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Frequency Dependence of Modulated Surface Photovoltage (SPV) to Characterize Surface Defects

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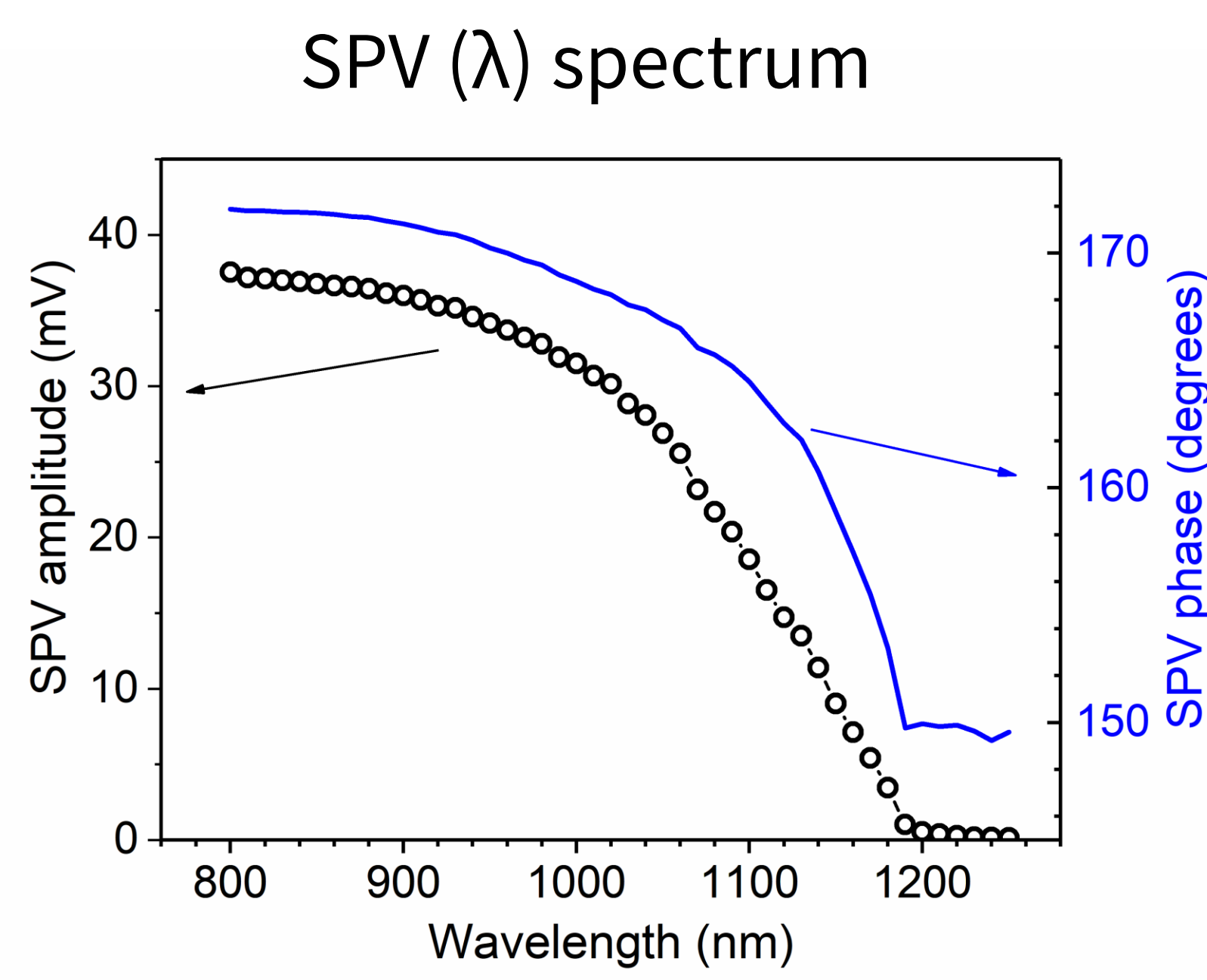
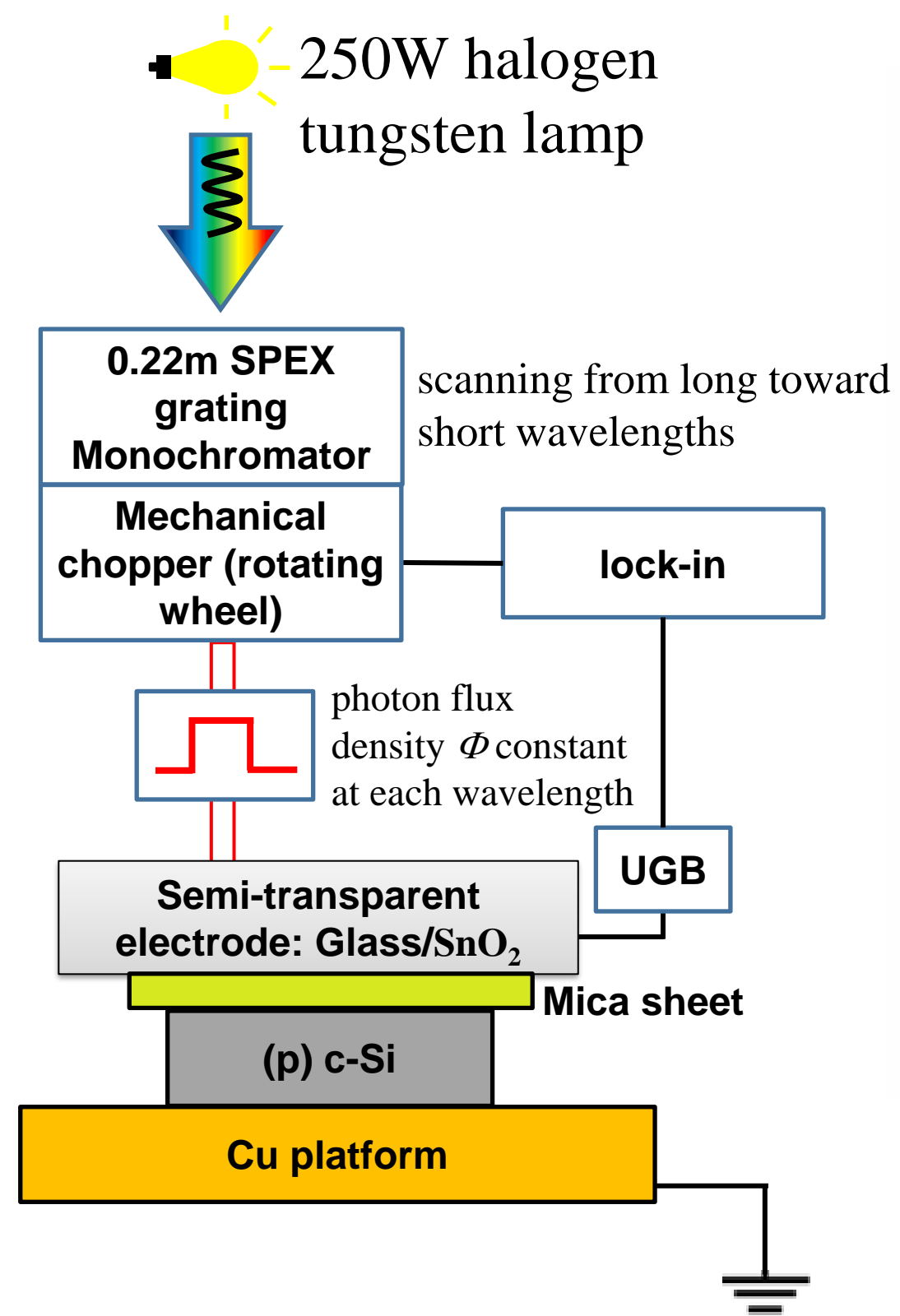
**40th EU Photovoltaic Solar Energy
Conference and Exhibition
Lisbon – September 2023**

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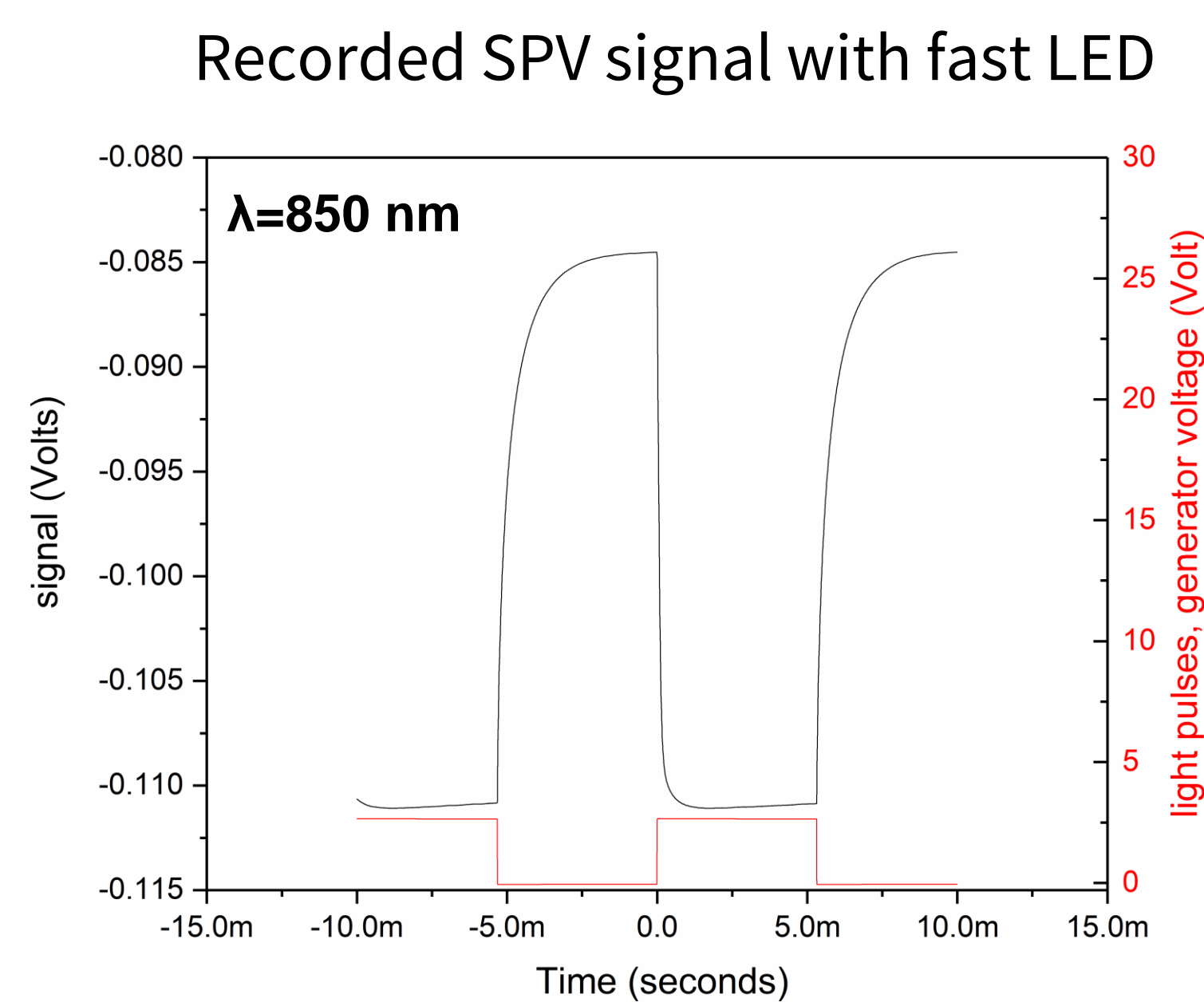
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Frequency Dependence of Modulated Surface Photovoltage (SPV) to Characterize Surface Defects

The Metal-insulator-semiconductor SPV experiment

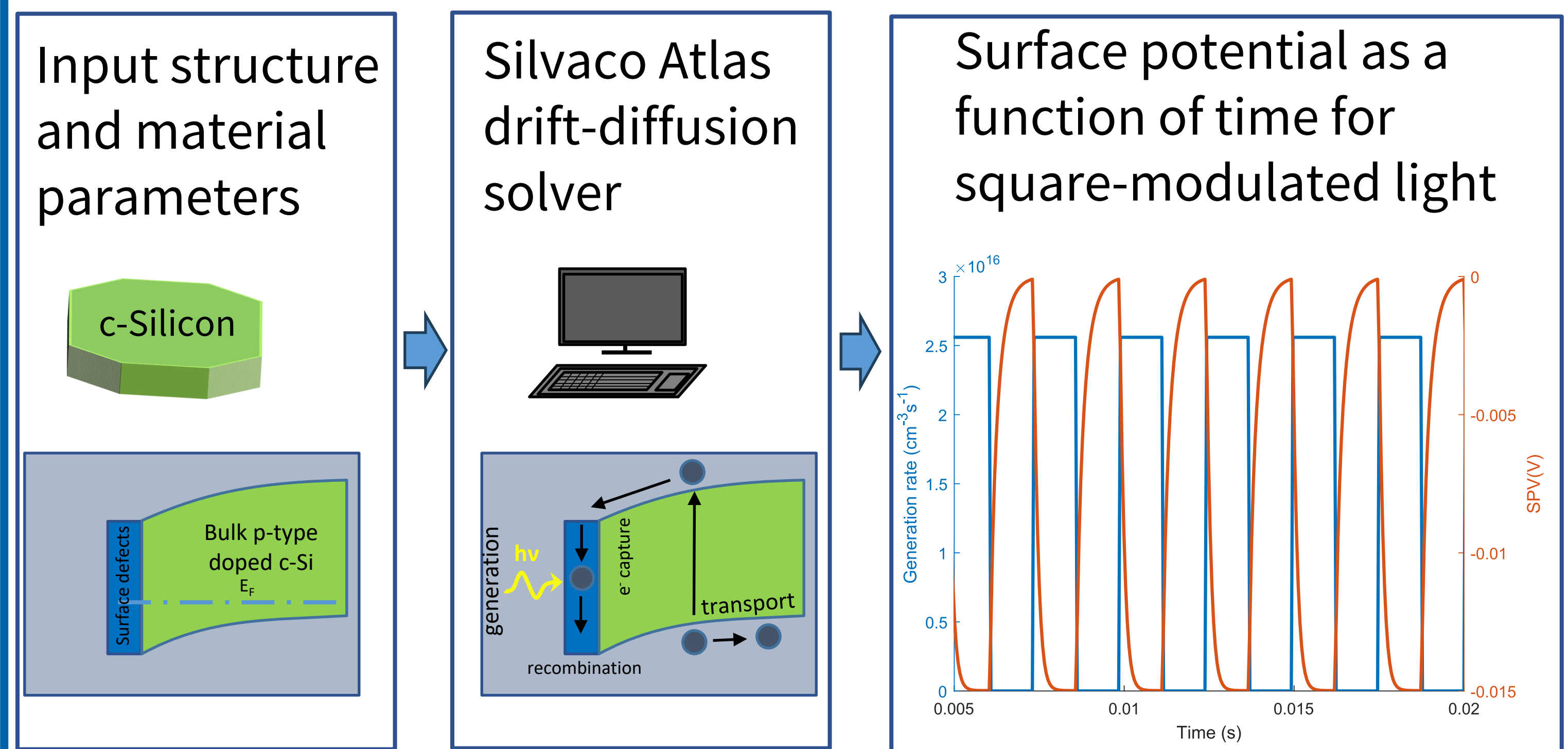


SPV = the illumination-induced change in the surface potential $\Delta V_s = V_s^{light} - V_s^{dark}$ as a result of the spatial separation of the photogenerated electrons and holes, for instance driven by the built-in electrical field in the surface space charge region of the semiconductor.

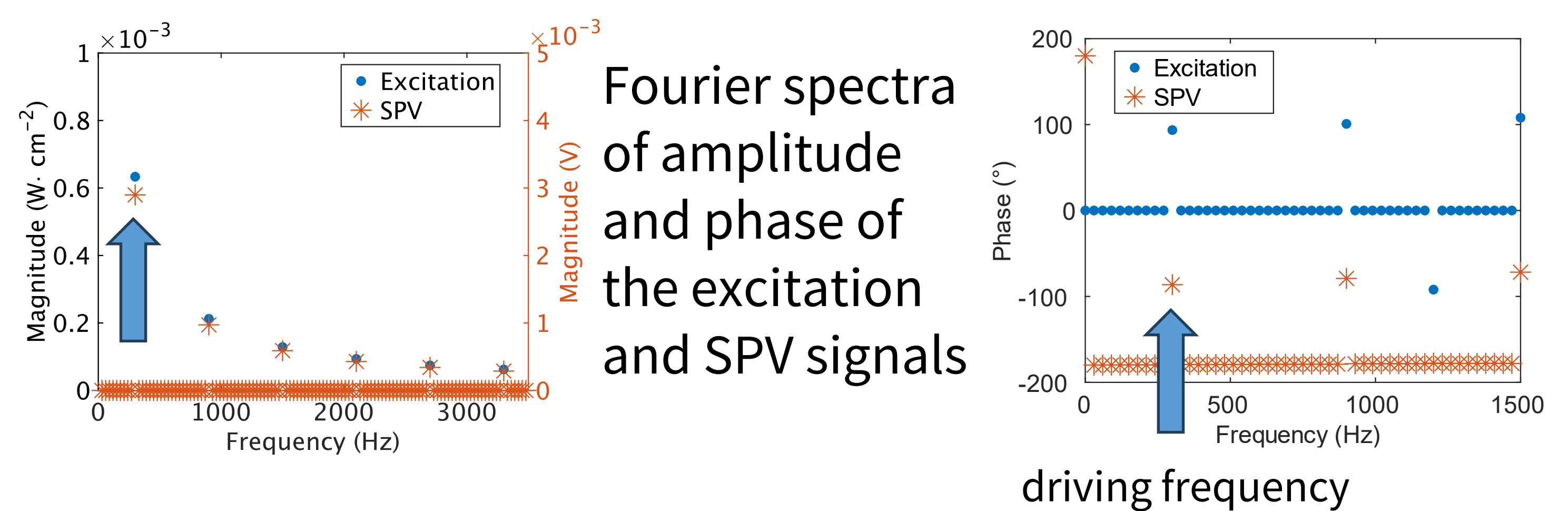


When the structure is illuminated with chopped light, the periodic changes of V_s due to the photovoltaic effect induce a periodic voltage between the capacitor plates (SnO_2 electrode and Cu platform). This voltage is fed to a high-impedance unity gain buffer (UGB) and measured by a lock-in amplifier (SR830) that extracts amplitude and phase of the fundamental frequency.

Modulated SPV simulations

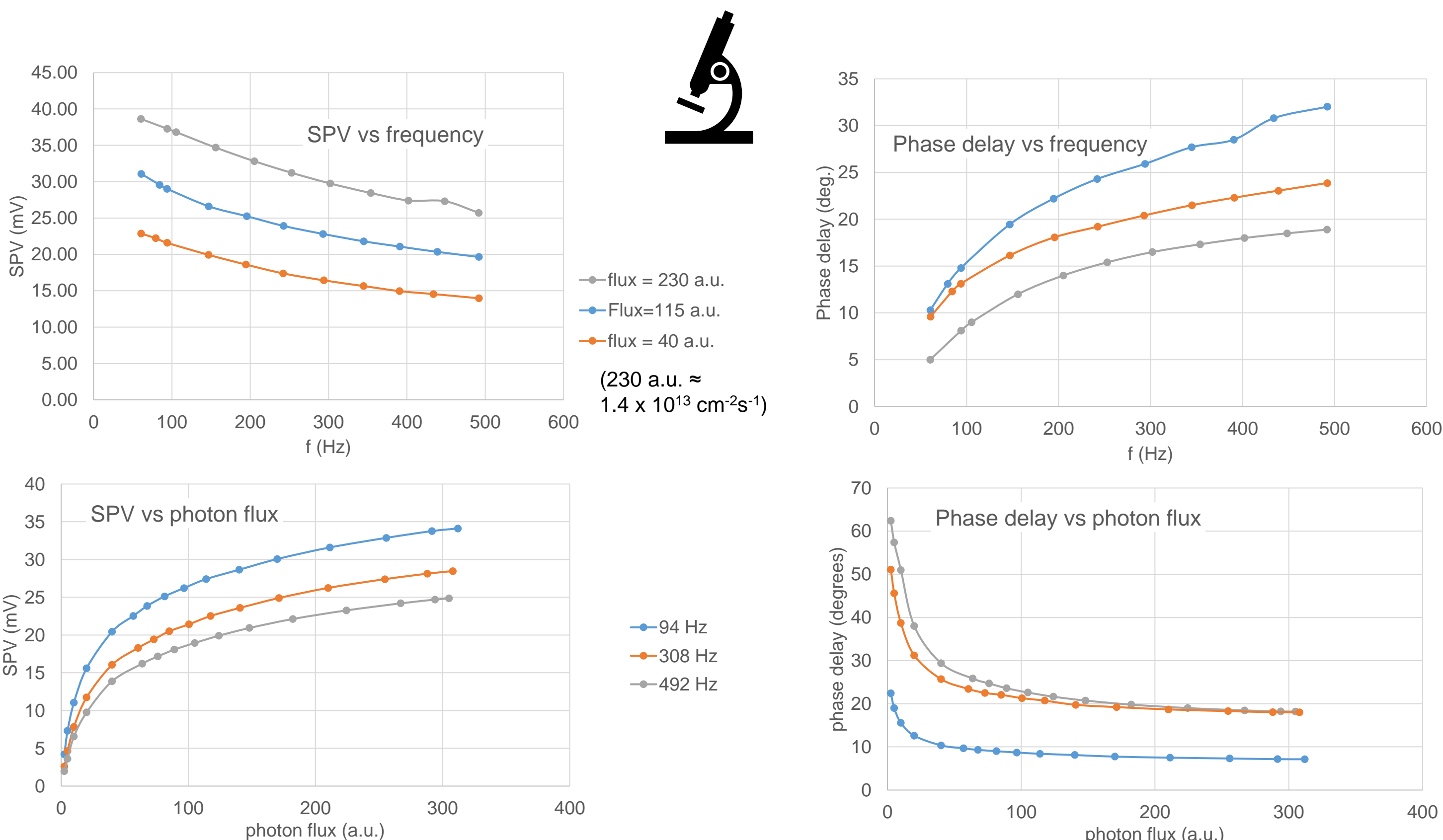


Silvaco Fast-Fourier Transform method



Extract the SPV amplitude and phase at the fundamental frequency (1st harmonic)

Frequency and flux dependence of SPV



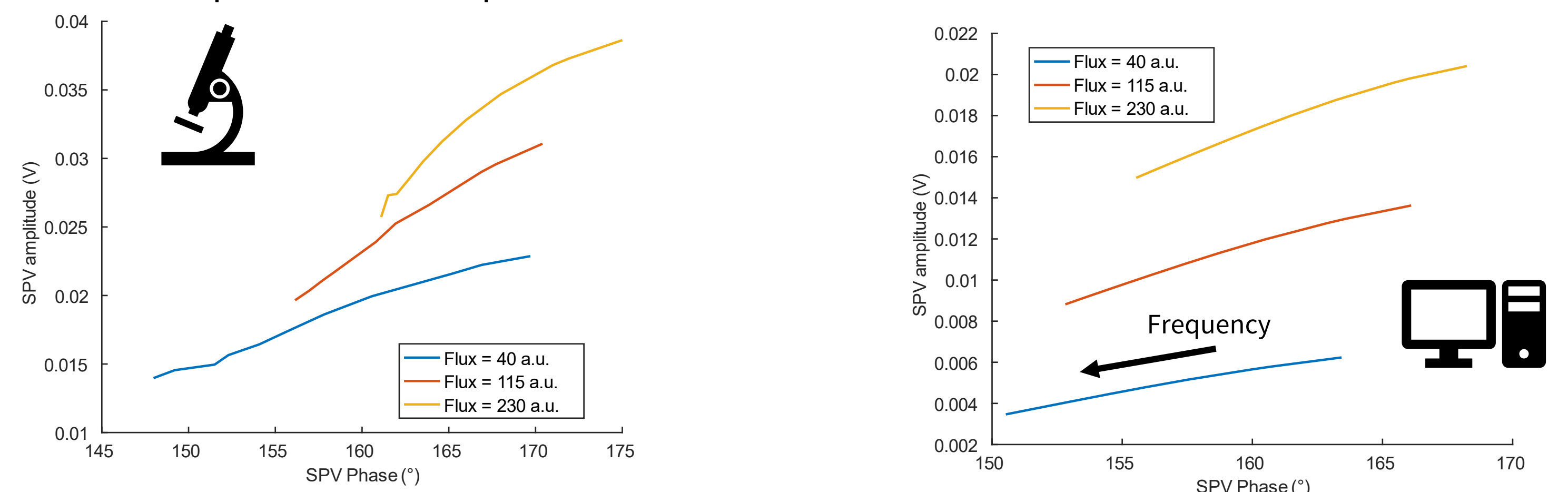
Interpretation with the DD model

The model reproduces the measured surface defect density of states across the Si bandgap

Amplitude/Phase curves experiment vs model:

Similar trends were achieved by varying p-doping, defect density, and capture cross-sections.

Other defect distributions could lead to a better reproduction of experimental data



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