LISA: Status and Recent Work

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Aspen Winter Conference on
Gravitational Waves and their Detection
Aspen, CO
8 February 2001

LIGO-G010083-00-M

Outline

- Overview
- Programmatic advances
- R&D
  - European
  - U.S.
- Demonstration flights
- Conclusions

Introduction

- The LISA concept
  - 3 spacecraft forming two interferometers with 5×10^6 km long arms, benign environment
  - Measure between free-falling test masses with drag-free spacecraft control to limit unwanted disturbances
  - Measurement band of 10^{-4} to 1 Hz, $10^{-23}/\sqrt{\text{Hz}}$ best strain sensitivity in a 1 yr integration
- Sources
  - Galactic binaries: WDs, NSs, stellar mass BHs (1-10^2)
  - Coalescence if intermediate mass black holes (10^2- 10^4)
  - Coalescence of supermassive black holes (10^5- 10^7)
  - Stellar mass black holes into SMBHs
  - Cosmological background(s)

LISA Researchers

The LISA Mission Definition Team (US)

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The LISA Science Study Team (Europe)

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S. Marcuccio	Centrospazio
S. Peskett	Rutherford Appleton Laboratory
P. C. E. Roberts	Cranfield University
R. Turner	Rutherford Appleton Laboratory

Programmatic Advances in Past Year

- NASA OSS Strategic Plan
  - Recommended new start in SEU, start around 2006
  - Launch 2010, data 2012-2013
- NRC Decadal Survey
  - Highest priority new start in intermediate class
- ESA selection
  - Joint cornerstone
  - Smart 2 demo flight
- Project startup
  - Draft U.S. management plan involving GSFC and JPL
  - Key positions being filled
  - ESA/NASA discussions
  - Science Team formation

Looming Programmatic Events

- ESA/NASA agreements
- Joint management plan
- Science team startup
- Cosmic Journeys

Technology Development

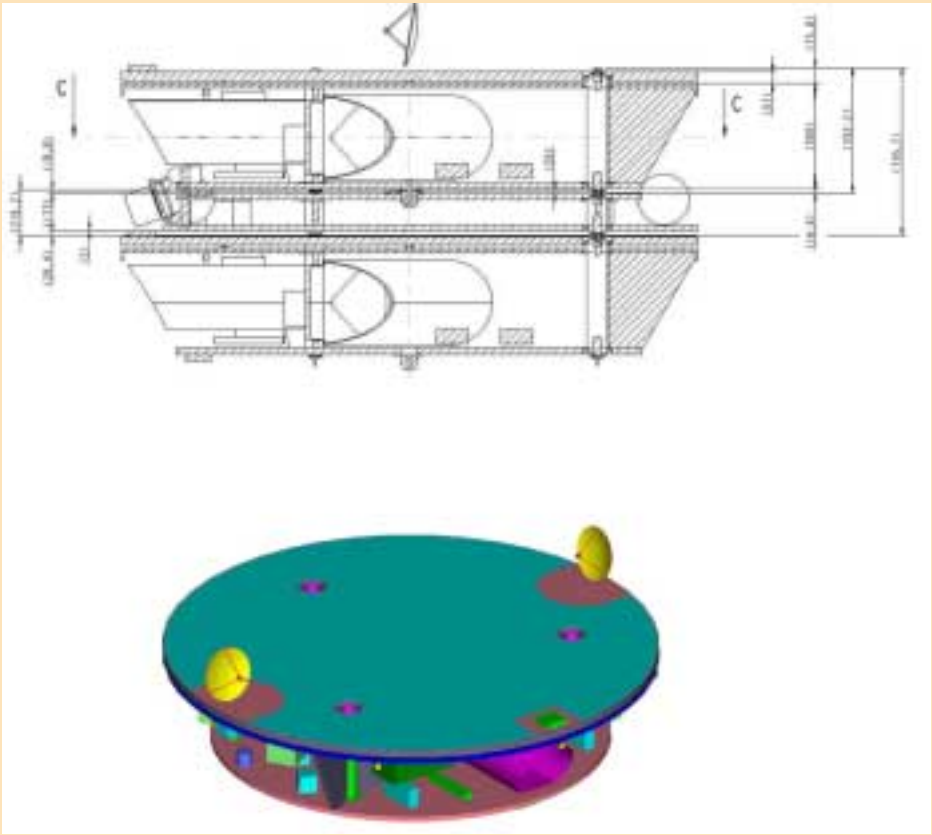
- Disturbance reduction system
  - Gravitational sensor: 3×10^{-15} m/s^2/$\sqrt{\text{Hz}}$, 10^{-4} - 10^{-2} Hz
  - μN thrusters: 50 μN max, 20 μN constant, 0.1 μN/$\sqrt{\text{Hz}}$, 10 yr lifetime
  - Drag-free control:10 nm/$\sqrt{\text{Hz}}$, 3 nrad/$\sqrt{\text{Hz}}$
- Interferometry
  - Space-qualified components
  - Fringe timing: 2×10^{-5} cycles/$\sqrt{\text{Hz}}$, 10^{-3} - 1 Hz
  - Stabilized laser: frequency stability of 30 Hz/$\sqrt{\text{Hz}}$ at 1 mHz, power stability of 2×10^{-4}/$\sqrt{\text{Hz}}$

European R&D Activities

- To be described in more detail by David Robertson, Thursday morning
- Phase A Industrial Study, and satellite studies
- Interferometry at Glasgow
- Laser stabilization at Hannover
- Gravitational sensor design, prototyping and testing at Trento
- Control system analysis at Trento
- In-FEEP noise measurements at Siebersdorf
- In-FEEP thrust measurements at ONERA
- Photodiode investigation at Birmingham
- FEEP testing at ESTEC

ESA Phase A Study

- Reviewed system design and trades
- Refined spacecraft and payload designs
  - Structural analysis
  - Thermal analysis
  - Gravitational analysis
  - Accommodation study
- Reviewed operational modes
- Modeled various drag-free control strategies
- Mass increase



U.S. R&D Activities

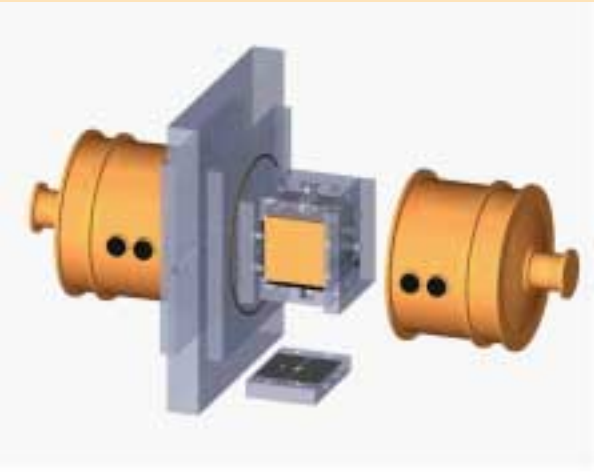
- Fringe timing at JILA (Scott Pollack, Friday afternoon)
- Control system and error analysis at JILA
- Noise correction at JPL (M. Tinto, Tuesday morning)
- Noise correction at Washington/JILA (P. Bender, Tuesday morning)
- Micronewton thruster testing at GSFC (S. Merkowitz, Friday afternoon)
- Colloidal thrusters at JPL
- Gravitational sensor design at Stanford

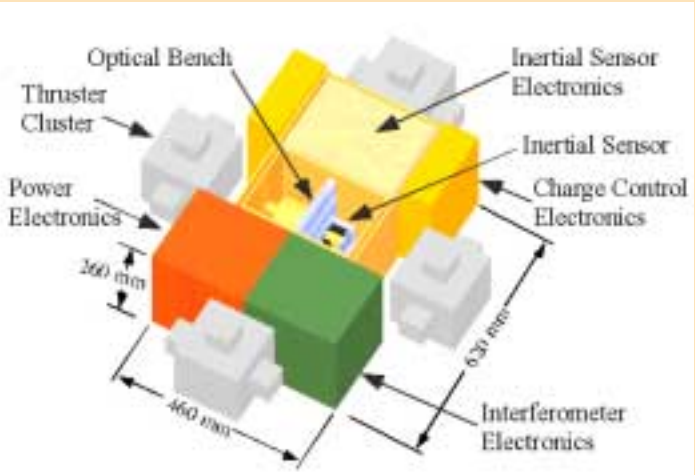
Demonstration Flights

- Gravitational sensor can't be tested on ground
- Two gravitational sensors, thrusters and servo control
- An interferometer to measure between sensors
- Drift-away orbit
- Test of residual acceleration within order of magnitude required by LISA and precision stationkeeping
- Lock spacecraft to one test mass, compare residual acceleration between two test masses
- Monitor stationkeeping
- Test noise models

ESA Smart 2

- LISA Test Package
- IRSI-Darwin test of formation-flying
- Two satellites
- Selected mission
- Phase A ITT in April ‘01
- Scheduled for launch in late '06
- ~120 Meuro allocated

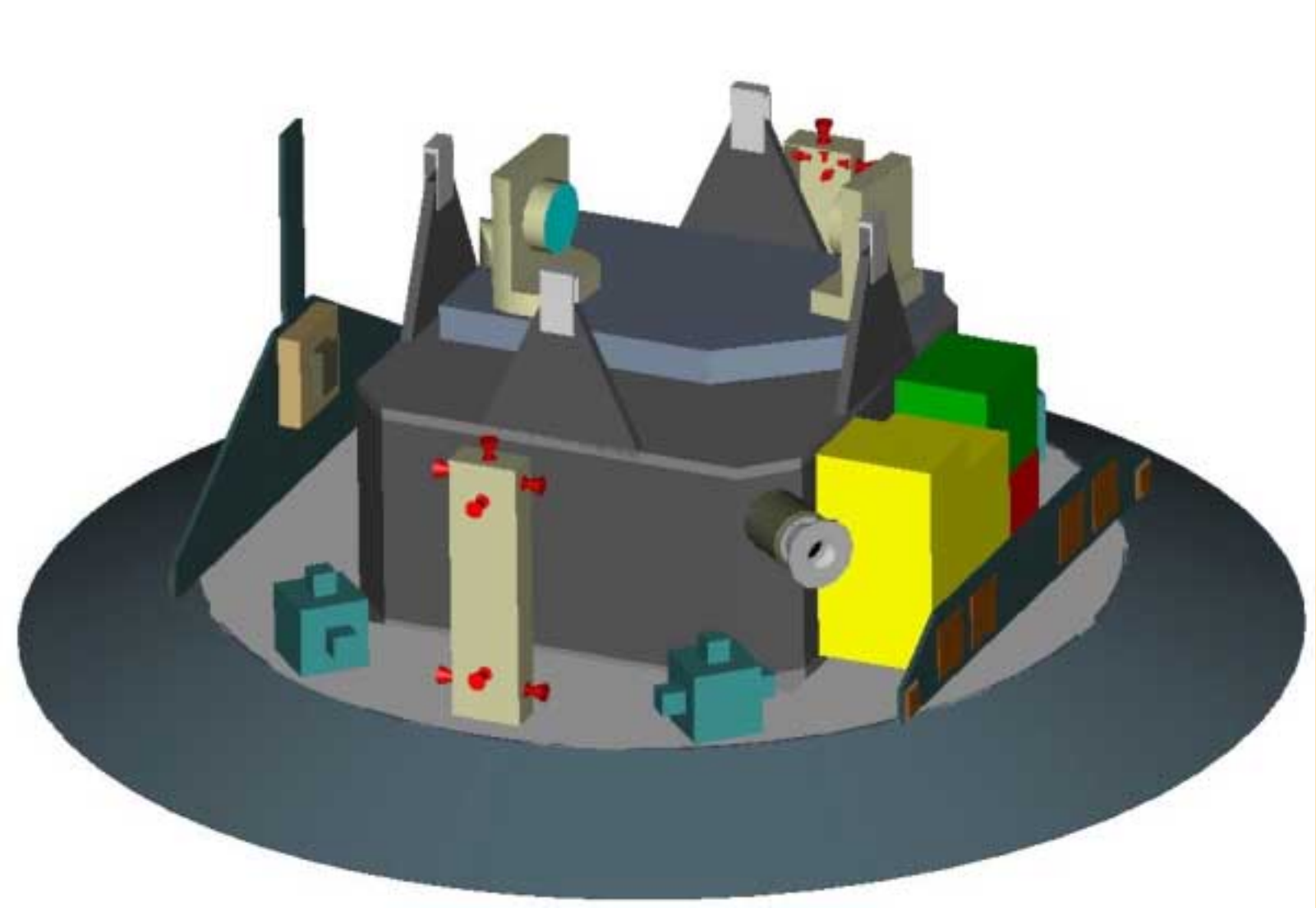




U.S. Space Technology 7

- The New Millennium Program tests technology that benefits multiple missions. US technology only.
- ST7 is a competition between 4 concepts testing a technology suite
- LV not included, piggyback on either Smart 2 or Starlight
- Starlight (nee DS-3, ST-3) is a TPF precursor testing formation-flying and star light interferometry, now in Phase B, two satellites, mid '06 launch.
- Phase A Study ends Nov. ‘01, technology selection in Dec.
- $52 M cost cap
- Launch in ‘05.

LISA Test Package on Starlight Spacecraft



Summary

- The LISA concept has made great strides toward becoming an established project. Still requires approval by Congress.
- Modest R&D efforts are progressing in both Europe and U.S. Awaiting significant funding for technology development.
- There are promising opportunities for a LISA technology demonstration flight.