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Hybrid bulk/fibre MOPA system based on Yb:KYW laser

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Outline

- Advantages of Yb:KYW/KGW lasers
- Fiber Amplifiers: different approaches
- Experiment setup
- Results
- Application for supercontinuum generation

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Yb:KYW / KGW lasers (Yb:KXW lasers)

Advantages:

1. Direct pump by standard diode lasers, λ = 975-980 nm
2. Broad range of generation, 1010-1080 nm, max ~ 1045 nm
3. Possibility to generate femtosecond pulses, $\Delta t < 100$ fs
4. Tunability in mode-locked regime, up to 70 nm for ps pulses

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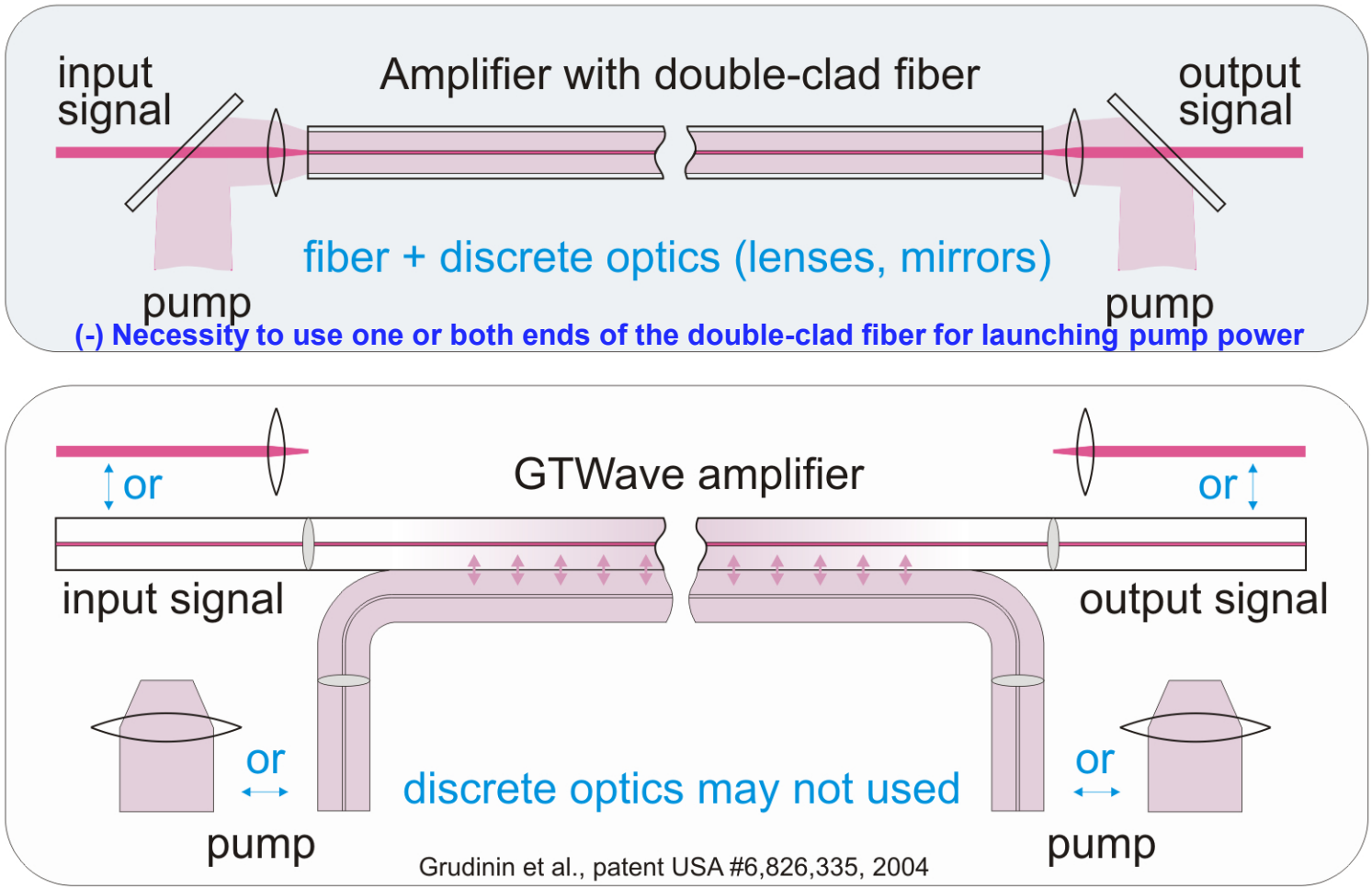
Fiber Amplifiers: different approaches



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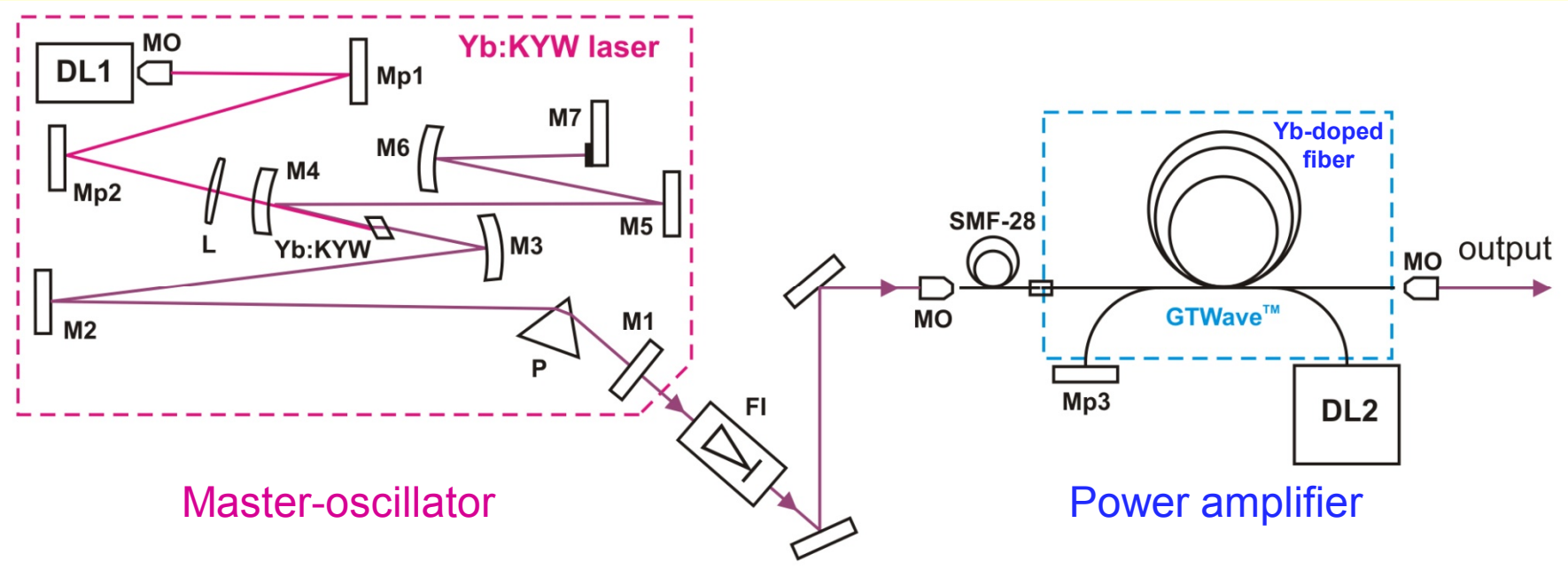
Experimental setup



Schematic of experimental setup: DL1/2 – pump diode laser, $Mp_{1/3}$- reflecting mirrors for pump radiation, M1-M7 - mirrors of Yb:KYW laser, L – lens, P – prism, FI - Faraday isolator, MO - microscope objective.

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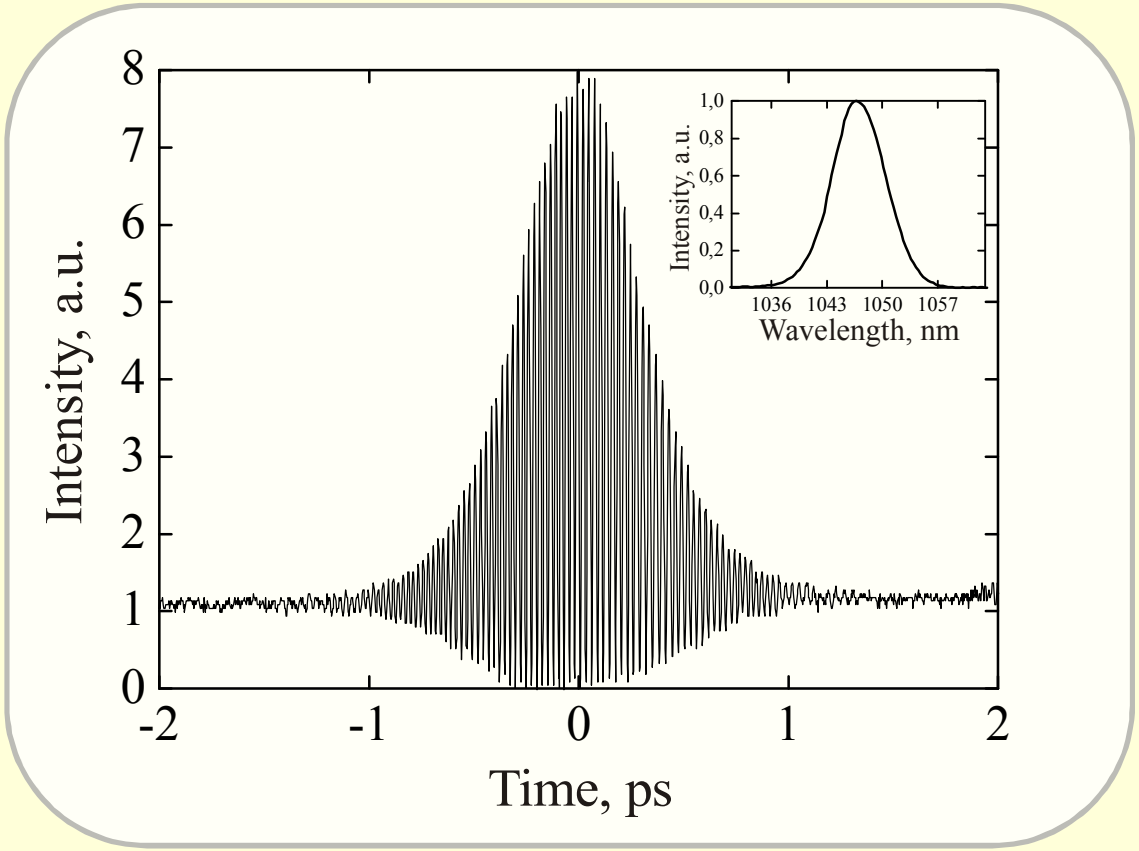
Master-oscillator



Parameters:
-Pulse duration:
250-300 fs
-Output power:
200 mW at 3 W pump
-Rep rate: 100 MHz
-Tuning range in mode-locked regime:
from 1038 to 1053 nm

Typical auto-correlation function of pulses and their spectrum

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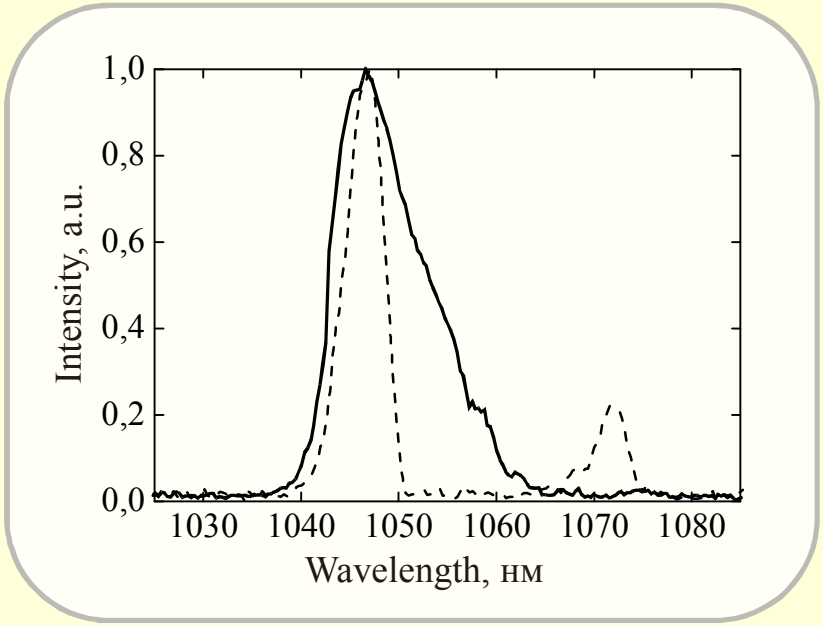
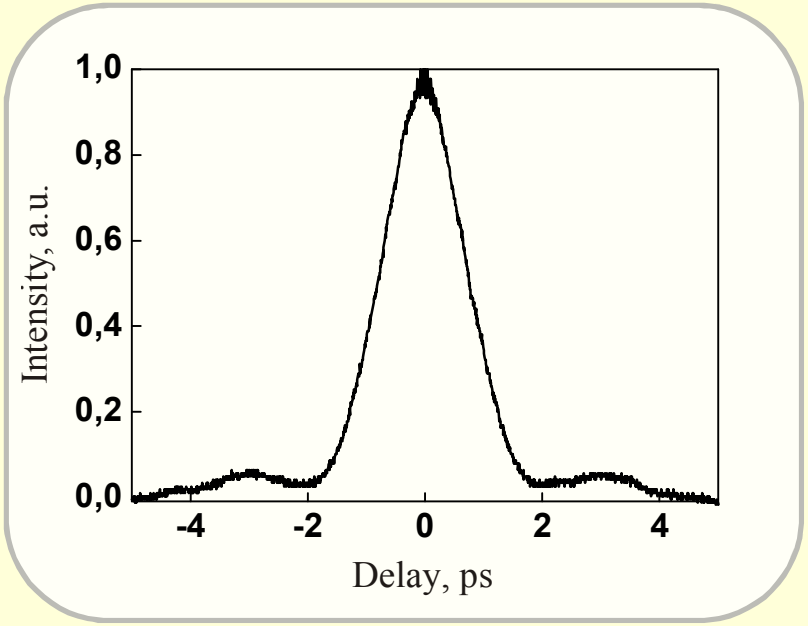
Amplified radiation



Spectrum of amplified radiation: dashed line – CW radiation, solid line – pulse radiation.



Autocorrelation function of the amplified pulses (non-collinear scheme of measurements)

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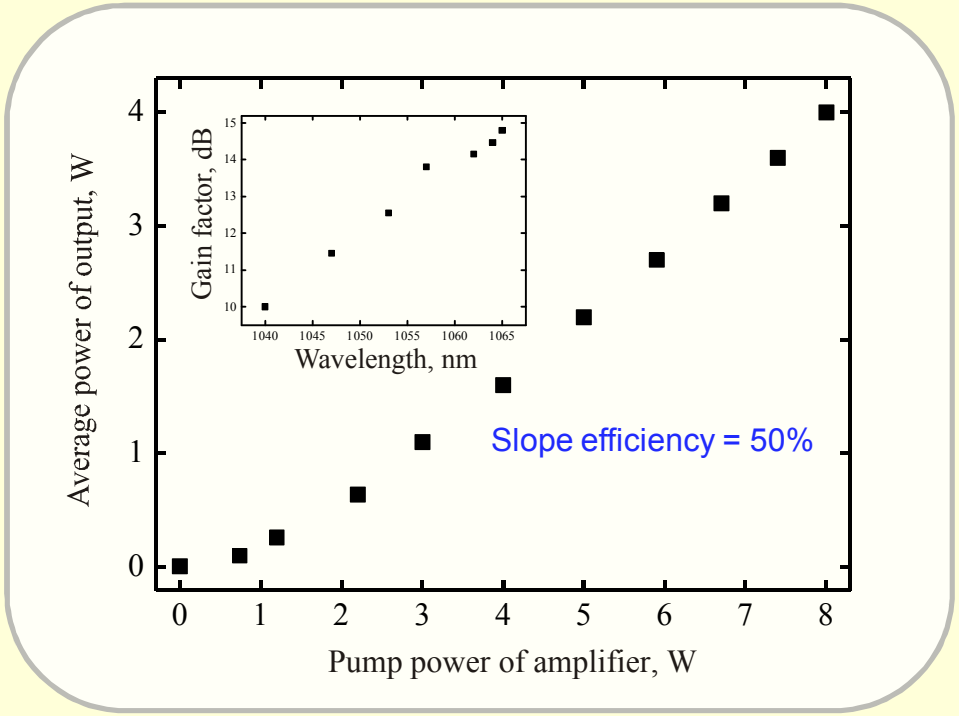
Output power and gain factor



GTWave Yb amplifier:
signal fiber:
15 um core, 125 um cladding, concentration of the Yb^{3+} ions: 10^{20} ions/cm^3, length 4 m;
small-signal gain:
14.8 dB at 1065 nm
10,9 dB at 1045 nm
Max. output: 4 W
Pulse duration: 0,9 ps
Pulse energy: ~40 nJ

Experimental results of measurement of average output power versus pump power of amplifier. Insert: experimentally determined spectral dependence of studied GTWave amplifier's gain.

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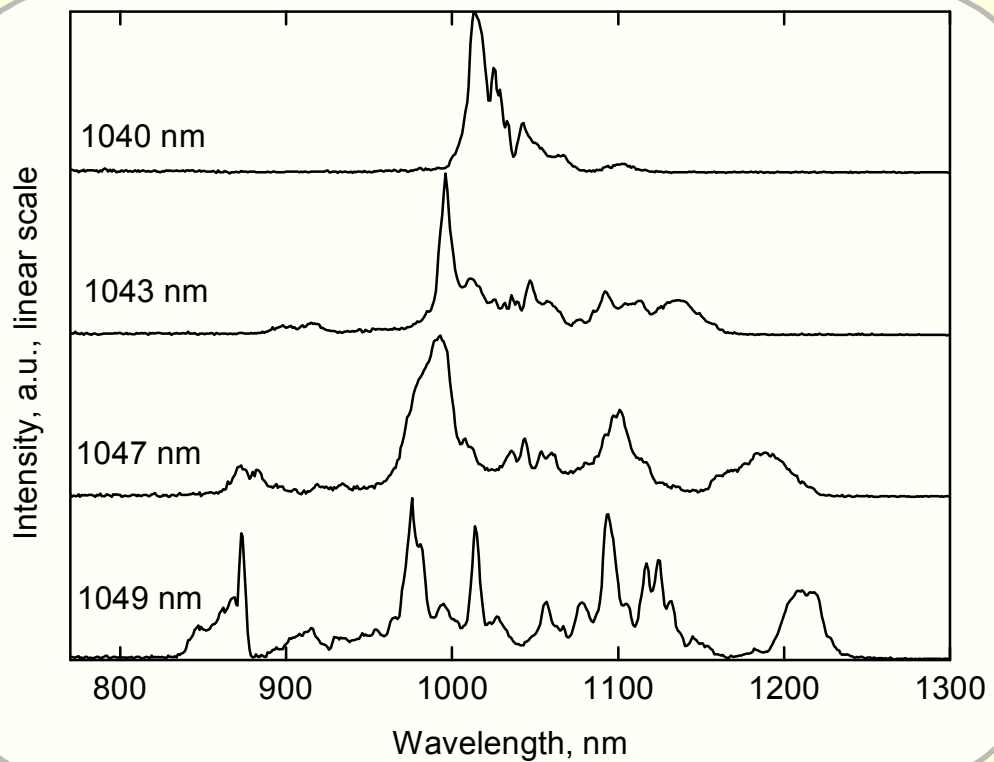
Application for supercontinuum generation

Evolution of the continuum generated in holey fiber (SC-5.0-1040, Crystal Fiber) upon variation of wavelength



Pump power (~130 mW) was fixed, we varied wavelength only

Importance of wavelength tunability

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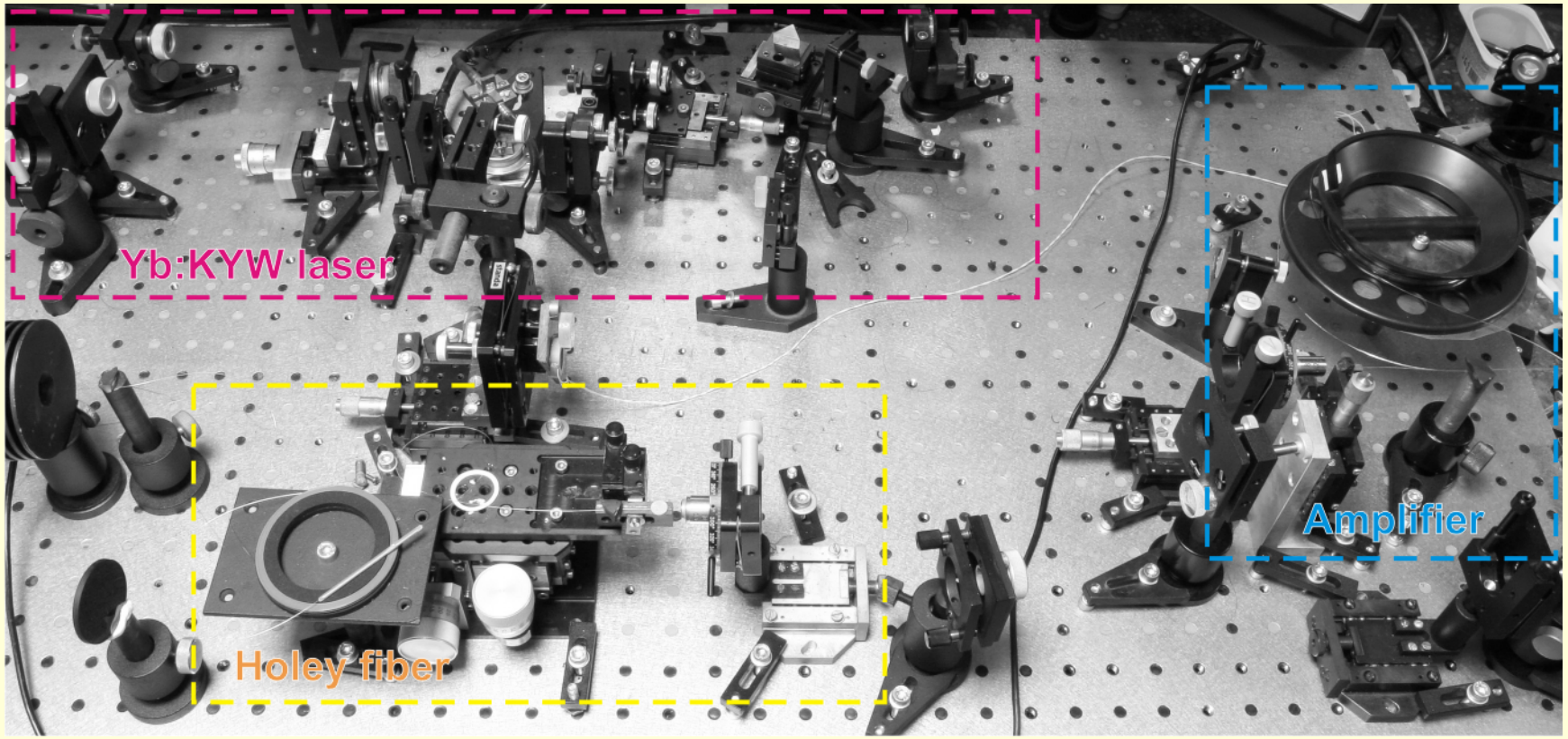
View of experimental setup



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Summary

Hybrid bulk/fiber systems may combine advantages of fibre-based technologies and discrete laser-optical devices.

In the system we implemented, using a mode-locked Yb:KYW laser has the advantage of wavelength-tuneable sub-picosecond pulses, whereas GTWave fibre optical ytterbium amplifier provides an undeniable benefit of high efficiency and ease of use.

Ytterbium GTWave amplifier studied in the present paper will provide high gain not only in systems with solid-state Yb:KYW/KGW lasers, but also with many other lasers that use active media doped with ytterbium: Yb:CALGO, Yb:glass, Yb:BOYS, Yb:SYS, Yb:GdCOB, Yb:YVO_4, Yb:CaF_2.