

## The Final-Focus Timing Monitor

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The final-focus beam timing monitor (BTM) measures changes in the arrival-time difference of electron and positron bunches in the SLC South Final Focus or, which should be equivalent, at the interaction point [1]. Though the monitor is still being commissioned, and has not yet been fully characterized, please feel encouraged to look for correlations of the BTM signal with other variables.

The e+/e- timing signal can be accessed from the SCP as

### ARRAY FB69 616 DATA 4

Figure 1 shows a timing scan of GADC 616, using the BPM definition 'SLC IP 2 beam'. The nominal timing of the GADC is centered in a region where the signal is close to zero when only one beam is present.

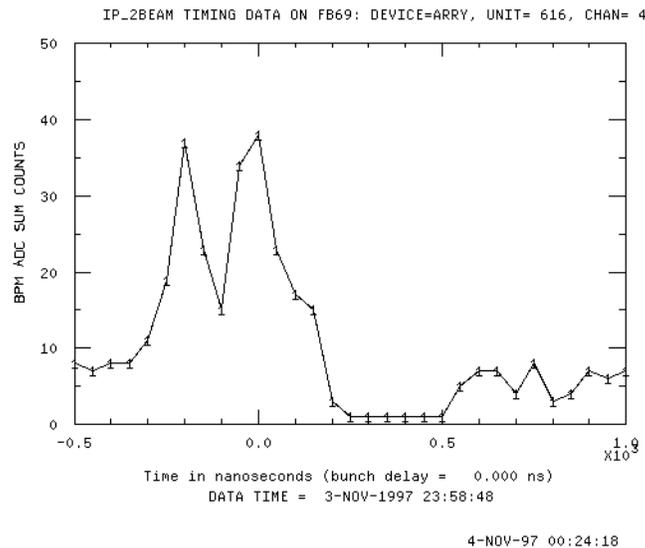


Figure 1: Typical timing scan of ARRAY 616 channel 4.

The raw signal has to be normalized by first subtracting the pedestal and then dividing by the product of the e+ and e- TMITs (in units of  $10^{10}$ ). Typically, a change of the normalized signal by 1 unit corresponds to a timing change of 4 degree X-band or 1 degree S-band (about  $300 \mu\text{m}$ ). This is illustrated by the two calibration curves in Fig. 2 showing the BTM signal as

a function of the delay time (in units of degree X-band) in one of two arms, which was varied using a trombone. The first picture is an autophase measurement (one beam only, delay cable removed); the second is an actual two-beam measurement (with an additional long delay cable approximately equal to the arrival-time difference of the two beams). The fitted slope can be used to convert a measured signal change into degree X-band (or time). The much larger scattering of the data in the two-beam measurement (right picture) appears to represent real beam-timing jitter, which is as large as  $14^\circ$  X-band peak to peak.

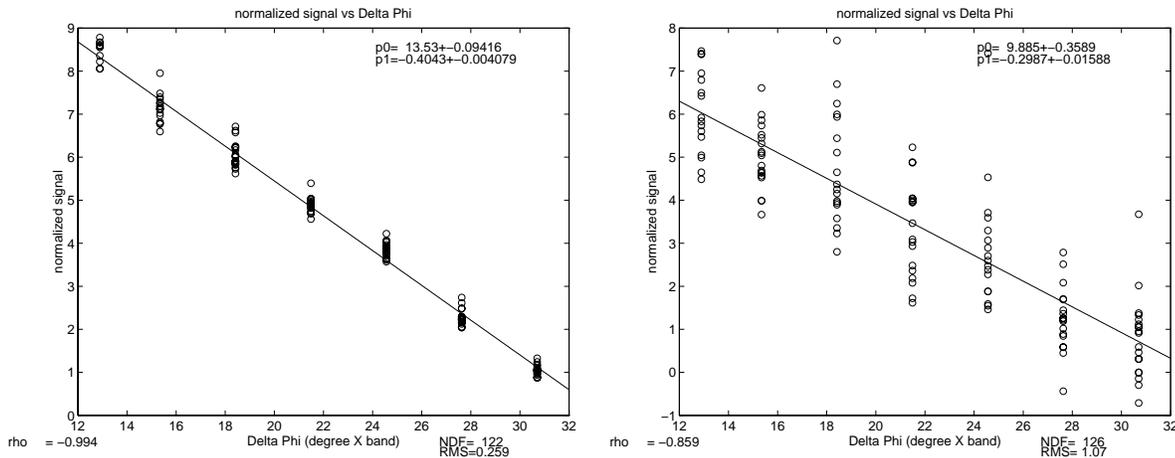


Figure 2: Calibration measurements: normalized timing-monitor signal versus the phase difference between the two arms in degree X-band; (left) signal for one beam with cable delay removed; (right) signal for two beams including cable delay.

A matlab routine which will do the correct normalization of the raw signal is available for correlation plot data:

### CORRELATION PLOT

To take e+/e- timing data from correlation plots, use the button macro **btm\_setup** from the index panel. This macro will select the correct BPM definition, 'SLC IP 2 beam', and it will enter a variety of sample variables (such as phasramp settings, NREX/SREX energies and FB31 energies) on the correlation plot data acquisition panel. From the auxiliary output panel, save the data to a matlab file (*e.g.*, "test.mat"). Choose the format 'U'.

To analyse the data, start a matlab session, preferably from the directory where you saved the data. Load the data (*e.g.*, "load test.mat"). Run the matlab program **btmanal**. This program will normalize and correct the data and, presently, will produce a plot of the BTM signal versus the energy difference of electron and positron beams as seen by the FB31 feedback. Other plots and correlations are easily obtained after the program was run. Figure 3 presents a typical result obtained from btmanal. The BTM signal is shown as a function of the FB31 e- energy setpoint. From this measurement and from the phase calibration performed at the same time, we can estimate the  $R_{56}$  of the SLC North arc as  $R_{56} \approx 120$  mm, which agrees to within 20% with the theoretical value (145 mm).

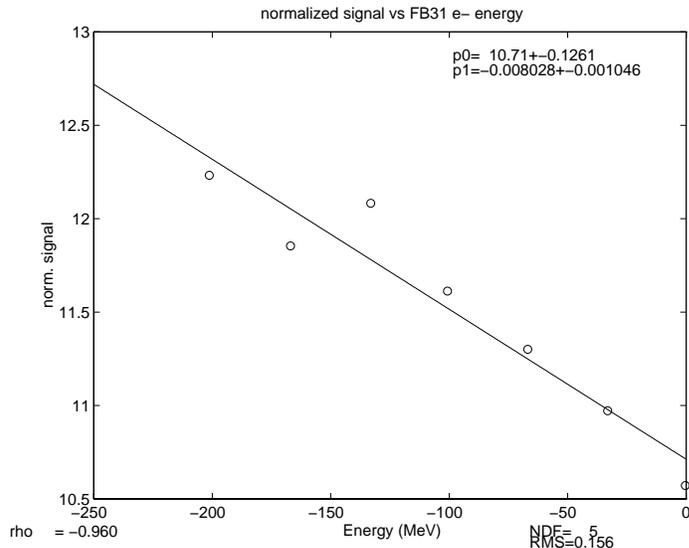


Figure 3: BTM signal versus FB31 e- energy setpoint; the slope is proportional to the momentum compaction factor ( $R_{56}$ ) of the North arc and agrees within 20% with the predicted value.

### HISTORY BUFFER

At the present stage the long-time stability of the timing signal is unknown. Fortunately, e+/e- timing jitter and timing drifts can have an impact on the SLC luminosity only if they occur over short periods of time (*i.e.*, pulse to pulse or over seconds/minutes). For these short time scales the signal has proven to be reasonably stable. Although not important and potentially unreliable, history-buffer information for the timing monitor is available from a special 'FB69 bunch length' history panel on the SCP. This panel is accessible from the 'more emittance history' panel, which itself is accessed from the 'lum history panel'. Note that the history-buffered data are the raw data and, thus, proportional to the product of the two TMITs.

### FURTHER STUDIES

In order to measure the sensitivity of the collision timing to different perturbations, we propose to scan the timing signal against the FB31 energy setpoints, the two phasramps, and the two compressor phases.

## References

- [1] D.H. Whittum and F. Zimmermann, "Beam Timing Monitor for the SLC South Final Focus", ARDB TN 129 (1997).