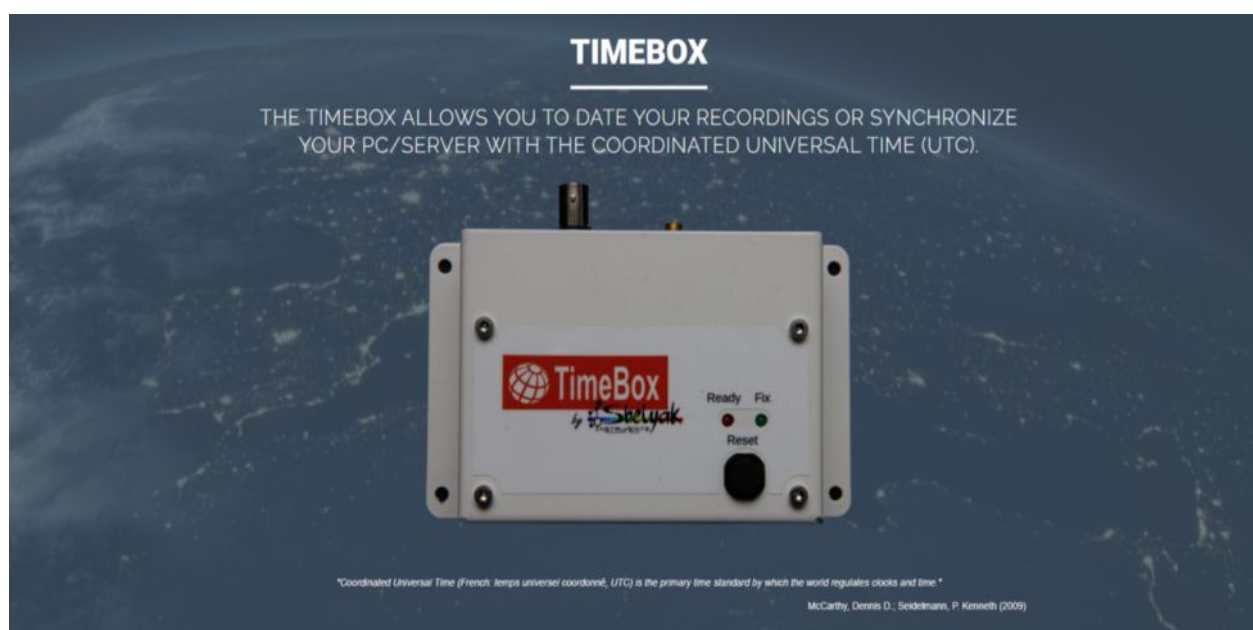




User Guide



Shelyak Instruments
73 rue de Chartreuse
38420 Le Versoud, France
<http://www.shelyak.com>
Phone : (33)4 76 41 36 81



Rev	Date	Who	what
A	20/01/2020	Cesar VALENCIA-GALLARDO	First version

Author : César VALENCIA-GALLARDO

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1. ABSTRACT

This is the user manual for the TimeBox, a device designed to date a PC/Server time and digital video recordings with the Coordinated Universal Time (UTC). The TimeBox was primarily designed for precise timing of astronomic phenomena, but it can be used for other applications that require precise timing with an absolute time reference (UTC). This manual provides instructions for installing the TimeBox device and software, to use the different timing modes of the TimeBox and a general troubleshooting to solve the most frequent problems found during the TimeBox operation.

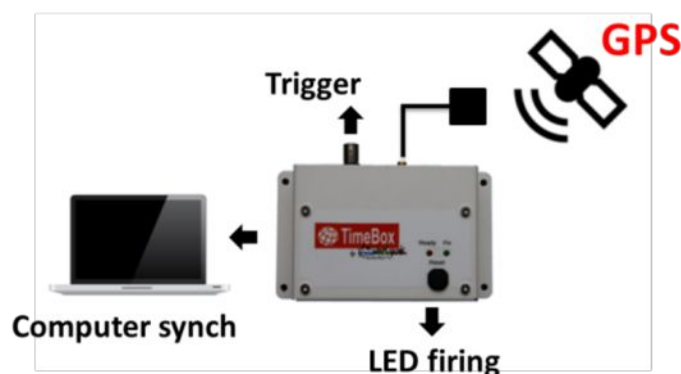
2. INTRODUCTION

Timing of astronomic occultation and other astronomic phenomena need to be done in an absolute time scale in order to pull and compare recordings done by different observers around the world. The timescale chosen is the Coordinated Universal Time (UTC) that is the primary time standard regulating clocks and time (McCarthy *et al.* 2009). Stellar occultation is a proven method used to determine the size, form and position of asteroids, and the topology and orbits of satellites as well (Trahan *et al.* 2014).

Before the Timebox availability, scientists and amateurs used a timing system that wrote the UTC time in every frame of an analogic video recording (such as IOTA-VTI and Watec cameras). This system was validated by the international occultation timing community (IOTA) for years and used by hundreds of observers for more than ten years.

However, almost all current video recorders devices are digital cameras, including those possessing the most sensitive and low noise CCD, EMCCD and CMOS image sensors. Last generation CMOS image sensors possess sensitivity and noise levels comparable to those of the best CCD sensors, without its major inconveniences (low frame rate and high cost of production). The evolution of CMOS image sensor capabilities will likely replace the CCD sensors thus favoring the development of highly sensitive/low noise digital video devices in the near future.

Up to now, no precise and portative solution was proposed for UTC timing using digital video cameras. The TimeBox fills this gap. The TimeBox is designed in order to allow **precise timing of astronomical phenomena using digital video devices**. The TimeBox recovers the UTC time from the GPS satellites and insert the UTC time in three different ways: LED firing, Computer clock synchronization and Trigger firing.



3. OUT OF THE BOX



The TimeBox comes with a:

- TimeBox device itself
- The GPS antenna
- A USB cable.

4. MINIMAL PC CONFIGURATION

- Processor. 1 gigahertz (GHz) Intel or AMD with [invariant TCS](#) support.
- RAM. 1 gigabyte.
- USB 2.0/3.0 port.
- OS: Microsoft Windows® 8 and up*.
- Microsoft .NET Framework 4.6.1.

The TimeBox Software and Hardware works only in Microsoft Windows® 8 and more recent operating systems.

* A version of the software running on Windows® 7 SP1 is available.

5. INSTALLATION

You will find on the Shelyak Instruments website (www.shelyak.com) in the Products/Occultations/Timebox menu the following software to download:

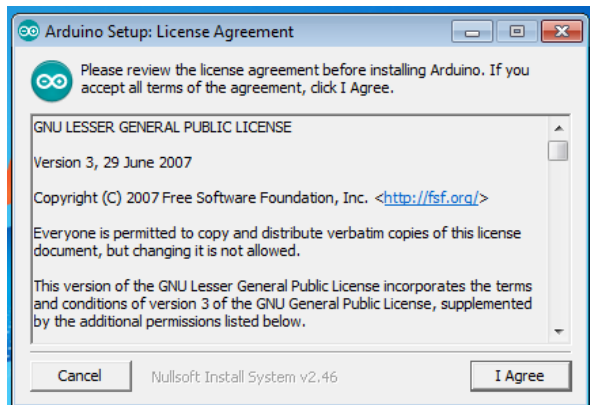
- arduino-1.8.11-windows.exe
- Install TimeBox.msi



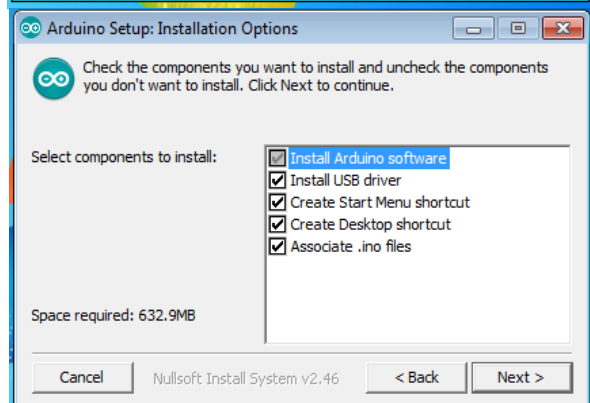
The TimeBox uses an Arduino to communicate with the PC. The first step is to install the Arduino software and drivers. Run the **arduino-1.8.8-windows.exe** file and install the IDE and drivers.

Install the Arduino Software:

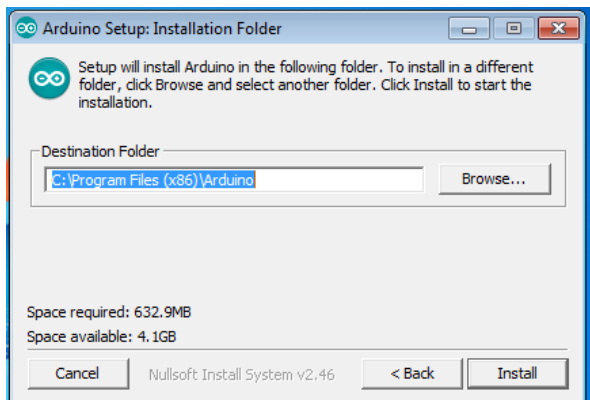
Run the **arduino -1.8.11-windows.exe** application and click on **I Agree**.



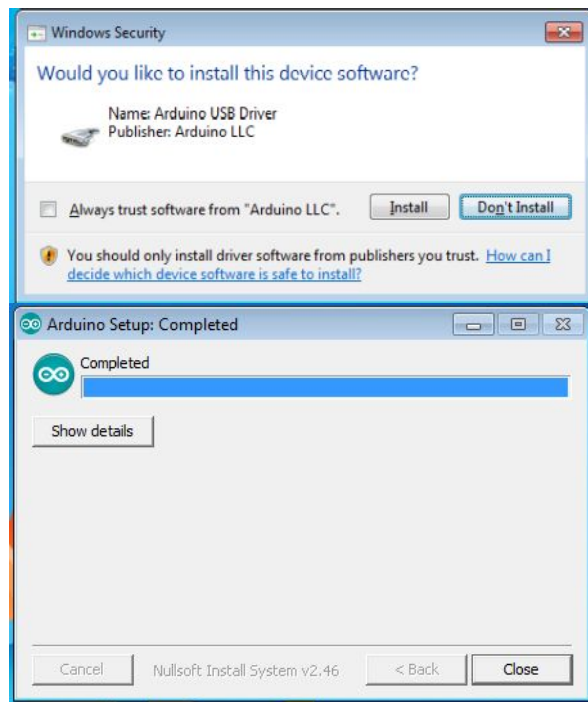
Select **Install Arduino software** and **Install USB driver**.



Click on **Install**.



Install the Arduino USB driver. Click on **Install**.

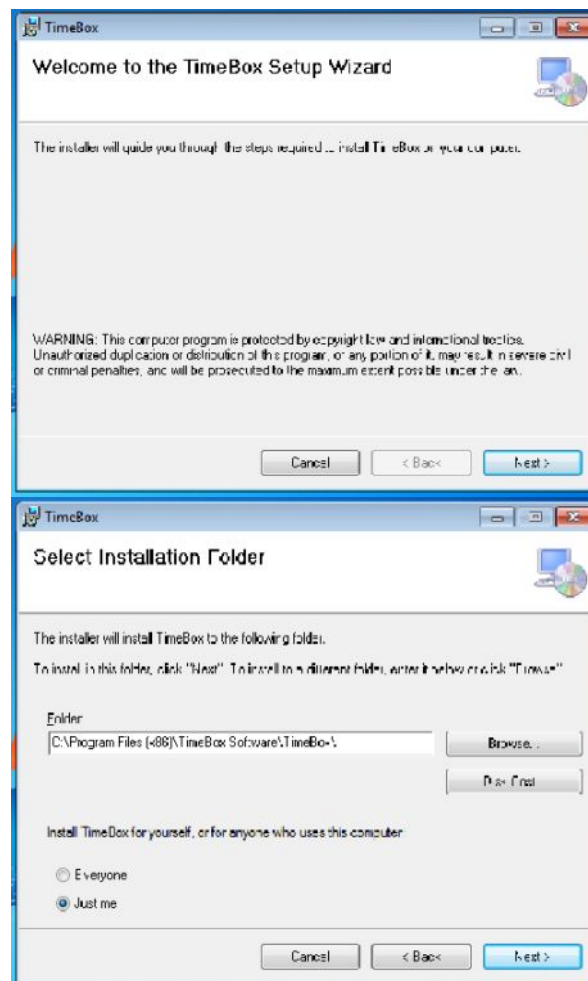


Once completed, **close** the Arduino installation program and **restart your computer**.

Once the Arduino IDE and drivers are installed, run the **Install TimeBox.msi** file to install the TimeBox software.

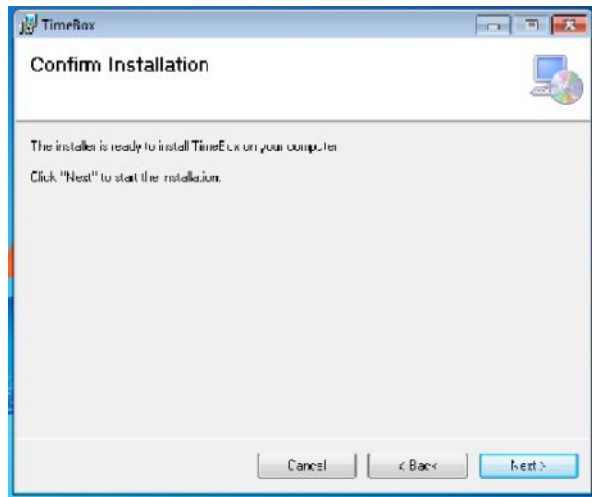
Install the TimeBox Software

Run the Install TimeBox.msi file and click on **Next**.

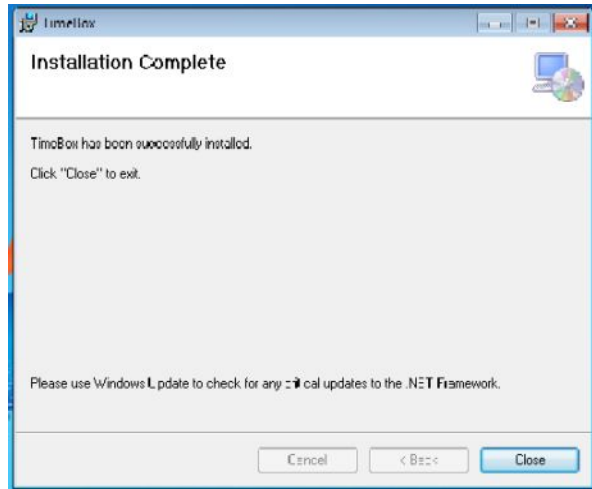


Select the destination folder and click on **Next**.

Confirm the installation by clicking on **Next**.



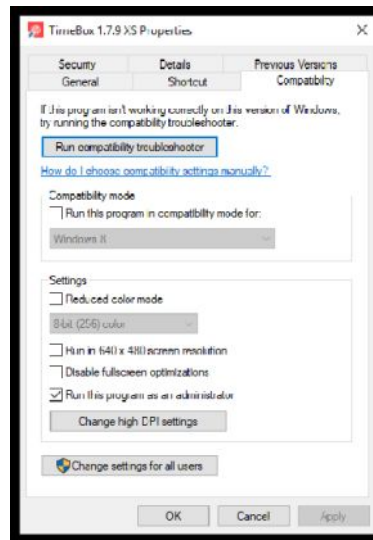
When the installation is complete **close** the program.



The TimeBox needs to be able to modify the PC clock to synchronize it with the UTC time. To do so the TimeBox needs to run as **Administrator**.



Right click on the TimeBox icon on your desktop and choose **Properties**.

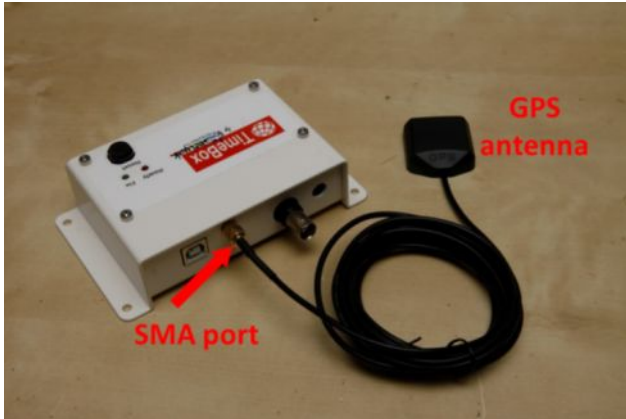


Go to **Compatibility** tab and check that **Run the program as an administrator** is checked.
Example: Windows 10.

You will need to modify your **time zone to UTC** to successfully calibrate and/or run a routine. Please **inactivate** the Windows **“Set time automatically”** and **“Set time zone automatically”** before calibrating or running a routine. **Inactivate** all software that **can set/modify your PC clock** before calibrating or running a routine.

6. CALIBRATION

When you run the TimeBox for the first time on your computer, you will need to perform a **one-time calibration** of your PC time drift. The calibration is needed to obtain information about the timestamping of your system; this information is used to define the PC synchronization properties (see page 16).



Connect the GPS antenna to the SMA port of your TimeBox. Put the **external antenna outside** with a clear and open view of the sky.



Connect the TimeBox USB port to a **USB 2.0/3.0** port on your computer.

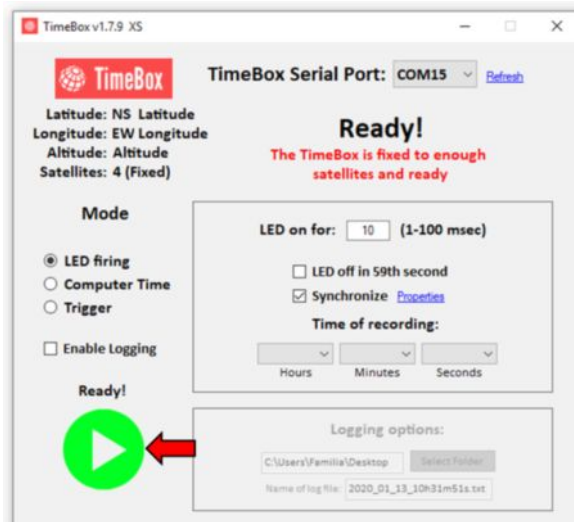
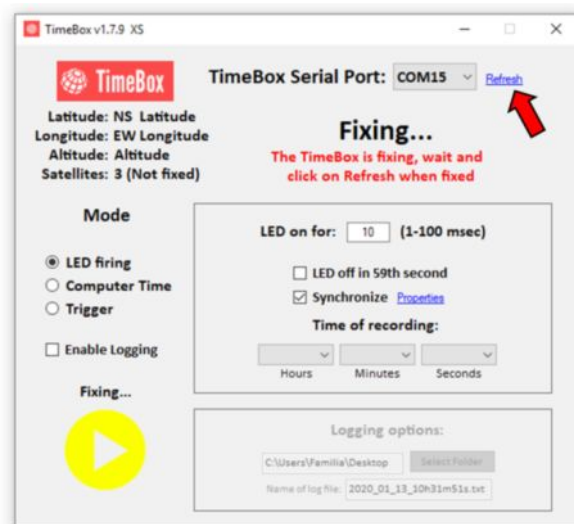
Open the TimeBox software using the shortcut in your desktop.

When fixed, the TimeBox **Fix** LED stops firing. It's better to wait at least 15 minutes after the **Fix** LED stops firing to be sure that the TimeBox is well fixed and is receiving a stable signal from the satellites.

You can verify the TimeBox fix status by clicking on [Refresh](#).

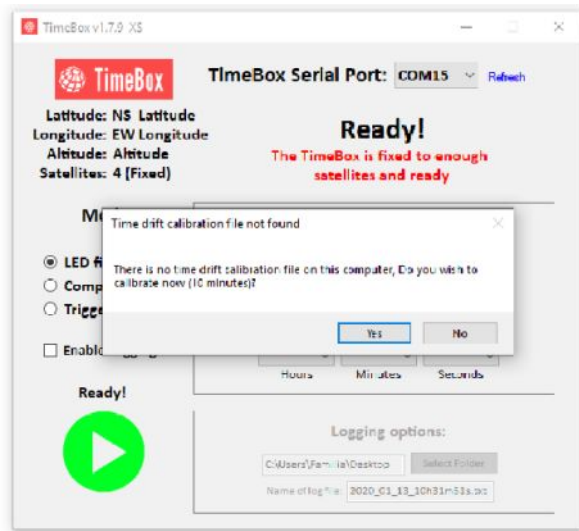
When the TimeBox is fixed to enough satellites, the main display will turn to **Ready!** and the play button will turn green.

Click on the green Ready! play button.

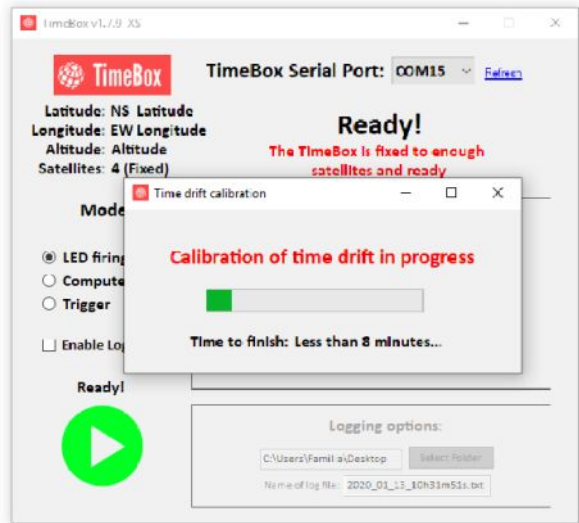


The **Time drift calibration file not found** window will ask you if you wish to perform the one-time calibration on your computer.

Click on **Yes** and wait until calibration is finished.

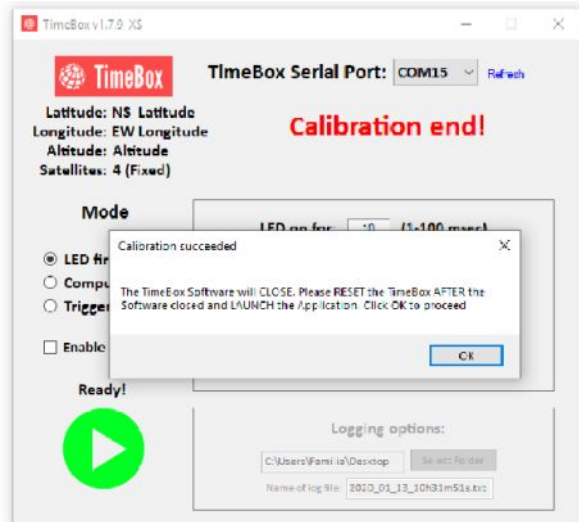


After clicking on **Yes**. The calibration will start, wait until is finished...



When calibration is finished, click on **OK**. After clicking on **OK**, The TimeBox software will close.

Restart the TimeBox by pressing the **Reset** button for 1 second and reopen the TimeBox Software.



If you desire, you can check the calibration to be sure that the time drift and correlation values are correct and constant. To do so, go to your TimeBox installation folder (example):

C:\Program Files (x86)\TimeBox XS

Open the file named **calibration.txt** using the *Notepad*. Check the correlation coefficient ("Rsquared:"). You can delete both calibration.txt and calibrationRAW.txt files to repeat and compare that the correlation coefficients measured are consistent between calibrations.

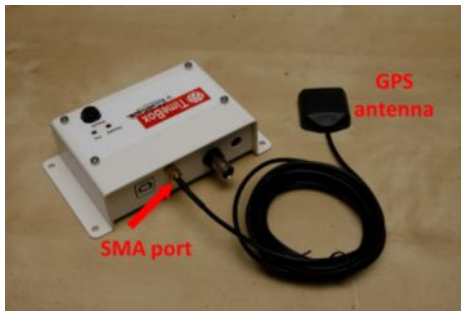
```
&Start of file#
&Calibration file, Date/Time:27/03/15 23:29:45.018#
&Drift(miliseconds/seconds):-0,0132142101179947#
&STD(miliseconds):0,6691562668375#
&Rsquared:0,89870120743131#
&Bvalue:-25,6335460881172#
```

7. TIMEBOX MODES

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

- A) **LED firing** (< 8 microseconds UTC).
- B) **Computer Synchronization** (± 2 milliseconds UTC).
- C) **Trigger** (< 1 milliseconds UTC).

These modes are controlled with a graphical interface provided by the TimeBox software. To start using the TimeBox, connect it to the PC USB 2.0/3.0 port and wait until the TimeBox fixes the GPS satellites as follows:



Connect the GPS antenna to the SMA port of your TimeBox. Put the **external antenna outside** with a clear and open view of the sky.



Connect the TimeBox USB port to a USB 2.0/3.0 port on your computer.

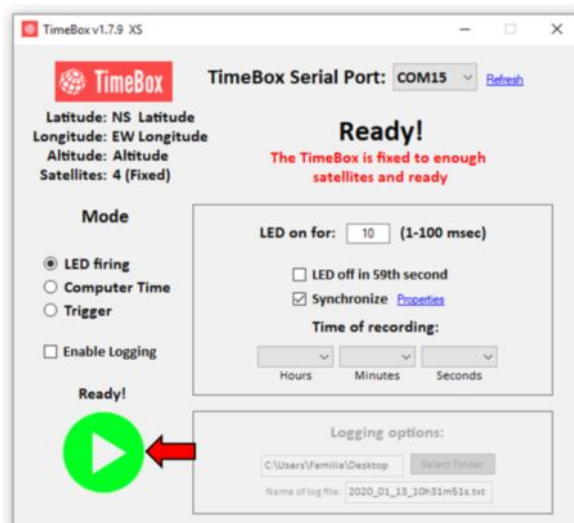
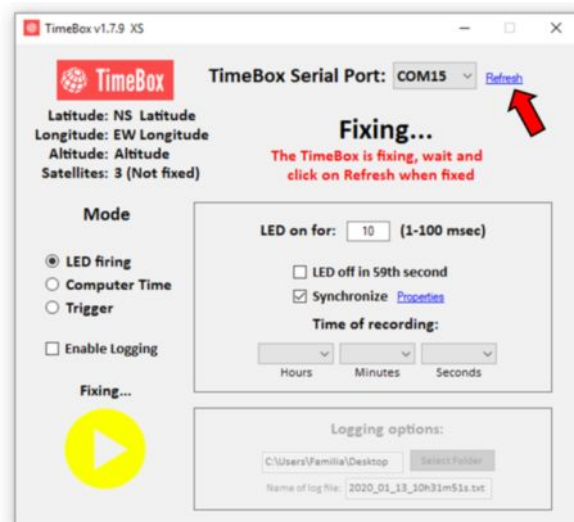
Open the TimeBox software using the TimeBox in your desktop.

When fixed, the TimeBox **Fix** LED stops firing. It's better to wait at least 15 minutes after the **Fix** LED stops firing to be sure that the TimeBox is well fixed and is receiving a stable signal from the satellites.

You can verify the TimeBox fix status by clicking on [Refresh](#).

When the TimeBox is fixed to enough satellites, the main display will turn to **Ready!** and the play button will turn green!

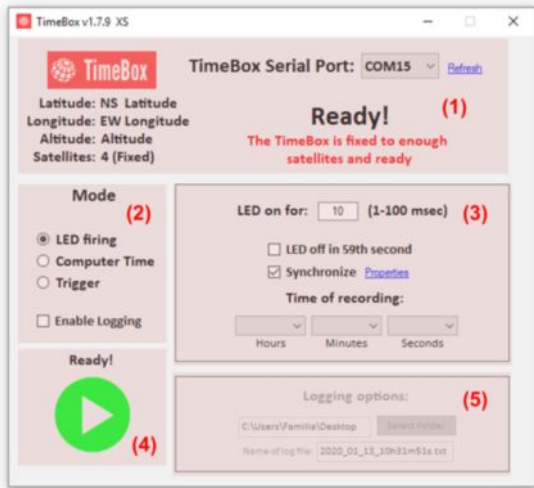
Click on the green Ready! play button.



To stop the routine or start a new routine. Press the **Reset** bouton on the TimeBox device.

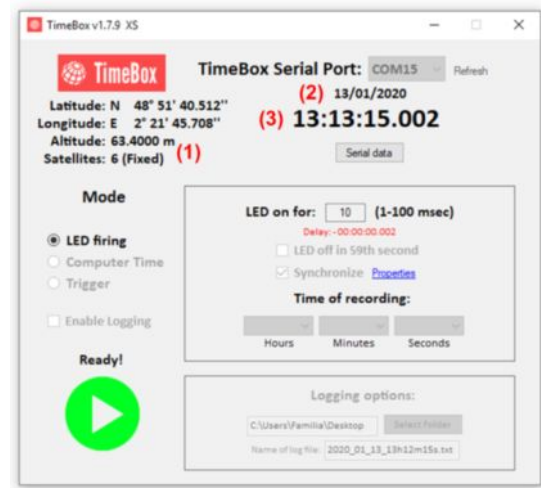


General View



TimeBox panels

- (1) GPS panel.
- (2) Mode panel.
- (3) Mode properties panel.
- (4) Start panel.
- (5) Logging panel.



GPS panel

- (1) Current Latitude, Longitude, Altitude and Number of satellites.
- (2) Current date (dd/mm/yyyy format).
- (3) Time received by the TimeBox GPS (hh:mm:ss .mm).

The TimeBox software **General view** is composed of 5 panels as shown above. The **GPS panel** gives the current coordinates, altitude, number of satellites, date and time as received from the GPS satellites in **UTC time** during the recording/synchronization routine.

The **Mode panel** allows you to choose between the different modes supported by the TimeBox (LED firing, Computer synchronization and Trigger). Selecting one of these modes will switch the tab on the **Mode properties panel** to show the corresponding properties of each mode.

The **Start panel** allows you to start your routine in the selected mode.

The **Logging panel** allows you to keep a record of your recording/synchronization routine in a text file.

GENERAL STATEMENT: When starting the synchronization by clicking on the **Ready!** button, the computer stops talking to the TimeBox; this is to ensure that no uncontrolled delay is added by the serial communication. Then the only way to **interrupt the time control** (and allow to changes parameters) is to click on the **Reset** button on the TimeBox.

7.A) LED firing: Use the TimeBox LED to insert the UTC time on any video recording.

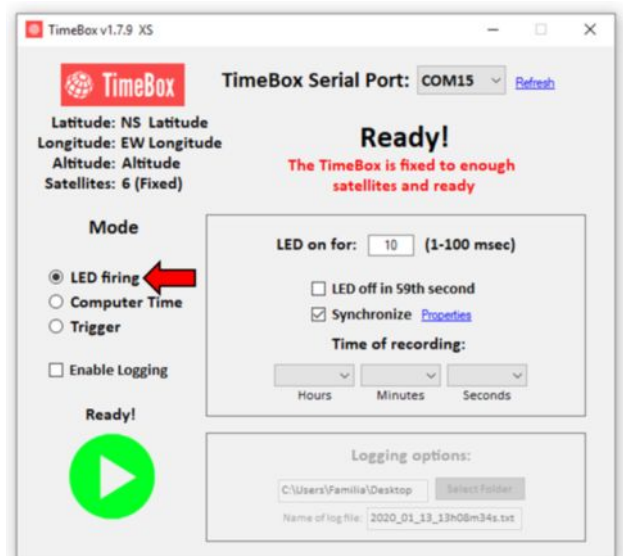
Features:

- ✓ Low delay (<math><8\mu\text{Sec}</math>) from UTC.
- ✓ Time-controlled pulse.
- ✓ Disable the 59th second firing (optional).



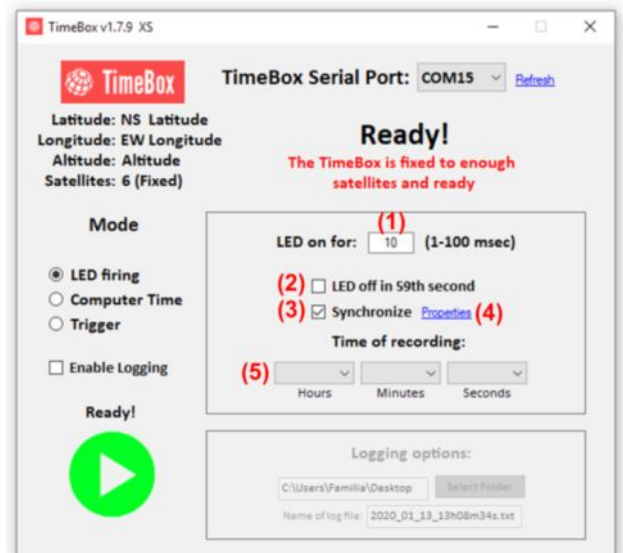
Be sure that the TimeBox is well fixed and ready to receive instructions (see page 8).

Choose the **LED firing** mode on the Mode panel.

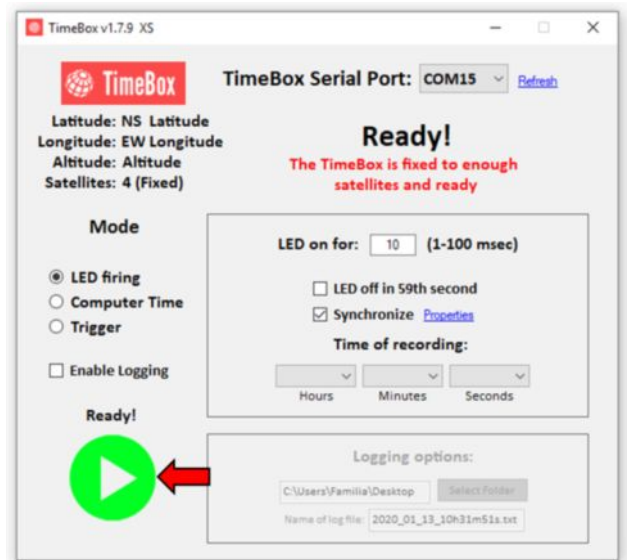


Choose the LED firing mode parameters on the **Mode properties** panel.

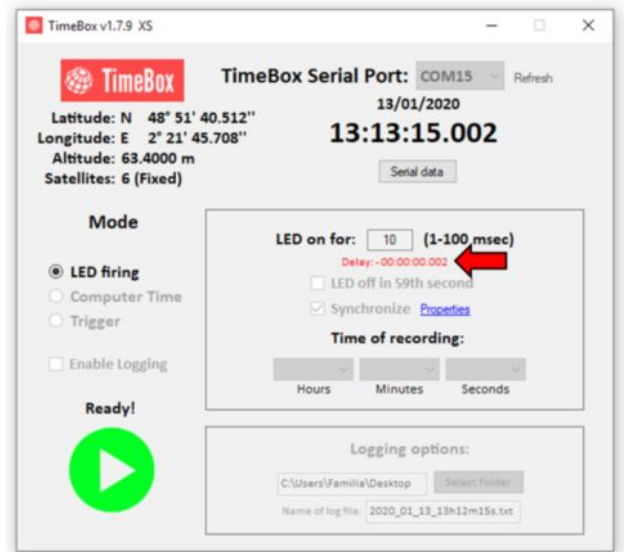
- (1) Duration of the LED pulse (milliseconds).
- (2) (Optional) Do not light the pulse corresponding to the last second (59th) of each minute.
- (3) **(Default)** Continuous synchronization of the PC clock with the TimeBox. See **Continuous PC synchronization** (page 16) for more information.
- (4) Continuous synchronization parameters. See **Continuous PC synchronization** (page 16) for more information.
- (5) (Optional) Duration of the routine.



Click on **Ready!** button to start the routine.



When the LED firing routine is running, the delay between the PC clock and the TimeBox GPS is displayed as “**Delay:**”.



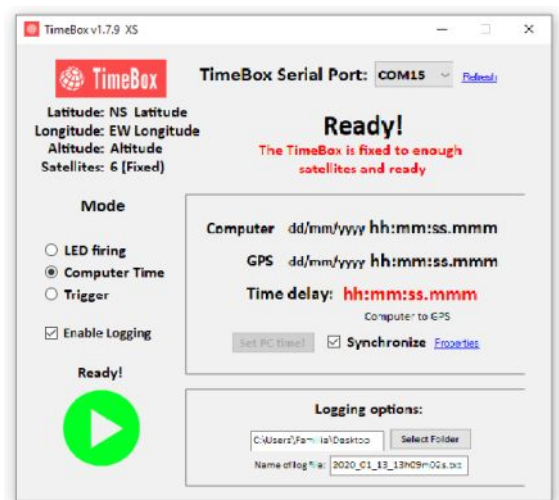
The **routine will start** and the **Ready LED** will turn on at the start of each UTC second.

7.B) Computer synchronization: Use the TimeBox to synchronize the PC time with the UTC.

Features:

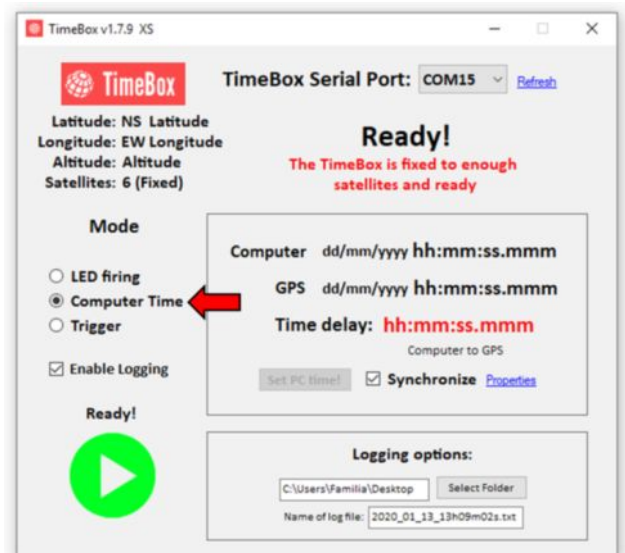
- ✓ One-click synchronization of the PC clock.
- ✓ Precise (± 2 milliseconds* UTC).
- ✓ Serial latency estimation to correct the conversion and transmission delay.
- ✓ PC time drift measured over time.

*Lenovo ThinkPad Intel i5 Core i5-540M (2.53GHz, 3MB Cache), 4GB DDR3 RAM, USB2.0/3.0 port. OS: Windows 10 x64 Professional.



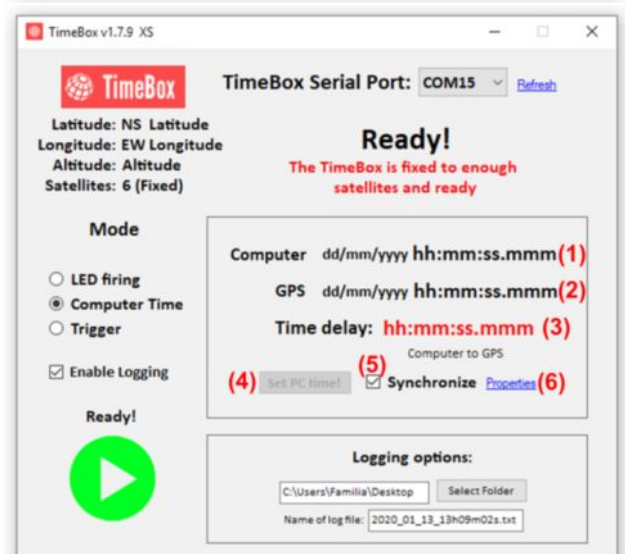
Be sure that the TimeBox is well fixed and ready to receive instructions (see page 8).

Choose the **Computer Time** mode on the Mode panel.

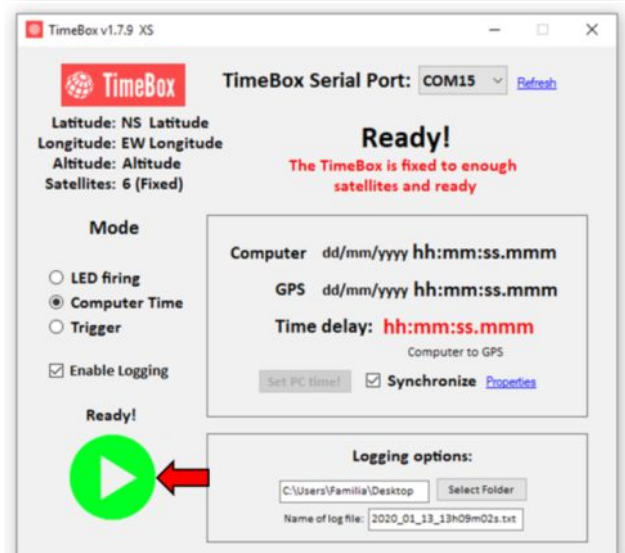


Computer Time mode parameters on the Mode properties panel.

- (1) PC internal clock date and time.
- (2) GPS TimeBox date and time.
- (3) **Difference** between the PC and GPS TimeBox.
- (4) **(Active when the routine started)** Set the PC time using the TimeBox **once per click** on **Set PC time!** button.
- (5) **(Default)** Continuous synchronization of the PC clock with the TimeBox. See **Continuous PC synchronization** (page 16) for more information.
- (6) Continuous synchronization parameters. See **Continuous PC synchronization** (page 16) for more information.

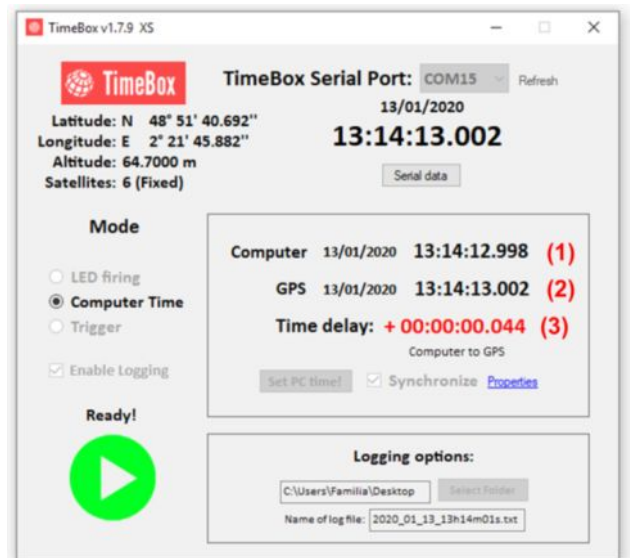


Click on **Start** button to start the routine.



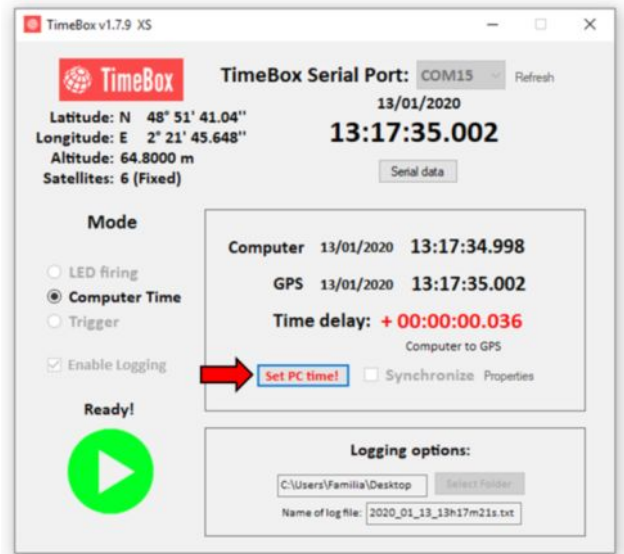
During the Computer Time mode routine, the TimeBox displays:

- (1) PC internal clock date and time.
- (2) GPS TimeBox date and time.
- (3) **Delay** between the PC and GPS TimeBox.



Set the PC time using the TimeBox **once** per click on **Set PC time!** button.

The Continuous PC synchronization is disabled during the routine.



7.C) Trigger: Use the TimeBox to trigger UTC-phased frames on cameras that supports this feature.

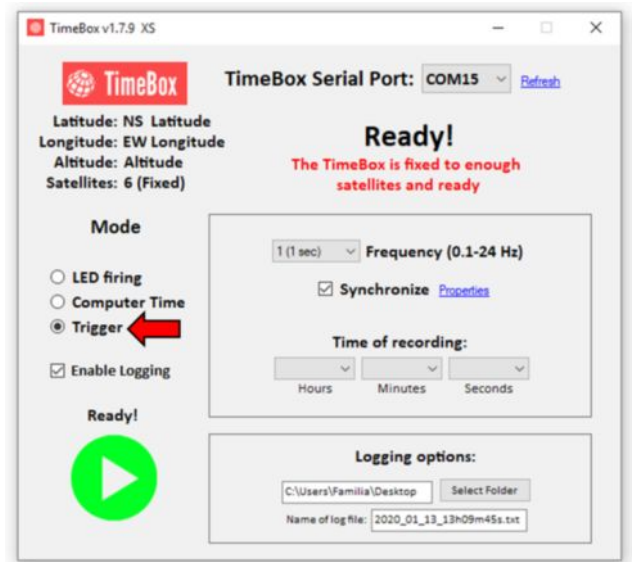
Features:

- ✓ Logic square pulses (3v/6v/9v, default: 9v).
- ✓ High precision (< 1 milliseconds UTC).
- ✓ Phase constant pulses.
- ✓ Wide range frequency: 0.1 to 24 Hz.



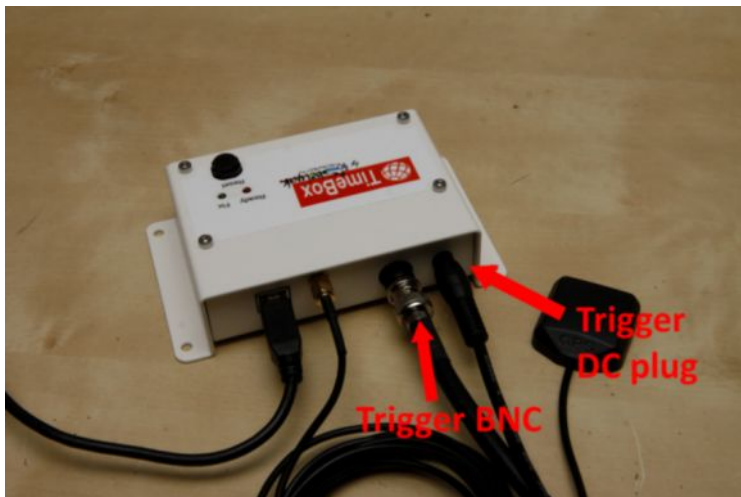
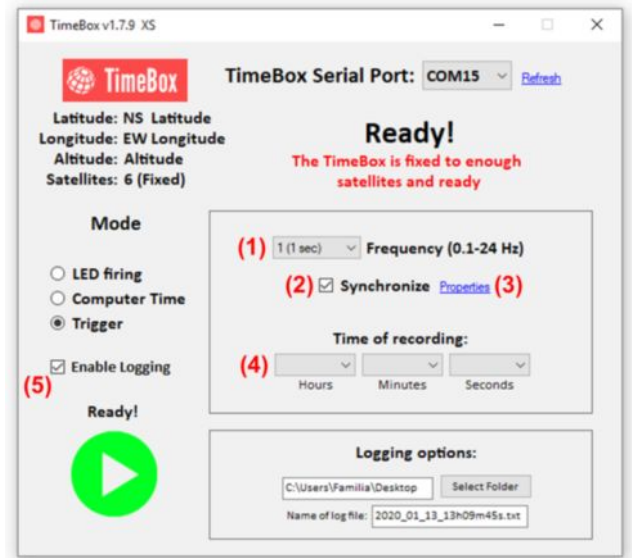
Be sure that the TimeBox is well fixed and ready to receive instructions (see page 8).

Choose the **Trigger** mode on the Mode panel.



Pulse timing parameters on the **Mode properties** panel.

- (1) **Frequency** of the triggering.
- (2) **(Default)** Continuous synchronization of the PC clock with the TimeBox. See **Continuous PC synchronization** (page 16) for more information.
- (3) Continuous synchronization parameters. See **Continuous PC synchronization** (page 16) for more information.
- (4) (Optional) Duration of the routine.
- (5) **(Default)** Activates the logging routine that keeps the time of each pulse up to μ Sec precision. See **Logging** (page 19) for more information.



Connect the Trigger BNC output to your camera **Trigger I/O port** and the DC 12v power supply to the TimeBox DC plug.



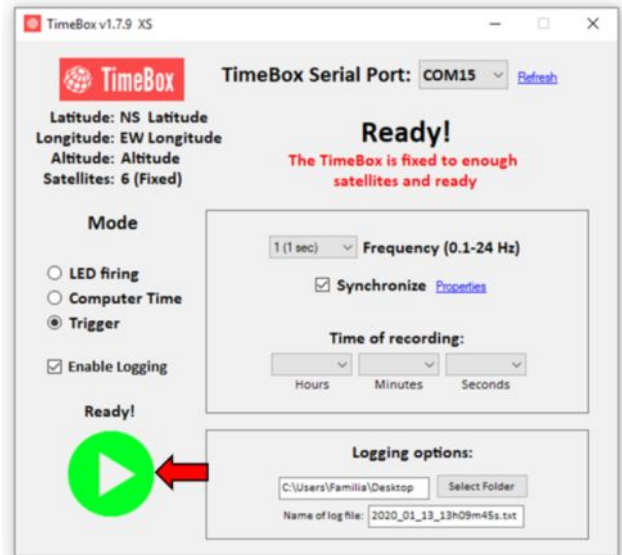
Be sure that your camera is correctly triggered at the chosen voltage. Do not exceed your camera's recommended voltage levels for triggering!

To ensure that the trigger pulses are precise, please connect both TimeBox Trigger BNC and camera Trigger I/O port using a BNC isolated low-impedance cable.

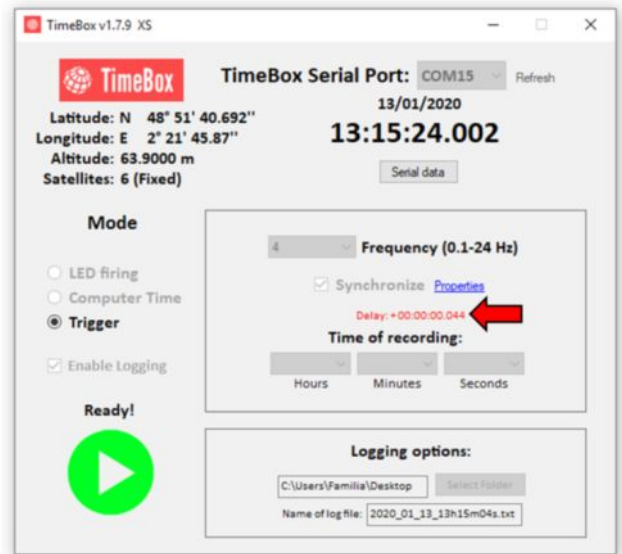
BE SURE THAT YOUR CAMERA IS TURNED ON AND WELL CONNECTED TO THE TIMEBOX BNC TRIGGER FIRING PORT BEFORE STARTING THE ROUTINE.

It is **strongly** recommended to let the **Enable Logging** and **Synchronize** checkboxes checked during the Trigger routine.

Click on **Start** button to start the routine.



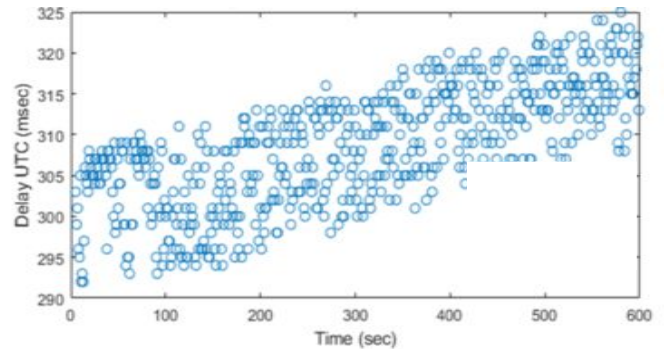
When the Trigger routine is running, the delay between the PC clock and the TimeBox GPS is displayed as "**Delay:**".



8. CONTINUOUS PC SYNCHRONIZATION

The reading of the PC time in Windows system is **affected** by system interrupts, tasks and random variations in read time.

For an accurate reading of the PC time in Windows environments, timing software needs to filter out these random variations to extract a **stable and accurate** time base.

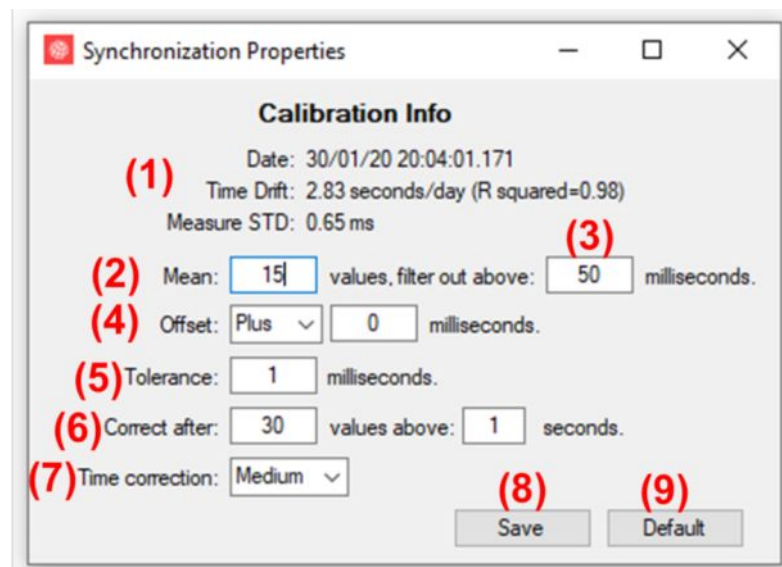


The TimeBox software is able to correct the PC system time continuously using his **Continuous PC synchronization** function in all three modes.

To activate the **Continuous PC synchronization** in those selected modes, check the **Synchronize** box as shown below. Then, you can choose the **Synchronization Properties** by clicking on the [Properties](#) link that activates when you check the **Synchronize** box.

Synchronization Properties

- (1) **Calibration Info** panel shows the calibration parameters.
- (2) **Mean** xx time values to reduce the random variations in the PC clock reading.
- (3) Filter out aberrant time readings **above** xx milliseconds.
- (4) (Optional) Add +/- **offset (milliseconds)** to compensate for a time offset.
- (5) **Tolerate** xx milliseconds of difference between PC clock and TimeBox.
- (6) Correct after **xx values above max Tolerance** (Default: 1 second).
- (7) **Time correction**. Three different speeds of the PC clock correction.
- (8) **Save** the current Synchronization properties.
- (9) **Set Synchronization properties to Default**.



You can access the **PC clock during the synchronization** by reading the resulting Log file, see the section "Logging" on page 19.

You might need to adapt the default values to **fit as best** your PC/capture software/Camera configuration, see the section "Offset correction" on page 17.

9. OFFSET CORRECTION

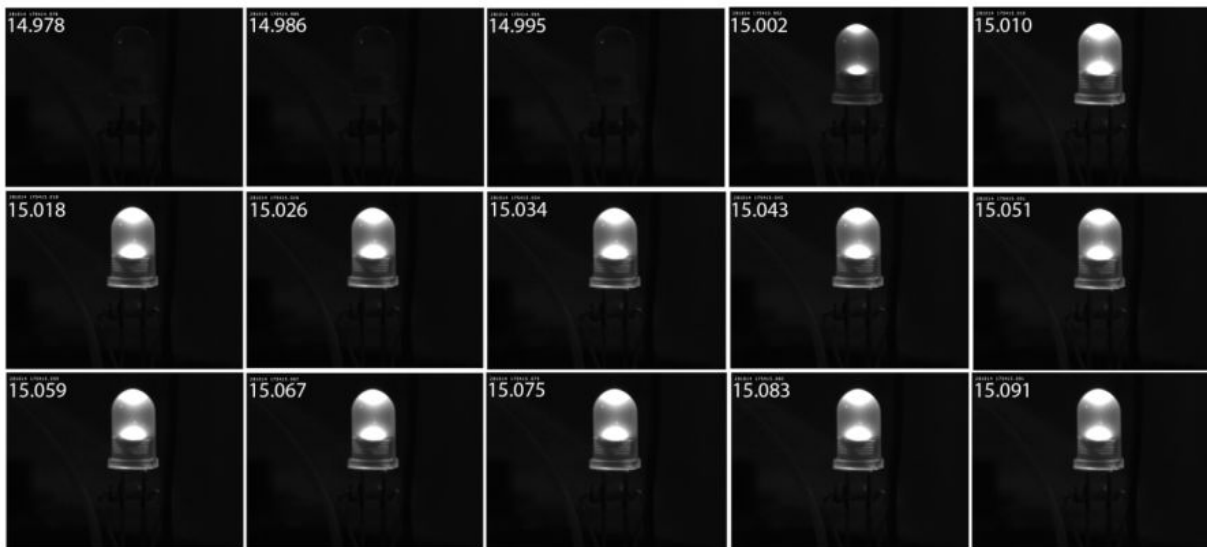
While the TimeBox is able to correctly set and continuously correct your PC clock, a constant positive/negative timestamp offset can be added to your images frames by your **recording software** and/or camera. This offset is **specific** for each system (PC/Recording software/Camera) and **has to be measured** to allow precise timing of your recordings.

The recording software is **very important** for correct timestamping of the frames. We tested and recommend **Genika Astro**, as a high performance and feature rich image acquisition software dedicated to astronomical applications.

One way to measure this time offset is to record the Ready LED during **LED firing** routine while the Synchronize box is checked, as described below:

1. Start a **LED firing** routine with the Synchronize box checked as showed in the page 10-11.
2. Set up your camera, open your recording software (Genika) and point your camera towards the TimeBox **Ready** LED.
3. Record the firing of the TimeBox **Ready** LED for a few minutes.
4. After the recording is finished, check the timestamps inserted in the images headers. Select the frames where the TimeBox **Ready** LED switched from OFF to ON (start of the UTC second).
5. Measure your constant offset (if any) between the timestamps in the frames and the lighting of the TimeBox **Ready** LED for a number of them.
6. (Optional) Modify the **Synchronization properties and framerates** and repeat these steps 1-5.
7. Measure the **offset** from these recordings and keep the **best** Synchronization parameters for your system.

Example of a TimeBox LED recording (made with Genika)



10. SERIAL LATENCY

The TimeBox will measure the serial communication delay with the PC at the start of each routine. This serial communication delay is more/less constant for each computer and will be used to measure for the communication delay between the TimeBox and the PC.

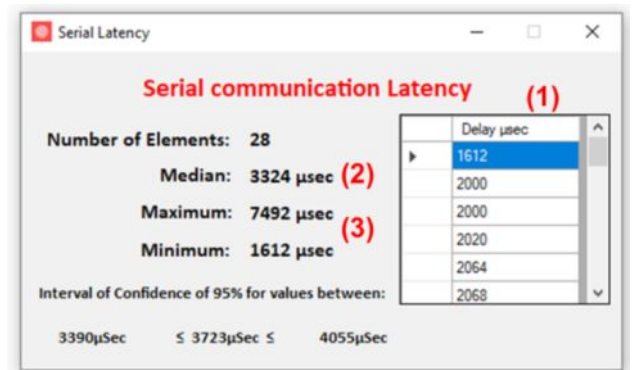
After starting a routine, the “**Serial data**” bouton will appear below the TimeBox GPS time.

You can access the results of the serial communication latency measures by clicking the “**Serial data**” bouton.



Serial communication latency

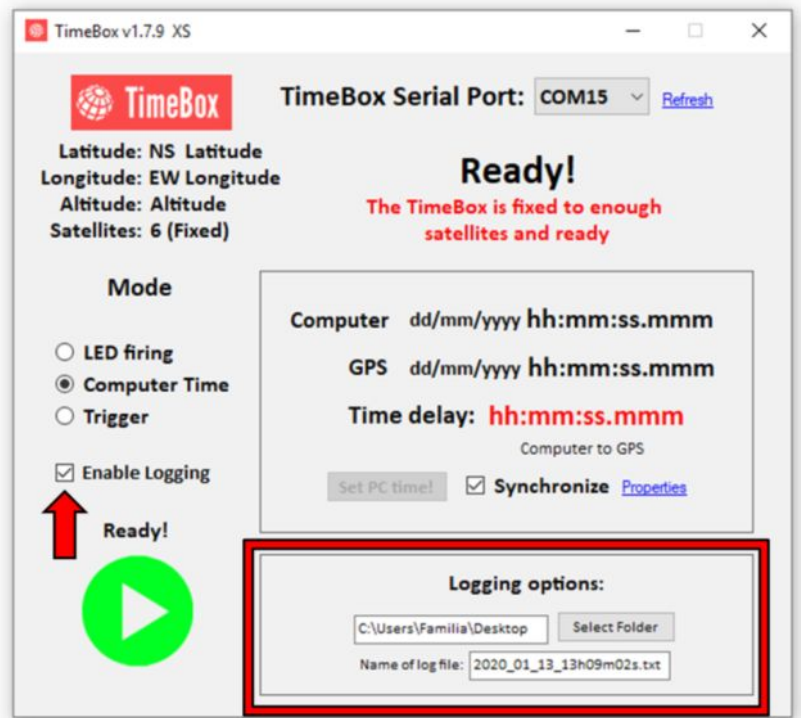
- (1) Table with the raw measures of the serial latency between the PC and the TimeBox in microseconds.
- (2) The **Median** (microseconds) of the serial communication latency test.
- (3) The **Maximum and Minimum** (microseconds) values of the serial communication latency test.



11. LOGGING

The TimeBox Software has the ability to keep a log of the recording/routine.

To activate the log check the **Enable Logging** box, select the folder and the name of the file that will contain the logging record.



Example of Log files

```
TimeBox GPS Log v1.7.8 XS, 13/01/20 13:19:10.373, Satellites: 6
Mode: LED pulse each second.

Computer Time, GPS Time, Delay
-----
Latitude: N 48° 51' 41.16'', Longitude: E 2° 21' 45.714'', Altitude: 64.8000 m
-----

(1)
(2) 13:19:14.623,13:19:14.002,0:0:0.044
    13:19:15.003,13:19:15.002,0:0:0.044
    13:19:16.000,13:19:16.002,0:0:0.044
    13:19:16.998,13:19:17.002,0:0:0.044
    13:19:18.000,13:19:18.002,0:0:0.044
    13:19:18.998,13:19:19.002,0:0:0.044
    13:19:19.996,13:19:20.002,0:0:0.043
    13:19:20.994,13:19:21.002,0:0:0.043
    13:19:21.992,13:19:22.002,0:0:0.042
    13:19:22.989,13:19:23.002,0:0:0.041
    13:19:23.991,13:19:24.002,0:0:0.040
    13:19:24.989,13:19:25.002,0:0:0.040
    13:19:25.987,13:19:26.002,0:0:0.038
    13:19:26.985,13:19:27.002,0:0:0.037
    13:19:27.983,13:19:28.002,0:0:0.008
    13:19:28.982,13:19:29.002,0:0:0.010
    13:19:29.983,13:19:30.002,0:0:0.011
    13:19:30.987,13:19:31.002,0:0:0.012
    13:19:31.988,13:19:32.002,0:0:0.013
    13:19:32.987,13:19:33.002,0:0:0.014
    13:19:33.988,13:19:34.002,0:0:0.014
    13:19:34.988,13:19:35.002,0:0:0.014
    13:19:35.988,13:19:36.002,0:0:0.015
    13:19:36.989,13:19:37.002,0:0:0.015
    13:19:37.993,13:19:38.002,0:0:0.015
    13:19:38.993,13:19:39.002,0:0:0.014
    13:19:39.993,13:19:40.002,0:0:0.014
    13:19:40.994,13:19:41.002,0:0:0.013
    13:19:41.994,13:19:42.002,0:0:0.012

(3) 1,1,13:15:17.0,0.045
    2,2,13:15:17.240,0.045
    3,3,13:15:17.480,0.045
    4,4,13:15:17.720,0.045
    5,1,13:15:18.0,0.045
    6,2,13:15:18.240,0.045
    7,3,13:15:18.480,0.045
    8,4,13:15:18.720,0.045
    9,1,13:15:19.0,0.045
    10,2,13:15:19.240,0.045
    11,3,13:15:19.480,0.045
    12,4,13:15:19.720,0.045
    13,1,13:15:20.0,0.045
    14,2,13:15:20.240,0.045
    15,3,13:15:20.480,0.045
    16,4,13:15:20.720,0.045
    17,1,13:15:21.0,0.045
    18,2,13:15:21.240,0.045
    19,3,13:15:21.480,0.045
    20,4,13:15:21.720,0.045
    21,1,13:15:22.0,0.044
    22,2,13:15:22.240,0.044
    23,3,13:15:22.480,0.044
    24,4,13:15:22.720,0.044
    25,1,13:15:23.0,0.044
    26,2,13:15:23.240,0.044
    27,3,13:15:23.480,0.044
    28,4,13:15:23.720,0.044
    29,1,13:15:24.0,0.044

LED firing / Computer
Trigger
```

LED firing/Computer modes

- (1) **Logging info** with the date, time, number of satellites, mode and GPS location.
- (2) Individual **time measurements**. Computer time, TimeBox GPS time and corrected delay between the TimeBox and the Computer time (hh:mm:ss.mmm)

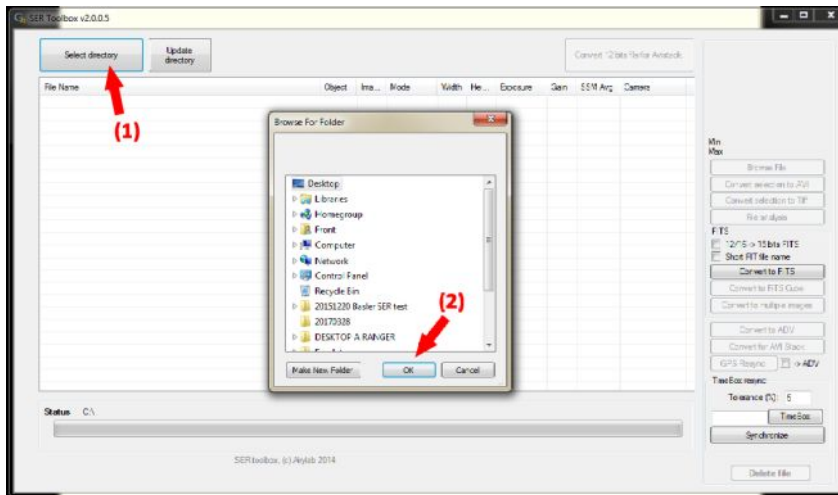
Trigger mode

- (1) **Logging info** with the date, time and mode.
- (3) Individual **trigger information**. Trigger number, Trigger number in the current second, TimeBox GPS time and delay between the TimeBox and the Computer time (hh:mm:ss.mmm).

12. TRIGGER-LOG SYNCHRONIZATION

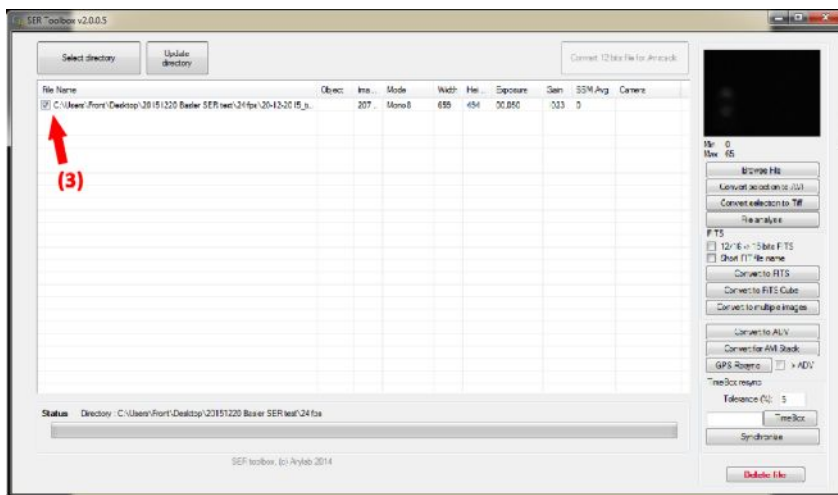
The Trigger logs can be **synchronized** with the Timebox time-stamped SER videos produced during a recording. For more information about the **Trigger** see page 13, and for more information about **Logging** see page 19.

The TimeBox synchronization routine is integrated into the **Genika Astro® SER TOOLBOX**. Genika Astro is a high performance and feature rich image acquisition software dedicated to astronomical applications. Genika Astro is used by professional observatories in Europe and USA, and hundreds of amateur astronomers.

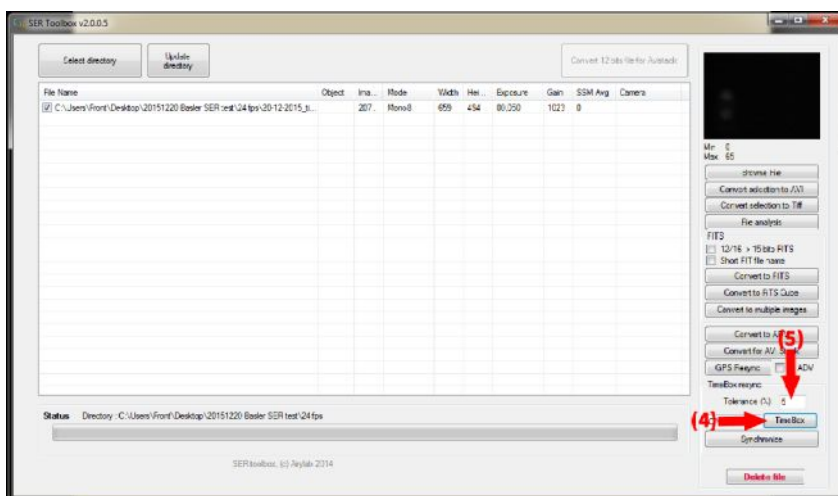


Open the **Genika Astro® SER TOOLBOX** (or *Convertisseur des fichiers*).

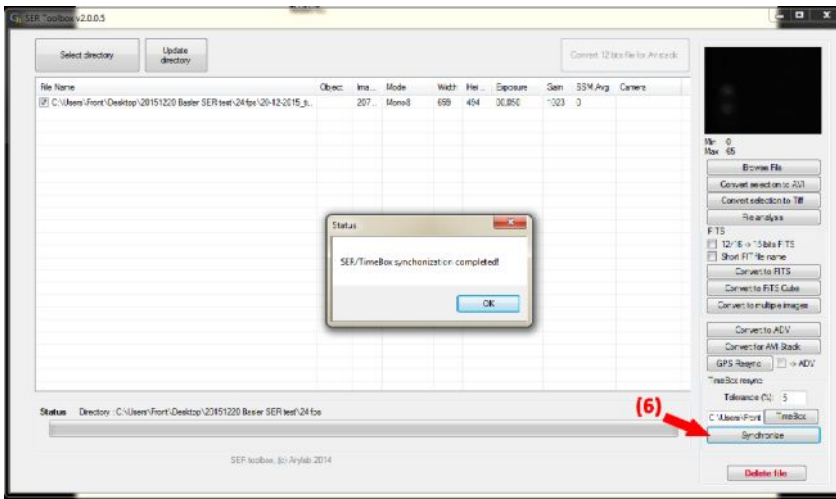
- (1) Click on **Select directory** to select the folder where the SER video file is located.
- (2) Select the directory where the SER video file is located and click on **OK**.



- (3) Select the **corresponding** SER video file containing the recording.



- (4) Click on **Timebox** to select the TimeBox log file **corresponding** to the right SER video recording.
- (5) Set the **Tolerance** value (percent) for the difference between the pulses and the SER timestamps. Example: 0.1-1 FPS Tolerance = 5%; 8 FPS Tolerance = 10% and 20 FPS Tolerance = 20%.



- (6) Click on **Synchronize** start the resynchronization of SER files with the corresponding TimeBox log pulses.

Resynch file in progress, please wait...

A message containing the “SER/Timebox synchronization completed” will appear when the process is finished. Click on **OK**.

In the folder where the selected SER video file is located, a new folder containing the **synchronized** FITS images will be created:

<nameSERfile>_Resynced

Two logs (simplified and detailed) with the corrected/original timestamps of the resynchronized FITS files:

<nameSERfile>_TimeBoxSynch.txt
<nameSERfile>_TimeBoxSynchFramesDetail.txt

And a log containing the resynchronization errors :

<nameSERfile>_TimeBoxSynchError.txt

```

SIMPLE =          T / file does conform to FITS standard
BITPIX =          8 / number of bits per data pixel
NAXIS =           2 / number of data axes
NAXIS1 =          659 / length of data axis 1
NAXIS2 =          494 / length of data axis 2
LXTITLE =         1 / FITS dataset may contain extensions
COMMENT FITS (Flexible Image Transport System) format is defined in 'Astronomy
COMMENT and Astrophysics', volume 816, page 359; bioconn: 2031A&A...376. 359+8
DATE-OBS= '2015-12-20T15:54:35.003' / YYYY-MM-DDThh:mm:ss.sss observation start
EXPTIME = 06.05 / Exposure Time in seconds
RSCAL F = 1 / physical = BZERO + RSCAL * array_value          P
BZERO = 255 / physical = BZERO + BSCALE * array_value        P
GAIN = 1023 / Camera gain
CCD_TEMP= 0.000 / CCD temperature at start of exposure in C
ROI = 0 0 659 494 / Agl X Y W H
PIXELFMT= 'Mono8' / Pixel format                             P
XBINNING= 1 / Binning factor in width                         P
YBINNING= 1 / Binning factor in height                        P
PIXELSZ = 0 / Pixel size in um                                P
FILTER = " " / Filter name                                    F
TELESCOP= " " / Telescope name                                P
OBSERVER= " " / Observer name                                 P
INSTRUMT= " " / Instrument name                               P
RESYNC = 'YES' / File timestamps have been resync by TimeBoxUTC
ORI TIME= '2015-12-20T15:54:35.003' / Time before resync with TimeBoxUTC
END
  
```

The resulting synchronized FITS are timestamped with the TimeBox log, and formatted as recommended by:

Definition of the Flexible Image Transport System (FITS)

R. J. Hanisch et al.
 A&A, 376 1 (2001) 359-380

In each FITS header the corrected timestamp is contained in **DATE-OBS**, and the original timestamp acquired during the recording in **ORI TIME**.

13. TROUBLESHOOTING

Problem:

The TimeBox software is not detecting the TimeBox device when connected to an USB port and displays a “None connected” status (see page 23, Figure 1).

Solution:

Verify that the TimeBox is properly connected to a USB 2.0/3.0 port. If this is the case, disconnect the TimeBox device from the USB port, connect it again and click on the [Refresh](#) link. If the problem persists, connect the TimeBox device to a different USB 2.0/3.0 port and click on the [Refresh](#) link.

Problem:

The TimeBox is not fixing enough GPS satellites.

Solution:

Put the external antenna outside with a **clear an open view of the sky** and keep it away from any source of electromagnetic interference.

Problem:

The TimeBox calibration started, but the time drift calibration bar does not advance after a few minutes (see page 7).

Solution:

Be sure than the TimeBox is well fixed and is receiving a stable signal from the satellites as shown on pages 8-9. If the TimeBox is correctly fixed and ready, **restart your TimeBox** by clicking on the Reset bouton as shown on page 9 and click on the Ready bouton to restart the calibration.

Problem:

The TimeBox routine does not start after clicking on the Ready! bouton.

Solution:

Be sure than the TimeBox is well fixed and is receiving a stable signal from the satellites as shown on pages 8-9. If the TimeBox is correctly fixed and ready, **restart your TimeBox** by clicking on the Reset bouton as shown on page 9, set up the routine and click on the Ready bouton.

Problem:

The TimeBox routine does not start while the location information is displayed and the Serial Data bouton appears on the GPS panel (see page 23, Figure 2).

Solution:

Restart your TimeBox by clicking on the Reset bouton as shown on page 9, set up the routine and click on the Ready bouton.

Problem:

The TimeBox software misses (or stop for some periods) some UTC seconds during the routine.

Solution:

Be sure than the TimeBox is well fixed and is receiving a stable signal from the satellites. It’s better to wait at least **15 minutes** after the **GPS fix green** LED stops firing to be sure that the TimeBox is correctly fixed.

Problem:

I cannot click on the Ready! button to start the routine.

Solution:

Be sure than the TimeBox software is in **Ready!** mode as shown in the page 8.

Problem:

The TimeBox serial communication delay (Mean) in the Serial latency window is outside of the normal expected range for my PC.

Solution:

Connect the TimeBox to a **different USB port**, wait until is correctly fixed and restart a routine. If the problem persists, check if the TimeBox is well connected to a USB 2.0/3.0 port.

Problem:

During the Computer PC synchronization, the PC time is not correctly synchronized with the UTC time.

Solution:

Adapt the **Synchronization properties** to fit as best your PC/capture software/Camera configuration (see the pages 16-17).

Problem:

My PC clock corrected delay with the TimeBox (see “Logging” on page 19) varies in cycles around a stable delay (see page 23, figure 3).

Solution:

Modify the **Mean xx** time value (increase/decrease) and repeat. If the problem persists, modify the **Time correction speed** and repeat the routine (see page 16).

Problem:

The SER re-synchronization with the Trigger log (pages 20-21) is missing a high number of frames listed in the `<nameSERfile>_TimeBoxSynchError.txt` file.

Solution:

Increase the Tolerance value (page 20) when re-synchronizing recordings at higher frequencies. Example: 0.1-1 FPS Tolerance=5%; 8FPS Tolerance=10% and 20 FPS Tolerance=20%.

Figure 1: TimeBox software is not detecting the TimeBox device

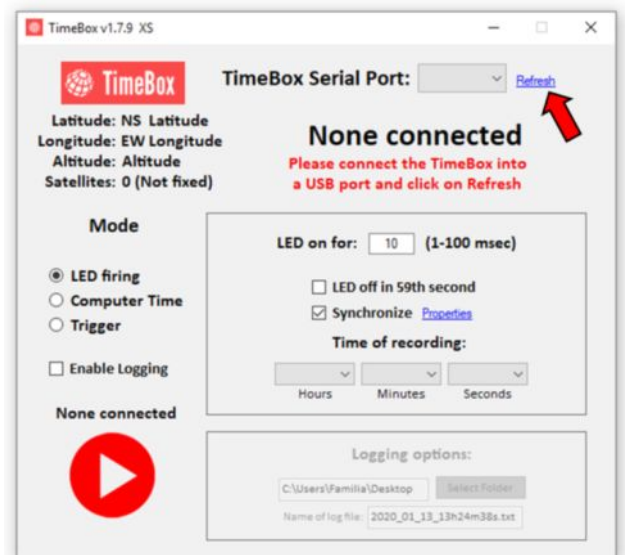


Figure 2: TimeBox routine does not start while the location information is displayed and the Serial Data bouton available.

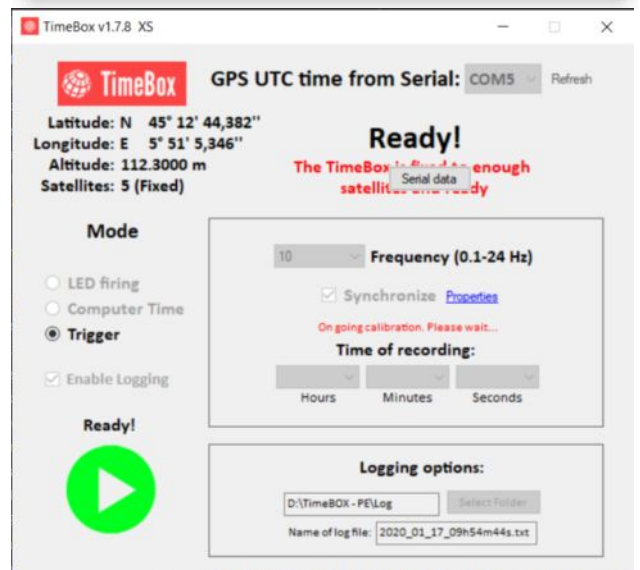
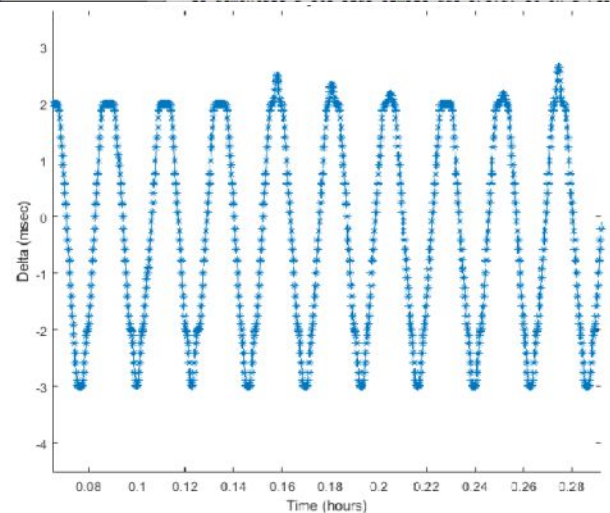


Figure 3: PC clock corrected delay with the TimeBox over a period of Time. Regular variations over a period of time obtained from the Log file during a synchronization routine.



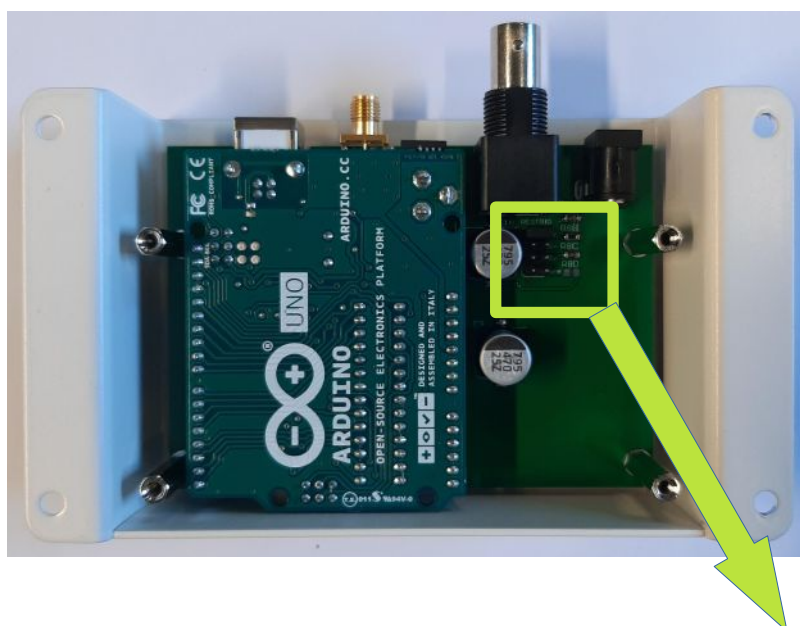
APPENDICES : POSSIBILITY TO CHANGE THE TRIGGER OUTPUT VOLTAGE

Careful: This requires opening the Timebox and changing the position of an electronic component. It is only necessary if you are using a camera with the trigger mode at a voltage other than 9V. Disconnect all connectors (especially power) before opening the TimeBox.

Remove the 4 screws of the box:



Remove the bottom sheet, so you can access the inside of the box:



And access to the jumper that determines the output voltage of the Trigger :

By default the voltage is at 9V, move the jumper (with a fine nose plier) to the desired voltage value (3V or 6V).

