First beam results of the ESRF Preinjector

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Abstract

The paper describes the beam measurements obtained during the commissioning of the 200 MeV ESRF preinjector. Both the results obtained for the 1 µs long pulse mode and for the 2 ns short pulse mode are reported.

1. INTRODUCTION

The 200 MeV linear electron accelerator of the ESRF was installed at the beginning of 1991. The preinjector, together with the transferline between linac and booster was partly commissioned in June 1991. The commissioning was completed in January and February 1992.

The accelerator operates in two different beam modes. In the long pulse mode the pulselength varies between 200 ns and 2 µs. This mode is used for multibunch operation of the storage ring. For single bunch mode the preinjector must deliver pulses with a maximum pulselength of 2 ns.

2. LONG PULSE MODE

In the long pulse mode the peak currents, within ± 1 % energy spread, of 25 mA were measured conform to the specified values.

The energy spectrum was measured using the signals obtained with the current transformers at the end of the accelerator and at the end of the transferline respectively. With the adjustable energy slits between the two dipole magnets the energy selection bin can be adjusted

In figure 2, two measured spectra are shown, one for a 39 mA / 1 µs beam at the end of the linac, one for a 39 mA / 2 µs beam.

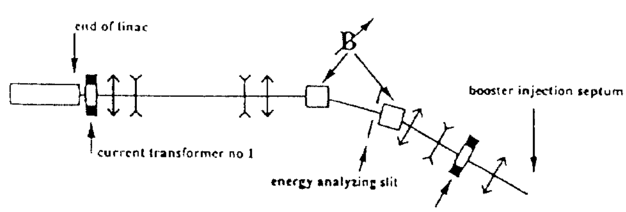

Figure 1 : Principle of energy spectrum measurements.

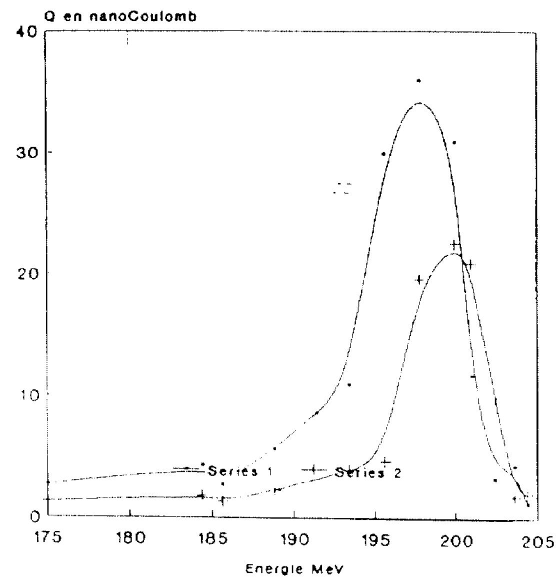

Figure 2: Long pulse energy spectra. ■ : 1 µs pulselength, + : 2 µs pulselength. The energy slits were positioned at ± 1 %. The ordinate gives the electron charge in nC, measured behind the energyslits.

Emittance measurements for the long pulse mode were performed using the horizontal / vertical wirescanner which is installed in the first straight section of the transferline. Profiles are measured for varying settings of the first two quadrupoles of the transferline (focussing and defocussing quadrupole respectively). The following values (FWHM) were obtained at 200 MeV, 1 µs pulselength:

Peak current 8 mA:

$ex = 40\ 10^{-9}$ m.rad, $ey = 60\ 10^{-9}$ m.rad

Peak current 25 mA:

$ex = 70\ 10^{-9}$ m.rad, $ey = 107\ 10^{-9}$ m.rad

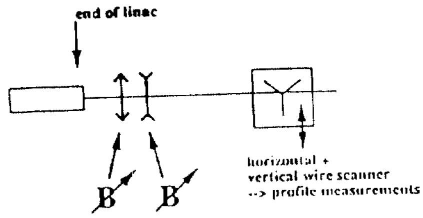

Figure 3 : Principle of emittance measurement

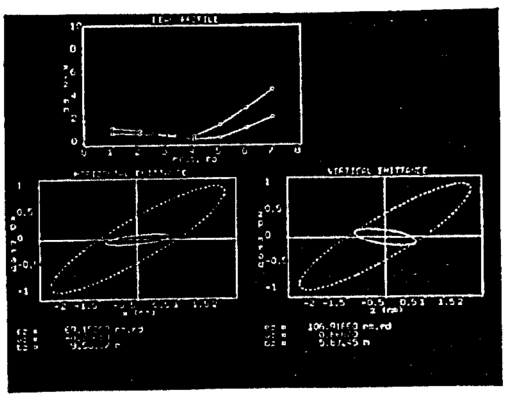

Figure 4 : Measured profiles and resulting horizontal and vertical emittance. Beam parameters: E = 200 MeV, I_{peak} = 25 mA, T_{pulse} = 1 µs.

3. SHORT PULSE MODE

The specified beam characteristics for the short pulse mode are : pulselength ≤ 2 ns, I_{peak} = 250 mA (electron operation), I_{peak} = 2.5 A (corresponding to a possible future positron extension).

Peak currents ≥ 2.2 A, with a pulselength < 2 ns were measured using a wall current monitor at the end of the linac.

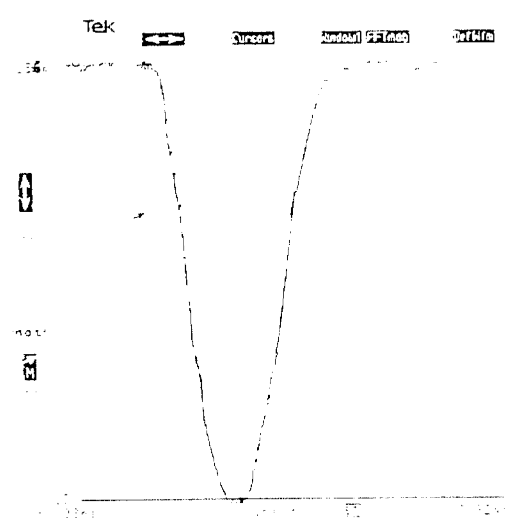

Figure 5 : Measured 2 ns beampulse. The peakcurrent corresponds to 2.2 A.

Although no complete spectrum measurements have been made for the short pulse mode, it could be seen from the fluorescent screen in front of the transferline energyslit that the total current is comprised in an energy bin of maximum ± 1 %.

An important factor for the 2 ns operation is the jitter which exists between the external trigger, delivered by the ESRF bunch clock and the actual beam. Since the 3 GHz of the linac is not synchronized to the 352 MHz frequency of the bunch clock a intrinsic jitter of 330 ps will always exist between the beampulse and the pulseclock. Jitter measurements were performed, both for the non-modulated beam immediately after the gun and for the modulated beam at the end of the linac. At the end of the gun the measured jitter is of the order of 100 ps, and therefore the total jitter is completely determined by the 330 ps intrinsic jitter.

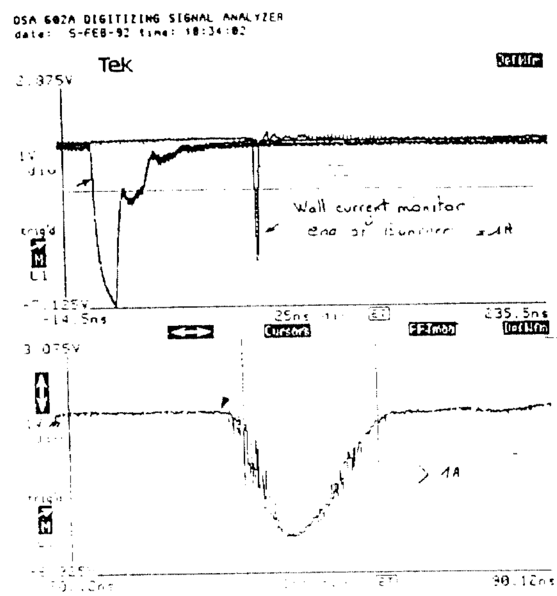

Figure 6 : Jitter measurement between the 3 GHz modulated beam and the external trigger from the 352 MHz bunch clock.