



***ETH*** zürich

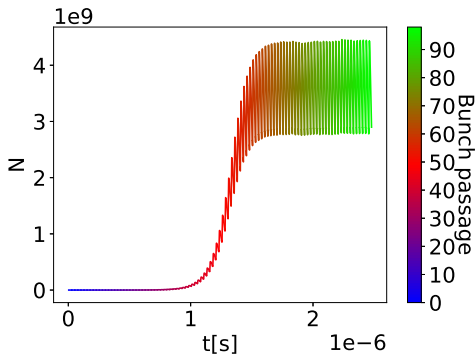
# A Study on the E-Cloud Saturation Mechanism

L. Giacometti, G. Iadarola

Many thanks to: K. Paraschou, L. Sabato

# The Challenge

After an extremely rapid growth, the Electron Cloud build-up process saturates.



We investigate the behavior of the electrons after the saturation has happened.

## The Effective SEY - $\delta_{eff,i}$

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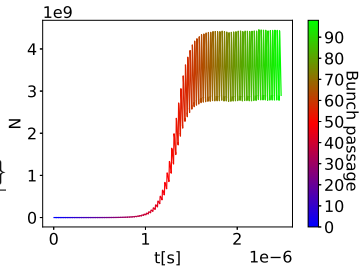
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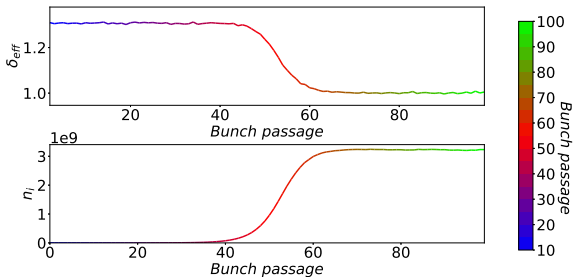
$$n_i \sim -\frac{\delta_{eff}^i}{1 - \delta_{eff}} \implies n_i \sim \frac{\exp\{i \log \delta_{eff}\}}{\delta_{eff} - 1}$$



exponential growth

# Exponential Growth and Saturation

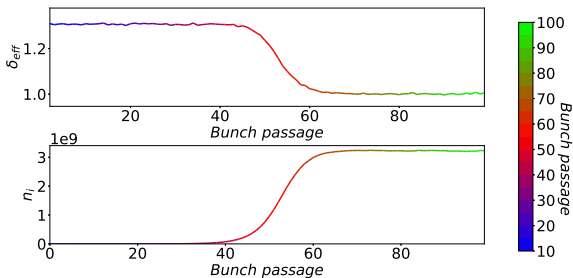
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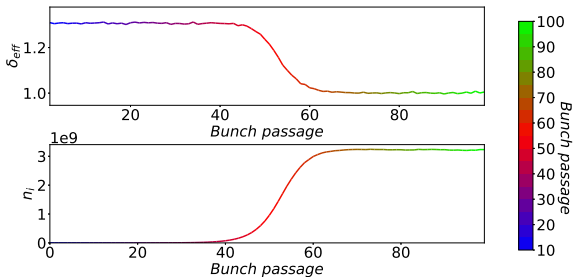


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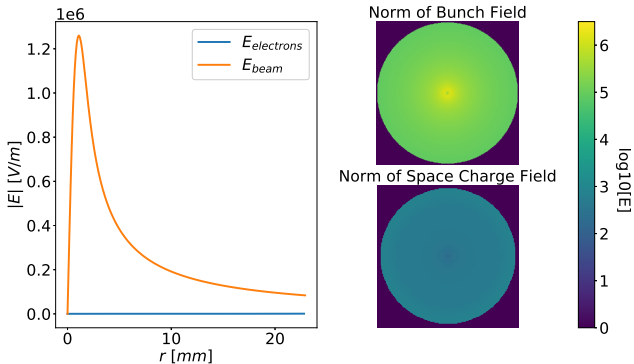
Why do we have a saturation? Does the emission of electrons decrease?

# Beam Shielding

At first glance, it might seem that the electrons space charge field could be able to shield the bunch field.

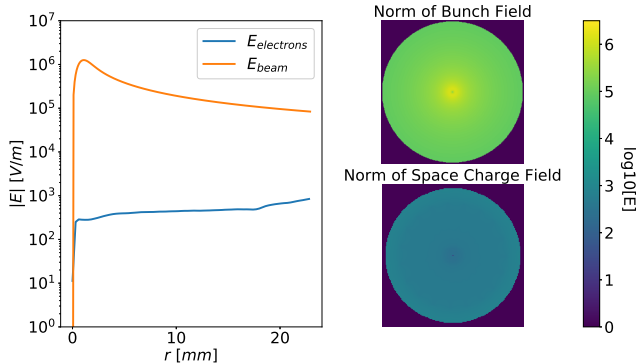
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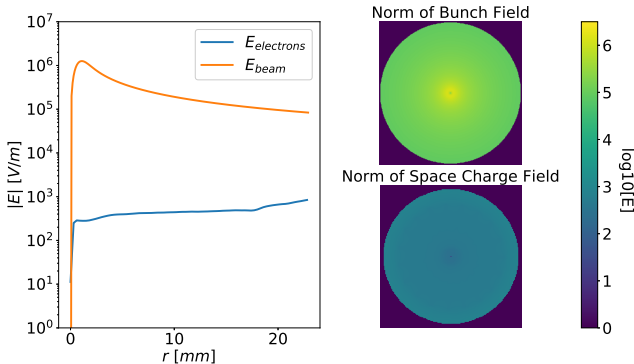
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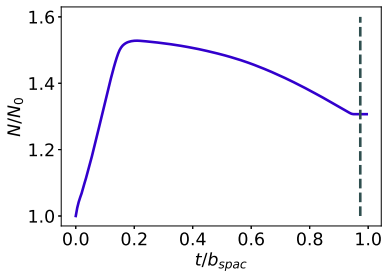
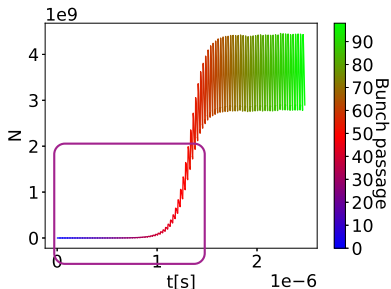
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**Wrong:** at saturation, the bunch field is still 2 orders of magnitude higher than the electrons space charge field.

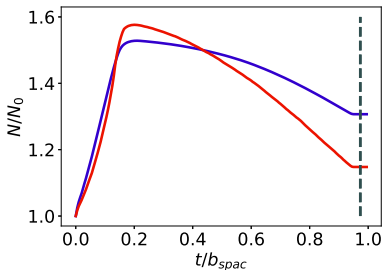
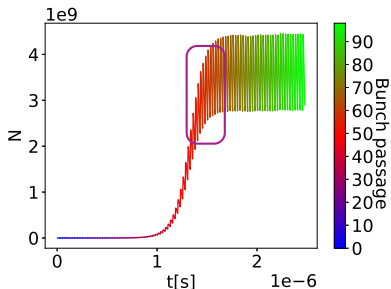
# The Balance

During the exponential growth the number of emitted electrons exceeds the number of absorbed electrons.



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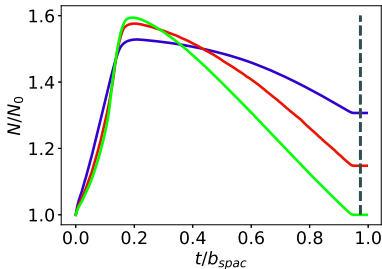
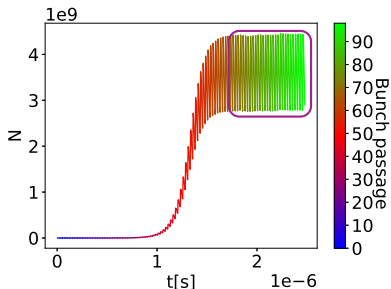
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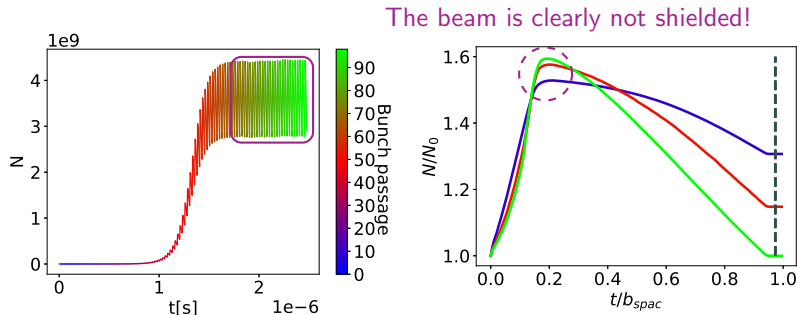
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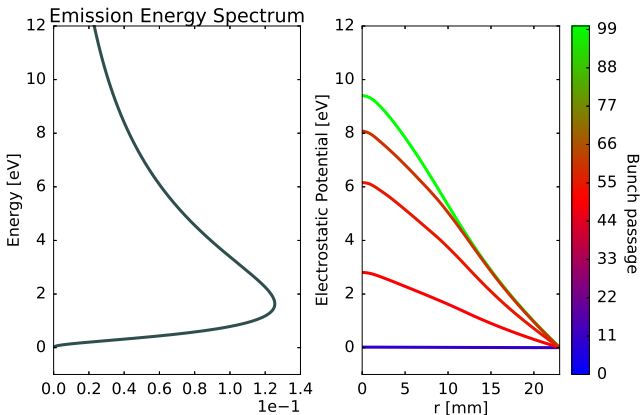
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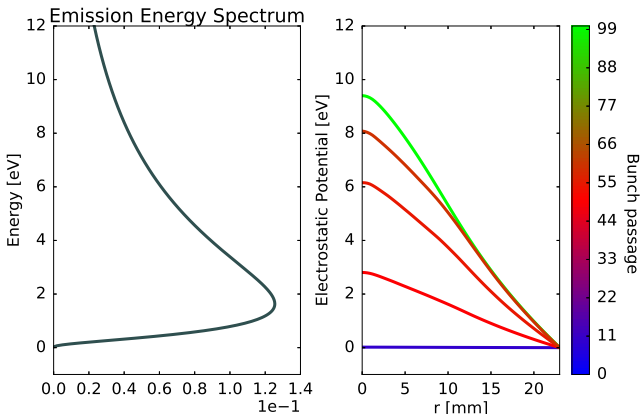
# Potentials

The potential in the chamber increases with the number of electrons.



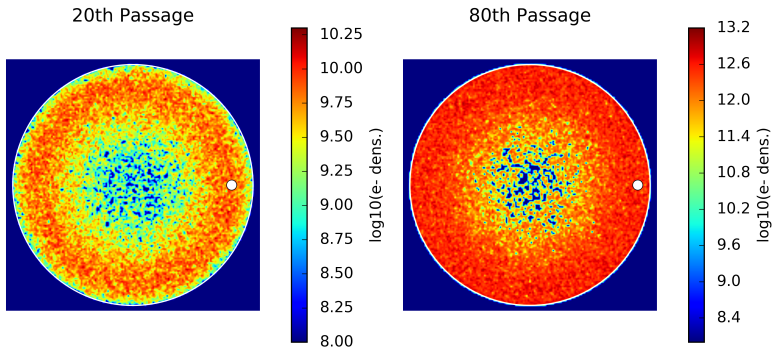
# Potentials

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Electrons which are emitted with low energies don't manage to "climb" the potential and impinge back on the wall before the new bunch passage.

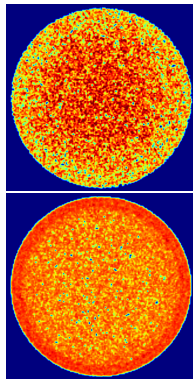
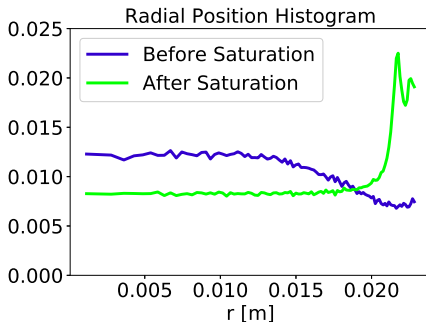
# The Journey of an Electron



Animation

# The Saturation

Because of the high potential, at saturation the electrons concentrate close to the chamber wall.



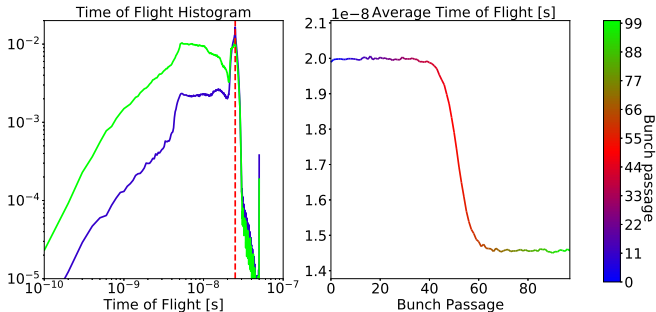
This happens because the initial kinetic energy of the electrons is not high enough for them to reach the center of the chamber.

# Electrons Time of Flight

We define the time of flight of an electron as the time interval between emission and collision against the wall.

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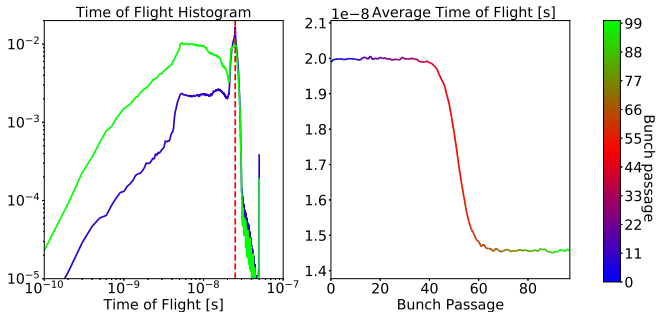
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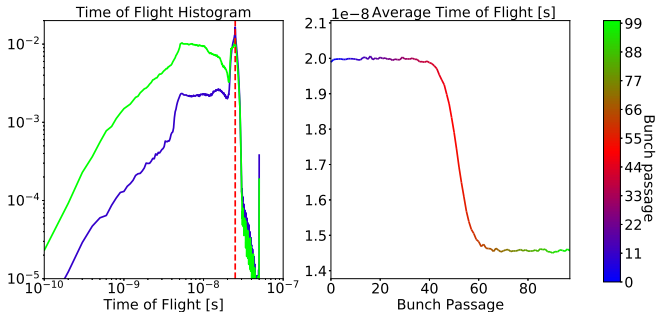
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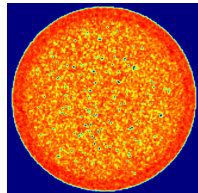
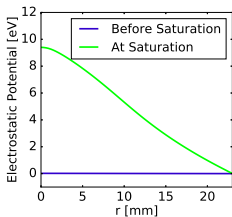
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Electrons which hit the wall before the next bunch passage have high chances of being absorbed, since they impinge on it with low energy.

# Conclusion

To summarize, the saturation happens because:

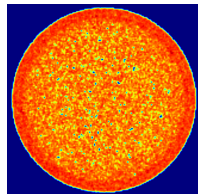
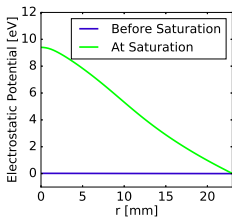
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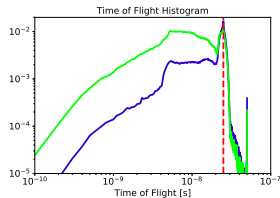
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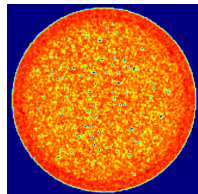
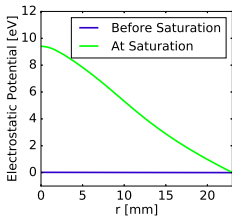


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- A bigger fraction of electrons hit the wall before the new bunch passage

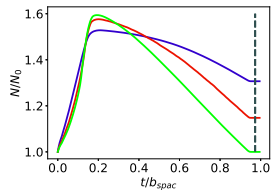
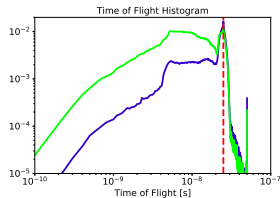


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- The potential increases with the bunch passages and, thus, many electrons don't reach the center of the chamber
- A bigger fraction of electrons hit the wall before the new bunch passage
- These electrons hit the wall with low energy and are absorbed





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