31/07/92

Proposal for an extraction scheme to reduce the TESLA Damping Ring circumference.

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The present TESLA damping ring circumference is dominated by the necessary rise and fall time of 25 ns between each of the 800 bunches for the extraction kickers leading to a total circumference of 6.3 km.

An extraction scheme is proposed below which is compatible with a distance between bunches of 3.08 ns (or 4 times the 1.3 GHz wavelength of the linac) leading to a more reasonable total damping ring circumference of 738.5 m.

It is based on a local orbit deformation at the extraction septum induced by RF transverse deflectors. Powered some msec before extraction at a sub harmonic (or a combination of sub harmonics), of the bunch repetition frequency, **they produce a local closed orbit deformation different from bunch to bunch.**

Principle of the RF local bump at a sub harmonic 4

Lets first assume a distance between bunches of 6.16 ns (Fig.1). A set of two RF horizontal deflectors powered with a sub harmonic 4 of the bunch repetition frequency (40.6 MHz) are placed at π/2 phase advance from the extraction septum with an RF phase adjusted to cancel each other. They produce a local bump with amplitudes varying from bunch to bunch (Fig. 1). As a result, the bunches with a closed orbit close to the septum have an interval

four times larger than the bunch separation, then 24.5 ns, just enough for the kicker rise and fall time.

In the example shown on fig 1 answered

The bunch #6 can then be extracted without affecting the bunches #2 and #10. The residual kick affecting the bunches 3,4,5,2,8,9 is too small to extract them because of their larger distance from the septum. It is canceled by a second kicker at π phase advance powered by the same current in series with the first one for an exact cancellation.

Use of a combination of sub harmonic

The distance between the bunches close to the septum can be increased to the delay of 8 bunches in a row by powering the RF deflectors by a 4th and a 8th of the repetition frequency (Fig. 2). As a consequence, the distance between following bunches can be reduced to 3.08 ns still leaving 25 ns for the rise and fall times of the kickers.

Limits of the scheme

This proposal should be carefully analyzed to check the feasibility of the different elements, especially the RF horizontal deflectors and their scanning in phase for the extraction of all the bunches. The most critical part is certainly the exact cancellation of the residual deflection of the two kickers to avoid any blow-up of the equilibrium beam emittance.

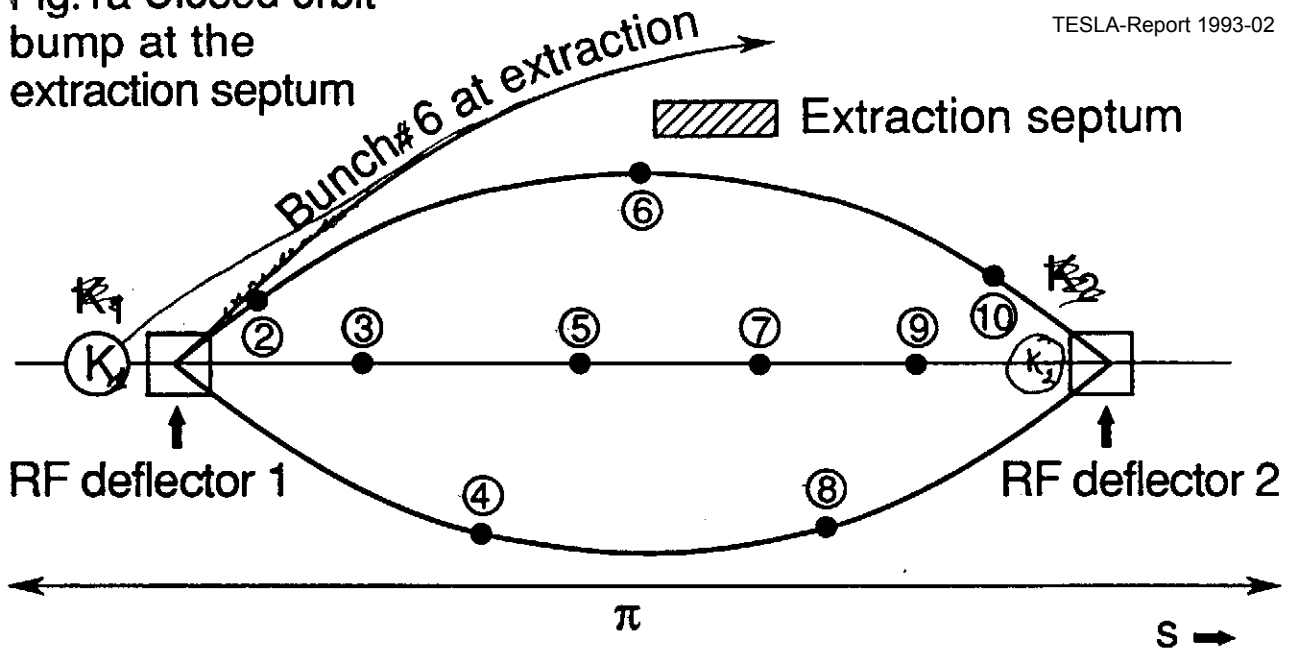# Fig.1a Closed orbit bump at the extraction septum

Bunch#6 at extraction

▨▨▨ Extraction septum

⑥

K_1
(K) ② ③ ⑤ ⑦ ⑨ ⑩ K_2 (k)

RF deflector 1

④ ⑧

RF deflector 2

π

S →

Fig 1b Deflection of the bunches by the RF horizontal deflectors: (in time)
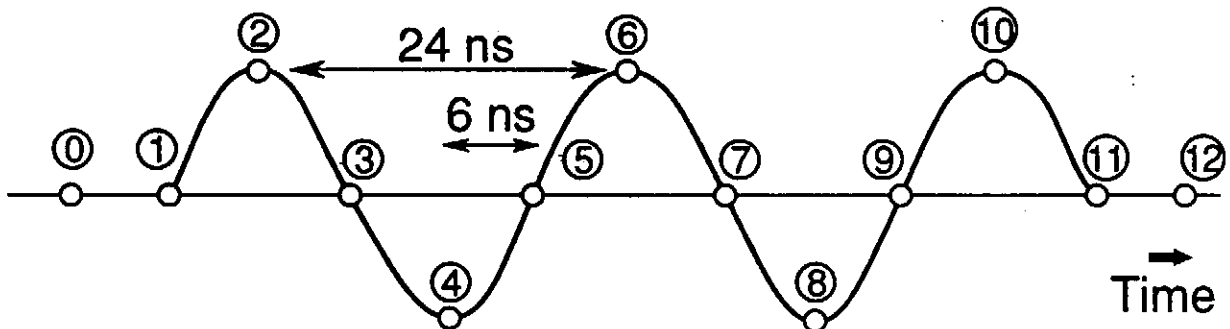
② 24 ns ⑥ ⑩
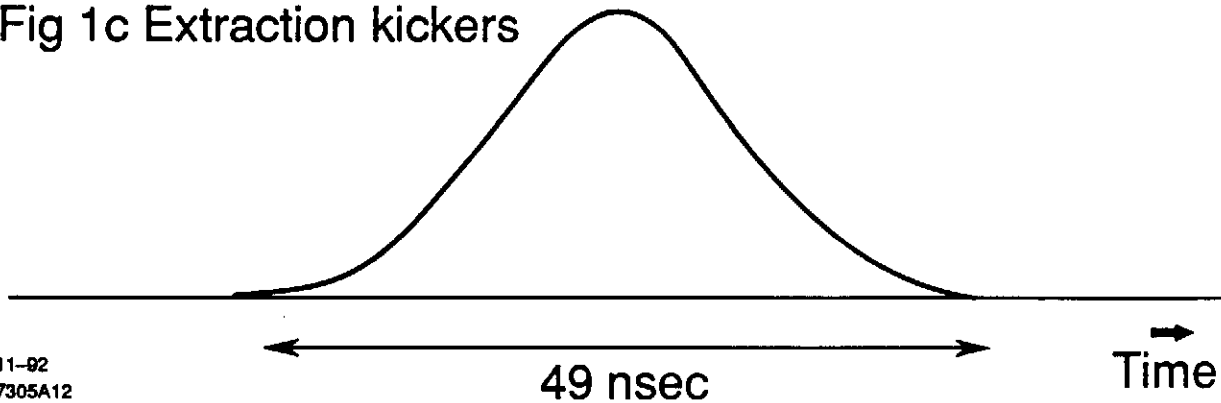
6 ns

⓪ ① ③ ⑤ ⑦ ⑨ ⑪ ⑫

④ ⑧

Time

Fig 1c Extraction kickers

49 nsec

Time

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Fig 1: Principle of the RF closed orbit bump at a subharmonic of of the bunch repetition frequency

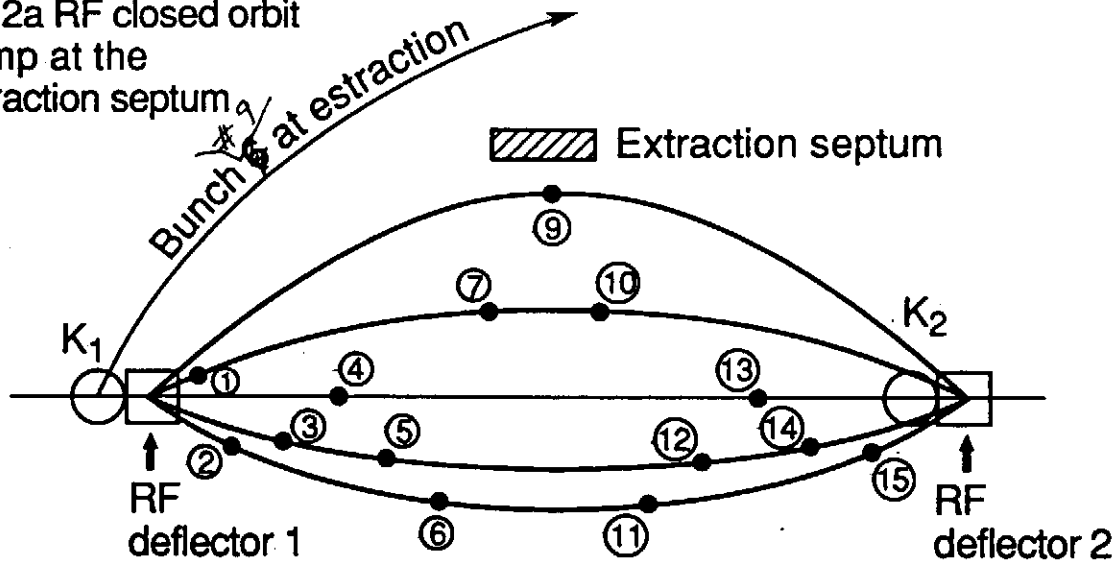## Fig.2a RF closed orbit bump at the extraction septum

Bunch at estraction

▨▨ Extraction septum

K₁

K₂

① ② ③ ④ ⑤ ⑥ ⑦ ⑨ ⑩ ⑪ ⑫ ⑬ ⑭ ⑮

RF deflector 1

RF deflector 2

Fig 2b Deflection of the bunches by the combination of subharm. 4 & 8 in the RF horizontal deflectors

① ⑨ ⑰

24.5 ns

6 ns

② ⑧ ⑩ ⑯ ⑱

⑬

Sub−harmonic 4

8

⑤ ⑭

④ ⑫

③ ⑥ ⑦ ⑪ ⑮

Fig 2c Extraction Kickers

49 nsec

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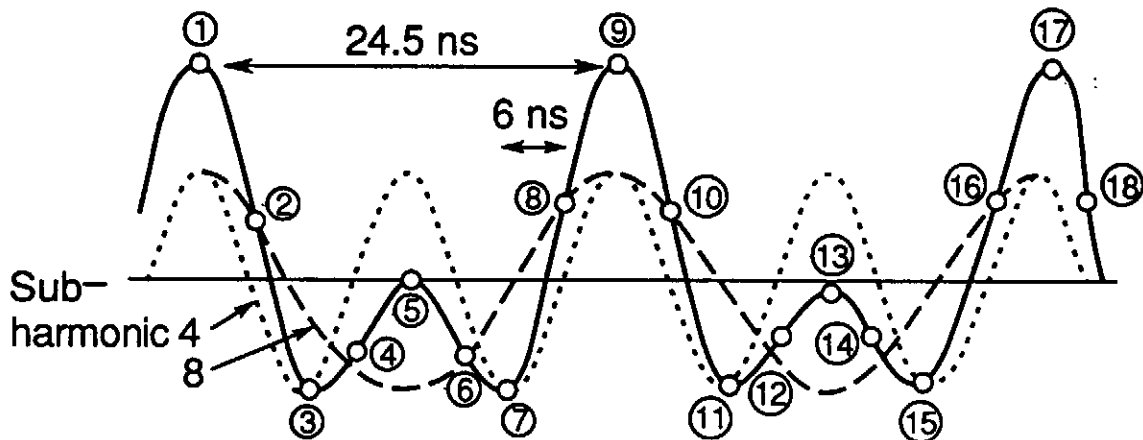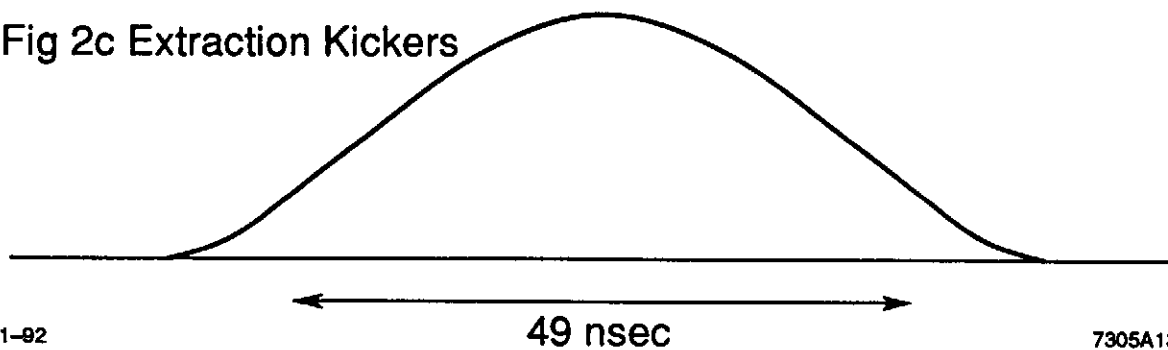
Fig 2: Principle of the RF closed orbit with a combination of subharmonic 4 and 8 of the bunch repetition frequency.