

Imaging station assembly instructions

Part 2 – Lighting and Cameras

This document contains diagrams to aid assembly of an imaging station structure. This imaging station is designed to take photographs of root systems contained in rhizoboxes (see file 'Rhizobox assembly instructions'). Assembly of the lighting and electrical components is split in to 2 sections: Lighting (1-5) and Camera arrangement (6-8). The general parts required are shown in Table 1 while a table of equipment required is included at the beginning of each section. A Tips section is included at the end of this document. It is assumed that assembly of the structural skeleton of the imaging station has already been completed (see file 'Imaging station assembly instructions – Part 1').

Safety

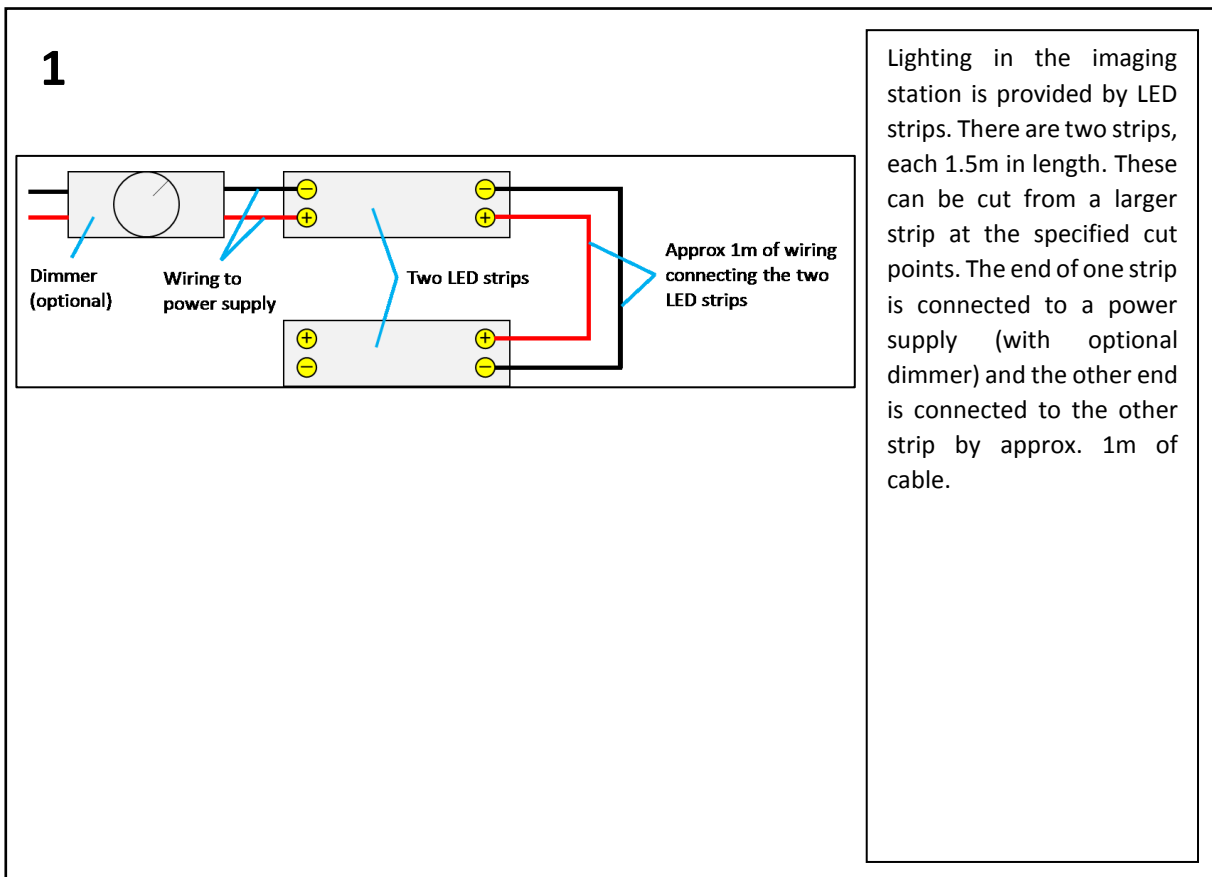
This document suggests the use of power tools, hand tools and work with electronic equipment. Follow all safety instructions which is provided or appropriate for any equipment used. Appropriate personal protective equipment should be used at all times such as gloves, eye protection etc. Work with tools and electronic equipment should only be carried out by competent persons.

Table 1

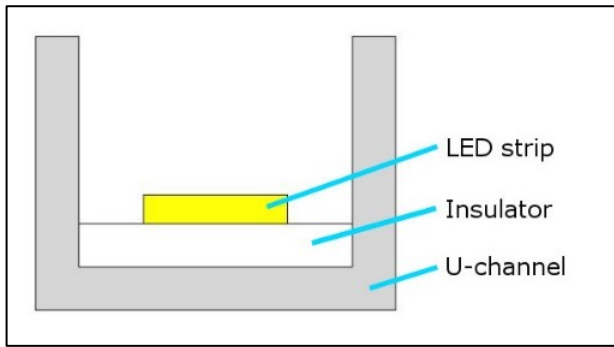
Part	Description	Example part source, country
LED light strip	2x 1.5m strips, dust and waterproof, Cool white	CPC, UK
Connecting cable	Matches power requirements of LEDs and local supply	-
Power cable, with dimmer switch (optional)	Matches power requirements of LEDs and local supply	-
Extension lead	Matches local supply and has 6 sockets	-
Raspberry Pi board	Raspberry Pi 3 Model B V1.2	CPC, UK
MicroSD card	16GB with preloaded OS installer	CPC, UK
Power cable	Official Raspberry Pi	CPC, UK
Case	Official Raspberry Pi	CPC, UK
Camera	B – adjustable focus	WaveShare, US

Lighting

Equipment	Description
Sealant gun	To hold chosen cartridges
Silicone sealant or grab adhesive cartridge	Heavy-duty , waterproof
Plastic strip	To line u-channel
Drill + drill bit	Suitable to drill into 0.3cm thick aluminium with a diameter of 0.3cm



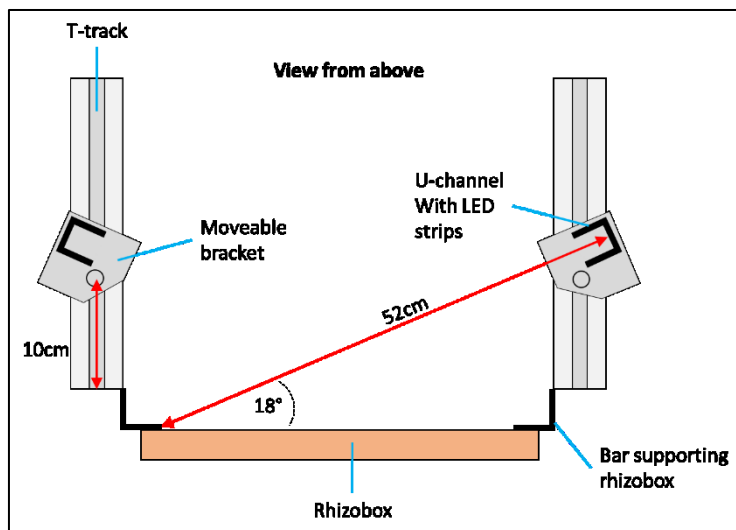
2



Each LED strip is contained in an aluminium u-channel and should be insulated from this using a strip of electrically non conducting material e.g. plastic (unless the u-channel used is electrically non conducting).

A hole of X diameter should be made in the u-channel. This will be used to attach the u-channel to the imaging station.

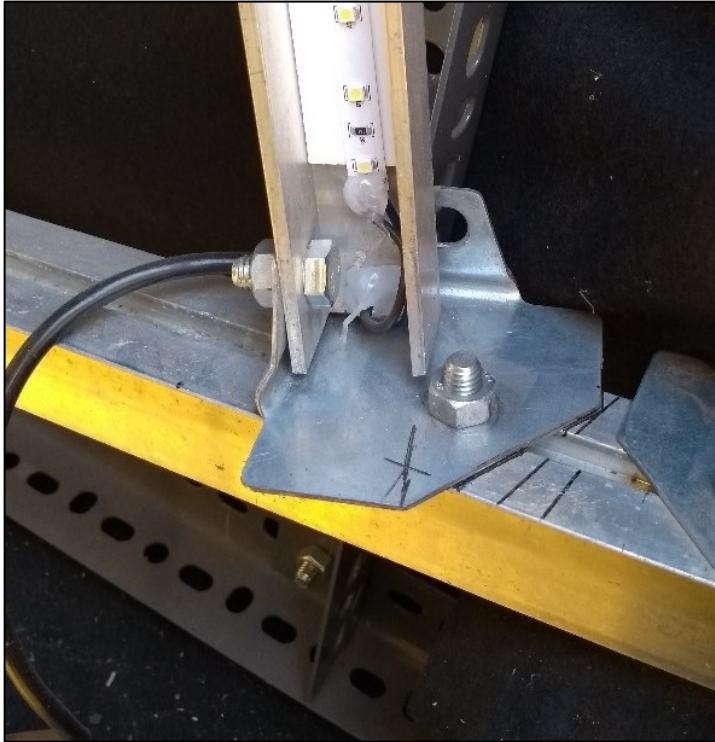
3



The LED u-channels are positioned in the imaging station, using brackets, between t-tracks (also see file 'Imaging station assembly instructions - Part 1').

The LED strips should face towards the opposite edge of the rhizobox but not the glass since this could cause reflections which will obscure the soil/roots. The lengths and angles shown in figure 3 should be used to initially position the LED strips but fine adjustment is necessary to obtain optimal images of the rhizobox.

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The u-channel holding the LED strips should be attached to the brackets and t-track using a bolt and nut. This bracket can move forwards or backwards and can be rotated to position the lights in the optimal position.

A small gap should be left between the u-channel and the bracket or small hole made to allow the LED wire to leave the bracket.

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The wiring connecting the LED strip to the power supply should be kept out of the way of the cameras and away from the floor where it may become wet or a trip hazard.

Camera arrangement

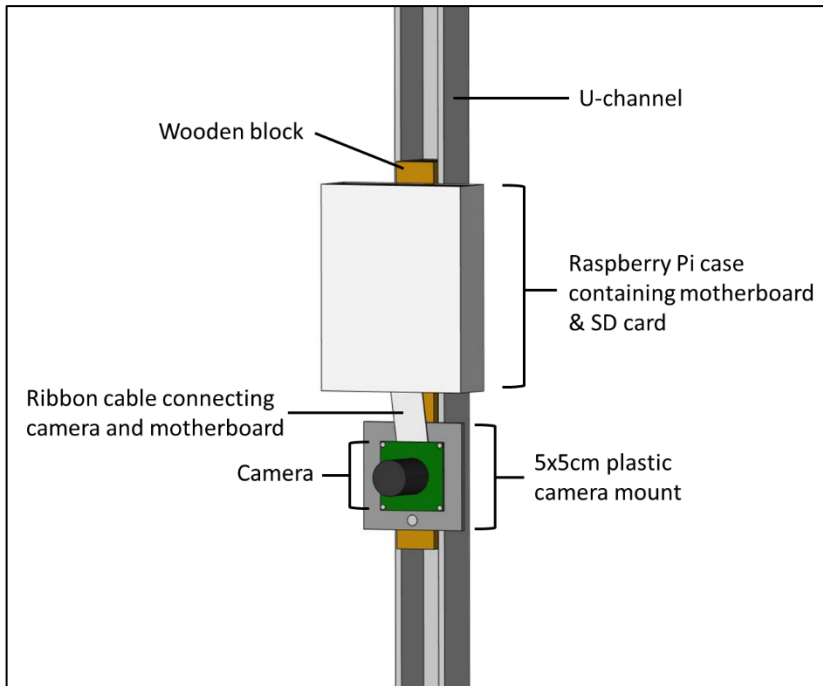
Equipment	Description
Double sided tape	To hold Raspberry Pi unit
Square of plastic	Flat, rigid & can be drilled (x5)
Screw driver & screws	Suitably sized to secure raspberry Pi camera
Drill + drill bit	Suitable to drill holes for screws
Block of wood	To fit in U-channel approx. 1.9x1.9x20cm (x5)

6



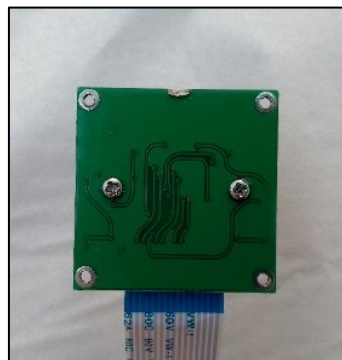
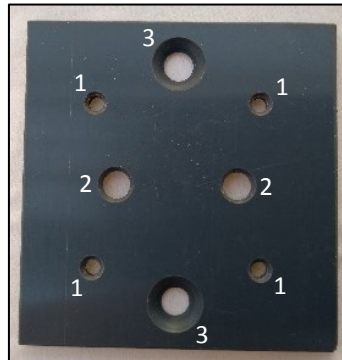
Raspberry Pi (RPi) units consist of a motherboard with SD card enclosed in a case, camera connected to the motherboard by a ribbon and a connection to a power supply.

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The RPi unit is attached to a piece of wood with double sided tape. The piece of wood should fit into the u-channel which holds the camera arrangement. The piece of wood should slide in the u-channel to allow for adjustment of the camera position. When the position is finalised the wood can be fixed.

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Each camera is fixed to a piece of plastic (5x5cm). Holes should be drilled into this as shown. The smaller holes (1) need to match the mounting holes on the RPi camera. Holes (2) need to match the position of the protruding screws on the back of the camera. The camera and plastic mount are then fixed to the same piece of wood as the RPi unit using holes (3).

This piece of plastic ensures the camera is firmly fixed in the imaging station and is flat. It is important that the camera is parallel to the rhizobox to properly capture images.

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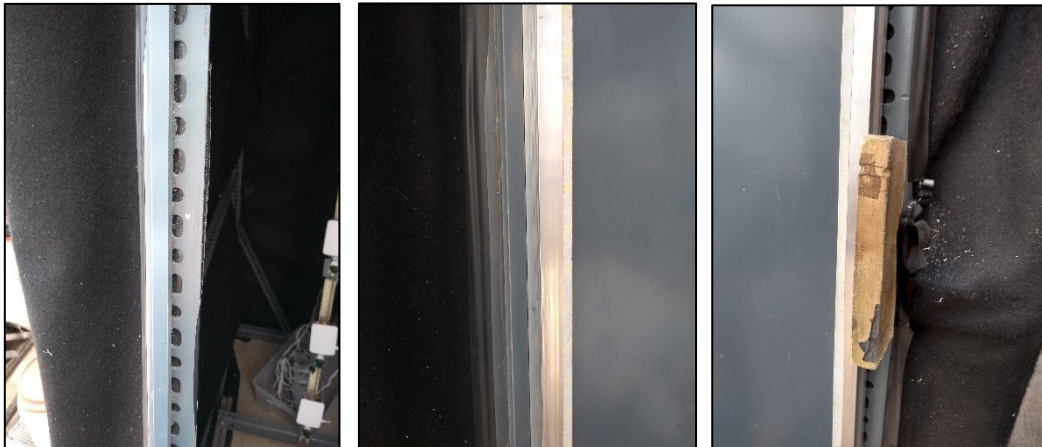


The camera array is positioned in the imaging station between two slotted angle bars approx. 78cm from where the rhizobox will be held (also see file 'Imaging station assembly instructions – Part 1'). The array should be central and parallel to the rhizobox (therefore at a 15° angle from the vertical).

Small pieces of black tape should be used to cover the LED lights on the camera and so stop these reflecting on the rhizobox glass.

Tips

- Cameras and lights should be installed as precisely as possible and then tested in the imaging station. This may require alteration of the imaging station, especially the position and angle of pieces holding the rhizobox, lights and cameras.
- Testing of the imaging station is best done with a real rhizobox filled with soil and preferably with a root system. This will help to confirm that the imaging station would work well for an experiment.
- The dimmer for the LED strip lighting may or may not be required. With 60 LEDs/m, 4.8W/m and a CCT of 5000k the dimmer was turned fully on as this was found to produce the best images.
- For consistent imaging, it is advisable to glue markers to the bars that support the rhizoboxes which ensure rhizoboxes are placed in the exact same location every time. A wooden block can be wedged between the imaging station and the rhizobox at the opposite side to the marker. This helps to hold the rhizobox straight.



- It is advisable to have a cover for the open front of the imaging station when not in use to prevent damage to the electronics and cameras. This can be a piece of cardboard, felt or other similar material. Cameras are supplied with removable lens covers but it is not advisable to use these since the action of adding and removing the lens cover could alter the focus and position of the camera between uses.

