Facility for Satellite Formation Flying Control System Verification and Electric Propulsion Systems

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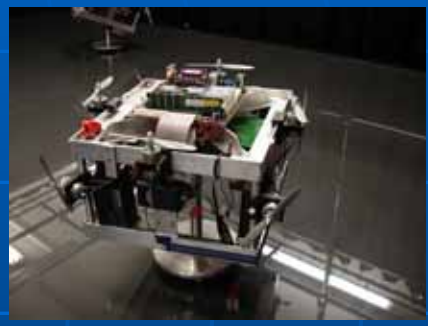
Outline of talk

- Modes of operation
- The GSF Testing
- Metrology Infrastructure
- Satellite Frames available
- Future development and use of facility
- Electric propulsion capabilities

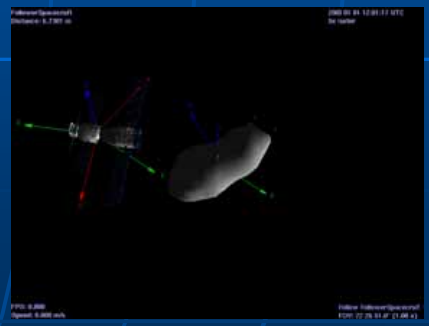
Two modes of operation

A two phase approach is taken to test a satellite formation flying system:

- *Testing of the processors and communication electronics* with a limited number of sensors and actuators (gyros, reaction wheels and air-jets) This is called *ground-based satellite frames testing* (GSFT).

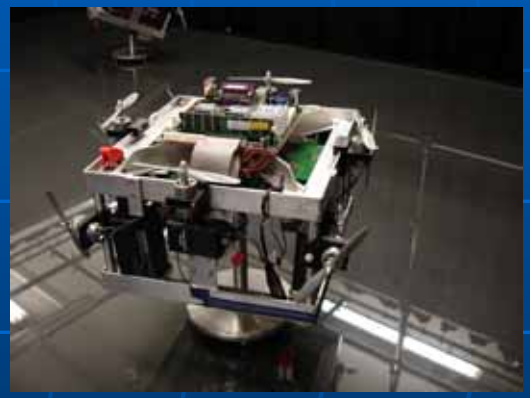


- *Testing of the actual control algorithms*, as they would be used in space, using hardware in the loop simulations: control electronics are real but the sensor, actuator and physical dynamics are simulated. This is called *hardware in the loop testing* (HILT).



The GSF Testing

GSFT (=*ground-based satellite frames testing*) allows testing of systems software and hardware in operation with real components:



- solid state gyros (actual)
- accelerometers (actual)
- reaction wheels (actual)
- on board computers (actual)
- communication electronics (actual)
- propulsion substitutes (similar in dynamics)

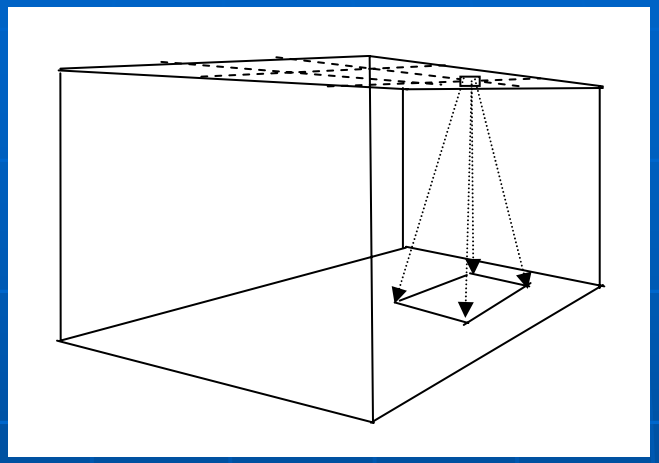
Testing of satellite autonomous cooperation

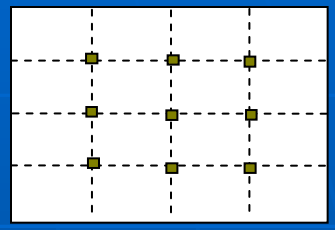
Frames in preparation for testing

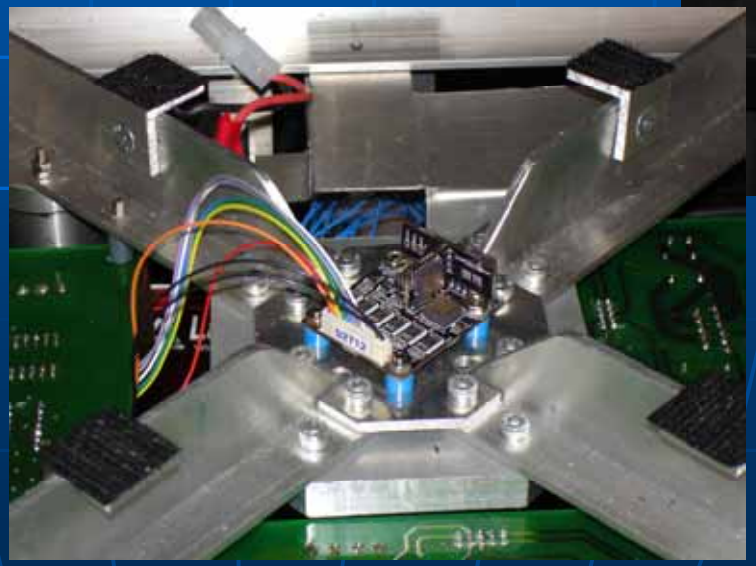
Metrology infrastructure

Metrology features

A calibrated 9 camera based observation system which can monitor the positions and attitudes of each frame in realtime. The highly sensitive solid state gyros and the camera based position and attitude estimates are processed through a data fusion system which provides realtime estimates of the 12 dimensional state of each frame moving on the table.



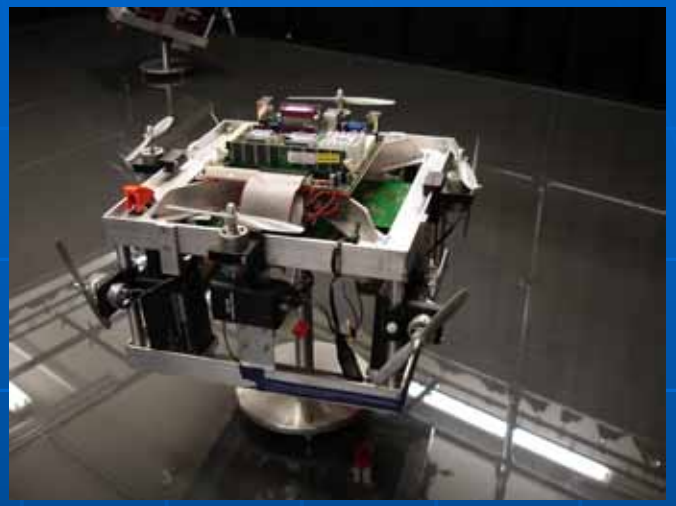




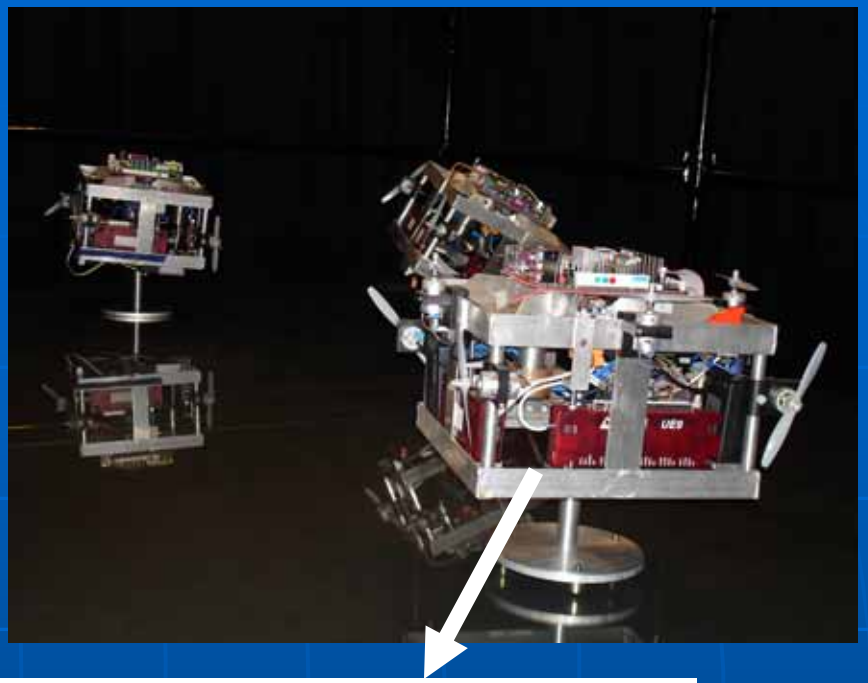
1 cm accuracy for coarse formation flying

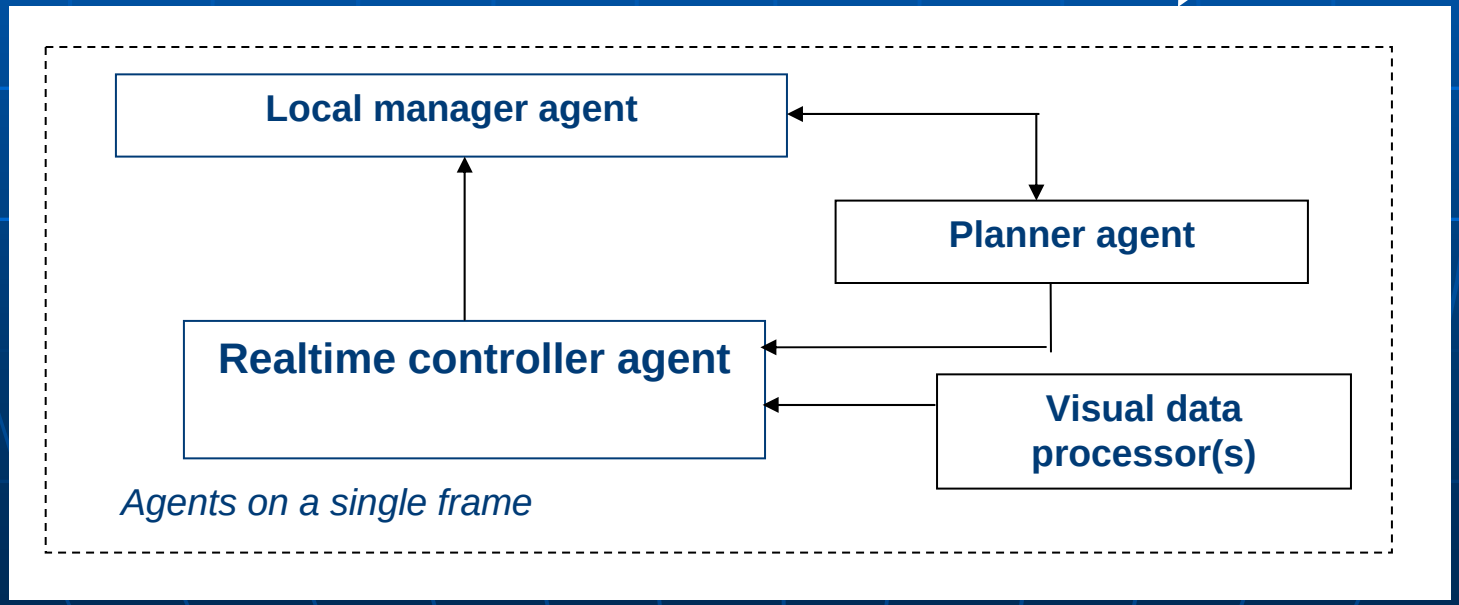
Available GSFT frames

- 3 with model aircraft propeller actuation (8 bidirectional actuators in each frame)
- 3 frames with air-jet actuators (16 unidirectional actuators on each frame)
- and 3 frames for future customer use



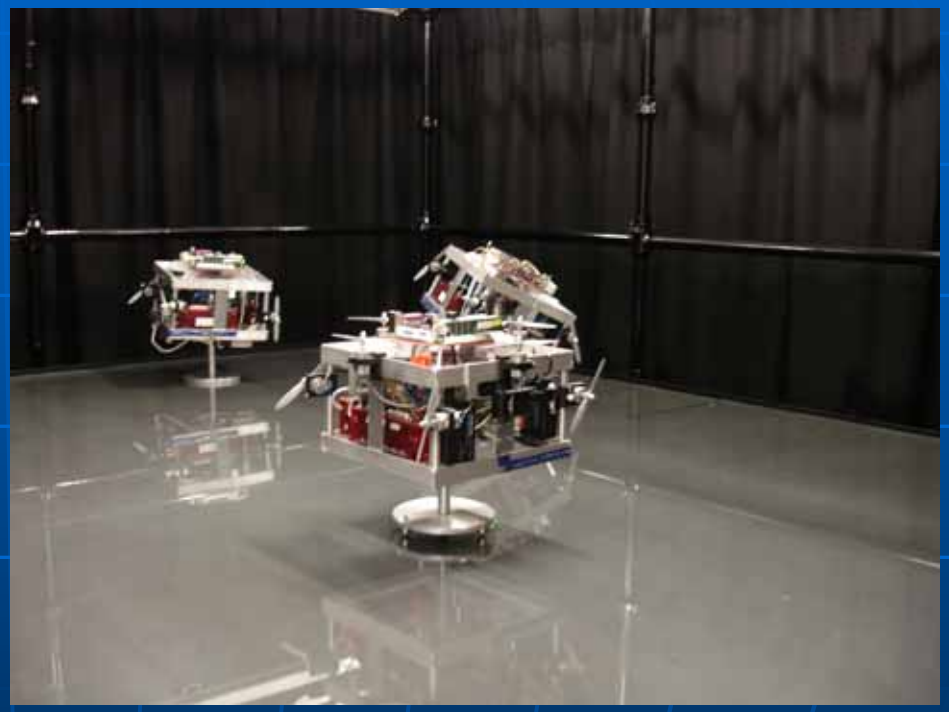
Anticipated use: testing of multi-agent systems on hardware





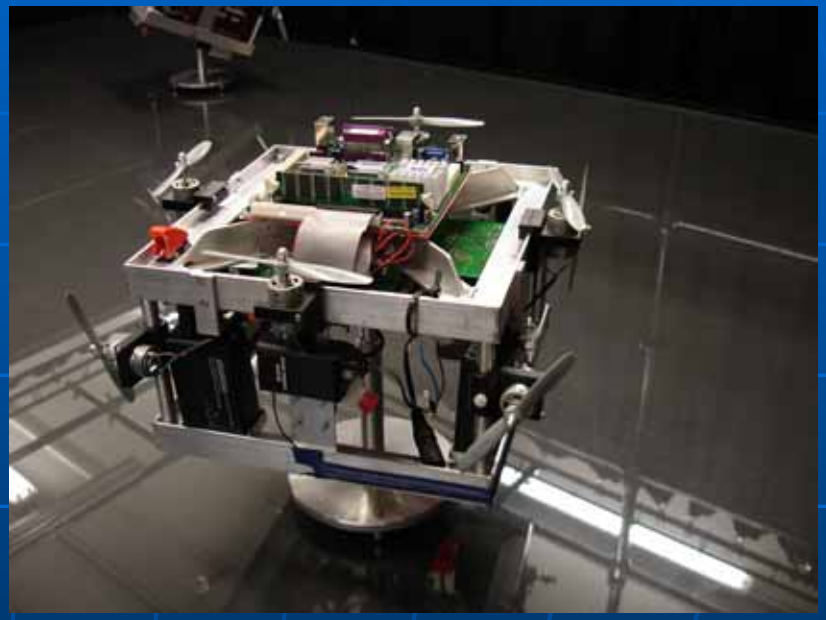
Future developments

- Precision positioning using laser range finders
- System verification software added
- Compliance with software standards
- Ready made modules with hardware standards
- Etc



Conclusions on SFF facility

- Facility almost ready for industrial use
- GSFT and HILT are complementary – the two together address all important issues before space use
- High quality design and built – cheaper to use our facility then recreate something similar for science missions

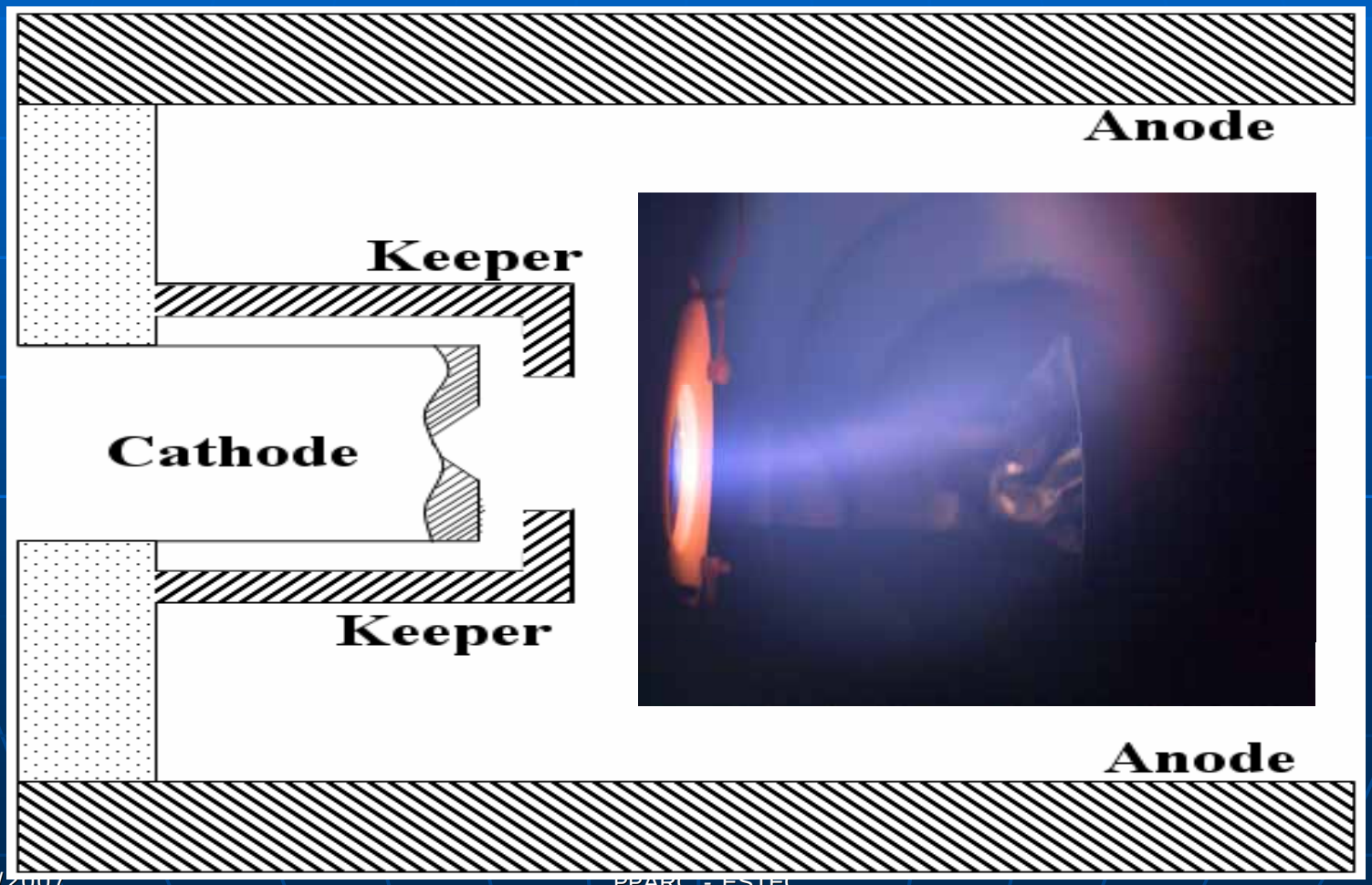


THANK YOU !

Hollow cathode micro-thrusters(HCMTs)

- Based on well developed and flight – qualified T series hollow cathodes
- Thrust range – 1-5 mN
- Specific Impulse in 100-500s range
- Possible application to ‘all-electric’ spacecraft : gridded ion thrusters for primary propulsion + HCMTs for attitude control → being studied for possible application to European Student Moon Orbiter(ESMO)

Preliminary Design of a HCMT



New Type of mini- ion thruster

- QinetiQ concept (patent pending, Neil Wallace)
- ESTEC contract : Southampton sub-contract to work on discharge chamber
- Applications to fine control for future formation flying missions (eg Lisa, Darwin, Xeus)