INTRODUCTION

Most instruments have been able to cope with the introduction of the four additional bunches of the Pretzel scheme, except the 32 BPMs near mi-arc and the BEXE detectors for which the signal multiplexing had to be redone. With bunch trains (B.T.) many instruments were unprepared to gate on individual bunches and lots of modifications have been proposed in 1994 [1] and realized since, some are still in the pipeline. Here is a status report on the performance of different instruments.

BUNCH CURRENT TRANSFORMERS (BCT)

For pretzel operation BCTs were acquired in parallel through 16 independent electronic channels which limited the accuracy of the bunch to bunch calibration to about 2-3 %. The relative precision (typically 90×10⁻⁶ in 1994) allowed measurement of individual bunch lifetimes.

Lecroy oscilloscopes with 8-bit fast sampling have been used in order to separate bunches in trains. The result was excellent for bunch to bunch normalisation, since all measurements went made through the same channel. But relative precision of single bunch measurements (typically 500×10⁻⁶) is insufficient for single bunch lifetimes.

In the course of 1996 a new acquisition system will be implemented which uses BOSC-type 16-bit acquisition channels and should have the advantages of both preceding systems so that BCTs should perform well, in the future, with either type of LEP filling [2].

BOM NB

The additional bunch crossings introduced at mid-arc by the Pretzel scheme rule out the measurements made with the 16 BPMs at QD48 and the measurements made with the 16 BPMs at QD46 are valid only for one of the beams (the one going toward the mid-arc crossing).

With B.T. a number of BPMs located from Q5 to Q9 can measure only the beam incoming toward the IP [3] and therefore do not deliver a complete information on the closed orbit [4]. In order to suppress this inconvenience in the even straight sections it has been decided to convert four BPMs on each side of even IPs, from NB to WB electronics. This conversion will be effective in 1997.

BOM WB

This system suffered no limitations with the addition of the four Pretzel bunches.

In order to cope with the B.T. mode an external triggering [5] has been introduced in 1995, in order to enable the measurement of all individual bunches. Since the WB signal detection needs a clean interval of ±40 ns, a BPM cannot work in the vicinity of a bunch crossing (±6 m). This condition was excluding the measurements at the 8 QL4 with trains of 3 bunches separated by 87 λRF.

In the future, when 32 more BPMs will be equipped with WB electronics in the even straight sections, the number of those put out of service, in function of the bunch separation, is shown in fig. 1.

TUNE METERS

A new generation of tune meters is now available at LEP and they provide a full functionality for both schemes. With bunch trains, the BPMs used for the vertical tune measurements would not work with a bunch separation lying in the interval 140 to 170 λRF. The shaker used for bunch excitation has a rise time of 2 µs for high power and of 300 ns for low power excitation which makes it impossible, resp. difficult to excite individual bunches in a train. On the observation side, when the two couplers are used instead of the normal buttons in order to enhance the sensitivity needed to observe π and σ-modes, for example, there is some crosstalk between bunches in a train, due to the limited cable bandwidth.

SYNCHROTRON RADIATION TELESCOPES (BEUV)

In the normal mode of TV observation (20 ms integration) the measured beam sizes stem from a superposition of all bunch images, including beam oscillations and systematic closed orbit differences. This latter effect exists with bunch trains and can lead to some blow-up of the measured emittances.

When the information is read in the burst mode, the use of the new microchannel plate amplifiers (MCP) allows the separation of bunches even within trains.
**Fig. 1** BPMs out of service with trains of two bunches, versus bunch separation

**X- RAY MONITORS (BEXE)**

BEXE detectors allow turn by turn observation of vertical bunch sizes. In order to gate on a given bunch in a train, pulsing of the detector bias voltage has been introduced which has a minor drawback of spoiling 3 to 4 of the 64 channels. BEXE detectors are being displaced from QL12 to QL8 in order to remain exposed to the same level of synchrotron radiation doses at LEP2. There is no indication that Pretzel or BT closed orbits should create any problem.

**STREAK CAMERA**

Now that a new card has been developed to trigger the camera at any moment in the cycle with a jitter of less than 4 ps, any configuration of bunches can be programmed to appear on the live display available at PCR.

**LUMINOSITY DETECTORS**

The acquisition system of the 8 pairs of Bhabha detectors has been adapted to allow parallel data taking for trains with up to four bunches and has been very much used for luminosity scans during 1995. In the upgrade of the system necessary to cope with the higher background to signal ratio at LEP2, this facility will be preserved so that there is no limitation of use of this detector in either configuration.

**POLARIMETERS**

The main difficulties encountered during polarimeter runs in 1995 come from synchrotron radiation produced by the B.T. vertical separation bump at IP1. The mirror with a multilayer dielectric coating which deflects the laser beam to meet with the electron beam has been damaged by s.r. during 1995 and will be replaced, for the future, with a more stable all metallic mirror [6]. The problem encountered with outgassing of the supporting structure should be solved by suppressing its nickel oxyde coating [6]. But it remains sure that this mirror system is more vulnerable to s.r. swept in the vertical plane with the B.T. separation bump than to s.r. stemming from the Pretzel orbit.

**BEAM LOSS MONITORS (BLM)**

The use of certain monitors has been limited through the strong synchrotron radiation produced in the vertical separation bumps. This inconvenience should be cured with an additional shielding of the diodes (4 cm instead of the present 5 mm) which will be installed during the present shut-down.
Table 1. Remaining limitations in the use of beam instruments

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Pretzel</th>
<th>Bunch Train</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCT</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>BOM NB</td>
<td>$8 \times 4$ BPM missing in mid-arc</td>
<td>$4 \times (2 \text{ to } 3 \text{ BPM})$ missing in odd straight sections</td>
</tr>
<tr>
<td>BOM WB</td>
<td>none</td>
<td>according to bunch separation</td>
</tr>
<tr>
<td>Tune-meter</td>
<td>none</td>
<td>no individual bunch excitation some coupling in bunch observation</td>
</tr>
<tr>
<td>BEUV</td>
<td>none</td>
<td>bunch size is influenced by closed orbits</td>
</tr>
<tr>
<td>BEXE</td>
<td>none</td>
<td>small limitations due to bias pulsing</td>
</tr>
<tr>
<td>Streak camera</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Luminosity det.</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Polarimeters</td>
<td>none</td>
<td>mirror for laser beam is heated by s.r.</td>
</tr>
<tr>
<td>BLM</td>
<td>no experience</td>
<td>use limited by synchrotron radiation</td>
</tr>
</tbody>
</table>

REFERENCES