# Practice Work Session (3h)

MIDI data reduction

O. Chesneau, T. Verhoelst
Observatoire de la Côte d'Azur, Leuven University

**2010 VLTI School**
*Observation and Data reduction with the Very Large Telescope Interferometer*
17-28 June 2010, Goutelas (France)

## 1 Introduction

The software used for the MIDI data reduction are the MIA and EWS packages. An extensive description can be found in the Twiki page at the following addresses: http://mia/. This web page contains the full description of the MIA and EWS softwares, including all the options used in some special cases. In this tutorial, we will just use the upper level commands. A large part of this tutorial comes from the MIA website and was written by Rainier Kohler and Thorsten Ratzka. You can also open the written tutorial of the Goutelas school.

For this tutorial, you have two datasets located in two directories Menzel 3 and MIDI (`/home/linux/Tuto_MIDI`). In the directory MIDI, you have a subset of some data recorded in visitor mode. As often in this case, the modes are various, as the astronomer can decide his preferred instrumental configuration for a source. This is a general rule: never give too much freedom to an astronomer!!. The second data set, Menzel 3 is more homogeneous, as it was secured in service mode, and went through the process of P2PP checking. P2PP is the software for preparing the technical parameters of the observation, once the scientific proposal has been accepted.

There are two main modes for MIDI observations. In the High-Sensitivity mode, the beamsplitters are not inserted in the optical path of the beams before combination, i.e. the photometric channels of MIDI are not used. The photometry is observed AFTER (or in some cases before) the fringe tracking and not simultaneously. Alternatively, two optional photometric channels can then be used to measure the photometric flux to the interferometric signal. In this mode chopping is necessary while tracking the fringes in order to reliably measure the flux in the photometric channels.

# 2 Working on the Menzel 3 data set

## 2.1 MIA

### 2.1.1 Making a log of Observations

First create a subdirectory `MIDI_TESTS` that will contain the reduced data.

You can look at the data by doing `ls -al` and look the size of different files.

You launch the IDL session, with the compilation of MIA+EWS by typing: `MIA+EWS-2010Mar13/mia.sh`

In a first step we want to look what files have been received. You can used a simple IDL procedure :

`make_midi_log,'path',LOGBOOK='target/filename.log'`

where 'path' is the directory where the downloaded files are located.

### 2.1.2 Choosing files with midigui

Another way to get that informations is "Gorgonzola":
`files=midigui(dir='path')`
After a few seconds a window pops up and lists all MIDI-files in the specified directory.

You might have noticed that the number of files is reduced. "Gorgonzola" recognizes files that belong together in one dataset and displays only the first file. If you now select one or more files by marking them in the first column and pressing the "SELECT" button in the upper part of the panel the names of the files are written into the array files that was specified in the calling command of "Gorgonzola".

A similar routine called with the command
`files=midiguis(dir='path')`
is preferred when handling large numbers of MIDI-files.

To check what is stored in the variable files just type `print,files` or `print,files[i]`.

### 2.1.3 Working with the MIA GUI

As a first step start "Gorgonzola" by typing
`calfiles=midigui(dir='path')`

where 'path' is the directory where the interferometric and photometric data are stored. Now select the data set for the fringe tracking (OBS_FRINGE_TRACK_FOURIER) and the two photometric measurements (OBS_PHOTOMETRY_CHOP) by marking the first column and pressing the button "SELECT". Then the names of the files are stored for this example in the array calfile. It is important that the data set containing the fringes is stored as the first entry in this array. The key command for MIA is called `XMDV`. You type: `cal = XMDV(calfiles)`
`cal` is an IDL object containing all the results of the data process. The job is done, but you need then to look into it, and decide to change some parameters.

`cal -> gui,/true` :To get the Gui

#### 2.1.4 Instrumental visibilities

In a next step we want to determine the instrumental visibility, i.e. the visibility of an unresolved point source, from a calibrator object of known diameter with the routine `insvis = x->instruvisi(diameter,NAME=name)` where diameter is the diameter of the calibrator in mas. If the object is listed in the calibrator database the diameter can be omitted. The name that is used to find the object in the database is either read from the MIDI data files or can be given with the parameter NAME. The instrumental visibility is calculated by dividing the raw visibility with the expected visibility of the calibrator. When /VISPLOT is specified one gets a plot of the instrumental visibility, i.e. insvis[2,*] vs. insvis[0,*]. The parameter /PLOT launches the display for the wavelength-binned spectral power of the fringes.

Check carefully the information provided by the command, that can be used for the interpretation of the data.

#### 2.1.5 Calibrating visibilities

To calculate the calibrated visibility of the science object, i.e. to divide the raw visibiliy of the science object by the instrumental visibility, use the routine

`calvis = sci->calibratedvisi(cal,diameter,NAME=name,/PLOT,/VISPLOT)`

where diameter is the diameter of the calibrator in mas. The advantage of the routine calibratedvisi() over calling instruvisi() manually and dividing the raw visibility of the science target by the result is the adjustment of the lambda-binning for the visibility of the calibrator, i.e. calibratedvisi() ensures that the same lambda-binning used for the science target is applied to the calibrator. The option /VISPLOT leads to a plot of the calibrated visibility. /PLOT launches the display for the wavelength-binned spectral power of the fringes for both the raw visibility of the science target and the now lambda-bins-adjusted instrumental visibility.
The wavelength and the calibrated visibility are stored in calvis[0,*] and calvis[2,*].

#### 2.1.6 calibrating the full dataset

Now you can reduce the full dataset. The questions are the following:

- Is the calibrated visibility changing when changing the calibrator?
- Have you used the best calibrator?
- How could you estimate the error bar of such a measurement?
- For each calibrated visibility, what is the visibility level at 8, 9 and 12 micron?

- Can you estimate already from this measurement an extension of the source? You can use the Uniform Disk model, as already seen, of a Gaussian model that is often more appropriate for a dusty source (see below).

- From this semi-quantitative approach, can you estimate the geometry of the source from the full dataset?

A Gaussian distribution is calculated as $V(f) = V_0\ exp(-3.56\, f^2\, \Theta^2)$, where $\Theta$ is the FWHM ($''$) of the Gaussian distribution and f the spatial frequency in units arcsec$^{-1}$.

# 3 EWS

In EWS, all reduction steps are executed in a Pipeline which gives you a few displays, but saves all the intermediate steps for later diagnoses of reliability.

The only additional required input parameter compared to MIA is a character string, *tag*, which gives a prefix that will be attached to all output files produced by the pipe. A typical pipe routine would be called:

$tagcal =' /home/reduced\_data/calibrator'$

$midipipe, tagcal, file = cal\_fileS$

You do the same for the science target: $tagscience =' /home/reduced\_data/science'$

$midipipe, tagscience, file = sci\_fileS$

Then you calibrate with:

$midiCalibrate, tagscience, tagcal$

This last command creates an impressive amount of output files; all of them in the FITS format (except one in PS format that contains all the useful graphs allowing you to check the data quality). The information of the projected baseline is also included.

# 4 Working on the MIDI data set

This directory contains a large set of data secured with different modes, different spectral resolution. The calibrators have usually a Henri Drapier name. The goals with this data set are the followings:

- Select Grism data and see what is different is the data reduction. What can you do for improving the SNR of the reduced data?

- Section Sci-phot data. Follow the data reduction scheme written in the Goutelas tutorial. You can perform a data reduction with MIA and EWS.

- For some Sci-Phot data, you have also photometric files that were secured. You can therefore perform a Sci-Phot reduction, and also a High-Sens reduction. Is the result identical?