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RECORDING PEP2 RING BEAM LOSSES AT SLAC*

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ABSTRACT

The PEP2 (e+)(e-) storage rings contain many complex interrelated systems. When the beam aborts, examining a record of the orbit from the time just before the abort can help identify the root cause. At the Stanford Linear Accelerator Center (SLAC) a system has been developed to continuously record beam orbits from Beam Position Monitors (BPMS) into a circular buffer. When the beam is aborted the buffers are frozen and their contents are stored for later analysis. BPM orbits are saved on a turn by turn basis for 2800 turns in both the high energy ring (HER) and the low energy ring (LER). Each BPM Processor (BPMP) can either monitor the HER or the LER, but not both as the readout of the two rings is multiplexed into a single readout channel. Tools exist as part of the SLAC Control Program (SCP) to collect, display, and save the data. A physicist or operator can choose a few BPMS in which to view all 2800 turns to identify the turn in which the beam went awry; then ask for that specific orbit from all of the BPMS in the storage ring to determine the root cause of the abort.

INTRODUCTION

Based on observing plots of BPM position versus turn number, or viewing the Power Density Spectrum versus Frequency, which employs a Fast Fourier Transformation, the PEP2 operations staff can quickly and easily determine the root cause of an abort of the PEP2 ring in order to contact the appropriate expert to get the problem fixed if the plots show a pattern they recognize. Easily recognized patterns include problems with the longitudinal feedback, the transverse feedback, magnets tripping offline, aborts due to excessive beam loss and instabilities introduced by the injection kicker magnet.

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LONGITUDINAL FEEDBACK ABORTS

For the PEP2 experiment at SLAC a Longitudinal Damping System[1] has been developed to try to correct for coupled-bunch instabilities. This system does a great job. From time to time, however, the system fails to correct for such instabilities and the beam aborts. Figure 1 shows a plot of horizontal, x-plane, HER BPM when the Longitudinal Feedback fails.

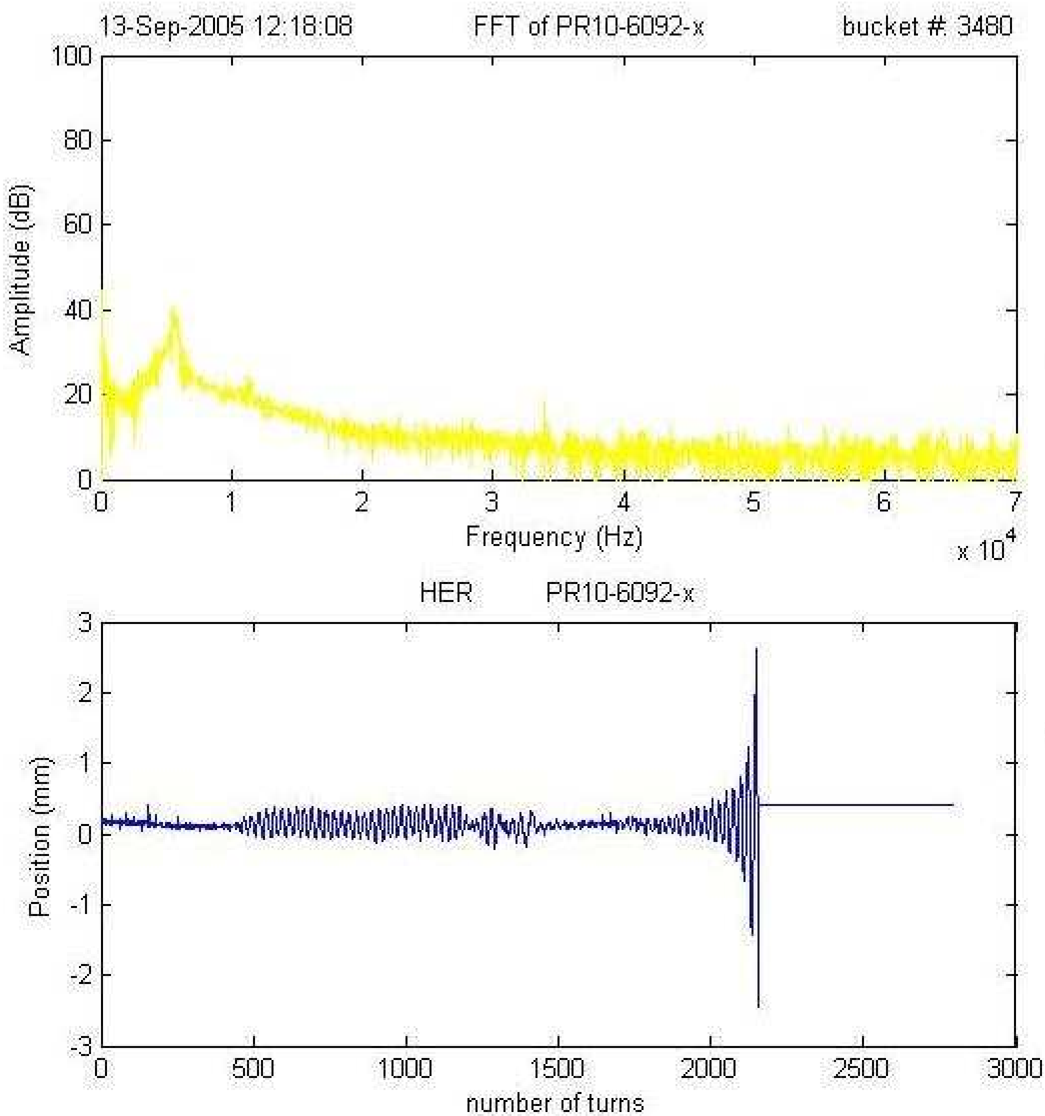

Figure 1[2] – Longitudinal Feedback Abort Beam Position Data

TRANSVERSE FEEDBACK ABORTS

In addition to the feedback system described above, a separate Transverse Feedback System[3] exists at SLAC to correct for horizontal and vertical instabilities in the electron and positron beams stored in the PEP2 rings. Figure 2 shows the characteristic frequency of an instability in the horizontal plane that the transverse feedback was unable to correct.

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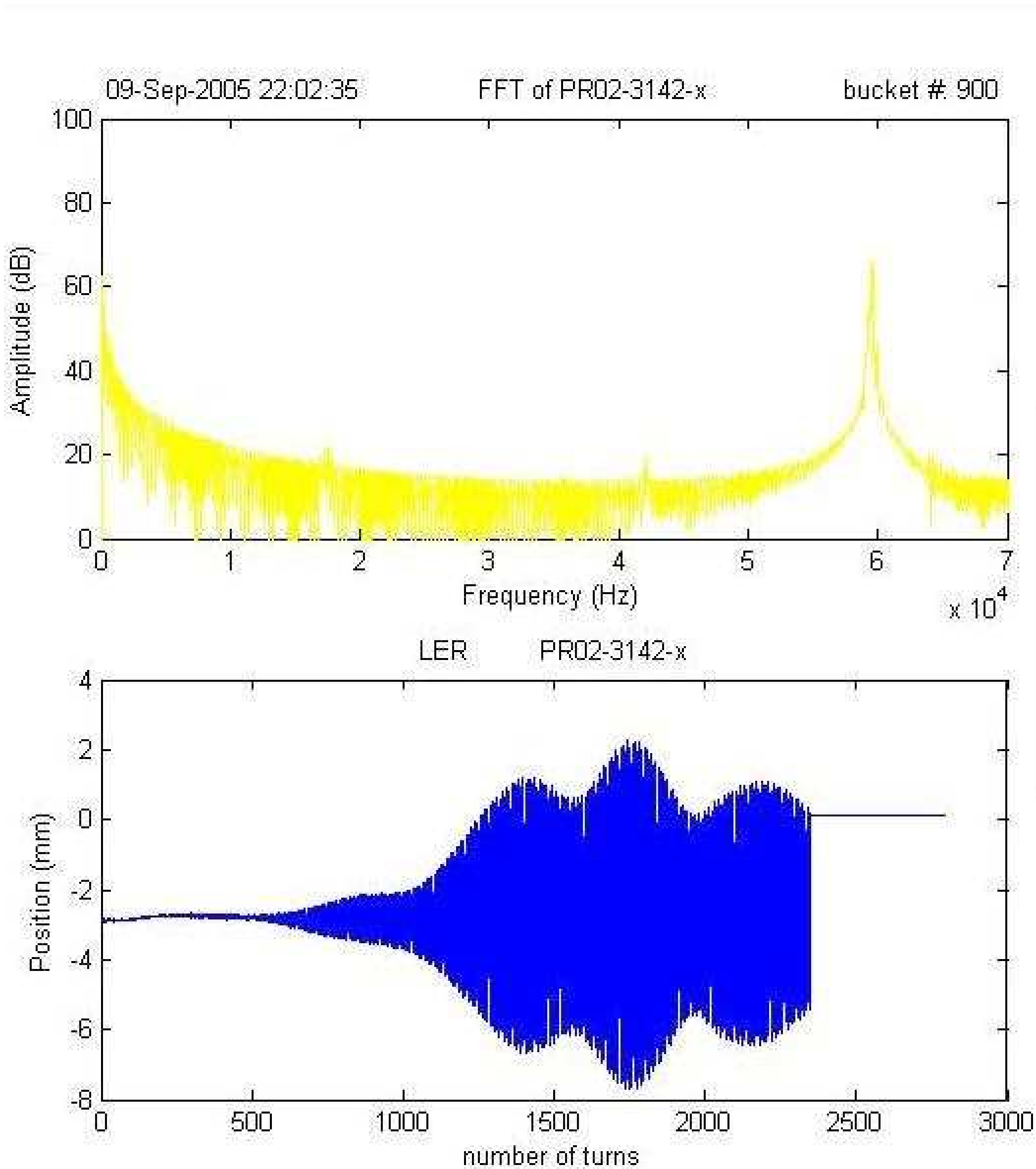

Figure 2 – Transverse Feedback Abort Horizontal Plane Data

The BPM abort data in figure 3 shows instabilities in both the horizontal and vertical plane that the transverse feedback system was unable to correct.

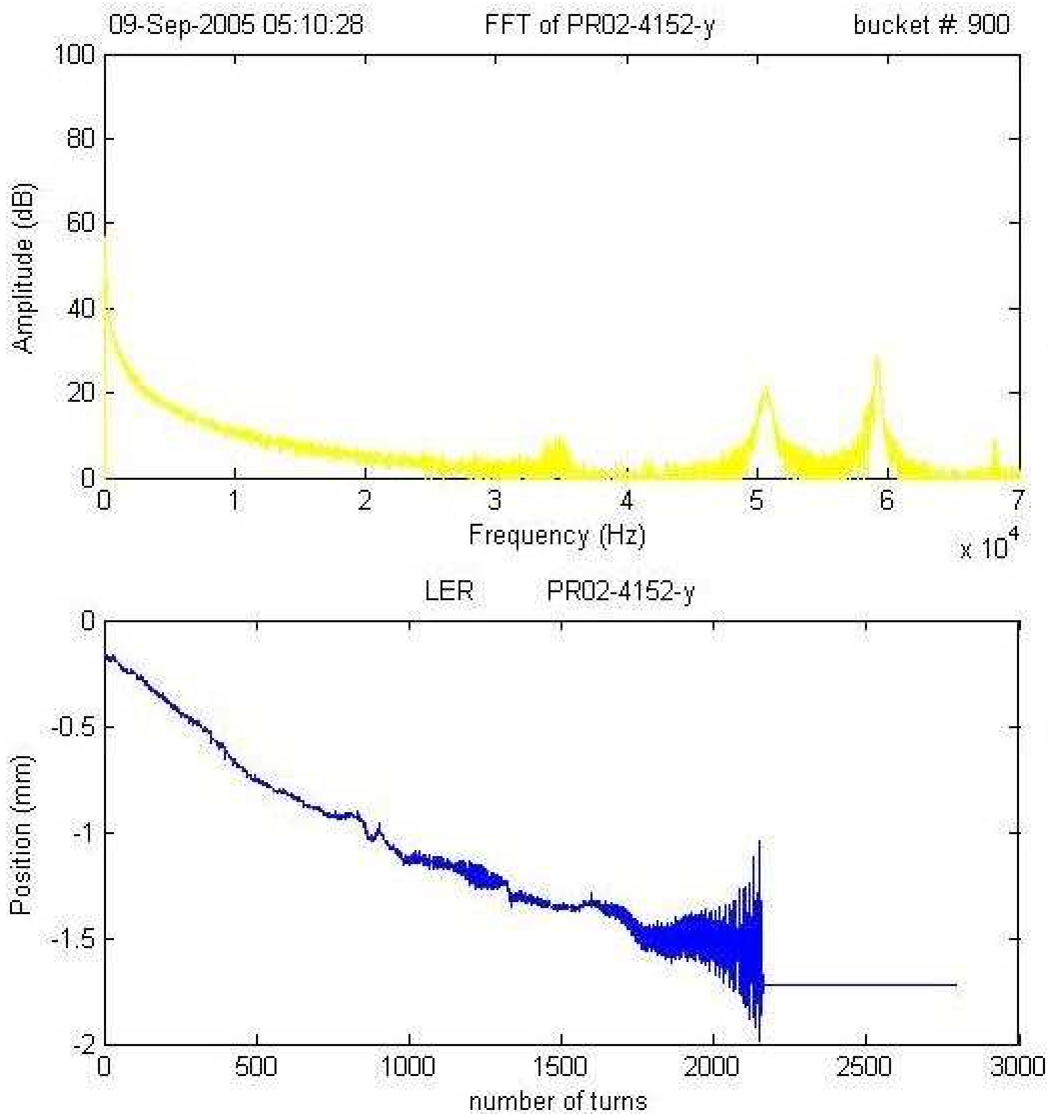

Figure 3 – Horizontal and Vertical Motion in BPM Abort Data

Figure 4 shows a beam instability that was captured by the beam abort system. SLAC physicist Franz-Josef Decker describes this plot as follows, “[The] Beam went transversely unstable in y which then damped down, followed by a huge transverse instability in x. […] This is a good example of dynamic aperture measurement as the electron beam became unstable in the vertical plane. The dynamic aperture is about 6mm in the arc or 18 mm at the injection point. We can see the beam loss from the BPM.” This plot was generated by the online SLAC Control Program (SCP).

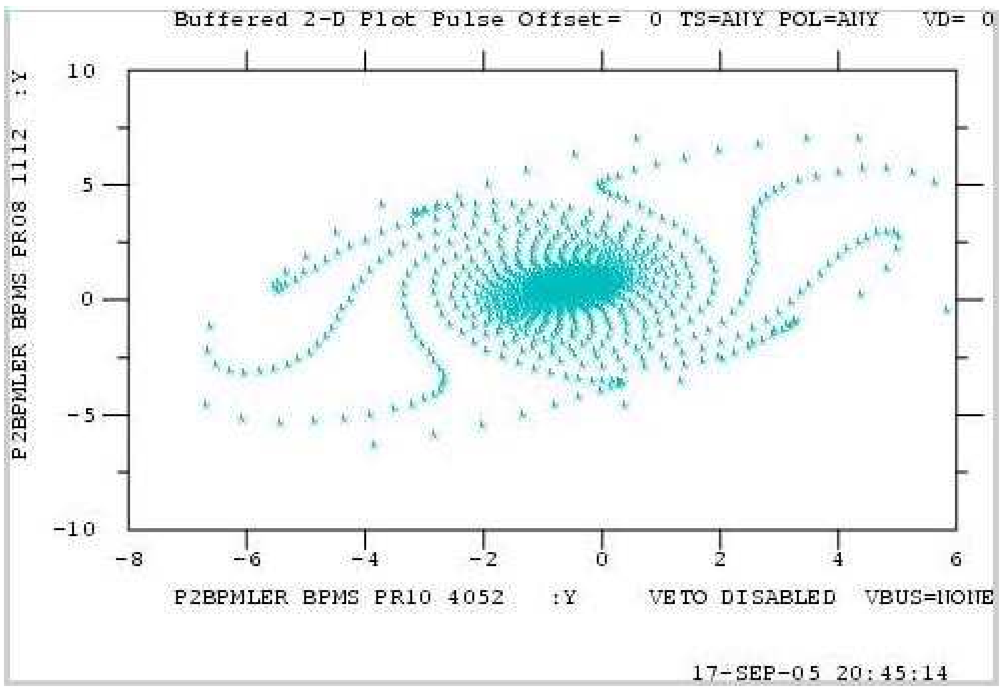

Figure 4 – LER Instability shown in BPM Abort Data

MAGNET TRIPPING OFFLINE

When a magnet in the PEP2 ring trips, the beam position will invariably spiral out of control. The plot in figure 5 shows the beam abort system catching beam positions as the beam drives toward the beam pipe. In this case the BPM data doesn't indicate any new information to the operator, but merely confirms what other systems have already reported.

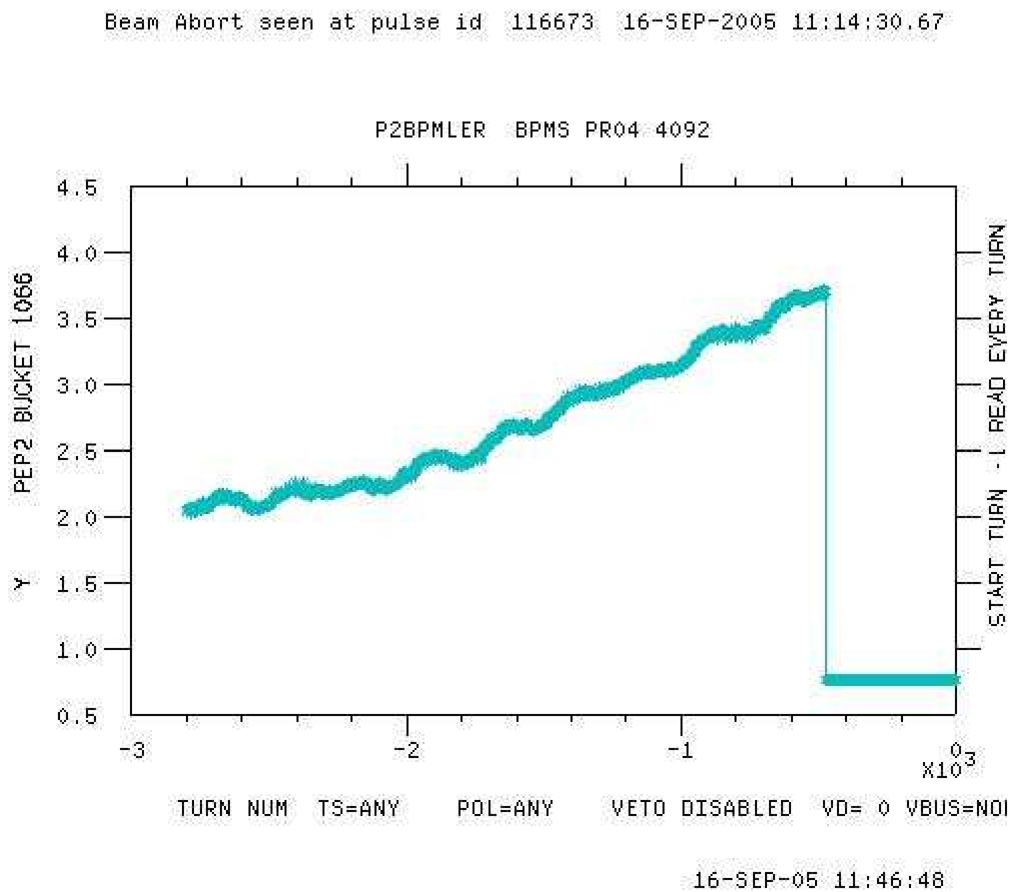

Figure 5 – Beam Abort due to Magnet Trip

SUMMARY

Recording PEP2 beam losses at SLAC has proved to be a useful tool in helping the operators and physicists determine and eliminate the root causes of stored beam aborts.

REFERENCES

[1] D. Teytelman, R. Claus, J. Fox & others, "Accelerator Diagnostic Techniques Using Time-Domain Data from a Bunch-by-Bunch Longitudinal Feedback System", SLAC-PUB-8416, March 2000.

[2] This plot was done from previously saved HER beam abort data using MATLAB™ and is the direct result of work performed by Johnny Warren of the SLAC Accelerator Operations Department.

[3] W. Barry, J. Fox, D. Teytelman & others, "Initial Commissioning Results From The PEP2 Transverse Couple-Bunch Feedback Systems", SLAC-PUB-9743, June 1998