

# **Imaging station assembly instructions**

## **Part 1 – Structural skeleton**

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'). It is mostly constructed from slotted angle bars that are fastened using nuts and bolts. General assembly is shown in figures 1-16 while the parts required are shown in Table 1 including example part sources. Equipment required is shown in Table 2. Before starting it is advisable to read the whole of this document. This document shows both assembly of the structural skeleton of the imaging station and some aspects of the electrical lighting and camera equipment, however, more detail for the electrical components can be found in the file 'Imaging station assembly instructions – Part 2'. Further to this, calibration and software set up of the cameras can be found in the file 'Imaging station assembly instructions – Part 3'.

### **Safety**

This document suggests the use of power tools, hand tools and adhesives. 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 should only be carried out by competent persons. Tools and materials can become hot when cut or filed and should be left to cool before handling.

Some of the components in this document are heavy. These components should be handled carefully and following manual handling guidelines. Further to this glass can be damaged and contain sharp edges. Glass should be handled with care using gloves and any broken glass should be disposed of appropriately.

Any work which uses tools or requires lifting is best carried out with two or more people.

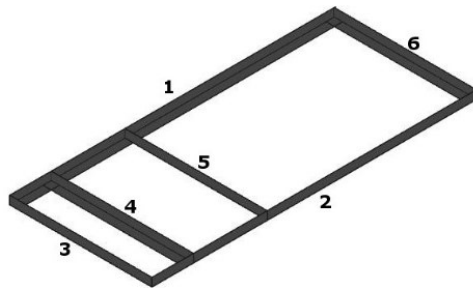
Table 1

Part type	Part number	Length (cm)	Example part source, country
Slotted angle bar	1, 2	155.5	<a href="#">Racking Man, UK</a>
	3, 4, 5, 6, 13, 14, 15, 22, 23	68	
	7, 8, 9, 10, 11, 12	20	
	16, 17, 18, 19	166	
	20, 21	100	
	24, 25	151	
	26, 27	81	
	28, 29	10	
	30, 31	122	
	32, 33, 34, 35	70	
	36, 37	15	
	42, 43	52	
T-track	38, 39, 40, 41	97	<a href="#">Mould Shop, UK</a>
U-channel (internal 1.9x1.6cm, external 2.5x1.9cm)	44, 45, 46	150	<a href="#">Aluminium Warehouse, UK</a>

Table 2

Equipment	Description
Spirit level	To assist in assembling pieces at correct angles
Carpenters angle/ protractor	To assist in assembling pieces at correct angles
Metal saw + blades	Suitable to cut 1.7mm thick steel
Measuring tape	To assist assembling pieces of correct lengths
Spanner/ ratchet	To fit bolts and nuts (likely M8 & 6)
Metal file	Round, approx. 5mm diameter

# 1



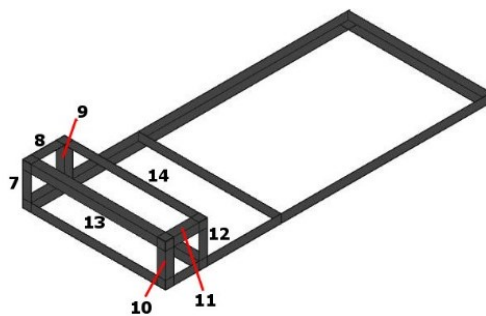
Slotted angle bars can be bought in the correct lengths or cut to size using a saw.



Bars should be cut precisely and assembled at exact angles. A spirit level and carpenter's angle/protractor should be used and will minimise misaligned holes and bars. This is particularly important in the imaging station to obtain good images from the cameras.

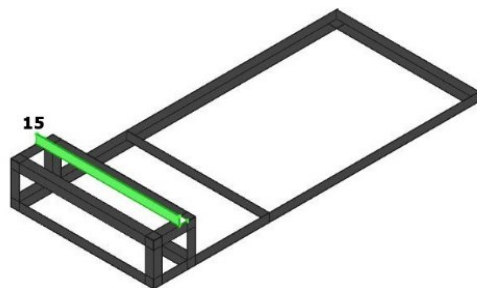
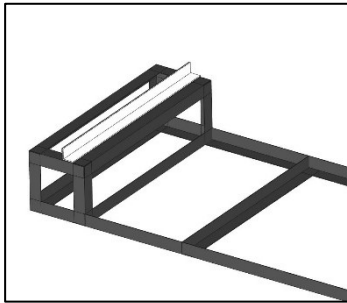
Bars 1 & 2 are at  $90^\circ$  to bars 3-6.

# 2



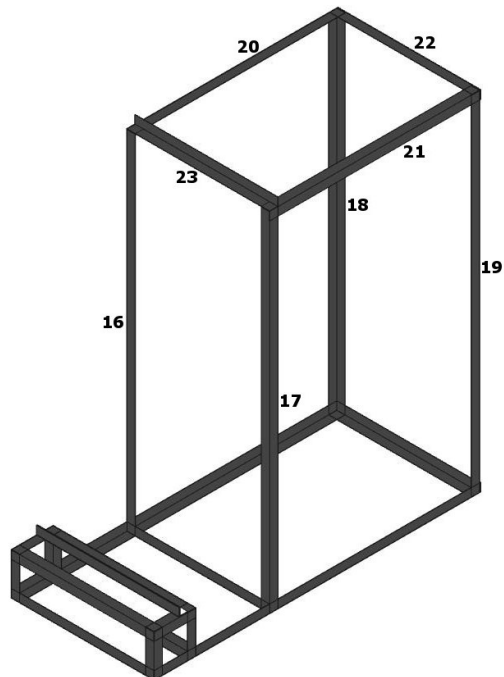
Bars 7-14 form a small right angled cuboid at the front of the imaging station.

3



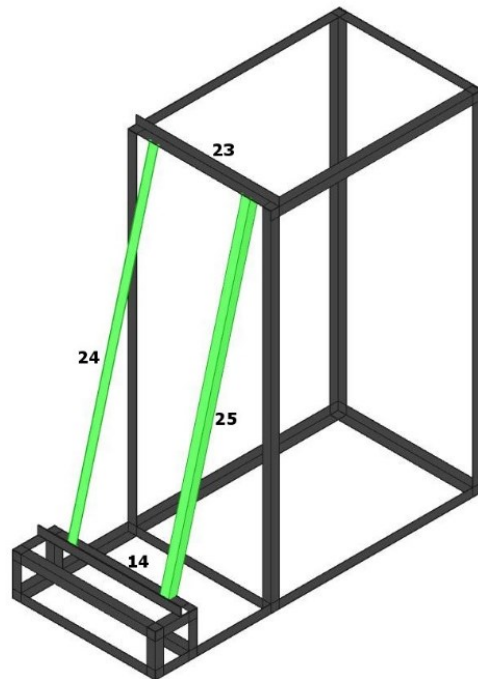
Bar 15 directly holds the base of the rhizobox and is lined with material (e.g. silicon) to prevent damage (see inset image). Holes should be made in the material to allow any water from the bottom of a rhizobox to drain.

4



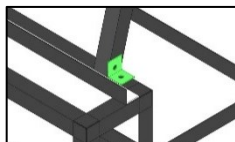
Bars 16-23 form a large right angled cuboid at the back of the imaging station.

5

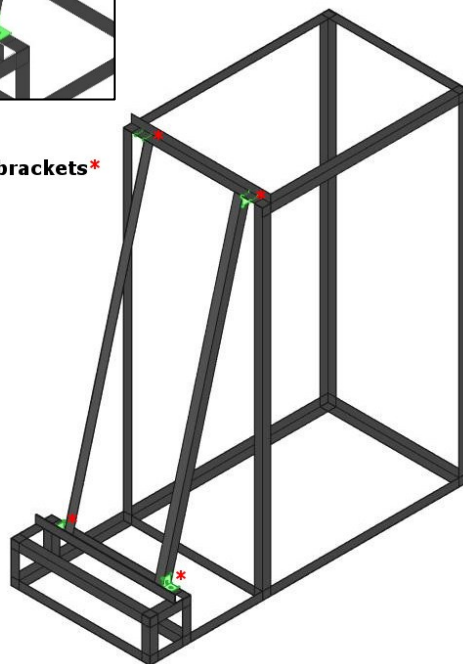


Bars 24 & 25 are attached at approximately 15° between bars 14 and 23. Take great care when cutting and attaching bars 24 & 25 as these will hold the rhizobox and their position is important to image quality.. It is best to measure the distance between bars 14 & 23 before cutting bars 24 & 25 at an angle to match this space. This step is easiest when the rest of the imaging station has been assembled accurately.

6

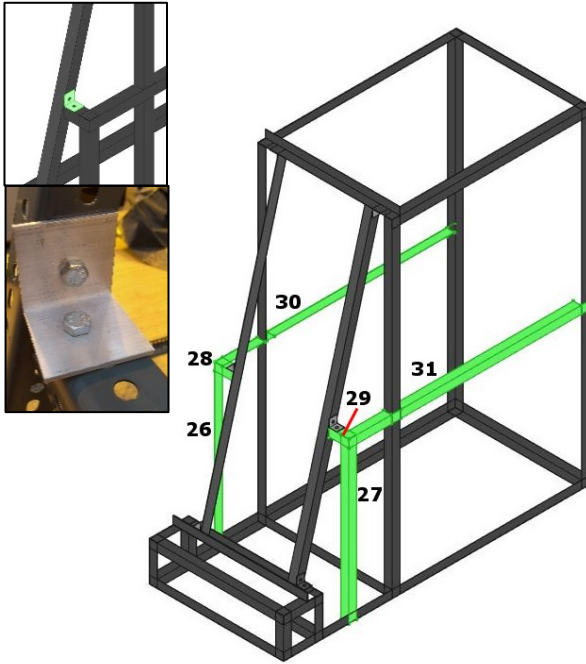


**brackets\***



Bars 24 & 25 are attached at the bottom and top using brackets (see inset image). This is best done where custom holes can be made in a plain bracket to ensure the holes align. If this is not possible a bracket with holes should be selected to fit.

7

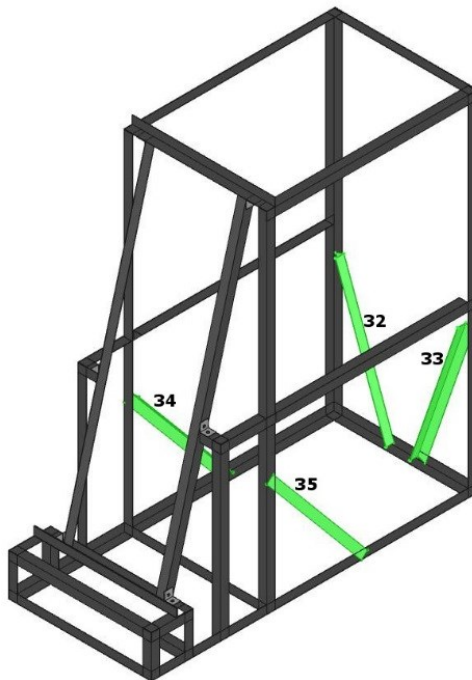


Bars 26-31 support the middle of the imaging station. These are at right angles. Bars 30 & 31 are cut fit around bars 18 & 19 and 16 & 17:



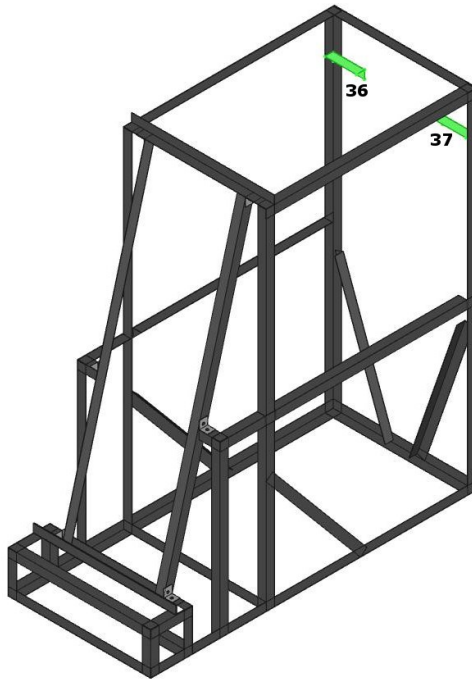
Bars 28 & 29 are attached to bars 24 & 25 using brackets (see inset images).

8



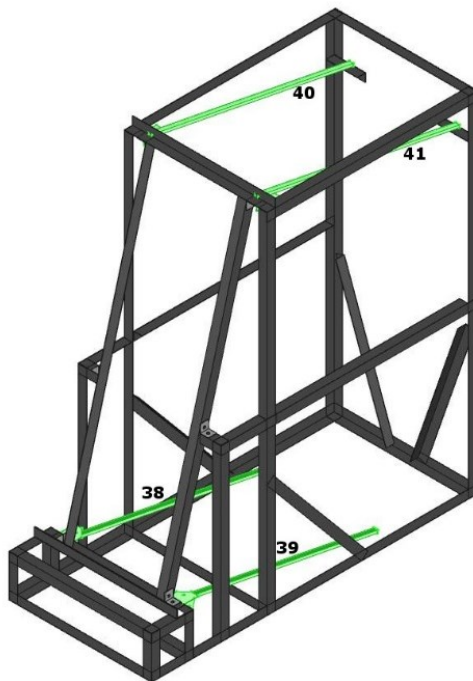
Bars 32-35 are not at a specific angle since these bars are only secondary support. Priority can be given to aligning holes rather than bar angle.

9



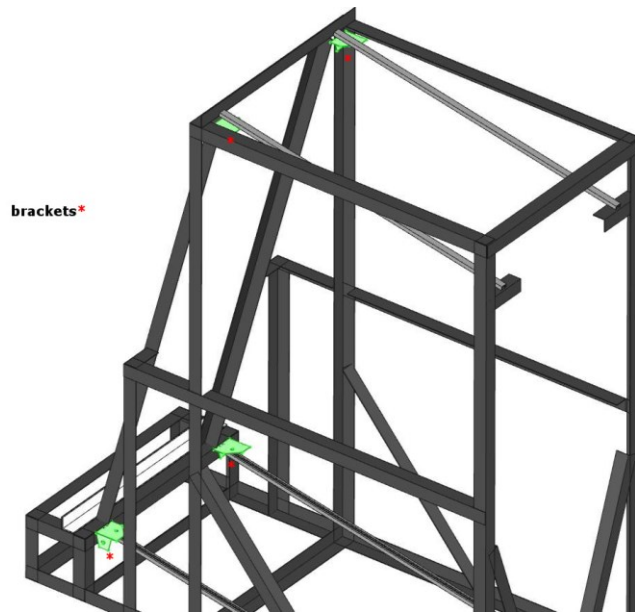
Bars 36 & 37 are small support bars for t-track pieces.

10



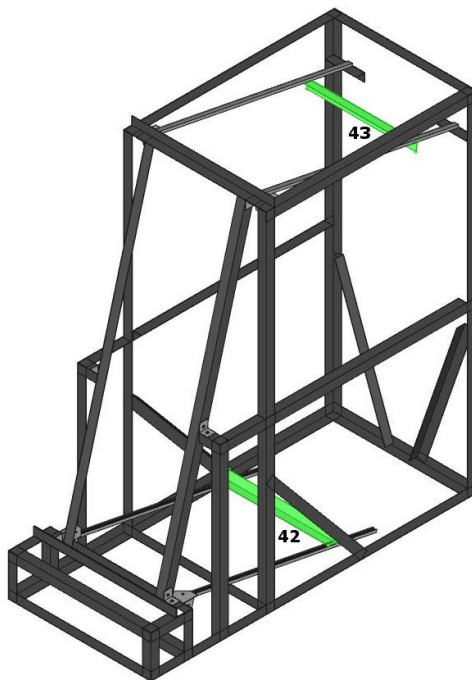
T-track pieces 38 -41 are attached using brackets (see Fig 11) and rested on bars 36 & 37. When a final position for the t-track pieces is decided it is best to permanently attach these to bars 36 & 37 with brackets.

11



T-track pieces 38 -41 are attached using brackets.

12

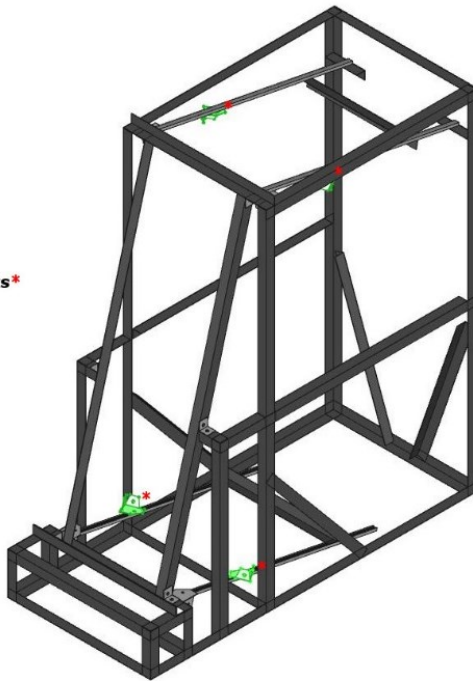


Bars 42 & 43 are attached using a nut and bolt in a t-track piece. This allows movement of the bar for subsequent camera set-up. These bars should be positioned approx. 78cm from where the rhizobox will be held.



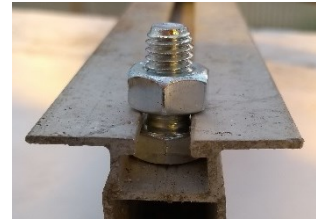
# 13

brackets\*

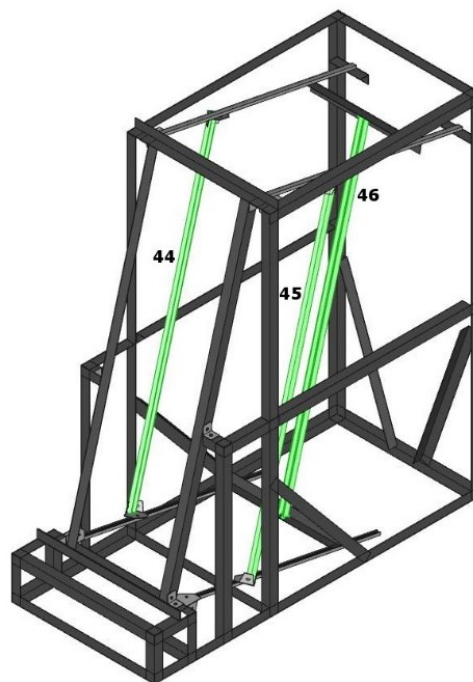


Brackets are added to the t-track.

T-track pieces can hold the head of a bolt which when loose can be moved along the track's length. Or the bolt's position can be fixed by tightening the nut:



# 14

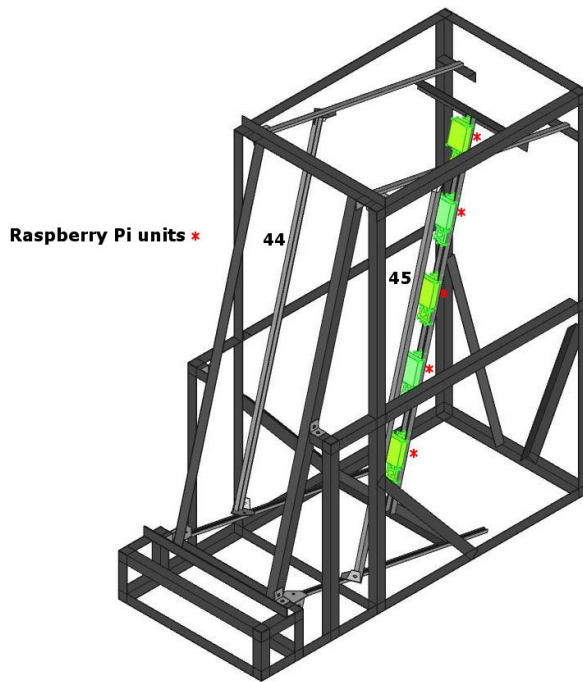


U-channel pieces 44 & 45 are attached between the bottom and top t-track pieces using the brackets:



U-channel piece 46 is attached to the centre of pieces 42 & 43.

15



Bars 44 & 45 are used to hold the LED lighting and bar 46 is used to hold the raspberry Pi camera units.

16



The imaging station should be covered with a black cover (e.g. felt material) to exclude external light. Any holes in the bars that would allow light into the imaging station should be covered with black tape.

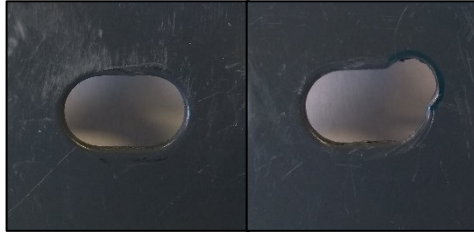
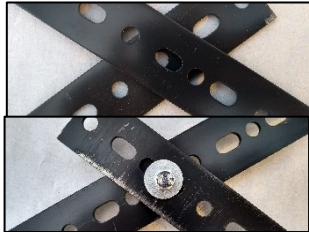
Rhizoboxes are placed against the open front of the imaging station with the glass surface (and so roots) facing the inside.

The felt cover should have an extra section which overlaps the top of the rhizobox to prevent light entering. This should sit around the shoot of the plant.



## Tips

- The imaging station should be assembled as precisely as possible which may require cutting each bar to measure as it is assembled rather than cutting all pieces before.
- Cameras and lights should be installed 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.
- For more detail on lighting and camera installation see “Imaging station lighting” & “X”).
- If a bar is slightly off angle or holes are misaligned a smaller diameter nut and bolt can be used or the hole in a slotted bar can be altered using a metal file to allow the point of attachment to be moved. These connections should be strengthened using washers:



- Feet can be added to the imaging station for stability. This may be particularly important where it is built on an uneven surface and adjustable feet could ensure it is level.



- Any sharp cut ends of bars should be filed smooth and/or covered for safety.

