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High intensity beam diagnostics system based on novel metal micro-detectors

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Physics principle and production technologies have been developed at KINR for the new type detectors of the charged particles as well as synchrotron radiation –Metal Foil Detectors (MFD). Micro-strip MFDs –Micro-strip Metal Detectors (MMD) 0.5 –1.0 micro-meter thick were used for the beam profile monitoring of the synchrotron radiation at HASYLAB (DESY, Hamburg) as well as for the charged particles beam profile monitoring. The number of photons (mean X-ray energy 18 keV) producing out of a strip a single SEE was evaluated as (1.5 +/-0.5)*10ˆ4. The MMD has demonstrated stable operation under the X-ray flux of 4.5*10ˆ14 photons/second/mm2. The current technology allows for production of the thin (˜1 μm) Ni-strips with a pitch of about few micrometers, providing high position resolution. Micro-strip Metal Detector technology includes some stages: micro-strip layout made by photo-lithography on silicon wafer, plasma-chemistry etching of the silicon wafer in the operating window, micro-cabling connection to the readout electronics and DAQ. The main technical features of the MMD: High Radiation tolerance (> 100 MGy); Low thickness of sensors (˜1 μm); Low operation voltage (20 V); Perfect spatial resolution (5 –25 μm); Stable operation at X-ray intensity up to 10ˆ16 photons•sˆ-1•mmˆ-2 and proton beam intensity up to 10ˆ11 protons/bunch. In comparison with the latest developments in beam profile monitoring based on the silicon micro-strip or micro-pixel detectors Metal Micro-strip Detectors have an advantage of being extremely thin and semi-transparent device. MMD could be used as a feedback element for stabilizing and/or focusing charged particles beams.
Multichannel data acquisition system based on ASIC chips VA_SCM3 (Gamma Medica –Ideas, Norway), XDAS (Sens-Tech, UK), TimePix (Medipix Collaboration) are discussed too. Design of the metal micro-detector as a multiplicity trigger in heavy-ion relativistic experiments is presented.
Characterization studies of the Metal Micro-detectors measuring in real time high level dose distribution at the Mini-beam Radiation Therapy setup (ESRF, Bio-Medical Beamline ID17) have been recently performed. The results obtained illustrate an excellent performance of the metal TimePix micro-detector providing 2D image of the dose distribution over many beams in (14 x 14) mm2 area. Peak-Valley-Ratios measured by the TimePix and gafchromic films agree well, in general. Possible reasons for some observed discrepancies are discussed.

Author: Mr KOVALCHUK, Oleksii (Kiev Institute for Nuclear Research (Ukraine))

Co-authors: Mr CHAUS, Andrii (Kiev Institute for Nuclear Research NASU (Ukraine)); Mr STOROZHYK, Dmytro (Kiev Institute for Nuclear Research NASU (Ukraine)); Dr TLUSTOS, Lukas (CERN); Dr CAMPBELL, Michael (CERN); Dr RENIER, Michel (ESRF); Dr FEDOROVICH, Oleg (Kiev Institute for Nuclear Research NASU (Ukraine)); Mr OKHRIMENKO, Oleksandr (Kiev Institute for Nuclear Research NASU (Ukraine)); Prof. POSPISIL, Stanislav (Institute of Experimental and Applied Physics (Prague)); Prof. PUGATCH, Valery (Kiev Institute for Nuclear Research NASU (Ukraine)); Dr LLOPART, Xavier (CERN); Dr PREZADO, Yolanda (ESRF)

Presenter: Mr KOVALCHUK, Oleksii (Kiev Institute for Nuclear Research (Ukraine))

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