GILDAS

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/Grenoble R. Zylka, J.M. Winters, E. Reynier, J.C. Roche, V. Pietu, J. Pety, A. Castro-Carrizo, D. Broguière, M. Bremer, J. Boissier, S. Bardeau.

  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

Actual activity: Helping people to make sense of

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

4c7225bfa4b317bff31e063f21fab6bd7846db3e0e4d5abf2f20803ed28e
b53e23910dbfa730babe1bbe2a3f8c2aa5be1e7f49bfcc4fe93e4bafe83e
46948b3f916efebe6984ae3e9798a23ecf39bb3f0d91e0be23fb423d4213
b93e2c81e8bb5caf18bff30531beccd7fabee326e7bc46a2d53e2da3963d
40ea9bbc91a2d53d0607b1bc98894ebe96ce19bd898f7cbf683f17bea624
4bbec1b9ef3e09f9923f0a1b0f3cf20d2cc0f4d189be7615fdbe37f3f4be
2418b6bcc7192e3fe047703fc38f93bfa4a2c8bfe4f765be4ae63b3e2cec
b23e7ef00c3f3409ef3e946d07bfce0ffcbd4fee443ea04f48bdabfb3bbe
1ad525bfcd5cedbdf95a883eb4ac373f539ac9be6db95c3e806deebef6d4
3b3e3d4cd33e0534053f52a12ebed6f397be2c71353f5f615a3f0357043f
29ca013e459010bf989f503ed1646f3e04a236bfe4dc01bf04ad0abf2e5b
7abcbede96bf42af0abf7f6d54be3c37c9be6d1c06becae9d0be314e72bd
34984abf0d5c5cbd528c0fbe4c32943e7732adbe96a0213eac883fbef537
0abfcfc050bf3b56dfbeb315123f35b80b3dfbfb7abda62325bf8356bcbf
df2834bf8b27a73f6105823f41881b3f75a00d3fedfea83fce354abf81bb
c33f8dc0053ea521343faba63a3fa0d037be3fcbaa3efe025e3f63fa2c3f
d91ffa3ea3bad13e3efd60bf4817073f11e714be1cf28ebc5a885dbf8dc5
8bbf88a339bd3f4d9d3f8cbc03bf9374dcbec0ef683e0368273f19e0453e
9e8fec3d0d93943ef5b085bfd0948e3f9980823fbbff7bbff2a55dbe9e6a
973de216d8befb3704bff2a88f3d761c71bfe6cb80be8b75003fbd59f63e
e8cc0a3fe8b24bbd2a7efabeea72313f2906a83edcdad1bbe0209dbd8625
fabda6f426be4a5e6e3ea91305bf3497233d5a3d783ee02e653f6cdc913f
071b99beef73ebbe17cfd83eb503783f962aae3efd2a93be8e64fc3edf58
4fbe33d70e3f448fb93e65e5be3d4b98b63e78b7173ecb4c7d3e492b063e
18e5373ec55eef3d924a5d3ec354583f9ce2f4bdca6e16bf59683cbe9598
223fda2a643e77bb8c3ed520193f1175a43e73e5b73ef992763dcb68c53e
6fa5b63e7dfc15bfb832063e25ab06bec64f10bf9c4d4abe8b6f83be451f
883d848e17be720c2c3f45d65e3fac91293f590dfd3eca0ca73e86acbc3e
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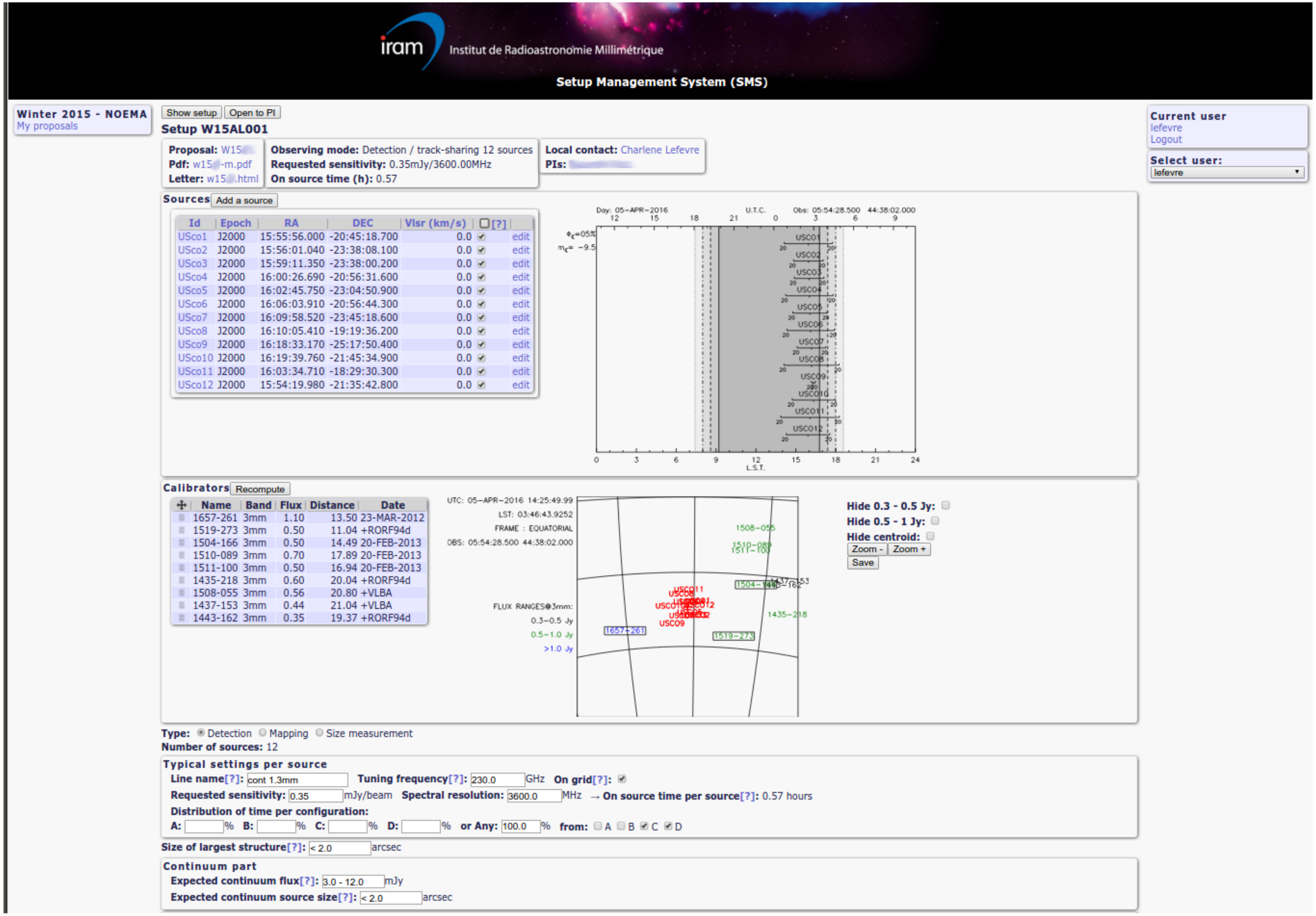
283f4289b73e025d1a3d824c68bef42c423e53df0cbef420db3e62dda13e

Scope: I. Softwares at IRAM

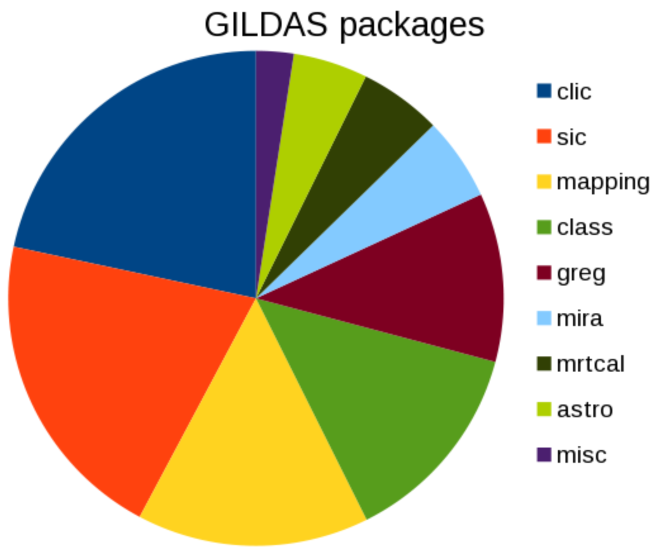
- Many different kinds of softwares at IRAM:
  1. Proposal and scheduling (statistics, dynamic scheduling, pool observing).
  2. Preparation of observations, *e.g.* setups.
  3. Data acquisition:
     3.1 Low level, *e.g.* hardware control (antennas, receivers, correlators, etc...)
     3.2 High level,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



GILDAS Strengths

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...

User support:
I. Documentation

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. Bardeau[1], J. Pety[1,2]

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

March, 26^{th} 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** kernel, i.e., none (unprojected spherical coordinates), gnomonic, orthographic, azimuthal, stereographic, lambert, aitoff, radio, and sfl. This required the introduction of the `MODIFY PROJECTION` command, the modification of the `MODIFY POSITION` command, and the modification of the position header section in the **CLASS** Data Format. This memo describes all this in details.

Keywords: coordinates, (re)projection, **CLASS** Data Format
Related documents: **CLASS** documentation, **CLASSIC** Data Container

IRAM Memo 2013-2

CLASSIC Data Container

S. Bardeau[1], V. Piétu[1], J. Pety[1,2]

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

October, 3^{rd} 2013
Version 1.0

Abstract

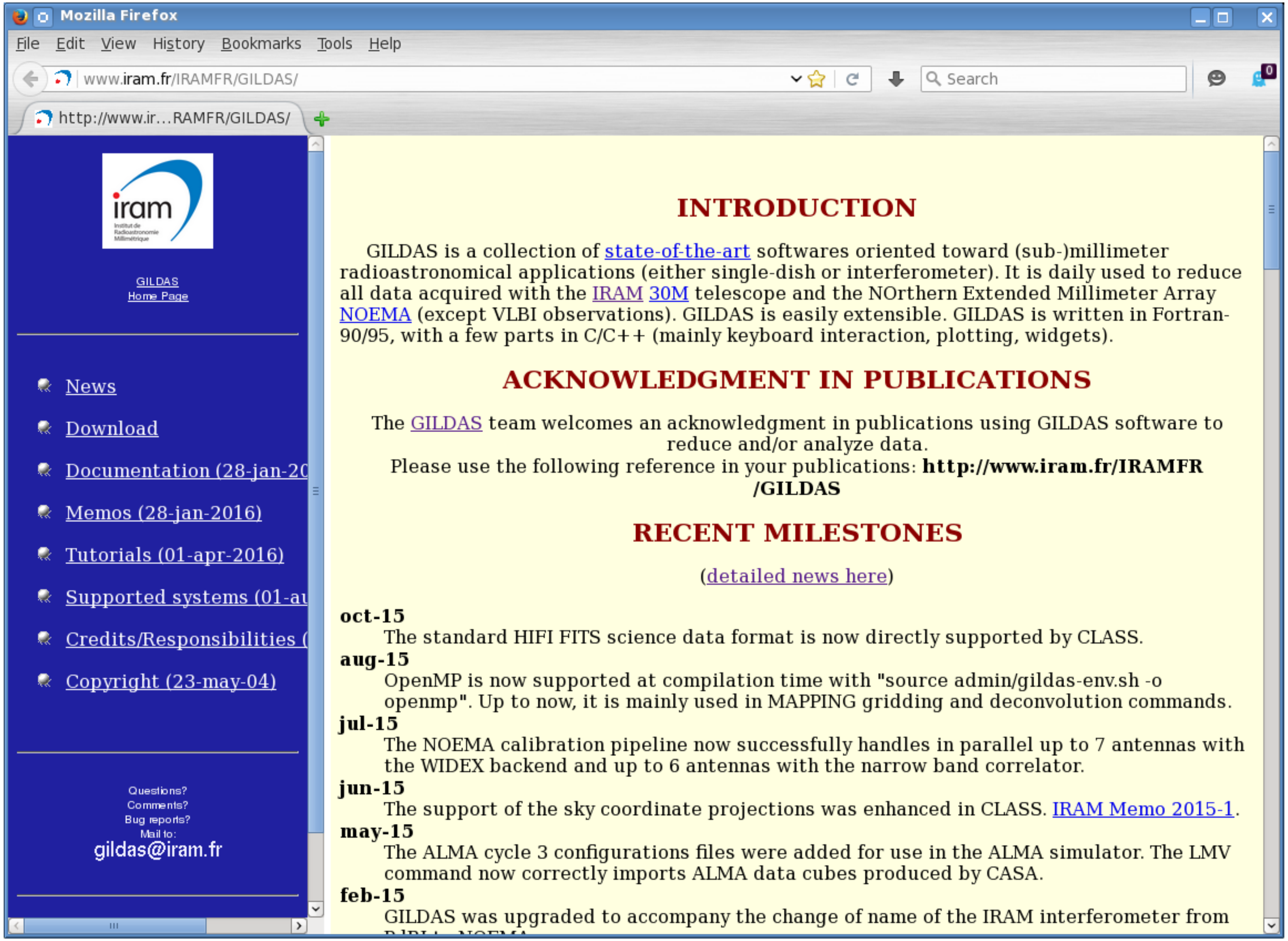
The **CLASS/CLIC** Data Format are digital formats used to describe single-dish/interferometric radio-astronomy data. They can be described in two layers: 1) a **CLASSIC** Data Container, which is generic enough to store many kind of data, typically several *observations* which gather observational parameters 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 datasets produced by the IRAM instruments experience a tremendeous 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 documents 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**.

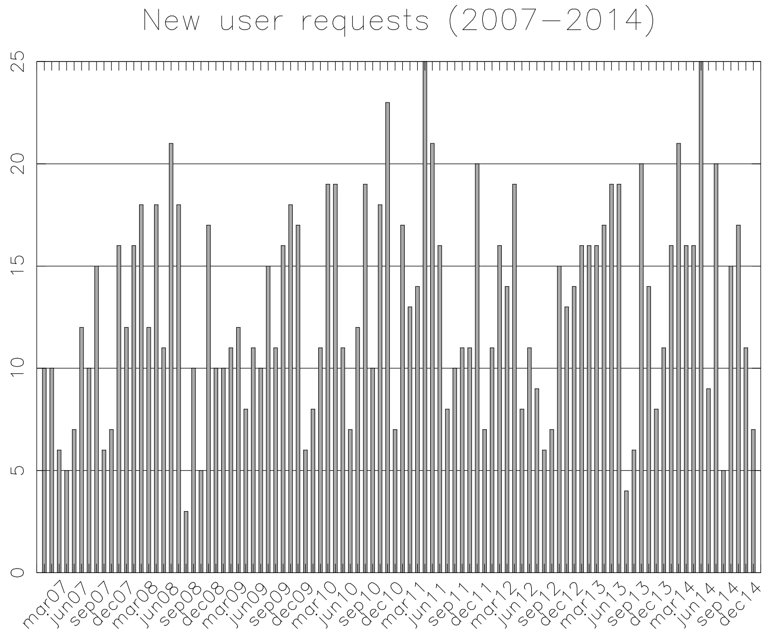
Related documents: The **CLASSIC** Library, IRAM memo 2013-3

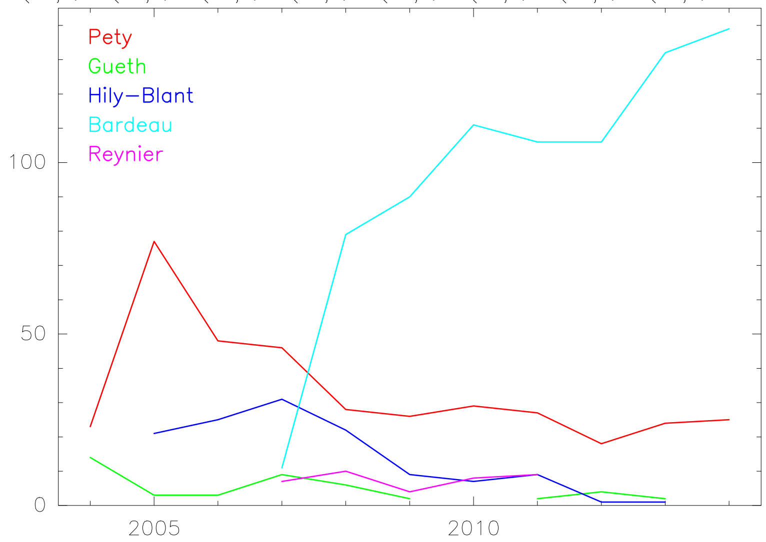
User support:

II. Web page http://www.iram.fr/IRAMFR/GILDAS

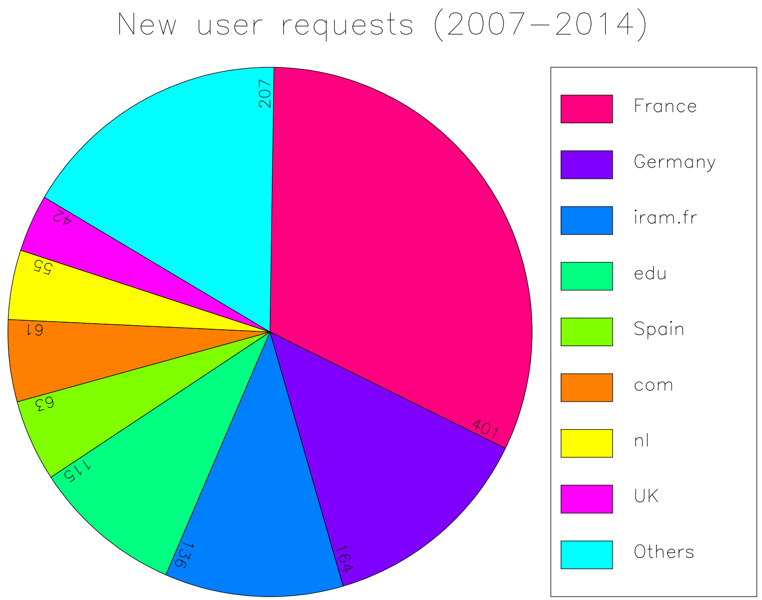


User support:
III. answers to `gildas@iram.fr`





- 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.



Bug report: I. Wrong way

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.

Bug report: II. Right way

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 $\Rightarrow$ 2 polar, 8GHz, 2SB.
- **Backend** XF $\Rightarrow$ 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 $\times N_{\mathrm{ant}}(N_{\mathrm{ant}}-1)/30$, *i.e.* 1.9, 3, and 4.4 for 8, 10, and 12 antennas.
- **Channels** PdBI-2010 $\times 32$.
- **Shorter integration times** PdBI-2010 $\times 1-45$.
- **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.**

$\Rightarrow$ Discovery of subtle, previously undetected "artifacts".

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.