Optical transmission line for streak camera measurements at CTF2 photo-injector

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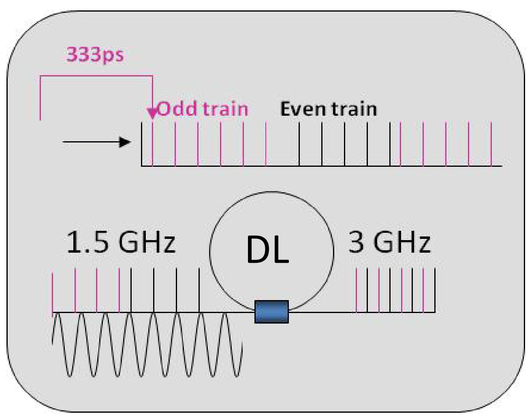
Abstract:

The actual drive beam of the CLIC Test Facility 3 (CTF3) is created by a thermionic gun, followed by a RF bunching and sub-harmonic bunching systems. In order to get a better emittance beam, to minimize beam losses in the injector and to eliminate satellite bunches, a photo-injector is actually under test in CTF2 at CERN. Among others, the phase-coding system, with the aim to prepare the beam for bunch spacing division, has to be tested. Longitudinal beam profile measurements need thus to be performed and a streak camera is then used to get picosecond resolution. An optical transmission line has therefore been built to transport the light from a Cherenkov screen to a streak camera, installed in an area with no radiation. This optical line is described as well as the measurements performed.

Phase coding:

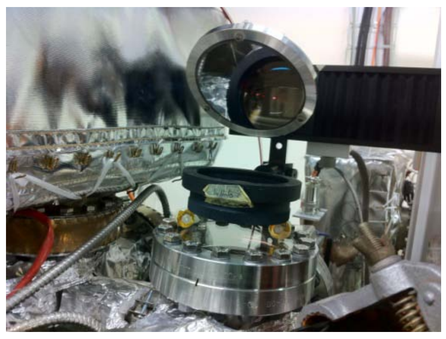
The phase-coding provides a special temporal distribution of sub-pulses. This is necessary to recombine them with a 1.5 GHz RF deflector in the delay loop, in order to divide by 2 the bunch spacing. The bunches are normally spaced by 666ps, but are spaced by 333ps and 999ps every 140ns thanks to this system.



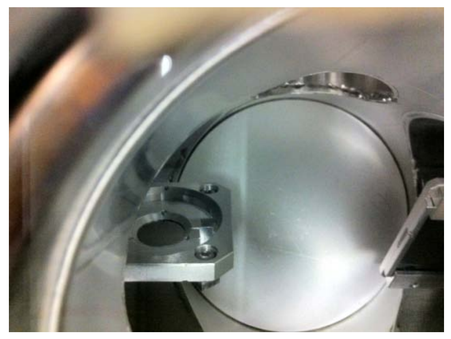
To check the efficiency of this system, longitudinal beam profile measurements with picosecond resolution need to be done. A streak camera is thus needed to obtain such a resolution.

Cherenkov target:

Downstream of the RF gun, a test beam line was installed on a dedicated test bench in CTF2 in order to measure the performance of the PHIN injector. A Cherenkov target was installed recently inside a tank in order to perform longitudinal beam profile measurements.



Tank in CTF2

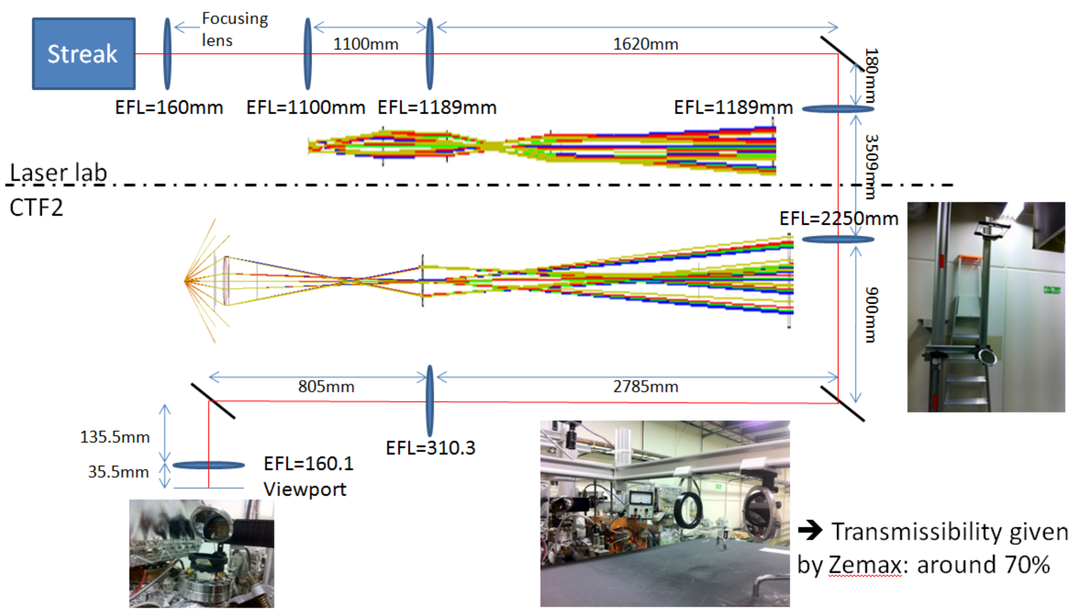


Cherenkov/OTR

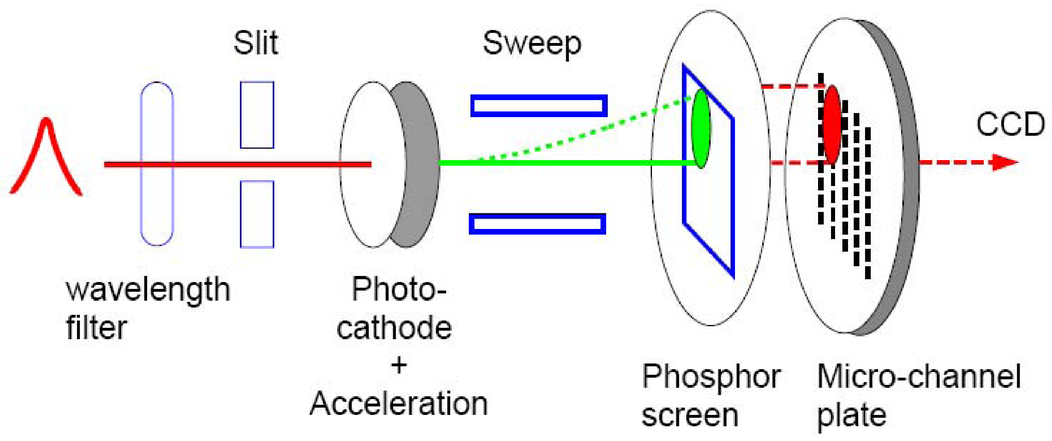
Because the beam energy is low at CTF2 (5MeV), a Cherenkov target was chosen in order to create enough light. In fact, this light has to be transmitted to the streak camera installed in an area without radiation (due to camera cost), and some light will be lost due to this transport.

Optical line to transport light from the target to the streak camera:

An optical line, made of a system of lenses and mirrors, was designed with the Zemax software and built recently. This line, of 12m length, has to transport the light from the Cherenkov target to the streak camera with as less light losses as possible and with small degradation of the time resolution compared to the one of the streak camera (picosecond scale). The streak camera was installed upstairs the machine.



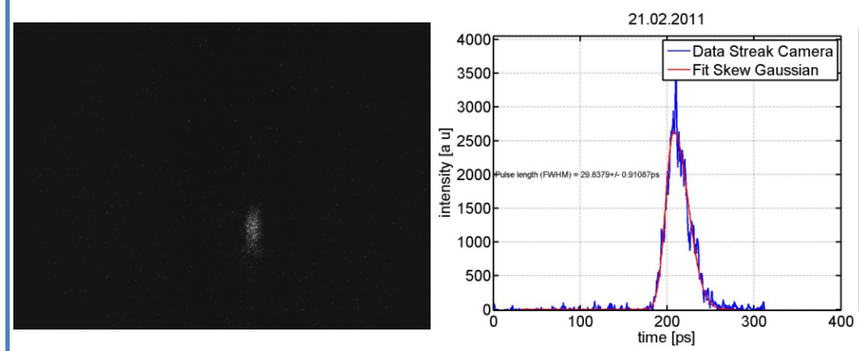
➔ Transmissibility given by Zemax: around 70%

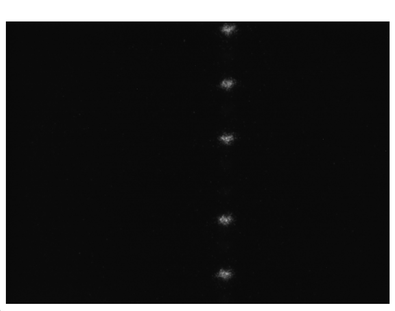


Principle of a streak camera to perform longitudinal beam profile measurements

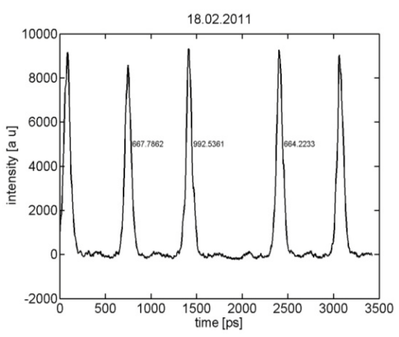
Longitudinal beam profile measurements:

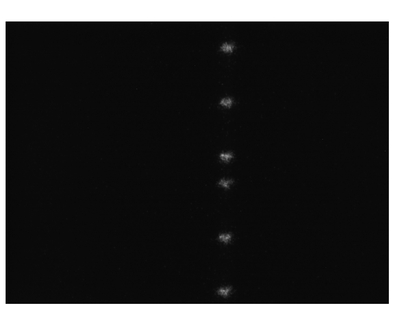
After the installation of the optical line, longitudinal beam profile measurements have been performed with the streak camera. The bunch length could have been measured accurately (30ps), showing the performance of the whole system. Moreover, the measurements show well the bunch spacing of 333ps and 999ps every 140ns, validating the efficiency of the phase coding.

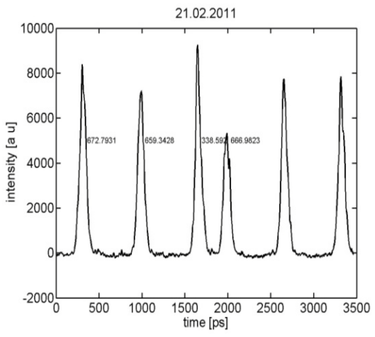




Bunch length measurements (25ps/mm)







Bunch spacing measurements for phase coding (250 ps/mm)