temperatures below the liquid nitrogen temperature, was conducted in a liquid helium cryostat. For this the HTS leads were connected in series with the conventional copper current leads in the vapor column (Fig.A.3.1) of the cryostat feeding a SC magnet dipped in liquid helium.

All the electrical measurements were carried out using the standard four-probe method using a nano-voltmeter (Keithley 182) with power fed by 1200A-3V current source. The current was ramped at the rate of 0.5 A/Sec. The critical current I_C is defined to be that value of current, which generates an electric field of 1 μV/cm across the HTS leads. This exercise was repeated to observe the reproducibility after thermal cycling.

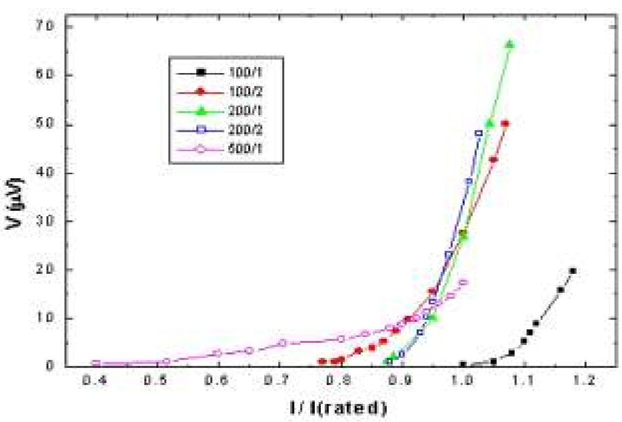

Fig.A.3.2 : The V-I characteristics of the HTS leads

The V-I characteristics (Fig.A.3.2) of the HTS leads were determined by increasing the current in discrete steps and recording the corresponding voltage drop. After each increment in the value of current, sufficient time delay was given to get the steady state voltage drop. This was done to ensure that the HTS lead was operating in thermal equilibrium with the surrounding liquid nitrogen. The measurements were continued till the voltage drop across the leads reached up to the level of 60 μV. Similar exercise was repeated both while increasing and decreasing the current.

The long duration testing at T~77 K was done by ramping the current up to 90 % of I_C. The current was kept stable at this value and then the voltage was recorded across the leads with respect to time. No thermal runaway was observed over a period of about 5 hours. To evaluate the operational stability of the HTS leads at temperatures below 77K, two leads marked 100/1 & 100/2 were connected to feed a current of 1000 A to a SC magnet for duration of about an hour. The temperatures recorded (using DT-470) were from 10 to 30 K The leads showed a stable behavior in the helium vapor column and did not show any thermal runaway with this current level at temperatures below 77K.

In conclusion, the critical current carrying capacity of five HTS leads has been evaluated at liquid nitrogen temperature. All the leads showed a stable behavior with respect to time, at liquid nitrogen temperature and there was no degradation in the self-field I_C after passing current for time periods of about 5 hours. The leads showed no signs of thermal runaway when they were connected to a SC magnet powered with a current of 1000A. This stable behavior at such a large current was consistent with the expectation that the I_C would enhance by about 4 to 5 times as the temperature is lowered.

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A.4 : Status of Indus controls

Indus control system is under continous evolution in order to fulfill the new requirements and offer enhanced features and services to users. Following newer aspects need mention:

1. New Independent References for Booster Quadrupole Power Supplies (Qd & Qf):

The earlier scheme provided for currents in quadrupole supplies (Qd, Qf) with linear proportionality to main dipole current. It is however felt that to get a better performance of the synchrotron, (1) the quadrupole strengths should be changed in a complex manner during ramping, (2) the reference of the QP secondary power supply should vary independently based on the look up table to provide greater flexibility of the QP strengths. Accordingly a new scheme for energizing the quadrupole power supplies of booster synchrotron has been developed. The output of the booster dipole current is given to the reference input of the multiplying DAC through the isolation (Fig A.4.1). The reference is generated as y = m x + c where x is the input from booster dipole current, m is the multiplying factor, and c is the offset.

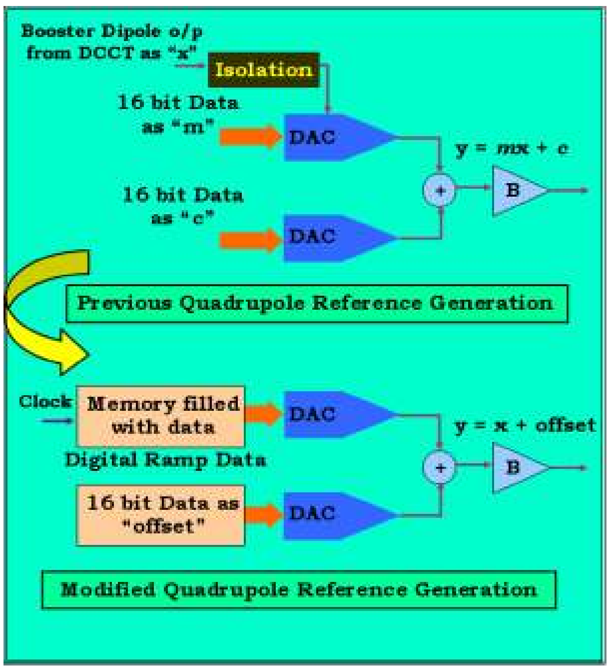

Fig.A.4.1 : Modified quadrupole reference generation

The modified reference is independent of the booster dipole current, as desired and synchronized with ramp start of booster dipole (Fig. A.4.1). The reference is generated as number of defined arbitrary points and linearly interpolated points in-between. This allows flexibility in the shape of the reference

The system is realized using VME hardware based around M68000 CPU board with OS-9 for delivering the required references to power supplies and a GUI application written in Visual C^{++} on PC to handle all the commands and monitoring of the references.

2. Improvement of Booster Injection Timings:

New time delay generator boards have been developed and put into operation in the timing system. These help to minimise the 100 ns occasional shift (Fig. A.4.2 and Fig. A.4.3) between the trigger signals of booster injection kickers K_2, K_3. The new boards facilitate the generation of coarse delay for the microtron modulator trigger and booster injection kickers K_1, K_2 and K_3 all from the same board and fine delays for all the above from another board, thus minimising the relative shift among these signals. The overall timing jitter in the trigger signals to three kickers now is reduced to less than 5 ns (Fig.A.4. 4).

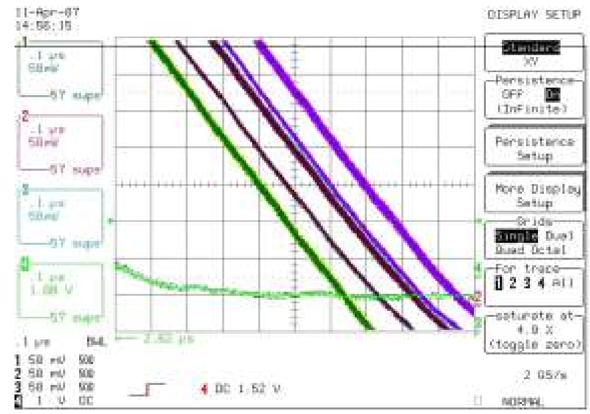

*Fig.A.4.2 Persistent mode display of kicker waveforms (falling edge) – **100 ns shift***

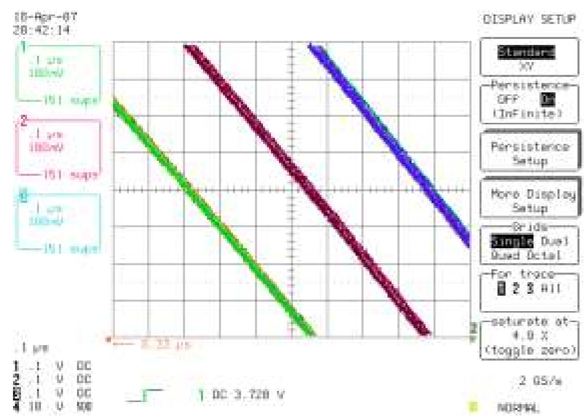

*Fig.A.4.3 Persistent mode display of kicker waveforms (falling edge) – **100 ns shift removed***

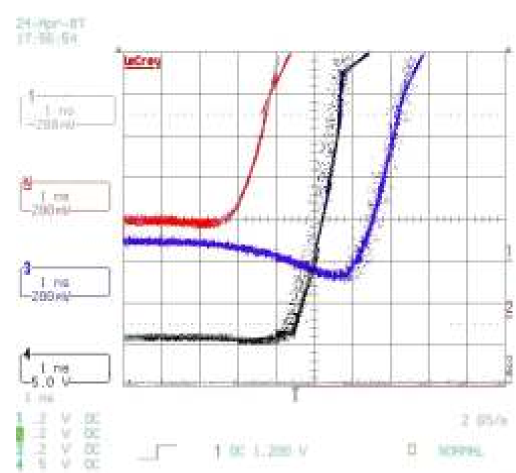

Fig. A.4.4: Persistent mode display of trigger pulses to the three3 kicker power supplies (jitter < 5 ns)

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