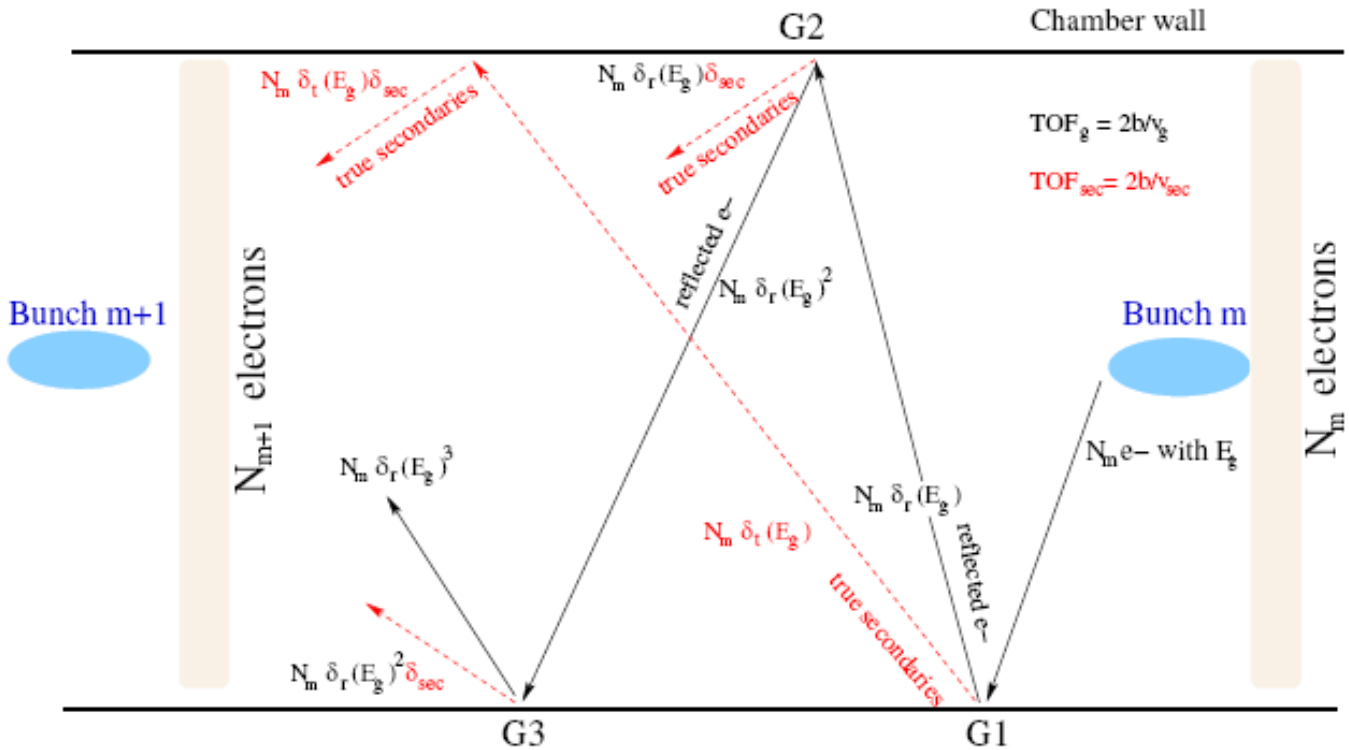
Maps for Electron Clouds



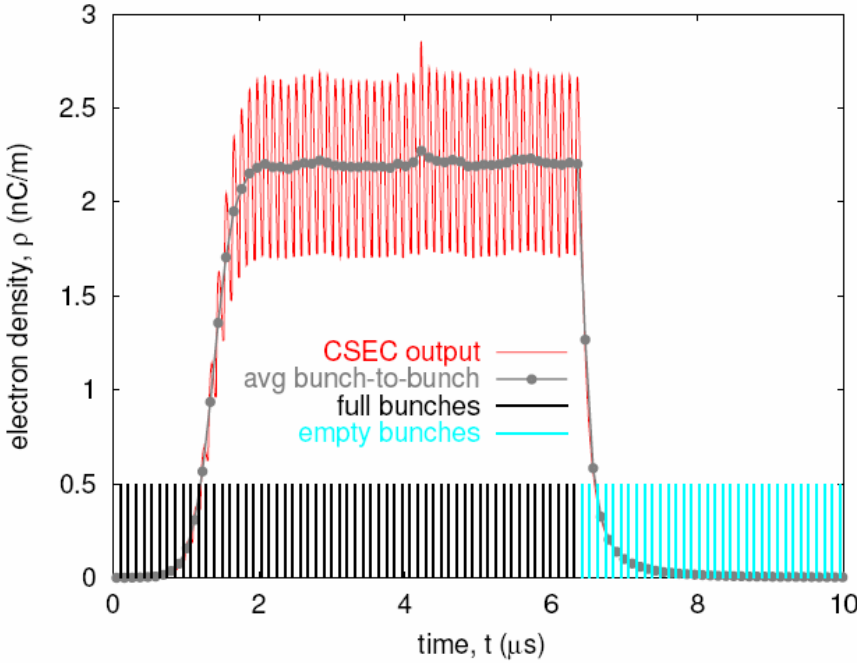
•For a given beam pipe characteristics (SEY, Chamber dimensions, etc.) the evolution of the electron density is only driven by the bunch passing by, and the existing electron density before the bunch passed by.

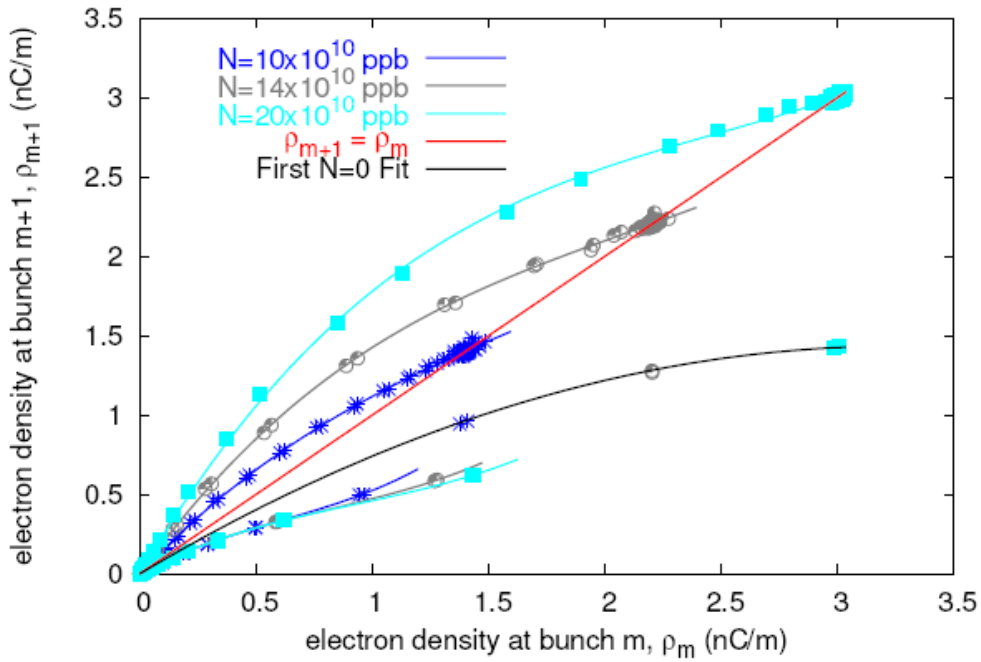
$$\rho_{m+1} = F(\rho_m)$$

• Simplify the Electron Cloud problem into a small number of mathematical parameters

Maps for Electron Clouds

U.Iriso, S.Pegg, Phys. Rev. ST-AB8, 024403 (2005)





- For the typical parameters of RHIC, the bunch-to-bunch evolution of the electron density can be represented by a cubic map:

$$\rho_{m+1} = a\,\rho_m + b\,\rho_m^2 + c\,\rho_m^3$$

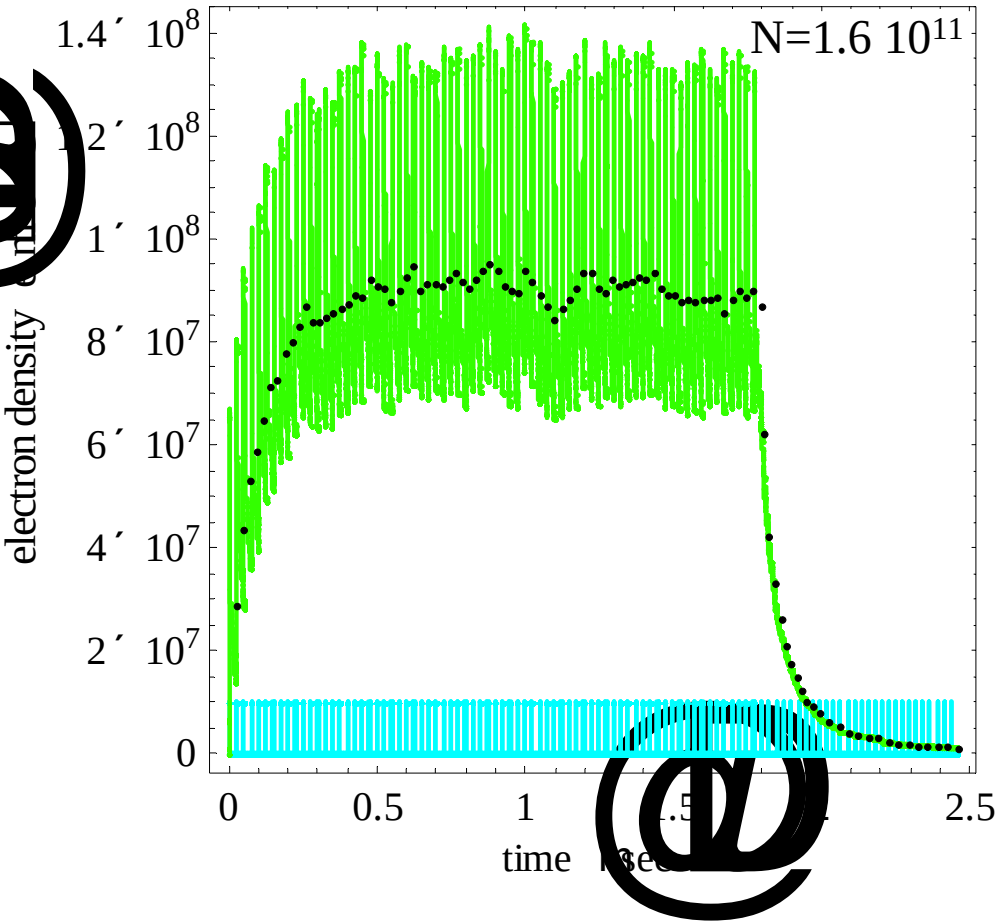
- Three sets of coefficients are needed to describe growth saturation and decay of the electron cloud density.

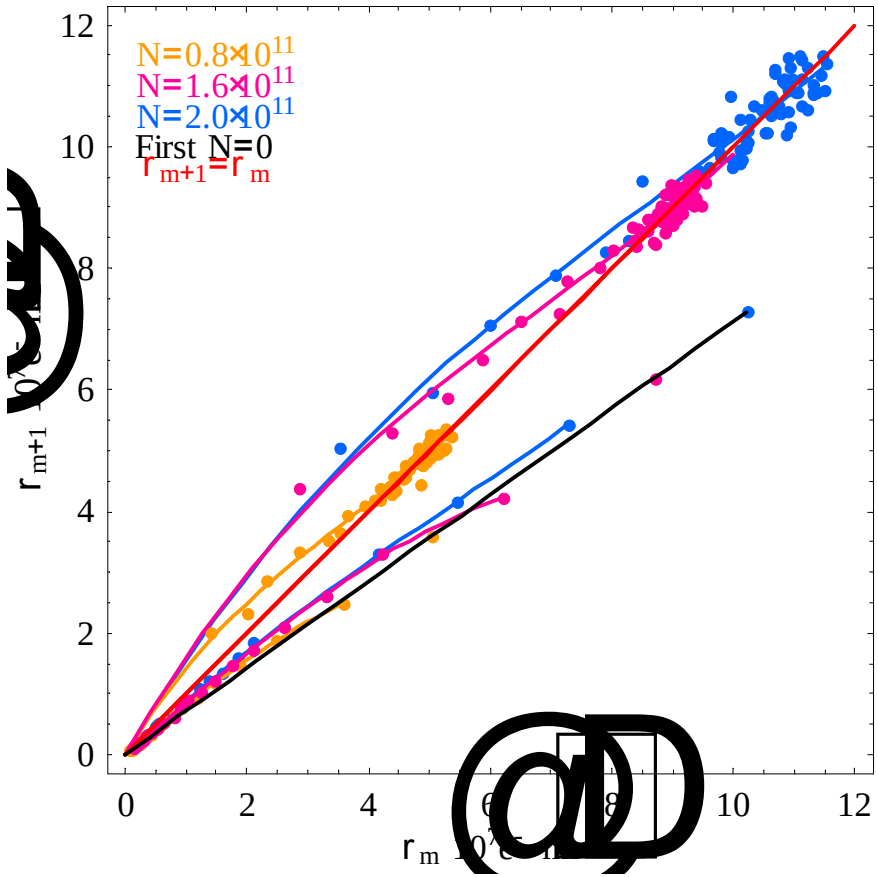
Table 1: List of input parameters for ECLOUD simulations.

parameter	unit	value
beam particle energy	GeV	7000
bunch spacing	m	7.48
bunch length	m	0.075
number of bunches N_b	–	80+20
number of particles per bunch N	10^{11}	0.8 to 2.0
bend field B	T	8.4
length of bending magnet	m	1
vacuum screen half height	m	0.018
vacuum screen half width	m	0.022
circumference	m	27000
primary photo-electron emission yield PEY	-	$7.98 \cdot 10^{-4}$
secondary emission yield SEY	-	1.2 to 1.7
energy for maximum SEY	eV	237.125
energy width for secondary e^-	eV	1.8
reflectivity at zero energy	-	0.5

Maps for Electron Clouds: Application to LHC

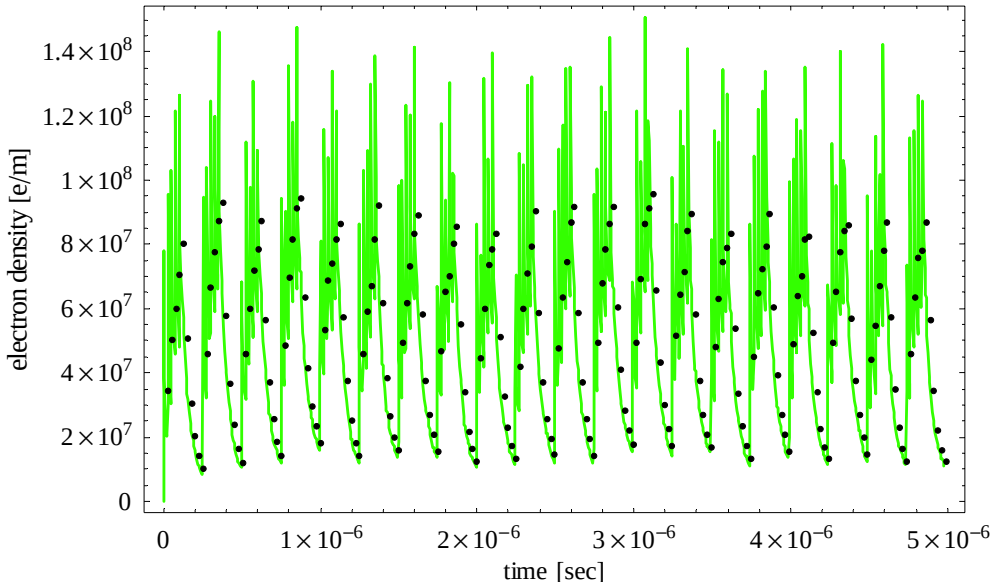
SEY=1.7

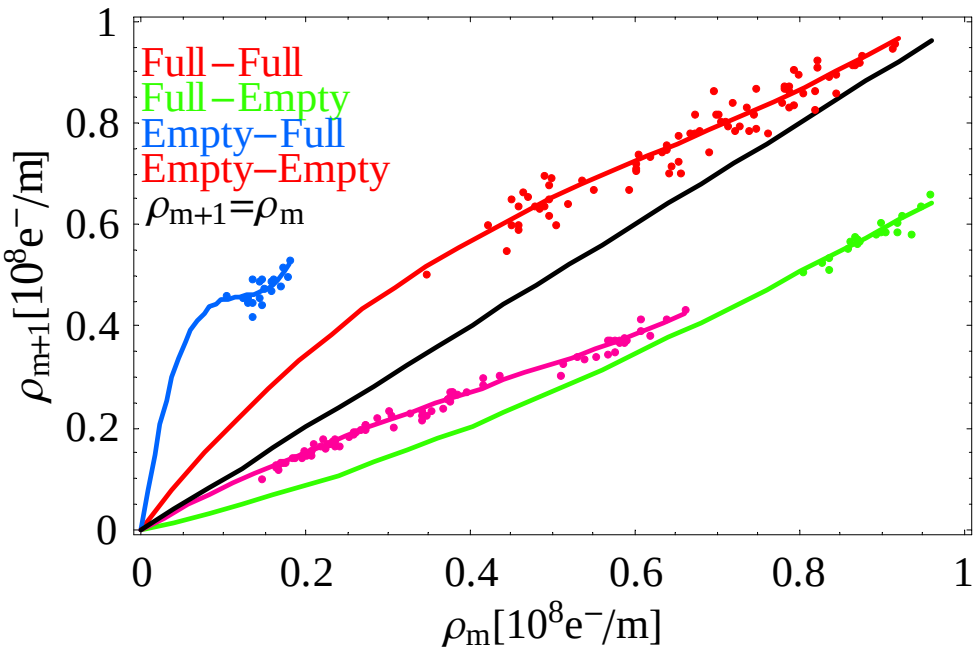




Qualitative agreement with previous results (Iriso and Pegg)

Bunch Patterns





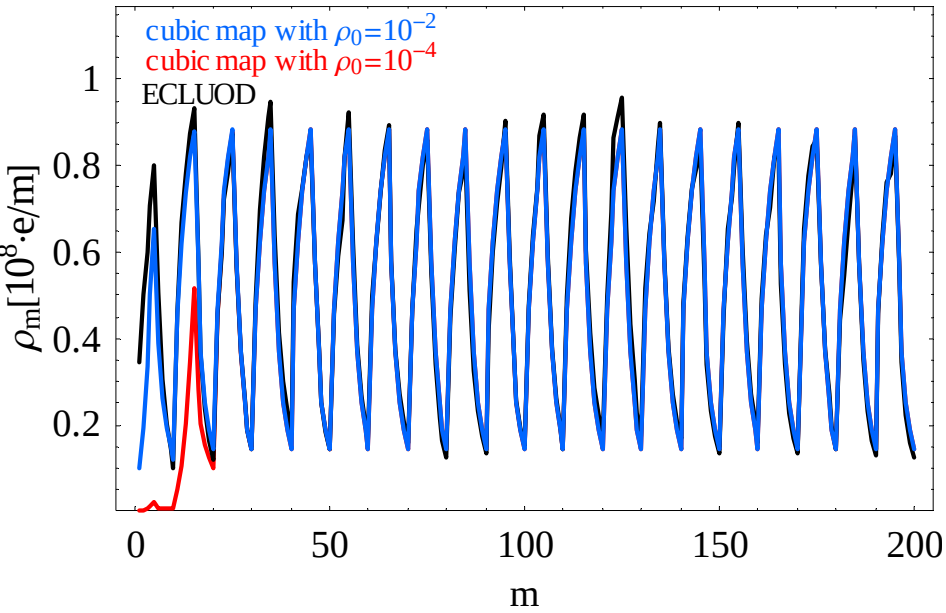
Number of Bunches = 200

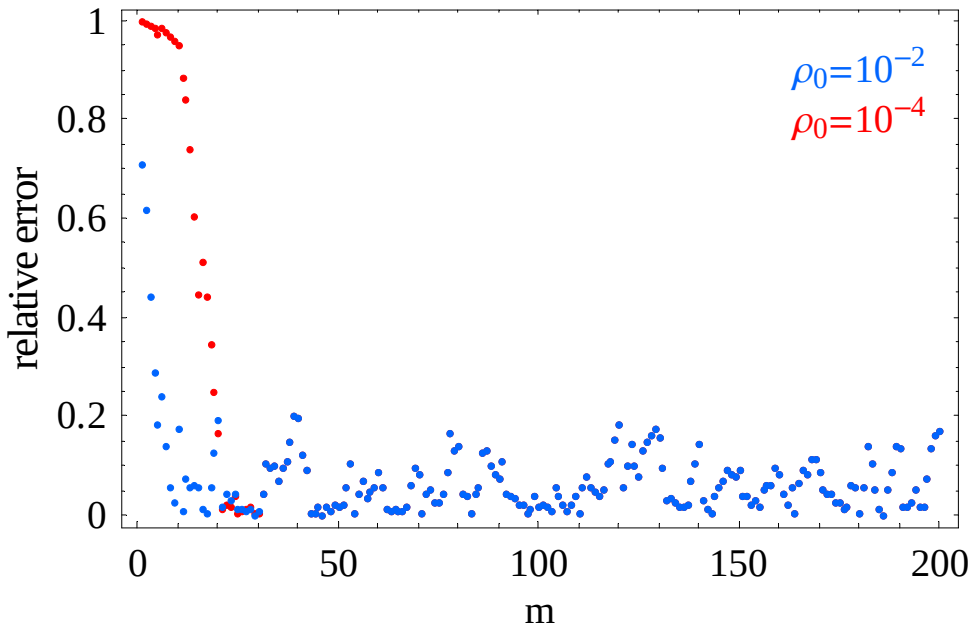
Bunch Pattern (5,5)

SEY=1.7; N=1.6 ·10^{11}

Four different sets of map coefficients are needed to describe the electron density evolution

Bunch Patterns cont.



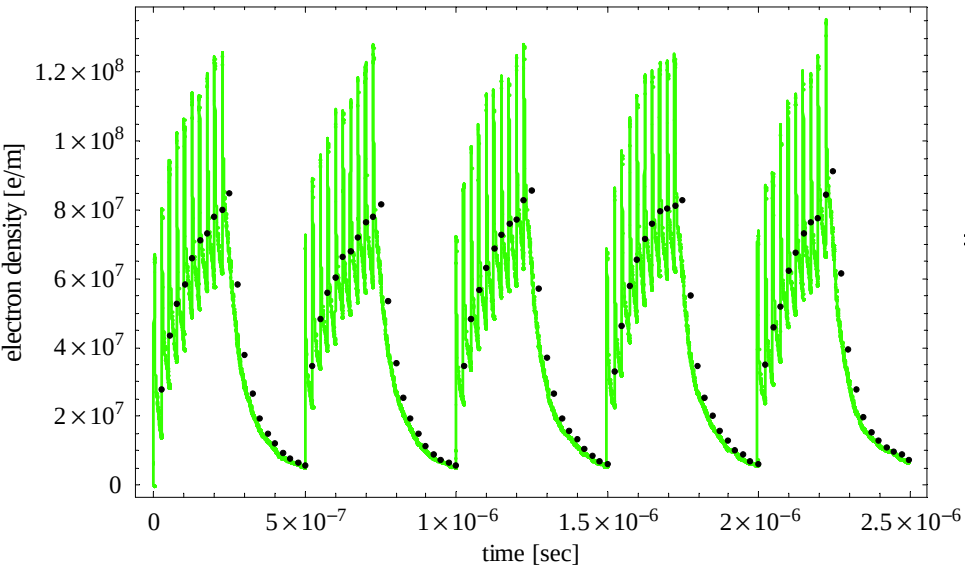


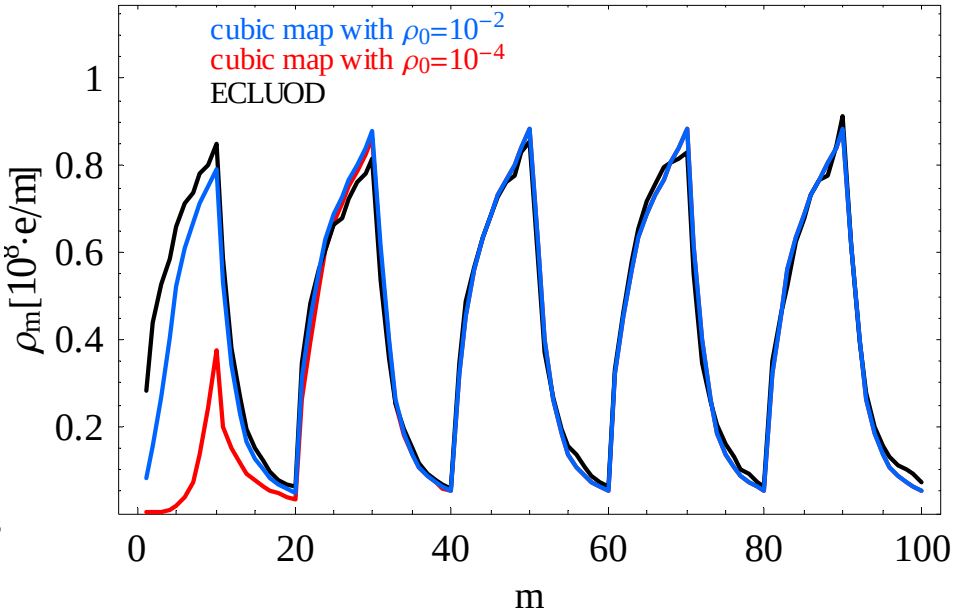
Map results do not depend on the initial electron density ρ_0

Relative error under 20%

For a given set of the physical parameters (Bunch Intensity, SEY, etc.), differenet Bunch Patterns can be described using the same Map coefficients

Bunch Patterns cont.

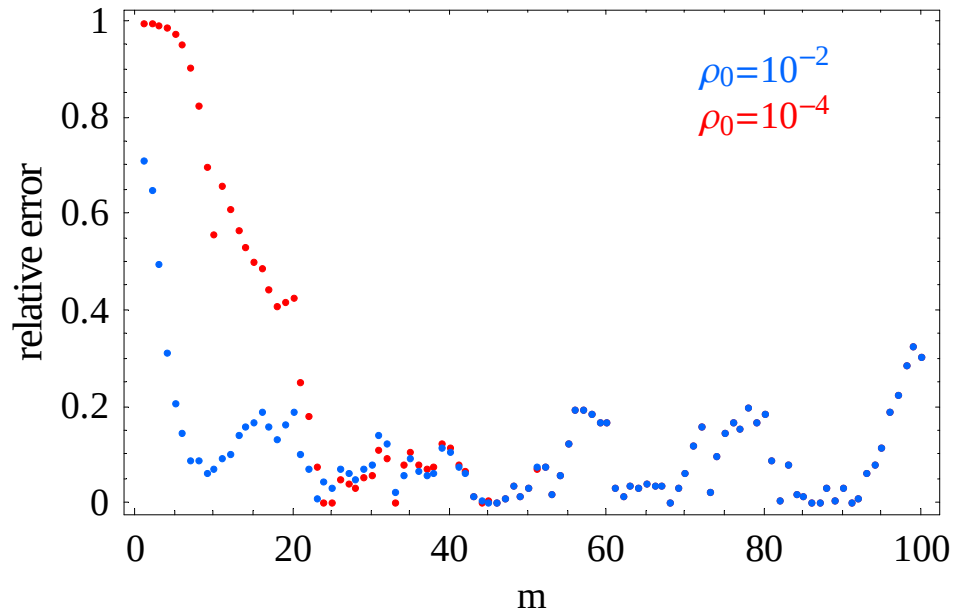




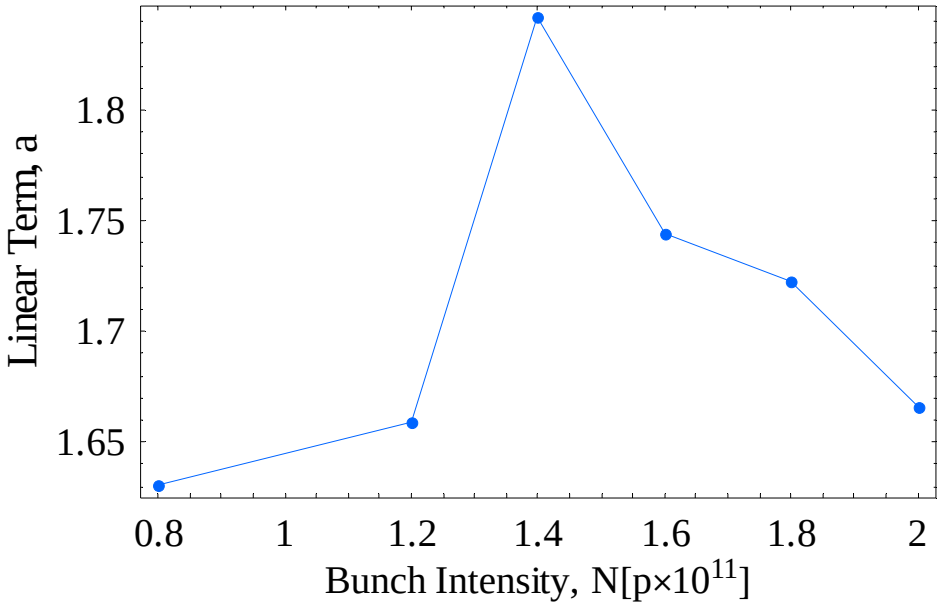
Number of Bunches = 100

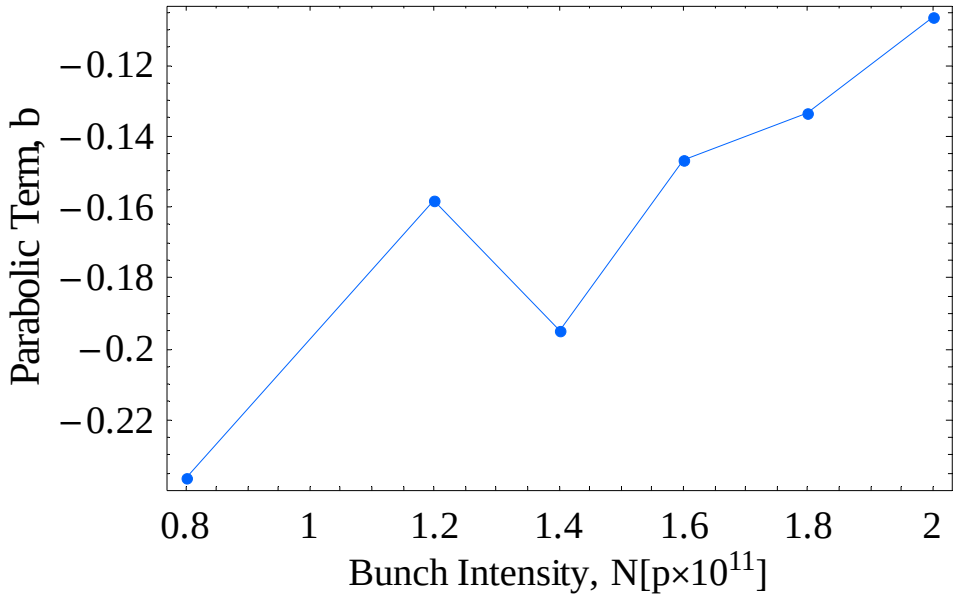
Bunch Pattern (10,10)

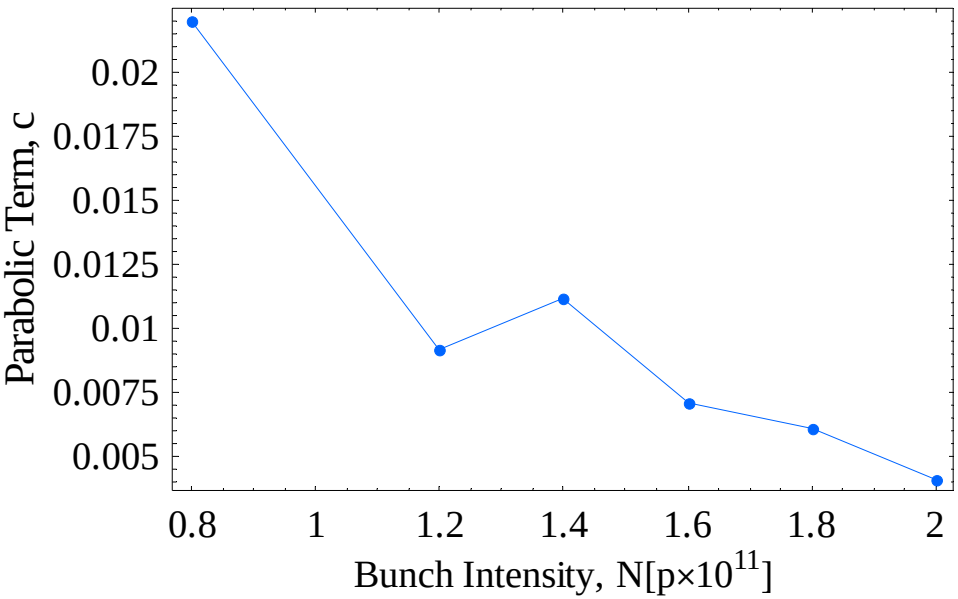
SEY=1.7; N=1.6 ·10^{11}



Evolution of the Map Coefficients





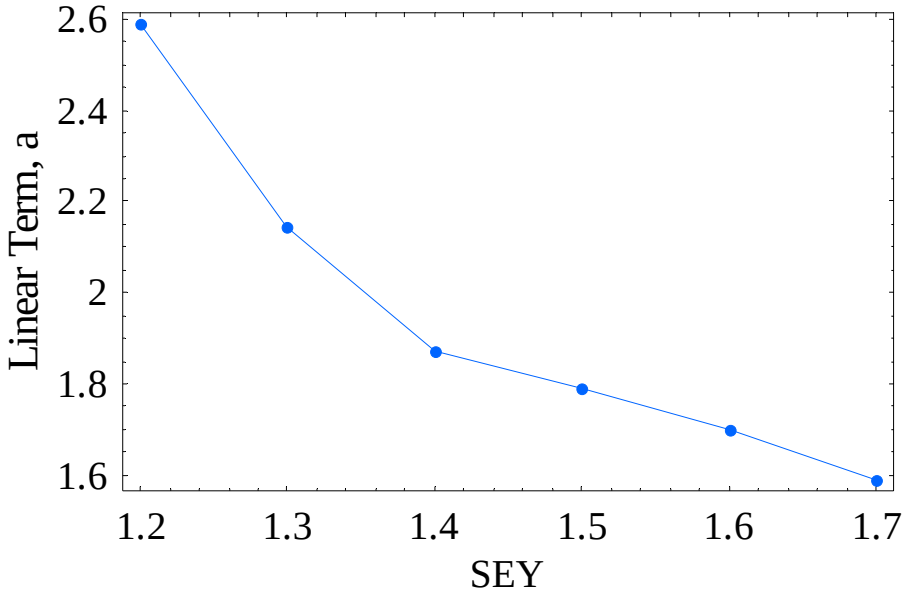


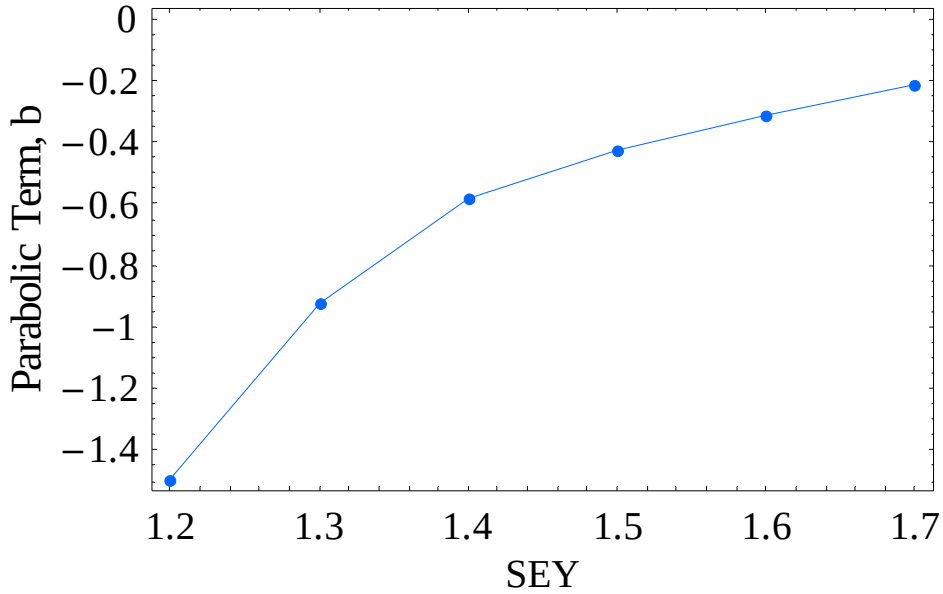
SEY=1.7

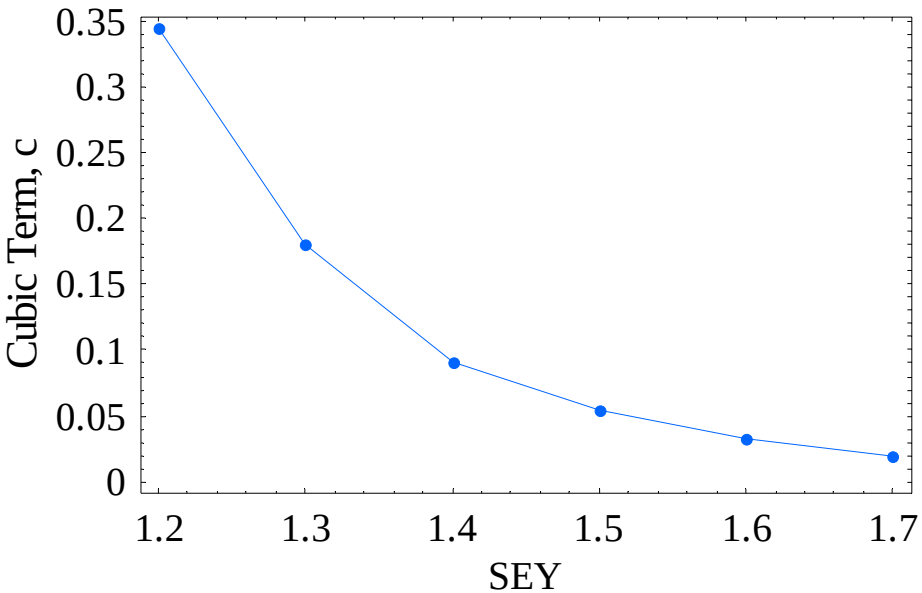
E_{max}=237.125 eV

PEY=$7.98 \cdot 10^{-4}$

Evolution of the Map Coefficients cont.



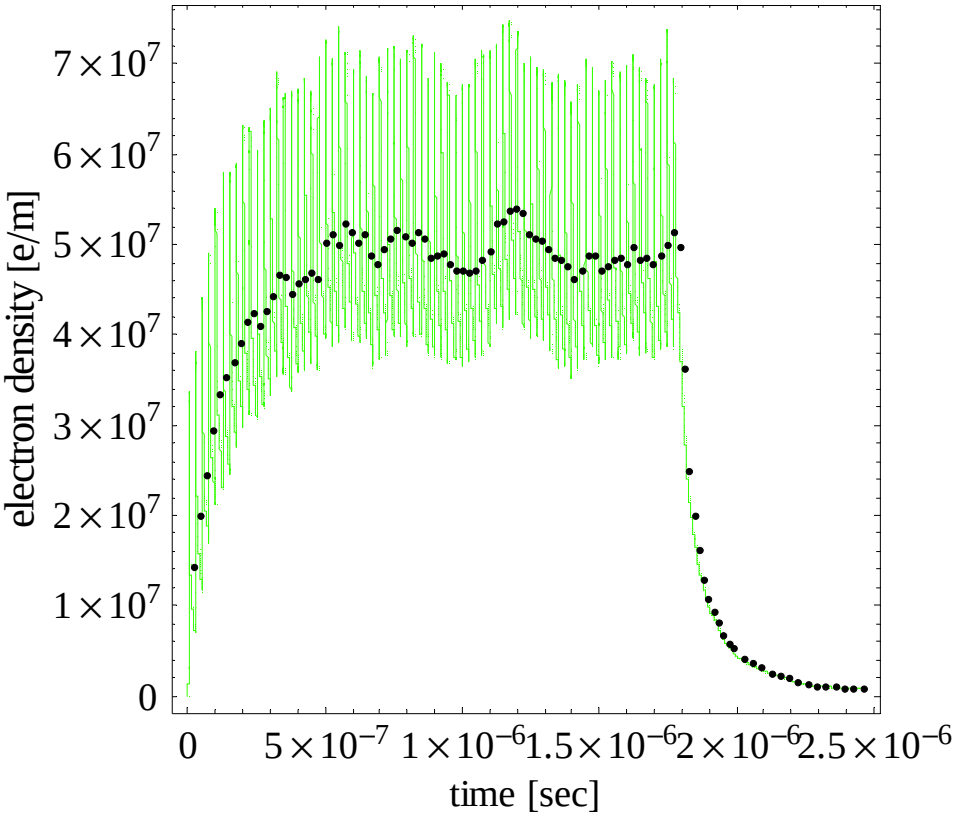


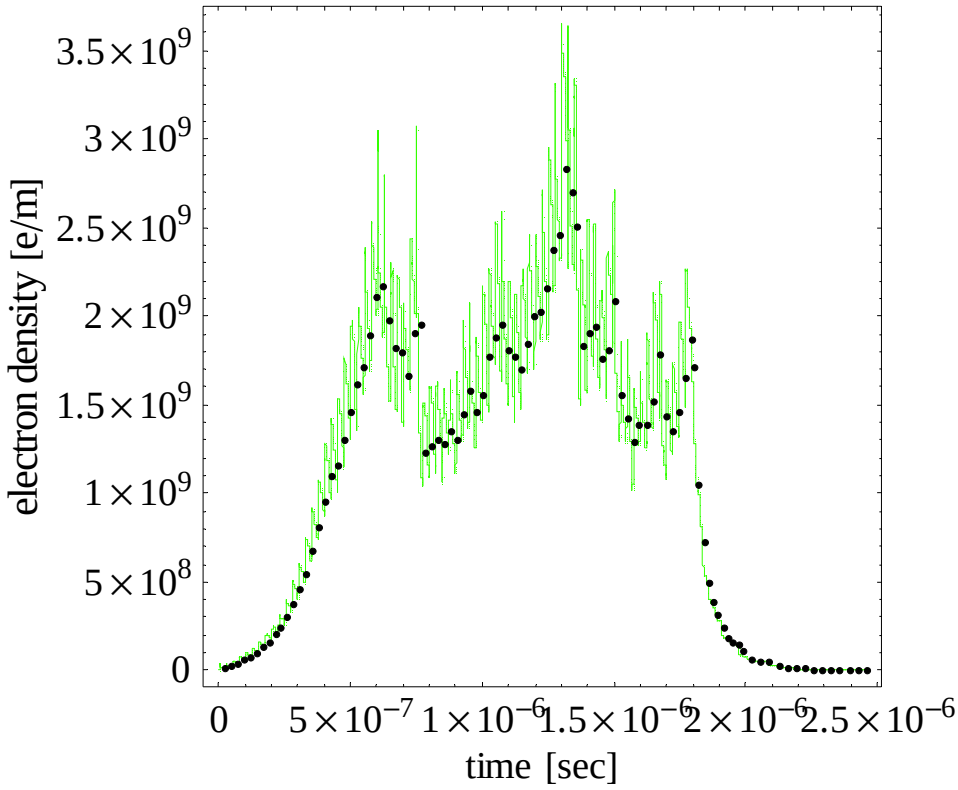


$N=1.0 \cdot 10^{11}$

$E_{max}=237.125$ eV

$PEY=7.98 \cdot 10^{-4}$


electron density [e/m]
7×10^7
6×10^7
5×10^7
4×10^7
3×10^7
2×10^7
1×10^7
0
0
5×10^−7
1×10^−6
1.5×10^−6
2×10^−6
2.5×10^−6
time [sec]


electron density [e/m]
3.5×10^9
3×10^9
2.5×10^9
2×10^9
1.5×10^9
1×10^9
5×10^8
0
0
5×10^−7
1×10^−6
1.5×10^−6
2×10^−6
2.5×10^−6
time [sec]