Release notes to the HIFI observations taken in the framework of the Performance Validation campaigns

HIFI ICC – 31-01-2013

This note describes the possible caveats associated with some of the HIFI data that were taken during the Performance Validation (PV) phase, and that have become available publically to the user community. Because of the early time in the mission when these observations were performed, and due to the exploratory nature of some of them, the instrument performance and/or observation strategy was not necessarily fully mature. Users of these data should therefore pay particular attention to the limitations listed below when trying to exploit the scientific information contained in those data.

The caveats listed below are especially applicable to the data that were taken during the PV phase. While most of them were solved in the meantime, there are still instrumental artifacts that do affect data as of today. For a detailed description of those, please refer to the general AOT release note, available on the following page:

http://herschel.esac.esa.int/twiki/bin/view/Public/HifiCalibrationWeb

We want to emphasize that none of these observations has undergone the standard quality control checks performed by the HSC and it is therefore up to the user to assess the usability of these data for science purpose.

In case of doubt, it is always possible to contact the Herschel helpdesk (**http://herschel.esac.esa.int/esupport/)**, but requests related to calibration data will be treated with lower priority.

1. HIFI AOT release time-line

Release milestone	OD	Description / limitations
Start of PV phase	68	Initial version of AOT logic
Release of DBS AOT	291	SlowChop in HEB discouraged
Band 7b pure in 1866-1888 GHz range	305	Previous observations in this range can suffer from larger calibration error
Release of FSW/LChop/PSW and SSCan	330	NoRef discouraged, SScan/FSW in HEB discontinued
Fix of 7b C+ tuning	377	Previous C+ observation potentially failed
Revision of map defintion	419	New Nyquist sampling definition
Release of Mapping AOT	441	OTF-FSW discontinued except C+ area
Band 1a spur removed	496	Spurs removed in 535-551 GHz
Bands 5a/5b purity achieved	595	Spurs removed in 5a, release of 5b

2. Caveats potentially affecting data irrespective of the AOT

LO tuning and stability issues

In the early days of PV, the LO tuning of band 7b in the vicinity of the C+ line was not fully robust. This resulted in observations performed with a degraded sensitivity (higher system noise temperature) and usually degraded stability performance (distorted baselines). This instrumental issue was solved for data taken after OD 377.

IF Saturation in the WBS

An update of the attenuator settings for spectral scans was performed for observations taken after OD 673. This means that spectral scans taken prior to this data, especially in the bands 4a and 6a, could suffer from significant IF saturation levels at some LO frequencies, and in some of the WBS CCDs.

Spectral purity issues

Several regions in the HIFI coverage have been known to suffer from spectral purity issues, which can result in larger calibration errors and the presence of spectral ghosts. While some of these regions still apply to date, and are compiled in the general AOT release notes, some others were cleaned in the course of the

PV, e.g. in bands 5a, 5b and 7b. Users should be particularly careful when using the following data:

- From band 5a and 5b prior to OD 595
- From band 7b in the range LO=1866-1888 GHz prior to OD305

Spurious signal issues

Similarly to the spectral purity, there are several regions in the HIFI coverage affected by spurs of various natures. Again, many of these spurs have remained to date, but several others were suppressed throughout dedicated campaigns. Such spurious features will affect the following data:

- Band 1a data in the range LO=535-553 GHz prior to OD 496
- Band 4b data around LO=1108 GHz prior to OD 81
- Band 5a and 5b data prior to OD 595

Table A.1 in the appendix lists the original compilation of spurious signals that was established early in the PV phase, and which is representative of the state of some of those bands prior to spectral cleaning (typically until October 2010). For a compilation of the spurs as of today, please refer to the general AOT release note.

Emission in OFF positions

It is a general comment that reference positions, either taken as part of chopped observations, or in mapping observations, may not always be optimal considering the source geometry, so that there is no guarantee that OFF positions are totally free of emission.

3. Caveats potentially affecting Pointed observations

Double-Beam Switching (DBS)

The use of slow-chop in HEB bands was discouraged because of the degraded baseline quality associated due to the limited stability performance in those bands. Such artifacts may affect calibration data taken in this fashion.

Frequency Switching (FSW)

FSW observations taken without a reference were discouraged as they do provide relatively poor baseline. Such artifacts may affect calibration data taken in this fashion.

Load Chop

Similar to the FSW case, Load Chop observations taken without a reference were discouraged as they do provide relatively poor baseline. Such artifacts may affect calibration data taken in this fashion.

4. Caveats potentially affecting Mapping observations

OTF mapping and DBS raster

OTF maps (of any referencing scheme type) and DBS raster maps taken prior to OD 419 use a different definition of the step size along the scanning leg for the so-called “Nyquist” sampling option. Before OD 419, this step was defined HPBW/2. After OD 419, this step was converted into HPBW/2.4, while the previous definition was renamed “half-beam” in the sampling option offered at the HSpot front-end level. Users should take this into account especially when performing re-gridding of data taken in this fashion.

OTF-FSW mapping

Similarly to the FSW Point mode, there can be significant baseline distortion associated with map taken in this mode without considering a Reference measurement.

On top of that, the use of FSW in HEB bands was shown to offer significantly distorted baseline quality, so that it was eventually discontinued at HSpot level, with the exception of the range 1890-1898 GHz in band 7b. Calibration taken outside of this narrow range should be considered with caution.

OTF-LoadChop mapping

Similarly to the Load Chop Point mode, there can be significant baseline distortion associated with map taken in this mode without considering a Reference measurement.

DBS-Cross mapping

Calibration data taken in DBS-Cross mapping modes have been considered unfit for public release.

5. Caveats potentially affecting Spectral Scan observations

SScan with frequency grouping

A special flavour of the Spectral Scans was tested during the PV phase, but never actually released to the user due to the poor data quality often achieved, and/or the immaturity of the current pipeline to make properly process data taken in this fashion. In this approach, calibration and/or reference measurements at a given LO frequency are shared among several neighbouring frequency points.

Spectral Scans (of any referencing scheme type) taken in this particular flavour should therefore be treated with particular care.

SScan in DBS mode

Similarly to the DBS Point mode, there can be some baseline distortion associated with such observations taken in slow-chop in the HEB bands.

SScan in FSW mode

Similarly to the FSW Point and Mapping mode, there can be significant baseline distortion associated with spectral surveys taken in this mode without considering a Reference measurement, as well as surveys taken in the HEB bands.

SScan in LoadChop mode

Similarly to the Load Chop Point and Mapping mode, there can be significant baseline distortion associated with spectral surveys taken in this mode without considering a Reference measurement.

6. Other potential data issues

Apart from the issues listed in the previous sections, artifacts not necessarily restricted to the framework of the calibration activities may affect the released calibration data. Several of them are already covered in the AOT release and performance note (see introduction), but we do highlight here those being present mode predominantly:

- Electric standing waves in bands 6 and 7: this non-sinusoidal baseline modulation is usually stronger in the V polarization data. We recommend to use the so-called *matching technique* (see details on the web page quoted in the introduction) to try and mitigate the magnitude of its effect

- Enhanced standing waves in strong continuum sources: observations of sources with strong continuum usually result in enhanced standing wave modulations from the internal loads used to perform the band-pass calibration. These modulations are sinusoidal so there is a fair chance that the FitHifiFringe task could deal with them. Alternatively, an option in the HifiPipeline task (*doFilterLoad*) can be activated in order to try and remove those ripples directly in the load measurements.

- Unstable bandpass calibration in SScans: Irrespective of the referencing scheme used for the spectral scans, there have been issues observed in spectral scans, whereby the time delay allocated for the Local Oscillator power to settle was deemed too short. The net effect is that of a load calibration and science measurements taken with difference mixer pumping levels, which manifests in the data as an imperfect band-pass correction and noticeable baseline distortion and jumps. Such an effect is illustrated in Fig. 1.

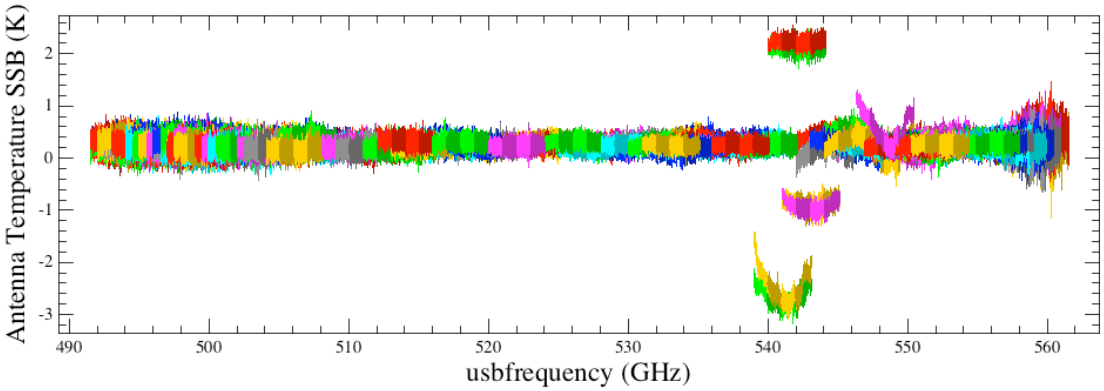

Fig.1: Illustration of baseline jumps in SScan due to un-settled LO output power

7. Stability measurements

Part of the calibration observations does not necessarily point at a pre-defined target. This is the case of the so-called *stability* measurements. These observations consist of long (1-2 hours) integrations on an a priori blank sky position. Although their scientific interest is probably limited, these observations can be very useful especially in bands 6 and 7 where they can provide a broad catalogue of representative OFF positions needed for the application of the *matching technique* code used to mitigate standing waves in this band.

8. Observations performed as *Proc Modes*

Some of the calibration observations are taken with an observing template that differs from that usually offered in HSpot and is referred to as *Proc Mode*s. Such modes can be recognized in the meta-data for *obsMode*. In those observations, you should be warned that not all uplink parameters could be propagated to the auxiliary products (see HifiUplinkProduct).

Appendix A: list of problematic LO frequencies applicable until October 2010 (applicable primarily to calibration data)

band	lo_frequency	lo_width	problem	affected_subbands
1a	537500	3000	LO_settling	1,2,3,4
1a	540497.25	2000	Strong_spur	1
1a	541500.75	2000	Strong_spur	1,2
1a	545499	2000	Strong_spur	2
1a	547499.25	2000	Strong_spur	1,2
1a	547499.25	2000	Weak_spur	1,3
1a	549499.5	2000	Strong_spur	1,2
1a	549499.5	2000	Weak_spur	1,3
1a	551499.75	2000	Strong_spur	3
1a	553500	2000	Weak_spur	1,2,3
1a	553500	2000	Strong_spur	4
1b	584500.5	2000	Strong_spur	4
1b	586500.5	1000	Strong_spur	4
2a	675000	2000	LO_settling	1,2,3,4
2a	692061	1000	Weak_spur	4
2a	699999	2000	Strong_spur	3,4
2a	708000	2000	Weak_spur	4
2a	711999	3000	Weak_spur	1
2a	714000	3000	Strong_spur	4
2a	716001	3000	Weak_spur	3
2a	717999	3000	Weak_spur	3,4
2b	724000	2000	LO_settling	1,2,3,4
2b	733000	3000	LO_settling	1,2,3,4
2b	744432	1000	IF_saturation	4
2b	752529	1000	IF_saturation	3
2b	755961	2000	IF_saturation	3
2b	760524	2000	IF_saturation	4
2b	762000	2000	Weak_spur	4
2b	764001	2000	Strong_spur	4
2b	765999	2000	Strong_spur	1
2b	768000	2000	Strong_spur	1
2b	770001	2000	Strong_spur	2,3
2b	776001	2000	Strong_spur	3
2b	783999	2000	Strong_spur	3
2b	786000	2000	Strong_spur	2,3
2b	786000	2000	Weak_spur	1,4
2b	794001	2000	Strong_spur	1
3a	809001	2000	IF_saturation	1
3a	810999	3000	IF_saturation	1
3a	822999	2000	IF_saturation	1
3a	824000	4000	Instability	1,2,3,4
3a	840999	2000	Weak_spur	2,3
3a	843000	4000	Instability	1,2,3,4
3b	868617	2000	IF_saturation	1,2
3b	869283	2000	IF_saturation	1,3

3b	870000	4000	Instability	1,2,3,4	
3b	872000	2000	IF_saturation	1,2	
3b	873000	2000	IF_saturation	1,2	
3b	874000	2000	IF_saturation	1,2	
3b	875000	2000	IF_saturation	1,2	
3b	876000.5	2000	IF_saturation	1,2	
3b	882000	2000	IF_saturation		1
3b	883998	2000	IF_saturation	1,3	
3b	886000.5	2000	IF_saturation	1,3	
3b	887998.5	2000	IF_saturation		1
3b	890001	2000	IF_saturation		1
3b	891999	2000	IF_saturation		1
3b	894001.5	2000	IF_saturation		1
3b	895999	2000	IF_saturation		1
3b	898002	2000	IF_saturation		1
3b	900000	2000	IF_saturation		1
3b	901998	2000	IF_saturation		1
3b	904000.5	2000	IF_saturation		1
3b	905998.5	2000	IF_saturation		1
3b	908001	2000	IF_saturation		1
3b	909999	2000	IF_saturation		1
3b	912000	4000	Strong_instability	1,2,3,4	
3b	915000	2000	LO_settling	1,2,3,4	
3b	913999.5	2000	IF_saturation		1
3b	918000	2000	IF_saturation	1,4	
3b	922000.5	2000	IF_saturation		1
3b	926001	2000	IF_saturation		1
3b	940000	2000	Impurity	1,2,3,4	
3b	952002	2000	Strong_spur		1
3b	953001	2000	Strong_spur	1,2,3	
4a	957978	2000	IF_saturation		1
4a	958175.9	2000	IF_saturation		1
4a	965632.25	2000	IF_saturation		1
4a	966000	2000	LO_settling	1,2,3,4	
4a	967000.5	2000	IF_saturation		1
4a	974000	4000	Instability	1,2,3,4	
4a	997000	2000	LO_settling	1,2,3,4	
4a	999958.5	2000	IF_saturation		1
4a	1000000	4000	Instability	1,2,3,4	
4a	1000998	2000	IF_saturation		1
4a	1003000	2000	LO_settling	1,2,3,4	
4a	1003000	2000	IF_saturation		1
4a	1007000	4000	Instability	1,2,3,4	
4b	1069000	2000	LO_settling	1,2,3,4	
4b	1088000	2000	LO_settling	1,2,3,4	
4b	1097221	2000	Weak_spur		1
4b	1098553	2000	Weak_spur		1
4b	1099174	2000	Strong_spur		1
4b	1103913	2000	Weak_spur		1

5a	1137000	10000	Impurity	1,2,3,4	
5a	1161000	12000	Impurity	1,2,3,4	
5a	1210500	17000	Impurity	1,2,3,4	
5a	1231767	2000	Weak_spur		1
5a	1232001	2000	Weak_spur		1
5a	1233998	2000	Weak_spur		1
5b	1232001	2000	Strong_spur		3
5b	1233999	2000	Strong_spur		1
5b	1236001.5	2000	Strong_spur		1
5b	1240002	2000	Weak_spur		3
5b	1256760	2000	Strong_spur		3
5b	1258002	2000	Strong_spur		3
5b	1260000	2000	Strong_spur		4
5b	1261998	2000	Strong_spur		4
5b	1264000.5	2000	Strong_spur	3,4	
5b	1265998.5	2000	Strong_spur		3
5b	1268001	2000	Strong_spur		4
6a	1429998	2000	Instability	2,3,4	
6a	1434000	2000	Instability	2,3,4	
6a	1444002	2000	Instability	2,3,4	
6a	1474000	4000	LO_settling	2,3,4	
6a	1497000	4000	Instability	2,3,4	
6a	1500500	3000	LO_settling	2,3,4	
6a	1530000	4000	Strong_instability	2,3,4	
6a	1534002	2000	Instability	2,3,4	
6a	1536000	2000	Instability	3,4	
6a	1540002	2000	Instability	2,3,4	
6a	1543998	2000	Weak_spur		4
6a	1549998	2000	Instability	2,3,4	
6a	1560000	2000	Instability	3,4	
6a	1561998	2000	Instability	2,3,4	
6a	1570002	2000	Instability	2,3,4	
6a	1576002	2000	Instability	3,4	
6b	1700001	2000	Instability	2,3,4	
7a	1701634.5	2000	IF_saturation		4
7a	1716646.5	2000	IF_saturation		4
7a	1718435	2000	Weak_spur		2
7a	1719000	2000	Impurity	1,2,3,4	
7a	1754000	1000	LO_settling	2,3,4	
7a	1756275	2000	Instability	2,3,4	
7a	1757000	2000	Impurity	1,2,3,4	
7a	1795999.5	2000	Instability	2,3,4	
7a	1808001	2000	Instability	2,3,4	
7a	1809999	2000	Instability	2,3,4	
7a	1811997	2000	Instability	2,3,4	
7a	1814001.75	2000	Instability	2,3,4	
7a	1815999.75	2000	Instability	2,3,4	
7a	1817997.75	2000	Instability	2,3,4	
7a	1820002.5	2000	Instability	2,3,4	

7a	1822000	2000	IF_saturation		2
7a	1828001	2000	IF_saturation	2,3,4	
7a	1834002	2000	IF_saturation		4
7a	1836000	2000	IF_saturation		4
7a	1840002	2000	Instability	2,3,4	
7b	1809000	2000	IF_saturation		4