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U. Bizzarri and A. Turrin: RESONANT EXTRACTION FROM THE 1 GeV FRASCATI ELECTRON SYNCHROTRON. -

(Nota interna: n. 276)

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(Submitted for publication to the Nuovo Cimento).

The 1000 MeV electron beam has been extracted from the Frascati Constant Gradient Synchrotron[1] on February 11, 1965 by exciting the 2 radial betatron oscillations/ 3 revolutions resonance[2]. The first successful extraction trials were made at 400 MeV on November 23, 1964.

In this method, pulsed currents are fed at the end of the acceleration cycle into few wires of the pole face windings, connected in a non-inductive loop (see Fig. 1), in order to obtain the eight regenerative "$\pm \eta$ regions" of reference (2).

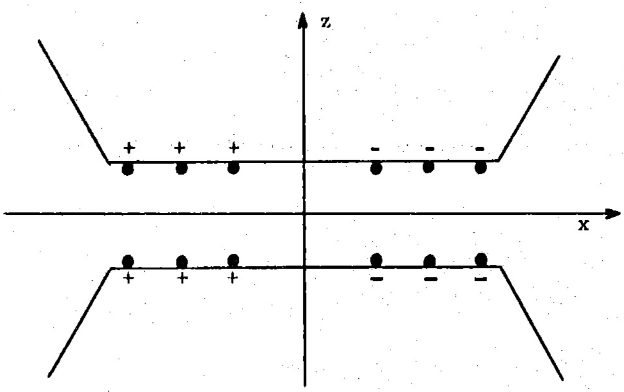

FIG. 1

This perturbation is strongly non-linear: the corresponding $\Delta B_z(x)$ variation is represented in Fig. 2.

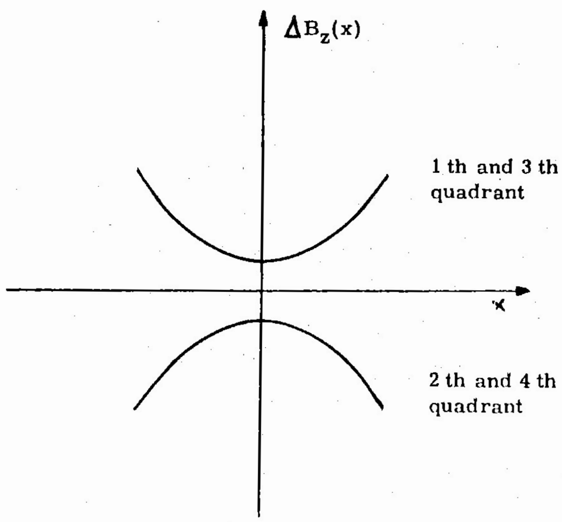


FIG. 2

The purpose of this non-linearity is to obtain a long spill-out time. As long as the beam is circulating close to the central orbit, the perturbation is unable to bring the oscillations into resonance. When the particles are caused to fall out of synchronism with the R. F. cavity (by reducing the R. F. peak voltage) they move inward, into the region in which the regenerative action of the field causes their betatron oscillations to grow rapidly. In this way the particles can be brought with high efficiency into a first "soft" pulsed magnet placed in the inner region of a straight section. This magnet deflects then the beam again to the inside. A second "hard" pulsed magnet placed in the next straight section deflects the particles outwards, so that the beam emerges at the end of the following quadrant, crossing a one-millimeter aluminium window.

The caracteristics of the external beam are at present the following:
i) the intensity is about $10^9$ electrons per pulse, or $2 \times 10^{10}$ electrons/ second; on this basis the extraction efficiency is roughly estimated to be $\gtrsim$ 60%.
ii) the emittance of the beam, estimated in air about five meters from the exit window, is $< 10^{-2}$ cm· rad in horizontal and few $10^{-3}$ cm· rad in vertical at 1000 MeV. This spread can be explained almost entirely with the scattering in the aluminium window and in the air.
iii) for spill-out times of $\simeq$ 2 msec the momentum spread remains bounded within $\pm 0.3$ % and appears to be due almost entirely to the variation of the guiding field during the spill-out time. Spill-out times up to about 4 msec can be easily obtained.

The gap's dimensions of the "soft" magnet are $20 \times 11$ mm$^2$, the septum thickness being 1 mm. The lenght is 30 cm. The "hard" magnet is like the "soft" one, with the septum thickness increased to 6 mm for cooling purposes.

The currents required for extraction at 1000 MeV are:
30 Ampères in the pole face windings;
550 Ampères in the "soft" magnet;
3500 Ampères in the "hard" magnet.

More details about the whole work will be given in a paper to be soon published.

The results above may encourage the attempts to apply the same extraction method to Constant Gradient Proton Synchrotrons.

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