NTF Interlocks Checking

What do the little LEDs mean?

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The NTF control system includes a special co-processor that shares a VME crate with the NTF local station. This 68000 cpu board runs a small program which performs certain NTF-specific checks relating to neutron beam delivery. This note describes these interlock checks the results of which can turn off the NTF beam and indicate the reason via a set of eight LEDs. These lights can be seen at the NTF station, but they are also part of the datapool that is available from node `061C` via the Arcnet connection. (See the document "NTF Connection" for a more extensive discussion.)

- ***Missing beam check***

Two toroids are used to measure beam for NTF. CTOR1 measures the beam that exits Linac tank 4, and CTOR2 measures the beam that is headed for the NTF target that produces the neutrons. There is a constant beam threshold that is used to discriminate whether either toroid reading represents *any* beam. That threshold, which is a program constant, is currently a value of 0.31 volts, corresponding to 3.1 ma using the current 100 ma fullscale value for those signals. Any reading less than this value is considered noise that is interpreted as no beam.

Both toroids are examined (in absolute value) every cycle. Only if *both* are below the threshold value, the pulse is ignored for purposes of determining missing beam status. If CTOR1 is above threshold, there is beam and CTOR2 is compared against a value of 0.68*CTOR1. If it is less, the transmission "around the bend" is considered too low, and the pulse is considered a "bad" beam pulse; if it is greater, then the pulse is a "good" beam pulse. After 15 valid beam pulses, if there are less than 8 "good" pulses out of 15, then Missing beam status results.

In the unlikely case that the reading of CTOR1 is below threshold, and the reading at CTOR2 is above the threshold, the pulse is counted as a "bad" beam pulse. In this case, the "missing beam" refers to inconsistent readings, as CTOR2 would not be expected to exceed CTOR1.

The missing beam logic does not depend on the ON-OFF sequencing described below. The determination is made after every 15 valid beam pulses.

- ***X1,X2,QP limit checks***

Long term accumulations are checked following the end of each ON sequence. Normally, the practice has been to program a sequence of 5 ON pulses followed by 0 OFF pulses, which just means that the following checks are made every 5 beam pulses. (Another detail relating to the #pulses in a sequence is that the long term accumulations for beam charge and ion chamber integrations are accumulated in a 16-bit word during the sequence. Since they are 12-bit resolution readings, keeping the #ON pulses below insures that there can be no overflow.) Note that a beam pulse here means any *scheduled* beam pulse, not one that is required to exceed the threshold described in the Missing beam section.

Each long term accumulation is compared against the established limit value. (See the

document "What are the Units of X1 LIMIT" for more details.) If the accumulation exceeds the limit, then the corresponding status results. This is the normal way that neutron dose treatments are terminated. (There are also hardware limits that are set slightly higher, including a time limit, as an extra measure of safety.)

- ***QP/X1, X2/X1 ratio check***

Ratio checks are made at the end of each ON sequence. The reference values for these ratios are stored in PROM and thus cannot be easily changed. This is intentional, for they are used to insure that the beam transport and neutron production are functioning normally as established via careful calibration. In the PROM are nominal and tolerance values for each ratio—and for each reference voltage as described below. If a ratio falls outside the tolerance window, the corresponding ratio status results.

- ***V1,V2 Reference voltage checks***

Reference voltages are checked at the end of each ON sequence. They are a measurement of the power supply voltages used for the integrators of the ion chamber signals. The nominal and tolerance values are kept in PROM. If a reference voltage falls outside the tolerance window, a voltage check status results.

- ***LED lights***

All eight checks are reported via a set of LEDs and also as data that can be monitored. Any LED that is set will inhibit further beam until CTF RESET is asserted.