Jérôme PETY
(IRAM/Obs. de Paris)
on behalf of the IRAM Science Software developers

IRAM Millimeter Interferometry Summer School
Oct. 10 - 14 2016, Grenoble
People (as of 2016 April)

- People participating in one way or another
  - IRAM/Granada  H. Ungerechts, A. Sievers.
  - IPAG/Grenoble  S. Maret.
  - LAB/Bordeaux  S. Guilloteau.

- Large code contributors:  \(\sim 5.0\) FTE/yr
  - R. Zylka  MOPSIC.
  - H. Ungerechts  PAKO.
  - A. Sievers  MIRA + MRTCAL.
  - E. Reynier  kernel + OMS.
  - V. Pietu  CLIC + RDI.
  - J. Pety  kernel + MRTCAL + CLASS + MAPPING.
  - A. Castro-Carrizo  CLIC pipeline + OBS.
  - J. Boissier  ASTRO.
  - S. Bardeau  kernel (including the python binding) + CLASS + MRTCAL.
  - S. Maret  CLASS/WEEDS.
  - S. Guilloteau  Kernel + MAPPING.
What my daughters think I do at IRAM

les pensées qui fleurissent
Dans la tête de Papa quand il travaille

merci
Actual activity: Helping people to make sense of

Hexadecimal representation of the $^{12}\text{CO}(1-0)$ LMV cube of the south-western edge of the Orion B molecular cloud...

GILDAS J. Pety 2016
Many different kinds of softwares at IRAM:
1. Proposal and scheduling (statistics, dynamic scheduling, pool observing).
2. Preparation of observations, e.g. setups.
3. Data acquisition:
   3.1 Low level, e.g. hardware control (antennas, receivers, correlators, etc...)
   3.2 High level, e.g. operator and observer interface.
4. Data archiving.
5. Data reduction and analysis (single dish + interferometry).

Science software deals only with a subset. Points: 1, 2, 3.2, 5, and 6.

GILDAS deals with an even smaller subset. Points: 2, 3.2, 5 and 6.
Scope: II. Observation Management System
40 000 executable lines
Scope: III. GILDAS at IRAM
450 000 executable lines

- **Common facilities**
  - Command line interpreter: SIC;
  - Graphical possibilities: GREG (1D: curves, 2D: images, 3D: spectra cubes).
  - Preparation of observations: ASTRO.

- **30m**
  - Spectroscopy: TELCAL + MIRA + CLASS.

- **PdBI**
  - Calibration: CLIC;
  - Imaging + Deconvolution: MAPPING.

- **ALMA**
  - Simulator: MAPPING @ alma.map;
  - Holographies of ALMA antennas are done in CLIC at San Pedro.
Large range of supported systems: Linux, Mac/OSX, Windows.

Light weight: Data reduction and analysis possible on laptops.

30+ years of history ⇒ Accumulated expertise.

Powerful advanced tools, e.g.,
- Interface to line catalogs;
- Easy OTF processing;
- Easy interferometric mosaicing;
- General fitting routines.
GILDAS users

- IRAM AODs: Instrument monitoring, data pipelining.
- IRAM users: Data reduction.
- Others:
  - CLASS is used in many facilities (*e.g.* APEX, CSO, NANTEN2, GBT, HHT, Effelsberg, Kosma, ...); CLASS is partly used by Herschel/HIFI, SOFIA, 45m.
  - ALMA: (Single Dish characterization in San Pedro).
- All kind of public from beginners to data specialists.
  - Easyness of use for new users.
  - Flexibility for data specialists.

⇒ **GILDAS evolutions must be thought with all users in mind.**
An example of the GILDAS daily life: CLASS

• The command SET WINDOW has been improved as follows.
  – SET WINDOW DEFAULT will revert to the default status, i.e. no signal window defined, BASE will return an error.
  – SET WINDOW NONE will define 0 window, i.e. BASE will fit all channels, assuming there is no signal at all in the spectrum.
  – SET WINDOW AUTO will reuse the previous windows as found in the current base section in the R buffer.
  – SET WINDOW /POLYGON (used in PLOT /INDEX mode) accepts now complicated polygons shapes resulting in more than 1 window per polygon.

• The support of different projection systems in CLASS was completed, i.e., the PLOT and HEADER commands now also display the projection kind and angle. We note that this support implied a change of data format (modification of the position section of the header). This implies that data written with recent version of GILDAS (after apr15) can not be read by older version of CLASS (in contrast, newer CLASS is obviously able to read old CLASS format). The documentation about the improved support of coordinate projections in CLASS is now available here: http://www.iram-institute.org/medias/uploads/class-projection.pdf

• After 5 years of obsolescence, the old averaging engine (AVERAGE /2010) is removed.

• The CLASS FITS reader did not convert UT and ST from second to radian, implying a wrong recomputation of the Doppler factor, when needed. This was fixed.

• The possibility to store 2D arrays in the USER section was added after a request from the SOFIA observatory.

• The LMV command now correctly imports ALMA data cubes produced by CASA into CLASS as we now enforce that Voff and Restf are aligned on the spectral reference channel.

• etc...
Web page http://www.iram.fr/IRAMFR/GILDAS.
Memos at http://www.iram-institute.org/EN/content-page-161-7-66-161-0-0.html.
Mail to gildas@iram.fr.

IRAM Memo 2015-1

Extended support of sky spherical coordinates in CLASS

S. Bardeau¹, J. Pety¹,²

1. IRAM (Grenoble)
2. LERMA, Observatoire de Paris

March, 26th 2015
Version 1.0

Abstract

Up to now CLASS only supported natively the radio projection of the sky spherical coordinates. The main limitation of the radio projection is the absence of support of a projection angle. This could imply some approximation in the handling of On-The-Fly data with rotated scanning directions. CLASS now supports all the projections already supported in the GILDAS format, i.e., nongeocentric spherical coordinates, geocentric, orthographic, azimuthal, stereographic, Lambert, still, radio, and all. This required the introduction of the MODIFY PROJECTION command, the modification of the MODIFY PROJECTION command, and the modification of the position header section in the CLASS Data Format. This memo details all this in details.

Keywords: coordinates, projection, CLASS Data Format
Related documents: CLASS documentation, CLASSIC Data Container

IRAM Memo 2013-2

CLASSIC Data Container

S. Bardeau¹, V. Pocri¹, 1. IRAM (Grenoble)
2. LERMA, Observatoire de Paris

October, 3rd 2013
Version 1.0

Abstract

The CLASS/CLIC Data Format are digital formats used to describe single-dish/interferometric radio-astronomy data. They can be described in two ways: 1) a CLASSIC Data Container, which is generic enough to store many kind of data, typically several observations which gather observational parameters with actual data, and 2) the CLASS/CLIC Data Format itself, which make a particular use of the CLASSIC Data Container.

The size of the data sets produced by the IRAM instruments experience a tremendous increase (because of multi-beam receivers, wide bandwidth receivers, spectrometers with thousands of channels, and/or new observing mode like the interferometric on-the-fly). This implied that the CLASS/CLIC Data Format were reaching common limits in the size of data which could be stored. To solve these issues, the CLASSIC Data Container standard was revised. This document aims to describe the new standard. A companion document describes the GILDAS library which implements this standard and which is now used by CLASS and CLIC.

Related documents: The CLASSIC Library, IRAM memo 2013-1

GILDAS
J. Pety 2016
INTRODUCTION

GILDAS is a collection of state-of-the-art softwares oriented toward (sub-)millimeter radioastronomical applications (either single-dish or interferometer). It is daily used to reduce all data acquired with the IRAM 30M telescope and the NOthern Extended Millimeter Array NOEMA (except VLBI observations). GILDAS is easily extendible. GILDAS is written in Fortran-90/95, with a few parts in C/C++ (mainly keyboard interaction, plotting, widgets).

ACKNOWLEDGMENT IN PUBLICATIONS

The GILDAS team welcomes an acknowledgment in publications using GILDAS software to reduce and/or analyze data.

Please use the following reference in your publications: http://www.iram.fr/IRAMFR/GILDAS

RECENT MILESTONES

oct-15
The standard HIFI FITS science data format is now directly supported by CLASS.

aug-15
OpenMP is now supported at compilation time with "source admin/gildas-env.sh -o openmp". Up to now, it is mainly used in MAPPING gridding and deconvolution commands.

jul-15
The NOEMA calibration pipeline now successfully handles in parallel up to 7 antennas with the WIDEX backend and up to 6 antennas with the narrow band correlator.

jun-15
The support of the sky coordinate projections was enhanced in CLASS. IRAM Memo 2015-1.

may-15
The ALMA cycle 3 configurations files were added for use in the ALMA simulator. The LMOV command now correctly imports ALMA data cubes produced by CASA.

feb-15
GILDAS was upgraded to accompany the change of name of the IRAM interferometer from IRAM 30M to NOEMA.
User support:

III. answers to gildas@iram.fr

- Total number of threads from new users: 155/year.
- Total number of threads from all users: 302/year.
- Number of emails per threads: 2.5 (min: 1, max: 27).
- Median time to:
  - First answer: 6h;
  - Final answer: 25h.
Hi,

I have just stumbled on an obnoxious bug which prevents me from making the discovery of the century. I will defend my PhD thesis tomorrow. Fix this bug in the coming minutes.

Toto.
Dear Gildas team,

Your software is great. For the first time in my life, I encountered a segmentation fault using it. I succeeded to reproduce the bug with a simple list of commands. I attach the following information: version of gildas I am currently using, list of commands and the data set to reproduce the bug. I hope this will help you solve the bug in the coming months. Continue the great work.

Best regards, Toto.

***************************************************************************
gildas version: sep15b (x86_64-redhat6.4-ifort) source tree

List of commands:
LAS90> file in test
LAS90> find
Blablablabla...
Segmentation fault

Data set attached: test.30m

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Coping with the NOEMA project: Challenges

Changes of technology

**Receiver**  2 polar, 4GHz, SSB ⇒ 2 polar, 8GHz, 2SB.

**Backend**  XF ⇒ FX.

New operation modes  *e.g.* double-array.

Increased complexity  More antennas + More frontend/backend chunks.

Increased data rates  by a factor 32 to 6000.

**Number of baselines**  PdBI-2010 × $N_{ant}(N_{ant} - 1)/30$, *i.e.* 1.9, 3, and 4.4 for 8, 10, and 12 antennas.

**Channels**  PdBI-2010 ×32.

**Shorter integration times**  PdBI-2010 ×1 − 45.

**Typical data rates**  at the end of phase 1, *i.e.* end of 2017

**Average (Single-field, 10 antennas)**  2.8 MB/s, *i.e.*, at most 77 GB for 8-hrs observation.

**Peak (Wide-field, 10 antennas)**  63.0 MB/s, *i.e.*, 1.7 TB for 8-hrs observation.

Bigger delivered data products  Large 3D data cubes.

Increased scientific capabilities

**Wide bandwidth.**

**Higher sensitivity.**

**Higher brightness dynamic.**

⇒ Discovery of subtle, previously undetected “artifacts”.

GILDAS  J. Pety 2016
No software is the answer to all these:

- Best *(i.e. most recent)* computing technology.
- Best *portability*.
- Best *speed*.
- Best *ease of use (CLI and GUI)*.
- Best *(i.e. shortest)* learning curve.
- Best *functionalities*.
  - Best *data calibration methods*.
  - Best *data mapping methods*.
  - Best *(i.e. most complete)* analysis methods.
  - Best *graphical possibilities*.
- Best *cost*.
IRAM Science Software Strategy

Maintain high-quality software for IRAM instruments while staying open to outside world

- Focused but generic developments;
- In/out fillers;
- Python binding.

“Short”, “focused” development cycles

- No one-fit-all-use-cases-in-astronomy software.
- Only exceptional ruptures, e.g., data formats.

A good balance between astronomers and software engineers

- In-house astronomers make the link between the community and the engineers.
- Keeping a science activity is the best way to understand the community needs on a daily basis.
- Prototypes are useful first steps for more professional developments (e.g., IPP ⇒ PMS).

Continuous aggregation of functionality without creating black boxes

- Integration of functionality enable to simplify the interaction with ever increasing data complexity.
- Viewing the intermediate processing steps enable to keep control of the data reduction.

Yearly versions for the online acquisition

- Ensure stability and evolution at Pico Veleta and Bure.

Monthly releases to the community enable

- the algorithms to follow observatory changes.
- us to quickly distribute new functionality or bug fixes.