First-Article Testing of LeCroy 2313 Discriminator for PMT Applications

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The purpose of this note is to describe the initial testing of the LeCroy 2313 leading-edge discriminator[2], which will be used to generate logic signals from CLAS [1] photomultiplier tube pulses that exceed some preset threshold. The discriminator will be used in the calorimeter, TOF and Cerenkov subsystems, corresponding to 2432 channels.

1 Test Results

The various tests performed are listed in Table 1, along with our specifications. [1] A summary of our measurements are given in the Table, showing that the discriminator meets or exceeds CEBAF specifications.

1.1 CAMAC Function Codes

The CAMAC control were tested by reading and writing to the discriminator and verifying the module responded correctly. Figure 1 gives the list of function codes tested and corresponding notes. All commands responded as expected.

1.2 Individual Inhibits

The individual external inhibits were tested with a home-built CAMAC module which can be used to output selected patterns (ECL signals) to be input to the back connector on the discriminator. We note that the signals must

[1]The specifications are based on CEBAF Specifications 66550-S-01155 and 66340-S-01107. The two are not identical. However, LeCroy choose to deliver a single discriminator satisfying both specifications.

be terminated at the driver as per common practice. The TOF pretrigger board, which provides these signals in CLAS, must be careful to do this for proper operation.

1.3 Jitter and Slewing

Figure 2 shows a typical setup for various tests related to jitter and slewing of the pulse under various conditions. The timing properties were recorded using the SR620 Time-Interval Counter, which measures relative time and jitter as a function of time. The intrinsic time jitter of the output pulses was less than 22 ps. Figure 3 shows how the time of channel 1 changes when an adjacent channel fires close in time. Figure 4 plots the time shift measured when channels 2, 3 or 4 fire at the same time as channel 1. We measured shifts of less than 50 ps, consistent with reproducibility of data under several conditions tested. The slew rate as a function of voltage is also plotted in Figure 3, resulting in smaller slew than expected solely from the rise time of the pulse.

1.4 Mininum width and Double Pulse Resolution

The minimum input width required to fire a channel was determined by varying the width of a 50 mV pulse with the threshold set at 25 mV. Figure 4 shows that the discriminator responded to the mininum width (2 ns) of the HP pulser. The double pulse resolution was checked at the same time. The discriminator was able to track two pulses separated by 7.5 ns. The minimum output width of the discriminator is 5 ns.

2 Graphical Interface to Discriminator

There are two working X-window type graphical control panels available for controlling the LeCroy discriminators. They are called pud4413 and pud2313 (PUD stands for Programmable Updating Discriminator), and may be found in

/clas/clas72/usr/local/COSMIC/Utility/HP-UX/bin/pud

Each program requires its own tcl script pudXXXX.tcl which defines the locations of libraries and input files, and an input file pudXXXX.txt which describes the crate and slot assignments and default startup settings. This program does not use EPICS and assumes the CAMAC crate is connected to CLASVME1. There is a HELP button which provides instructions on use of the program.

The programs are still under development. The current version displays a panel similar to that shown in Figure 6. The user is provided with a slide bar and a text window for changing input thresholds and output pulse widths on individual modules. Each channel within a module can be toggled active or inactive using the mouse. Future releases will combine the 4413 and 2313 capabilities, merge with EPICS and provide a CED type display option.

3 Conclusion

The tests indicate that the discriminator performance meets or exceeds CEBAF specifications. Table 2 is a list of tests we expect to perform on each production board to be accepted for payment. The proposed schedule for delivery of production quantitities of the discriminagtor is May through July.

ACKNOWLEDGEMENTS
We are grateful to Claude Marchand for helping with testing the first discriminator boards submitted for First-Article Testing.

References

[1] "Conceptual Design Report — Basic Experimental Equipment," CEBAF April 13, 1990.

[2] LeCroy Corporation, "1994 Research Instrumentation Catalog," 700 Chesnut Ridge Road, Chestnut Ridge, NY 10977.

Table 1: First-Article Test results of LeCroy 2313.

Parameter	*Specification*	*Measurement*
Threshold	-10 → -250 mV	+600 → 1030mV
Software Mask	required	√
Time Slewing	≤0.5ns for 1ns rise	≤0.9ns for 3ns rise
Time jitter	30 ps	22 ps
Connectors	lemo/ribbon	√
Protection	± 100 V /0.5μs	not tested
Min Input Width	3 ns	2 ns
Unused Inputs	float	√
Reflections	≤5% for 3.5ns rise	√ (†)
Global Veto	required	√
Individual Inhibits	required	√
Test Input	required	√
Output Width	10 → 100ns	5 → 140 ns
Double Pulse Resolution	≤10ns	≤7.5 ns
Interchannel Isolation	complete/allowable inputs	√
Input/Output Delay	≤40ns	10ns (specs)
Maximum Rate	≥100 MHz	≥133 MHz
Multiple Pulsing	none	√

† Measured with preliminary version of First Article discriminators.

Table 2: Testing frequency of LeCroy 2313 discriminator.

Specification	*Every Channel*	*Every Board*	*Selected Boards*	*Comment*
Threshold	√	√		uniformity @ 10mV
Software Mask	√	√		
Time Slewing			√	
Time jitter			√	
Connectors			√	
Protection			√	
Input Width			√	
Unused Inputs			√	
Reflections			√	
Global Veto	√	√		
Individual Inhibits	√	√		
Test Input	√	√		
Output Width			√	
Double Pulse Resolution		√	√	
Interchannel Isolation	√	√	√	@5V inputs
Input/Output Delay			√	
Maximum Rate	√	√		
Multiple Pulsing			√	

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Serial # A77579 Model 2313
CAMAC FUNCTION CODES

F0 A0 READ MASK REGISTER [R1 - R16]
Function reads properly. Did not note any discrepancies. Readback value corresponds to disabled output channels.

F0 A1 READ THRESHOLD [R1 - R12]
F0 A2 READ WIDTH [R1 - R12]
Function should only place data on CAMAC R1 - R12 but it appears as if R13 - R16 are enabled during this read command. I masked R13 -R16 and the data agreed with the value that was written to the threshold and width registers.

F16 A0 WRITE MASK REGISTER [W1 - W16]
Function operates properly. I was able to control each mask bit and the corresponding channel output was disabled/enabled.

F16 A1 WRITE THRESHOLD [W1 - W12]
Write threshold command functions properly. The range setting is as follows:

WRITE VALUE	MEASURED FRONT PANEL VOLTAGE
0h	-1.03 VDC
800h	0 [very near]
FFFh	+0.6 VDC

F16 A2 WRITE WIDTH [W1 - W2]
Write width command functions properly. The range setting is as follows:

WRITE VALUE	MEASURED WIDTH FROM O'SCOPE
0h	140 nSec [See First order Jitter Figure X]
800h	10 nSec
FFFh	5 nSec

exceeds

The range ~~is outside~~ the LeCroy specifications of 10nSec - 100nSec.

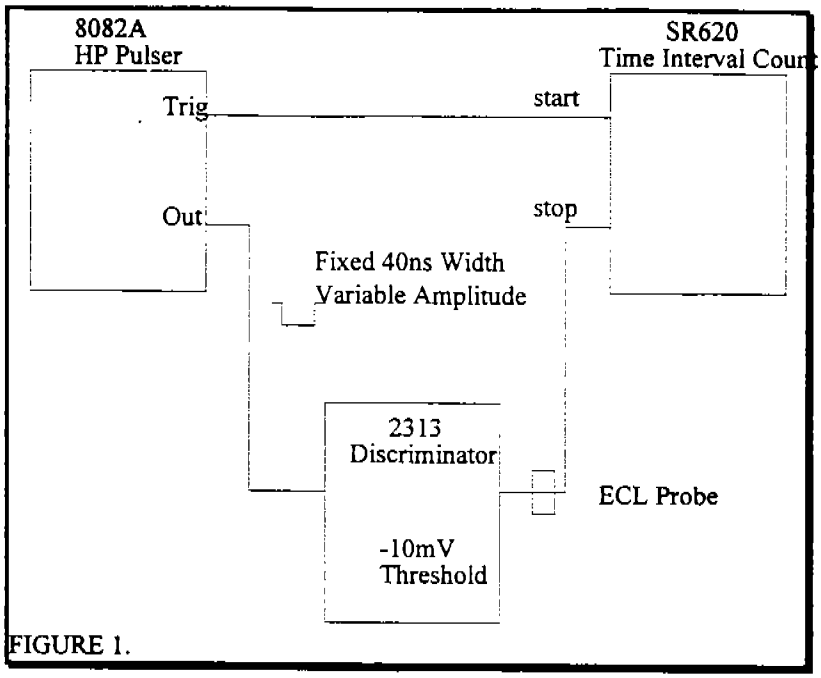
F24 A0 SET TO LOCAL MODE
Set to Local command works properly. The front panel local switch also works properly. The unit powers up in the local mode as described in the manual. When switching from LOCAL mode to REMOTE mode, via computer control or front panel control, the settings for width, mask and threshold MUST be re-programmed.

F25 A0 TEST STROBE
CAMAC trigger command operates properly. The TEST input also works properly and accepts an external NIM level signal and generates output pulses on enabled channels.

F26 A0 SET TO REMOTE MODE
Set to Remote command works properly. Again though, when switching from LOCAL mode to REMOTE mode, via computer control or front panel control, the settings for width, mask and threshold MUST be re-programmed. Default settings are -1.03 VDC Threshold, All outputs enabled and Maximum width.

F27 A0 CHECK LOCAL/REMOTE MODE
Q=1 IF REMOTE MODE
Did NOT verify this feature.

Figure 1: CAMAC function code tests and corresponding comments.



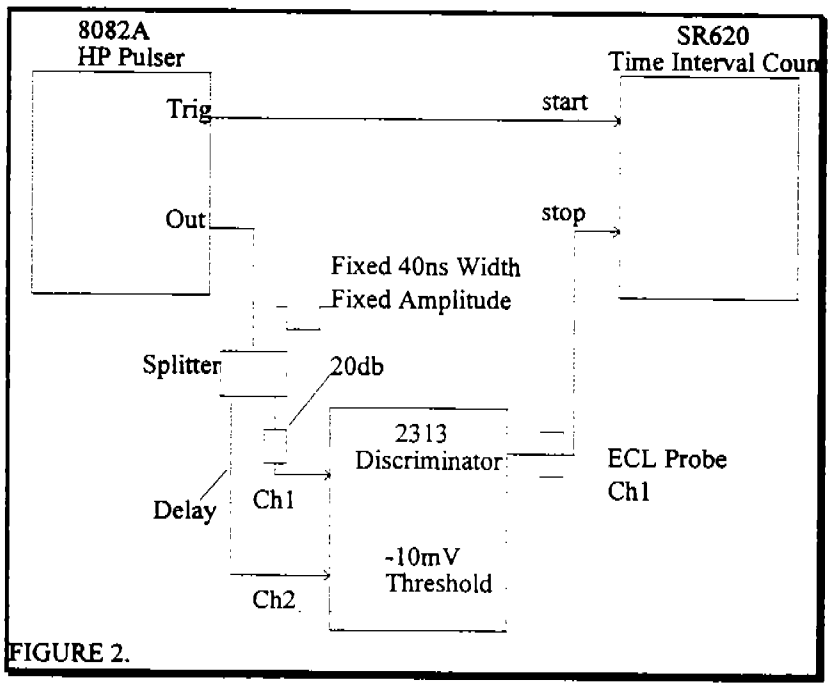


Figure 2: Setup for time jitter and isolation measurements.

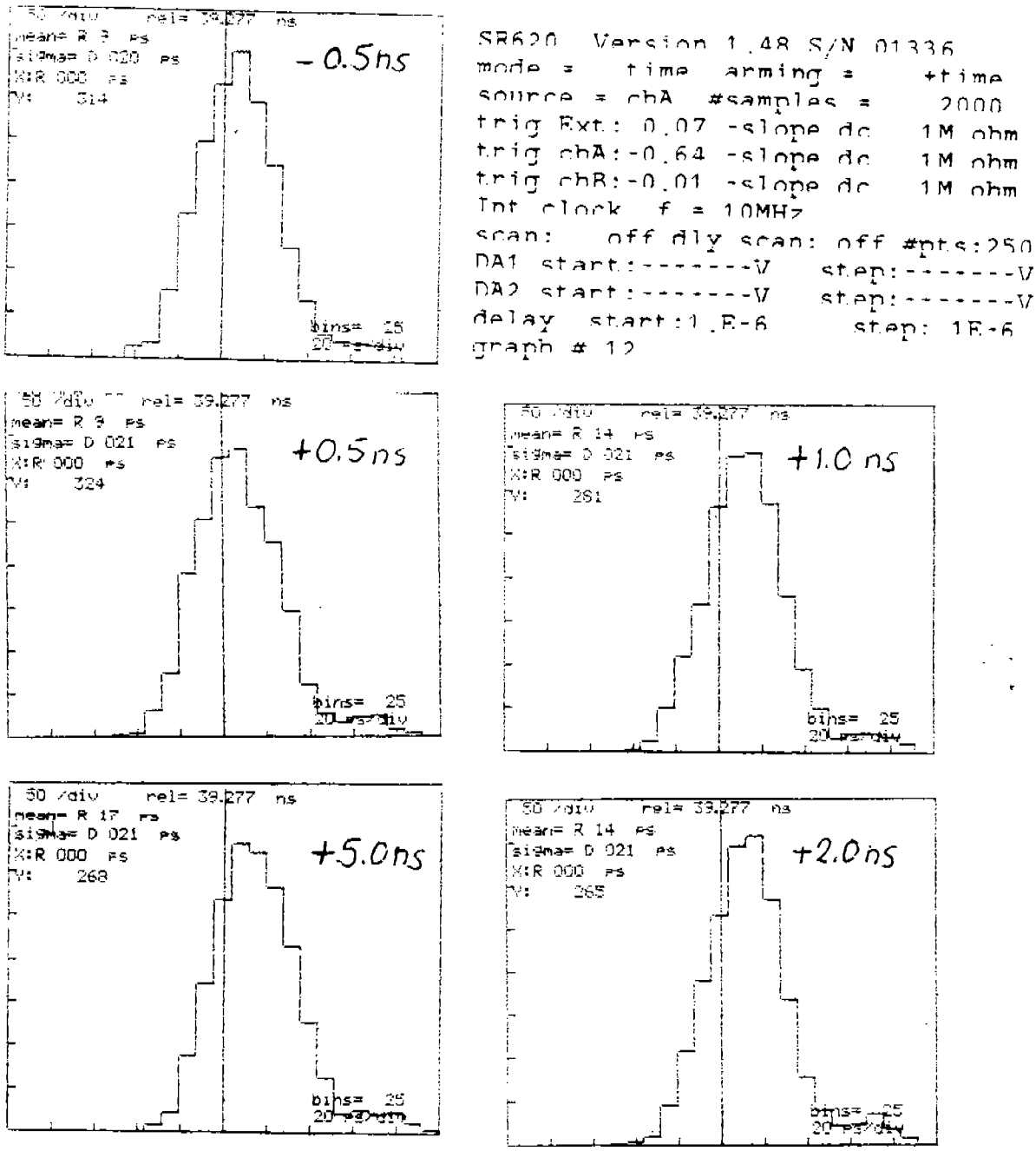


Figure 3: Typical plots for the distribution of times for the output of channel 1, when an adjacent channel fires close in time. The time on channel 1 is virtually unchanged by adjacent channel activity.

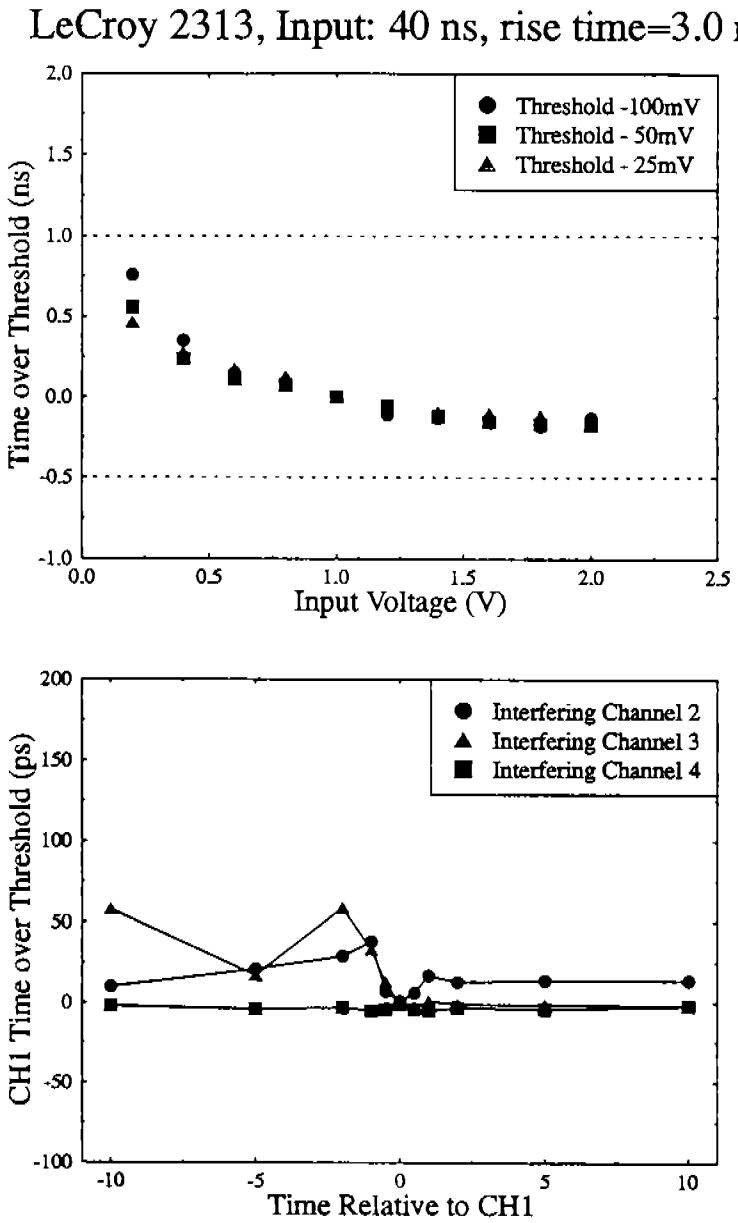


Figure 4: Slewing for variable input size and the influence of one channel on the timing of another.

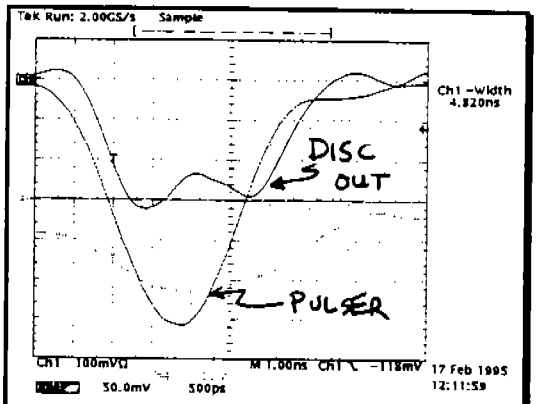


Figure 3

- Figure 3 shows an expanded view of a single pulse output from the HP Pulser with an amplitude of -50mV and 2nS width. [Ref1]
- CH1 is the output of the 2313 measured with the LeCroy ECL probe. The pulse width is 5nS and agrees with the programmed output pulse width setting.
- CH4 shows the output of the 2313 measured directly with a scope probe.
- Threshold measured @-25mV

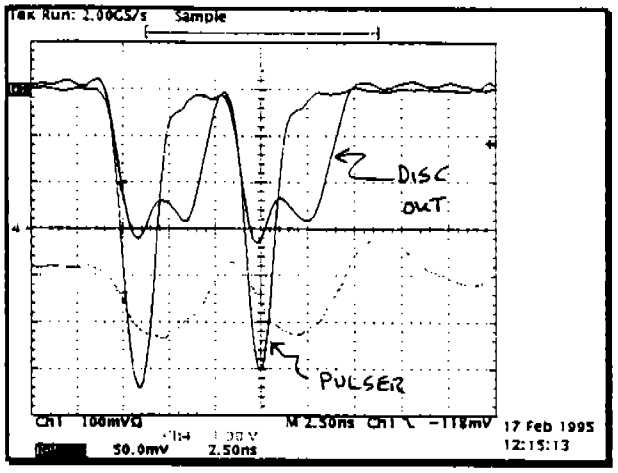


Figure 4

- Figure 4 shows the minimum double pulse delay settable from the HP Pulser on Ref1. The amplitude is approximately -300mV. The pulse width setting is 2nS.
- CH1 is the output of the 2313 as measured by the LeCroy ECL probe.
- CH4 is the output of the 2313 as measured by a scope probe.
- Threshold measured @-25mV

Figure 5: Results of mininum width and double pulse resolution.

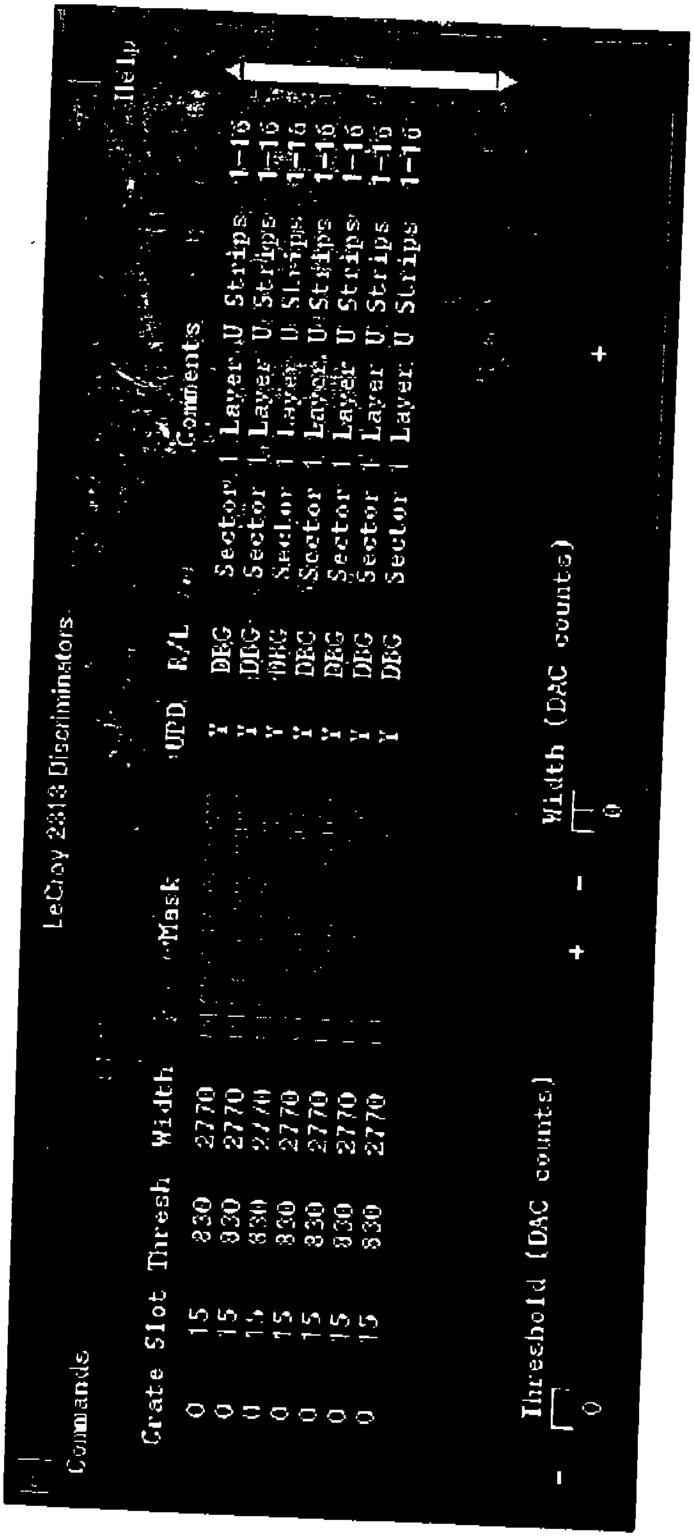


Figure 6: Graphical interface panel to control LeCroy 2313 discriminator operation.