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

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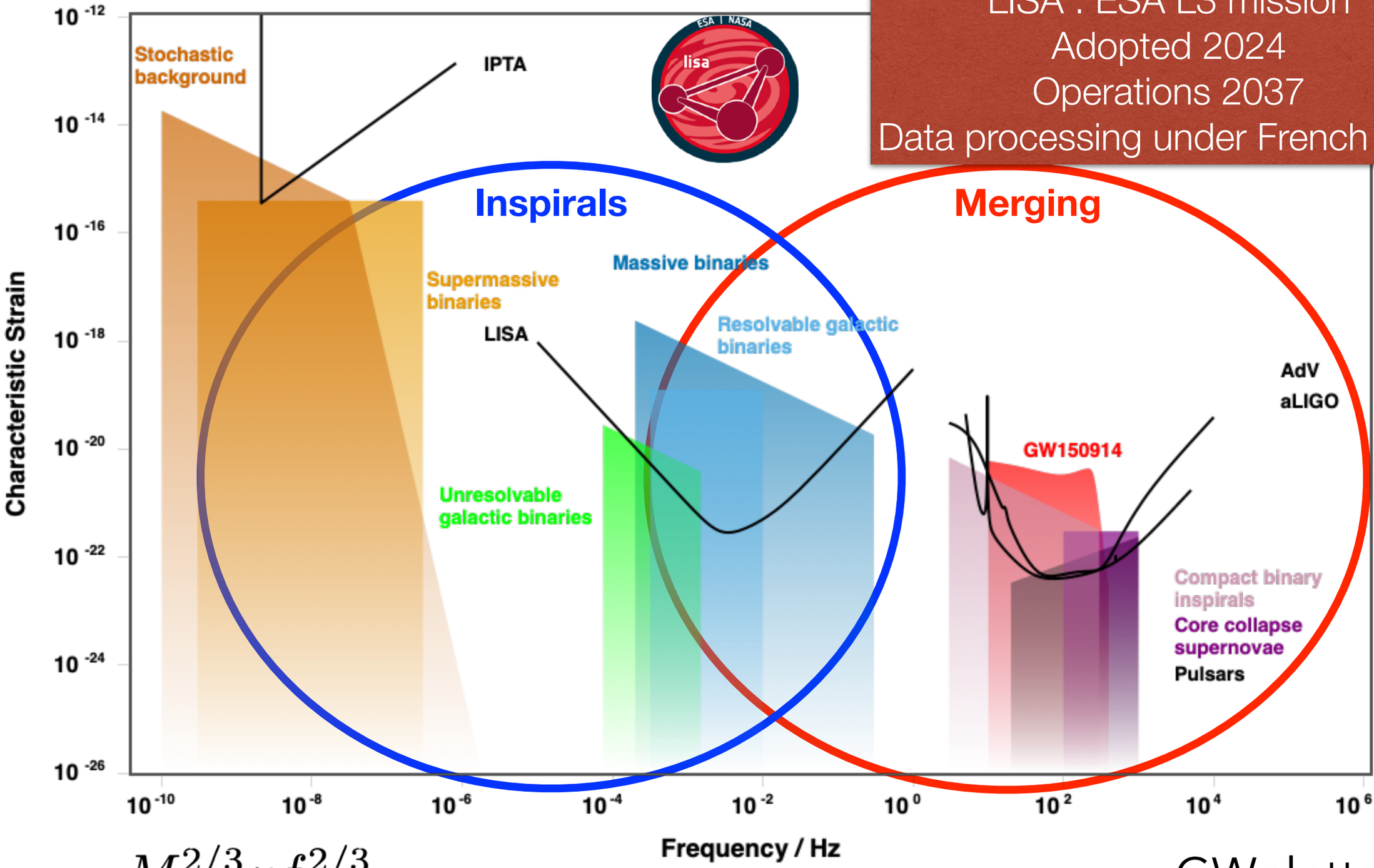
Lead CU « catalog production »

Interop meeting 2025/6/5

DIFFERENT SOURCES OF GW

LISA : ESA L3 mission
Adopted 2024
Operations 2037
Data processing under French resp.



$$h \propto \frac{M^{2/3}\mu f^{2/3}}{d} \qquad f_{GW} \simeq 2 f_{orb}$$

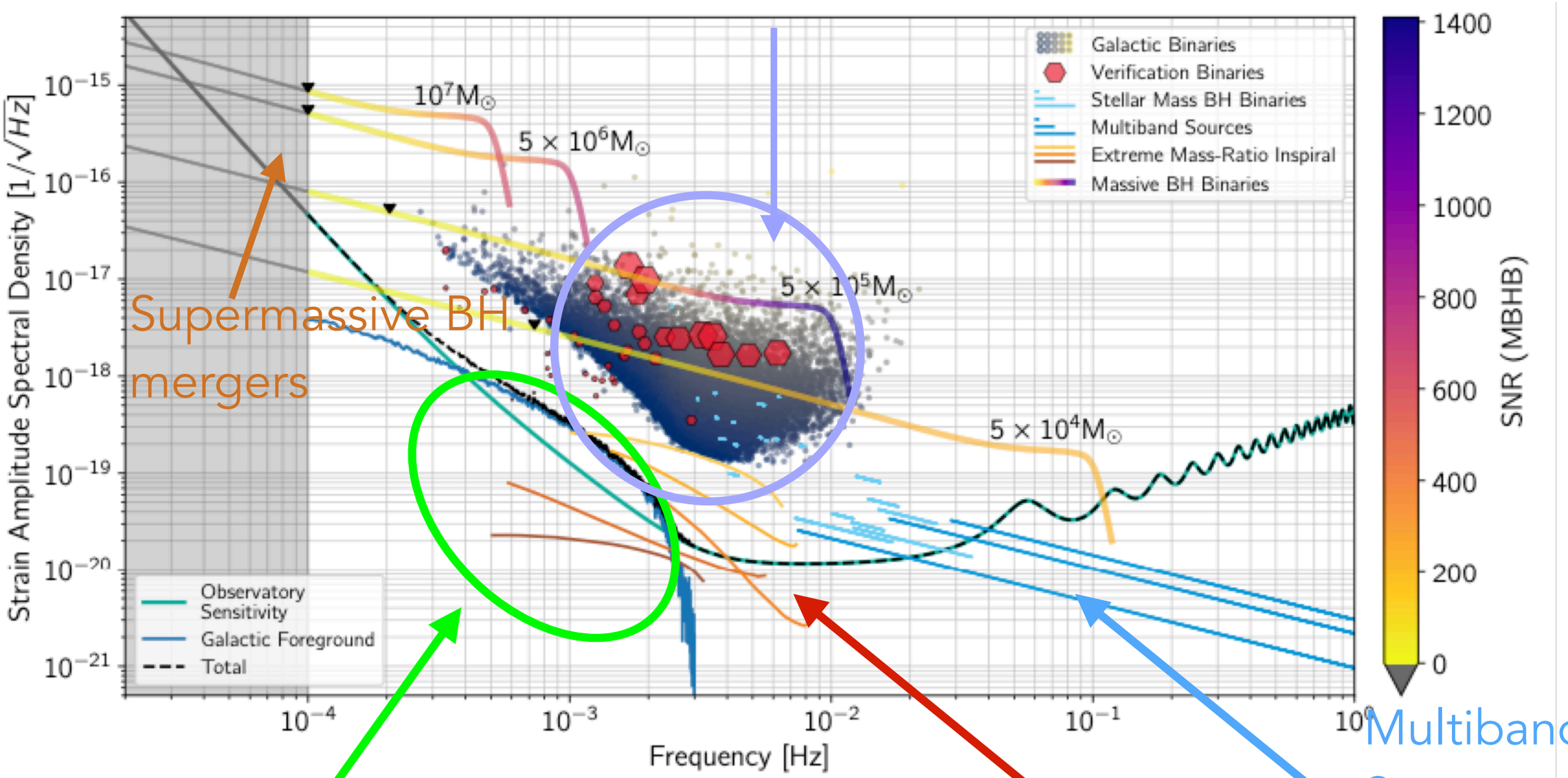
GWplotter.com

A WIDE VARIETY OF SOURCES

LISA Red Book

Transient and permanent sources

Galactic binaries



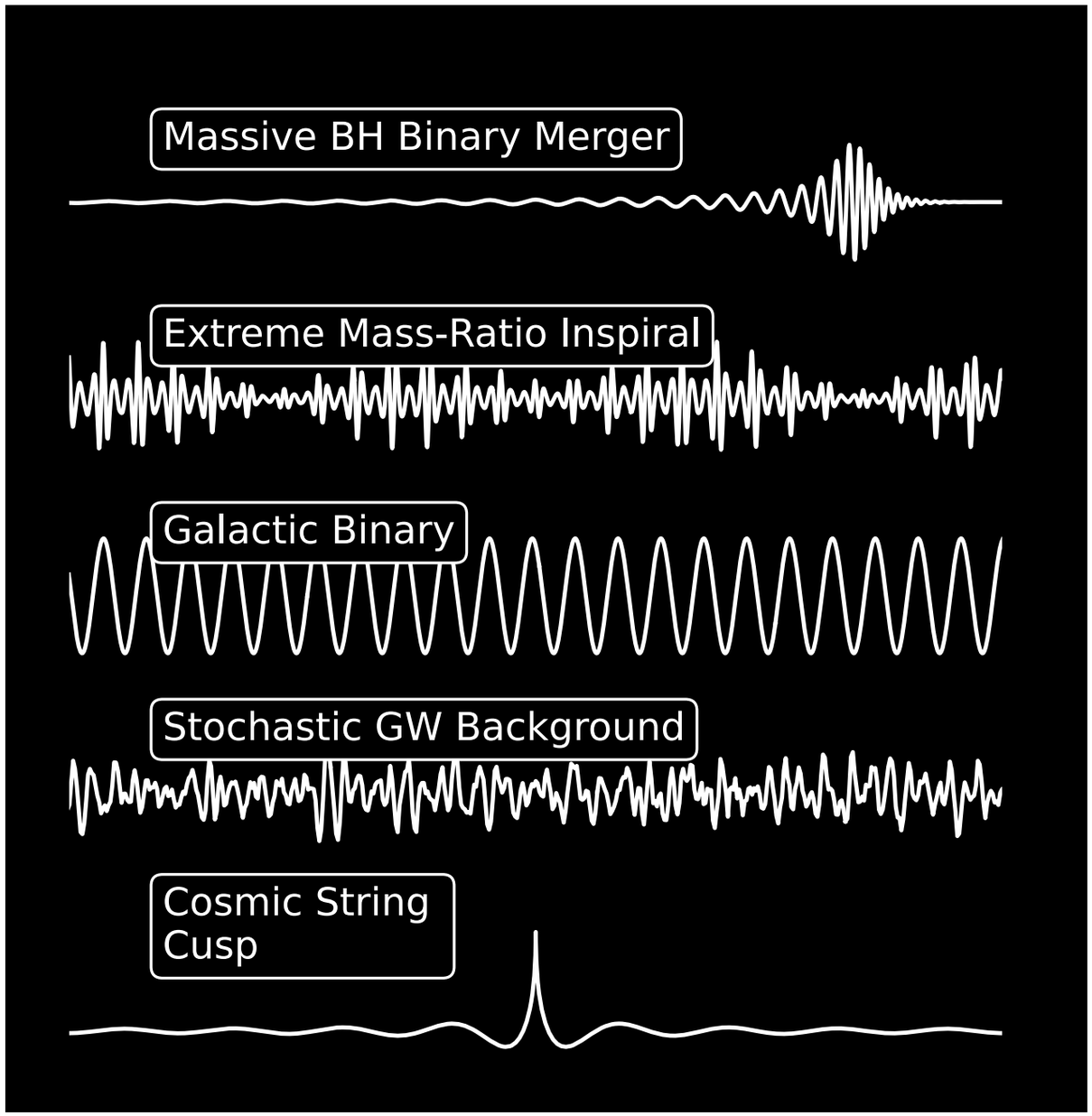
Supermassive BH mergers

Unresolved sources: Confusion noise

Extreme Mass Ratio Inspirals

Multiband Sources

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

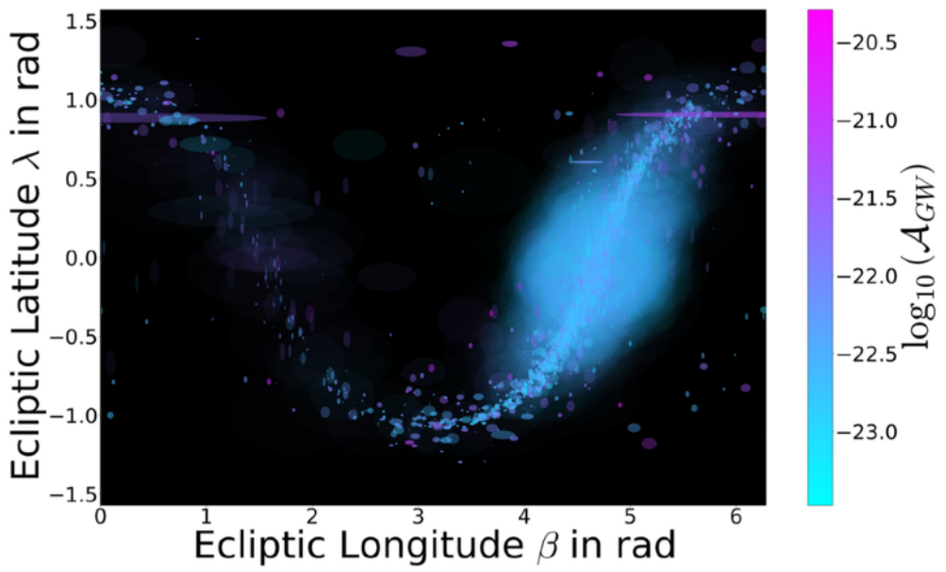
Modulations of amplitude and phase -> spins & eccentricity

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

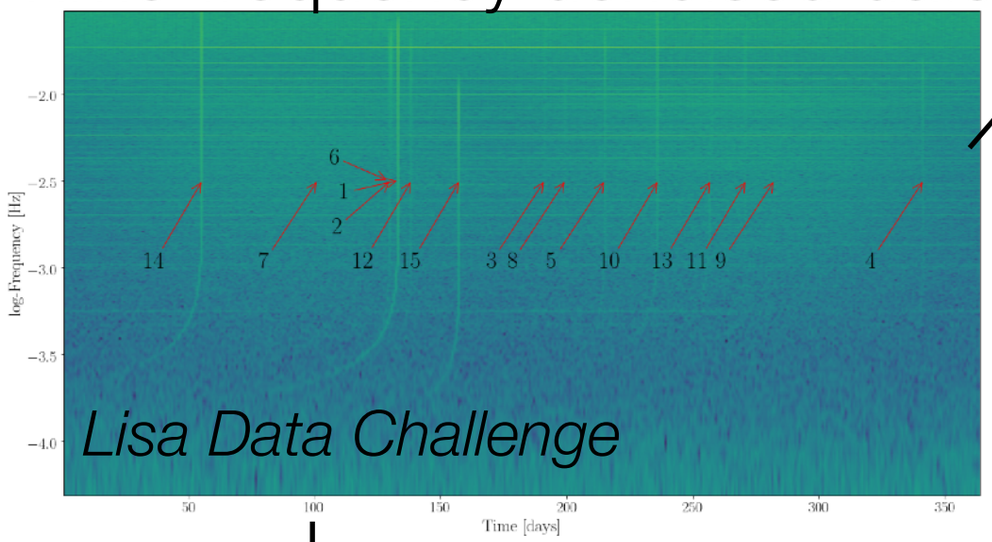
Limited sky localisation -> many traditional tools not (well) adapted



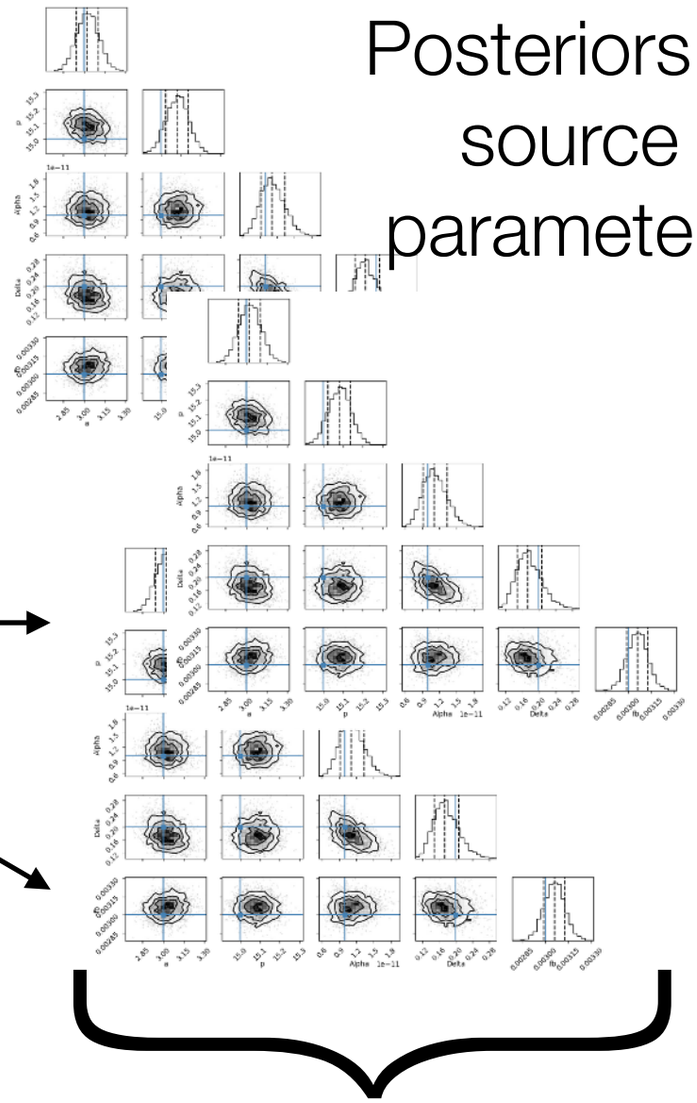
LISA DATA ANALYSIS

L0 data

L1 data
Time-frequency denoised data



L2 data
Posteriors of source parameters



Alerts for EM follow-up

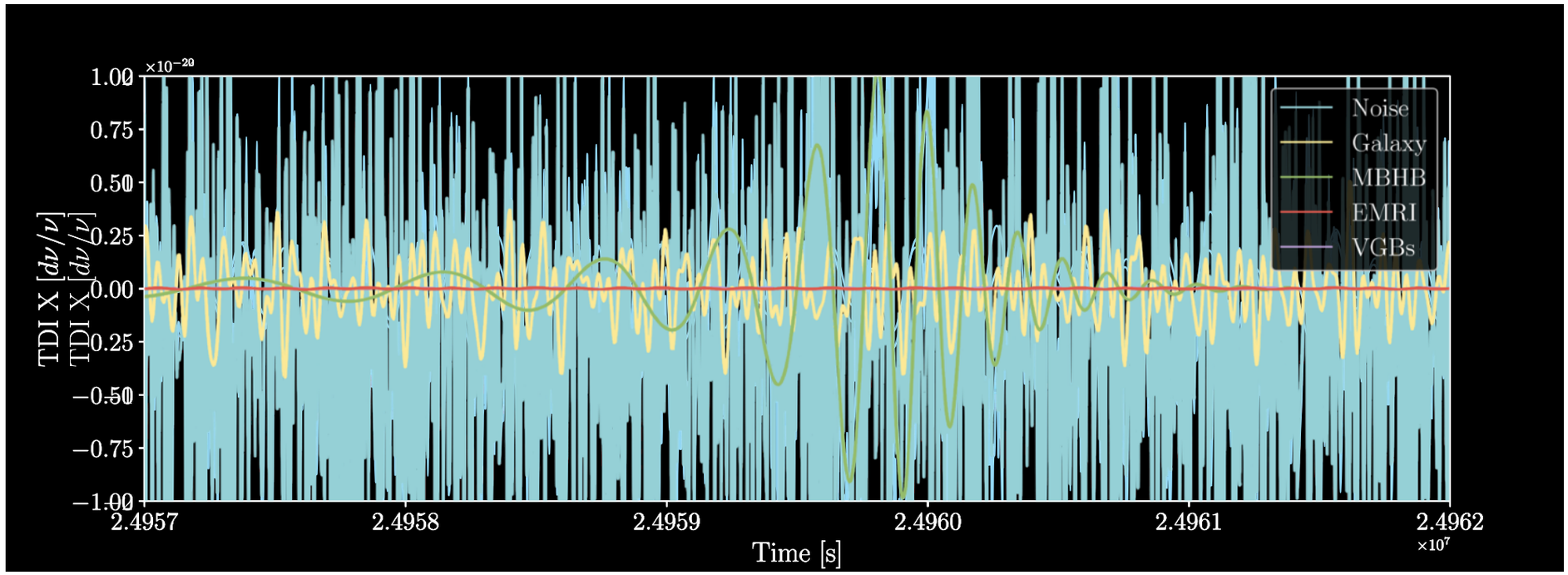
L3 data
Consolidated source list, user interface

LISA DATA ANALYSIS

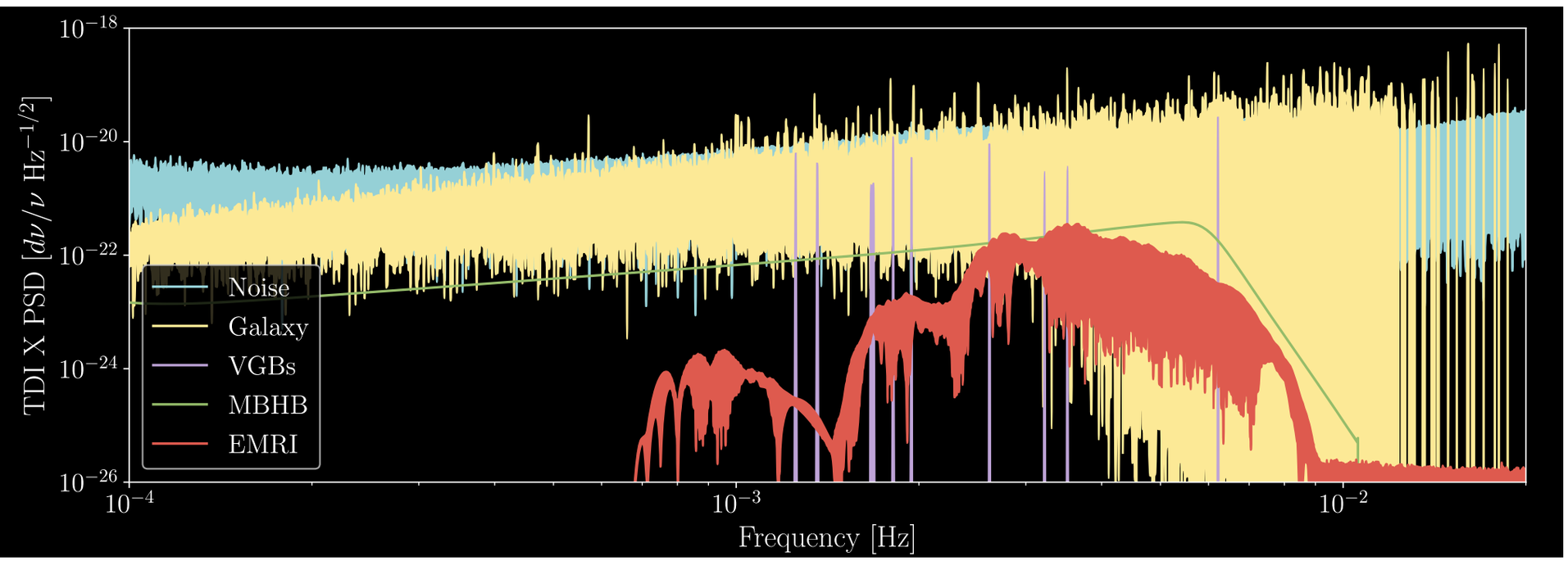
LISA DATA ANALYSIS

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

LISA DATA CHALLENGES



Time domain and frequency domain



Verification GBs

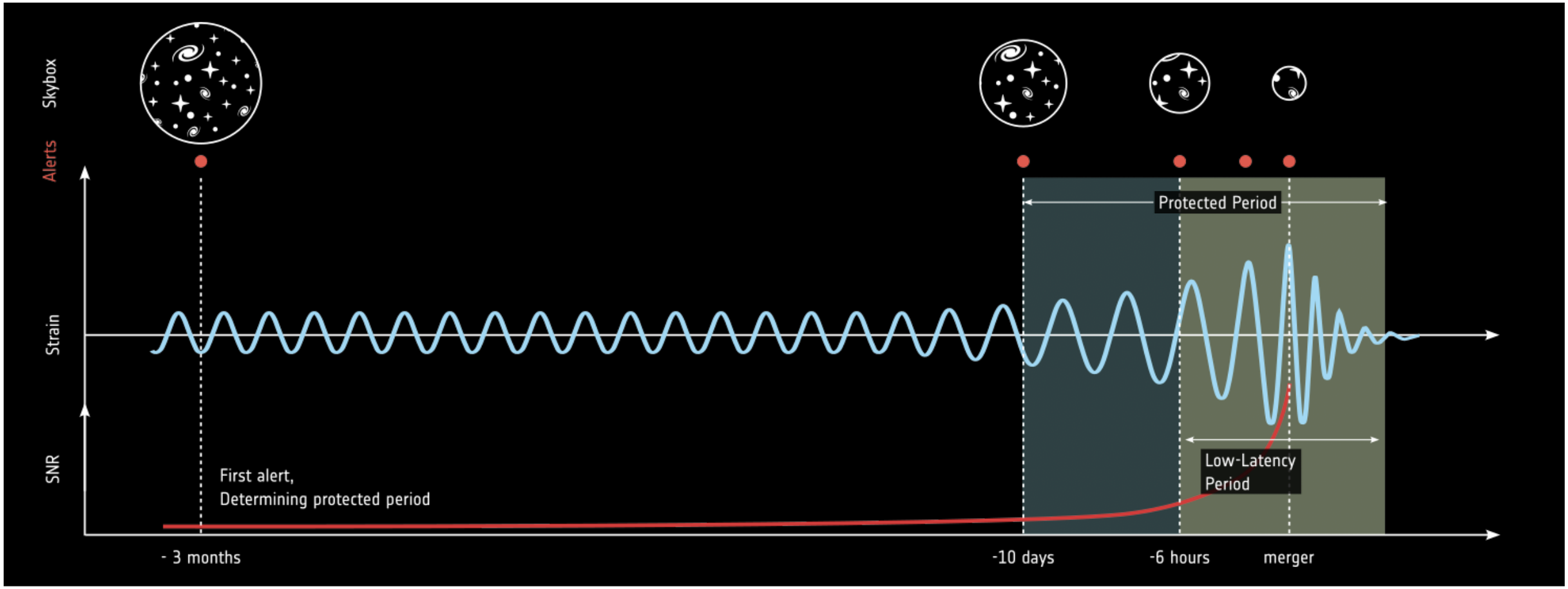
+ EMRI

+ MBHB

+ Galaxy

+ Noise

ALERTS & MULTI-MESSENGER

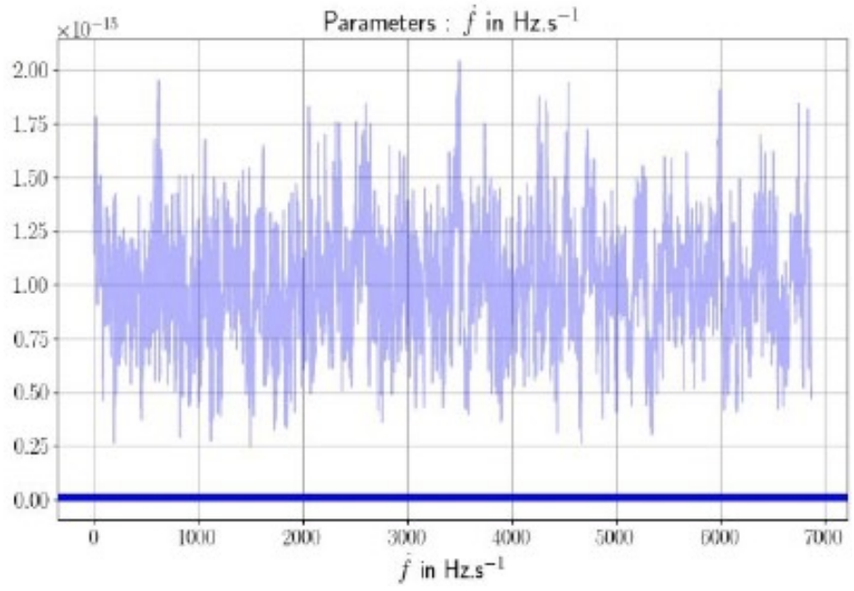


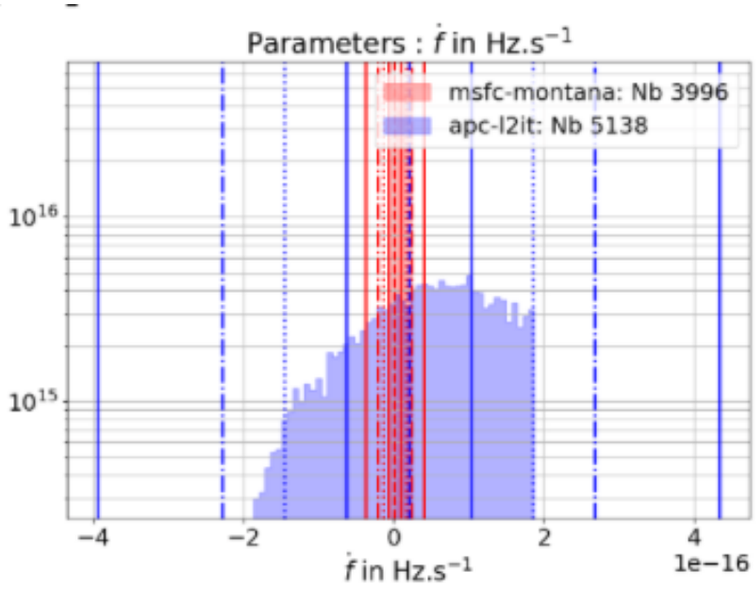
- Several low-latency alert pipelines
  - Alerts for new sources
  - Updates on known transients

CONTENT OF DATA RELEASES (WORK IN PROGRESS)

Science Management Plan :

- First DR 12 months after end commissioning : ~2038
- Then, major (1/yr) and minor releases (2/yr)
- All data levels are 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

- 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!