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## Incorporating Electron Range Approximations into Secondary Electron Emission Models

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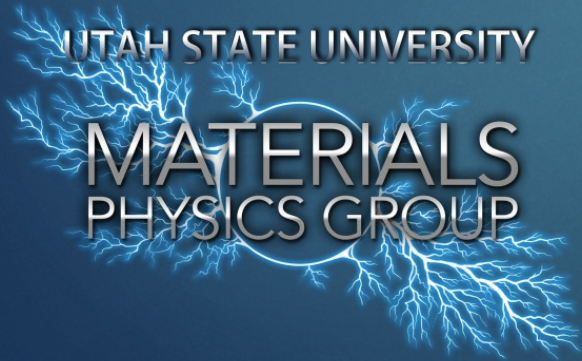
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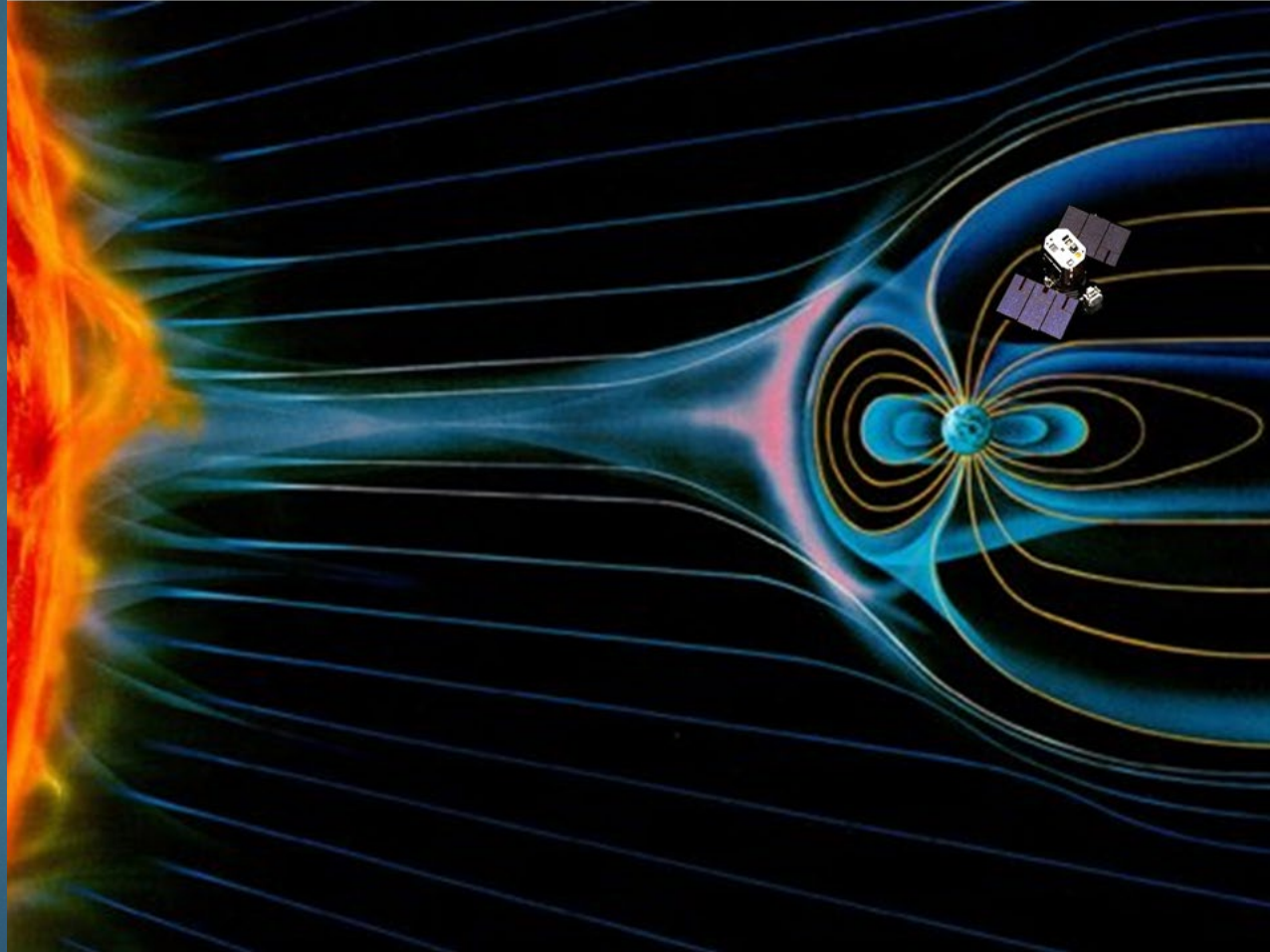
# Incorporating Electron Range Approximations into Secondary Electron Emission Models

GREGORY WILSON

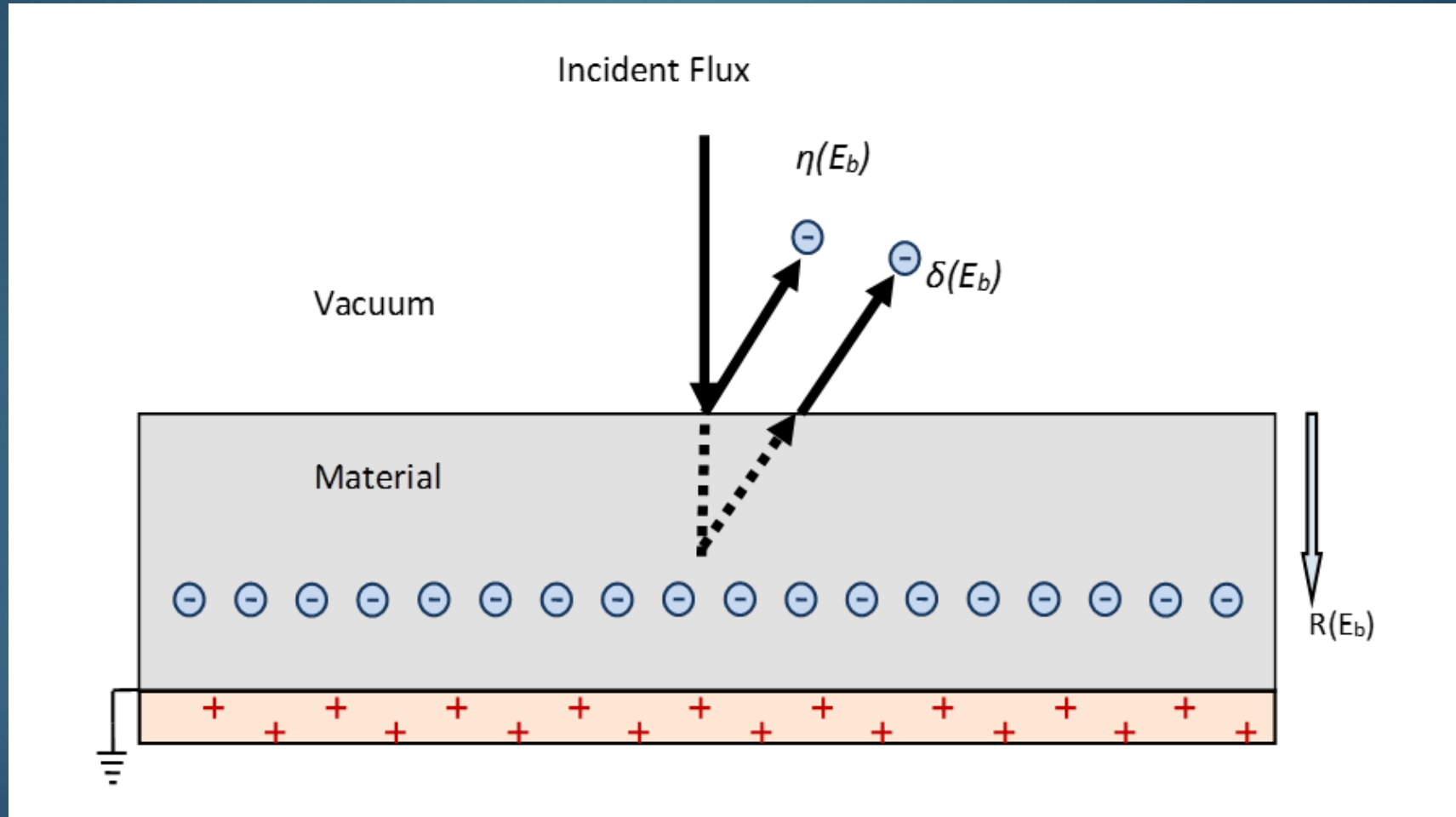




# Motivation



# Electron Interactions with Material





# Electron Range Models

- ▶  $R(E, b, n) = bE^n$

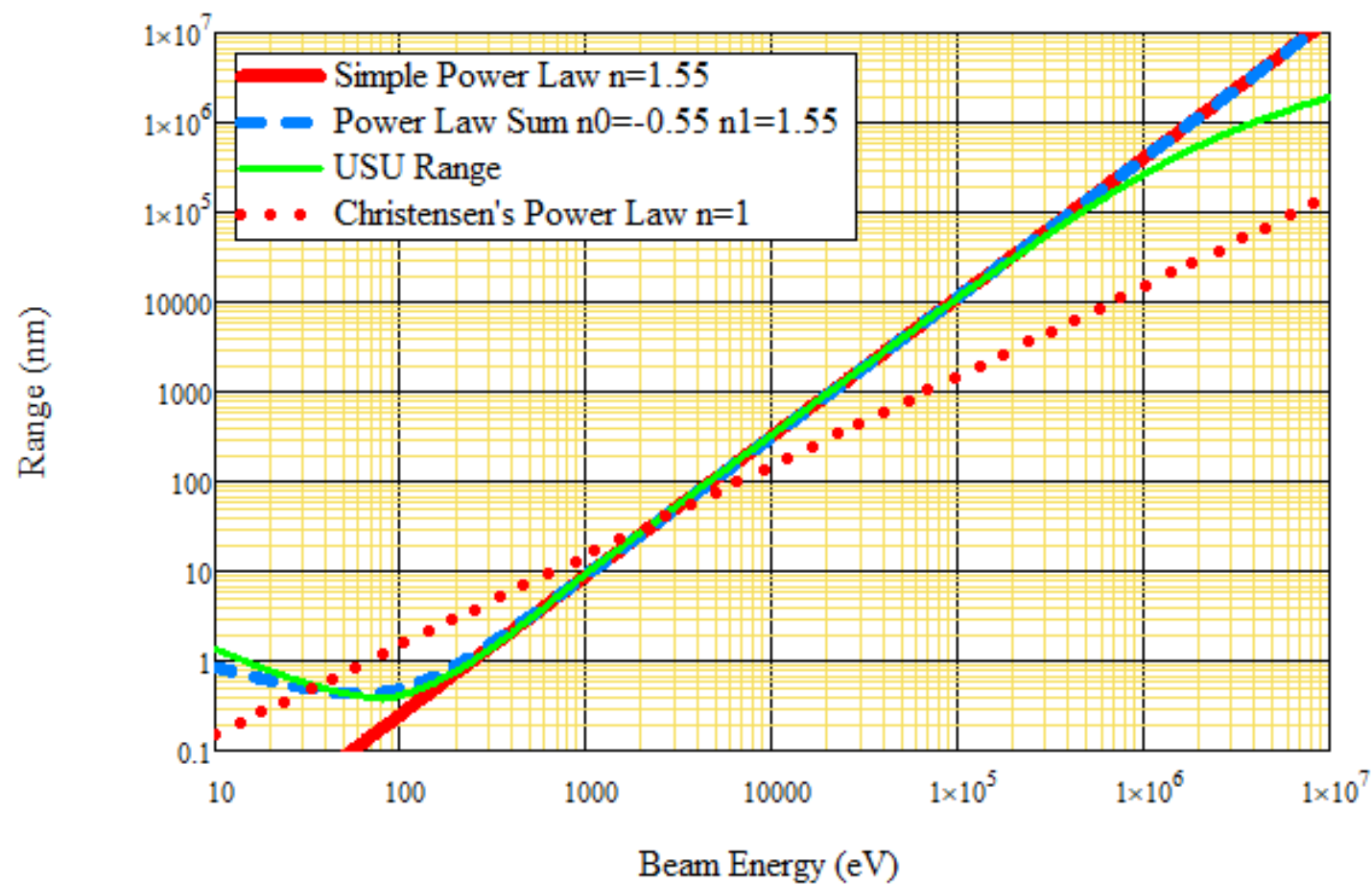
- ▶  $R(E, b_1, b_2, n_1, n_2) = b_1E^{n_1} + b_2E^{n_2}$



# Electron Range Models

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

# Electron Range





# Secondary Electron Yield

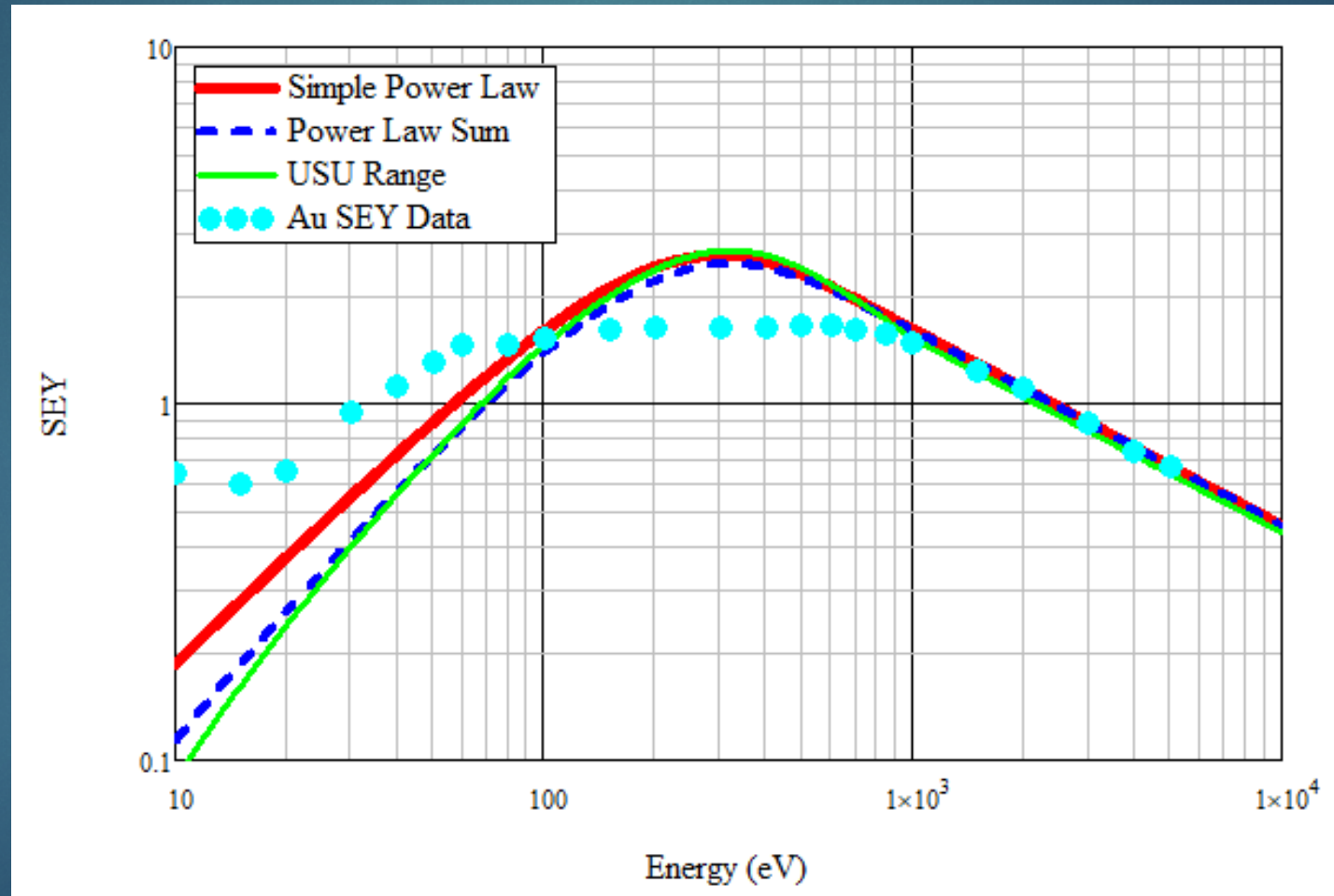
$$\text{▶ } \delta(E_b) = \frac{\beta \lambda_{SE}}{2b\epsilon_m} E_b^{1-n} \left( 1 - e^{-\frac{bE_b^n}{\lambda_{SE}}} \right)$$

$$\text{▶ } \delta(E_b) = \frac{\beta \lambda_{SE}}{2(b_1 E^{n_1} + b_2 E^{n_2})} \frac{E_b}{\epsilon_m} \left( 1 - e^{-\frac{b_1 E^{n_1} + b_2 E^{n_2}}{\lambda_{SE}}} \right)$$

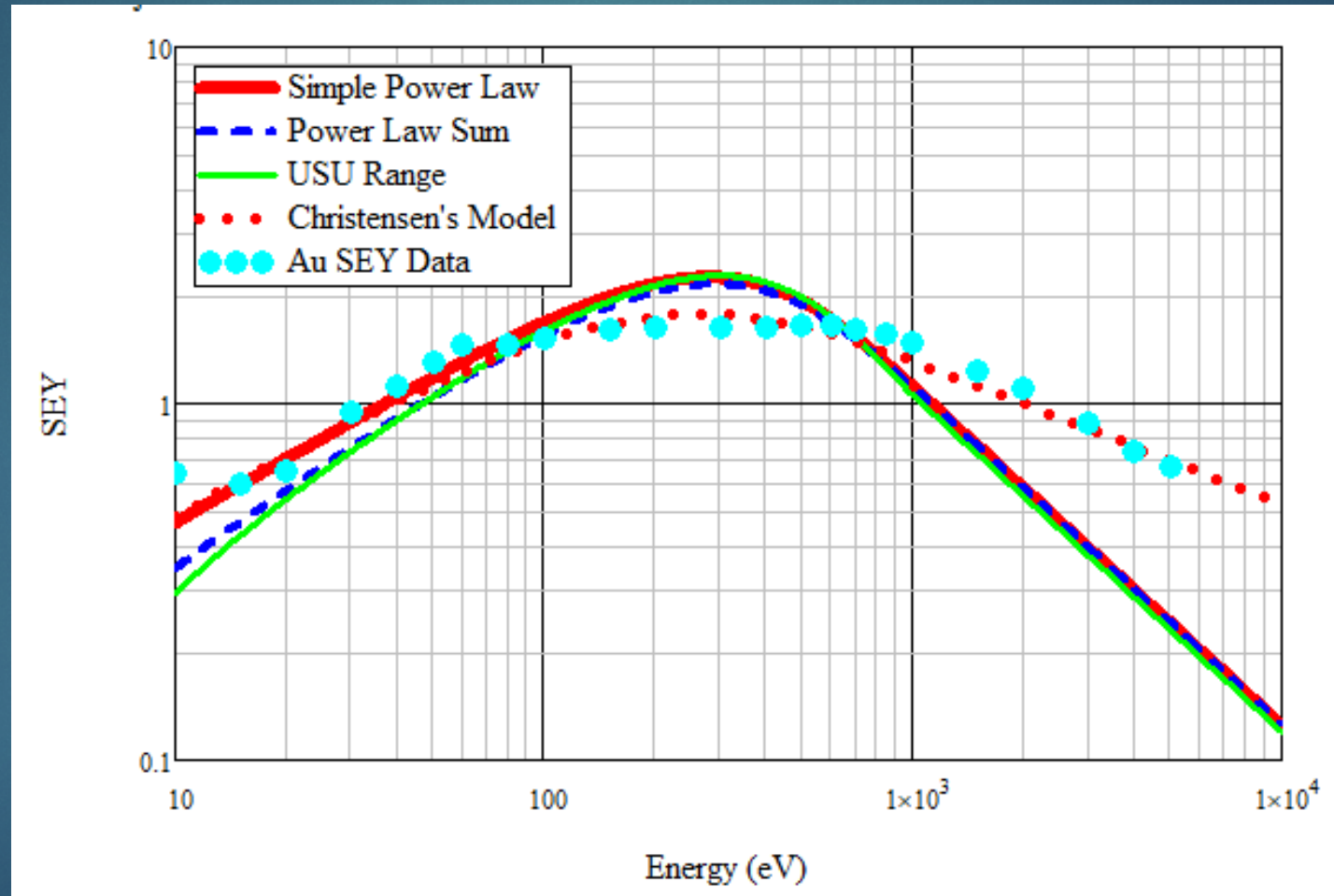
$$\text{▶ } \delta(E_b) = \frac{\beta \lambda_{SE}}{2R(E_b)} \frac{E_b}{\epsilon_m} \left( 1 - e^{-\frac{R(E_b)}{\lambda_{SE}}} \right)$$



# Secondary Electron Yield Models

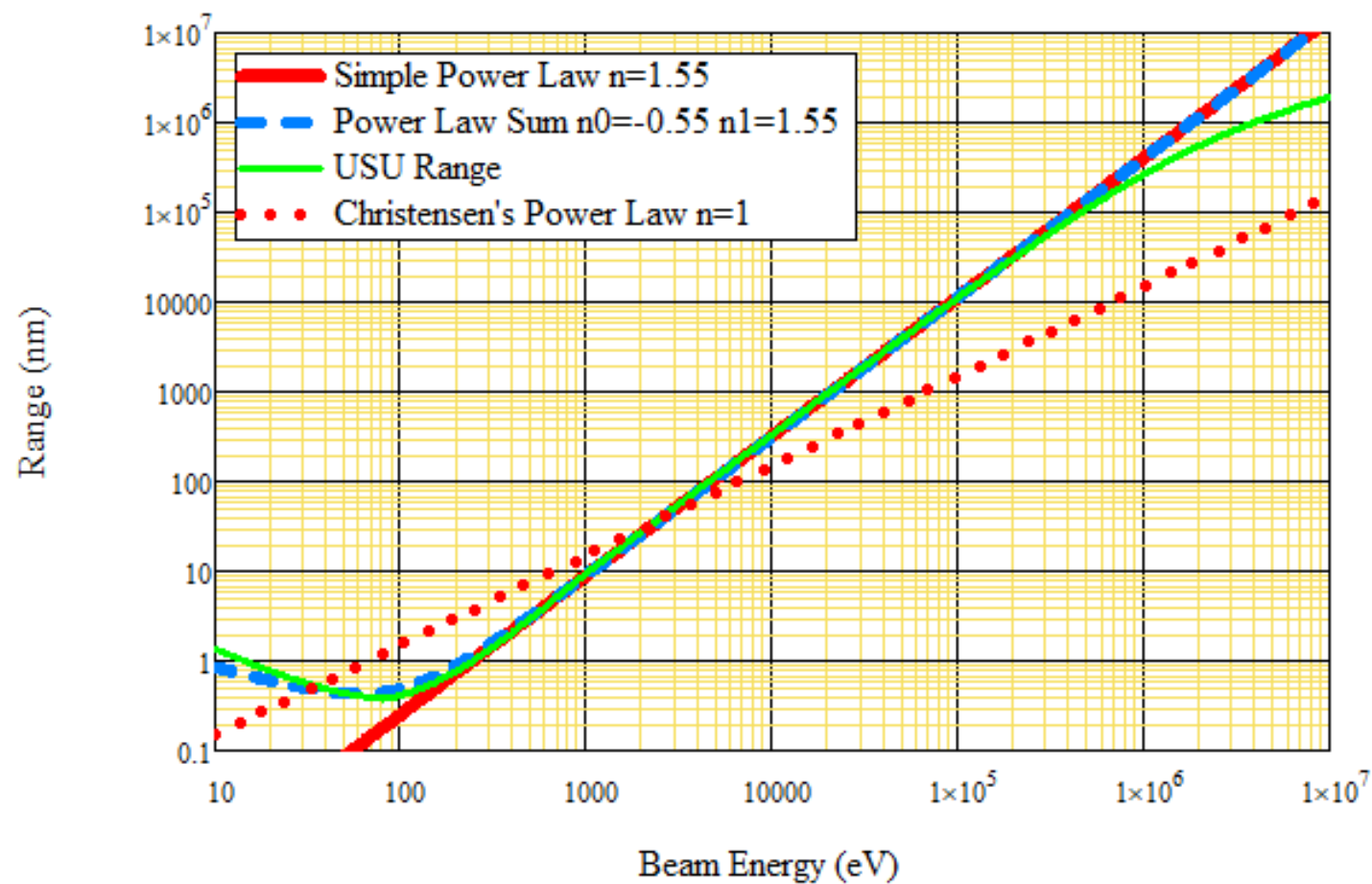


# Secondary Electron Yield Models

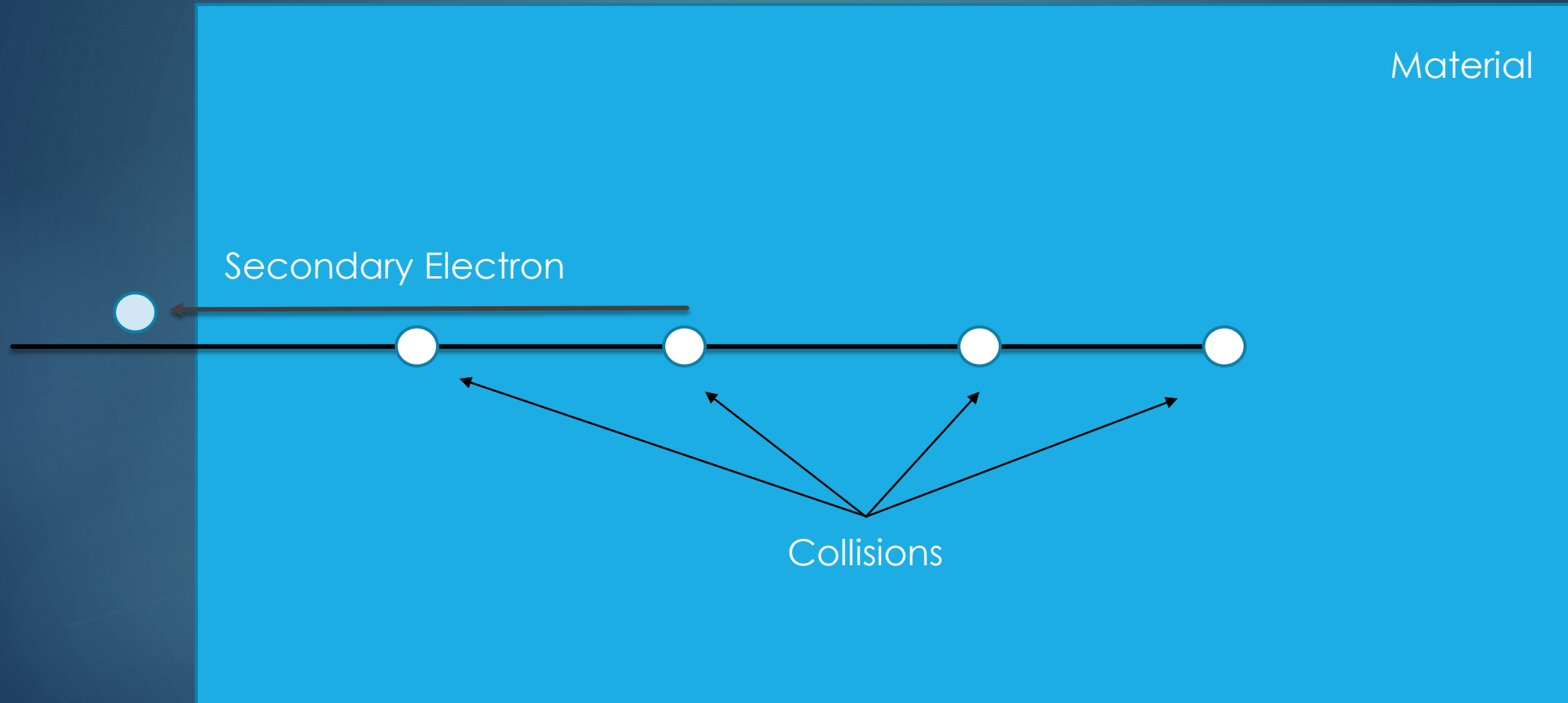




# Electron Range



# Discrete Collision Yield Model





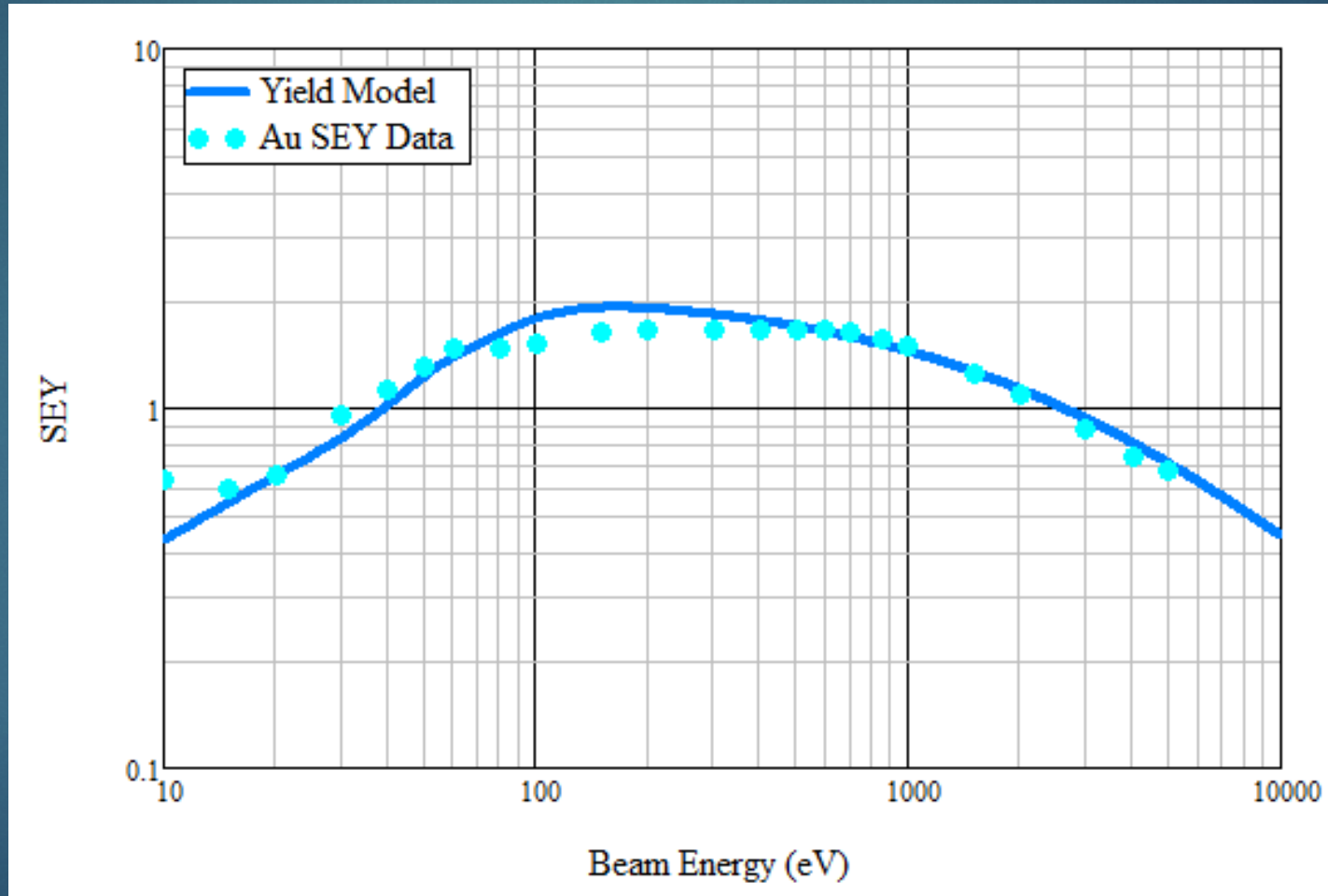
# Discrete Collision Yield Model

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

Probability of Secondary Creation

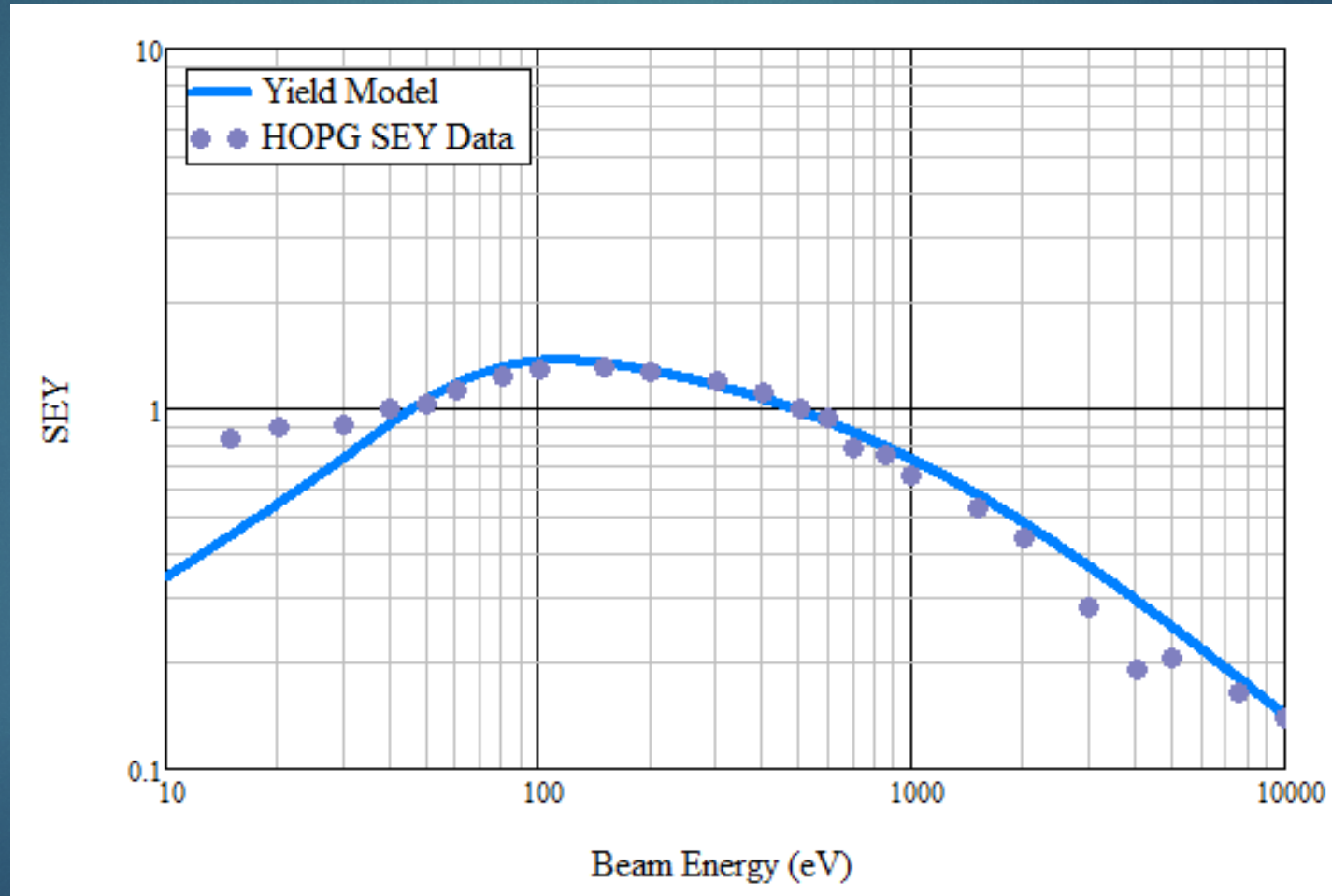
Probability of Secondary Emission

# 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