E. Faught

10/7/83

Operations Bulletin #924

Towards a Better Understanding of BPM Data Acquisition

R. Gerig

This note will review the basic BPM/BLM data frames, discuss some of the problems we have encountered in interpreting the data and suggest solutions where these are possible.

REVIEW OF DATA AVAILABLE FROM BPM'S

The basic data frame in the BPM system is called the Snapshot Data Frame. This is a measurement of the closed orbit in the Tevatron, and is analogons to the MR orbit you are familiar with on page 7 of the MRx530. A primary difference between the Main Ring system and the Tevatron system is that the Tevatron system can measure the closed orbit continuously (up to a rate of a measurement every millisecond), and generate a Snapshot Data Frame each time.

The manner in which these data frames are organized in BPM memory is determined by the application. The Snapshot Data Frames appear in four different data structures. These will be outlined, and their primary functions and limitations discussed.

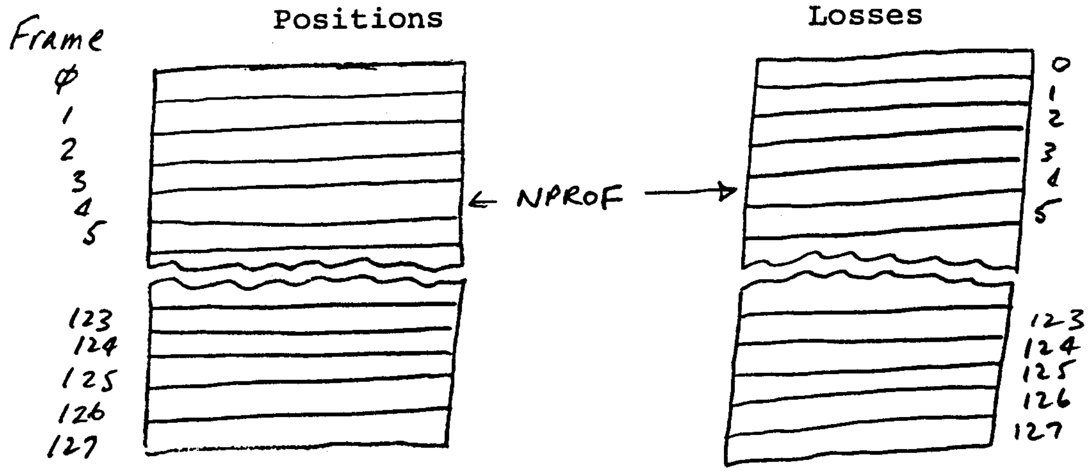
SNAPSHOT BUFFER

First of all note that a distinction is being made between Snapshot Data Frames and the Snapshot Buffer. All of the closed orbit measurements use the same Snapshot data Frame format; the Snapshot Buffer on the other hand is the buffer which contains at any instant in time the most recent 512 Snapshot Data Frames. The primary application of this buffer is abort analysis, as the buffer stops being written into at either an abort, or End of Flattop lock event. Since the buffer is a circular buffer, entry Ø is the most recent; that is it is the entry closest in time to the event of interest-the abort.

The range of time over which this buffer extends is a function of the BPM measurement period. The value of this time can be found on page T37, the control page; or on page T39 the display page, on the bottom of the touch panel. The Loss monitor Snapshot Buffer, to which these remarks also apply, differs only in that the depth of the buffer is 256, and the measurement period is 8 msec (32 msec for the straight section BLM's).

PROFILE BUFFER

The Profile Buffer contains 128 Snapshot Data Frames. These 128 frames are written when the 'Profile"clock event (75_{16}) is decoded by the BPM's.



At the BPM 'Prepare for Beam' clock event a pointer, NPROF is reset to Ø. When the first Profile Clock Event occurs, the BPM processor retrieves the most recently written Snapshot Data Frame from the Snapshot Buffer, (both position and losses) and copies it into the Profile Frame that NPROF points to. NPROF is then incremented.

The purpose for creating the Profile Buffer was to provide an input for the Orbit Correction program. However, when the Orbit Correction program is not being used the timing of the 'Profile' clock events can be set up on page T60 to provide a useful history of an acceleration cycle, (i.e. send out an event every 250 msec).

The Profile Buffer is not very useful in examining aborts. In fact the Profile Buffer can be very misleading in this case, because when the abort occurs the memory will stop filling. Recall that when the last 'Prepare for Beam' occured only the pointer was reset, and the data wasn't erased. Therefore, it is possible to retrieve data which was not from the cycle which aborted, but from previous cycle.

DISPLAY FRAME BUFFER

The Display Frame is a single Snapshot Data Frame Buffer, created for page T39. It is written when the BPM's decode a 'Write Display Frame' clock event. When this event occurs the most recently written Snapshot Frame in the Snapshot Buffer (Positions and Losses) is copied into the Display Frame Buffer. Again, there is the chance that the data taken was from a previous cycle, particularly if an abort occured just before the time of the clock event.

ALARM FRAME BUFFERS

This buffer contains a single Snapshot Data Frame. Rather than being copied at a clock event, this buffer is copied from the Snapshot Buffer the first time during an acceleration cycle that any channel within the BPM exceeds its alarm limit. The positions and losses are handled independently; loss alarm frames are written when loss alarm limits are exceeded, and position alarm frames are written when position alarm limits exceeded. At present there are no high level applications programs which utilize these data frames. One reason is that these are not ringwide data frames, each house may generate a frame at different times, and many will not generate any at all.

FLASH FRAME BUFFER

The Flash Frame is (as far as positions are concerned) a different frame from the Snapshot Frame. It contains single-turn position measurements and intensities. There is a Snapshot type loss frame associated with it. The data for these frames are taken when the BPM processor decodes a 'Flash' (77_{16}) clock event. Special hardware and software are utlized to take this data; suffice it to say that it is not associated with the position Snapshot data drame. The Flash Event is normally set at the first turn in the Tevatron.

Turn by Turn Data Buffers

The Turn by Turn (TBT) buffers are generated at housed specially equipped to take TBT data. These houses are E1 and E2. Each of these BPM processors have an additional multibus board which contains hardware and RAM to take and store the position data for 1024 turns for all twelve channels.

The memory will fill in either of the following situations:

1. First 1024 turns after 'Prepare for Beam'. This is a low priority mode of operation and is used primarily to provide data for the TV display of the first 256 turns. In BPM lingo it's called the Parasitic TBT mode. Anything else the BPM has to do will cause those turns which occur during this other activity to be ignored with no gaps etc. on the display to warn the user this has happened.

2. TBT studies: In this case the timing channels on page T42 are used to trigger the filling of TBT data. Secondly, this filling mode is high priority and preempts other data acquisition, i.e. Flash.

The following observations apply to TBT data regardless of the mode used to get the data.

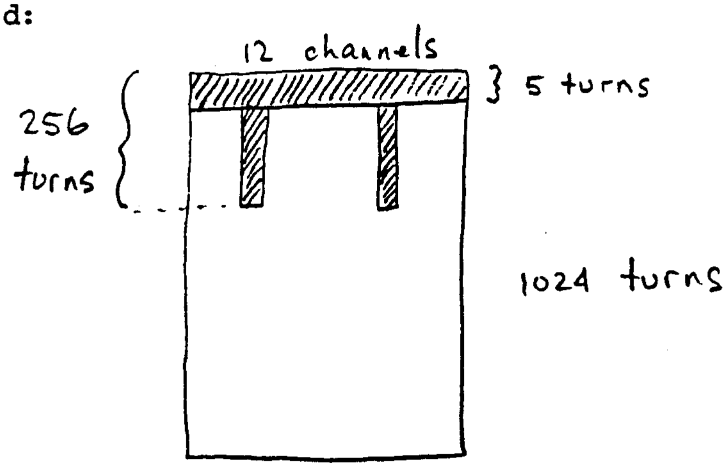
1. A selectable group of 256 turns from 2 detectors will be plotted on the TV (E1 only), nonlinearized. This is normally set to the first 256 turns.

2. Data is available to the host on a 12 channel/turn access method, (Used in the orbit correcting program for closure),

or a single channel, 1024 turns method used by page T42 for tune measurement.

3. No status bits are available with TBT data as opposed to all other BPM data formats.

4. It is impossible to have the BPM processor clear the 1024 x 12 = 12288 bytes of TBT data at 'Prepare for Beam', particularly since this memory is not in the processors data space. However, in order to minimize confusion the following is cleared:



The first five turns of all 12 channels are cleared insuring the orbit correction program of either recent data, or non physical values; and the first 256 turns of the two channels selected for TV display are cleared. Thus if a situation exists in which beam is injected into the Tevatorn, survives for about 10 turns and dies, the TV display will indicate the positions of the 10 turns, and then show non physical values; similar to the MR digitizer over console Ø. However, if immediately following injection someone desired to see the 10 turns on a different channel, and interrupted on page T37 to do so, the TV display will be redrawn, but the new channel will show beam in all 256 turns since its memory contains data from previous cycles. A similar situation existed recently when the TBT Studies data was used to look at the beam around the time of an abort; it so happened that the beam was aborted during the 1024 turns of fill. The display on page T42 showed small oscillations, typical of beam at higher energy for the turns prior to the abort, and then large oscillations following. These were not the cause of the abort, but were data left over from the fill at injection time.

Solutions to Some of the Problems

One of the confusing points regarding the data has been the question of when it was taken. This can arise because the BPM retains older data in its memory until new data is taken. Thus it is possible to retrieve old data rather than what is expected by either interrupting slightly too soon (i.e. before the 'Display Frame' Event occurs) or by being uncertain as to whether an abort occured before or after the event, etc.

The solution to most of these problems was implemented Thursday, Oct. 6, by attaching Time Of Day stamps to the data at the BPM processor level. When data is displayed via page T39 this TOD stamp is displayed following the word 'Taken' (see Figures 1 and 2) with second resolution. As a reference, the TOD of the data transfer from BPM to host is also displayed with second resolution.

The following data buffers:

FLASH FRAME
BPM ALARM FRAME
BLM ALARM FRAME
BPM DISPLAY FRAME
BLM DISPLAY FRAME

Have the Time of Day Stamp appended to the data resulting in a unique time identification. The Snapshot and Profile Buffers utilize a single TOD stamp which is updated each time the circular buffer wraps around.

For the Snapshot Buffer this results in a TOD identification no worse than 7.5 seconds (if the measurement period is 15 msec) however I will point out one situation in which some confusion may still exist if all the facts are not considered. If an abort occurs during the first N seconds of an acceleration cycle (where N is the time required to fill the Snapshot Buffer once) then some of the frames will contain data from a previous cycle. This will cause the TOD stamp to be wrong for these frames. However, the cycle time stamp will indicate at what point this occurs.

The Profile buffer can also lead to confusion in that the data is not erased each cycle, a pointer is reset. Therefore it has been ambiguous as to what cycle the data is from if an attempt is made to read a frame close to the time at which it is written. The TOD stamping as implemented does not solve this problem. However the problem is solved by the application (T39) which reads the present value of the pointer at the time of the request for Profile data, and disallows acquisitions from previous cycles. (Note that the Profile Pointers can be read and displayed from all BPM's by a touch panel switch on page T39. Note also that if there is a reason to read old Profile Frames this can be accomplished by pressing the 'Old Profile Enable' touch siwtch while interrupting). Thus for Profile Frames the TOD stamp has a resolution of no better than one acceleration cycle.

Another source of confusion exists between the relative priorities between TBT data taking and Flash data taking. Although the overall priority scheme in the BPM is :

TBT Studies Data
Flash Data Frame
Snapshot Data Frames
Parasitic TBT Data

The only thing that needs to be remembered is that if the Flash Event is set to look at the first turn it will cause the first ∿20 turns to be ignored by the Parasitic TBT data. And if

TBT studies are set to look at one of the turns that Flash is set to, then the Flash data will not be taken at E1 and E2. A future version of BPM software will zero the Flash data at 'Prepare for Beam' so that this second problem will not lead to erroneous interrpretations while doing TBT studies at injection.

RG/ew

Distribution:

Normal
Commissioners and Studiers
Ed Faught
Jerry Firebaugh

cycle time stamp

DISPLAY FRAME 4.989

TAKEN 10/07/83 1049: 30

'time of day' stamp

time at which host read BPMs

(MM) 10/07/83 1049: 43

	C	D	E	F	A	B
11	-2.32	6.49	10.04	-2.17	-3.28	-.61
13	-2.17	0	-6.49	-1.08	.46	3.28
15	1.85	-3.44	-2.96	.15	1.7	.77
17	-.3	-2.17	-2.96	1.39	.46	-1.85
19	NOBEAM	1.08	1.85	2.48	-1.08	-1.23
22	-.46	1.85	1.39	.46	-1.23	1.08
24	.3	1.23	-1.39	-.77	-.92	2.01
26	1.39	-2.32	-1.85	-.3	1.08	1.7
28	.61	-2.64	2.01	-.15	1.39	-.46
32	-2.17	-.61	.77	2.64	-.15	-1.54
34	-2.32	3.12	.46	.77	-.46	-1.54
36	.61	2.8	-.15	.3	-.3	1.7
38	2.17	-.46	-2.01	-2.01	1.7	2.96
42	-.92	-4.09	-.92	2.01	1.23	1.85
44	-2.01	-.92	1.54	1.39	.15	-2.64
46	-.77	1.08	2.96	.46	-1.08	-4.09
48	3.93	2.8	.15	.46	-1.08	0
49	7.6	8.57	.77	-4.42	-1.23	.46

RMS (MM) = 2.462 DP/P (%) = .0101 MOM CORR RMS = 2.481

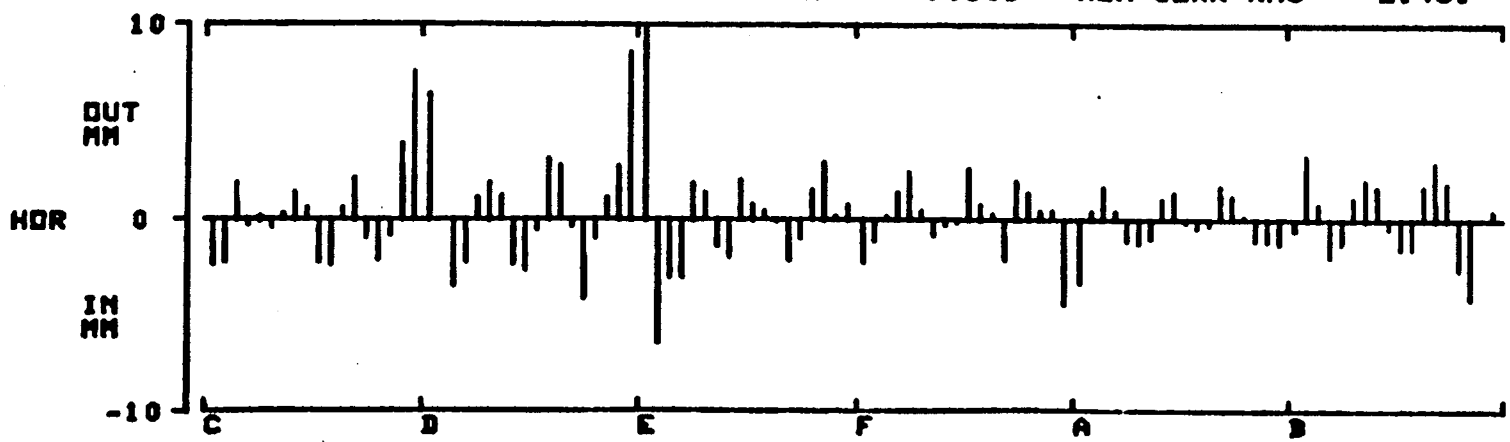
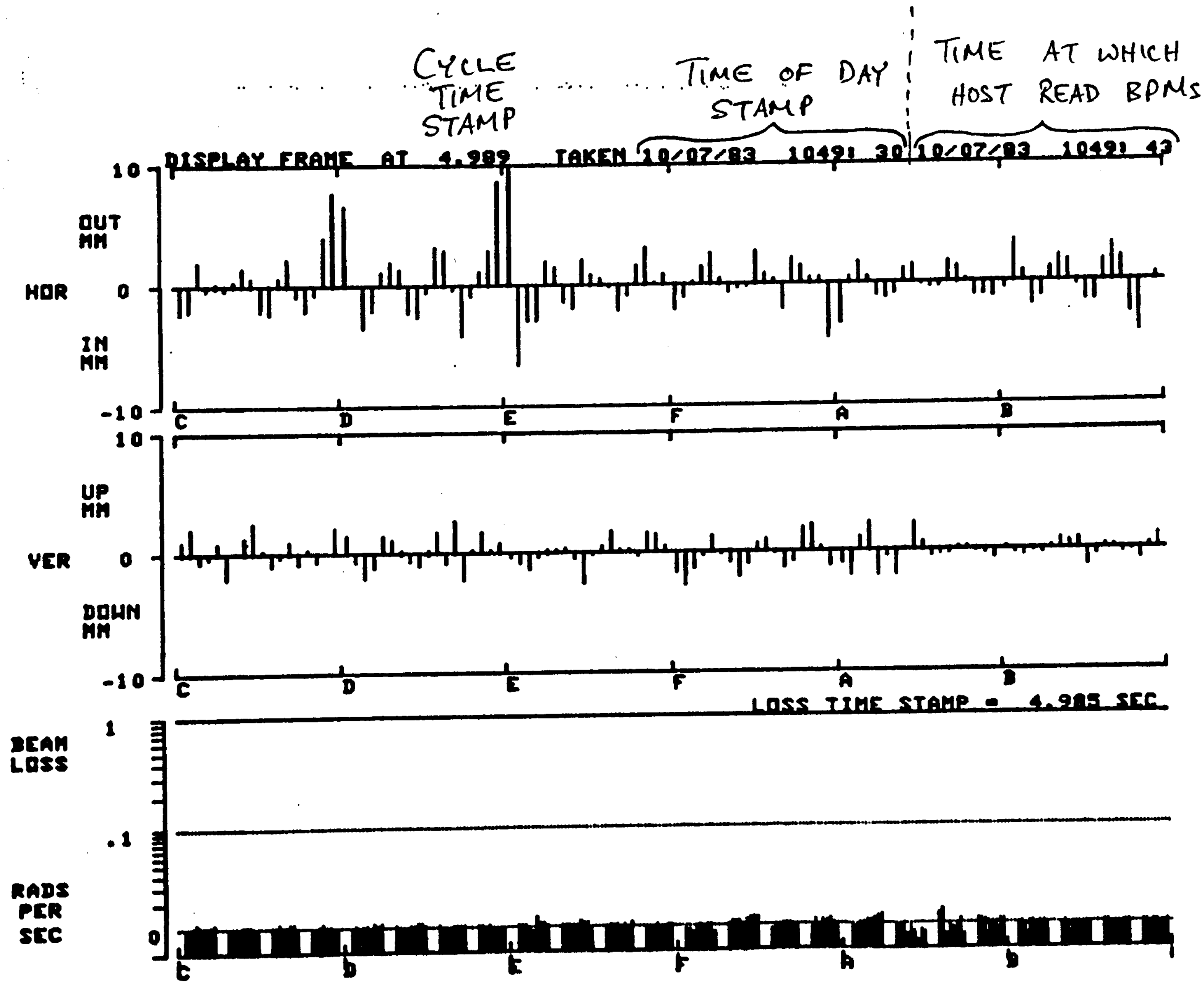


Figure 1


CYCLE TIME STAMP
TIME OF DAY STAMP
TIME AT WHICH HOST READ BPMs
DISPLAY FRAME AT 4.989 TAKEN 10/07/83 1049: 30 10/07/83 1049: 43
10
OUT MM
HOR
0
IN MM
-10
C
D
E
F
A
B
10
UP MM
VER
0
DOWN MM
-10
LOSS TIME STAMP = 4.985 SEC
1
BEAM LOSS
.1
RADS PER SEC
0