2018

Incorporating Electron Range Approximations into Secondary Electron Emission Models

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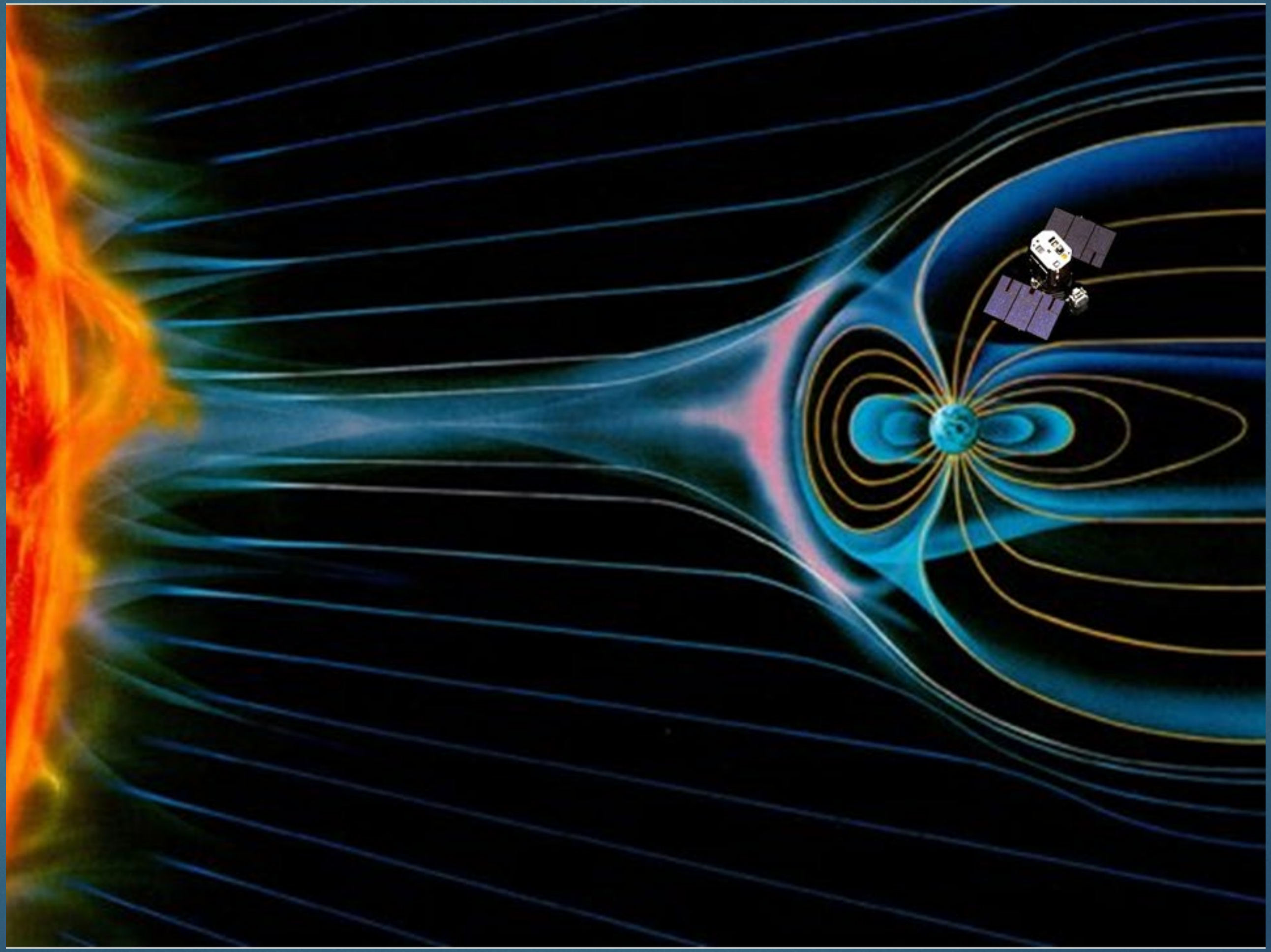
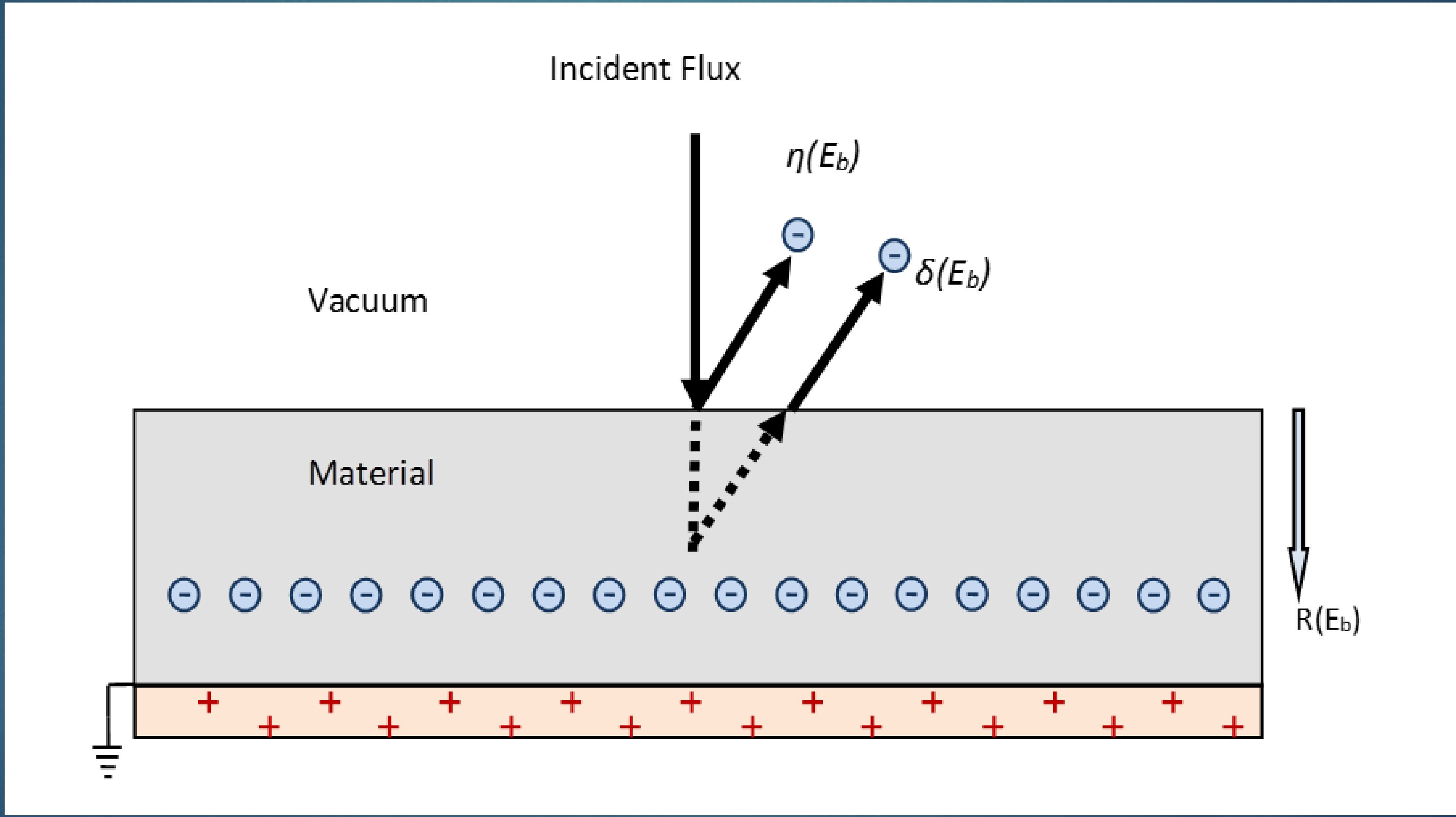
Motivation



Electron Interactions with Material



Electron Range Models

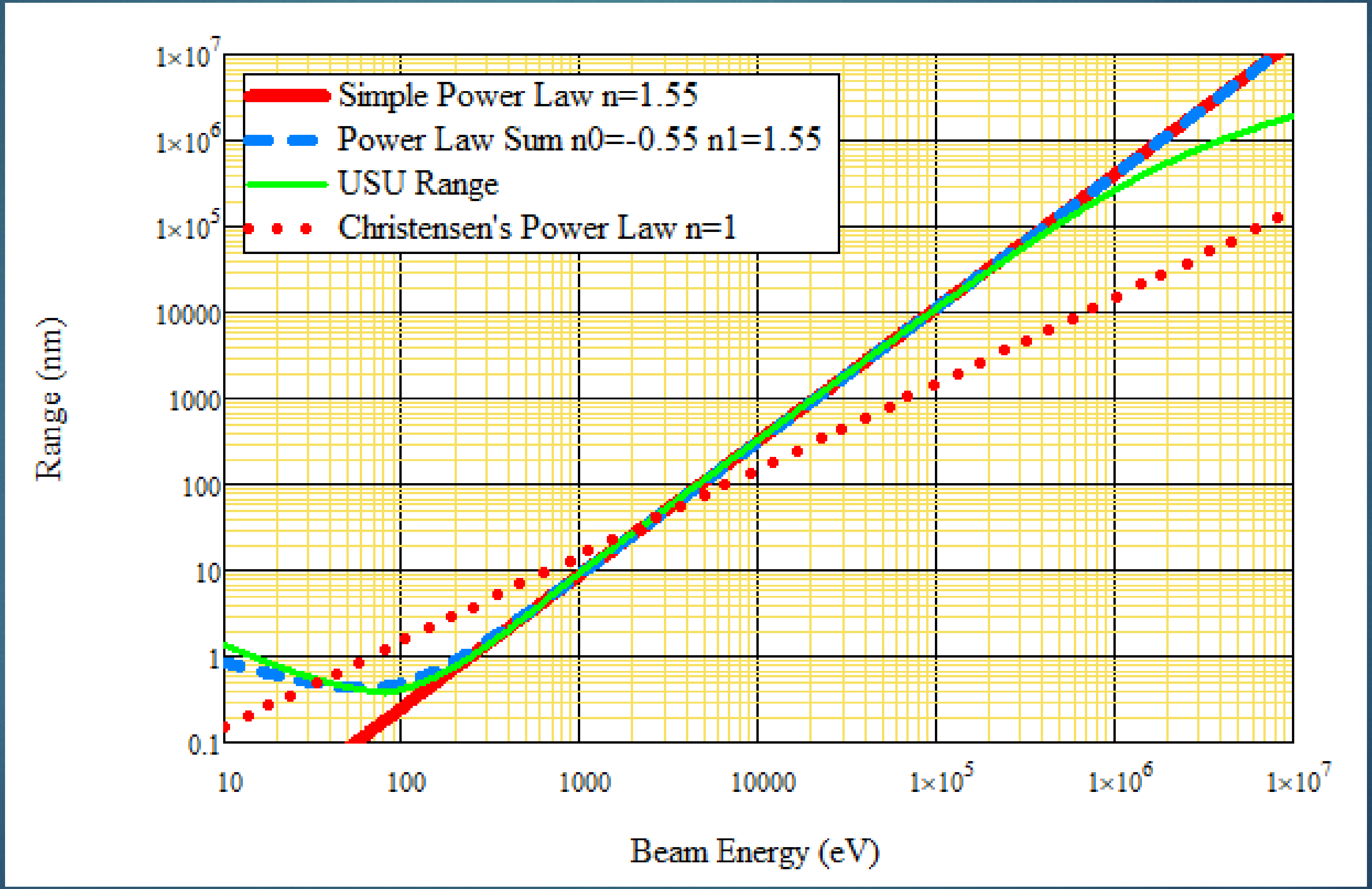
- $R(E, b, n) = bE^n$

- $R(E, b_1, b_2, n_1, n_2) = b_1 E^{n_1} + b_2 E^{n_2}$

Electron Range Models

- $$R\left(E_b; N_v^{eff}\right) = \begin{cases} \left[\frac{E_b}{\overline{E}}\right] \lambda_{\mathrm{IMFP}}\left(\overline{E}\right) \left(\frac{1-e^{-\overline{E}/\overline{E}}}{1-e^{-E_b/\overline{E}}}\right)^2 & \text{if } E_b < \overline{E} \\ \left[\frac{E_b}{\overline{E}}\right] \lambda_{\mathrm{IMFP}}\left(E_b\right) \left(\frac{1-e^{-\overline{E}/\overline{E}}}{1-e^{-E_b/\overline{E}}}\right) & \text{if } \overline{E} \le E_b \le E_{\mathrm{HI}} \\ b\, E_b^n \left[1 - \left[1 + \left(\frac{Z^{0.39} E_b}{3N_v^{eff} m_e c^2}\right)\right]^{-2}\right] & \text{if } E_b > E_{\mathrm{HI}} \end{cases}$$

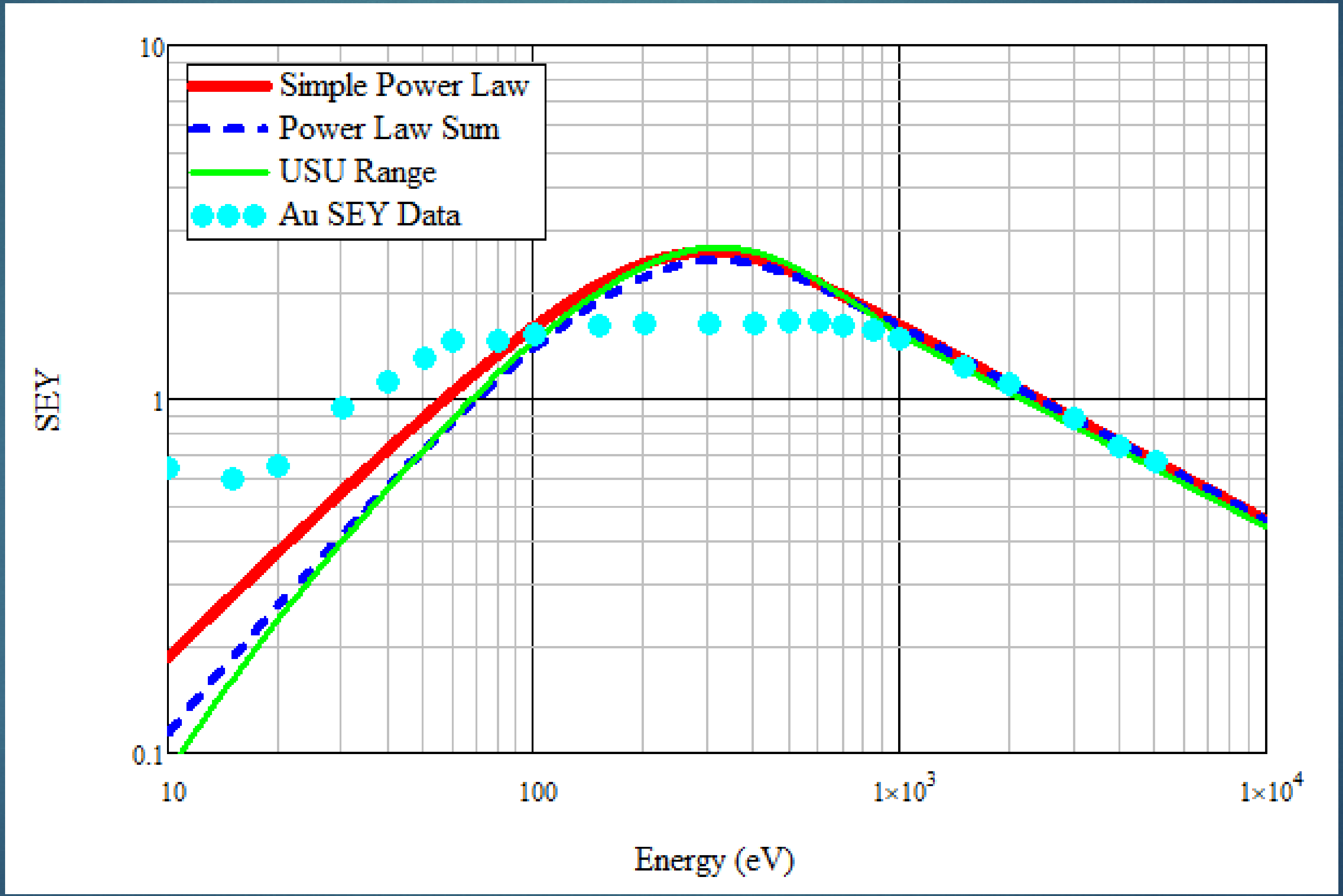
Electron Range



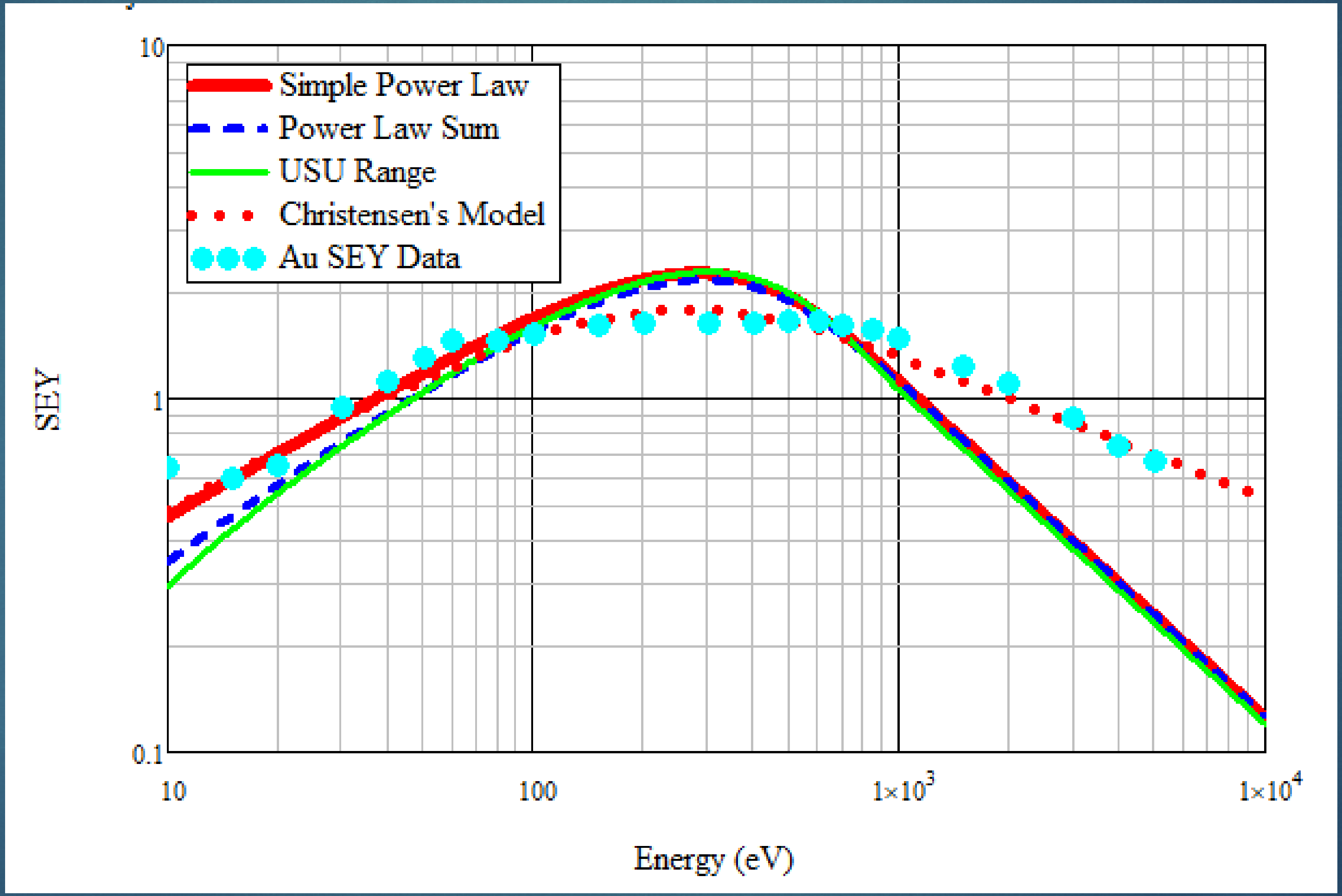
Secondary Electron Yield

- $\delta(E_b) = \frac{\beta\lambda_{SE}}{2b\epsilon_m} E_b^{1-n}\left(1 - e^{-\frac{bE_b^n}{\lambda_{SE}}}\right)$
- $\delta(E_b) = \frac{\beta\lambda_{SE}}{2(b_1E^{n_1}+b_2E^{n_2})}\frac{E_b}{\epsilon_m}\left(1 - e^{-\frac{b_1E^{n_1}+b_2E^{n_2}}{\lambda_{SE}}}\right)$
- $\delta(E_b) = \frac{\beta\lambda_{SE}}{2R(E_b)}\frac{E_b}{\epsilon_m}\left(1 - e^{-\frac{R(E_b)}{\lambda_{SE}}}\right)$

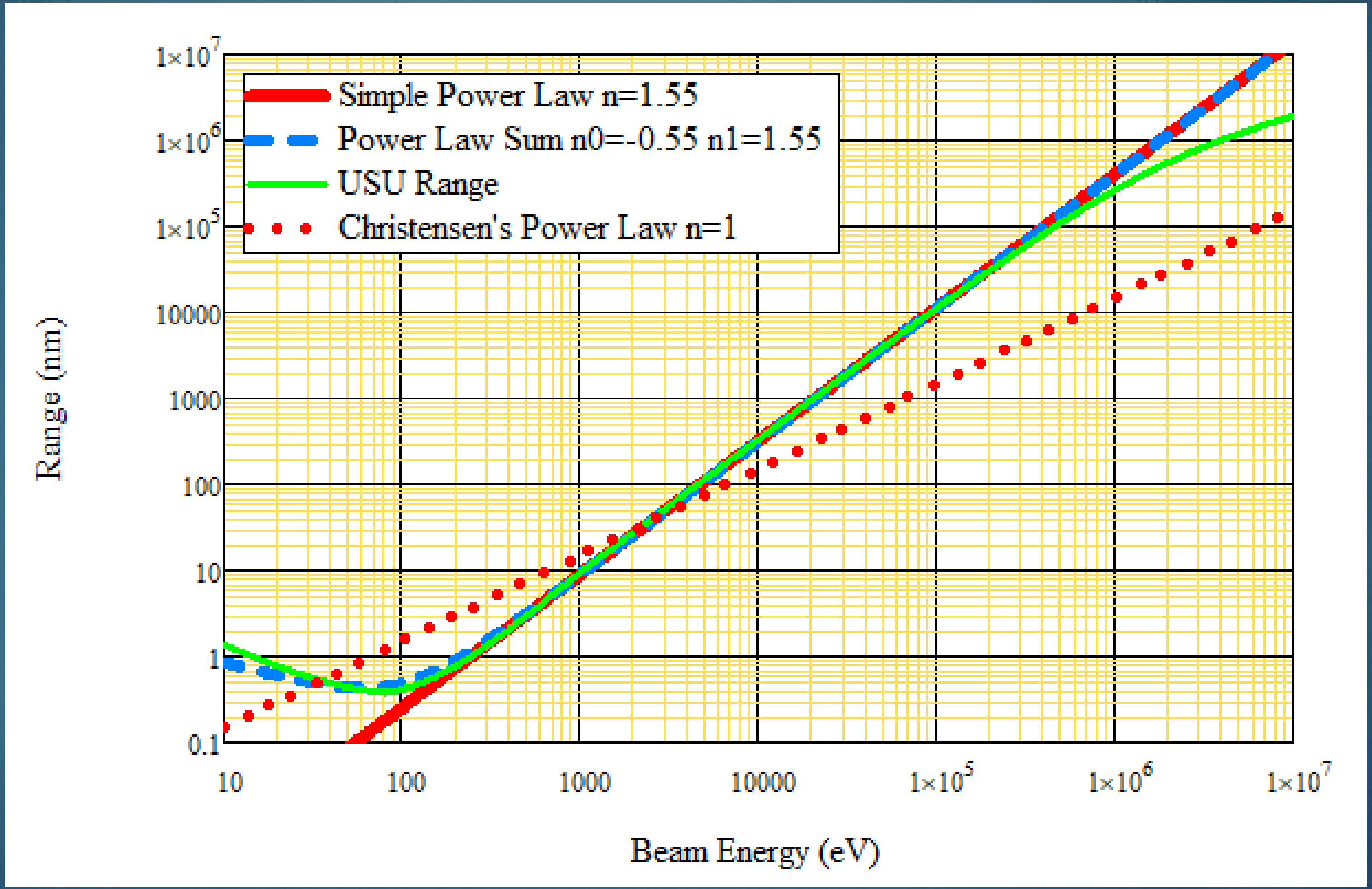
Secondary Electron Yield Models



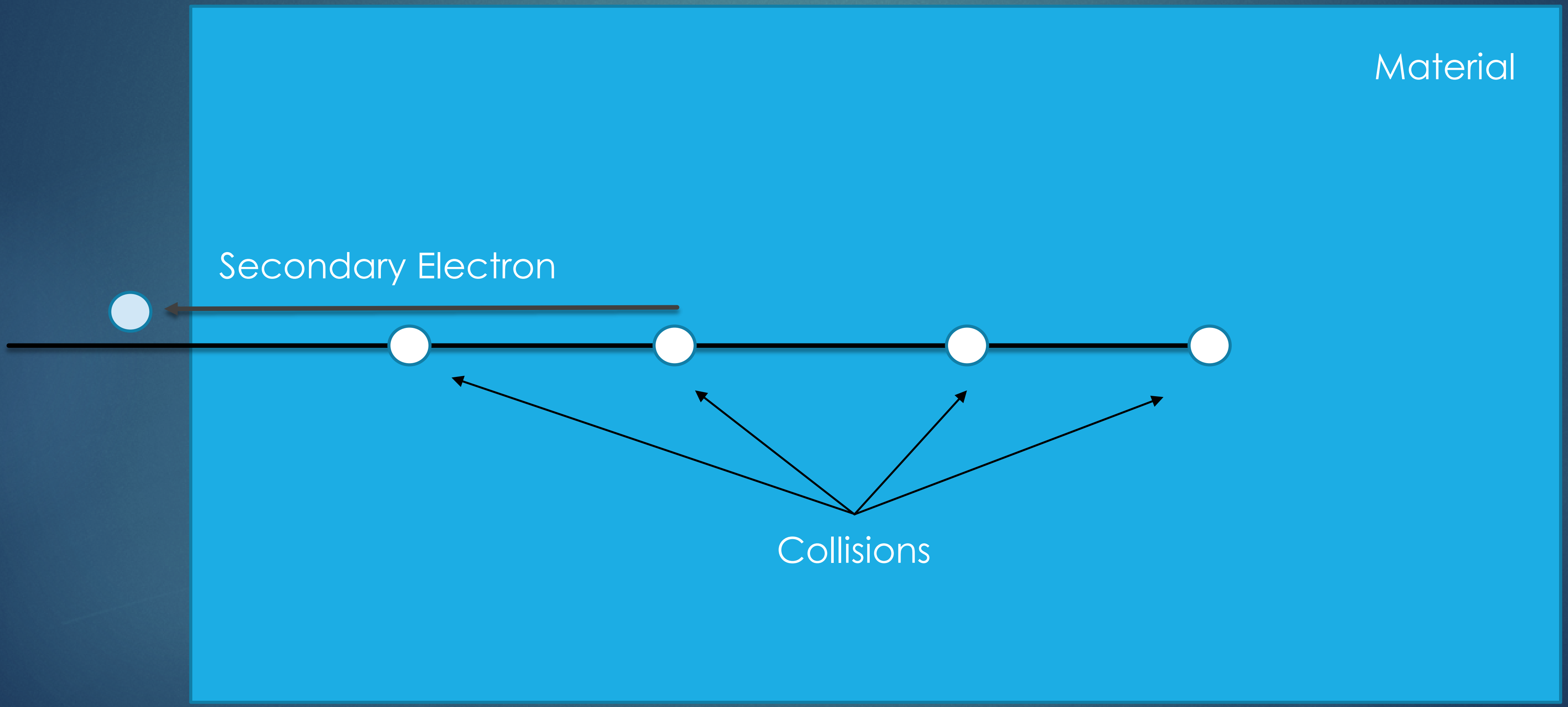
Secondary Electron Yield Models



Electron Range



Discrete Collision Yield Model



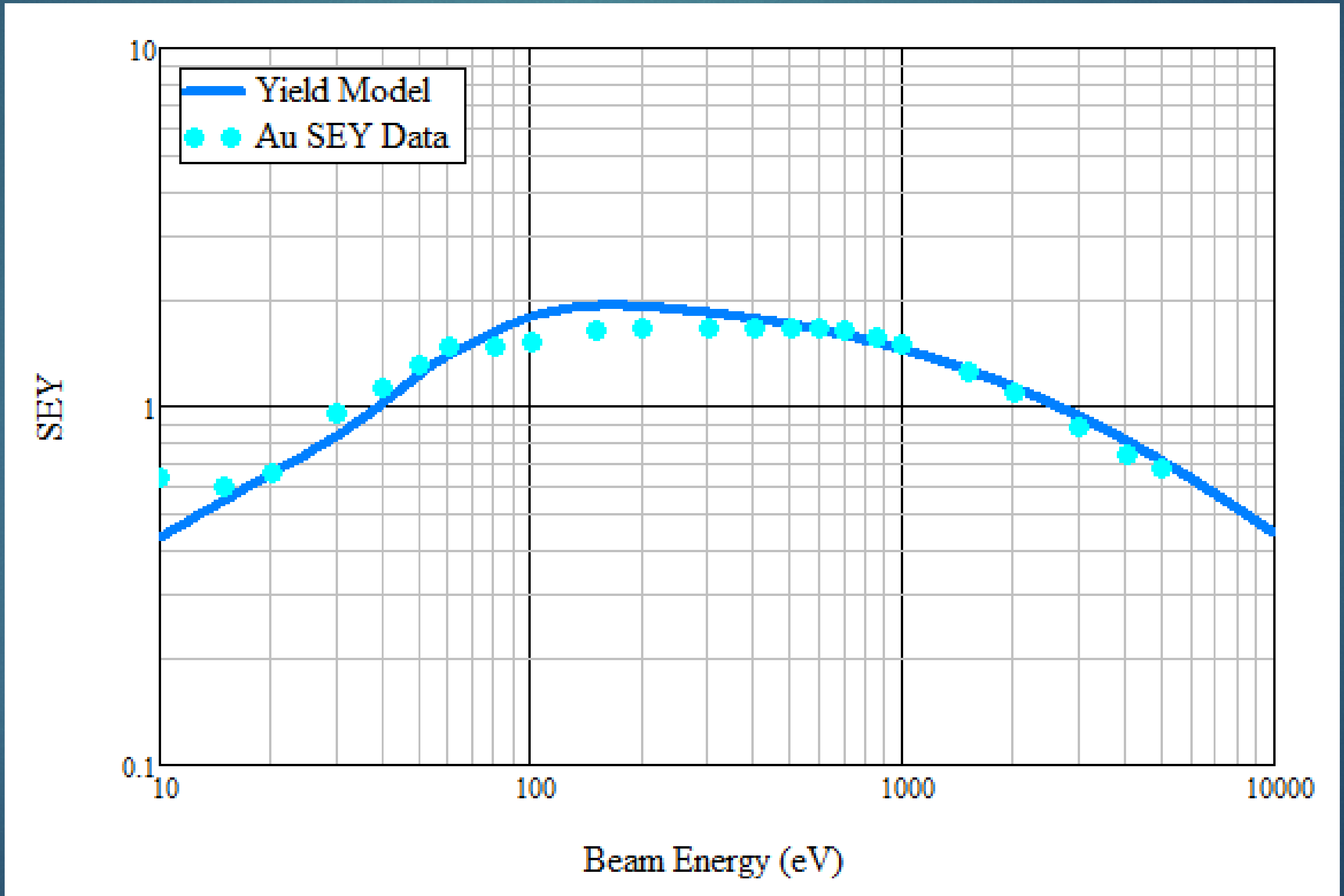
Discrete Collision Yield Model

- $\delta(E_b) = \int_0^{R(E_b)} n\,(z, E_b) P(z) dz$

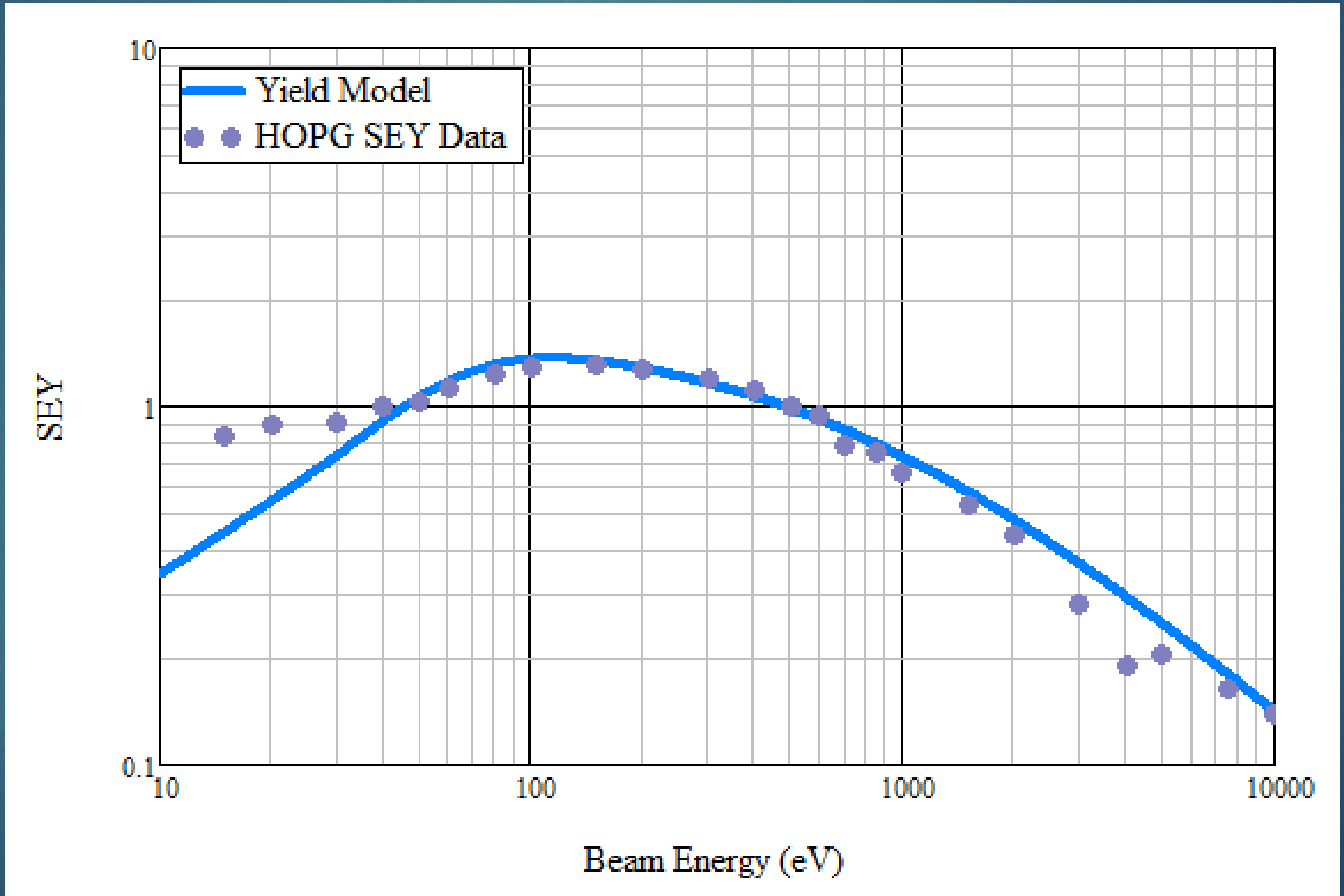
Probability of Secondary Creation

Probability of Secondary Emission

Secondary Electron Yield Model for Au



Secondary Electron Yield Model for HOPG



Conclusion

- Electron Emission Models → Spacecraft Charging Models
- Range Models → Electron Emission Models
- Discrete Collisional Model → Predictive Model