

New diagnostics timing setup Information:

(As implemented on about February 6, 2006.)

Definitions:

Turn (Time)	The time of flight for the beam over a distance equal to the circumference of the ring.
Turn (Distance)	248 m
Fixed Time	Essentially time in SI units. Use where delays are not a function of the beam energy. Time adjustments for pre-triggers, delays due to cable propagation and beam propagation near the source end of the linac are fixed time.
Cycle	The timing system runs at 60 Hz and keeps time within a cycle in turns. The Cycle Start event defines turn 0. The beam gate occurs at turn 5048 minus the Beam Gate Width. The extract event occurs at turn 5050.
Beam Gate	The time when the ion source and the RFQ LLRF are both on. The beam gate starts when the ion source turns on and stops at turn 5048. The width is set by the "Gate Width" slider in the "Beam" column of the timing master screen.
First Mini-pulse	The first turn of chopped beam from the LEBT chopper. In the future this will be the first turn of the Ramp Up time.
First Full mini-pulse	The first turn of the chopped beam from the LEBT chopper after the Ramp Up time and in the Beam On time.
Ring Period Frame	Frame 4 of the RTDL holds the ring period in pico seconds. This only changes when an operator or the shift physicist sets the ring period/energy. Controls has requested that the beam should be turned off during adjustments.

Events and event behavior for diagnostics.

Event	Event Number	Rep-rate	Definition
Beam Ref	37	60	2939 Turns before the start of the beam gate
Beam On	36	Beam Rep-Rate	2937 Turns before the start of the beam gate
Diag-Fast	47	Up to 6 Hz limited by the Beam Rep-Rate	2935 Turns before the first mini-pulse from the LEBT chopper
Diag-Slow	46	Up to 1 Hz limited by the Beam Rep-Rate	2933 Turns before the first mini-pulse from the LEBT chopper

Diag-Demand	45	On the next beam on cycle after the request	2931 Turns before the first mini-pulse from the LEBT chopper
Diag-Laser Trigger	41	30 Hz (sync to beam)	2929 Turns before the first full mini-pulse from the LEBT chopper.
Diag-Laser	49	Up to 10 Hz limited by the Beam Rep-Rate	2927 Turns before the first full mini-pulsed from the LEBT chopper.
Diag-RTBT	61	Beam Rep Rate	2925 Turns before the extract event.
Diag-RTBT-Fast	60	Up to 6 Hz limited by the Beam Rep-Rate	2923 Turns before the extract event.
Diag-RTBT-Slow	59	Up to 1 Hz limited by the Beam Rep-Rate	2921 Turns before the extract event.

Discussion.

1. Linac Diagnostics timing.

V124 Cards: Diagnostics timing can simply use the table above to set the V124 to trigger at the time of arrival of the beam at the diagnostic. If a fixed time pre-trigger is a requirement the timing database can be modified to allow adjustments in fixed time.

ETC Card: The delay in turns can be selected from the table based on the event. Timing specified in turns is converted to fixed time and adjusted for pre-trigger and fixed delays.

Time in is done by adjusting the fixed delays.

2. HEBT Diagnostics timing.

Use the settings for linac timing. Diagnostics concerned with turn by turn timing can possibly be improved by adding the distance past the end of the linac (in turns) to the turn delay in the table.

Time in is done by using fixed delays.

3. Ring Diagnostics timing.

Use the settings for linac timing based on the selected event. Turn by turn timing may vary based on LEBT chopper settings and time of flight variations in the linac. This information can be provided for use by diagnostics IOC through channel access. PVs containing timing information from the timing system can be provided on request.

Time in is done by adjusting the fixed delays.

4. RTBT and Target Diagnostics timing.

Diagnostics for the extracted beam pulse in the RTBT must add the extraction kicker delay to the delay specified in the table and use one of the Diag-RTBT events. A fine adjustment based on the distance (in turns) from the extraction kicker in turns can be added. The PV to add is: **Ring_Mag:Gate_KickExt:TotalDlyEcho**

Time in is done by adjusting the fixed delays.

NOTE:

Information within the timing system not available to diagnostics can be provided on request.

Development test and results:

In the development lab setup the timing master was set to the following operating conditions:

Beam gate: 6 Hz, 100 turns

Flavor 4 Delay: 20 turns

Flavor 4 Ramp up: 15 turns

The event link monitor provides the results:

Timing and control events			Soft events			Diagnostic Events		
Event 63 Pre-Pulse	60.0 Hz	17624.063 Turns	Event 240 Fla 0	54.0 Hz	5287.063 Turns	Event 47 Fast	6.0 Hz	2033.063 Turns
Event 1 Cycle Start	60.0 Hz	17625.063 Turns	Event 241 Fla 1	0.0 Hz	5305.313 Turns	Event 46 Slow	1.0 Hz	2035.063 Turns
Event 27 Source On	60.0 Hz	2.063 Turns	Event 242 Fla 2	0.0 Hz	0.000 Turns	Event 45 Demand	0.0 Hz	2037.063 Turns
Event 52 60 Hz	60.0 Hz	21.063 Turns	Event 243 Fla 3	0.0 Hz	5309.125 Turns	Event 41 LASER Trig	30.0 Hz	2054.063 Turns
Event 53 30 Hz	30.0 Hz	22.063 Turns	Event 244 Fla 4	6.0 Hz	5294.438 Turns	Event 49 Laser	6.0 Hz	2056.063 Turns
Event 54 20 Hz	20.0 Hz	23.063 Turns	Event 245 Fla 5	0.0 Hz	5309.688 Turns	Event 61 RTBT	6.0 Hz	2125.063 Turns
Event 55 10 Hz	10.0 Hz	24.063 Turns	Event 246 Fla 6	0.0 Hz	0.000 Turns	Event 60 RTBT Fast	6.0 Hz	2127.063 Turns
Event 56 5 Hz	5.0 Hz	25.063 Turns	Event 247 Fla 7	0.0 Hz	0.000 Turns	Event 59 RTBT Slow	1.0 Hz	2129.063 Turns
Event 57 2 Hz	2.0 Hz	26.063 Turns	Event 249 Test Net mark	0.0 Hz	0.000 Turns	<i>External Trigger Events</i>		
Event 58 1 Hz	1.0 Hz	27.063 Turns	Event 232 Dev Net mark	60.0 Hz	5616.750 Turns	Event 3 MPS-AR	0.0 Hz	0.000 Turns
Event 37 Beam Ref	60.0 Hz	2009.063 Turns	Event 233 Spare Net mark	0.0 Hz	0.000 Turns	Event 4 MPS-LATCH	0.0 Hz	0.000 Turns
Event 36 Beam on	6.0 Hz	2011.063 Turns	Event 250 MPS Snap	0.0 Hz	0.000 Turns			
Event 38 End Inj	60.0 Hz	5048.000 Turns	Event 251 Compute RR	0.0 Hz	0.000 Turns			
Event 39 Extract	60.0 Hz	5050.063 Turns	Event 244 RR Set	0.0 Hz	0.000 Turns			
Event 48 No Beam	6.0 Hz	5053.063 Turns	Event 253 MPS Err RST	0.0 Hz	6305.500 Turns			
Event 40 Kicker	1.0 Hz	5063.063 Turns	Event 254 Util Err RST	0.0 Hz	0.000 Turns			
Event 43 RTDL Send	60.0 Hz	5611.750 Turns	Event 255 Cycle 0	0.1 Hz	5620.188 Turns			
Event 44 RTDL Valid	60.0 Hz	5804.813 Turns						

The following table illustrates by example how to calculate the correct event link monitor time stamps for each event.

Event	Position calculation	Correct position
Beam Ref	5048-2939-100	2009
Beam On	Beam Ref+2	2011
Diag Fast	Beam On+2+20	2033
Diag Slow	Diag Fast +2	2035
Diag Demand	Diag Slow +2	2037
Diag Laser Trigger	5048-2929-100+20+15	2054
Diag Laser	Diag Laser Trigger +2	2056
Diag RTBT	5050 – 2925	2125
Diag RTBT Fast	Diag RTBT+2	2127
Diag RTBT Slow	Diag RTBT Fast +2	2129