First low frequency all-sky search for continuous gravitational wave signals (target: PRD)

In this paper we present the results of the first low frequency all-sky search of continuous gravitational wave signals conducted on Virgo VSR2 and VSR4 data. The search covered the full sky, a frequency range between 20 Hz and 128 Hz with a range of spin-down between -1.0×10^{-10} Hz/s and $+1.5 \times 10^{-11}$ Hz/s, and was based on a hierarchical approach. The starting point was a set of short Fast Fourier Transforms (FFT), of length 8192 seconds, built from the calibrated strain data. Aggressive data cleaning, both in the time and frequency domains, has been done in order to remove, as much as possible, the effect of disturbances of instrumental origin. On each dataset a number of candidates has been selected, using the FrequencyHough transform in an incoherent step. Only coincident candidates among VSR2 and VSR4 have been examined in order to strongly reduce the false alarm probability, and the most significant candidates have been selected. The criteria we have used for candidate selection and for the coincidence step greatly reduce the harmful effect of large instrumental artifacts. Selected candidates have been subject to a follow-up by constructing a new set of longer FFTs followed by a further incoherent analysis, still based on the FrequencyHough transform. No evidence for continuous gravitational wave signals was found, therefore we have set a population-based joint VSR2-VSR4 90% confidence level upper limit on the dimensionless gravitational wave strain in the frequency range between 20 Hz and 128 Hz. This is the first all-sky search for continuous gravitational waves conducted at frequencies below 50 Hz. We set upper limits in the range between about 10^{-24} and 2×10^{-23} at most frequencies. Our upper limits on signal strain show an improvement of up to a factor of ~ 2 with respect to the results of previous all-sky searches at frequencies below 80 Hz.

- Motivations for this search:
  - ITF data never analyzed below 50 Hz for all-sky CW searches;
  - Good VSR2/VSR4 sensitivity below ~80 Hz;

Cristiano Palomba – INFN Roma

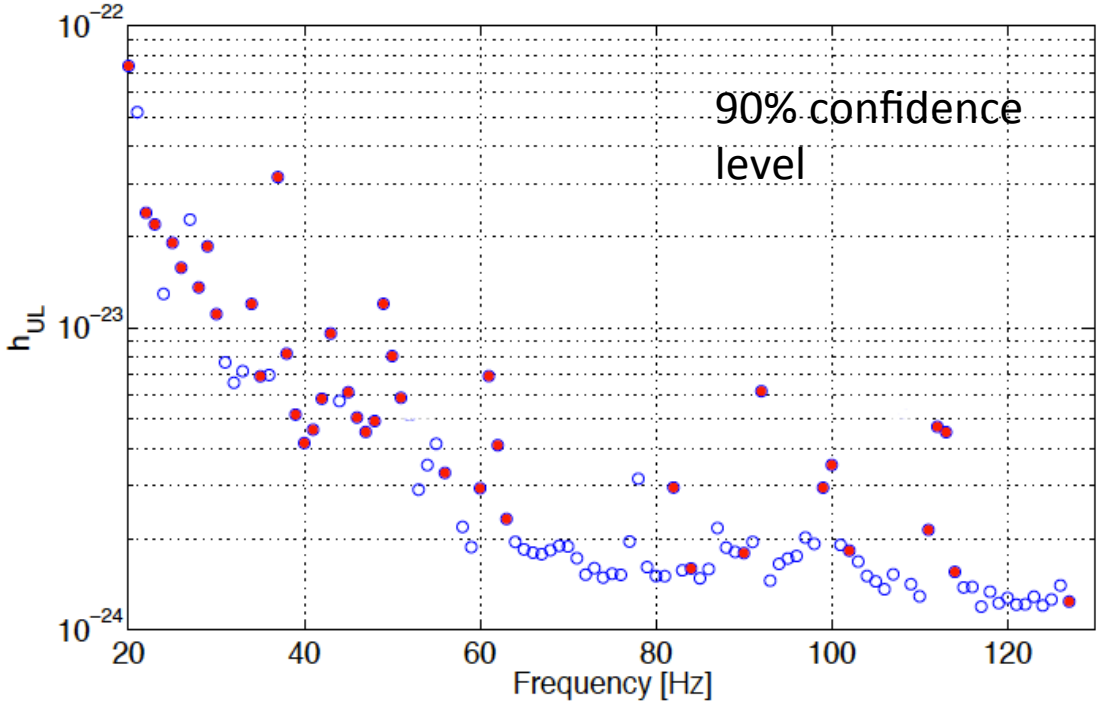

FIG. 18: Joint VSR2-VSR4 upper limit on dimensional strain as a function of the frequency. Open circles refer to upper limits vslues valid over the full corresponding 1 hz band, while filled circles refer to upper limit values valid only in a portion of the corresponding 1 Hz band.

- First upper limits ever for CW searches below 50 Hz
- Improvement up to a factor of 2 with respect to past all-sky searches below about 80Hz.

- Astrophysical reach of the search

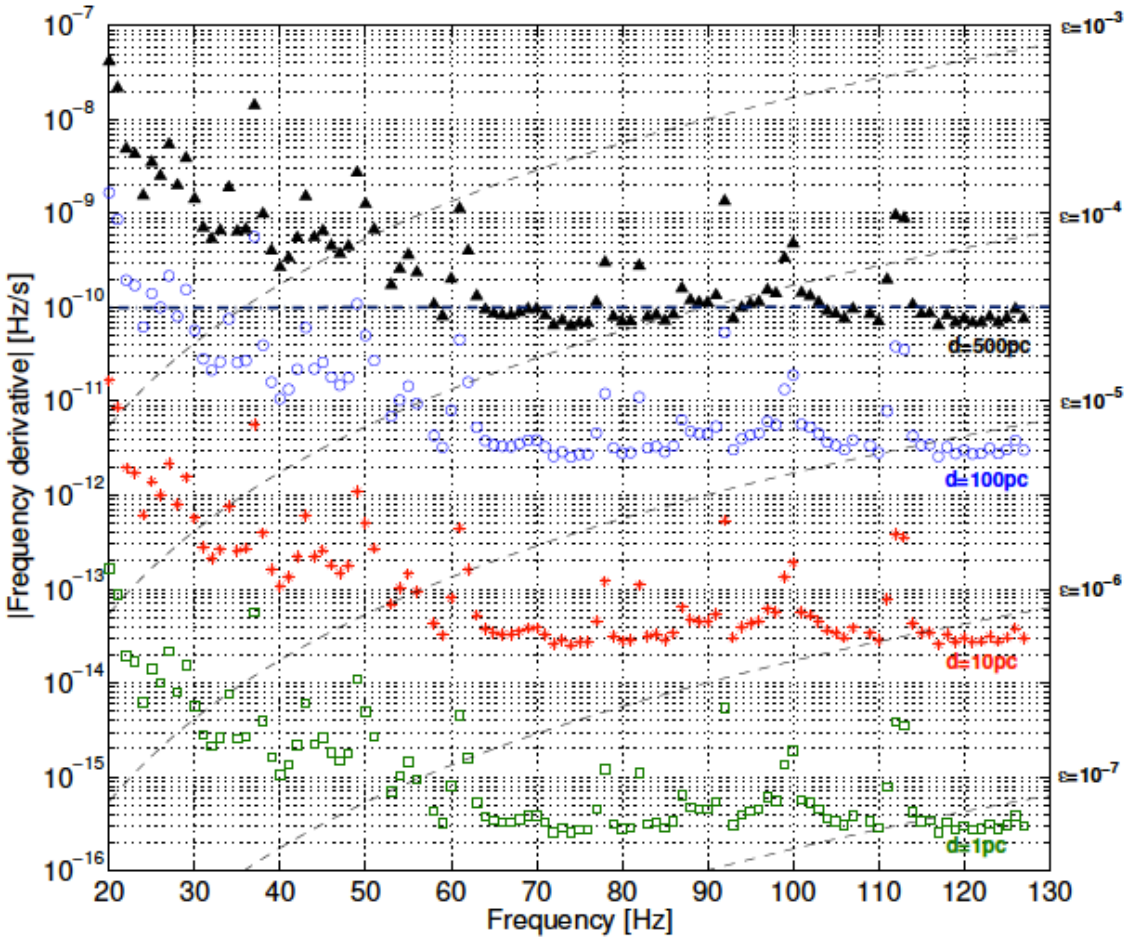

FIG. 13. Astrophysical reach of the search. The sets of points gives the relation between the frequency derivative and the frequency of a signal emitted by a detectable source placed at various distances. The triangles correspond to a distance of 500 pc; the circles to a distance of 100 pc; the stars to a distance of 10 pc and the squares to a distance of 1 pc. The dashed lines represents lines of constant ellipticity. The horizontal dot-dashed line indicates the maximum spin-down values searched in the analysis.

- We ask for including two students in the author list: **Matteo Di Giovanni** and **Simone Mastrogiovanni**.

- Matteo has contributed to the analysis and in particularly to the choice of a reasonable threshold for the coincidence distance.

- Simone has contributed to generalize the re-sampling procedure (used in the follow-up) and significantly speed-up the follow-up procedure