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AA - ME -NEWS

SUMMARY OF PERIOD 4 : 3 AUGUST TO 21 SEPTEMBER 1982

INTRODUCTION

The period followed the long summer shutdown and it is worth recalling the major activities in that shutdown which were to :

- Strengthen shielding wall around the injection line and the ring.

- Let the second half of the ring up to air to remove tanks, search for obstacles, reassemble, bake out and pump down.

- Modify the four stack-tail pick-up tanks 17-20 to install cryocooling systems for the amplifiers and their load resistors.

- Dismantle the precooling kicker tanks in 16 to fit new pivots.

- Replace several hundred flexible hoses on the magnet manifolds with stronger hoses.

- Install the remaining half of the remote motor driven quadrupole jacks.

This activity was completed on time and the machine came up without a problem. We used reverse magnet polarity and protons round the loop to set up. There was inevitably some adjustment of the vertical orbit with the motorised jacks and some power supply tuning to be done and it took a couple of days to be sure that the optics and the cooling systems were properly tuned. Then followed a further ten days of Machine Experiments before the accumulation , first to LEAR and then to the SPS, which occupied the second half of the period.

The first of the the three ME sessions in this ten day period was dedicated to experiments with proton stacks . In the second session we reverted to normal polarity and p-bar production and indulged in tests of long term hopes such as new horns and the conducting target. Finally we went back to reverse polarity to study the low frequency cooling systems and particularly the stack-tail.

THE BUMP IN QFW6

In the last period a horizontal orbit bump of 12 mm. had been applied in QFW6 to center the stack in the HF pick up. This was causing the beam to ride close to the chamber wall elsewhere and we decided to reduce it to 6mm. The first iteration of the procedure for moving quadrupoles to change the bump gave a value within 1mm. of the prediction and we checked that HF cooling was not adversely affected. We still do not know the reason for this bump.

COOLING ON A COUPLING RESONANCE

This experiment was prompted by the idea of using a single transverse cooling system to cool both transverse phase planes. This might have implications in designing a new accumulator. The experiment consisted of deliberately dilating a cooled stack of 2E11 protons in both trasverse phase planes and then tuning the machine to the coupling resonance, QH=QV. We could clearly see that the beam was coupled from the transverse Schottky sidebands. The vertical stack cooling was then switched on and the horizontal and vertical betatron sidebands observed. The result was consistent with what one might naively expect. The two sidebands shrank at about the same rate, which was half the rate under normal circumstances.More details are in ME/Note 46.

MICROWAVES IN THE STACK TAIL PICK-UPS

For some time we have realised that the stack tail system disturbs the high frequency stack cooling system. The intense stack signals are perhaps exciting the stack-tail amplifiers. In theory this should not happen because there are compensating electrodes in the stack tail kickers, shorter but closer to the stack than the main electrodes. These are balanced to cancel the effect of the stack frequency. In this experiment it was found that the compensation signal showed a very ragged response in the 250 to 500 MHZ spactrum to a beam of protons on the stack orbit. At other positions the response was smoother and tha compensation much better. The source of the trouble is thought to be microwave signals which propagate in the chamber and dominate the response when the beam is on the stack orbit. It is not yet understood haw to solve this problem and until it is solved we are forced to cool without stacking for an hour or two before transfer.

COOLING RATES FOR A BAND OF FREQUENCIES

Using a new experimental technique a stack of 2E11 protons was smeared out in momentum corresponding to a frequency spectrum of 2.5 kHz. This covers more than the frequency region of the stack over which transverse cooling is effective. The betatron sidebands seen by the HF transverse cooling systems are also smeared out and as the transverse cooling systems do their work one can see the spectrum falling at those frequencies where they are most effective. It seems that the horizontal transvese cooling is well centered on the stack but that the low frequency end of the vertical cooling is ineffective. The frequency spectrum was calibrated with an empty bucket.

CONDUCTING TARGET

One of the most fashionable means to collect more antiprotons at the moment seems to be to pass a current equal to that in the horn through the target itself. This is calculated to reduce the depth of focus of the target to a disc at its end. It is a relatively simple matter to make the electrical connections but of course the apparant source is moved 10 cm towards the horn - a highly non-optimum configuration. Nevertheless it seemed a good idea to pulse the target in the beam if only to find if the combined thermal shocks destroyed it. This was done in an experiment in which, after carefully optimising the yield, only the target-horn assembly was exchanged and hands were kept away from other knobs.

The horn-target reached full excitation but not without a brazed joint giving trouble which produced sparking. We now know how this joint problem can be avoided and we are looking forward to tests in the new year with a more robust target in an optimum position. Our predictions for yield for a normal target give 10 to 15% more yield than we find. For the pulsed target in this unfavourable geometry the disagreement was more like 30%. The yield was no higher than normal but we only expected a rise of 15% for this geometry. Theory suggests there is quite a lot more to be gained when we get the geometry right and solve the engineering problems of the thermal shock.

MEASUREMENTS OF PRODUCTION ON RE-ENTRANT HORN

There had been difficulties in the technique for making horns of the new re-entrant type and more refined calculations began to suggest the gain might not be as great as had been thought at first. Although none of the horns so far produced seemed robust enough to stand 100,000 pulses it seemed prudent to try one out and find the yield before further time and effort were invested. Single pulse yields were measured with this horn in place and plotted as a function of current.The results were inconclusive and not encouraging. The new horn gave 5+or-5% improvement when swapped for the old one in a hands-off test. We shall continue to look at ways of making new horns but with low priority.

MASUREMENT OF TRANSVERSE INJECTED P-BAR DISTRIBUTIONS

We are now able to measure the horizontal and vertical projection of a single injected pulse of antiprotons. This is thanks to a new technique in which scrapers are driven in at a constant rate while the secondaries produced are counted with a simple array of scintillators. Profiles are reconstructed with our on-line microcomputer system.

The first surprise is that the distributions are very lean in high amplitude anti-protons. One expects the distribution versus amplitude to be a right angle triangle, its hypotenuse rising steadily from zero amplitude to peak at about 28mm. The measured profile starts to rise but turns over at 15mm to fall to zero at 28 mm. Much of the large amplitude distribution is missing although clearly some particles can exist there.

We find that a triangular distribution extending to a more modest amplitude can be produced by scraping and this does not degrade but all attempts to put particles in the high amplitude part of the distribution by kicking fail. It is as if the vacuum chamber were an ellipse and not a square.

We intend to follow up glimpse of where antiprotons are lost by experiments to identify the cause. Three possible causes have been suggested. Either there is a hair or other obstacle obscuring a corner of the chamber, or non linear betatron coupling is making an equivalent obstruction or, finally, the injection kicker might have stray fields which deflected the "corner" particles into the vacuum chamber.

INTENSITY LIMITS TO THE STACK-TAIL SYSTEM

The ability of the stack tail cooling system to cope with the design intensity can only be tested with protons and with the AA polarity reversed. The injection line was detuned to inject only a weak pulse of protons, somewhat above the design intensity of 2.5E7 per shot. There was no need to precool and the protons were deposited directly into the stack tail using the normal RF program but with a bucket size reduced from the operational 625 HZ to the design value of 340 HZ. We were short of a good intensity monitor for the deposited protons but conditions were such that a calibration of the single shot deposited intensity versus the injection line current transformer seemed to be stable. We compared the rate of accumulation with this deposit rate integrated over 50 pulses once equilibrium had been established in the tail of a stack of about 2E11 protons.

The results were encouraging in that when an intensity 40% above the design value per shot was allowed to cool in the tail for 10.5 seconds, 84% of the protons were absorbed into the stack. On the other hand, when a more realistic cooling time of 1.9s. per shot was used, the efficiency of the stack tail absorbtion dropped to 35%. At the moment, even with the much lower p-bar rate encountered in normal operation, we are forced by the inefficiency of precooling to use a large 625 Hz bucket for the deposit. Testing this bucket we found that although the deposited protons went up, the number being stacked went down to 1.0E7. The lost particles are being phase displaced back into the shutters as they close on the next pulse and we must improve the stack-tail system if it is to absorb these particles before the next pulse comes along. We must also greatly improve the stack tail system whose inefficiency drives us to use the larger bucket. See ME/Note 41 for further details.

USE OF COHERENT ELECTRON INJECTION OSCILLATION IN SETTING-UP

Thanks to particle counters linked to a microprocessor we are able to view the time variation of electrons which come in with the anti-protons but which spiral into our counters. This structure reflects their initial coherent betatron oscillations and, we think, that of the antiprotons. The phase and amplitude of the coherent oscillation can be distentangled with an on-line fast fourier transform to give us our first diagnostic signal to indicate injection steering during accumulation.

We compared the amplitude of this signal with p-bar yield during a scan of septum current and found excellent agreement showing that injection steering is indeed important and can now be checked.

ORBITS FOR P AND P-BAR

We are able to measure the closed orbit with a bunched P-bar beam although the opportunity to do so does not often occur. For the record, we are able to confirm that the closed orbits for a given RF frequency are the same as for protons to 1 mm.

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