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Flattop Tune and Chromaticity Measurements for 24 GeV/c SEB.

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Subject Flattop Tune and Chromaticity Measurements for 24 GeV/c SEB

The horizointal betatron tune and chromaticity were measured across the 24 GeV/c flattop as part of an effort to document the 24 GeV/c setup. One delightful discovery was the ability to measure the tune spread of the beam by observing a PUE difference signal on the LeCroy 9400 Dual 125 MHz Digital Oscilloscope with the FFT while triggering the tune meter on a real time clock (with a 2.5 microsecond kick pulse $\cong$ 1 revolution). Figures I, II, and III demonstrate what these transforms looked like.

Experiment

To measure the tune across the flattop, the tune meter was set up on an ms clock (ms from injection peaker). The momentum spread was derived from the spill length and GC down counts as given on the computer CLYDE display (SWP = % dP/P per second, derived from Δ(GC down counts)/second and so it is really the ΔB field/second of the flattop). To get the beam momentum spread, this slope was assumed to be constant during the spill, which is not strictly true. I would have done better to measure the GC down counts directly (and will next time).

Results

Figures IV - VIII summarize the data results. Figure IV shows the minimum and maximum tunes taken from the transforms. 8-2/3 is drawn in as a reference. Note that this shows the tune space is being completely filled. Figure V simply shows the tune spread taken from this data. Figure VI shows the derived beam momentum spread used to calculate the chromaticities. Figure VII is the tune spread plotted vs the assumed momentum spreads. Finally, Figure VIII shows the chromaticities as a function of time across the flattop. The drop in the values at the end of the spill is probably due to my assuming a linear decrease in the momentum spread.

Conclusions

This method in measuring the tune spread and chromaticities of the debunched beam is relatively easy to implement and is non-destructive to the beam. These measurements were made while running the SEB program and none of the experiments were affected by them It is also another way of measuring the momentum spread. Since the chromaticity is a constant through the flattop, the tune spread should directly reflect the momentum spread. Figure IX shows the momentum spread through flattop, assuming a chromaticity of -3.0.

Further Studies

1. As mentioned, the change in field (or momentum) with time during extraction should be measured directly rather than using "SWP".
2. This experiment relies heavily on an interpretation of the FFT of tune meter data beyond simply extracting a tune, namely, also extracting a tune width. This assumption could be tested directly using a beam of known momentum spread (gap volt and bunch length measurements) and a machine of known chromaticity ($\Delta r/\Delta R$ measurement). This could be done at a lower p where chromaticity is easier to change.

Acknolwedgments

I would like to thank W. van Asselt for demonstrating this method of measuring tune spreads, J.W. Glenn for many valuable discussions, and also L. Ahrens for his comments.

Figure I: FFT of PUE Difference.

(trigger T = 1000 ms Inj Packet).

T = 1000

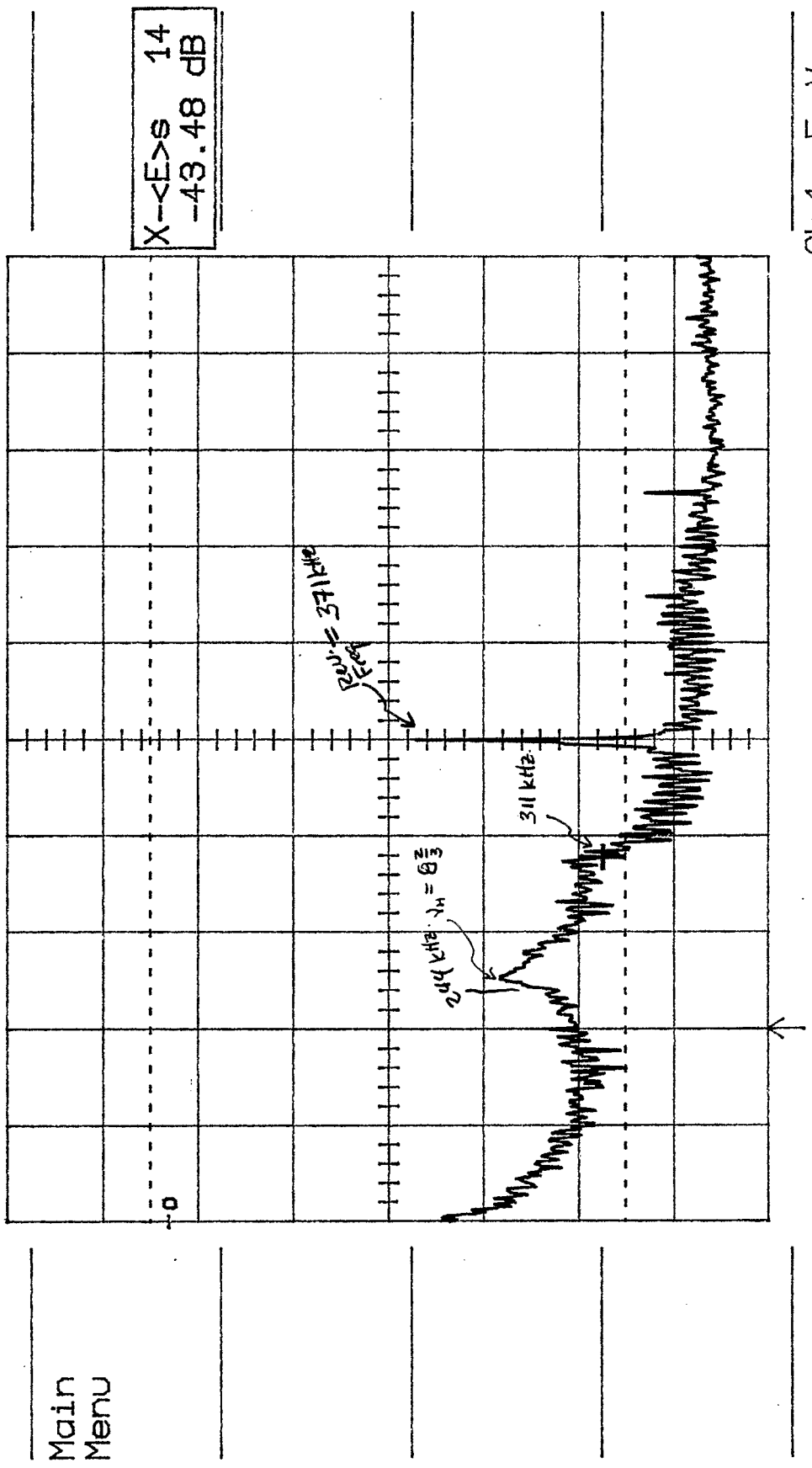

Figure II : FFT of PUE Difference.

(T = 1600 ms Inj. Peaker).

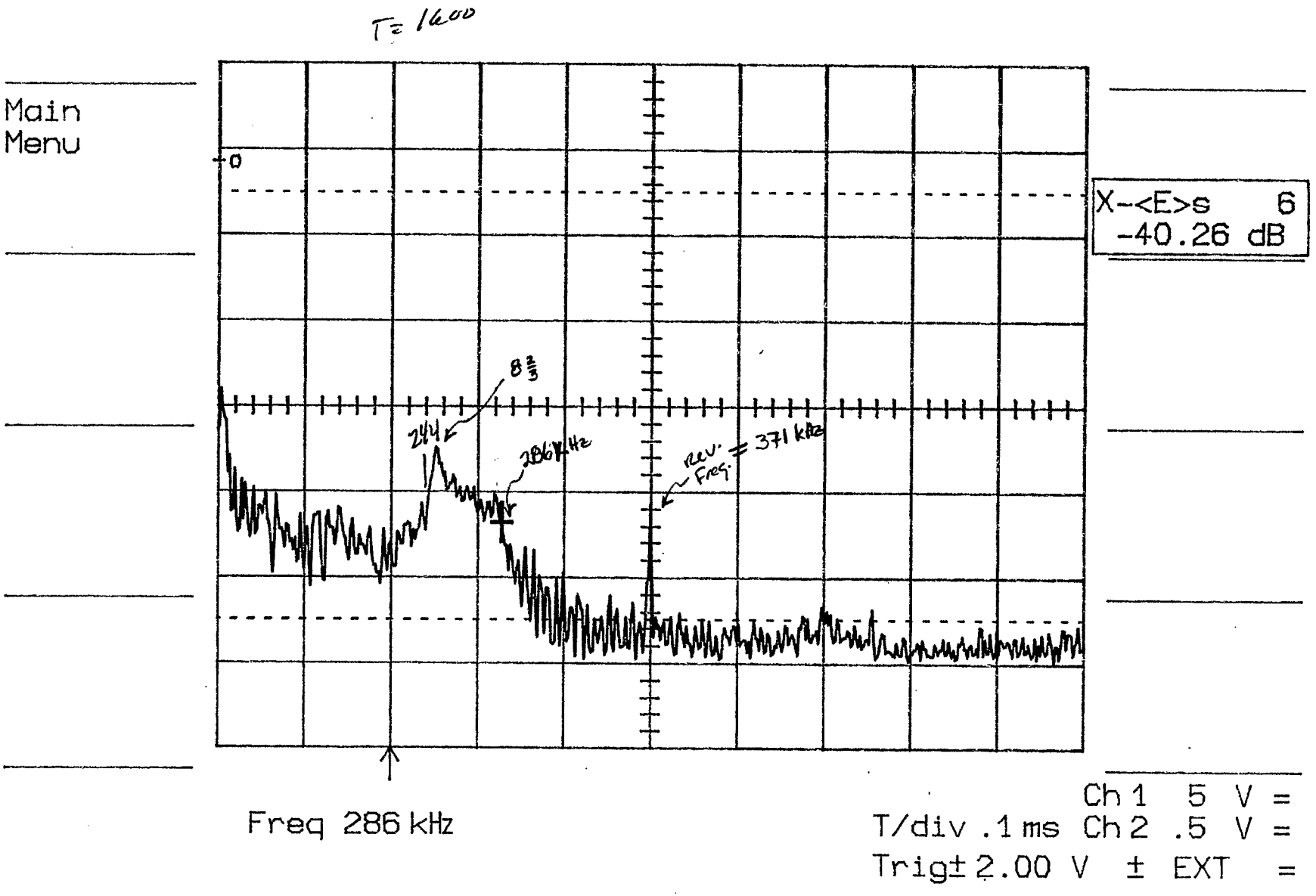

Figure III: FFT of PUE Difference
(T = 2600 ms Inj. Pacher).

T = 2600

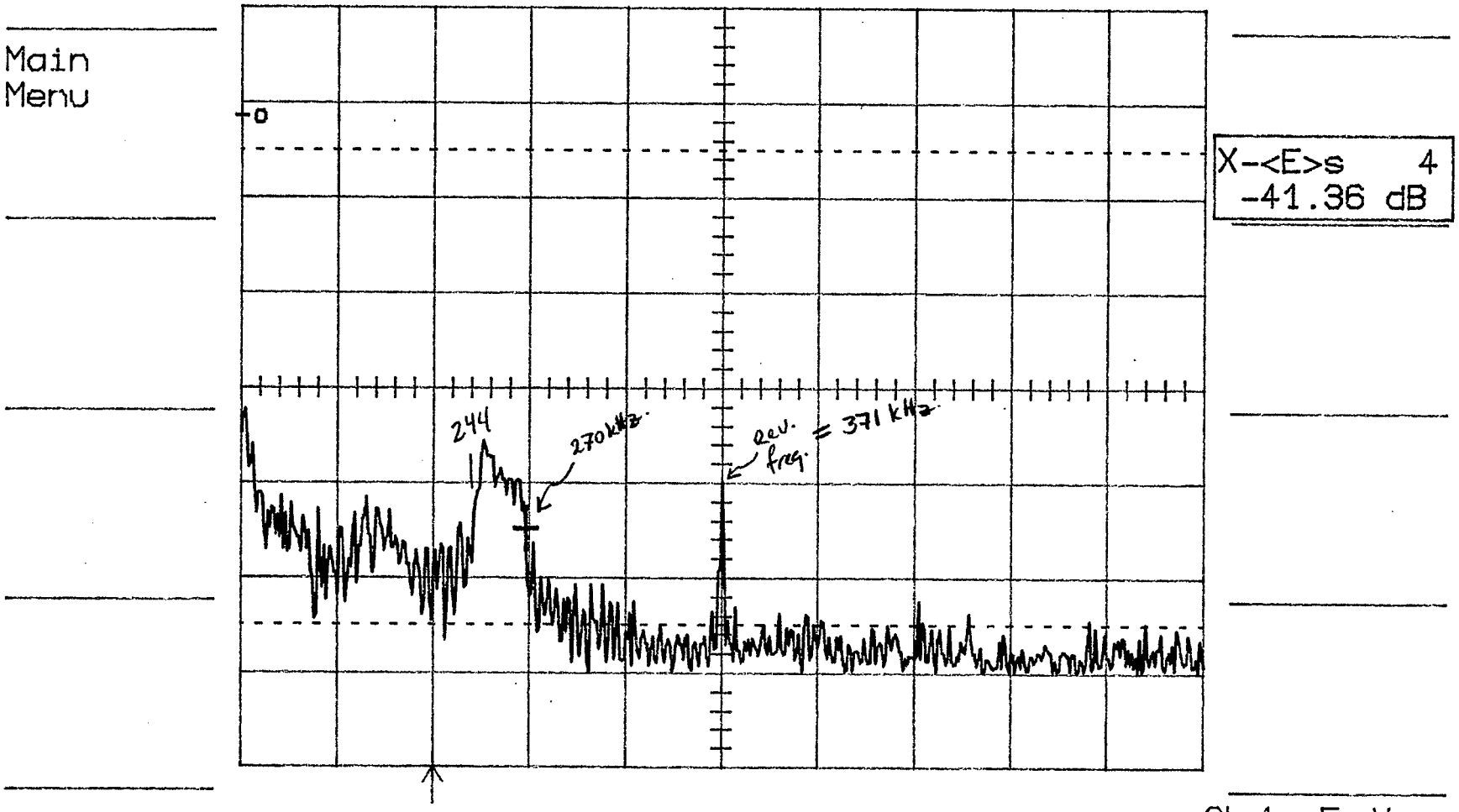

FIGURE IV: TUNE SPREAD THROUGH FLATTOP

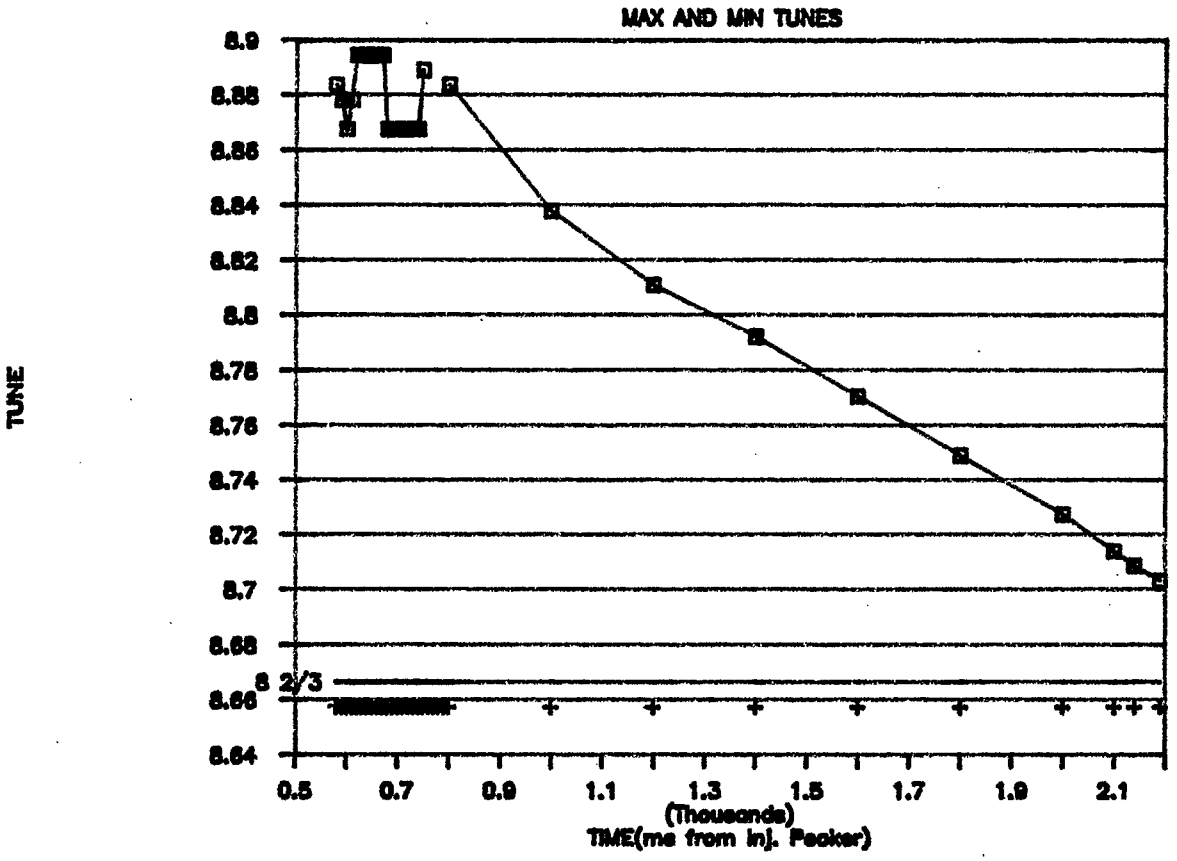

FIGURE V: TUNE SPREAD THROUGH FLATTOP

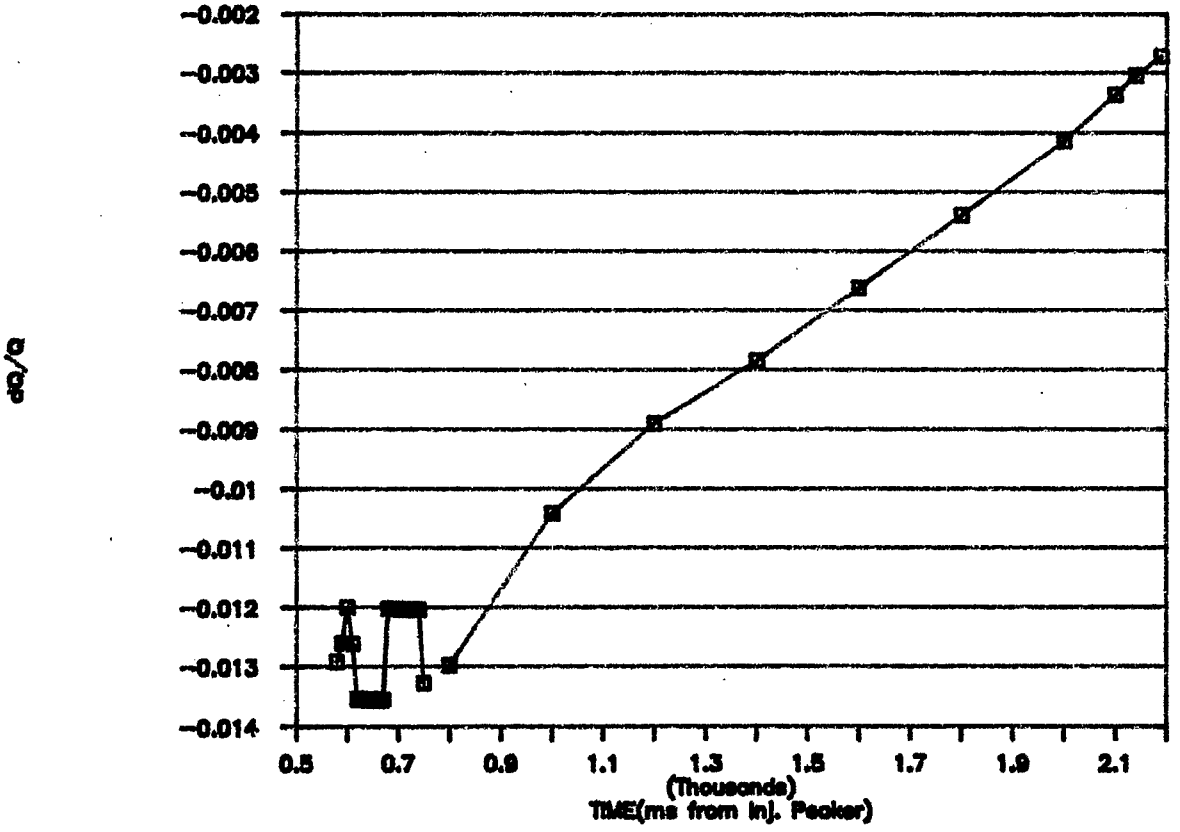

FIGURE VI: MOMENTUM SPREAD THROUGH

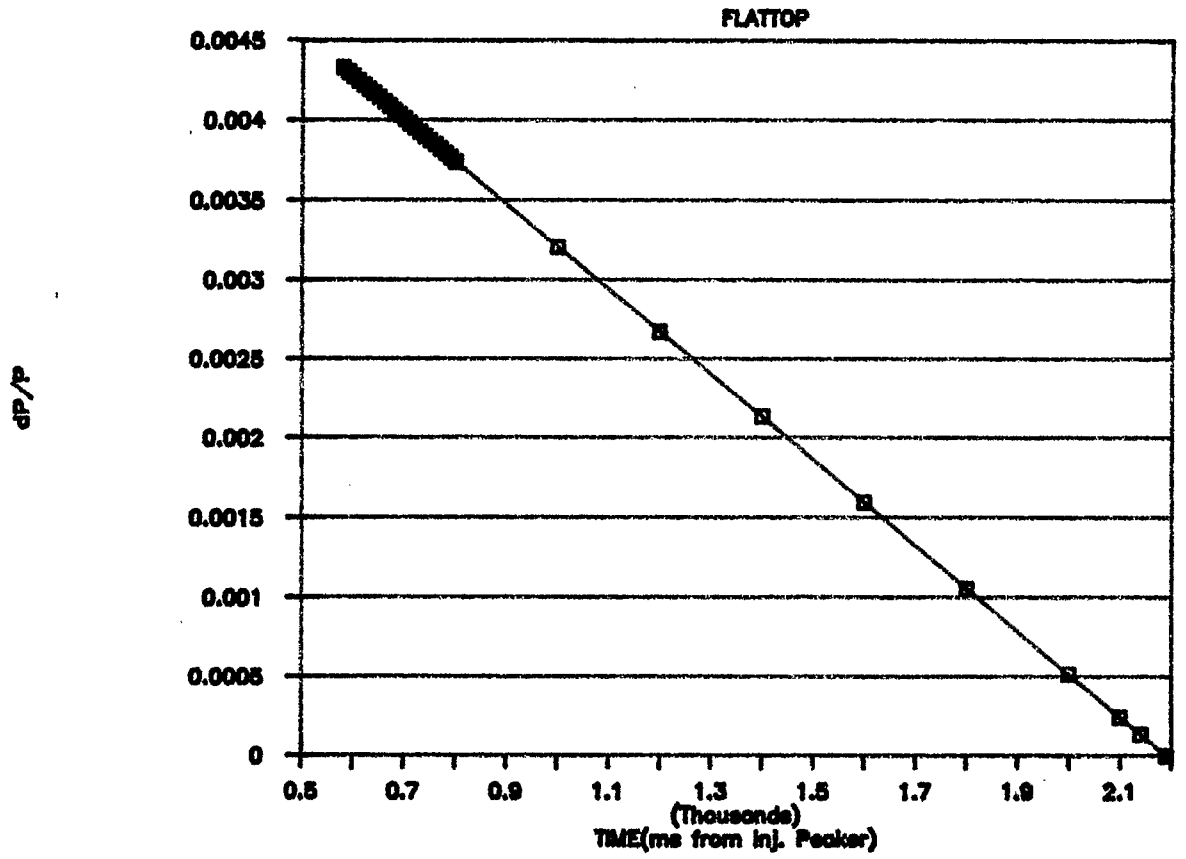

FIGURE VII:

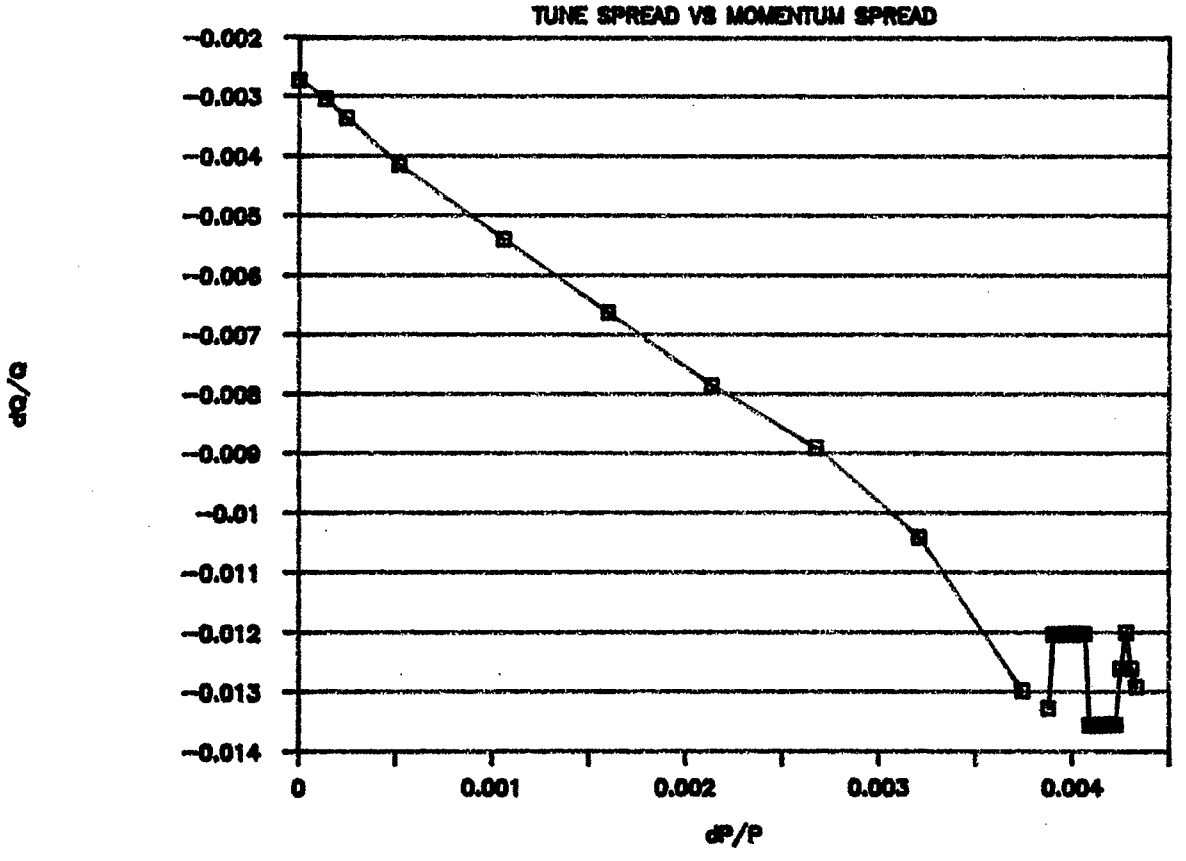

FIGURE VIII: CHROMATICITY

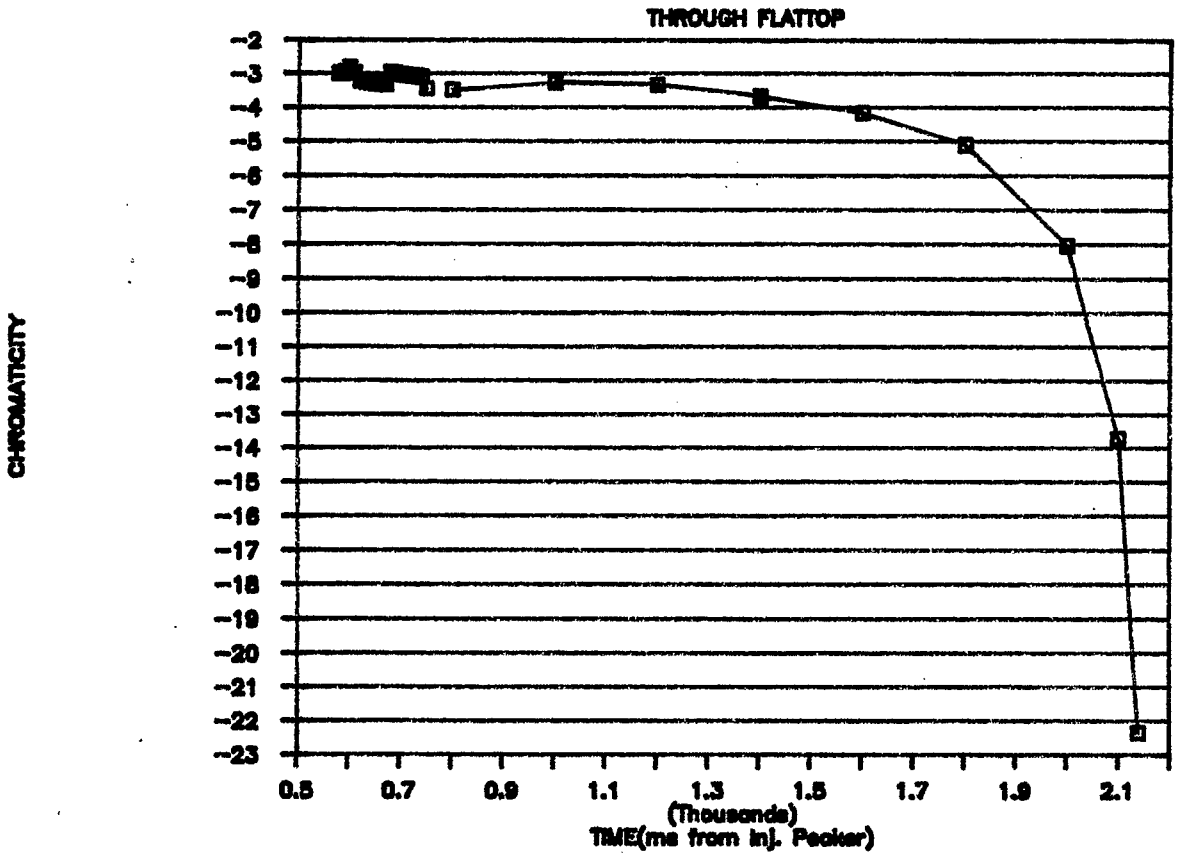

FIGURE IX: