Narrative: two-page limit, excluding references

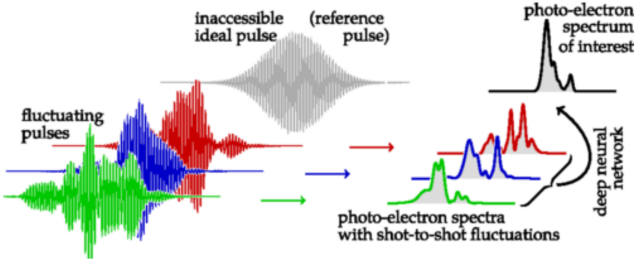
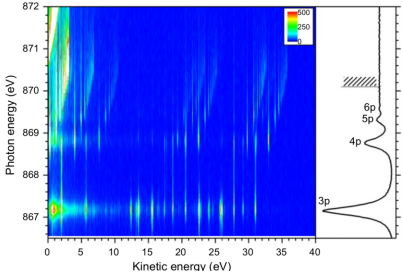


Figure 1. Reproduced from Ref. [1]. Noisy incident spectra cause fluctuations in the measured signal. Notably the fluctuating relative contributions for the partial wave patterns allow the deep neural network to lock onto correlation and thus "predict" what the purified nonlinear spectrum would be.

We will demonstrate how stochastic field fluctuations, that are natively produced at SASE FELs, can be used in combination with machine learning methods to uncover nonlinear multiphoton resonant effects in atomic systems. We will test the hypothesis that so-called "spectral purification" [1-2] can reveal nonlinear resonant absorption. This experiment will reveal the extent to which the CookieBox end station, with a fully outfitted array of 20 Time-of-Flight spectrometers, can capture nonlinear atomic and molecular spectroscopic methods.



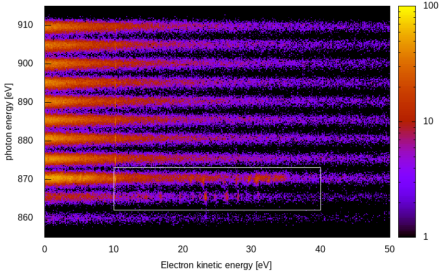


Figure 2 (left) Reproduced from Ref. [5]. (right) Preliminary results from June 2021 indicating 1s-3p excitation and subsequent auto-ionization bin the 30-40eV range.