X-Ray Intensities in CASINO

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I_{CASINO} is the x-ray intensity displayed by CASINO or saved inside the .cas file.

$$I_{CASINO} = I_{tmp} \cdot F$$

where I_{tmp} is the intensity calculated in CASINO during the simulation and F is a factor multiplied at the end of the simulation.

$$I_{tmp} = L \cdot \sigma \cdot \rho \cdot f_w$$

where L is the electron trajectory length in nm, the σ is the ionization cross section in barn, ρ is the region mass density in g /cm^3, and f_w is the element weight fraction.

$$F = A \cdot B \cdot C \cdot \frac{10^{-7}}{N_e}$$

where 10^{-7} is to convert the length in nm to cm and N_e is the number of electrons.

1 Constant

$$A = 6.023 \times 10^{23} \frac{1}{A} \cdot w \cdot z_{nl} \cdot 10^{-24}$$

where 6.023×10^{23} is the Avogadro constant in mol^{-1}, A is the atomic weight in g /mol, w is the fluorescence yield, z_{nl} is the number of electrons in the subshell nl, and 10^{-24} is to convert the ionization cross section from barn to cm^2.

$$B = \epsilon \left(E_X\right)$$

where $\epsilon(E_X)$ is the detector efficiency

$$
\begin{aligned}
C &= \frac{\Omega}{4\cdot\pi}\cdot\frac{I\cdot t}{e} \\
&= \frac{0.0025}{4\cdot 3.1416}\cdot\frac{1\times 10^{-9}\cdot 1}{1.6\times 10^{-19}}
\end{aligned}
$$

where Ω is the solid angle in sr, I is the current in A, t the acquisition time in s, and e the electron charge in C.

1.1 Detector Efficiency $\epsilon(E_X)$

If $E_X < 7\,\mathrm{keV}$

$$
\begin{aligned}
\epsilon &= \exp\left[-\left.\frac{\mu}{\rho}\right|_{Al}\rho_{Al}t_{Al} - \left\{0.0707\left.\frac{\mu}{\rho}\right|_{H} + 0.6063\left.\frac{\mu}{\rho}\right|_{C} + 0.3231\left.\frac{\mu}{\rho}\right|_{O}\right\}\rho_C t_{Parylene} - \left.\frac{\mu}{\rho}\right|_{Si}\rho_{Si}t_{DL}\right] \\
t_{Al} &= 120.0\times 10^{-7}\,\mathrm{cm} \\
t_{Parylene} &= 130.0\times 10^{-7}\,\mathrm{cm} \\
t_{DL} &= 50.0\times 10^{-7}\,\mathrm{cm}
\end{aligned}
$$

where $-\left.\frac{\mu}{\rho}\right|$ is the mass absorption coefficient in $\mathrm{cm}^2\,/\mathrm{g}$, ρ the mass density in $\mathrm{g}\,/\mathrm{cm}^3$, and t the layer thickness in cm.

If $7.0 < E_X \leq 15\,\mathrm{keV}$

$$
\epsilon = 1.0
$$

If $E_X > 15\,\mathrm{keV}$

$$
\begin{aligned}
\epsilon &= 1.0 - \exp\left[-\left.\frac{\mu}{\rho}\right|_{Si}\rho_{Si}t_{Si}\right] \\
t_{Si} &= 0.3\,\mathrm{cm}
\end{aligned}
$$

2 Comparison with Experimental Intensity

Based on Pierrre Hovington slides from MM2009.

$$
I_{exp} = I_{CASINO}\cdot\frac{\epsilon_{exp}\cdot T_{exp}}{\epsilon_{CASINO}}\cdot\frac{\Omega_{exp}}{\Omega_{CASINO}}
$$

where ϵ is the detector efficiency, T is the transmission of the x-ray detector windows (support grid open area ~ 0.77), and Ω is the solid angle in sr.