P-907 Beam requests

As requested in the letter from Mike Witherell, dated Jul 21,2000, we present here a discussion on the proposed beam time requests for P-907.

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Introduction

In the proposal we submitted to the June 2000 PAC, we have made the following requests for beam time. 3.3 data points for NUMI low energy , 6 data points for liquid hydrogen targets, 6 data points for atmospheric neutrino measurements, 10 data points for p-Nucleus measurements and another 3.3 data points for a second medium energy NUMI target., making a total of 26.6 data points. Each data point consists of 3 million events and will be acquired in a period of 126 hours. This assumes a TPC data taking rate of 60Hz, a factor of 3 in duty factor (1 year $=10^7$ sec) and a 1 second slow spill from the Main Injector every 3 seconds. It is this latter assumption that was at the cause of the problems since it implied that the rate of anti-proton production would have to be halved, if nothing was done to the spill structure, since the spill structure implied fast extracting a single booster batch for anti-proton production at the beginning of the slow spill and using the remaining booster batches for the 1 second slow spill. This implies 1 anti-proton booster batch every 3 seconds as opposed to 1 every 1.467 sec as would be the case in the pure anti-proton mode.

Remedy

The amount of beam requested by P-907 ranges from 10^9 protons per second to 10^{11} protons per second. The average booster batch in the Main Injector has $5x10^{12}$ protons. The beam request for P-907 is $2x10^{-4}$ to $2x10^{-2}$ of a single booster batch. We propose a new spill structure, called the “double slow spill”, whereby we inject two booster batches to the Main Injector and deliver one of the booster batches to anti-proton production as before. We then put the second booster batch close to the slow spill half integer resonance and extract a small fraction of the beam (< 10%) to Meson in a time period of ~1.1 seconds. At the end of this slow spill, the tune of the Main Injector is set back to normal . The crucial point is whether the emittance of the beam returns to what it was before the slow spill. In the accompanying note entitled “A scheme to extract a low intensity slow spill Main Injector beam to the meson area without compromising antiproton production rate”, we show both by the Main Injector Simulation program and also by actual Main Injector data that the beam returns to the emittance it had before the slow extraction, when the resonance producing quadrupoles are switched off. The beam is then fast extracted to anti-proton production yielding 2 anti-proton production shots in a period of ~3secs, preserving the anti-proton rate and the duty factor at P-907.

The power consumption with the “double slow spill” is slightly higher than the single slow spill of the Main Injector proposal, due to the slightly longer flat-top. We thus propose to mix pure anti-proton production shots with the “double slow spill” in a one to one ratio. This is Option 11 in Table 1 of the accompanying note. In this mode, the anti-proton production rate is the same as before and the amount of beam delivered to Meson is 76% of what it was before. This would require a running period of 6.6 months to complete the requested P-907 data acquisition as opposed to 5 months as in the proposal.

Time Period for P-907 data taking

It should be pointed out that the slow-spill schemes necessary for fixed target data taking at the Meson area are incompatible with MINOS running, which requires a fast extraction of a single booster batch to anti-proton followed by fast extraction of 5 booster batches to the NUMI target. This spill cycle takes 1.87 seconds, leading to a reduction of 20% in the pbar production rates. It is thus advisable to finish P-907 data taking before MINOS starts up (end of 2003). This is possible, if we set up the experiment in 2001 and acquire data in 2002 and the first half of 2003. It is possible run simultaneously with MINOS by modifying the spill cycle further to accommodate MINOS using a triple spill scheme as outlined in the note.