Pipeline at Vilspa

- V6 May 1997 - New Illuminator flash processing
- V6.1 End of July - correction to FP wavelength calibration
- V6.2 End of August - Updates to non-validated products only. No updates are planned.
- V7 End of mission

Pipeline at RAL

- Current pipeline at RAL is identical to V6.1 at Vilspa
- Updates planned for V7 are added to RAL pipeline as they become available
- Information about pipeline at RAL should be obtained via IPAC

Glitches

What are they?

- Impact of ionising radiation on detectors
- Causes jump in ramp voltage
- Affects responsivity of detector
- Approximately 1 glitch per 10 seconds per detector

How do we detect them?

- Check difference between each point on ramp and following two points. Search for characteristic patterns produced by glitches

Derive SPD (SPL)

- Removes instrument specific peculiarities
- Input to SPL - ramps for ten detectors plus mechanism positions
- Produces photocurrent vs grating or FP mechanism position
- Main output is LSPD file
- Also processes illuminator flash data to produce photocurrents vs illuminator level. Illuminator flashes are not used until AAL stage

The basic stuff

- Overview of pipeline
- Details of Derive SPD (raw data to photocurrents)
  - Glitches, how they are detected and handled
- Illuminator flashes, what they are and how they are used
- ISO LWS Data Users Manual is best reference source for all aspects of the pipeline

Illuminator flashes

- Illuminator flashes use the 5 internal illuminators for calibration
- Illuminator flashes are made at the beginning and end of an observation and during long observations
- Only 'closed' ('opaque') illuminator flashes are used by the pipeline
- Illuminator flashes are used for two purposes:
  - To measure the 'dark current'
  - To perform an absolute calibration of the flux levels by comparing with reference flash data
- SPL produces LIPD file containing photocurrents vs illuminator level. AAL processes and uses flash data. Results written to LIAC file

Illuminator flashes (continued)

- An illuminator flash consists of a background measurement, followed by operation of each of the 5 illuminators in turn, followed by a background measurement.
- Three different types of flash have been used:
  - Start to rev 236 - Each illuminator operated at two levels 1/2 second ramps
  - Rev 237-378 - Same as above, but using 1 second ramps (oops!)
  - Rev 442 onwards - Only single illuminator level used

Dark current calculation

- Only ‘closed’ illuminator flashes are used
- Only the dark current measurement at the start of the illuminator flash is used
- The photocurrents of the individual ramps are median clipped to remove any outliers. The remaining points are then averaged to obtain a single value for each illuminator flash. These values are written in the LIAC file.
- Between each pair of closed illuminator flashes the dark current from the two surrounding illuminator flashes are averaged to obtain a single value for each detector
- Only a single dark current value per detector is used between each pair of closed illuminator flashes

Absolute responsivity correction

- Illuminator flash photocurrents are ratioed against a set of reference flash data

- Ratio for each detector for each illuminator flash is written into LIAC file

- Single correction factor per detector is applied to all data in a single 'group'

- correction factor for a particular group is calculated by linear interpolation in time from the two surrounding illuminator flashes to the middle of the group

Updates planned for V7

- New method of converting detector ramps to photocurrent ('Delta-V, Delta-t'). Removes transition between 1st and 2nd order fitting and reduces noise
- Time dependent grating wavelength calibration
- Drift correction switched off for L02 and L04
- Strong source correction
- Updates to uncertainty calculations
- Possible use of fixed dark signal

Information in LSPD header

- Software and calibration file version numbers (OLPVERS, SPLVERS, AALVERS)
- Start and end time of observation
- Number of points rejected after each processing stage for each detector
- Number of glitches found for each detector
- Number of 1st and 2nd order fits for each detector
- Number of points processed into SPD (total and as percentage of raw data points)
- etc.

What do we do once we have detected a glitch?

- All of ramp following glitch is discarded
- Start of ramp is still used if it contains 10 or more valid points
- Following two ramps are discarded. Photocurrent value will be set to zero, but points are not flagged
- Ramp containing glitch is flagged in LSPD status word (see IDUM)
- Number of glitches and glitched ramps per detector are recorded in LSPD header
- LSPD contains both deglitched and undeglitched photocurrent values

Limitations of deglitching

- Glitch detection performs reasonably well, but is not perfect
- Section of ramp discarded at beginning of ramp is not checked for glitches. Version 7 of pipeline will check more of ramp
- Difficult to set thresholds to suit all signal levels
- Discarding two ramps following a glitch is not always necessary

Sensitivity to glitches

Percentage of glitches for each detector from a sample of 100 observations containing 298,000 glitches.

SW1	10.84 %
SW2	11.25 %
SW3	11.62 %
SW4	10.60 %
SW5	10.65 %
LW1	10.78 %
LW2	8.15 %
LW3	8.79 %
LW4	8.61 %
LW5	8.72 %

LSPD status word

Bit	Description
0	Glitch flag
1	Saturation flag
2-4	Number of (mini) ramps
5-7	Percentage of available data used

These fields are described in more detail below.

- Glitch flag. This flag is set if one or more glitches were found in this ramp.
- Saturation flag. This flag is set if the ramp contains one or more saturated points.
- Number of ramps in this point. This value will now be either 1 or zero. The value will be zero if the ramp has been deleted because of a glitch or saturated points.
- The amount of data used refers to the number of detector readouts for this detector for this ramp which were used to calculate the photocurrent value. This is expressed as a percentage of the available data points.

  The number of 'available' data points is defined as the number of sampled detector readouts for this ramp, minus the number of points discarded because of detector resets and mechanism movements. This is the maximum number of points which can potentially be used in the photocurrent calculation.

LSPD status word (continued)

The following table gives the meaning of each of the possible values of this bit field:

Bit value	Meaning
0	$data = 0\%$
1	$0\% < data \leq 10\%$
2	$10\% < data \leq 20\%$
3	$20\% < data \leq 40\%$
4	$40\% < data \leq 60\%$
5	$60\% < data \leq 80\%$
6	$80\% < data < 100\%$
7	$data = 100\%$

LWS Auto-Analysis

Processing steps for grating AOTs:

- Dark current/Straylight subtraction
- Grating scan wavelength calibration
- Grating spectral responsivity calibration (removal of the RSRF)
- Bandwidth correction
- Absolute responsivity correction
- Relative responsivity drift correction
- Velocity correction

What's in the LSAN file?

General schematic equation representing the terms for creating a fully calibrated flux spectrum:

$$F(\lambda) = \frac{P(\lambda) f_R(t) - D(\lambda)}{f_A R(\lambda) \Delta\lambda}$$

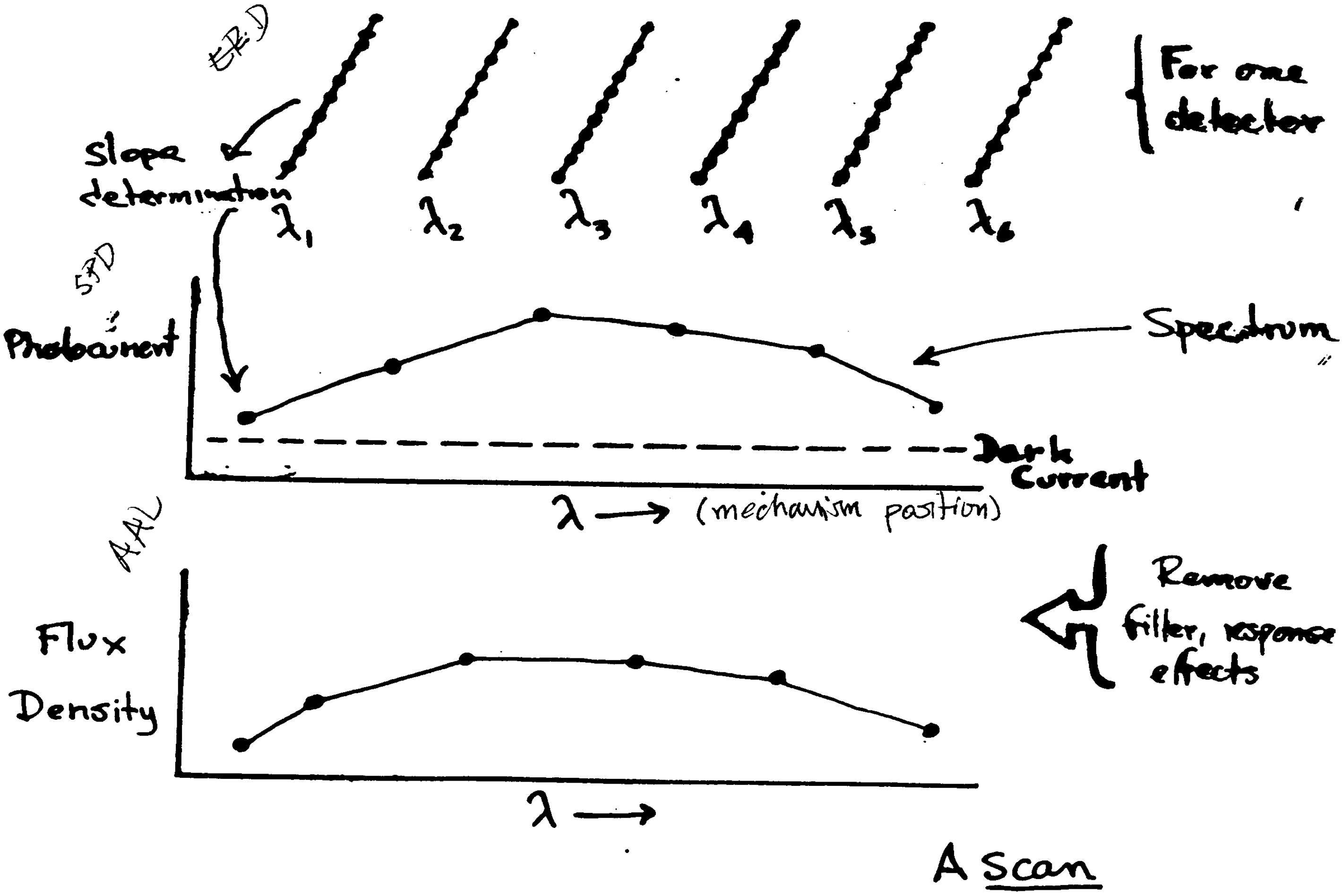
where

- $F(\lambda)$ is the flux in $Watt\, cm^{-2} \mu\, m^{-1}$ at wavelength λ.
- $P(\lambda)$ is the photocurrent in $Amps$ at wavelength λ.
- $f_R(t)$ is the relative responsivity drift correction factor for detector at wavelength λ and time t.
- $D(\lambda)$ is the dark current/straylight contribution for detector at wavelength λ.
- f_A is the absolute responsivity correction factor for detector at wavelength λ. It is defined as a ratio of illuminator flash data from a routine observation to the reference illuminator flash data taken at the time of the flux calibration observation.
- $R(\lambda)$ is the spectral response function (RSRF) for detector at wavelength λ and measured in units of $Amp\, cm^2/Watt$.
- $\Delta\lambda$ is detector resolution element at wavelength λ.

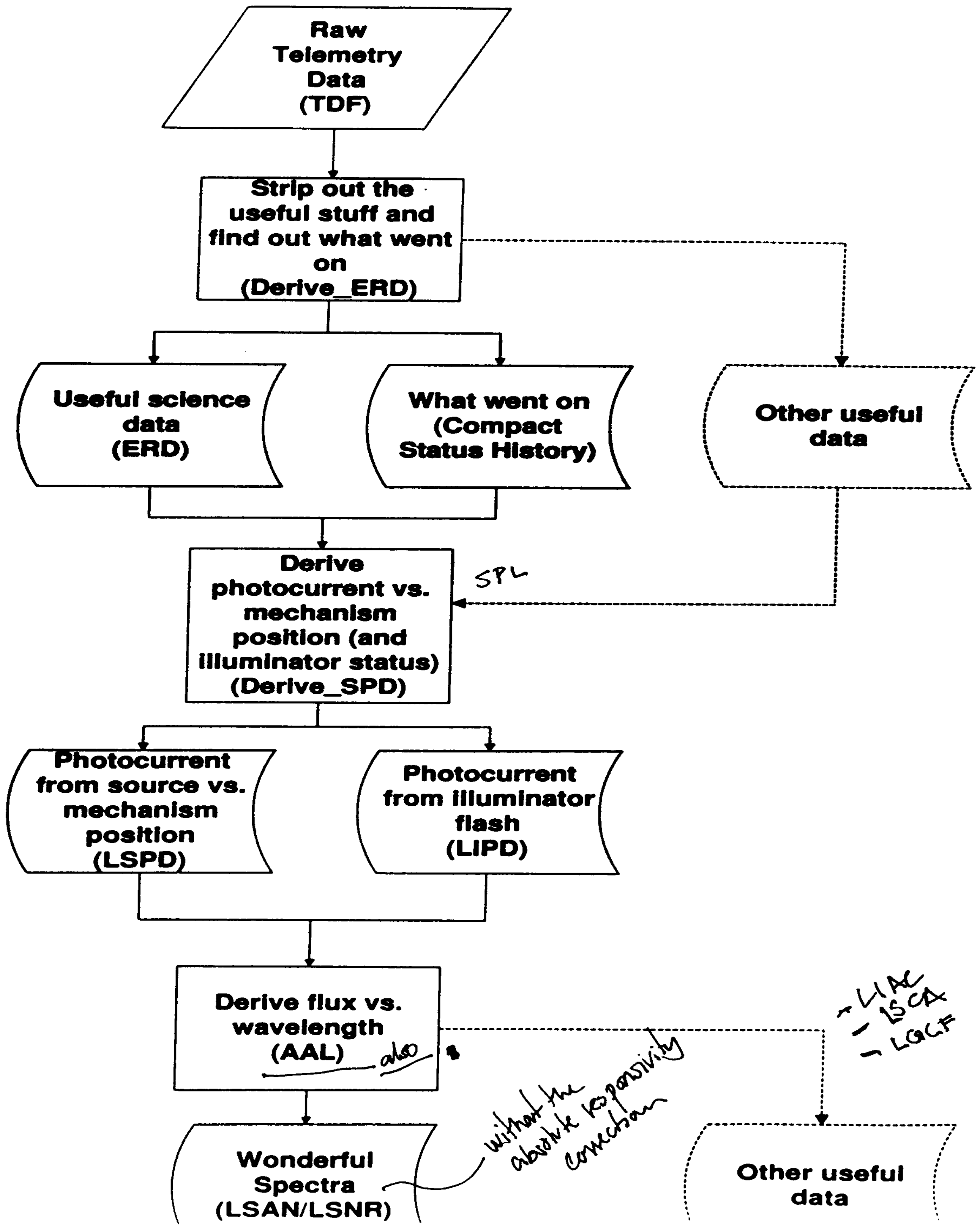
Observations: A sketch

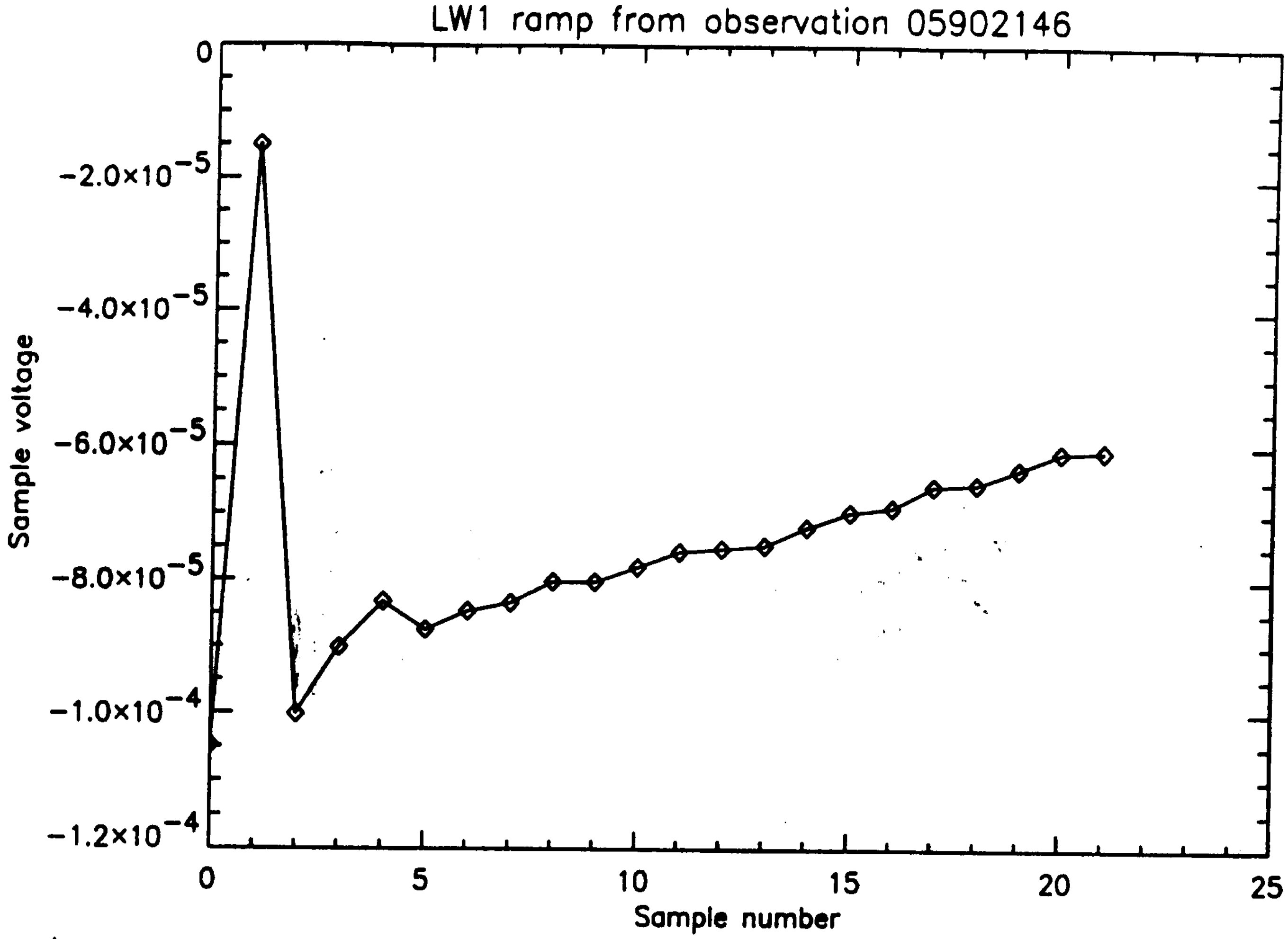
• Instrument puts grating at a mechanical position for a specific wavelength — in each of 10 detectors.

• One RAMP is produced with ~ ~~40~~ 44 readouts samples in 1/2 sec.

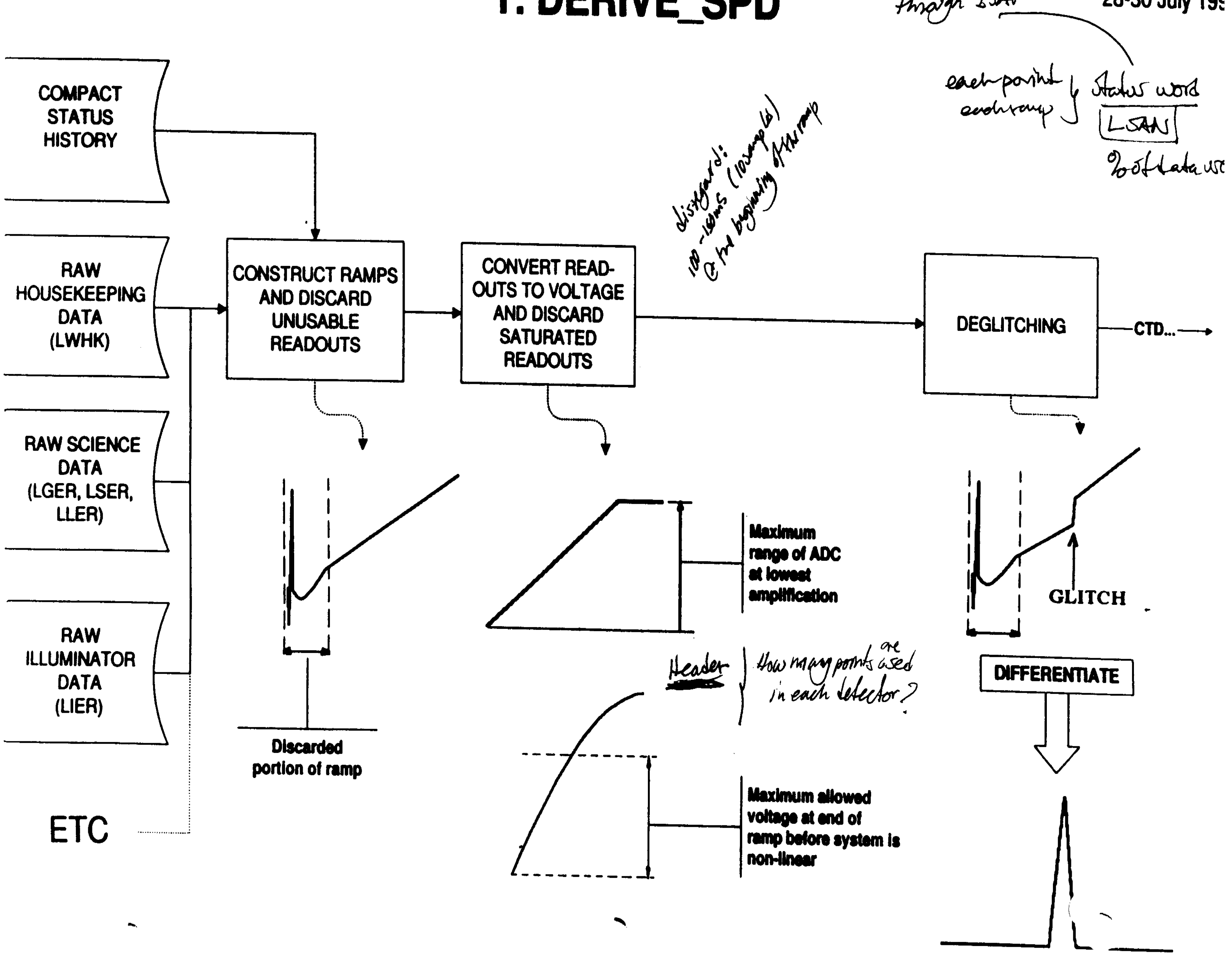


LWS OFF-LINE PROCESSING (V6)
0: Overview




LW1 ramp from observation 05902146
Sample voltage
0
-2.0×10^{-5}
-4.0×10^{-5}
-6.0×10^{-5}
-8.0×10^{-5}
-1.0×10^{-4}
-1.2×10^{-4}
0
5
10
15
20
25
Sample number

LWS OFFLINE PROCESSING (V6)
1: DERIVE_SPD



LWS OFFLINE PROCESSING (V6)
2: DERIVE_SPD ctd...

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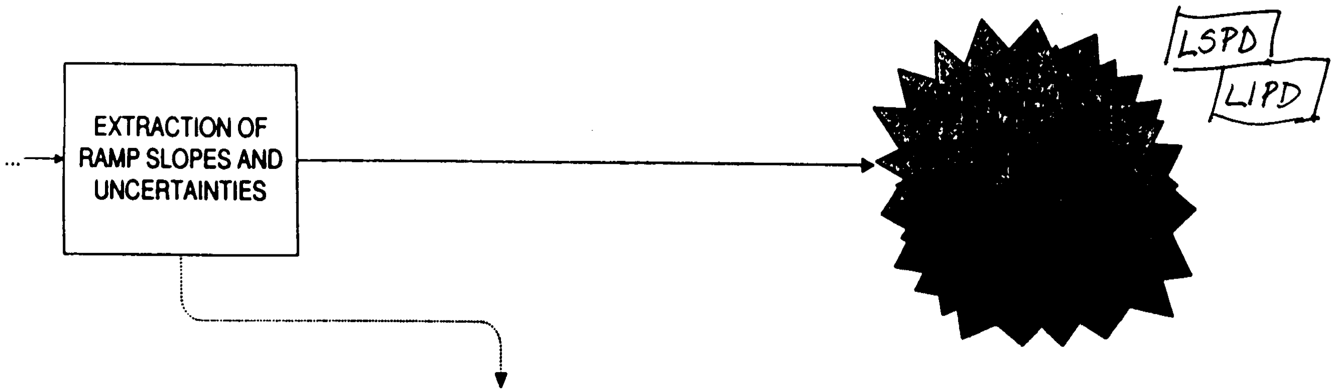
28-30 July 1997



$V_t = a_o + a_1 t$ — $V < V_{switch}$

@ a voltage level.

$V_t = a_o + a_1 t + a_2 t^2$ — $V > V_{switch}$

quadratic

→ Strong sources: discontinuity
Q: how strong?

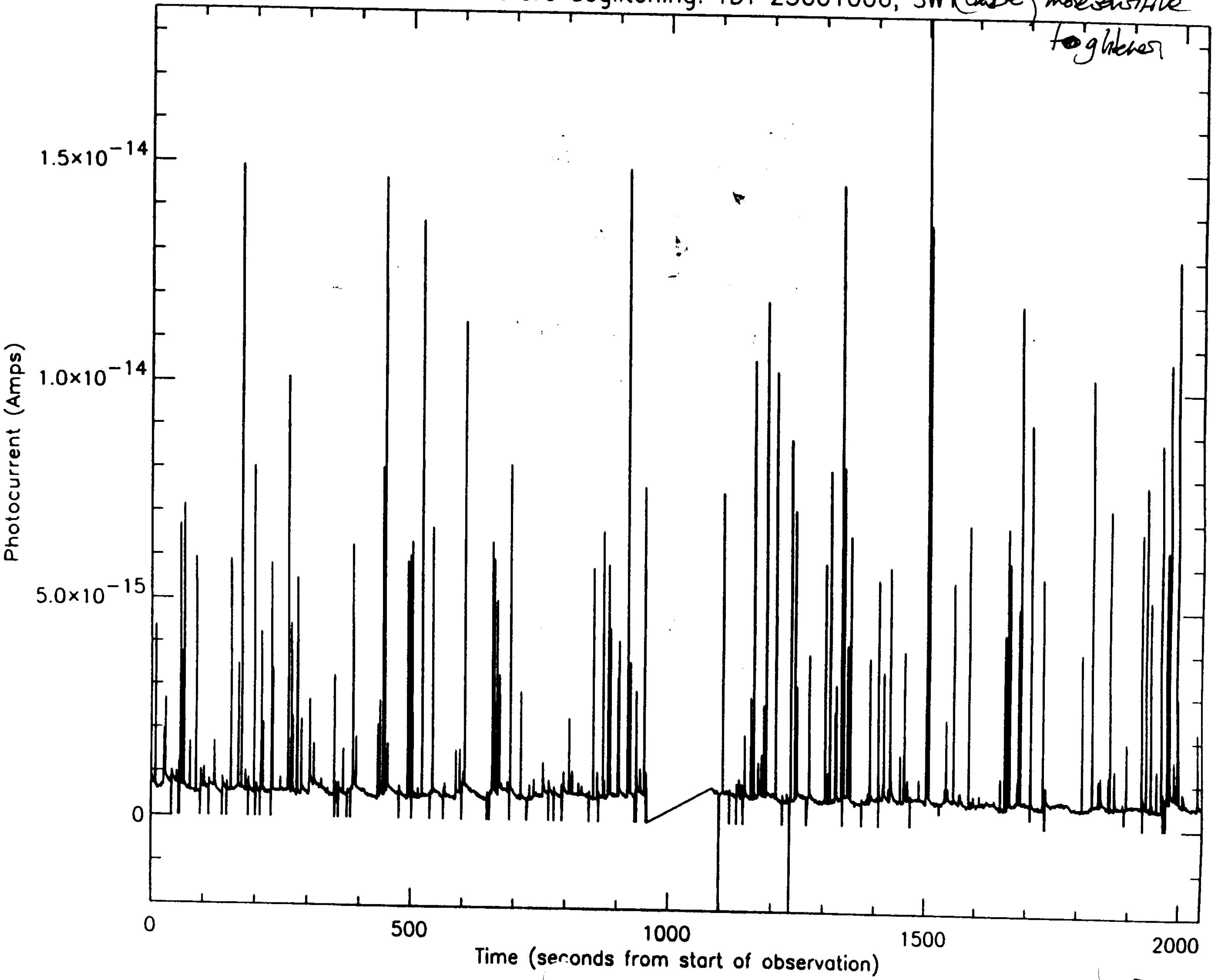
$I = a_1 C/(1-sV_s)$

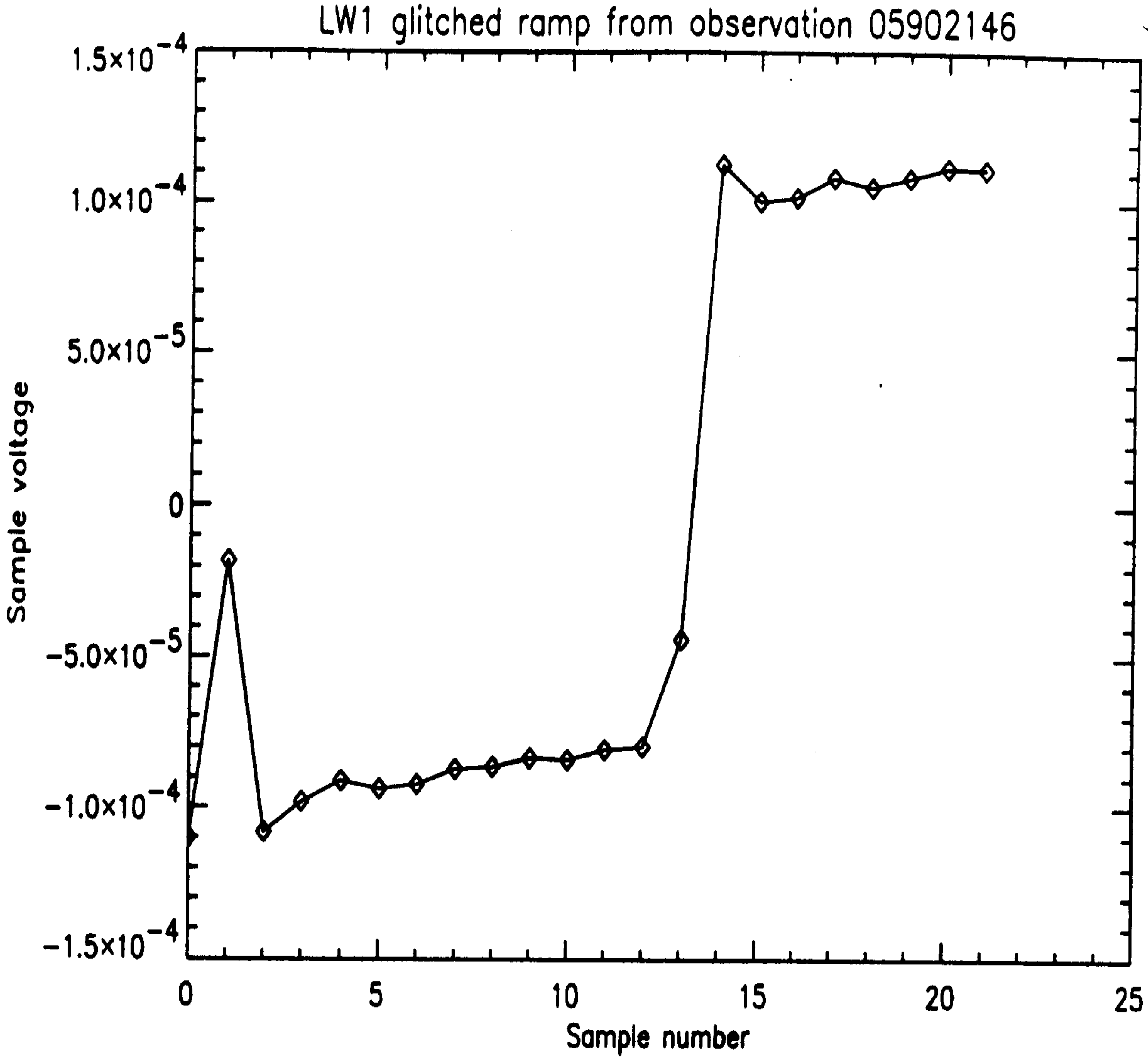
Header: how many fits for each detector. (slope fits)

s = 'debiasing' parameter

V_s = voltage at start of ramp

LSPD before deglitching: TDT 25601006, SW1 (GaBe) more sensitive to glitches




LW1 glitched ramp from observation 05902146
Sample voltage
Sample number
1.5×10^-4
1.0×10^-4
5.0×10^-5
0
−5.0×10^-5
−1.0×10^-4
−1.5×10^-4
0
5
10
15
20
25

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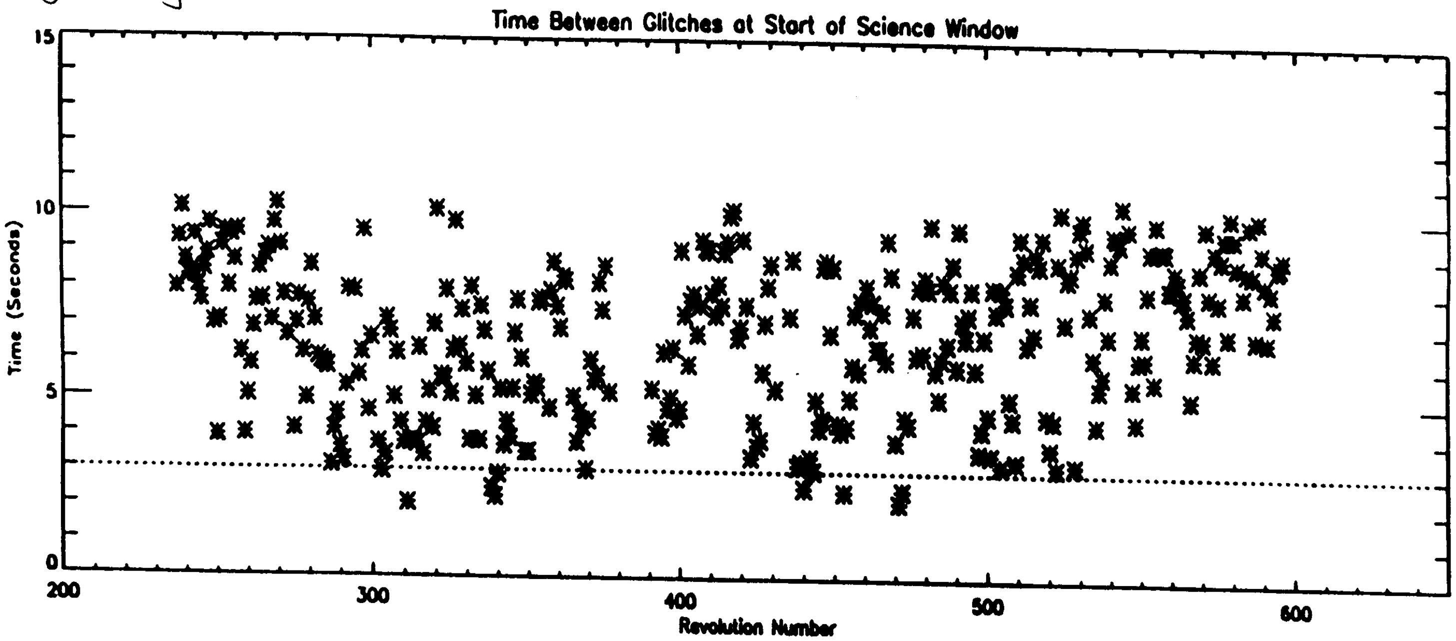
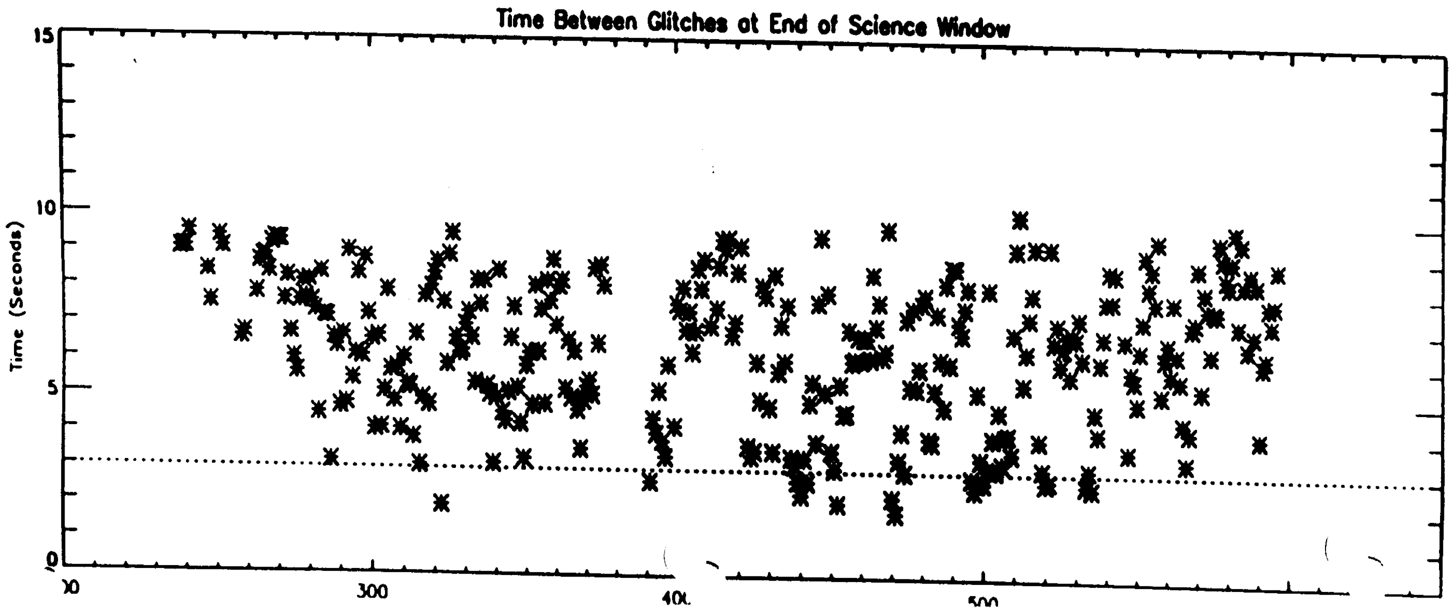
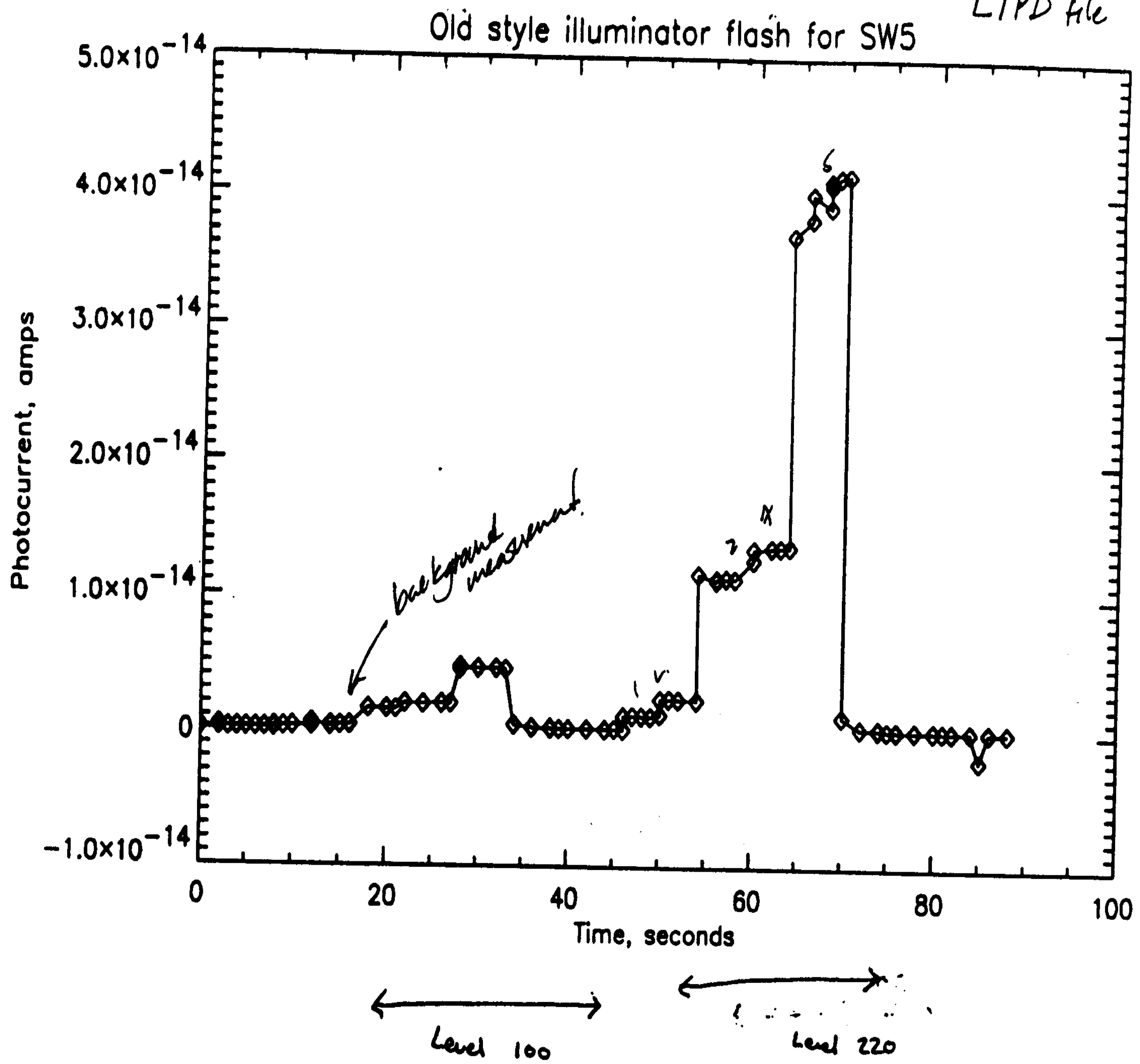
ramps → 1/2 S] 44 samples per ramp
glitch every 10 secs.

→ 16hr science window ← shorter the science window: space weather wipe out all scans





from the
LIPD file



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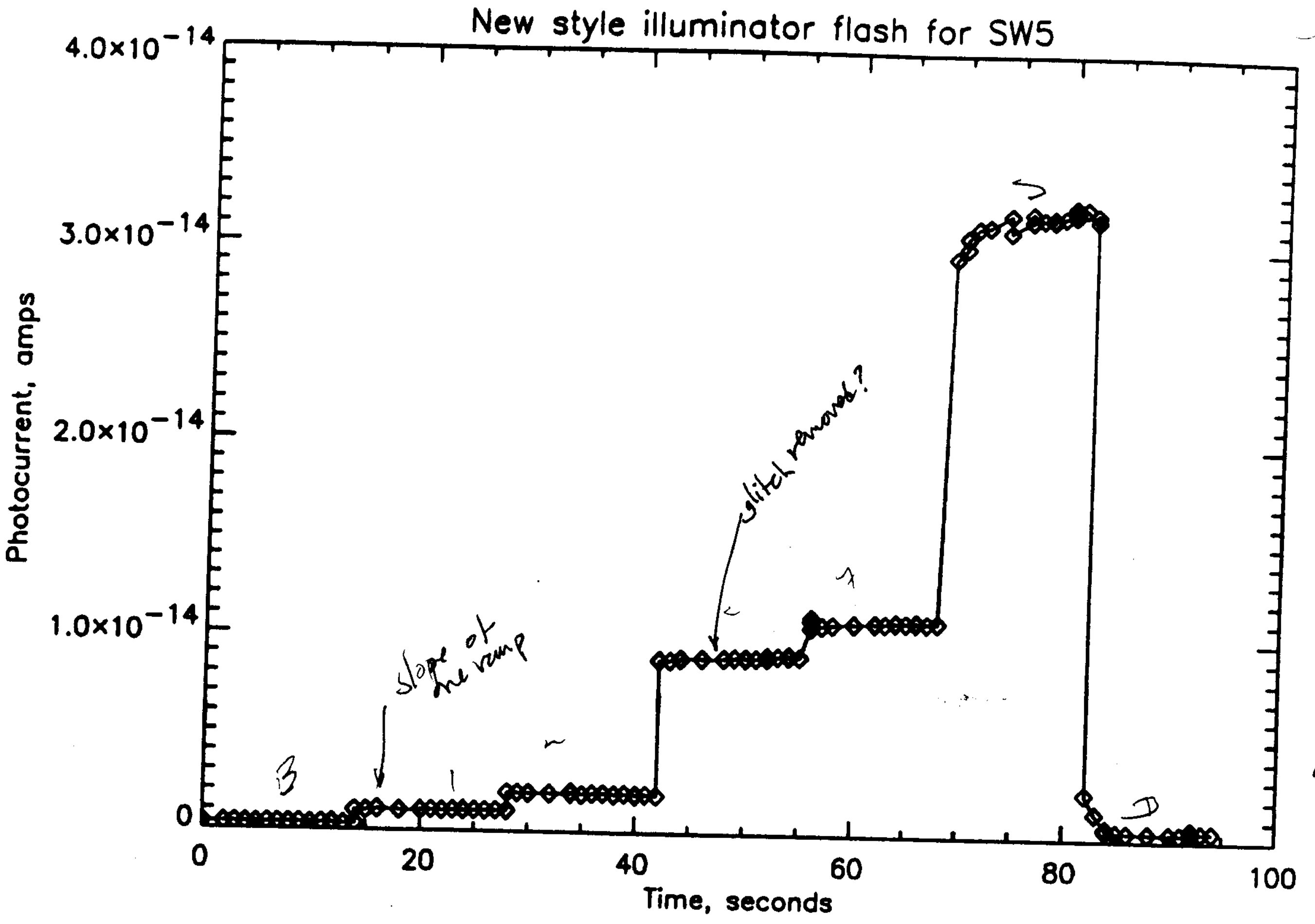

B = background

level = 180

$$\frac{\text{photocurrent}}{200 \left\{ \dfrac{\text{responsivity}}{\text{resolution element}} \right\}}$$