Table-top narrow-band soft-X-ray laser source for spectroscopy.

I. Velchev, W. Hogervorst, W. Ubachs
Laser Centre, Vrije Universiteit Amsterdam
De Boelelaan 1081, 1081-HV Amsterdam, The Netherlands
tel: +31 20 4447944, fax: +31 20 4447999, E-mail: iavor@nat.vu.nl

Tunable radiation in the extreme ultra-violet (XUV) range (50-100 nm) can be generated by frequency up-conversion of the output of powerful nano-second pulsed laser sources; in case of Fourier-transform limited pulses, a bandwidth of $\delta\nu/\nu \sim 5 \times 10^{-8}$ has been achieved [1]. Alternatively, with high-peak intensity femto-second laser pulses the water window at 2-4 nm can be reached via high-harmonic generation; the spectral resolution, however, is very poor. We aim at filling the gap between the two, reaching wavelengths as short as 30 nm, with tunability and spectral purity orders of magnitude better than the synchrotron sources usually used for spectroscopy in this wavelength region.

In this presentation we report on a new design of a laser system, which generates powerful Fourier-transform limited 300 ps pulses tunable in wavelength within the Ti:Sapphire range with $\delta\nu/\nu \sim 3 \times 10^{-6}$. On Fig. 1 a scheme of the set-up is presented. The frequency *clock* for the experiment is a CW Ti:Sapphire ring-laser, pumped by a frequency-doubled (532 nm) solid state CW laser. This narrow-band (~1 MHz) tunable radiation is used as injection seeding for a three-stage pulse-dye-amplifier (PDA) pumped by 300 ps Fourier-transform limited pulses from the compressed secondary output of an injection seeded, Q-switched and frequency-doubled Nd:YAG laser (Quanta Ray GCR-330). The pulse compression from 6 ns down to 300 ps (factor of 20) is achieved by stimulated Brillouin scattering in a water cell [2]. After the dye amplification pulses of 300 ps and energy ~3 mJ/pulse are obtained and further amplified in multi-pass Ti:Sapphire amplifier pumped by the main frequency-doubled output (6 ns, 1 J 532nm) of GCR-330. Pulses of ~300 mJ and 300 ps duration can be achieved after the amplification stage. Such narrow-band powerful pulses, tunable over a broad wavelength range, can

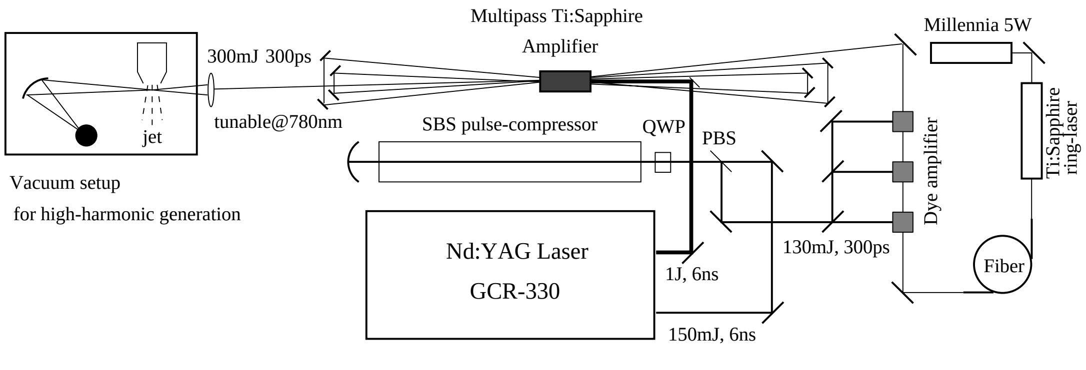

Figure 1: Experimental set-up.

generate high-harmonics, down to 30nm, either in a pulsed gas jet (focusing geometry), or in a gas-filled hollow fiber (guided geometry). Work is in progress to investigate and compare the results of both techniques applied in our case with Fourier-transform limited 300 ps pulses.

References:

[1] K. S. E. Eikema *et al.*, Phys. Rev. Lett. **76**, 1216 (1996)
[2] D. Neshev *et al.* Appl. Phys. **B 68**, 671 (1999)