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LEAR MD REPORT: BUNCHED BEAM SCHOTTKY SPECTRUM

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LEAR MD Report: Bunched Beam Schottky Spectrum

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1. Aim

The aim of the MD was to measure the bunch length and the bunch frequency spectrum as a function of intensity. Experiments on bunched beam cooling at Fermilab have in fact shown a frequency spectrum extending far beyond the "cut-off" $f_c=6/\Delta t$ (where Δt is the total bunch duration).

The proton beam from the linac was injected on the 309 GeV/c flat top. Electron cooling was used to provide a small bunch area and RF-voltages between 100 and 1000 V where applied at 1.19 MHz (h=1 at 309 MeV/c). The resulting bunch length was the equilibrium between intra beam scattering and cooling. The bunch length was observed with a digital scope from a wide band electrostatic pick-up and the bunch spectrum from frequency analysis of the signal from a Schottky pick-up. Below the "cut-off" the longitudinal current spectrum is given by the bunch signals {~N at low harmonics } and above by the Schottky signals { $\sim(N)^{1/2}$ at high harmonics nf_0}. Most measurements were made at 2 different intensities , 10^9 and 5 10^9 protons.

2. Results

Results are compiled in table 1. One notes that for the lower intensity the cut-off of the frequency spectrum is approximately at $f_c=6/\Delta t$, as expected for a smooth bunch. However at the higher intensity, the cut-off is considerably higher, indicating high frequency ripple on the bunch and or very sharp edges.

intensity N [p]	voltage V [Volt]	b. length Δt [ns]	cut-off f.. f_c [MHz]	length*cut-off f. $f_c * \Delta t$. [MHz*ns]
10^9	100	180	30	5.4
10^9	1000	80	100	8
5 10^9	100	450	40	18
5 10^9	200	300	70	21
5 10^9	1000	150	300	45

Table 1 : *Measured bunch length and cut-off frequency as function of intensity (rounded numbers). For a smooth bunch the product* $f_c * \Delta t$ *is about 6.*
