4 - 23 An Initiative Design of High Energy Electron Radiography with Ultrahigh Spatial and Temporal Resolution*

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In general, high energy density matter can only be transiently produced in the laboratory on a time scale of nanoseconds. In addition, the pressure in a high energy density sample exceeds 1 Mbar, thus the hydro-dynamic response of the sample is a high expansion velocity in the range of km/s (or μm/ns). Therefore diagnostics which are capable of high time resolution (< ns) and high space resolution (< 10 μm) are needed. Here, we present a scheme that uses a high energy electron beam as a probe for dynamic imaging measurements of high energy density processes in materials with spatial, temporal resolution and frame rate in the order of 1 μm, 1 ps and 10^{10} FPS, respectively.

The device uses an e-LINAC (electron Linear Accelerator), which can produce electron beams with bunch intensity ranging from a few pC to 100 nC, bunch length and bunch interval of 1 and 100 ps in minimum, respectively. The beam energy can be increased easily from a few MeV to GeV by adding more accelerating sections. Details can be found in Ref. [1].

With a flexible beam from such an e-LINAC, one can easily generate a bunch group of 3 or more electron beamlets separated by one or more RF period. As shown in Fig. 1, in order to image a target in the 3 orthogonal directions, here 3 beamlets will be set in one bunch group. When the beamlets exit the accelerator, they can pass through a 1/3 harmonic deflecting cavity and separate into three directions. With a septum magnet and achromatic matching beam lines, the three beamlets are then delivered to the target and image it in three orthogonal directions simultaneously. In addition, a second and third bunch group can be generated at arbitrary time delays and used for a time evolution study of the HEDP target to ps accuracy. Since it is not easy to find such a fast imaging screen with reasonable high fluorescence conversion efficiency in addition to such a rapid CCD camera for recording the sequence of the images, a new design similar with a streak camera is proposed as shown in the right hand side of Fig. 1. An RF deflector could be introduced after the magnet imaging system for spatially separating the images of individual time, sampling electron beamlets to different transverse positions on the screen.

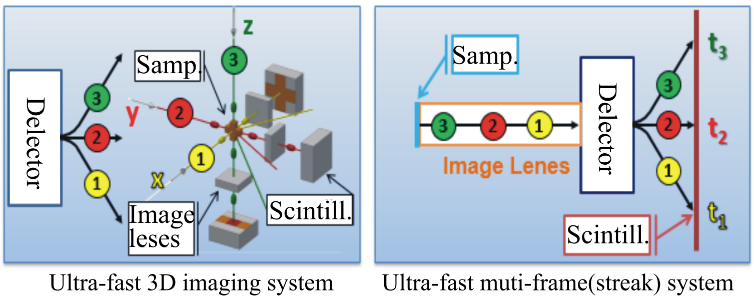

Fig. 1 (color online) Initiative design for untra-fast 3D or multi-frame imaging system.

References

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