Electron Cloud Memory Effects

F. Petrov

[a] *Institut für Theorie Elektromagnetischer Felder (TEMF), Technische Universität Darmstadt, Schloßgartenstr. 8 64289 Darmstadt*

Abstract

Typically the electron cloud effects are simulated in two stages: electron-cloud build-up simulations and electron-cloud induced instability simulation. In the latter stage the clouds are usually refreshed after each beam-cloud interaction. In this note we study memory effects of the cloud within the 2D electrostatic particle-in-cell code.

1. Simulations

The idea of the study is very simple(Fig. 1). We begin with a typical electron cloud build-up simulation and wait until the saturation. Several bunches before the train end we introduce an offset to the bunch. This bunch sees the strongest transverse electric field. Moreover, the electron cloud distribution changes slightly. Latter bunches interact with this distorted cloud.

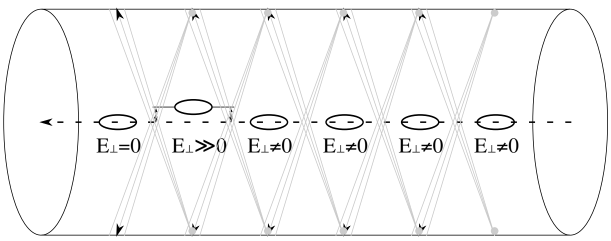

Figure 1: (Color) The arrangement of the bunches in the simulation.

Figs. 2, 3, and 4 show the transverse electric field averaged over the centered bunch profile. One can clearly see that the first bunch induces no transverse field. The next off-centered bunch sees the strongest transverse electric field. Centered bunches that follow the distorted bunch continue inducing the transverse electric field.

However, the actual field seen by the offcentered bunch is significantly different from the field on the pipe axis (Figs. 5, 6 and 7).

These simulations indicate clearly the memory effect of the electron cloud at 25 ns bunch spacing.

2. Electron cloud memory as a function of SEY

In this section we analyze how the features of the electron cloud field depend on the secondary emission curve. We have chosen two ways to perform this study. One way is to have a fixed SEY curve an preform a scan over bunch

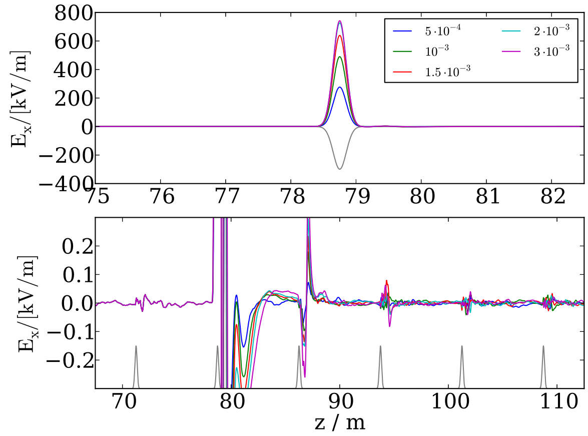

Figure 2: (Color) Transverse electric field seen by the bunches in the train passing through the round field free section. At 75 m starts the offceneted bunch. Its offset is listed in the figure. Upper graph shows the field seen on the pipe axis near the offcentered bunch. Lower graph shows the transverse field seen by one bunch before and two bunches after the distorted bunch.

intensities. Second way is to have a fixed intensity but varying position of the SEY maximum. The first approach is closer to reality because one typically have a certain pipe material with almost fixed SEY parameters. To change the intensity is not a problem in most of the accelerators. However, at different intensities the dynamics of the pinch changes significantly and the comparison of the fields for different intensities becomes complicated. The second approach in this sense is better, because the dynamics of the pinch is basically the same. The effect of the pipe geometry on the transverse field is studied in this section as well.

3. Appendix: Line density

This section shows the evolution of the line density after the distorted bunch.

References

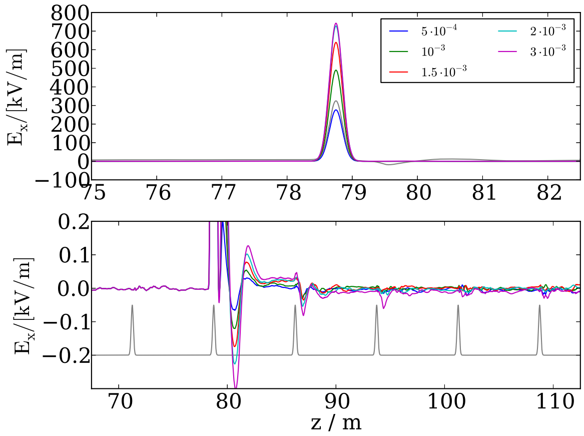

Figure 3: (Color) Horizontal electric field seen by the bunches in the train passing through the round field free section. At 75 m starts the offceneted bunch. Its offset is listed in the figure. Upper graph shows the field seen on the pipe axis near the offcentered bunch. Lower graph shows the transverse field seen by one bunch before and two bunches after the distorted bunch.

Table 1: Simulation parameters for LHC-type bunches.

Bunch length, σ_z / m	0.1
Bunch radius, σ_r / m	10^{-3}
Bunch intensity	$1 \cdot 10^{11}$
Bunch spacing / ns	25
Pipe radius, R_p / m	$2 \cdot 10^{-2}$
Magnetic field, B / T	0.1
Maximum SEY, δ_{max}	1.4
Energy of δ_{max}, $W_{sey,max}$ / eV	250
Rediffusion probability	0.7

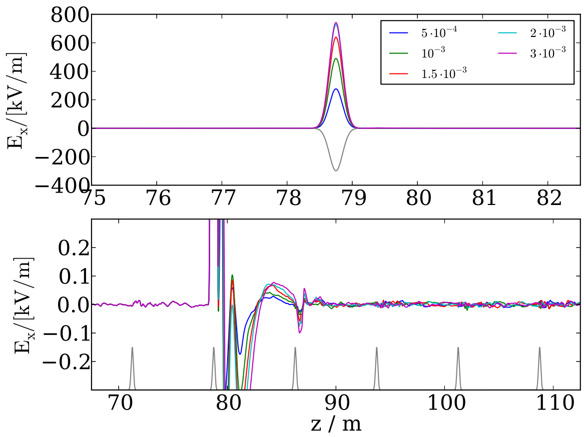

Figure 4: (Color) Vertical electric field seen by the bunches in the train passing through the round field free section. At 75 m starts the offceneted bunch. Its offset is listed in the figure. Upper graph shows the field seen on the pipe axis near the offcentered bunch. Lower graph shows the transverse field seen by one bunch before and two bunches after the distorted bunch.

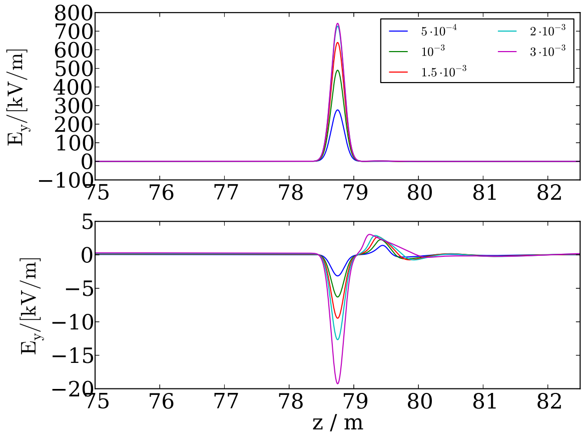

Figure 5: (Color) Comparison of the field on the pipe axis (upper) and on the bunch axis (lower) in dipole with vertically offcentered bunch.

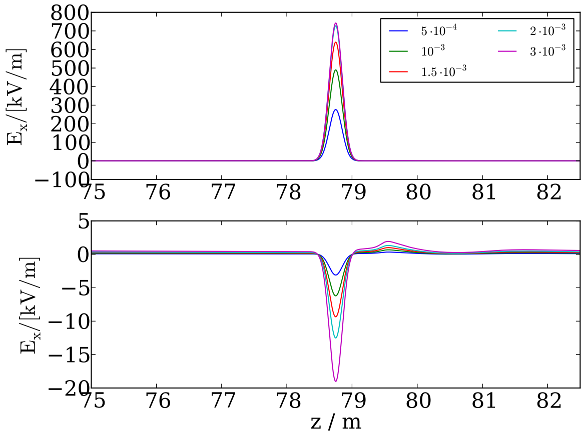

Figure 6: (Color) Comparison of the field on the pipe axis (upper) and on the bunch axis (lower) in dipole with horizontally offcentered bunch.

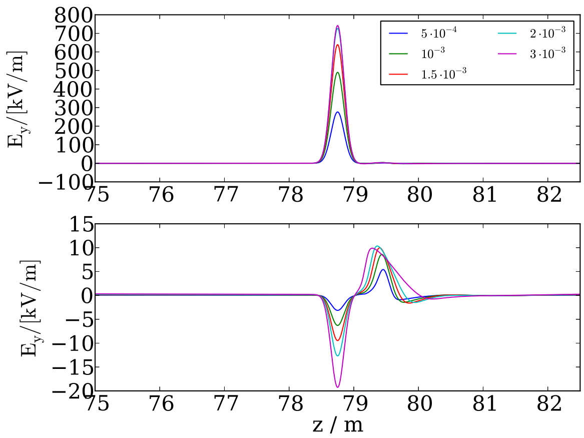

Figure 7: (Color) Comparison of the field on the pipe axis (upper) and on the bunch axis (lower) in drift with vertically offcentered bunch.

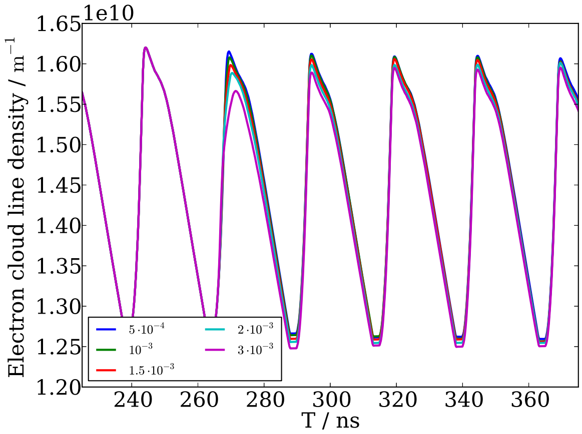

Figure 8: (Color) Line density at saturation for the vertically offcentered bunch in the dipole section.

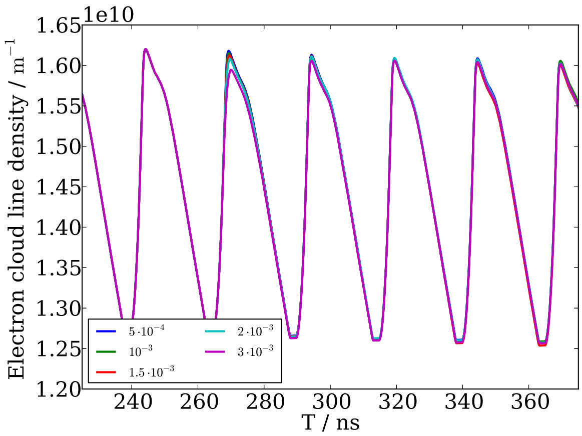

Figure 9: (Color) Line density at saturation for the horizontally offcentered bunch in the dipole section.

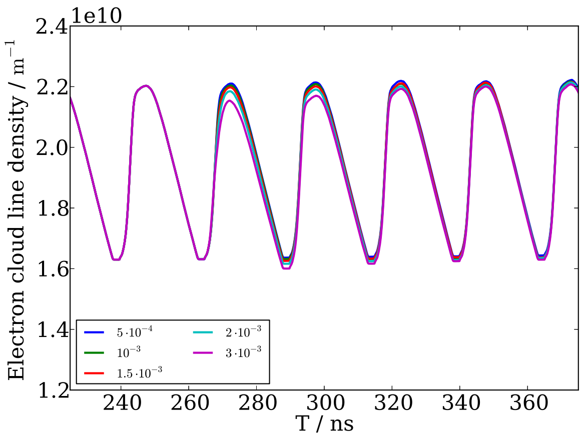

Figure 10: (Color) Line density at saturation for the vertically offcentered bunch in the dridt section.