Proposal: 42 – Galileo Galilei

Version: 1.2 date: 02/03/2015

42 – Galileo Galilei (Description)

Main science objectives:
- Measurement of Eotvos Parameter (universality of free fall) to 1E-17
- Local Lorentz Symmetry violation (SME parameter test)

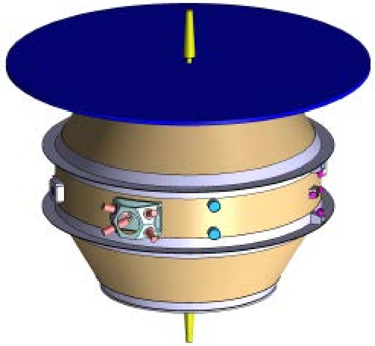
Mission profile
- Launch with VEGA into 630 km SSO (97.9 degree inclination)
- Dusk-dawn or dawn-dusk, spin axis normal to orbit plane
- 1 year operations (one measurement signal acquired after 15 orbits (1 d), rest statistics and null tests)

Spacecraft:
- Spinning spacecraft (587 kg, 390 W) at 1 Hz, 1.2 m high, 1.5 m diameter
- Solar panel on top, always in sun
- Cold Gas Microthrusters for disturbance compensation
- 2N cold gas for spin axis re-orientation and de-orbit burn

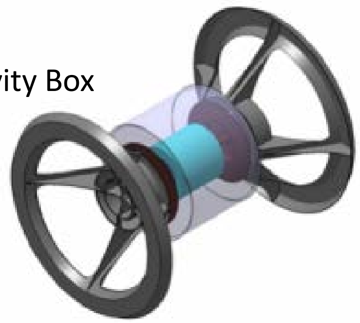
Payload:
- Mass: 86 kg, Power 90W, Data rate 9.2 kbit/s
- Two cylindrical test masses of 10kg each, nested
- Test mass material: Be, Ti (option: C_2H_4, Pb → 1E-18)
- Distance change readout with Laser gauge to 1E-12 m/√Hz @ 1Hz (cf LISA level)
- Test masses weakly coupled to structure, “free floating”
- Test masses spin at same rate as platform

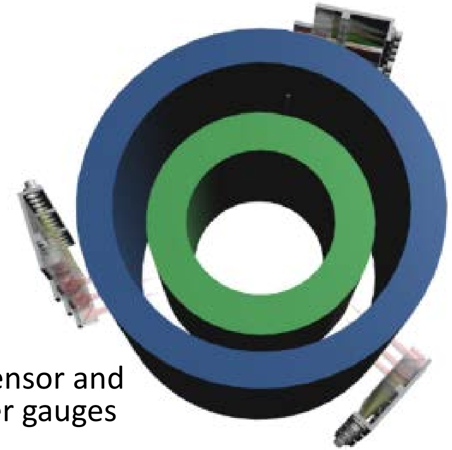
Implementation scheme & ESA contribution :
- Role of ESA: Full mission including payload design and development
- Role of Member States: Science Evaluation.
- International cooperation: none, possible JPL contribution (Laser gauge)

Spinning spacecraft



Pico Gravity Box





GG sensor and
9 laser gauges

42 – Galileo Galilei (Evaluation)

S/C Major challenges & critical issues:

- High spin-rate @ 1Hz, controlled to 1E-4 Hz, requires delta-qualification of rate sensor development (at 1E-4 Hz accuracy) (TAS-I breadboard at TRL4/5), equipment compatibility to be checked.
- Adaptation of drag-free / cold gas control systems to spinning spacecraft (e.g. control laws, thruster configuration)

P/L Major challenges & critical issues:

- Test mass locking and mounting requires a high number of mechanisms, as well as mount characterization on ground/via tests in 0-g.
- Test mass manufacturing requires Be machining with associated precautions
- Test mass mounting interface to S/C not fully described, especially with respect to nutation damping and weak coupling
- Laser gauge sensor estimated at TRL 3-4 based on information in proposal with deviations from SIM developments and assumed European supplier. Components are available.
- Direct validation on ground appears not possible (combination of test and simulation), ground model GGG appears not fully representative (only for measurement concept itself, not for mechanical/mounting/thermal)
- Full payload concept at TRL 3-4

Qualification status (S/C and P/L):

- Platform requires delta-qualification of equipment for high spin rate and sensor development
- Payload development from concept level (with ground prototype) to space instrument. Low TRL of critical components (mechanisms and read-out)

Programmatic aspects:

- Low spacecraft effort implies different implementation scheme/spending profile?
- Payload and spacecraft development very integrated – payload development and testing drives industrial cost

Clarity of implementation scheme, split of responsibilities and interfaces:

- Appears compatible with M4 scheme with risks highlighted above

42 – Galileo Galilei (Summary)

Cost	M€
ESA Project Team	43
Industrial Cost	179
Payload Contribution (ESA)	37
Mission Operations (MOC)	35
Science Operations (SOC)	27
Launcher	45
Contingency (15%)	48
Total EaC	**414**

Summary Evaluation		Comment
Mission Profile	G	VEGA into SSO, standard
Spacecraft design	G	Spin-stabilized, high spinrate
Spacecraft TRL	Y	Rate sensor, equipment validation for high spin
Payload Design	Y	Payload design at phase A level, but high uncertainty
Payload TRL	Y	Yellow based **on capacitive sensor**. Laser gauge readout at TRL 3-4, locking mechanisms -> red
GS & Science Ops	G	1 year ops
Programmatic /Cost	G	Cost estimate within M4 envelope. Development schedule to be adapted
Implementation Scheme	Y	
General Summary	**Y**	**High uncertainty on payload design, based on capacitive readout**

Sharing of Responsibility

Element	ESA	MS / (SL)		Int. Partner / SL		comment
Launcher	X					
S/C	X					
P/L	X		X			Payload support by ASI (provision of previous studies, assistance), paid and provided by ESA
G/S & OPS	X					
other	X					

Conclusion of Evaluation:

1: High uncertainty on cost at completion related to payload development.

2: Low spacecraft design effort, low effort operations.

3: Cost estimate within ESA M4 envelope with risk on payload development cost. **High uncertainty on cost-at-completion**