Service observing management at the APEX telescope

Michael Dumke

ESO, Alonso de Cordova 3107, Vitacura, Santiago, Chile

ABSTRACT

The execution of scientific observations in service observing mode requires an efficient transfer of information about project setup and observing procedures from the PI to the actual observer. At the APEX telescope, we have implemented an efficient, web-based system to manage the service observing of astronomical projects. This system includes the submission of relevant project information through a web form, the monitoring of the observing progress through collaboration tools, and the data handling and archiving. In this paper I give an overview over how service observing is managed and performed at APEX. I explain the implementation of the project submission facility, the information flow from submission to observation, and the various components involved. I conclude highlighting the advantages of this system.

Keywords: APEX telescope, Service observing

1. INTRODUCTION

Astronomical observatories are ideally constructed and operated in locations that offer excellent observing conditions. In mm- and sub-mm astronomy, the limiting factor is the absorption of the astronomical signal in Erth's atmosphere due to broad wings of atmospheric absorption lines, mainly oxygen and, even more, water. As a result, mm- and sub-mm observatories are usually located at remote locations, in dry deserts and/or high-altitude mountain ranges. One of the best locations in this respect is the Chajnantor plateau in the Atacama desert in northern Chile, not without reason the home of the ALMA observatory, currently under construction.

The Atacama Pathfinder EXperiment (APEX)[1] is a modified ALMA prototype antenna, with 12 m diameter, used for frequencies between 200 GHz and 1.5 THz. It is located at an altitude of 5100 m in the Chilean Altiplano, close to the desert village San Pedro de Atacama. This remote location requires some thoughts about how observations are to be performed. This does not only include economic concerns (e.g. air fares), but also safety issues. Even at the APEX base camp, at an altitude of 2400 meters, health problems can occur.

The classical observing mode is the "visitor mode", where the observer travels to the observatory at the time when his/her project is scheduled, to observe exactly this project. This mode is cost intensive and time consuming, and doesn't allow for flexible scheduling based on the atmospheric conditions required for a given project, but has the advantage that the visiting observer (usually the project principal investigator (PI)) has full control over the observations, and – assuming that he is well experienced – can optimize the observing strategy in real-time in order to maximize the scientific value of the observations. In terms of observing management, "remote observing" is very similar, except that the observer is connected to the observatory remotely, which reduces travel costs with only a slight reduction in flexibility and efficiency. "Pool observing" takes a different approach, here an observer usually travels to the observatory, but observes projects which are selected, at the time of the observations, from a project pool, depending on the LST range and instrumental and atmospheric requirements. For all the above cases, the observer is usually an astronomer from outside. The efficiency of the observing depends on his experience in observational astronomy, and he may not be up to date with the latest developments at the telescope he is observing at, like instrument changes or software upgrades.

In service observing, the observations are performed by observatory staff (astronomers and/or operators) who are working at the telescope a significant percentage of their working time, and therefore (ideally) know all the details about the hard- and software which is used for the observations. In addition, this observing mode allows flexible scheduling, since the astronomer on duty can decide in real-time which project to observe based on weather conditions or telescope problems. It therefore *can* be the most efficient observing mode possible.

Further author information: E-mail: mdumke@eso.org

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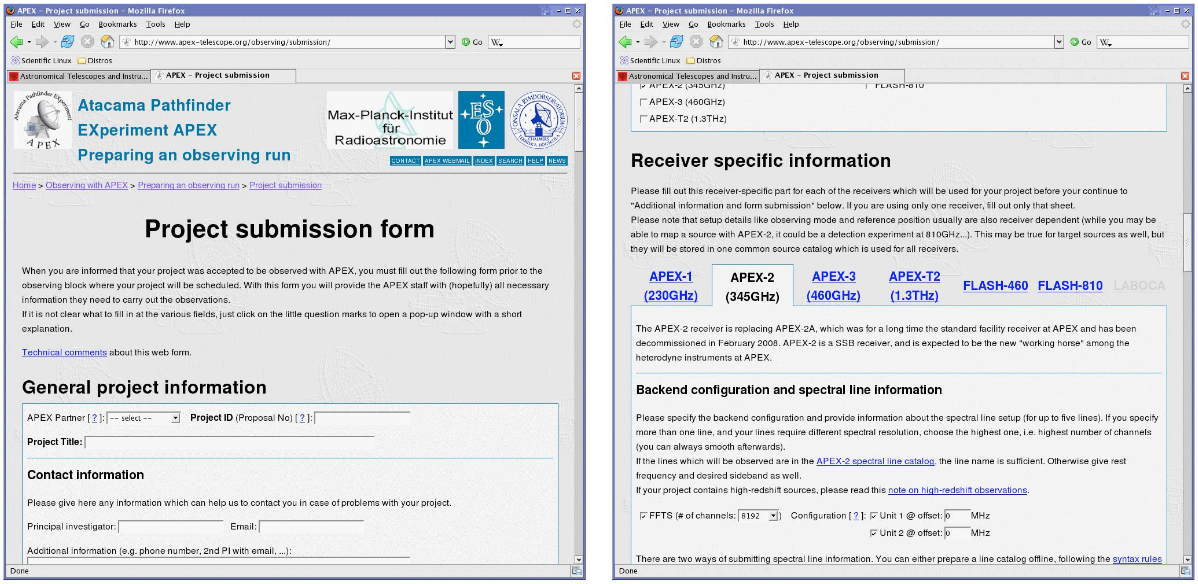

Figure 1. Two sections of the project submission web form used at APEX. In the upper section of the form (left) the PI has to enter general information, while in one of the central section (right) the form asks for receiver specific information.

In service observing mode, the PI of a project is not present at the time of the observations. Thus measures have to be taken to make sure that the project is observed in a way that the scientific goals are reached. This includes the preparation of the project, the actual observations (including real-time decisions about issues which define the data quality, like pointing sources, integration time per scan, etc.), and the progress monitoring of a project (in order to define a project as ongoing or finished). The most important of these measures is an efficient information transfer from the PI to the observatory staff about how the project should be observed.

At APEX, service observing is the standard observing mode. Observing management tools had to be developed to use service observing successfully and with a high degree of efficiency. In Section 2 I describe the project submission facility, i.e. how the project information is transferred from the PI to the observer. In Section 3 I outline the actual observing steps, while Section 4 explains how the APEX staff keeps track of the progress of any observing program, and Section 5 covers the handling of the resulting scientific data. In Section 6 I evaluate the service observing concept at APEX, outlining its advantages, and give an outlook on future activities.

2. PROJECT SUBMISSION

Observing time with APEX is granted by the time allocation committee (TAC) of the corresponding partner institute, which is either the Max-Planck-Institut für Radioastronomy, Onsala Space Observatory, the European Southern Observatory, or the Chilean astronomical community. When a PI is informed about the allocation of observing time for his/her project, he/she is asked to submit all relevant information concerning the project through our project submission facility, which is accessible on the APEX web pages after entering a valid user/password combination.

2.1 The PHP/HTML web form

The project submission form is a standard web page written in HTML and PHP, and is accessible by any web browser (see Fig. 1). Its usage therefore does not require any additional software to be installed on the PI's computer.

The submission form contains three sections which have to be filled out by the PI. The first section contains general project information: Proposal number, APEX partner organization, PI name and email, etc. Besides these, also the information about target sources should be submitted in this section, either by filling out the

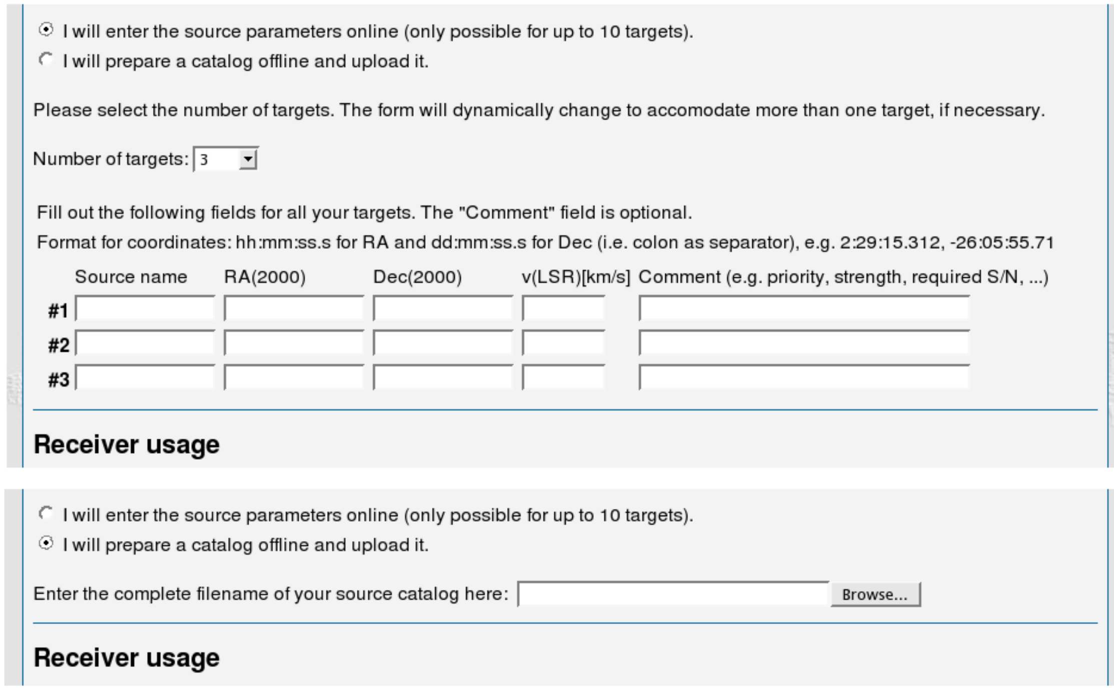

Figure 2. Dynamic HTML in the project submission form. The upper part shows the target source section for the online submission of 3 sources, while the lower part shows exactly the same part of the form for the upload of an already prepared source catalog.

provided fields, or by uploading an already prepared source catalog. In addition, the selection of the receivers to be used for this project is part of this first section.

The second section should provide receiver-dependant information, and can be filled out for each receiver independently. The information which is to be provided here contains observing modes, switch modes, pointing sources, or mosaic setup, and also backend setup and spectral lines for heterodyne receivers. While the provided input fields are sufficient for the majority of projects, there are always more complicated observing programs that require different setups or observing modes depending on the source or spectral line. Several comment fields are provided to enable the submission of these projects as well.

A third section is provided to submit additional observing instructions, or for general project information.

2.2 Interactive JavaScript elements

For design reasons, and also in order to keep all input options easily accessible, the project submission form uses JavaScript and Dynamic HTML in combination together with CSS style sheets. This allows to display only the necessary form elements. Only one receiver is displayed at a time, but the user can switch easily between the receivers. As visualized in Fig. 2, the form changes dynamically depending on the user input, hereby hiding the input fields which are not necessary for the current submission.

JavaScript is also used for an immediate verification of the values entered by the PI in some input fields. Thus unreasonable input is detected before the form content is submitted to the server, hereby saving network capacities and server computing power.

2.3 Form readout and translation with Perl

The core of the submission process builds a Perl script `submit_setup.pl`, which by now has grown to more than 6.000 lines of code. Still, under normal conditions, a submission is processed within a few seconds. The script reads the form, using standard Perl commands and modules, and performs a series of tasks, which are described below.

- **Input verification.**
  In contrast to the verification of individual input fields, which can be done in the webbrowser using JavaScript code, the majority of input fields can only be verified after combination with other fields. An example is the proposal number, for which the syntax differs depending on the APEX partner. If the user input has syntax errors, or leads to impossible setup configurations or observing procedures, the submission is rejected by the system. In this case, an error message will be sent to the web browser, which allows the PI to correct the input.

- **Input backup.**
  Before the script processes the input data, the content of all form fields is saved in a simple text file, which is accessible by the APEX staff and is consulted in case the input leads to ambiguous output files. This feature is mainly used for debugging.

- **Source catalog.**
  The submission facility allows to enter the target source information in the form itself, or to prepare a source catalog offline and to upload it. In both cases the input is checked for syntax errors, and a properly formatted APEX source catalog is created.

- **Line catalog.**
  The creation of a line catalog uses the information supplied in the line section of every selected heterodyne receiver, or the information from all uploaded line catalogs. This task is not necessary if only standard lines (i.e. those contained in the system line catalogs) are to be observed, or for bolometer projects.

- **Project summary.**
  This summary is written in HTML format and therefore readable with every webbrowser. Since it is the main source of information for the observer, it is also linked from the TWiki project page (see below and Section 4.1). It contains information that includes the used receivers, backends, observing modes, sources, and other details which are verified upon the start of the observations.

- **Setup and observing macros.**
  For each receiver, the program creates a pair of macros. As the names imply, they contain the information about system setup and observation commands, respectively. The location of some setup details (e.g. the source to be loaded) depends on the type of the project (heterodyne or bolometer).

- **TWiki page.**
  Creation of a text file that contains the raw text of the TWiki project page (see Section 4.1).

- **PHP database input file.**
  Creation of a PHP script which is used to enter the project details into the APEX observing database (see Section 4.2).

- **Notification email.**
  The script prepares an email message which contains all created files, and sends it to the project PI, the APEX astronomers, and the project scientist of the coresponding APEX partner.

- **Submission acknowledgements.**
  As a last step, a reception acknowledgment is displayed by the webbrowser of the user, indicating the success of the submission.

2.4 Associated programs

The Perl script `submit_setup.pl` calls additional programs for special tasks. These tasks are not embedded in the Perl code. One reason is that these task can be easily activated or de-activated for tests during phases of development or improvement.

The first of these tasks is the creation of a project page on the APEX TWiki. This is a collaboration platform for APEX staff and partners, using the TWiki software*. This task is performed by a TCL script named `createProjectPage`. TCL was chosen for this task because it allowed the re-use of already existing software components working within the APEX TWiki.

The second task is the creation of a project account in the APEX Observing database, and to fill the database fields with information about the project. For this purpose the Perl program `submit_setup.pl` writes a PHP script, which naturally interfaces with the observing database.

3. THE OBSERVING PROCESS

After the submission of project information is complete, an APEX staff astronomer is assigned to each submitted project as *Local Contact*. This person is responsible for all matters regarding this project.

3.1 Project accounts

For each APEX project for which project information has been successfully submitted, a project account is created. The creation of a user account in the APEX computer network is a sensible issue in terms of security, thus the account has to be created manually by the APEX staff. With the creation of the project account, a few other tasks are performed automatically, among them:

- All files generated during project submission which were not handled by associated programs (see Section 2.4) are copied into the project account home directory.
- Directories are created on the data reduction computer and the archive computer to store the MBFITS raw data files and (in case of heterodyne projects) the calibrated CLASS format spectra.

Before an observation session is started, the APEX staff performs another task manually: the verification (and adjustment, if necessary) of the previously created and copied setup and observe macros. With this step, the project is ready to be observed.

3.2 Servers and clients

From the observers point of view, the APEX Control System (APECS) is composed of a server level and a client level. Actually, APECS contains many more aspects, which are of minor interest here.[2] The servers contain the main functionality of APECS, they run on three computers which are located in the telescope itself or the control building nearby. The clients can run on any computer within the APEX network; they provide the main interface for the observer and run under the project account. One of them, the APECS command line interface (APECS CLI), provides a scripting language to set up the system and run the observations. The macros created by the project submission system are executed under this scripting language.

4. PROGRESS MONITORING

With the flexible scheduling used at the APEX telescope, several projects are scheduled at a time. Usually, a project is not finished within one observing session. The average project has to be observed during several nights, in order to optimize the telescope efficiency. In order to keep track of the status of a project, a proper progress monitoring is needed, to make sure that the amount and quality (i.e. signal-to-noise ratio) of the data is sufficient to reach the scientific goals of the project, and, on the other hand, not to overobserve one project on the cost of others. We have implemented two monitoring tools for this purpose.

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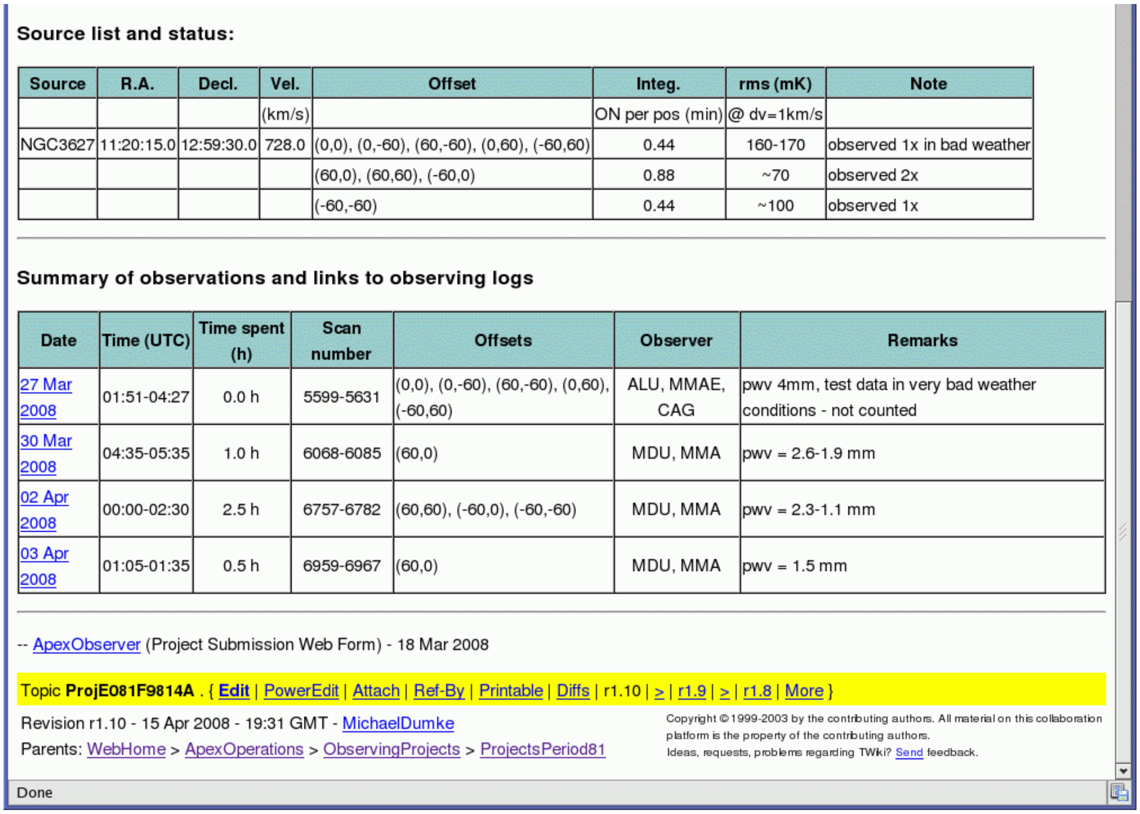
*`http://twiki.org`



Source list and status:

Source	R.A.	Decl.	Vel.	Offset	Integ.	rms (mK)	Note
			(km/s)		ON per pos (min)	@ dv=1km/s	
NGC3627	11:20:15.0	12:59:30.0	728.0	(0,0), (0,-60), (60,-60), (0,60), (-60,60)	0.44	160-170	observed 1x in bad weather
				(60,0), (60,60), (-60,0)	0.88	~70	observed 2x
				(-60,-60)	0.44	~100	observed 1x

Summary of observations and links to observing logs

Date	Time (UTC)	Time spent (h)	Scan number	Offsets	Observer	Remarks
27 Mar 2008	01:51-04:27	0.0 h	5599-5631	(0,0), (0,-60), (60,-60), (0,60), (-60,60)	ALU, MMAE, CAG	pwv 4mm, test data in very bad weather conditions - not counted
30 Mar 2008	04:35-05:35	1.0 h	6068-6085	(60,0)	MDU, MMA	pwv = 2.6-1.9 mm
02 Apr 2008	00:00-02:30	2.5 h	6757-6782	(60,60), (-60,0), (-60,-60)	MDU, MMA	pwv = 2.3-1.1 mm
03 Apr 2008	01:05-01:35	0.5 h	6959-6967	(60,0)	MDU, MMA	pwv = 1.5 mm

-- ApexObserver (Project Submission Web Form) - 18 Mar 2008

Topic **ProjE081F9814A** . { **Edit** | PowerEdit | Attach | Ref-By | Printable | Diffs | r1.10 | > | r1.9 | > | r1.8 | More }

Revision r1.10 - 15 Apr 2008 - 19:31 GMT - MichaelDumke
Parents: WebHome > ApexOperations > ObservingProjects > ProjectsPeriod81

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Ideas, requests, problems regarding TWiki? Send feedback.

Done

Figure 3. The lower part of a typical TWiki project page used at APEX for progress monitoring. The two tables visible are created automatically, and filled out by the APEX staff during and after the observations.

4.1 TWiki Project Pages

The first monitoring tool implemented at APEX are TWiki pages. TWiki is a Wiki software used to create a web-based collaboration platform. While the APEX TWiki is mainly used for that purpose, it also serves as a tool to organize and monitor observing programs.

The initial version of the TWiki project pages are created upon project submission. In this stage the pages contain all information necessary to start the observations of this project, like source and line names, observing patterns, or special instructions for the APEX staff entered into the submission form by the PI.

During the submission two tables are created on these pages, one is supposed to contain information about the status of the observations, the other summarizes the already performed observations and provides links to observing log files created by the control system. After a first data verification and preliminary data reduction is done by the APEX astronomer (ideally still during the same observing night), these tables are filled out with all necessary information to indicate the current status of the project (see Fig. 3).

Upon completion of a project, these project pages are converted to standard HTML format and sent to the PI, together with the data and the observing log files.

4.2 Observing database

A second monitoring tool is the APEX observing database. This data base is a modified version of the pool observing database used successfully for several years now at the IRAM 30-m telescope.[3]

Upon project submission, a database account with the project name is automatically created. The software also fills in details about target sources, instrumental requirements, and general project information. The instructions entered by the PI into the web submission form are also used to fill the corresponding database fields.

The APEX control system has direct access to this database. When a project with an existing database account is observed, information about target sources, observing pattern, scan numbers, and observing time are transmitted to the data base. This database therefore can also serve as a tool to follow the progress of a given project. Up to now, however, no data reduction tools have been implemented. As a result, while the total observing time can be tracked, it is not possible to verify the data quality using this database. Thus it is mainly used for scheduling purposes.

5. DATA HANDLING

The data obtained at the APEX telescope are written in MBFITS[4] format, which is designed for data from multi-beam receivers. For bolometer projects, these data can directly be read with the BoA reduction software. For heterodyne projects, the data are calibrated online and written out in GILDAS format to be reduced by CLASS, a software in use at various radio telescopes.

A project is usually declared finished when it obtained its allocated observing time or the data quality has reached the required signal-to-noise ratio for all targets. After validation of the data by the APEX astronomer who serves as local contact for this project, the data are sent - together with complementary information - to the ESO data archive[†]. From there it is sent to the project PI for reduction and analysis, and is available for download after the data proprietary period (usually 1 year).

6. EVALUATION AND OUTLOOK

In the previous sections I described how service observing is prepared and performed at the APEX telescope. The implemented observing submission facility, together with the observing database and the TWiki project pages, represent an efficient tool to manage scientific observations in service observing mode.

- Only products are used in the implementation which are freely available. This includes the programming languages and their interpreters (Perl, JavaScript, PHP, TCL) and the software components (Apache Webserver, TWiki, mySQL).
- The system is easy to use for the project PI and the APEX staff. No additional software installations are necessary. The submission of project information and the progress monitoring are all accessed through a standard webbrowser.
- The project submission facility was completely developed within the APEX Science Operations group. It can therefore be easily maintained, extended and modified by the APEX staff. This is of importance considering that APEX will continue to expand its suite of receivers and available observing techniques.
- With the automatic creation of setup and observing macros by the submission facility, as well as database entries and observing logs by the APEX control system, the workload on APEX staff is siginificantly reduced. This frees manpower to perform other observatory duties.

It must be noted that the whole system is under constant development. Improvements planned for the future include a better interconnection between the various components, in order to reduce redundancy and to further automatize the observing process.

[†]http://archive.eso.org

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