



LISA

Alessandra De Rosa

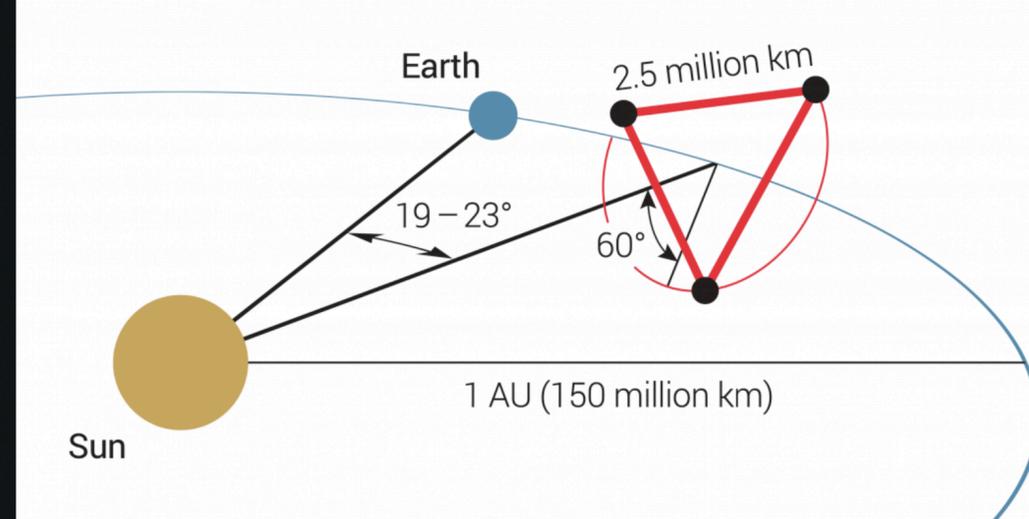


IAPS

ISTITUTO DI ASTROFISICA
E PLANETOLOGIA SPAZIALI

LISA

project status



LISA is a large-scale space mission designed to detect gravitational waves in the mHz domain (0.1 mHz-0.1 Hz). It will be the first space-based gravitational wave observatory.

LISA will consist of three spacecraft separated by 2.5 million km in a triangular formation, following Earth about 50 million km in its orbit around the Sun.

The LISA launch is expected in 2035

The LISA Consortium is a large international collaboration that combines the resources and expertise from scientists in many countries all over the world. Together with ESA, its member states, and NASA, the LISA Consortium is working to bring the LISA Mission to fruition.

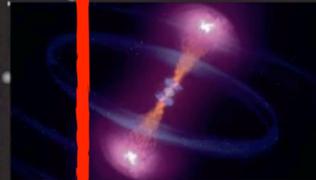
Sources



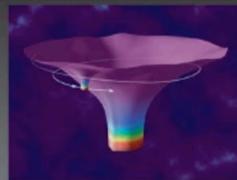
Big Bang



(Super-)massive black hole inspiral and merger



Compact binary inspiral and merger



Extreme-mass-ratio inspirals



Pulsars, supernovae

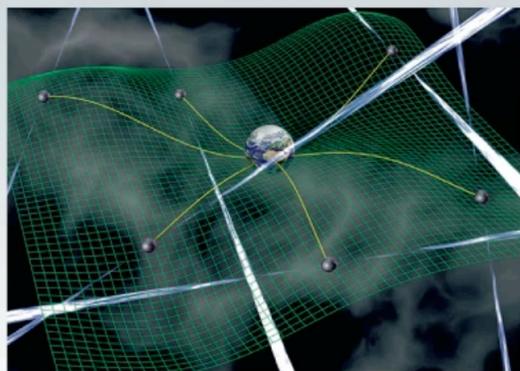
Wave period

Wave frequency

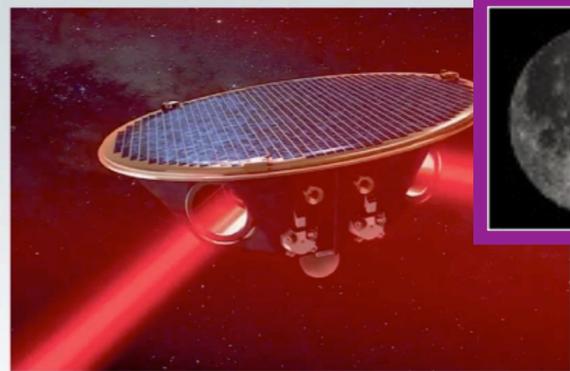


lunar antenna

Radio pulsar timing arrays



Space-based interferometers



Terrestrial interferometers

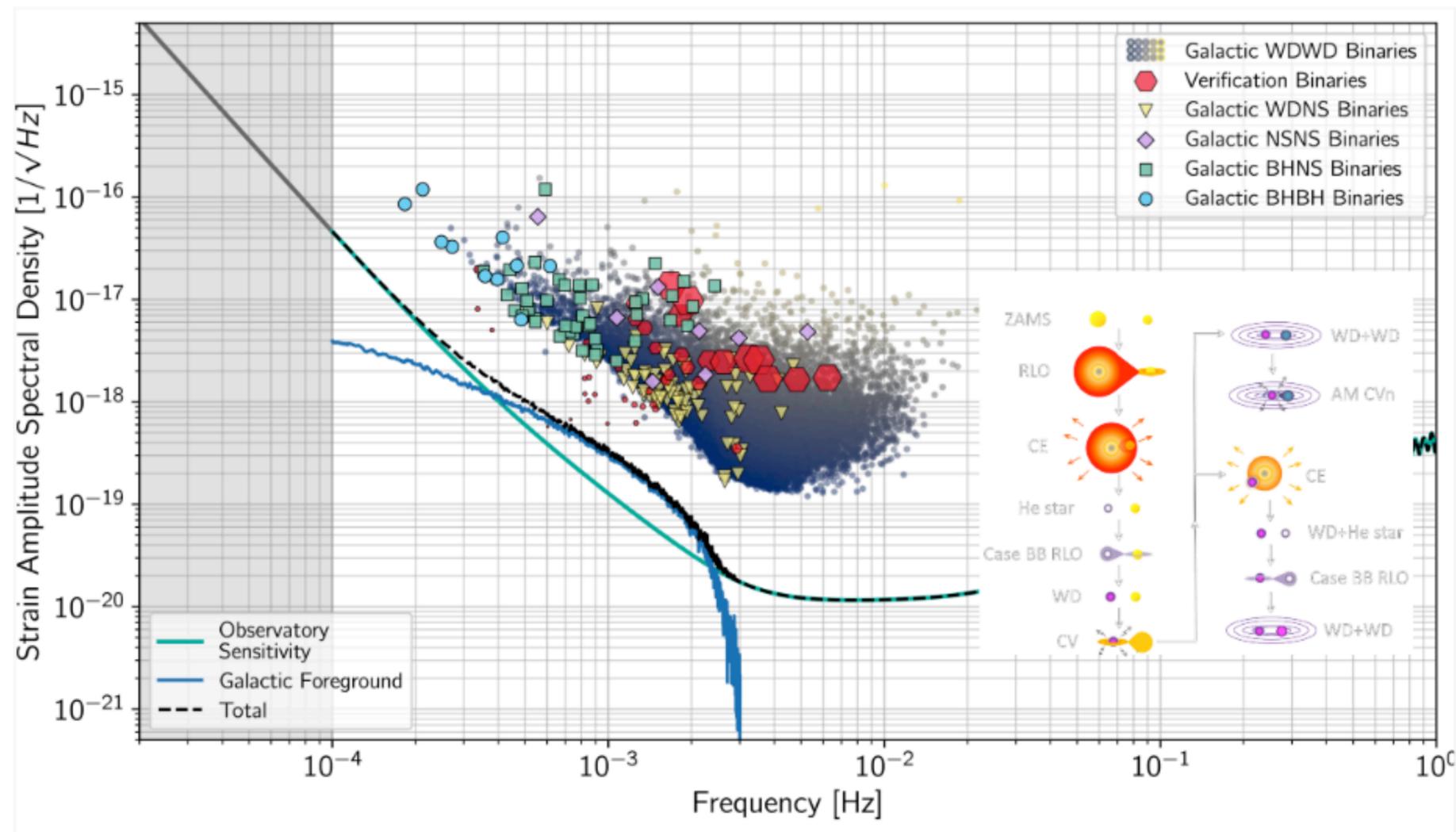


Detectors

adapted from Bailes+2021

LISA

science I - Compact binaries

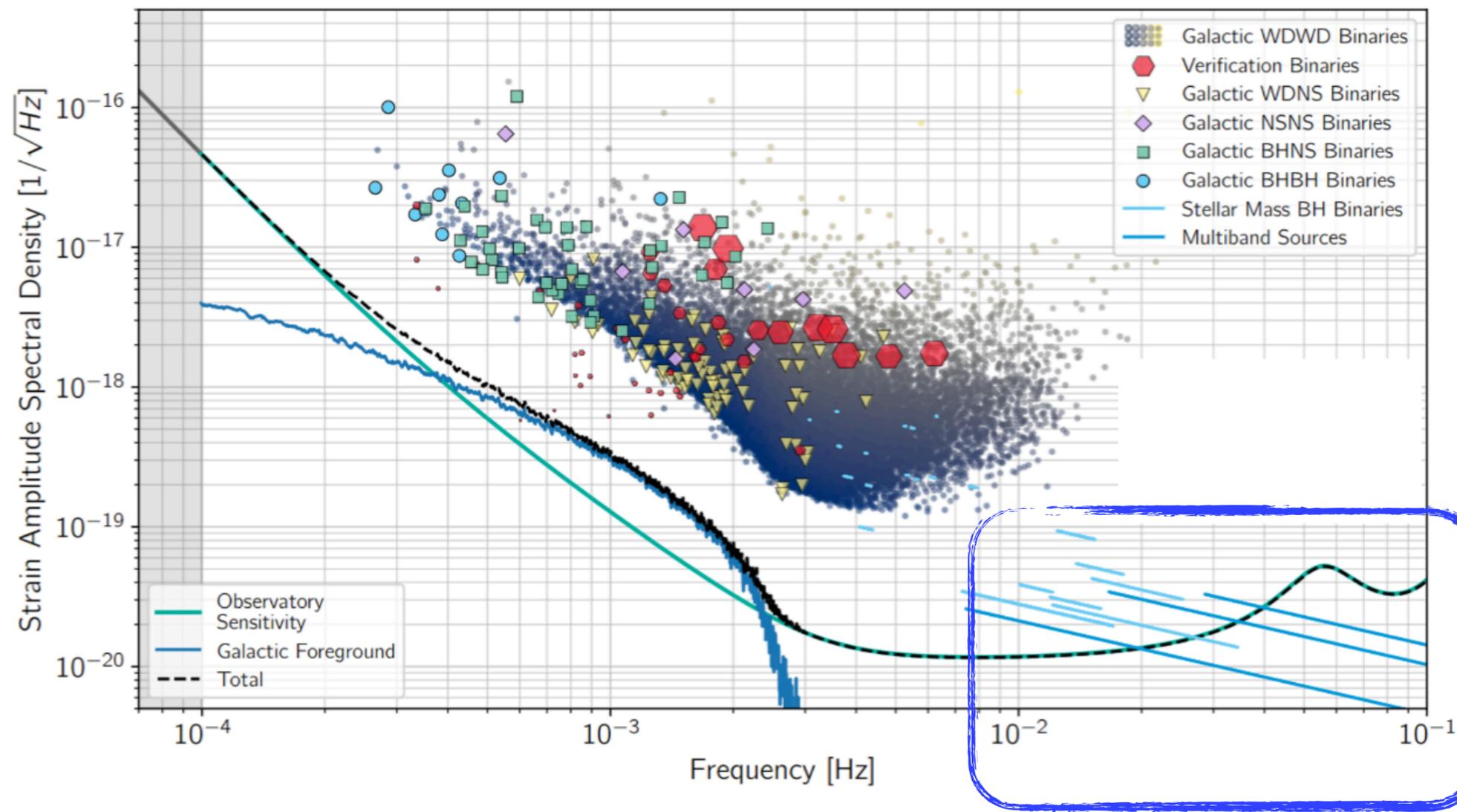


| Source | N | N^{detected} |
|--------|--------------------|-----------------------|
| WD+WD | $\sim 10^8$ | 6,000–10,000 |
| NS+WD | $\sim 10^7$ | 100–300 |
| BH+WD | $\sim 10^6$ | 0–3 |
| NS+NS | $\sim 10^5$ | 2–100 |
| BH+NS | $\sim 10^4 - 10^5$ | 0–20 |
| BH+BH | $\sim 10^6$ | 0–70 |

Stellar compact binaries will be the most numerous GW sources in the LISA band; many are invisible in EM while some will be multi-messenger sources.

LISA

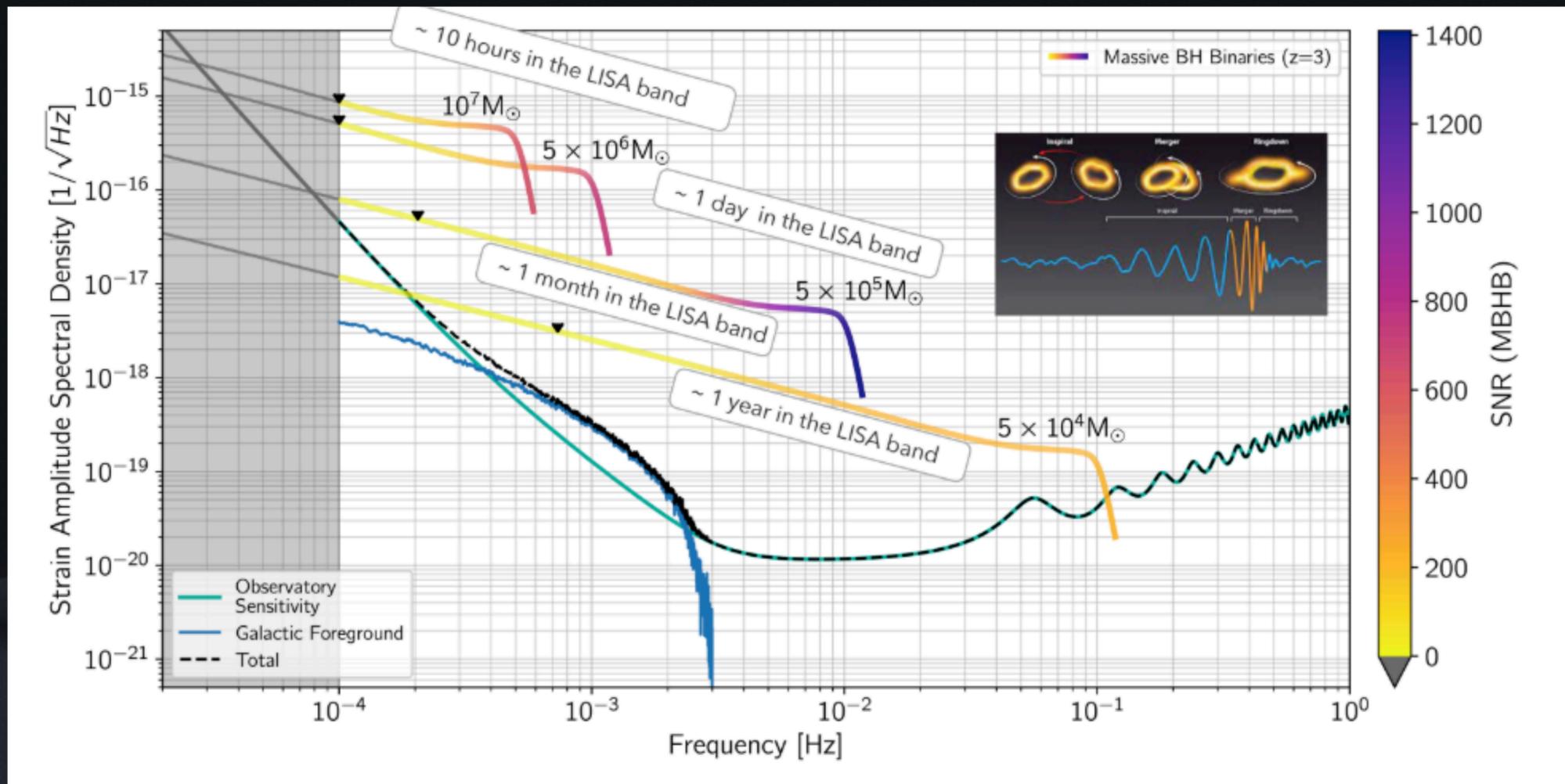
science II - stellar mass BH binaries and multi-band sources



GW150914-like binaries a few years prior to their coalescence. The inferred sky position and time to coalescence will inform ground-based GW detectors and EM observatories to enable GW multiband and multimessenger observations

LISA

Science III - Growth and merger of MBH

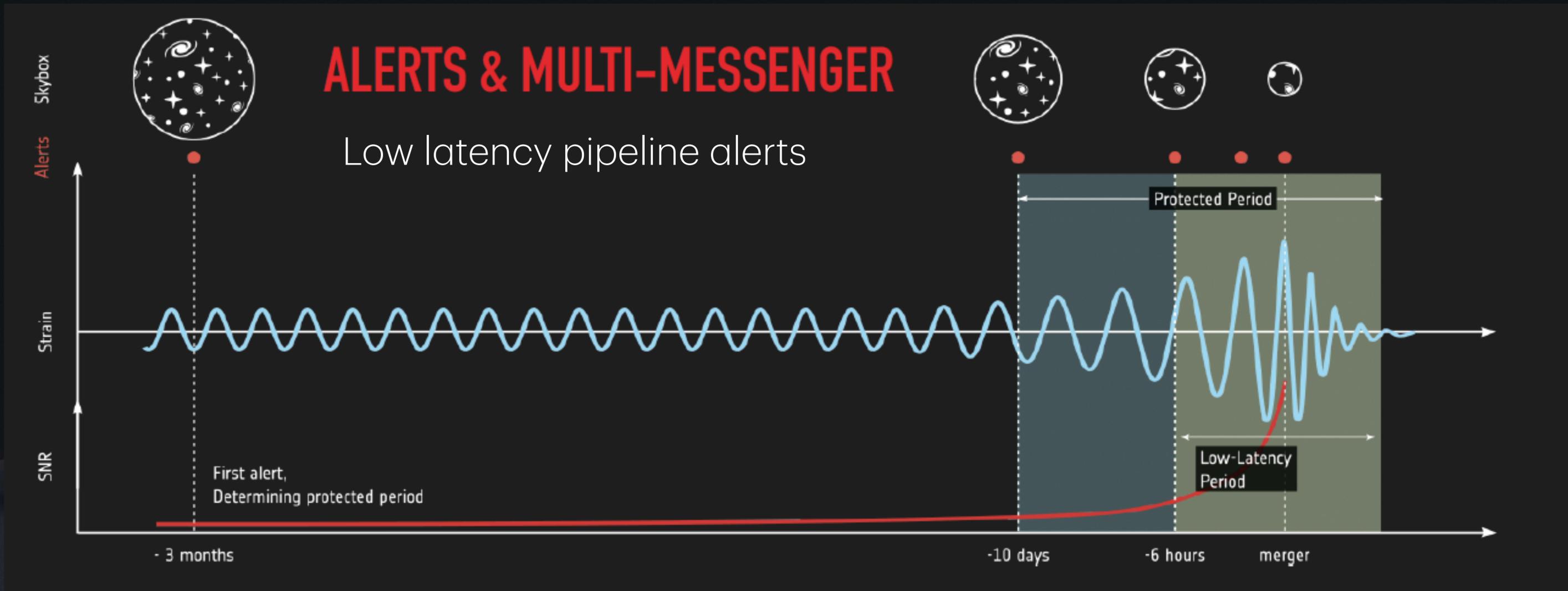


MBH binaries become detectable by LISA weeks/days/hours before the merger, depending on BHM and redshift, and become quiescence shortly after coalescence, forming a class of transient sources

(in contrast to the continuous sources such as Galactic binaries)

LISA

Science III Growth and merger of MBH



protected period of quasi-realtime data (outside the nominal 8 hr)

LISA consortium



The LISA Consortium is a scientific collaboration working together to maximize the scientific return of LISA, in particular using the LISA data. The Consortium will support all aspects of the LISA mission throughout the mission lifecycle.

The LISA Consortium is committed to promoting the long-term growth and development of the LISA scientific Community, by providing a supportive and inclusive environment that offers training, mentoring and opportunities for scientists at all stages of their careers, in particular, early career scientists. The Consortium will also engage with the wider scientific community to foster interest in and support applications of the LISA data.

Two types of members

- **Core members** [commit to deliverables]
- **Community members** [involved and informed]

LISA Consortium Members



- Involved and informed
- Directory and email lists
- Workshops and meetings
- Announcements and LISA communications
- No proprietary access to LISA data

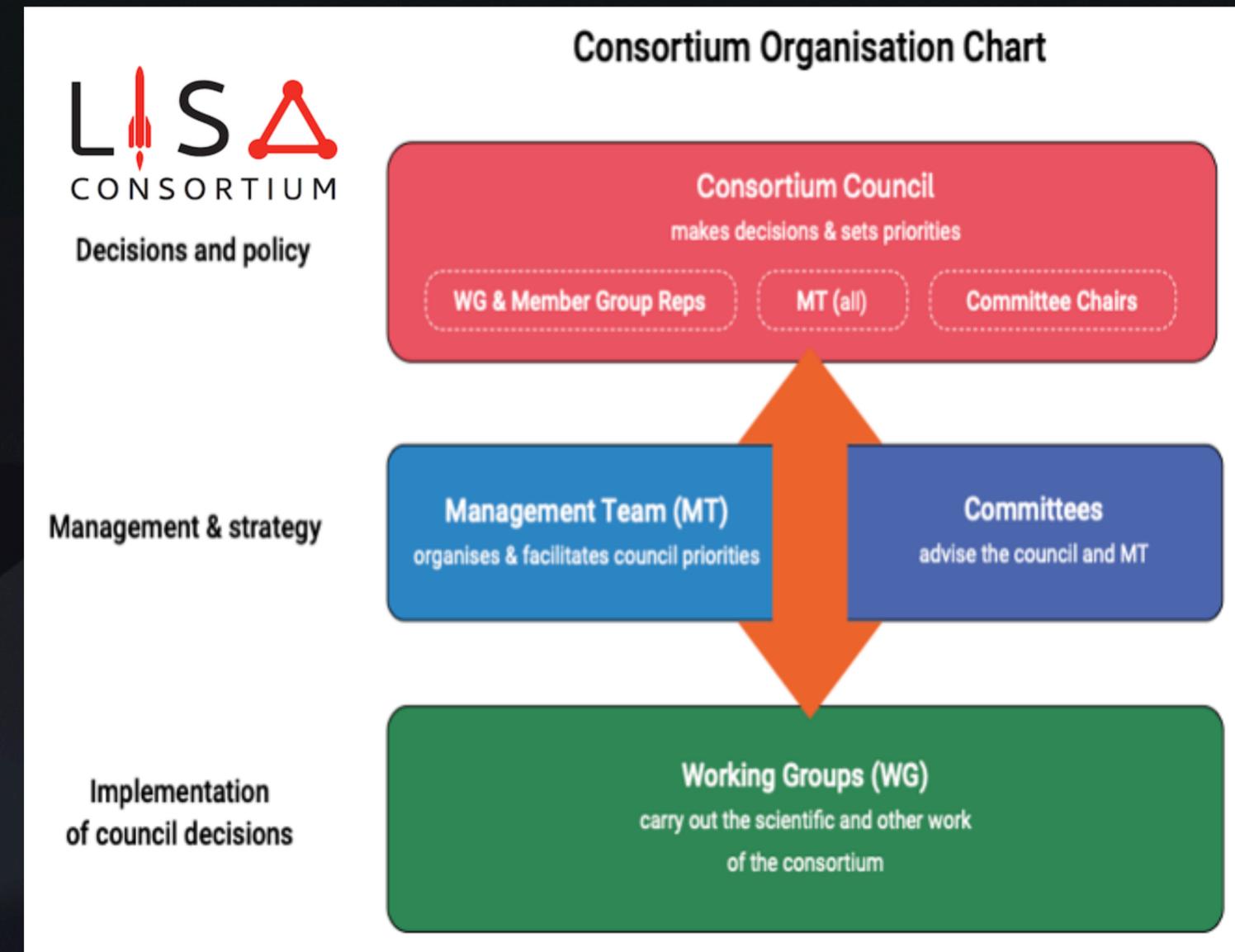
| Community members | Core members |
|--|---|
| <ul style="list-style-type: none">•No deliverables required•No membership contribution reviews•No automatic right to opt-in to author list of consortium papers•Cannot be attached to member groups | <ul style="list-style-type: none">•Deliverables required•Membership contribution reviews•Opt-in to author list of consortium papers•Can self-organise into member groups |

LISA Consortium organization and structure

- **Council** + Management Team (MT)
- Committees
 - Permanent (e.g. DEI, communication, membership etc)
 - Temporary (e.g. conference team etc)
- Working Groups (WGs)
 - Science WGs (Astrophysics, Cosmology, Data analysis, Fundamental physics, Instrument, Waveform)
 - Other Core WGs (LECS, communications, etc.)
- **Member groups** (self-organised groups of core members from institution/country/other)

A. De Rosa (3 years), F. Mannucci (2 years)
representative at the Council

A. De Rosa as member groups chair



INAF contribution to LISA

LISA-Science@INAF member groups

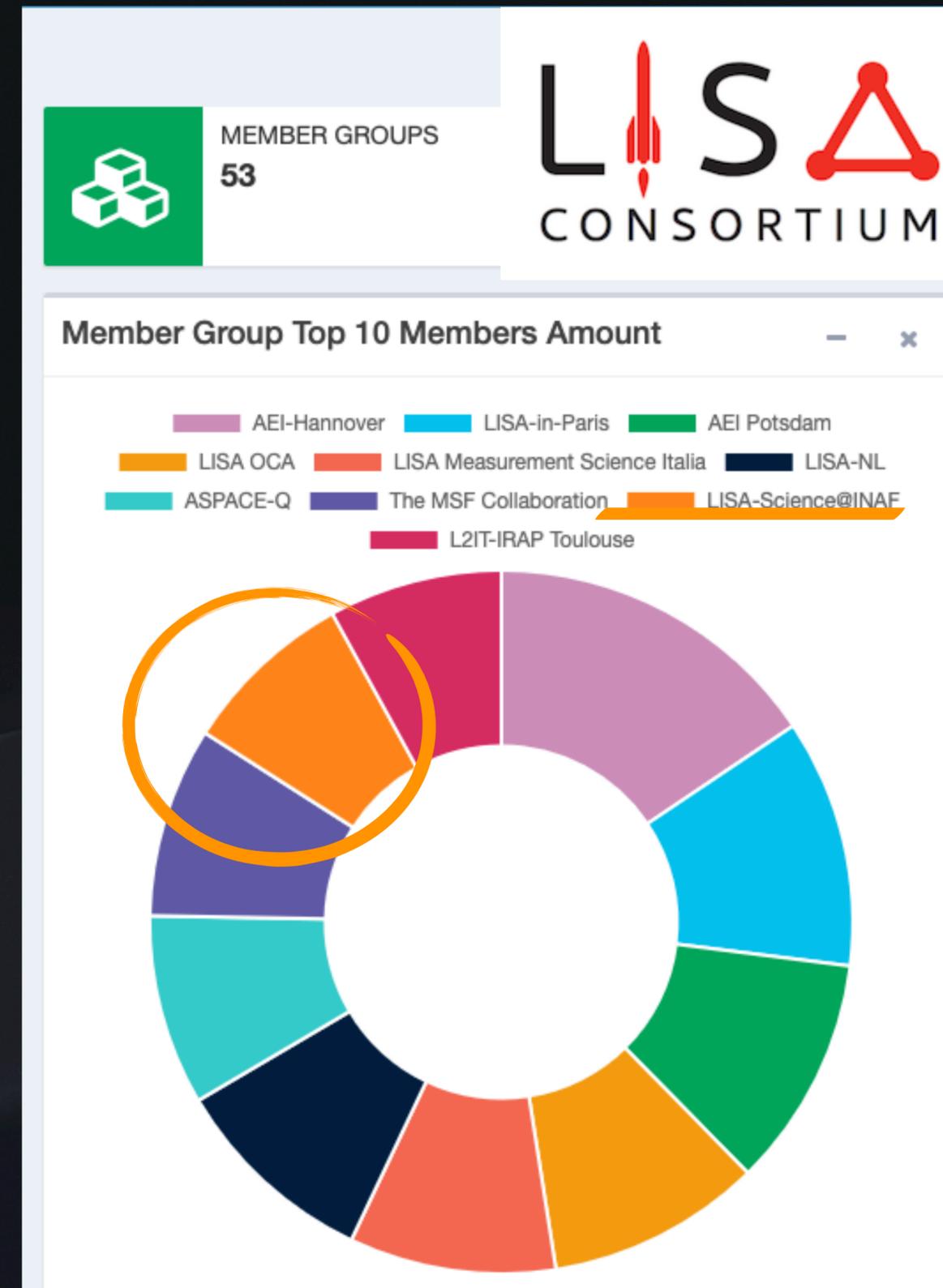
Chair A. De Rosa (IAPS)

Group Comment: The group will coordinate the scientific activities conducted at INAF. The proposed activities encompass a broad range of LISA-related science, including astrophysics (such as the study of massive black hole catalogs and simulations, compact objects, and multi-messenger astronomy) and cosmology. The group will also oversee data analysis efforts, including INAF's contributions to the DDPC.

It is among the largest Member groups in LISA (21)

Italy LISA Data Analysis: E. Barausse (SISSA) 2 INAF + 2 INAF Ass

Italy LISA Astrophysics: A. Lupi (U Bicocca, INAF Ass), 6 INAF Ass



INAF contribution to LISA

Astrophysics LISA Science Projects

call to apply is open till Jan 31!

INAF and INAF associated coordinators

- *Dual and binary AGN* - [Alessandra De Rosa](#), Leonid Gurvits, David Izquierdo-Villalba, Kunyang Li
- *EMRI catalogs* - [Elisa Bortolas](#), [Matteo Bonetti](#), Luca Broggi, [Alessandro Trinca](#)
- *Environment of MBH mergers* - Nianyi, Chen, John Regan, Sean McGee
- *Waveform parameter space (with wavWG)* - Luca Broggi, Lucio Mayer, Sean McWilliams, Marta Volonteri
- *Data standard and DDPC-friendly catalogs* - Laurentiu Caramete, Golam Shaifullah, Tristan Bruel, David Izquierdo-Villalba
- *Comparing UCB catalogues for LISA with existing observations* - Alexey Bobrick, [Simone Scaringi](#), Silvia Toonen
- *Extending UCB catalogs to include mass-transferring systems (e.g. AM CVns, CVs, UCXBs, etc.)* - Thomas Kupfer, [Simone Scaringi](#), Nathan Steinle
- *Dynamical binaries in the Galaxy and Local Volume* - Sara Rastello, [Manuel Arca Sedda](#), Tristan Bruel, [Cristiano Ugolini](#)
- *Extragalactic DWD foreground* - Valeriya Korol, Mauro Pieroni, Gijs Nelemans
- *LISA triples and CBPs* - [Camilla Danielski](#), Nicola Tamanini, Silvia Toonen
- *Updatable predictions for stBBH in LISA* - Riccardo Buscicchio, Alexandre Toubiana
- *Updating the astroWG LRR (2025): Compact binaries* - Thomas Kupfer, Thomas Tauris, Tassos Fragos
- *Updating the astroWG LRR (2025): Massive black holes* - [Elisa Bortolas](#), Melanie Habouzit, Pedro Capelo [Alessandra De Rosa](#) coordinates MM chapter
- *Updating the astroWG LRR (2025): EMRIs* - Pau Amaro-Seoane, Lorenz Zwick, Saavik Ford, Alejandro Torres Orjuela, Verónica Vázquez-Aceves

LISA ASI Contribution

Attività per la fase B2/C della missione LISA

La progettazione dettagliata e la realizzazione del GRS vengano affidate da ASI all'industria italiana, sulla base delle competenze acquisite per LISA-PF.

Per l'attività scientifica, l'Italia, oltre ad essere responsabile delle prestazioni del GRS e a partecipare al Performance and Operations Team di ESA, ha un ruolo importante nel Science Ground Segment della missione, in particolare nel Distributed Data Processing Center (DDPC) che è responsabile del processamento e dell'analisi dei dati di LISA. Il team scientifico degli enti di ricerca e lo Space Science Data Center (SSDC) di ASI contribuiranno alle attività e alla gestione del DDPC con un DDPC scientist e curando il coordinamento con i team strumentali; inoltre saranno responsabili

- dello sviluppo di una delle pipeline di riduzione dati (Global Fit Pipeline - GFP o Low Latency Alert Pipeline - LLAP),
- dello sviluppo del work package "Source Population Generation" per le sorgenti Massive Black Hole e EMRIs,
- della realizzazione di un nodo del DDPC.

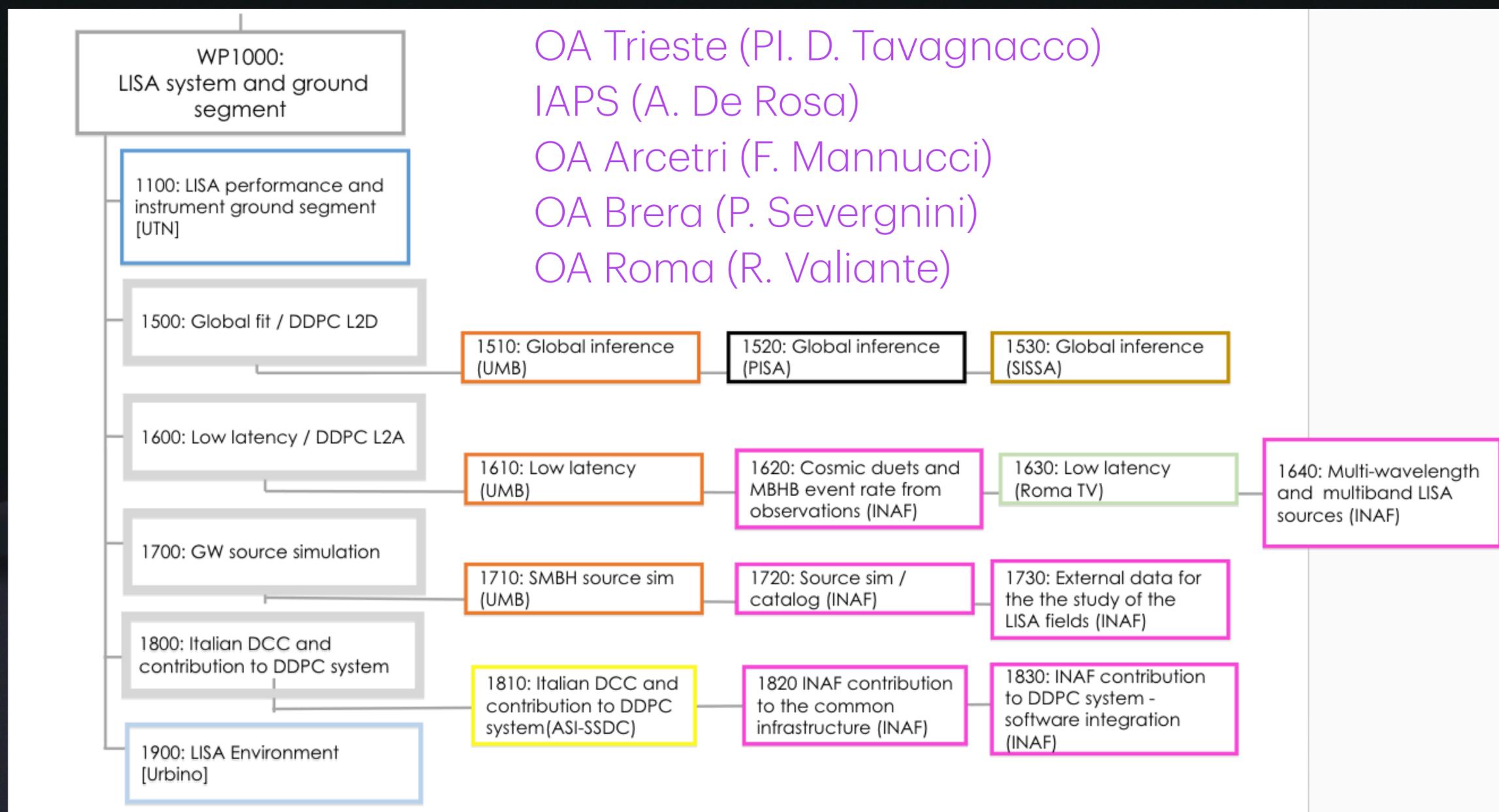
L'Italia contribuirà anche alla produzione dei dati di Livello 3, allo sviluppo del software e data processing del SGS e alle operazioni.

Infine, la comunità scientifica sarà anche responsabile della realizzazione del simulatore del comportamento delle *test mass* di LISA (GRS-TM/EH emulator) per uso a terra nei test di sistema condotti da ESA.

- Accordo ASI U Trento
- **INAF (OA Trieste
Daniele Tavagnacco)**
- U Bicocca
- U Urbino
- U Pisa
- U Tor Vergata
- SISSA
- INFN
- INRIM

Attività per la fase B2/C della missione LISA

INAF contribution is part of the following LISA DDPC branches: Simulations and external data (Source population generation); Low Latency alert (LA2); Catalogues (L3C); System Engineering and DCC



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LISA

Coinvolgimento della comunità INAF

- Partecipazione al consorzio ha avuto un buon feedback da INAF
- INAF con ruoli di coordinamento nel Consorzio (Council, Projects Chairs, members group chair) che abbiamo potuto “costruire” grazie al supporto **INAF LG 2022** (Severgnini-RSN1) e **INAF LG 2024** (De Rosa-RSN4)
- qualche numero sul sondaggio fino a Gennaio 2025 : TI: 40; TD: 4; ADR: 5; Associati (uni+quiescenti): 5, PhD: 9 **TOT: 63 (~40 RSN4 primaria/secondaria) partecipanti - 5.3 FTE**
- Coinvolgimento nello sforzo nazionale per la partecipazione alla missione come **contributo al DDPC** (Distributed Data Processing Center, Addendum Accordo ASI-U Trento).
- Sinergia con team MM in INAF (e.g. Grawita)
- Call per partecipazione ai progetti (come core member). Molti progetti di interesse RSN1, RSN2, RSN4, RSN5, **deadline 31 Gennaio. Ask me!**
- Formare oggi una comunità scientifica di astrofisici (e fisici) per arrivare preparati ai dati MM e GW