Ultrahigh brilliance quasi-monochromatic MeV γ-rays based on self-synchronized all-optical Compton scattering

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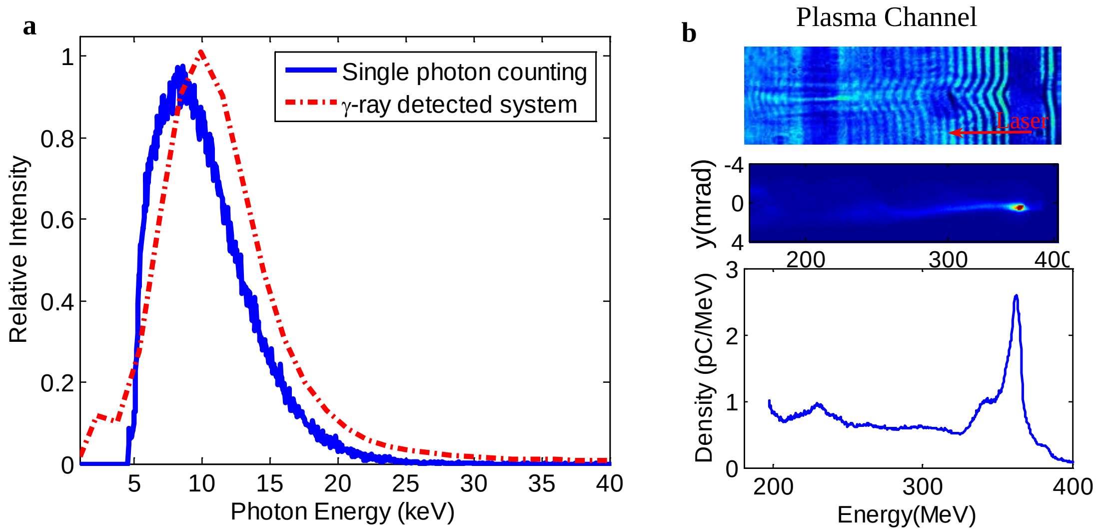
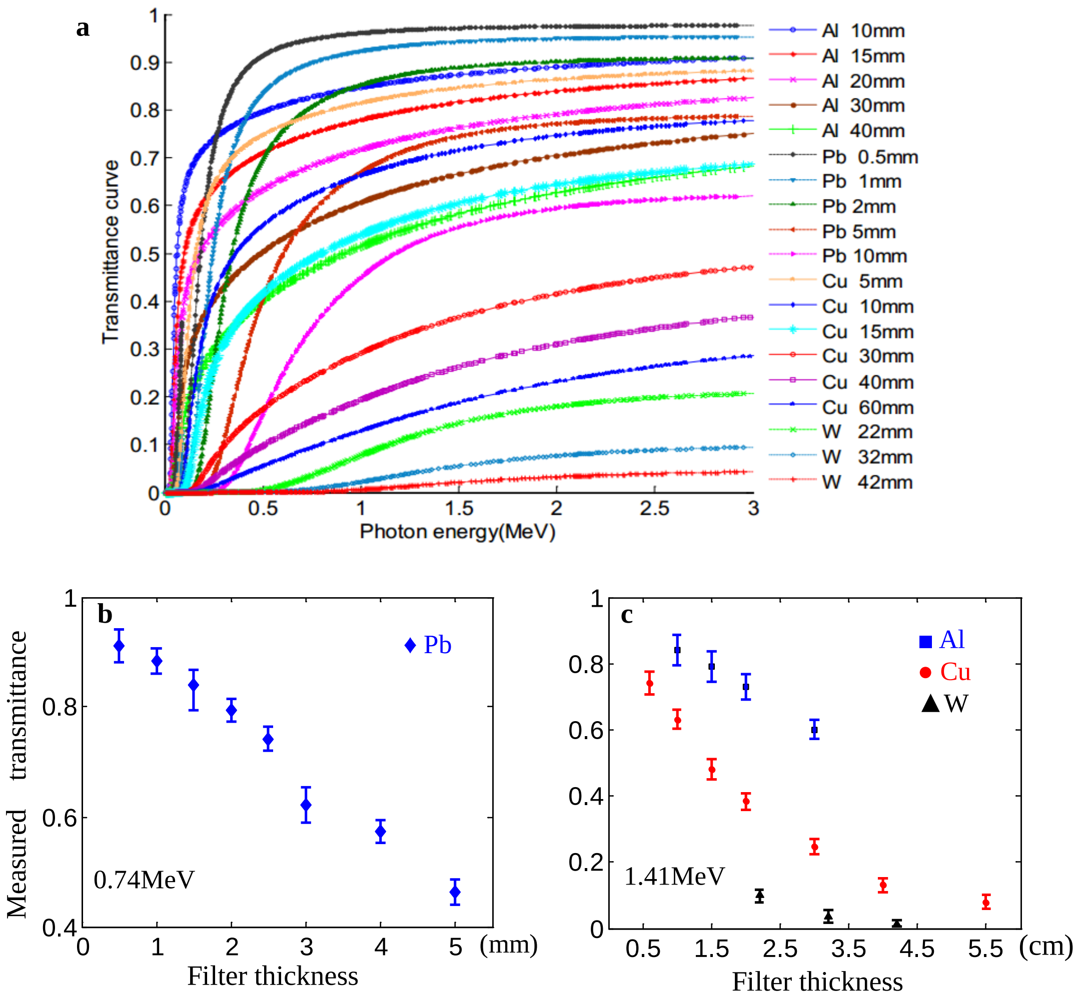
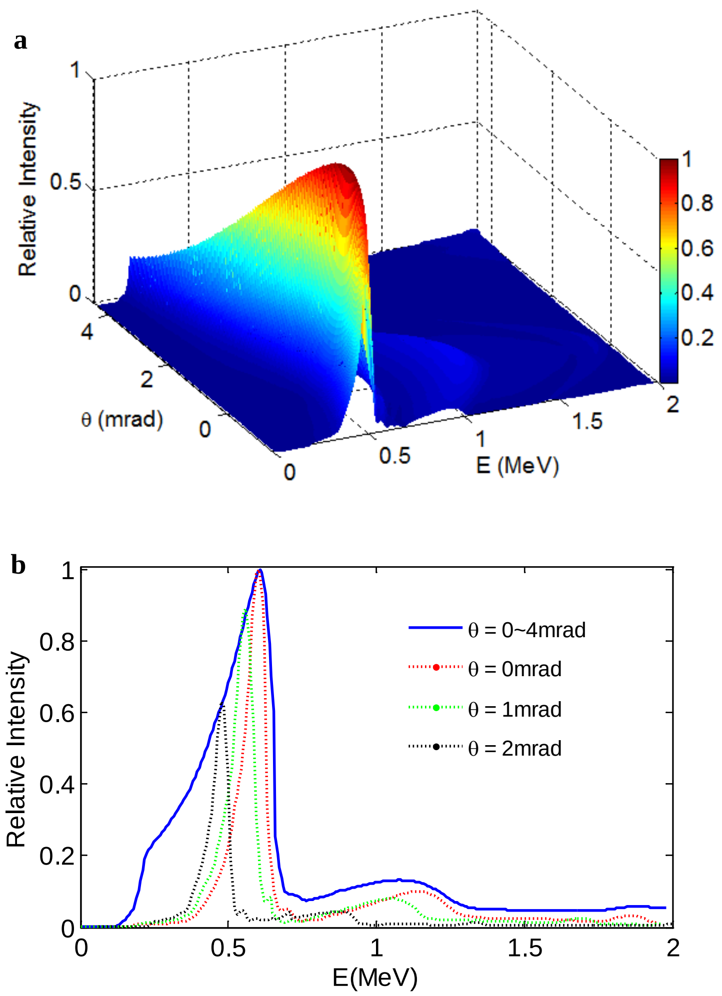


Supplementary Figure 1 | The betatron x-ray diagnostic and generated e-beam. (a) Single-shot x-ray betatron spectra obtained from the single-photon counting method (SPC) method (blue), detected by a thermoelectrically cooled, back-illuminated, deep-depletion x-ray CCD cameras and the residual laser light was blocked by a 80nm-thick Al filter placed in front of the x-ray CCD, comparing with the γ-ray detected system (red), both measured with the critical energy around $\hbar\omega_c \approx 5.24\times 10^{-24}\ \gamma^2\ n_e[\mathrm{cm}^{-3}]\ r_\beta[\mu\mathrm{m}]$ keV $\approx(10.5\pm1)$ keV; **(b)** The measured plasma channel via the optical interferometry and the corresponding e-beam spectra: peak energy 360MeV, 1.4% rms energy spread, 49.7pC integrated charge, 0.35mrad rms divergence.



Supplementary Figure 2 | The material transmittance and measured γ-ray signal including angular correction vs. filter thickness. (a) Material transmittance of the filters with different thickness for Al (10-40mm), Pb (0.5-10mm), Cu (5-60mm), W (22-42mm); (b-c) Typical transmission data for reconstructing the typical spectra with peak energies at 0.74MeV and 1.41MeV, using a 3×3 squared lead-grid (♦) filter and a sixteen-hole-array filter packed with Al (■), Cu (●) and W (▲) material attenuated bars, respectively. The error bars of each point represents the measurement uncertainties considering the beam spatial profile angular correction.



Supplementary Figure 3 | Spectra radiation simulations. (a) The 10000 test particles are used to sample an collimating 200 MeV electron beam with 3% FWHM energy spread. Relative radiation intensity distribution for the electrons wiggling in the intense laser field N_l=13, a_r=0.95 based on the direct numerical integration of the Lienard-Wiechert potentials in the far field; **(b)** The angular-resolved radiation intensities integrated with respect to the emission angles from 0 to 4mrad, the center axis θ = 0 mrad, and off-axis angle detected angle θ =1mrad and θ =2mrad, respectively.