INVESTIGATION OF THE PCT PERFORMANCE DURING CE-25

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CE-25, an investigation of the ^{3}He wave function by quasi-free scattering, was completed last year.[1] During the experiment the PCT, a non-destructive beam current transducer,[2] was used to monitor the stored beam current in the Cooler. This device is now available to all Cooler experiments, so a report on its performance should be of general interest. More details are contained in an IUCF internal report.[3] The PCT is designed to provide pulses with a frequency proportional to the beam current with a full scale of 500 KHz for 10 mA of beam. In CE-25 approximately 100 μA of beam was accumulated during a 1-2 minute interval. Data were then taken during 7-17 minute long flat tops. Before the end of the cycle, the beam was killed by inserting a skimmer target allowing us to measure the DC offset with no beam while the ring was still at operating conditions. A typical PCT spectrum is presented in Fig. 1.

Initially, the beam is injected into the ring and the stored beam intensity increases with time until it reaches a maximum value during the energy ramping. Then the beam intensity decreases due to its interaction with the target gas. This portion of the PCT typically has the form of an exponentially decaying curve.

Superimposed on this exponentially decaying spectrum is a non-continuous component that consists of a discrete number of 20 μA calibration pulses (10 s long in the spectrum shown) whose length and number were varied to match the running conditions. These pulses were used for the determination of the PCT calibration constant which is required in order to convert the number of counts in the PCT spectrum to charge. When the beam

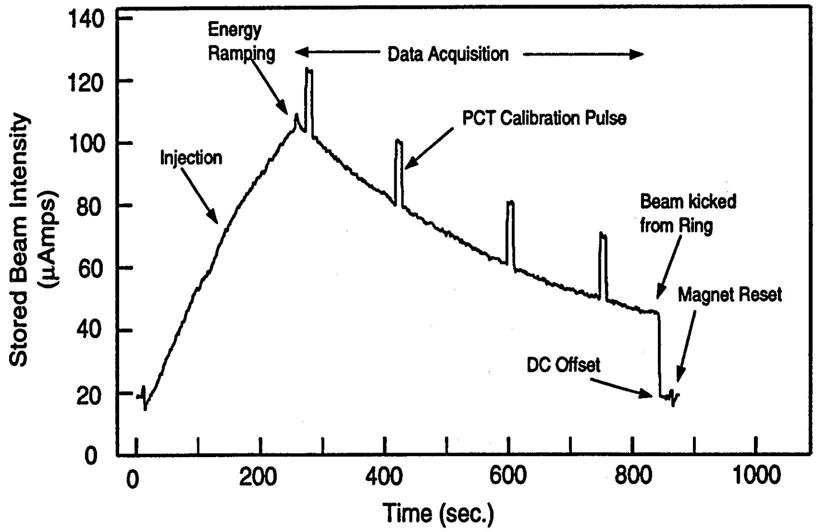

Figure 1. Stored beam intensity from injection time, when the beam starts to accumulate in the ring, until the magnet reset time, when the beam has been kicked from the ring.

is finally kicked from the ring, the beam intensity is seen to decrease abruptly to a non-zero value. This value, the DC offset of the PCT, is due to the instrument itself and varies with time, so it has to be measured at the end of each cycle.

The information from the PCT and the clock were read by the computer every 0.1 s, and the corresponding spectra were then incremented. At the end of each cycle, these spectra were fed to a FORTRAN subroutine which calculated the average number of counts in the DC offset region and subtracted it from the PCT spectrum. Afterwards, the subroutine fitted an exponential function to a short time period before and after each calibration pulse. This period was usually 16 s long, equally split before and after the calibration pulse. Subtraction of this fitted exponential spectrum from the offset subtracted PCT gave the area under each calibration pulse. Since the calibration current was known, a calibration constant could be calculated for each pulse. At times this analysis was complicated because of the presence of beam losses in the PCT spectrum. These were identified as 'monotonic' changes in the PCT spectrum with a magnitude larger than 200 counts. When such a beam loss occurred close to a calibration pulse, the subroutine adjusted the time period for the exponential fit so as to exclude the beam loss from it. The results from the PCT analysis are shown in Figs. 2-3.

Figure 2 shows the calibration constant versus the cycle number for each calibration pulse. There are changes from one cycle to another, but they seem to be statistical in nature. For the particular sample used, the calibration constant has a mean value of 0.01975 μCb/count with a standard deviation $\sigma = 0.00018$, which is close to what would be expected from the noise limit – quoted in the specifications as 0.4 μA rms in a 1 s measurement. There is no evidence for a long term drift. The data shown represent 55 hours of data acquisition taken during a five day period.

On the other hand, the DC offset varies in a non-statistical way. Figure 3 reveals that the change of the DC offset with time follows a continuous drift, thus allowing one to extrapolate its value for a given cycle from the values it took during previous cycles. The

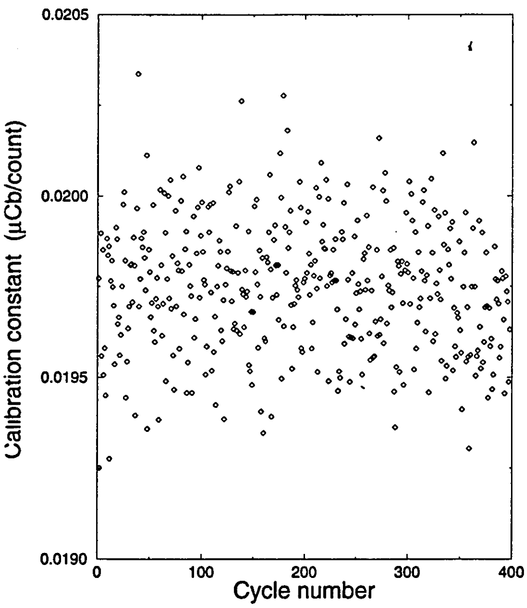

Figure 2. Calibration constant vs. cycle number. The data points shown in the plot represent 55 hours of data acquisition during a five day period.

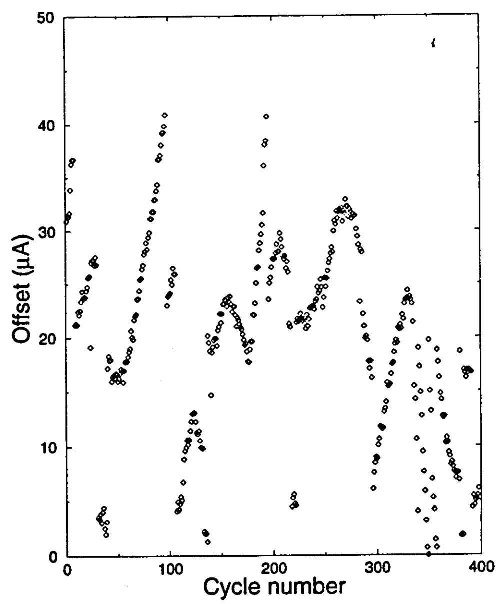

Figure 3. PCT offset versus cycle number. The data show the drift of the DC offset with time. They cover 123 hours of data acquisition.

data shown cover a time period of 123 hours. A typical drift rate was 2.33 μA/hr. Later measurements revealed that the cause for this drift was temperature fluctuations. There are plans under way to address this problem. We also investigated the linearity of the PCT over the range 10 μA-150μA of beam currents. This was done by looking for a dependence in the calibration peak versus current and offset. We have found no evidence for a non-linearity in the above-mentioned current region. As a further check on its operation the luminosity, as determined from the target pressure and the PCT, agreed to 1% with the luminosity monitor detectors.

The PCT is now an operational device. The calibration and offset can be monitored fairly easily in an experiment. Efforts to stabilize its temperature should eliminate the DC offset drift.

1. C.E. Jones, *et al.*, contribution to this report.
2. K. Unser, IEEE Trans. Nucl. Sci. **28**, 2344 (1981).
3. Internal report I-605, February, 1994.