MARK 5 MEMO #022

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886

January 3, 2005

Telephone: 978-692-4764
Fax: 781-981-0590

To: Mark 5 Development Group
From: Roger Cappallo
Subject: Mk4 Correlator System Timing

In order to ensure that the Mk5B would conform to the current timing specs of the Mark 4 correlator, we investigated the system as it is now operating. Normally the relative timing of various subsystems is monitored via the *counts* program, which examines the delay between SYSTICK's generated throughout the system (see Figure 1). Apparently there is a substantial delay in going through both the 10 MHz and 32 MHz direct serial links.

	Δt (s)	
Playback_0	+1.4252E-006	OK
Playback_1	+1.4267E-006	OK
Playback_2	+1.4162E-006	OK
Plabyack_3	+1.4262E-006	OK
Playback_4	+1.4297E-006	OK
Playback_5	+1.4592E-006	OK
Playback_6	+1.4607E-006	OK
CNTL0	+8.122E-007	OK
CNTL1	+7.802E-007	OK
TSPM	+9.757E-007	OK

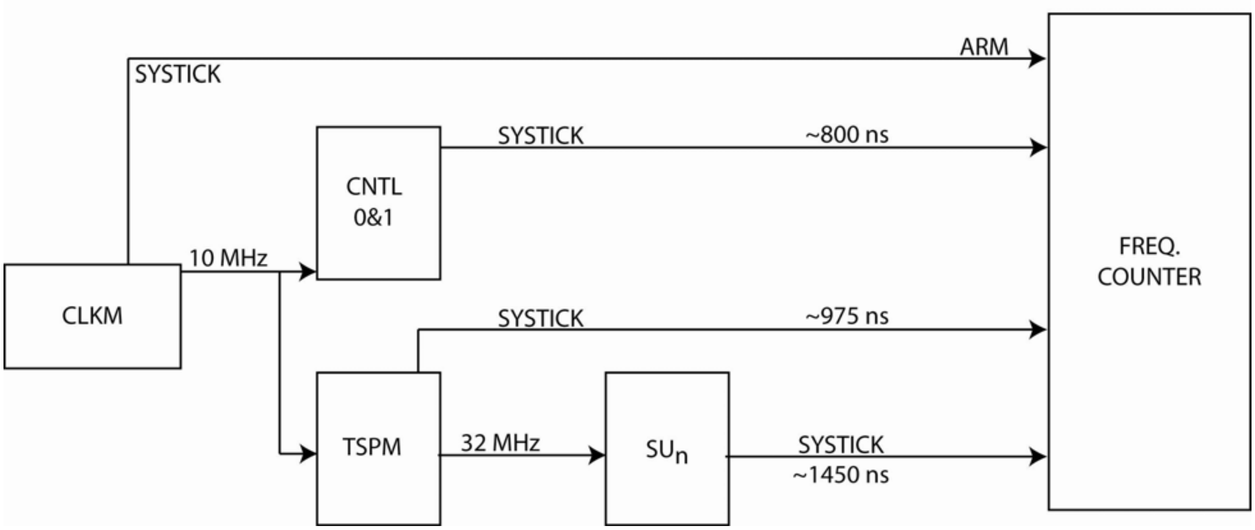

Figure 1 Mk4 System Timing

The inevitable skew of clocks from different SU's was planned for, however, by a 64 clock deep FIFO on the input board of the correlator. Basically, all incoming correlator frames are held up and released synchronously with the local RBOCF signal. This RBOCF is flexibly generated by the correlator control (Bos) board, and is delayed relative to SYSTICK. There is a constant offset of 24 sysclks, plus an additional user-settable offset of 0, 16, 32, or 48 sysclks. Thus the total range in RBOCF, relative to the control board's version of systick, is 24–72 sysclks or 0.75–2.25 μs (since sysclk always runs at 32 MHz in the Mk4 correlator).

Measurements of some of the pertinent signals with a digital oscilloscope are shown in Figure 2. The top two traces show the local (i.e. control board) version of SYSTICK, and a slightly delayed regenerated version called RSYSTICK. The third trace is RBOCFSYNC, which defines the start of the RBOCF signal. Note that the actual RBOCF is a signal that is high for the full duration of the correlator frame header – 240 sysclks – and which is matched bit for bit with the incoming BOCF signal from each of the station units. Finally, the fourth trace is of one of the BOCF signals coming from a station unit.

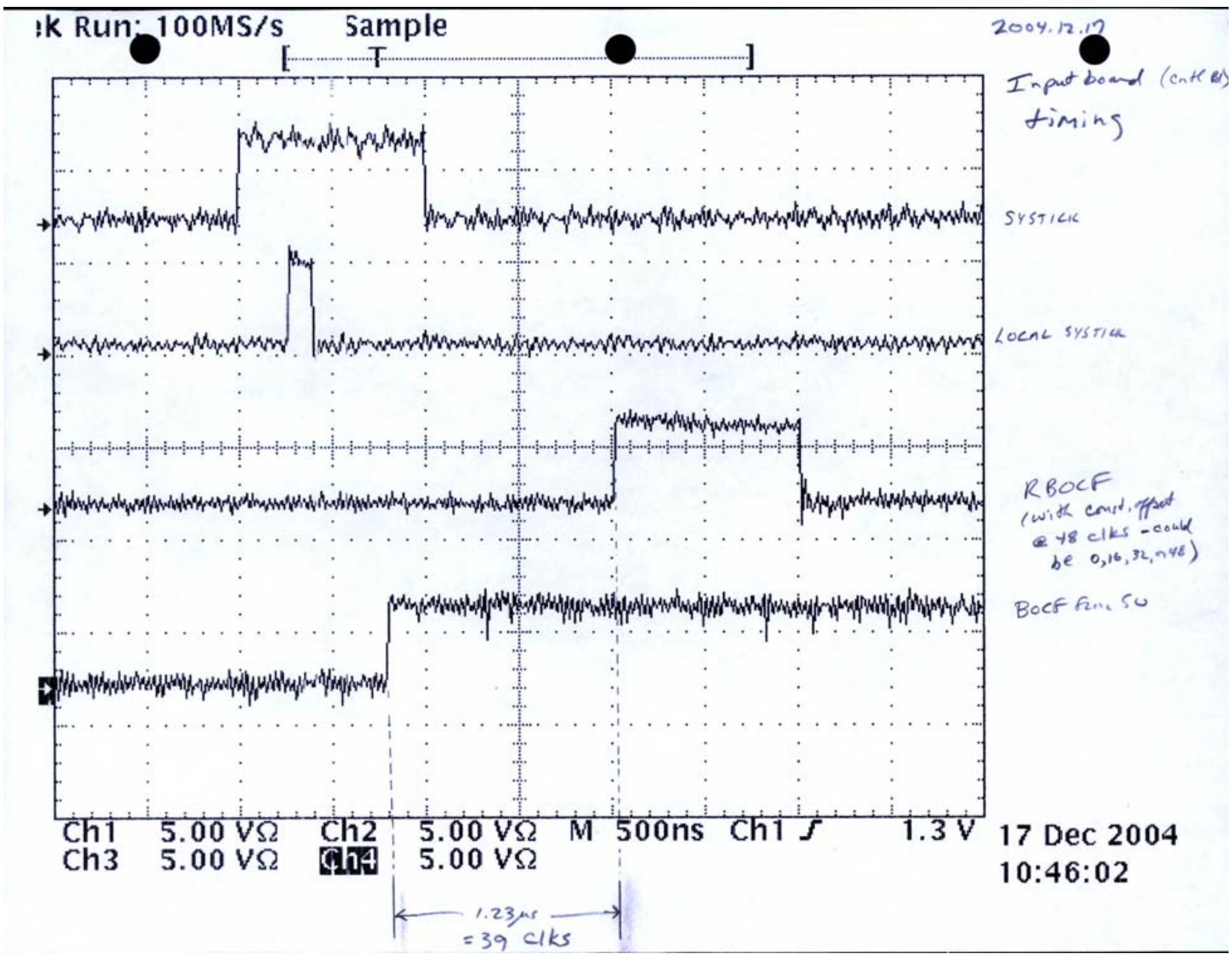

Figure 2 Control and Input Board Waveforms

It is readily seen that the BOCF signal from the SU is arriving about 1.23 μs (~39 sysclks) before the start of RBOCF. This is comfortably within the range of the input board FIFO, which can handle delays of 8 – 64 clocks. Since the local systicks at each of the SU's are so close together ($\leq$44 ns in the *counts* measurements), it seems very likely that the dispersion in arrival times of the SU BOCF's is small (1 or 2 sysclks), although this has not been experimentally verified.

As the control board is currently configured, the DOM in the Mark5B has a wide window for timing. The data could be delayed by up to 39 sysclks relative to the SU's (which send the BOCF out concurrently with the locally received SYSTICK), or advanced by 25-8=17 sysclks. Also, since the adjustable delay is currently set at the maximum of 48 sysclks, it could be set to 32 sysclks, which would allow the signal to arrive another 16 sysclks earlier, for a total of 33 sysclks earlier than the SU.