Detector and Data Developments within GEO 600

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It is not the landscape that makes Ruthe, near Hannover, Germany, an exciting place. The site of the British-German GEO-600 gravitational wave detector is a peaceful and relaxed placed. Unlike Hanford and Livingston, which host its larger LIGO brethren, there is no danger of earthquakes or wildfires, radioactivity is low, and alligators have not been seen around for a very long time.

GEO is the first medium-scale interferometer to enter in operation in Europe. By mid 2002, GEO plans to achieve its full sensitivity. Although GEO's armlength is only 600 meters, compared to LIGO 4 km, it features advanced mirror suspensions and optics which, by the way, are planned to be incorporated into advanced LIGO. The use of such advanced technology makes GEO design sensitivity almost comparable to initial LIGO, and therefore it has reasonable chances of detecting gravitational waves (especially from compact binary inspirals, neutron stars and supernova events). Moreover, GEO will be unique among the first interferometers in being able to operate in narrow-band mode which will give it a better sensitivity to continuous, nearly periodic signals than the larger projects (LIGO and the French-Italian VIRGO) would have in the selected band.

While getting closer to completion, 2001 has been an intensive year for GEO. Detector and environmental data have been produced continuously throughout the year. GEO generates on the order of 50 GBytes of data per day, which are stored using a data format fully compatible with LIGO and VIRGO. In addition, GEO and LIGO have become partners: they have signed full reciprocal data exchange agreements, GEO is part of the LSC (LIGO Scientific Collaboration), and they are jointly developing data analysis software. Besides, GEO is building four different computer clusters at AEI-Golm, Birmingham, Cardiff and Hannover where the different data analysis tasks are to be performed.

In February 2001, a workshop took place in Ruthe and gave the main kick to GEO Detector Characterization (DC) activities. Those who attended realized that the site is cold in winter, especially if you need to walk to the next building equipped with facilities, which highlights the enthusiasm experimentalists are putting in bringing the interferometer to work. Later on, in June, another GEO-DC workshop took place, but this time at AEI-Golm. On that occasion, the need of the DC-Robot, as an efficient automated system to characterize the data, and its interaction with a database were pushed forward.

Another effort, largely invisible to outsiders, is the analysis of GEO data. With the aim of gaining a better understanding of the detector behavior and its environment, data from environmental monitors, e.g., seismometers, magnetometers, and, of course, from the detector itself are being analyzed. As the the detector status has been progressing, data analysis activities have turned more complex and organized. After the summer, different subgroups focused their attention to the commissioning of different detector subsystems. Of particular interest was the GEO engineering run that took place in October 15-18, 2001. The mode-cleaners were in almost final configuration and the Michelson was

locked on mid fringe with no power recycling. This run was a success, shift scheme and data transfer Ruthe-Hannover-AEI were exercised, and the long term behavior of the whole system was tested.

As in any other project, GEO has overcome many hardships, some of them unexpected. At the end of October, data acquisition at the north-end station was interrupted for several days because mice had eaten too many optical fibers. This time, new fibers with a 40 year guarantee of mouse-proofness were ordered to give us the upper hand in the fight.

From November onwards, a big effort was devoted to lock the Michelson on a dark fringe and incorporating the power recycling cavity. In parallel, a deep analysis of the detector subsystems (geophones, laser power, magnetometers, mode-cleaners, etc) has taken place. To keep track of the detector and data acquisition status, GEO detector database is available via a web interphase. This includes also signal descriptions, calibration information, data viewer, and two electronic labbooks (GEO-600 and GEO-DC) actively used by both experimentalists and theorists.

It is worth mention, although not being a gravitational wave detection, GEO first astronomical observation has already occurred. The geomagnetic storm due to two fast moving coronal mass ejections on November 22, 2001, was observed in the GEO magnetometers as expected in November 24 data.

The last thing I want to mention and most exciting one, is the coincidence run with LIGO. Both LIGO and GEO detectors were on operation from December 28th until January 14th. The run was a great success. GEO had a duty cycle of about 80%. For some days the power-recycled interferometer was in lock for more than 95% of the time. The longest continuous lock segment was of 3h 48min. Monday 14th was a day for celebration in Ruthe with all the operators and people that participated in the shifts. We really got very good data!

During the run other events took place. For example, on January 2nd, the waves from an earthquake near Australia (Vanuatu Islands, magnitude 7.1 on the Richter scale) hit GEO. The interferometer lost lock, but it was realigned and locked automatically from then on. Almost all the earthquakes worldwide, with a magnitude bigger than 4.5, can be seen on our seismometer data but often do not influence the detector output so much. In the data (e.g., from the feedback to the intermediate masses) we can clearly see the influence of the moon with a period of 12.4h, and our magnetometers continue recording information of the Sun-Earth environment. With the gravitational wave data taken from this coincidence run we hope to be able to set astrophysical upper limits on different gravitational wave sources.

Pay attention to the next Matters of Gravity edition, I am sure there will be plenty of news from the gravitational wave community.

Jorge Pullin 2002-02-11