The CTFII laser system modifications Feb. 2000

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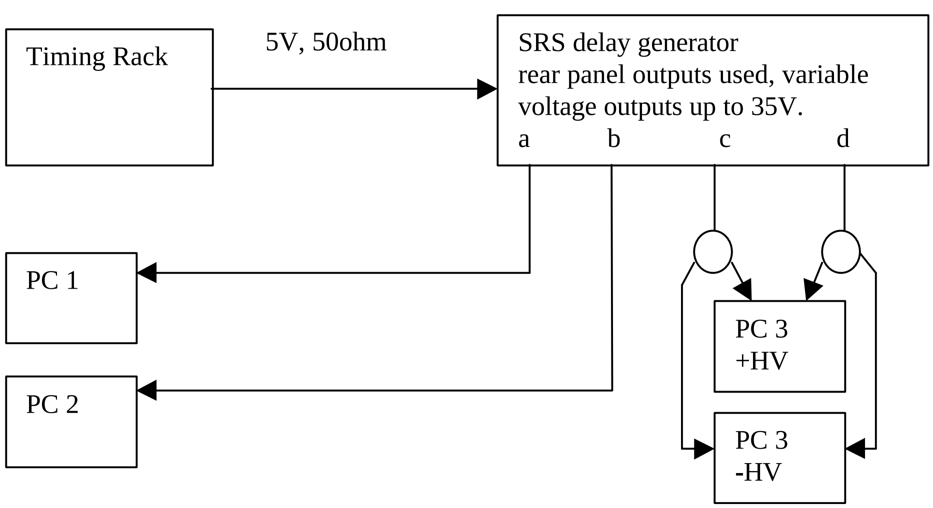
This note is a compliment to CTF Note 98-18 "The CTFII laser system" and is limited to a description of the changes that have been made to the system since November 1998.

Timing system

In order to balance the two amplified pulses, the leading one must have lower energy at the output of the RA, as it is preferentially amplified in the following single-pass amplifiers. The second pulse experiences a slightly lower gain due to the energy depletion caused by the passage of the first pulse. The best method to achieve this was found to be a fine adjustment of PC1 timing in the regenerative amplifier. PC3 can also be used for this purpose. As the Pockels cells are now used as variable attenuators, the timing jitter translates into amplitude jitter. A timing system with lower drift and jitter was required. A secondary problem has been the ability to set PC2 accurately, the timing drift coupled with the step size of 0.5ns and rise-time of 4ns often lead to one of the output pulses being cut, which generates satellite pulses.

The solution has been the development of a single channel, stable timing in the timing rack. This was originally intended for the streak camera timing, and has now been duplicated for the Pockels cells (this work was done by R.Pittin). The delay is controlled locally on the rack by a series of binary-weighted switches that set the delay counter. A single 5V pulse is generated, it has a fast risetime, and low jitter with respect to the RF signals, 250MHz and 3GHz.
This fast signal is the trigger for a 4-channel delay generator (Stanford Research Systems, SRS 535) which is mounted locally in the laser control rack. The 4 channels are used to trigger Pockels cells 1,2 and 3 (Pockels cell 3 requires 2 triggers, one each for the leading and trailing edges).



The HV (Belke) switches are designed to operate with a trigger pulse of between 2-10V, the original timing system provided 20V pulses, some pulses were split using resistive dividers. The inputs of the HV switches were adapted to permit the use of standard 20V input pulses to the system, PC1 and PC2 (channels a and b) should have 20V at the input of the HV modules. The trigger pulses for PC3 (channels c and d) were all derived from one 20V pulse, in the present system they are generated from two, each of 14V and then divided to give 10V at the input of the HV module, as can be seen from fig.1. The levels of the rear panel outputs can be individually set, up to a maximum of 35V, the output level is 10x the front panel output, which is the displayed value.

Injection

The LWE 131 oscillator is now used in place of the model 130, it has the advantage of a higher output level (400mW) than the older unit, which is to be used for CTF3 laser developments. This unit, although installed in the CTF for the first time in 1999, should not be considered as “new”, it was ordered in December 1994 and has suffered 4 years of transport damage, modifications and repairs, it has not yet proved its reliability or stability specifications. It is in service due to the reduced performance of the model 130, which with an aging laser diode pump, has reduced output levels and often creates satellite pulses, which cannot be controlled. A repair of the model 130 would be advisable, although it will be expensive, it is necessary in order to provide a “spare” for this key element of the CTF2 system.

The rf drive for the (LWE131) mode-locker is provided from timing rack in the laser room. A stable 249.879MHz oscillator is derived from the master oscillator of the timing and 3 GHz RF system.

Several mirrors have been replaced, in the injection path. These were Aluminium coatings on glass, in good condition this type of mirror has a reflectivity of 95%, but with age and exposure to atmospheric moisture they had developed a “milky” surface. These were exchanged for high reflectivity, multi-layer dielectric mirrors. The few remaining QS optics mounts were replaced with new supports incorporating fine adjustment screws and hardened bearing surfaces, with the aim of increasing the injection alignment stability.
266nm waveplates for 262nm zero-order

2 single pass amplifiers, using the existing flashlamp housings.
Pulse compression after the amplifiers, new mechanical mounts
Beam diameter adaptation changes

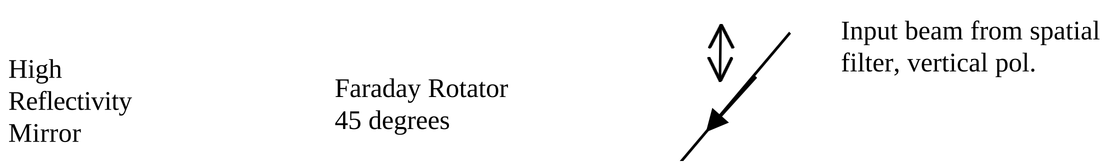
Motorised mounts for both harmonic generators,
Motorised controller/driver to be assembled and tested
New BBO 4th harmonic generator crystal

Replacement of suspect optical mounts in RA cavity

Phase plates for Drive and Probe beams

Amplification: Amplifier 2 and the Harmonic Generators

The available energy has been increased by changing the second amplifier from single to double pass. As well as the extra energy, pulse to pulse stability and the transverse profile are improved. In a single pass amplifier configuration the light pulse could not extract sufficient energy at a gain of 10, at higher gains the energy fluctuations increased. By operating the amplifier in a near-saturated gain configuration, pulse-to-pulse amplitude variations from the regenerative amplifier were reduced and the available energy per pulse increased.



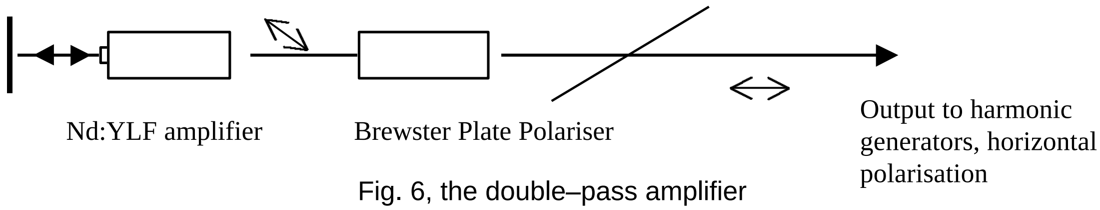


Fig. 6, the double–pass amplifier

The pulse amplified in this way has its transverse profile improved for our application, from a Gaussian towards a broader “flat top” distribution, which makes more efficient use of the photocathode surface.

To achieve double pass operation in Nd:YLF requires that both passages through the material are of the same polarisation, as the material is birefringent and for the two polarisations operates at two different wavelengths. To separate the input and output beams a polarisation selection was used.

In this configuration, a Brewster plate is used to enter the amplifier section, this is immediately followed by a Faraday rotator which advances the polarisation angle by 45 deg., the Nd:YLF rod also has to be rotated to this angle, the incoming beam is then amplified through the rod, is reflected off the end mirror, and passes a second time with the same polarisation angle through the amplifier rod. On the second pass through the Faraday rotator the polarisation is rotated by a further 45 degrees to become vertically polarised. The amplified pulse is then transmitted through the Brewster plate.

The horizontal polarisation of the output beam is rotated by 45 degrees by a $\lambda/2$ waveplate before the KDP doubling crystal to enable Type II harmonic generation.