

Mopra QRH

The Mopra Quick Reference Handbook

Available online at
<http://www.narrabri.atnf.csiro.au/mopra/>

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1. Preamble

1.1. How to use the Quick Reference Handbook (QRH)

The QRH is meant to be used as a reference for all observers. It contains checklists, procedures and recommendations on how to proceed when certain conditions exist.

Most importantly, the QRH should be consulted by new observers on how to set up their observing environment. The QRH alone provides sufficient guidance for a new observer who has never observed with Mopra before to get all observing software up and running.

Important notes are outlined like this text. Please take extra care to follow instructions precisely as indicated.

The QRH features seven sections:

- **Preamble**
- **Changes**
- **Observatory Characteristics**
- **Normal Procedures**
- **Abnormal Procedures**
- **Emergency**
- **TOAD Message Reference**

The **preamble** is this section you are reading now. It contains general information on how to use this handbook.

Changes provides a list of changes that were made to the QRH. Whenever you observe with Mopra, you are expected to read at the very least that section of the QRH. For your convenience, the changes are dated, therefore you only need to read up on the sections that changed since you last.

The **Observatory characteristics** section lists tables and figures characterising the telescope such as beam efficiency, beam maps, tuning limitations, spectral resolution tables and the likes.

Normal procedures provide you with checklists on how to set up the software when you take over from previous observers, and how to configure standard parameters.

The **Abnormal procedures** section is what you refer to when a problem has occurred and you need to work around it within the scope of what we expect you to be able to accomplish.

The **Emergency** section lists some initial actions you should perform when operationally critical problems occur, as well as information on whom to contact and when to contact them.

The **TOAD Message Reference** gives more detailed information on message and alert states as issued by TOAD.

1.2. Important note

The Mopra Telescope is a very complex system exhibiting a plentitude of peculiarities. It is **imperative** that instructions are followed to the iota.

The purpose of this QRH is **not** to give you in depth knowledge about **why** things should be done a certain way, **but how** they should be done to make sure everything is set up in a way that avoids potential pitfalls.

We herewith acknowledge that certain individuals amongst you are more proficient than others in matters IT.

We kindly request the advanced users to treat the Mopra VNC sessions as a critical and static aspect of the Mopra observing software suite. Specifically,

- please avoid moving windows around and/or opening new terminal sessions unless required to start observatory software
- please stick to the two approved observing configurations (see the section on VNC setup in **Normal Procedures** for details)
- please either use your own computer, or a virtual desktop **outside** the VNC sessions to log into bigrock and modify, copy and manage files.

The support staff as well as the next observer are grateful for your compliance in these matters.

2. Changes

Date	Who	What
20 JUN 2009	ind006	QRH created
06 JUL 2009	ind006	New chapters: 5.2 Creating your schedule 5.3 Selecting your pointing source 5.3 Find your zooms with mops_vis or OTF v6 Modified: Table formatting has been changed. 5.10 Monitoring
07 JUL 2009	ind006	New chapters: 5.8.5 Verifying your data (QuickData.py) 5.10.1 TOAD
22 JUL 2009	ind006	New chapters: 5.11 Finishing the observations Modified: 5.5.1 Setup using four monitors 5.8.1 Moving/copying your schedule files 5.10.1 TOAD
05 AUG 2009	ind006	Modified: Focus position for 3mm
17 SEP 2009	ind006	Modified: Focus position and graphs for 3mm
08 OCT 2009	ind006	Modified: Fig 3 Tsys calculation annotation
02 FEB 2010	ind006	New Chapters: 3.5 Fast mapping mode 5.9 Online data analysis tools 6.5 MOPS programming errors 6.6 Problems with the VNC sessions Modified: 3.3 MOPS configurations 4.1 SPD Table 8 SPD command reference MOTP 5.3 Find your zooms with mops_vis or OTF v6 6.4 Restarting the ACC
03 FEB 2010	ind006	New Chapters:

		<p>5.7.1 Using Python Chat for coordination Error! Reference source not found. Error! Reference source not found.</p> <p>Modified: Replaced missing figure 14 Consistently put captions below figures 5.7.3 Handing over from 2-screen to 4-screen and vice versa</p>
30 MAY 2011	ind006	<p>New Chapters: 5.7.1 Using Python Chat for Coordination 6.8 Unable to bring GTP's down/up into normal range</p> <p>Replaced Chapters: 5.7.1 IRC instructions for Coordination (replaced by Python Chat)</p> <p>Modified: 5.3 Find your zooms with mops_vis or OTF v6 or PSW v5 5.10 Monitoring</p>
06 AUG 2012	ind006	<p>Modified: 3.2 Updated focus position</p>
15 MAY 2013	ind006	<p>New Chapters: 5.7.2 Using Skype Chat for coordination</p> <p>Modified: Preamble 3.2 Removed Figures 1 & 2 (old focus positions) Updated global pointing model parameters 3.3 Updated Bandwidths in Table 7 4.1 Updated Table 8 5.1 Added recommendation for pointing maser 5.8.2 Table 12 Focus positions 6.3 Restarting atdaemon</p>

3. Observatory Characteristics

3.1. Location

Mopra is located in the foothills of Siding Spring, near Coonabarabran in rural New South Wales, Australia.

Latitude	Longitude	Altitude
S 31° 16' 04"	E 149° 05' 59"	866m
S 31.2678	E 149.0997	866m

Table 1 Observatory position

3.2. System Characteristics

Parameter	Value	Comment
Global pointing model	8.3"	rms model error in fz
	13.0"	rms model error in fx
Global fx	-197.5	Derived October 2008
Global fz	10.1	Derived October 2008

Table 2 Pointing parameters

Band	Frequency	Comment
3mm	77 – 116 GHz	
7mm	30 – 50 GHz	Due to LO chain tuning limitations, the center frequency cannot be within 38 – 44 GHz
12mm	16 – 27 GHz	

Table 3 Tuning and center frequency limitations

Band / Mode	BW	Resolution	Comment
12mm Broadband	112050 km/s	3.38 km/s	BW for one entire IF
12mm Zoom mode	1863 km/s	0.41 km/s	BW per window
7mm Broadband	56025 km/s	1.69 km/s	BW for one entire IF
7mm Zoom mode	932 km/s	0.21 km/s	BW per window
3mm Broadband	30378 km/s	0.915 km/s	BW for one entire IF
3mm Zoom mode	505 km/s	0.11 km/s	BW per window

Table 4 MOPS spectral resolution in all bands

Band	Beam FWHM	width	Average good weather Tsys
12mm @ 24 GHz	119"		~ 70K

7mm @ 42 GHz	82"	~ 80K
3mm @ 90 GHz	38"	~200K
3mm @ 115 GHz	30"	~ 600K

Table 5 Beam widths and average Tsys's

Frequency	Efficiency	Comment
16 GHz	0.55 +/- 0.05	2009 Measurements by Urquhart et al
20 GHz	0.5 +/- 0.03	2009 Measurements by Urquhart et al
25 GHz	0.55 +/- 0.05	2009 Measurements by Urquhart et al
31 GHz	0.5 +/- 0.05	2009 Measurements by Urquhart et al
35 GHz	0.57 +/- 0.02	2009 Measurements by Urquhart et al
37 GHz	0.58 +/- 0.02	2009 Measurements by Urquhart et al
43 GHz	0.55 +/- 0.03	2009 Measurements by Urquhart et al
45 GHz	0.53 +/- 0.03	2009 Measurements by Urquhart et al
49 GHz	0.46 +/- 0.03	2009 Measurements by Urquhart et al
86 GHz	0.49 +/- 0.03	Based on 2005 data (Ladd et al)
100 GHz	0.44 +/- 0.03	Based on 2005 data (Ladd et al)
115 GHz	0.42 +/- 0.02	Based on 2005 data (Ladd et al)

Table 6 Antenna efficiency

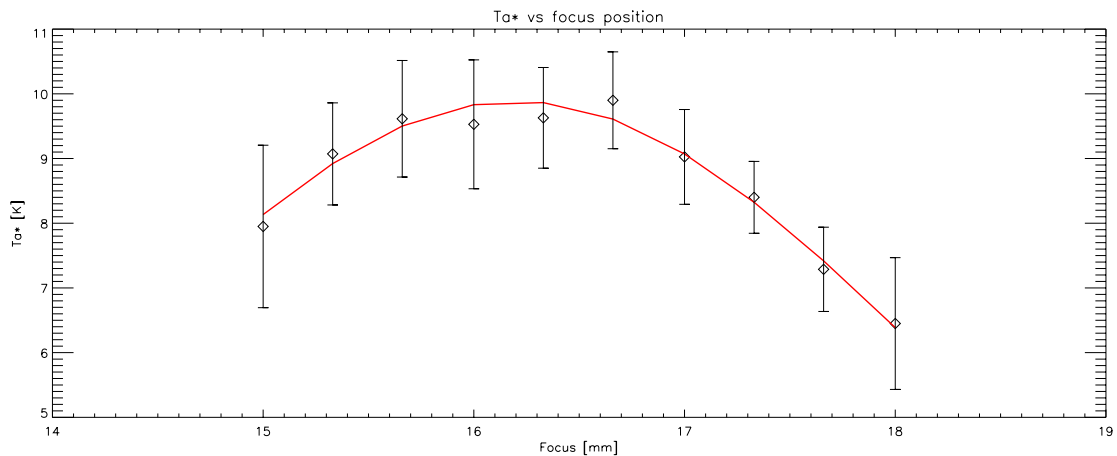


Figure 1 Focus positions at 86 GHz measured July 2012. Gaussian fit to data suggests best focus position is at 16.2mm.

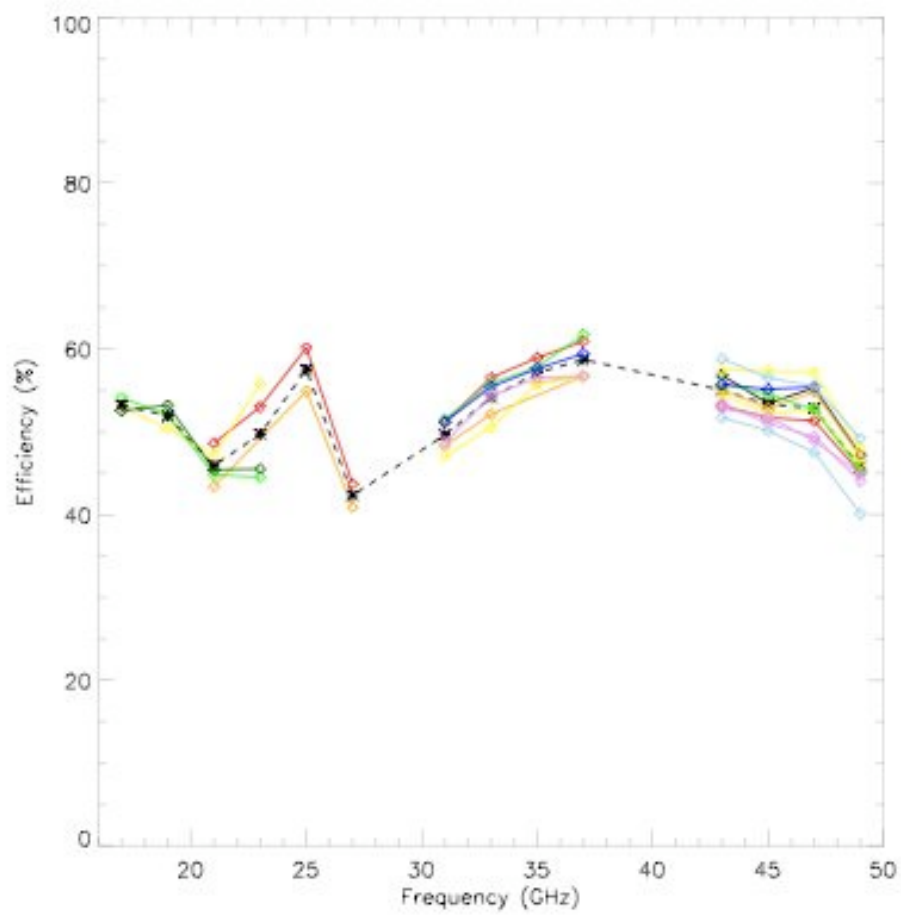


Figure 2 Antenna efficiency at 12mm and 7mm

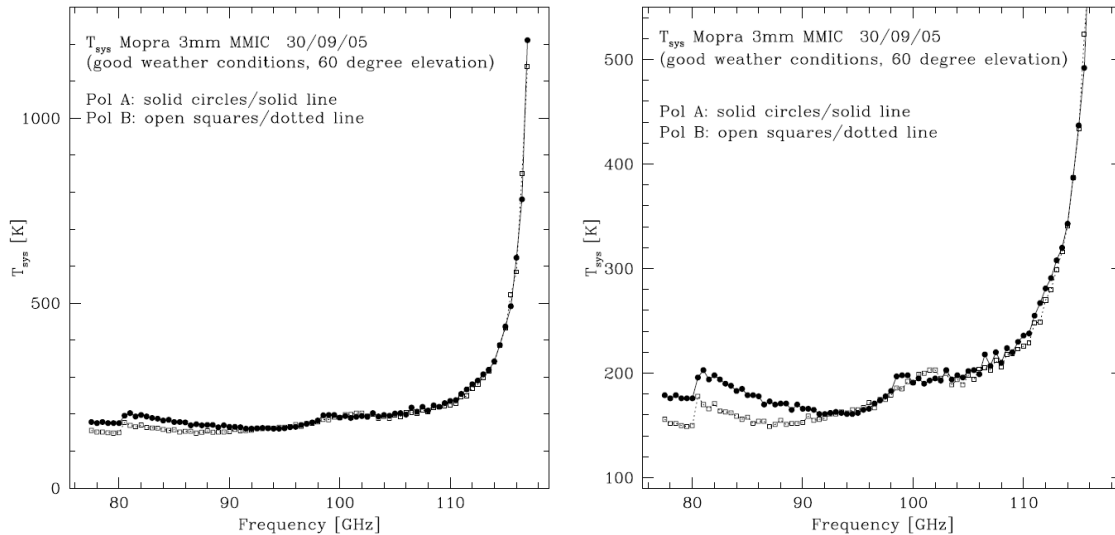


Figure 3 T_{sys} at 3mm from Ladd et al.

The following fit is used to calculate in TOAD whether the T_{sys} is in range that yields a somewhat conservative fit to the Ladd data above. The yellow limit is $T_{\text{sys}}[\text{max}]$, the red limit is $T_{\text{sys}}[\text{max}] + 150$.

3.3. MOPS configurations

MOPS is a spectrometer implemented as a digital filter bank rather than a correlator. Note that for historical reasons, it is often and throughout the community referred to as the correlator as well.

Configuration	BW [MHz]	Chans [n_{ch}]	IF's [n_{IF}]	Data [MB/h]	rate
mops_2208_8192_4f	2208	8192	4	Max 193 MB/h	
mops_2208_1024_4f	2208	1024	4	Max 24 MB/h	
mops_il_zoom	138	4096	16	Max 770 MB/h	
mops_bn8_zoom	138	4096	8 * 8 bins	Max 1.44 GB/h	

Table 7 MOPS configurations and data rates

Internally, MOPS contains 4 IF's, or Bands. Refer to

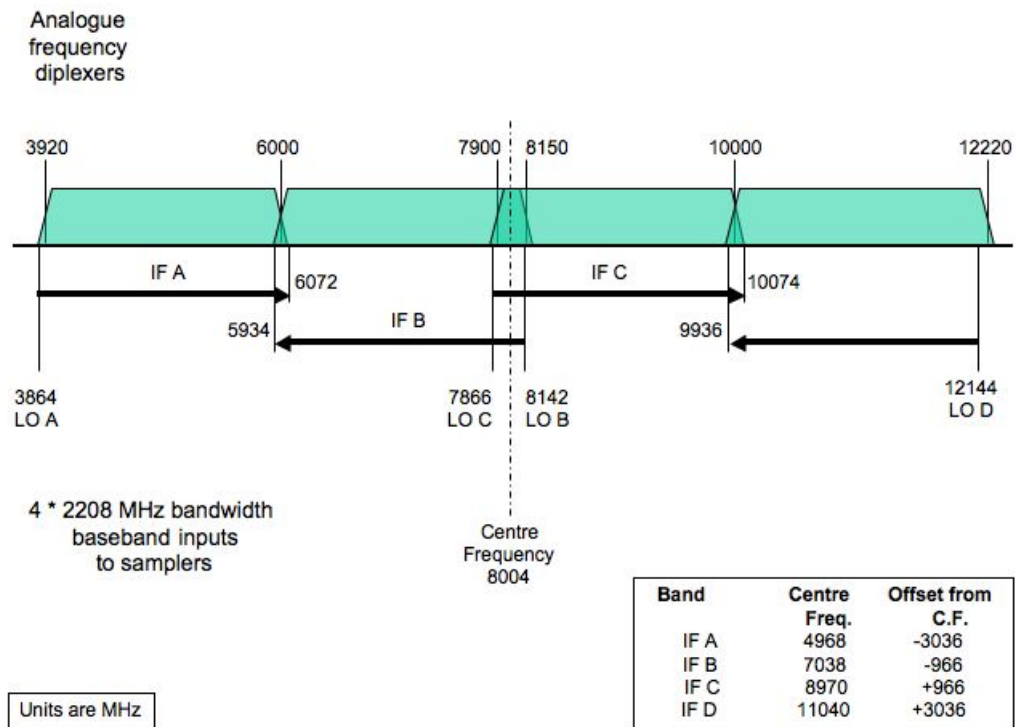


Figure 4 MOPS bands and IF's to see how they are arranged and relate to each other.

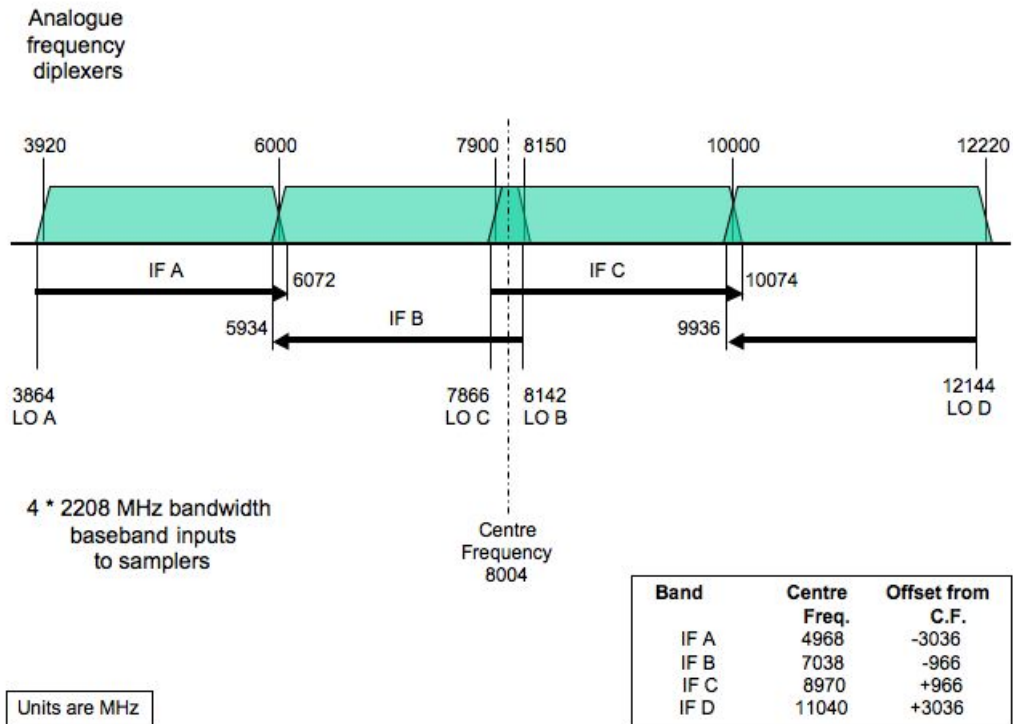


Figure 4 MOPS bands and IF's

In Zoom mode, the zoom windows are arranged as depicted in the following graph. Use `mops_vis` to determine the window numbers to use in your schedule, as well as to optimize the center frequency.

Alternatively, you can also use the new on the fly schedule maker version 6.0, it features a graphical zoom window editor similar to `mops_vis`.

ZOOM BANDS

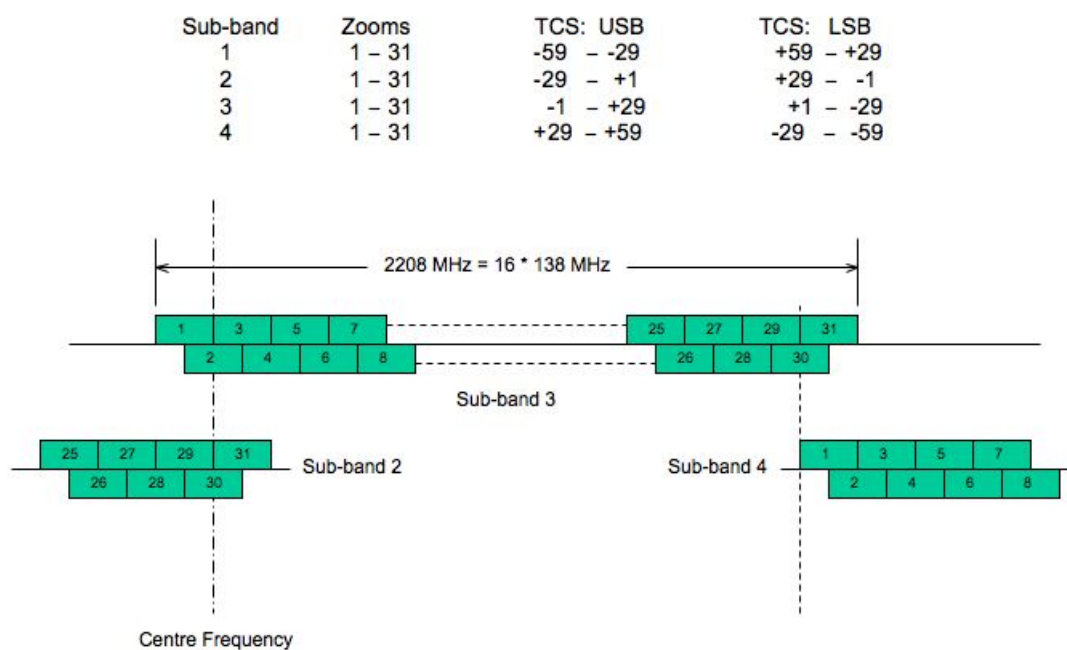
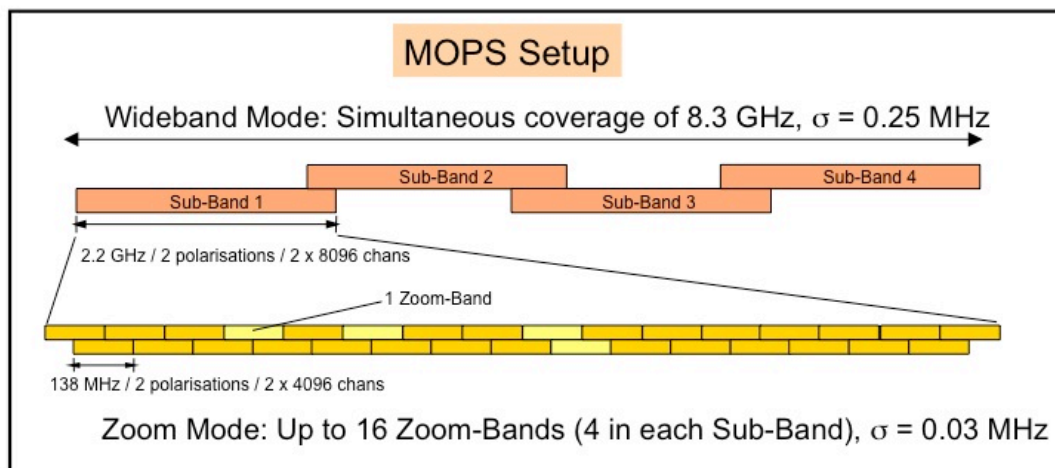


Figure 5 MOPS zoom window definitions

Further to this, the MOPS zoom window setups and spectral resolutions can be seen in the following graph



Receiver	Wideband Mode		Zoom Mode	
	Bandwidth	Resolution	Bandwidth	Resolution
12-mm (22 GHz)	112 050 km/s	3.38 km/s	1 863 km/s	0.41 km/s
7-mm (44 GHz)	56 025 km/s	1.69 km/s	932 km/s	0.21 km/s
3-mm (90 GHz)	30 378 km/s	0.915 km/s	505 km/s	0.11 km/s

Figure 6 MOPS zoom mode specifications

3.4. Data rates

You need to make sure you bring enough disk space to take your data home. Refer to Table 7 MOPS configurations and data rates above to calculate the amount of data your observing run will generate.

3.5. Fast mapping mode

As of 2010, Mopra now also supports a fast mapping mode, where a maximum of 8 zoom windows can record spectra in 8 time bins per cycle. The cycle time for fast mapping is changed from 2 seconds to 2.048 seconds, so each time bin lasts for 256 milliseconds. The data rate correspondingly increases to twice the amount of regular zoom mode observations. The noise figure also increases by $\sqrt{8}$ or approximately 3 fold. More information will be available soon.

4. Command references

4.1. SPD

Command	Action
select 1 2 3 4	View both pols in IF's 1 & 2 in separate graphs, amplitude vs. frequency
select 1 & 2	View both pols in one graph
a	View the bandpass amplitude
auto	Performs the av and save functions automatically to capture the reference scan in the background and display the data in quotient mode
noauto	switch off auto
av	Average the data
save	saves the current scan as reference
d	View the difference between source and reference
q	View the quotient between source and reference
a y1 y2	Displays the amplitude in range y1 to y2
d y1 y2	Displays data in difference mode and sets the range to y1 to y2
chan x1 x2	Changes the display range of IF 1 to channels x1 to x2
chan f2 x1 x2	Changes the display range of IF 2 to channels x1 to x2
chan	Shows all channels
bins u v w	<p>Show the individual time bins when fast mapping. U v w stand for IF's 1 2 and 3. You'll have to insert "dummy" bins, e.g. if you want to display bins 1 through 8 for IF5, you need to enter:</p> <pre>bins 1 1 1 1 1-8</pre> <p>Note 1-8 is the fifth entry on the line.</p>
sca [lin, log]	Set scaling to linear or logarithmic

Table 8 SPD command reference

4.2. MOTP

Command	Action
sel *	Selects all powers, required when MOPS has been restarted.
sca y1 y2	Changes the Y scale of the display to the range y1 to y2
sca	Changes the scale automatically to include the largest and smallest values.
sel cal	Displays the calibration signal powers.

Table 9 MOTP command reference

4.3. MOPS

Command	Action
matten au	Switches the attenuators to automatic. A maximum attenuation of 12 is set when automatic mode is selected. If more attenuation is required, use the manual setting method below.
matten ma	Switches the attenuators to manual
matten a w x y z	Switches the attenuators for polarization A to w, x, y and z. Always 4 values must be given.

Table 10 MOPS command reference

5. Normal procedures

5.1. Observing Checklist

Before starting your observations make sure you have

- Selected a good pointing source. Good means:
 - As close to your target as possible. Use our SiO maser database with the angular distance display.
 - As bright as possible: At 3mm in Zoom or Broadband mode you'd like a source brighter than 1.5K to reliably point, in Fastmap mode 2K or brighter.
- Plan to update the pointing every 1.5 hours if not moving away to other sources.
- Check the attenuation levels (Gated Total Power, or GTP, displayed in TOAD)
- If observing at 3mm, include a Tsys measurement in your schedule in 30 minute intervals (the online schedule maker tools include that for you)
- Consider observing one of the standard sources once per day:
 - M17SW
 - Orion KL
 - L1527

5.2. Creating your schedule files

The telescope control software (TCS) requires schedule files that tell the telescope what to do. In a schedule file, you must define (and therefore know):

- Project number
- Your initials
- Receiver setup. This includes
 - Which MOPS configuration to use
 - Center frequency
 - If using zoom configuration, the zoom window numbers. Refer to the next chapter on using mops_vis to find the appropriate Band and Zoom window numbers, or use the OTF schedule maker version 6.

Optionally, you can define:

- Source and offset positions.

You can also create your own source catalogues if you have a large number of objects to observe. Refer to the TCS manual accessible online from the main Mopra website <http://www.narrabri.atnf.csiro.au/mopra/>

5.3. Find your zooms with mops_vis or OTF v6 or PSW v5

mops_vis is a script application written by Erik Muller, which runs on any platform supporting wish. It has been tested on Linux, Windows/Cygwin as well as OSX. Simply enter the frequencies of the lines you are interested in or select them from a list of preloaded molecular species. Then enter a center frequency you think will optimize detection. You can optimize the center frequency by pressing the +10 MHz or -10 MHz buttons. Download the script from here: http://www.narrabri.atnf.csiro.au/mopra/mops_vis.tgz

In the example below, you would enter a center frequency of 86080 MHz in order to observe SiO, H₁₃CO⁺, HCN, and CH₃OH. In the zoom window definitions of the schedule maker, you would leave the first Zoom Band empty, in the second one you would enter -23, in the third one you enter 2,10 and in the third one 37.

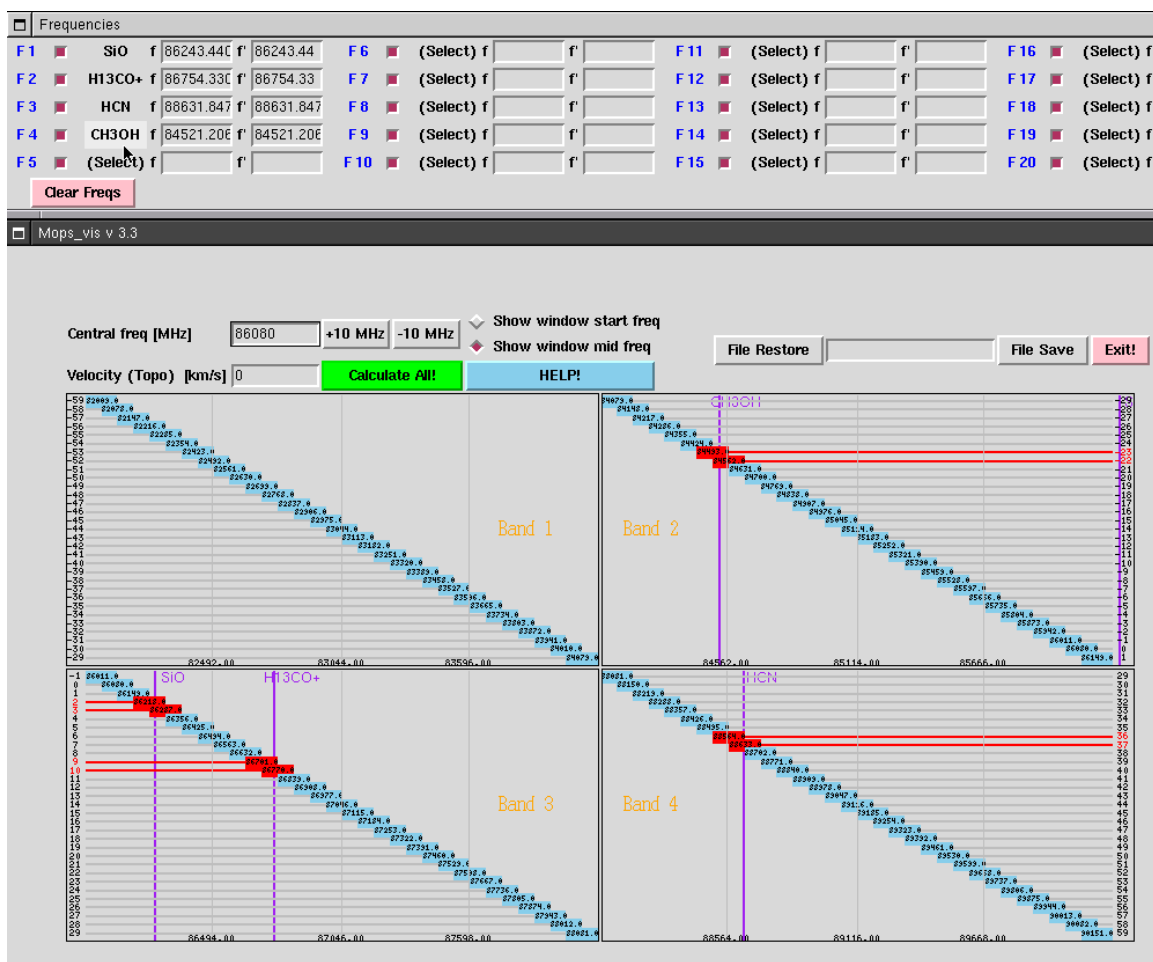


Figure 7 mops_vis sample screen

Alternatively, you can use the graphical editor from the on the fly (OTF) or the position switch (PSW) schedule maker version 6 (version 5 for PSW). It's slightly less elegant, but requires no installation on your part, simply point your browsers

at the schedule maker
<http://www.narrabri.atnf.csiro.au/mopra/scheduler/potf-v6.0.html>

or

<http://www.narrabri.atnf.csiro.au/mopra/scheduler/pswitch-v5.0.html>

and open the Graphical Zoom Window Editor:

Project:
Observer Initials:
MOPS Configuration:

How this works:

- Enter up to 20 line frequencies in MHz or select them from the list
- The program automatically tries to optimize which zoom windows to use giving preference to the window with the least distance of the line from the band center
- You can manually enter a different center frequency and click the Update button to reflect the changes
- You also can move the center frequency up and down by 10 MHz increments using the respective buttons
- If you're satisfied that the center frequency looks good, click the Save and Close button. The values for the zoom windows and the center frequency will automatically be entered into the appropriate inputs.

OR enter manual frequency: MHz
Optional: Topocentric velocity correction to apply: km/s (+ redshift, - blueshift)
Optional: Line width to plot (km/s). Note that the zoom window optimization does not work when this is set! km/s
Press to add the velocity corrected frequencies, or simply enter the sky frequencies manually below:

1: <input type="text" value="115271.20"/>	MHz 6: <input type="text"/>	MHz 11: <input type="text"/>	MHz 16: <input type="text"/>
2: <input type="text" value="112358.98"/>	MHz 7: <input type="text"/>	MHz 12: <input type="text"/>	MHz 17: <input type="text"/>
3: <input type="text" value="110201.35"/>	MHz 8: <input type="text"/>	MHz 13: <input type="text"/>	MHz 18: <input type="text"/>
4: <input type="text" value="109782.17"/>	MHz 9: <input type="text"/>	MHz 14: <input type="text"/>	MHz 19: <input type="text"/>
5: <input type="text"/>	MHz 10: <input type="text"/>	MHz 15: <input type="text"/>	MHz 20: <input type="text"/>

Center Frequency: MHz
Band 1 Zooms:
Band 2 Zooms:
Band 3 Zooms:
Band 4 Zooms:
When satisfied with the zoom window numbers and center frequency, press

Figure 8 OTF v6 Graphical zoom window editor

Simply follow the on screen instructions on how to fill in the values.

5.4. Selecting your pointing source

For observations at 3mm and 7mm, refer to our SiO maser catalog at this URL:

<http://www.narrabri.atnf.csiro.au/cgi-bin/obstools/siomaserdb.cgi>

Note that you can search the catalog for the nearest pointing source based on your target position either in RA / Dec or in Galactic coordinates.

5.5. Setting up the observatory software

While observing from an ATNF supported Mopra control desk, you will be presented with a four-monitor setup. The screens are meant to display the following softwares (in brackets the names of the corresponding virtual desktops):

Screen 1 (TCS)	Screen 2 (MOPS)	Screen 3 (SPD)	Screen 4 (TOAD)
atdaemon TCS dclocks	MOPS MOTP atdrivemon	SPD Pointings attest Depends on which virtual desktop is selected in this window.	TOAD (in browser, on local machine, not in a VNC session)

Table 11 Application distribution in the VNC sessions

Please read the following sections depending on whether you are using a two or four monitor setup.

If you have not yet set up your VNC connections, refer to 5.6 Setting up your VNC connections first.

Note that

- blue terminal windows refer to terminals logged into **bigrock** as user **atcaobs**
- green terminal windows refer to terminals logged into **MPCCC1** as user **corr**

5.5.1. Setup using four monitors

Begin by setting up Screen 2.

- Connect your VNC client to **mpvnc1.atnf.csiro.au:11**
- Make sure the top left “virtual screen square” says MOPS. If it doesn’t, click the up or down arrow until it does.
- Right click on the desktop to produce two xterms on MPCCC1 and one on bigrock
- On the first MPCCC1, start MOPS by executing the command `mops`
- On the second MPCCC1 terminal, start the total power monitor `motp`
- In the blue bigrock terminal, start the drive monitor: `atdrivemon`

Do not send any of those tasks into the background (i.e. do not use ampersand (&) after the tasks. Terminals only serve a single application startup purpose in this observing setup).

Compare the layout of the screen you have just created, try to make it look similar:

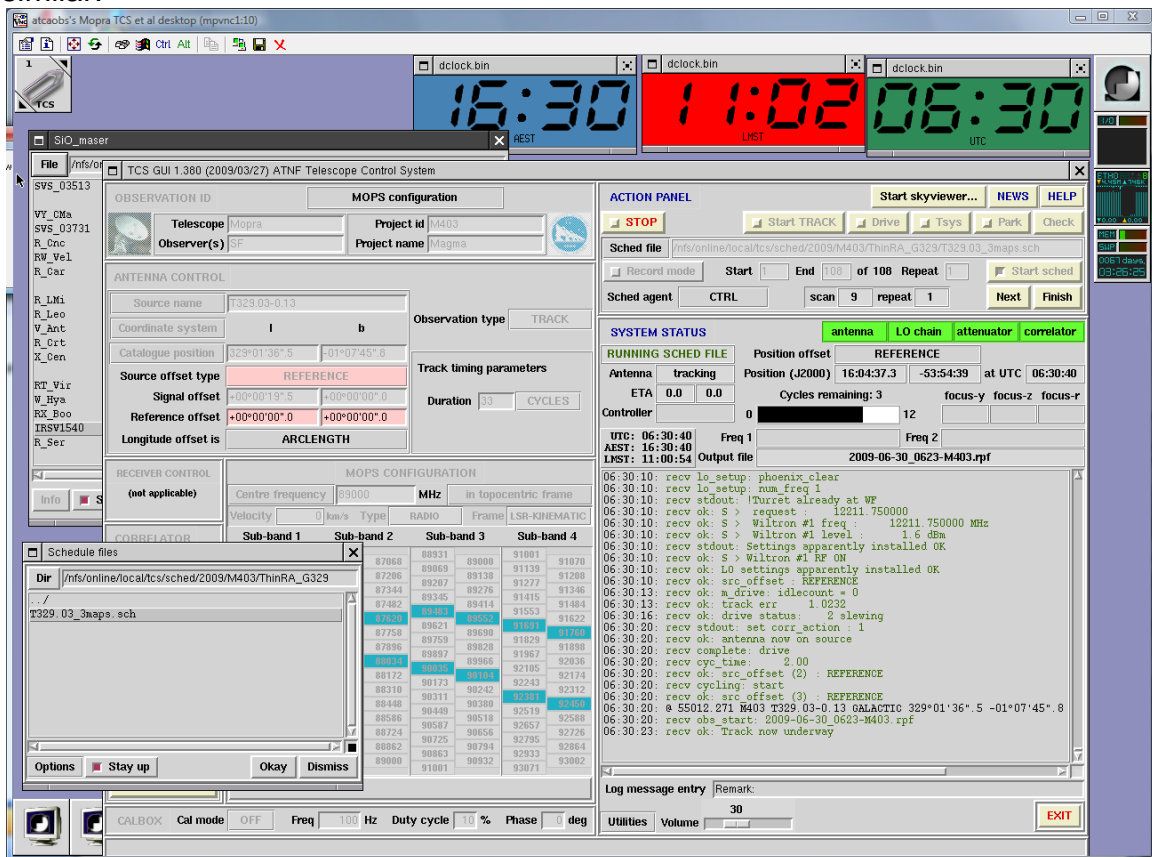


Figure 9 VNC screen 1

Then set up screen number 1, the one that is controlling TCS:

- Connect your VNC client to **mpvnc1.atnf.csiro.au:10**
- Make sure the virtual screen square says "TCS", if not, press the up or down arrows with the mouse until it does so.
- Start a blue bigrock terminal (right click on background) and execute the following commands in it:
 - Restart atdaemon: `atdaemonrestart`
 - Start the clocks. Note the ampersand: `dclocks &`
 - Arrange the clocks as displayed in the screen below.
 - Start TCS by first issuing a `killtcs`
 - Make sure you're aware which version of TCS is used, **current** or **next**. If in doubt, contact the DA.
 - Execute `atcsver current` or `atcsver next`, depending on which version is used
 - Then start TCS: `tcs`

- When the window has come up, dismiss the skyviewer window (unless you would like to use it), and dismiss any warnings that might be present.
- Ascertain that the “antenna”, “LO chain”, “attenuator” and “correlator” indicators are green. If any of them are amber, click on them and try to enable/set them. If that does not work, contact the DA or staff.

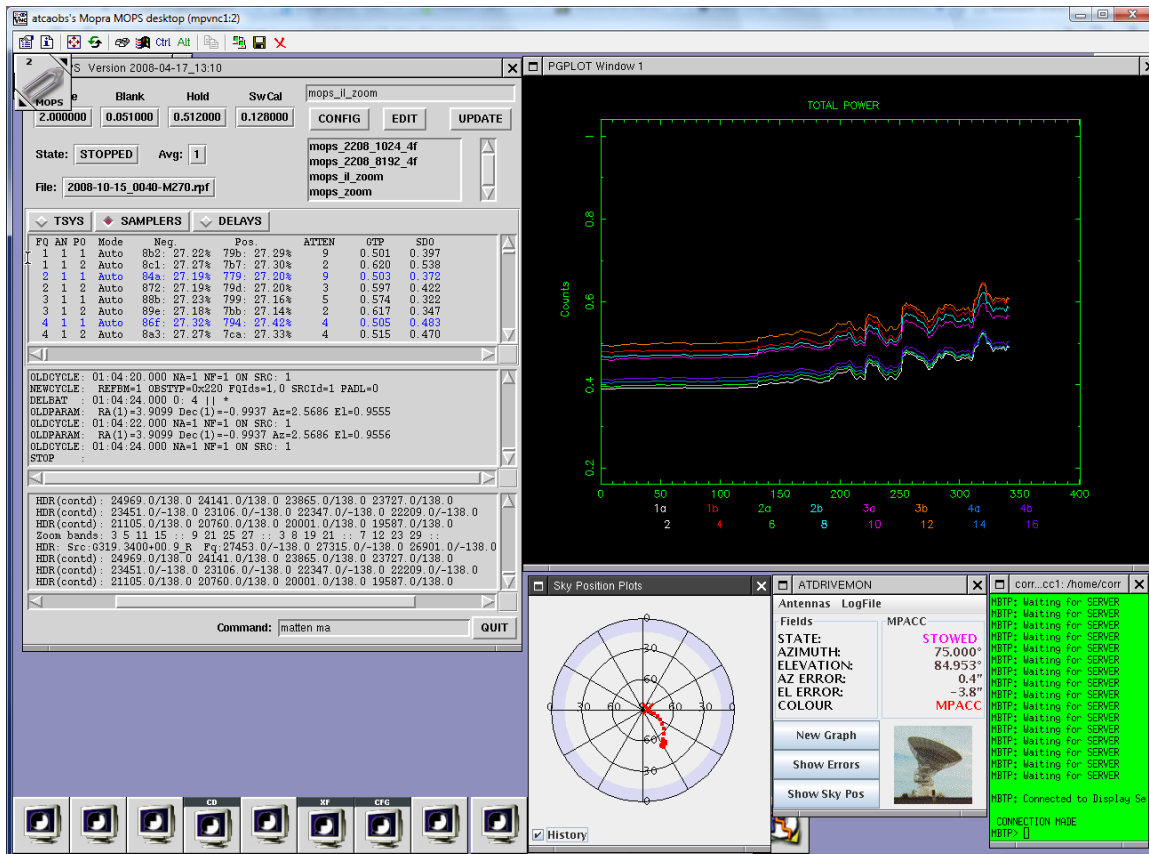


Figure 10 VNC screen 2

Continue by setting up screen number three:

- Connect your VNC client to **mpvnc1.atnf.csiro.au:12**
- Make sure the top left virtual screen square states “SPD”.
- Again, use the up and down arrows with your mouse to make it say “SPD” if it doesn’t.
- Open a terminal window to MPCCC1 (green) and start SPD: `spd`
- Move/resize the windows to match this setup:

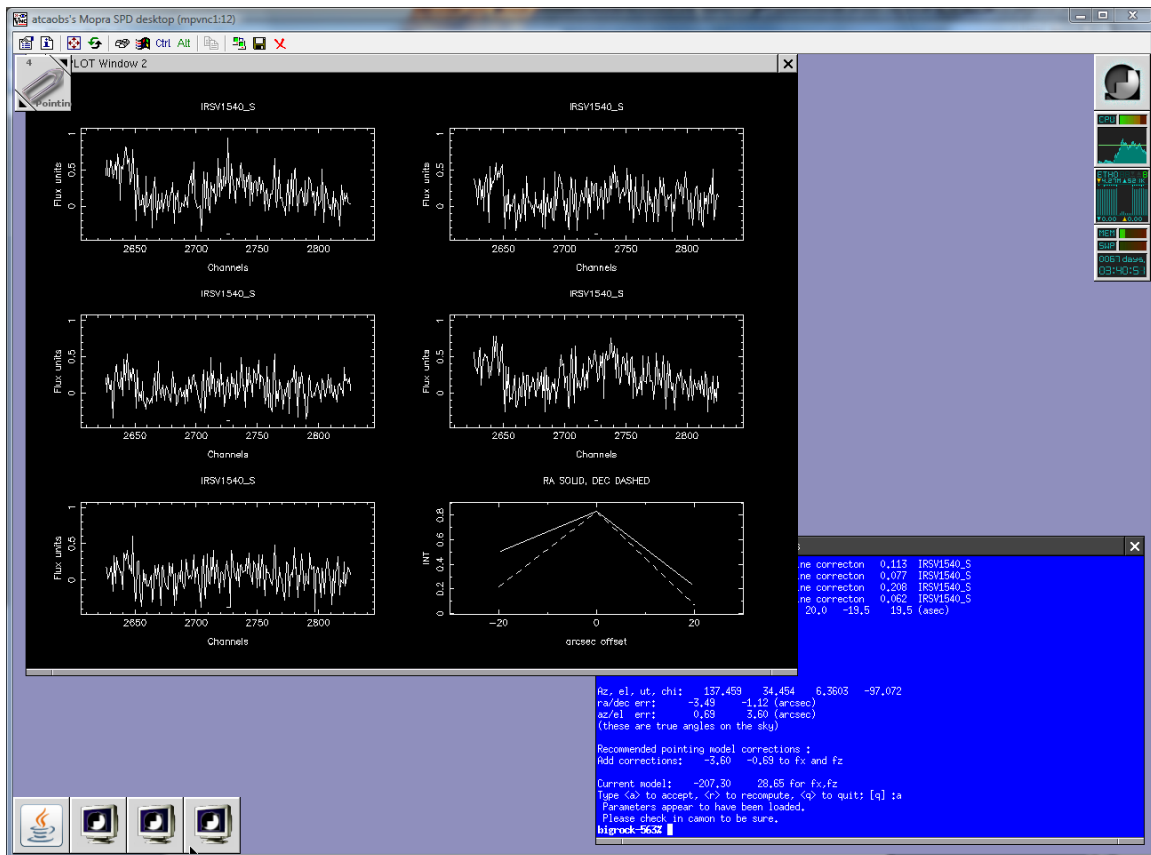


Figure 12 VNC screen 3 on the pointing virtual desktop

- Lastly, click on the up arrow one more time to access the “Utilities” screen.
- Open another blue bigrock terminal and execute `attest`
- You can also use this utilities screen to muck around with other terminal windows and editors to your liking.

Last, but not least, start a web browser and point it at the TOAD address:

<http://www.narrabri.atnf.csiro.au/mopra/TOAD>

Please do not start any other terminals on any of the other monitors you have just started. You will needlessly confuse others and draw the wrath of the Moprabub if you do so.

5.5.2. Setup using two monitors

The identical setup procedure as above applies, however, all of the screens 2 and 3 functions are taking place in a virtual desktop on screen 1. For that

purpose make use of the virtual screen button's top right and bottom left arrows to click into to the next available virtual desktop:



Figure 13 Virtual desktop switcher

5.6. Setting up your VNC connections

All Mopra observing is done from one machine residing physically at Mopra by way of connecting to it via VNC. VNC is a remote desktop software, allowing you to control the observatory software.

The computer you will be connecting to for all your observing is called `mpvnc1.atnf.csiro.au`

On that machine, three VNC servers are running. Depending on what kind of display setup you have available for observing, you will be connecting either to all three servers, or just to one of them.

5.6.1. Four screen setup

In the four screen setup:

- The first three screens connect to each of the VNC servers.
- The last screen runs TOAD (locally, not in a VNC window!)

Please note that in each of those VNC servers, all five virtual desktops are visible as outlined below, however, you should only use the desktops outlined in blue below.

To avoid confusion when handing over between two screen and four screen observers, **do not use the virtual desktops outlined in red!**

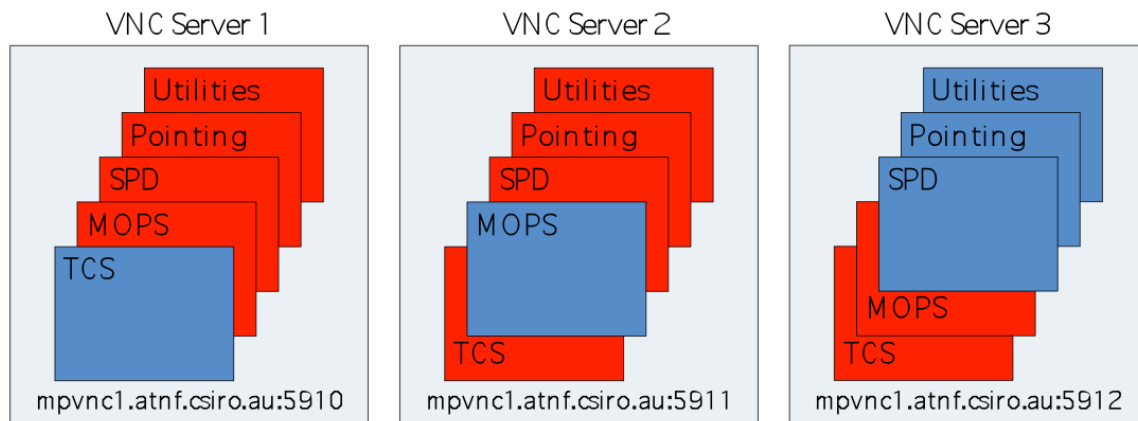


Figure 14 VNC screens and virtual desktop arrangements in multi screen mode

5.6.2. Two screen setup

In the two screen setup:

- One screen is used to connect to the first VNC server
- The second screen runs TOAD (locally, not in a VNC window!)

Most remote observers that operate from their own institutions will probably find themselves connecting in this kind of setup. Note that all observatory software is run in that one single VNC session and you must switch between the virtual desktops to monitor different aspects of your observing program.

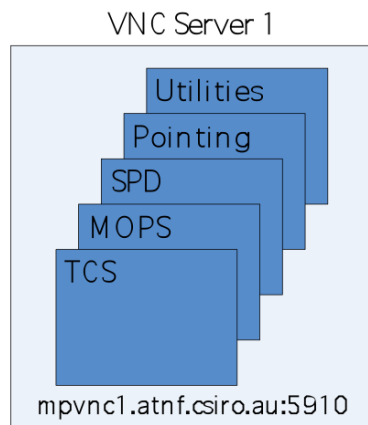


Figure 15 VNC screen and arrangement in single screen mode

5.7. Handover between observers

When one observer hands over to the next, it is advisable to establish contact at some point prior to when your scheduled time starts. Please refer to the next

section (5.7.1) detailing one facility we have installed to facilitate this coordination. This is to

- Exchange information on the status of Mopra
- Coordinate the actual handover details:
 - Are you taking over immediately and does the telescope not need to be stowed?
 - Will you be running a four-screen setup and the previous observer ran in a two-screen setup? If so, follow the procedures below.

5.7.1. Using Python Chat for coordination

When several observers are remote observing, it becomes impractical to rely on telephone connections or emails. Sometimes you will also depend on one of the technical staff at Narrabri to communicate with you. In the TCS window, you will find a chat window which you can use to type in.

In the event that this chat window is not available, you can start the chat client in any other bigrock window by simply typing this command:

```
bigrock-101% python bin/chat.py
```

5.7.2. Using Skype Chat for coordination

Since 2013, we use the Skype “Mopra Operations” chat to keep in touch between observers and observatory staff. Please have your skype ID added. Anyone who already is a member of the chat can add you.

5.7.3. Handing over from 2-screen to 4-screen and vice versa

The only program that requires attention when switching between the two and four screen observing modes is MOPS.

In the four-screen observing mode, MOPS runs in the second VNC server.

In the two screen observing mode, MOPS runs in the second virtual Desktop of the VNC server

If you're in four-screen mode and would like to make sure MOPS is not running already, in the terminal window that starts MOPS in the second VNC window, type `killmops`, then `mops` to start it.

If you're in two-screen mode and would like to make sure MOPS is not running already, in the terminal window that starts MOPS in the second VNC window, type `killmops`, then `mops` to start it.

5.8. Running your observations

5.8.1. Moving/copying your schedule files

Your schedule files need to be copied to bigrock into the following directory structure:

```
bigrock:/nfs/online/local/tcs/sched/2011/MXXX
```

where XXX is your project number.

If your project directory does not exist, create it using the `mkdir` command.

If you're on a pink visitor network cable, you cannot access bigrock directly. In that case, scp the files onto minos, and then from minos, scp them to bigrock. Contact observatory staff if you need help with this.

Directory structure on bigrock:

```
/nfs/online/local/tcs/sched/2011/M123
```

this is where all schedules and catalogs you would use for project M123 go.

```
/nfs/online/local/tcs/sched/CALIB
```

is where all the pointing schedules and other calibration schedules are kept. DO NOT copy anything in there yourself. The Moprabub will get you if you do!

```
/nfs/online/current/aux/tcsgui/catalogue
```

is where the source catalogues are kept. If observing with TCS version next, substitute "current" with "next" in the path.

```
/nfs/online/local/tcs/sched is the same directory as  
~/sched_tcs or /home/atcaobs/sched_tcs
```

5.8.2. Setting focus

Use attest in the utilities screen to set the focus. Refer to this table for focus values:

Wavelength	Subreflector position	focus
3mm	16.2	
7mm	16.2	
12mm	16.2	
2.5cm	10.0	
3cm	-2.0	
20cm	-25	

Table 12 Focus positions

Select the slider in the focus tab, and click the GO button:

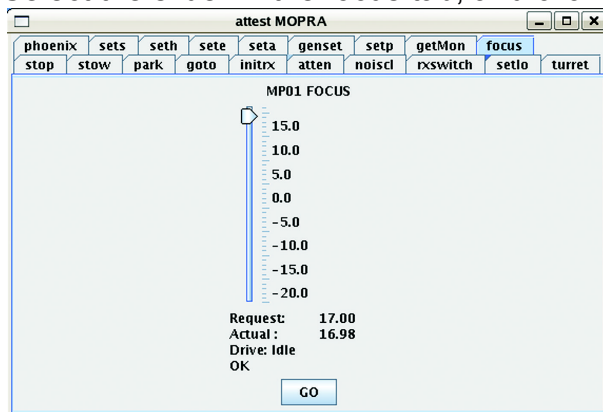


Figure 16 Focusing screen

5.8.3. Pointing

The telescope needs pointings done about once every 1.5 hours during observing in the same area of the sky, or whenever you move more than 30 degrees away from the last pointing source, and once before you start your observations.

In the unlikely event that you cannot see a maser at all, you might want to reset the pointing model to the global pointing model by executing the command `newcain pparam` in the same blue bigrock terminal where you start the `sio_point` command from and then restart the pointing schedule.

5.8.4. Starting your observations

Upon completion of the pointing, you can start your schedule by loading the schedule file into TCS and execute them. Use appropriate monitoring to make sure you are receiving proper data.

Remember to always check the bandpasses in your data in SPD on your first scan of the day, and every time you change from broadband to zoom mode. FPGA programming errors can result to spikes in the bandpasses that will ruin the data for that particular IF.

To verify this, use the SPD screen, type a to go into bandpass mode and verify that there are not extreme spikes visible. Talk to the DA or observatory staff if you see anything suspicious.

5.8.5. Verifying your data (QuickData.py)

Cormac Purcell has created a quick GUI for verifying your data with ASAP. The script is called QuickData.py and is accessible from Kaputar. It lets you easily preview Mopra data (not OTF Mapping data however). You can run this by logging into Kaputar and running the command `python /DATA/ARCHIVE_1/Mopra/QuickData.py`

QuickData quickly lets you

- Load rpf files
- Average scans
- Average polarisations
- Display the line profiles
- Save them in FITS format

Refer to the following screenshot.

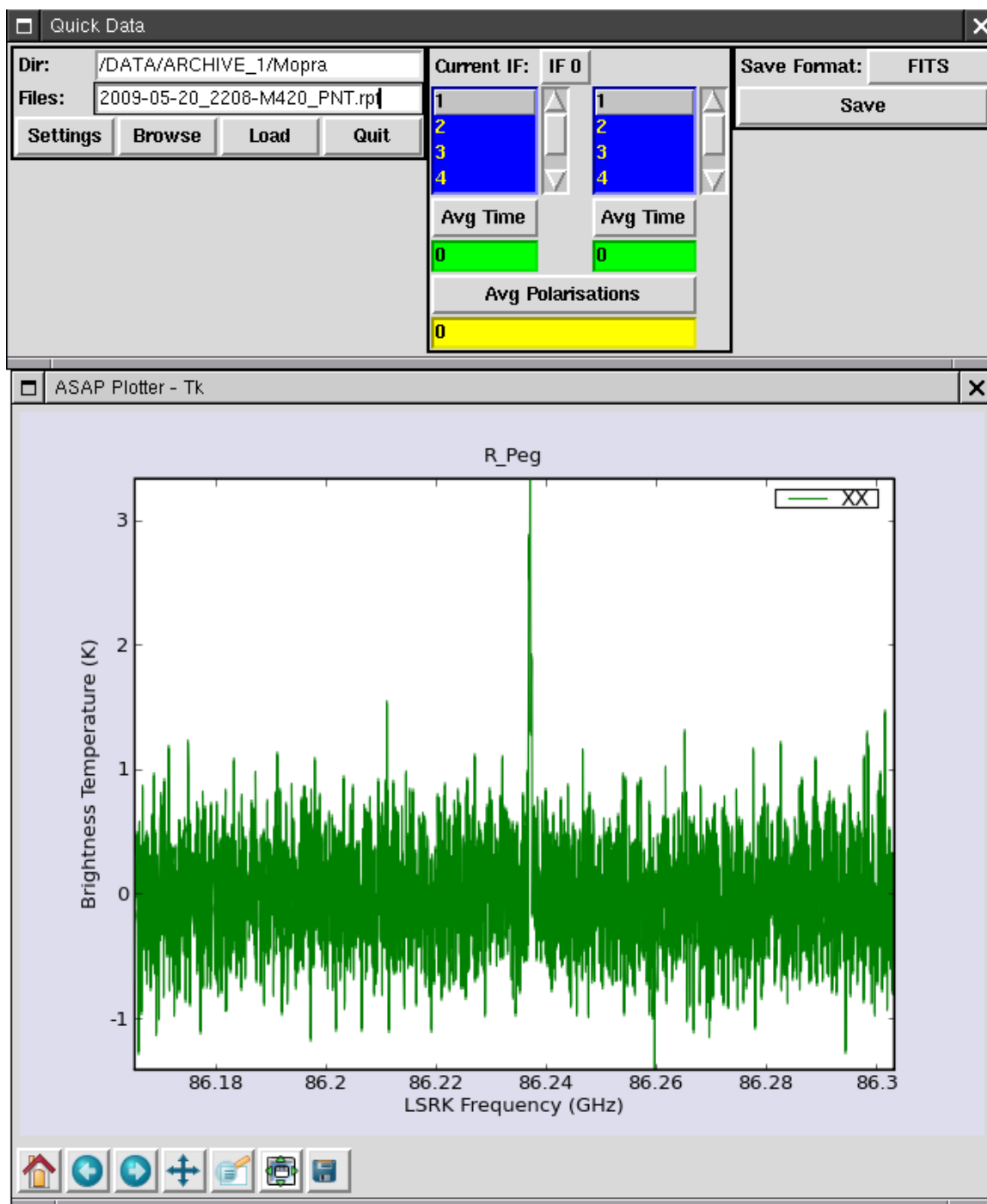


Figure 17 QuickData interface

5.8.6. Processing your data

Your data is initially stored on MPCCC1 (the MOPS control computer), and gets rsynced every 15 minutes to the archive disk at Narrabri, where you will be picking the data up.

Mopra data is stored in `/DATA/ARCHIVE_1/Mopra/` accessible from Kaputar.

The file name convention is `YYYY-MM-DD_HHMM-MXXX.rpf`, where `XXX` is your project number.

You can access those files by logging into Kaputar with your ATNF account.

For further details on data processing, refer to the online tutorials for ASAP as well as Livedata/Gridzilla here:

<http://www.atnf.csiro.au/computing/software/asap/>

<http://www.atnf.csiro.au/computing/software/livedata.html>

5.9. Online data analysis tools

We provide a few web-based tools that help you taking a first glimpse at your data. This is currently mainly oriented towards on the fly mapping observations, where it is important to get a grasp on the beam positions and noise in the maps. This will then help you in assessing whether a map needs to be repeated or not.

5.9.1. Beam position mapping tool

Point your browser at

<http://www.narrabri.atnf.csiro.au/cgi-bin/obstools/beammap.pl>

and you'll be presented with a file listing of recent observations. Note that these files are located on `ARCHIVE_1`, and hence only updated when the `rsync` between `MPCCC_1` and Kaputar is started, once every 15 minutes. Please allow for enough time before inspecting your data or you will wrongfully suspect incomplete data because the file didn't finish copying before you analysed it!

By clicking on a filename, you're sending this file into a batch process that extracts all beam positions and plots them. Here's what a map on windy day looks like:

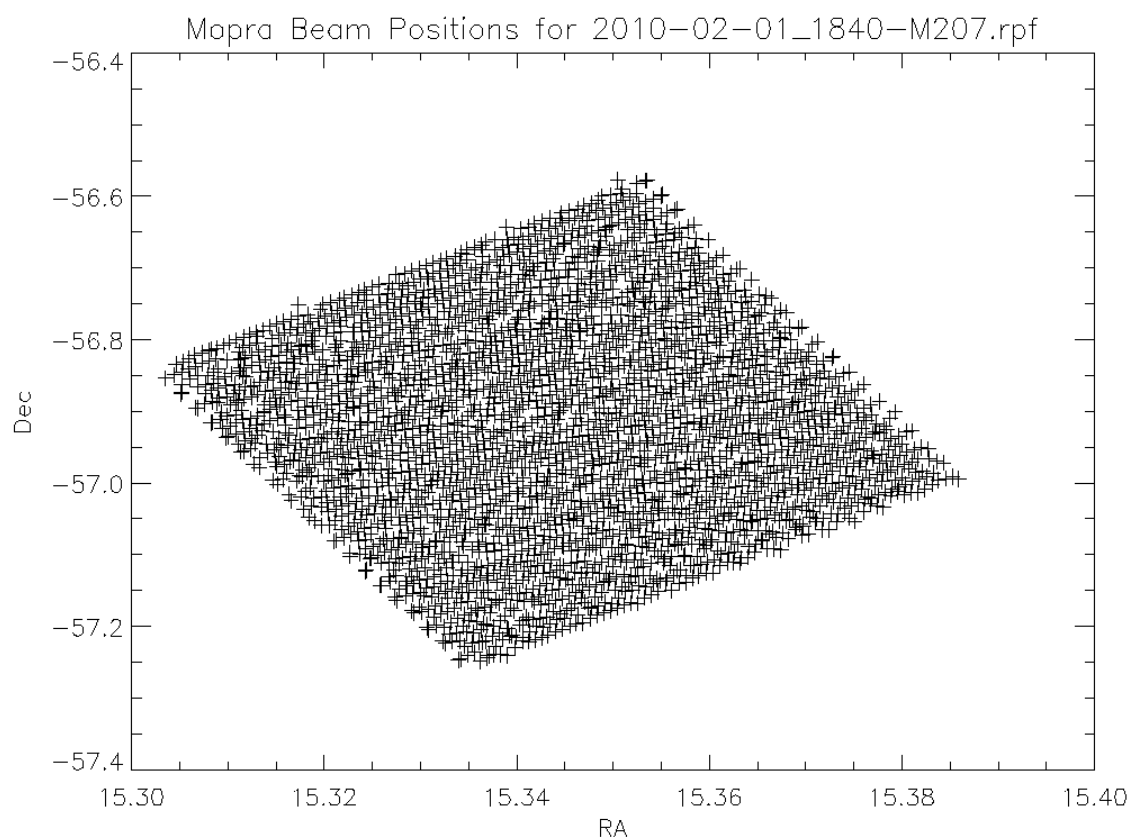


Figure 18 Beam position map on a windy day

Compare this to a map with missing scans. If you see a map like this, you are very likely going to want to redo it.

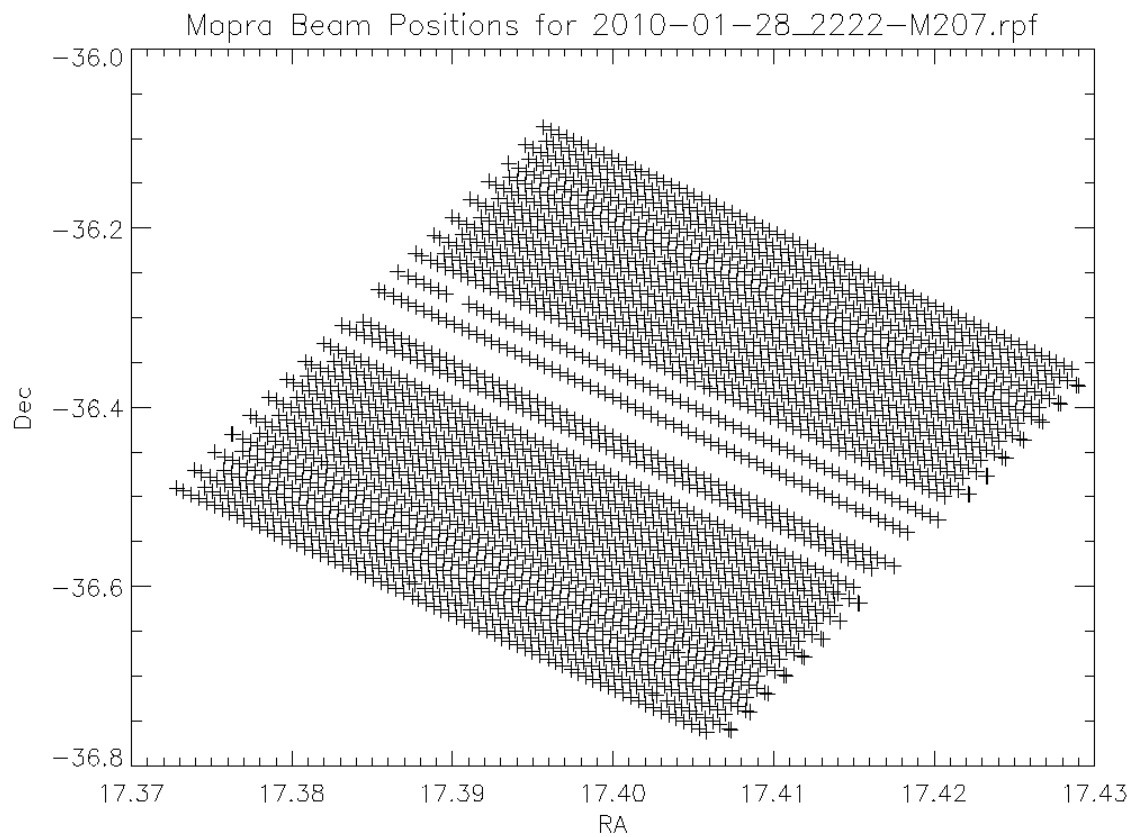


Figure 19 Beam position map with scans gone badly

5.10. Monitoring

5.10.1. TOAD

TOAD (Telescope Operator Alerting Display) is a web browser based monitoring tool. It monitors well over 400 parameters of the telescope systems and knows dozens of failure modes of various components and how to fix them.

Use this URL from inside or outside ATNF to load TOAD:

<http://mopra-ops.atnf.csiro.au/TOAD>

TOAD is compatible with Mozilla based browsers such as:

- Firefox / Iceweasel
- Google Chrome
- Safari
- Opera

It is **NOT** compatible with Internet Explorer due to Microsoft's lack of canvas object support. TOAD somewhat works on IE5 through 7, but does not work at all in IE8. It is also **NOT** compatible with Konqueror.

On first startup in a new browser, TOAD will display an INVALID PAGE. Simply click on one of the page buttons such as SYNOP to select the synoptic page.

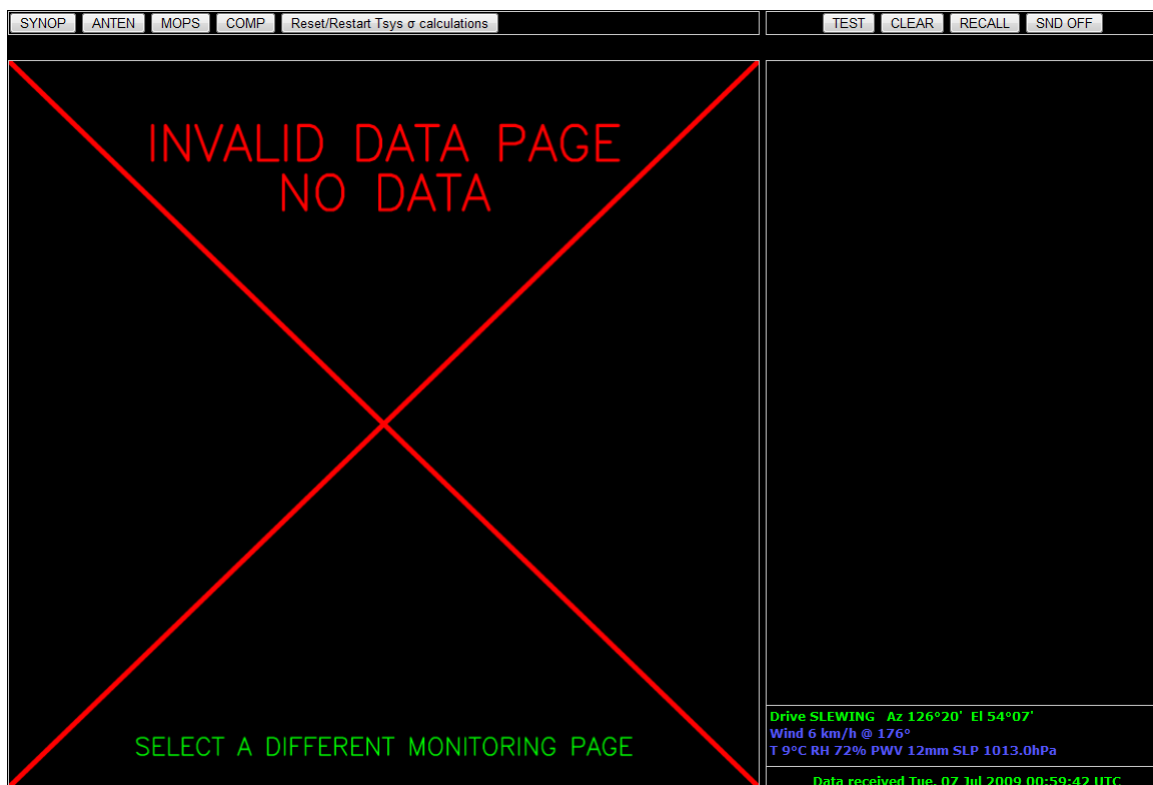


Figure 20 TOAD invalid data page

The SYNOPtic page displays (Refer to

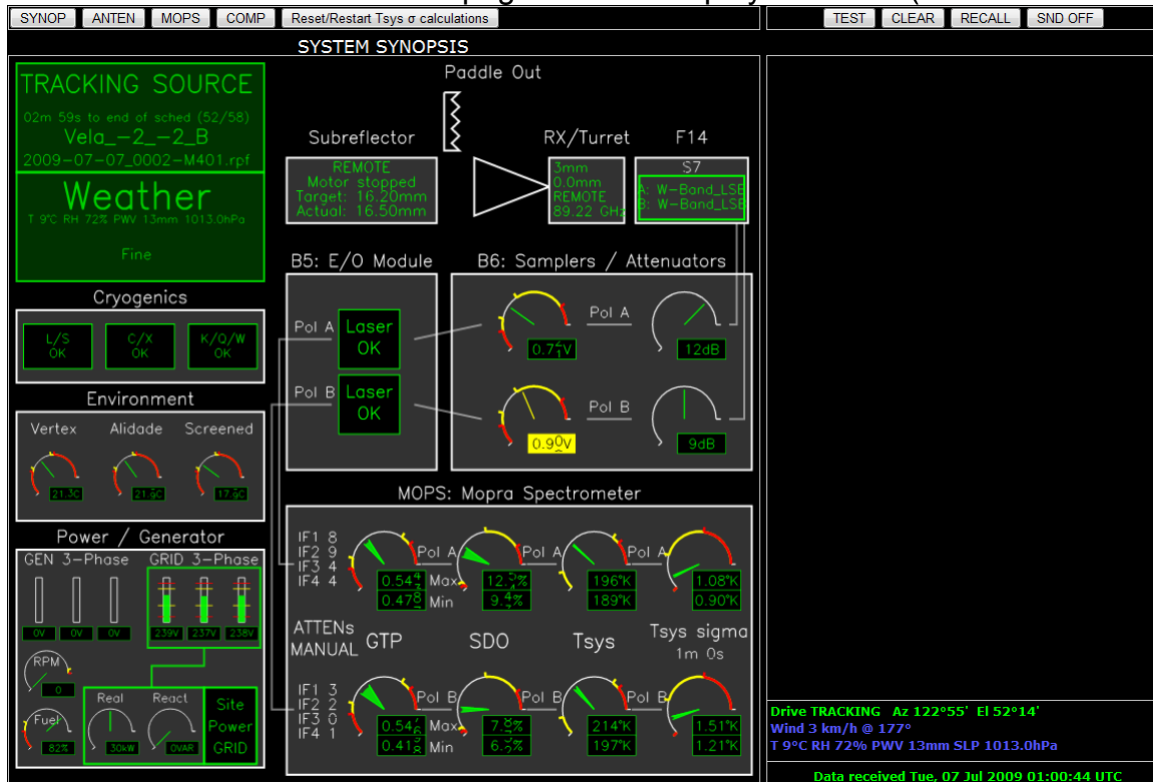


Figure 21 TOAD synoptic display):

- Antenna state (TRACKING, SLEWING, STOWED etc.)
- Weather conditions. Note that the weather condition quality (i.e. Fine) refers to Antenna safety, not observing data quality due to weather!
- Cryogenics system status
- Environment temperatures
- Power / Generator status
- Subreflector position and status
- Paddle status
- Receiver and Turret status and positions, as well as center frequency
- Millimetre switch position
- Upstairs attenuators and samplers (B6)
- Laser diode status (B5)
- MOPS samplers
 - GTP = Gated Total Power expressed in scaled units. Ideal range is between 0.2 – 1.0
 - SDO = Noise injection in % over the signal floor.
 - Tsys per sub band (i.e. each is a 2 GHz wide band!)
 - Tsys sigma = standard deviation of the Tsys over the specified amount of time. You can reset those calculations by pressing the “Reset / Restart Tsys sigma calculations” at the top of the screen.
- Messages

- Static quick access data. This data is always displayed, regardless of which page is selected.
 - Drive state, Azimuth and Elevation
 - Wind direction and speed
 - Temperature, relative humidity, precipitable water vapour (calculated figure) and atmospheric pressure.
 - Timestamp in UTC when the last chunk of monitoring data was received. This can be useful to determine whether TOAD is updating properly or whether it has frozen

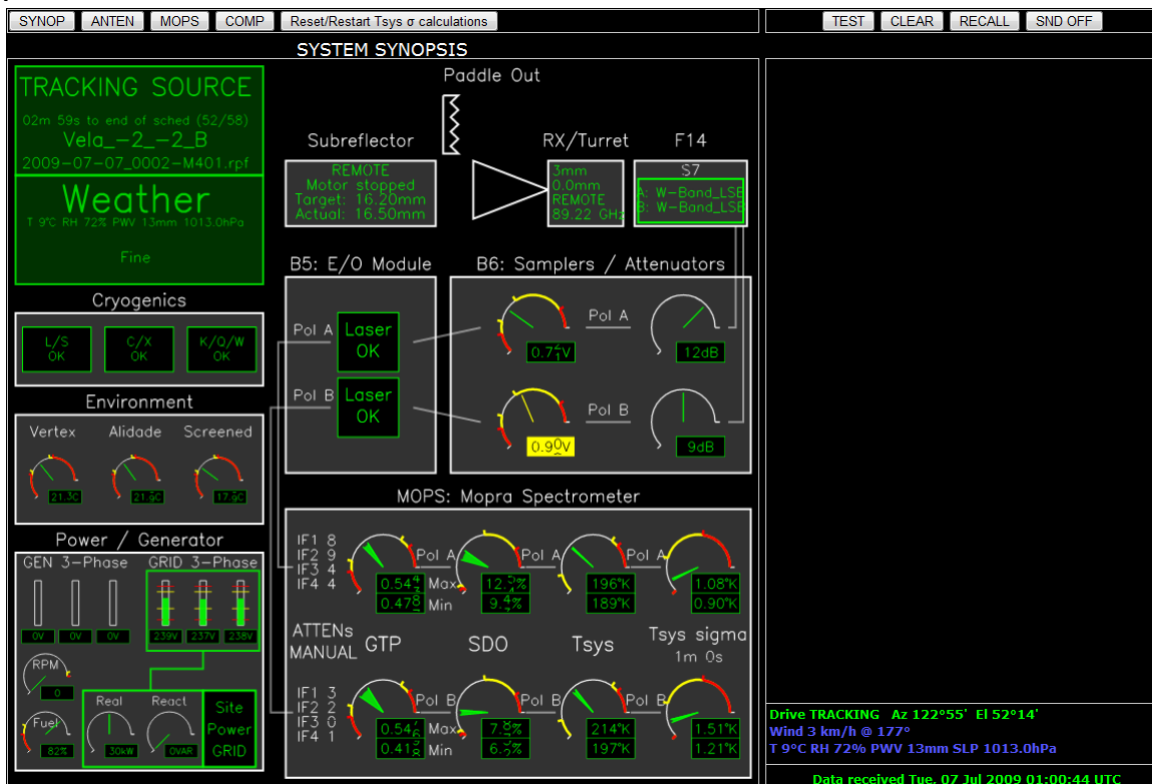


Figure 21 TOAD synoptic display

Always follow the instructions TOAD gives to recover from a failure.

Acquaint yourself with the CLEAR and RECALL functions for the warning display:

- CLEAR stops any alarm sounds and puts the warnings into the background.
- RECALL displays those warnings that are still current and have been CLEARed.

These functions will help you manage a clean workflow with good situation awareness.

5.10.2. Monica

Apart from TOAD, which should give you all operationally required monitoring information, you can selectively monitor data points using Monica, the ATNF's monitoring tool used throughout all observatories.

Monica uses a Java based viewer. You can install it on your computer and use from both inside and outside the ATNF network. If you're using it from outside, you will be prompted for your ATNF UNIX login and password.

Install the Java webstart Monica from here:

<http://www.narrabri.atnf.csiro.au/monitor/monica/>

Once installation has been completed, you first need to select which observatory to connect to, then you can either select from predefined standard pages or add your own pages with your datapoints of interest.

Good starting points are the standard pages accessible from the menu Navigator -> Favourites. As an example, refer to the wind-monitoring page:

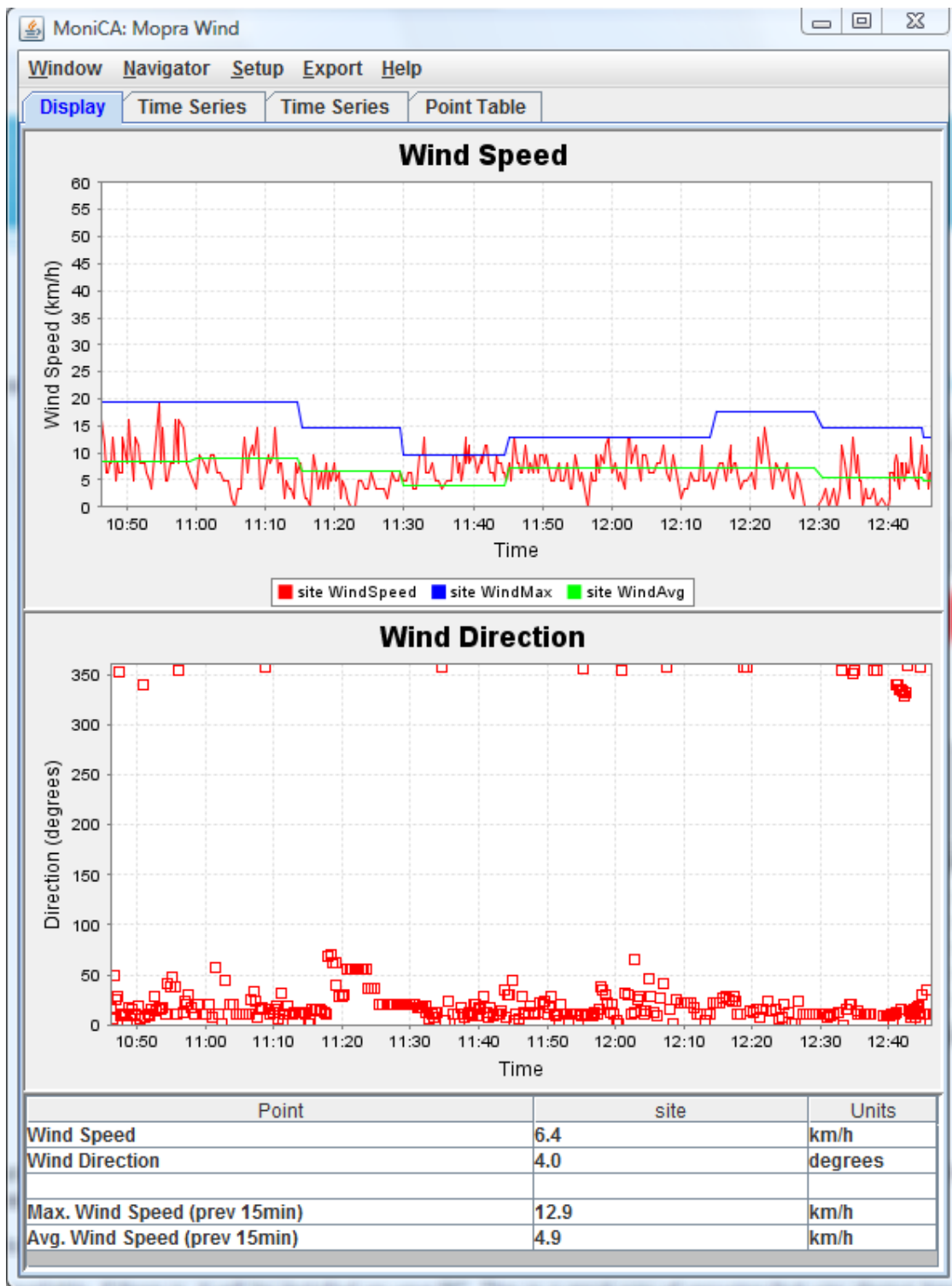


Figure 22 Wind monitoring page in Monica

5.11. Finishing the observations

When your observations are done, either hand over the telescope to the next observers or stow it. There is no further cleanup activity required apart from stowing. Stowing is accomplished by pressing the “Park” button in TCS.

6. Abnormal procedures

Most system malfunctions and advisory conditions are programmed into TOAD. You will be presented with a diagnostic message along with a recommended remedial action to resolve the conflict. Please follow the on screen instructions in the event of such a failure.

Consult with the DA or observatory staff if you're not sure what to do.

6.1. Restarting TCS

If TCS is hanging, or starting to behave very sluggishly, a restart of TCS can be indicated:

- If possible, press the EXIT button in TCS and wait for the TCS window to disappear.
- If TCS is hung:
 - bring forward the blue bigrock terminal that started TCS (hidden behind the TCS window)
 - press <ctrl>-c to kill TCS
- Make sure all TCS related processes have ended by executing the command `killtcs` repeatedly until `killtcs` does not report any processes left. If some processes are hung stubbornly, you may have to manually force kill them by executing a `kill -9 PID`, where PID is the process ID number shown during the `killtcs` command.
- Restart TCS by issuing the command `tcs`

6.2. Restarting MOPS

- If possible, attempt to quit MOPS by pressing the QUIT button on the lower right of the MOPS GUI.
- If that is not possible, switch to the green terminal window behind the MOPS window which started MOPS and press <ctrl>-c to kill MOPS
- Execute the command `killmops` repeatedly until no more processes are found.
- If some processes are stubbornly refusing to go away, you may have to manually force kill them by issuing a `kill -9 PID` command, where PID is the process ID that is displayed by the `killmops` command.
- start MOPS by executing the command `mops`.

- After MOPS has restarted, TCS must be reconnected to MOPS. For that purpose,
 - dismiss the warning messages informing you of the demise of MOPS
 - click on the amber indication displaying CORRELATOR
 - select ENABLE from the dropdown menu

6.3. Restarting atdaemon

Do not run this procedure unless instructed to do so by observatory staff. No wiki/FAQ/someone's notes should be used to justify running this. **Only do it when staff tell you explicitly to do so.**

Because an atdaemon restart requires TCS to restart and atdaemon requires a terminal that never goes away, atdaemon must only be restarted from the same terminal window that starts TCS.

- If possible, press the EXIT button in TCS and wait for the TCS window to disappear.
- If TCS is hung:
 - bring forward the blue bigrock terminal that started TCS (hidden behind the TCS window)
 - press <ctrl>-c to kill TCS
- Make sure all TCS related processes have ended by executing the command `killtcs` repeatedly until `killtcs` does not report any processes left. If some processes are hung stubbornly, you may have to manually force kill them by executing a `kill -9 PID`, where PID is the process ID number shown during the `killtcs` command.
- issue the command `atdaemonrestart` and wait. This will take a minute or so, and you will momentarily lose all monitoring data in TOAD
- Restart TCS by issuing the command `tcs`

6.4. Restarting the ACC

6.4.1. Via remote access / VNC

- connect your vnc client to **mpacc-con.atnf.csiro.au**.
- the password is the same as the atcaobs password.
- press the ctrl-alt-del button in the top left hand side of the VNC window.
- watch the ACC boot and note any error messages.

6.4.2. Via MAPS reset button

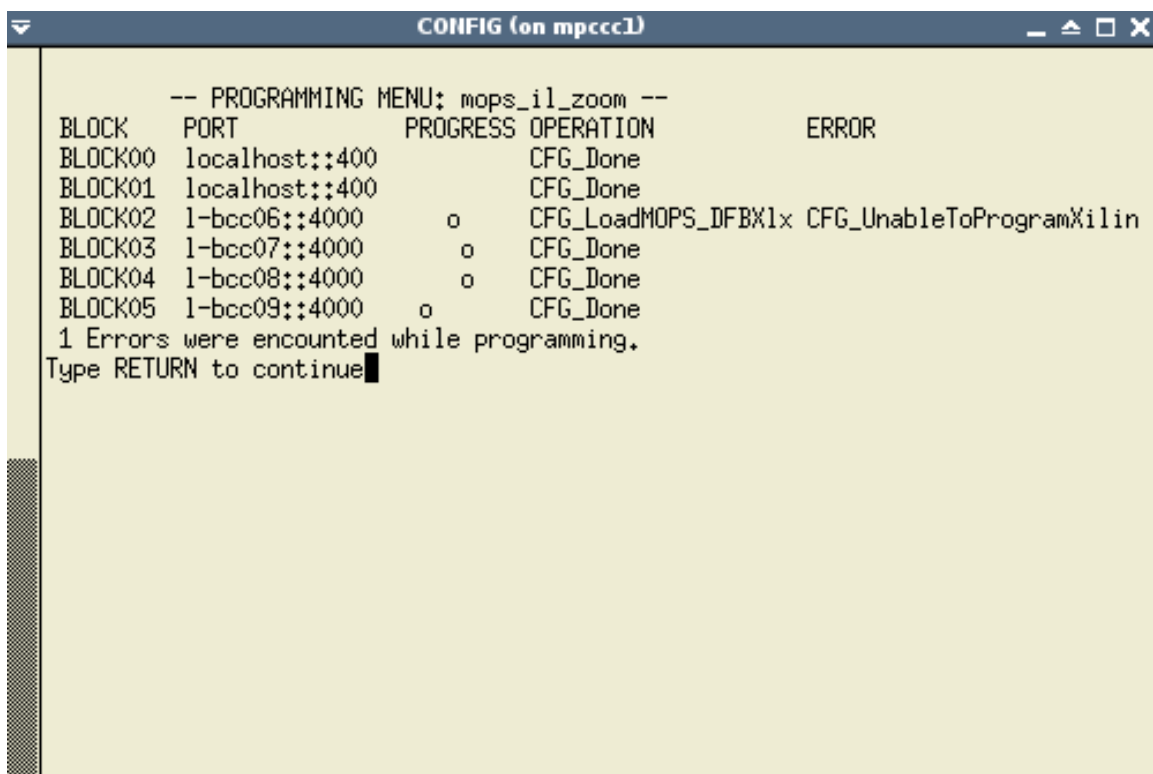
- Walk to the MAPS panel in the PMON rack at Narrabri (this obviously only works if you're on site in Narrabri)
- Press the button labelled "ACC Reset" **for at least 30 seconds (you will need a watch)** and give it a minute to reboot

Once the ACC has rebooted, it automatically becomes available and the required setup information is automatically furnished to the ACC.

6.5. MOPS programming errors

MOPS sometimes does not properly complete its own programming. In such cases, a terminal window that was displaying the progress will remain open on top of the MOPS window, so it will be immediately obvious that something has gone wrong.

Simply click the mouse into that terminal, hit [RETURN] and then type "prog" and hit [RETURN]. The programming will restart. If it fails again, repeat until it worked.



```
CONFIG (on mpccc1)
-- PROGRAMMING MENU: mops_il_zoom --
BLOCK  PORT          PROGRESS OPERATION          ERROR
BLOCK00 localhost::400      CFG_Done
BLOCK01 localhost::400      CFG_Done
BLOCK02 1-bcc06::4000    o  CFG_LoadMOPS_DFBX1x CFG_UnableToProgramXilin
BLOCK03 1-bcc07::4000    o  CFG_Done
BLOCK04 1-bcc08::4000    o  CFG_Done
BLOCK05 1-bcc09::4000    o  CFG_Done
1 Errors were encountered while programming.
Type RETURN to continue
```

Figure 23 MOPS programming error

6.6. Problems with the VNC sessions

6.6.1. VNC Server does no longer accept keyboard input

Right-click with the mouse on the desktop, and select “Workspace Menu” -> “Restart Window Manager”. This will make a temporary mess on your screen, and you will find yourself in the wrong virtual desktop inside the VNC session. Simply go back to the original desktop using the navigation buttons on the top lefthand side and you should now be able to enter text with the keyboard again.

6.6.2. Mouse exhibits weird behaviour, can't set Z-order of windows when clicking on them.

This can be fixed by restarting your VNC connection. Simply close the VNC client on your end, and restart it.

6.6.3. Ok, VNC completely pooped itself. How can I restart the VNC Server?

You'll need to `ssh atcaobs@mpvnc1.atnf.csiro.au`, `cd` into `.tightvnc` (note the leading dot) and execute `restart_Xtightvnc{x}.pl`, where {x} stands for 10, 11 or 12, depending on which VNC server you would like to restart.

Please note that executing the `restart_Xtightvnc{x}.pl` script will terminate, quite forcefully, all applications running in those VNC servers. You also will need to set up your screen as you found it after doing this.

6.7. Generator messages

Generator operation at Mopra is completely automated. You do not really need to interfere at all, except for letting us know when something happens that you or TOAD feel is out of the ordinary.

If, however, you wish to be a particularly good Mopra observer, we appreciate it if you turn the generators on manually using the MAPS control panel when you see a storm approaching on the weather radar.

This is only possible when you are observing from Narrabri. You cannot use attest or any other software method to start the generator!

6.8. Unable to bring GTP's down/up into normal range

Under some circumstances (usually weather inflicted), it is possible that you are unable to use “matten au” in MOPS to bring the gated total powers into the appropriate range. In these cases you always first try to tame the powers with the MOPS attenuators: MOPS only automatically sets attenuators in the range of 0 to 12. Any higher attenuation (up to 15 is available) must be set manually.

To set them manually, use this command in MOPS (example to set all IF's in Pol A to 15):

```
matten a 15 15 15 15
```

Repeat for Polarisation B and use different attenuator values as needed.

If that still does not produce enough attenuation (or if you are already at a marginally low power with attenuators set to 0), you can change the upstairs attenuators (B6).

Here's how to do it properly:

1. Check the B6 attenuator settings in the TOAD SYNOP window **while observing your science target**. Take note of what the numbers are at your observing frequency of interest.
2. **Note:** The attenuators change completely depending on what frequency you are observing at, so you cannot make a guess while pointing at 86 GHz for what the attenuators will be at your observing frequency of 111 GHz!
3. Open a bigrock terminal (blue) and prepare the following command (do not press enter yet):
4. `atds control -a 27 -d 0xa9 -f 0x100 -h mpacc -p 8019`
5. The 0xa9 part defines the attenuator values for Pol B and Pol A (in that order) in hexadecimal format. You need to replace those with the values you want. In this example, the numbers would set Polarisation B to 10 ('A' in hexadecimal) and Polarisation A to 9 (same in hexadecimal).
6. Start the schedule on your science target.
7. Run the above command and make sure your GTP's are within range.
8. Stop and restart, a few seconds after you've started the schedule, run the atds command again.

Note that this atds command must be repeated after every start of a schedule because TCS resets the B6 after every start!

7. Emergency

If an emergency occurs that is not covered by any of the other checklists or is not covered by TOAD:

- Contact the Duty Astronomer. If you are remote observing, the telephone numbers for the DA should have been communicated to you. If not, ring the following numbers and ask for the Duty Astronomer:
 - ATCA Control Room: +61 2 6790 4033
 - Mopra Control Desk: +61 2 6790 4088
 - Observers Area: +61 2 6790 4031 (near MAPS Rack)
 - Observers Area: +61 2 6790 4022 (middle of the area)
 - Observers Area: +61 2 6790 4048 (near Mopra Desk)
 - Lodge +61 2 6790 4027
 - DA Bedrooms: +61 2 6790 4008 or +61 2 6790 4009
- During working hours, If the DA is not available, proceed to contact one of the observatory staff:
 - +61 2 6790 4033 (ATCA Control Room in Narrabri)
 - +61 2 6790 4088 (Mopra control desk in Narrabri)

8. Glossary

Moprabub

Your nemesis. Do you know what "nemesis" means? A righteous infliction of retribution manifested by an appropriate agent, personified in this case by an 'orrible <bleep>... me! (For the full, uncensored version of this, refer to the movie "Snatch")

9. TOAD Message Reference

9.1. Information Messages (Gray)

These messages refer to information content only.

9.1.1. Track has started

Message ID: 21

Triggers when: The telescope has started moving from either stowed or idle.

9.1.2. Track has ended

Message ID: 22

Triggers when: The telescope has stopped moving from either slewing or tracking.

9.1.3. Tsys high

Message ID: 28

Triggers when: at 12mm, the Tsys is greater than 190K, with no paddle in, and the telescope unstowed.
at 3mm, the Tsys is greater than 410K with no paddle in and the telescope unstowed

9.1.4. Tsys noise high

Message ID: 29

Triggers when: at 12mm, the Tsys standard deviation is greater than 3K

This is indicative of cloudy and variable conditions.

9.2. Caution Messages (Yellow)

These messages alert the observer to conditions that can affect your data and the operation of the telescope.

9.2.1. 30min WindMax High

Message ID: 3

Triggers when: The 30 minute maximum wind is greater or equal 35km/h and
the antenna servo state is not stowed.

This message alerts the observer to strong winds and the possibility of a wind stow.

9.2.2. Telescope idle and not stowed

Message ID: 4

Triggers when: Idle or drive_error time exceeds 5 minutes while at an elevation of less than 84 degrees.

Alerts the observer to stow the telescope, or to initiate action to resolve the drive error condition preventing the telescope from stowing.

9.2.3. Generator is running

Message ID: 11

Triggers when: Generator is running and lightning threat level equals 0

The generator should not normally run, only when the lightning threat level is significant . This message can be indicative of a mains power failure.

9.2.4. Some lightning activity

Message ID: 12

Triggers when: Generator is not running and lightning threat level is greater than 1

This alerts the observer to keep an eye on the weather. The generator does not need to be started (yet).

9.2.5. Heavy lightning activity nearby

Message ID: 13

Triggers when: Lightning threat level equals 3 and the telescope is not stowed.

Alerts the user to a potentially impending storm stow.

9.2.6. ACC in local mode

Message ID: 17

Triggers when: the ACC is in local mode.

The ACC can be put into local or remote mode by connecting to the remote console.

9.2.7. MOPS Pol A counts out of bounds

Message ID: 38

Triggers when: Any of the Pol A GTP's are below 0.1 or above 1.0

9.2.8. MOPS Pol B counts out of bounds

Message ID: 39

Triggers when: Any of the Pol B GTP's are below 0.1 or above 1.0

9.3. Error Messages (Red)

These messages concern critical components of the telescope that have failed or are about to fail. Your data taking abilities will be or already are impacted by these messages.

9.3.1. Turret feed / translator disagree

Message ID: 5

Triggers when: 12mm feed is online and translator is not at 0.0mm
7mm feed is online and translator is not at 105.7 +/- 0.2mm
3mm feed is online and translator is not at 0.0mm

Alerts the observer to the feed not being on axis. Data taken while this error is active will be unusable.

9.3.2. Turret translator control is not in remote

Message ID: 6

Triggers when: Turret translator remote control is set to Local

The receiver will not be able to be changed.

9.3.3. Severe lightning threat

Message ID: 9

Triggers when: The telescope is not stowed and the lightning threat level equals 4.

The lightning threat level is derived from the lightning detector and expresses a threat level indicating the need to run generators up to storm stowing the telescope.

9.3.4. Severe lightning threat with generator off

Message ID: 10

Triggers when: The generator is not running and the threat level is greater than 2

Indicates possibly a failed generator start. Give the generator ample time to start running, on the order of 5 minutes.

9.3.5. Focus disagree

Message ID: 15

Triggers when: The difference between the actual and the requested focus position is greater than 1.0mm and the requested focus position is not 1000.0, the value it reverts to after an atdaemonrestart

9.3.6. ACC CPU load high

Message ID: 16

Triggers when: CPU load of ACC is greater than 98%

9.3.7. ACC unreachable

Message ID: 18

Triggers when: the ACC is not pingable from bigrock for three consecutive pings

9.3.8. Drive Error in AzEl exceeds 1 minute

Message ID: 19

Triggers when: the drive error in azimuth or elevation is larger than 1 minute and it persists for more than 2 consecutive data polls (i.e. 10 seconds).

This error can hint at tracking problems.

9.3.9. Drive Error

Message ID: 20

Triggers when: the drive error condition persists for more than 2 consecutive Data polls (i.e. 10 seconds).

This error can have many different origins and does not necessarily mean something is broken. When a hardware stow is issued for instance, the drive error triggers as well, because the ACC is no longer in control of the drives. The hardware stow can be issued manually by setting the stow switch on the PMON rack in Narrabri, or when the anemometers on the dish register winds in excess of 45km/h, or when the Mopra protect script detects lightning and/or wind above threshold values, a hardware storm stow is also triggered.

9.3.10. MOPS B5 module error

Message ID: 23

Triggers when: the B5 module indicates an error

The message provides detailed recovery information on how to reactivate the B5

9.3.11. MOPS B6 module error

Message ID: 24

Triggers when: B6 Pol A or B sampler levels are dropping below 0.1V

This message indicates no signal is being fed down the conversion chain.

9.3.12. Turret rotation control is not in remote

Message ID: 25

Triggers when: The turret is in local mode and cannot be rotated.

You will not be able to change receivers. Apart from that, your observations will not be affected.

9.3.13. Focus control is not in remote

Message ID: 26

Triggers when: The focus control is in local mode.

You will not be able to change the focus.

9.3.14. MOPRA PROTECT Hardware Stow

Message ID: 30

Triggers when: Mopra protect has issued a hardware stow.

This stow cannot be overridden, you have to wait for it to be released.

9.3.15. WIND Hardware Stow

Message ID: 31

Triggers when: Mopra anemometers have issued a hardware stow.

This stow cannot be overridden, you have to wait for it to be released.

9.3.16. NARRABRI Hardware Stow

Message ID: 32

Triggers when: Mopra has been issued a hardware stow from the PMON rack in Narrabri.

This stow cannot be overridden, you have to wait for it to be released.

9.3.17. Dataset Query Failed

Message ID: 33

Triggers when: MAPS 5MQ failed. An attempt at reading stow information failed

This is indicative of a severe problem involving hardware. Please contact staff if this error occurs.

9.3.18. MAPS M Card Error occurred

Message ID: 34

Triggers when: Any of the MAPS M cards could not be read.

9.3.19. Dataset Query Failed (MAPS)

Message ID: 35

Triggers when: MAPS 7MQ has failed

9.3.20. MAPS Serial Heartbeat Error occurred

Message ID: 36

Triggers when: MAPS SC6, SC7 or SC8 heartbeat failure indicator is set

9.3.21. MAPS System Error occurred

Message ID: 37

Triggers when: MAPS system error flag is set

9.3.22. MOPS Pol A noise diode faulty

Message ID: 40

Triggers when: Pol A SDO is below 0.002 or above 1

This is indicative of the noise injection having failed.

9.3.23. MOPS Pol B noise diode faulty

Message ID: 41

Triggers when: Pol B SDO is below 0.002 or above 1

This is indicative of the noise injection having failed.

9.3.24. Sound is switched off

Message ID: 42

Triggers when: The sound is switched off on TOAD.

Note that the sound should never be switched off. If you encounter nuisance warnings, please let staff know so that they can be addressed rather than silencing an essential monitoring tool!

9.3.25. MAPS dataset RPC server down

Message ID: 43

Triggers when: The dataset queries fail due to an RPC timeout

This can be indicative of the RPC server on bigrock having failed

9.3.26. Monitoring data error

Message ID: 44

Triggers when: The webserver fails to deliver monitoring data

This can be indicative of the web server being down, connectivity problems between the browser and the web server, as well as connectivity problems between the web server and the monica server (bigrock).

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