# Design, fabrication and characterization of chirped multilayer soft X-ray mirrors for attosecond pulses in the 100-190 eV photon energy range

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Attosecond physics is an increasing research field, allowing to probe dynamics of fundamental electronic processes in atoms, molecules nanostructures and solids. Attosecond pulses from High Harmonic Generation (HHG) sources are inevitably in the (soft) X-ray range and control of the resultant pulse duration, center wavelength, spectral bandwidth and phase is accomplished by dedicated soft X-ray optical elements, as filter and mirrors. With the recent availability of single cycle several mJ laser pulses, the generation of useable High Harmonic radiation is shifted towards higher photon energies above 100 eV.

We will present latest experimental results of Lanthanum based XUV multilayer mirrors La/Mo and La/B4C between 100 and 180 eV as well as ternary Mo/B4C/Si multilayer (consisting of three materials per period) at 130 eV. The designs are optimized with respect to bandwidth limited short pulses in the sub 200 attosecond regime and we present soft and hard X-ray reflectivity measurements.

For controlling the spectral phase of the HHG soft X-ray pulses, a-periodic multilayer mirrors have been designed, optimized and fabricated with different amounts of Group Delay Dispersion (GDD). The resultant spectral phase of the reflected pulses has been analyzed by an IR/soft X-ray cross correlation experiment dubbed attosecond streak camera which is capable of quantitatively reconstructing the pulse duration and the spectral phase of the attosecond soft X-ray pulses.
Soft X-ray pulses of comparable spectral envelope, but of positive, negative and zero GDD have been realized by three different multilayer mirrors and are compared.
Further applications to electron dynamics in atoms and on solid surfaces are presented and discussed.