Impact of the Secondary Emission Model on e-cloud build-up

50 ns

vs

25 ns

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Electron Cloud meeting #58

CERN

Introduction

- Recent heat-load measurements seemed to point to very high heat-load densities (> 10 W/m) with 25 ns spacing incompatible with simulation results for 25ns and 50ns beams (more recent analysis by the cryo team, shows in fact lower heat-load densities)
  - We want to understand which features of the surface modeling influence the heat load ratio between 25 ns and 50 ns spacing

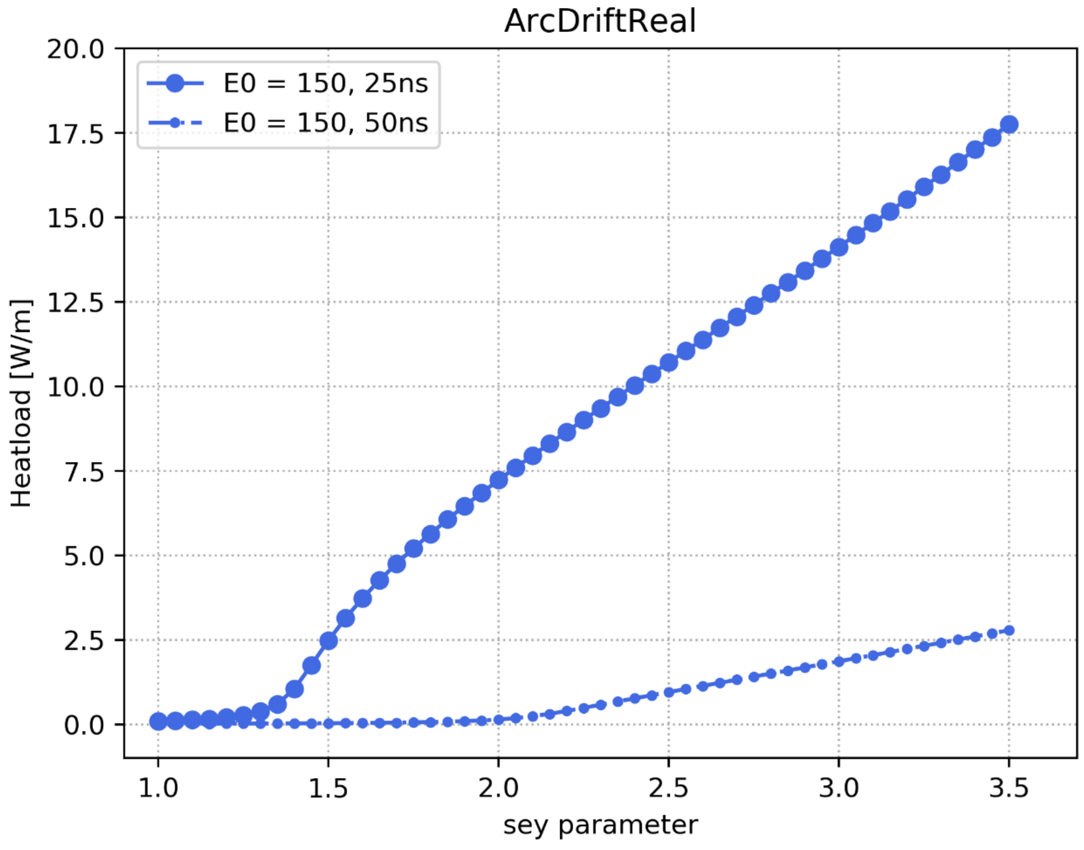
- Changing the values of the *Cimino et al.* model parameters to find parameters that induce a difference in heat-load ratio of 25ns and 50 ns beams
  - Interested in understanding the scaling → probed also unphysical/exaggerated effects to see the trends

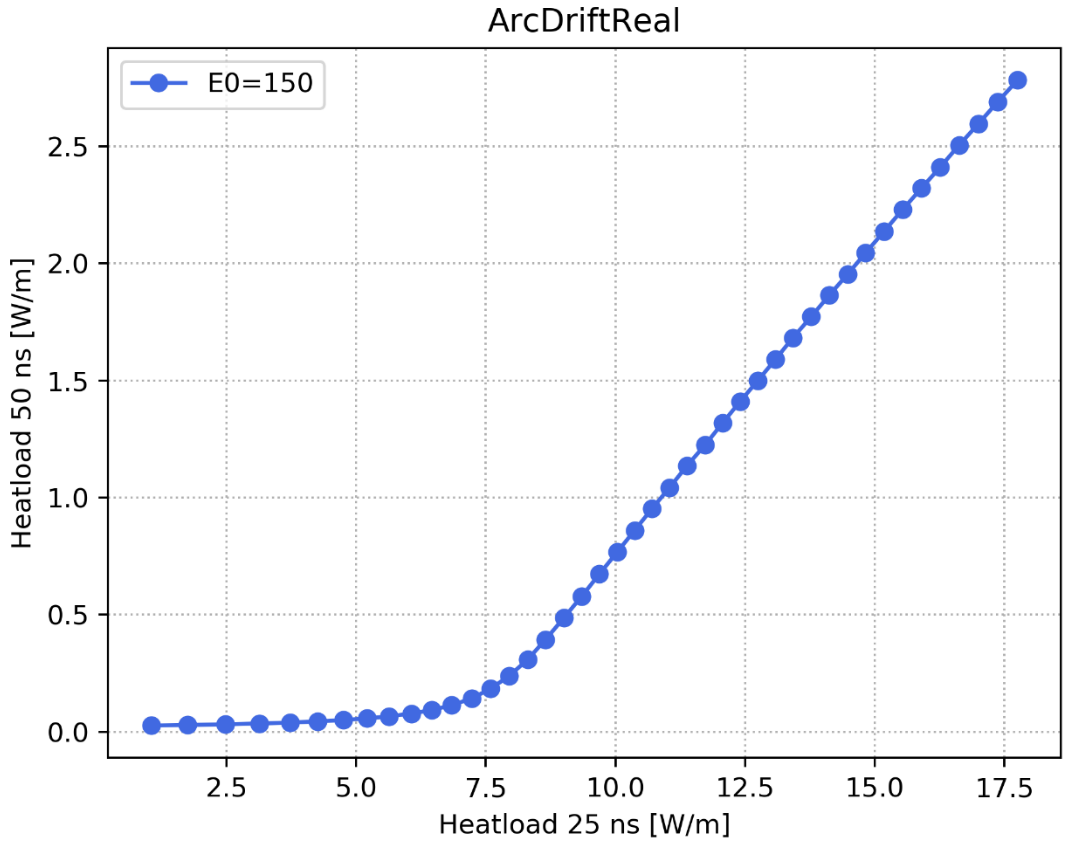
The question we want to address is:

Given a certain heat load with 25 ns,
what is the heat load expected for 50 ns?

Cimino et al. model

E_0 = 150 eV





Simulation Parameters

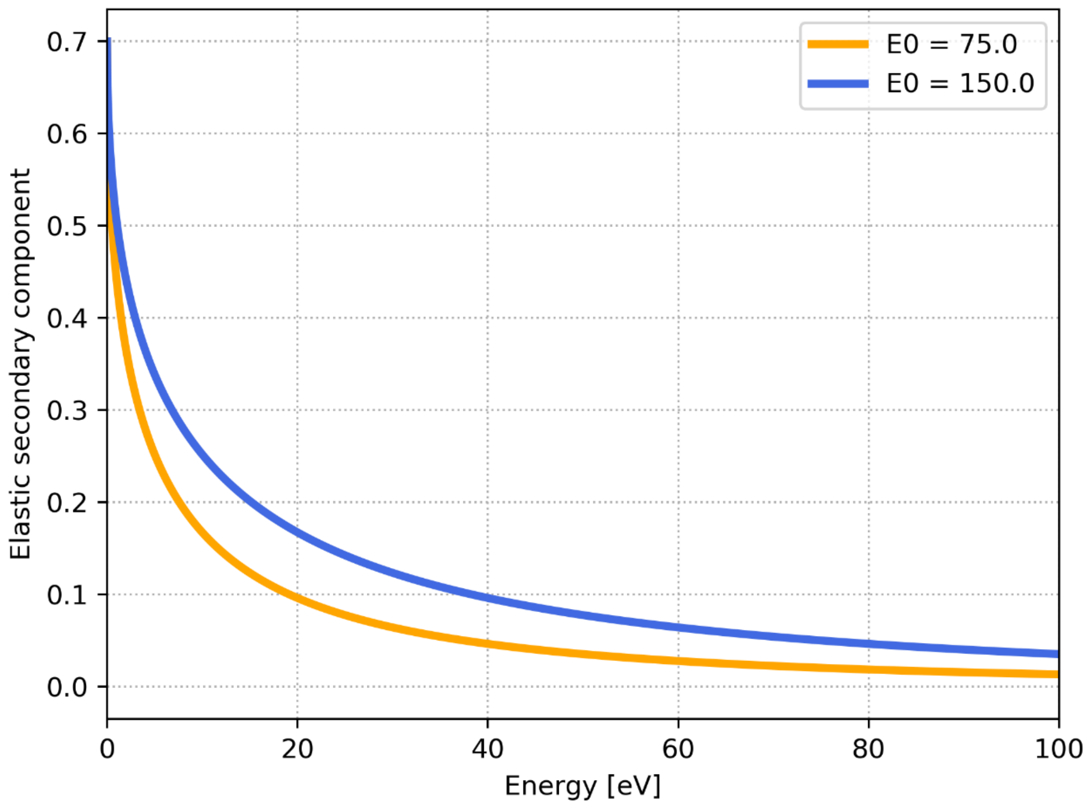
- 25 & 50 ns
- Drift
- 6.5 TeV
- 1e11 ppb
- $\delta_{max} = 1 \sim 3.5$
- Scanning different values of Cimino et al. surface model (explained in the following):
  - E_0 of the elastics component
  - R_0 >>
  - s of the true component
  - E_{max} >>
  - μ_{true} of the energy spectrum → Spoiler Alert!

Elastic Component

- Parameters for the elastic component of the Secondary Electron Yield
  - E_0
  - R_0

E_0 parameter

- The E_0 parameter controls the elastic component of the Secondary Electron Yield (δ_{elas}) according to the relation:
  - $\delta_{elas}(E) = R_0 \left(\frac{\sqrt{E} - \sqrt{E+E_0}}{\sqrt{E}+\sqrt{E+E_0}}\right)^2$
- In LHC beam chambers:
  - $R_0 = 0.7$
  - $E_0 = 150\ eV$

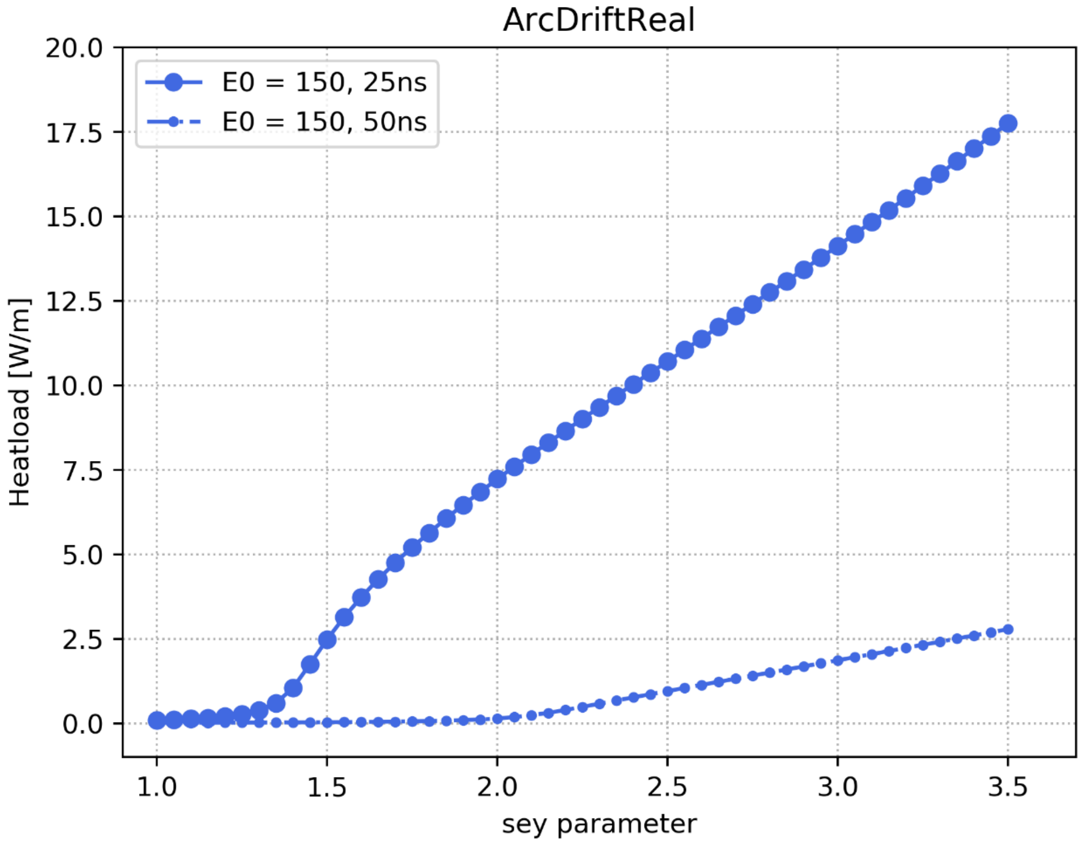


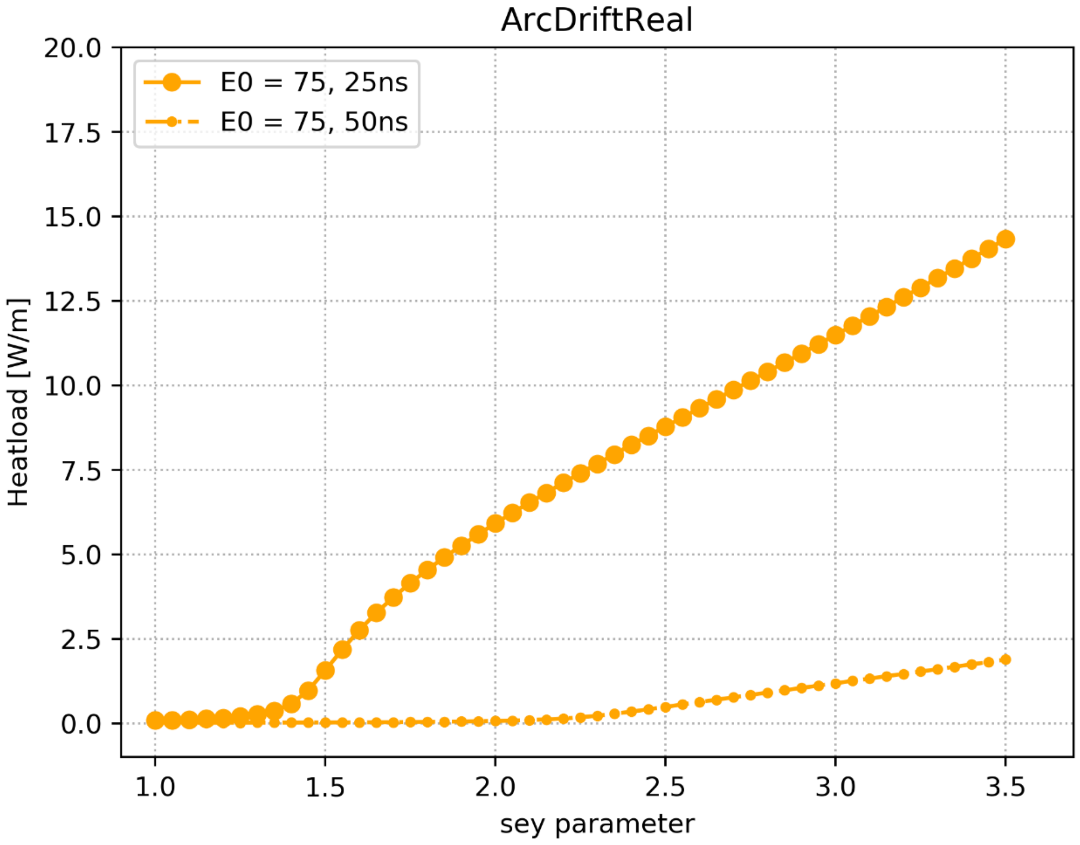
Heatload vs sey parameter

Cimino et al. model

E_0 = 150 eV

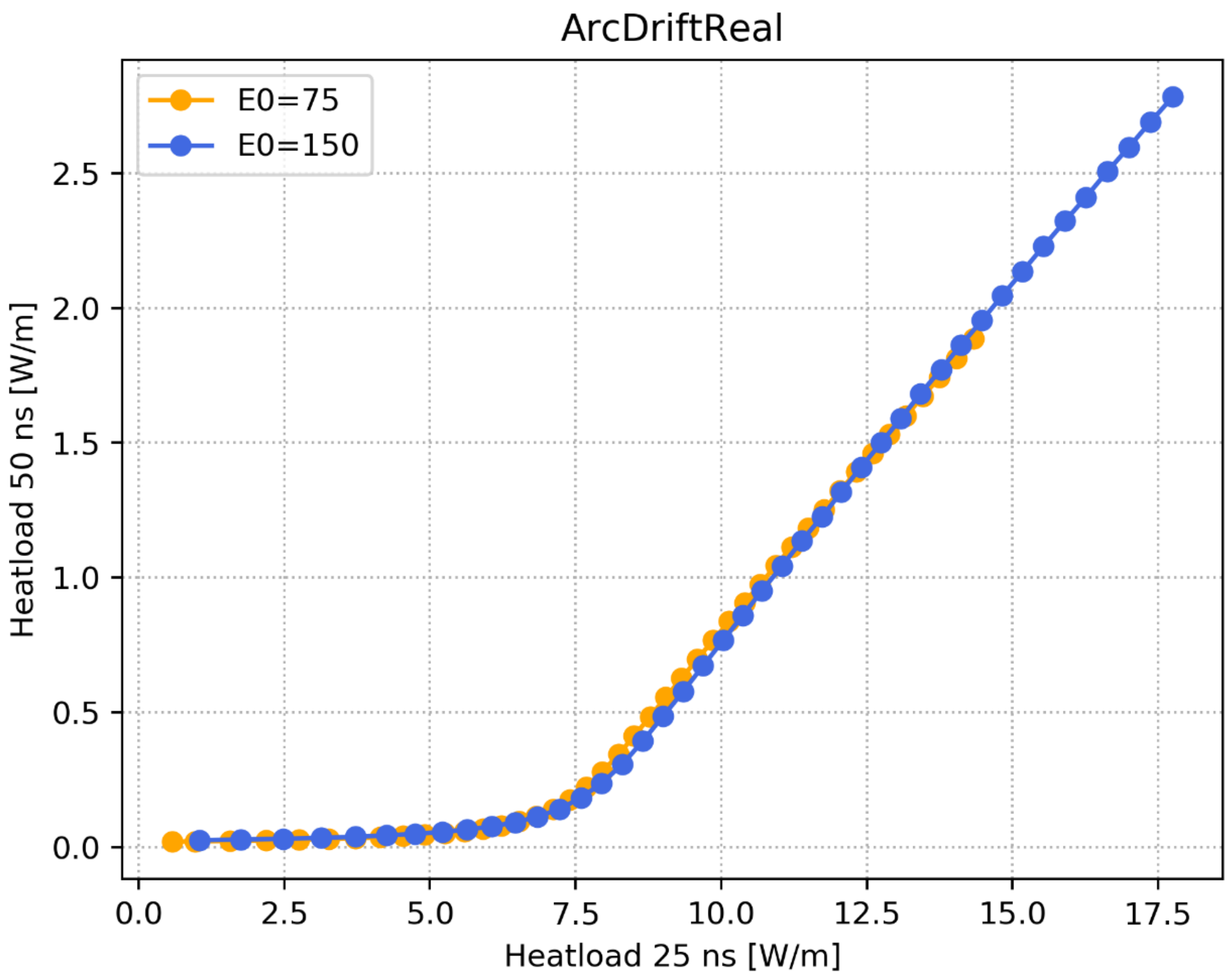
E_0 = 75 eV





Heatload 50 ns vs Heatload 25 ns

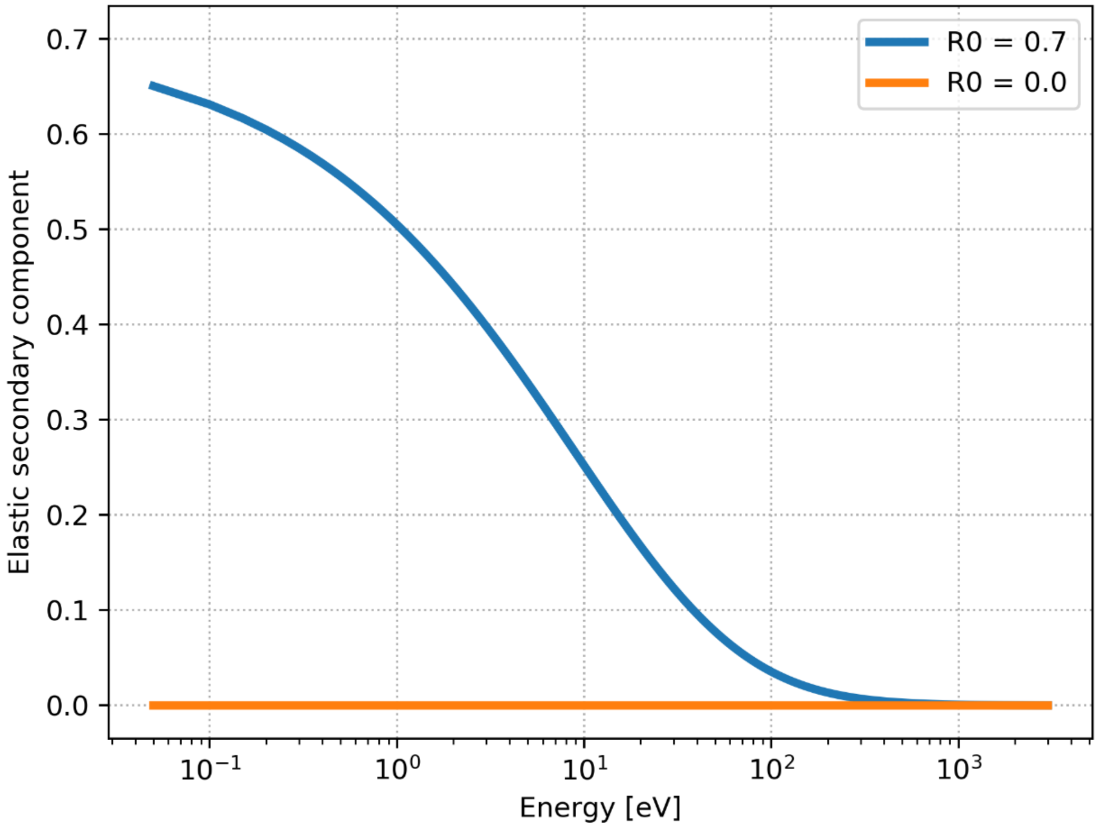
$E_0 = 150\ eV$
$E_0 = 75\ eV$



No impact of the E_0 parameter on the the 50ns/25ns ratio

R_0 parameter

- The R_0 parameter controls the elastic component of the Secondary Electron Yield (δ_{elas}) according to the relation:
  - $\delta_{elas}(E) = R_0 \left(\frac{\sqrt{E} - \sqrt{E+E_0}}{\sqrt{E}+\sqrt{E+E_0}} \right)^2$
- In LHC beam chambers:
  - $R_0 = 0.7$
  - $E_0 = 150\ eV$



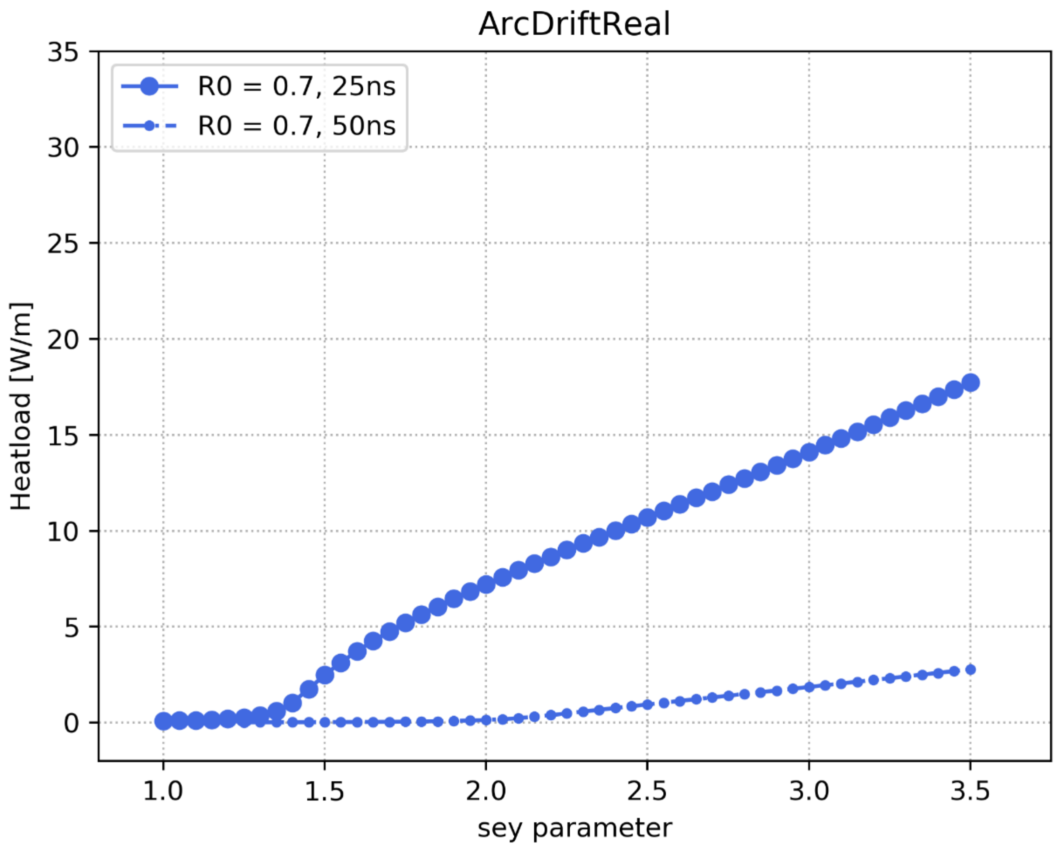
Heatload vs sey parameter

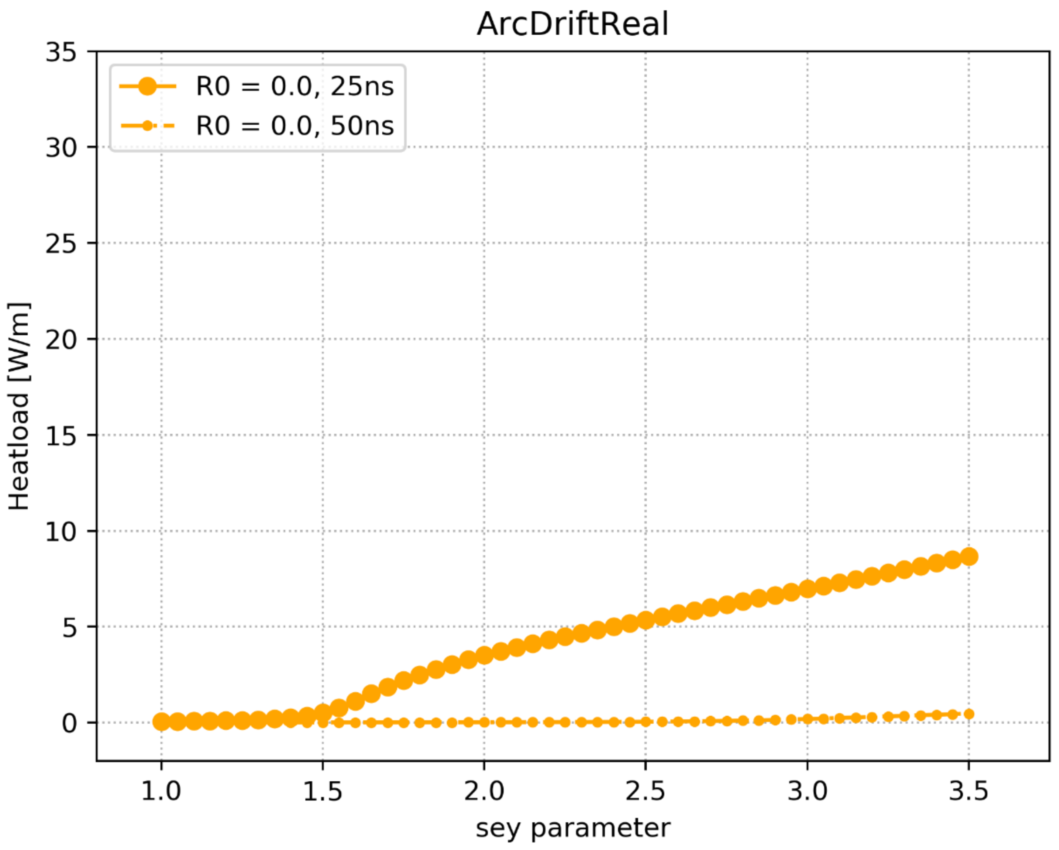
Drift

Cimino et al. model

$R_0 = 0.7$

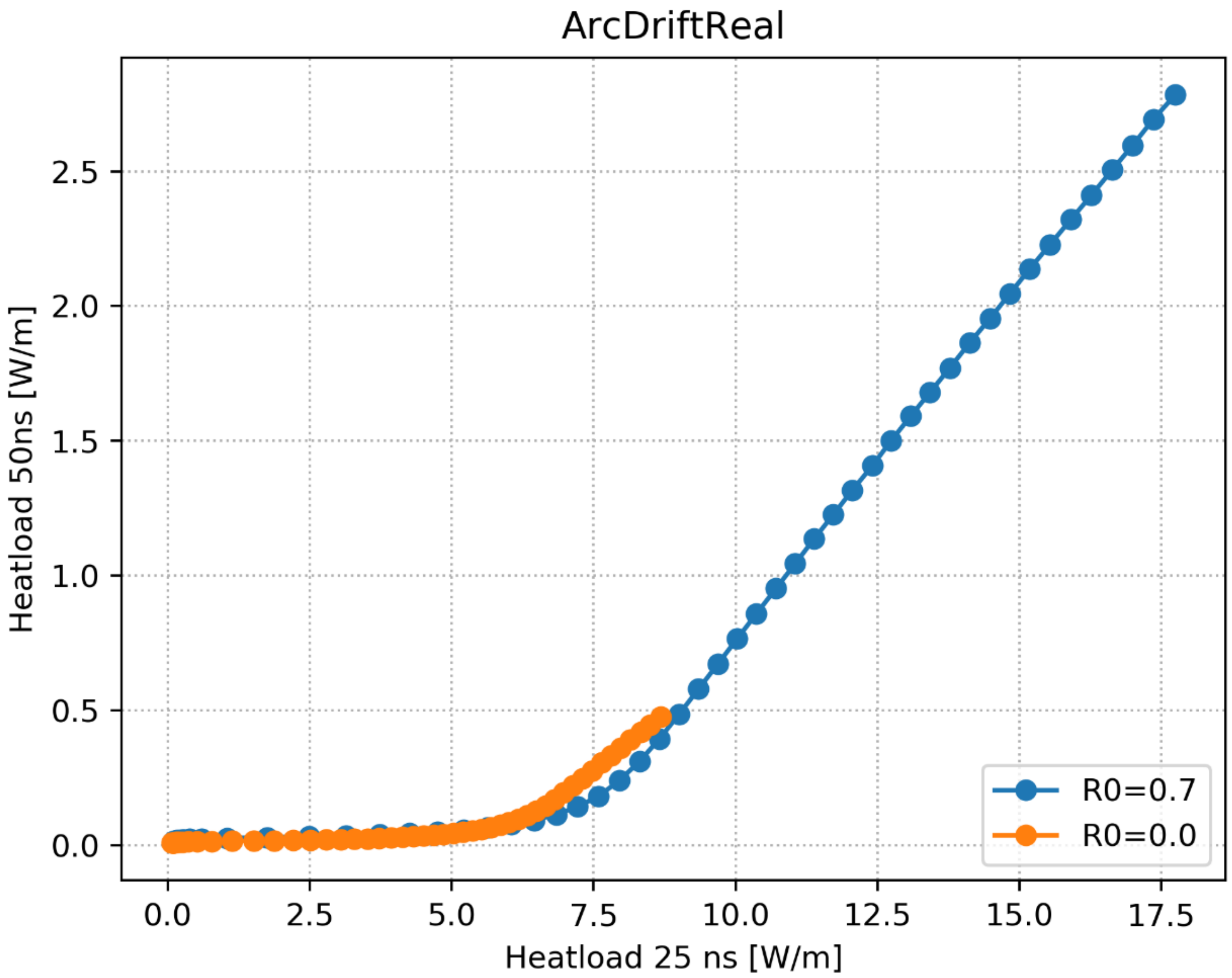
$R_0 = 0.0$





Heatload 50 ns vs Heatload 25 ns

$R_0 = 0.7$
$R_0 = 0.0 \rightarrow$ No elastics



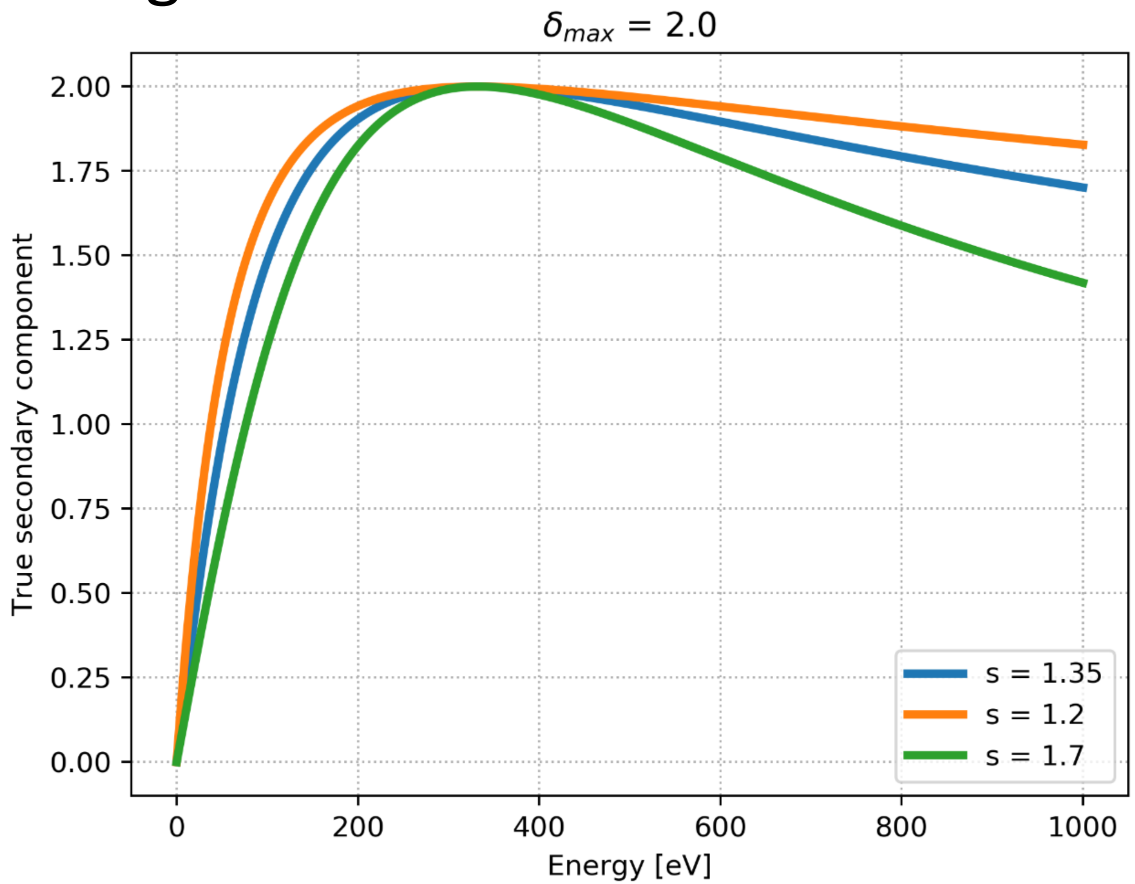
Only minor effect on the 50ns/25ns ratio

True Secondary Component

- Parameters for the true secondary component of the Secondary Electron Yield
  - s
  - E_{max}

s parameter

- The s parameter controls the true secondary component of the Secondary Electron Yield (δ_{true}) according to the relation:
  - $\delta_{true}(E) = \delta_{max} \frac{s\frac{E}{E_{max}}}{s-1+\left(\frac{E}{E_{max}}\right)^{s}}$
- In LHC beam chambers:
  - $s = 1.35$
  - $E_{max} = 332\ eV$

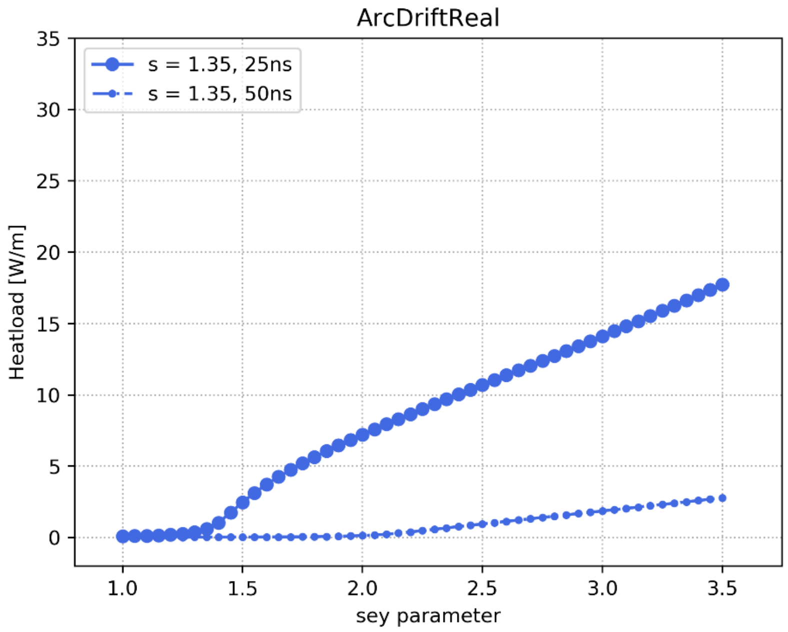


Heatload vs sey parameter

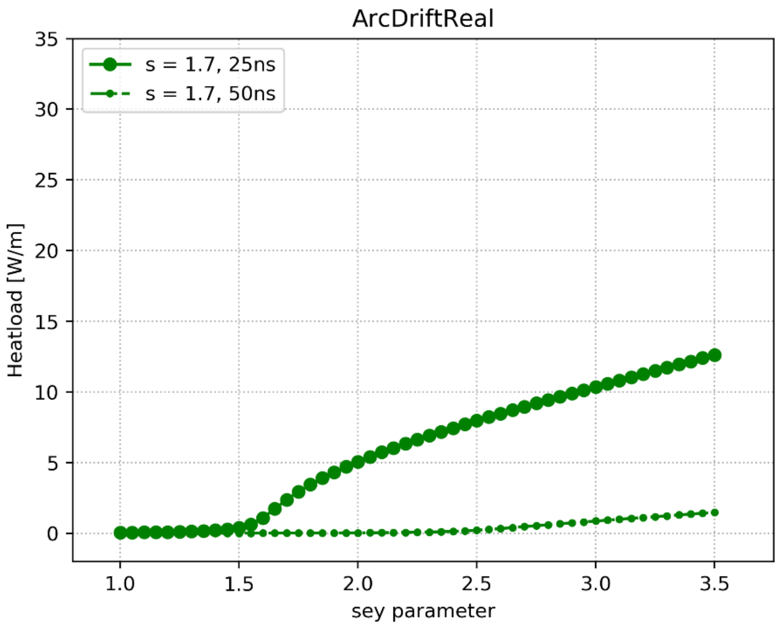
Drift

Cimino et al. model

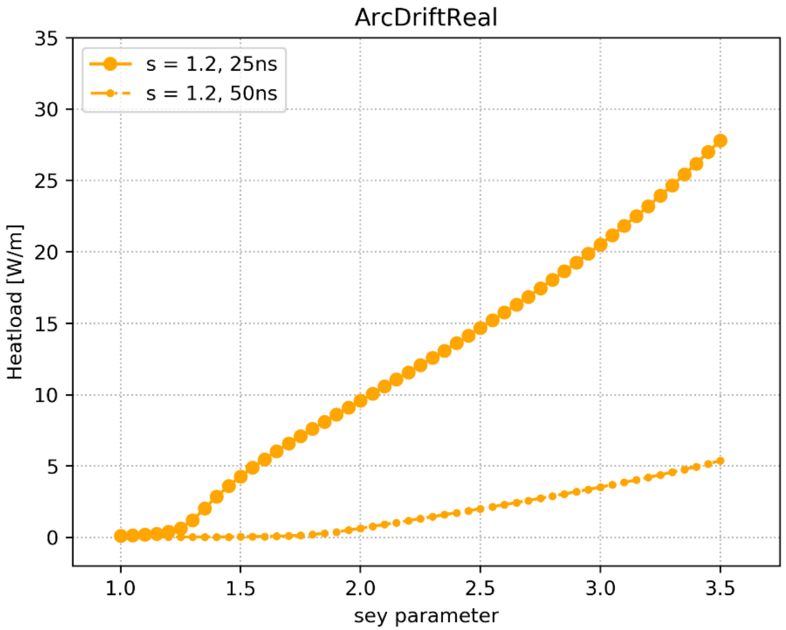
$s = 1.35$



$s = 1.70$

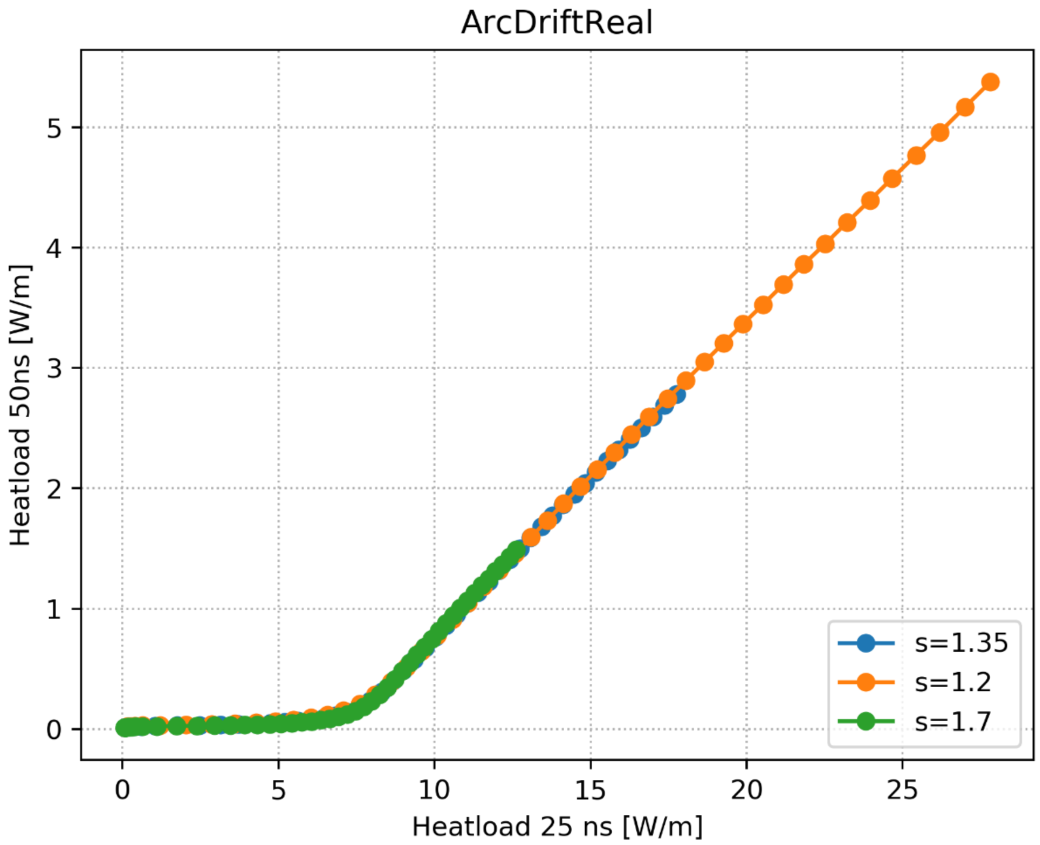


$s = 1.20$



Heatload 50 ns vs Heatload 25 ns

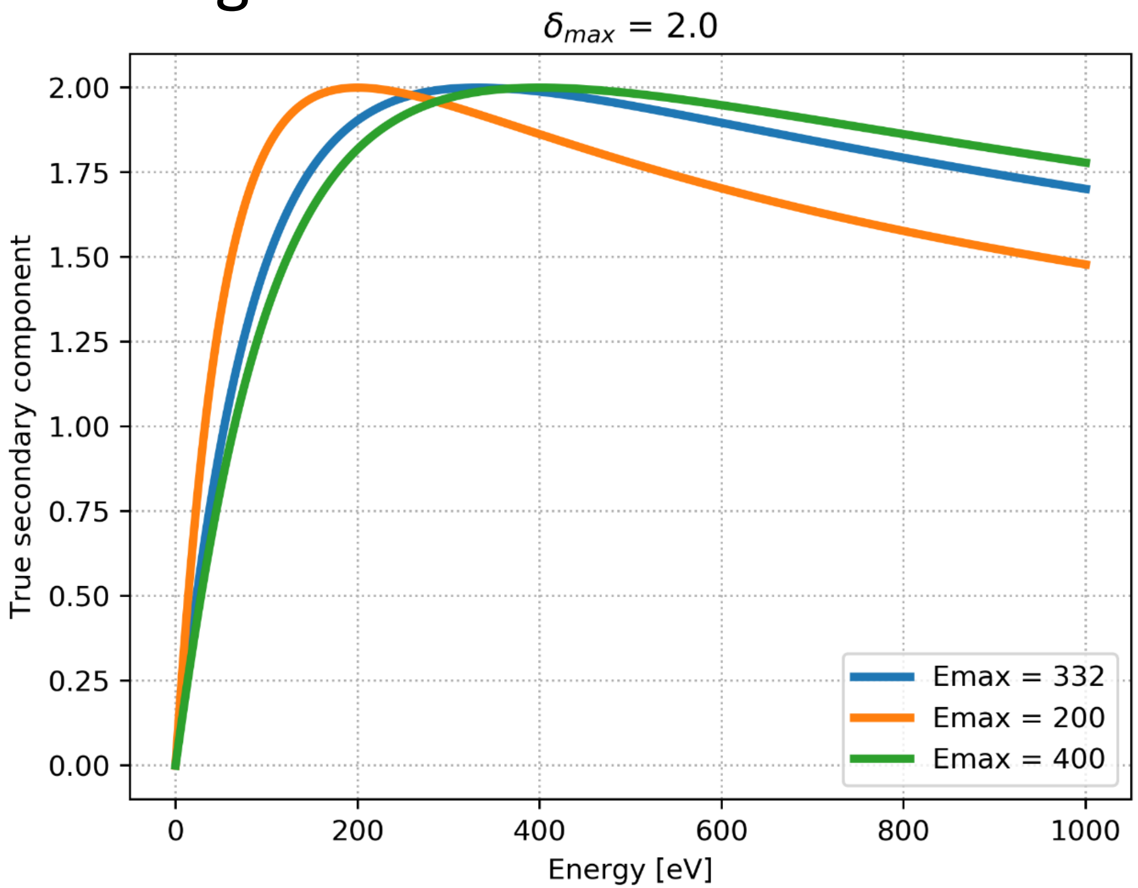
$s = 1.35$
$s = 1.20$
$s = 1.70$



No impact of s parameter on heat-load ratio

E_{max} parameter

- The Emax parameter controls the true secondary component of the Secondary Electron Yield (δ_{true}) according to the relation:
  - $\delta_{true}(E) = \delta_{max} \frac{s\frac{E}{E_{max}}}{s-1+\left(\frac{E}{E_{max}}\right)^{s}}$
- In LHC beam chambers:
  - $s = 1.35$
  - $E_{max} = 332eV$

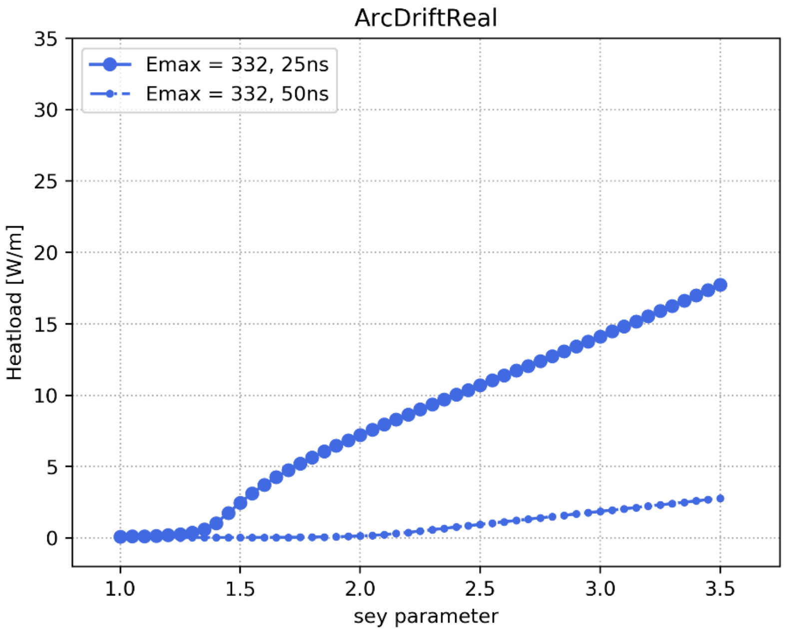


Heatload vs sey parameter

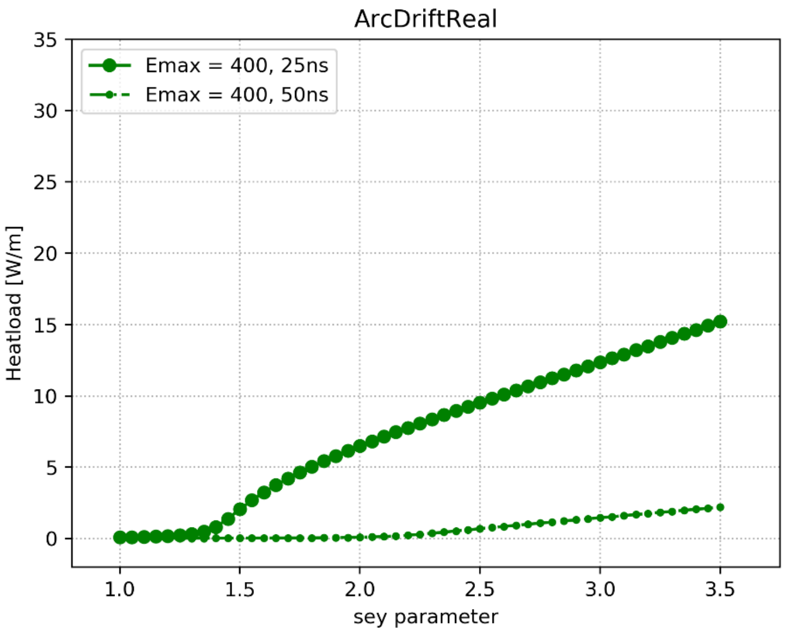
Cimino et al. model

Drift

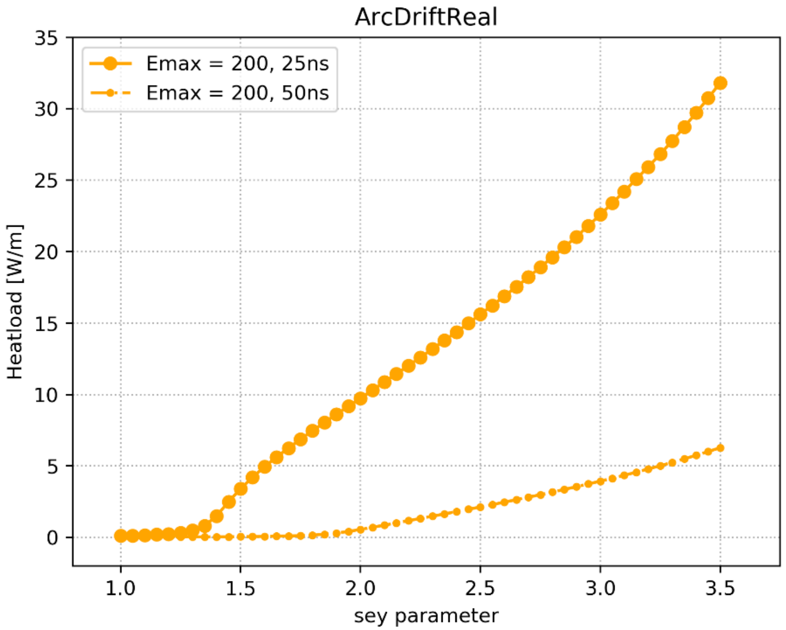
Emax = 332 eV



Emax = 400 eV

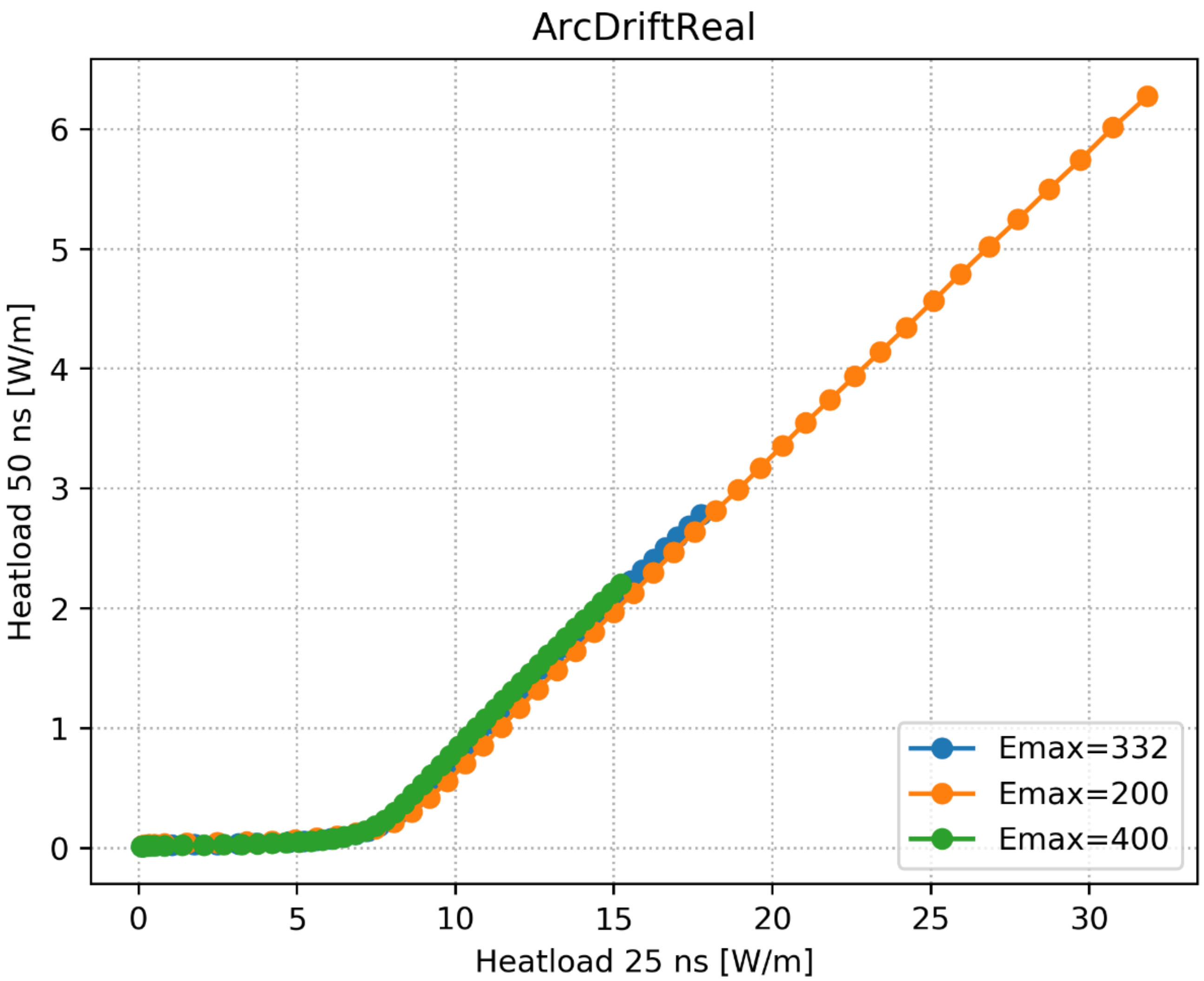


Emax = 200 eV



Emax = 332 eV
Emax = 200 eV
Emax = 400 eV

Heatload 50 ns vs Heatload 25 ns



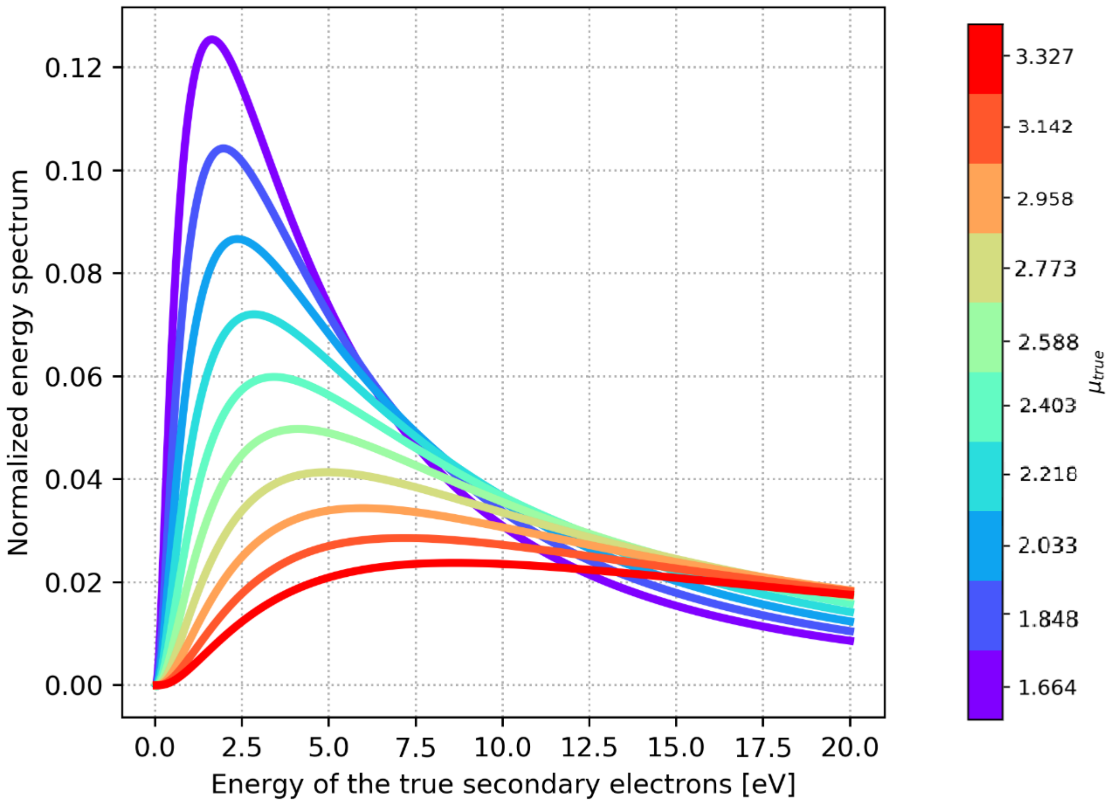
minor impact of E_{max} parameter on heat-load ratio

Energy spectrum of true secondaries

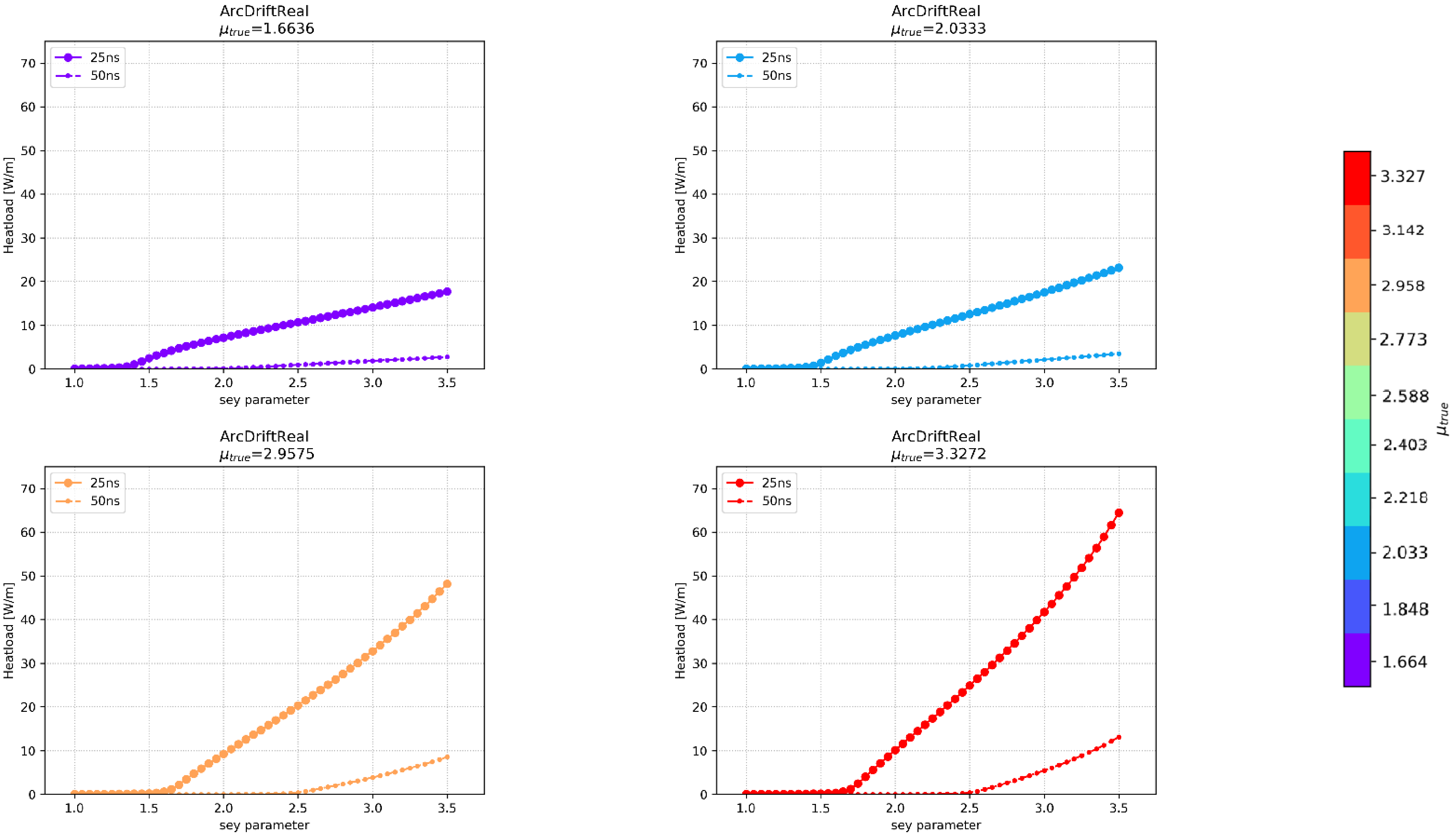
- Parameters for the energy spectrum of the true secondary electrons
  - μ_{true}

μ_{true} parameter

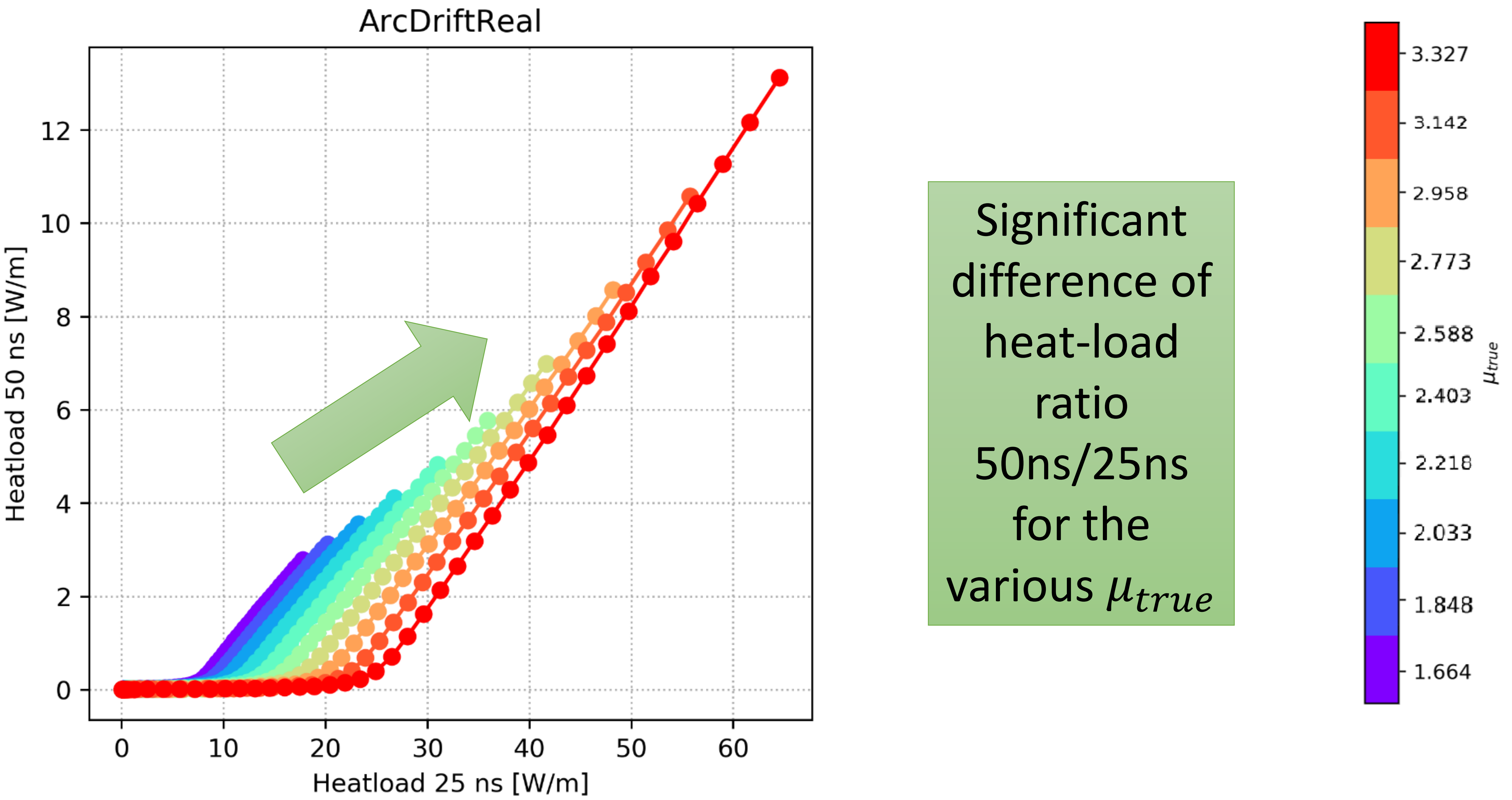
- The μ_{true} parameter (mufit) controls the energy spectrum of the true secondaries according to the relation (lognormal distribution):
  - $\frac{d\, n_{true}}{d\, E} = \frac{1}{E\, \sigma_{true} \sqrt{2\pi}} e^{-\frac{(\ln(E)-\mu_{true})^2}{2\, \sigma_{true}^2}}$
- In LHC beam chambers:
  - $\sigma_{true} = 1.0828$
  - $\mu_{true} = 1.6636$



Heatload vs sey parameter



Heatload 50 ns vs Heatload 25 ns



Significant difference of heat-load ratio 50ns/25ns for the various μ_{true}

Conclusions

- E_0 → no significant difference in heat-load ratio 50ns/25ns
- R_0 → only minor difference in heat-load ratio despite unphysical case of $R_0 = 0$ (no elastically scattered electrons)
- s → significant change of true secondary component but no visible difference in heat-load ratio
- E_{max} → minor impact on heat-load ratio

Conclusions

- μ_{true} parameter of the energy spectrum of true secondaries has a significant impact on heat-load ratio of 50ns/25ns beams