Filling Herschel/HIFI and ALMA data into GILDAS

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Questions, comments about GILDAS?
Visit *http://www.iram.fr/IRAMFR/GILDAS/* or contact us at *gildas@iram.fr*

Why filling non-IRAM data into GILDAS?

- User request.
- Comparison of data coming from different instruments => Better use of the science archives.
- Availability of specific data reduction algorithms (example: processing of the short-spacings).
- Availability of analysis tools (example: hyperfine or shell fit).
- Quality publication plot.

Scope

Data reduction can be split into 2 categories:

1) Instrument specific calibrations.
2) Generic data processing steps.

We thus recommend to calibrate the data inside the software developed by the instrument teams (Herschel/HIPE and ALMA/CASA). On the other hand, baselining, imaging, deconvolution, etc can be done in user prefered software. We thus provide the fillers to do this.

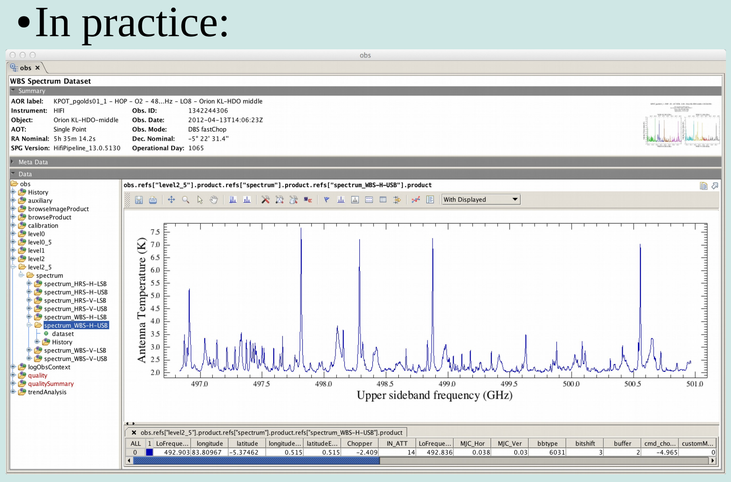
Herschel/HIFI to GILDAS/CLASS

- Context:
  - Herschel/HIFI data were already readable by CLASS after conversion into specific FITS file by the HiClass task (Delforges/Rabois) from HIPE.
  - These FITS files are however not the ones served by the Herschel science archive as result of the standard data processing.
  - The community thus requested to be able to feed Herschel/HIFI archive science products directly into CLASS => CNES+IRAM support.
  - Started on october 1st, 2014, delivery of the prototype foreseen on July 1st, 2015.
  - Double sideband deconvolution was imported in CLASS by IPAG and it is currently maintained by Cologne University.
- In details:
  - Automated recognition of Herschel/HIFI FITS level 2.0 and 2.5
  - List of the standard CLASS header sections that are filled from the FITS header parameters: General, Position, Spectroscopy, Calibration.
  - Addition of a dedicated Herschel section in the CLASS Data Format (see table on the right).
  - The data are filled as one or several CLASS spectra depending of the FITS level and/or context (On-The-Fly, spectral survey, etc).
  - The associated FLAG array will be filled in an array associated to each spectrum data (CLASS feature under development).

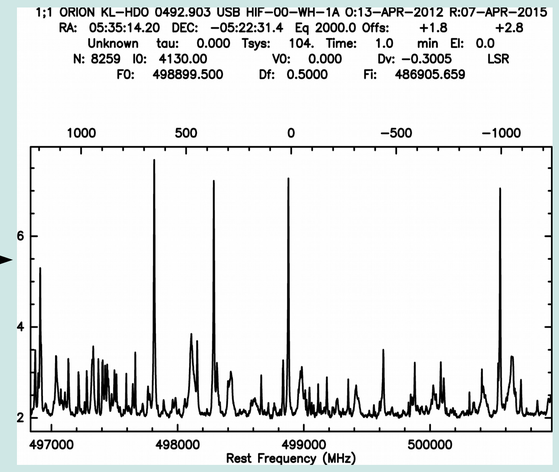
Herschel/HIFI parameters exported to the dedicated CLASS section

FITS keyword	FITS description
OBS_ID	Observation ID
ODNUMBER	Operational day number
CREATOR	Generator of the product
CALVERS	HIFI calibration version
ETAMB	Main beam efficiency
ETAL	Forward efficiency
TEMPSCAL	Temperature scale in use
POSANGLE	Spacecraft pointing position angle
LODOPPAV	Average LO frequency Doppler-corrected
GIM_COEFF(4)	Sideband gain polynomial coefficients
INSTRUME	Instrument name
OBS_MODE	Observing mode
PROPOSAL	Proposal name
AOR	AOR Label as entered in HSpot
LEVEL	Pipeline level
RAOFF	Sky reference OFF RA
DECOFF	Sky reference OFF declination
	Longitude average H and V
	Latitude average H and V
	Calibrated mixer junction current (H)
	Calibrated mixer junction current (H)
DATE-OBS	Beginning date of this product
DATE-END	End date of the product

- In practice:




```
LAS> file out Obsid_1342244306_WBSH_Level2.5.hifi
single
LAS> fits read Obsid_1342244306_WBSH_Level2.5.fits
LAS> file in Obsid_1342244306_WBSH_Level2.5.hifi
LAS> find
LAS> get first
LAS> plot
```



ALMA to GILDAS

- In details:
  - After the calibration, CASA delivers the frequency axis of the UV data in the topocentric frame and the frequency axis is transfered to the source frame during the imaging step.
  - In constrast, GILDAS currently assumes that the frequency axis is delivered in the source frame.

  => There is currently a need to convert the frequency axis from the topocentric to the LSRK frame in CASA before exporting the data to GILDAS. Then GILDAS offers the possibility to convert the frequency axis from LSRK to source frame.

  - ALMA handles several polarization at once. GILDAS only handles one.
  - ALMA only handles relative weights for visibilities. GILDAS uses absolute weights to predict the noise level.

  => Polarization states must be merged, and the proper weights re-estimated from the dispersion of measurements on independent channels.

- In practice:

3 steps in CASA:

1) Extracting the data to be exported:

```
split(vis='calibrated.ms',outputvis='source0-spw2.ms',
    field='0',spw='2',keepflags='F')
```

2) Setting the velocity reference frame and correcting for the Doppler effect from the topocentric to the LSRK frame:

```
cvel(vis='source0-spw2.ms',
    outputvis='source0-spw2-cvel.ms',
    outframe='LSRK',restfreq='345795MHz')
```

3) Exporting to UVFITS

```
exportuvfits(vis='source0-spw2-cvel.ms',
    fitsfile='source0-spw2.uvfits',multisource=F)
```

1 step in GILDAS:

```
@ fits_to_uvt Fitsfile UVTable
  FREQUENCY Freq VELOCITY Value LINE Name
```

which encompasses UVFITS to Gildas data format conversion, polarization averaging, noise estimation, and automatic flagging of abnormal noise levels, as well as proper conversion of the Frequency / Velocity axis.

If needed, the reverse operation (from GILDAS UVT to UVFITS) is also possible, though UVFITS format restriction do not allow complete exchange of data.

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