

# **ANC of mains power interference in CW searches**

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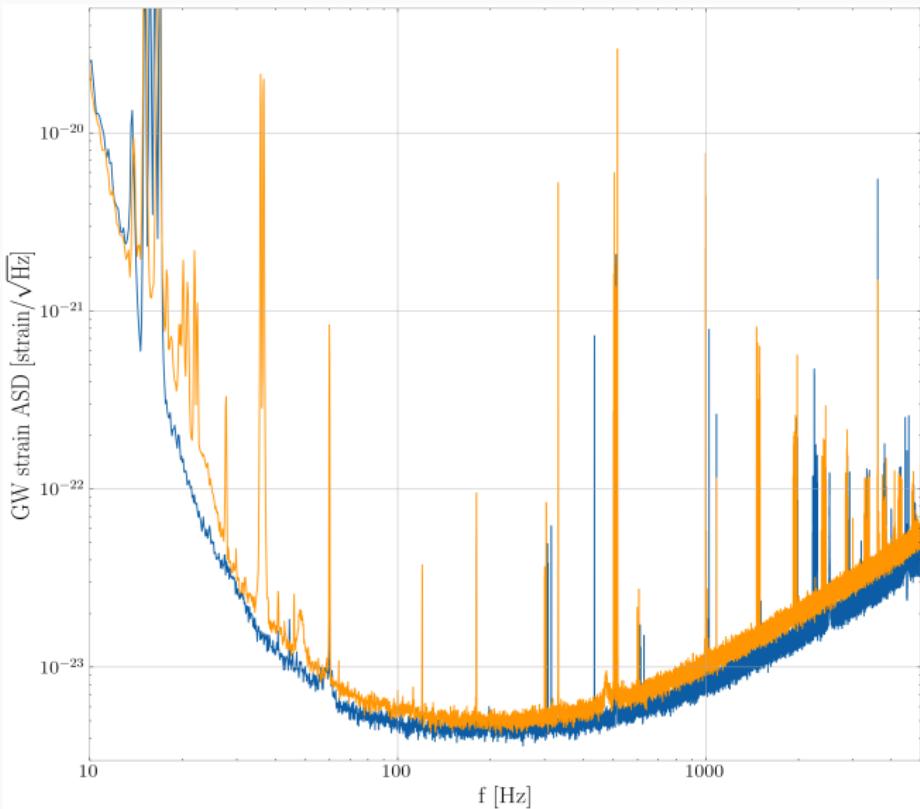
ARC Centre of Excellence for Gravitational Wave Discovery

# Summary

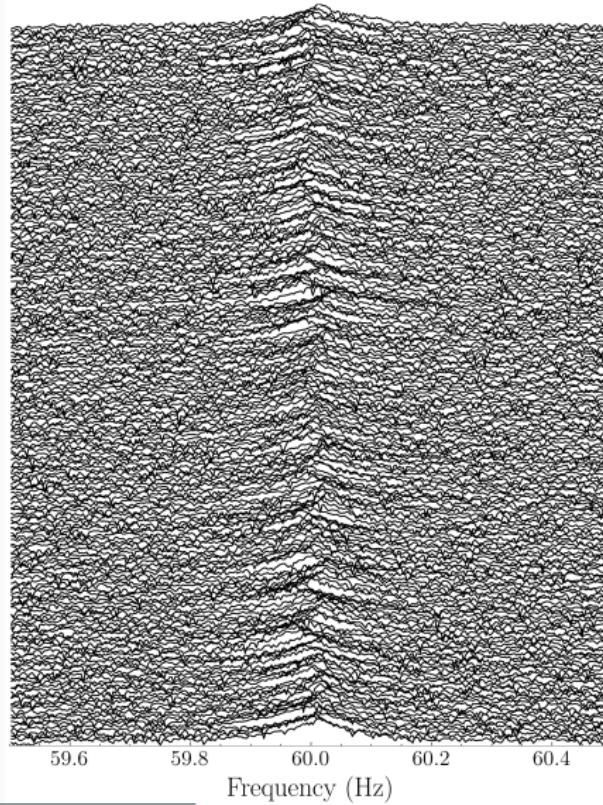
## Takeaway points

- Instrumental lines hamper CW searches.
- It is possible to subtract lines using adaptive noise cancellation (ANC)
  - ... if there is reference data from a PEM
- ANC + HMM search on synthetic data can recover CW signal which overlaps with mains power interference at 60 Hz

# Instrumental lines



Some lines are static, but some are wandering:



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channel H1:PEM-CS\_MAINSMON\_EBAY\_1\_DQ

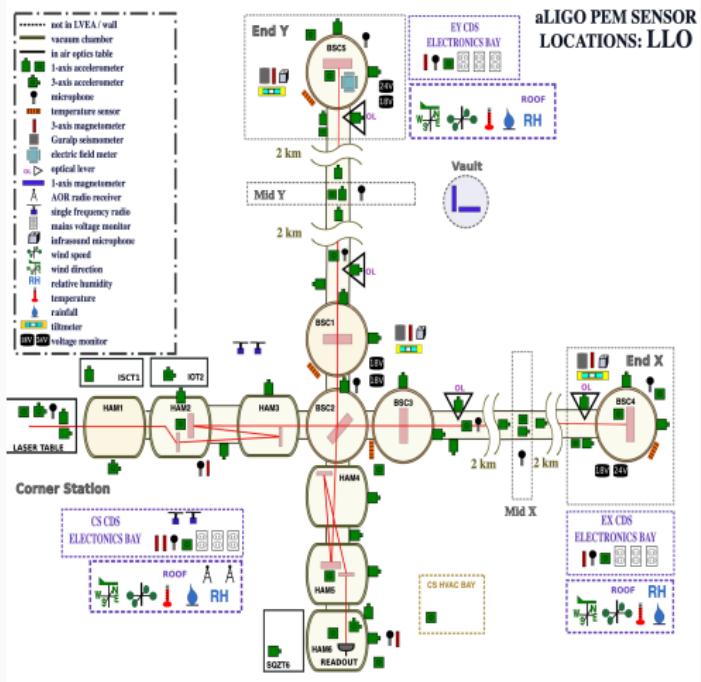
- How do we typically deal with lines?
  - Veto candidates / gate frequency bands
- **This work:** can we detect a synthetic CW signal that overlaps with a line?
  - We focus exclusively on the **60 Hz line** (North America power grid)

We can subtract the line “**clutter**” using adaptive noise cancellation (ANC).

- Signal channel:  $x(t) = h(t) + \text{c}(t) + n(t)$
- Reference channel:  $r(t)$
- Use  $r(t)$  to construct real-time estimate  $\hat{c}(t)$  via an **adaptive** filter
- Define a “residual”  $e(t) = x(t) - \hat{c}(t)$
- As  $\hat{c}(t) \rightarrow c(t)$ ,  $e(t) \rightarrow h(t) + n(t)$

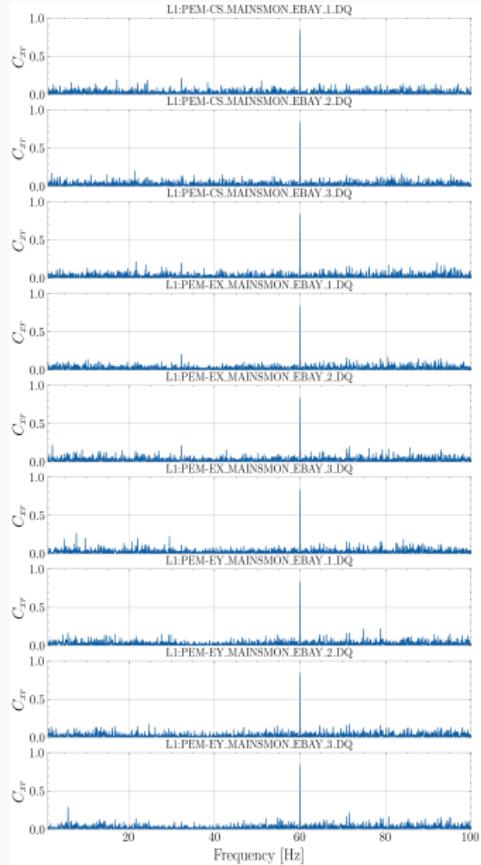
Analogous to how your noise cancelling headphones work.

- Where does our  $r(t)$  come from?
  - PEMs
- There are 9 PEM mains voltage monitors:
  - $3 \times EX$
  - $3 \times EY$
  - $3 \times CS$



- Is the 60 Hz interference recorded by  $r(t)$  also in  $x(t)$ ?
- Coherence

$$C_{xr}(f) = \frac{|P_{xr}(f)|^2}{P_{xx}(f)P_{rr}(f)}$$



## Validation with synthetic data

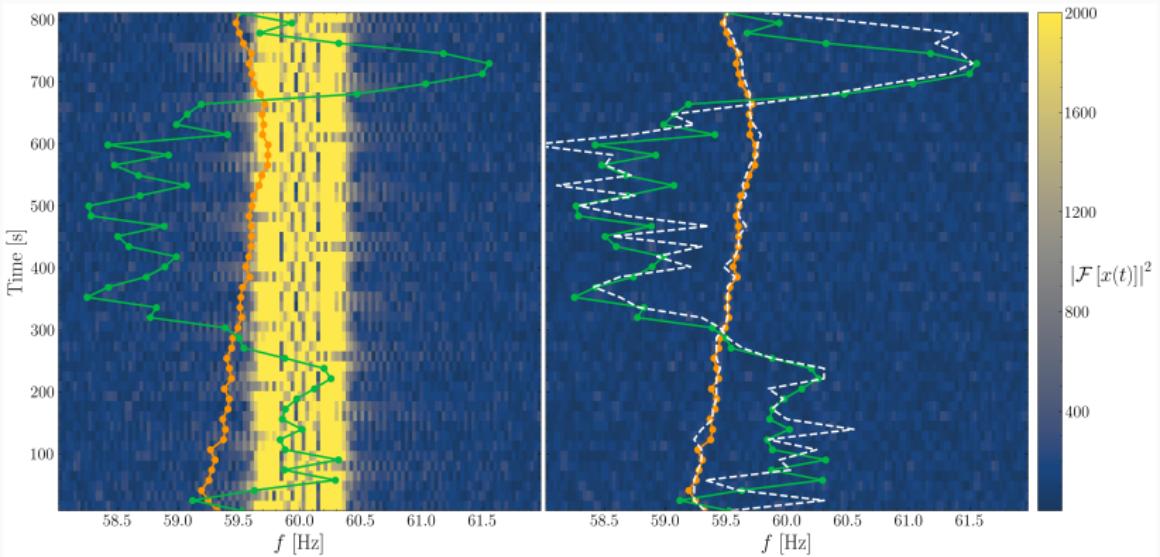
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**Goal:** Find a (wandering) CW signal that overlaps with the (wandering) 60 Hz interference line

Create some noisy synthetic data:

$$x(t) = h(t) + c(t) + n(t); r(t)$$

Search for  $h(t)$  using a HMM (Suvrova et al. 2016) + ANC



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