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Active Sensing: Bayesian Measurement and Control

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This work explores the application of Bayesian methods to enhance measurement and optimization in experimental physics, with a focus on laser-plasma interactions. Bayesian updates enable the integration of prior knowledge with new data, facilitating refined parameter estimation and uncertainty quantification. These methods have been employed to achieve the first single-shot measurement of complete spatio-temporal vector fields, providing a comprehensive characterization of petawatt laser pulses. Additionally, Bayesian Autocorrelation Spectroscopy (BAS) is introduced as an innovative technique for spectral measurements, leveraging prior information for rapid convergence. Finally, Bayesian optimization demonstrates exceptional efficiency in tuning laser wakefield accelerators, enabling precise control over electron beam properties through systematic exploration of parameter space.

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