# CohMon

A python tool to measure  coherence

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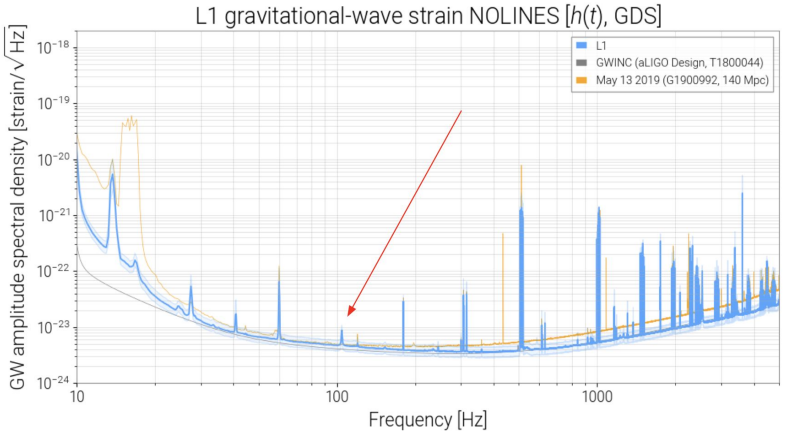
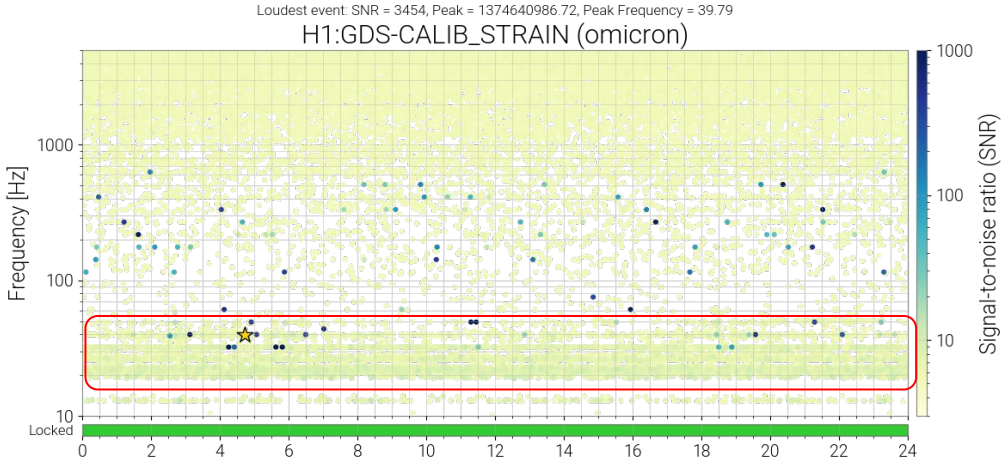
# Motivation




- Noise couplings (linear and non linear) can pop up any time
- No easy to run coherence monitoring tool
- Connect Coherence monitor with Noise Cleaning

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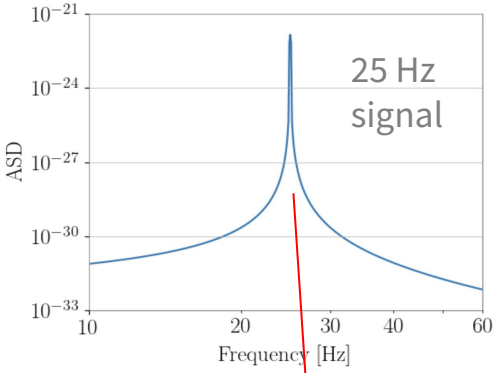
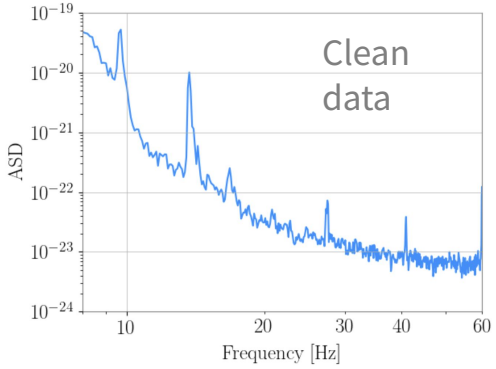
# Coherence analysis

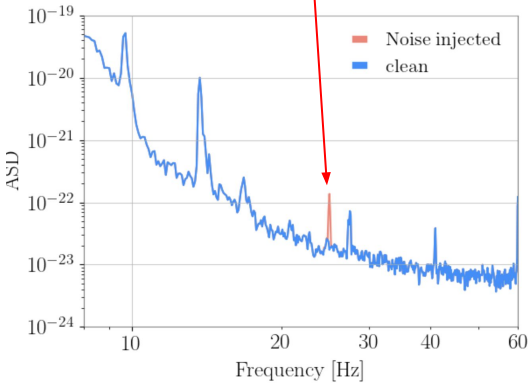
Coherence is frequency domain analog of cross corelation and is a measure of similarity between two signals

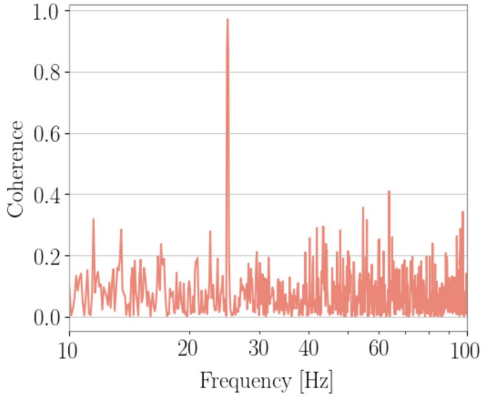
$$C_{xy}(f) = \frac{G_{xy}(f)^2}{S_{xx}(f)S_{yy}(f)}$$

Gxy is cross spectral density and Sxx, Syy is power spectral density of the signals x(t) and y(t)



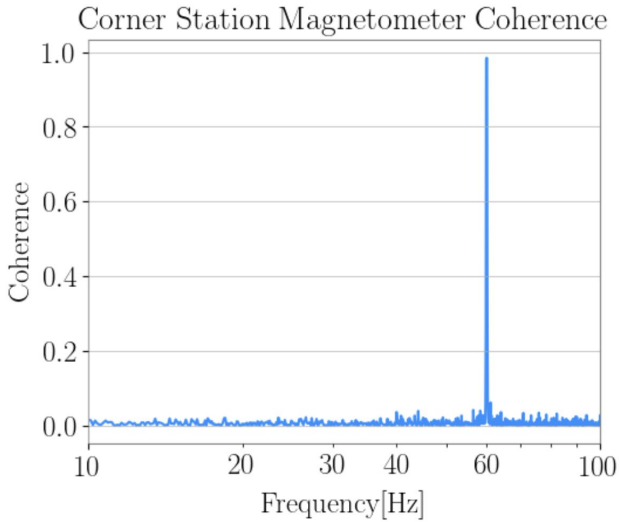



# Coherence monitoring

Apply coherence analysis to LLO and LHO:

- Gwpy based coherence calculation
- Code stored in git repository here
- measure signal coherence between h(t) and aux channels everyday
- Which channels have high coherence and at what frequency?
- Are the coherences changing on some timescale (day, week)?
- Summarize the results using summary page style plots
- User friendly interface: users can find coherence for any given channel

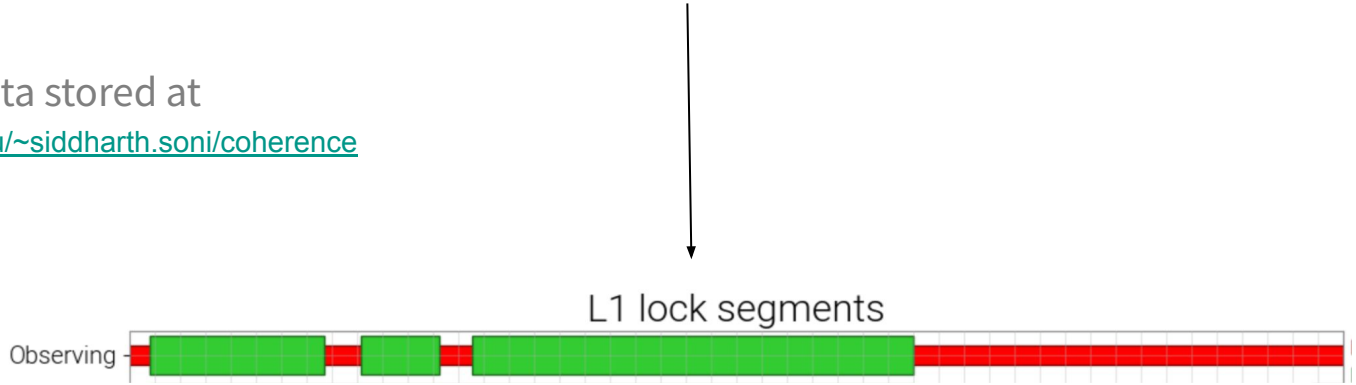



https://gwpy.github.io/docs/stable/

# Coherence monitoring: current setup

- Cron jobs running the monitor three times a day. Analyses data: midnight to 8 UTC, 8 - 16 UTC and 16 - midnight UTC
- We plot the max coherence, channel at each frequency
- Plots and coherence data stored at https://ldas-jobs.ligo.caltech.edu/~siddharth.soni/coherence_monitor/

The observing times are divided into 1 hour segments and from each of these 1 hour segments, we calculate coherence on 1024 seconds



# Output data: Nov 18 L1

| Name | Last modified | Size | Description |
|---|---|---|---|
| Parent Directory | | - | |
| data/ | 2024-11-18 19:49 | - | |
| log.log | 2024-11-18 19:59 | 6.8K | |
| max_coherence/ | 2024-11-19 10:15 | - | |
| plots/ | 2024-11-18 20:02 | - | |

Inside data

- L1:ALS-C_TRX_A_LF_OUT_DQ.csv
- L1:ALS-C_TRY_A_LF_OUT_DQ.csv
- L1:ASC-AS_A_DC_PIT_OUT_DQ.csv
- L1:ASC-AS_A_DC_YAW_OUT_DQ.csv
- L1:ASC-AS_A_RF36_I_PIT_OUT_DQ.csv
- L1:ASC-AS_A_RF36_I_YAW_OUT_DQ.csv
- L1:ASC-AS_A_RF36_Q_PIT_OUT_DQ.csv
- L1:ASC-AS_A_RF36_Q_YAW_OUT_DQ.csv
- L1:ASC-AS_A_RF72_I_PIT_OUT_DQ.csv
- L1:ASC-AS_A_RF72_I_YAW_OUT_DQ.csv
- L1:ASC-AS_A_RF72_Q_PIT_OUT_DQ.csv
- L1:ASC-AS_A_RF72_Q_YAW_OUT_DQ.csv

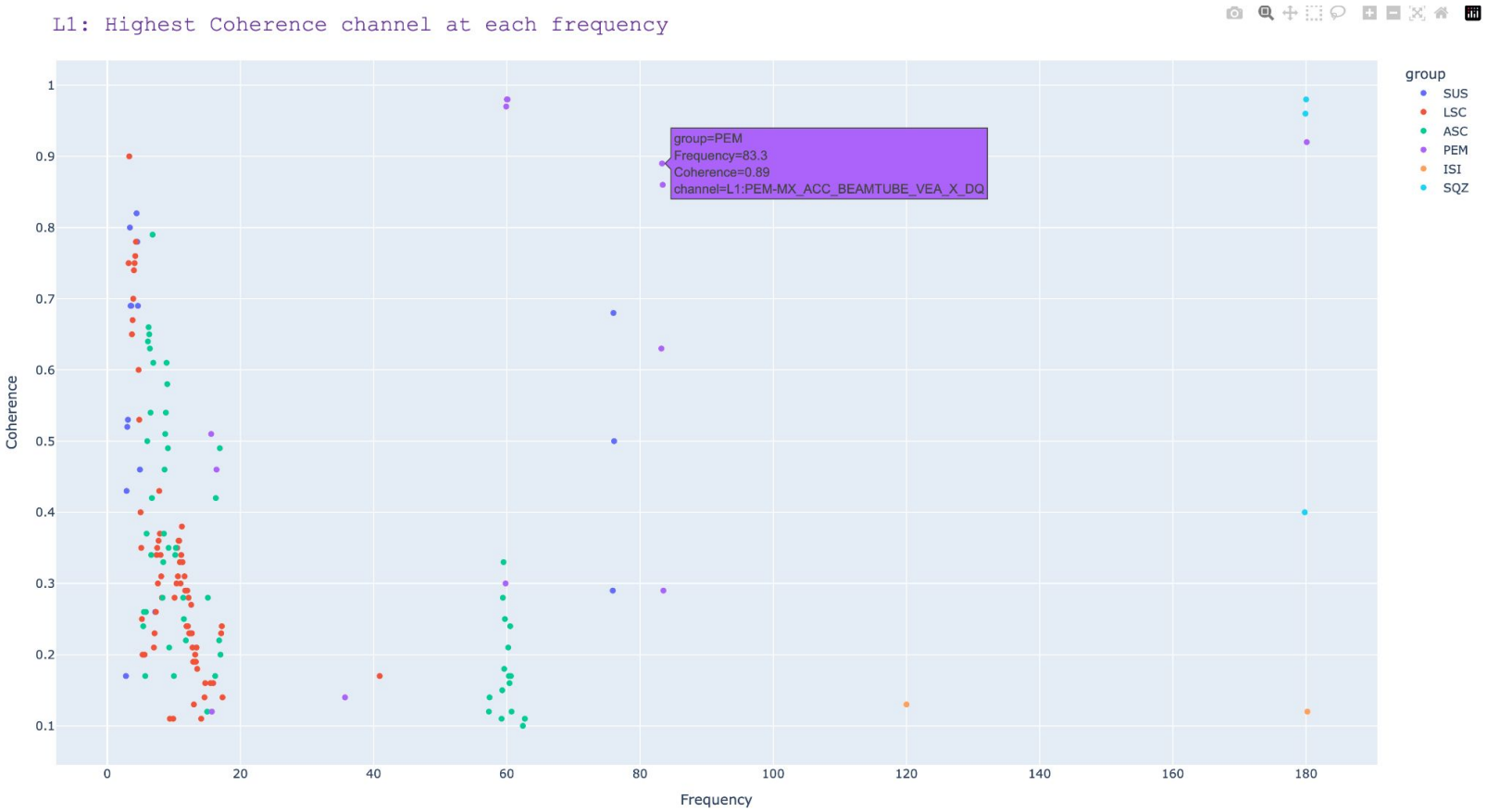
Inside any of these gpstimes

| | | |
|---|---|---|
| Parent Directory | | - |
| 1415923518/ | 2024-11-18 01:26 | - |
| 1415927118/ | 2024-11-18 01:33 | - |
| 1415930718/ | 2024-11-18 01:39 | - |
| 1415934318/ | 2024-11-18 01:45 | - |
| 1415937918/ | 2024-11-18 01:52 | - |
| 1415941518/ | 2024-11-18 01:59 | - |
| 1415945118/ | 2024-11-18 02:05 | - |
| 1415952318/ | 2024-11-18 09:27 | - |
| 1415955918/ | 2024-11-18 09:34 | - |
| 1415959518/ | 2024-11-18 09:41 | - |
| 1415963118/ | 2024-11-18 09:47 | - |
| 1415966718/ | 2024-11-18 09:54 | - |
| 1415970318/ | 2024-11-18 10:01 | - |
| 1415973918/ | 2024-11-18 10:08 | - |
| 1415993586/ | 2024-11-18 17:27 | - |
| 1415997186/ | 2024-11-18 17:33 | - |
| 1416000786/ | 2024-11-18 19:49 | - |
| 1416004386/ | 2024-11-18 19:58 | - |

Frequency Coherence

```
5.990000000000000568e+01,1.044615851792861788e-0
6.000000000000000000e+01,1.893770237469268036e-0
1.199000000000000057e+02,1.999361354901777743e-0
1.200000000000000000e+02,2.048337647704300546e-0
1.799000000000000057e+02,1.915880707943857508e-0
1.800000000000000000e+02,1.528237364702366707e-0
```

# Plots

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# Running CohMon and Utility functions

# Check single channel coherence with h(t)

```
from utils import check_channel_coherence
coh = check_channel_coherence(channel='L1:SUS-ETMY_L1_WIT_P_DQ', ifo='L1', t1=1415319831, t2=1415319831+200)
```

```
coh
```

[0.00016030351, 0.0023252803, 0.015160833, …, 0.024127105, 0.0036402967, 0.0022793662] coherence

# Run for all channels between t1 and t2

```
python run_coherence.py --t1 1416301218 --t2 1416301618 --ifo 'L1' --savedir data/
```

# Max Coherence

## What is the maximum coherence at each frequency for a given run?

```
from utils import combine_data_files, get_max_coherence

pathNov11_a = '/home/siddharth.soni/public_html/coherence_monitor/L1/2024-11-11/1415318418/data/1415319831/'
frame_1415319831 = combine_data_files(path=pathNov11_a)
```

```
maxcoh_Nov11 = get_max_coherence(dataframe=frame_1415319831, min_freq=0.0, max_freq=100.0)
```

```
maxcoh_Nov11
```

| | freq | value | channel |
|---|---|---|---|
| **0** | 2.8 | 0.13 | L1:SUS-ETMY_L1_WIT_P_DQ |
| **1** | 2.9 | 0.46 | L1:SUS-ETMY_L1_WIT_P_DQ |
| **2** | 3.0 | 0.44 | L1:SUS-ETMX_L2_WIT_L_DQ |
| **3** | 3.1 | 0.57 | L1:SUS-ETMX_M0_DAMP_L_IN1_DQ |
| **4** | 3.2 | 0.68 | L1:LSC-MICH_OUT_DQ |
| **...** | ... | ... | ... |
| **179** | 60.5 | 0.33 | L1:ASC-DHARD_P_OUT_DQ |
| **180** | 60.6 | 0.14 | L1:ASC-DHARD_P_OUT_DQ |
| **181** | 75.9 | 0.12 | L1:SUS-FC2_M1_DAMP_T_IN1_DQ |
| **182** | 76.0 | 0.62 | L1:SUS-FC2_M1_DAMP_T_IN1_DQ |
| **183** | 76.1 | 0.62 | L1:SUS-FC2_M1_DAMP_V_IN1_DQ |

184 rows × 3 columns

# Access the data for a specific date

```
from utils import get_day_data
L1_nov12 = get_day_data(date='2024-11-12', ifo='L1')
```

```
L1_nov12
        frequency   coherence   gpstime date    channel
0       2.9 0.145740    1415451918  2024-11-12  L1:LSC-REFL_A_RF45_Q_ERR_DQ
1       3.0 0.128458    1415451918  2024-11-12  L1:LSC-REFL_A_RF45_Q_ERR_DQ
2       3.2 0.135717    1415451918  2024-11-12  L1:LSC-REFL_A_RF45_Q_ERR_DQ
3       3.3 0.395392    1415451918  2024-11-12  L1:LSC-REFL_A_RF45_Q_ERR_DQ
4       3.4 0.408285    1415451918  2024-11-12  L1:LSC-REFL_A_RF45_Q_ERR_DQ
... ... ... ... ... ...
1027910 299.9   0.284965    1415444718  2024-11-12  L1:HPI-ETMY_BLND_L4C_Z_IN1_DQ
1027911 300.0   0.190348    1415444718  2024-11-12  L1:HPI-ETMY_BLND_L4C_Z_IN1_DQ
1027912 359.8   0.113181    1415444718  2024-11-12  L1:HPI-ETMY_BLND_L4C_Z_IN1_DQ
1027913 359.9   0.300835    1415444718  2024-11-12  L1:HPI-ETMY_BLND_L4C_Z_IN1_DQ
1027914 360.0   0.123539    1415444718  2024-11-12  L1:HPI-ETMY_BLND_L4C_Z_IN1_DQ
```

# Thank You!
# Questions?