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29 Feb 2008

Some simple PrismSpect tests of recombination spectra in photoionized plasmas

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

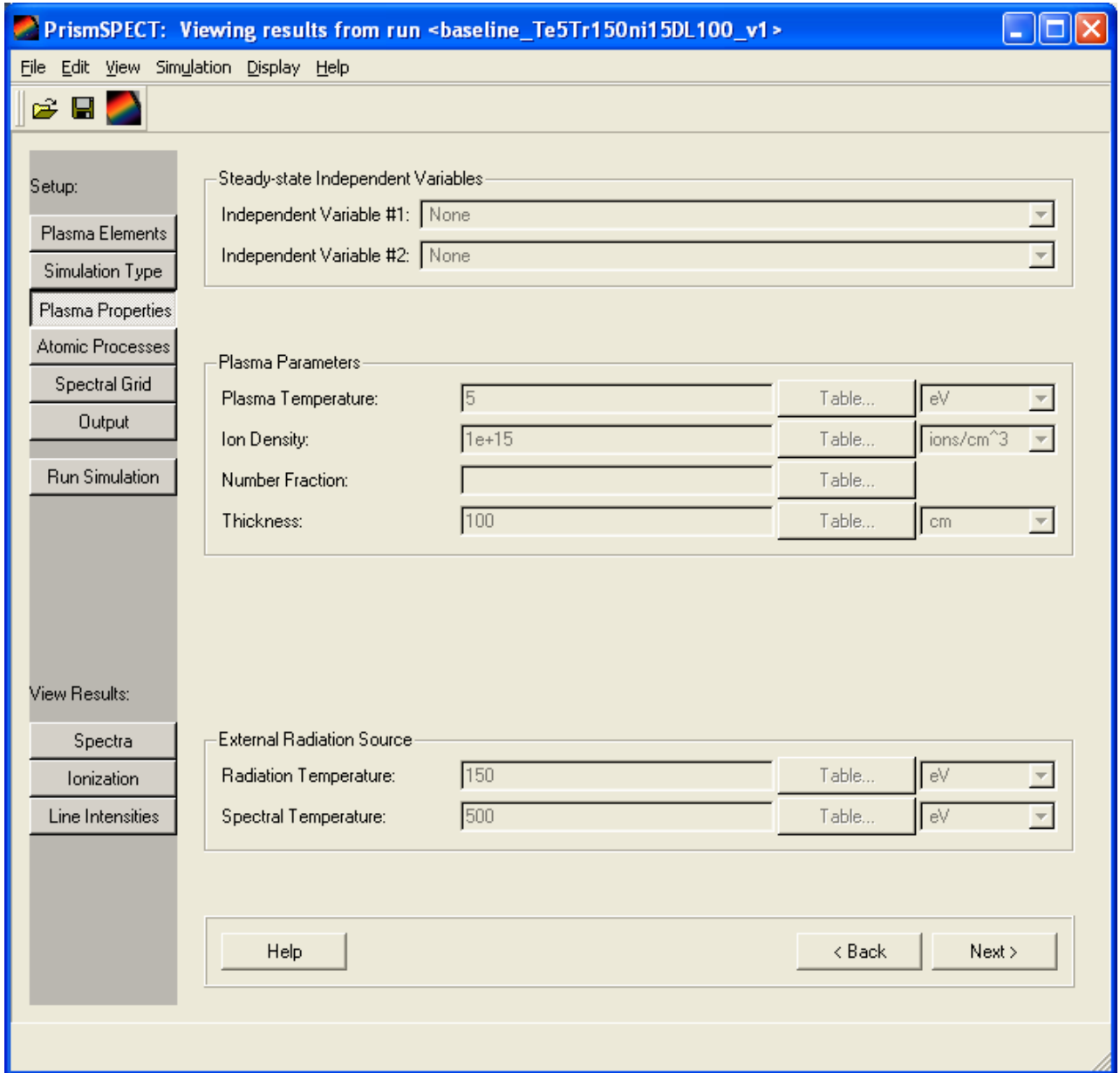
$n_i = 10^{15} \text{ cm}^{-3}$
 $T_e = 5 \text{ eV}$

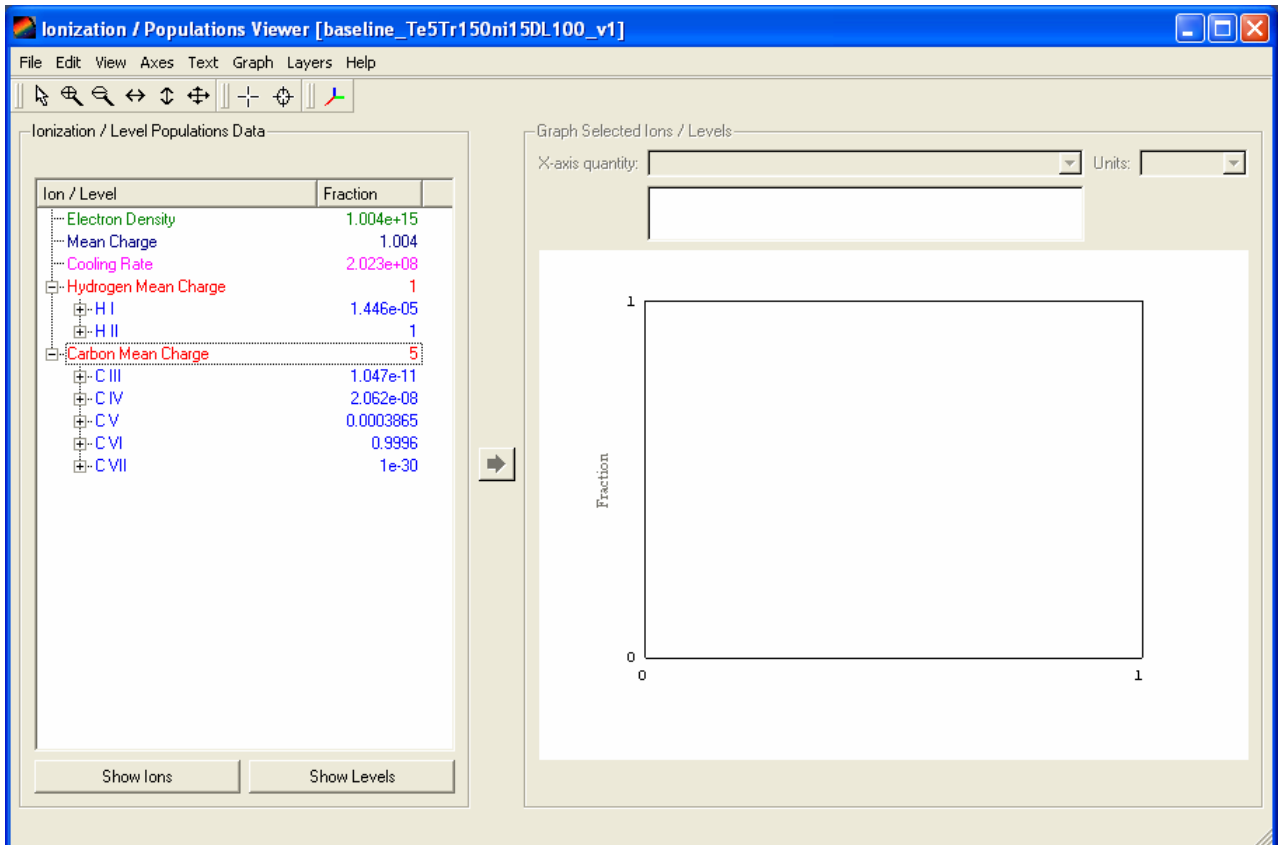
$T_r = 150 \text{ eV}$
 $T_{\text{spec}} = 500 \text{ eV}$

I used the canned K-shell emission atm files

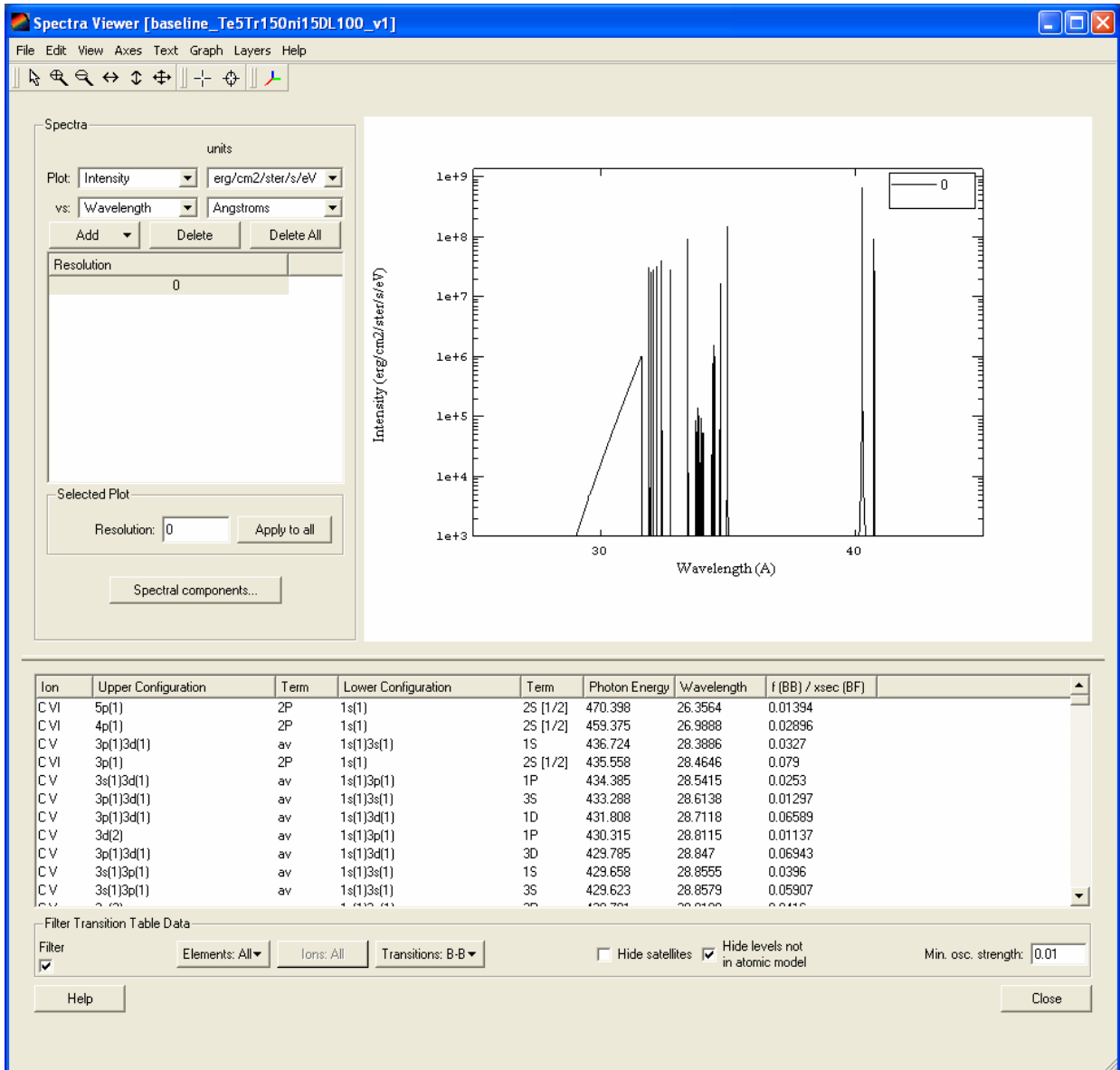
I wanted a cold, highly ionized plasma of relatively low density to focus on the spectral signatures of recombination

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





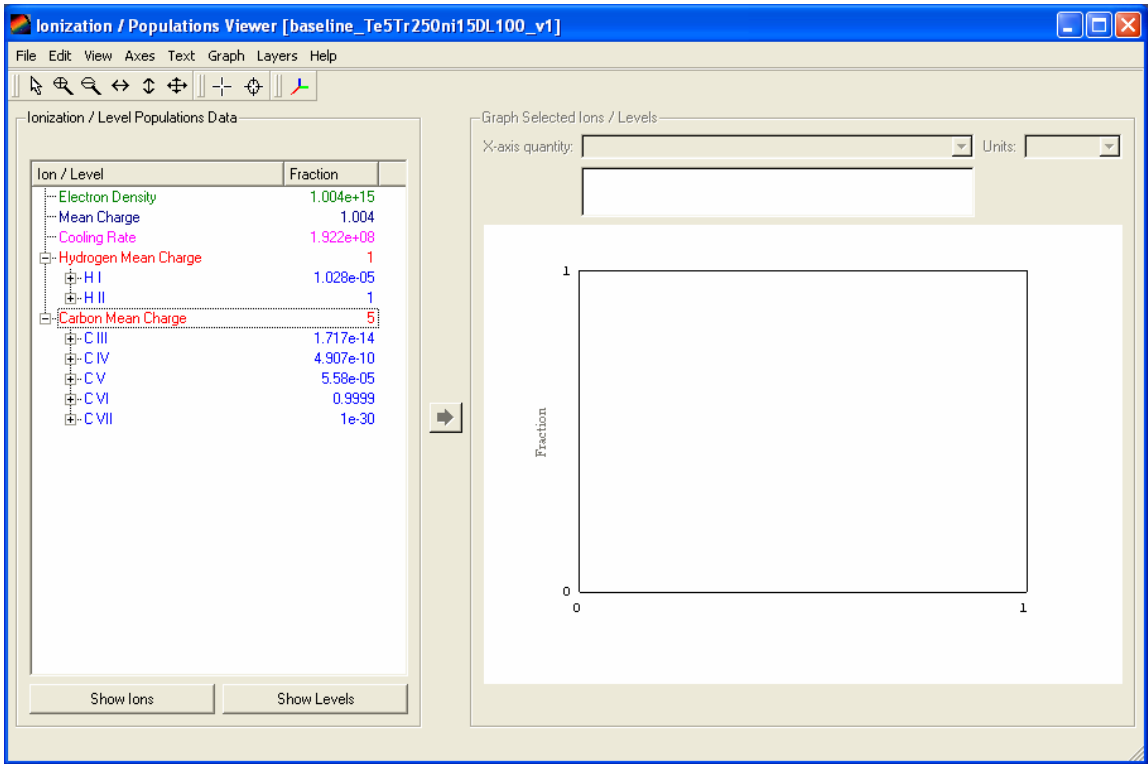
Note the carbon is nearly all H-like, but essentially none of it is bare.

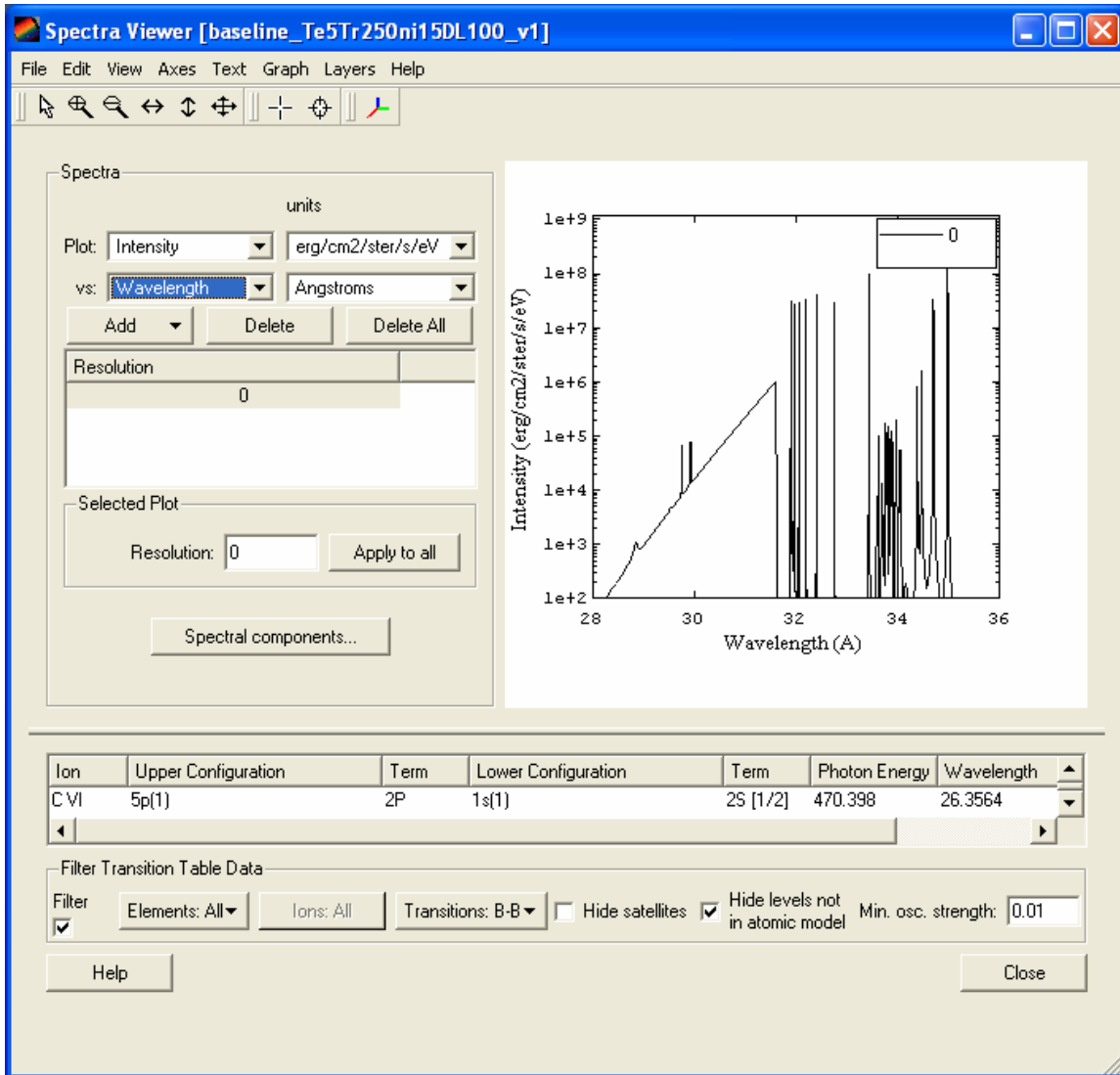


Note: The C VI K-edge is at 25.3 Angstroms; the edge that's visible here, near 32 Angstroms, is the C V edge/RRC. This reflects the fact that for a pure recombination spectrum, the strong features are from the $i-1$ ionization state.

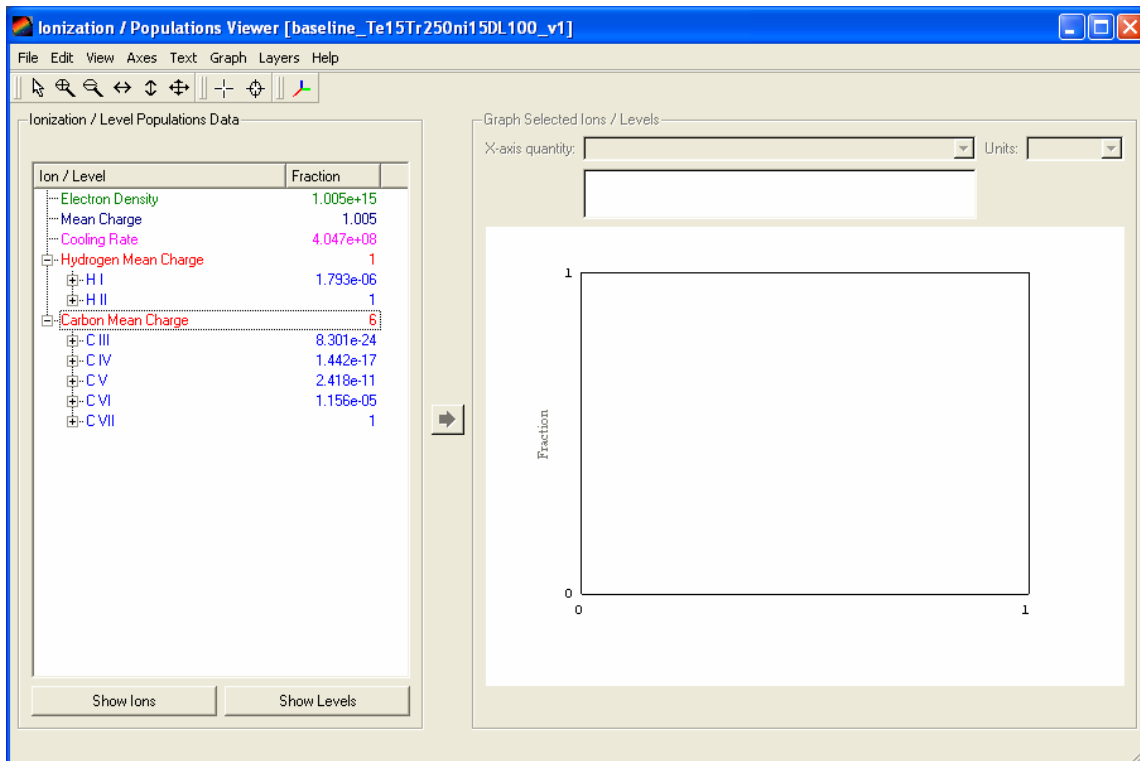
The lines at 40+ A are the resonance and intercombination lines of C V. Presumably the forbidden line is absent because of the relatively high density, but I'm surprised that the intercombination line isn't stronger, as $G > 1$ for photoionized plasmas.

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





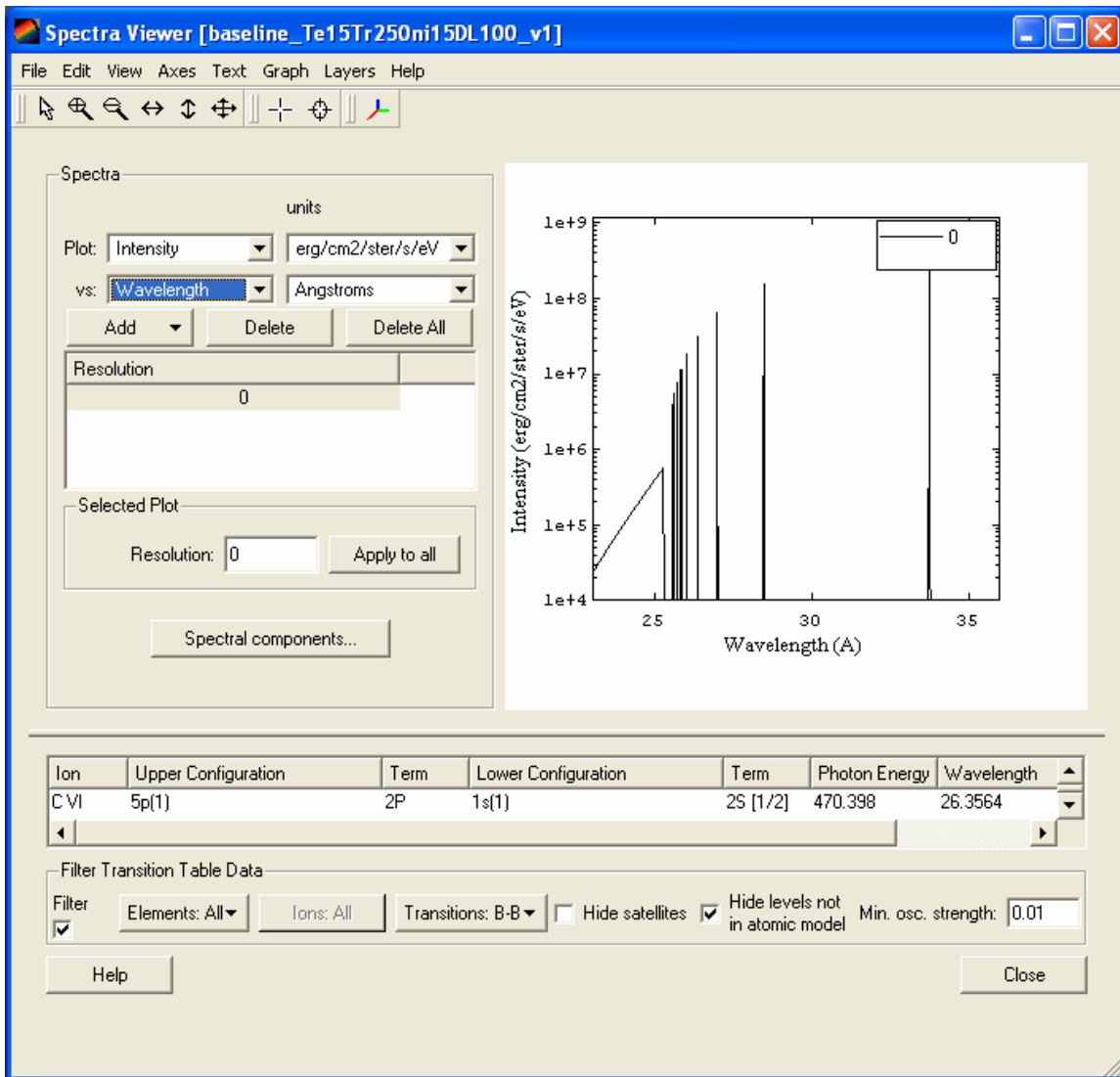
Maybe the electron temperature is just too low. Try $T_e=15\text{eV}$. But still $T_r=250$. $n_i=1e15$.



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

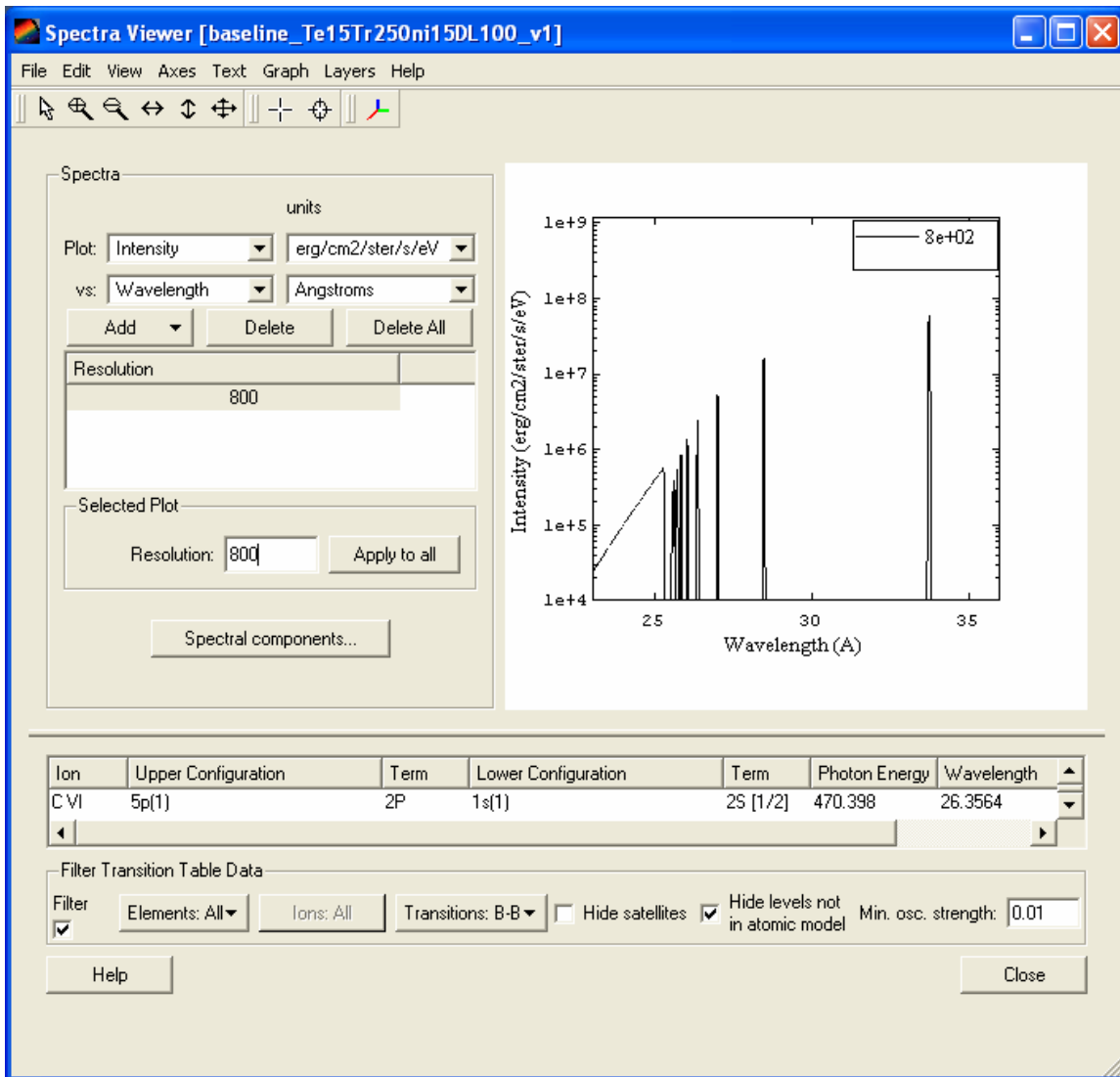
Though I'm somewhat surprised that it went from nothing to completely dominant going from just $T_e=5\text{eV}$ to 15eV .

Here's the synthetic spectrum from this simulation:



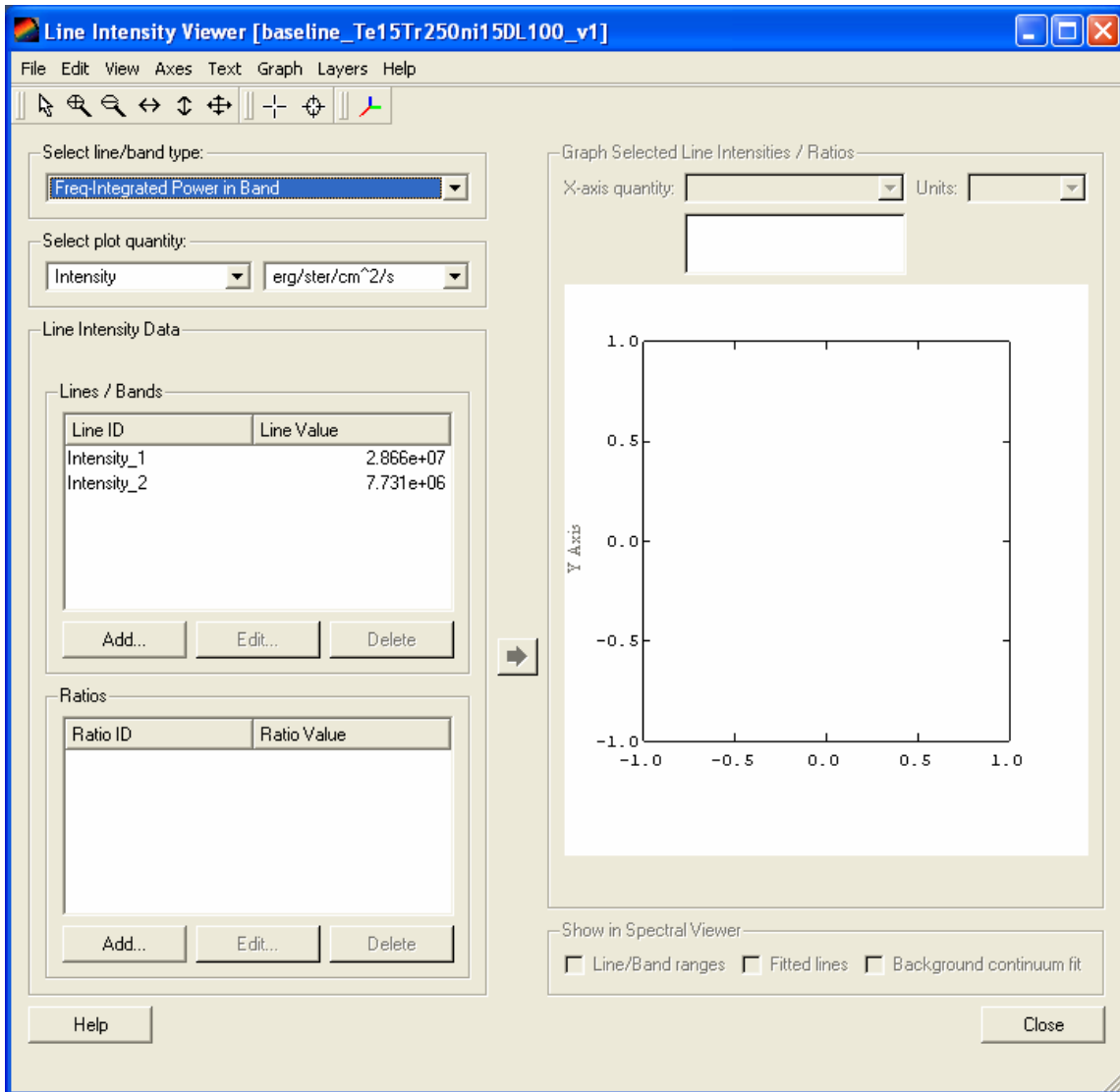
The RRC (at 25.3 Å) is still very weak compared to Ly-alpha (near 33 Å).

Let's convolve down to R=800



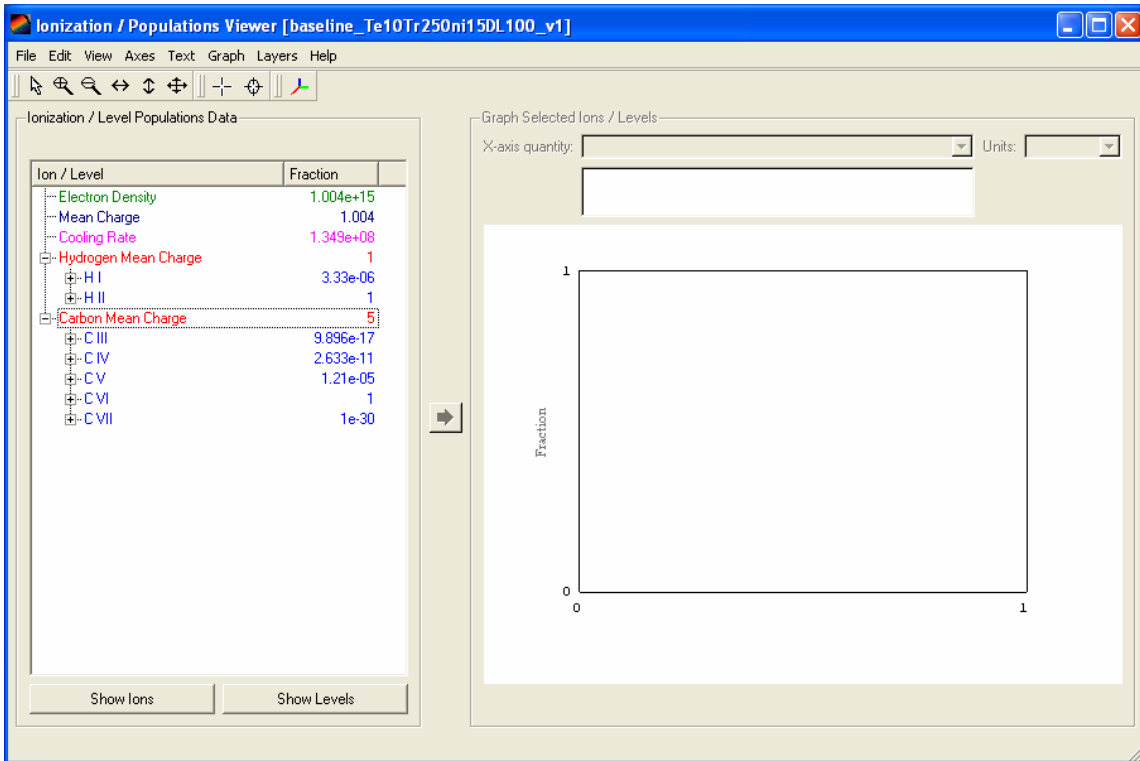
Doesn't make much difference

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:



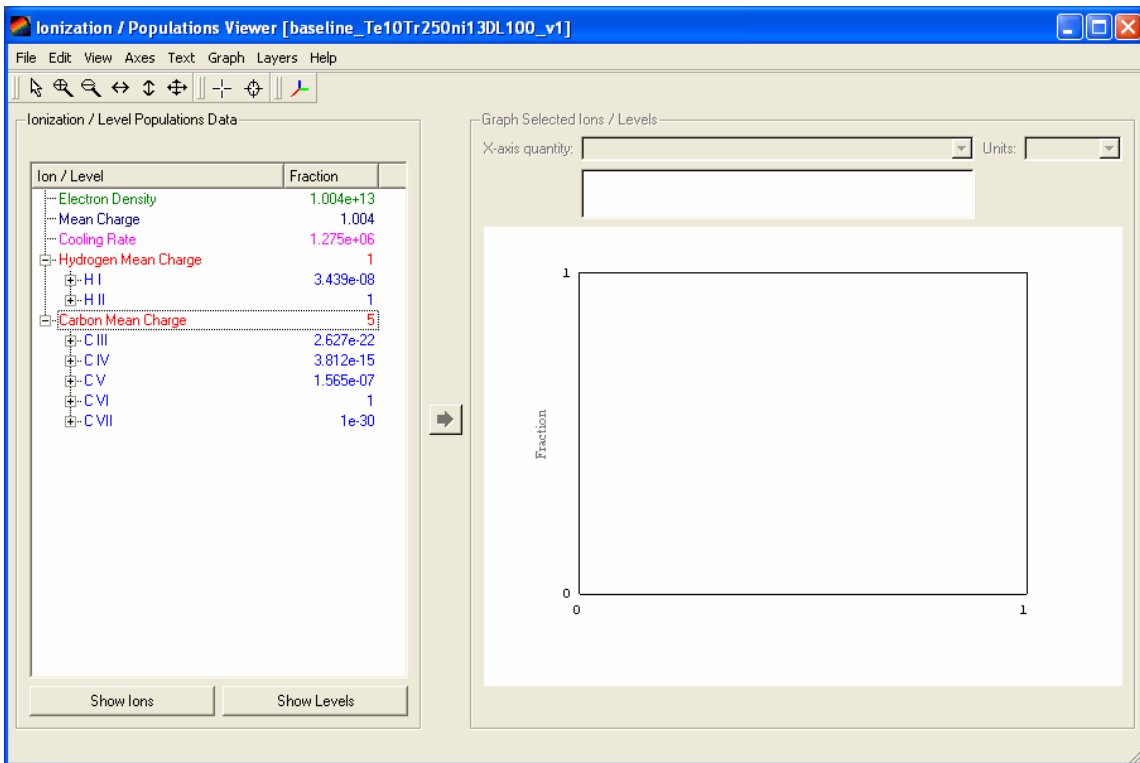
Hmmm... so there's significant integrated power in the RRC... but it's not highly peaked (though in linear space, it looks plausibly to have a width of $\sim kT$).

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



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

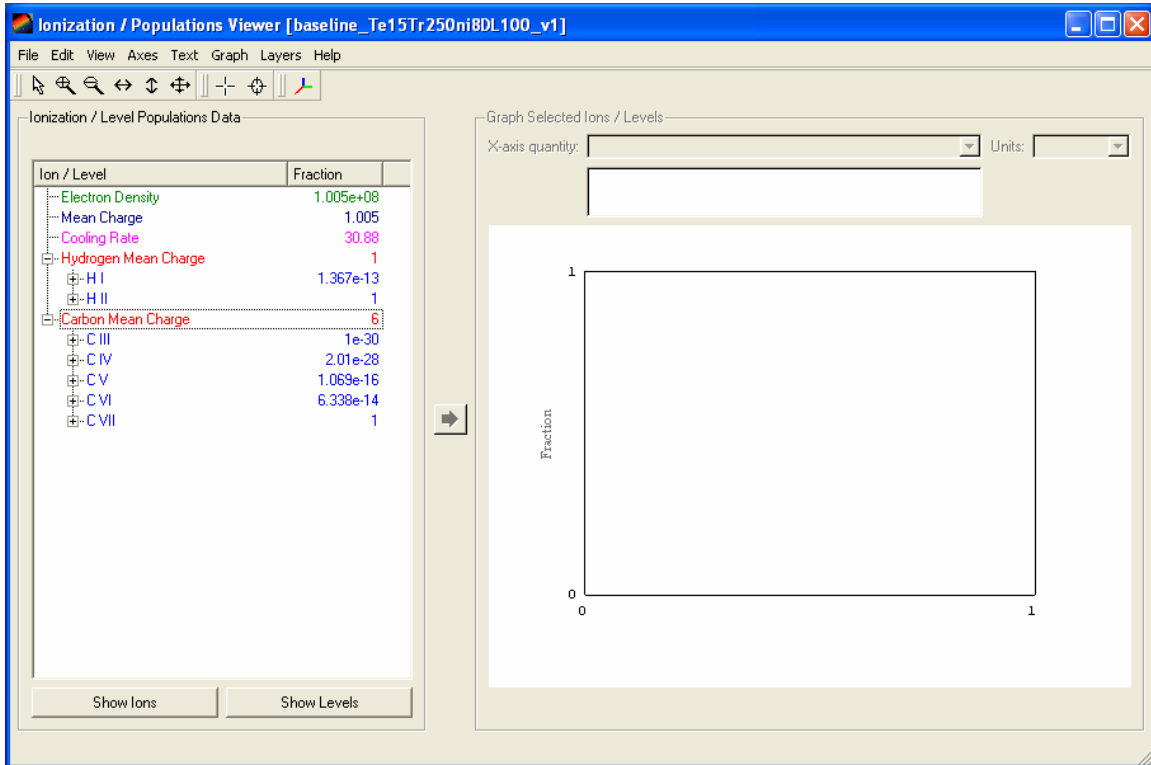
Now try ni=1e13 and Te=10eV



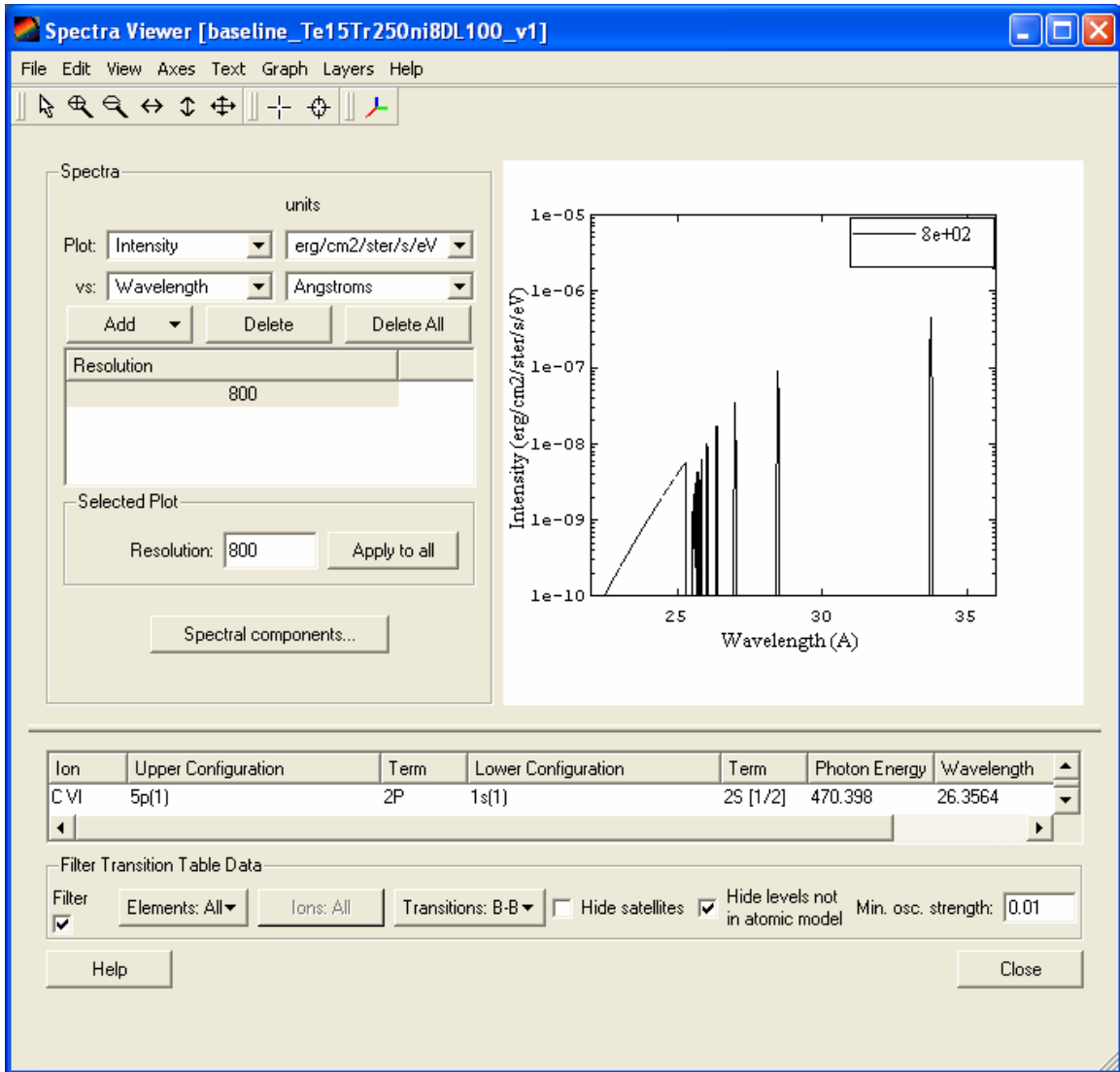
same thing – still no bare C at all.

5 March 2008 – looking at lowering the density (not so much for the RRC, but for the f-i-r complex

$n_i = 1e8$, $T_e=15eV$



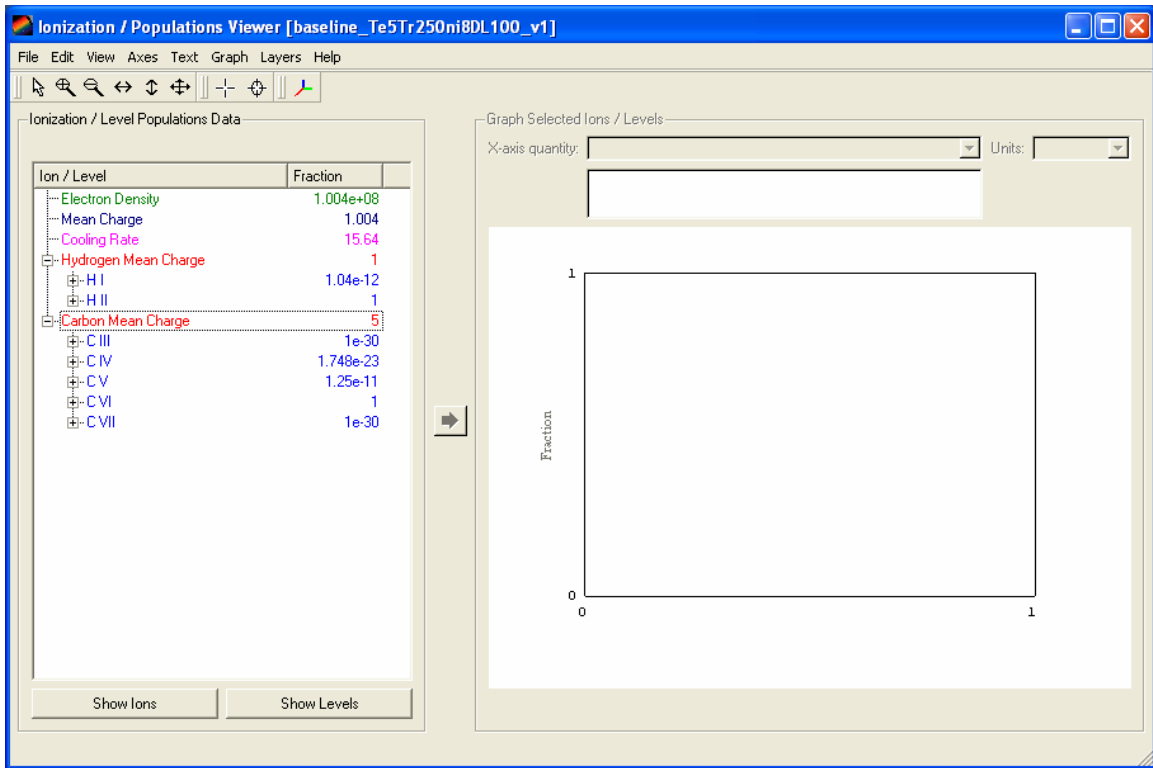
Ionization is very high



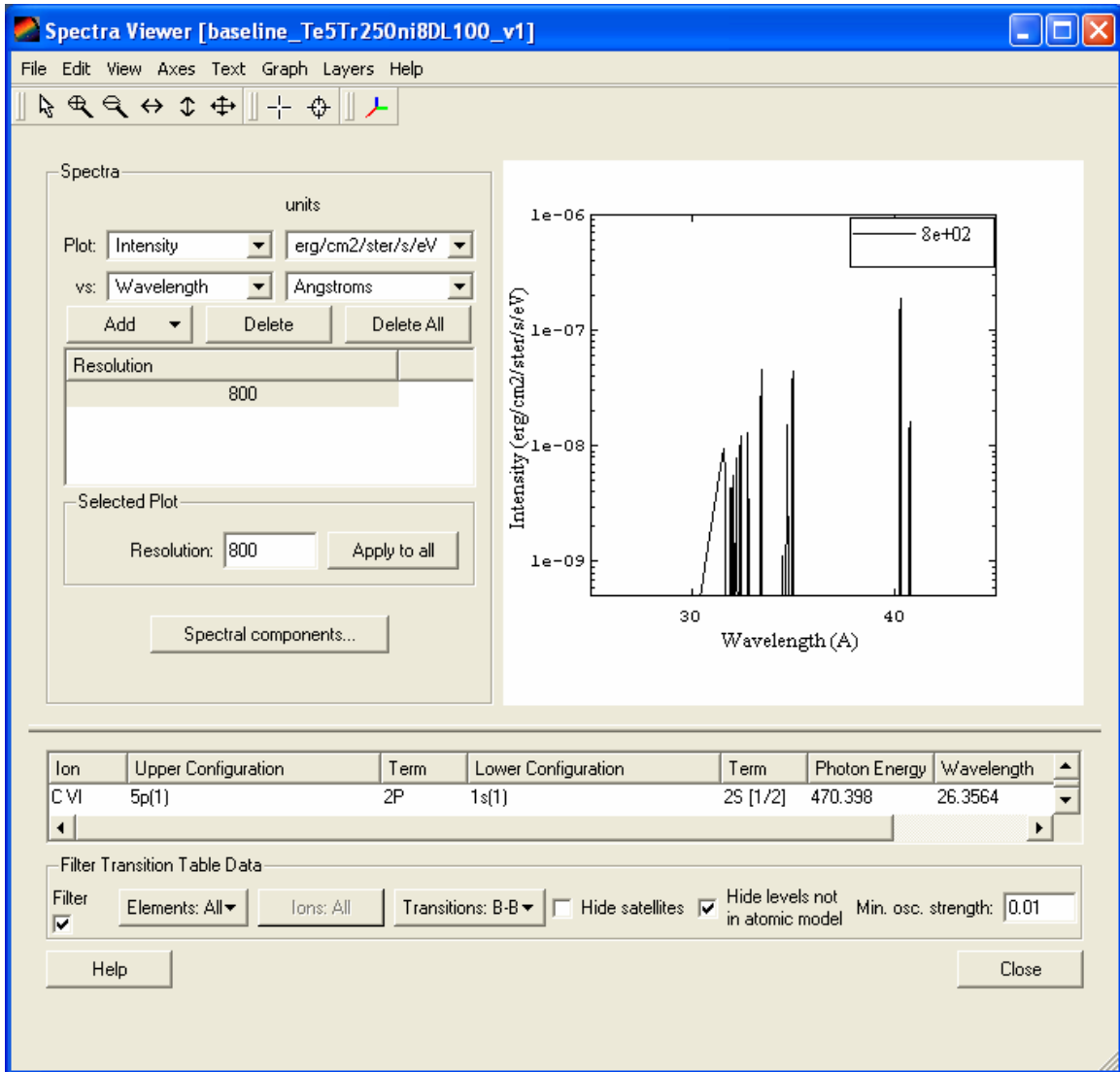
Spectrum is very, very similar to the higher density, highly ionized case (here in the Lyman series)

There are no helium-like features b/cs of the very high ionization

Let's go down to 5 eV now



The ionization is significantly lower (again), despite the much lower density



This doesn't look much different than the higher density models: RRC is narrow, but still weak, and $G \ll 1$.