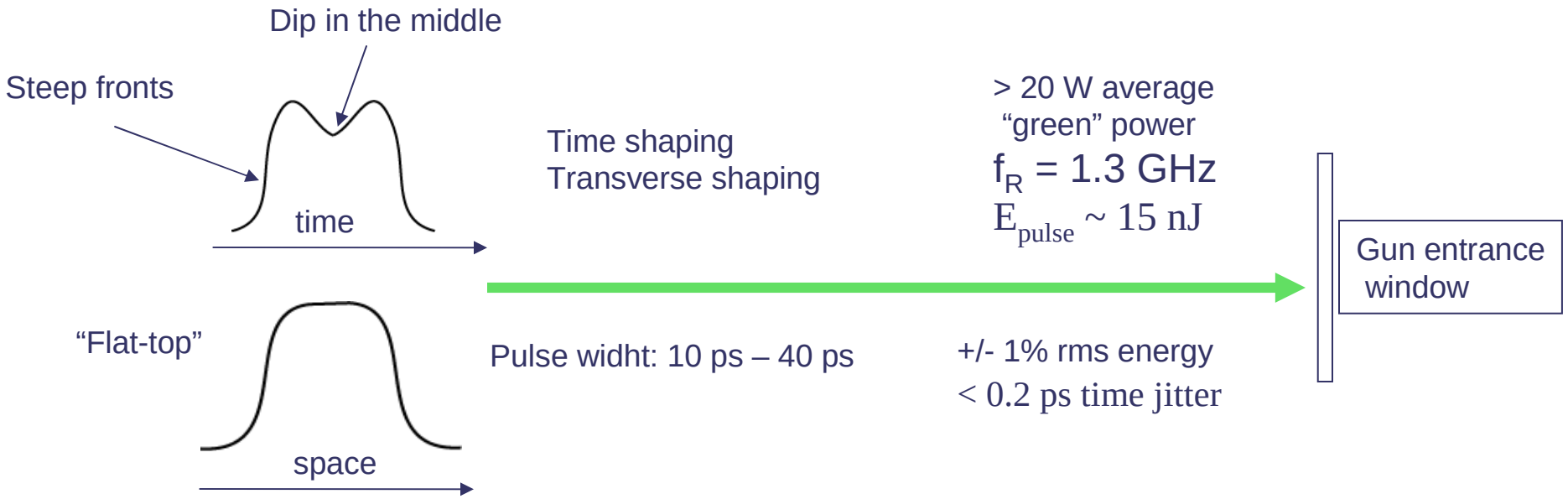
Cornell ERL laser systems

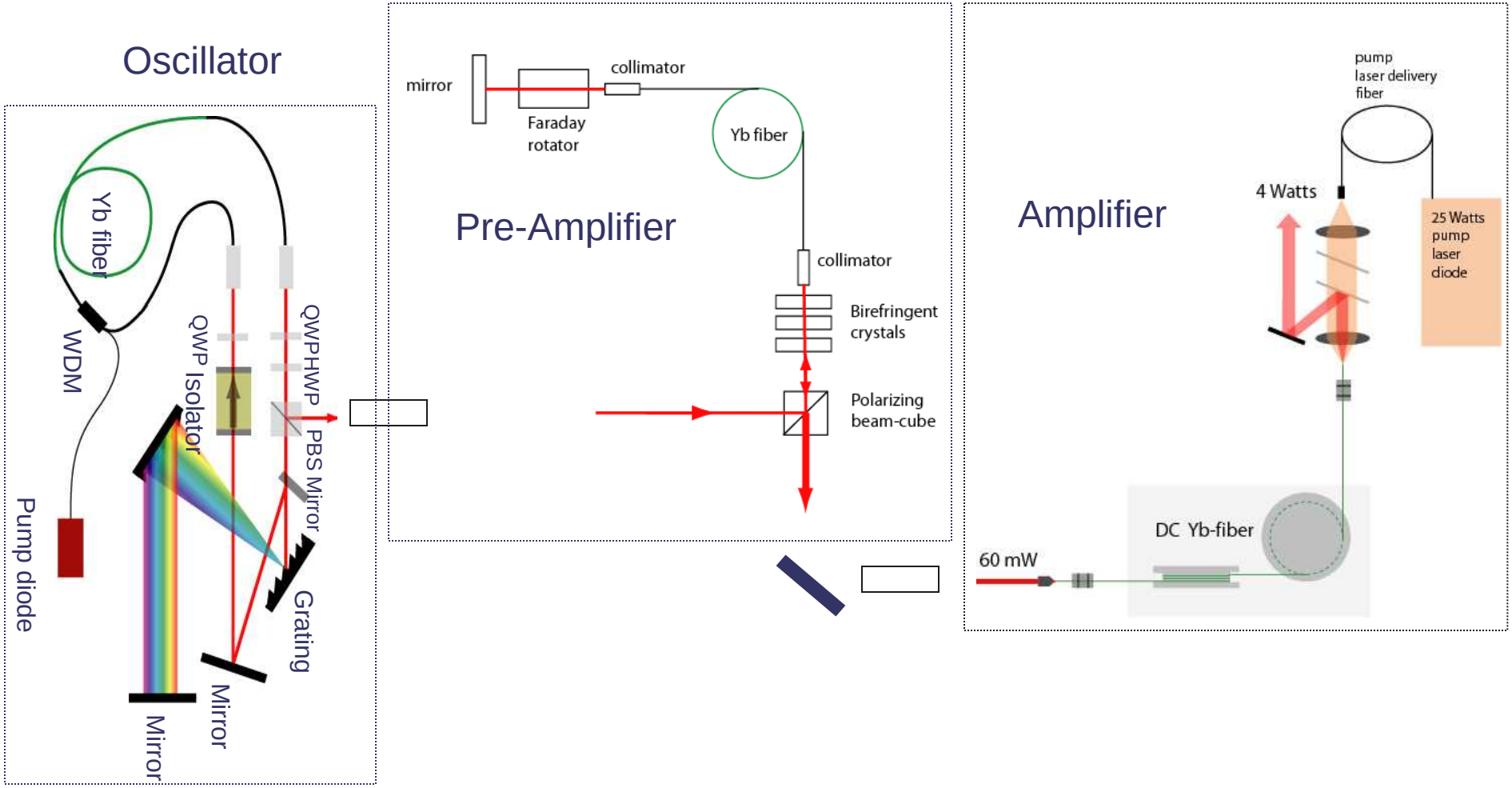
Dimitre Ouzounov

Functional overview



seed | amplifier | Rep-rate control | SHG | Time and space shaping

The 50 MHz amplification system



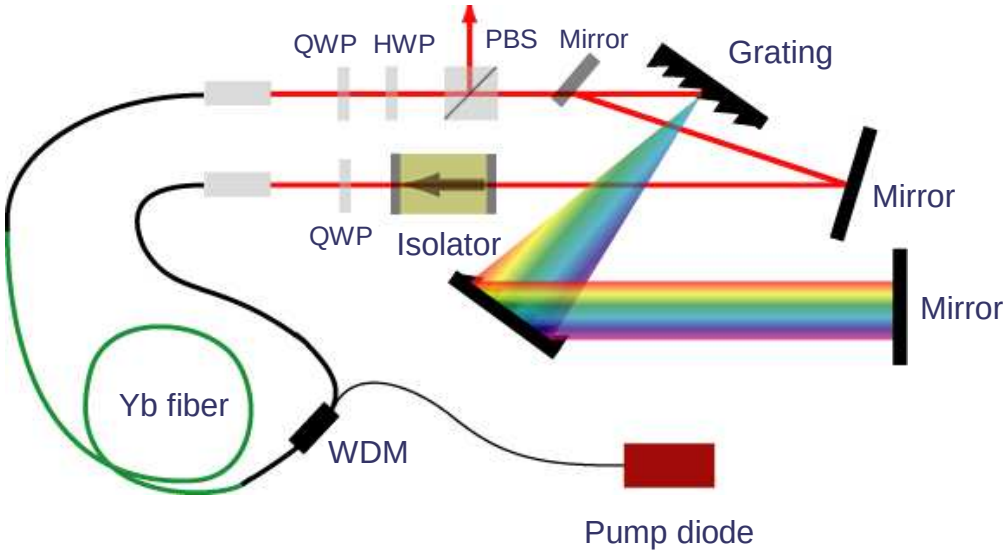
~15 mW
~300 pJ

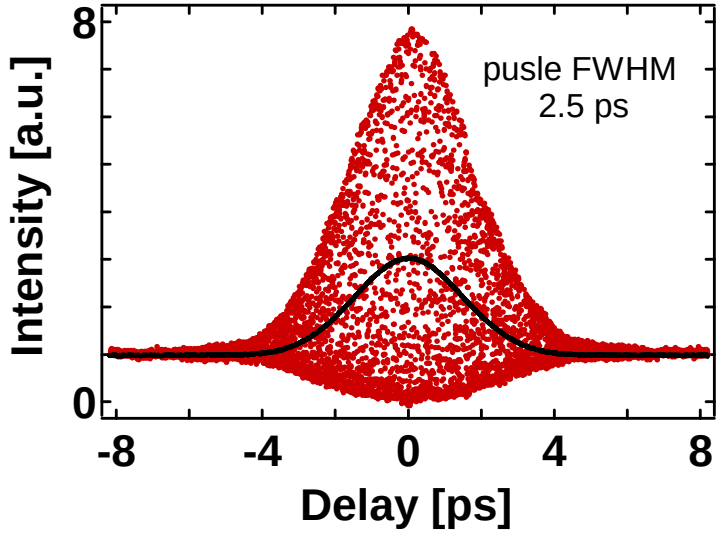
70 mW
1.4 nJ

>5 W
>100 nJ

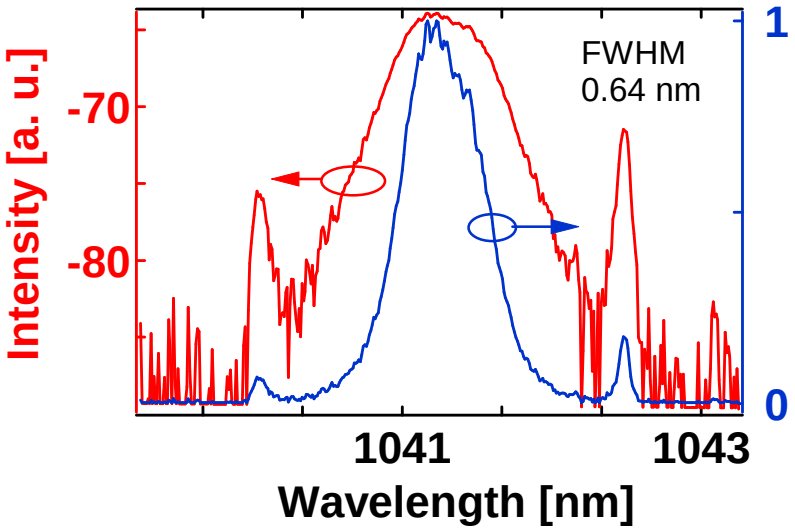
The 50 MHz amplification system

The Oscillator

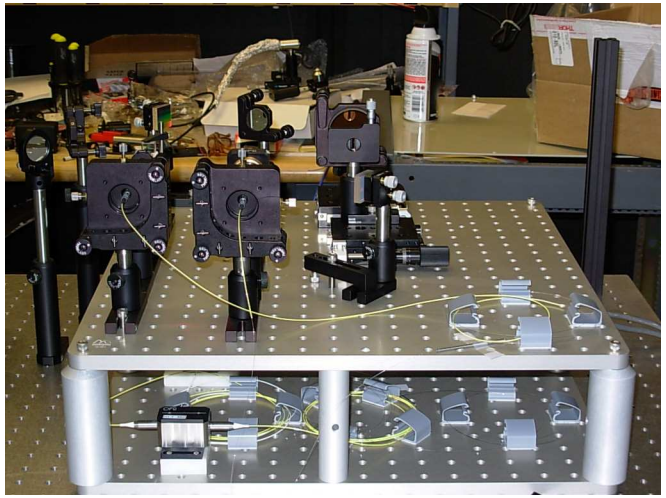


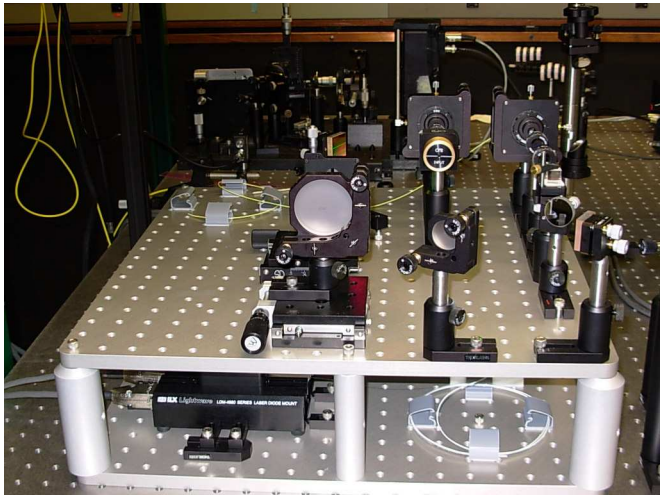


λ = 1041 nm
pulse duration ~ 2.5 ps
power ~ 15 mW
f_r ~ 50 MHz
TBWP ~ 0.41

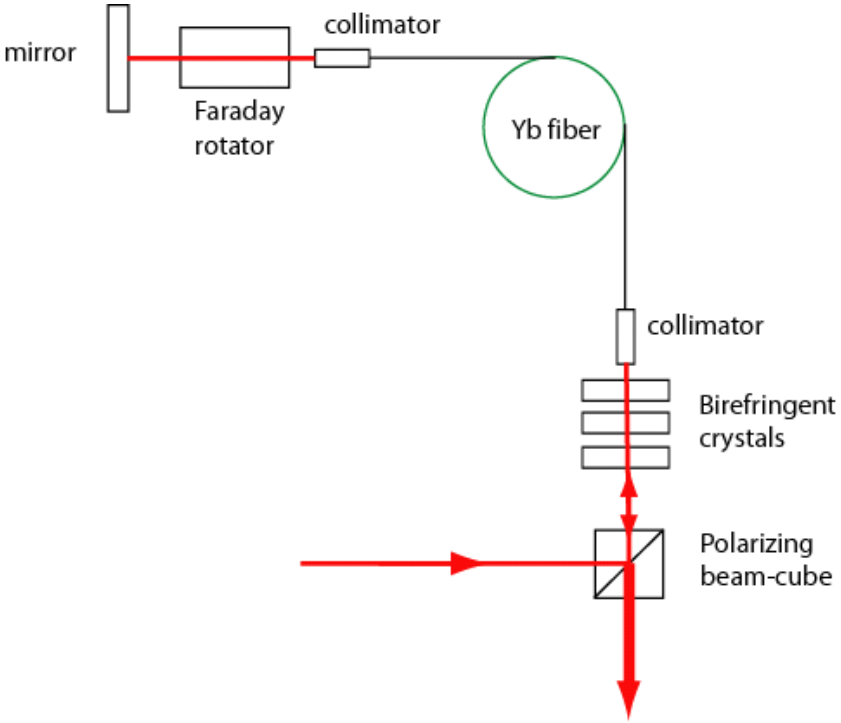


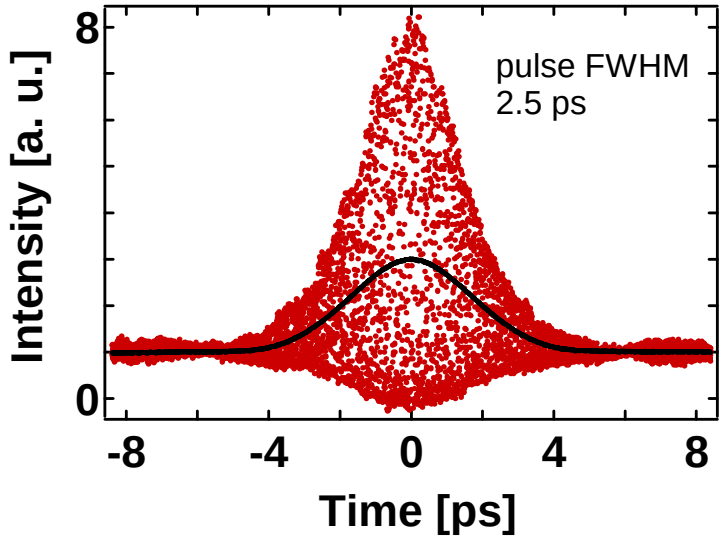
The Oscillator



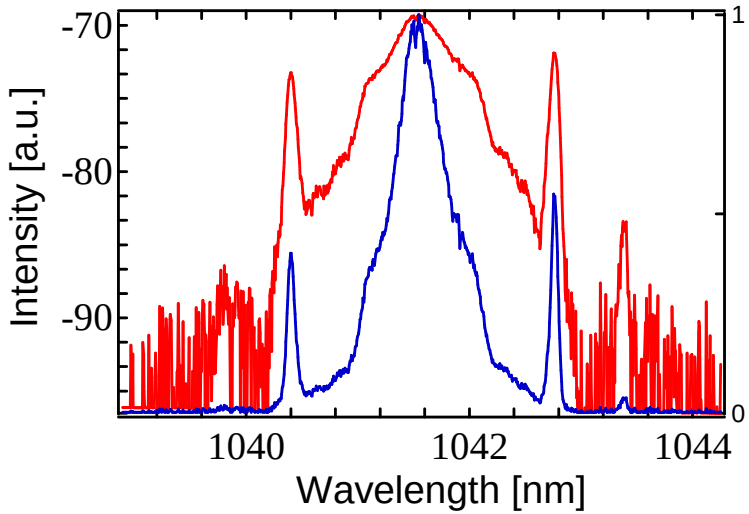


The pre-amplifier

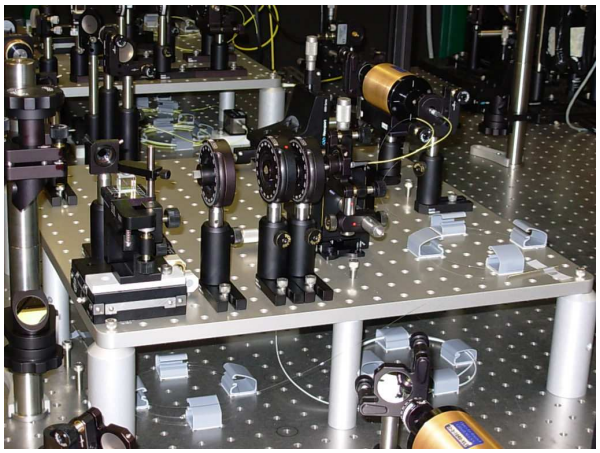


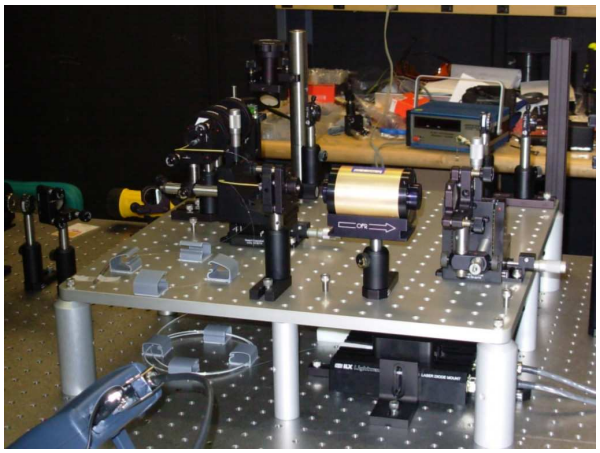


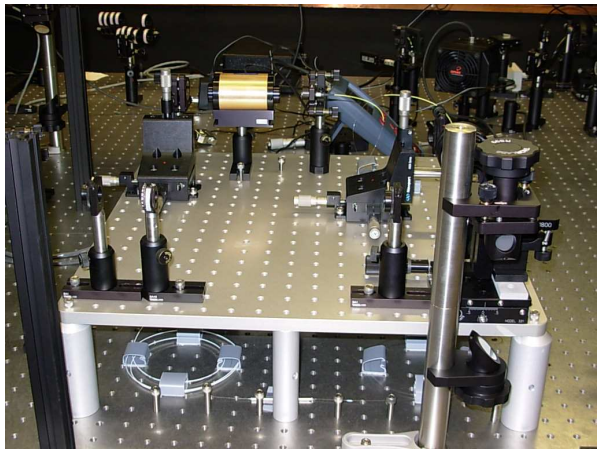
Pulse energy of 1.4 nJ
Average power of 70 mW
Peak power of 540 W



The pre-amplifier

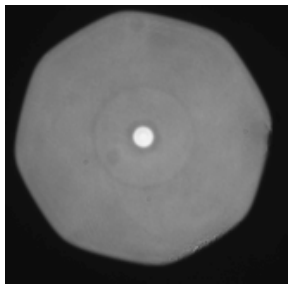




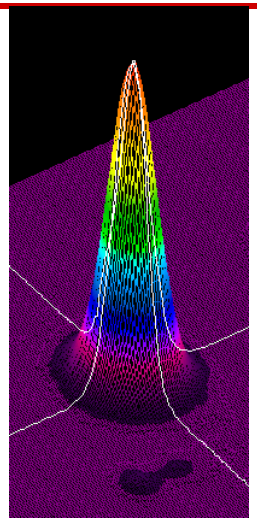


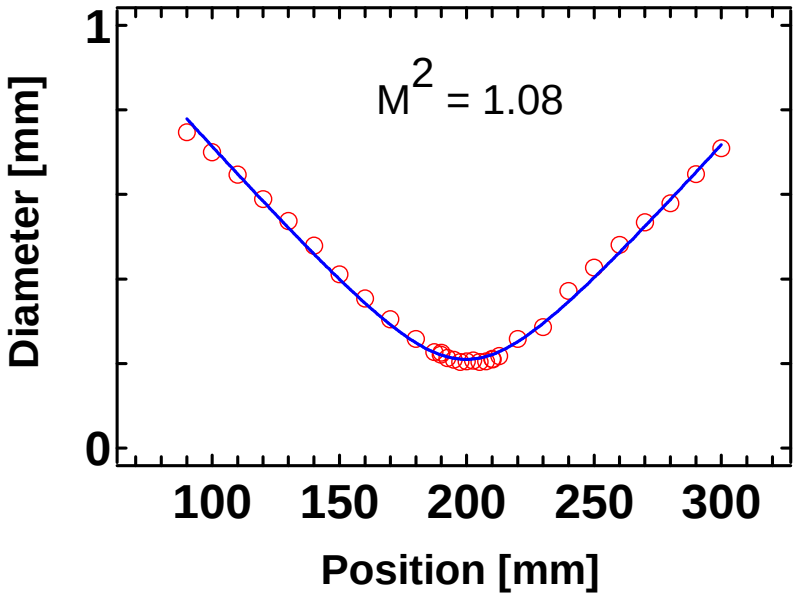
The Amplifier

DC LMA fiber



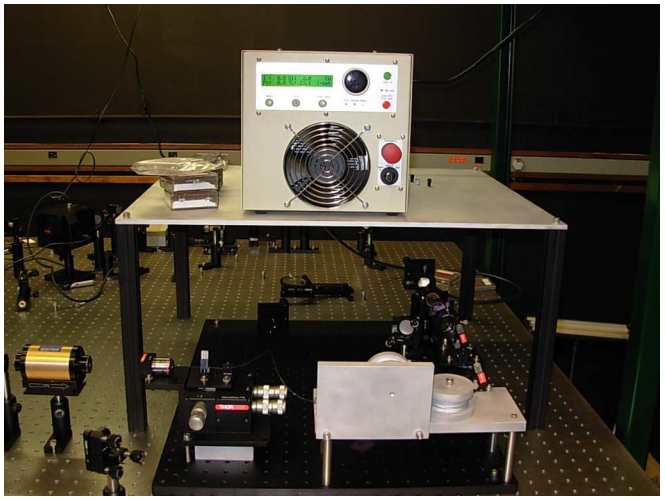
Liekki Yb1200-30/250



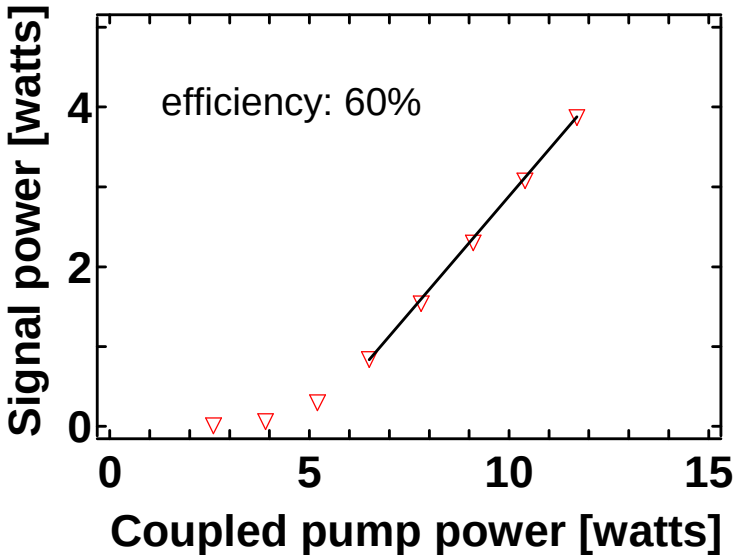


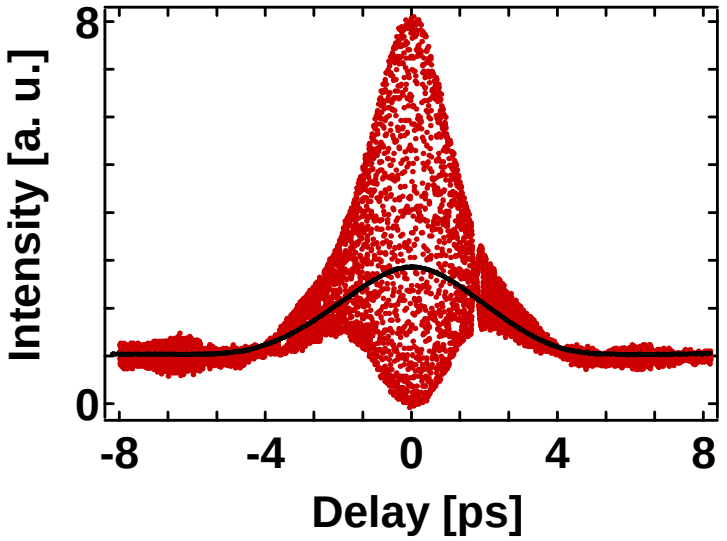
The DC fiber is coiled in two orthogonal planes to strip high-order modes.

The Amplifier

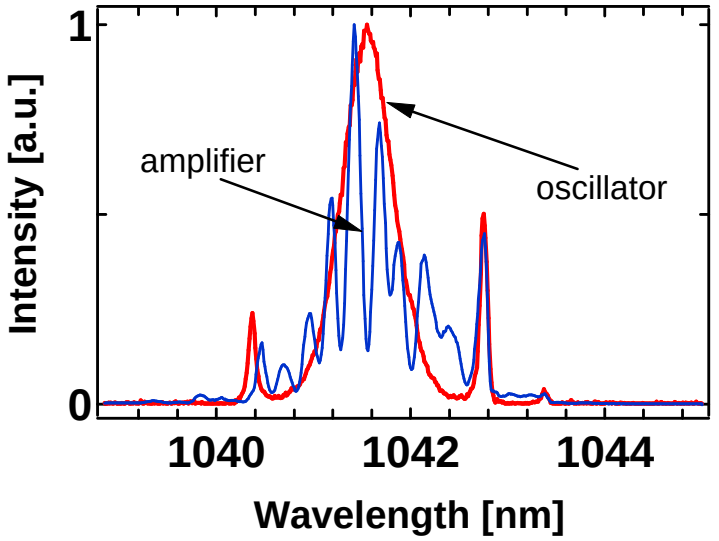


Amplified pulse characterization

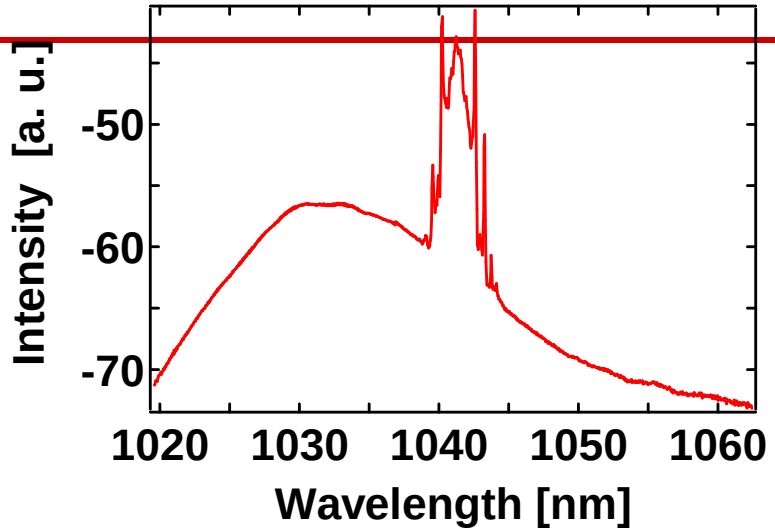


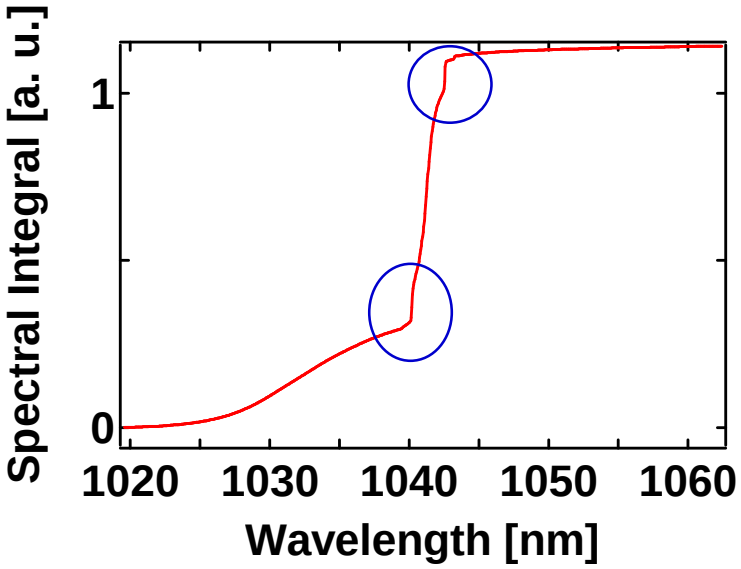


Average power: 4 W



Side-Bands amplification

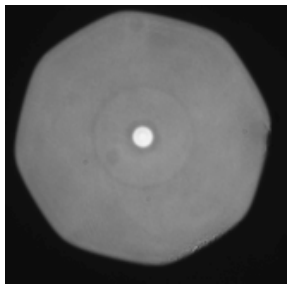




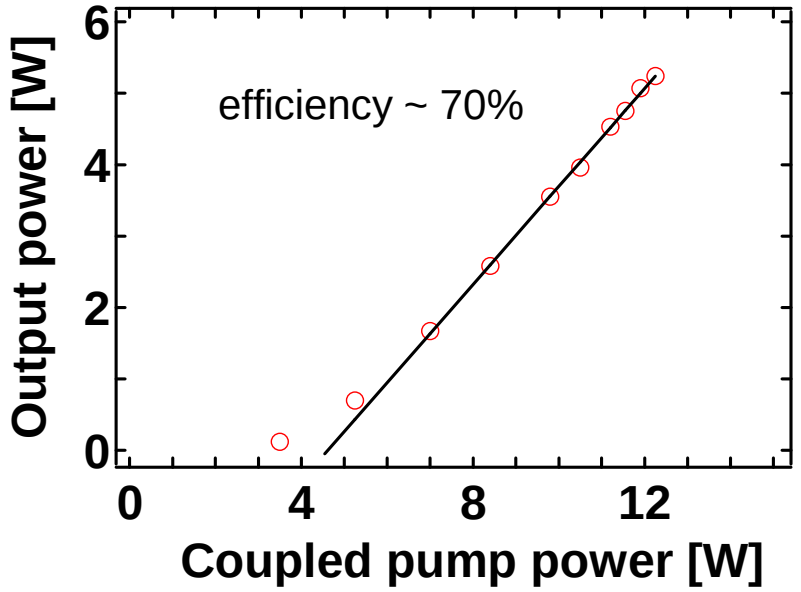
Side-Bands contributes to about 20% of the output power.

PM LMA fiber amplifier

DC LMA fiber

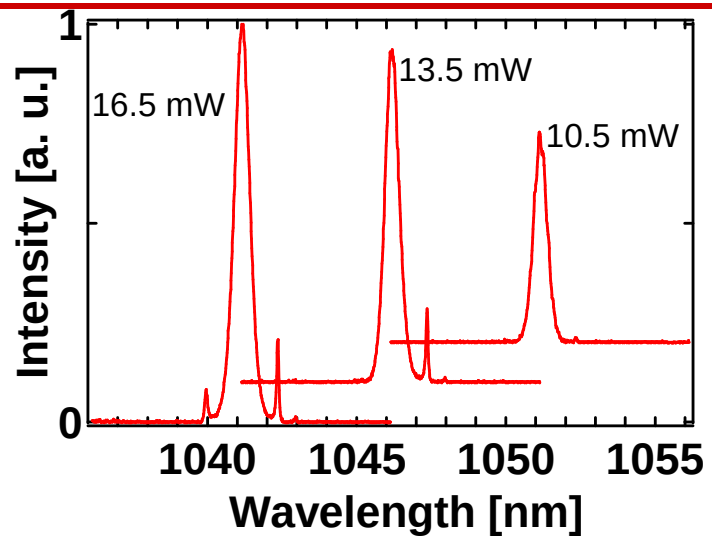


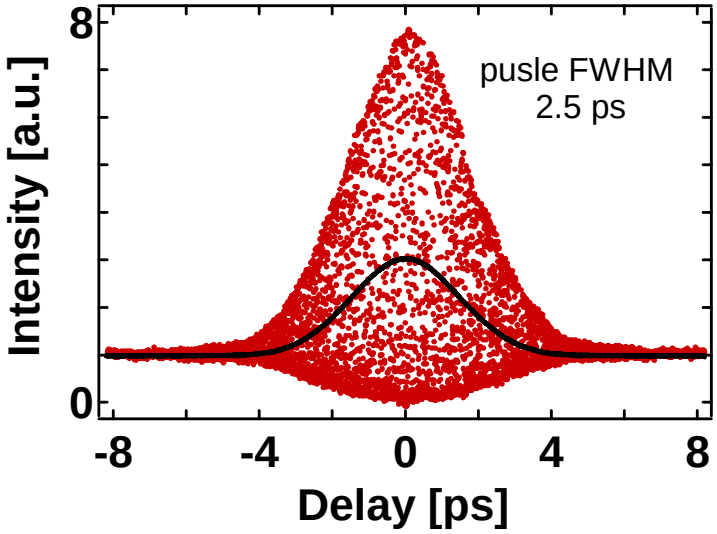
Liekki Yb1200-30/250-PM

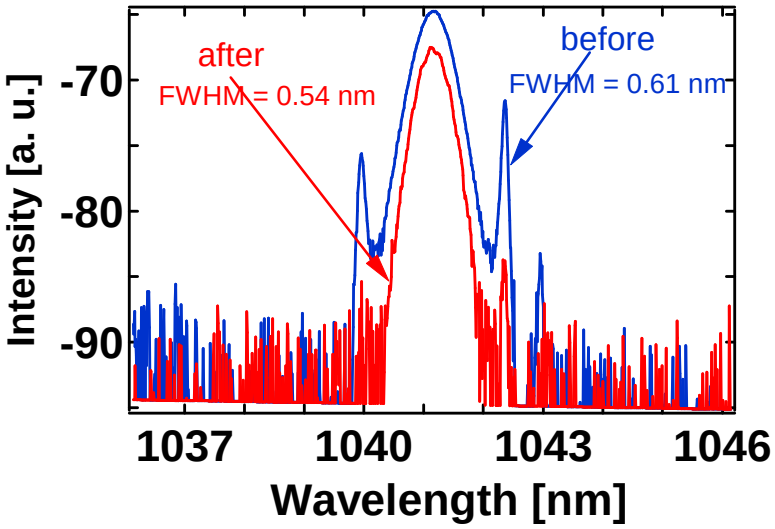


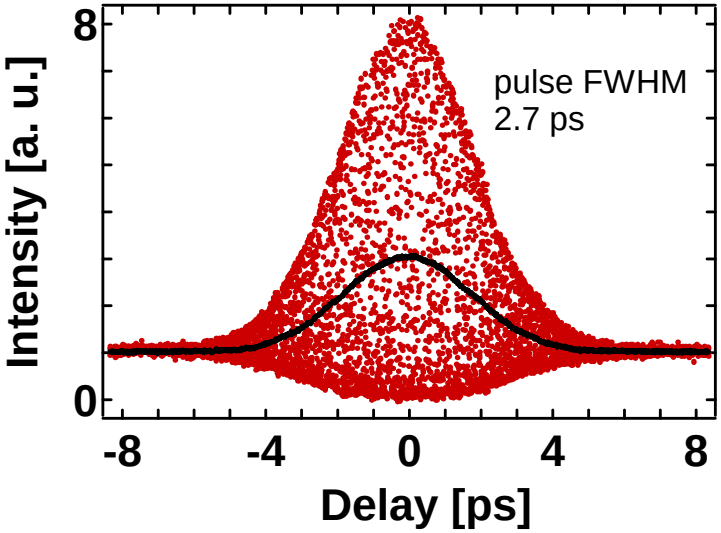
The DC fiber is coiled in two orthogonal planes to strip high-order modes.

Spectral Side-Bands cut





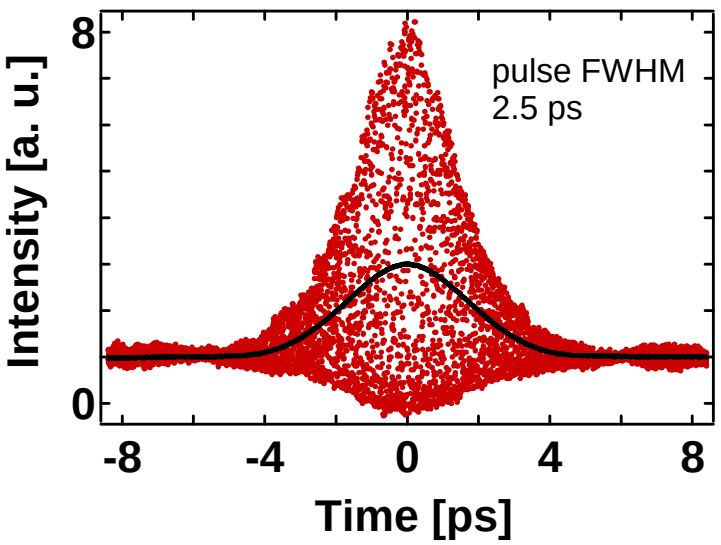


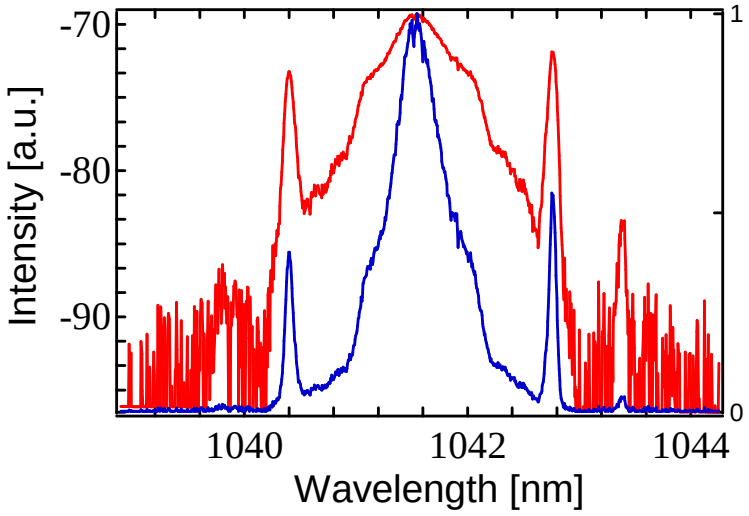


Side-Bands removed with narrowband filters

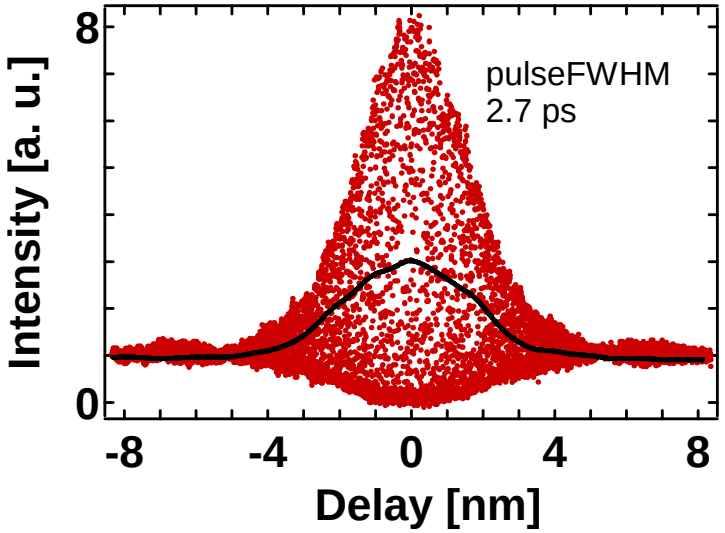
Pulse pre-amplification

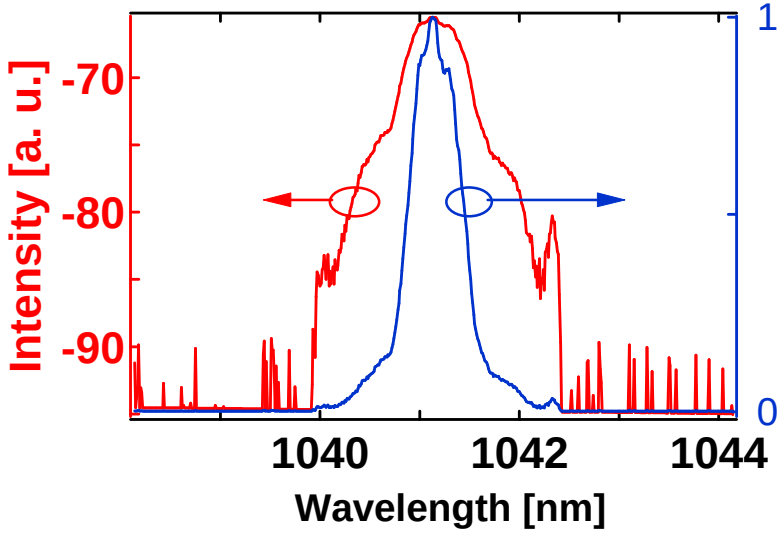
with side-bands



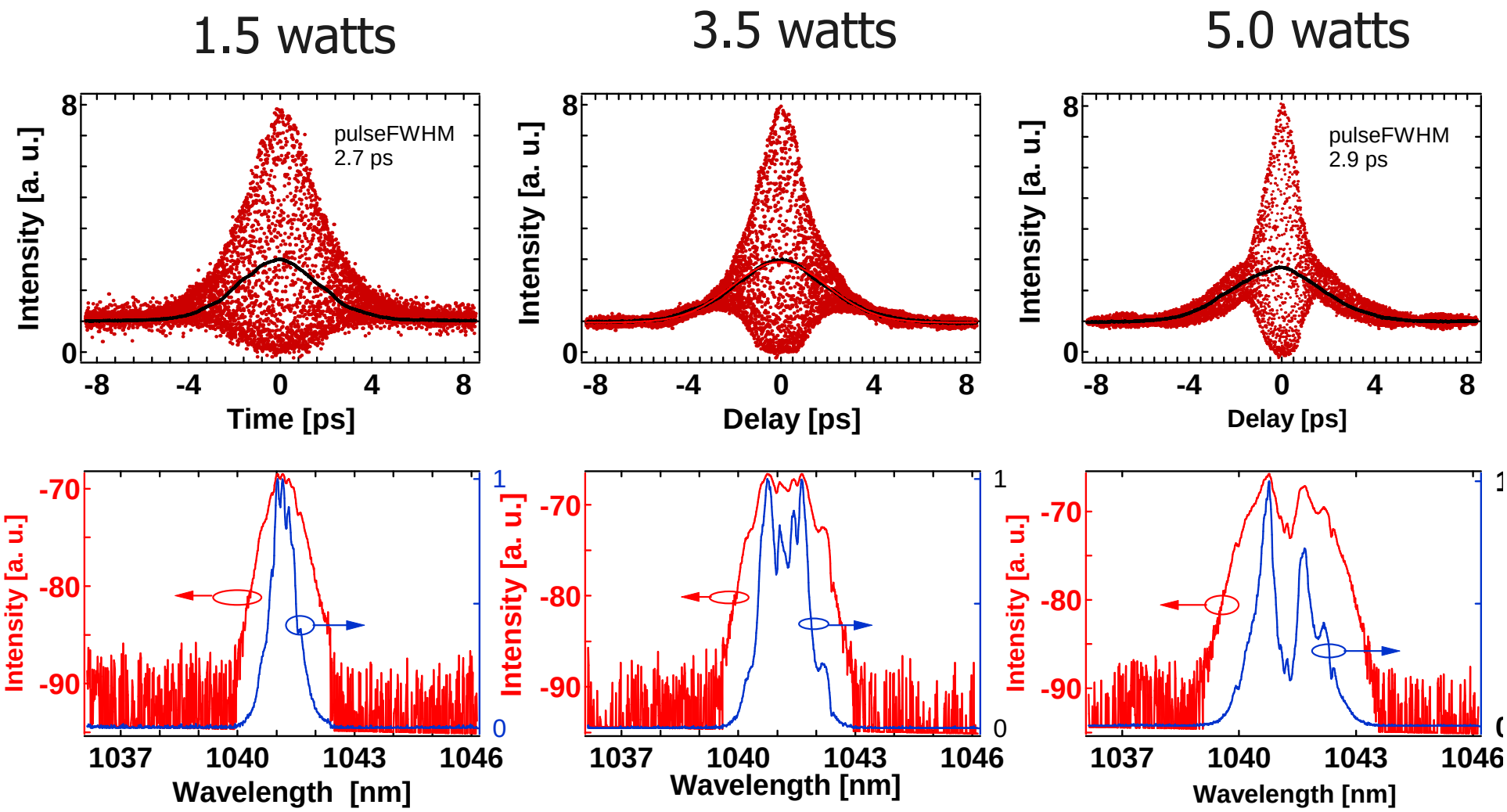


no side-bands

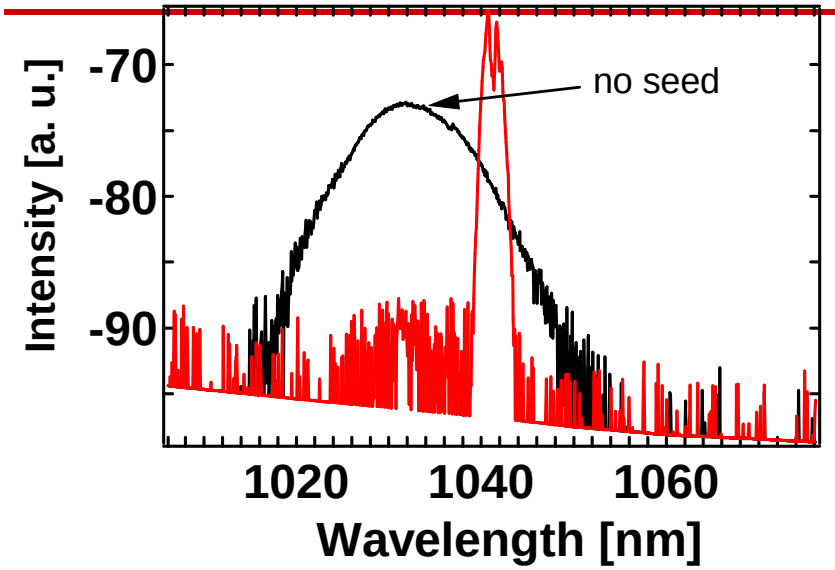


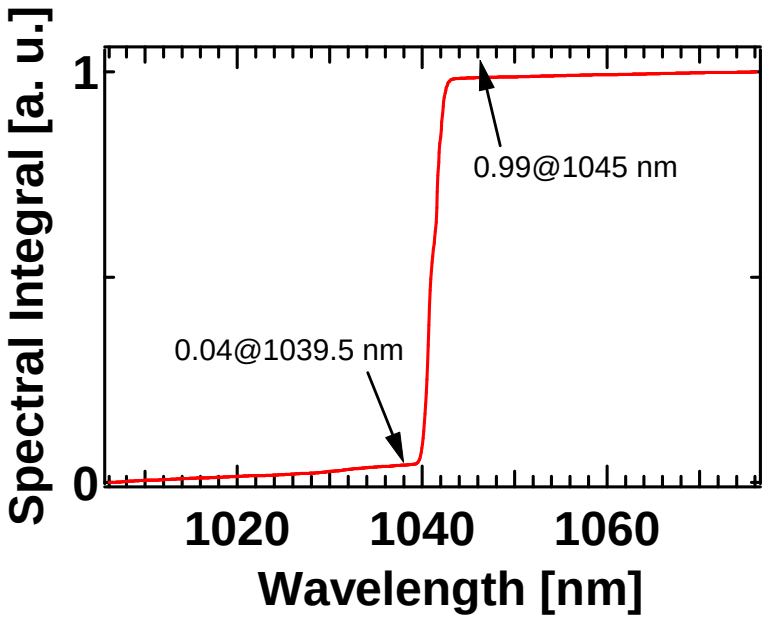


Amplified pulses



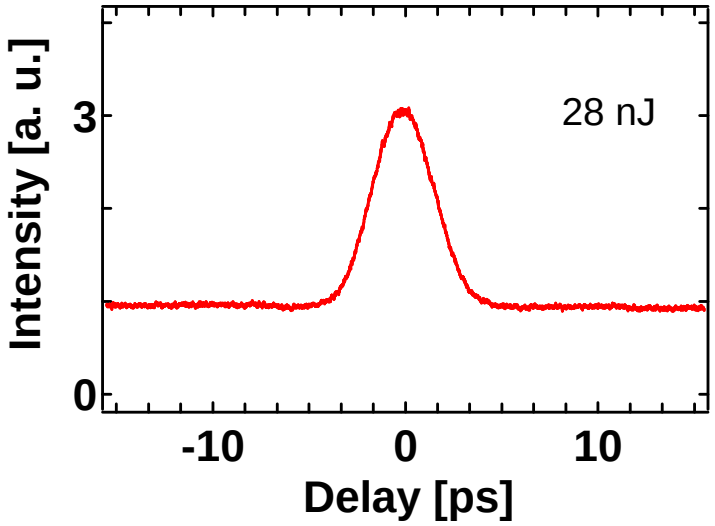
ASE estimation

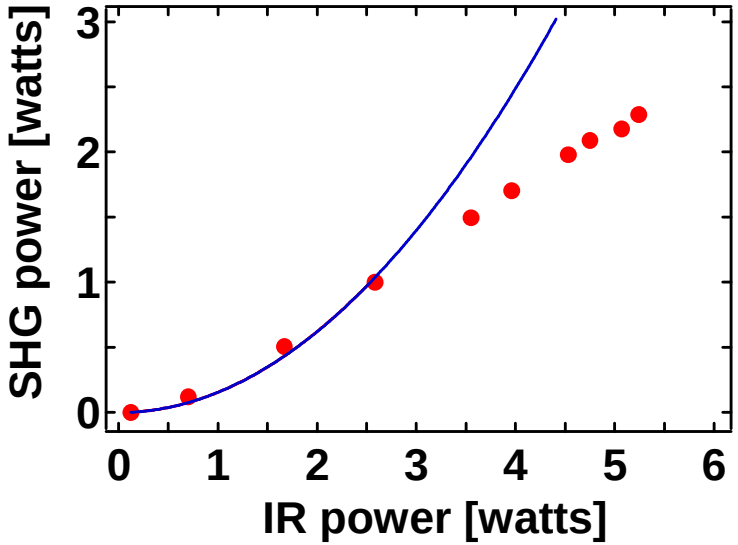




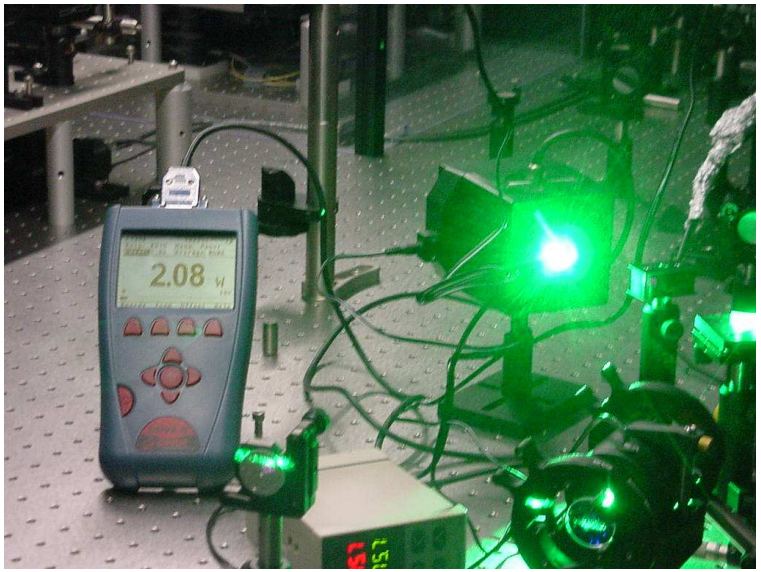
- 25 dB spectral contrast
- no amplified side bands
- ASE contributes around 5% to the output power

SHG



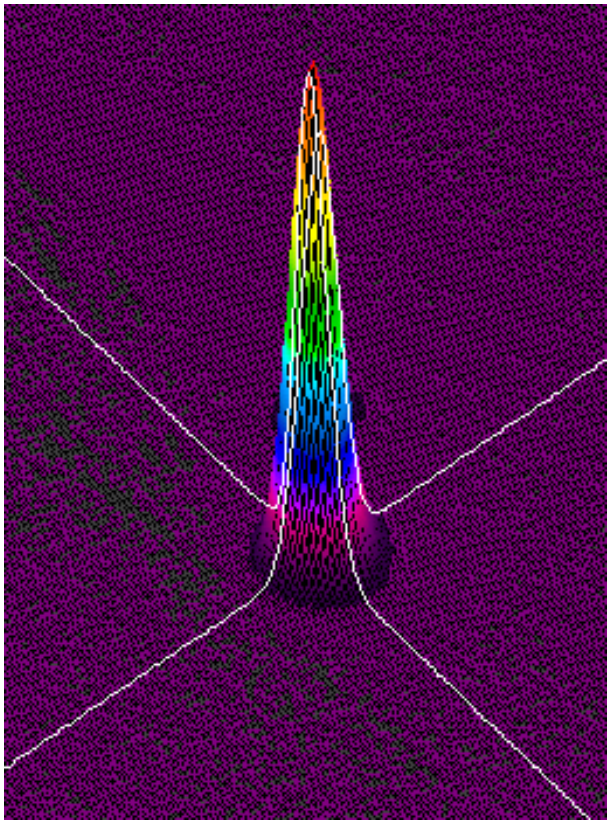


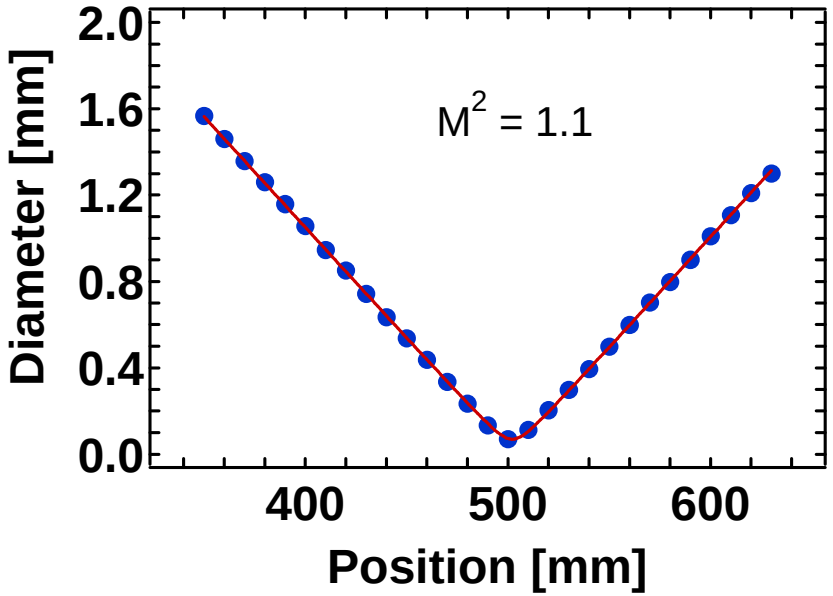
15-mm-long LBO crystal
non-critically phase
temperature tuning



~ 44% efficiency at 100 nJ IR pulse
~ 44 nJ green pulse

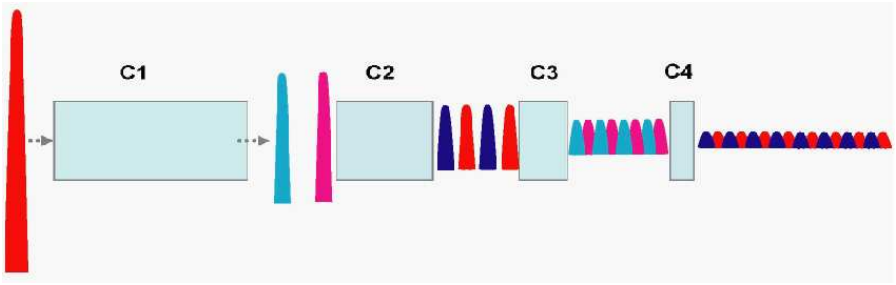
SHG: beam quality

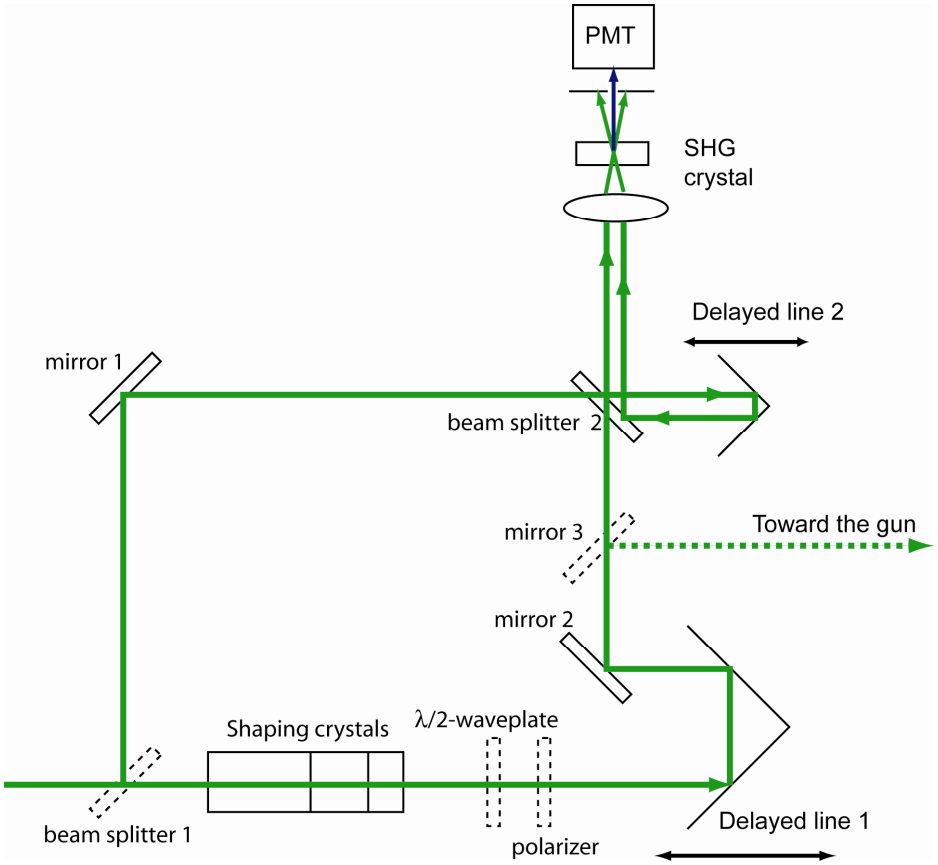


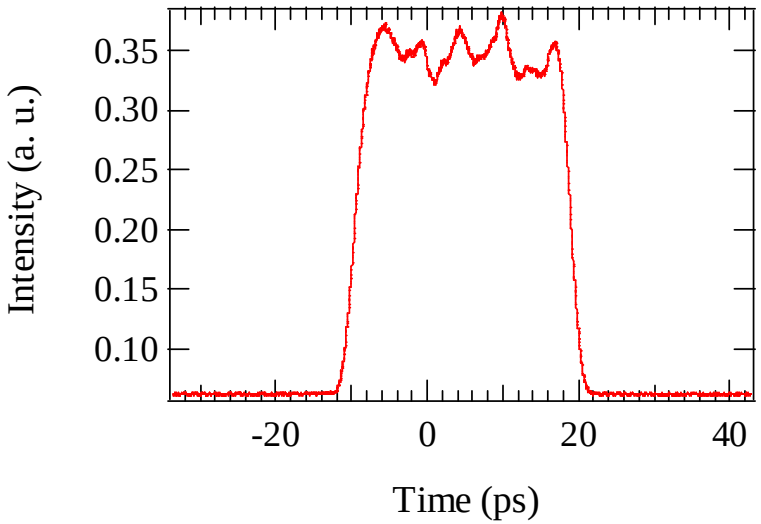


The SHG beam is near diffraction limited

Longitudinal shaping



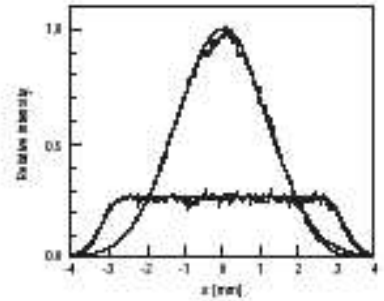




Transverse shaping

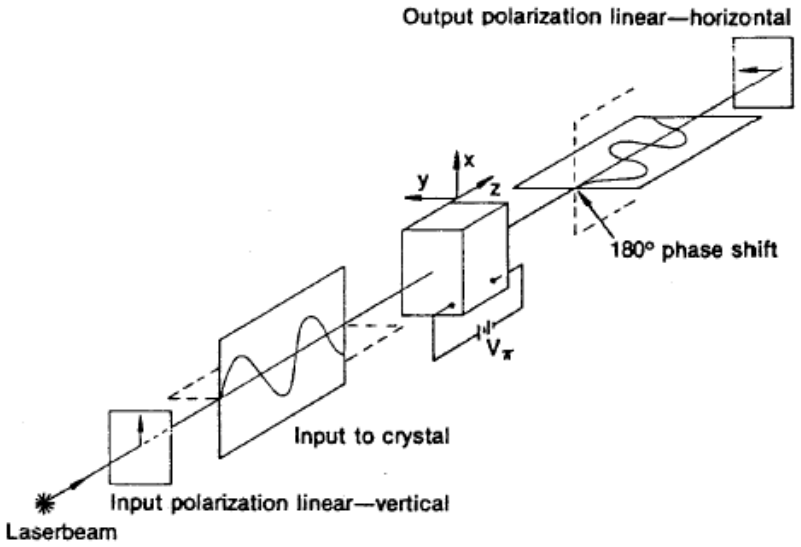
Newport Refractive Beam Shaper

Input Beam



Cross Sections of the Input and Output Beams

Rep rate control



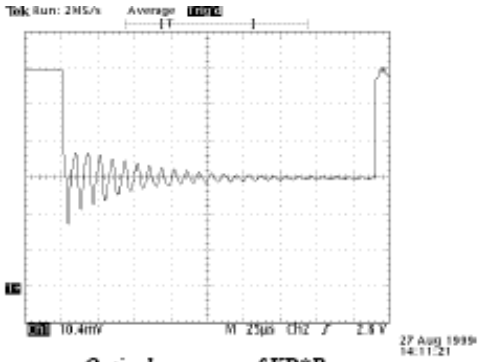
Pockels cell

linear electro-optical effect

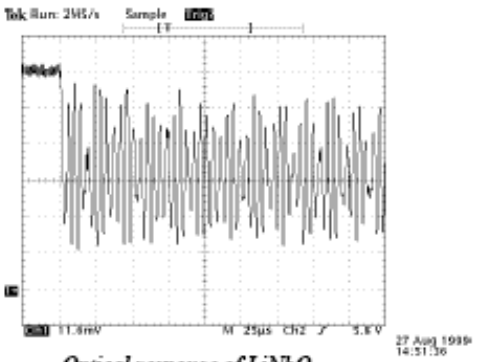
piezoelectric effect – excitation of acoustic modes in the crystal

photoelastic effect – refractive index change through mechanical deformation

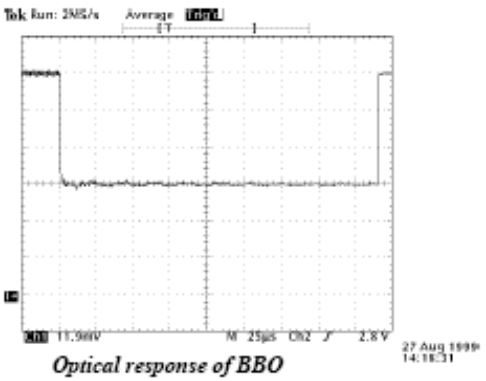
BBO Pockels cell



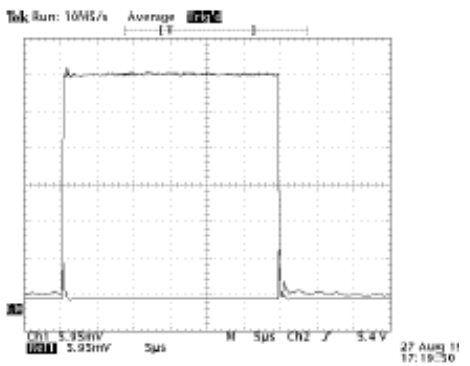
*Optical response of KD*P Pockels cell.*



Optical response of $LiNbO_3$ Pockels cell.



Optical response of BBO Pockels cell.



Optical response of BBO Pockels cell. Lower trace is with beam blocked

1.3 GHz system