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Development of an Atmospheric Radioxenon Detection System for Nuclear Explosion Monitoring

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Abstract : Measurement of radioactive isotopes of atmospheric xenon is used to detect, locate and identify any confined nuclear tests as part of the Comprehensive Nuclear Test-Ban Treaty (CTBT). In this context, the Alternative Energies and French Atomic Energy Commission (CEA) has developed a fixed device to continuously measure the concentration of these fission products, the SPALAX process. During its atmospheric transport, the radioactive xenon will undergo a significant dilution between the source point and the measurement station. Regarding the distance between fixed stations located all over the globe, the typical volume activities measured are near 1 mBq m^{-3}. To avoid the constraints induced by atmospheric dilution, the development of a mobile detection system is in progress; this system will allow on-site measurements in order to confirm or infringe a suspicious measurement detected by a fixed station. Furthermore, this system will use beta/gamma coincidence measurement technique in order to drastically reduce environmental background (which masks such activities). The detector prototype consists of a gas cell surrounded by two large silicon wafers, coupled with two square NaI(Tl) detectors. The gas cell has a sample volume of 30 cm^3 and the silicon wafers are 500 µm thick with an active surface area of 3600 mm^2. In order to minimize leakage current, each wafer has been segmented into four independent silicon pixels. This cell is sandwiched between two low background NaI(Tl) detectors (70x70x40 mm^3 crystal). The expected Minimal Detectable Concentration (MDC) for each radio-xenon is in the order of 1-10 mBq m^{-3}. Three 4-channels digital acquisition modules (Pixie-NET) are used to process all the signals. Time synchronization is ensured by a dedicated PTP-network, using the IEEE 1588 Precision Time Protocol. We would like to present this system from its simulation to the laboratory tests.

Keywords : beta/gamma coincidence technique, low level measurement, radioxenon, silicon pixels
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