Presentation 72

Control Room Diagnostics

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Under this heading diagnostic equipment which concerning the RF system is described.

72.1 Q_s measurements

The synchrotron frequency is measured with the bunch RF phase measurement system developed for the longitudinal feedback system but only the signal from one bunch is used. The main characteristics of this system are:

1. Dynamic range: 5 μA to 2.5 mA/bunch
2. Resolution: 0.1 degree RF ($\delta E/E$ = 11 ppm)

Excitation was foreseen but has never been used because the bunches always oscillate, even at very low intensities.

Two systems have been installed. This allows for simultaneous Q_s measurements of electrons and positrons.

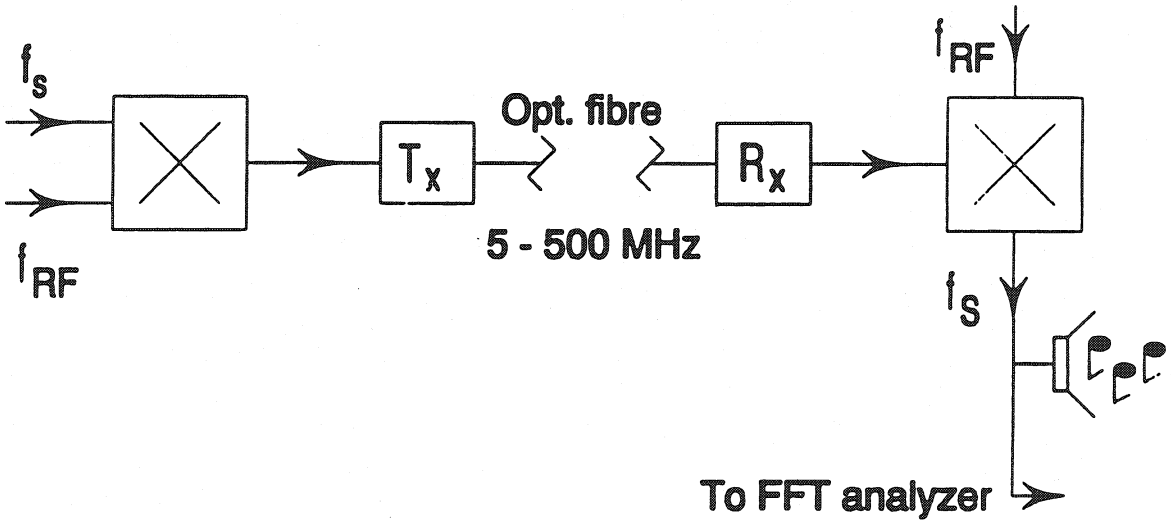

Figure 72.1: The Q_s Transmission System

At present the synchrotron frequencies are transmitted to the PCR via optical fibres (Figure 72.1). Due to the frequency range of the fibre links (5-500 MHz), amplitude modulation with the RF frequency as carrier is used. In the PCR the signals are applied to a two channel FFT spectrum analyzer. One of the signals is also connected to an audio amplifier and a loudspeaker.

It is planned to connect the spectrum analyzer to the PCR network so that the signals can be seen on an Apollo screen.

Next year when the multiplexing equipment for the global voltage control system has been installed it is planned to use two audio channels for the Q_s transmission and use the two optical fibres for diagnostic purposes as originally foreseen.

72.2 Mountain range display

A mountain range display has been developed for direct observation of longitudinal dipole oscillations. The instrument can also be used for the optimization of the injection phase. In this case the bunches should be injected in an empty ring. An already circulating beam would upset the trigger and mask the oscillations of the newly injected bunches.

Figure 72.2 shows a block diagram of the system. The beam signal is taken from a sum pick-up in RA 27. This signal is applied to a Tektronix 11302A 'Brighteye' oscilloscope which has a very fast writing speed (6 cm/ns). This feature is required because of the extremely wide bunch spacing in LEP. The oscilloscope trace is read by a video camera and stored in a VME frame store.

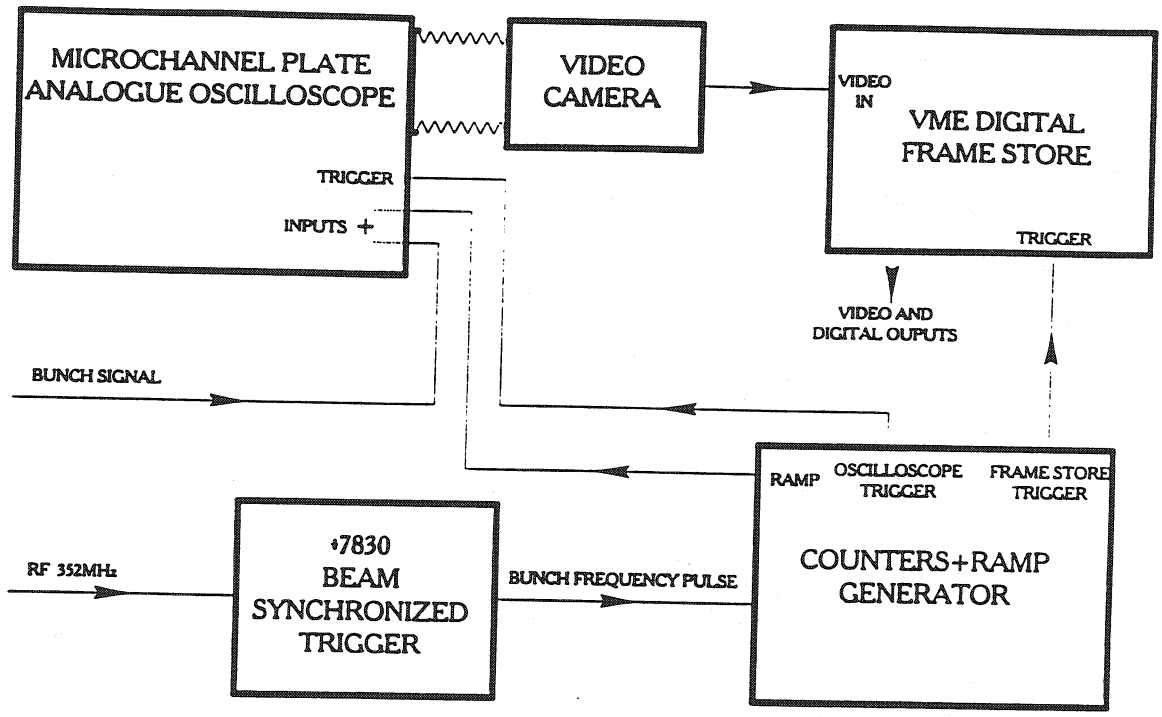

Figure 72.2: Mountain range display block diagram

The system has the following features determined by the counters and the ramp generator:

1. One or two bunches out of 36 can be selected.
2. Number of revolutions / trigger can be any number between 1 and 16.
3. Number of lines / picture can be any number between and 64.
4. Picture updating: Manual or automatic.
5. Resolution: ~50 ps. Limited by the oscilloscope bandwidth and the attenuation in the 40 m of coaxial cable between pick-up and oscilloscope.

In Figure 72.3 results without and with dipole oscillations are shown. It is found that Q_s is about 0.04 from the number of revolutions per oscillation period.

The display is transmitted to the PCR by video or in digital form through the LEP control system.

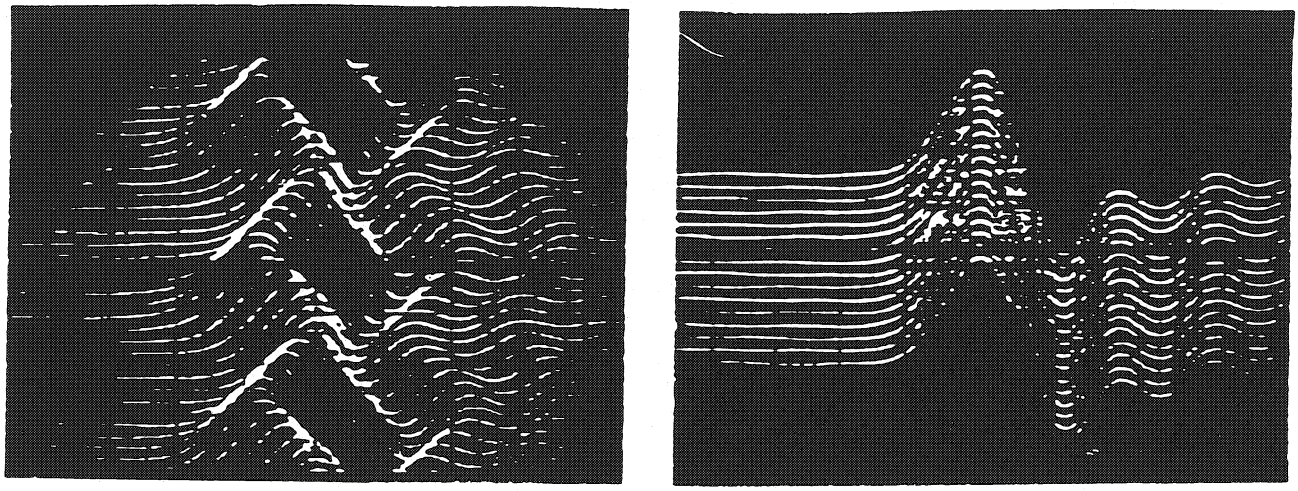

Figure 72.3: Results. Two revolutions/trace. 500ps/division

72.3 Bunch "position" measurements

The collision points are measured with a programmable delay generator (developed by J. Sladen) which is used to trigger an oscilloscope at the bunch frequency a certain number of buckets after a reference bucket. With a sum pick-up signal applied to the oscilloscope the number of RF periods between the passage of an electron and a positron bunch can be measured. For correct collision point and with the present pick-up position the electron bunch should precede the positron bunch by 354.3 RF wavelengths.

This system is also used to check for 'guest bunches' but it has two drawbacks:

1. There is no synchronization between the reference bucket and the injection timing. This means that the correct settings on the delay generator change in case of a power cut. If phase stable optical fibres are installed in the links to P4 and P8 this can be cured by sending a reference pulse from the RF injection timing system to the delay generator.
2. The measurement is tedious and time-consuming, especially if it is used to check for "guest bunches". However, the system cannot be made automatic because no bunch counting system can reliably distinguish between reflections from a large bunch and a small "guest bunch".