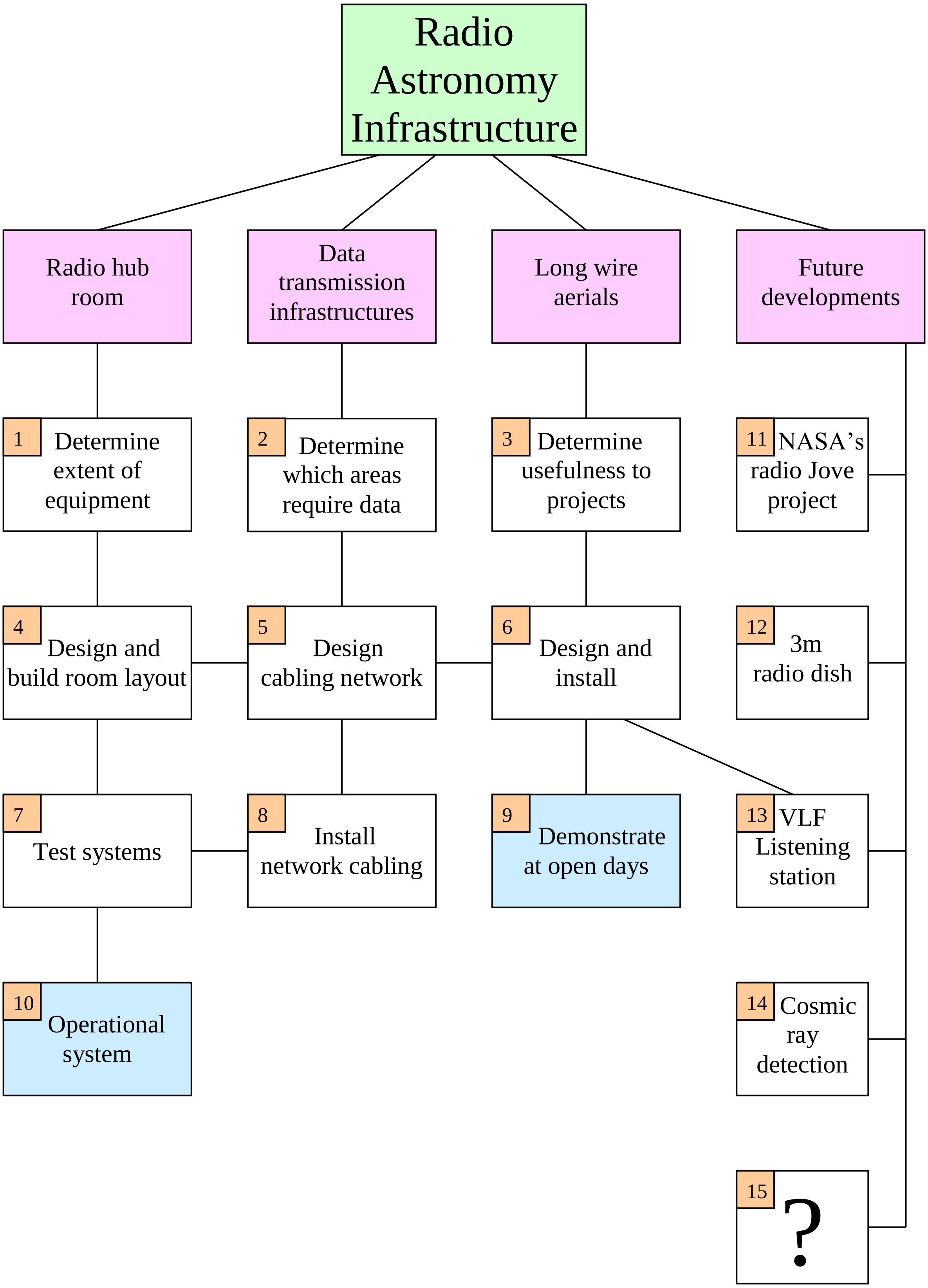
Radio Astronomy - General infrastructure



Key and explanations

Primary project
Project development areas
Completed projects
Stages of development

1. **Determine extent of equipment needed -**
   At the beginning of the RAP the extent of the scope of the project was unclear since we have not done this before. It was therefore decided that out of all the possible divergence of topics that could be developed, we selected two main areas, that of “Meteor detection” and “Solar observation in radio frequencies”. These afforded us the best chance of success since these two radio sources would give us the highest signal strengths.
   The individual projects where analyzed as to what was needed as outlined in other sections of this report.

2. **Determine which areas require data feeds -**
   Much thought went into the planning of this aspect of the project. We had to consider what and where data that we collected could be used productively around the observatory. Things like the uses of demonstrating to the public at open days externally, the uses in lectures in the main lecture room for the members and the public. The position of the main hub for the lowest signal loss across all the projects. The ability to transmit the data over the internet so we can display in real time on our website and on members computers at their home so they can work on the data. And the ability to expand to encompass future projects.

3. **Determine usefulness to project -**

At the onset of the project we came to the conclusion that the general populace of our society (and the general public) had perhaps only a nodding acquaintance of radio and how it works (other then you turn the radio on and listen to it). So it was purposed that a number of workshops would be developed to demonstrate the principles of radio. These are to include the basic layout of the electromagnetic spectrum, how radio waves propagate, the principle workings of aerials, the making of a simple crystal radio and amplifier.

These could also be demonstrated to the general public at open days. So a pair of long wire aerials was decided upon for this purpose.

4. **Design room layout and build -**

It was necessary to house the project somewhere in the main observatory building, and after much discussion it was decided to take over half of the "Inner Sanctum". Existing redundant equipment, shelving and stored items were removed and a layout plan was conceived around existing equipment that needed to remain.

A work station was built consisting of desk to work at, shelving for the computers, receivers and the storage of books and ancillary equipment.

A new clean electrical supply was fed from the local distribution board and a clean earth was built externally from a nest of earth electrodes to reduce interference. The fluorescent light was also removed as this gives off low frequency radio waves which would interfere with the equipment. Incandescent lights were fitted in its place.

Trunking and conduit was also installed for the support of and routing of data cabling in accordance with the needs of the various projects as described under their own sections.

Chair and stool was also acquired along with draw storage containers for the containment of basic components that would be used in the development of project builds.

5. **Design cable network -**

The design of the cable network had to take many variables in to consideration. Not at least taking into account possible local sources of interference. The building structure and position of things had to be taken into account. An example of this is what's called mains hum given off by mains carrying cables so these had to be avoided. Fluorescent light fitting also give off radio waves and so these have to be avoided or removed and incandescent lights fitted in their place.

6. **Design and install long wire aerials -**

Having decided to install along wire aerial system for the use in demonstrations at open days and members workshops, a position had to be found. The first one that was installed went through to the lecture room and then split to form a branch into the radio hub room. This was fine for internal usage but a second one was installed reducing interference, feeding the signals into the covered in area for the use of external open days.

7. **Test systems -**

The wiring for both mains supplies and the data cabling were all tested to the current IEE Wiring Regulations.

The transmission of data to all parts external to the Radio Hub Room was successful.

The SuperSID aerial, receiver and the computer data logging all worked fine and gave good clear results.

The signals received from both Brams and Graves meteor aerials was clean and strong, but it was found that the programs that process the data was incompatible with the computers operating system and so both operating systems and data processing programs were reinstalled with new updates. They now work fine.

8. **Install cable network -**

Once we had a plan in place then it was down to the selection of the type of cables, connection plates, outlet and input points, means of containing cables, the construction of the building materials these were all taken into account.

The type of coax cable and its rating was also much debated and various types were used for different applications.

9. **Demonstration at open days -**

A number of times these have now been successfully used for the demonstration of radio principles to members and the general public. At present only one person is demonstrating this, whereas there needs to be more people to take this on board.

10. **Operational systems -**

We now have basic operational systems in place for Brams (forward scatter), Graves (back scatter) meteor detection, and SuperSID Sudden Ionic Disturbance monitoring and recording in place, but further developments in interpreting data in needed.

We now have an operational video and audio feed directly to the wide screen TV in the main lecture room giving up to 40 people a view of our meteor detection system.

At present there are four of us that know the systems, a wider populace of the membership need to be involved for the project to grow and thrive. Home access for remote viewing is I believe the way forward, as accessing and processing the data becomes a lot simpler for the members.

11. **NASA's Radio Jove project -**

"NASA's Radio Jove project is a hands-on inquiry-based educational project that allows students, teachers and the general public to learn about radio astronomy by building their own radio telescope from an inexpensive kit. The Radio JOVE project began in 1998. Since then, more than 1100 teams of students and interested individuals have purchased our non-profit radio telescope kits and are learning radio astronomy by building and operating a radio telescope".
NASA website quote.

The receiver picks up at a frequency of 20MHz, the Galactic background radiation, solar sun spot bursts /prominences, Jupiter/Io radio emissions.

This would be a good future addition to our solar observational arsenal and would be a natural development into deeper planetary radio observations.

Being a tried and trusted method NASA invite the uploading of observations to their website.

Their kit contains a built and tested Radio JOVE Receiver, RJ Reference CD (RJC), the Educational CD (RJJ), Radio-SkyPipe, and Radio-Jupiter Pro software Licenses. Antenna systems can also be purchased.

12. 3 meter radio telescope -

The 3 meter radio telescope is a dish of 3 meters in diameter, and is about the smallest useful size for picking up deep space radio emissions such as the detection and mapping of the distribution of synchrotron and atomic hydrogen in the Milky Way. Pulsars my also be detected.

By changing the detector, different frequencies and therefore different targets my be detected.

These telescopes can be purchased “off the peg” or can be built using tried and trusted plans. One such set of plans are available off the internet from our old friend Dr David Morgan.

13. V.L.F. listening station -

VLF or Very Low Frequency radio waves are natural occurring phenomena emitted from the Earths own radio sources. There is a project set up by NASA in 1989 and goes under the name INSPIRE. The Inspire kit can be purchased from NASA and is used to pick up frequencies in the range 0 - 10 kHz range. It picks up atmospheric disturbances from such sources as lightning emitting sounds called “***SFERICS***”, “***TWEEKS***” and “***WHISTLERS***”.

The INSPIRE network of observers represents the largest of its type in existence. Past and future observations are designed to add to the scientific understanding of the ionosphere, the magnetosphere and the behaviour of electromagnetic waves.

During times of high geomagnetic activity you can actually hear the Northern Lights (even if it’s cloudy or the skies are too bright!). Therefore, the best time to tune in is night time. You can hear lightning striking the planet almost 24/7.

14. Cosmic ray detection -

Although commonly called cosmic rays the term **"ray"** is a misnomer, as cosmic particles arrive individually as a primary particle, not as a ray or beams of particles. 90% are Protons, 9% helium nuclei, and the remainder electrons or other particles. When these primary particles hit, they do so with such tremendous energy they rip their way into our atmosphere with atom smashing power. These interactions produce an exotic zoo of high energy particles and anti-particles high in the earth's atmosphere. The resulting flux of particles at ground level consists mainly of muons and electrons/positrons still with energies greater than 4GeV travelling at near the speed of light ~0.998c.

As muons have little mass and travel at nearly the speed of light, they do not interact efficiently with other matter. This means they can travel through substantial lengths of matter before being stopped. Consequently, muons are all around us, passing through just about everything. Unfortunately a muon created as a result of Cosmic Rays is not easily seen, but their after-effects when passing through is a little more easier, typically most forms of radiation detectors will do the job. The oldest and most famous example of this is the Cloud chamber. We have one at the Obs but it has not been demonstrated yet as it requires solid dry ice to operate it. This is being organised for a future demonstration.

Other radiation detectors can be used like Geiger Counters, Spark Chambers, Resistive Plate Chambers and materials called Scintillators which give off light when an ionizing particle passes through them.

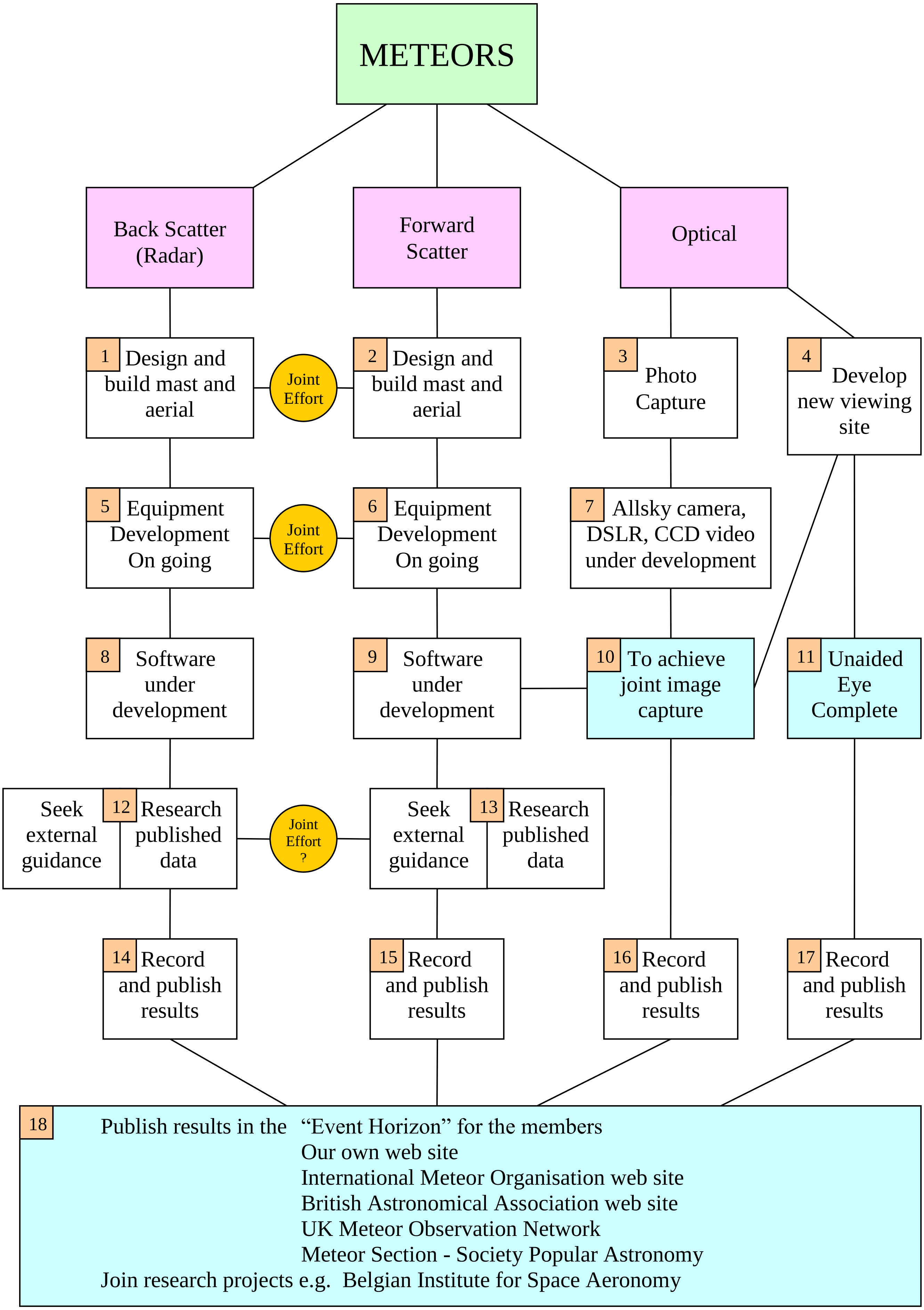
The problem using a radiation detector for a cosmic ray observation is that there are larger amounts of terrestrial radiation as much 73% of background radiation is due to the natural decay of matter. Although in small quantities it is sufficient to make it difficult to discriminate between a terrestrial or cosmic source.

Consequently at least two detectors are needed placed one above the other, feed into electronics that can monitor coincidence between the two detectors quickly thus potentially filtering out most terrestrial radiation.

There are proven designs available over the internet.

15. Future new projects -

Who knows what’s out there - SETI?


METEORS
Back Scatter (Radar)
Forward Scatter
Optical
1 Design and build mast and aerial
Joint Effort
2 Design and build mast and aerial
3 Photo Capture
4 Develop new viewing site
5 Equipment Development On going
Joint Effort
6 Equipment Development On going
7 Allsky camera, DSLR, CCD video under development
8 Software under development
9 Software under development
10 To achieve joint image capture
11 Unaided Eye Complete
Seek external guidance
12 Research published data
Joint Effort ?
Seek external guidance
13 Research published data
14 Record and publish results
15 Record and publish results
16 Record and publish results
17 Record and publish results
18 Publish results in the “Event Horizon” for the members
Our own web site
International Meteor Organisation web site
British Astronomical Association web site
UK Meteor Observation Network
Meteor Section - Society Popular Astronomy
Join research projects e.g. Belgian Institute for Space Aeronomy

Key and explanations

Primary subject under investigation - **Meteors.**

Means of investigation - **Radio** - (Forward and Back scatter) - **Optical.**

Stages of development

1. **Design and build - Mast and Graves Aerial.**

An aerial for the Graves transmitter was constructed from a design found in the Sky and telescope magazine. This was mounted on the original mast under the Brams aerial. This also did not produce any results.

A radio ham was contacted and he came to test the aerial system and found it was working well, so well in fact it could have been used for transmitting a signal. So it was a puzzle as to why we weren't getting any results. A long period of research was conducted and the conclusion was that the mast was not high enough. The aerials needed to be able to see the horizon to be able to pick up a signal and it was found that the dome of the observatory was in the way. So a plan was drawn up to construct a new mast of 12 meters in height, this would give us a 3 meter clearance above the dome and the surrounding trees.

The design work was undertaken and the funds secured for the build. A one piece galvanised steel mast was constructed with two sets of 4 guy ropes secured to 4 anchor points around the roof of the Obs. The mast raised and lowered satisfactorily and was left in position for a period of time to prove its stability.

During this period it was decided that after more research that we would include a band pass filter at the mast head in an attempt to reduce interference from local sources. With the mast lowered and the aerials and mast head equipment fixed in place, the mast was attempted to be raised. Unfortunately with the mast in a horizontal orientation, the mast head equipment was too heavy for it and the mast bent. A new plan was needed.

The mast was split in half, the bottom half of the mast was fixed in place, secured by 4 guy ropes. The top section was replaced with a lighter aluminium pole of 6 meters in length and the antennas, guy ropes etc was attached. A tower scaffold was constructed next to the mast and the top section was raised and successfully secured in place with mast clamps and the guy ropes.

2. **Design and build - Mast and Brams Aerial.**

The original mast was put up some time ago at the end of the covered in area and was attempted to be used at open days without any success.

A radio ham was contacted and he came to test the aerial system and found a problem with the antenna. After much debate and disagreements, some time passed and the decision was made to take the antenna down and rebuild it.

It was decided that it would be prudent to include in the new design a mast head amplified and a band pass filter to filter out local interference and to amplify the very week signal from the Brams transmitter. The equipment was attached and on the second attempt was raised in place successfully.

The same mast was used as for the Graves antenna.

3. **Photo capture.**

It was considered that it would be a worthwhile project to attempt to capture an image of a meteor by using both photographic and radio reflection techniques. So a plan was put together.

4. **Develop new viewing site.**

After the consideration of the layout of the observatory site, the present viewing pad was deemed unsatisfactory for what we were about to attempt since it was surrounded by trees and buildings in the direction of the field of view. The Graves meteor reflections are over the south of France, and so would not be visible from this site. But on the other hand, using the Brams forward scatter technique, the reflections would come from meteors somewhere over the south east England/North Sea. This would put them between 17 - 30 degrees above the horizon as viewed from this site. It became obvious that a greater elevation was needed to see beyond the tree and buildings if this part of the project stood any chance of succeeding. So we looked at developing a viewing site on top of the reservoir. The steps leading to the top of the Res and the Res itself was overgrown and uneven making it a potential tripping risk hazard. We embarked upon a clearing and flattening operation, then installed fencing to contain the safe area, constructed a new hand rail up the steps and tapped off the pathway leading from the steps to the new viewing area. At night this was illuminated using red lights. This area gives us a much clearer view of the horizon.

5. **Graves equipment development.**

A FUNcube dongle was acquired as the receiver, so to were a second-hand computer, mouse, keyboard and monitor also installed in the Radio Hub room, and the hardware tested. Additional video splitter was added and a video and sound feed was installed to the remote TV in the external sheltered area for use at the public open days.

6. **Brams equipment development.**

A FUNcube dongle pro plus was acquired as the receiver, so to were a second-hand computer, mouse, keyboard and monitor also installed in the Radio Hub room, and the hardware tested. Additional receives of a different type were also acquired for use in comparative signal analyzing. Additional video splitter was added and a video and sound feed was installed to the remote TV in the main lecture room for general viewing.

7. **Means of recording image.**

A number of alternatives are possible. First, since we now have a new viewing area, DSLR cameras with time laps capability can be used by individual members in pursuit of photographing meteors and satellites. It was also agreed and funded to purchase and mount on top of the new mast an All Sky camera automatically recording meteors, satellites and cloud formations. If we are fortunate and the conditions are favourable, perhaps aurora as well. Unfortunately the All Sky camera which was purchased from the USA was found faulty and so needs sending back for replacement.

The other area in this field that may be developed is CCD video. If a network were developed then triangulation could be done producing a 3D image giving speed and direction of meteors and what’s more the trajectory can be projected backwards and the orbital path of the meteoroid determined.

Other ammeter astronomers have also attached diffraction gratings to the cameras and have been able to successfully determine the composition of the meteors photographed by spectrographic analysis. The software for this is freely available as shareware over the internet. If this was recorded on our observational computers, then members would be able to access it from the comfort of their own homes.

8. Graves software development.

Once the hardware was checked out, the system was fired up it was found that the operating system on the computers, the meteor capture software and certain hardware were incompatible with each other. New operating systems, meteors capture software, and new driver software was reinstalled. The meteor capture program currently being used is the free shareware program SDR Sharp and is working well. The programs have been sink-tested for well over a week without any unwanted system crashes occurring. What is considered the more complex “industry standard” Spectrum Lab is still under configuration with guidance for the use and setting up being sort from external experienced sources. It was also considered that it would be easier to show and explain to members and the general public at open days, the working of meteor detection using the simpler SDR Sharp program.

Inroads have been made into the remote accessing of the detection computer in the Radio Hub. It is now a distinct possibility that this data can be accessed from a members home. This could get our members more involved with the project.

9. Brams software development.

Once the hardware was checked out, the system was fired up and was found that the operating system on the computers, the meteor capture software and certain hardware were incompatible with each other. New operating systems, meteors capture software, and new driver software was reinstalled. The meteor capture program currently being used is the free SDR Sharp program and is working well. The programs have been sink-tested for well over a week without any unwanted system crashes occurring. What is considered the more complex “industry standard” Spectrum Lab is still under configuration with guidance for the use and setting up being sort from external experienced sources. It was also considered that it would be easier to show and explain to members and the general public at open days, the working of meteor detection using the simpler SDR Sharp program.

Inroads have been made into the remote accessing of the detection computer in the Radio Hub from the newly made observational viewing area on top of the Res. This has now been achieved, and accessing it from a members home is now a distinct possibility. This could get our members more involved with the project.

10. Achieving joint capture.

Now that we have the three things in place to make joint capture possible ie a suitable viewing site, the means to capture photographically and recording the radio echo with synchronised timing, it is now possible to achieve our goal. The only thing we need now is patent persistence and clear skies! At this juncture of the project development, it still requires the human input to be with the equipment while it is running as DSLR cameras and equipment can easily go walkabout if left unattended. A more secure way could be the use of a mast mounted CCTV type equipment, automatically recording images with synchronised timings to the radio detection computer. This would mean that members could take part in the project by using remote observing and then pairing up data in the comfort of their own homes!

11. Unaided eye viewing.

There has always been the ability for anyone to go outside and look up, but it seems to me that a trend is growing for amateur astronomers to be developing the armchair approach to observing. One cannot fault them as cold lonesome nights viewing can some times be a daunting task. The warmth and comfort of their home is a magnet keeping them from going through the door and looking up. In the development of this project I believe that we should recognise this as being a real trait, and make provision for it. The diehards among us will always face the weather knowing that this is “real” astronomy accepting it as being all part of the fun of our hobby.

The concept of “Meteor watch” will I hope bring members together in group viewing sessions that will build a greater involvement in meteor detection as a hole, with a bit of fun competitiveness and camaraderie thrown in for good measure. With the automated recording and live feeds over the internet, members will be able to take part also from, if they wish, the comfort of their own homes. Not only in viewing live feed sessions, but also in processing the data that we collect and in helping to publish the findings.

The continued development of our web site could also afford non members from all over the globe the ability to gain access to the observational records and live feeds.

It was heart warming to have 17 members turn up for the first of our meteor watch program, with 5 more being planed throughout the following year. Many said afterwards how much they enjoyed it.

12. External input. (Graves)

The extent of input from knowledgeable external sources has mainly been limited to what we could fine out researching the internet. Much information was gleamed from the publications by a chap named Dr David Morgan, a member of the BAA and he seems to head up the radio astronomy section of that organisation. His own web site was found and I attempted to contact him through the contact details given, but to no avail. I believe that it is very important to develop relationships with other organisations and people active in this field as a lot of time and effort could be saved by building on others experiences. To this end I have joined the IMO (International Meteor Organisation) which have a long track record in the field of both forward and back scatter meteor detection. These are only the beginning steps in the development of relationships with people in the know. More of our members could help with this if they were willing.

13. External input. (Brams)

BRAMS (Belgian RAdio Meteor Stations) is a network of radio receiving stations using forward scattering techniques to study the meteoroid population. The project is coordinated by the Belgian Institute for Space Aeronomy (BISA), in the frame of the Solar-terrestrial Centre of Excellence (STCE). It is also a very fruitful collaboration between professionals and amateurs since most stations are hosted either by Belgian radio amateurs, groups of amateur astronomers or astronomical public observatories. The transmitter in Belgium is located near Dourbes (South of Belgium) some 325 miles away and transmits at a frequency of 49.97 MHz with a constant power of 150W. Because of the low power it gives off, and the remarkable results that we have attained in these early stages, I decide to try to contact the Project Leader, Hervé Lamy and inform him of what we were attempting to do here in the East Midlands. He replied to my email saying he was always interested in people using their station. Further correspondences have, and continue to take place and I am hopeful in further developing it. He will be a good contact for us.

14. Record and publish results. (Back scatter)

This is a major part in which members can help. The project will produce a large amount of data which will need processing and editing. The result of this would then be passed on to the person collating the data and producing graphs, charts, photos etc ready for publishing.

15. Record and publish results. (Forward scatter)

This is a major part in which members can help. The project will produce a large amount of data which will need processing and editing. The result of this would then be passed on to the person collating the data and producing graphs, charts, photos etc ready for publishing.

16. Record and publish results. (Photographic)

This is a major part in which members can help. The project will produce a large amount of data which will need processing and editing. The result of this would then be passed on to the person collating the data and producing graphs, charts, photos etc ready for publishing.

17. Record and publish results. (Optical)

This is a major part in which members can help. The project will produce a large amount of data which will need processing and editing. The result of this would then be passed on to the person collating the data and producing graphs, charts, photos etc ready for publishing.

18. People/Organisations that may be interested in our results.

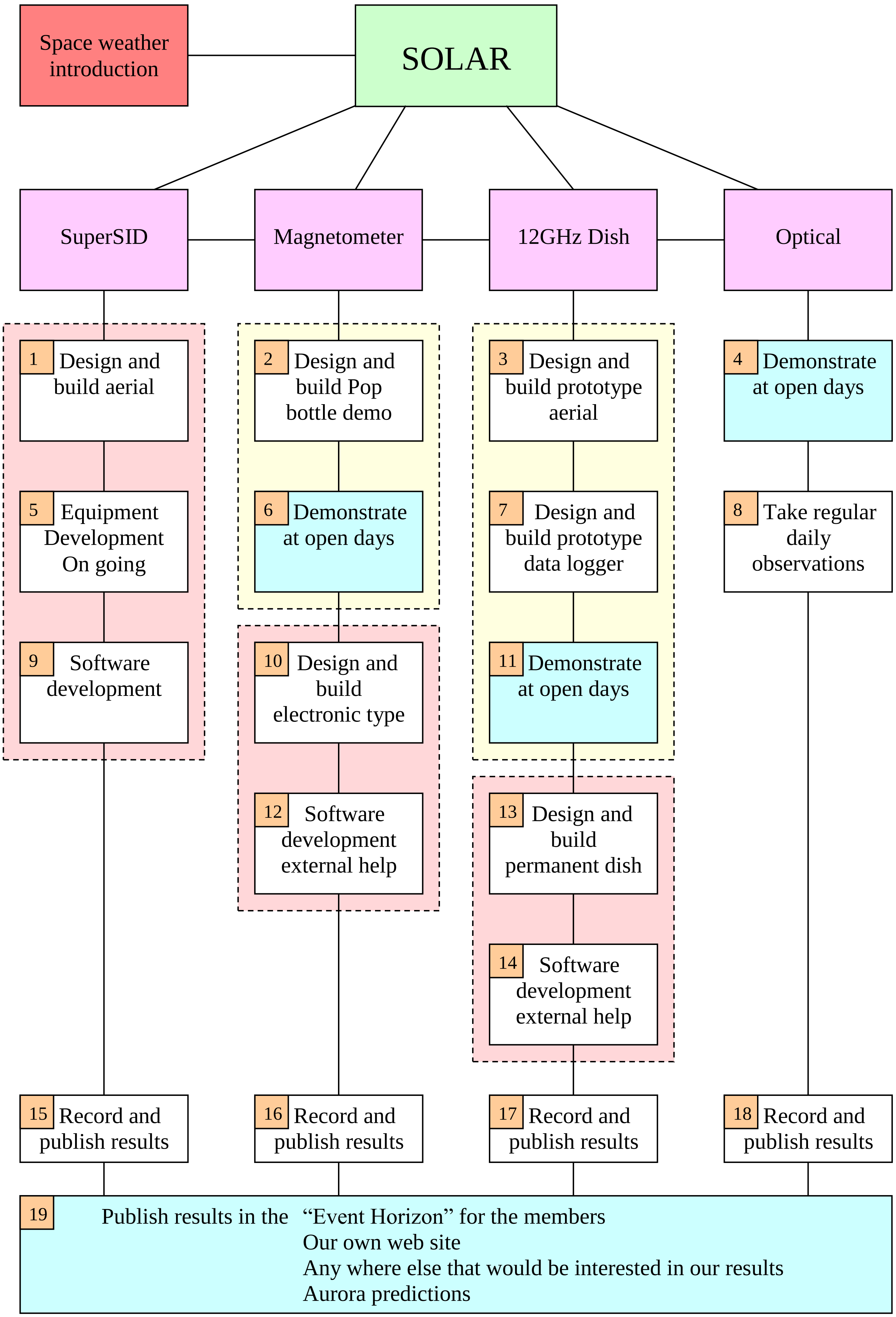
As the overall project has developed during the past 18 months, an awareness has been developing of some of the other organisations and individual people that are working in this field. We have only just scraped the surface of the potential sources of experience and data logging.

Our membership could be a lot more involved in this area in developing communication bonds with other interested parties.

I believe that we need a central person to crystallise the data that our membership has processed, to display it in a format that is both informative and useful to ourselves and other organisations. Discussions could be started with other groups and combined results could be published on our web site and EH, and incorporated into other people’s data.

I believe that an exciting time lies ahead for us at Sherwood Observatory if we get this right.

Radio Astronomy - Solar project development



Key and explanations

Primary subject under investigation - **Solar**

Means of investigation - **SuperSID - Magnetometer - 21GHz Dish - Optical**

Prototype development

Permanent fixed equipment developed at the Obs

Completed project

Stages of development

Introduction - Space weather

We have heard a lot of the term “Space Weather” used recently, but what does it mean?

Wikipedia define **Space weather** as “a branch of space physics and aeronomy concerned with the time varying conditions within the Solar System, including the solar wind, emphasizing the space surrounding the Earth, including conditions in the magnetosphere, ionosphere and thermosphere”.

The term **Space weather** was first used in the 1950s and came into common usage in the 1990s. Its focus in the main part is on what the Sun is up to and how that is affecting us in space and here on the earth. Other contributing factor to Space weather is the extent of inbound **Galactic Cosmic Rays** ("**GCR**").

As we populate the space that surrounds us with satellites, the effect of **space weather** becomes more acute. As examples of this, 46 of the 70 space craft failures reported in 2003 occurred during the October 2003 **geomagnetic storm**. The two most common adverse space weather effects on spacecraft are radiation damage and spacecraft charging. Higher UV emitted radiation given off during solar disturbances e.g. **coronal mass ejection** (**CME**) heat the earth’s atmosphere causing it to expand. The orbits of spacecraft in low Earth orbit (LEO) decay to lower and lower altitudes due to the resistance from the friction between the spacecraft's surface (*i.e.*, drag) and the outer layer of the Earth's atmosphere. Eventually, a LEO spacecraft falls out of orbit and towards the Earth's surface. Many spacecraft launched in the past couple of decades have the ability to fire a small rocket to manage their orbits.

Other effects include the energization of the Van Allen radiation belts, Ionospheric disturbances and scintillation of satellite-to-ground radio signals and long-range radar signals, aurora and geomagnetically induced currents at the earth’s surface. Space weather phenomena can cause damaging surges in long distance transmission lines and expose passengers and crew of aircraft travel to radiation, especially on polar routes. An example of this was the magnetic storm of March 1989. It caused the complete collapse of the Hydro-Québec electric-power grid in Canada, temporarily leaving nine million people without electricity.

So whether we like it or not, Space weather is here to stay. Here at Sherwood Observatory as part of the growing interest in radio astronomy, it was considered an interesting idea to include the observation of the sun and aeronomy under that banner.

The 3 current investigative projects underway are:-

- **SuperSID** - The investigation of Sudden Ionospheric Disturbances using the perturbations of the reflective D layer in the ionosphere.
- **Magnetometer** - The measurement of the change in local magnetic field strength and direction due to the induced magnetic fields by solar radiation in the upper atmosphere. This is only a demonstration model used at present for open days. A permanent electronic observatory based one is hoped for the future.
- **12 GHz satellite dish** - A direct measurement of the radiation given off by the sun in its Chromosphere. This is only a demonstration model used at present for open days. A permanent electronic observatory based one is hoped for the future.

Other solar observing techniques that could be developed include;-

- **Radio Jove** - A NASA produced receiver to study the sun and the Jovian system at 20 MHz frequency.
- **INSPIRE project** - A NASA produced VLF receiver tuned to the 0 - 10 kHz used to listen to the low frequency emissions of the earth produced in the atmosphere.
- **Cosmic ray effects** - A receiver to detect muons produced by incoming high energy cosmic partials.

1, Design and build - Aerial.

The design of this aerial was adapted from different designs displayed in the Stanford Solar centre web site. It is what is called a “wire-loop antenna” and it appears that at this long wavelength that we will be picking up; the overall design didn’t matter too much so long as it was more then 120m in length. We decided to build a 2m diameter 8 sided frame. The larger the diameter and the more turns of wire used makes it more sensitive. We used a total length of 200m and found it very sensitive. We had to use a non magnetic, non metallic material to make the frame, and the installation of the antenna should not be allowed to touch the ground or any metal object.

The antenna was mounted on top of the observatory roof were it remains today. Cable from the antenna makes its way into the Radio Hub room below.

2. Design and build - Pop bottle demo

The impetus to build a magnetometer came from reading an article in the Aurora Watch UK web site. It is used a lot in the classroom environment showing students perturbations in the local magnetic field lines due to hi energy UV and X-rays inducing electric flows high in our atmosphere. These emanate from Coronal Mass Ejections from the sun. Because the radiation is travelling at near the speed of light, the magnetometer is able to detect these in real time indicating an event happening on the sun. The slower more massive charged partials travelling at a much slower rate, can take one or two days to get to us. When they arrive our magnetosphere sweeps them up and directs them down into our atmosphere at the poles causing the Aurora. So the magnetometer can act as an early warning of Aurora activity.

Father investigations found other sites displaying similar ideas.

Our magnetometer is made from a clear 2 litre water bottle. The top 1/3 was cut off for access, some sand put in the bottom for stability and a 50mm long, 6mm diameter neodymium magnet sort. A length of cotton was securely attached to the centre of the magnet, and a 50mm square piece of paper was sellotaped to the magnet. This acts as a damper and further more a sequin was stuck to the middle of the paper this is to act as a mirror.

A low power laser pen was acquired and a stand made for it such as to allow the laser light to shine on the sequin and reflect out of the pop bottle onto a target board with equidistant markings on it. The target board needed to be at least 1meter away for it to be sensitive enough to detect any magnetic perturbations.

It works well as a demonstration tool at open days. Members could get involved with this.

3. Design and build - Aerial

I was reading and article on the BAA website regarding building your own simple radio telescope using an ordinary satellite dish. The principle was simple. The sun emits radiation across a wide range of frequencies, from 100 GHz in the Photosphere, through 1.4 GHz at the top of the Chromosphere to 0.1 GHz in the Corona. So some where in the middle of the Chromosphere it's giving off 12GHz and 12GHz is the microwave frequency of a satellite dish. So by simply attaching a satellite finder to the dish and then pointing it at the sun, you can pick up a signal from the sun.

An 800mm diameter dish was acquired along with cable, a satellite finder and an old second hand power supply from a rechargeable torch; this was simply put together and mounted on its floor standing tripod. A way of safely targeting the sun was devised and when we pointed it at the sun we had an increase in signal strength above that of the background radiation. We also found that human beings give off that frequency of radiation as well.

A drift scan of the sun was proposed, and the dish lined up. It took a number of attempts before we got the sun to track diagonally across the detector (LNB) as each time we had to wait for the sun to move enough. The drift scan was a success but we had no way of recording the results. We also had a problem with the stand that came with the dish. Because it was not meant to be moved when set up, and because satellites do not go as high in the sky as the sun does, it meant adjusting nuts and bolts and pivoting the tripod on bricks to get it to point high enough. So a change of supporting stand was needed. I opted for using an equatorial mount with the addition of a Dovetail mounting plate, an angled tube to mount the plate and clamp the dish to. We needed to have made a balancing arm that we could attach to the tube and slide a weight up and down to counter balance the weight of the dish. This done the dish was a dream in targeting the sun. But there was still the problem of recording data. This was solved by purchasing a voltage data logger. The satellite finder was hacked and an output feed was taken directly off the meter and fed into the data logger. This worked but the output at full scale deflection (FSD) was only 0.6 volt, and the logger is 10v FSD. So the display is only tiny. A way of increasing the output of the meter to a FSD of at least 6 volt needs to be found. This will make the system much more accurate.

This is a great tool for demonstrating radio astronomy at open days and has been successfully used on a number of occasions. This would be a great way of getting members involved in the project.

4. Demonstrate at open days

Solar days have always been apart of the yearly observational open day planning. Whether for solar eclipses, transits or just a solar open day in the summer the public have always been interested in what's happening with our local star. It's great to see the sun spot activity on a clear day, or look through the Hydrogen Alpha telescope at the myriad of bubbling granulations. Its not just open days at the Obs, we take the show on the road conducting outreach events such as village fates, county shows and school visits. All promote our hobby to the local people. But some times it rains or is over cast, what then. Radio astronomy comes into its own on those occasions. Radio sees through clouds, rain and bright sunshine. It has proved its worth on a number of times now. Optical astronomy doesn't have to be apart from Radio; many times what you see in the visible spectrum can also be detected in the radio frequencies. This would be a good goal to go for, and one in which our membership can their hands dirty in doing. The prediction of Aurora is some thing that is possible using the techniques outlined in this paper. It is possible to photograph the sunspot activity associated with results that we attain from our other data sources.

5. Equipment development

A new receiver was purchased from the Stanford Solar Center in the USA, a second hand computer, mouse, keyboard and screen was acquired and installed in the Radio hub room. The equipment switched on and tested out.

6. Demonstrate at open days

The Magnetometer has been set up at numerous open days and I have demonstrated it successfully. More of our members could demonstrate this piece of equipment, its simple and the physics behind it is straight forward.

7. Design and build - Data logger

The Data Logger was purchased off the shelf from an educational supplier. The software for the device installed and readings taken. It was found the device worked very well, but the output from the detector was only low so the results of the graph produced are only 1/10 of the spread that could be achieved. What needs to happed is a voltage multiplier needs introducing into the circuit to boost the signal. This is being sort at present.

8. Daily observations

This is some thing that I would hope the membership would get involved with when the weather is favourable. It would be good to attempt to combine the results of the radio with optical observations. There is a lot the membership could do along these lines.

9. Software development.

The SuperSID setup is supplied complete by the Stanford Solar Center in the USA. The only part the observer needs to do in this respect is to configure the software for the area in which it is being used. Most of the transmitters around the world that we can pick up have been identified. An extensive research into the distortion effects caused by local interference have been identified and eliminated. The results that we have been getting have been very clear. What I would hope now is the membership to come onboard and sift through the results comparing it to known data produced by the GOES (**Geostationary Operational Environmental Satellite)** system which is freely available over the internet.

10. Design, build and install - electronic Magnetometer

The design and build of a fully functional electronic magnetometer has already been carried out by the UK Radio Astronomy Association (UKRAA), the business arm of the British Astronomical Association (BAA). The equipment is available to order over the internet along with the leads for connecting to a monitoring computer. Details of how to install the unit will come with the kit.

11. Demonstrate at open days

The dish is simple to erect, exactly the same as an equatorial mounted optical telescope. The safe targeting of the scope is straight forward, as is the demonstrating of it. It shows the enquirer that the sun gives off light in radio frequencies and that people also give off radiation.

This is an area that the membership can get involved with now.

12. Software development

The UKRAA have free shareware software on their website for downloading.

13. Design build and install - permanent dish

Having built up experience in the development of a portable dish, the step to building a permanent Observatory based 12 GHz radio telescope is not beyond our ability and would be a great project for the membership to get involved with. The main concepts are proven; the main area of development needed is the support of the dish and the synchronised driving of it. Much work and experience has already been gained in this area since our main optical 605mm Newtonian telescope has undergone many drive and tracking updates in its life time. It now has a fully functional “go to” system, much the same would in my opinion be needed for the 12 GHz project.

The mounting of the dish would need to be positioned at the end of the covered in area since a clear view of the sun is required 365 days a year.

14. Software development - with external help

The drive systems I have already described in an earlier section are freely available since they are already in use at the Obs. The data logging is a simple monitoring of voltage and a interface to a computer could easily be accomplished.

The monitoring of that voltage by some sort of program on the computer would need to be looked into.

15. Record and publish results (SuperSID)

This is a major part in which members can help. The project will produce a large amount of data which will need processing and editing. The result of this would then be passed on to the person collating the data and producing graphs, charts, photos etc ready for publishing.

16. Record and publish results. (Magnetometer)

This is a major part in which members can help. The project will produce a large amount of data which will need processing and editing. The result of this would then be passed on to the person collating the data and producing graphs, charts, photos etc ready for publishing.

17. Record and publish results. (21 GHz Dish)

This is a major part in which members can help. The project will produce a large amount of data which will need processing and editing. The result of this would then be passed on to the person collating the data and producing graphs, charts, photos etc ready for publishing.

18. Record and publish results (Optical)

This is a major part in which members can help. The project will produce a large amount of data which will need processing and editing. The result of this would then be passed on to the person collating the data and producing graphs, charts, photos etc ready for publishing.

19. People/Organizations that may be interested in our results

As the overall project has developed during the past 18 months, an awareness has been developing of some of the other organisations and individual people that are working in this field. We have only just scraped the surface of the potential sources of experience and data logging.

Our membership could be a lot more involved in this area in developing communication bonds with other interested parties.

I believe that we need a central person to crystallise the data that our membership has processed, to display it in a format that is both informative and useful to ourselves and other organisations. Discussions could be started with other groups and combined results could be published on our web site and EH, and incorporated into other people's data.

I believe that an exciting time lies ahead for us at Sherwood Observatory if we get this right.