

Mini-SAOZ Instrument

Ozone and NO₂ column observations
by zenith sky UV-visible spectrometry

Part 2 Operational Handbook



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Mini-SAOZ Manual

1. Instrument

The Mini-SAOZ instrument is composed of four parts (cf. Figure 1):

1. “Mini-SAOZ box” containing the spectrometer, shutter, electronics and temperature sensors;
2. “Optical head” connected to the Mini-SAOZ box via a fibre optics;
3. GPS antenna connected to the Mini-SAOZ box via a cable and a SMA connector;
4. “Acquisition and Analysis Device” (computer) connected to the Mini-SAOZ box via an USB cable.

The Mini-SAOZ box and the “Acquisition and Analysis unit” are located inside a room with temperature not exceeding 25°C, if possible. The Optical head and the GPS antenna are installed at the outside.

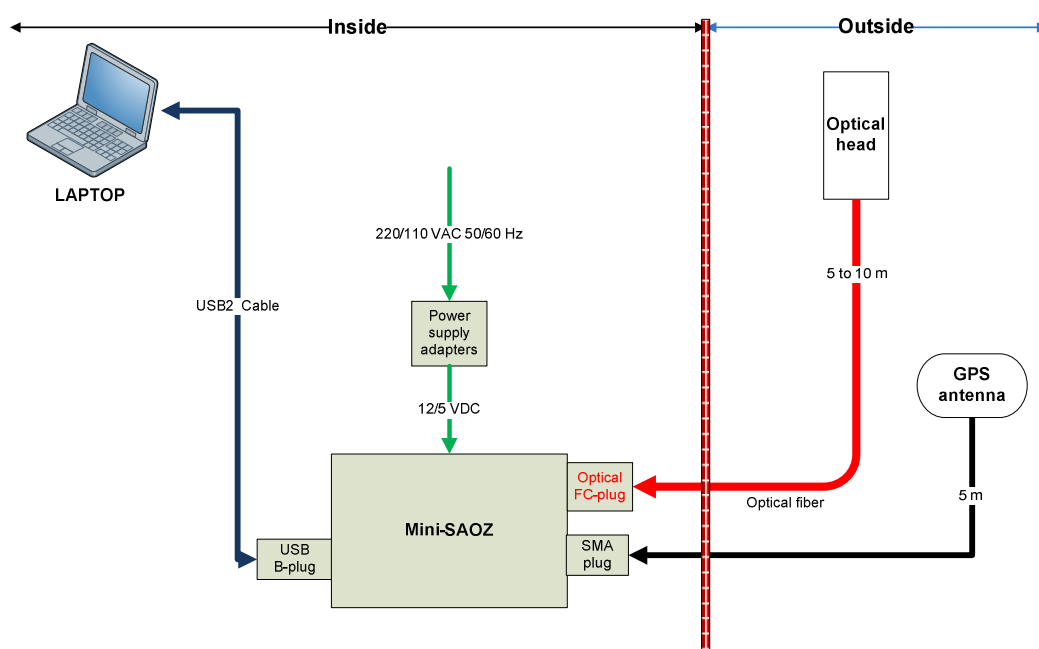


Fig. 1 Scheme of Mini-SAOZ instrument

The Mini-SAOZ box contains:

- Czerny-Turner spectrometer equipped with a CCD 2048 uncooled detector and its electronics;
- Shutter;
- Four temperature sensors distributed inside the Mini-SAOZ for spectrometer, electronics, box and GPS electronics;
- USB high speed Hub connected to spectrometers, temperature sensors, shutter and GPS receiver.

The Mini-SAOZ data sheet and specifications are reported in APPENDIX 1.

2. Installation

2.1 Hardware installation

In the inside: Mini-SAOZ box and Computer (English version) with more than two USB ports.

At the outside: Optical head and GPS antenna. The GPS antenna can be installed close to the building wall.

The optical head must be placed outdoor, so that the optical head can look at the sky vertically within a conical field of view of 8° . For example, if the wall of the building is 20 meters high, the optical head must be mounted at the extremity of a stick of 2 meters (see table 1 below). Accuracy of alignment is $\sim 1^\circ$.

Table 1: Length of the stick to support the optical head as a function of building height

Building height (m)	Length of the stick (m)
3	0.40
6	0.85
9	1.25
12	1.70
15	2.10
20	2.80

For protecting from stray light from walls or windows, an additional baffle can be installed on the optical head (cf. Figure 2). The baffle is a tube painted in white at the outside and in black inside with a length adapted to the entrance window aperture.



Fig. 2 Optical head equipped with a tube (white) for stray light protection and without a tube (grey).

The optical head is installed on an inox 316L plate, see the mechanical drawing in Fig 2a. This plate is optional on Marion Dufresne.

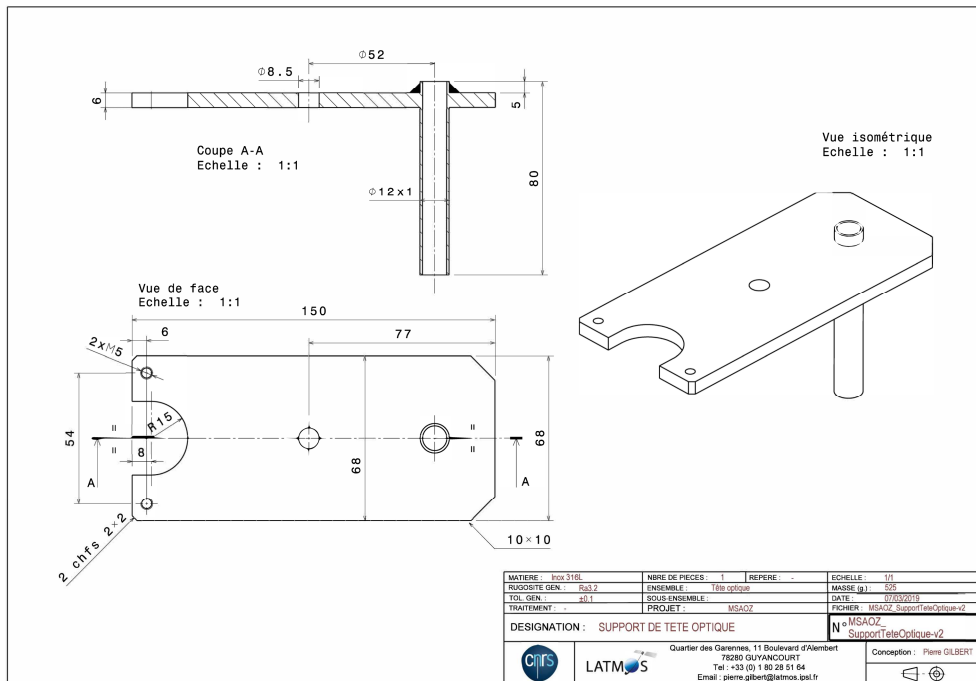


Fig. 2a. Mechanical drawing of the support of the optical head.

2.2 Hardware connections

The Mini-SAOZ box is connected to:

- power supply adapters connected to "power supply" (220Vac/110Vac - 50/60Hz);
- USB cable to Computer;
- GPS antenna (outdoor) via a standard 5 meter long coaxial cable and a SMA connector (30 m cable for Marion Dufresne);
- Optical fibre bundle standard 5-10 meter long connected to an optical head (outdoor) via a bulkhead special FC/PC connector (30 m long fibre for Marion Dufresne).

Computer: **see Handbook Part3 for Computer installation**

If the computer is a laptop, it is important to open the laptop before connecting to power.

USB connections: It is important to respect the identified USB ports for the mouse and mini-SAOZ box. Do not mix.

Computer internal clock must be in local time.

- First: Switch ON Mini-SAOZ box
 Second: Switch ON Computer

When the computer is connected, it switches ON automatically, boots and starts all automatic software.

The software "SAOZ" starts automatically.

The default screen appears Figure 3 (Windows 10)

The updated version of SAOZ software on October 15, 2020 is v1.39-5f5dff.

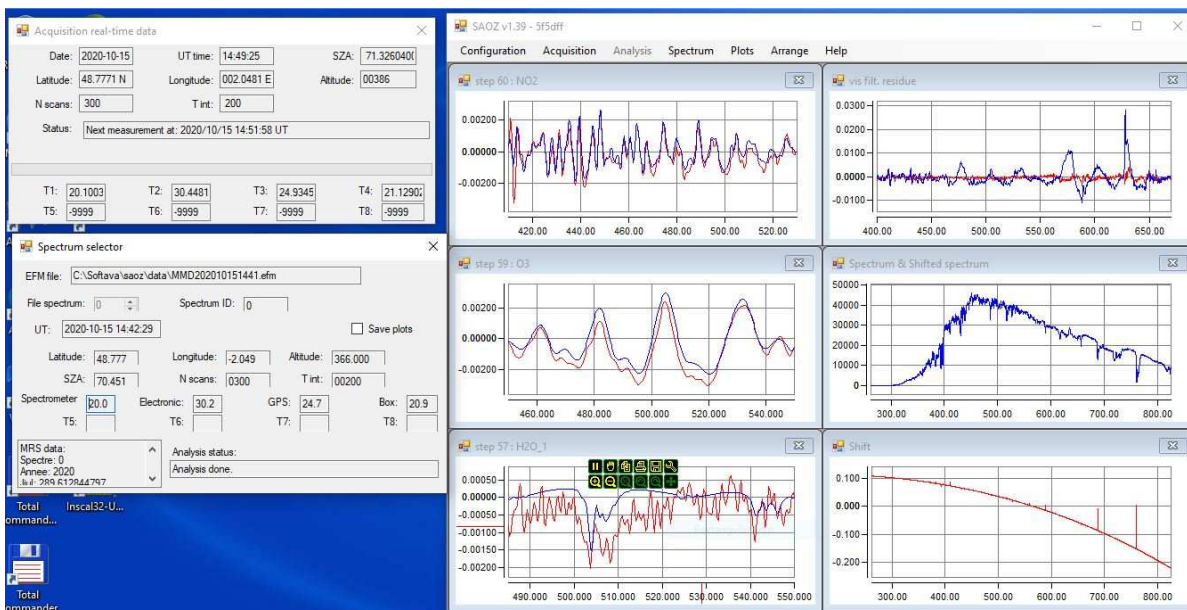


Fig. 3 Mini-SAOZ software (SAOZ) screen in automatic Real-time mode (windows 10)

The software runs automatically with pre-stored parameters stored in: <c:\softava\sam\conf.acq>, which **MUST** be adapted to the station site.

This file ([conf.acq](c:\softava\sam\conf.acq)) is used by the acquisition software (and possibly by the level 2 Igor software if installed).

The file is also used in case of GPS malfunction.

SAOZ software “SAOZ” must be stopped to modify pre-stored parameters.

- a- STOP SAOZ: (see fig 4)
 - o Menu “ACQUISITION”
 - o Choose “STOP”



Fig. 4 SAOZ software screen to STOP (quit) the Real-time mode.

The “STOP” command will not be immediately taken into account if the instrument is getting spectra. It is necessary to wait until the end of the cycle: SPE (spectrum) and OBS (dark current). (Fig 4a)

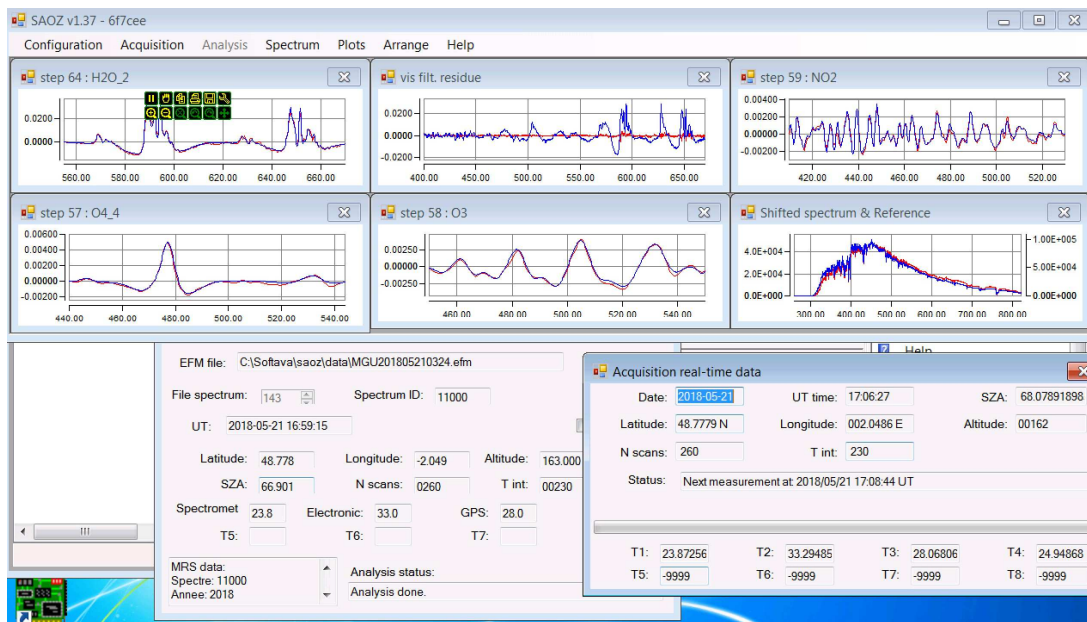


Fig. 4a STATUS in acquisition window is “Next Measurement at ...”.

When the STATUS in acquisition window is “Next Measurement at ...” it is possible to have access to the configuration menu.

- b- Modify the parameters stored in **c:\softava\sam\conf.acq**
 - o Menu “CONFIGURATION”
 - o Choose “Configure”
 - o Choose the tab “Acquisition”

A new window will open (Fig 4b)

There are 4 parameters, which need to be carefully checked and modified:

- latitude=+**48.778** (Sign: + North; - South; location in decimal degree)
- longitude=-**2.048** (Sign: + West; - East; location in decimal degree)
- altitude=**163** (Elevation in Meters)
- File prefix=**MGU** (Three characters, the first being “M” for Mini-SAOZ” and the last two characters indicate the station name “GU” for GUYANCOURT, “OH” for OHP)

Here below the example for OHP/LATMOS site (Fig 4b)

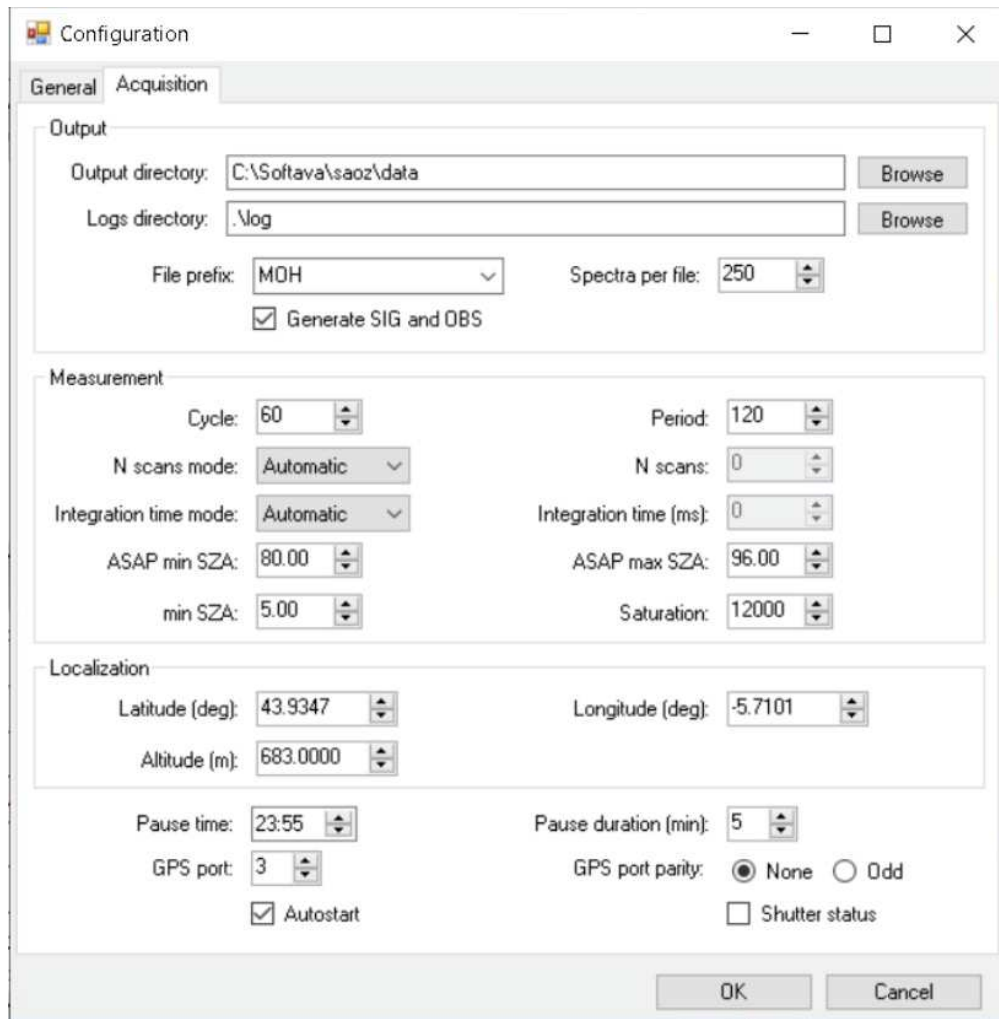


Fig. 4b SAOZ software screen to modify the parameters of the station.

An example and description of the “conf.acq” file is proposed in Appendix 2.

3. Description of Software Folders

The Mini-SAOZ software has been installed during the computer installation (see Handbook part 3) before delivery of the instrument and the Mini-SAOZ is ready to operate.

The installation process creates a “Main” folder named “c:\Softava” and 6 (six) “Sub” folders named:

- “c:\Softava\Batchs”
- “c:\Softava\CDs”
- “c:\Softava\installer”
- “c:\Softava\reanalyse”
- “c:\Softava\sam”
- “c:\Softava\saoz”

3.1 Batches

The batch files located in the “Batch” folder are used every day to process the data and archive them in the SAOZ directory.

- listFolder_data.bat Creates the lists of files to be transferred after midnight, each day;
- codeStation.txt Created by ListFolder_data.bat Batch, 3 letters station code;
- fdate.txt Created by ListFolder_data.bat Batch, gives the date of the last Level2 processing;
- transfertData.bat Transfer the daily data (and spectrometer optional files) in separate folders:
 - *efm files -> saoz\mini\0\YYYY ;
 - *mrs files -> saoz\mini\1\YYYY
 - *.Sig, *.Obs, *.gps -> saoz\avantes\last_week.
- mrs_an_trier.cmd Concatenate *yyyy*.mrs files into an_en_cours.mrs in saoz\mini\1\YYYY;
- Weeklzarcc.bat Zip all avantes optional files into a WLog *.zip;
- igor.cmd Batch to launch the level2 processing (optional). The program is located in AMF folder (see below);
- AMF Folder Contains:
 - The Retraite_ALLXX.pxp Igor program;
 - The Look-up tables used for O3 and NO2 daily AMF;
 - The Dos program to calculate AMF.
- Cygwin_tools Folder Contains:
 - .Dll used for Unix DOS program;
 - dos software used by various batch programs.
- ftp2Paris.cmd Transfer to LATMOS *.efm and *.mrs files.
If the script is activated a log folder (ftp_log folder) is which are stored the name of the transferred files is ftp2parisYYYYMMJJ.txt

3.2 Cds

This folder contains a copy of the various CD installers used by Mini-SAOZ:

- Avantes Folder Contains the Avasoft installation software;
- Compressor Folder Contains various compressio software;
- GPS Folder Contains various software to test the GPS;
- Ms_libs Folder Contains various software to re-install libraries;
- USB_TC Folder Contains various software to re-install the temperature Sensors;

- Watchdog Folder Used to reinstall the watchdog (optional hardware);
- Wavemetrics Folder Used to reinstall the IGOR software. Use the setup software first and the update after (Igor 6.3.7)
- Shutter Folder shutter.exe used to monitor shutter functioning;
- Utilities Folder Tcmd951ax32_64.exe used to reinstall total commander;
- Npp7.8.6installer.x64
- Win_update_stop_setup.exe
- Winscp-5.15.9-setup.exe (for ssh and sftp)
- Remote Desktop Folder Contains Software Folder with software not installed:
 - Anydesk5.exe
 - Teamviewer15.exe

3.3 Installer folder

This folder contains a copy of all necessary software program for the real-time and re-analysis software installation in case of problem.

A USB “installation flash drive” is provided with the Mini-SAOZ in case of installation of a new PC with all acquisition, analysis and visualisation software.

The name of the USB flash drive is “SpectrometerSerialNumber” where serial is the number of the Avantes spectrometer.

3.4 Re-analysis folder

The Reanalyse folder is made of one folder:

- Folder “c:\Softava\reanalyse\sam”

This folder is similar to the one used in real-time described below in §4.3.5.

The default output folder to re-analyse the data is:

- Folder “c:\Softava\reanalyze\sam\data”

This folder is used to copy *.efm files to be re-analysed.

3.5 SAM folder

The SAM folder is composed of 18 files and 4 folders:

- Main software “saoz_gui.exe”;
- Main configuration file “conf.gui”;
- Acquisition configuration file “conf.acq”; (see Appendix 2);
- Seven “dll” files used by main software:
 - Mitov.PlotLab.dll;

- Mitov.PlotLabBasic.dll;
 - Mitov.SignalLabBasic.dll;
 - AS5216.dll;
 - Cbw32.dll;
 - Saoz_acq.dll;
 - Saoz_analysis.dll;
- log files “gui.log”
- log file “gui_old.log”.
- hot_pixels_SERIAL_DATE_VERSION.cfg is a text file, which contains the location of the “bad/hot” pixels if any. (“SERIAL” is serial number of spectrometer)
 - For Marion Dufresne: hot_pixels_1810209U1_20200728_2.cfg
- nl_correct_SERIAL_DATE_VERSION.cfg is a text file which contains the parameters taking into account the default of linearity of the detector. (“SERIAL” is serial number of spectrometer)
 - For Marion Dufresne: nl_correct_1810209U1_20200728_2.cfg
- Folder “SecRV_Serial_YYYYMMDD_HHMMSS_v”: (“serial” is serial number of spectrometer followed by date and time of Reference spectrum, v: version number)
 - For Marion Dufresne: nl_correct_1810209U1_20200728_2.cfg.
 - This folder contains the absorption cross sections (xxx.ibw) and the wavelength law (lambda.ibw) adapted to the spectrometer plus the reference spectrum (spectre.ibw)
 - The analysis configuration file “INIT_v3Rms_mini” is located in this folder.
 - Informations about the date and time of the reference spectrum: Resolutions.pdf
 - An IGOR software containing information about the residual in reference spectrum (O3 and NO2) is in the following folder:
 - “c:\Softava\Batchs\StationRealTime.pxp
- Folder “doc”:
 - Help on line ... to be updated
- Folder “log”:
 - The log files are created every time “SAOZ” software is launched.
- Folder “plots”:
 - The plot files are created by an action: tick “plot” in the “spectrum selector window”.

3.6 SAOZ folder

The folder “SAOZ” contains three folders:

- Folder “avantes”
 - where the log files of the spectrometer will be stored (for further check in case of problem of the spectrometer or GPS) and compressed (Zip files).

- Folder “data”:
 - where the real-time *.efm and *.mrs data are stored during daytime;
 - where all optional files (used in case of problem of the spectrometer or GPS) obs*.efm, sig*.efm, *.gps files are stored during daytime.

- Folder “mini” where the data will be transferred and stored every day:
 - Spectra xxxxxxxx.efm in folder “0”
 - Slant columns xxxxxxxx.mrs in folder “1”
 - If vertical columns are calculated using
 - Vertical columns O3_YYYY.ZZ in folder “2”

In each folder, “0” for Level 0, “1” for Level 1, “2” for Level 2 there are sub-directory corresponding to the various years of measurements, for example “2020”, “2021”.

3.7 Program aliases on desktop

Program aliases are on the left side of the desktop (Fig 5).

- Saoz -> to run SAOZ Real-Time program
- Saoz_reanalysis -> to run the re-analysis software
- Trimble_Studio -> to test the GPS and configure if necessary
- Avasoft 8 -> to test the spectrometer
- Disable_mad_mouse -> to disable the “mad mouse”
- Arduino -> not used (to run the watchdog)
- Inscal32-USB-TC -> to test the temperatures
- Total Commander 64 -> to run Total Commander

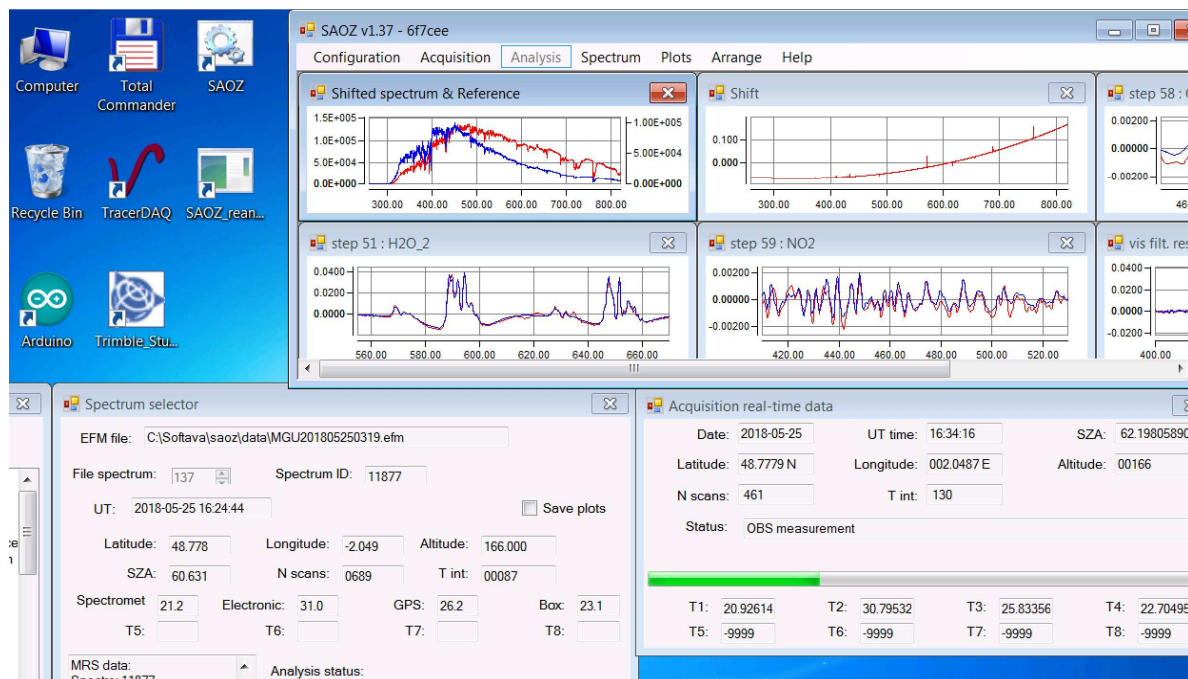


Fig. 5 Program aliases on the left side of the desktop.

4. Description of General Operations

Mini-SAOZ measurements are performed from sunrise to sunset up to 96° SZA. The exposure duration is adjusted automatically between 0.02s to 72s and the spectra co-added in memory during a 60s duty cycle (in case of low signal, the duty cycle is increased to 72s). Dark current are measured, with the same exposure time and spectra number. The true signal at each pixel is then the observed sky spectra corrected for dark current. The Mini-SAOZ processor is driven by accurate SZA calculated from GPS time, latitude and longitude measurements. The configuration of the instrument is recorded in a text file, which can be modified if necessary.

The Mini-SAOZ software is driving the spectrometer, the shutter, the temperature sensors, the GPS, it records spectra and functioning log files and analyses in real time to get slant columns of the various molecules (Ozone, Nitrogen dioxide, water vapour, oxygen, etc.), see the schematic in Figure 6.

The Mini-SAOZ software is composed of three principal modules located in c:\Softava\sam\:

- The main software saoz_gui.exe
- The acquisition module saoz_acq.dll
- The analysis module located in a sub-directory saoz_analysis.dll

The main software is driving the acquisition and the analysis software. It is also used for the various graphics presentations. This main software, “saoz_gui.exe” is hereafter referred as SAOZ software.

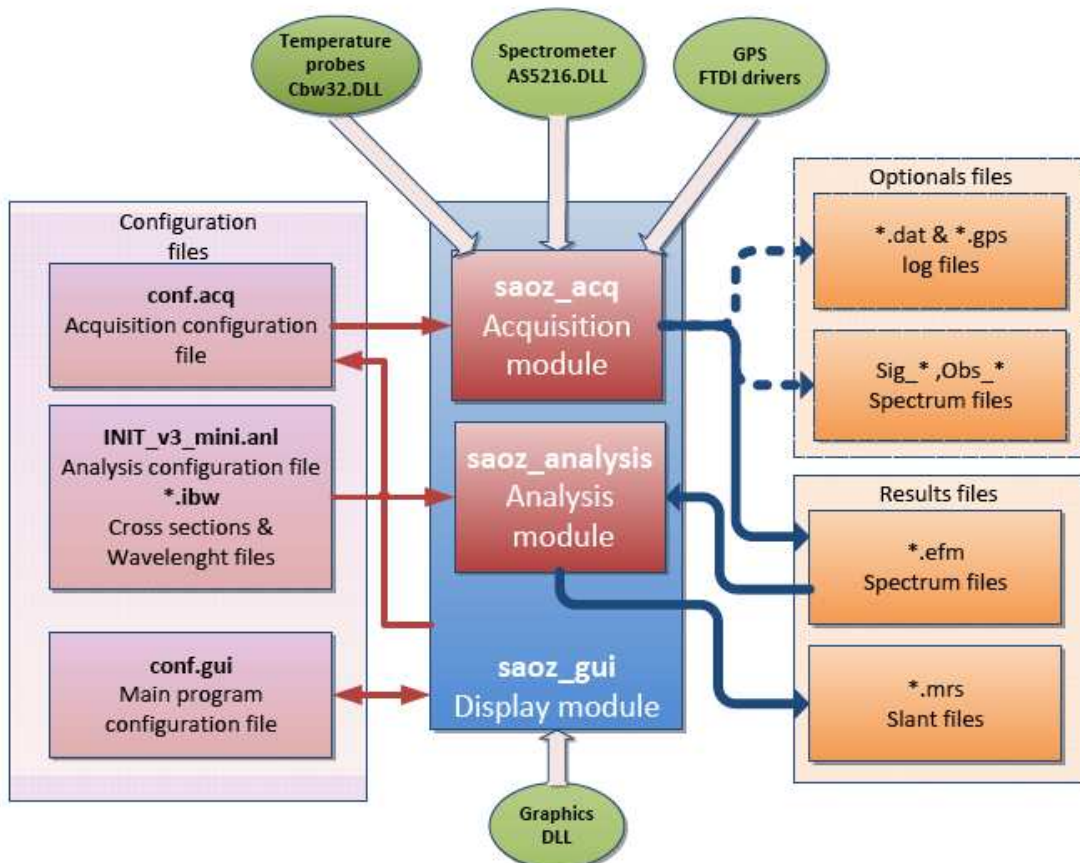


Fig. 6 Schematic of the SAOZ software

4.1 Measurement Cycle

As already explained in previous section, the Mini-SAOZ measurements are performed during daytime, that is between 96° SZA in the morning and 96° SZA in the evening.

One can distinguish two measurement cycles, twilight and daytime cycle.

Note that the measurement (observed spectrum) is obtained only when the shutter of the spectrometer is open. In order to take into account the temperature variations of the detector, it is necessary to record regularly dark current spectra (obs. spectrum).

Note also that “Dark current” is not recorded after each spectrum. It is recorded:

- ✓ If the integration time has changed
- ✓ After 10 acquired spectra with the same integration time.

a) Twilight cycle

The typical cycle (cf. Figure 7) during sunrise and sunset (when the light is changing rapidly the integration time (T_{int}) is adjusted automatically after each acquisition) is the following:

Measurement (60 sec.) is followed by Dark current (60 sec.).

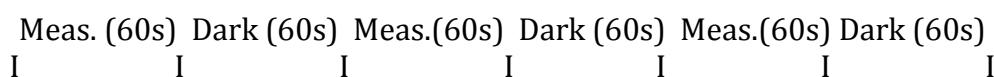


Fig. 7 Typical cycle during sunrise/sunset periods

Usually this cycle is used when $SZA > 80^\circ$.

b) Daytime cycle

During daytime, that is when $SZA < 80^\circ$ the instrument is no more sensitive to the stratospheric minor constituents and the interval between two measurements is increased (cf. Figure 8).

Usually an interval of 900 sec is chosen between two measurements. This period can be reduced to 300 sec to study tropospheric pollution every 5 minutes or increased to 3600 sec to perform measurements every hour to save space on the hard disc.

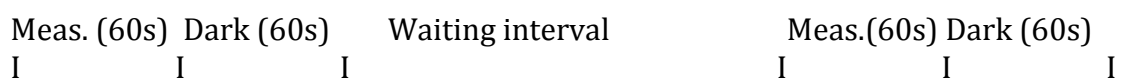


Fig. 8 Typical cycle during daytime

The interval between two measurements during daytime is given by the “daytime_measurement_period” parameter as indicated in conf.acq file.

The raw spectra are stored in “Level 0” binary files (.efm files) in which dark current is already removed. Ancillary data such as time, SZA, GPS location, exposure time, number of co-added spectra, and temperature inside the instrument, are also recorded.

The measurement cycle parameters are stored in “conf.acq” configuration file (cf. Appendix 2).

4.2 Data organization

During daytime, after each spectrum acquisition, the data are analysed and the spectra together with the results of analysis are stored in

c:\Softava\saoz\data

- Data: *.efm and *.mrs files of the day are stored in this folder;
- Optional files (sig*.efm, obs*.efm, *.gps) are stored in this folder.

During night that is just before the local midnight the lists of the data to be transferred during night-time are produced, the three lists are:

- List_efm.tmp of *.efm files;
- List_mrs.tmp of *.mrs files;
- List_forAvantes.tmp for optional data.

Just after midnight,

❖ The three file lists are used to transfer the data:

- Using List_efm.tmp, the spectra or level 0 data, named ***.efm are transferred in c:\Softava\saoz\mini\0\YYYY
- Using List_mrs.tmp, the results of analysis or level 1 data, named ***.mrs are transferred in c:\Softava\saoz\mini\1\YYYY
- Using List_forAvantes.tmp all optional data are transferred in the log files and transferred in c:\Softava\saoz\avantes\last_week

❖ The optional level2 “RETRAITE_ALL27” software process the level 1 data in order to build the level 2 which results are located in

c:\Softava\saoz\mini\2\YYYY

The level 2 are annual files.

It is also possible to transfer the data locally or elsewhere for archive purposes.

4.3 Task scheduler

All operations described here below are planned and performed daily using the scheduler of the computer. See the Figure 9 for the timing of the scheduled tasks.

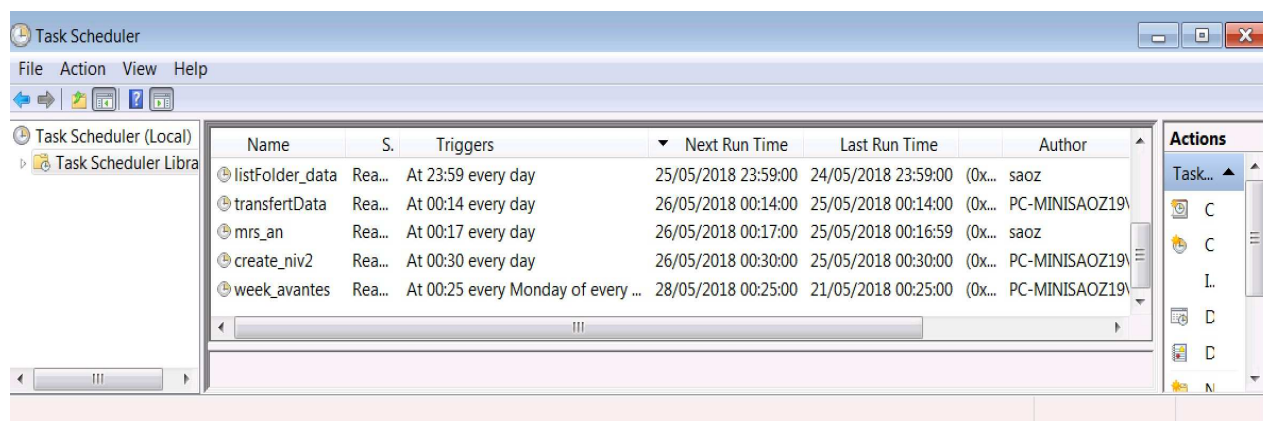


Fig. 9. Scheduled tasks and time of operations

The action of scheduled tasks is described below:

a) At 23:59 - list_folderdata

Action: calls c:\Softava\Batchs\List_folderdata.bat

List the files of the day to be transferred in final directory

- Calculation the date
- List of *.efm files located in c:\Softava\saoz\data
- List of *.mrs files located in c:\Softava\saoz\data
- List of optional Sig,obs and GPS log files in c:\Softava\saoz\data

b) At 00:14 – transfer_data

Action: calls c:\Softava\Batchs\ TransferData.bat

Do the transfer of the files listed by the above action (List_folderdata) in final directory (spectra *.efm, analysis *.mrs and optional files)

- Level 0 *.efm files
 - Transfer in c:\Softava\saoz\mini\0\YYYY
- Level 1 *.mrs files
 - Transfer in c:\Softava\saoz\mini\1\YYYY
- Optional files
 - Transfer in c:\Softava\saoz\avantes\last_week

c) At 00:17 – mrs_an

Action: calls c:\Softava\Batchs\mrs_an_trier.cmd

Concatenate all the daily analysis files (M*.mrs) in c:\Softava\saoz\mini\1\YYYY in an annual file named an_en_cours.mrs in the same folder

d) At 00:30 – create_niv2 (optional)

Action: calls c:\Softava\Batchs\igor.cmd

This task will calculate the vertical columns (Level 2).

- It calls an IGOR procedure located in
 - c:\softava\Batchs\AMF\Retraite_ALLXX.PXP
 - XX: version number
- The results of this processing (Level 2 files) are stored in
 - Transfer in c:\Softava\saoz\mini\2\YYYY

e) Every Monday at 00:25 –Week_avantes.bat

Action: calls c:\Softava\Batchs\WeekIzarcc.bat

This task will compress all files located in c:\Softava\saoz\avantes\last_week into c:\Softava\saoz\avantes.

Overall schematic of the Mini-SAOZ data organization and scheduled tasks is shown in Figure 10.

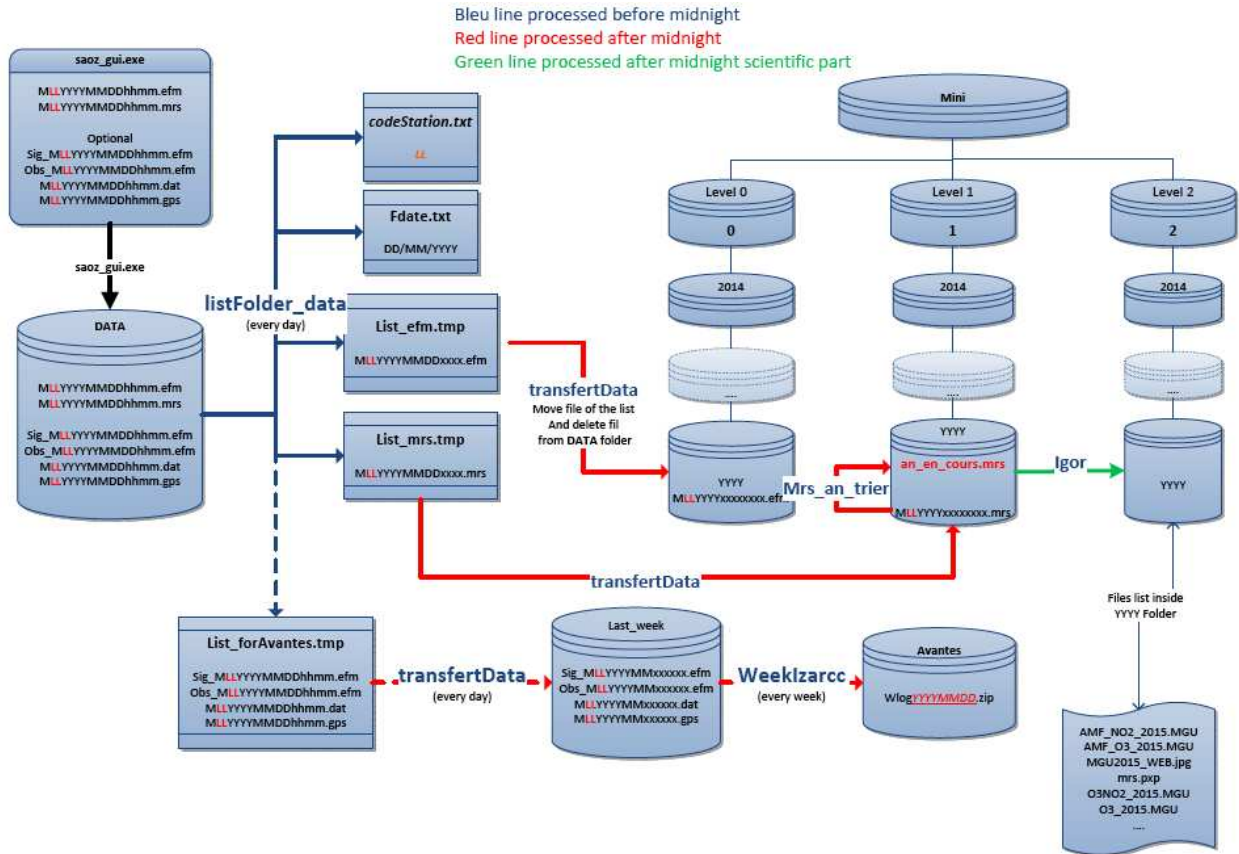


Fig. 10. Schematic of the Mini-SAOZ data organization and scheduled tasks

5 Description of Mini-SAOZ files

The Mini-SAOZ instrument provides three kinds of data: **(see Handbook Part 1)**

Level 0: the raw spectra (binary files)

Level 1: the results of spectral analysis (ascii files)

Level 2: the geophysical data like ozone or NO₂ columns (optional text files)

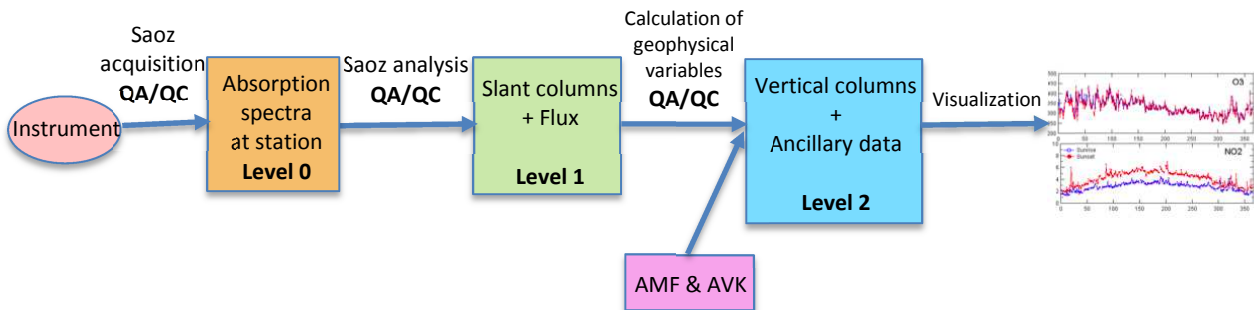


Fig. 11. Scheme of SAOZ data (At each step, there is quality control check- QA/QC)

5.1 Absorption Spectra – Level 0

The SAOZ program creates daily spectra files defined by *.efm.

For example: the file MZG201410031503.efm for Mini-SAOZ instrument, located at Zhigansk recorded on October 3, 2014 at 15:03.

M	→ the suffix indicates which instrument type. S for SAOZ - M for Mini-SAOZ - B for Balloon borne instrument.
ZG	→ corresponds to the station name ex: Zhigansk
2014	→ Year ex: 2014
10	→ Month
03	→ Day
15	→ Hour
03	→ Minute

The *.efm files are binary ones.

The level 0 files are located in c:\Softava\saoz\mini\0\YYYY.

They can be read by “saoz re-analysis” program.

5.2 Slant columns - Level 1

The SAOZ program analyses the daily spectra files (*.efm) and creates daily result (*.mrs) with the same prefix as the corresponding *.efm file.

For example: MZG201410031503.mrs when analysing the MZG201410031503.efm.

The level 1 files are located in c:\Softava\saoz\mini\1\YYYY.

The *.mrs files are ASCII files. They can be read with any spread-sheet software (Excel) or Igor.

The description of the Header of *.mrs files can be found in Appendix 3 “Mini-SAOZ File formats”.

5.3 Vertical columns - Level 2 (optional)

The vertical columns are averaged for each twilight, sunrise and sunset in the range of solar zenith angles of 86°-91°.

These files, named for example O3_2014.ZG for the year 2014 and the Zhigansk station, are Yearly files.

The Level 2 data are generated using the following Igor software [RETRAITE_allXX.pxp](#) (where XX is the version number of software).

Ozone and NO₂

The O3_YYYY.XX file contains the NO₂ and Ozone stratospheric vertical columns.

The header of the files indicates which AMF have been used, the units and the name of the columns:

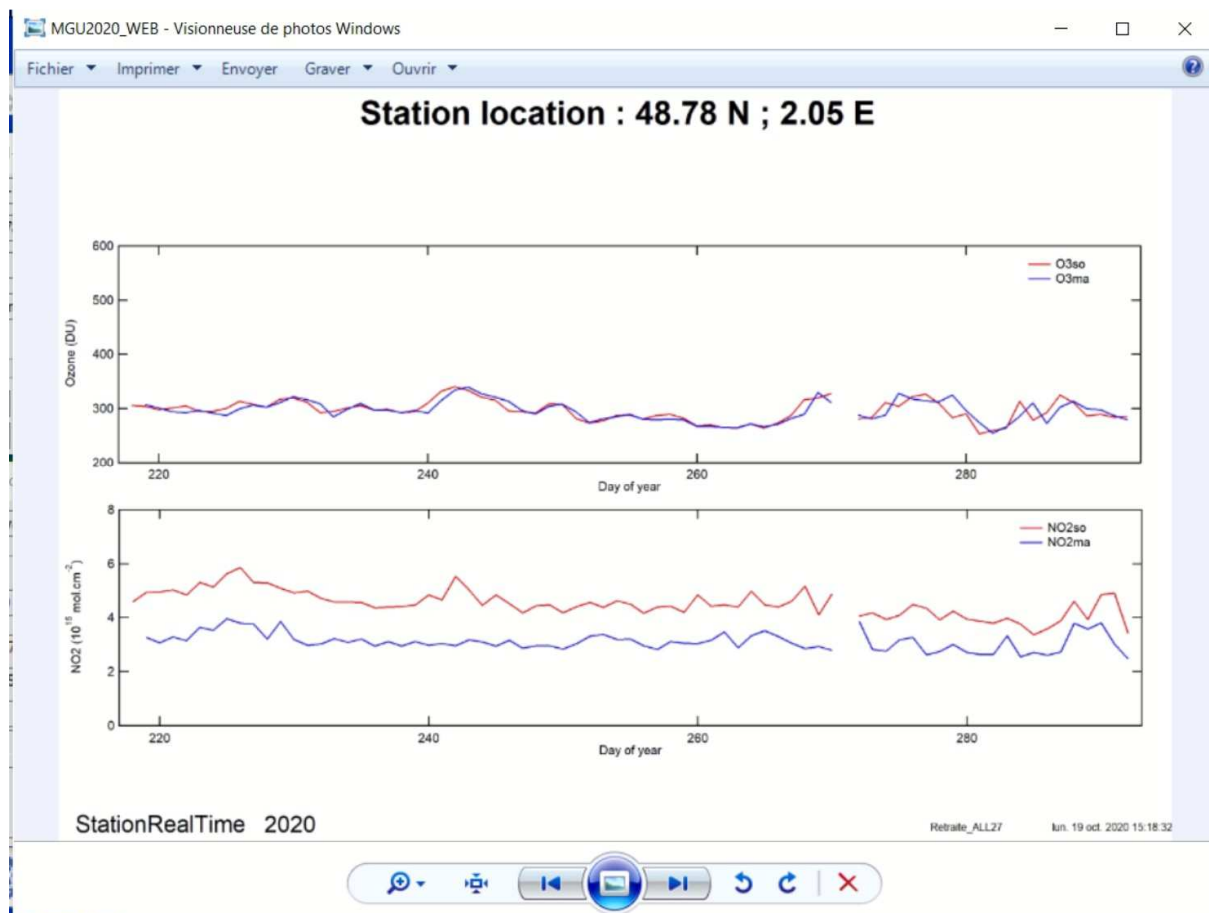


Fig. 12. Mini-SAOZ Ozone and NO2 vertical columns (M*_WEB.jpg)

6 Getting started with the software

Before starting the main Mini-SAOZ software (“SAOZ”) check that the `c:\Softava\sam\conf.acq` is correct (see Appendix 2).

Restart the computer or choose the shortcut SAOZ located on the laptop desktop to start the SAOZ software or run `c:\Softava\sam\saoz_gui.exe`.

This program will run automatically in Real-Time mode.

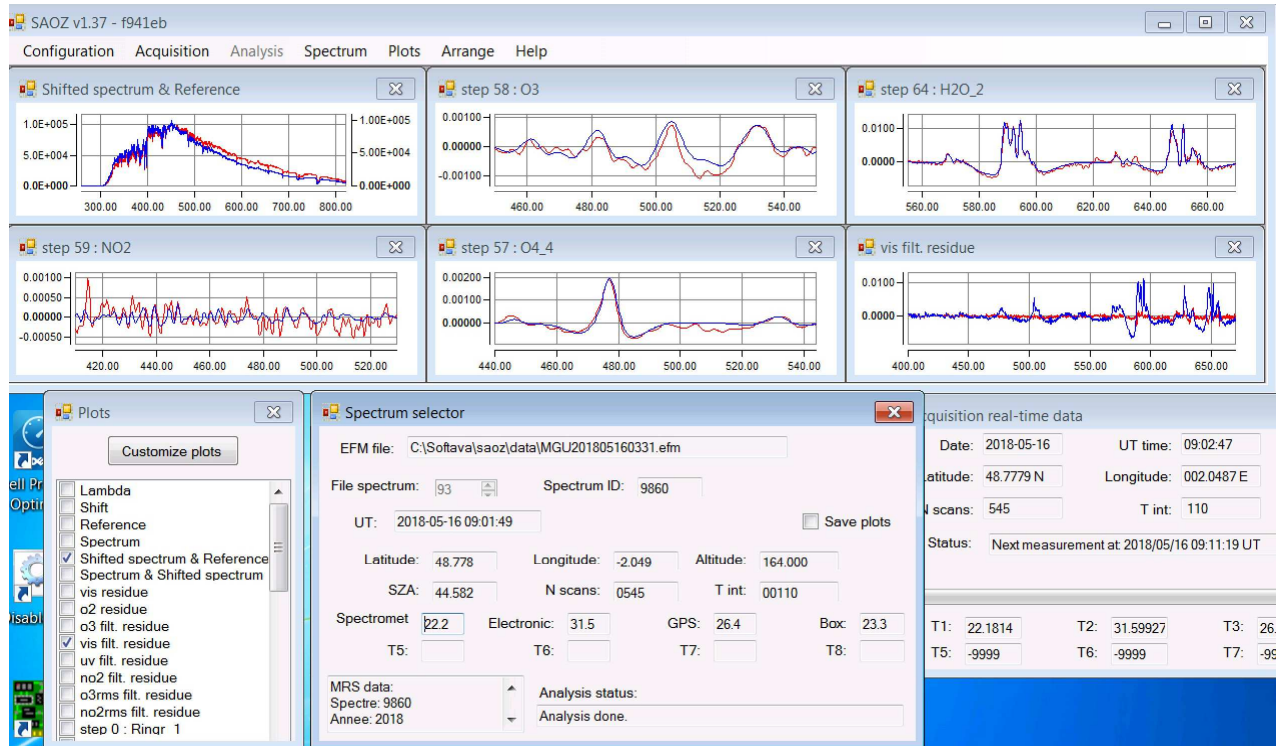


Fig. 13. SAOZ software default screen

The default screen (cf. Figure 13) displays six graphs and three windows below the graphs:

- The top left graph named “Spectrum & Reference” displays the actual spectrum (red) and the reference spectrum (blue). The X axis is the wavelength law, the Y axis is in counts/sec.
- The middle top graph named “Step 58: O3” displays the comparison between cross section (blue) and differential absorption spectrum (red). The X axis is the wavelength law, the Y axis is optical thickness.
- The top right graph named “Shift” displays the shift between actual spectrum and the reference spectrum. The X axis is the wavelength law, the Y axis is in pixel.
- The bottom right graph named “Vis fit residue” displays differential absorption spectrum before (blue) and after (red) processing. The X axis is the wavelength law, the Y axis is optical thickness.
- The bottom left graph named “Step 59: NO2” displays the comparison between cross section (blue) and differential absorption spectrum (red). The X axis is the wavelength law, the Y axis is optical thickness.
- Bottom left window named “Spectrum selector” with the last recorded spectrum information :
 - EFM file: Name of EFM file
 - File spectrum: Number of recorded spectra in the file
 - Spectrum ID: Spectrum ID of the last recorded spectrum
 - UT: Date and Time in UT of last recorded spectrum
 - Latitude: In decimal degree (North positive)
 - Longitude: In decimal degree (West positive)
 - Altitude: in meters
 - SZA: Solar Zenith Angle of the last recorded spectrum
 - N scans: Number of co-added spectra

- T Int: Integration time of the last recorded spectrum
 - Spectrometer: Temperature of the spectrometer
 - Electronics: "" electronics
 - GPS: "" GPS
 - Box: "" Mini-SAOZ Box
 - MRS data: Results of analysis of the last recorded spectrum
 - Analysis status: Analysis done (OK) or Flux too low (not analysed)
- Bottom right window named "Acquisition real-time data" with information after the instrument has performed a measurement (otherwise all boxes are empty except the temperature information):
 - Date: Actual Date in "Year-Month-Day" format
 - UT time: Actual Time (in UT) in "HH:MM:SS" format
 - SZA: Actual Solar Zenith Angle
 - Latitude: In decimal degree (North or South indication)
 - Longitude: In decimal degree (West or East indication)
 - Altitude: in meters
 - N scans: Number of scans of the on-going spectrum
 - T Int: Integration time of the on-going spectrum
 - Status: see fig 24a, 24b, 24c
 - Spectrometer: Temperature of the spectrometer
 - Electronics: "" electronics
 - GPS: "" GPS
 - Box: "" Mini-SAOZ Box
 - T5 to T8 not used

The "Acquisition real-time data" window displays what the Mini-SAOZ is doing. There are three possibilities:

1. The instrument is recording a spectrum with the shutter open (see Fig. 14a).
2. The instrument is recording a dark current with the shutter closed (see Fig. 14b).
3. The instrument is in hold. It displays at what time the next measurement will be performed (see Fig. 14c).

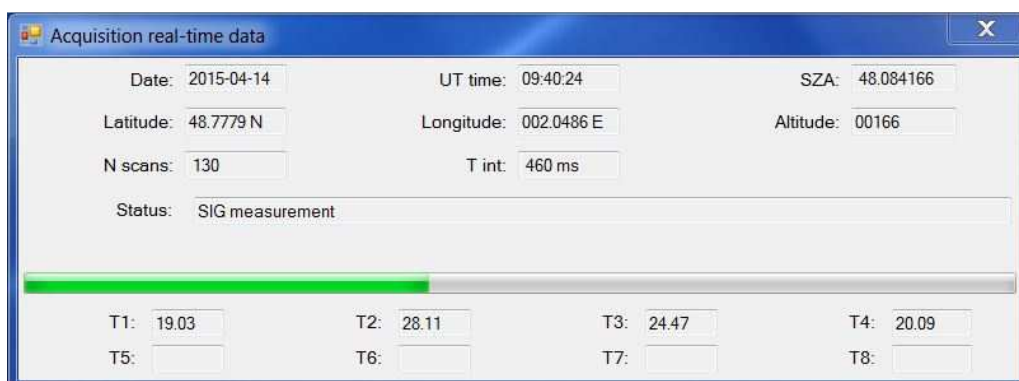


Fig. 14a Window: Acquisition Real-time data: SIG Measurement



Fig. 14b Window: Acquisition Real-time data: OBS Measurement

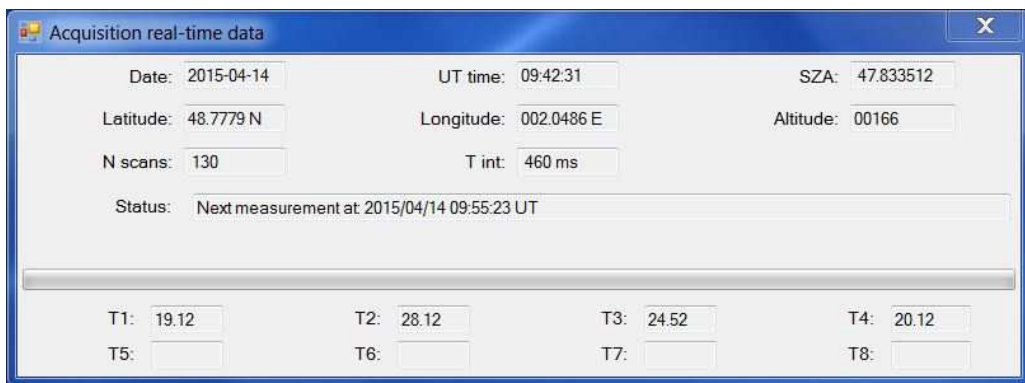


Fig. 14c Window: Acquisition Real-time data: Next Measurement

6.1 Description of the various Menu

6.1.1 Configuration Menu

See Figure 15.

- Configure: *Edit sub-menu "Configure"*
 - Two windows:
 - General
 - Acquisition
- Quit

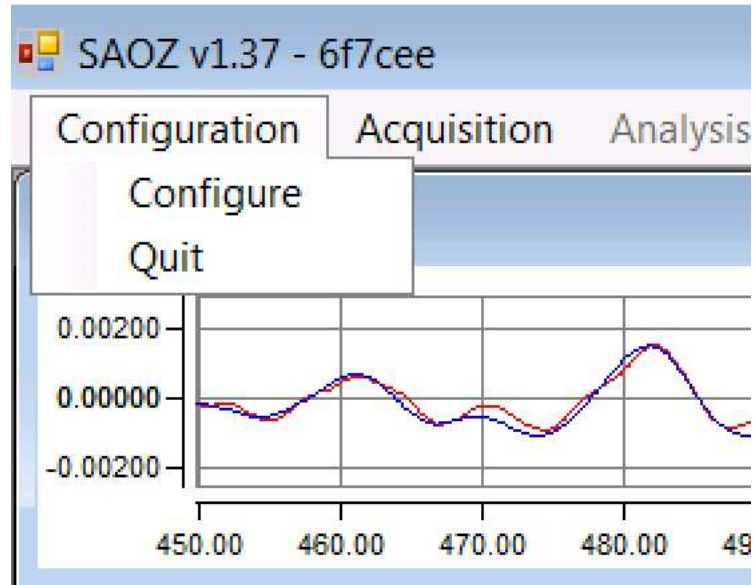


Fig 15. Configuration Menu

Edit Sub-Menu

- General sub-menu

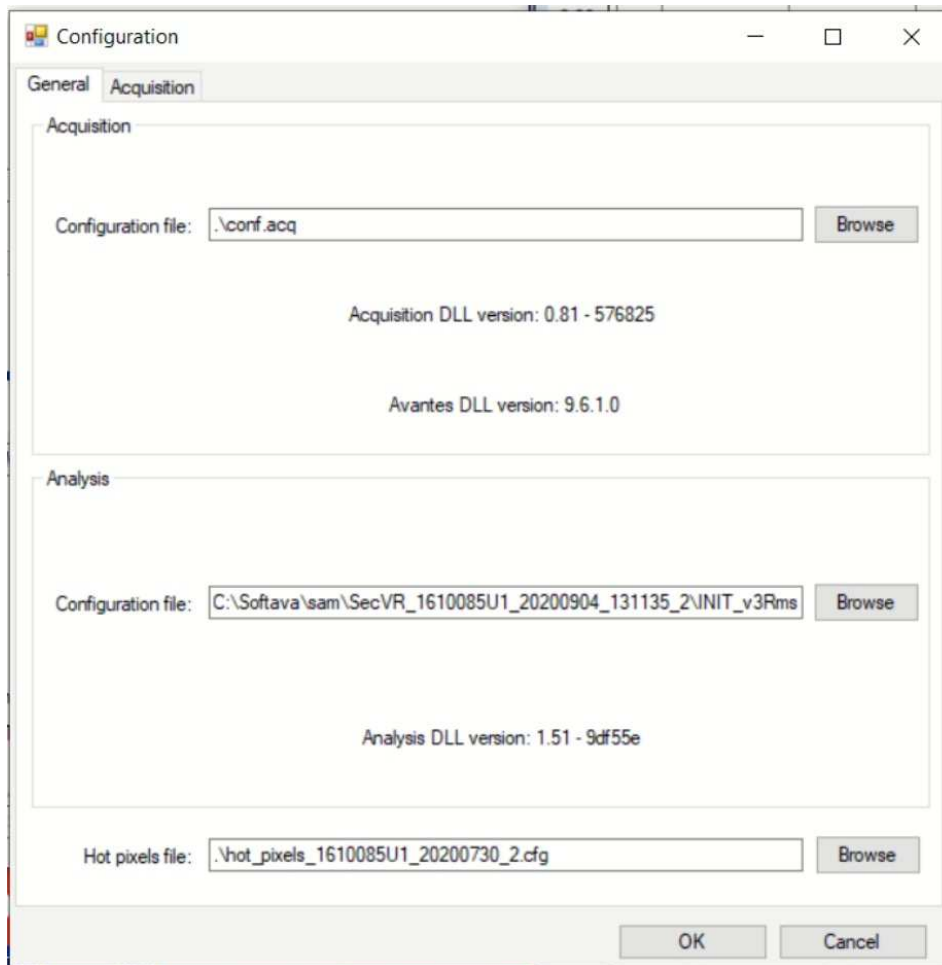


Fig 16. Configuration Menu: General Window

- This window shows in which folder is the acquisition configuration file.
- This window indicates in which folder are the analysis configuration file (Init_v3Rms_mini.anl) and the location of “hot pixels” file
- Note that the path to various folder are relative to the SAOZ software location.
- In addition, there is an indication of the “.DLL” used in the SAOZ software. The last version are the following:

SAOZ 15/10/2020

GUI	1.39	-	5f5dff
Analysis	1.51	-	e8ef45
Acquisition	0.81	-	576825
Avantes	9.6.1.0		

○ Acquisition window

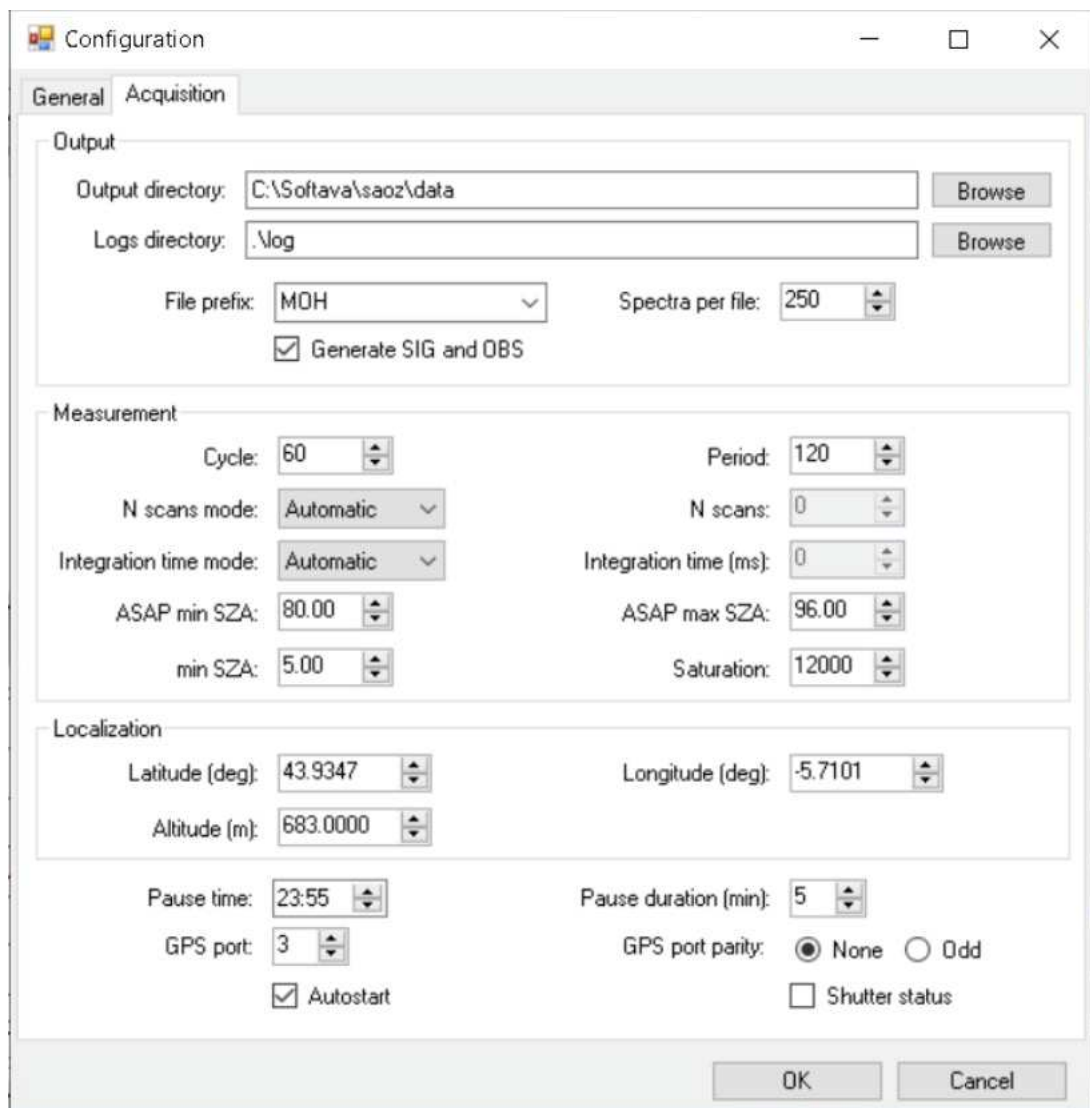


Fig 17. Configuration Menu: Acquisition Window

Output: This part allows to modify Output parameters:

- Output directory
- Log directory if any
- EFM and MRS file prefix (Three letters) here MGU
- The number of spectra per file (by default 250)
- Generate SIG and OBS separate files in case of problems
-

Measurement: This part allows to modify the measurement parameters which can be modified and stored in conf.acq file.

- Cycle: number of seconds
- Period: Time between 2 measurements during daytime
- N scans mode: automatic by default
- Integration time mode: automatic by default
- ASAP min SZA (see Table App 2-1: in Appendix 2)
-

Location:

- Latitude
- Longitude
- Altitude

The parameters in the bottom part of the configuration Menu, Acquisition Sub-Menu, are stored in C:\Softava\sam\conf.gui

- Pause time 23:55 (0 by default)
- Pause duration 5 (0 by default)
- Autostart 1 by default (0 in Re-analysis mode)
- Watchdog 0 by default (not used)

6.1.2 Acquisition Menu

There are two sub-menus:

- Real-time data To start the real-time data
- Start To start the analysis (real-time)

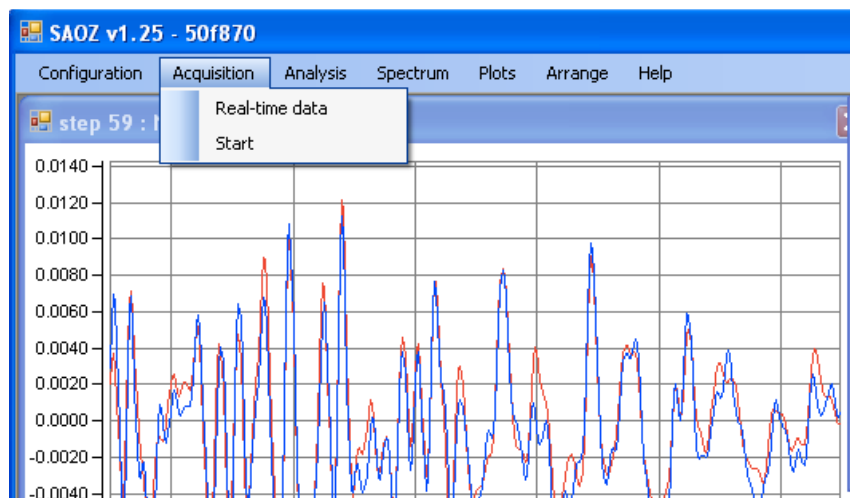


Fig. 18. SAOZ software screen to start the Real-time mode.

- Shutter_status 0 by default (not used)

6.1.3 Analysis Menu

This menu is only active in Re-Analysis mode, that is if the Real-time program has been stopped by pushing “Stop” in Acquisition Menu.

There are two sub-menus:

- Analyse EFMs To choose the *.efm files to be re-analysed
- Create reference To create a reference spectrum.

6.1.4 Spectrum Menu

Displays the “spectrum selector” window

6.1.5 Plot Menu

Displays the “Plot” window

For example choose: Shift
 Spectrum & reference
 Vis filt. Residue
Step 51 H2O_2
Step 58 O3
Step 59 NO2

And gives access to the sub-menu: “customize Plots”

Note that the first column of customize plots are X axis and second column Y axis

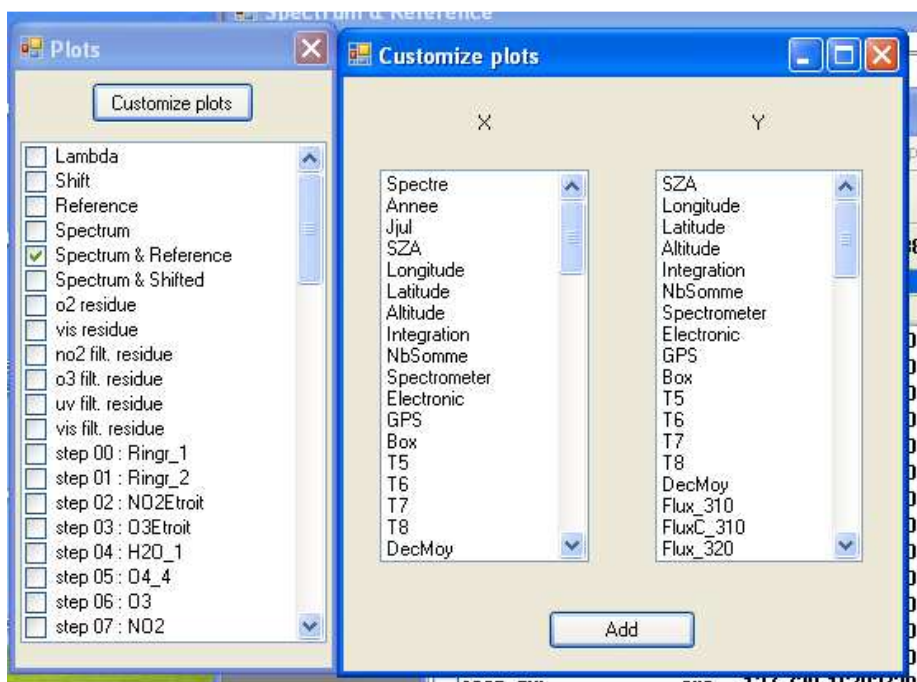


Fig. 19. SAOZ software “Plot” Sub-Menu

6.1.6 Arrange Menu

Arrange the various plots on the SAOZ window.

6.1.7 Arrange Menu

Displays the “Help on-line” (under Construction).

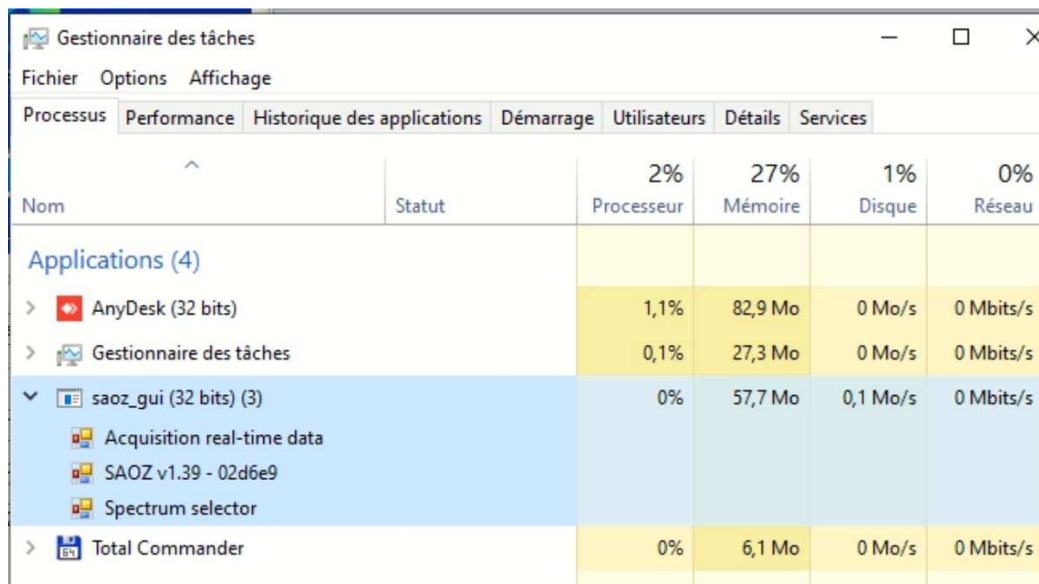
4 Troubleshooting

In case of problem: Switch OFF the instrument. After a while, the PC will restart automatically. When PC restarts, Switch ON the instrument. The SAOZ software will restart.

7.1 Software

If there is a problem with SAOZ software use the Task Manager Software to kill the program (CTRL+ALT+SUPPRESS)

- Select *Processes* (cf. Figure 20 Windows 10)

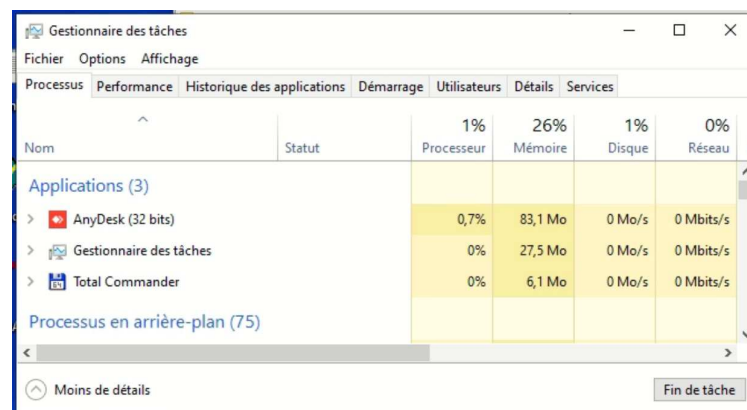


The screenshot shows the Windows Task Manager Performance tab. The 'Processus' tab is selected, and the 'Applications (4)' group is expanded. The 'saoz_gui (32 bits) (3)' group is selected, showing three sub-processes: 'Acquisition real-time data', 'SAOZ v1.39 - 02d6e9', and 'Spectrum selector'. The 'Total Commander' process is also visible. The table below summarizes the resource usage for the visible processes.

Nom	Statut	Processeur	Mémoire	Disque	Réseau
Applications (4)					
> AnyDesk (32 bits)		1,1%	82,9 Mo	0 Mo/s	0 Mbits/s
> Gestionnaire des tâches		0,1%	27,3 Mo	0 Mo/s	0 Mbits/s
saoz_gui (32 bits) (3)					
Acquisition real-time data		0%	57,7 Mo	0,1 Mo/s	0 Mbits/s
SAOZ v1.39 - 02d6e9					
Spectrum selector					
> Total Commander		0%	6,1 Mo	0 Mo/s	0 Mbits/s

Fig. 20. Task Manager: use the “Processes window”. Windows 10

- Or Kill saoz_gui.exe (windows 10) Figure 21



The screenshot shows the Windows Task Manager Performance tab. The 'Processus' tab is selected, and the 'Applications (3)' group is expanded. The 'Total Commander' process is visible. The table below summarizes the resource usage for the visible processes.

Nom	Statut	Processeur	Mémoire	Disque	Réseau
Applications (3)					
> AnyDesk (32 bits)		0,7%	83,1 Mo	0 Mo/s	0 Mbits/s
> Gestionnaire des tâches		0%	27,5 Mo	0 Mo/s	0 Mbits/s
> Total Commander		0%	6,1 Mo	0 Mo/s	0 Mbits/s
Processus en arrière-plan (75)					

Fig. 21. Task Manager: Force to kill saoz_acq.exe – Windows 10.

- Restart SAOZ

7.2 Printer setup

If there is a problem with the impression of graphics it may come from printer setup.

For a correct presentation of the "Layouts", it is necessary to have set a default printer in A4 format.

In the start menu select: (see Handbook_Part3)

Devices and Printers

Left click on « Microsoft XPS Document Writer »

Right click on « Set as default printer »

Left click on « Microsoft XPS Document Writer »

Right click on « Printing preferences »

Click on « Advanced »

Select A4 for « Paper Size: »

Right click on « OK »

Right click on « Apply »

Right click on « OK »

The virtual printer "**Microsoft XPS Document Writer**" becomes the default printer in A4 format.

7.3 Configuration of the acquisition program in the configuration file

The optional *Retraite_ALLxx.pxp* uses the location information of the instrument stored in the acquisition software configuration file "c:\Softava\sam\conf.acq".

The procedure to build correctly the *conf.acq* file is described in Appendix 2.

If SAOZ real time software is stopped, it is possible to modify the *conf.acq* file using *NotePad* to edit it. There are 4 lines to be modified.

latitude= <i>XX.XXXX</i>	(Sign: + to the north and - for the South)
longitude=± <i>XX.XXXX</i>	(Sign: + to the West - to the East)
altitude= <i>MMM</i>	(Elevation in meters)
efm_prefix= <i>MXX</i>	(Three characters, the first being an "M" for "Mini SAOZ" and the last two characterize the station name)

Example for mobile instrument:

Latitude = 0.000

Longitude = 0.000

Elevation = 0

efm_prefix=*MMD* (**M** for Mini-SAOZ; **MD** for Marion-Dufresne)

7.4 Task Scheduler problem

Facts:

- The level 2 data are NOT created

Reasons:

- The "create_niv2" task does not run correctly "igor.cmd" in c:/softava/Batches

Solution:

- Delete "create_niv2" in the "Task Scheduler" window.
- Run: "schedule_tasks.bat" in c:/softava/Installer
- Refresh the "Task Scheduler" window to check that the task has been created.
- The task can be run manually.

Facts:

- The various scheduled task do not work

Reasons:

- There is a problem with run user and run password

Solution:

- Delete “listFolder_data” in the “Task Scheduler” window.
- Delete “Transferdata” in the “Task Scheduler” window.
- Delete “mrs_an” in the “Task Scheduler” window.
- Delete “create_niv2” in the “Task Scheduler” window.
- Delete “week_avantes” in the “Task Scheduler” window.
- Run: “schedule_tasks.bat” in c:/softava/Installer
- Refresh the “Task Scheduler” window to check that the task has been created.
- The task can be run manually.

7.5 Power failure

Facts:

- Instrument not detected: Power diode 12V, 5V OFF;
- Acquisition failed: Acquisition window blocked or empty.

Reasons:

- Instrument not correctly powered.

Solution:

- Check connections and power supply;
- Check tension at the output of power supply on the 5 pin DIN connector (cf. Figure 22).

5 way 45° DIN	
Pin	Tension/current
1	Common Pins/Ground
2	Common Pins/Ground
3	+5Vdc 2.5A
4	Common Pins/Ground
5	+12Vdc 1A
Shield/Ground	Common Pins/Ground

Fig. 22 Connector at the output of Power supply

7.6 SerialBallPoint problems

Facts:

- The cursor moves on the screen by itself;
- Icons or program are selected or activated without any action.

Reasons:

The GPS is using a FTDI. The system is considering wrongly this FTDI as a « SerialBallPoint » (this default is well-known by Microsoft but never corrected). All messages coming from the GPS activate cursor and/or click.

The FTDI driver is correctly installed BUT the « SerialBallPoint » driver is not disabled.

Normally, when installing SAOZ, the « SerialBallPoint » driver is disabled. However, it may happen that a system update activates the « SerialBallPoint » driver.

Solution:

If possible, click on the alias “disable_ballpoint” on the desktop. However this action is very difficult since the cursor is permanently moving.

Switch OFF the instrument and click rapidly on the alias “disable_ballpoint”.

The best solution is:

- Switch Off the instrument;
- Quit SAOZ software (or “kill” using task manager);
- Click on the alias “disable_ballpoint” on the desktop to run the software which will wait until the « SerialBallPoint» is activated to disable it;
- Switch ON the instrument. When receiving data from the FTDI the system will activate the « SerialBallPoint» and the “disable_ballpoint” software will disable it;
- Run SAOZ (using alias on desktop);
- The « SerialBallPoint» will be disabled until the next Update of Microsoft.

7.7 Instrument is not working

7.7.1 Check drivers' installation

Look for “**Device Manager**” on the command line

The nominal behaviour of the driver activated or disabled is shown on Figure 23.

- **driver AvaSpec-USB2** is missing
-> there is a problem with the spectrometer
- **USB serial Port** missing or **USB Serial Converter** missing
-> there is a problem with GPS or Driver FTDI

7.7.2 AvaSpec-USB2 driver is missing

Facts:

- No spectra acquired;
- Error message.

Reasons:

- Spectrometer/power diode switched OFF: No power on the spectrometer (12V);
- Driver AS5216 is missing: electronic noise perturbs the USB link;
- System default: driver AvaSpec-USB2 is missing, spectrometer is not detected.

Solution:

- Check power supply;
- Switch OFF instrument and PC and switch ON again (the instrument first);
- If there is still a problem Look for **AvaSoft8** on command line. The spectrometer should be automatically detected;
- If the spectrometer is not detected contact Mini-SAOZ Manufacturer.

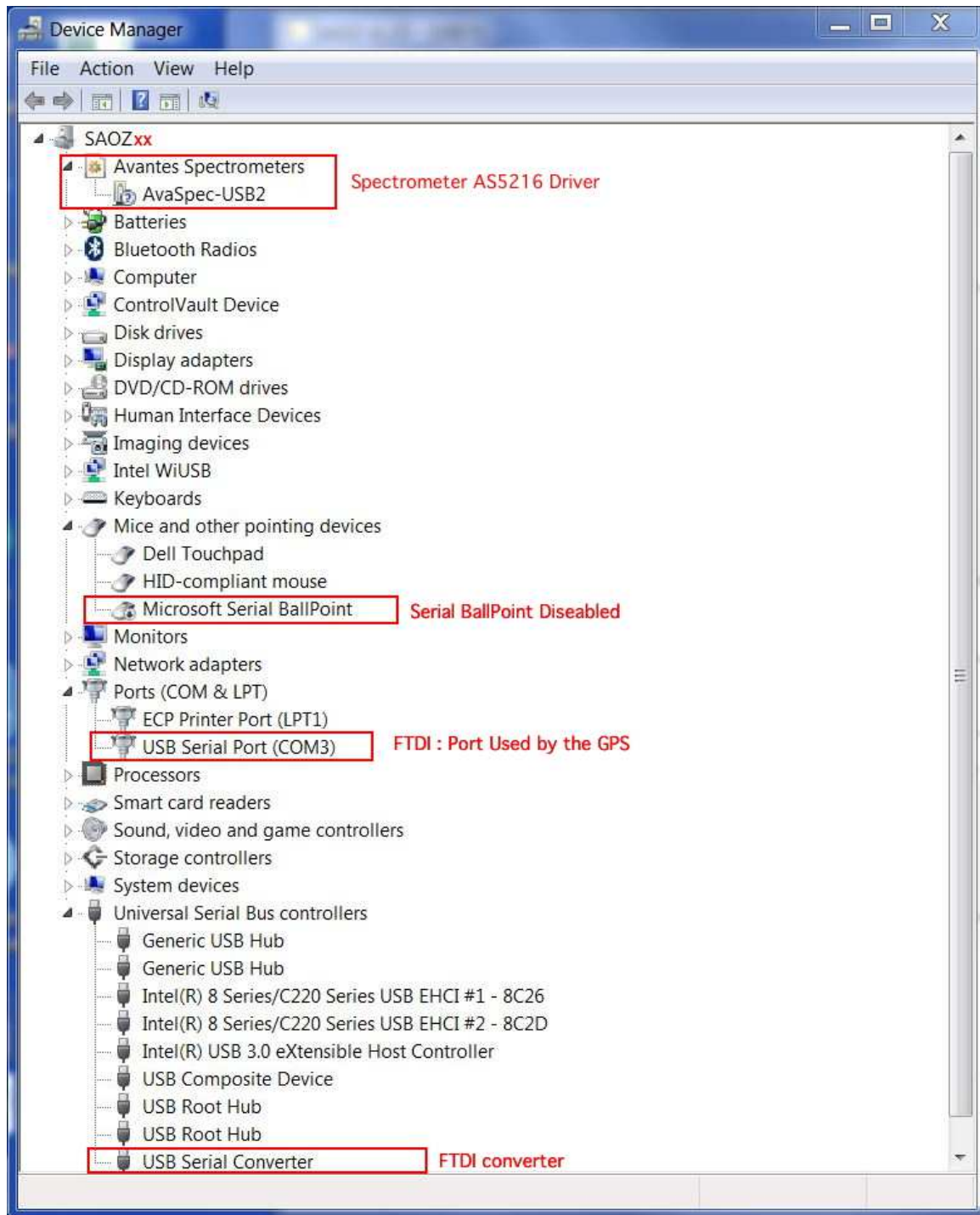


Fig. 23 Device Manager Window

7.7.3 GPS Problem

Facts:

- No position data (longitude, latitude, altitude) in the “Acquisition real-Time data” window.

Reasons:

- Antenna is not connected;
- FTDI driver problem;
- Problem with port (COM);

- Loss of the GPS configuration.
Solution:
 - Check the connection of the Antenna (the antenna must be outside);
 - Check if the FTDI driver is present;
 - If Driver FTDI is missing, reinstall it using
C: \Softava\CDs\GPS\DRiver FTDI (VCP) Windows\ CDM20814_Setup;
- Test the GPS:
 - STOP SAOZ (Menu Acquisition/Stop and Configuration/Quit);
 - Look for **“Trimble_Studio”** on command line
 - If this windows appears, asking to update the software (Figure 24) answer **“NO”**.

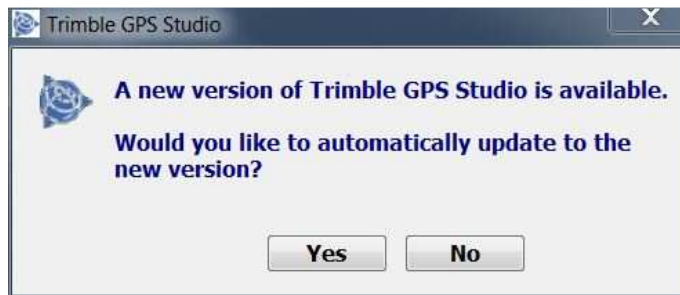


Fig. 24 Testing GPS: Answer “NO”

- With this test program it is necessary to provide the correct port number. In Menu choose **New Connection.../ USB Serial Port (COMxx)** (cf. Figure 46) It is necessary to test COM1, COM2 etc... to find the correct one. Usually the GPS is connected in COM3.



Fig. 25 Choose “New Connection”

- Check that the settings are correct (cf. Figure 26).
 - Nominal settings are (4800, None, 8, 1)
 - If the settings are not correct see APPENDIX 5.

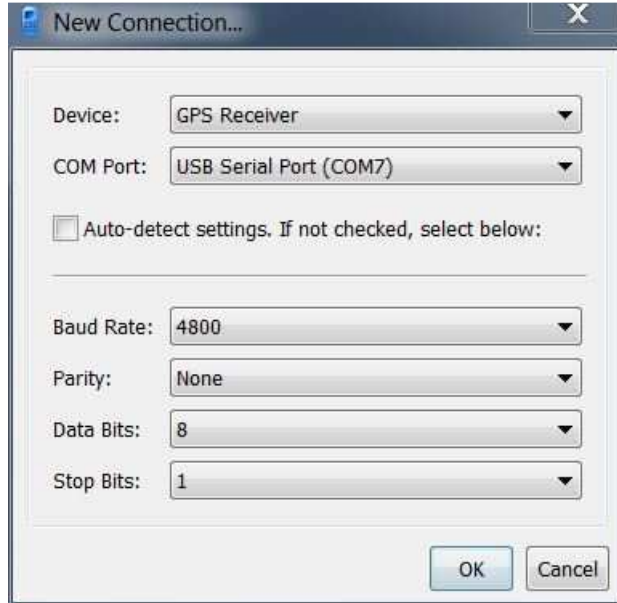


Fig. 26 GPS settings

The Figure 27 shows the nominal display when GPS is working properly.

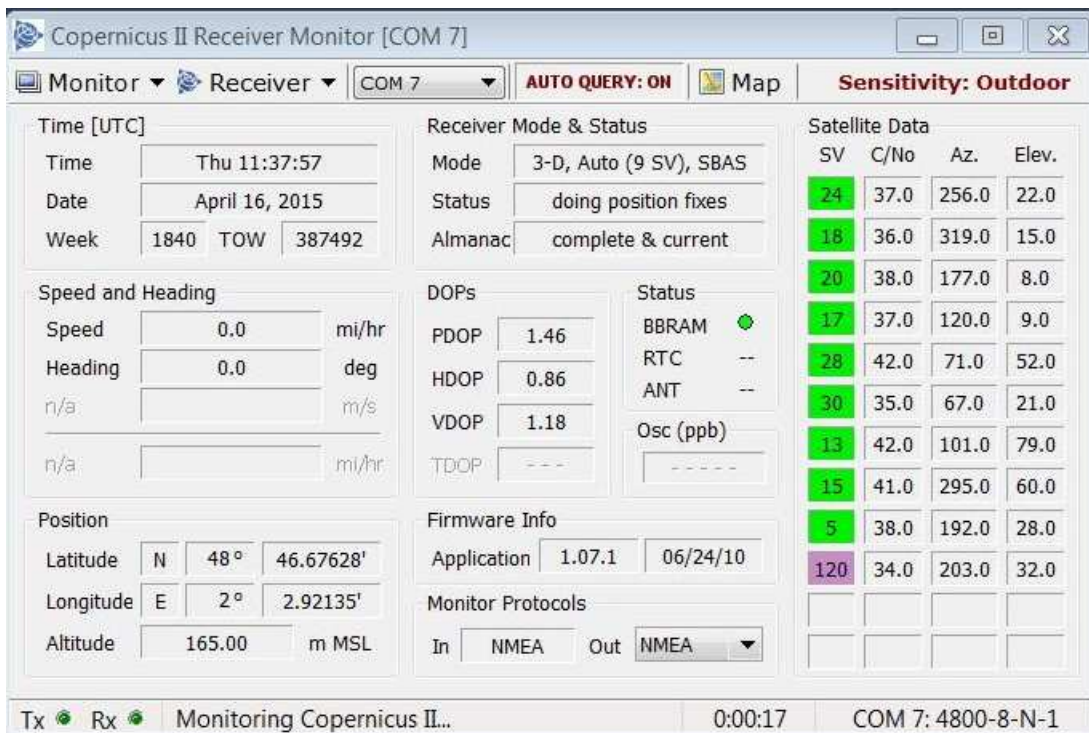


Fig. 27 GPS active and works nominally.

The Figure 28 shows the GPS window if there is a problem with the antenna.

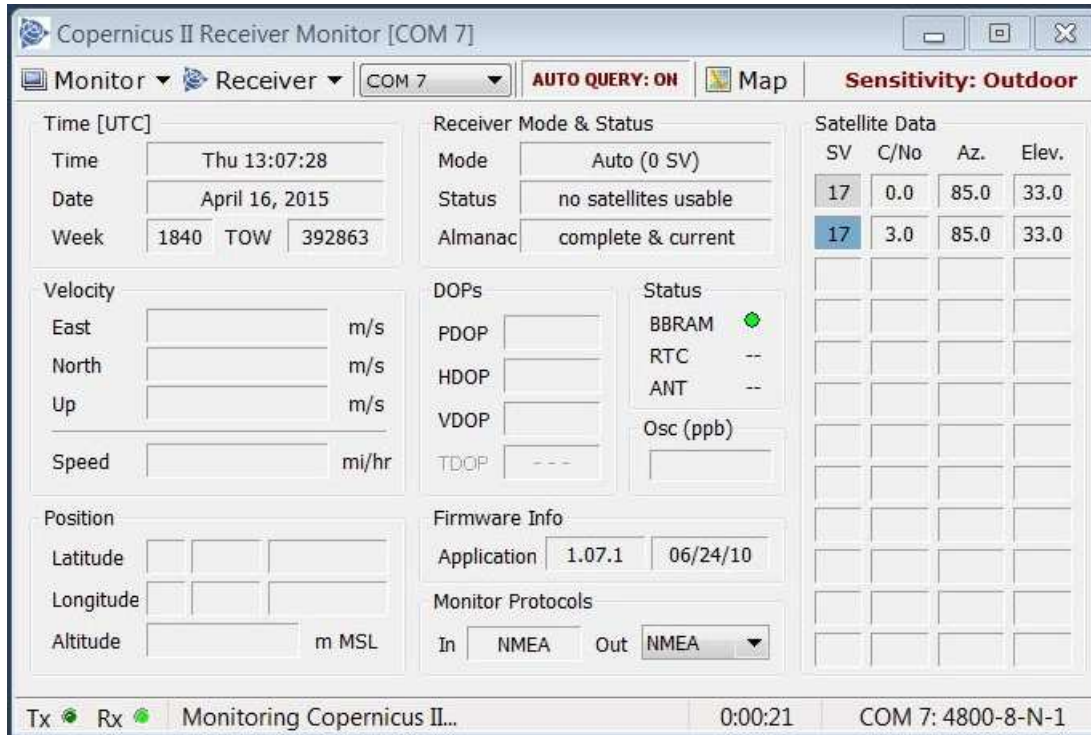


Fig. 28 GPS is not working properly – antenna problem.

If the GPS has lost its configuration see **APPENDIX 4**

7.7.4 Temperature sensors

In case of problems, check if the temperature device is working:

- Run “**inscal32 - USB-TC**” alias on desktop
 - Measurement Computing
 - Instacal
 - Click on Board#0 – USB-TC
 - Select “Test” menu
 - Analog
 - Test

7.7.5 Shutter

If there is a problem with the shutter, use a software provided by the Mini-SAOZ manufacturer to test it on DOS.

Open a command line as shown on Figure 29.

Change folder `cd "c:\Softava\cd\shutter`

- Write `Shutter open` to open the shutter
- Write `Shutter close` to close the shutter

```
Administrator: C:\Windows\system32\cmd.exe
C:\Softava\Test Program>shutter
Usage: shutter <COMMAND>
Commands:
  open   :   open shutter
  close  :   close shutter

C:\Softava\Test Program>shutter open
CMD SHUTTER: init USB-TC DO 0
CMD SHUTTER: init USB-TC DO 1
CMD SHUTTER: init USB-TC DO 2
CMD SHUTTER: init USB-TC DO 3
CMD SHUTTER: init USB-TC DI 4
OPEN SHUTTER
LOG: shutter not closed

C:\Softava\Test Program>shutter close
CMD SHUTTER: init USB-TC DO 0
CMD SHUTTER: init USB-TC DO 1
CMD SHUTTER: init USB-TC DO 2
CMD SHUTTER: init USB-TC DO 3
CMD SHUTTER: init USB-TC DI 4
CLOSE SHUTTER
LOG: shutter closed

C:\Softava\Test Program>
```

Fig. 29 Shutter acquisition window

7.7.6 No more signal

If there is no more signal inside the Mini-Saoz, there could be a problem with the fibre optics connexion. See Appendix 6

APPENDIX 1

Mini-SAOZ Data Sheet and Specifications

<u>Specifications:</u>	Power supply adapters
Input voltage	100-240 VAC (limits: 90-264VAC)
Input frequency	47 to 63Hz (Limits: 47-440Hz)
Input current	0.3A (rms) for 115VAC, 0.2A (rms) for 230VAC
Safety ground leakage current	0.25mA max @ 240 VAC 50Hz
Output voltage	+5Vdc/+12Vdc (±5% tolerance)
Output current	2.50A/1.00A
Output power range	25 Watts max
Ripple	1% peak to peak maximum
Over voltage protection	Provided on outputs set at 112~132% of its nominal output voltage
Over current protection	all outputs protected to handle short circuit conditions
Temperature coefficient	all outputs ±0.04% /°C max.
Transient response	maximum excursion of 4% or better on all models recovering to 1% of final value within 500uS after a 25% step load change
Operating temperature	0°C ~ +40°C
Storage temperature	-40°C to +85°C
Relative humidity	5% to 95% non-condensing
Weight and dimensions	0.6 kg 11x6.7x3.7 cm (LxWxH)
<u>Specifications:</u>	SAOZ Box
Input voltage	+5Vdc/+12Vdc (+/-5% tolerance)
Input current	2.50A/1.00A
Operating temperature	0°C ~ +25°C
Weight and dimensions	4.1 kg 37x25x15 cm (LxWxH)
<u>Specifications:</u>	Optical head
Operating temperature	-40°C ~ +70°C
Fibre length, weight	5 to 10 m, 0.3 Kg (Marion Dufresne 30m)
Maximum radius curvature of the optical fibre	15 cm
Humidity	5 % to 95 %
Weight and dimensions	0.5 kg 15 x 6.8 x 8 cm (LxWxH)
<u>Specifications:</u>	GPS Antenna
Cable length	5 m (Marion Dufresne 30m)
Operating temperature	-40°C ~ +85°C
Humidity	20 % to 95 %
<u>Specifications:</u>	Laptop
Manufacturer	DELL (for bios configuration)
Processor	i7-4610M CPU @ 3.00GHz or more
Memory	8 Gb or more
USB 2 port	2 or more
Hard disk	≥ 500 GB
Operating System	Windows 10 Pro
Weight and dimensions for DELL Precision M4700	3.9 kg 36x26x33 cm (LxWxH)
Mouse	Wired Mouse
<u>Specifications:</u>	DELL Laptop Power supply
Input voltage	100-240 VAC 50-60 Hz 2.34 A
Output voltage	+19.5Vdc 9.23 A

APPENDIX 2

Acquisition file description

Example of conf.acq acquisition file

```
[GLOBAL]
output_dir=C:\Softava\saoz\data
efm_prefix=MGU
n_file_spectra=250
write_sig_obs_efm=1
n_measurements=-1
measurement_cycle=60
daytime_measurement_period=600
obs=algo
min_sza=5
asap_min_sza=80
asap_max_sza=96
latitude=48.778
longitude=-2.048
altitude=163
n_scans=0
integration_time=0
gps_port=3
gps_port_parity=0
n_int_times = 68
n_base_int_times = 17
base_int_time_0 = 10
base_int_time_1 = 11
base_int_time_2 = 13
base_int_time_3 = 15
base_int_time_4 = 17
base_int_time_5 = 20
base_int_time_6 = 23
base_int_time_7 = 26
base_int_time_8 = 30
base_int_time_9 = 34
base_int_time_10 = 39
base_int_time_11 = 44
base_int_time_12 = 51
base_int_time_13 = 58
base_int_time_14 = 67
base_int_time_15 = 76
base_int_time_16 = 87

shutter_type=RDI232

# first spectrometer parameters
# spectrometer serial (see saoz_acq.exe -l)
[1802166U1]
saturation=12000
lambda_file=.\SecRVxxxxxxxxxxx\lambda.ibw
```

Overall description of “conf.acq” file is given in Table App 2-1.

Table App 2-1: Description of the “conf.acq” file

NAME	VALUE	DESCRIPTION
output_dir	..\saoz\data	Folder of all data
Efm_prefix	MXX	Three letters: M for Mini-SAOZ 2 letters for the name of station
n_file_spectra	250	Maximum number of spectra per data files
write_sig_obs_efm	0	0 by default, 1= allows to have a record of raw spectra and dark current separately.
n_measurements	-1	-1 by default for ground-based instruments.
measurement_cycle	60	Measurement cycle of SAOZ in seconds (usually 60)
daytime_measurement_period	900	During daytime (outside twilight) interval in sec. between two measurements (usually 900)
obs	algo	Performs a dark current spectrum every 10 spectra or every time the integration time has changed
min_sza	10	No spectra recorded/analysed if the SZA is < min_sza.
asap_min_sza	80	Minimum SZA value of twilight measurements =ASAP mode (As Soon As Possible).
asap_max_sza	96	Maximum SZA value of twilight measurements=ASAP mode
latitude	XX.XXXX	Sign + for NORTH - for SOUTH The value is in decimal degree
longitude	XXX.XXXX	Sign + for WEST - for EAST The value is in decimal degree
altitude	XXX	The Altitude must be in meters
n_scans	0	0 by default, calculated automatically using integration_time and cycle parameters
integration_time	0	0 by default, calculated automatically depending of the light entering in spectrometer
gps_port	X	Port on which the GPS is connected In case of failure of the GPS, gps_port=0 puts the GPS in fixed mode using latitude, longitude and altitude parameters.
gps_port_parity	0	None by default.
N_int_time	68	
N_base_int_time	17	Number of various integration time.
Shutter_type		4 types of shutter RDS001 (Mini-SAOZ 1-4) RDS132 (Mini-SAOZ 5-7)

		RDI132 (Mini-SAOZ 8-12) and 19 RDI232 (Mini-SAOZ 13-18)
spectrometer_id	xxxxxxxxxxx	Spectrometer serial number used to identify the spectrometer
saturation	12000	12000 by default. Maximum number of counts above which, the detector is no more linear.
lambda_file	..\SECxx\lambda.ibw	Folder location of the wavelength law of the spectrometer.

APPENDIX 3

Mini-SAOZ File formats

1. Daily Level 0 files

SAOZ software creates daily spectra files with filename extension “*.efm”.
For example, the filename MZG201410031503.efm comes from the following parameters:

- M → the suffix indicates which instrument type.
S for SAOZ - M for Mini-SAOZ - B for Balloon borne instrument.
- ZG → corresponds to the station name ex: Zhigansk
- 2014 → Year ex: 2014
- 10 → Month
- 03 → Day
- 15 → Hour
- 03 → Minute

2. Daily level 1 files

SAOZ software analyses the daily spectra files and creates daily result (*.mrs) with the same prefix as the corresponding *.efm file.

For example: the file MZG201410031503.mrs

The *.MRS files are ASCII files. They can be read with any spreadsheet software (Igor, Excel).

The header of *.mrs files is described in the Table A1-1.

Table App3-1: Header of the MRS files

Column Name	Description
Spectre	Spectrum number (0-64000)
Annee	measurement year
Jjul	day of year (day1=Jan 1)
SZA	Solar Zenith Angle
Longitude	west is positive (0-180°)
Latitude	north is positive (0-90°)
Altitude	meters
Exposure	integration time (msec) or exposure
Sommation	Nb. of spectra co-added during the measurement cycle
T1	temperature of spectrometer
T2	temperature of electronics
T3	temperature of power supply
T4	temperature of Mini-SAOZ housing
T5	NA=not applicable
T6	NA=not applicable
T7	NA=not applicable
T8	NA=not applicable
DecMoy	difference in pixel with reference spectrum

Flux_310	flux measured at 310nm from individual spectrum **
FluxC_310	flux measured at 310nm after correction of O3, NO2, etc...
Flux_320	flux measured at 320nm
FluxC_320	flux measured at 320nm after correction of O3, NO2, etc...
Flux_330	flux measured at 330nm
FluxC_330	flux measured at 330nm after correction of O3, NO2, etc...
Flux_350	flux measured at 350nm
FluxC_350	flux measured at 350nm after correction of O3, NO2, etc...
Flux_450	flux measured at 450nm
FluxC_450	flux measured at 450nm after correction of O3, NO2, etc...
Flux_550	flux measured at 550nm
FluxC_550	flux measured at 550nm after correction of O3, NO2, etc...
Flux_600	flux measured at 550nm
FluxC_600	flux measured at 550nm after correction of O3, NO2, etc...
Q_Ringr_1	ring measured in window range 405-465nm
R_Ringr_1	NA=not applicable
Q_Ringr_2	ring measured in window range (466-495) and (515-537) nm
R_Ringr_2	NA=not applicable
Q_NO2etroit	not to be used
R_NO2etroit	not to be used
Q_O3etroit	not to be used
R_O3etroit	not to be used
Q_H2O_1	not to be used
R_H2O_1	not to be used
Q_H2OT	Slant column of H2O measured in 530-620 nm
R_H2OT	error bar on slant column of H2O (One sigma)
Q_O4_4	Slant column of O4 at 470nm
R_O4_4	error bar on slant column of O4 at 470nm (One sigma)
Q_O4_5	Slant column of O4 at 570nm
R_O4_5	error bar on slant column of O4 at 570nm (One sigma)
Q_O3	Slant column of O3
R_O3	error bar on slant column of O3 (One sigma)
Q_NO2	Slant column of NO2
R_NO2	error bar on slant column of NO2 (One sigma)
Q_O2	Slant column of O2
R_O2	error bar on slant column of O2 (One sigma)
Q_bord1	Not used
R_bord1	Not used
Q_bord2	Not used
R_bord2	Not used
Residu O3 Dif.	average differential residual in the O3 window 450-620 nm
Residu Vis Dif.	average differential residual in the visible 405-620nm
Residu Uv Dif.	not to be used
Residu NO2 Dif.	average differential residual in the NO2 window 406-531 nm
Residu O3 RMS Dif.	RMS in the O3 window 450-620 nm
Residu NO2 RMS Dif.	RMS in the NO2 window 406-531 nm
Residu Vis Abs.	not to be used
Residu O2	Not used

** Mini-SAOZ: Flux/sec = Flux / exposure

*Note : Regular SAOZ: Flux/sec = Flux / (Sommatation*exposure)*

3. Yearly Level 2 files

The Level 2 (L2) files defined by NN_YYYY.XX are generated using the following IGOR software [RETRAITE_allXX.pxp](#).

3.1 Ozone and NO₂

The O3_YYYY.XX contains the NO₂ and Ozone stratospheric vertical columns.

As explained in the text, the vertical columns are weighted averages between 86 and 91 SZA.

The header of the files indicates which AMF have been used, the units and the name of the columns Climatological or SAOZ AMF

Climatological AMF used *(this line does not exist in case of SAOZ AMF)*

Units --- O3 Dobson, NO₂: 1e15 mol/cm²

Year	Month	Day	DoY	O3sr	O3ss	dO3sr	dO3ss	NO ₂ sr	NO ₂ ss	dNO ₂ sr	dNO ₂ ss
Year											
Month											
Day											
DoY				Day of year (1/1/YYYY is day 1)							
O3sr				Ozone vertical column during sunrise							
O3ss				Ozone vertical column during sunset							
dO3sr				One sigma error on Ozone vertical column during sunrise							
dO3ss				One sigma error on Ozone vertical column during sunset							
NO ₂ sr				NO ₂ vertical column during sunrise							
NO ₂ ss				NO ₂ vertical column during sunset							
dNO ₂ sr				One sigma error on NO ₂ vertical column during sunrise							
dNO ₂ ss				One sigma error on NO ₂ vertical column during sunset							

This RETRAITE_allXX.pxp software generates also the following annual files in case of climatological AMF.

I. AMF_O3_YYYY.XX

Daily Climatological AMF at 90SZA calculated using “o3_amf_interpolation_v2_0_dos.exe”
The DOS procedure can be found on <http://uv-vis.aeronomie.be/groundbased/> web site.
The AMF is calculated at 510 nm.

II. AMF_NO2_YYYY.XX

Daily Climatological AMF at 90SZA calculated using “no2_amf_interpolation_v1_0.exe”.
The DOS procedure can be found on <http://uv-vis.aeronomie.be/groundbased/> web site.
The AMF is calculated at 470 nm.

III. AVK_O3_YYYY.XX

Daily averaging kernel O3 profile calculated using “o3_avk_interpolation_v2_0_dos.exe”.
The DOS procedure can be found on <http://uv-vis.aeronomie.be/groundbased/> web site.

IV. AVK_NO2_YYYY.XX

Daily averaging kernel NO₂ profile calculated using “no2_avk_interpolation_v2_0_dos.exe”
The DOS procedure can be found on <http://uv-vis.aeronomie.be/groundbased/> web site.

V. Mrs.pxp

This file (which is an ASCII file) contains all level1 results plus, for each measurement, the NO₂ diurnal variation calculated using the following software “NO₂_extraction_tool_v2.exe”.

For information, the RETRAITE_allXX.pxp software generates also the O3NO₂_YYYY.XX file, identical to O3_YYYY.XX in which the missing data (NAN) have been replaced by 999.9 for Ozone and 99.99 for NO₂.

3.2 Tropospheric vertical columns

3.2.1 O₄ at 470 nm

The O4_YYYY.XX contains the O₄ tropospheric vertical columns.

As explained in the text, the vertical columns are weighted averages between 86 and 91 SZA.

The header of the files indicates the units and the name of the columns:

```
Units --- O4: 1e42 mol/cm2
Year Month Day DoY O4sr O4ss
Year
Month
Day
DoY          Day of year (1/1/YYYY is day 1)
O4sr         O4 measured at 470nm vertical column during sunrise
O4ss         O4 measured at 470nm vertical column during sunset
```

3.2.2 O₄ at 570 nm

The O45_YYYY.XX contains the O₄ tropospheric vertical columns measured around 570nm.

The vertical columns are weighted averages between 86° and 91° SZA.

The header of the files indicates the units and the name of the columns:

```
Units --- O4_570: 1e42 mol/cm2
Year Month Day DoY O4_570sr O4_570ss
Year
Month
Day
DoY          Day of year (1/1/YYYY is day 1)
O4_570sr     O4 measured at 570nm vertical column during sunrise
O4_570ss     O4 measured at 570nm vertical column during sunset
```

3.2.3 H₂O at 590 nm

The H2O_YYYY.XX contains the H₂O tropospheric columns measured around 590nm.

The vertical columns are weighted averages between 86° and 91° SZA.

The header of the files indicates the name of the columns:

```
Units --- H2O: mol/cm2
```

Year	Month	Day	DoY	H2Osr	H2Oss
Year					
Month					
Day					
DoY			Day of year (1/1/YYYY is day 1)		
H2Osr				H2O measured at 590nm vertical column during sunrise	
H2Oss				H2O measured at 590nm vertical column during sunset	

3.3 Clouds information

The CI_YYYY.XX contains the colour index measured at 90° SZA ($\pm 0.5^\circ$) which provides information on cloud cover while a colour index ratio (CI at 93°SZA / CI at 90°SZA) provides information on Polar Stratospheric Clouds (PSC) or Volcanic plumes. The colour index is the ratio of two fluxes at 550nm and 350 nm.

The color index ratio is the ratio of the two colour indexes.

The header of the files indicates the units and the name of the columns

Color Index (550 nm / 350 nm corrected for ozone absorption) Units --- Dimensionless Units						
Year	Month	Day	DoY	Clsr	Clss	CI90sr CI90ss
Year						
Month						
Day						
DoY			Day of year (1/1/YYYY is day 1)			
Clsr				Color index ratio (93°SZA $\pm 0.7^\circ$ / 90°SZA $\pm 0.5^\circ$) during sunrise		
Clss				Color index ratio (93°SZA $\pm 0.7^\circ$ / 90°SZA $\pm 0.5^\circ$) during sunset		
CI90sr				Color index at 90°SZA $\pm 0.5^\circ$ (ratio of fluxes) during sunrise		
CI90ss				Color index at 90°SZA $\pm 0.5^\circ$ (ratio of fluxes) during sunset		

3.4 Instrument information

In the case of Mini-SAOZ, the T_det_YYYY.XX file contains the temperature of the spectrometer, weighted averages between 86° and 91° SZA.

The header of the files indicates the units and the name of the columns:

Units ---Deg Celsius					
Year	Month	Day	DoY	T_det_sr	T_det_ss
Year					
Month					
Day					
DoY			Day of year (1/1/YYYY is day 1)		
T_det_sr				Spectrometer temperature during sunrise	
T_det_ss				Spectrometer temperature during sunset	

APPENDIX 4

Re-Analysis Software

The re-analysis software is c:/softava/reanalysis/sam/saoz_gui.exe

Or use an alias on the desktop

Before starting, check that Autostart=0 in conf.gui

First copy the Level0 *.efm files to be re-analyzed in c:\softava\reanalyse\sam\data.

If there is no “sam\data” folder create it before re-analysis.

1. Configuration Menu

Edit Sub-Menu: “Configure”

- General window

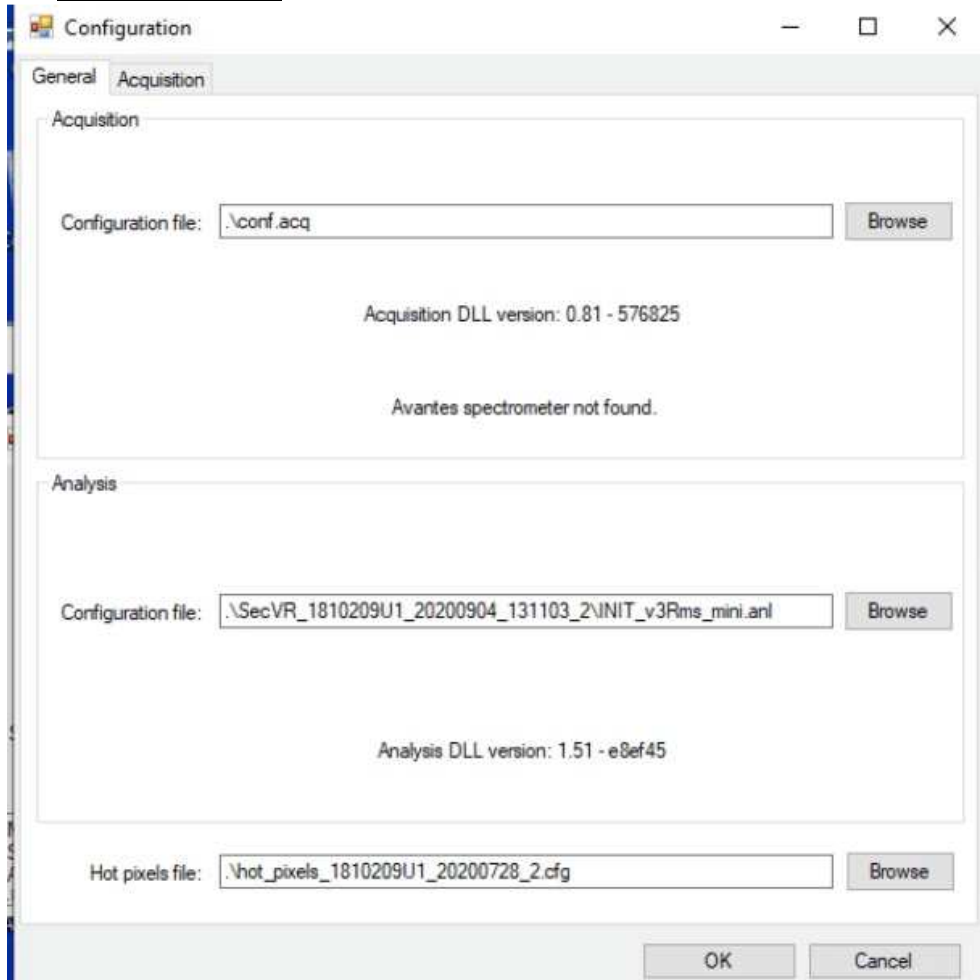


Fig. App4-1. Configuration Menu: General Window

This Menu displays the path for the analysis. The “cross section” folder contains the cross sections and the analysis configuration file: INIT_v3Rms_mini.anl

- Acquisition window

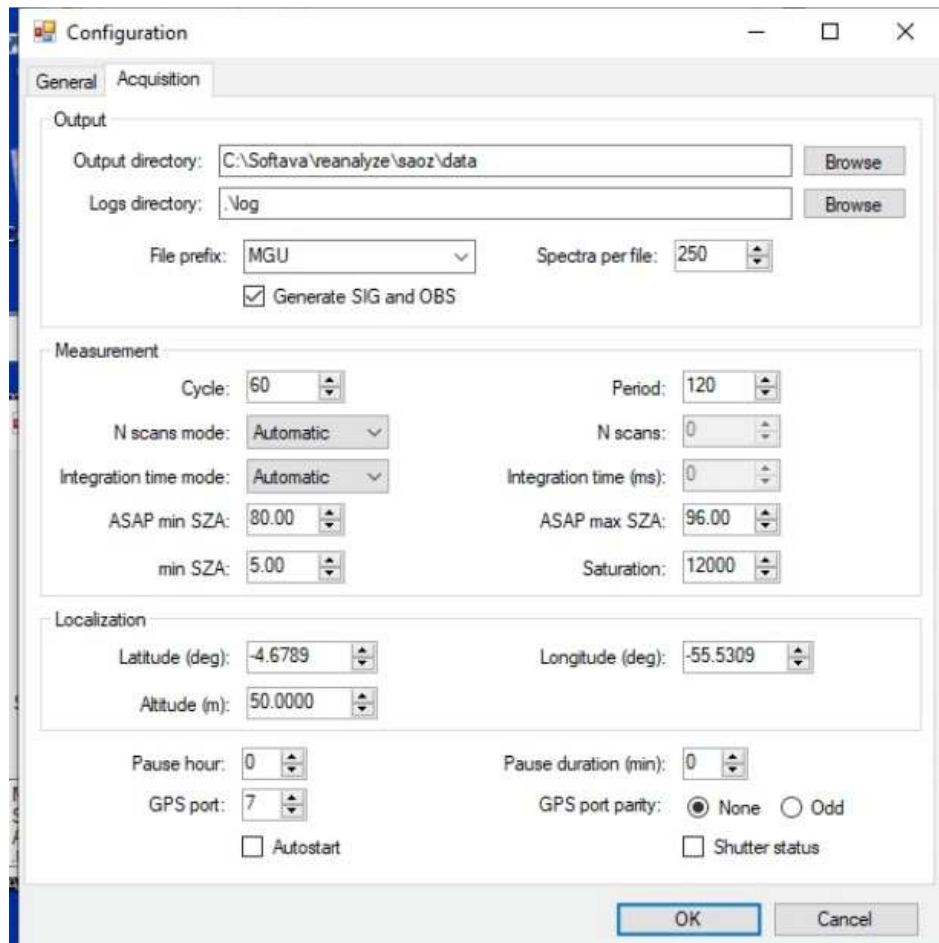


Fig. App4-2. Configuration Menu: Acquisition Window

This Menu allows modifying the Output directory

Attention: Check that

- Autostart is not selected in “Re-analysis mode”

2. Analysis Menu

This menu is only active in Re-Analysis mode.

There are four sub-menus:

- Open EFMs choose the *.efm files to be displayed
- Analyse EFMs Choose the *.efm files to be re-analysed
- Path through EFMs choose the *.efm files to be re-analysed one spectrum after the other.
- Analysis steps
- Create reference To create a reference spectrum.

3. Save Plot menu

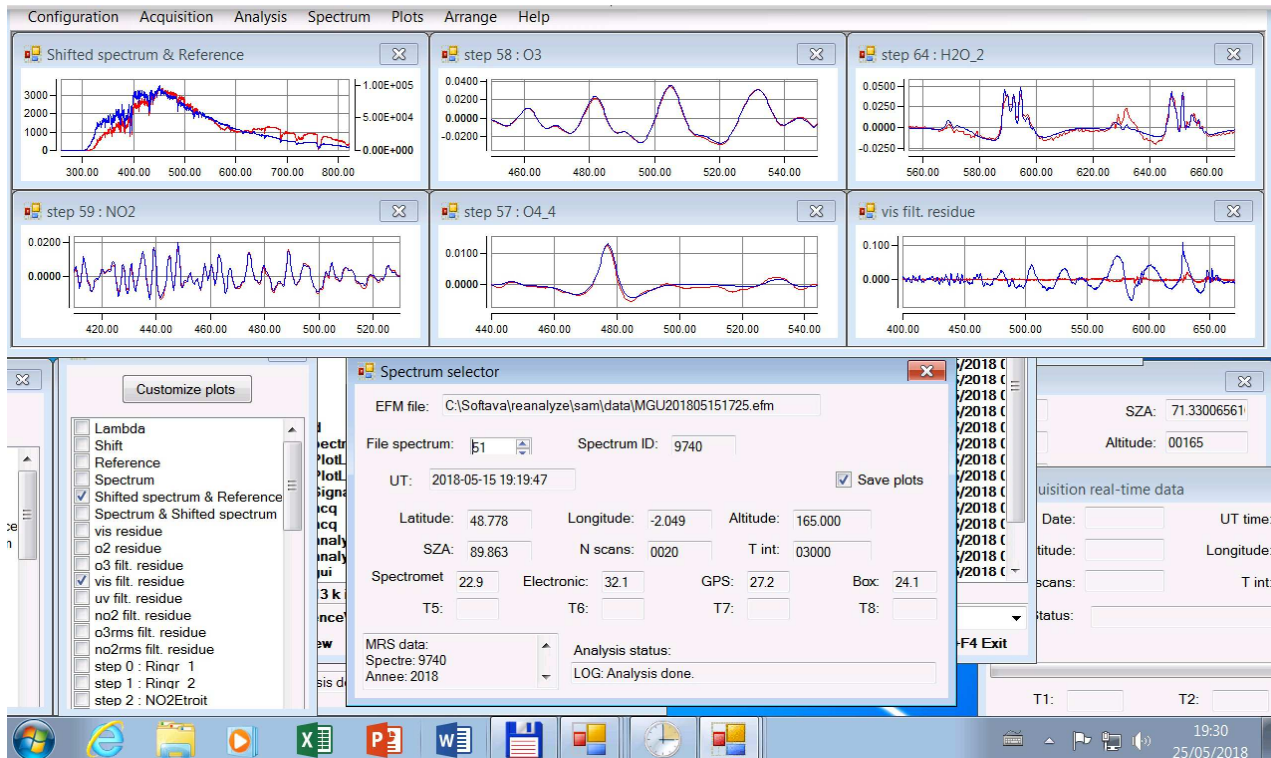


Fig. App4-3. Save Plots selected: To save result of analysis in a text file

If “save plots” in the window “spectrum selector” is selected, all the graphs are stored as text files in the following folder: c:\softava\reanalyse\sam\plots.

4. Spectrum Menu

Displays the “spectrum selector” window

5. Plot Menu

Displays the “Plot” window

For example choose: Shift
 Spectrum & reference
 Vis filt. Residue
 Step 51 H2O_2
 Step 58 O3
 Step 59 NO2

“Plot Menu “gives access to the sub-menu: “customize Plots” for additional plots (Figure App4-3).

For example: X=Jjul and Y= Temperature displays temperature as a function of time.

Note that the first column of “customized plots” window are X axis and second column Y axis.

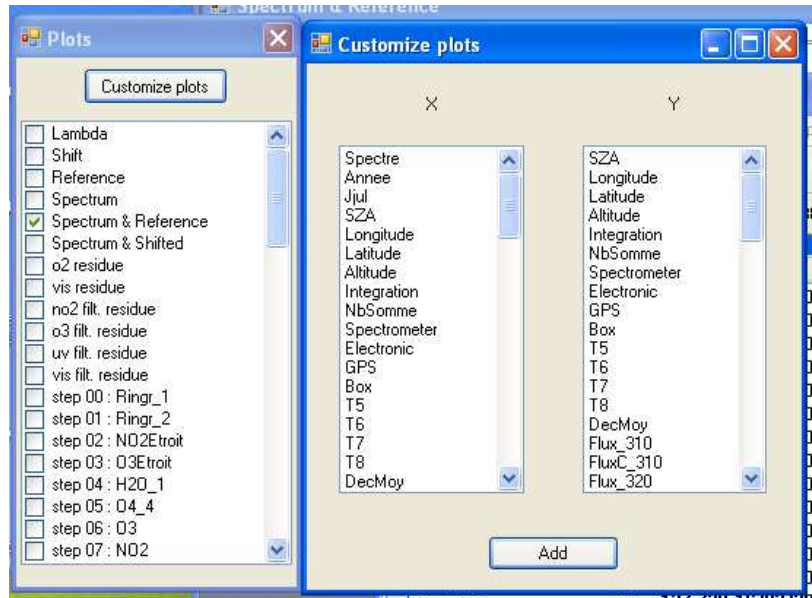


Fig. App4-4. SAOZ software “Plot” Sub-Menu

6. Create a new reference

This operation is done in five steps:

6.1 Step one: Menu Analysis- Sub-Menu Analyze EFM

First select an EFM file (Figure App4-5).

Second choose a folder for the result of analysis or create a new folder (Figure App4-6).

When you click “OK” the re-analysis program starts.

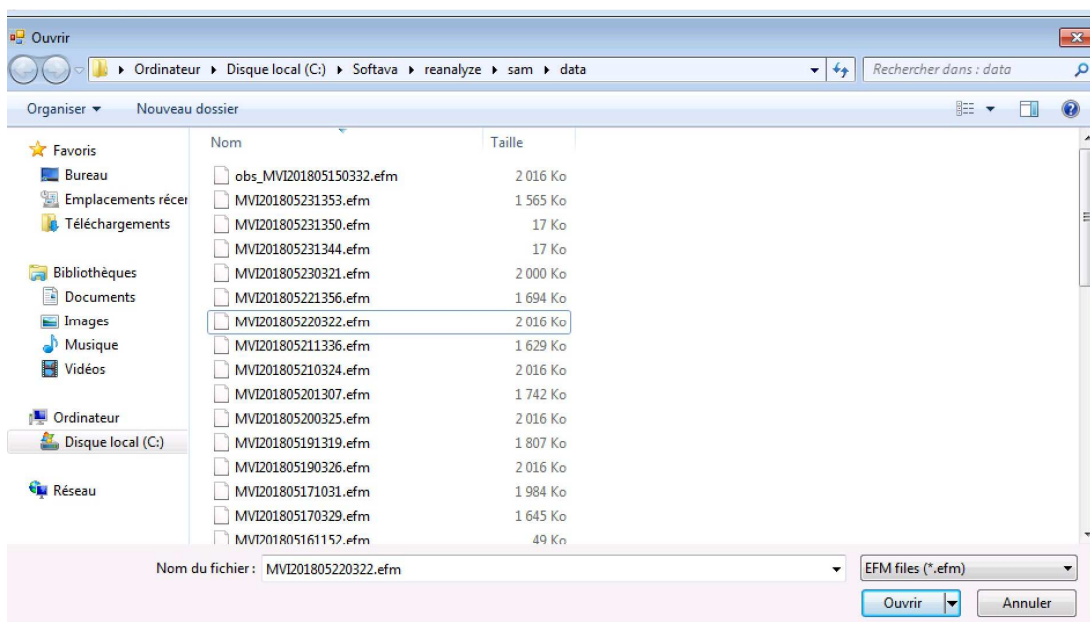


Fig. App4-5. SAOZ software select an efm file

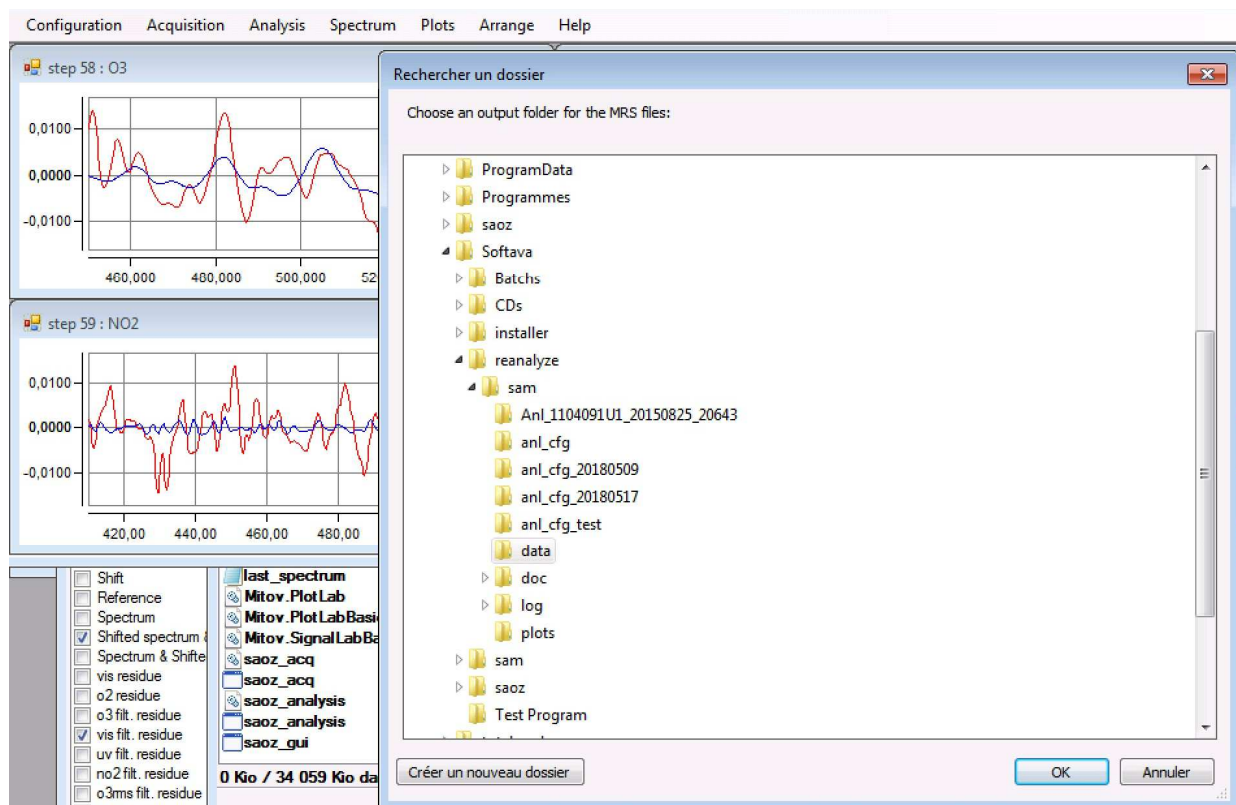


Fig. App4-6. SAOZ software Output folder selection for the mrs files

The Re-analysis program stores the result of analysis in an mrs file, with the same name as the efm file. Look for the “spectrum selector” window (or Menu “Spectrum”) to check if analysis is finished. If the window is not visible, select “foreground” in Arrange Menu.

6.2 Step two: look at the results of analysis (mrs files)

Click on spectrum to see the “spectrum selector” window. If the window is not visible, select “foreground” in Arrange Menu.

After analysis it may happen the following window:

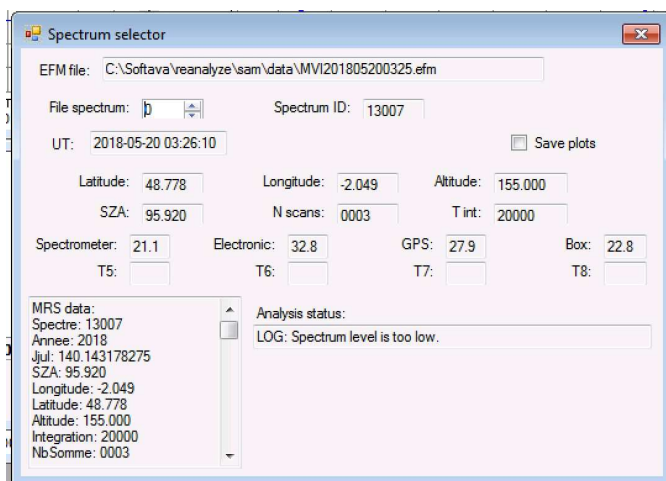


Fig. App4-7. SAOZ Re-analysis: Spectrum Selector

Move the “File spectrum” with the Up and Down arrow.
 When moving the Up and Down arrow, it is possible to see the results of analysis stored in the .mrs file. The result of analysis can be also monitored in the bottom left part of the spectrum selector window.



Fig. App4-8. SAOZ Re-analysis Spectrum Selector

To select a good reference spectrum look at the results of analysis (plots and values)

Select one of the first spectra just after local noon.

- Criteria: spectrum not saturated
- Small SZA
- Low pollution
- Low humidity

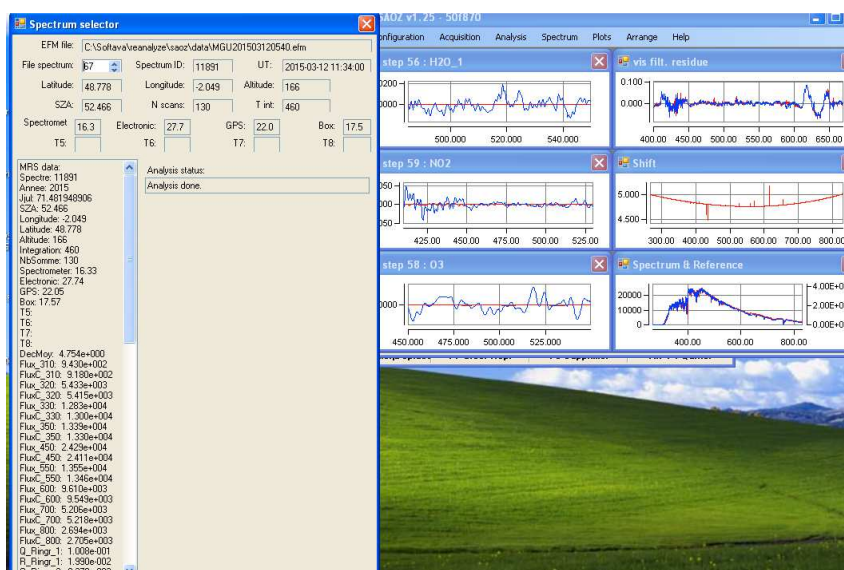


Fig. App4-9. SAOZ Re-analysis Spectrum Selector: results of analysis stored in “.mrs” file

6.3 Step three: create reference spectrum

Display the future reference spectrum.
Select “Create reference” in Analysis Menu

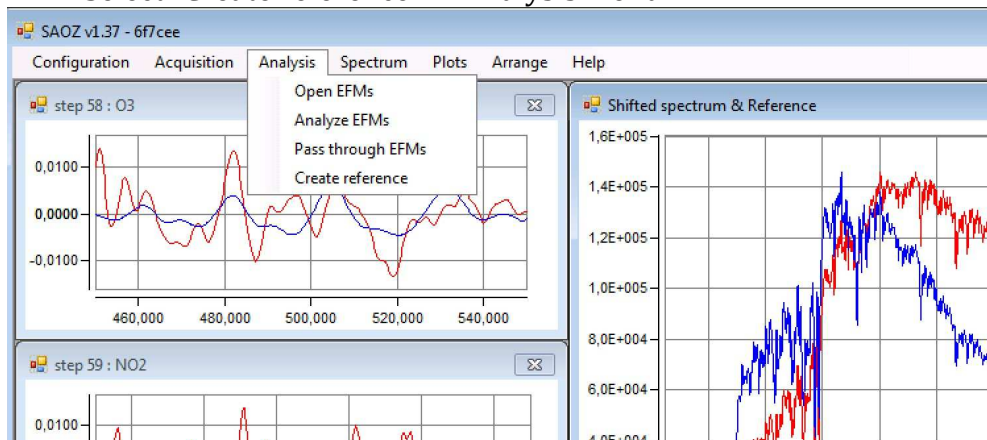


Fig. App4-10. Sub Menu “Analysis”: create a new reference.

Note that the new folder must be empty.

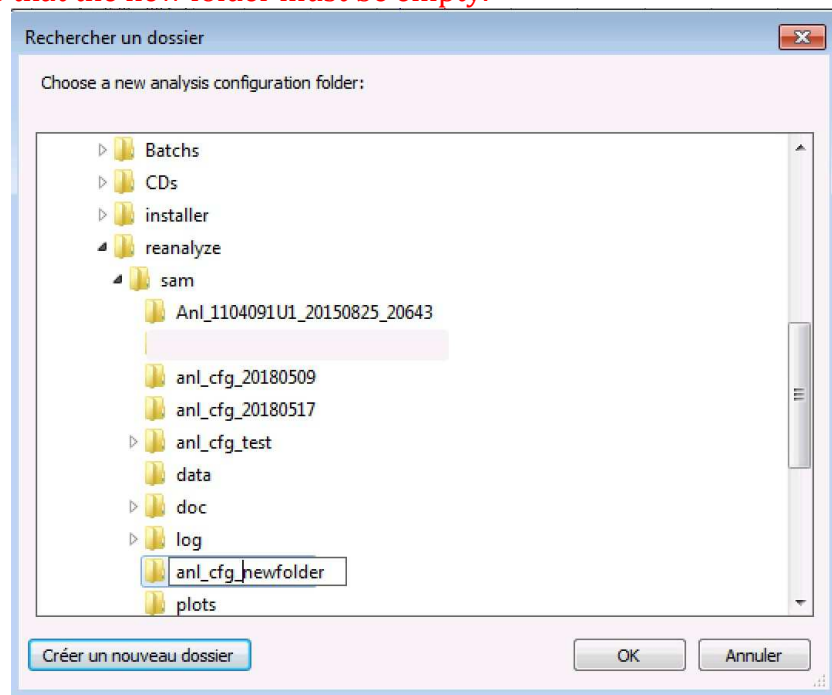


Fig. App4-11. Menu Analysis – Sub-menu Create reference: create a new folder for the new reference spectrum or use an empty one.

When you click on “OK” the new reference spectrum is stored together with the following files: LAMBDA.ibw, SPECTRE.ibw, CrossSections.ibw, Check that INIT_v3_mini.anl, reference_info.txt and StationsRealTime.pxp are in the same folder.

Important: If the new reference has been correctly generated, the reanalysis software has automatically changed the configuration in order to use the new reference.

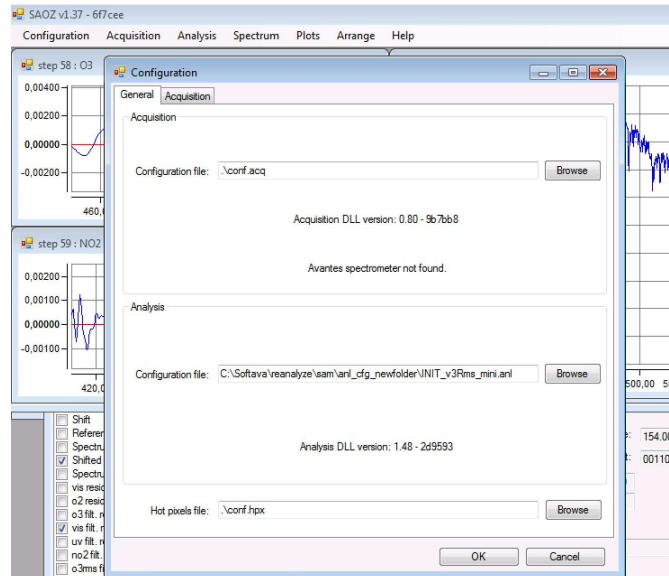


Fig. App4-12. SAOZ “configuration window”: use new reference automatically.

6.4 Step four: adjust residual in reference spectrum

Every time the reference spectrum is changed, it is necessary to determine the new ozone and NO₂ residual.

The residual is determined by the Bouguer-Langley plot (see Handbook part1).

Once the residuals have been determined, they should be entered in StationsRealTime.pxp.

Run StationsRealTime.pxp

Change	Coef[][0]=	new value for ozone (Re-analysis)
	Coef1_RT[0] =	new value for ozone (Real-time)
	Coef[][1]=	new value for NO ₂ (Re-analysis)
	Coef1_RT[1] =	new value for NO ₂ (Real-time)

Save the experiment

Then Quit

6.5 Step five: Install the “new” reference for the RealTime processing

- Check if SAOZ is not recording a spectrum
- Otherwise Stop Acquisition (Acquisition Menu: QUIT)
- Quit the SAOZ software (Configuration Menu: QUIT)
- Rename “anl_cfg” folder in c:\softava\reanalyse\sam\anl\cfg_old
- Rename the new “reference folder” to c:\softava\reanalyse\sam\anl_cfg
- Once the new “reference folder” has been renamed to anl_cfg, it is necessary to modify the path for the configuration menu of the re-analysis software.
- Rename “cfg” folder in c:\softava\sam\anl_cfg_old
- Copy c:\softava\reanalyse\sam\anl_cfg to c:\softava\sam\anl_cfg

Check by running SAOZ on the desktop that the instrument is operating in real-time mode with the new cross sections. Check the configuration and the results of analysis.

APPENDIX 5

Procedure for GPS Initialization/Configuration

- STOP SAOZ (Menu Acquisition/Stop and Configuration/Quit);
- Do not turn OFF the Mini-SAOZ Instrument box;
- Run Alias “**TrimbleStudio**” on desktop
- If this windows appears, asking to update the software (cf. Figure A2-1) answer “NO”.

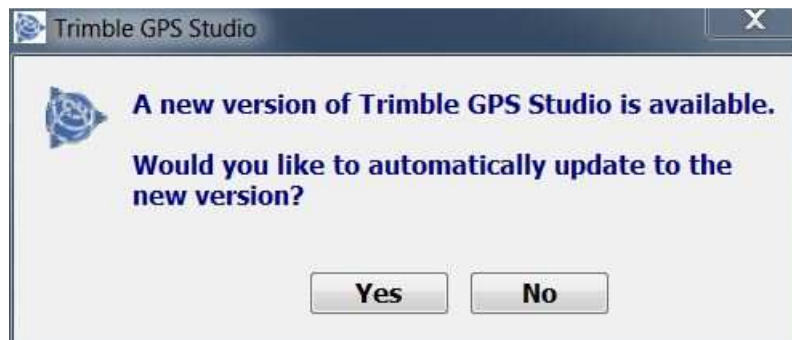


Fig. A2-1. Testing GPS: The answer is “NO”

With this test program it is necessary to provide the correct port number.

Menu **New Connection.../ USB Serial Port (COMxx)** (cf. Figure A2-2)



Fig. A2-2. Choose “New Connection”

The Copernicus II Receiver Monitor window should open (cf. Figure A2-3)

In the window Copernicus II Receiver Monitor select the GPS COM for your instrument, normally COM3 (in this example COM14).

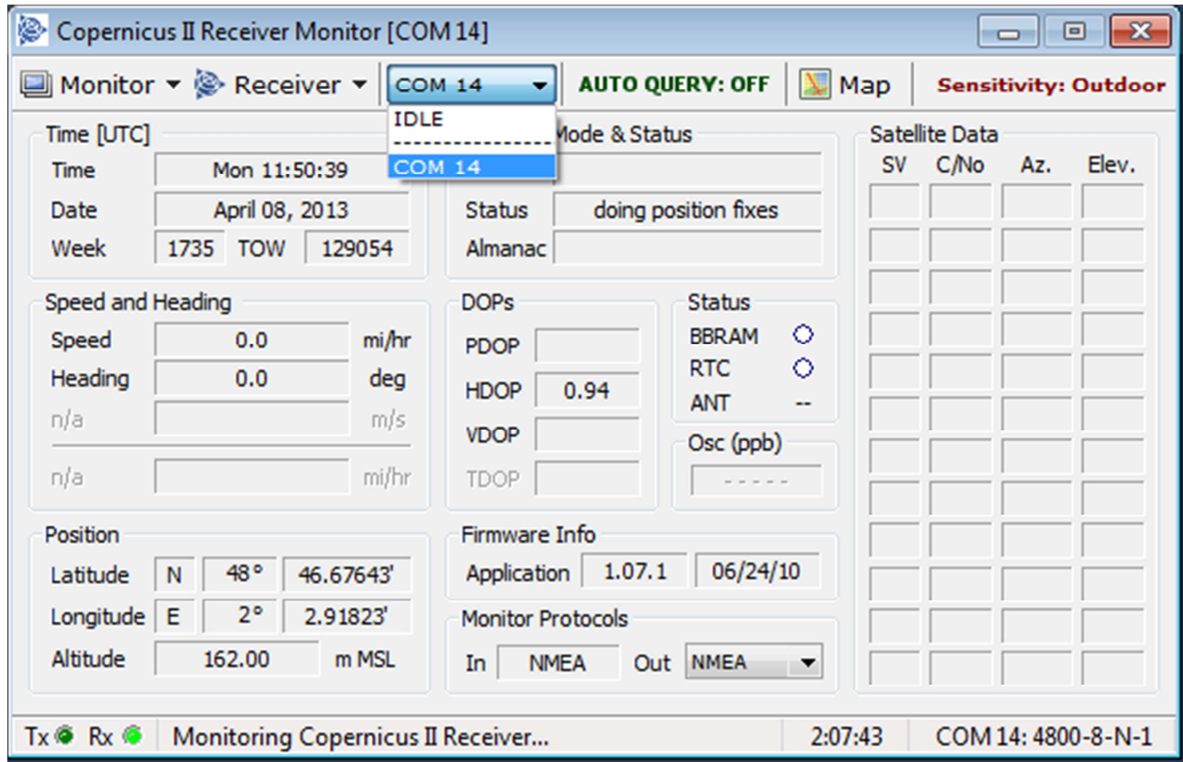


Fig. A2-3. Copernicus II Receiver Monitor window

After receiving some data select **“Configure...”** in menu **Receiver** of this window.

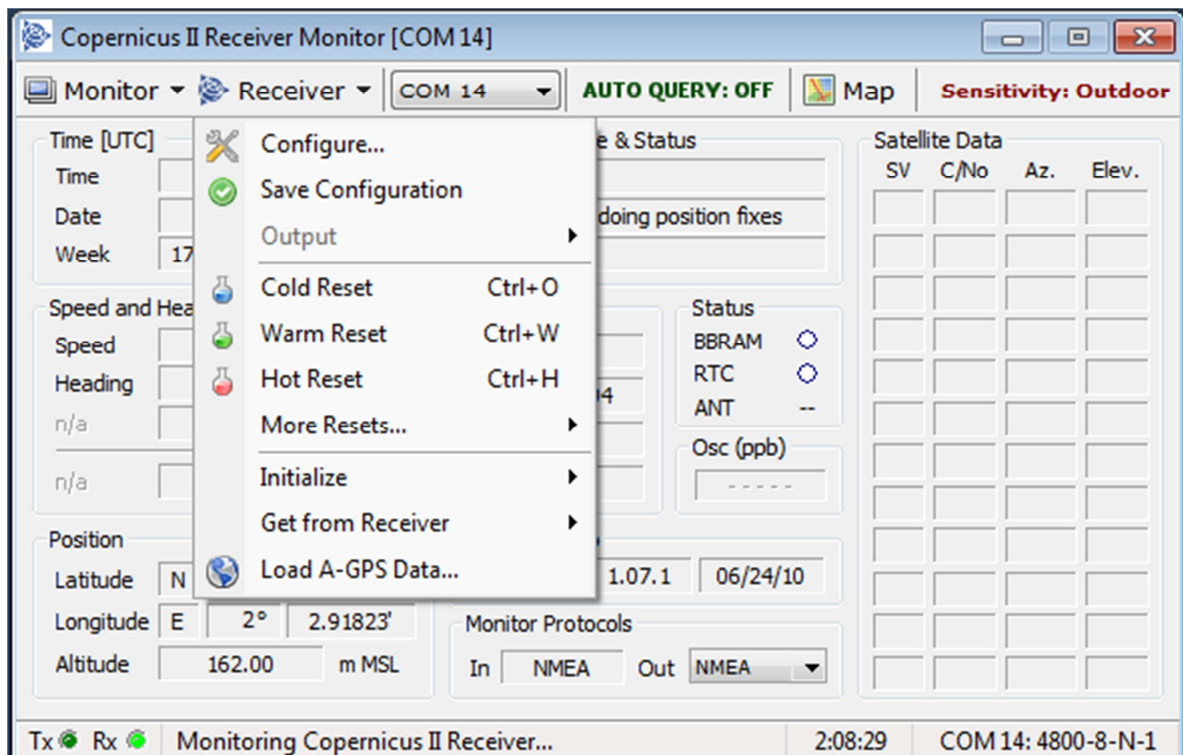


Fig. A2-4. Copernicus II Receiver Menu

A new window should appear: **“Receiver Configuration”**.
Check that all parameters in **“GPS Configuration”** are correct.

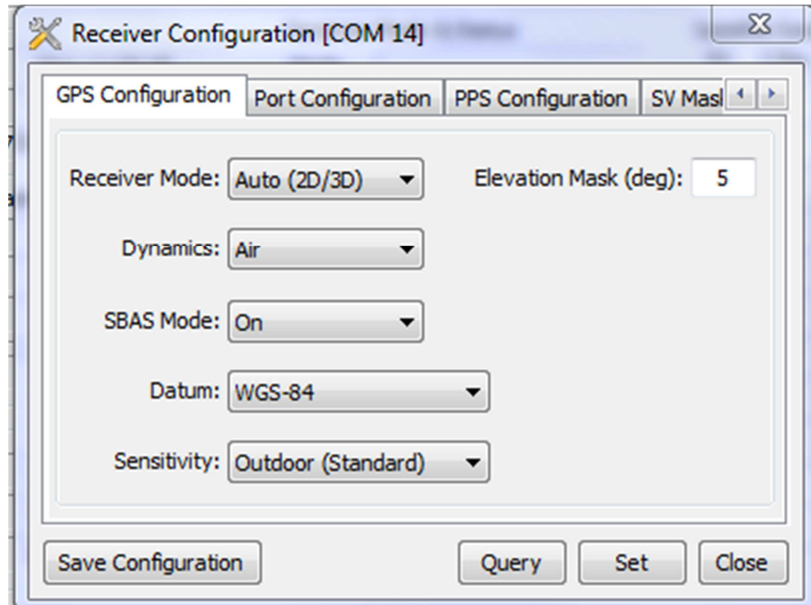


Fig. A2-5. GPS configuration Menu

Next step select “Port Configuration” menu.
You should have the following:

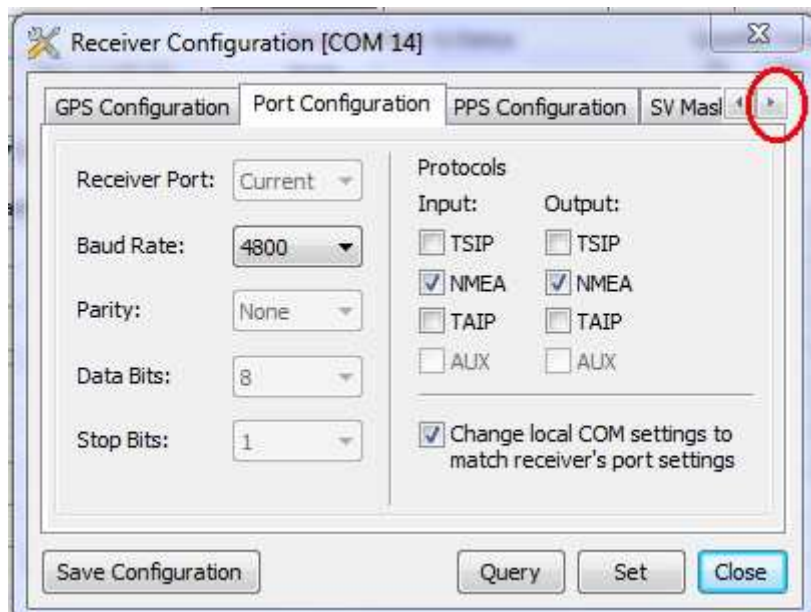


Fig. A3-5. Port configuration Menu

If not, with the right arrow on the top corner, move until you get the “**NMEA Configuration**” menu.

Select GGA and RMC and unselect the others as indicated below.

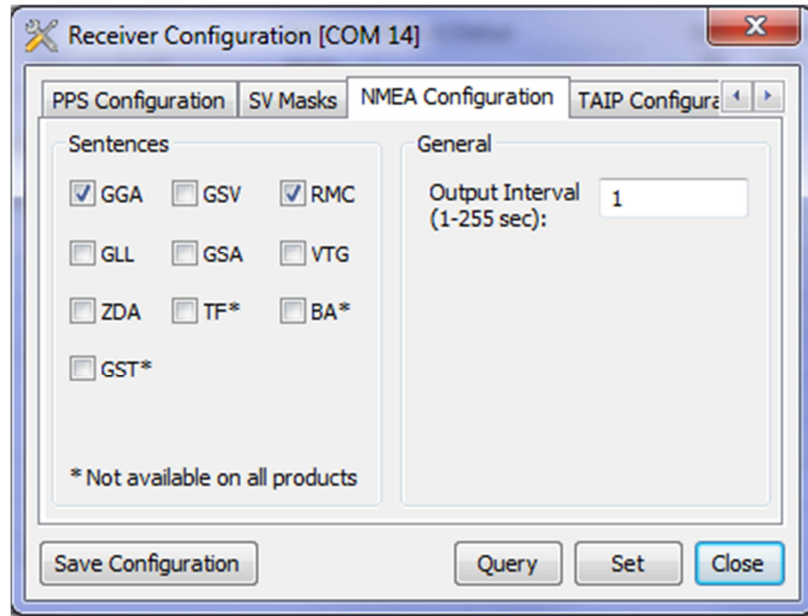


Fig. A2-6. NMEA configuration menu

Click On **“SET”**
and on **“Save Configuration”**
and then **“Close”**

If everything is correct and nothing has been changed, you need to restart the procedure but after reinstalling the FTDI driver (Softava/CDs/GPS/ Driver FTDI (VCP) Windows/ CDM20814_Setup.exe)

If the raw window data is not open select **View Raw Data** in **Monitor Menu** (see Figure A2-7)

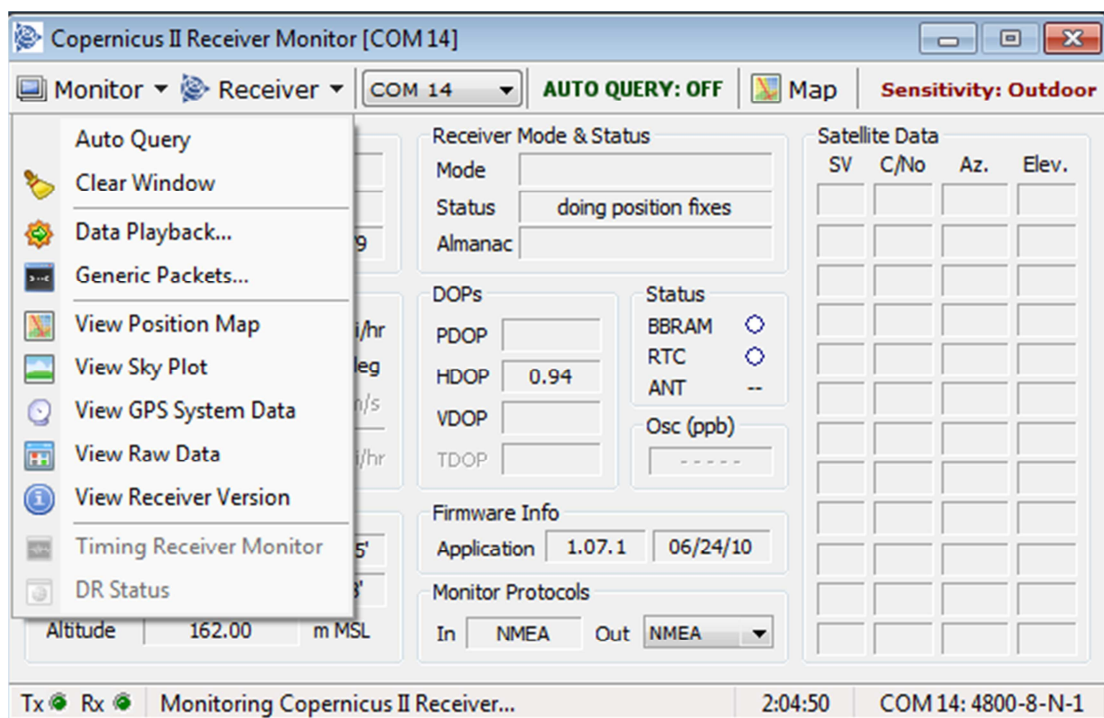


Fig. A2-7. Click on View Raw Data in Monitor Menu

In Raw Data Monitor Window you should have only:
\$GPGGA and
\$GPRMC String as shown in Figure A2-8.

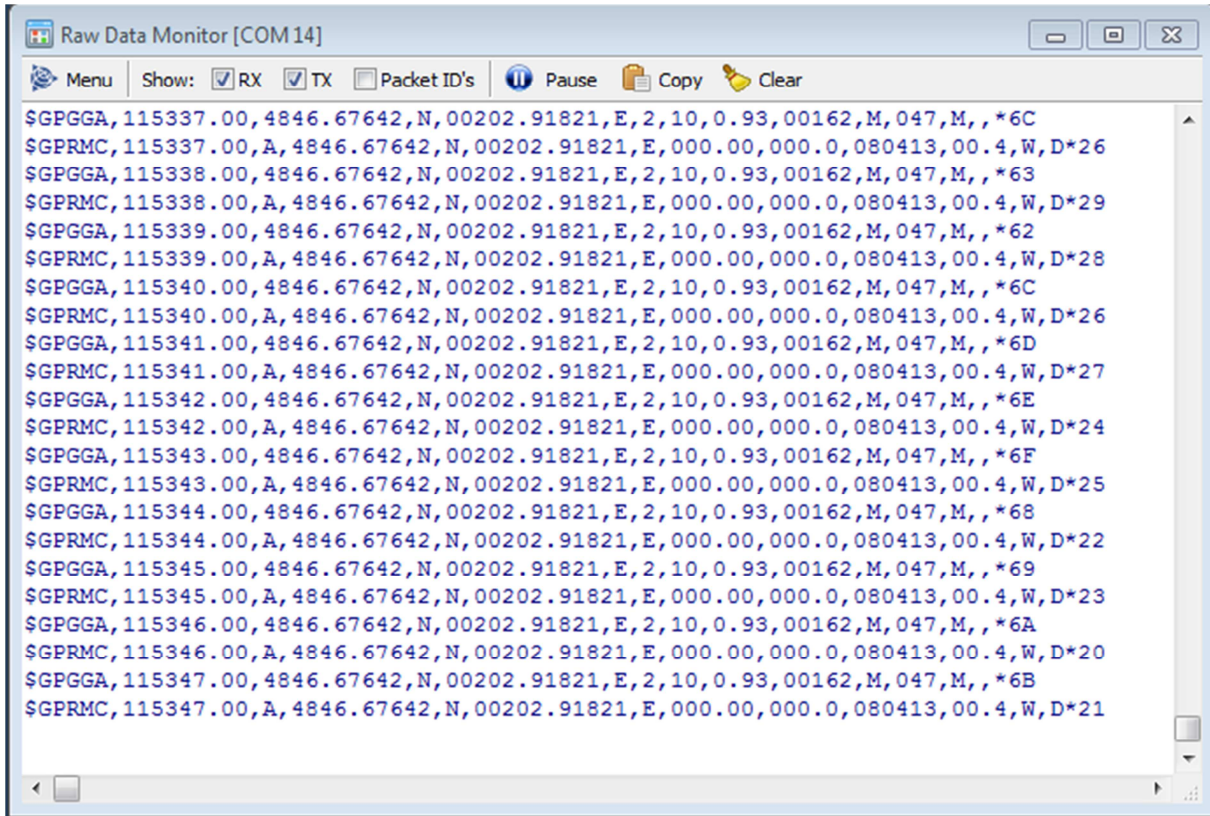


Fig. A2-8. Raw data monitor window

If all is ok
Quit the TrimbleStudio software by **Exit** in **file** menu and Restart Saoz_gui.EXE.

APPENDIX 6

Optical Fibre Installation

1. Characteristic of the optical fibre

- Length: 10 m
- Connector: FC
- Yellow label: SEDI-ATI-13.263-940UV
- Minimum radius of curvature: 15 cm

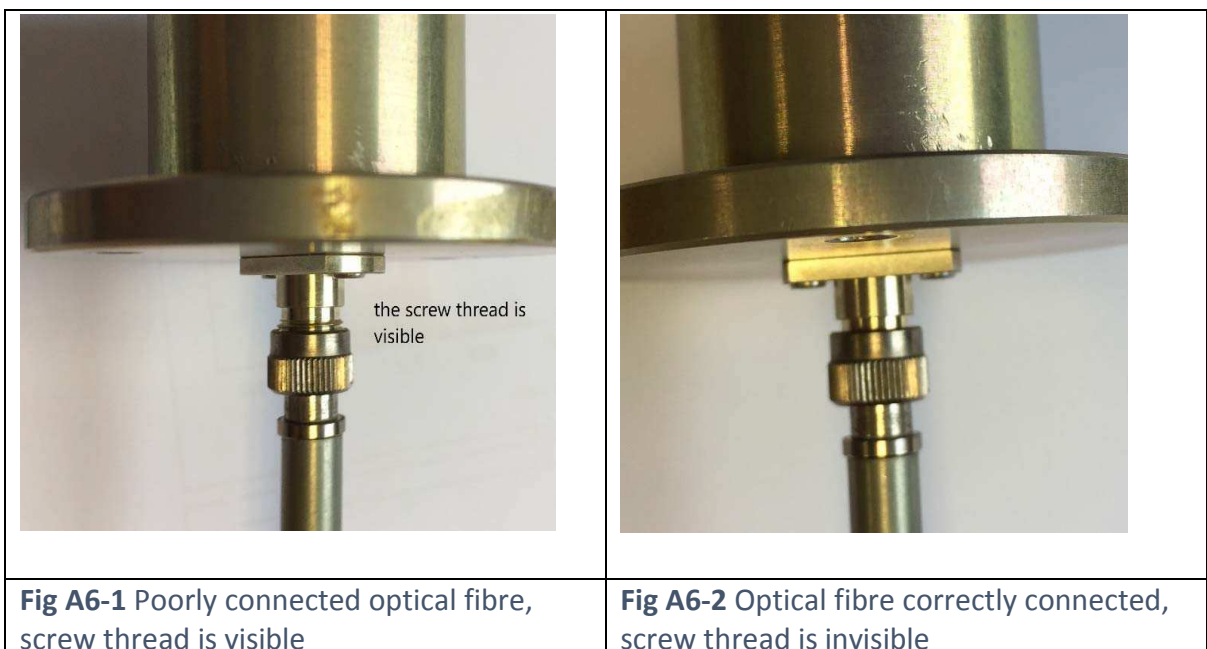
2. Optical fibre connection.

Figure A6-1 shows a badly connected optical fibre, screw thread is visible. The poor Optical fibre connection is one of the reasons for significant loss of measured flux.

To connect the optical fibre, make sure that the pin of the optical fibre connector is correctly positioned in the notch of the FC connector (example Figure A6-3).

When the optical fibre is properly connected you should not see the screw thread of the FC/PC connector (Figures A6-2, A6-6).

- The side with the yellow label should be on the instrument side (Figure A6-4).
- Pay attention to the bending radius of the fibre along the entire length.
- Position the fibre lug in the notch of the connector on the instrument and optical head side (Figures A6-3, A6-5, A6-2).
- Aim at the connectors by hand without over tightening. DO NOT use pliers for this.



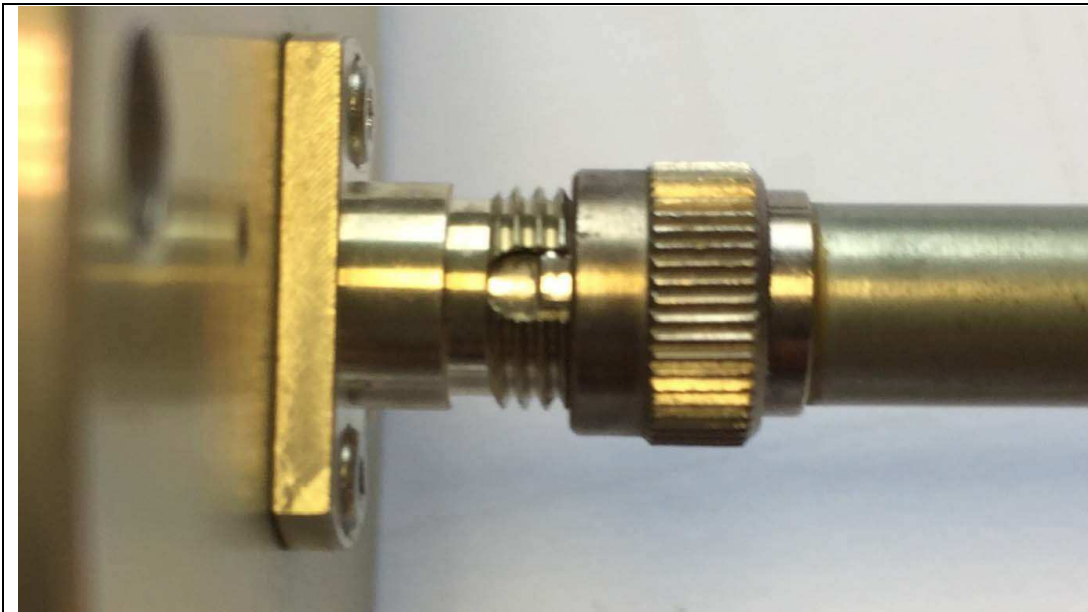


Fig A6-3: To connect the optical fibre, make sure that the pin of the fibre optic connector is correctly positioned in the notch of the FC connector

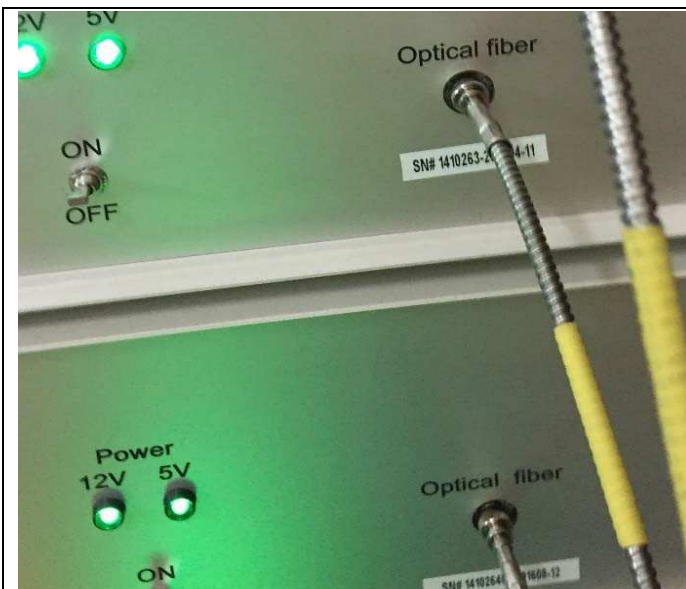


Fig A6-4: The yellow label should be on the instrument side



Fig A6-5: Position the fibre lug in the notch of the connector on the instrument and optical head side.



Fig A6-6: Optical fibre well connected, the screw thread is invisible



APPENDIX 7

Mini-SAOZ Rapid Un-installation

1. Stop acquisition

- ❖ STOP SAOZ:
 - Menu “ACQUISITION”
 - Choose “STOP”
 - Menu “CONFIGURATION”
 - Choose “Quit”
- ❖ STOP Laptop:
 - Menu “START”
 - Choose “SHUT DOWN”
 - Close the laptop
- ❖ SWITCH OFF the instrument

2. Disconnect cables

- ❖ Disconnect the optical fibre:
 - Put the small black cover to protect the output of the fibre.
 - Screw the white cap on the instrument to protect the fibre optic connector.
- ❖ Disconnect the GPS antenna.
- ❖ Disconnect the USB cable between laptop and instrument.
- ❖ Disconnect the instrument power supply.
- ❖ Disconnect all cables on the laptop
 - USB mouse
 - USB cable between laptop and instrument
 - Ethernet cable (if existing)
 - Laptop power supply
- ❖ Disconnect laptop and instrument power supplies from the multi-plug.

3. Dismount the optical head

- ❖ Disconnect the optical fibre from the optical head:
 - Put the small black cover to protect the entrance of the fibre.
 - Screw the white cap on the optical head mounting to protect the fibre optic connector.
- ❖ Dismount the optical head.
- ❖ Unscrew the white tube for stray light protection if present.

4. Final preparation

- ❖ Put the fibre optics in its plastic bag.
- ❖ Put in a paper box:
 - Laptop power supply and cable.
 - Instrument power supply and cable.
 - USB mouse.
 - GPS antenna.
 - USB cable to laptop.
 - Ethernet cable if present.