

→ OBSERVING GRAVITATIONAL WAVES FROM SPACE

LISA Mission Update @ Joint NLST/SST



Martin Gehler



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Timeline



- October 2013: Selection of "The Gravitational Universe" as science theme for the 3rd ESA flagship mission (L3)
- October 2016: Call for mission proposals for L3
- June 2017: Selection of LISA as L3 with an anticipated 2034 launch date
- May 2018: Phase A Kick-Off
- 2018/2019: Mission Phase A
- November 2019: Mission Formulation Review (end Phase A)
- >2020: Mission Phase B1
- <2024: Mission Adoption
- >Adoption: Mission Implementation (Phase B2/C/D)
- <2034: Launch
- >Launch:

6.5 years operations (+6 years potential extension)

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European Space Agency

ESA Definition Phases - Process





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European Space Agency

Roles and Responsibilities (as per Aug 2018)



- ESA (mission lead):
 - Overall mission definition ("architect"), management, and mission performance responsibility
 - Space Segment, Operational Ground Segment and Science Operations Centre development, Launch
- Member States:
 - Development and provision of nationally funded contributions (MOSA, subsystems) under LISA Consortium umbrella, provision of data processing
 - Nationally funded Phase A activities
- NASA:
 - Development and provision of NASA contributions to space segment, ground segment, science ground segment, and to Consortium provided items

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Goals of Phase A



► Establish preliminary mission design in order to verify whether the candidate mission can be implemented within cost and schedule and to provide sufficient information to enable transition into phase B1.

Work in Phase A:

- Review and refinement of top-level requirements
- Investigation of alternative architectures, trade-offs, mission analysis and operations
- Identification and verification of design drivers and critical elements (especially those that have no or little heritage) with a corresponding mitigation plan (e.g. new technology developments)
- Identification of a feasible mission design and baseline definition
- Identification of suitable launcher(s)
- Definition, execution, review of technology developments
- Programmatics (cost, schedule, risk)
- Refine split of responsibilities and provisions by member states and international partners that should be endorsed at the end of Phase A (note: MoU/MLA comes later at adoption)

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Status of Phase A Activities – Industrial



- Two parallel industrial contracts for "LISA System Phase A Study"
 - 2.7 MEUR each
 - Awarded to Airbus Defence and Space GmbH and to Thales Alenia Space S.p.A.
- Status: Kicked-off in mid-May 2018, running on schedule, 2nd progress meetings in Sept.
- Scope of Work:
 - Review of Requirements, Trade-offs and baseline selection, mission architecture definition, payload interface definition
 - Spacecraft design and analysis, System Engineering Plan, ground segment and operations definition support, programmatic assessment
 - Support of Agency Reviews
 - <u>LISA specific engineering tasks</u>: Performance budget, telescope shadow preliminary design and engineering, DFACS, STOP analysis, laser system architecture support, EMC and gravitational disturbances analysis and control, SEO activity support, mission AIV

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Current System Status (Phase A kick-off)

Item	Mass
Platform dry mass	860 kg
Payload dry mass	504 kg
Payload system level margin (20%)	101 kg
Total dry mass / spacecraft	1465 kg
System margin (20%)	293 kg
Total dry mass / spacecraft incl system margin	1758 kg
Transfer Propellant (Xe)	169 kg
Cold Gas	242 kg
Total wet mass / spacecraft	2169 kg
Launch Adapter/Dispenser estimate	1000 kg
Total	7507 kg
Launcher Capacity	7000 kg

Note: Per spacecraft 169 kg over target, many conservative assumptions Main increase vs CDF came from payload.

esa lisa GRS OB Telescope MOSA LCA

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Status of Phase A Activities – Instrument



- ESA-funded:
 - One contract in direct negotiation with the Consortium (represented by AEI)
 - 1 MEUR target firm fixed price
 - Status: In negotiation with AEI, delayed.
- Nationally Funded:
 - Activities officially kicked-off in June 2018
 - Industrial support to Consortium Lead (AEI) provided by Airbus GmbH (instrument architect role) with AIV/T under CNES responsibility
 - Dedicated activities on provisions within member states (e.g. Phasemeter, Data & Diagnostics, GRS, Optical Bench, DPC)

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Status of Activities – Technology Developments



MCR now

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17-030MM	High-power laser system for eLISA							TRL6	
17-046FM	Gravitational Wave Observatory Metrology Laser	-							
17-046FM B	Gravitational Wave Observatory Metrology Laser							1	
17-068MM	Fine-structure of laser radiation in the far-field			-	-				
17-066MM	Hollow core fibre gas cell for laser frequency stabilization			-	TRL5		TRL6		
ASA-2	Laser	1		-	∇		—	і Т <u>R</u>	L6
16-137FM	Optical Bench Manufacturing Industrialisation Study			National Funding					
16-138FM	Metrology Telescope Design for a Gravitational Wave Observatory Mission		-						
16-138FM-B	Metrology Telescope Design for a Gravitational Wave Observatory Mission		-						
21-016MT	Enhanced temperature measurement for LISA						TRI	5	TRL6
SA-1	Telescope			-			∇		
7-045FM	Phase Reference Distribution for Laser Interferometry		1.1	in the second					
SA-3	Phasemeter System			-					
4-125EP	Test mass charging toolkit and LPF lessons learned					TRL5	-	TRL6	
SA-5	Charge Management System					∇			
97-021EE	Design and Development of an electrically steerable antenna for science missions					-		TRL6	
7-070MM	LISA Constellation Acquisiton Sensor								
95-033EC	Assessment and Preliminary Prototyping of a Drag Free Control System for the L3 Gravity Wave Observatory							TRI 6	
19-009MP	Preliminary qualification status assessment of heritage Cold Gas Micro-thruster for LISA							V	
15-038EP	Micro-particle impact related attitude disturbances		1					1	
04-120EP	Development and validation of a contamination package in SPIS for liquid based Electric Propulsion subsystems for LISA								
19-001MP	Electric Micropropulsion System for a Gravitational Wave Observatory Mission					TRL5	-	T <u>R</u> L6	
ISA-4	Colloid MPS					∇			

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Meeting	Main focus
SEO #01	KO meeting
SEO #02	Requirements Review (aligned with Phase A ind req review), Iteration on Noise Budget, System analysis
SEO #03	System level analysis and trade offs in support to baseline definition, Noise Budget iteration, interfaces iteration - US
SEO #04	Baseline definition prior to MCR, first draft of EID-A, consolidated Noise Budget, programmatic assesment
SEO #05	MCR results analysis (or earlier for MCR preparation if needed)

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