

Study on the development of the streak tubes for the ultra-fast light measurement

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This report is on the whole developments of the streak tubes for the ultra-fast light measurement. Firstly, the limit of the time resolution which is the most important characteristics was analyzed by the original method. Based on the results, the best time resolution in the world of 180fs in single shot mode and 660fs in synchroscan mode was attained using the new electron lens system and the new operating method. Also, the time spread in femtosecond region depending on the light intensity was analyzed in the transient state for the first time. It was clarified that the spread had been caused by space charge effect and it was improved. Then, the photocathode useful length was enlarged in order to increase the capacity along the spatial direction perpendicular to the time axis for the multi-channel measurement, time resolved spectroscopy etc. High spatial resolution and low distortion over the useful length were obtained using the low distortion electrostatic focusing lens. Moreover, the dynamic range (D-range) wider than 10^5 was attained using the electromagnetic focusing lens instead of the lens. Next, the noise characteristics on the fluctuation in the electron multiplication of the MCP and the others were analyzed. The relation between the method composing the tube system, the tube elements etc. and the characteristics was clarified and the methods to improve S/N were shown. Also, the removal of the background noise due to the high voltage, high electric field, high frequency deflection field etc, and the decrease of the cross talk between the neighbor channels raised the quality as the measurement device. In order to make the streak camera system easy to operate, a high sensitive streak tube incorporating an MCP was developed. It produced the smallest streak tube system in the world without an image intensifier. The use of the cascaded MCPs into the tube enabled to detect single photoelectron in picosecond region. The sensitive area was extended from visible to infrared and soft X ray. Lastly, the new operating methods such as synchroscan with long elliptical sweep, sampling with cheap price and wide D-range, the time resolved imaging with the unique operating principle etc. were studied and they resulted in the development of the tubes which had new useful functions.