IRAM OMS SMS guide

From Proposal to Setup Management System

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Nov, 2nd 2020
Version 1.0

Abstract

This memo describes how the information of an accpeted proposal for NOEMA is converted into technical parameters as neeeded to set up the instruments for observations.

Note that only technical aspects and the logics of the tools are discussed here. Any question related to policy should be addressed to science coordinator or project scientist.

Contents

1 Introduction

1.1 Principle

The Setup Management System (SMS) is the subproject of the Observation Management System (OMS) which converts accepted proposals into observing procedures.

It was designed to :

- be user friendly to be accessible to newcomers and PI
- automate as many operations as possible to free the local contacts from tedious tasks
- keep room for fine tuning so that expert users can use non-standard parameters
- fill in the setup header part to be read by monitoring scripts at NOEMA
- centralize communication between PI and Local Contact for traceability purpose

1.2 Glossary

1.2.1 Users

Science Validator (SV): person among the proposal authors who will follow the setup creation process. It is the PI by default, but in can be changed by the Local Contact on the project main page.

Local Contact (LC): All projects get an IRAM astronomer as Local Contact. In SMS the Local Contact prepares first version of a setup and then interact with Scence Validator to modify or validate it. When an IRAM astronomer is in the author list, he is automatically the local contact. When there are several IRAM astronomers are in the project, the scheduler can chose which one is Local Contact.

Scheduler, or Science Coordinator: in SMS the Scheduler is responsible for the final validation of the observing procedures (a.k.a. Setup files) and their installation in the online system.

1.2.2 Project

Project: a project is an accepted proposal. It consists of a set of sources and a set of technical sheets, as defined in PMS before the submission. The technical sheets and sources are associated in sub-projects to define how the project will be observed.

Sub-project: a sub-project is the association of a technical sheet to a source or a set of sources to be observed together.

Setup: the setup is a file that contains the sequence of OBS commands needed to prepare the observations of a sub-project (receiver tuning, sources, backend configuration). It also contains project tracking information in a header part (such as required sensitivities, observing times,...). It is visible with the *Show Setup* button in the sub-project page.

1.3 Workflow

The workflow works at the level of the sub-project. The sub-project goes through several stages before its setup is actually installed at NOEMA

1. **Created:** At first association of a source (or set of sources) to a technical sheet, the sub-project is created and get a number.

2. **Edited:** Once the sub-project has been opened by the Local Contact it gets the status *edited*. This status stands as long as the LC is working on it. The Science Validator can see the setup, but cannot edit any variable.

3. **Opened to SV:** When the LC has a first working version of the setup, he opens the access to the SV with the *Open to SV* button. The sub-project gets the status *Opened to SV* and the LC cannot edit any parameter anynore. The sub-project is in the hands of the SV who can check the parameters, edit them if needed and then either re-send it to the LC (back to *Edited* status) or validate it to go to the next step.

4. **Validated by SV:** The Scientific Validator validated the sub-project, which is again in the hands of the Local Contact for final checks and validation. If the LC sees something wrong, he can *re-open to SV* to go back to previous step.

5. **Validated by LC:** In this status, the sub-project has been validated by both the SV and the LC. None of them can edit it. The sub-project has to be checked by the Scheduler who can either *Send to observatory* if everything is fine, or *re-open* the setup if he wants something to be changed by the LC or SV.

6. **Sent for observation:** This is the last step of the workflow, after validation by the Scheduler. The sub-project is ready to be observed and the corresponding setup file is installed at NOEMA.

1.4 Permanent ChatBox

A communication space is present in the sub-project page. It contains the log of all the changes of state undergone by the sub-project, together with the message written by the LC or SV when they triggered the change of state. In addition, at any time, and whatever the state of the subproject, the LC or the SV can write a message for the other using the *Send* button.

1.5 Automatic e-mails

An automatic e-mail is sent each time a subproject changes state. The content of the e-mail is the message written within SMS and a list of changes in the sub-project parameters.

An e-mail is also sent when the SV or the LC write a message in the chatbox without changing the state of the sub-project. In that case only the message is present, not the list of changes.

2 Project main page

2.1 Define sub-projects

The project main page displays the list of sources and the list of technical sheets that were entered in PMS. The source list can be edited if needed. A first association of sources and technical sheets can be made from this page.

A PMS technical sheet is convered into a sub-project and and gets a number (e.g. S18AG001) when a source or a set of sources is associated to it, and when the Local Contact oepns it for the first time.

If several sources have to be observed with the same technical sheet, we can distiguish 2 cases:

- *Track sharing* The sources are close in space and frequency and they can be observed in the same track, this is track sharing. SMS checks that the sources are not too far away and issues a warning if the most distant sources are separated by more than 15 degrees. Also, all track shared sources should have a declination value which is on the same side of the NOEMA latitude ϕ_{NOEMA} (i.e. source at Dec$> \phi_{NOEMA}$ cannot be observed together with a source at Dec$< \phi_{NOEMA}$)

- *Sub-projects* The sources are not close in space or frequency and several sub-projects have to be created (using the duplicate button).

The setup parameters of a sub-project are defined through the edit button.

Duplicated sub-projects can be removed with the delete button. Trying to delete the last occurence of a technical sheet will result in a reset: all parameters will be retreived from PMS and all changes made in SMS will be lost.

2.2 Actions from project page

The Local Contact has access to several action from the project page. They will affect the whole project with its associated sources and sub-projects.

Change Science Validator: By default the SV is the PI of the project, but the LC can choose another person from the list of author.

Disable expert mode: Some sub-project advanced parameters are not needed for most SV (e.g. change scan length,...). To avoid confusion, the LC can chose not to show the advanced parameters to the SV by ticking the *Disable expert mode* from the project page

Set all redshift to 0: Some users are entering the redshifted frequency in PMS, with a redshift 0, but define their sources with the redshift. In SMS this results in a double redshift correction since the redshifted frequency is understood as a rest frequency and the redshift of the source attached to the sub-project is applied. In such cases the local contact can modify the sources in SMS and put their redhift to 0 using the button *Set all redshift to 0*. The drawback of this approach is that the redshift information is lost in SMS.

Convert high LSR velocities into redshifts: For projects with sources defined with velocities greater than a limit (arbitrarily set to 250 km/s right now), SMS proposes to perform the conversion from LSR to redshift according to the radio definition of redshift:

$$z = \frac{v_{LSR}}{c - v_{LSR}} \tag{1}$$

This can be useful for sources (typically nearby galaxies) defined in PMS with a LSR velocity so high (e.g. 1000 km/s) that cannot be used for Doppler tracking at the observatory.

3 Sub-project page

3.1 Setup template

The *setup* is the observing procedure in OBS laguage. All parameters required to perform the observations are in it. Also some information for progress tracking of the observation is stored as comments in the so-called "header" section.

SMS go through the setup template and inserts the relevant values for all the needed parameters.

3.2 Source selection

The whole source list attached to the proposal is displayed. Source association, as performed in the project main page can be modified from the sub-project page.

The visibility of the selected sources is presented through the plot created by the ASTRO\HORIZON command.

A change of the source selection must be followed by a click on the *validate* button so that the correct parameters are used in the Horizon plot and in the calibrator selection.

Track sharing In that case SMS issues in addition to the setup file a source catalog containing the sources that will be observed together. Note that the order of the sources can be changed in the source list, this will define the sequence in which the sources will be actually observed.

By default SMS (like PMS) assumes that the time is evenly distributed between the sources. This is not mandatory, and can be changed by hand in the advanced parameters section, at the bottom ot the sub project page ("number of scans per source"). The way to distribute the time consists in defining a number of scans that will be spent on each source during a single cycle on source.

Based on this, SMS computes the required sensitivity per source and put it in the header (in the format read by the status generator at the observatory). In addition the percentage of time spent of the different sources is also indicated in the header.

3.3 Calibrator choice

SMS uses a script to find the best choice of calibrators for a given targetted position on the sky.

3.3.1 Targetted position

When a single source is attached to the sub-project, SMS searches calibrator near its position. When several sources are attached (track sharing) the average position is used instead.

3.3.2 Calibrator selection rules

SMS searches for calibrators in the NOEMA calibrator catalog (phase-pdb.sou). The calibrators get a score according to their distance to the targetted position and to their last measured flux. To make sure the fluxes used by SMS to compute the scores are up to date, SMS gets every day the latest version of the catalog as downloaded from the observatory by the SOG.

The score S is computed as:

$$S = D + \frac{1}{F^2} \tag{2}$$

where D is the distance to the targetted position in degrees and F the flux in Jansky.

The calibrators are then sorted by increasing score (the best calibrator has the lowest score). Depending on the number of calibrators requested, SMS selects the first (or first two or three) calibrators in the list. They appear on a green background on the list and in a frame on the displayed plot (output of ASTRO\SOURCE command in equatorial frame). By default, 1 calibrator is selected for detection projects, while 2 are used for mapping projects. It is up to the Local Contact to change this number if needed (mapping project can be done with a single calibrator if it is close and strong enough). Please refer to Science Coordinator or Project Scientist to get the rules to follow to chose the number of calibrators.

The user can change the rank of a calibrator in the list by clicking and grabing its line to the desired position.

SMS makes sure that "northern sources" (i.e. Declination $> \phi_{NOEMA}$) are associated with "northern calibrators" to avoid divergences in tracking. The same is obviously true for "sourthern sources", i.e. with Declination $< \phi_{NOEMA}$.

The dates associated to calibrators with fluxes measured more than one year before the current date are written with a red font to emphasize the fact that their fluxes might not be reliable.

The button *reset* allows the user to come back to the orginal proposition of the system

3.4 Technical setup

In this section several fields are requested that were not present at the PMS stage. They are indicated by the red background, like when a value given in PMS is changed in SMS.

One of them is the name of the tuning, to be given as input of the OBS\LINE command. This name will also appear in the data in CLIC. By default it is a short version of the technical sheet name entered in PMS but it can be changed.

For project requesting both line and continuum, the user has to specify what will be the stopping criterion for the observations : when the requested line or continuum sensitivity will be reached.

3.4.1 Frequency setup

- **Frequency Coverage Plot:** The frequency plot in SMS is created by the ASTRO\NEWVEL command. This command applies the receiver and backend configuration of the script that was uploaded to PMS to the source attached to the current sub-project.

  When several sources are selected, a fake source with average position and velocity or redshift is used.

  In the plot, the frequency coverage for the sub-project source (green) is compared to the coverage as seen in PMS (hatched area).

  Several cases are possible:

  - When the same source is used in PMS and SMS, no difference should appear.
  - When different sources are used then the SPW coverage changes. This is due to the fact that a different source velocity will be compensated by a change of the IF1 center frequency to keep the LO frequency on the grid. *This implies that a change in LSR velocity large enough to bring the tuning to a different tuning grid point will significantly change the REST frequency coverage of spectral windows.*
  - When the fixed frequency button is ticked, no difference should appear since the tuning grid is ignored.
  - Track sharing: When several sources are selected, the frequency offset of the sources with min and max LSR or redshift values with respect to average value are indicated by additional arrows.

- **Tolerance parameter** The difference between the PMS and the SMS frequency coverages of the *high resolution* spectral windows is estimated and compared to a tolerance that has to be set by the user. By default, the tolerance is 0, but it can/should be adjusted according to the science of the project (distance between spectral lines and SPW edge, width of the lines,...).

  If the offset is larger than the tolerance then SMS will not create the final setup. In that case the user has two possibilities:

  1. *Re-upload script:* The user can upload a new version of the PMS script, adapted to the selected source to make sure that the frequency coverage is the right one.
  2. *Tick the FIXED FREQUENCY button:* With this option, the tuning grid is ignored and the offset between the coverages becomes very small.

- **Case of "SET FREQUENCY" projects**

  For the projects defined with SET FREQUENCY in PMS, SMS will correct the requested rest frequency by the velocity or the redhift of the source attached to the sub-project and do a tuning with default parameters.

  Since these projects do not use high resolution spectral windows, the estimated offset in frequency is always 0 and the tolerance field is not relevant.

- **Script conversion**

  Once the offset is smaller than the tolerance, NEWVEL creates the commands in OBS syntax to set up the system and transfer them to SMS, so that they can be included in the setup file.

  Redshifted sources appear with null LSR velocity and the frequency in LINE command is already redshifted. The original redshift is then indicated as a comment.

- **Special Cases**

  1. **Track sharing**
     - **Basic case** A first handling of track sharing is implemented in SMS. SMS computes the average velocity or redshift of all the sources attached to the setup and uses this value to compute the frequency coverage. The frequency offsets of the sources with min and max LSR or redshift values with respect to average value are indicated on the figure by additional arrows (smaller than the arrows representing the tuning and representative frequencies). Local contact and PI should make sure that these offsets will not push any line out of the right spectral window coverage. The track-shared sources are listed in a sub-project catalog (e.g. s19aa001.sou). For projects with sources defined with LSR velocities, all the sources in the catalog get the average LSR value. For projects defined with redshift, the sources get a LSR 0, like in standard, not-tracksharing sub-projects.
     - **Case of sources with similar LSR velocities**
       If the track-shared sources have very similar velocities they could be all observed with true doppler tracking for each of them. In that case the sources in the subproject catalog keep their original LSR velocities. The first source in the list is the one for wich the tuning will be performed right on the tuning grid; the next sources will be Doppler Tracked and thus have a shifted frequency axis. This might affect the RF calibration quality (RF done for 1 of the tuning only).
       Note that we donot have official number for the limit between the Similar and Different LSR velocities. Please refer to the SOG/Science coordinator.
     - **JB - Nov 2020 - It was planned to create a toggle button to switch from LSR-Average track-sharing (default mode) to Doppler-tracked track-sharing mode is SMS, but this is not done yet. Get in touch with OMS team if you want to setup a Doppler Tracked track sharing project.**

3.5 Mosaics

Whatever the way the mosaic was defined in PMS (offset list or image area) SMS needs the list of offsets to prepare the observing setup.

For mosaic defined with an area in PMS, we propose in "offset from area" a tool to define the pointings to cover the inner part of a rectangle with hexagonal compact sampling, at the representative frequency. The offsets can then be adjusted (number and positions) in the "Offsets from User Input" page.

A full list of user defined offsets can also be uploaded from the "Offsets from User Input" page.

The mosaic coverage is drawn (with beam computed at the representative frequency), and the sequence followed to scan the offsets is indicated with arrows. Note that there is no way to change the sequence in SMS, the user has to download the offset list, edit it and uplaod with the deisred order.

Note that the overal sensitivity is driven by the number of offsets. A warning is thus issued when the number of offsets defined in SMS is different from what was computed in PMS by more than a given percentage (typically 5%).

SMS, like PMS, do not take into account the actual positions of the fields and assumes a standard sampling for the mosaics.

SMS compute also the sensitivity per indivudual pointing, which is independant of the sampling pattern and is useful to track the progress of the observations. It is written in the header part of the setup file.

3.6 Other parameters

3.6.1 Specific observations requests

Some projects have special requirements (time constraints, low elevation observation,...). All this is grouped in this section. This is not filled in automtatically.

3.6.2 Advanced parameters

In some exceptional cases, some specific parameters can be modified with respect to standard observations. They are grouped in this section. Nothing is done automatically for the time being. This part is visible to the external user (PI, or science validator) upon local contact's choice (using the "expert mode" button).