Performance of CMOS imager as sensing element for a Real-time Active PIxel Dosimeter for Interventional Radiology procedures

D. Magalotti[1,2], L. Bissi[1], E. Conti[1,3], M. Paolucci[1,4], P. Placidi[1,3], A. Scorzoni[1,3], L. Servoli[1]
(leonello.servoli@pg.infn.it),

[1] Istituto Nazionale di Fisica Nucleare, Perugia
[2] Università degli Studi di Modena
[3] Dipartimento di Ingegneria Elettronica e Informatica - Università degli Studi di Perugia
[4] Azienda USL Umbria 2, Servizio di Fisica Sanitaria, Foligno

Our group has proposed the use of CMOS imagers as detection elements for 10-50 keV photons scattered by the patient body in Interventional Radiology procedures. Interventional radiologist and staff members applying these procedures are exposed to these ionizing radiation, which can induce detrimental effects, such as skin and non-solid cancer effects (leukemia, lymphoma, and myeloma), due to the exposure of skin and peripheral blood. There is an increased interest in improving radiation protection in IR, particularly for more complex procedures, hence increasing fluoroscopy times and dose. This research is carried out within the framework of the INFN RAPID project, focused on the development of a wireless real-time dosimeter to be weared by the medical staff during the Interventional Radiology procedures.
The CMOS imager has been first characterized in laboratory using fluorescence X-ray sources, then a PMMA phantom was used to diffuse the X-ray photons from an angiography system. In the test setup the sensor ~~CMOS Active Pixel Sensor~~, five TLDs and a commercial active pixel dosimeter were mounted on a plastic holder that could be moved along the z axis at a distance of 0 to 100 cm from the phantom (a typical range between medical staff and a patient during IR procedures).
Different parameters working sets have been used to test the detector response in realistic conditions, either concerning the X-ray tube (continuous/pulsed mode, kV, current, pulse parameters), than the sensor (gain, integration time) and the relative positions between sensor and phantom (distance, orientation).
The sensor response has been compared with measurements performed using both TLD and the commercial active pixel dosimeter for the observables. A linearity could be observed in all cases and the correlation holds for both pulsed and continuous mode.
The detector has also been exposed to a certified beam in an accredited calibration centre, in order to obtain an absolute calibration, and results are very encouraging, with dose and dose rate measurements uncertainties below the 10% level even for the most demanding protocols.
The operation of an Active Pixel Sensor as sensing element for monitoring individual dosimetry during interventional radiology procedures has thus been verified, obtaining a precision in the measurement of dose and dose-rate comparable or better with respect to other measurement systems.