



## Halo Photonics Stream Line Scanning Doppler LiDAR system - Profiler Software Guide.



Our modular, autonomous, turn-key, pulsed Doppler LiDAR systems were conceived to meet the need for remote sensing of motion and backscatter in the atmosphere. In this mode of operation, naturally occurring aerosols and clouds act as a distributed target and backscatter the transmitted pulses. The receiver detects the Doppler shift brought about by the motion of the distributed targets and therefore the line-of-sight component of their velocity. The novel optical technology employed and the design approach have led to a new class of eye-safe (Class 1M), high performance LiDAR exhibiting exceptional stability which is compatible with a continuous and unattended mode of operation. Typical applications include boundary layer wind profiling, plume dispersion, analysis of complex flows, cloud studies, cloud base measurements and gust and air quality monitoring.

While every effort has been made to provide accurate and calibrated data products, HALO Photonics does not currently guarantee the calibration of the data in absolute terms.

The system has been designed to be rugged and autonomous. Even so, the end user must respect the fact that the system is a precision optical instrument that must be treated with great care.

The laser emission from the antenna is in the **class 1M category**. The responsibility for ensuring suitable safety procedures and operating modes lies entirely with the end user. HALO Photonics does not accept any responsibility for issues relating to the field deployment of the equipment and propagation of the beam in the atmosphere.



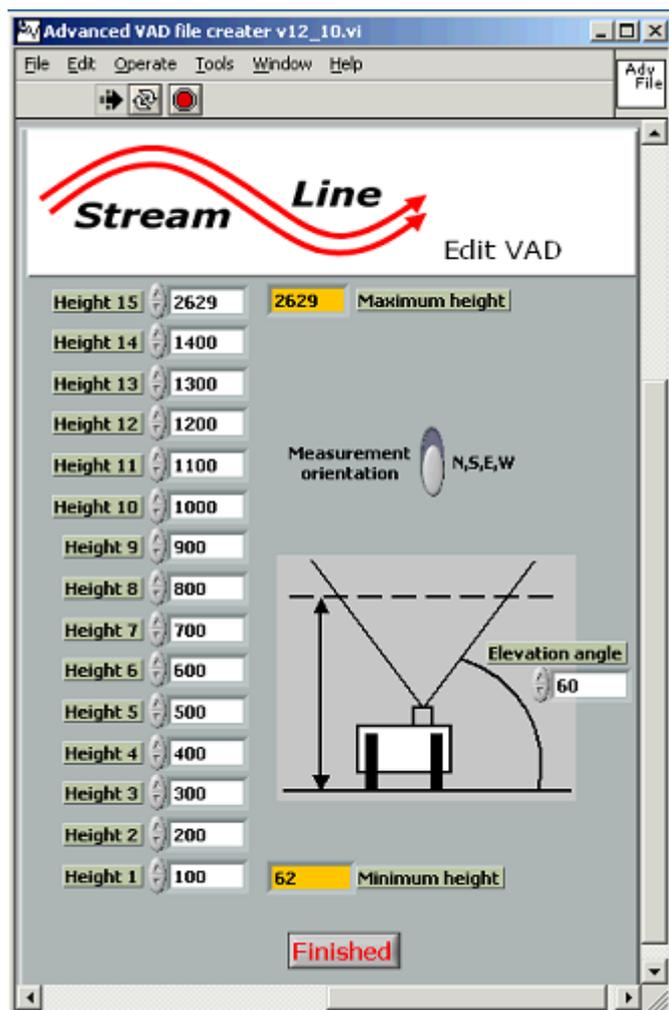
This manual will describe the usage of the Profiling software only – please refer to the ‘Halo Photonics Stream Line Scanning Doppler LiDAR system - Hardware and Software Guide’ for all other aspects of the system.

There are three modules associated with the Profiler software, shown below.



The Advanced VAD and Basic VAD modules are used to set up VAD scans for use with the main ‘StreamLine Profiler’ software.

### Advanced VAD file creation and editing.

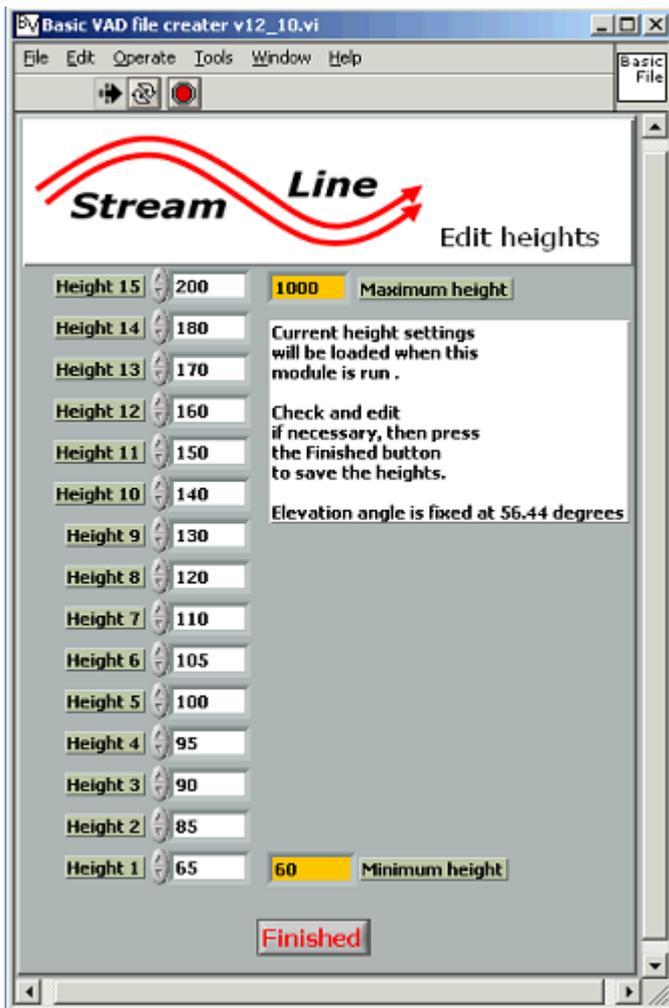


When the Advanced VAD icon is double clicked, the screen to the left will be displayed. Previous values will be read in and displayed – in case minor adjustments to the existing setup are needed.

15 measurement heights can be selected, along with an elevation angle. The 4 measurement points can also be selected as N,S,E,W or NE,SE,SW,NW. The maximum LOS range that can be selected is 3km.

When the Finished button is pressed, the selected data are converted to a scan file that is used with the main software.

## Basic VAD file creation and editing.



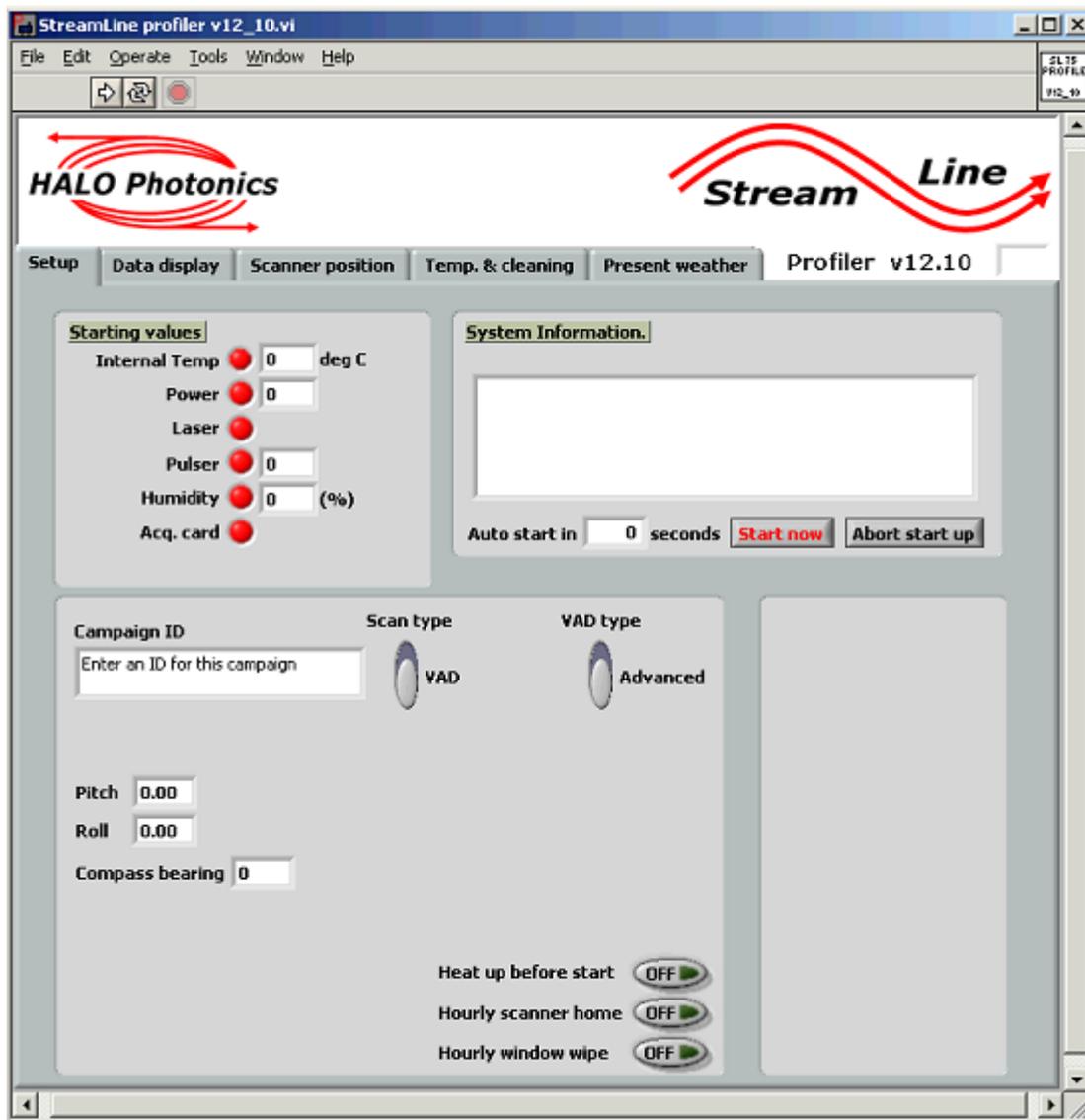
When the Basic VAD icon is double clicked, the screen to the left will be displayed. Previous values will be read in and displayed – in case minor adjustments to the existing setup are needed.

15 measurement heights can be selected, the elevation angle is fixed at 56.44 degrees, and a N,S,E,W scan will be used. The maximum LOS range that can be selected is 1km.

When the Finished button is pressed, the selected data are converted to a scan file that is used with the main software.

## StreamLine Profiler main control software.

Double click the Profiler icon, and press the start button (right facing arrow, top left of front panel).



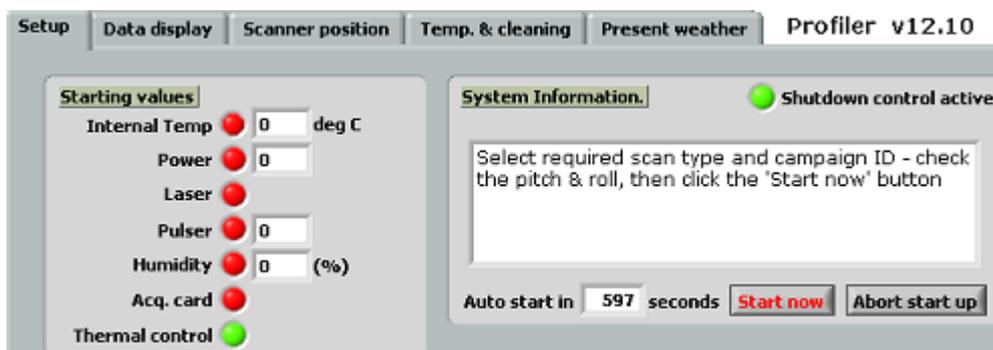
Some initial checks will take place, followed by a 10 minute delay, which will start to count down. This is a feature of the auto start function and can be skipped by pressing the '**Start now**' button. It is possible to prevent the software from going any further by clicking the '**Abort start up**' button.

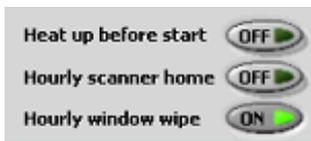
If the timer counts down to zero, the software will continue to start up as if the Start now button had been pressed.

During the start delay, the pitch and roll data are updated – so the system can be levelled using the leg adjuster knobs.

If the extended temperature option has been fitted to your system, the Thermal control test will be performed. If the test fails, then the software will stop.

The system information window contains information and guidance.



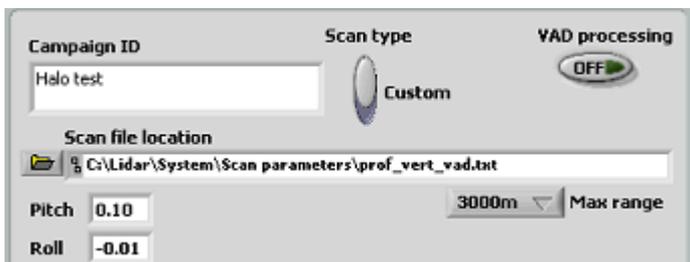


The **hourly wipe** option will cause the window to be wiped every hour. This is a useful feature and it is recommended that it be selected. The system will perform a noise background every hour, which will take longer than this wiping routine, and they will occur simultaneously.

**Hourly scanner home** should only be enabled when scans involving continual rotation of the scanner are used for extended periods. The scanner encoder numbers will build up over time, and will eventually overflow, so the home option will reset the encoders every hour, and prevent this from happening.

The **Heat up before start** function is only needed if your system has been switched on after being allowed to cool down to lower than 5 degrees C.

During this selection period, a Campaign ID can be entered, the pitch and roll data can be used to aid levelling of the system, and an appropriate scanning mode can be chosen.



**Campaign ID** – this should always be used and acts as an identifier for the measurement campaign. It will be used in some of the data file headers, and will also be written to a file and will contain the start time, pitch and roll data, the scanning file that will be used and the bearing. Each campaign file has a unique number that will be referred to in the corresponding data header.

An example campaign file:

C:\Lidar\Campaigns\Halo test\_53.hdr

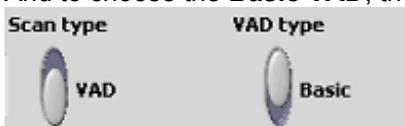
```
System ID      121020
Campaign number: 35
Scan file:     C:\Lidar\System\Scan parameters\prof_vert_vad.txt
Bearing:      0.0
Lat:          N/A
Long:         N/A
Altitude:     N/A
Roll:         -0.516
Pitch:        0.815
Start time:   08/01/11 16:03:04
*****
```

**Scan type:** VAD or custom

To choose the **Advanced VAD** option, use the following switch configuration:



And to choose the **Basic VAD**, the following configuration:



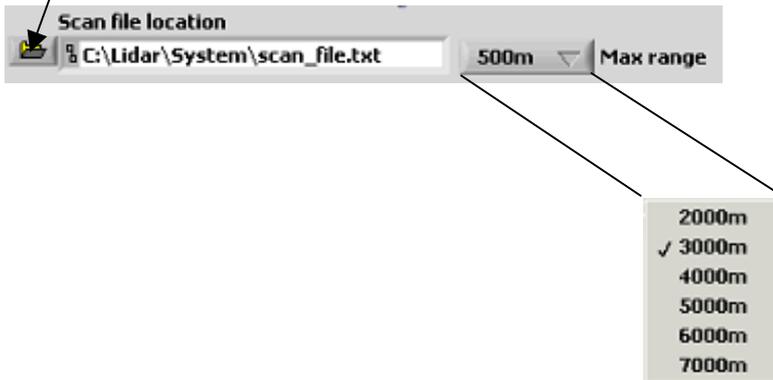
## Custom scan:



With the custom file, the option is available to perform **VAD processing** on the data. This processing option will only work on single elevation, arc scanning configurations where the arc covers 90 degrees or more in azimuth.

**It is advised that VAD processing is turned off for custom scan files, and that the data is post-processed.**

Choosing the custom file option will cause the fields shown below to appear. Use the file browser icon to select the previously generated scan file to be used. **Scan file format will be covered later.**

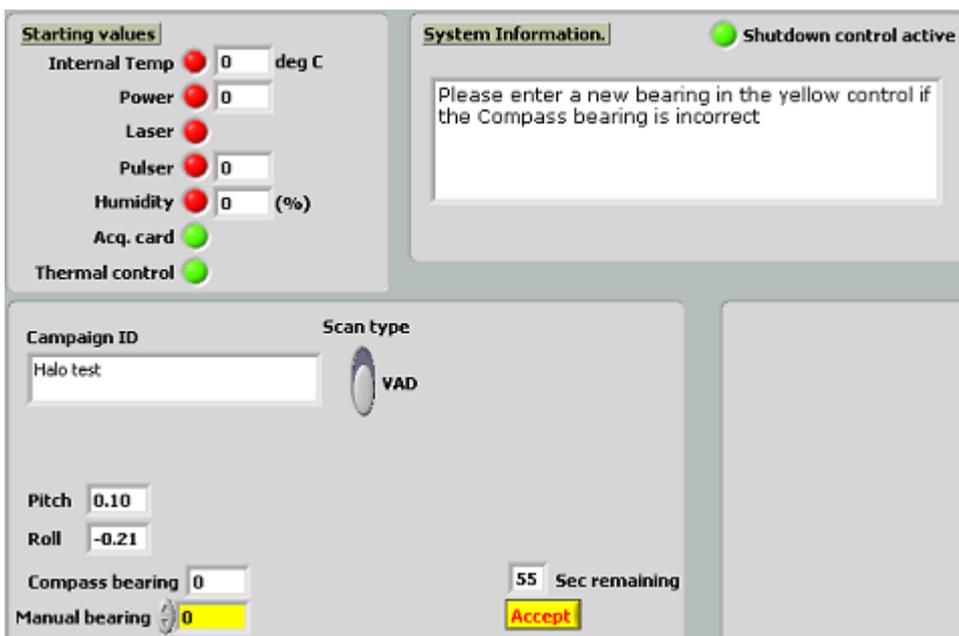


Next, choose the maximum LOS range that the LiDAR will collect data to.

**Atmospheric conditions will determine the actual maximum range to which data can be collected.**

## Bearing entry.

After the **Start now** button is pressed, the data acquisition card will be tested, and the bearing that is currently being used can be changed if necessary. The countdown will last for 60 seconds, after which time the value shown in the yellow box will be used as the system orientation. Pressing the 'Accept' button will stop the count and continue the software.

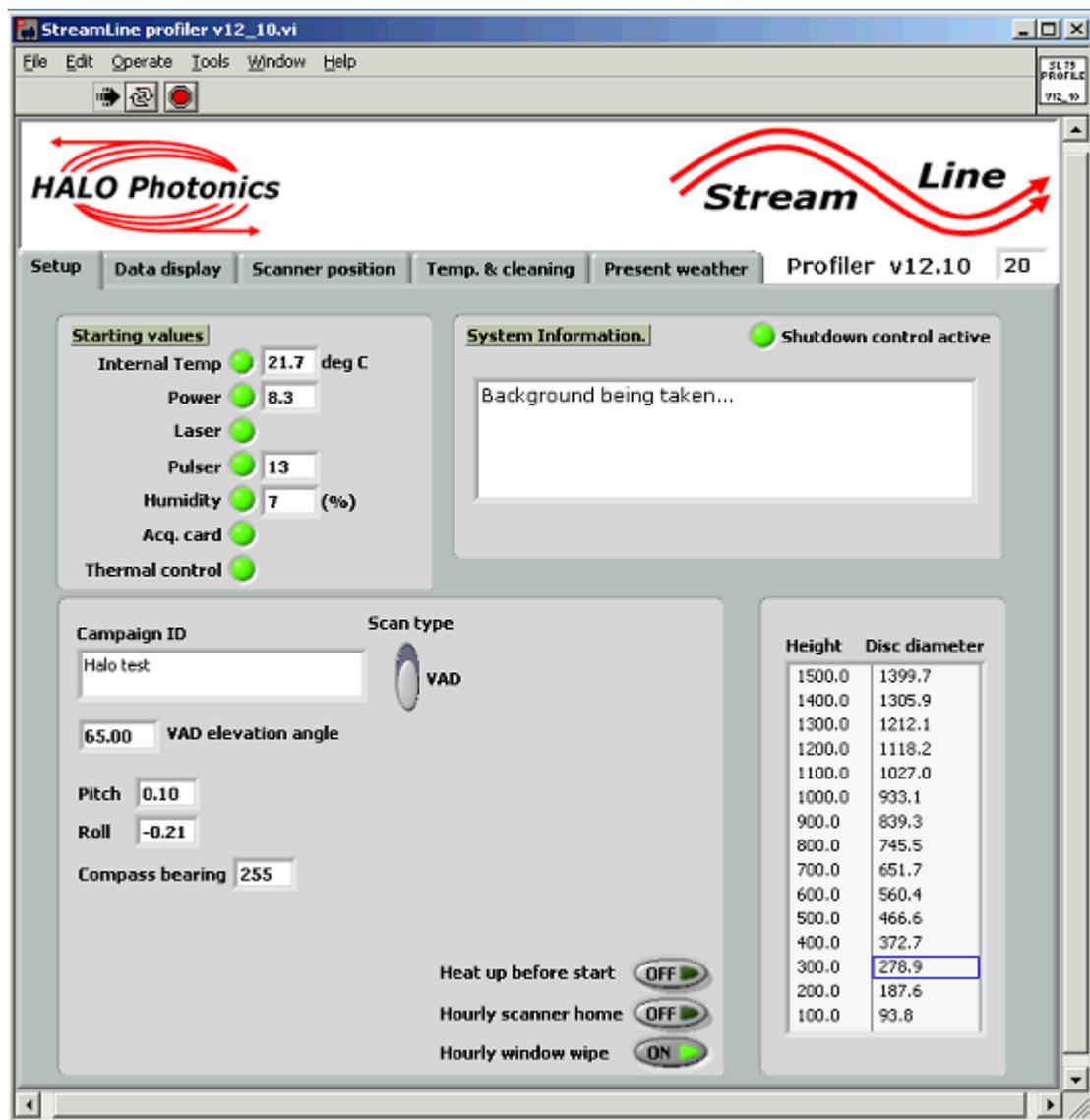


The software will continue through the rest of the start up checks once the 60 seconds has elapsed, or the Accept button is pressed.

The screenshot below shows all LEDs being green with a VAD scan type selected. The chosen heights are displayed bottom right, along with their corresponding disc diameters.

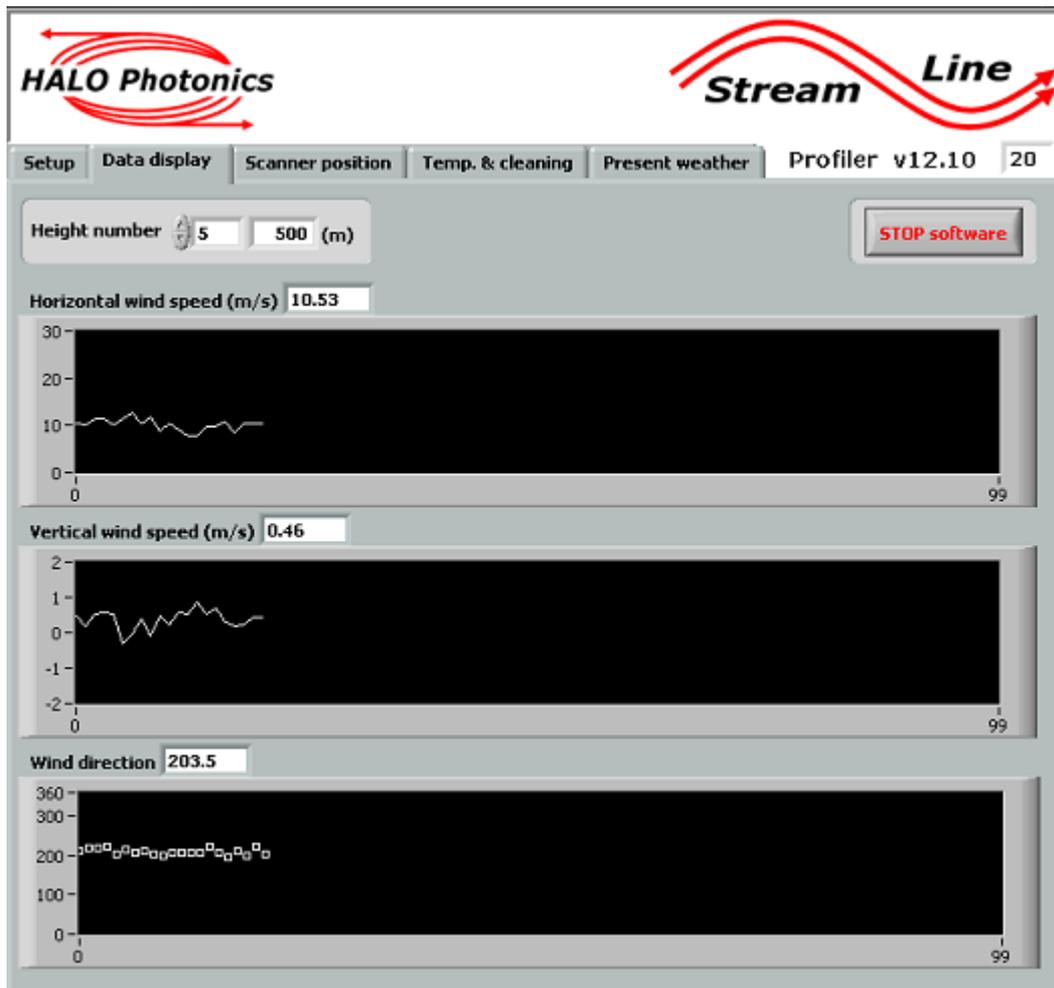
After starting, the system will take a **background** file (it will look down at its base plate for this), and will wipe the window, if the **'Hourly window wipe'** button is selected.

The data on this setup screen are not updated once the software is taking data, and will remain displaying the values as they were at start up.



## Data display – VAD

The three chart displays show the horizontal and vertical speeds, and the wind direction (where the wind is coming from) at a chosen height. If the selected height is changed, then new data displayed to the graphs will be from the new height.



## Individual height files.

The data from this mode of operation are logged into the directory shown, and with the file naming convention shown:

C:\Lidar\Data\Profiler\yyyy\yyyymm\yyyymmdd\500m\_height\_20.txt

The 20 is a reference to the system's serial number, and is useful for situations where more than one LiDAR is being used.

An example output from a **tab delimited** height file is shown below.

Date/time	Decimal time	Hsp	Vsp	Wdir	Turb	El angle	Min intensity	Mean intensity	
11/01/2011	11:50:18	42618	2.351	0.286	337.039	1.298495E-2	75.000	1.019	1.023
11/01/2011	11:50:35	42635	1.691	0.183	319.393	5.635829E-4	75.000	1.012	1.014
11/01/2011	11:50:52	42652	1.928	0.503	338.811	3.606840E-4	75.000	1.012	1.016
11/01/2011	11:51:08	42668	2.331	0.139	331.825	1.767391E-2	75.000	1.015	1.018
11/01/2011	11:51:25	42685	2.034	0.090	352.751	2.921596E-2	75.000	1.014	1.017
11/01/2011	11:51:41	42701	2.548	-0.004	353.389	2.254783E-5	75.000	1.013	1.015
11/01/2011	11:51:58	42718	1.964	-0.136	302.795	9.018019E-5	75.000	1.014	1.016
11/01/2011	11:52:15	42735	1.520	0.006	340.260	1.104621E-3	75.000	1.015	1.017
11/01/2011	11:52:31	42751	2.019	-0.058	340.911	1.767385E-2	75.000	1.012	1.018

## Wind\_data.txt files output.

All of the individual height data are also saved to a single file, saved in the same location as the individual files:

C:\Lidar\Data\Profiler\yyyy\yyyymm\yyyymmdd\wind\_data\_20\_25.txt

Where again, the 20 is a reference to the system serial number, and the 25 corresponds to the Campaign ID number. Every time the software is started, the Campaign\_ID is appended with a unique number, which increments by one each start up time.

Date/time	Height/range	Hsp	Vsp	Wdir	Turb	Min intensity	Mean intensity
11/01/2011 11:50:18	100	2.351	0.286	337.039	0.013	1.019	1.023
11/01/2011 11:50:18	200	7.088	0.065	348.048	0.461	1.045	1.049
11/01/2011 11:50:18	300	8.419	0.198	328.182	0.381	1.085	1.111
11/01/2011 11:50:18	400	9.256	-0.146	318.858	0.110	1.086	1.106
11/01/2011 11:50:18	500	6.840	-0.741	319.136	0.966	1.055	1.065
11/01/2011 11:50:18	600	9.670	-0.181	335.582	0.298	1.028	1.034
11/01/2011 11:50:18	700	9.582	0.365	341.707	0.123	1.020	1.025
11/01/2011 11:50:18	800	11.452	0.625	345.342	0.114	1.016	1.025
11/01/2011 11:50:18	900	14.666	1.029	329.652	0.966	1.006	1.136
11/01/2011 11:50:18	1000	8.516	0.611	317.449	1.409	1.011	1.675
11/01/2011 11:50:18	1100	9.618	-0.195	311.290	0.714	1.001	1.079
11/01/2011 11:50:18	1200	12.846	-2.132	26.637	0.175	1.003	1.005
11/01/2011 11:50:18	1300	36.137	-3.454	102.461	39.817	0.999	1.001
11/01/2011 11:50:18	1400	37.226	0.493	241.237	0.003	0.998	1.001
11/01/2011 11:50:19	1500	7.156	-0.903	144.593	1.595	1.001	1.005
11/01/2011 11:50:35	100	1.691	0.183	319.393	0.001	1.012	1.014
11/01/2011 11:50:35	200	4.916	-0.141	302.506	0.050	1.031	1.033
11/01/2011 11:50:35	300	8.523	0.503	339.070	0.006	1.063	1.070
11/01/2011 11:50:35	400	7.372	0.586	331.143	0.000	1.056	1.060
11/01/2011 11:50:35	500	5.861	0.016	327.006	0.000	1.029	1.033
11/01/2011 11:50:35	600	5.748	0.080	345.963	0.000	1.021	1.024
11/01/2011 11:50:35	700	7.761	-0.073	340.967	0.031	1.016	1.016
11/01/2011 11:50:35	800	9.047	0.060	337.599	1.091	1.012	1.015
11/01/2011 11:50:35	900	10.568	0.768	1.195	0.831	1.007	1.146
11/01/2011 11:50:35	1000	15.016	1.486	352.702	0.007	1.018	1.548
11/01/2011 11:50:35	1100	26.057	-0.280	357.138	3.482	1.001	1.045
11/01/2011 11:50:35	1200	37.691	4.894	169.515	6.844	0.998	1.000
11/01/2011 11:50:35	1300	-25.148	6.068	81.008	30.596	1.002	1.004
11/01/2011 11:50:35	1400	22.518	1.133	189.327	22.453	1.001	1.002
11/01/2011 11:50:35	1500	19.847	-2.270	90.107	3.901	1.002	1.005

## VAD files.

The individual VAD scan files that are processed to produce height and wind data files are also available. They are saved into the following location:

C:\Lidar\Data\Profiler\yyyy\yyyymm\yyyymmdd\hh\890\_05011117\_20.vad

Where the 890 is a unique incrementing file number, and the 20 is again the system serial number. VAD scans consist of a N,S,E,W (or NE, SE, SW, NW if selected – advanced VAD) and one ray at vertical.

Here is an example of a VAD file (first ray shown):

```
Filename: C:\Lidar\Data\Profiler\2011\201101\20110105\17\890_05011117_20.vad
Campaign code: Halo test
Campaign number: 25
Rays in scan: 5
Start time: 17:23:47
```

Height	Doppler	Intensity	Ray time	Az	El	Pitch	Roll	
80	-0.238992	0.998836	17:23:47		0.000	56.440	0.401	-0.203
85	-0.314959	0.999813	17:23:47		0.000	56.440	0.401	-0.203
90	-0.561854	1.001120	17:23:47		0.000	56.440	0.401	-0.203
95	-0.390927	1.000559	17:23:47		0.000	56.440	0.401	-0.203
100	-0.504878	1.001253	17:23:47		0.000	56.440	0.401	-0.203
105	-0.182016	1.000993	17:23:47		0.000	56.440	0.401	-0.203
110	0.140846	0.999555	17:23:47		0.000	56.440	0.401	-0.203
120	-0.561854	0.998008	17:23:47		0.000	56.440	0.401	-0.203
130	-1.055643	0.998753	17:23:47		0.000	56.440	0.401	-0.203
140	0.007903	0.998102	17:23:47		0.000	56.440	0.401	-0.203
150	-4.797043	0.999914	17:23:47		0.000	56.440	0.401	-0.203
160	16.568823	1.001994	17:23:47		0.000	56.440	0.401	-0.203
170	8.972070	1.001482	17:23:47		0.000	56.440	0.401	-0.203
180	-7.569858	1.001279	17:23:47		0.000	56.440	0.401	-0.203
200	8.041468	1.003898	17:23:47		0.000	56.440	0.401	-0.203

**Scanner position tab.**

This tab shows the current position of the scanner, along with a display of the voltage reaching the LiDAR.

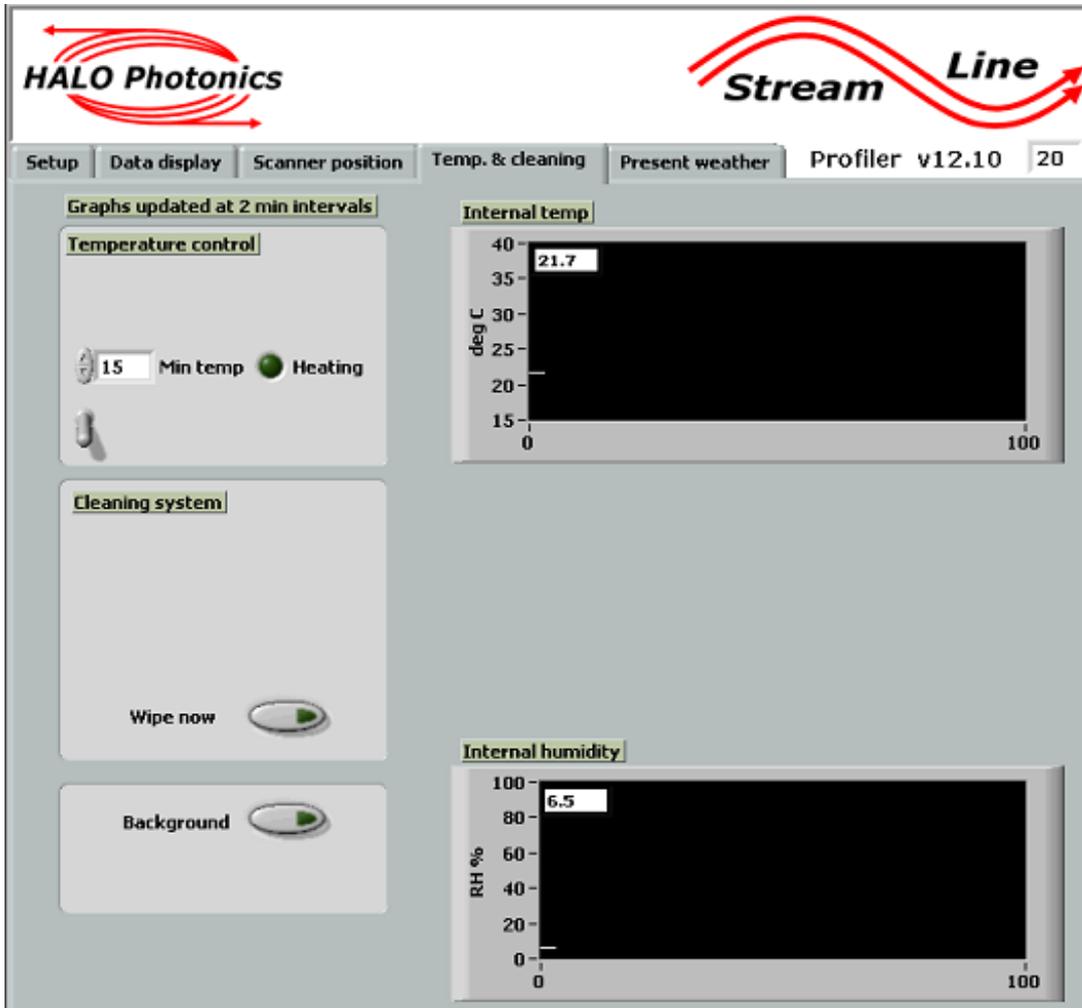


The screenshot displays the 'Scanner position' tab of the HALO Photonics Stream Line Profiler v12.10. The interface includes a navigation bar with tabs for Setup, Data display, Scanner position, Temp. & cleaning, Present weather, Profiler v12.10, and 20. The main content area is divided into two sections. The left section contains input fields for 'D actual' (1762), 'Supply voltage' (23.53), 'No. of rays' (5), and 'Campaign code' (Halo test). The right section, titled 'Scanner position', shows 'AZ' (359.998) and 'EL' (064.999) values.

Parameter	Value
D actual	1762
Supply voltage	23.53
No. of rays	5
Campaign code	Halo test
Scanner position (AZ)	359.998
Scanner position (EL)	064.999

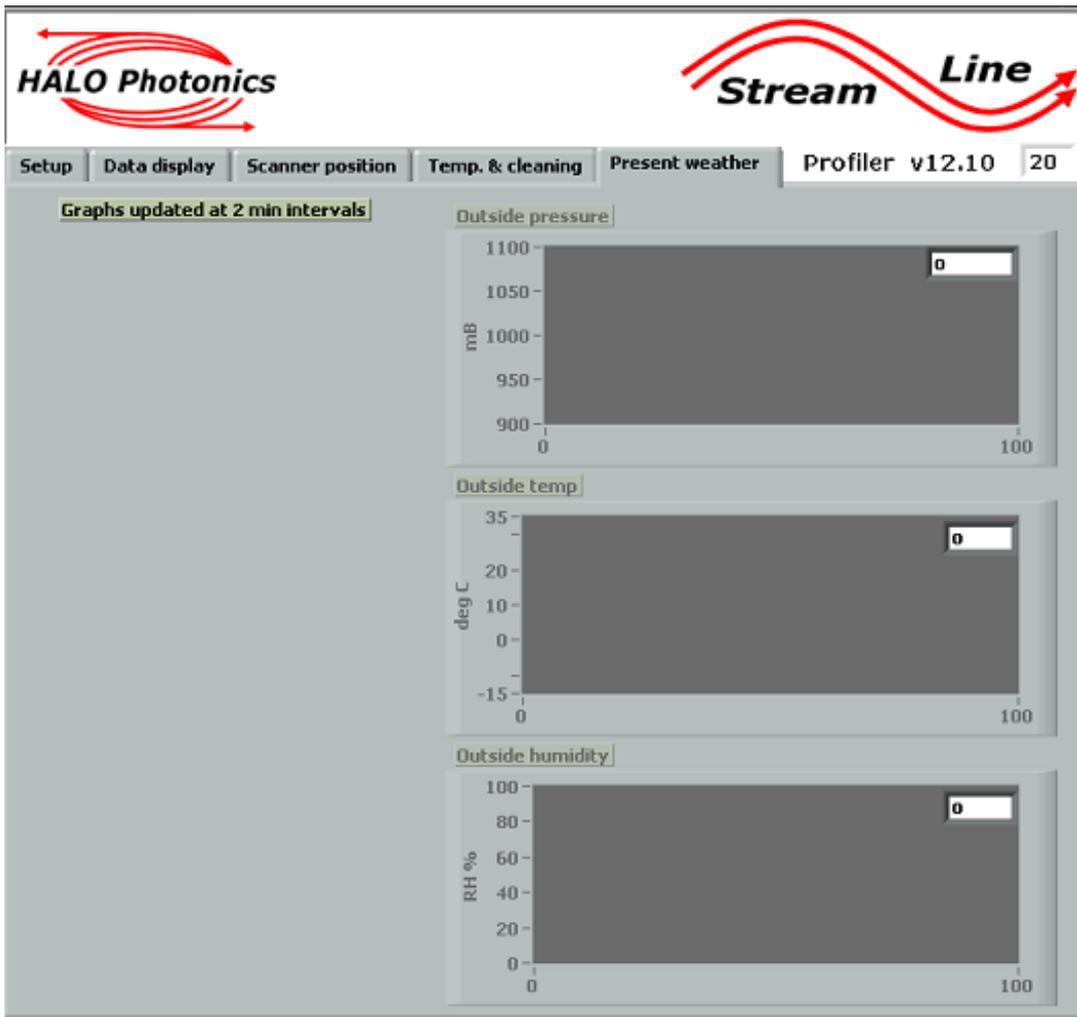
### Temp. & cleaning tab.

This displays the internal temperature and humidity, and also allows a manual window wipe to be performed, or a renewal of the background file. The Heating LED will be red (and the internal heater on) if the system temperature is below the 'Min temp' value. It will go off when the temperature is at least 2 degrees above the minimum value. These graphs are updated every 2 minutes.



**Present weather tab.**

If the LiDAR doesn't have a local met mast fitted, then this tab will not be updated.



## Scan file format.

For all scanning options, the LiDAR will look for a scan file containing coordinates that will be used to orient the scanner prior to collecting data.

The **VAD** scan files will be stored in **C:\Lidar\System**

The custom scan files can have any Windows acceptable name, and can be stored in any directory. The format that **must be used** for any scan file is shown below.

```
8 ←
1 ←
000.000063.200 ←
045.000063.200 ←
090.000063.200
135.000063.200
180.000063.200
225.000063.200
270.000063.200
315.000063.200 ←
```

Number of pairs of coordinates[CR]  
Not used – leave at 1[CR]  
Coordinate pair 1 aaa.aaaaaa.eee[CR]  
. . . . .  
Coordinate pair 8[CR]

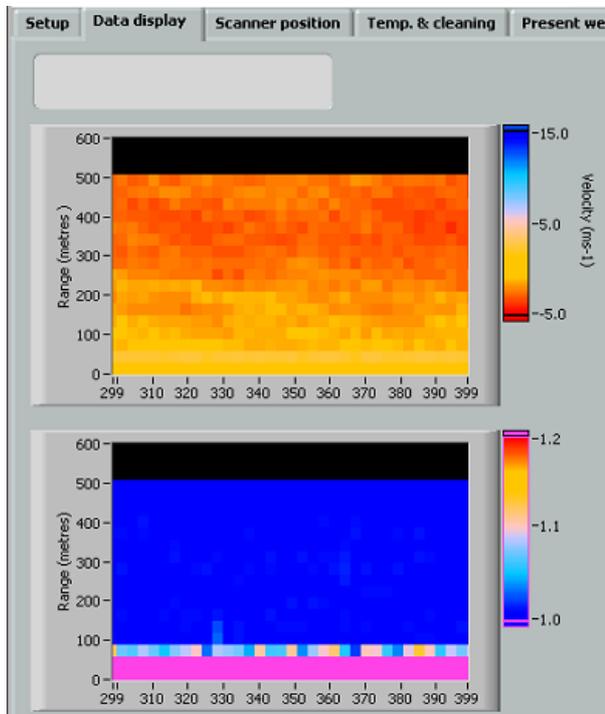
The example shown above shows 8 pairs of coordinates making up an 8 position VAD scan at an elevation angle of 63.2°.

Coordinates are entered as 3.3 azimuth followed by 3.3 elevation with no space and a carriage return [CR].

The 8 at the start of the file represents the number of pairs and the 1 is not used, but must be left.

## **Data display while running a scan file.**

The Data display tab will show the LOS velocity versus range (top display), and the signal intensity versus range. New rays will be plotted on the right in a waterfall plot mode.



Data from scan files will be stored in the same location as height files, but will have the naming convention:

ScanFile20\_20110108\_160345.hpl

Again, the 20 corresponds to the system serial number, followed by the date, then the time that the file was first saved into.

```
Filename: C:\Lidar\Data\Profiler\2011\201101\20110108\ScanFile20_20110108_160345.hpl
System ID: 20
Number of gates: 60
Range gate length (m): 30.0
Gate length (pts): 10
Pulses/ray: 15000
No. of rays in file: 12
Scan type: ScanFile
Focus range: 0
Start time: 20110108 16:03:51.00
Resolution (m/s): 0.0190
Altitude of measurement (center of gate) = (range gate + 0.5) * Gate length
Data line 1: Decimal time (hours) Azimuth (degrees) Elevation (degrees) Pitch (degrees) Roll (Degrees)
f9.6,lx,f6.2,lx,f6.2,lx,f6.2,f6.2
Data line 2: Range Gate Doppler (m/s) Intensity (SNR + 1) Beta (m-1 sr-1)
i3,lx,f6.4,lx,f8.6,lx,e12.6 - repeat for no. gates
****
16.064167 0.00 0.00 -0.62 0.31
 0 -4.8061 0.998756 -2.199013E-8
 1 2.5627 0.775683 -3.967805E-6
 2 -0.4190 1.069723 1.234737E-6
 3 -0.3810 1.079519 1.410864E-6
 4 -0.3810 1.075004 1.334181E-6
 5 -0.3810 1.078009 1.392155E-6
 6 -0.4000 1.074187 1.329193E-6
 7 -0.4000 1.073827 1.328886E-6
 8 -0.4000 1.080016 1.447931E-6
 9 -0.3620 1.078926 1.436752E-6
10 -0.4190 1.077470 1.419610E-6
```

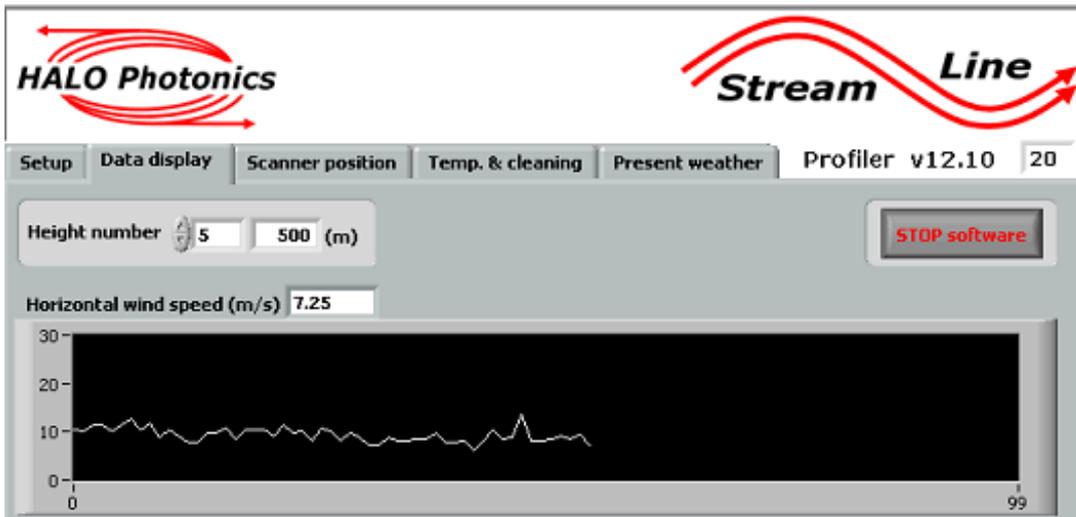
Decimal time, Az, El, Pitch, Roll

First 10 range gates of the ray showing gate number, LOS Doppler and backscatter.

If VAD processing has been enabled, then in the same way that height files were save for VAD scans, range gate files will be saved, and will be VAD processed by range gate rather than by height.

## Stopping the LiDAR.

Press the STOP software button on the Data display tab to stop the software. Note that depending on the scan type and the timing of the button press, the LiDAR may take one or two more scans before stopping.



The following message will be displayed when the software has stopped. The LiDAR scanner will go to its parked position – i.e. looking down at its base plate.

