LONGITUDINAL QUADRUPOLE MODE FEEDBACK TESTS

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Abstract

A copper RF unit was used to try to damp the longitudinal quadrupole mode oscillation seen at 22 GeV in LEP. Either the electron or positron bunches could be damped but not simultaneously due to the limitation imposed by the cavity fill-time.

1 INTRODUCTION

In October 1998, tests were carried out of a longitudinal quadrupole mode damping system. A strong quadrupole oscillation is observed in LEP during accumulation when the total current reaches about 4.8 mA.

Unfortunately, the fill-time of the copper cavities excludes their use for simultaneously damping electrons and positrons (a Q_s split, as was used for the original dipole mode feedback system, is no longer feasible without switching off the superconducting cavities at injection). However damping of the $2Q_s$ signal on one set of particles could still be of use to facilitate the proper functioning of the Q-loop.

The purposes of these tests were firstly to find a suitable detection method for the $2Q_s$ signal and secondly to attempt to damp it for either electrons or positrons using one of the copper RF units.

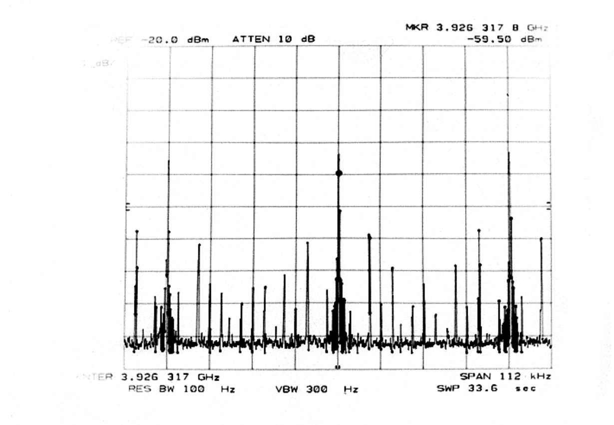

Figure 1: HOM spectrum from 1 GHz cavity. Centre frequency 3.926 GHz, span 112 kHz. 22 GeV, 5.5 mA total current.

2 SYSTEM DESCRIPTION

The 3.9 GHz HOM output of one of the 1 GHz cavities of the LEP longitudinal feedback system was found to be well suited as a means of detecting the $2Q_s$ signal, being strongly amplitude modulated. These cavities are situated far from the interaction point, thus facilitating separation of the positron and electron signals. The $2Q_s$ sidebands in the HOM spectrum, ± 3 kHz from the revolution frequency harmonics, are clearly visible in Fig. 1.

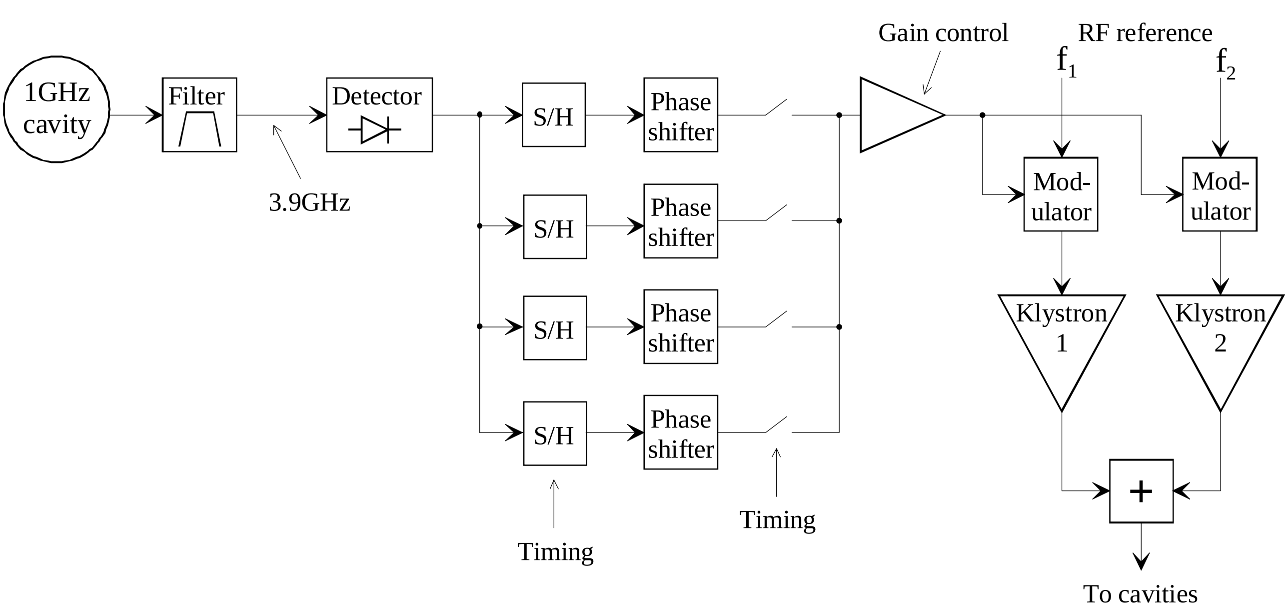

Figure 2: Longitudinal quadrupole mode feedback system.

Due to its proximity to the 1 GHz cavities, RF unit 631 was chosen for installation of the test system. A block diagram of a complete system is shown in Fig. 2. After detection, the signals from each bunch enter the individual sample-and-hold circuits. They then pass through variable delays before they are recombined, timed so as to act on the correct bunch one turn later. After passing through a common gain control element, the signal is used to amplitude modulate both of the klystrons of the copper unit.

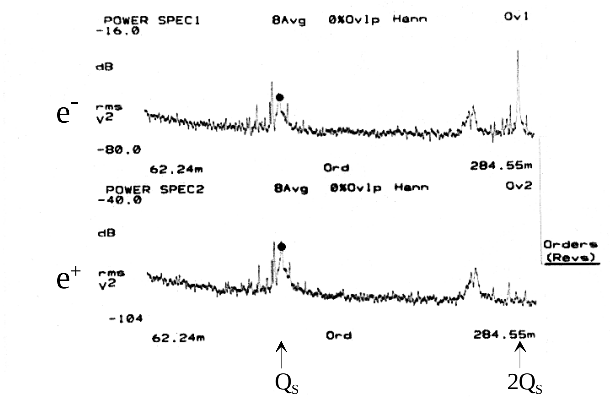

Figure 3: Control room Q_s display. Quadrupole longitudinal feedback operational on positrons.

3 RESULTS AND CONCLUSIONS

The system was set up during accumulation for physics. Injection conditions were standard (total of 500 MV) with the exception that the copper RF unit 631 was set to 20 MV. The 1 GHz dipole longitudinal feedback was operational. With low gain, the phase shifters were adjusted. The gain was then increased until the $2Q_s$ signal was well damped. Satisfactory operation was achieved with either electrons or positrons. The control room Q_s display with quadrupole feedback on positrons is shown in Fig. 3. The plot was taken with a total of 6 mA beam current at 22 GeV. The large peak at $2Q_s$ visible for electrons is damped for positrons.

Feedback on only one particle type has only the limited use of facilitating operation of the Q-loop. However the installation of a definitive system is relatively inexpensive and does not interfere with the operation of the copper RF unit for acceleration. One is therefore being installed.