Scanning systems for medical X-ray imaging

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Detectors for medical X-ray imaging have been exhibited significant progress during last decade. Numerous systems based on scintillating screen coupled to large area CCD or CMOS matrix have appeared. Storage phosphors were further developed towards faster readout and better detective quantum efficiency (DQE). Large flat panels based on amorphous silicon coupled to CsI were introduced on the market. Amorphous selenium flat panels have been developed that allowed pixel size smaller than 100 micron and thus could be successfully applied to mammography.

Although the progress in digital imaging is quit evident, in most of the cases radiology is performed with traditional film-based systems. Thus further development is needed towards cheaper technologies with improved efficiency and image quality. Moreover most of the systems with full image capture are still far from being ideal in terms of DQE and thus patient dose is higher than it could be with better detection system.

Scanning systems utilize one-dimensional detectors (slit scanning systems) or detectors with significantly reduced aperture in one dimension (slot-scanning systems). Spatial distribution of the incident X-ray flux is measured with detector in one direction and with mechanical scanning in the other direction. As detector technology can be simpler in such case, more efforts can be spent towards improvement of DQE and providing better spatial resolution. Such approach with narrow detector aperture automatically rejects almost all scattered radiation from the patient's body. Scattered radiation constitutes over 90% of the incident flux on the detector. In case of full field detectors it is reduced with special anti-scatter grid, that can further deteriorate DQE by more than 10%.

Known detector technologies that are used in scanning systems are scintillating screen coupled to one-dimensional CCD (64x4096 pixels) through fiber optics (Fischer Senoscan), monolithic silicon strip detectors (Sectra MicroDose Mammography). Another scanning system based on gaseous detector is Low-Dose Radiographic Device (LDRD) "Siberia", that has been developed in the Budker Institute of Nuclear Physics and is being produced by several companies in Russia including "Nauchpribor" in Orel.

LDRD "Siberia" is based on multi-channel ionization chamber filled with Xe at 20 atm or Kr at 40 atm depending on particular type of detector and application. There are several detector versions with channel pitch of 0.4mm, 0.3mm, 0.2mm and 0.1mm for mammography. DQE in all the cases reaches ~70% with the noise level at about 1 photon rms. This allows operation with very wide dynamic range and down to very low doses. For chest imaging the detector dose reaches 4 microSv only. At present several hundreds of such systems are in operation in hospitals all over Russia. The lisences for production are sold to companies in South Korea, China and Malasia.