Tools for noise characterization in Virgo

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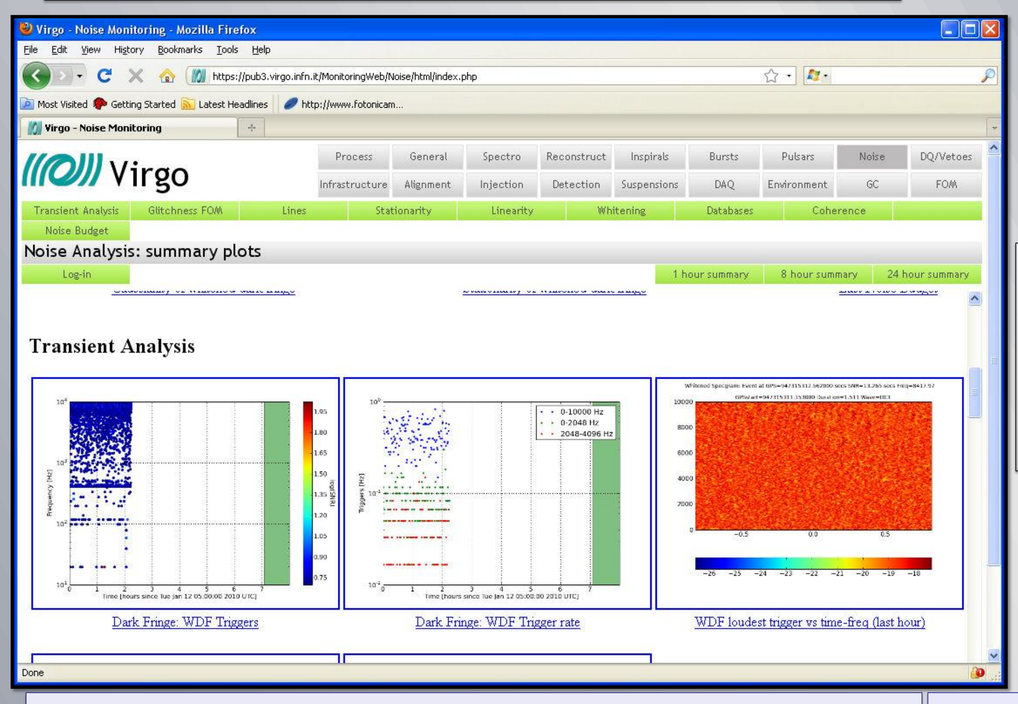
In July 2009 Virgo has started its second science run (VSR2), in coincidence with LIGO's run S6. Several tools were used to perform on-line and off-line noise analysis, to monitor the rate of glitches, the occurrence of non stationary noise, the presence of environmental contributions, the behavior of narrow spectral features and the coherence with auxiliary channels as a support to commissioning activities.
We will report about the use of these tools to study the main sources of identified noise: broadband, spectral lines and glitches.
Plans for the upgrade of the tools will be presented, for example for lines identification purpose to let the shifters do noise characterization.

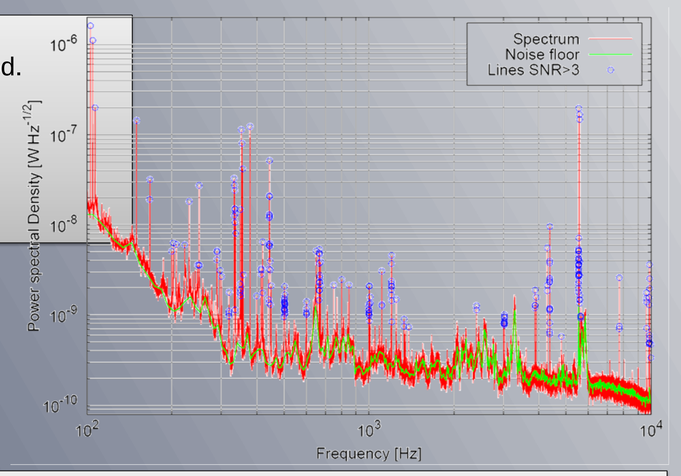
Before VSR2 we setup up tools to monitors on line the Data. Plots are produced and web pages automatically updated.[1]



The idea was to have tools which, looking either at on-line or off-line data, produce results and plots which could be archived on files or mysql database.
We aim to give to Scientists on shift and Commissioning people instruments to easily catch a snapshot of the noise behavior.
We monitored:

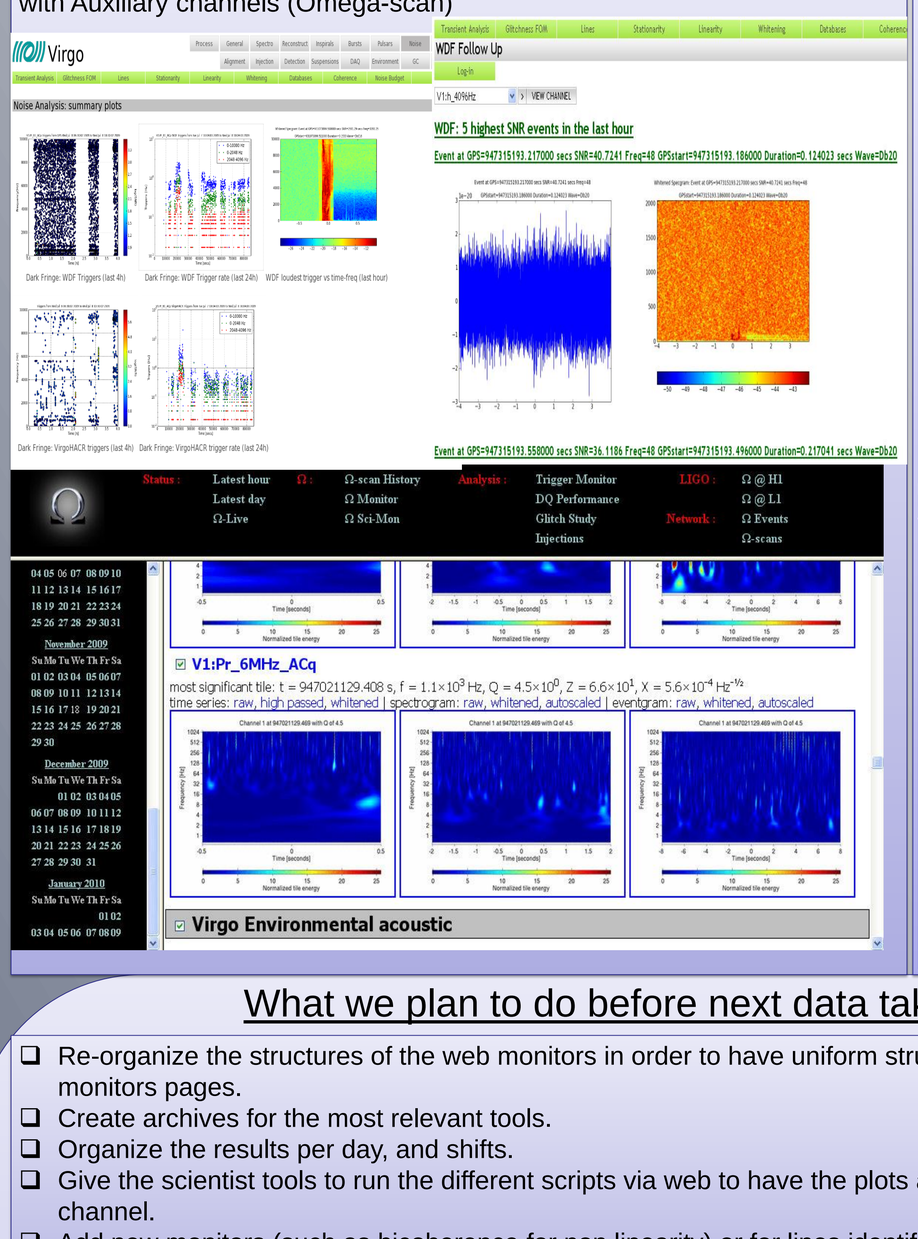
- Glitchness (several transient signal detection tools):WDF [2](find excess of energy in a wavelet map), VirgoHACR [3](find excess of energy in a STF map), OutlierMoni [4](find excess of energy in a whitened STF map),Omega,OmegaScan[5]
- Stationarity rms in band, spectrograms[6]
- Coherence with auxiliary channels

Lines (spectral peaks monitor)[7]:
Compute averaged PSD of dark fringe using Welch periodogram method.
Usually over 5 minutes of data, averaging 5 times.
Frequency resolution about 8 mHz.
Estimates the background: it starts from all local maxima of the PSD.
Define SNR as peak value over background value in the same bin.
Select only those with SNR>4. Cluster neighboring peaks.

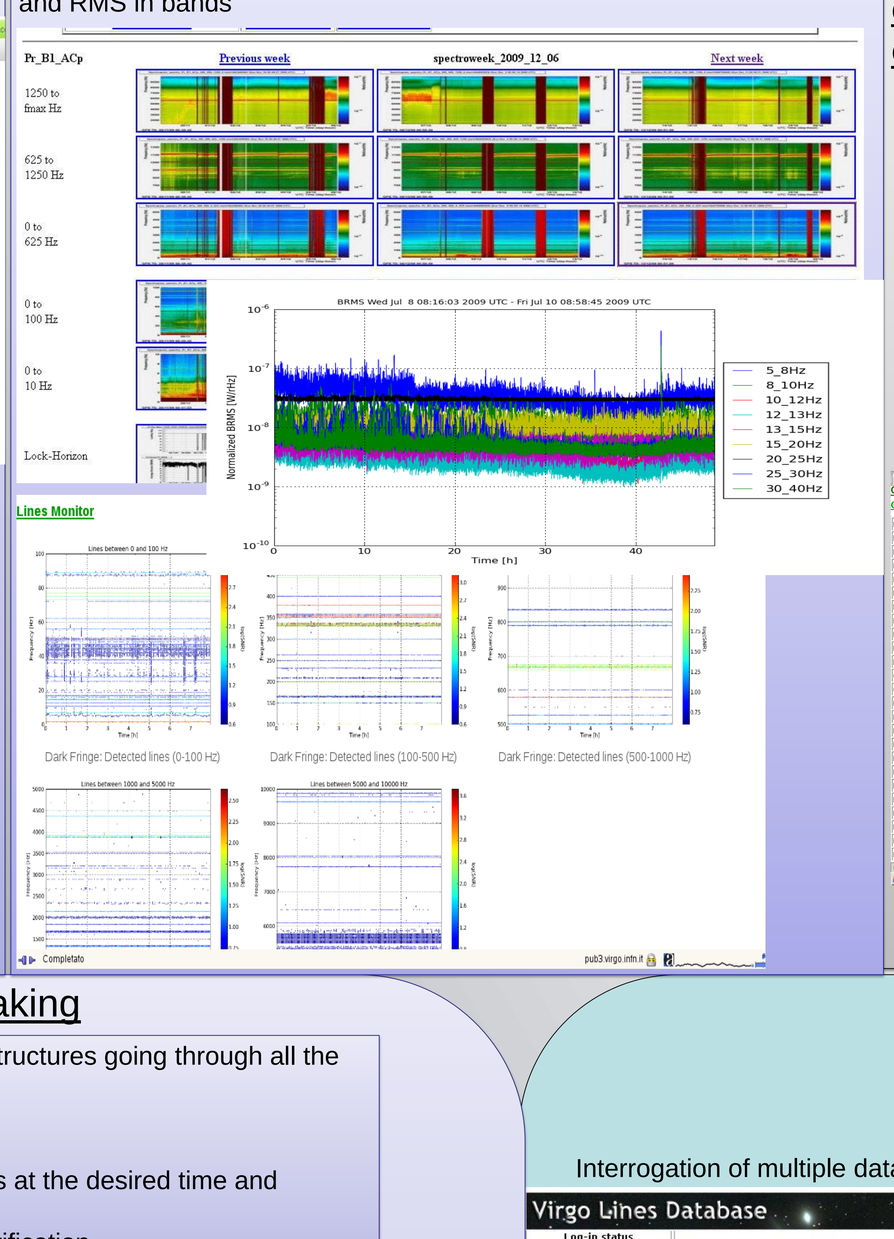


Existing tools

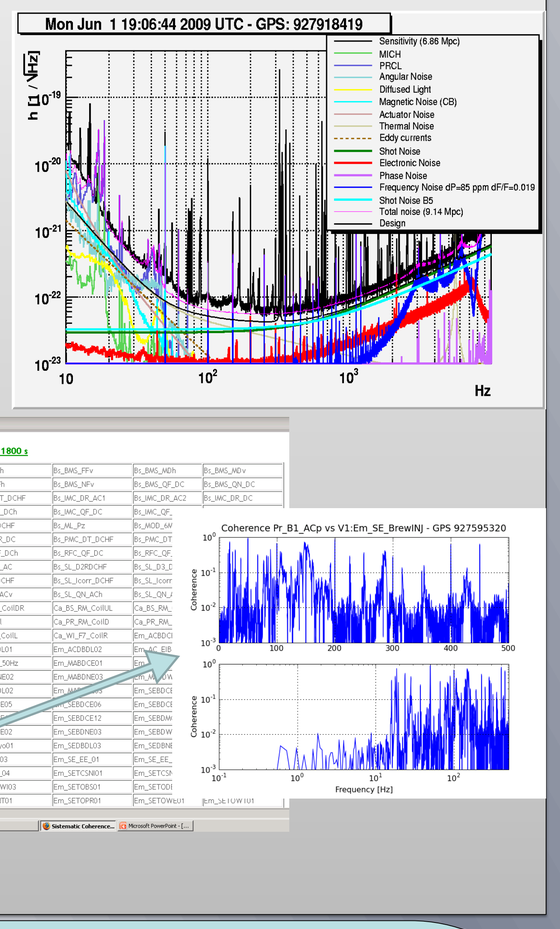
Glitchness: Monitor for glitches rate, high SNR events, coincidence with Auxiliary channels (Omega-scan)



Stationarity: lines identification and behaviour, time-frequency map and RMS in bands



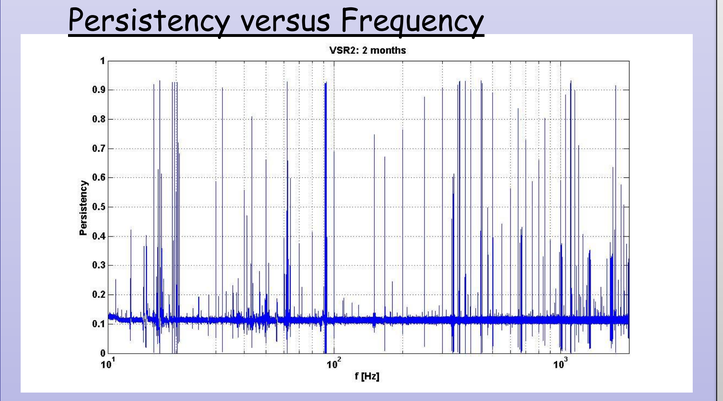
Automatic Noise Budget estimation and coherence between GW signal and auxiliary channels



What we plan to do before next data taking

- ❑ Re-organize the structures of the web monitors in order to have uniform structures going through all the monitors pages.
- ❑ Create archives for the most relevant tools.
- ❑ Organize the results per day, and shifts.
- ❑ Give the scientist tools to run the different scripts via web to have the plots at the desired time and channel.
- ❑ Add new monitors (such as bicoherence for non linearity) or for lines identification.
- ❑ We plan to use the pulsar group software for the monitor of the lines on auxiliary channels with a better frequency resolution[7]

Persistency versus Frequency

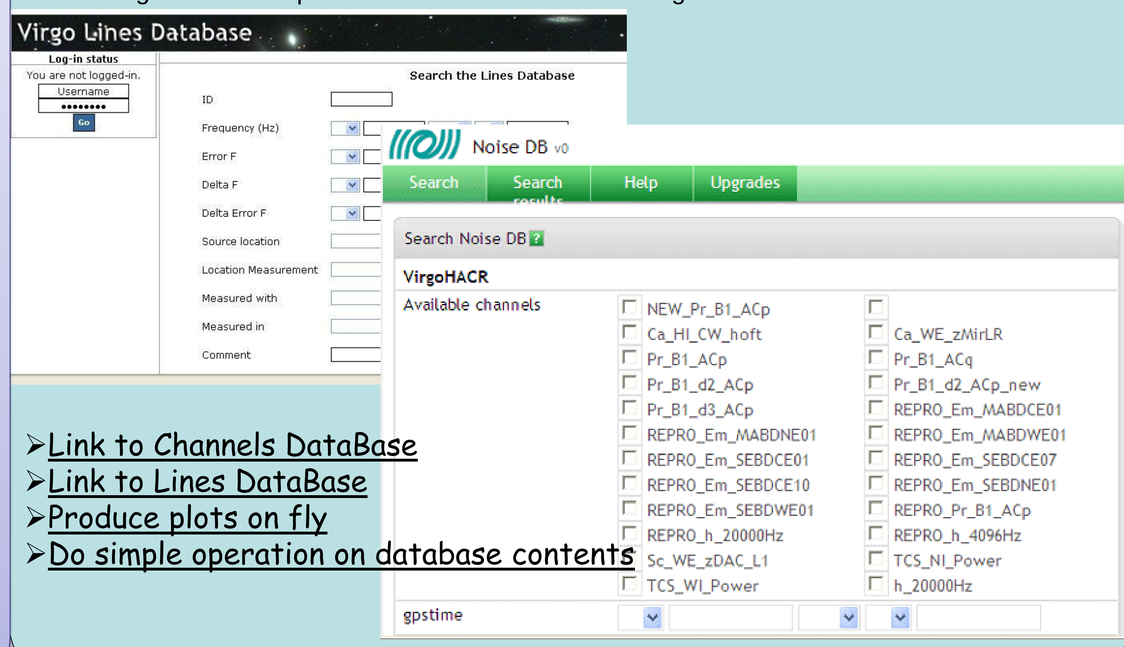


Freq. (Hz)	Persistency	Comment
16,32,64	~.9->.4	B2 digital camera
30,40,60,70,80, 110,120,210,270, 290,490,510,520, 530,580,590	~.55-><0.1	"old" ADC board
25.2	.19	2 broad lines
25.915	.15	
27.9	.2	broad line
30.835	.2	
33.314	.21	
34,35,36,38,39,41	<.15	likely "old" ADC board

We plan to archive results like these
In mysql database in-time during data taking

Noise DataBase Interface[8]

Interrogation of multiple database sources to form single coherent result resource.



- ➢ Link to Channels DataBase
- ➢ Link to Lines DataBase
- ➢ Produce plots on fly
- ➢ Do simple operation on database contents

References:
[1] https://pub3.virgo.infn.it/MonitoringWeb/Noise/html/
[2] VIR-NOT-EGO-1390-308
[3] VIR-0002A-08
[4] VIR-0284A-05
[5] http://wwwcascina.virgo.infn.it/DataAnalysis/Burst/wonline/V1/index.html?latest_day
[6] VIR-004A-08
[7] VIR-0714A-09
[8] VIR-0024A-10