# 3GHz, 257nm Picosecond Source for Electron Guns

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Gigahertz level repetition rate lasers with pulse duration of picosecond or femtosecond are drawing more attention due to demands in variable applications [1, 2]. For the application of photoelectron generation for electron accelerators and Free Electron Lasers, a pulse-train in the deep ultra-violet (DUV) with tight synchronization to the accelerating RF field is required. For the Relativistic Electron Gun for Atom Exploration (REGAE) at DESY we are planning a new operation mode for overcoming the limitation on spatial resolution caused by space charge effects in time-resolved electron microscopy [3]. This mode runs at low bunch charge of 100 fC per microsecond at a repetition rate of 3 GHz, requiring a 3.3 fJ, 2ps, 3GHz DUV drive laser. In this contribution, we report on the drive laser for this operation mode.

We choose to generate the ps-pulses in the "EOM-comb" scheme [4,5] at 1030nm, with the advantage of intrinsic synchronization to RF over mode-locked sources. The system is schematically shown in Fig1. It includes a 10mW continuous wave seed laser (50kHz linewidth), Yb-fiber amplifers (YDFA), the pulse generation stage comprising four electro optical modulators, a dispersion compensation stage, and a frequency conversion stage.

We use three cascaded low V-pi phase modulators, working at frequencies up to 20 GHz, are for frequency sideband generation and a successing intensity modulator for pulse train generation. To achieve sufficient bandwidth to support 2ps pulses, a modulation frequency of 3GHz is not sufficient. Therefore we choose to frequency double our 3GHz RF reference to 6GHz. This signal is amplified to a power of 35 dBm using low noise RF amplifiers. The generated pulse train is sent into a pulse shaper (FINISAR W1000A) for dispersion compensation, followed by two YDFAs. The last amplifier is cladding pumped with a core-diameter of 10µm. At the output the 1030nm pulses have duration of 1.8 ps at 10W average power, corresponding to a pulse energy of 3.3 nJ and a peak power of 1.83 kW.

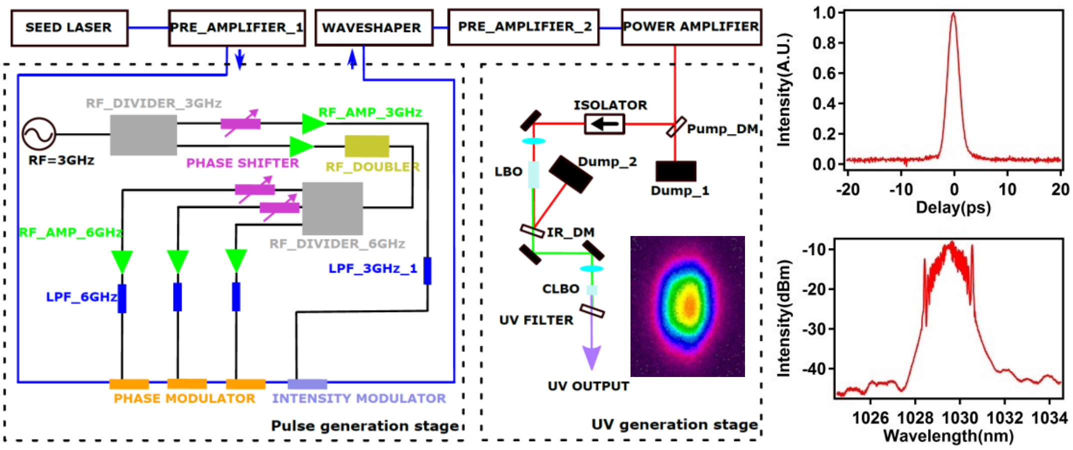


**Fig. 1** Left: The Schematic of the system; LPF: low pass filter, RF_AMP: electronic amplifier for radio frequency signal, Pump_DM: dichroic mirror for pump splitting, IR_DM: dichroic mirror for splitting the IR beam from the second harmonic; Inset: Focused beam profile in DUV Right: Upper: autocorrelation of the power amplifier output; Lower: spectrum of power amplifier output

Frequency quadrupling at this low pulse energies and peak powers is challenging. We use a 15mm long non-critically phase matched Lithium Borate (LBO) crystal working at 189.5 ºC, to generate more than 600mW (200pJ) 515nm pulses. A critically phase matched Caesium lithium borate (CLBO) crystal with 5 mm length at Φ=66.2º and 155 ºC is used for UV generation. We achieve long term stable over 3mW (1pJ) of 257.5nm output pulses at 3GHz repetition. In conclusion we generated to our knowledge for the first time ultrafast DUV pulses at GHz repetition frequencies.

## References

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