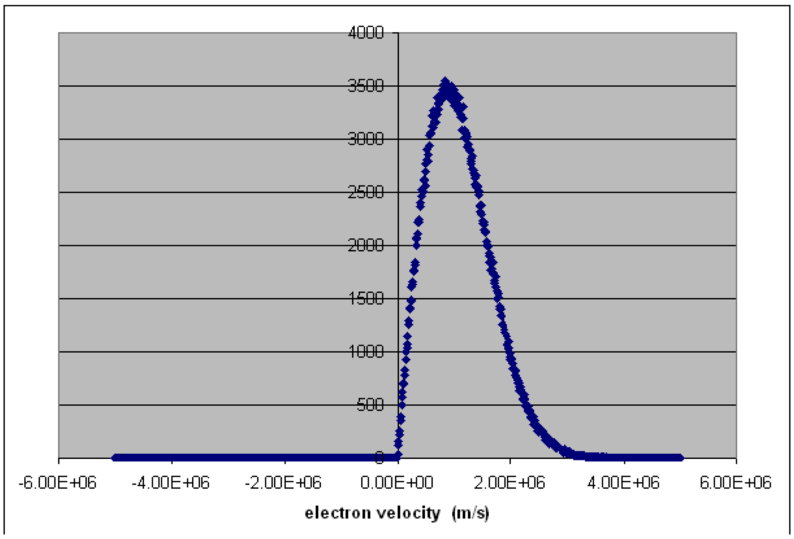
In the book "Plasma physcis via computer simulation" by Birdsall and Langden on pg 388 they say for particle loading the following formula should be used:

$$R = \frac{\int_a^v f(v)dv}{\int_a^b f(v)dv}$$

where R is a random number between 0 and 1. To obtain the particle velocities this equation is solved for v. In our case a = v_L = lower velocity cut-off , b = v_u = upper velocity cut-off and for a Maxwellian flux distribution unlike a Maxwellian one f(v) is of the form

$v \exp\left(-\frac{v^2}{2v_t^2}\right)$ which produces the following (generated by below formula):



If you use the fact that $v \exp\left(-\frac{v^2}{2v_t^2}\right) = -v_t^2 \frac{d}{dv} \exp\left(-\frac{v^2}{2v_t^2}\right)$ and solve for v you get the following formula:

$$v = v_t \sqrt{-2.0 \ln\left((1-R)\exp\left(-\frac{v_L^2}{2v_t^2}\right) + R\exp\left(-\frac{v_u^2}{2v_t^2}\right)\right)}$$

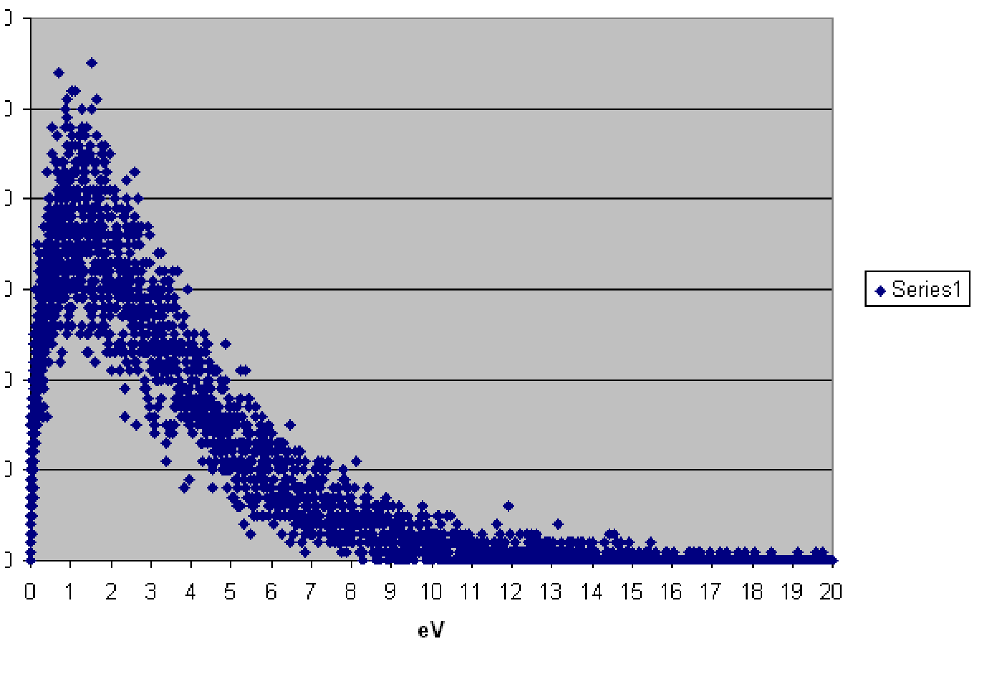
If there is no lower cut-off $v_L = 0$ and the correct distribution is produced. However, if there is no upper cut-off $v_u \rightarrow \infty$ so a large enough default upper velocity must be used to make $\exp\left(-\frac{v_u^2}{2v_t^2}\right) \approx 0$. I have tested this formula for the cases no upper or lower cut-offs, upper cut-off exclusively, lower cut-off exclusively and both lower and upper cut-offs. In all the cases it works fine. A drift velocity can be implemented by replacing v with v – vdrift. Unlike the current vmaxwellian.cpp file where a different formula has been used for each scenario this one formula can be used for all cases. Since the distribution is always forwards directed like the current vmaxwellian.cpp file positive/negative directions have to be specified.

Tests:

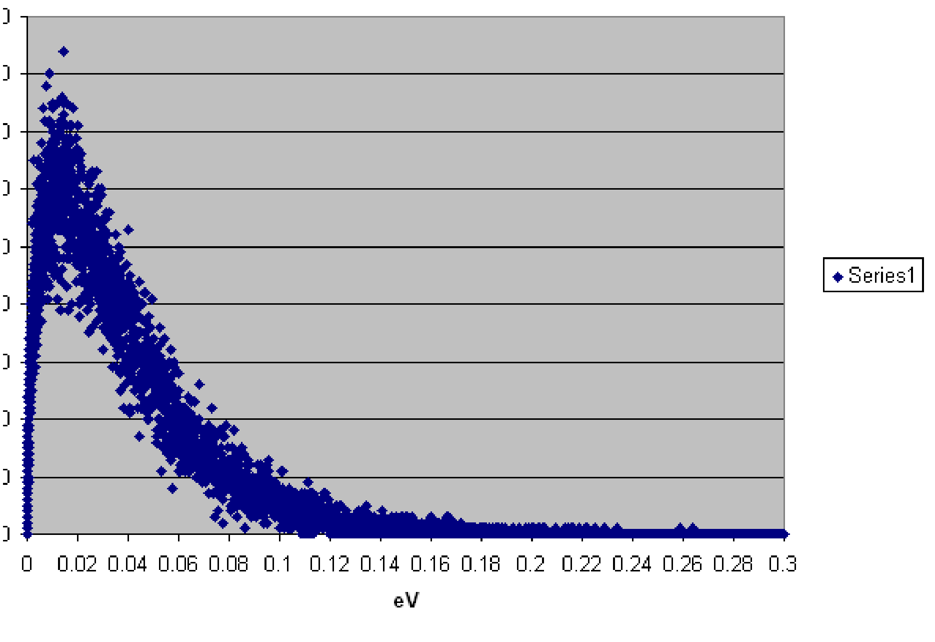
Beam emitter uses maxwellian flux and so OOPIC was run by injecting an electron beam and a neutralizing beam, to remove space charge effects. Then the particle velocities were dumped and the velocity distribution that they produced was obtained using a python script.

A few of the particle velocity distributions from the tests are presented below:

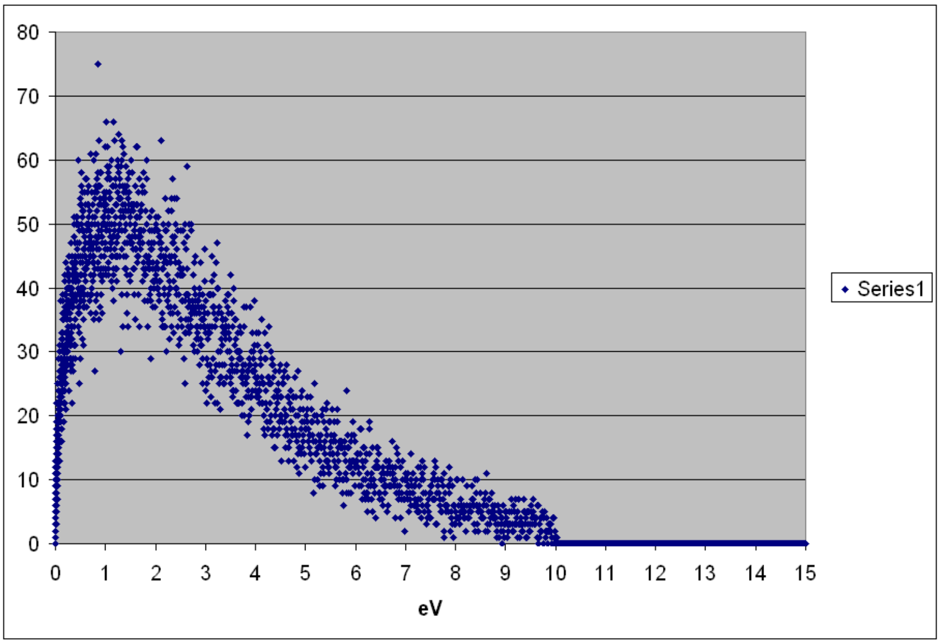
Temperature 2.2eV no drift,lower or upper cut-offs:



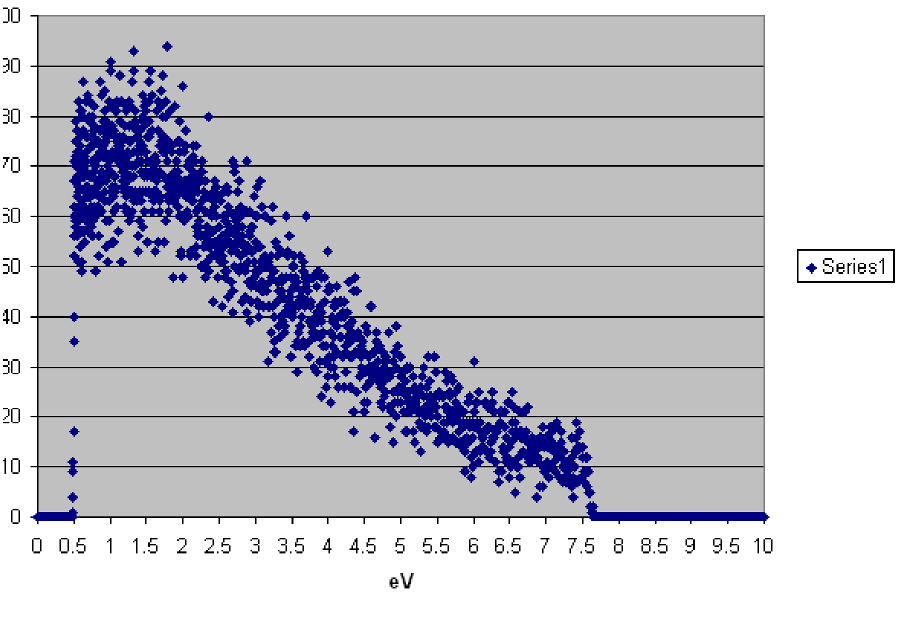
T = 0.025eV no drift or lower/upper cut-offs:



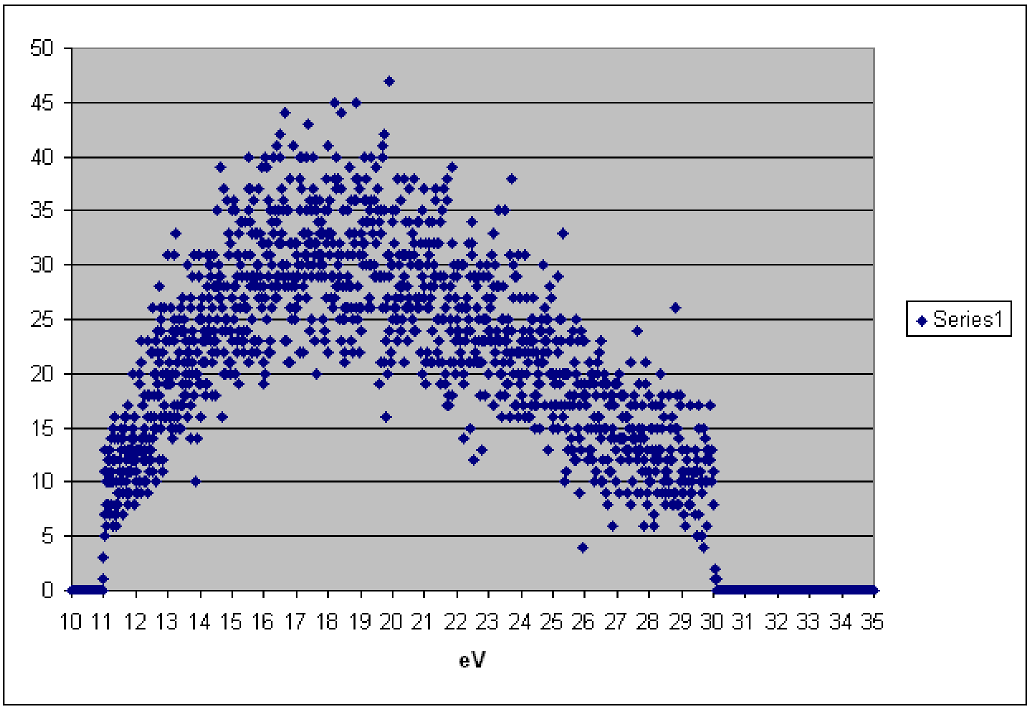
T=2.2 eV, no drift, upper-cutoff= 10:



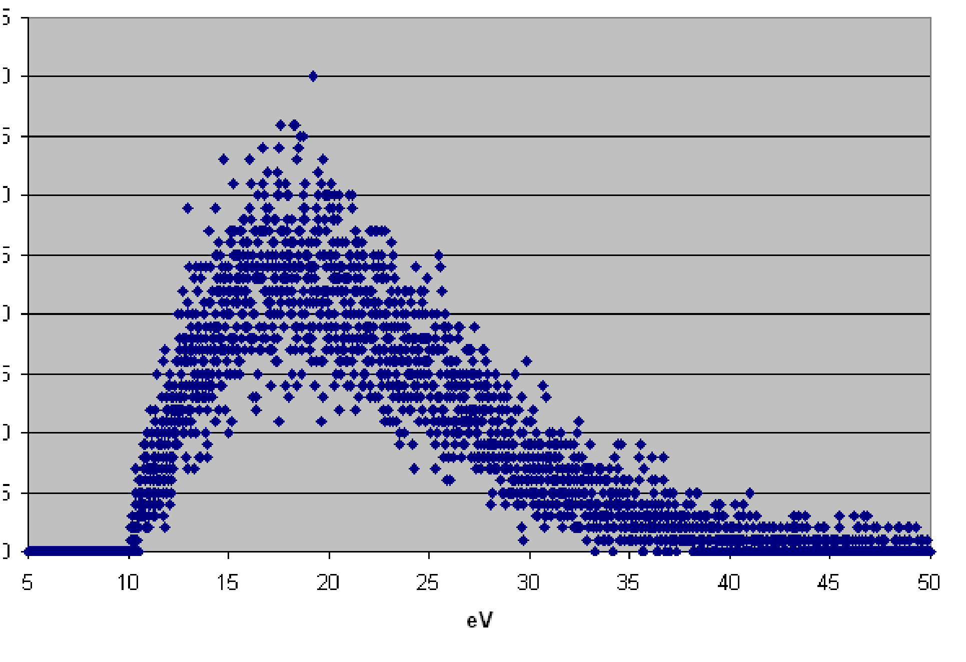
T 2.2 eV no drift, lower cut-off =0.5, upper cut-off = 7.6:



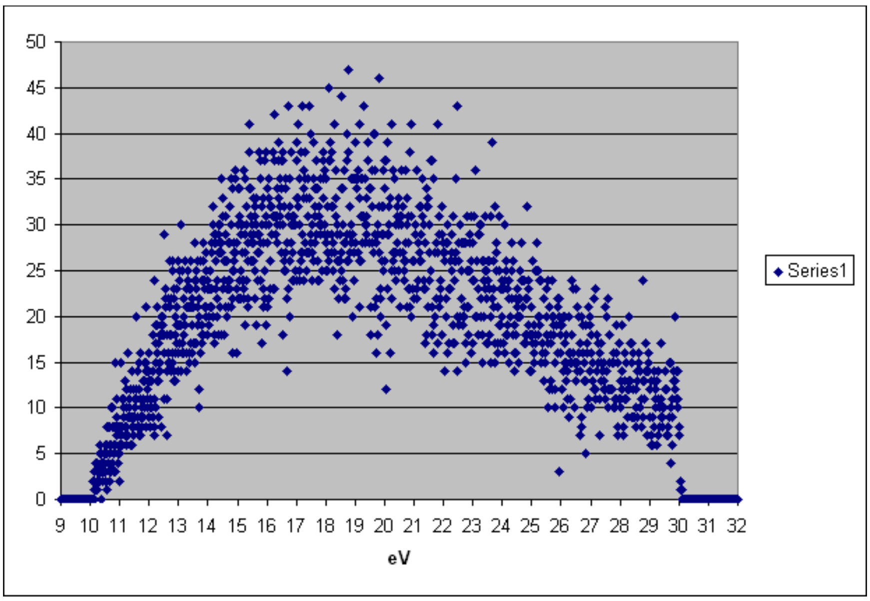
T 2.2 eV , drift = 10 , lower cut-off=11, upper cut-off=30:



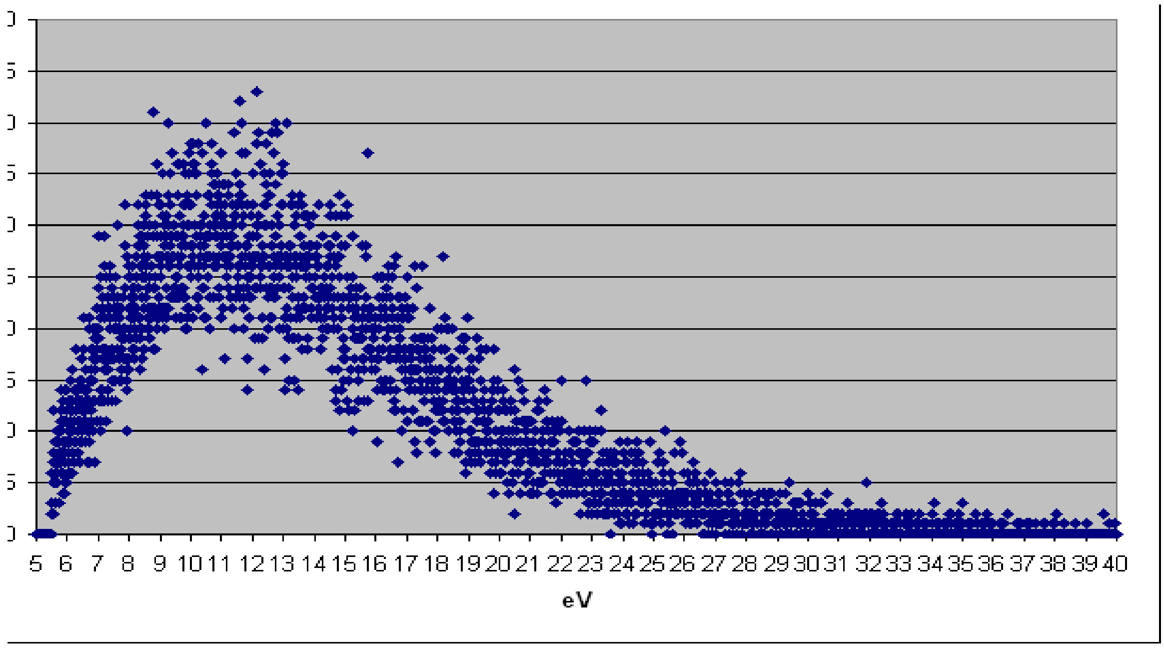
T 2.2 eV, drift =10 , no lower or upper cut-offs specified:



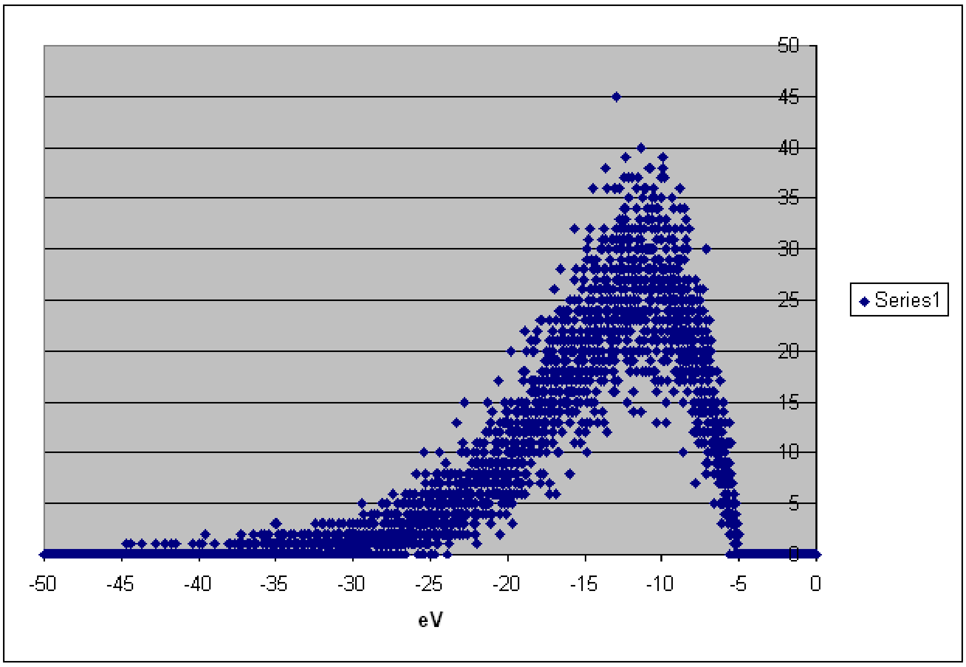
An examination of the first figure in the document and the one above shows that the maxwellian flux distribution starts at the mean velocity and is not centered around it like a maxwellian. The following test with a lower cut-off velocity specified than the drift ensures this is enforced, where drift = 10, lower cut-off =6 and upper cut-off = 30:



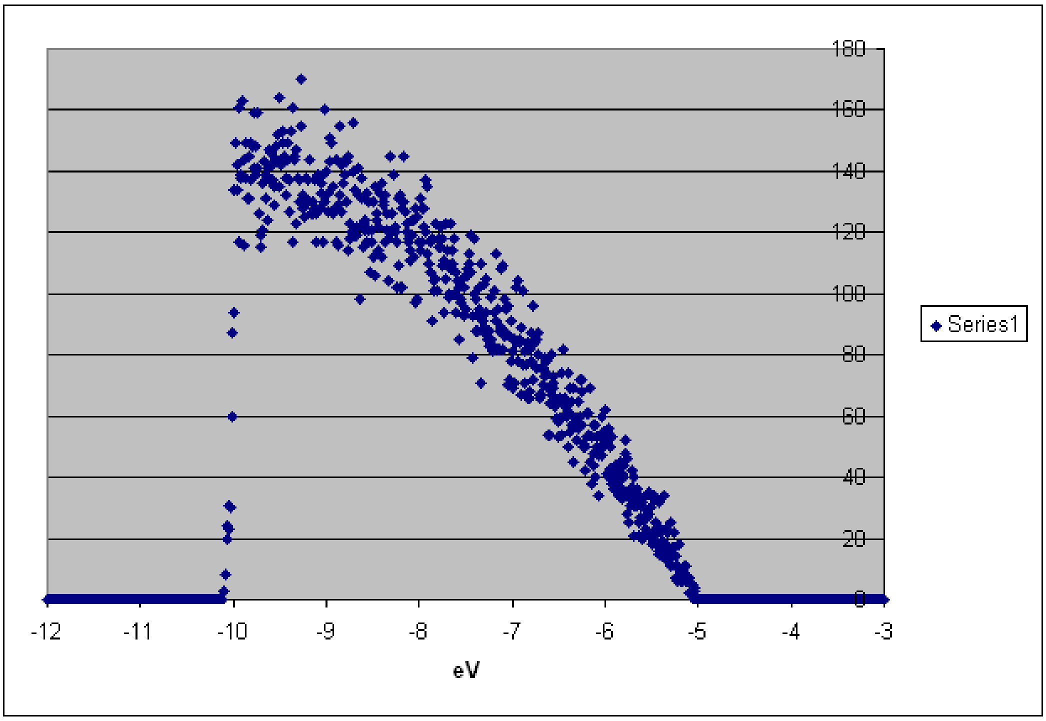
T = 2.2 eV drift = 5 lower cut-off = 5.5, no upper cut-off velocity specified:



Inject from opposite side with a negative wall normal, drift =5 no lower or upper cut-offs:

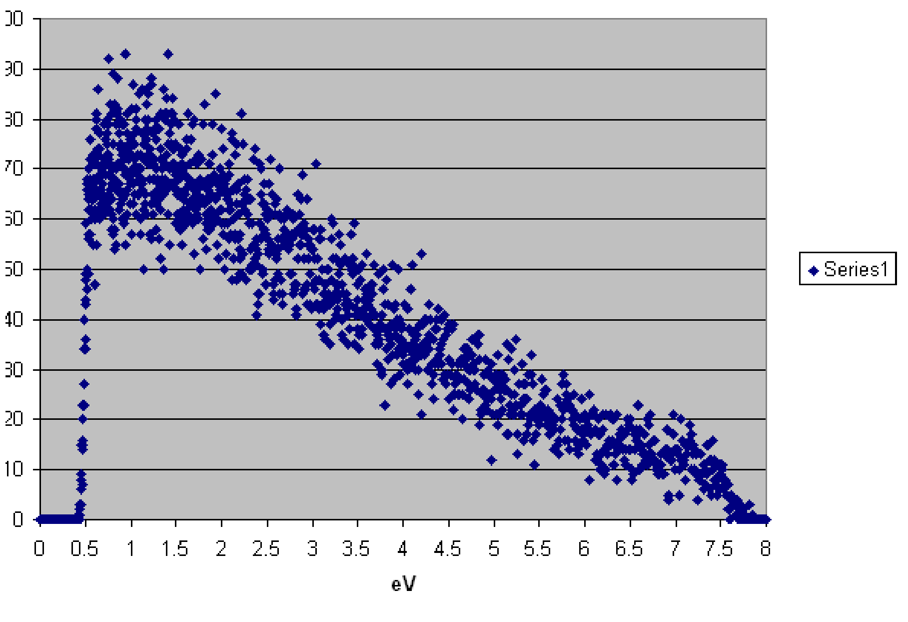


Inject from opposite side with a negative wall normal, drift =5 lower cut-off = 4, upper cut-off =10:



Check in a cylindrical version of the input file:

T 2.2 eV , no drift, lower cut-off=0.5, upper cut-off =7.6:



T = 2.2 eV , drift =10, no lower/upper specified: