Wirescanner by TTF - XFEL

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Beam control is important when using an accelerator. One method of control is to use a wirescanner. This report contains a short introduction to the wirescanner used by TTF XFEL.

I. INTRODUCTION

A wirescanner is used by the TTF XFEL project. TTF XFEL stands for Tesla Test Facility X - ray Free Electron Laser. This project is a test accelerator for Tesla and XFEL. Tesla will be used in particle physics for the investigation of collisions between electrons and positrons. The aim of XFEL is to produce X-rays, which have the properties of laserlight.
To obtain the laserlight, electrons are manipulated in a undulator. A undulator consits of small magnets with alternating magnetic field gradients.

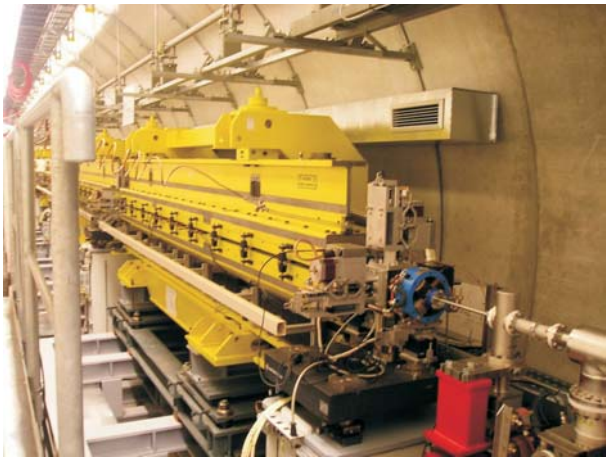

FIG. 1: undulator

During the manipulation, the electrons emit synchroton radiation, which is called undulator radiation. This electromagnetic radiation interacts with the electrons, which have emitted this radiation. Through this interaction, some electrons are more accelerated than others. The result is a electrobunch. In the bunch, all electrons have the same path through the undulator. Thus all electrons emit undulator radation with the same wavelenghth and have some proporties of laserlight.

During this it is necessary to control the electron beam. This is done using a wirescanner.

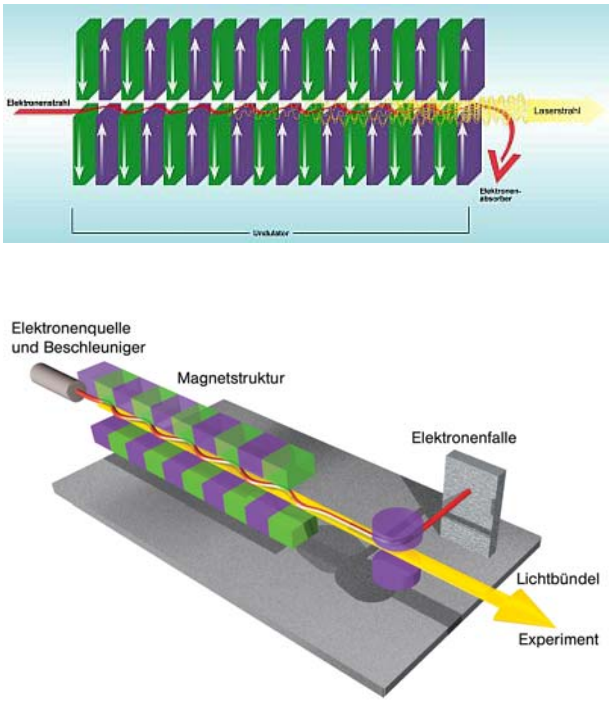

FIG. 2: scheme of XFEL

II. WIRESCANNER

The wirescanner can be used to measure the position and spread of the beam. In the front of the wirescanner is a fork including three wires. For observation, the wire is inserted in the electron beam, where the electrons in the bunches scatter on this wire. These electrons are then registered by a scintillator, which is connected to a photomultiplier.

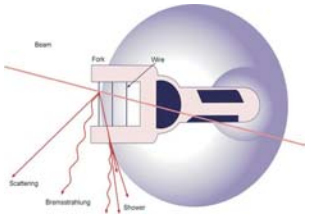

FIG. 3: prinziple measurement: electrons scatter on the wire

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The results are three peaks.

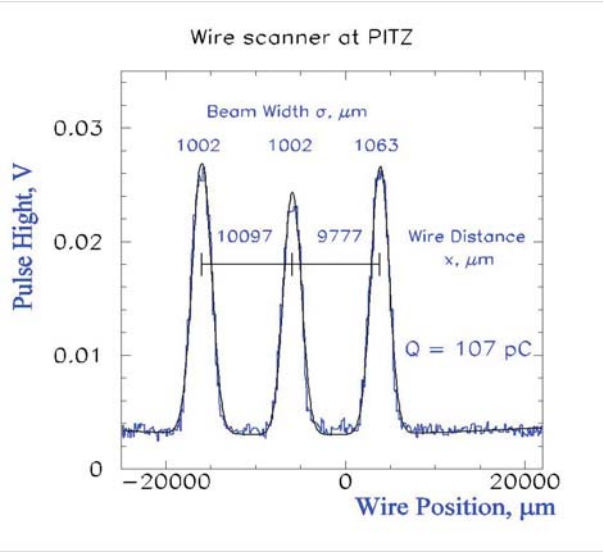

FIG. 4: peaks obtain in a measurement

Moreover, the position of the wire is else known. The position of the beam can be determined using the information from the peak and the wire position. A further result is the spread of the beam from the width of the peak.
A special property of the TTF - XFEL - Wirescanner is the transfer function between the movement of the engine and movement of the fork. The transfer function can be described by the Bestehorn Sinoide. This allows the accuracy of the measurments to be increased.

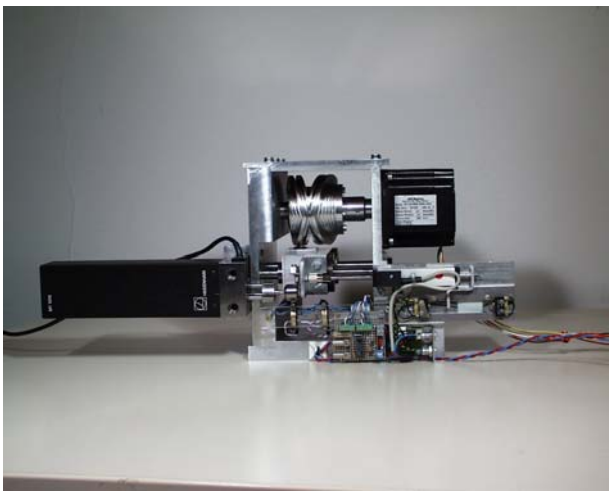

FIG. 5: Wirescanner by XFEL

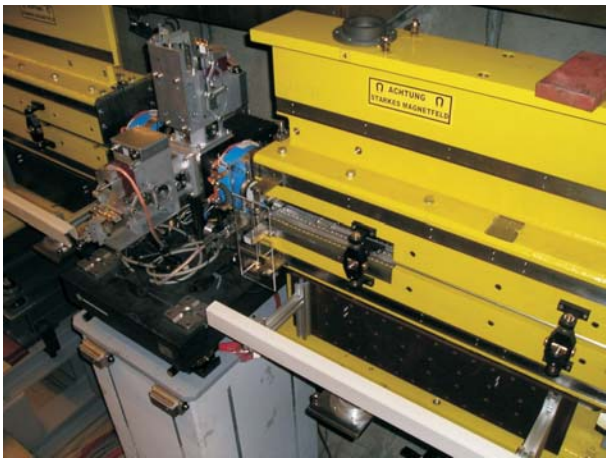

FIG. 6: position of the Wirescanner

A. Slow Scan

The TTF - XFEL - Wirescanner has two modes, which can be used to check the beam, a slow and a fast scan. By the slow scan, the wire would enter in the beam with a small velocity. Because the movement is slow, many bunches are observed. The result is a average peak, which shows the correct position and the whole spread.
A big disadvantage is a large thermal load in the wire inside the beam. Thus the wire can be spoilt when the beam is controled in the slow scan mode. To avoid damage to the wire there is a second mode, the fast scan, which can be used for a short investigation.

B. Fast scan

During the fast scan, the Wirescanner moves with a maximum velocity of 1 m/s. Since the wire is only in the beam for a short time, the thermal load of the wire is smaller as then for the slow scan, and it is possible to control the beam in this way more times.
However, the disadvantage of a fast scan is that only one bunch may be measured at a time. Moreover, it is not sure that the wire hits the beam, or that it only observes a small part of the electron bunch.