Supplementary Information: Role of Van Hove singularities and effective mass anisotropy in polarization-resolved high harmonic spectroscopy of silicon

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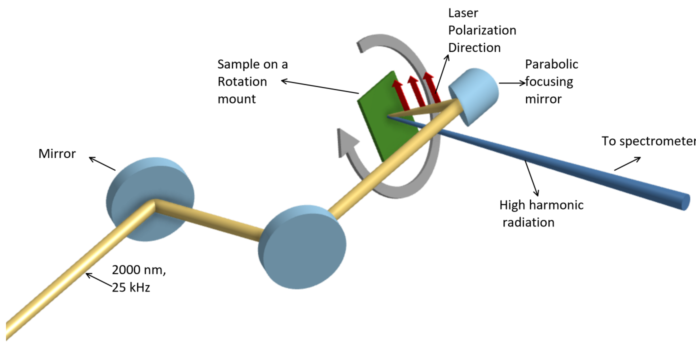
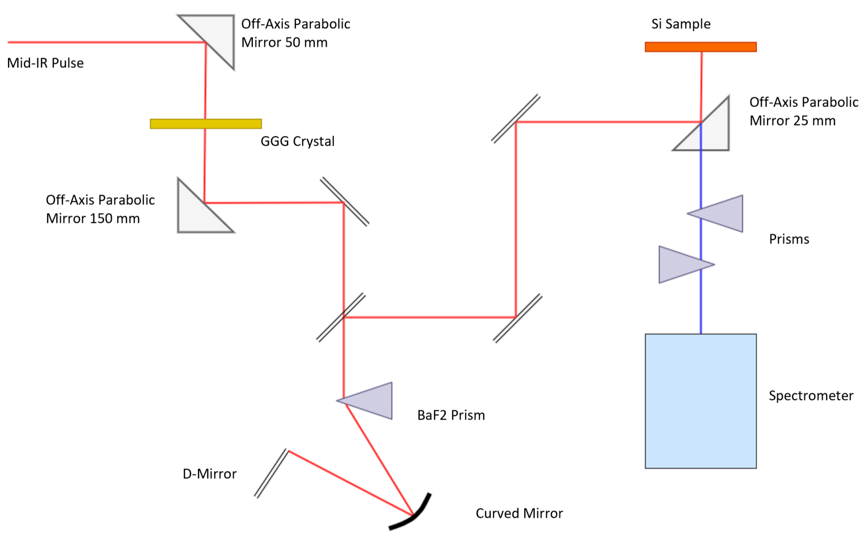
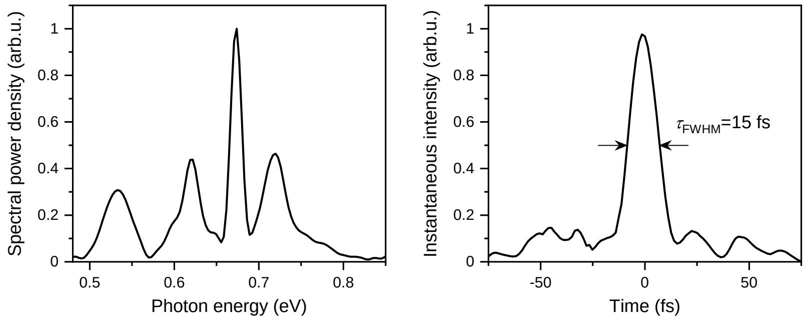


Supplementary Figure 1: **Experimental setup for high harmonic generation.** The experimental setup used for measurements of high harmonic spectra in the reflective geometry. The sample is placed on a rotation stage allowing to adjust the angle of its crystallographic axes with respect to the linear polarization of the pump pulse without changing the polarization direction of the generated harmonics.



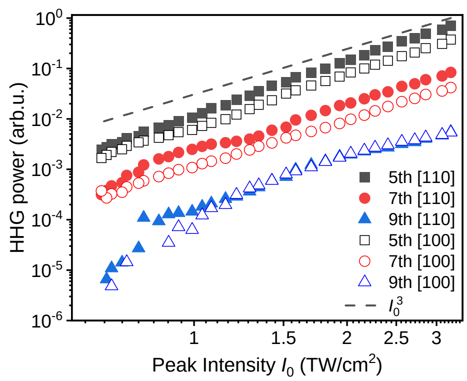
Supplementary Figure 2: **Experimental setup for nonlinear spectral broadening and self-compression of the infrared pulses.** The beam is focused by an off-axis parabolic mirror with focal distance of 150 mm to a gallium gadolinium garnet (GGG) crystal. After collimation by another parabolic mirror, the beam passes through 4-f setup with close-to-zero dispersion at wavelength of 2000 nm. Carrier envelope phase of the pulses is adjusted by introducing the BaF_2 prism in the beam path. Subsequently, the beam is focused by off-axis parabolic mirror to the sample and the reflected light is sent to the UV detection setup consisting of UV fused silica prisms and spectrograph with a cryo-cooled CCD detector.



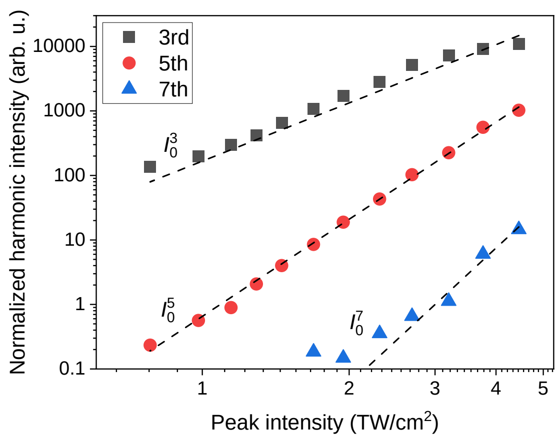
Supplementary Figure 3: **Characterization of mid-infrared pulses used in CEP-dependent measurements.** Spectrum (left) and temporal intensity profile (right) of the pulses used for CEP-dependent measurements of HHG spectra. The data were obtained from reconstructed interferometric third harmonic frequency-resolved optical gating traces.

1 Supplementary Note 1: Dependence of high harmonic power on the peak intensity of the driving pulses

The measured dependence of the power of individual high harmonic orders is plotted in Supplementary Fig. 4 for both orientations of linear polarization of the driving pulses. We observe the nonperturbative scaling $\sim I_0^3$ (dashed gray line in Supplementary Fig. 4). In Fig.



Supplementary Figure 4: **Power scaling of high harmonic generation driven by low-frequency field.** Dependence of the high harmonic yield in the individual harmonic orders on the peak intensity of the driving mid-infrared pulses (central wavelength of 2060 nm). Dashed gray line shows the dependence $\sim I_0^3$.



Supplementary Figure 5: **Power scaling of high harmonic generation driven by high-frequency field.** Dependence of the high harmonic yield in the individual harmonic orders on the peak intensity of the driving near-infrared pulses (central wavelength of 750 nm). Dashed lines show the power-law dependences corresponding to perturbative scaling $\sim I_0^n$, where n is the harmonic order.