Catalogue of SWS[1] Observations of Asteroids and Planetary Satellites

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Abstract

We reprocessed the ISO SWS observations of nine asteroids and five planetary satellites at wavelengths between 2.38 and 29.0 μm. Up-to-date (as of September 2003) data reduction procedures and calibration files used together with recent extensive analysis of instrumental effects have enabled a significant improvement in the quality of the final spectra obtained in comparison to the pipeline (OLPv10) products available in the ISO Data Archive (IDA). The resulting reduced spectra will be available as part of the Highly Processed Data Products (HPDP) set in the IDA. This document describes this data, outlines the basic data reduction steps and gives an overview of the remaining instrumental effects like fringe residuals, memory effects and tracking artifacts.

1 Introduction

The ISO Data Archive (IDA[2]) contains 66 observations of nine asteroids and 46 observations of seven planetary satellites taken with the Short Wavelengths Spectrometer (SWS; de Graauw et al. [1996]) instrument in the AOT02 or AOT06 observation templates. We restricted the reprocessing to AOT06 observations only and excluded observations without reasonable wavelength coverage. For some faint sources, the flux obtained in bands 1A, 1B, 1D, 1E and 2A is especially low hence these data are excluded from the final catalogue (although we did inspect this data). We also have not reprocessed band 4 data as this band suffers strongly from glitches and memory effects. Regarding planetary satellites we did not include two objects for the following reasons:

- **Iapetus** observations showed no sufficient flux level in any of the observations carried out on this object.
- **Deimos** observations are strongly affected by straylight from Mars. With an angular separation of only 22 arcseconds between Deimos and Mars it is impossible to extract any spectral information from these observations.

This version of the catalogue thus consists of 47 observations of all nine observed asteroids, 11 observations of the four Galilean satellites and 7 observations of Titan. Generally, the re-reduced data products of this project will have reduced instrumental effects such as tracking artifacts or fringe residuals on a level significantly below 5 %.

[2] `http://www.iso.vilspa.esa.es/`

Table 1: Abbreviations used to characterize sub-bands in the observations table

-	Insufficient wavelength coverage, mostly seen in calibration observations. These obervations were not reduced.
l	Low signal level, indicating that structural or flux information should be interpreted with great care.
m	Band was scanned two or more times.
p	Band was scanned only partial.
s	Band was split into two or more separately scanned parts.
x	Data of this band was not reduced. This comment normally appears together with **l**, meaning that the flux level was far too low. Otherwise the reason for exluding this observation is given as a special remark.

2 Observations and Data Reduction

2.1 Overview

Table 2 summarizes the observational details of our sample of asteroids and planetary satellites: the Target Dedicated Time (TDT number, a unique identifier for the ISO Data Archive), the observed subbands and band-specific comments. Table 1 explains the abbreviations used to characterize sub-bands regarding the type of scan and common problems like low flux, memory effects and tracking or fringe residuals. Not all of these observations were re-reduced, the reasons for excluding them are given in the table. Observations with an empty "Observed Bands"-column are in most cases calibration observations with insufficient wavelength coverage. For details on the observing technique and the definition of the SWS bands see Volume V of the ISO Handbook on "SWS – The Short-Wavelength Spectrometer" (Leech et al., [2003]).

Table 2: Overview of all asteroid and satellite observations made with the AOT06 observation template.

	Object	TDT	Observed Bands	Remarks
(1)	Ceres	10001105	-	
		10001206	-	
		10001307	-	
		25600201	1B	
		25600209	1D, 2Ap	
		31200315	-	
		31200416	-	
		31200517	-	
		71401706	2C, 3E	
		71401805	1Dml, 1El, 2Am, 2B, 3C, 3D	Band 2A affected by memory effect. Bands 3C and 3D may contain fringe residuals.
		71401904	1Al, 1Bl, 3A	Band 3A may contain fringe residuals.
		74803502	-	
		76202701	-	
(2)	Pallas	05200401	-	
		05200502	-	
		05200603	-	
		22100102	1Bl	
		22100110	1Dl, 2Ap	
		49602801	-	
		55205005	2Cs, 3E	

Table 2: (continued)

	Object	TDT	Observed Bands	Remarks
(2)	Pallas	67100703	1Dl, 1El, 2A, 2B, 3C, 3D	Band 2A affected by memory effect. Band 3D may contain tracking artifacts.
		72800110	1Al, 1Bl, 3A	
(3)	Juno	41906902	2Cs, 3E	
		46103901	-	
		46104002	-	
		46104103	-	
(4)	Vesta	57900503	1Al, 1Bl, 3A	Band 3A may contain fringe residuals.
		57900604	1Dml, 1El, 2Aml, 2B, 3C, 3D	Absolute flux differs significantly between end of 3C and start of 3D.
		57900705	2Cs, 3E	Band 3E may contain fringe residuals.
		77604303	1Al, 1B, 3A	Band 3A may contain fringe residuals.
(4)	Vesta	77604404	1Dml, 1El, 2Aml, 2B, 3C, 3D	Absolute flux differs significantly between end of 3C and start of 3D.
		77604505	2C, 3E	
		79000201	2Cp	
		79002302	2Cp	
		79002503	2Cp	
		79002704	2Cp	
		80400301	1Dl, 2Al, 3D	Band 2A affected by memory effect.
		80402002	1Dl, 2Al, 3D	
		80402903	1Dl, 2Al, 3D	
		80403104	1Dl, 2Al, 3D	Band 3D may contain tracking artifacts.
		82500203	2B, 3C	
		82501804	2B, 3C	Band 3C may contain tracking artifacts.
		82502205	2B, 3C	
		82502706	2B, 3C	
(10)	Hygiea	40602104	2Csp, 3E	
		41204403	1Dlx, 2Ap, 2Bp, 3C, 3D	
		41204504	1Blx, 3A	
		43201003	-	
		43201804	-	
		43204305	-	
		67000903	3A	
		67000904	1Dlx, 2Bl, 3C, 3D	Absolute flux differs significantly between end of 3C and start of 3D.
		67000905	2C, 3E	
		83201902	-	
(52)	Europa	73200108	1Dlx, 1Elx, 2Alx, 2Bl, 3C, 3D	Absolute flux differs significantly between end of 3C and start of 3D.
		73200209	2C, 3E	
		73200307	1Alx, 1Blx, 3A	

Table 2: (continued)

	Object	TDT	Observed Bands	Remarks
(114)	Kassandra	62500210	3Al	
		62500211	2Blx, 3Cl, 3Dl	Band 3C may contain tracking artifacts.
		62500212	2Cl, 3El	
(308)	Polyxo	51600117	3Al	
		51600118	2Blx, 3C, 3Ds	Absolute flux differs significantly between end of 3C and start of 3D. Band 3C may contain tracking artifacts.
		51600119	2Cs, 3E	
(624)	Hektor	39001703	3Al	
		39001704	3C, 3Ds	
		39001705	2Cslx, 3E	
	Deimos	62700201	2Bx	Highly affected by straylight from Mars.
		62700403	2Cpx	Highly affected by straylight from Mars.
		62700520	1Dmx, 1Ex, 2Amx, 3Dx	Highly affected by straylight from Mars.
		64400435	1Dmx, 1Ex, 2Amx, 3Dx	Highly affected by straylight from Mars.
	Io	34100601	1A, 1Bs, 3As	Possibly contaminated with straylight from Jupiter.
		34100602	1Ds, 1Es, 2Aps, 3Cs, 3Dps	Possibly contaminated with straylight from Jupiter.
	Europa	71400903	2Cl, 3E	Possibly contaminated with straylight from Jupiter.
		72801604	1Dlx, 1Elx, 2Alx, 2Blx, 3C, 3D	Possibly contaminated with straylight from Jupiter.
		72801703	1A, 1B, 3A	Possibly contaminated with straylight from Jupiter. Band 3A may contain fringe residuals.
		72802011	-	
		72802112	-	
	Ganymede	70603501	2C, 3E	Possibly contaminated with straylight from Jupiter.
		70603602	1A, 1B, 3A	Possibly contaminated with straylight from Jupiter. Band 3A may contain fringe residuals.
		72100503	-	
		72100604	-	
		74200906	1Dl, 1El, 2Aml, 2B, 3C, 3D	Possibly contaminated with straylight from Jupiter. Band 2A affected by memory effect. Bands 3C and 3D may contain tracking artifacts.

Table 2: (continued)

Object	TDT	Observed Bands	Remarks
Callisto	56600204	-	
	69800203	1A, 1B, 3A	Possibly contaminated with straylight from Jupiter. Band 3A may contain fringe residuals.
	69800504	1Dml, 1El, 2Aml, 2B, 3C, 3D	Possibly contaminated with straylight from Jupiter. Absolute flux differs significantly between end of 3C and start of 3D. Bands 3C and 3D may contain tracking artifacts.
	69800605	2C, 3E	Possibly contaminated with straylight from Jupiter.
	72100907	-	
	72101008	-	
Titan	42100713	2Cs	
	42100911	1Aplx, 1Blx, 3A	
	42100912	1Dl, 1El, 2Alm, 3C, 3D	Bands 3C and 3D may contain fringe residuals.
	42100915	2Cp, 3E	
	42101301	2Bmsl	Band 2B affected by memory effect.
	58100701	1Amsl, 1Bmsl	
	77201002	2Cmp, 3E	
Iapetus	77002014	-	
	80403005	2Clx	

2.2 Data Reduction

Data reprocessing was performed with the latest versions (as of September 2003) of the "Observers SWS Interactive Analysis" (OSIA, Version 3.0a)[3]. The basic pipeline reduction steps were followed with additional interactive steps including visual inspection of the data. The processing consisted of a reduction of detector memory effects (OSIA command `ANTIMEM`) and interactive subtraction of the dark current (`DARK_INTER`). The interactive dark current subtraction was applied not only to faint sources but to all observations to get uniformly reduced data sets. A manual check of the photometric calibration (`PLOT_PHOT`) was followed by an interactive masking (`MASK_INTER`) of residual glitches (which had not been identified by the automated deglitching earlier in the reduction) and identification and masking of faulty detectors. Especially in band 3, where fringes dominate the raw spectrum, only the strongest glitches can be detected by visual inspection at this level. For band 2 data the Relative Spectral Response Function (RSRF) correction was applied (`RESPCAL`) and flux conversion was performed (`FLUXCON`). For band 3, we first determined the flux densities (`FLUXCON`) and then corrected interactively for the RSRF (`RESP_INTER`). A second interactive masking of glitches was followed by the standard velocity correction (`VELCOR`). The removal of tracking artifacts (`POINT_CORR`) was based on ISO-centric asteroid ephemeris generated with JPL's HORIZONS system[4] in combination with measured SWS beam profiles. The offset parameters were visually optimised to eliminate tracking effects. Finally, the remaining fringes were reduced by eliminating fringe frequencies with (`FRINGES`). As `FRINGES` is quite sensitive to steep baseline variations caused by tracking artifacts, we decided to perform this reduction step at the end of the pipeline. The final spectra include only data in the validated band limits (using `EXTRACT_AAR`, `CUTAAR` and `CLEANSTRUCT`) i.e. include no off-band data.

The resulting spectra were further processed with the "ISO Spectroscopic Analysis Package" (ISAP,

[3] OSIA is a joint development of the SWS consortium. Contributing institutes are SRON, MPE, KUL and the ESA Astrophysics Division.

[4] `http://ssd.jpl.nasa.gov/horizons.html`

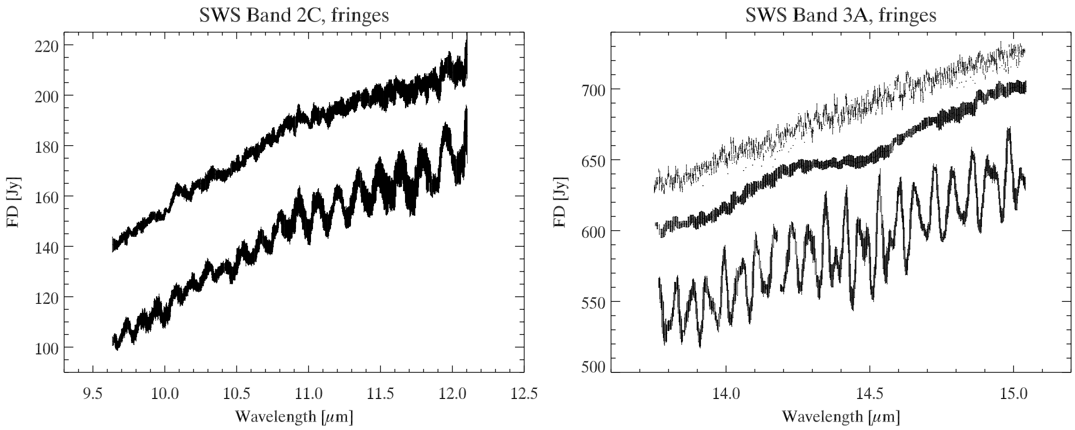

Figure 1: The long wavelength part of band 2 C of Vesta (TDT 57900705) and part of band 3 A of Ceres (TDT 71401904). Only detectors 19 to 23 are plotted for band 2C. The fringe patterns can be easily recognized. The fringe-corrected spectra have been offset by 30 Jy (band 2 C) and 60 Jy (band 3 A) for clarity. For band 3 A a round of low-level defringing was performed. The resulting spectrum (offset by 90 Jy) shows no baseline wiggles anymore.

Version 2.2)[5]. The basic reduction steps are described in the SWS06 recipe "How to reduce SWS AOT06 Data in the ISAP GUI" (Sturm [2002]). After visual inspection of every detector's data in both scan directions and zapping of outliers or complete masking of noisy detectors, averaging over all lines was performed, followed by shifting of the detectors' signals to their common mean value. The data of all remaining detectors was averaged once again, resulting in the final spectra.

The final products were stored in the standard AAR-FITS format, with a different `SCAN`-tag for each observed wavelength range. So the AAR for an observation of i.e. the bands 1A, 1B and 2B will contain data with the `SCAN`-tag 1 for band 1A, 2 for band 1B and 3 for band 2B. Bands observed multiple or in several parts received different `SCAN`-tags for each repetition or part.

2.3 Fringes and RSRF residuals

Upon re-reducing the spectra, it became clear that the SWS pipeline defringing mechanisms do not perform well in many cases. This is especially true for moving targets which partly traverse the aperture during an exposure. In this case interactive defringing with `RESP_INTER` and `FRINGES` is highly recommended to correct the complicated fringes patterns that arise. The reprocessing also brought up fringes at unexpected frequencies as in the case of the "slow fringes" at cycle 890 which appear in band 2C in the spectra of bright sources. These fringes are not constant in phase for all twelve detectors and thus do not appear as a familiar fringe pattern in the final product but as increased noise. In this case, additional defringing with `FRINGES` using adjusted parameters had to be performed on the separate detectors. Besides this, there exist low frequency baseline ripples which appear particularly in band 3A (Lahuis [2003]). OSIA v4.0 now includes a modified RSRF to automatically remove these ripples, but during re-reduction of the data included in this catalogue we used `FRINGES` with adjusted `cylce` and `ncycle` parameters. Figure 1 shows two extreme examples of the fringe patterns (Vesta, TDT 57900705 and Ceres, TDT 71401904).
Please note that `FRINGES` should be applied with great care only, as it is even possible to "correct" for the leakage at the end of band 3D with this procedure using improper input parameters. For further analysis of the final spectra it is essential to use the RSRF curves and uncertanties given in the SWS Handbook, as spectral features seen in final spectra may coincide with RSRF residuals escpecially at steep parts of the RSRF curves.

[5]The ISO Spectral Analysis Package (ISAP) is a joint development by the LWS and SWS Instrument Teams and Data Centers. Contributing institutes are CESR, IAS, IPAC, MPE, RAL and SRON.

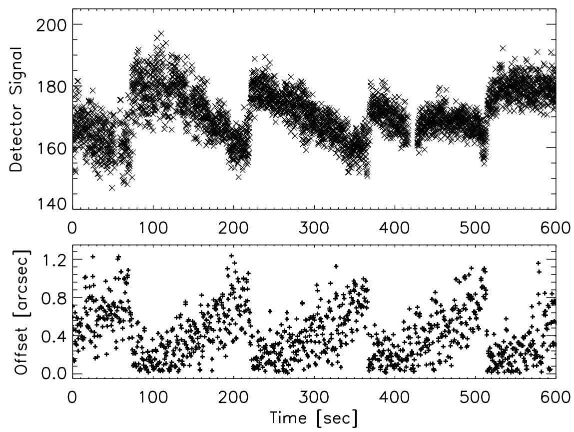

Figure 2: Band 3C data from Vesta (TDT 80400301), plotted before averaging of up- and downscan. The lower part shows the pointing offset of the satellite, the upper part gives the flux of detectors 25 to 36. It is clearly visible that offsets below 1 arcsecond result in significant flux variations. The gap at 420s corresponds to the change of the scan direction. Fringes and glitches have been removed.

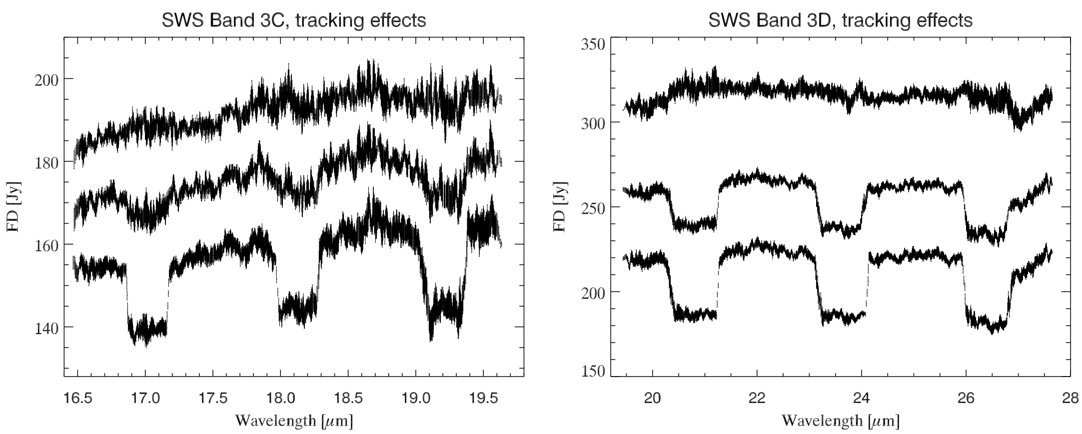

Figure 3: The tracking pattern in band 3 D pipeline data of Vesta (TDT 80400301, lower part in the right figure) is one of the worst examples of our whole data set. The default tracking correction reduced the signal jumps only slightly (middle part, shifted by 40 Jy). An optimized tracking correction lowered the tracking influences typically to a 1-2 % level. In the extreme case above, tracking residuals on the 5 % level remained (upper part, shifted by 40 Jy). In band 3C (left figure), the situation is slightly better, but default tracking correction also results in distinct residuals.

2.4 Tracking

The tracking of the satellite caused a sawtooth modulation of the observed flux (Fig. 2) which results in a rectangular or sinusoidal structure in the final spectrum after up- and downscan were averaged (Fig. 3). During re-reduction, tracking artifacts were observed from band 2B on, becoming strongest in band 3D, depending on speed and orientation of the object's motion.

Precise ISO-centric ephemeris calculations in combination with beam profiles (Salama [2000]) and the satellite pointing history allowed the correction of the tracking effects. Optimal offset parameters for the pointing/tracking correction still had to be determined from visual inspection of remaining artifacts. Unsatisfactory removal of tracking artifacts was observed especially in observations of the Galilean satellites, where straylight from Jupiter introduces additional tracking artifacts.

3 Comments on individual bands

3.1 Band 1 (2.38-4.08 μm)

Only the brightest objects (Ceres, Pallas, Vesta and the Galilean satellites) showed sufficient flux levels in this wavelength range. Besides this, band 1 seemed to be quite unproblematic regarding tracking, fringes, glitches or memory effects.

3.2 Band 2 (4.08-12.0 μm)

As thermal emission increases in this wavelength range, most objects showed a good SNR, at least in band 2C. From band 2B upwards tracking artifacts were observed in most spectra. Defringing was slightly complicated for brighter sources in band 2C as there appeared slow fringes at cycle 890 which could only be removed with custom input parameters to `FRINGES`. RSRF residuals appear as emission features at approximately 10.0 μm and 11.05 μm, additional residuals may appear in the range $9.0 - 9.3 \mu m$. Band 2 data generally may suffer from memory effects, causing wrong slopes or erroneous absolute flux values.

3.3 Band 3 (12.0-29.0 μm)

Band 3 data was generally affected by tracking artifacts and fringe residuals and could therefore be reduced only with great efforts including visual inspection at most levels of the reduction process. At 12.3 μm remain RSRF residuals and bands 3A, 3C and 3D may suffer from undercorrected baseline wiggles. Order leakage from 14 μm shows up as increasing flux at the end of band 3D in the spectra of most objects. Glitches appeared more frequently as in the other bands and contributed to an overall higher noise level.

4 Caveats and flags

Most caveats have to be considered during reduction of the data only, but some still apply to the end-product as contained in the catalogue. Specific flags have been defined and are explained together with the criteria for setting them and listed per sub-band for each re-reduced observation in Table 3. A more detailed explanation of most caveats together with examples is given in the SWS handbook. Some of the caveats and flags do not apply to any of the re-reduced observations, these are only briefly mentioned below.
Some of the caveats and flags required checking of the "Revolution Reports" (RRP), which are accessible in the ISO Data Archive. A short summary of major events is given in Volume I of the ISO Handbook on "ISO – Mission & Satellite Overview" (Kessler et al., [2003]).

4.1 Caveats

- **Memory effects**: Memory effects can affect bands 2 and 4 and arise from the fact that the detectors of these bands "remember" their previous illumination history. For band 2 exists a model allowing correction of memory effects but some observations still show wrong slopes or distorted dark currents. This does generally not affect narrow structures but results in unreliable photometric information and differences between up- and downscan. Information about affected observations is given in the "Remarks" column of Table 2 and via the flag "Check dark subtraction" (see description below).

- **RSRF residuals**: Some features of the RSRF are artifacts which may cause residues in the processed spectra. See Section 3 for the wavelengths of these residuals. RSRF residuals have no influence on broadband photometric information but affect only narrow parts of the spectra at well-defined positions.

- **Pointing effects**: Inaccurate source positions can cause low throughput which was not the case in any of the re-reduced spectra. The effects of tracking are described in Section 2.4, the user of the re-reduced data should check the “Remarks” column of Table 2 for information about remaining tracking artifacts.

- **Fringe residuals**: This is explained in detail in Section 2.3. Information about fringe residuals in the re-reduced spectra can be obtained from Table 2 or by checking the corresponding flag in Table 3.

- **Partially corrected detector/scan jumps**: In most observations there occured at least one jump per line in at least one detector, some jumps of a whole detector block were also observed. The manual masking during re-reduction guarantees that jumps do not affect the end-products in the sense of artificial spectral features or wrong slopes, but in some cases jumps required the clipping of considerable parts of a line, resulting in a substantial loss of redundancy and a higher noise level. The criteria for setting the corresponding flag are explained below.

- **Uncorrected glitch tails**: Glitch tails are not automatically corrected by the pipeline and were frequently found in band 3 data of the re-reduced spectra. Manual clipping of the affected data normally solves this problem sufficiently, but simultaneous glitch tails in all detectors result in loss of redundancy and a higer noise level. The corresponding flag is described below.

- **Unsubtracted Zodiacal light contribution**: The typical zodiacal light contribution is of order 0.3 mJy in a SWS aperture which is far below the flux of the objects contained in this catalogue. This caveat does not apply to any of our spectra.

- **No in-orbit correction of the band 4 RSRF**: None of the re-reduced spectra contains band 4 data, so this caveat does not apply.

- **Reference scan memory effect in band 4**: This caveat does not apply as well.

4.2 Flags

- **Glitch tails identified in band 1,2,3,4,5 or 6**: As mentioned above, clipping of data contaminated with glitch tails will not affect the end-product in most cases. However, some observations showed simultaneous glitch tails in all detectors of an up- or downscan, which results in a loss of redundancy for at least a small part of the re-reduced spectrum. Of course, the term “simultaneous” here refers to the time of the event rather than the wavelength, but depending on the width of the clipped part there will be a non-negligible overlap in wavelength. This flag was set in case of a glitch tail requiring clipping of data (at the same wavelength) of at least six detectors of a line. The user should be aware of the possibility of small-scale variations in noise, while broadband photometric information will not be affected.

- **Detector/Scan jumps identified in band 1,2,3,4,5 or 6**: Similar to glitch tails, this could easily be corrected during the manual masking process in most cases. This flag was set if at least six detectors suffered from a jump event, requiring clipping of data or manual adjustment of the baseline. This generally affects the data quality on a broader wavelength range than glitch tails and can result in unreliable photometry and a higher noise level.

- **Fringe residuals identified in band 1,2,3,4,5 or 6**: As already mentioned above, proper defringing of solar system observations is a non-trivial task and does not always result in perfectly corrected spectra. This flag is set for all observations where fringe residuals are clearly visible or highly suspected, these are basically the same observations which have a corresponding entry in the “Remarks” column of Table 2.

- **Check dark subtraction**: Generally only a few samples of the dark current measurements are taken with closed shutter and these samples are vulnerable to glitches, glitch tails and memory effects. The visual inspection of all dark currents allowed for an efficient correction of glitch-affected darks but memory effects in band 2 still remain a problem for some observations. The corresponding flag is set for all observations with unreliable dark subtraction due to memory effects..

- **Light leakage at 28 μm**: Due to the low efficiency of the order selection filters in the light path of band 3D about 10% of the light from 14μm leaks into the region at 28μm. Since all of the objects contained in this catalogue show at 14μm a flux of at least one third of that at 28μm, this problem affects all observations at a significant level. Consequently, this flag is set for all observations with band 3D data.

- **High glitch rate**: The reasons for an anomalously high glitch rate could be enhanced space weather or observing close to the end of the science window. Checking of the Revolution Reports did not result in any indications of increased space weather, and even though a few observations were scheduled at the end of the science window, they do not suffer from an increased glitch rate which would have required more clipping of affected data during the manual masking process. This flag is not set for any of the spectra of the catalogue.

- **Pointing problem**: This flag accounts for loss of pointing during the observation or problems with the guide star. This did not occur during any of the observations included in this catalogue, therefore this flag is generally not set. Please note that there exists no specific flag for tracking artifacts as described above. Such information has to be obtained from the "Remarks" column of Table 2.

- **Increased noise due to preceding CAM-CVF observation**: Prior to June 1997 there was the possibility that CAM-CVF observations preceding a SWS observation caused an increased dark current in band 3, returning to nominal values within 30 minutes after the CAM-CVF observation. None of the observations contained in this catalogue did follow a CAM-CVF observation within an interval of less than 50 minutes, so this flag is generally not set for our spectra.

- **Extended source: check photometry**: Actually all sources in this catalogue can be treated as point sources, so this flag does not apply to any observation.

- **No simultaneous SW grating scan**: This would only apply to a failed SW grating scan simultaneous to a Fabry Perot observation. This flag is not true for any of the presented observations.

- **Post-helium observation**: None of the presented observations was scheduled in the post-helium phase, so this flag generally does not apply.

- **Wrong instrument configuration**: This includes incorrectly designed configurations, instrumental problems and problems with the transmission of the command sequences. This did not occur during any of the re-reduced observations.

- **Instrument disabled/failed**: This flag would include instrument activation failures, recuring of the detector or closing of the instrument due to malfunction or protection against saturation or cosmic rays. Checking of the Revolution Reports showed no indications of such events, so this flag is not set for any of the included observations.

- **Telemetry drop**: According to the Revolution Reports only Titan 77201002 suffered from a telemetry drop of approximately 3 minutes duration. The resulting data of this observation was not substantially affected, so consequently this flag is not set for any of the end-products.

- **Pipeline Problem**: Re-reduction of the catalogue data started at SPD level, the necessary pipeline products were available and free of errors for any of the re-reduced observations. This flag does not apply to any of the presented spectra.

Table 3: Overview of relevant flags for all re-reduced observations. The flags are set for individual sub-bands rather than for complete scans.

TDT	Glitch tails	Det./Scan jumps	Fringe resid.	Check darks	28μm leakage
Asteroids:					
(1) Ceres					
25600201					
25600209		2A			
71401706					
71401805			3C, 3D	2A	3D
71401904			3A		
(2) Pallas					
22100102					
22100110					
55205005	3E				
67100703	3C			2A	3D
72800110	3A				
(3) Juno					
41906902					
(4) Vesta					
57900503			3A		
57900604					3D
57900705	3E		3E		
77604303			3A		
77604404					3D
77604505					
79000201					
79002302				2C	
79002503					
79002704					
80400301				2A	3D
80402002					3D
80402903					3D
80403104					3D
82500203					
82501804				2B	
82502205					
82502706					
(10) Hygiea					
40602104					
41204403	3C				3D
41204504	3A				
67000903					
67000904					3D
67000905					
(52) Europa					
73200108		3D			3D
73200209	3E				

Table 3: (continued)

TDT	Glitch tails	Det./Scan jumps	Fringe resid.	Check darks	28μm leakage
73200307	3A				
(114) Kassandra					
62500210	3A				
62500211	3C				3D
62500212					
(308) Polyxo					
51600117					
51600118	3D				3D
51600119					
(614) Hektor					
39001703	3A				
39001704	3D				3D
39001705					
Satellites:					
Io					
34100601					
34100602					3D
Europa					
71400903					
72801604					3D
72801703	3A		3A		
Ganymede					
70603501					
70603602			3A		
74200906				2A	3D
Callisto					
69800203			3A		
69800504		3C			3D
69800605					
Titan					
42100713					
42100911	3A				
42100912			3C, 3D	3D	
42100915					
42101301				2B	
58100701					
77201002					

5 Conclusions

We inspected and uniformely reduced more than 60 % of the asteroid SWS observations stored in the archive. This corresponds to approximately 60 hours of total 100 hours observing time. Further we reduced all AOT06 observations of planetary satellites, excluding observations affected by straylight (such as Deimos) or suffering from low flux (Iapetus). The final spectra therefore represent a major improvement in quantity as well as quality of available SWS data of solar system objects.
In this document we demonstrated the improvements in data quality which can be achieved by interactive re-reduction. Obviously, re-reduced data is much more suitable for further analysis than pipeline data. Early during this project it became clear that proper re-reduction is not an easy task at all but requires a thorough understanding of the underlying reasons for the various instrumental effects. This applies not only to the reduction of moving targets but to all types of objects.
The final spectra are an invaluable resource for future mineralogic and meteoritic studies, for thermal emission studies and the determination of surface or regolith properties. They will also provide the basis for the planning of future mid-infrared observations and, very likely, initiate new laboratory studies and constrain surface modelling efforts.

References

[1996] de Graauw Th., Haser, L.N., Beintema, D.A. et al. 1996, A&A 315, L49

[2003] Lahuis, F. 2003, RSRF correction of band 3 wiggles, technical report, 10 April 2003 & private communication

[2003] Kessler, M. F., Müller, T. G., Leech, K., Arviset, Ch., Garcia-Lario, P., Metcalfe, L., Pollock, A. M. T., Prusti, T., Salama, A. 2003 ISO – Mission & Satellite Overview, The ISO Handbook Volume I.

[2003] Leech, K., Kester, D., Shipman, R., Beintema, D., Feuchtgruber, H., Heras, A., Huygen, R., Lahuis, F., Lutz, D., Morris, P., Roelfsema, P., Salama, A., Schaeidt, S., Valentijn, E., Vandenbussche, B., Wieprecht, E., de Graauw, T. 2003, SWS – The Short Wavelength Spectrometer, The ISO Handbook Volume V, T. G. Müller, J. Blommaert, P. Garcia-Lario, Eds.

[2000] Salama, A. ISO Beam Profiles and Extended Source Flux Calibration, in ISO Beyond Point Sources, ESA SP-455, R.J. Laureijs, K. Leech and M.F. Kessler (Eds.), p7-10.

[2002] Sturm, E. 2002, How to reduce SWS AOT06 Data in the ISAP GUI, available from the ISO Explanatory Library at `http://www.iso.vilspa.esa.es/`