Submillimeter Telescope Observatory Mount Graham, Arizona

SMTO

User's Manual
Mount Graham, Arizona

Version 6.5

SMTO Staff

May your data be exciting and your results publishable!

May 1, 2002

Preface

This manual is intended to be the sole volume needed for successful operation at the SMTO. It contains information from previous manuals (e.g. OBST, Calibration Guide, etc) distilled into a single reference. This manual is expected to evolve as more astronomers use the facility and send comments to us.

The structure and content of this Manual are based on the NRAO 12-m manual written by Jeff Mangum who kindly lent us a preliminary version of that document. The original version of this Manual was written by Joseph McMullin.

The current Editor is Harold M. Butner (Friend of the Telescope - FOT).

Also check out our web page at

http://maisel.as.arizona.edu:8080/smt.html

Please send any suggestions for improvements to the manual or the webpage that you might have to hbutner@as.arizona.edu.

Good Luck Observing!

SMTO Staff

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Introduction

The Submillimeter Telescope Observatory (SMTO) is operated as a joint facility for the Steward Observatory of the University of Arizona and the Max-Planck-Institut für Radioastronomie in Bonn. The SMTO is one of the first astronomical facilities to be located on Mount Graham. The SMTO facility on site includes the Heinrich Hertz Telescope (HHT) inside of the Eugene Frazier Submillimeter Facility.

The telescope is scheduled for around-the-clock observing 10 months of the year, with the remaining time used for long term maintenance. The SMTO is available to and used by astronomers from any Arizona or German institution. In addition, a minimum of 10% of the Arizona observing time is made available to astronomers from other institutions on a competitive basis.

In this chapter, we present an overview of the site, the telescope, the receivers, and the backends available for use. We discuss:

- Current Observing Capabilities
- Proposal Preparation
- Travel to Telescope
- Observing Policies
- Checklist before an SMTO Observing Run

Chapter 2 presents a quick cookbook of the basic commands for observers. Here we will have quick examples of how to do basic tasks:

- Set up Commands for either continuum or line observations
- Pointing
- Continuum observations
- Line observations

While not complete, it should allow an observer to get a flying start on the observations and serve as a useful reminder of those nagging details!

In later chapters, we present more detailed information on:

- Care and Feeding of SIS Receivers (Chapter 3)
- Care and Feeding of the Bolometer Array (Chapter 4)
- Backends (Chapter 5)
- The OBST control language (Chapter 6)
- Data Reduction (various Chapters)
  - CHEF (Chapter 10.1)
  - TOOLBOX (Chapter 10.2)
  - CLASS (Chapter 8)
  - MOPSI (Chapters 9 and 4)
  - NIC (Chapter 4)
- Calibration (Chapter 11)
- Useful Appendicies on Pointing and other tidbits.

1.1 Overview of the Observatory

1.1.1 The Site and Telescope

Table 1.1 lists basic information on the observatory site and the telescope.

Table 1.1: Telescope and Site Characteristics

Site		
	Longitude:	$-109^\circ\ 53'\ 28.5''$
	Latitude:	$+32^\circ\ 42'\ 05.8''$
	Elevation:	3186 meters (10,453 feet)
Telescope		
	Main Reflector:	paraboloid D=10 m F/D = 0.35
	Subreflector:	hyperboloid D=0.69 m Fe/D = 13.8
	Focus:	Nasmyth or bent Cassegrain foci
		(2-outside each elevation bearing)
	Surface Accuracy:	<12 μm rms (from Holography 1998)
	Wavelength Range:	0.3 to 1.3 mm
	Mount:	Elevation over Azimuth
	Slew Rate:	90°/minute
	Elevation Range:	-2 to 91°
	Azimuth Range:	-90 to 450eg
	Enclosure:	Corotating building

The position/altitude of the observatory is based on 1998 GPS measurements, and refers to the intersection of our azimuth and elevation axes. Thanks to Shep Doeleman and Per Jarlemark for providing these numbers.

At 3186 meters, some people may be subject to altitude sickness. Please check with your doctor if you have heart conditions or other health problems that might be affected by high altitude.

1.1.1.1 The Dish Surface - Holography Measurements

In September 1997 and September 1998, we measured the dish surface through holography observations of the LES-9 satellite. The observations allowed us to identify panels with large deviations from the average dish surface. We adjusted the panels to reduce the deviations, and remeasured the surface. This procedure was repeated as many times as needed to bring the panels to the desired surface accuracy.

In 1997, we achieved an average surface of better than 20 μm rms. We reobserved the dish in September 1998 and found that the dish had changed little between 1997 and 1998. After further adjustments, the final surface accuracy (October 1998) is better than 12 μm rms. Details can be found on our web site or by contacting Bill Peters.

1.1.2 The Receivers

The details of the various receivers available at the HHT are given in Chapter 3, which also covers the start-up, tuning, and shutdown procedures for each of the receivers available. Detailed manuals for each receiver prepared by the receiver builders are also available at the site. We present a brief summary of each of the receivers available in Table 1.2 and Table 1.3.

Table 1.2: Spectrometer Receiver Summary

Name	**Type**	**Range (GHz)**	**# Channels**	**T_{rcvr} K (DSB)**	**T_{sys} K (DSB)**
230SIS	Facility	200-300†	1	90-110 K	500
345SIS	Facility	320-365	2	<140 K	700
490SIS	Facility	425-500	1	<150 K (430-480GHz)	3000
				225 K (490GHz)	5000
HEB	CFA	810	1	900 K	15000

† The nominal range is 215 to 275 GHz, but it possible to observe over the 200-300 GHz range.

The T_{rcvr} are those typically seen by observers doing calibrations on sky, where the receivers have been optimized for both baseline characteristics and sensitivity.

The T_{sys} values are typical in good weather (for that receiver). I.e. Tau_{225} of 0.15 or below for SIS345, 0.08 for SIS490, and 0.06 for SIS490 at 490 GHz and HEB. Note that the lower frequency receivers can achieve better T_{sys} than shown if used in excellent weather.

The HEB (or Hot Electron Bolometer) was built by the Center for Astrophysics and is used by Steward/CFA during Steward time.

Table 1.3: Bolometer Receiver Summary

Name	**Type**	**Range Wavelength**	**Comments**
19chan	Facility	0.87mm	19 element array being tested
4-color	Facility	1.30mm 0.87mm 0.45mm 0.35mm	
HUMBA	PI Kresya	2 mm	7 element array

Information on the sensitivity of these instruments is found in Chapter 12.

1.1.3 Backend Signal Processors

Several different types of spectrometers are/will be available at the SMTO:

- AOSs (Acousto-Optical Spectrometers)
- Filterbanks
- PI backends like the CHIRP.

Their characteristics are summarized in Table 1.4. The details of the spectrometers is discussed further in Chapter 5.

Table 1.4: SMTO Spectrometer Characteristics

Backend	**# Channels**	**Res.[MHz]**	**status**
AOSs			
MPIfR 1 GHz (AOS A)	2048	1.021	online
MPIfR 1 GHz (AOS B)	2048	0.996	online
MPIfR 250 MHz (AOS C)	2048	0.4	online
Filterbanks (FBS)			
256 MHz	256	1.0	online
64 MHz	256	0.25	online
8 MHz	128	0.0625	online
CHIRP			
3×180 MHz	4100	0.044	expected late spring 2000 PI - Hofstadter

Continuum data is processed with DRUMBEAT (Digital Recording Using Multichannel Backend with AT), a 64 channel backend derived from the Effelsberg 80-channel backend. See Chapter 3 for details.

The observer must tell OBST which backends to connect to which frontends (see chapter 5). Various options are possible, such as all backends going to one receiver or having two backends attached to one receiver and the others attached to a second receiver.

The software will keep track of the mode (line or continuum), depending on the type of observation requested and use the appropiate backend.

1.2 Observing Capabilities

1.2.1 Spectroscopy

The following spectral line observing techniques are supported at the SMTO; for more detailed information, see Chapters 2 and 6.2

(a) **PSWITCH**

Position Switching – The telescope moves between an offset, or OFF, position (in relative or absolute coordinates) and a source, or ON, position. The spectrum is recorded as a ratio of (ON - OFF)/OFF.

(b) **WSWITCH**

Beam Switching plus Position Switching – The subreflector is chopped at a rate of between 1 to 5 Hz (typically 2 Hz is the default). The telescope is repositioned at a prescribed rate (typically every 30-90 seconds). The spectrum is recorded as (ON - OFF)/OFF.

(c) **Total Power scans** Total Power Scans – ON and OFF total power spectra are recorded separately for later processing into final spectra. The observer may take several ON scans for each OFF.

(d) **PRASTER**

Conventional Mapping – Total power or absolute position data are acquired while the telescope moves to user-specified spatial positions on a rectangular grid.

(e) **WRASTER**

Convential Mapping – Beam Switching plus Position Switching while the telescope moves to user-specified spatial positions on a rectangular grid.

(f) **PMAP**

On-The-Fly Mapping – Telescope scans in a raster pattern at a constant rate. Preferred method for maps.

1.2.2 Continuum

The following continuum observing procedures are supported at the SMTO; for more detailed information, see Chapters 2 and 6.2 They work for the bolometer array as well as the 4-color.

(a) **CONOFF**

ON/OFF's – With the subreflector chopping, the telescope moves first to one beam position and then the other. Appropriate for point source observations.

(b) **CMAP**

On the Fly Mapping – The telescope scans in Azimuth and then steps in elevation. While doing this, the telescope will wobble in azimuth. This nod data can then be reconstructed with MOPSI or NIC software to produce a map of the region.

Useful to map a source or map the beam if one has a known source. Will be the preferred option for the array in most cases.

1.3 Computer Systems

We have a internet link to the outside world, that will allow you to telnet from the SMTO computers to anywhere else.

1.3.1 VAXs and X-terminals at the SMTO

Two VAXstations perform the bulk of the work for observing:

- Kronen The processes involving telescope control and data acquisition are performed with Kronen while Frankenheim is used for the observer interface and data reduction (see Chapters 2, 6, 10.1, 9). Raw data is stored in the area TEL$NEW_DATA, currently KRAW:[SMT.DATA].

- Frankenheim[1] When logging into Frankenheim, the observer logs on under OBS. This initializes a number of processes on both Kronen and Frankenheim. The observer has his/her main account on Frankenheim in the directory FDATA:[OBS.XXX], where XXX are the observer's initials used in setting up OBST. New class spectra are automatically stored in the file SPECTRA.SMT in the observer's area. In the observer's account, she can set up procedure files and catalogs for her own use.

Several X-terminals are also available. Two X-terminals are at the main control table.

- Hachenburger — which is a display terminal, providing information on the telescope position, status and diagnostic information. Usually there are four windows, including an error log window, a color monitor (which has detailed telescope information), and a window displaying the current scan information. The fourth window monitors the phase lock of each receiver and the AOS chiller.

- Koenigsbacher — is used for monitoring the data as it comes in and also is used for occansional system tasks. The CHEF window displays the most current observation automatically. The ONDIS window displays the online display program status. It is located on the other side of Frankeheim and typically runs the xephem program which provides up-to-date information on the location of planets and bright continuum pointing sources.

- Waldschloss — which is utility x-terminal available for data reduction, access to the internet, etc, located by the laser writer. It is usually used as a second console for the Sun Workstation, Jever.

[1] The SMTO follows the convention of naming its computers after German beers

1.3.2 Unix machines

Currently, there are two Sun workstations,

- jever (a Sun Ultra-Sparc) - the main UNIX machine, in control room.
- hannen (a Sun Sparc-10) - located in the office on the 2nd floor.

In general, the observer will use the smtobs account (see below), and create a subdirectory with his/her initials.

If a special account is needed, contact Bill Peters about the possibility of generating a specific user account.

The following software has been installed on jever (and is accessible from hannen):

- TOOLBOX (CONT2 and DRAW2)
- MOPSI
- GAG (NIC, CLASS, GREG, LOVAS, FREQ, ASTRO, XCLASS ... etc)
- PGPLOT

1.3.3 The SMTOBS account on jever/hannen

There is a site account, smtobs, which is accessible to visiting astronomers. This account has access to the software discussed above in addition to a netscape icon setup for the SMTO homepage (mirror site and httpd server setup on jever or hannen to (mostly) avoid network torpor for browsing SMTO documents),

Since many observers will use this smtobs account, we recommend that observers create a subdirectory based on their initials and do their data reduction and other tasks there.

Jever and Hannen's disks have been crossmounted with Kronen's and Frankenheim's.

To get to the VMS disks from hannen (or jever):

```
    cd /net/kronen/dua0              for kronen$dua0
    cd /net/kronen/kdata             for kronen$dua2     (kdata)
    cd /net/frankenheim/dka0         for franke$dka0     (fdisk)
    cd /net/frankenheim/dka100       for franke$dka100   (fdata)

  for example: If you are on a hannen account, then
  to copy SPECTRA.SMT over to your current hannen directory:

       cp /net/frankenheim/dka100/obs/XXX/SPECTRA.SMT .
```

To get to hannen (or jever) from VMS machines:

```
     set def hannen_home:[directory]    for /export/home
     set def hannen_home0:[directory]   for /export/home0
     set def hannen_home1:[directory]   for /export/home1
     set def hannen_opt:[directory]     for /opt       *
     set def hannen_usr:[directory]     for /usr       *
                                       *=mounted read-only
```

Remember that on Frankenheim you are OBS. On jever/hannen, you are smtobs.

1.3.4 Class on Jever and Hannen

The smtobs account on the Unix workstations jever and hannen is used to access and reduce SMT data. All data reduction programs (Grenoble software including Class, Graphic, Astro, NIC, Mopsi, XClass, Karma, etc...) are installed on these workstations.

Your data are written onto a disk in the Vax Frankenheim

```
FDATA:[OBS$<$your initials$>$]
```

In the smtobs home directory on jever and hannen, there is a symbolic link to the FDATA:[OBS] directory. This is called obs and invoked by

```
ls obs       --- will list the FDATA:[obs] directory
cd obs       --- will change to the cross mounted FDATA:[obs] directory
```

Thus, your data is available under /home/smtobs/obs/<your initials> where <your initials> are the initials you used for your OBS session on Frankenheim.

In *Class*, use

```
FILE IN "/home/smtobs/obs/<initials>/spectra.smt"
```

to access the data (the double quotes are necessary because of the slash (¨/¨) which is the GAG option separator.

We provide two aliases (spectra and fspectra) whcih make access to your *Class* data even easier. Type either command and you will be asked for your initials (used on Frankenheim).

Typing *spectra* in *Class* will do a *FILE IN* like above.

Typing *fspectra* starts *Freq* (i.e. *Class* plus *Lovas*) instead of just *Class*.

1.3.5 Tucson Computer Facilities

In Tucson, there is a Sun Sparc-20 workstation – **steffens** – (currently used by Michael Dumke), located in room 478.

Three visitor accounts have been set up on steffens: **smtv1, smtv2, and smtv3**. These accounts are moderated by the staff Friends of the Telescope; see them for current passwords and/or instructions.

These accounts are also currently setup to use the following software:

- TOOLBOX (CONT2 and DRAW2)
- GAG (CLASS, GREG, NIC, etc)
- XCLASS
- PGPLOT
- MOPSI

You can run them from **maisel** as well, located in Room 482.

1.4 Proposal Preparation and Submission

1.4.1 Proposal Refereeing

Each institution (SO and MPIfR) has a separate TAC committee to referee and approve proposals for its share of the facility time. The approved proposals then are scheduled by the SMTO director (Dr. Tom Wilson).

1.4.2 Proposal Preparation

All proposals should include a completed SMTO Observing Application Cover Sheet (Appendix H). The body of the proposal must include:

(a) A concise scientific justification for the project (Do not exceed 1000 words);

(b) An estimate of the observing time required;

(c) Frequencies and source coordinates to be observed.

As a proposer, you should insure that the project is within the capabilities of the telescope, both in terms of available equipment and the sensitivities and integration times required. (Otherwise you will just be giving the TAC a good laugh...) The telescope and receiver parameters given in Chapter 1.1 and the system sensitivities in Chapter 12 will be of use in estimating the required integration times. The most up-to-date information on these parameters can be found on the SMTO Home page (*http://maisel.as.arizona.edu:8080/smt.html*).

1.4.3 Proposal and Observing Propriety

Observers are expected to confine their observations to those described in their refereed proposal. It is absolutely essential that observers consult with the scheduler (the SMTO director) and obtain his approval before altering scheduled observing programs. Approval for changes can be granted under those circumstances that do not lead to an infringement on work proposed by others, and when the changes are in keeping with the spirit of the original, refereed proposal. These rules are fundamental to the integrity of the observing system at SMTO and are taken very seriously by the management.

1.5 Traveling to the Telescope

1.5.1 Logistics before Arriving

Please submit refugium permit requests to Susan Lake in the SMTO Tucson office at least 1 week in advance. Her email address is slake@as.arizona.edu, (phone 520-621-5290, fax 520-621-5554).

Site support (for the SMTO, Vatican Advanced Technology Telescope(VATT) and the Large Binocular Telescope (LBT) project) is supplied by the Mount Graham International Observatory (MGIO). The observatory site is located at an altitude of 3200 m near Emerald Peak on Mount Graham in the Pinaleno Mountains of Eastern Arizona. The site is within a squirrel refugium. The refugium is an area of limited access, designed to protect the endangered Mount Graham red squirrel subspecies. For this reason, only persons with observatory business are allowed to enter the refugium and they must be in possession of a special permit. In addition, there are restrictions on where in the refugium visitors are allowed to walk. Generally, visiting astronomers will be limited to the immediate area surrounding the SMTO site and the access road. Hiking trails are available on other portions of Mount Graham *outside* of the refugium.

Before proceeding up the mountain, you are required to check in at the base camp. Here you sign in with MGIO and also pick up your permits. Permits are issued by the MGIO support staff during check-in at the base camp. In addition, a separate permit is required for any non-SMTO/VATT/MGIO vehicle. The observer's name and vehicle license plate number are required for the refugium permits. This information should be provided to Susan Lake in the SMTO Tucson office before you arrive. For safety reasons, all personnel must sign in and sign out at the base camp for each and every trip up to the observatory site. The SMTO is significantly higher in elevation than either Pico Veleta or Kitt Peak. The effects of altitude vary from individual to individual but they are generally quite noticeable. Persons should be cognizant of the health hazards of working at high elevations.

We recommend that persons in poor health do not attempt to work at the observatory site.

SMTO has a limited number of vehicles and they primarily are used by the staff for trips to the SMTO. There is a Chevy Blazer (4 wheel drive) for use by visiting German astronomers. The SMTO therefore encourages observers to obtain a rental vehicle for use in Tucson and trips to Safford or the observatory outside of staff travel times. This will allow maximum flexibility for visitors. For observers who fly into Tucson, the SMTO will make hotel reservations upon request, normally at the Plaza International. This hotel is a five minute walk from the SMTO offices on campus. Affordable transportation from the airport to the hotel is available from "Arizona Stagecoach"-a shuttle service, although groups of two or more may prefer a taxi. Car rental facilities are also available at the airport. The University of Arizona is approximately 20 minutes by car from the airport. *Please arrange travel details with Susan Lake in advance* The SMTO offices in Tucson are located on the fourth floor of Steward Observatory (SO). The SO is located at 949 N. Cherry Avenue (between 2nd Street and the UA Mall) and is directly opposite the Kitt Peak National Observatory building. The office hours for the Tucson SMTO offices are

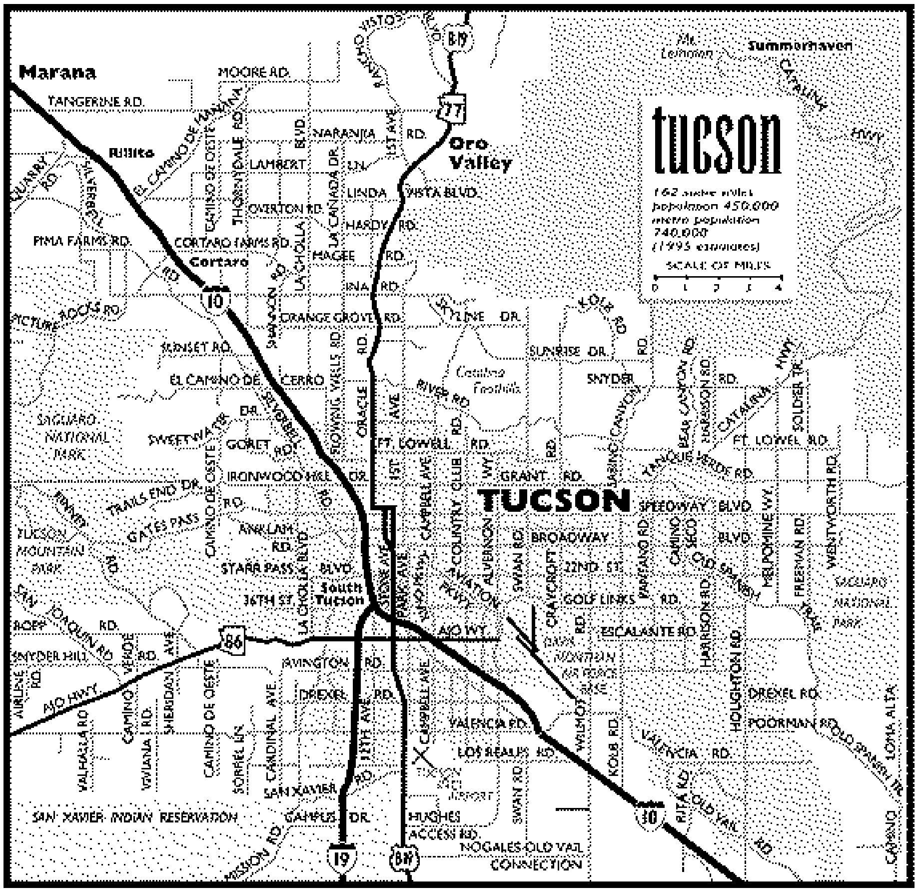

Figure 1.1: Tucson Map

generally between 08:00 and 17:00 Arizona time, Mondays through Fridays. Parking on campus is very limited, so if you have a car, please contact the SMTO on where to park.

The MGIO base camp is located 120 miles (190 km) from campus (about 2 hours drive). Drive east on Interstate 10 to exit 352, then north on State Route 191 to State Route 366. This latter highway is also called The Swift Trail. The base camp is at 1480 W. Swift Trail. The base camp is directly across the street from the Federal Prison which is clearly visible by its barbed wire double fence. All personnel must stop at the base camp to sign in and obtain all required permits. In addition, if you do not have a radio and keys, you can pick them up here. However, it is preferred to get these items at the SMTO office in Tucson. Since there is a locked gate, you will need the keys. The radio serves two purposes: (1) Safety, (2) it allows you to find out if any traffic is on the access road. (See below)

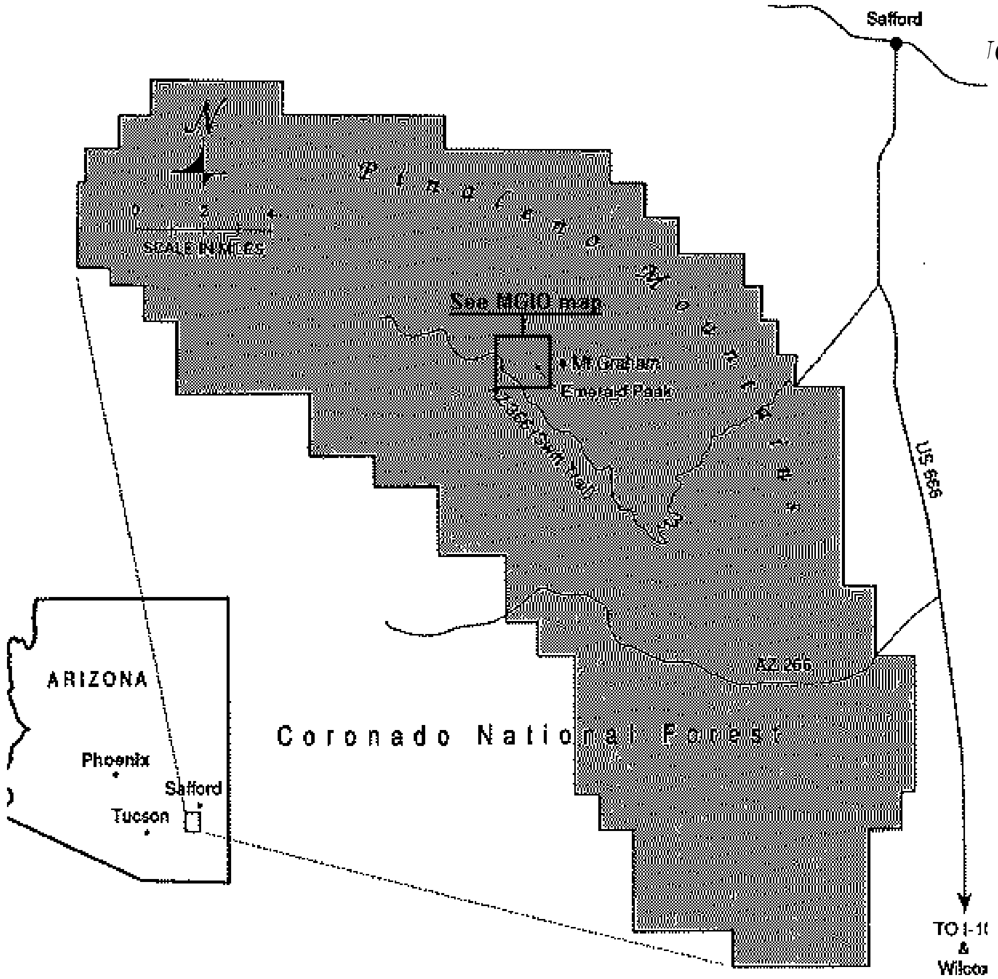

Figure 1.2: Coronado Forest Map

1.5.2 Driving from Base Camp

The distance from the base camp to the observatory is about 30 miles, covering an altitude difference of about 7,600 ft (2300 m). The first 22 miles are a well maintained (but slow) paved mountain road; the remainder is unpaved road. Normally, outside the winter season, the observatory can be reached by passenger car in less than 75 minutes. In winter, a four-wheel drive vehicle and more time are required. The paved section of road is cleared of snow by ADOT, the dirt section by MGIO.

There is a locked gate. During the winter, the locked gate is at the end of the paved road (mile marker 136). In the spring/fall, the locked gate is at the bottom of the access road, just after mile marker 142. The access road is a one way road, about 2 miles in length (shown in Figure 1.3 as the road leading down from the SMTO/VATT), so that you must ask if there is any traffic coming the opposite way before you proceed. Usual

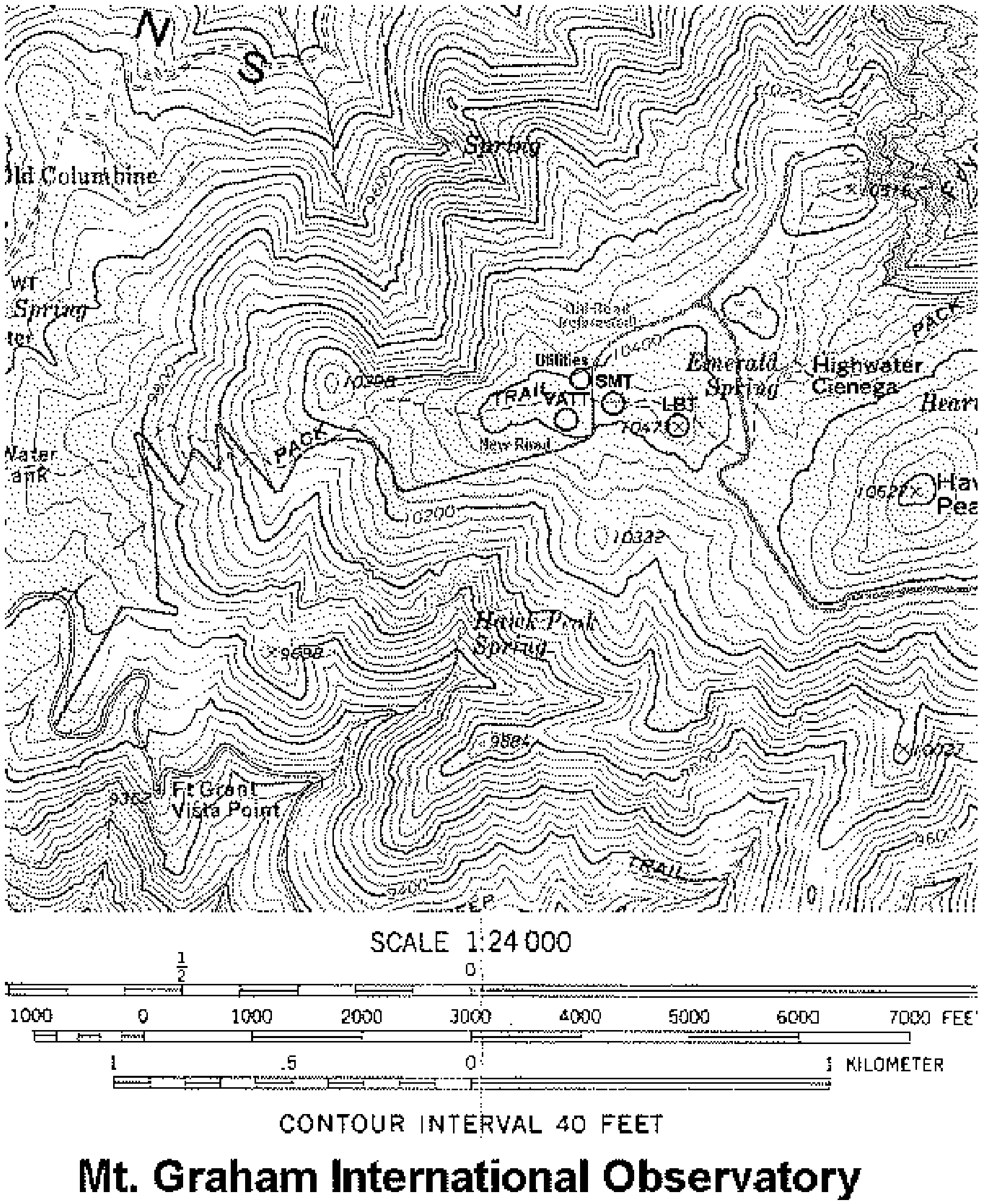

Figure 1.3: MGIO Topographic Map

protocal is to ask three times (to give time for a response) and then to announce that which way you are going. If going to the telescope, you would say "One car going up the access road". If going down to base camp, you would say "One car going down the access road". **Observers are required to get keys and radios before leaving the base camp in Safford. They must be aware of the driving protocal on the mountain at the access road. Ask if you are not sure on how to work the radio.**

MGIO provides a shuttle service between the base camp and the site. The shuttle leaves the base camp at 6:30 and returns by 16:30. An hour and one quarter is the nominal driving time up the mountain. This is a four-wheel drive, six-passenger vehicle. If needed, observers are encouraged to schedule their time to utilize this service. An experienced mountain driver operates this vehicle.

1.5.3 At the site

At the site, the SMTO maintains 8 bedrooms, each with a bathroom. Five rooms are inside the SMTO building, 3 others are in an adjoining trailer. In view of SMTO's responsibility for the safety of the facility and technical assistance, two SMTO staff will always be on site, leaving room for visiting observers to stay overnight at the observatory. If an observer team needs to be larger, some of its members will have to commute to a motel in Safford. It is also possible to stay at the VATT if there is space available, but that can not be guaranteed in advance.

Each observer at the SMTO site is responsible for buying and preparing his/her own food while at the telescope. Facilities provided by the SMTO include a fully equipped kitchen with refrigerators, gas range and oven, microwave oven, etc. General condiments, like salt, pepper, sugar, tea and coffee are also stocked by the SMTO. Food also may be acquired in Tucson prior to driving to the Observatory; however, there are no supermarkets within walking distance of the Plaza International Hotel. Again, a rental car is recommended. Limited shopping opportunities (a large grocery store) are also available at Willcox, AZ or at the small market just before the MGIO base camp.

Presently, communication to and from the site is available through two telephone lines, one of which doubles as a FAX connection. We also have a continuous data link to the Tucson computer and Internet. This link provides telnet communication to the outside world. Observers will be billed for telephone calls while at the observatory. The use of a telephone calling card for this purpose is strongly encouraged.

1.6 Observatory Policies

1.6.1 Safety is Our First Priority!

Due to the isolated location of the observatory, personal safety is our top priority. We advise all new users, particularily those unused to high altitudes, to pace their activities for the first few days at site. This will give you a chance to aclimatize. As an example, we do not allow observing when only one person is on site. Since there should always be at least one SMTO staff person on duty (usually two), a single observer at the telescope is possible. Two or more observers naturally increases your safety Coincidently, it is much easier to do many of the telescope operations if at least two observers are present! 24 hour observing is possible when there are at least two observers. (Note that if you will not be using the telescope for an extended period of time, let the staff know-we always have staff tasks to do!)

Be sure to allow time for you to sleep and for driving to and from the site. The roads can be an adventure at time-particularily if you are tired. We would like to see you come back!

Second in our list of priorities is the safety of the telescope, which includes NOT pointing at the sun or observing during 100 mile gales-no matter how neat the data! People violating safety rules (personal or telescope) will be reported to the SMTO director and appropiate actions will be taken.

1.6.2 Staff Responsibilities

The following is the responsibility of the SMTO staff:

- To insure that the equipment needed for your observations is available and installed at the telescope.
- To provide sound telescope pointing.
- To provide you with fundamental telescope calibration parameters – efficiencies, beamwidths, etc – at standard observing frequencies.
- To provide advice on observing strategies, if requested.
- To provide training on how to use the telescope system, including both the computers and the receivers. This will primarily be done by the Friends of the Telescope (FOTs).
- To help the observer in case of trouble.
- To care and feed the telescope system.

1.6.3 Observer's Responsibilities (HEY YOU!)

As the visiting observer, you have the responsibility for proper supervision of all aspects of the observing program. This includes:

- Providing to the SMTO staff, well in advance of the time scheduled, a full description of the equipment needed for the observations as well as a complete list of frequencies to be observed. Usually this information is included on the proposal cover sheet.
- To verify the telescope pointing and fine-tune it as needed.
- To obtain all calibration and other receiver/telescope parameters necessary for data reduction. This can be done either by adopting or scaling the SMTO-provided information from standard frequencies, and/or by making the appropriate measurements. In either case, proper data calibration is your responsibility, not the SMTO's.
- After a short training period, to operate the telescope and tune the receivers as necessary.
- To take great data and publish it!

1.6.4 Maintenance and Repairs

Regularly scheduled periods of maintenance and system tests are scheduled each week, typically between the hours of 0800 and 1700 MST Wednesday (while the Safford crew is on the site).

There are also regular sessions of pointing observations.

Once a month, there is staff time for extended maintence and system work.

1.6.5 Sharing Telescope Facilities with Other Observing Teams

Since living quarters and work spaces at the telescope are limited, you should leave the mountain as soon as possible at the end of your run, allowing, of course, for a reasonable period of rest. If you wish to continue the reduction of your data sets, you should do so at the SMTO visiting astronomer's office. When two or more observing teams are sharing observing time, the team currently observing has priority to all telescope facilities, including computer usage. The other observing teams should endeavor to stay out of the control room and not interfere in any way with the ongoing observations. Unless one group of observers is declared the "prime observer" on the telescope schedule, equipment changes needed for a program will be done at the beginning of that program's time.

Note that the possibility of multiple teams is why it is important to coordinate travel arrangements with Susan Lake, so that the vehicle and housing arrangements are clear.

1.6.6 Observations Under Poor Weather Conditions

There are a variety of weather conditions which can endanger the safety of the telescope. It is the responsibility of the *observer* to take appropriate action if any of the conditions listed below occur. Several monitors of weather information are available:

- A tipping radiometer operating at 225 GHz takes measurements every 30 minutes. The control to the tipper is in the control room. Currently the control panel is located in the SAMBUS rack. A plot of the last day or two is given on the taumeter screen. In addition, updated tau plots can be found on the SMTO website: (http://maisel.as.arizona.edu:8080/smt.html)

- The color monitor display (on hachenburger) gives information on the current wind speed, the wind speed averaged over 5 minutes, the highest wind speed (gust) in the last hour, and the highest wind speed (gust) in the last 24 hours. If the wind limits are exceeded, warning messages are posted on OBST display. The color monitor will also go red in the appropiate wind speed area. You are responsible for shutting down the telescope if the winds get too high.

- The SDH display (on hachenburger) reports the current readout of the pressure, temperature, relative humidity, and the estimated refraction index. In addition, it displays the most current tau reading from the tipper.

- Current satellite maps may be brought up through the links on the netscape session on jever or hannen.

If the site manager or FOT judges that the telescope is in danger - he has the authority to shut the telescope down! That includes for wind, rain, snow, sun, etc. We want you to get data, so if we ask you to shut down, please realize that it is because the telescope/building has to be protected. We will try and let you open as soon as it is safe to do so.

The next section provides the ground rules for closing.

1.6.7 When to Close

- **High Winds** If the wind is gusting to above 30 mph, or the 5 min average wind velocity exceeds 15 mph, the doors and roof must be closed. The wind velocity is printed out in the lower right hand corner of the color monitor display. The top number is the immediate value, the second number is the 5 minute average, the third number is the hour gust, and the bottom number is the 24 hour maximum value of a gust.

  If the limit is exceeded, then the appropiate display changes to red. *Stow the telescope and close the doors.* Then consult with the FOT or site manager about when it will be safe to open.

- **Moisture Accumulation In or On the Dome:** If the outside railings or the door panels show signs of dew or ice, close the building. If the 225 GHz opacity (or T_{sys}) shows a sudden change, it is necessary to step outside to check the sky conditions. If the conditions are threatening, then you may have to close. Close immediately if it starts to rain or snow. Clear any accumulation before resuming. We have a rain gauge-which will warn you if it starts raining. However, you should be closed BEFORE it rains. The reason is that the doors take a long time to close. You will have to wait for a while (at least 60 minutes) after the rain/snow stops before observing again.

- **Humidity Above 95%:** Close if the relative humidity gets above 95%. Observers can open again if humidity drops to 90% (and it is not snowing or raining!).

- **Sun on the Dish:** The sun safety circle for the SMTO is 30 degrees. Software is installed to prevent moving within this circle. However, if the drive has been disabled, it is still possible to have the sun drift into the safety limit. Thus, be aware in the daytime where the telescope and where the sun are if you happen to wander upstairs to tune!

  A CCD camera has been mounted on the telescope to detect the sun within a circle of 29 degrees; if it detects the sun, an alarm will sound throughout the building. **Run (don't walk) up to the control room and move the telescope to a safe position.** Tell the site manager what you did and he will punish you accordingly.

If you have doubts about the weather - consult an FOT or site manager. Remember, FOTs and Site Managers can/will remove observers who do not use the telescope responsibly. Better safe than sorry.

You CAN and SHOULD get an FOT/Site Manager when you are in doubt about whether it is safe to open up or necessary to close down. Even if we are sleeping - wake us!

1.7 Checklist Before Your SMTO Observing Run

Get Time!

- Submit Proposal to appropiate Time Allocation Committee
- Wait by the Phone to hear the TAC results, check email every ten minutes...

After Awarded time:

- Contact Susan Lake (phone: 520-621-5290, fax: 520-621-5554, email: slake@as.arizona.edu).

  You have to make coordinate travel plans and to make sure that you have all necessary permits for you and your car ready at base camp. You will confirm with Susan what hotel arrangements you will need to have made (you will be paying for them yourself).

  If you **do not** intend to drive up the mountain in your car, you will have to ride with staff, which requires coordinating your schedule to ours - not the other way around.

  Also you will confirm where you are to pick up the keys/maps/radios. Usually you will pick the keys up in Tucson at the SMTO office.

- contact Friends of the Telescope (Bill Peters (Friend-in-chief), Harold Butner, Michael Dumke, Paul Gensheimer, Baltasar Vila Vilaro) for latest on the telescope/instrument status as well as what information to bring.

  You should plan to bring a list of the program objects, the appropiate calibration objects, the required backends, and the desired frequencies.

- Pick up food before heading to base camp. Wilcox is convenient for this, with a nice Safeway Store, though shopping can be done in Tucson as well.
- Stop at base camp on way up to sign in, pick up your permits, verify radio call procedures, and make sure that you have the keys and radio you need to go up the access road.
- DRIVE SAFELY! Winter time in particular can be very dangerous due to ice on the road. *Always* be alert for oncoming traffic. Due to the LBT construction, there is a lot of traffic on the road at times. If ADOT is out plowing, be aware of oncoming snowplows in your lane!