# Data reduction and analysis of HIFI data within CLASS

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**Herschel-HIFI wideband spectra require specific tools to be efficiently reduced and analyzed. Here we present a suite of tools that have been implemented in the CLASS data reduction software for that purpose. These tools allow for the import of HIPE data into CLASS, the data reduction (spur removal, polynomial baseline fitting, sideband deconvolution), as well as the data analysis (line identification and modeling) within the same environment. We show how that these tools makes CLASS a fast and very efficient alternative to HIPE for post-level 2 data reduction and analysis.**

CLASS is a software dedicated to the reduction and analysis of continuum and spectral line observations. It is part of the GILDAS software suite developed and maintained by IRAM (Pety 2005). CLASS has several advantages over similar packages: it is efficient, robust, and can be easily scripted. Powerful extensions can be written in the Python language using the PyGILDAS interface (Bardeau et al. 2010)

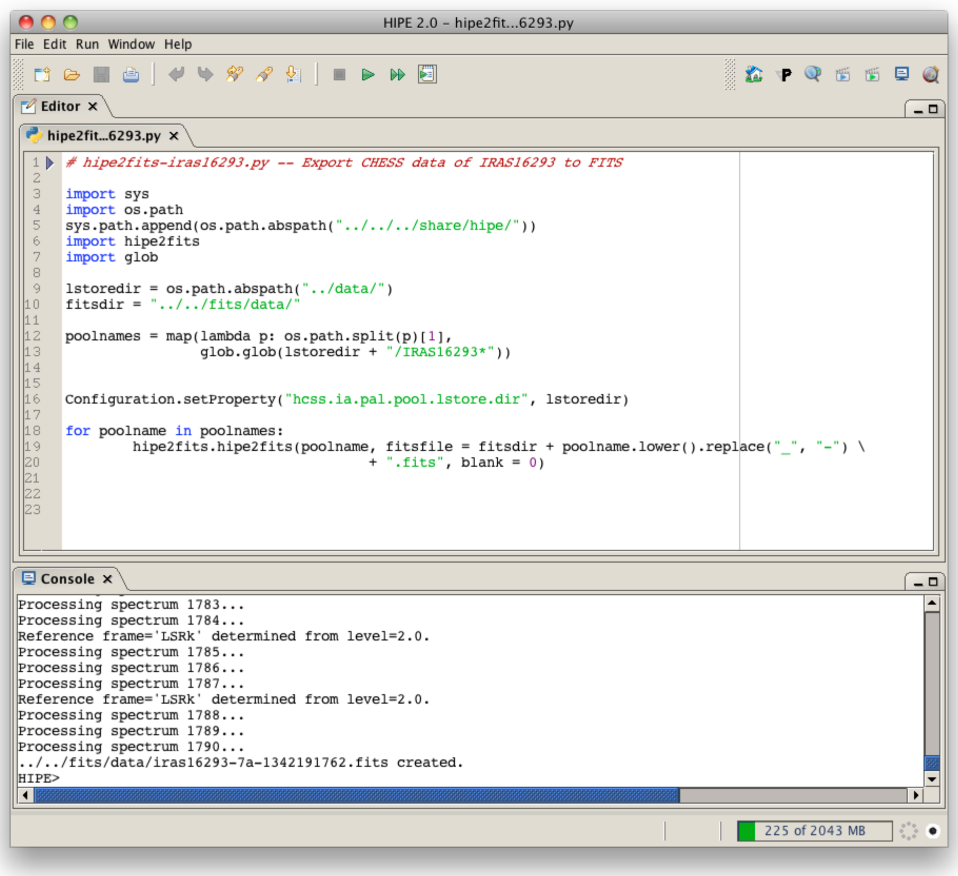

**Figure 1:** Export of level 2 HIFI data to FITS using HiCLASS.

CLASS can be used to reduce and analyze HIFI post-level 2 data. Several tools have been developed to that purpose. First, an HIPE module, HiCLASS, has been written to convert level 2 data into CLASS readable FITS files (see Fig. 1; Delforge et al. in prep).

Several CLASS commands have been implemented for the reduction of HIFI spectral surveys (e.g those obtained in the CHESS and HEXOS key programs; Ceccarelli et al, Bergin et al., this conference). Such surveys consist in many double side band (DSB) spectra, each corresponding to a different receiver tuning. These scans can be quickly visualized in CLASS using the VIEW command (see Fig. 2).

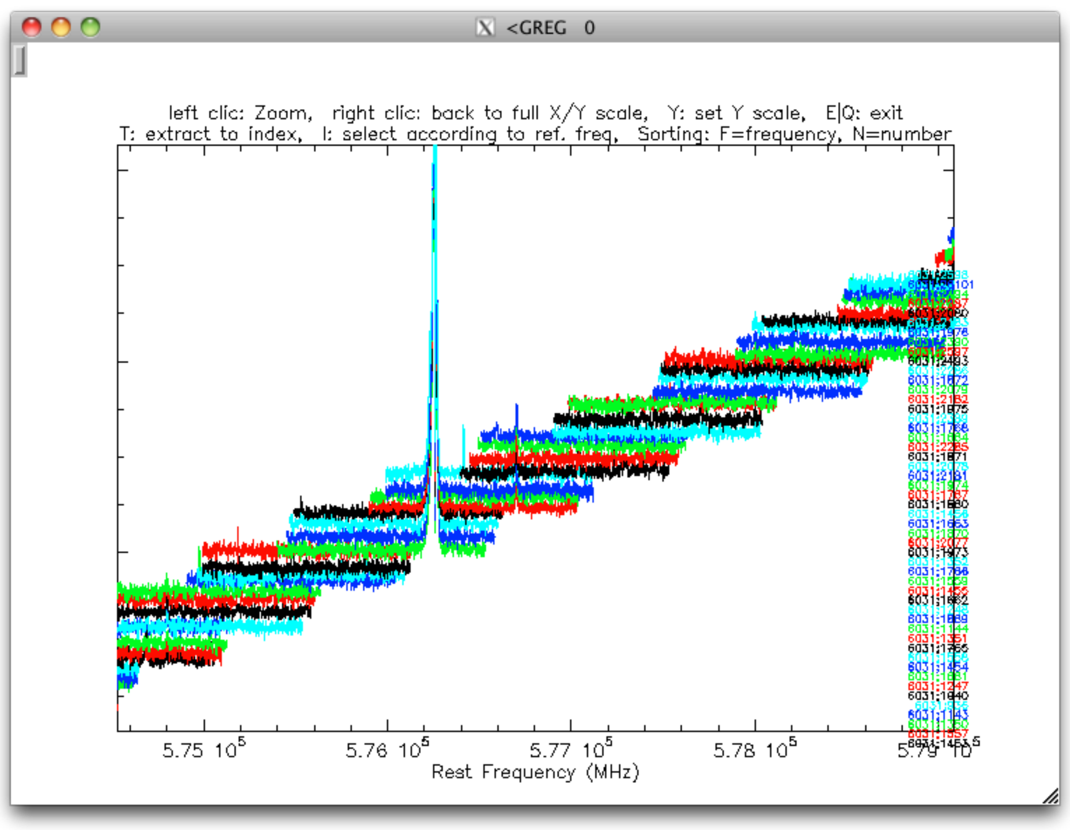


**Figure 2:** Visualization of an HIFI spectral survey in CLASS. The level 2 DSB spectra exported in the upper side band (USB) frequency scale are shown. For each LO tuning, the 4 sub-bands are displayed. A line from the USB is clearly detected around 576 GHz.

Two other commands, ISPUR and IBAS, have been implemented to remove the spurs that affect some scans, and to remove a polynomial baseline in each of these (see Fig 3). The signal and image sidebands can then be separated using the DECONV command (Fig. 4), which uses the sideband deconvolution algorithm of Comito & Schilke (2002).

A typical data reduction of a spectral surveys takes about 1.5 hours per receiver band. However once the spurs and baseline subtraction has been performed interactively, the data can be re-reduced automatically in less then a minute.

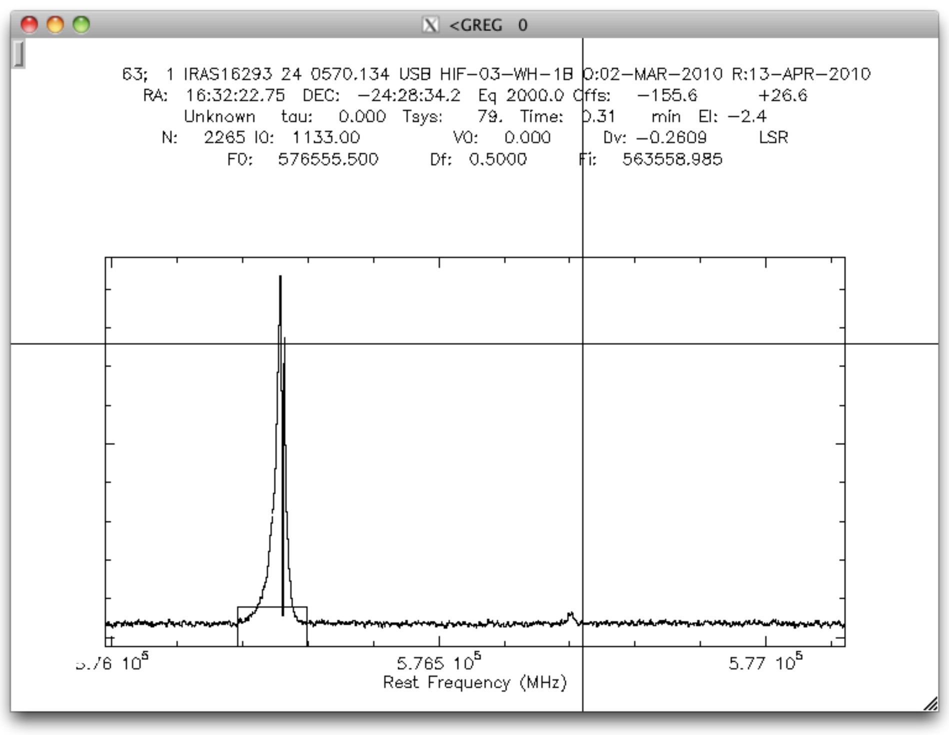


**Figure 3:** Interactive selection of the frequency windows to be avoided when fitting a polynomial baseline in each DSB spectra, using the IBAS command. Windows are stored in text files, so that the data can be re-processed automatically.

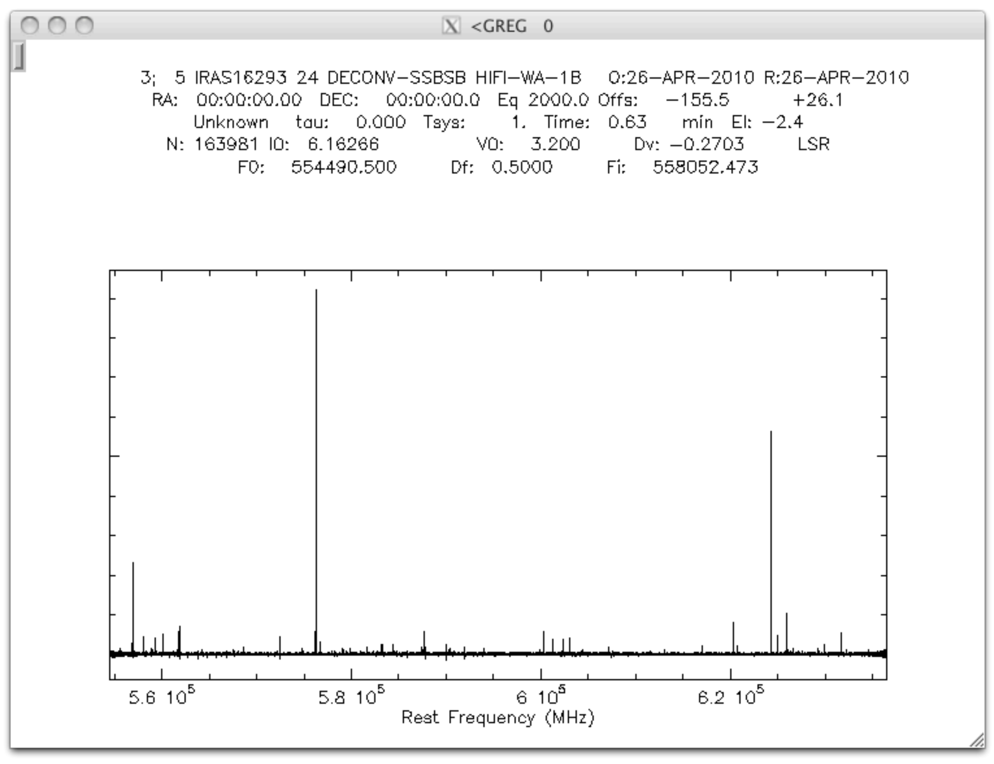


**Figure 4:** Single sideband (SSB) spectra deconvolved with the DECONV command.

Finally, CLASS can be used for the data analysis, using the WEEDS extension (Maret et al. 2010). This extension implements several commands for line identification and modeling. On Fig. 5, we show an example of a line identification in a SSB spectra using the LID command. This command makes a query in spectral line databases (CDMS or JPL; Pickett et al. 1998, Müller et al. 2001) and displays the line candidates.

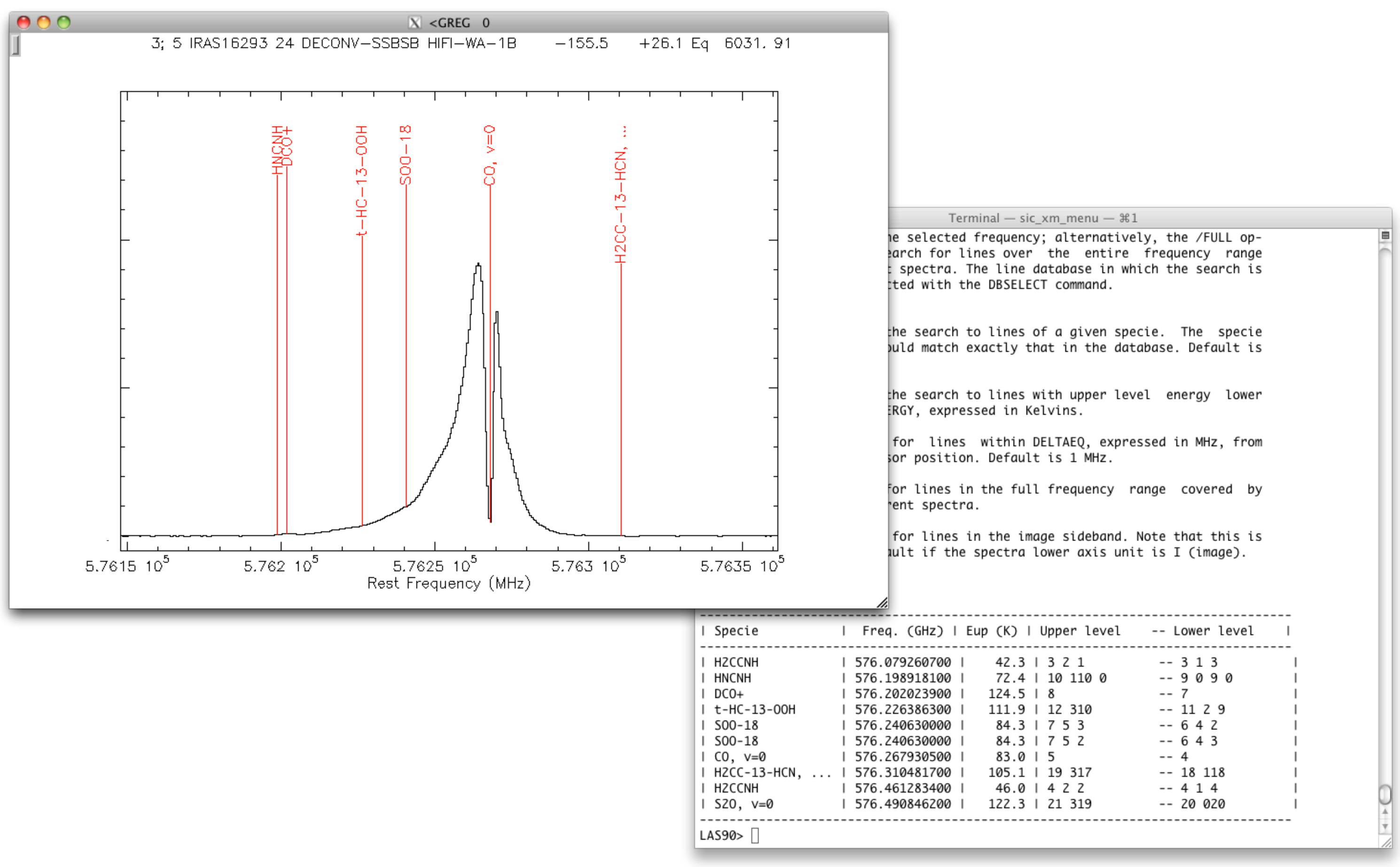


**Figure 5:** Typical line identification session with WEEDS

In conclusion, thanks to the continuous development efforts of the GILDAS group, CLASS can now be used to reduce HIFI data. It also provides generic tools for the spectral surveys analysis. This makes CLASS an efficient alternative to HIPE for post-level 2 data.

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