Beam Monitoring Time Stamps

based on discussions with Jim Patrick

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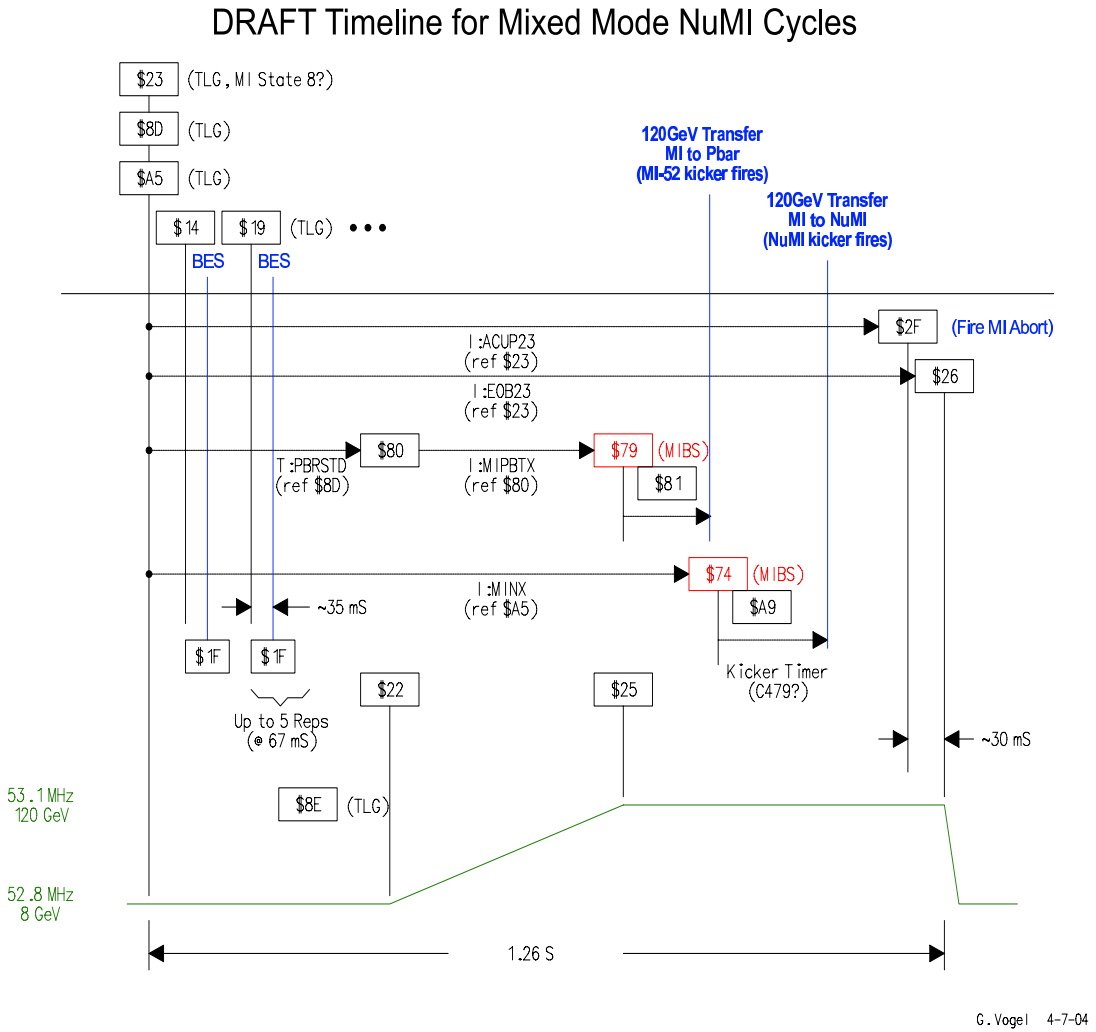
NuMI TCLK beam cycle timeline



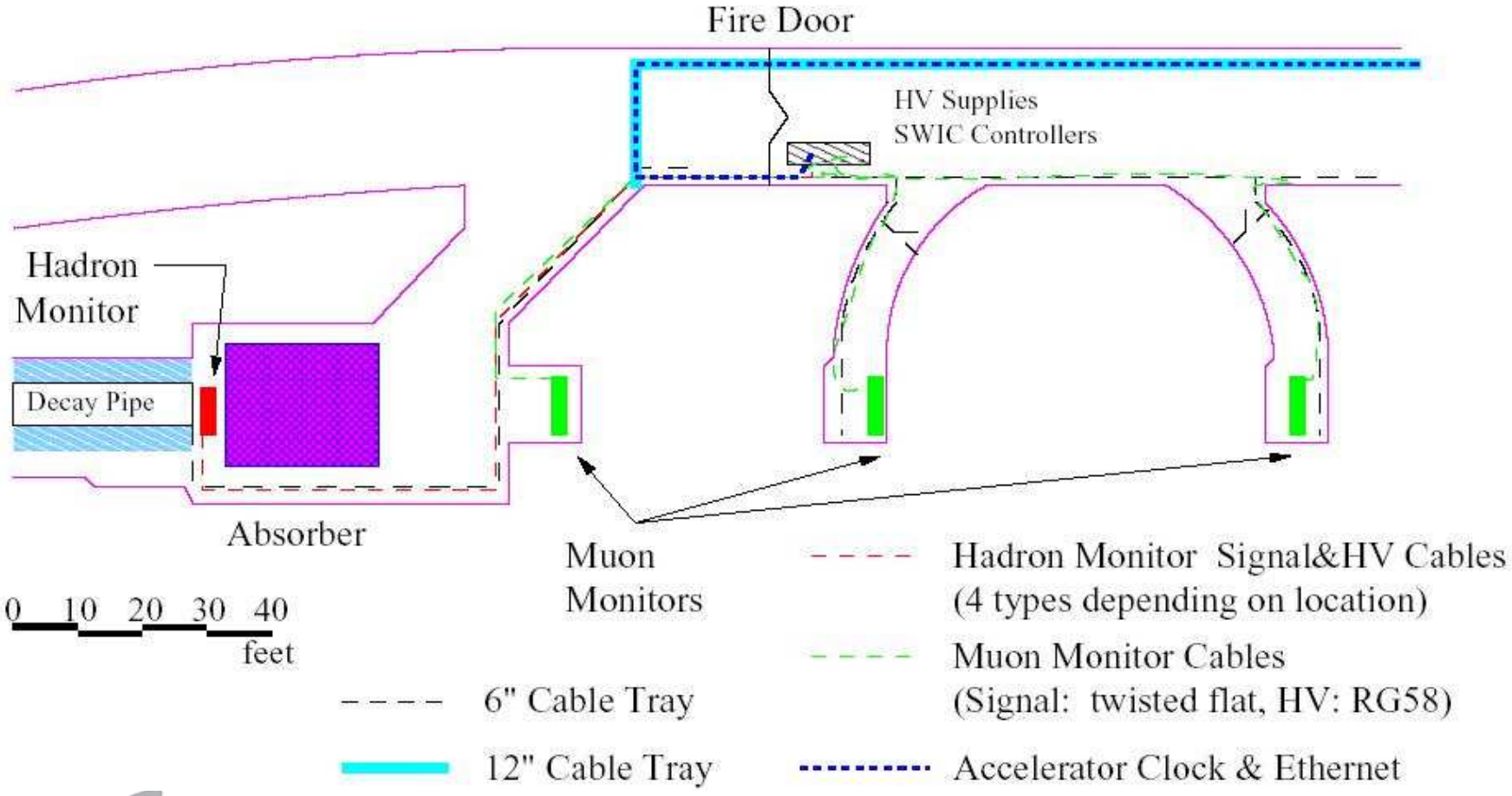
- TCLK is a 256 bit frame sent throughout the accelerator system on a 10 MHz serial line.
- Each bit represents a beam cycle
- Cycle names are just hex representations of the TCLK bit
- <- This is the latest NuMI beamline timing (subject to change)

TCLK event definitions can be found at

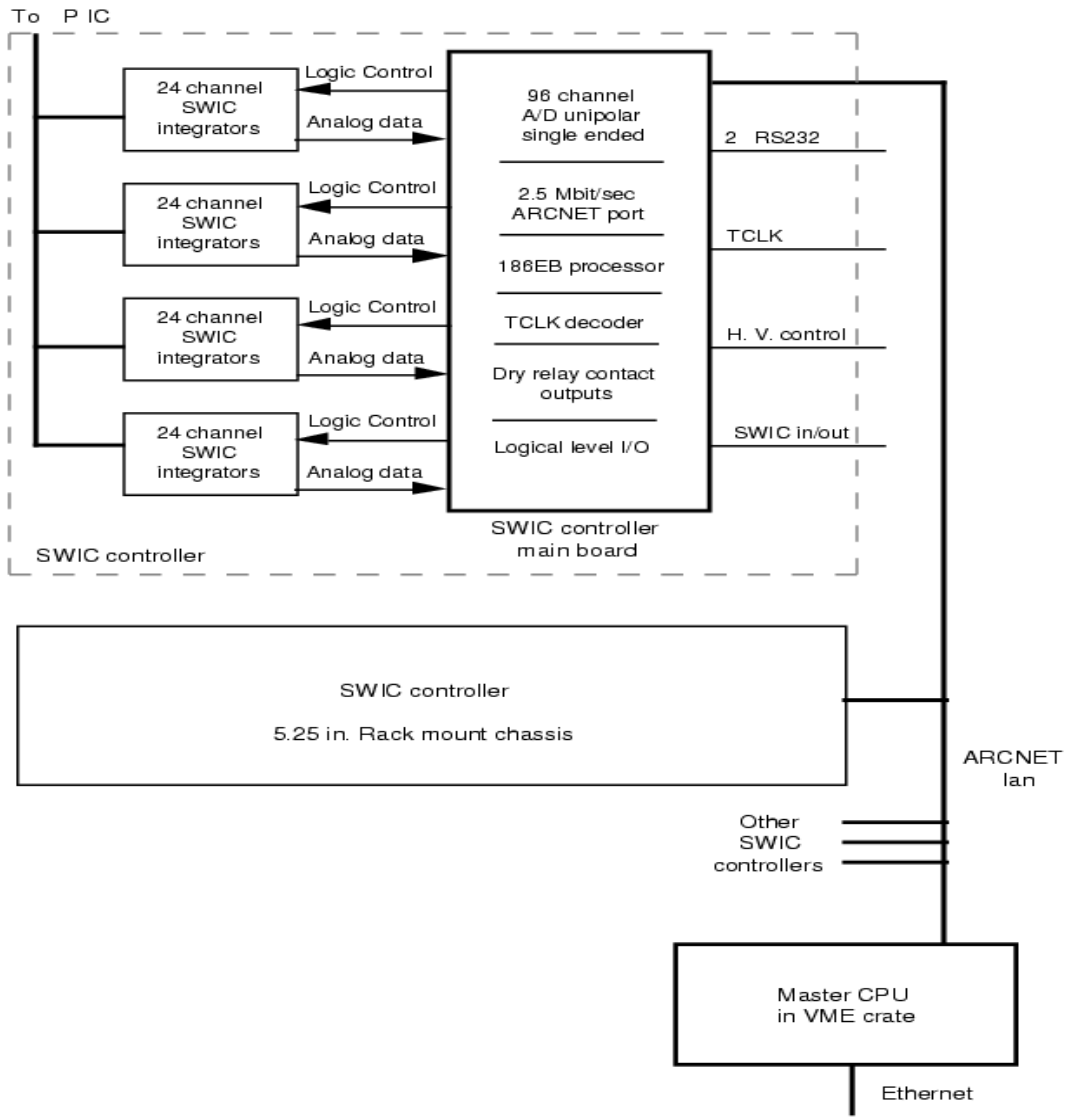
http://www-bd.fnal.gov/controls/hardware_vogel/tclk.htm

Had/Muon monitors

Hadron and muon monitors are Pad Ionization Chambers located approx 2500 feet from target. A SWIC controller system decodes TCLK, digitizes and reads out the PIC:



PIC → SWIC → → → → VME



- The first time stamp is applied by the VME CPU after it obtains the SWIC data via a very long ARCNET serial link (2.5 Mbit/sec.)
- This is also available for newer NuMI BPMs
- Time stamps for other devices are obtained futher downstream in the DAQ timeline.

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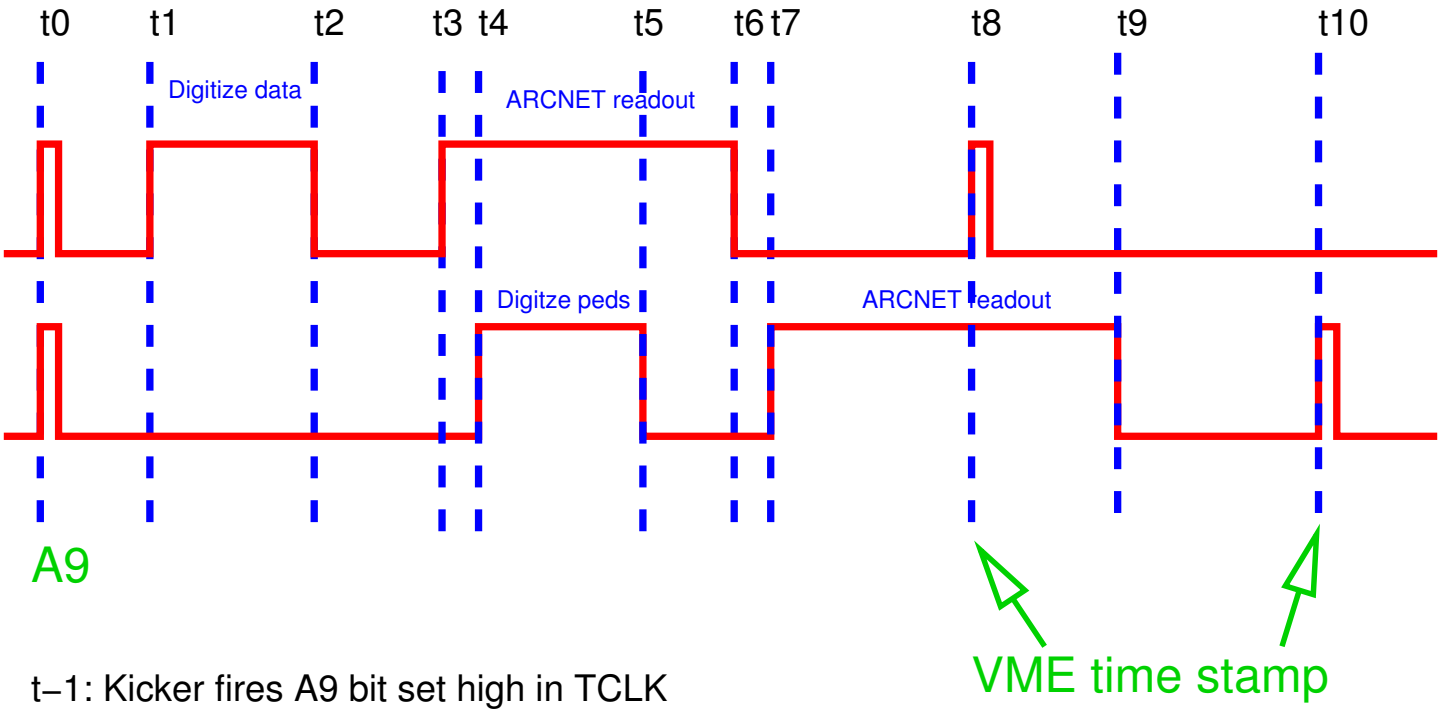
A Timing Diagram

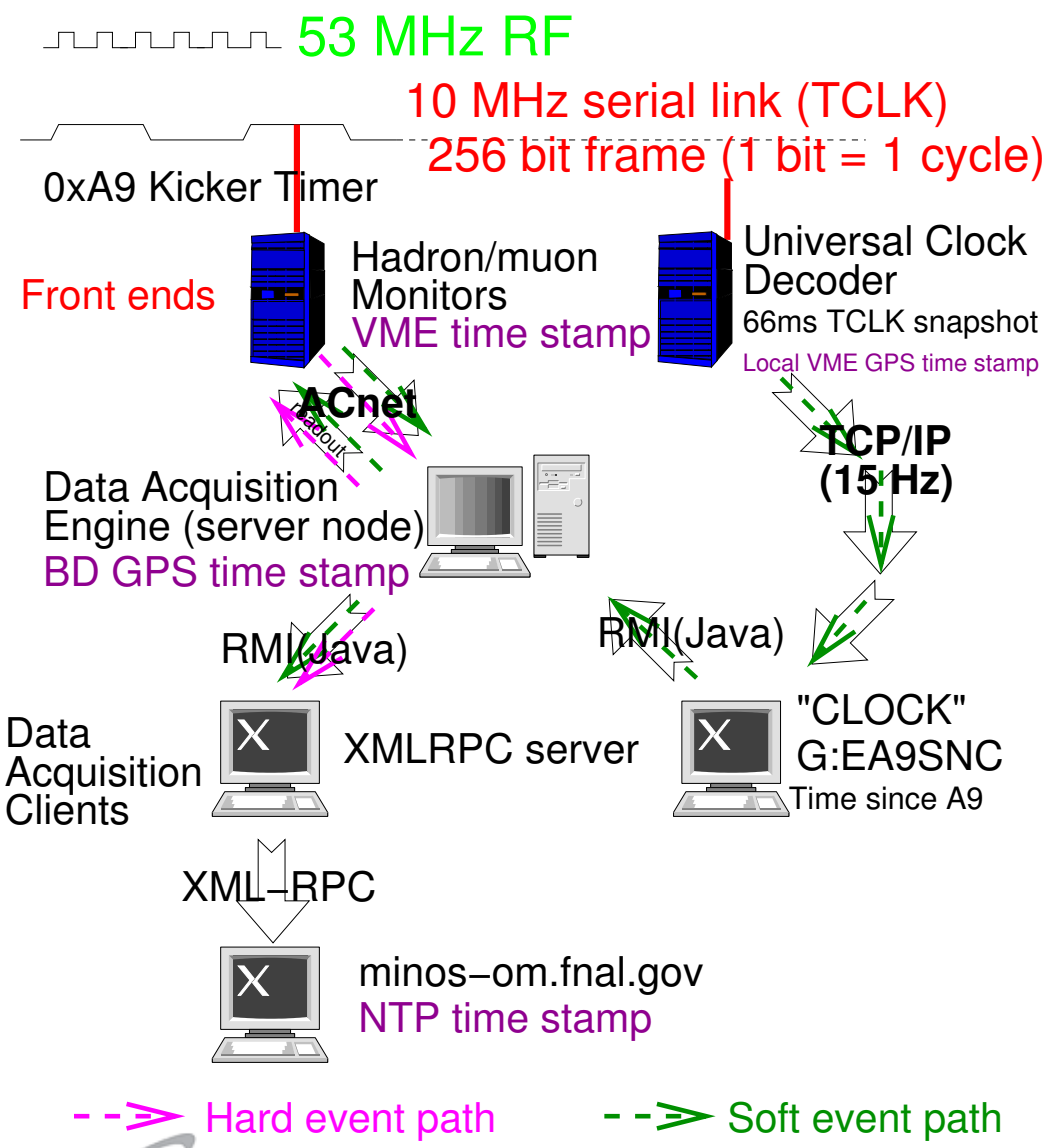


t–1: Kicker fires A9 bit set high in TCLK
t0: TCLK A9 triggers beamline monitor
t1: spill data digitization begins
t2: spill data digitization ends
t3: begin ARCNET readout of beamline monitor spill data
t4: begin digitization of pedestal data
t5: end digitization of pedestal data
t6: end ARCNET readout –spill data in VME buffer
t7: begin ARCNET readout of beamline monitor pedestal data
t8: Master VME CPU adds BD GPS time stamp to beamline monitor spill data
t9: end ARCNET readout – peds data in VME buffer
t10: Master VME CPU adds BD GPS time stamp to beamline monitor peds data

VME Timestamps

- VME controller runs VxWorks - a real time unix-like OS
- The VxWorks processor synchronizes with a unix system that is synchronized with a GPS. $\approx$ ms precision.
- IN ADDITION a GPS front-end generates an 8F TCLK event every second as measured by the GPS.
- When the front-end receives the 8F event, it further synchronizes its internal time, and keeps doing this. $\approx 10\ \mu$s precision.
- This infrastructure was mainly driven by miniBoone requirements, where they need 15 Hz precision.

DAQ Time Stamps & Data Access



- Data Acquisition Engines (DAE) speak ACNET to FEs and serve data to client software.
- All data are time stamped when recieved by the DAE.
- Front ends with a hardware TCLK link can collect data on a hard event. FE immediately sends data back to DAE when FE sees TCLK cycle requested.
- All other data access (including delays) is via soft access mode. DAE waits until it recieves the TCLK via an ethernet multicast (15 Hz) before requesting data from FE.

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Accessing the FE timestamps

From: Jim Patrick <patrick@fnal.gov>
To: Brett Viren <bv@bnl.gov>
Cc: Mary Bishai <mbishai@bnl.gov>, Charles King <kingc@fnal.gov>
Subject: Re: ACNet readout time

SWIC data can be read as a number of individual devices with
a common prefix. Picking a NUMI example, these are
E:M101HM - horizontal mean position
E:M101HS - horizontal sigma
E:M101xx ... for 20 or so devices
In this method, timestamp devices are NOT defined.
An alternative is to read a single block (array device)
containing all the information for a given measurement.
This does include a time stamp that is supposed to be
derived at some level from a GPS.

Brett is developing accessor classes for block data reads

Time stamps: NTP,GPS,UTC,TAI

- Timescales are based on International Atomic Time (TAI) derived from cesium clocks. UTC is the civilian timescale based on TAI but deviates with the addition of leap seconds.
- GPS timescales are syntonic with TAI but at a fixed time offset of 5s.
- Computers use NTP (Network Time Protocol) to set their time. NTP is based on the UTC timescale.
- Computers sync their clocks using NTP timeservers.
- Computers on the BD network get NTP time from two local GPS stratum 1 servers; bdtime-1.fnal.gov & bdtime-2.fnal.gov.

Does MINOS GPS = BD GPS timescale?

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Testing Status

- The beams division software infrastructure for the NUMI line is configured and the devices have been put into the general SWIC application program. The devices are called E:MXXXDS where XXX=101, 105, 107, 108, 112, 114, 115, 117, 121, TGT. The NUMI instance is "E41". The SWIC scanners are physically attached and can be programmed by local experts to trigger an any TCLK cycle we choose.
- The newer NuMI BPMs also have a FE time stamp applied. There is currently only one prototype BPM of this type installed.
- See Bretts talk on the status of BeamData development.

We need the SWIC scanners operating and triggering on 29 to test.

Impact of accelerator shutdown = no realtime data!