

1. TS system operator GUI

The operator's GUI of the TS is shown in Figure 1 with circled numbers for explanation purposes (Van Niekerk, 2008).

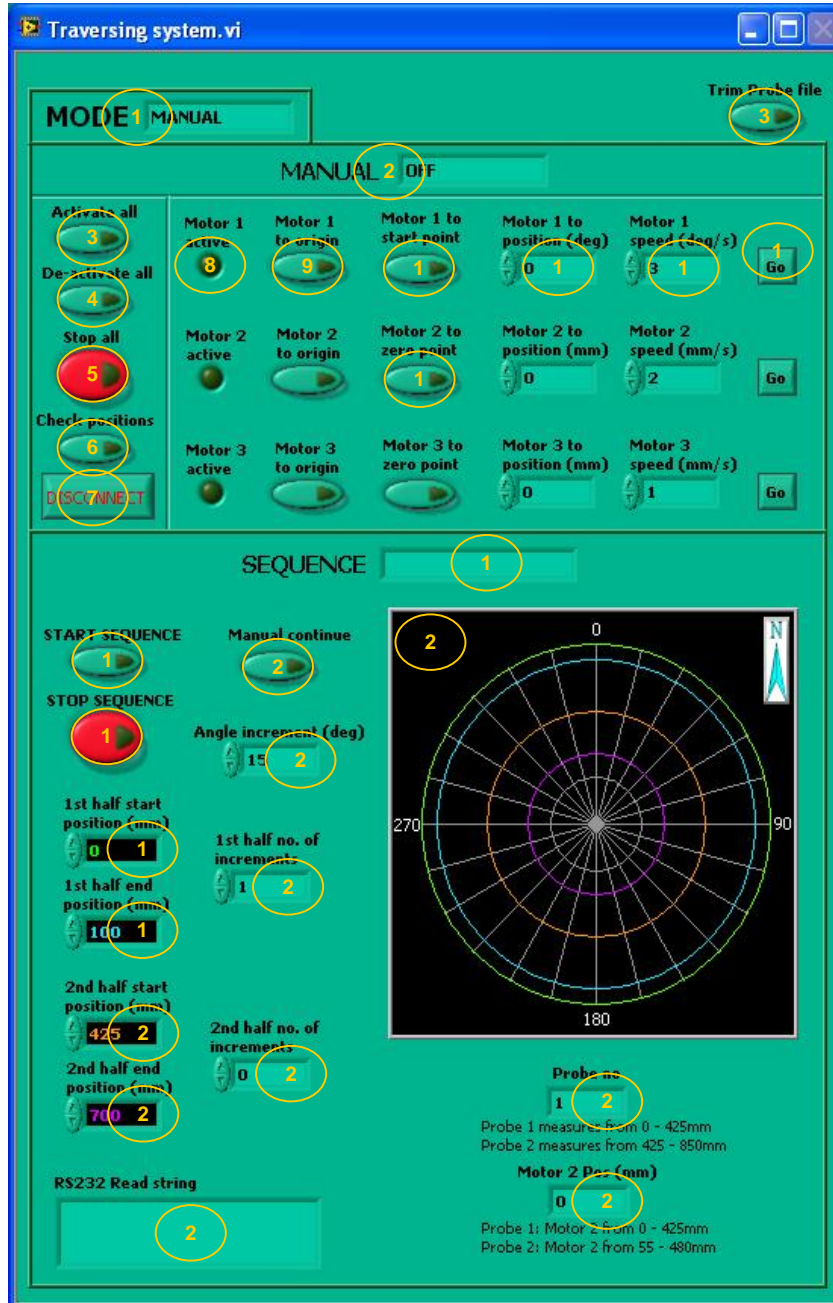


Figure 1: Traversing system GUI

The following controls and indicators are used (Van Niekerk, 2008):

1. *MODE*: The system can either be in manual mode or sequence mode.
2. *MANUAL*: Manual mode
3. *ACTIVATE ALL*: When the GUI is started up, the RS232 connection with the motors is established. Each motor however still has to be activated before it can act on commands. This button activates all three the motors.
4. *DE-ACTIVATE ALL*: De-activates all three the motors.
5. *STOP ALL*: Stops all three the motors when in manual mode. In the case of an emergency for instance excessive wind up of wires, this button should be pushed.
6. *CHECK POSITIONS*: By pushing this button the motors is given requests to provide information on their current positions. The information is displayed at the same location on the GUI where the position commands are displayed (Motor 1 to position (deg) – explained at 11, Motor 2 to position (mm) and Motor 3 to position (mm)). These commands disappear temporarily whilst the position information is displayed in their places.
7. *DISCONNECT*: This shuts down the GUI and disconnects the RS232 link with the motors.
8. *MOTOR 1 ACTIVE*: The light turns on when motor 1 is activated and stays on for as long as motor 1 is active. The same applies to the lights for motors 2 and 3 below it.
9. *MOTOR 1 TO ORIGIN*: Pushing this button will return the probes to the proximity switch and to reset the motor position offset with the condition that its current position is negative. The reason for this is that the origin search occurs clockwise since the start and end position for motor 1 is at -15° . If the current position is positive, an origin search will cause the motor to reach 360° in stead of 0° . The same applies to the buttons for motors 2 and 3 below it except that no conditions apply here.
10. *MOTOR 1 TO START POINT*: Motor 1 moves the probes to the -15° point.
11. *MOTOR 2 TO ZERO POINT*: This command applies to both motor 2 and 3 and is the only command in the manual mode that is different from motor 1. Since the origin points of motors 2 and 3 are different from their zero points, this button will move the probes to the zero points.
12. *MOTOR 1 TO POSITION (DEG)*: If the operator wishes to rotate the probes manually to a given position, the position is typed in here.

13. *MOTOR 1 SPEED (DEG/S)*: If the operator wishes to rotate the probes manually to a given position, the desired speed is typed in here.
14. *GO*: After the position and speed is set (see 11 and 12 above), this button can be pushed to set motor 1 in motion.
15. *SEQUENCE*: Sequence mode
16. *START SEQUENCE*: Starts a sequence. The program automatically checks whether conditions are safe and correct to start the sequence.
17. *STOP SEQUENCE*: Stops the current sequence. The program stops the motors and return to manual mode.
18. *1st HALF START POSITION (MM)*: Sets the starting position the first half. The green line in the diagram (29) will correspond to this position.
19. *1st HALF END POSITION (MM)*: Sets the end position of the first half. The blue line in the diagram (29) will correspond to this position.
20. *2nd HALF START POSITION (MM)*: Sets the starting position of the second half. The orange line in the diagram (29) will correspond to this position.
21. *2nd HALF END POSITION (MM)*: Sets the end position of the second half. The purple line in the diagram (30) will correspond to this position.
22. *RS232 Read string*: This block shows any communication activity between the motors and the computer. If a motor was given a command to acquire a certain position, its current position will be fed back to the computer until the motor has stopped.
23. *MANUAL CONTINUE*: Continues the sequence if the sequence is interrupted.
24. *ANGLE INCREMENT (DEG)*: Set the angle increments at which the probes must be stationary to acquire the velocity. The angle increment lines are shown in the diagram (29)
25. *1st HALF NO. OF INCREMENTS*: This selects which probe will be used. If a value of 1 is entered probe 1 will be used to measure the velocity. If 0 is entered probe 1 will be ignored.
26. *2ND HALF NO. OF INCREMENTS*: This selects which probe will be used. If a value of 1 is entered probe 2 will be used to measure the velocity. If 0 is entered probe 2 will be ignored.
27. *PROBE NO*: Indicates the probe that is used.
28. *MOTOR 2 POS (MM)*: Shows the current position of motor 2 whilst in the sequence mode.

29. *DIAGRAM*: This diagram shows the first and second halves and angle increments. When a sequence starts, the angle increment lines disappear and a yellow line appears indicating the position of motor 1 and 2.
30. *TRIM PROBE FILE*: At the end of a sequence or sub sequence both the traversing system and the anemometry system will have exported a data file. The file exported by the anemometry system will however have to be trimmed of its headers to be suitable for processing.

2. MiniCTA project Setup

This section describes the manner in which the anemometry system was setup prior to the execution of the velocity tests. Since two probes were used they were first setup and calibrated independently in their own MiniCTA project. After their calibration a new MiniCTA project was created which included both probes and their respective calibration data. The process of setting up the anemometry system, containing both one and two probes, is discussed bellow independently.

SINGLE PROBE MINICTA SETUP

Since the process for both probes is basically identical, only the setup for probe 1 will be discussed and differences between the setup of probe 1 and 2 pointed out.

It should be noted that the power adapter should not be connected to the MiniCTA system before the probes are connected and the decade resistance, of the CTA bridge, is adjusted to the proper overheat ratio.

Hardware list:

- multi channel CTA system with mini CTA software and 10 m cables,
- single sensor fiber-film probes (55R01),
- 4mm dia. probe supports (55H21),
- reference velocity transducer (54T29) and
- reference temperature sensor (55P32).

Hardware Setup:

1. Insert the probe (55R01) into the probe support (55H21) and connect the probe support to channel 0 on the back of the multi channel mini CTA system via the supplied 10 m BNC cable. If probe 2 is used the exact same procedure is followed but the probe support is connected to channel 1 of the multi channel mini CTA system
2. Connect the reference temperature sensor (54T29) to the marked connection point at the back of the multi channel mini CTA system via the provided 10 m BNC cable.
3. Connect the reference velocity transducer (55P32) to the marked connection point at the back of the multi channel mini CTA system via the provided 10 m BNC cable.
4. Connect the multi channel mini CTA system to the A/D board (installed in computer) via the provided flat cable.

MiniCTA software setup:

Create a new Database:

1. Open the MiniCTA software package and choose “New Database” from the panel.
2. Choose an adequate Database description e.g. Probe 1 and choose “Open” to create the Database as shown in Figure 2.

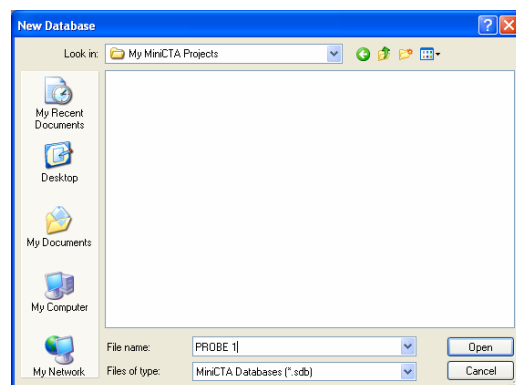


Figure 2: Create a new Database

Create a new Project:

You are informed that the database is empty and prompted to create a new Project. A “New Project” window opens as shown in Figure 3.

1. Enter the name of the project in “Project ID name” field e.g. PROBE 1.
2. Enter you name or initials in the “Created by” field.

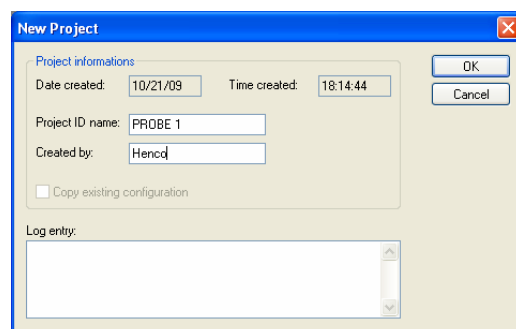


Figure 3: Create a new Project

Define Devices:

The software informs you that no A/D board is selected and prompts you to select an A/D board. Select “Yes”. The “Select A/D Driver” dialog box opens as shown in Figure 4

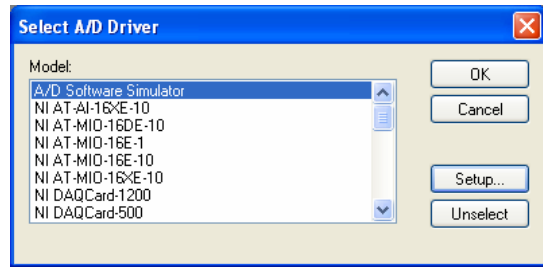


Figure 4: Select A/D Driver

1. Select the A/D board that is installed on the computer. In the case of the HTTU select the PCI-6220 board found under NI DAQmx Supported devices
2. Select “OK”

System Configuration:

You are informed that the system is not configured and prompted to do configure the system. Select “Yes”. “The System Configuration” window opens.

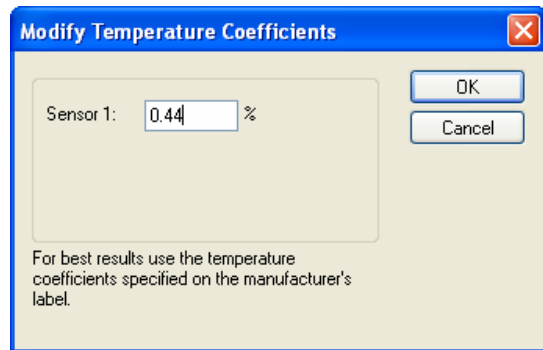


Figure 5: Modifying the probes temperature coefficient.

1. Click on the “Multichannel CTA frames” icon. The “Multichannel CTA frames” selection window opens.
2. Select “54N81 Multichannel CTA frame incl. References”.
3. Click the “1D wire probe” icon. The Probes, Support and Cable selection window opens.
4. Select probe 55R01, support 55H21 and BNC/BNC cable A1865 in the list box.

5. You are prompted to enter the probes temperature coefficient as shown in Figure 5. This coefficient is found on the probe's container. The probe, support and cable are connected to channel 0 on the Multichannel CTA frame. For probe 2 and steps 3 to 5 are repeated. Afterwards probe 1 is deleted from the system leaving only probe 2 connected to channel 1 on the Multichannel CTA frame.
6. Select the "Miscellaneous Probes" icon. "The Probes and Cables" selection window opens.
7. Select temperature probe 55P32 and BNC/BNC cable "A1865".
8. Select the "Reference Probes" icon. The "Probes" selection window opens.
9. Select the 1D reference velocity probe 54T29.

The final system component configuration for probe 1 and 2 is shown in Figure 6.

10. Select "Save"

Define Hardware Setup:

You are now prompted to define the hardware setup. Firsts you are prompted to configure the temperature probe. Select "Yes". The "Select Temperature Probe" window opens as shown in Figure 7.

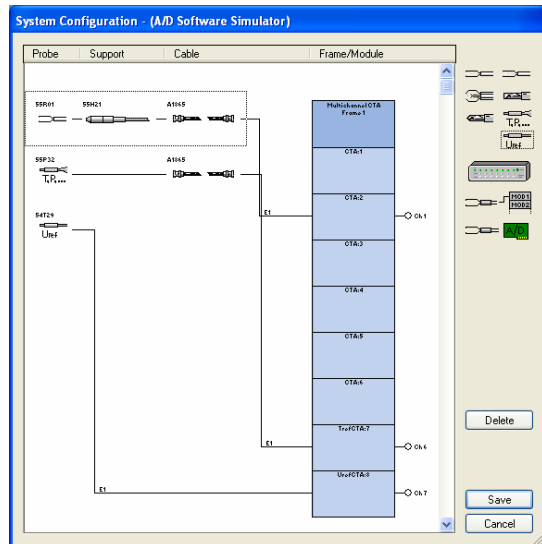
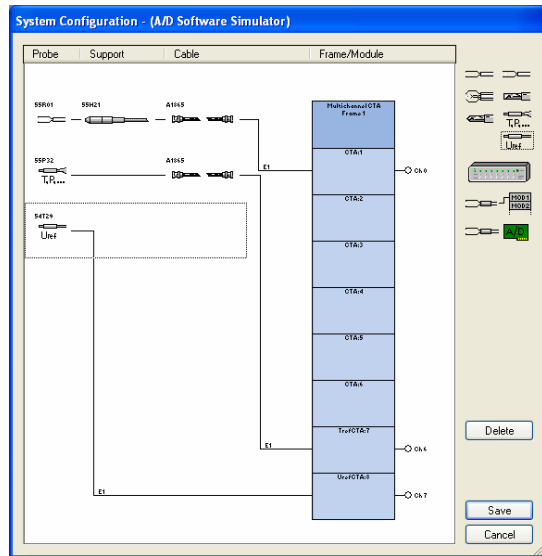


Figure 6: CTA system configuration for probe1 (top) and probe 2 (bottom)

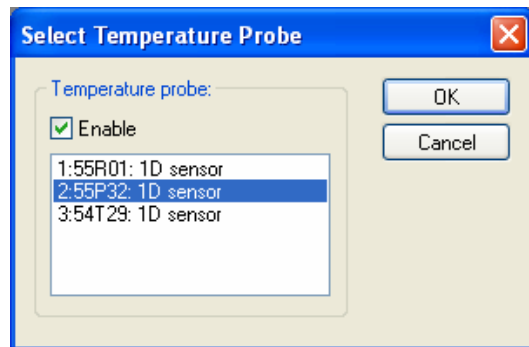


Figure 7: Temperature selection window

1. Mark the “Enable” checkbox
2. Select the temperature sensor 55P32
3. Select “OK”

Next you are prompted to setup the CTA hardware. Select “Yes”. The “Hardware Setup” window opens as shown in Figure 8.

1. In the reference temperature text box enter the expected temperature of the fluid during the experiment. For the HTTU the reference temperature was taken as 21°C. This temperature is used as the reference temperature during the temperature correction of the velocity.
2. Enter the cold resistance of the probe in the “R₂₀” text box. This value provided by the probe manufacturer and can be found on the probe container.
3. Click “Update”. The corresponding probe operational data and dipswitch settings are displayed.
4. Manually adjust the dipswitch settings on the multi channel CTA system to the displayed switch setting.
5. Select “OK”.

This concludes the hardware setup and anemometry overheat adjustment. The power adapter can now be connected to the multi channel CTA system.

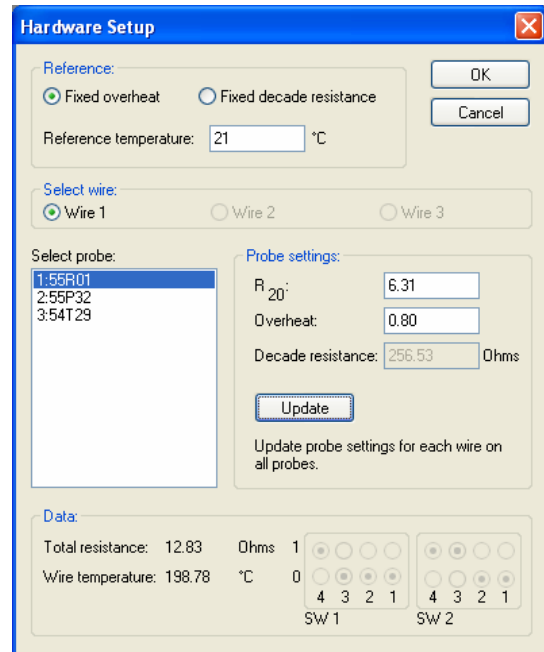


Figure 8: CTA hardware setup window

Velocity Calibration:

You are now prompted to carry out a velocity calibration for the probe. Select “Yes”. The “Calibration method” selection window opens. Select “Velocity Calibration”. The “Velocity Range” window opens as shown in Figure 9.

1. Enter the minimum and maximum expected velocity along with the number of calibration points.
2. Leave the rest unaltered and select “OK”.

The “System Calibration” window opens as shown in Figure 10.

1. For point 1 select the “Read” button under “Parameters”. The velocity from the reference velocity transducer (54T29) and temperature from the reference temperature probe (55P32) is read.
2. Select the “Read” button under “Voltages”. The probe voltage from the CTA bridge is read.
3. Click “Update”. The read velocity, temperature and voltage are placed into the calibration data sheet.
4. Repeat steps 1 to 4 for all the remaining calibration points.
5. Select “Fit”. The probe “Curve Fit Analysis” window opens as shown in Figure 11. The linearization coefficients and errors are shown. To fit a higher polynomial curve click the “Curve fit”

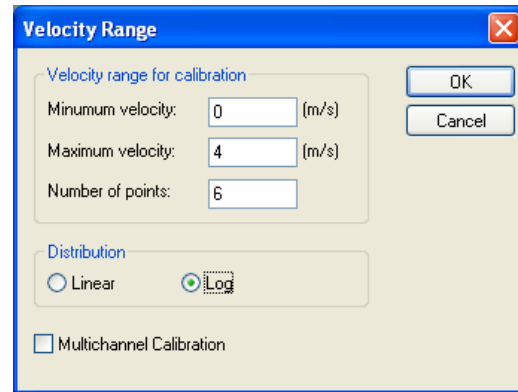


Figure 9: Velocity calibration range window

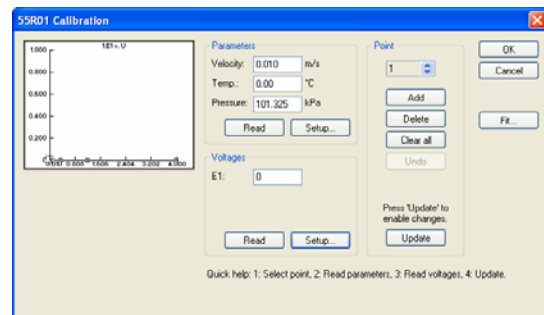


Figure 10: Velocity calibration window

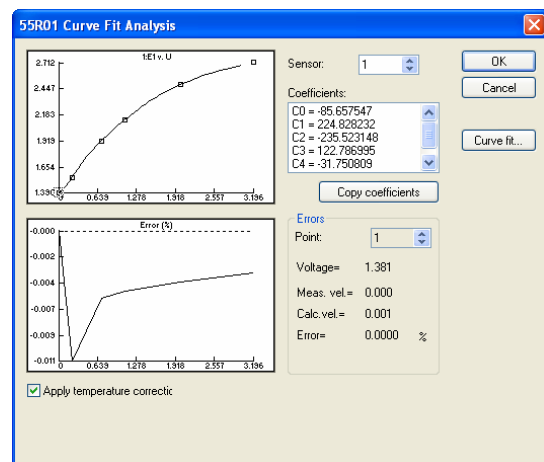


Figure 11: Curve fit analysis window

button and increase the polynomial count. For the HTTU a 5th order polynomial provided the best fit.

6. Check the “Apply temperature correction” check box to temperature correct the voltages before linearization since the fluid temperature varied during calibration.
7. If you are satisfied with the quality of the calibration and linearization curve select the “OK” button. The “Velocity

| | U | E1 | T(C) | P(kPa) | E1corr | U1calc |
|---|-------|-------|--------|---------|--------|--------|
| 1 | 0.000 | 1.381 | 23.270 | 101.325 | 1.390 | 0.001 |
| 2 | 0.219 | 1.552 | 20.980 | 101.325 | 1.552 | 0.219 |
| 3 | 0.702 | 1.928 | 19.720 | 101.325 | 1.921 | 0.702 |
| 4 | 1.085 | 2.139 | 19.930 | 101.325 | 2.133 | 1.085 |
| 5 | 2.006 | 2.504 | 19.420 | 101.325 | 2.483 | 2.006 |
| 6 | 3.196 | 2.771 | 13.130 | 101.325 | 2.712 | 3.196 |
| 7 | | | | | | |

Figure 12: Velocity calibration data window

Close and save the calibration event:

1. Double click in the upper left corner of the “Velocity Calibration Data” window. The “Save Event” window, as seen in Figure 13, opens. In the “Associated ID” text box enter a relevant description of the event e.g. PROBE 1 CALC for probe 1 and PROBE 2 CALC for probe 2.
2. Select Yes.

Figure 13: Save calibration event window

You are now prompted to create a data reduction setup. Select “Yes”. The data reduction’s “Save Event” window, as shown in Figure 14, opens.

1. In the “Associated ID” text box enter a relevant description of the event e.g. Calibration Data” window is opened as shown in Figure 12. PROBE 1 RED for probe 1 and PROBE 2 RED for probe 2.

Figure 14: Save data reduction event window

2. Select “Yes”.
3. You are prompted to set the data conversion setup as the current default. Select “Yes”.

A new “Data Conversion/Reduction Setup” is created in the project manager. Double-click on the conversion setup. The “Data Conversion/Reduction Setup” window, as seen in Figure 15, opens. To close the window click “Cancel”.

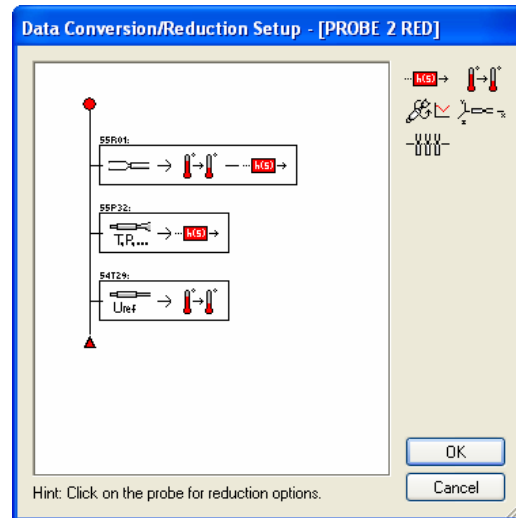


Figure 15: Data conversion/reduction setup window

This concludes the hardware and software setup of the MiniCTA when only one probe is used. Next the hardware and software setup procedure of the MiniCTA system, employing both probes, is discussed.

DUAL PROBE MINICTA SETUP

Since the range of stepper motor 2 is less than the radial span of the annulus, two hot-wire probes were used to cover the entire span of the annulus.

Hardware list:

- multi channel CTA system with mini CTA software and 10 m cables,
- 2 x single sensor fiber-film probes (55R01),
- 2 x 4mm dia. probe supports (55H21),
- reference velocity transducer (54T29) and

Hardware Setup:

1. Insert the probes (55R01) into the probe supports (55H21). It is important to keep track of which probe was designated as probe 1 and probe 2 during the single probe MiniCTA setup, discussed above, as the overheat ratios and decade resistance of

the Multichannel MiniCTA system has already been configured to each particular probe. Connect the probe support, containing probe 1, to channel 0 of the Multichannel MiniCTA system via the 10 m BNC/BNC cable. Connect the probe support, containing probe 2, to channel 1 of the Multichannel MiniCTA system via the 10 m BNC/BNC cable.

2. Connect the reference temperature sensor (54T29) to the marked connection point at the back of the multi channel mini CTA system via the provided 10 m BNC cable.
3. Connect the multi channel mini CTA system to the A/D board (installed in computer) via the provided flat cable.

MiniCTA software setup:

The creation of a new Database, Project and A/D device definition is exactly the same as with the single probe MiniCTA setup discussed above.

During the system configuration the same procedure is followed as described in the previous section. The only difference is that instead of one probe, two probes are connected to the Multichannel MiniCTA frame. The reference velocity transducer isn't added into the system configuration since the probes have already been calibrated. The system configuration can be seen in Figure 16.

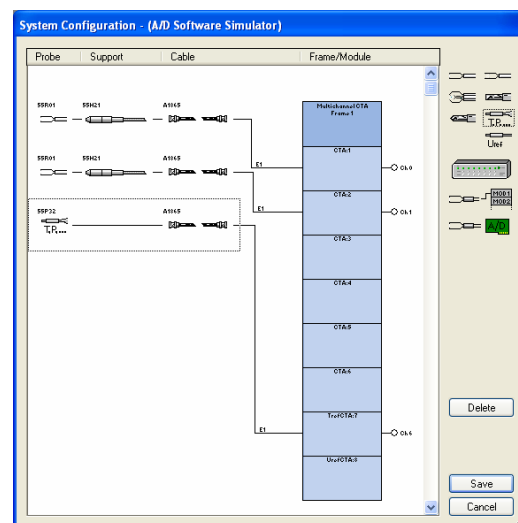


Figure 16: Multi-probe system configuration

Defining the hardware setup, as described in the single probe MiniCTA setup, is carried out in exactly the same manner with the exception that instead of one probe, two probes no have to be configured. In the Probe Select list box, shown in Figure 8, two 55R01 probes rather than one will be displayed. Clicking on the first probe allows you to alter the reference temperature and cold resistance of probe 1. Similarly the values of probe 2 can be altered by selecting the second listed

55R01 probe. When prompted to calibrate the probes select Cancel since the probes have already been calibrated. The calibration data from the single probe projects will be carried over to new multi-probe project. This is done as follow:

1. Open the database of probe one which contains the probe's calibration data. This is done by selecting "File/Database/Open". Select the folder containing the Database file of probe 1.
2. In the Project Manager tree select the "Velocity Calibration" event and copy the event.
3. Open the multi-probe database in the same manner as described in (1).
4. Paste the copied calibration data of probe 1 into the Project Manager tree.
5. Repeat steps (1-4) to import the calibration data of probe 2 into the multi-probe project.

The layout of the final Project Manager tree is shown bellow in Figure 17.

| Date/Time | Type | ID | Probe | Filename |
|----------------|----------------------|--------------|-------|--------------|
| 2008/10/23 ... | Project Header | | | |
| 2008/10/23 ... | Velocity Calibration | PROBE 1 CALC | 55R01 | FNAC2801.CAL |
| 2008/10/23 ... | Velocity Calibration | PROBE 2 CALC | 55R01 | FNAC2903.CAL |

Figure 17: Multi-probe MiniCTA project manager tree

Since the two probes contain independent calibration data sets a custom data conversion/reduction event need to be created.

Create a custom data conversion/reduction event:

1. Select "Setup/Define Reduction and Conversion". "The Data Conversion/Reduction Setup" window, shown in Figure 18, opens.
2. Click on the top 55R01 probe (Probe 1). The "1D Probe Reduction Options" window, shown in Figure 19, opens.
3. Select the "Options" button. The "Conversion Level" window, as shown in Figure 20, opens.

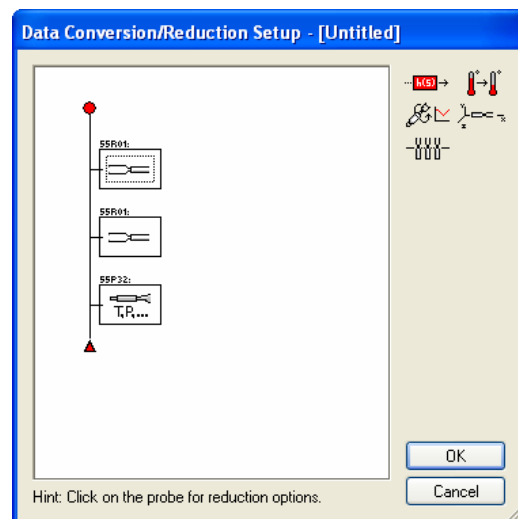


Figure 18: Custom data conversion/reduction setup window

4. Check the “Velocity from Calibration” and “Apply temperature correction” check boxes. Click “OK” and “OK”.
5. Repeat steps (2) to (4) for the second listed probe (Probe 2).
6. Repeat steps (2) to (4) for the reference temperature probe (55P32). In step (4) leave the “Apply temperature correction” checkbox unchecked.
7. Click just left of the first listed 55R01 probe. A small black border will enclose the probe. Click the “Temperature correction” icon and then the “Linearization” icon. Repeat this step for the second listed 55R01 probe.
8. Do the same with the temperature probe but only click the “Linearization” icon. The final “Data Conversion/Reduction Setup” is shown in Figure 21.
9. Click on the “linearization” icon placed next to the first listed 55R01 probe. The “Transfer Function” window, shown in Figure 22, opens.
10. Uncheck the “Use probe Library Defaults” check button.
11. Click the “Load” button. The “Select Event Window” opens.
12. From the listed events select the calibration event of probe 1.
13. Repeat steps (9) to (12) for the second 55R01 probe but select the calibration event of probe 2

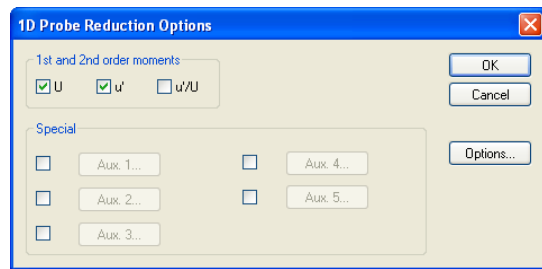


Figure 19: Probe Reduction Options window

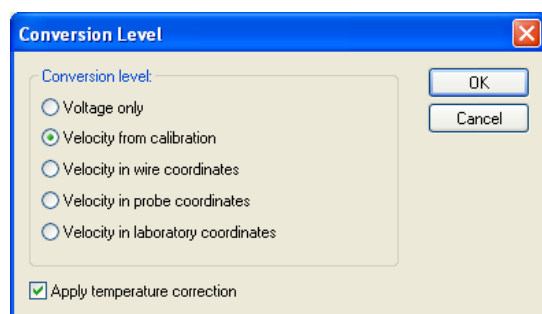


Figure 20: Conversion level window

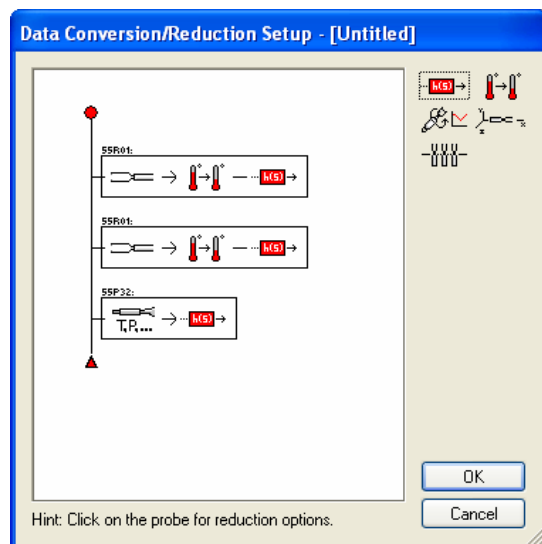


Figure 21: Applying temperature correction and linearization of probe readings.

14. Leave the linearization event of the temperature probe unaltered.
15. Select “OK” and save the Data Conversion/Reduction Setup Event, shown in Figure 14, using a proper description.

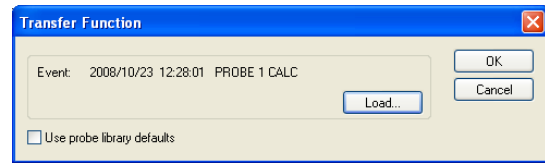


Figure 22: Transfer function selection window.

This concludes the setup of the Multichannel MiniCTA system for multiple probes. The MiniCTA system can now be switched on and set to operate to measure the velocity above the bed.

3. Test Execution Procedure

This section describes the procedure followed during the test to obtain the average velocity at a specified radius.

Setting up the traversing system:

1. Click the “Activate All” button on the TS GUI. This activates all the motors of the traversing system.
2. Send motor one to its start position by clicking the “Motor 1 to start point”. This moves motor 1 to -15° .
3. Send motors two and three to their origins as defined by their proximity switches and this resets their positions.
4. Send motor two to its zero point by clicking the “Motor 2 to zero point”. Since the zero point had been previously adjusted this procedure positions probe 1 at a radius of 1150 mm.
5. Enter a value of 50 into the “Motor 3 to position (mm)” text box. Enter a value of 1 in the “Motor 3 speed (mm/s)” text box. Click GO. Motor 3 first moves to its zero point and then moves 50 mm upwards. At this height it was determined that the probes are approximately 60 mm from the bed.

Defining tangential traversing sequence:

The next step is to define the radius where the velocity should be measured; at what angle increments the probes should be brought to a halt and which probe should be positioned at the point of interest.

Depending on the radius where measurements are wished to be made, the values which have to be entered in the traversing system’s GUI differ. Table 1 provides an overview of the settings and values which have to be entered into the traversing system’s GUI to allow the probes to measure the velocity at a specified radius. The last column in Table 1 shows which probe is used to measure the velocity.

Table 1: Traversing system settings for defining measurement position

| Radius (mm) | 1st Half start position (mm) | 1st Half end position (mm) | 2nd Half start position (mm) | 2nd Half end position (mm) | Angle Inc (deg) | 1st Half no. of inc | 2nd Half no. of inc | Probe Used |
|--------------------|-------------------------------------|-----------------------------------|-------------------------------------|-----------------------------------|------------------------|----------------------------|----------------------------|-------------------|
| 1150 | 0 | 15 | 0 | 0 | 3 | 1 | 0 | 1 |
| 1135 | 15 | 30 | 0 | 0 | 3 | 1 | 0 | 1 |
| 1120 | 30 | 45 | 0 | 0 | 3 | 1 | 0 | 1 |
| 1105 | 45 | 60 | 0 | 0 | 3 | 1 | 0 | 1 |
| 1090 | 60 | 75 | 0 | 0 | 3 | 1 | 0 | 1 |
| 1075 | 75 | 90 | 0 | 0 | 3 | 1 | 0 | 1 |
| 1060 | 90 | 105 | 0 | 0 | 3 | 1 | 0 | 1 |
| 1045 | 105 | 120 | 0 | 0 | 3 | 1 | 0 | 1 |
| 1030 | 120 | 135 | 0 | 0 | 3 | 1 | 0 | 1 |
| 1015 | 135 | 150 | 0 | 0 | 3 | 1 | 0 | 1 |
| 1000 | 150 | 165 | 0 | 0 | 3 | 1 | 0 | 1 |
| 985 | 165 | 180 | 0 | 0 | 3 | 1 | 0 | 1 |
| 970 | 180 | 195 | 0 | 0 | 3 | 1 | 0 | 1 |
| 955 | 195 | 210 | 0 | 0 | 3 | 1 | 0 | 1 |
| 940 | 210 | 225 | 0 | 0 | 3 | 1 | 0 | 1 |
| 925 | 225 | 240 | 0 | 0 | 3 | 1 | 0 | 1 |
| 910 | 240 | 255 | 0 | 0 | 3 | 1 | 0 | 1 |
| 895 | 255 | 270 | 0 | 0 | 3 | 1 | 0 | 1 |
| 880 | 270 | 285 | 0 | 0 | 3 | 1 | 0 | 1 |
| 865 | 285 | 300 | 0 | 0 | 3 | 1 | 0 | 1 |
| 850 | 300 | 342 | 0 | 0 | 3 | 1 | 0 | 1 |
| 808 | 342 | 383 | 0 | 0 | 4 | 1 | 0 | 1 |
| 767 | 383 | 425 | 0 | 0 | 4 | 1 | 0 | 1 |
| 725 | 425 | 97 | 0 | 0 | 4 | 1 | 0 | 1 |
| 683 | 0 | 0 | 467 | 509 | 4 | 0 | 1 | 2 |
| 641 | 0 | 0 | 509 | 550 | 4 | 0 | 1 | 2 |
| 600 | 0 | 0 | 550 | 565 | 6 | 0 | 1 | 2 |
| 585 | 0 | 0 | 565 | 580 | 6 | 0 | 1 | 2 |
| 570 | 0 | 0 | 580 | 595 | 6 | 0 | 1 | 2 |
| 555 | 0 | 0 | 595 | 610 | 6 | 0 | 1 | 2 |
| 540 | 0 | 0 | 610 | 625 | 6 | 0 | 1 | 2 |
| 525 | 0 | 0 | 625 | 640 | 6 | 0 | 1 | 2 |
| 510 | 0 | 0 | 640 | 655 | 6 | 0 | 1 | 2 |
| 495 | 0 | 0 | 655 | 670 | 6 | 0 | 1 | 2 |
| 480 | 0 | 0 | 670 | 685 | 6 | 0 | 1 | 2 |
| 465 | 0 | 0 | 685 | 700 | 6 | 0 | 1 | 2 |
| 450 | 0 | 0 | 700 | 715 | 6 | 0 | 1 | 2 |
| 435 | 0 | 0 | 715 | 730 | 6 | 0 | 1 | 2 |
| 420 | 0 | 0 | 730 | 745 | 6 | 0 | 1 | 2 |
| 405 | 0 | 0 | 745 | 760 | 6 | 0 | 1 | 2 |
| 390 | 0 | 0 | 760 | 775 | 6 | 0 | 1 | 2 |
| 375 | 0 | 0 | 775 | 790 | 6 | 0 | 1 | 2 |
| 360 | 0 | 0 | 790 | 805 | 6 | 0 | 1 | 2 |
| 345 | 0 | 0 | 805 | 820 | 6 | 0 | 1 | 2 |
| 330 | 0 | 0 | 820 | 835 | 6 | 0 | 1 | 2 |
| 315 | 0 | 0 | 835 | 850 | 6 | 0 | 1 | 2 |
| 300 | 0 | 0 | 850 | 850 | 6 | 0 | 1 | 2 |

Setting up MiniCTA measuring sequence:

1. On the MiniCTA software toolbar select Setup/Setup... The “Define Setup” window, shown in Figure 23, opens.
2. Click on the “Data Acquisition” icon (encircled in red). The “A/D Board Setup” window, as shown in Figure 24, opens.
3. Enter the chosen “Sampling frequency” into the provided scroll box. For the velocity tests on the HTTU a sampling rate of 0.030 kHz was used.
4. Enter the number of samples (Number of velocity measurements) that you wish to take. For the HTTU this value differed. When readings were made in region one, 23 400 were used. In region two 19 800 samples were used and in region three 14 400 samples were used.
5. Select “OK” to close the window.
6. Click on the “Scheduling” icon (encircled in blue). The “Group Schedule Setup” window, as shown in Figure 25, opens.
7. You can either select to start the velocity acquisition immediately or schedule it to start at a certain time in the future. In the case of the velocity tests of the HTTU, the acquisition was always scheduled.

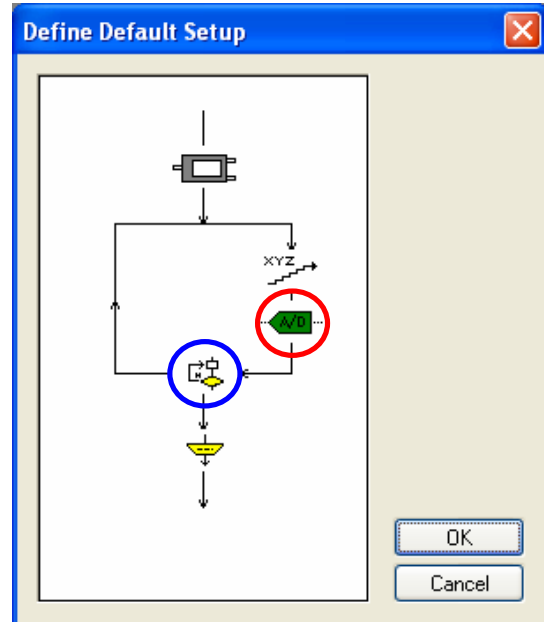


Figure 23: Define default setup window

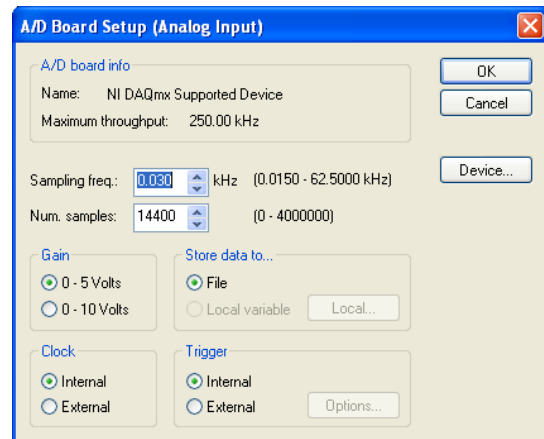


Figure 24: A/D board setup window

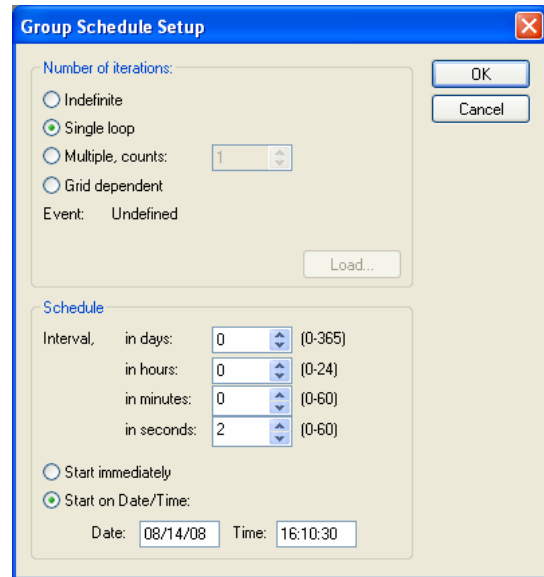


Figure 25: Group schedule setup window

Running the CTA and traversing sequence:

When the tangential traversing and anemometry sequences have been setup accordingly the sequences can be started.

1. In the MiniCTA software package on the toolbar, select Run/Run Default Setup. The “Acquire Data” window opens as shown in Figure 26.
2. Enter the proper “Event ID” describing the event and select “Run”.
3. The “Acquisition Status window”, shown in Figure 27, opens. If the data acquisition event was run prior to the time it was scheduled the Status of the acquisition will be “Ready”. As soon as the acquisition starts the status will change to “Acquiring”.
4. As soon as the acquisition starts, start the traversing sequence by clicking on the

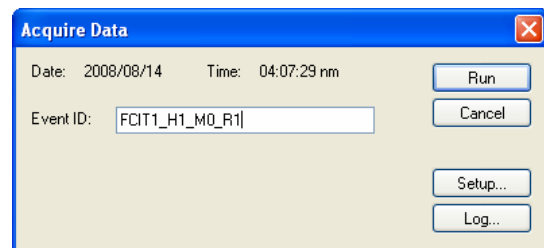


Figure 26: Acquire data window

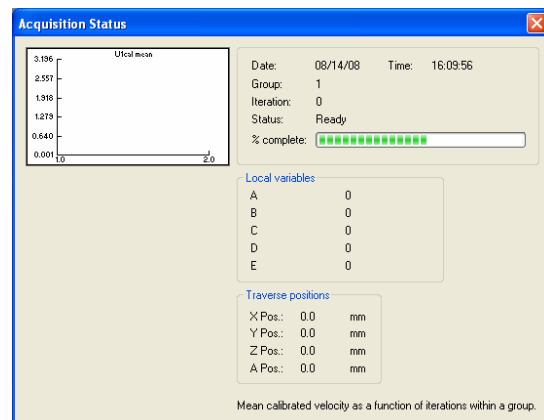


Figure 27: Acquisition status window

- “Start Sequence” button on the GUI of the traversing system
5. Once traversing sequence is finished a buzzer will sound. When the MiniCTA acquisition sequence is finished the “Status” in the “Acquisition” window will change to “Ready”. Close the “Acquisition Status” window.
 6. The raw data of the acquisition event is added to the project manager tree. Select the event by clicking on it.
 7. Go to File/Global Export. The “Global Export” window, shown in Figure 28, opens.
 8. Select “Options”. The “Global Export – Conversion Level” window, shown in Figure 29, opens.
 9. Be sure to select the “Velocity from calibration” radio button and the “Apply temperature correction” checkbox. Click “OK” to close the window.
 10. Click on the “Probes” button. The “Global Export-Probes” window, shown in Figure 30, opens.
 11. Select the “Export all probes” radio button and the select “OK” to close the window.
 12. Select “OK”.

You are now prompted to name the file, specify the file type and location to where the file should be exported.

13. Export the file as “Probes.csv” to the

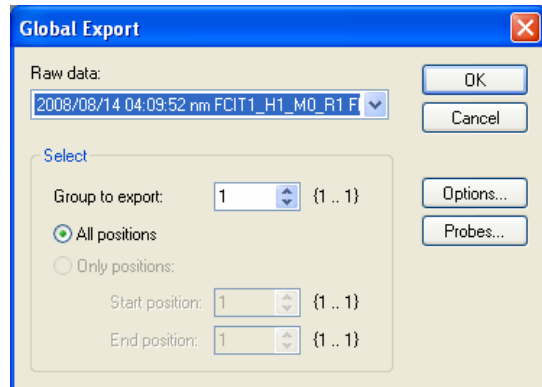


Figure 28: Global export window

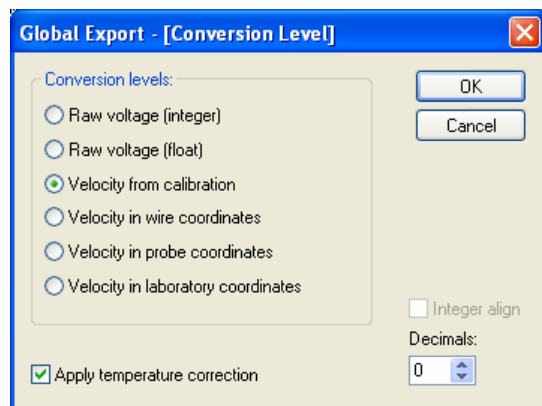


Figure 29: Global export conversion level window

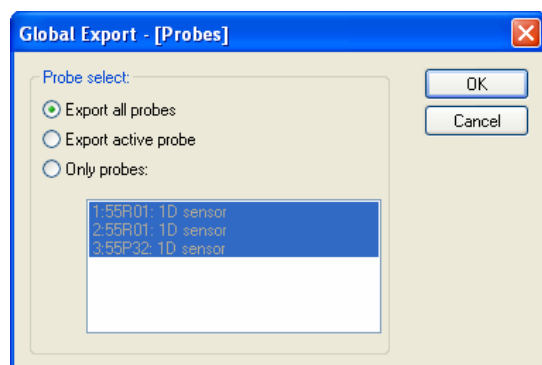


Figure 30: Global export probe selection window

directory c:\velocity measurements\data.

Post processing of data:

At the end of the traversing sequence the directory c:\velocity measurements\data should contain a file named Positions.csv, which was generated by the traversing systems operating system, and the MiniCTA exported file Probes.csv.

1. On the traversing system's GUI click the Trim probe file button. This removes the excess headers from the file and makes it suitable for further post processing.
2. In the directory c:\velocity measurements there is two files named Calculations.xls and Template.xls. Both these files were created by Van Niekerk (2008). Open the Calculations.xls file.
3. Select the "Refresh all" button on the "External toolbar".
4. Hit CNTR-D to run the post processing macro (Van Niekerk, 2008).
5. With the Calculation.xls file still open, open the Template.xls file.
6. Once again select the "Refresh all" button on the "External toolbar". This imports the needed data from the Caluclations.xls file without all the formulas.
7. Save both these files using the "Save as" function. Save the Calularion.xls as FCIT1_H1_M0_R1_Calc.xls and the Template file as FCIT1_H1_M0_R1_Temp.xls.

The identifiers used in the naming of the files are as follow:

- FCIT1: Forced Convective Isothermal Test 1. Second and third tests were conducted to establish the repeatability of the results.
- H1: Describes measurement height above the bed (H1 = 60 mm)
- M0: Describes mass flow rate during test (M0 = 0.5 kg/s; M1 = 1 kg/s; M2 = 2kg/s etc.)
- R1: Describes the radius at which the probes were traversed in the tangential direction during the test (R1 = 1150 mm; R2 = 1135 mm; R3 = 1120 mm ect.)

This whole process was repeated for all the listed radiuses in Table 1 at a certain mass flow rate. Once all the tests, at the different mass flow rates, were conducted they were repeated two more times to determine the repeatability of the measurements.