First results from PyECLOUD simulations with measured SEY curves

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Electron Cloud meeting
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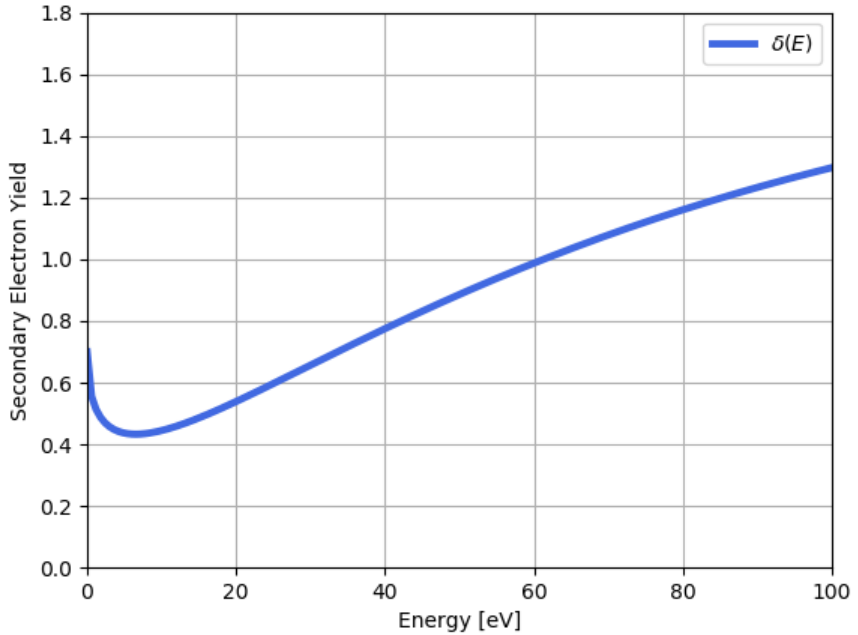
Secondary Electron Yield

- The main quantity involved in the electron cloud buildup is the Secondary Electron Yield (SEY):

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

Ratio between emitted and impacting electron current as a function of the energy of the impinging electrons



Low energy part of the sey curve

Secondary Electron Yield

- We typically divide the SEY in two components

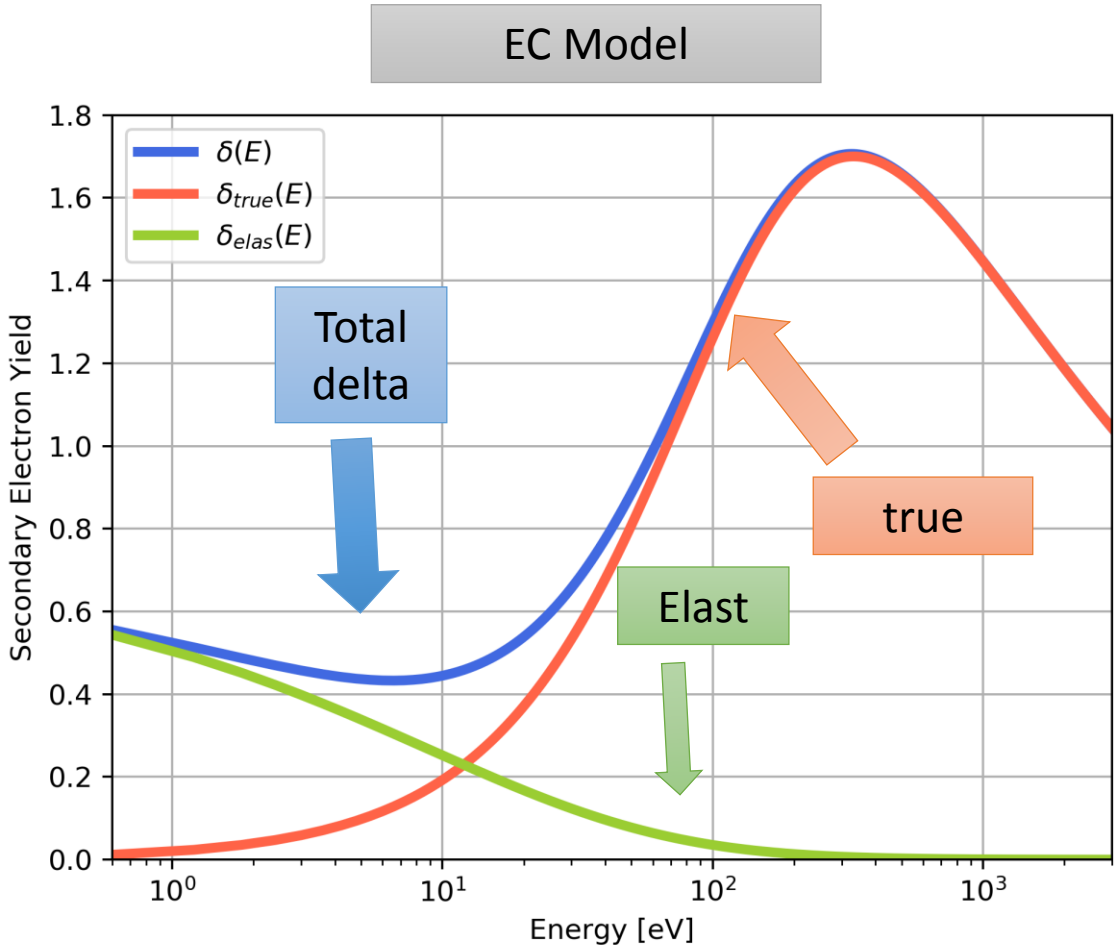
elastic

true

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

Electrons elastically scattered by the chamber's wall's

True secondary electrons



Secondary Electron Yield

- The SEY also depends on the angle of incidence of the impinging electron:

$$E_{max}(\theta) = E_{max}(\theta = 0)\,(1 - 0.7\,(1 - \cos\theta))$$

Shifting the Emax to larger values according to the impinging angle

- $$\delta_{max}(\theta) = \delta_{max}(\theta = 0)\, e^{\frac{(1-\cos\theta)}{2}}$$

Scaling the δmax according to the impinging angle

For the purpose of this study we implemented the possibility of disabling these dependencies in PyECLOUD using the flags:

- flag_costheta_Emax_shift
- flag_costheta_delta_scale

Objective

- Our objective is to check where the usual secondary emission model stands in comparison with the measured SEY curves.

- Two are our main issues concerning the model:
  - What to do with elastics? Measurements do not distinguish between the two components
  - What to do with angular dependence? Measurements are made for normal incidence

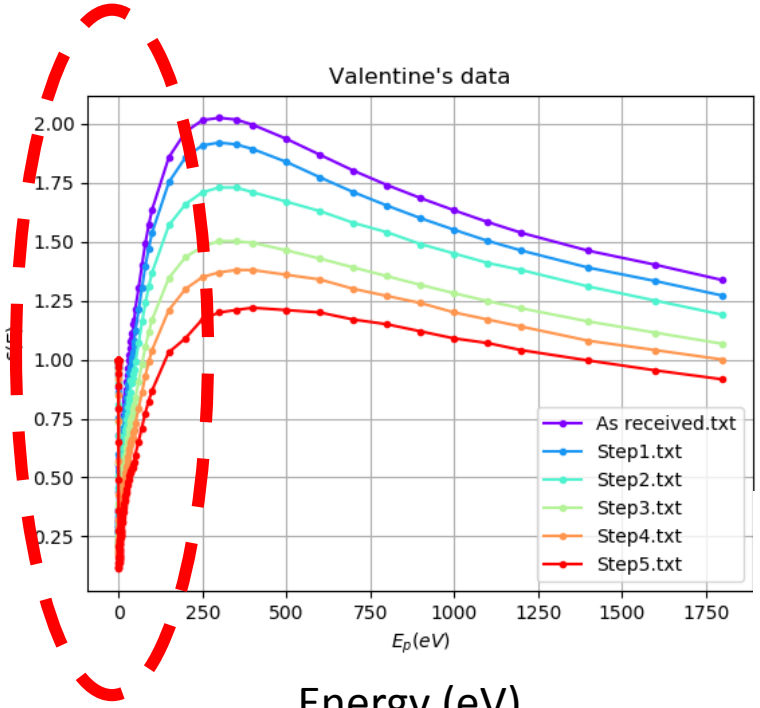
- As a first step, in order to make a first comparison we simulate the usual EC model with no angular dependence and treating all the elastics as true secondaries
  - Later we will introduce these complications one by one to evaluate their impact

Measured SEY curves

By Valentine Petit

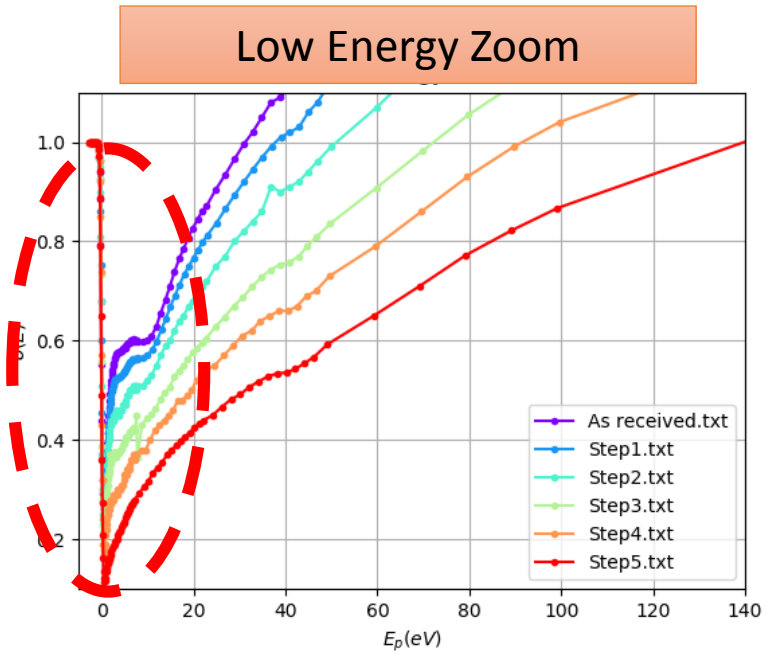
https://indico.cern.ch/event/685341/

SEY

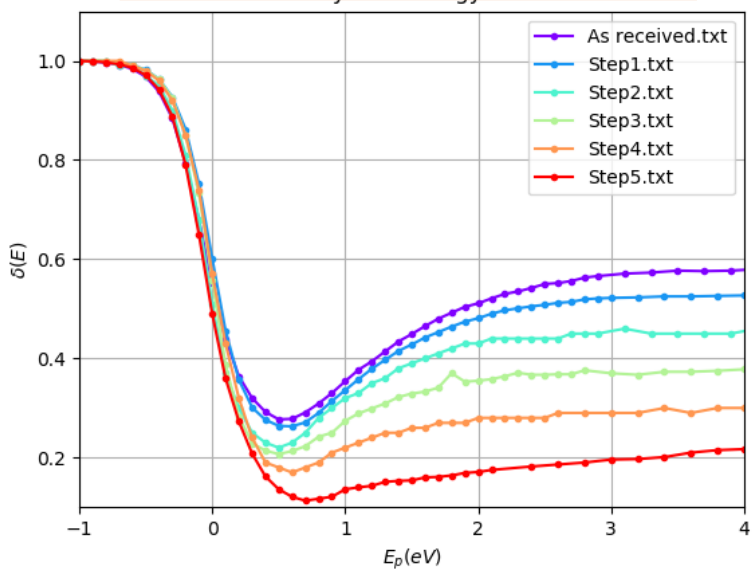


Energy (eV)

Low Energy Zoom



Really Low Energy Zoom



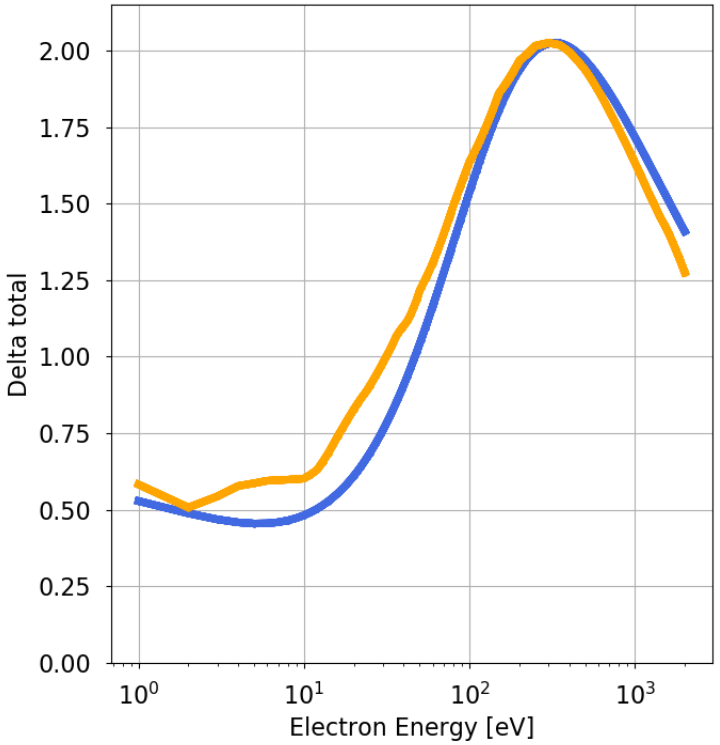
Simulation Studies

- Simulate EC buildup with the measured SEY curves and the EC model to compare.

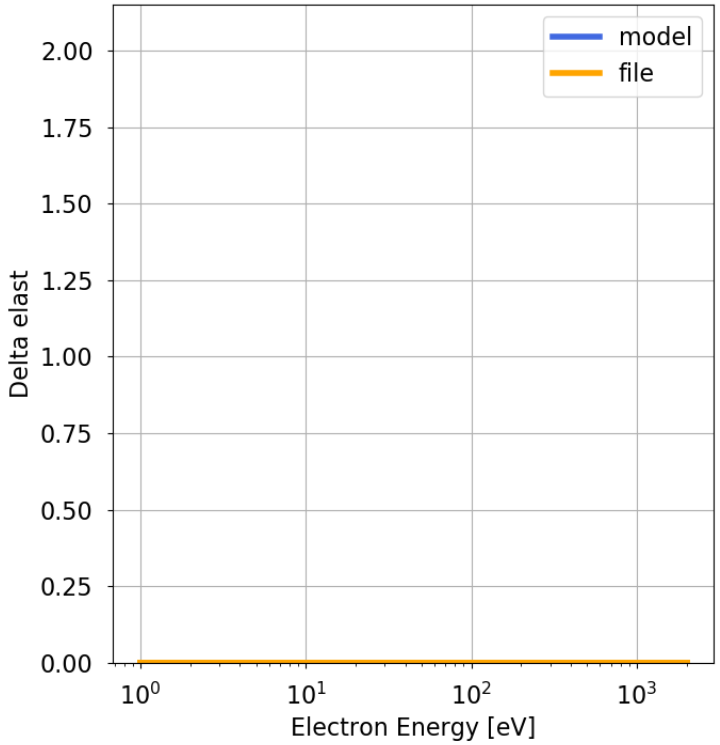
- Parameters:
  - SEY parameter (dmax) scan → Graphically computed
  - Intensity Scan: 0.0 - 2.5 e11 ppb
  - Angular dependence OFF
  - Elastics treated as true secondaries in both cases → Need to sample the EC model adding the elastic component of the SEY to the true

- Identified δmax on each of the curves

Total SEY



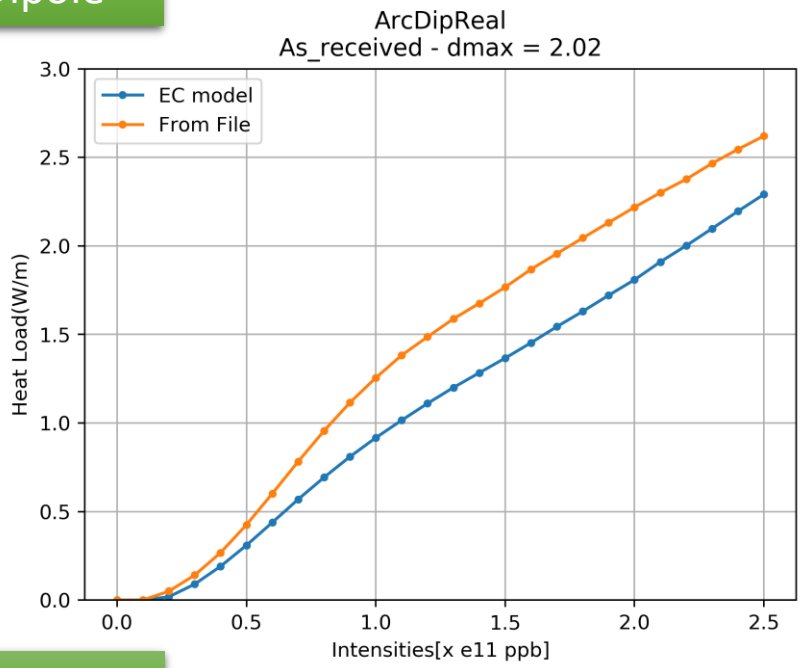
Elastic component



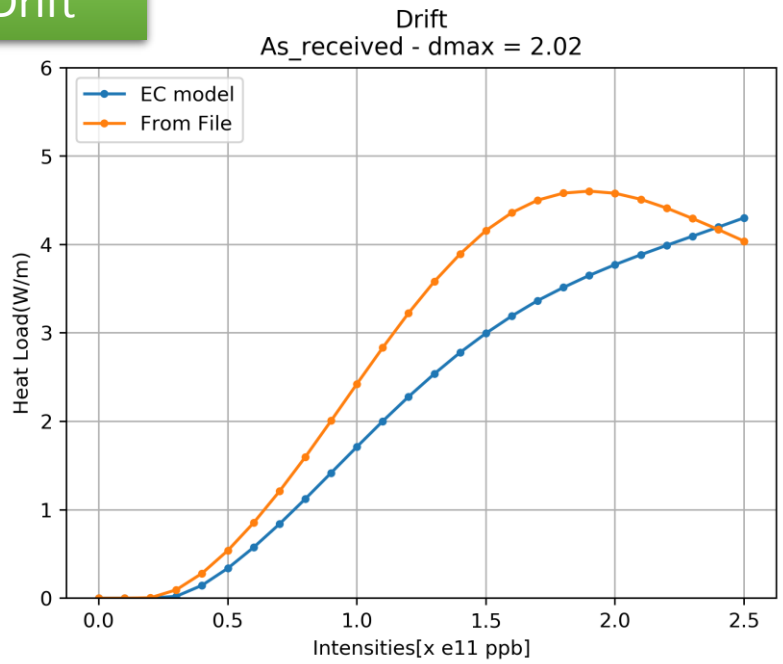
δmax	filename
2.02	As received
1.91	Step 1
1.72	Step 2
1.50	Step 3
1.38	Step 4
1.20	Step 5
1.14	Step 6

Results

Dipole



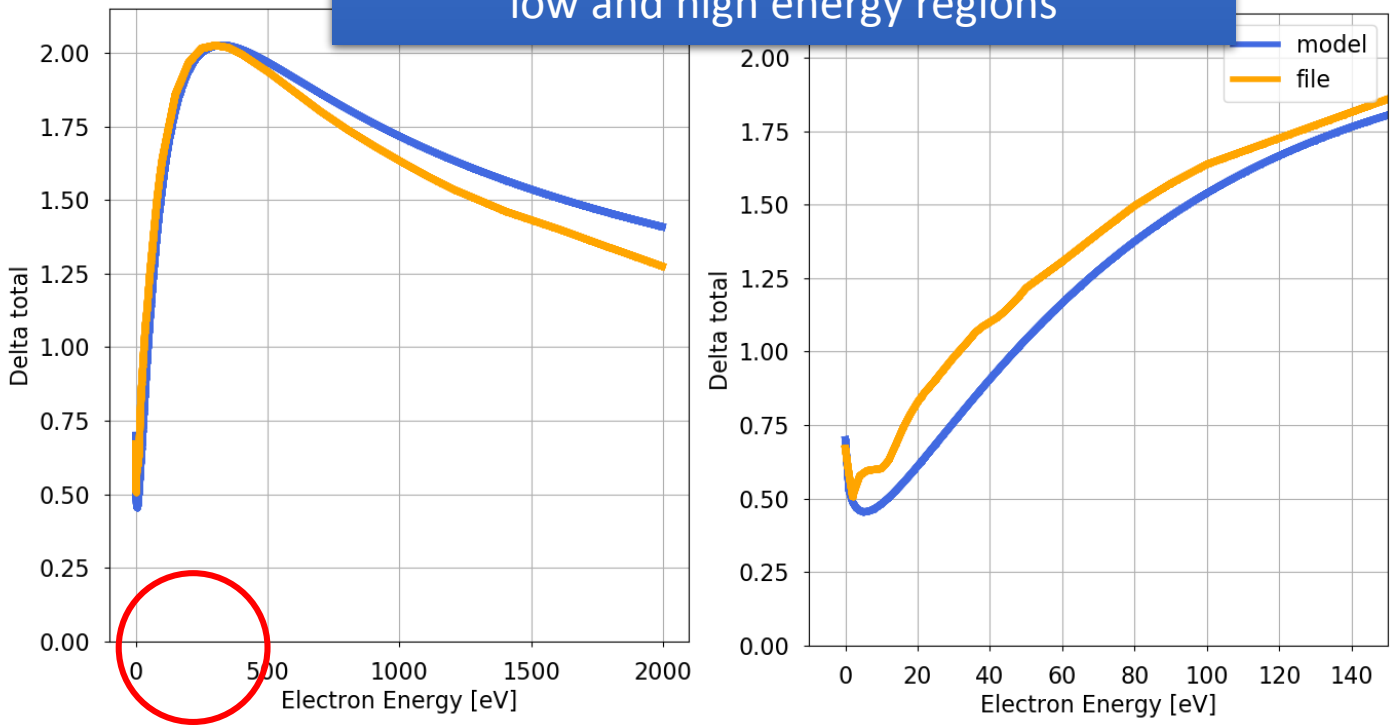
Drift



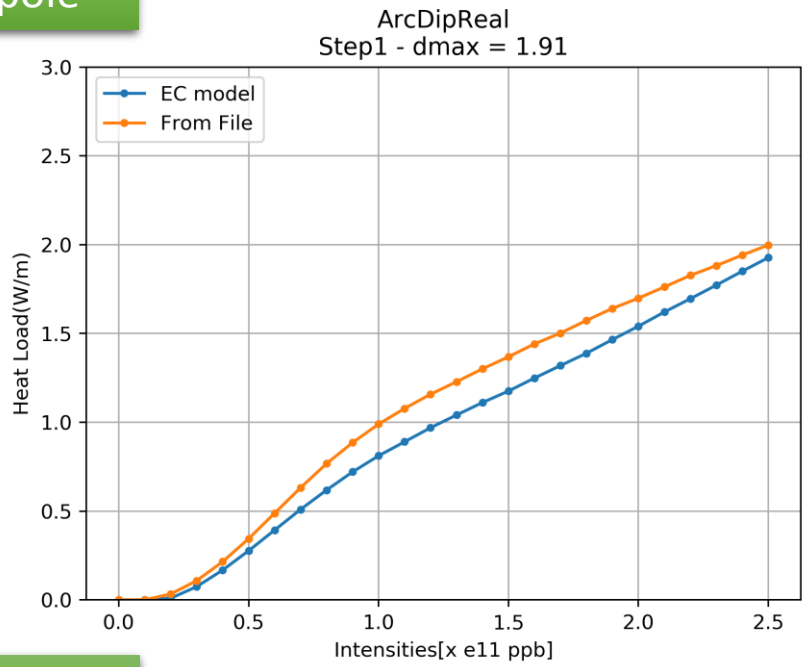
High δmax

Visible difference between Heatloads

Visible difference between SEY curves in the low and high energy regions



Dipole



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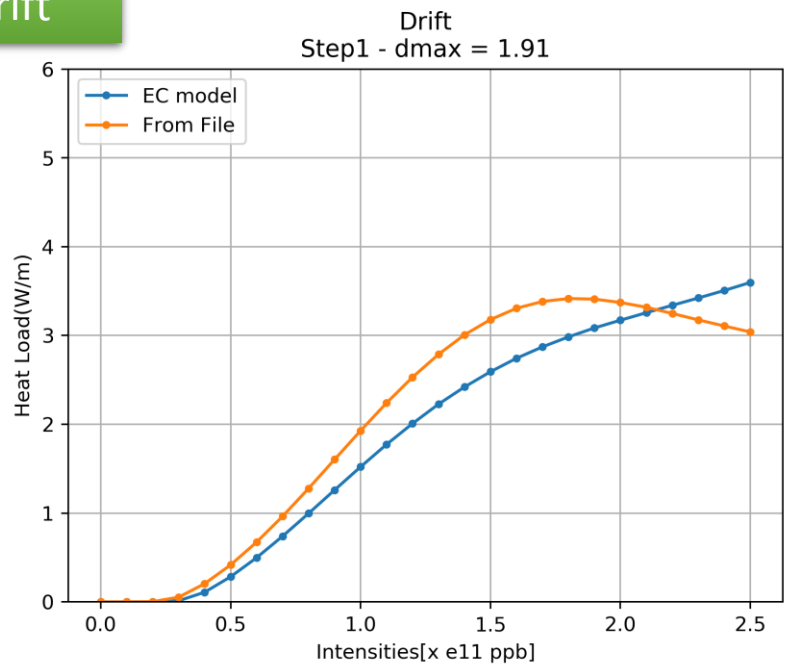
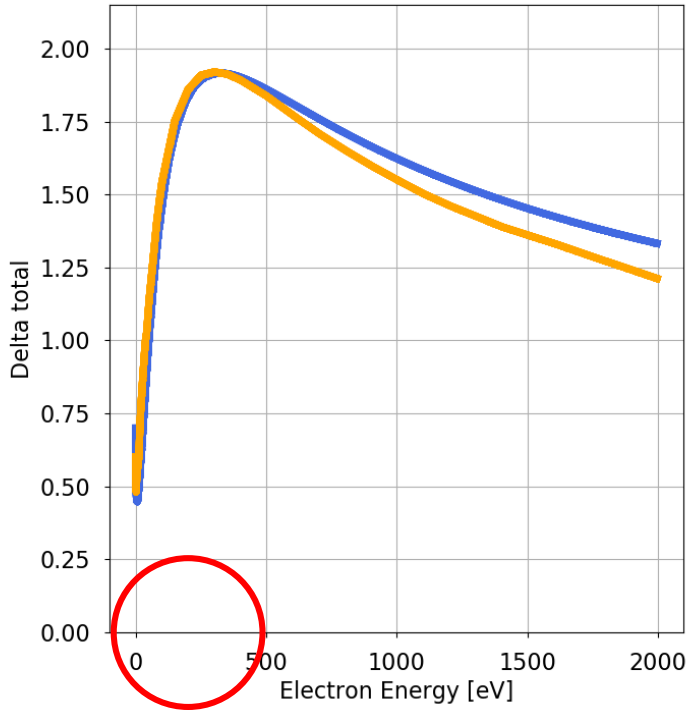
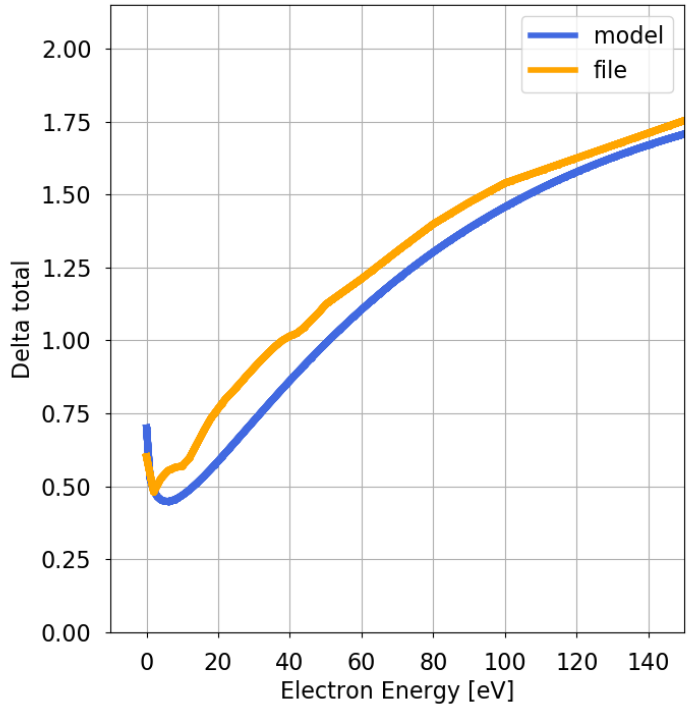


Difference becoming smaller as δmax lowers

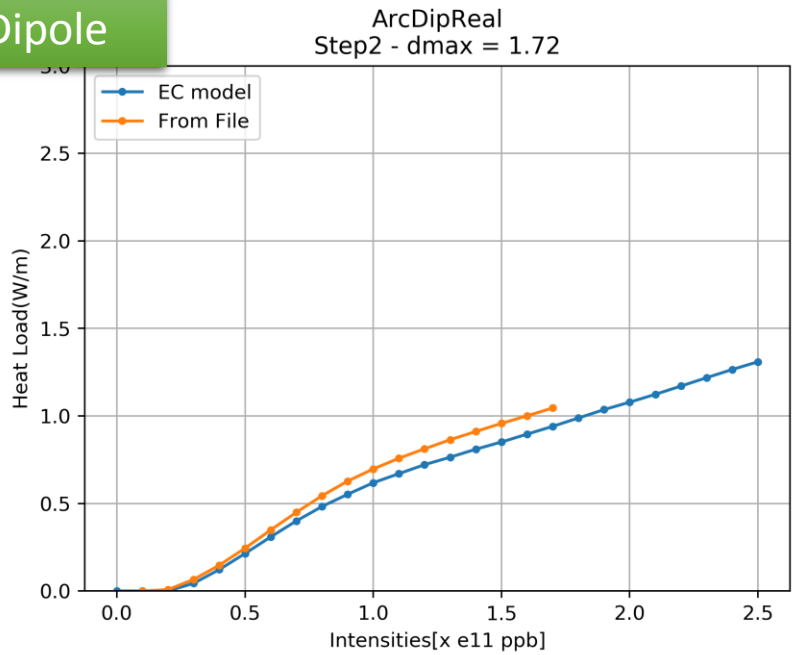
Sey curve



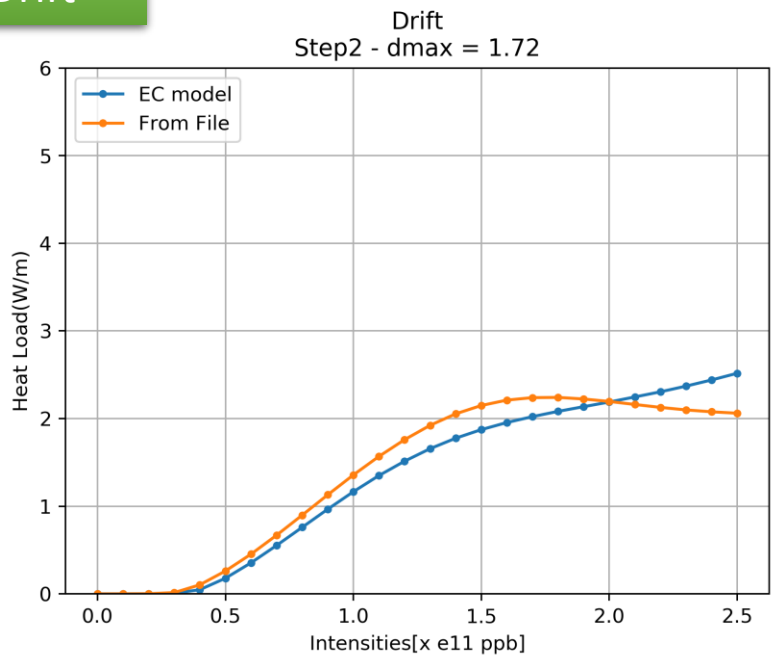
Low Energy Zoom



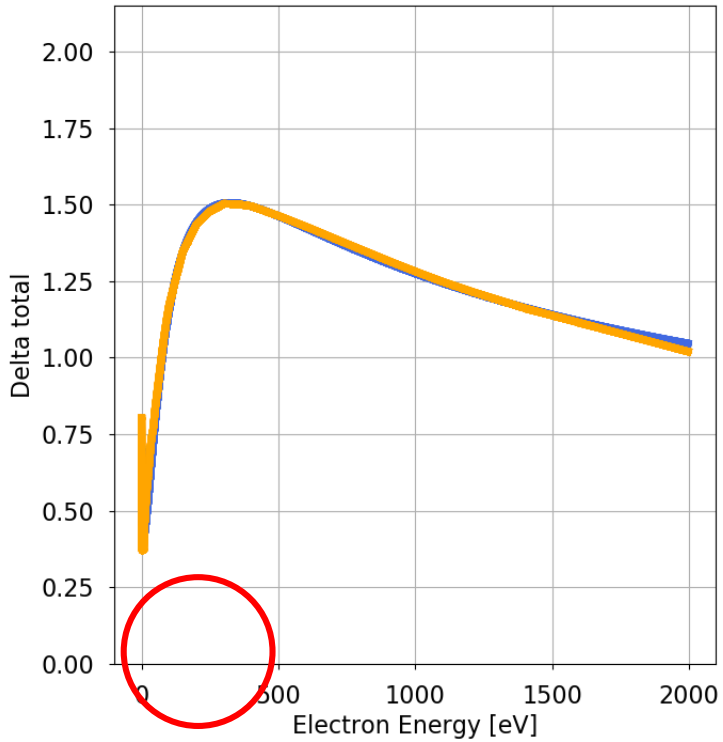
Dipole



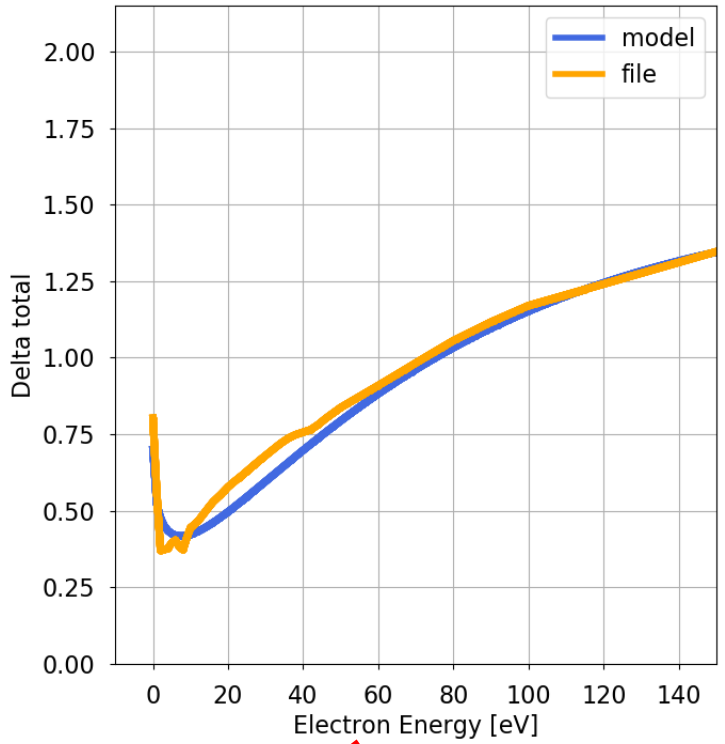
Drift



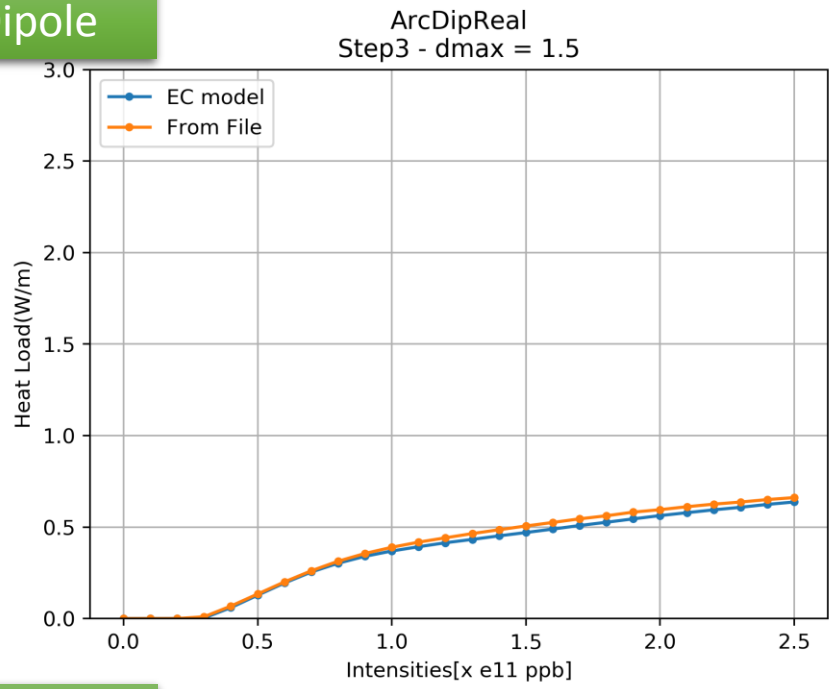
Sey curve



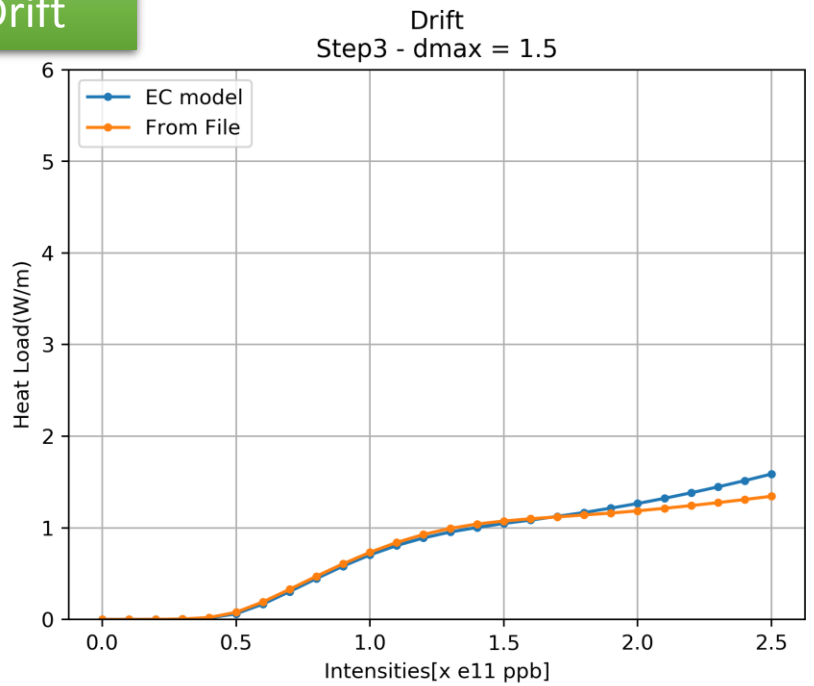
Low Energy Zoom



Dipole

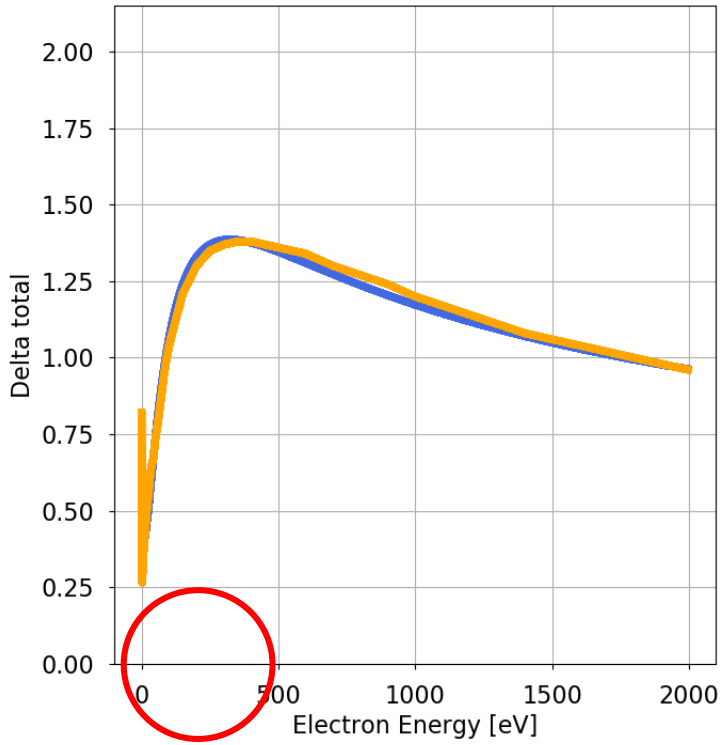


Drift

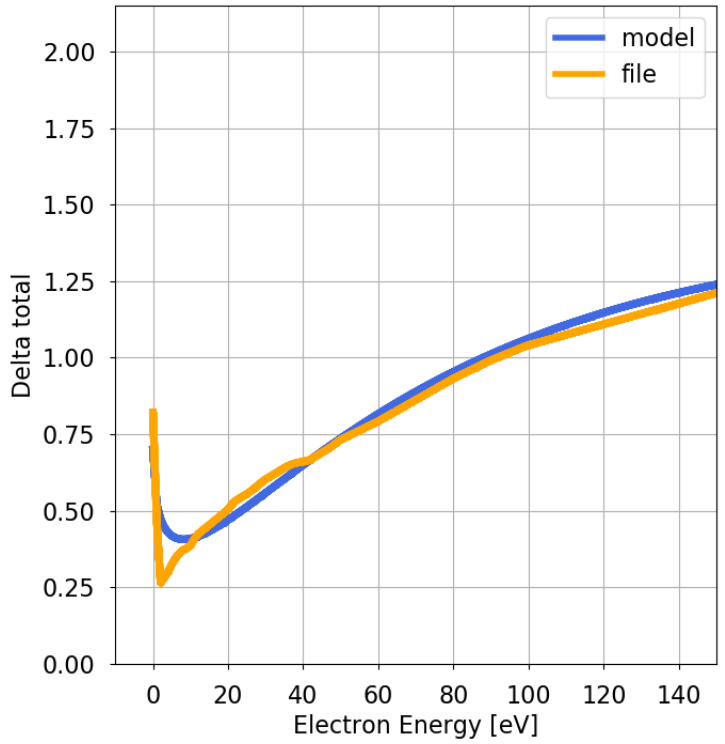


For low δmax heat load dependence on intensity flattens above 1e11 (both for models and measurements)

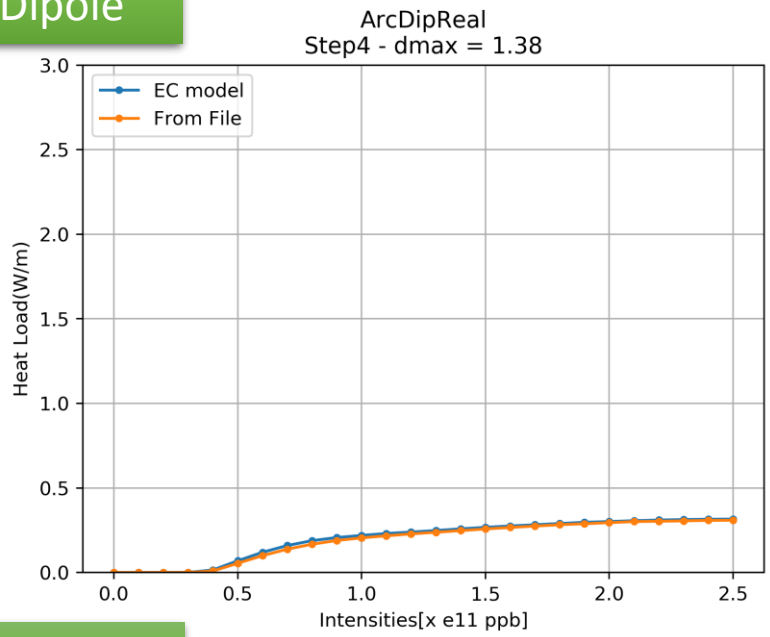
Sey curve



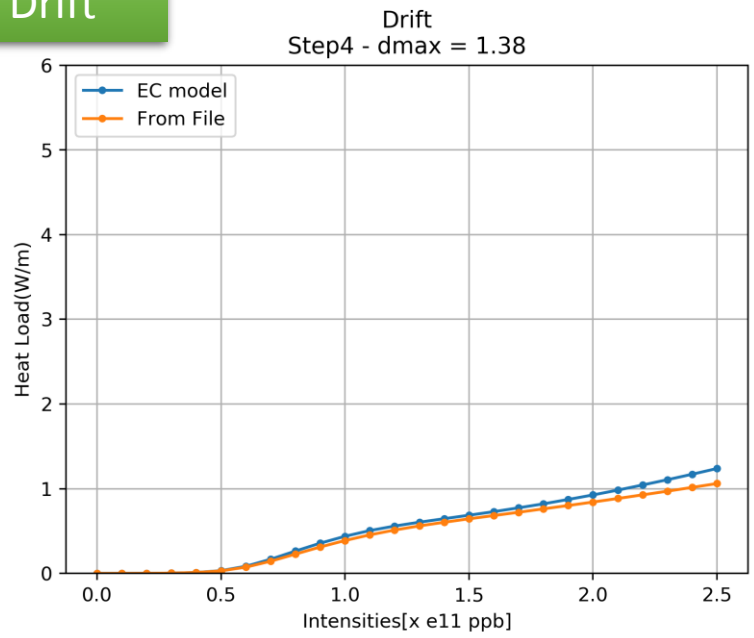
Low Energy Zoom



Dipole

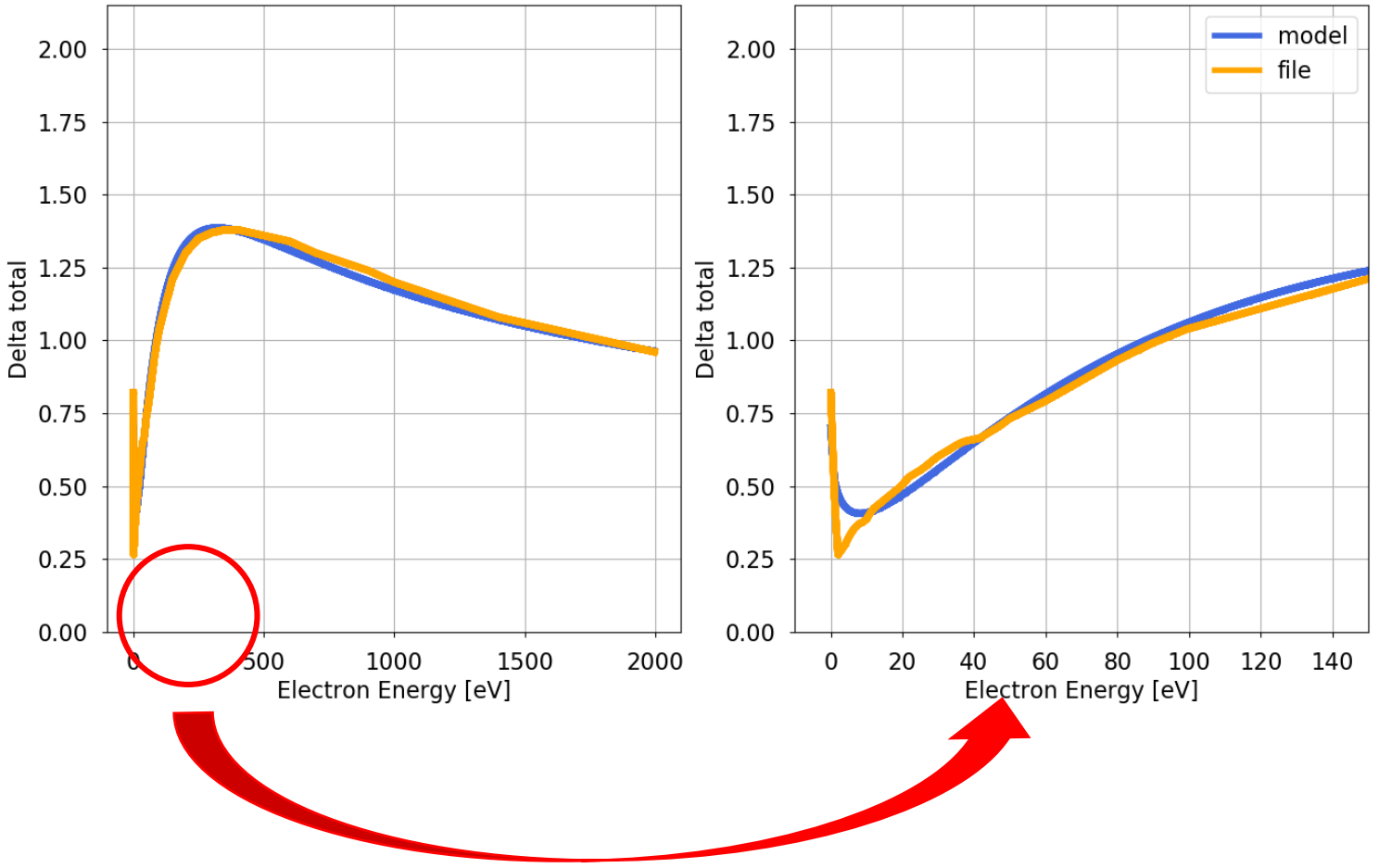


Drift

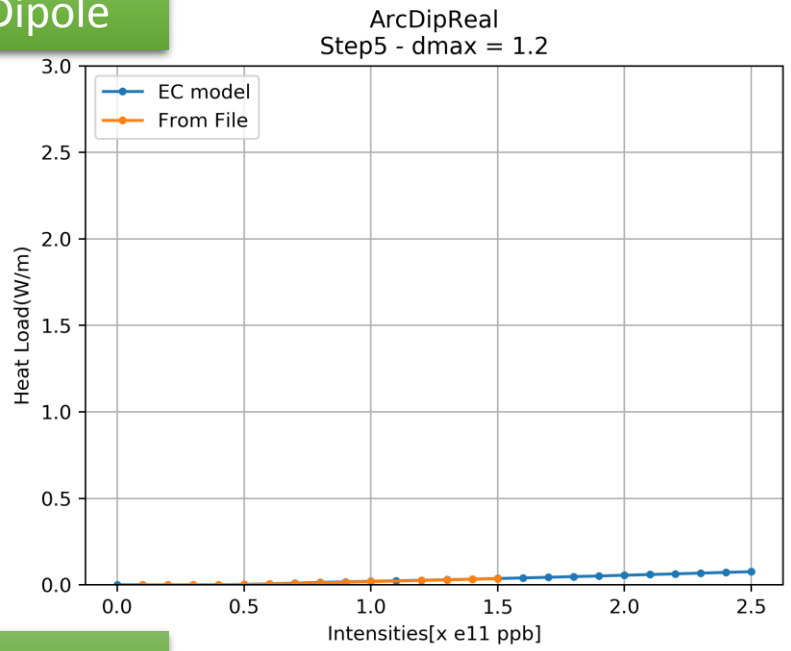


Sey curve

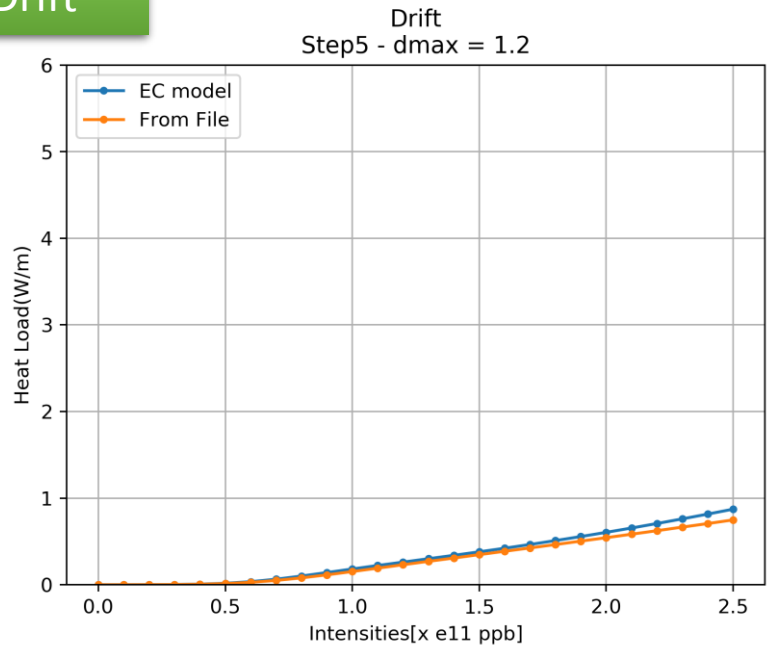
Low Energy Zoom



Dipole



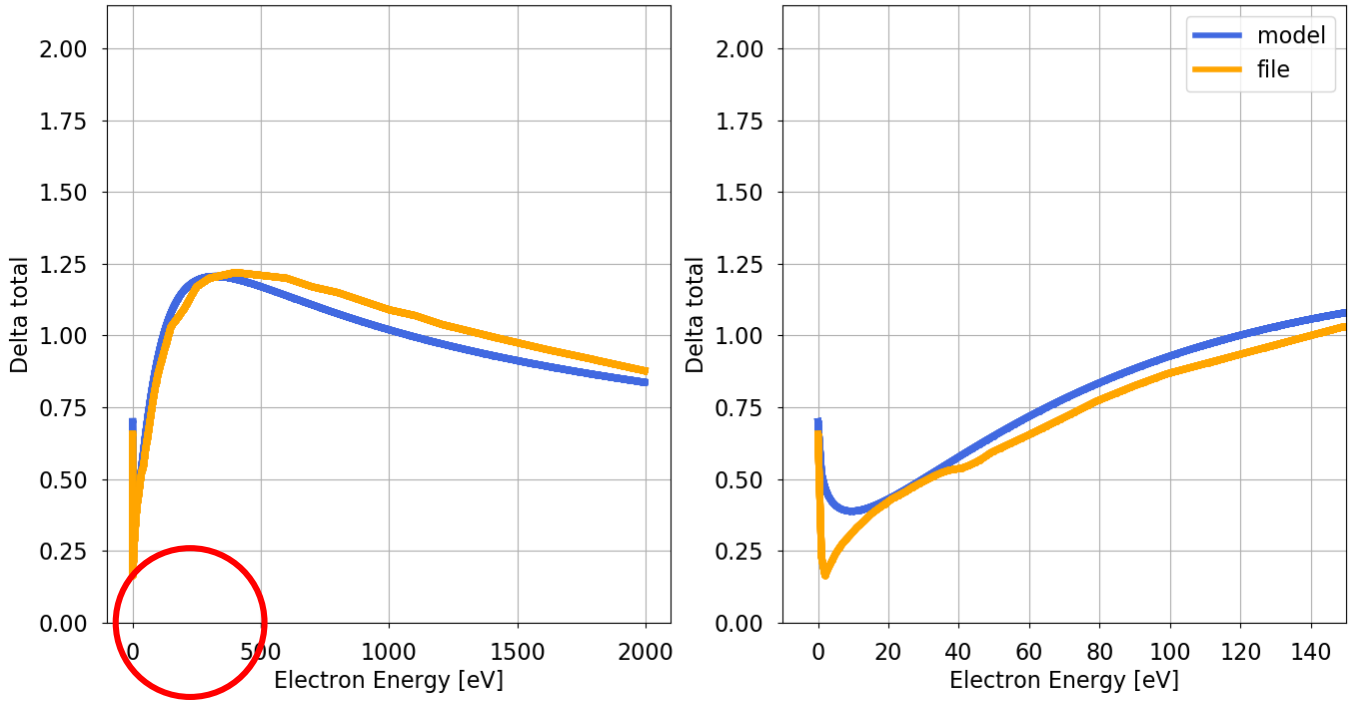
Drift



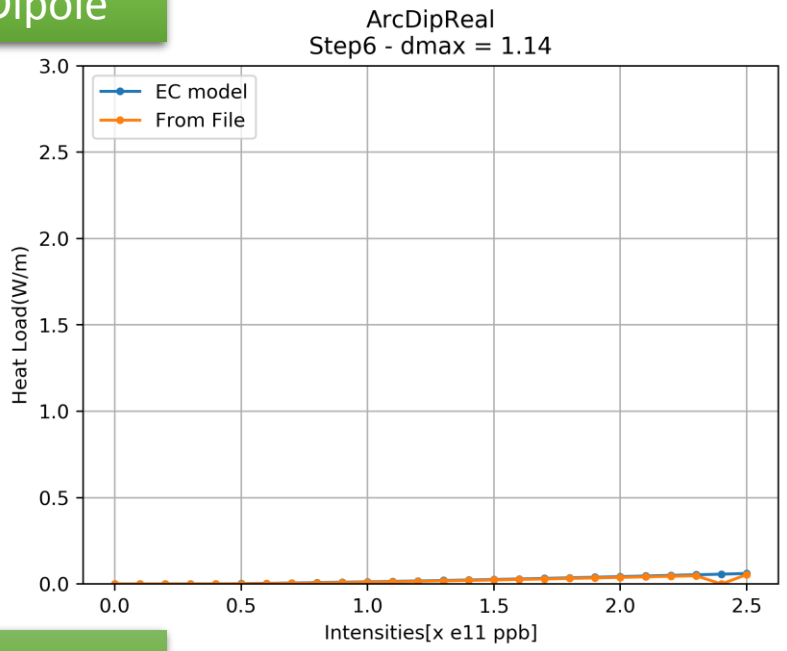
Low Heatloads (below mutipacting threshold)

No difference despite the difference in the SEY curves, heat load dominated by photoelectrons

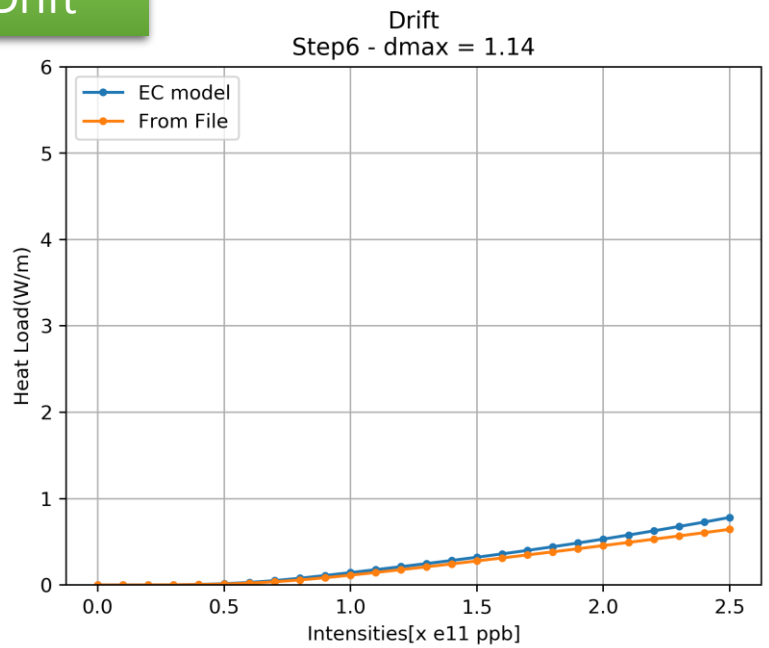
S oom



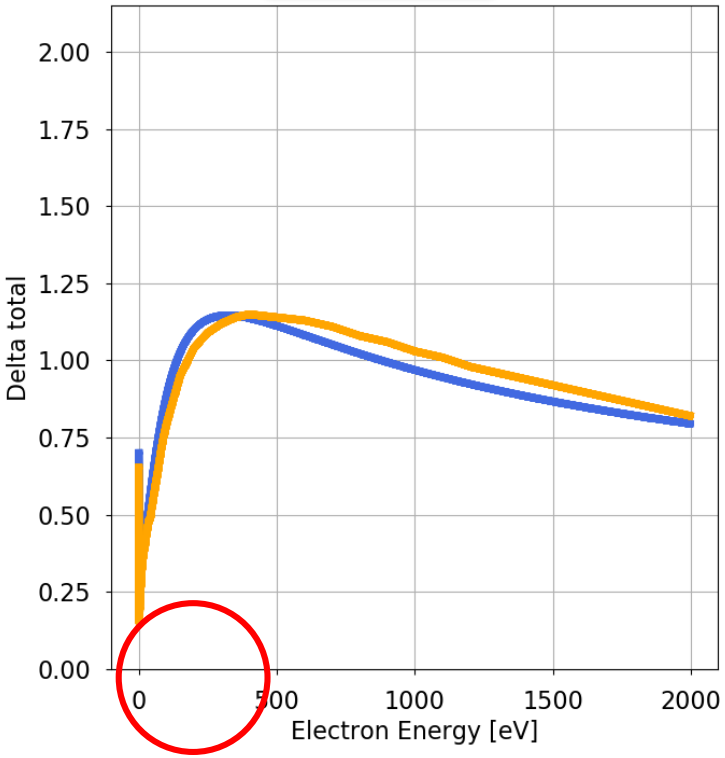
Dipole



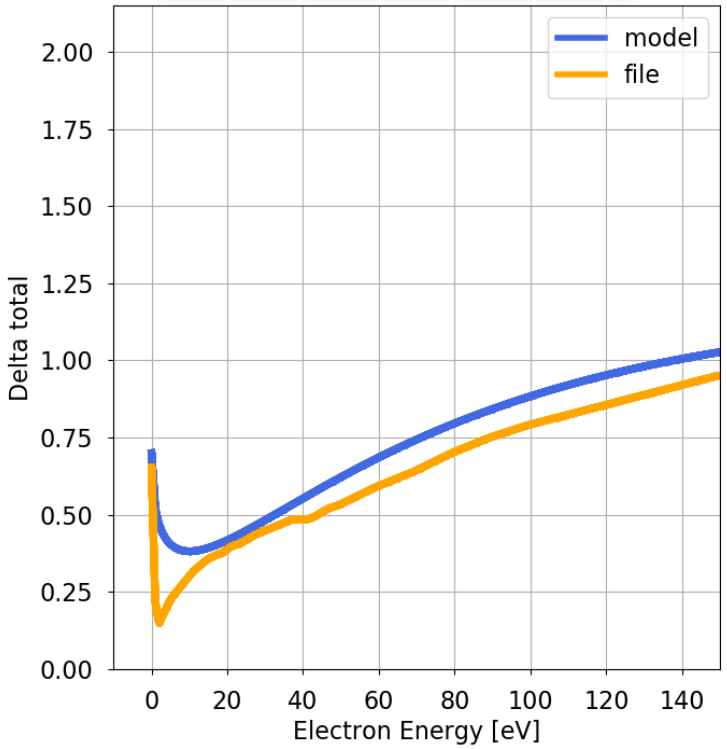
Drift



Sey curve



Low Energy Zoom



Conclusions

- Neglecting angular dependences and peculiar behavior of elastic interactions, usual SEY model is a good approximation for a large part of the SEY curves
- Next steps:
  - Study the effect of the e- angle of impact
  - Introduce a more realistic model for elastics
  - Repeat the study for quadrupole magnets