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Abstract for an Invited Paper for the DAMOP06 Meeting of the American Physical Society

## Control and Measurement of Attosecond Pulses<sup>1</sup>

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We introduce a new approach to attosecond measurement. We use a weak field to perturb the highly nonlinear generation process without significantly modifying it. Yet, the subtle changes that we can induce on the attosecond pulse can give us all information needed to measure the both the spatial and temporal properties of attosecond pulses. Our measurement relies on a phase "gate." The phase of attosecond pulses is easily manipulated because attosecond pulses arise in an interferometric process — the interferometer formed by an electron being removed by the atom, propagating in the laser field and recolliding with the parent ion where the interference occurs. Slightly modifying (gating) the phase of the electron along the trajectory encodes spatial and temporal information. We also introduce a method for producing transient optical elements for attosecond pulses and high harmonics. For control we use a slightly stronger, yet still very weak control beam. We produce a diffraction grating in the nonlinear medium itself and we observe the diffracted radiation. These experiments are the high harmonic analogue to cross-phase modulation and 4-wave mixing. Gating is a general approach to measurement (and control), applicable to a broad range of dynamic measurements. Other gates are possible. Similar approaches can be extended to other areas of re-collision physics, opening the door to fully time resolved experiments in collision science and in nuclear physics.

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