SOFIA iodine laser system as a driver for OPCPA
(Solid-state Oscillator Followed by Iodine Amplifiers)

Jan Dostál, Martin Divoký, Martin Smrž, Ondřej Novák, Jaroslav Huynh
Faculty of Nucl. Sciences & Physical Engineering, Czech Technical University, Prague, Czech Republic
e-mail: dostal@ipp.cas.cz

Lukáš Král, Božena Králiková, Petr Straka, Hana Turčičová
Institute of Physics, Academy of Sciences of the Czech Republic, Prague

Introduction

Iodine photodissociation lasers are characterized by a low saturation energy and a high amplification. They are mainly operated in a single shot regime. The population inversion is achieved by the photodissociation of a fluorinated iodide, e.g. C_3F_7I, by UV light of 270 nm (Xe flashlamps).

High power iodine lasers are supposed to be excellent OPCPA drivers due to a high cross-section homogeneity and a smooth temporal profile [1]. On the other side, the OPCPA technique presents a unique possibility for the iodine laser to transfer its energy to an ultrashort high-intensity pulse, as its gain bandwidth is very narrow (~10 pm) and therefore the classical CPA cannot be used.

SOFIA laser system (a driver)

SOFIA has been built up as a test iodine OPCPA driver aiming to convert 20J@1ns to 1J@30fs. Its peculiarity is the use of a narrow band Optical Parametric Oscillator (MOPO-HF, Spectra Physics) as a solid-state oscillator that is followed by gaseous iodine laser amplifiers, see fig. 1,2,3.The OPO idler is tuned to match the iodine line 1315 nm. Using the solid-state oscillator enables a precise synchronization of this driver with the signal beam source, i.e. an ultrashort -pulse Ti:sapphire laser, see fig. 4.

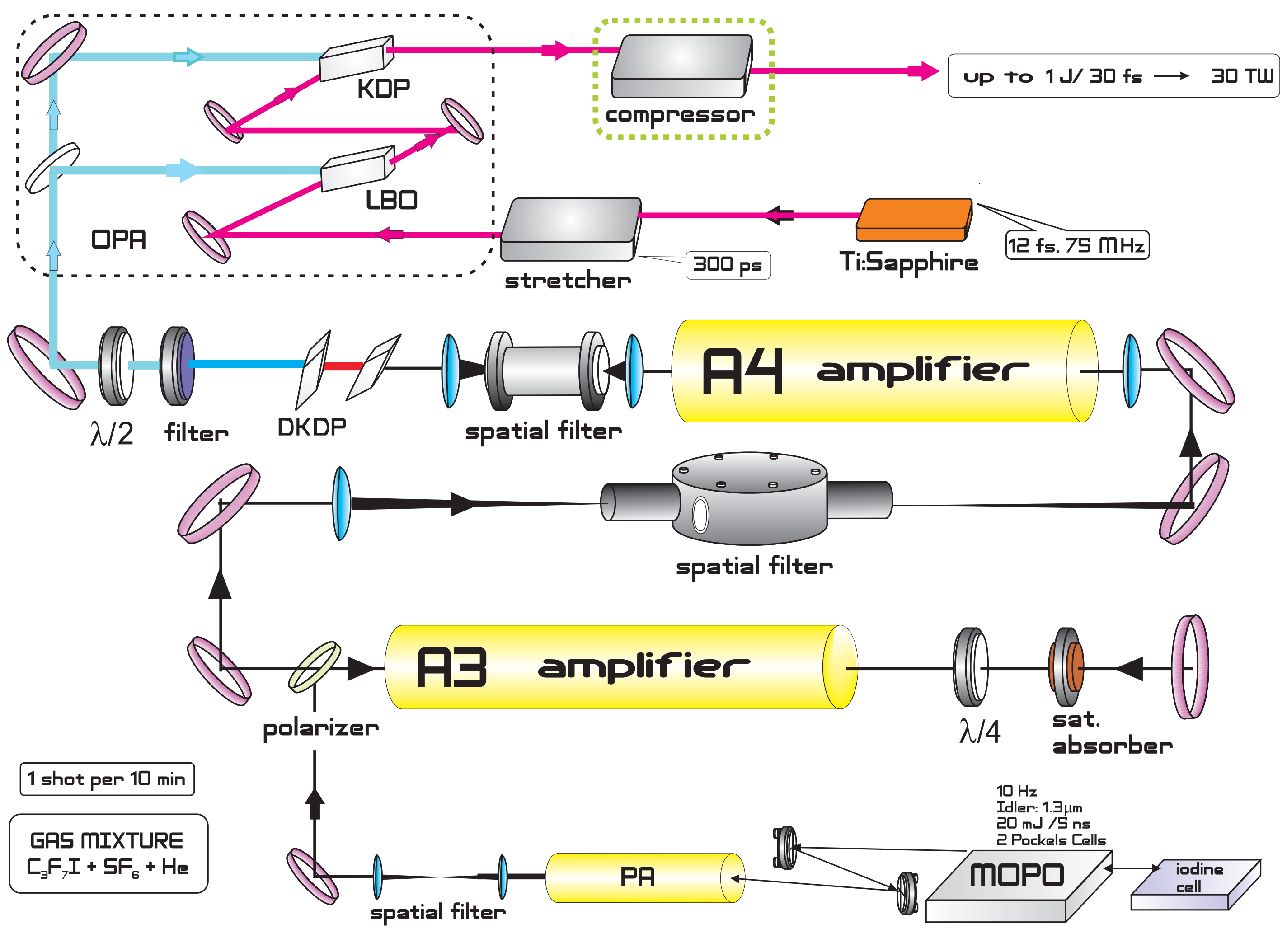

Fig. 1. Scheme of SOFIA laser system and its integration into the OPCPA system. The final goal is a beam of 1 J compressed to 30 fs. A three-stage OPA will substitute the present two-stage one.

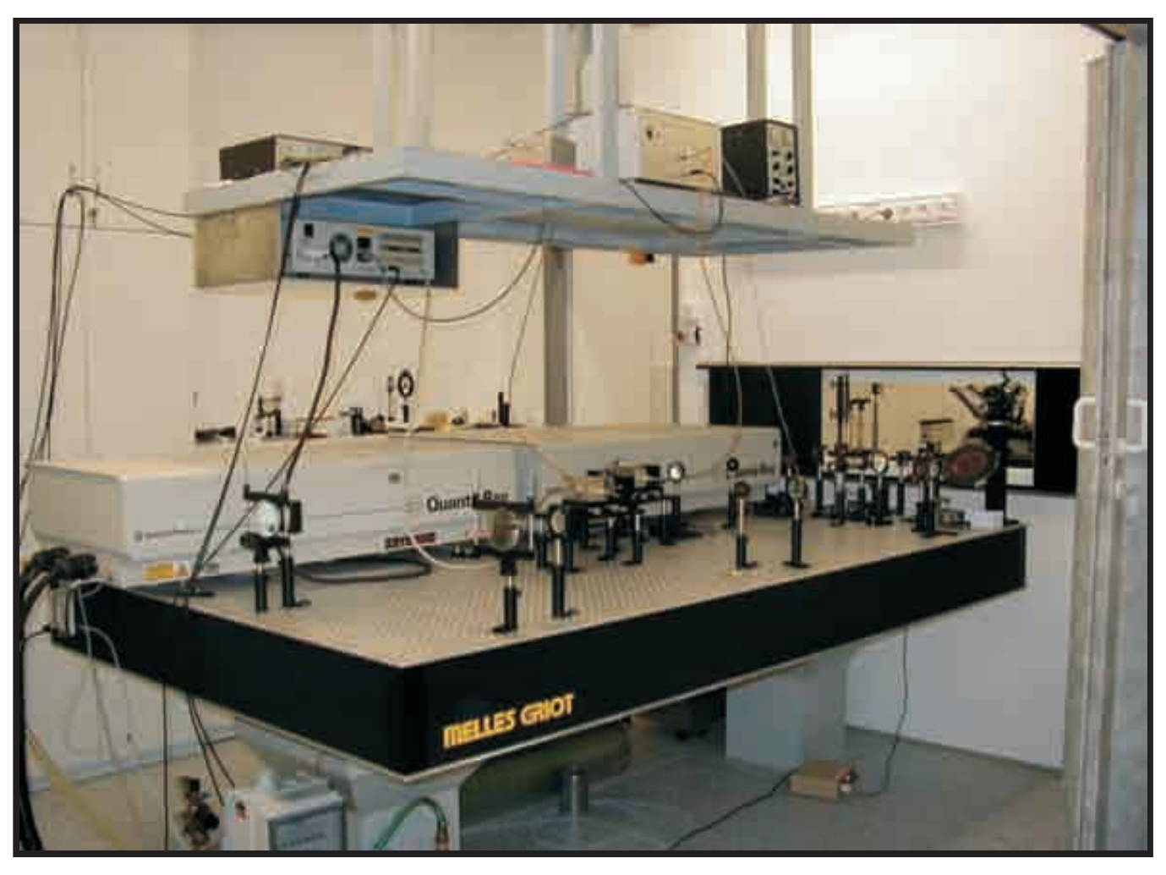

Fig. 2. SOFIA front-end (OPO and Pockels cells).

Fig. 3. View of SOFIA hall.

Synchronization of devices for the OPCPA

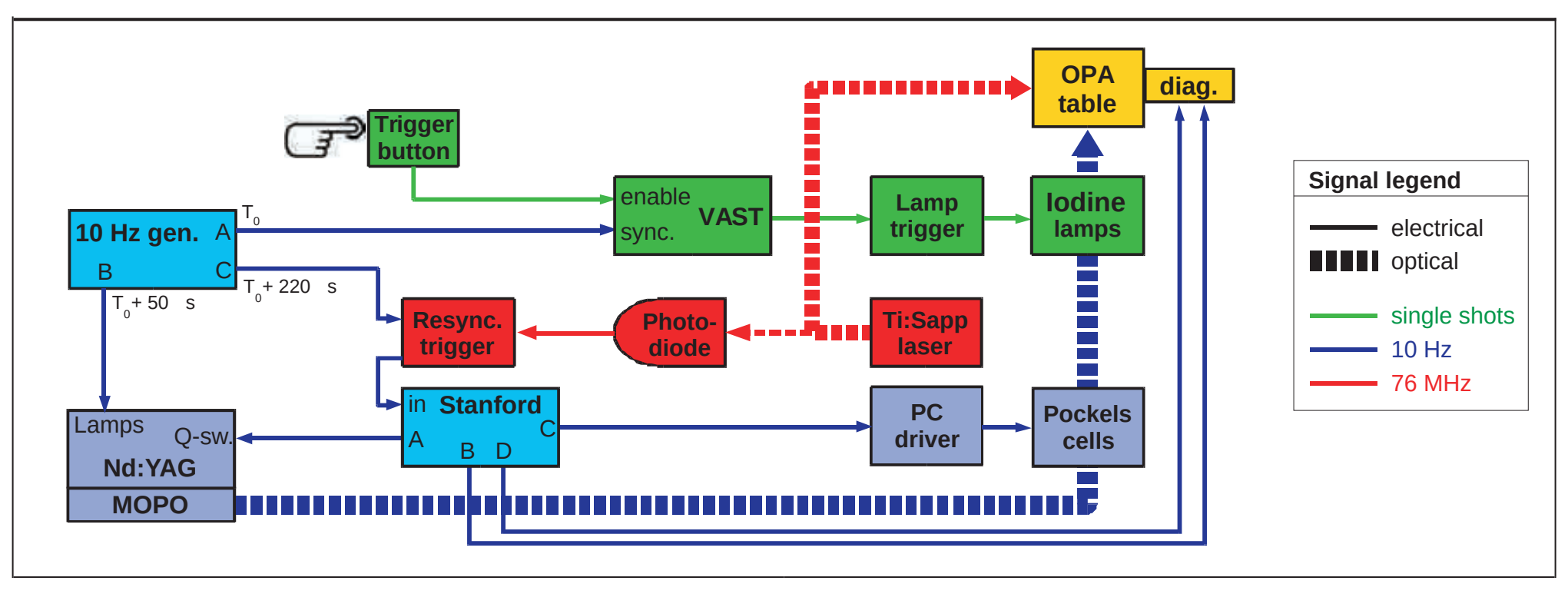

Fig. 4. Scheme of synchronization of OPO and Ti:sapphire laser

The precise temporal overlap of the signal and pump beams in OPA crystals is controlled by a home made *Resync. trigger* that synchronizes Ti:sapp pulses (75 MHz) with Nd:YAG lamps and Q-switch, then Pockels cells and the single shot iodine lamps.

OPO automatic stabilization system

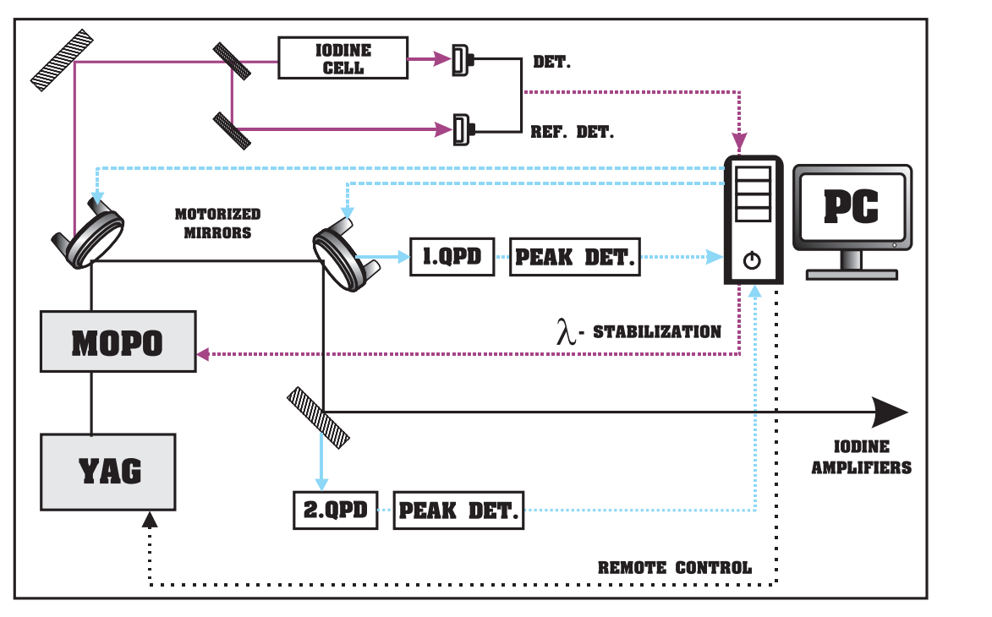

Fig. 5. The automatic stabilization of wavelength and spatial position of OPO idler beam

Owing to very narrow spectral lines of both iodine amplifiers and the OPO idler(~10 pm), their wavelenghts must be thoroughly matched. Moreover, the spatial position of the idler has to be fixed. Therefore an automatic stabilization system controlled by PC via a hot iodine cell was produced [2] with a precision better than 1 pm. Subsequently, the spatial position of the idler beam has been automatically fixed via two quadcells [3],see fig. 5.

Signal beam for OPCPA

The seeding ultrashort signal beam is produced by a Ti:sapphire oscilator (12 fs, 75MHz, 10 nJ, Femtolaser). The pulse is stretched in a home made pulse stretcher (see fig. 6,7) from 12 fs to 300 ps. The stretcher is based on a single diffraction grating and an Öffner telescope. Fig. 7 shows the spectral transmission of the stretcher.

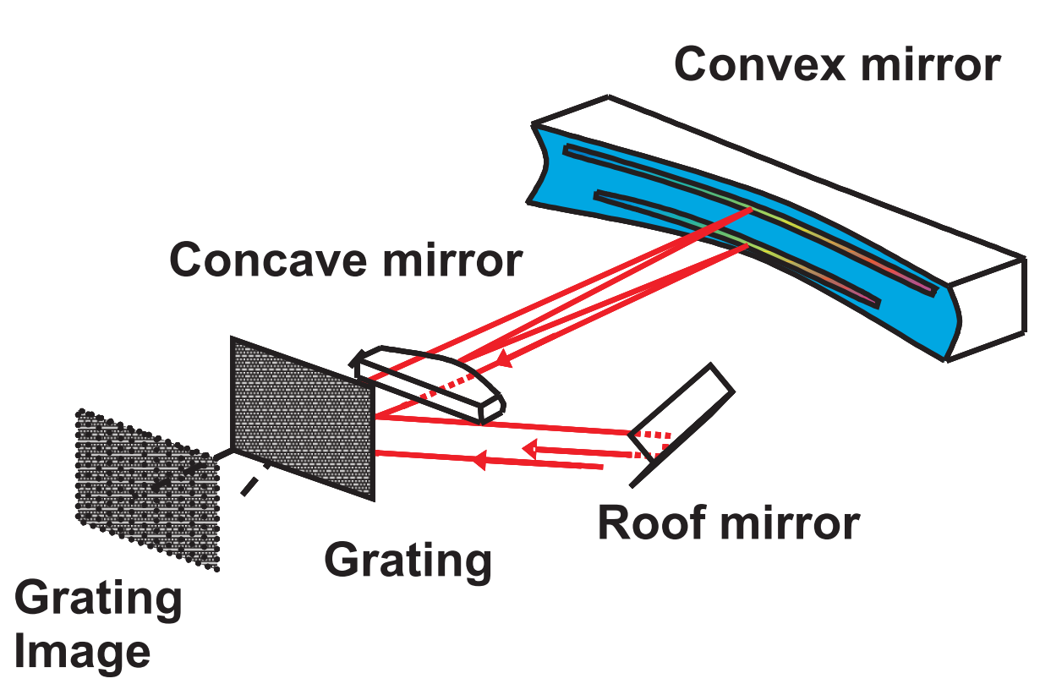

Fig. 6. Optical scheme of our Öffner triplet based pulse stretcher

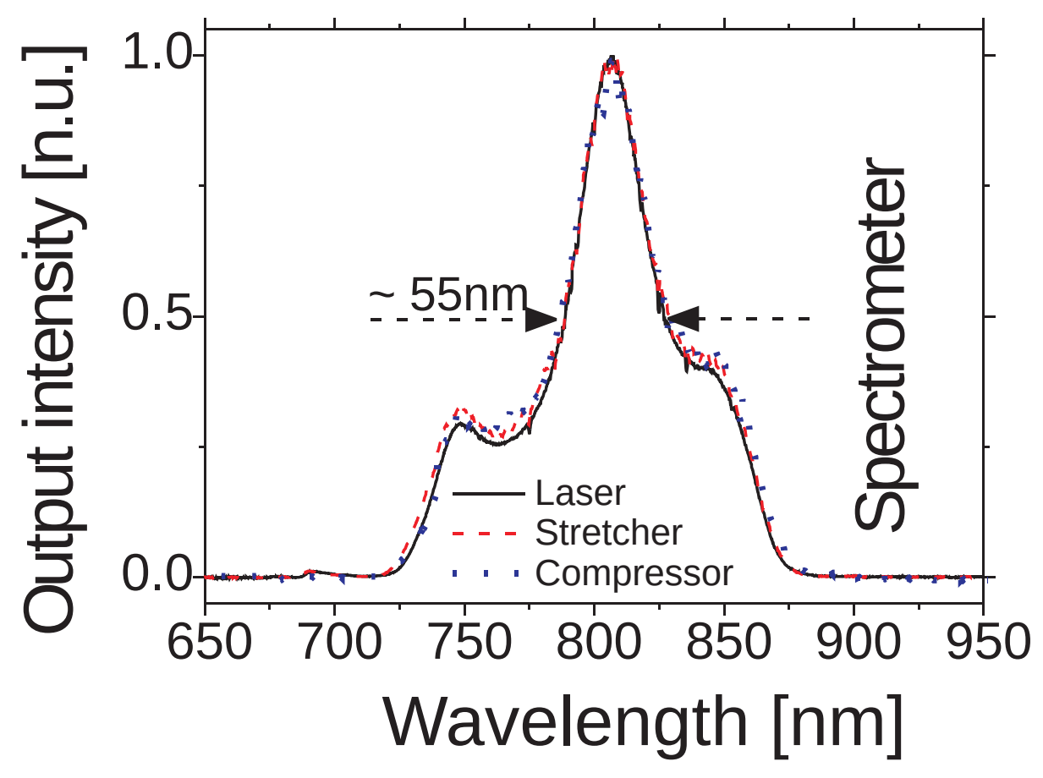

Fig. 7. Spectral transmission of the pulse stretcher

Double-pass compressor (fig. 8) consists of a pair of gratings and a roof mirror. Its power transmission is > 50%. Compressor design allows compression to sub-20 fs pulse width (see experimental autocorrelation in fig. 9).

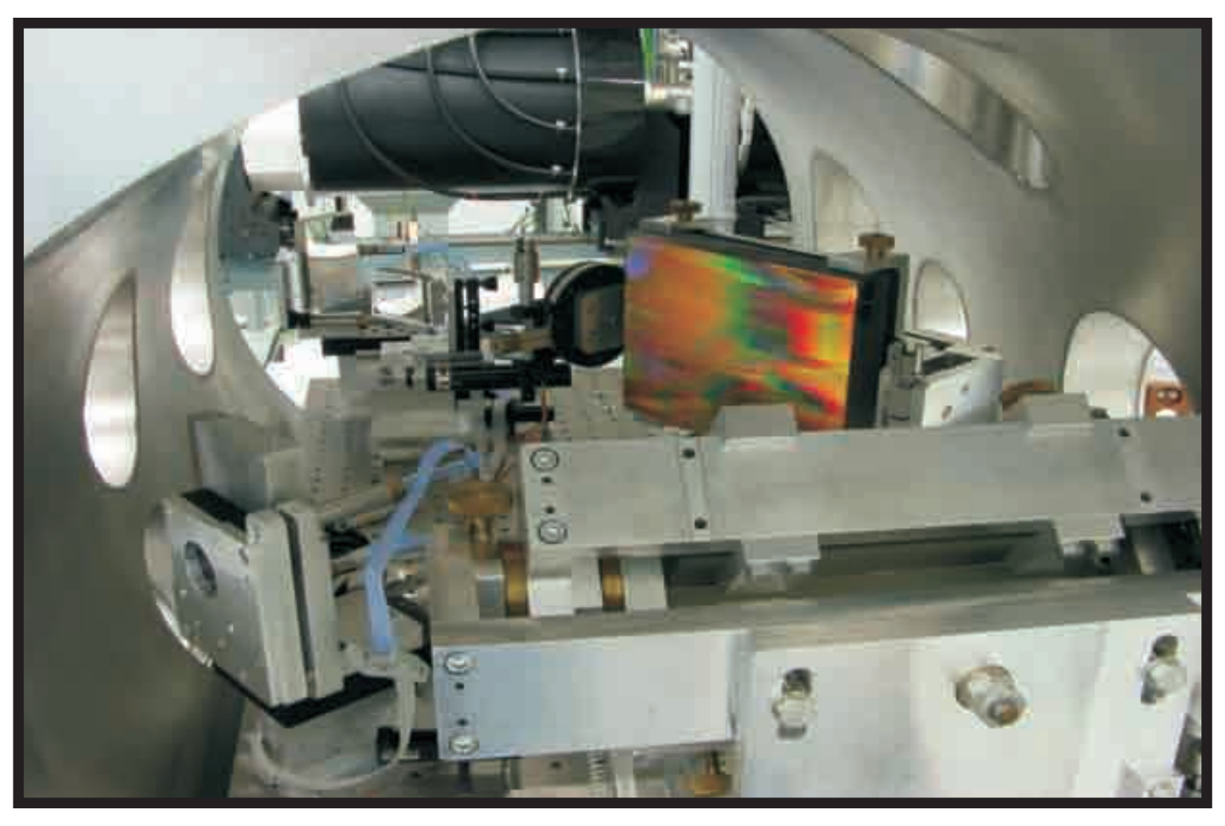

Fig. 8. View of a compressor for a beam of dm size.

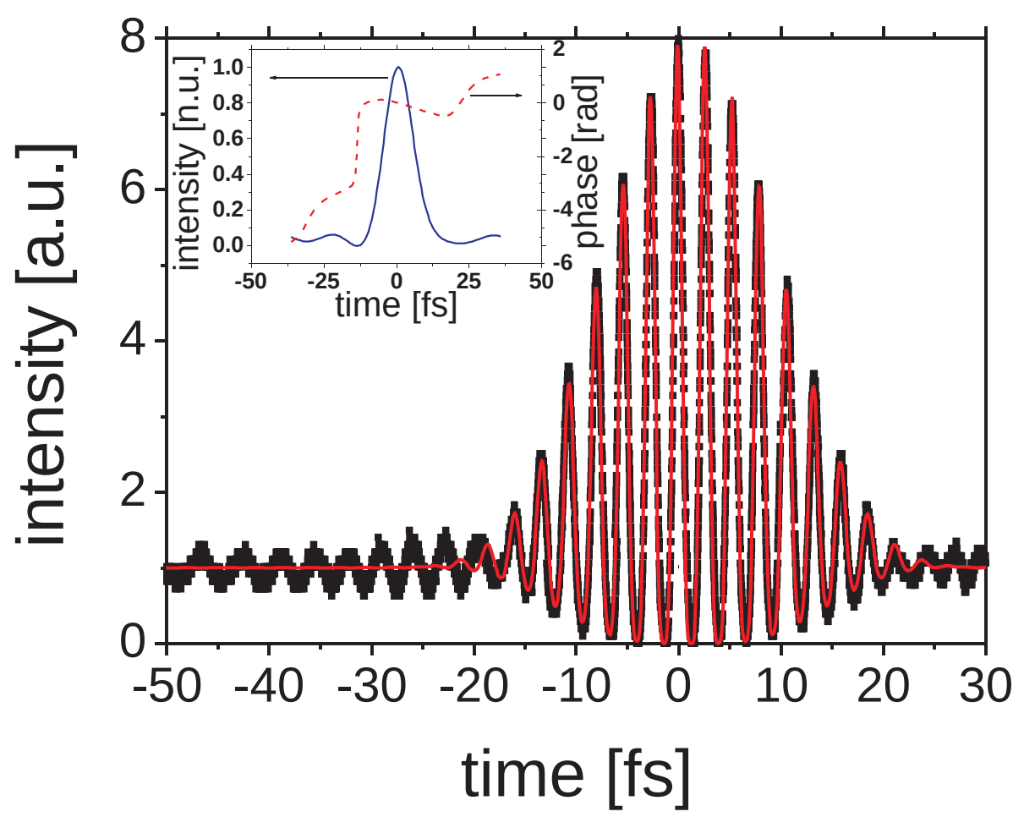

Fig. 9. Interferometric correlation and iteratively retrieved [4] temporal intensity and phase of the compressed pulse.

Present state

- 15-25 J @ 1315 nm 0.8-2.5 ns (pulse width tuning possible)
- 4 J @ 438 nm (third harmonic)
- Automatic stabilization of the front-end beam. The OPO has a day-long stable output without an operator action
- External synchronization of OPO controlled by Ti:sapphire pulses accomplished
- Full scale pumped OPCPA experiments are about to restart

References & Acknowledges

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