The x-ray energy as a function of time relative to the pulse was measured using polychromators with different channel settings. The above plots were generated by averaging the reduced photon count data obtained from the simulated experiments.

Each of the models was trained on a simulated dataset to generate the x-ray energy spectra. The best-fit models were then used to predict the x-ray energy spectra of the real experiments. The results show that the kappa model provides a better fit than the Maxwellian model, especially at high energies.

The kappa model is more suitable for modeling the x-ray energy spectra of tokamak discharges because it can account for the non-Maxwellian energetic electron tail generated during magnetic reconnection events. The kappa model also provides a better fit to the reduced photon count data obtained from the real experiments.


Noise, Error Estimation, and Uncertainty
To get an accurate picture, one needs to model all sources of noise in the measurement. Below is the noise model expressed as the signal variance:

\[ \sigma^2 = \sigma^2_g + GMFS + (GMFS)^2 \]

where:
- \( \sigma^2_g \) is the noise variance due to the instrumental noise
- GMFS is the total gain and frequency shift
- \( (GMFS)^2 \) is the cross-talk noise

Noise, error estimation, and uncertainty will need to be injected into the analysis.

Monte Carlo Simulations
Generation of synthetic data example for one simulation “shot”

Sample the spectral density to generate the synthetic scattered photons.

For a six-channel polychromator (excluding the 0th channel in the fit) with \( i=1 \), the result of grid search:

\[ F = -0.2 \]

\[ \gamma = 4.14 \]

\[ n = 250 \]

\[ m = 0.65 \]

\[ n = \text{total number of polychromator channels} \]

\[ m = 0.65 \]

Best-fit results are from averaging reduced photon count data from 500 shots on a 50x50 parameter space grid for the kappa model and a “grid” of length \( \kappa \) for the Maxwellian model. The above plots were generated by averaging the reduced photon count data obtained from the simulated experiments.

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Notice that even without information about the density distribution from the soft x-ray diagnostic, it could still be used to provide a clearer picture of that parameter’s probability distribution when used in conjunction with Thomson data in EA0.

Electron energization and magnetic reconnection

- **Magnetic Reconnection** - increasing the amount of energy in the plasma
- **Particle Acceleration** - converting magnetic to kinetic energy
- **Energetic Electron Tail** - generated during magnetic reconnection events

Mechanisms leading to the areas of magnetic reconnection and particle energization not yet understood (e.g., the process located inside or outside the diffusion region?)

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