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COMPARISON OF VARIOUS DEBUNCHING PROCEDURES

The purpose of this paper is to give a short comparative review of various debunching methods at Brookhaven and at CERN.

There is an important difference between the two accelerators as far as RF cavity voltage is concerned.

At Brookhaven RF frequency is derived from the beam itself and even if no amplitude modulation would be applied, there is no RF voltage if there is no bunched beam in the machine.

At CERN, because of the phase loop in beam control, the RF system was developed so that the RF voltage is present on the gaps all the time. Therefore debunching procedures have been different, adapted to the circumstances.

After several modifications on the RF system, the RF voltage can be modulated in amplitude and a reduction to zero is possible. More efficient debunching methods became possible.

The following modifications have been done on the RF system to enable RF voltage modulation:

1. Suppression of the frequency discriminator on the cavities.

2. To reduce the transients in the power stage of tuning amplifier, antiflash has been modified.

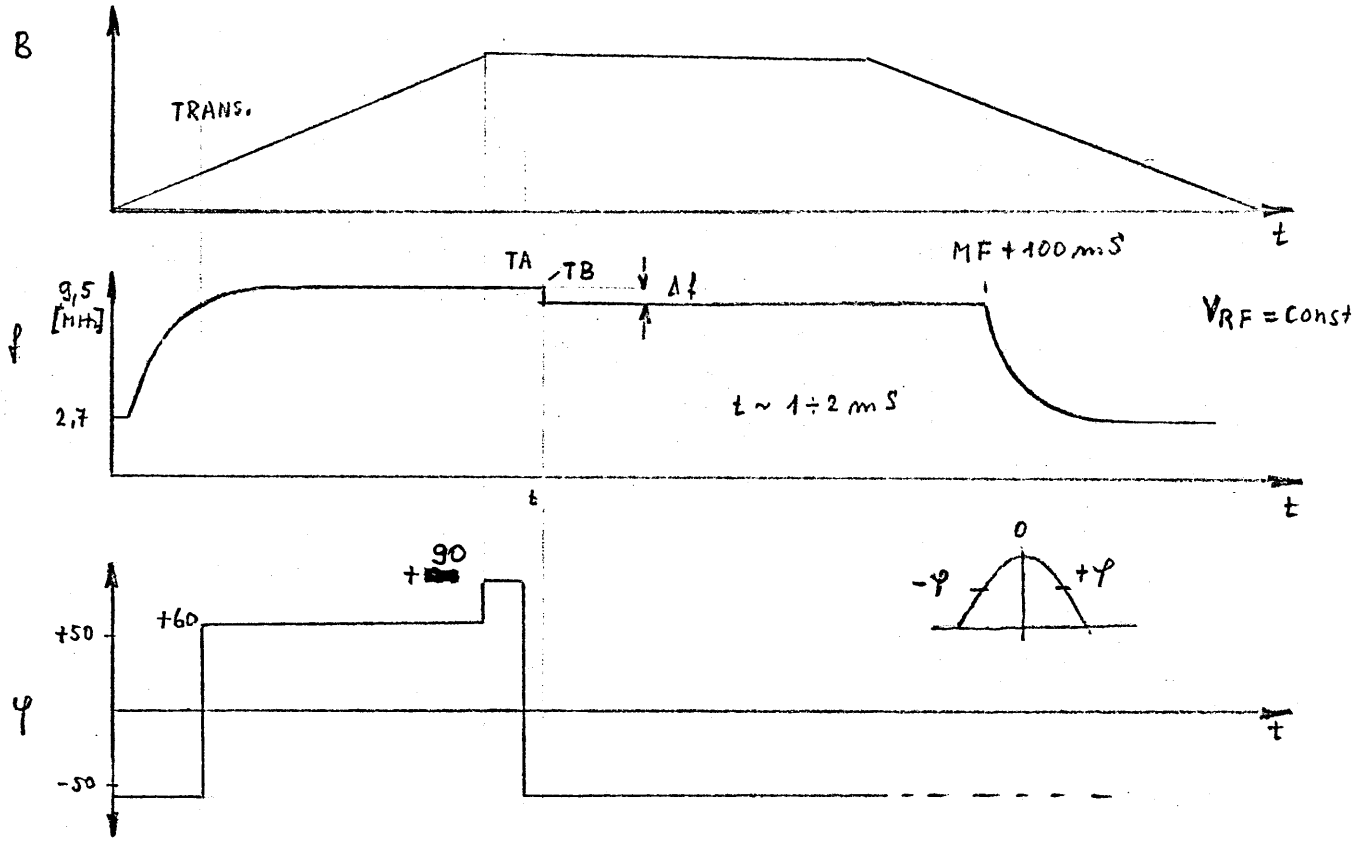
3. A DC amplifier to give the reference voltage to AVC has been added to each of the cavities.

4. A distribution driver amplifier has been developed and installed in the Central Building.

5. When the RF voltage on the cavities is zero, φ loop of the beam control has no information on one side and a "lock out" would follow each machine pulse. To prevent this, an auxiliary RF voltage is switched to the input of the summing network of BC during the time when $V_{RF} = 0$.

J. Jamšek

Debunching for targets ①



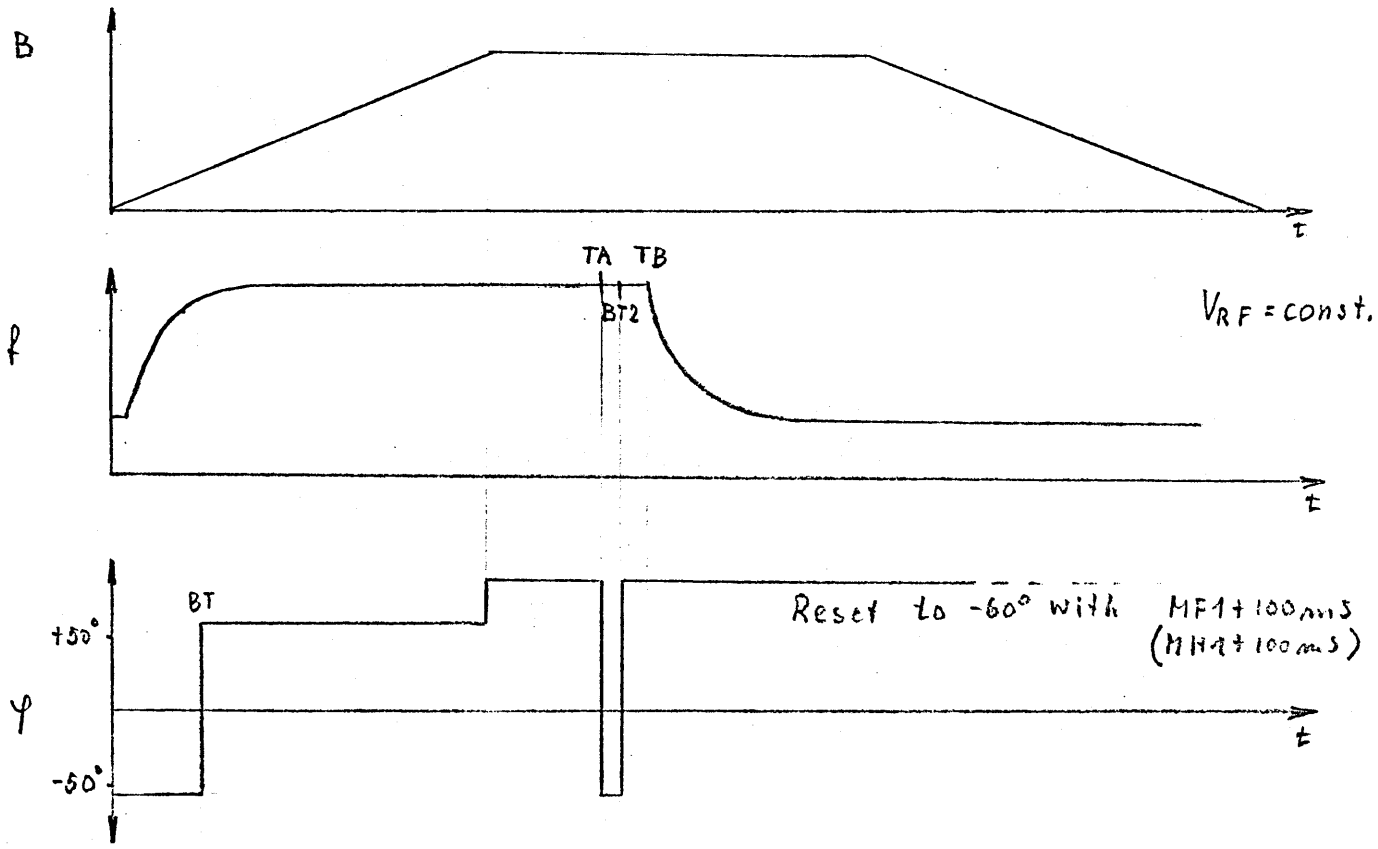
OPERATION:

T_A .... φ jump to the φ before transition,

T_B .... frequency jump for Δf by switching from BC back to frequency programme (Δf is adjusted by f_{max})

Debunching for slow ejection ②

(with constant RF voltage)

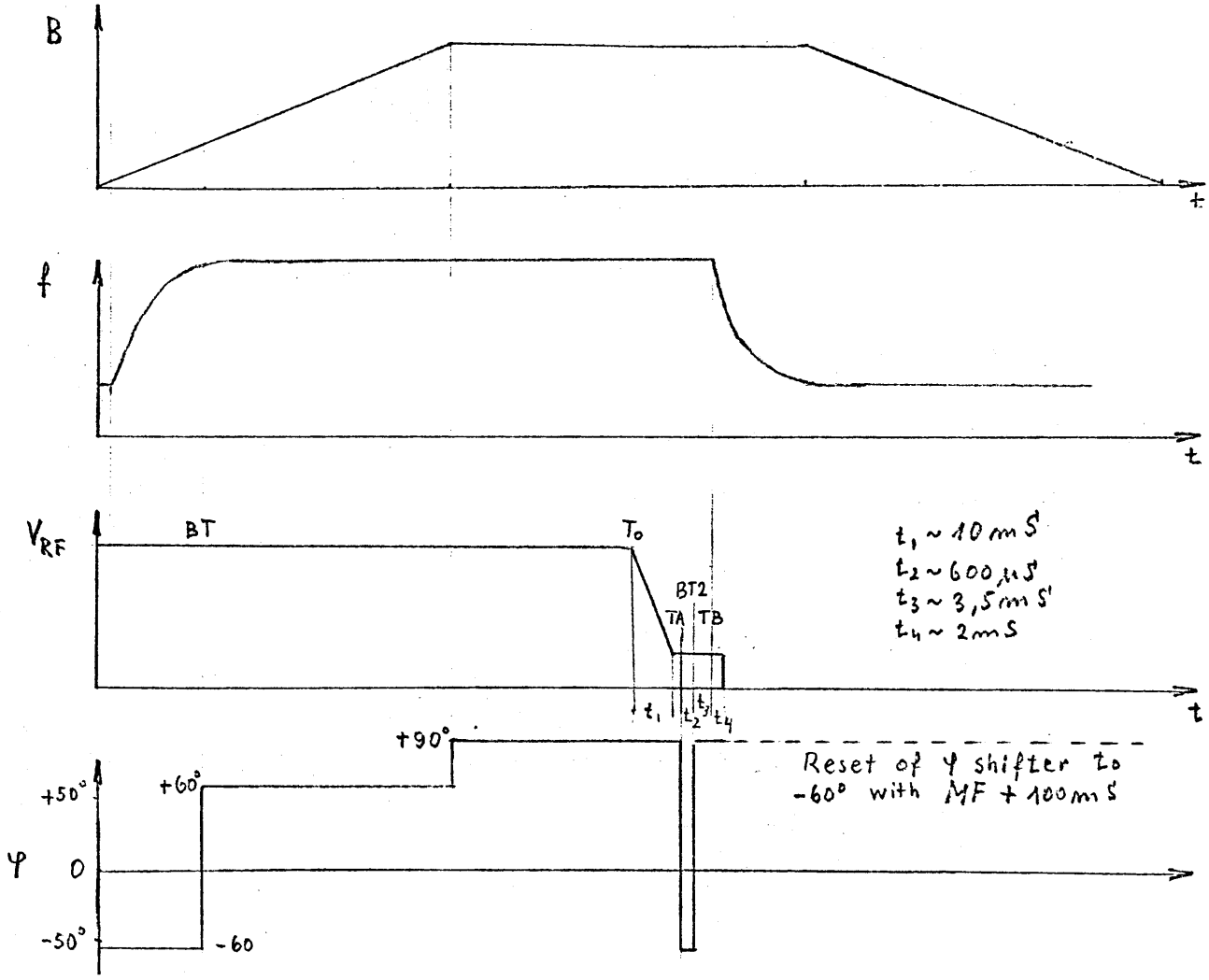


OPERATION: T_A ... φ jump to the φ before transition,
BT2 .. φ jump to the correct φ after transition,
TB ... reset of frequency programme,

REMARKS: The reset of the frequency programme seems to excite resonances with the beam which manifest themselves by spikes in the burst.
Since f_{min} was observed in the beam, it has been proposed to reset frequency programme to a higher frequency (>3 MHz). This procedure has only an experimental caracter and has not been used for continuous operation.

Debunching for slow ejection ③

(With reduction of RF voltage)



OPERATION:

T_o... start of a progressive voltage reduction (from 100% to about 20% in 10 mS),

TA... φ jump to the φ before transition,

BT2.. φ jump to the correct φ after transition,

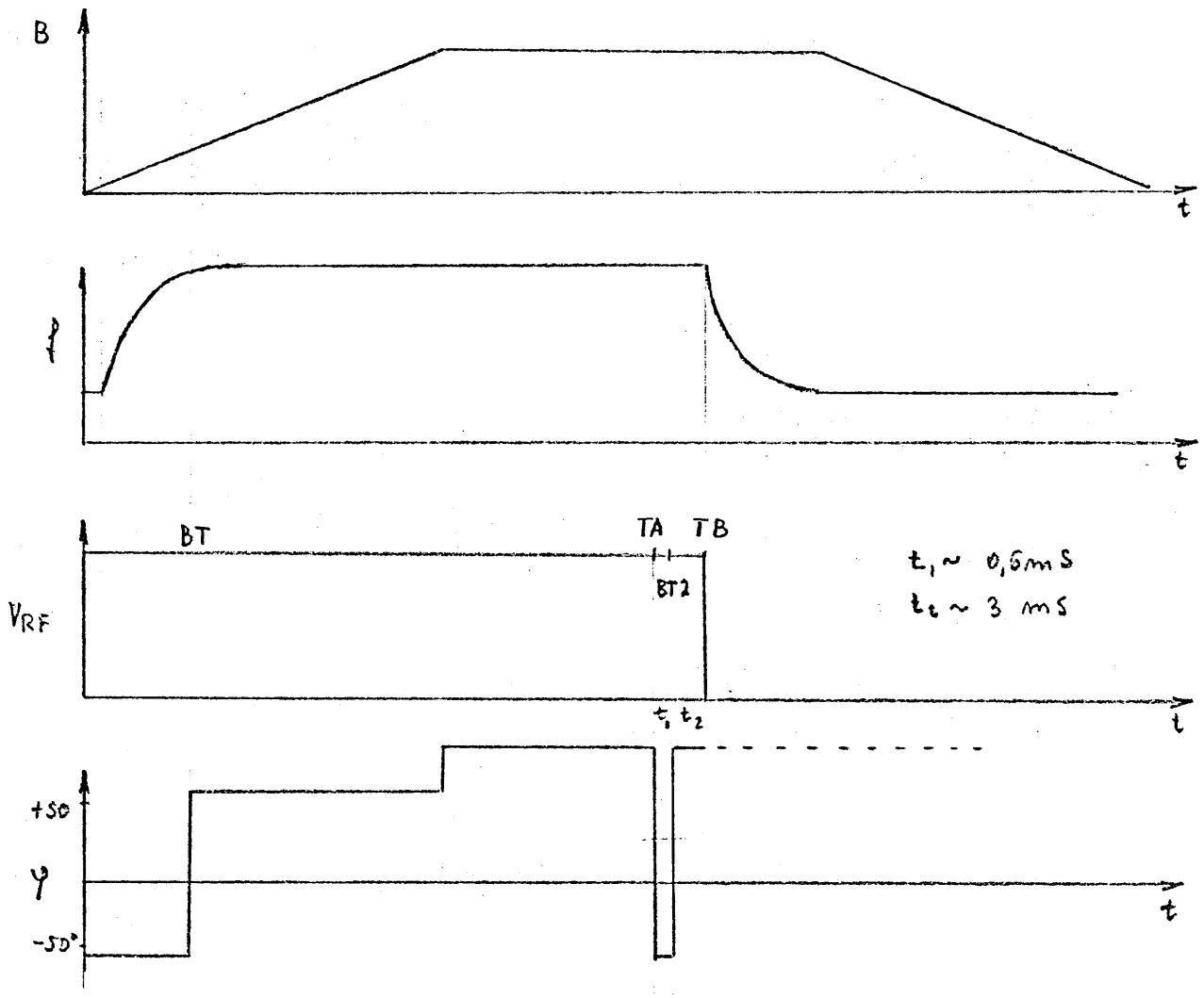
TB... reset of frequency programme,

TB+2mS .. voltage reduction from 20% to zero.

REMARKS:

This low energy spread debunching procedure was proposed by the machine study group. It gives an improvement in comparison with method ② The adjustment is very delicate.

Debunching for slow ejection
(with reduction of RF voltage)



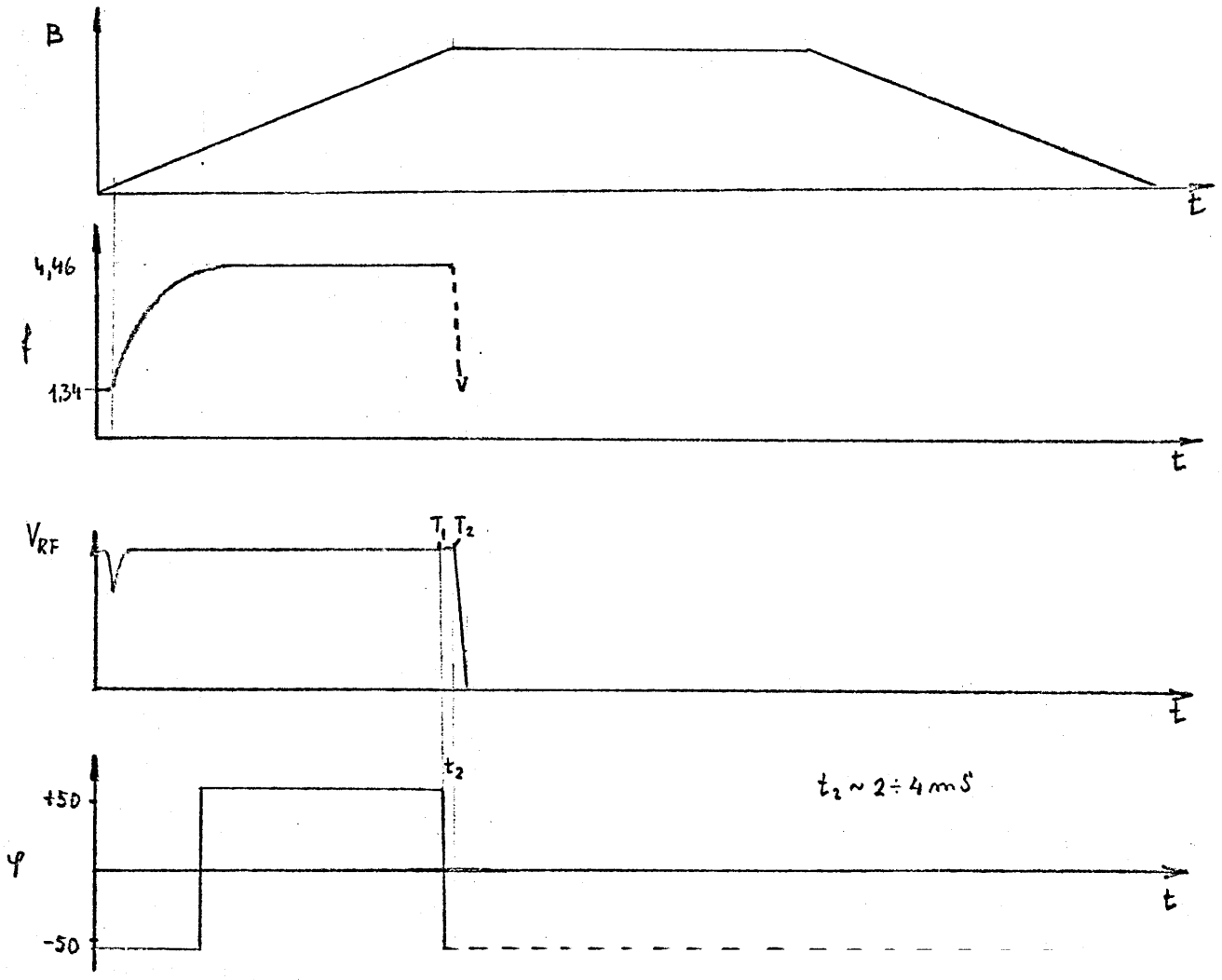
OPERATION:

TA.... φ jump to the f before transition
BT2... φ jump to the correct φ after transition
TB ... reset of frequency programme and RF reduction to zero (in ~0,5mS)

REMARKS:

This programme has been put into operation recently and there is no much experience available. Nevertheless it seems to improve the situation as far as RF structure is conserned and it has been kept for operation.

Debunching at AGS



OPERATION: T_1 .... φ jump to the φ before transition
T_2 .... reduction of RF voltage to zero

REMARKS: ALL operations are at the beginning of the flat-top. When 4th harmonic appears, beam delivers the energy to the cavities and spiralises inside, until it get lost in the vacuum chamber. With φ jump optimisation 4th harmonic can be suppressed.
With debunching the momentum spread $\frac{\Delta p}{p}$ increases from 0,05 ÷ 0,1% without, to 0,5 % with φ jump.