Temperature Dependence of SiO_2 Cathodoluminescence

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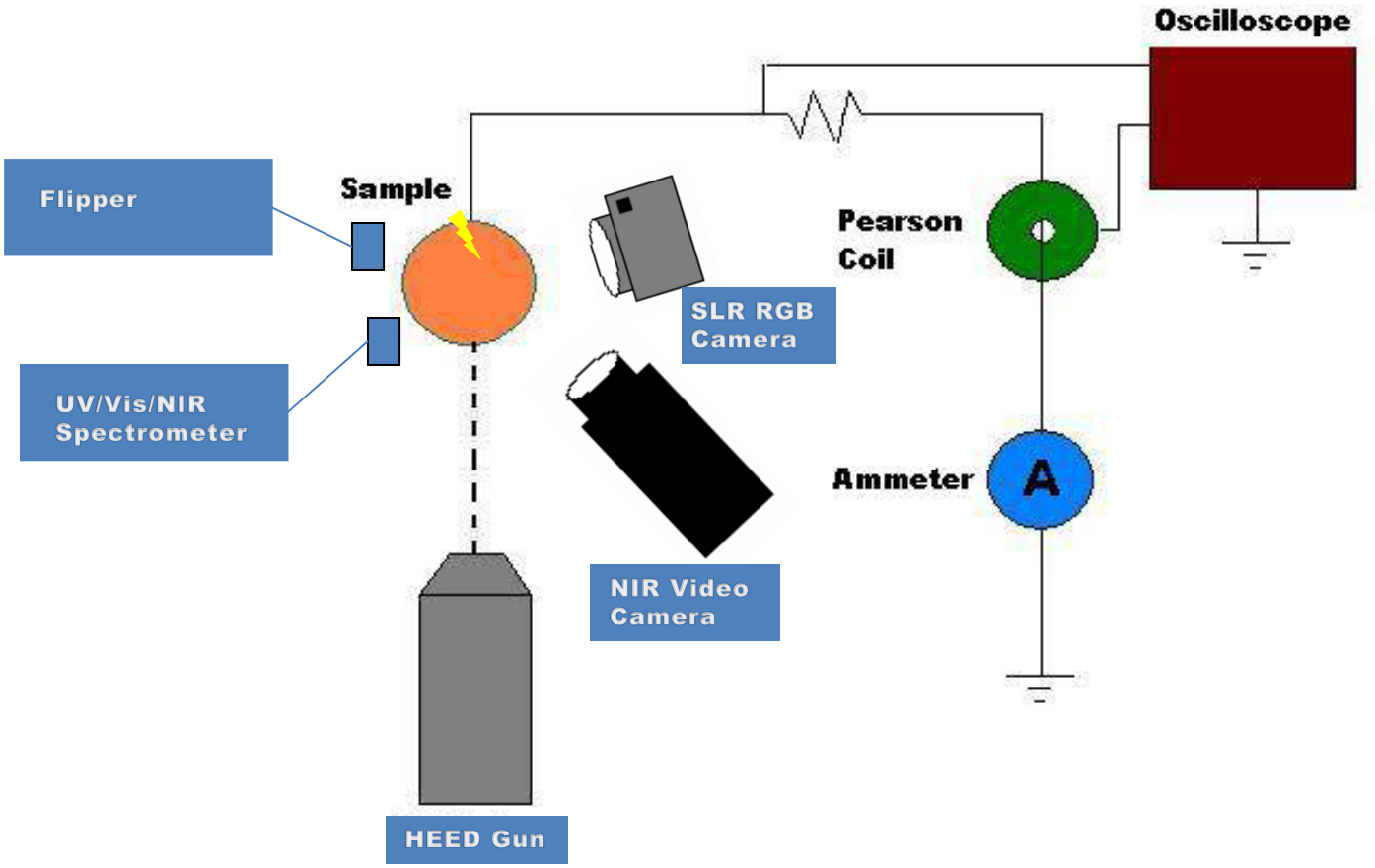
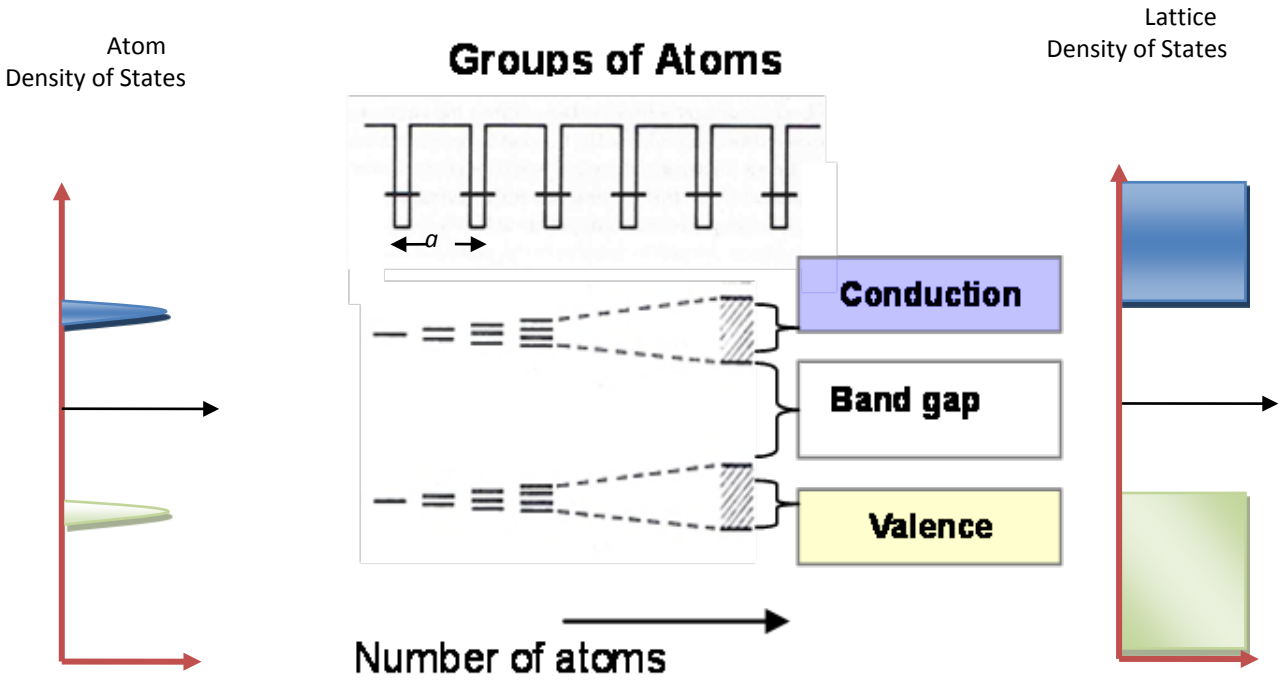
Outline

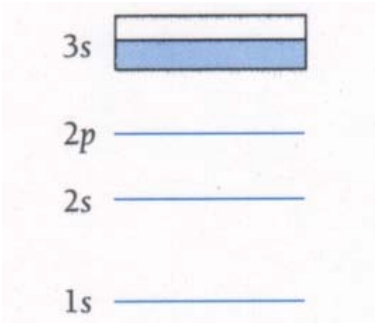
- Experimental set-up
- Theory and Results
  - Band theory of crystals
  - Electron excitation
    - One relaxation energy
    - Multiple relaxation energy's
  - Qualitative temperature dependent model

Experimental Set-Up



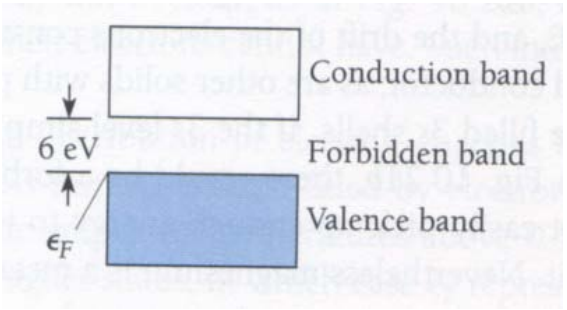
Band Theory of (Crystalline) Conductors, Insulators and Semiconductors





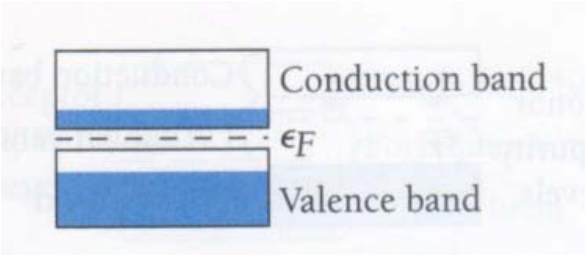
Conductor

Partially filled bands



Insulator

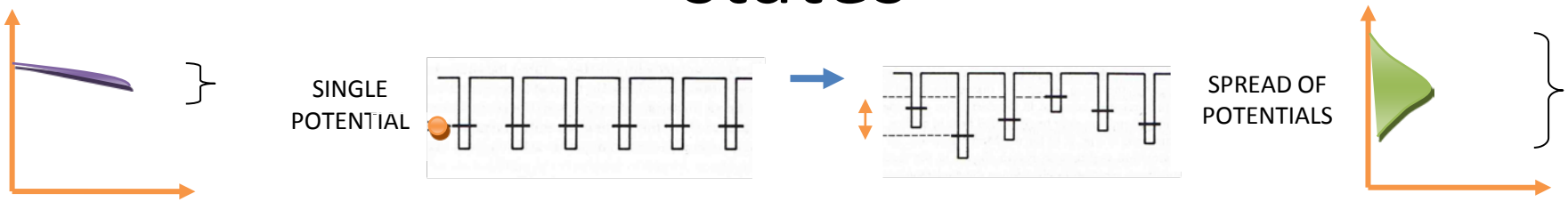
Completely filled bands



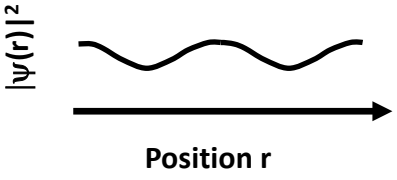
Semiconductor

Insulators at finite T

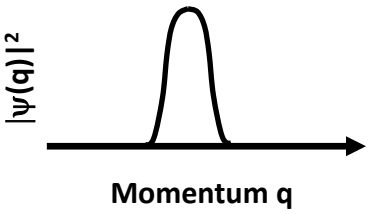
Disorder introduces localized states

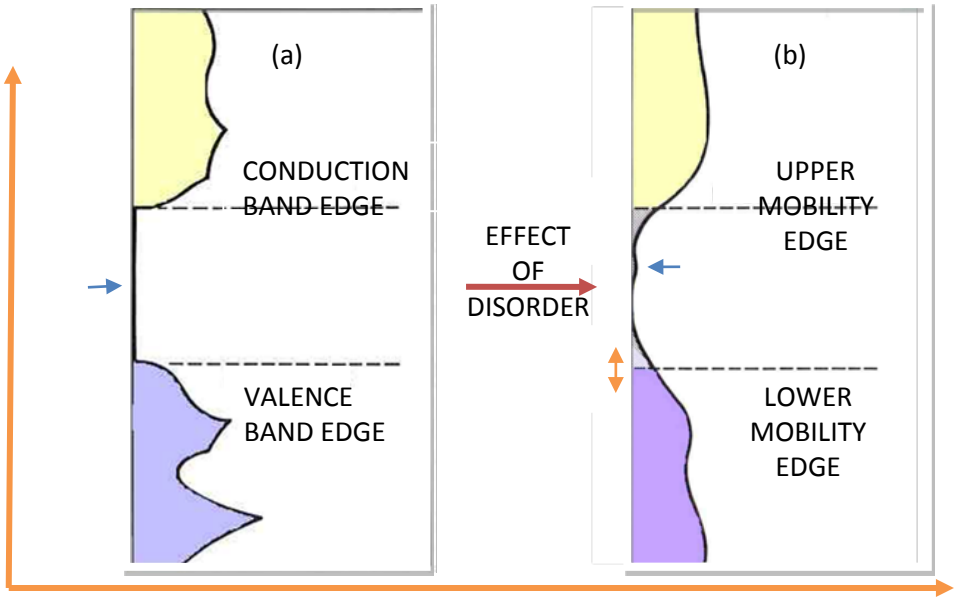


Delocalized in real space

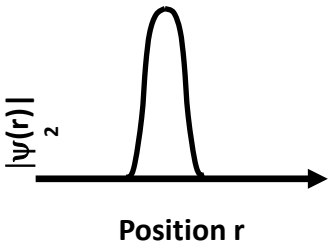


Localized in momentum space

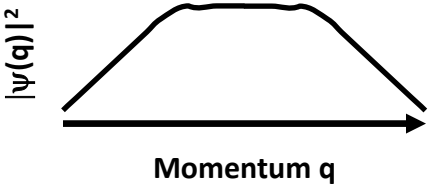




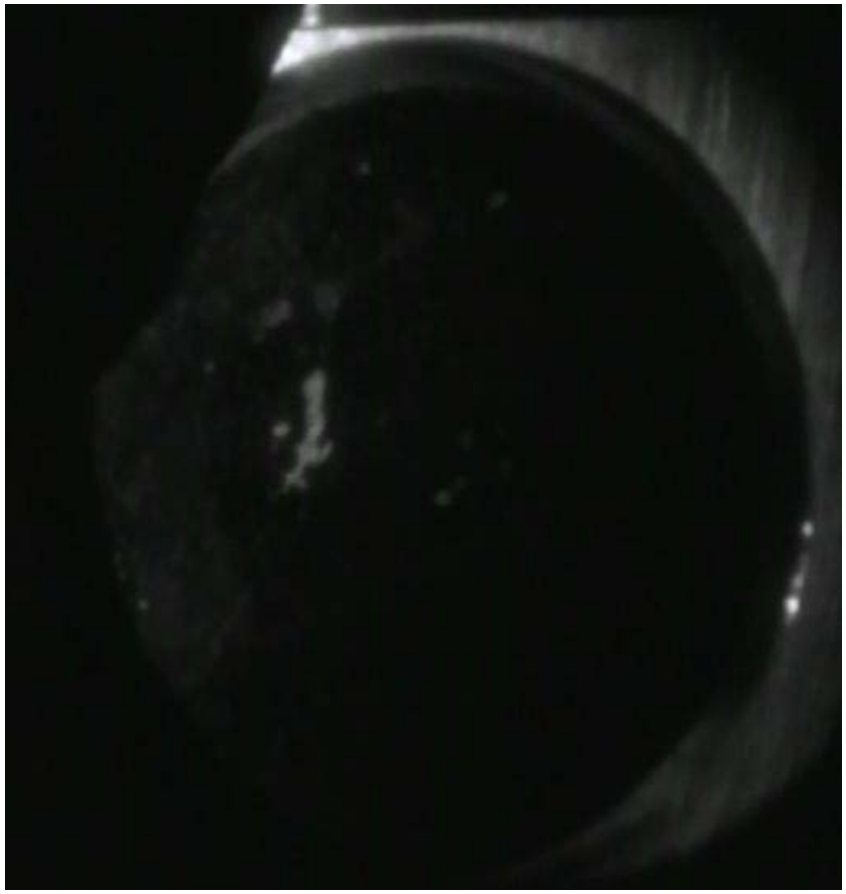
Localized in real space



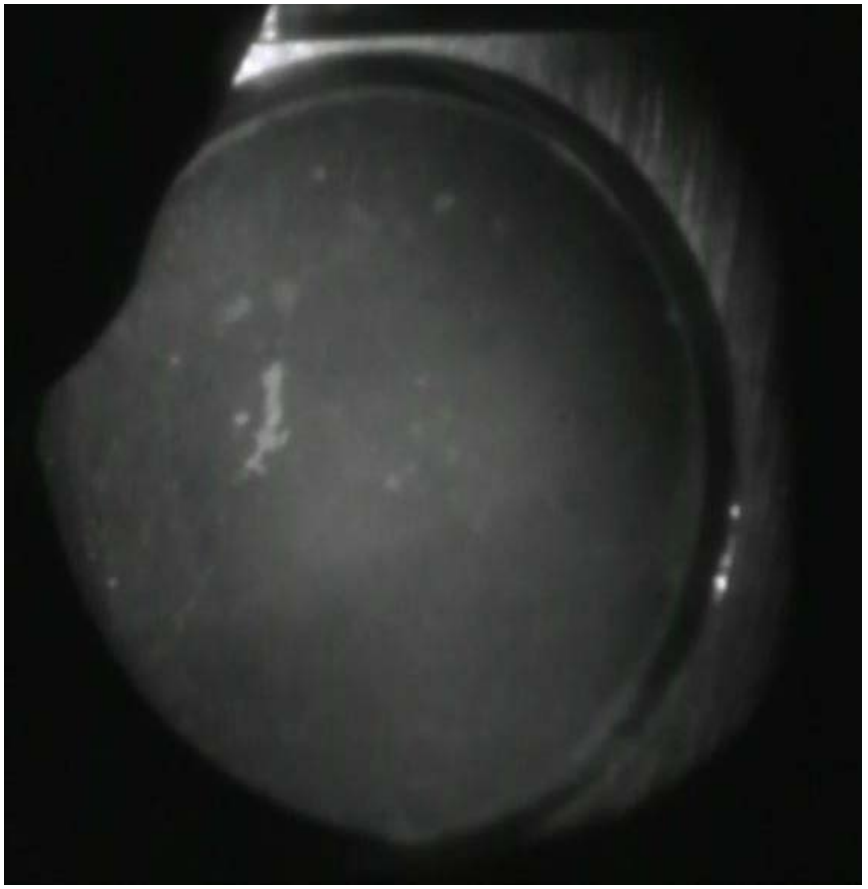
Delocalized in momentum space



Cathodoluminescence of SiO_2 Mirror

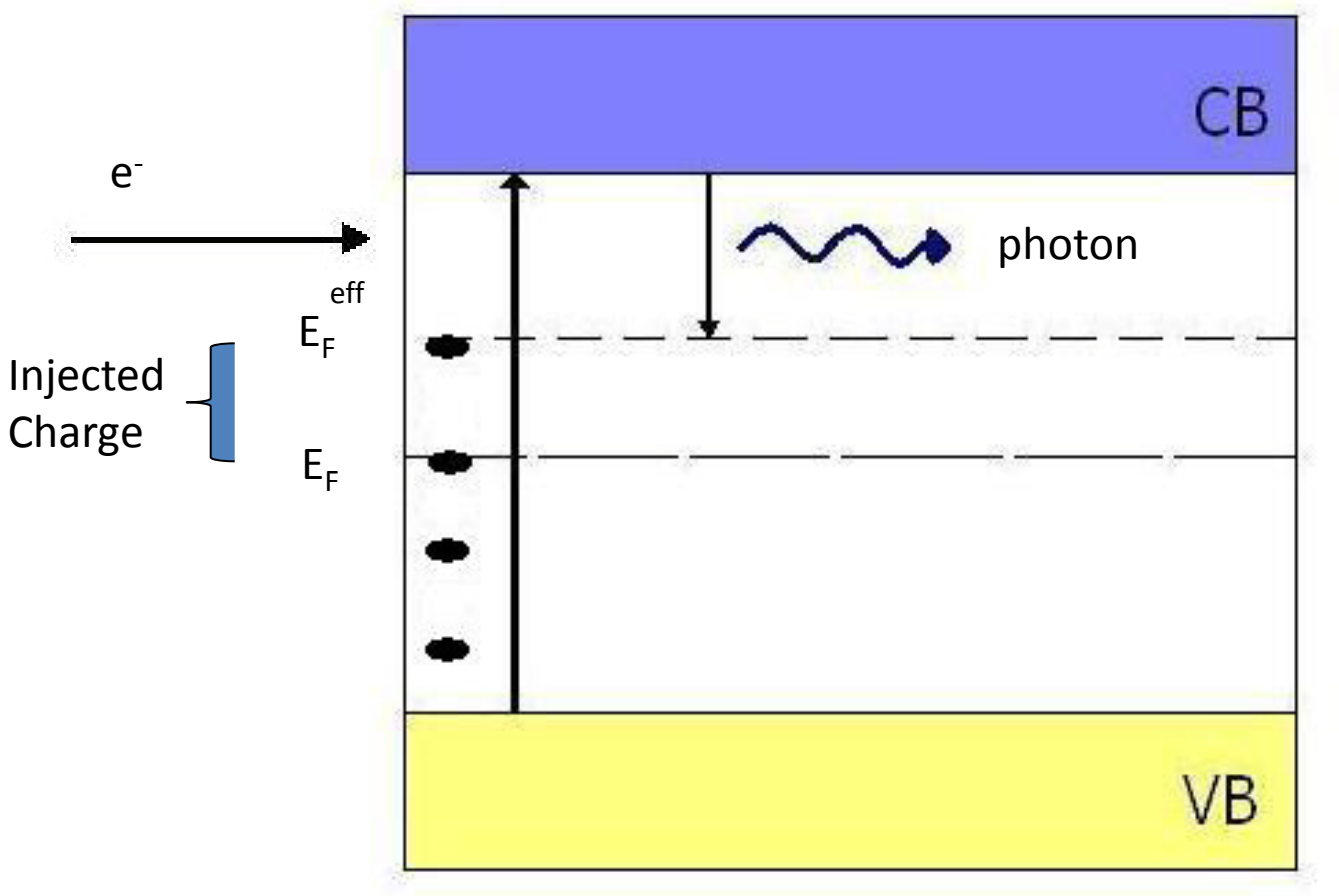


Beam off

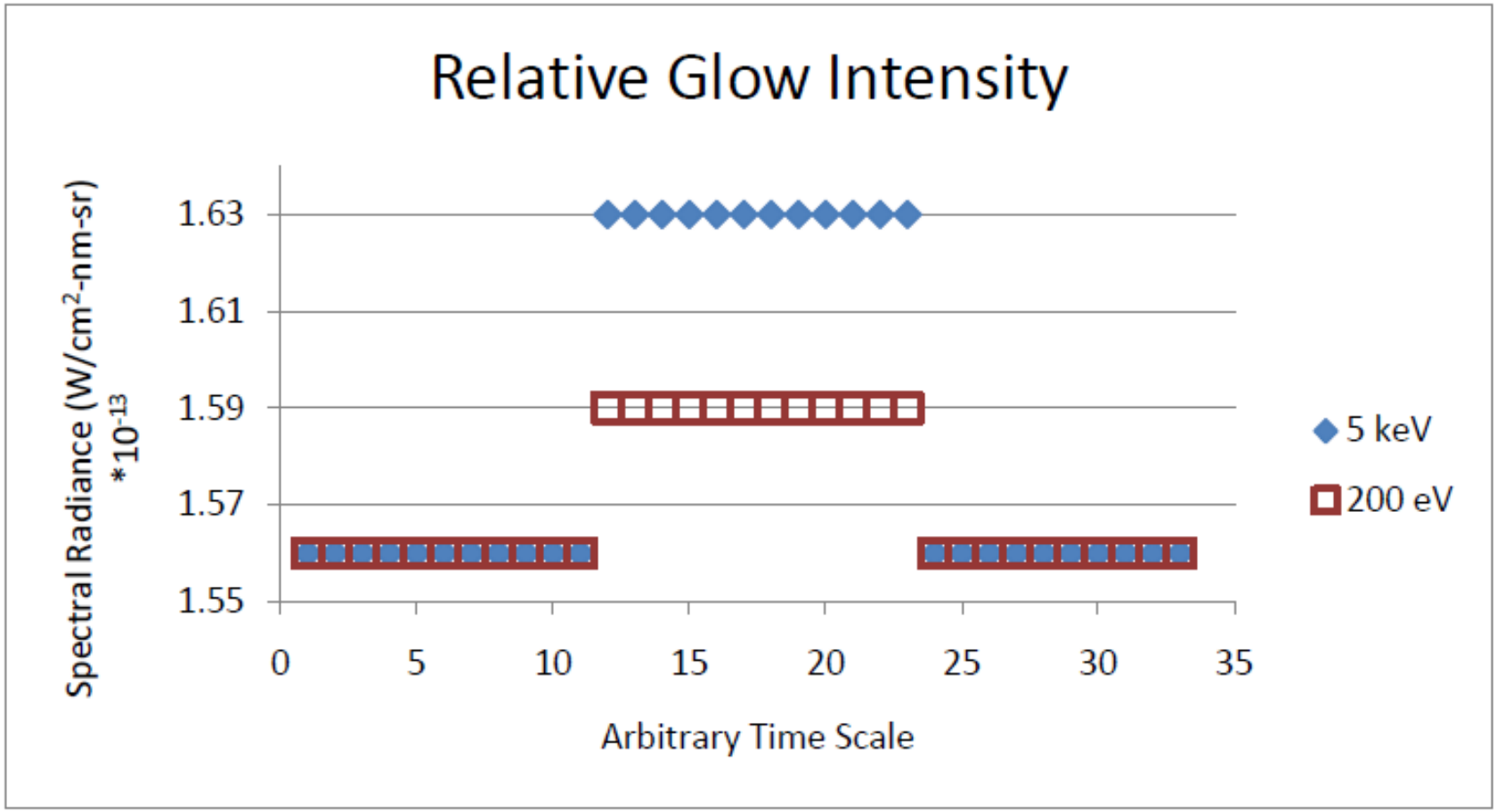


Beam on

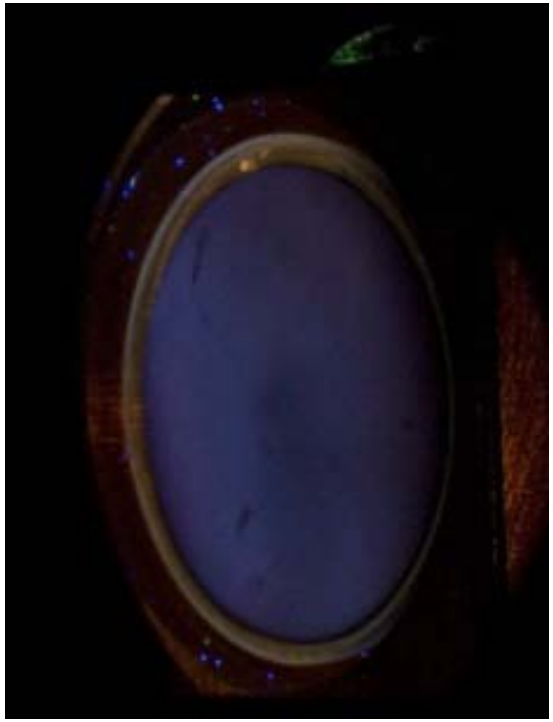
Luminescence: Excitation and Relaxation

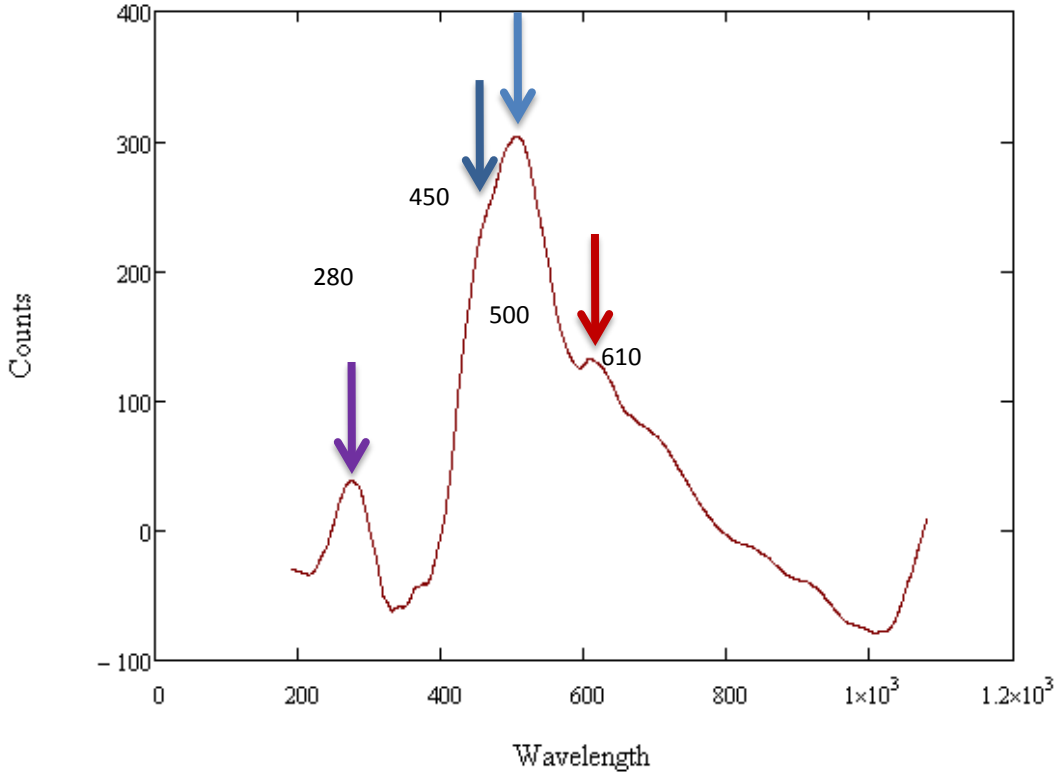


Effect of Beam Energy

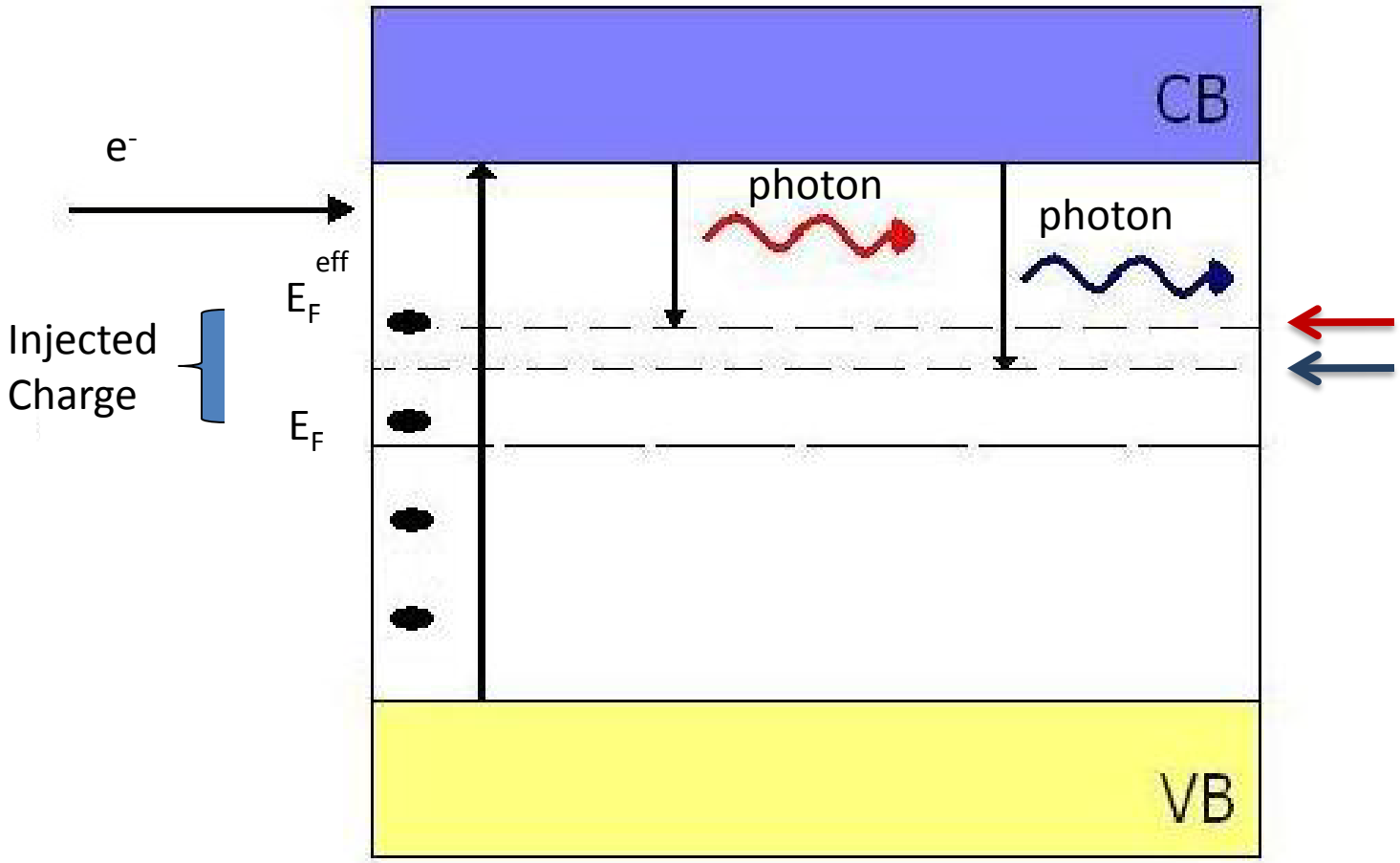


Multi-Photon Luminescence

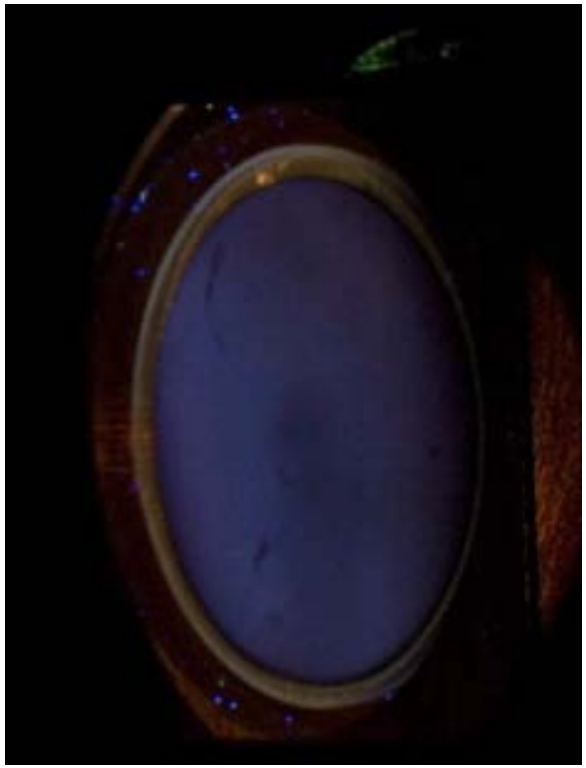




Multi-Photon Relaxation



Temperature Dependent Luminescence

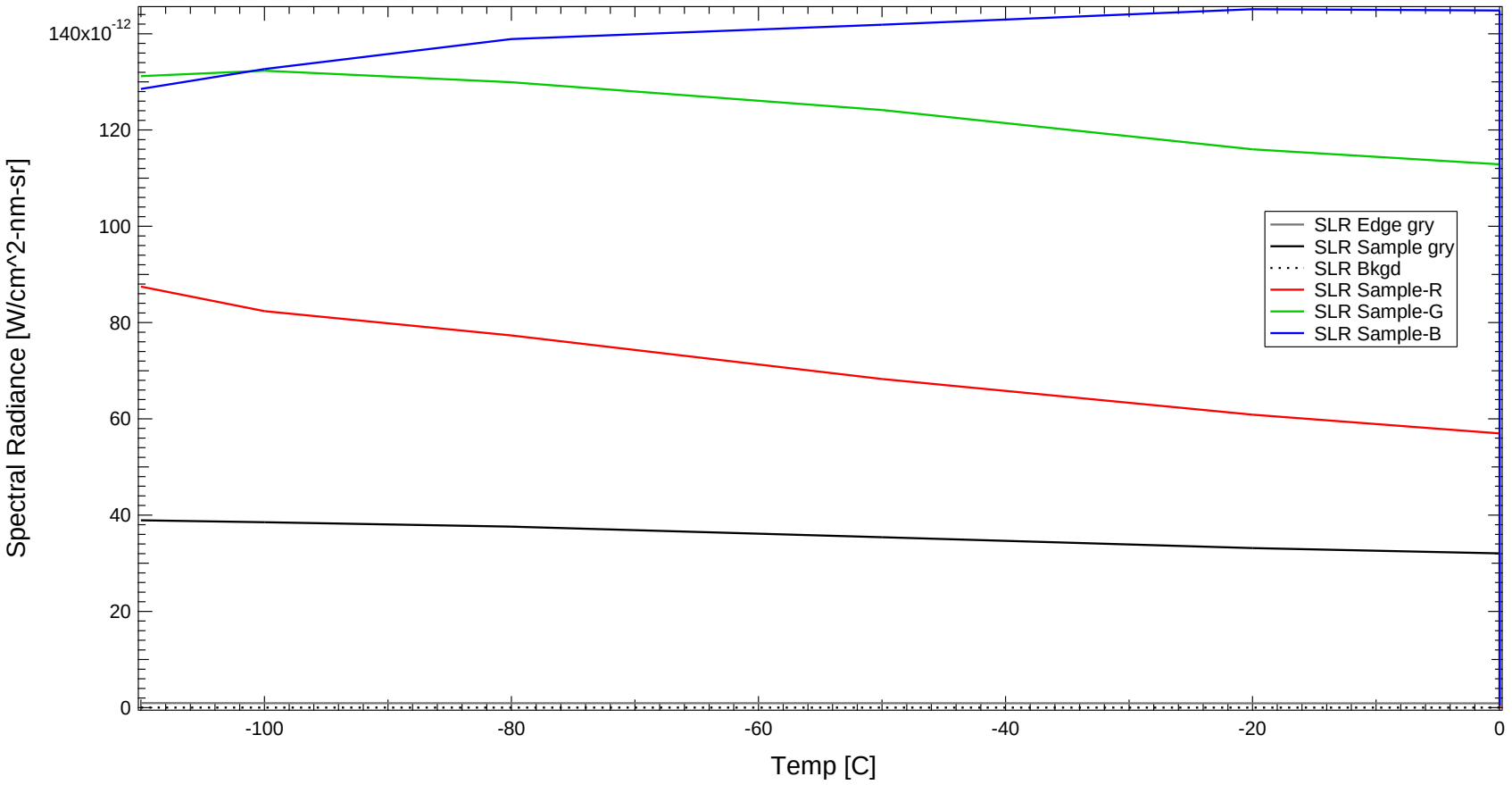


-4 C

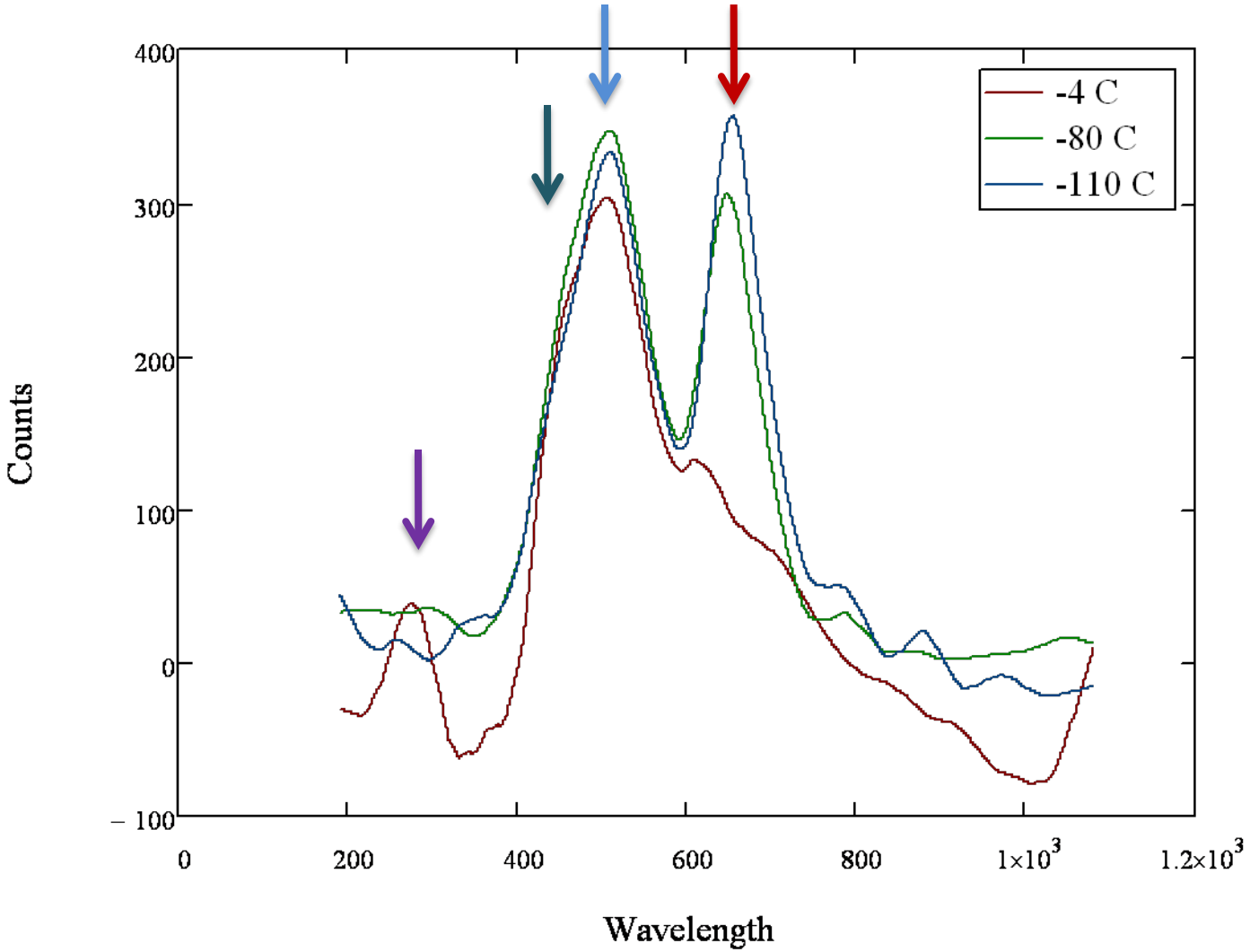
-80 C

-110 C

SLR Spectral Radiance vs Temperature

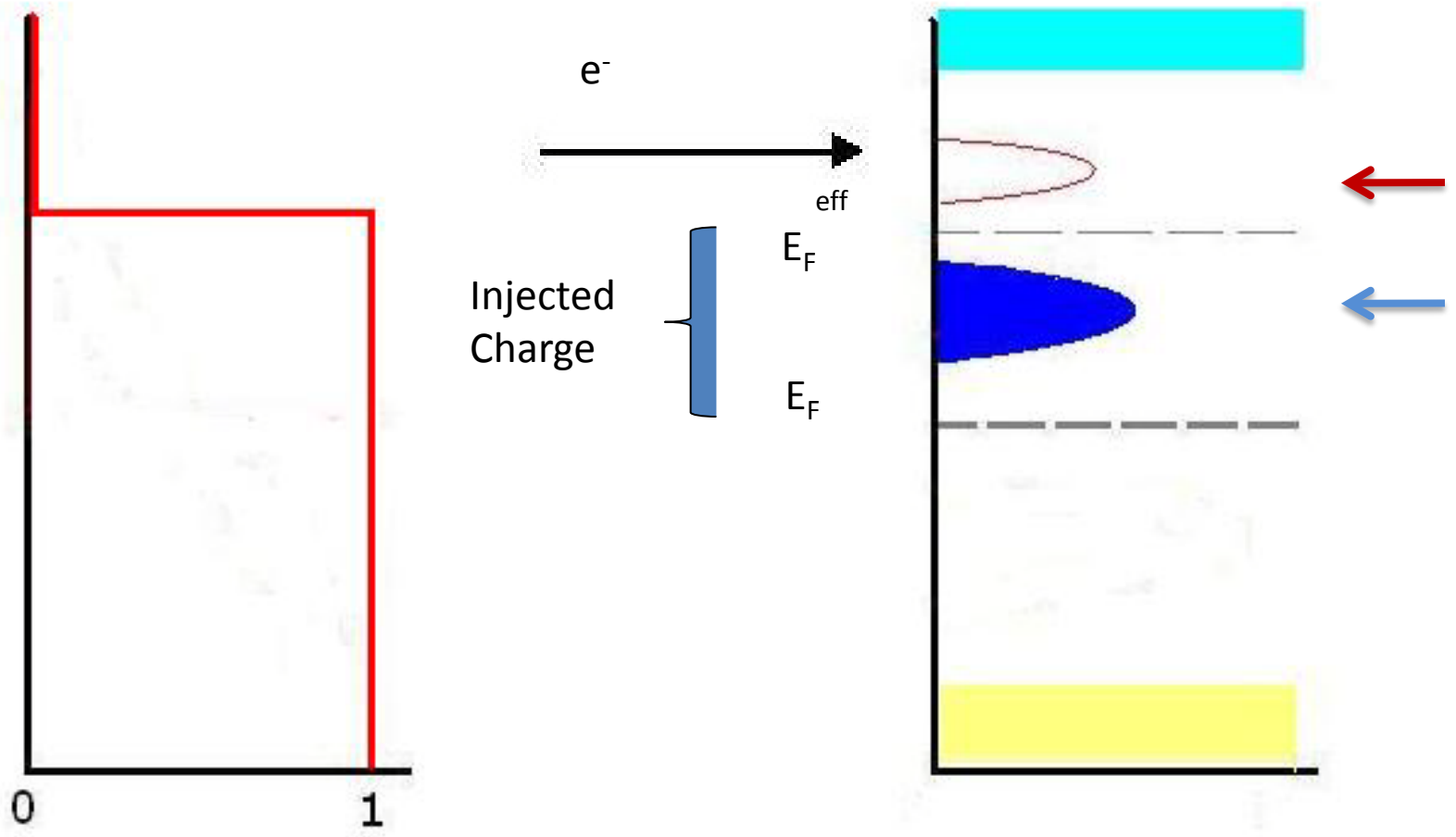


Temperature Dependent UV-Vis Spectra

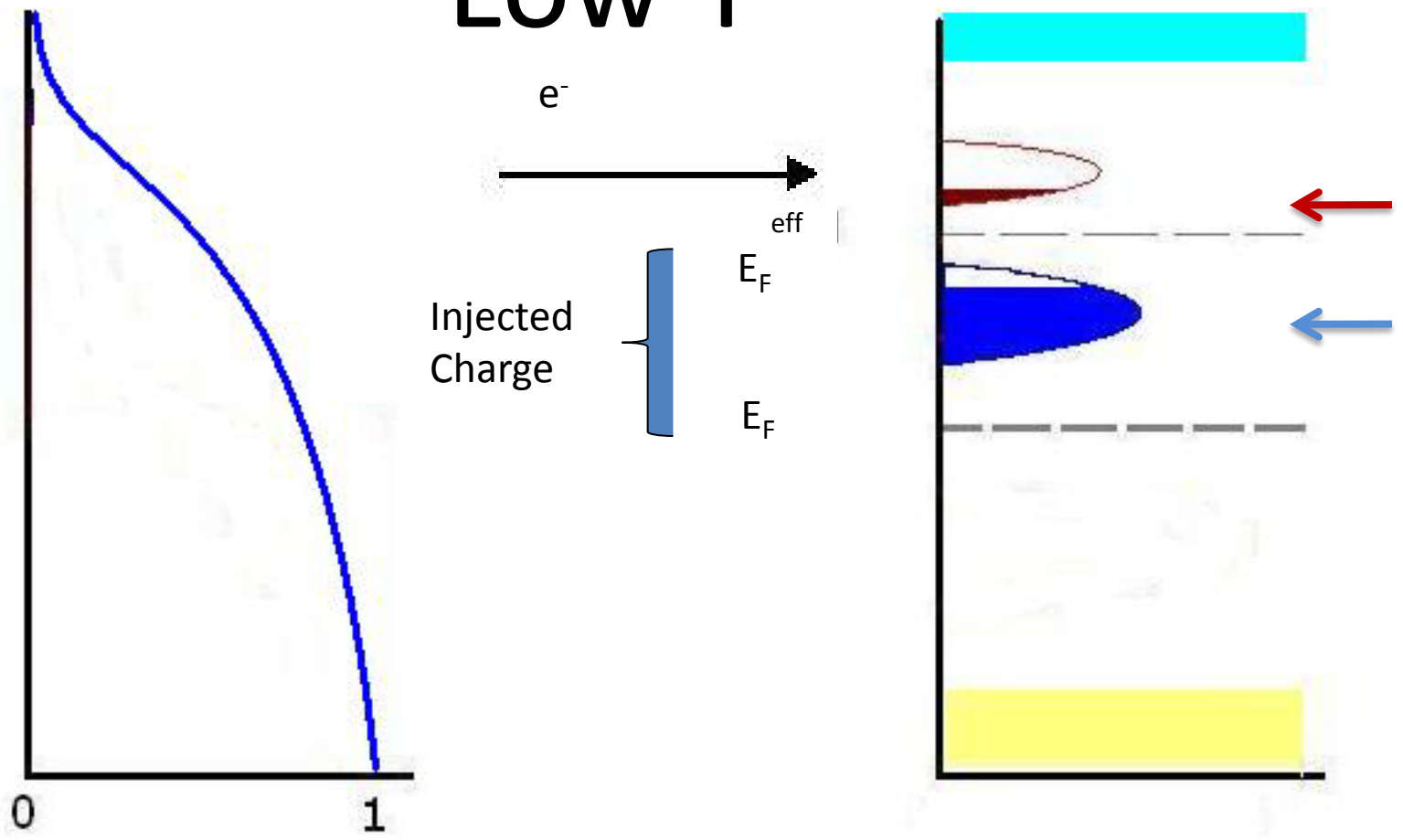


Temperature Model for Multiphonon Luminescence

T = 0

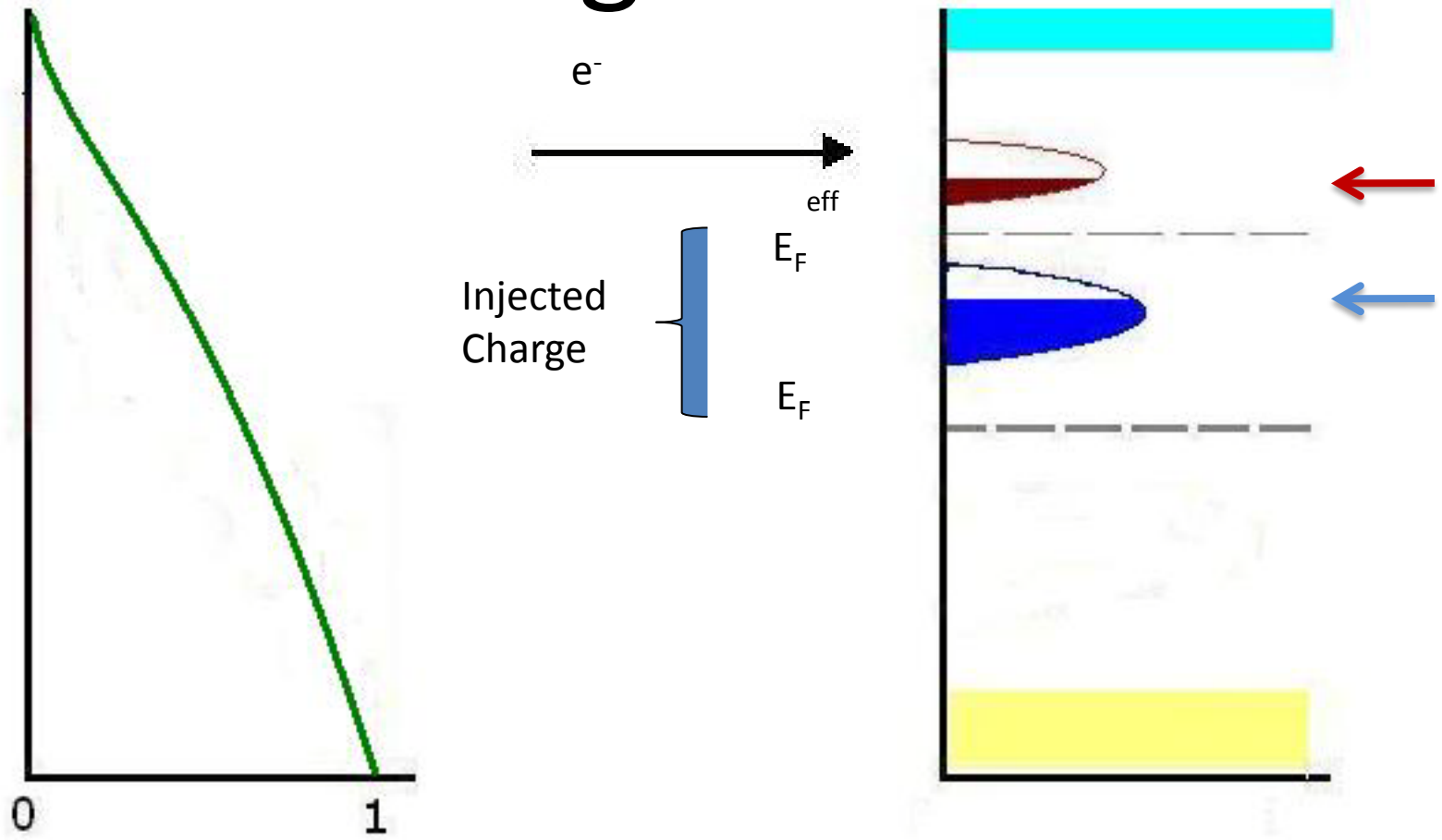


Low Temperature Model



High Temperature Model

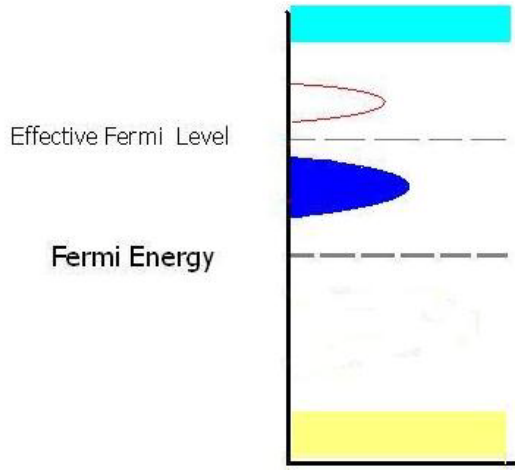
High T



Luminescence: Conclusions

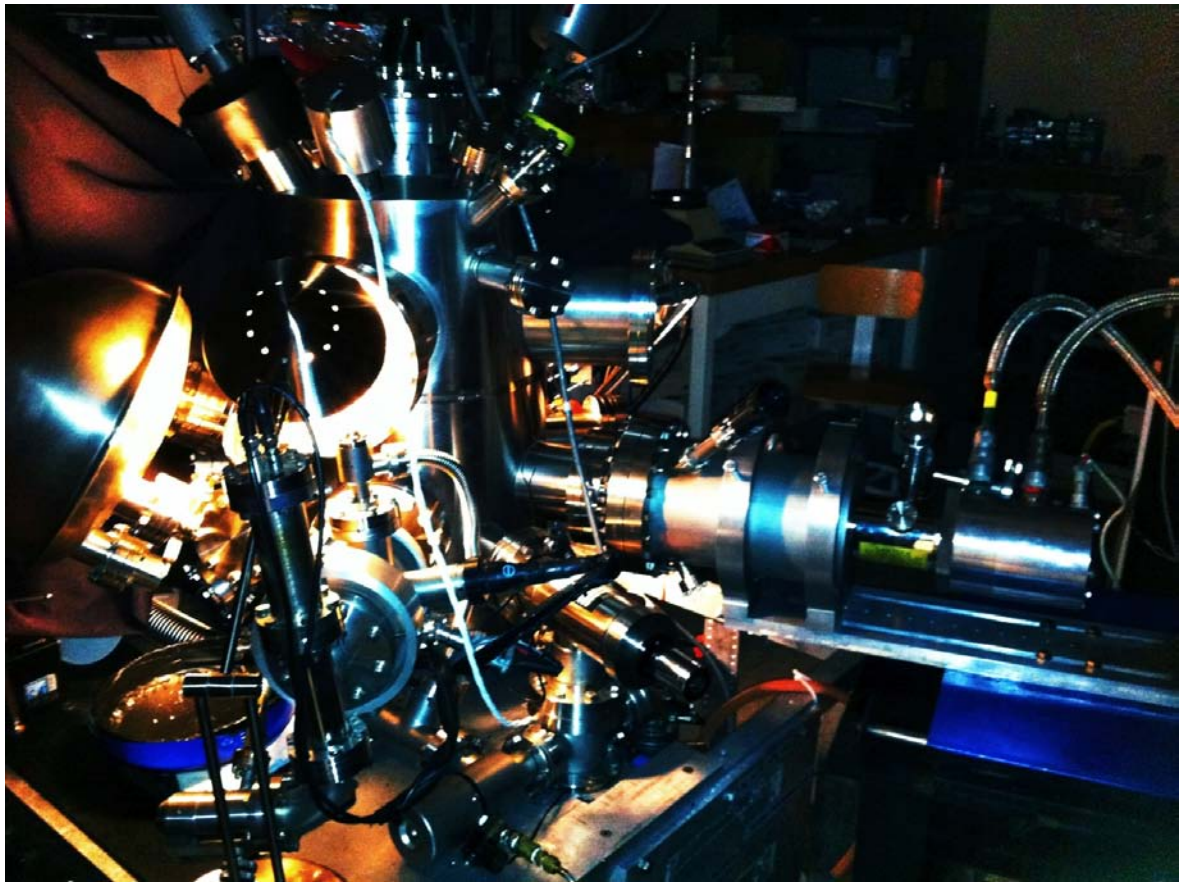
Color of Electron-Induced Luminescence

Temperature (K)	Gaussian Energy State		
	Blue	Red	
0	→0	→max	
Low	in between	in between	
High	→half max	→half max	



- Identify specific defect mechanisms
- Quantify luminescence intensities, peak positions, and peak shifts with T
- Study initial time dependence as traps fill to E_f^{eff}
- Make lower T (<30 K) and higher (<400 K) T measurements

Future Work



Acknowledgement
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