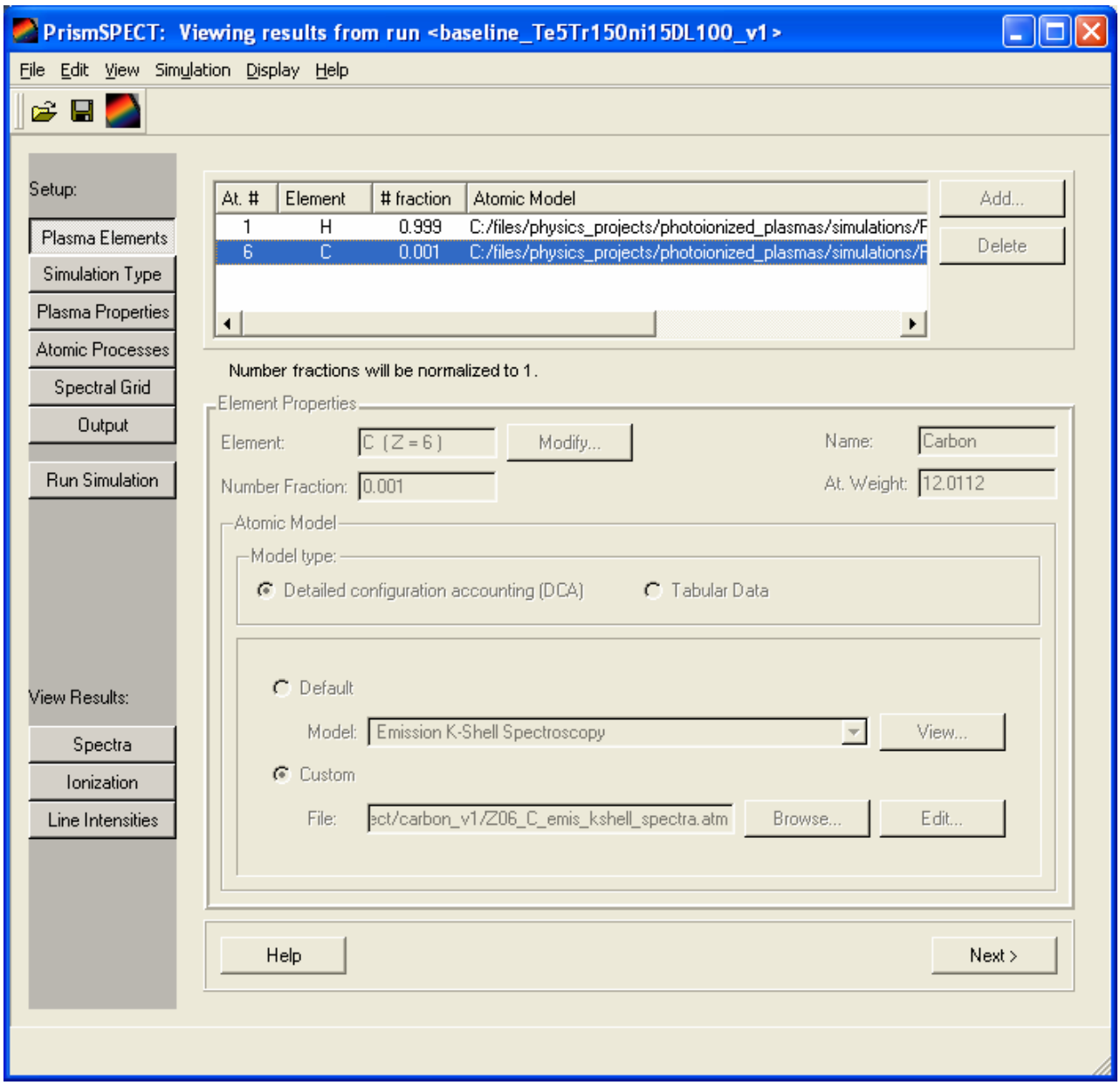


D. Cohen
29 Feb 2008

Some simple PrismSpect tests of recombination spectra in photoionized plasmas

H: 99.9% at.
C: 0.1% at.

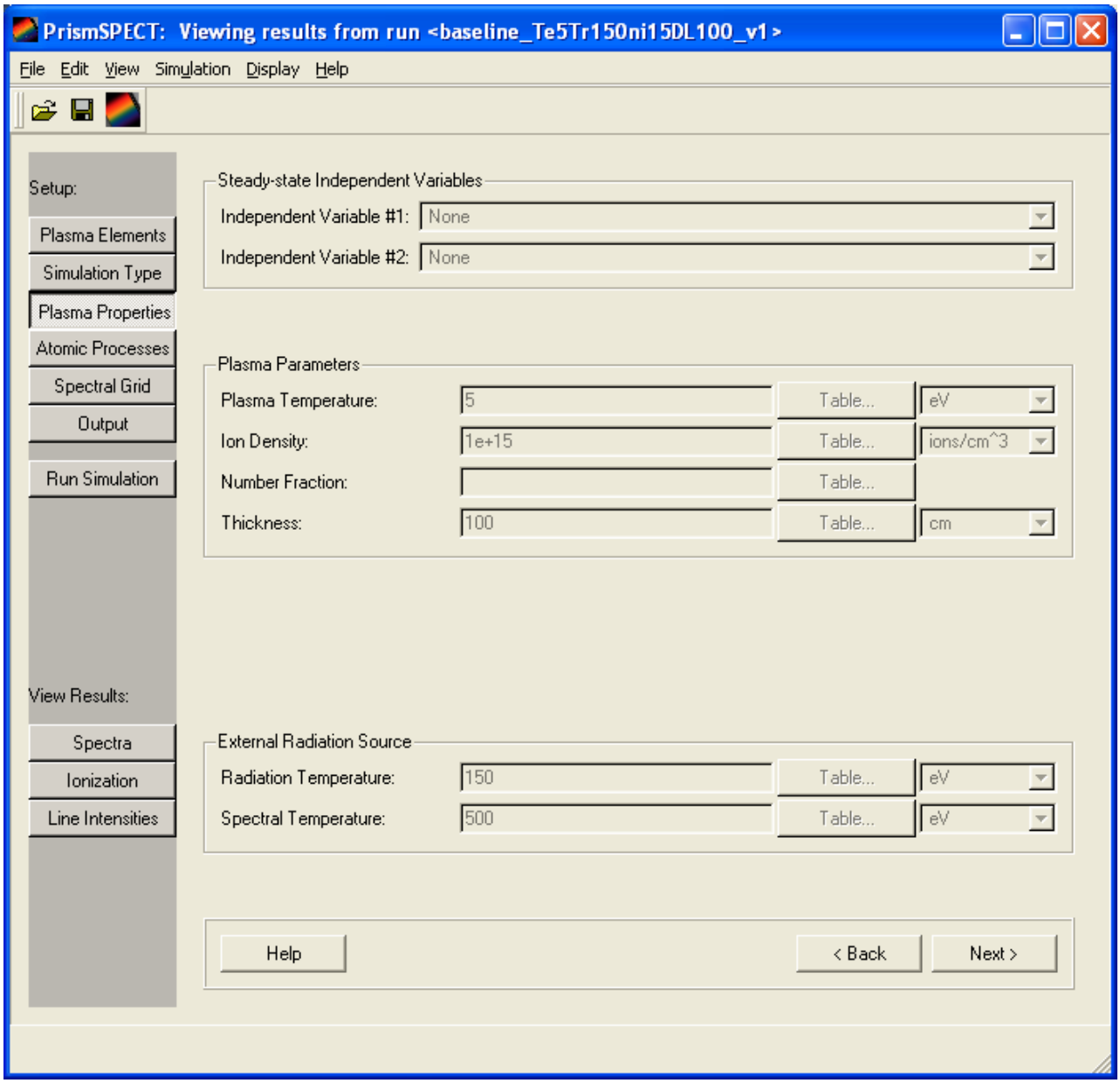
n_i = 10^15 cm^-3
T_e = 5 eV

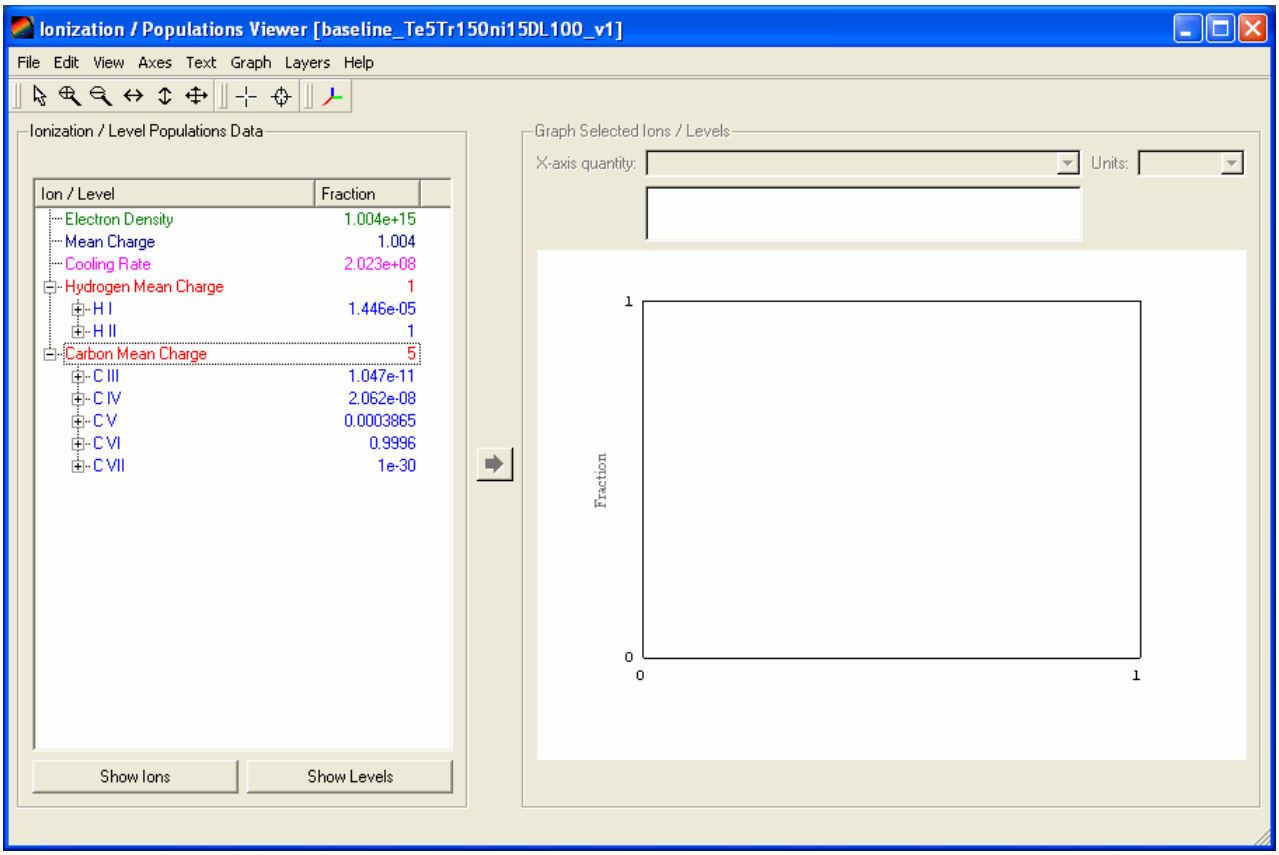
T_r = 150 eV
T_spec = 500 eV

I used the canned K-shell emission atm files

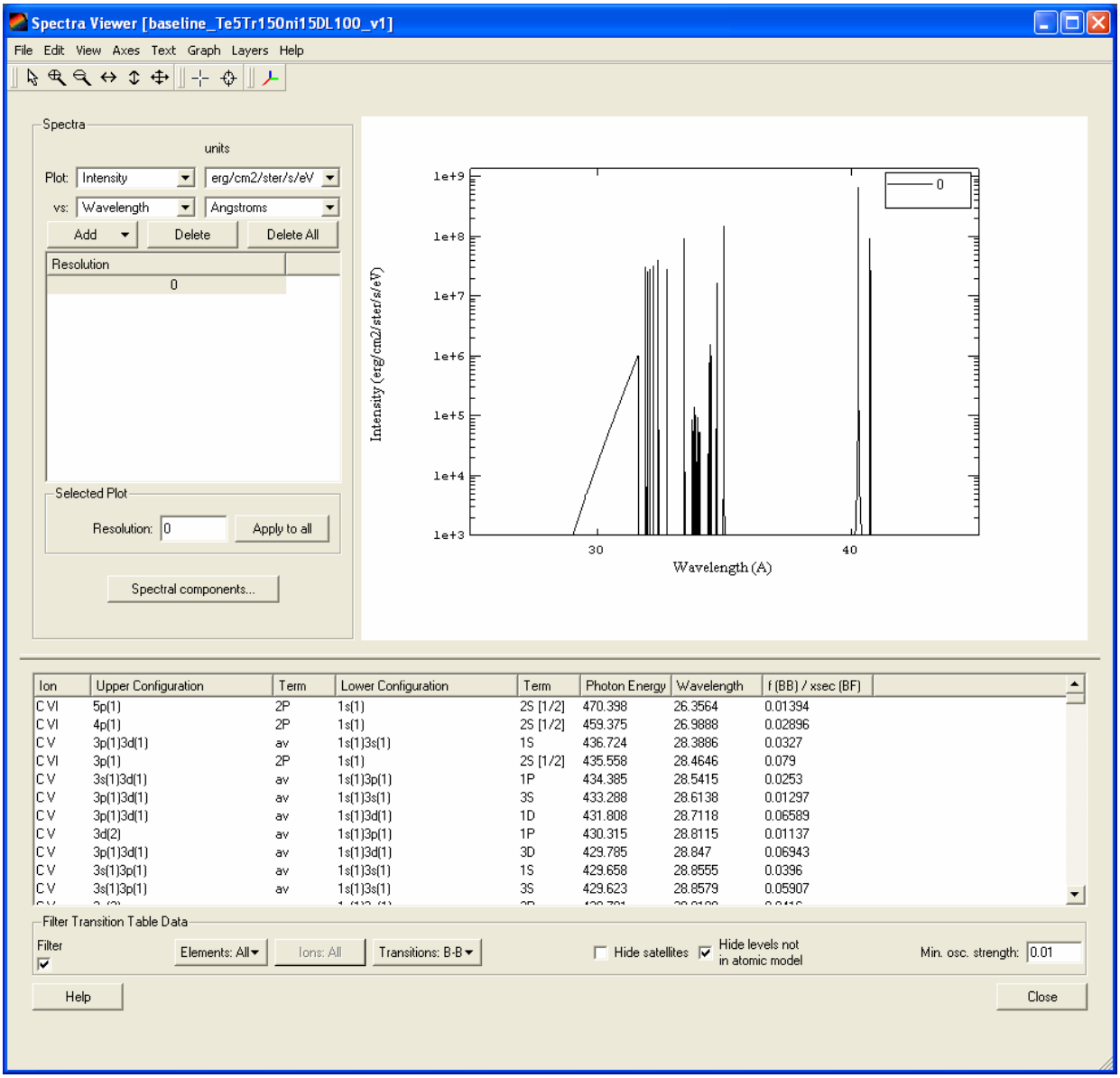
I wanted a cold, highly ionized plasma of relatively low density to focus on the spectral signatures of recombination

Here's some of the set-up screens for the baseline PrismSpect simulation:





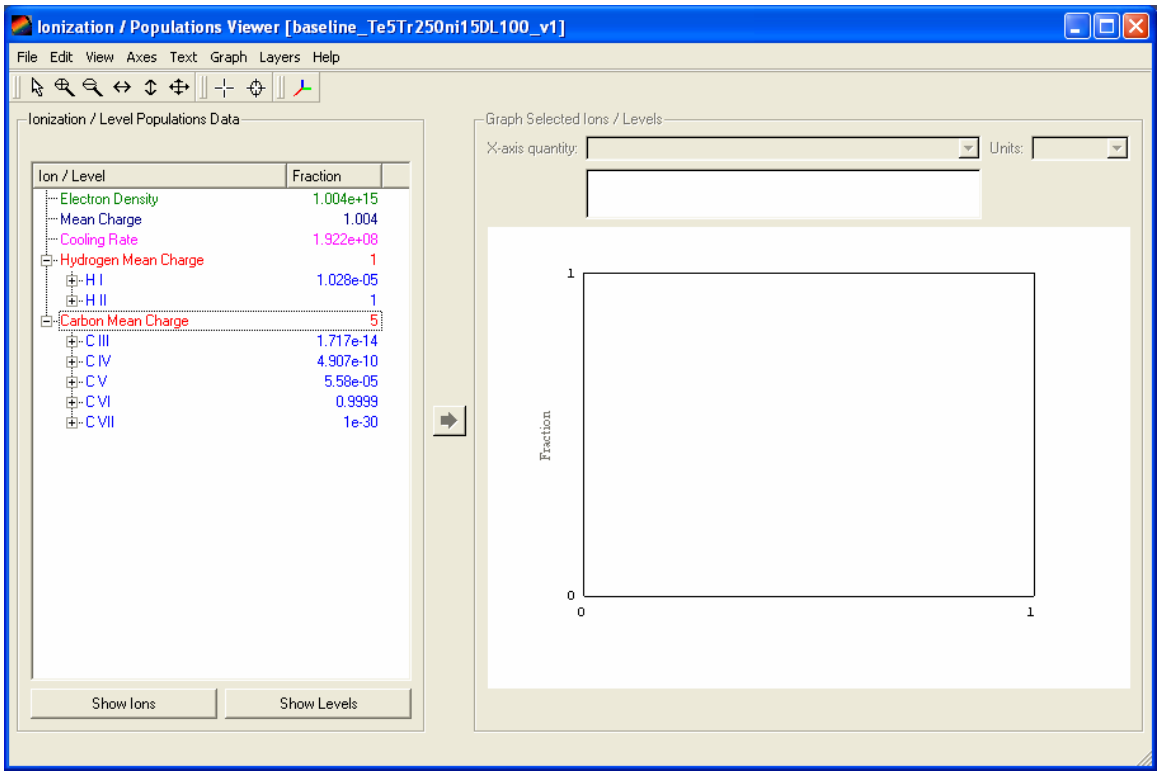
Note the carbon is nearly all H-like, but essentially none of it is bare.

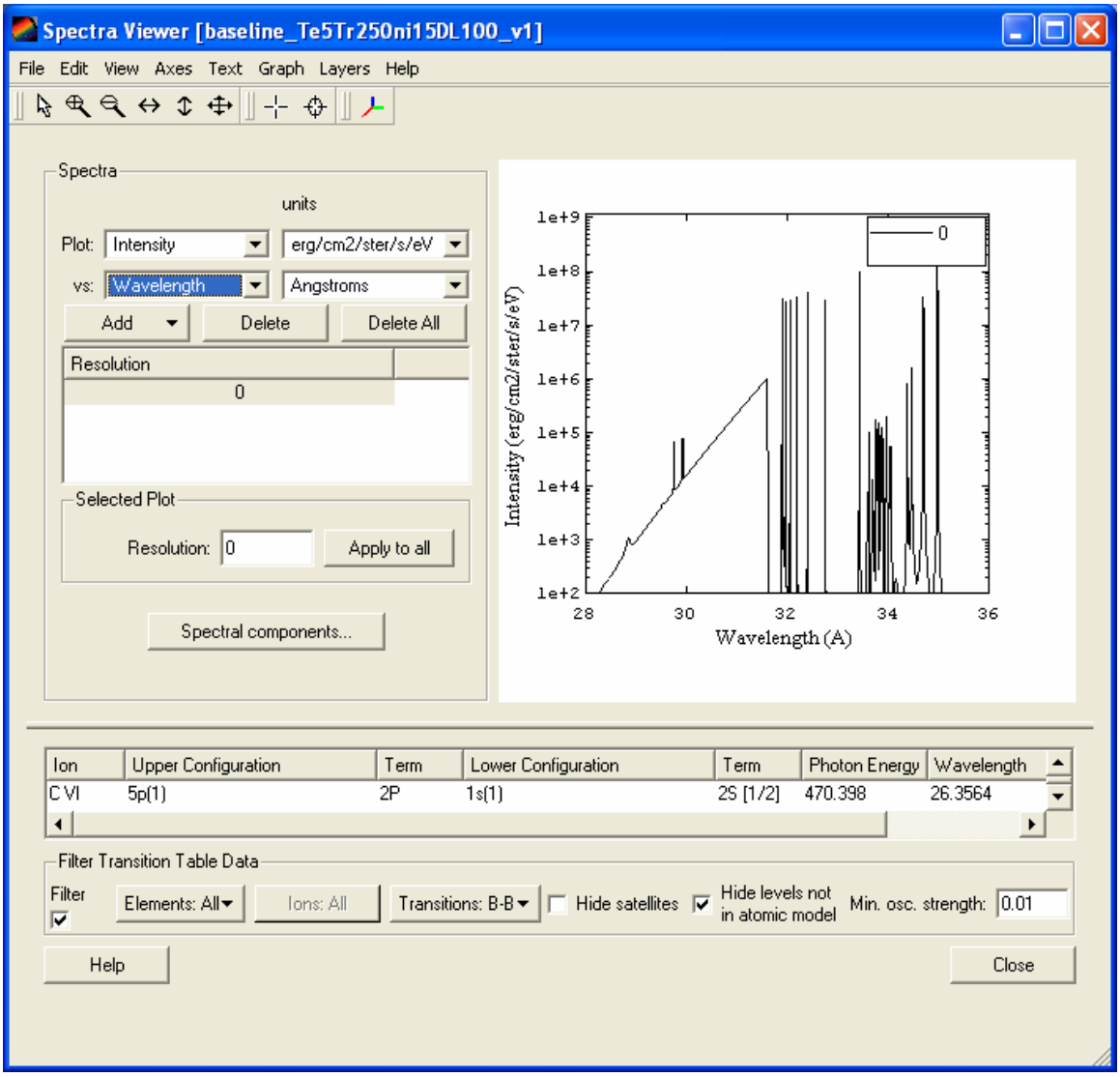


Note: The C VI K-edge is at 25.3 Angstroms; the edge that's visible here, near 32 Angstroms, is the C V edge/RRC. This reflects the fact that for a pure recombination spectrum, the strong features are from the i-1 ionization state.

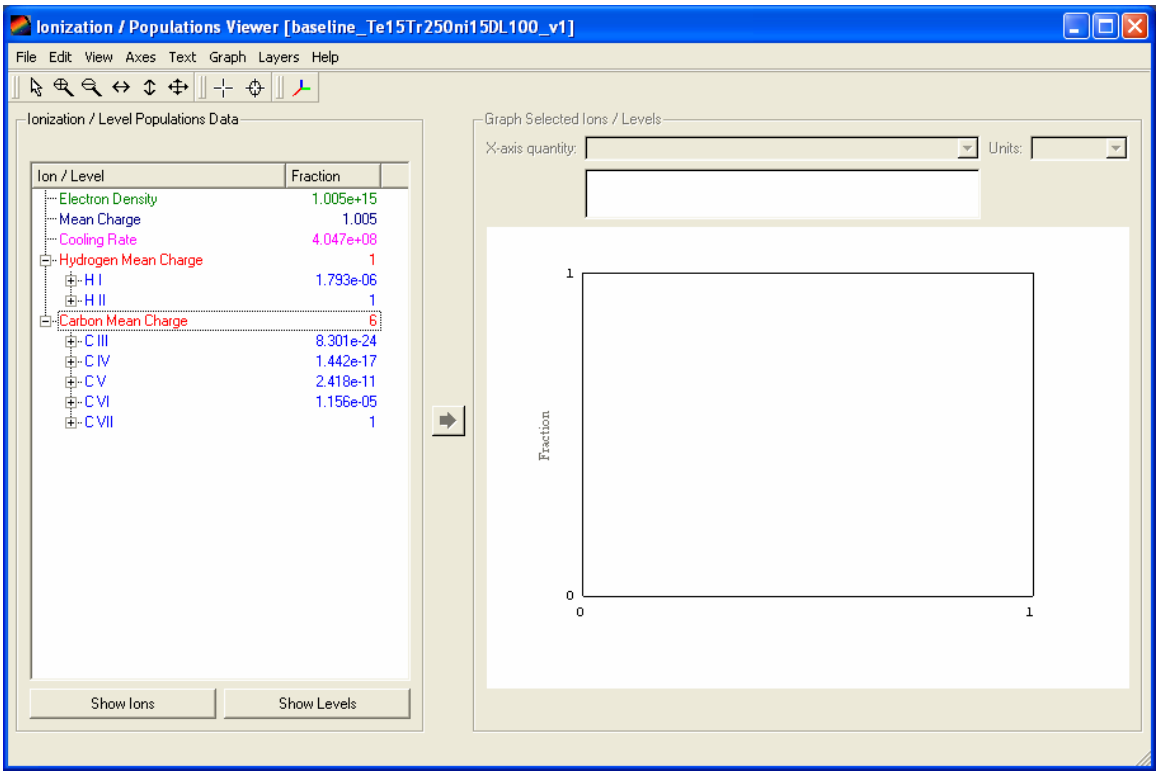
The lines at 40+ A are the resonance and intercombination lines of C V. Presumably the forbidden line is absent because of the relatively high density, but I'm surprised that the intercombination line isn't stronger, as G > 1 for photoionized plasmas.

Turning up the radiation field (Tr=250) – still no bare C:


Ionization / Populations Viewer [baseline_Te5Tr250ni15DL100_v1]
File Edit View Axes Text Graph Layers Help
Ionization / Level Populations Data
Ion / Level
Fraction
Electron Density 1.004e+15
Mean Charge 1.004
Cooling Rate 1.922e+08
Hydrogen Mean Charge 1
H I 1.028e-05
H II 1
Carbon Mean Charge 5
C III 1.717e-14
C IV 4.907e-10
C V 5.58e-05
C VI 0.9999
C VII 1e-30
Show Ions
Show Levels
Graph Selected Ions / Levels
X-axis quantity:
Units:
Fraction
1
0
0
1



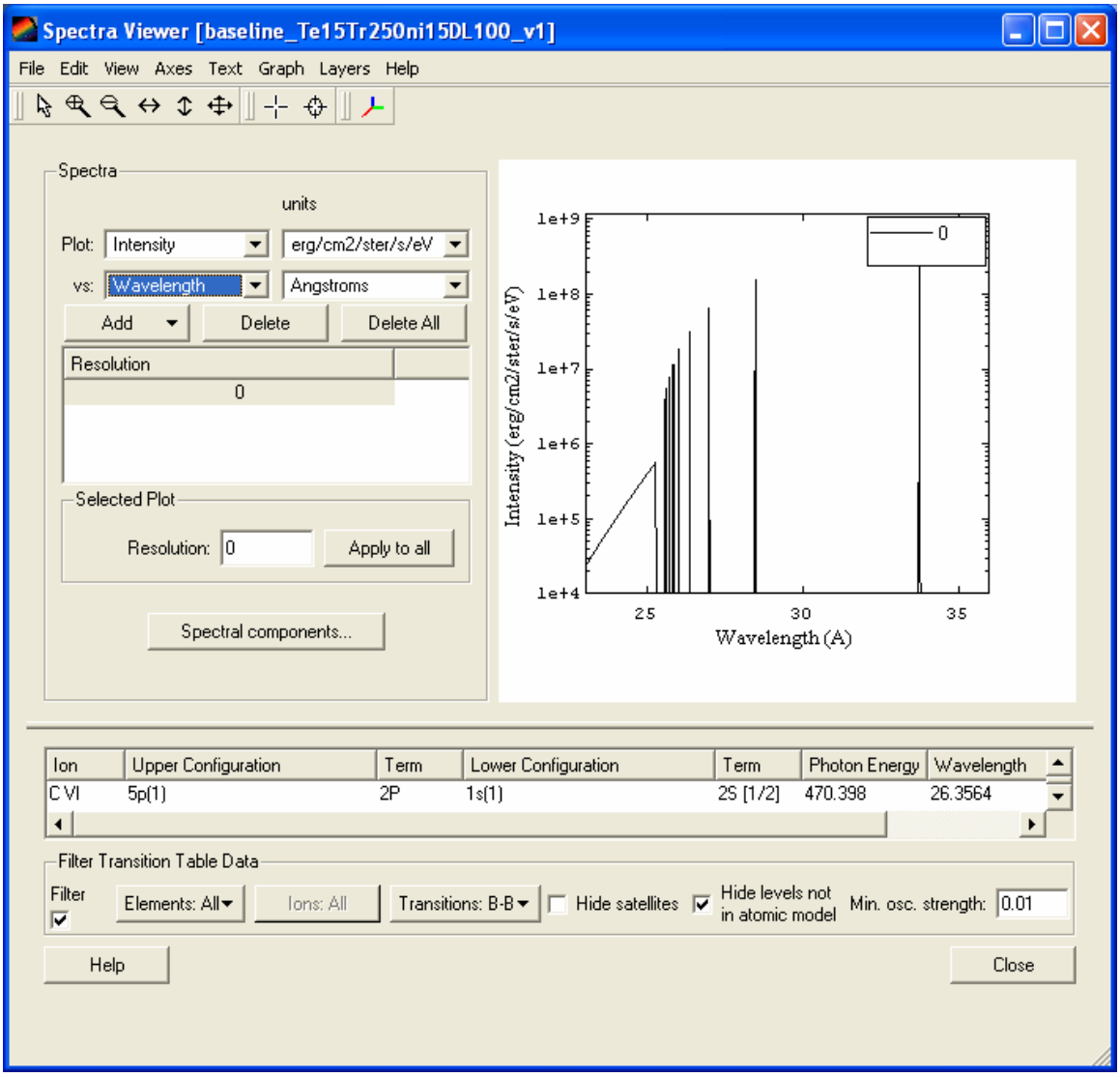
Maybe the electron temperature is just too low. Try Te=15eV. But still Tr=250. ni=1e15.



OK, this made a huge difference; now bare C is dominant.

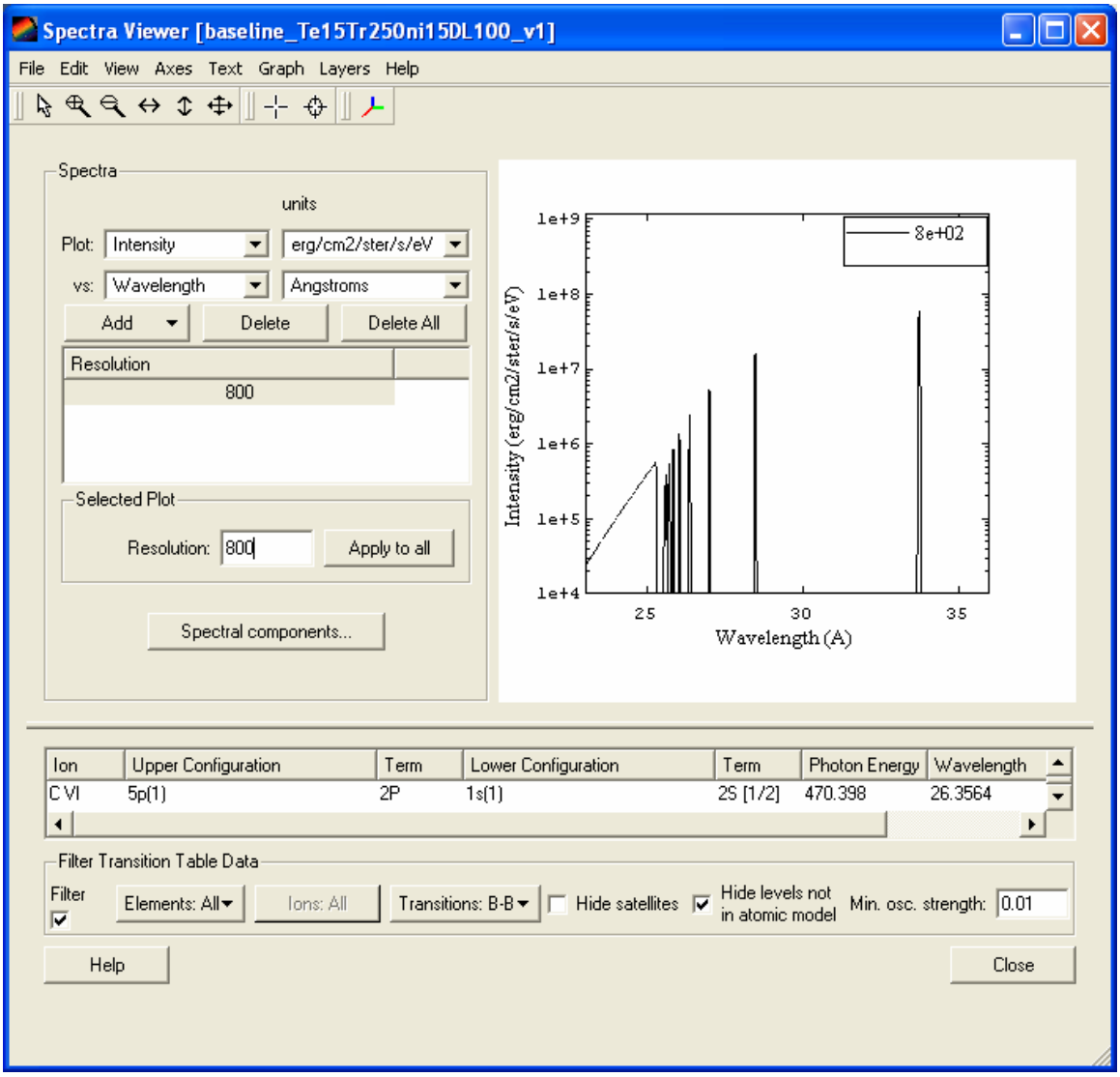
Though I'm somewhat surprised that it went from nothing to completely dominant going from just T_e=5eV to 15eV.

Here's the synthetic spectrum from this simulation:



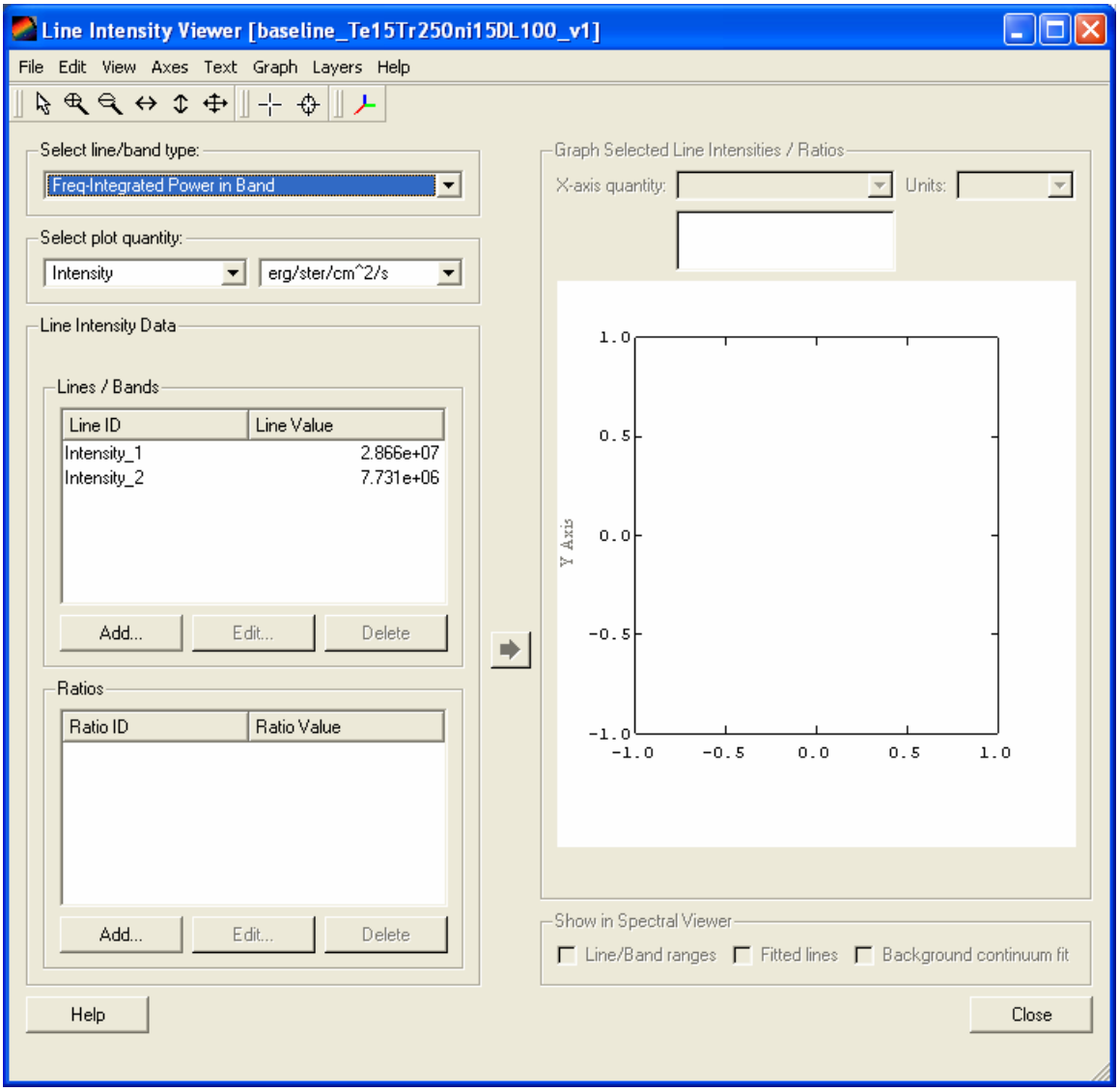
The RRC (at 25.3 A) is still very weak compared to Ly-alpha (near 33 A).

Let’s convolve down to R=800



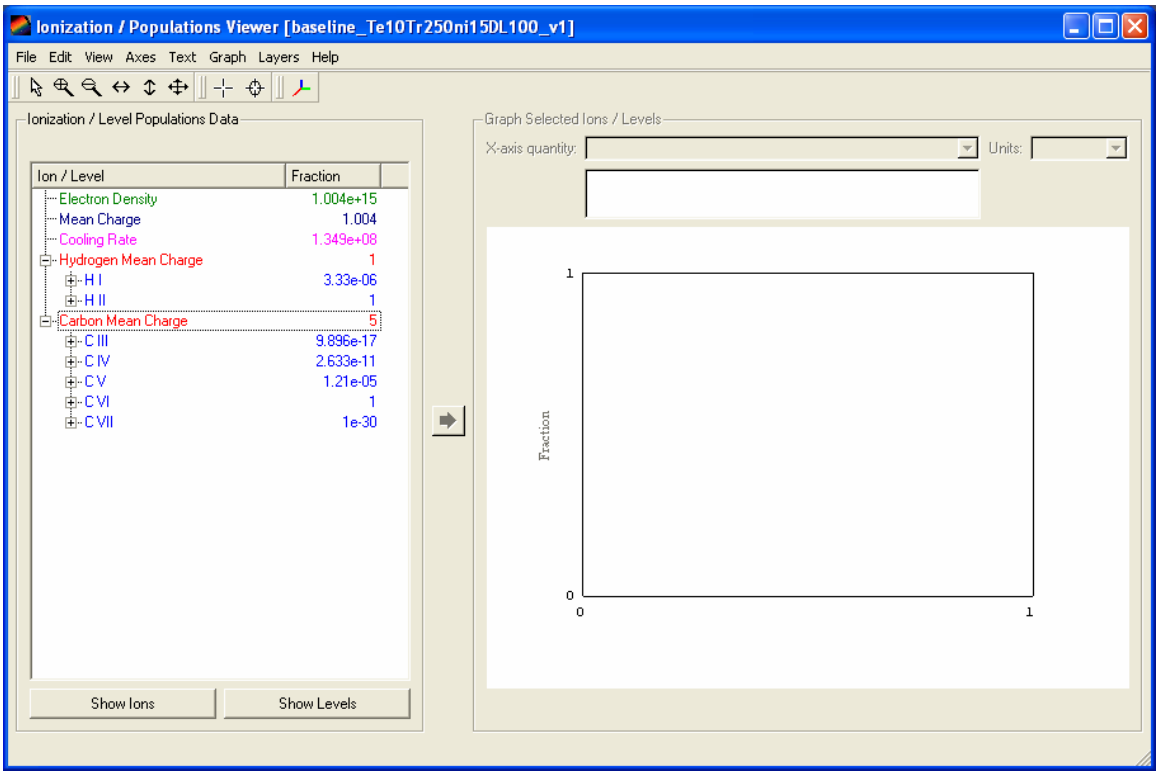
Doesn't make much difference

But, when I integrate the power in a band around Ly-alpha and then around the RRC, I get just a factor of 4 ratio in integrated power:



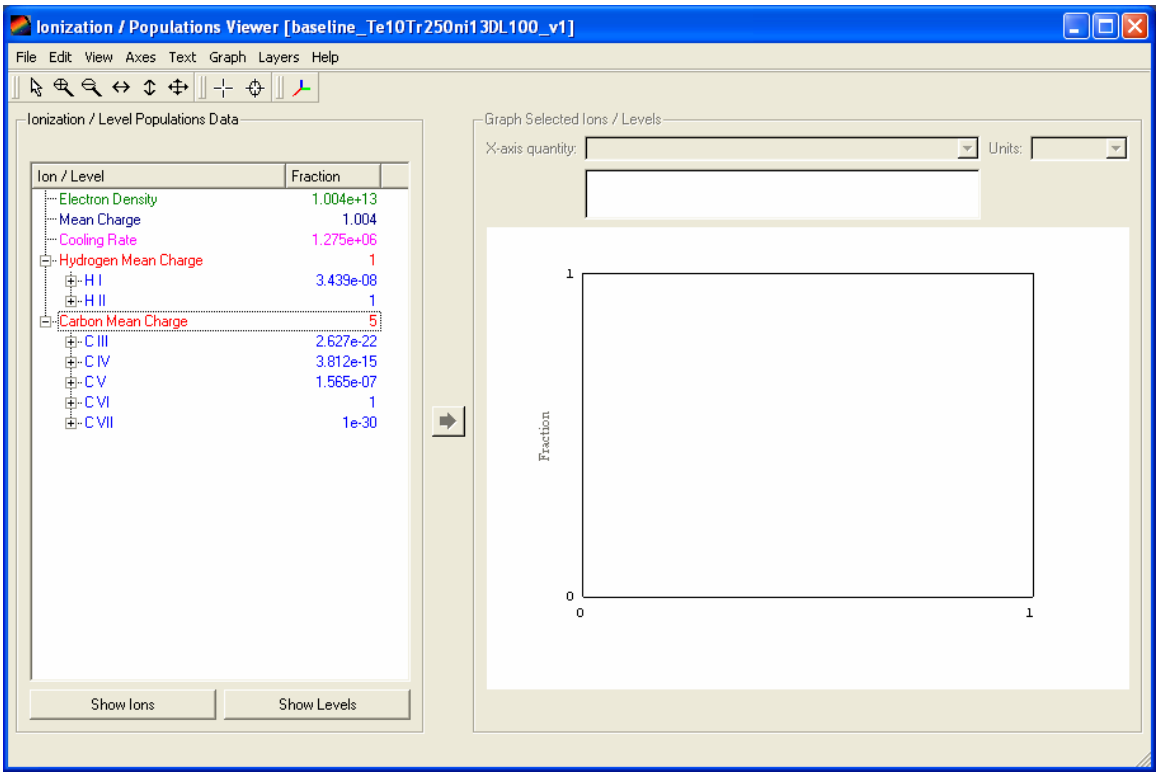
Hmmm… so there's significant integrated power in the RRC… but it's not highly peaked (though in linear space, it looks plausibly to have a width of ~kT.

See what difference it makes to lower T to 10eV:



Wow, Ionization completely different – back down to no bare C at all.

Now try ni=1e13 and Te=10eV



same thing – still no bare C at all.