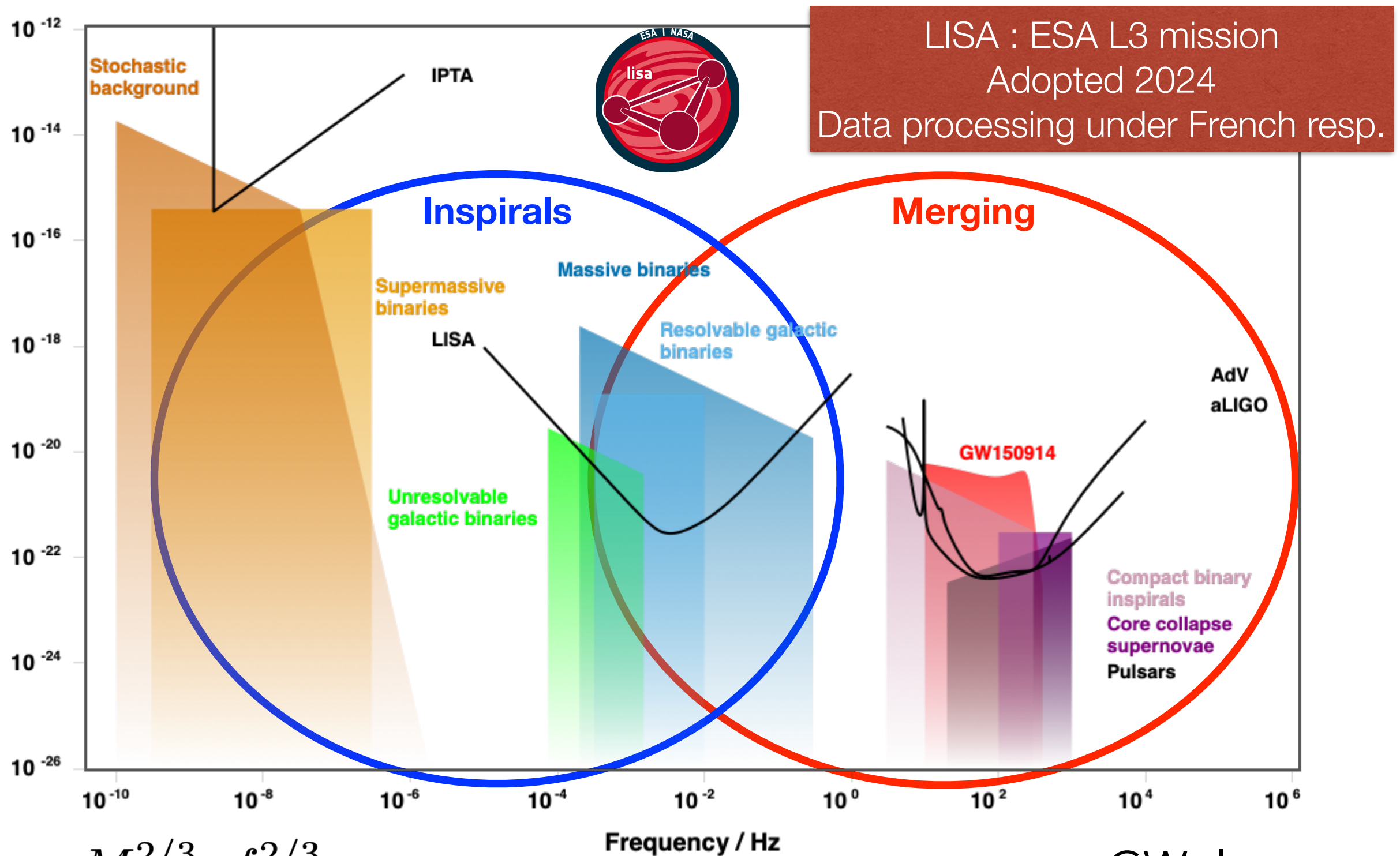


The LISA data (or the current understanding we have of it)

DIFFERENT SOURCES OF GW



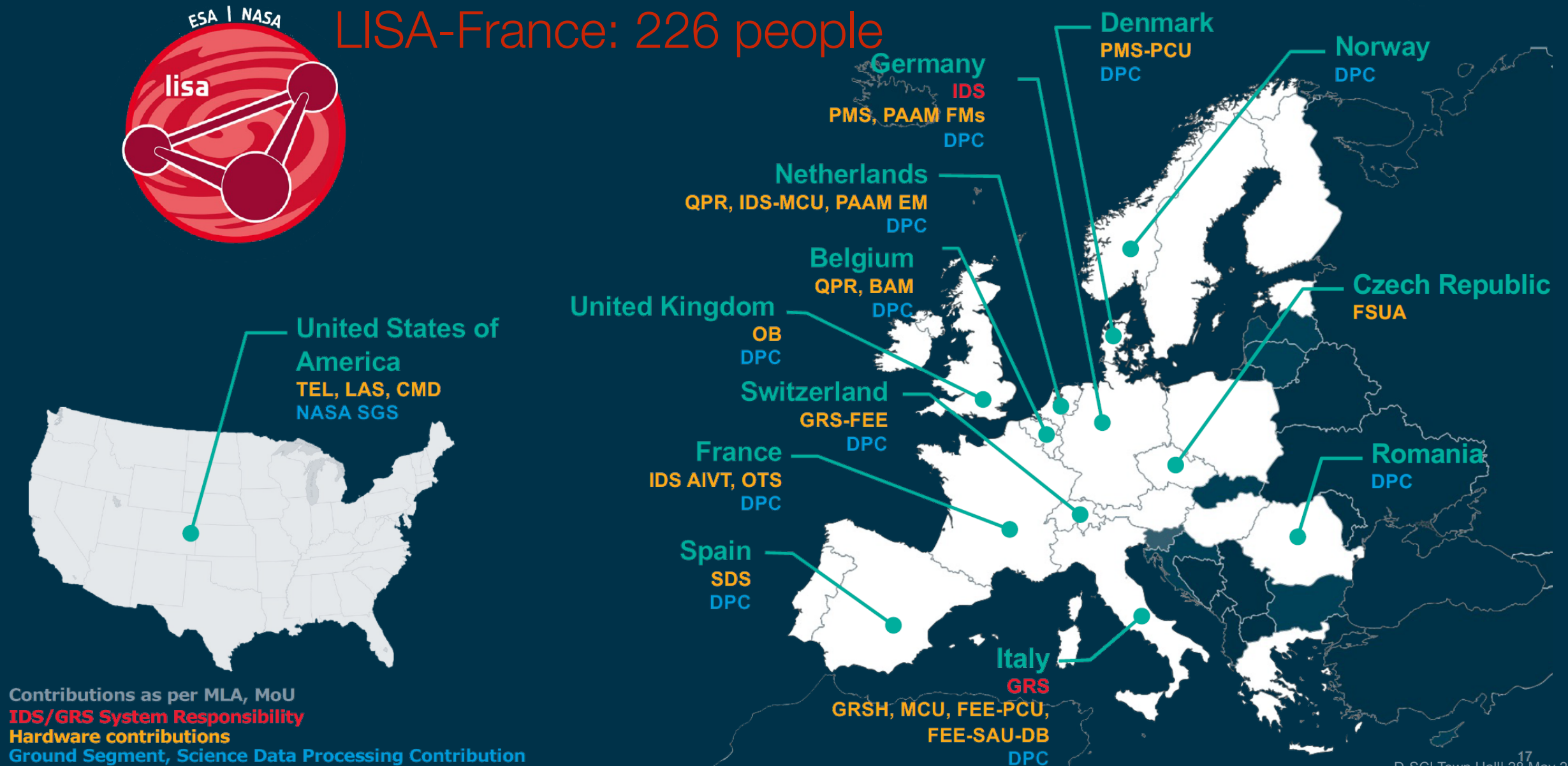
$$h \propto \frac{M^{2/3} \mu f^{2/3}}{d}$$

$$f_{GW} \simeq 2f_{orb}$$

GWplotter.com

LISA COLLABORATION

LISA - An international mission led by ESA



D-SCI Town Hall | 28 May 2024

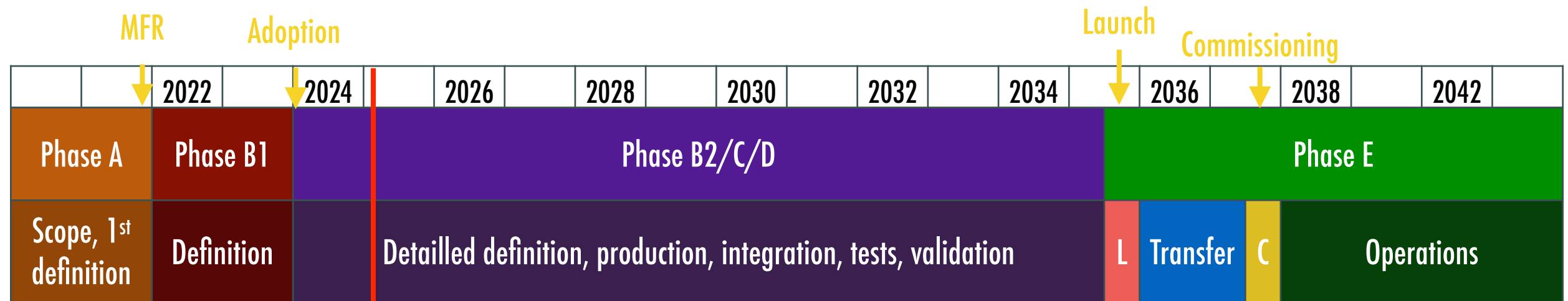


Astrid Lamberts - ASOV WS 24/3/25

3



TIMELINE AND STATUS



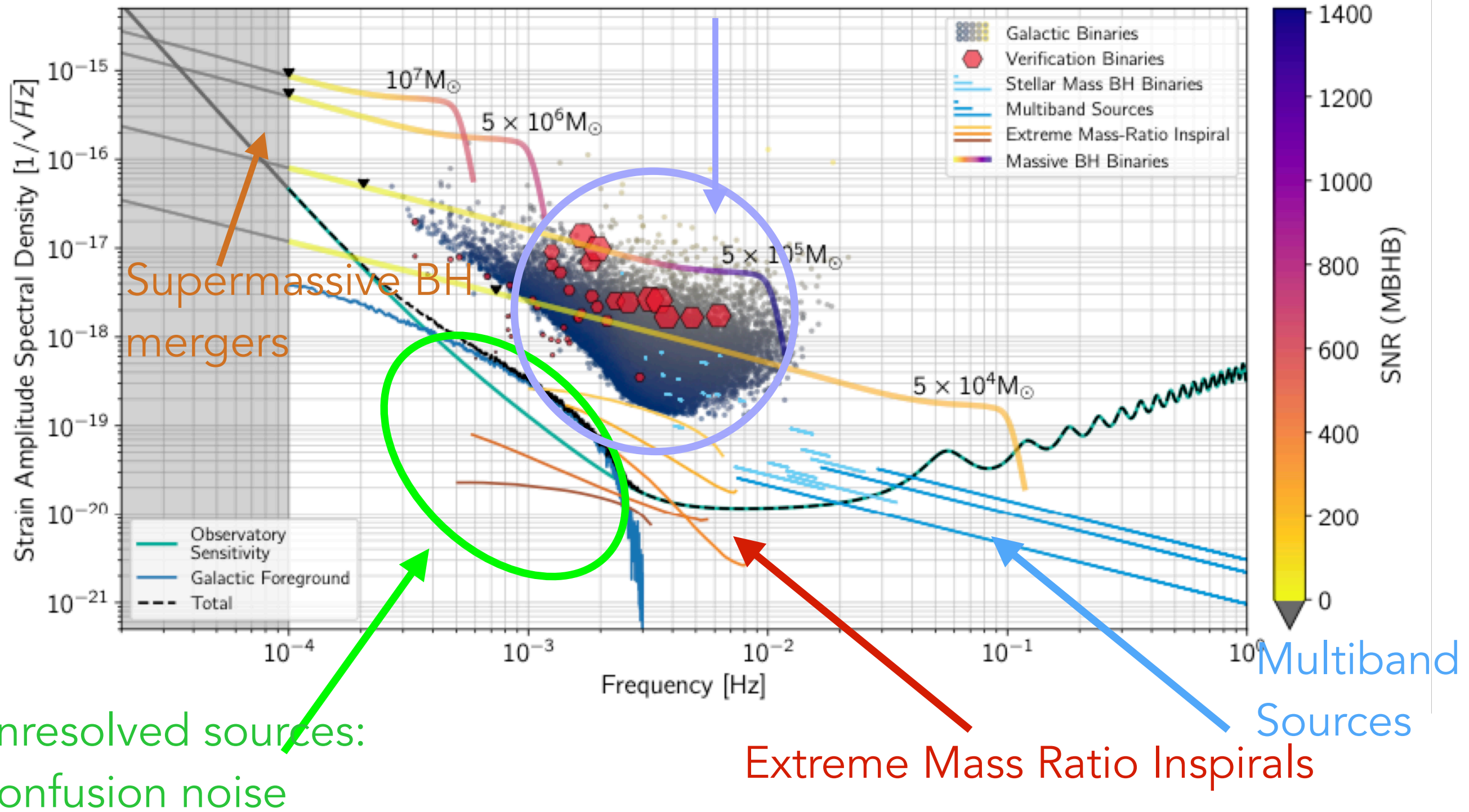
- 1993: first proposal ESA/NASA
- Selection 2017
- End 2021: success of the ESA Mission Formulation Review
- 25/01/2024: adoption
- (New) LISA Science Team in place -> group on content of Data releases
- Long building phase of multiple MOSAs: 6 flight models + test models
- Launch 2035
- 1.5 years of transfer, 4.5 years nominal mission, 6.5 years extension

A WIDE VARIETY OF SOURCES

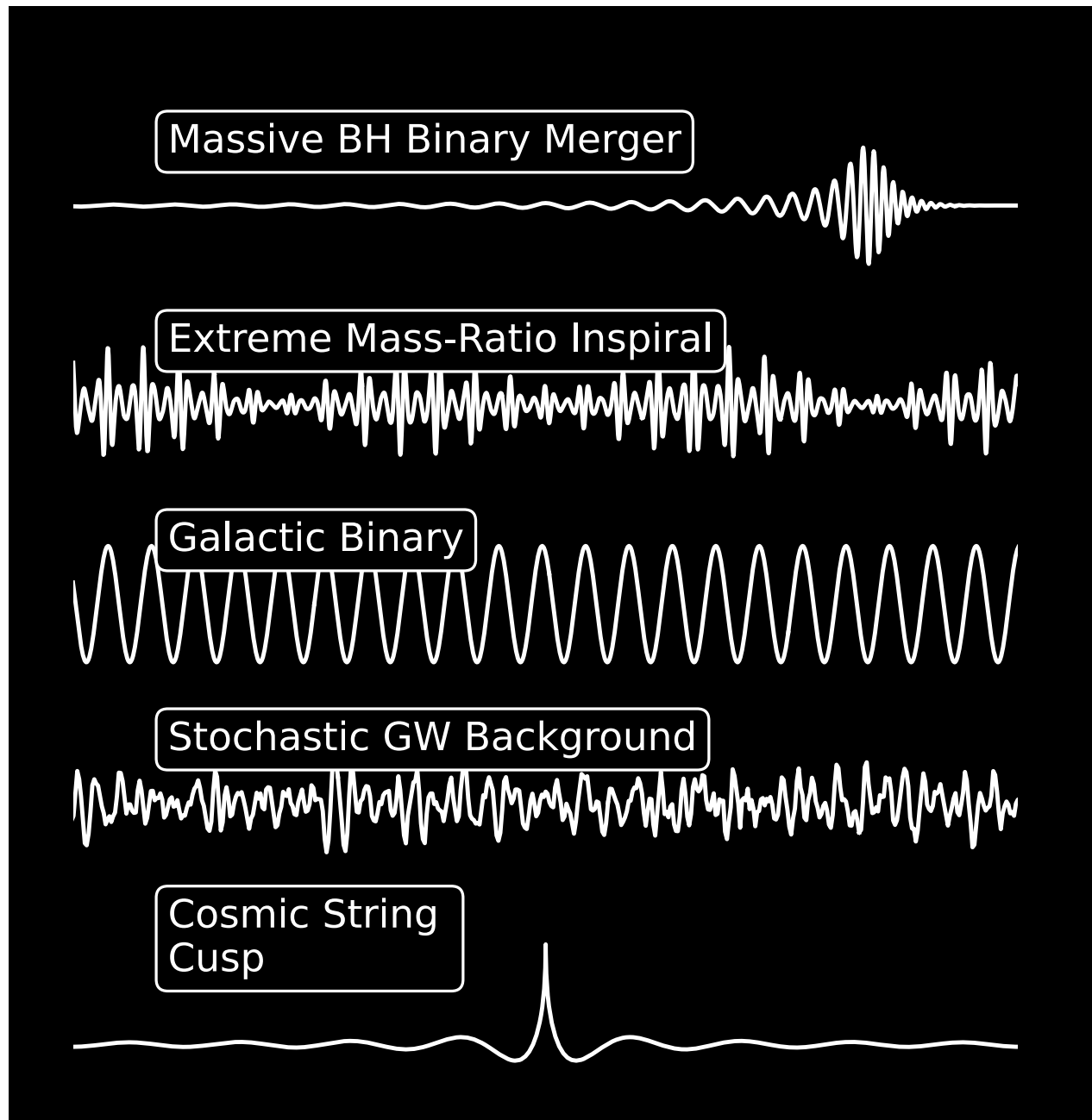
LISA Red Book

Transient and permanent sources

Galactic binaries



INFORMATION FROM GWS



Frequency, amplitude

Frequency evolution -> masses

Amplitude+masses -> luminosity distance

Time of arrival, amplitude, phase
-> sky localisation, (very) poor in comparison to EM

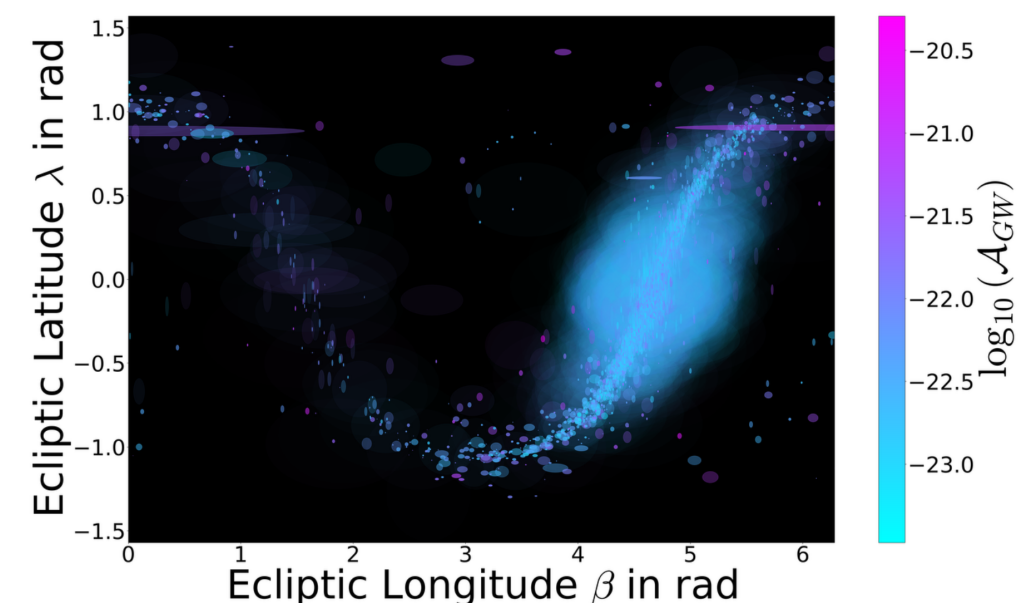
Modulations of amplitude and phase -> spins & eccentricity

Effects of matter...

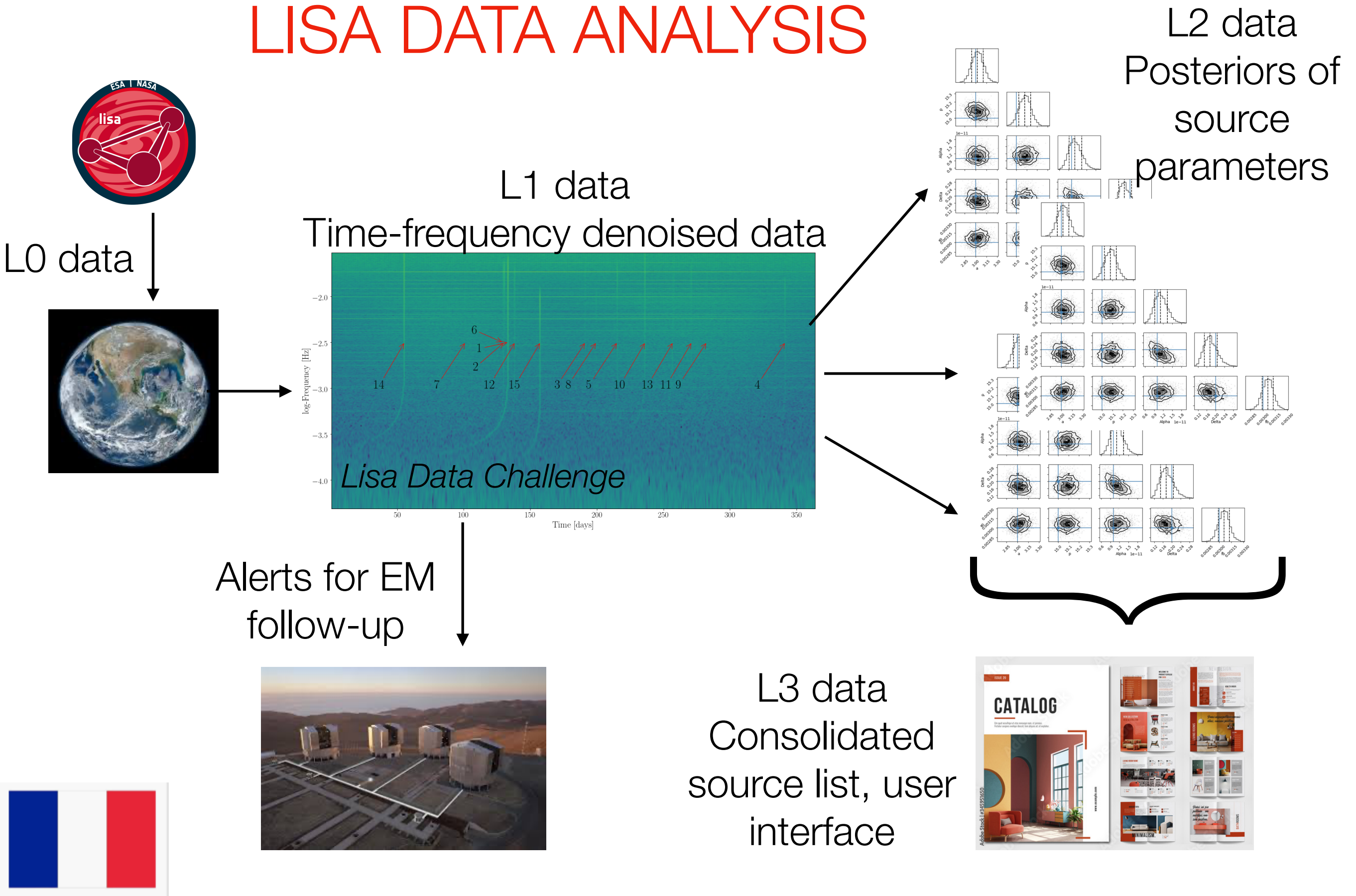
NUMBER OF SOURCES & SKY LOCALISATION

Sources	SNR	Duration	Event rate	Sky localisation
Galactic binaries	10 – 500	permanent	10000 – 30000 detectable + background	deg ² at best, ten deg ² for good sources, up to 10 ⁴ for most sources
Verification binaries	7 - 100	permanent	~40 (today)	Exact (from EM)
Stellar mass black hole binaries	7 - 30	1 to 10 years	1 to 20	Possibly < deg ²
EMRIs	7 - 60	1 year	1 to 2000 / year	< deg ² to ~10 deg ²
Massive Black Hole binaries	10 - 3000	Hours - months	10 to 1000 / year	~ deg ² at merger ~100 deg ⁴ 4 hours before

Limited sky localisation -> many traditional tools not (well) adapted



LISA DATA ANALYSIS



LISA DATA ANALYSIS

Dream of a beautiful symphony



LISA DATA ANALYSIS

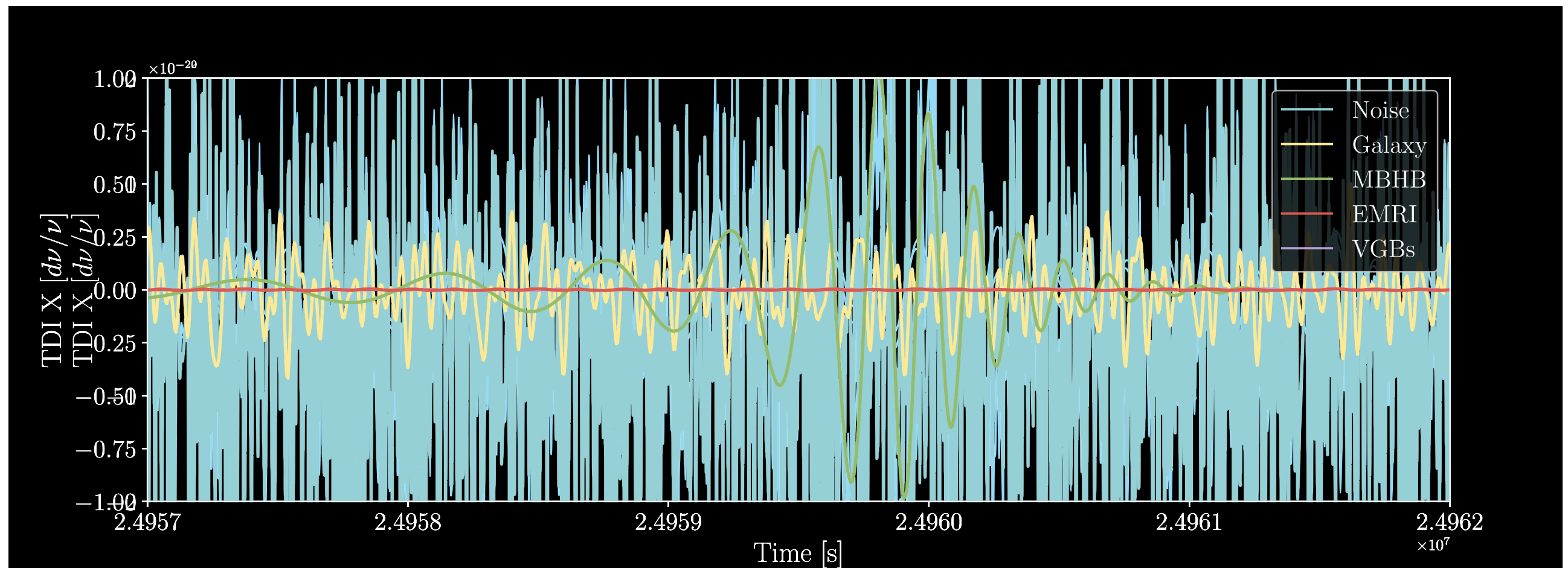
Dream of a beautiful symphony



Millions of superposed sources, very different from (current) ground-based detectors, uncertainties are part of the pipeline -> many « ugly » uncertain PDFs

LISA DATA

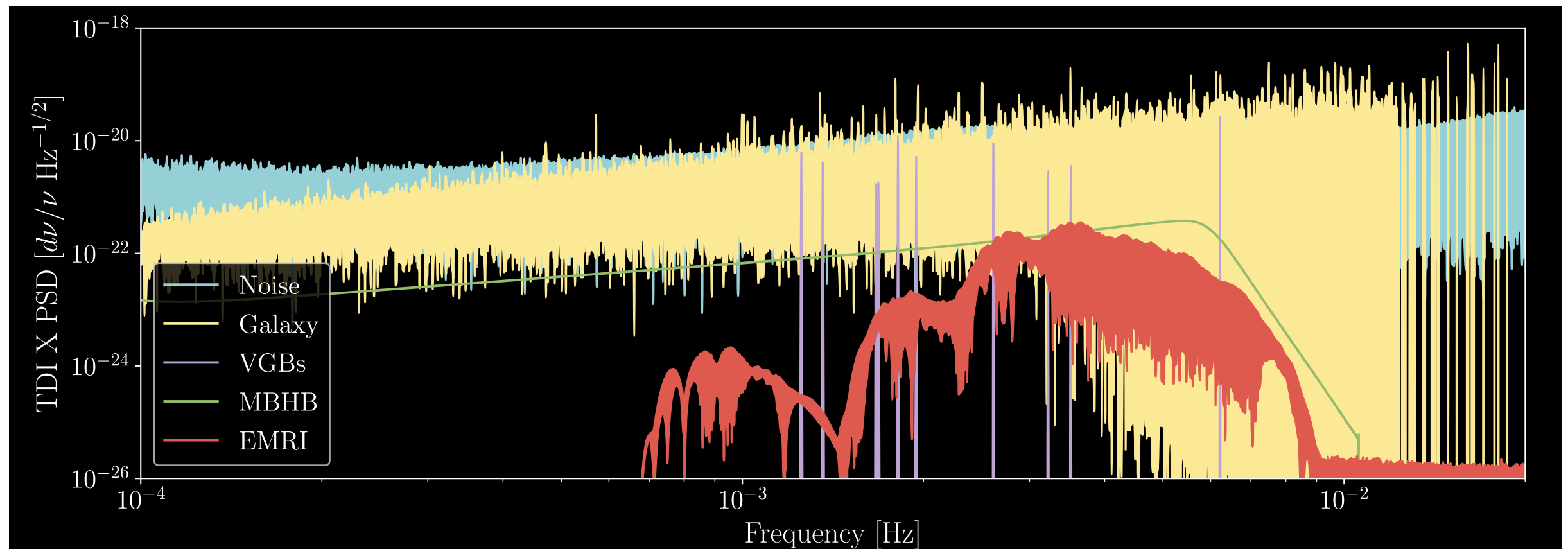
LISA data challenges: time domain data



Verification GBs + EMRI + MBHB + Galaxy + Noise

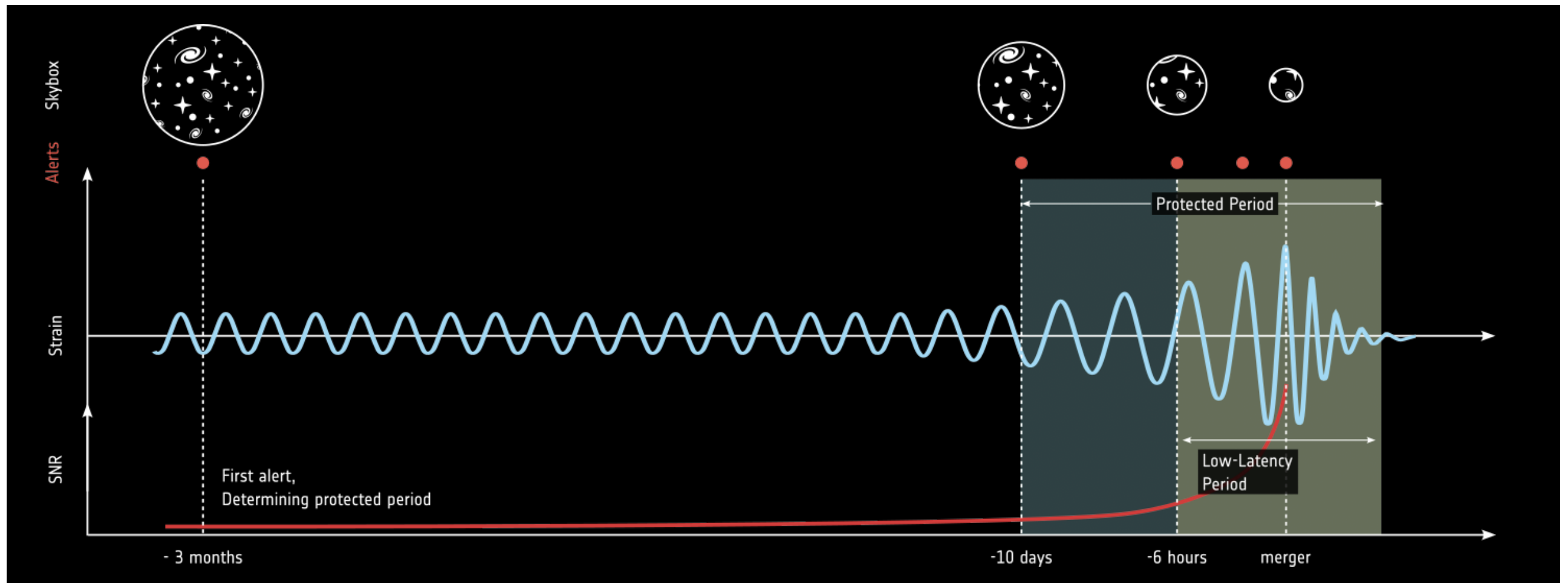
LISA DATA

LISA data challenges: frequency domain data



Verification GBs + EMRI + MBHB + Galaxy + Noise

ALERTS & MULTI-MESSENGER

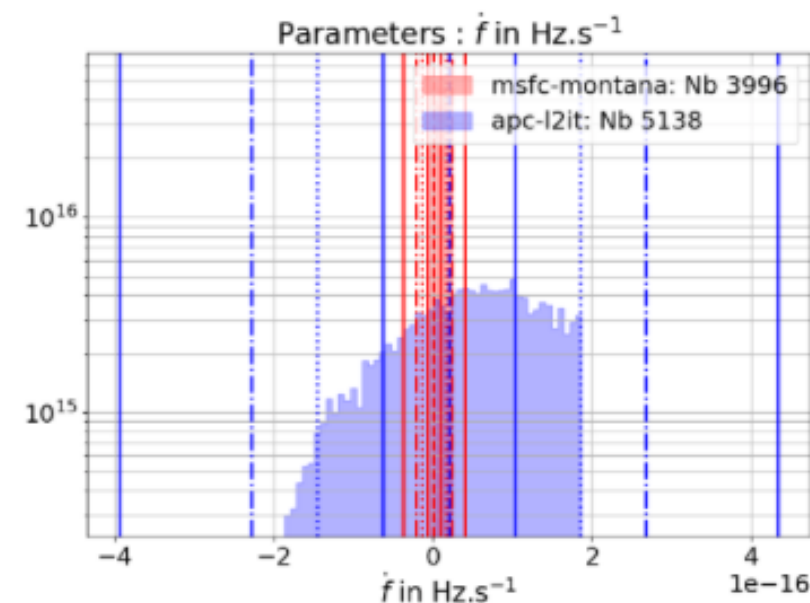
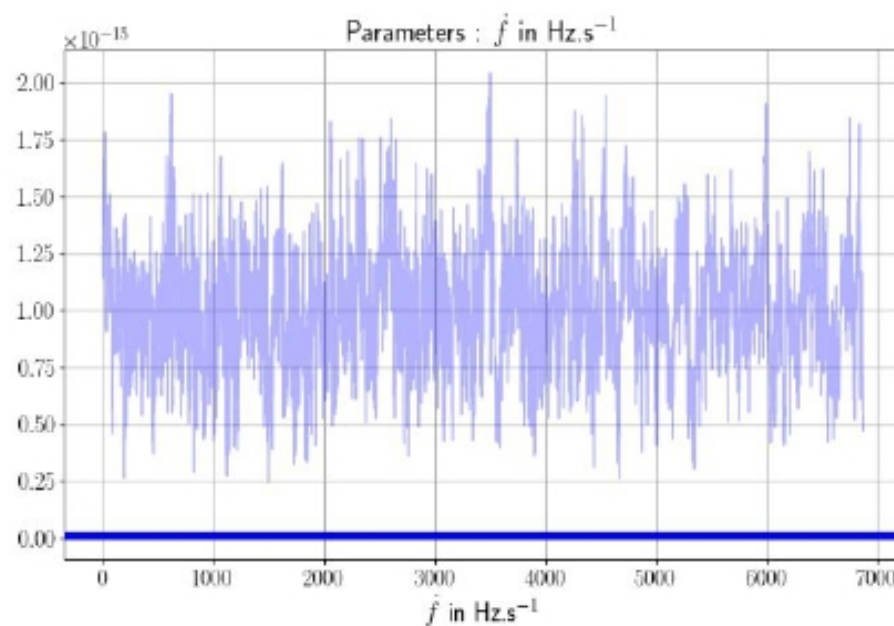


- Several low-latency alert pipelines
 - Alerts for new sources
 - Updates on known transients

CONTENT OF DATA RELEASES (WORK IN PROGRESS)

All data levels released at the same time:

- « raw » data (combination of time series)
- denoised data : time and/or freq. domain
- several outcomes of global fits as posterior distributions, with some information on confidence
- Consolidated source list, many « uncertain » sources

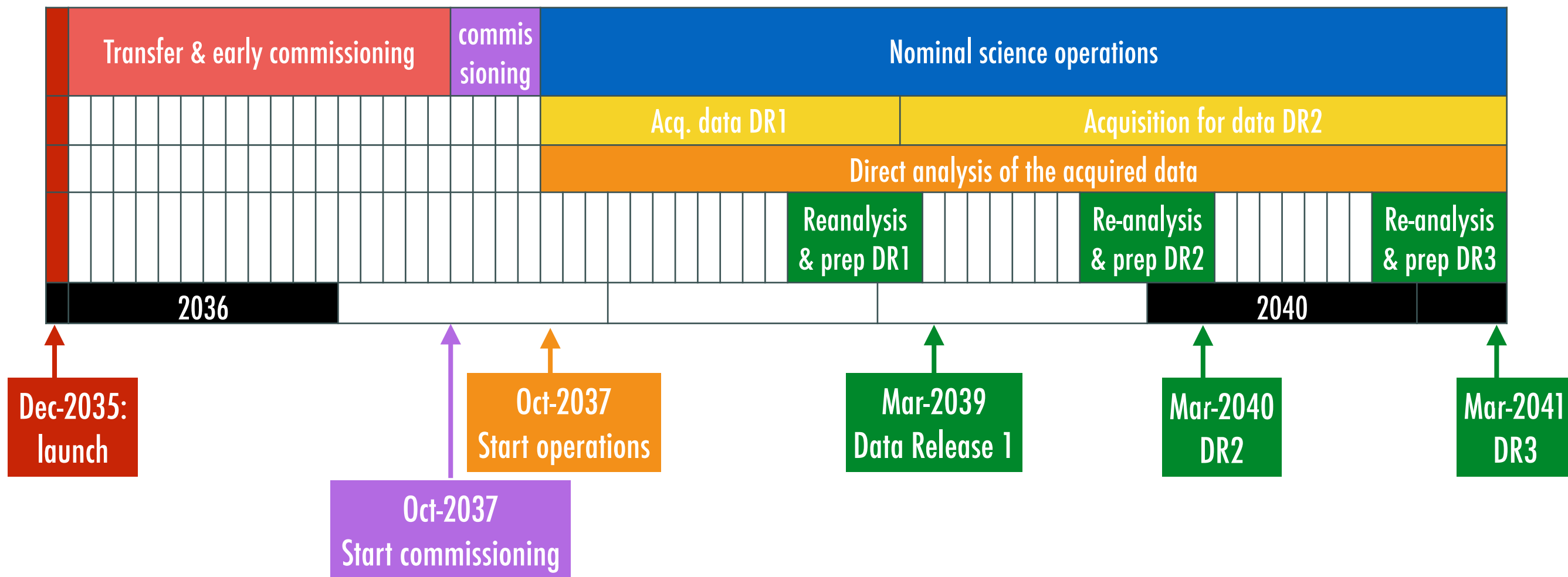


Trace of parameter in global fit -> posterior distribution

CONTENT OF DATA RELEASES (WORK IN PROGRESS)

- Noise model (very limited measurements on the ground)
- Data quality information
- Tools for X-matching with other data (but with bad sky localisation)
- => need to make it as compatible as possible with astronomy data standards, possible need for new standards

EXAMPLE OF DATA RELEASE SCENARIO



Science Management Plan :

- First DR 12 months after end commissioning
- Then, major (1/yr) and minor releases (2/yr)
- All data levels are released at the same time

KEY MILESTONES FOR DATA RELEASES

- Operations start 2037+
- First DR ~2038
- 3 mock data challenges with mock data release of increasing complexity (TBD)
 - Early 2028
 - Early 2030
 - Mid 2032
- => we want to approach/think about astro standards as soon as possible
- => looking for input and help!