Calibration of image plates for pulsed plasma diagnostic

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Several types of detectors exist in order to diagnose high-energy ions and electrons of pulse plasma: CR-39, radiochromic films (RCF), scintillators and image plates (IP). Although an IPs is passive detectors and cannot be used in high repetition rate experiments, IPs has several advantages over other particle detectors: persistency to electromagnetic pulse, high dynamic range (up to 10^5), high spatial resolution (usually 10–50 m). In addition, IP can be erased with white light, allowing for reuse. The most widely used IPs in plasma diagnostics are BAS (Biological Analysis System) image plates: BAS-MS, BAS-TR and BAS-SR, the sensitive layer of which is the $BaFBr_{0.85}I_{0.15}$: Eu phosphor layer. When the detector is exposed to radiation, electrons of Eu^{2+} in the phosphor layer are ionized and trapped in FBr or FI sites, forming metastable states. During scanning, the phosphor layer is irradiated with 2 eV photons, electrons in metastable states are re-excited and recombine with Eu^{3+} and emit photons with energy of 3 eV (photostimulated radiation, PSL).

The signal with IP (PSL) obtained after scanning is proportional to the absorbed energy in the luminescent layer of the detector. However, there is no theoretical expression for the relationship between the PSL and the absorbed energy, which leads to the need for calibration the system "detector-scanner". In addition, some of the electrons in the metastable states recombine spontaneously, which leads to a decrease in the signal from the detector (fading effect). In this work, the BAS-MS and BAS-TR image plates were calibrated for electrons and alpha particles using the medical scanner VistaScan Mini from Durr Dental.