AUSTRALIAN NATIONAL UNIVERSITY

System Design Note 02.05

# SKYMAPPER CRITICAL DESIGN REVIEW

# OVERALL SKYMAPPER OBSERVATORY OPERATIONAL CONCEPT DEFINITION DOCUMENT

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**Revision History**

| Revision No. | Author & Date | Approval & Date | Description |
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**Contents**

# 1 Purpose

This document describes the normal automated operation of the SkyMapper Observatory from the Science Scheduler to the Observatory Control system, through the acquisition of CCD Images, to processing via the Science Data Pipeline and the publishing of results on the Internet.

This document also describes normal calibration procedures, fault modes, remote and local fault sensing and remote and local fault recovery.

# 2 Applicable Documents

| Document ID | Source | Title |
|---|---|---|
| 201-00-002 | RSAA | SkyMapper System Overview Schematic |
| SDN02.02 | RSAA | Imager Filters |
| SDN03.06 | RSAA | Chilled Water System |
| SDN03.10 | RSAA | SkyMapper Cassegrain Imager Overview |
| SDN04.01 | RSAA | SkyMapper Components Control System |
| SDN05.01 | RSAA | SkyMapper Software Control System |
| SDN07.04 | RSAA | The SkyMapper Imager Detector Science Mosaic |
| SDN08.01 | RSAA | SkyMapper Science Requirements |
| SDN08.02 | RSAA | SkyMapper Science Data Pipeline & Scheduler System |
| TS-07590-2 | EOS | EOS Technical Specification - SkyMapper 6.5m Telescope Enclosure |
| TS-07591-2 | EOS | EOS Technical Specification - SkyMapper 1.3m Wide-Field Telescope |

# 3 List of Acronyms

| | |
|---|---|
| ANU | Australian National University |
| ANUSF | ANU Super Computing Facility |
| API | Application Programming Interface |
| CAN | Controller Area Network |
| CCD | Charger Coupled Device |
| CDR | Critical Design Review |
| EOS | Electro Optics Systems |
| LAN | Local Area Network |
| PC | Personal Computer |
| RSAA | Research School of Astronomy and Astrophysics |
| SDN | System Design Note |
| S-H | Shack-Hartmann |
| SOAP | Simple Object Access Protocol |
| SSO | Siding Spring Observatory |
| TAROS | Telescope Automation Remote Observatory System |
| TCS | Telescope Control System |
| THuD | Temperature, Humidity and Dewpoint |
| UPS | Uninterruptible Power Supply |
| VESDA | Very Early Smoke Detection Apparatus |
| WPCCC | Windows PC Client Computer |
| WWW | World Wide Web |
| XML | Extensible Mark-up Language |

# 4 Automated Observing Routine

The SkyMapper Observatory will run in a fully automated manner. There will not normally be a local or remote observer. The SkyMapper enclosure will open and the telescope and Imager instrument will commence observations each evening governed by a scheduler system. The enclosure will close at dawn. Should the weather deteriorate the telescope enclosure will close when commanded by an array of humidity, rain or wind sensors, the telescope and Imager will then wait in readiness and, should the weather clear, the enclosure will re-open after a preset interval and observations will resume until the pre-programmed dawn closure. This sequence of opening, observing, and then closing may occur several times per night.

## *4.1 Daytime Preparation for Observing*

### *4.1.1 Enclosure Environment Preparation*

Preparation of the SkyMapper enclosure for observing will automatically begin soon after the dawn each day. The master computer in the enclosure will link to the Bureau of Metrology, obtain a prediction for the coming night-time temperature at Siding Spring, and set the temperature control system for the enclosure observing space (Level 3). Air handling units will begin operation as soon as the enclosure shutters and vents close and these will keep the telescope and observing space cool during the normally hot day. These units will also de-humidify the air and keep the telescope and observing space dry. For further information see TS-07590-2 EOS Technical Specification – SkyMapper 6.5m Telescope Enclosure, SDN03.06 Chilled Water System and additional CDR documentation.

### *4.1.2 Observing Scheduler System*

The SkyMapper Scheduler System, hosted on a computer in the equipment room (PC Linux), will maintain an optimised list of field centres for the coming night's observing. During the night the Scheduler will automatically select from this list the most opportune 5-Sec or Main Survey field centre to observe in real time at the telescope. There will not normally be any human intervention in this object selection process. For further information see SDN08.02 SkyMapper Science Data Pipeline and Scheduler System.

## *4.2 Night-time Automated Observing*

### *4.2.1 Acquisition of Dusk Bias & Dome Flatfield Calibration Data*

At dusk (sunset + 10 mins), the Scheduler will initiate the automatic acquisition of dusk calibration data. This automated routine it will obtain a number of bias frames. It will then open the primary mirror covers, point the telescope at a white panel on the lower half of the lower shutter that is illuminated by Halogen lamps, and obtain dome flatfields through each filter in the Imager Instrument.

### *4.2.2 Preparing the Enclosure*

At twilight (civil twilight – 10 mins), the observatory control computer will read data from the external weather station. If the rain sensor does not signal rain and the humidity is below preset values, then the control system will clear the enclosure to open and will close down the air handling units in the observing space. The control system will then read the wind direction and velocity from the weather station and will open the enclosure shutter and vents. The vents and shutter are servo controlled and will open to preset angles and directions that are derived from a look up table that is wind velocity and direction dependant. If the wind velocity is below ~5m/s all the vents and shutters will fully open. If the velocity is higher, the dome shutters will move in aperture tracking mode with the telescope altitude and the dome vents will be opened selectively on the downwind side of the enclosure. For further information see TS-07590-2 Technical Specification – SkyMapper 6.5m Telescope Enclosure and additional documentation.

### *4.2.3 Preparing the Telescope*

Once the enclosure is open the observatory control computer will clear the telescope control computer to slew the telescope and enclosure to a suitable field for twilight flatfields. For further information see TS-07591-2 EOS Technical Specification - SkyMapper 1.3m Wide-Field Telescope and additional documentation.

### *4.2.4 Preparing the Imager*

While the telescope is slewing, the Imager servo system will simultaneously configure the filters and slides inside the Imager for twilight flatfields. For further information see SDN03.10 SkyMapper Cassegrain Imager Overview & SDN07.04 The SkyMapper Imager Detector Science Mosaic.

### *4.2.5 Acquisition of Dusk Twilight Flatfields*

The Scheduler will then attempt to gather twilight flatfields in each filter starting from the bluest to reddest with exposure times determined from the time after civil twilight. Twilight flatfields will be obtained for exposure times longer than 0.5 secs until such time as either 5 have been obtained in each filter or the required exposure times become too long.

### *4.2.6 Focusing Sequence*

At dark (astronomical twilight - 10 mins), a focusing sequence will be conducted. This consists of acquiring a suitable focusing area containing a number of suitable stars and then applying an averaging algorithm based on the suitable stars in the field of view to determine the focus. The necessary control and data reduction for this automated process will be handled by the master computer (TAROS/CICADA).

### *4.2.7 Automated Shack-Hartmann Focusing*

An automated Shack-Hartmann (S-H) focusing system will be implemented some time after telescope commissioning. Once operational, this system will focus the telescope by using the Imager mounted S-H system. This system will take S-H images, reduce these images, extract the focus component and re-focus the telescope via the secondary mirror. The S-H system shades only one third of the mosaic and images will be simultaneously taken by the mosaic and inspected for focus, particularly in the corners of the mosaic. Data from these will be fed back to this focusing routine. For further information see SDN04.01 SkyMapper Components Control System.

### *4.2.8 Acquiring Southern Sky Survey CCD Images*

Shortly after astronomical twilight, the SkyMapper observatory will begin the routine task of acquiring images for the Southern Sky Survey. The master computer will take the suggested field centre from the Scheduler, slew the telescope to this position, insert the scheduled filter, expose for the scheduled time then read and store the CCD mosaic data. Long and short exposures through different filters may be scheduled one after another as commanded by the Scheduler.

Sky conditions are monitored by the on-site Scheduler System which performs a series of quality control checks on the data. For each image the photometric zeropoint is determined (this equates to sky transparency). Rapidly fluctuating zeropoints or zeropoints less than the nominal range indicate the presence of cloud. The 5-Sec Survey can only continue under photometric conditions – if conditions become non-photometric during the night the operation mode will switch from 5-Sec to Main Survey. The Main Survey can continue under uniform diminished transparency such as might occur with cirrus. If the transparency drops below a threshold, then the data is flagged as poor quality and the field is available for rescheduling. Under solid cloud, the telescope would attempt to obtain the highest ranked Main Survey field throughout the night without success. At present, we do not input information regarding the spatial distribution of cloud (such as could be obtained with an all-sky optical or IR camera) into the scheduling.

Another critical aspect of image quality, the seeing, is also monitored by the Scheduler System. Only the Main Survey has a seeing limit. If this limit is exceeded and the conditions are photometric then the 5-Sec Survey is pursued or else the data is flagged poor quality and rescheduled as in the case of cloud discussed above. For more information see SDN08.02 SkyMapper Science Data Pipeline & Scheduler System.

Data taking will continue in this manner until the start of morning astronomical twilight. On long winter nights the Imager may make 1000 filter changes and acquire ~1000 images. For further information see SDN08.01SkyMapper Science Requirements & SDN05.01 SkyMapper Software Control System, SDN02.02 Imager Filters.

### *4.2.9 Automated Autoguiding*

Automated autoguiding will be implemented on the SkyMapper Imager some time after telescope commissioning. This system will expose immediately after telescope slew, find the brightest, non-saturated star in the field, test that it is a suitable distance in from the edge of the detector, and then begin autoguiding the telescope. If no suitable guide star is found in an initial exposure, then the system will double the exposure time to preset limits. For further information see SDN03.10 SkyMapper Cassegrain Imager Overview.

### *4.2.10 Watchdog Timers*

Watchdog timers will run on the master, observatory control, and telescope control computers and will close the enclosure if no new field centre is commanded from the scheduler, if no data returns from the mosaic, if the telescope does not respond to slew commands or if the weather station sensors do not respond. For further information see SDN05.01 SkyMapper Software Control System.

### *4.2.11 Acquisition of Dawn Twilight Flatfields*

At twilight (morning civil twilight – 10 min), the Scheduler will attempt to gather twilight flatfields in each filter starting from the reddest to bluest with exposure times determined from the time after astronomical twilight. Twilight flatfields will be obtained for exposure times longer than 0.5 secs, until such time as 5 have been obtained in each filter on this night.

#### *4.2.12 Automatic Dome Closure*

At dawn (morning civil twilight + 10 mins), the telescope will be driven to park position and the dome shutters and enclosure vents closed. Air handling units in the observing space will now commence operation and prepare the telescope for the next nights observing.

#### *4.2.13 Acquisition of Dawn Dome Flatfield & Bias Calibration Data*

After the dawn dome closure, the Scheduler will initiate the automatic acquisition of dawn calibration data. This automated routine will point the telescope at a white panel on the lower half of the lower shutter that is illuminated by Halogen lamps and obtain dome flatfields through each filter. The routine will then close the primary mirror covers, obtain a number of bias frames, and then park the telescope.

## *4.3 Automated Image Data Handling*

### *4.3.1 Transferring data to the Slave Computer*

A slave or pair of slaves to the master computer will control the mosaic CCD controllers, open and close the Bonn shutter, read the mosaic, buffer the data, perform some data validation, then transfer the data to mass storage (RAID). The slave(s) will be running the CICADA software system. For further information see SDN05.01 SkyMapper Software Control System

### *4.3.2 SSO Data Mass Storage*

The data mass storage system (RAID) is located in the SkyMapper enclosure and will store all of the mosaic data, until it is transferred to the ANU supercomputing facility (ANUSF). This mass storage system will erase the local data only after it has been validated at the ANUSF. The SkyMapper mosaic can produce 700 GB of data per night. For further information see SDN05.01 SkyMapper Software Control System

### *4.3.3 Data transfer to ANUSF*

The large volumes of data produced by SkyMapper will be trickled back to ANU-Supercomputing Facility over a gigabit link from SSO to ANUSF.

## *4.4 Automated Pipeline Data Handling*

### *4.4.1 The Science Data Pipeline*

The Science Data Pipeline will run at the ANU Supercomputing Facility in Canberra. The pipeline will take raw image data from the observatory and produce and apply the required calibration data. Depending on the observation mode, the data will proceed through either the 5-Sec or the Main Survey branch of the pipeline. Quality control checks are performed during processing and data that fails is marked for reobservation. For further information see SDN08.02 SkyMapper Science Data Pipeline & Scheduler System.

Following pipeline reduction, the Southern Sky Survey scientific results will be available to the astronomical community via an image server and a data server accessible via the Internet. It is our intent to provide a web service (i.e. essentially a web API) utilising SOAP (http://WWW.w3.org/TR/SOAP/) , XML Remote Procedure Call (http://WWW.xmlrpc.com). This will ensure maximum integration into the Virtual Observatory effort. For further information see SDN08.01 SkyMapper Science Requirements.

# 5 Automated Close, Shut Down, & Emergency Modes

The SkyMapper enclosure will close, or be prevented from opening, after scheduled commencement of observations by an array of weather sensors located inside and outside the enclosure. Should mains power fail, there will be sufficient power stored in the enclosure UPS to safely close the enclosure shutters and vents.

## 5.1 Primary Enclosure Rain Sensors.

### 5.1.1 Enclosure External Rain Sensor

This external VAISALA capacitive rain sensor will be the primary rain sensor for the SkyMapper observatory. The prevailing rain direction at SSO is from the north-west sector and this sensor will be carried on a 1m long boom that protrudes horizontally towards the north-west from the enclosure wall and about 6m above the ground. This rain sensor provides immediate switch closure on detection of droplet precipitation. A small heater dries the sensor when precipitation ceases. This sensor is directly wired to the enclosure CANbus (Controller Area Network) and signals to the enclosure control servo system via the most closely coupled loop, avoiding the observatory or TCS computers. This sensor and the telescope mounted rain sensor will also close the telescope mirror covers though a link through both the observatory and telescope control computers. The onset of rain *is not* an emergency situation and the CANbus will be programmed to simply close the enclosure and wait for the precipitation to clear.

### 5.1.2 Telescope Mounted Internal Rain Sensor

This internal VAISALA capacitive rain sensor is the secondary rain sensor for the SkyMapper observatory. This sensor is carried on one edge of the telescope tube secondary mirror ring frame. The sensor tilts as the telescope slews from zenith to horizon and is mounted so that it presents the maximum area to falling rain. This sensor will peer-out under the party closed dome shutters in poor weather and will sense condensate blowing off the dome that may fall onto the primary mirror. This sensor is protected from the daytime sun which is thought to slowly degrade the performance of capacitive sensors. This rain sensor provides immediate switch closure on detection of droplet precipitation. This sensor is directly wired to the enclosure CANbus and signals to the enclosure control servo system via the most closely coupled loop. The incidence of rain *is not* an emergency situation and the CANbus will be programmed to simply close the enclosure and wait for external rain sensors to show that precipitation has cleared.

These two primary rain sensors will be regularly cleaned and tested by SSO site staff.

## 5.2 Enclosure Temperature and Humidity Sensors

### 5.2.1 Observing space Temperature and Humidity Sensors

Two internally mounted THuD sensors (Temperature Humidity & Dewpoint) will be mounted in the observing space L3 and the service level L3, with provision to mount more if required. These sensors are connected to the enclosure CANbus and will control the daytime thermal preparation of the enclosure via the air handling units and will close the enclosure if very high humidity is sensed during observing.

### 5.2.2 Equipment Room Temperature and Humidity Sensors

One internally mounted THuD sensor (Temperature Humidity & Dewpoint) will be mounted in the L1 equipment room, with provision to mount more if required. This sensor is connected to the enclosure CANbus and will control the temperature of the equipment room via the air handling units. The equipment room hosts the observatory's six computers and all of the servosystems. Cooling is essential and this THuD sensor will alert the TCS to send warning email and SMS messages to site staff if the enclosure temperature should run over specified temperature limits and then close down all observatory systems.

## 5.3 The Mets Mast Weather Sensors

The Mets mast is a 2.5m high steel structure located ~15m west of the SkyMapper enclosure and on the very crest of the Siding Spring Mountain. This mast will carry a lighting air terminal and a VAISALA Weather Transmitter. This transmitter will send full weather data directly to the enclosure control computer via a dedicated link every 10 seconds. One entire data string from this weather transmitter will be written to the FITS header of every image taken by the telescope.

### *5.3.1 Acoustic Rain and Hail Sensor*

The acoustic rain and hail sensor records rain, rain rate, and hail fall by counting each drop. This sensor will cause the enclosure shutters and vents to close, though the latency period is ~10s and the coupling path through the enclosure computer is probably less reliable than that through the CANbus. This sensor will close the enclosure in the event of hail fall from an otherwise dry sky and this does happen occasionally at Siding Spring, the primary rain sensors on the enclosure will not do this.

### *5.3.2 External Temperature Sensor*

The external temperature sensor in the weather transmitter will be the primary temperature sensor for SkyMapper. This data will be written to all FITS image files.

### *5.3.3 External Humidity Sensor*

The external humidity sensor in the weather transmitter will be the primary humidity sensor for SkyMapper. This sensor will close the enclosure shutters and vents when the relative humidity exceeds ~90% and will override the THuD sensors located inside the enclosure should they read lower values of humidity.

### *5.3.4 Wind Velocity and Direction Sensor*

The wind velocity and direction sensor in the VAISALA weather station uses acoustic Doppler techniques to measure velocity and direction without moving parts. This sensor will close the enclosure shutters and vents when the wind velocity exceeds ~15m/s.

## ***5.4 Mains Power Failure Modes***

Mains power to Siding Spring observatory is supplied by Country Energy Ltd and power failure at Siding Spring is infrequent during winter, perhaps every 60 to 90 days but more common during summer storms, perhaps every 7 days. To supplement this, RSAA maintains a large diesel generator that provides mountain top emergency power. This is complemented by two UPS power supplies that will be fitted in the SkyMapper enclosure equipment room. The SkyMapper observatory will use both of these emergency supplies during mains power failure.

### *5.4.1 Short Term Power Failure*

During a power failure of less than 10 seconds the SkyMapper enclosure will remain open, the telescope will stop tracking, and the enclosure and telescope control computers will run on UPS power. The Imager instrument CCD controllers, master and slave computers and LAN router will draw power from UPS power supplies, close the Imager shutter, and read any data from the mosaic. The Helium compressor and water chillers will stop, but the mosaic temperature will rise only by a small amount and data should still be valid. When mains power returns, the helium compressor and water chillers will start and observations will continue. If the power failure exceeds 10 seconds the diesel generator will start and normally restores power in less than 30 seconds. The SkyMapper control system will then see diesel power as mains power, the Helium compressor and water chillers will start, the CCD controller will wait for the mosaic temperature to stabilise, and observations will continue. The observatory control computer, weather sensors, the CANbus, and the enclosure servo system will remain under UPS power and can react to adverse weather and close the enclosure shutters and vents if necessary. Returning from diesel power to Country Energy power requires manual intervention see below.

### 5.4.2 Long Term Power Failure

If a mains power failure of more than 60 seconds occurs then the diesel generator has failed to start, or emergency switchgear or wiring has failed, this has occurred only once in the last eight years. When a power failure extends beyond 90 seconds, the observatory control computer will, under UPS power, close the enclosure shutters and vents, and close down the telescope servo system and telescope control computer. The Water chillers, pumps and air handling units will have stopped, heat will no longer be removed from the enclosure and most electronic systems will need to be shut down within 12 minutes. In this event the master computer will shut down all systems except the LAN router, and will then shut itself down to a "Wake on LAN" condition. In this condition, the dry air system will continue to flush the mosaic window from air stored in a receiver of the dry air compressor, when this receiver runs low a pneumatic slide valve will source dry Nitrogen from a bottle in the equipment room. This air system should flush for ~8 hours, by then the mosaic will have reached ambient temperature and will no longer need flushing.

The present restoration to Country Energy procedure at SSO is, following a mains power failure, the mountaintop remains on diesel power until the following morning. Site staff then power down the mountaintop and progressively connect sections of the mountaintop to Country Energy power, this process takes 60 to 80 seconds and will pull down the SkyMapper observatory for some of this time. On restoration of Country Energy power the SkyMapper master computer will wake on LAN and restore all observatory systems, but some human intervention may be necessary to fully restore observing operations.

A local observatory power failure (i.e. circuit breaker triggered) will require manual resetting. SSO staff will not be on call throughout and observing night, so the SkyMapper system will be shutdown using UPS power until the next morning.

## 5.5 Smoke Sensor Warning and Emergency Modes

A VESDA LaserSCANNER smoke detector will be fitted in the SkyMapper enclosure. This unit uses a vacuum pump and piping to draw air from each of the three levels inside the enclosure, and one on the outside north-western face of the enclosure ~5m above ground. This detector can distinguish where the source of the smoke is, while sampling multiple sectors. The VESDA detector will continue to sample from all sectors to monitor the fire growth and maintain full protection. The VESDA detector signal output will be hard wired via a private copper, copper clad, line to the SSO site central fire alarm. A flashing light and audible alarm may also be installed in the enclosure and linked to the VESDA system.

### 5.5.1 Level One Smoke Sensor Warning

A level one smoke alert from the VESDA smoke sensor will be assumed to be a small electrical fire, perhaps in computing or control systems. The VESDA system will be programmed to send an SMS and email messages to SSO site staff and Coonabarrabran fire units alerting them to smoke in the enclosure.

### 5.5.2 Level Two Smoke Sensor Warning

A level two smoke alert from the VESDA smoke sensor will be assumed to be a serious fire in the enclosure. The VESDA system will be programmed to close the enclosure, call fire units and SMS and email emergency messages to SSO site staff and Coonabarrabran fire units alerting them to smoke inside or perhaps outside the enclosure.

### 5.5.3 Level Three Smoke Sensor Observatory Complete Shut Down

A level three smoke alert from the VESDA smoke sensor will be assumed to be a serious fire in the enclosure, or if sensed from the external sample point on the north-western face of the enclosure, then it will be assumed to be an approaching uncontrolled bushfire. The VESDA system will be programmed to close the enclosure, call Coonabarrabran fire units and SMS and email messages to SSO site staff alerting them to dense smoke outside or inside the enclosure. If the level three alert continues for more than five minutes the VESDA unit will be programmed to shut down the SkyMapper observatory but will continue to run itself from one of the UPS's in the enclosure until these are exhausted.

## *5.6 Enclosure and Telescope Personnel Safety Modes*

### *5.6.1 Enclosure Safety System*

The SkyMapper enclosure will be fitted with an emergency close keyswitch located near the entrance door and emergency close press buttons at each level. These buttons will remain closed until manually released. The observatory control computer will be aware of these via the CANbus and will signal these as warning messages to the master computer.

### *5.6.2 Telescope Safety Systems*

The SkyMapper enclosure is not co-rotating with the telescope and it will be possible, and even desirable to rotate the telescope with respect to the enclosure during telescope maintenance periods. Emergency stop buttons located near the telescope will stop the telescope, and the observatory control computer will be aware of these via the CANbus and will signal these as warning messages to the master computer.

# 6 Remotely Controllable Systems

## *6.1 Remote Observing Modes*

### *6.1.1 Observing from the SSO Site*

The SkyMapper telescope and CCD mosaic will be fully controllable and remote observing will be possible from any point on the SSO LAN via the TAROS telescope control software. In addition the EOS WinXP based computers will be accessible via the Microsoft Remote Desktop programme.

### *6.1.2 External Observing*

The SkyMapper telescope and CCD mosaic will be fully controllable and remote observing will be possible, by authorised users, from anywhere on the World Wide Web (WWW), via the TAROS JAVA WWW browser interface. In addition, the EOS WinXP based computers may be accessible via the Microsoft Remote Desktop programme.

## *6.2 Remote Telescope Collimation*

### *6.2.1 Using the Shack-Hartman System*

The SkyMapper Shack-Hartmann telescope collimation system can be used from any point on the SSO LAN. This will require the use of both the TAROS JAVA system to point and control the telescope and control the Imager instrument, and a WinXP Remote Desktop to acquire S-H camera images and to reduce these with the EOS S-H reduction program. The WinXP Remote Desktop will also be used to control the secondary hexapod and adjust the telescope collimation. This system may be accessible from the WWW.

### *6.2.2 Modifying the Look-Up Table*

The SkyMapper telescope control Look-up Table is hosted on the WinXP computer running the EOS Telescope Control System. Parameters in the table such as secondary hexapod versus telescope altitude angle corrections and telescope focus versus temperature corrections are stored in this file. These values can be changed remotely via a WinXP Remote Desktop session from the SSO LAN and may be accessible via the WWW.

## 6.3 Telescope Remote Sensors

### 6.3.1 Observing space Web Camera and LED Array

A standard web-enabled video camera fitted with an auto-iris fish eye lens will be mounted from the L3 handrail and pointed at the telescope. This will allow remote conformation of the telescope and enclosure movements, allow remote confirmation the enclosure is closed, and other fault finding requirements. An adjacent Halogen lamp array will provide diffuse illumination of the observing space when the camera is remotely commanded to take images. These images will then pass over the SSO LAN or WWW to the remote observer. The Halogen lamp array will also be used for dome flats, and remote testing of the Imager mosaic shutter and filters.

### 6.3.2 Observing Space Microphone

A sensitive microphone will be mounted on the L3 handrail near the web camera and when commanded will pass compressed sound packets through to the LAN or WWW. This acoustic information will be used in conjunction with the Delta Tau P-Mac servo control system to tune the telescope servo systems, and for other fault finding requirements.

## 6.4 Remote CCD Adjustment

### 6.4.1 Read Back of CCD Parameters

Remote read back of mosaic CCD control parameters including individual temperatures will be available on both the SSO LAN and the WWW.

### 6.4.2 Adjustment of CCD Clock and Bias Settings

Remote adjustment of mosaic CCD control parameters including clock and bias settings will be available on both the SSO LAN and the WWW.

## 6.5 Remote Computer Control & Administration

### 6.5.1 Remote Solaris Computer Control

Both of the Sun Solaris computers in the SkyMapper enclosure; the Master Host computer and the CICADA Slave computer(s), can be remotely administered from the SSO LAN and the WWW via the UNIX rlogin or secure shell login commands.

### 6.5.2 Remote WinPC Control

All four of the WinXP computers in the SkyMapper enclosure; the Enclosure Control, the Telescope Control, the WinPC Client and perhaps the Autoguider Control computer, can be remotely administered from the SSO LAN and the WWW via the WinXP Remote Desktop interface.

### 6.5.3 Remote Linux PC Control

The single LINUX PC in the SkyMapper computer hosts the Scheduler. This computer can be remotely administered from the SSO LAN and the WWW via the UNIX rlogin command.

## 6.6 Remote Engineering Diagnosis and Repair

There will not normally be any personnel in the enclosure during night-time observations or daytime preparation, though engineering day staff may occasionally call to check and repair telescope and instrument systems, and to manually administer computers. The SkyMapper observatory system contains many embedded computer controlled modules and most of these allow some degree of remote engineering, these systems include;

- Telescope Enclosure CANbus.
- Telescope P-Mac Servo Controller
- Telescope GPS
- Secondary Mirror Hexapod
- Primary Mirror Puck
- Imager Galil Servo Controller
- Bonn Shutter
- Water Chiller System
- Helium Compressor
- Pneumatic System

## 7 System Overview Schematic

See drawing number 201-00-002: SkyMapper System Overview Schematic, for a pictorial representation of the entire SkyMapper system. This Schematic shows interconnections between the WWW, the Science Data Pipeline, Master Control System, The Imager instrument and the Telescope and Enclosure System.