TimeBox: A standard device for timing astronomical occultations

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Abstract

The TimeBox is used to synchronize the internal clock of PCs / Servers and to date digital video recordings with absolute universal time (UTC).

The TimeBox has been designed to allow precise timing of astronomical phenomena using **digital video cameras**. The TimeBox has been **validated**[1] and is commonly used in their observations by Professionals[2,3], Astronomy clubs and individual observers in France and Europe[4].

Due to its small size, robustness and accuracy the TimeBox aims to become a **standard** for timing astronomical phenomena by producing a stable and accurate time base for occultations.

TimeBox modes

The TimeBox recovers the UTC time from GPS satellites and synchronize your measures/PC in three different ways:

1. **LED firing** (Delay: < 8µsec UTC).
2. **Computer Synchronizati**on (±2msec UTC).
3. **Trigger/Intervalometer** (Jitter: ±25µsec UTC).

These modes are controlled with a **graphical** inter phase on the TimeBox proprietary software running on MS Windows 8/10 systems.

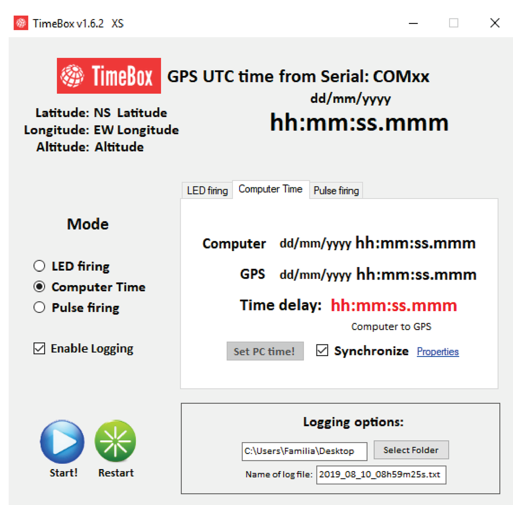


Fig. 1. TimeBox Software

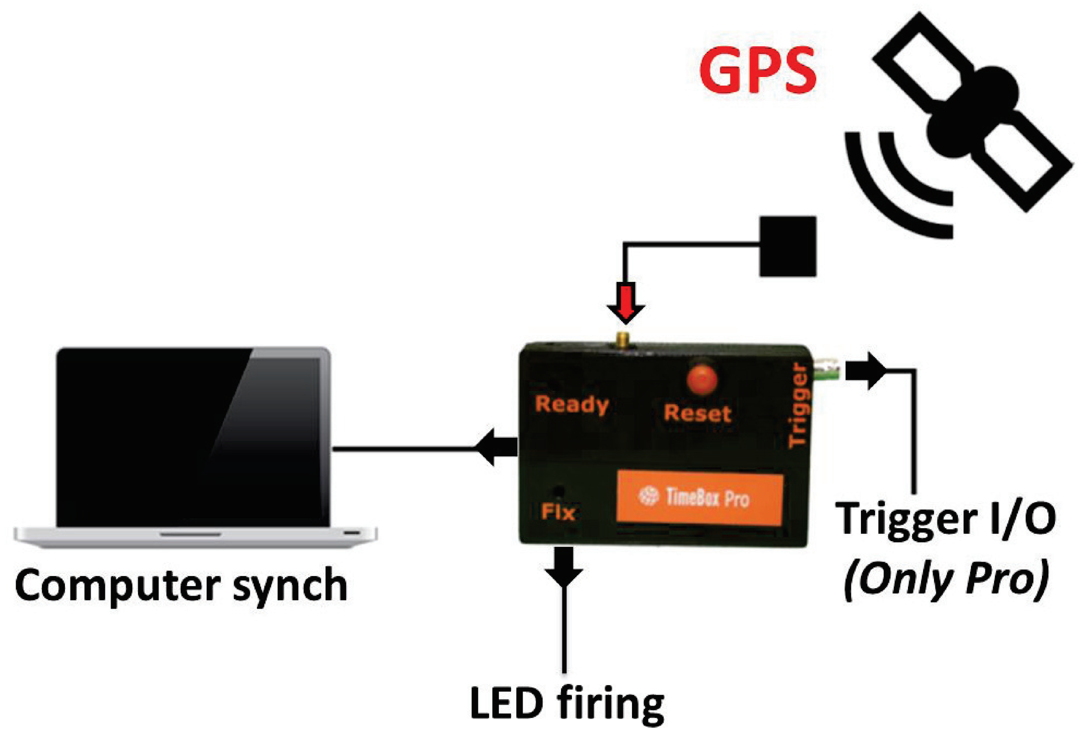


Fig. 2. TimeBox modes of synchronization

Materials and Methods

TimeBox vs IOTA-VTI/OccuRec Computer mode

OccuRec[5] was used to survey the synchronization of the internal clock of a Windows 10 64-bits system (Toshiba Qosmio F750, Intel processor i7, 8Gb RAM and Samsung EVO 850 SSD hard drive) to the Coordinated Universal Time (UTC) for 24h. The computer internal clock was permanently synchronized using a TimeBox in computer mode with default synchronization parameters. During the test, OccuRec checked the system time against a time reference provided by the IOTA-VTI. More specifically OccuRec automatically read (OCR) on the fly the inserted timestamp by IOTA-VTI in every single frame (40msec PAL) and use its time as the reference time.

TimeBox vs. SEXTA Computer mode

SEXTA[6] device was used to verify the precision of the UTC timestamp of frames recorded using a digital system. To achieve this, a Windows 10 64-bits system (described above) was permanently synchronized using a TimeBox in computer mode for at least 1 hour using default synchronization parameters. Following, the screen of a SEXTA device was recorded using a Basler 640-100gm GigE digital camera and Airylab Genika Astro[7] 64 bits as recording software. Timestamps where recovered from the image header and compared to the optical timestamp extracted using the provided SEXTAreader software.

TimeBox vs. SEXTA Trigger mode

SEXTA[6] device was used to verify the precision of the UTC timestamp of frames recorded using a camera triggered by a TimeBox (PRO version). To achieve this, a TimeBox in trigger mode was used to produce UTC TTL pulses used to trigger frames on a Basler 640-100gm GigE digital camera recording the screen of a SEXTA device. Airylab Genika Astro[7] 64 bits was used as recording software. The timestamps from the images where recovered from headers and compared to the optical timestamp extracted using the provided SEXTAreader software.

Results

TimeBox vs IOTA-VTI/OccuRec Computer mode

Around 2 million timestamps (24 hours at 25 fps) comparing the timestamp of the internal clock of a Windows 10 64-bits system synchronized with the TimeBox vs a IOTA-VTI time-base was obtained as described in Materials and Methods and Figure 3.
As shown in the Figure 6, a steady delay of 51.57 msec ± 3.60 msec for the recordings done during the first day (Figure 6, Day 1) and 51.60 msec ± 3.43 msec for the recordings done during the second day (Figure6, Day 2) was measured. This constant offset was attributed to the frame grabber delay when acquiring the IOTA-VTI timestamps.

TimeBox vs. SEXTA Computer mode

Recordings of a SEXTA screen at different frequencies were done with a digital camera controlled by a Windows 10 64-bits system synchronized by a TimeBox in computer mode, as described in Materials and Methods and Figure 4.
As shown in Figure 8, no clear tendence on the delay of the image timestamp vs the optical reading was observed in a range of frequencies around 3-70 fps (time of exposure 14-320 msec). Statistical comparison of all different recordings showed a global offset of 3.12 msec ± 1.88 msec of the image timestamp compared to SEXTA optical timestamps.

TimeBox vs. SEXTA Trigger mode

Recordings of a SEXTA screen at different trigger/firing frequencies were made using a digital camera trigged by a TimeBox, as described in Materials and Methods and Figure 5.
As shown in Figure 9, the difference of the image timestamp vs the optical reading observed in a range of 8-24 Hz frequencies were found to be estimated to 1 msec, equivalent to the precision of the SEXTA device optical display[6]. A longer recording at 10 Hz (10 minutes) was done and showed comparable results, with an overall error under 1 msec as observed in the first series of recordings between 8-24 Hz.

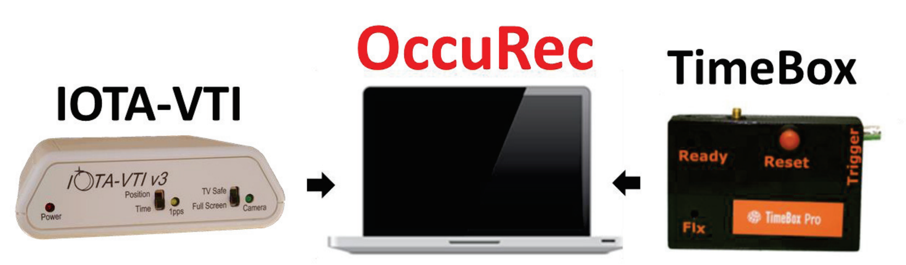


Figure 3. IOTA-VTI/Occurec vs. TimeBox computer mode

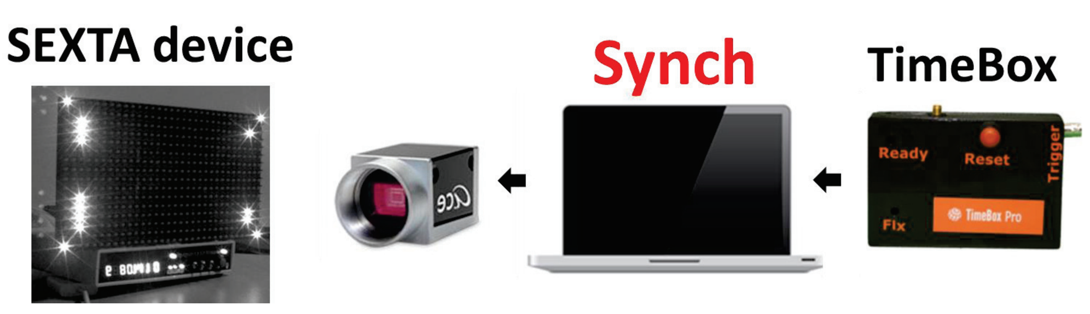


Figure 4. SEXTA vs. TimeBox computer mode

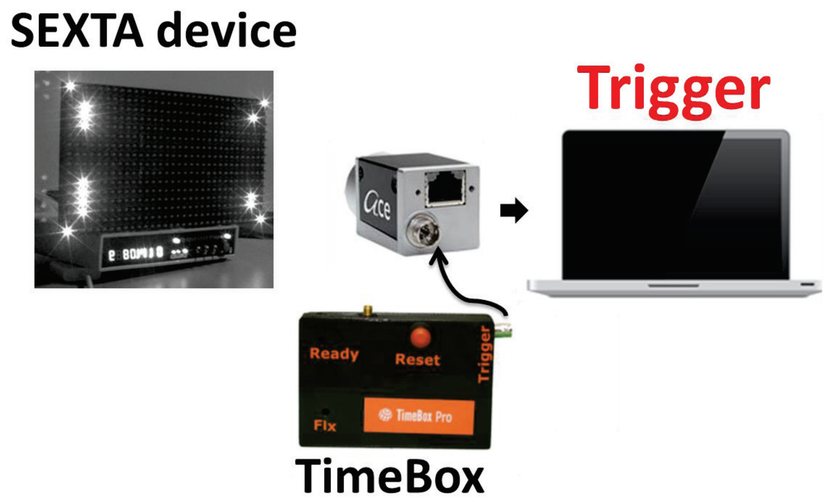


Figure 5. SEXTA vs. TimeBox trigger mode

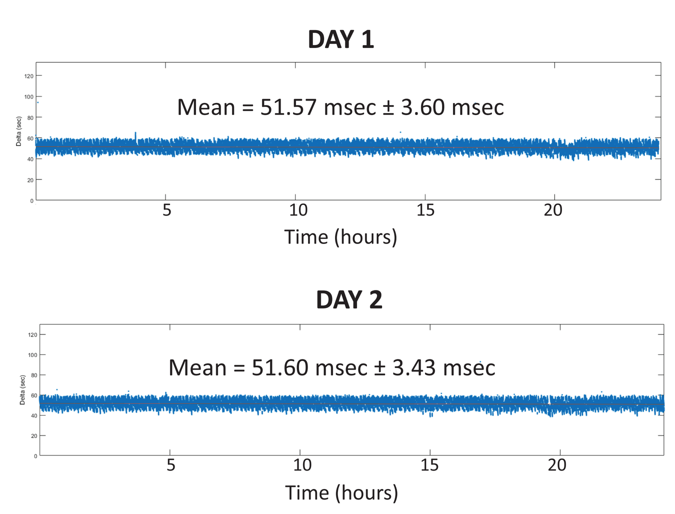


Figure 6. TimeBox vs IOTA-VTI/OccuRec

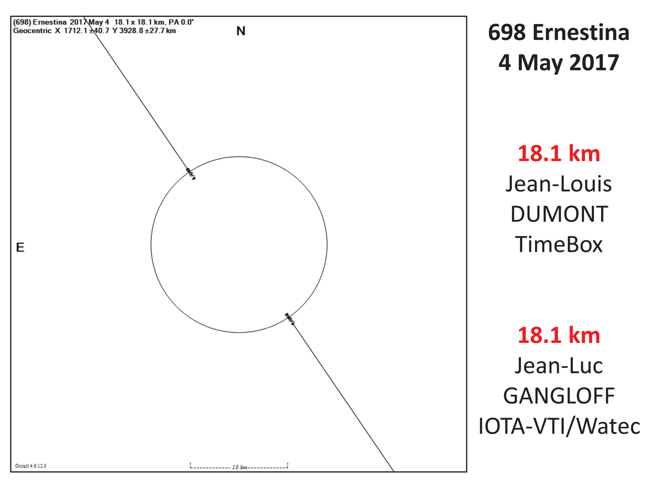
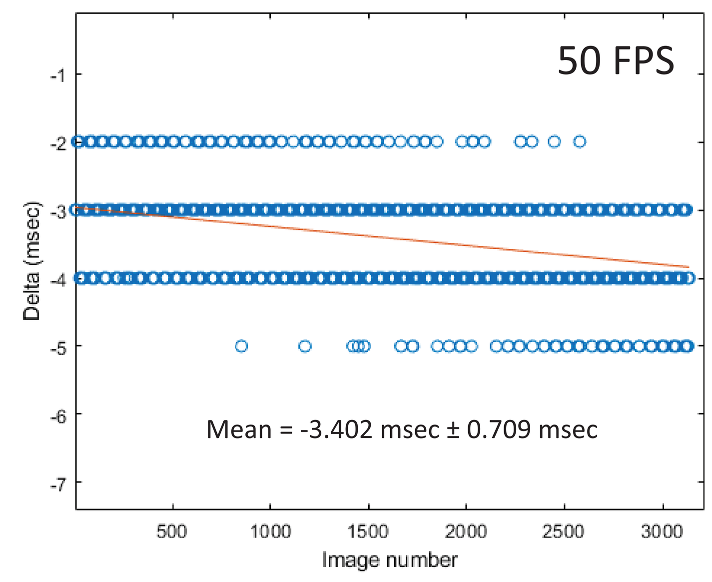
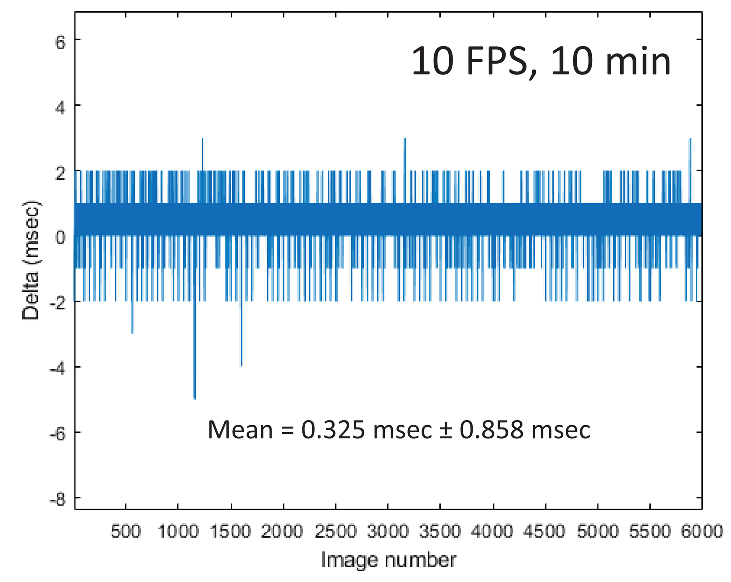


Figure 7. TimeBox vs IOTA-VTI/Watec



Exp. time (msec)	FPS	Delay (msec)
14	71	4.65
20	50	3.4
20	50	0.89
40	25	5.58
40	25	1.64
80	13	0.25
100	10	1.74
160	6	3.94
200	5	5.32
320	3	3.83
	Mean	3.12
	STD	1.88

Figure 8. TimeBox vs SEXTA, Computer mode.



Short Tests (< 20 sec)		
FPS	Delay (msec)	STD (msec)
8	0.53	0.74
10	0.03	0.82
15	0.04	0.73
20	0.18	0.98
24	0.38	0.94
	Mean	0.23
	STD	0.11
Long Test (10 min)		
10	0.32	0.85

Figure 9. TimeBox vs SEXTA, Trigger mode

Contact

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