

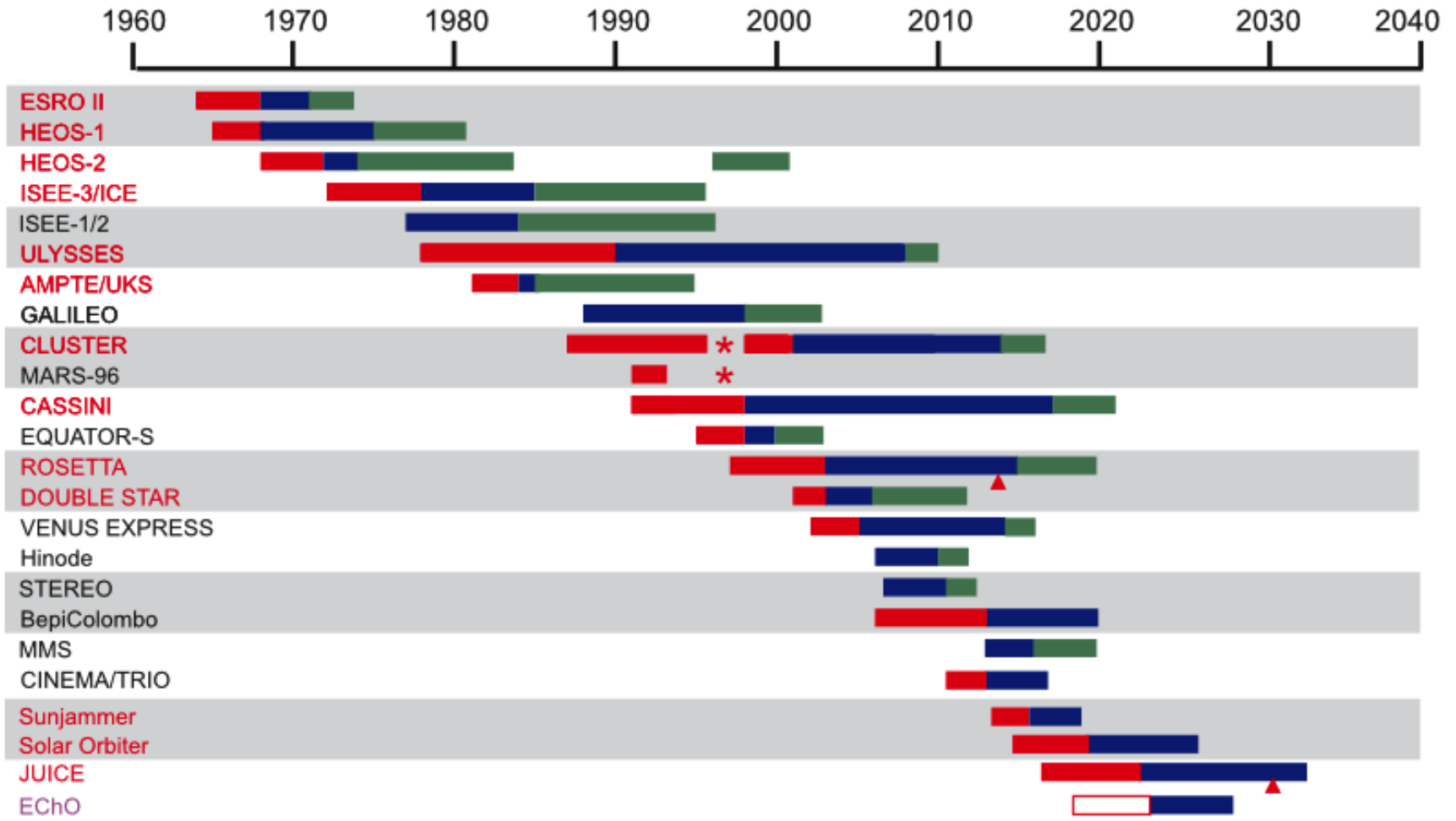
Space Physics: Instrumentation and Industrial Partnerships

Chris Carr and Patrick Brown

c.m.carr@imperial.ac.uk

patrick.brown@imperial.ac.uk

Space Physics: Mission timeline



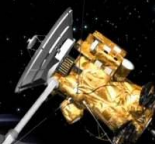
Key: Build Phase Operations Phase Further Exploitation Instr. PI Proposed
Col ▲ Arrival/Orbit Insertion



soho
Facing the Sun




venus express
Studying Venus' atmosphere



juice
Characterising the conditions of
ocean-bearing moons around Jupiter



bepicolombo
Exploring Mercury



proba-2
Observing coronal
dynamics and solar eruptions



cassini-huygens
Studying the Saturnian system
and landing on Titan



mars express
Investigating the Red Planet



cluster
Measuring Earth's magnetic shield



solar orbiter
The Sun up close



rosetta
Chasing a comet

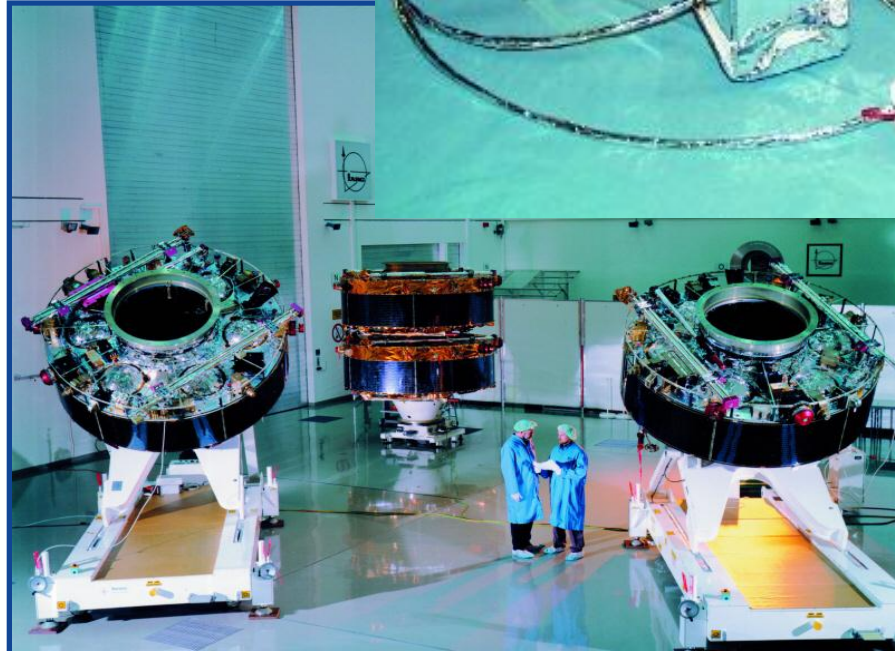
→ ESA'S FLEET IN THE SOLAR SYSTEM

The Solar System is a natural laboratory that allows scientists to explore the nature of the Sun, the planets and their moons, as well as comets and asteroids. ESA's missions have transformed our view of the celestial neighbourhood, visiting Mars, Venus, and Saturn's moon Titan, and providing new insight into how the Sun interacts with Earth and its neighbours. The Solar System is the result of 4.6 billion years of formation and evolution. Studying how it appears now allows us to unlock the mysteries of its past and to predict how the various bodies will change in the future.

Fluxgate Magnetometer Instrument for the Cluster mission:

Imperial College (PI), IGeP Braunschweig, IWF Graz, NASA-GSFC

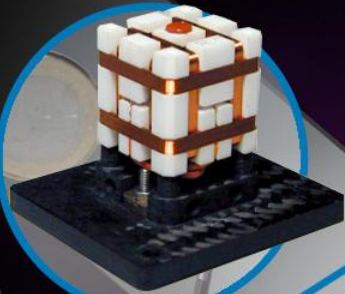
- Radiation hard
- Hi-Reliability
- Dual-redundant bus architecture
- Fault-tolerant by design
- 12-years continuous operation
- (4 instruments)
 - No degradation



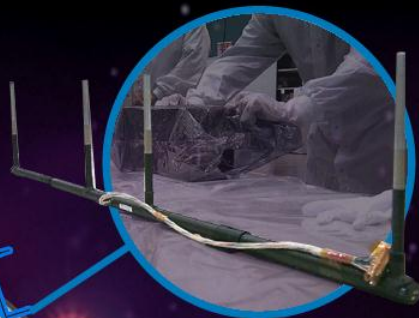
Cluster, 4th June 1996



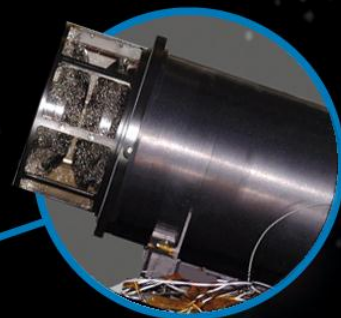
MAG
Germany



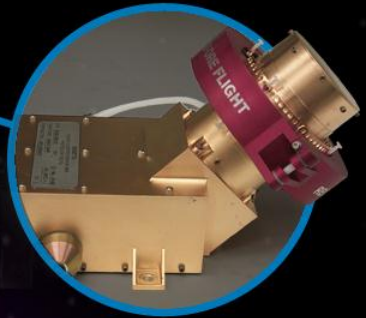
MIP
France



ICA
Sweden



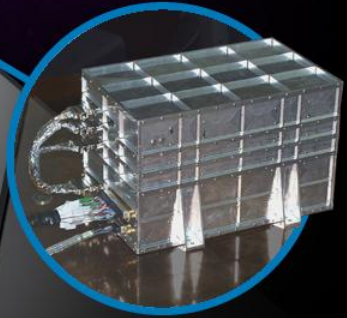
IES
USA



LAP
Sweden



PIU
UK



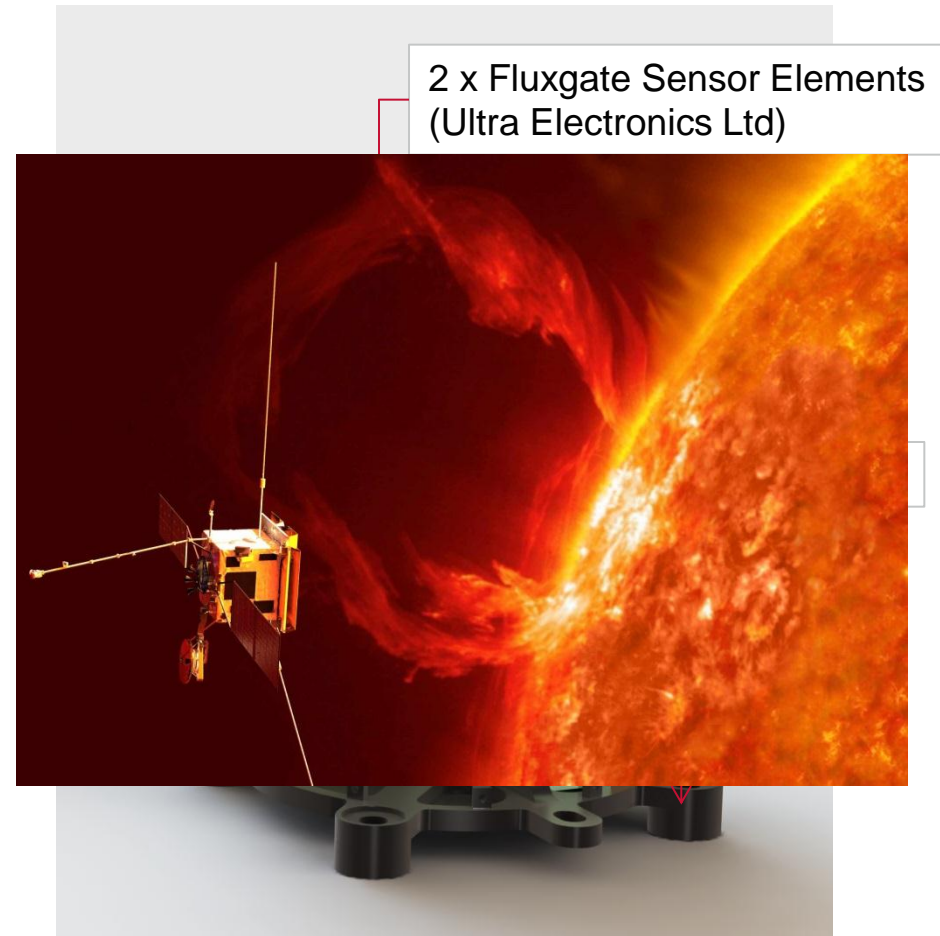
ROSETTA

for the closest inspection of a comet ever made



Solar Orbiter Magnetometer

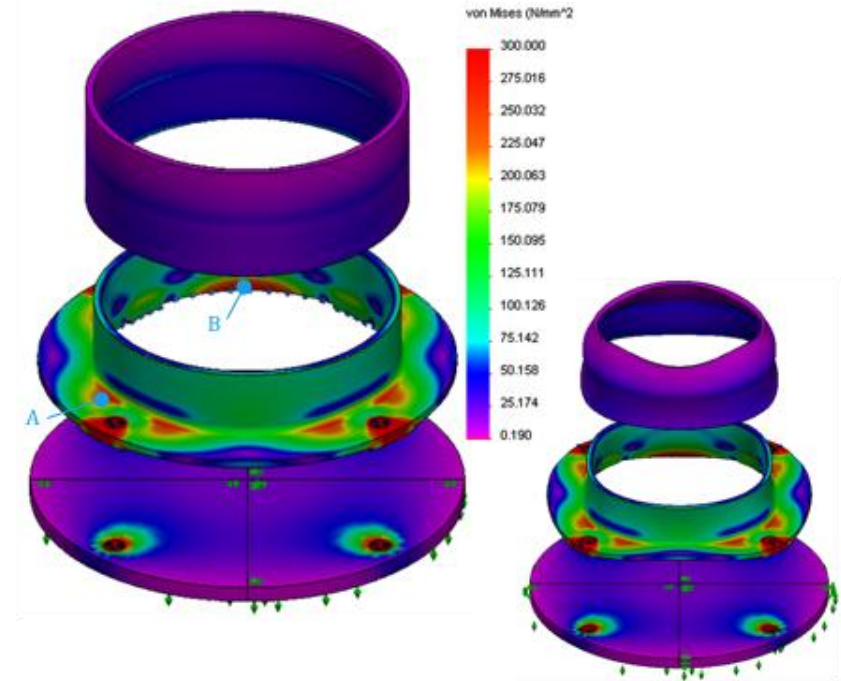
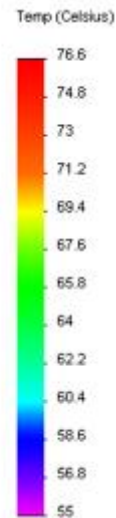
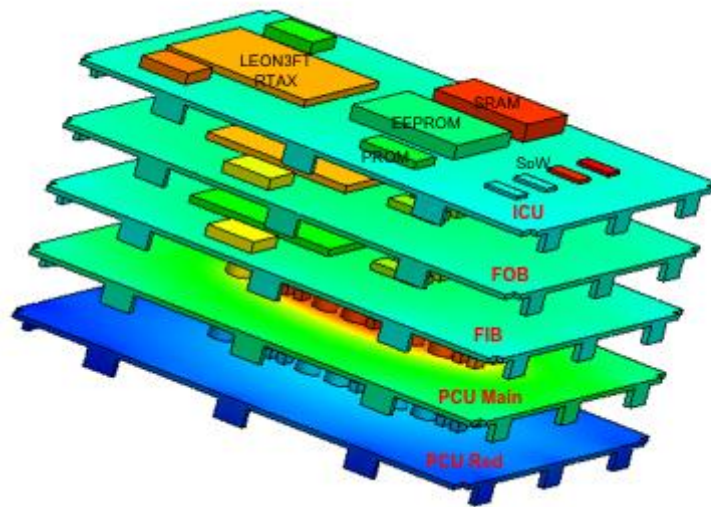
- Solar Orbiter's trajectory goes to less than 0.3 AU
 - Closer to the Sun than Mercury
- Spacecraft behind heat-shield
 - Boom-mounted sensor in permanent shadow
- Extreme thermal environment for the magnetometer
 - Maximum $+80^{\circ}\text{C}$
 - Minimum -190°C
- In-house mechanical, thermal design and simulation



Mechanical and Thermal FEM Analysis

SolidWorks Simulation plus
ThermXL

In accordance with
ECSS-E-ST-32



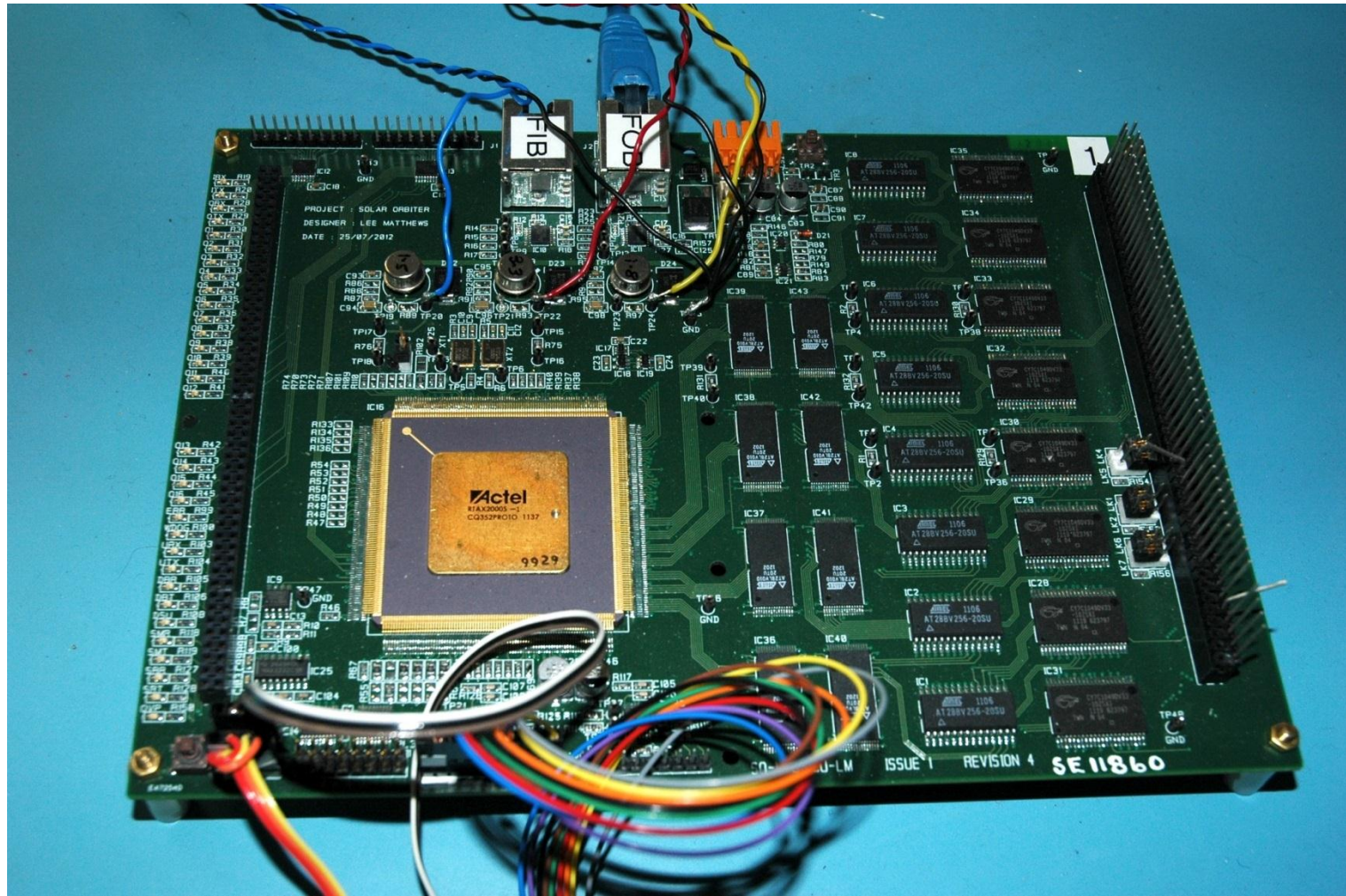
Magnetoresistive Sensor

- Miniaturised magnetic field sensor
 - Developed for use on very small satellites (e.g. CubeSat)
 - Honeywell magnetoresistive sensor
- First flown on the US 'CINEMA' CubeSat
 - 2 new launches in 2013
 - Selected for Sunjammer
 - ESA SSA 'SOSMAG'
- Technology licensed to Satellite Services UK Ltd as an attitude sensor
 - 8 flight units sold
 - Through Imperial Innovations plc



Payload data processor

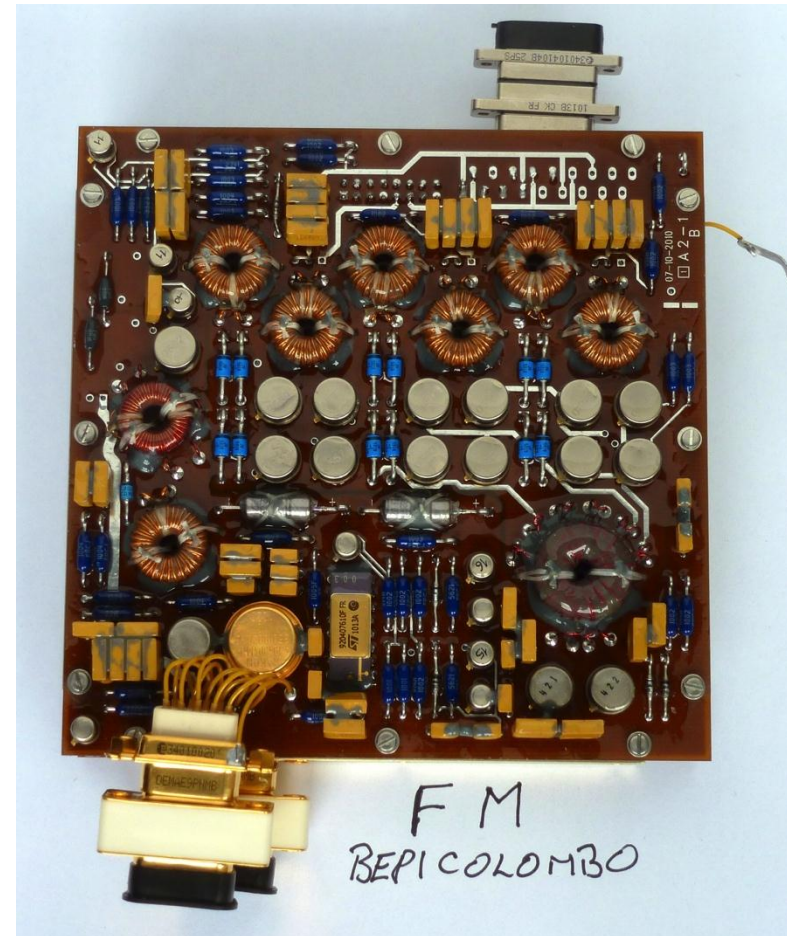
Leon3FT Processor



Prototype for Solar Orbiter

Low-voltage DC/DC power converters

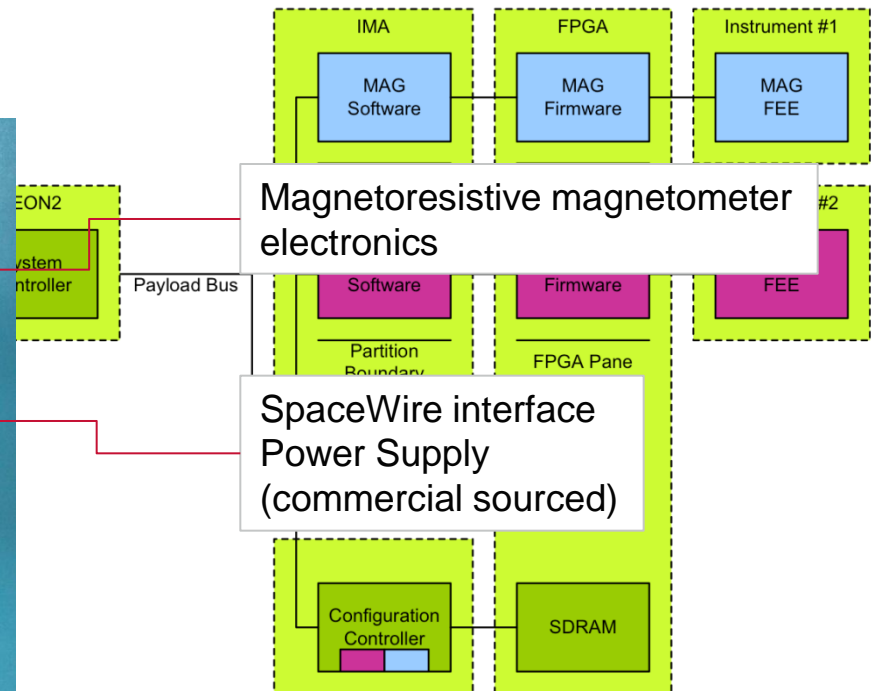
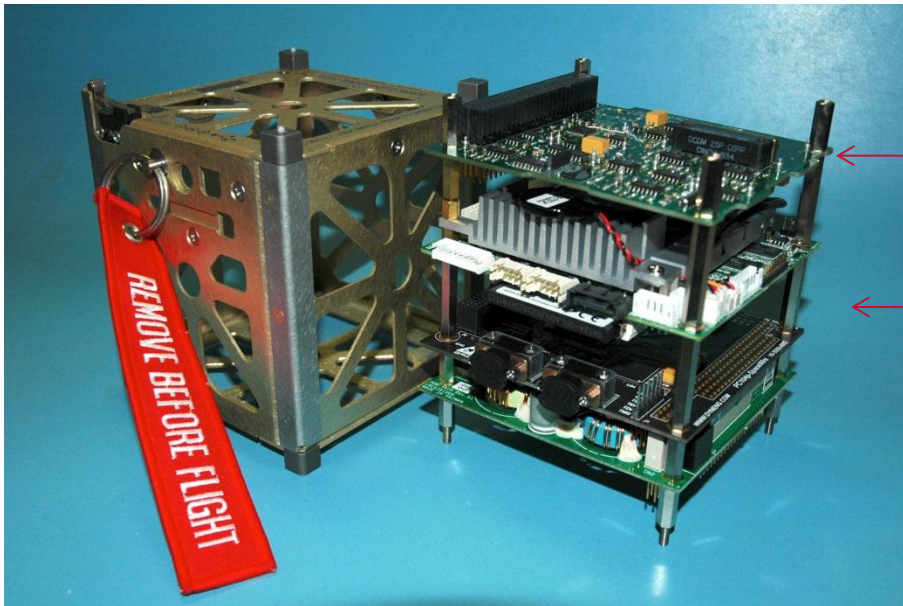
- Flight model for BepiColombo
 - High efficiency
 - Multiple output voltages
 - Modular redundancy
 - Recent heritage:
 - » Cluster
 - » Double Star
 - » Venus Express etc.
- Potential for commercialisation
- We have a 'pump-priming' research contract from Lockheed Martin



Integrated Payload Data Handling Systems (I-PDHS)

- Astrium lead with SciSys
- Imperial and RAL payload
- Demonstrate new onboard data handling architectures
 - Reduced mass, power and complexity

I-PDHS is a NSTP Space-CITI project hosted by the Catapult



Industry Collaborations

Ultra Electronics (UK)

Fluxgate Sensors R&D
Magnetic test facility
(available through **Imperial Consultants Ltd**)

Lockheed Martin (USA)

Power converters (research contract)

Astrium (UK)

CASE-funded postgraduate student
and magnetometer ASIC development

ESA/MST Aerospace (Germany)

Technology transfer contract (2010/11)

MAGSON (Germany)

Magnetometer prototype for ESA
SSA (Space Situational Awareness) programme

Satellite Services BV Ltd (UK)

Licensed by **Imperial Innovations plc** to sell our
magneto-resistive magnetometer

