E-6

ISR-OP/SM/ps *11th January 1977*

ISR PERFORMANCE REPORT

Runs 793P, 794P, 31.4 GeV/c, 26.6 GeV/c

Non-destructive working line measurement in a stack by placing markers on the Schottky scans

Summary

It is demonstrated that a complete measurement of the working line in the presence of a stack is possible if markers are placed on the stack by a phase displacement technique. The marker technique has apparently no adverse effects on the beam quality and causes no significant loss of beam current. The same technique may also be used simultaneously for a closed orbit measurement in the stack.

Introduction

The normal combination of the longitudinal and transverse Schottky equipment allows measurement of the radial positions and the Q values at the extrema of the stacked beams. Subsequent working line adjustment is usually based on a linear interpolation between these measured extreme points. This technique has on certain occasions led to beam loss due to local deviations of the Q' or Q" in the midst of the stack. Consequently a more complete working line measurement has been required for some time.

Method and Results

The marker technique is based on the fact that the amplitude of the longitudinal Schottky signal is proportional to the square root of the longitudinal density in the stack, whereas the amplitude of the transverse Schottky signal is proportional to the product of the square root of the density and the betatron amplitude at the same radial position. Hence if a localized density reduction is placed on the stack this should be apparent simultaneously on both the longitudinal and transverse scans and should therefore provide a measurement of the radial position and corresponding Q value of the density reduction. The density reduction is brought about by phase displacing (ref. Fig. 1) a proportion of the stack up to the required position of the marker. This technique of course increases the radial width of the stack by an amount proportional to the area of the phase displacing bucket. By phase displacing to lower momentum, the stack width is then increased solely at its low momentum end which is a long way from being the aperture limitation after removal of the injection equipment.

Since the markers are inserted on the stack by longitudinal fields there is no adverse effect on the transverse beam size.

This technique was first attempted at the end of run 793P just before dumping the beam. Five markers were successfully applied and the working line measured using the operational longitudinal and transverse Schottky scan. In run 794P, near the beginning of the run, three markers were placed on beam 1 and two markers on beam 2. Using these markers the working lines were subsequently measured, corrected and remeasured, all with accuracy of at least $\Delta Q = 0.001$. At the same time the closed orbit in the stack was successfully measured. Near the end of this same run four markers were placed on ring 1 and the working line was measured once more. As an example the results of these tests are shown in Fig. 2 and Fig. 3 and the measured points are shown in Fig. 4.

From these series of tests, as many as five markers may be placed on a stack, using RF parameters which increase the low momentum flank of the stack by as little as 1.5 mm, and apparently having no other adverse effect on the beam. These markers last for at least several hours and can be used for repeated working line manipulations during this time.

Conclusions

A technique now exists for making markers on the Schottky scans of a stack. The required radial position of these markers can be controlled very accurately and the Q values at the position of the markers can be evaluated with great accuracy. Such measurements, at the beginning of each physics run, will eliminate any doubts about local Q' deviations and allow accurate correction of the complete working line. The technique for making the features on the stack is harmless and could even be done during stable beams although this is not recommended. This technique will be implemented operationally as soon as possible.

S. Myers

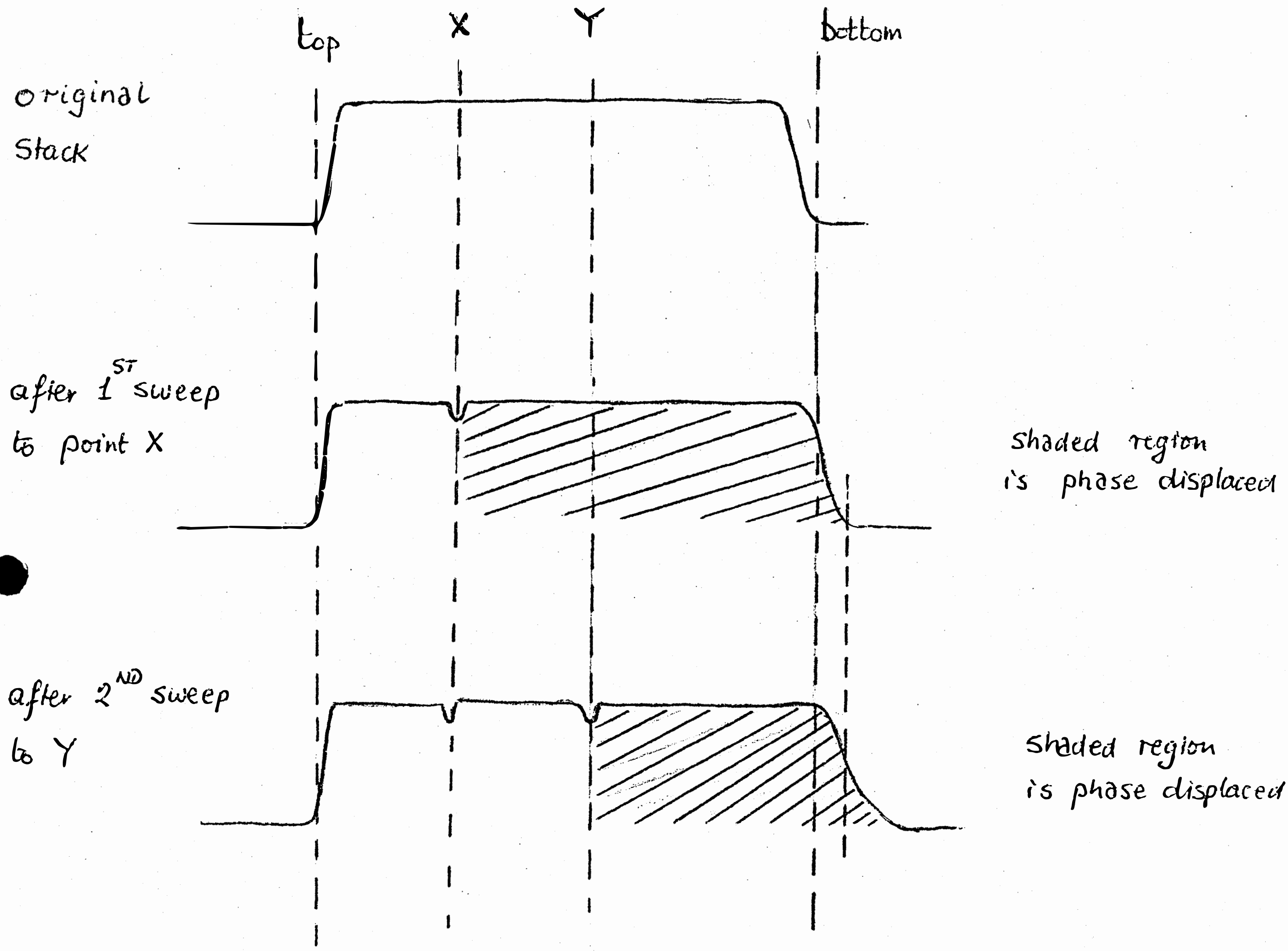
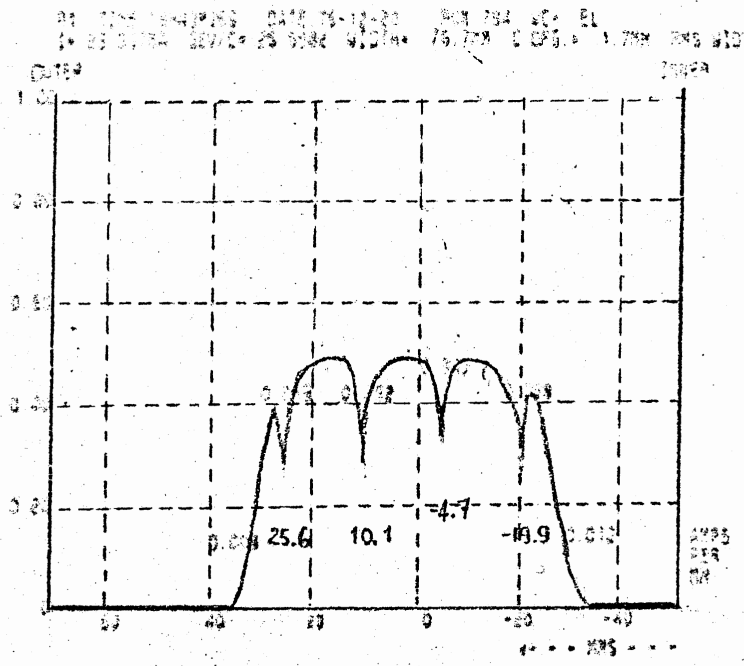


FIG. 1. LONGITUDINAL SCHOTTKY SCANS DURING MAKING OF MARKERS



N	MMS	A/MM	P 33.3	MMS	MMS -33.0	I	A/MM
1	35.3	0.003	27.2156				
2	33.0	0.012	26.2151				
3	25.6	0.293	27.0725				
4	10.1	0.292	26.8469				
5	-4.7	0.347	25.6287				
6	-19.9	0.298	26.4072				

FIG 2. LONGITUDINAL SCHOTTKY SCAN WITH 4 MARKERS

RUN 794, R1, 20.12.76 $I_1 = 25.997$ A

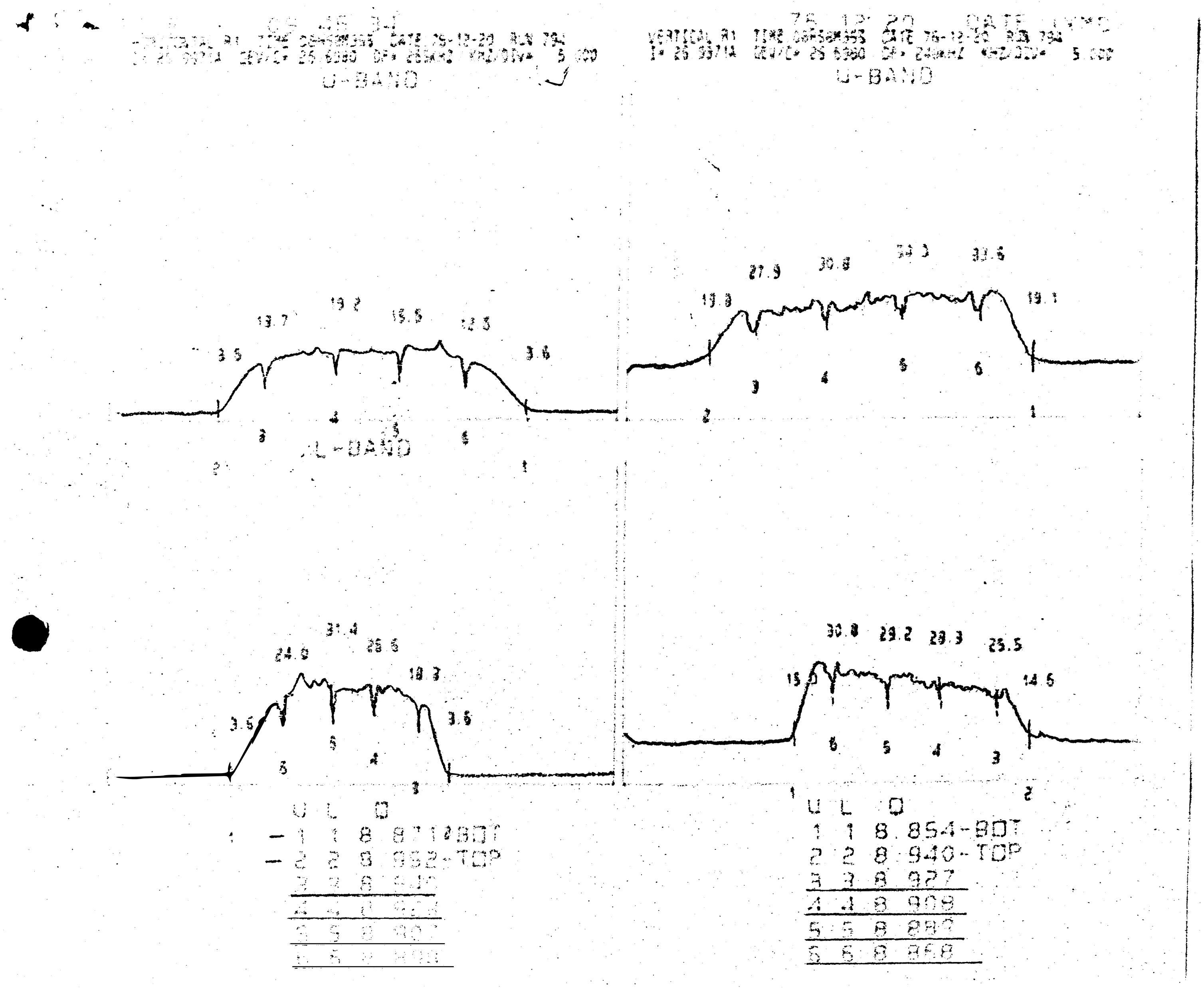


FIG. 3 TRANSVERSE SCHOTTKY SCANS WITH
4 MARKERS

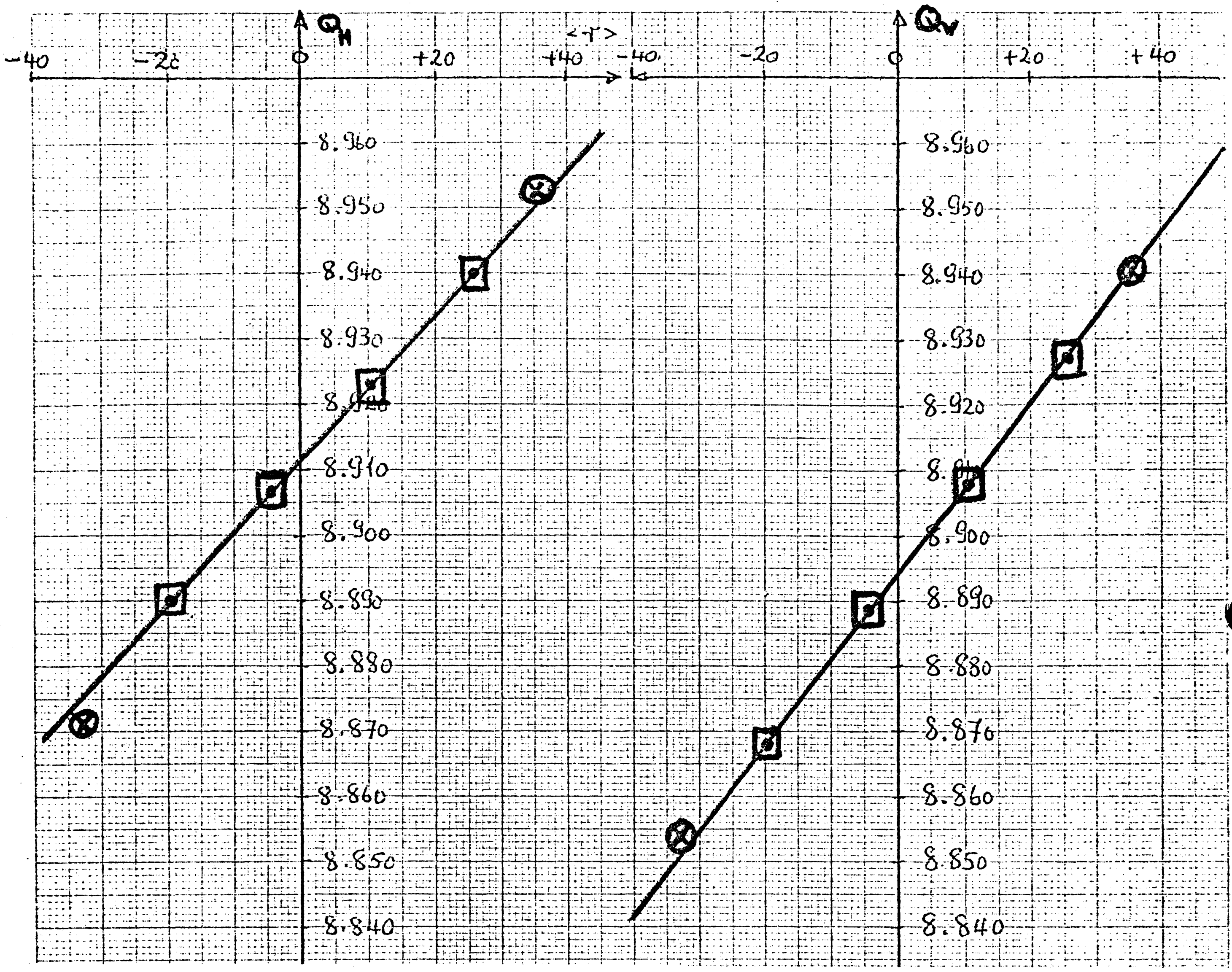


FIG. 4 Measured Working Lines Using Marker Technique

- ⊡ points measured using markers
- ⊗ " " " stack edges