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2/18/92
PBAR NOTE 526

Recent measurement of Debuncher longitudinal
beam size during stacking

During the recent collider studies period there were a few time periods when 120 GeV beam was delivered with a slow repetition rate. This gave us a rare chance to study the effectiveness of additional cooling in the antiproton source.

The measurements shown below were taken on 1/15/92. Although we have several FFT analyzers connected to the debuncher schottkey monitor we cannot readout the measured spectrum except with a TV camera. The following measurements, therefore, were taken with a spectrum analyzer. It is necessary to use a resolution bandwidth of 100 HZ to see the effectiveness of the momentum cooling system, and therefore the sweep time was 3 seconds. It took about 1 hour to complete the series of measurements. The main ring performance was up to it's normal standards during this time period, but it's performance can vary greatly from on minute to the next.

The debuncher longitudinal schottkey spectra are shown in Figures 1-5 with different trigger times for the spectrum analyzer. These are shown using a scale linear in power, which should also be linear in particle density. There are two effects of momentum cooling that are apparent. 1) The momentum distribution after bunch rotation has very long non-gaussian tails, momentum cooling rapidly pushes these tails into the central peak. 2) The width of the central peak is gradually reduced, as is shown in Table I. The FWHM shown in TABLE I is at $h=127$, and the 95% dp/p is the full width in percent dp/p that contains 95% of the beam.

TABLE I

Width of central peak v.s. cooling time

Cooling time	FWHM in HZ	Full 95% dp/p
1.5	644 HZ	0.24%
3.5	492 HZ	0.18%
6.5	415 HZ	0.15%
9.5	376 HZ	0.14%
12.0	440 HZ	0.16%

Momentum cooling definitely helps reduce the momentum spread of the beam. Even 1.5 seconds of cooling gives a small enough momentum byte that the central peak should fit through the DTOA channel. It takes longer for the non-gaussian tails to be swept in.

As a check we can measure the momentum byte on the accumulator injection orbit during stacking. The measurement taken more than a week later on 1/26/92 is shown in Figure 6, and was obtained by turning off ARF1 during stacking. The FWHM of the central peak is 2839 HZ, which gives a 95% emittance of 0.26%. This is a little larger than is expected, which may indicate that bunch rotation was not as effective at that time.

In the future we hope to make similar measurements using a FFT analyzer and a special applications program. This should enable us to more accurately diagnose problems with bunch rotation.

Figure 1

PARTICLE DENSITY IN DEBUNCHER 0-3 SEC AFTER INJECTION

02/18/92 1047

Scale 10 dB/div

Atten 0 dB

Swp 3 sec

Vid BW 100 Hz

Res BW 100 Hz

Ref Lvl 15.85E-15

CONSOLE LOCATION 04, MCR-E2
Pbar SA Plot
18-FEB-1992 10:47

Start Freq 74.93259001 MHz

Stop Freq 74.93679001 MHz

FWHM = ~~570~~ Hz
647

Figure 2

PARTICLE DENSITY IN DEBUNCHER 2-4 SEC AFTER INJECTION

02/18/92 1049

Scale 10 dB/div

Atten 0 dB

Swp 3 sec

Vid BW 100 Hz

Res BW 100 Hz

Ref Lvl 15.85E-15

CONSOLE LOCATION 04, MCR-E2
Pbar SA Plot
18-FEB-1992 10:49

FWHM = 492 Hz

Start Freq 74.93259001 MHz

Stop Freq 74.93679001 MHz

Figure 3

PARTICLE DENSITY IN DEBUNCHER 5-8 SEC AFTER INJECTION

Start Freq 74.93259001 MHz

Stop Freq 74.93679001 MHz

02/18/92 1050

Scale 10 dB/div

Atten 0 dB

Swp 3 sec

Vid BW 100 Hz

Res BW 100 Hz

Ref Lvl 15.85E-15

FWHM = 415 Hz

CONSOLE LOCATION 04, MCR-E2
Pbar SA Plot
18-FEB-1992 10:50

Figure 4

PARTICLE DENSITY IN DEBUNCHER 8-11 SEC AFTER INJECTION

Start Freq 74.93259001 MHz

Stop Freq 74.93679001 MHz

02/18/92 1053

Scale 10 dB/div

Atten 0 dB

Swp 3 sec

Vid BW 100 Hz

Res BW 100 Hz

Ref Lvl 15.85E-15

FWHM = 376 Hz

CONSOLE LOCATION 04, MCR-E2 18-FEB-1992 10:53
Pbar SA Plot

FIGURE 5

PARTICLE DENSITY IN DEBUNCHER 10.5-13.5 SEC AFTER INJECTION

Start Freq 74.93259001 MHz

Stop Freq 74.93679001 MHz

02/18/92 1052

Scale 10 dB/div

Atten 0 dB

Swp 3 sec

Vid BW 100 Hz

Res BW 100 Hz

Ref Lvl 15.85E-15

FWHM = 440 Hz

CONSOLE LOCATION 04, MCR-E2
Pbar SA Plot
18-FEB-1992 10:52

Figure 6

PARTICLE DENSITY ON ACC INJ ORBIT DURING NORMAL STACKING

Start Freq 79.20922401 MHz

Stop Freq 79.22922401 MHz

02/18/92 1056

Scale 10 dB/div

Atten 10 dB

Swp .5 sec

Vid BW 3 KHz

Res BW 300 Hz

Ref Lvl 6.651E-15

VID AVG

FWHM = 2839 Hz

CONSOLE LOCATION 04, MCR-E2 18-FEB-1992 10:56
Pbar SA Plot

BEAM ON INJECTION ORBIT - NORMAL STACKING D:FFTEFF=70.5%

01/26/92 1523

Scale 5 dB/div

Atten 10 dB

Swp .5 sec

Vid BW 3 KHz

Res BW 300 Hz

Ref Lvl -60 dB

VID AVG

Start Freq 79.20922401 MHz

Stop Freq 79.22922401 MHz