Design Strategies for Pressurized Xenon Microstrip Detectors in Radiography

Microstrip gas chambers (MSGC) using pressurized xenon are currently being studied for radiographic imaging due to their high spatial resolution and capability for energy discrimination. We consider three designs – full field 2D arrays, narrow 2D scanning arrays, and 1D scanning arrays. The design considerations are based on incident photon energy, range of photoelectrons, range of fluorescent x-rays, xenon pressure and thickness. The dependence of spatial resolution and quantum efficiency on each quantity was calculated. An increase in gas pressure or thickness increases the probability of x-ray-xenon interaction hence increasing the quantum efficiency and decreases the photoelectron range providing for improved spatial resolution. Above the xenon K-edge (34.56 keV), K-fluorescence yield is high (88.8%) with a mean free path (mfp) for K-characteristic x-rays of 185 mm at STP. This can substantially degrade spatial resolution. Below the K-edge, spatial resolution can be maintained since the L-fluorescent x-rays (only 11% yield) have much shorter mfp of 4.8 mm at STP (480 microns at 10 atm). As a consequence of K-fluorescence, a thick full field 2D detector is only appropriate with x-rays below the xenon K-edge for applications such as mammography or imaging of iodine contrast media with x-rays having energy above the iodine K-edge and below that of xenon. Above the xenon K-edge, narrow 2D arrays, 1D detectors or multiple 1D detectors separated by x-ray absorbent septa should be employed so that the fluorescent x-rays have maximum probability of escape from the detector.