Figure 1. Laser pulse growth and three-dimensionally [spatially (2D) and temporally (1D)] shaping process. The pulse duration of THG (263 nm) depends on the compressor length at fundamental wavelength (790 nm). To obtain a 20-ps pulse by stacking eight micro pulses (three stages of pulse stackers), a 2.5-ps micro pulse should be initially prepared by shifting compressor length.

Figure 2. Improvement in laser oscillator's long-term stability [just passive (a), full-active (b), Femto-align – Femto-lock]. Full-active feed-backing, the mode-locking and spectral distribution have been kept constant.
Figure 3. Three-dimensionally [spatially (2D) and temporally (1D)] UV-laser pulse shaping system. The 3D shaping system consists of a deformable mirror (DM) and a pulse stacker. These two shaping techniques can be optimised independently, since there is no interference between them. The schematic drawing of pulse stacking shows 10-ps pulse generation by stacking four 2.5-ps micro pulses (two stages of pulse stackers).
Figure 4. Closed control system for the experiment. With evaluation of top-hat (flattop) profiles on laser profiler (LBA300-PC), the deformable mirror (DM) is automatically controlled to optimise the spatial profile toward the top-hat as a target profile.

Figure 5. Top Hat Factor (THF) [10] for evaluation of top-hat profiles: In the top figure, curve (A) is a top-hat beam with THF of 1.0, curve (C) is a Gaussian beam, and curve (B) is beam profile between top-hat and Gaussian.
**Figure 6.** Result of spatial profile optimisation to top-hat with a deformable mirror (laser profile monitor: LBA300-PC).

**Figure 7.** Principle of chirped-pulse stacking (8 pulses: three stages). Avoiding interference, the s- and p-polarised micro pulses are alternatively stacked with the optical delay as long as the micro pulse duration.

**Figure 8.** Optical system (left) and timing chart (right) of UV-laser pulse stacker. The drawings are shown in the case of three stages (pairs of polarising UV-laser beamsplitter cubes) of pulse stacker. The initial UV-laser pulse duration is set to 2.5 ps for generating a ~20-ps combined macro pulse. The optical kit of this pulse stacker is commercially available from Luminex Trading, Inc. (http://www.luminex.co.jp/) under license of SPring8/JASRI.
Figure 9. Fused surface structure of a fibre bundle (diameter of 8 mm; collection of 1300 small fibre strands). In developing a compact source system for high-quantum-efficiency photocathode backward illumination, the combination of a blue (404 nm) laser diode and the fibre-bundle-based 3D-pulse shaper has been examined (left photo).

Figure 10. Closed control system for a fibre bundle with a computer-aided DM. The laser spatial profile is homogenised perfectly. At the same time, the temporal profile is elliptically shaped. The shaping results shown for both the spatial and temporal profiles were done by using only the fibre-bundle shaper. Without using DM and GA, it is possible to generate a 3D quasi-ellipsoidal pulse. By applying a computer-aided DM as shown in this figure, the 3D pulse shape can be precisely optimised.