

## A proposal for a 5m satellite ground station / radio telescope to be hosted at The Norman Lockyer Observatory



### Overview

Nanosatellites such as CubeSats and PocketQubs are an exciting new class of satellite that allow university students (and even private individuals) the chance to gain hands on experience of designing, building, launching and operating satellites.

They transfer data such as telemetry data and images using amateur radio frequencies to ground stations on the earth. These are very weak signals and as the data rates get higher to support higher resolution images large dishes for reception of these signals are required.

As a typical CubeSat is in an orbit that makes it pass overhead six times a day for about ten minutes a pass, a global network of thirty steerable large satellite dishes and ground stations is required to be in continuous contact. myGroundStations.com is an open source open access initiative to build such a network of dishes and make them available to the CubeSat community to solve this problem.

A famous scientific fiction author from the West Country had a large (approximately 5m) satellite dish in his garden. When he passed away, this dish was made available to good causes and it is now available for use by the myGroundStations.com project. In addition, a dish of this size can be used as a useful radio telescope and, as there is a substantial amount of downtime due to the relatively infrequent passes of CubeSats, it could be usefully utilised for this at the same time.



This is a large piece of equipment and needs a space friendly location to install it. Due to the historic connection of the available dish (around which a nice exhibition could be built), and its active amateur and education communities, The Norman Lockyer Observatory (NLO) was thought of as a possible ground station location if it would be of interest to the Observatory.

It is proposed that the Observatory provides a location to install the dish, the ground works for the installation (estimated to be approximately £2500), and a power supply and permanent broadband (>1 Mbps) internet connection for operation.

myGroundStations.com will arrange for the shipping of the dish and support equipment to the Observatory, assist with the installation, ongoing operation and training of members of the NLO Radio and other groups in its use and provide an exhibition describing its purpose and heritage. It is suggested that the equipment be provided on a permanent loan basis whilst the NLO remains open to the public and its current goals and purpose remain broadly unchanged.

Thank you for your interest and we hope that this proposal is of interest. Please do not hesitate to ask any questions or make any suggestions.

## Plan

It is proposed that if the project goes forward, it does so in three stages:

- Stage 1 – storage
- Stage 2 – fixed installation
- Stage 3 – steerable installation

### Stage 1 (storage)



The 5m dish is currently at a location which is only available until the end of May. It would be very helpful if the NLO could provide a location to store the dish until it is ready to be erected.

The dish breaks down so that it fits into a standard twenty foot shipping container which also functions as a secure storage system and equipment bunker. It is therefore proposed that the dish will be delivered in the twenty foot container to the NLO car park marked 'A' in the satellite image.



A twenty foot shipping container takes up approximately the same space as a large Ford Transit van - the exact dimensions are 6.1m x 2.4m x 2.6m.

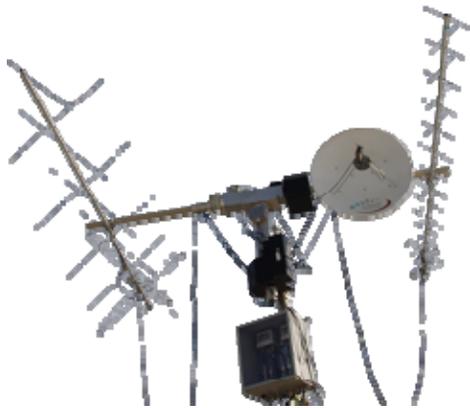
The storage container will require no power or other services although coverage by a webcam or CCTV system would be appreciated and could be supplied by myGroundStations.com

**Stage 2 (fixed installation)**



At the moment, the dish is configured for communications with geosynchronous satellites. This means that it is setup to point at a single static point in the sky. For the dish to be fully utilised, it needs to be adapted so that it can be steered and pointed in any direction.

myGroundStations.com has commissioned a steerable mount for the dish. However, it will be six to twelve months before this is ready as it is being done by an engineering company who have donated the conversion in their spare time.



It is therefore proposed that the dish be initially erected in its current configuration (top photo) for the first year. That is pointing at a single spot in the sky. It is also suggested that the dish be augmented with an omni directional and steerable twin Yagi setup (middle photo) mounted on the steerable configuration pole to allow communication with higher power CubeSats until the system is fully steerable.

The fixed dish will need to be mounted on a concrete base. When converted to be steerable, it is estimated that this will need to be a 16 ton fibreglass concrete slab to allow for the strong winds at NLO. To avoid pouring two slabs, it is proposed that the slab for the fixed installation be substantial enough to support the steerable installation and include its mounting pole.



Directors of NLO have suggested that suitable locations for the dish might be either location B or C in the satellite photograph. Another member of NLO has suggested they might donate their sophisticated microwave system. If this is the case, if one system is installed at B and the other at C it may be possible to synthesise a 100m diameter radio telescope using interferometry techniques.

### Stage 3 (steerable)



The upgrade of the dish to a fully steerable system should result in an installation similar to the photograph at the top of this page although this photograph shows a 7m mesh dish instead of the 5m solid dish that is available.

The shipping container is installed close to the dish to provide an equipment bunker for the equipment that operates the dish. Some of this is obsolete heritage equipment previously owned by the science fiction writer, the rest is modern equipment used for satellite operations and radio astronomy.

The equipment bunker could be configured to have windows in its side to allow members of the public to see how it works and for posters to be mounted on the sides explaining what it is for and its heritage.

The complete installation should end up being approximately the same height and diameter as the existing optical telescopes at the NLO. The dish needs to be sufficiently high off the ground that it can track up to 180 degrees of elevation and 360 degrees of rotation above the tree line and people's heads. It would also be wise to install a small fence to keep people out of the area directly below the dish if experimental radio astronomy equipment is attached to the focal point.

### Science and outreach opportunities

As well as providing an exciting new resource for the NLO Radio and Observing Groups and fulfilling an operational need for the nanosatellite community, the ground station will provide a superb scientific and outreach resource.

UK SEDS ([ukseds.org](http://ukseds.org)) – the national Students for the Exploration and Development of Space organisation, have expressed great interest in using the facility for their own nanosatellite projects, radio astronomy, SETI and other projects. It is expected that members of UK SEDS from the University of Exeter and elsewhere would be available to assist NLO on open days to explain the uses of the facility and demonstrate its operation to members of the public.

In addition to the proposed signage on the equipment bunker, myGroundStations.com also proposes donating a video exhibition system for the main foyer of the NLO for displaying PowerPoint presentations on a loop, explaining what the ground system is for and how it is used. This facility would of course be available for the use of any of the NLO groups to display their own presentations.