APPENDIX B

CORRELATION ISSUES AMONG INSTRUMENTS

Issues applicable to all instruments*

- Probing
- Fixturing

***Major area leading to correlation issues. In this seminar, an assumption is made that participants are knowledgable in these two areas and are using best lab practices.**

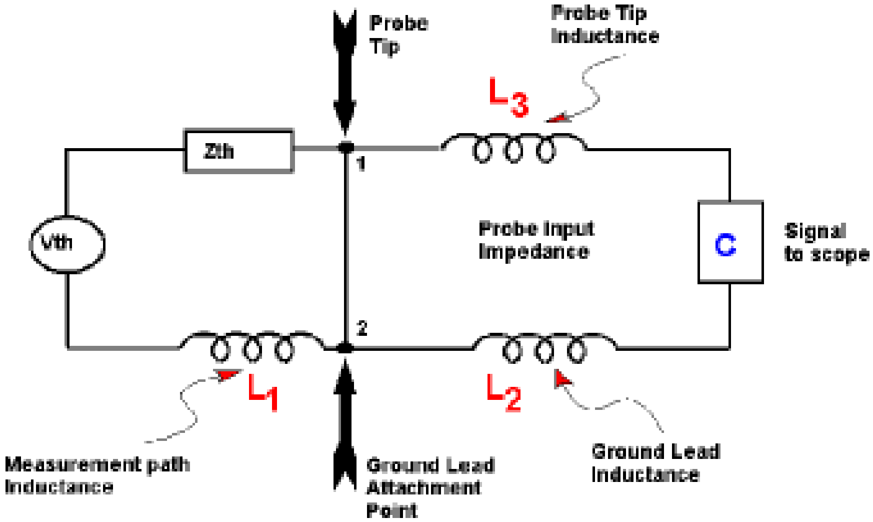
Issues dependent on particular instruments

- Equipment resolution/accuracy vs. range and other specifications
- Instrument noise floor
- Record Length (ability to resolve low frequency modulation)
- Asynchronous vs. Synchronous measurements
- Instrument Calibration techniques
- Operating beyond equipment limitations
- Instrument Setting
- Changes in external environment (temp./Vcc noise/line noise, etc.)

IDEAL PROBE

- Infinite Bandwidth
- Zero input capacitance
- Infinite input resistance
- Infinite dynamic range
- Attenuation of 1
- Zero delay
- Zero phase shift
- Mechanically well suited to application

Ground Lead Resonance*



$$F = \frac{1}{2\pi\sqrt{LC}}$$

$$T_R = \frac{.35}{BW}$$

F = Resonance Frequency

$L = L_1 + L_2 + L_3$

C = Probe Tip Capacitance

T_R = 10%-90% Rise Time

BW = Probe Bandwdith

Example:

L = 100 nH (4 inches of ground lead @25 nH/in.)

C = 8 pF

$$F = \frac{1}{6.28\sqrt{(100x10^{9})(8x10^{-12})}}$$

F = 178 MHz

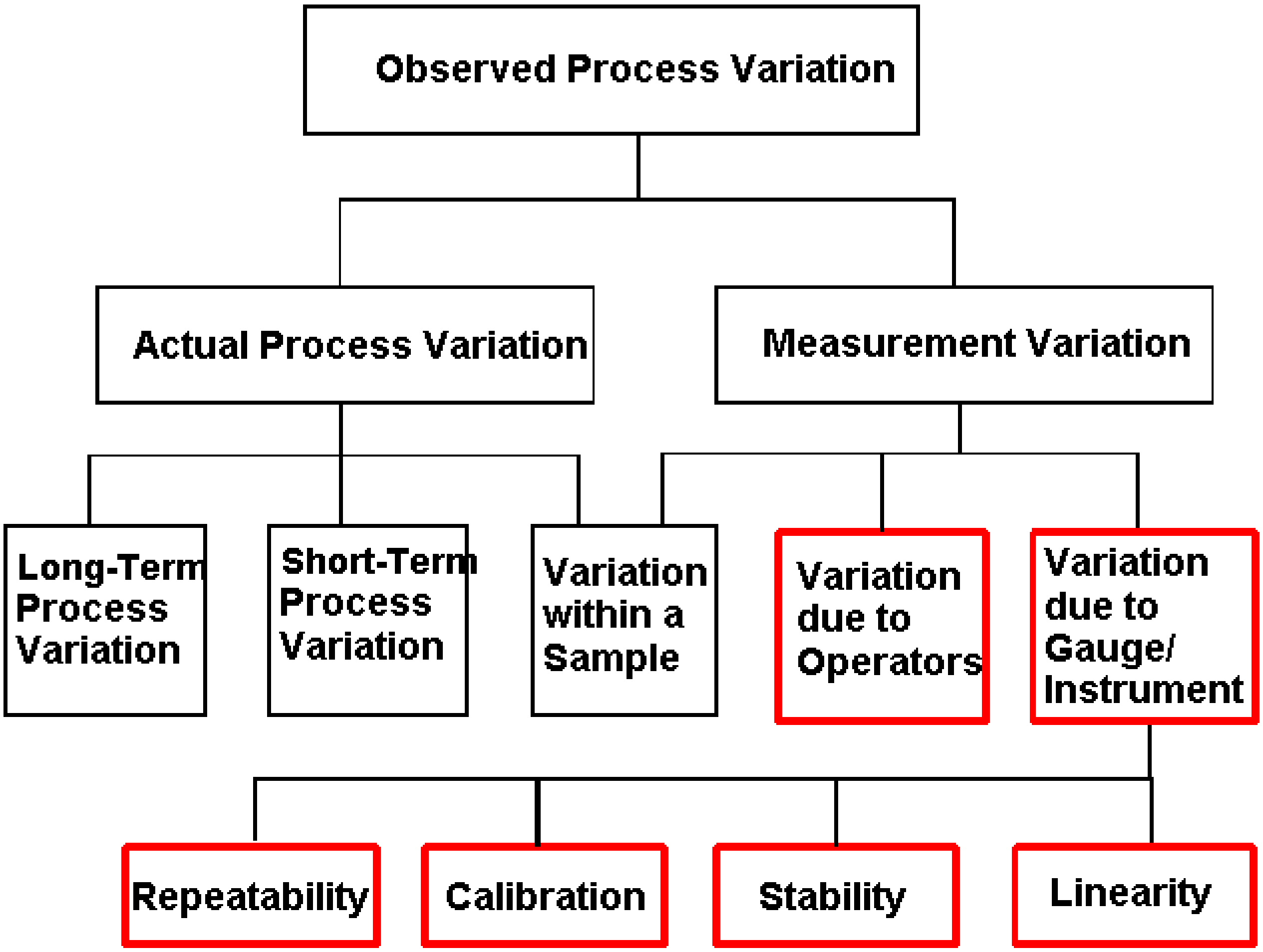
$$T_R = \frac{.35}{178\ \text{MHz}}$$

T_R = 1.9 ns

Therefore a signal with a harmonic component of 178 MHz will ring.

*Adapted from "How an oscilloscope works", HP scope manual

Repeatability and Reproducibility*



- Repeatability (Is there variation of the gauge when used by one operator in a brief time interval?)
- Calibration (Is the gauge accurate?)
- Stability (Does the gauge change over time?)
- Linearity (Is the gauge more accurate at low values than at high values?)

☐ =areas uniquely addressed by the DTS instrument

*adapted from Concepts for R&R Studies

Correlation issue examples

With DSO

(will show issues with delay setting and using hardware vs. software measure)

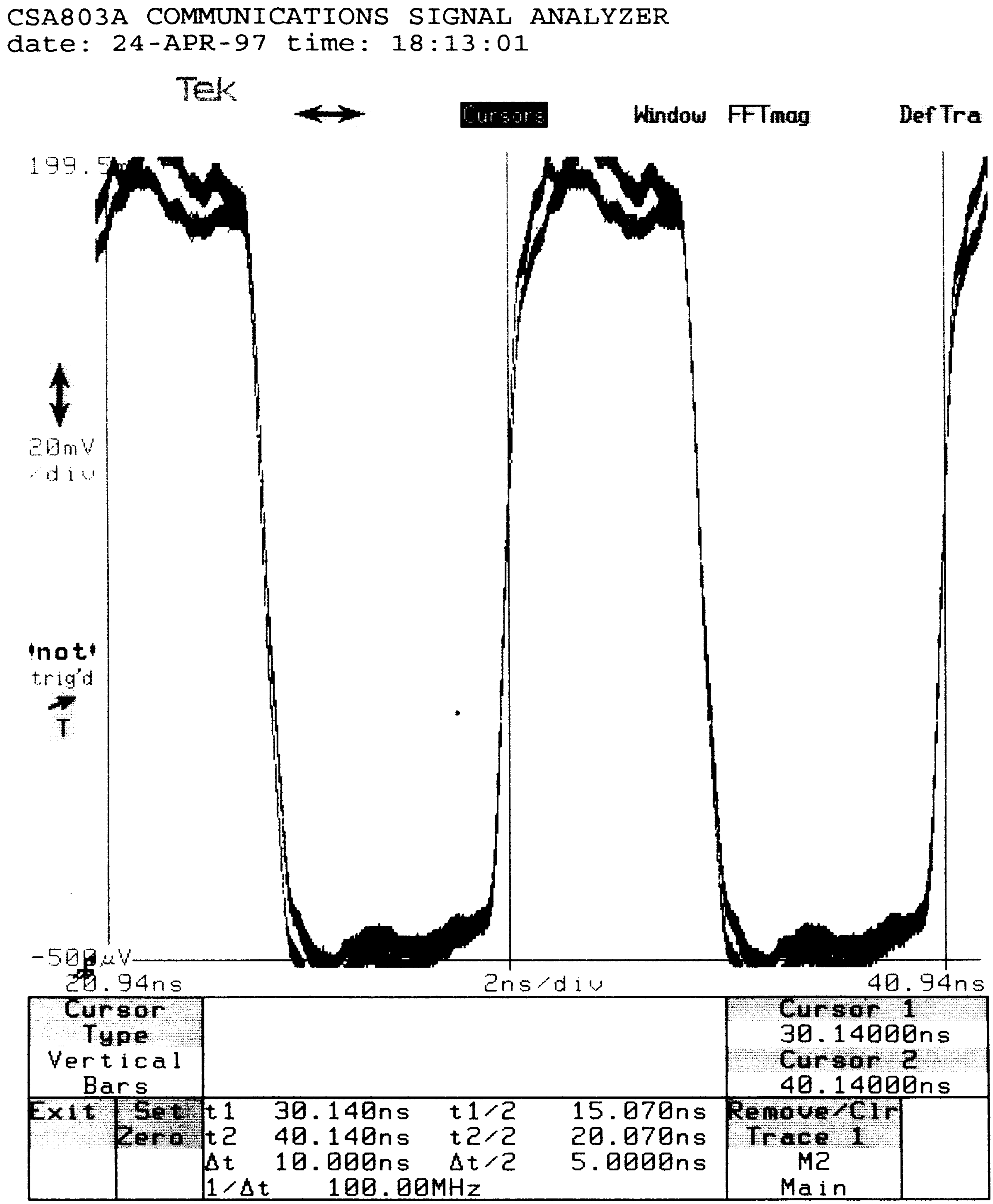
(will show jitter dependency on trigger source)

With Real Time Digitizer

(will show resolution issues and record length issues)

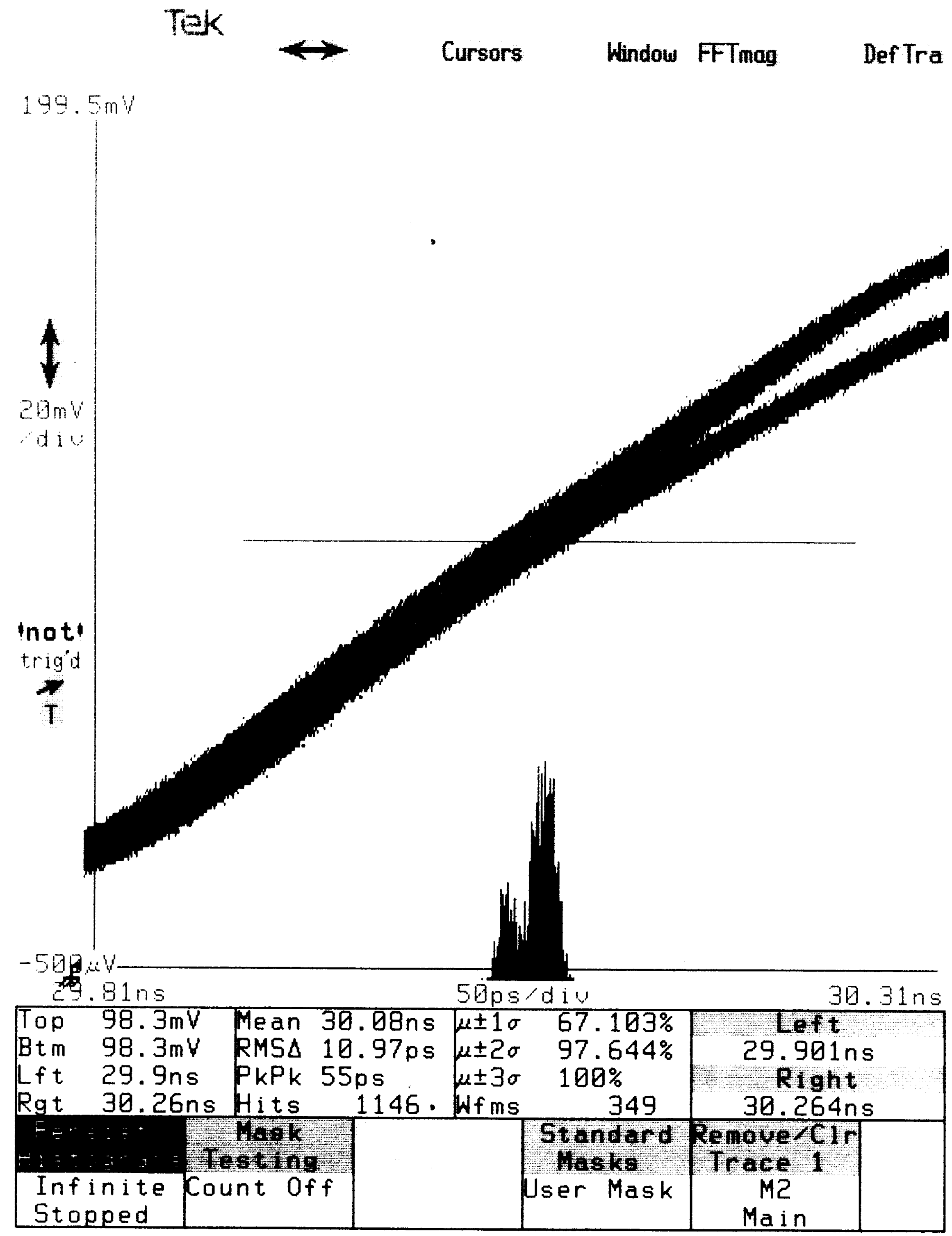
With TIA

(will highlight limitations from supplier data sheet for product)



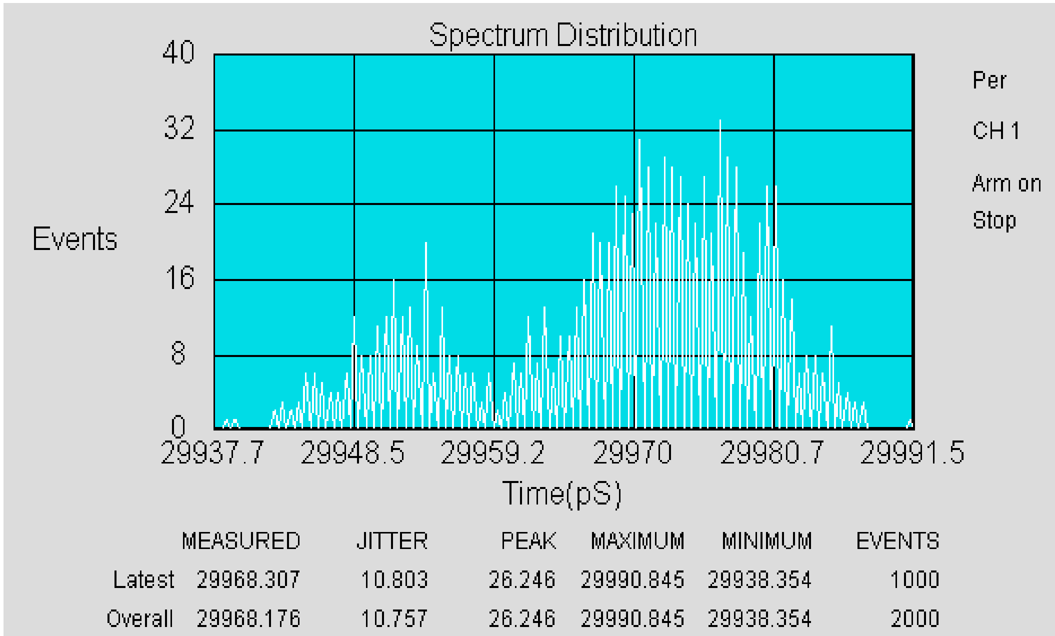
– 100MHZ PLL output triggered by signal via splitter

CSA803A COMMUNICATIONS SIGNAL ANALYZER
date: 24-APR-97 time: 18:02:28

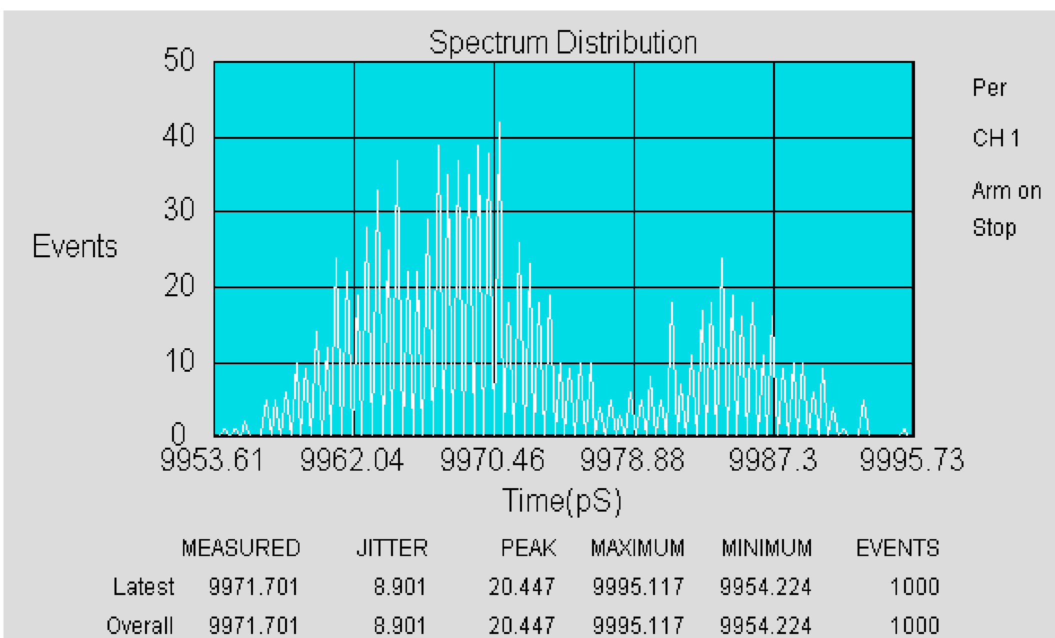


– **100MHZ PLL output triggered by signal**
– **Looking at 3rd cycle which is first measurable cycle**

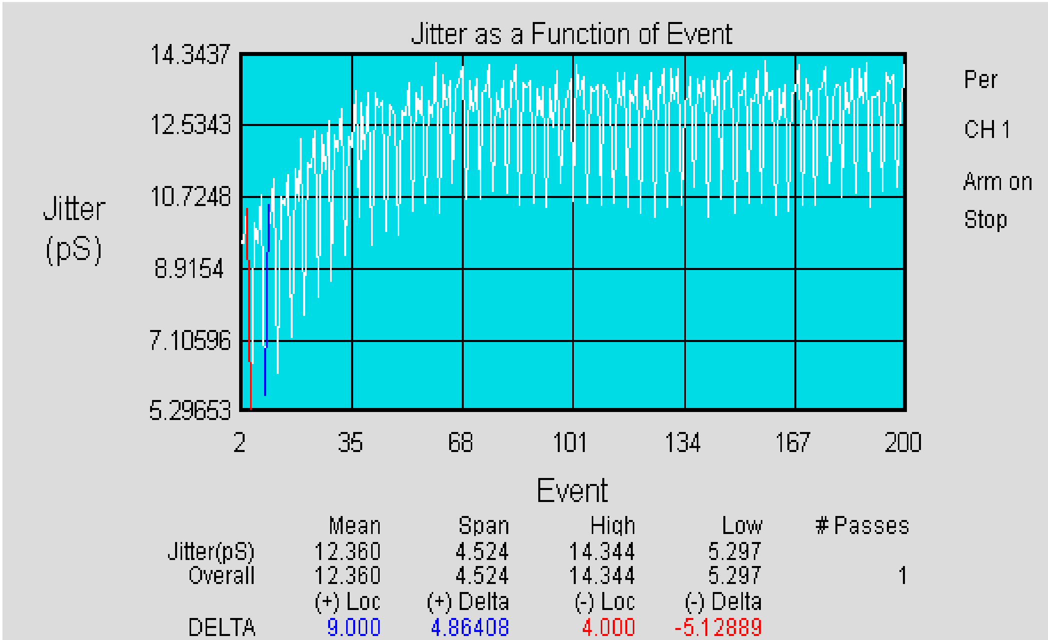
DTS FIRST PERIOD JITTER MEASUREMENT



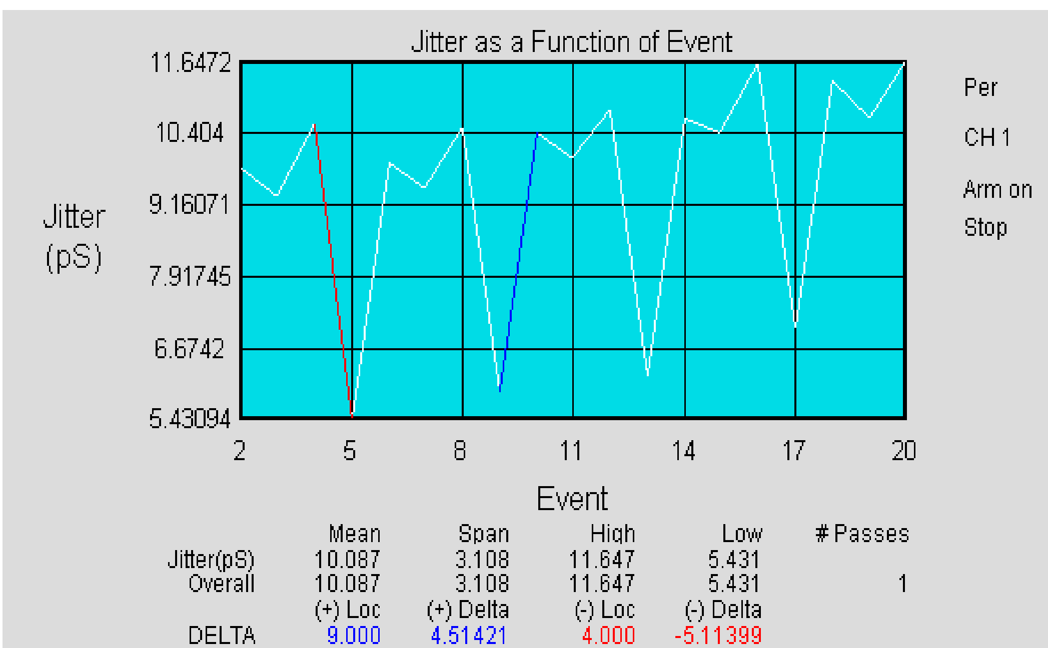
100 MHz (10ns) PLL output. For comparing to CSA 803A, DTS measures time duration from rising edge 1 to rising edge 4 or effectively 3 cycles. As can be seen, the DTS correlates well in rms jitter and shape of the bimodal histograms.



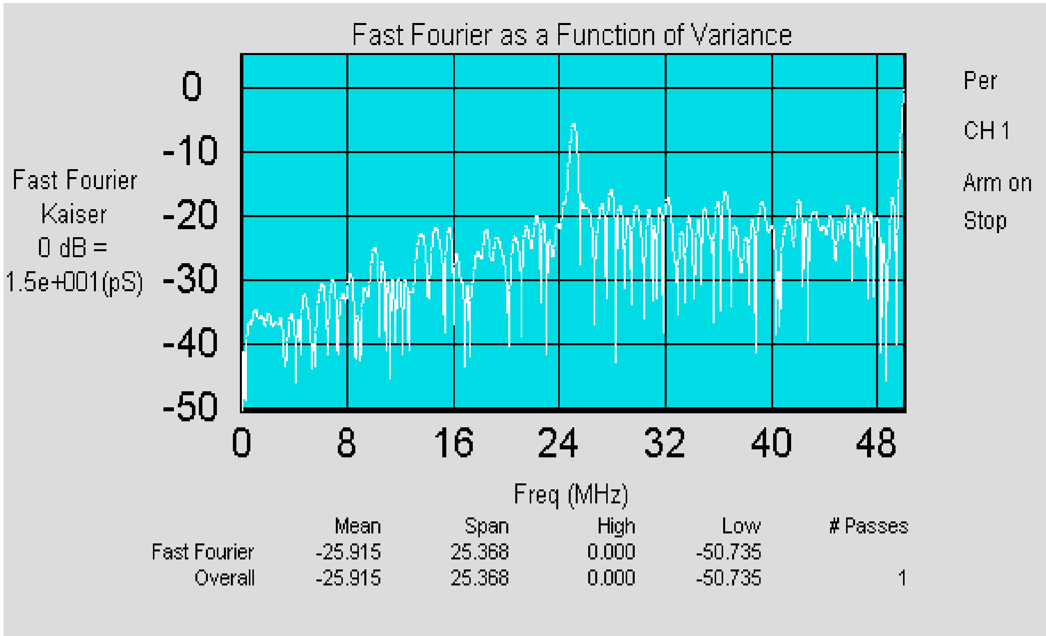
Same signal as above, except DTS is measuring from 1 rising edge to 2nd rising edge (1 cycle or period). Notice lower jitter and shifting of histogram shapes. CSA 803A cannot easily measure just 1 cycle because of minimum delay requirement.



Jitter Analysis of 100 MHz PLL output. Up to count 200. Notice the accumulated jitter modulation in the time domain.

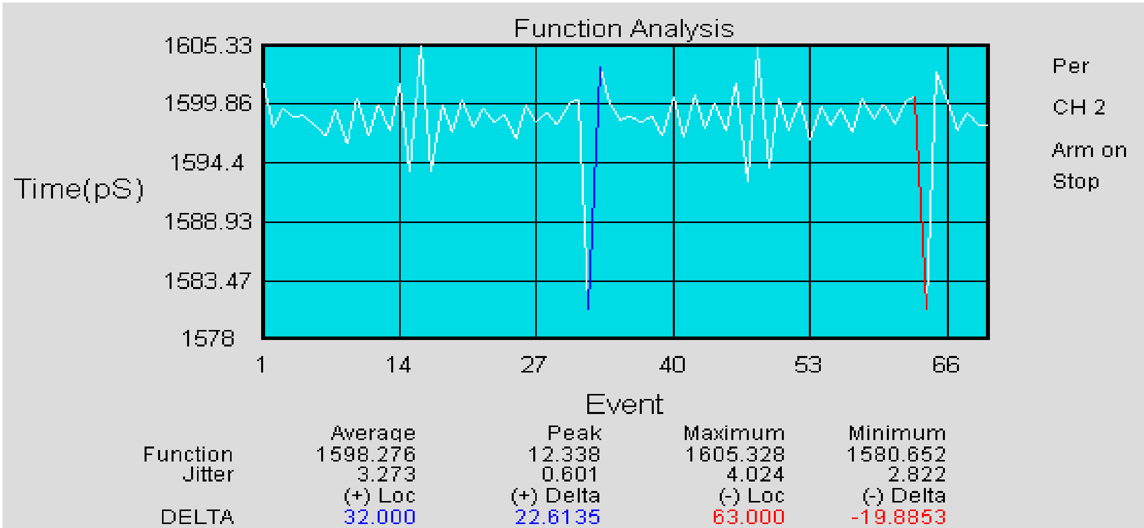


Jitter Analysis of 100 MHz PLL output. Count was set to 20. This is a zoomed plot of the above. Notice the distinct pattern to the accumu-ated jitter.

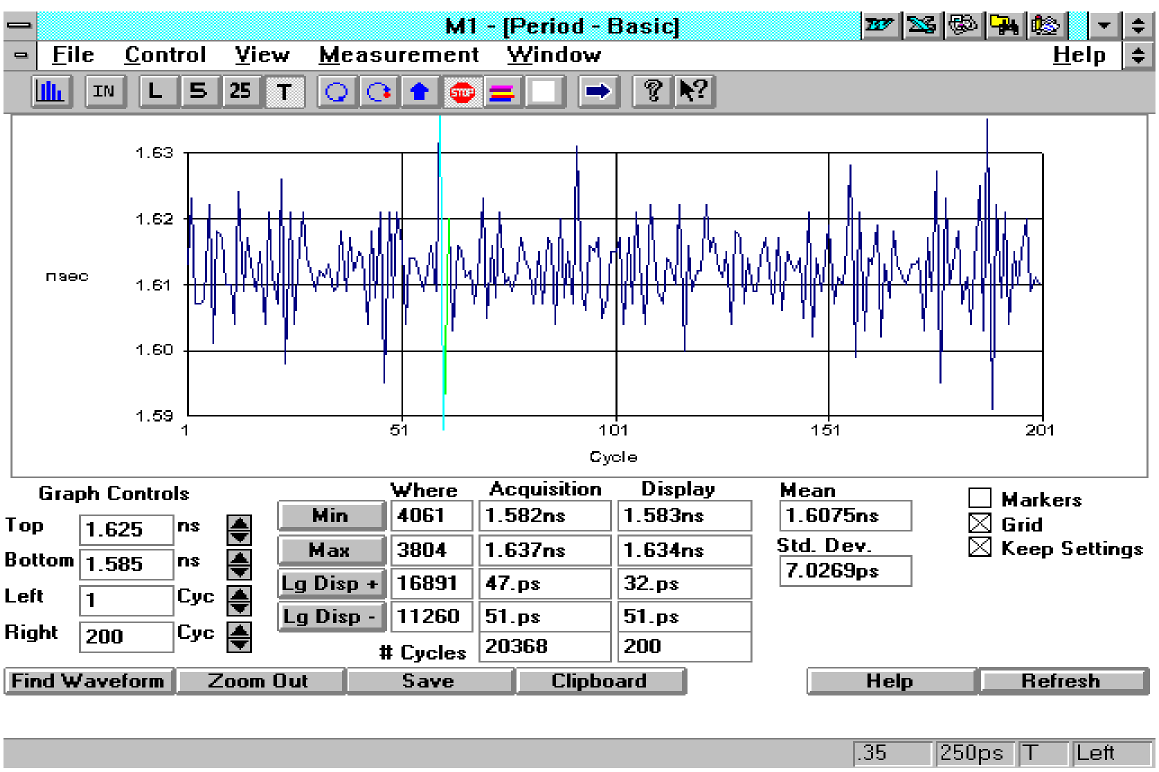


Jitter Analysis FFT of 100MHz PLL output. Modulation detected at 50 and 25 MHz.

Real Time Digitizer Correlation issue (resolution)

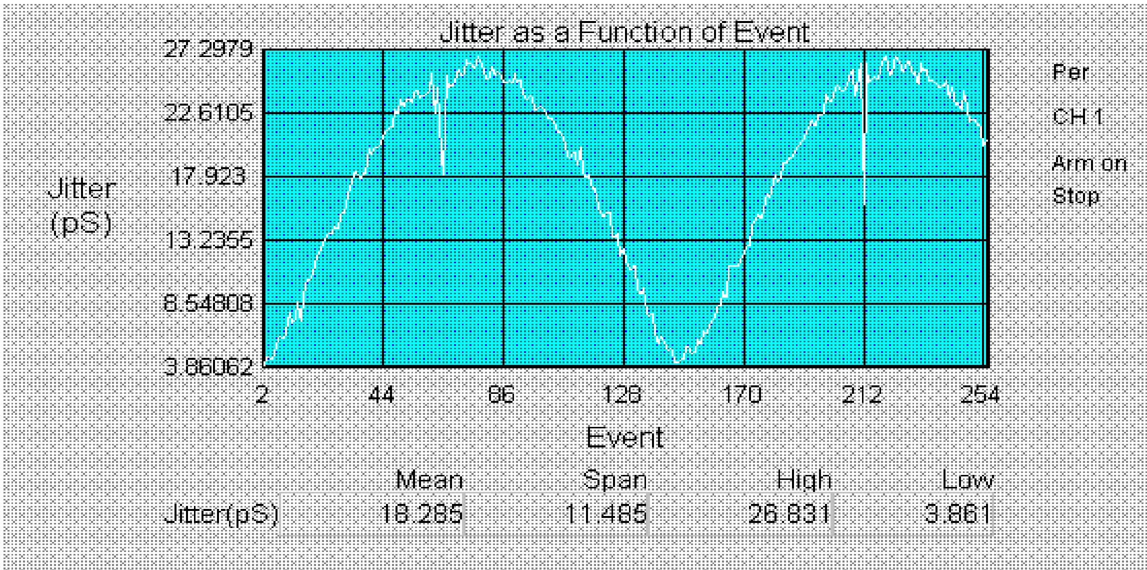


Above is a DTS 2070 Function Analysis plot on a 622 MHz ATM device. Notice the 20 ps short cycle every 32 cycles. The 800 fs resolution of DTS 2070 allows one to "see" the small period push out.

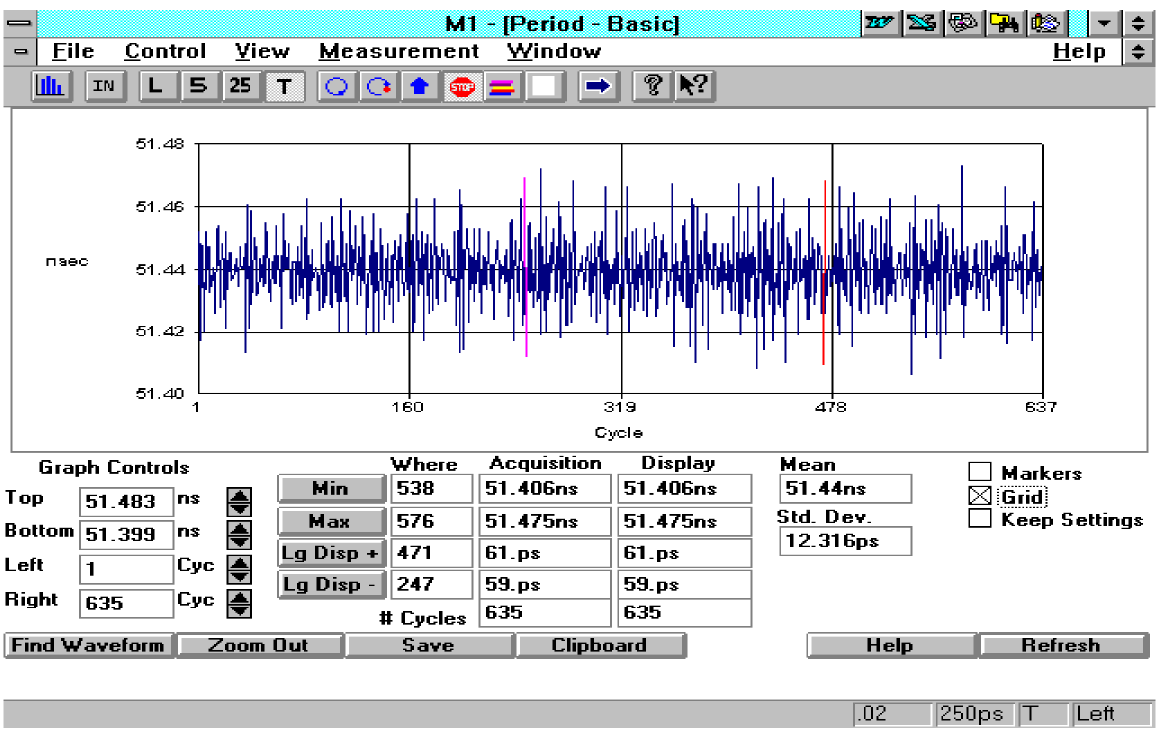


The above is a cycle by cycle plot using a 4 GSa/sec real time digitizer with custom software. You cannot resolve the 20 ps period push out due to the lower resolution of the digitizer.

Real Time Digitizer Correlation issue (small record length)



Above is DTS 2070 Jitter Analysis plot for a 19.4 MHz oscillator signal to an ATM device. This modulation is caused by the 130 kHz switching power supply coupling to the test fixture.



The above plot is a cycle by cycle plot using a 4 GSa/sec real time digitizer with custom post processing software. You cannot see any modulation due to the small record length.

TIA/MDA Performance Limitations

5372A*

Frequency range 16 kHz to 13 MHz
Singe Shot Resolution 150ps
Single Shot Accuracy .... +-250ps
RMS Jitter noise floor .... <=160ps
Input Bandwidth 500 MHz

Using FFT option ($3000 additional cost)

The FFT is not supported for the following measurement functions:

- Rise Time
- Fall Time
- Positive Pulse Width
- Negative Pulse Width
- Duty Cycle
- Peak Amplitude
- Histogram Time Interval
- Histogram Continuous Time Interval
- Histogram+- Time Interval

HP E1725A*

Sample Rate

The maximum frequency that can be time stamped any time is 80 MHz. However, this parameter controls the maximum rate at which every edge can be captured. For single channel measurements, every edge of a clock can be captured up to the indicated Sample Rate (e.g. to 80 MHz with the Sample Rate set to 80 MHz). However, there are trade-offs with the Sample Rate setting as summarized in this table.

Sample Rate	Pacing	Min. Freq.	Max. Time Interval
80 MHz	Auto	4 MHz	250 ns
	Manual	625 kHz	1.7 us

If the signal frequency goes below the minimum frequency, it will be measured incorrectly or not at all. If any time interval between clock edges is longer than the maximum time interval (actually the maximum time between time stamps), it will be measured incorrectly or not at all. Note that the limits change with the setting of the Pace parameter.

*Information from HP literature