HOW TO BUILD A LOW COST ROLL-OFF ROOF OBSERVATORY

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1 Introduction

In 2001 I built my first roll off roof observatory for my scope at that time; a Meade 10" LX200 on a permanent pier. Having the scope permanently mounted and polar aligned in an observatory resulted in a far more pleasurable observing experience primarily because the physical logistics of setting up and observing are made far easier.

After moving house in 2011 I essentially repeated the build process I performed for my old observatory with various improvements that I learned from that first observatory build experience.

This time I decided to photograph every step of the process and this document is the fruit of those labours; it contains step by step instructions, with approximately 50 photographs, of how to build a roll-off roof observatory from scratch, or in other words, how to go:

From this…

To this…

With about fifteen days of effort and for a total materials cost of about £550 (GBP in 2017).

2 Tools, materials and required skill

To tackle this project, you will need some degree of DIY ability (or at least a degree of DIY confidence). If you are the sort of person who would be happy putting up a flat pack garden shed for example then it's probably well within your ability.

Although I have worked in the computer industry for the last 30 years, I started my working life in engineering and completed a five-year mechanical and production engineering apprenticeship. I would therefore classify myself as reasonably good on the general technical and engineering front which transposes itself as being reasonably competent at DIY.

A couple of general concepts that I learnt from my engineering days, and which have served me well in my DIY endeavours, and certainly apply to the construction of a roll off roof observatory, are as follows:

- Plan before you do; remember the 5 'P' rule – Prior Planning Prevents Pretty Poor Performance. Agile may be a good methodology for constructing computer software but it rarely works for DIY;
- Add contingency – when you estimate cost and time for a job, add 20% as there is always the unexpected;
- Have the right tools for the job. See Table 1 below for a list of the tools that you will need to construct this observatory. There are only a couple of items here that you may not find in your average DIY shed, and they are not mandatory;
- Let the tool do the work and don't rush. This means don't force things – brute force is hardly ever needed if you plan before you do, and do things the right way;
- You will make mistakes. Use the gift of hindsight to make it better the second time.

Tool	Comment	This is what I used
Spirit Level	Possibly the most important tool of the lot as if things are not square and level during construction everything gets more difficult. Use a 1 metre level if possible.	
Square	Invaluable for good wood working	

Tool	Comment	This is what I used
Metal Tape measure	3 meters is good.	
Hammers	A variety of tapping sticks including a wooden mallet	
Screwdrivers	Cordless electric makes life so much easier.	 
Hand Drill	Again, a cordless electric makes life easier. I use an 18v lithium battery drill.	
Saws	Hand saws and an electric jig saw if available	

Tool	Comment	This is what I used
Chisels	Useful for all sorts to things	
Spade	Digging and levelling of ground.	You all know what a spade looks like
Trowel and a bowel or bucket	Used for mixing and laying concrete and mortar	
Workbench	A Black and Decker workmate or something similar	
G-clamps	Not essential, but it makes life easier to hold items in position during construction	

Tool	Comment	This is what I used
Router	Definitely not essential but I used one during the construction of the roof runners to cut U shape channels for the wheels to run in. The same U shape channel could be made from three pieces of wood (i.e. floor and two sides) screwed together.	

Table 1 – List of tools

The following table gives a summary of the main building materials required. Just about everything is available from your average DIY store (I used Wickes in the UK). All of the items below are photographed and detailed in the subsequent sections.

Item	Used for
Wood – lots of it.	Detailed in the sections below, but essentially the entire construction is based on a wooden frame. I used standard planed square-edged timber.
Shiplap cladding wood	Used for the walls.
Bitumen Corrugated sheets.	Used for the roof covering
Wood Screws – lots of them	Buy a large pack (a couple of hundred) of assorted lengths up to about 8 cm.
Metal brackets	To add rigidity to the light weight roof.
Bricks	Not essential but I used these for the observatory base.
Loft flooring chip board	Used to make the elevated floor.
Instant Concrete (just add water)	Concreting in posts and the pier – I used about four 25kg bags.
Mortar (ready mixed – just add water)	For the brick base. I used about two 25KG bags.
Metal framed plastic Trolly wheels	Screwed to the wooden roll off roof runners and run in a U channel.
A pier	For this build I purchased an Altair Astro Skyshed 8" pier, but for my first observatory build I used an 8 inch metal pipe with a plate welded on the end.

Table 2 – List of building materials

3 The Observatory Plan

All builds need to be planned so that a workable design can be derived which leads to a reasonable estimate of the materials and cost. I created the following observatory construction plan shown below in Figure 1 and Figure 2.

My observatory construction design philosophy was as follows:

- Size: The observatory was to be rectangular; just under 3 meters long by 2.4 metres wide. This provides plenty of room for my C11 Celestron on a permanent pier with room for a table and chair;

- Typical wood lengths sold by DIY stores include 3m, 2.4m and 2.1m (and obviously smaller). The observatory dimensions of 3m by 2.4m took this into account and also the fact that 3m was about the longest length I could get into my car – this sort of practicalities have to be considered;

- Height: Height from floor to top of sides (when roof retracted) was to be 1.6 metres;

- Use 4 large corner posts that are to be concreted into the ground and made as level and square to each other as possible. Everything else is to be centred off of these foundation posts and hence they are absolutely key items to set up accurately;

- Floor: The floor is to be elevated off the ground, supported by beams fixed across a brick base. The brick base must be as level as possible and placed on top of a simple concrete foundation. The floor is to be made from loft chipboard flooring packs. Raising the floor off the ground like this keeps it away from any potential damp and the floor I built for my last observatory in 2001 used this same technique and it was still in perfect condition after 10 years when I moved house;

- Walls: Walls are to be made from shiplap cladding wood (just like your average garden shed). Get the best quality and thickness you can afford as thin cladding will warp as the years trip past;

- Pier: For my first observatory in 2001 I used an 8” metal pipe as the pier. In this scenario the pier needs to be concreted into the ground to a depth approximately equal to the height above the ground. In this case the pier was to be 2 metres long, therefore 1 metre of it was to be concreted into the ground. The pier is obviously a critical component and there is no such thing as a pier that is too rigid. For this build I purchased a commercial pier for which just the bolts needed to be concreted into the ground to secure the pier onto.

- Roof: The roof needs to be light enough to easily roll on and off but sufficient cross braces must be used to give enough rigidity. I used corrugated bitumen sheets and heavy-duty wheels.

- All of the main construction would be of wood that can be bought from any DIY store (in my case Wickes in the UK). The only exceptions to this are the bricks for the base (of which I had a few dozen lying around) and the purchased pier.

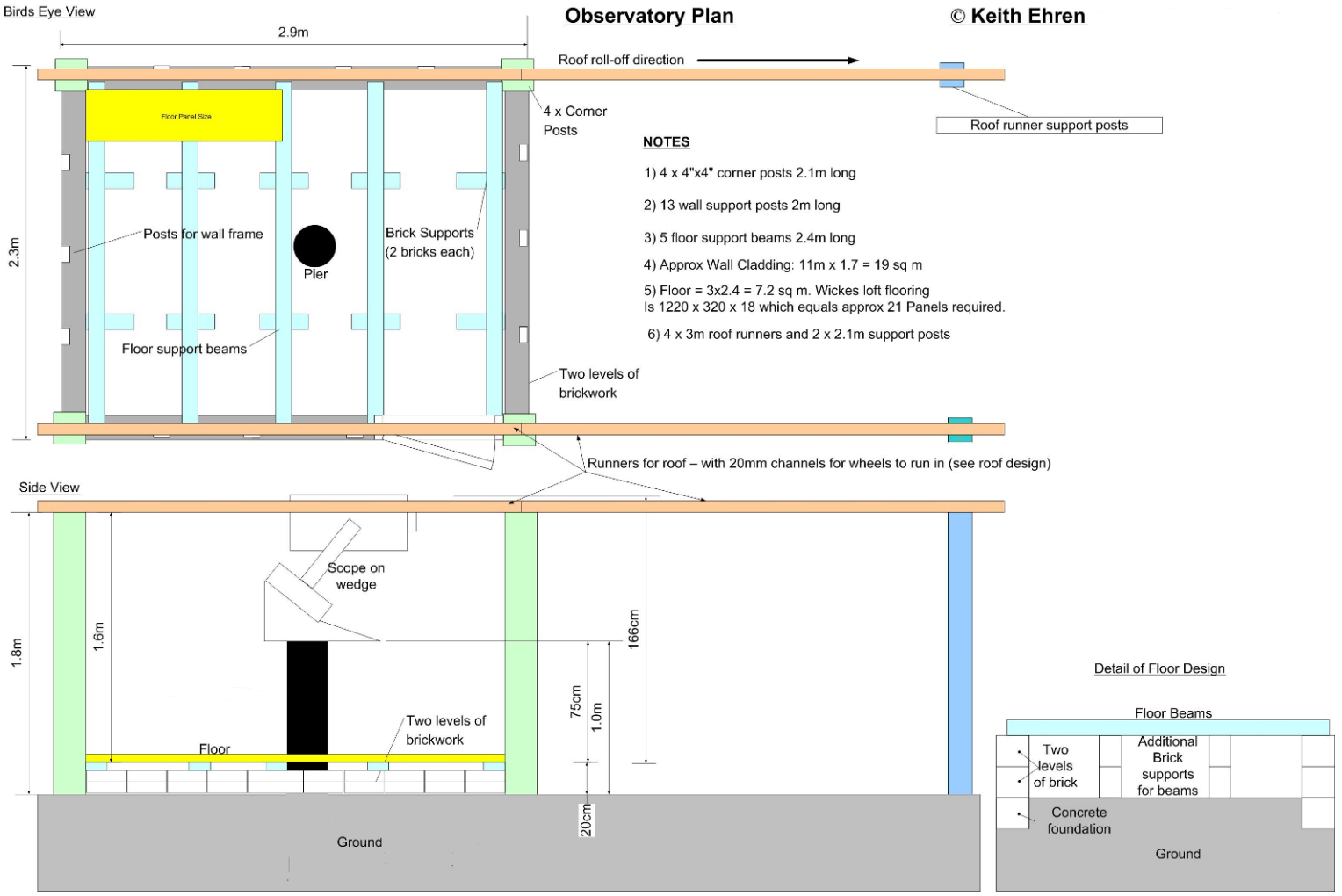

Figure 1 – The observatory plan

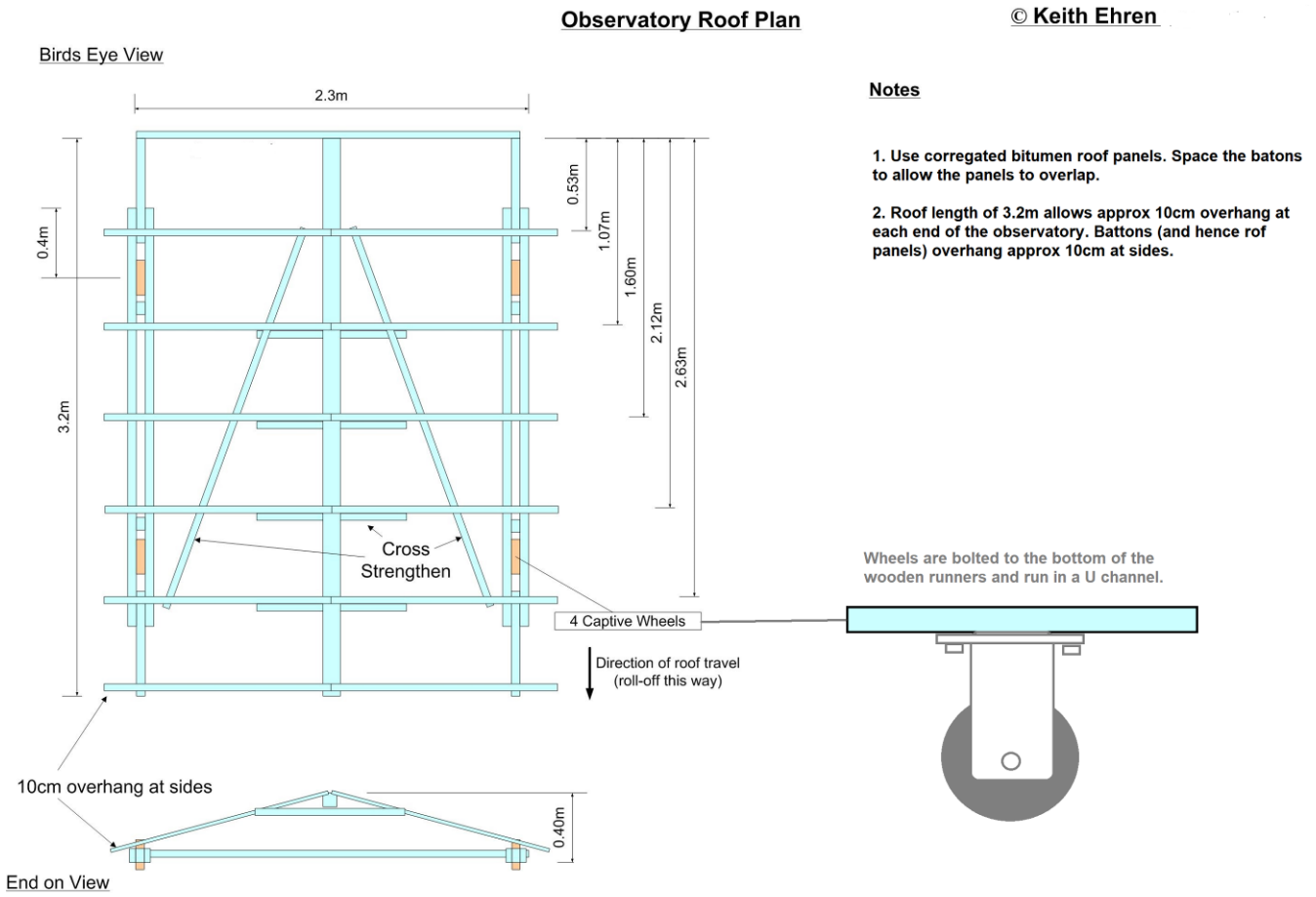

Figure 2 – The observatory roof plan

4 Observatory Positioning

The first step is to decide where to position the observatory. The obvious metric for this is to position it where the horizon would be least obscured. For me this was on a piece of scrubby old rockery (see Figure 3 below). To ensure that the selected ground was suitable I pegged out the planned area of the observatory as shown in Figure 4 below and dug a couple of test holes to make certain there was nothing unexpected about (or buried in) the ground.

Figure 3 – Select the best site

Figure 4 – Cleared the ground and marked out observatory area

5 Prepare the corner posts

The core components of the observatory about which everything else would be positioned against are the four corner posts. It is therefore absolutely essential that the posts are substantial enough (I used 4" square posts) and concreted into the ground so that they are as square and level to each other as possible.

The positioning and concreting of the corner posts is shown in the figures below. The 1m spirit level can also be seen which I used throughout construction. The various wooden and metal cross posts and supports that can be seen were just temporary to hold the posts in place while the concrete set.

Figure 5 – Dig in the first corner post (temporary supports also visible)

Figure 6 – Get the concrete ready – just add water

Figure 7 – Concrete each post (temporary cross support also visible)

Figure 8 – Ensure the corner posts are correctly spaced, level and square to each other

6 Prepare the Brick Base

The next step was to prepare the foundations for, and lay, the brick base that would be used to support the suspended floor. The foundations were simply a case of digging a trench approximately 10cm deep, filling it with concrete and then laying the bricks on top.

The process is shown in Figure 9 to Figure 15 below. I'm no brick layer, so it may not be pretty but just make certain that the base is square and solid.

Figure 9 – Dig a shallow trench between posts for the brick foundations

Figure 10 – Fill the trench with concrete – just add water

Figure 11 – Foundation done - make certain it is square and level

Figure 12 – Mortar for the brick laying – just add water

Figure 13 – Laying the two levels of brick

Figure 14 – Checking everything is square and level

Figure 15 – Brick base completed (hole for the pier concrete base also visible)

7 Side Construction

The sides are to be made from shiplap cladding. Before this can be done a simple frame needs to be constructed so that the cladding can be screwed into place.

Figure 16 – Start Side Frames

Figure 17 – Side Frames In Progress

Figure 18 – Screw Shiplap cladding to the frame

Figure 19- Add sides down to brickwork

Figure 20- First side completed

8 Roof Runners

So that the roof can roll off I placed runners along both sides of the observatory, fixed to the top of the corner posts. I made these from 3m length wood with U channels cut out via use of a router (see Figure 21 and Figure 22 below) for the roof wheels to run in. I then screwed these on top of the respective corner posts as shown in Figure 23.

If you do not have a router pre-fabricated U-shaped metal sections can be purchased or you can easily make a U shape by screwing together three pieces of 3m wood – one for the bottom and two for the sides.

Figure 21- Start making the roof runner

Figure 22 – Cutting out a channel for the roof wheels to run in

Figure 23 – The first Roof runner in place and the second side

Figure 24 – Ensure roof runner is level

9 Complete Sides

Now it was just a case of screwing on the rest of the shiplap cladding – remember to leave space for a door!

Figure 25 – Front complete with gap for door

Figure 26 – Three sides complete

Figure 27 – Last side in progress

Figure 28 – All sides complete

Figure 29 – All sides complete – view through door

Figure 30 – All sides complete – birds eye view

10 Making the Roof

The mechanism for the roof was based around having four captive wheels which would run in the U shape channels in the two roof runners (two wheels per side) previously attached to the sides of the observatory. The roof frame is therefore fixed on top of 3m lengths of wood whose purpose is to hold the wheels captive.

To show this better, the nearly completed frame is shown below in Figure 31. I used metal brackets at every joint for rigidity and added cross braces which can be seen later.

An important note here is that the roof structure extends approximately 10cm over the edges of the observatory walls. An overlap is important so that any rain runs off and just drips onto the ground and does not get back into the observatory.

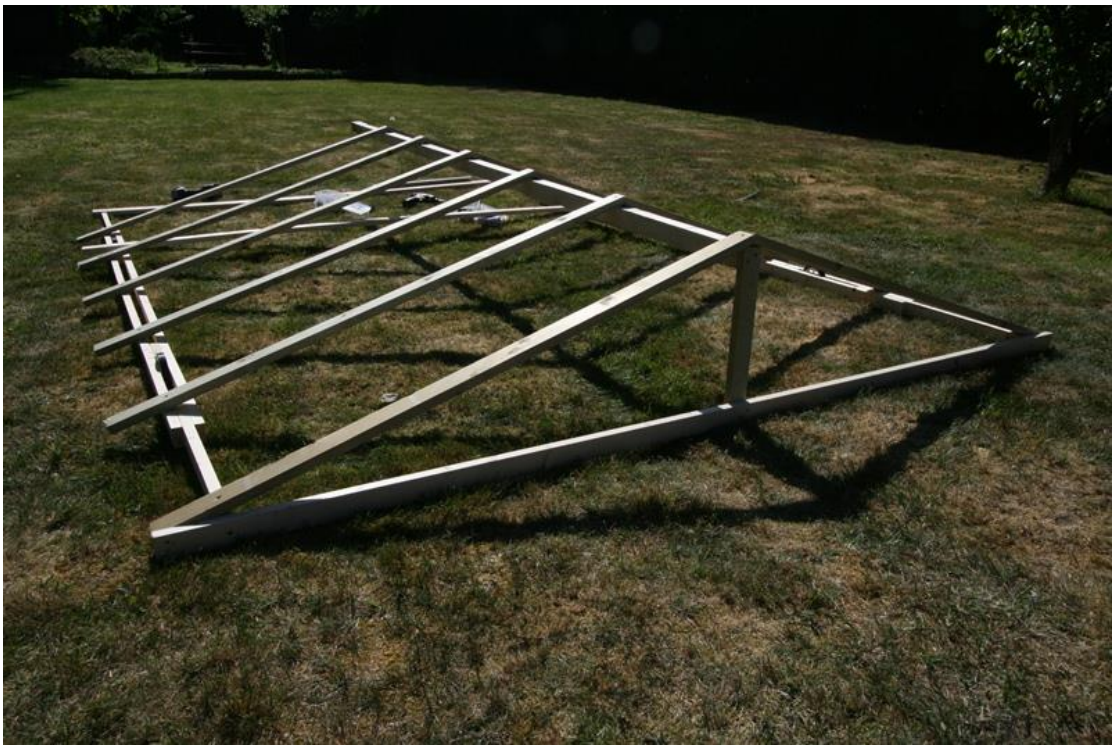

Figure 31 – The (nearly) completed roof frame

Figure 32 –Wheels attached to roof and running in the U channel

Figure 33 – Example roof brackets

Figure 34 – Check that roof moves freely before adding bitumen sheets

Figure 35 – Final roof assembly in place – note metal brackets at every joint

11 The roof covering

To keep weight to a minimum but provide 100% waterproofing I used corrugated bitumen sheets and ridge pieces. The main thing here is to ensure that the corrugated sheets are overlapped and that the ridge pieces are joined with roofing tape so that rain cannot enter. Roofing screws with built in caps are used to screw the sheets to the frame.

The roof covering extends approximately 10cm over the edges of the observatory (as the frame has been made longer and wider that the observatory walls).

Figure 36 – Roof ridge

Figure 37 – Tape used to join the roof ridge sections

Figure 38 – Roof completed and retracted

12 The Floor

For the floor construction, I fixed wooden beams spanning the brick base, positioned additional brick piles to support the beams and then screwed the 18mm thick loft boarding to them.

Figure 39 – Loft boarding for floor

Figure 40 – Floor completed

13 The Pier

For my first observatory in 2001 I used an 8” metal pipe with a plate welded on the end that I concreted 1m into the ground.

For this observatory I decided to spend some money and I purchased an Altair Astro Skyshed 8” pier. This just requires 4 bolts (supplied) to be concreted into the ground then the pier fixed to them.

To ensure that the bolts would be in the correct place I put the pier on top of a piece of board and traced out where the holes were located in the pier base. I then drilled the board, attached the bolts to the board and then concreted the bolts into the ground. Once the concrete was dry I removed the board and lowered the pier onto the bolts.

Figure 41 – Pier bolts attached to board

Figure 42 – Pier lowered onto the concreted in bolts

14 Add a door

The door is simply made by constructing a frame and then screwing on ship lapped wood as shown below.

Figure 43 – Make a door

15 Add roof runner extensions

The next step is to add the runner extensions so that the roof can be rolled all the way off. This was a case of concreting into the ground some support posts and then extending the runners. Two 3m lengths of word were used, channelled out as shown in Figure 22 previously, and then screwed to the top of the observatory posts at one end and the new support posts at the other.

Figure 44 – Roof runner supports posts concreted into ground

Figure 45 – Roof runners and supports completed

16 Construction completed

All of the main structural work for the observatory is now complete.

The inside of the observatory has been lined using spare bits of sheet material – this includes all of the sides from an old flat packaged wardrobe and bits of laminate that I had in the garage which gives a bit of a funky appearance. These have all just been screwed to the frame. Chip board sheets would be fine!

The two images show the final state once I added an old desk and some carpet.

Figure 46 – Completed Outside

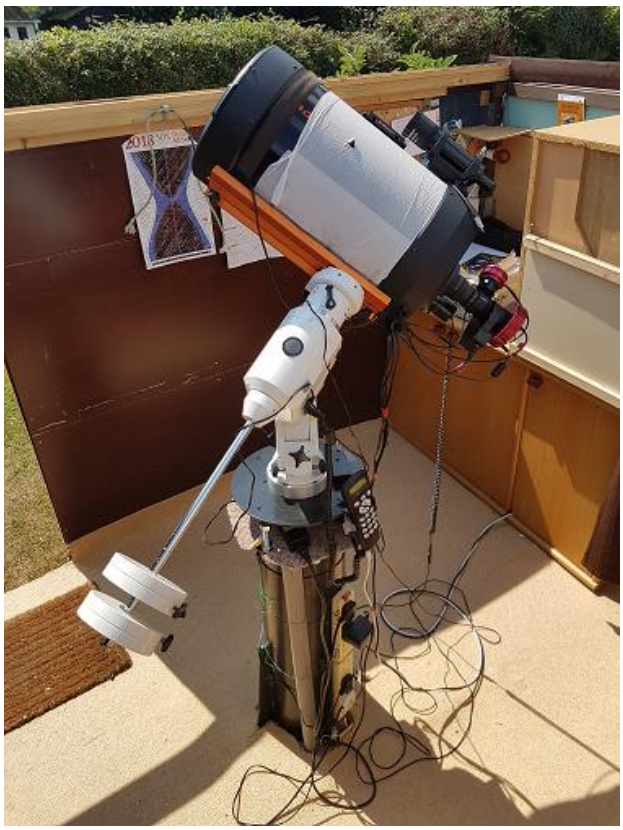

Figure 47 – Completed Inside

17 Electrical Requirements

The table below details the main electrical requirements for my observatory.

Component	Max Load
Sky-Watcher EQ6 Mount	2 Amps
Dew Heater	2.4 Amps
PC	3.5 Amps
Monitor	1 Amp
Total:	8.9 Amps

Table 3 – Electrical Load

Additional items that I use which require mains power all have minimal electrical requirements such as red and white lights and a CCD.

For the electrics the normal household (UK) 13 Amp supply (fused) with a surge protection trip was therefore sufficient. All outdoor wiring must of course use certified outside electrical components which most DIY and garden centres stock these days and be carried out by a certified electrician.

18 Further Information

Please visit my website www.astroworkbench.co.uk for further documents and articles.

If you find this document helpful in constructing your own observatory then please consider donating a beer token of £1 via my PayPal account – please see my website www.astroworkbench.co.uk for details.

Thanks.

Keith.