Buildup Simulations with 25 ns and 50 ns Beams for Large SEY

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23rd March 2018

Outline

- Introduction
- Buildup Simulation Results
- Conclusion

Outline

- **Introduction**
  - Heat Load in LHC
- Buildup Simulation Results
- Summary

Heat Load in LHC

Recent heat-load localization measurements by the cryogenics teams seem to point to very high heat-load densities (> 10 W/m) with 25 ns spacing, which are compatible only with very large SEY max values (>2.0)

- What do we expect with 50 ns spacing in this range?

Outline

- Introduction
- **Buildup Simulation Results**
  - R_0 = 0.7 (standard case)
  - R_0 = 0.3
- Summary

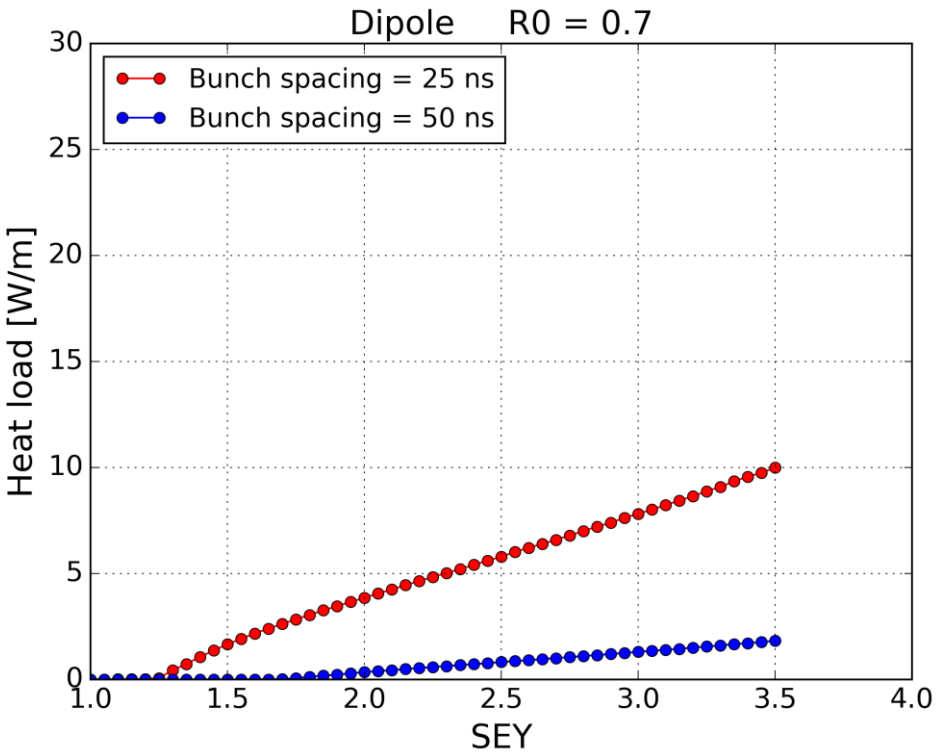
Buildup Simulation Results

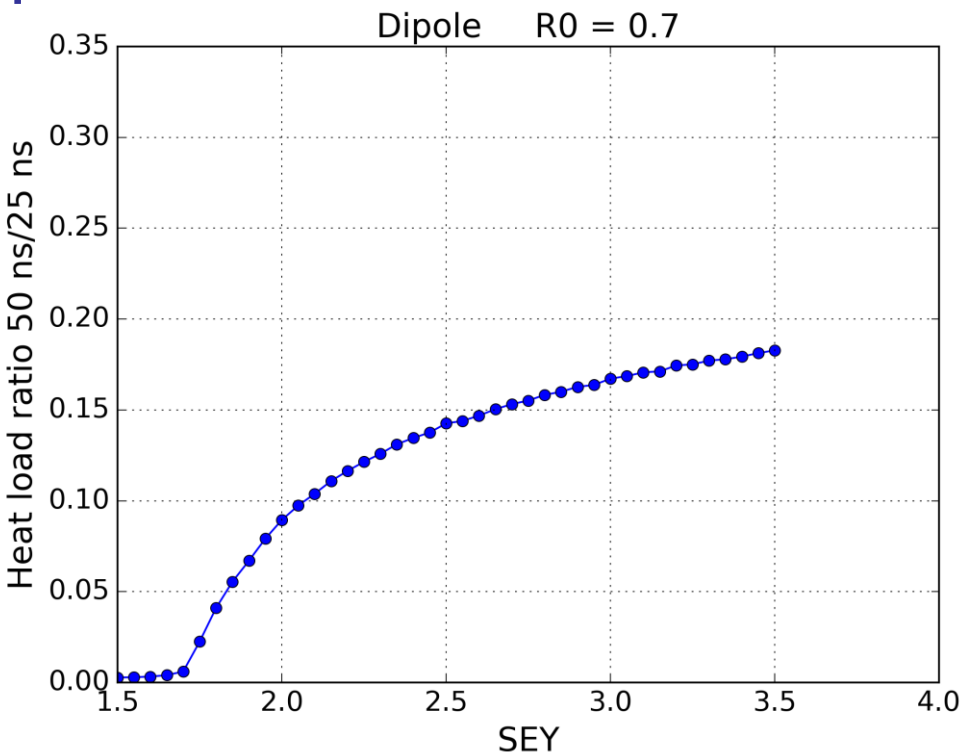
Simulation Parameters

- Energy: 6.5 TeV;
- Intensity: 1e11 protons per bunch;
- Bunch length: 1.10 ns;
- $\varepsilon_{nx} = \varepsilon_{ny} = 2.5\ \mu m$;
- Bunch spacing: 25 ns and 50 ns;
- Number of bunches per train: 72 (25 ns) and 36 (50 ns);
- Number of trains: 4;
- Results rescaled to 2808 bunches (25 ns) and 1404 bunches (50 ns);
- δ: from 1 to 3.5 with step of 0.05;
- R_0 = 0.7 (standard case)

Buildup Simulation Results

Dipole

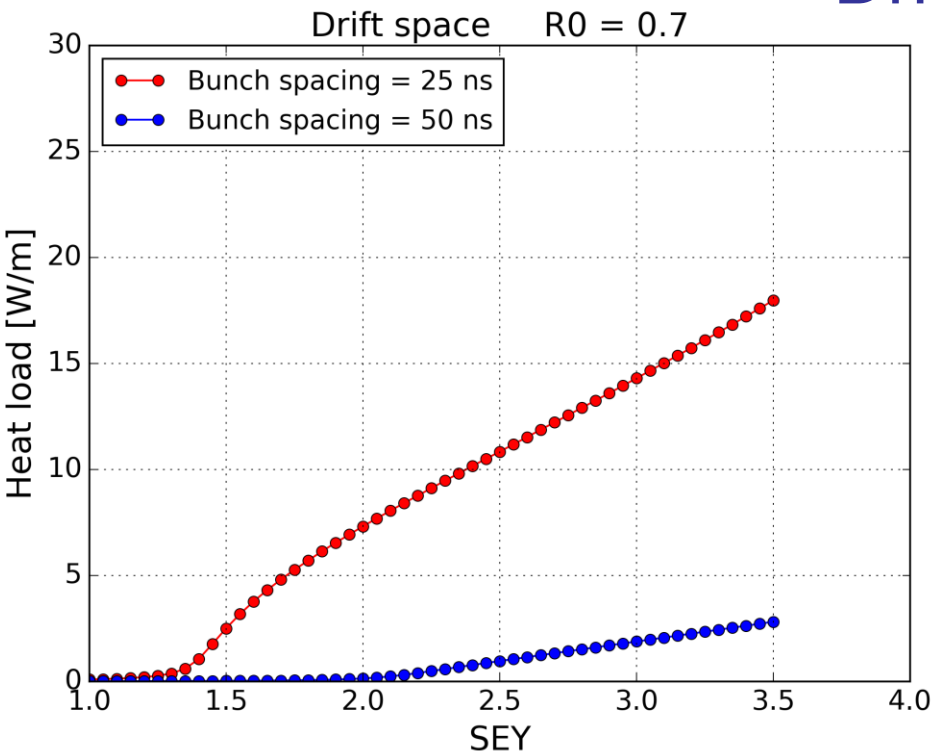


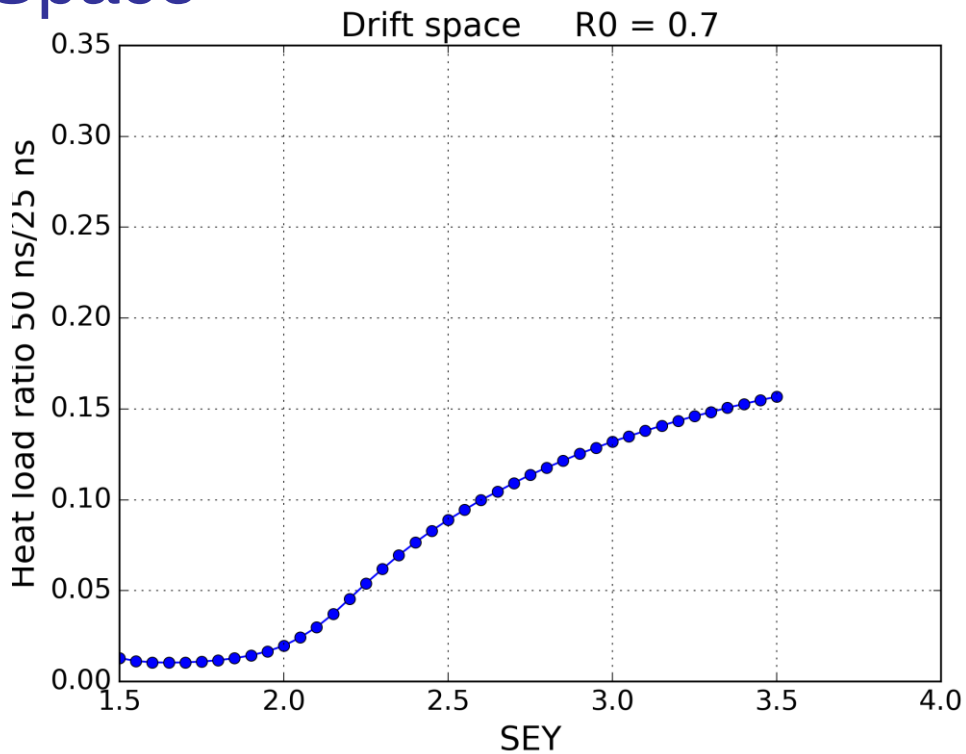


- In the case of a dipole for a bunch spacing 25 ns the multipacting threshold is lower:
  - $\delta \approx 1.25$ for bunch spacing 25 ns
  - $\delta \approx 1.75$ for bunch spacing 50 ns
- In the case of a dipole the ratio between the heat loads due to the electron cloud for the bunch spacing 50 ns and 25 ns is less than 0.2 (up to $\delta = 3.5$).

Buildup Simulation Results

Drift Space

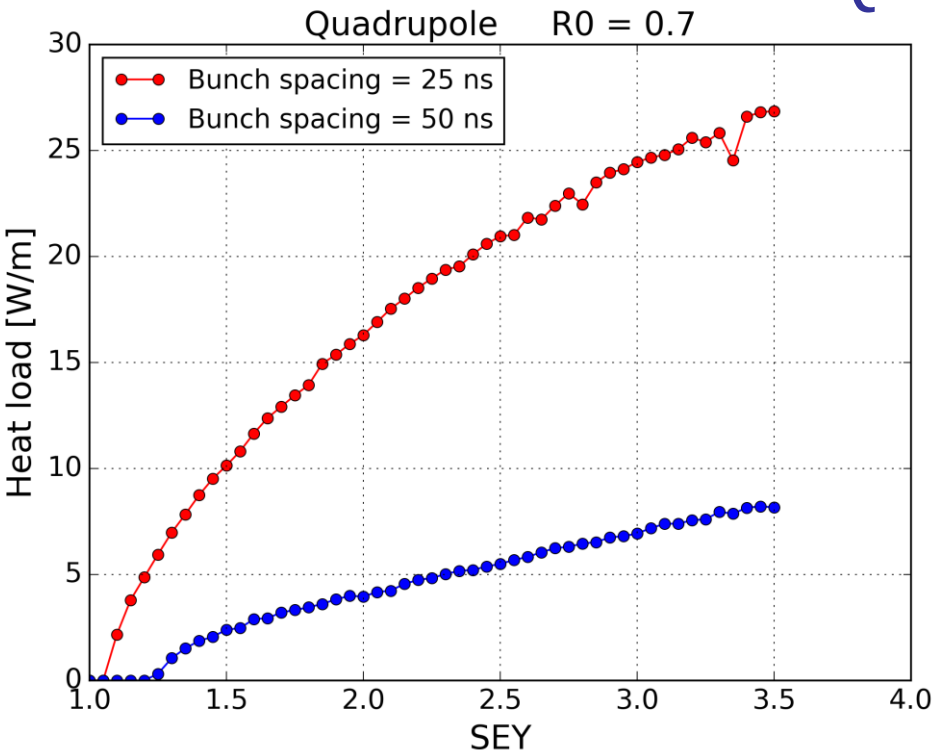


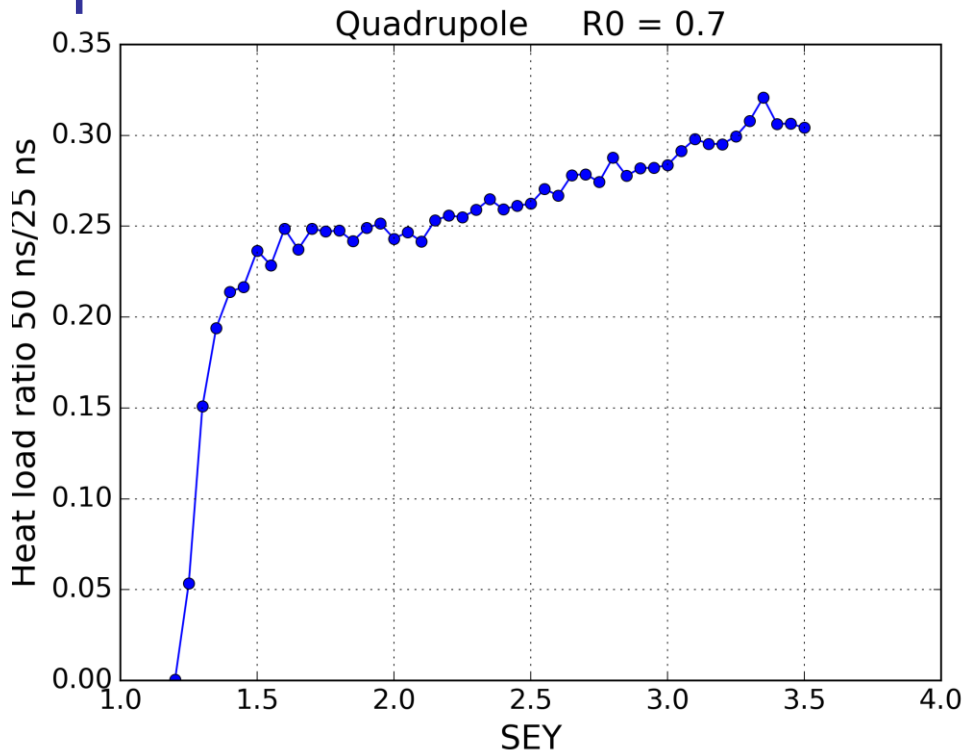


- In the case of a drift space the heat load is bigger than the case of a dipole.
- For bunch spacing 25 ns the multipacting threshold is lower as well:
  - $\delta \approx 1.25$ for bunch spacing 25 ns
  - $\delta \approx 2$ for bunch spacing 50 ns
- In the case of a dipole the ratio between the heat loads due to the electron cloud for the bunch spacing 50 ns and 25 ns is less than 0.2 (up to $\delta = 3.5$) as well.

Buildup Simulation Results

Quadrupole





- In the case of a quadrupole the heat load is bigger than the previous cases
- For bunch spacing 25 ns the multipacting threshold is lower as well:
  - $\delta \approx 1$ for bunch spacing 25 ns
  - $\delta \approx 1.25$ for bunch spacing 50 ns
- In the case of a quadrupole, the ratio between the heat loads due to the electron cloud for the bunch spacing 50 ns and 25 ns is less than 0.35 (up to $\delta = 3.5$).

Buildup Simulation Results

Are the results affected by modeling of elastics?

- Parameters of the electron production

1. large SEY: up to 3.5

$$\delta(\mathrm{E}) = \frac{I_{emit}}{I_{imp}(E)}$$

→ Larger SEY means more emitted electrons for a fixed number of impacting electrons with a fixed energy

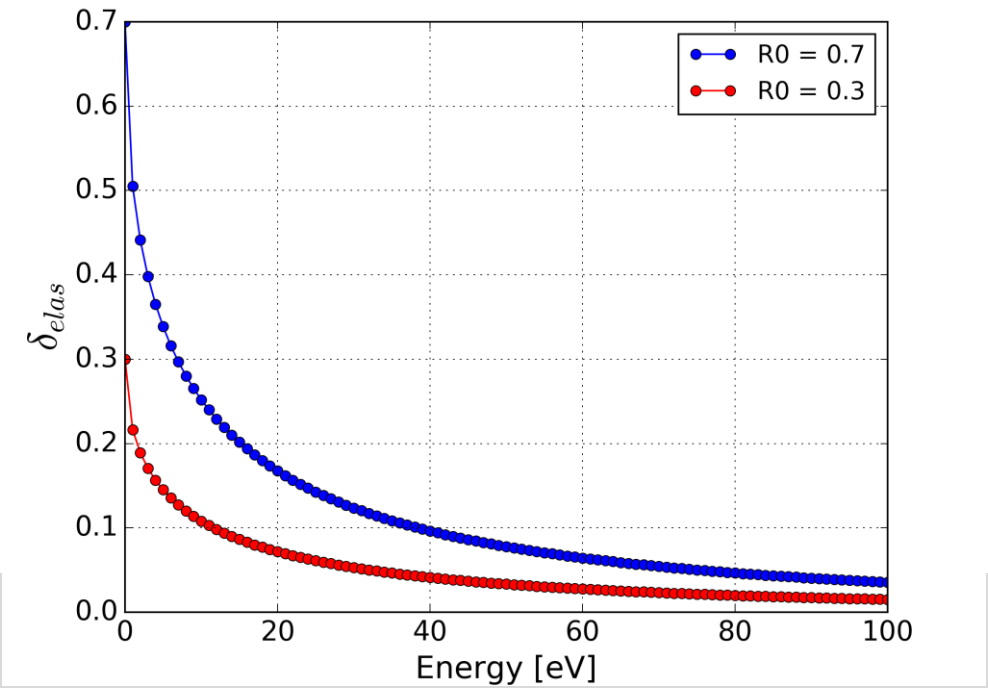
2. R_0 = 0.7 and 0.3

$$\delta(\mathrm{E}) = \delta_{elas}(\mathrm{E}) + \delta_{true}(\mathrm{E})$$

→ True secondary

→ Elastically-reflected electrons

$$\delta_{elas}(\mathrm{E}) = R_0 \left(\frac{\sqrt{E} - \sqrt{E + E_0}}{\sqrt{E} + \sqrt{E + E_0}} \right)^2$$



Buildup Simulation Results

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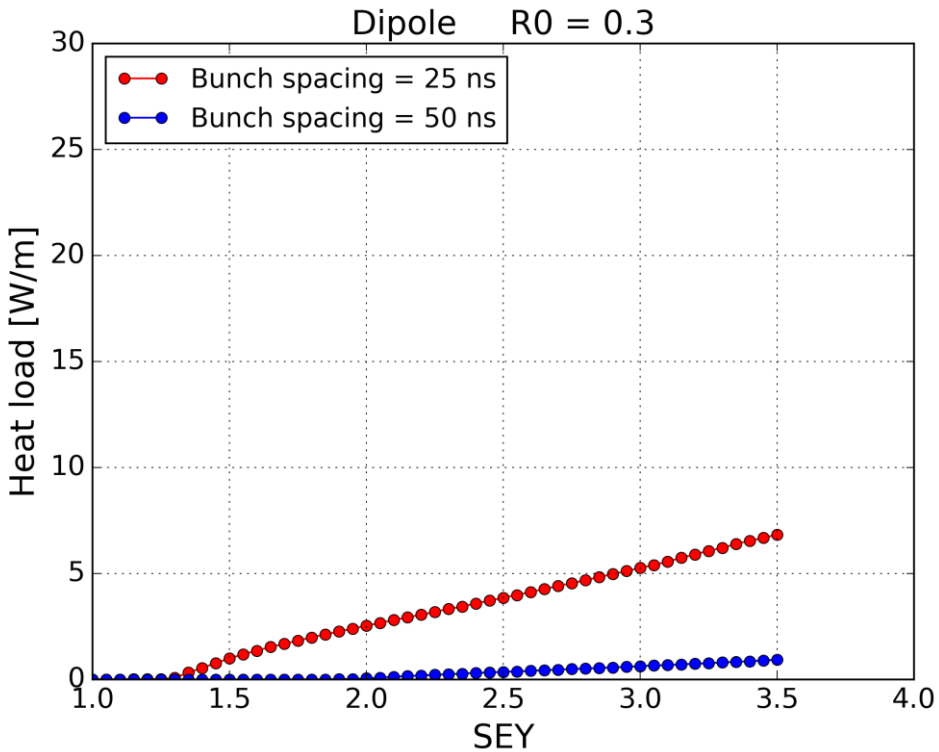
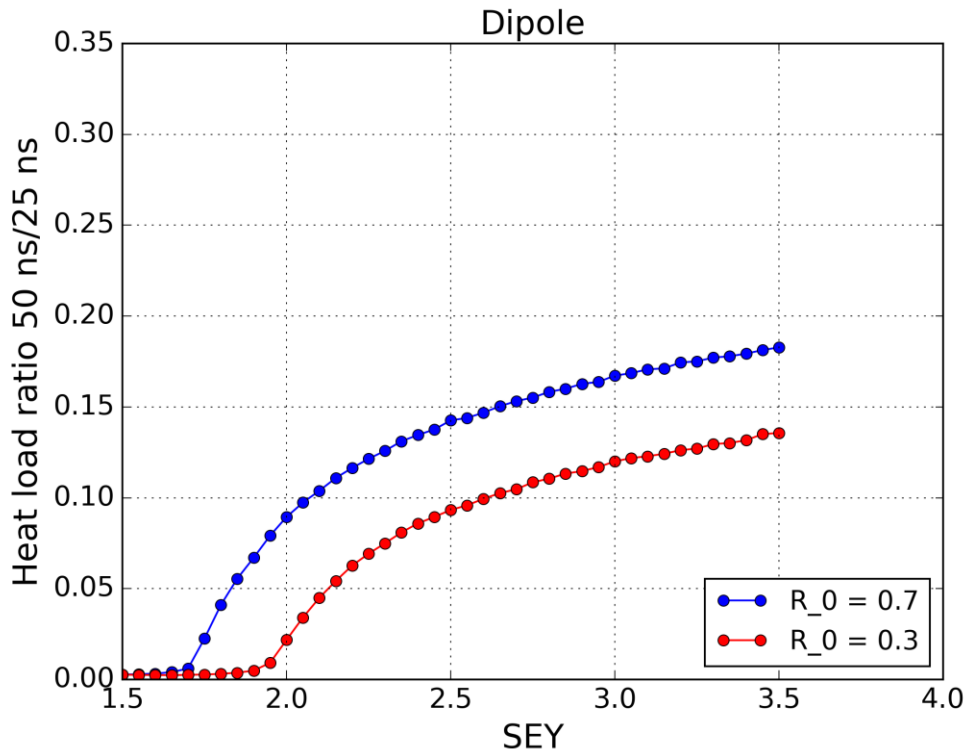
- Results rescaled to 2808 bunches (25 ns) and 1404 bunches (50 ns);
- δ: from 1 to 3.5 with step of 0.05;
- **R_0 = 0.3**

Buildup Simulation Results: $R_0 = 0.3$

Dipole

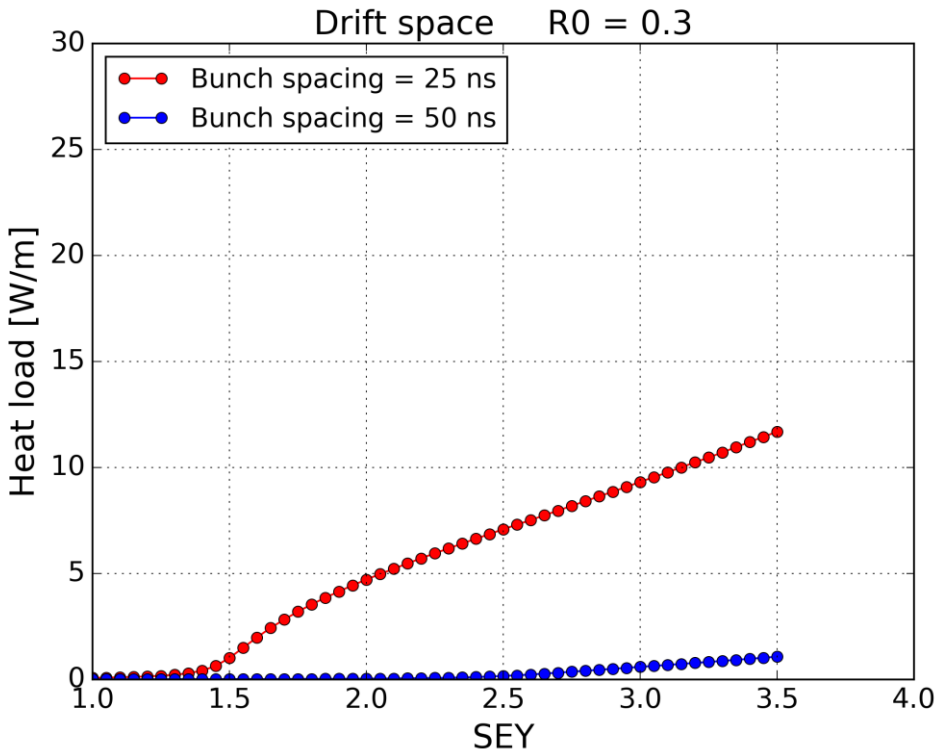


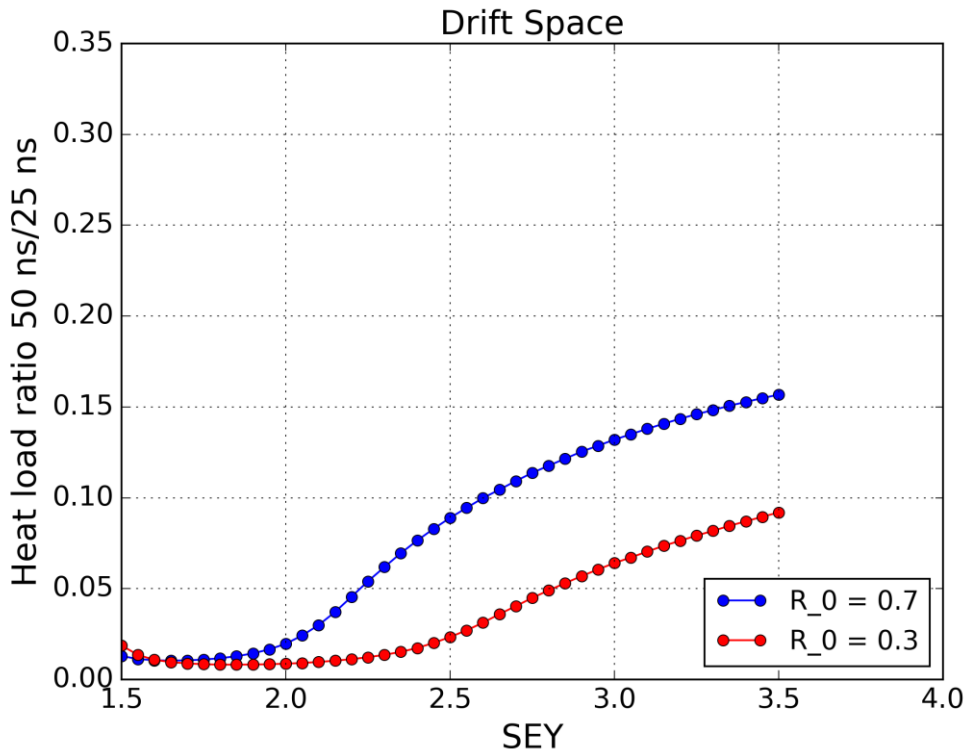


- In the case of a dipole the ratio of heat load due to the electron cloud with $R_0 = 0.3$ is lower than the heat load due to the electron cloud with $R_0 = 0.7$.

Buildup Simulation Results: $R_0 = 0.3$

Drift Space

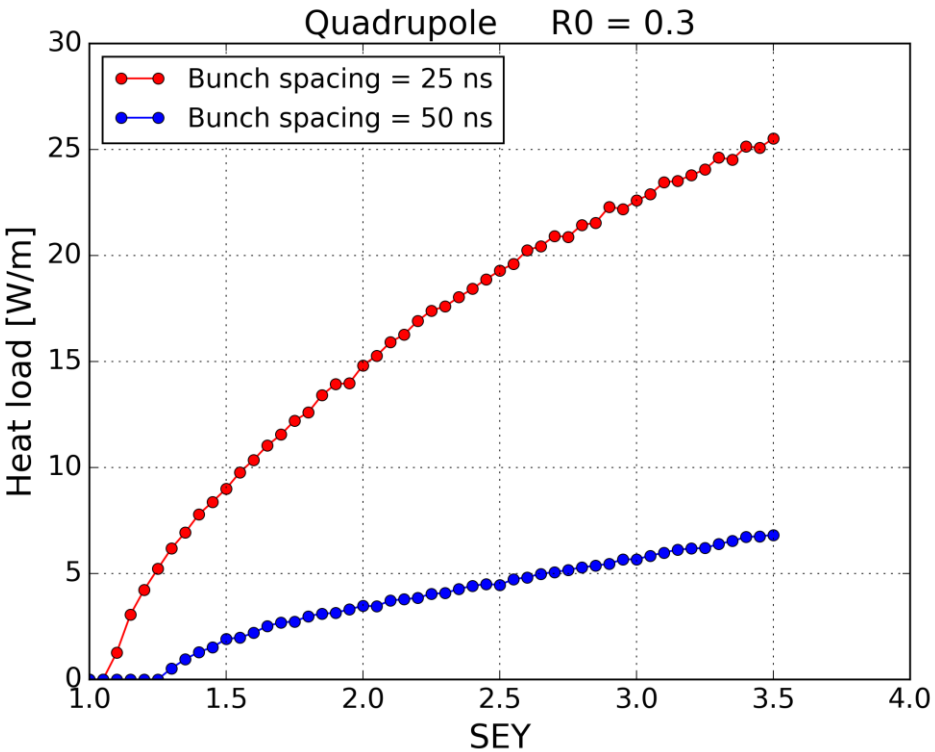


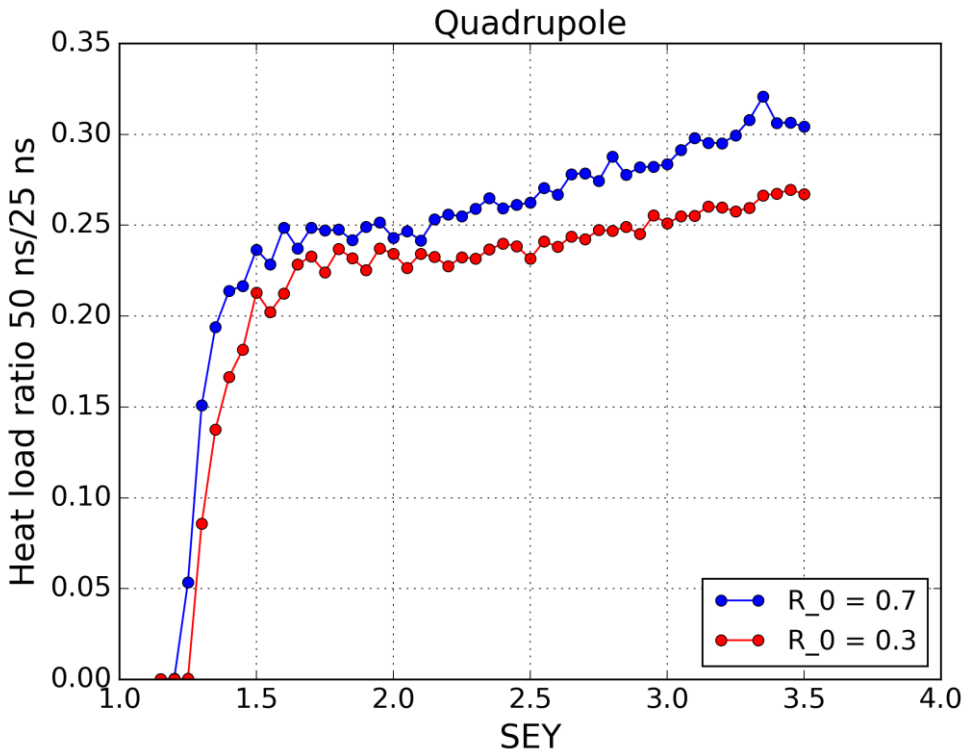


- In the case of a drift space the ratio of heat load due to the electron cloud with $R_0 = 0.3$ is lower than the heat load due to the electron cloud with $R_0 = 0.7$ as well.

Buildup Simulation Results: $R_0 = 0.3$

Quadrupole





- In the case of a quadrupole the ratio of heat load due to the electron cloud with $R_0 = 0.3$ is lower than the heat load due to the electron cloud with $R_0 = 0.7$ as well.

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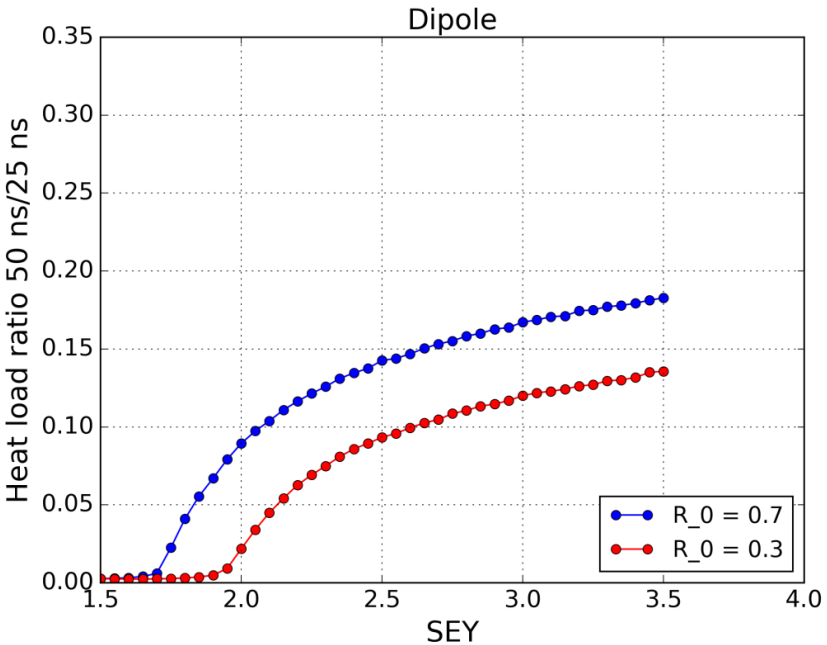
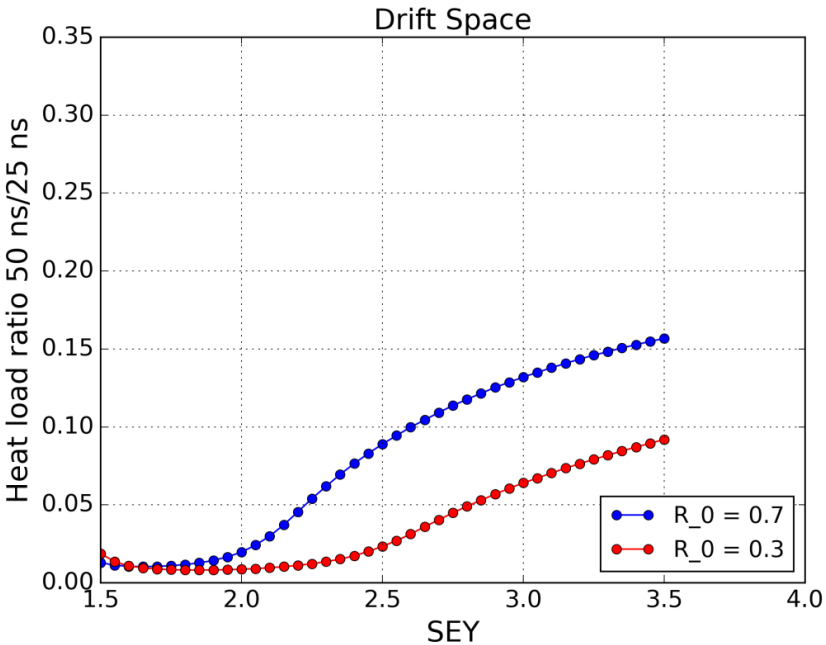
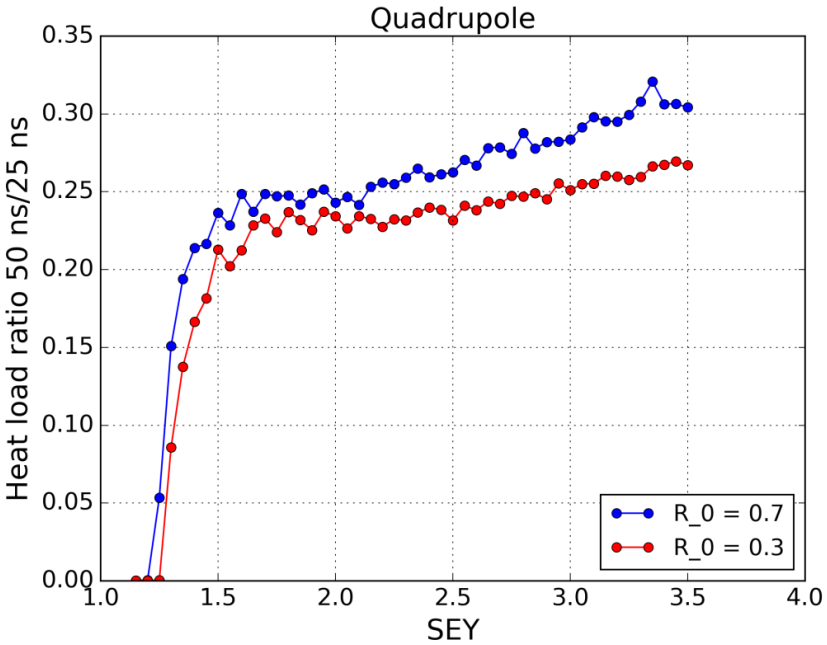
Summary







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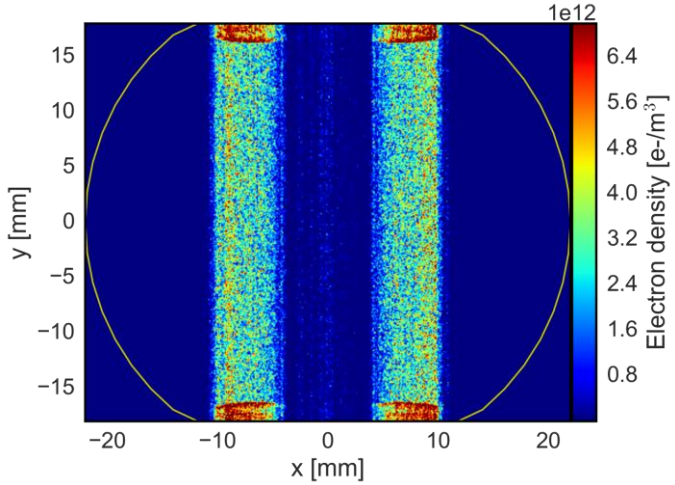
Thank you for your attention

Parameters under Investigation 2/2

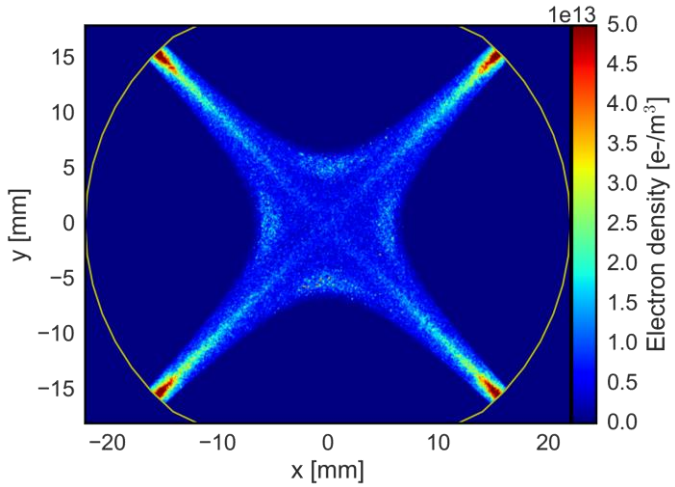
- Magnetic field configurations

1. Dipole



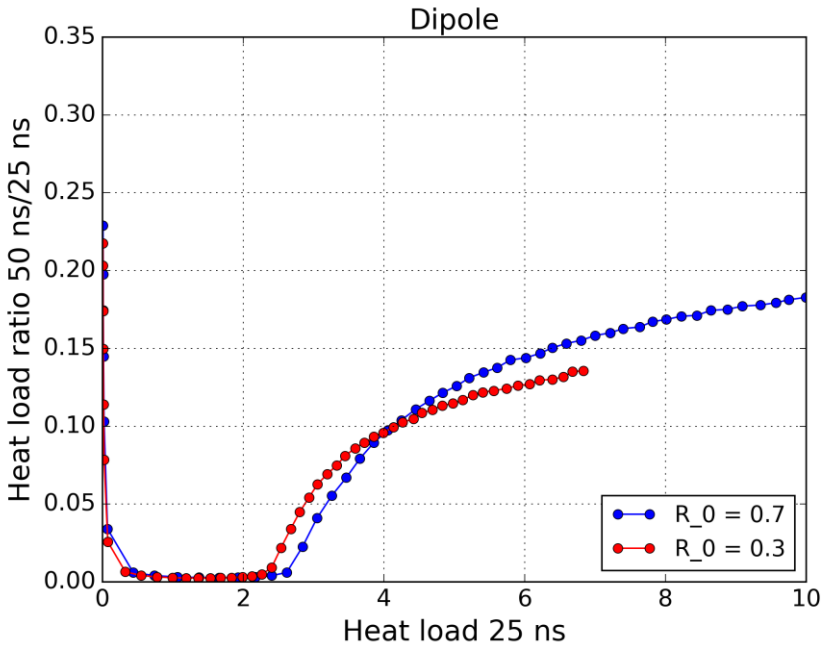
Courtesy of Giovanni Iadarola (from presentation at LBNL, 26 April 2017)

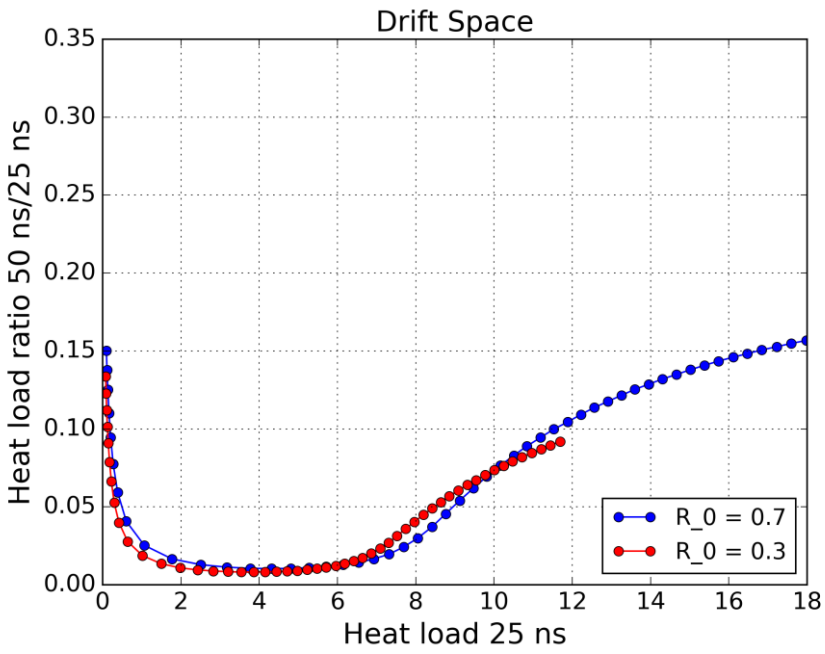
2. Quadrupole

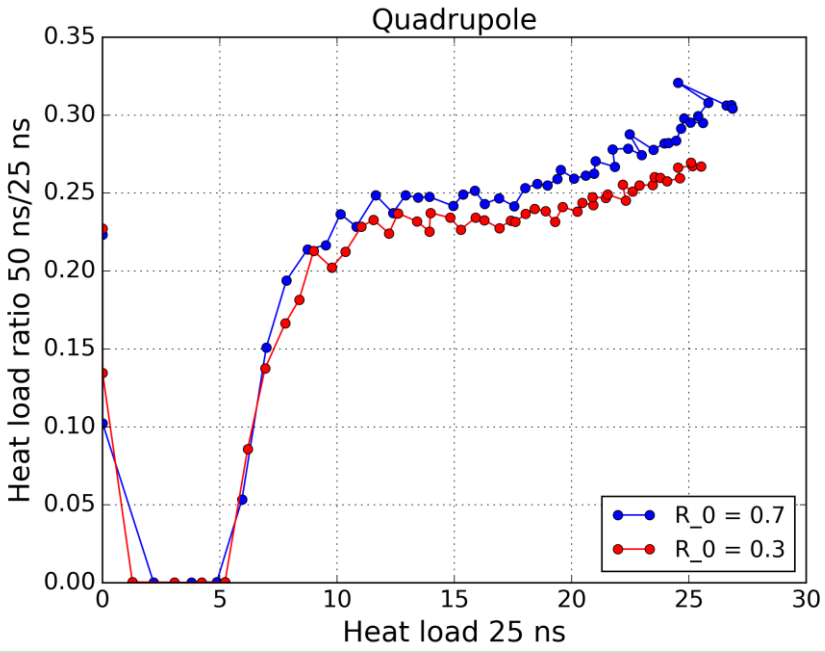


3. Drift Space: uniformly distributed

Summary







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