Status of coalescing binaries search activities in Virgo

GWDAW 11

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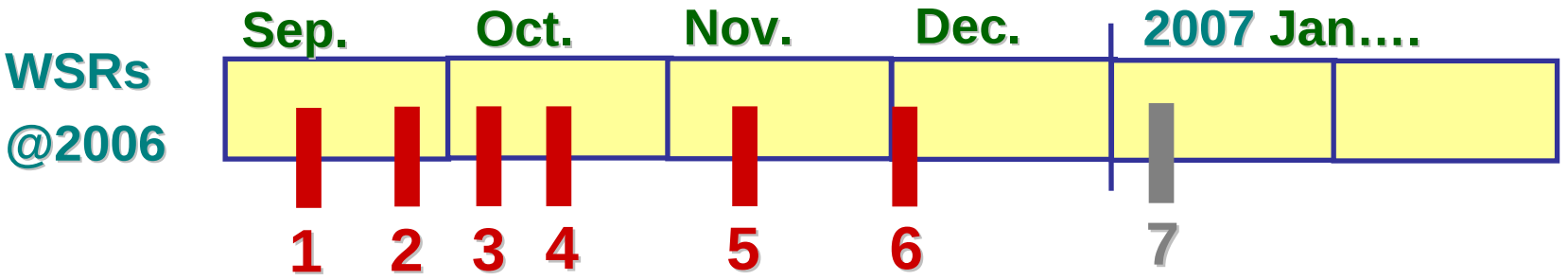
On behalf of the Virgo Collaboration

Introduction on Coalescing Binaries activities:

The Virgo CB group tasks:

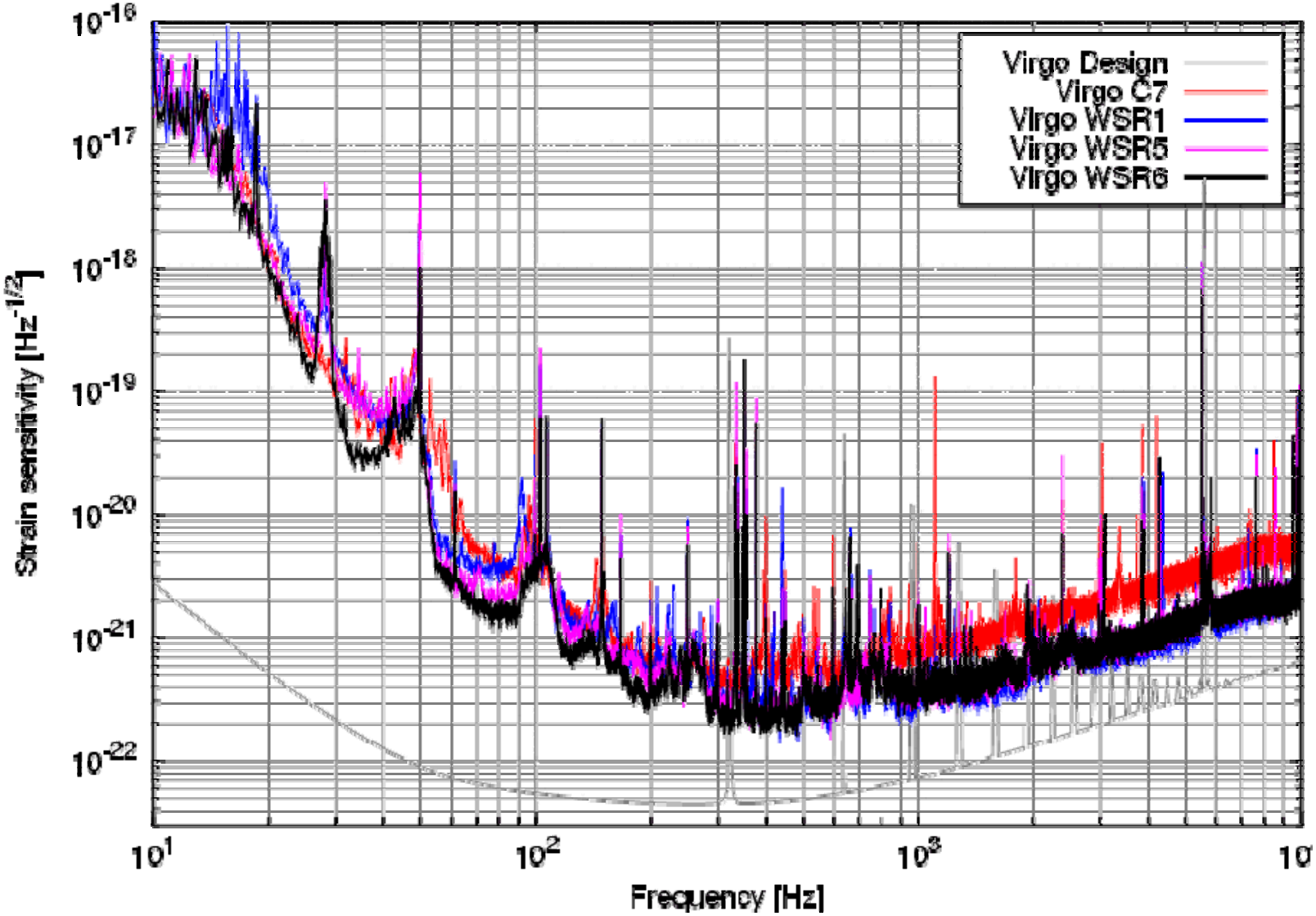
- Binary Neutron Stars search
  - Two pipelines up and running (online and offline)
  - Detector non-stationarity still significant
  - Vetoes
- We are working to extend to:
  - non spinning Black Hole
  - Spinning binaries
  - High mass ratio binary system
- Network Analysis
  - Small scale real data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

Weekly Science Runs (WSR)



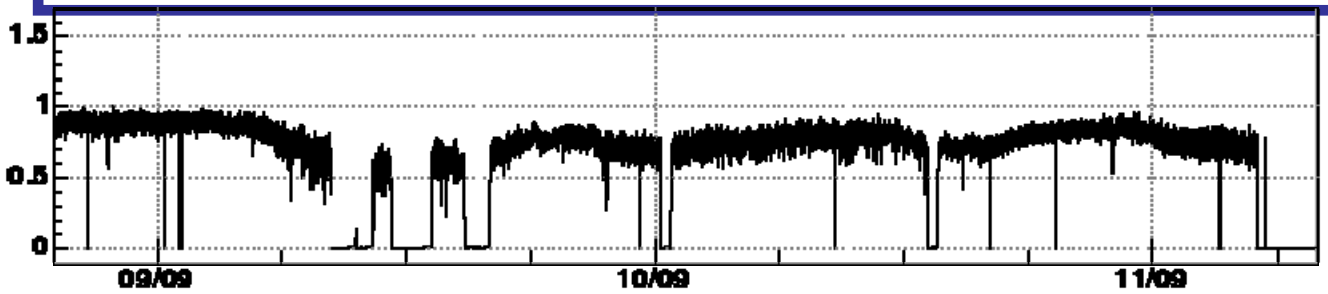
- WSR stands for ***Periodic Weekend Data Taking***
- Collect "***Science mode***" data without any experiment performed on the detector
- The interferometer run in recycled "***science mode***"
- Take data in controlled conditions to exercise data analysis procedures
- Give some ***feedback*** to commissioning
- 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

Data Quality: WSRs sensitivity

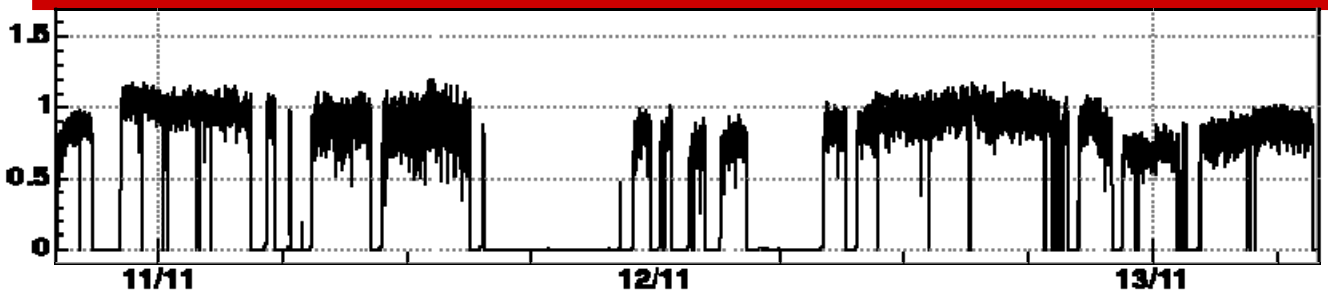


horizon distance and sensitivity

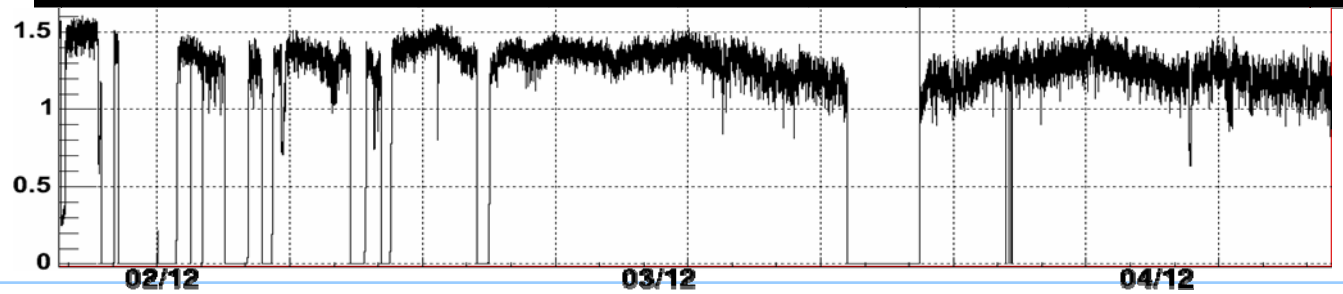
WSR1: Duty cycle 87.7% - Longest lock 15 h



WSR5: Duty cycle 64.2% - Longest lock 10 h



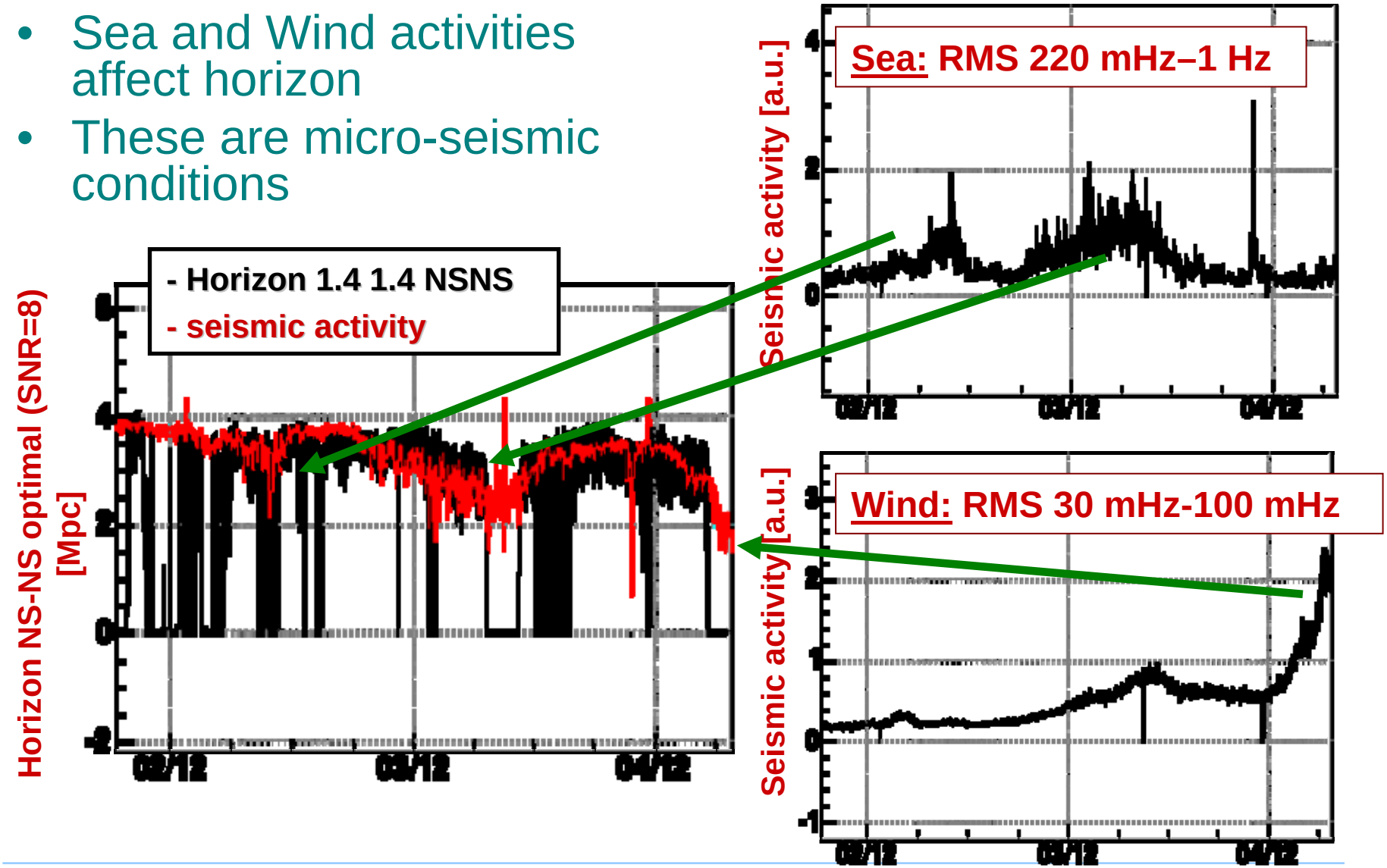
WSR6: Duty cycle 80.5% - Longest lock 18 h



Averaged Horizon for NS NS [Mpc]

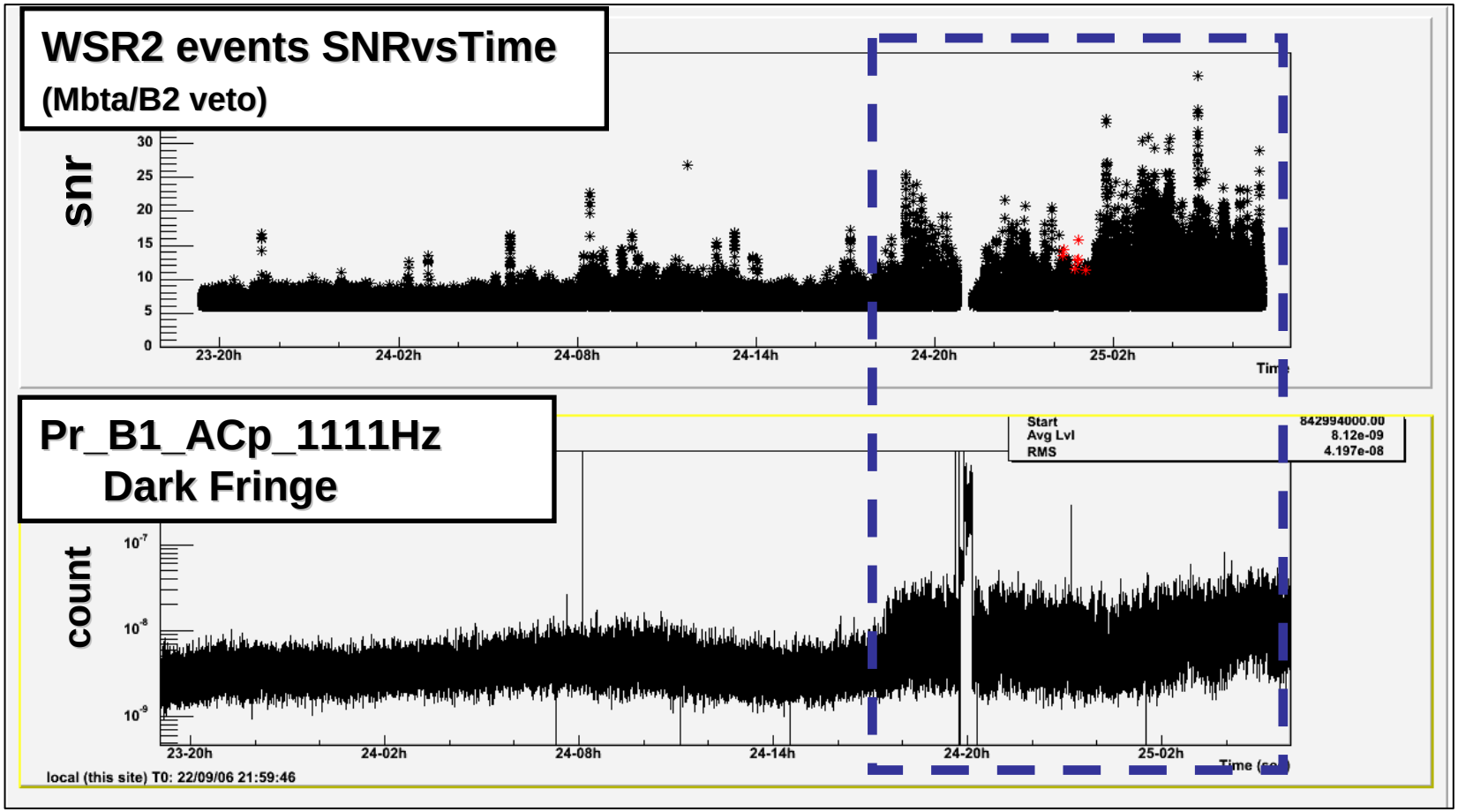
Horizon distance and environmental conditions

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



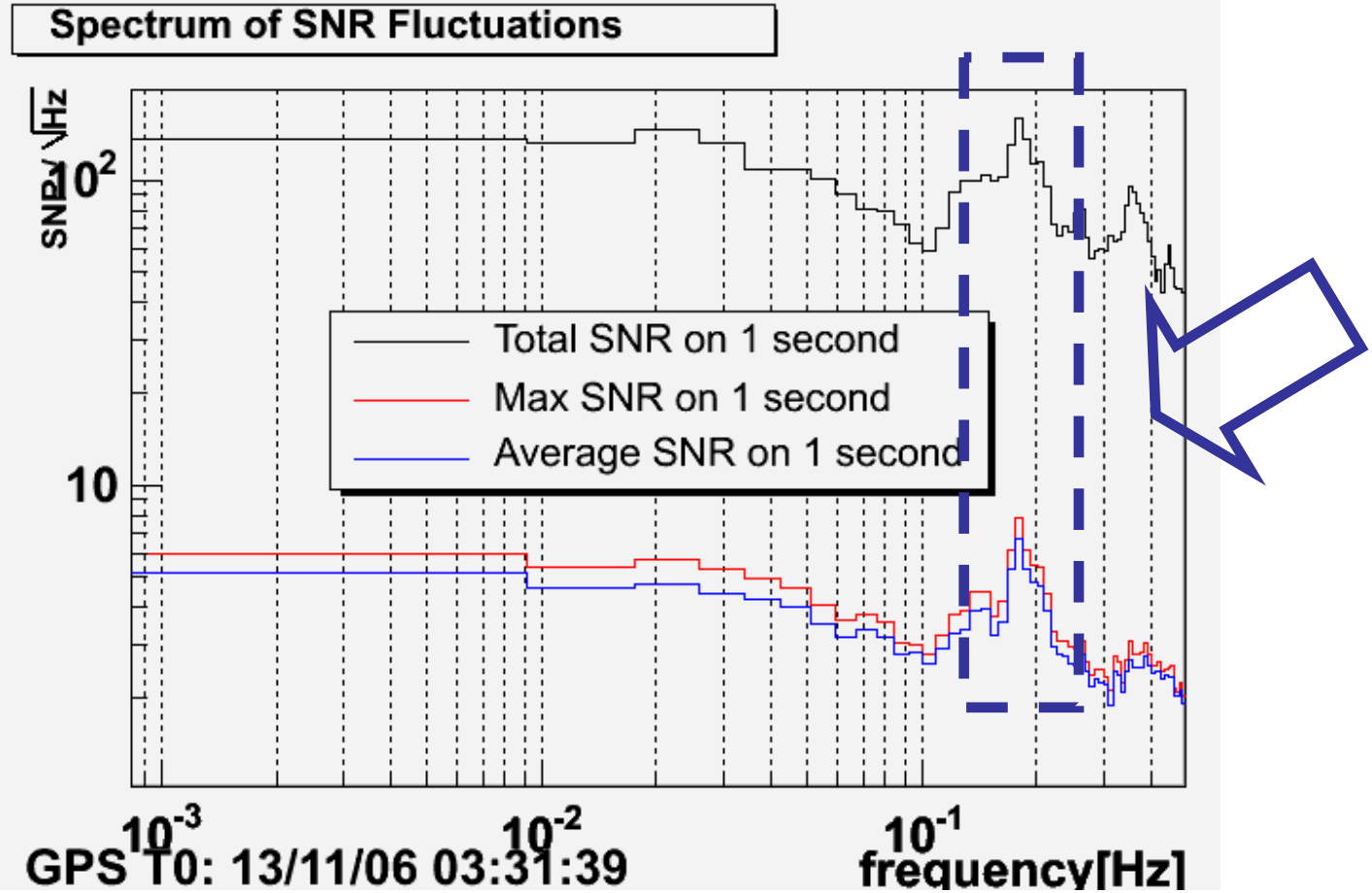
Triggers amplitude and detector behavior

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



Trigger rate and detector behavior

- Correlation between CB trigger rate and micro seismic peak



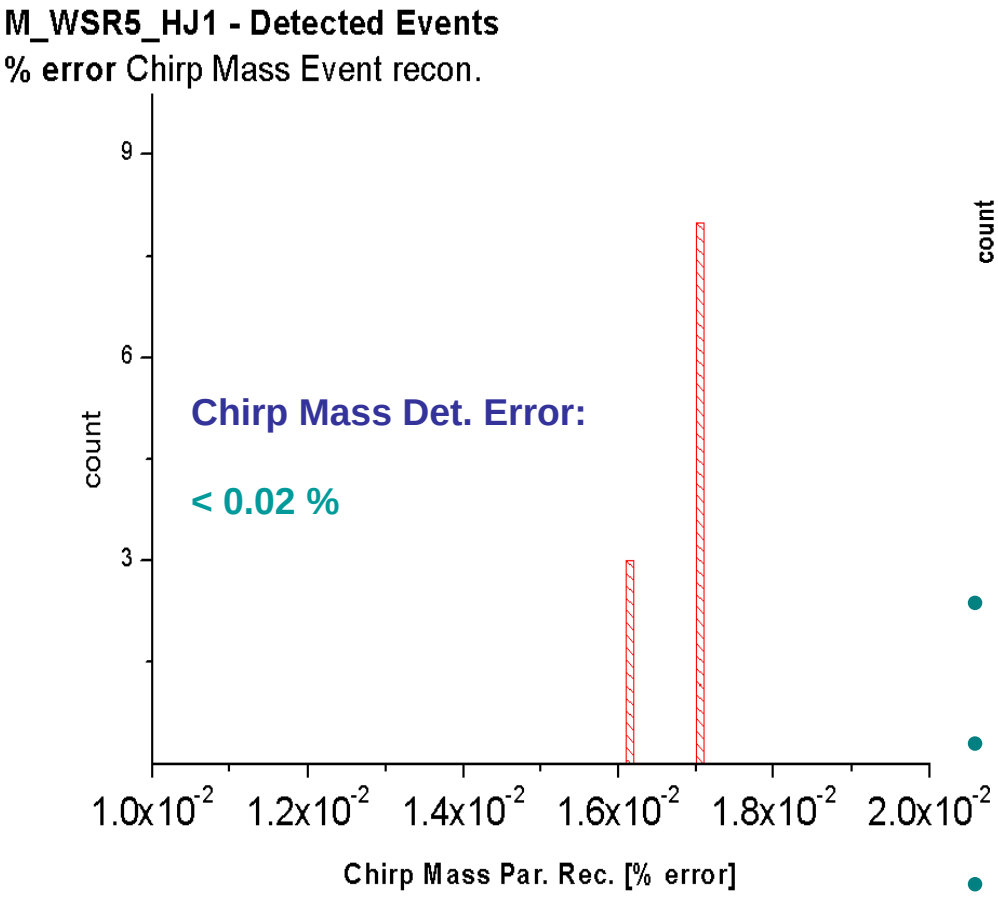
WSR: CB hardware injections

- 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 fl=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

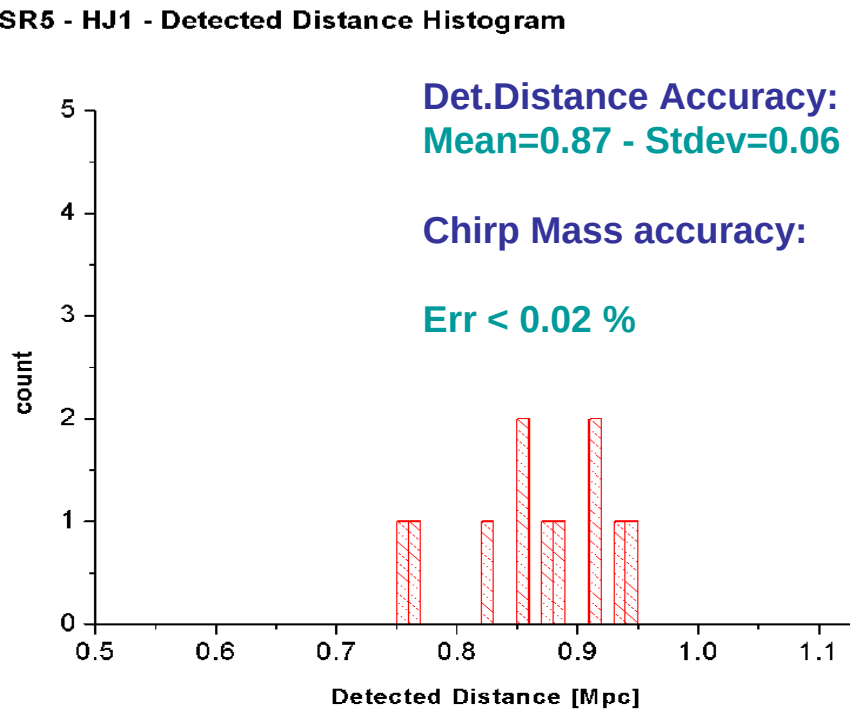
WSR Hardware Injection: parameters reconstruction WSR 5

(e.g. Merlino)



Chirp Mass Det. Error:

< 0.02 %



Det.Distance Accuracy:
Mean=0.87 - Stdev=0.06

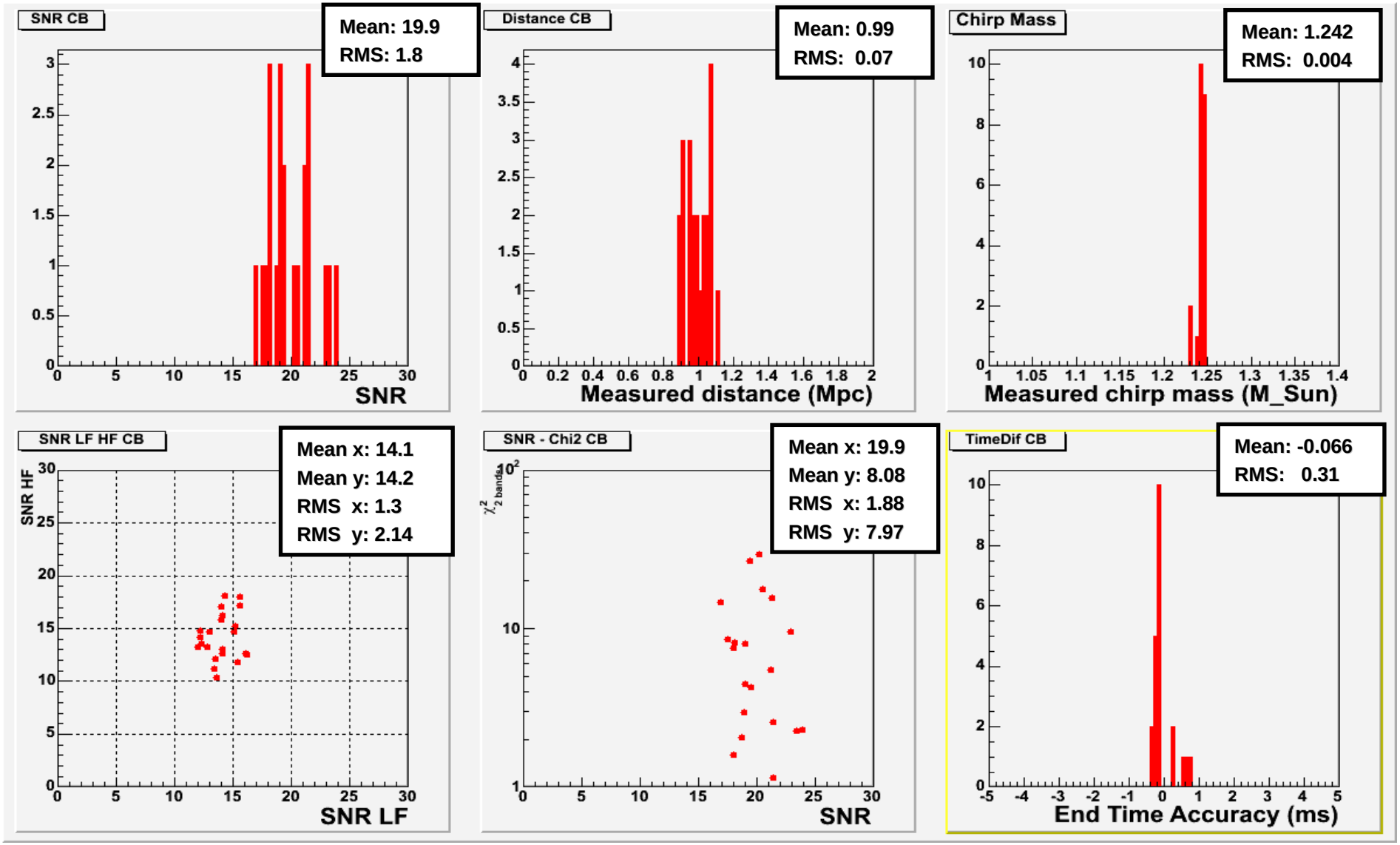
Chirp Mass accuracy:

Err < 0.02 %

- 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

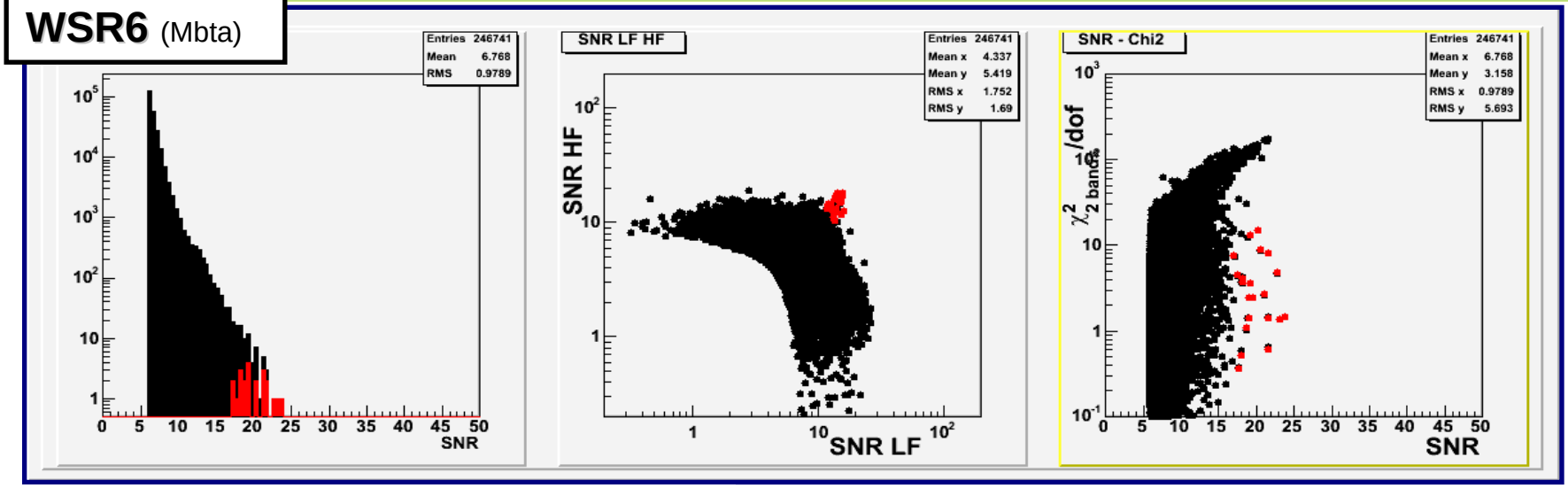
WSR Hardware Injection: parameters reconstruction WSR6

(e.g.Mbta)

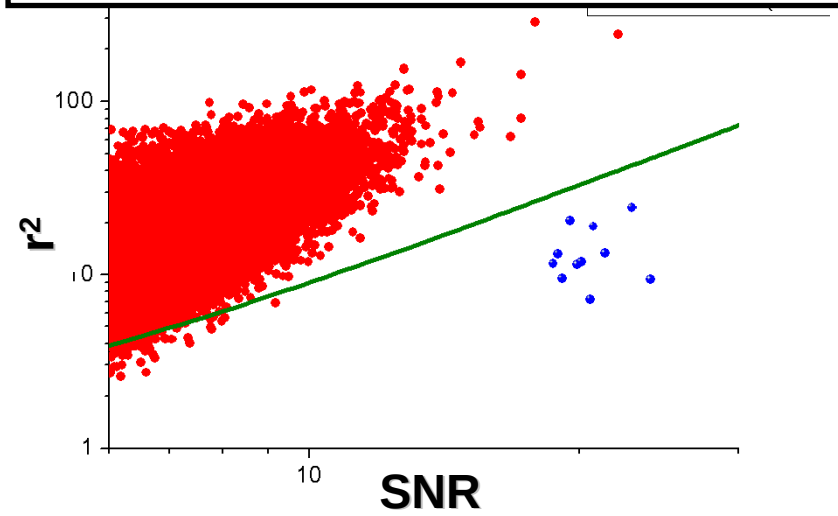


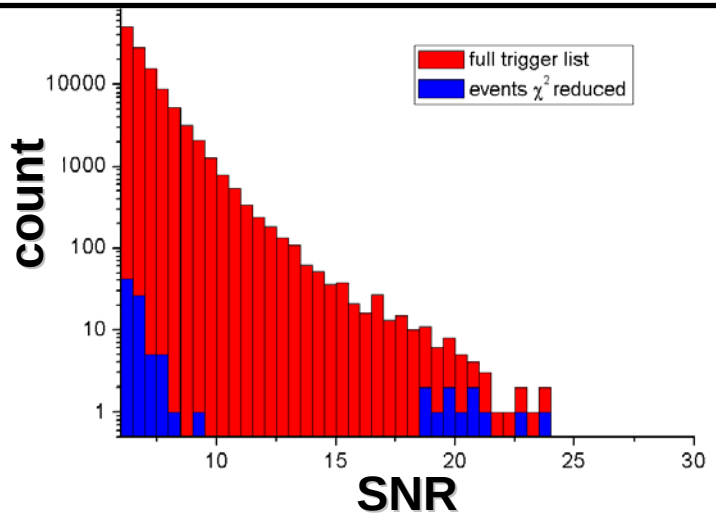
WSR Hardware Injection: Detection and Chi2 veto

WSR6 (Mbta)



WSR5 (Merlino)





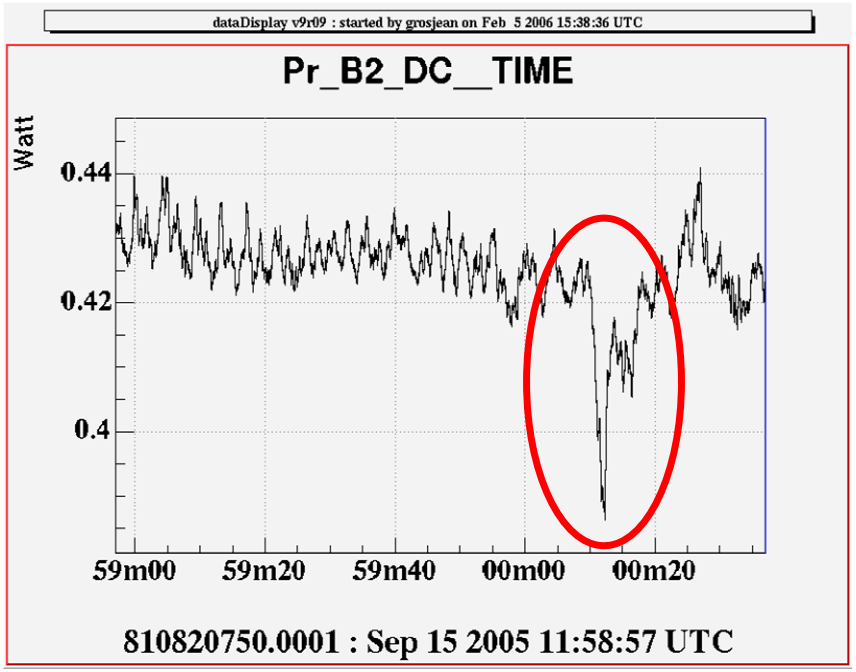
Veto

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:

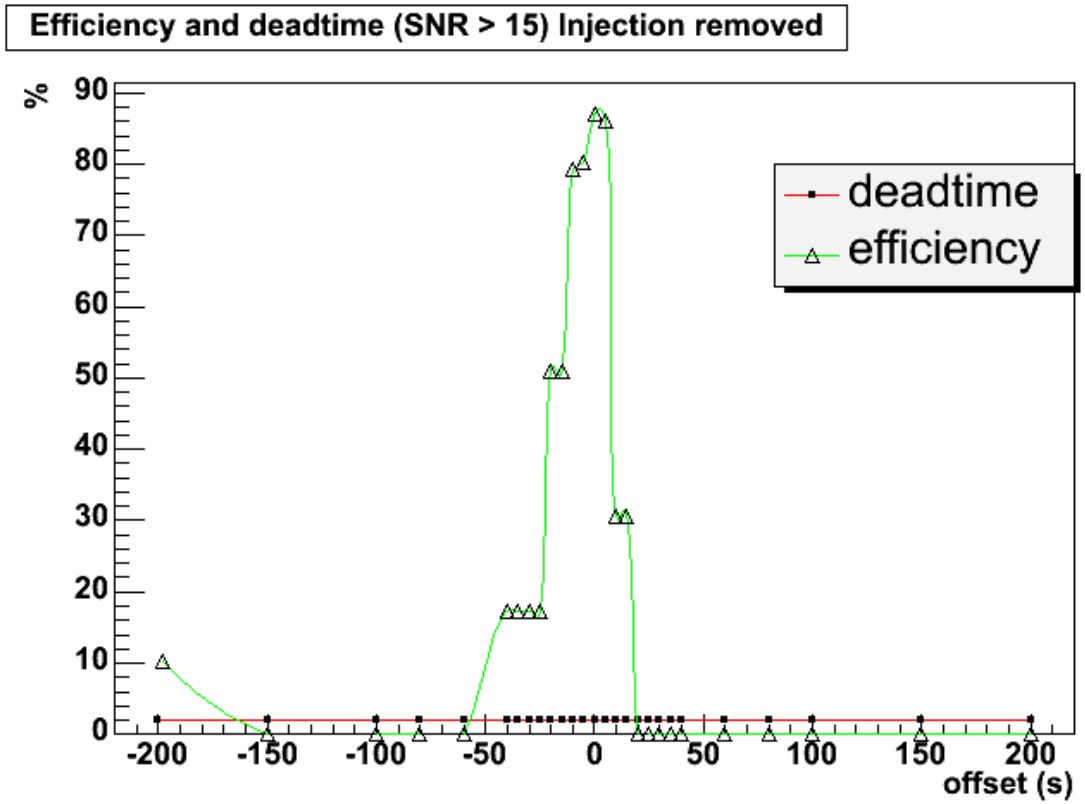
- Remove high SNR triggers
  - Power variation in cavities: e.g. B2
- We follow the mean and RMS behavior of Pint_B2



- Comparing RMS with a reference value, we flag a period as: beginning of noisy period

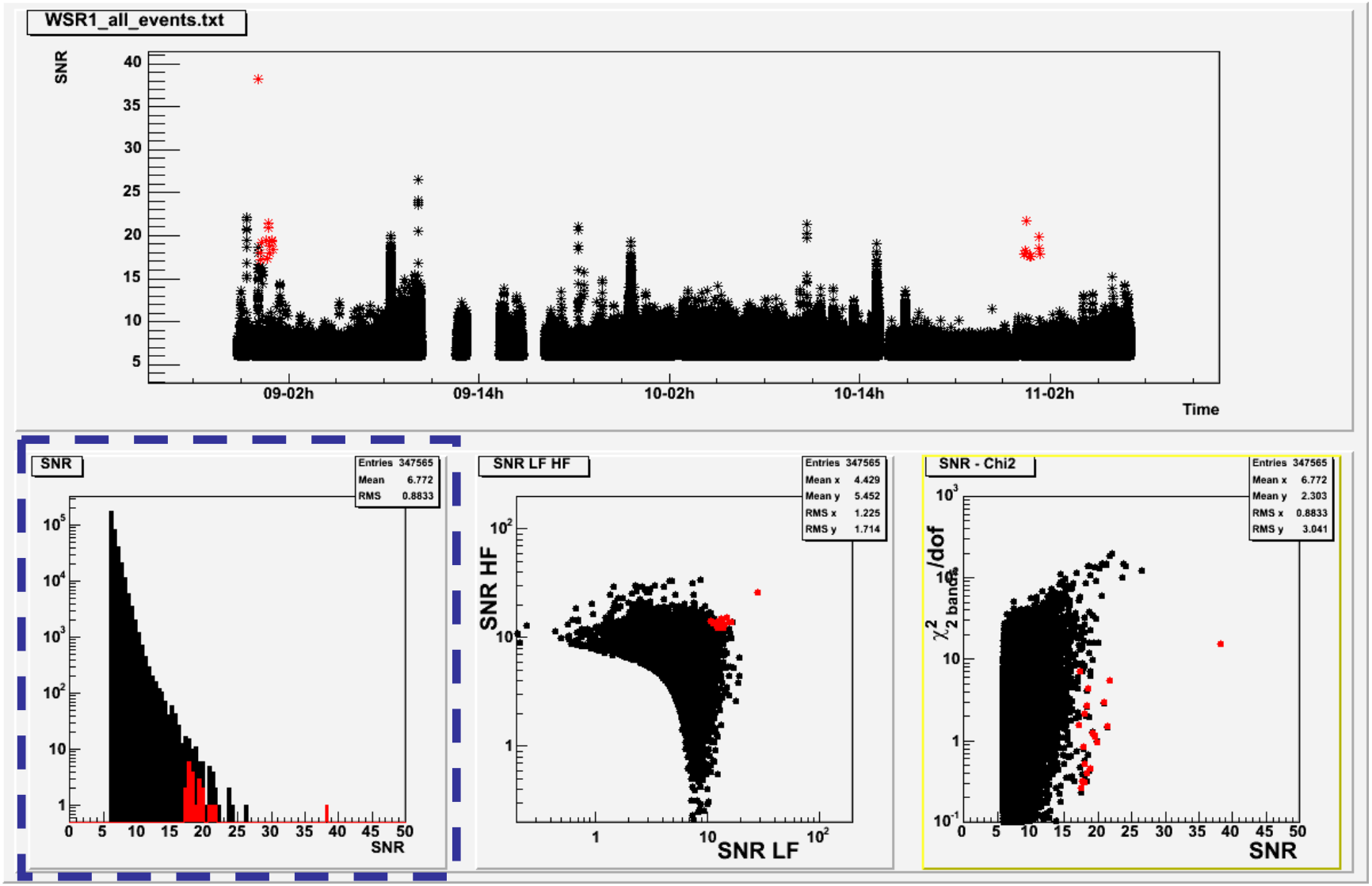
WSR1 and B2 Veto efficiency

- 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

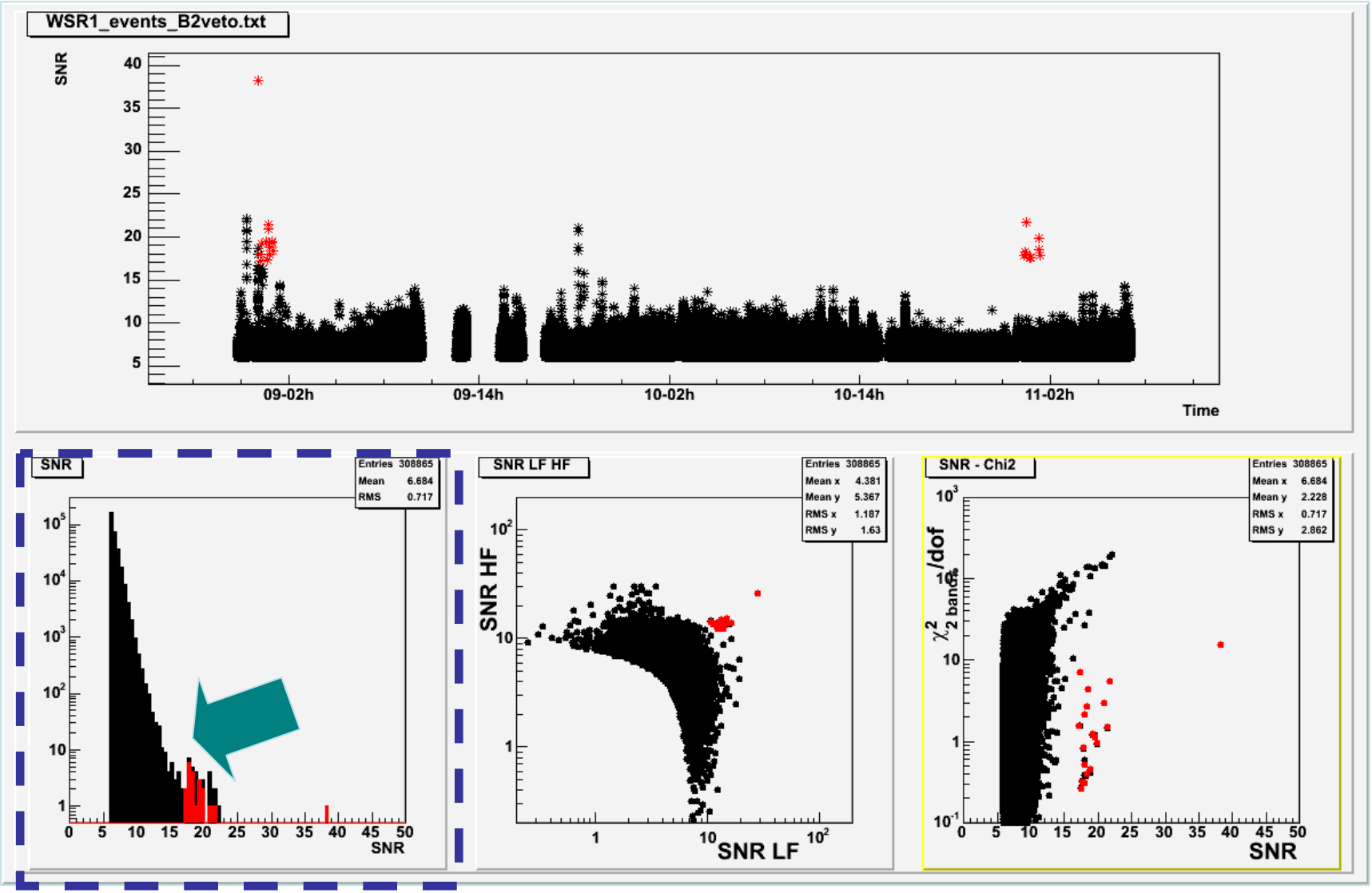


we are not randomly excluding events.

B2 Veto applied on WSR1 data
The original data set

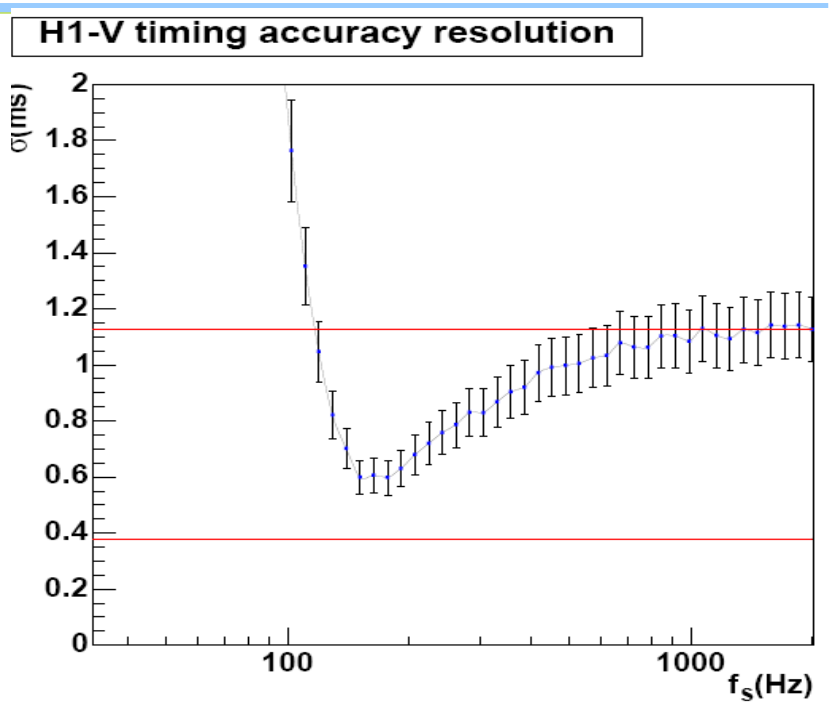


B2 Veto applied on WSR1 data
The data set after the B2 veto



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)



"timing accuracy variation between H1 and Virgo as a function of the reference frequency fs"

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

Poster Session ***D.Grosjean***

Network Analysis: Coherent Analysis (poster)

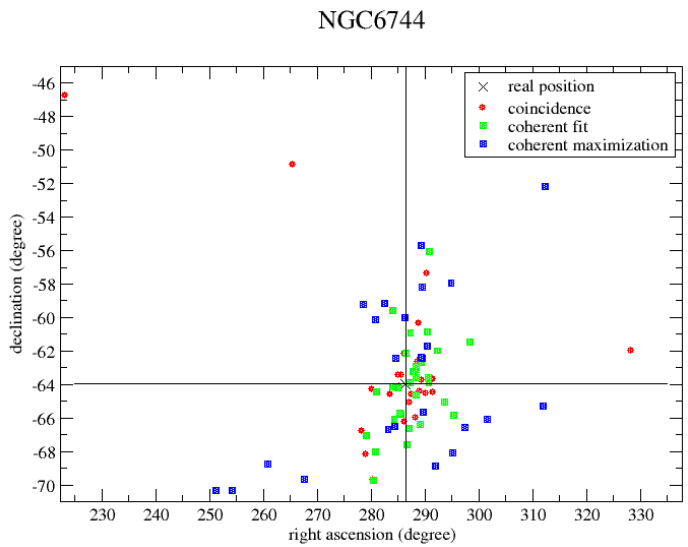
- In order to start a gravitational wave sky-map, it is important the accuracy in the source parameters estimation
- There are two different methods to analyze network data and extracting stellar parameters:

1) Compare event list, searching from a compatible ones on each detector

→ **Coincidence Analysis**

2) "construct" an ideal detector equivalent to the network, to which each real detector coherently contributes

→ **Coherent Analysis**



Poster Session ***S. Birindelli***

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**