Comparing the K500 beam pulser and phase shifter: A timing study

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There are currently two methods to turn off the beam on the K500 on a "fast" time scale in real time during data taking. The beam pulser consists of two plates located on the injection line just downstream of the ECR ion source. An electrical field is applied to divert the beam from the cyclotron. The time of the beam to turn off at the target is limited by the time it takes for the remaining beam after the plates to cycle through the cyclotron and travel to the cave. The phase shifter, in contrast, changes the phase of the cyclotron, causing the beam to be stopped within the cyclotron. The limiting factor is the time needed to change the phase of the cyclotron.

The time required to turn off the beam is of great concern for NIMROD experiments. The free neutron multiplicity is measured using the neutron ball detector [1] through neutron capture on Gd. Scalers are used to measure the number of hits within 2 consecutive 100 μs gates. As soon as the data acquisition is triggered, a signal is sent to turn the beam off to mitigate the background rate during the capture time of the neutron ball. The beam must be turned off as quickly as possible to ensure a free neutron multiplicity measurement with minimum contamination from background.

A Si detector was placed at directly in the beam in the NuStars chamber. The computer was triggered using the Si signal. The RF signal was input into a scaler to create a clock. This scaler was cleared at the same time that the signal was sent to turn the beam off. The beam was turned on for 30 ms and then turned off for 30 ms. The RF frequency was multiplied by the scaler value to obtain the time of further hits in the Si detector.

The results are shown in Fig. 1. The beam pulser (left side) turns off within 50 μs and the phase shifter (right) turns off within 100 μs. The first peak appears in at 20 μs due to VME timing, which

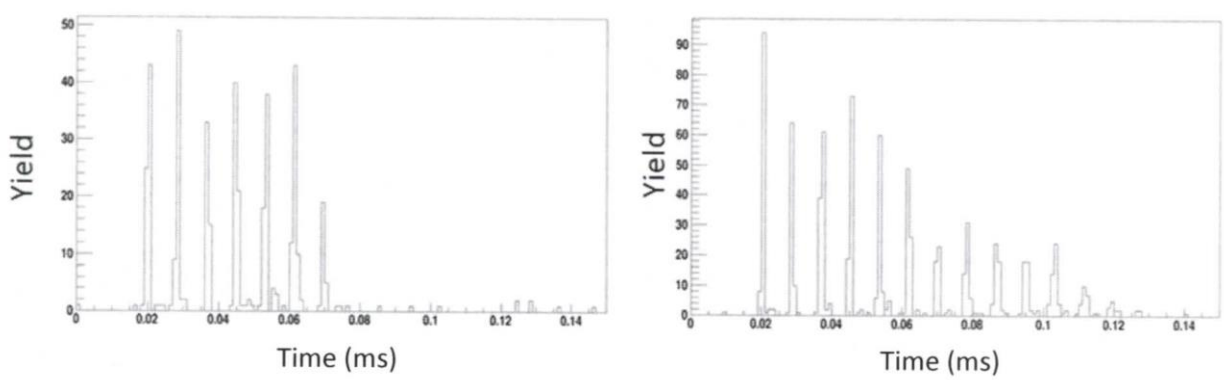

FIG. 1. Timing of the beam pulser (left) and the phase shifter (right). The timing is plotted in microseconds. The beam pulser turns off in 40 μs with some beam leaking through up to 50 μs . The phase shifter turns out within 100 μs with most turning off within 80 μs. The first peak comes in 20 μs late due to VME dead times. The 7 μs interval between peaks also corresponds to VME read out time.

correlates to the last peak coming 20 μs later than the actual value. Most of the beam is absent within 40 μs for the beam pulser with a small amount of beam leaking in up to 10 μs later. The phase shifter turns off within 80 μs with some beam leaking in up to 100 μs. The 7 μs spacing between peaks is due to

VME read-out timing. The percentage of beam leaking through after the beam has been completely turned off was not tested in this experiment due to threshold changes between measurements and the amount of noise was not quantified.