MATRIX | WIND TUNNEL

WIND TUNNEL MANUAL

CP5135

Inspiring The Next Generation Of Engineers

www.matrixtsl.com

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Wind Tunnel Overview

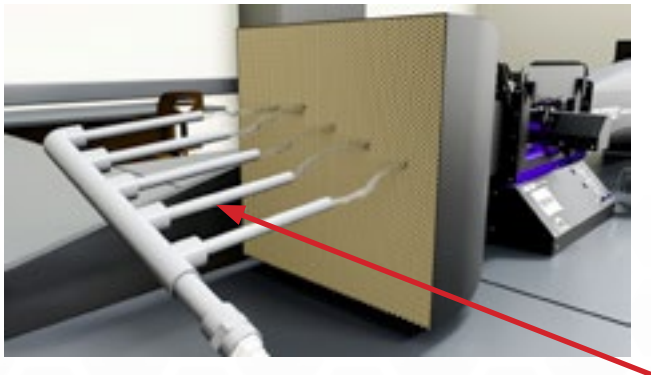
Wind Tunnel

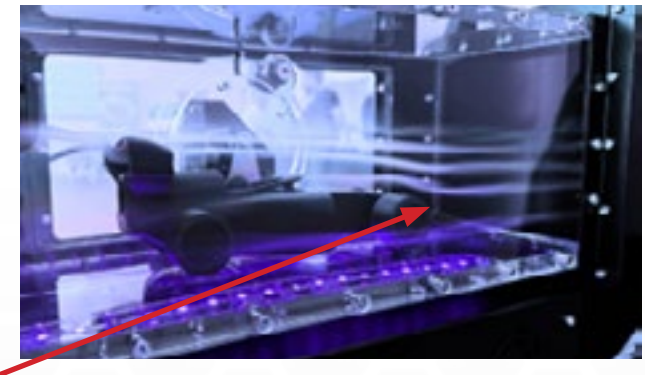
Dimensions: 125mm x 125mm x 350mm
Test section cross sectional area: 125mm x 125mm.
Max Air speed in test section = 35.7m/s.

Transparent test section

Moving LED lights mimic air flow

Touch-screen panel controls air flow & built in data acquisition system





A smoke generator shows flow patterns around test objects.

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Wind Tunnel Overview

Components

Pitot Static Tube

Pressure Tapped Cylinder

Pressure Tapped Aerofoil

2 Force Control Box

3 data acquisition cables 2 x 4 pin male cable and 1 x 5 pin male cable

Smoke Machine, Tubing & Smoke Rake

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Wind Tunnel Overview

Manometer & Holding Plate

Connection points for manometer to holding plate

IEC Mains Lead

2M USB2 Type A Male – Type B Mail

Data Acquisition Box

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Wind Tunnel Overview

Test Specimens

6 X Drag Test Specimens

3 X Aerofoil Specimens

Aerofoil Profiles

NACA0015 S1223 NACA4415

STEM Racing Car Bracket *STEM Racing car not included*

2 force modules with adjustable clamp and locking nut.

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Product Contents

Product Code	Description	Quantity
AV1600	Pressure tapped cylinder for AV5289	1
AV1700	2 Force Control Box for AV5289	1
HP5540	Deep tray	1
HP4039	Tray Lid	1
AV1000	Drag test pieces (6) and aerofoils (3) kit for the AV5289	1
AV1200	4 pin male cable for wind tunnel AV5289	2
AV1400	5 pin male cable for wind tunnel AV5289	1
AV1500	Pitot static tube experiment forthe AV5289	1
AV1850	Pressure Tapped aerofoil for wind tunnel	1
AV1875	Pressure test tube for wind tunnel	3
HP3701	IEC Mains Lead (UK)	2
BOX1023	Wind tunnel wooden crate v2	1
AV1900	Smoke Machine for AV5289	1
AV5289-00-2	Wind Tunnel 125 main build	1
LAS00929	Foam inserts for Wind tunnel parts packaging	1
AU1073	Tubing, 4mm, clear, 30 m length	0.02
HP8600	Crash Foam 360mm x 260mm, thickness 25mm	9
HPUSB	2m USB2 Type A Male - Type B Male	1
AV2000	Smoke Rake for AV5289 and AV0461	1
AV1250	Manometer for wind tunnel	1
AV2100	Stem racing car bracket	1

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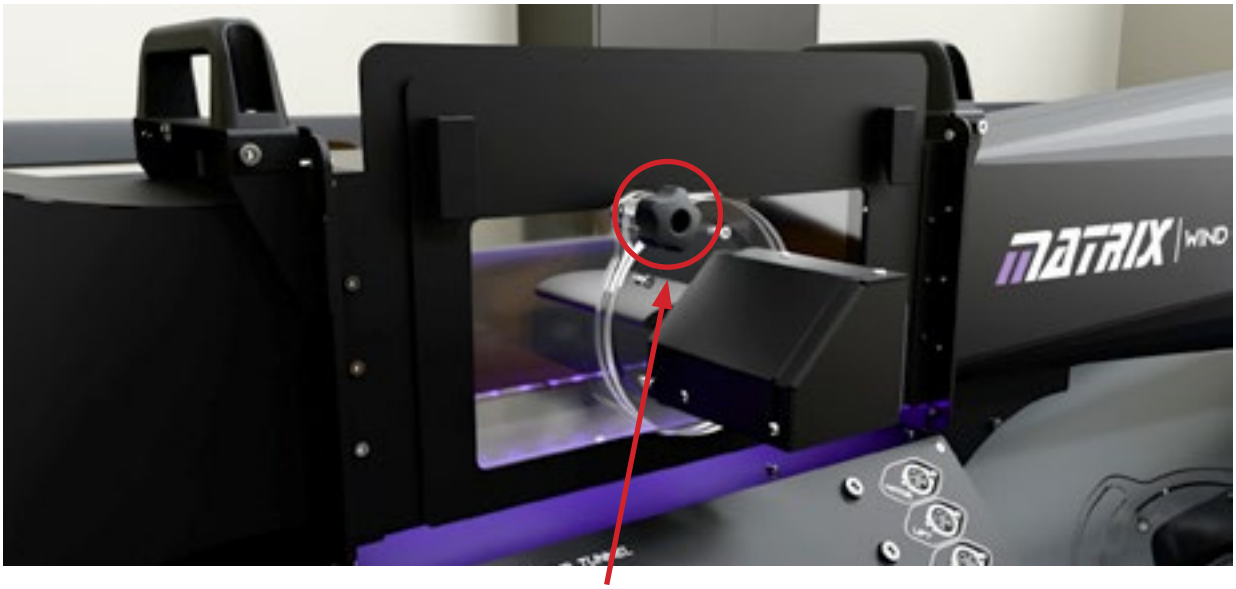
Hardware Setup

Securing Test Specimens to Test Chamber

The Data Acquisition Box can be controlled using the touch screen interface. When the device powers up it will show a home screen containing the main menu.

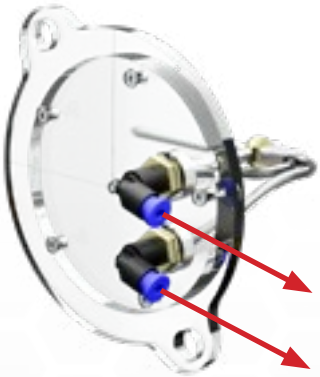


Secure test specimens by tightening thumb nuts.

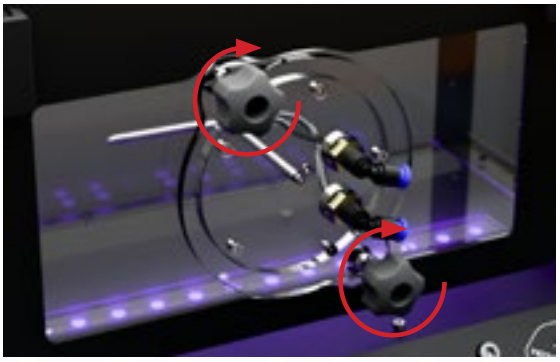
Using the U-tube Manometer

1. Place the pitot-static tube experiment holder into the wind tunnel test area and secure it with the two thumb-nuts, as shown in the diagram.
2. Make sure that the tube points directly into the air flow.
3. Add water to the manometer via one of the ports identified in the diagram below so that the water level sits at near 50.

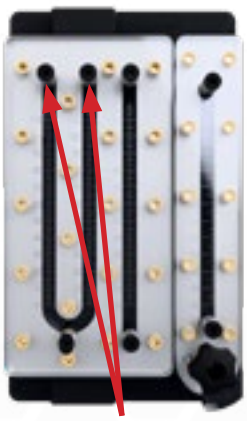
(It doesn't matter which tube goes to which port. The important thing is the difference in the heights of the water columns.)



To manometer



Thumb nuts



Add water via one of these ports

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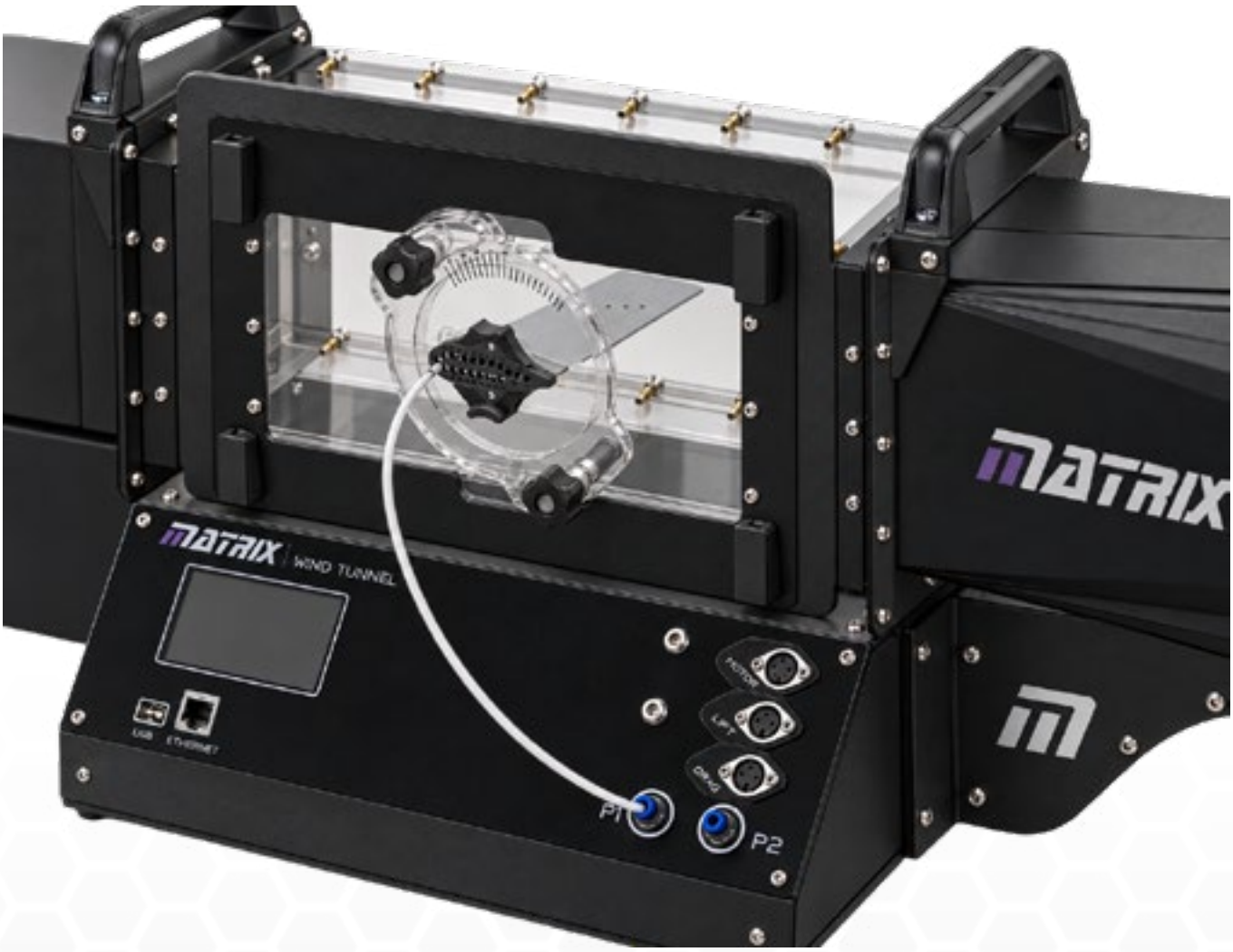
Hardware Setup

Pressure Tapped Aerofoil

1. Place the pressure tapped aerofoil (AV1850) into the wind tunnel test section.
2. Twist the module to the desired angel of attack using the angle markings and the vertical mark in the test section opening.
3. Secure in place with the thumb nuts provided.
4. Place the AV1865 tube in p1 on the control box, leaving p2 open to ambient and unconnected
5. To take a reading slide the black smaller tube of the AV1865 into the desired hole on the module, they are numbered to help locate the different tapping.



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Touch Screen Guide

Home

On the home screen, the display shows the angle of attack, fan power in percentage and wind speed. It also then shows the readouts of lift, drag and pressure from the sensors (if connected). To turn on the wind tunnel to generate air flow. Push the 'speed' button.

Then push the required amount of percentage change. If you want 10% more power, push the +10, then you'll see the fan percentage change accordingly. The speed is automatically generated from calibrated factory data. However, this can be recalibrated and entered for on site data. If the user wants to go back to the home page, push the 'Back' button. The Fan red/green button is an electronic e stop, when red the fan isn't on. When green the fan is running. By pressing the green button the fan will stop and the button will go red. Another press and it will return to the previous fan power setting and the button will be green. Once the setup of the sensors has been done by the user, the sensors can be zero'ed out to start the experiment from a known position by the using the 'Zero' button. This will make the lift, drag and pressure readouts zero.

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Touch Screen Guide

To change the angle of attack

Once the 2 force component module is connected, the angle of attack can be numerically controlled by the touch screen. On the home screen push 'Angle' Then push the desired incremental change of angle which will be displayed. To zero out the angel of attack, move the object and angle of attack to desired position, then simply push 'Zero'

The LED's

To change the LED settings push 'Lights' This will then display a menu for 2 options. 'Test' will control the LED's in the test section of the wind tunnel. 'Ambient' will change the settings for the LEDs underneath the tunnel. (the ambient lights do not effect functions of the tunnel)

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Touch Screen Guide

The test section has a few modes to choose between. ‘O’ is no lights in the test section ‘Static’ is a constant light, displayed in the colour chosen with the ‘colour’ button which cycles through a prescribed set of colours. Bright colours work well for illuminating the smoke. ‘Strobe’ ashes all the LEDs’ rapidly on and o. Giving a stop frame eect for the smoke patterns. ‘1:20’ matches the speed of the wind tunnel air ow in m/s but at 1/20th of the real speed. This is great for slow motion camera videoing of the smoke patterns. ‘1:1’ is the real time representation of the air ow speed through the through.

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Recalibrate Air Speed

To change the angle of attack

The wind speed is displayed on the touchscreen. The speed is factory calibrated. Each percentage increase has its own speed reading.
If you need to redo this due to error or difference in environment (ie altitude or ambient temperature) follow the below steps to overwrite the factory calibration.
Open the calibrate software in the downloaded software package off https://www.matrixtsl.com/windtunnel/resources/

Connect the wind tunnel to a PC with the USB cable. Turn the power to the product on.

Place the pitot static module into the wind tunnel test section, making sure everything is set up correctly, like in worksheet of the curriculum using the digital pressure output.

Record the pressure values for every 10% increment of wind speed which are displayed on the home screen of the touchscreen menus (1).
Turn this Pa value into wind speed m/s which following formula:

V (m/s)
P (Pa)

$$v = \sqrt{\frac{2P}{1.2}}$$

Repeat for all 10 values

2

Run the calibration software, with the play button in top left corner (2)
Click edit (3) and follow the instructions that pop up.

Once all 10 values are entered. Check the display shows the same number in m/s for the percentage increment chosen.

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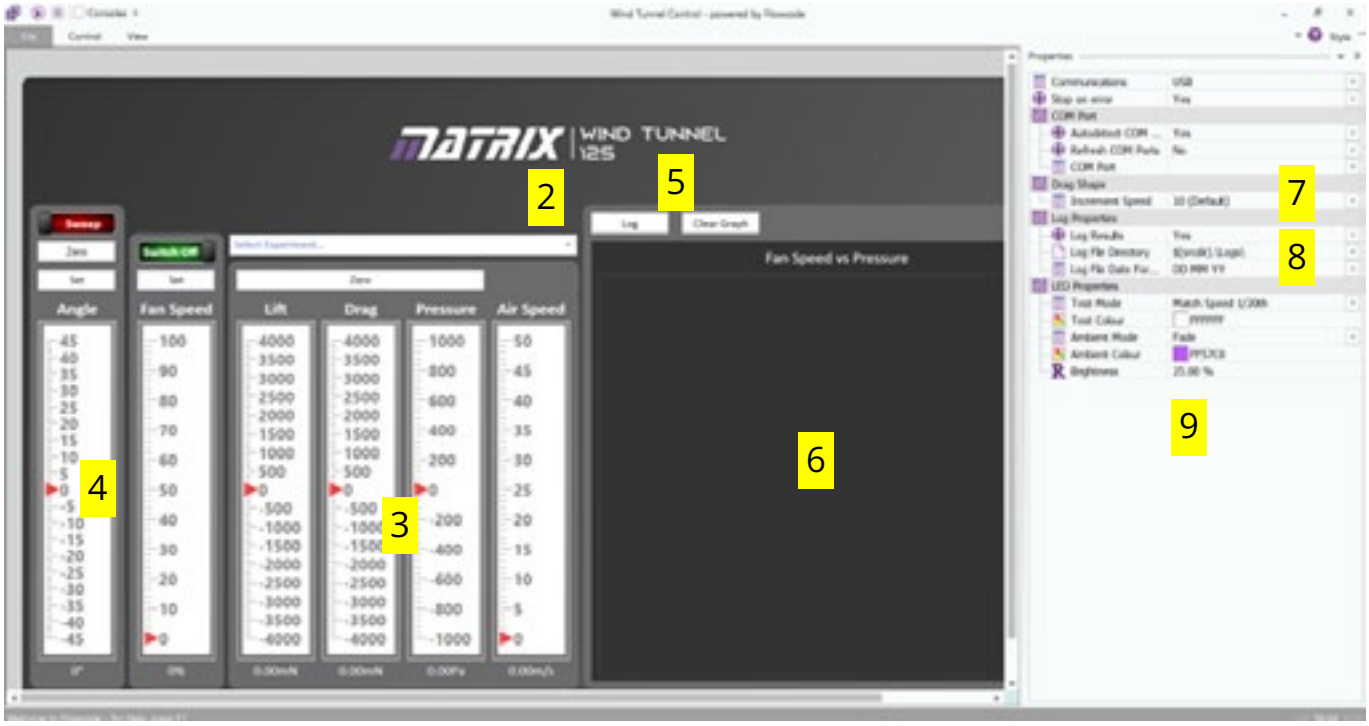
Software

How to Use Wind Tunnel Software

Use the:

1. Wind tunnel control.exe to use the wind tunnel via software control

Click run in the top left (play button) to run the software.



1. Sensor readouts, with zero functionality
2. Control panels—fan speed and angle of attack each with set functionality and zero'ing for angle of attack
3. Log data and clear graph button
4. Graph area
5. Sweeping properties
6. Log file properties
7. LED functionality properties

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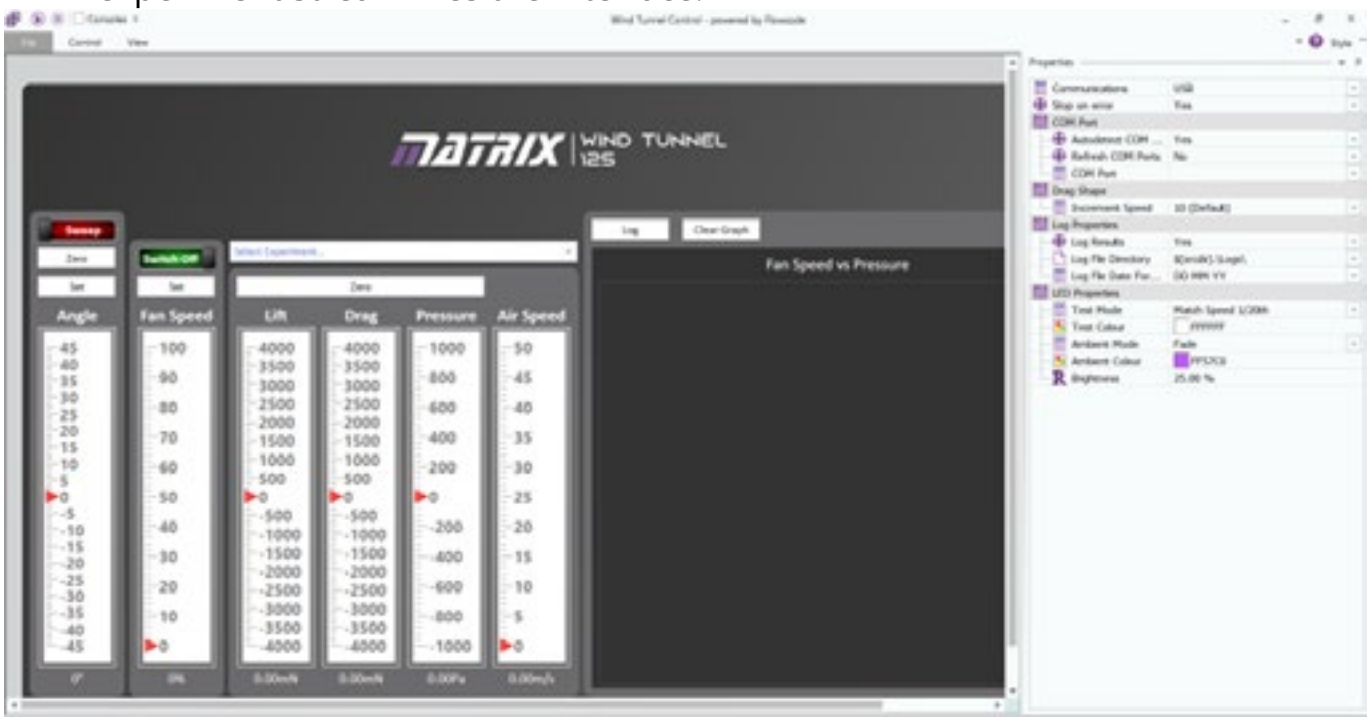
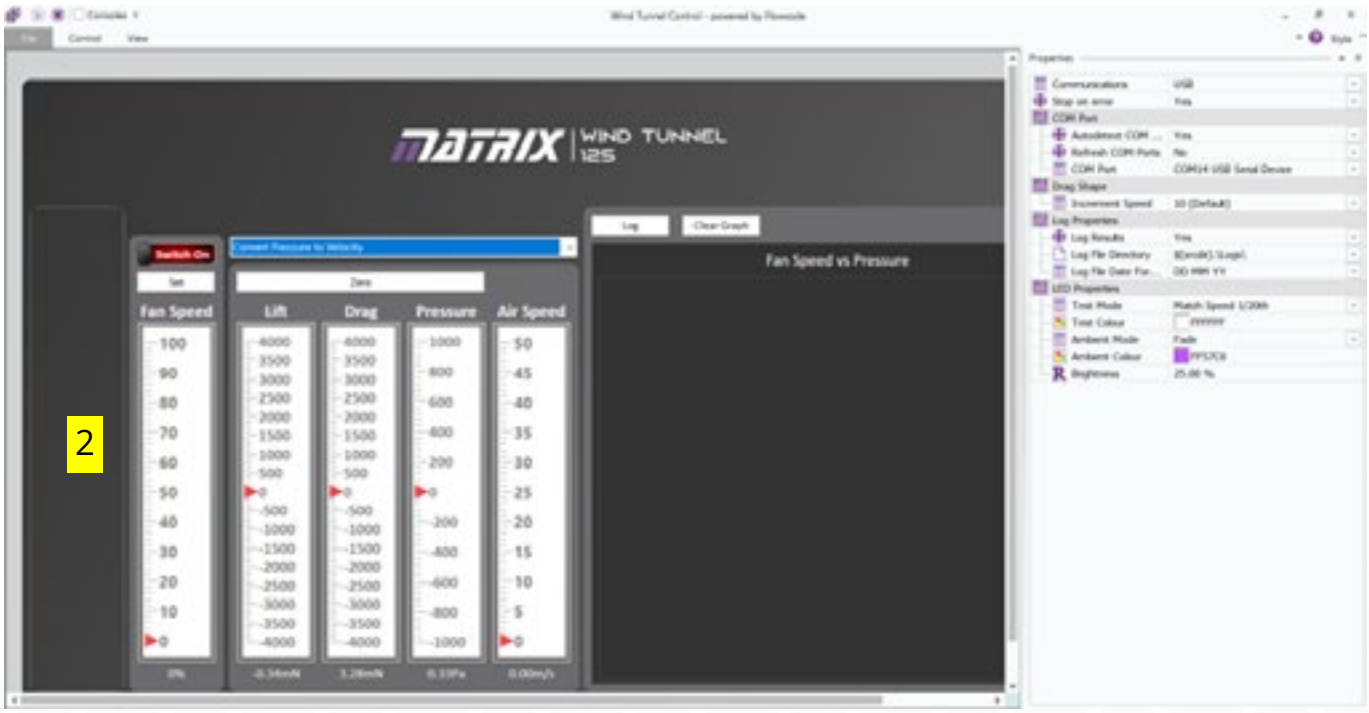
Software

1. Choose the experiment type from the drop down in the menu.

Each worksheet is represented in the drop down menu with the experiment name, however experimental testing can utilise the functionality independently of the worksheets.

2. Different controls are represented depending on experiment. This is due to the experiment functionality not being required, so hiding controls that are not present in experiment streamlines the interface.





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Software

1. Control the fan speed

User can click on the red slider handle and drag to desired fan percentage, and click to confirm before moving away

Or

Use the set button at the top of the slider, to type in the exact value of fan speed that is required

2. Click the switch fan on/off button to start or stop fan once speed has been set

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Software

Pitot static module—Pressure to velocity
The first experiment in the worksheet requires the pitot static module to be attached to the test section. Both P1 and P2 pneumatic ports should be connected.

Pressure readouts
The zero button for sensor readout should be pushed before any experiment
Switch fan on as shown previously
The column for pressure is highlighted (2) and the sensor readout should be display in the slider and below numerically.

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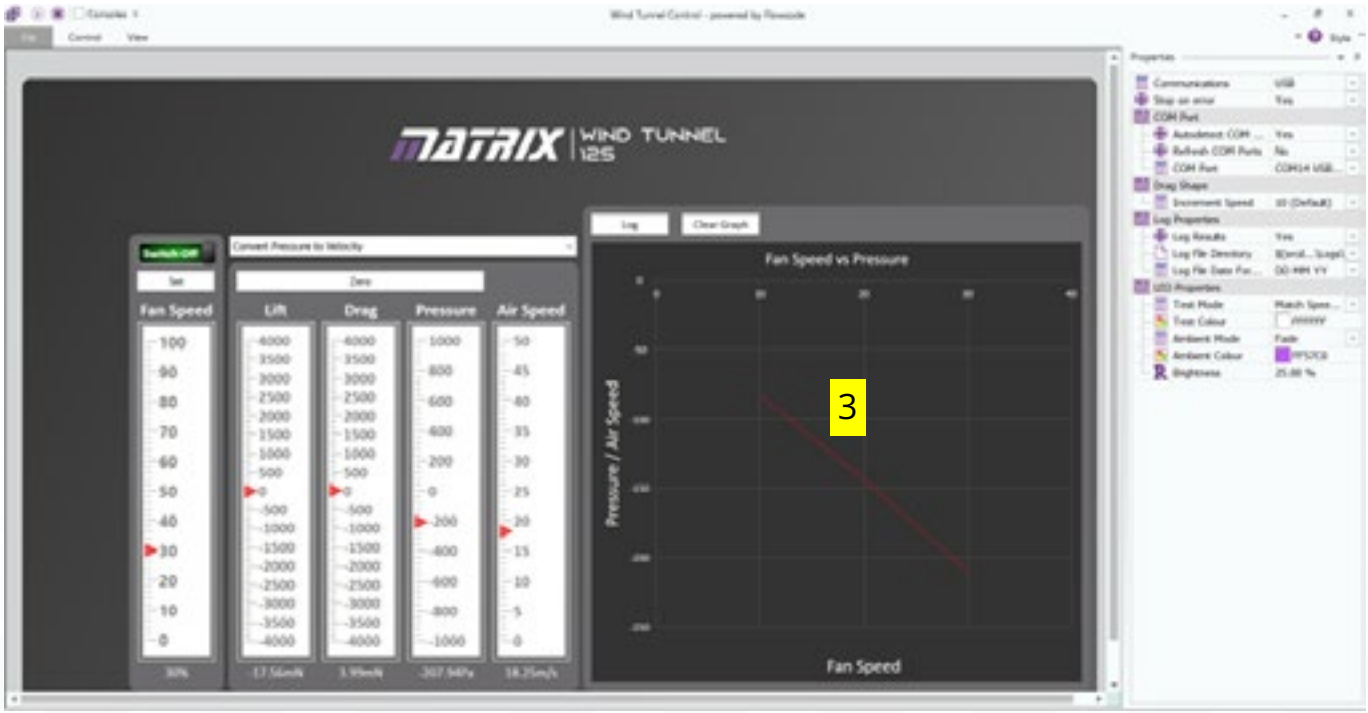
Software

Logging data/graphing
When the software has a sensor readout, a user may want to graph this value.
This is achieved by logging the data.

1. Click log button

The graph area should then display axis approximate to the experiment setup (2)

Change the speed to 10%, 20% and 30% clicking log between speeds. (for best results wait for sensors to settle)
The graph area should now display a graph (3)



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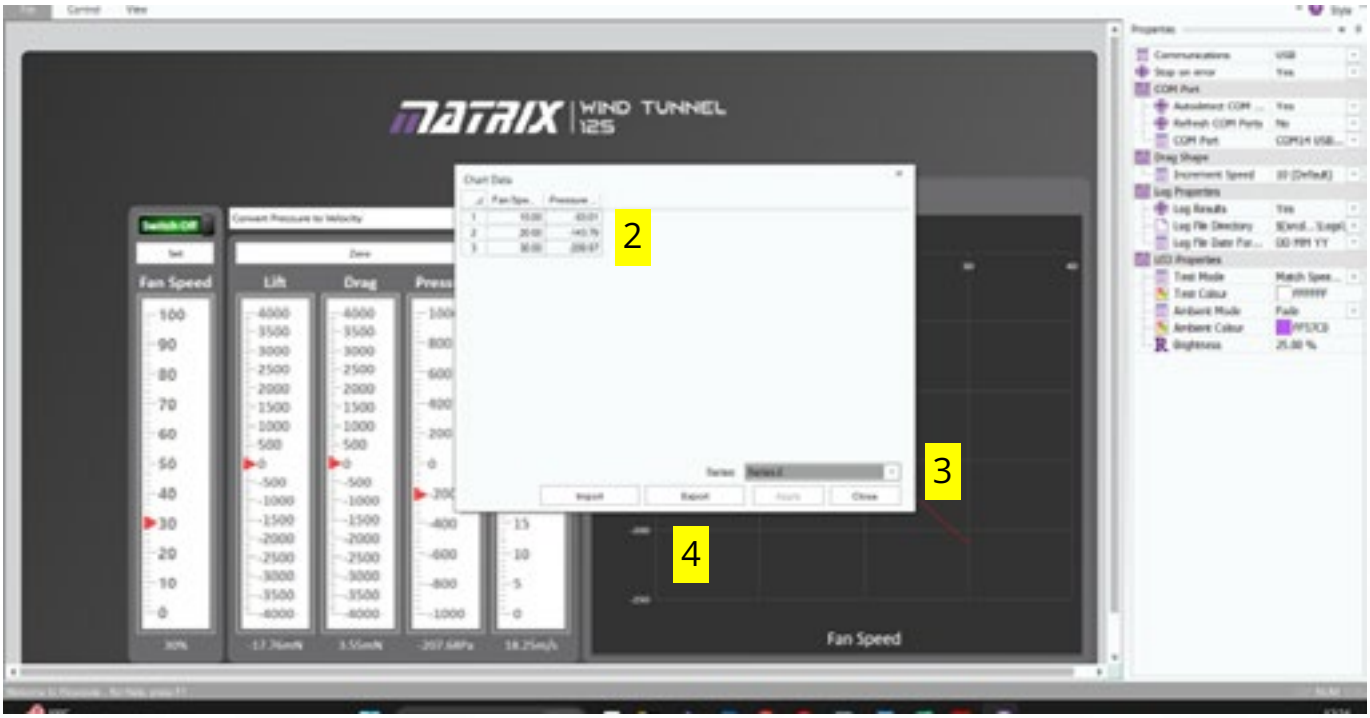
Software

1. Right click the graph area

Click show stored data, and the following window will present the data taken in current experiment (2)

Changing the series is possible if multiple sensors are represented on the graph. For example, lift and drag load cell data. (3)

Data can be saved out as .csv file with export button (4)



Click clear graph to delete graph

Data is not lost even with clear graph, and the log file stores the data with a date stamp and experiment section.

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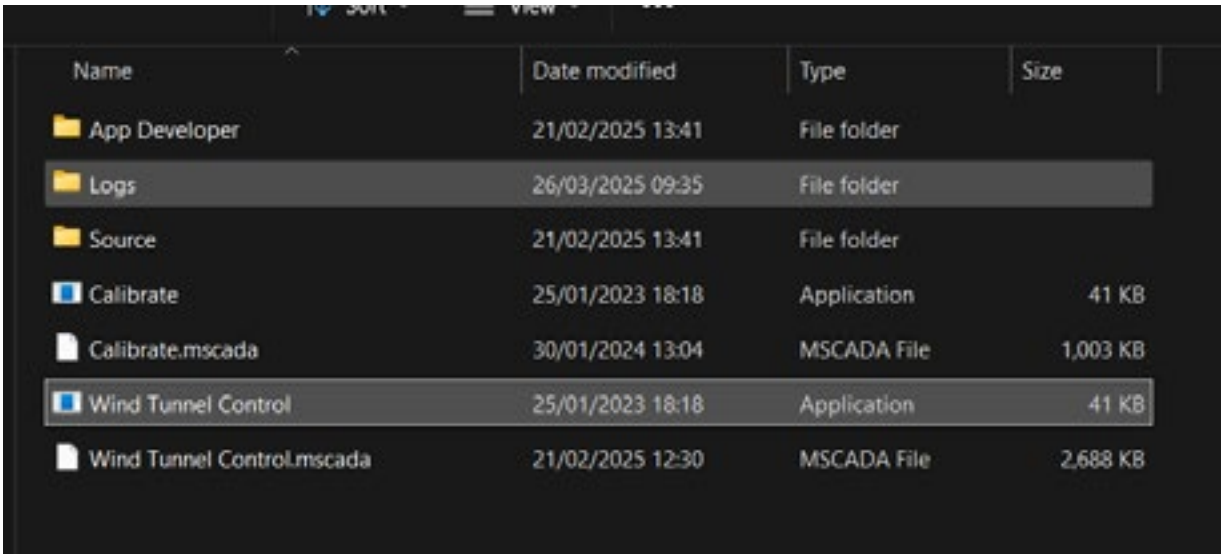
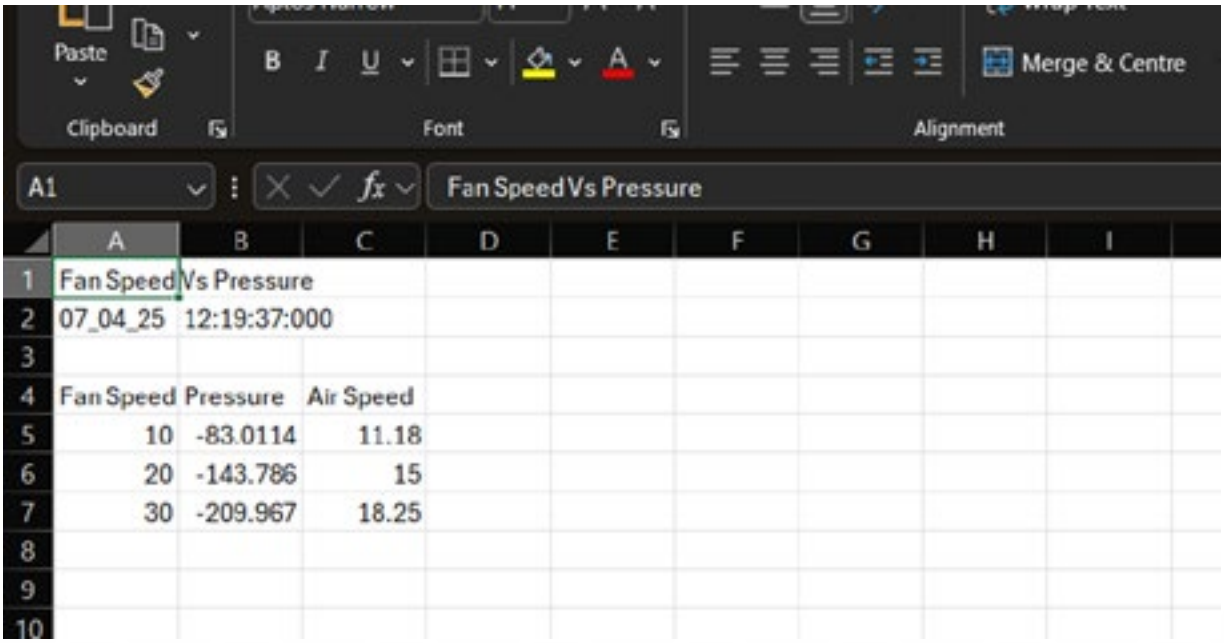
By default the log file will be in the logs folder in level above the wind tunnel control.exe (1)
You will need write access to this folder
Opening the log file, the data and time of the test is displayed and separates the experiments taken.
New log files are taken per day



Name	Date modified	Type	Size
App Developer	21/02/2025 13:41	File folder	
Logs	26/03/2025 09:35	File folder	
Source	21/02/2025 13:41	File folder	
Calibrate	25/01/2023 18:18	Application	41 KB
Calibrate.mscada	30/01/2024 13:04	MSCADA File	1,003 KB
Wind Tunnel Control	25/01/2023 18:18	Application	41 KB
Wind Tunnel Control.mscada	21/02/2025 12:30	MSCADA File	2,688 KB



	A	B	C
1	Fan Speed Vs Pressure		
2	07_04_25	12:19:37:000	
3			
4	Fan Speed	Pressure	Air Speed
5	10	-83.0114	11.18
6	20	-143.786	15
7	30	-209.967	18.25
8			
9			
10			

Log file location can be stored in the properties pane of the software, using windows explore to select location.

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Software

Control more functionality
Angle of attack control

1. Click the lift coefficient experiment, the angle of attack control slider will appear (requires 2 force component module and aerofoil to be connected)

1. Set zero angle of attack
2. Click on the slider and pick a positive random number, the aerofoil attached to the 2 force component module should rotate.

Rotate the aerofoil until its at 0 angle of attack if its close. Then click zero
If the aerofoil is over 45deg away from this position, click +45deg let the aerofoil rotate. Click zero and repeat process till the desired position is met.
Zero sensors out to reset them before experiment (2)
Set the speed on the fan speed slider or set button as before, in this example its at 30% (4)
Switch fan on and move aerofoil to -20deg angle of attack (5)

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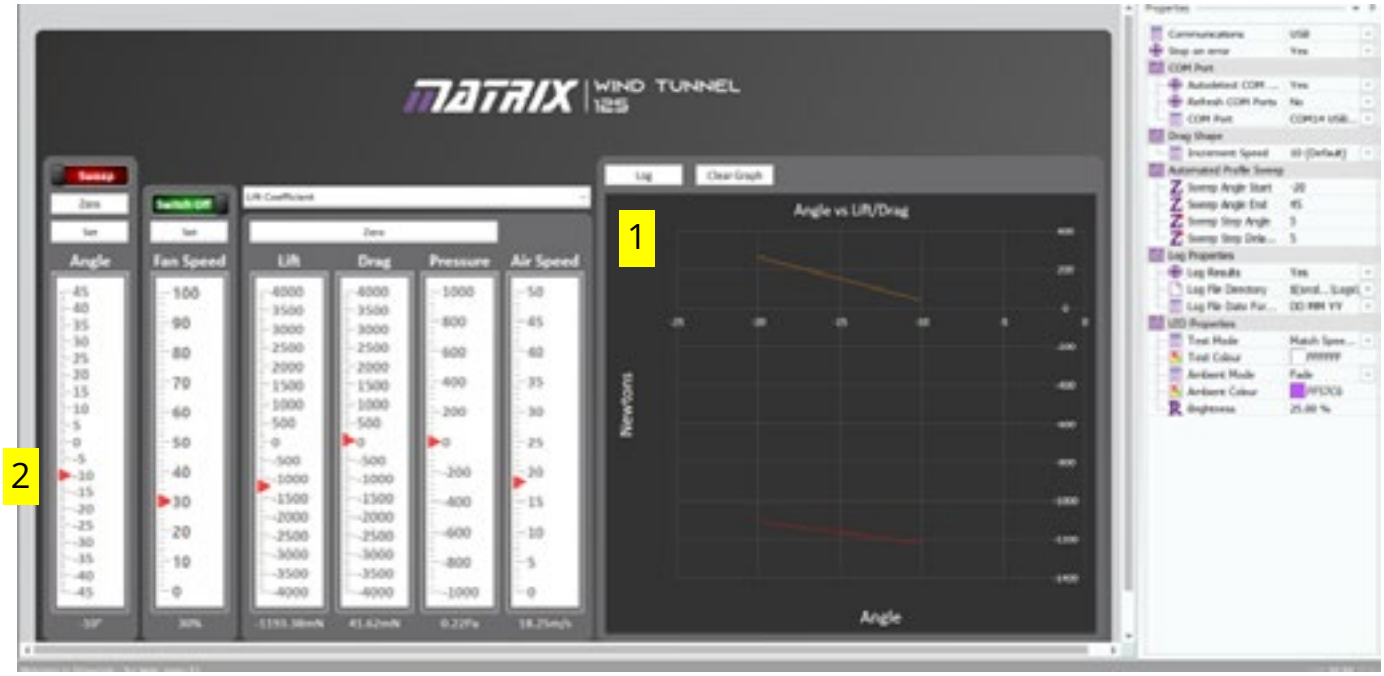
Software

1. Click log to record data
2. Click -10deg for angle of attack and then click log (1)



3. Click 0deg of angle of attack, then click log. This is a manual sweep of the angle of attacks at one test section wind speed.

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Software

Automatic sweeps
Setting up an automatic sweep in done in the right hand properties.
Sweep angle start, sweep angle end, sweep step angel and sweep step delay, can be altered and inputted by clicking into the box.
This experiment is set at -20 to 45edg angle of attack, with 5 deg steps every 5 secs. (1)

2. Switch fan on at desired experiment speed.
3. 4. Click sweep, and wait for experiment to finish

(this is a course example of an experiment, not representative of data from worksheets)

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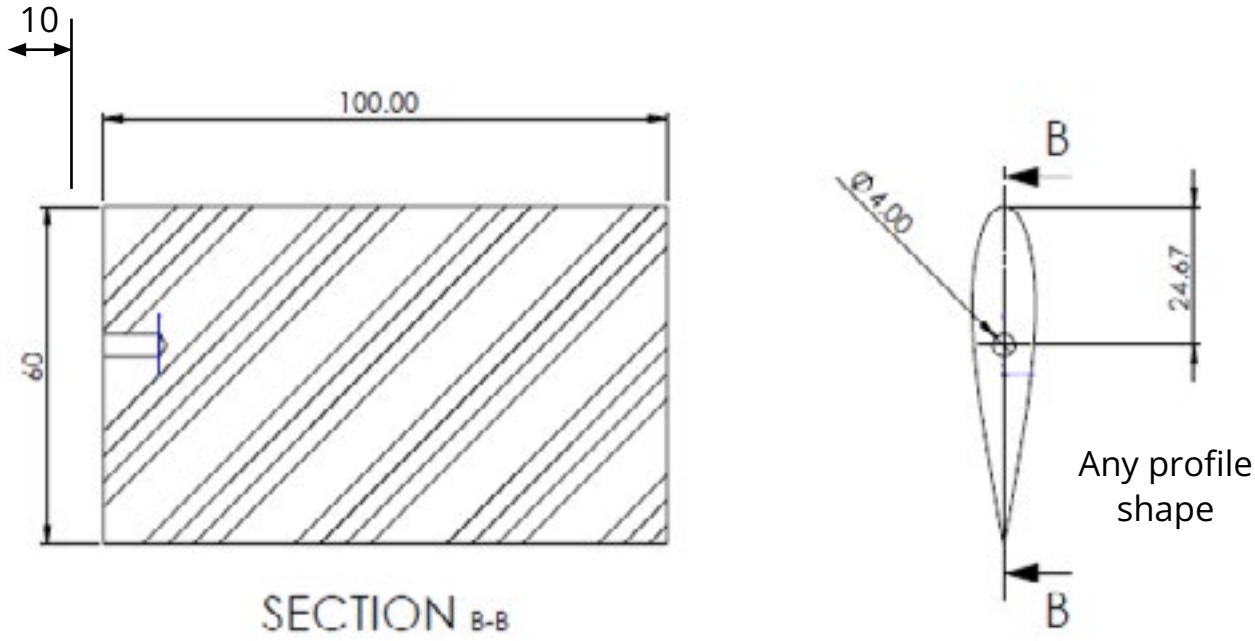
Custom Aerofoils

Step 1

3D model a new aerofoil, this can be done in any 3D CAD software.
Please follow the following guide line dimensions (mm) to make sure the aerofoil is compatible.



https://aerotoolbox.com/naca-4-series-airfoil-generator/
New NACA profile codes and shapes can be generated on a website like above.

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Custom Aerofoils

Step 2

Create STL file of the 3D CAD model.
Insert this into your 3D slicer software, for example CURA

Print model to desired quantity and quality.

Step 3

Insert a M3 threaded inserted into the 4mm hole on side of the profile, to allow compatibility.

This can be done by melting the insert into the 3Dprint with a soldering iron gently.

Purchase a non-flanged m3 threaded insert.

If you want to change the type of insert, it has to be maintained M3, but type can be altered.
Therefore make corresponding changes to the change 3D CAD model.

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Smoke Machine

Smoke Machine Guidance

- Overview
- Filling & Operation
- Safety
- Cleaning & Maintenance

Overview

The Matrix Wind Tunnel is supplied with a smoke machine and smoke rake to enable airflow visualisation during aerodynamic experiments.

The smoke machine generates a fine stream of fog which is introduced into the smoke rake, allowing airflow over test models to be clearly visualised during demonstrations and experiments.

The smoke machine is supplied with a high-quality, water-based fog fluid. Different brands of fog fluid may be supplied depending on availability, but all provide equivalent performance for normal operation.

The supplied fog fluid is safe for normal educational use when handled in accordance with the guidance provided in this manual.

Note: A smoke machine compatible with the electrical supply in the destination country is supplied with every Wind Tunnel system.

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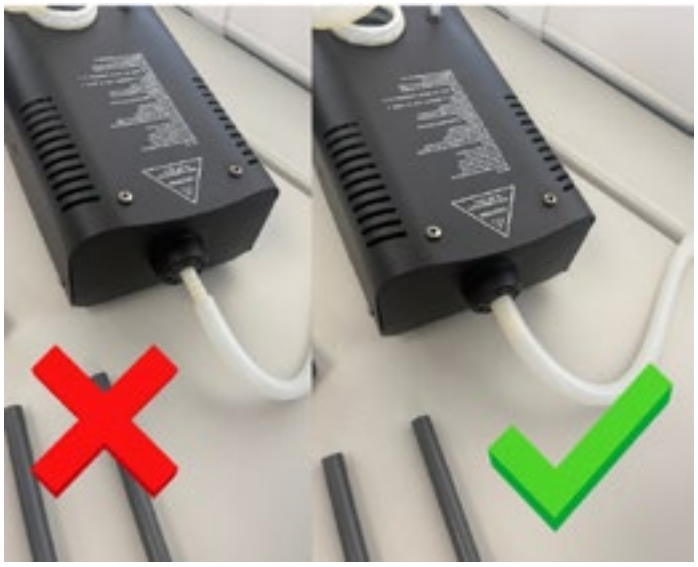
Smoke Machine

Filling & Operation

1. Ensure the smoke machine is switched **OFF** and disconnected from the mains before filling.
2. Unscrew the fluid reservoir cap.
3. Fill the reservoir with the supplied fog fluid.
   - For extended use throughout the day, fill the reservoir to approximately **three-quarters full.**
   - For occasional demonstrations, a smaller quantity of fluid is sufficient, as the smoke machine consumes relatively little fluid during operation.
4. Ensure the fluid pick-up tube attached to the cap is fully submerged in the fog fluid before replacing the cap. If the tube is not submerged, the machine may draw in air instead of fluid, reducing smoke output.
5. Refit the cap securely and check that the **tubing between the smoke machine and smoke rake is fully connected.**



6. Connect the smoke machine to the mains supply and switch it **ON**.

7. The controller will illuminate **RED** to indicate power is connected. Allow the machine to warm up until the **READY** indicator illuminates **GREEN**.

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Smoke Machine

8. Once ready, press the controller button to generate smoke. For best results, use **short, repeated presses** rather than holding the button continuously.

Safety Information

- Use the smoke machine in a well-ventilated area.
- Switch the smoke machine OFF after use and allow it to cool before moving or storing.
- Only use the recommended water-based fog fluid supplied with the system or an equivalent approved replacement.
- Do not ingest the fog fluid.
- Avoid prolonged or concentrated inhalation of the fog.
- The nozzle, outlet fittings and connecting ports may become hot during operation. Allow sufficient cooling time before handling.
- Keep the smoke machine away from flammable materials.
- Do not operate the machine if the reservoir is empty.

**Replacement fog fluid should be a high-quality water-based fog fluid. Oil-based or specialist theatrical fluids should not be used.*

Cleaning & Maintenance

The smoke machine is designed to produce a fine fog for airflow visualisation and requires very little maintenance during normal use. Under typical operating conditions, only a small amount of fog fluid residue may be present, so minimal cleaning is required.

- Wipe the wind tunnel test section with a soft, damp cloth as required to maintain clear visibility during experiments.
- Clean any spilled fog fluid immediately.
- If the smoke machine will not be used for an extended period, empty any remaining fog fluid from the reservoir before storage.
- Store the smoke machine in a clean, dry environment.

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WIND TUNNEL MANUAL

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