Status Report of the Gravitational Wave Detector AURIGA

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Abstract. We present the status of the ultracryogenic gravitational wave detector AURIGA, which is taking data since may 1997 with an energy sensitivity in the mK range and bandwidth greater than 1 Hz. The typical detector output is summarized in daily reports which are important tools for detector diagnostic and for checking the vetoes of periods of unsatisfactory operation of the detector.

THE AURIGA DETECTOR

The ultracryogenic gravitational wave detector AURIGA [1] is data taking since May 1997 [2]. The recorded data cover a fraction of about 80% of the elapsed time. The rest of the time has been employed for detector ordinary (He4 main bath refill and 1K-pot filling) and extraordinary (cryogenic or electronic failures) maintenance or for calibration operations. An automatic vetoing procedure [3] is applied to the data in order to select the time periods when the detector noise is almost Gaussian and stationary and the assumption of a two mode system dynamics is accurate. The resulting overall duty cycle is of the order of 25%. However it could be consistently increased once filtering procedures are able to handle the presence of spurious peaks appearing around the two relevant modes.

The acquired data are summarized in daily reports which cover the detector noise, the analysis output, the efficiency of the filter adaptive procedure, the vetoes and the monitor of ambient disturbances (seismometers). These reports are consulted for the certification of the AURIGA events list before sharing these data with the

IGEC [4] collaboration.

Recent Improvements and Current Performances

During the data taking period many attempts have been performed to increase the duty cycle and improve the sensitivity. In cryogenic circle a continuous liquid helium transfer from an external dewar with a capacity of 3500 liters to the main AURIGA cryostat has been implemented. This operation does not affect the detector sensitivity and increases helium consumption by less than 10%. The liquid helium refill procedures are thus reduced to one external dewar substitution each $20 \div 25$ days. Many attempts to continuously fill the 1K-pot has been also performed: in this case the filling procedures turn out to be very noisy unless the liquid level in the pot ranges in a very narrow interval. In order to keep the level almost constant in time we are developing a computer controlled refilling procedure.

A sensitivity enhancement has been obtained substituting the commercial room temperature electronic controls of the SQUID with an up-graded version. This model allow the SQUID noise parameters optimization without any stability problem. The resulting white noise power spectrum is $4\mu\Phi_0/\sqrt{Hz}$ at 1.8 K and $3.5\mu\Phi_0/\sqrt{Hz}$ at 0.5 K, about a factor two better than in the previous configuration. These values are approximately equal to the noise amplitude we measured for the SQUID alone in a separated bench test before the AURIGA final assembling. As a consequence of the amplifier noise improvements, the detector bandwidth increased up to about 2 Hz and the equivalent noise strain power spectrum is less than 6×10^{-21} $/\sqrt{Hz}$ in a frequency span of 40 Hz around the two modes, while the minima, at the mode frequencies (911 Hz and 929 Hz), were as low as 4×10^{-22} $/\sqrt{Hz}$.

In terms of energy the present SQUID amplifier sensitivity is about $4000\hbar$ that corresponds to a noise temperature of $T_n = 0.2$ mK. Thus according to the Giffard limit the expected detector best effective temperature should be $T_{eff} = 2T_n = 0.4$ mK while the measured AURIGA best energy sensitivity is only slightly less than 1 mK. The reason of this excess can't be attributed to the oscillators thermal noise since, by a simple estimation, the thermal contribution accounts for less than one half of the excess. The origin of this unknown noise source is still under investigation.

REFERENCES

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2. G. A. Prodi *et al.* in *Second E. Amaldi Conf. on Gravitational Waves*, edited by E. Coccia *et al.* (World Scientific, Singapore, 1998), p. 148.
3. G. A. Prodi *et al.* and L. Baggio *et al.* in these proceedings.
4. see the Web site "http://igec.lnl.infn.it".