iii. Pulser and PFN Requirements and Design

A separate power modulator will provide the drive currents for each of the five abort kicker magnets in each RHIC ring (see block diagram Fig. 6-8). For each modulator an inductance of 100 nH was assumed for the sum of the inductance of the switch tube (80 nH) and the inductance of the cable connecting the modulator to the magnet structure. An additional inductance of 0.87 µH/m or 1.06 µH for the 1.22 m long magnet (including fringe fields) was calculated by finite element analysis run on the ferrite H-core magnet. Therefore, the total load inductance seen by the modulator is approximately 1.16 µH, and in order to achieve the ≤1 µsec rise time a PFN impedance of approximately 1 Ω is required if the modulator is operated into a shorted magnet.

The beam absorber will be capable of sustaining a bunch overlap of less than 10 (the equivalent of 10 bunches hitting the same spot on the target). To accomplish this, the beam must always be moving across the face of the target. Simulations show that a magnetic field pulse which rises by approximately 45% in oscillatory fashion during the 13 µs pulse length will sufficiently spread the beam resulting in a bunch overlap of less than 10. Both the ramp and the oscillations can be accomplished by using a PFN in which the impedance of the network is tapered from one end to the other and the impedance of the output cell is mismatched. Table 6-2 summarizes the power modulator requirements and design.

SPICE simulations have been run and a model has been built for the circuit shown in Fig. 6-9 which was designed to meet the above requirements. The computed output current is shown in Fig. 6-10 for the charge voltage of 33.3 kV as required at top field.

The PFN charging supply will have to track the beam energy from injection through acceleration and make up any lost charge due to leakage currents while the beam is stored. The supply will be required to ramp the voltage on the PFN from the injection energy voltage to full voltage in ~1 min. The modulator tubes will always be sitting at the proper voltage (± 5%) required for safe extraction for all points along the injection, acceleration and storage cycles. Failure in any of the critical components, in particular the 50 kV power supply and delay generators, must cancel the "beam allowed" status. In the event of sensing loss of, or out of specification voltage, on any modulator, the beam abort link will be pulled in order to effect safe extraction immediately. The most economical way of ramping up the charging voltage on the five PFN's is by using a single power supply feeding the five PFN's (refer to block diagram Fig. 6-8) which tracks the ring dipole magnet

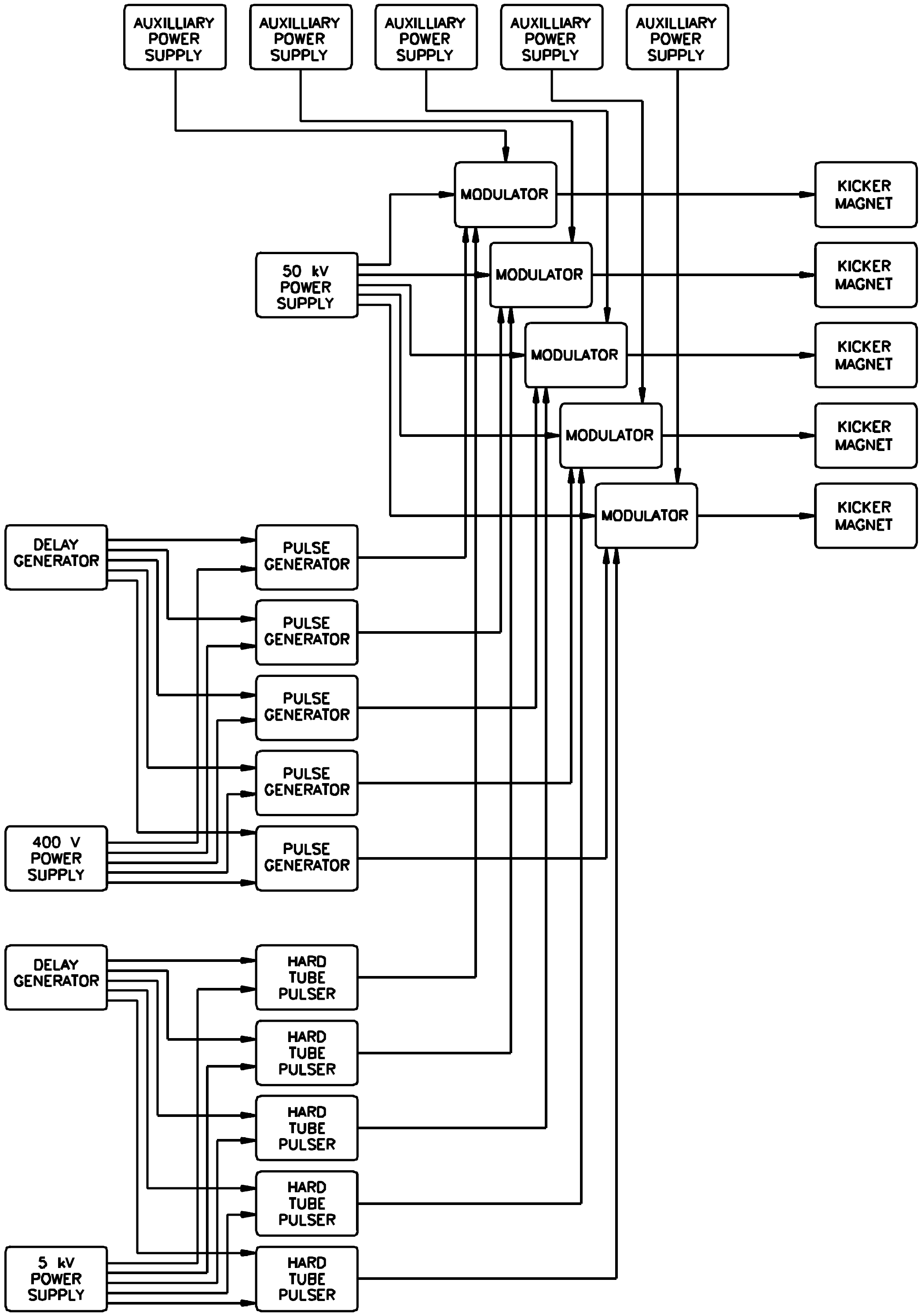

Fig. 6-8. Abort kicker power supply block diagram.

Table 6-2. Kicker Modulator Requirements

Requirement	Value
Power supply rating	50 kV
Charge voltage @ top energy @ injection	33.3 kV 4 kV
Voltage tolerance	± 5 %
Minimum voltage charge time from injection to top energy	60 s
Kicker current min. @ top energy max. @ top energy	13.3 kA 20.2 kA
Current tolerance	+10%/-20%
Pulse width	>13 μs
Rise time	<900 ns
Fall time	Not Applicable
Jitter	<10 ns
Maximum pulse repetition rate	1 pulse per minute
Load impedance	1.16 μH
Dimensions, each modulator (H×W×D)	183×61×94 cm (72×24×37 in.)

current through a Real Time Data Link (RTDL) from the central control system. The details of beam tracking and coordination with either single or multiple charging supplies have not yet been worked out.

In order to minimize the cable lengths between modulators and kicker magnets, each PFN will be contained in a separate enclosure which will be placed underneath the beamline directly below its corresponding magnet.

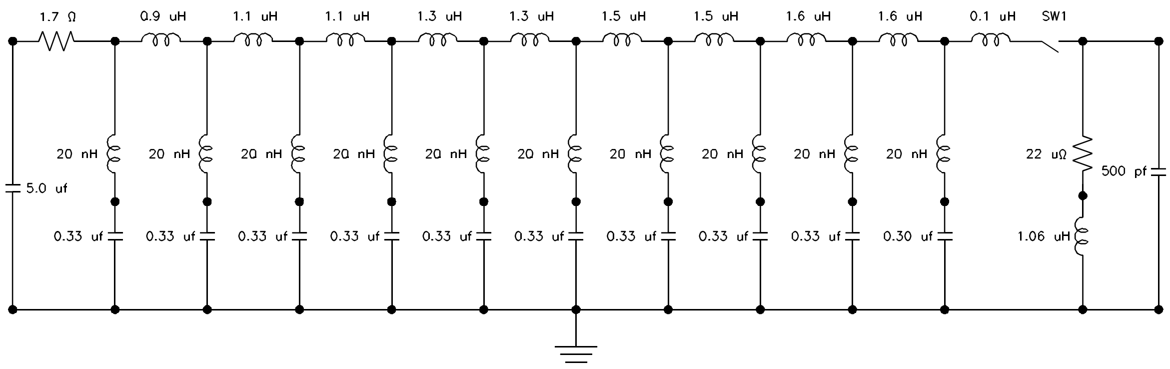

Fig. 6-9. Abort kicker Pulse Forming Network (PFN) SPICE simulation circuit.

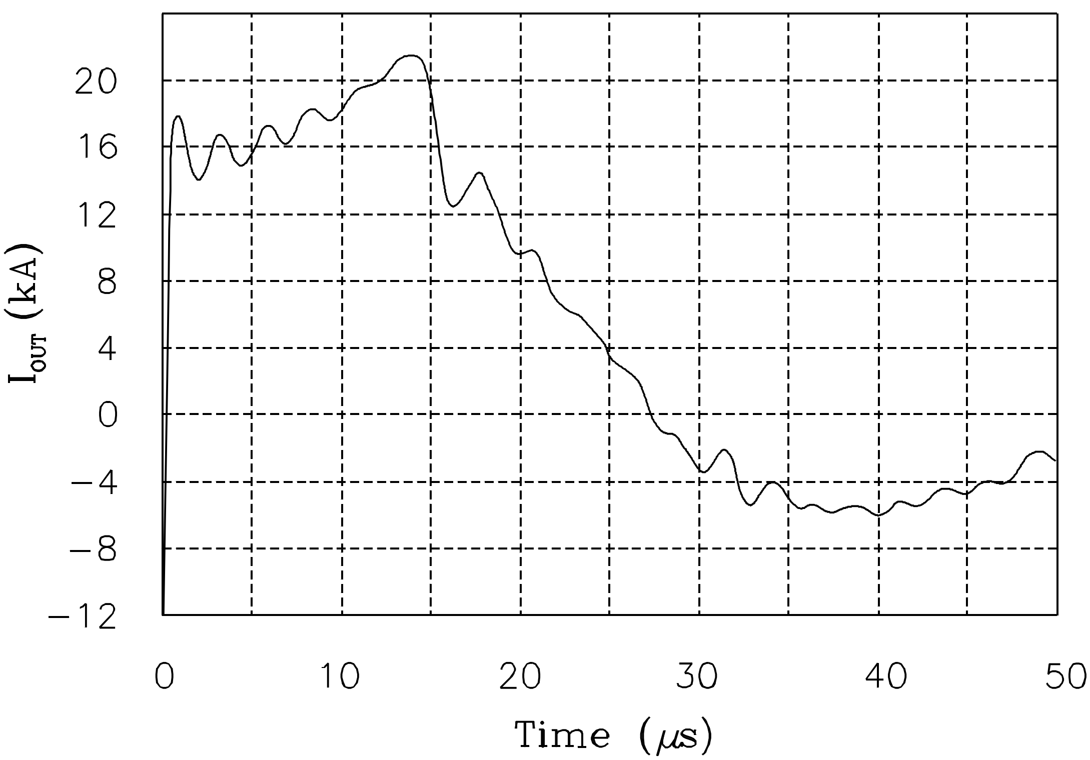

Fig. 6-10. Output current waveform for V_{0ut}= 33.3 kV.