Electrons detection with fast responding scintillators

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The 200 keV electrons are challenging to detect with high efficiency and high resolution. In the case of single crystal scintillators (SCS) the electrons are converted in a bunch of photons, which are in turn transferred to a CCD camera through an optical device. The output signal is dictated by the amount of energy deposited in the SCS as well as its electron-photon conversion. In principle thick or heavy SCS could arrest swift electrons (i.e. 200 keV would be deposited), however, in that case the emission point is spread out by elastic scattering (Rutherford scattering). Thus, on one hand one desires to use relatively dense (or thick) material in order to maximize the slowing down of electrons and on the other hand heavy nuclei should be avoided because they induce large deviations. Therefore an optimization of the whole detection system is desirable taking into account multiple parameters like thickness, conversion efficiency, density, optical index, etc… We have theoretically studied 5 different scintillators with different densities: LPS, LSO, LuAP, YAP, YAG. The two first (LPS & LSO) have very high efficiency and the LPS has exhibit no after-glow. We have performed Monté-Carlo simulations of the trajectories of the swift electrons in the SCS using a of elastic and inelastic scattering events. The photon emission is assumed to be isotropic and we final estimate the point spread function (PSF) of a complete system including the optical coupling to the CCD. Thanks to their high conversion efficiency LSO and LPS are been found to be very promising materials. We have developed an optical coupling device in the blue-UV range with -1 magnification and high transmittance which allows the use of either one of these SCS. The mean transfer function (MTF) of the whole system is found to be within the 20 µm² pixel size of the CCD. Comparison with actual measurements will be presented.