

Booster Fault Study CA-223

C.J. Gardner

January 26, 2009

1 Study Plan

1.1 Goal

The goal of this study is to produce a loss of beam in Booster near the EBIS-Booster feed-through pipe openings and measure the resulting prompt radiation near the pipe openings in the Linac building. The study is to be conducted in accordance with C-A-OPM 9.1.9.

1.2 Conditions

1. The proton kinetic energy is 1.5 GeV.
2. The repetition period is at least 4 seconds.
3. The intensity in Booster at 1.5 GeV kinetic energy is no more than 5×10^{11} protons per repetition period.

1.3 Energy Deposition and Radiation Estimate

1. Under the above conditions the average rate of beam loss is at most 1.25×10^{11} protons per second. The average rate of energy deposition due to the loss is at most 30 watts.
2. Dana Beavis [1] has estimated the dose rate at the feed-through pipe openings in the Linac building due to a local beam loss near the pipe openings in Booster. According to his analysis the conservative dose rate estimate for a loss of 10^{12} protons per second at 2 GeV kinetic energy is 130 mrem/hr using the curves of Sullivan [2] and 4 mrem/hr using the Goebel [3] formula.

3. Under the conditions of this fault study the corresponding dose rates would be 12 and 0.38 mrem/hr.

1.4 Instrumentation

1. The beam current in Booster is to be monitored with the C6 current transformer.
2. Losses are to be monitored with the Booster RLM system.
3. Radiation surveys are to be conducted with the HP1010 meter or comparable instrument.
4. Chipmunk NM114 has been placed near the EBIS-Booster feed-through pipe openings in the Linac building. The scaler readout from this device is to be monitored (via the Chipmunk Viewer application) during the fault study.

1.5 Method

1. Prepare for the fault condition as per C-A-OPM 9.1.9.
2. With the beam OFF, measure and record the radiation levels near the EBIS-Booster feed-through pipe openings in the Linac building.
3. Set up acceleration of protons to 1.5 GeV kinetic energy in Booster. The standard magnetic cycle for polarized proton acceleration may be used.
4. Adjust the B6 dump bump and the radius so that at 1.5 GeV kinetic energy all (or most) of the beam is lost on the dump. (The revolution period at 1.5 GeV kinetic energy is 1.371331 MHz; the nominal magnetic field is 5414 Gauss.)
5. Measure and record the radiation levels under the loss condition. Record the beam current and losses throughout the magnetic cycle. **The beam loss is to be maintained only as long as necessary to make the measurements. Turn the beam OFF when not in use.**
6. Now adjust the dump bump and radius so that at 1.5 GeV kinetic energy all (or most) of the beam is lost near quadrupole QHC4.

7. Measure and record the radiation levels under the loss condition.
Record the beam current and losses throughout the magnetic cycle.
The beam loss is to be maintained only as long as necessary to make the measurements. Turn the beam OFF when not in use.

2 Results

We were able to produce beam loss in the region stretching from the dump at B6 to the C4 quadrupole. With 3.7×10^{11} protons lost in this region at 1.5 GeV kinetic energy per 4 second repetition period, the radiation levels measured by Ken Boland at the three feed-through pipe openings in the Linac building were 0.5, 0.7, and 0.5 mrem/hour. (0.7 mrem/hour is the reading at the center pipe.) The loss pattern in the Booster ring is shown in **Figure 1**. Here it is seen that the peak loss is centered on B6, B7 and B8. The peak to the right of this is at C4 and is most likely due to loss on the downstream end of the C3 inflector.

The recorded details of the study may be found in the 13–15 January 2009 FaultStudies-2009 elog and in the Fault Study Logbook residing in the Main Control Room.

References

- [1] D. Beavis, “Cable Penetrations into Booster for Ebis”, October 9, 2008.
- [2] A.H. Sullivan, “A Guide to Radiation Protection and Radioactivity Levels near High Energy Accelerators”, Nuclear Technology Publishing, 1992.
- [3] K. Goebel, et al., CERN LABII-RA/Note/75-10 (1975).

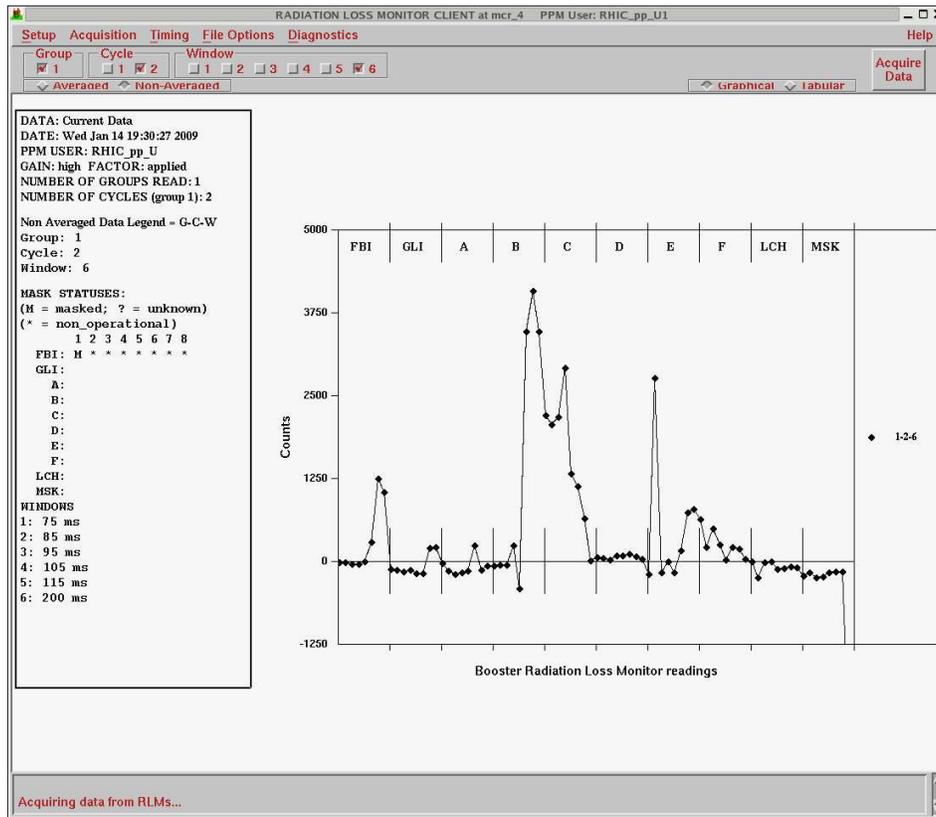


Figure 1: Losses in Booster under Fault Condition.