Status of coalescing binaries search activities in Virgo
GWDAW 11
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Introduction on Coalescing Binaries

activities:

The Virgo CB group tasks:

• Binary Neutron Stars search
  – Two pipelines up and running (online and offline)
  – Detector non-stationarity still significant
  – Vetoes
• We are working to extend to:
  – non spinning Black Hole
  – Spinning binaries
  – High mass ratio binary system
• Network Analysis
  – Small scale real data exchange between LIGO and Virgo
  – Coherent analysis
  – Timing accuracy
Weekly Science Runs (WSR)

- WSR stands for *Periodic Weekend Data Taking*
- Collect "*Science mode*" data without any experiment performed on the detector
- The interferometer run in recycled "*science mode*"
- Take data in controlled conditions to exercise data analysis procedures
- Give some *feedback* to commissioning
- Only "*calibration*" and "*hardware injection*" are allowed (CB and Burst signals).
- *On-line* data analysis is performed running the Multi-Band and Merlino CB Analysis processes.
- ITF status and behaviour monitoring
- *Off-line* analysis

![Weeks Schedule](image)

WSRs @2006

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Data Quality: WSRs sensitivity
horizon distance and sensitivity

WSR1: Duty cycle 87.7% - Longest lock 15 h

WSR5: Duty cycle 64.2% - Longest lock 10 h

WSR6: Duty cycle 80.5% - Longest lock 18 h
Horizon distance and environmental conditions

- Sea and Wind activities affect horizon
- These are micro-seismic conditions

Sea: RMS 220 mHz–1 Hz

Wind: RMS 30 mHz-100 mHz
Triggers amplitude and detector behavior

- CB trigger rate correlated to amplitude of laser frequency line injected at 1111 Hz, measuring the coupling of frequency noise to the dark fringe.

![Graph showing WSR2 events SNR vs Time and Pr_B1_ACp_1111Hz Dark Fringe count over time.](image-url)
Trigger rate and detector behavior

- Correlation between CB trigger rate and micro seismic peak
**WSR: CB hardware injections**

- **Hardware Injections**
  - This activity is performed in the first and last run night
  - CB signals and Burst signals are injected
  - A single Taylor CB signal with $[1.39;1.47]$Ms and $f_1=50$

- **Analysis parameters**
  - The template bank covers the $[0.9-3]$ Ms space
  - 98% minimal match
  - Threshold SNR=6 and Chi2 veto
  - Data clustered with 10ms time
WSR Hardware Injection: parameters reconstruction WSR 5 (e.g. Merlino)

- But the expected distance was 1.08 Mpc
- Mbta and Merlino provides the same results
- Calibration error due to failure in actuation electronics, fixed later on
WSR Hardware Injection: parameters reconstruction WSR6
(e.g. Mbta)

- Mean: 19.9
  - RMS: 1.8

- Mean: 0.99
  - RMS: 0.07

- Mean: 1.242
  - RMS: 0.004
WSR Hardware Injection: Detection and Chi2 veto
Veto

Veto a priori data quality cuts:

- Monitor for saturation in coil current in NE and WE towers
- Monitor for picomotor
- Monitor SSFS saturation
- ...

A posteriori:

- Remove high SNR triggers
  - Power variation in cavities: e.g. B2
- We follow the mean and RMS behavior of Pint_B2

Comparing RMS with a reference value, we flag a period as: beginning of noisy period
WSR1 and B2 Veto efficiency

- The periods tagged as noisy by "B2 veto" are well correlated to high SNR triggers.
- As when applying an offset to these periods, the rejection efficiency decreases.

[Graph showing efficiency and deadtime (SNR > 15) injection removed]

we are not randomly excluding events.
B2 Veto applied on WSR1 data
The original data set
B2 Veto applied on WSR1 data
The data set after the B2 veto

WSR1_events_B2veto.txt

SNR

0 5 10 15 20 25 30 35 40 45 50

SNR LF

10^0 10^1 10^2 10^3 10^4 10^5 10^6 10^7

SNR HF

1 10 10^2 10^3 10^4 10^5

SNR - Chi2

1 10 10^2 10^3 10^4 10^5 10^6 10^7

1/2 chi^2/dof

0 5 10 15 20 25 30 35 40 45 50

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Network Analysis: Timing Accuracy (poster)

- Source direction reconstruction by a network of detectors depends on signal timing accuracy at each site.
- In a template bank analysis, timing uncertainties are dominated by errors due to signal/template parameter mismatch.
- This error accumulates across the frequency band as signal timing is usually taken at the end (max frequency).

Study how **timing accuracy can be improved** considering a reference time at some intermediate frequency.

"timing accuracy variation between H1 and Virgo as a function of the reference frequency $f_s$"
• In order to start a gravitational wave sky-map, it is important the accuracy in the source parameters estimation
• There are two different methods to analyze network data and extracting stellar parameters:

1) Compare event list, searching from a compatible ones on each detector
2) “construct” an ideal detector equivalent to the network, to which each real detector coherently contributes

How can a coherent follow-up improve source direction reconstruction?
Conclusions

• Binary neutron stars search
  – Mature pipelines
  – Use WSR data to test and refine the analysis procedure
  – Understand how detector non stationarities affect the analysis
  – Work on data quality and vetoes
  – Pipelines now routinely run online, providing useful information

• Now moving to extend the search
  – Wider parameter range
  – Share the load between the two pipelines

• Prepare network data analysis