

# Science on Low Cost Space Missions Workshop 24 January 2007

## Enabling Technologies for maximising science from low-cost missions

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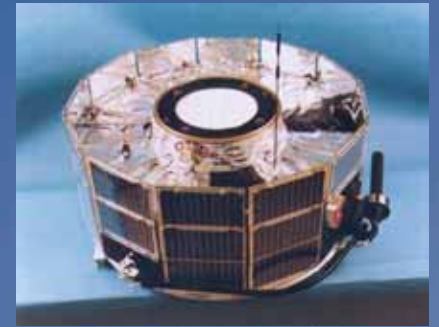
## how much science ?

- mission constraints
  - destination
  - radiation dose
- laws of physics relating to instruments
  - optical (diffraction, telescope technology,...)
  - detector environment (cooling, shielding,...)
- spacecraft constraints  
(derived from instrument needs)
  - demanding attitude control, magnetic cleanliness, ...
  - demanding orbit control (including Formation Flying),...
- operational constraints
  - telecommand and data rates/volumes
  - mission risks (e.g. 1 view of the Sun terminates the mission)



# what sort of (science) missions?

- planetary
    - inevitably relatively costly
  - astronomy and solar physics
    - long time series
    - but inevitably with small-aperture optics
  - plasma physics
    - low cost spacecraft (usually spinning); low operations costs
    - but all the easy missions have been done
    - future missions will need large numbers of satellites
      - each very simple, but magnetically clean
      - and with complex/costly launch scenarios
  - fundamental physics
    - complex and novel payloads
    - conceptually simple, but very demanding, spacecraft
  - Earth Observation
    - operational/quasi-operational missions well demonstrated
    - scientific missions limited by optical aperture etc
- in general, morphology and environmental science is more accessible than process science



## does technology help?

- budgets available for space-specific technology are tiny by comparison to those for commercial technologies
  - pharmaceuticals, computing, ...
- spin-in is required to make equipment affordable
  - IR detectors from military/security industry
    - enables EO and space science
  - MEMS Rate Sensor from automotive industry
    - makes gyro-based AOCS affordable
    - facilitates agile spacecraft
- the challenge is to find the optimum balance between
  - minimum acceptable modification for the space environment
  - intellectual desire for the ultimate performance



# MEMS Rate Sensor



Today's Production  
MEMS rate sensor



Commercial  
MEMS  
Technology



Space Gyro  
Heritage



Space  
Electronics

**SELEX**  
Sensors and Airborne Systems

**BAE SYSTEMS**



flight unit production

basic technology

adaptation for space

## so, what missions will be enabled by technology advances?

- Proba3 will demonstrate spacecraft flying in formation
  - using a solar physics instrument
  - still a relatively low-cost mission
- Darwin requires this technology
- what about Earth Observation?
- are there missions which will become affordable?
  - SEA is performing a study for ESA
  - after mission tradeoffs we will be selecting subcontractors to support specific mission studies



## summary

- some missions can be made affordable by a spin-in of COTS technologies
- but some classes of science inevitably lead to costly missions
  - no matter how innovative we are, we are still constrained by the laws of physics
- the new challenge is
  - to identify good science which can be made affordable by the adaptation of COTS technologies
  - and to spin-in the required technologies
    - in a manner acceptable to the technology owner!

