BNL-104176-2014-TECH
AGS.SN303;BNL-104176-2014-IR

Signal Induced on the Booster Current Transformers by Pulsing the C7 Fast Injection Magnet

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October 1993

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U.S. Department of Energy
USDOE Office of Science (SC)

DISCLAIMER

AGS Complex Machine Studies (AGS Studies Report No. 303) Signal Induced on the Booster Current Transformers by Pulsing the C7 Fast Injection Magnet
Study Period: October 14-18, 1993
Participants: L. Ahrens
Reported by: L. Ahrens
Machine: Booster
Beam: None / Au^{33}
Tools: MUX, Scope
Aim: Quantify induced signal from pulsed magnet.

Both the injection current transformer (INJXF) and the circulating beam current transformer (BCBM) in the AGS Booster suffer a substantial induced signal when the fast injection bump is pulsed. One magnet in this bump is located adjacent to the current transformers in the C6 straight section. The pickup "noise" is associated with this ("C7") magnet pulsing. The purpose of this "study" was to document and quantify the effect and perhaps to encourage more thought on how to reduce the problem.

Booster Injection Current Transformer

Figure 1a shows the current pulse in the C7 magnet (negative going pulse) and the signal observed on the INJXF with no beam in the machine. The sweep speed is 0.2 ms per box. Figure 1b gives the same two traces with the C7 magnet set to standby. Were the beam present, it would appear on the rising section of the C7 signal. Measurements of stacking efficiency using the injection current transformer are complicated by this additional signal. Careful measurements can be made using the storage and reference subtraction capabilities of a digital scope. One other fact, the amplitude of the induced signal scales with the gain setting of the current transformer. The gain is set in a chassis located in the C6 section. Hence, the pickup must enter upstream of this point. An effort is underway to "feed forward" a processed version of the C7 current signal to compensate for the pickup. To avoid further corruption of the beam signal, this compensation will probably not be made at the front end and so will have to follow the gain setting of the current transformer.

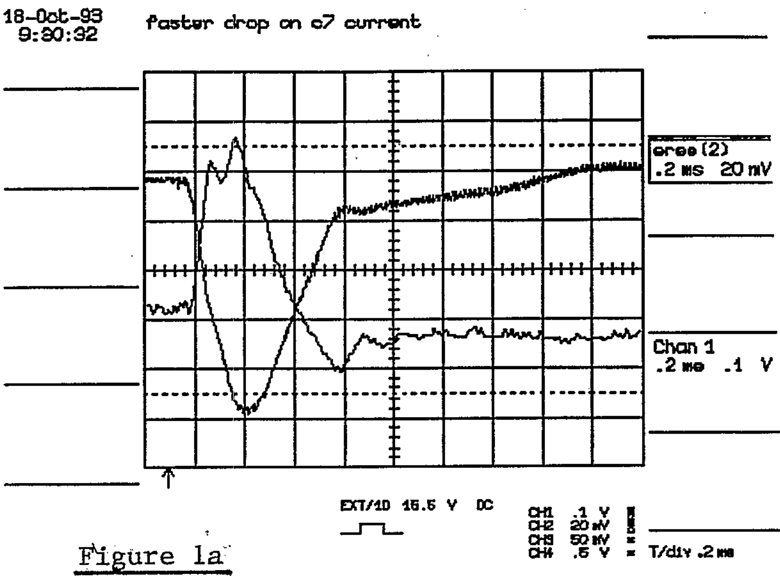


Figure 1a

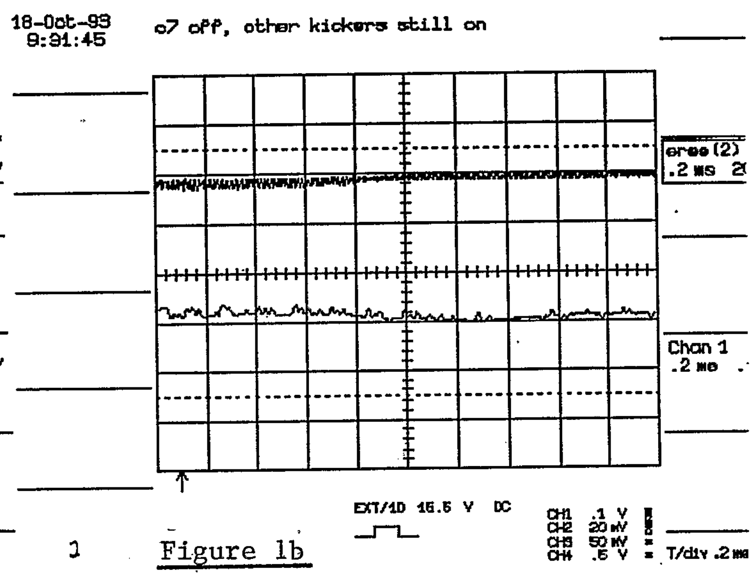


Figure 1b

Booster Circulating Beam Monitor

Figure 2 shows two versions of the BCBM with about 7 x 10^8 Au^{33} ions injected. In this figure, the normalized (divided by the revolution frequency) version (beam intensity) is presented. The upper trace is a 10 pulse average, the lower is a "smoothed" single shot. The sweep speed is 5 ms/box. Both show a ringing after injection. We contend that a substantial part of this ringing is induced by the pulsing of the C7 magnet. Figure 3 show the (now unnormalized) BCBM (lower trace) and the C7 magnet pulse, with no beam in the machine (sweep speed 0.5 ms/box). The higher frequency (7 kHz) component on the BCBM is apparently inherent in this active current transformer. The processing of the signals in Figure 2 was to suppress this component. Figure 4a differs from Figure 3 only in that the scope sweep speed has been reduced to 2 ms/box. Figure 4b shows the reduction in the "ring" when the C7 magnet is put to standby. Figures 5a and 5b are repeats of Figure 4 using the normalized version of the signal, which effectively amplifies the signal by more than a factor of 5. The normalized signal is clamped just above zero and so has a flat spot. By comparing Figure 4 and 5 to fill in the "flat", the amplitude of the oscillation on the normalized BCBM just due to the C7 magnet pulse is seen to be about 0.4 Volts, which agrees with the total oscillation seen with beam in Figure 2. Figures 6a and 6b give an averaged version of the induced signal on the unnormalized BCBM with the C7 magnet on and in standby.

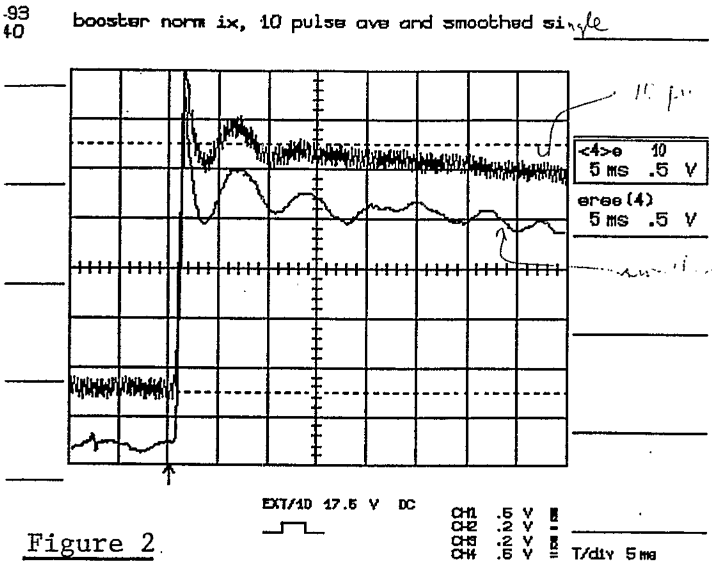


Figure 2

er norm ix, 10 pulse ave and smoothed single

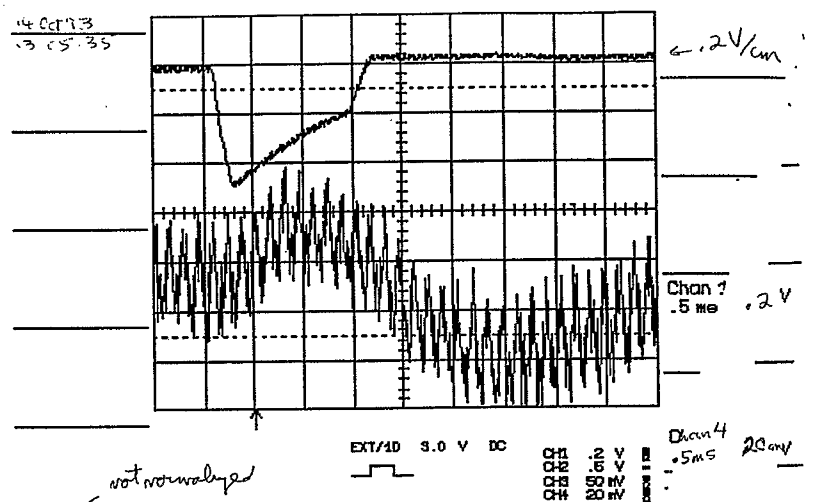


Figure 3

4 cbm and c7 kicker

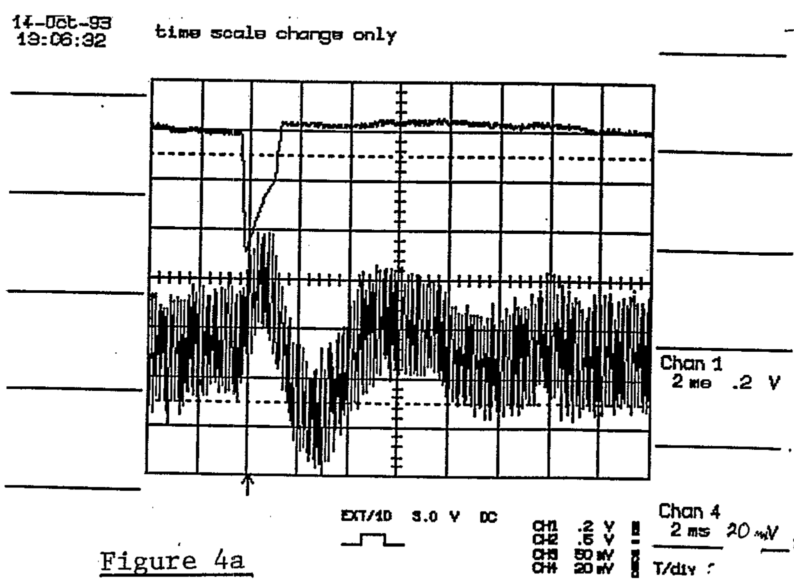


Figure 4a

time scale change only

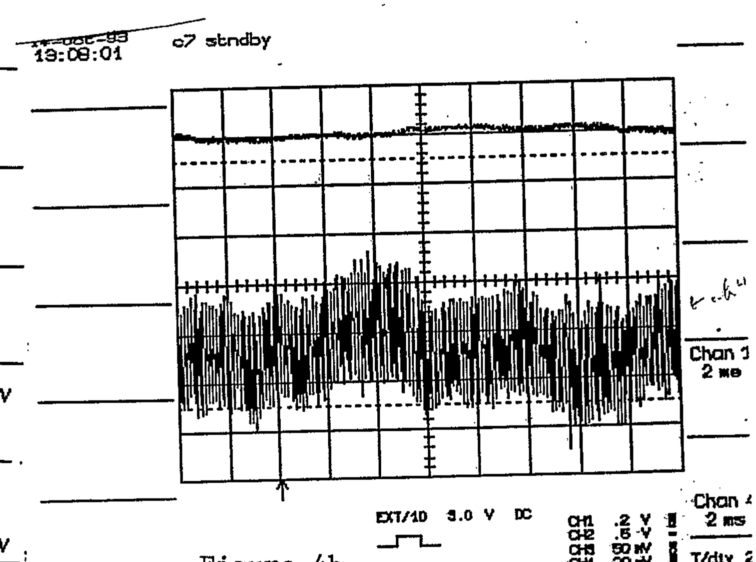


Figure 4b

c7 stndby

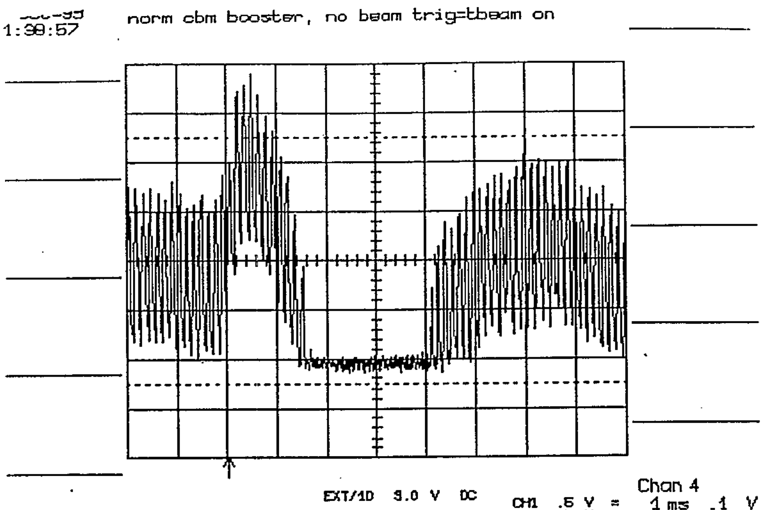
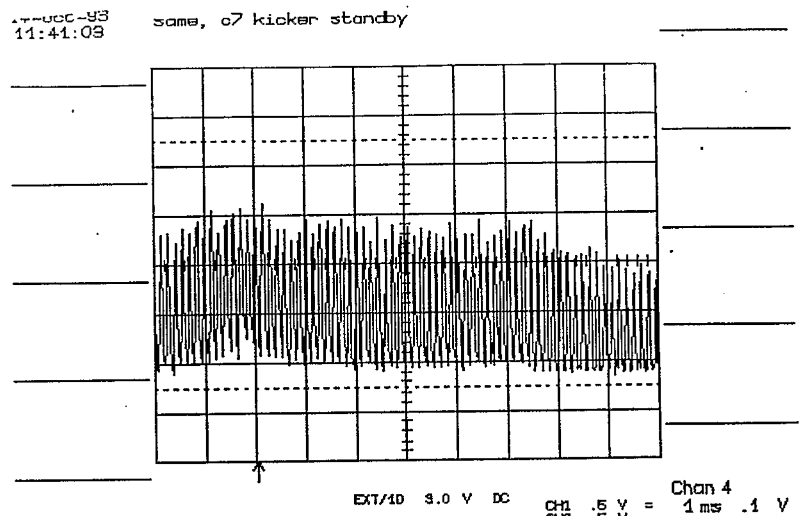


Figure 5a

norm cbm booster, no beam trig=tbeam on (c7 kicker on) c6 ≈ 200A



(norm CBM) Figure 5b

same, c7 kicker standby

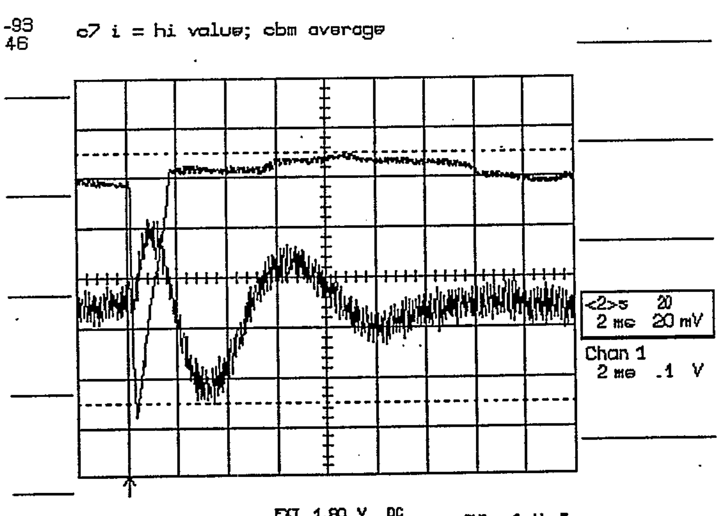


Figure 6a

= hi value; cbm average → pk pk ~ 60 mV

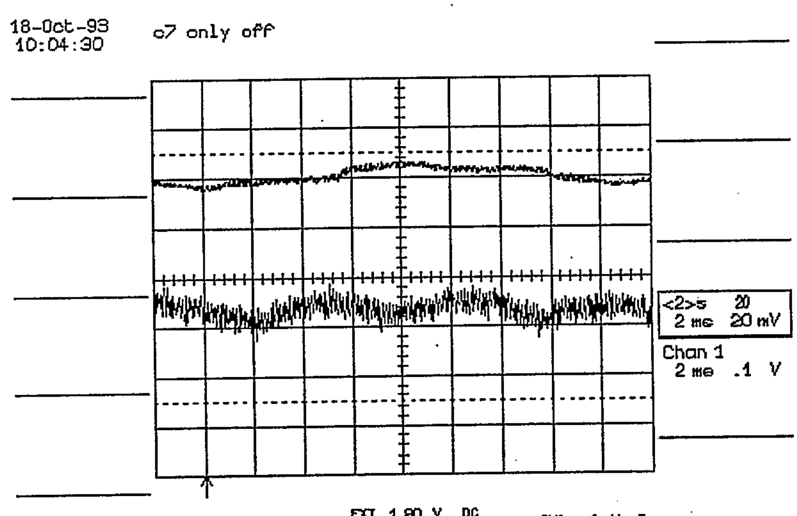


Figure 6b

c7 only off

While the pickup on the injection current transformer is seen to be largely proportional to a combination of the C7 current itself and its time derivative, the signal on the BCBM is much slower. It is not clear if this can also be significantly suppressed by some sort of feed forward.

An Aside

Reliable information on Booster beam intensity is obtained from these two current transformers, but only if the following selections are made:

Booster injection with heavy ions--INJXF, with the effect of the C7 pulse properly compensated.

Booster acceleration with heavy ions--BCBM, normalized, with poor information near injection.

Booster injection with high intensity protons--either transformer. The injection transformer is faster, but has been rolled off to permit its use for Booster high intensity acceleration.

Booster acceleration with high intensity (> 3×10^{13}) protons per cycle--INJXF, normalized. The BCBM dies at high intensity. The reason is perhaps associated with some leakage of rf into the electronics.