Check of the DAQ timing during O2

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Abstract

This note describes the tests made to check the stability of the Virgo timing during the O2 run.

Summary

1 The Advanced Virgo timing system

The GPS receiver is producing a 10 MHz clock plus the GPS signal encoded in the IRIG-G signal used to time stamp the data. Both signals are produced by a single GPS receiver and distributed all over the site, using the timing distribution system (see VIR0073B-08), to all devices used for the control of the interferometer.

2 Checking the main GPS receiver versus the spare GPS receiver.

Two GPS receivers are installed in the DAQ room. One is used as a master GPS receiver, and the other one as a backup receiver. The IRIG-B signal of both receivers are send to the DAQ system and recorded as channel of the "raw_full" stream (a circular buffer with a lifetime of a few days) but are not part of the regular raw frame archived during the O2 run.

When they have been installed, they both have been compared to the old VME GPS receiver that was successfully crosschecked with the LIGO GPS receiver.

After the run, we compared again the two GPS receivers on two different days (see Figure 1) and they both agree, having the same offset of 16 us since one is the direct IRIG-G signal and the other one is delayed by 16 us by the optical fiber of the timing distribution. Therefore we can say that they produce the same timing within a few us.

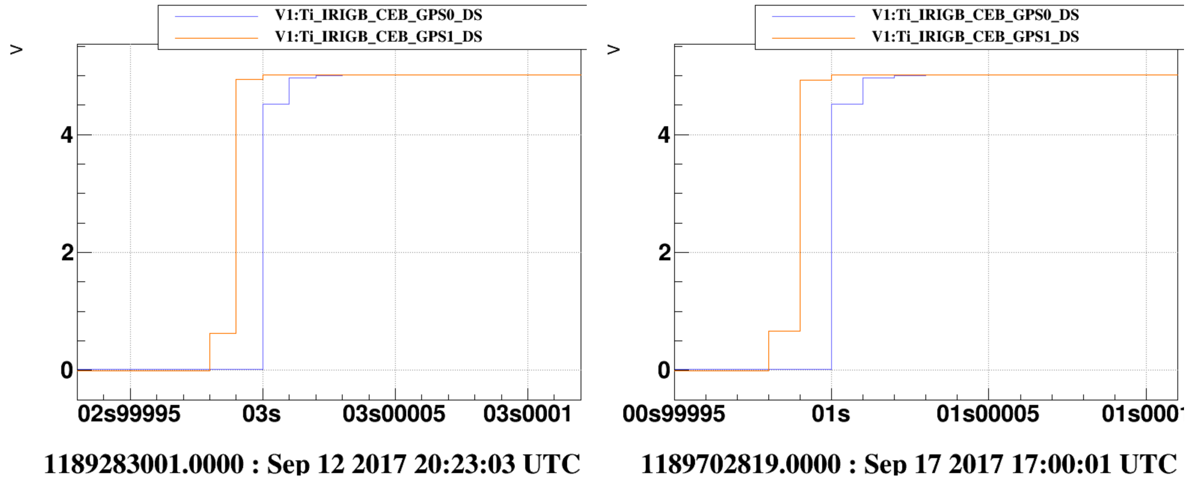

Figure 1 Zoom on the start of the IRIG-B signals of the master GPS receiver (blue) and backup GPS receiver (red) monitored by the DAQ system.

3 Checking the stability of the timing 10 MHz signal

A free running atomic clock is available in the DAQ room. This clock is producing another 10 MHz signal that is digitally demodulated to monitor its phase relative to the timing system. This signal (V1:DAQ_Atomic_Clock_phi) has been recorded during the full O2 run. Figure 2 is presenting about an hour of these data.

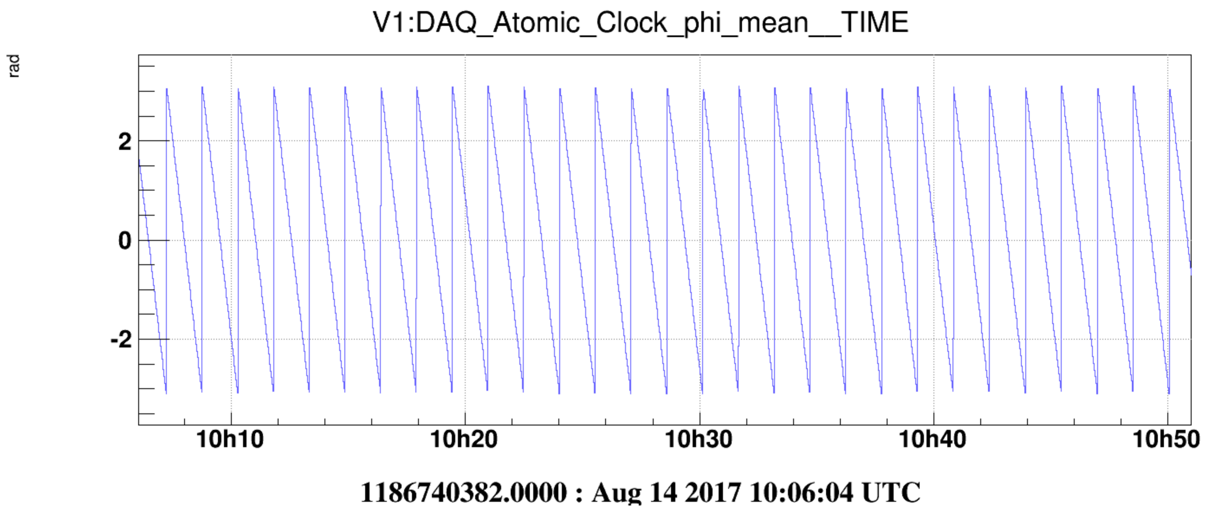

Figure 2 Example of the trend data of the10 MHz atomic clock phase relative to the timing system

By integrating this phase over time and removing the jumps between -pi and + pi, we can search for glitches in the timing system. Figure 3 is presenting this signal after having removed a linear drift of 1.102 ns/s since the atomic clock was not exactly calibrated. This drift was measured between September 12 and September 17 (using the same times as in Figure 1). One can see that 10MHz clock of the Virgo timing is stable within +- 13 us during O2. The stability is probably better since this value is likely limited by the fluctuations of the atomic clock.

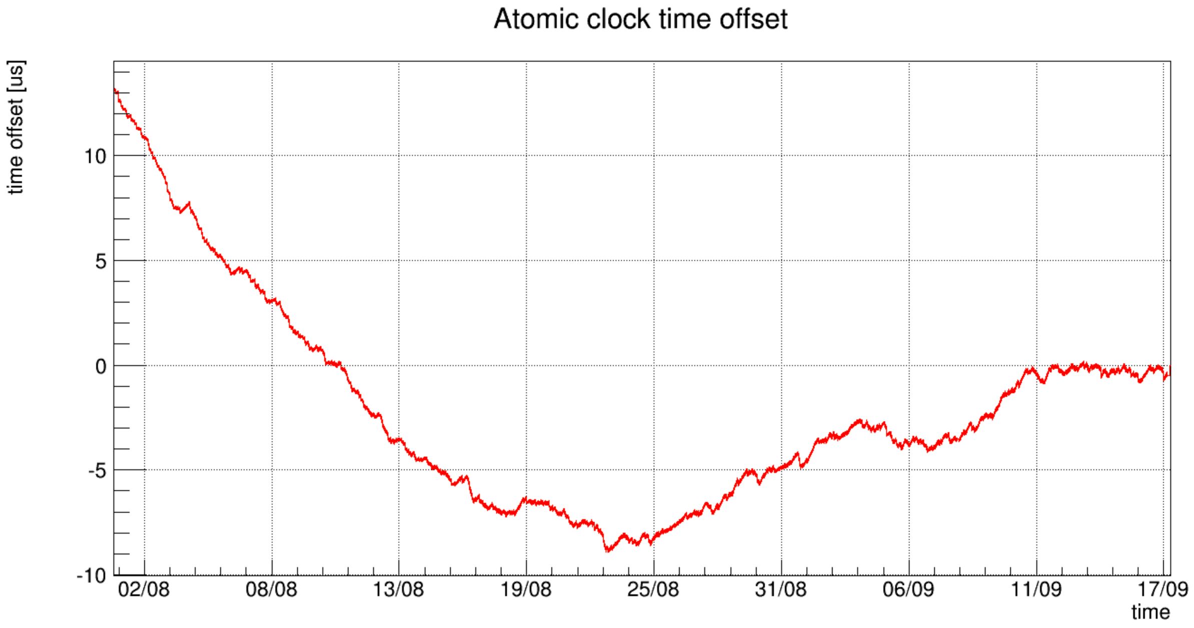

Figure 3 Atomic clock time offset after subtracting the linear drift.

4 Stability of the IRIG-B signal relative to the 10 MHz

The main photodiode ADC's are located in DAQbox that are slaved to the 10 MHz timing signal. They are also receiving the IRIG-B signal and every second they are monitoring the time offset between the start of the IRIG-B frame and a local counter derive from the 10 MHz clock.

Figure 4 is showing this offset for the DAQbox monitoring the atomic clock and for the DAQbox of the dark fringe photodiode. The same fluctuations are observed on the two DAQbox because the offset between the IRIG-B signal and the 10 MHz is due to the GPS received. On the basis of this plot, we can state that the IRIG-G signal is stable (versus to timing 10 MHz) within +- 200 ns during O2, a much smaller number than the check of stability of the 10 MHz clock by the atomic clock. This check is not just a consistency check of the GPS receiver, but also the check that no samples of the 10 MHz timing clock is lost by the timing distribution.

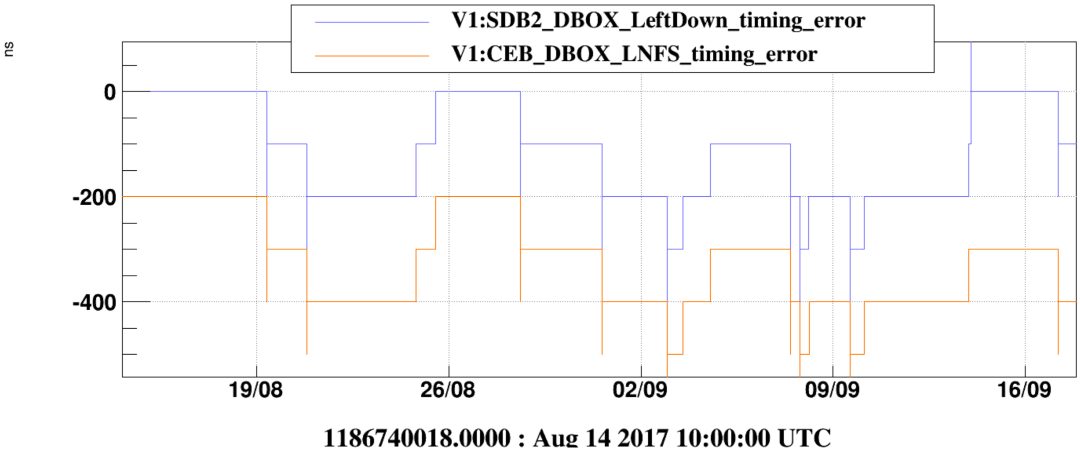

Figure 4 Time difference between the start of the IRIG-G frame and the DAQbox internal clock for the dark fringe photodiode DAQbox (blue) and for the atomic clock DAQbox (red)

5 Check with NTP

A coarse check of the timing system could be made using the NPT service. The front-end frame builder for the SDB2 bench (which is hosting the dark fringe photodiode) is measuring the latency of the frame production using its internal clock slave on a NTP server. Therefore, this is a direct measurement between the IRIG-B signal and an independent clock slave on NTP.

Figure 5 is presenting this latency for a few front-end frame builders. This latency has been averaged over bin of 1000 seconds to remove the local fluctuation. It includes the 1s frame duration and the time to build/compress the frame (typically 0.12 to 0.16 s). The fluctuations at the level of up to 10 ms are usually correlated, suggesting that they are due mostly to the NTP service, which is anyway not expected to be very accurate.

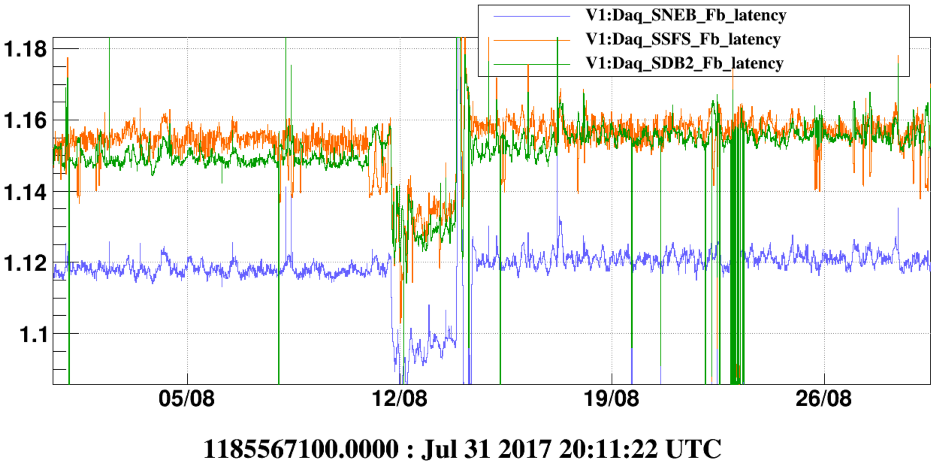

Figure 5 Latency of a few front-end frame builders. Vertical unit is seconds.