

Operational manual for the EM27SUN

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Kindly note: This report contains information of preliminary character and is intended for internal use for the COCCON community.

General information:

This document is intended to be an operational manual for the EM27SUN spectrometer from BRUKER. It will provide the user with information regarding the start-up, measurement procedure, shut-down and troubleshooting procedures for the EM27SUN spectrometer.

The EM27SUN spectrometer measures the direct solar radiation from ground in the near infrared (NIR) spectral range. The spectra recorded with the EM27SUN spectrometer gives information about the presence of atmospheric constituents, namely, H₂O, CO₂, CH₄ and O₂. The recorded spectra are evaluated to retrieve the total columns of the corresponding gases and subsequently dry air mole fractions e.g. $X_{CO_2} = CO_{2, \text{column}} / O_{2, \text{column}}$ and $X_{CH_4} = CH_{4, \text{column}} / O_{2, \text{column}}$

Each spectrometer has a designated notebook with windows operating platform. It is advisable not to go online with the notebook once the relevant software is installed on the notebook. This precaution is taken mainly to prevent the interference of virus scanner with the programs.

A list with the mandatory software is given below:

- 1) OPUS 7.0 or higher: measurement and display software.
- 2) CamTracker 3.8 or higher: performs the tracking of the sun with the tracker optics.
- 3) GPSclock: synchronizes the computer time. Note that the EM27Sun spectrometer has its own clock which is used for data recording but this clock has a certain drift in time. As a result the spectrometer clock is synchronized with the computer clock. The time synchronization is done at the start of the GPSclock software BktTimeSync. It is recommended to use a macro for the measurement and perform the synchronization at an hourly interval to have minimal drift during the measurement period.

The following procedure should be followed while performing measurements with the EM27SUN spectrometer.

Experimental setup:

- 1) The EM27SUN spectrometer should be placed on a stable horizontal table, alternatively the top-cover of the spectrometer box can also be used for placing the spectrometer for performing measurements. The spectrometer might encounter problems due to high or low temperatures while operating in extreme hot or cold conditions. In such cases it is advisable to design a temperature controlled cover for the spectrometer. The notebook should be sheltered from the sun.
- 2) The tracker side of the spectrometer should be placed facing north for operations in the northern hemisphere and vice-a-versa for the southern hemisphere.
- 3) Connect all cables (power, TCP/IP, camera USB) to the spectrometer and the dedicated ports in the measurement computer.

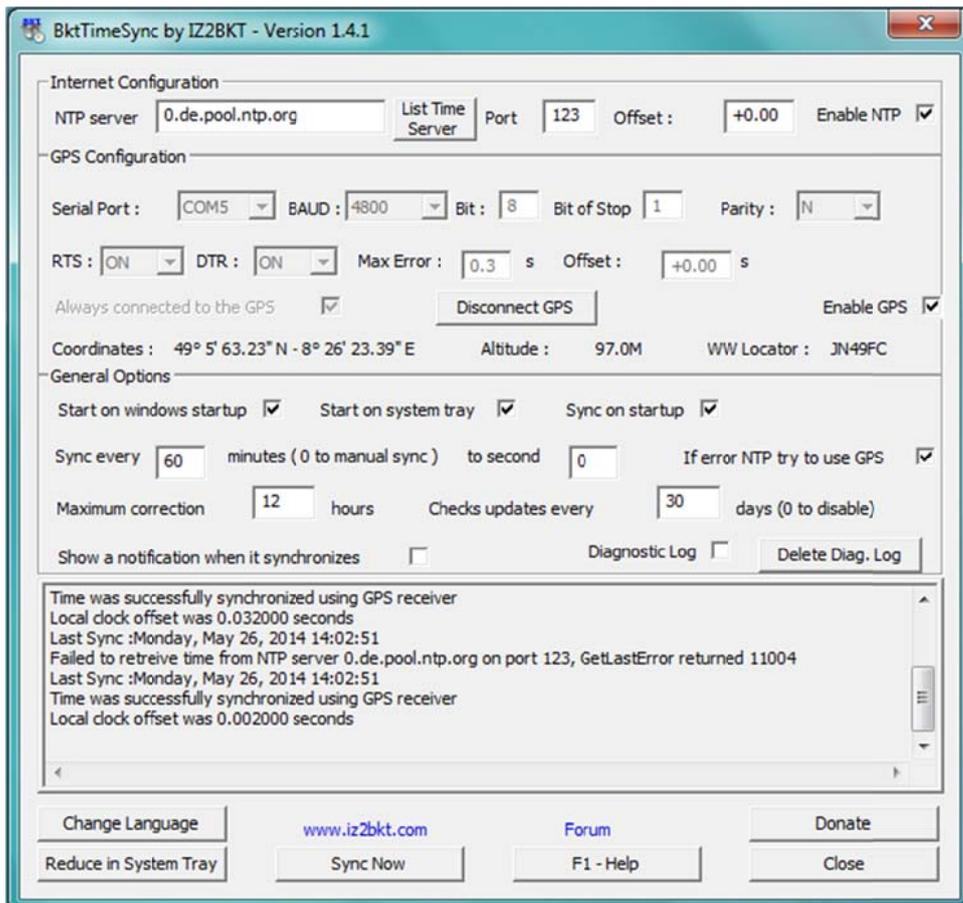
Start-up procedure:

4) Start the computer, login account: “xxxxxxadm”, login password: “xxxxxxx”

5) Connect the GPS receiver to the specified port on the computer.

Note: GPS receiver has a magnetic holder and should be placed further away from the computer hard disk.

Check in the system tray if BktTimeSync program started automatically. If not then start BktTimeSync program from start menu and wait for about 1 min till the GPS receiver actualizes. The use of UTC time is suggested for instrument operation in European countries.



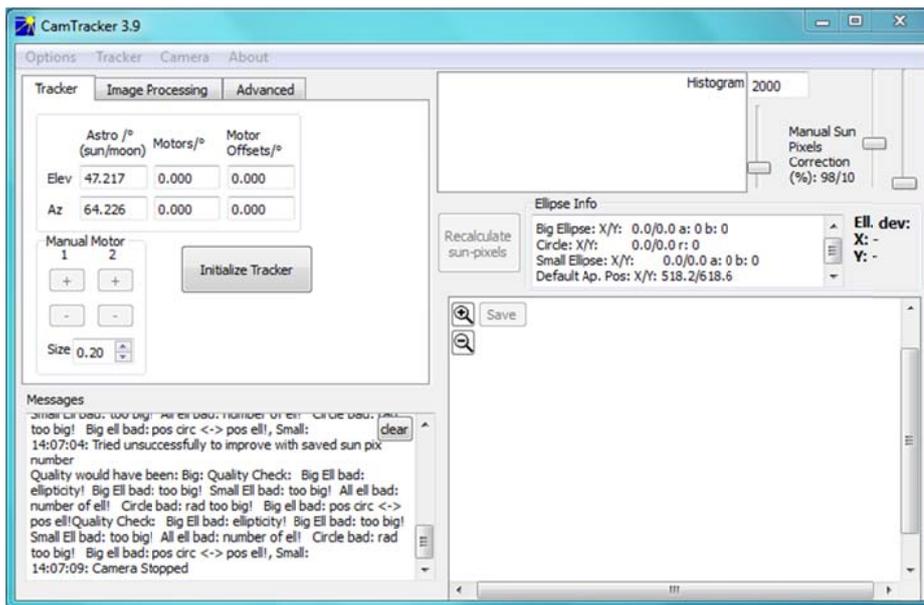
After the clock is synchronized click on “Reduce in System Tray” button to minimize the BktTimeSync program. Do not close the program. If done so you need to start the BktTimeSync program again. Check if the time and date on the computer clock are correct.

6) Remove the protective cover from the window of the spectrometer entrance and switch on the spectrometer. The spectrometer will connect itself to the computer; you can see it in the network connection symbol.

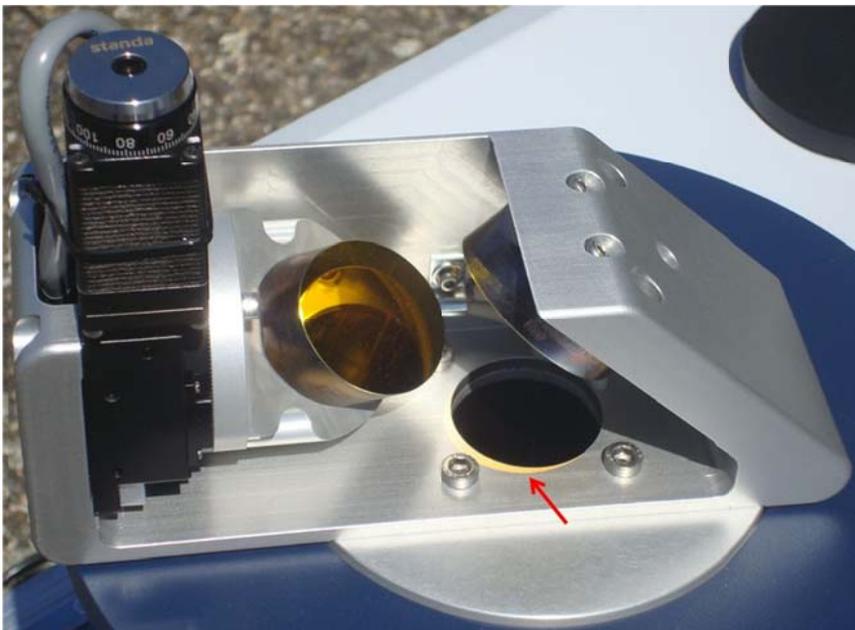


or you can ping at 10.10.0.1 and wait for the response from the spectrometer.

7) When moved to a new location, change the longitude/latitude/height settings in the CamTrackerConfig file which is found in the CamTracker 3.8/3.9 folder. Start the program CamTracker 3.8/3.9. Select “Tracker” option in the software and click on “Initialize Tracker”. At this point you will hear the tracker moving from the park to its initializing position.

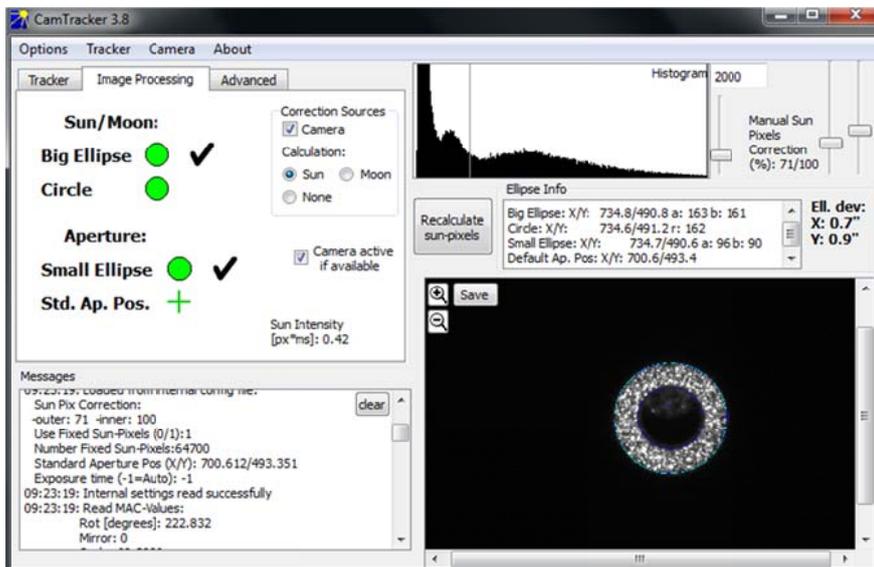


Select “Image Processing” option in the CamTracker software and click on “Sun”. The image of the sun should be visible now on the Camera image section. If not then perform visual inspection of the light beam at the top plate of the tracker. If needed rotate the spectrometer around the vertical axis such that reflected light beam is passing totally through the hole and falling on the spectrometer entrance window and no part of the beam is obstructed by the rim of the tracker.



Activate Correction sources by clicking on the box “Camera”. The image of the aperture will appear inside the image of the sun. Click on the menu option “Camera” and select Save current field stop as standard. This will save the current position in the file. Go to Advanced option and display the contour lines and perform a visual check of the contour lines. If necessary adjust the gain. Standard gain is chosen as: Sensor gain: 32. Exposure time is set to Auto. This

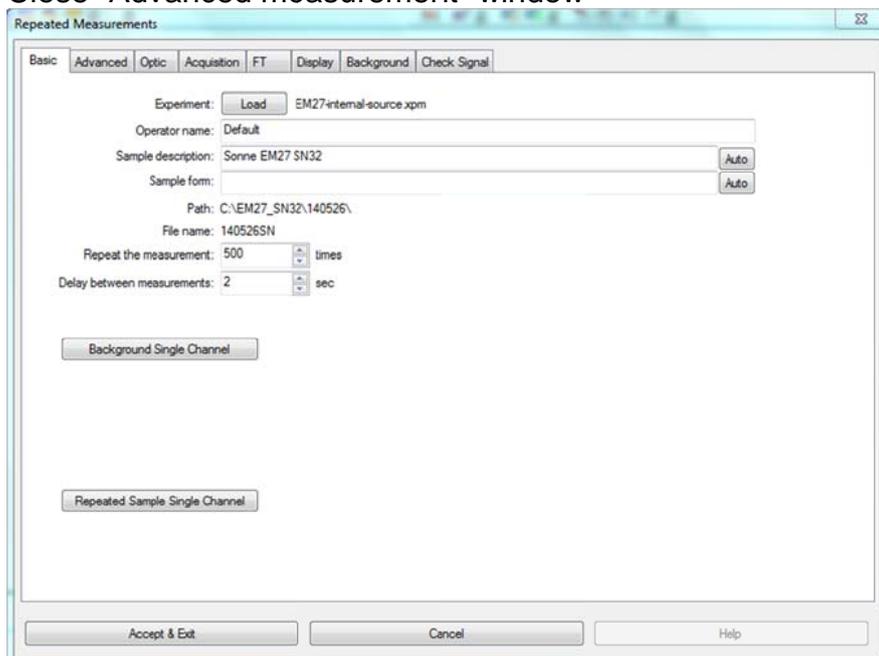
will adjust the exposure time according to the scene (sunny or cloudy). One may also use the option “Recalculate sun pixel” in order to get new image.



Performing measurements:

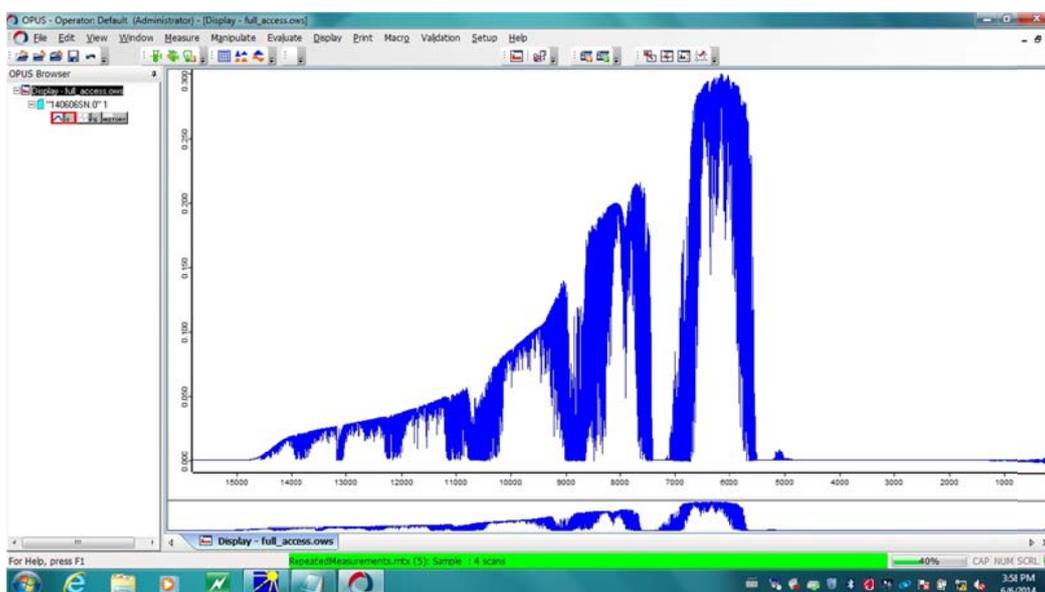
- 8) Startup the spectrometer 30 min before performing the measurements. This time is necessary as laser warm up time.
- 9) Start OPUS software – password: “OPUS”
click on “advanced measurement”, select menu as “Basic”,
click on “Load” in line Experiment and load EM27SUN.xpm file if it is not loaded. The file can be found here “c:\...\OPUS\xpm\EM27SUN.xpm”
select menu as “Check Signal” then select “Interferogram” and “scale display”
click on “save peak position”. This will save the interferogram peak position for future measurements. Note that the interferogram count level has a negative sign. This is due to the negative multiplication factor of the analog-to-digital converter.

Close “Advanced measurement” window



10) Select “Macro”; then choose “Run Macro”. Start “Repeated Measurements.mtx” which is located in “c:\OPUS\Macro\”. Now select a large loop number (e.g. 1000) on the next screen. The macro will reconnect the spectrometer at every full hour with the computer to synchronize time. Files are saved as designated in EM27Sun.xpm. Note that the user has to close OPUS forcefully as the macro is continuing even after clicking “Abort task”. Unload all measurement files prior to closing OPUS.

Alternatively select “Repeated measurements”; check if path is “\.\EM27\<y><m><d>” and the file name is “<y><m><d>” and click on “Repeated Sample Single Channel”. Note that now the spectrometer is only synchronized with the computer at the beginning of the measurement. The program will start to save the interferograms in the folder “\.\EM27\<y><m><d>\” check the spectrum in Display window.



Shut down procedure:

- 11) Right click on the green scan bar and click on “Abort task”. This will stop the interferometer scan.
- 12) Close OPUS software. The measurement data is saved automatically.
- 13) In CamTracker software select menu “Tracker” and click on “move tracker to park position”. Wait till the tracker moves to the park position. Close the CamTracker software.
- 14) Switch off the spectrometer and close the entrance window with the lid. Cover the tracker with the plastic protection bag.
- 15) Transfer the measurement data to an external hard disk. Shutdown the computer after data transfer is completed.
- 16) Remove/unplug power, TCP/IP, Camera USB from the spectrometer and the computer.

- 17) Pack the spectrometer and its accessories into the box at the designated place.



Trouble shooting:

- 1) CamTracker showing blue screen with no image:
Reconnect the camera USB to the computer without stopping the CamTracker software.
- 2) CamTracker showing no image of the sun:
Check for the spectrometer entrance window and remove the window cover.
- 3) The aperture and the solar disk image do not overlap:
Check if the default aperture position is correct. If not, adjust the mirrors to the right position via Camtracker software and save position of aperture as new standard position. The exact procedure is described in the Bruker manual for the EM27Sun spectrometer.
- 4) CamTracker lost image of the sun despite being sunny:
Motors may not be moving correctly because of friction. Move tracker to parking position and click on sun option again. Driving the motor at higher current can be helpful in such case but at the same time it increases the power consumption of the instrument. One can also “help” the motors by gently rotating the worm axis in the moving direction.
Note that you don't need to stop the measurements for the above points. Simply make a note of the corrupted files and discard them from the processing chain.
- 5) CamTracke/OPUS is not responding:
Check the Ethernet cable connection.
- 6) OPUS shows laser timing error:
This may happen due to the spectrometer being too hot. Cover the spectrometer from the sun and wait for it to cool down. Restart the measurement again.
- 7) The spectrometer cover should not be opened in any case without the supervision of experts. A class II laser is included in the spectrometer. Do not stare into the laser beam in case if the cover of the spectrometer is opened.

In case of further troubles please contact:

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