



Template Banks For MBTA

M. Panzeri, Univeristy of Urbino (togheter with F. Fabrizi, G. Joubert, S. Viret, G. M. Guidi)

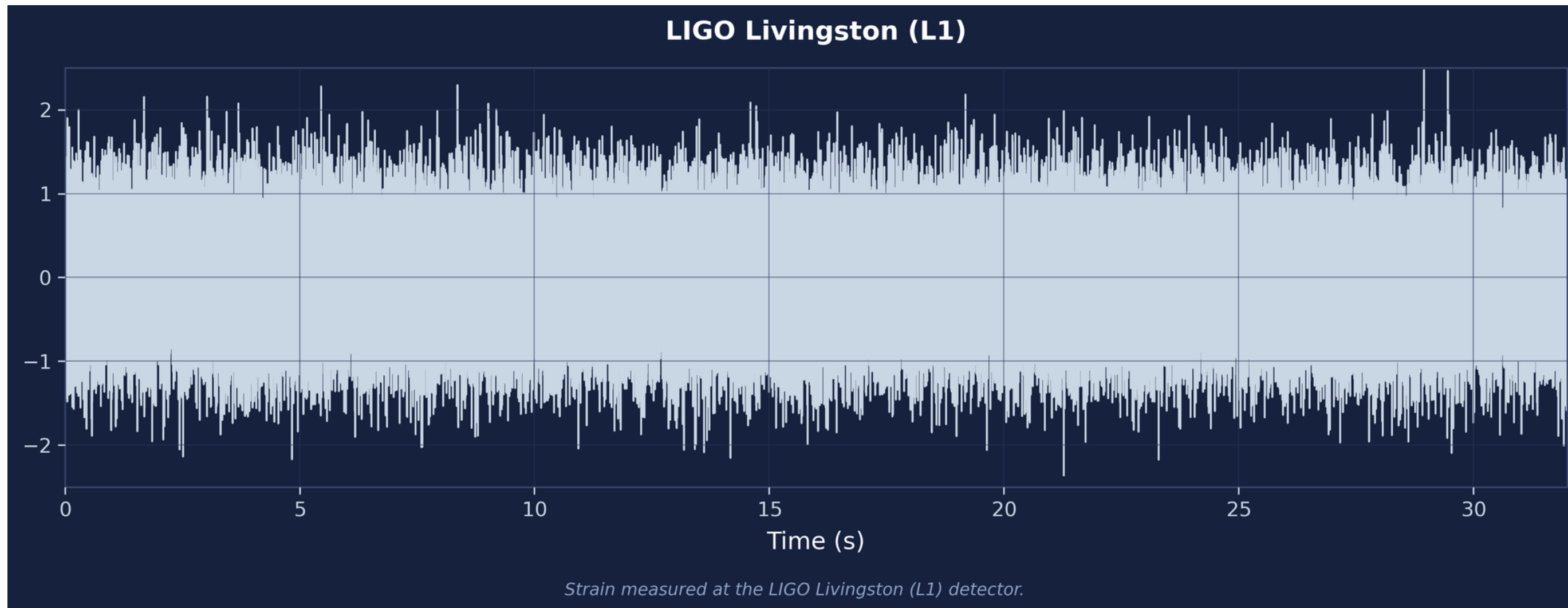
IS THERE A SIGNAL?

2



AND HERE?

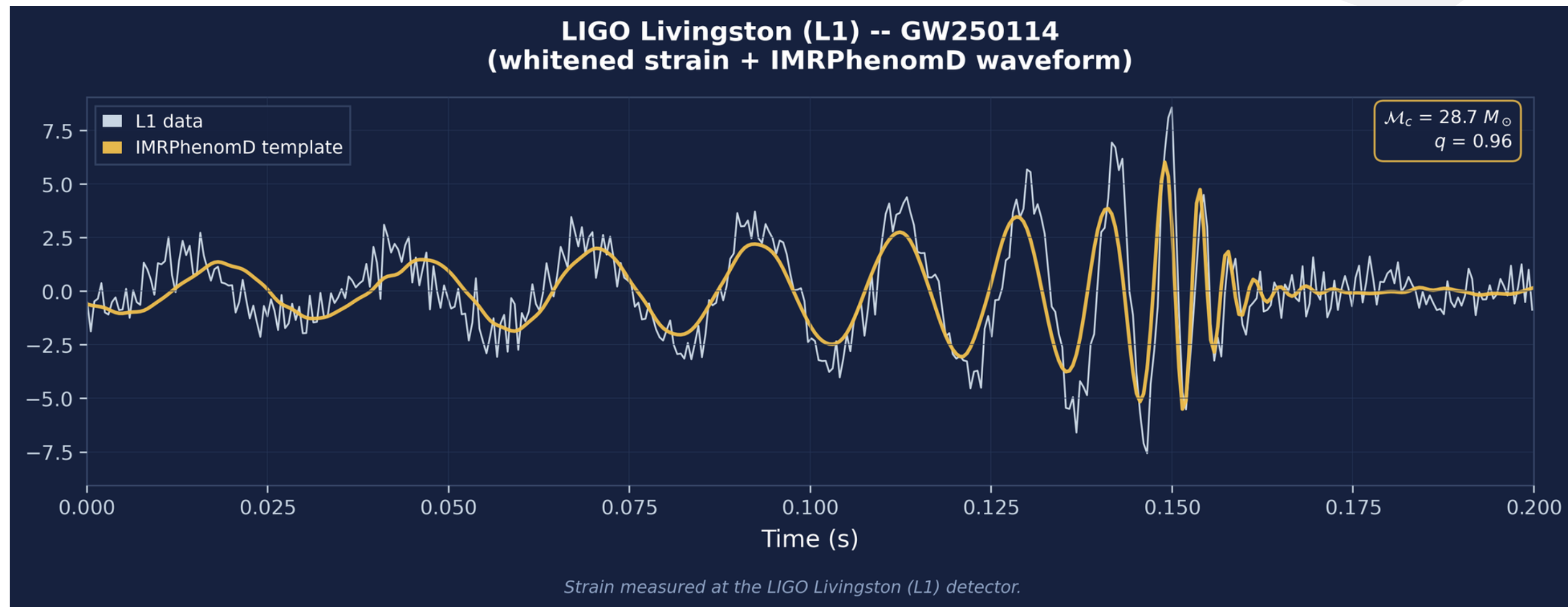
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FOR SURE!

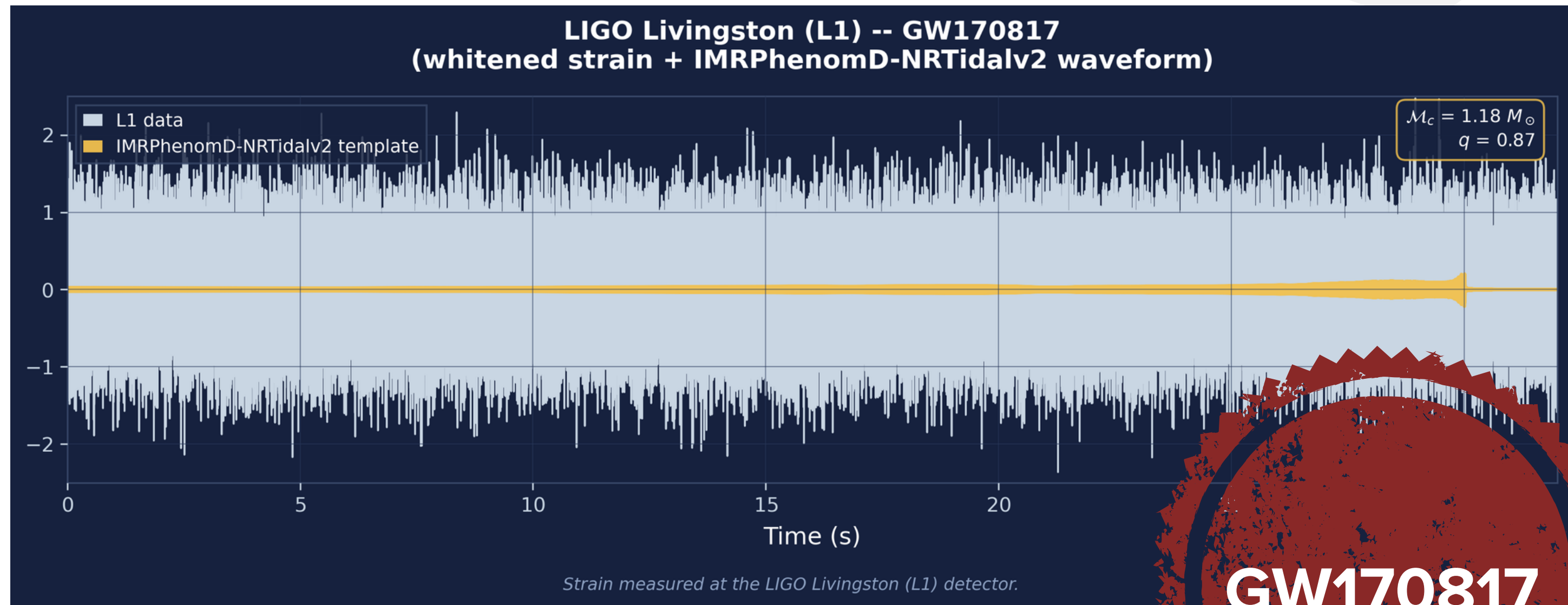


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GW250114

BUT ALSO HERE!



DATA FROM [GWOSC.ORG](https://www.gwosc.org)

Searching for Transient GW in LVK

→ **GOAL:** Find gravitational-wave (GW) signals buried in noise and provide a statistic to distinguish between noise and real events.

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→ **WHY ARE THEY IMPORTANT FOR NS**

The search pipelines **trigger electromagnetic (EM) follow-up observations**. Each alert includes a sky map and an estimated neutron star (NS) probability, enabling telescopes to search for potential multimessenger events, such as **GW170817**.

TEMPLATES BANKS

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→ **COMPROMISE:**

- Finite number of points, roughly around 10^6
- Define a minimal match: a **max allowed loss of SNR**

TEMPLATES BANKS

→ ALGORITHM TO BUILD A TEMPLATE BANK

Geometric:

- a mathematical approach
- it computes the metric of the parameter space
- **PRO:** minimal match is “assured”
- **CONS:** the metric is an **analytical approximation** of a **non flat-space**, it might undercover

Stochastic:

- a brute force approach
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Hybrid approach → 🎵 get the best of both world 🎵 → HdBank (S. Roy et al, 2017):

- stochastic seed
- geometric lattice growth

HdBank2

→ GOAL: Get the best template bank

HdBank2

9

→ **GOAL:** Get the **best** template bank

→ **How:**

- Start stochastic distribution using **Normalizing Flow** → “learn the metric”
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- **Speed:** parallelize the geometrical part using **HT Condor**

HdBank2

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HdBank2

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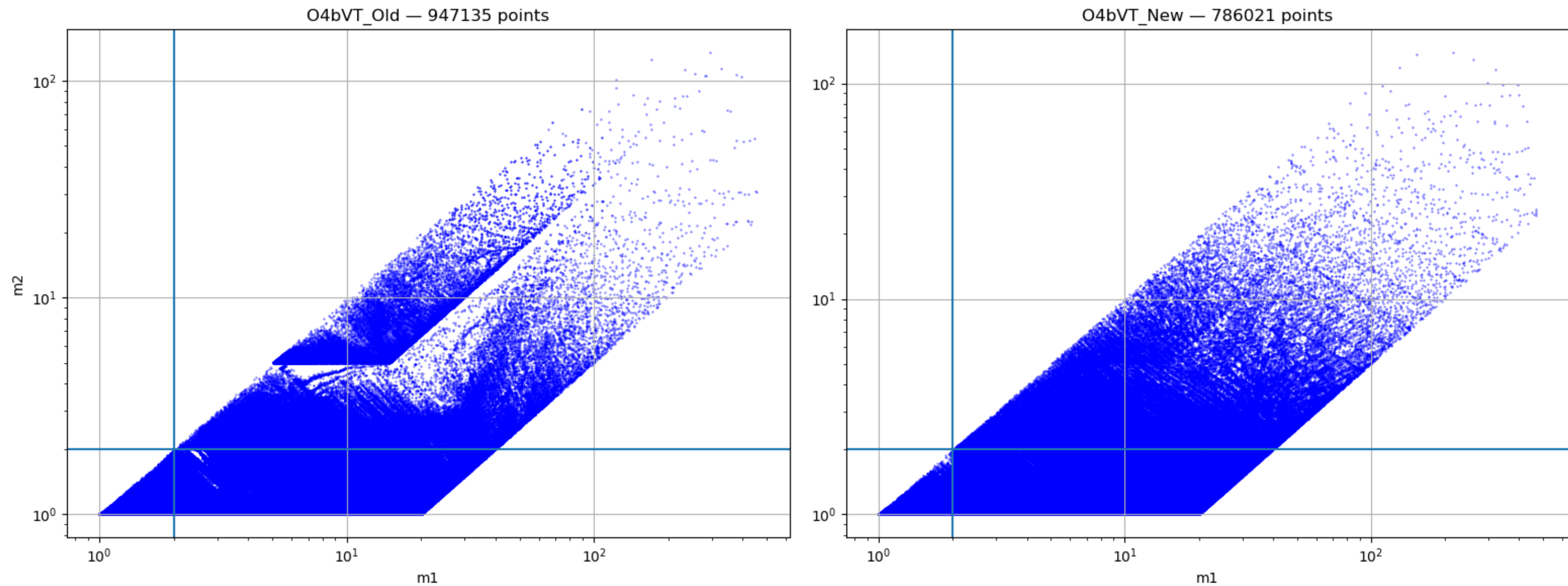
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→ **NB:** what is the best bank?

- **compute the actual minimal match** ($\text{SNR}/\text{SNR}_{\max}$), on a set of injections (use [pycbc banksim](#) or [FastBankCheck](#))
- **goal:** a better minimal match and possibly also **less templates**.

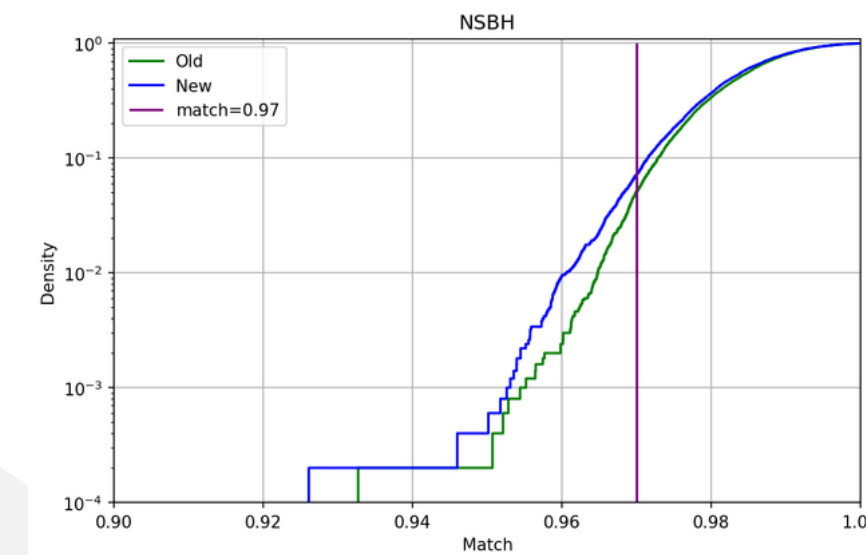
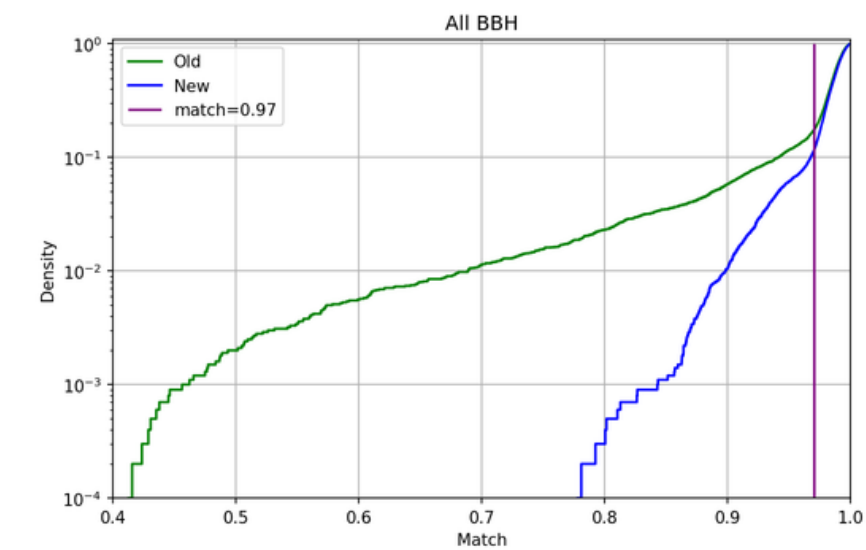
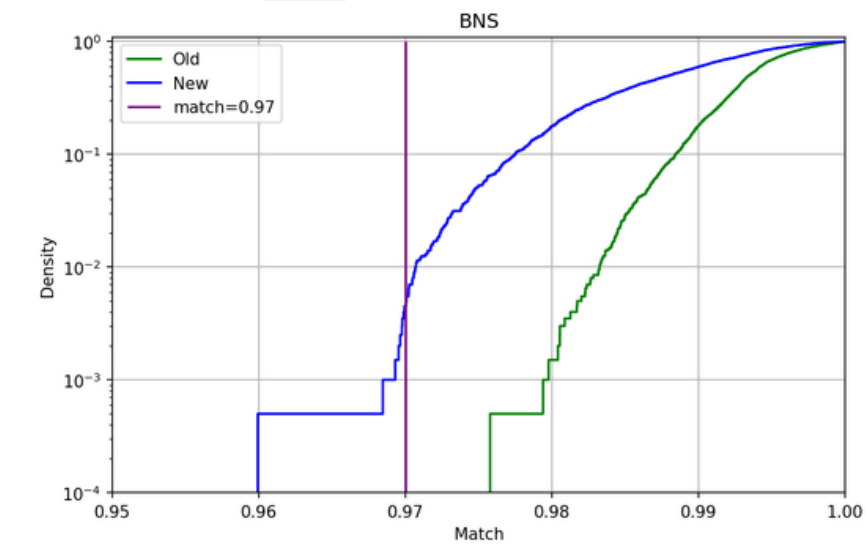
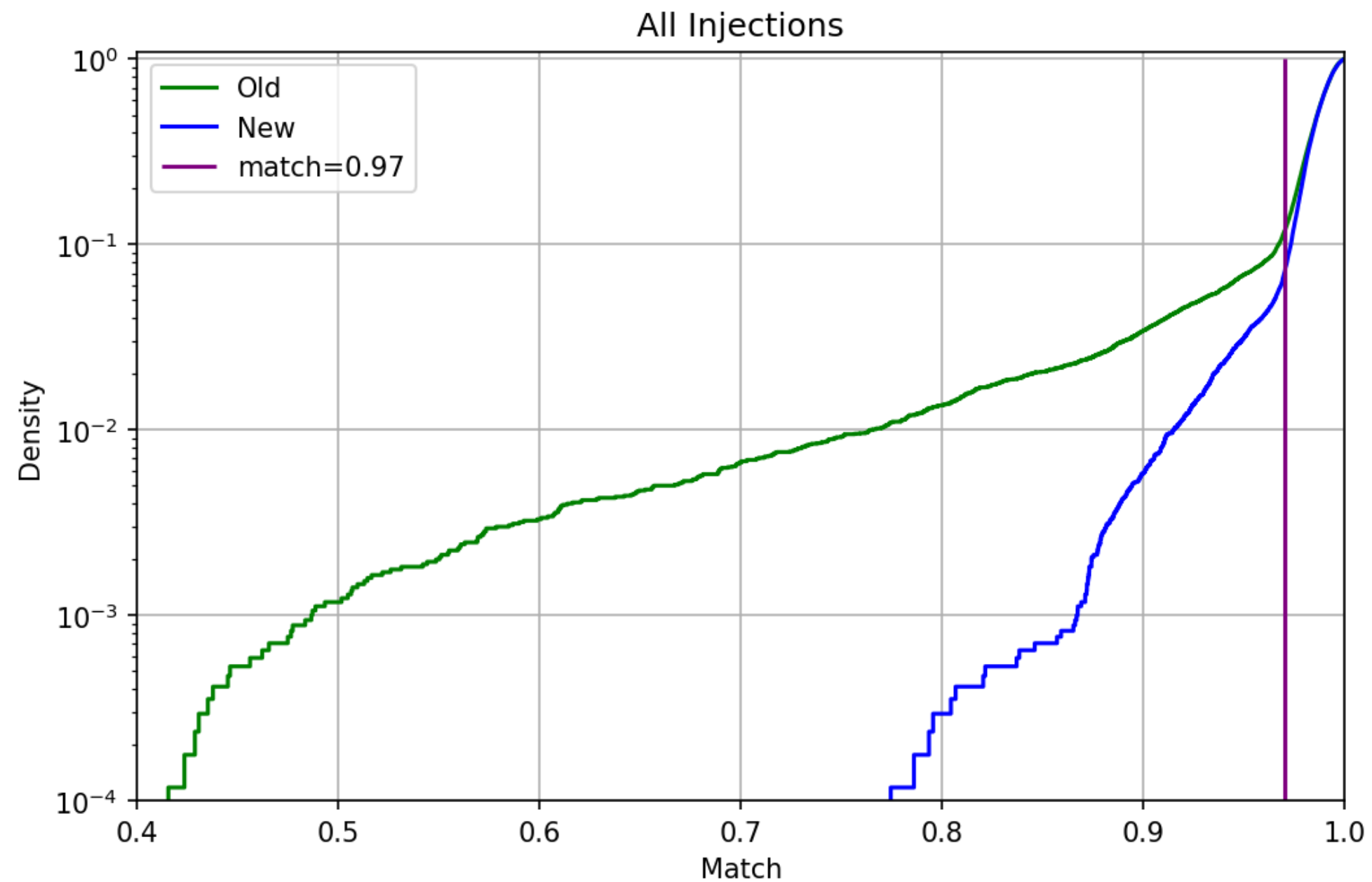
Results: a bank for MBTA



Less Templates! 947135(old) VS 786021 (new)

Bank verification

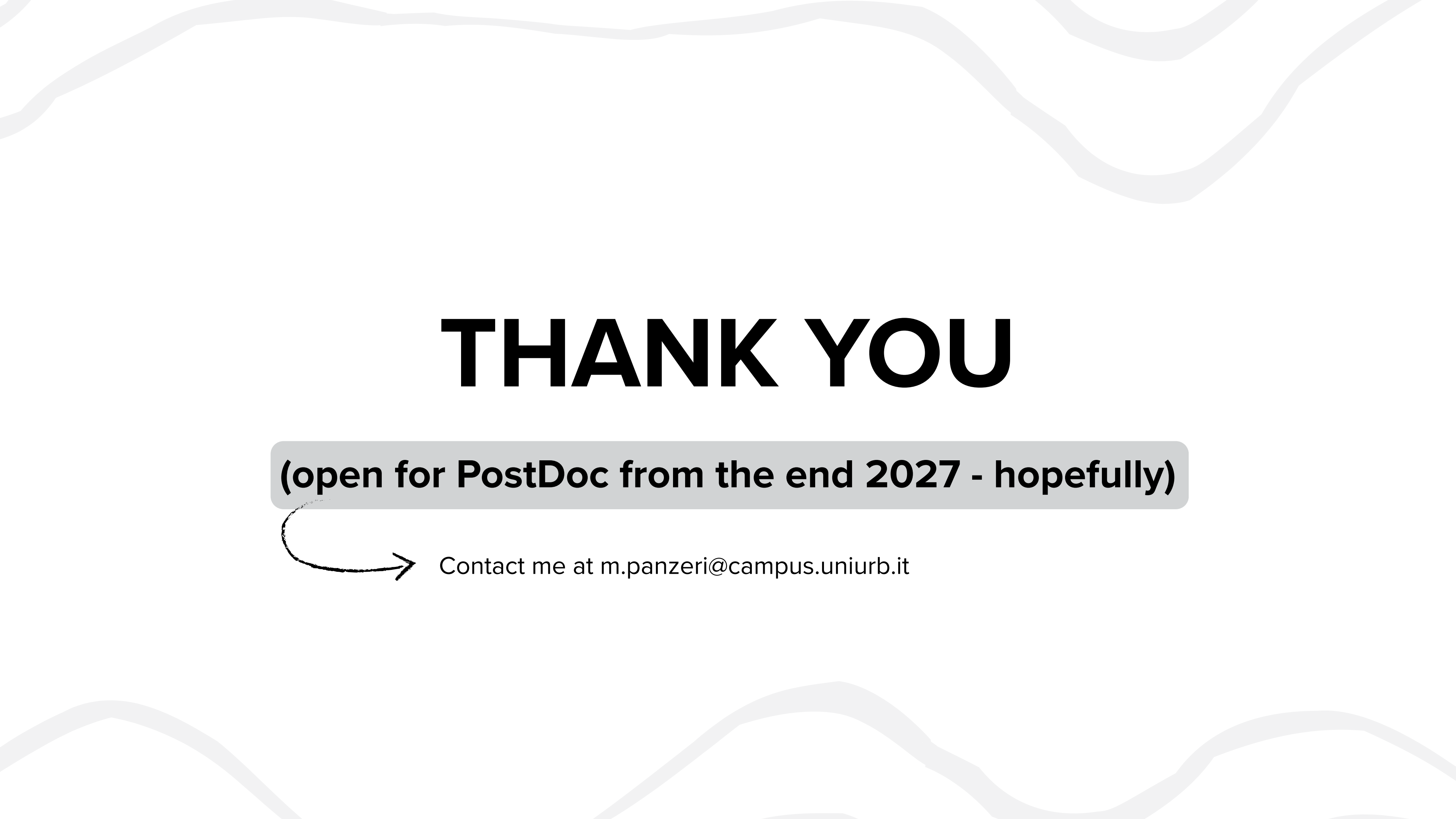
→ Using 17000 injections: the new bank is better!



Conclusion

- The new bank seems to work better than the old one.
- There is **much more to do** to produce the **banks to run MBTA**:
 - Real template banks (original bank divided in 2 frequency bands)
 - Optimized frequency cut
 - 1 band bank
 - Gating studies
 - Removal of noisy templates
- **Good news**: everything is done.
- **Bad news**: currently filtering o4c data.

The outcome will be publically available by the end of the year: **stay tuned for GWTC6!**



THANK YOU

(open for PostDoc from the end 2027 - hopefully)

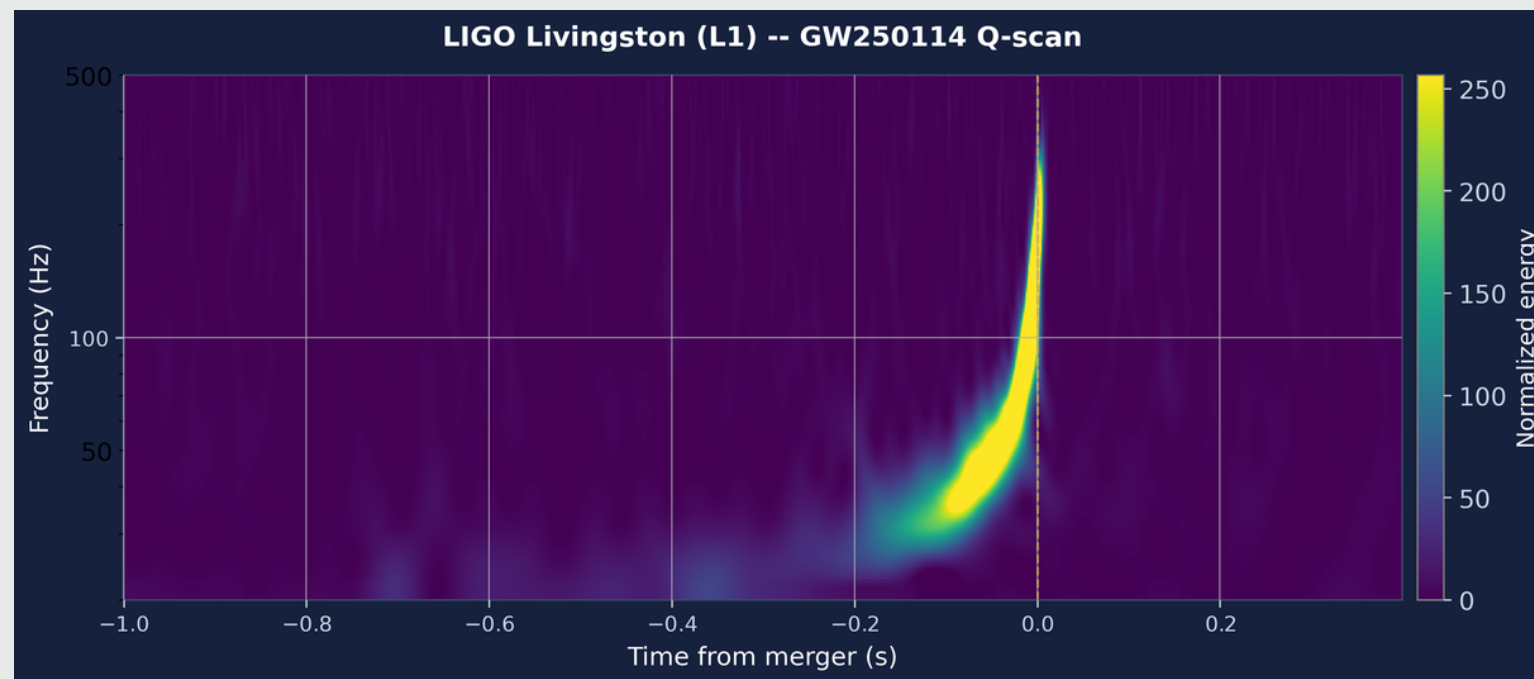


Contact me at m.panzeri@campus.uniurb.it

BURST vs MATCH FILTERING

BURST:

- **unmodelled**: any known or unknown source;
- relies on **coherent excess of energy**
- **Pipeline**: CWB



MatchFiltering:

- **modelled**: known and modelled sources
- relies on the **match filtering technique**.
- **Pipelines**: GSTLaL, MBTA, PyCBC

