Technical Note : DSPD HIGH RESOLUTION MODE FOR AOT1 OBSERVATIONS

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Abstract

This note is describing the AOT 1 high resolution mode for the SWS Interactive Analysis module DSPD. This mode allows to split reset intervals into partial ramps by introducing faked reset pulses and flaggings. On AOT1 observations this is increasing the resolution with the disadvantage of decreasing S/N ratio.

1 Introduction

AOT SWS01 makes full SWS grating wavelength scans at a reduced spectral resolution. The scans are effectively continuous, using small and frequent steps, much shorter than the selected reset interval.

speed	step size [LVDT]	dwell time [sec]	reset time	total steps	steps/sec
1	4	1/8	1	32	8
2	2	1/8	2	32	8
3	1	1/8	2	16	8
4	1	1/4	2	8	4

It was intended to give the option to compute partial ramps out of the reset interval to achieve a higher resolution for AOT1 scans. This is particular important for fast AOT1 scans.

2 Implementation

An additional keyword 'SECOUT' has been added to the call of the IA module DSPD. This keyword indicates the number of partial ramps which will be computed for one second. The number of partial ramps may be 1, 2 or even 4. Note that for four you might run into memory problems as it blows up your SPD by almost this factor.

IAS_DSPD is calling the new module SPS_PREPARE_HIGH_RES. This new module is expanding the reset interval loop and flagging the data by NODATA and RESET as necessary to split the related SPD into partial ramps. This is done only where an associated run flag in the LW section is set or a dark current measurement is flagged. Unfortunately this includes the dark current measurement in front of photometric checks as well. The photometric checks themself stay untouched. It is the assumption that SW and LW part have the same reset interval. This is the case for SWS01 observations

The SPD tag raster(0) has been 'misused' to fill in the partial ramp number for a certain reset interval.

Also the aot1_lr_data array, containing bit patterns to re-compute the grating position and associated wavelength, has been slightly expanded by low resolution informations (BIT 22 to 27).

SPS_WAVELENGTH has been modified to assign proper wavelengths to the partial ramps as it is done for AOT1 observations.

For proper dark current subtraction for the photometric check the tool ADAPT_PHOT2HIGH is available. It unflags the last DARK data in front of the photometric check and introduces the 'original' dark values.

For responsivity calibration it is appropriate to use the keyword aot_number=6 to avoid smoothing using calfile 19.

3 Analysis

For testing the AOT 1 speed 4 observation on W51 has been chosen. The strong SIII line should give first ideas about the performane of the tool and uncover possible software problems.

Figure 1 shows SPD outputs using a secout factor of 2. The two second reset interval has been split into four partial ramps. Partial ramp one has been computed using 5 samples, partial ramp 2 to 4 using 12 samples. The glitch detection had been switched off. Dark subtraction has been done.

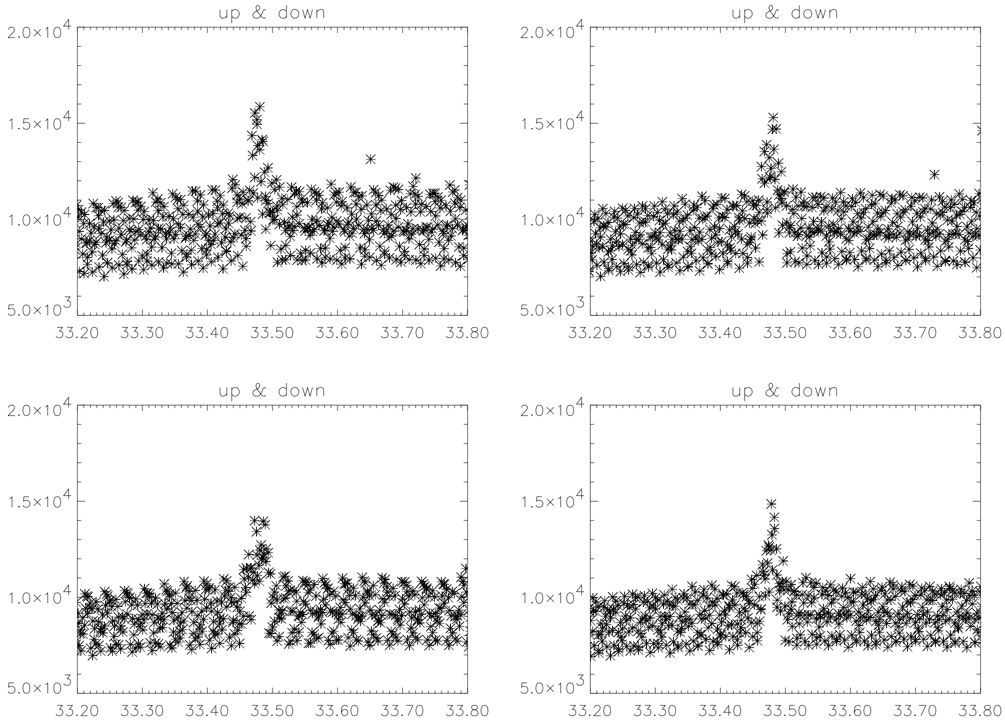
Figure 2 shows the same result. Only this time the second has been splitted into 4 parts. As only 6 points are used to compute the ramp the whole first partial points are ignored due to reset cut out.

For further analysis the SPD has been split into parts containing only one partial ramp number (1 ... 4, by selection on raster(0) entries) and processed to an AAR using DAAR. To avoid calfile 25 smoothing applying calfile 19 the AOT number 6 has been assigned via keyword. The flatfielding is done with a SCALING onto the observation without high resolution mode to compensate for introduced flux uncertainties. After sigma clipping the data have been rebinned to resolution 3000. Figure 3 shows the result of the overplottet AARs.

Now the AOT1 has been processed again with SECOUT set to two, but the result was processed in once, not splitted apart. The tool ADAPT_PHOT2HIGH was used to correct the dark current before the photometric check. This complete SPD was passed into DAAR under the same conditions as above.

This is mainly done for demonstration purposes. A careful analysis of the partial ramps is required for scientific data analysis. A follow up processing of apart ramps with flatfielding them together afterwards could be an appropriate

Figure 1: SPD results of 4 partial ramps



method to reduce this data. To find the final recipe is not subject of this technical note.

For comparison reasons an AOT6 observation on the same object was processed.

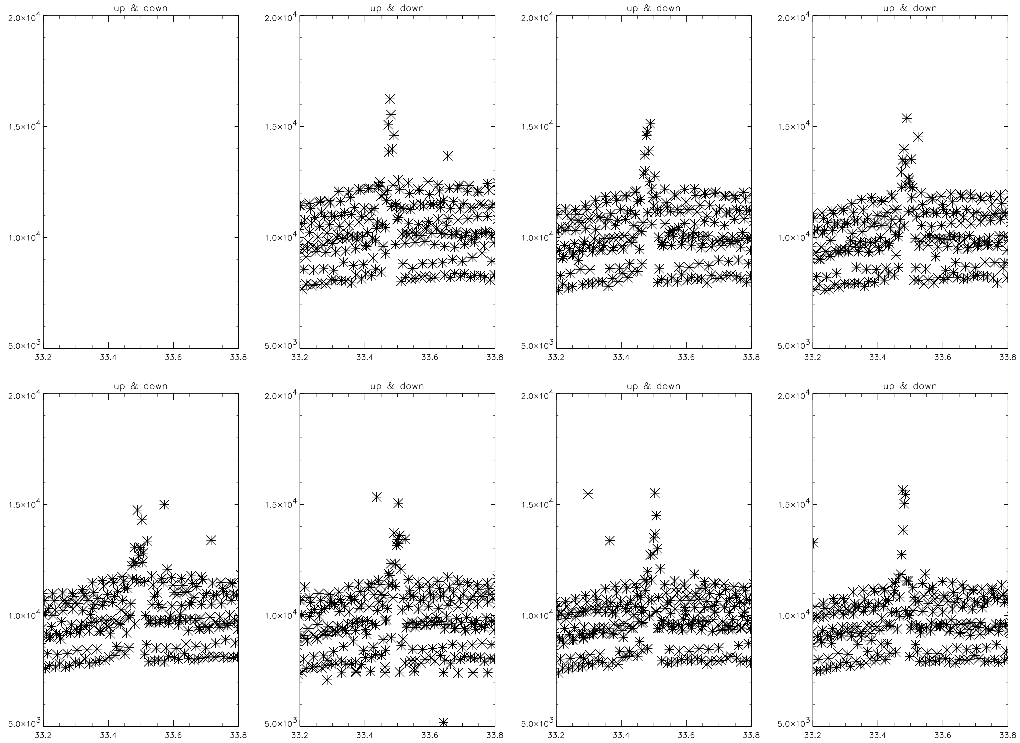
Figure 4 shows the resulting Auto Analysis products of the 4 AOTs (AOT1 SECO:0, AOT1 SECO:1 , AOT1 SECO:2, AOT6)

After flatfielding and sigma clipping a simple gaussian has been fitted to the curves. Figure 5 shows the results of a comparison between AOT 6 (stars) and AOT 1 (secout=2, diamons) observations. For the two following figures the AAR has been rebinned to an resolution of 3000. Figure 6 shows that the usage of SECOUT equal two (stars) does not change the FWHM compared against the result using SECOUT of one. Thus the theoretical resolution seems to be almost reached using a SECOUT factor of one.

Figure 7 demonstrates the difference between the AOT 1 observation using SECOUT factor one (stars) and the AOT 1 observation without special treatment. This demonstrates the gain user can achieve by high resolution processing for SWS01 speed 4.

To analyse the behaviour on low flux sources an AOT 1 speed 3 on NGC

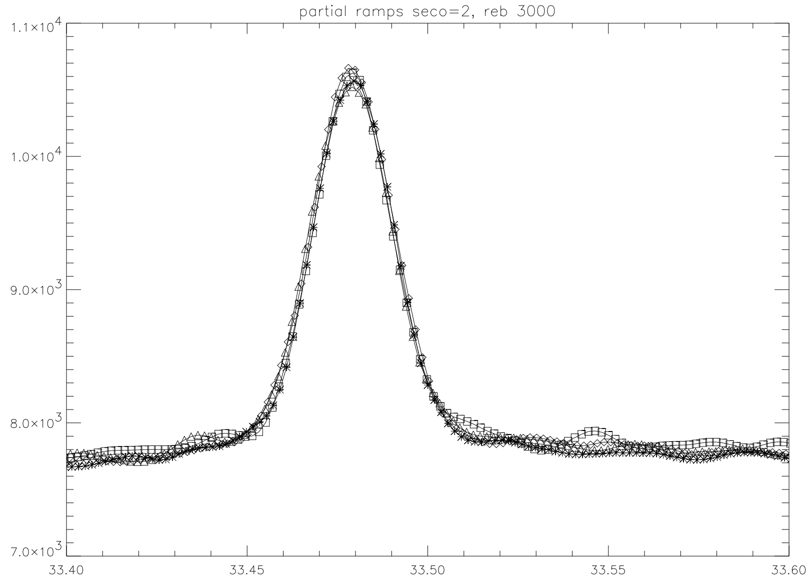
Figure 2: SPD results of 8 partial ramps



7027 has been taken. Figure 8 shows a result for all partial ramps of the SPD after dark subtraction. It is obvious that the data of the first partial ramp are not usable. Only 5 data samples decrease the S/N to much. Also the other partial ramps are heavily affected by decreasing S/N. It is remarkable that the continuum is significant different for the partial ramps. The linear inconsistency of the ramp might be caused by not perfect AC-correction. To apply a PULSE SHAPE CORRECTION correction first might improve the result.

For further processing the data of ramp one have been skipped. After applying ADAPT_PHOT2HIGH the result was processed using DAAR with AOT number set to six. Figure 9 shows the result compared against the standard AOT1 speed 3 result. After quick data processing using flatfielding and sigma clipping the AAR has been rebinned to a resolution of 2000. A quick check on the FWHM using MULTI_FIT gave 0.011122 (center 3.73994) for the standard AOT1 observation and 0.00434251 (center 3.73987). That is acceptable taking in account that the first partial ramps haven't been used.

Figure 3: AARs starting from 4 SPDs of partial ramps



4 Conclusion

It seems that the high resolution mode of DSPD is now working proper from the technical point of view. A few examples have been given on strong lines. Due to the increase of the noise it is questionable wether this tool can be applied to low fluxes as well. Extensive study on objects like 7027 and careful comparing line fluxes are missing and would be separate workpackages. The final recipe is not given as this needs more careful investigations.

Figure 4: AAR AOT1 SECO 0/1/2 and AOT6

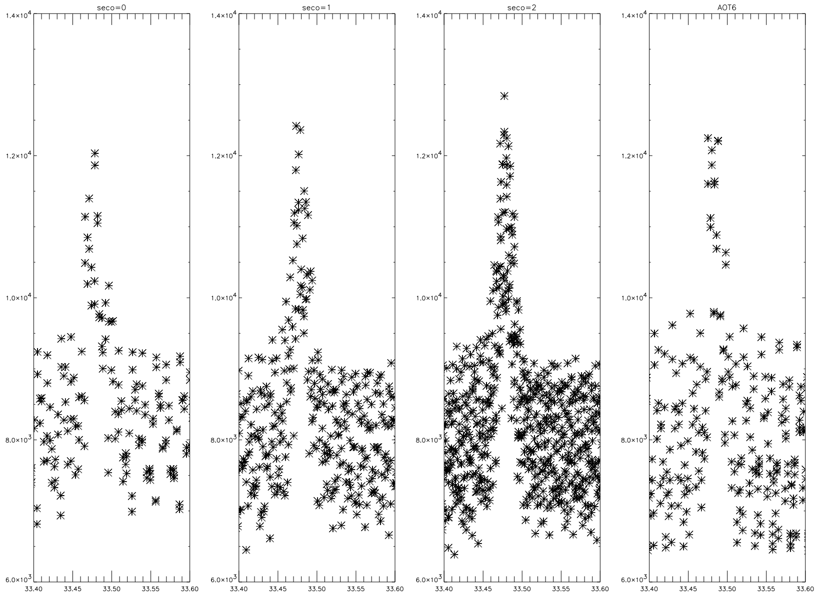


Figure 5: Auto Analysis Results AOT1 SECO1 and AOT6

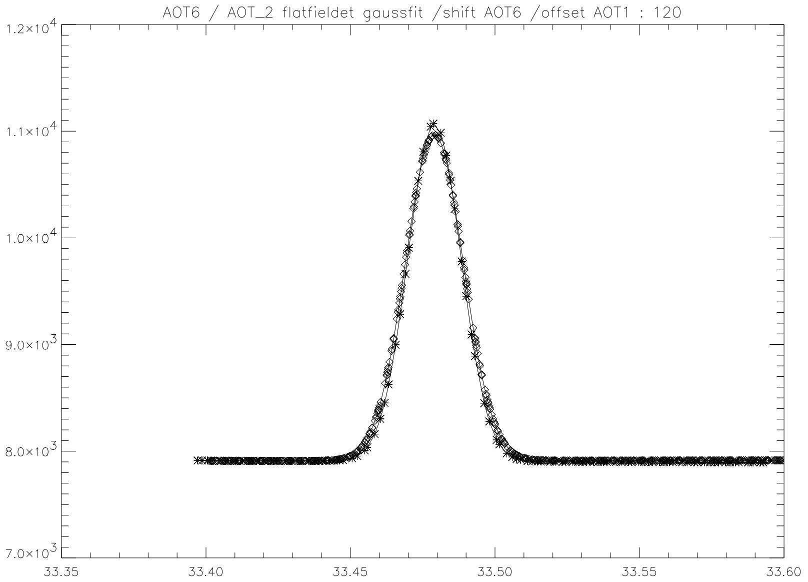


Figure 6: AOT1 SECO 1 and AOT1 SECO 2

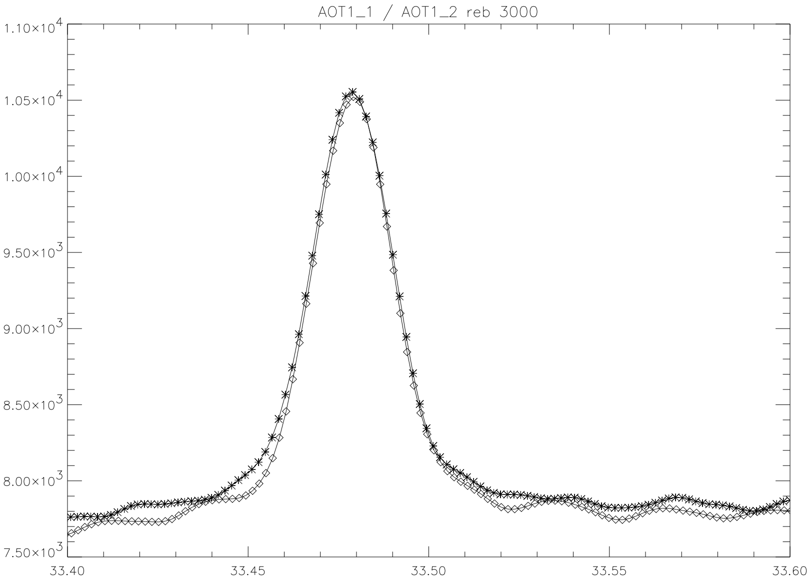


Figure 7: AOT1 SECO 0 , AOT1 SECO 1

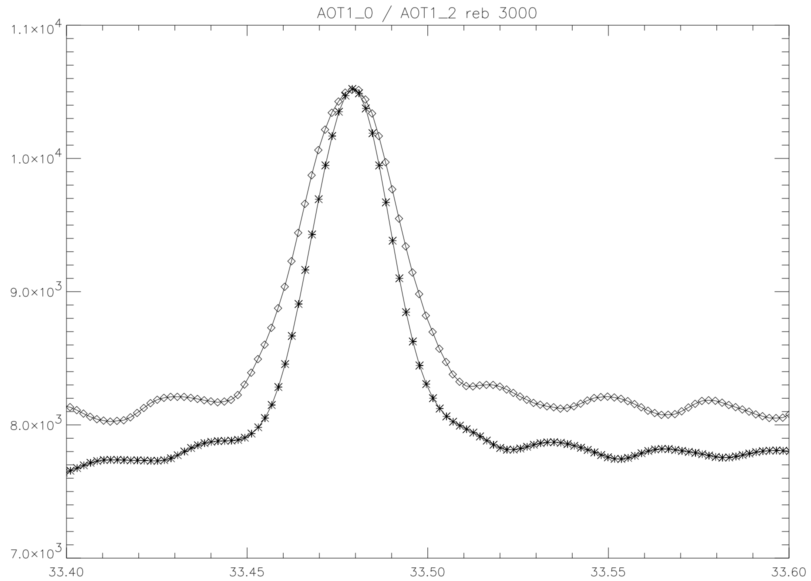


Figure 8: SPDs on 7027 after DARK / SECOUT=2

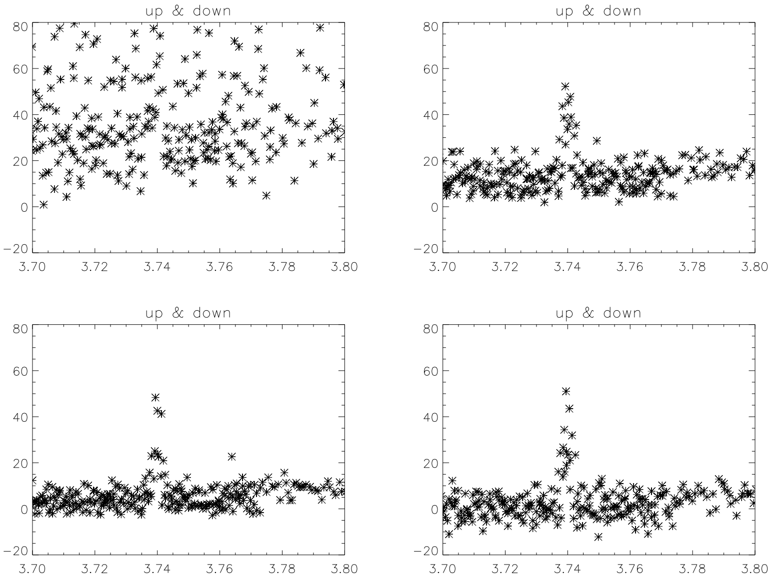


Figure 9: AARs on 7027 AOT1 speed 3 / AOT1 speed 3 SECOUT=2