

# 1 kHz repetition picosecond pulse laser system

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**Abstracts:** We have been developed a 1 kHz repetition picosecond pulse laser system based on the chirped pulse amplification (CPA) technology. The main amplifier is a regenerative amplifier using Yb:YAG or Yb:Y<sub>2</sub>O<sub>3</sub> thin-disk. Present status of the output pulse is 10 mJ/1.3 ps and 2 mJ/0.9 ps by using Yb:YAG and Yb:Y<sub>2</sub>O<sub>3</sub> regenerative amplifiers, respectively. The pulses are mainly used for terahertz pulse generation based on an optical rectification in a nonlinear crystal.

The laser system, which is named “QUADRA-T”, consists of a master oscillator, a pulse stretcher, a fiber pre-amplifier, a regenerative amplifier using a Yb:YAG thin-disk [1] or Yb:Y<sub>2</sub>O<sub>3</sub> thin-disk [2], and a pulse compressor, shown in Fig. 1. The master oscillator is a mode-locked Ti:Sapphire laser operating at the central wavelength of 1030 nm with band width of 6 nm. The laser frequency is 80 MHz and the power is 150 mW. The pulse stretcher with a reflection grating gives the chirp of 400 ps/nm to each pulses. The throughput power from the pulse stretcher is 30 mW. The pulse energy is amplified up to 2 W in a laser diode pump Yb-doped fiber amplifier. Then 1 kHz pulses picked up by a pulse picker 1 and 2 are inserted into Yb:YAG and Yb:Y<sub>2</sub>O<sub>3</sub> thin-disk regenerative amplifiers respectively. The thin-disk geometry is preferable for high average power operation because this geometry affords good cooling efficiency by facilitating volume heat transfer through the contacted disk surface. In this system ceramic Yb:YAG and Yb:Y<sub>2</sub>O<sub>3</sub> thin-disks with 10 mm in the diameter and 0.2 mm in the thickness are used. Yb dopant ratios are 7at% for YAG and 5at% for Y<sub>2</sub>O<sub>3</sub>. In general, Yb:YAG is preferable for high power operation due to higher emission cross section than Yb:Y<sub>2</sub>O<sub>3</sub>. While Yb:Y<sub>2</sub>O<sub>3</sub> has wider emission bandwidth, therefore it can provide shorter duration pulses. The output pulse energy and the spectral bandwidth are 12 mJ and 1.2 nm by the Yb:YAG regenerative amplifier and 2 mJ and 1.8 nm by the Yb:Y<sub>2</sub>O<sub>3</sub> regenerative amplifier, respectively. Those pulses are compressed to 1.3 ps (YAG) and 0.9 ps (Y<sub>2</sub>O<sub>3</sub>) by pulse compressors with a pair of gold coated gratings of 1740 grooves/mm. Now we are developing Yb:YAG thin-disk multi-pass amplifier after the Yb:YAG regenerative amplifier to increase the pulse energy for a few tens mJ.

[1] Y. Ochi, et al., Opt. Express **23**, 15057-15064 (2015).

[2] M. Maruyama, et al., Opt. Express **24**, 1685-1692 (2016).

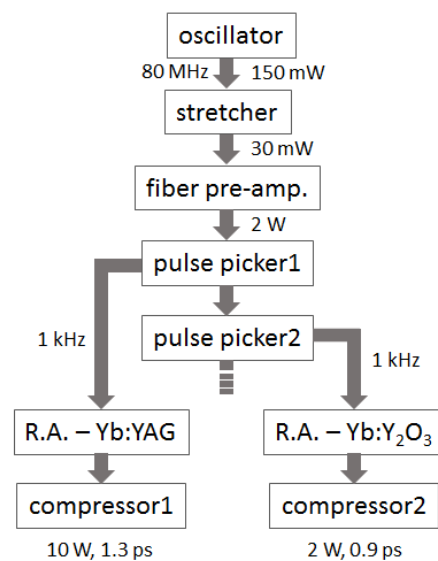


Fig.1 System configuration of QUADRA-T.  
(R.A.: regenerative amplifier)