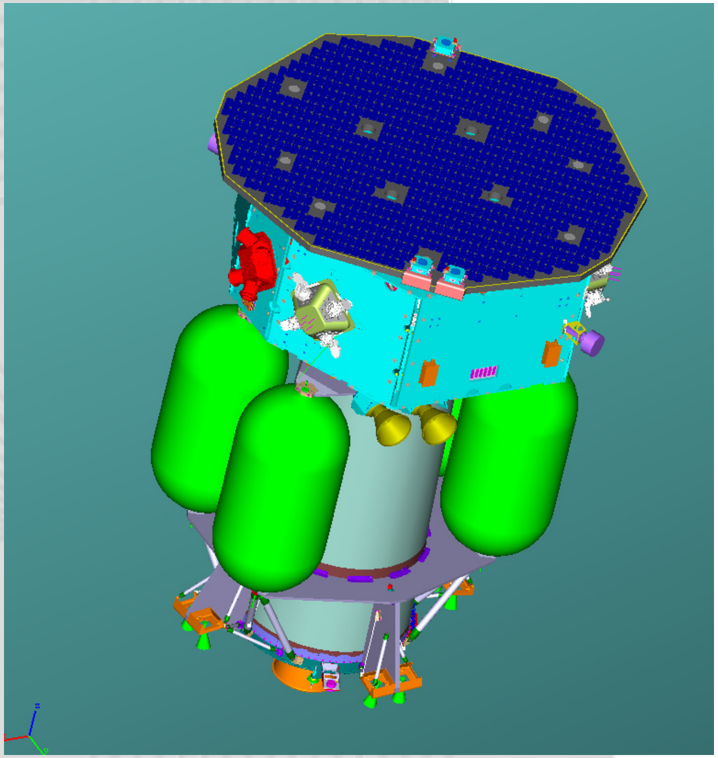
**Streamlined Electrical and Mechanical Interface**

- Designed for easy and separate payload integration
- Mechanically decoupled from Dewar

# Astrium and LISA Pathfinder
# Overview of LISA Pathfinder

- Testing key technologies for LISA – inertial sensors, disturbance free control, optical metrology, FEEP's
- Launch into LEO using Rocket, Disposable Chemical propulsion module to transfer to L1



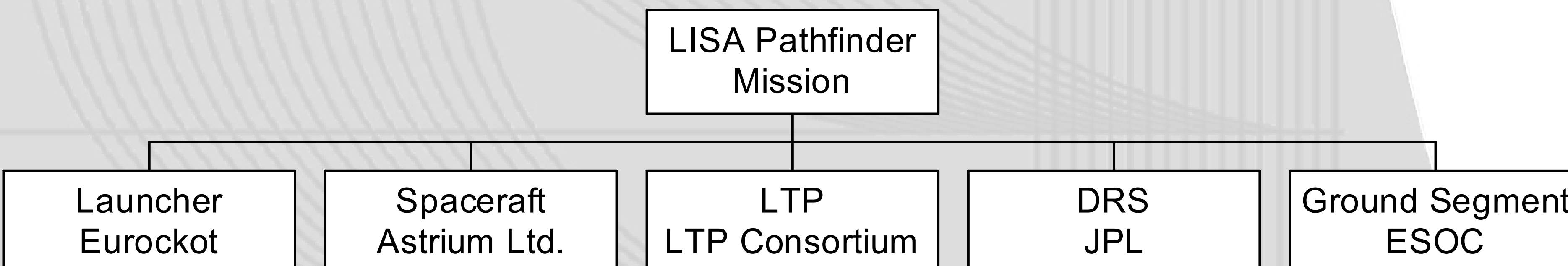



# Astrium and LPF Requirements

- Key Requirements
  - Integrated Science spacecraft designed for minimum disturbances: no moving parts, minimised thermal distortion, controlled gravity and magnetic fields
  - Provide power, accommodation, communications and thermal stability for the payload
  - Provide pointing data (star tracker), safe mode and coarse pointing mode
  - Minimum disturbance L1 orbit
  - 20 days autonomous operation – 7 days of data storage

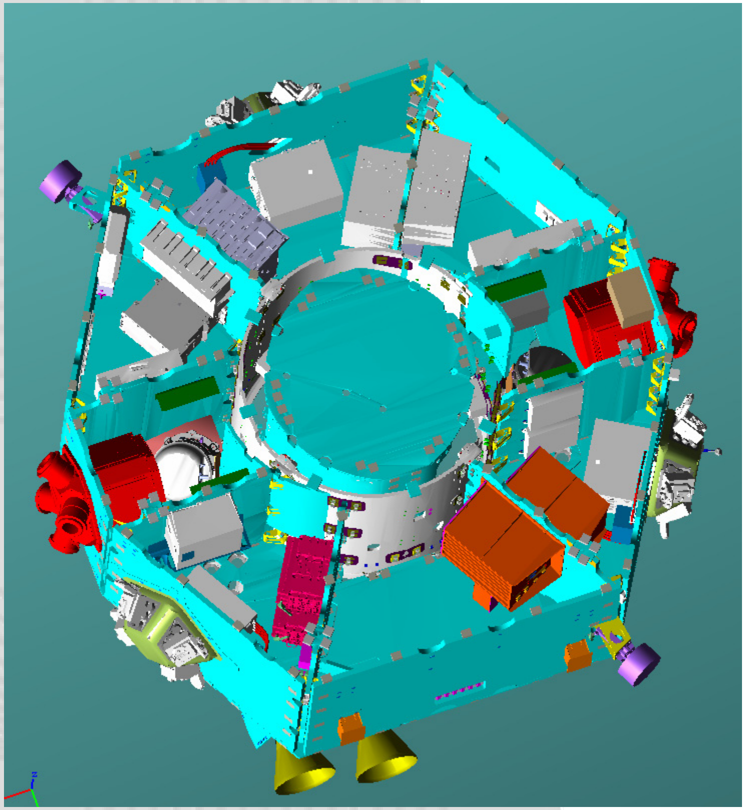
# Astrium and LISA Pathfinder
# LISA Pathfinder Team

- Spacecraft Prime Contractor is Astrium Ltd (UK) with core industrial team including Astrium GmbH (D) and SciSys (UK)
- LISA Technology Package (LTP) is provided by European team managed by the LTP Architect (Astrium GmbH)
- Disturbance Reduction System (DRS) provided by NASA-JPL
- Eurockot baselined as launch service provider
- Ground Segment is designed and implemented by ESOC



# Astrium and LISA Pathfinder
# Key Challenges

- Minimisation of Disturbances
  - No mechanisms on spacecraft
  - No actively controlled thermal elements
  - No liquids
  - Fixed Sun-shield
  - Thermo-elastically stable structure
  - Well known mass distribution
  - Control of magnetic field variations
- Integration of LTP
  - LTP is highly integrated into spacecraft configuration
- Drag-Free Attitude Control System
- Micro-Propulsion System using FEEPs
  - Challenging new technology



# Astrium and LISA Pathfinder Platform Design

- Structure – CFRP sandwich panels for low mass, high stiffness and low distortion
- Thermal – Highly stable, passive thermal system using radiators, MLI, heaters and material finishes, but no active heater control
- Astrobus Architecture (evolution of Leostar)
  - Single On-Board Computer managing all systems (Data Handling, AOCS, TT&C, FDIR etc.)
  - Architecture common to all Astrium EO and science missions
- Highly integrated payload (LTP and DRS) – units distributed throughout platform structure
- Micro-Propulsion provided by Field Effect Electric Propulsion (FEEPs)
- Compatibility with low cost launcher (Rockot)

# Applicability of STEP and LPF Experience to Future Fundamental Physics Missions

- Mission requirements for STEP, LPF and other fundamental physics missions similar
  - Highly thermo-mechanically stable platform
  - Drag-free attitude control (using payload as sensor/actuator)
  - Standard technology for provision of services to payload (power, commands, data storage and download, temperature control)
- Advantages of adapting LISA Pathfinder platform for future Low Earth Orbit fundamental physics missions
  - Use of proven platform technology and experience reduces cost and risk of future mission development
  - Substantial volume available for payload equipment
  - Astrobus architecture compatible with LEO (e.g. GOCE, Aeolus)
  - Compatible with VEGA fairing volume (scope to provide greater power than for LPF)