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Fermilab

MEASUREMENT OF MOMENTUM DISTRIBUTION AT 400 GeV IN THE SPS

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February 15, 1979

By means of the Schottky scan,[1] the momentum distribution of the beam during the flattop at 400 GeV has been measured in the SPS. Since the signals to be analyzed are relatively small, a tuned-type pickup[2] with high sensitivity has been used for the measurement. The sensitivity is approximately 400 V/A at the resonance frequency of 1.15 GHz.

The signal from the pickup is converted to low frequency and it is analyzed by a conventional spectrum analyzer and/or by the computer NODAL. The processing system is shown in Fig. 1. The original signal at 1.15 GHz is converted to the first IF (200 MHz) by the microwave tuner (Watkins-Johnson WJ7380) which has a local oscillator of the frequency synthesizer type. This signal is then converted to the second IF (10.7 MHz) by a signal generator[3] (189.3 MHz) and a 200 MHz mixer (SPS standard module). The signal from the second IF is converted to low frequencies (1 to 5 kHz) with a crystal oscillator and a mixer. Finally, the low frequency signal is digitized and recorded by the computer controlled wave-form recorder (Biomation 8100). The power spectrum is computed by NODAL and is displayed on the CRT screen.

The momentum distribution of the beam during the slow extraction is shown in Fig. 2. The height of spectra depends not only on the beam intensity but also, to some extent, on the structure of the beam caused by instabilities during the debunching. On the other hand, the

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position and width of the spectra should correspond to the central momentum and the momentum spread, respectively. The resolution of this measurement is 4×10^{-5} in $\Delta p/p$. It is clear from the figure that the low momentum part of the beam is extracted first in this mode of slow extraction. The signal from the transverse pickup (directional coupler type) has also been analyzed for the measurement of the tune.

References:

1. J. Borer, et al., CERN Internal Report ISR-DI/RF/74-23.
2. T. Linnecar, CERN Internal Report SPS/ARF/78-17.
3. A crystal oscillator should be better for this.

Parameters of the SPS RF system

	10 GeV		400 GeV
Revolution Frequency	43.2 kHz		43.4 kHz
Accelerating Frequency	199.7 MHz		200.4 MHz
Harmonic Number		4620	
Transition Energy E_{t/E_o}		$\gamma_t \tilde{-} 24$	
Frequency Slip Factor	-0.0056		0.0017
Mean Orbit Radius		R=1100m	

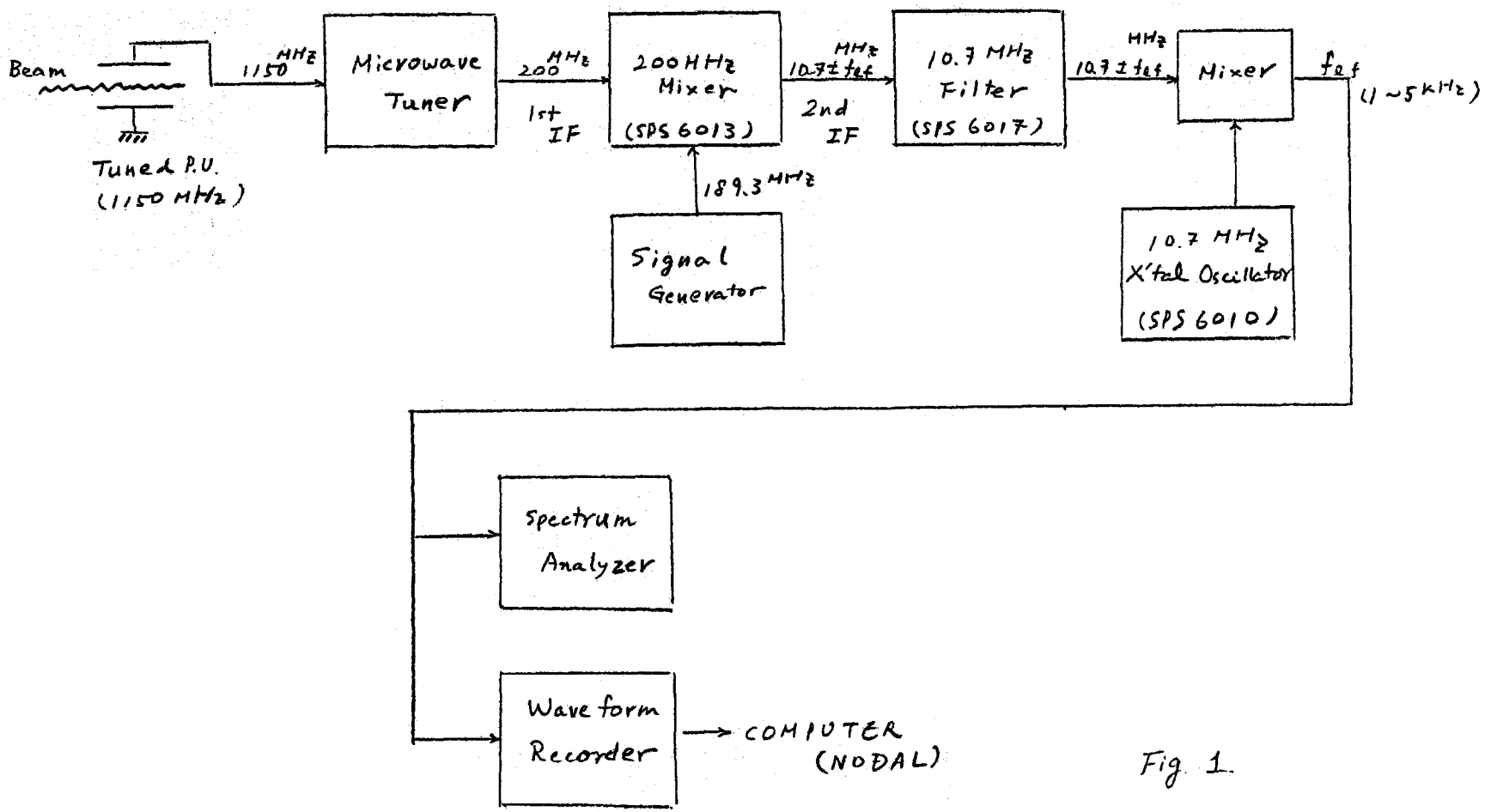
Beam
1150 MHz
Microwave Tuner
200 MHz
1st IF
200 MHz Mixer (SPS 6013)
10.7 ± f_ef MHz
2nd IF
10.7 MHz Filter (SPS 6017)
10.7 ± f_ef MHz
Mixer
f_ef
(1 ~ 5 KHz)
Tuned P.U. (1150 MHz)
189.3 MHz
Signal Generator
10.7 MHz X'tal Oscillator (SPS 6010)
Spectrum Analyzer
Wave form Recorder
COMPUTER (NODAL)

Fig. 1.

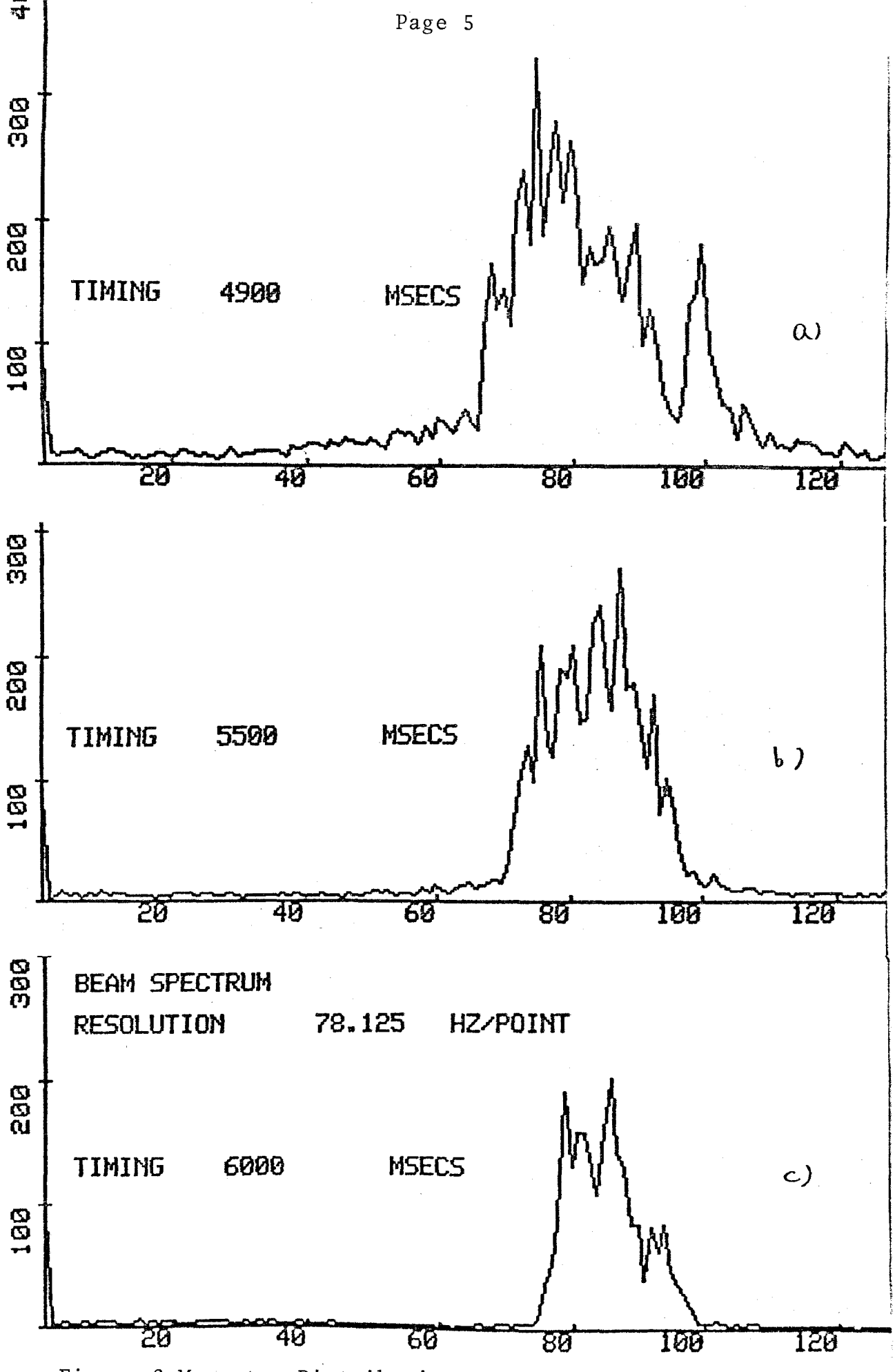

Figure 2 Momentum Distribution