IPAC ISO–SWS data reduction workshop
18–20 November 1997

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I Summary SPD→ AAR reduction steps

II Traps & Pitfalls:

- A Dark subtraction—memory effects
- B RSRF correction—fringing, spurious features
- C Flux calibration—pointing errors, band jumps
- D Extract AAR—reference scans
- E Inspect AAR—compare scans, glitches etc...

(22 pages)

2–correct memory effects *spd=antimem(spd)*

o dark current

(o responsivity variation)

At present, detector characteristics like dark current behaviour as function of time and flux history are poorly known. Thus pipeline makes no corrections, which can be serious problem for low fluxes in

- band 2 (4-12 μm)

- band 4 (30-45 μm)

"antimem" ONLY removes few points at beginning and end of dark current blocks.

Possible alternative ways to correct for time dependent effects:

- step **3**: "sophisticated" dark subtraction with dark_inter

- (step **4**: use reference scans. This method has serious bugs. DO NOT APPLY)

- after pipeline: align individual scans to reference spectrum using "sws_flatfield". **Problem:** what is good reference spectrum? Otherwise this method is artificial, and may affect spectral shape negatively

3–subtract dark current *spd=dark(spd)*
(spd=dark_inter(spd))

- Dark current observations are done at start and (mostly) end of each scan.
- "Dark" takes median of each dark current block and interpolates linearly as function of time.
- For band 2 and 4, this may be too simple, as can be seen by comparing up and down scans.
- At low flux levels it may even result in negative flux
- Dark current is function of flux history and several time constants may be involved.
- The non-pipeline routine "dark_inter" can be used for more sophisticated dark subtractions.
- For band 1 and 3 this is probably not necessary.

Do memory effects affect scientific conclusions? Check by analyzing pipeline reductions of up and down scans separately; is there agreement?

4–Correct for dark current/RSRF drifts (AOT6/7 only)

. *spd=fscal(spd)*

DO NOT APPLY THIS REDUCTION STEP

"Sad story of reference scans":

- Instead of just monitoring the dark current, reference scans actually *influence* it. Especially true for band 2&4, if continuum has strong gradient.
- Therefore, observations after July 1997 have no reference scans anymore.
- Procedure "fscal" has serious bug→ removed from pipeline V6.0 and higher.
- Some valid science data erroneously flagged as reference data, which is then removed in "extract_aar" (see further step **9**).

6—Divide out wavelength dependend detector responsivity, filter transmission etc. (i.e. system throughput), combined in RSRF tables (CAL25's).

. *spd=respcal(spd)*
. or: *spd=resp_inter(spd)*
. or: *spd=respcal(spd)+spd=fringes(spd)*

Some problems:

1. RSRF table and observed spectrum must have same resolution:
   - degraded resolution AOT1's corrected for by applying smoothing factor to RSRF, given in CAL19.
   - RSRF derived from lab observations, i.e. applicable for extended sources. In orbit, standard stars used for overall broad band point source correction (except band 4). Detailed structure RSRF still based on lab observations. Thus, residual sharp features will still be present in spectrum point sources, after "respcal". This is one cause of residual fringes band 3.

2. RSRF table and observed spectrum must have same wavelength calibration. Not the case for point sources out off slit center. Again, sharp RSRF features insufficiently divided out, esp. fringes in band 3.

Solutions:

- Use interactive procedure "resp_inter" to smooth or artificially enhance resolution RSRF tables, and find appropriate λ shift.

- This may not be sufficient, because of different "FP's" (filters, detectors) in light path, giving different fringe shift and frequency. Hence, overall change of RSRF not just 1 shift→ use program "fringes" after applying "respcal" (see reduction session Thursday).

3. edge band 3d at 27 μm unreliable due to leakage from 13 μm. Noticable in sources with strong gradient in continuum.

4. general shape band 4, esp. edges, may be wrong because of lack calibration sources.

5. spurious features at few % level in band 2c: 9.35, 10.05, 11.05 μm. Be aware for confusion 11.05 μm spurious feature with interstellar PAH emission band at 11.3 μm.

6. spurious absorption feature band 3a at 12.3 μm.

Further check Ch. 6 of SWS–IDUM V3.1

7–flux calibration (μV/s → Jy)

spd=fluxcon(spd)

- calibration number (in CAL13) depends on revolution. Blocks of revolutions have different CAL13's.

- absolute calibration accuracy (much) better than 30%, but....

- fluxcalibration too low by large amount if point source $\geq$4" off center slit in dispersion (z-) direction. Beam profile very steep: goes from 90-10% for 3-9" away. Spacecraft jitter of 1" will then give spikes in spectrum, different for up and down scans.

  Since beam profile wavelength dependend, amount of lost flux depends on wavelength→ slope AOT bands may be wrong

11–Inspect individual detector scans and compare them to recognize:

1. single detector jumps: sudden increase (decrease) of dark current over large time interval (>> 10 sec.) for single detector scans. **Solutions:**
   - adjust dark baseline with "dark_inter"
   - throw out affected data, using "cleanstruct" or "mask_inter" procedures

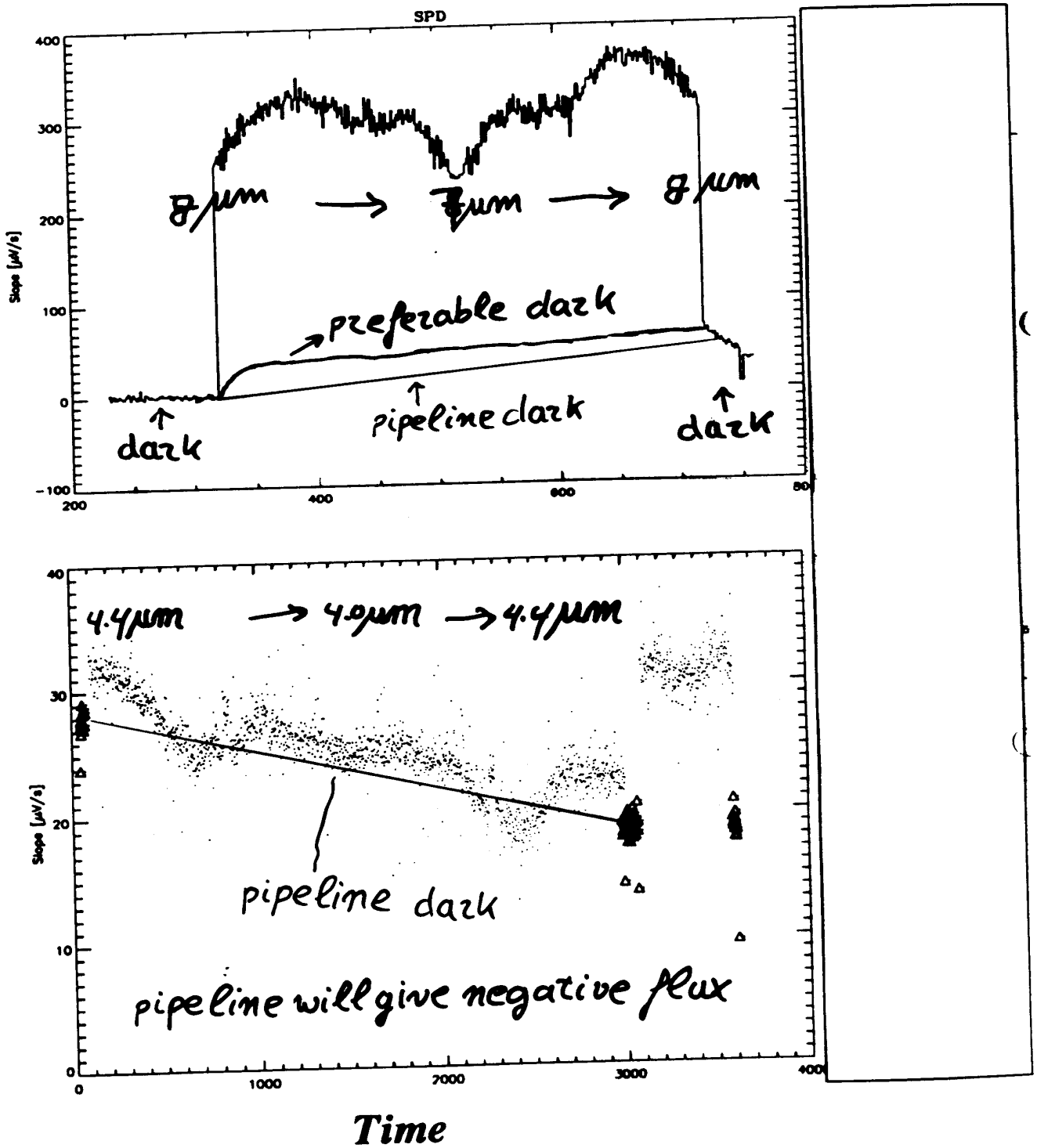
2. multiple detector jumps: large increase dark current, decreasing ~exponentially with time. Several neighbouring detectors affected. Due to cosmic ray hit on electronics? Throw out affected wavelength ranges.

3. glitches. Still a large number of gitches not recognized by the pipeline. Remove these by sigma clipping (σ=2.5-3).

4. 'flux jumps' due to satellite jitter for wrong pointings (see step **7**).

Are features, their shape and continuum shape real? Compare rebinned up and down scans. Do differences affect scientific conclusions? Do analysis both on up and down scans. This way error bars may be estimated.

Detector memory effects



SWS-IOUM V3.1

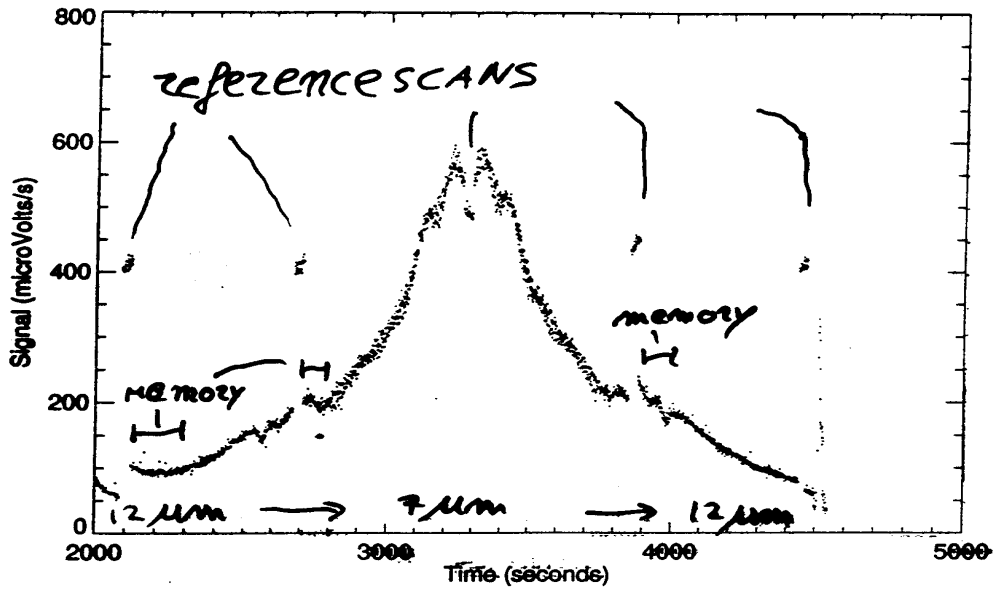


Figure 5.7: SPD data from detector 13 for the same time interval

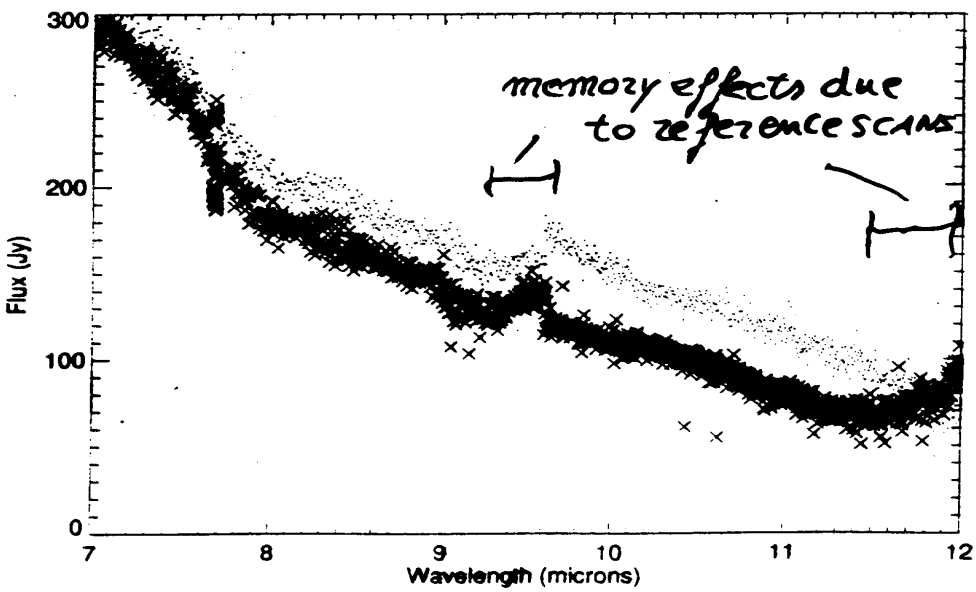
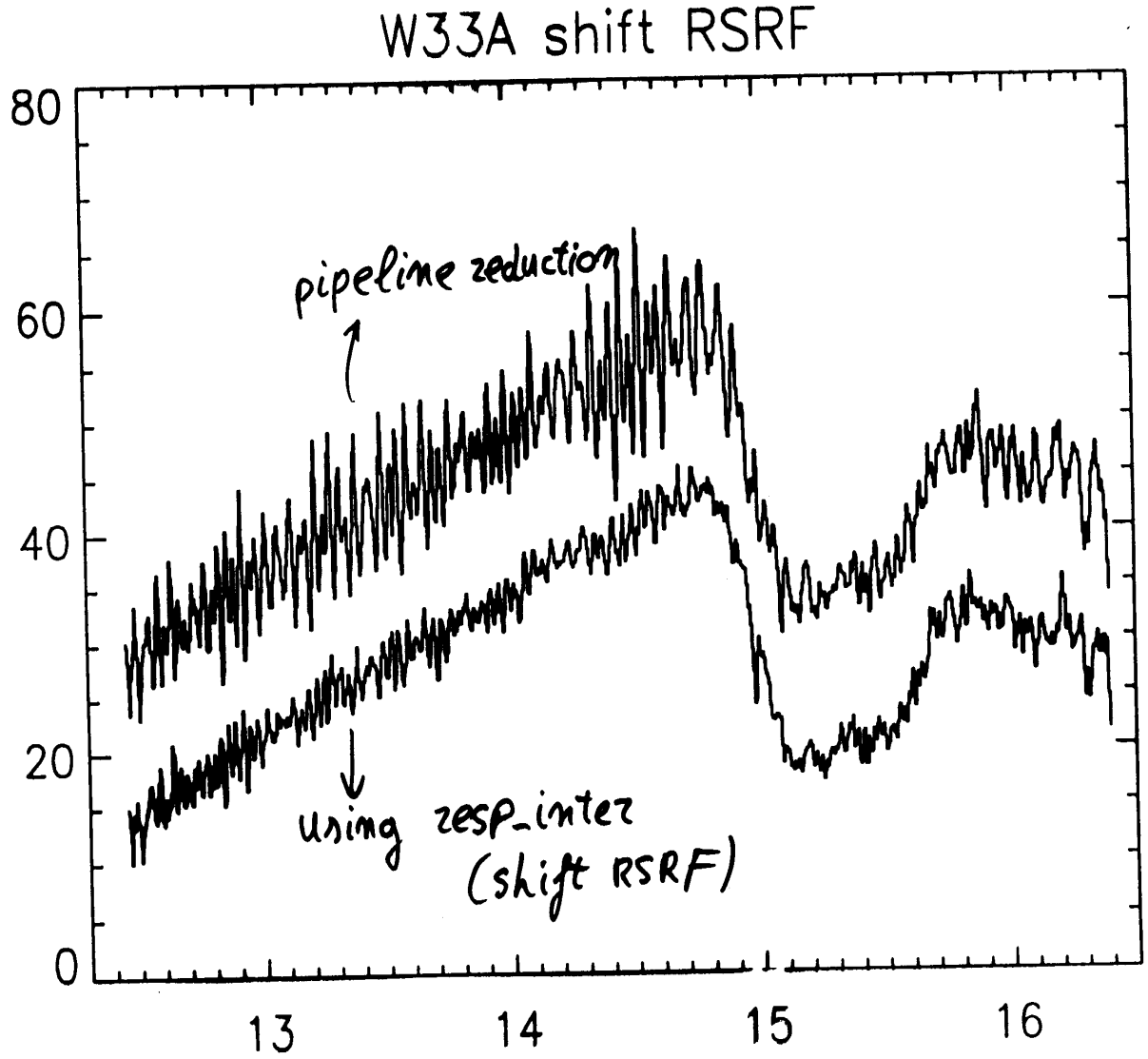


Figure 5.8: AAR from the above. The dots come from the up-scans, the crosses from the down-scans. The cluster of points around 7.7 microns come from the reference scans


W33A shift RSRF
80
60
40
20
0
13
14
15
16
pipeline reduction
using zesp_inter
(shift RSRF)

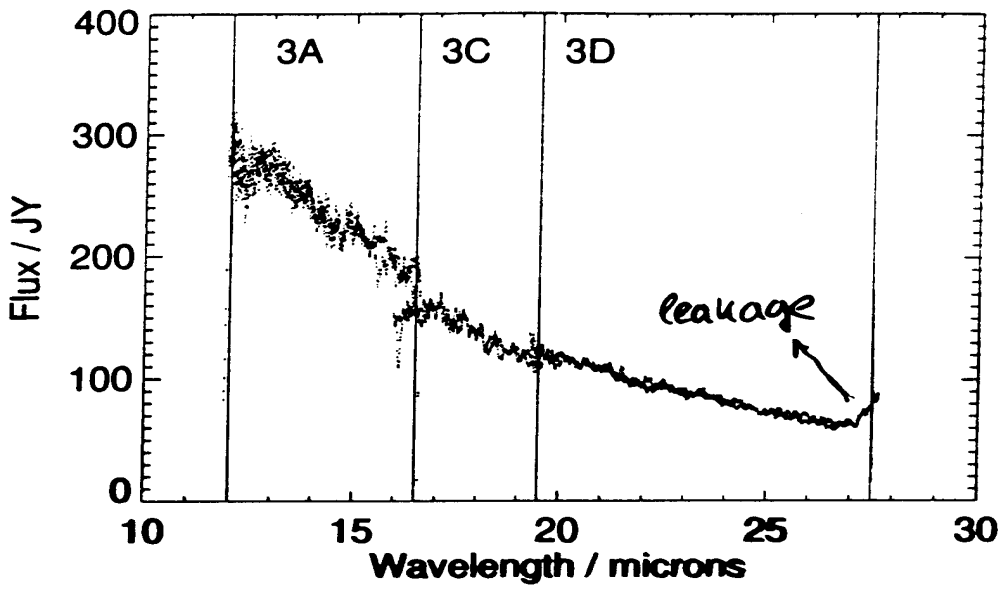


Figure 6.5: Band 3 data showing the leak around 27 microns

Data

Forty-three Band 2C spectra were collected from 9 observers in order to find trends in the strength of the features. The spectra are from both carbon and oxygen rich objects which are, in turn, stellar and nebular in origin. Since a rather broad wavelength range is required, only data from AOT SWS01 observations was used. This does not preclude the features being present in the data from other AOTs.

Table 6.1 shows a summary of the 43 sources in the sample with at least one feature. The peak wavelengths, FWHM and Percent of continuum levels ("% Cont", negative meaning absorption, positive emission) are median values in the sample. Also listed are the minimum and maximum values for each parameter that were seen in the dataset. Some of the spread is due to noisy data and the difficulty of measuring the continuum and width of a line.

Feature	#	Peak Waveln.	(Min,	Max)	Median FWHM	(Min,	Max)	% Cont	(Min,	Max)
9.35	36	9.26	(9.2 ,	9.4)	0.295	(0.029,	0.482)	-7	(-14,	1)
10.05	30	10.07	(9.96,	10.10)	0.094	(0.017,	0.280)	3	(-5,	11)
11.05	37	11.05	(11.01,	11.11)	0.090	(0.050,	0.180)	6	(4,	15)

Table 6.1: Sources with features

The summary for the absence of features is shown in Table 6.2. We have listed the number of sources that do NOT show a feature and the continuum level where we expect the feature to be. In general the absence of a feature correlates with the continuum strength. Of the sources that

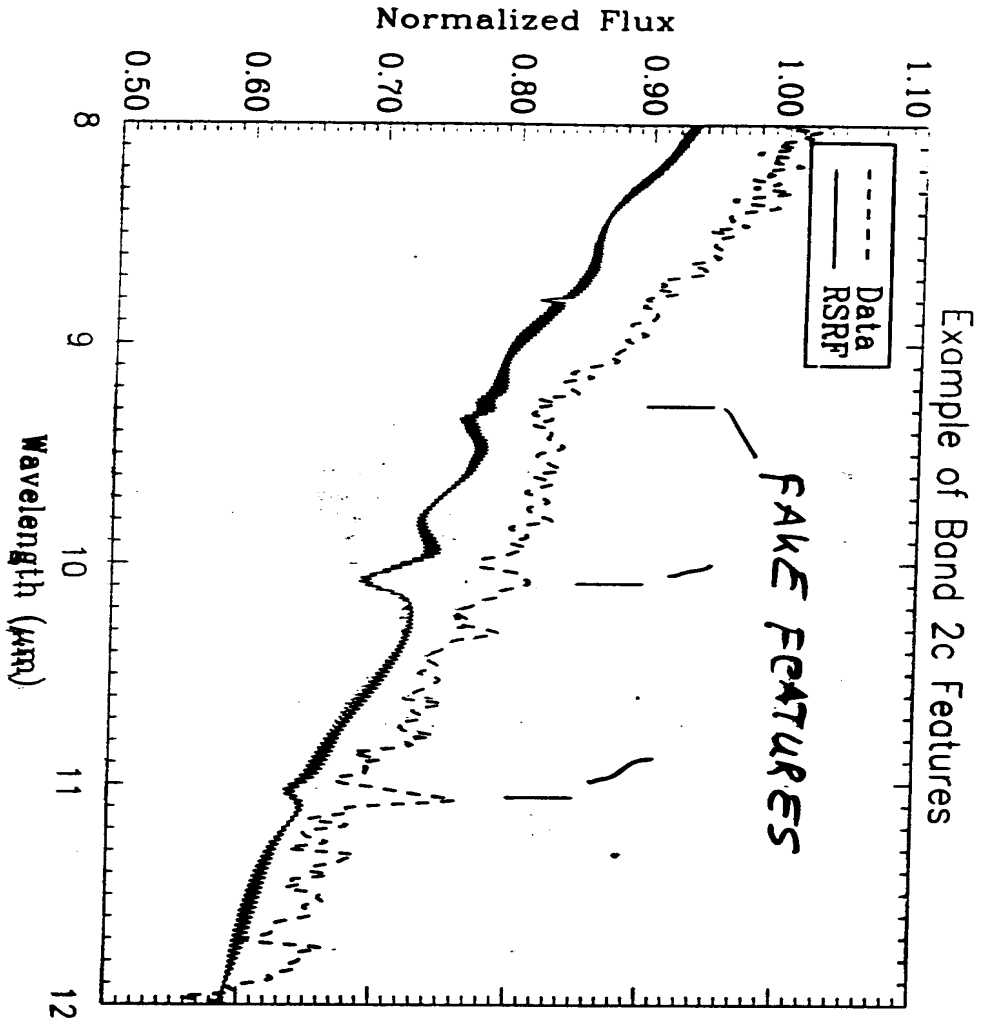


Figure 6.6: SWS spectrum showing spurious features

SWS-IOUM V3.1

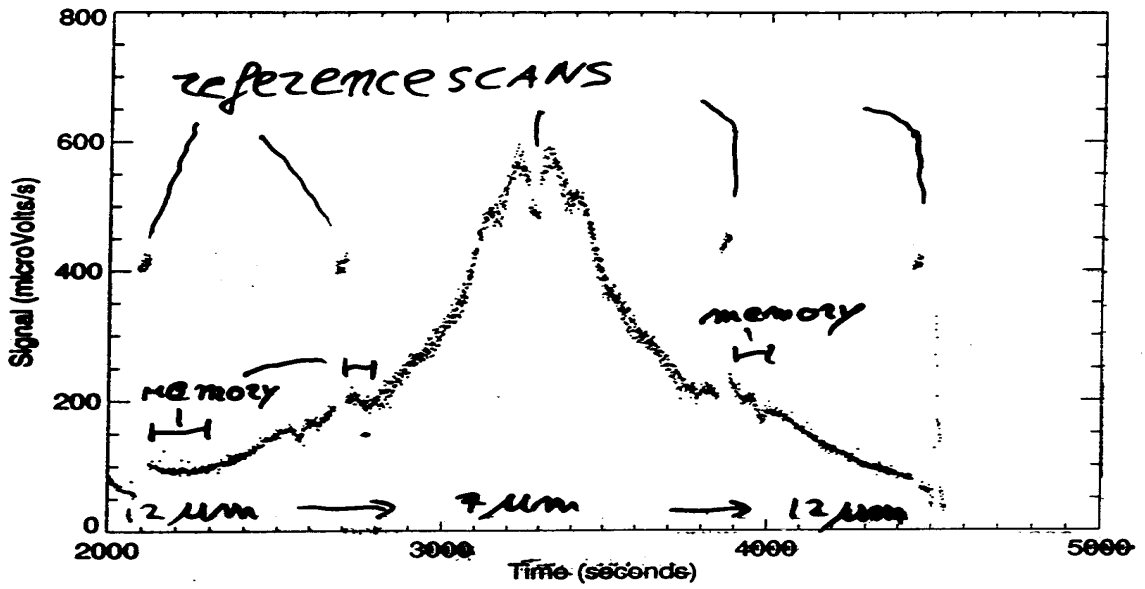


Figure 5.7: SPD data from detector 13 for the same time interval

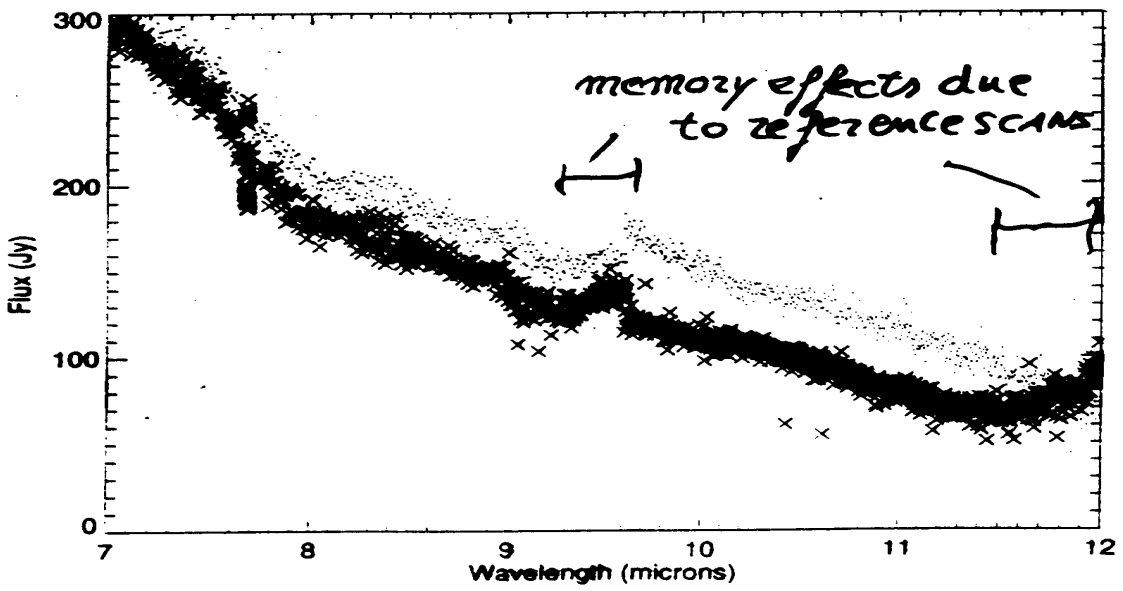
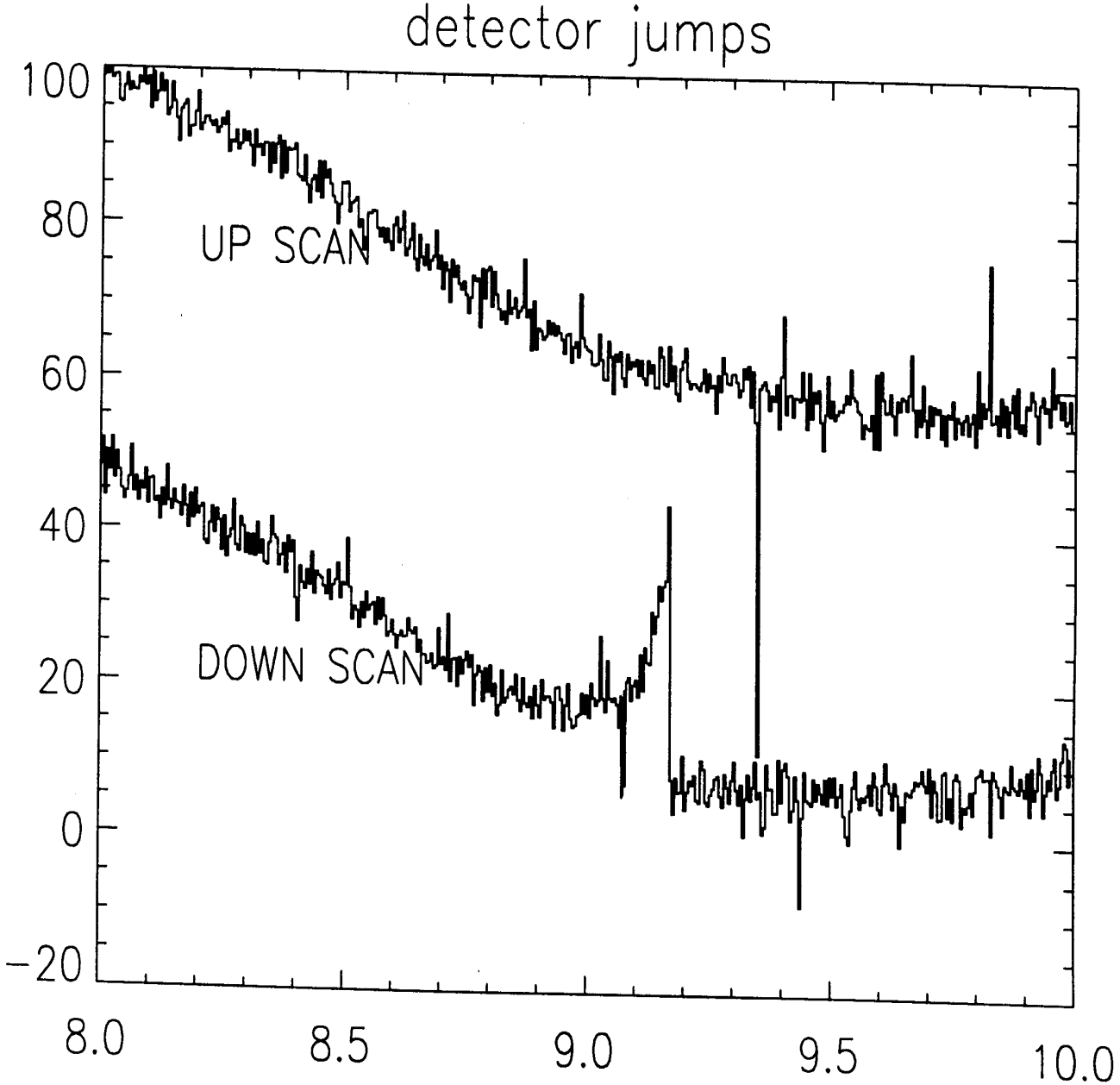
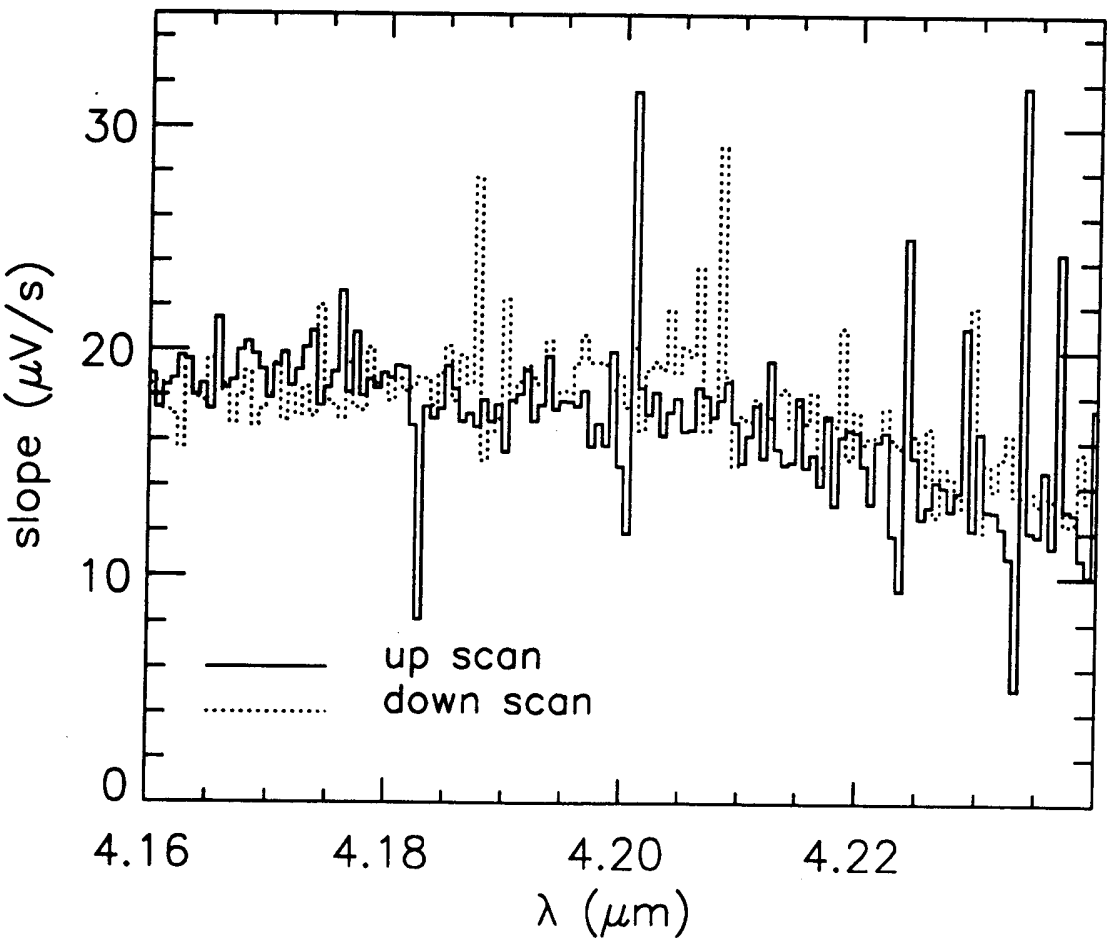


Figure 5.8: AAR from the above. The dots come from the up-scans, the crosses from the down-scans. The cluster of points around 7.7 microns come from the reference scans


detector jumps
100
80
60
40
20
0
-20
UP SCAN
DOWN SCAN
8.0
8.5
9.0
9.5
10.0

'Glitches'



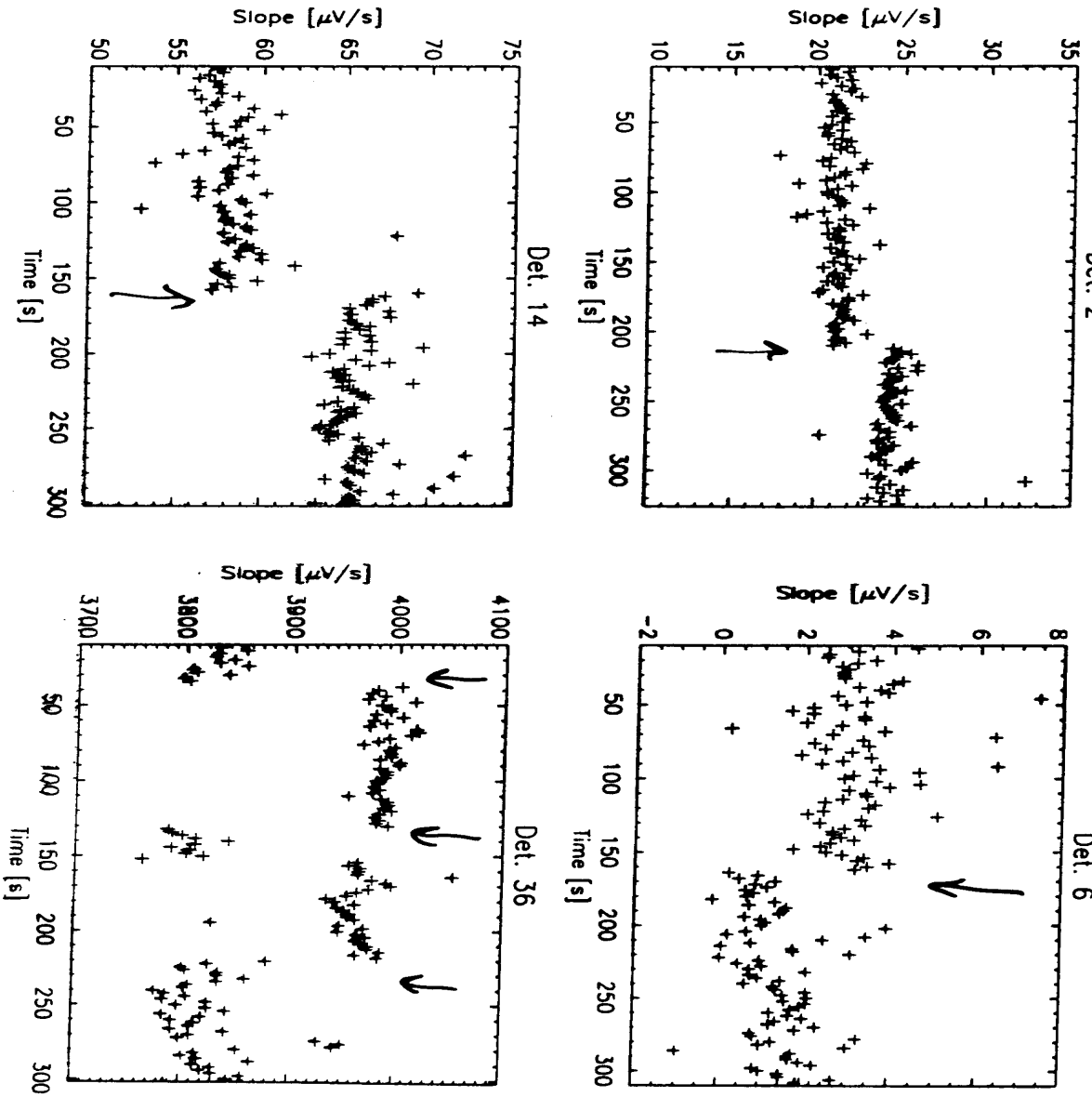


Figure 5.17: Examples of single detector jumps

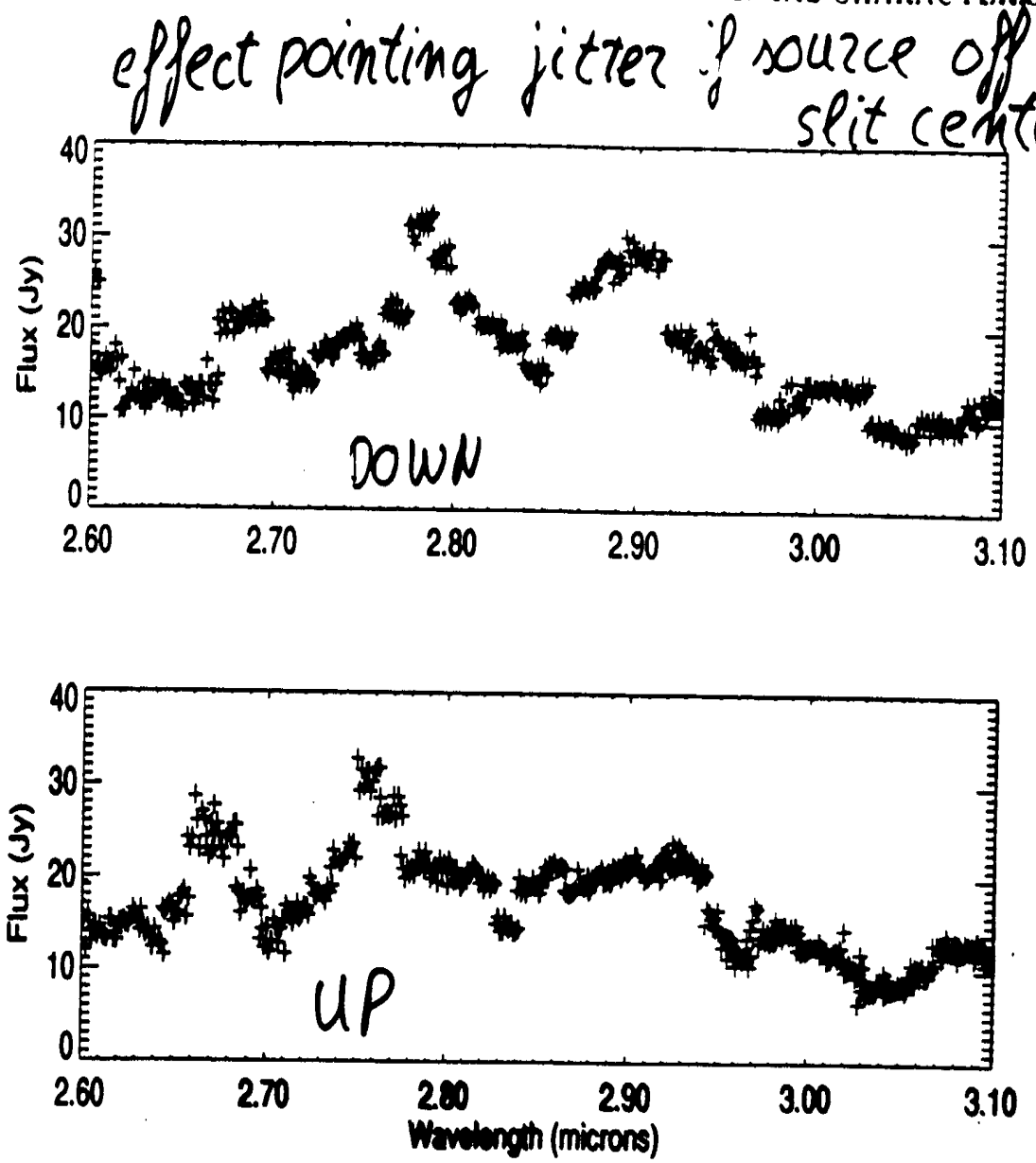
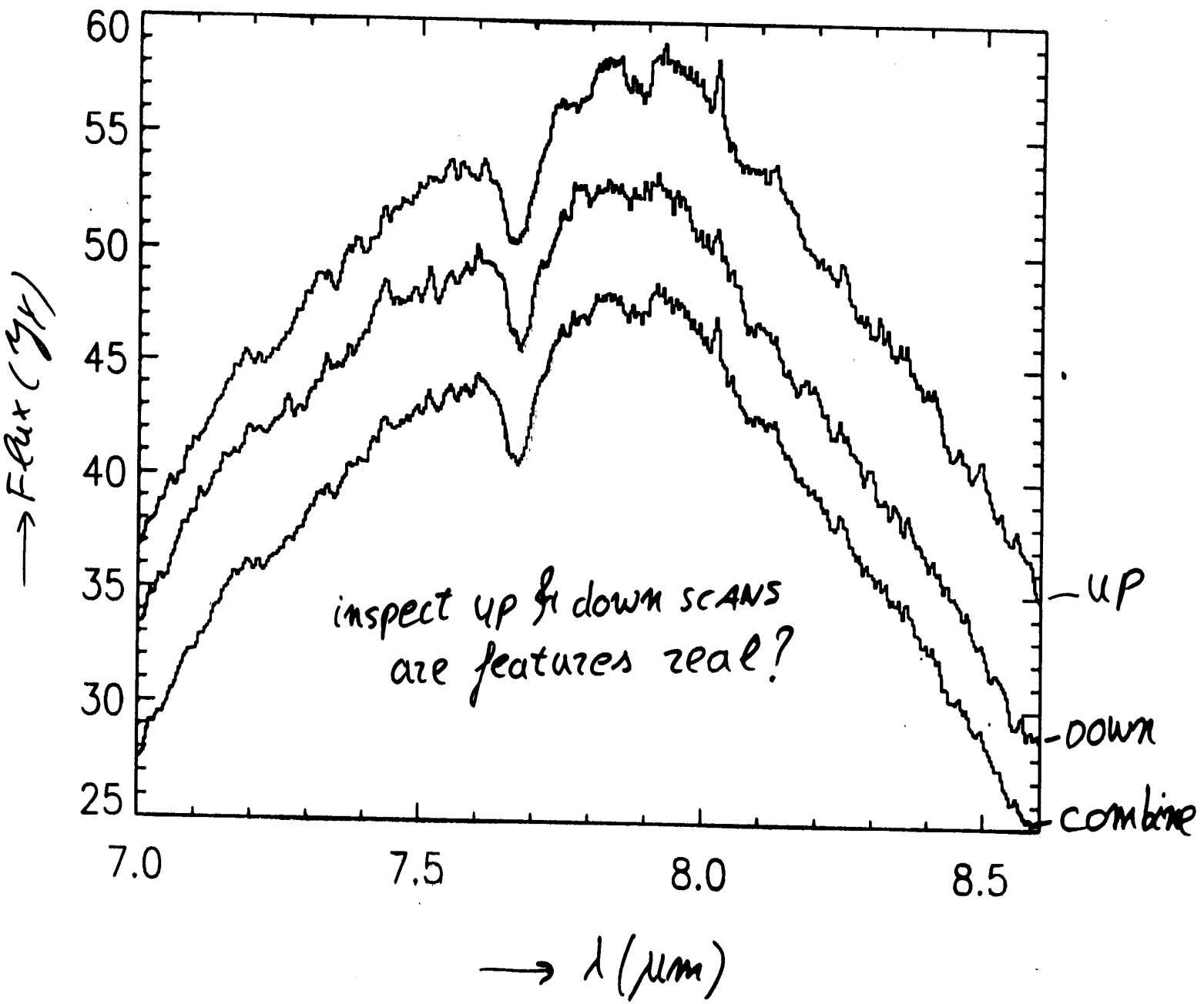
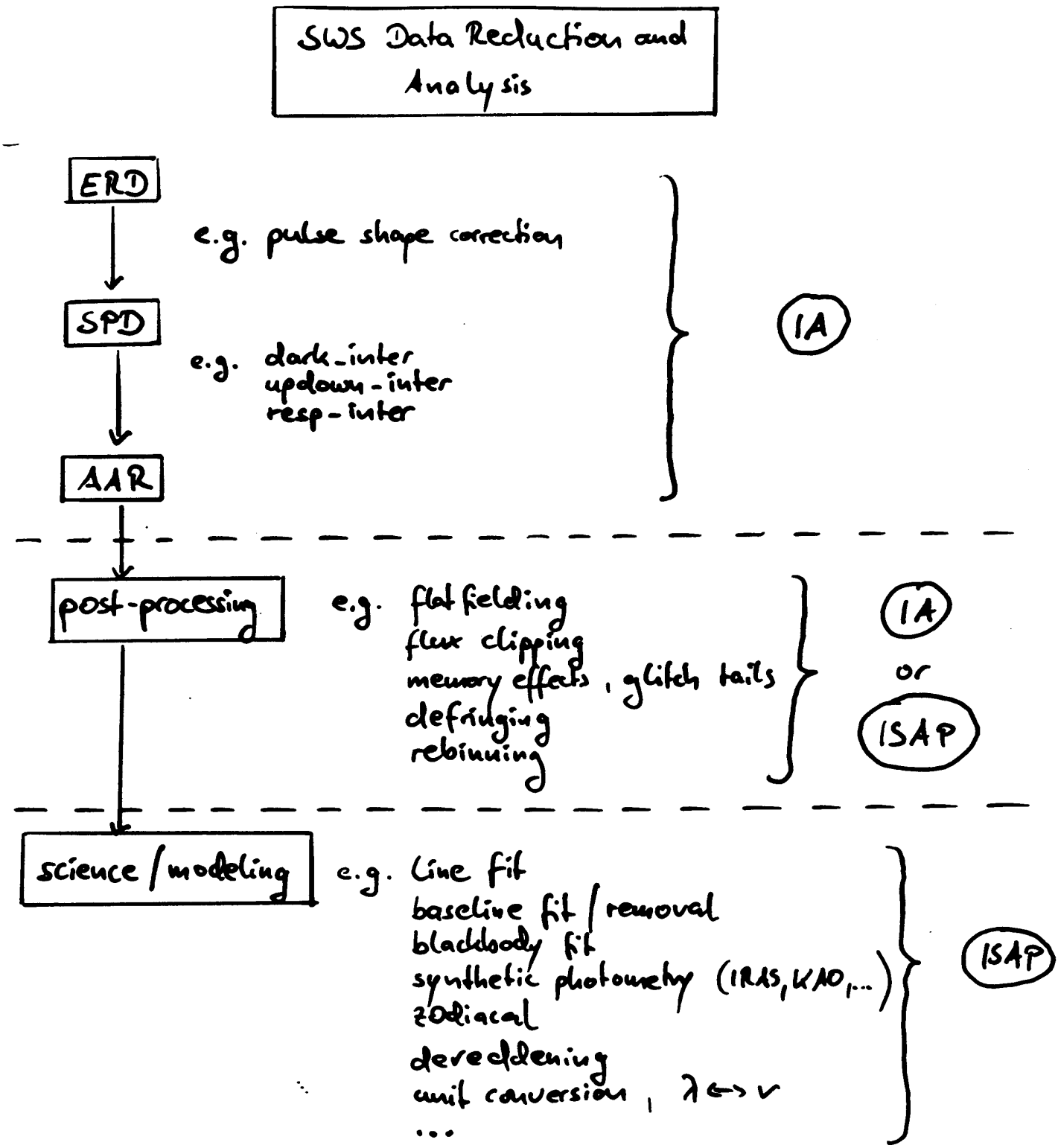


Figure 5.9: Effect of pointing jitter as seen in AAR. Top plot is the down scan (up in wavelength), bottom plot is the up scan. The difference is due to pointing jitter.


60
55
50
45
40
35
30
25
→ Flux (Jy)
7.0
7.5
8.0
8.5
→ λ (μm)
inspect up & down scans
are features real?
- up
- down
- combine


SWS Data Reduction and Analysis
ERD
SPD
AAR
e.g. pulse shape correction
e.g. dark_inter
updown-inter
resp-inter
IA
post-processing
e.g. flat fielding
flux clipping
memory effects, glitch tails
defringing
rebinning
IA
or
ISAP
science / modeling
e.g. Line fit
baseline fit / removal
blackbody fit
synthetic photometry (IRAS, KAO, ...)
zodiacal
dereddening
unit conversion, λ ↔ ν
...
ISAP

Post-Processing Alternatives

IA ⟷	IA ⟷	ISAP
sws-flatfield sigclip sws-rebin	updown_inter flat-inter shiftscans mask_inter aarfilt	average shift zap rebin
aarfringe		
quick script-able	most insight most interactive	All-fied public
best for: medium-strong sources	medium-weak sources	all sources
no check of bad data mask (bit 30 in flag tag)	full bad data mask treatment	full bad data mask treatment
see AOT 7 IA recipe	see AOT 1/2/6 IA recipe	see AOT 1/2 ISAP recipe

Eventually : 2 public software packages :

- IA Base : reprocessing, recalibration (dark, resp...
- ISAP : post-processing (flatfielding, masking...), + analysis