

# News from the LISA Science Team (LST)

# WHAT IS THE LISA SCIENCE TEAM

*LISA Science Management Plan*

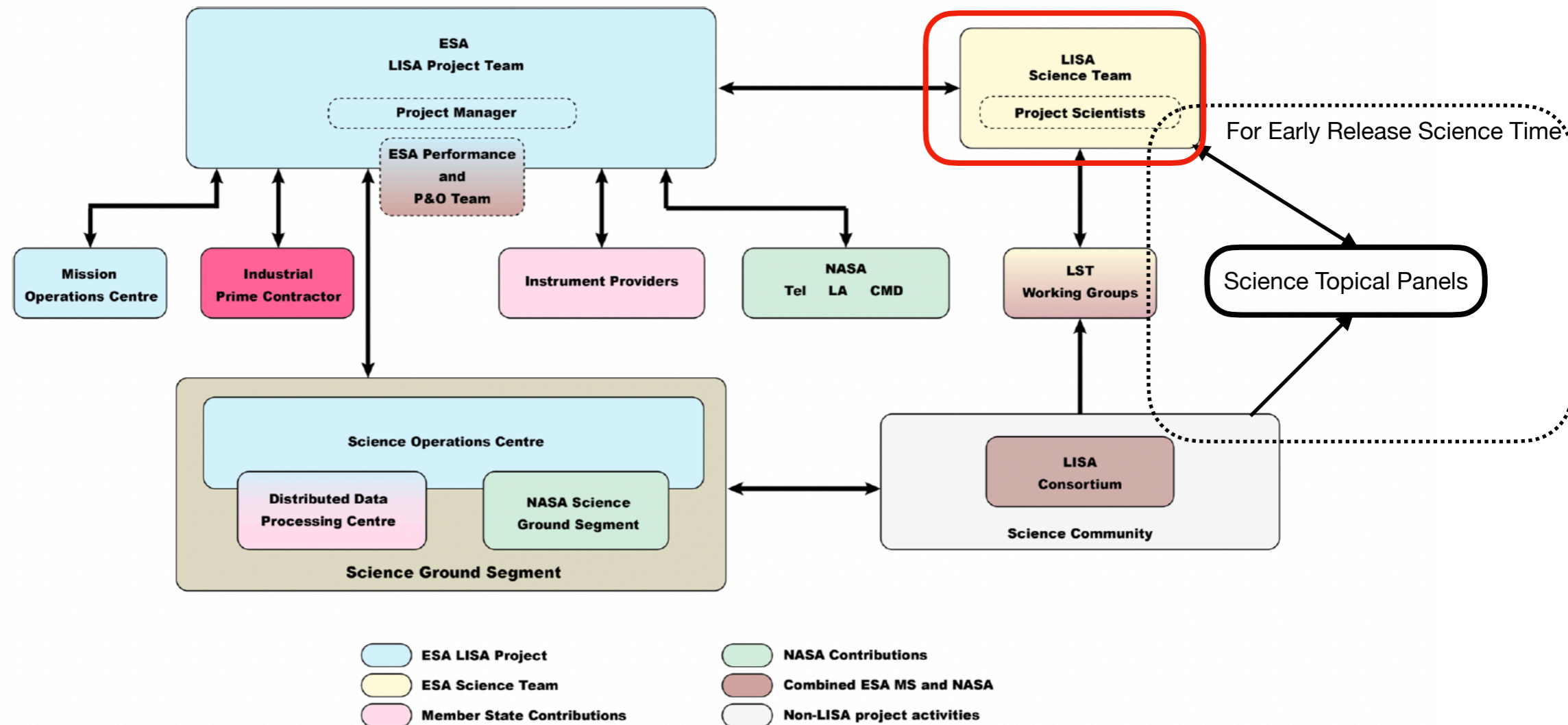


Figure 1: Overview of the LISA management scheme during the Implementation phase.

# TASKS OF THE LST

*LISA Science Management Plan*

- maximising the scientific return of LISA within programmatic constraints, while ensuring that the development and operations of the mission remain compatible with its main scientific objectives;
- optimising the scientific performance of the instrument and spacecraft;
- formulating, optimising, and maintaining the gravitational wave calibration strategy;
- optimising access to the data via the mission archive(s);
- optimising the analysis and utilisation of LISA data;
- overseeing the generation of the Level-3 source catalogue from Level-2 data products;
- authorising the release of scientific data products to the community;
- establishing, when necessary, Working Groups to provide expertise to support the LST in providing scientific advice to the Project and Mission Managers;
- establishing and managing the Science Topical Panels (STPs) of the Early Release Science Time;
- promoting public awareness and appreciation of the LISA mission, and supporting ESA and its partners in their outreach efforts.

LISA Data releases are under the responsibility of the Project Scientists and the LST

2 in-person meetings/year, online every month

13 participants from ESA member states, 6 from USA + Consortium representative + 2 « complementary scientists »

# LISA SCIENCE OBJECTIVES

## Astrophysics

## Fundamental Physics

## Cosmology

SO1: Study the formation and evolution of compact binaries in the Milky Way

SO2: Trace the origin, growth and merger history of massive black holes across cosmic ages

SO3: Probe the dynamics of dense nuclear clusters using EMRIs

SO4: Understand the astrophysics of stellar origin black holes

SO5: Explore the fundamental nature of gravity and black holes

SO6: Probe the rate of expansion of the Universe

SO7: Understand stochastic GW backgrounds and their implications for the early Universe and TeV-scale particle physics

SO8: Search for GW bursts and unforeseen sources

# MEET THE LST

## THE LISA SCIENCE TEAM 2024-2027

ESA/NASA Project Scientists  
 Nora Luetzendorf  
 Oliver Jennrich  
 Ira Thorpe  
 Ann Horshmeier



<b>Chiara Caprini</b> Université de Genève, CH 	<b>Guido Müller</b> AEI Hannover, DE 	<b>William Joseph Weber</b> University of Trento, IT 	<b>Deirdre Shoemaker</b> UT Austin, US 
<b>Anna Heffernan</b> University of the Balearic Islands, ES 	<b>Antoine Petiteau</b> CEA - Centre de Saclay, FR 	<b>Neil Cornish</b> MT State, US 	<b>Stephen Taylor</b> Vanderbilt, US 
<b>Nikolaos Karnesis</b> Aristotle University of Thessaloniki, GR 	<b>Elena Maria Rossi</b> University of Leiden, NL 	<b>Krista Lynne Smith</b> Texas A&M, US 	<b>Catia Grimani (Complementary)</b> Università di Urbino, IT 
<b>Valeriya Korol</b> SRON, NL 	<b>Alberto Sesana</b> University of Milano Bicocca, IT 	<b>Joey Shapiro Key</b> UW Bothell, US 	<b>Zoltán Haiman (Complementary)</b> ISTA, AT 
<b>Astrid Lamberts</b> Observatoire de la Côte d'Azur, FR 	<b>Alberto Vecchio</b> University of Birmingham, UK 	<b>Erin Kara</b> MIT, US 	<b>Jonathan Gair (Consortium Rep.)</b> AEI Potsdam, DE 

- Galactic Binaries
- EMRIs
- Fundamental Physics
- Stochastic Backgrounds
- Multiband GWs
- Waveforms
- Interferometry
- Massive Black Holes
- Stellar Mass BHs
- Expansion of the Universe
- Multimessenger
- Data Analysis
- Cosmic Ray Physics
- Free-falling Test Masses



Astrid Lamberts - Journées LISA-Fr - 4/5/25



# MEET THE LST

Last week in Geneva



# LST WORKING GROUPS

First years of the LST: lots of work to set things up/clarify and get some working habits.  
Boundaries are (often) set by Science Management Plan and timelines from Project

**Communications:** streamline and improve communication from/to the community

**Figures of Merit (FOM):** providing ESA with a scientifically validated tool to assess impact of changes in instrument performance on science objectives

**Catalogues:** What should be in the LISA data?

**Alerts:** When/how should alerts be sent out about transients in the LISA data stream

**Authorship:** Who will be an author on certain LISA papers

**Science Topical Panels:** How should teams be selected and work during Early Release Science Time

**Task force** on Science Data Processing Requirements: Provide requirements on data processing

# FIGURES OF MERIT

Chairs: Alberto Sesana + Antoine

Initial design by Formulation Management Team for adoption (mostly done by Stas Babak, Maude Le Jeune, Andrea Sartirana)

Computes impact of certain instrumental changes on capability to reach science objectives

- Scientific (re)assessment and validation of the figures of merit : detectability, signal to noise estimate and parameter estimation of sources

- Provides « traffic light » blue, green, yellow, red according to abilities to make the measurements ->fast, needed by ESA
- When lights turn yellow or red, LST should make further evaluation

- Improvement and execution of the software by software engineer being hired at ESTEC

<b>FoM 2.3</b>	<b>Discovering unequal mass IMBHs [4.5 yr]</b> <b>Discovering nearly equal mass IMBHs in the local universe [4.5 yr]</b>
Description	As for the FoM paper, explore the range $M_{tot} \in [1e4, 1e6]$ and $z \in [0.5,3]$ , with mass ratio $0.01 < q < 1$
Runtime	30 CPUh (for all SO2 FoM)
S.I. answered	SI 3.2.4a, SI 3.2.4b
Explorative?	no
Traffic light?	yes
Code on Git?	<a href="https://gitlab.in2p3.fr/LISA/lisa-fom/-/tree/develop/SO2">https://gitlab.in2p3.fr/LISA/lisa-fom/-/tree/develop/SO2</a>
Notes	Depends on waveform assumptions. Now using aligned spins.
Comments and discussion points	<ul style="list-style-type: none"> <li>• The equal mass IMBH FoM is automatically achieved if the unequal mass one is and if FoM 2.1 is, so connect the FoM to the unequal mass IMBH only.</li> <li>• As for the FoM paper, explore the range <math>M_{tot} \in [1e4, 1e6]</math> and <math>z \in [0.5,3]</math>, with mass ratio <math>0.01 &lt; q &lt; 1</math></li> </ul>

Publication by this summer



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# ALERTS

Chairs: Zoltan Haiman, Valeriya Korol (includes Antoine)

Started recently, urgent need to provide requirements to Science Ground Segments

- Conditions for sending alerts to the public
- Timing for the alerts and updates (latency -> requirements on pipelines)
- Content of the alerts

Discussion tomorrow

To come: better connection with multimessenger community: Workshop to understand which observatories would do follow-up

Mock exercise for the community?

# COMMUNICATIONS

Chairs: Anna Heffernan, Krista Smith

- Provide monthly updates on LST activities to the Consortium
- Updates in newsletters
- Maintain a list of « frequently asked questions »
- Procedures for communicating important documents to the community and asking for feedback (or not)
- Procedures to involve outside experts to LST working groups
- Keep track of (some) presentation material

# CATALOGUES

Chairs: Astrid, Nikos Karnesis

What should be in the LISA catalogue? Can we imagine a LISA data release?

LST+outside experts (including Natalie Webb, IRAP): make a wishlist covering all science objectives

Provide list of source parameters in catalogue

Ongoing: Feedback from Science Ground Segments (DDPC, SOC, NASA Science Ground Segment) and extraction of requirements.

Should be public mid 2027.

Discussion session tomorrow morning

# AUTHORSHIP

Chairs: Neil Cornish, Guido Mueller

Who will be authors on the LISA Collaboration papers?

**LISA Collaboration** = Instrument Provided + Science Ground Segments + LST (not the Consortium)

Collaboration will write instrument papers and a set of factual papers with each data release (e.g. « We found X Galactic binaries »), no science interpretation papers.

**LISA heritage author list:** list of people having made a significant contribution to the mission, no expiration date. Likely separation between:

- founders (~10 people, mostly retired by the launch)
- builders

**LISA member author list:** list of people active at the time of science operations, roll-off period of 2 years

- contribution level TBD
- discussion of qualifying activities

# SCIENCE TOPICAL PANELS

Chairs: Elena Rossi, Steve Taylor

Early Release Science Time (1st year of data), Science Topical Panels have (some) data access -> write **Science Validation publications for 1st data release**

Compromise between extended proprietary period and no proprietary period.  
Period of close collaboration between DDPC and STPs.

Paper uses 6-9 of data and is written fast -> team should be efficient (5-20 people) with limited focus.

First document states:

- LST makes list of STP topics
- ESA/NASA opens call for proposals (topics) and members
- Selection done ~3 years before data
- Additional call a bit later for « cutting edge new topics »
- Team members selected first, (co-)chairs later
- Clear code of conduct on data usage and publication